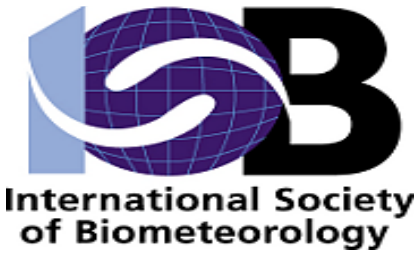
20TH INTERNATIONAL CONGRESS OF BIOMETEOROLOGY

International Society of Biometeorology



28 September - 1 October 2014
Embassy Suites – Cleveland Rockside
Cleveland, Ohio

The ICB will be organized and sponsored by the International Society of Biometeorology (ISB). Since 1956, the ISB has provided an international forum for the promotion of interdisciplinary collaboration between meteorologists, health professionals, biologists, climatologists, ecologists and other scientists.

The American Meteorological Society is co-sponsoring ICB20.

Generous support has been provided by the College of Arts and Sciences as well as the Department of Geography at Kent State University.

Generous support has been provided by Springer, publishers of the *International Journal of Biometeorology*.

Special thanks to the above listed sponsors and partners

ICB2014 Program and Organizing Committees

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LOCAL ORGANIZING COMMITTEE

Thomas Schmidlin, Kent State University
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20th International Congress of Biometeorology

28 September-1 October 2014 Embassy Suites Cleveland-Rockside Cleveland, OH

General Information

Conference Location

All meeting sessions for the conference will be held at Embassy Suites Cleveland-Rockside, 5800 Rockside Woods Boulevard, Independence, Ohio, 44131, USA

Welcome Reception

The welcome reception will be held 7-9 p.m. on Sunday, 28 September. It will be in the prefunction space outside of the Grand Ballroom.

Conference Dinner

Tuesday, September 30th 6:30-11:00 p.m.

An evening at the Rock and Roll Hall of Fame

A ticket is needed to attend the Hall of Fame Conference dinner event. Please note that no tickets are included with registration, one must be purchased in order to attend. The cost is $95.00 per person. The ticket provides private admission for one to the museum, a 50s-style dinner, and transportation from the conference hotel to and from the Rock Hall. Bus will arrive at 6:30, get to HOF 7; leave HOF 10:30, get back to hotel 11

Additional tickets ($95.00) may be purchased on-site until noon Tuesday 30 September.

Don't forget to bring your ticket with you- they will be collected!!

Conference Badges

Everyone presenting (both oral and poster) and/or attending must register and wear a badge. Please wear your badge at all times during the conference and social events.

Please not that Guest badges does not include technical session attendance; anyone wishing to attend technical sessions must register and pay. Guest must have a Conference Dinner tickets to attend.

Presentation Upload Information

On site, speakers may upload their presentation directly onto the session room computer, in the room your presentation will take place. The use of personal laptops for presentations is discouraged as it can cause technical delays and cut into a presenter's time. A student volunteer will be in the session room to assist during breaks (You will not be able to upload on-site at any time during sessions).

Presenters who choose to load their presentations at the meeting will be required to use special installer software running on the meeting room PC. These presenters will not be permitted to store their files on the PC desktop. The installer software will automatically create a directory for those file(s). Once stored there, presenters will be able to check that their files were copied and that they will run properly.

General Information

Posters Presenters

Formal Poster Viewing

A Formal Poster Viewing session is scheduled for Monday afternoon 2:30-4pm. Posters will remain up from Monday evening until the end of Tuesday. Be sure to be at your poster during your assigned poster session time. You may also be at your poster during coffee breaks as well. The poster setup/tear down schedule for this meeting will be:

Set-Up:	after 1:00 PM on Monday, 29 September
Tear-Down:	before 5:30 PM on Tuesday, 30 September*

*Please note ICB or the staff of AMS are not responsible for posters not taken down by the tear down time.

All poster viewing sessions will take place in the Salon I section of the Grand Ballroom of the Embassy Suite

Internet Accessibility

- All attendees who book within the AMERICAN METEOROLOGICAL SOCIETY block at the Embassy suite will enjoy free internet access in guest rooms,
- There is Wireless internet access available in the conference space

HOTEL SHUTTLE

The hotel comp shuttle is available from 7AM - 10PM
It leaves the hotel on the hour (ONLY when a guest calls from the airport and tells the hotel they are there). The airport is approximately 12 miles from the hotel. Guests are picked up at exit #2. To schedule a pick up please call the hotel at +1-216-986-9900

Parking

Self Parking is available at the hotel for free. There is no valet parking.

Special Needs

It is our sincere desire to comply fully with both the letter and the spirit of the Americans with Disabilities Act of 1990 (ADA). Attendees with special needs should call the AMS Meetings Department at (617) 227- 2426 and press 4, 4–6 weeks prior to the meeting to request special arrangements. Special housing needs should be requested when making hotel reservations.

Optional Outing

Thursday, October 2nd: Day trip to visit Ohio's Amish country

The Amish are well known for their life style that has changed little from their original days, as their culture is devoid of most modern technology. Dressed simply, living simply, they are commonly sighted in horse-drawn buggies on the roadways throughout many parts of Ohio.
This all-day excursion will pick you up and drop you off at the Embassy Suites hotel. We will visit the Amish and Mennonite Center, have a scenic back road tour that will highlight Dawdy houses, case houses, Amish homes and, businesses. You will visit an Amish school and have lunch in a typical Amish home. After lunch, you will have time to shop in the village of Berlin. The guide will depart in Berlin, before the bus returns to the Embassy Suites.

Please note that no tickets are included with registration, one must be purchased in order to attend. A limited number of tickets will be available to purchase on-site at the registration desk until Tuesday, the cost is $80.00 per person.

General Information

Table Top Exhibits:

The Table top exhibit program will be held in the Grand Ballroom Salon 1, in conjunction with the poster presentations. The hours for exhibits are listed below.

Exhibit Setup

Mon., 29 Sept. 9:00 A.M.–1:00 P.M.
*All exhibits must be installed by 1:00 p.m.

Exhibits Open

Mon., 29 Sept 2:00–5:30 P.M.
Tues., 30 Sept 9:30 A.M.–4:00 P.M.

Exhibit Dismantle

Tues., 30 Sept 4:00–6:00 P.M.
*Exhibitors are not allowed to dismantle before 4:00 P.M. All exhibitor material must be removed from the exhibit facility by 6:00 P.M.

Suitcasing Policy:

Only contracted Exhibitors are permitted to promote their products, services or company at the Meeting. All company promotion and product sampling must occur within the contracted booth space. This includes, but is not limited to handing out flyers, approaching Exhibitor booths to sell products, and leaving and/ or distributing product information in public spaces and show floor aisles. Exhibitors found doing so will be sent back to their booth space and materials left will be confiscated and disposed of properly. Attendees will be asked to leave the show and forfeit their badge. Additional penalties may apply. Any “suit-casers” observed by both attendees and exhibitors should be reported to the Show Management immediately.

FOREWORD

On behalf of the Executive Board of the International Society of Biometeorology and the Program and Local Organizing Committees, I would like to warmly welcome you to Cleveland for the 20th International Congress of Biometeorology. Our theme for this Congress is "Adaptation to Climate Risks," which cross-cuts much of the research that will be presented this week. True to the diversity of biometeorological studies, there is a large variety of topics across the individual sessions, including human biometeorology, animal biometeorology, phenology, agriculture and forestry, the built environment, tourism, thermal comfort, aerobiology, extreme events and disasters, and infectious diseases. The societal challenges presented through these studies are addressed through other fields, including risk communication, climate change, adaptation, and challenges particular to the developing world. New technologies will be discussed as part of animal biometeorology as well as data collection and analysis.

For over 60 years, the International Society of Biometeorology has served as a professional group of colleagues and researchers. A Congress is held every three years, which gathers biometeorologists from across the globe. This meeting is no exception with over 260 presentations or posters that collectively include authors from 42 countries. I encourage you to meet your fellow researchers and explore new collaborations. The conference has been designed to foster such opportunities with the hotel and conference site being collocated. Aside from the general conference activities, there also is an icebreaker on Sunday night, the conference dinner at the Rock and Roll Hall of Fame on Tuesday night, and an excursion to Ohio's Amish country on Thursday that will enable you to meet colleagues. There will be several commission meetings throughout the week — these are excellent opportunities to engage others that are within your particular subdiscipline. Tuesday's General Membership meeting will provide an excellent overview of our society's work.

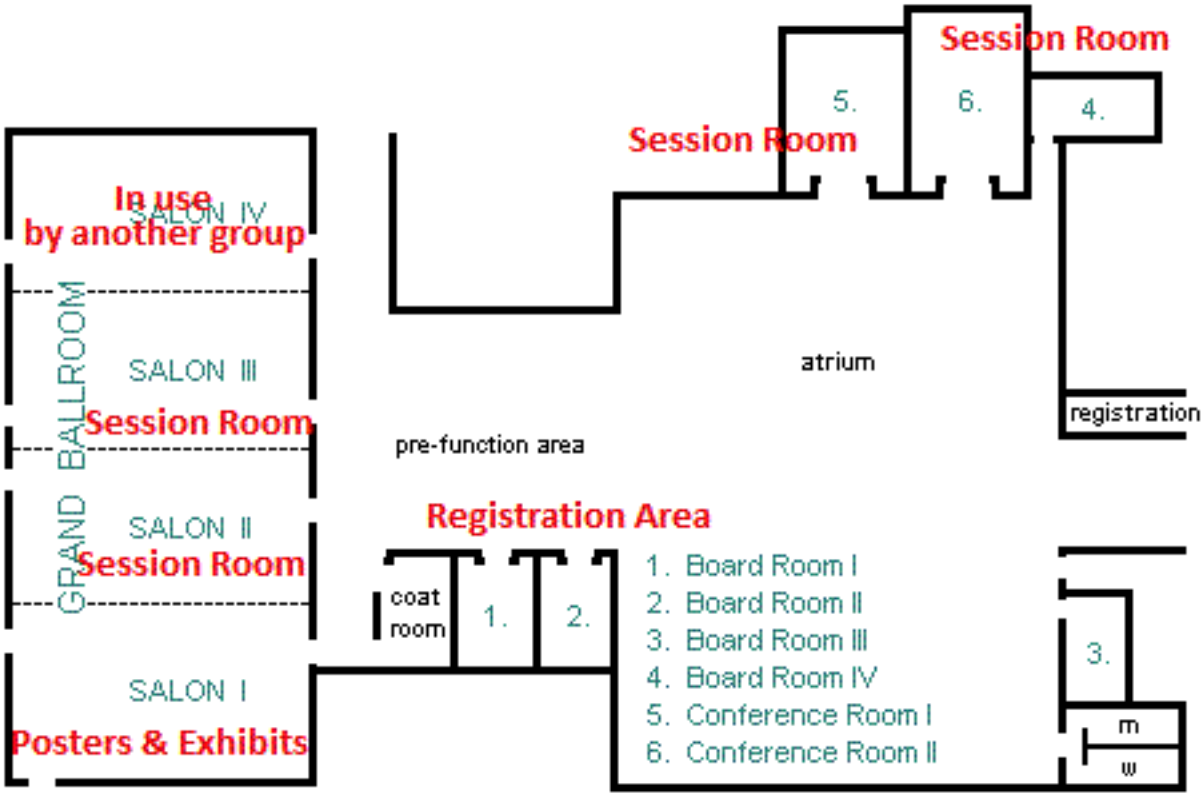
Eager to encourage the next generation of biometeorologists, the Student and New Professionals group of ISB has organized several professional and social activities that are aimed at engaging those early in their careers, and helping them network and exchange ideas. Nearly 70 student submissions were received for this conference, and I especially encourage you to visit their talks and posters this week so that ICB veterans and first-timers can connect.

This conference would not be possible without the significant financial and logistical assistance that was received. I would like to thank the financial sponsors of this Congress: the Executive Board of the International Society of Biometeorology, Dean James Blank of the College of Arts & Sciences at Kent State University, Mandy Munro-Stasiuk of the Department of Geography at Kent State University, and Margaret Deignan at Springer, the publishers of the *International Journal of Biometeorology*. The efforts put in by Brenda Ward and the staff at the American Meteorological Society in co-organizing the Congress is greatly appreciated. I would also like to thank the Program and Local Organizing Committees for their work in making this Congress a success and the keynote speakers for agreeing to participate.

Welcome again to Cleveland, and I hope that your time at the meeting and in our local area is fruitful.

Scott Sheridan
Chair, Program Committee

EMBASSY SUITES HOTEL CLEVELAND - INDEPENDENCE



Monday, 29 September 2014				
Room	**Conference Room 1**	**Conference Room 2**	**Salon II**	**Salon III**
			Welcome and Opening Session	
8:30			Welcome to ICB 2014- Scott C. Sheridan	
8:45			**ISB President's Welcome- Glenn R. McGregor**	
9:00			KS1.1 Hoeppe, P.	
10:00	**Coffee Break**			
	2C: Aerobiology and air pollution	**2D: Climate and extreme event trends**	**2A: Climate challenges in the developing world**	**2B: Modification of the Built Environment**
10:30	2C.1 Malik, P.		2A.1 Ebi, K. L.	2B.1 Szapocznik, J.
10:45	2C.2 Wanka, E. R.	2D.2 Jacobs, S. J.		
11:00	2C.3 Njokuocha, R. C.	2D.3 Cheng, C. S.	2A.2 Gosling, S. N.	
11:15	2C.4 Beggs, P. J.	2D.4 Vecellio, D. J.	2A.3 Ayobami, O. O.	2B.2 Declet-Barreto, J.
11:30	2C.5 Levetin, E.	2D.5 Ballinger, T. J.	2A.4 Ssengendo, G.	2B.3 Erell, E.
11:45	2C.6 Steiner, A. L.	2D.6 Leung, A. C. W.	2A.5 bohra, N. K.	2B.4 Bhiwapurkar, P.
12:00	**Lunch Break 12-1:30pm**			
12:30	**Climate and Human Health Commission Meeting**	**International Journal of Biometeorology Editorial Board meeting**		
	3A: Thermal Comfort and Indices I: UTCI	**Animal Biometeorology Commission Meeting**	**PD2: Public Health Science and Bioclimatology: Toward a More Efficient Collaboration**	**3B: Biometeorology and physiological responses**
1:30	3A.1 Blazejczyk, K.		PD2.1 Kalkstein, L.	3B.1 Hrushesky, W. J. M.
1:45	3A.2 Walikewitz, N.			3B.2 Melnikov, V. N.
2:00	3A.3 MacDonald, M.			3B.3 Stoupel, E. G.
2:15	3A.4 Lokys, H. L.			3B.4 Gabriel, K. M. A.
2:30	**Formal Poster Viewing with Coffee Break**			
	4C: Infectious Diseases	**4D: Forest Biometeorology**	**4A: Risk, communication, and behavior**	**4B: Urban Heat - Health Issues**
4:00	4C.1 Naumova, E. N.	4D.1 Kong, W. S.	4A.1 Samenow, J.	4B.1 Lee, H.
4:15	4C.2 Ghaffar, A.	4D.2 Khan, A. U.		4B.2 Burkart, K. G.
4:30	4C.3 Akinbobola, A.	4D.3 Jana, T. K.		4B.3 Chen, L.
4:45	4C.4 Aworinde, S. A.	4D.4 Miller, D. R.	4A.2 Stewart, A. E.	
5:00	4C.5 Schreiber, K. V.	4D.5 Frank, K. L.	4A.3 Coleman, J. S. M.	4B.5 Hondula, D. M.
5:15	4C.6 Kolivras, K. N.	4D.6 Zapata, A. F. Sr.	4A.4 Stewart, A. E.	4B.6 Kim, K. R.
5:30	**Sessions End for the Day**			

Tuesday, 30 September 2014				
Room	**Conference Room 1**	**Conference Room 2**	**Salon II**	**Salon III**
	5C: Thermal Comfort and Indices II	**5D: Atmospheric Effects on Human Behavior**	**5A: Heat Stress in Domestic Animals: New Technologies and Approaches**	**5B: Phenology I: Monitoring**
8:00	5C.1 Odhiambo, G. O.	5D.2 Dixon, P. G.	5A.1 Gebremedhin, K. G.	5B.1 Henebry, G.
8:15	5C.2 Tokizawa, K.	5D.3 Phan, M. D.		
8:30	5C.3 Kántor, N.	5D.4 Lin, X.		
8:45	5C.4 Lee, J. S.	5D.5 Didyk, L. A.	5A.2 Spiers, D. E.	5B.2 Wang, C.
9:00	5C.5 Briggs, A. G.	5D.6 Bhattacharya, D.	5A.3 Gaughan, J. B.	5B.3 Rodriguez-Galiano
9:15	5C.6 Ndetto, E. L.		5A.4 Lees, A. M.	5B.4 Liu, Y.
9:30	5C.7 Park, S.		5A.5 Wallage, A. L.	5B.5 Qader, S.
9:45	Discussion			5B.6 Zhang, X.
10:00	**Coffee Break**			
	6C: Thermal Environment and Human Health I		**6A: Heat and Animal Health Outcomes**	**6B: Phenology II: Modeling**
10:30	6C.1 Sheridan, S. C.		6A.1 Zhang, X.	6B.1 Schwartz, M. D.
10:45	6C.2 Jacobs, S. J.		6A.2 Singh, S. V.	6B.2 junhu, D.
11:00	6C.3 Greene, J. S.		6A.3 Yahav, S.	6B.3 Zhang, J.
11:15	6C.4 Konrad, C. E. II		6A.4 Khalifa, H. H.	6B.4 Keatley, M. R.
11:30	6C.5 Grigorieva, E.		6A.5 Sejian, V.	6B.5 Chambers, L. E.
11:45	6C.6 Ma, Y.		6A.6 Lacetera, N.	6B.6 Cola, G.
12:00	**Lunch Break 12-1:30**			
			General Membership Meeting	
12:15			L1.1 McGregor, G. R.	
12:30			L1.3 Liang, L.	
12:45			L1.4 Gaughan, J. B.	
1:00			L1.6 Vanos, J. K.	
1:15			L1.7 McGregor, G. R.	
	7C: Thermal Environment and Human Health II	**7D: Climate Change: Research and Adaptation Assessment**	**7A: Animal physiology**	**7B: Phenology III: Observations**
1:30	7C.1 Osipov, L.	7D.1 Ebi, K. L.	7A.1 Sinkalu, V. O.	7B.1 van Vliet, A.
1:45	7C.2 Gronlund, C. J.		7A.2 Sinkalu, V. O.	7B.2 Chambers, L. E.
2:00	7C.3 Koppe, C.	7D.2 Cegnar, T.	7A.3 Nascimento, S. T.	7B.3 zexing, T.
2:15	7C.4 de Freitas, C.	7D.3 Hondula, D. M.	7A.4 Kumar, M.	7B.4 Bolmgren, K.
2:30	7C.5 Blazejczyk, K.	7D.4 Alkan Olsson, J.	7A.5 Dangi, S. S.	7B.5 Liang, L.
2:45	7C.6 Fujino, T.	7D.5 Nejedlik, P.	7A.6 Khalifa, H. H.	7B.6 Chen, X.
3:00	**Coffee Break**			
	8C: Thermal Environment and Human Health III	**8D: Warning Systems: Methods and Implementation**	**8A: Animal bioclimatological modeling**	**8B: Tourism**
3:30	8C.1 Zhang, S.	8D.1 Muecke, H. G.	8A.1 Patra, A. K.	8B.1 Lindner-Cendrowska
3:45	8C.2 Spencer, J.	8D.2 Senkbeil, J. C.	8A.2 Samara, E. M.	8B.2 Blazejczyk, K.
4:00	8C.3 Koppe, C.	8D.3 Frank, K. L.	8A.3 Khalifa, H. H.	8B.3 de Freitas, C.
4:15	8C.4 Wu, R.	8D.4 Trubina, M.	8A.4 Maia, A. S. C.	8B.4 Perkins, D. R. IV
4:30	8C.5 Liss, A.	8D.5 Knowlton, K.	8A.5 Morais Leite, J. Sr.	8B.5 Lam, C. K. C.
4:45	8C.6 Allen, M. J.		8A.6 Façanha, D. A. E.	8B.6 Zaninovic, K.
5:00	8C.7 Davis, R. E.		8A.7 Costa, C. C. D. M.	8B.7 Pecelj, M.
5:15			8A.8 Nascimento, C. C. N.	8B.8 Rutty, M.
		Commission on Climate, Tourism and Recreation		
5:30				
5:45				
6:00	**Conference Dinner at the Rock n Roll Hall of Fame**			

Wednesday, 1 October 2014			
Room	**Conference Room 1**	**Salon II**	**Salon III**
	9C: Thermal Environment and Human Health IV	**9A: Health and atmospheric hazards research: new data sources and field technologies**	**9B: Agricultural Biometeorology I**
8:00	9C.1 Vanos, J. K.	9A.1 Curtis, A.	9B.1 Singh, S.
8:15	9C.2 Gosling, S. N.		9B.2 Faris, A. A. Sr.
8:30	9C.3 Lee, C. C.		9B.3 Meng, F.
8:45	9C.4 Vanos, J. K.	9A.2 Schuch, L. M.	9B.4 Halder, D.
9:00	9C.5 Tonouchi, M.	9A.3 Kuras, E.	9B.5 Orlandini, S.
9:15	9C.6 Suzuki-Parker, A.	9A.4 Rajkovich, N. B.	9B.6 Luo, Q.
9:30	9C.7 Fuhrmann, C.	9A.5 Nakayoshi, M.	**Assessment of water satisfaction index for maize in the Free State**
9:45	9C.8 Kalkstein, L.		
10:00	**Coffee Break**		
	10C: Urban Bioclimatology	**10A: Atmospheric Effects upon Human Health I**	**10B: Agricultural Biometeorology II**
10:30	10C.1 Yang, S. R.	10A.1 Fdez-Arroyabe, D. P.	10B.1 Kapkoti, B.
10:45	10C.2 Hardin, A. W.	10A.2 Peng, L.	10B.2 Qian, B.
11:00	10C.3 Gosselin, P.	10A.3 Kalkstein, A. J.	
11:15	10C.4 Uejio, C.	10A.4 Souza, A. Sr.	
11:30	10C.5 Jeganathan, A.	10A.5 Mutai, B. K.	
11:45	10C.6 Gal, C. V.	10A.6 Wanka, E. R.	
12:00	10C.7 Kakitsuba, N.	10A.7 Gabriel, K. M. A.	
12:15		10A.8 Chiu, Y. M.	
12:30	**Lunch Break 12:30-2pm**		
1:00	**Student and New Professionals Meeting**		
	Phenology Commission Meeting	**11A: Atmospheric Effects on Human Health II**	**11B: Disasters and Hazards**
2:00		11A.1 Kumar, N.	11B.1 Thomas, W. M.
2:15		11A.2 Lecha Estela, L. B.	11B.2 Chen, X.
2:30		11A.3 Blazejczyk, K.	11B.3 Paulikas, M. J.
2:45		11A.4 Masselot, P.	11B.4 Hao, C.
3:00		11A.5 Petit, N.	11B.5 Akinbobola, A.
3:15		11A.6 Vintzileos, A.	11B.6 Rahman, M. K.
3:30			11B.7 Ojeh, V. N.
3:45			Kabir, M. I.
4:00		**Closing Ceremony**	
4:15			
4:30	**Conference Adjourns**		

20TH INTERNATIONAL CONGRESS OF BIOMETEOROLOGY

28 September-1 October 2014 Embassy Suites Cleveland-Rockside Cleveland, OH

ICB PROGRAM COMMITTEE

Scott Sheridan, Chairperson
Michael Allen, Lynda Chambers, Grady Dixon, Kris Ebi, John Gaughan, Masaaki Hashimoto, Thomas Holst, Kyu-rang Kim, George Luber, Helmut Mayer, Simone Orlandini, Mark Schwartz, Daniel Scott, and Wendy Thomas

LOCAL ORGANIZING COMMITTEE

Thomas Schmidlin, Cameron Lee,
Mandy Munro-Stasiuk, Michael Allen, and Sandra Morgan

Sunday, September 28

5:00 P.M.–7:00 P.M.	Registration Opens
7:00 P.M.–9:00 P.M.	Evening Icebreaker and Conference Welcome- Foyer
10:00 A.M.–5:00 P.M.	Executive Board Meeting

Monday, September 29

7:30 A.M.–5:30 P.M.	Registration Continues throughout Confernece
10:00 A.M.–10:30 A.M.	Coffee Break
12:30 P.M.–1:30 P.M.	International Journal of Biometeorology Editorial Board Meeting, Organized by Scott Sheridan–Conference Room 2
12:00 P.M.–1:30 P.M.	Lunch Break
2:30 P.M.–4:00 P.M.	Formal Poster viewing with Coffee Break–Salon I

8:30 A.M.–10:00 A.M.
Keynote Speaker 1: WELCOME AND OPENING SESSION –*SALON II*

Chair(s): Scott C. Sheridan, Kent State Univ., Kent, OH

8:30A.M. Welcome to ICB 2014- Scott C. Sheridan

8:45A.M. ISB President's Welcome- Glenn R. McGregor

9:00 A.M.
KS1.1 *Assessment of changing risks caused by severe weather – roles of natural climate cycles and global warming.* **Peter Hoeppe**, Munich Re, Munich, Germany

10:30 A.M.–12:00 P.M.
Session 2A: CLIMATE CHALLENGES IN THE DEVELOPING WORLD –*SALON II*

Chair(s): Kim Knowlton, Natural Resources Defense Council, New York, NY

10:30 A.M.
2A.1 *Health adaptation in low- and middle-income countries.* **Kristie L. Ebi**, ClimAdapt, LLC, Los Altos, CA

11:00 A.M.
2A.2 *The impact of climate change on global water scarcity.* **Simon N. Gosling**, Univ. of Nottingham, Nottingham, UK; N.W. Arnell

11:15 A.M.
2A.3 *Changing Climate:Assessment of Community and Household Preparedness in Flood Affected Areas of Lagos.* **Olaniyi Oluwatosin Ayobami**, Coastal cities at risk(ccar) Lagos site., Ibadan, Oyo, Nigeria; O. Uchendu, E. Owoaje, K. Omode, I. Adelekan

11:30 A.M.
2A.4 *Climate Change Adaptation In East Africa and Its Challenges a Case Of Uganda.* **Gerald Ssengendo**, NOAA/CAC, Kampala, Uganda

11:45 A.M.
2A.5 *Changing Climatic Parameter and Its Effect on The Socio-Economy of Western Rajasthan.* **Naveen Kumar Bohra**, SUNY, JODHPUR, India

10:30 A.M.–12:00 P.M.
Session 2B: MODIFICATION OF THE BUILT ENVIRONMENT –*SALON III*

Chair(s): Pravin Bhiwapurkar, Univ., Kent, OH

10:30 A.M.
2B.1 *Neighborhood walkability, behavior and health and possible implications toward improving the urban environment.* **Jose Szapocznik**, Univ. of Miami, Miami, FL

11:15 A.M.
2B.2 *A socio-spatial vulnerability model of the Urban Heat Island: exposure, sensitivity and health impacts of high temperatures.* **Juan Declet-Barreto**, Natural Resources Defense Council, Washington, DC; S. L. Harlan, D. B. Petitti, B. L. Ruddell

11:30 A.M.
2B.3 *A 'green sol-air' temperature to estimate the radiation effect of ground cover vegetation on pedestrian thermal comfort in hot climates.* **Evyatar Erell**, Ben Gurion Univ. of the Negev, Midreshet Ben Gurion, Israel; T. Williamson

11:45 A.M.
2B.4 *Aging Buildings and Aging Communities: How to Adapt to the Changing Climate?* **Pravin Bhiwapurkar**, Univ., Kent, OH

10:30 A.M.–12:00 P.M.
Session 2C: AEROBIOLOGY AND AIR POLLUTION –*CONFERENCE ROOM 1*

Chair(s): Paul J. Beggs, Macquarie Univ., Sydney, New South Wales, Australia

10:30 A.M.
2C.1 *Alarmingly Rising Particulate Matters and Noxious Gases in the Aerosol are the Cardinal Causes of Immeasurable Deaths in India.* **Pritanshu Malik**, Maharishi Markandeshwar Univ., Ambala, Haryana, India; D. A. K. Gupta

10:45 A.M.
2C.2 *Significant Associations between Meteorological and Air Quality Parameters and the Daily Number of Emergency Calls because of Breathing Difficulties in Graz (Austria) – A Time Series Analysis from 2001 to 2009.* **Eva R. Wanka**, Klinikum der Univ. München, Munich, Germany; L. Kutschenreuter, S. Seng, R. A. Jörres, S. Budweiser

11:00 A.M.
2C.3 *Influence of meteorological factors on the occurrence of airborne fungal spores in Nsukka zone, Enugu State, Nigeria.* **Reginald C. Njokuocha**, Botanical Society of Nigeria, Enugu, Nigeria; C. E. A. Okezie

11:15 A.M.
2C.4 *Pollen allergy and variability in seasonal exposure in Australia.* **Paul J. Beggs**, Macquarie Univ., Sydney, New South Wales, Australia; J. M. Davies

11:30 A.M.
2C.5 *Aerobiology of Juniperus Pollen in Oklahoma, Texas, and New Mexico.* **Estelle Levetin**, Univ. of Tulsa, Tulsa, OK; P. Van de Water, L. Bunderson, J. Luvall

11:45 A.M.
2C.6 *A phenological model of pollen emissions for climate models.* **Allison L. Steiner**, Univ. of Michigan, Ann Arbor, MI

10:30 A.M.–12:00 P.M.
Session 2D: CLIMATE AND EXTREME EVENT TRENDS –*CONFERENCE ROOM 2*

Chair(s): Cameron C. Lee, Kent State Univ., Kent, OH

2D.1 WITHDRAWN

10:45 A.M.
2D.2 *Trends of apparent temperature in Australia.* **Stephanie J. Jacobs**, Monash Univ., Clayton, Victoria, Australia; A. B. Pezza

11:00 A.M.
2D.3 *Climate Change and Extreme Weather Events at Local Scale over Canada.* **Chad Shouquan Cheng**, EC, Toronto, ON, Canada

11:15 A.M.
2D.4 *Determining Synoptic Air Mass Modifications for Advance Health-Effect Preparedness.* **Daniel J. Vecellio**, Texas Tech Univ., Lubbock, TX; J. K. Vanos, D. M. Hondula

11:30 A.M.
2D.5 *Circulation Regimes Affiliated with Boreal Polar Marine Climate and Ecological Change.* **Thomas J. Ballinger**, Kent State Univ., Kent, OH; T. W. Schmidlin, D. F. Steinhoff

11:45 A.M.
2D.6 *Changing climate: How it affects air travel in northern Canadian communities.* **Andrew C.W. Leung**, Univ. of Toronto, Toronto, ON, Canada; W. A. Gough, T. Mohsin, K. A. Butler

12:30 P.M.–1:30 P.M.
Panel Discussion 1: CLIMATE AND HUMAN HEALTH COMMISSION MEETING –*CONFERENCE ROOM 1*

Moderator(s): Dr. Pablo Fdez-Arroyabe, Univ. of Cantabria, Santander, Cantabria, Spain

1:30 P.M.–2:30 P.M.
Panel Discussion 2: PUBLIC HEALTH SCIENCE AND BIOCLIMATOLOGY: TOWARD A MORE EFFICIENT COLLABORATION –*SALON II*

Moderator(s): Laurence Kalkstein, Univ. of Miami, Miami, FL

Panelist(s): Robert E. Davis, Univ. of Virginia, Charlottesville, VA, Simon N. Gosling, Univ. of Nottingham, Nottingham, UK, Kim Knowlton, Natural Resources Defense Council, New York, NY, George Luber, Center for Disease Control and Prevention, Atlanta, GA, Glenn Russell McGregor, Univ. of Durham , Durham , UK Jose Szapocznik, Univ. of Miami, Miami, FL

1:30 P.M.
PD2.1 *Public Health Science and Bioclimatology: Toward a More Efficient Collaboration.* **Laurence Kalkstein**, Univ. of Miami, Miami, FL

1:30 P.M.–2:30 P.M.
Panel Discussion 3: ANIMAL BIOMETEOROLOGY COMMISSION MEETING –*CONFERENCE ROOM 2*

Organizer(s): John B. Gaughan, The Univ. of Queensland, Gatton, Queensland , Australia

1:30 P.M.–2:30 P.M.
Session 3A: THERMAL COMFORT AND INDICES I: UTCI –*CONFERENCE ROOM 1*

Chair(s): Sookuk Park, Jeju National Univ., Jeju, South Korea

1:30 P.M.
3A.1 *Application of Universal Thermal Climate Index For Bioclimatic Regionalization (An Ex Ample from Europe).* **Krzysztof Blazejczyk**, Polish Academy of Sciences, Warszawa, Poland; A. Blazejczyk, V. Vinogradova, K. Lindner-Cendrowska

1:45 P.M.
3A.2 *Heat Waves and their Impact on Indoor Environments: An Assessment of Human Bioclimate using the UTCI.* **Nadine Walikewitz**, Humboldt-Univ. of Berlin, Berlin, Germany; M. Langner, W. Endlicher

2:00 P.M.
3A.3 *Application of the Universal Thermal Climate Index for Operational Forecasting in Canada.* **Melissa MacDonald**, MSC, Dartmouth, NS, Canada; T. C. Farrell, D. Henderson

2:15 P.M.
3A.4 *Future changes in bioclimatic index classes in three regions of Luxemburg.* **Hanna Leona Lokys**, Centre de Recherche Public –Gabriel Lippmann, Belvaux, Luxembourg; J. Junk, A. Krein

1:30 P.M.–2:30 P.M.
Session 3B: BIOMETEOROLOGY AND PHYSIOLOGICAL RESPONSES –*SALON III*

Chair(s): Katharina M. A. Gabriel, Univ. of Bremen, Bremen, Germany

1:30 P.M.
3B.1 *Sunspot Dynamics Are Reflected in Human Physiology and Pathophysiology.* **William J.M. Hrushesky**, Oncology Analytics, Inc., Plantation, FL; R. B. Sothern, J. Du-Quiton, D. F. T. Quiton, W. Rietveld, M. E. Boon

3B.2 WITHDRAWN

2:00 P.M.
3B.3 *Three aspects of Clinical Cosmobiology.* **Eliyahu G. Stoupel**, Rabin Medical Center, Petah Tiqwa, Sackler Faculty of Medicine, Tel Aviv Univ., Hod Hasharon, Israel

2:15 P.M.
3B.4 *Natural Light and its Rhythms - Do we know enough to modify without regret?* **Katharina M.A. Gabriel**, Univ. of Bremen, Bremen, Germany

2:30 P.M.–4:00 P.M.
Poster Session 1: POSTERS –*SALON I*

1 *Latent Heat Loss of Dairy Cows Bred in a Semiarid Environment.* **Vinicius Carvalho Fonseca**, Federal Univ. of Paraiba, Areia, Brazil; S. G. Dos Santos, E. P. Saraiva Sr., E. C. Pimenta Filho Sr., P. J. Rodrigues Neto, R. D. S. Paulino, A. D. C. Pinheiro

2 *Down-regulation of milk synthesis through PA-PG-PL system: an adaptation mechanism during heat stress.* **Nilufar Haque**, SDAU, Dantiwada, India; M. singh, A. Hossain

3 *Housing system in dairy cow farms affects green house gas emissions from manure.* **Nicola Lacetera**, Univ. of Tuscia, Viterbo, Italy; A. Vitali, A. Nardone, S. Lo Presti, T. Schipani

4 *Genome-wide analysis of the heat stress response in dermal fibroblasts of zebu and crossbred cattle.* **Anil Kumar Singh**, National Dairy Research Institute (ICAR, New Delhi) India, Karnal, Haryana, India; R. C. Upadhyay, S. Saini, D. Malakar, S. Kumar, S.V. Singh

5 *Influence of the Climatic Environment on the Mother-Offspring Interaction in Morada Nova Sheep.* **Vinicius Carvalho Fonseca**, Federal Univ. of Paraiba, Areia, Brazil; E. P. Saraiva Sr., E. C. Pimenta Filho Sr., D. A. Furtado, M. L. Amorim, M. E. Almeida, T. N. Veríssimo

6 *Development and Application to the Forecasting System of Indoor Environment in Cattle Shed.* **Ji-Sun Lee**, Korea Meteorological Administration, Seogwipo-si, Jeju-do, South Korea; K. R. Kim, S. Y. Lee, B. C. Choi, W. S. Kang, J. M. Choi

7 *In Vivo Environmental Stress On Bovine Fertility And In Vitro Kinetic Effect Of Heat Shock On Nuclear OOCYTE's Maturation.* **Krishna Chaitanya Pavani**, Department of Agrarian Sciences, CITA-A (Research Centre for Agricultural and Environmental Sciences and Techno, Angra do Heroísmo, Azores, Portugal; M. S. Faheem Sr., A. C. A. P. M. Geraldo Sr., F. J. Vieira Reis Sr., J. F. Moreira da Silva Sr.

8 *Influence Of Type Of The Bed On The Air Quality, Performance, Carcass Injuries, Scores Of The Hygiene And Locomotion In Broiler Raised In Thermal Comfort.* **Eduardo Alves de Almeida**, Universidade Estadual Paulista, Jaboticabal, Brazil; R. L. Furlan, M. Macari, L. F. A. Souza, A. C. Sant'Anna

9 *Effect of different types of shelter on microenvironment, physiological response and growth performance of lambs under semi-arid tropical environment during summer.* **Kalyan De**, Central Sheep and Wool Research Institute, Avikanagar, Malpura, Rajasthan, India; D. Kumar, A. K. Singh, K. Kumar, A. Sahoo, S. M. K. Naqvi

10 *Environmental Variables And Their Influence On Coquillettidia Mosquitoes At Para State, Brazil.* **Fabio L. T. Gonçalves**, Univ. of Sao Paulo, São Paulo, Brazil; R. B. C. Silva, M. A. Sallum, L. Carvalho

11 *Microclimate changes caused by the conversion of a forest into grassland in an area of Brazilian Savanna.* **Nadja Gomes Machado**, IFMT = Instituto Federal de Mato Grosso, Cuiabá, Mato Grosso, Brazil; D. M. D. S. Mützenberg, L. P. Angelini, D. C. S. Nassarden, M. S. Biudes

12 *Effects of landuse on net radiation and evapotranspiration in a protected area in the Northern Brazilian Pantanal.* **Marcelo Sacardi Biudes**, Universidade Federal de Mato Grosso, Cuiabá, Mato Grosso, Brazil; V. H. D. M. Danelichen, N. G. Machado, J. D. S. Nogueira

13 *Agro-climatic zoning of Jatropha curcas as a subside for crop planning and implementation in Brazil.* **Paulo Cesar Sentelhas**, Univ. of São Paulo, Piracicaba, São Paulo, Brazil; E. S. M. Yamada

14 *White mold for soybean crop in Brazil as affect by climate and agricultural management conditions.* **Gustavo Castilho Beruski**, Univ. of Sao Paulo, Piracicaba, Brazil; A. B. Pereira, D. D. S. Jaccoud Filho, F. F. Sartori, P. C. Sentelhas

15 WITHDRAWN

16 *Plant Phenological Monitoring Based On Automated Recording Of High Resolution Digital Images.* **Carla Cesaraccio**, Institute of Biometeorology; National Researcher Council, CNR-IBIMET, Sassari, Sassari, Italy; A. Piga, A. Ventura, A. Arca, P. Duce

17 WITHDRAWN

18 *Recent applications of continental-scale phenology data for science and resource management.* **Ellen G. Denny**, USA National Phenology Network, Kittery Point, ME; Staff of the USA-NPN National Coordinating Office

19 *Impact of advections of particulate matter from biomass combustion on mortality in Madrid.* **R. Carmona**, Carlos III Institute of Health, Madrid, Spain, Madrid, Spain; C. Linares, A. Tobias, I. Miron, J. Díaz

20 *Impacts of climate change on the crop invasion of oilseed rape by the rape stem weevil, Ceutorhynchus napi, in North-Western Germany.* **Hanna Leona Lokys**, Centre de Recherche Public – Gabriel Lippmann, Belvaux, Luxembourg; M. Eickermann, B. Ulber, J. Junk

21 *Early Corn Planting as a Water Conservation Strategy in the Southeastern USA.* **W. Brien Henry**, Mississippi State Univ., Mississippi State, MS; P. G. Dixon, T. Graham

22 *Downy Mildew Warning Systems For Vineyards Cultivated Under Plastic Covering - Influence On Yield And Quality.* **Ester Holcman**, Univ. of São Paulo, Piracicaba, São Paulo, Brazil; P. C. Sentelhas, M. A. F. Conceição, M. B. Sposito, H. T. Z. Couto

23 *Four plants, two hemispheres, same baseline?* **Marie R., Keatley**, Univ. of Melbourne, Creswick, Vic, Australia; I. L. Hudson

24 *Communication of climate change impacts via phenology.* **K. Bolmgren**, Swedish Univ. of Agricultural Sciences, Asa, Lammhult, Sweden; E. Koch, T. Rutishauser, T. Hübner, A. Jurkovic, H. Scheifinger, M. Ungersböck

25 *Recent Trends in Blooming Dates of Spring Flowers in Korea.* **Ho-Seung Lee**, Kyung Hee Univ., Yongin, South Korea; J. I. Yun, J. H. Kim

26 *Inquiry-Based Activities and Biometeorology: Implementing In-Class Exercises and Examining Biomet Education Research Possibilities.* **Jeremy Spencer**, The Univ. of Akron, Akron, OH

27 *Albedos and Emissivities of Urban Materials in Korea for Computer Simulations.* **Sookuk Park**, Jeju National Univ., Jeju, South Korea

28 *Modeling intra-urban extreme heat exposures with fine-scale land use data.* **Kathryn C. Conlon**, NCAR, Boulder, CO; A. Monaghan, M. Hayden, O. Wilhelmi

29 WITHDRAWN

30 *Simulation of extremely hot events in Croatia with RegCM4.2.* **Lidija Srnec**, Meteorological and Hydrological Service, Croatia, Zagreb, Croatia; I. Güttler, K.

31 *Modeling of Solar UV Reaching Ground Level for the Purpose of Antipsoriatic Climatotherapy in Poland.* **Janusz W. Krzyscin**, Institute of Geophysics Polish Academy of Sciences, Warsaw, Poland; P. Sobolewski, J. Narbutt, A. Lesiak

32 *Climate Analysis In Natal/Rn To The Variation Of Thermal Comfort.* **Maytê Duarte Leal Coutinho**, Climate Sciences, Federal Univ. of Rio Grande do Norte, Natal, Brazil; M. D. S. Costa, A. C. D. S. Gomes, T. S. D. Santos, A. R. Silva, M. D. C. D. Morais, P. V. D. Santos

33 WITHDRAWN

34 *Building façade greening as a mitigation option for climate change in cities.* **Melissa A. Hart**, Univ. of New South Wales, Sydney, Australia; M. Lipson, P. Osmond, A. Rohde

35 *Influence of climate variation on tourism and hospitality in Nigeria.* **Sheyi, Adewole Aworinde**, Education, Akoka Yaba, Lagos , Nigeria

36 *Climatic regionalization of Rio Grande do Sul (Brazil) based on zoning of the human thermal comfort.* **João Paulo Assis Gobo**, Univ. de São Paulo, São Paulo, Brazil; E. Galvani

37 *Gradual changes of climate in the west of Iran based on frequency of air masses presence in winter.* **Ramin Beedel**, Scientific Member of Researches Center of Agriculture and Natural Resources, Kermanshah, Iran & PhD Student, Kermanshah, Kermanshah, Iran

38 *Biologically effective UV radiation trend in Florence, Italy as measured at ground station and assessed by remote sensing..* **G. Zipoli**, CNR National Research Council, Sesto Fiorentino, Firenze, Italy; L. Fibbi, D. Grifoni, F. Sabatini

39 *Temporal Synoptic Index of Winter Season for Southern Coasts of IRAN.* **Ramin Beedel**, Scientific Member of Researches Center of Agriculture and Natural Resources, Kermanshah, Iran

40 *Frequency Analysis of Extreme Temperature Events.* **Tanja Likso**, Meteorological and Hydrological Service of Croatia, Zagreb, Croatia, Croatia; K. Pandzic

41 *Characterizing joint effects of spatial extent, temperature magnitude and duration of heat waves and cold spells over Central Europe.* **Jan Kysely**, Institute of Atmospheric Physics AS CR, Prague, Czech Republic; O. Lhotka

42 *Effects of Retrofitting Living Rooms with Thermal Insulation on the Health of the Elderly.* **Shigeki Nomoto**, Tokyo Metropolitan Institute of Gerontology, Tokyo, Japan; M. Ogawa, K. Tsuzuki, Y. Sakamoto, R. Takahashi

43 *Ageing in changing climate.* **Nilufar Haque**, SDAU, Dantiwada, India; A. Hossain

44 *Urban Heat Island Magnitude Impacts on Raw Mortality in Three Midwestern US Cities.* **Kelly D. Boyd**, Mississippi State Univ., Starkville, MS

45 *A discussion about the climate change impacts on elderly mortality rates in the metropolitan region of São Paulo – Brazil: what to expect?* **Rafael Jonas Righi Batista**, Univ. of São Paulo, São Paulo, Brazil; F. L. T. Gonçalves Sr.

46 *Urban Heat Island In Warsaw (Poland) And Its Bioclimatic Consequences.* **Krzysztof Blazejczyk**, Polish Academy of Sciences, Warszawa, Poland; M. Kuchcik, P. Milewski, J. Szmyd, A. Blazejczyk

47 *Outdoor heat stress and ultraviolet-induced erythema by months in Florence: useful information for the local population and tourists.* **Simone Orlandini**, Univ. of Florence, Firenze, Italy; M. Morabito, D. Grifoni, A. Crisci, L. Fibbi, G. F. Gensini, G. Zipoli

48 *Effect of atmospheric conditions on clinical, physiological, and biologic parameters of asthma.* **Haseena Rajeevan**, Yale Univ., New Haven, CT; X. Yan, W. Sessa, R. Scatena, G. Chupp

49 *Thermoregulation and periodically forced SEIR model: Understanding asthma seasonality in South Florida.* **David Quesada**, St. Thomas Univ., Miami Gardens, FL

50 *Burning and its Effects on Cardiovascular and Respiratory Health of the Population of the eastern Region of the Brazilian Legal Amazon.* **Ana Carla dos Santos Gomes**, Federal Univ. of Rio Grande do Norte, Natal, RN, Brazil; A. R. Silva, M. D. S. Costa, M. D. L. Coutinho, T. S. D. Santos, M. H. C. Spyrides, P. S. Lúcio

51 *Relationship Between Temperature and Influenza: Case Study for the month of March.* **Allan Rodrigues Silva**, Univ. Federal do Rio Grande do Norte, Natal, Brazil; T. S. D. Santos, M. D. S. Costa, M. D. L. Coutinho, A. C. D. S. Gomes

52 WITHDRAWN

53 *Cold Spell Impacts on Daily Mortality in 6 Metropolitan Cities in Korea (1991-2010) : using Spatial Synoptic Classification.* **Dae-Geun Lee**, National Institute of Meteorological Research, Jeju-do, South Korea; K. R. Kim, K.Y. Nam, B. Choi, L. Kalkstein, S. C. Sheridan, S. M. Yi

54 *Heat- and cold-related cardiovascular mortality and morbidity in urban and rural populations in the Czech Republic.* **Aleš Urban**, Institute of Atmospheric Physics AS CR, Prague, Czech Republic; J. Kysely

55 *Lack of Association between Barometric Pressure and Completed Suicide.* **Kavita Lohano**, Univ. of Louisville, Louisville, KY; Y. Gao, R. S. El-Mallakh

56 *Risk Populations for Temperature-associated Myocardial Infarction Admissions in South Korea.* **Bo Yeon Kwon**, Korea Univ., Seoul, South Korea; E. Lee, S. Lee, S. Heo, K. Jo, J. Kim, M. S. Park

57 *Increase of the Cutaneous Vitamin D3 Synthesis for a Person Wearing UV Transparent Clothes: A Model Study.* **Piotr S. Sobolewski**, Institute of Geophysics Polish Academy of Sciences, Warsaw, Poland; J. W. Krzyscin, J. Narbutt, A. Lesiak

58 *Experimental Study Of Thermal Comfort In Human Hospital Wards University Hospital Of The Federal University Of Alagoas, Northeast Brazil.* **Micejane da Silva Costa**, Federal Univ. of Rio grande do Norte, Natal, Brazil; A. C. D. S. Gomes, T. S. D. Santos, A. R. Silva, M. D. L. Coutinho

59 *Study Of Human Discomfort In Salvador– Bahia.* **Thalyta Soares dos Santos**, Federal Univ. of Rio grande do Norte, Natal, Brazil; M. D. L. Coutinho, A. R. Silva, A. C. D. S. Gomes, M. D. S. Costa

60 *Study on the modification of heat balance model by observed mean radiant temperature and mean skin temperature.* **Jong-Kil Park**, Inje Univ., Gimhae, South Korea; E. B. Kim, W. S. Jung

61 *Increasing in mean temperature affects mortality by stroke in a Tropical environment.* **Priscilla Venancio Ikefuti**, Univ. of São Paulo, São Paulo, Brazil; L. V. Barrozo, A. L. Braga

62 *Heat-related morbidity and mortality for ischaemic heart disease and cerebrovascular disease in the Czech Republic.* **Hana Davidkovova**, Institute of Atmospheric Physics AS CR, Prague, Czech Republic; E. Plavcova, J. Kyncl, B. Kriz, J. Kysely

63 *Association of High and Low Temperature with Hospital Admissions for Subarachnoid Hemorrhage in Susceptible Populations in Korea.* **Suji Lee**, Korea Univ., Seoul, South Korea; E. Lee, B.Y. Kwon, J. Kim, S. Heo, K. Jo, M. S. Park

4:00 P.M.–5:30 P.M.
Session 4A: RISK, COMMUNICATION, AND BEHAVIOR –*SALON II*

Chair(s): Jill S. M. Coleman, Ball State Univ., Muncie, IN

4:00 P.M.
4A.1 *Risk communication: New and innovative ways of reaching the masses in the digital era, and lessons learned.* **Jason Samenow**, Washington Post, Washington, DC

4:45 P.M.
4A.2 *Explorations of the Psychological Origins of Weather Salience.* **Alan E. Stewart**, Univ. of Georgia, Athens, GA

5:00 P.M.
4A.3 *Severe Weather Phobia: Prevalence, Severity, and Traumatic Events.* **Jill S. M. Coleman**, Ball State Univ., Muncie, IN; K. D. Multon, C. L. Taylor, K. D. Newby

5:15 P.M.
4A.4 *Edwin Grant Dexter: An Early Researcher in Human Behavioral Biometeorology.* **Alan E. Stewart**, Univ. of Georgia, Athens, GA

4:00 P.M.–5:30 P.M.
Session 4B: URBAN HEAT-HEALTH ISSUES –*SALON III*

Chair(s): Helmut Mayer, Albert-Ludwigs-Univ., Freiburg, Germany

4:00 P.M.
4B.1 *Simulated Mitigation of Heat Stress for Pedestrians in an Urban District of a Central European City by Different Green Scenarios.* **Hyunjung Lee**, Albert-Ludwigs-Univ., Freiburg, Germany; H. Mayer

4:15 P.M.
4B.2 *Do urban green and urban blue mitigate heat-related excess mortality? Evidence from Lisbon, Portugal.* **Katrin Gabriele Burkart**, Humboldt-Universität zu Berlin, Berlin, Germany; W. Endlicher, P. Canário, M. João Alcoforado

4:30 P.M.
4B.3 *How much does urbanization contribute to extreme heat events in Shanghai: Observations and trend analysis.* **Liang Chen**, East China Normal Univ., Shanghai, Shanghai, China; R. Jiang, W. N. Xiang

4B.4 WITHDRAWN

5:00 P.M.
4B.5 *Challenges in projecting urbanization-induced heat-related mortality.* **David M. Hondula**, Arizona State Univ., Phoenix, AZ; M. Georgescu, R. C. Balling Jr.

5:15 P.M.
4B.6 *BioCAS: Biometeorological Climate impact Assessment System for Building-scale Impact Assessment of Heat-stress Related Mortality.* **Kyu Rang Kim**, National Institute of Meteorological Research/KMA, Seogwipo-si, Jeju Province, South Korea; C. Yi, J. S. Lee, B. C. Choi, D. Scherer, F. Meier

4:00 P.M.–5:30 P.M.
Session 4C: INFECTIOUS DISEASES –*CONFERENCE ROOM 1*

Chair(s): Kristie L. Ebi, ClimAdapt, LLC, Los Altos, CA

4:00 P.M.
4C.1 *Water-borne Outbreaks and Climate: a Meta-analysis Approach.* **Elena N. Naumova**, Tufts Univ. School of Engineering, Medford, MA

4:15 P.M.
4C.2 *Relationship of Dengue with Malaria and other social and climate covariates from four different cities of Pakistan.* **Abdul Ghaffar**, COMSATS, Islamabad, Pakistan; B. Khalid

4:30 P.M.
4C.3 *Temporal and Spatial Variations of Some Meteorological Parameters and Malaria Occurrence In Ekiti State, Nigeria.* **Ademola Akinbobola**, Federal Univ. of Technology, Akure, Nigeria; J. B. Omotosho, E. Okogbue

4:45 P.M.
4C.4 *Impacts of climate changes on human health a case study on malaria disease in Nigeria.* **Sheyi, Adewole Aworinde**, Education, Lagos , Nigeria

5:00 P.M.
4C.5 *Improvements in Estimation of Malaria Transmission Potential Modeling with Anthropogenic Climate Warming.* **Kathleen V. Schreiber**, Millersville Univ., Millersville, PA; K. P. Paaijmans, J. I. Blanford, R. G. Crane, M. E. Mann, L. Ning, M. B. Thomas

5:15 P.M.
4C.6 *Modeling Potential Future Lyme Disease Emergence Patterns Based on Projected Land Cover Under Different IPCC Scenarios.* **Korine N. Kolivras**, Virginia Tech, Blacksburg, VA; J. Surendrababu, S. Prisley, J. Li, J. Campbell

4:00 P.M.–5:30 P.M.
Session 4D: FOREST BIOMETEOROLOGY – *CONFERENCE ROOM 2*

Chair(s): Katrina L. Frank, Applied Climatologists, Inc., Flower Mound, TX

4:00 P.M.
4D.1 *Vulnerability of Warmth-sensitive Plant at Un-glaciated Refugia Under the Global Warming Environment.* **Woo-seok Kong**, Kyung Hee Univ., Seoul, South Korea; K. Choi, J. C. Yang, S. H. Oh, S. G. Lee, H. N. Park

4:15 P.M.
4D.2 *Documenting the distribution of Salvadora persica L., to establish a baseline on the pattern of its occurrence with the meteorological data and assessing its adaptation in the adjacent warmed up zones: a case study.* **Amin U. Khan**, Sustainable Development Study Centre, G.C. Univ., Lahore, Lahore, Pakistan; F. Sharif, A. Hamza

4:30 P.M.
4D.3 *Biosphere-Atmosphere coupling – a tropical mangrove system perspective.* **Tapan Kumar Jana**, Calcutta Univ., Kolkata, West Bengal, India

4:45 P.M.
4D.4 *Group Tree Sway in a Coniferous Forest Canopy.* **David R. Miller**, Univ. of Connecticut, Storrs, CT; X. Zhao, M. Rudnicki, A. A. Hixcox

5:00 P.M.
4D.5 *Meteorological Influences on the Dispersal of the Gypsy Moth: Spread to the Arrowhead of Minnesota.* **Katrina L. Frank**, Applied Climatologists, Inc., Flower Mound, TX; P. C. Tobin, H. Thistle, L. Kalkstein

5:15 P.M.
4D.6 *Annual and Interannual Variability of Forest Fires in Tropical South America and their association with the Normalized Difference Vegetation Index (NDVI) during 2000-2010.* **Andrés F. Zapata**, Investigation Center of Colombia's Climate, Medellín, Colombia

Tuesday, September 30

10:00 A.M.–10:30 A.M.	Coffee Break
12:00 P.M.–1:30 P.M.	Lunch Break
7:00 P.M.–10:00 P.M.	Conference Dinner at the Rock and Roll Hall of Fame- Transportation provided. *Be sure to have your ticket- admission will not be permitted without it.*

8:00 A.M.–10:00 A.M.
Session 5A: HEAT STRESS IN DOMESTIC ANIMALS: NEW TECHNOLOGIES AND APPROACHES –*SALON II*

Chair(s): Nicola Lacetera, Univ. of Tuscia, Viterbo, Italy

8:00 A.M.
5A.1 *Bio-Energetics of Animals and Novel Ways of Cooling High-Producing Dairy Cows during Heat Stress.* **Kifle G. Gebremedhin**, Cornell Univ., Ithaca, NY

8:45 A.M.
5A.2 *Thermoregulatory Adjustments of Cattle to Long-Term Heat Stress in a Field Environment.* **Don E. Spiers**, International Society of Biometeorology, Columbia, MO

9:00 A.M.
5A.3 *Using an RFID device to obtain rumen temperature in cattle.* **John.B Gaughan**, The Univ. of Queensland, Gatton, Queensland, Australia; A. Lees, M. Sullivan, J. Cadwell-Smith

9:15 A.M.
5A.4 *Using infrared thermography as an assessment of body temperature in cattle.* **Angela M. Lees**, The Univ. of Queensland, Gatton, Queensland , Australia; J. C. Lees, A. L. Wallage, M. L. Sullivan, A. T. Lisle, J. B. Gaughan

9:30 A.M.
5A.5 *Scrotal thermoregulation in the bull: The effect of surgery, body temperature and ambient temperature.* **Andrea L. Wallage**, The Univ. of Queensland, Gatton, Queensland , Australia; S. D. Johnston, A. T. Lisle, A. M. Lees, L. Beard, A. J. Cawdell-Smith, C. W. Collins, J. B. Gaughan

8:00 A.M.–10:00 A.M.
Session 5B: PHENOLOGY I: MONITORING –*SALON III*

Chair(s): Mark D. Schwartz, Univ. of Wisconsin, Milwaukee, WI

8:00 A.M.
5B.1 *Observing Land Surface Phenologies: Back to the Future with the Planetary Macroscope.* **Geoffrey Henebry**, South Dakota State Univ., Brookings, SD

8:45 A.M.
5B.2 *Monitoring Alpine Grassland on the Tibetan Plateau: its Phenological Change and Climatic Dependencies with Satellite Time Series.* **Cuizhen Wang**, Univ. of South Carolina, Columbia, SC; Li, H. Guo

9:00 A.M.
5B.3 *European vegetation response to climate drivers in the last decade: using 1 km MERIS data for modelling changes in land surface phenology.* **Victor F. Rodriguez-Galiano**, Univ. of Southampton, Southampton, UK; J. Dash, P. Atkinson

9:15 A.M.
5B.4 *Monitoring Vegetation Phenology Using Daily Nadir BRDF-Adjusted VIs from VIIRS.* **Yan Liu**, UMASS, Boston, MA; C. Schaaf, Z. Wang

9:30 A.M.
5B.5 *Crop Area Estimation in Iraq Based on Satellite Derived Phenological Metrics and the Influence of War and Drought.* **Sarchil Qader**, Southampton, UK; J. Dash, P. Atkinson

9:45 A.M.
5B.6 *Long-term Global Land Surface Phenology Derived from AVHRR and MODIS Observations and Its response to Climate Changes.* **Xiaoyang Zhang**, South Dakota State Univ., Brookings, SD; L. Liu

8:00 A.M.–10:00 A.M.
Session 5C: THERMAL COMFORT AND INDICES II –*CONFERENCE ROOM 1*

Chair(s): Krzysztof Blazejczyk, Polish Academy of Sciences, Warszawa, Poland

8:00 A.M.
5C.1 *An Analysis of Biometeorological Thermal Comfort in an Oasis City within The Sub-tropical Climate Zone: The Case of Al Ain City, UAE.* **George, O. Odhiambo**, UAE Univ., Al Ain, Abu Dhabi, United Arab Emirates

8:15 A.M.
5C.2 *Practical Precooling Technique in Occupational Settings.* **Ken Tokizawa**, National Institute of Occupational Safety and Health, Japan, Kawasaki, Kanagawa, Japan; T. Oka, A. Yasuda, T. Tai, S. Son, J. Wada, H. Ida

8:30 A.M.
5C.3 *Outdoor thermal comfort requirements of Taiwanese and Hungarians in the warm months.* **Noémi Kántor**, National Chung Hsing Univ., Taichung, Taiwan; K. T. Tsai, L. Égerházi, T. P. Lin

8:45 A.M.
5C.4 *Development of a Diagnostic Index on the Heat-wave considering Accumulative Effect of Heat-stress: the Accumulated Heat stress Index (AHI).* **Ji-Sun Lee**, KMA, Seogwipo-si, Jeju-do, South Korea; H. R. Byun, D.W. Kim, K. R. Kim, B. C. Choi

9:00 A.M.
5C.5 *Effects of Facial Cooling on Thermal Comfort in Windy Winter Conditions.* **Andrew G. Briggs**, Univ. of Guelph Graduate, Vancouver, BC, Canada

9:15 A.M.
5C.6 *Investigation of human thermal perception and local adaptation to climate change in hot-humid climates – the case of Dar es Salaam, Tanzania.* **Emmanuel Lubango Ndetto**, Univ. of Freiburg, Freiburg, Germany; A. Matzarakis

9:30 A.M.
5C.7 *Korean Human Thermal Sensation and Comfort Model.* **Sookuk Park**, Jeju National Univ., Jeju, South Korea

9:45A.M. Discussion.

8:00 A.M.–10:00 A.M.
Session 5D: ATMOSPHERIC EFFECTS ON HUMAN BEHAVIOR –*Conference Room 2*

Chair(s): Adam J. Kalkstein, United States Military Academy, West Point, NY

8:00 A.M.
5D.2 *Temperature-Suicide Associations using DLNM.* **P. Grady Dixon**, Fort Hays State Univ., Hays, KS; A. J. Kalkstein

5D.1 WITHDRAWN

8:15 A.M.
5D.3 *A Proposed Regional System of Categorizing Wet Bulb Globe Temperature for Athletic Outdoor Policy.* **Minh Duc Phan**, Univ. of Georgia, Athens, GA; C. A. Williams, A. J. Grundstein

8:30 A.M.
5D.4 *Change of Summer Thermal Control Use in Homes after Electricity Shortage Caused by 3.11 Disaster in Japan.* **Xiaoyong Lin**, Osaka City Univ., Osaka, Japan; N. Umemiya

8:45 A.M.
5D.5 *Slight atmospheric pressure fluctuations as the risk factor promoting aggressive behaviour.* **L.A. Didyk**, Institute of Applied Problems of Physics and Biophysics, Kyiv, Ukraine; Y. P. Gorgo, S. A. Mamilov, I. A. Semenova

9:00 A.M.
5D.6 *Medical Meteorology : Weather Assists Ease of Labor (child birth) - A Unique Location in India.* **Deepak Bhattacharya**, Sri Radha Krishna, Bhubaneswar, India

10:30 A.M.–12:00 P.M.
Session 6A: HEAT AND ANIMAL HEALTH OUTCOMES –*Salon II*

Chair(s): Don E. Spiers, International Society of Biometeorology, Columbia, MO

10:30 A.M.
6A.1 *Effects of Simulated Heat Wave on Senile Mice.* **Xiakun Zhang**, Nanjing Univ. of Information Sciences and Technology, Nanjing, Jiangsu, China; S. Zhang, C. Wang, Y. Tian, B. Wang, P. Guo

10:45 A.M.
6A.2 *Effect of Thermal Stress on HSP 72 and Leptin mRNA Expressions In Peri-Parturient Dairy Cows.* **Sohan Vir Singh**, National Dairy Research Institute (ICAR, New Delhi) India, Karnal, Haryana, India; M. M. Vaidya, R. C. Upadhyay, A. K. Singh, B. Baliyan

11:00 A.M.
6A.3 *The Epigenetic Approach of Broiler Chickens to Cope with Global Warming.* **Shlomo Yahav**, ARO the Volcani Center, Bet-Dagan, Israel; Y. piestun, O. halevy

11:15 A.M.
6A.4 *Biological and Mathematical Analysis of Desert Sheep and Goats Responses To Natural Heat Stress, in Egypt.* **Hesham H., Khalifa**, Al-Azhar Univ., Cairo, Egypt; A. R. Elbeltagy, A. M. Aboul-Naga, T. M. M. Abdel Khalek, M. H. Elshafie, B. Rischkovesky

11:30 A.M.
6A.5 *Concept of multiple environmental stresses impacting sheep production and adaptation under the changing climate scenario.* **Veerasamy Sejian**, National Institute of Animal Nutrition and Physiology, Bangalore, India; S. M. K. Naqvi, V. P. Maurya, J. P. Ravindra, C. S. Prasad

11:45 A.M.
6A.6 *Heat waves related mortality in dairy cows.* **Nicola Lacetera**, Univ. of Tuscia, Viterbo, Italy; A. Vitali, A. Felici, S. Esposito, L. Bertocchi, C. Maresca, U. Bernabucci, A. Nardone

10:30 A.M.–12:00 P.M.
Session 6B: PHENOLOGY II: MODELING –*Salon III*

Chair(s): Liang Liang, Univ. of Kentucky, Lexington, KY

10:30 A.M.
6B.1 *Modeling Phenological Change at Global-Scales Using Climate Data.* **Mark D. Schwartz**, Univ. of Wisconsin, Milwaukee, WI

10:45 A.M.
6B.2 *Response of Robinia Pseudoacacia First Leaf Date to temperature and Precipitation Change in China in the Past 50 Years.* **Dai Junhu**, Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, Beijing, China; T. zexing, W. huanjiong, G. quansheng

11:00 A.M.
6B.3 *Integrating MODIS satellite information and maize phenological data to detect maize cultivated area.* **Jiahua Zhang**, Chinese Academy of Sciences, Beijing, China; L. Feng, F. Yao

11:15 A.M.
6B.4 *Differential changes in the reproductive cycle of two temperate plants in response to experimental warming.* **Marie R. Keatley**, Univ. of Melbourne, Creswick, Vic, Australia; B. J. Nugent, P. K. Ades

11:30 A.M.
6B.5 *Phenology and seasonal forecasting in the Pacific: combining traditional knowledge with statistical and dynamical methods to increase community resilience.* **Lynda E. Chambers**, Australian Bureau of Meteorology, Melbourne, Victoria, Australia; M. S. Waiwai, P. Malsale, P. Feke, R. Plotz

11:45 A.M.
6B.6 *Space and Time Variability Of Grapevine Phenology In Europe.* **Gabriele Cola**, Univ. of Milan, Milan, Italy; L. Mariani, O. Failla, L. Rustioni, S. G. Parisi, R. Alilla, C. Epifani, G. Dal Monte

10:30 A.M.–12:00 P.M.
Session 6C: THERMAL ENVIRONMENT AND HUMAN HEALTH I –*Conference Room I*

Chair(s): Robert Davis, Univ. of Virginia, Charlottesville,VA

10:30 A.M.
6C.1 *Updated trend analysis of heat vulnerability in the United States using a Distributed Lag Nonlinear Model.* **Scott C. Sheridan**, Kent State Univ., Kent, OH; P. G. Dixon

10:45 A.M.
6C.2 *Heat stress during the Black Saturday event in Melbourne, Australia.* **Stephanie J. Jacobs**, Monash Univ., Clayton,Victoria, Australia; T. Vihma, A. B. Pezza

6C.3 *The Application of the European Heat Wave of 2003 to Korean Cities to Analyze Impacts on Heat-Related Mortality* J. Scott Greene, Univ. of Oklahoma, Norman, OK; and **L. Kalkstein**, K. Kim, Y. J. Choi, and D. G. Lee

11:15 A.M.

6C.4 *Relationships between Temperature and Heat-Related Illness across North Carolina.* **Charles E. Konrad**, Southeast Regional Climate Center, Chapel Hill, NC; M. M. Kovach, C. M. Fuhrmann

11:30 A.M.
6C.5 *Summer mortality and synoptic climatology in Khabarovsk.* **EA Grigorieva**, Russian Academy of Sciences, Birobidzhan, Russia; L. Kalkstein, S. C. Sheridan, J. K. Vanos

11:45 A.M.
6C.6 *Heat Wave Impacts on Motality in Nanjing,China.* **Yuxia Ma**, Lanzhou Univ.,China, Lanzhou, China; J. Zhang, J. Wang

12:15 P.M.–1:30 P.M.
Lecture 1: GENERAL MEMBERSHIP MEETING – *Salon II*

Moderator(s): Glenn Russell Univ. of Durham , Durham , UK

12:15 P.M.
L1.1 *President's Report.* **Glenn Russell McGregor**, Univ. of Durham , Durham , UK

12:25 P.M.
L1.2 *Congress Report.* **Scott C. Sheridan**, Kent State Univ., Kent, OH

12:35 P.M.
L1.3 *Secretary and Membership Report.* **Liang Liang**, Univ. of Kentucky, Lexington, KY

12:45 P.M.
L1.4 *Treasurer's Report.* **John.B Gaughan**, The Univ. of Queensland, Gatton, Queensland , Australia

12:55 P.M.
L1.5 *Report on the International Journal of Biometeorology.* **Scott C. Sheridan**, Kent State Univ., Kent, OH

1:05 P.M.
L1.6 *Report from the Students and New Professionals Group.* **Jennifer K.Vanos**, Texas Tech Univ., Lubbock, TX; M. Allen, D. M. Hondula

1:15 P.M.
L1.7 *Tromp Award Presentation.* **Glenn Russell McGregor**, Univ. of Durham , Durham , UK

1:20 P.M.
L1.8 *New President's Report.* **Mark D. Schwartz**, Univ. of Wisconsin, Milwaukee, WI

1:30 P.M.–3:00 P.M.
Session 7A: ANIMAL PHYSIOLOGY –*Salon II*

Chair(s): Nicola Lacetera, Univ. of Tuscia, Viterbo, Italy

1:30 P.M.
7A.1 *Tonic Immobility and Vigilance Responses of Broiler Chickens to Lighting Regimens during the Hot Dry Season, and the Beneficial Effect of Melatonin.* **Victor Olusegun Sinkalu**, Ahmadu Bello Univ., Zaria-Nigeria, Zaria, Kaduna, Nigeria; J. O. Ayo, A. B. Adelaiye, J. O. Hambolu

1:45 P.M.
7A.2 *Melatonin Entrains Circadian Rhythmicity of Colonic Temperature In Laying Hens During The Hot-Dry Season.* **Victor Olusegun Sinkalu**, Ahmadu Bello Univ., Zaria-Nigeria, Zaria, Kaduna, Nigeria; A. A. Abimbola, J. O. Ayo

2:00 P.M.
7A.3 *Respiratory evaporation of poultry – the development of a ventilated hood system.* **Sheila Tavares Nascimento**, UNESP, Jaboticabal, Brazil; A. S. C. Maia, M. D. D. Carvalho, C. C. N. Nascimento, L. G. Leite

2:15 P.M.
7A.4 *Effect of Chromium Supplementation on Endocrine Variables in Summer Exposed Murrah Buffaloes (Bubalus bubalis) Calves.* **Muneendra Kumar**, College of Veterinary Science and Animal Husbandry, India, Mathura, ID, India; H. Kaur, A. K. Tyagi, R. S. Deka, V. Mani, N. J. Kewalramani

2:30 P.M.
7A.5 *Effect of antioxidants and betaine supplementation on serum HSPs and stress hormone during long-term heat stress adaptation in goat.* **Satyaveer Singh Dangi**, Indian Veterinary Research Institute, Bareilly, UttarPradesh, India; M. Gupta, S. K. Dangi, V. S. Chouhan, V. P. Maurya, P. Kumar, G. Singh, M. Sarkar

2:45 P.M.
7A.6 *Seasonal Variation in the Reproductive Hormones of Rabbit Does and its Relation to Their Reproductive Performance.* **Hesham H., Khalifa**, Al-Azhar Univ., Cairo, Egypt; M. M. Mahmoud, S. S. Mostafa

1:30 P.M.–3:00 P.M.
Session 7B: PHENOLOGY III: OBSERVATIONS – *SALON III*

Chair(s): Lynda E. Chambers, Australian Bureau of Meteorology, Melbourne, Victoria, Australia

1:30 P.M.
7B.1 *Nature Today; What is the business/communication potential of your scientific information?* **Arnold van Vliet**, Wageningen Univ., Wageningen, Netherlands; W. Bron

1:45 P.M.
7B.2 *ClimateWatch: Australia's phenological citizen science program.* **Lynda E. Chambers**, Australian Bureau of Meteorology, Melbourne, Victoria, Australia; C. Gillies, L. Ashcroft, M. R. Keatley

2:00 P.M.
7B.3 *Plant Phenological Reconstructions and Temperature Sensitivity in Beijing in the Past 100 Years.* **TAO zexing**, Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, Chaoyang District, Beijing, China; W. Huanjiong, G. Quansheng, D. Junhu

2:15 P.M.
7B.4 *Phenological environmental assessment indicators–proposing an international standard.* **K. Bolmgren**, Swedish Univ. of Agricultural Sciences, Asa, Lammhult, Sweden; B. I. Cook, Dahl, O. Langvall

2:30 P.M.
7B.5 *Exploring Geographically Variant Climatic Requirements of Plant Phenology through Common Garden Observations.* **Liang Liang**, Univ. of Kentucky, Lexington, KY

2:45 P.M.
7B.6 *Impacts of climate change on the Taraxacum mongolicum growing season in the temperate zone of eastern China.* **Xiaoqiu Chen**, Peking Univ., Beijing, China

1:30 P.M.–3:00 P.M.
Session 7C: THERMAL ENVIRONMENT AND HUMAN HEALTH II –*CONFERENCE ROOM 1*

Chair(s): Michael J. Allen, Old Dominion Univ., Norfolk, VA

1:30 P.M.
7C.1 *Temperature and human health.* **Lev Osipov**, Institute of Cytology, Novosibirsk, Russia

1:45 P.M.
7C.2 *Vulnerability Among the Elderly to Extreme Heat-Associated Cardiovascular Mortality in Michigan, 2000-2009.* **Carina J. Gronlund**, Univ. of Michigan, Ann Arbor, MI; K. C. Conlon, Y. Ou, M. S. O'Neill

2:00 P.M.
7C.3 *Influence of the Thermal Environment on IHD Mortality and Morbidity in Germany (2001-2010).* **Christina Koppe**, Deutscher Wetterdienst, Offenbach, Germany; S. Zacharias, D. Bernhard, H. G. Muecke

2:15 P.M.
7C.4 *Possible role of acclimatization in weather-related human mortality during the transition seasons of autumn and spring in an extreme continental climate.* **CR de Freitas**, Univ. of Auckland, Auckland, New Zealand; E. Grigorieva

2:30 P.M.
7C.5 *Regional Differences of Heat and Cold Stress in Europe And Their Influence On Human Health And Well Being.* **Krzysztof Blazejczyk**, Polish Academy of Sciences, Warszawa, Poland; A. Blazejczyk, J. Baranowski

2:45 P.M.
7C.6 *Increase in incidences of emergency conveyance related to heat stroke in 2006-2013 in Saitama, Japan – local climate change and aging of society.* **Takeshi Fujino**, Saitama Univ., Saitama, Japan; S. Koda, C. Takahashi

1:30 P.M.–3:00 P.M.
Session 7D: CLIMATE CHANGE: RESEARCH AND ADAPTATION ASSESSMENT –*CONFERENCE ROOM 2*

Chair(s): David M. Hondula, Arizona State Univ. Phoenix, AZ

1:30 P.M.
7D.1 *Overview of a new scenario framework for climate change research.* **Kristie L. Ebi**, ClimAdapt, LLC, Los Altos, CA

2:00 P.M.
7D.2 *Role of biometeorology in development and implementation of adaptation strategies.* **Tanja Cegnar**, Slovenian Environment Agency, Ljubljana, Slovenia

2:15 P.M.
7D.3 *Evaluating Adaptation Strategies for Extreme Weather: Cooling Center Utilization and Accessibility in Phoenix, AZ.* **David M. Hondula**, Arizona State Univ., Phoenix, AZ; A. Asburry, D. Bentz, V. Berisha, K. Goodin, M. Luc, M. McCullough, A. Mohamed, M. C. Roach, B. Salas, K. Starr, J. Uebelherr

2:30 P.M.
7D.4 *Impacts and solutions of increasing heat on humans and ecosystems- a multi disciplinary identification of gaps in the research area.* **Johanna Alkan Olsson**, Lund Univ., Lund, Sweden; T. Kjellström

2:45 P.M.
7D.5 *Adaptation Options To Climate Change Impacts In Slovakia, Agriculture.* **Pavol Nejedlik**, AES, Bratislava, Slovakia; B. Siska

3:30 P.M.–5:30 P.M.
Session 8A: ANIMAL BIOCLIMATOLOGICAL MODELING –*SALON II*

Chair(s): John.B Gaughan, The Univ. of Queensland, Gatton, Queensland, Australia

3:30 P.M.
8A.1 *Prediction of enteric methane emission from buffaloes using linear and non-linear statistical models.* **Amlan Kumar Patra**, West Bngal Univ. of Animal and Fishery Sciences, Kolkata, West Bengal, India

3:45 P.M.
8A.2 *Estimating the Thermo-Neutral Zone of Dromedary Camels Using Surface Heat Transfer Modelling.* **E. M. Samara**, King Saud Univ., Riyadh, Saudi Arabia; A. A. AL-Haidary

4:00 P.M.
8A.3 *Assessment of Climate Change Impacts on Livestock in Egypt.* **Hesham H., Khalifa**, Al-Azhar Univ., Cairo, Egypt

4:15 P.M.
8A.4 *Analytical and Numerical Modeling of Skin Surface Temperature in Livestock.* **Alex Sandro Campos Maia**, UNESP, Jaboticabal, Brazil; H. F. M. Milan, K. G. Gebremedhin

4:30 P.M.
8A.5 *Evaporative Heat Losses in Different Coloured Brazilian Hair Sheep.* **Jacinara Hody Gurgel Morais Leite**, USDA, Rio Grande do Norte, Mossoró, Brazil; D. A. E. Façanha, L. A. B. Asensio IV

4:45 P.M.
8A.6 *Adaptative Responses of Brazilian Brahman Bulls in Different Seasons.* **Débora Andréa Evangelista Façanha**, USDA/ARS, Rio Grande do Norte, Mossoró, Brazil; W. P. Costa II, P. P. L. D. E. Campos, J. H. G. Morais Leite, L. A. B. Asensio IV, J. E. R. Sousa

5:00 P.M.
8A.7 *Influence of solar radiation in Nelore cattle thermoregulation.* **Cíntia Carol de Melo Costa**, São Paulo State Univ., Jaboticabal, Brazil; A. S. C. Maia, N. La Scala Júnior, S. T. Nascimento, C. C. N. Nascimento, M. D. D. Carvalho

5:15 P.M.
8A.8 *A Heat Transfer Model for the Upper Respiratory Tract of Livestock under Tropical Conditions.* **Carolina Cardoso Nagib Nascimento**, UNESP, Jaboticabal, Brazil; A. S. C. Maia, S. T. Nascimento, C. C. D. M. Costa, M. D. D. Carvalho

3:30 P.M.–5:30 P.M.
Session 8B: TOURISM –*SALON III*

Chair(s): CR de Freitas, Univ. of Auckland, Auckland, New Zealand

3:30 P.M.
8B.1 *Tourist Weather Perception and its Consideration in Bioclimate Assessment Methods.* **Katarzyna Lindner-Cendrowska**, Univ. of Warsaw, Warsaw, Poland; K.

3:45 P.M.
8B.2 *ASSESSMENT OF ADAPTATION STRAIN DURING TOURISM ACTIVITY.* **Krzysztof Blazejczyk**, Polish Academy of Sciences, Warszawa, Poland; V. Vinogradova, A. Blazejczyk, M. Kuchcik

4:00 P.M.
8B.3 *On-site behavior as a measure of tourist sensitivity to and satisfaction with weather and climate conditions.* **CR de Freitas**, Univ. of Auckland, Auckland, New Zealand

4:15 P.M.
8B.4 *Biometeorology in tourism: Using thermal comfort classifications and weather-types to predict consumer behavior.* **David Richard Perkins**, Univ. of North Carolina, Greensboro, NC

4:30 P.M.
8B.5 *Outdoor human thermal comfort in Melbourne's botanic gardens.* **Cho Kwong Charlie Lam**, Monash Univ., Clayton, Victoria, Australia; M. Loughnan, N. Tapper

4:45 P.M.
8B.6 *Climate potential for different kinds of tourism in Croatia.* **Ksenija Zaninovic**, Meteorological and Hydrological Service of Croatia (DHMZ), Zagreb, Croatia

5:00 P.M.
8B.7 *Biothermal Conditions in Serbia in Function of Health Tourism and Recreation.* **Milica Pecelj**, Serbian Academy of Sciences and Arts, Belgrade, Serbia, Serbia

5:15 P.M.
8B.8 *Bioclimatic comfort of coastal tourists.* **Michelle Rutty**, Univ. of Waterloo, Waterloo, ON, Canada; D. Scott

3:30 P.M.–5:30 P.M.
Session 8C: THERMAL ENVIRONMENT AND HUMAN HEALTH III –*CONFERENCE ROOM 1*

Chair(s): Chris Uejio, Florida State Univ., Tallahassee, FL

3:30 P.M.
8C.1 *Effects of Moderate Strength Cold Air Activity on Hypertensive Patients.* **Shuyu Zhang**, Lanzhou Institute, CMA, Lanzhou, Gansu, China; X. Zhang, C. Wang, B. Wang

3:45 P.M.
8C.2 *Hypothermia Mortality in the United States: A Quantitative Assessment of Meteorological Thresholds.* **Jeremy Spencer**, Univ. of Akron, Akron, OH; S. C. Sheridan

4:00 P.M.
8C.3 *Influence of heat waves on ischemic heart diseases in Germany – present situation and climate change.* **Christina Koppe**, Deutscher Wetterdienst, Offenbach, Germany; S. Zacharias, H. G. Muecke

4:15 P.M.
8C.4 *Heat stroke related hospitalizations in older adults: disproportionally high impact of the first heat wave.* **Ruiruo Wu**, Tufts Univ., Medford, MA; A. Liss, K. Chui, E. N. Naumova

4:30 P.M.
8C.5 *Adverse Health Consequences of Exposure To Ambient Temperature in A Changing Climate.* **Alexander Liss**, Tufts Univ., Medford, MA; G. E. Metcalf, M. Koch, E. N. Naumova

4:45 P.M.
8C.6 *Assessing Risk to Heat Waves and Cold Spells using a Distributed Lag Non-Linear Model.* **Michael J. Allen**, Old Dominion Univ., Norfolk, VA

5:00 P.M.
8C.7 *Observation time, temperature diurnality, and weather variable selection influence heat-related mortality.* **Robert E. Davis**, Univ. of Virginia, Charlottesville, VA; D. M. Hondula, A. Patel

3:30 P.M.–5:30 P.M.
Session 8D: WARNING SYSTEMS: METHODS AND IMPLEMENTATION –*Conference Room 2*

Chair(s): Jason C. Senkbeil, Univ. of Alabama, Tuscaloosa, AL

3:30 P.M.
8D.1 *'Do Air Hygiene-related Forecasting and Early Warning Systems Reach Vulnerable Target Groups?'* **Hans-Guido Muecke**, Federal Environment Agency Germany, Berlin, Germany; M. Capellaro, D. Sturm

3:45 P.M.
8D.2 *Do We Need a Tornado Watch Scale?* **Jason C. Senkbeil**, Univ. of Alabama, Tuscaloosa, AL; J. B. Mason

4:00 P.M.
8D.3 *The development of an extreme cold warning system for livestock in northeastern Montana.* **Katrina L. Frank**, Applied Climatologists, Inc., Flower Mound, TX; T. E. Fransen, W. J. Martin, L. Kalkstein

4:15 P.M.
8D.4 *Human's adaptation to weather changes: Media Project "Biomet_Forecast".* **Marina Trubina**, Russian State Hydrometeorological Univ., Saint-Petersburg, Russia

4:30 P.M.
8D.5 *Case Study in Heat: Global Cities Address Climate-Health Threats With Early Warning Systems.* **Kim Knowlton**, Natural Resources Defense Council, New York, NY; D. Mavalankar, A. Jaiswal, G. S. Azhar, A. Tiwari, A. Rajiva, B. Deol, N. Kaur, P. J. Webster, V. Toma, P. Sheffield, J. Hess

5:30 P.M.–6:00 P.M.
Panel Discussion 4: COMMISSION ON CLIMATE, TOURISM AND RECREATION –*Conference Room 2*

Moderator(s): CR de Freitas, Univ. of Auckland, Auckland, New Zealand

Wednesday, October 01

10:00 A.M.–10:30 A.M.	Coffee Break
12:30 P.M.–2:00 P.M.	Lunch Break
1:00 P.M.–2:00 P.M.	Executive Board Meeting–Conference Room 2
4:30 P.M.	Conference Adjourns

8:00 A.M.–10:00 A.M.
Session 9A: HEALTH AND ATMOSPHERIC HAZARDS RESEARCH: NEW DATA SOURCES AND FIELD TECHNOLOGIES –*Salon II*

Chair(s): Wendy Marie Thomas, NOAA/NWS, Silver Spring, MD

8:00 A.M.
9A.1 *Mapping Challenging Environments: How can mobile geospatial technologies be used to support intervention strategies in Crime, Disaster, Epidemic, and Informal (Slum) landscapes?* **Andrew Curtis**, Kent State Univ., Kent, OH

8:45 A.M.
9A.2 *Mobile air quality monitoring of particulate matter at the neighborhood scale: challenges and opportunities through the incorporation of geospatial technologies.* **Laura M. Schuch**, Kent State Univ., Kent, OH; A. Curtis

9:00 A.M.
9A.3 *Intra-Neighborhood Variation in Individually Experienced Temperatures (IETs): Insights from a New Approach to Measuring Heat Exposure.* **Evan Kuras**, Boston Univ., Boston, MA; D. M. Hondula, J. Brown-Saracino

9:15 A.M.
9A.4 *A Bicycle-Based Field Measurement System for the Study of the Urban Canopy Layer in Cuyahoga County, Ohio.* **Nicholas Bly Rajkovich**, SUNY, Buffalo, NY; L. Larsen

9:30 A.M.
9A.5 *Human Biometeorology along Human Pathway using Wearable Measurement System.* **Makoto Nakayoshi**, Tokyo Univ. of Science, Noda, Chiba, Japan; M. Kanda, R. D. Dear

8:00 A.M.–10:00 A.M.
Session 9B: AGRICULTURAL BIOMETEOROLOGY I –*Salon III*

Chair(s): Christina Koppe, Deutscher Wetterdienst, Offenbach, Germany

8:00 A.M.
9B.1 *Biometeorological characterization of agro-environments under varying climatic conditions in Haryana, India.* **Surender Singh**, CCS Haryana Agricultural Univ., Hisar, Haryana, India; D. Singh

8:15 A.M.
9B.2 *Utilization of SEBAL Algorithm and Landsat8 Data for Estimation of Evapotranspiration–A Case Study: Tatra Mountains Region.* **Ayad Ali Faris**, Univ. of Mustansiriyah, Baghdad, Iraq; A. H. Al Sulttani, A. Jarociñska III, A. Ochtyra IV, A. Marcinkowska V

8:30 A.M.
9B.3 *Interactive Effects of Elevated CO2 Concentration and Irrigation on Photosynthetic Parameters and Yield of Maize in Northeast China.* **Fanchao Meng**, Chinese Academy of Meteorological Sciences, Beijing, China; J. Zhang

8:45 A.M.
9B.4 *Prediction of rice yield with DSSAT crop simulation model and multiple linear regression analysis.* **Debjani Halder**, Indian Institute of Technology, Kharagpur, India; R. K. Srivastava, D. K. Swain, R. K. Panda

9:00 A.M.
9B.5 *Durum wheat yield and protein content responses to meteorological conditions: improvement of Ceres-Wheat routine with a simplified forecasting index for early assessment.* **Simone Orlandini**, Univ. of Florence, Florence, Italy; A. Dalla Marta, F. Orlando, F. Guasconi, M. Mancini, A. Baldi

9:15 A.M.
9B.6 *Adaptation to climate change of wheat growing in South Australia: Analysis of management and breeding strategies.* **Qunying Luo**, Univ. of Technology, Sydney, NSW, Australia

8:00 A.M.–10:00 A.M.
Session 9C: THERMAL ENVIRONMENT AND HUMAN HEALTH IV –*Conference Room 1*

Chair(s): Dr. Pablo Fdez-Arroyabe, Univ. of Cantabria, Santander, Cantabria, Spain

8:00 A.M.
9C.1 *ISB Students and New Professionals Group Update & Workshop Experience.* **Jennifer K. Vanos**, Texas Tech Univ., Lubbock, TX; D. M. Hondula, S. N. Gosling

8:15 A.M.
9C.2 *Quantification of the benefit of global climate change policy for avoiding some of the effect of climate change on heat-related mortality.* **Simon N. Gosling**, Univ. of Nottingham, Nottingham, UK

8:30 A.M.
9C.3 *Wintertime associations between spatiotemporally-relative synoptic weather types and lagged cardiovascular mortality across various US climate regions.* **Cameron C. Lee**, Kent State Univ., Kent, OH

8:45 A.M.
9C.4 *Heat-Mortality Demographic Sensitivities in Los Angeles County and Potential Climate Change Impacts.* **Jennifer K. Vanos**, Texas Tech Univ., Lubbock, TX; S. C. Sheridan, A. J. Kalkstein, L. Kalkstein, D. Eisenman

9:00 A.M.
9C.5 *Heat stroke information in Japan.* **Michihiko Tonouchi**, Japan Meteorological Business Support Center, Tokyo, Japan; M. Ono

9:15 A.M.
9C.6 *Multi scenario urban climate projection for Tokyo and Osaka, Japan: An application of dynamical downscaling and urban planning.* **Asuka Suzuki-Parker**, Univ. of Tsukuba, Tsukuba, Ibaraki, Japan; H. Kusaka

9:30 A.M.
9C.7 *Evaluation of the Effectiveness of National Weather Service Heat Forecasts in North Carolina.* **Chris Fuhrmann**, Mississippi State Univ., Mississippi State, MS; C. E. Konrad II, M. Kovach

9:45 A.M.
9C.8 *Evaluating Climate Change Impacts on Human Mortality in Korean Cities: Challenges and Findings.* **Laurence Kalkstein**, Univ. of Miami, Miami, FL; S. C. Sheridan, K. R. Kim, J. S. Lee

10:30 A.M.–12:30 P.M.
Session 10A: ATMOSPHERIC EFFECTS UPON HUMAN HEALTH I –*Salon II*

Chair(s): P. Grady Dixon, Fort Hays State Univ., Hays, KS

10:30 A.M.
10A.1 *Biometeorological Distress and Influenza Epidemics on the East Coast of USA.* **Dr. Pablo Fdez-Arroyabe**, Univ. of Cantabria, Santander, Cantabria, Spain

10:45 A.M.
10A.2 *Cold Forecasting and Evaluation in Shanghai.* **Li Peng**, Shanghai Meteorological Service, Shanghai, China; Z. Mu, X. Ye

11:00 A.M.
10A.3 *Comparing Weather-Influenza Relationships in Four Cities across the Southwest United States.* **Adam J. Kalkstein**, United States Military Academy, West Point, NY

11:15 A.M.
10A.4 *Impacts of climate variability on respiratory morbidity.* **Amaury Souza**, ANL, Campo Grande, MS, Brazil; F. Aristone Sr., A. P. A. Bertossi Sr.

11:30 A.M.
10A.5 *Current and Future Impacts of Climate Change on Asthma Incidence in Kenya.* **Bethwel K. Mutai**, Univ. of Nairobi, Nairobi, Kenya; J. N. Ngaina

11:45 A.M.
10A.6 *No Association between Foehn and Daily Number of Emergency Calls or Calls to Medical Call Centers in Bavaria (Germany) – A Longitudinal Data Analysis from 2006 to 2009.* **Eva R. Wanka**, Klinikum der Univ. München, Munich, Germany; S. Hogger

12:00 A.M.
10A.7 *Night Sky Brightness in Climatic Health Resorts – Association between outdoor artificial light at night and cancer in selected communities of Bavaria, Germany.* **Katharina M. A. Gabriel**, Univ. of Bremen, Bremen, Germany; H. U. Kuechly, J. Meier, F. Falchi, M. Meyer, W. Wosniok, F. Hölker, G. Bolte

12:15 A.M.
10A.8 *Extremes in health-meteorology relationship, applied to cardiovascular diseases in Québec, Canada.* **Yohann Moanahere Chiu**, Institut National de la Recherche Scientifique, Québec, QC, Canada; F. Chebana, B. Abdous, D. Belanger

10:30 A.M.–12:30 P.M.
Session 10B: AGRICULTURAL BIOMETEOROLOGY II –*SALON III*

Chair(s): Simone Orlandini, Univ. of Florence, Firenze, Italy

10:30 A.M.
10B.1 *Impacts of climatic variables on pollinator abundance, flower blooming and yield of Apple in Kumaun, West Himalaya, Uttarakhand, India.* **Bhawana Kapkoti**, G.B. Pant Institute of Himalayan Environment and Development, Almora, Uttarakhand, India; R. K. Joshi, R. S. Rawal

10:45 A.M.
10B.2 *Historical trends in the risk of spring frost damages to fruit trees in Eastern Canada.* **Budong Qian**, Agriculture and Agri-Food Canada, Ottawa, ON, Canada; D. Neilsen, G. Bourgeois, X. Zhang

10B.3 WITHDRAWN

10B.4 WITHDRAWN

10:30 A.M.–12:30 P.M.
Session 10C: URBAN BIOCLIMATOLOGY – *CONFERENCE ROOM I*

Chair(s): David M. Hondula, Arizona State Univ., Phoenix, AZ

10:30 A.M.
10C.1 *Evaluation and adaptation of thermal stress due to climate change in traditional settlements in Taiwan.* **Shing-Ru Yang**, National Cheng Kung Univ., Tainan, Taiwan; T. P. Lin

10:45 A.M.
10C.2 *Assessment of Localized and City-Specific Urban Heating in Four North-Eastern Cities Using Spatial Synoptic Classification.* **Aaron W. Hardin**, Texas Tech Univ., Lubbock, TX; J. K. Vanos

11:00 A.M.
10C.3 *Characteristics of the neighbourhood and dwelling most strongly associated with the harmful health effects of heat in low-income areas.* **Pierre Gosselin**, INSPQ, Quebec, QC, Canada; D. Belanger, P. Valois, B. Abdous

11:15 A.M.
10C.4 *Indoor Environments and Extreme Heat Sensitive Health Outcomes in New York City, NY.* **Chris Uejio**, Florida State Univ., Tallahassee, FL; J. D. Tamerius

11:30 A.M.
10C.5 *Spatial Variation of Comfort Level in Chennai Metropolitan Area under Present and Future Climate Scenarios.* **Anushiya Jeganathan**, Anna Univ., Chennai, Tamil Nadu, India; R. Andimuthu

11:45 A.M.
10C.6 *The influence of facade properties on the canopy layer microclimate within city blocks.* **Csilla V. Gal**, Illinois Institute of Technology, Chicago, IL

12:00 A.M.
10C.7 *Analyses of Environmental Factors Affecting Change in Microclimate.* **Naoshi Kakitsuba**, Meijo Univ., Nagoya-shi, Aichi Prefecture, Japan

1:00 P.M.–2:00 P.M.
Panel Discussion 5: STUDENT AND NEW PROFESSIONALS MEETING –*CONFERENCE ROOM I*

Moderator(s): Jennifer K. Vanos, Texas Tech Univ., Lubbock, TX

2:00 P.M.–3:00 P.M.
Panel Discussion 6: PHENOLOGY COMMISSION MEETING –*CONFERENCE ROOM I*

Moderator(s): Mark D. Schwartz, Univ. of Wisconsin, Milwaukee, WI

2:00 P.M.–4:00 P.M.
Session 11A: ATMOSPHERIC EFFECTS ON HUMAN HEALTH II –*SALON II*

Chair(s): Laurence Kalkstein, Univ. of Miami, Miami, FL

2:00 P.M.
11A.1 *Perspectives on Climate Mediated Health Effects of Air Pollution.* **Naresh Kumar**, Univ. of Miami, Miami, FL

2:15 P.M.
11A.2 *The global monitoring of meteor-tropic effects: results for the region of North America and the Caribbean.* **Luis B. Lecha Estela**, Centro de Estudios y Servicios Ambientales de Villa Clara, Santa Clara, Villa Clara, Cuba

2:30 P.M.
11A.3 *Acoustic climate of selected road sectors in poland and its influence on quality of life.* **Krzysztof Blazejczyk**, Polish Academy of Sciences, Warszawa, Poland; J. Baranowski, A. Blazejczyk

2:45 P.M.
11A.4 *Weather and Cardiovascular Diseases in Quebec Using Empirical Mode Decomposition.* **Pierre Masselot**, Institut National de la Recherche Scientifique, Quebec, QC, Canada; F. Chebana, D. Belanger, B. Abdous, A. St-Hilaire, T. B. M. J. Ouarda

3:00 P.M.
11A.5 *Time Lag Analysis in Health-Weather Effects.* **Noel Petit**, Augsburg College, Minneapolis, Minnesota

3:15 P.M.
11A.6 *Investigating links between mortality and slow atmospheric variations.* **Augustin Vintzileos**, Univ. of Maryland/ESSIC/CICS-MD, Camp Springs, MD; S. C. Sheridan, C. C. Lee, J. Gottschalck, M. Halpert

2:00 P.M.–4:00 P.M.
Session 11B: DISASTERS AND HAZARDS –*SALON III*

Chair(s): Simon N. Gosling, Univ. of Nottingham, Nottingham, UK

2:00 P.M.
11B.1 *Weather-Ready Nation: Hospital Resilience in The United States.* **Wendy Marie Thomas**, NOAA/NWS, Silver Spring, MD

2:15 P.M.
11B.2 *Harvesting Twitter's tweets through Web GIS for disaster relief.* **Xiannian Chen**, West Virginia Univ., Morgantown, WV; X. Ye, G. Elmes

2:30 P.M.
11B.3 *Projecting Residential Tornado Exposure Rates Through Arc-map Digitization Techniques And The Employment of Both U.S. Census And Migration Pattern Data.* **Marius J. Paulikas**, Kent State Univ., Kent, OH

2:45 P.M.
11B.4 *Combination of multi-sensor remote sensing data for drought monitoring over Southwest China.* **Cui Hao**, Chinese Academy of Meteorological Sciences, Beijing, Beijing, China; J. Zhang

3:00 P.M.
11B.5 *A GIS-Based Flood Risk Mapping Along The Niger-Benue River Basin In Nigeria Using Watershed Approach.* **Ademola Akinbobola**, Federal Univ. of Technology, Akure, Nigeria; E. C. Okogbue, O. Olajiire

3:15 P.M.
11B.6 *Health Factors and Medical Emergency Issues of Fishing Communities of Kutubdia Island, Bangladesh.* **Munshi Khaledur Rahman**, Kent Univ., Kent, OH; T. W. Schmidlin

3:30 P.M.
11B.7 *Effects Of Environmental Degradation On Human Health In Selected Oil Communities In Delta State.* **Vincent Nduka Ojeh**, WASCAL WACS, Akure, Ondo State , Nigeria

3:45 P.M.
11B.8 *School based clustered randomised intervention trial to climate change adaptation in Bangladesh.* **Md Iqbal Kabir**, The Univ. of Newcastle, New Lambton Heights, NSW, Australia; M. B. Rahman, W. Smith, M. A. F. Lusha, A. H. Milton

4:00 P.M.–4:30 P.M.
Session 12: CLOSING CEREMONY –*SALON II*

Speaker(s): Scott C. Sheridan, Kent State Univ., Kent,OH, Mark D. Schwartz, Univ. of Wisconsin, Milwaukee,WI

Thursday, October 02

9:00 A.M.–6:00 P.M.	Optional excursion, Ohio's Amish Country- *Limited tickets available until Tuesday afternoon*

KS1.1

Assessment of changing risks caused by severe weather – roles of natural climate cycles and global warming

Welcome and Opening Session
Peter Hoeppe, Munich Re, Munich, Germany

As extreme weather events affect the core business of insurance this industry has quite early addressed potential effects of natural climate cycles and global warming on natural catastrophe hazards. Munich Re's experts have been researching loss events caused by natural hazards around the globe for 40 years. These losses are documented in the NatCatSERVICE database currently documenting more than 34,000 single events. The analyses of the NatCatSERVICE data clearly show a high interannual variability, in some regions decadal oscillations, and a long term trend to an increase in the number of natural catastrophes around the globe, with ever growing losses. The trend curve indicating the number of loss relevant natural catastrophes worldwide reveals an increase by a factor of about three within the last 35 years. As the rise in the number of natural catastrophes is predominantly attributable to weather-related events like storms and floods, with no relevant increase in geophysical events such as earthquakes, tsunamis, and volcanic eruptions, there is some justification in assuming that climatic changes in the atmosphere and global warming in particular, play a role as well. The main contribution to the upward trend of the losses caused by natural catastrophes comes from socio-economic/demographic factors such as population growth, ongoing urbanization and increasing values being exposed. Prevention measures, especially flood protection programs, on the other hand have a high potential to even reduce losses while the hazard has increased. Because of such factors influencing the loss trends a clear attribution of at least part of the effects to global warming is very difficult. There is, however, an increasing number of studies, which show significant increases in losses even after they have been normalized to the exposed values today. Looking at trends of extreme weather events and their effects, natural climate variability has to be considered. Short term oscillations such as ENSO as well as decadal oscillations in hurricane (Atlantic Multidecadal Oscillation) or typhoon activity (Pacific Decadal Oscillation) still play a dominant role on the variability of losses caused by weather extremes. As global warming will continue and most probably even accelerate in the coming decades, its contribution to increasing natural catastrophe losses will become more prominent, a projection also given by the 5th assessment report of the Intergovernmental Panel on Climate Change (IPCC 2014). There is no sensible way to interfere with natural climate oscillations influencing natural catastrophe losses. Humankind, however, still has the chance to avoid catastrophic increases of losses caused by global warming driven weather extremes by ambitious climate protection and adaptation measures.

2A.1

Health adaptation in low- and middle-income countries

Climate challenges in the developing world
Kristie L. Ebi, ClimAdapt, LLC, Los Altos, CA

Climate variability and change are exacerbating many climate-sensitive health outcomes and have the potential to affect the ability of health system institutions and organizations to maintain or improve health burdens in the context of changing climate and development patterns. While the health sector has long experience with controlling the burden of climate-sensitive health outcomes, there is limited knowledge of and experience with incorporating concerns about a changing climate into policies and programs. The first five years of implementation (2008-2013) of health adaptation projects in low- and middle-income countries were synthesized to identify lessons learned and best practices. The countries included were Barbados, Bhutan, China, Fiji, Jordan, Kenya, and Uzbekistan (in the UNDP/WHO GEF project "Piloting climate change adaptation to protect human health"); China, Jordan, and the Philippines (in the health components of the MDG Achievement Fund); and Albania, Kazakhstan, Kyrgyzstan, Macedonia, Russia, Tajikistan, and Uzbekistan (in the WHO EURO project "Protecting health from climate change: a seven-country initiative" funded by the International Climate Initiative of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety). Conclusions include: (1) Increasing resilience to the health risks of climate variability and change is likely to be achieved through longer-term, multi-faceted, and collaborative (multi-disciplinary) approaches, with supporting activities (and funding) for capacity building, knowledge communication, and monitoring and evaluation. (2) National health plans, policies, and budget processes need to explicitly incorporate the risks of current and projected climate variability and change. (3) Sufficient time and resources are needed during the development phase of adaptation proposals, to ensure that country ownership, an enabling environment, stakeholder engagement, and other conditions that facilitate project success are maximized. (4) Capacity development is needed for the full range of actors from public health and health care professionals to the general public to decision- and policy-makers within the health sector and across ministries. This includes facilitating developing methods, tools, and guidance documents to support countries as they implement adaptation programs and activities. (5) Research and development should be supported to further understanding of the health risks of climate change, including projections of risks across temporal and spatial scales, and to further understanding of the programs and activities that if implemented would facilitate avoiding, preparing for, responding to, and recovering from impacts. (6) Adaptation projects are opportunities to identify co-financing for adding mitigation components.

2A.2

The impact of climate change on global water scarcity

Climate challenges in the developing world
Simon N. Gosling, University of Nottingham, Nottingham, United Kingdom; N. W. Arnell

We present a global scale assessment of the impact of climate change on water scarcity. The Water Crowding Index (WCI) is used to calculate exposure to increases and decreases in global water scarcity across 1339 watersheds in the year 2050 under four Intergovernmental Panel on Climate Change (IPCC) 4th Assessment Report (AR4) Special Report on Emissions Scenarios (SRES) population change scenarios. To isolate the effect of climate change only, we compare water scarcity in 2050 with and without climate change respectively. Patterns of climate change from 21 Global Climate Models (GCMs) used in the Coupled Model Intercomparison Project Phase 3 multi-model dataset (CMIP3) under four SRES emissions scenarios are used to represent climate change. We find that by 2050 under the SRES A1B scenario, 0.5 to 3.1 billion people are exposed to an increase in water scarcity due to climate change (range across 21 GCMs). This represents a higher upper-estimate than previous assessments because we included more of the CMIP3 GCMs in ours. When considering the range in estimates from using all CMIP3 GCMs, a greater global population experience an increase in water scarcity due to climate change than a decrease, but this is not necessarily the case for individual GCMs. Lastly, we demonstrate that our results are robust across both the older IPCC AR4 SRES emissions scenarios with the CMIP3 GCMs, and the latest scenarios used in the IPCC AR5: the representative concentration pathways (RCPs) with the CMIP5 GCMs.

2A.3

Changing Climate: Assessment of Community and Household Preparedness in Flood Affected Areas of Lagos

Climate challenges in the developing world

Olaniyi Oluwatosin Ayobami, Coastal cities at risk(ccar) Lagos site., Ibadan, Oyo, Nigeria; O. Uchendu, E. Owoaje, K. Omode and I. Adelekan

BACKGROUND Flooding is the most common type of major disaster and a leading cause of 'natural disasters' deaths worldwide, responsible for 6.8 million deaths in the 20th century. The risks of future flood events in Lagos Nigeria are enormous considering its dense population; proximity to coastlines; increasing development of coastal areas; environmental degradation and climate change. Comprehensive disaster preparedness must be integrated and inclusive of preparedness at the community level through creation of functional groups with capacities for organization, education and linkage to national disaster management system. The study therefore assessed current community and household disaster preparedness in areas of Lagos State affected by flood disasters in the last 3years.

METHODS This was a community-based cross sectional study carried out in 6(six) Local Government Areas (LGAs)/Local Council Development Authority (LCDAs) affected by floods in Lagos State. A multi-stage sampling technique was used to select 622 households from the selected LGAs. Households of communities affected by flood from 2011 were surveyed with a semi-structured interviewer administered questionnaire and a focus group discussion (FGD) was conducted among representatives of affected communities. The questionnaire was used to obtain information on: socio-demographic information, health outcomes and household disaster preparedness using a validated modified questionnaire. The FGD guide was used explore the existing inter-relationship among households, communities, local government and non-governmental organizations towards flood disaster preparedness .Using 14 questions scored 1points each, preparedness was measured in four categories of not prepared; poorly prepared ; mildly prepared and moderately prepared.

RESULT About half (45.2%) of all households surveyed has experienced at least one disaster. 4.0% had no preparedness plan; 77.8% had poor emergency preparedness; 15.4% mildly prepared, while 2.7% of households were moderately prepared. Of all households that experienced flood disasters, 10% had any form of injury, 18.8% had at least one health symptom and 20.6% had depression with varying severity(mild, moderate, severe). Among moderately prepared households, 23.5% reported any form of injury compared to 15.6% among mildly prepared and 8.1% among poorly prepared (p=0.02). 41.7% of the moderately prepared had depression with varying severity compared to 28.6% among mildly prepared and 18% among poorly prepared (p=0.038). 35.3% of moderately prepared households reported at least one health symptom compared to 30.2% among mildly prepared households and 16.3% among poorly prepared households (p=0.03).

Analysis of the FGD showed that there is a general resignation to fate regarding disaster preparedness due to ignorance; poverty and disconnect between communities and local governments.

CONCLUSION The study revealed that adverse health outcomes of flood disaster are considerable. There is generally no adequate preparedness plan at the household and community level. However, households that reported more health outcomes from previous flood disaster experience were better prepared. Because these findings have implication for disaster risks reduction, communities must be mobilized and empowered to improve awareness and promote self-help initiatives using local resources. Also, households found to be better prepared can be engaged as community change agents to incorporate lessons from previous disaster incidents into future preparedness plans.

2A.4

CLIMATE CHANGE ADAPTATION IN EAST AFRICA AND ITS CHALLENGES A CASE OF UGANDA

Climate challenges in the developing world

Gerald Ssengendo, NOAA/CAC, Kampala, Uganda

The world's climate is changing and will continue to change in the coming century at rates projected to be unprecedented in recent human history. The risks associated with these changes are real but highly uncertain. Societal vulnerability to the risks associated with climate change may exacerbate ongoing social and economic challenges, particularly for those parts of society dependent on resources that are sensitive to changes in climate. The main thrust of this paper is on the risk management and challenges of climate change in Uganda. It reviews the incidence of climatic change in Uganda, the vulnerability of Uganda as a nation to climate change, and the consequences of climate change in Uganda. The research design approach adopted in this work is the survey research technique. The findings provided the following insights: first, that industrial releases, deforestation, improper sewage disposals are human activities responsible for climate change; secondly, that flooding, drought, erosion, make up the challenges resulting from climate change, and lastly that government/agencies in charge do not really help to reduce the risk associated with climate change in Uganda. Based on findings obtained, it can be concluded that bush burning, over grazing, gas flaring, CO2 are responsible for Uganda climate change while creation of environmental/climate refugees , threats to the future of children, reduction in economic growth, Increases in diseases, immediate setback on agriculture, loss of biodiversity are some of the challenges as a result of change in climate. Essentially, Ugandan Government should provide solutions to manage the associated risk with climate Change in Uganda like, afforestation program, good policies, development of biotechnology, integrated climate risk management, and technology that can capture at least 80% of carbon emitted by industries

2A.5

CHANGING CLIMATIC PARAMETER AND ITS EFFECT ON THE SOCIO-ECONOMY OF WESTERN RAJASTHAN

Climate challenges in the developing world

naveen Kumar bohra, SUNY, JODHPUR, India

2B.1

Neighborhood walkability, behavior and health and possible implications toward improving the urban environment

Modification of the Built Environment

Jose Szapocznik, University of Miami, Miami, FL

The physical environment built for human use such as neighborhood, city and suburb designs has been found to have an impact on human health. Qualities such as four way intersections, placing in close proximity places we live (residential), work (e.g., office) and play (e.g., retail, parks), moderate

residential density, and pedestrian infrastructure (sidewalks, cover from weather), impact our likelihood of walking or driving. Walking is the most common type of physical activity in which Americans engage. Walking is predicted by what has come to be known as “walkable built environments” found in small traditional towns and mixed use urban cores. On the other hand, less walkable environments such as suburbs are associated with increased car use. Walking contributes to lower Body Mass Index, lower body weight and less chronic diseases. In contrast, non-walkable built environments are associated with less likelihood for walking and greater driving, particularly in communities with poor public transportation systems. The number of minutes we drive per day is directly related to our weight. Hence, the nation's and perhaps the world's most pervasive epidemic, overweight and obesity, is linked in the U.S. to whether we walk or drive, which in turn is linked to whether we live in walkable or non-walkable built environments. In addition, non-walkable environments that require driving to nearby and far destinations, confront the individual with much greater stress due to congested roads and long commutes. Greater stress is both a risk factor for overweight and obesity as well as for mental health challenges. Our program of research has documented the beneficial effects of mixed use at the block level with children's conduct problems at school, of the ability of elders to make eye contact between pedestrians and residents with better physical functioning, of the impact of walkability of the built environment in contributing to the Hispanic Paradox (Hispanics become less healthy as they spend more time in the US), in our case, as a result of living in less-walkable built environments. More recently our research has demonstrated that walkability of the built environment predicts a range of obesity related disorders such as diabetes among Medicare recipients, suggesting that increasing walkability of the neighborhoods in which Medicare recipients live can lower burden of illness of Medicare recipients and possibly health care costs for this population. What if we could lower rapidly growing Medicare costs – which threaten the economic well-being of our nation -- by improving the walkability of our neighborhoods? The findings in the impact of walkable environments on psychosocial and physical health may comprise yet one more argument for creating pedestrian vs. car dominated environments. Arguments about reducing our carbon footprint -- by reducing car use – because of its impact on upper respiratory diseases and climate change can be supplemented by the more immediate and urgent need to target the nation's and the world's obesity epidemic. In the United States one third of the population is overweight and another one third is obese. While the proportion of overweight has not changed dramatically in over half a century, the proportion of obese individuals has nearly tripled in this period of time. What is most remarkable about the interventions required to improve walkability, walking and health is that they do not require an outlay of governmental funds, but rather political will. Zoning, or re-zoning of communities can transform them over time from non-walkable to more walkable. In Miami, for example, a place that historically has been considered as “must have a car”, now fully one third of residents of the Brickell downtown community do not own cars, in large part because of the easy access to rapid public transit and local amenities. Miami 21 is an initiative that rezoned the city of Miami as a walkable community, supported in part by our research and led by one of our co-investigators. Public health scientists and bioclimatologists have a common cause! Not only are the objectives of this research important in lessening trace gases and other factors that can contribute to climate change and diminished air quality, a good working knowledge of neighborhood walkability can help bioclimatologists control more efficiently for certain social-behavioral factors that might reduce or exacerbate extreme weather/human health outcomes.

2B.2

A socio-spatial vulnerability model of the Urban Heat Island: exposure, sensitivity and health impacts of high temperatures

Modification of the Built Environment

Juan Declet-Barreto, Natural Resources Defense Council, Washington, DC; S. L. Harlan, D. B. Petitti and B. L. Ruddell

Urban Heat Islands in cities are increasing human vulnerability to rising temperatures already elevated due to global climate change. Vulnerability to extreme heat exists along a socio-spatially differentiated spectrum of exposure, sensitivity, and coping capacity that can mitigate or exacerbate the impacts of extreme heat. In this research, we assess the role of exposure and sensitivity in shaping human vulnerability to extreme heat by answering two research questions:1) How do exposure and sensitivity to extreme heat vary spatially according to socio-economic and built environment conditions in residential neighborhoods in an urbanized area, and 2) what are the effects of exposure and sensitivity to high temperatures on heat-related hospitalization rates in different types of neighborhoods? We construct and map a predictive index of sensitivity to heat health risks for neighborhoods in Maricopa County, Arizona, compare predicted neighborhood sensitivity to heat-related hospitalization rates, and estimate relative risk of hospitalizations for neighborhoods with different sensitivity profiles. Our results indicate that hospitalization rates increase exponentially beyond a threshold of 32 degrees C, and that for each 1 degree C > 32, there is a 21 percent increase in hospitalizations. Sensitivity to heat significantly affects heat-related hospitalizations: Compared with low-sensitivity groups, individuals living in neighborhoods with medium heat sensitivity are almost twice as likely to be hospitalized due to heat, while those in high sensitivity neighborhoods are almost four times as likely to be hospitalized. Two distinct sub-populations are found to be most sensitive to heat hazards: low-income, ethnic minorities in sparsely-vegetated urban core neighborhoods, and elderly people in retirement communities in the suburban fringe.

2B.3

A ‘green sol-air' temperature to estimate the radiation effect of ground cover vegetation on pedestrian thermal comfort in hot climates

Modification of the Built Environment

Evyatar Erell, Ben Gurion University of the Negev, Midreshet Ben Gurion, Israel; T. Williamson

Pedestrians' thermal sensation is affected by exchange of energy with their surroundings, mainly through radiation and convection. Ground-cover vegetation can have an important influence on this energy exchange. However, not all plants are the same, and although most plants have a similar albedo, water-efficient plants such as succulents may have substantially higher daytime temperature than grass or broad leafed species. Modelling pedestrian comfort thus requires a means of characterizing different plants and their effect not only on air temperature and moisture, but most importantly on radiant exchange.

The study proposes a new method for estimating the surface temperature of surface cover plants such as grass, creepers and succulents that is based on an adaptation of the sol-air temperature. The ‘sol-air temperature' offers a close approximation of the actual surface temperature and is defined as “the equivalent outdoor temperature which will cause the same rate of heat flow at

the surface and the same temperature distribution throughout the material as results from the outdoor air temperature and the net radiation exchange between the surface and its environment".

The 'green sol-air temperature' introduced here adds the effect of evapotranspiration:

$$T_{sol} = T_a + \frac{\Delta R}{h_c} + \frac{\Delta M}{h_v}$$

where T_a is air temperature, ΔR and ΔM are net radiant exchange and net mass transfer (evaporation or condensation) respectively, and h_c and h_v are surface transfer coefficients for heat and water vapor. The third term on the RHS of the equation is added to the first and second terms that were part of the previous formulation. ΔR is the sum of the net shortwave component $\alpha K\downarrow$ and the net long wave radiation $\varepsilon_s L^*$, where $K\downarrow$ is incident solar radiation, α is absorptivity, ε_s is the emissivity of the surface and L^* is the net long wave radiation. ΔM is given by $\rho\lambda(q^*)/(R_{aV}-R_s)$ where ρ is air density, λ is the latent heat of vaporization of water, q^* is the vapor pressure deficit and R_{aV} and R_s are the aerodynamic and stomatal resistances of the plant canopy. h_c and h_v are functions of air speed at the surface, and are assumed to be approximately equal. The model in this form is applicable to ground vegetation that covers the entire area of soil.

The 'green sol-air' is derived from a simple, single layer model with one effective surface, similar to so-called 'giant leaf' models used in large-scale climate models. It is suitable for dry foliage, and ignores both physical and chemical heat storage, as well as heat and mass transfer processes within the canopy.

The utility of the model was tested by comparing the predicted green sol-air temperature for different ground cover plant types, as well as dry bare soil and asphalt, with surface temperatures of the respective plants obtained (separately) by infra-red thermography. The ground cover plants, which were chosen according to their compatibility to arid conditions and their potential for rapid growth and year-round appearance, displayed a wide range of temperatures in sunny conditions, providing a good test of the model as well as indication of its importance.

For example: On a typical clear day with global solar radiation reaching a maximum of 970 Wm^{-2}, the average surface temperatures of all vegetated plots were higher than air dry bulb temperature, but considerably lower than those of the non-vegetated surfaces. The temperatures of the three CAM-type succulent plants (malephora, aptenia and drosanthemum) were higher than the leafy plants (kikuyu grass, lippia and convolvulus) by approximately 10°C at midday, with all three succulents reaching temperatures above 45°C, compared with an air temperature of 31°C. Bare ground temperature was some 15°C warmer still, reaching almost 60°C.

Using meteorological parameters obtained from a weather station about 1 km. away, and introducing appropriate values of Rs, the error in estimated surface temperature during the daytime hours over three measuring periods for all plant types was less than 2°C.

The effect on pedestrian thermal comfort of ground cover plants is manifested to a great extent through modification of the mean radiant temperature (Tmrt). This may be illustrated in the case of a pedestrian standing in a hypothetical open space at 30N latitude with a sky view factor of '1' and a ground surface an albedo of 0.25. On June 22, assuming a solar flux of 750 Wm^{-2} and an incoming IR flux of 315 Wm^{-2}, the difference in Tmrt impacting on a pedestrian due to an increase in surface temperature of 10 C (grass at 35°C to succulents at 45°C) would be over 4 degrees (from 44.4 to 49.1°C). For a wind speed of 1 ms^{-1} and RH=50%, this translates into a change of the UTCI from 34.0 to 35.2 degrees.

A change of this order in the UTCI value does not change the classification, which in this case remains 'strong heat stress'. However, it adds to the uncertainty in estimating other components of the radiant balance, and users of the Index should be provided with a means of incorporating the effect of plants in their calculations. In the conditions illustrated, a paved surface with a similar albedo (0.25) would have a surface temperature of about 60°C, giving Tmrt=61°C and UTCI=38.2. A difference of over 4 degrees compared to a similar grassy surface is too large to ignore.

2B.4

Aging Buildings and Aging Communities: How to Adapt to the Changing Climate?

Modification of the Built Environment
Pravin Bhiwapurkar, University, Kent, OH

The role of the existing buildings during changing climatic conditions is investigated to explore the relationship between warming trends and thermal zones in buildings. Zones sensitive to outside temperature changes are most critical for aging community due to varying daily as well as seasonal intensity of its thermal conditions. A combination of aging buildings and aging community is considered disastrous in warming climatic conditions due to increased external as well as increasing internal heat gains.

PROBLEM STATEMENT Dense urban environments and expanding boundaries with increased use of air conditioners in buildings are commonly studied features related to the urban climate change, provides foundation for this study on its implications for the aging community. Majority of the buildings are part of the urban area creating warmer conditions than countryside and power outage during hottest days is not very uncommon. Chicago heat wave underlines social segregation in urban planning, socio-cultural aspects of the community, and power (outage) connection in the heat related mortalities among aging community. This paper focuses on mixed-use development in dense urban environment to identify most suitable location for aging community with minimal thermal variations.

Majority of the existing buildings comply with the energy codes applicable at the time of its construction. Energy codes suggest most appropriate building envelope, lighting, and HVAC in relation to specific climatic zones identified by ASHRAE. Heating and cooling degree days primarily distinguishes climatic zones from one another which is changing at rapid rate since buildings are built, more frequently in recent years though. Building envelope; wall, roof, and glazing properties are crucial for balancing internal and external climatic conditions for reduced heating and cooling loads inside the thermal zone. However, existing buildings shows degradation of envelope thermal properties and increased infiltration rate due to cracks and leaks, which increases energy needs, particularly critical during summer months.

Building enclosures can exacerbate temperature within thermal zones and it varies per building type, shape, materials and inside activities. If 90% of the time indoor environment is occupied then such high percentage of occupancy makes the role of buildings critical, particularly for aging/elderly community. This study investigates sensitivity of outdoor temperature increase and infiltration rate on balanced thermal conditions during representative days of summer, fall, winter and spring. Increased dependency on air conditioning system in buildings to deal with warming climate not only

increases building energy consumption but also adds significant amount of anthropogenic heat to the immediate environment. In particular, thermal zones on southern side are most sensitive to outdoor climatic conditions and it is hypothesized that elderly occupancy in such zones are particularly susceptible to external warming trends. Most heat related studies in the literature reports increased outdoor temperature over normal temperature however; its impact on buildings and its thermal zones is less studied for aging community, is highlighted of this paper.

METHODS AND MATERIAL This investigation is made possible by whole building energy simulation approach. This approach provides an opportunity for in-depth investigations of balanced thermal conditions on hourly basis through the year as it allows for variation in key parameters to be tested. Towards this, a hypothetical but representative experimental model of a 10-storied building is developed for ASHRAE Cold Climatic Zone 5 (represents Chicago, Heating Degree Days over 5500-7500 and Cooling Degree Days less than 2000) that follows ASHRAE 90.1 Energy Standard for Building except Low-Rise Residential Buildings (2004) as a baseline. The project follows a simplified “perimeter and core” type thermal zoning pattern on each floor to study sensitivity of the zone per orientation in this study. Further, these zone are categorized at three levels; lower level (floor 1), mid-level (floor 2-9), and top level (floor 10) to account for ground level conductive heat transfer and radiative roof exposure. A Typical Meteorological Year, TMY-2 (averaged for 1961-1990), weather file is used for estimation of thermal loads for this study.

Comparison Method Thermal conditions of each thermal zone will be compared at Floor Level and Building Level. In addition, to account for variation in changing climatic conditions previous comparison will be repeated using TMY-3 (averaged for 1976-2005) weather file.

The Floor Level comparison includes five thermal zones (4-perimeter and a core) and is studied for hourly temperature in relation to the outdoor temperature to understand influences of the orientation influences. The most sensitive thermal zone with highest variation and intensity is selected for the Building Level comparison. At this stage, sensitive thermal zone located at three levels is compared to understand the role of location of thermal zone in the building. These comparisons will be iterated using TMY-3 weather file to understand changes in climatic conditions and its influences on thermal conditions in the building.

RESULTS: The results of this study will be presented in three categories as well. Floor level results will show hourly thermal zone temperature comparison for North, South, East, West and Central Zone. Four representative days of summer, fall, winter and fall will be selected for hourly temperature analysis. The Building Level results will present comparative South Zone temperatures at lower, mid, and top levels. These results will be followed by comparative thermal zone temperature using TMY-3 weather file over TMY-2 weather file. The variation and intensity of thermal changes will be analyzed and discussed in relation to aging process and the role existing can play. OUTCOME: The outcome of this investigation provides insights on revitalization of existing communities and buildings in particular with special emphasis on thermally active occupancy areas. The quantified temperature data to inform preparatory actions for heat related vulnerability within existing buildings.

2C.1

Alarmingly Rising Particulate Matters and Noxious Gases in the Aerosol are the Cardinal Causes of Immeasurable Deaths in India

Aerobiology and air pollution
Pritanshu Malik, Maharishi Markandeshwar University, Ambala, Haryana, India; D. A. K. Gupta

Rapid, uncontrolled urban growth in Africa, Latin America and Asia has contributed to ecosystem degradation and increased pollution, with consequent serious health impacts such as carcinogenesis, myocardium infarction, damage to the immune system, as well as neurological, reproductive (e.g., reduced fertility), developmental, respiratory and other health problems. According to WHO, Yale University and World Bank, air in Delhi is most foul in the world. India is one of the countries encumbered with highest particulate matter (PM10 and PM2.5). A report of the year 2010 from Central Pollution Control Board (CPCB), New Delhi says that PM10 in Delhi touches value of 748 µg/m3. Small and mid-sized towns, above and below one million population size, in the country are equally polluted now. It was recorded that several towns are having PM10 in the range of 523 µg/m3 against the Ambient Air Quality Standards 60 µg/m3 which is alarmingly 10 times higher than the standard value. Thirteen of the world's 20 most-polluted cities are in India, and three in Punjab including Khanna Asia's biggest grain market and Ludhiana an industrial hub. Clearly, in India there is a wider apathy towards the issue of environment. Major sources of pollutants in Indian air are rampant vehicular pollution, highly toxic gases emitting from industries, gargantuan burning of agricultural waste in millions of acres of lands and burning of municipal solid wastes in terms of several hundred thousands of metric tons. In addition, non-point sources such as domestic waste burning, construction activities, and roadside air borne dust due to vehicular movement and adulteration in fuels also contribute to the total emission load. Previously limited to metropolitan cities, traffic congestion and aerosols are now disseminated to even small cities and towns.

In the last three decades, the number of motorized vehicles in India has increased 29 times from 1.9 million in 1971 to 55 million in 2001. The increase was not uniform for all vehicle types; it was 7-fold for buses, 9-fold for trucks, 10-fold for cars, jeeps and taxis but 67-fold for two wheeler. The air pollution emanate from the incomplete combustion of automobiles mainly from the diesel exhaust. During the last decade, the annual consumption of diesel in India was 38,000 tons against 6,640 tons of petrol. It is estimated that at the end of the present decade, the annual consumption could rise to 78 million tons in 2021. Diesel exhaust consists of a complex mixture of chemicals which contain known carcinogenic agents including benzene, arsenic, dioxins, formaldehyde and toluene. Benzene and dioxins are the top concern. Benzene is one of the primary air pollutants contributing to added individual cancer risk. Benzene is emitted in vehicle exhausts not only as incompletely burnt fuel but also as a product of the decomposition of other aromatic compounds. Dioxins continue to release in the environment by the combustion of diesel in automobiles and carelessly burning of municipal solid waste. The average emission of dioxins in India by the automobiles only accounts for 38000 MT per year approximately. Nationally, mobile sources account for 57% of estimated benzene concentrations. The annual average benzene emission adopted as standard is 5 µg per cubic meter but the actual emission has reached at an alarming stage in metropolitan cities. The daily average levels reach alarming heights of more than 100 µg per cubic meter in Bangalore, close to 55 µg cubic meters, 35 µg per cubic meter in Delhi and 50 µg per cubic meter in Kolkata. If these carcinogens continue to release in the environment, then in the coming years, they can reach at uncontrollable levels causing cancer cases in every house. And also the noticeable fact is that these kinds of carcinogens released by diesel exhaust remain at lower level of breathing zone which is inhaled by humans. According to estimate, lifetime exposure to diesel exhaust at the outdoor average concentration (2.2µg/m3) may result in about one in every 2,000 people developing cancer due to this exposure. The risk is even higher for those living near highly polluted urban communities. The short and long-term exposures to these toxic gases have also been linked with premature mortality and reduced life expectancy. It is visualized that if this trend of rise in carcinogens is not controlled, it will cross the permissible limit and once it crosses the limit it shall be beyond control. The World Health Organization (WHO) estimates that "fine particulate air pollution (PM 2.5), causes mortality from cardiopulmonary diseases, cancer of the trachea,

bronchus, lungs and acute respiratory infections in children under 5 yr. Its vexatious that heart related disorders will kill almost 20 million people by 2015, exceptionally prevalent in the Indian sub-continent. According to Global Burden of Diseases air pollution is the fifth largest cause of death in India.

Indian government has enacted several laws for protection of environment and fragile ecosystem, viz. Environment (Protection) Act, 1986, Environment (Protection) Rule, 1986, The Air (Prevention and Control of Pollution) Act, 1981and Rule 1982, Ozone Depleting Substances (Regulation and Control) Rules, 2000, Municipal Solid Wastes (Management and Handling) Rules 2000. If country does not get alert and pro-active it would lead to inevitable threat to its denizens and even to developing countries in its neighborhood.

2C.2

Significant Associations between Meteorological and Air Quality Parameters and the Daily Number of Emergency Calls because of Breathing Difficulties in Graz (Austria) – A Time Series Analysis from 2001 to 2009

Aerobiology and air pollution
Eva R. Wanka, Klinikum der Universität München, Munich, Germany; L. Kutschenreuter, S. Seng, R. A. Jörres and S. Budweiser

On the one hand, meteorological conditions influence the human body directly, but on the other hand, they have an indirect effect, because sources and spatial distribution of air pollutants in the atmosphere depend on those conditions. A great number of studies documented an association between different environmental factors and the daily number of emergency calls due to a variety of diseases.

In this study we analyzed the pattern of the relations between the environmental factors and the daily frequency of emergency ambulance calls in Graz (Austria) during the period from January 2001 to December 2009. The analysis was performed for emergency calls with focus on breathing difficulties. In addition to the identification of environmental predictors the aim of the study was to assess whether the relationship was linear or nonlinear.

Data and Methods: To describe the morbidity of patients with breathing difficulties, we analyzed the correspondent cases of emergencies (provided by the Medical University of Graz, Austria, G. Prause) which were diagnosed by the emergency physician. Diseases were coded according to the international classification of diseases (10th version; ICD10). For data analysis we used the disease considered as the subject's major disorder which was coded as first or second diagnose and included all cases of asthma, chronic obstructive pulmonary disease (COPD), pneumonia, bronchitis, acute spasmodic laryngitis, epiglottitis and other reasons of dyspnea.

The environmental data were provided by the meteorological measurement station of the University of Graz (IGAM, E. Putz), Austria. Daily mean values of temperature, air pressure and relative humidity as well as particulate matter (PM10), ozone, nitrogen monoxide and dioxide were used, either as values at the day of emergency call and with time lags of up to three days for meteorological parameters and up to seven days for air pollutants. All data sets were available for January 2001 to December 2009.

To account for the expected large influence of anthropogenic and social factors, a number of formal variables such as the day of the week, public and school holidays, and season were included as covariates.

After descriptive analyses two different kinds of variable selection procedures were performed to select variables with statistically significant relationship to emergency calls due to breathing difficulties. Using generalized additive models (GAMs) as well as distributed-lag nonlinear models it was checked, whether these variables had a linear or nonlinear impact on the emergency frequency in the observation period. All statistical analyses were performed in R (version 2.8.0) using different packages.

Results: In total, about 14,300 calls to the emergency ambulance were available of which only 520 were due to breathing difficulties diagnosed by an emergency physician.

The variable selections and the regression analyses identified relative humidity, PM10 and nitrogen dioxide as significant predictors for the daily number of emergency calls because of airway diseases.

Not only the values of these parameters of the actual day had a significant association to the selected emergency calls but also different time lags: relative humidity 2 days before, 5-day lagged values of PM10 and 3, 6 and 7 days before the actual day of nitrogen dioxide.

The results of the GAM indicated that only 2-day lagged values of relative humidity and values of three days before the actual day of nitrogen dioxide had a linear relation to the outcome variable. The other significant predictors had a nonlinear relation to the emergency calls because of airway diseases. Thus, the associations with these environmental predictors had to be described by functions involving more than two parameters.

Conclusion: The results indicate that several environmental parameters had an impact on the daily number of emergency calls due to breathing difficulties in Graz (Austria) as derived from a data set covering the period from 2001 to 2009. The effects of the meteorological predictors were considerably smaller than those of air pollutants. The results of this study are in accordance to other studies which analyzed hospitalizations instead of emergency calls.

2C.3

Influence of meteorological factors on the occurrence of airborne fungal spores in Nsukka zone, Enugu State, Nigeria

Aerobiology and air pollution
Reginald C. Njokuocha, Botanical Society of Nigeria, Enugu, Nigeria; C. E. A. Okezie

Airborne fungal spore concentrations vary considerably over time and location and that was the case in this investigation. Studies on airborne fungal spores and associated allergies in Nigeria are few, and are limited to some urban areas and cities. The main aims of the study were to identified as far as possible and to correlate the fungal spore concentrations with meteorological factors in Nsukka zone, Enugu State, Nigeria during March, 2005 and February, 2006. The study was conducted with the gravitational samplers of Tauber's trap at six locations. Analysis of variance showed that there were very highly significant differences in the mean quantity of fungal spores recorded monthly and between the study locations. Some correlations were found between the spore types and meteorological factors such as temperature, relative humidity, rainfall, light intensity and wind speed. A total of 84 four fungal spore types were identified at generic levels. This by no means

represents the total number of fungi recorded because the unidentified ones were grouped under "fungal spores". The most predominant fungal spore types identified were Nigrospora, Ustilago, Pithomyces, Curvularia, Endophragmiella, Corynespora and Botryodiplodia. The spore types were distinguished into dry and wet airspora. The members of the Deuteromycetes constituted over 60 % of the fungal spore types identified. Some of the fungal spores identified have notable impact on humans.

2C.4

Pollen allergy and variability in seasonal exposure in Australia

Aerobiology and air pollution
Paul J. Beggs, Macquarie University, Sydney, New South Wales, Australia; J. M. Davies

Allergic asthma and allergic rhinitis are important chronic diseases and public health issues in Australia, and elsewhere. Pollen are significant sources of clinically relevant outdoor aeroallergens. This presentation will describe research conducted by a working group that formed in 2013 with the support of the Australian Centre for Ecological Analysis and Synthesis (ACEAS), a virtual and physical facility within the Australian Terrestrial Ecosystem Research Network (TERN). This research provides a national, and indeed international, perspective on the state of Australian pollen monitoring and data. Atmospheric grass pollen concentration is examined over a number of years for Brisbane, Canberra, Darwin, Hobart, Melbourne, and Sydney, including determination of the "clinical" pollen season and pollen peak. The results of this study describe, for the first time, a striking spatial and temporal variability in grass pollen seasons in Australia, with important implications for clinicians and public health professionals, and the Australian pollen-allergic community. Establishment of an Australian national pollen monitoring network would help facilitate advances in the clinical and public health management of the millions of Australians with allergic asthma and allergic rhinitis.

2C.5

Aerobiology of Juniperus Pollen in Oklahoma, Texas, and New Mexico

Aerobiology and air pollution
Estelle Levetin, University of Tulsa, Tulsa, OK; P. Van de Water, L. Bunderson and J. Luvall

Background: Pollen from members of the Cupressaceae are major aeroallergens in many parts of the world. In the south central and southwest United States, Juniperus pollen is the most important member of this family with J. ashei (JA) responsible for severe winter allergy symptoms in Texas and Oklahoma. In New Mexico, pollen from J. monosperma (JM) and other Juniperus species are important contributors to spring allergies, while J. pinchotii (JP) pollinates in the fall affecting sensitive individuals in west Texas, southwest Oklahoma and eastern New Mexico. Throughout this region, JA, JM, and JP occur in dense woodland populations. Generally monitoring for airborne allergens is conducted in urban areas, although the source for tree pollen may be forested areas distant from the sampling sites. Improved pollen forecasts require a better understanding of pollen production at the source. The current study was undertaken to examine the aerobiology of several Juniperus species at their source areas for the development of new pollen forecasting initiatives.

Methods: Burkard volumetric samplers were established at six Texas or Oklahoma woodland sites for two winter seasons (2009-2010 and 2010-2011) to monitor JA pollen and for two fall seasons (2010 and 2011) to monitor JP pollen. In New Mexico samplers were established at six sites for two spring seasons (2010 and 2011) for JM and other Juniperus pollen. In addition, on-going sampling at the University of Tulsa provided data for local J. virginiana (JV) pollen as well as evidence of long distance transport of JA and JP. Standard methods were used for the preparation and analysis of Burkard slides. Season start date was defined as 1% of the cumulative season total and end date as 99% of total. Meteorological data were obtained from the NWS stations close to each sampling site and the Oklahoma Mesonet. Wind trajectories were calculated using NOAA HYPSLIT dispersion model.

Results: Pollen concentrations varied greatly across all sampling locations for each species and for each season. For JA the highest seasonal pollen concentrations occurred during the 2009-2010 season at Junction, Texas with the mean seasonal concentration of 1,285 pollen/m3 and the lowest was during the 2010-2011 season at Sonora, Texas with a mean of 484 pollen/m3. The highest single day concentration for JA (18,073 pollen/m3) was recorded at Junction on 18 Jan 2010, and the peak hour during that day was 70,367 pollen/m3. In New Mexico, the highest seasonal pollen concentration was registered at Santa Fe in 2010 with a seasonal mean of 1,647 pollen/m3 and the lowest seasonal concentration was recorded at Mountainair in 2011 with a mean of 39 pollen/m3. The peak one-day concentration (16,171 pollen/m3) was recorded at Santa Fe on 30 Mar 2010 with the peak hourly concentration of 52,198 pollen/m3. For JP the highest seasonal concentration was observed at Quanah, Texas with 4,463 pollen/m3 in 2010, while the lowest occurred at Erick, Oklahoma in 2011 with a seasonal concentration of 18 pollen/m3. The peak one-day concentration of JP (25,758 pollen/m3) occurred on 18 Oct 2010 at Quanah, Texas with the peak hourly concentration of 67,160 pollen/m3. The extreme heat and drought in Texas and Oklahoma during the summer of 2011 resulted in significantly lower concentrations of JP pollen during 2011 at all locations. In Tulsa *Juniperus* pollen was present in the atmosphere for 7 months each year. Local JV pollen was registered from February through April. The mean seasonal concentrations were 169 pollen/m3 in 2010 and 92 pollen/m3 in 2011. Peak concentrations these years were 1,900 and 1,564 pollen/m3, respectively. In addition, incursions of JA pollen were present during December and January and incursions of JP pollen were registered in October and November. Forward HYSPLIT trajectories from the woodland sampling locations and backward trajectories from Tulsa for the periods of these incursions confirm the source areas and *Juniperus* species.

Conclusions: Very high concentrations of *Juniperus* pollen were recorded in natural populations of JA, JM, and JP. Sampling in Tulsa confirmed the incursions of JA and JP pollen proving that woodland populations of allergenic plants are an important source of pollen that can impact sensitive individuals at downwind locations. Improved pollen forecasting is needed to consider local, regional, and distant sources of airborne pollen. The data collected during this study will contribute to the development of these forecasting models.

2C.6

A phenological model of pollen emissions for climate models

Aerobiology and air pollution
Allison L. Steiner, University of Michigan, Ann Arbor, MI

To understand the climatic relevance of pollen in the atmosphere, a prognostic model of pollen emissions for interactive input into climate models is needed. We use modern surface pollen count data to develop a model that can simulate pollen count over the seasonal cycle based on geography, vegetation type and meteorological parameters such as temperature, solar radiation, and wind speed. Analysis of pollen data from 2003-2010 suggests that latitude is a strong driver for the start day of year, with event duration controlled by temperature. This provides evidence that observed data can be used to develop a pollen emissions model that predicts pollen on interannual climate

timescales. These emissions will be provided as input data to climate models and allow assessment of the direct and indirect effects of pollen on the atmosphere for present-day and potentially paleoclimate studies.

2D.2

Trends of apparent temperature in Australia

Climate and extreme event trends
Stephanie J. Jacobs, Monash University, Clayton, Victoria, Australia; A. B. Pezza

This study compares historical and future temperature and apparent temperature trends across Australia. Observational weather station data from ten chosen urban locations show that eight have annual average warming trends in temperature and/or the apparent temperature (up to 0.4°C per decade) over the second half of the twentieth century. Trends are explored spatially using high resolution ERA Interim reanalysis, revealing that in the continental interior the apparent temperature is warming faster than the temperature, by up to 0.2°C per decade. Therefore, over much of Australia's desert interior, it has been feeling warmer than would be expected. Future trends were explored using high resolution CMIP3 model data. A best practice model for the Australian climate was used as well as best case and worst case scenario models selected using the CSIRO Representative Climate Futures framework. It was found that at 2070 using the A1B emissions scenario the temperature is projected to warm faster than the apparent temperature by up to 1°C in central Australia. Projected increases in wind speed and drying across central Australia, partially offset the thermal comfort impacts of global warming. 18.139.66.39 on 5-22-2014-->

2D.3

Climate Change and Extreme Weather Events at Local Scale over Canada

Climate and extreme event trends
Chad Shouquan Cheng, Environment Canada, Toronto, ON, Canada

The weather typing method has been successfully applied for several research projects to analyze climatic change impacts on a number of extreme weather events, such as freezing rain, heavy rainfall, high-/low-streamflow, wind gust events, air pollution, and human health. These studies comprise of three major parts: (1) historical simulation modeling to verify the extreme weather events, (2) statistical downscaling to provide station-scale future hourly/daily climate scenarios, and (3) projections of changes in frequency and intensity of future extreme weather events late this century. To achieve these goals, in addition to synoptic weather typing, the modeling conceptualizations in meteorology and hydrology and a number of linear/nonlinear regression techniques were applied. Furthermore, a formal model result verification process has been built into each of the three parts of the projects. The results of the verification, based on historical observations of the outcome variables predicted by the models, showed very good agreement. The modeled results from these projects found that the frequency and intensity of future extreme weather events are projected to significantly increase under a changing climate late this century.

This talk will introduce these research projects and outline the modeling exercise and resulting verification process. The major findings on future projections from the studies will be summarized in the presentation as well. One of the major conclusions from the studies is that the procedures used in the studies are useful for climate change impact analysis on future extreme weather events. The implication of the significant increases in frequency and intensity of future extreme weather events would be useful to be considered when revising engineering infrastructure design standards and developing adaptation strategies and policies.

2D.4

Determining Synoptic Air Mass Modifications for Advance Health-Effect Preparedness

Climate and extreme event trends
Daniel J. Vecellio, Texas Tech University, Lubbock, TX; J. K. Vanos and D. M. Hondula

As air masses move through the atmosphere, they inherit the characteristics of both the ambient air that they move through, as well as the properties of the surface they advect over. Due to the motion of said air masses, they become modified, both in temperature and moisture content. It is advantageous to trace how these air masses are modified spatially and temporally from their sources, as specific air masses have been found to be detrimental to human health with respect to the season. The goal of this project was to develop the methodology to create an automated model that will incorporate specific upper and lower level meteorological variables.

The Spatial Synoptic Classification System (SSC) will be employed to classify air masses into one of six types, plus a transition, during warm season (May-September) events. Five cities have been selected as target locations (Wilmington, DE, Raleigh-Durham, NC, Huntsville, AL, Lexington, KY and Oklahoma City, OK). These were chosen as they have readily available SSC data and are located eastward enough that air parcels will track over land for a suitable duration before ending at the target location. Using the Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model, back trajectories from these target regions will be computed from Eta Data Assimilation System (EDAS) reanalysis data. A multinomial logistical regression model was then to incorporate both upper-air variables from HYSPLIT, surface moisture characteristics, and stability metrics to better understand how and why the air masses changed along their paths from source to target. The results provide a physical narrative and discussion of the air mass modification results, and the potential for more advanced and accurate predictions of incoming of air masses.

Predictive values for air mass modification have been calculated and the study has produced the ability to somewhat accurately discern which air mass will move into a target location four days before the event's occurrence. This knowledge becomes immensely useful when forecasting for harmful air masses moving into a region. Extreme temperatures, in particular, are associated with the highest mortality numbers, which make the presence of Dry Tropical (DT) and Moist Tropical Plus (MT+, MT++) air mass types hazardous for at-risk groups such as the extremely active, the very young, and the elderly. On the other hand, Dry Polar (DP) air masses have been shown to produce spikes in morbidity (namely, influenza) and mortality in certain populations. If these hazardous air masses can be accounted for multiple days ahead of time, policy changes can be implemented to provide more advanced alerts and planning for the public, which will further protect those most at risk to the oppressive air masses from significant health consequences.

2D.5

Circulation Regimes Affiliated with Boreal Polar Marine Climate and Ecological Change

Climate and extreme event trends
Thomas J. Ballinger, Kent State University, Kent, OH; T. W. Schmidlin and D. F. Steinhoff

Polar marine climates and ecosystems are tremendously sensitive to changes in climatic conditions. In a recent study, Ballinger et al. (2013) mapped and analyzed the variability of polar marine (EM)

climates globally, adapting criteria introduced by Shear (1964) as an addendum to Köppen's polar (E) climates. One of the primary findings from Ballinger et al. was that Northern Hemisphere EM climates have been decreasing in area, accounting for the overwhelming majority of global EM area decline from 1979-2010. However, climatic factors beyond the influence of summer sea surface temperatures and winter sea ice concentration have not been analyzed in detail as it relates to the observed hemispheric EM area change. In particular, any relationship between atmospheric circulation patterns (CPs) associated with the EM changes remains to be identified. This study will build on the aforementioned research by 1) quantifying the EM area changes from 1979-2012 in the North Atlantic and North Pacific respectively, 2) analyzing any EM changes with respect to CPs and their frequency of occurrence, derived from reanalysis variables, over these regions, and 3) relating CP results to ecological productivity, or lack thereof, in the EM zones. Emphasis will be placed on interannual and low frequency variability in determining what circulation patterns, if any, influence EM climate and ecological conditions beyond the established impacts of sea surface temperature and sea ice extent variability.

2D.6

Changing climate: How it affects air travel in northern Canadian communities

Climate and extreme event trends
Andrew C.W. Leung, University of Toronto - Scarborough, Toronto, ON, Canada; W. A. Gough, T. Mohsin and K. A. Butler

Travel in northern Canadian communities is impacted by climate change. A warmer environment results in shorter operational period for ice road in winter and longer window for sealift in summer. However, isolated communities continue to rely on air travel for year-round transportation and perishable goods. Our research focused on historic changes of surface wind conditions (wind speed and wind direction) over time that may affect airport operations in communities around Hudson Bay and James Bay. Results showed that overall wind speed recorded at airports were generally increasing over time, in some cases significantly. Wind direction patterns also appeared to be changing. Variability between different seasons could be possibly affected by synoptic weather, large scale circulation patterns, and reduction of sea ice caused by accelerated warming in the region. Consequences of changing wind conditions include runway direction no longer aligning with prevailing wind direction, aircraft facing crosswind during takeoff and landing, and possibly higher chance of encountering foggy weather which could lead to more delays and higher potential for plane crashes. Suggested airport adaptation strategies will be presented in response to the changing wind conditions.

PD2.1

Public Health Science and Bioclimatology: Toward a More Efficient Collaboration

Public Health Science and Bioclimatology: Toward a More Efficient Collaboration
Laurence Kalkstein, Univ. of Miami, Miami, FL

There are numerous environment/health evaluations being pursued by both the medical community and by bioclimatologists. The groups seldom interact when they conduct their research, and thus novel methodologies, new analyses, and innovative approaches often go unshared. The goal of this workshop is to bring together researchers from both public health and bioclimatology to discuss some of the differences in research emphasis, and how the two groups can collaborate more effectively in the future. The emphasis will be on climate/health analysis, data sharing, and technology transfer. The hope is that such a session will prove most beneficial to the bioclimatologists who are attending ICB, including young professionals who will be present from both the public health and bioclimatological community.

3A.1

Application of universal thermal climate index for bioclimatic regionalization (an ex ample from Europe)

Thermal Comfort and Indices I: UTCI
Krzysztof Blazejczyk, Polish Academy of Sciences, Warszawa, Poland; A. Blazejczyk, V. Vinogradova and K. Lindner-Cendrowska

Till now several classifications were developed to present climate differentiation in regional and global scales. The classifications use various indicators of climate (e.g. air temperature, precipitation, circulation type, vegetation etc.). The general classifications describe quite well the global variability of climates based on thermal and humidity/precipitation regimes. However, they do not provide any characteristics of human bioclimate. The possible reason is that bioclimatic indices used previously in research have many limitations which caused that they can't be used in wide (regional and global) scales. The newly developed Universal Thermal Climate Index (UTCI) is valid in all climates around the world and can be applied to develop regional and global bioclimatic regionalization. The aim of the presented research is to define and analyse principal features of bioclimate in Europe and to validate which characteristic are the most valuable as bioclimatic indicators. The research is carried out on the background of the Köppen-Geiger climate classification. Several characteristics based on UTCI were examined and found to be valuable in bioclimatic regionalization of Europe: 1) mean values of UTCI in the hottest and the coldest months; 2) frequency of days with at least strong heat stress in summer season and strong cold stress in winter season; 3) lasting of periods when risk of strong heat stress and strong cold stress can occur.

3A.2

Heat Waves and their Impact on Indoor Environments: An Assessment of Human Bioclimate using the UTCI

Thermal Comfort and Indices I: UTCI
Nadine Walikewitz, Humboldt-University of Berlin, Berlin, Germany; M. Langner and W. Endlicher

Because of the fact that people in industrialized countries spend on average 90% of the day in confined spaces and can be negatively affected by unfavourable thermal conditions, the assessment of indoor heat stress is an important issue, regarding adaptation. The study aims to assess indoor heat stress with the focus on differences between building structures (year of construction, percentage of window surfaces) and differences within the buildings regarding floor level and orientation of the rooms. Additionally, the nighttime situation was investigated separately, paying attention to the influence of heat stress on the recovery phase of the human body.

The Universal Thermal Climate Index (UTCI) was used to assess the indoor environment in 26 rooms within 5 different buildings in Berlin. The buildings differ in their usage between two office buildings, two residential care homes for the elderly and one public school. In each building the considered rooms are south-west oriented, located on different floor levels and have the same size. The presented results were derived through a detailed measurement campaign from the 1st of June to 31st of August 2013. During this period three heat waves were recorded from the German

weather service. In the two office buildings air temperature, relative humidity, air velocity and mean radiant temperature were measured in 5min time steps and UTCI values were calculated. The three remaining buildings were equipped with air temperature and relative humidity sensors. To measure air temperature and relative humidity, each room was equipped with two Testo 174H loggers. Air velocity was derived by one hot wire anemometer per room (PCE-009) and mean radiant temperature through the use of one black globe thermometer per room (150 mm in diameter; 0.4 mm thickness). The sensors were fixed at a height of approximately 1.1 m above the ground, corresponding to the average height of the center of gravity for adults. For the UTCI calculations, mean radiant temperature was set to air temperature, if not measured separately, and air velocity was set to a constant air flow of 0.3 m/s. A metabolic heat production of 135 W/m2 was assumed for all UTCI calculations.

Within the study period, the mean UTCI values ranged from 23.1 ± 1.2 °C to 29.9 ± 3.2 °C. Whereas differences within the school and the two residential care homes for the elderly were just around 1 K, the two office buildings showed noticeable differences of 4-7 K. Maximum UTCI values in all buildings were recorded from 25.6 °C up to 37.7 °C. All rooms showed moderate heat stress and rooms within three buildings strong heat stress during the heat waves. At two days, one room exceeded the 38 °C threshold for very strong heat stress with UTCI maximum values of about 39 °C. Additionally, two buildings showed discrepancies from the assumption that heat stress increases with increasing floor levels, as stated in previous literature. The night time analysis was conducted using UTCI minimum values. Data were recorded from 20.1 °C up to 24.5 °C. The internal difference of two buildings was approximately 1 K, whereas three buildings showed internal differences between 1.9 K, 2.7 K and 4.4 K. All rooms showed moderate heat stress and two rooms within one building strong heat stress during nighttime.

The variations between the buildings can be explained by differences in building material as well as by the percentage of window surfaces. The two office buildings presented the highest heat stress levels and have concurrently the highest ratio of window surfaces. The year of construction is no determining factor, because the two latest buildings in this study showed diverse heat stress patterns. One office building constructed in 2003 showed the highest heat stress values, whereas one residential care home for the elderly (2004) experienced the lowest values within this study. Differences within the buildings can be traced back to floor level, orientation and user behavior. Especially the decrease of heat stress with increasing floor levels within two buildings is caused by the influence of users. The rooms at the lower floors are occupied by people with no or limited knowledge about possibilities to reduce heat stress, whereas the users at the higher floors took measures to reduce heat stress. The same effect was analyzed within one residential care home for the elderly due to bedridden people at the lower floors and mobile residents at the higher floors. In summary, the results indicate that indoor heat stress is a prevailing threat during heat waves throughout the day. People within the buildings are likely affected by heat conditions regarding thermal comfort and health issues, especially when they have no possibilities or knowledge about adaptation measures.

3A.3

Application of the Universal Thermal Climate Index for Operational Forecasting in Canada

Thermal Comfort and Indices I: UTCI

Melissa MacDonald, MSC, Dartmouth, NS, Canada; T. C. Farrell and D. Henderson

The Universal Thermal Climate Index (UTCI) has been explored as an evidence-based tool for alerting Canadians of thermal stress due to extreme outdoor temperatures. UTCI, an equivalent temperature, incorporates both physiological and meteorological factors of heat and cold stress including air temperature, humidity, wind speed and solar radiation. These features allow the UTCI to be used as a health impact-based forecast index for the various climates found in Canada. Communicating forecast values of UTCI presents several challenges. The UTCI's sensitivity to wind speed causes it to be unreliable in very high wind conditions. It is not recommended that UTCI be used when wind speeds exceed 17ms-1, speeds that are not unheard of in Canada. Winter values can be much lower than the currently used Canadian Wind Chill Index. In tests conducted at Canadian sites in summer, the UTCI demonstrated less sensitivity to humidity than the Canadian Humidex and, in high heat, exhibited lower daily maximum values than the Humidex. When considering forecasting the UTCI, questions remain on the capacity to reliably forecast the mean radian temperature, a key element during summer. Other challenges are related to the best method for communicating a forecast UTCI value, either through an equivalent temperature or thermal stress category. UTCI's sensitivity to wind speed and solar radiation could make it difficult to communicate to the public and may cause confusion amidst other thermal indices currently used by the public and private media on both sides of the Canada-US border. A forecast UTCI could consider a daily worst case scenario, such as maximum solar radiation and sheltered wind conditions in the warm season, and full shade and strongest forecast winds in the cold season. Assumptions regarding exposure time and to simplify the calculation of the UTCI may be necessary in order to forecast and communicate the risks associated with thermal stress so that it is understandable and useful to Canadians while retaining the integrity of the UTCI. Validation of any assumptions will be necessary before application of the UTCI in Canada.

3A.4

Future changes in bioclimatic index classes in three regions of Luxemburg

Thermal Comfort and Indices I: UTCI

Hanna Leona Lokys, Centre de Recherche Public – Gabriel Lippmann, Belvaux, Luxembourg; J. Junk and A. Krein

Future climate change will cause increasing air temperatures affecting human thermal comfort and health (Smith et al. 2013). A large population in Europe, in particular in Luxemburg - with its dense population and the high number of cross border commuter flows - is vulnerable to the changing thermal stress levels. Most severe health effects could be associated with the projected increase of extreme events (Smith et al. 2013), but adverse effects on human health could already be shown with only moderate levels of heat stress (Hajat and Kosatky 2010, Kovats and Hajat 2008). The objective is to assess the impact of climate change on three different regions of Luxemburg at a high spatial resolution. The assessment will include all classes of the bioclimatic indices, evaluating the changes in time and space.

Materials and methods: Our analysis is based on two bioclimatic indices, the Physiological Equivalent Temperature (PET) (Mayer and Hoppe 1987) and the Universal Thermal Climate Index (UTCI) (Jendritzky et al. 2012). Both indices include the projected input parameters air temperature, wind speed, relative humidity and global radiation. In addition to these parameters, physiological aspects of the human body, such as activity, clothing, sex and age are taken into account (Matzarakis et al. 2007). To assess the influence of climate change on human thermal comfort, we analysed two sets of future climate projections all based on the A1B emissions scenario. To account for uncertainties in the projections, we used a multi-model ensemble of 12 transient simulations with a spatial resolution of 25 km for the period from 1971 until 2098. The differences between

three regions in Luxemburg were analysed based on a single regional climate model run with the COSMO-CLM model (spatial resolution: 1.3 km).

Results and Discussion: Based on the multi-model ensemble projections we could show that there is a significant (P <0.05) trend in air temperature, relative humidity, PET and UTCI, whereas wind speed and global radiation do not show trends. Our analyses of the three regions of Luxemburg show that regional differences with regard to thermal comfort exist in present and future climate conditions. We could show for both indices that cold stress levels will decrease significantly in the near future up to 2050, while the increase in heat stress turns significant in the far future up to 2100. Our analysis showed that the lowest bioclimatic indices are found in the north of Luxembourg throughout all time periods. The highest occurrence of hot index classes can be found in the south of Luxemburg. Regional differences that are already present in the reference period remain throughout the following time slices in most cases. All but one index classes above “thermal comfort” (PET) - respectively “no thermal stress” (UTCI) - show regional differences in the future periods. Merging the index classes to three categories “cold stress” “no thermal stress” and “heat stress” it can be seen that the number of hours causing any form of cold stress decreases through all stations (-5.6% to -23.4% for the far future). In contrast, the number of hour in the comfortable and heat stress class increase (264.6% to 596.9% heat stress increase in the far future). In total these changes result in fewer hours with thermal stress in the future. The global warming leads to a higher amount of hours in the thermal comfort range for the projected future. As this process continues, hours that are now present in the comfort range might than shift towards heat stress levels. According to Donaldson and Keatinge (1997, 2002) cold temperature increases the risk of mortality. In contrast, a recent study by Staddon et al. (2014) shows that decreasing cold stress does no longer lead to decreasing mortality rates in temperate countries.

Conclusion: Our study confirms the general decrease in cold stress as well as the general increase in heat stress for the region of Luxemburg by analysing the bioclimatic indices PET and UTCI in detail. The analysis revealed that the change in stress levels is caused by significant trends in air temperature and relative humidity. Changes in cold stress tend to appear already in the near future (2041-2050), whereas the heat stress levels changes become significant in the far future (2091-2100). In total the number of hours in index classes that are considered to be stressful for the human body decreases in the future. To evaluate if this also causes a decrease in thermal stress related mortality and morbidity, further studies are foreseen.

3B.1

Sunspot Dynamics Are Reflected in Human Physiology and Pathophysiology

Biometeorology and physiological responses

William J.M. Hrushesky, Oncology Analytics, Inc., Plantation, FL; R. B. Sothern, J. Du-Quiton, D. F. T. Quiton, W. Rietveld and M. E. Boon

Periodic episodes of increased sunspot activity (solar electromagnetic storms) occur with 10–11 and 5–6 year periodicities and may be associated with measurable biological events. We investigated whether this sunspot periodicity characterized the incidence of Pap smear-determined cervical epithelial histopathologies and human physiologic functions. From January 1983 through December 2003, monthly averages were obtained for solar flux and sunspot numbers; six infectious, premalignant and malignant changes in the cervical epithelium from 1,182,421 consecutive, serially independent, screening Pap smears (59°9”N, 4°29”E); and six human physiologic functions of a healthy man (oral temperature, pulse, systolic and diastolic blood pressure, respiration, and peak expiratory flow), which were measured ~5 times daily during ~34,500 self-measurement sessions (44°56”N, 93°8”W). After determining that sunspot numbers and solar flux, which were not annually rhythmic, occurred with a prominent 10-year and a less-prominent 5.75-year periodicity during this 21-year study span, each biological data set was analyzed with the same curve-fitting procedures. All six annually rhythmic Pap smear-detected infectious, premalignant and malignant cervical epithelial pathologies showed strong 10-year and weaker 5.75-year cycles, as did all six self-measured, annually rhythmic, physiologic functions. The phases (maxima) for the six histopathologic findings and five of six physiologic measurements were very near, or within, the first two quarters following the 10-year solar maxima. These findings add to the growing evidence that solar magnetic storm periodicities are mirrored by cyclic phase-locked rhythms of similar period length or lengths in human physiology and pathophysiology.

3B.3

Three aspects of Clinical Cosmobiology

Biometeorology and physiological responses

Eliyahu G. Stoupel, Rabin Medical Center, Petah Tiqwa, Sackler Faculty of Medicine, Tel Aviv University, Hod Hasharon, Israel

The aim of this study is to present different links between Space Weather components (Time, Solar, (SA), Geomagnetic (GMA), Cosmic Ray (Neutron) – (CRA) and human homeostasis in context of Clinical Cosmobiology.

Patients & methods: It's a summary from many clinical studies performed in 3 countries -Israel, Lithuania, Azerbaijan,, comparing clinical events, laboratory data with Space Weather indices; physical data was from Space Institutions in the USA, Russia, Finland. Results: SA and GMA are related, r=0.5, p<0.0001 and inverse related to CRA SA/CRA, r=-0.85, P<0.0001, GMA/CRA r=-0.66, p<0.0001. 1.Month of birth and human pathology- victims of Sudden Cardiac Death (SCD), patients with Acute Myocardial Infarction (AMI) and , also, Cancer patients show significant differences in month of birth. 2.Timing of acute events: Acute Myocardial Infarction , Sudden Cardiac Death, Cardiac arrhythmia's , Electrical Heart Storm , Stroke show significant links by timing with CRA, SA. The culprit artery in AMI related to CRA and GMA. Deaths from Stroke are linked to CRA, SA and GMA. Many congenital lesions - Down Syndrome, Congenital Heart Disease are related to Space Whether activity, mostly in the month of conception. Blood coagulation and inflammation markers are connected with GMA and inverse to CRA. Hormone production is connected with Space Weather. 3.Gene activity and Space Weather: The Human Genome Project give a basis for homeostasis regulation. The timing of events is often related to Space physical activity. We can presume, that Gene functional activity is, partially, regulated by changing Space Weather. Conclusion: human homeostasis is affected by changing Space Weather physical activity. Different space weather components affect different human health risk factors resulting the equilibrium paradigm in clinical cosmobiology.

3B.4

Natural Light and its Rhythms - Do we know enough to modify without regret?

Biometeorology and physiological responses

Katharina M. A. Gabriel, University of Bremen, Bremen, Germany

Background

Diurnal and seasonal Rhythms

Insolation of sunlight is the driving force for all life on earth. Due to declination it varies for a given place over a cycle around the sun and gives the seasonal rhythm. Another important timer is the rotation of earth around its axis. Only on the side facing the sun radiation occurs and the rhythm of day and night evolves. Over millions of years life on earth has adapted to these conditions.

Actinic complex in Bioclimatology

The full spectrum of the sun is considered in the actinic complex of the atmospheric impact complex. While short wave radiation of UV as well as long wave radiation of IR is well considered in our research the visible spectrum in between is neglected. We call it ‘visual' – why don't we take a look at it? Is it because we think we know everything about it?

Adaption to rhythms

Of course we do have knowledge about adaption of plants, animals, and humans to natural rhythms of light:

• In plants we have those which blossom when days are short and those which blossom when days become longer. Most flowers open their blossoms during daytime, but there are some blooming during nighttime (like Nachtkerze). Famous botanist Peter Lenné made a flower clock, indicating each hour by another plant opening its blossom.

• The niche of day and night for main action we also find in animals. We have night active insects as well as we have night active birds and mammals which use the darkness to hide from their predators. Which, in turn, evolved in that way that their senses either adopted to the faint light of moon and stars or that they improved those independent of light, like scent or hearing. Also well-known is the dependency of hibernation and reproduction to the rhythms of natural light.

• What do we know about human being? We can count ourselves to the day active mammals with vision being the strongest sense for orientation. Only recently it was discovered, that in the human eye next to rods and cones (for vision) another type of cells exist which signal the body via hypothalamus whether it is day or night outside. In darkness melatonin is set free and swamps all over the body resetting the internal circadian clock. These cells can be compared to the ‘third eye' of reptiles and fish.

As we are day active and as our strongest sense is vision and – in turn – it only works properly in brightness, we fear darkness. Human ability to solve problems learned to brighten darkness artificially and about one hundred years ago we invented electric light. In another aspect, we became independent of nature and its rhythms like we did before in thermal aspects or in agricultural aspects.

Still: Life is adapted to natural cycles of brightness and darkness, and changing its rhythm has an impact on well-being.

Known effects of artificial light

Plants increased growth – but what about thermal resistance? What about nutrition content? What about strength, e.g. resistance to wind? In fall, trees next to a street lamp keep their leaves on branches next to the light. When frost hits, these branches are not prepared and are damaged.

Animals

• Salmon in Norway: artificial light at night suppresses hormonal development: animals gain weight but do not reach adulthood. Thus, they don't feel the need for migration or to fight for revier but they stay peaceful within the group.

• Hamster in Israel: In two fields the same number of animals was put. Aim of the study was to test whether light at night was a possibility for pest control. By influencing their hormonal system it was expected to suppress reproduction. However, the experiment was over-effective as none of the animals on the lit field survived winter. Obviously, artificial light at night also influenced their system of thermal regulation.

• Cattle in Brazil: Due to high temperatures during daytime animals are phlegmatic and hardly show appetite. To increase their weight, food and water is also offered during night. Compared to a dark food station a lit one is more attractive and more frequented.

• Hamster in lab: While one group of animals was provided a normal rhythm of day and night another group of animals was kept in a rhythm with artificial light at night. The latter ones changed their rhythm of food intake and became obese compared to their mates with normal light schemes.

Whether these effects of artificial light at night were wanted ones or not – why do we think that they have nothing to do with ourselves?

Human

Indeed, medical research has begun pointing toward adverse effects of artificial light at night on human health. Artificial light at night (ALAN) was brought into discussion as causation for cancer in 1987. Since then the relationship was investigated for different types of the disease: in women focus was on breast cancer while in men focus was on prostate cancer. Whereas the knowledge about the impact of indoor artificial light at night is fairly advanced and shift work was declared as carcinogenic by WHO in 2007, insights into the health-effects of outdoor artificial light in the sense of light pollution (e.g. outdoor illumination shining in through bedroom windows) is still in emergence.

Also, there are hints that artificial light at night influences metabolism and thus plays a role in epidemic of obesity.

Conclusion: In Bioclimatology we are interested in the wavelengths of UV and IR – why do we ignore the part in between? In Bioclimatology we are interested in natural thermal conditions outdoors as well as in more artificial thermal conditions indoors – why don't we consider those aspects of light in our research? With this presentation I would like to start a discussion what contribution we can give as bioclimatologists to the topic of effects natural and artificial light has on life on earth.

4A.1

Risk communication: New and innovative ways of reaching the masses in the digital era, and lessons learned

Risk, communication, and behavior

Jason Samenow, Washington Post, Washington, DC

Information bombards people in this digital age across a growing range of platforms and media. Attention spans are shrinking while information sources are proliferating. How do scientists effectively break through to the public with salient information given these challenging circumstances?

Understanding how information is consumed is critical to reaching your audience. Writing eye-catching headlines (or "tweets"), engaging in two-way conversations on social media, making emotional connections, building trust, and effectively communicating uncertain information are all critical tactics for reaching your audiences. This presentation will focus on lessons learned in building a receptive, engaged audience for climate and weather information based on over 10 years of experience and experimentation.

4A.2

Explorations of the Psychological Origins of Weather Salience

Risk, communication, and behavior

Alan E. Stewart, Univ. of Georgia, Athens, GA

Peoples' interests in the weather and their individual differences in being oriented to the weather and its changes fall within the realm of human biometeorology and psychology. What is it about people and the weather that some individuals are highly oriented and cognizant of the atmosphere while other people seem oblivious to it? This question echoes the sentiment attributed to Benjamin Franklin that “some people are weatherwise but most are otherwise.”

Stewart (2009) examined the individual variations in the orientation and psychological significance that the weather has for people using a self-report measure created for this purpose, the Weather Salience Questionnaire (WxSQ). Weather salience is conceptualized here as a multifaceted and primarily individually based construct that encompasses the general psychological significance of the weather. People will attend to the weather to the extent that its nature or magnitude makes it perceptually salient given their sensory and perceptual characteristics (Stokols, 1979). The weather may be psychologically significant for the emotional and motivational salience that can arise insofar as weather can be broadly experienced as good or bad. Stewart created the WxSQ using a sample of university undergraduate students to evaluate the item characteristics pertaining to the different ways the weather may be of psychological significance to people. These components were consistent with the environmental psychology theories that informed the WxSQ's development: 1. Attention to weather and weather information (e.g., ‘‘If a friend or family member asked me what the weather forecast was for today I could not tell him or her what to expect.’’); 2. sensing, observing, and experiencing the weather directly (e.g., ‘‘I can tell when there seems to be a lot of moisture in the air’’); 3. effects of weather on daily plans, work, and activities [e.g., ‘‘During certain seasons of the year, the weather conditions routinely (i.e., at least once per week) affect my ability to perform tasks at school or work.’’]; 4. effects of weather on moods (e.g.,‘‘The weather affects my mood from day to day’’); 5. attachment to weather of certain places (e.g., ‘‘I am attached to the climate of the place where I live or used to live’’); 6. need for weather variability and interest in weather changes (e.g., ‘‘I like to experience variety in the weather from day to day.’’); and 7. attention to weather when it may create interruptions, cancellations, or holidays, for example, ‘‘I become interested in the weather when there is a possibility that I may have a weather-related holiday (e. g., snow day from school or work).’’ Detailed information regarding the development of the WxSQ and other psychometric information appears in Stewart (2009) and in Stewart, Lazo, Morss & Demuth (2012).

In the present investigation, Stewart examined the contributions of two cognitive and perceptual variables that may underlie the extent to which the weather and its changes are noticed, attended to, and processed (i.e., perceptually salient). One of these variables measured the cognitive style construct of field dependence/independence. This variable represents more of an established processing style (bordering on an ability) to perceive one's environment along a continuum created by two endpoints: 1. A holistic, top-down, organic, encompassing way of processing the visual field versus 2. A bottom-up, piecemeal, detail-oriented approach (Witkin & Goodenough, 1981). The author used the Portable Rod-and-Frame test with a sample of 84 undergraduate students (71% women) to assess cognitive style. The second variable that the author examined in relation to weather salience was perceptual curiosity (Collins, Litman, & Spielberger, 2004). The perceptual curiosity scale assessed trait-level needs and motives for sensorially receiving information about one's environment. The participants were run individually in session that lasted for 75 minutes.

The results from this project suggested that both of the underlying psychological variables (cognitive style and perceptual curiosity) contributed rather independently to the participants' scores on weather salience. Table 1 shows the magnitudes correlations of selected WxSQ subscale and total scores with performance on the Rod-and-Frame Test and the Perceptual Curiosity Scale.

The results presented in Table 1 suggested that a progressively more detail-oriented, piecemeal visual cognitive style was associated with increasing scores on the WxSQ and its subscales. That is, a cognitive style that allows a person to disembed visual features from the environmental “ground” is associated with increasing psychological significance (informationally, perceptually, and emotionally) of the weather. Conversely, people with a global and holistic perceptual style tended find weather and its changes less psychologically significant.

With respect to perceptual curiosity, greater expressed curiosity about the sensory stimuli that exist in the environment was correlated positively with seeking information about the weather, sensing and observing the weather, noticing and needing variety in the day-to-day ambient weather, and noticing effects of weather upon one's mood.

The results from this project are noteworthy because they indicate the deeper psychological origins of the attention and significance that people accord the weather. Beyond a passing interest in the “content” of the weather that one experiences personally or via the media, this project has identified and documented the contributions of two human organismic variables that are associated with meaningful attention to the weather. The author will discuss these findings in terms of their adaptive significance for our human ancestors as well as for efforts to adjust to more extreme weather events that will arise from global climate change.

4A.3

Severe Weather Phobia: Prevalence, Severity, and Traumatic Events

Risk, communication, and behavior
Jill S. M. Coleman, Ball State Univ., Muncie, IN; K. D. Multon, C. L. Taylor and K. D. Newby

The primary objective of this study (as largely reported in Coleman, et. al., 2014) is to provide preliminary empirical evidence for the occurrence, symptoms, and spatial extent of severe-weather related phobias in the United States. Westefeld et al. (2006) published a short quantitative analysis on symptoms and behavior associated with severe-weather phobia which is described as "an intense, debilitating, unreasonable fear of severe weather" (p. 509). For comparison, we replicate and expand upon the Westefeld et al. (2006) study, noting several key differences. A larger sample from a more demographically and geographically diverse population subset was obtained, whereas the sample in Westefeld et al. (2006) were Caucasian, university students (< 25 years old) from one Midwestern location. Our dataset (n = 298) encompasses age and race demographics similar to the U.S. population and represents subjects from 43 states with a variety of educational backgrounds. Additional questions regarding the extent and frequency of exposure to severe-weather were also added. Although Midwesterners are accustomed to thunderstorms and tornadoes as the definition of severe-weather, we sought to determine if severe-weather terminology and experiences are geographic specific. For example, East coasters may experience more fear with hurricanes than individual thunderstorm warnings. To further expand upon Westefeld et al. (2006), questions regarding their level of meteorology education and most severe weather event experienced to assess the relationship between weather knowledge, anxiety, and specific weather-related trauma. Recognizing the spatial patterns and demographics behind inclement weather phobia may indicate new areas for focusing on treatment options, such as meteorology education and/or counseling.

Based on our broad definition of severe weather, nearly all participants (99%) had experienced some form of severe weather during their lifetime. The most commonly experienced severe weather events were thunderstorms (90.9%) and high winds (90.3%), followed by heavy snow and freezing rain (at approximately 80% each). In reflection of their severe weather experience (s), respondents generally reported having feelings of anxiety (72%), increased heart pounding (62.9%), changing schedules (60.8%), and feelings of helplessness (60.4%) at least occasionally; however, the majority of participants reported no evidence of 8 of the 14 symptoms or behaviors listed in the survey.

Participants who reported having taken a weather course also reported experiencing more anxiety symptoms and behaviors, particularly heart pounding, feeling anxious, changing their schedule, and monitoring television, radio, internet, or weather applications during severe weather events. Schedule changes, appetite loss, nausea, and obsessiveness were all behaviors found to be significantly higher ($p < 0.05$) for those with some formal meteorology education than those with none. In comparison, participants who reported having never taken a formal weather course reported no evidence of any symptoms other than monitoring television, radio, internet, or weather applications during severe weather events. These findings suggest that more weather knowledge can increase anxiety levels in some individuals as they may have a greater understanding of the potential dangers associated with severe weather.

When asked about overall fear of severe weather, participants overwhelmingly reported (85.1%) having at least some degree of severe weather fear with most (46.1%) describing their fear level as “a little bit”. Approximately 10% of participants classified themselves as having an overall fear level in the “extreme” and “quite a bit” categories, possibly indicating severe weather phobia prevalence. However, when respondents were asked to assess whether or not they (or someone they know) had severe weather phobia, the majority (80.5%) of participants reported they do not suffer from severe weather phobia. Other respondents reported they believe they do suffer from severe weather phobia (4.7%) and the remaining 14.8% was “not sure”. Only 3% of our sample reported seeking treatment (professional or other self-help resources) for severe weather phobia or specific inclement weather events.

Participants were also asked open-ended questions about the most severe weather event experienced during their lifetime and their greatest fears during the event. Nearly half of all participants had their most major severe weather event occur by their early-20s and three-quarters by the age of 30. The most severe weather experienced largely reflected regional geography, hurricane and tropical storms for the southeast coast, blizzards for the northeast, tornadoes, floods, and ice storms for the interior, and wind storms for the west coast. Named storm system events (e.g., Hurricane Andrew; Blizzard of ‘77) had stronger memories and details for participants than other type of events, suggesting the importance of media in shaping our experiences. Although the greatest losses during the events were personal property and lost wages, participants reported their greatest fears were linked to personal and family death/injury, long-term isolation and power-outages, and direct storm impacts (e.g., lightning strike). Consequently, many respondents reported feeling anxious during subsequent storm events and/or having stronger mitigation plans (e.g., insurance, evacuation route).

4A.4

Edwin Grant Dexter: An Early Researcher in Human Behavioral Biometeorology

Risk, communication, and behavior
Alan E. Stewart, Univ. of Georgia, Athens, GA

Edwin Grant Dexter (1868-1938) was one of the first researchers to study empirically the effects of specific weather conditions on human behavior. Dexter (1904) published his findings in a book, Weather Influences. The author's purposes in this presentation are to: 1. describe briefly Dexter's professional life and to examine the contexts and motivations that led Dexter to conduct some of the first empirical behavioral biometeorological studies of the time; 2. describe the methods Dexter used to examine weather-behavior relationships and briefly to characterize the results that he reported in Weather Influences; and 3. provide an historical analysis of Dexter's work and assess its significance for human behavioral biometeorology. Dexter's investigations are significant for historical reasons because he was the first person following the formal emergence of psychology as an academic discipline in the late 1800's to investigate weather, psychology and social relationships. Further, Dexter utilized comparatively large samples of adults and children along with data from the U. S. Weather Bureau offices in Denver, Colorado and New York City to describe these relationships and to formulate a psychophysiological theory of weather influences. Dexter's scholarship is significant at the current time given the growing interest of the atmospheric science community in societal impacts.

Dexter's Weather Influences

Background. The first 54 pages of Weather Influences were devoted to a description of weather folklore and literature. This examination appears to have served two purposes, the first which was to legitimize posing the questions of: to what extent does weather influence psychological and social processes and how might these influences operate? Second, such a review made it clear to Dexter that no empirically-based studies of weather influences had been undertaken. Given the recent

emergence of large-n paradigms in psychology and sociology, conducting empirical studies of weather influences using the new methodology seemed to be a logical next-step for Dexter.

Populations and Variables Studied. Dexter studied a range of social and behavioral variables that could be influenced by the weather. To examine the relationship of the social or psychological variable, Dexter tabled the occurrence of each variable (e. g., assaults) according to the meteorological parameter under consideration and determined the relative frequency of the occurrence within each interval of the variable. For each meteorological variable, Dexter differenced the expectancy and occurrence curves to ascertain whether the social or psychological variable under analysis was more or less likely to occur under the given conditions.

Legacy of Dexter's Weather Influences

A search of multiple databases along with a search of Google Books, revealed that Dexter's Weather Influences has been cited in approximately 250 books and professional journal articles. This figure represents a lower limit because not all sources that may have cited a book published in 1904 have been incorporated into the searchable scholarly databases. Regarding the citation trends of Weather Influences over time, a peak of citations appears between 1910 and approximately 1935. Although such a peak in citations is expected for many scholarly works, followed by a gradual and steady decrease over, it is noteworthy that approximately 18% of the identified citations occurred from 1980 to 2010. This result suggests that Dexter's work continues to be of interest, value, and use to researchers and writers. In this regard Weather Influences seems to have become somewhat of a classic reference in being the first systematic contribution to examine the effects of weather on individual and social behavior.

Dexter's work appears to have influenced at least two significant lines of scholarship that focused upon weather-behavior relationships. First, the human geographer Ellsworth Huntington significantly incorporated some of Dexter's results and his theory of vital nerve energies (Weather Influences, Chapter XV) in describing the effects of weather upon the behavioral traits of people in Asia. A second and lasting legacy of Weather Influences appears in the criminology literature. Specifically, Dexter's empirical observations of greater behavioral problems in school and higher arrest rates for conflict and assault during times of warmer weather has remained of interest to researchers in criminology since the book's publication. Since 1990 eight journal articles have been published that investigated the relationships of weather with aggressive, violent, or otherwise criminal behavior. Biometeorology is a wonderfully integrative field with a rich history (Bouma 1987; Höppe 1997; Weihe 1997). The pure and applied research questions that gave rise to biometeorology stretch far into the past, beyond the formal establishment of the International Society of Biometeorology. Although I have examined the contributions of one researcher who primarily was interested in the behavioral aspects of human biometeorology, there are many other scientists whose work has been relevant in shaping the history, nature, and scope of the field.

4B.1

Simulated Mitigation of Heat Stress for Pedestrians in an Urban District of a Central European City by Different Green Scenarios

Urban Heat - Health Issues

Hyunjung Lee, Albert-Ludwigs-University, Freiburg, , Germany; H. Mayer

Simulations of regional climate change in Central Europe project not only an increase of the near-surface temperature, but also an intensification of embedded heat waves. Combined with the demographic change, which leads to an enhanced portion of the risk group "elderly people", the future atmospheric situation presents urban planning with the challenge, to develop and apply methods in a preventive way in order to mitigate the regionally predetermined heat stress on the local urban scale for pedestrians. Several investigations have shown that the promotion of urban green turns out to be a particularly effective method to achieve mitigation aims under the point of view of urban human-biometeorology. Against this background specific simulations by use of the ENVI-met model, version 4.0, were conducted in an urban district in Freiburg, a mid-size city in Southwest Germany. Their general aim was to quantify the potential of three different green scenarios for the maintaining of thermal comfort for pedestrians during severe heat. The current situation in this district characterised by regularly arranged three-storey buildings in E-W and N-S orientation, street canyons in the same directions, grassland and trees represents scenario A. In scenario B, only all trees were removed. Thus, buildings, streets and grassland remained. In scenario C, the complete urban green was removed, i.e. the urban district consisted of only buildings and asphalt surfaces. To describe thermal comfort in a human-biometeorologically significant way, near-surface air temperature T, mean radiant temperature MRT and physiologically equivalent temperature PET were used. For each of the three scenarios, the simulations were performed on a clear-sky day (27 July 2009), which is characteristic for summer in Central Europe, and a day (4 August 2003) within the severe heat wave in August 2003. It exemplarily represents the thermal conditions in the future due to regional climate change. On 27 July 2009, additional experimental investigations on human thermal comfort were carried out at five sites within this urban district. Their results enabled the validation of the T and MRT simulation results for the scenario A. The correlations between simulated and experimentally determined T and MRT values were distinctly stronger than it was reported in the literature for previous versions of ENVI-met. For each of the three scenarios, the simulations provide T, MRT and PET results in different spatial scales. They were averaged over the period 10-16 CET as it represents the typical time scale of outdoor heat for Central European citizens on clear-sky summer days. The spatially detailed results are analysed on the micro-scale as well as for selected sectors, e.g. both sidewalks of an E-W oriented street canyon. In addition, mean values including standard deviations of T, MRT and PET are calculated for the complete simulation area. Thus, the influences of the three green scenarios on human thermal comfort can be quantified in a detailed way.

4B.2

Do urban green and urban blue mitigate heat-related excess mortality? Evidence from Lisbon, Portugal

Urban Heat - Health Issues

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It has been shown that elevated temperature can exert adverse effects on human health and well-being. Especially increased levels of mortality during periods of extreme heat have been highlighted in the literature. Several studies have shown that different cities and population groups exhibit different responses to heat. The underlying reasons for these differences are only partially understood. The demographic composition as well as the spatial structure, the degree of urbanisation, population density or the urban design and morphology might be crucial in shaping the atmospheric effect. Given the superimposed urban heat island effect, urban areas seem to be particularly vulnerable toward heat stress. The shape and magnitude of the urban heat island is rather heterogeneously developed throughout the urban landscape. While bigger and more densely build and populated urban areas generally show higher excess temperatures compared to their rural

surroundings, there are also intra-city specifications of the UHI with warmer and less warm micro- and meso-environments. The primary objective of this study was to assess the influence of urban characteristics on heat-related excess mortality on a small-scale intra-urban level. Special attention was given to the mitigation potential emanating from urban vegetation and urban water bodies. In a first step we investigated the association between day- and night-time land surface temperature (LST), urban green, urban density and coastal proximity. Following, the data was stratified by spatial criteria, i.e. amount of urban green, density and proximity to the coast. Additionally, we calculated the Universal Thermal Heat Index (UTCI) in order to assess the combined effects of different meteorological parameters, i.e. temperature, humidity, wind-speed, and radiation on the human heat balance. In order to assess the mortality-atmosphere relationship, the modelled atmospheric information was combined with the spatially stratified mortality data using different kinds of Poisson regression models adjusting for various confounders. For determining the lag structure of heat effects, we applied Distributed Lag Non-Linear Models (DLNM). Subsequently, we used non-parametric generalized additive models (GAMs) including interaction terms in order to allow for interaction by spatial category. For quantifying heat effects we modelled GAMs having segmented relationships were modelled. Land surface temperature shows to be associated with heat mortality and findings furthermore demonstrate a mitigating effect of urban green. Similarly, distance to the coast seems to have an effect on heat-related mortality with decreased heat-related mortality in areas located within closer proximity to the coast line.

4B.3

How much does urbanization contribute to extreme heat events in Shanghai: Observations and trend analysis

Urban Heat - Health Issues

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In 2013 Shanghai has experienced the hottest summer in the last 140 years. Indeed the extreme heat events in Shanghai have occurred more frequently with increasing intensities. The objective of the present paper is to investigate the effect of rapid urbanization since the reform in the 1980s on the temperature change trend of Shanghai. Daily surface air temperature records from 11 weather stations covering both urban and rural areas of Shanghai from1980-2013 were used. The numbers and distributions of hot days and hot nights were studied, which were compared with urban development intensity indices including population density, residential area, energy consumption, and car number etc. selected from census data. On the other hand, remote sensing images, including Landsat TM image and DMSP/OLS nighttime light data were used to derive the spatial pattern of the urban development, which was further compared with the spatial pattern of UHI as derived from the weather station data. Based on the analysis, the paper summarized on the trend of the heat stress induced by urbanization in both temporal and spatial dimensions, and further discussed the possibility for sustainable planning to adapt the urban form to reduce the city's heat vulnerability.

4B.5

Challenges in projecting urbanization-induced heat-related mortality

Urban Heat - Health Issues

David M. Hondula, Arizona State University, Phoenix, AZ; M. Georgescu and R. C. Balling Jr.

Maricopa County, Arizona, anchor to the fastest growing megapolitan area in the United States, is located in a hot desert climate where extreme temperatures are associated with elevated risk of mortality. Continued urbanization in the region will impact atmospheric temperatures and, as a result, potentially affect human health. We aimed to quantify the number of excess deaths attributable to heat in Maricopa County based on three future urbanization and adaptation scenarios and multiple exposure variables. Two scenarios (low and high growth projections) represent the maximum possible uncertainty range associated with urbanization in central Arizona, and a third represents the adaptation of high-albedo cool roof technology. Using a Poisson regression model, we related temperature to mortality using data spanning 1983–2007. Regional climate model simulations based on 2050-projected urbanization scenarios for Maricopa County generated distributions of temperature change, and from these predicted changes future excess heat-related mortality was estimated. Subject to urbanization scenario and exposure variable utilized, projections of heat-related mortality ranged from a decrease of 46 deaths per year (- 95%) to an increase of 339 deaths per year (+ 359%). Projections based on minimum temperature showed the greatest increase for all expansion and adaptation scenarios and were substantially higher than those for daily mean temperature. Projections based on maximum temperature were largely associated with declining mortality. Low-growth and adaptation scenarios led to the smallest increase in predicted heat-related mortality based on mean temperature projections. Use of only one exposure variable to project future heat-related deaths may therefore be misrepresentative in terms of direction of change and magnitude of effects. Because urbanization-induced impacts can vary across the diurnal cycle, projections of heat-related health outcomes that do not consider place-based, time-varying urban heat island effects are neglecting essential elements for policy relevant decision-making.

4B.6

BioCAS: Biometeorological Climate impact Assessment System for Building-scale Impact Assessment of Heat-stress Related Mortality

Urban Heat - Health Issues

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An urban climate analysis system for Seoul was combined with biometeorological models for spatially distributed assessment of heat stress risks in urban areas. The Biometeorological Climate impact Assessment System (BioCAS) is based on the Climate Analysis Seoul (CAS) workbench, which provides urban planners with gridded data relevant for local climate assessment at 25 m and 5 m spatial resolutions. The influence of building morphology and vegetation on mean radiant temperature Tmrt was simulated by the SOLWEIG model. Gridded hourly perceived temperature PT was estimated using the Klima-Michel Model for a heat event day in 2012 using data from the CAS workbench and gridded T_{mrt}, along with relative humidity and wind speed observed at the Seoul Weather Station. Daily maximum perceived temperature PT_{max} was mapped and applied to an empirical-statistical model that explains the relationship between PT_{max} and excess mortality rate r_{EM} in Seoul, expressed as mortality increase relative to the expected base mortality. The resultant r_{EM} map quantifies the detrimental impact of the heat wave event at the building scale. Maximum values of r_{EM} in old and new town areas in an urban re-development site in Seoul were estimated at 51% and 8%, respectively, indicating that urban re-development in this area has generally resulted in a significant reduction of heat-stress related mortality. The study illustrates that BioCAS can be generally applied for quantification of the impacts of severe weather heat events on human health for different urban development scenarios with variable building morphologies and vegetation. Further

improvements are required, particularly to consider indoor climate conditions causing heat stress, as well as socio-economic status and population structure of local residents.

4C.1

Water-borne Outbreaks and Climate: a Meta-analysis Approach

Infectious Diseases

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Seasonality is universal phenomenon for many infectious diseases with a strong environment component that affects the probability of exposure and transmission. The global synchronization of spatio-temporal patterns has been noted for water-borne infections worldwide. Rotaviral infection is most prominent in colder weather; peaks of cryprosporidiosis fluctuate and may exhibit one or two seasonal spikes: in summer and late fall; seasonality of cholera correlates with changes in aquatic environment. A meta-analysis was conducted to examine how patterns of waterborne infections, including cryptosporidiosis and rotavirus, relate to vegetation, ambient temperature, and precipitation on a global scale. This presentation introduces the notion of seasonality by outlining several of its essential terms and factors, provide comparisons of current methods for assessing seasonality, and illustrate synchronization of waterborne infections with respect to climatic regions. Incidence data were abstracted from published epidemiological studies and related to temporally aggregated ambient temperature and precipitation for each study location using non-linear mixed effects models. Vegetation was measured by using remote sensing, which has a great potential for developing a unifying approach to comprehensively study seasonal patterns across various climatic zones and vulnerable populations. In temperate, tropical and humid mid-latitude climates, low temperature and precipitation levels are significant predictors of an increase for both infections. In South Asia, for example, the highest incidence of rotavirus is seen in the colder, drier months. A lagged structure is well pronounced for different strains and an increase in the proportion of undetects is indicative for emergence of a new strain in the next season. Seasonality of cryptosporidiosis varies by climate region. On a local scale, an event of hot weather in a temperate climatic region exhibits a time-distributed effect on the rate of cryptosporidiosis, characteristic to its incubation period. Given the strong lagged association with temperature, meteorological parameters can be used to strengthen public health prevention programs. In this communication we argue, that seasonal patterns depicted globally are not necessarily a simple sum of patterns observed locally. Deviations from seasonality, or a break out from an expected pattern, might be indicative of various environmental, demographic and social changes affecting exposure and transmission of waterborne infections.

4C.2

Relationship of Dengue with Malaria and other social and climate covariates from four different cities of Pakistan

Infectious Diseases

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The rational of this study is to highlight the possible relationship of Dengue with Malaria and other social and climate covariates from four different cities (Lahore, Karachi, Islamabad and Rawalpindi) of Pakistan. For this purpose the relationship between the occurrences of Dengue and Malaria, Dengue and flooding, Dengue and population, and Dengue and travelling in the study areas have been taken into account. Generalized Linear Mixed Model (GLM) with Markov Chain Monte Carlo (MCMC) algorithm is computed to see the random effects of different social (population, travelling, and malaria) and climate (minimum-maximum temperature, and rainfall) covariates on Dengue occurrence. Neural Network with Multilayer Perceptron is used to analyze the normalized importance of different covariates relative to Dengue occurrence. Results show that flooding, travelling, population and occurrence of Malaria are affecting the occurrence of Dengue in the study areas. Change in occurrence of Malaria is affecting the occurrence of Dengue as much as 5.4 times, whereas GLM with MCMC also shows significant random effects of Malaria, population and rainfall on the Dengue occurrence during the studied years (2009-2012). Key Words: Dengue occurrence, Malaria, social covariates, climate covariates, Linear Mixed Model and Neural Network

4C.3

Temporal and Spatial Variations of Some Meteorological Parameters and Malaria Occurrence In Ekiti State, Nigeria

Infectious Diseases

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Malaria is a major public health burden in the tropics with the potential to significantly increase in response to weather/climate parameters variations. Some meteorological elements have been widely associated with the dynamics of malaria vector population and, therefore, with spread of the disease. However, at the local scale, there is lack of thorough understanding of the effects of these factors on malaria transmission. Most of the attempts to quantify this effect are based on proxy meteorological data acquired from satellites or interpolated from a different scale. This has led to possible doubt in the contribution of weather variations to malaria prevalence and transmission risk among others. This study makes use of meteorological data measured at the local scale with malaria occurrence collected at the same time and scale to explore the temporal and spatial variations of malaria occurrence with meteorological parameters in Ekiti State; a tropical rain forest, in Nigeria. This work makes use of medical data and meteorological data spanning six years period (2005-2010).The medical data collected include monthly diagnosed cases of malaria for ages less than 5years, above 5years, and those in pregnancy while meteorological data collected were monthly values of relative humidity (%), minimum and maximum temperature (°C) and rainfall (mm) for six local government areas of the State. Descriptive, quantitative and time series analysis were carried out on the dataset. Also, temperature and relative humidity threshold were assumed to know which threshold the occurrence of the disease is at maximum. The results show that, there was a weak correlation between weather parameters and number of malaria occurrence in pregnancy. While the correlations are strong with children (below 5yrs) and adults (above 5yrs). Malaria prevalence among children was higher in the rainy season and has a good correlation of 0.76 which shows that, children <5 years old, are more susceptible to malaria occurrence than those >5 years old as their correlation coefficient with rainfall is 0.70. Also, the results from temperature and relative humidity threshold shows significantly that malaria parasite develop more between the temperature range of (30.1-32)°c with corresponding relative humidity of (60.1-80)% than any other temperature and relative humidity threshold. These results further show that the inhabitants of these areas are susceptible to malaria occurrence as the weather conditions in the areas are favorable to development of malaria parasite. Keywords: Weather, malaria prevalence, time series, threshold

4C.4

Impacts of climate changes on human health a case study on malaria disease in Nigeria

Infectious Diseases

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Impacts of climate changes on human health a case study on malaria disease in Nigeria

The patterns of general circulation of the atmosphere which determines the characteristics of global and regional climate variation will be different from what it is currently. If the current global warming persists unchecked, it may lead to significant change in global and regional climate these changes are expected to have substantial impacts on human health. The main purpose of this work is to investigate the potential impact of climatic variations in relation to human health. This research work focuses on human health diseases caused by climatic variation. This work focus on malaria and mapping of the breeding patterns as it relates malaria sickness to human health and factors of climatic variation. The climatic parameter that was used includes the average temperature, rainfall amount, and health indexes of the study area. This study investigates the factors responsible for increases or decreases in human's health in relation to climate variations. Ten years data was used for this investigation. Bivariate correlation, multiple correlation and regression analyses were conducted in this study; also (SPSS) was used to investigate the relationship between human health challenges and malaria sickness and climate variations. The climate variables used in the bivariate correlation analyses include annual and seasonal totals and monthly rainfall in Nigeria. Climate variable used in the multiple correlation and regression analyses. The preliminary result of the work shows that there is a relationship between climate variation and challenges in human's heath considering malaria as a case study. Key words: Climatic Variation, Weather, Human Health and Malaria Disease.

4C.5

Improvements in Estimation of Malaria Transmission Potential Modeling with Anthropogenic Climate Warming

Infectious Diseases

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This paper addresses improvements that can be made to malaria transmission potential modeling using precise environmental inputs. While many malaria models employ measures of monthly or daily temperature to drive transmission processes, use of diurnal temperature variation can more fully replicate the local ambient environment that drives organism development and behavior. Similarly, in climate change impact assessment, use of course-scale general circulation model (GCM) output lacks the spatial and temporal resolution necessary to derive robust biophysical impact projections. In this study, empirical downscaling (Hewitson and Crane 2006) was applied to a series of GCMs to predict location-specific malaria transmission potential for four Kenyan sites representing disparate climate conditions. Hourly temperatures used in driving the transmission model were derived from Parton and Logan's (1981) procedure based on daily maximum and minimum temperature. Results show raw GCM data underestimates the effect of climate change at hot and cold extremes, while overestimating it under intermediary temperatures. Use of mean monthly temperatures alone underestimates the rate of malaria development under cool conditions, but overestimates it for warmer conditions. Thus, techniques to derive high spatio-temporal resolution of modeling inputs have great potential for improving accuracy of malaria projections and likely other biophysical phenomena impacted by climate change.

4C.6

Modeling Potential Future Lyme Disease Emergence Patterns Based on Projected Land Cover Under Different IPCC Scenarios

Infectious Diseases

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The emergence of infectious diseases over the past several decades has highlighted the need for new approaches to better understand and prepare for epidemics as endemic infectious diseases expand their geographic range. Specifically, the range of Lyme disease, the most common vector-borne disease in the United States, is currently emerging southward along the East Coast. An infection with Borrelia burgdorferi, the bacterium that causes Lyme disease, creates significant public health burdens so an improved understanding of geographic and ecologic dimensions of the disease's future emergence pattern will enhance diagnosis and reporting efforts, and potentially decrease numbers of human cases.

Research indicates that land cover is the most important contributor to Lyme disease emergence, and while a handful of other studies have considered future Lyme disease distributions under projected climate conditions, this study is the first to forecast potential spatial distributions of Lyme disease based on projected land cover. Using a previously developed statistical model, we predict future distributions of Lyme disease in Virginia based on land cover conditions under two different IPCC scenarios (A1B and A2) from 2010 to 2060. A Poisson point process is implemented with land cover and demographic parameters as the spatial covariates. Risk maps for both IPCC scenarios were generated from 2010 through 2060 by estimating incidence in each county in Virginia, and the land area and population affected were calculated. Results show that the A1B scenario has a 22.34% higher incidence estimate for the year 2060 than the A2 scenario. In the A1B scenario, 28% of the total area of Virginia is under high risk in 2010 which increases to 66% in 2060; in the A2 scenario, 22.4% is under high risk in 2010 with an increase in 2060 to 62.7%. In terms of population, 22% of Virginia residents are in the high risk zone for A1B scenario in 2010, with an increase to 42.9% in 2060; in the A2 scenario, 21% of the population is under high risk in 2010 and increases to 33% in 2060. Observed Lyme disease incidence data was used for model validation. Our results suggest that Lyme disease will continue to emerge in Virginia, with variation based on specific future land cover conditions.

4D.1

Vulnerability of Warmth-sensitive Plant at Un-glaciated Refugia Under the Global Warming Environment

Forest Biometeorology

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Presence of large number of cold-tolerant but warmth-sensitive Arctic-Alpine Plant (A-AP) and Alpine Plant (AP) at previously un-glaciated heterogeneous habitats, such as alpine and subalpine belts, islands, and specific topographic locations are biogeographically interesting topic. Occurrence

of A-AP and AP at East Asian lowland wind hole under the global warming environment is unique biometeorological phenomenon.

Wind hole or air hole is a micro landform with an abnormal local climatic condition, in which the layer of air next to the earth's surface is cooler in summer, but milder in winter than an overlying layer. Micro climate basically maintained due to cool air blows out during the summer, but mild air comes out during the winter from an underground cave or hole.

Wind holes in the Korean Peninsula are scattered at many locations with the rocky periglacial landforms, such as at talus, block field, and block stream on steep slope of mountains. On the wind holes of Korea surveyed, many cold-tolerant but warmth-sensitive A-AP and AP, including Vaccinium vitis-idaea, are found. Vaccinium vitis-idaea (lingonberry or cowberry) is a short evergreen shrub in Ericaceae or the heath family that bears edible fruit, native to boreal forest and Arctic tundra throughout the Northern Hemisphere from Eurasia to North America.

In the Korean Peninsula, Vaccinium vitis-idaea occurs at several locations in DPRK or North Korea, and two sites in ROK or South Korea. This species thrives well at exceptionally low elevation of wind hole (c. 200 square meters in size at elevation of 350m a.s.l.) of Hongcheon (128.16.15 E, 37.48 .28 N), and the nearest population is ituated at the subalpine belts (1,200m a.s.l.) of Mt. Sorak or Soraksan (128.27.55 E, 38.07.08 N) at central Korea.

Vaccinium vitis-idaea at these two sites, which are separated each other about 56km distance away, shows a typical disjunctive distribution pattern in respect of both latitude and altitude. Vaccinium vitis-idaea at Hongcheon wind hole is, at present, regarded as the one of the global southernmost distribution limits

Cold-tolerant Vaccinium vitis-idaea might be widespread in distribution during the glacial epochs of Pleistocene at primary refugia. Since the Holocene period, this warmth-sensitive species are forced to retreat back toward the secondary refugia in search of cooler places, such as circumpolar areas, alpine and subalpine belts, as well as few specific habitats, including wind hole. Wind hole of Hongcheon belongs to one of the glacial and post glacial relicts. Current horizontal and vertical ranges of

Vaccinium vitis-idaea between Soraksan subalpine belt and Hongcheon lowland wind hole might indicates that the temperature of this region during glacial epoch was colder than today, down to -6 to -7°C. Hongcheon wind hole probably might serve as the floristic refugia in connection with climate change during the Pleistocene and Holocene periods. Vertical temperature differences on ground and 1.5 meter height of Hongcheon wind hole recorded about 15.0 degree centigrade. Thanks to relatively cooler summer air temperature and milder winter ambient airs, the isolated survival of Vaccinium vitis-idaea at small patch of Hongcheon wind hole could be maintained.

Vaccinium vitis-idaea at this small and fragile Hongcheon wind hole habitat will be providing a potentially important in-situ conservation site for the warmth-sensitive Vaccinium vitis-idaea under the global warming environment.

However, their continued survival could be endangered if current global warming continues, along with extensive anthropogenic agricultural activities. Potential climatic vulnerability of Vaccinium vitis-idaea in the Korean Peninsula is also projected in connection with global warming scenarios.

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4D.2

Documenting the distribution of Salvadora persica L., to establish a baseline on the pattern of its occurrence with the meteorological data and assessing its adaptation in the adjacent warmed up zones: a case study

Forest Biometeorology

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A reconnaissance survey was conducted to document the natural occurrence of the *S. persica* L., stretching from coastal area of Arabian sea to north-word along the Indus flood plains in order to establish a baseline on the pattern of its occurrence with the available meteorological data. In addition, information was compiled from various sources to generate the past and present temperature data in order to establish relationship between the changing temperature factors and extent of area available due to climate change for introducing species beyond its range of distribution. In addition, the species was experimentally introduced in the warmed up zones to monitor its performance at regular interval to evaluate its adaptability. The reconnaissance survey showed that the natural populations of thorn forest communities with *S. persica*, as associate, are now surviving as degraded remnants. Its common occurrence is documented in zones where the mean winter temperatures are above the threshold level of frost, where as it is rarely found in zones where it drops below this level for a single month, which seems to be its range edge, as it does not occur in zones where low temperature persists for two months. Recent temperature data suggests that the month of December has warmed up above the threshold level north-word and therefore correspondingly the range edge of the frost sensitive species has potentially shifted further north. The response of the species over the years also suggests high survival and growth, demonstrating its adaptability to the new site beyond its limit of distribution.

4D.3

Biosphere-Atmosphere coupling – a tropical mangrove system perspective

Forest Biometeorology

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Biological regulation of climate depends on how the biosphere-atmosphere coupling is manifested or how the biosphere could provide an environment suitable for its own sustainability. Discovery of the oldest Gilboa fossil Eospermatopteris forest which was periodically affected by brutal episodes of sea-level rise indicates that little is known how changes in early terrestrial ecosystem influenced global processes. Mangroves evolved in the eastern Tethys sea during the early Cretaceous followed by their westward dispersal via the Mediterranean route until about Miocene (18 Ma) and exhibited considerable speedy resilience to disturbance on a geological time frame. This coincides with the event of atmospheric CO2 fall from the Eocene level of 1400 ppmv to possibly as low as 200 ppmv during the Miocene. Now mangroves dominate the majority of the world's tropical and subtropical coastline and are highly productive, fixing and storing considerable amount of carbon. The Indian Sundarban mangrove forest (210 32/ and 220 40/ N; 880 05/ and 890 E) at the land-ocean boundary of the Gangetic delta and the Bay of Bengal comprises 9,630 km2 , out of which 4,264 km2 of intertidal area is subdivided as forest sub-ecosystem and 1,781 km2 of water area as aquatic sub-ecosystem. It contributes about 2.84 % of the global mangrove area (15x104 km2) and is a net sink

for CO2. The net biosphere-atmosphere exchange of CO2 was found to be 3.05 Tg C a-1 and the surface waters exported 6.03 x 106 kg C, out of which 3.57 x 106 kg C was pumped out by the biological activity in the water annually. Model prediction showed enhancement of CO2 sequestration in response to the future atmospheric CO2 increase in spite of existing low nitrogen availability in the sediment and genetic DNA base heterogeneity. Mangrove adjusted the limited supply of nitrogen in the sediment through the stomatal uptake of atmospheric NOx and NH3. Carbon sequestration rate showing an increase with density varied between 0.088 and 0.171 µg C kg-1 AGB s-1, and Avicennia marina showed the maximum value and Bruguiera gymnorrhiza, the minimum. The changes in FTIR bands at 4000–2500 cm-1 and 1700–800 cm-1 were correlated to the variations in cellulose in mangrove woods and lignin to cellulose ratio ranged between 0.21 and 1.75. Thermal analyses of mangrove wood suggested that the fuel value index (985–3922) exhibited an increase with the decrease in maximum decomposition temperature and density. The mean annual incoming short wave radiation (435 ±32.8 Wm2) was partitioned into 29% sensible heat, 35% latent heat, 4% ground heat, 7% physical storage energy and 10% photosynthetic storage energy. The mean budget closing energy flux (68.96 ±24.6 Wm2) or, budget error was 15.8% of incoming short wave radiation. The extent of warming effect by CH4 and sensible heat flux was predominant over the resultant cooling effect due to the processes such as photosynthesis, evapotranspiration and albedo. Non sea-sulphate aerosol sourced from anaerobic soil H2S efflux could counteract the extent of regional atmospheric warming effect by methane and sensible heat flux. CO2 induced greater litter production could make sediment more anoxic leading to the occurrence of more non-sea sulphate aerosol and higher albedo. The mangrove ecosystem is capable of resisting al least some of the anthropogenic perturbation and the crucial question is whether humanity's actions can drive the system beyond any Gaia repair capability.

4D.4

Group Tree Sway in a Coniferous Forest Canopy

Forest Biometeorology

David R. Miller, University of Connecticut, Storrs, CT; X. Zhao, M. Rudnicki and A. A. Hixcox

This paper reports on research to measure and map tree sway motions in a dense coniferous forest canopy in both time and space. Biaxial clinometers mounted on 149 dominant trees in a 150 m diameter circular plot were used to monitor the trees' sway dynamics. Tree bending vectors (magnitude and direction), and their spatial correlations, are mapped to visualize and quantify group sway and gust impressions in the canopy.

4D.5

Meteorological Influences on the Dispersal of the Gypsy Moth: Spread to the Arrowhead of Minnesota

Forest Biometeorology

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The gypsy moth, *Lymantria dispar*, is a non-native forest pest that continues to invade new areas in North America. Spread usually occurs through stratified dispersal in which local growth and diffusive spread are accompanied by long-distance jumps ahead of the expanding leading edge. Anthropogenic movement of life stages is a well-documented, stochastic mechanism of gypsy moth spread dynamics. Another mechanism is through the atmospheric transport of early instars and adult males over both long and short distances. Pheromone-baited traps have been deployed across Minnesota since 2000 to monitor populations. Gypsy-moth-trap catches have been particularly high in the arrowhead region of northern Minnesota (St. Louis, Lake, and Cook counties). The time series of male moth trap catch data in northern Minnesota shows a temporally continuous pattern of low male moth counts with a spatial pattern that suggests adult males, or immature life stages, were introduced at various spatial locations nearly simultaneously, such as through a discrete atmospheric transport event. This type of pattern was also observed in Wisconsin as gypsy moth was first invading. These patterns are in contrast to observations of the patterns of newly-established gypsy moth populations elsewhere in which there is a structure that generally originates from a single location, such as one that is initiated through the anthropogenic movement of egg masses. The Minnesota trap catch data also reveal a bimodal structure over the course of a season, in which one peak phenologically corresponds to climatic conditions in northern Minnesota while an earlier peak phenologically corresponds to climatic conditions elsewhere. Furthermore, there is evidence from measurements of wing length from male gypsy moths collected in traps from 2007–2009 that the individuals trapped in Northern Minnesota may be comprised of different populations. This study uses a probabilistic climatological model to explore the question of whether there exists a reproducing population established at low density (resident population), or if trap catch data are the result of yearly re-introductions (immigrating populations), or a combination of both. The ability to ascertain the degree of introductions through atmospheric transport would greatly improve management decisions and better target treatments against those areas most likely to contain established populations. This project expands understanding of the dispersal mechanisms in the Great Lakes region, and perhaps nationwide, and works toward validation of the previously-developed meteorological model to predict atmospheric transport of the gypsy moth.

4D.6

Annual and Interannual Variability of Forest Fires in Tropical South America and their association with the Normalized Difference Vegetation Index (NDVI) during 2000-2010

Forest Biometeorology

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We study the space-time dynamics of the Normalized Difference Vegetation Index (NDVI), in tropical South America at annual and interannual timescales, and their association with forest fires for the period spanning from 2000 to 2010. NDVI is defined as the ratio between (NIR-Red) and (NIR+Red), where NIR is the spectral response in the band of the near infra -red (0.73 µm -1.1µm) and Red is the spectral response in the red band (0.55 µm to 0.68 µm). NDVI data correspond to the MOD13A2 MODIS sensor (Moderate Resolution Imaging Spectroradiometer) with a 1-km spatial resolution, and a 16-day temporal resolution, using the reference GRS80 ellipsoid and sinusoidal map projections. Regarding information about forest fires, thermal anomalies are used from the Landsat TM imagery (MOD14A2 MODIS sensor) with a 1 km spatial resolution and 8-day temporal resolution. The average seasonal cycles of both variables are estimated, and the interannual variability is estimated in association with the occurrence of El Niño/Southern Oscillation (ENSO), as quantified by the Multivariate ENSO Index (MEI), provided by the National Oceanic and Atmospheric Administration (NOAA) for the decade. All analysis are performed for the Colombian-Venezuelan Llanos, and four regions defined over the Amazon River basin, namely Western, Central, Southern, and Eastern. Fires over the Colombian-Venezuelan Llanos exhibit a marked bi-modal annual cycle, with maxima during September and April, and minima during December-January and June-August, whereas a uni-modal annual cycle in Amazonia, with maximum during August-October and minimum during February-April. Such fires dynamics are closely associated with the annual cycle of NDVI. Results for the interannual variability allow us to conclude that forest fires are tightly

associated with dry periods, but also with those regions subject to agricultural expansion. Forest fires exhibit an increase of around 30% with respect to normal years, whereas forest fires diminish (around 15%) with respect to normal years.

5A.1

Bio-Energetics of Animals and Novel Ways of Cooling High-Producing Dairy Cows during Heat Stress

Heat Stress in Domestic Animals: New Technologies and Approaches
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All processes of life -all physiological events -require energy expenditure. A climatic energy demand (food and water requirements) of an endotherm is a coupled heat and mass transfer problem and can be predicted using an energy balance model. To survive, animals need an environment that allows them to dispose of their excess metabolic heat. Thus, heat stress occurs when high ambient temperature or humidity leads to the animal having difficulty disposing of their metabolic heat. As body temperature begins to rise, a heat-stressed cow will breathe rapidly and start panting and sweating, all of which require additional energy expenditure and increase the total heat load the cow must dispense. Cows under heat stress will also have reduced feed intake and reduced milk output, with milk production falling in response to less incoming energy from feed consumption as well as other physiological factors. Heat stress tends to disproportionately affect higher producing cows since a higher producing cow will have higher metabolic heat production. Effects of heat stress can linger for several months as chronic heat stress leads to compromised immunity and fertility, and even a relatively short exposure to severe heat stress may damage a cow's milk production until the next time she freshens. The US dairy industry, a $37 billion industry in 2012, already loses more than $1.5 billion/yr. to the effects of heat stress. Climate change could exacerbate these losses. Current methods to alleviate heat stress are usually based on using fans to create forced convection as well as using misters or sprinklers to create evaporation. These methods of cooling cows take a lot of water and energy, and both fans and misters are less effective under humid conditions. High water consumption is especially a problem in the Western US, where water is scarce. Furthermore, use of water to cool cows leads to hygiene and disease concerns, which limits evaporative cooling applications near bedding areas. Increasing energy costs have also led to less return on investment for cooling systems that require significant energy use. Conductive cooling is an alternative animal cooling strategy that uses cold water to cool the beds that cows lie on, and thus conductively cool the cows. In this closed-loop system, all of the water is recirculated and re-cooled so no water is lost. Energy to run the system can potentially be recovered waste energy as well, making the system completely sustainable. Our results show that conductive cooling is very effective in relieving heat stress and increasing milk production as well as decreasing respiration rates and rectal temperatures. Cows conductively cooled also tend to spend more time lying down, and time spent lying down is positively correlated with milk production. This presentation will discuss bioenergetics (energy budget) of animals and novel ways of cooling cows in thermally stressful environments.

5A.2

Thermoregulatory Adjustments of Cattle to Long-Term Heat Stress in a Field Environment

Heat Stress in Domestic Animals: New Technologies and Approaches
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Few studies have examined the changes in maintenance of thermal balance in cattle during repeated daily heat exposure over a summer period. One challenge with this type of study is the continuous measurement and analysis of animal and ambient conditions over an extended period of time. An objective of this study was the development of a routine that allows for this process. Another goal was the determination of time-dependent change in several key physiological indicators of thermal status as a function of ambient condition. The present study measured thermoregulatory ability over 90 days to identify early and late periods of heat response. Crossbred Angus steers (n=36; average body weight = 284±29kg) were stratified by weight, and housed in feedlots with approximately 50% shade coverage. Ambient conditions were recorded using Hobo loggers (Onset Computer, Bourne, MA). Overall ambient temperature (Ta) range was 12.2 to 36.6°, and calculated temperature humidity index (THI) was 54.4 to 85.3. A corn-based diet and water were provided ad libitum, and core temperature (Tcore) measured hourly using intraruminal telemetric boluses (Smartstock, Pawnee, OK). Respiration rate (RR) was measured at 0800 and 1700h on selected days to record daily low and high periods of performance, respectively. Relationships between RR, Tcore, and Ta were examined using linear regression and ANOVA procedures (JMP Statistical Software; SAS Institute; Cary, NC), and focused on early (Period 1; Days 1-24) and late (Period 2; Days 70-90) responses to heat. The purpose of deriving these relationships was to determine effector response (i.e., RR) to Ta, thermal status (i.e., Tcore) shift with Ta, and the RR relationship to Tcore. Mean daily Ta values showed a slight increase in heat stress level (P=0.005) from Period 1 (28.0±0.7¨¬C) to 2 (31.2±0.7¨¬C). Mean daily THI values were nearly identical (P=0.12) for Periods 1 (76.8±1.0) and 2 (79.0±1.0). Maximum Ta and THI values for the two periods ranged from 34.4 to 36.6¨¬C and 84.8 to 85.3, respectively. As a result of the slight increase in heat stress from Periods 1 to 2, mean RR and Tcore values increased from 69.0 to 85.4±0.8 bpm (P°Â0.0001) and 39.7 to 40.1±0.02¨¬C (P°Â0.0001), respectively. The most adaptive change was RR versus Ta, with a linear regression slope reduction from 3.70 to 2.61 bpm/° from Periods 1 to 2 (P<0.0001) to indicate a decreased sensitivity response for RR with continued heat exposure. In contrast, the slope change in the linear relationship of Tcore versus Ta from Periods 1 to 2 was insignificant (P=0.85). The slope change in the same relationship of RR versus Tcore was also insignificant (P=0.76) from Periods 1 to 2. Interestingly, correlation coefficient values for all relationships increased (P range = 0.02 to 0.08) from Periods 1 to 2 to suggest less variance in heat stress response with adaptation. The results of this study indicate that respiratory rate response to ambient temperature decreases with heat adaptation in cattle. This is possibly due to the adaptive reduction in metabolic heat production that is known to occur in controlled studies, and the concomitant decreased need for heat dissipation through avenues such as respiratory evaporation.

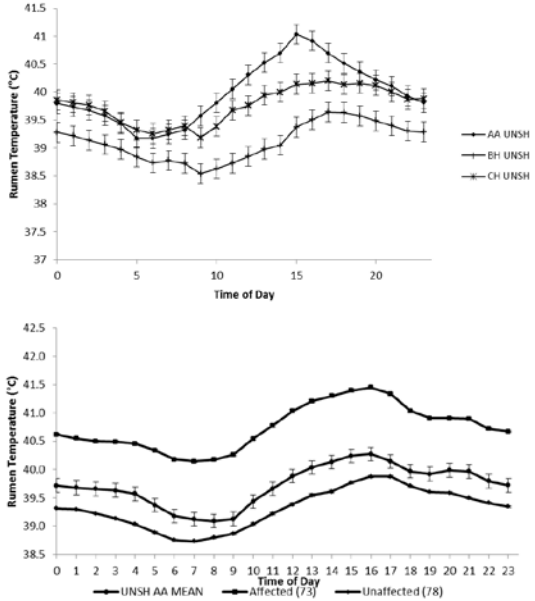
5A.3

Using an RFID device to obtain rumen temperature in cattle

Heat Stress in Domestic Animals: New Technologies and Approaches
John.B Gaughan, The University of Queensland, Gatton, Queensland , Australia; A. Lees, M. Sullivan and J. Cadwell-Smith

Numerous behavioural and physiological parameters have been used to assess heat tolerance in cattle. Core body temperature is considered to be the best indicator of thermal load in animals but is difficult to obtain for long periods, i.e. weeks to months. Rumen temperature (TRUM) sensor boluses were administered to 18 steers (318.5±6.7kg). Six Brahman, 6 Angus and 6 Charolais steers were used in the study. The steers were held in un-shaded feedlot pens (2/breed/pen; 3 pens were used) over 130 days (Australian summer), and fed a 70% grain based diet. Rumen temperature was transmitted to a base station at 10-min intervals using transponder rumen boluses (RFID transmitter; Smartstock™, USA). The radio transmissions were converted from an analogue signal into a temperature value using proprietary software (TechTrol Inc., USA). In addition to rumen

temperature, panting scores (0, no panting; 4, open mouth, tongue extended, drooling) were obtained daily for each animal at 2 h intervals between 0600 and 1800 h. These data (panting score and rumen temperature) were used to assess the heat load status of each animal. Heat susceptible animals were identified has having a panting scores >2 and a mean rumen temperature > 40.5 oC. The weather conditions over the duration of the study were sufficient to induce a heat stress response in the Angus on most days. Five heat wave events also occurred during the study. As expected the Brahman cattle were least affected by the climatic conditions and Angus the most affected (Figure 1). Rumen temperature was analysed by day (D; 0600-1800 h) and night (N; 1700-0500 h). The heat affected steers (Angus) had a higher TRUM ($P<0.01$) over the duration of the study; D means were 40.8±0.03 oC and N means were 40.7±0.03 oC; compared with 39.3 ± 0.03 oC (for both D and N) for the unaffected steers (Figure 2). During periods of high heat load TRUM of the non-heat tolerant Angus (affected steers) was greater ($P<0.01$) during the day (41.6±0.09 oC) and at night (41.0±0.03 oC). For the heat tolerant Angus steers (unaffected) the day time (39.7±0.03 oC) and nightime (39.4±0.03 oC) rumen temperatures were lower ($P=0.01$) than for the affected steers. As a reference for heat tolerance Brahman steers maintained a mean TRUM of 39.1±0.08 oC throughout the study (Figure 1). It would appear that TRUM may be a useful measure for identifying heat tolerant cattle both within and between breeds; however more work is required to fully establish the relationship. Further to this there is also a need to establish potential performance trade-offs between heat tolerant and non-tolerant animals withi a breed. Figure 1. Mean rumen temperature (oC) at hourly intervals (Time of Day) for unshaded Angus, Brahman and Charolais steers over 130 days (Australian summer). Figure 2. Mean hourly rumen temperature (°C) of un-shaded Angus (UNSH AA) steers and of heat tolerant steers (unaffected) and non-tolerant steers (affected).



5A.4

Using infrared thermography as an assessment of body temperature in cattle

Heat Stress in Domestic Animals: New Technologies and Approaches

Angela M. Lees, The University of Queensland, Gatton, Queensland , Australia; J. C. Lees, A. L. Wallage, M. L. Sullivan, A. T. Lisle and J. B. Gaughan

Body temperature is a reliable indicator of thermal balance in cattle and can be measured at several locations e.g. tympanic, abdominal, rumen (T_{RUM}), and rectal. Rectal temperature is the most common method used and is considered to be the 'gold standard' for the measurement of body temperature in cattle. However these procedures do have limitations as the animal needs to be restrained for data loggers to be inserted and because the use of data loggers within animals is restricted to short term use (≤ 10 days) or requires surgical implantation, thus limiting continuous data collection. Methods of non-invasive measurements of body temperature that are fast, efficient and reliable need to be investigated. Infrared thermography (IRT) is a non-invasive method used to visualise and determine body surface temperature. Studies investigating the relationship between body temperature and body surface temperature are limited. In this study IRT images of the head and body of feedlot cattle were collected using a thermal camera (Fluke Ti25, Fluke Corporation, Everett, WA, USA) and these were used assess the relationship between body surface temperature and T_{RUM}.

Twelve Angus steers were housed in individual pens (10 m x 3.4 m) with access to shade for 5 d. Animals were observed at 3 h intervals for behaviour (ruminating/eating/drinking), posture (standing/laying), location (shaded/unshaded), panting score (using 0 – 4.5 score; where 0 is no panting, and 4.5 is open mouth, tongue extended panting) and IRT images of the head and body. Animals were observed from outside the individual pens and IRT images were taken after the completion of observations at a distance no greater than 2 m away from the animal. Mean body surface temperatures were recorded along the medial line on the head between the poll and the nose and on the transverse medial plane between the point of the shoulder (greater tubercle of humerus) and the hind limb of the animal. Rumen temperature was obtained every 10 min from each animal via orally administered boluses (Smartstock, Pawnee, OK, USA). The boluses were an active RFID transmitter which relayed a signal to a base station and then into a database (TechTrol Inc., Pawnee, OK, USA). At each transmission of T_{RUM} the previous 12 data points (previous 120 minutes) were also downloaded, thereby minimalizing data losses. Individual 10 min T_{RUM}data were converted to an hourly mean.

Pearson's correlation coefficient (Minitab® 16.2.0, 2010 Minitab, Inc.) were used to determine the relationship between the body surface temperature and T_{RUM}. A strong relationship between the IRT images of the head and body (r = 0.88) was determined. However there was little relationship between the T_{RUM} and IRT images (Figure 1) of the head (r = 0.07) and body (r = 0.06). Temperatures recorded by the IRT were generally lower than that of T_{RUM} where mean head and body surface temperatures were 7.79 ± 0.24 °C and 7.25 ± 0.17 °C below T_{RUM} respectively.

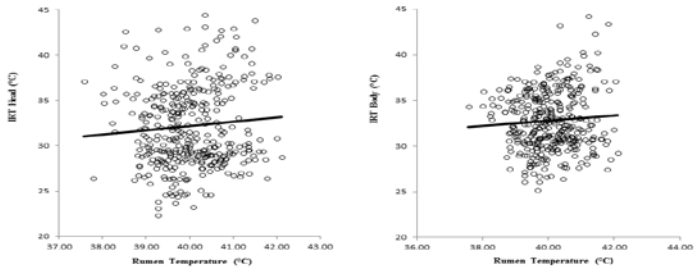


Figure 1: Linear trend between infrared thermography (Y axis) of the head and body against rumen temperature (X axis)

Infrared thermography may not be a suitable method in the determination of T_{RUM}, as these data suggest that there was little relationship between the IRT of the head and body and T_{RUM}. However further analysis is required to determine the true relationship between IRT and T_{RUM}. Furthermore on-going work will assess the usefulness of IRT from other parts of the body, e.g. eye, as potential indicators of body temperature.

5A.5

Scrotal thermoregulation in the bull: The effect of surgery, body temperature and ambient temperature

Heat Stress in Domestic Animals: New Technologies and Approaches

Andrea L. Wallage, The University of Queensland, Gatton, Queensland , Australia; S. D. Johnston, A. T. Lisle, A. M. Lees, L. Beard, A. J. Cawdell-Smith, C. W. Collins and J. B. Gaughan

The bull's scrotum and associated scrotal cord vasculature is traditionally regarded as a thermoregulatory device for maintaining the testis at an optimal temperature for sperm production. Most studies on this topic have focussed on the direct effects of applied heat on spermatogenesis and/or only considered static measurements of scrotal temperature (ST) of no more than a few days. Continual measurement of ST in a natural setting has not been documented and as such the dynamic relationship between ST, body temperature (BT) and ambient temperature (TA), if one exists, has not been clearly defined. Cattle possess a strong diurnal cycle for BT, so if ST is to remain at a constant temperature the difference between the two must vary throughout the day, which would explain the range in reported differences from the literature of 2 to 7 °C. The aim of this study was to determine whether ST does in fact remain at a constant temperature relative to BT and if it does, how this relationship changes over days and weeks.

Four Wagyu bulls (identified as B2 to B5) were surgically implanted with two implants, each containing a calibrated and wax coated temperature data-logging iButton (DS1922T, Maxim, California; 30 minute logging interval); one implant was sutured approximately 20 mm into the muscle layer on the right hand side flank and the other attached mid-testis to the parietal vaginal tunic within the scrotum. Post-surgery, all bulls were allowed to recover individually in a shaded pen (IP1 and IP2; 34 m^2) and were then released into a nearby paddock (PAD; 1200 m^2) with access to shade, where the bulls remained for 20 to 27 days and after which time they were then returned to the individual pens for implant removal (IP2). This study was conducted from mid-summer to early autumn. Half hourly climatic data was recorded using a weather station (Esidata MK-3; Environdata Australia Pty Ltd, Warwick, Australia). Photoperiod data was obtained from Bureau of Meteorology from the closest weather station (040082, 27.54°S, 152.34°E).

Pearson correlations (Minitab® 16.2.0, 2010 Minitab, Inc.) were used to identify the relationship between BT, ST, TA, and photoperiod for each bull. All relationships were significant and ranged from moderate to strong ($r = 0.501$ to 0.936, $p < 0.001$); however, the strongest relationship for every bull was between ST and photoperiod ($r > 0.803$, $p < 0.001$). As photoperiod is almost perfectly correlated with time, this correlation is likely to be a trend over time rather than an underlying relationship with photoperiod. A repeated measures analysis using the MIXED procedure with a first order auto-regressive error structure assumed, was completed in SAS to model the long term trend (Figure 1) (SAS Institute Inc., NC, USA); the individual animals were subjects and the date of observation included as a fixed effect. This same model was also used to examine the diurnal trend (Figure 2) with time of day added as a fixed factor and location (IP1, PAD and IP2) as a covariate as the different locations represented different periods of time.

During IP1, there was a small daily decline in mean ST (Figure 1); this increased to a steeper decline from 37 °C to around 35.7 °C during PAD, followed by a steady temperature for 5 days and then an increase in ST during IP2. The pattern of ST is not mirrored by BT suggesting a more complex relationship between the two. As time passes it can be seen that both the shape of the ST cycle and the temperature itself changes over time (Figure 2). ST appears to follow the BT diurnal cycle in IP1 indicating a possible breakdown or compromise in thermoregulation, before returning to a more steady temperature in PAD and IP2.

The lack of thermoregulation in IP1 is probably due to post-surgical recovery (inflammation) resulting in a compromised thermoregulatory ability, in combination with the fact that TA was highest during this period. Whilst any noticeable inflammation from the bull's scrota appeared resolved within 7 to 10 days, the data would suggest that the effect on thermoregulation ability is longer lasting. The steeper descent (> 1°C) in mean ST when the bulls were in the paddock is thereby likely due to “full” surgical recovery and resumption scrotal thermoregulation. Additionally, the PAD was an open environment where behavioural thermoregulation was an option and the authors believe that behaviour plays an important role in the control of ST. Finally, once returned to the confines of the pen (IP2) the opportunity for behavioural thermoregulation was reduced so that a slight increase in ST may have been associated with increased periods of time where the bull was lying down with the scrotum in direct contact with the body (Figure 1); this despite the fact that ST during the day remains at a relatively constant temperature (Figure 2 IP2). Additionally mean TA during this period is around 20 °C thus the animals would not be under a significant heat load. Given this dataset spans less than 3 months and behavioural observations were not a focus, conclusive long term trends and the effect of behaviour if they exist cannot be fully determined. A longer data set covering a larger portion of the year with more detailed behavioural observations would be required to separate the effects of behaviour and post-surgical recovery.

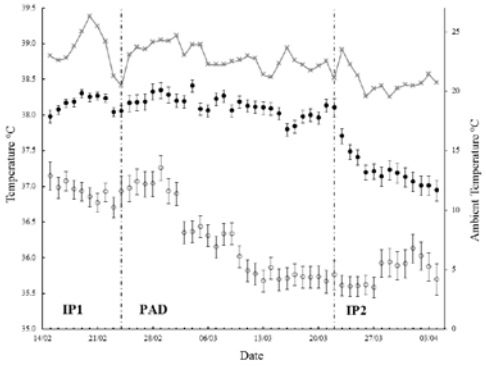


Figure 1: Means ± SEM for BT (filled circles) and ST (open circles) representing the long term trend. TA (crosses) is plotted on a secondary vertical axis. Vertical dashed lines indicate where animals moved location (IP1 to PAD to IP2).

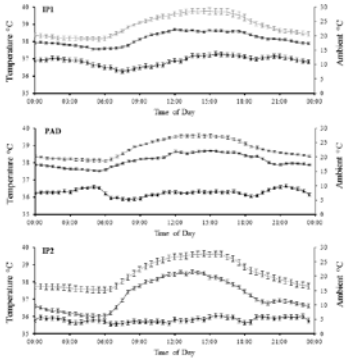


Figure 2: Diurnal pattern of ST (Bottom line), BT (middle line) and TA (top line on secondary vertical axis) (Mean temperature, °C ± SEM) from the different locations (IP1, PAD and IP2).

5B.1

Observing Land Surface Phenologies: Back to the Future with the Planetary Macroscope

Phenology I: Monitoring
Geoffrey Henebry, South Dakota State University, Brookings, SD

Among the first studies conducted using data from sensors onboard the first Earth Resource Technology Satellite (ERTS-1, later renamed Landsat-1) were investigations into tracking the seasonal progression of vegetation at the continental scale. Although these remote sensing pioneers demonstrated that observations from Landsat could indeed track the “green wave”, various logistical constraints inhibited widespread development of land surface phenology until the advent of synoptic time series from Advanced Very High Resolution Radiometers (AVHRR) onboard NOAA's operational the Polar Orbiting Environmental Satellites (POES) nearly a decade later. Trading higher temporal resolution for lower spatial resolution, AVHRR time series enabled the use of maximum value compositing of the Normalized Difference Vegetation Index (NDVI) to defeat cloud cover and reveal the land surface. The Moderate Resolution Imaging Spectrometer (MODIS) on the NASA Terra and Aqua satellites launched in 1999 and 2002, respectively, ushered in a productive era for land surface phenology with multiple high quality products freely available. The opening of the USGS Landsat archive in 2008 to free online access marked a watershed event in terrestrial remote sensing. The mining of the archive is now well underway, but of particular note are the NASA Web Enabled Landsat Data (WELD) projects that are lowering the technical bar to access high quality time series of historic Landsat data. I will survey the current state-of-the-art in land surface phenology with particular emphasis on exploiting WELD for high spatial resolution land surface phenology in croplands and in urbanized areas.

5B.2

Monitoring Alpine Grassland on the Tibetan Plateau: its Phenological Change and Climatic Dependencies with Satellite Time Series

Phenology I: Monitoring
Cuizhen Wang, University of South Carolina, Columbia, SC; Z. Li and H. Guo

The Tibetan Plateau, with an area over 2.5 million km2 and an average elevation higher than 4000 m, is a unique cold and dry highland recognized as the Earth's 3rd Pole. Its fragile ecosystems are sensitive to climate change on the plateau that has been experiencing a distinct warming trend in past decades. The plateau is primarily composed of alpine grasslands (>60%) with an east-west transition of alpine meadow, alpine steppe and alpine desert grass, respectively. Due to geographic difficulties to access, the bio-properties of these alpine ecosystems and their phenological variations in the changing climate are not well documented.

This study extracts the biophysical and phenological features of alpine grasslands from satellite time series and examines their relationships with climate and permafrost conditions on the plateau. The 8-day, 500-m MODIS surface reflectance products (MOD09A1) in 2000-2010 are downloaded to extract the normalized difference vegetation index (NDVI). The annual NDVI time series are then processed to extract peak NDVI, growing-season NDVI and a set of pheno-phrases of alpine grasslands. The MODIS snow cover products (MOD10A2) at the same scale are used to extract snow accumulation in this period. At 25-km grid size, daily soil moisture distributions are available with the Advanced Microwave Scanning Radiometer-Earth Observation System (AMSR-E) Level-3 Soil Moisture products in 2003-2010. Permafrost maps on the plateau are also available via previous collaborative research. A non-parametric Mann-Kendall trend analysis is performed to find the trends of all these metrics. Their correlations are then examined to identify the environmental drivers that influence the change of alpine grasslands.

Opposite trends of phenological change are observed between the east and west of the plateau, with delayed Start of Season, Peak Date and End of Season in the west and advanced pheno-phases in the east. The correlation analysis indicates that precipitation, with a decreasing trend in the west and increasing in the east, may serve as the primary driver of the onset and peak dates of greenness. Temperature increases all over the plateau. While the delay of the End of Season in the west could be related to higher late-season temperature, its advance in the east needs further investigation in this unique cold region. Impacts of permafrost thawing on the plateau are still under investigation. This study demonstrates that frequent satellite observations are able to extract phenological features and environmental conditions of alpine grasslands, which provides spatio-temporally detailed base information for long-term monitoring on the Plateau under the rapid climate change.

5B.3

European vegetation response to climate drivers in the last decade: using 1 km MERIS data for modelling changes in land surface phenology

Phenology I: Monitoring

Victor F. Rodriguez-Galiano, University of Southampton, Southampton, United Kingdom; J. Dash and P. Atkinson

Phenological events, such as onset on greenness and senescence, occur at a specific time depending upon the local climatic conditions. Given this dependency between phenology and climate, the former has emerged as an important focus for scientific research because phenological events are regarded as an indicator of global warming. On the other hand, phenology also affects climate, playing an important role in many feedbacks of the climate system by influencing albedo, and fluxes of water, energy and CO2. Thus, a better understanding of the drivers of phenology is of paramount importance, especially for the senescence phenophases, to which the controlling factors are not well documented.

Temperature is one of the key parameters to regulate vegetation growing states in high latitude regions such as Europe, changes in air temperature will lead to changes in vegetation growth. Numerous studies have been conducted to evaluate the sensitivity of spring phenology to warming using plant phenological records. Additionally, others studies have used time series of satellite sensor derived vegetation indexes to up-scale phenology (Land Surface Phenology; LSP) and study the influence of climate at global or continental scales. These studies performed linear regression between phenology trends or anomalies and temperature values. However, the relation between phenology and climatological drivers is complex, and it is not necessarily linear. Therefore, there is a need for the application of new generation computational tools to assist in extracting as much information as possible from the rapidly growing volumes of digital data. This is the case of the present research, related to a considerably large phenological and climatological dataset retrieved for the whole Pan-European Continent in the last decade.

Regression Trees (RT), a machine learning technique, appears as an alternative to traditional regression (global single predictive models), allowing for multiple regressions using recursive partitioning. When the database has many variables which interact in complicated, nonlinear ways, assembling a single global model can be very difficult and hopelessly confusing. An alternative approach to nonlinear regression is to sub-divide, or partition, the space into smaller regions, where the interactions are more manageable. The application of machine learning techniques has different advantages: i) ability to learn complex patterns, considering nonlinear relationships between explanatory and dependent variables; ii) generalisation ability, hence applicable to incomplete or noisy databases; iii) integration of different types of data in the analysis due to the absence of assumptions about the data used (e.g. normality); and iv) interpretability of results, since RT allows obtaining patterns for a better explanation of a given phenomenon, showing the most important variables and their threshold values.

This contribution reports the application of RT to model the differences in phenology for the natural vegetation of Europe in the last decade using temperature and precipitation data. Multi-temporal Medium Resolution Imaging Spectrometer (MERIS) Terrestrial Chlorophyll Index (MTCI) data at 1 km spatial resolution were used to derive key phenological metrics (onset on greenness and end of senescence) for a 10-year time series data from 2002 to 2012. Differences in phenology were computed as the difference from the decadal median. Surface air temperature data and precipitation were acquired from the European Climatic Assessment Dataset and interpolated at the satellite data spatial resolution from an original of 0.25°. We used the daily mean temperature and precipitation and computed monthly and trimestral averages, as well as growing degree days and chilling requirements for every year. All these variables were used as input to the Regression Tree model. This approach is, to the knowledge of the authors, attempted here for the first time. The goal is to gain access to novel information regarding relationships and potential interactions between differences in phenology (synergy between different climatological drivers and threshold values in temperature, growing degree days, etc), not directly or easily provided by more traditional statistical methods. Apart from focusing on the present case, this research aims to encourage other researchers dealing with complex and interacting systems or processes to further contribute with new insights to this novel line of research.

5B.4

Monitoring Vegetation Phenology Using Daily Nadir BRDF-Adjusted VIs from VIIRS

Phenology I: Monitoring

Yan Liu, UMASS Boston, Boston, MA; C. Schaaf and Z. Wang

Vegetation phenology is the timing of the biological events in plants such as flowering, leafing, fruiting and leaf-out (Lieth, 1974; Reed, 1994). Longtime accurate and consistent estimation of phenology at global scale can help understanding of inter-annual variability of vegetation and how climate changes affect vegetation. Vegetation Index (VI) from AVHRR (Advanced Very High Resolution Radiometer) and MODIS (Moderate Resolution Imaging Spectroradiometer) have been used to monitor timing of vegetation greenup, maturity, senescence and dormancy at regional to global scales in the past decades (Reed, 1994; Moulin, 1997; Zhang, 2003).The Visible Infrared Imaging Radiometer Suite (VIIRS) on the Suomi-NPP satellite (launched on October 28, 2011) can continue providing global observations to monitoring vegetation phenology. By fitting VIIRS Nadir BRDF- adjusted VIs of 2012 to a series of piecewise logistic functions, intra-annual vegetation dynamics (vegetation phenology) at SURFRAD (Surface Radiation) sites can be estimated.

Methodology: Three major steps were performed. First, Nadir BRDF- adjusted Reflectance(NBAR) is derived by utilizing a similar approach that used for the Collection V006 daily MODIS Bidirectional Reflectance Distribution Function (BRDF)/Albedo product. Second, NBAR are used to calculate VIs using Eq. (2) and Eq. (3). Then the VIs are fitted to estimate the timing of greenup, maturity, senescence and dormancy.

Multidate, multispectral, cloud-cleared, atmospherically-corrected VIIRS surface reflectances are used to fit the Ross-Thick/Li-Sparse-Reciprocal (RTLSR) semi-empirical BRDF model to generate BRDF model parameters.

$$R(\theta,\upsilon,\phi,\lambda) = f_{iso}(\lambda) + f_{vol}(\lambda)K_{vol}(\theta,\upsilon,\phi,\lambda) + f_{geo}(\lambda)(\lambda)K_{geo}(\theta,\upsilon,\phi,\lambda) \quad (1)$$

Where θ,υ and ϕ are solar zenith, view zenith and relative azimuth angles; *iso, vol* and *geo* mean isotropic, volumetric and geometric. K_{vol} is the volumetric kernel derived from Ross-Thick volume scattering radiative model, and K_{geo} is the geometric kernel derived from Li-Sparse geometric shadow casting theory. f_{iso}, f_{vol} and f_{geo} are the weights given to the BRDF model parameters (Schaaf, 2002).

Clear sky observations are weighted based on their quality (shadowed or affected by aerosol), observation footprint, and proximity to the production date of interest (Wang, 2012). A Least-Squares Error function (LSE) is used to establish the analytical solutions for the model parameters f_k (Lucht, 2000). When a high quality full inversion is not possible due to insufficient of reflectance observations, a lower quality magnitude inversion is produced by using the latest full inversion retrieved as *a priori*. The model parameters f_k are then utilized to calculate NBAR (Schaaf, 2002).

Two VIs are used, NDVI (Normalized Difference Vegetation Index) and EVI (Enhanced vegetation index).

$$NDVI = \frac{\rho_{NIR} - \rho_R}{\rho_{NIR} + \rho_R} \quad (2)$$

$$EVI = 2.5 * \frac{\rho_{NIR} - \rho_R}{\rho_{NIR} + 6 * \rho_R - 7.5 * \rho_B + 1} \quad (3)$$

To monitor vegetation phenology, same approach used by Zhang (2003) is utilized to fit time series VIs of SURFRAD sites to identify phonological transition dates.

Results: Figure 1 is the annual VIs of Fort Peck. It clearly shows the annual cycle of vegetation phenology. More results at other sites will be provided, but this initial case demonstrates that VIs from VIIRS can detect the inter-annual variability of vegetation, and assure data continuity for land surface climate and biosphere models.

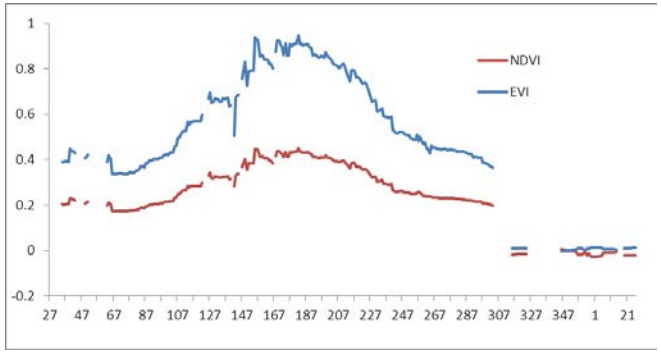


Figure 1 VIs of Fort Peck

5B.5

Crop Area Estimation in Iraq Based on Satellite Derived Phenological Metrics and the Influence of War and Drought

Phenology I: Monitoring
Sarchil Qader, Southampton, United Kingdom; J. Dash and P. Atkinson

War and political conflicts can affect the land use practices, particularly agriculture in a country and in turn could affect the availability of food grain and food security of a country. Over last decade, Iraq had been involved in 'Post-Gulf' war mainly to oppose the previous regime. Due to the political instability and fear for life during the war many farmers were unable to grown any crops, which affected the overall production of the country. In addition to the war, due to its geographical location, the region is affected by irregularities in precipitation resulting in frequent occurrence of drought. Both these factors made the region vulnerable to sustained food production.

However, at present there are no reliable estimation of both crop areas and crop yield across the country. Therefore, the current research will attempt to use the phonological information to classify the country's land cover type in order to provide an accurate estimation of crop area and their changes through time. Thirteen successive years of 8 days Normalized Difference Vegetation Index (NDVI) with the spatial resolution of 250 m derived from the Moderate Resolution Imagery Spectrometer (MODIS) were analysed. Fourier technique will use to smooth the phonological signal. Eleven phenology metrics were extracted from MODIS NDVI time series with elevation from Shuttle Radar Topography Mission (SRTM) for Iraq to classify the crop areas. A decision tree based classifier was used to o discriminate crop types (irrigated and rainfed) to natural vegetation. Initial results suggested significant changes in crop area in Iraq from 2001 to 2013 mostly attributed to Post-Gulf war and occurrence of drought. A Detail quantitative estimate of the impact of these factors on total crop area and resulting crop yield will be presented.

5B.6

Long-term Global Land Surface Phenology Derived from AVHRR and MODIS Observations and Its response to Climate Changes

Phenology I: Monitoring
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Land surface phenology has been widely retrieved from satellite observations at regional and global scales. Since it is an ideal indicator of recent climate changes, spring vegetation greenup has been frequently applied to explore the warming climate impacts in middle-high latitudes. However, we understand poorly the diverse responses of sequent phenological indicators that comprise an entire vegetation growing cycle to climate changes at broad environments. It is hypnotized that the timing of individual phenological indicators in a seasonal cycle may be independently advanced, delayed, or unchanged in responses to climate change. Integrating a sequence of key phenological indicators is expected to more effectively reflect long-term climate variation in various seasons. It is also more effective to track, trace and project the climate impacts as climate change continues. This study detected global land surface phenology from AVHRR and MODIS from 1982-2010. Specifically, based on a dataset of daily enhanced vegetation index (EVI) at a spatial resolution of 0.05 degrees, we simulated the seasonal vegetative trajectory for each individual pixel and then detected the phenological indicators including onset of greenness increase, onset of greenness maximum, onset of greenness decrease, onset of greenness minimum, the onset of middle greenup phase, the onset of middle senescent phase, growing season length, magnitude EVI, and growing season aggression in EVI. Further, we examined the interannual variations and trends of the phenological indicators from 1982-2010. Meanwhile, the phenological variations were directly linked to long-term global precipitation and temperature. The results indicate (1) spring green up is consistently advanced in some regions, such as Alaska; (2) vegetation greenup phase become short in southern hemisphere; (3) interannual variation in vegetation growth is significantly increased during summer and autumn globally; (4) these temporal and spatial patterns effectively reflect the variations in climate variables.

5C.1

An Analysis of Biometeorological Thermal Comfort in an Oasis City within The Sub-tropical Climate Zone: The Case of Al Ain City, UAE

Thermal Comfort and Indices II

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Outdoor thermal comfort is an important issue of public health concern, especially for an arid region like the UAE where summer air temperatures can soar to 50°C inducing heat discomfort conditions. Excessive outdoor heat exposure pose well-known health risks such as heat stroke and limits the outdoor workers' capacity to sustain physical activity. Several thermal indices have been developed for evaluating human thermal comfort. In order to evaluate human thermal comfort in the Oasis City of Al Ain, in the United Arab Emirate (UAE), variation in the biometeorological thermal conditions as indicated by a number of heat indices were analyzed using pertinent meteorological data (air temperature, relative humidity and wind speed) for the year 2012. The thermal indices analysed include effective temperature (ET), Temperature Humidity Index (THI), Discomfort Index (DI), and Humidex (H). Results show that severe thermal conditions occur in Al Ain for most part of the summer months which prevail from April through to September. During the study period, mean air temperature was 29.0°C (range: 12.0 to 40.8 °C), mean maximum temperature 36.1 °C (18.3 to 48.6 °C) and mean minimum temperature 22.8 °C (6.6 to 36.0°C). The mean relative humidity was 41.8 % (14.9 to 85.2%). Mean maximum effective temperature (ETmax), Mean effective temperature (ETmean) and mean minimum effective temperature (ETmin) values ranged from 53.1°C to 20.2°C, 43.1 °C to 12.2 °C, and 37.9 °C to 5.4 oC, respectively. The mean THI was 34.3 (17.9 to 51.6), DI was 23.8 (12.4 to 31.6) and mean H was 32.2 (11.8 to 51.1). The Humidex analysis results show that comfortable conditions prevail for 114 days, representing 31% of the total days in the year; some discomfort is experienced for 42 days (11%); great discomfort for 117 days (32%); and dangerous conditions prevail for 93 of the days (25%). Great discomfort and dangerous conditions occur during summer, beginning from May through to September. Based on the Discomfort index results, comfortable thermal conditions occur in 101 of the days (28%) with days when 10% of population experience discomfort prevailing in 103 of the days (28%); days when approximately 50% of population experience discomfort being 21 (6%); when 100% of population experience discomfort occurring in 19 of the days (5%) and days when discomfort is considerably high and hazardous were 122, accounting for 33% of the total days in the year of study. Comfortable thermal conditions prevail during the winter period which begins from December and ends in late February, but as is clearly demonstrated by both the THI and H indices, severe thermal conditions prevail in Al Ain most of the days in the year, mainly as a result of extremely high summer temperatures. Diurnal variation of Humidex on selected days in summer show that dangerous thermal conditions prevail for 70.83% of the time while great discomfort occur for the remaining 29.17%. Exposure to these extreme thermal conditions increases the heat stress of outdoor workers during summer considerably.

5C.2

Practical Precooling Technique in Occupational Settings

Thermal Comfort and Indices II

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Precooling (i.e., removal of heat from the body immediately prior to exercise) is a popular strategy for improving exercise performance in hot conditions. Immersion in water is the procedures most commonly used to precool in sports activities. However, the supply of a large volume of water and ice in all occupational settings is not always possible, or practical. We recently reported that fanning (4.5 m/s) and spraying water over the body for 30 min before walking reduced thermal strain while wearing impermeable protective suits (Tokizawa et al. Int J Biometeorol, 2014). Because the effects were less than those of conductive cooling, we here tried to investigate more effective conductive and evaporative cooling procedure by changing the velocity of the fan and exposure time (Study 1). In addition, we examined the effectiveness of hands and foot water immersion and wearing a cool-vest as alternative precooling method on heat strain while wearing protective clothing (Study 2).

Study 1: Eight males engaged in five cooling trials: 2 m/s, 4 m/s, and 8 m/s fan velocity for 30 min and 15- and 45-min fan exposure time in 4 m/s fan velocity. They sat with their anterior surface closest to two tandem fans at 28°C with 40% relative humidity. The water was sprayed continuously from a sprayer over the volunteers' entire anterior body during fanning. Study 2: Eight males engaged in 60 min of walking at a moderate speed (2.5 km/h) in a hot environment (37°C, 50%relative humidity). Before walking, they immersed hands and foot in water at 18°C and wore a cool-vest (PCM) for 30 min. The water was wiped off and the vest was put off, then they wore protective clothing and a full-face gas mask.

Study 1: In all trials, esophageal temperature showed the lowest at an hour after the end of the cooling. The decreases were not different among three fan velocities (0.4 ± 0.1°C, 0.5 ± 0.1°C and 0.5 ± 0.1°C in 2 m/s, 4 m/s, and 8 m/s, respectively). In 4 m/s fan velocity, 45-min fan exposure exhibited greater hypothermia than 30-min fan exposure (0.6 ± 0.1°C, $p<0.05$), whereas in 15-min fan exposure, the decrease was less (0.3 ± 0.1°C). Study 2: Rectal temperature increased by 1.1 ± 0.1°C at the end of the walking in the control trial (without the precooling). The precooling inhibited the increases (0.6 ± 0.1°C, $p<0.05$). In addition, sweat rate, heart rate, and thermal and fatigue perceptions were significantly lower in the precooling than in the control trial.

Convective and evaporative cooling may need longer exposure times to decrease core temperature regardless of fan airflow velocity. In the other hand, peripheral water immersion and cool-vest could be an alternative precool method reducing heat strains.

5C.3

Outdoor thermal comfort requirements of Taiwanese and Hungarians in the warm months

Thermal Comfort and Indices II

Noémi Kántor, National Chung Hsing University, Taichung, Taiwan; K. T. Tsai, L. Égerházi and T. P. Lin

Thermal conditions of an urban space, as well as the way how people perceive these conditions are highly relevant to their satisfaction and, as a consequence, they influence the patterns of area usage. In this paper we compare the thermal perceptions and thermal conditions related preferences of

citizens (healthy adults) from two nations: the people in Central Taiwan (living under hot-humid subtropical climatic conditions) and the Hungarians living in Szeged (under cooler and drier climate). Using the databases of more field measurement campaigns carried out in the last 10 years (microclimatic measurements, questionnaire surveys as well as observations) we compare the thermal sensitivity of healthy adults in the warm seasons. In Taiwan it covers the months from March to November, while in Hungary it means the June–August period. Thermal conditions were expressed in terms of the Physiologically Equivalent Temperature (PET) index which incorporates the effect of air temperature, humidity, wind velocity and the mean radiant temperature (Tmrt) measured during the human monitoring. To overcome the problem of the differences in obtaining the Tmrt, namely the fact that the Taiwanese group used a standard globe thermometer, while the Hungarian researchers applied the six-directional pyranometer–pyrgeometer technique, we made preliminary corrections on the Taiwanese Tmrt database to eliminate the differences between the techniques. Subject's perception about the thermal conditions was recorded on a 7-degree scale in Taiwan (TSV – Thermal Sensation Vote; ranging from cold=-3 to hot=3 with a neutral=0) and on a 9-degree scale in Hungary (from very cold=-4 to very hot=4). To support the equal-based comparison, the Hungarian scale was converted into the same 7 categories. Preferences for changes in terms of the air temperature, sunshine and wind were measured on 3-degree scales in both nations. While the neutral temperature (Tn; the PET value at which the mean TSV=0) of the Taiwanese subjects (27.5°C) was considerably higher than that in Hungary (20°C), the difference between the preferred temperature (Tp; PET value at which the lowest proportion of subjects want cooler or warmer conditions) values was small (23.5°C and 26°C). While in Taiwan the neutrally perceived conditions were warmer than the preferred conditions (Tn>Tp), the situation was quite the opposite in Hungary (Tn < Tp). The neutral zone (the PET range when the mean TSV is between -0.5 and 0.5) was significantly wider in Taiwan (21–33.5°C) than that in Hungary (17–22.5°C), and the boundaries of the slightly warm and warm thermal sensation categories occurred at much higher PET values in Taiwan, showing the effect of adaptation to the hot conditions (both physiologically and psychologically). Not only the wider neutral zone indicated the increased tolerance of the Taiwanese people; but we discovered comparatively lower proportion of Hungarians who were satisfied with the thermal environment as it was. Namely, the 'preferred' PET zone, where more than 50% of the questioned individuals wanted no change in terms of the temperature, was much wider in Taiwan (more than 15°C wide) than that in Hungary (only 3°C wide). Contrary to the thermal perception characteristics, and the width of the so-called preferred PET zone, we couldn't discover big differences between Taiwanese and Hungarian subjects in terms of their other thermal-comfort related preferences. More than half of the Taiwanese subjects wished for cooler conditions (lower temperature), less sunshine and stronger wind when the PET values exceeded the 34, 37 and 39°C, respectively. The corresponding 'too hot PET benchmarks' of Hungarians were 32, 36 and 38.5°C.

5C.4

Development of a Diagnostic Index on the Heat-wave considering Accumulative Effect of Heat-stress: the Accumulated Heat stress Index (AHI)

Thermal Comfort and Indices II

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Heat stress accumulates in the human body when a person is exposed to thermal condition for a long time. Considering this fact, we have developed the accumulated heat stress index (AHI) in order to quantify the level of accumulated heat stress. AHI represents the heat stress accumulated 72-h period using a time-weighted function, and the accumulated heat stress is then standardized using an equiprobability transformation (from a fitted Weibull distribution to the standard normal distribution). To verify the advantage offered by the AHI, it was compared with four thermal indices – the Humidex, Heat Index, Wet-Bulb Globe Temperature, and Perceived Temperature – used by national meteorological agencies. The results indicated that the AHI provides better detection of dangerous days than the other indices. In particular, the AHI detected deaths that were caused not only by extremely hot and humid weather, but also by the persistence of moderately hot and humid weather (for example, consecutive daily maximum temperatures of 28–32°C) that the other indices failed to detect.

5C.5

Effects of Facial Cooling on Thermal Comfort in Windy Winter Conditions

Thermal Comfort and Indices II

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Winter winds can strongly reduce the thermal comfort of visitors to urban plazas yet there is little guidance in the literature as to what can be done to improve the situation. This study explored how wind affects the thermal comfort of people in winter and used that information to provide guidance for how urban plazas can be designed to increase the thermal comfort of visitors. A thermal camera recorded the face temperatures of volunteers over time in a range of winter conditions. An energy budget model of a person's face (COMFA FACIEM VENTOSUS) was developed and applied to vignettes of evidence-based windbreak designs to illustrate the effects of a windbreak on winter thermal comfort.

5C.6

Investigation of human thermal perception and local adaptation to climate change in hot-humid climates – the case of Dar es Salaam, Tanzania

Thermal Comfort and Indices II

Emmanuel Lubango Ndetto, Albert-Ludwigs-University of Freiburg, Freiburg, Germany; A. Matzarakis

The coastal urban areas in the tropics are well known for their hot and humid climates. The impacts of climate change are likely to exacerbate the already sultry conditions to the level of limiting the local human thermal comfort. In this study, micro-meteorological measurements accompanied by human thermal sensation interview surveys at two outdoor public spaces (i.e. a park and a beach) were performed in Dar es Salaam Tanzania, one of the current rapidly urbanizing metropolis in Africa. The study aimed at determining the acceptable range of human thermal comfort and the local adaptive capacity to climate change in urban areas, typical to African cities. The human thermal perception was interpreted using the thermal indices of Physiologically Equivalent Temperature (PET) and Universal Temperature Climate Index (UTCI) as analyzed in the RayMan model. Additionally, the measurements done in various local climate zones (LCZ) were used to model the thermal effects of several adaptation measures and varying meteorological parameters in the ENVI-met model. The neutral thermal comfort range for PET in Dar es Salaam was found to be a bit higher to that experienced in mid-latitude cities. The lightweight low-rise local climate zone predominate the urban settlements especially in the unplanned areas. However, the existence of multicultural backgrounds in many fast growing cities like Dar es Salaam limit the local adaptation to the climate hence calling for various adaptation measures to ensure thermal comfort and quality of life in hot-

humid urban areas. This includes parks with sufficient shade-providing trees and water bodies as contribution to urban planning.

5C.7

Korean Human Thermal Sensation and Comfort Model

Thermal Comfort and Indices II
Sookuk Park, Jeju National University, Jeju, South Korea

Effects on outdoor human comfort are an important consideration in urban and landscape planning and design. Several human thermal sensation and comfort models were developed. However, universally applicable models cannot exist because they should be modified for each climatic or cultural zone when used to assess the local effects of specific planning options. For the reason, Korean human thermal sensation and comfort models were investigated with surveying. The survey was seasonally conducted at university campuses, downtown and parks of southern Korean cities, Changwon and Daegu, in 9 times between 12:00 and 15:00 on clear days. The total participants were 892 people (male, 53.3 %; female, 47.7 %), and the survey form was prepared using ISO 10551. In the survey, five major questions were asked to participants about thermal environment: perceptual, affective evaluation, thermal preference, personal acceptability and personal tolerance. Also, four important microclimatic factors for estimating human thermal sensation were also collected in situ: air temperature, relative humidity, wind speed and short- and longwave radiation.

The air temperature was 17.2-23.9 ℃ in fall, 4.6-6.5 ℃ in winter, 27.2-29.5 ℃ in early summer and 33.6-34.3 ℃ in summer. Relative humidity was 26.3-42.6 % in fall, 18.4-38.9 % in winter and 45.1-53.3 % in early summer and summer. Wind speed was around 1.0 ms-1 in all the seasons. Radiation varied by the season and location.

In the perceptual, most Koreans felt slightly cool to warm in fall, slightly cool to cold in winter, hot in early summer and hot to very hot in summer. However, in the affective evaluation, most of them responded comfortable in fall (58.4-69.9 %) and winter (70.9-83.6 %), slightly uncomfortable in early summer (39.7-44.9 %) and slightly uncomfortable (27.1-33.3 %) to very uncomfortable (24.2-30.0 %) in summer. In the thermal preference, they preferred neither warmer nor cooler in fall (38.1-42.1 %), a little warmer in winter (42.6-45.3 %), slightly cooler in early summer (47.1-56.4 %) and cooler in summer (40.9-42.9 %). In the personal acceptability and tolerance, most people thought just acceptable and perfectly tolerable in all the seasons. These results showed that strong acclimatization existed among Koreans and that local human thermal sensation levels and its comfort levels were different. Therefore, local human thermal sensation will be more adequate levels for urban and landscape planning and design than its comfort ones. Comparison between Korean human thermal sensation and comfort models and existing models, PET and UTCI, is in progress.

5D.2

Temperature-Suicide Associations using DLNM

Atmospheric Effects on Human Behavior
P. Grady Dixon, Fort Hays State University, Hays, KS; A. J. Kalkstein

There has been much research on the associations between weather variables and suicide rates. Unfortunately, the state of understanding has remained rather stagnant due to many contradictory findings. Recent research has made use of distributed-lag nonlinear modeling (DLNM) to quantify how suicide rates tend to change with anomalous temperatures. The purpose of this project is to build upon those previous findings by analyzing a longer period of record that includes more recent suicide data (1975–2010) than has been published before as well as studying more locations across the USA. DLNM is used to relate those suicide data to daily surface temperature data representative of the study locations. Results suggest some consistency with previous findings as seasonally warmer temperatures are associated with increased suicides, but spatial and temporal variations are also evident.

5D.3

A Proposed Regional System of Categorizing Wet Bulb Globe Temperature for Athletic Outdoor Policy

Atmospheric Effects on Human Behavior
Minh Duc Phan, University of Georgia, Athens, GA; C. A. Williams and A. J. Grundstein

Exertional heat illnesses affect thousands of athletes each year across the United States. The Wet Bulb Globe Temperature (WBGT) is a common measure of heat exposure used widely in athletics, the military, and occupational safety. Many interscholastic athletic programs rely on heat safety guidelines established by The American College of Sports Medicine (ACSM) which use the WBGT. These guidelines, however, employ fixed thresholds that neglect regional variations in acclimatization to heat. It is well known that there are geographically diverse exposure-response relationships for heat morbidity and mortality related to regional acclimatization. Here, a modeled climatology of WBGT (1991-2005), consisting of data from around the contiguous United States, is used to identify geographic patterns of various warm season (May-September) local extreme WBGT values. The data reveal large regional variability in extreme WBGTs across the country, indicating that a “one size fits all” approach to heat safety categories is insufficient. We develop three sets of heat safety categories using the 90th WBGT percentile as the critical cutoff for canceling exercise: ≥ 32.3°C as category 3, 30.1-32.2°C as category 2, and < 30°C as category 1. It is our hope that these preliminary categories will serve as a foundation for promoting future changes to preexisting heat safety protocol.

5D.4

Change of Summer Thermal Control Use in Homes after Electricity Shortage Caused by 3.11 Disaster in Japan

Atmospheric Effects on Human Behavior
Xiaoyong Lin, Osaka city university, Osaka, Japan; N. Umemiya

Electricity has been shortened in Japan after the Earthquake occurred in Tohoku in March 11 in 2011. Fukushima atomic electric generating station stopped and exploded because tidal waves after the earthquake washed away the cooling plants of the station. Safety of atomic electric generation is suspected and almost atomic electric generating stations were stopped after the disaster.

Electricity saving was required for the nation by government. Excessive illuminations and air-conditioning were accused. Circumstances were more serious in Kansai area where half of the electricity generation depended on atomic power generation. Electricity saving up to 15 percent was appealed to business sections and households in Kansai area by electric power company in summer season in 2011.

We carried out a questionnaire survey of air conditioner use in summer for apartment house occupants in the south of Osaka city in Kansai area in 2004. The surveyed items were number of air-

conditioners, setting temperatures, electricity use and charge in May and August, subjective degree of air-conditioner use and consciousness for using air-conditioners and so on. Usage of electric fan and natural ventilation were also surveyed. We carried out another survey of the same items for the same apartment buildings just after the period of electricity saving in 2011, though the occupants were not the same.

Electric charge difference between August and May decreased by 43% and electric use difference between August and May decreased by 46%. Mean setting temperature of air conditioners increased from 25.9 in 2004 degree to 27.5 degree in 2011.

Number of air conditioners, living style such as regularity of living time, almost constitution such as duration to heat or perspiration and environmental consciousness of the respondents such as preference of natural wind or anxiety of global warming were not different between 2004 and 2011. On the other hand evaluation of air conditioner performance, consciousness of electric cost, positive or negative thinking toward air conditioner use changed significantly. Subjective frequency of natural ventilation use both in daytime and nighttime did not changed, though air conditioner and electric fan use changed significantly. Subjective evaluation of ventilation, noise in buildings, moldiness, sunshine heat and sunshine glare of the apartments were significantly different between 2004 and 2011.

Correlation between subjective electric saving and frequency of opening windows in daytime and frequency of electric fan use, correlation between air pollution and window opening in nighttime, correlation between outside noise and window opening in daytime disappeared in 2011.

5D.5

Slight atmospheric pressure fluctuations as the risk factor promoting aggressive behaviour

Atmospheric Effects on Human Behavior
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Atmospheric pressure fluctuations (APF) are considered to be an adaptive meteorological factor, influencing human health, psychical and physical state, and behavior. Particular interest is the meteorotropic features of the APF with periods from seconds to deco-minutes related to the infrasound (APF-I) and internal gravity waves (APF-G) phenomena. The common low levels of APF-I with periods from 3 s to 120 s are considered to be a stimulating factor for human mental and physical activity. Meanwhile, their high levels are a risk factor resulting in the additional strain for adaptation mechanisms. Such APF-I can increase mental and physiological strain, creating potential danger for a failure of the adequate behaviour resulting in injuries occurrence. In contrast, the same high level APF-G with longer periods (120 s < T < 1200 s) is rather a weak physical factor, which have the activating influences on normal human activity. As a result of their effects the decrease in sport injuries number was documented on days with high APF-I and low APF-I levels. It follows from the previous studies that the high APF-G as well the low APF-I being an activating factor can also promote the human aggressive behavior. Meanwhile, the high APF-I disrupting effects on people purposeful activity is positive factor favoring to decrease in risk of aggressive actions. The purpose of this study is to verify hypothesis that there is the relation between APF physical characteristics and criminal aggressive behavior with injury consequences, and to analyze the physical characteristics of natural APF from view of their possible effects on the aggressive behavior.

Methods: The study was conducted in Kyiv city (Ukraine). The continuous measurements of atmospheric pressure carried out every 0.5 s with a standard microbarometer outdoors. These monitoring data during the one-year period (from 1 July 2005 to 30 June 2006) are used for the analysis. The APF average hourly integral amplitude (HA) in two ranges of periods related primarily to the far infrasound (I-range, HAI: 3 s - 120 s) and to internal gravity waves (G-range, HAG: 120 s - 1200 s), as well the daily mean of HAI (DHAI) and HAG (DHAG) were calculated. The previous studies revealed the threshold effects of the DHAI and DHAG. Therefore, their values were divided into two categories: the high, when they exceeded the threshold criteria (3.9 Pa and 2.4 Pa, respectively), above which a behaviour response related to injury occurrences were observed, and the low for the other less values. These criteria with the database on the DHAI and DHAG values, and concomitant meteorological variables, particularly the wind velocity (WV) within the interval analyzed are applied to examine the hypothesis that a relation exists between APF and a daily number of emergency transport events due to human criminal behaviour related to injury occurrences (EECI).

Results and discussion: Comparative analysis of DHAI (95% CI: 2.65 – 3.06 Pa, n = 345) and DHAG levels (CI: 2.27 – 2.50 Pa, n = 345) with their threshold criteria (3.9 Pa and 2.4 Pa, respectively) indicates prevalence their common low levels in an atmosphere within the one-year interval analyzed (the number of days for the DHAI and DHAG low levels: n = 254 and n = 214, respectively against their high levels n = 91 and n = 131, respectively). At this atmospheric background the EECI number proved to be significantly greater on days with the high DHAG and the low DHAI values (CI: 48.8 – 53.7, n = 75) when compared to days with the high DHAI (CI: 44.7 – 49.1, n = 72, p = 0.012). These findings corroborate the suggestion that activating influences of the high APF-G as well as the low APF-I, but not the high APF-I, can promote human inadequate aggressive actions with injury consequences. It is believed that APF is the physical agent responsible, at least partially, for biological response to other geophysical factors related to APF origination, particularly wind-induced turbulence. It is also hypothesized that APF could be one of the factors transmitting the influence of solar activity to the biosphere. Our analysis show the higher correlation between the APF-I and WV yearly dynamics (r = 0.72 p = 0,000) than between the APF-G and WV (r = 0.49, p = 0,000). These findings corroborate the more pronounced causal relations of WV with the APF-I, than with the APF-G. Of interest are the facts, that within the five days interval, when the high APF-G with their highest hourly values were observed on the background of the low APF-I, the correlation between hourly dynamics of APF-I and APF-G, as well as between APF-G and WV dynamics proved to be below of the level of significance (r = - 0.17, p = 0.3 and r = - 0.067, p = 0,68, respectively), while the significant correlation is shown between APF-I and WV dynamics (r = 0.56, p = 0,0002). These facts evidences once more in the favor of causal relations between APF-I and WV, while the high level APF-G are more associated with the other physical sources. To conclude, the present study contributes to the understanding of psychotropic effects of APF. It seems, that certain physical characteristics of this atmospheric factor present risk for the increase in the level of aggression and as a consequence in the number of injured victims. It also follows from this study that further investigations are needed to clear up the question on relationships between the APF and other biologically significant geophysical as well as cosmic factors.

5D.6

Medical Meteorology : Weather Assists Ease of Labor (child birth) - A Unique Location in India

Atmospheric Effects on Human Behavior
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In 1853, British clinician H. E. Hoskins used the term “medical Meteorology” (BMJ), which apparently was also in vogue across Europe (BJHS). Unaware of such pre-use we in 2006 had also used this term in our caption (IMS-Vayu mandal) - now acknowledged. Acute Low pressure assists child birth. Labor occurs due to contraction of the abdominal musculature. Atmospheric pressure is the sole external opposing force (at partum). Abdominal muscular contraction at human labor generates a pressure gradient of 50mm Hg during the 2nd stage of labor (actual delivery). This is 1/15th of fair weather barometric pressure at mean sea level i.e 67 gm/cm2 (latitude & orography specific). True for all non-temperate India regions. In fair weather i.e., normal atmospheric pressure, labor requires full muscular contractive thrust. A very severe cyclonic storm/tornado, develops a estimated central pressure of 970-950hPa which is equal to a reduction of the order 30 – 50 gms/cm2. Hence, atmospheric conditions come close to that of what is generated during the 2nd stage of labor (~50% reduction in natural opposing thrust). Severe cyclones collinearly also induces psychosomatic response in existing pregnancies of final trimester, and hastens onset of the 1st stage contractions. Atmospheric low smoothens the 2nd stage labor. There is also expression of extra large doses of Oxytocin by the brain. And Oxytocin upregulates abdominal contraction. Severe cyclones also have high impact causing internal eddies (micro-bursts), that have more steep pressure gradients; wind energy and sonic boom. Actual delivery always seem to be timed with microbursts. The natural phenomena apart, short, easier labor and child birth also results in ‘nil' mother and\or child mortality; specially in the rural and in the remote; where there aren't any medical facility. Due such natural phenomena the primigravidae (1st time mothers) suffer much less, i.e., least labor pangs. A unique ever present low pressure region is reported from India. Dahod is a fair weather locus on the western shore board of India. It too has a coastal location (Dahod-Gujarat - western India) having year long fair weather - with rainlessness (semi-arid). On ground co-relation is done and ease of labor is noted as collinear phenomena (clinically validated). Dahod is compared with another location on geographical parameters (Sambalpore- Odisa) on the eastern sea board of India. Tornados are micro and norwesters (kaal vaisakhi weather systems) are meso scale members. Year out such eastern shore board of India experiences events of all the 3 scales. The contrast is presented in tabulated form based on 30yrs., average. Numerous interesting and fruitful observations have been adduced. Globally 1st time report. Study is not exhaustive offers unique opportunity.

6A.1

Effects of Simulated Heat Wave on Senile Mice

Heat and Animal Health Outcomes

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Effects of simulated heat wave on senile mice were investigated in the present study. Heat wave was simulated in a meteorological environment simulation chamber according to a heat wave occurred in July 2001 in Nanjing, China. Eighteen senile mice were divided into control group, heat wave group, and heat wave BH4 group. Mice in heat wave and BH4 groups were exposed to simulated heat waves in the simulation chamber. Mice in BH4 group were treated with gastric lavage with BH4 2h prior to heat wave exposure. Weight and rectal temperature were recorded daily. Levels of soluble intercellular adhesion molecule (sICAM-1), endothefin (ET-1) and nitric oxide (NO) in plasma were determined at the end of the experiment as biomarkers of cardiac function. Heat wave significantly raised body temperature. However, mice in heat wave group had significantly higher NO level and sICAM-1and lower ET-1 compared with mice in control group ($P < 0.01$); indicating that heat wave had negative effect on cardiac function in senile mice. When the heat wave duration is longer, heat stress response of senile mice will be more intense, heat stroke and other cardiovascular diseases may occur. Rectal temperature and sICAM-1 content in BH4 group had no significant difference with that in control group ($P>0.05$) while NO increased apparently ($P<0.01$). Collectively, these beneficial effects demonstrate that BH4 may potentially mitigate the risk of coronary heart disease in human under heat wave exposure.

6A.2

EFFECT OF THERMAL STRESS ON HSP 72 AND LEPTIN mRNA EXPRESSIONS IN PERI-PARTURIENT DAIRY COWS

Heat and Animal Health Outcomes

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In order to establish the relationship between expression of Hsp72 and leptin gene, 10 each of high and low producing periparturient Sahiwal and Karan Fries cows were selected from the Institute herd during summer and winter season. Blood samples were collected from both the breeds of cattle on -45, -30, -15, 0, 15, 30 and 45 days with respect to parturition during both the seasons. HSP72 gene expression was significantly higher in lymphocytes of high producing Karan Fries and Sahiwal cows compared to low producing groups during both the season, but the magnitude of increase was higher during summer than winter. Before calving, leptin gene expression in lymphocytes of low producing Sahiwal cows was higher than high producing Sahiwal and KF cows. Whereas on the day of calving, leptin gene expression decreased in both the breeds and remain lower up to 45th day of postpartum. The relative leptin mRNA expression in high and low yielding Sahiwal cows decreased to 89.3 and 80.7% on 15th day of calving during summer season, whereas in Karan Fries the values decreased to 84.6 and 79.5% on the day of calving and 15th day of postpartum from the pre calving values (45 day) respectively. Leptin and HSP72 mRNA expression were negatively correlated to each other in both the breeds, seasons and groups. Based on the results of the present study it can be concluded that, lower levels of leptin and higher levels of HSP72 during and after parturition compared to prepartum indicates the stress on the lactating cattle. Keywords: HSP72, Leptin, Karan Fries, Sahiwal, Thermal stress

6A.3

The Epigenetic Approach of Broiler Chickens to Cope with Global Warming

Heat and Animal Health Outcomes

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Poultry products are one of the most important sources for protein and other ingredients of human diet.

Scientists expect that the average global surface temperature will rise by 0.6-2.5°C until 2050. Global warming enhances desertification which on a yearly basis enlarges the arid to semi arid lands. Soil degradation caused by human intensive agriculture induces desertification too. More than 110 countries consist of dry/degraded lands that are potentially at a desertification risk. Dry land compromises 41.3% of the global terrestrial land, which is the home for 34.7% of the global population, expected to be raised by 2050 to 9 billion. These evidence led the UN General Secretary to announce that “The world farm production must be raised by 50% by 2030 to meet human demands for food”. Thus, the poultry industry faces great challenges: a. increasing production performance and quality; b. improving poultry thermotolerance.

Birds are endotherms, able to maintain their body temperature within a narrow range. However, an alteration in body temperature as a result of exposure to extreme environmental conditions may lead to a cascade of irreversible thermoregulatory events that could be lethal for the bird. To sustain thermal tolerance and avoid the deleterious consequences of thermal stresses, three direct responses are elicited: the rapid thermal stress response; acclimation; and epigenetic temperature adaptation. Although domestic fowl respond to changes in the environment with the same mechanisms as other endotherms, their intensive production causes them to face serious difficulties in coping with extreme environmental changes. Recent decades have seen significant progress in the genetic selection, on the one hand, of fast-growing meat-type broiler chickens and turkeys and, on the other hand, of egg-producing laying hens. However, the significant improvements in body and muscle growth and in egg production have not necessarily been accompanied by equivalent growth of specific visceral organs, and the probable consequence is a reduced ability to cope with extreme changes in environmental temperatures.

The incubation period of broiler chickens gets more attention during the last decade. It can be related to the recognition that during this period various environmental manipulations may induce long-lasting-physiological-memory (LLPM) caused by epigenetic adaptation. Several environmental manipulations have been adopted lately; this abstract focuses on thermal manipulations (TM's) based on the strategy of long term mild manipulations. The hypotheses underlying this strategy are: a. during embryogenesis, it is possible to induce LLPM; b. LLPM can be defined, most probably, as an alteration in the threshold response to changes in the environment; and c. the manipulations must be conducted during sensitive embryogenesis periods, by means of a specific level and duration. These manipulations will induce an improved potential to withstand changes in the environment during the bird's life span. Heat TM's (elevating incubation temperature from 37.8 to 39.5°C coupled with relative humidity elevation from 56 to 65% for 12 hours, or continuously, on each day from day 7 to 16 of incubation) during the period of the hypothalamus-pituitary-thyroid (thermoregulation) or adrenal (stress) axes development and maturation were employed in these experiments. These treatments demonstrated a significant improvement of thermotolerance acquisition in broiler chickens up to marketing age. The improvement achieved by a significant reduction of heat production, coincided with significant increase in sensible heat loss and significant decline in stress level. These responses were detected already during embryogenesis, where oxygen consumption, heart rate, eggshell temperature, as well as plasma thyroid hormones (thyroxin - T4 and triiodothyronine - T3) and corticosterone concentrations were significantly lower in the TM's embryos after the exposure to TM's. It also appeared to improve the quality of broilers that were treated for 12 hours during incubation, by means of improving feed conversion rate, increasing breast muscle relative weight and reducing abdominal fat pad. It is concluded that TM's during embryogenesis improve thermotolerance during life span coupled with improving quality of the 12 hours-treated broilers.

6A.4

Biological and Mathematical Analysis of Desert Sheep and Goats Responses To Natural Heat Stress, in Egypt

Heat and Animal Health Outcomes

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The study aimed to assess the physiological responses of the desert Barki sheep and goats to natural heat stress, under the hot-dry conditions of the Coastal Zone of Western Desert, Egypt. Fifty nine Barki ewes and twenty five Barki does, at non reproductive status, were exposed to natural heat stress (NHS) under direct solar radiation within the period from 12:00 to14:00 for 3 successive days in summer of 2009 (July and August). Meteorological and biological parameters were recorded pre- and directly post-exposure to NHS. To assess individual physiological responses of desert Barki sheep and goats to natural heat stresses the variability in individual responses of the main five physiological parameters rectal temperature (RT), respiration rate (RR), tidal volume (TV), minute ventilation (MV) and metabolic rate (MR) as well as their normality were statistically tested. The possibility of developing animal heat tolerance index to natural heat stress based on the changes in these physiological parameters was evaluated. Results indicated that all physiological parameters studied were significantly affected by NHS, in terms of change between post and pre exposure values. The minute ventilation volume (MV) increased in sheep, while decreased in goats, reflecting specie differences in respiratory response to NHS. Increase shallow panting and decreasing metabolic rate seems to be the primary mechanisms for goats to tolerate NHS. Meanwhile, sheep depend more on respiratory heat loss where respiration rate (RR) was almost tripled in response to NHS in sheep with high significant increase in MV reflecting higher gas exchange than in goats. Based on the changes in RR, RT, TV, MV and MR an animal heat tolerance index (AHTI) was developed to assess individual animal response to NHS. Evaluation of AHTI indicated that although RR followed by RT were the two main physiological parameters contributing to the AHTI depth of respiration (TV) and MR must be included to identify heat tolerant from heat susceptible animals.

6A.5

Concept of multiple environmental stresses impacting sheep production and adaptation under the changing climate scenario

Heat and Animal Health Outcomes

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Background: Climate change is a major threat to the viability and sustainability of livestock production systems in many regions of the world. A considerable population of poor people depends on animals for food, fibre, income, social status, security, and companionship. Hence one of biggest challenges facing animal science currently is to increase the production in the context of climate change. Animals reared in tropical environments are generally subjected to more than one stress at a time. This greatly influences the animal production and reproduction under such environmental conditions. Nearly all studies on the effect of environmental stress on farm animal productivity have generally implicated one stress at a time since comprehensive, balanced multifactorial experiments are technically difficult to manage, analyze, and interpret.

Hypothesis and Objectives: The hypothesis of the present study is that multiple stresses effecting livestock productivity is a common phenomenon due to climate change under semi arid tropical environment and this has much profound impact on livestock production than temperature stress alone. With this intention, the proposed study has been undertaken with the primary objective to establish the effect of multiple stresses (thermal, nutritional and walking stress) on physiological response, blood biochemical and endocrine responses in Malpura ewes.

Methodology: Two experiments were conducted to satisfy the objectives. The study was conducted for a period of 35 days covering two estrous cycles under controlled conditions. Twenty-eight adult Malpura non-pregnant ewes were used in the present study. The ewes were randomly allocated into four groups of seven animals each viz., GI (n=7; Control), GII (n=7; thermal stress), GIII (n=7; nutritional stress) and GIV (n=7; combined stress). In the second experiment, the Malpura ewes

were randomly allocated into two groups of twelve animals each viz., GI (n=12; Control) and GII (n=12; Multiple stresses). The animals were stall fed with a diet consisting of 60% roughage and 40 % concentrate (barley, 650 g/kg, groundnut cake, 320 g/kg, minerals 30 g/kg including 10 g/kg NaCl, with crude protein = 180 g/kg and total digestible nutrients = 650 g/kg). GI and GII ewes were provided with ad libitum feeding while GIII and GIV ewes were provided with restricted feed (30% of intake of GI ewes) to induce nutritional stress. Further, the multiple stress group ewes were subjected to walking stress by forcing them to walk for 14km. This 14Km was covered in two spans. The animals took one hour and 30 minutes to complete one span (7KM) and accordingly the first span was between 9:00 h to 10:30 h and the second span between 15:00 h to 16:30 h. Physiological responses and body weight measurements were recorded at weekly interval. Blood collection was done at weekly interval and plasma was separated for estimating the biochemical and endocrine parameters. The parameters studied were: body weight, respiration rate, pulse rate, rectal temperature, plasma glucose, total protein, total cholesterol, cortisol, thyroxine, tri-iodo-thyronine, estradiol, and progesterone. Data generated were analyzed using multivariate analysis for repeated measurements.

Combined Stress: The results from the first experiment indicated that combined stress (heat and nutritional stress) significantly ($P < 0.05$) reduced body weight, estrus duration, conception rate, lambing rate, birth weight of lambs, and estradiol 17-β while significantly ($P<0.05$) increased estrus cycle length and progesterone. Further, combined stress significantly ($P<0.05$) affected the feed intake, water intake, respiration rate and rectal temperature. In addition, in relation to thermal stress, restricted feeding had less significant effect on the growth and reproductive hormone levels in the ewes. However, when both these stresses were coupled, it had severe effect on growth and hormone parameters studied in these ewes. Results from the second experiment showed that multiple stresses (heat, nutritional and walking stress) significantly ($P<0.05$) affected body weight, estrus %, estrus duration, conception rate, lambing rate, respiration rate, pulse rate, rectal temperature, sweating rate, tri-iodo-thyronine, thyroxine, cortisol, estradiol, progesterone haemoglobin, packed cell volume, glucose and total protein. Compared to single and two stresses (heat and nutritional stress) simultaneously in previous studies, multiple stresses in the present study had much higher detrimental effects on most of the parameters studied. When walking stress is coupled with heat and nutritional stress, it had severe impact on all the parameters studied in these ewes. As these are the first detailed studies which report effect of multiple stresses in domestic livestock, the findings have greater significance in terms of understanding the ideal requirement for these animals to adapt to tropical environment without compromising production.

Conclusion: The studies clearly establish the severe impact of multiple stresses on biological functions, necessary to cope with these stresses, in Malpura ewes. This is evident from the significant differences in majority of the parameters studied in multiple stresses group. Further, the study indicates that Malpura ewes have the capability to adjust their physio-biochemical responses to cope with multiple stresses under hot-semi arid environment. The findings from the study have higher significance since it's not only the heat stress that is causing severe damage to livestock productivity but also the multiple stresses which occur simultaneously as result of changing climatic conditions. Hence its very pertinent to conclude from these studies that when two or more stressors occur simultaneously, they may have severe impact on biological functions necessary to maintain homeostasis in sheep.

Future Perspectives: Multiple stresses are a common phenomenon under semi arid tropical environment due to climate change. Any research pertaining to climate change effect on livestock production must address these multiple stresses simultaneously in future. These types of investigations will be instrumental in gaining a thorough understanding of the exact requirements in mitigating the adverse effects of environmental stress simultaneously on sheep production.

6A.6

Heat waves related mortality in dairy cows

Heat and Animal Health Outcomes

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Previous studies demonstrated that the risk of death for dairy cows is higher during summer compared to other seasons. The present study was aimed at investigating the effects of heat waves on dairy cows mortality. 46,582 events (deaths) recorded from 1st May to 30th September during a 6-yr period (2002 to 2007) were considered. Mortality data were extracted from the Bovine Spongiform Encephalopathy databases available at the Italian Reference Centre for Animal Encephalopathies (Turin, Italy) and at the National Reference Centre for Animal Welfare (Brescia, Italy). Data were referred to cows older than 24 months that died on a farm from all causes, were slaughtered in an emergency state, or were sent for normal slaughter but were found sick at the pre-slaughter inspection. The latter two categories accounted for approximately 2% of total deaths. Mortality counts were categorized by the age of the cows as follows: 24-28, 29-60, 61-96 and 97+ months. Furthermore, on the basis of the geographic localization of the farms, data were also categorized as referred to northern, central or southern Italy. Considering all classes of age, the overall consistencies were 555,852, 169,779 and 162,063 heads yr-1 for northern, central and southern Italy, respectively. Average milk yields (kg/lactation on 305 days on average) were 9,226, 8,785 and 7,882 for northern, central and southern Italy, respectively. Average number of lactations/life were 2.44, 2.54, and 2.76 for northern, central and southern Italy, respectively. Data on cows population were obtained from the Italian National Bovine Registry. Weather data were obtained by 12 weather stations. Heat wave was defined as a period from 1st May to 30th September when the daily maximum temperature exceeded at least the 90th percentile of the reference distribution (1960-1990) for more than three consecutive days. The relationships between heat waves and mortality were evaluated using a case-crossover design. This approach allows to assess the impact of transient exposures to acute events using only cases and compares each case's exposure during a time period just before the case-defining event (hazard period) with that subject's own exposure in other reference periods (control period). Each subject serves as own control hence measured and unmeasured potential confounding factors are controlled by design. The referent days were selected from the same month and year and matched by day of week to the health outcome. This time-stratified method of selecting comparison days ensures unbiased conditional logistic regression estimates and avoids bias resulting from time trends. Conditional logistic regression models were used to calculate odds ratios (OR) and 95% confidence intervals (CI) stratified by zone and age. The mortality on days post heat wave (1 to 3 days after) was evaluated to account for possible prolonged effect of heat wave. P-values ≤ 0.05 were considered statistically significant. The analysis of temperature data pointed out differences among the three geographic zones considered in the study. Daily mean of maximum temperatures (°C) were 27.2, 28.3, and 28.4 for the northern, central and southern Italy, respectively. Mean maximum temperatures (°C) during heat wave were 30.9, 32.4 and 34.7 for the northern, central and southern Italy, respectively. The number of days classified as heat wave days yr-1 were 38, 32 and 18 for northern, central and southern Italy, respectively. The average length of heat waves were 6.6, 7.3 and 5.4 days for northern, central and southern Italy, respectively. Pooled data indicated that mortality was greater ($p<0.001$) during heat waves with an OR of 1,163 (CI: 1.132-1.196). When geographic zones were considered, the OR

were 1.186 (CI: 1.149-1.225), 1.105 (CI: 1.036-1.179) and 1.075 (CI: 0.968-1.194) for northern, central and southern Italy, respectively. For the mortality recorded during the three days post heat wave, the model pointed out a significant OR for pooled data; considering the three zones separately, the OR was significant only for northern Italy ($p<0.001$). When the age was considered, pooled data indicated lower mortality ($p>0.05$) in heat wave for younger cows (age 24-28) with an OR 1.119 (CI: 0.996-1.258). On the other hand, older cows showed a greater risk ($p<0.001$) to die during heat wave with an OR of 1.170 (CI: 1.122-1.219), 1.200 (CI: 1.145-1.259) and 1.092 (CI: 1.022-1.167) for 29-60, 61-96 and 97+ classes of age, respectively. Considering geographic zones and ages together, the analysis provided conflicting results. Younger cows raised in the northern Italy were less susceptible ($p>0.05$) to heat waves with an OR of 1.062 (CI:0.929:1.213) whereas mortality in older cows was greater ($p<0.001$) with an OR of 1.180 (CI:1.126:1.236), 1.248 (CI:1.182-1.318) and 1.118 (CI: 1.028-1.216) for 29-60, 61-96 and 97+ classes of age, respectively. The mortality in central Italy for the class of age 29-60 was affected ($p<0.05$) by heat waves with a OR of 1.140 (CI:1.024-1.268), whereas it was not significant ($p>0.05$) for the other classes (24-28, 61-90, 97+). Considering southern Italy the younger cows showed the greater ($p<0.05$) mortality during heat waves with a OR of 1.551 (CI:1.043-2.307), whereas that recorded for the older cows was not affected by heat wave in a significant manner. Results reported herein clearly indicated that heat waves increase the risk of mortality in dairy cows and that this effect varies in relation to the age of the cows and to the geographic localization of the farms. On this regard, geographic differences of production systems and climate authorize some interesting speculations which encourage further studies on this topic. Finally, especially in the light of climate scenarios, present results strongly support the adoption of structural, management and pro-active adaptation strategies which may limit heat stress related impairment of animal welfare and economic losses in dairy cow farms.

6B.1

Modeling Phenological Change at Global-Scales Using Climate Data

Phenology II: Modeling

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Phenology is the study of recurring plant and animal life cycle stages, such as leafing and flowering, maturation of agricultural plants, emergence of insects, and migration of birds, especially their timing and relationship with weather and climate. Recently, the value of phenological research for understanding Earth systems interactions and facilitating global change studies has been realized. As a simple expression of seasonal biology, phenology offers another independent measure (along with climate records and remote sensing observations) of the extent and impact of climate change. However, phenological data are still not collected and recorded in spatially comprehensive and comparable ways around the world. Thus for now, phenological models can allow simulation of general plant responses, facilitating testing of broad hypotheses in locations and at times when actual phenological data are not available, but with more detail than possible when using remote sensing-derived measures. One set of phenological models that have been successfully applied to assess impacts of climate change on the onset of the spring growing season across temperate regions around the Northern Hemisphere are the Spring Indices (SI). This suite of metrics includes several sub-models and associated measures, all of which can be calculated using daily maximum/minimum surface temperatures and station latitude. SI models process weather data into a form mimicking the spring growth of plants that are not water limited, and are responsive to temperature increases. This paper summarizes earlier SI results from station data that have confirming a nearly universal quicker onset of early spring warmth (SI first leaf date, -1.2 days/decade), late spring warmth (SI first bloom date, -1.0 days/decade), and last spring freeze date (-1.5 days/ decade) across most temperate Northern Hemisphere land regions over the 1955–2002 period. Further, more recent work using longer and denser station data since 1900 across the continental USA has shown: 1) the SI onset of spring growing earlier since the late 1950s, including a dramatic shift in the mid-1980s; 2) regional differences in the Southeast USA; 3) 2012, the earliest year on record; and 4) 2013, among the latest years on record. Finally, preliminary results from on-going work will be presented that uses gridded air temperature data and SI to assess changes in the spring phonological response around the globe in both the past and the future at the century time-scale.

6B.2

Response of Robinia Pseudoacacia First Leaf Date to temperature and Precipitation Change in China in the Past 50 Years

Phenology II: Modeling

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Plant phenology is a significant indicator of climate change. Climate change has affected plant phenology greatly over the past few decades in mid-high latitudes of the Northern Hemisphere. Previous studies mainly focus on the relationship between plant phenology and temperature, but few of them have evaluated plant response to other climate factors, e.g. precipitation. In order to explain how plant phenology responses to precipitation and compare the magnitude of the impacts of temperature and precipitation on plant phenology, long-term (1963-2012) observations of First Leaf Date (FLD) of Robinia pseudoacacia at 9 stations in China over the past 50 years were analyzed using linear regression and partial least squares (PLS) regression analysis. The results suggest that the years with more precipitation exhibit later Robinia pseudoacacia FLD in most stations except Xi'an and Haerbin, but the correlations are not significant. Compared to temperature, precipitation shows opposite and much lower effects on plant phenology. FLD of Robinia pseudoacacia correlated positively to the spring precipitation in the 2-3 months before the onset dates of FLD. Meanwhile, it is negatively associated with the winter precipitation of the former year. However, the exact dates when such relationship appears varies among different stations, ranging from the former October to February. In addition, precipitation has smaller effect on plant phenology in stations with more precipitation, especially in semi-humid regions.

6B.3

Integrating MODIS satellite information and maize phenological data to detect maize cultivated area

Phenology II: Modeling

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Abstract: The accurate and timely information of crop area is vital for crop production and food security. In this study, the Enhanced Vegetation Index (EVI) data from MODerate resolution Imaging Spectroradiometer (MODIS) integrated crop phenological information was used to estimate the maize cultivated area over a large scale in Northeast China. The fine spatial resolution China's Environment Satellite (HJ-1 satellite) images and the support vector machine (SVM) algorithm were employed to discriminate distribution of maize in the reference area. The mean MODIS-EVI time series curve of maize was extracted in the reference area by using multiple periods MODIS-EVI data. By analysing the temporal shift of crop calendars from northern to southern parts in Northeast China, the lag value was derived from phenological data of twenty-one agro-meteorological stations;

here integrating with the mean MODIS-EVI time series image of maize, a standard MODIS-EVI time series image of maize was obtained in the whole study area. By calculating mean absolute distances (MAD) map between standard MODIS-EVI image and mean MODIS-EVI time series images, and setting appropriate thresholds in three provinces, the maize cultivated area was extracted in Northeast China. The results showed that the overall classification accuracy of maize cultivated area was approximately 79%. At the county level, the MODIS-derived maize cultivated area and statistical data were well correlated (R2 = 0.82, RMSE = 283.98) over whole Northeast China. It demonstrated that MODIS-EVI time series data integrated with crop phenological information can be used to improve the extraction accuracy of crop cultivated area over a large scale.

6B.4

Differential changes in the reproductive cycle of two temperate plants in response to experimental warming

Phenology II: Modeling

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The evidence of a changing climate influencing plant phenology has grown exponentially over the last 25 years with the majority coming from the examination of flowering records. Given each part of the reproductive cycle influences the preceding and succeeding phases it is not yet clear how changes in one phase may influence another.

Elevated temperature environments allow changes in reproductive phenology to be assessed in greater detail (rather than only using first flowering date), and also allow greater replication to better understand population variability of plastic responses to increased mean temperature.

We examined the differences in the timing of first bud appearance, first flowering, last flowering, seed dispersal, and height of inflorescence in *Cynoglossum suaveolens* (Sweet Hound's Tongue) and *Coronidium scorpioides* (Button everlasting) in both an elevated temperature and control (outside) environment (n = 20 plants per treatment). In addition the differences in the seed weight of *C. suaveolens* and floral disc diameter in *C. scorpioides* between the two environments were also compared. These are two co-occurring perennial understory species.

The glasshouse mean temperature was on average 5.6°C warmer than the controls. Plants received the same irrigation regime and were watered to field capacity every 1 – 3 days, depending on weather, to standardize any soil moisture interactions with the phenophases.

We found that for both species those subjected to warmer temperatures reached each phenological stage significantly earlier ($P < 0.001$). For *C. suaveolens*, the differences in magnitude in the first three phases were similar: bud appearance (54.3 days), first flowering (60.0 days), last flowering (52.9 days). The difference in seed dispersal between the two environments was 38.6 days. In *C. scorpioides* the largest difference was in first flowering (56.6 days); followed by bud appearance (50.1 days) and last flowering (38.7 days) and as with *C. suaveolens* seed dispersal had the least difference (20.9 days).

These differences in turn were reflected in the total durations with glasshouse durations beings significantly longer: 67.5 versus 44.9 days in *C. suaveolens* and 104.1 versus 75.0 days in *C. scorpioides*. For both species the duration from bud appearance to first flowering was significantly longer ($P < 0.05$) with the flowering and seed development period significantly shorter in the control ($P < 0.001$). Also for both species the average inflorescence height was significantly taller ($P < 0.01$) in the warmer environment: *C. suaveolens* 205.8 ± 47.5 mm compared to 137.7 ± 43.9 mm; *C. scorpioides* 283. 0 ± 65.6 mm compared to 212.0 ± 48.0 mm. The warmer environment also resulted in significantly heavier seed weight in *C. suaveolens* (5.25 ± 0.46 mg compared to 3.21 ± 1.53 mg) and significantly wider floral disc diameter in *C. scorpioides*(19.7 ± 2.9 mm compared to 14.9 ± 3.1 mm).

Warming advanced the timing of each phenophase; however, the advancement was not constant across phenophases resulting in differing durations. The extended flowering and seed development duration in the warmer environment resulted in heavier seed in *C. suaveolens* whereas larger floral discs developed in *C. scorpioides* during a shorter development phase.

This demonstrates that reproductive phenophases may have differing advancements in response to increased mean temperature depending on species. Also, advances in first flowering date may be partly compensated through increased flowering and seed maturation durations that can reduce the advancement of seed dispersal date relative to advances in first flowering date. These phenological changes have resulted in changes to the vegetative and reproductive output which could ultimately lead to changes in species abundance, composition and distribution.

6B.5

Phenology and seasonal forecasting in the Pacific: combining traditional knowledge with statistical and dynamical methods to increase community resilience

Phenology II: Modeling

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Many indigenous people in the Pacific forecast seasonal climate conditions through observation and monitoring of meteorological, astronomical and biological indicators (e.g. phenology). Built over many generations, these knowledge systems are adapted to local conditions to cope with a highly variable and vulnerable environment. Traditional climate knowledge systems continue to influence all aspects of modern Pacific livelihoods from agricultural productivity to disaster response and recovery. In recent years, alternative forecasting methods have been promoted by national meteorological services based on statistical and dynamical modeling of the climate system. However, in some locations, uptake of these 'new' methods is low, with locals continuing to use traditional forecasts for many reasons including inadequate access to the new forecasts, insufficient trust in new forecasting methods or historical usefulness of traditional forecasts. Enabling adaptation to changing climatic conditions in the Pacific requires improved understanding of how traditional forecasting methods compare to those based on climate models. Building on global experiences with traditional seasonal forecasting, we develop a methodology for the Pacific region that includes:

1. Documenting traditional indicators used for seasonal climate forecasting;
2. The development of a national monitoring network, based on the traditional indicators identified, including phenology;
3. Comparing the outcomes of traditional forecasts with those based on statistical and dynamical modeling of the climate system;
4. Development of methods for optimally combining traditional and modeling-based forecasts.

This integrated approach to forecasting, illustrated with a case study from Vanuatu, has the potential to improve the accuracy and utility of local forecasts as well as ensuring the communication of climate information is in a locally relevant context.

6B.6

SPACE AND TIME VARIABILITY OF GRAPEVINE PHENOLOGY IN EUROPE

Phenology II: Modeling

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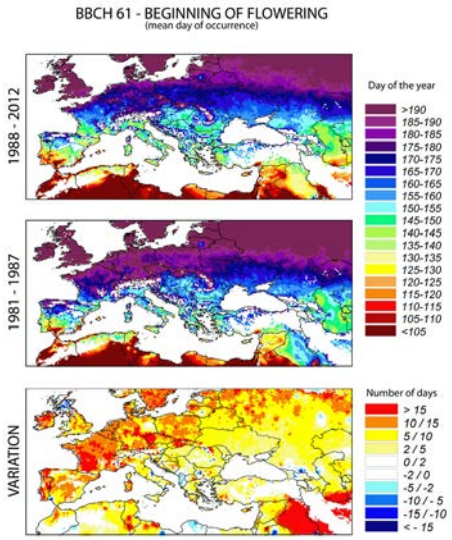
Grapevine (Vitis vinifera L.) is cultivated in Europe since five thousand years and during this long period it was exposed to a wide climatic variability with conditions ranging from hot phases (e.g. the Roman optimum) to cold ones (e.g. the Little Ice Age). This work aims to evaluate the effects of European climate variability and change on grapevine cv Chardonnay phenology along the recent period (1981-2012) which was characterized by two homogeneous thermal phases divided by an abrupt shift occurred at the end of the 80s. This goal was pursued applying the operational phenological model of the Iphen project to daily European thermal fields and analyzing the deriving behavior of grapevine phenology (cv Chardonnay) . Since 2006 the Iphen Project (http://cma.entecra.it/iphen/index_EN.html) periodically produces and broadcast Italian maps of phenological analysis and forecasts for grapevine and other relevant natural and cultivated plants such as Olive tree, Cypress, and Locust tree. Maps are the result of the match between phenological modeling and observational data gathered by the volunteer network of the Project. The Iphen phenological model is based on the accumulation of thermal resources - Normal Heat Hours and the whole set of grapevine phenological stages (vegetative and reproductive) is simulated as the overcoming of specific thresholds of cumulated thermal resources. Phenological stages are expressed following the international BBCH scale. The model, calibrated and validated for the Italian area, is here applied the whole European continent on the base of daily temperature fields, obtained by means of geostatistical techniques from free weather station data gathered and broadcasted by NOAA-GSOD (https://data.noaa.gov/dataset/global-surface-summary-of-the-day-gsod). A first validation of the simulation at the continental scale is obtained by comparison with the phenological data collected all over Europe during 2012 by the COST Action FA1003 – Grapenet: East-West Collaboration for Grapevine Diversity Exploration and Mobilization of Adaptive Traits for Breeding. Eight COST observational sites provided phenological monitoring for Chardonnay in 2012, ranging from Spain to Ukraine, from Cyprus to Czech republic. With reference to observational data, the model showed a Mean Absolute Error of 2.75 days in the simulation of the day of occurrence of the phenological stage of beginning of flowering (BBCH 61). Afterwards, the model was run on the whole 1981-2012 period and maps of the day of occurrence of phenological stage BBCH 61 were produced for each year. The model simulation was limited up to 1000 m of elevation, in order to focus on high quality viticulture. Average data for the two sub-periods 1981-1987 and 1988-2012 and the difference between the two, are presented in figure 1. In order to rightly interpret the results it must be taken into account that the simulation for countries of South Mediterranean and Middle East is negatively affected by the scarcity of meteorological data. The comparison between the phenological behavior of the two sub-periods shows a general advance of recent phenology, more relevant in Koeppen's Cfb climate areas (Oceanic climate, e.g.: France and Germany) and Csa ones (Mediterranean climate, e.g.: Portugal, Spain and Italy). This is explained by the reinforcement of Westerlies after the 1987 climate shift which determined both the strengthening of anticyclonic conditions over the Mediterranean and an higher degree of Oceanicity ove central-western Europe. The final consequence was the presence of milder temperatures with an advanced phenological development clearly shown by the variational map of figure 1. Furthermore, it is interesting to highlight the northward shift of the limit of commercial viticulture, represented by the 180-185 doy limit for flowering in the two phenological maps and coherent with results previously presented by the authors. Figure 1 – Mean day of occurrence of beginning of flowering (phenological stage BBCH 61). Maps for period 1988 – 2012and 1981 – 1987 b) are presented. The difference between the two periods, expressed in number of days is also shown. A positive number of days stands for advance of the recent period.



6C.1

Updated trend analysis of heat vulnerability in the United States using a Distributed Lag Nonlinear Model

Thermal Environment and Human Health I

Scott C. Sheridan, Kent State University, Kent, OH; P. G. Dixon

The impacts of heat upon human health have been studied by myriad researchers. Several current themes have been identified: heat events in some areas are becoming more common; the impacts of heat on all-cause mortality seem to have declined over time; and there is a growing debate as to the impacts of mortality displacement (harvesting) on overall mortality totals during heat events. To build upon these themes, we use a recently extended US national database on mortality to assess heat vulnerability across the United States.

For 40 US metropolitan areas, we divide up the full mortality record into 4 sub-periods: 1975-1983, 1984-1992, 1993-2001, and 2002-2010. Using a distributed-lag non-linear model (DLNM), we assess spatio-temporal variability to heat using apparent temperature thresholds for heat-events.

Spatial and temporal variability is observed in the results, with an overall greater vulnerability in the northern and Midwestern cities than in southern cities and most western cities. Trends broadly show a decreased vulnerability over time, although statistically significant increases in mortality still occur with excessive heat events over many locations.

6C.2

Heat stress during the Black Saturday event in Melbourne, Australia

Thermal Environment and Human Health I

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The Black Saturday bushfire event of February 7 2009 devastated the state of Victoria, Australia resulting in 173 deaths. On this day the maximum temperature in Melbourne (state capital of Victoria, population 4 million people) exceeded 46°C, there were wind gusts of over 100 km hr-1 and the relative humidity dropped below 5%. We investigate the severe meteorological conditions of Black Saturday and the risk of heat stress and dehydration for the residents of Melbourne. This is through the analysis of weather station data, air pollution data, the apparent temperature (AT) and the Comfort Formula human energy budget model.

In Melbourne, the PM10 concentration was at dangerous levels (over 350 μgm-3) due to bushfire smoke on Black Saturday and the AT showed that heat stress conditions were present, albeit underrepresented due to assumptions in the AT formula. Further investigation into dehydration from energy budget analysis revealed that the meteorological conditions required a sweating rate of 1.1 kg h-1 to prevent heat accumulation to the body. If sweating stopped, hyperthermia could occur in 20 minutes. Sensitivity tests on the human energy budget indicate that the dry air and strong winds on Black Saturday aided latent heat release, but the required sweating rate was virtually unattainable for an average person and would have lead to intense dehydration. In the future, for extremely hot, dry and windy events like Black Saturday, we recommend that the AT is not used as a thermal comfort measure as it underestimates the physical stress people experience.

6C.3

The Application of the European Heat Wave of 2003 to Korean Cities to Analyze Impacts on Heat-Related Mortality

Thermal Environment and Human Health I

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The goal of this research is to transpose the unprecedented 2003 European excessive heat event to six Korean cities and to develop meteorological analogs for each. Since this heat episode is not a model but an actual event, we can use a plausible analog to assess the risk of increasing heat on these cities instead of an analog that is dependent on general circulation (GCM) modeling or the development of arbitrary scenarios. Initially, the meteorological conditions from Paris are characterized statistically and these characteristics are transferred to the Korean cites. Next, the new meteorological dataset for each Korean city is converted into a daily air mass calendar. We can then determine the frequency and character of "offensive" air masses in the Korean cities that are historically associated with elevated heat-related mortality. One unexpected result is the comparative severity of the very hot summer of 1994 in Korea, which actually eclipsed the 2003 analog. The persistence of the offensive air masses is considerably greater for the summer of 1994, as were dewpoint temperatures for a majority of the Korean cities. For all the Korean cities but one, the summer of 1994 is associated with more heat-related deaths than the analog summer, in some cases a sixfold increase over deaths in an average summer. The Korean cities appear less sensitive to heat-related mortality problems during very hot summers than do large eastern and midwestern U.S. cities, possibly due to a lesser summer climate variation and efficient social services available during extreme heat episodes.

6C.4

Relationships between Temperature and Heat-Related Illness across North Carolina

Thermal Environment and Human Health I

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Heat kills more people than any other weather-related event in the United States, resulting in hundreds of fatalities each year. In North Carolina, heat-related illness (HRI) accounts for over 2,000 yearly emergency department (ED) admissions. In this study, data from the North Carolina Disease Event Tracking and Epidemiologic Collect Tool (NC DETECT) is used to identify empirical relationships between temperature and morbidity across North Carolina across six warm seasons (May-September) from 2007 through 2012. Relationships are explored across different regions (e.g. coastal plain, piedmont, mountains) and demographics (e.g. gender, age, socioeconomic level, and rural/urban) to determine the differential impact of heat stress on population. Research to date reveals that most of these heat-related admissions occur on days with climatologically normal temperatures; however, admission rates increase substantially on days with abnormally high daily maximum temperatures. The highest admission rates are found in rural areas where labor-intensive crops are grown, and the biggest differences in rates are identified between the counties with the highest and lowest rates of poverty. The empirical relationships identified in this study will be used in a web-based heat vulnerability tool that translates National Weather Service (NWS) temperature forecasts into useful information regarding the probability of public health emergencies (e.g. spikes in heat related morbidity).

6C.5

Summer mortality and synoptic climatology in Khabarovsk

Thermal Environment and Human Health I

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The significant impact of weather and climate on human health and well-being has been known for many years. Weather particularly affects public health during the most frequent extreme natural events, resulting in loss of human life during excessive cold and heat events. Heat has a devastating impact on human health: it kills more people in most mid-latitude countries than any other weather phenomenon. Extremely hot periods are associated with increases in weather-related morbidity and mortality in temperate regions, where summer climate variability is at a maximum.

Since all-cause mortality increases during heat waves, an accurate system to warn the public and stakeholders is a necessity. Numerous techniques have been devised in an effort to reduce the impact of extreme heat on the population and to check the effectiveness of warning systems in major cities around the world. As a result of increased awareness related to heat/health system implementation, mortality has decreased over the last few decades (Sheridan et al. 2011). The assumption behind these heat-health systems is a good understanding of the actual heat-health relationship at each region where a system is in place. For this reason, the threshold conditions that induce a harmful health response need to be identified.

The research presented here is the third stage the project “A Climate Assessment of the Russian Far East (RFE) for the Purpose of Developing Weather Health Warning Systems”. It involves an evaluation of mortality/weather relationships, which includes a detailed air mass description using the Spatial Synoptic Classification or SSC (Kalkstein et al. 1996; Sheridan 2002). The ‘synoptic' approach takes into account weather situations rather than single elements and links mortality to objectively determined air masses. The initial method of analysis involved the classification of all days into one of seven weather types.

The study area has a midlatitude monsoon climate, characterized by an extreme continental annual temperature regime. The weather data include air temperature, dew point temperature, total cloud cover, sea level pressure, wind speed and wind direction measured four times daily, using months from May to September, 2000-2012, and are organized by 6 hour daily intervals (03, 09, 15 and 21 Local Standard Time). Daily mortality data for the same period were provided by City of Khabarovsk Administration so we could develop the relationship between daily weather and variations in deaths. Data were subdivided between all cause deaths, gender and the elderly (age 65 and over). For each month, female mortality is 44 %, male mortality 56 % and elderly is near 51 % of all-cause mortality. The first step in mortality evaluation was the creation of daily air mass calendar. Air mass frequencies over months from May to September were examined. The most dominant air mass in summer is moist moderate (27 %) with the same frequency for tropical air masses (moist plus dry). ‘Oppressive' types were identified among the objectively determined air masses as those associated with elevated mortality.

The results show that moist tropical plus and dry tropical air masses are most offensive in Khabarovsk. In particular, for the period from May to September, all cause mortality is 9 % higher than average during days with moist tropical plus air mass (MT+), and 14 % higher during moist tropical double plus (MT++) days. For eldery people mortality is 20 % higher for moist tropical plus, and 30 % higher for moist tropical double plus, yielding 3.4 excess deaths. For summer months mortality may increase more dramatically during oppressive tropical moist days, specifically by 12 (MT+) and 15 % (MT++) for all cause mortality, by 22 (MT+) and 32 % (MT++) for age 65 and over, 14 (MT+) and 16 % (MT++) for women, 9 (MT+) and 14 % (MT++) for men.

For each month from May to September days with moist tropical plus air are the most oppressive. The month with the greatest anomalous mortality is August. Elderly mortality averaged over 30 % higher during days with moist tropical plus air mass, and even more – 45 % above the mean value at moist tropical double plus days, when daily mortality averages 4.8 deaths above the baseline among people aged 65 and over. Somewhat similar, but less extreme increases in excess mortality are seen during days with dry tropical air, with an increase of 5 % in overall mortality for the period from May to September, and rise of 10 % for summer. During summer season as a whole, dry tropical days yield 17 % excessive deaths for eldery people, 11 % for women and 9 % for men.

The persistence of oppressive air masses clearly plays a role in excess mortality sensitivity in Khabarovsk, with magnitudes similar to other vulnerable mid-latitude cities like Seoul and New York. Results demonstrate that the air-mass-based approach is a useful method in assessing impacts of heat stress on mortality, and may be applicable also for predicting health outcomes and increased mortality. Next step is developing of a heat/health watch warning system for Khabarovsk, Russia. Algorithms will be developed to determine which variables within these air masses explain the greatest variations in mortality (eg, consecutive days of oppressive heat, maximum temperature, time of season).

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6C.6

Heat Wave Impacts on Motality in Nanjing,China

Thermal Environment and Human Health I

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A variety of research has linked extreme heat to heightened levels of daily mortality. This paper analyses the relationship between mortality and heat wave (duration of high temperature above 35°C is more than 3 days) in Nanjing ,China. Daily mortality in Nanjing was analysed by cause, from January 2004 to December 2009. When the daily maximum temperature is above 35°C, it is defined as a hot day. Extra mortality was calculated by EM=(D-DNo-heat)/DNo-heat, here EM refers to the extra mortality, D is daily death cases, DNo-heat means the average of death cases in no-heat days (the daily maximum temperature is lower than 35°C) in summer. Our results showed that impact of heat wave on mortality in all causes. Order of causes in Nanjing is Circulatory, Neoplasm, Respiratory, Endocrine, Digestive, Genitourinary, Nervous, Mental, Infectious, Blood and other diseases. Circulatory cause accounts for 37.44%. Second is Neoplasm, occupying 30.02%. The third is Respiratory, taking by 12.99%. Three causes attribute 80.05%. Heat wave impact the order of causes and extra mortality. The highest five extra mortality are Genitourinary, Infectious, Endocrine, Nervous and mental diseases in heat wave, accounting for 100.4% A97.4% A62.0% A56.1% and 48.6%, respectively. There is an attributable of 13.2% of circulatory causes extra mortality.

7A.1

Tonic Immobility and Vigilance Responses of Broiler Chickens to Lighting Regimens during the Hot Dry Season, and the Beneficial Effect of Melatonin

Animal physiology

Victor Olusegun Sinkalu, ABU = Ahmadu Bello University, Zaria-Nigeria, Zaria, Kaduna, Nigeria; J. O. Ayo, A. B. Adelaiye and J. O. Hambolu

Experiments were conducted with the aim of determining the influence of melatonin administration on vigilance and tonic immobility (TI) responses of Marshall Broiler chickens, reared on different lighting regimens during the hot dry season in the Northern Guinea Savannah zone of Nigeria.

Simple random sampling was used to assign 300 broiler chicks into three groups, comprising 100 chicks each. Group I (12L:12D cycle) was raised under natural photoperiod of 12 h light and 12 h darkness, without melatonin supplementation. Group II (LL) was kept under 24-h continuous lighting, without melatonin administration. Group III (LL + MEL) was raised under 24-h continuous lighting; with melatonin supplementation at 0.5 mg/kg *per os*, via drinking water. Beginning from day-old, birds in group III were individually administered with melatonin once daily for 56 consecutive days at 17:00 h. Tonic immobility (TI), induced by manual restraint, and vigilance, by self-righting, were graded for three days, 14 days apart in 15 labeled broiler chickens from each of the three groups at 06:00 h, 13:00 h and 18:00 h starting from day 28 up to day 56. The dry-bulb temperature (DBT) and relative humidity (RH) were recorded at the experimental site and

concurrently during the vigilance and TI tests. The weekly mean temperature-humidity index (THI) was calculated inside the poultry house using the DBT and RH values.

The THI was lowest on day 28 and highest on day 56 of the study, with the values of 48.00 ± 0.08 °C and 51.57 ± 0.98 °C, respectively ($P < 0.05$). At day 28, the relationship between the THI and the TI induction attempts was stronger in 12L:12D cycle ($r = 0.589$, $P < 0.001$) than LL ($r = 0.264$, $P > 0.05$) and LL + MEL ($r = 0.096$, $P > 0.05$) broilers, indicating that the broiler chickens on 12L:12D cycle were more active compared to their melatonin-treated counterparts, apparently due to the adverse effects of high DBT and RH on the broilers during the hot-dry season. The results showed that the number of TI induction trial attempts fluctuated insignificantly as the hours of the day increased, especially in 12L:12D cycle birds ($r = -0.130$, $P > 0.05$). The highest numbers of TI induction trial attempts were 2.13 ± 0.34 and 2.15 ± 0.22, and the values were both recorded at 13:00 h in 12L:12D cycle and LL groups, respectively, when the birds were 56 days' old. The overall mean values of induction trial attempts differed significantly ($P < 0.0001$) between the groups, with the lowest mean values of 1.22 ± 0.4 recorded in Group III birds, administered with melatonin. At day 42, the lowest mean TI duration of 101.87 ± 10.24 s in the LL group recorded at 06:00 h rose ($P < 0.001$) to 184.07 ± 23.69 s at 13:00 h. Again, the overall mean values of TI duration differed significantly ($P < 0.0001$) between the groups, with the highest mean duration of 167.82 ± 8.35 s, recorded in group III broiler chickens administered with melatonin. Unlike the result obtained on TI duration, similar to that recorded in the number of induction attempts, the values of mean vigilance behaviour rankings at the different hours of the day did not differ ($P > 0.05$). The overall mean vigilance behavioural ranking values of 1.85 ± 0.07 and 1.70 ± 0.08, recorded in 12L:12D cycle and LL broiler chickens, respectively were higher (Kruskal-Wallis test = 20.87; $P < 0.0001$) than the value of 1.44 ± 0.05 recorded in melatonin-treated birds. The results indicated that the broiler chickens belonging to both 12L:12D cycle and LL groups were more emotionally unstable, fearful or anxious compared to those in group III that were treated with exogenous melatonin.

It is concluded that melatonin elicits boldness and confidence by suppressing freezing behaviour in broiler chickens.

7A.2

MELATONIN ENTRAINS CIRCADIAN RHYTHMICITY OF COLONIC TEMPERATURE IN LAYING HENS DURING THE HOT-DRY SEASON

Animal physiology
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Experiments were conducted with the aim of evaluating effects of melatonin on fluctuations in colonic temperature (CT) of 26 Isa Brown layers during the hot-dry season. The CT of 14 melatonin-treated and 12 control laying hens were taken for 2 days, one week apart, at 06:00 h, 14:00 h, using standard digital thermometer, inserted through the cloaca into the rectum. Unlike the control birds that were given water only, the treated layers were individually administered at 18:00 h with melatonin orally at 1.5 mg/kg daily throughout the period of the experiment. The overall mean CT in experimental ($n = 14$) and control ($n = 12$) birds were 41.0 ± 0.050C and 40.9 ± 0.040C, respectively ($P < 0.05$). The recorded hourly CT of the melatonin-treated group was lowest at 06:00 h (40.9 ± 0.100C) and highest at 18:00h (41.2 ± 0.050C, $P < 0.05$). The hours of the day had an opposite effect on CT of melatonin-treated ($r = 0.4154$, $P < 0.01$) and control ($r = 0.2447$, $P > 0.05$) layers. The relative humidity was negatively correlated with the CT in both melatonin-treated ($r = -0.6495$, $P < 0.001$) and control ($r = -0.3294$, $P < 0.05$). The results indicated that only the CT of the melatonin-treated layers showed distinct diurnal fluctuations. The findings showed that layer birds administered with melatonin had higher CT values. This indicated the entrainment of CT circadian rhythm and considerable metabolic effect of melatonin administration on the treated layers. It is concluded that melatonin administration to layers sustained homeostasis and enhanced metabolic processes during the stressful period of the hot-dry season, and, thus, may enhance their productivity in the Northern Guinea Savannah Zone of Nigeria.

7A.3

Respiratory evaporation of poultry – the development of a ventilated hood system

Animal physiology
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The main function of the respiratory system is the gas exchange, carrying oxygen to the tissues and removing carbon dioxide from them and supplying the metabolic requirements of the animals. Furthermore the respiratory system is essential to the thermoregulation because the loss of water is a way to the maintenance of body temperature in conditions of high air temperature. When there is an increase of the air temperature, consequently it is observed a decrease in the temperature gradient with the body temperature, birds like broiler chickens, quails and turkeys increase their respiratory evaporation to increase the loss of heat to the environment. Thus, the increase of respiratory evaporation to the maintenance of body temperature results in an energy expenditure greater than the sensible flow, and consequently we can observe changes in the acid-basic equilibrium of blood and in the content of water of the body. Some techniques are described in the literature to the settlement of the respiratory evaporation of poultry, but all used in controlled environments (chambers). Two-compartment metabolic chambers are described to calculate separately the cutaneous and respiratory losses of small birds. However, the measurements must be done in the dark to avoid the animals to shake inside the chamber. Other technique is the intubation of birds using an endotracheal tube connected to a pneumotachograph but this can be considered an invasive technique. Masks can be developed to the settlement of respiratory evaporation and connected to a spirometer can be used to the study of respiratory functions of poultry in similar conditions of facilities (tidal volume, respiratory frequency, temperature of expired air). The use of masks coupled to gas analyzers enables the measurement of oxygen consumed and carbon dioxide produced, and it is possible to measure the metabolic heat production. Previous experiments showed that a mask isolating only the beak of broilers is not appropriate because it causes discomfort and the leakage of the expired air. Therefore we developed a plastic and transparent hood to envelop the head and neck of the birds to permit their vision sealed with a rubber sheet. The Animal Biometeorology Laboratory developed the System of Physiological Measurement to the continuous measurement of respiratory gases (oxygen; carbon dioxide; water vapour), respiratory functions (tidal volume, respiratory flow and respiratory rate) and body temperatures (skin, feather, rectal and expired air). The system used for poultry is composed by: the hood (developed by the Laboratory); oxygen and carbon dioxide analyzers (model FMS-1201-05, Field Metabolic System); two water vapour analyzers (one for the atmosphere and one for the expired air of broilers, model RH-300, Sable System); two pumps (model SS4 sub-sample, Sable System); a dessicant column (Magnesium Perchlorate); spirometer (model ML141, ADInstruments); chamber to the mixture of gases (developed by the Laboratory); one breathing tube; a flow head (model MLT10, ADInstruments); a probe for the expired air temperature (model MLT415/AL, ADInstruments). Respiratory evaporation (W m-2) can be calculated by eq. (1): q_ER^"=(λ RF(φ_A-φ_exp))/A, where: λ is the latent heat of water vaporization (J g-1); RF is the respiratory flow (m3 s-1); φA is

the absolut humidity of air (g m-3); φA is the absolut humidity of expired air (g m-3); A is the surface body area (A=0.000819 (⟦BW⟧^0.705), m2, BW is the body weight, kg). Metabolic heat production (W m-2) can be calculated by eq. (2): q_M^"=RF[(QO_2 DO_2 0.75)+(Q⟦CO⟧_2 D⟦CO⟧_2 0.25)]/A, where: RF is the respiratory flow (L s-1); QO2 is the caloric coefficient of oxygen (kJ L-1); ΔO2 is the difference between oxygen concentrations in the atmosphere and in the expired air (%);QCO2 is the caloric coefficient of carbon dioxide (kJ L-1); ΔCO2 is the difference between carbon dioxide concentrations in in the expired air and in the atmosphere (%). Some tests were made to validate the methodology. Considering broilers as very uniform animals (from a same strain) we chose a 15 minutes sampling of a broiler at 23ºC, with a temperature of expired air of 30ºC and with a body weight of 1.6 kg. We observed the following mean values (±SE): respiratory rate, 24±0.17 breaths min-1; respiratory flow, 0.00779±0.001 L s-1; ventilation, 0.467±0.002 L min-1; tidal volume, 0.01977±0.0001 L breath-1. All the observed values are in accordance to data described in literature, mainly tidal volume and ventilation. These results show our system has no leakage of the expired air during measurements. The mean value of metabolic heat production was 53.61±0.23 W m-2 and we observed an average of respiratory evaporation of 1.14±0.005 W m-2. The results of metabolic heat production are in agreement with values described in literature for broilers with similar body weight. The respiratory evaporation little contributed to the heat loss considering the air temperature of the test. We can consider as the most valuable result of our work the evidence of a reliable technique to measure respiratory evaporation of poultry, considering the animals exposed to environmental conditions and not under controlled environments as respiratory chambers. We are performing an assay to the study of respiratory functions, metabolic heat production and respiratory evaporation of broilers during all the rearing period.

7A.4

Effect of Chromium Supplementation on Endocrine Variables in Summer Exposed Murrah Buffaloes (Bubalus bubalis) Calves

Animal physiology

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Summary: In present study, we elucidate the effect of chromium (Cr) supplementation on the endocrine variation, plasma glucose and Cr concentration in summer exposed buffalo calves. Twenty-four female buffalo calves,either received a basal diet devoid of supplemental Cr (control) or were supplemented with 0.5, 1.0 and 1.5 ppm trivalent Cr from an inorganic source $CrCl_3.6H_2O$. Dietary Cr supplemented buffalo calves had low plasma concentration of insulin, glucose and cortisol during summer season. In contrary, plasma Cr concentration increased with increased dietary Cr levels. However, thyroid hormones showed no alteration in their plasma concentration among different groups. In conclusion, dietary addition of Cr improved glucose utilization and reduced stress in summer exposed buffalo calves.

Introduction: The effects of heat stress are costly to dairy farmers due to reduced performance of farm animals specially crossbred and buffaloes. Buffaloes exhibit signs of great physical distress when exposed to environmental stress as compared to other farm animals (Das et al., 1999). This is due to fact that their body absorbs a great deal of solar radiation because of their dark skin and sparse coat or hair. In addition, they possess a less efficient evaporative cooling system due to their rather poor sweating ability. Exposure of animals to heat stress increased the production of adrenal cortisol (Kim et al., 2009) which antagonizes synthesis, release and action of insulin hormone. In domestic animals, Cr has been recognized as a newer essential trace mineral (Anderson, 1987) and suggested to alleviate stress-associated effects (Garg, 2000).

Materials and methods: Twenty four female buffalo (*Bubalus bubalis*) calves were selected from the herd of National Dairy Research Institute, Karnal and randomly assigned to four treatment groups (*n= 6*) and fed for 120 days. Calves either received a basal diet devoid of supplemental Cr (control) or were supplemented with 0.5, 1.0 and 1.5 ppm trivalent Cr from an inorganic source $CrCl_3.6H_2O$. Peripheral blood samples were collected at days 0, 15, 30, 45, 60, 75, 90, 105 and 120 post-supplementation of Cr for estimation insulin, glucose, cortisol, thyroid hormones and Cr level.

Insulin was determined in plasma of calves by "bovine insulin ELISA test kit" (ERK B1009, Endocrine Technologies, New York, USA). Plasma glucose was quantified by glucose oxidase method with the use of an enzymatic colorimetric assay (Trinder, 1969).Cortisol was determined by "cortisol EIA kit" (Cayman's Chemical Company, Ann Arbour, Michigan, USA). Cayman's cortisol EIA kit is a competitive assay that can be used for quantification of cortisol in plasma. The T3 and T4 hormone concentrations in plasma were estimated by radioimmunoassay (RIA) using ISOPHARM kits (Bhaba Atomic Research Center, Bombay, India). Plasma Cr level was estimated by using atomic absorption spectrophotometer (Model Z-5000, polarized Zeeman atomic absorption spectrophotometer (AAS), Hitachi High-Technologies Corporation, Tokyo, Japan).

Results: Plasma levels of insulin, glucose, cortisol, thyroid hormones and Cr in buffalo calves fed on diet supplemented with Cr is presented in Table 1. In present study, plasma insulin and cortisol levels were found significantly low (P<0.001) in 1.5 mg of Cr/kg DM fed buffalo calves. However, dietary addition of Cr in summer exposed buffalo calves did not had any effects on plasma concentration of T3 and T4 hormones. Plasma glucose had negative and plasma Cr had positive correlation with dietary Cr levels. As the level of Cr supplementation increased, level of plasma glucose decreased (P=0.020) and plasma Cr increased (P=0.031).

Conclusion: Dietary Cr supplementation reduced stress by reducing synthesis and release of cortisol during summer season. Supplementation of Cr in summer exposed buffalo calves also increased efficiency of glucose utilization by increased potency of insulin to words its receptors.

Table 1. Effect of Cr supplementation on endocrine variation, plasma glucose and Cr levels

Parameters	Supplemental Cr (mg/kg of DMI, ppm)				SEM	P-value		
	0	0.5	1.0	1.5		Group (G)	Period (P)	GxP
Insulin level, ng/ml	1.87[b]	1.84 [b]	1.86[b]	1.76[a]	0.04	<0.001	0.089	0.999
Glucose level,	58.80[c]	56.28	54.57	53.33	4.1	0.020	0.440	1.00

mg/dl		[b]	[a]	[a]	7			0
Cortisol level, ng/ml	4.38[b]	4.45[b]	4.52[b]	3.82[a]	0.15	<0.001	0.110	1.000
Thyroxine (T4), nmol/l	68.97	71.48	70.93	73.48	6.66	0.431	0.534	0.667
Triiodothyronine (T3), nmol/l	1.68	1.86	1.79	1.93	0.03	0.114	0.133	0.826
Cr, ppb	0.21[a]	0.29[a]	0.40[b]	0.43[b]	0.01	0.031	<0.001	1.000

Means bearing different superscript differs significantly (P<0.05) and treatments by time interactions were not significant (P > 0.50).

7A.5

Effect of antioxidants and betaine supplementation on serum HSPs and stress hormone during long-term heat stress adaptation in goat

Animal physiology

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Menacing global rise in surface temperature compelled more focus of research over decoding heat stress response mechanism of animals and mitigation of heat stress. Thirty female goats were taken and randomly divided into 5 groups (n=6) such as NHS (Non heat stressed), HS (Heat stressed supplemented with normal saline- 5mL I/M), HS+B (Heat stressed supplemented with betaine- 0.2g/kg BW I/M), HS+VC (Heat stressed supplemented with Vitamin C- 40mg/kg BW I/M), HS+VE+Se (Heat stressed supplemented with Vitamin E- 50 mg and Selenium- 1.5 mg I/M). After 14 days acclimatization, except NHS group, other groups were supplemented and exposed to repeated heat stress (42°C) for 6 h for sixteen consecutive days. Blood samples were collected at the end of heat exposure on day 1, 6, 11 and 16. Stress hormones and extracellular HSPs concentration were measured by RIA and ELISA, respectively. The body weight (BW) and body condition score (BCS) was decreased by considerable amount in heat stressed goats except HS+B group. Stress hormones responses to heat stress in goats between groups on study days: On first day, cortisol concentration decreased significantly (P<0.05) in HS+VC group in comparison to HS and HS+VE+Se groups. On day 6, T3 level in HS group and T4 level in HS+VC group was found significantly (P<0.05) lower than HS+VE+Se group. Cortisol level in HS and HS+VE+Se group was investigated significantly (P<0.05) higher than NHS and HS+VC groups. On day 11, T3 concentration in HS+VC and HS+VE+Se group and cortisol concentration in HS+B group increased (P<0.05) in comparison to other groups. On day 16, T3 and T4 concentration in antioxidants and betaine administered groups was found significantly (P<0.05) higher in comparison to HS group. T3 concentration in HS group decreased (P<0.05) than NHS group. Stress hormones responses to heat stress in goats between study days within groups: In HS group, T3 concentration decreased (P<0.05) on day 16 in comparison to day 1 through day 6. A non significant (P>0.05) decrease was observed in T4 concentration. Cortisol concentration increased (P<0.05) to reach at peak on day 6 and thereafter decreased to basal level on day 11. In HS+B group, T3 concentration was observed significantly higher (P<0.05) on day 6 and 16 in comparison to day 1 and 11. Its concentration on day 6 was significantly (P<0.05) lower than day 16. T4 concentration increased (P<0.05) on day 16 in comparison to day 1. Cortisol concentration increased (P<0.05) to reach at peak level on day 11 through day 6 in comparison to day 1. Thereafter, it decreased (P<0.05) towards basal level on day 16. In HS+VC group, concentration of T3 on day 11 and 16, and T4 on day 16 was found significantly (P<0.05) higher in comparison to day 1 and 6. Cortisol concentration increased (P<0.05) on day 11 than day 1. In HS+VE+Se group, T3 concentration increased (P<0.05) on day 6 in comparison to day 1 and maintained at higher level on subsequent days. T4 on day 16 was found significantly (P<0.05) higher in comparison to day 1. Cortisol concentration was recorded significantly (P<0.05) higher on day 6 than day 1, 11 and 16. T3 mean concentration was increased (P<0.05) in antioxidants supplemented groups and decreased (P<0.05) in HS group in comparison to NHS and HS+B groups. Vitamin E with Se increased (P<0.05) the T4 mean concentration than HS group. Cortisol concentration was found significantly (P<0.05) higher in HS and HS+B group in comparison to other groups. Responses of extracellular HSP70 to heat stress quantified by ELISA: Six hour heat stress at 42 °C on first day was found to have no effect on the extracellular HSP70 (eHSP70) in all groups. On day 6, eHSP concentration was found significantly (P<0.05) higher in heat stress exposed animals in comparison to control animals. On day 11, eHSP70 level in serum was differed (P<0.05) in all groups and the increasing order of eHSP70 concentration was follows: - NHS < HS+VC < HS+VE+Se < HS group. On day 16, there was observed higher (P<0.05) level of eHSP70 only in HS group animals than other groups. The eHSP70 increased significantly (P<0.05) after day 1 in all groups in comparison to NHS group and reached to peak value on day 11. After that, it decreased (P<0.05) towards basal level concentration in heat stressed animals. Mean eHSP70 increased (P<0.05) in all heat stressed groups in comparison to NHS group and in HS group it was significantly (P<0.05) higher than HS+B, HS+VC and HS+VE+Se groups. Responses of extracellular HSP90 to heat stress quantified by ELISA: On day 1, extracellular HSP90 (eHSP90) concentration was significantly (P<0.05) higher in HS, HS+B and HS+VE+Se group in comparison to NHS and HS+VC groups. However on day 6, no significant (P>0.05) difference was observed between groups. Concentration of eHSP90 increased (P<0.05) in HS group than NHS group on day 11. On day 16, eHSP90 level increased (P<0.05) in HS, HS+VC and HS+VE+Se in comparison to NHS and HS+B group. In antioxidants administered groups, eHSP90 concentration was significantly (P<0.05) lower than HS group. In HS group, the expression of eHSP90 declined (P<0.05) on day six in comparison to day 1; gradually increased (P<0.05) through day 11 and reached again at second peak on day 16. In contrast, the eHSP90 concentration in antioxidant administered groups remained at basal level up to day 11 and thereafter, increased significantly (P<0.05) on day 16. However, we could not observe any difference in betaine administered group on eHSP90 between days. Mean eHSP90 increased (P<0.05) in HS group in comparison to all other groups. In conclusion, betaine and antioxidants supplementation significantly affect the BW, BCS, cortisol, T3, T4, extracellular HSP70 and HSP90 during heat stress. eHSP70 and eHSP90 may be used as a useful biomarker of heat stress in animals.

7A.6

Seasonal Variation in the Reproductive Hormones of Rabbit Does and its Relation to Their Reproductive Performance

Animal physiology
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The present study was carried out at the Rabbits Experimental Farm, belonging to the Department of Animal Production, Faculty of Agriculture, Al–Azhar University. Twenty Californian does aged 3 months with average live body weight of 2.2kg were used (10 in each season). Rabbit that born in February (ten does) represented the summer group while that born in August represented the winter group. Breeding does and bucks were housed individually in wire bottomed-cages in visual contact with their neighbors with standard dimension arranged in double-tier batteries of column type. Mash ration of about 16% total protein and 60% starch equivalent was provided ad lipitum twice daily in the morning and at evening. During winter barseem (Egyptian clover) Trifolium alexandrinum was provided. During summer months clover hay was supplied. Fresh clean water was available to rabbit all times. Weaning was practiced at the 21th day after parturition. The following reproductive and productive traits were estimated in each season: Age and live body weight at puberty, litter size at birth, mortality rate and litter interval. Serum estradiol-17β and progesterone levels were measured at the following physiological stages: Pre-puberty, at puberty, during gestation period (1st, 2nd and 3rd weeks of gestation) and during lactation period (1st, 2nd and 3rd weeks of lactation). The objective is to study the seasonal variation in the levels of female sexual steroidal hormones (estradiol 17β and Progesterone) with respect to the productive and reproductive activity in does of California breed.

Results indicated that in winter, serum level of estrogen was significantly ($p \leq 0.05$) higher at puberty than pre-puberty, pregnancy and lactation levels except at the third week of lactation. During pregnancy, estrogen level tended to increase during the second week of pregnancy until the end of pregnancy period (at parturition). After lambing, serum estrogen tended to increase linearly with the advance in lactation although the changes were not statistically significant. A similar trend was found in summer, however the increase in estrogen level during mid-pregnancy (second week) as well as during the end of lactation period (third week) was significant ($p \leq 0.05$). In both seasons, serum progesterone level did not differ significantly between at puberty and pre-pubertal stages, but increased dramatically to reach its highest level at early pregnancy. During summer season serum progesterone level decreased during mid-pregnancy and slightly increased towards the end of pregnancy. In contrast serum progesterone level decreased towards the end of pregnancy period in winter season. After delivery serum progesterone gradually decreased during lactation period reaching almost the pre-pubertal level at the end of lactation period. Regarding the effect of season, serum estrogen concentration during different physiological status was higher under heat stress in summer than under thermoneutral temperature in winter. The difference was significant at the pre-pubertal stage and during different stages of pregnancy. An opposite significant trend was found in serum progesterone levels which were significantly higher in winter than in summer during pregnancy and early lactation. Reproductive performance was better in winter than in summer where does bred in winter season had significantly shorter litter intervals than had those bred in summer season. Also, letter size was slightly higher in winter with significantly higher survivability (number of live bunnies). It could be concluded that higher serum progesterone and lower serum estrogen during pregnancy in winter than in summer may be related to better reproductive performance in winter than in summer and breeding season must be taken in consideration if high efficiency of reproduction is aimed to be obtained.

7B.1

Nature Today; What is the business/communication potential of your scientific information?

Phenology III: Observations
Arnold van Vliet, Wageningen University, Wageningen, Netherlands; W. Bron

During our presentation we will discuss our plans for setting up Nature Today. Nature Today aims to be an organization that will publish daily news from nature and environment from local to possibly global scale. The large and continuous ecological responses to changes in weather, climate and other environmental variables are relevant for and interesting to many people. We see possibilities for Nature Today to generate financial resources, institutional and societal support for ecological or environmental monitoring projects and their related research activities.

The ideas for Nature Today originate from the Dutch phenological network Nature's Calendar that we revived in 2001. Since then we set up a number of related citizen science networks that focus on, for example, hay fever, ticks & Lyme disease and mosquitoes. We have been very successful in generating public attention for our projects. The launch of the Dutch nature news website Natuurbericht.nl on which we publish two nature reports per day significantly helped in bridging the gap between scientists, journalists and the public.

It, however, remains a continuous struggle to find the required funding for continuation of our monitoring programs and the accompanying research activities. This will not be very different for most phenological networks, (long-term) monitoring networks or many scientific projects in general. One reason is probably that most scientists miss the ‘business gene' and we are not trained to actively commercialize and communicate our knowledge. It is probably even not done to think of business opportunities.

In the past year we participated in various business acceleration programs in the Netherlands. Besides becoming familiar with a whole new world we became even more convinced that many scientists have numerous opportunities to better connect their data, their models and their knowledge to the interest of the general public and specific target groups. More importantly, we think that many people, stakeholders and organizations are willing to pay for the information or to support the networks/projects in other ways. To make this happen Nature Today will: 1)Help environmental scientists and scientific organizations to present their data and knowledge in the right way (form, timing, language, etc.); 2)Connect scientists and journalists; 3)Offer scientists the network, platform and tools to get their data and knowledge to large amount of potentially interested people. 4)Help in identifying and realizing ‘business opportunities'.

We hope that we can inspire participants to consider involvement in Nature Today and that they are willing to help us in validating our assumptions.

7B.2

ClimateWatch: Australia's phenological citizen science program

Phenology III: Observations

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ClimateWatch is a phenology monitoring program developed by Earthwatch Institute with the Australian Bureau of Meteorology and The University of Melbourne. The nation-wide program encourages all Australians to observe the world around them and record sightings of over 170 indicator plant and animal species, covering the tropics, temperate, arid, alpine and marine zones.

Indicator species were selected based on four mandatory and 10 optional criteria, designed to maximise community engagement and minimise misidentification among untrained observers.

Observations are recorded using an online interface or a free smartphone app. ClimateWatch users can make sightings anywhere in Australia, including at more than 40 self-guided trails in urban parks, botanic gardens and education centres.

Since 2009, over 13,000 Australians have registered for ClimateWatch, contributing in excess of 60,000 sightings. The program is currently used by nine universities across Australia to teach biology and scientific observation techniques, resulting in more than 4000 new phenologists in training every year.

This presentation will describe the implementation of ClimateWatch across Australia, including its unique engagement with the tertiary sector. Spatial and observation biases in the dataset will be discussed, as well as the issues associated with collecting data from such a wide network. Preliminary analysis suggests that with the correct approach, observations from the ClimateWatch network provide valuable data to analyse phenological changes across Australia.

7B.3

Plant Phenological Reconstructions and Temperature Sensitivity in Beijing in the Past 100 Years

Phenology III: Observations

TAO zexing, Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, Chaoyang District, Beijing, China; W. huanjiong, G. quansheng and D. junhu

Plant phenology can reflect the climate change very sensitively. Reconstructing long-term phenological time series could contribute to the study of the climate-vegetation relationship from a historical perspective. However, previous studies have some problems in the interpolation method of missing data, the reconstruction method of time series as well as the uncertainty analysis. To overcome these problem, we use modern phenological observation data to calibrate the transfer functions between different phenophases and first flowering date (FFD) of lilac (Syringa oblata), and reconstructed the lilac FFD in Beijing over the past 100 years based on the historical records. Meanwhile, we assess the associated reconstruction uncertainty. In addition, the 30-year moving trend, temperature sensitivity and abrupt change in the reconstructed phenological time series are analyzed. The moving linear trend analysis suggests that the spring phenophase in Beijing fluctuated about 36 days in the past 100 years. The spring phenophase showed advancing trend in all the 30-year period after 1980. The maximum trend of -0.46 days/year is found between 1979 and 2009. However, the trends slowed down in the recent 10 years. The sensitivity of spring plant phenology to the March-May temperature ranged from 1.5 days /°C to 5.6 days /°C. Temperature sensitivities were greater during every 30-year periods with the center year from 1930s onwards. It is worth noting that after the 1980s, temperature sensitivities became continuous greater. Finally, the moving t-test showed a common shift towards earlier FFD in 1982 in temperature and plant phenological records.

7B.4

Phenological environmental assessment indicators – proposing an international standard

Phenology III: Observations

K. Bolmgren, Swedish University of Agricultural Sciences, Asa, Lammhult, Sweden; B. I. Cook, Dahl and O. Langvall

Phenological change is the most obvious ecological effect of climate change on ecosystem properties, processes and services. Estimates of phenological change are increasingly being used in environmental, ecological and climate change assessments, both at the international (e.g. IPCC WG2) and national levels (e.g. NCA, USA). Despite of this, there is no international standard for the analytical procedures (A), no standard for the pheno-metrics (PM), no standard for baselines (B), and no standard for data quality classification (QC). The phenology monitoring community represents a wide range of systems – from professional to volunteer observers, from developing systems to those that have been working for over a century, from spatially large networks to point observations, from systems with a focus on agriculture to those more oriented to wildlife. To be able to merge data from these different systems and to provide widely applicable pheno-metric products, there is a great need for a common standard. We present a proposal for a phenological environmental assessment indicator standard. Standardized quality classification (QC) includes four levels: (QC1) Observer self-validation. (QC2) Error check (e.g. of required phase order) leading to flagging of erroneous data to exclude from the analysis. (QC3) Outlier check of both single observations and inter-annual variation leading to parallel analyses with/without flagged outliers. Outlier check should be based on (i) models using historical data and (ii) models using present-year neighboring observations. (QC4) Image-based confirmation that can overrun (QC3) flagging decisions. As a standardized baseline (B), we propose estimated phenology data for the climatological standard periods (e.g. 1961-90), using a phenology model that has been calibrated regionally. We propose two different pheno-metrics: The first (PM1) is simply number of days deviation from the baseline, B, and the second (PM2) is the proportion of deviation compared to the local, meteorologically defined, vegetation period. Analysis could be (A1n) single-year estimates, (A2n) short period averages based on at least 5 years of data, or (A3n) long-term averages based on at least 30 years of consecutive data. A1n-A3n could be presented as (Am1) point estimates or (Am2) spatial averages based on at least 10 separate stations with data overlapping in time. Indices, combining different species+phase combinations, can be developed if all included combinations can be referred to the same, minimum level of (Amn). We present an example of pheno-metrics (PM) developed for the Swedish Environmental Assessment and Environmental Objectives, and how we applied the proposed quality classification (QC), two different types of baseline (B), and analytical procedures (A) using historical and present-day data from the Swedish National Phenology Network.

7B.5

Exploring Geographically Variant Climatic Requirements of Plant Phenology through Common Garden Observations

Phenology III: Observations
Liang Liang, University of Kentucky, Lexington, KY

A more detailed understanding of population-level variations in plant phenology and the corresponding environmental drivers is crucial for monitoring and predicting geographically different phenological responses to climate change. Here I report an on-going project observing spring and fall phenology of an important native forest species Fraxinus americana (white ash) in a common garden/plantation in Kentucky, U. S. A total of 41 populations from across the species' distribution range are represented at this site. Weekly visual phenology surveys were conducted in spring and fall seasons of 2013, and spring season of 2014 (with the fall 2014 observation anticipated). Concurrent temperature variations have been recorded at the common garden with automatic data loggers. Preliminary results showed that in 2013 the southern populations demonstrated earlier spring leaf bud burst and later autumn leaf coloration and leaf fall than the northern populations. In spring 2014, with a delayed phenology overall, the southern populations obscurely appeared to show later leaf bud burst, and with frost damage observed on some of the trees from these populations. The 2012-2013 winter was warmer than normal, and the 2013-2014 winter had record low temperatures followed by a cold spring.

I hypothesize that the spring phenology timing of white ash is controlled by a strong chilling requirement with a less influential warming requirement, and the northern populations require more chilling (and less warming) than the southern populations. This is supported by the delayed phenology with the northern populations after a relatively warm winter in spring 2013. When the chilling requirement was fulfilled very early in spring 2014, the effect of warming was more manifested, leading to earlier phenology for the northern populations. Due to the quick response to warmth after the abundant chilling for some of the southern populations in 2014, frost injury occurred and may have confounded the phenological observations for some individuals. Moreover, the differential photoperiod requirement is also useful for explaining the geographic patterns in 2013, which may serve as an alternative hypothesis. However, given the observed interannual variations, these environmental factors are unlikely to operate alone, but are most possibly coupled with one another. More in-depth study of both the spring and autumn phenology (with additional data to be collected) of this particular species with the environmental drivers may provide important insight on and facilitate building a modeling framework for assessing geographically explicit climate change impact on plant phenology.

7B.6

Impacts of climate change on the Taraxacum mongolicum growing season in the temperate zone of eastern China

Phenology III: Observations
Xiaoqiu Chen, Peking University, Beijing, China

Using leaf unfolding and leaf coloration data of a widely distributed herbaceous species, Taraxacum mongolicum, we detected linear trends of the growing season and identified responses of the growing season to temperature at 52 stations from 1990 to 2009. Across the temperate zone of eastern China, the growing season beginning date advanced nonsignificantly, while the growing season end date was delayed significantly at a rate of 3.2 days per decade and the growing season length was prolonged significantly at a rate of 5.5 days per decade. At individual stations, linear trends of the beginning date correlate negatively with linear trends of spring temperature, whereas linear trends of the end date and length correlate positively with linear trends of autumn temperature and annual mean temperature. Moreover, linear trends of the growing season are also closely related to responses of the growing season to temperature and geo-location parameters. Regarding to growing season response to temperature, a 1°C increase in spring temperature may induce an advancement of 2.1 days in the beginning date of the growing season, while a 1°C increase in autumn temperature may cause a delay of 2.3 days in the end date of the growing season, and a 1°C increase in annual mean temperature may result in an extension of 8.7 days in the length of the growing season over the research region. At individual stations, response of the beginning date to spring temperature depends obviously on local annual mean temperature and geo-location parameters. Namely, a 1°C increase in spring temperature may induce a larger advancement of the beginning date at warmer locations with smaller latitudes and longitudes than at colder locations with larger latitudes and longitudes, while a 1°C increase in spring temperature may cause a larger advancement of the beginning date at higher altitudes than at lower altitudes.

7C.1

Temperature and human health

Thermal Environment and Human Health II
Lev Osipov, Institute of Cytology, Novosibirsk, Russia

Temperature influences human health.

7C.2

Vulnerability Among the Elderly to Extreme Heat-Associated Cardiovascular Mortality in Michigan, 2000-2009

Thermal Environment and Human Health II
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Background: A better understanding of which populations are most vulnerable to the health effects of extreme heat will help communities adapt to climate change. Previous research has suggested that vulnerability is enhanced among individuals with certain socio-demographic characteristics, e.g., black race, advanced age, low educational attainment and low income. Additionally, vulnerability may be increased among individuals who lack adequate transportation to reach cooler locations; who reside in older homes that may have inadequate weatherproofing; and/or who live amidst areas with high levels of impervious surfaces, which increase ambient temperature. Cardiovascular mortality, particularly in cool climates such as Michigan, has been associated with extreme heat.

Objectives: Our objectives were 1) to determine if the extreme-heat-cardiovascular mortality association was present among Michigan elderly in 2000-2009 and 2) to determine which characteristics modified the association between extreme heat and cardiovascular mortality.

Methods: We used the following data: 1) geocoded death records from ten Michigan counties from the Michigan Department of Community Health (including date and causes of death, age, race and educational attainment), 2) daily mean temperature and humidity from the nearest airport weather station from the National Climatic Data Center, 3) Census block group characteristics from the 2005-

2009 American Community Survey (median income among individuals aged 65 years and older and percents of residents in poverty, homes built before 1940 and residents aged 65 years and older without a vehicle), and 4) National Land Cover Data Set percent imperviousness (averaged at radii of 90m, 150m, 300m, 600m and 1.5km). For each county we calculated daily apparent temperature, which is based on temperature and dew point. We defined extreme heat exposure as four-day mean apparent temperature at or above the 97th percentile of four-day mean apparent temperature for that location from 2000-2009. We employed a time-stratified case-crossover design with conditional logistic regression to assess the association between cardiovascular death and extreme heat, and we assessed vulnerability as interactions between extreme heat and each characteristic of interest in individual models. Significant interactions were then included together in a single model. Continuous measures were mean centered and standardized for an interquartile range increase.

Results: In models with only a single interaction, the odds of cardiovascular mortality were increased during extreme heat vs. non-extreme heat among individuals of black race (19%, 95% Confidence Interval: 9%-31%), residing in areas with high (68%) percent imperviousness within 1.5km (13%, 95% CI: 5%-22%) and residing in block groups with: high (46%) proportions of homes built before 1940 (26%, 95% CI: 8%-48%) and high (43%) proportions of households with at least 0.51 occupants per room (33%, 95% CI: 5%-68%). In models with all these interaction terms included simultaneously, these effects were all attenuated and non-significant. In a model with all these terms except black race, the effects of homes built before 1940 and imperviousness within 1.5km remained significant.

Conclusions: Surrounding imperviousness and living in an older home may confer vulnerability to extreme heat in Michigan. Increased vulnerability among individuals of black race may be at least partially mediated by characteristics of the built environment. Future adaptation efforts should improve housing quality and decrease the effects of impervious surfaces on ambient temperature.

7C.3

Influence of the Thermal Environment on IHD Mortality and Morbidity in Germany (2001-2010)

Thermal Environment and Human Health II

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There is some evidence from the literature that the atmospheric environment influences the frequency of acute cardiovascular problems. In our study we analyzed the influence of meteorological parameters on the occurrence of ischemic heart diseases (IHD, ICD codes I20-I25), a subgroup of cardiovascular diseases in Germany. Data on the daily occurrence of IHD death rates and hospital admission rates were provided for the period 2001-2010 on a regional resolution of NUTS2 for Germany by the Federal Research Data Center. In total about 7.5 million cases of hospital admissions and about 1.5 million IHD deaths occurred in the studied period. We analyzed total IHD mortality (ICD codes I20 – I25), for women and men separately as well as the subgroups I20-I22 (mainly myocardial infarctions) and I24-I25 (other acute and chronic ischemic heart diseases). Since the daily numbers of IHD deaths and/or hospital admissions were low in several regions, these regions were aggregated for data protection reasons. Daily mortality rates were detrended and corrected for the course of the year. Morbidity data were additionally corrected for the weekly course. We found a strong relationship between the thermal environment and daily mortality rates. In order to describe the thermal environment we used daily averages of air temperature, perceived temperature and humidex. The differences in the shape and strength of the relationship between these parameters / indexes and IHD mortality were small. Therefore results are described for daily mean temperature. The detrended mortality data that were not corrected for the course of the year, showed the typical V-or U-shape relationship with the thermal environment. The lowest mortality rates occurred at daily mean temperatures between 15°C and 19°C. Below and above this range, mortality increased nearly linearly. We found that the increase below this thermal optimum was mainly due to the seasonal feature. The mortality rates that were corrected for the course of the year didn't show any increase in mortality below the optimum temperature. An exception was the mortality with ICD codes I20-I22 (mainly myocardial infarctions) that was increasing also after correction for the course of the year at very low daily mean temperatures (< -7°C). Apart from absolute values of air-temperature we also analyzed the influence of changes compared to the previous day. The relative risk of IHD mortality increased for increases of air-temperature of more than 5°C for men and ICD codes I24-I25 (other acute and chronic ischemic heart diseases) and for decreases of more than 3°C for women and ICD codes I24-I24 and of more than 5°C also for men and ICD codes I20-I22. We couldn't find any significant relationship between the number of hospital admissions due to ischemic heart diseases and the analyzed meteorological parameters.

We also analyzed the increase in morbidity and mortality during heat-waves. A heat wave in this study was identified when at least three consecutive days exceeded the 97.5th percentile of daily mean temperature. During heat waves the daily risk for IHD mortality increased on average by 15 %. Women were more affected than men (women: 19 %, men: 11 %).We couldn't find any increase in the number of hospital admissions during heat-waves. This was the first study analyzing the relationship between IHD morbidity and mortality all over Germany. We were able to demonstrate that there is a significant increase in IHD mortality in Germany especially on days with high average temperatures and heat-waves. The high numbers of IHD mortality rates in winter show only little relationship to average temperatures when corrected for the course of the year. A potential relationship between the atmospheric environment and IHD morbidity remains unclear.

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7C.4

Possible role of acclimatization in weather-related human mortality during the transition seasons of autumn and spring in an extreme continental climate

Thermal Environment and Human Health II

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Statistical evidence shows that human mortality is closely related to levels of thermal environmental stress and resulting thermophysiological strain. Most climate-mortality research has focused on seasonal extremes when mortality is highest (winter) or most affected by extreme heat events (summer). Relatively little research has considered patterns of mortality, during the transitional seasons of autumn and spring. The body acclimatizes to heat in summer and cold in winter and readjusts through acclimatization during the transitions between the two. Consequently, the thermophysiological strain of re-adjustment may be expected to occur in the changeover seasons of spring and autumn. This adaptation period is not risk free, so it may be necessary to take into account the impact of the change in physiological well-being during the period of adjustment.

To better understand the influences of weather on mortality through the acclimatization process, the aim here is examine the periods that link summer and winter. The study uses the Acclimatization

Thermal Strain Index (ATSI), which is a relative measure of short-term thermophysiological impact on the body. ATSI centers on heat exchange with the body's core via the respiratory system, which cannot be protected. Respiration is the body-environment heat exchange process in which the body is in closest contact with the ambient air. There are no behavioral or other adjustments to prevent the ambient air entering into the body's core area through the respiratory tract. ATSI describes the acclimatization thermal loading (ATL) on respiratory organs until full adaptation is achieved. Unlike widely used bioclimatic indices, ATSI is a relative measure, based on physiological responses known to negatively impact human wellbeing. The analysis here is based on data for Khabarovsk, a major city in the climatic region of the Russian Far East characterized by very hot summers and extremely cold winters.

The results suggest that the most severe thermal strain occurs with the adjustment shift from hot-humid to cold, in that mortality data show that the sensitivity of the body to the acclimatization process to cold during autumn is greater than the seasonal shift to heat during spring. Although mortality peaks in winter (January) and is at its lowest in summer (August), there is not a smooth rise through autumn. A secondary peak occurs in autumn (October), but nothing similar is evident in spring. This suggests the acclimatization transition from warm-to-cold produces more thermophysiological strain than the transition from cold-to-warm, which is apparent in the high coefficient of correlation between mortality and ATSI in autumn. The results show the extent to which biophysical adaptation plays a role in increased strain on the body during re-acclimatization and for this reason is a more appropriate climatic indictor than air temperature alone. The work gives useful bioclimatic information on risks involved in transitional seasons in regions characterized by climatic extremes. This could be helpful in planning and managing health services to the public and measures that might be used to help mitigate impacts.

7C.5

Regional differences of heat and cold stress in Europe and their influence on human health and well being

Thermal Environment and Human Health II
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Actual atmospheric conditions strongly influence human organism. Special attention is usually paid either on comfort zone or on thermal extremes. It is well documented influence of cold and heat stress on the human health and well being. Till now, many various bioclimatic indices were in use to assess thermal conditions from the point of view of human thermal perception, tourism and recreation as well as mortality and morbidity rates. In the present paper heat and cold stress differentiation in Europe was assessed with the use of Universal Thermal Climate Index (UTCI). The data for 10 years period (1991-2000) from about 20 European meteorological stations were applied. Regional and seasonal differences of thermal extremes as well as their day-to-day variability are analysed. The observed differences are the background for the assessment of the influence of bioclimatic conditions on human health and well being in particular regions in Europe. We have found great regional and seasonal variability in heat and cold stress in Europe. The researches confirm great differences between southern and northern as well as between western and eastern parts of the continent. However, some unexpected results related to frequencies of hot and cold thermal extremes were found for the stations located in central Europe. The studies were supported by a grant from the Polish National Centre for Research (NCN) grant No 2011/01/B/ST10/06972 "Assessment of climate change impacts on population health in various regions of Poland and predictions to 2100".

7C.6

Increase in incidences of emergency conveyance related to heat stroke in 2006-2013 in Saitama, Japan – local climate change and aging of society

Thermal Environment and Human Health II
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Before the 1990's, heat stroke was not recognized as a social issue in Japan. It mostly occurred during exercise outdoors. However, the number of incidences of emergency conveyance and death due to heat stroke in the last 10 years was increased to six times that in the previous 30 years. A trend of global warming in Saitama, a part of the Tokyo metropolitan area, has become significant in the past 30 years. Also, with the local inland climate, the daily maximum temperature in Saitama is higher than that in Central Tokyo. Since 1994, seasonal heat waves have occurred increasingly. The first significant disaster related to heat stroke was recorded in 2007. On August 16th, a maximum temperature of 40.9 oC, a new Japanese record at that time, was recorded in Kumagaya City in northern Saitama. Six hundred eighty-one calls for emergency conveyances were received and 20 people died. The second significant event occurred in the summer of 2010. The mean summer temperature was the highest in the past 113 years in Japan, exceeding the past record set in 1994. Three thousand six hundred seventy-nine calls for emergency conveyances were received (a total of 53,843 in Japan) and one hundred twenty-four people died (a total of 1,718 in Japan). Since 2011, more than 3,000 people have required emergency conveyance every summer. Using the 2006-2012 recorded data, a relationship between the maximum daily temperature and incidence rate of heat stroke was shown by a logistic regression curve. However, large variations in the number of incidences of emergency conveyance are seen at around the maximum temperature of 35 oC. To perform a higher precision evaluation of heat stroke risk, the 3-day-accumulated Apparent Temperature defined by Steadman in 1984 was calculated, and the number of calls for emergency conveyance was found to be high when the 3-day-accumulated Apparent Temperature was more than 1,900 oC. During 2006-2012, the number of cases of heat stroke indoors increased, and more than 70 % of those afflicted were elderly persons. This finding reflects the rapid advance of aging as a social background. Factors for heat stroke increase are 1) rapid increase to high temperature in the daytime, and 2) consecutive high-temperature days of more than 35 oC. As another aspect of the social background, the increasing in the number of single-elderly-person households in the past 30 years may promote the aggravation of heat stroke.

7D.1

Overview of a new scenario framework for climate change research

Climate Change: Research and Adaptation Assessment
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The scientific community is developing new integrated global, regional, and sectoral scenarios to facilitate interdisciplinary research and assessment to explore the range of possible future climates and related physical changes; the risks these could pose to human and natural systems, particularly how these changes could interact with social, economic, and environmental development pathways; the degree to which mitigation and adaptation policies can avoid and reduce the risks; the costs and benefits of various policy mixes; residual impacts under alternative pathways; and the relationship with sustainable development.

Developing new scenarios for use in impacts, adaptation, and mitigation research requires more than emissions of greenhouse gases and resulting climate change. Scenarios also require assumptions about socioeconomic development, including a narrative, and qualitative and quantitative assumptions about development patterns. An insight recently gained is that the magnitude and extent of greenhouse gas emissions is relatively independent of demographic and socioeconomic development; that is, multiple demographic and socioeconomic development pathways can lead to any particular emission scenario. A relatively wealthy world with high population density could have low greenhouse gas emissions because of policies that encourage energy efficiency and sufficient low emission technology. The opposite also is possible. Therefore, demographic and socioeconomic development pathways can be described separately from the Representative Concentration Pathways and then combined using a matrix architecture into a broader range of scenarios than was possible with the SRES.

Shared Socioeconomic Pathways (SSPs) define the state of human and natural societies at a macro scale. To encompass a wide range of possible development pathways, five SSPs are defined along two axes describing worlds with increasing socioeconomic challenges to mitigation (y-axis) and adaptation (x-axis). They include a narrative storyline and a set of quantified measures that define the high-level state of society as it evolves over the 21st century under the assumption of no significant climate feedback. The reality that the development pathways may be affected by climate change will be taken into account when combining SSPs with climate change projections to generate a socioeconomic-climate scenario.

The new scenario process, although complex, provides a flexible toolkit to facilitate research and assessment that can characterize the range of uncertainty in mitigation efforts required to achieve particular radiative forcing pathways, in adaptation efforts that could be undertaken to prepare for and respond to the climate change associated with those pathways, and in residual impacts.

7D.2

Role of biometeorology in development and implementation of adaptation strategies

Climate Change: Research and Adaptation Assessment
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Climate change impacts can be observed already today and according to IPCC report are expected to increase in future. Impacts of climate change vary across continents and countries depending on climate, geographic and socioeconomic conditions. Because projected effects of climate change are serious and potentially very costly for, adaptation is necessary to minimise negative impacts resulting from current and expected climate change, and in order to maximise our ability to benefit from any opportunities that climate change may bring. In April 2013, the European Commission adopted an EU Strategy on Adaptation to Climate Change to encourage all Member States to adopt comprehensive adaptation strategies. The most vulnerably sectors are agriculture, water management, human health, tourism, energy, forestry, biodiversity, disaster risk reduction and spatial planning. In all these sectors biometeorology can provide valuable information. To enable well informed and timely adaptation to climate change up-to-date, reliable and targeted information and data are necessary. Contribution of biometeorological science can be significant in all the above listed sectors.

7D.3

Evaluating Adaptation Strategies for Extreme Weather: Cooling Center Utilization and Accessibility in Phoenix, AZ

Climate Change: Research and Adaptation Assessment
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Extreme heat is a significant public health concern in municipalities across the globe and especially so in the Phoenix metropolitan area, one of the hottest large cities in the United States. Access to cool environments, even for a few hours, has been shown to be protective in reducing heat related death and illness. Publicly-available cooling centers have the potential to reduce heat risk to those who cannot afford to cool their homes or do not have cool spaces in which to seek refuge. The Phoenix Heat Relief Network was founded in 2005 by the City of Phoenix and Maricopa Association of Governments in response to excessive heat-related mortality among the homeless population. Each summer, the network recruits local public and private facilities to serve as cooling centers and water donation and distribution sites to combat public health concerns related to heat. To date, however, there is minimal knowledge or data available to understand the role the network as an adaptation strategy for coping with extreme weather. In summer 2014, the Maricopa County Department of Health, Arizona Department of Health Services, and Arizona State University implemented an evaluation of the Phoenix Heat Relief Network cooling center sites to document the sites' utilization, services offered, and the public and private resources needed to operate the network. Initial results from three separate instruments are discussed: in-depth interviews with managers of cooling center facilities, paper surveys of cooling center visitors, and observational data collected by members of the evaluation team. Information collected from the evaluation campaign identifies best practices for the establishment of heat relief networks in other counties and opportunities for future improvements in Maricopa County, highlights effective communication strategies for dissemination of intervention activities, and informs the strategic climate and health adaptation plan for the state of Arizona.

7D.4

Impacts and solutions of increasing heat on humans and ecosystems- a multi disciplinary identification of gaps in the research area

Climate Change: Research and Adaptation Assessment
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Impacts and solutions of increasing heat on humans and ecosystems- a multi disciplinary identification of gaps in the research area.

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There are several scientific indications that heat is going to become the next big societal and scientific challenge. The earth's climate is changing in an accelerating pace and the link between climate change and increasing average global temperature is well established. The latest AR5 report on the physical science basis (IPCC, 2013) states that not only the average temperature has risen, but also the number of warm days and nights has increased. The frequency of heat waves has likely increased in some parts of the world, for example Europe. These trends will continue

(Rummukainen 2012; 2013), with widespread and ever more negative effects on populations, societies, animal health and terrestrial and aquatic ecosystems (Baker, 2008; Allen et.al., 2010; Andre et.al., 2011).

Climate change affects and is already affecting living environments and our societies in multiple of ways, either directly or indirectly, touching on a wide range of societal issues such as, food and water security, human health, work housing and urban environments, livelihood and vulnerability, human rights, mobility and migration, gender equality, attitudes and behaviour. An increased integrated understanding of these issues combined with an improved modelling of heat at the local and regional level and an assessment of the economic and societal costs of increase heat is imperative to address the heat challenge.

Existing policies and social protection systems are inadequate to enhance resilience and adaptive capacity and to mitigate negative climate change impacts. New approaches are needed both in relation to policy, technical solutions as well as in relation to how we plan and develop our societies.

Despite the potential negative effects and dilemmas related to societal developments we know that humans and human societies have a capacity to adapt to environmental stresses including extreme heat. To do so, however, it is essential that we are able bring together the benefits from increasingly detailed foresights and downscaling, availability of effective solutions both technical and social and, not least, action to reduce exposure and the potential impacts of heat on especially vulnerable groups.

This paper gives an account of a trans-disciplinary project (around 20 different disciplines) financed by Lund University, Sweden with the aim to increase the understanding of and solutions to the impacts of increasing heat, at the local level, resulting from anthropogenic climate change and thereby encourage new cross-disciplinary research ideas focused on finding solutions addressing this problem.

The project is guided by three overarching integrative research questions; • How does heat stress influence ecosystems and human life today and how will it influence it tomorrow. • How do societies and individuals cope with heat in their everyday lives, for example when confronting a heat wave or general seasonal heat increase? • How can we mitigate and adapt to increasing extreme heat stress in the future?

The used method is a multidisciplinary dialogue, which aim to develop a multifaceted understanding and answer to the above mentioned research questions. To ensure these dialogue with a sustained as well as deepened multifaceted understanding the project engage in three research faces where phase one focuses on heat issues which consist of bringing up heat related issues from a disciplinary perspective and discuss it in a multidisciplinary context. The next phase focuses on four case studies, Öresund region a part of South Sweden and Denmark, Istanbul, Turkey, Chennai, India and Lake Victoria Region, Afrika. The case studies will be supported by local measurement of heat in the case reagion which will assisst in developing a solid bassis for analysis of the heat challenges facing each specific case area. The project will interact with researchers as well as policymakers in the case regaions.

Expected results of the project is the development a joint matrix, “a multi faceted answer” to the research questions as well as testing and adjusting this matrix to four different specific geographical and cultural context. The main reason for doing this is to deepen the understanding of the more detailed answer as to what heat stress is, how does our societies cope with it and which are the potential for adapting to it in a longer perspective. The multidisciplinary approach, will create a better basis for the development of future international research on heat stress as well as recommendations of how our societies may need to act to handle the risk of a future increased heat.

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7D.5

ADAPTATION OPTIONS TO CLIMATE CHANGE IMPACTS IN SLOVAKIA, AGRICULTURE

Climate Change: Research and Adaptation Assessment

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Agriculture sector is affected by changes in climate in many aspects. Adaptation activities focus on the potential to build sectoral resilience to climate and to increase adaptive capacity through sustainable management of agriculture and other complementary factors. In Slovak territory, which is mostly hilly, the climate change can bring the shift of climate zones and to move the most temperate regions to the north and to higher altitudes. General factors of the Slovak agriculture show about 1,9 mil. ha of cultivated area which is slowly shrinking as well as diminishing animal husbandry production. Quite stable structure of the production concentrated on the cereals production which occupied about 50% of agricultural land has strongly changed in favour of higher production of oil producing and other "technical" crops with big inter-annual changes in seeded areas. Further characteristics is the drastic shrink of irrigated area (from more than 300000 ha to about 120000 ha) in recent two decades. Diminishing agricultural area is a consequence of forestation, especially in mountainous areas, urbanization and on a part of agricultural area was any production abandoned because of low economic effectivity. Based on the index method (calculating indexes relevant for agricultural production: Length of vegetation period, Photosynthetically Active Radiation, precipitation, Evapotranspiration and Index of dryness over 1961-2010) the vulnerability of different geomorphological units to the risks in agriculture was assessed. The most productive areas situated in the south and south-east part of Slovakia show the highest level of vulnerability. By using the outputs of daily values of basic climate parameters from two global and two regional general circulation models above described indexes were calculated for the period up to 2100 and similar projections of the selected indexes together with their sapace distribution were done for the horizon 2061-90. The results showed the need of the adaptation measures for the next 1-2 decades as well as what we can expect within 50-80 years. It shows the change of productive potential of individual crop in the particular region and that the changes in precipitation amount will influence the water use for irrigation both in area and rate. Consequently, the suggestions for adapting measures to these changes in agricultural sector include following points: • change of structure of grown crops in Slovakia and the change of variety structure • adaptation of agro-technical terms

(mainly sowing) to changed agro climatic conditions • to finish construction of irrigation system and to introduce much more portable irrigation systems • to ensure sufficient amount of irrigation water in cooperation with water services Further to the climatic assessment an economic analysis of the inputs to the adaptations and possible diminishing of the loses done by the climate change impacts was done. Computable general equilibrium model (CGE) was applied to evaluate the economic value of the estimated loses, the value of possibly applied adaptation measures and the value of the benefits. CGE represents a model of an integrated evaluation based on a macroeconomic structural model at the country level divided in to 11 selected economic sectors. Generally, the right applied adaptation measures in agriculture can bring 25-35% benefit in comparison if not being applied.

8A.1

Prediction of enteric methane emission from buffaloes using linear and non-linear statistical models

Animal bioclimatological modeling

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Methane (CH_4) production from world buffalo population contributes a substantial share to the global greenhouse gas production by livestock after cattle. The annual growth rate of enteric methane from buffaloes is higher than the growth rate of enteric methane emission from cattle. However, there is no model for predicting enteric CH_4 production in buffaloes, though there are several models developed for prediction of enteric CH_4 from cattle. Thus, the objective of this study was to develop linear and nonlinear statistical models to predict CH_4 production from dietary and animal characteristic variables. A database from 24 publications was constructed, which included 64 mean observations of CH_4 outputs measured on 394 buffaloes. Extant equations developed for cattle were also evaluated for suitability of those CH_4prediction equations in buffaloes. The simple linear equations that predicted with high precision and accuracy were CH_4 (MJ/day) = $1.29_{(\pm 0.576)}$ + $0.788_{(\pm 0.099)}$ × dry matter (DM) intake (kg/day) [RMSPE = 19.4%, with 94% of mean square prediction error (MSPE) being random error; R^2 = 0.81] and CH_4 (MJ/day) = $0.135_{(\pm 0.767)}$ + $1.717_{(\pm 0.233)}$ × neutral detergent fiber (NDF) intake (kg/day) [RMSPE = 18.3%, with 99.7% of MSPE being random error; R^2 = 0.79]. Multiple regression equations that predicted CH_4 slightly better than simple prediction equations were CH_4 (MJ/day) = $-0.436_{(\pm 0.665)}$ + $0.678_{(\pm 0.184)}$ × DM intake (kg/day) + $0.697_{(\pm 0.347)}$ × NDF intake (kg/day) [RMSPE = 16.1%, with 99.9% of MSPE from random error; R^2 = 0.85] and CH_4 (MJ/day) = $-0.819_{(\pm 0.801)}$ + $0.690_{(\pm 0.432)}$ × crude protein (CP) intake (kg/day) + $1.527_{(\pm 0.215)}$ × NDF intake (kg/day) + $0.930_{(\pm 0.413)}$ × non-fibrous carbohydrate (NFC) intake (kg/day) [RMSPE = 16.5%, with 99.7% of MSPE accounting random error; R^2 = 0.84]. Among the nonlinear equations developed, monomolecular model, CH_4, MJ/day = $39.99_{(\pm 17.23)}$ × {1 – exp(- $0.0276_{(\pm 0.0132)}$ × DM intake (kg/day)) [RMSPE = 19.1%, with 99.9% of MSPE accounting random error; R^2 = 0.80], performed better than other nonlinear models, but the predictability and robustness of the equation did not improve compared with the linear models. Extant equations overestimated the methane production, and had low accuracy and precision. There was no significant mean and linear biases (P>0.05) for all models except for non-linear models. The mean and slope biases of the non-linear equations, although significant statistically resulted in a maximum bias of less than 1.13 and 1.52 MJ/day over the full range of predicted values for monomolecular and Gompertz equations, respectively. In contrast, the mean and linear biases of two best extant equations (one each from linear and non-linear models) were significant (P<0.001) and resulted in a maximum bias of 3.28 to 4.31 MJ/day over the full range of predicted values. The equations developed in this study would be useful for national inventory preparation to improve an estimation of methane production in buffaloes particularly for tropical feeding situations.

8A.2

Estimating the Thermo-Neutral Zone of Dromedary Camels Using Surface Heat Transfer Modelling

Animal bioclimatological modeling

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Thermal homeokinesis is a term used to describe a steady state, where core body temperature of any homeotherm is relatively maintained constant with little or no additional energy expenditure. However, to maintain such state there has to be a thermal balance. The simplest form of the thermal balance implies that the total rate of heat production (Ptotal) must be met by an equal rate of total heat dissipation (Qtotal). Dromedary camels, as a homeotherm, demand to maintain a state of thermal homeokinesis within a specific range of ambient temperatures (Ta); the thermo-neutral zone (TNZ). Nevertheless, there is no study we are aware of reporting any information about the TNZ for any kind of camelidae species. Instead of measuring the absolute heat production, the current study offers an alternative method to estimate the TNZ using the theories and principles of heat transfer modelling. This study was carried out on 10 dromedary camels (5 calves and 5 bulls) individually fed at maintenance, and was divided into two periods; preliminary and experimental periods. During the preliminary period, several measurements were predetermined for each camel encompassing the following; the biophysiological parameters (body weight and daily feed intake) as well as body biomorphometry (length, circumference, surface area) and surface thermal properties (skin emissivity and coat distribution). Additionally, all camels were surgically implanted with highly-calibrated data loggers to record their core (Tb) and tympanic (Ttym) temperatures. Furthermore, camels were accustomed to the measuring equipment and trained to be inside a climatic-controlled chamber. During the experimental period, on the other hand, each camel at first was placed inside a chamber under a stable Ta (24°C; presumed to occur inside the TNZ) for at least 48 hours to be acclimatized, and then randomly exposed to one of 5 different levels of Ta; 0, 10, 20, 30, 40, and 50°C. In each experimental Ta set, each camel was kept for 2 hours to be stabilized to the selected Ta, and then several measurements -mentioned below- were quantified twice in the next 60 min. Thereafter, the camel was transferred to 24°C for at least 2 hours to be stabilized, and then one more set of Ta was randomly chosen and measurements were recorded again. Accordingly, two Ta were tested per day for each camel. Each camel was given at least 7 days of rest between experiments. Experimental measurements were include; the ambient and radiant temperatures as well as relative humidity inside the chamber, in addition to camel's body temperatures (core, tympanic, rectal, skin, coat, and surface temperatures) and thermophysiological responses (respiratory, heart, and sweating rates). For analysis, heat exchange from camels was modelled on the basis of a simple geometric shape. Camel's body was divided into five regions. The head and body regions were modelled as a horizontal circular cylinder, the neck and appendage regions as vertical circular cylinders, while the feet were modelled as flat plate. Using the appropriate heat transfer modelles, the rate (W•m-2) of radiative, convective, conductive, and evaporative heat dissipation mechanisms from each region were calculated. Ultimately, the rate (W•m-2) of Qtotal from whole body was then estimated by adding the rates of heat dissipation from each region at the intended Ta. On the other hand, total body thermal insulance (Itotal, m2•K•W-1) was estimated using the combined and calculated values of the three body thermal insulative layers (i.e. body tissue, coat, and air boundary) from whole body at the intended Ta. To determine the TNZ range, it is widely useful to use two limit temperatures (i.e. the lower and upper limit temperatures). When Ptotal was considered to follow Qtotal, the starting point of increasing Ptotal at a low set of Ta, while maintaining a relatively constant Tb and simultaneously expressing maximum Itotal, was found to be at 10oC and selected to be the lower limit temperature of TNZ in camels. Meanwhile, the starting point of increasing evaporative heat dissipation mechanisms at a high set of Ta, while maintaining a

relatively constant Tb and simultaneously expressing minimum Itotal, was coincided with 40oC and selected as the upper limit temperature of TNZ in camels. This study was designed to give us a better understanding and to improve the knowledges in camel's basic thermophysiology. Due to the morphophysiological adaptabilities of camels compared to other species, current study clearly substantiates that both the heat exchange profile and body thermal insulance have manifested particular differences in camels, which reflected on possessing a wider TNZ that occurs in a higher range of Ta. We hope that the knowledge gained from this study will enhance our understanding of the bioenergetic requirements of camels under different environmental conditions, and will improve the housing management of camels in regard to their thermal comfort, which subsequently may increase their productivity (e.g. growth, milk, meat, et al.) as well as their welfare (e.g. neonatal post-parturition care, during transportation, or post-racing) under the harsh environmental conditions.

8A.3

Assessment of Climate Change Impacts on Livestock in Egypt

Animal bioclimatological modeling
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Egypt appears to be particularly vulnerable to climate change because of its dependence on the Nile River as the primary water source, its large traditional agricultural base, and its long coastline, already undergoing both intensifying development and erosion. The current evidence for livestock production in Egypt shows that temperature increases induce harmful heat stress impacts on animals' productivity. New animal diseases emerged in Egypt, and have strong negative impacts on livestock production i.e. the blue tongue disease and rift valley fever. Both are attributed to some observed changes in the Egyptian climate. The availability of fodder is subject to decrease due to climate change impacts on crops productivity, and higher competition for land and water resources between fodder and cereal crops. Also, projected rise in sea level in the Atlantic Ocean may have catastrophic impacts on Nile Delta region. The cost of adaptation to avoid this, however, may put a heavy burden on countries' GDPs. Livestock play a significant role in food production through the provision of high value protein-rich animal products; they indirectly support crop production through draught power and manure; and finally, they are the most significant source of income and store of wealth for smallholders Currently, livestock is one of the fastest growing agricultural sub-sectors in Egypt and takes an important share of natural resource use in agriculture. The impacts of climate change on animals' health and production under Egyptian conditions are not yet covered by scientific research (ESNC, 2010). Current evidence for livestock production shows that temperature increases induce harmful heat stress impacts on animals' productivity (IPCC, 2007 which varies according to the animal type, the husbandry type, and the animal initial condition (Kadah et al., 2008). New animal diseases emerged in Egypt, and have strong negative impacts on livestock production. These are the blue tongue disease and rift valley fever. Both are attributed to some observed changes in the Egyptian climate. The availability of fodder is subject to decrease due to climate change impacts on crops productivity, and higher competition for land and water resources between fodder and cereal crops In summary the main impacts of climate change on Egyptian agriculture sector are: • Temperature increases of 1.4°C and 2.5°C projected by 2050 and 2100 • See level rise (SLR) in Nile delta and all its projected impacts • Decrease in water supply as precipitation and water flow of Nile may decline due to climate change, meanwhile water demand will rise due to population growth. • Increase the gap between production and demand in food and feed as well as the competition between food and feed. • Decrease in production of main crops (wheat, maize, sorghum, barley, rice and soybean). • Direct and indirect impacts on livestock production. • Decline of agriculture self-sufficiency from 60% to 10%. The main objective of this assessment is to analyze the changing demands for livestock products under changing climate to identify the adaptation and mitigation policies and strategies for coping livestock production system with climate change.

The assessment main conclusions and recommendations are: The main effects are the decrease in livestock production under hot and cold climates due to a decrease in feed intake and increase in maintenance requirement under hot climate, while under cold climate they are due to a more increase in maintenance requirement than in feed intake. Heat stress affects all reproductive performance parameters e.g. puberty, spermatogenesis and semen quality, estrous cycle, fertilization, embryonic development and conception rate and fertility and hatchability of poultry eggs. It also increases livestock morbidity and mortality. The increase in morbidity is by increasing non-infectious diseases due to the decrease in livestock immunity, affecting feed availability and quality which decreases animal resistance and increase microbial insult as a result of behavioral thermoregulation. The most reliable mitigation policies for reducing GHG emissions from livestock are: • increasing grazing land productivity and nutrient management, • restoration of degraded lands, • improving livestock feeding practice and dietary additives, • animal breeding, • improving manure management (storage and handling, anaerobic digestion and use as nutrient source) and • bio-energy (biogas). The most feasible methane mitigation strategies are: • improving animal productivity to decrease the level of methane emissions per kg of animal product, • increasing concentrate level at high level of intake, • forage processing (grinding/pelleting), • forage species and maturity, • rotational grazing of animals, • use of high quality forage or pastures, • preservation of forage as silage, • fat supplementation in ratios and genetic selection. Adaptation options for coping livestock production system with climate change are discussed. A National Egyptian strategic plan for achieving self-sufficiency in livestock products with minimum effect on climate change is suggested.

8A.4

Analytical and Numerical Modeling of Skin Surface Temperature in Livestock

Animal bioclimatological modeling
Alex Sandro Campos Maia, UNESP, Jaboticabal, Brazil; H. F. M. Milan and K. G. Gebremedhin

Heat exchange between livestock and environment is very complex. It is influenced by environmental factors (air temperature, relative humidity, wind speed and solar radiation) and animal factors such as metabolic heat generation, sweating, heat dissipation by convection, radiation and respiration. The heat exchange models between livestock and environment available in the literature are simplified models that do not consider all these aspects. We developed a comprehensive analytical model that predicts heat exchange between a pig and the environment. Physiological parameters (skin temperature, rectal temperature) and environmental parameters (air temperature, black globe temperature and wind speed) were measured to validate the model. The model is one-dimensional and was developed based on the principles of energy balance. The predicted skin surface temperatures were compared against measured values using the correlation-regression and deviation approaches. The measured mean core temperature and skin surface temperature were 39.33±0.047 °C and 35.43±0.089 °C, respectively. The predicted skin temperatures by the analytical approach was 35.38 ±0.11°C and by the numerical approach was 35.68±0.10°C suggesting that there was no statistical difference ($P>0.05$) between the predicted and measured values. In addition, a strong correlations ($r = 0.866$ for the analytical and 0.865 for the numerical) between the measured and the predicted skin surface temperatures were obtained.

8A.5

Evaporative Heat Losses in Different Coloured Brazilian Hair Sheep

Animal bioclimatological modeling

Jacinara Hody Gurgel Morais Leite Sr., USDA, Rio Grande do Norte, Mossoró, Brazil; D. A. E. Façanha and L. A. B. Asensio IV

In the year 2030, it is estimated that the planet is probably 1°C - 2°C warmer than today and these changes can have a significant impact on livestock production and on food supply to human population. Thermal comfort of animals in tropical regions depends largely on their ability to dissipate excess body heat by evaporative cooling, being skin surface evaporation the main way for heat dissipation. Heat stress is one of the most important factors that affect sheep production in tropical regions. The searching of locally adapted genotypes is increasing in the last years, in brazilian semiarid regions, with the aim to develop efficient livestock systems in these areas. The Morada Nova hair sheep is a native breed of Northeastern of Brazil, adapted to the high levels of solar radiation that occurs during all seasons. There are two official varieties, the Red Colored and the White Colored animals, both reared under extensive system conditions, exposed to high temperatures during the wet and the dry seasons. These animals are generally able to maintain satisfactory indexes of reproductive traits, as high fertility and maternal ability, compatible with a high meat production. The red variety have maintained its census, however, white colored animals have been reducing the female amount over the last year, and now it became a threatened genetic resource.

The goal of this study was to evaluate the evaporative heat losses in Red and White varieties of Morada Nova hair sheep, in a semiarid region, during the rainy season.

The study was performed during the wet season in a semiarid region of Brazil, located at 5,4°S. The data were collected during two months in 40 white colored ewes and 80 red colored Morada Nova ewes from commercial herds. Rectal temperature (RT, °C), respiratory rate (RR, breath for minute) and skin surface temperature (ST; °C) were collected in each animal once a day. The cutaneous evaporative thermolysis (CE; W/m²) of two body regions (neck and flank) was estimated with a ventilated capsule, at the same time of the other thermoregulatory traits. The device was fixed on body surface in order to obtain the amount of evaporated water. This variable was calculated using the following function: $CE = X\lambda/AT$, where CE is the cutaneous evaporation (W/m²); X is the water lost by sweating (g); λ is the latent heat of vaporization of water (J/g); A is the contact area of the capsule (m2) and T is the time of contact between the capsule and the body surface. At the time of sample, around 11am and 2pm the animals were exposed to the sun. The environmental traits registered consisted in wind speed (WS, m/s), air temperature (AT, °C), wet bulb temperature (WBT,°C) and black globe temperature by sun (BGT, °C), utilized to estimate the radiant heat load (RHL, W/m²). The data were initially analyzed by the last-squares method, the model consider the effect the coat color (white and red), sampling day, the CE in body region (neck and flank). To test our hypothesis, a distance-based permutational-repeated measures MANOVA was fitted, with variety and sampling day as fixed factors and RR, RT, ST and neck and flank CE as variables. The interactions between variety (coat color) and sampling day were investigated using posteriori pairwise comparisons with PERMANOVA t statistic. Variables more affected by factors (variety and sampling day) were determined using Canonical analysis of principal coordinates (CAP) and Spearman correlation between variables and principal coordinates. The environmental variables as RHL and RH, were used as covariate in order to correct the MANOVA model and ensure that there were differences between varieties regardless of these environmental variables. All statistical analysis were carried out by PERMANOVA + (PRIMER-E Ltd., Plymouth, UK).

We did not detect differences in Radiant Heat Load (RHL) between white (Mean RHL = 653.77 W/m2) and red (Mean RHL = 650.12 W/m2) varieties environment. However, significant differences were found in environmental relative humidity where red (RH = 89.0%) and white (78.0%) colored ewes were located.

The variance analyze showed that the effects of body region (neck and flank) were no significant to heat loss. The white variety showed significantly higher values (312.42 w/m²) of CE than red animals (255.96 w/m²). However, surface temperature was significantly higher in red variety (40.67°C) than in white variety (37.40°C). In both variety the rectal temperature were not differences. There are differences between red and white coat color reflectance and absorptance, in this study the exposure of the goats to sun caused the animals to gain an excess thermal energy and an increase of the coat surface temperature.

In both sampling, the white ewes exhibited higher CE and lower RR and body ST, while the red colored ewes tend utilized more efficiently respiratory thermolysis. It is possible that the red animals presented a higher ST and, therefore they activated the respiratory losses to reach homeothermic conditions, then the need of sweating was lower. Light coats above pigmented skin have been considered most desirable ones for livestock in tropical areas as dark coated animals tend to acquire greater heat from solar radiation, in this experiment each varieties showed different way to reach homeostasys.

The white Morada Nova variety have a similar adaptive capacity when compared to the red Morada Nova so it can be included in breeding programs as a superior locally adapted genotype to meat production in semiarid regions.

We conclude that White Morada Nova used CE as a main way of heat loss and maintain homeothermic conditions; however, Red Morada Nova tend used RR as the main way to ensure homeothermic conditions.

8A.6

Adaptative Responses of Brazilian Brahman Bulls in Different Seasons

Animal bioclimatological modeling

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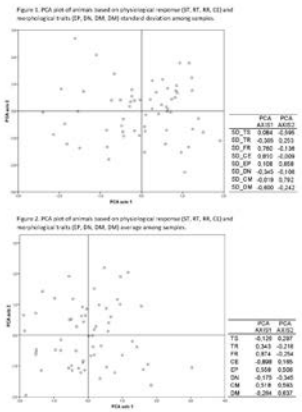
Environmental high temperatures are detrimental to the productivity of livestock industry, because animals of better genotype normally have a higher endogenous heat, due to their metabolic activity. Heat stress is one of the most important factors that affect animal performance in tropical regions, meanly beef cattle managed in extensive field conditions. With the aim of develop efficient livestock systems in brazilian tropical regions, research about heat tolerant genotypes is increasing in the last years because of their ability to adjustments to climatic changes. The capability of animals to maintain the equilibrium with environment is directly associated with their ability to trigger thermoregulatory mechanisms, which depends on a pool of morphological and physiological traits acquired during the evolutionary process, in order to guarantee the efficiency of thermoregulation. Brahman cattle have strong skin pigmentation, which filters the intense short wave radiation as well as keeps the breed free of cancer. A special feature of Brahman breed is its higher ability to sweat

freely in comparison with other breeds. This fact contributes to their heat tolerance greatly. Other adaptive advantages become Brahman well suited to many environmental conditions include the ability to utilize lower-quality food, to travel longer distances for feed and water, to resist insects and external parasites and the ability to reproduce on a regular basis in a stressful environment. A factor that contributes to the Brahman outstanding ability to withstand temperature extremes is a short, thick, glossy hair coat that reflects much of the sunrays, allowing them to graze at noon without suffering. The goal of this work was to evaluate the adaptive responses of young Brahman Bulls, based on thermoregulatory, morfophysiological and blood biochemistry parameters, during the dry and wet seasons. The study was performed in a commercial farm located in Uberlândia-MG, Brazil, at 18°55'S, in the Cerrado Bioma. 63 young Brahman bulls were sampled, aging about 233 to 264 days. The trial begun at the weaning and the assessment was conducted during seven months, including dry and wet season. Sampling were carried out once a month and the data were collected at 8:00 AM, under natural field conditions. The included environmental variables were wind speed (WS, m/s), air temperature (AT, °C), wet bulb temperature (WBT,°C) and black globe temperature (BGT, °C), utilized to estimate the radiant heat load (RHL, W/m²) and Black Globe Humidity Index (BGHI). The animal assessment based on rectal temperature (RT,°C); respiratory rate (RR, breaths for minute) and sweating rate (g/cm2/min). Blood parameters were hematologic analysis, thyroid hormones (T3 and T4) and Cortisol concentrations. The morphologic evaluations were coat density (CD, hair/cm2); coat thickness (CT, mm), hair length (HL, mm) and mean hair diameter (HD, mm); To test our hypothesis, were considered as fixed factors the collect and the animals. We did not detect significant differences in blood parameters, such as hematologic and thyroid hormones values. On the other hand, we observed significant effect of the month of sampling. In December and January, the animals exhibited highest values of rectal and skin surface temperature, followed by highest means of respiratory rate and sweating rate, as shown in Table 1. These results indicated the use of cutaneous and respiratory evaporative losses as an efficient way to dissipate the excessive heat. Principal Component Analysis (PCA) of physiological and morphological variables average showed that respiratory rate, sweating rate, coat thickness and hair length are the most relevant variables of bull distribution in axis 1 (29,8% of explained variance) and coat thickness, hair length and mean hair diameter in axes 2 (17% of explained variance). Therefore, bulls that showed high coat thickness and hair length used respiratory rate instead of sweating in order to maintain normal body temperature as axis 1 showed. Less relevant is the fact that some bulls characterized by high hair length, mean diameter and coat thickness did not modify physiological variables (as show axis 2). According to PCA results, most relevant variables were used to k-means clustering analysis. Bulls were classified in three groups basing on PCA most relevant variables (CT, HL, MD, respiratory rate and sweating rate): high, mean and low adaptive capacity. The high adaptive considered group showed lower CT, HL, RR and SR. Additionally, PCA of physiological and morphological variables standard deviation showed that bulls distribution depends on uneven level response of respiratory rate, sweating rate and hair diameter, as axis 1 showed (22,8% of explained variance). PCA axis 1 point out that those animals that tend to maintain mean diameter among samples showed uneven evaporative thermolysis, indicated by higher respiratory and sweeping rate standard deviation. Among animals characterized by stable respiratory and sweating rate (low value of PCA axis 1), PCA axis 2 shows that animals tend to maintain body temperature when they are characterized by uneven hair length and coat thickness among samples. The animals that exhibited higher phenotypical plasticity for hair coat traits were able to keep normal and stable physiological responses. We concluded that Brahman bulls were able to keep homoeothermic features under Brazilian cerrado conditions. For that reason this breed can be indicated to meat production in extensive system, however special attention must be pay to heat stress management during the hottest and the most humid months, since heat stress response increased even in more adapted animals. The authors acknowledge the Uberbrahman Group, specially Dr. Thiago Valente and Dr. Aldo Valente.



8A.7

Influence of solar radiation in Nelore cattle thermoregulation

Animal bioclimatological modeling

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Studies on thermal balance of Nelore cattle in tropical conditions are very limited. Therefore the aim of this study was to evaluate the influence of solar radiation on the thermal balance of Nelore cattle, by addressing the metabolic heat production, latent and sensible heat exchanges.

The study was conducted in the city of Jaboticabal, at São Paulo State University – UNESP, in southern Brazil (south latitude 21° 8', longitude: 48° 11' and elevation of 583 meters). Five Nelore cattle with an average body weight of 750kg and same age and body condition were evaluated. A 5x5 latin square experimental design was conducted in two environmental conditions, shade and exposed to solar radiation under natural conditions. Two replicates were done in both environments totaling 20 days of data collection. The animals were evaluated in five different periods during the day (1=08:00h-10:00h, 2=10:00h-12:00h, 3=12:00h-14:00h, 4=14:00h-16:00h, 5=16:00h-18:00h).

The Animal Biometeorology Laboratory developed the System of Physiological Measurement to the continuous measurement of respiratory gases (oxygen; carbon dioxide; water vapour), respiratory functions (tidal volume, respiratory flow and respiratory rate) and body temperatures (skin, haircoat, rectal and expired air). The system used for cattle is composed by: the mask (developed by the Laboratory); oxygen and carbon dioxide analyzers (model FMS-1201-05, Field Metabolic System); two water vapour analyzers (one for the atmosphere and one for the expired air of cattle, model RH-300, Sable System); three pumps (model SS4 sub-sample, Sable System); a dessicant column (Magnesium Perchlorate); spirometer (model ML141, ADInstruments); chamber to the mixture of gases (model MLA246, ADInstruments); two breathing tube; a flow head (model MLT1000, ADInstruments); a probe for the expired air temperature (model MLT415/AL, ADInstruments). To measure the heat loss by cutaneous evaporation was used a ventilated capsule placed in a corporal surface of the animal and maintained manually. The heat flows by convection (q_{CONV}, W m^{-2}) and long-wave radiation (q_{RAD}, W m^{-2}) were also measured. In each sampling day the air temperature (T_A,

°C) and relative humidity (H_R, %) were measured using a data logger that recorded in regular intervals of 1 second. The mean radiant temperature (M_{RT}, °C) was calculated according Silva (2000). The solar radiation (R_S, W m^{-2}) was measured using a Pyranometer (model CMP 22, Kipp & Zonen) in regular intervals of 10 minutes. The statistical model of the study was:

Y_{ijklm} is the m-th observation of variables (q_{MET}, q_{RE}, q_{CE}, q_{CONV}, q_{RAD}, R_R, R_V, T_R, T_S e T_{HC}), A is the random effect of the i-th animal (1, 2, 3, 4 e 5); M is the fixed effect of the j-th environment (sun or shade); R is the fixed effect of the k-th latin square (1 and 2); I is the interaction between the j-th environment and the k-th latin square replicates; D is the random effect of the l-th sampling day inside the interaction between environment and latin square; CH is the fixed effect of the classes of hours (1=8:00h-10:00h, 2=10:00h-12:00h, 3=12:00h-14:00h, 4=14:00h-16:00h, 5=16:00h-18:00h); e_{ijklmn} is the residual term and μ is the parametric mean.

During the hottest hours of the day, between 12 and 13 hours, the solar radiation reached more than 800 W m^{-2}; while before 9h and after 16h the solar radiation averaged 400 W m^{-2}. The average of metabolic heat production was 233.66±5.92 W m^{-2} ($P<0.05$), with a higher mean at shade (245.25±5.67 W m^{-2}), than exposed to solar radiation: 222.03±5.43 W m^{-2} ($P<0.01$). The heat loss by respiratory evaporation (q_{RE}) represented a little part of the heat dissipation produced by metabolism, with an average of 13.59±0.55 W m^{-2}. The same was observed for the heat loss by the sensible mechanisms, with an average of 10.23 W m^{-2} for the heat flow by convection and 15.81 W m^{-2} for long-wave radiation. The respiratory rate did not differ statically between the environments with an average of 20.04±3.0 breaths min^{-1}. However, the respiratory flow was higher average at shade (6.09±0.13 L $breath^{-1}$), while at sun was 5.62±0.12 L $breath^{-1}$. The heat loss by cutaneous evaporation (q_{CE}) was the mechanism that most contributed to the heat loss of Nelore cattle, and it was higher at sun (74.70±3.86 W m^{-2}) and lower in shade (66.83±3.70 W m^{-2}). However this mechanism was not enough to the dissipation of the heat metabolic produced. Thus, these animals did not change significantly their physiological answers. This effect could be due to heat storage, because rectal temperature during the 10 sampling hours increased approximately 1°C. We observed a heat storage for these animals around 70 W considering the interval of 10 hours.

Therefore, our results indicate that solar radiation influenced the metabolic heat production. Furthermore, the mechanisms of heat loss were not efficient to the dissipation of all the thermal energy and the heat storage was an important mechanism for the thermoregulation of these animals.

8A.8

A Heat Transfer Model for the Upper Respiratory Tract of Livestock under Tropical Conditions

Animal bioclimatological modeling

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To determine the heat and mass transport in the respiratory tract it is necessary to obtain estimatives of the expired air temperature and its water vapor contents, but the measurement of these variables require a lot of expensive equipments. A way to estimate the temperature and the water vapor concentration in upper animals' airway is by solving the energy balance for the mass and heat transport in the trachea considering it as a horizontal cylinder. The aim of this work was to discuss the development of a mathematical model to the upper airway of trachea to predict the expired air temperature and the water vapor concentration in sheep, goats and beef cattle.

The model considered the trachea a circular tube with 0.014 m of diameter and 0.256 m of length for sheep; 0.015 m of diameter and 0.385 m of length for goats and 0.036 m of diameter and 0.526 m of length for beef cattle measuring using a digital caliper. The model was considered a one-dimensional steady-state condition, only the axial direction, and no includes the heat generation by the metabolism and assumes a constant core temperature to be the same of the trachea wall. The model will be validated against experimental data collected using a database of tree experiments for sheep, goats and beef cattle, developed under the environmental conditions of Jaboticabal, SP, Brazil (21o08' South latitude, 595 m high), at the São Paulo State University – UNESP. All environmental conditions were continuously monitored by a datalogger (Hobo, Onset). The Exercise Physiological System used to the continuous measurement of respiratory flow (, L seg-1), respiratory rate (RR, breaths min-1) and Tidal Volume (VT, L breaths-1); and body temperatures (rectal and expired air), while the Metabolic System measures the water vapor (PExp, kPa).

The results showed that the respiratory rate of sheep was higher than of goats and beef cattle ($P<0.001$) and we observed average values of 154±26 breaths min-1, 17± 3 breaths min-1 and 19± 1 breaths min-1 respectively. For sheep averages for tidal volume and respiratory flow of 0.257±0.047 L breaths-1 and 0.653±0.109 l min-1 were observed, respectively. Goats and beef cattle presented a lower RR and showed a tidal volume of approximately 0.740±0.135 L breaths-1 and 7.8±0.3 L breaths-1, respectively, and an average value for respiratory flow of 0.213±0.047 l min-1 for goats and 2.47±0.030 l min-1 for beef cattle. Expired air temperature was an average of 31.12±1.6 °C, 34±0.8 °C and 32.8±0.18 °C for sheep, goats and beef cattle, respectively.

These results will be compared with values estimated by the model.

8B.1

Tourist Weather Perception and its Consideration in Bioclimate Assessment Methods

Tourism

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Weather and climate are important natural resources for tourism and recreation, although sometimes they can make outdoor leisure activities less satisfying or even impossible. Upon steadily increasing number of tourists, development of appropriate tools and assessment schemes to evaluate bioclimate for tourism purpose has become an important issue. Until now, a number of indices based on particular meteorological element valuation for tourism, such as Tourism-Climate-Index (TCI), as well as common biometeorological indices derived from human heat budget models have been used for this purpose. For long-term climate analysis, biometeorological weather classifications or diagrams summarizing the frequencies of particular weather limitations and opportunities (Climate-Tourism-Information-Scheme - CTIS) were applied. Many of previous researches were focused on weather-dependent types of tourism, e.g. Sea, Sand & Sun (3S) tourism, where relationships between biometeorological conditions and tourist satisfaction or well-being were more evident and easier to predict. In one work (de Freitas et al. 2008) an interesting concept of climate index for 3S tourism, calibrated and verified in weather perception studies, was developed. However, evaluation methods of bioclimatic conditions especially for general tourism activities, i.e. sightseeing, still need to be improved because most of them, while using popular biometeorological indices, hinge on the assumption that the most favourable conditions for tourism are those which do not arouse heat load in humans.

The aim of this work was to determine seasonal and regional variability of tourist weather perception in urban environment, as well as to determine whether thermal sensation scales of commonly used

indices reflect estimation of tourist actual biometeorological condition and personal expectations towards weather elements. To investigate how human thermal sensations vary upon meteorological conditions typical for temperate climate, weather perception field researches were conducted in Warsaw (Poland) in all seasons. Both tourists and locals (women and men of different ages) were included in the survey. We identified specific features of tourist preferences towards weather elements and found out, that thermal conditions considered to be optimal for sightseeing, frequently differed from thermoneutral conditions. The results confirmed existence of phenomena called alliesthesia, observed earlier by Spagnolo & de Dear (2003). Next, we analysed the possible influence of non-meteorological factors on weather perception. Great impact of clothing insulation on creating thermal sensations was observed. To investigate regional differentiation of bioclimate perception among tourists, we also carried out field researches both in Madrid (Spain) and Warsaw (Poland), under comparable biothermal conditions during hot summer days. The results suggest that in different regions of the world, tourist thermal sensations were affected not only by physiological processes, but they were also conditioned by psychological factors. Finally, we referred our data to commonly used methods of bioclimate assessment for tourism and recreation. The obtained data suggests that development of a single universal climate index for tourism would be difficult, as it would require its calibration each time to a given climate zone, season and type of tourism. We propose that one of these problems can be overcome by taking into account the changing human perception throughout the year and using shifting thermal sensation scales.

8B.2

Assessment of adaptation strain during tourism activity

Tourism

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During last decades tourism activity increases all over the world. According to United Nation World Tourism Organization international arrivals have raised from 436 million in 1990 to 1095 million in 2012. For people travelling at long distances very important is information about climate contrasts they can experience in comparison to home location and their organisms must adapt to new climate stimuli. In general, increase in differences of climate stimuli intensifies magnitude of adaptation processes in an organism. Several adaptation strategies of human organism to varied atmospheric stimuli were defined. The special attention is paid for physiological and behavioural costs to keep homeothermy, i.e. constant core temperature (about 37ºC) in different thermal environment. Till now few adaptation indices were proposed. However, each of them has advantages and weaknesses. BD and ATSI are mostly dedicated to cold climates. BCI can be used in wide range of environmental conditions but it uses non normalized values of partial components and in specific weather situations its values are unrealistic. In the present research Adaptation Strain Index (ASI) was applied. It includes several physiological and behavioural reactions which are crucial to adapt to new thermal conditions, i.e. water loss, clothing insulation and, thermal stress caused by atmospheric stimuli. ASI index was applied to validate adaptation strain which occurs at tourists travelling between Mediterranean region and central and northern European cities. Both, spatial and temporal patterns of adaptation strain were analysed and discussed. Summer was found as the season with the most spatially differentiated adaptation strain. However, in winter great spatial and temporal (day to day changes) adaptation needs were noticed.

8B.3

On-site behavior as a measure of tourist sensitivity to and satisfaction with weather and climate conditions

Tourism

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Weather is widely considered to influence human behavior, but given the pervasiveness of this belief, research on the topic is surprisingly limited. To help fill the gap, this study examines links between biometeorological variables and the behavior of beach recreationists along with their rating of overall weather conditions. In order to identify and describe significance of on-site atmospheric conditions, two separate forms of response are used. The first is sensory perception of the immediate atmospheric surrounds expressed verbally, which was the subject of earlier work. The work here examines on-site actions of individuals experiencing conditions first hand. The actions are a manifestation of how individuals react, adapt and adjust, which can be interpreted objectively. Compared to subjective verbal response (i.e. questionnaire) data, behavioral reactions to weather and climate are separate and independent indicators of on-site experience and preferences. It is field observation using people engaged in ‘real' tasks and interacting with ‘real' environments, rather than contrived experiments.

The study site is King's beach on the coast of Queensland, Australia. On-site observations of atmospheric variables and beach user behavior are made for the daylight hours of 45 days spread over a 12 month period. The results of the study show that climate conditions within the broad zone of acceptability are those that the beach user can readily cope with or effectively modify. Certain adjustments, such as the use of shading devices, clothing and windbreaks, substantially affect the immediate thermal environment and thus the thermophysiological state of the individual. Optimal thermal conditions appear to be those requiring no specific adjustment or behavioral fine-tuning. In general terms, attendance levels reflect the outer limits of acceptability of the meteorological environment, while duration of visit enables calibration of levels of approval in so far as it reflects ratings of on-site conditions within the broad zone of tolerance.

A large amount of recreation research has been concerned with assessing recreation 'demand', mainly used to estimate the attractiveness of environmental attributes. The most commonly used demand indicator is attendance (visitation) data. The results here suggest attendance is likely a poor measure of demand. Allocation of leisure time, or time spent on site per visit (duration of visit), is a more accurate measure of user response and preference. Similar sensitivity associations are reflected in behavioral responses.

In a broad theoretical sense, the results of this research add to an understanding of the relationship between weather and human behaviour. The findings highlight the close relationship between weather and tourism, in particular those aspects that relate to tourist sensitivity to weather. Weather preferences are identified and light is thrown on the merits of using attendance figures as indicators of demand. They provide objective response criteria to calibrate, supplement and validate questionnaire (descriptive) response scales related to a wide range of atmospheric phenomena. Also, behavioural data may be preferred over subjective assessments of user satisfaction and preferences. Collectively, this information is potentially useful in effective tourism management and planning. Information proved by studies such as this could be used for forecasting the level of beach-use during the year to prepare for the provision of tourist resources and facilities, water safety services and site conservation. The results imply that tourism planning should incorporate more

than simple, general descriptions of climate and weather. The same applies in cases of communicating climate information and descriptions used in weather forecasts. Various authorities or agencies may have to improve their networks of meteorological observatories and data gathered and provide better access to the information. The focus should be on the climate at a particular place or space, functionality of the destination, the level of satisfaction to be achieved, and the influence on future visits.

8B.4

Biometeorology in tourism: Using thermal comfort classifications and weather-types to predict consumer behavior

Tourism

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Attendance decisions involving outdoor activities require that people understand and interpret the weather. One sector of the economy that is particularly vulnerable to the impact of weather conditions on its consumers is tourism, recreation, and leisure (TRL). Part of the TRL sector is comprised of zoos and aquariums. In 2012 zoos and aquariums contributed over $16 billion to the U.S. economy, supported 142,000 jobs and attracted 175 million visitors (AZA 2013). In this research I study the impacts of weather on daily visitor attendances at four U.S. metropolitan zoos, each with annual attendances typically exceeding one million visitors.

Because weather can impact visitor attendance in substantive ways, this research assesses how ambient environmental conditions coincide with attendances at zoological parks. Daily attendances are grouped in magnitude-typologies and evaluated with regard to thermal classifications and weather types. Visitor attendances at each zoo are paired with (1) the warmest biometeorologically-derived thermal category and (2) the Spatial Synoptic Classification. Biometeorological temperatures are defined with Hoppe's Physiologically Equivalent Temperature (PET) which captures the physiological experience of an environment by equating the heat balance of the body in the tested environment to that which is experienced indoors under light activity. PET is one of the most commonly applied biometeorological indexes in outdoor tourism settings and is calculated with the RayMan model. After calculation, PET is classified into a nine-point thermal sensation scale derived by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). The nine categories of this scale are specified using the European baseline as defined by Matzarakis & Mayer. Daily SSC measurements are classified using the seven main weather types as defined by Sheridan.

Findings display general agreement in thermal preference and weather type for the highest attendance days across the diverse geographical study area. However, while there is general agreement for high-attendance days, there is disagreement among low-attendance days including varying thermal tolerances. There are also specific regional nuances when comparing results across zoos. This indicates that zoo management must take regional weather preferences and specific socio-cultural factors into account when forecasting future visitor-demand patterns. Conclusions of this research provide further insight into human behavioral responses to environmental stimuli. The results and methodologies are not limited to the study of zoological park visitation and can be applied in many contexts within the TRL sector with appropriate contextual alterations.

8B.5

Outdoor human thermal comfort in Melbourne's botanic gardens

Tourism

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Climate change is likely to increase the frequency of hotter days, which will affect the thermal comfort of visitors to botanic gardens and outdoor parks. Urban green space has previously been shown to reduce the perception of thermal discomfort under hot conditions. However, the overall cooling benefits of gardens in Australia are not well understood. In this study we aim to demonstrate the importance of landscape design for thermal comfort using the Royal Botanic Garden (RBG) in Melbourne as our case study. RBG Melbourne has a mixture of native and exotic plants, as well as a regular irrigation regime.

Data gathered during the Australian summer of 2013/2014 included visitor surveys and meteorological data. During that summer 2204 visitors were surveyed in the RBG Melbourne. In total 148 surveys were conducted in Chinese. This provides a unique understanding of how Chinese tourists perceive thermal comfort in Australia. Furthermore, a network of 11 automatic weather stations was established in the RBG Melbourne during the summer season (18 December 2013 to 26 March 2014).

The study included several periods of extremely hot weather when temperatures reached close to 45 °C. Preliminary analysis indicates that there are mean daytime temperature differences in the order of 2 °C between well-irrigated areas and unirrigated areas at the RBG Melbourne during very hot weather. This temperature difference could contribute substantially to visitors' relative comfort levels during hot days in summer.

Our study provides empirical evidence of the relative thermal comfort perception of visitors from different countries. The multiple nationalities of visitors and the diverse microclimates inside the garden offer novel insight into the roles of various factors that affect thermal comfort perception. Since the garden visitors are from different climate zones, they have different clothing behaviour. Therefore it is important to appreciate how cultural and ethnic differences in dress affect the thermal comfort of visitors in the garden. Moreover, the project compares the visitors' thermal comfort perception with weather measurements.

Understanding the variability of temperature and thermal comfort in the RBGs can assist in improving garden design, so that RBG management can prepare for future changes in climate. Our work can be used to inform garden landscape planning, and ultimately improve visitor comfort levels, especially during hot weather. Currently, microclimate and thermal comfort play a minor role in landscape and urban planning since planners frequently have little knowledge of urban climatology and human biometeorology. In light of the future rising temperature, it is essential to emphasise the role of parks and gardens in mitigating the urban heat island and promoting human thermal comfort.

8B.6

Climate potential for different kinds of tourism in Croatia

Tourism

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During their activities, tourists are affected by atmospheric conditions and therefore weather and climate constitute one of the most important natural resource for recreation tourism. In Croatia beach tourism is one of the most important economic sectors, but due to its geographical diversity, Croatia also has the potential for a variety of other kinds of tourism. The climate potential for tourism is estimated by means of climate index for tourism. The climate index for tourism (CIT) integrates thermal, aesthetic and physical facets of atmospheric environment and therefore it is suitable for estimation of climate satisfaction that ranges from very poor to very good. The thermal component is estimated using the physiologically equivalent temperature (PET), taking into account the work activity and clothing in calculation of PET. The paper analyzes the suitability of the climate conditions in Croatia for different types of tourist activities: cultural tourism, beach tourism, cycling, hiking, football, golf, sailing and motor-boating. Climate potential is estimated for regions with different climate in Croatia in the period 1981-2010.

8B.7

Biothermal Conditions in Serbia in Function of Health Tourism and Recreation

Tourism

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The territory of Serbia is surrounded by the two large geographic regions, Adriatic basin on the south and Pannonian Basin on the north. Among them are the Dinaric mountain system extending to the southwest Serbia, Carpathian mountain system in the northeastern Serbia, the highest-Pindus mountain range and the Rhodope mountain system on the south. In such geographical ambient there is rich hydro-structure consists of number of rivers and lakes.

In particular, the richness of nature is a huge number of thermal springs of mineral water. In more than 40 spa centers there are over 300 sources of mineral and thermo-mineral water and many sites of medical gas and medical peloids which makes Serbia the richest area in Europe. Serbian spas are located mainly in the valleys of the mountains, so their immediate environment is surrounded by dense forests, lakes, rivers and caves which is very convenient for recreation.

This paper represents a part of the research in the field of human bioclimatology and refers to the possible identification of favorable or unfavorable biothermal conditions in Serbia. The assumption is that spas are often places with favorable climate with healing air. The idea is to present the impact of meteorological parameters on the humans in order to represent climate identity for recreation and health tourism. We tried to compare bioclimatic analysis of six weather stations located in different geographical areas. Specific identification of bioclimatic condition is proposed by bioclimatic index heat load in man which is result of the human heat balance calculated under the menex model. For this calculation, daily meteorological data were taken for the warmest month of July for the decade 2000-2010.

8B.8

Bioclimatic comfort of coastal tourists

Tourism

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To date, outdoor bioclimatic comfort assessments have been limited to local residents in open urban areas, making it unclear whether thermal comfort is perceived differently in non-urban environments or by non-residents (i.e., tourists). Coastal tourism is the largest segment of global tourism, which is highly contingent upon the thermal conditions at the destination. This study provides needed insight into bioclimatic comfort in a coastal environment, while simultaneously identifying important psychological factors that differentiate coastal tourists from everyday users of urban spaces. To examine tourists' thermal comfort, meteorological measurements were taken concurrently with questionnaire surveys (n=472) on Caribbean beaches in Barbados, Saint Lucia and Tobago. UTCI conditions of 32°C to 39°C were recorded, which can be classified as “strong” to “very strong thermal stress”. However, respondents perceived the thermal conditions as being “slightly warm” or “warm”. Even at UTCI of 39°C, 62% of respondents stated that they would not change the thermal conditions, with an additional 10% stating that they would like to feel even warmer. These results reveal that beach users' thermal preferences are up to 18°C warmer than the preferred thermal conditions identified in existing outdoor bioclimatic studies from urban park settings. Moreover, acceptable thermal conditions, as currently defined in the human biometeorology literature (i.e., slightly cool, neutral or slightly warm [e.g., 18-28°C PET]), cannot be applied to coastal tourism without modification. This study also found personal characteristics influenced thermal perceptions and preferences, with statistically significant differences (p ==.05) recorded based on demographic groups (gender, age) and climatic place of origin (residence).

8C.1

Effects of Moderate Strength Cold Air Activity on Hypertensive Patients

Thermal Environment and Human Health III

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Objective: The mechanism underlying the effects of cold air on hypertensive disorders was investigated in an experimental study examining blood pressure and biochemical indicators. Methods: Zhangye, a city in Gansu Province, China, was selected as the experimental site. Health screening and blood tests were conducted, and 30 cardiovascular disease patients and 30 healthy subjects were recruited. The experiment was performed during a cold event during April 26–April 29, 2013. Blood pressure, norepinephrine (NE), epinephrine(E) and angiotensin II (ANG–II) levels of the 60 subjects were evaluated 24 h before cold air activity (April 26, morning), during cold air activity (at minimum temperature, between 7:00 and 8:00 on April 28), and 24 h after cold air activity (morning of April 29). The change before, during, and after the cold air activity were analyzed. Results: Cold air exposure can cause significant metabolism and secretion of norepinephrine (NE), epinephrine (E) and angiotensin II (ANG-II) in subjects; take the patient group as an example, NE, E, ANG II and systolic blood pressure was 306.86, 78.65, 34.2ng/L and 136.3mmHg, respectively, during the cold air exposure, respectively increased by 148.13, 1.34, 39.1ng/L and 11.6mmHg, compared with that before the cold air exposure. Furthermore, the mean value of NE, E, ANG II and the systolic blood pressure was still maintained at a high level one hour after the end of the cold air exposure, which was 363.39, 81.3, 67.3ng/L and 131.7mmHg

respectively, increased by 204.66, 3.99, 26.1ng/L and 7.1mmHg, respectively, compared with before the cold air exposure. The impact of cold air exposure on the change of blood pressure was shown in both cardiovascular patients and healthy people, and the effect on the cardiovascular patients lasted longer. Conclusions: Cold air exposure increases blood pressure in cardiovascular disease patients and healthy subjects via the sympathetic nervous system (SNS) that is activated first and which augments ANG-II levels accelerating the release of the norepinephrine and stimulates the renin-angiotensin system (RAS). The combined effect of these factors leads to a rise in blood pressure. This paper discusses preliminarily the possible mechanism for increasing in human blood pressure leaded by cold air.

8C.2

Hypothermia Mortality in the United States: A Quantitative Assessment of Meteorological Thresholds

Thermal Environment and Human Health III
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Excessive heat and its associated hazards has an extensive body of literature that includes many aspects of vulnerability and warning methodology. In contrast, there is a comparatively small body of research examining these same aspects for excessive cold weather. Hypothermia is a drop in core body temperature caused by cold exposure, with social factors contributing to higher levels of risk among some populations. This research investigates the spatio-temporal distribution of hypothermia mortality in the United States for the years 1979-2004. Hypothermia death data were aggregated by U.S. Census Combined Statistical Area (CSA) and the weather conditions were assessed in each CSA using daily weather data. Descriptive statistics and binomial probability distributions were utilized to determine the probability of a hypothermia death event occurring within a CSA for wind temperatures temperatures ranging from -60º F to 50º F. NWS wind chill criteria were obtained for Advisories, Watches, and Warnings for all Weather Forecast Office (hereafter, WFO) county warning areas. Each CSA was then matched up with the appropriate county warning area wind chill alert criteria. The frequency and probability of hypothermia fatalities was then compared to the criteria to determine if NWS wind chill alert criteria encompass days with high levels of hypothermia mortality. Preliminary results indicate that there are several regions with high level of hypothermia fatalities: these include the Rust Belt and Megalopolis cities, mid-size cities in the southern Piedmont region, along with several areas of the Desert Southwest. The preliminary results also indicate that deaths occur before NWS wind chill alert criteria are reached.

8C.3

Influence of heat waves on ischemic heart diseases in Germany – present situation and climate change

Thermal Environment and Human Health III
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The impact of heat waves on ischemic heart disease (IHD) mortality and morbidity in Germany during 2001-2010 is analyzed. Heat waves are defined as periods of at least 3 consecutive days with daily mean temperature above the 97.5th percentile of the temperature distribution. Daily excess mortality and morbidity rates are used. All calculations were performed separately for 19 regions to allow for the investigation of regional differences. The results show that IHD mortality during heat waves is significantly increased (+15 % more deaths on heat wave days). In stark contrast, no heat wave influence on hospital admissions due to IHD could be observed. Regional differences in heat wave IHD mortality are present, with the strongest impact in Western Germany and weaker than average effects in the Southeastern and Northwestern regions. The increase in mortality during heat waves is generally stronger for females (+19 %) than for males (+11 %), and for chronic ischemic diseases (+18 %) than for myocardial infarctions (+12 %). Longer and more intense heat waves feature stronger effects on IHD mortality, while timing in season seems to be less important. Furthermore, the influence of future climate change on the occurrence of heat waves in Germany is studied. Simulations of 19 regional climate models with a spatial resolution of 10-25 km are analyzed. All of the models use a moderate green house gas forcing according to the SRES scenario A1B. Three model time slices of 30 years are evaluated, representing present climate (1971-2000), near future climate (2021-2050) and remote future climate (2069-2098). Heat waves are identified by the above mentioned heat wave definition, each time using the present climate 97.5th percentile temperature threshold. Based on the model simulations, future heat waves in Germany will be significantly more frequent and longer lasting. By the end of the 21st century, the number of heat waves will be tripled compared to present climate. Additionally, the duration of heat waves will increase by 25 %. Altogether, the number of heat wave days will be four times higher in the period 2069-2098. Regional analyses show that stronger than average climate change effects are observed particularly in the Southern regions. Even though the used methodology does not imply possible adaptations to climate change, it is most likely that the individual heat burden will increase considerably. The obtained results point to public adaptation strategies to reduce the vulnerability of the population to heat waves.

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8C.4

Heat stroke related hospitalizations in older adults: disproportionally high impact of the first heat wave

Thermal Environment and Human Health III
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Older adults are vulnerable to extreme temperature events, which have been documented to be increasing in intensity and frequency. As the US continues on its aging trajectory, it is crucial to characterize the effects of extreme temperature events on older adults' hospitalizations, so that we can optimize preventive efforts.. This study examines the effects of high ambient temperature on hospitalizations directly related to heat exposure among older adults aged 65 or above, and to compare the effects caused by the first and subsequent heat waves. We abstracted all 701 cases of hospitalizations due to heat stroke (HSH), defined as ICD-9-CM 992.0 – 992.9, occurred in older adults living in Boston Metropolitan Statistical Area (MA-NH MSA) between January 1st 1991 and December 31st 2006 from the Centers for Medicare and Medicaid Services databases. Daily temperature records of the area were obtained from the National Oceanographic and Atmospheric Administration for the study period. The dataset includes daily maximal and minimal temperature from over 50 stations within 120 miles radius from the area's centroid. The daily temperature data were interpolated for each ZIP code using an inverse distance weighting method, which allows for multivariate interpolation by assigning the values to unknown locations calculated with a weighted average of the values available at the known points. To characterize temporal variations of daily counts of HSH and their relationships with maximum and minimum ambient temperatures a time series study was conducted using Poisson regression applied. The seasonality of HSH and

temperatures was through harmonic regression with four terms to account for two annual peaks. The peak timing for HSH and daytime temperature were estimated using d–method. The non-linear effect of high temperatures was captured by a specially designed function allowing for exponential growth above thresholds of 95th percentiles for daily minimum and maximum temperatures to reflect the peak of daytime and nighttime exposure to heat. The heat wave periods in the Boston MSA was defined as 3 consecutive days with daily maximum temperature above the threshold. This definition of a heat wave offered the highest explanatory power (as compared to five other commonly used definitions) and was selected for the final model. The impacts of the first and subsequent heat waves on HSH were investigated. The regression model with the temporal elements: long-term trend, effects of individual years, seasonality, and the effects of weekday and holidays) explained 30.8% variability in the HSH. On average HSH peaked on July 8th with median (IQR) of 190 (185.5; 198) days, 15 days earlier than the peak in maximum temperature, observed on July 24th with median (IQR) of 205 (203; 206.6) days. The regression model including a binary indicator for heat wave episodes and adjustments for temporal features explained 43.5% variability in HSH. The relative risk of HSH associated with a heat wave episode was 9.119[95%CI: 7.584 - 10.964]. While the average maximum and minimum temperature values were relatively stable across 36 heat wave periods, however the rate of HSH occurred within the first heat wave period was twice higher as compared to fourth wave (9.64±11.62 vs 4.20±2.79 HSH/per heat wave episode, respectively). Similarly, a number of HSH per day significantly declined from 2.7±4.13 during 14 first heat waves to 1.05±1.68 during 5 observed fourth heat wave. The estimated annual peaks of HSH closely correlate with the occurrence of the first heat wave each year ($r=0.557$, $p<0.038$). Based on a heat wave definition generated for this study, we found that a heat wave resulted in ten-fold increase in hospitalizations due to heat stroke among the older adults, residing in temperate climate of Boston, MA. In a given season, the first heat wave causes more severe health impact than the subsequent heat waves. We advocate for increasing the awareness of detrimental health effects of heat exposure in older adults and for systematic improvement of living conditions, infrastructure and medical support for most vulnerable population to ensure their wellbeing and reduce the cost of health care.

8C.5

ADVERSE HEALTH CONSEQUENCES OF EXPOSURE TO AMBIENT TEMPERATURE IN A CHANGING CLIMATE

Thermal Environment and Human Health III

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Climate change with its associated elevated climate variability has the potential to substantially increase the number and intensity of frequent and rapid fluctuations in ambient temperature that, in turn, has a detrimental effect on susceptible and fragile population. Increased life expectancy in the last half-century and overall better treatment of life threatening conditions such as HIV and cancer has led to communities with a high proportion of elderly who are highly vulnerable to thermal exposure. Extreme weather events, such as heat waves and cold spells, can cause excess mortality and morbidity of this affected population due to hypothermia and heat strokes. Other highly vulnerable groups include children, pregnant women, and people with chronic conditions such as diabetes, kidney failure, cardiovascular and respiratory diseases, electrolyte disorders, and patients undergoing immunosuppressive treatment.

Public health professionals, economists, and environmental scientists, apply two main designs for statistical modeling to study these issues. One design usually employs annual or monthly panel data methods, using mixed effects model, controlling for differences over large geographic areas, coarse time scales, seasonality and temporal trends. The exposure to ambient temperature is estimated as a single set of exposure gradients for a study area. Another design is usually based on a repeated cross-section or time series study of daily measures of temperatures and health outcomes at a city or community level. This design typically explores the associations between meteorological parameters (most commonly, ambient temperature and its derivatives) and adverse health outcomes on a refined spatio-temporal scale.

In this work we examined the relationship between meteorological conditions and spatial-temporal patterns of hospitalizations due to hypothermia and heat strokes, regional risk rates and adaptation effects, in Medicare recipients 65 years old and older in the United States. We applied both designs to 124,900 records of hypothermia and heat stroke related hospitalizations abstracted from 220 million hospitalization records collected during time span of 16 years (1991-2006). We studied relationship between ambient temperature and hospitalization rates, adjusted for patient's age, gender, seasonal and annual fluctuations in temperature and population. We also evaluated differences in hospitalization rates due to adaptation to prevailing climate conditions in eight predefined climate regions. These climatic regions were constructed using satellite remote sensing data with machine learning techniques. We applied generalized mixed effects models with log-link and Poisson distribution to fit both study designs . We found, that both designs agreed in the magnitude and direction of estimated effect, however, the second design provided better resolution in cases when the spatio-temporal scales of exposure and effect match.

We found that hospitalizations during study period in the USA due to excessive cold are more frequent (74,030 cases versus 41,927 cases) and deadlier (13,146 cases (17.76%) versus 1,526 (3.64%) than those due to heat exposure. The annual average rate of hospitalizations related to hypothermia and frostbites was 123.6 ± 15.2 cases per one million Medicare enrollees. The annual average rate of hospitalizations due to exposure to heat was 79.5± 70.1 cases per one million Medicare enrollees. Relative risk associated with 10 degree Fahrenheit changes in ambient temperature for exposure to cold is 1.35 (CI: 1.33-1.36), and for heat 1.1245 (CI: 1.123-1.126). We also found significant difference in regional risk rates, suggesting presence of a strong adaptation effect to prevailing climate conditions. Specifically, subjects residing in a relatively warm climate exhibit stronger sensitivity to lower temperature than those living in colder climates. On the other hand, those who live in continental climate with a large range of annual variability of ambient temperature, exhibit less sensitivity to temperature fluctuations, suggesting a better adaptation to both cold and hot environments.

8C.6

Assessing Risk to Heat Waves and Cold Spells using a Distributed Lag Non-Linear Model

Thermal Environment and Human Health III

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In a changing climate, further understanding the physiological strain associated with heat waves and cold spells remains a topic of continued research. Acute, rapid responses to heat have been observed while the complexity surrounding cold-related mortality yields a more delayed response. The distributed lag non-linear model (DLNM) is commonly used in public health to assess the non-linear health responses following environmental conditions. Thresholds of daily mean apparent temperature are used to define anomalous temperature events (ATEs) of heat, extreme heat, cold,

and extreme cold. Using daily mortality data, mortality responses following these heat and cold events are evaluated for 52 U.S. cities. The binary variables were incorporated into the DLNM to assess the impact of ATEs on daily mortality compared to days without anomalous temperatures. Geographic differences were observed with higher heat-related risk in northern locations. Similarly, elevated risk for cold-related mortality was found to be greater in more southern locations. This research supports the geographic variability found in other studies which suggest populations adapt or are better prepared for particular environmental conditions. Additionally, early season events showed higher risk values when compared to later occurring events. The impact of ATEs on human health outcomes is dependent on various factors including seasonal timing, duration, and intensity.

8C.7

Observation time, temperature diurnality, and weather variable selection influence heat-related mortality

Thermal Environment and Human Health III
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Mortality associated with extreme heat is the main weather-related cause of death in the United States. Although models that explore temperature/mortality relationships have become quite sophisticated, the influence of observation time and lag of the weather variables has not been thoroughly examined. If the temporal sampling of the independent variable influences heat-mortality relationships, it is important to know which temperature variables to incorporate into models and retrospective analyses.

Mutli-decadal time series of daily mortality counts and hourly temperature for seven U.S. cities with different climates were examined via a generalized additive model. The temperature effect was modeled separately for each hour of the day (with up to three-day lags) in addition to several different methods of determining daily maximum, minimum, and mean temperature.

In three northern U.S. cities that are typically considered to have “heat-sensitive” populations (Boston, Philadelphia, and Seattle), the heat-mortality response is diurnal, with the strongest relationships for afternoon or maximum temperature at lag zero (day of death) or lag one (afternoon and evening). The temperature-mortality relationships are weaker in the warmer, southern U.S. cities, where slightly stronger relationships to morning temperatures are evident. The strongest temperature-mortality relationships are associated with maximum temperature, though the results using mean temperature are comparable.

The results for the three northern cities, in which heat-mortality relationships developed using afternoon/maximum temperatures are stronger than those using morning/minimum temperatures, suggest that cooler mornings may provide a protective effect from heat-related mortality in these climates. In general, choice of observation time, lag, and variable calculation method often impacts the robustness of the model results. In general, heat-related mortality is most closely coupled to afternoon and maximum temperatures in most cities, particularly those that are typically heat-sensitive.

8D.1

'Do Air Hygiene-related Forecasting and Early Warning Systems Reach Vulnerable Target Groups?'

Warning Systems: Methods and Implementation
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Introduction: For more than a decade air related forecasting and early warning systems have been established in Germany. Their aim is to inform the general population and vulnerable groups (e.g. elderly, one-person household) on the current and predicted situation to prevent health damages by better individual adaptation. Recently these systems were expanded by the heat health warning system. From environmental health viewpoint it is of utmost interest to know if, when and how the information reaches the people. Important is also, whether the information is sufficient and understandable. For effective adaptation people need adequate information. Due to the fact that information about the reception of the air hygiene-related information systems already existing is missing, the Federal German Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) and the Federal Environment Agency (UBA) launched in 2012 a research investigation to evaluate selected forecasting and early warning systems at the national scale as contribution to health-related aspects of the National Adaptation Strategy on Climate Change. Following four systems are under investigation: (1) heat health warnings, because about 7,000 people died during the summer heat wave 2003; (2) UV index, because increased solar radiation could raise the risk for skin cancer; (3) pollen forecasting, because an increase of allergic reaction is associated with linger and shifted in time occurring biological aero allergens; and (4) tropospheric ozone forecasting, because more frequent summer high pressure weather conditions could favor ground-level ozone formation, which could cause breathing and pulmonary problems.

Methodology: How do we approach vulnerable population groups, which suffer from environmental burden, for example extreme air pollution events, and how can we improve their individual resilience as well as their adaptation capacity? Do we reach these groups of people at all? To answer these questions, we recently started a two years research investigation (2012-2014) to evaluate existing air hygienic and climate change associated information systems (for heat, solar UV radiation, pollen and tropospheric ozone) in Germany. Hence, a first German-wide representative telephone survey among 4,000 residents has been carried out during late summer 2013 in cooperation with local physicians. The project results should give guidance to improve the public's understanding of published information and to modify current risk communication concepts and strategies between health and environment administrations, to physicians and health care systems, to day care centres and foster homes, as well as to elderly singles.

First results: The study investigation has started with a baseline search on established information channels, multipliers and applied measures and scientific studies, followed by a first unrepresentative test phase among members of local health authorities which tested and estimated the usefulness of air hygiene-related warning systems. Great or some benefit is expected by the majority of asked representatives (75 % heat health warnings, 67 % solar UV radiation index, 44 % pollen forecasting, 56 % tropospheric ozone forecasting). The study was supported by both National and Regional Associations of Statutory Health Physicians. The main investigation was carried out as a national representative survey (computer assisted telephone interviews – CATI) of the general German population (app. 30 minute interviews of up to 4,000 German residents, aged 14 years and older; about 250 per Federal State), added by an additional questionnaire for vulnerable subgroups (n=400), each for heat, UV, pollen and ozone. The questionnaires used in this survey were pretested

to assure understanding. First selected tentative results show no geographical gradient in Germany, e.g. between North and South or West and East. As most important environmental health information sources were identified: family/friends 88%, physician 88%, newspaper/journal 84%, health insurance 80% and TV 80%. Peoples' impression on the extent which of the four investigated air hygiene-related factors suffers most is quite diverse: UV radiation 46%, heat 41%, ozone 28% and pollen 21%. But the knowledge about the different forecasting and warning systems shows a different order: pollen 87%, heat 71%, ozone 54%, and UV index 29%. In general, deficits were identified, particularly concerning risk communication, acknowledging one main problem for vulnerable groups: despite the knowledge of expected health impacts during extreme weather events, e.g. heat, an adapted personal behavior is often ignored and missing. Therefore, the study wants further to indentify causal links between air quality information, forecasting, early warnings and the respective risk perception of people, particularly vulnerable groups. The willingness to adapt changes of the personal behavior due to the perceived risk depends on predisposing factors (such as individual knowledge, attitudes, beliefs and values before intervention that affect willingness to change), enabling factors (like individual or community information and help), and reinforcing factors (positive or negative effects or social support that encourage continuing the behavior).

Conclusion: To prevent public health damages and to strengthen the individual health literacy of the population it seems to be essential to adapt a strategy to cope with (extreme) air hygiene-related events and changes of human bioclimate.

Acknowledgement: As part of the German Environment Research Programme the study is financially granted by the Ministry for the Environment, Nature Conservation and Nuclear Safety (UFOPLAN2012; FKZ 371262207).

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8D.2

Do We Need a Tornado Watch Scale?

Warning Systems: Methods and Implementation
Jason C. Senkbeil, University of Alabama, Tuscaloosa, AL; J. B. Mason

A tornado refuge rubric was revised into a six-level, hierarchical Tornado Watch Scale (TWS) from level 0 to level 5 based on the likelihood of high or low-impact tornadic events. Levels correspond to an estimate of the maximum potential tornado intensity for a given day and include refuge/shelter categories of “Adequate,” “Questionable” or “Inadequate,” which encompass a range of refuge/shelter locations taken from the enhanced Fujita scale. Ratings are based on a conservative estimate of damage indicators in high winds and the safety of a person taking refuge inside buildings of varying structural integrity. Audio recordings similar to those used in current NOAA weather radio communications were developed for each TWS intensity level. Recordings representing an existing tornado watch, existing particularly dangerous situation (PDS) tornado watch, and three proposed levels from the TWS were then used in interviews with Alabama residents to determine how changes to the information contained in the watch statements would affect each participant's tornado safety actions and risk perception. Participants were also questioned about their knowledge and past experience with tornado hazards, and their preference between the existing NWS tornado watches and the TWS. Results indicate a strong preference for the TWS when compared to existing products. The TWS was favored for providing additional information, containing descriptions of expected severity, and being easy to understand. The TWS also elicits more adequate safety decisions and more appropriate risk perception when compared to existing products, and these increases in safety were statistically significant.

8D.3

The development of an extreme cold warning system for livestock in northeastern Montana

Warning Systems: Methods and Implementation
Katrina L. Frank, Applied Climatologists, Inc., Flower Mound, TX; T. E. Fransen, W. J. Martin and L. Kalkstein

The coldest temperature ever recorded at Glasgow, Montana, was -59°F on February 15, 1936. Arctic outbreaks with wind chills in the -30°F to -50°F range occur frequently during the winter months. These bitterly cold temperatures affect the agricultural community of northeast Montana as ranchers typically breed their livestock such that calving and lambing occur in February and March. During these critical weeks, ranchers require advanced warning of extreme cold to move susceptible livestock to shelter. Newborn animals (less than 24h old) are especially vulnerable to cold because they are not yet able to regulate their body temperature effectively (Stanko et al., 1991). For example, in one spring cold outbreak, a rancher in Big Sandy, Montana, lost more than 10% of his herd: 250 calves from his herd of 2000 head. This equated to a loss of approximately $110,000. Development of a warning system for dangerous events should allow producers to minimize mortality rates of newborn calves and lambs and the associated economic losses.

This study explores the development of such a cold warning system for northeastern Montana, the Cold Advisory for Newborn Livestock (CANL) system, with a focus on identifying weather conditions that result in livestock losses. System development was accomplished by two means: 1. a literature review identified studies which had been undertaken in other areas, or in climate chambers, to determine the effects of cold exposure on newborn animals; 2. livestock producers in the region were interviewed to identify specific weather events that had caused losses in the area in the past. This study defines meteorological thresholds for which a cold warning would be called, discusses the development of an operational warning system and sets the stage for the development of similar systems in other areas.

8D.4

Human's adaptation to weather changes: Media Project “Biomet_Forecast”

Warning Systems: Methods and Implementation
Marina Trubina, Russian State Hydrometeorological University, Saint-Petersburg, Russia

ABSTRACT Modern problems climate changes require of innovation assessment of the impact of weather on humans. Processes of adaptation of the person to various climatic conditions depend both on a condition of its health, and from climatic features of regions of residing. The analysis of known methods of an estimation of comfort of the climate, which are applied in complex climatology and balneology, allows to select such optimum parameters and indicators which characterize degree meteopathy of the person, and to use them for a bioclimatic estimation of a climate. The purpose of the presented work is the investigation of the complex environmental parameters in the region of St. Petersburg and their influence upon the human health. The idea of project “Biomet_Forecast” is important because research results are presented in mass media for a wide audience. INTRODUCTION There are many facts that big groups of the town's people feel bad because of the same reason someday, for example because of the headache or weakness. There are so many erratic

explanations of such effects of common illness in the mass media that we decided to investigate this problem in our city and try to help ill-people, which especially need for the forecast of the critical variation of the environment. The most complicated problem is the impact of environmental and geophysical factors on health of persons and activities. One of the leading geophysical factors is the weather, which defines the territory of recreational opportunities, selection of new resort areas, sporting events, tourism development, including environmental. A distinctive feature of St. Petersburg is unfavorable environmental conditions and weather changes so healthy are somehow connected with these factors. In St. Petersburg and Leningrad region, there are a range of environmental concerns. Each of them has its own causes and their solutions especially in the ways. But practice shows that this complex is always allocated the most urgent problems that should be addressed immediately. Over time, priorities change, sometimes there are new, changed, and the conditions in which these problems to be addressed. Therefore, each time interval of duration approximately 3 years is characterized by its specific priorities that set on the basis of comprehensive analysis of the competent evidence and expert opinion. Based on systematic observations of the state of the environment, on the opinion of competent experts and forecasts of development of ecological situation today in the region there are several priorities. Environmental quality is mainly determined by the pollution of air and water pollution, waste collection and disposal of production and consumption, the state of the soil cover, green spaces and other factors. The solution of these problems is integrated assessment of bioclimatic conditions it's a key element of future climate policy In Russia, main objectives of research: 1.estimate bioclimate of the regions; 2.effects to space weather and meteorological factors on human health (assessment at the population and individual degree of meteopathics); 3.estimate of environmental and social issues risk to human health. These problems can be taking into account available development a choice of the climatic criteria, allowing to estimate and count various degrees of comfort/discomfort for health care of a recreation, tourism, sports, etc. METHODS Study and content analysis Carrying out the content analysis of existing results of researches on project subject, drawing up the review of references on this problem, with allocation of the existing techniques including empirical formulas taking into account weather and climatic conditions. Taking into account available development a choice of the climatic criteria, allowing to estimate and count various degrees of comfort/discomfort for health care of a recreation, tourism, sports, etc. Researches Studying of medico-ecological features of various regions of St. Petersburg with the subsequent formulation of the main directions of prevention the eco-dependent diseases. Specification of regions with endemic diseases, the analysis of available statistical data on influence of polluting substances on the main diseases: cardiovascular, pulmonary, endocrine, allergic, skin, rheumatic etc. Carrying out the comparative correlation and regression analysis of influence of negative ecological factors on a state of health of the population living in conditions of the megalopolis. Monitoring of quality of environment, studying of effects of extreme weather and risk assessment for health. Experimental studies and assessment of individual meteosensitivity of human body. Methodology Transformation of basic meteorological parameters in metropolitan areas with the release of synoptic conditions of pollution, affecting human health, for the health risk assessment of megalopolises. Scientific research on bioweather forecasting depending on the synoptic situation and the development of warning systems unfavorable prognosis. Development of techniques of the account meteosensitivity of factors and their possible forecasting. Development of medico-ecological passports for megalopolises. Development of a technique and information system of bioweather forecasts of weather for the short-term period (till 2-5 days). Statistical analysis of diseases caused by atmospheric circulation, weather conditions and air pollution. To establish connection the meteosensitivity of diseases with variability of weather conditions, and that number and extreme weather. Evaluation criteria and characteristics uncomfortable and dangerous weather conditions (overheating, overcooling, stuffiness, etc.) that affect the state of the human body. Implementation Formation mechanisms adaptation support in terms of adverse health effects of medico-geographical, weather and environmental factors. Establishment system of early warning of adverse weather or environmental conditions in the megalopolises. Biometeorological assessment of weather and climate of especially extreme characteristics which influence health and main types of a disease. Polluting role of megalopolises and their influence on health. Development of methods of an assessment and forecasting of meteorological and geophysical factors, and possible environmental pollution in various climatic and physiographic conditions. RESULTS Developed the technology training of specialized weather forecasts in collaboration with Hydrometeoservice. The project results are regularly presented on television in St. Petersburg.

8D.5

Case Study in Heat: Global Cities Address Climate-Health Threats With Early Warning Systems

Warning Systems: Methods and Implementation

Kim Knowlton, Natural Resources Defense Council, New York, NY; D. Mavalankar, A. Jaiswal, G. S. Azhar, A. Tiwari, A. Rajiva, B. Deol, N. Kaur, P. J. Webster, V. Toma, P. Sheffield and J. Hess

Even with technological adaptations like air conditioning, extreme heat threatens human health today globally in both developed and developing nations. Climate change is fueling more frequent, more intense and longer-lasting heat waves, heightening the need to develop robust heat-health preparedness plans for growing global cities. In many locations including the US, a lack of centralized reporting on heat-related illness and death hampers efforts to fully assess its burden on public health.

With these goals in mind, and after a devastating 2010 heat wave, the Indian city of Ahmedabad, Gujarat began to explore options for developing and launching an extreme heat early warning system. The project team was comprised of collaborators from the Ahmedabad Municipal Corporation (AMC), the Public Health Foundation of India (PHFI), the Indian Institute of Public Health (IIPH), and the Natural Resources Defense Council (NRDC), along with several independent heat-health and climate change experts from the US and India.

Just two years after the project's 2011 kickoff workshop, a Heat Action Plan and heat wave early warning system was launched, in April 2013. The project in this growing city in western India has yielded insights into methods to integrate climatology, meteorological forecasting and public health system coordination to reduce urban heat vulnerability, especially for Ahmedabad's most vulnerable residents.

Neighborhood-scale risk communication and citywide outreach about the health risks of extreme heat in Ahmedabad can help enhance climate change preparedness, moving forward. Planning and preparedness efforts to address the effects of increasing heat, storms, and flooding in a changing climate can help improve public health.

9A.1

Mapping Challenging Environments: How can mobile geospatial technologies be used to support intervention strategies in Crime, Disaster, Epidemic, and Informal (Slum) landscapes?

Health and atmospheric hazards research: new data sources and field technologies
Andrew Curtis, Kent State University, Kent, OH

This presentation will focus on three broad research areas drawn from “challenging” environments where fine scale spatial and temporal data collection is either missing or limited. It will present an overview of current research projects being conducted by the GIS, Health & Hazards Lab at Kent State University where novel geospatial field collection approaches, especially the use of spatial video, are being used to overcome such limitations. The topical areas covered in this presentation include the health-crime nexus in declining cities of the United States, post-disaster damaged and recovering landscapes, and emerging epidemics as well as other health concerns associated with poverty in the developing world. The variety in these research areas has been chosen to show common threads in methodological development designed to overcome data collection challenges, and to (hopefully) spark interest from a broad range of conference participants. Indeed, the purpose of the talk is to suggest potential collaboration with rather than lecture at biometeorological researchers.

In this spirit, each subject area will be discussed from a perspective of the "scale of intervention", meaning data collection, analysis and insight dissemination will occur at a scale relevant for stakeholders focused on intervention. This scale primarily consists of micro-geographies. In developing world environments this scale might include a pathway through an informal settlement, or the location of standing water and trash both of which have disease implications. The "scale of intervention" also presents excellent opportunities for collaboration, because the focus, irrespective of discipline, is on what factors cause the problem, and then how to fix it. Traditionally this has meant project participation not only by researchers, but by communities, residents, experts and officials.

The presentation will focus mainly on novel geospatial data collection technologies, especially spatial video that can be used to collect fine scale spatial data suitable for spatial analysis where previously either no data was available, was extremely expensive to collect, or existed at too coarse an aggregation for effective intervention. These new mobile mapping approaches also facilitate longitudinal analysis, which is an imperative for dynamic landscapes. In addition, they can also be used to enhance integration of additional technology such as mobile air quality monitors, or to adapt different theoretical or methodological approaches, such as mixed methods, and in this case, geonarratives.

Within these three topical areas, a series of case studies will showcase ongoing research projects: nine years of Hurricane Katrina research, spatial patterns of damage and recovery from tornadoes, a post-earthquake cholera-impacted town in Haiti, assessing health risks in the informal settlements of Bangladesh and Kenya, and the crime and health nexus in the declining urban neighborhoods of Akron, Cleveland and Youngstown.

The presentation will conclude with a few words regarding spatial confidentiality, and emerging ethical concerns in the broadly defined area of GIS, Health and Hazards.

9A.2

Mobile air quality monitoring of particulate matter at the neighborhood scale: challenges and opportunities through the incorporation of geospatial technologies

Health and atmospheric hazards research: new data sources and field technologies
Laura M. Schuch, Kent State University, Kent, OH; A. Curtis

Although more than 44 million people live in an area with unhealthy levels of particulate matter (PM) pollution, according to the American Lung Association (ALA), “the burden of air pollution is not evenly shared” (2014). Higher exposure is experienced by low-income individuals, certain racial and ethnic groups, less-educated individuals and those living closer to major sources such as roadways and emission sites. As a compounding factor the overburdened populations may also lack access to resources such as healthcare and suitable employment. Furthermore, the complexity of the health burden experienced by those living in such neighborhoods may exaggerate the exposures and impacts from PM exposure (ALA, 2014). Currently the monitoring of airborne PM occurs at over 500 stations across the United States (EPA, 2013). This network provides a sufficient understanding of a regional level of PM but is not dense enough to capture local patterns. Some environmental professionals and researchers have turned to mobile platforms as an alternative to the costly option of installing more stationary air monitors. This allows for a finer-scale of data collection and analysis which may identify pockets of PM pollution missed by a regional monitor. Furthermore the mobile platform facilitates the identification of specific areas within a neighborhood with higher levels of PM which can be compared to other fine scale data as health outcomes, housing conditions or even crime. The combination of all these data layers can help in understanding health disparities, and then identifying interventions for those neighborhoods most at risk.

The purpose of this research is to investigate the variability in PM levels at the neighborhood scale in a post-industrial city in northeast Ohio using a mobile air quality monitoring device in tandem with geospatial video, and then demonstrate how such data can enhance the understanding of health and quality of life within a neighborhood. This paper describes the process used to measure PM in two lower income neighborhoods in Akron, Ohio, using the Dylos DC1700 air monitor. Spatial video provides a visual snapshot of the environment at the time of data collection which can be coded and mapped in a GIS and compared to air quality readings of the same location, also mapped in a GIS. This toolset not only enhances understanding of the immediate conditions affecting the residents of a neighborhood, but when collected repeatedly over the duration of months, can identify changes and patterns over time. Furthermore, the layering of data related to health and quality of life within a GIS, such as transportation, environmental hazards, housing conditions, walkability, mortality data, crime, and perceptions of the neighborhood, facilitates the ability to draw critical connections between environment, health outcomes and behavior.

9A.3

Intra-Neighborhood Variation in Individually Experienced Temperatures (IETs): Insights from a New Approach to Measuring Heat Exposure

Health and atmospheric hazards research: new data sources and field technologies
Evan Kuras, Boston University, Boston, MA; D. M. Hondula and J. Brown-Saracino

Urban environmental health hazards, including exposure to extreme heat, have become increasingly important to understand in light of ongoing climate change and urbanization. In cities, neighborhoods are often considered a homogenous and appropriate unit with which to assess heat

risk. This paper presents results from a pilot study examining the variability of individually experienced temperatures (IETs) within a single urban neighborhood. In July 2013, 23 research participants were recruited from Boston's South End neighborhood and equipped with Thermochron iButtons that measured the air temperatures surrounding individuals as they went about their daily lives. The researcher asked participants to fill out daily surveys, conducted exit interviews, and engaged in a field ethnography during the summer months. IETs were measured during a heat wave period (July 18-20), which included two excessive heat warnings and a heat advisory, as well as a reference period (July 21-23) in which temperatures were below seasonal averages. IETs were not homogeneous during the heat wave period and the majority of participants recorded IETs significantly lower than outdoor ambient temperatures. More than half of participants did not experience statistically different temperatures between the two test periods, despite the fact that mean outdoor temperatures were 6.5˚C higher during the heat wave period. The IET data collected for this sample and study period suggest that heterogeneity in individual heat exposure can exist within a neighborhood and that outdoor temperatures overestimate mean experienced temperatures during a heat wave. Findings from daily surveys and exit interviews suggest that behavior (schedules, preferences, lifestyles) and access to cooling resources (air-conditioned homes and business, parks, and pools) were variable among participants. Further, Individual attributes such as gender, race, socioeconomic status, age, and neighborhood tenure, also proved important in predicting heat exposure. Individual heat exposure can best be understood when the intersection of individual attributes, behavior, and access to cooling resources are framed by the neighborhood social and biophysical context. Individual differences are an overlooked determinant of heat exposure and should be better integrated into multi-scalar analyses. Understanding IETs for the population at large may lead to innovative advances in heat-health intervention and mitigation strategies.

9A.4

A Bicycle-Based Field Measurement System for the Study of the Urban Canopy Layer in Cuyahoga County, Ohio

Health and atmospheric hazards research: new data sources and field technologies

Nicholas Bly Rajkovich, University at Buffalo, State University of New York, Buffalo, NY; L. Larsen

Each year in the United States, more people die from heat waves than from any other type of natural disaster. Assessments of climate change project an increase in the intensity, frequency, and duration of extreme heat events. Of particular concern is the impact of climate change on cities; higher global temperatures combined with the urban heat island effect will increase heat-related morbidity and mortality over present levels.

Urban planners and city officials interested in targeting interventions need to identify neighborhood level hotspots. However, urban microclimate measurement poses substantial challenges. For example, data taken at local airports are not representative of the conditions at the neighborhood or district level because of variation in impervious surfaces, vegetation, and waste heat from vehicles and buildings. In addition, fixed weather stations cannot be deployed quickly to capture data from a heat wave. While remote sensing can provide data on land cover and ground surface temperatures, spatial and temporal resolution remain significant limitations. In an effort to overcome some of these issues, we have designed, constructed, and validated a mobile measurement bicycle to investigate the microclimates of Cuyahoga County, Ohio.

Mobile measurement provides a simple way to gather mesoscale data along a transect that spans urban and rural land uses. Mobile surveys are a common method used in urban climate studies for assessing and quantifying canopy layer UHIs; they are also used as part of a larger observation network. Automobiles or light trucks are the most common platform for these studies; temperature sensors are typically attached in front of the engine or on the roof or to avoid thermal contamination. Advantages of mobile surveys include high temporal resolution of data, low cost compared to the installation of multiple stationary weather stations, and no requirement to cross-calibrate sensors from multiple sites.

However, while automobile-based measurement allows for analysis at the urban scale, this equipment is often too cumbersome to investigate microscale phenomena that might occur at the neighborhood- or block-level. To overcome these limitations, we borrowed insights from the thermal comfort literature to understand how researchers use mobile measurement carts to support their work. Although automobile transects and thermal comfort using carts are both well established approaches for their respective literatures, until recently there were few efforts that bridged the gap between these meso- and microscale methods.

To the best of our knowledge, this is the first time a research grade weather station has been installed on a bicycle to gather multiple types of data (e.g., ground surface temperature, solar radiation, sky view factor) for analysis. For our research, we also wanted to determine the limits to the amount of equipment that could be carried, if a bicycle was a suitable platform for this type of analysis, and what limitations non-motorized transportation imposed on rural to urban transects.

Because we needed to place meteorological equipment at least 1.25-meters above grade to avoid interference from the ground and travel up to 50 kilometers per transect, we chose a cargo bicycle as a base for the equipment. Cargo bicycles are commonly used for bicycle touring with large amounts of camping equipment. They differ from standard bicycles in that they have a heavier duty frame, spokes, and brakes, and a longer wheelbase to improve stability under load. We were especially interested in bicycles with high weight capacities (>100kg) to hold the equipment on front and rear mounted racks, multiple gears to assist pedaling from site to site, but a size small enough to be stored on a standard bicycle rack to move from site to site.

A thermocouple, hygrometer, and GPS unit was installed at the top of a 2.0-meter tall aluminum tower constructed of extruded aluminum sections. The GPS unit collected latitude, longitude, and speed, and provided a time stamp to synchronize fisheye images taken by a camera to determine Sky View Factor. A four component net radiometer and infrared radiometer were installed off the back of the bicycle at 1.25-meters above the ground to gather information about incoming and outgoing short- and longwave radiation and ground surface temperature. All of the equipment took a reading once every second; the datalogger averaged the measurements for each minute and stored it to an onboard solid state hard drive.

The bicycle performed well as a platform to gather data to analyze ground and surface temperatures. The bicycle allowed us to access locations that would be inaccessible by automobile and was less expensive than setting up multiple research grade weather stations. In addition, riding a bicycle helped us in the validation of land cover data from satellites, something that would be difficult to accomplish from the confines of an automobile.

However, bicycles do have significant limitations, such as safety, heat stress, fatigue of the rider, and difficulty scaling steep terrain. Interpretation of weather data from mobile measurement systems

was more difficult than interpreting results from a static weather station because of the need to account for spatial effects like the bicycle speed, location, and autocorrelation of thermal data.

While the data we collected is helpful for understanding temperature variations and the extent of the urban heat island effect, more research is needed before the results broadly inform policy. For example, there is no document to standardize mobile measurements like the WMO guidance to obtain representative meteorological observations from urban sites, or ASHRAE Standard 55 which governs thermal comfort in buildings. We suggest that there should be more standardization among equipment, measurement heights, and protocols for data collection and analysis; this will promote the comparability of results among multiple studies.

9A.5

Human BIometeorology along Human Pathway using Wearable Measurement System

Health and atmospheric hazards research: new data sources and field technologies
Makoto Nakayoshi, Tokyo University of Science, Noda, Chiba, Japan; M. Kanda and R. D. Dear

An outdoor summer experiment on thermal physiology along the subjects' pathways was conducted in a Japanese city using a unique wearable measurement system that measures all the relevant thermal variables: ambient temperature (Ta), humidity (q), wind speed (U), short/long wave radiation (S and L), and some physio–psychological parameters: pulse rate (PR), skin temperature (Tskin), subjective thermal sensation (Tsv), and state of body motion (BM). U, S, and L were measured using a globe anemo-radiometer, which is a suitable sensor for mobile observations. The accuracy of the meteorological instrument in wearable use was carefully validated. The subjects were 26 healthy Japanese adults (14 males, 12 females) ranging from 23 to 74 years in age. Every subject wore a set of instruments that recorded individual microclimate and physiological responses along the observed route, which covered various urban textures. The subjects experienced widely varying thermal environments that could not be assessed from fixed-point routine observational data. S fluctuated highly, reflecting the mixture of sunlit/shade distributions within the complicated urban districts. Ta was generally higher in urban districts than in typical data, except for urban green spots and biotopes. U was generally low within urban canyons due to drag by urban obstacles such as buildings, and the subjects' movements enhanced the convective heat exchange from the body to the atmosphere, leading to a drop in Tskin. The amount of sweating increased as SET* increased. Moreover, a clear dependence of sweating on gender and body size was found. Males sweated more than females, and overweight subjects sweated more than standard and underweight subjects. Tskin had a linear relationship with SET* and a similarly clear dependence on gender and body-size differences. The Tskin of the higher-sweating groups was lower than that of the lower-sweating groups, reflecting differences in evaporative cooling by perspiration.

9B.1

Biometeorological characterization of agro-environments under varying climatic conditions in Haryana, India

Agricultural Biometeorology I
Surender Singh, CCS Haryana Agricultural University, Hisar, Haryana, India; D. Singh

Climate being a key driver for choice of crops and farm activities in a region, delineation of homogenous climatic zones has always received thrust. The biometeorological characterization paves way for identifying potential productivity zones for various crops, livestock and related human activities. Global climate change will increase outdoor and indoor heat loads, and may impair health and productivity for millions of working people in farm sector. In most regions, climate change will decrease farm manpower efficiency and agricultural productivity, under the simple assumption of no specific adaptation. Climate of Haryana, an agrarian province situated in North-West plain region of India is subtropical, semi arid to sub humid continental and monsoonal type which is very hot in summer and predominantly cold in winter. The annual rainfall in the province is less than 750 mm. The agro environment of the province has been classified into dry sub-humid, semi arid and arid.

For bioclimatic characterization of a region, heat index (HI) is necessary to when heat and humidity have reached the point where farm manpower is at serious risk of heat illnesses, such as heat cramps, heat exhaustion or even heat stroke affecting work efficiency and farm productivity. The Heat Index is a measure of how hot it really feels when relative humidity is factored with the actual air temperature whereas wind chill is the felt air temperature on exposed skin due to wind. The wind chill temperature is never higher than the air temperature, and the wind chill is undefined at the higher temps (>10 °C). In the present study, appropriate open source statistical techniques and formulae of heat indices and wind chill factors for apparent temperature calculation have been applied for bioclimatic characterization of agro-environments. Historical meteorological data for the period 1980-2011 of provincial stations at Hisar and Karnal have been considered wherein both the stations represent Western and Eastern Agroclimatic Zones of Haryana. The interpretation of comfort indices during different time scale suggested the comfort period (HI $\leq 26.5^{0}$C) during 42 to 14 Standard Meteorological Weeks i.e. 15th October onward until 8thApril in both the agro-environments. As per wind chill index values, comfort environment was found both at Hisar and Karnal throughout the year exhibiting no wind chill impact on farm productivity throughout the growing seasons.

The biometeorological characterization at regional/micro scale needs to be done and should also be revisited at appropriate spatial and temporal scale more frequently since more warming trends have been projected in future. Such an exercise may not reveal a substantial change in the overall area under different climates, even than may reveal spatial shifts of bioclimatic zones, which has bigger implications for farm manpower efficiency and agricultural productivity. Rationalized biometeorological characterization at micro/regional level will be of immense use to various stakeholders for efficient agricultural manpower use, planning, assessment of climate driven agro-biological entities including pests/diseases in humans, crops and livestock etc.

9B.2

Utilization of SEBAL Algorithm and Landsat8 Data for Estimation of Evapotranspiration – A Case Study: Tatra Mountains Region

Agricultural Biometeorology I
Ayad Ali Faris Sr., University of Mustansiriyah, College of Education, Baghdad, Baghdad, Iraq; A. H. Al Sulttani, A. Jarociñska III, A. Ochtyra IV and A. Marcinkowska V

The evapotranspiration is one of the climate elements, which plays an important role in water balance, and affects the ecosystem of any region. Accordingly, there are many mathematical equations and algorithms that found and designed to calculate and estimate the values of evapotranspiration, either based on data from weather stations or other sources in areas devoid from weather stations. Remote sensing data are one of the important sources and techniques to estimate the values of evapotranspiration. Landsat8, which was launched in early 2013, as a new source of remote sensing data, still some reluctance from researchers to use Landsat8 data, due to

uncompleted reflectance and albedo calculation parameters of the sensor. In fact, this research represents a serious and aggressive attempt to use Landsat8 data in estimation of evapotranspiration. The surface reflectance values are calculated according to COST method for atmospheric correction and the effect of terrains are corrected based on ESTER DEM data, while a new equation is implemented to calculate the surface albedo, both parameters represent the first step to achieve the inputs spatial modelling of solar radiation and ET calculations. The study area is located in Tatra Mountains, which are natural border between Poland and Slovakia. The Tatra Mountains are one of the most valuable areas in Poland and Slovakia. Furthermore, these areas are protected (Polish and Slovakian National Parks).geologically the area was subjected to tectonic uplift caused mixing igneous rocks, metamorphic rocks and sedimentary rocks. The High Tatras are constructed of igneous rocks, mainly granites, Western Tatras are mostly built of metamorphic rocks (gneisses and schists), igneous (granites) and in certain parts of the sedimentary rocks. The Bielskie Tatra Mts. and the Siwy Wierch massif are built of limestone. Selected area is characterised by the lack of weather stations. The main objectives of this study are to utilize the remote sensing represented by Landsat- 8 data to calculate the values of evapotranspiration based on SEBAL algorithm. The data of Landsat8 OLI/TIRS with Path 188/Row 26, acquired on 08-SEP-2013, and the one arc-second resolution ASTER digital elevation model with some reference weather parameters are used as inputs for the models. The analyses are curried out using 16 ERDAS models, designed to calculate the various parameters related to solar radiation i.e surface radiance surface reflectance, surface albedo, NDVI, LAI, surface emissivity, surface temperature, net radiation, soil heat flux, sensible heat flux, latent heat flux, which are used later to calculate the hourly and daily evapotranspiration in study area. The results of pixel wise calculations shows, the values of surface temperature are varied from 6.2 oc at area covered by snow to 34.6 oc at bare rocks area, while the spatial variability of evapotranspiration (ET) for different land covers shows, the hourly ET ranged from 0 to o.72 mm/hr., the daily ET varied between 0.0 to 17.0 mm/day. Generally, the results proved the efficiency of Landsat8 data in calculation of all the required solar radiation parameters for estimating the ET values in a pixel wise when compared to results from other satellite data.

9B.3

Interactive Effects of Elevated CO2 Concentration and Irrigation on Photosynthetic Parameters and Yield of Maize in Northeast China

Agricultural Biometeorology I

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Maize is one of the major cultivated crops of China, having a central role in ensuring the food security of the country. There has been a significant increase in studies of maize under interactive effects of elevated CO2 concentration ([CO2]) and other factors, yet the interactive effects of elevated [CO2] and increasing precipitation on maize has remained unclear. In this study, a manipulative experiment in Jinzhou, Liaoning province, Northeast China was performed so as to obtain reliable results concerning the later effects. The Open Top Chambers (OTCs) experiment was designed to control contrasting [CO2] i.e., 390, 450 and 550 μmol•mol-1, and the experiment with 15% increasing precipitation levels was also set based on the average monthly precipitation of 5-9 month from 1981 to 2010 and controlled by irrigation. Thus, six treatments, i.e. C550W+15%, C550W0, C450W+15%, C450W0, C390W+15% and C390W0 were included in this study. The results showed that the irrigation under elevated [CO2] levels increased the leaf net photosynthetic rate (Pn) and intercellular CO2 concentration (Ci) of maize. Similarly, the stomatal conductance (Gs) and transpiration rate (Tr) decreased with elevated [CO2], but irrigation have a positive effect on increased of them at each [CO2] level, resulting in the water use efficiency (WUE) higher in natural precipitation treatment than irrigation treatment at elevated [CO2] levels. Irradiance-response parameters, e.g., maximum net photosynthetic rate (Pnmax) and light saturation points (LSP) were increased under elevated [CO2] and irrigation, and dark respiration (Rd) was increased as well. The growth characteristics, e.g., plant height, leaf area and aboveground biomass were enhanced, resulting in an improved of yield and ear characteristics except axle diameter. The study concluded by reporting that, future elevated [CO2] may favor to maize when coupled with increasing amount of precipitation in Northeast China.

9B.4

PREDICTION OF RICE YIELD WITH DSSAT CROP SIMULATION MODEL AND MULTIPLE LINEAR REGRESSION ANALYSIS

Agricultural Biometeorology I

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Rice is one of the most important food crop of India in term of area, production and consumer preference. West Bengal is one of the leading states of India which is known as bowl of rice, as it cultivate and produce a major portion of rice of the whole produce from 90% of its agricultural field. Weather variability has a significant impact on crop growth and development. Timely and accurate crop yield forecasts are essential for crop production, marketing, storage and transportation, decision making and managing the risk associated with these activities. Weather variable includes maximum and minimum air temperature, total solar radiation, relative humidity (morning and afternoon) and total rainfall. In this study two different approach CERES-Rice model and Multiple Linear Regressions analysis were used for predicting rice yield for West Medinipur district of West Benagal, India. DSSAT CERES-Rice model was used to simulate the seasonal yield with long term weather data and to establish the relationship between weather variables and crop yield and forecast rice yield (1983-2010). Statistical technique includes dependent variable namely yield data of a crop and independent variable namely daily weather data, arranged weekly from sowing to maturity and time (year) as technology trend. The relation between weather parameters and crop yield was determined by using statistical tool like correlation and linear regression analysis. The results of the study shows that the average relative root mean square error computed for the year 2011 and 2012 by regression analysis were 131.5 and 108.4 respectively. The Mean Absolute Error 11.7 & 9.47 for same duration.

9B.5

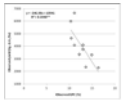
Durum wheat yield and protein content responses to meteorological conditions: improvement of Ceres-Wheat routine with a simplified forecasting index for early assessment

Agricultural Biometeorology I

Simone Orlandini, University of Florence, Florence, Italy; A. Dalla Marta, F. Orlando, F. Guasconi, M. Mancini and A. Baldi

Durum wheat yield and protein content responses to meteorological conditions: improvement of Ceres-Wheat routine with a simplified forecasting index for early assessment. Orlandini S. a, c, Dalla Marta A. a, Baldi A. a, Orlando F. b, Guasconi F. a, Mancini M. a, c a Department of Agrifood Production and Environmental Sciences, University of Florence, Piazzale delle Cascine 18 – 50144 Florence, Italy simone.orlandini@unifi.it b Department of Agricultural and Environmental Sciences, Production, Landscape, Agroenergy – CASSANDRA Lab., University of Milan, Via Celoria 2 – 20133 Milan, Italy francesca.orlando@unimi.it c Climate and Sustainability Foundation Via Caproni 8 –

50144 Florence, Italy m.mancini@climaesostenibilita.it ////// Durum wheat (Triticum turgidum L. var. durum) grain protein content (GPC) is a key factor in determining the technological and rheological properties of flour for making high quality pasta. For this reason, a premium price is commonly paid to the farmer for wheat with a high grain protein content. The sensitiveness of durum wheat to weather conditions and the uncertainty of the Mediterranean environment affect both harvest quantity and quality, making it difficult to warrant the standard quality. Moreover, the inverse relation between GPC with grain yield, which are both important agronomic targets, makes the field management decision-making process even more complicated. In this context, an operational tool for durum wheat production estimation becomes necessary not only to forecast the final crop production, but also to better identify the driving climate variables in the specific productive area. Crop models are recognized to be useful tools able to capture and describe the interactions between environmental variables and crops, helpful for the interpretation and extrapolation of experimental results and the identification of the weather driving variables. Unfortunately, few studies on durum wheat modeling were carried out, especially in the Mediterranean and particularly for GPC simulation, therefore the modeling of the durum wheat responsiveness needs further investigations. In most wheat simulation models (CERES-Wheat, SWHEAT) the GPC is determined by the soil N availability and the plant N demand, the latter being positively related to the leaf area expansion, and thus to the leaf biomass able to store N. The models assume the "source-limited" nature of the grain protein deposition, and the LAI is the main descriptor of the source of N available for the translocation. However, while wheat models show high performances in the yield assessment, poor results are obtained for GPC estimation, also because the majority of models have been developed for soft wheat, where GPC has much less importance. Therefore, current algorithms must be revisited, and GPC modeling is still a challenge. Our goals were: to evaluate the suitability of a mechanistic and deterministic model (CERES-Wheat) to identify the forcing and status variables affecting the GPC of durum wheat; to improve the model performance, through the assessment of a new routine for GPC simulation; to develop and test a simplified forecasting index (SFI). The research was carried out in Val d'Orcia (Lat. 43.03 N, Long. 1.66 E), a rural area of Tuscany (Central Italy). Meteorological, productive and phenological data for cv. Claudio were used for calibration and validation of CERES-Wheat (DSSAT-CSM 4) (years 1998-2011), and for a long-term analysis (LTA) (1955-2011). The model performance was assessed by means of a correlation analysis between measured and simulated data. A new routine for GPC simulation during the LTA was developed: GPC = {(TN/NS*100)+ 0.5}*5.7. Where: 0.5 = additional factor due to the genetic difference between durum and soft; 5.7 = conversion factor for grain N to protein; TN = total N available for the translocation from aerial biomass into the grain; NS = grain nitrogen sink. In the long-term study, the fertilization was entered accordingly to the protocol most widespread in the study area: a total amount of N ranging from 95 to 200 kg/ha, split into one fertilization at sowing, and two applications during the crop cycle, at tillering and stem elongation stages, was adopted. Sowing and harvest dates were simulated automatically, within the period 10 Nov-30 Dec, when optimum soil conditions occur and at grain maturity, respectively. Monthly meteorological indices were computed for the main crop development stages: March (tillering), April (stem elongation, booting and ear emergence) and May (anthesis and grain filling). To identify the main environmental and crop variables affecting production, a linear regression analysis between the harvest components (yield and GPC), the meteorological indices, and the maximum LAI simulated by the model at the end of growth stage was performed. Furthermore, a multiple linear regression analysis was performed (with SPSS.18 software) to develop the simplified index for harvest forecast (SFI). Field measurements were carried out during two growing seasons (2010 and 2011) and the data collected (LAI, plants density, yield, GPC, phenology) were used to validate the SFI and the CERES performance in determining the variables affecting the GPC. A highly significant correlation (P≤0.001) was always found between CERES estimates and observed yield data. A significant correlation (P ≤ 0.01) was found between the observed and simulated GPC with both routines; however the new one was able to improve the simulation enhancing the values of all statistical indicators. The LTA highlighted that rainfall during the tillering stage affects final GPC and confirmed the well established inverse relationship between yield and GPC: rainfall during the tillering promotes yield, while drought and warm conditions during the grain-filling promote GPC. The results of LTA also confirmed the positive role of LAI at heading stage on harvest quantity and quality. Rainfall distribution at tillering and LAI at heading stage were then included in the SFI as a main status and forcing variables. SFI was validated in two conditions; the first validation was made over 56 years and SFI failed in the prediction of GPC variability (no correspondence between simulated and forecasted data). The second validation was made using data observed during 2009-2010 and 2010-2011 growing seasons. Therefore, fields were distinguished on the base of LAI value at the heading stage in intermediate (1≤LAI≤2) and extreme (2<lai<1). the="the" gpc="GPC" sfi="SFI" grain="grain" gpc,="GPC," which="which" content="content" that="that" not="not" deposition,="deposition," yield="yield" valid="valid" on="On" –="–" 1="1" variability="variability"



9B.6

Adaptation to climate change of wheat growing in South Australia: Analysis of management and breeding strategies

Agricultural Biometeorology I
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Evaluation of adaptive management options is very crucial for successfully dealing with negative climate change impacts. Research objectives of this study were (1) to determine the proper N application rate for current practice, (2) to select a range of synthetic wheat (Triticum aestivum L.) cultivars to expand the existing wheat cultivar pool for adaptation purpose, (3) to quantify the potential impacts of climate change on wheat grain yield and (4) to evaluate the effectiveness of three common management options such as early sowing, changing N application rate and use of different wheat cultivars derived from (2) and given in the APSIM-Wheat model package in dealing with the projected negative impacts for Keith, South Australia. The APSIM-Wheat model was used to achieve these objectives. It was found that 75 kg ha-1 N application at sowing for current situation is appropriate for the study location. This provided a non-limiting N supply condition for climate change impact and adaptation evaluation. Negative impacts of climate change on wheat grain yield were projected under both high (-15%) and low (-10%) plant available water capacity conditions. Neither changes in N application level alone nor in wheat cultivar alone nor their interactive effects could offset the negative climate change impact. It was found that early sowing is an effective adaptation strategy when initial soil water was reset at 25 mm at sowing but this may be difficult to realise given that a drier environment was projected, which will limit the opportunity for early sowing.

9B.7

Assessment of water satisfaction index for maize in the Free State Province of South Africa

Agricultural Biometeorology I

9C.1

ISB Students and New Professionals Group Update & Workshop Experience

Thermal Environment and Human Health IV

Jennifer K. Vanos, Texas Tech University, Lubbock, TX; D. M. Hondula and S. N. Gosling

This presentation will share with ISB members what the Students and New Professionals group has been up to over the last 3 years since the meeting in Auckland. Topics to present include the publication of the Biometeorology Glossary, the Tromp Funded Proposal, and the corresponding workshop. We will highlight how SNP members are growing and coming together to collaborate internationally, and thank the ISB for the generous Tromp Funding. We hope to garner increased attention to the ISB SNP group, and help it continue to grow.

9C.2

Quantification of the benefit of global climate change policy for avoiding some of the effect of climate change on heat-related mortality

Thermal Environment and Human Health IV

Simon N. Gosling, University of Nottingham, Nottingham, United Kingdom

In order to avoid 'dangerous' climate change, countries participating in United Nations Framework Convention on Climate Change (UNFCCC) international negotiations have agreed that global-mean warming should be limited to 2°C. Information on the potential impacts that climate change could have for different amounts of global-mean warming is therefore of considerable importance to policy-makers. Furthermore, the impacts associated with different climate change mitigation policies relative to "business-as-usual" scenarios can be used to better-inform the decision-making process. This presentation explores, for six cities (Boston, Budapest, Dallas, Lisbon, London and Sydney), what the heat-related mortality rate attributable to climate change could be under a business as usual scenario, as well as under a set of defined climate change mitigation policy scenarios, including an aggressive mitigation scenario that gives a 50% chance of avoiding a 2°C global-mean temperature rise. Climate change projections from 21 climate models are applied, to provide a more rigorous consideration of climate change uncertainty than ever before.

9C.3

Wintertime associations between spatiotemporally-relative synoptic weather types and lagged cardiovascular mortality across various US climate regions

Thermal Environment and Human Health IV

Cameron C. Lee, Kent State University, Kent, OH

Previous research has shown that a cold environment can adversely impact human health, especially the cardiovascular system. Despite this link, there has been a relative dearth of research into the relationship between wintertime weather variability and cardiovascular-related mortality. Utilizing a newly developed gridded weather typing classification (GWTC), this research systematically examines this relationship across 19 US cities, spanning several different climate zones. Results indicate that a geographically- and seasonally-relative dry and cool (DC) surface weather type relates to significantly increased wintertime cardiovascular-related mortality at all locations, and is associated with a disproportionate number of spike days in cardiovascular-related deaths in each city. Oppositely, a humid and warm (HW) weather type leads to decreases in mortality. Both of these effects peak at 2-6 days after the occurrence of the weather type – reaching magnitudes of +6.6% (DC) to -5.0% (HW) in terms of anomalous mortality – though significant effects can last upwards of 7 to 10 days in some locations. These results are largely consistent across cities in varying climate regions (including Miami, Los Angeles, San Francisco, and Chicago, among others), indicating the relationship between cardiovascular-related mortality and spatiotemporally-relative conditions is important, possibly due to the acclimatization of a city's population to its own climate.

9C.4

Heat-Mortality Demographic Sensitivities in Los Angeles County and Potential Climate Change Impacts

Thermal Environment and Human Health IV

Jennifer K. Vanos, Texas Tech University, Lubbock, TX; S. C. Sheridan, A. J. Kalkstein, L. Kalkstein and D. Eisenman

The city of Los Angeles (LA), with 3.858 million residents, currently experiences a high number of hot days each year with a highly variable summer climate. The region is also expected to undergo a significant increase in heat events over the 21st century. Such events have been correlated with reduced air quality and elevated rates of human mortality and morbidity. Climate change is predicted to alter the frequency and intensity of excessively hot days, yet Los Angeles-specific modeled projections of extreme heat events has been minimally studied. Additionally, demographic changes are expected to dramatically increase the number of people vulnerable to these events, in turn affecting public health. A key question concerns vulnerable populations with respect to age and ethnicity in LA, and how various subcategories of the population respond to synoptic-scale extreme heat events, both now and in the future. In the state of California, the 'oppressive' air masses (found to result in excess mortality and morbidity) are dry tropical (DT) and moist tropical (MT).

Accordingly, the first objective of this project is to evaluate the impact of the most oppressive synoptic air masses (DT and MT+) upon six categories of standardized mortality data in LA, and further develop historical mortality algorithms for those particular air masses. The framework for analyzing heat events is rooted in synoptic climatology using the Spatial Synoptic Classification (SSC) system, which classifies each day into one of seven weather types based on surface conditions. The following demographic designations are used: all cause total mortality, all cause elderly (65 and older) mortality, all cause male and female mortality, all cause non-Hispanic white, Hispanic, and black mortality. Moreover, these are divided into three racial and gender categories within the all-cause 65 and older population group.

The second objective of this study is to estimate future mortality using two climate models (Community Climate System Model 3 (CCSM3) and the Coupled Global Climate Model, (CGCM3)), and three scenarios (A1FI ("higher emissions"), A2 ("mid-high emissions"), and B1 ("lower emissions")). This is completed for two decades: the 2050s and the 2090s. The demographic groups outlined above are used in the future mortality estimates through application of the predictive mortality algorithms developed in the initial historical modeling.

Results show that there is an approximately 5 percent average increase in summer mortality among all demographic groups in LA during days that oppressive air masses are present. This number varies considerably when we subdivide by population category or by consecutive days of oppressive

air masses. For example, for the entire population, after three consecutive oppressive air mass days, the average increase in mortality increases to 12 percent. Blacks, Hispanics, and females appear to be more vulnerable to heat-related death than non-Hispanic white men. The overall findings presented will provide better understanding of the specific city-level subpopulation responses to hot weather in LA, and highlight those groups with vulnerabilities to extreme heat. As of the development of this abstract, we have not yet determined the climate change modeled impacts upon mortality, which will also be presented.

With the expected improved observations and understanding, we can support operational meteorologists and other stakeholders (e.g., LA public health) in their warnings, leading to more targeted adaptation and intervention strategies now, and for projected climate change and city-specific growth. Future work is also planned to address the response at the neighborhood-level, due to vulnerabilities and demographic compositions, to oppressive weather. Further, we plan to examine heat island reduction strategies on lessening frequency of the offensive air masses and their impact on mortality, and involve stakeholder collaboration, intervention, and improving disaster resilience from heat/mortality.

9C.5

Heat stroke information in Japan

Thermal Environment and Human Health IV
Michihiko Tonouchi, Japan Meteorological Business Support Center, Tokyo, Japan; M. Ono

Heat stroke patients, caused by hot environment, has been increasing in these 10 years and 'heat stroke' becomes the one of big issues in Japanese summer. In order to inform heat stroke risks to the public for preventing heat strokes, Ministry of the Environment manages heat stroke information web site from May to October. At the site, 1 hourly actual WBGT value and WBGT forecast for 840 towns (2days forecast in 3 hourly interval) are provided and 1.14 million hits were recorded in 2013 summer. Additionally Fire and Disaster Management Agency and National Institute for Environmental Studies report daily number of heat stroke patients (whole Japan and big cities) once a week, and Ministry of Health, Labour and Welfare provides the number of heat stroke patients in previous day based on a prompt report from emergency hospitals.

9C.6

Multi scenario urban climate projection for Tokyo and Osaka, Japan: An application of dynamical downscaling and urban planning

Thermal Environment and Human Health IV
Asuka Suzuki-Parker, University of Tsukuba, Tsukuba, Ibaraki, Japan; H. Kusaka

Tokyo and Osaka are the two largest cities in Japan. With increasing heat-island effect and global warming, along with rapid aging of the population, heat-induced health impact is becoming a major social problem in these cities.

In this study, heat-related health impact indices are projected for the next 80 years using dynamical downscaling (DDS) approach, whereby outputs of coarse-resolution global climate model (GCM) are used as initial and boundary condition for a high-resolution regional climate model. DDS is an effective technique to obtain fine-scale climate information. With urban canopy dynamics implemented, regional climate models allows for proper assessment of urban effect. Projection is made for multiple future decades (namely 2030's, 2050's, 2070's, and 2090's) with multiple GCM's (MIROC, CSIRO, and MRI) to account for projection uncertainties arising from each of them.

Results show that by 2090's, temperature is projected to increase by ~2.5 degrees for Tokyo and Osaka. Yet there exists a considerable uncertainty and sub-decadal variation in the projection. Uncertainty ranges (by different GCM) grow from ~0.5 degrees in 2030's to ~1.5 degrees in 2090's, and are larger for Osaka than for Tokyo. The number of extremely-hot days (days with maximum daily temperature exceeding 35 degree Celsius) is projected to double for Osaka, and increase by four-times more for Tokyo. Based on WBGT, which has been adopted as an official heat-stroke risk index by the Japanese authorities, number of danger-level days (daily maximum WBGT exceeding 31 degree Celsius) are also calculated from the projection. This figure is projected to increase from almost none in the 2000's to more than half of the days in August for Tokyo, and to more than 20 days for Osaka.

In addition, impact of metropolitan-scale urban planning scenarios is evaluated in terms of the potential for urban heat mitigation. We assume three future urban scenarios for Tokyo; status-quo (urban structure remain the same), spread city (population and built-up area spread to suburban areas), and compact city (population and high-rise buildings concentrated in central Tokyo). Additional DDS experiments are conducted with each of the urban scenarios, this time with single GCM (namely MIROC5) and for a single decade (2050's).

Evaluation based on WBGT revealed that urban scenario have relatively small impact (~0.2 degree Celsius) compared to the global warming signal (~2 degree Celsius). However, urban scenarios have statistically significant impact on the local climate. Compared to status-quo scenario, compact city scenario increases WBGT in central Tokyo and reduces in suburban area. Opposite is shown for compact city scenario, with a WBGT reduction in central Tokyo and an increase in suburban areas. However there are some parts in suburban area that showed a decrease in WBGT under compact scenario. This decrease is associated with a substantial reduction in wet-bulb temperature. This result indicates that urbanization generally increases WBGT but may cause reduction depending on moisture response.

9C.7

Evaluation of the Effectiveness of National Weather Service Heat Forecasts in North Carolina

Thermal Environment and Human Health IV
Chris Fuhrmann, Mississippi State University, Mississippi State, MS; C. E. Konrad II and M. Kovach

Extreme heat is the leading cause of weather-related mortality in the U.S. As many as 700 people die each year as a direct result of the heat. Extreme heat also affects human health through heat stress and can exacerbate underlying medical conditions that lead to increased morbidity. The North Carolina Division of Emergency Management is currently developing a heat response plan with the goal of "providing timely, adequate, and sustainable heat emergency response and operational planning guidance, in coordination with state and federal agencies, to protect lives during a heat emergency." The plan is to be activated, or triggered, in phases when one or more National Weather Service (NWS) forecast offices issues a heat advisory, heat watch, or excessive heat warning. To evaluate the effectiveness of these triggering criteria, the relationships between the issuance of NWS heat products and the number of emergency department (ED) visits for heat-related illness were examined across each NWS forecast region in North Carolina for the period 2007 to 2012. Results reveal that, while 3 to 7 percent of all summer days during the six year period met heat advisory,

watch, or warning criteria, these days only accounted for 10 to 29 percent of all ED visits for heat-related illness. In other words, the majority of heat-related ED visits occurred on days that fell below the thresholds for an advisory, watch, or warning. While adjusting the triggering criteria would likely decrease the number of "unwarned" ED visits, doing so would also increase the number of heat products issued, which may desensitize the public to the seriousness of the heat hazard. Therefore, it is recommended that heat response plans incorporate awareness and prevention strategies that address the health effects of heat at temperatures below current NWS thresholds.

9C.8

Evaluating Climate Change Impacts on Human Mortality in Korean Cities: Challenges and Findings

Thermal Environment and Human Health IV

Laurence Kalkstein, Univ. of Miami, Miami, FL; S. C. Sheridan, K. R. Kim and J. S. Lee

The goal of this project is to determine the increase in excessive heat episodes (EHEs) that will occur in three major Korean cities using several climate change models and emissions scenarios. In addition, we will estimate the increase in heat-related mortality within one Korean city (Seoul) over at least two distinct decadal periods in the 21st century.

In consultation with the National Institute of Meteorological Research, we selected climate models and emissions scenarios to develop a set of climatologies for each of the cities, including new synoptic air mass calendars for each. We concentrated upon the frequency changes of those air masses that are historically associated with increased mortality during EHEs, specifically the dry tropical (DT) and moist tropical plus (MT+ and MT++) air masses. We compared the present numbers of offensive air mass days to those calculated using he scenarios for the two target decades in the 21st century. We compared summers for the 2000s (specifically the summers of 2006-2012) for each Korean city to see how they measured up to the numbers of health-debilitating air mass days under the various scenarios. We looked at consecutive day strings of such air masses (3 and 5 days) to see if they are becoming more frequent using the various scenarios.

We also estimated how heat-related mortality will be impacted under the various scenarios for Seoul. For example, we know that, at present, Seoul mortality increases by an average of 7 percent during DT and MT+ days. We also know, from previous collaborative research with NIMR, that the DT air mass occurs during an average summer on 7.3 percent of days in Seoul, and the MT+ average occurrence is 4.9 percent. Considering these frequencies, we have estimated that there have been over 1100 heat-related deaths during the 16 year period between 1991 to 2006, which averages to about 70 deaths per summer. Once we determined the frequency of these oppressive air masses under the various modeled scenarios, we then developed estimates of heat related mortality for Seoul under these scenarios.

We worked with two separate modeled climate scenarios, which we utilized for two different decades during the 21st century. The two scenarios, RCP 2.6 and RCP 8.5, were performed using the HadGEM2-AO global climate model, developed by the UK Met Office. The RCP 2.6 and 8.5 scenarios represent the most conservative and most aggressive scenarios in the suite, with the former assuming 420ppm of carbon dioxide by 2100 and the latter assuming 940ppm. Mean temperature increases over the next century for the RCP2.6 scenario are about 1/3 that forecast by the RCP8.5 scenario, and increases in precipitation are about half the magnitude in the former than in the latter.

An evaluation of the modeled air mass frequencies for three time periods, 2006-2012, 2041-2050, and 2091-2100, shows how the most oppressive air masses become more dominant, while the benign air masses become less prevalent. For the Busan RCP 2.6 scenarios for those time periods, it is clear that the DT, MT+, and MT++ air masses increase tremendously through the 21st century. DT, a very uncommon air mass in Busan, increases from less than 1 percent in the early 21st century to almost 3 percent by the end of the century. The increases for MT+ and MT++ are even more dramatic; the increase of MT++ is almost fortyfold in Busan, from 0.24 percent to 9.33 percent in the 2090s. For the RCP 8.5 scenario, we see an even more dramatic change in oppressive air mass frequency.

As expected, the estimated heat-related mortality in Seoul under the various scenarios shows sharp and dangerous increases. For the decade of the 2040s, the average number of excess deaths increases by about fivefold for both the RCP 2.6 and RCP 8.5 scenarios. Even more dramatic are the values for the highest years; about half the years exceed 100 deaths by a sizable margin under RCP 2.6, and almost half the years exceed 200 deaths under RCP 8.5, with two years having estimates of 400 deaths or more.

There is one very important caveat to these results. There is a significant issue involving model bias. There is no doubt that the model's inability to duplicate the observed air mass frequencies properly lessened the robustness of the results. We compared the historical modeled data over the same period (2006-2012) to the observed, with the goal of seeing how different the general frequencies in air mass type were. Some sizable differences were found. For example, the observed percent of summer days within the DT category for Daegu was 22.4; the modeled percent for the RCP 2.6 scenario was 1.31. This is clearly an unacceptable difference, particularly when we are depending upon frequencies of offensive air masses to estimate heat-related mortality. At this time, we are working with NIMR to greatly reduce the bias in the models and to redevelop the results. We are very confident that the new results will be available by the time we present this research at ICB.

10A.1

Biometeorological Distress and Influenza Epidemics on the East Coast of USA

Atmospheric Effects upon Human Health I

Dr. Pablo Fdez-Arroyabe, University of Cantabria, Santander, Cantabria, Spain

INTRODUCTION The study of the relationship between influenza and climate is a complex issue because of the number of aspects and factors that must be considered for the understanding of processes that link the disease and atmospheric patterns. Epidemic spreading responds mainly to the biological reasons of life spreading itself. In this sense, it is obvious that environmental factors play a key role on the process of triggering or neutralizing any epidemics but it is not an easy task to define the mechanisms through which a simple case can become or not a pandemic. The main aim of this research is to assess the applicability of the Meteorological Contrast Index (MCI) as a predictor of the influenza epidemics outbreaks on the East Coast of United States. This method has previously been tested in Spain for the epidemic period 2001-09 by Fdez-Arroyabe (2012). In this particular case, it was used as input for the estimation of the meteorological contrast a daily classification of circulation types adapted to the Iberian Peninsula by Rasilla et al. (2000).

The Spatial Synoptic Classification (SSC) has been used as input for the index calculation. The SSC was initially developed by Kalkstein et al. (1996) in the mid-1990s, and later on it was re-developed by Sheridan (2002). It is an automatic air mass-based classification method that it is daily applied for nearly 400 weather stations across the United States, Canada and some areas of Europe.

DATA SOURCES AND METHODOLOGY Influenza data have been obtained from the reports generated by World Health Organization (WHO) and the National Respiratory and Enteric Virus Surveillance System Collaborating Laboratories (NREVS). Isolated influenza viruses cases by U.S. Health Regions are registered for each epidemic week. Epidemic periods from 2001-02 to 2006-07 have been studied in four U.S. East Health Regions. For each region, weekly epidemic information related to the total number of positive cases of influenza are registered considering types A(H1), A(H3), A without subtyping performed and B type. The ratio per one thousand between positive cases in relation to the total number of tested cases has been estimated for each health region. From a meteorological point of view, SSC weather types, Sheridan (2002) have been used. This information is available at http://sheridan.geog.kent.edu/ssc.html where a large list of results can be obtained for numerous locations. The four selected weather stations are located in Boston, MA (code BOS); New York, NY (code JFK); Philadelphia, PA (code PHI); and Atlanta, GA (code ATL). Daily weather types corresponding to seven categories (DP) Dry Polar; (DM) Dry Moderate; (DT) Dry Tropical; (MM) Moisture Moderate; (MP) Moist Polar; (MT) Moist Tropical and (T) Transitional have been used as inputs in the model estimations for the study period 2001-07.

The index is based on three parameters which express atmospheric contrast at a synoptic level. In order to calculate the parameters, it has to be previously defined an array of contrast in which transitions among defined weather types, are assigned a numeric value that represents the physiological impact of meteorological change in terms of biometeorological stress.

RESULTS AND CONCLUSIONS This study confirms the idea of biometeorological distress as a trigger of the outbreaks in the influenza epidemics has produced interesting results. The impact varies among the different regions and epidemic years of the study period.

In general terms, the percentage of confirmed cases of influenza was higher in the epidemic periods 2003-04 and 2005-06, especially in the sanitary region of Philadelphia. Moreover, there are three periods, from 2001 to 2004, in which there is a clear delay of virus activity in the area of Boston with more than one peak in the disease evolution through time. Apart from these incidences, the evolution of influenza curves is relatively synchronic in the four study areas.

In the region with the highest percentage of influenza, Philadelphia zone, the biometeorological distress becomes a relevant factor in relation to the spreading of the disease. This is something that also happens in other regions but it cannot be defined a statistical model to express the influenza relation to biometeorological distress. Because maximum values of the meteorological contrast index vary from 35 in the region of Boston to 24 in then Atlanta zone, biometeorological impact must be considered a relative concept that makes sense in the specific context in which influenza epidemic takes place. Moreover, it is important to take into account microbiological issues such as the type of viruses that are registered during each epidemic season and the bias that the spatial variability of introduces in the analysis.

10A.2

Cold Forecasting and Evaluation in Shanghai

Atmospheric Effects upon Human Health I
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In this study, the effect of weather on common cold was investigated in Shanghai. Based on the relationship between meteorological factors and cold, cold forecast products were developed and the forecast services were supplied to some pilot schools, hospitals and vulnerable people for the first time. A one year evaluations study of cold forecast services was conducted in 10 kindergartens, the results of the survey showed that cold forecast was benefit to public health, and may reduce the family health care costs.

The effect of weather on common cold: People of all ages are affected by the common cold, children, the elderly are the most susceptible. Common cold are caused by viruses, weather is an indirect cause of the cold as well. We investigated the impact of meteorological factors on daily outpatients for common cold with medical insurance in Shanghai during 2008-2010 using Generalized Additive Model (GAM). Natural cubic spline smoothing function was used to control the seasonality and the long-term trend, and the dummy variables were used to adjust weekday, holidays and medical insurance policy effects. We found a non-linear negative relationship between cold outpatients and temperature, and a linear positive relationship between cold outpatients and relative humidity. Cold outpatients increase as the temperature decrease at all age groups, however, adults were more resilient to low temperature, e.g. children (ages: 0-14) were prone to catch colds at 10.9℃ while adults (ages: 15-64) and the old (ages: 65+) were more sensitive at 6.5℃ to 6.8℃. Interestingly, adult outpatients for cold increased in the summer season, the reason may be the lower temperature in the office and public traffic facilities caused by central air condition.

Health forecast service: Shanghai Meteorological Service has developed cold forecast product based on the scientific research results to help people take care of their health. Cold risk forecast and relevant prevention measures has be given to some kindergartens, community hospitals and voluntary participants in Shanghai through mobile phone message, email, post and brochure, when the poor weather conditions are forecast. The community hospitals and kindergartens taking part in the service will display cold forecast messages on electric screens and on their websites, it can help patients and students' parents to mitigate cold risks by avoiding or decreasing expecting exposure to deteriorated weather.

Evaluation of health forecast: An intervention study of health forecast evaluation was conducted in 10 kindergartens in Shanghai for a year, the aim of the intervention trial was to assess the effect of the service and its ability to prevent cold. More than 800 children in five kindergartens were randomly assigned into the intervention group, and the approximate number of children in another five kindergartens were assigned into the control group without cold forecasting service. Parents and teachers in the intervened kindergartens were informed by sending cold risk forecast and relevant prevention measures through mobile phone message and email. At the same time, an education corner in each class was set, where lovely weather symbols and popular cartoon characters symbolizing alert levels were used. Seminars were also held to help them better understand the forecast service. At the beginning of the intervention study, a baseline questionnaire was surveyed which include age, gender, height, weight, family general status, medical history and children's quality of life. In the process of research, kindergarten teachers in both groups were asked to record sickness absence of children from school caused by cold, it can help us evaluate the effect of the service objectively. After a year of service, a satisfaction questionnaire was surveyed to measure parents' satisfaction with cold forecast service. Over the half of the respondents considered cold forecast accurate and may reduce the family health care costs, 65% of the respondents satisfied with the cold forecast service. Average number of cold attack for Children in Intervention group was 10% lower than that in the control group, the results of evaluation showed that cold forecast has a positive effect on public health.

10A.3

Comparing Weather-Influenza Relationships in Four Cities across the Southwest United States

Atmospheric Effects upon Human Health I
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Predicting cases of influenza in advance remains a challenging problem for scientists across numerous disciplines. While there is increasing evidence that cool, dry air acts to exacerbate the spread of the disease in laboratory settings, few studies have examined such weather-influenza relationships among the human population. Here, winter season hospital admissions are examined for four cities in the Southwest United States to determine if specific climatic conditions are associated with elevated numbers of influenza-related hospital admissions. The results suggest that passages of cool, dry air masses are often followed by increases in hospital admissions, although the relationships vary somewhat by city. A closer examination of specific meteorological variables reveals there is the potential to create a predictive model which can possibly be used to forecast influenza-related hospital admissions in advance.

10A.4

Impacts of climate variability on respiratory morbidity

Atmospheric Effects upon Human Health I
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To assess the effects of air pollution levels on respiratory morbidity among children from 2005 and 2008. Data were obtained from daily visits for respiratory diseases for children in health units in the Unified He- alth System (SUS) in the municipality of Campo Grande, MS, Brazil. Daily levels of ozone concentration were obtained from the Department of Physics, UFMS. Daily measurements of temperature and relative humidity were provided by the Agricultural Research Corporation-Embrapa Gado de Corte-MS. To assess the relationship between respiratory diseases and ozone concentration were carried out descriptive analysis of quantitative variables described by means of central tendency (mean, median) and dispersion (standard deviation) and coefficient of variation (CV) and later via modeling Generalized Linear Models (GLM) using the model of multiple Poisson regression. The results suggest that the surface ozone concentration promotes adverse effects on children's health even when pollutant levels below what is required by law. Key words: Air pollution, Child health (public health), Respiratory diseases.

10A.5

Current and Future Impacts of Climate Change on Asthma Incidence in Kenya

Atmospheric Effects upon Human Health I
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The linkage between climate change, air quality and human respiratory health was examined in four counties in Kenya. Daily weather observations and satellite air quality measurement for ten years (2004-2013) were used. Daily two-year (2011-2013) hospital admissions records of asthma were used as the predictand. Based on the geoclimatic conditions, Nairobi, Nyeri, Mombasa and Garissa counties were classified as urban, rural, coastal and arid respectively.

A generalized linear model was used to study the relationship between current, multi-day lagged O3, PM2.5, geoclimatic condition, and asthma hospital admissions. This was only possible after adjusting for meteorological variables, nonlinear seasonal effects and day of week effects.From the analysis, it was concluded that all the four geoclimatic conditions (humid coastal, dry arid, moderate urban, and moderate rural), in conjunction with ambient air pollution levels, are associated with increased asthma hospital admissions.

Modeling analyses designed to assess the potential impacts of geoclimatic conditions and air quality on morbidity were then focused into future years. COSMO (Consortium for Small-scale Modeling) model was implemented for the slots 1991-2020 (current) and 2021-2050 (future). The ECHAM4 (European Centre Hamburg Model version 4) model outputs were downscaled to the appropriate resolution needed to characterize the geoclimatic conditions. The outputs were then interfaced with COSMO ART (Aerosols and Reactive Trace gases) Regional Chemistry Transport Model. As was expected, the preliminary agreement with geoclimatic classifications derived from observations was not strong because of the coarse resolution of the ECHAM4 results. The geoclimatic patterns revealed were compared with those based on meteorological observations for the four counties. Good agreement was obtained between the two data sources. This supports the use of the model when characterizing geoclimatic conditions based on future climate scenarios.

Projection results indicate elevated particulate matter concentrations which may lead to a greater likelihood of allergic respiratory disease, upon exposure. However, the limited availability of extensive epidemiological datasets presents lots of uncertainty in making much inference from such association. Areas presently considered rural will observe elevated levels of pollen and could result in new sensitization to asthmatics. This may be attributed to the anticipated changes in environment and land use or long distance transport. Changes in pollen production, allergenicity and geographic distribution of plants may be another attribution for the projected spatial patterns. It is therefore, projected that the nature of these changes may be region specific. In fact the trend in prevalence is decreasing in the coastal region in contrast to the rural and arid areas. On seasonal scale, allergy symptoms may be observed earlier and are likely to last longer. Greater severity from the new allergic cases is also anticipated due to elevated concentrations and subsequent exposure.

From the observed projections, it is concluded that air pollutant concentration and distribution and will be influenced by the anticipated changes to the climate. This in turn, will negatively affect the human respiratory health. Kenya, being one of the Least Developed Countries LDCs and located in Africa will be affected more severely because of its low adaptive capacity.

10A.6

No Association between Foehn and Daily Number of Emergency Calls or Calls to Medical Call Centers in Bavaria (Germany) – A Longitudinal Data Analysis from 2006 to 2009

Atmospheric Effects upon Human Health I
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Introduction: Foehn is a warm, dry, downslope wind descending the lee side of the Alps as a result of synoptic-scale, cross-barrier flow over the mountain range. The south foehn blows from northern Italy, where the air is warm, to the north of the Alps where the air is cooler. Usually foehn occurs only in the southern administrative districts of Bavaria (about up to Munich) while in the northern districts of Bavaria foehn occurs very rarely. A number of studies documented an association between foehn winds and different diseases. Some other studies could not verify such an association. The aim of our study was to find out whether foehn has an influence on the daily number of all emergency calls or calls to medical call centers in southern Bavaria during the period

from January 2006 to December 2009. The reasons for the different kind of calls were not considered.

Data and Methods: emergency calls to the twenty six rescue coordination centers in Bavaria as well as the data pool of all calls to medical call centers of the Association of Statutory Health Insurance Physicians in Bavaria. Information about foehn was provided by the Meteorological Observatory in Hohenpeißenberg (Germany Weather Service). The German Weather Service offered information on the type of foehn (foehn gaps, foehn in the upper atmosphere, foehn at ground level) and its intensity (light, moderate, unknown).

Expecting a large influence of several anthropogenic factors, different administrative variables like day of the week, public and school holidays, bridge days, begin/end of quarter and season were included in the analyses.

At first, we divided fifty six of the ninety six administrative districts of Bavaria into a northern and a southern part. For these regions we calculated the daily number of emergency calls and calls to medical call centers.

After a descriptive analysis, generalized linear models (GLMs), general additive models (GAM) and general additive mixed models (GAMM) were used to model the number of emergency calls and the number of calls to medical call centers. To account for possible over- or underdispersion Quasi-Poisson models were used. To consider the longitudinal structure of the data and the resulting problem of autocorrelation specific nonlinear time trends were integrated into the GAMs and GAMMs as well as auto regressive models of order 1 (AR1 processes) into the GAMMs. A p-value of lower than 0.05 was determined as statistically significant.

To verify the influence of foehn on the daily number of calls to medical and emergency call centers in Bavaria, Germany, we analyzed three different subdivided data sets:

- By sub set A, which includes only days with foehn, we compared the number of calls in the northern and southern regions of Bavaria.
- Sub set B includes only the southern region of Bavaria and was taken for a comparison between days with and without foehn.
- By our third approach, based on sub set C with data only from the southern region of Bavaria, we compared the differences between days with and without foehn at ground level (strongest kind of foehn).

The analyses were performed in R (version 2.8.0).

Results: Altogether, in northern and southern Bavaria 6.34 million calls (62.16 %) out of 10.21 million calls in the period under consideration were analyzed. Of those, 2.81 million (44.25 %) were emergency calls and 3.45 (55.75 %) were calls to medical call centers. For both types of calls there was a significant influence of the day of the week, public and school holidays, bridge days as well as the season independent of the model used (GLM, GAM, GAMM).

For no subdivided data set (A, B, C) the modelling of an AR1 process led to a better adaptation to the structure of the data and the remaining partial autocorrelation could not be reduced. For all subdivided data sets (A, B, C) the GAM had the lowest partial autocorrelation, was significantly better than the GLM and had a lower adjusted R^2 than the GAMM. Therefore, the presented results are based on the GAM.

For both data sets it could be shown that there is a statistically significant effect of the geographical region (sub set A) which is not attributed to foehn, because both days with foehn and without foehn had a statistically significant influence on the daily number of calls to emergency call centers and medical call centers. It could be assumed that other effects than foehn are responsible for these results.

The analyses of days with and without foehn in southern Bavaria (sub set B) and days with foehn at ground level in southern Bavaria (sub set C) did neither show a statistically significant result for emergency calls nor for calls to medical call centers (p-value for both data sets and both sub sets greater than 0.8).

Conclusion: The results indicate that foehn did not have an influence on the daily number of calls to medical or emergency call centers in general in Bavaria, Germany, in 2006 to 2009. These results are not in accordance to other studies which showed a correlation between foehn and different medical data sets. It might be that we would also get a relation if we specified the reasons for each call. The main disadvantage of both data set is, that we only have a first guess of the real diagnosis and not a final diagnosis of a physician. Therefore, further studies with more detailed information are necessary.

10A.7

Night Sky Brightness in Climatic Health Resorts – Association between outdoor artificial light at night and cancer in selected communities of Bavaria, Germany

Atmospheric Effects upon Human Health I

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Background: Light is essential for life on earth; but so is its absence. Life is adapted to natural cycles of light and darkness, and changing its rhythm has an impact on well-being. This is becoming increasingly clear as medical research has begun pointing toward adverse effects of artificial light at night on human health. Artificial light at night (ALAN) was brought into discussion as causation for cancer in 1987. Since then the relationship was investigated for different types of the disease: in women focus was on breast cancer while in men focus was on prostate cancer. Whereas the knowledge about the impact of indoor artificial light at night is fairly advanced and shift work was declared as carcinogenic by WHO in 2007, insights into the health-effects of outdoor artificial light in the sense of light pollution (e.g. outdoor illumination shining in through bedroom windows) is still in emergence.

Designation schemes exist that promote the preservation of areas with near-natural conditions both in terms of their lightscapes and in terms of health benefits. Currently, the designation schemes that aim to preserve darkness in areas that are fairly unaffected by artificial illumination, such as the International Dark-Sky Association's Dark Sky Parks and Dark Sky Reserves, do not consider aspects of human health. This is not surprising given the emergent nature of inquiry into the health effects of light pollution. Conversely, artificial light at night is not currently an aspect relevant to the designation of areas supporting human health, such as the German Spa Organisation's Climatic Health Resorts. These focus on the local climate's qualities in order to ensure the absence of adverse effects on human health and the occurrence of health-promoting effects. Climatic Health Resorts work with atmospheric conditions as remedies – and with the strict rhythm of day and night.

This contribution will investigate to which extend communities labelled as Climatic Health Resorts suffer from light pollution. Furthermore, it will be tested whether an association between the incidence of selected types of cancer and light pollution can be observed on community level.

Procedure: In Germany, 58 communities labelled as Climatic Health Resorts were identified. Non-classified communities of similar size according to their number of inhabitants (no. of inh. ± 2 %) were taken as controls (n = 4 566). Evaluation was conducted in two steps: First, night time brightness was determined for Climatic Health Resorts and for their non-classified counterparts by existing remote sensing data. Second, for Resorts in the German Federal State of Bavaria and their Bavarian matches data on cancer incidence was compiled by the Population Based Cancer Registry for 10 years (2002 to 2011).

The Night Sky Brightness of the Resorts and their non-classified counterparts was evaluated by two means:

• The new Visible Infrared Imaging Radiometer Suite (VIIRS) of the Soumi National Polar-orbiting Partnership (SNPP) for the year 2012 gives information about the upwards emitted and reflected light. Thus, it is reporting the light's place of origin in detail.

• Data of the "World Atlas of Artificial Night Sky Brightness" (WA: World Atlas) shows zenith artificial night sky brightness at sea level. Here, emitted light is combined with atmospheric conditions to model the skyglow luminance at zenith with the radiance calibrated DMSP-OLS data for the year 2001. Thereby, values do not reflect a measurement at a single point but can be influenced by surrounding light sources.

Results of both datasets show that Night Sky Brightness is smaller in Climatic Health Resorts on average than in non-classified communities.

For those communities situated in Bavaria data on cancer incidence was compiled by the Population Based Cancer Registry for 10 years (2002 to 2011). Altogether, 17 Climatic Health Resorts and their 386 non-classified counterparts were chosen. As outcome, breast cancer and ovarian cancer will be analysed for women and prostate cancer and testicular cancer for men, respectively. For the same period, incidences in intestine and lung cancer will be chosen as control for both sexes. Analysis of data is still in progress and results of cancer incidence and light will be handed in later.

Conclusion: As Climatic Health Resorts aim to offer atmospheric conditions with stressors absent or reduced compared to other/ normal / the majority of communities, next to a reduction of stressors like heat or air pollutants Climatic Health Resorts offer low levels of light pollution. Whether an association between Night Sky Brightness and cancer incidence can be observed or not is still open.

10A.8

Extremes in health-meteorology relationship, applied to cardiovascular diseases in Québec, Canada

Atmospheric Effects upon Human Health I

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Cardiovascular diseases (CVDs) are serious events which can lead to hospitalisation or death. More and more scientific publications examine how meteorological conditions can affect them. They usually focus on the mean statistics of the health issues (e.g. mean numbers or rates of hospitalisations and deaths). However, extreme values are also problematic and cause management issues in the public health network (e.g. hospital emergencies). It is therefore essential to consider studying the extremes with the appropriate statistical tools. As most parts of the world, the province of Québec has experienced an increase in mean temperatures over the last 30 years which is expected to continue for the next 60 years. This would bring fewer cold spells, particularly in southern Québec, while heat waves would become more frequent and would last longer. Consequences could be important on public health since temperature has a strong effect on cardiovascular diseases. It is therefore necessary to better understand their relationship to meteorological conditions (temperature, humidity, atmospheric pressure, precipitations, snow), in order to prevent or at least to reduce climatic changes consequences and to improve health care management. The aim of this study is to focus on establishing relationships with extreme health issues using appropriate statistical tools and then consider the case of CVDs in Québec as an application.

Extremes techniques are required to specifically study extremes series of the sanitary variables. Two approaches are employed to this purpose: extreme value theory (EVT) and quantile regression (QR). EVT has been seldom used in a public health context, while it is well exploited in finance and hydrology. First, two methods contribute to select extreme series to be modeled: threshold and block methods. Then, the selected extreme observations are fitted with an extreme distribution, including in particular Generalized Pareto, Generalized Extreme Value, Lognormal, Gamma or Exponential. This univariate modeling is a required step, since EVT has never been used in the health context, not to mention CVDs. Then, in order to establish relationships between CVDs peaks and meteorology, we use Generalized Additive Models (GAM). GAM is largely employed in usual health-weather studies. The flexibility and nonlinearity of GAM is very useful in the case of temperature for instance, as more people die due to CVDs in both very cold and very hot situations, but there is a comfort zone between the two, implying a "U" or "J" relationship.

The second approach is QR. Even though QR is well known in medicine, it has not been used to study extremes of sanitary variables in connection with weather. Whereas classical regression models study the conditional mean response, QR focuses on a specified conditional quantile. Extremes can be classified via high quantiles, e.g. observations greater than the 95th or 99th quantile can be considered extremes. Thus, there is no need to extract extreme observations, as with EVT. This is interesting since we are now able to detect different trends (if any). A meteorological variable can be non-significant in the 90th quantile although it could become so in the 99th quantile, or it can have a different effect. Furthermore, QR is combined to non-linear techniques for more flexibility.

The obtained results show that temperature, relative humidity, precipitation and snow have an impact on extreme events of hospitalisations and deaths, whereas atmospheric pressure does not. In particular, temperature is found to be significant in most extreme quantiles for both hospitalisations and deaths (QR case). It contributes a lot more to the explained deviance of the established models than usual analytical models (EVT case). Moreover, in the case of sanitary extremes, the shapes of the relationships are different from what they are in the mean case (non extreme). Note that the proposed procedure is valid for other chronic diseases and other regions.

10B.1

Impacts of climatic variables on pollinator abundance, flower blooming and yield of Apple in Kumaun, West Himalaya, Uttarakhand, India

Agricultural Biometeorology II

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Apple (*Malus domestica*, Family Rosaceae), an important cash crop, relies on insect pollination. Climatic variables (temperature, humidity and light intensity, etc.), impact on flowering and insect visitation activity of apple thereby influencing pollination. The activity of bees and other visitors varies throughout the flowering period. However, precise information on such impacts is meagerly available.

Towards understanding impacts of climatic variable on insect pollination and apple production, eight apple orchards in Ramgarh region of Kumaun in Indian west Himalaya were intensively investigated. The work plan included recording of phenological observations, pollinator density and diversity, and yield data as per the protocols developed under Global Pollination Project by FAO (2011). For the climatic variables (temperature, Humidity and light intensity) of same day was considered and for the production the number of fruit set, total yield per tree was recorded. Diverse insect visitations were recorded during the blooming period of apple that included honey bees, wild bees, wasps, hoverflies and other insects (i.e., butterflies, lady bird, flies and beetles).

It was revealing that the climatic variable affected the flowering phenology and the visitation rate of the insects/pollinator diversity and also impacted on the number of fruit setting and production. The increasing temperature (Maximum and Minimum) the number of open flowers ($p < 0.05$) increased along with the increased visits of other insects ($r = 0.199$; $p < 0.05$). Light intensity, however, showed positive response of the honey bees ($r = 0.246$; $p < 0.01$) and hoverflies ($r = 0.302$; $p < 0.01$). On the contrary, humidity exhibited negative relationship with the honey bees ($r = -0.272$; $p < 0.01$), hoverflies ($r = -0.335$; $p < 0.01$) and other insects ($r = -0.189$; $p < 0.05$). With the increasing number of open flowers the number of insects visitors diversity of honey bees ($r = 0.424$; $p < 0.01$), hoverflies ($r = 0.295$; $p < 0.01$) and other visitors ($r = 0.261$; $p < 0.01$) increased significantly. While considering yield data, number of fruits per tree showed significant positive relationship with the visit of honey bees ($r = 0.325$; $p < 0.01$) and hoverflies ($r = 0.421$; $p < 0.01$).

Therefore, the study concluded that the apple yield is sensitive to pollinator (insect visitor) density. This calls for adopting best practices for pollinator conservation and management so as to harness optimal yield of apple in the region.

10B.2

Historical trends in the risk of spring frost damages to fruit trees in Eastern Canada

Agricultural Biometeorology II

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As one of the consequences of the global warming, growing season has become longer with an earlier start for both annual and over-wintering crops in Canada. An earlier start of growing season implies that the phenological development of crops could have been advancing. It has been suspected that crops, especially the over-wintering perennial crops such as fruit trees, could become more vulnerable to spring frost damages. More speculations were stimulated by extreme events in recent years, such as spring frost damages to fruit trees in 2007 and 2012 in the United States and Eastern Canada, together with a potential increase of climate extremes in the projected future climate. However, historical trends in the risk of spring frost damages were seldom reported, given the rarity of major frost events and very limited phenological observations. In this study, phenological stages of apple trees, a major fruit crop in Eastern Canada, were estimated from historical daily temperature data through phenological models recently developed with laboratorial and field experiments. Using a homogenized historical daily temperature dataset, dates when the apple crops met their chilling requirement and forcing requirements to reach their phenological development stages of bud break (green tip), ½ inch green, tight cluster, first pink, full pink, first bloom and full bloom, were estimated for each year, respectively. A non-parametric trend analysis method was employed to estimate historical trends in these dates for the development stages of apple crops and the last spring occurrences of two critical low temperatures (-2.2°C and -3.9°C) that are corresponding to 10% and 90% kills to the buds at the later flowering stages after full pink. Results showed that all the dates became 8-10 days earlier throughout the past 110 years for all phenological stages from bud break to full bloom although a significant trend was not observed in the dates when the chilling requirement was met as widely as other phenological stages. Meanwhile, the last spring occurrences of the two critical low temperatures were also observed by approximately 11 and 15 days earlier. The risk of frost damages was estimated by the probability of a critical low temperature occurring at a phenological stage that could result in a 10% or 90% kill to the buds. Both significant positive and negative trends were found in the risk of a 10% kill at phenological stages ½ inch green, first pink and full pink but no significant trends were found in the risk of a 90% kill. Therefore, it was difficult to draw a conclusion whether the risk of spring frost damages became higher or lower to apple crops in Eastern Canada.

10C.1

Evaluation and adaptation of thermal stress due to climate change in traditional settlements in Taiwan

Urban Bioclimatology

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Climate change has a significant impact on human living environment, while the traditional settlement may suffer extreme thermal stress due to its specific building type and living behavior. This study selected Lutaoyang, which is the largest settlement in mountainous areas of Tainan County, for the investigation area. The microclimate parameters, such as air temperature, relative humidity, wind speed, and mean radiant temperature, are recorded during the survey. Meanwhile, the video recordings and questionnaires survey for residents are conducted simultaneously. The measured values were applied in the simulation of the micro-climate models and long-term thermal comfort performance were calculated based on both the past climate data (2002-2011) and projected climate data generated and morphed from the MICRO3.2-m GCM of the IPCC A1B scenarios (2080-2099).The results showed the banyan tree area providing good thermal comfort condition due to the shading. On the contrary, the courtyard (traditionally for the crops drying) surrounded by low rise building and consisted of artificial pavement contribute heat stress especially in summer noon. In the climate change simulations, the courtyard will became very hot and are not suitable for residents activities. These analytical results will shad light on the sustainability related to thermal environment in traditional settlements and develop adaptive measure towards sustainable development under the climate change challenges.

10C.2

Assessment of Localized and City-Specific Urban Heating in Four North-Eastern Cities Using Spatial Synoptic Classification

Urban Bioclimatology
Aaron W. Hardin, Texas Tech University, Lubbock, TX; J. K. Vanos

The urban heat island (UHI) is a well-documented phenomenon that occurs when temperatures within an urban area are greater than that of the surrounding rural area. This is due to increased sensible heat storage, anthropogenic heating, and many other factors. There have been many studies completed on understanding city-specific UHIs, yet there has been minimal research conducted on how different synoptic air masses modify the intensity of the localized UHI within the canopy layer. Increased temperatures in urban areas have been associated with a negative impact on human health by elevating personal mortality risk, exacerbating already harmful heat waves, and not allowing relief from daytime heat with higher overnight temperatures; hence, it is important to study the spatiotemporal variations in the surface UHI. For cities to manage the growing risks and vulnerability of such exposures, progress in understanding the spatial and temporal variations in the development of UHIs is critical.

The current study will use the comprehensive Spatial Synoptic Classification System (SSC) as a means to account for daily air mass type. The objectives of this project are first to study the development of the UHI, and differences in its intensity, under the seven synoptic air masses using data from more than 300 UrbaNet stations (NOAA and Earth Networks) in four northeastern cities: Philadelphia, New York, Boston, and Baltimore. Data from 2006 through 2013 during the months of May-September is used with each station collecting 27 meteorological variables at 5-min or 1-hour intervals, providing a very high temporal and spatial resolution for urban analysis. Second, we address the intra-city heterogeneous variation in UrbaNet's high frequency observations and account for local urban fabrics. This is important as temperatures across a city can vary by as many as 4°C due to different land cover types such as urban parks, asphalt, and white roofs. However, most UHI studies only use two stations to determine UHI intensity, which does not account for this variation in surface types. Inter-city comparisons will be made as well as comparisons between the cities themselves, to help understand localized UHIs. Understanding which regions of each city have the strongest warming potential can aid mitigation strategies in affected areas and help address urban risks and hazards to extreme heat. Further, the knowledge of which air mass type results in the most intense UHI can aid operational meteorologists and public health officials to issue targeted heat warnings when an oppressive air mass is forecasted to arrive.

10C.3

Characteristics of the neighbourhood and dwelling most strongly associated with the harmful health effects of heat in low-income areas

Urban Bioclimatology
Pierre Gosselin, INSPQ, Quebec, QC, Canada; D. Belanger, P. Valois and B. Abdous

Objective: To identify the characteristics of the dwelling and neighbourhood of residence, adjusted for health characteristics, of the people who feel more the harmful impacts of heat on their health, during summer, in the most disadvantaged neighbourhoods of the 9 largest cities in the province of Québec (Canada).

Methods: The study is a cross-sectional study by stratified sample. For each of the cities studied, the 2-step selection procedure produced representative samples. 3,485 people were interviewed in their residences, by means of a questionnaire. The data were weighted to ensure calibration of the survey frequencies on the theoretical frequencies (population). The analyses take into account these weights and the sampling plan.

Results: The prevalence of impacts was 46%; the prevalence of the impacts that led to a health professional being consulted was 12%. In both cases, six indicators were determinant, independent of age, namely dissatisfaction with the temperature inside the dwelling in summer, the perception that the neighbourhood of residence is polluted due to the density of urban traffic, as well as four indicators of state of health. The latter were chronic multimorbidity, a state of health perceived as poor or fair, daily or almost daily perceived stress, and being on long-term disability due to a disease or handicap.

Conclusion: The prevalence of heat-related impacts was very high in these neighbourhoods located in intra-urban heat islands. The few indicators that emerged from this study will help to identify, from existing or future population studies and basic spatial data, subgroups at high risk of suffering the harmful consequences of oppressive heat. This can lead to better targeted interventions by public authorities.

10C.4

Indoor Environments and Extreme Heat Sensitive Health Outcomes in New York City, NY

Urban Bioclimatology
Chris Uejio, Florida State University, Tallahassee, FL; J. D. Tamerius

Most extreme heat studies relate outdoor weather conditions to mortality and morbidity. However, many at-risk populations are exposed to extreme heat inside of buildings. In developed countries, people spend approximately 90% of their time indoors. Indoor temperature and humidity conditions widely vary across households despite equivalent outdoor conditions. Sealed buildings may magnify outdoor extreme heat exposure. The composition and configuration of the built environment, sociodemographic characteristics, and human actions and behaviors further alter outdoor/indoor linkages. A review of 96 papers found only a couple of studies that explicitly linked indoor heat exposure to human health (Anderson et al. 2012). We present an innovative observational study design to associate indoor conditions to extreme heat health outcomes. This pilot study directly measured indoor temperature and humidity of New York City, NY USA buildings where individuals receive emergency medical care. The study took place during August 2013. Objective morbidity information may be more reliable than self-reported health status and can provide the strongest evidence for developing extreme heat warnings.

10C.5

Spatial Variation of Comfort Level in Chennai Metropolitan Area under Present and Future Climate Scenarios

Urban Bioclimatology
Anushiya Jeganathan, Anna University, Chennai, Tamil Nadu, India; R. Andimuthu

Chennai is fourth largest metropolis in India and one of the fastest growing economic and Industrial growth centers in South Asia. The long term temporal changes and spatial distribution of comfort level in Chennai Metropolitan Area were studied and the influence of green cover on thermal comfort

also analyzed in this work. For long term changes past 60 years data was used. The results show there is an increasing trend of discomfort level in the city particularly in summer months. And there is an alarming and distressing fact that the discomfort level in winter season is increasing high. Spatial distribution of comfort level was mapped using GIS from the reading taken at predetermined sites. The comfort and dangerous zones were identified through mapping. The severe discomfort level was observed in central core city, which is distinguished for its commercial activities and dense residential buildings.In south Chennai, severe discomfort was recorded near Chennai's main dumping yard Perungudi landfill.Future comfort level are calculated using PRECIS output. Thus, the study urges city administration, policy makers and architects to take up effective mitigation and adaptation strategies in the city to make people more comfortable.

10C.6

The influence of facade properties on the canopy layer microclimate within city blocks

Urban Bioclimatology
Csilla V. Gal, Illinois Institute of Technology, Chicago, IL

The application of high albedo surfaces and highly reflective or 'cool' materials is often advocated as a means to mitigate urban heat island and to decrease indoor temperatures and thus to reduce cooling loads in warm weather. Besides the horizontal surfaces of roofs and roads, the application of reflective coatings is increasingly recommended for walls as well. In case of facades, the influence of surface reflectivity is shown to be greater for lightweight structures. The effect is most pronounced during daytime, under clear and calm conditions. The current paper investigates the role of facade albedo, heat transmission coefficient and fenestration ratio on the canopy layer microclimate though a numerical simulation study. To consider the interplay between built form and facade properties, the study takes four metropolitan urban block typologies from Budapest as models. The examination focuses on the airspace within these urban blocks. Considering that mean radiant temperature and air temperature govern human thermal comfort during clear and calm weather, the analysis is performed on the basis of these two parameters. The study utilizes ENVI-met for microclimate modeling and MATLAB for data analysis. The results indicate that among the three facade parameters albedo drives the canopy layer microclimate. Changes in facade albedo are found to be directly proportional with changes in air and radiant temperatures: higher values increased both air and radiant temperatures. The impact of fenestration ratio is primarily exerted though the albedo indirectly, as increasing fenestration ratio decreases the albedo of walls. The influence of heat transmission coefficient is found to be marginal.

10C.7

Analyses of Environmental Factors Affecting Change in Microclimate

Urban Bioclimatology
Naoshi Kakitsuba, Meijo University, Nagoya-shi, Aichi Prefecture, Japan

Prior to the present study, microclimates in the housing estate located east of Nagoya city, JAPAN had been consecutively observed for eight years. The results indicated that cool or hot spots appeared periodically on the specific locations. Considering such unfathomable observation, the present study was designed to analyze an underlying mechanism of microclimate formation. Ambient temperature (Ta), relative humidity, wind velocity (V), wind direction, solar irradiation and surface temperature of planimetric features in the vicinity of the location in the housing estate were observed in addition to observation to estimate effect of a difference in soil surface and solar irradiation on change in Ta. The results demonstrated that wind direction, wind temperature and surface temperature of planimetric features were the major contributory factors. For example, it was found that Ta was directly proportional to V (r=0.6) in summer whereas it was inversely proportional to V (r=0.86) in winter. The underlying mechanism of microclimate development was then discussed.

11A.1

Perspectives on Climate Mediated Health Effects of Air Pollution

Atmospheric Effects on Human Health II
Naresh Kumar, University of Miami, Miami, FL

The atmospheric physical and chemical processes can greatly alter the concentration, type and composition of air pollutants when they interact with weather conditions such as solar radiation, temperature, wind, and relative humidity. While the health effects of air pollution have subject to intensive research investigation for the past several decades, how climate especially extreme weather events mediates the effects of air pollution on health has received little attention. This research offers perspectives on interdisciplinary data and methodologies to conduct research on climate mediated health effects of air pollution, and future implications of such this type of research to face and manage the challenges of global warming. We will discuss an application of the effects of criteria pollutants (PM2.5, CO, O3, NO2, SO2 and Pb), mediated by extreme temperature and precipitation, on adverse birth outcomes, including premature delivery and low birth weight.

11A.2

The global monitoring of meteor-tropic effects: results for the region of North America and the Caribbean

Atmospheric Effects on Human Health II
Luis B. Lecha Estela, Centro de Estudios y Servicios Ambientales (CESAM) de Villa Clara, Santa Clara, Villa Clara, Cuba

At the end of the XX century Lecha and Delgado (1996) developed a method of biometeorological forecasts for Cuba, supported on the observed relationship between the occurrence of abrupt weather changes and the increase of the daily number of attentions by some chronic illnesses in the medical emergency services of the cities of Havana, Santa Clara and Sagua la Grande. The biometeorological forecasts are operational by means of the PronBiomet model, necessary to calculate the differences in 24 hours of the partial oxygen density of the air (PODA index), starting from the Global Forecast System objective forecasts of the atmospheric pressure at the sea level, the surface temperature and humidity of the air available on-line from (http://nomads.ncep.noaa.gov/cgi-bin/filter_gfs_hd.pl). The emission of biometeorological forecasts to the Cuban health institutions began experimentally in May of 2007 and their content underwent national validation during 3 years (2007-2009). Later on applications were made in Brazil (2010), Spain (2011) and Mexico (2012-2013), being obtained satisfactory results in all cases. The official service to the health institutions of Villa Clara province began in February of 2012 and so far, the 70 emitted forecasts have had acceptance inside the medical community and a good operational performance, given appropriately informative watches, warnings or alerts to the health system before the occurrence of significant meteor-tropic effects among the local population. However, the effectiveness has shown different success levels according to the illness: for the increases of bronchial asthma crises (97%), in the hypertensive crises (88%), with the brain-vascular illnesses (85%), the migraines (82%) and they were acceptable in the case of the cardiovascular diseases (75%). That is to say, with 3 successes every 4 emitted forecasts. The practical implementation of

the service from the medical counterpart allowed the design and implementation of new procedures for the surveillance and treatment of the meteor-pathological reactions that occurs in the population, associated to abrupt weather changes or to the presence of other adverse environmental conditions. The procedures of surveillance and treatment of the arterial hypertension and the bronchial asthma attentions at Emergencies are already working, and they are in development new procedures for the attentions of medical urgencies due to brain-vascular and cardiovascular diseases. From the year 2008 the application of the model PronBiomet was extended to the regions of North America and the Caribbean, South America, Europe and oriental Asia, as well as personalized applications were programmed for isolated countries as Australia, New Zealand, Spain and Mexico, besides Cuba that also has a high resolution version of the model. It permited to develop the daily & global monitoring of the more significant meteor-tropic effects, using in all the cases the normalized scale of the PODA index like the main reference biometeorological indicator for analysis and comparisons among regions and populations. The monitoring of meteor-tropic effects is expressed in synoptic-statistical terms by means of the mean number of days with contrasting and very contrasting weather changes in boxes of 5 X 5 degrees of latitude and longitude, containing each one of them: 121 nodes of data obtained from the GFS database with a space resolution of 0.5 degree. The workspace for North America and the Caribbean extends from the 10°N up to 80°N and from the 40°W up to 120°W, with a total of 12,400 nodes with information of the atmospheric pressure reduced at the mean sea level, the surface temperature and humidity of the air, variables needed to calculate the partial oxygen density of the air and its differences in 24 hours (inter-daily) for each node of the region and every day during the period from January of 2008 until December of 2013. The results of the monitoring made for this geographical region indicate that it was happened a very remarkable increase of the biometeorological inter-daily contrasts during the last two years in a wide geographical area that extends from Alberta in Canada until the southern states of the USA. A clear regional difference exists in the spatial patterns of occurrence of inter-daily weather contrasts, corresponding to the increase of the PODA index (hyperoxia sensations) most of the extreme contrasts in the northern part of the area of more frequent contrasts; while in the southern portions of the area of maxima contrasts the decrease of the PODA index prevails (hypoxia sensations) such as the cause of occurrence of the more outstanding meteor-tropic effects. From the point of view of their genesis, the hyperoxia sensations are related with the influence of the polar air masses and the hypoxia sensations are in correspondence with the frequent formation of extratropicales cyclones, that coming from the Gulf of Mexico or near areas move through the southern and oriental states of the USA. The maximum nuclei of inter-daily weather contrasts are located and they displace, according to the season of the year, following the behavior of the main synoptic patterns, reaching in the quarter December-February their maximum decline to the south and in the summer (quarter June-August) their maximum northern decline. However in the tropical zone of the region and along the Pacific ocean coast, including most of the west coast of Mexico, the behavior and influence of the subtropical anticyclones and the presence of hurricanes and tropical waves determines the highest or smaller occurrence of inter-daily weather contrasts able to produce significant meteor-tropics effects. The increment of meteor-tropic impacts associated to intense winter storms on the USA and Canada during the winter 2013-2014 coincide with the remarkable increase of winter cyclones affecting Europe, especially Spain, France and UK. Also the presence of a "polar vortex" was observed in the half troposphere in the middle of the United States last winter 2013-2014. It favored the occurrence of significant biometeorological contrasts in the region. Such evidences may be early signals of a new global very meteor-tropic pattern of the general circulation of the atmosphere, that it would be consequence of the increasing unbalance of mass and energy through latitudes, derived from an increase, already physically perceptible, of the temperature of the whole climate system.

11A.3

ACOUSTIC CLIMATE OF SELECTED ROAD SECTORS IN POLAND AND ITS INFLUENCE ON QUALITY OF LIFE

Atmospheric Effects on Human Health II

Krzysztof Blazejczyk, Polish Academy of Sciences, Warszawa, Poland; J. Baranowski and A. Blazejczyk

Traffic noise is integral part of life in contemporary societies. Because of increasing number of cars and development of road network about 20% of population of Poland lives under great acoustic stress and its number increases from year to year. There are some regulations dealing with environmental noise in specific types of landscape and settlements. The paper will present the essential results of field research of acoustic climate observed in the surroundings of selected sectors of national roads in Poland. The noise levels were measured in different distance (up to 1 km) from state roads and highways. Daytime and night levels of noise were monitored. Several features of acoustic climate (equivalent noise level, its amplitude and frequency of overloaded noise) were compared with traffic characteristics. We have observed the greatest influence of road traffic within 200-300 m belt along studied roads. 500 m was defined as a distance of stressed acoustic climate. When considering propagation of noise we have found great influence of local environmental factors as relief, land cover and ground moisture. The research was supported by Polish National Centre for Research (NCN) grant No N N306 564940, “Multi criteria assessment of the influence of selected road corridors on natural environment and socio-economic development of surrounded areas”.

11A.4

Weather and Cardiovascular Diseases in Quebec Using Empirical Mode Decomposition

Atmospheric Effects on Human Health II

Pierre Masselot, Institut National de la Recherche Scientifique (INRS), Quebec, QC, Canada; F. Chebana, D. Belanger, B. Abdous, A. St-Hilaire and T. B. M. J. Ouarda

Climate change has an impact on human health with an increase in mortality associated to extreme meteorological events. Among the diseases influenced by climate change are cardiovascular diseases (CVD) which represent the second cause of mortality in Quebec. Therefore, the understanding and quantification of the influence of weather on CVD is an important issue for future years. The difficulty to quantify the influence of weather on health lies partly in the complexity of their cycles. Indeed, weather processes are often nonstationary, interdependent and can present several levels of influence which can make the true influence difficult to detect. To overcome such drawbacks, empirical mode decomposition (EMD) is performed on weather data series to obtain components called intrinsic mode functions (IMF). An IMF represents one mode of oscillation of the original series, e.g. annual variations of temperatures. They are basic oscillations allowing little changes in amplitude and frequency over the IMF. They are (quasi) stationary and orthogonal to each other. Moreover, the sum of all the obtained IMFs from a series is equal to this series, meaning that there is no loss of information. The methodology proposed here consists in using IMFs obtained from weather series as new covariates in regression models to explain health issues, applied to CVDs in Quebec (Canada). This approach allows to explain CVDs according to the different modes of variations of the weather, e.g. the influence of weekly variations alone. Since each weather series is decomposed in several IMFs (at least ten in our case), the whole number of new covariates increases quickly. The Lasso method is able to manage a large number of covariates to

shrink the regression model and keep only few covariates. This method allows to outline the most important IMFs on the triggering of CVDs. For instance, this method outlines the importance of annual variation of temperatures and long term trends of temperatures and precipitation on CVD deaths in Montreal. Furthermore, EMD also allows decomposing mortality and morbidity CVD series and separates their different scales of variations. Then, undesired variations, such as the weekend effect on hospitalizations, can be removed. Moreover, each remaining IMF of CVD series can be separately introduced as new response variables in regression models with weather IMFs as covariates. This could help to outline the effect of different weather variables at different scales. Preliminary results of the Lasso in a linear fashion show that, in Montreal, ten days lagged annual variations and long term trend of temperatures along with the trend of precipitations have a major influence on CVD mortality. Those three components explain the annual seasonality and the trend of deaths.

11A.5

Time Lag Analysis in Health-Weather Effects

Atmospheric Effects on Human Health II
Noel Petit, Augsburg College, Minneapolis, Minnesota

A review of health-weather effect research over the past few years indicates some effects are immediate and some may have a lag of up to 30 days. We found many lags in the 1 to 7 day range such as Ozone affecting Asthma in the 2-3 day lag (Li, Wang, etal, 2011) and temperature changes correlated with Pacemaker replacement with lags up to 30 days (Liu, Chang, etal, 2011) Of course, many environmental health effects have much longer time lags (air and water pollution, eg.). This paper is concerned only with fairly immediate effects that can be attributable to day-to-day weather and leaves the long term environmental effects to others. Our med-weather.com web site has attempted to show health effects such as asthma, cardio-vascular, arthritis, migraine, reaction-time and heat stress. We forecast from previous research but only use a 5 day forecast as the time-line for our effects. Many weather related effects may have longer lag time, so we will review the literature and discuss how we extended our weather analysis to account for this lag.

11A.6

Investigating links between mortality and slow atmospheric variations

Atmospheric Effects on Human Health II
Augustin Vintzileos, University of Maryland / ESSIC / CICS-MD, Camp Springs, MD; S. C. Sheridan, C. C. Lee, J. Gottschalck and M. Halpert

In this paper we analyze mortality data from 1975 to 2004 over several metropolitan areas of the United States in conjunction with meteorological data from the NCEP Reanalysis-1 to investigate links between weather/climate and mortality. In an attempt to detect the strongest signals between mortality and climate we only consider the 75+ age group. We first detrend mortality data in order to account for the increasing number of people entering the 75+ age group. We then compute the mean annual cycle of mortality which we remove from the detrended data. We show that the resulting time series is related to the Pacific Decadal Oscillation. Finally we present composite meteorological conditions during abnormally high summer mortality events specifically focusing on the Madden-Julian Oscillation. We conclude the presentation by discussing these links between mortality and slow atmospheric variations from the perspective of subseasonal forecasting.

11B.1

WEATHER-READY NATION: HOSPITAL RESILIENCE in the UNITED STATES

Disasters and Hazards
Wendy Marie Thomas, NOAA/NWS, Silver Spring, MD

The National Oceanic and Atmospheric Administration (NOAA) is working through the Weather-Ready Nation (WRN) program to advance hospital resilience in the face of extreme weather events. It is all too common that these critical infrastructures become damaged or destroyed during severe weather events, or that life-threatening service interruptions ensue. It has become a high-level concern that is raised as an area for needed activity in the President's Climate Action Plan. Building preparedness and resilience to these critical infrastructure requires an All-Hands on Deck approach between federal agencies and also engagements between the public and private sectors. This presentation will explore National Weather Service's engagement internally and with its partners in addressing this issue of critical national need.

11B.2

Harvesting Twitter's tweets through Web GIS for disaster relief

Disasters and Hazards
Xiannian Chen, West Virginia University, Morgantown, WV; X. Ye and G. Elmes

With technologies advancement, such as Web 2.0 and mobile devices, average citizens can contribute data based on their understanding to a problem, a phenomenon, or an event. Jeff Howe (2005) coined a new term “crowdsourcing”, which was later defined by Brabham (2008) as “online, distributed problem-solving and production model”. In crowdsourcing, the efforts from general public (voluntarily or without notices) or participants can help to solve problems or provide own their own about an event. The data from crowdsourcing actions has gained great attentions from academia researchers and industrial practitioners. One big category of crowdsourcing data are from social media websites, such as Twitter, Flickr. As user-generated-content, social media data provides real-information by volunteers from a local perspective which is not always realistic to have official agents on site during one event. Social media data has been used in national security, disaster management, social/crisis event, and other fields. In some climatic disaster events, such as Hurricane Sandy, social media data that were utilized by official agencies, such as FEMA and Red Cross demonstrated its power in locating victims, dispatching resources, and saving lives.

The advancements in technologies also enable new means of data collection. By utilizing APIs that are provided by social media websites, Web 2.0-based Web GIS portal can easily have users visually specify location for data harvesting, data mapping if applicable, and data storing. It can fuse collected, geo-tagged social media data with other geospatial data. The collected data can be saved in format as standalone files, such as CSV file, or can be saved in database for distributed access.

In the case of tweets from Twitter, this presentation majorly introduces Web GIS platform for real time tweets collection and live mapping of the geo-tagged tweets. By using Twitter's Search API, the web platform provides an interface for users to specify corresponding search parameters, including search keywords, search location, and other parameters, to retrieve subjects related and location related social media. Most importantly, it presents a way to save the real-time collected social media data into a distributed (geo)database, and disseminate the saved data lively.

11B.3

PROJECTING RESIDENTIAL TORNADO EXPOSURE RATES THROUGH ARCMAP DIGITIZATION TECHNIQUES AND THE EMPLOYMENT OF BOTH U.S. CENSUS AND MIGRATION PATTERN DATA

Disasters and Hazards
Marius J. Paulikas, Kent State University, Kent, OH

Multiple tornado studies in the past have employed U.S. Census blocks on Arcmap software as a means of estimating total numbers of individuals who may be directly impacted by a tornado event. This process has consisted of mapping tornado damage paths with U.S. census block polygons on Arcmap software. While U.S. census blocks provide total numbers of homes and population counts for a given geographic area, they do not capture the true spatial patterns of individual housing structures populating a given area. Given that tornadoes are relatively small-scale geographic features, the intersection of census blocks with synthetic tornado damage paths provide limited degrees of spatial accuracy when compiling estimates of homes that may be exposed to such events. This study outlines a proposed methodology intended to allow more precise estimates to be gauged when accounting for total numbers of homes and individuals that may be exposed to various small-scale natural disaster events. The process first consists of manually digitizing individual building footprints through satellite imagery on Arcmap software to account for actual spatial locations of residential structures; the digitization process simply requires the creation of individual residential centroid point features, which represent the mean location of each structure. Each centroid point is then spatially joined with data stemming from the respective U.S. census block polygon the centroid falls underneath. Lastly, to better gauge the likelihood of individuals being home during the time of a natural disaster event, data stemming from a national migration survey is incorporated into this study; the migration data is comprised of aggregated daily business activities stemming from over 9,000 interview subjects. The intersection of a synthetic tornado damage path with individual centroids (representing homes) consisting of census and migration statistics may ultimately yield more precise numbers of residents who may be exposed to a hypothetical tornado event.

11B.4

Combination of multi-sensor remote sensing data for drought monitoring over Southwest China

Disasters and Hazards
Cui Hao, Chinese Academy of Meteorological Sciences, Beijing, Beijing, China; J. Zhang

Abstract: The existing remote sensing drought indices were seldom used in complex areas with varied landforms, climates and vegetation types. This paper intended to propose the optimized meteorological drought index (OMDI) and the optimized vegetation drought index (OVDI) from multi-source satellite data to monitor drought in three bio-climate regions of Southwest China. The OMDI and OVDI were integrated with parameters such as precipitation, temperature, soil moisture and vegetation information, which were derived from Tropical Rainfall Measuring Mission (TRMM), Moderate Resolution Imaging Spectroradiometer Land Surface Temperature (MODIS LST), AMSR-E Soil Moisture (AMSR-E SM), the soil moisture product of China Land Soil Moisture Assimilation System (CLSMAS), and MODIS Normalized Difference Vegetation Index (MODIS NDVI), respectively. Different sources of satellite data for one parameter were compared with in-situ drought indices in order to select the best data source to derive the OMDI and OVDI. The Constrained Optimization (CO) method was adopted to determine the optimal weights of each satellite-based index generating combined drought indices. The result showed that the highest positive correlation and lowest root mean square error (RMSE) between the OMDI and 1-month Standardized Precipitation Evapotranspiration Index (SPEI-1) was found in three regions of Southwest China, suggesting that the OMDI was a good index in monitoring meteorological drought; in contrast, the OVDI was best correlated to 3-month SPEI (SPEI-3), and had similar trend with soil relative water content (RWC) in temporal scale, suggesting it a potential indicator of agricultural drought. The spatial patterns of OMDI and OVDI along with the comparisons of SPEI-1 and SPEI-3 for different months in one year or one month in different years showed significantly varied drought locations and areas, demonstrating regional and seasonal fluctuations, and suggesting that drought in Southwest China should be monitored in seasonal and regional level, and more fine distinctions of seasons and regions need to be considered in the future studies of this area.

11B.5

A GIS-BASED FLOOD RISK MAPPING ALONG THE NIGER-BENUE RIVER BASIN IN NIGERIA USING WATERSHED APPROACH

Disasters and Hazards
Ademola Akinbobola, FEDERAL UNIVERSITY OF TECHNOLOGY, Akure, Nigeria; E. C. okogbue and O. olajiire

Floods are water induced disasters that lead to temporary inundation of dry land and cause serious damages in the affected location such as loss of lives and properties and destruction of infrastructures. They have become common occurrences in Nigeria and the recorded impacts of flooding on the inhabitants are alarming, causing hundreds of deaths and rendering thousands homeless. The impact of floods on people globally has led to the development of mitigation measures that could reduce the associated risk of floods to a manageable point. The management of flood risk begins with identification of areas prone to flood. This study used the scientific technique of GIS to identify flood risk areas along the River Niger-Benue basin. Satellite imageries SRTM DEM that covers the study area was used in this research. Monthly rainfall data was used to generate maps of standardized precipitation index (SPI) for thirty years (1978 to 2007). The SPI maps were used to determine the degree of precipitation condition across Nigeria and also to identify the locations where flood events are being triggered. The SRTM DEM was used to generate the flow direction and flow accumulation maps. Flow direction and Flow accumulation were used to generate the watershed and flood risk map. The flood risk map shows that 45% of Nigeria towns and villages are within the flood risk zone. Finally, some recommendations were made which will help the policy makers improve on flood management in the country. Keywords: Flood, Flood risk, flow direction, satellite imagery

11B.6

Health Factors and Medical Emergency Issues of Fishing Communities of Kutubdia Island, Bangladesh

Disasters and Hazards
Munshi Khaledur Rahman, 413 McGilvrey Hall, Kent, OH; T. W. Schmidlin

Sickness from sea motion or other causes is a common concern among the people who spend time at sea. The people of Kutubdia Island do not have access to advanced health care locally. Fishers who stay on the sea for a long period of time are susceptible to multiple health problems. The objectives of this research are to explore sickness patterns and medical emergencies that fishers face during their fishing activities. This study was conducted based up on primary data using

questionnaire surveys of 300 households. Both qualitative and quantitative techniques are used in this study. The respondents were asked whether they experienced any kind of sickness during their fishing activities at sea. The survey results showed that 62% of the fishers experienced sickness during fishing activities at sea. These included vomiting, dizziness, diarrhea, cough, back pain, and fever.

11B.7

EFFECTS OF ENVIRONMENTAL DEGRADATION ON HUMAN HEALTH IN SELECTED OIL COMMUNITIES IN DELTA STATE

Disasters and Hazards

Vincent Nduka Ojeh, WASCAL WACS, Akure, Ondo State , Nigeria

The study investigated the effects of environmental degradation on human health in nine selected oil communities in Delta State using well-structured 450 copies of questionnaires. Specific oil spillage and gas flaring data within the selected communities were also used. Result showed that 95.2% of the people had experienced environmental degradation from the oil producing communities and some agreed that most of the effects are still ongoing. The overall major cause of environmental degradation in all the oil producing communities is the negligence of duty by government agencies charged with oversight duties of monitoring and compliance (30.8%), Neglect of Environmental regulations/compliance (26.8%), corruption (23.6%), Lack of Environmental Impact Assessment (EIA) reports from Companies either at the beginning of the project or periodic assessment (14.7%) respectively. This has however given rise to high degree of sabotage that causes oil spillage in the area. Each community agreed that they were vulnerable to environmental degradation. In Afiesere (33.3%) were vulnerable, 82.2% were vulnerable in Okpai, 77.8% in Kwale, 72.5% at Benekuku, 82.6% at Erhoike, 73.3% at Ekakprame, 97.7% at Ubeji, 95.2% at Uzere and 86.7% at Bomadi. In all, 77.5% of the residents in oil producing communities were vulnerable to environmental degradation while 22.5% were not during the period of study. The implication of this high vulnerability to environmental degradation by the people of these oil producing communities in Delta State shows that something must be done urgently to make living conditions better in these areas for them to be resilient to oil activities which will continue to increase in the area. The study also revealed that a total of 235 Diarrhoea cases were recorded, 187 Asthma cases, 511 cases of eye infection, 90 cases of Bronchitis and 157 cases of skin infection were reported at the hospitals in the area. This high figure could be linked to environmental degradation of air, water and land which is rampant in the area. The Federal Government through the Federal Ministry of Environmental Protection Agency (FEPA), Niger Delta Affairs Ministry, NOSDR and all Policy stakeholders in environment and oil and gas sector should revisit and review existing environmental and oil drilling laws in Nigeria with a view of updating them to international and environmental friendly standards.

11B.8

School based clustered randomised intervention trial to climate change adaptation in Bangladesh

Disasters and Hazards

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Bangladesh is one of the most vulnerable countries to climate change (1,2) where children and women are at higher risk (3,4). A school manual, based on a 2008 WHO manual(5), was developed for high school students on climate change and health protection by the Ministry of Health, Bangladesh in collaboration with the National Curriculum and Textbook Board (6). The objective of this study was to test the effectiveness of the manual in increasing the knowledge level of the school children on climate change and health adaptation. Thirty upazilas (sub-district) from seven coastal districts that are most vulnerable to climate change in Bangladesh were randomly allocated in this cluster randomised controlled trial. Among the 30 upazilas, 15 were randomly allocated to the control group and 15 to the intervention group. From each upazila, two high schools were randomly selected to include in the study. All the year seven students from both group of schools sat for a pre-test of 30 uniform short questions of binary response. Total of 1515 students from 30 intervention schools received the intervention through training based on the school manual. Contents of the manual include essential knowledge about climate change and health issues, do's and don'ts during extreme weather events, and adaptation activities. At the same time a leaflet containing general message on climate change and health was distributed among 1778 students of the 30 control schools. Six months later, a post-intervention test of the same questionnaire was taken for both intervention and control schools. The pre and post test scores were analysed along with the demographic data by using random effects model to determine the effect of the manual based training program on increasing the knowledge of school children on climate change. None of the school level and student level variables was significantly different between the control and intervention group. The intervention group had 17.42% (95% CI: 14.45% to 20.38%, P=0.000) higher score in the post-test after adjusting for pre-test score and other covariates in a multi-level linear regression model. Students whose family head is house wife had lowest score compared to other occupation and the population density at home had an inverse association with post-test score in the multivariable model. Analyses of scores from individual questions demonstrated significantly higher score among the intervention group. Thus, the school manual was very effective in increasing the knowledge level of students on climate change.

POSTERS

1

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Latent Heat Loss of Dairy Cows Bred in a Semiarid Environment

It has long been recognised that the ability of an animal to withstand with hot environments is proportional to its ability to eliminate latent heat by evaporation of sweat from the skin or from the respiratory system. Direct determination of the evaporation from the skin and the respiratory tract can be done by ventilated capsules and respiratory masks, but they are extremely difficult to measure under field conditions. In those situations, indirect methods of evaluation of the cutaneous and respiratory evaporation rate would be interesting. Thus, for this study, it was aimed to estimate evaporative losses from sweating and the respiratory tract of dairy cows bred in a semi-arid environment. Thirteen dairy cows from a herd in the city of Caturité, PB, Brazil (07° 25' 13'' S, 36° 01' 38" W, 405 m altitude) were allocated in two groups (n = 15 for group 1, n = 15 for group 2) on the basis of their milk yield: low (<15 kg day-1) and high (>20 kg day-1); the cows were 7/8 Holstein – 1/8 Zebu and predominantly black. The herd was managed on open confinement, fed silage and concentrated diet. The cows remained in the field exposed to sun between the milkings (3:50 a.m and 3:50 p.m., respectively). The observations (n = 450 observations) on the selected cows were made just after the first milking (7:00, 9:00 and 11:00 a.m.). An infra-red thermometer (Fluke, mod. 568), adjusted for an emissivity of 0.98 was used to determine the hair coat surface temperature (Ts), measured by scanning the dorsal area. The respiration rate (RR) was measured by

the counting of flanks movements in the animal. At the same time, environmental variables were recorded: Air temperature (Ta), black globe temperature (Tg), relative humidity (RH) and wind speed (W). The black globe was a standard one, with 15 cm diameter and placed 0.90 m above the ground close to the animals; air temperature and relative humidity were measured with a thermohigrometer (HOBO, mod. U12-013) under the sun, 1.2 m above the ground; wind speed was measured near the black globe using a digital anemometer (LM-8000). The following equations were used in order to calculate the latent heat flux through the respiratory tract: (ER = λ (ΨEXP – ΨATM)/rVR W•m-2). where, ER is the heat flux through the respiratory tract, W m-2; λ (2500.7879 – 2.3737tA [J•g-1]) is the latent heat of water vaporization, ΨEXP is the absolute humidity (g•m-3) of the expired air, ΨATM is the atmospheric absolute humidity, and rVR is the water vapor resistance to the heat loss through the respiratory tract. In order to estimate the heat loss due to sweating, the equation considering the animal's hair surface temperature (Ts) was used: Es = 31.5 + 3.67e(Ts – 27.9)/2.1915 W•m-2, where Es is the rate of heat loss by cutaneous evaporation, W m-2 and Ts is the hair coat surface temperature, ºC. The statistical analyses were based on the Generalized Linear Model (Glimmix Procedure). Environmental conditions during the observations (7:00, 9:00 and 11:00 a.m.), and their standard deviation were as follows, respectively: air temperature (ºC): 25.14±0.9, 27.71±1.2, 30.1±1.4; black globe temperature (ºC): 30.55±0.9, 32.01±0.4, 35.23±1.2; relative humidity (%): 75.52±1.34, 64.60±1.85, 53.71±2.45 and wind speed (m s -1): 1.68±0.34, 2.15±0.28 and 2.95±0.52. The results of analyses of variance for the different periods of observation demonstrated a significant effect on Es and Ts. However, the RR (53±7.5, 61.17±5.5 e 66.84±9.5 breaths min-1) and Er (29.20±0.6, 30.01±0.2 and 30.23±0.72 W.m-2) did not change (P > 0.05). The average value for Ts (34.22±0.4ºC) at 7:00 a.m. differed significantly (P < 0.01) with the observed at 9:00 a.m. (35.55±0.6ºC) and 11:00 a.m. (36.50±0.35ºC). These differences can be explained by the levels of radiation load in the different periods of observation, measured by the black globe temperature. Sweating rate seems to follow skin temperature, therefore, the skin temperature is the primary driving force for sweating. Thus, the cutaneous evaporation at 7:00, 9:00 and 11:00 a.m. were 131,41±12.3, 161.76±15.20 e 224.57±11.34 W.m-2, respectively. In our study, the contribution of cutaneous evaporation for the latent heat losses increased as a function of the environmental temperature (75, 80 and 90% at 7:00, 9:00 and 11 a.m., respectively). The heat loss from the respiratory tract was constant between the periods of observation, results that differ from those reported in the literature, showing that Er increases exponentially with the levels of environmental temperature. Considering the level of milk yield, there was no difference (P > 0.05) in the physiological responses between the groups for both heat losses from the respiratory tract (29.50±2.01 W.m-2 for group 1 and 30.25 for group 2) and cutaneous evaporation (164.03±22.30 W.m-2 for group 1 and 180.40 ± 16.50 W.m-2 for group 2). Milk yield can leads to a metabolic heat production due to the metabolism of a large amount of nutrients, making the high producing cows more vulnerable to heat stress than lower yielding ones. However, the metabolic heat production in cows of both groups may be similar, causing minimal differences in the thermal balance of these animals. Based on the results, we can conclude that the cutaneous evaporation represent up to 90% of the latent heat loss in 7/8 Holstein x 1/8 Zebu crossbred cows in an environment with average temperatures of 30 ° C.

2

Down-regulation of milk synthesis through PA-PG-PL system: an adaptation mechanism during heat stress

Posters

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Dairy farming plays an important role in strengthening the rural economy. It provides supplementary employment, an additional source of income to many small and marginal farmers, household nutrition security. However, heat is a major constraint on animal productivity in the tropical belt and arid areas. The negative effects of global warming will be manifest in animal agriculture of both developed and developing countries. According to IPCC predictions, the global average surface temperature may increase between 1.8 and 4°C by year 2100. Under such circumstances, milk production is impaired as a result of the drastic changes in biological functions under heat stress. Heat stress in dairy cows as all temperature-related forces encourage changes or adjustments which may occur from the cellular to the total animal level to help the cows stay away from physiological disorders and then to better adapt to an adverse thermal environment. Such adaptation involves activation of the hypothalamus-pituitary-adrenocortical axis by external stress, liberating cortisol into blood plasma, which in turn induces the liberation of plasminogen activator (PA) from the mammary epithelial cells into the mammary cistern, where it activates the plasminogen-plasmin (PG-PL) system. Thus this PA-PG-PL system is a milk-borne factor which down regulates the milk secretion during the heat stress. This negative feedback system specifically forms β-casein (CN) fragment (f) (1–28) from β-CN, which acts as the negative control signal by closing potassium channels on the apical membrane of the epithelial cells of mammary gland. Along with that, this caseinophosphopeptides through their phospho-serine residues can bind 20 to 40 moles of Ca2+ which is essential for maintaining the tight junction integrity of the mammary secretory epithelium. As a result, disruption of the integrity of mammary epithelial cell tight junction depresses milk yield. Determination of such adaptation of animals to thermal stress opens new opportunities as means of improving thermal tolerance. Further research is needed, to determine the nature of the interaction of β-CN f (1–28) with regulatory elements in the apical membrane of mammary gland epithelial cells, and to identify these channels and the components of the inward signal transduction. However, continued research evaluating methods to improve productive performance of thermally stress animals is warranted.

3

Housing system in dairy cow farms affects green house gas emissions from manure

Posters

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This study is part of the evaluation process of the Rural Development Policy adopted by the Italian Region of Emilia Romagna during the period 2007-2013. The study was aimed at assessing the emissions of methane (CH4) and direct nitrous oxide (N2O) from manure handling in relation to the housing system in dairy cow farms. A total of 1,403 dairy farm records were considered. The following eight housing systems were evaluated: tie stall with straw (#847), tie stall without straw (#7), straw yard (#125), straw loose yard (#21), free stall cubicle with mattress (#96), free stall cubicle with straw (#61), free stall cubicle tail-tail with straw (#109), free stall cubicle head-head with straw (#137). Single farm demographic structure (cows, heifers and calves consistencies) was obtained from the National Bovine Registry and was referred to the years 2009-2011. Total live weight yr-1 (LW) for each livestock category was calculated considering 600 kg LW, 300 kg LW and 100 kg LW for cows, heifers and calves, respectively. Liquid and solid manure yield yr-1 and nitrogen excreted yield yr-1 were calculated according to the housing system, livestock categories and total LW as indicated by the regional nitrogen balance database. Volatile solid (VS) yield yr-1 were calculate as 73% and 82% of liquid and solid manure dry matter, respectively. Greenhouse gases emitted were estimated by using a Tier 2 approach as suggested in the guidelines provided by

the International Panel on Climate Change (IPCC). Specific conversion factors calculated at regional basis and used in the Italian National Inventory Report (NIR) were applied to calculate CH4 manure emissions from total VS. The specific conversion factors were 15.32 g CH4/kg VS and 4.8 g CH4/kg VS for liquid and solid manure, respectively. Direct N2O emission were calculated using the emission factors adopted in the NIR and correspondent to 0.001 kg N2O-N/kg N excreted and 0.02 kg N2O-N/kg N excreted for liquid and solid manure, respectively. The CH4 and N2O emissions were calculated for each farm and expressed as kg CO2 equivalent (CH4, kg x 25; N2O, kg x 310) to account for the Global Warming Potential (GWP). Livestock Units (LSU) were calculated for each farm as 1 LSU equivalent to 600 kg live mass, 0.6 LSU equivalent to 300 kg live mass and 0.1 LSU equivalent to 100 kg. The CH4, N2O and total GWP (mean ± SD) were referred to LSU yr-1. The variation of emissions were evaluate by GLM (general linear model) where housing system was set as categorical variable and kg CH4, N2O and CO2 eq. emitted for LSU yr-1 as independent variables. The differences were analyzed by Tukey test and the significances were set for value of $p<0.01$. The emissions of CH4 were greater for straw yard housing system with value of 19.35±0.65 kg CH4/LSU year-1 ($p<0.01$). The CH4 emissions were related both to the great amount of solid and liquid manure produced in this housing system. The tie and free cubicle stall systems without the use of straw produce only liquid manure and were associated to high CH4 emissions with values of 18.0 ± 0.17 and 17.8 ± 0.53 CH4/LSU year-1, respectively. The other systems that produced more solid manure emitted less CH4 with the lower value of 13.6±0.54 kg CH4 LSU year-1 ($p<0.01$) for free stall cubicle with straw. The N2O emissions were related to the amount of N excreted in the liquid or solid manure produced. When housing system produced only liquid manure, the emissions of N2O were low due to the low emission factor adopted (0.001). The free cubicle and tie stall systems without the use of straw showed the lower N2O emissions ($p<0.01$) with values of 0.30 ± 0.16 kg N2O/LSU yr-1 and 0.31± 0.09 kg N2O/LSU yr-1, respectively. On the other hand, when housing system was straw based, high yield of solid manure were produced and greater N2O emissions were achieved due to high emission factor adopted (0.02). The housing systems tie and free cubicle stall with the use of straw and straw yard loose pointed out the grater N2O emissions ($p<0.01$) with values of 1.86±0.07, 1.84±0.09 and 1.86±0.12 kg N2O/LSU yr-1, respectively. When the greenhouse gasses were considered together to account at GWP, the housing systems without use of straw showed lower values ($p<0.01$) of GWP corresponding to 540±42 and 547±30 kg CO2 eq./LSU yr-1 for free cubicle and tie stall systems without straw, respectively. The lower GWP in these housing systems were related to the lower N2O emissions. In the systems with higher use of straw the GWP resulted greater ($p<0.01$) with values of 948±35, 945±40, 937±22, and 916±38 kg CO2 eq./LSU yr-1 for straw yard, straw loose yard, tie and free cubicle stall with straw, respectively. Interestingly, changing the disposition of animal in free cubicle stall with straw impacted on final GWP. The tail to tail disposition emitted 757±31 kg CO2 eq./LSU yr-1 compared with head to head system that accounted for 869± 22 kg CO2 eq./LSU yr-1 ($p<0.01$). This result is likely to be related to a lower intake of straw and consequently lower emission of N2O in tail to tail free stall. In synthesis, the housing systems which produced mostly solid manure emitted more nitrous oxide; conversely, the housing systems which produced mainly liquid manure emitted more methane. The greater conversion factor of nitrous oxide to carbon dioxide equivalent affected negatively the final GWP of housing systems based on the use of straw. Housing systems that use no organic litter such as mattress or sand are oriented to produce more liquid manure and may result more sustainable in terms of GWP. However, it has to be noticed that, compared to liquid manure, the solid manure increases the carbon sink potential when applied to arable soil as fertilizer. These trade-offs associated with utilization of inorganic versus organic bedding materials surely need further investigations. Their results will help in orienting future agro-environmental policies toward mitigation options which may reduce GWP of dairy production.

4

Genome-wide analysis of the heat stress response in dermal fibroblasts of zebu and crossbred cattle

Posters

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The molecular mechanism underlying the physiology of heat stress in the cattle remains undefined. The present study sought to evaluate mRNA expression profiles in the cultured dermal fibroblast of zebu and crossbred cattle in response to heat stress. In this study, gene expression profiling by micro-array was done in dermal fibroblast of zebu (Tharparkar, n=4) and crossbred (Karan-Fries, n=4) cattle in response to heat stress (44°C, 3 h). Present micro-array platform contains 51338 synthesized oligonucleotide probes corresponding to at least 36713 unigenes. Total 11183 and 8126 genes were deferentially expressed with fold change 2; in detailed 3918 and 3458 genes were up regulated; whereas 7265 and 4668 genes were down regulated in Tharparkar and Karan-Fries, respectively. Randomly selected real-time validation showed that 75.02% correlation with micro-array data. Functional annotation and pathway study of the DEGs reveals that, up-regulated genes significantly ($P<0.05$) affect the protein processing, NOD like receptor pathways (NLRs), apoptosis and melanogenesis while down regulated genes were significantly ($P<0.05$) found to associated with apoptosis and cellular homeostasis. Bioinformatics' analysis identified temperature-regulated biological processes and pathways. Biological processes over-represented among the earliest genes induced by temperature stress include regulation of transcription, nucleosome assembly, chromatin organization and protein folding. Gene expression changes include activation of heat shock transcription factors (HSFs), increased expression of heat shock proteins (HSPs) and decreased expression and synthesis of other proteins, immune system activation via extra-cellular secretion of HSPs. These findings may provide insights into the underlying mechanism of physiology of heat stress in zebu and crossbred cattle. In conclusion, the present study showed that heat stress deferentially affects expression of significant number of genes in dermal fibroblast of zebu and crossbred cattle. Further analysis is required to understand their functional role in zebu and crossbred cattle.

5

Influence of the Climatic Environment on the Mother-Offspring Interaction in Morada Nova Sheep

Posters

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Even in Brazil, a country with a tropical climate, a newborn can suffer stress from cold, especially during labors that occur at night. Newborn lambs are highly susceptible to hypothermia due to their high surface area to mass ratio and because they have trouble conserving heat, as they are wet when born and do not have a well-developed insulating surface. A good portion of the energetic supply for the newborn comes from colostrum, and the faster they access the udder, the greater their chances of surviving the adversities of the external environment. Thus, the objective of this study was to evaluate the influence of the BGTHI (Black globe temperature and humidity index) at the time of the birth on the formation of the mother-offspring bond in Morada Nova sheep. The study was conducted in the Small Ruminants Research Unit of the Experimental Station of São João do Cariri (07°23'27'' S, 36°31'58'' W, 458m altitude), which belongs to the Agrarian Sciences Center of the Federal University of Paraíba – UFPB. Data were collected on 80 Morada Nova multiparous ewes and

their 80 lambs. Based on the average of BGTHI (black globe temperature-humidity index) at the time of the birth, the ewes were grouped into three ranges: low (less than 65), intermediate (greater than 65 and less than 80) or high (greater than 80). Ten days prior to the predicted labor date, the ewes were taken to a maternity pen (6-m wide and 12-m long) with a conventional floor of washed sand. A set of thermometers was placed in the interior of the pen at a height of 1.0 m from the floor for the collection of the environmental data, including ambient temperature (AT), black globe temperature (BGT), air relative humidity (RH) and wind speed (Ws). The climatic variables were measured every two hours, 24 hours per day. With the climatic data, the black globe temperature-humidity index (BGTHI) was calculated according to the equation: BGTHI = BGT + 0.36 DPT – 330.08, where, BGT is black globe temperature (K); and DPT is dew-point temperature (K). To characterize the mother-offspring behavior, evaluations were performed from the first apparent signs of labor until the first two hours after birth or at the moment of the first suckling of the newborn. When the neonate was unable to suckle within two hours, a latency to suckle value of 120 minutes was assumed. In the case of twin births, the observation as conducted only for the first lamb. The observations were carried out in a direct and continuous manner by the method of focal animal sampling from a previously prepared ethogram for the records of duration (time) and frequency (n) of the behavioral states and events of the ewes and the newborns. The ewes were marked with non-toxic black paint on the right and left sides to facilitate their identification by the observers at the time of evaluation. During the postpartum observations, maternal factors such as maternal grooming (percentage of total observation time spent cleaning the newborn), facilitating sucking (percentage of total observation time in which the ewe exposes her udder to the newborn or remains still while the lamb seeks the udder), frequency of low-pitched bleats (expressed as the number of occurrences per minute that the ewe vocalizes with her mouth closed) and the time until the ewe touched the lamb (latency to groom) were recorded. For the lambs, attempts to seek the udder (percentage of total observation time that the lamb spent in the parallel inverse position with its head nudging the ewe in the udder region), the frequency of low-pitched bleats (expressed as the number of occurrences per minute that the newborn vocalized with its mouth closed), the time until the lamb raised and shook its head (latency to first reaction), the time taken by the lamb to place its four legs on the ground for a period of approximately five seconds (latency to stand) and the time until the newborn performed its first successful suckling (latency to suckle) were recorded. A generalized linear model (GLIMMIX procedure) was used to examine the effect of ranges of BGTHI (low, intermediate or high), on the maternal and neonatal behaviors. The lambs were slower ($P < 0.05$) to stand when they were born under BGTHI conditions below 65. Additionally, the time elapsed for the execution of the first suckling (latency to suckle) was lower ($P < 0.05$) when the index was equal to or greater than 80 . However, the latency to the first reaction of the newborns did not differ ($P > 0.05$) as a function of the BGTHI range. Under BGTHI conditions in which the newborns were slower to suckle, the lambs spent more time seeking the udders of their mothers ($P < 0.05$). There were differences ($P > 0.05$) in the frequency of low-pitched bleats between lambs experiencing different BGTHI conditions at birth. This frequency was greater ($P < 0.05$) when the lambs were born under BGTHI conditions below 65. Among the maternal behavioral progress, the time elapsed until the dams touched their lambs (latency to groom) was not affected ($P > 0.05$) by the range of the bioclimatic index. However, maternal grooming and the facilitation of suckling occurred more often ($P < 0.05$) during the time periods with higher bioclimatic index values (> 80). Moreover, the low-pitched bleats were emitted at similar ($P > 0.05$) frequencies in the different BGTHI ranges. From the present study, it can be concluded that, Newborn Morada Nova lambs are slower to stand and suck when born under BGTHI conditions below 65. Therefore, lambs born in periods with lower temperatures require greater care from the breeder, especially during the first 24 hours after birth.

6

Development and Application to the Forecasting System of Indoor Environment in Cattle Shed

Posters

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In the light of the increasing trend of the recent milk consumption in Rep. of Korea, a Cowshed Environment Forecasting(CEF) system has been developed. This system is operated through the following 2 steps: First, high-resolution atmospheric environment around the cowshed is predicted using the agro-meteorological analysis and forecasting(AMAF) system. It was developed by National institute of meteorological research of Rep. of Korea based on Weather Research and Forecasting model. And weather variables predicted for the next 12 hours are outputted as 333m resolution. In the second step, if the output of AMAF system applied to Energy Plus model, simulation of the indoor environmental factors reflecting heat exchange by the structure and material property of cattle shed is available. Therefore, CEF system is able to provide the extreme heat warning information fitted to not only workers but also cattle in the cowshed. And the daily milk yield is able to be inferred by the heat stress index of cattle(THI). The comparison results of milk yield observed in Anseong cattle ranch from 13 JUL 2013 to 9 MAR 2014 and milk yield derived from formula developed by NRC show that the derived milk yield reaches its peak when daily maximum temperature is 7°C(25.85kg/cattle), and it is underestimated about 10kg/cattle. Also, the mean derived milk yield is less than 6.4kg/cattle(prediction: 23.79kg/cattle, observation: 30.22kg/cattle). To find the well-fitted statistical model for actual milk yield, relations to the daily maximum temperature and THI are analyzed. As a result, 4-parameter Modified Gaussian model, which is reached peak between the thermal comfort range, simulates the milk yield ideally(Rt=0.7261, RTHI=0.6974). There is a little hard to universalize the model because it is still incomplete in the analyzed period aspect. However, it will helps to serving as the foundation of development for a domestic customized CEF system.

7

IN VIVO ENVIRONMENTAL STRESS ON BOVINE FERTILITY AND IN VITRO KINETIC EFFECT OF HEAT SHOCK ON NUCLEAR OOCYTE'S MATURATION

Posters

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As known, breakthrough of global warming, changes in nutrition and expansion of metabolic disorders affect human and animal reproduction. Environmental stress had reduced fertility in cattle and these cares mainly due to hyperthermia with a great impact on cow's conception, especially during the hot months of the year, with a dramatic reduction in fertility rate. The present study was performed to evaluate the effect of weather factors on bovine (Holstein) fertility, in Terceira Island (Azores) which is a dry summer sub-tropical climate. Successively, in vitro kinetic heat shock was performed on bovine oocytes during maturation, simulating cow exposed to heat. For such purpose the success of the first artificial insemination (AI) after calving of 630 cows were recorded for one year. Cows were considered pregnant if they were not observed in estrus at least 90 days after the first AI. In parallel, climatic data was obtained from CLIMAAT (Centre of Climate, Meteorology and Global Change) at different elevation points from 0 to1000m and grazing points of cows. THI was

calculated using the formula purposed by Garcia-Ispierto: THI = (0.8 x Tmax + (RHmin (%) /1 00) × (Tmax – 14.4) + 46.4) For in vitro experiments, oocytes (n=598) were maturated in vitro (IVM) for 24 hours, divided in five groups: Control at 38.5 ºC for 0 - 24hr and heat shock groups in which oocytes were exposed at 39.5ºC in four different periods 0-6hr; 0-12hr; 0-18hr; 0-24hr during IVM. Oocytes from each group were used for meiotic assessment. For weather records, it was observed differences of THI according the altitude in the Island, being higher near the sea and minimum above 500 m high (Figure 1). THI of grazing points were intermediate between maximum and minimum altitude. Relating THI and fertilizing success, it was observed a negative correlation between cow's conception rate (CR) and THI (-91.3%; p<0.05) (Figure 1). Mean THI in summer was 72.3±1.5 with a CR of 36.8%, while in winter THI was 56.6±2.0 and the CR was 65%. Regarding in vitro maturation, results showed an effect on nuclear oocyte maturation rate (NMR) for every 6hr of heat stress at 39.5 ºC (Figure 3). As observed in vivo, a high negative correlation (-0.96%; p<0.05) was observed between the time which oocytes were submitted to stress and their ability to develop to the stage of metaphase II. For every 6hr of heat shock a significant decrease in nuclear maturation rate was observed. Further studies will be performed to evaluate the ability of heat shock matured oocytes to develop after in vitro fertilization to the stage of blastocyst. As THI values in hot months are lower in highest elevations, above 500m altitude, one could purpose, to reduce the impact of heat stress in cow conception rate, to locate the cows in high elevation point during the warmest seasons.

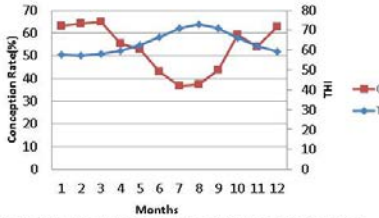

Figure 2: Relation between THI calculated though the sensors placed in grazing points and CR as measured by the non-return in estrus at least 90 days after the first insemination after calving.

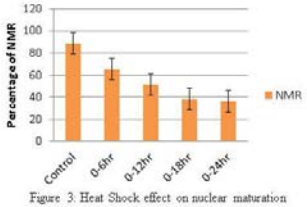

Figure 3: Heat Shock effect on nuclear maturation rate for every 6hr at 39.5 ºC and control represents the 38.5 ºC for 24hr of maturation.

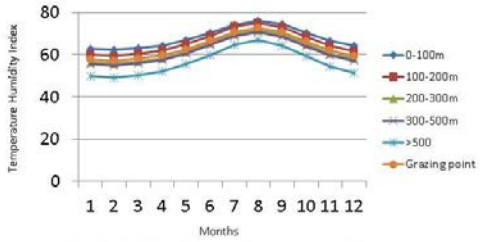

Figure 1: Mean of Temperature Humidity Index (THI) calculated through the sensors placed in different points located in the island.

8

INFLUENCE OF TYPE OF THE BED ON THE AIR QUALITY, PERFORMANCE, CARCASS INJURIES, SCORES OF THE HYGIENE AND LOCOMOTION IN BROILER RAISED IN THERMAL COMFORT

Posters

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The surface where the birds are raised (bed) has great importance in the production process, is directly linked to welfare and animal production. This study aimed to evaluate the use of plastic floor replacement in poultry litter. The experiment consisted of four treatments in a 2x2 factorial with the factors, types of flooring (plastic bed and conventional floor) and sex (male and female). Two climatic chambers were used in a camera was used shavings and the other suspended plastic floor, these being divided into 16 boxes, with an approximate area of 1m2 each, being 8 for males and 8 for females. The animals were weighed weekly, quantified feed intake and feed conversion. Measurements of CO2 and ammonia concentration were performed at 28, 32, 35, 39 and 42 days. At the end of the cycle was evaluated scores of hygiene, locomotion, breast lesions, hock and footpad, viability, production of meat, carcass and parts. The performance data were subjected to analysis of variance and Tukey's test at 5% in SAS (Statistical Analysis System). The concentrations of ammonia and CO2 were higher in the atmosphere with wood shavings in relation to the plastic floor. From the 28th day of creation, the concentration of ammonia in the air began to rise considerably in the environment in which we used the shavings due to the large accumulation of waste and the decomposition of the same within the authoring environment, while the concentration this gas in the plastic floor remained almost nil, reaching a maximum value of 2 ppm at 42 days, which is significantly lower than the concentration of ammonia reached in shavings (25ppm). The ammonia concentration in the air with the use of wood shavings was higher than that recommended by the GLOBALGAP (2007), the main program of farm assurance value of the world, where the ammonia concentration in the air of the production environment is expected to reach a maximum value of 20ppm. In plastic floor there was greater production carne.m-2 for males compared to shavings, and better performance (weight gain, feed conversion and average weight) for males reared in plastic flooring. At 42 days the males created the plastic floors obtained a numerically larger than males raised in the conventional system (shavings) having average weight of 3.180 kg and 3.100 kg, respectively, but this was not significant average weight. The plastic floor favored the cleanliness of animals, but disfavors locomotion. At the 42 days there was a best alimentar conversion for males reared on the plastic floor (1.64) than females reared on the same system (1.71), with animals kept on shavings, males (1.65) and females (1.70) with intermediate values did not differ from the other treatments. There were significant differences for meat production (p <0.05), with the highest value observed for males created the plastic floors (38,900 kg m-2), followed by males raised on wood shavings (36.020 kg m-2), observing lower meat production for females reared on the plastic floor (32.310 kg m-2) and shavings (32,810 kg m-2). Birds reared in plastic floor had a higher incidence of lesions in the footpad, whereas birds reared on wood shavings had higher incidence of lesions in the hock. The plastic floor showed satisfactory results and can be a good alternative for the replacement of poultry litter.

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Effect of different types of shelter on microenvironment, physiological response and growth performance of lambs under semi-arid tropical environment during summer

Posters

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Heat stress is a major predisposing factor for impaired growth performance of growing lambs during summer in semi-arid tropics. Therefore, the present study was conducted to ameliorate heat stress in growing lambs through shelter management. Thirty three Malpura lambs of 3-5 months age (average body weight 19.5 kg) were divided equally and randomly into three groups, viz. GI (control, lambs kept in conventional asbestos roof shed), GII (lambs kept in Yagga type shed) and GIII (lambs kept in open area under tree-shade) to determine the effect of different types of shelter on microenvironment, physiological response and growth performance of lambs under hot semi-arid tropical environment during summer. In all three type of system lambs were provided with sufficient space to move and play. The side walls of asbestos roof were made up of wire netted fencing where as in Yagga type shed; the side walls are double walled. The empty space between the two walls, were filled with sand. The sand was kept in moist condition by continuous water drips which provide extra evaporative cooling. The Yagga type shed was basically constructed with bamboo. Tree-shade was made under the natural shades of large trees. The shaded area was protected by wire fence. The experiment was conducted for two months during extreme summer (May-June, 2013). During the experimental period the temperature-humidity index remained 33.73±1.23, 32.42±1.26 and 37.60±0.38, respectively in the shed of GI, GII and GIII at 1400h. Whereas, maximum temperature remained 45.48±0.51, 41.42±0.47 and 43.46±0.44 at 1400 h during experimental period in the shed of GI, GII and GIII, respectively. The lambs were provided with adlibitum green fodder, dry roughage, 200 g concentrate and adlibitum drinking water. The respiration rate at morning and afternoon, pulse rate at morning and afternoon and rectal temperature at afternoon was significantly ($p<0.05$) lower in lambs of GII as compared to other groups. Body weight did not differ significantly among the groups but average daily gain (g/day) was higher in GII (112.57±21.74) as compared to GI (94.99±21.74) and GIII (94.45±20.73). It can be conclude from this study that amongst the three housing types, Yagya-type shed (GII) provided maximum comfort with lower THI, temperature, physiological responses of lambs and higher average daily gain during extreme summer in semi-arid tropical environment.

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ENVIRONMENTAL VARIABLES AND THEIR INFLUENCE ON COQUILLETTIDIA MOSQUITOES AT PARA STATE, BRAZIL

Posters

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The Amazon region is considered one of the most important ecosystems that encompass the largest biodiversity of the planet. Among this biodiversity there are vector diseases where, the dynamics of transmission are complex systems of interactions between insects, parasites and animal hosts that are associated with environmental determinants that contribute to the intensity of transmission. The genus Coquillettidia is one of them comprising the tribe Mansoniini, which includes 57 species. Females of several species are voracious, opportunistic blood feeding, becoming serious pests to humans in areas of Africa, Europe, and North and South America. Moreover, some species are involved in the transmission of viruses to humans and domestic animals. Therefore, this study aims to characterize the impact of atmospheric variables, including CO2, on the Conquiletidia species of mosquito population variability at Caxiuinã Station, Pará St., North of Brazil, in Amazonian region, during 5 Campaigns in 2005-2006. The preliminary results suggest that there is no clear CO2 variability on Coquillettidia population densities where the total period is analyzed. However, when it is analyzed separating nighttime and daytime there is a clear positive association between this greenhouse gas and the genus Coquillettidia at nighttime. Precipitation amount affects these mosquitoes population density negatively as expected due to the physical impact of the raindrops. Air temperature is another variable which affects negatively associated with Coquillettidia.

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Microclimate changes caused by the conversion of a forest into grassland in an area of Brazilian Savanna

Posters

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The political and social pressures for the brazilian economic development have intensified deforestation once economic activity is based on agribusiness. Natural ecosystems are rapidly being replaced by pastures and plantations, which modify the microclimate and functioning of these ecosystems. Thus, the aim was to evaluate microclimate changes caused by the conversion of a forest into grassland in an area of Brazilian savanna. The experiment was conducted in a forest and grassland from December 2011 to December 2012, in which solar radiation, air temperature, air relative humidity and wind speed were measured. Grassland showed higher values of solar radiation, average, maximum, and minimum temperature, and wind speed in both seasons than forest, except relative humidity. Solar radiation showed seasonality in the grassland with higher values in the dry season, but no seasonality in the forest which showed a slightly higher value in the dry season. Relative humidity showed a strong seasonality in both areas with higher values in the forest during the wet season. The mean air temperature showed no seasonality in both areas, but it was higher during the dry season in the grassland and higher during the wet season in the forest. The maximum air temperature showed seasonality in the grassland with higher values during dry season and it showed no seasonality in the forest with slightly higher value in the dry season. The minimum air temperature was lower in the dry season in both areas, but only forest showed seasonality. The speed wind was higher in the dry season in both areas, but only grassland showed seasonality. The analysis indicated significant microclimate changes, with a significant increase in 87% of solar radiation, 17.5% of mean temperature, 10% of maximum temperature, 23.5% of minimum temperature, and 95.2% of wind speed, and a decrease in 6.7% of relative humidity.

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Effects of landuse on net radiation and evapotranspiration in a protected area in the Northern Brazilian Pantanal

Posters

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The Pantanal is the largest floodplain in the world and some non-flooded native areas are used for agriculture and livestock, which lead to a change in net radiation and evapotranspiration. A private protected area was created in 1999 by National Service of Commerce (SESC) to recover pasture areas into a native vegetation to protect biodiversity from Pantanal. Thus, our goal was to estimate net radiation and evapotranspiration before, during and after the creation of a protected area in the Northern Brazilian Pantanal. We used the Surface Energy Balance Algorithm for Land (SEBAL) and Landsat 5 TM images from 1984, 1989, 1999, 2008 and 2009 to estimate net radiation and evapotranspiration in the dry and wet seasons. The net radiation and evapotranspiration varied significantly between seasons and among years. The highest values of net radiation and evapotranspiration occurred in the wet season and they also increased from 1984 to 2009. These results highlight the seasonal pattern of the functioning of the Pantanal ecosystems due to seasonality of water availability and the increase in biomass after the creation of the protected area.

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Agro-climatic zoning of Jatropha curcas as a subside for crop planning and implementation in Brazil

Posters

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As jatropha (Jatropha curcas L.) is a recent crop in Brazil, the studies for defining its suitability for different regions are not yet available, even considering the promises about this plant as of high potential for marginal zones where poor soils and dry climate occur. Based on that, the present study had as objective to characterize the climatic conditions of jatrophaxs center of origin in Central America for establishing its climatic requirements and to develop the agro-climatic zoning for this crop for some Brazilian regions where, according to the literature, it would be suitable. For classifying the climatic conditions of the jatrophaxs center of origin, climate data from 123 weather stations located in Mexico (93) and in Guatemala (30) were used. These data were input for Thornthwaite and Matherxs climatological water balance for determining the annual water deficiency (WD) and water surplus (WS) of each location, considering a soil water holding capacity (SWHC) of 100 mm. Mean annual temperature (Tm), WD and WS data were organized in histograms for defining the limits of suitability for jatropha cultivation. The results showed that the suitable range of Tm for jatropha cultivation is between 23 and 27°C. Tm between 15 and 22.9°C and between 27.1 and 28°C were classified as marginal by thermal deficiency and excess, respectively. Tm below 15°C and above 28°C were considered as unsuitable for jatropha cultivation, respectively by risk of frosts and physiological disturbs. For WD, suitability for rainfed jatropha cultivation was considered when its value is below 360 mm, while between 361 and 720 mm is considered as marginal and over 720 mm unsuitable. The same order of suitability was also defined for WS, with the following limits: suitable for WS up to 1,200 mm; marginal for WS between 1,201 and 2,400 mm and unsuitable for WS above 2,400 mm. For the crop zoning, the criteria previously defined were applied to 1,814 climate stations in the following Brazilian regions: Northeast (NE) region and the states of Goiás (GO), Tocantins (TO), and Minas Gerais (MG). The suitability maps were generated by crossing the crop climate requirements with the interpolated climate conditions of the selected regions. The maps showed that only 22.65% of the areas in the NE region are suitable for jatropha as a rainfed crop. The other areas of the region are classified as marginal (62.61%) and unsuitable (14.74%). In the states of GO and TO, the majority of the areas (47.78%) is classified as suitable, and in the state of MG 33.92% of the territory has suitability for the crop. These results prove that jatropha cannot be cultivated everywhere and will require, as any other crop, minimum climatic conditions to have sustainable performance and high yields.

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White mold for soybean crop in Brazil as affect by climate and agricultural management conditions

Posters

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In Brazil, epidemics of white mold in field crops of soybean have frequently and significantly compromised crop yield and quality. The aim of the current research was to assess epidemiology of white mold (Sclerotinia sclerotiorum) on soybean crop grown at Arapoti, PR, Brazil, utilizing data related to plant populations, row spacings and local meteorological factors. The experiment was conducted in a naturally infested area. The experimental design adopted was a randomized block distributed in a factorial combination with 4 row spacings (0.35, 0.45, 0.60, 0.75 m) and 4 plant populations (150, 200, 250, 300 thousand plants per hectare), totaling 16 treatments and 4 replications. In the current study we performed four assessments of incidence and severity. The temporal analysis of the epidemic was carried out from the area under the disease progress curve. For the incidence data it has been shown that both logistic and monomolecular models were those that were best fitted to the experimental data. For severity, the best model related to the experimental data was the logistic one, revealing a mean coefficient of determination of 0.971. Either for incidence or for severity, air temperature was considered to be the environmental factor most affecting the progress of the disease in production fields of soybean. The variability in the apparent infection rates of white mold on soybean was not affected by different row spacings and plant populations, therefore, suggesting that macroclimatic variations prevailed in such a fashion to mitigate the effect of cultural practices adopted in the field.

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PLANT PHENOLOGICAL MONITORING BASED ON AUTOMATED RECORDING OF HIGH RESOLUTION DIGITAL IMAGES

Posters

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The importance of phenological research for understanding the consequences of global environmental change on vegetation is highlighted in the most recent IPCC reports. Collecting time series of phenological events appears to be crucial to better understand how vegetation systems respond to climatic regime fluctuations, and, consequently, to develop effective management and adaptation strategies. However, traditional monitoring of phenology is labor intensive and costly and affected to a certain degree of subjective inaccuracy. Other methods used to quantify the seasonal patterns of vegetation development are based on satellite remote sensing (land surface phenology) but they operate at coarse spatial and temporal resolution. To overcome the issues related to the application of these methodologies, different approaches for vegetation monitoring based on “near-

surface" remote sensing have been proposed in recent researches (Sonnentag et al., 2010). In particular, the use of digital cameras has become more common for phenological monitoring. Digital images provide spectral information in the red, green, and blue (RGB) wavelengths. Inflection points in seasonal variations of intensities of each color channel can be used to identify phenological events. Canopy green-up phenology can be quantified from the greenness indices. Species-specific dates of leaf emergence can be estimated by RGB image analyses (Richardson et al. 2009). In this research, an Automated Phenological Observation System (APOS), based on digital image sensors was developed for monitoring the phenological behavior of shrubland species in a Mediterranean site. The APOS system was developed under the INCREASE (an Integrated Network on Climate Change Research) EU-funded research infrastructure project, which is based upon large scale field experiments with non-intrusive climatic manipulations. The experimental site is located in North-West Sardinia, within the Nature Reserve Porto Conte – Capo Caccia. Vegetation mainly consists of Mediterranean shrubland species. Vegetation monitoring was conducted from October 2012 to November 2013. The APOS system was set to acquire one panorama per day at noon (36 shots x panorama - 3 rows x 12 columns) with a 30% of image overlapping. On each panorama ROIs (Regions of Interest) focusing major species of the shrubland ecosystem were fixed. An image analysis was performed to obtain information on vegetation status (i.e. color signals and phenology). From the visual analysis of the high resolution images, dates of the key phenological stages (i.e. leafing and flowering) were identified. The color channel information (digital numbers) was extracted using a Mathlab script (R2014b, The MathWorks). Chromatic coordinates and several indices were calculated over a 2-years period from May 2012 to end of 2013. Mean daily values of the green chromatic coordinates (gcc) were calculated for the most representative species of the site (such as Cistus monspeliensis L. and Pistacia lentiscus L.). The green colors signals clearly followed the pattern of vegetative development, with evident peaks of gcc when leafing stage was observed in the studied species. For some species (i.e. Cistus), values of Red Excess Index were related to the changes of vegetation status during the drought periods, when leaf fall occur to avoid water stress by reducing transpiration surface. The use of near-surface remote sensing methods based on digital images appeared to be promising (e.g. increasing rates of data collection and standardized data sets). Preliminary results indicate that the use of digital images is well-suited to identify phenological behavior of shrubland Mediterranean species. Results of digital images analysis provide information useful to interpret phenological responses of plants to climate change, to validate satellite-based phenology data, and to provide input to adaption strategies and action plans to climate change.

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Recent applications of continental-scale phenology data for science and resource management

Posters

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The USA National Phenology Network (USA-NPN; www.usanpn.org) serves science and society by promoting a broad understanding of plant and animal phenology and the relationships among phenological patterns and all aspects of environmental change. The National Phenology Database, maintained by the USA-NPN, is experiencing steady growth in the number of data records it houses; these data are now being used in a number of applications for science, conservation and resource management. The majority of the data in the database has been provided by participants in the USA-NPN national-scale, multi-taxa phenology observation program Nature's Notebook. Participants, including both professional scientists and volunteers, follow vetted protocols that employ phenological "status" monitoring. On each repeated visit to a site, observers indicate the status of each phenophase (e.g., "breaking leaf buds" or "open flowers") for individual plants or for animal species with a 'yes' if the phenophase is occurring or a 'no' if it is not. Additionally, an estimate of the intensity of the phenophase can also be reported (e.g. "less than 3 leaf buds breaking" or "25-49% of flowers open"). This approach has a number of advantages (e.g., estimation of uncertainty in dates of phenophase onset and end, measure of phenophase duration and magnitude, measure of within-season gaps in the presence of a phenophase due to periodic activity or repeat events) and is especially well-suited for integrated multi-taxa monitoring to create a robust ecological dataset.

Between 2008 and June 2014, the 3580 active participants registered with Nature's Notebook have contributed over 3.5 million observation records for plants and animals, including historical lilac and honeysuckle data that go back to 1956. Customizable data downloads are freely available from www.usanpn.org/results/data. Data are accompanied by FGDC-compliant metadata, data-use and data-attribution policies, vetted and documented methodologies and protocols, and version control. Quality assurance and quality control, and metadata associated with field observations are also documented. Data are also available for exploration, visualization and preliminary analysis at www.usanpn.org/results/visualizations.

We demonstrate several types of questions that can be addressed with this observing system and the resultant data, and highlight several ongoing local- to national-scale projects as well as some recently published studies. Projects include national-level bioclimatic indices, regional assessments of historical and potential future trends in phenology, sub-regional assessments of temperate deciduous forest response to recent variability in spring-time heat accumulation, and local monitoring for invasive species detection across platforms from ground to satellite. Additional data-mining and exploration by interested researchers and/or resource managers will likely further demonstrate the value of these data.

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Impact of advections of particulate matter from biomass combustion on mortality in Madrid

Posters

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Background / Objective: Approximately 20% of particulate and aerosol emissions into the urban atmosphere are of natural origin (including wildfires and Saharan dust). During these natural episodes, PM10 and PM2.5 levels usually exceed WHO health protection thresholds. The objective is to evaluate the possible effect of advections of particulate matter from biomass fuel combustion on daily specific-cause mortality among the general population and the segment aged ≥75 years in Madrid. Materials and methods: Ecological time-series study in the city of Madrid from 01/01/2004 to 31/12/2009. The dependent variable analysed was daily mortality due to natural (ICD-10:A00-R99), circulatory (ICD-10:I00-I99) and respiratory (ICD-10:J00-J99) causes in the population, both general and aged ≥75 years. The following independent and control variables were considered: a) daily mean PM2.5 and PM10 concentrations (Madrid Municipal Air Quality Monitoring Grid) ; b) maximum daily temperature (State Meteorological Agency); c) daily mean O3 and NO2 concentrations; d) advection of particulate matter from biomass combustion (http://www.calima.ws/), using a dichotomous variable; and, e) linear trend and seasonalities. We conducted a descriptive analysis, performed a test of means and, to ascertain relative risk, fitted a model using autoregressive Poisson regression and stratifying by days with and without biomass advection, in both populations. Results: Of the 2192 days analysed, biomass advection occurred on

56, with mean PM2.5 and PM10 values registering a significant increase during these days versus those without advection. PM10 levels displayed a significant effect on natural-cause mortality on days with advection, while PM2.5 levels displayed a significant effect on all-cause mortality on days without advection. PM10 had a greater impact on organic mortality with advection (RRall ages=1.035 [1.011-1.060]; RR≥75years=1.066 [1.031-1.103]) than did PM2.5 without advection (RRall ages=1.017 [1.009-1.025]; RR≥75years=1.012 [1.003-1.022]). Among specific causes, respiratory -though not circulatory- causes were associated with PM10 on days with advection in ≥75-year age group. Conclusion: PM10 levels, rather than PM2.5 levels, were associated with an increase in natural-cause mortality on days with advection of particulate matter from biomass combustion, particularly in the ≥75-year age group. Expected trends in terms of population ageing and an increasing number of fires (consequence of climate change) mean that measures must be adopted to minimise the health impact in such situations

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Impacts of climate change on the crop invasion of oilseed rape by the rape stem weevil, Ceutorhynchus napi, in North-Western Germany

Posters

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1. Introduction: The rape stem weevil, *Ceutorhynchus napi* Gyll, (Coleoptera: Curculionidae), is a severe pest in oilseed rape (Brassica napus L.) in Europe and can cause yield losses up to 50% (Williams 2010). Based on a refined model by Debouzie and Wimmer (1992), we analyzed interactions between meteorological variables and pest activity. This new impact model was combined with a multi model ensemble of regional climate change projections (Junk et al. 2012). This ensemble of different Global (GCM) and a Regional Climate Model (RCM) covers the period from 1961 to 2100. All projections were based on the A1B SRES emission scenario (Nakićenović and Swart 2000). The range of projected changes in future air temperature and precipitation were comparable with the recently published results presented in the 'Fifth Assessment Report: Climate Change 2013` by the IPCC. To eliminate systematic biases a non-linear bias correction scheme was applied to the air temperature and precipitation time series. The onset of the crop invasion by the rape stem weevil was projected to occur between 7 days (near future, 2021-2050) and 17 days (far future, 2069-2098) earlier in comparison to the reference period (1971-1990).

2. Materials and methods: The model by Debouzie and Wimmer (1992) predicts the crop invasion, when daily maximum air temperature exceeds 9°C on three consecutive days up to DOY 74. In addition, on these days no precipitation should occur. After DOY 74 only one day is taken into account with the same threshold values. Based on long-term observational data the threshold values of this model were optimized in an iterative process minimizing the root mean squared error (RMSE). The adopted values were 12.0°C, 12.5°C, and 13.0°C for the consecutive days (up to DOY 74). The daily totals of precipitation on these days must be less than 2 mm on each day. From DOY 75 onwards the thresholds values refer to only one day and were 9°C for the daily maximum air temperature and less than 1 mm precipitation. The in situ-observations at Goettingen, Germany (Lat. 51°56', Long. 9°94', 333 m AMSL) consist of field surveys (1989-2010). Daily data of maximum air temperature as well as precipitation were retrieved from the data archive of the German Meteorological Service (1971-2010) and used to calibrate the forecast model of Debouzie and Wimmer (1992) and for the bias correction of the different RCMs. We used 15 GCM RCM combinations of the EU ENSEMBLES project, covering the period from 1961 until 2100 (van der Linden and Mitchell 2009) with a spatial resolution of 25 km. For the air temperature and precipitation time-series a non-linear bias correction (quantile mapping) was applied that corrects the mean and also the width and the shape of the distributions (Te Linde et al. 2008).

3. Results & Discussion: A comparison of long-term averages of the measured (9.0°C) and modelled (8.9°C) mean air temperature of the reference timespan (1971-2000) differed only by 0.1 K. The 30-year long-term averages of the multi-model annual mean air temperatures increased from 8.9°C in the reference period to 10.1°C in the near (2021-2050) and 11.7°C in the far future (2069-2098). The long-term average annual precipitation sum - derived from the multi model ensemble mean - increased from 658 mm in the reference period to 706 mm in the near and 719 mm in the far future. The model by Debouzie and Wimmer (1992) adopted to the local climate conditions is able to reproduce the observed dates of crop invasion with a RMSE value of 10.9. In most of the years the differences are - with less than 3 days - very small. The combination of the multi model regional climate change projections and the immigrations model for C. napi were analyzed for 10-year time slices in the reference period as well as for the near and far future. In the control time-span, first appearance was on average at DOY 77 ± 2.8 (18 March). For the two future time-spans, shifts towards earlier dates are expected: DOY 70 ± 5.7 (11 March) for the near and DOY 60 ± 12.3 (1 March) for the far future. Although higher air temperatures increase the probability towards earlier migrations dates the changes in the precipitation mask this effect considerably. Even under significantly higher air temperatures in the far future the slightly higher precipitation amounts in March could hamper the crop invasion by C. napi.

4. Conclusion: Our study demonstrated that simple models using locally-adjusted weather-based thresholds have the potential to offer sufficiently accurate forecasting of first immigration flights by *C. napi*. This is the basis for an appropriate timing of insecticide application for controlling this pest.

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Early Corn Planting as a Water Conservation Strategy in the Southeastern USA

Posters

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In the agricultural region of the Mississippi River Alluvial Plain of Arkansas and Mississippi, USA, known as the "Mississippi Delta," corn is typically planted between March 15 and April 20 each year. As regional climate change continues to threaten agricultural productivity, the search for stabilized corn production becomes imperative. Even in this humid, subtropical climate, crops are often exposed to hot temperatures and drought in the summer months, which result in reduced yields at harvest. Conversely, corn planted earlier in the season may be susceptible to frost damage, so there is a risk-tradeoff annually debated by farmers. Recent research shows that planting earlier is associated with a higher probability of moderate harm to the crops while planting later increases the likelihood of severe harm to the crops. The purpose of this project is to determine the amount of water saved by planting earlier by analyzing irrigation requirements (based on temperature and precipitation data) during critical times in the corn-growth period for both early and late plantings. Results suggest that interannual variability is large, but early planting consistently results in decreased water use for irrigation, which reduces the use of valuable groundwater resources across the region.

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DOWNY MILDEW WARNING SYSTEMS FOR VINEYARDS CULTIVATED UNDER PLASTIC COVERING - INFLUENCE ON YIELD AND QUALITY

Posters

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In Brazil, the use of disease warning systems and plastic covers are promising alternatives to minimize the occurrence of grapevine downy mildew, which can improve productivity and quality. Although the use of plastic covers is a common technique in other regions, in northwestern São Paulo, Brazil, its use, associated with the disease warning systems, is still inexpressive, which has led to an excessive number of sprays for downy mildew control. Based on that, the objective of this study was to evaluate the effect of using different downy mildew warning systems associated to plastic cover on the productivity and quality of cv 'BRS Morena' grapevine. The experiment was conducted at the Embrapa Grape and Wine - Tropical Viticulture Experimental Station in Jales, SP, Brazil. Three rows of 60 m of the seedless grape cultivar 'BRS Morena', spaced 3.0 m between plants, were conducted. The vineyard was covered with braided polypropylene plastic film installed over a metallic arc-shaped structure (PPT). The experimental design was randomized blocks composed of five treatments, with six repetitions. The treatments were defined by the different grapevine downy mildew management: (TE) Control (no sprays against downy mildew); (CA) Conventional control (calendar); (BA) Warning system named 'Rule 3-10' (BALDACCI, 1947); (MA25) Warning system with moderate-infection efficiency - i0 > 25% (MADDEN et al., 2000) and (MA75) Warning system with high infection efficiency – i0 > 75% (MADDEN et al., 2000). According to the results, despite the timing of fungicide application in the region require a higher frequency of sprays, the vines presented productivity and fruits quality similar to those sprayed based on the warning systems. Therefore, it is recommend for northwestern São Paulo the replacement of the conventional control scheme of grapevine downy mildew by the management of spraying based on disease warning systems coupled with the grapevine cultivation under plastic cover, since these techniques allowed, on average, a reduction of 70% in the number of sprays for downy mildew control, which represents important savings in the production cost.

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Four plants, two hemispheres, same baseline?

Posters

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Changes in plant phenology due to anthropogenic climate change are now well documented – although, the phenological record base for the northern hemisphere is much richer. Currently, the overall picture between the two hemispheres is similar (e.g. earlier occurrence of spring events), however, the rate of change in many cases appears to be faster in the southern hemisphere. So is this in part attributable to climate or species sensitivity or a combination of both? A step to this is to examine the early phenology of species prior the significant influence of climate.

Hence we have started to find and compare early/legacy records (pre-1900) from the southern and northern hemisphere. This, naturally, necessitates comparison of only native species from one hemisphere and/or agricultural species. As indicated southern hemisphere records are sparse. However, pre-1900 datasets are available for a few locations, of these the records from the Tasmanian Royal Society (Hobart, Australia) covering the period 1864 to 1886 contain primarily northern hemisphere species. The PEP725 (http://www.pep725.eu/) database was examined for matching species, phases and coinciding time periods. Four species (*Aesculus hippocastanum* – first flowering; *Fraxinus excelsior* – leafing, *Robinia pseudoacacia* – leafing and *Sambucus niger* – leafing) from seven locations overlapped. Each of these is from the Dutch Royal Meteorological Organisation (KNMI) records (1868 to 1898). In all there were seven locations with one location, Oostkapelle, shared between species. We have assumed that the descriptive terms used in Hobart (e.g. commencing to flower is equivalent to 60 in the BBCH code used in PEP725 data).

As a first step we compared the seasons the phases occurred in as well as correlations between and among species, and locations. For *A. hippocastanum* and *F. excelsior* the respective phases occurred in the same season but in early Spring in Hobart and mid to late Spring in the Netherlands. For *S. niger* and *R. pseudoacacia* the phases did not occur in the same season. In Hobart leafing in these species always occurred earlier: *S. niger* was always coming into leaf by late winter (August) compared to late Spring and early Summer (May/June) in the Netherlands, *R. pseudoacacia* was in leaf by early Spring (September) in Hobart compared to Summer (June/July). These differences in timing could in part be explained by Hobart being between 2.4 and 3.5 °C warmer on average.

The strongest correlation (R = 0.60) within species was in *F. excelsior* between Oostkapelle and Hobart. Although this was not significant (P = 0.11) and over a very limited period; 1869 and 1876. The largest number of coinciding years, from 1868 to 1883, was in *S. niger* at both Slijk-Ewijk and Zaandam. These correlations were weak (R = 0.13 and -0.16, respectively) and also not significant (P > 0.2). Weak agreement also occurred within species in the Netherlands: for example in *S. niger* between Aardenburg and Varsseveld (R = 0.04) and *A. hippocastanum* between Aardenburg and Bovenkarspel (R = -0.19).

Interestingly, equally as strong or stronger correlations were found between the species. The strongest of these relationships was between F. excelsior in Hobart and *R. pseudoacacia* in Oostkapelle (R = 0.92, P = 0.009), however, it was over the same limited time period previously mentioned (1869 and 1876). This does, however, rise the possibly of using surrogate species for current monitoring.

This limited examination of phenological phases across the two hemispheres has not provided a clear answer on whether the current differences are attributable to climate or species sensitivity or a combination of both. The reasons for this could be differences in interpretation of phases, the limited number of coinciding years, phenological plasticity or real regional differences. Hence further exploration such as the examination of commonality of growing degree days within the longer periods of these data as well as locating legacy datasets with greater overlapping periods are needed to provide a clear answer.

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Communication of climate change impacts via phenology

Posters

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Phenology has come back to the center of interest, not only in research but also as a way to communicate effects of climate change to the public. The first and most obvious biological impacts of climate change was detected in the environment using long-term phenological data: “Phenology –

the timing of seasonal activities of animals and plants – is perhaps the simplest process in which to track changes in the ecology of species in response to climate change" (IPCC 2007). Organizations funded new phenological networks, long existing networks got new impetus. IPCC (2014), the European Environmental Agency EEA and many single countries have been publishing reports on climate change and CC impacts using phenological indicators. Networks communicate the outcome of monitoring efforts and data-analyses via both traditional and social media. As many of the phenological observers are citizen scientists the delivered data need quality control and the citizen scientist must be kept on track to get longer time series and qualitatively good network data sets. In the end of March 2014 the team of PEP725 (www.pep725.eu) started a questionnaire among the global phenology community to get an overwiew on ways of communication, utilization of phenological indicators, data quality procedures and data analyses used. The evaluation of the questionnaire will be presented. 1) How do you communicate the "nature's calendar" in your country? 2) Are governmental indicators used? If yes: what kind of indicators based on phenological observations or modelsare used? 3) Criteria for data cleaning/correction 4) Does it make sense to use/provide standardized analyses for phenological applications?

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Recent Trends in Blooming Dates of Spring Flowers in Korea

Posters

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The spring season in Korea features a dynamic landscape with a variety of flowers such as magnolias, azaleas, forsythias, cherry blossoms and royal azaleas flowering sequentially one after another. This enables local governments to earn substantial sightseeing revenues thanks to festivals featuring spring flowers, and bee keepers who move from the southern tip of the Korean Peninsula all the way northward in quest of spring flowers to secure nectar sources over a sustained period of time. However, the narrowing of areal differences in flowering dates and those among the flower species is taking a toll on economic and shared communal values of seasonal landscape. Data on flowering dates of forsythias and cherry blossoms, two typical spring flower species, as observed for the recent 60 years in 7 weather stations of Korea Meteorological Administration (KMA) indicate that the difference spanning the flowering date of forsythias, the flower blooming earlier in spring, and that of cherry blossoms that flower later than forsythias was 30 days at the longest and 14 days on an average in the climatological normal year for the period 1951 - 1980, comparing with the period 1981 - 2010 when the difference narrowed to 21 days at the longest and 11 days on an average. The year 2014 in particular saw the gap further narrowing down to 7 days, making it possible to see forsythias and cherry blossoms blooming at the same time in the same location. The synchronized flowering of the two flower species is attributable to the fact that acceleration of flowering due to abnormally high spring temperature was more significant in cherry blossoms that flower later than forsythias. In the case of the 1951-1980 normal year, while cherry blossom flowering dates as observed by 7 weather stations across the nation ranged from March 31 to April 19 (an areal difference of 20 days), for the 1981 - 2010 normal year the difference ranged from March 29 to April 12 (with an areal difference of 16 days), thus further narrowing the gap, and in 2014 the gap in flowering dates further shrank to a duration spanning March 25 and March 30 (with an areal difference of 6 days). On the other hand, in the case of forsythias for the 1951-1980 normal year, flowering dates from the 7 weather stations ranged from March 17 through April 5 (an areal difference of 20 days), comparing with the 1981 - 2010 normal year when the flowering dates narrowed down to a duration from March 17 through April 2 (an areal difference of 17 days), and the year 2014 saw the range of flowering dates further narrowing from March 16 to March 27 (an areal difference of 12 days), with the gap of decrease getting narrower than in cherry blossoms. It is presumed that the latest climate change pattern in the Korean Peninsula as indicated by rapid temperature hikes in late spring contrastive to slow temperature rise in early spring immediately after dormancy release brought forward the flowering date of cherry blossoms which comes later than forsythias which flowers early in spring. A phenology-based flowering model that can explain this phenomena could contribute toward the clarifying of multi-faceted and complex effects of the flowering pattern change on terrestrial ecosystems.

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Inquiry-Based Activities and Biometeorology: Implementing In-Class Exercises and Examining Biomet Education Research Possibilities

Posters

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Inquiry-based activities are constructivist pedagogical methodologies, or one in which students "construct" knowledge, and the teacher helps to facilitate the students' education. Classes that utilize inquiry methodologies create an interactive environment in which there is peer-to-peer and teacher-to-student exchange of knowledge through active learning and a reduced focus on traditional lecture. These teaching approaches have been particularly effective in STEM classes for developing student critical thinking skills and a deeper appreciation of the scientific method.

This purpose of this folder is two-fold: 1) To demonstrate inquiry-based methodologies used by the author to integrate basic hazards and biometeorology principles into the curricula of several geoscience courses (Introduction to Geography, Physical Geography, Maps and Map Reading). 2) To examine research possibilities for implementing and assessing biometeorology education in introductory-level geoscience courses. The goal is to develop research that compares student development to teaching methodology, to determine best practices for biometeorology instruction.

27

Albedos and Emissivities of Urban Materials in Korea for Computer Simulations

Posters

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Urban environments are composed of various materials which create different human spaces. Especially, those materials are main effects in its thermal environments. Recently, three dimensional computer simulations have been adopted to urban climate studies including urban heat/cool island, human thermal sensation and comfort modeling and so on. Several researchers tested albedos and emissivities of urban materials, which are important input data for the computer simulation. However, the albedos were in broad ranges, and how the albedos change depending on solar altitudes has rarely been studied. This study investigated albedos and emissivities of 17 urban materials (10 ground surfaces, 3 trees, 2 rooftops and 2 building walls) at the campus of Changwon National University (35°14'31"N, 128°41'52"E; altitude, 63 m), Republic of Korea, on three times (morning, noon and afternoon) in clear summertime (June 4-5, 2013) and wintertime (January 14, 2013). The solar altitudes were 29.3-74.9° in summertime and 5.5-33.2° in wintertime. Short- and long-wave radiation was measured using a CNR4 net-radiometer, and ground surface temperatures were measured with a Testo 830-T1 infrared thermometer.

Limestone walls had the highest albedo, over 43 %, and asphalts had the lowest, around 10 %. Flagstones on the grass had also low albedos, 11-14 %. Conifer trees had mean 3 % lower albedo than those of deciduous trees, and dried grasses in wintertime had mean 8 % higher one than those of green grasses in summertime. In the comparison between solar altitudes and albedos, there were two typical patterns: a curved pattern with the highest values within 30-35° [i.e. wooden deck (brown), brick (apricot), polyurethane basketball ground (green), soil with gravel, flagstone on the grass, conifer tree and concrete rooftop (gray)]; a decreasing pattern with increasing solar altitudes [i.e. brick (red), brick (gray), polyurethane rooftop (green), deciduous tree and grass]. Some materials [i.e. asphalt, brick wall (red) and limestone wall] did not show any typical patterns. Only 6 materials had a little bit high values of the coefficients of determination (r2): brick (red), 73.5 %, concrete rooftop, 81.8 %, grass, 81.7 %, polyurethane basketball ground (green), 70.3 %, polyurethane rooftop, 95.8 %, and wooden deck (brown), 68.7 %.

The emissivities in summertime were mean 3 % higher than those in wintertime. Most ground materials showed a typical pattern between solar altitudes and emissivities: increasing emissivities with increasing solar altitudes. However, trees and building walls revealed no relationship between them. Only 3 materials had a little bit high r2s: brick (apricot), 64.4 %, grass, 61.4 %, and polyurethane basketball ground, 93.5 %.

Albedos and emissivities of urban materials depend on their components, colors, surface roughnesses, thermal admittances, solar locations and so on. Therefore, more data collection is required for the use of input data of computer simulations. However, this study showed possibility of creating algorithms of albedos and emissivities of urban materials depending on solar altitudes for the computer simulations.

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Modeling intra-urban extreme heat exposures with fine-scale land use data

Posters

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Climate models suggest that large United States (U.S.) urban populations will disproportionately experience extreme heat, in part due to the urban heat island (UHI) observed in metropolitan areas. The System for Integrated Modeling of Metropolitan Extreme Heat Risk (SIMMER) is a NASA-funded project aimed at characterizing and addressing extreme heat risk through interdisciplinary approaches. SIMMER focuses on two cities, one of which is Houston, Texas. Houston is currently experiencing trends of increasing populations, changing demographics and urban sprawl. Houston's changing UHI – which is substantially influenced by urban morphology and vegetation – poses a potential challenge to public health and planning officials interested in reducing exposure to extreme heat. Recent regional climate simulations performed at the National Center for Atmospheric Research suggest that the number of 'high heat stress' days and nights in Houston will more than double by mid-century, raising the potential for increased exposure to extreme heat. We employ a simplified approach to modeling the distribution of temperature for current and future (2040) Houston, using high-resolution (1km) climatic and fine-scale land use (parcel-level) data. We will present results from meteorological and land use surface modeling components of SIMMER for Houston, Texas. We will focus on a series of sensitivity simulations that evaluate how changes in the urban form, derived from parcel-level present and future land use types, exhibit changes in the intra-urban temperature distribution with 1°C incremental climate perturbations. The results of these experiments will be discussed to reflect how alterations made to the urban environment via land use changes influence the distribution of heat, and consequently could impact climate change adaptation strategies.

30

Simulation of extremely hot events in Croatia with RegCM4.2

Posters

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The characteristics of summertime hot events in Croatia are examined by using regional climate model RegCM4.2. Model is forced over the EURO-CORDEX domain by ERA-Interim reanalysis for the period 1989-2008 and two different horizontal resolutions. First experiment is done for 50 km resolutions whereas in the second the resolution is increased to 12.5 km. Daily mean, maximum and minimum temperatures are analysed in order to define climate extreme indices during summer in Croatia. Number of summer days, warm and very warm days, warm and tropical nights, heat weaves and their duration are compared among two experiments. Results from both experiments are also compared with the daily E-OBS data as well as with the observed data from the Croatian meteorological stations. Although the model in both simulations generally overestimates observed results, the experiment on finer resolution better reproduce the spatial distribution of the analysed indices over Croatia.

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Modeling of Solar UV Reaching Ground Level for the Purpose of Antipsoriatic Climatotherapy in Poland

Posters

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The antipsoriatic effectiveness of artificial UV light ,emitted by fluorescent tubes, has been supported by many authors. Nowadays, the climate therapy is carried out rather sporadically; only at a very few southernmost holiday resorts (the Dead Sea, the Canary Islands) with intense solar radiation throughout almost the whole year. Statistical analysis of the daily course of exposures to TL-01 tube radiation for 93 psoriatic patients from the Medical University of Łódź during 20-day phototherapy shows that the dose of 1J/cm2 represents a unit of single exposure necessary for psoriasis healing. This value is converted to the antipsoriatic effective dose of 317.9 mJ/m2 using the TL-01 lamp irradiance spectrum and the antipsoriatic action spectrum. It is proposed that the daily exposure of 317.9 mJ/m2 serves as the standard antipsoriatic dose (SAPD) providing a link between the cabinet and the out-door exposures. This value could be used for planning heliotherapy at any site.

A model is proposed to calculate ambient antipsoriatic doses for 3 h exposures around the local noon (9-12 GMT) based on satellite (OMI) measurements of ozone and the radiative cloud fraction. The model constants are determined by a comparison with pertaining antipsoriatic doses measured by the Brewer spectrophotometer in central Poland. It is found that 3 h exposures to solar radiation in the period 15 May-15 September provides the mean (2005-2013) doses in the range 2.7 -3.1 SAPD over Poland. The most effective site for antipsoriatic heliotherapy is the south/east part of Poland (the Bieszczady Mountains). The regional differences in the antipsoriatic potential of solar radiation are quite small, i.e. 15% difference between the site with the highest and lowest doses.

Thus, heliotherapy could be treated as an alternative to the cabinet phototherapy for almost 4 months.

To help a patient with planning next day sunbathing schedule we prepare a numerical prognostic model to inform of optimal starting time and necessary sunbathing duration at any site in Poland. The prognostic map is available at web page. The model uses the forecasted column amount of ozone (by GFS High Resolution model) and the cloud cover (by WRF model) to calculate duration of sunbathing to take 1 SAPD. The duration of sunbathing in the upright body position is provided for next day every full hour between 6 am and 3 pm. We hope that for some patients self-controlled sunbathing will be more effective than standard indoor therapy as the psychological stress usually involved with medical treatment will be not present during individual heliotherapy.

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CLIMATE ANALYSIS IN NATAL/RN TO THE VARIATION OF THERMAL COMFORT

Posters

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The climate has a major influence on the man, so that monitoring of thermal sensation is necessary to then propose measures to solve the health problems linked to the possible climate variability. The objectives of this study were: to relate climate variations to the thermal comfort and health (symptoms) in urban population. And as the main objective to analyze the microclimatic variables of Natal city/RN during the period of 1961 to 2010, through the index of effective temperature (ITE) proposed by Nieuwolt (1977), demonstrating what the thermal sensation for the inhabitants of this region during this period. Used in this study, monthly data of temperature and relative humidity, obtained from the National Institute of meteorology (INMET). According to the calculated index, it was observed that in Natal/RN the average temperature has increased along the time series from 1961 to 2010. Considering the ITE of the whole time series, thermal comfort was mainly response physical track of "great discomfort", the same band was observed in the last ten years, already during the first 10 years the track was "no discomfort (ideal)". This increase in the index can be explained by several factors: growth of the city, intensifying heat island phenomena and thermal inversion, among others at the mesoscale level. Moreover, it can be inferred that increases in temperature and thermal comfort range were also due to climatic variability, so atmospheric systems begin to act act more or less pronounced over the city, causing the change in the local climate.

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Building façade greening as a mitigation option for climate change in cities

Posters

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Urban greening, through increased street level vegetation and urban parks, or vegetation affixed to buildings as green roofs and walls, is one technique to mitigate climatic impacts from both global climate change and urbanisation. Green walls and roofs have a dual benefit in that they can moderate atmospheric conditions both internal and external to the building.

This study quantifies the impacts of façade greening on a single prototypical building representative of an area undergoing urban renewal in an inner suburb of Sydney. The microclimate surrounding the building was simulated for a typical summer day using the three-dimensional prognostic micrometeorological model Envi-met. Simulations were undertaken for two vegetation species suitable for façade greening, one representing a native species (Myoporum parvifolium a ground cover plant with a leaf area index of 1.5) and one representing an exotic species (Glycine max, a sub-shrub with a leaf area index of 4). The total amount of vegetation cover across the façade was also modified for different simulations. Whilst the impacts on surrounding microclimate were found to be small (< 0.3 °C) the green walls reduced outdoor surface temperature of the walls by up to 15 °C. Future work will evaluate the impact of this decrease in building wall temperature on building energy consumption.

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Influence of climate variation on tourism and hospitality in Nigeria

Posters

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Influence of climate variation on tourism and hospitality in Nigeria Abstract on tourism

Climate change is not a remote event, but a phenomenon that already affects the tourism sector and certain destinations in particular, mountain regions and coastal destinations among others. At the same time, the tourism sector is contributing to greenhouse gas emissions (GHG), especially through the transport of tourists. tourism is a major source of global day to day activities emerging from business, cultural trends and global economy. Tourism is a potential revenue generation and employments creation for the people. This paper investigates the relationship between climate, weather and tourism from the perspective views of geography of tourism and climatology. This work will analyze the nature of influences climate change has on tourism, hospitality and recreation. It focuses on the need to improve the simplicity descriptions traditionally reported in planning projects which are often unconnected to the requirements of tourism and revealing the links that atmospheric phenomena has on tourism. The research find out the relationship between extreme weather conditions by using correlation and regression coefficient between the weather parameters and the visitors to the tourist sites for different weather season in Nigeria. The tourism sites investigated are Beach in Lagos and Idanre Hill in Ondo. Key words: Climatic Variation, Weather, Season, Tourism Site, and Tourist

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Climatic regionalization of Rio Grande do Sul (Brazil) based on zoning of the human thermal comfort

Posters

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Thermal comfort is associated with the rhythm of heat and humidity exchanges between the human body and the environment. The human body reacts accordingly to temperature variations and attempts to self-regulate in order to maintain its internal temperature in balance, in order to adapt to the surrounding environment.

The reason for creating thermal comfort conditions resides therefore in the human need to feel thermally comfortable; furthermore, thermal comfort can be justified from the point of view of human performance as well as resistance to certain diseases and productivity of individuals.

So, thermal comfort can be viewed and analysed in two ways: from a personal standpoint and an environmental standpoint. From this, the objective of this research was to evaluate the thermal comfort conditions in the regional and sub-regional scales in the state of Rio Grande do Sul, Brazil, according to the mean monthly and seasonal air temperature, relative humidity and wind speed in order to establish a climatic regionalization zoning based on human thermal comfort.

Also, the thermal comfort conditions were established for rainy years, drier years and usual years. Weather systems prevalent in these years were also evaluated. A theoretical research on the topic was performed, and the climatic database of the National Institute of Meteorology (INMET) was used, digitalized using GIS (Geographic Information System).

The database for the research was built assigning Effective Temperature with Wind (ETW) indexes for autumn and winter, and the Resulting Temperature index (RT) for spring and summer seasons. The thermal sensation zones or categories were defined from the classes developed by Fanger (1972) and adapted to São Paulo, SP and by Maia and Gonçalves (2002). We used a total of 23 weather stations, distributed across different geomorphological compartments of the study area, into a series of 30 years with daily data.

In autumn, summer and spring, the determination of thermal sensation zones in the study area are influenced by geographic controls, such as altitude, continentality, distance from the ocean and latitude, while the winter station showed a stronger influence of regional atmospheric dynamics. Among the atmospheric systems defining the climatic zonation, we can highlight the Polar Atlantic Mass (PAM) and Atlantic Polar Front (APF) in spring, Old Polar Mass (OPM), Tropical Atlantic Mass (TAM) and Tropical Continental Mass (TCM) in summer, PAM and Stationary Front (SF) in autumn and PAM in winter.

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Gradual changes of climate in the west of Iran based on frequency of air masses presence in winter

Posters

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Significant repetition of daily dominance of definite air mass in each region that requires good condition of meteorological conditions creates a definite climate. In this research, winter air masses were studied in 5 synoptic stations in the west of Iran including Kermanshah, Ilam, Khoram Abad, Nozhe and Sannadaj in period 1961-2004. 3 kinds of winter air mass being identified by Spatial Synoptic Classification of Islamic Republic of Iran (SSCIRI), annual and monthly distribution and daily share of each of them in each month were evaluated in terms of historical and climatic changes. The west of Iran in a brief look and from temperature aspect is divided into the stations including Kermanshah, Nozheh of Hamedan and Sanandaj as being cold and Khoram Abad and Ilam stations inclined to southwest and are hot. The calculations of monthly and annual evaluation of air masses frequency based on Kermanshah station was done as relative representation of the west of Iran. Totally and according to the studies, it is concluded that winter in Kermanshah station and for west of Iran had hot condition and winter period with its historical characteristics in which coldness and snowfall are its main components, had less occurred and it is getting short and spring condition is more and more visible namely in March. Keywords: Iran; Climate change; air masses; presence frequency; trend; Kermanshah; SSC

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Biologically effective UV radiation trend in Florence, Italy as measured at ground station and assessed by remote sensing.

Posters

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Solar Ultraviolet radiation (280-400 nm) is responsible for various biological effects relevant ...

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Temporal Synoptic Index of Winter Season for Southern Coasts of IRAN

Posters

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Each place reflects the properties of the air mass dominant on that area based on its geographical, topographical, and environmental characteristics, which can create unique meteorological conditions on station scale. In this research, Temporal Synoptic Index of winter season or according to its localized definition, surface weather types of the Persian Gulf's and the sea of Oman's coastal stations consisting of six stations were examined. For this purpose, identification and categorization of different climatic types on station scale were carried out. This task was perfomed based on nine meteorological variables including sea level pressure, dew point, minimum temperature, maximum temperature, daily minimum and maximum saturation deficit, cloudiness, daily temperature range, and daily dew point range on daily scale during 1961-2004 period using Principal Components Analysis and Cluster Analysis. The meteorological properties of each of the weather types were determined through organizing 40 variables and employing and emphasizing on elements such as precipitation, daily temperature, relative humidity, cloudiness, maximum and minimum daily temperature and the number of rainy days. The results of this investigation showed that the weather types of the Strait of Hormuz's eastern stations including Jask and Chabahar from meteorological conditions and amount of precipitation aspects were distinguishable from the western stations. In addition, a kind of relative homogeneity between station types can be observed considering heat and humidity aspects, by disregarding the precipitation characteristics. If so, this homogeneity could cause error. Therefore, the precipitation element has relative salience in categorization of the types. High-precipitation types in the western stations of the Strait of Hormuz were consistent with moderate and humid type from precipitation aspect while it is consistent with partly warm and humid type in the eastern stations. Furthermore, high-precipitation types in Bandar-Abbas's and Bandar-Lengeh's stations and Bushehr's and Chabahar's stations and Kish's and Jask stations during statistical period of the station had the maximum, middle, and minimum abundance, respectively. Therefore, by considering the number of rainy days and presence frequency of weather types, winter season of Bandar-Abbas's, Bandar-Lengeh's, Bushehr's, Chabahar's, and Kish's and Jask stations can be defined as relatively rainy, semi rainy, low rainy, relatively low rainy, and very low rainy, respectively. Keywords: Iran, Principal Component Analysis, TSI, Weather Types.

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Frequency Analysis of Extreme Temperature Events

Posters

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Two main meteorological stations from two different climate regions of Croatia (the continental and the coastal region) have been selected to analyse the annual number of days above 90th percentile (days fall under the categories considerably warm and extremely warm) and days below 10th percentile (days within the categories considerably cold and extremely cold). In other words, all available daily mean temperatures for Zagreb-Grič and Split-Marjan are compared with the multi-annual average (1961-1990), which is common practice in climate analyses. Moreover, temperature anomaly for each day is expressed as a percentile. Secular trends at the Zagreb-Grič Observatory (1862–2012) of the annual number of days above 90th percentile indicate a positive significant trend of 19.0 days/100 years whilst for days below 10th percentile, a significant negative trend of -18.1 days/100 years could be observed. At Split-Marjan (1948-2012) trends were not significant in both cases. There was the positive significant trend of 0.5 days/10 years for days above 90th percentile and negative non significant trend of -1.0 days/10 years for days below 10th percentile. The significance of linear trends was tested by Mann-Kendall test for a 0.05 significance level. The results obtained show that extreme temperature trends follow global warming trends in continental part of Croatia, represented by Zagreb-Grič, whilst it is not the case in the coastal region, represented by Split-Marjan.

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Characterizing joint effects of spatial extent, temperature magnitude and duration of heat waves and cold spells over Central Europe

Posters

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Heat waves and cold spells have pronounced impacts on the natural environment and society. The main aim of this study is to identify major Central European heat waves and cold spells since 1950 and assess their severity not only from the viewpoint of temperature and duration but also as to the affected area. The heat waves and cold spells are delimited from the E-OBS gridded data set. An extremity index is proposed that captures joint effects of spatial extent, temperature and duration of heat waves and cold spells. During the 1950–2012 period, we identified 18 major heat waves and 24 major cold spells over Central Europe. The most severe heat wave occurred in summer 1994, followed by the 2006 heat wave; both these events were far more extreme over Central Europe than heat waves in the well-known 2003 and 2010 summers. The most severe cold spells occurred in the winters of 1955/56 and 1962/63. The recent winter of 2011/12 was found to be the 6th coldest since 1950/51 according to the seasonal sum of the extremity index. The heat waves and cold spells were classified through a hierarchical cluster analysis of their characteristics (temperature amplitude, spatial extent of the core, and duration) into 4 basic types. The established list of major Central European heat waves and cold spells might be utilized in further analyses, and the extremity index may be applied over different areas to perform comparative studies and used also for evaluation of regional climate model simulations.

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Effects of Retrofitting Living Rooms with Thermal Insulation on the Health of the Elderly

Posters

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INTRODUCTION Human life expectancy is affected by numerous factors, including heredity and disease, which have been studied in considerable detail. However, other factors influencing human health and life expectancy have not been studied quite as extensively. The quality of housing affects human health, but little is known about the specific health effects of the indoor environment. People spend most of their time indoors, mostly in their own homes, and thus, improving the quality of housing could potentially aid in the prevention of ill health. The elderly spend most of their time in their living rooms; therefore, in the present study, we investigated the effects of retrofitting living rooms with thermal insulation on the indoor environment and the health of elderly residents.

METHODS Most areas of Japan have a temperate climate, with mean winter daytime temperatures ranging from -8°C in the north to 17°C in the south. The mean winter daytime temperature in Tokyo is 6°C (mean values from 1981-2010). This study was carried out in two areas of Tokyo as well as Saitama, a prefecture adjacent to Tokyo. The participants were living in 10 households in Saitama and four households in Tokyo. The four houses in Tokyo were conventional wooden structures built between 1941 and 1952 (mean age of structure, 63.5 years). In Saitama, eight houses were wooden structures and the other two were light-gauge steel framed; these 10 houses were an average of 26.6 years old. All houses had no or poor insulation. Most of the residents usually heated only their living rooms and occasionally their bedrooms. The living room of each house was retrofitted with one of the following four insulation levels: 1) replacing single-pane with double-pane windows (Tokyo, n=3); 2) replacing single-pane with double-pane windows and retrofitting the living room walls and floor with thermal insulation (Tokyo, n=1); 3) replacing single-pane with double-pane windows, installing thermal insulation in the living room walls and floor, and installing a floor heating system (Saitama, n=5); and 4) the same changes as level 3 except that vacuum insulation panels were used to retrofit the walls (Saitama, n=5). Residents comprised six elderly males and 12 elderly females (mean age, 67.9 years; age range, 59-85 years). All residents were in good health and were not taking antihypertensive drugs. The initial indoor environment and residents' health were assessed from October to December 2011 (baseline), before the thermal insulation retrofitting. After the retrofitting, the indoor environment and residents' health variables were assessed as outcomes in the following two measurement periods: the first winter (January to February 2012) and the second autumn/winter (October to December 2012). In this study, we focused on outcomes measured during the second autumn/winter (follow-up), which were obtained in the same seasons as the baseline measures. For each house, temperatures and relative humidity were measured every 10 minutes in the living room, the bedroom, the bathroom, and the changing area, and outside of the house for 4 weeks in each measurement period. Each participant's blood pressure was automatically measured every 30 minutes for 24 hours by a portable automated sphygmomanometer (TM-2431C, A&D Co. Ltd., Tokyo, Japan) once in each measurement period. Participants measured their own blood pressure five times per day (after waking, after breakfast, after lunch, after dinner, and before bedtime) and recorded the number of hospital visits and daily frequency of defecation and urination for 4 weeks in each measurement period. Each resident was interviewed at home and answered a questionnaire composed of the following scale items: subjective view of health; WHO-5 well-being index1); Overactive Bladder Symptom Score (OABSS)2); St. George's Respiratory Questionnaire (SGRQ); Pittsburgh Sleep Quality Index

(PSQI)3); Rhinoconjunctivitis Quality of Life Questionnaire Japanese Version (JRQLQ No.1)4); thermal sensation; thermal comfort; humidity sensitivity; and clothing insulation value (CLO). Residents completed this questionnaire once for each measurement period.

RESULTS and DISUSSION The mean outdoor temperatures were 16.5±1.19°C in autumn/winter 2011 and 11.7±1.51°C in autumn/winter 2012. Autumn/winter 2011 was significantly warmer than autumn/winter of 2012 ($P<0.01$). The mean temperatures of the residents' living rooms were 20.3±0.76°C at baseline and 18.7±1.49°C at follow-up ($P<0.01$). The mean temperatures of the residents' bedrooms, bathrooms, and changing areas were lower in 2012 than in 2011 by 3.6°C, 3.5°C, and 3.7°C, respectively. Although the mean living room temperature was lower in 2011 than in 2012, residents started using heating appliances in their living rooms 1 to 2 weeks later in 2012. On the contrary, they turned the heater on in their bedrooms 4 or 5 days earlier in 2012 than in 2011. No significant differences were observed in thermal sensation, thermal comfort, humidity sensitivity or clothing insulation between baseline and follow-up. The difference in the timing of heating appliance use in the living room might be attributed to factors other than temperature and relative humidity, such as sensitivity to drafts. No significant changes were seen in blood pressure measured every 30 minutes for 24 hours before and after the thermal insulation retrofitting. Coefficients of variance of self-assessed blood pressure, which were obtained by dividing the standard deviation by the mean value across 4 weeks, were significantly smaller at follow-up than at baseline, indicating relative stability in the residents' blood pressure after the retrofitting. Significant improvements were evident in PSQI and JRQLQ items after the retrofitting. Furthermore, in personal interviews, residents reported that they perceived better thermal conditions, greater anti-noise effects, and less dew condensation in their living rooms after the retrofitting. These results suggest that retrofitting living rooms with thermal insulation improves some aspects of the health of elderly residents.

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Ageing in changing climate

Posters

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Population ageing and climate change are two of the most pressing issues nowadays, yet there has been little attention given to the relationship between the two. Climate change is expected to result in a rise in average temperature. Changing climate with accelerated warming of global temperatures is also directly attributed to human activity. It is at least 90 per cent certain that human emissions of greenhouse gases (GHGs) rather than natural variations are warming the planet's surface. Climate change is expected to have adverse effects on natural and human systems. The risk and harm resulting from climate change will not be evenly distributed. Older people, because of a range of physiological, psychological and socio-economic dispositions, are more vulnerable to the impacts of climate change and extreme weather events. The world is ageing rapidly and will continue to do so over the coming century. Growing old in the twenty-first century will bring a unique challenge of changing climate. The share of those aged 55-plus rose from 12 per cent of the world's population (approx. 300 million) in 1950 to 16 per cent in 2010 (1 billion). By 2050 there will be a dramatic increase in the number of over 55s who will represent nearly a quarter (just over 2.5 billion) of the global population. Though, older people are likely to be more vulnerable to the direct and indirect impacts from climate-related events, they can also be seen as potential contributors to this climate change. The over 50s contribute to the problem of climate change due to carbon emissions resulting from their level of consumption. The diversity of this group is reflected by their life stage and carbon footprint. The carbon footprint is the total amount of CO_2 emissions which result directly and indirectly from the individual consumption of goods and services. Baby boomers (aged 50–64 years) have a higher carbon footprint compared to other age groups, approximately 13.5 tonnes, and emit 1.5 to 2.5 tonnes more CO_2 per year than any other age group. A senior (aged 60-69 years) has a carbon footprint of approximately 12.1 tonnes of CO_2 per year. Elders (aged 75 plus) represents 40 per cent of their carbon footprint. Their CO_2 emissions from energy use in the home are 40 per cent higher than the national average. However, these groups of older people are more at risk from climate related threats due to an increased likelihood of deteriorating health that comes with age and reduced capacities for coping independently. The physical and social well-being of older people will be affected directly and indirectly from a changing climate. High temperature is more likely to result in mortality when combined with poor air quality which makes respiratory symptoms worse. They are often more susceptible to infectious disease, and as environments change, so will disease patterns and prevalence. Not only that, climate change is likely to influence economic output via the escalating the price of necessary commodities such as water, food and energy induced by supply shortages. The vulnerability of an older person to these effects of climate change will be determined by genetic disposition, pre-existing burden of disease or ill health, income, geographic location, family support systems, quality of public health infrastructure and access to relevant local information. Therefore, healthy lifestyles, coping skills, strong family and social ties, active interests and of course, savings and assets, will all assist in ensuring that people's reserves are and remain strong in later life. Along with, necessary actions should be taken to build adaptive capacity at a community level that can effectively reduce either the level of climate-induced exposures or reduce the sensitivities of older persons to them, thereby increasing overall resilience to climate change.

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Urban Heat Island Magnitude Impacts on Raw Mortality in Three Midwestern US Cities

Posters

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Three urban areas in the Midwestern United States were studied for five years (2013-2008) to determine whether the urban heat island (UHI) temperature magnitude or the temperature differences between selected urban and rural stations had an impact on raw mortality within the urban areas of Omaha, Nebraska; Des Monies, Iowa; and Dayton, Ohio. The author ot this study was curious to determine if mesoscale connections of temperature had a connection with death rates. Monthly mean UHI temperatures for these cities were compared to raw death counts to determine a correlation of these two independent variables. Results were reported and are discussed with surprising results.

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A discussion about the climate change impacts on elderly mortality rates in the metropolitan region of São Paulo – Brazil: what to expect?

Posters

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As consequence of the age-structural transitions observed in Brazil over the past years the elderly population (age ≥ 60 years) of the metropolitan region of São Paulo has increased from 1.2 million in 1996 to 2.1 millions in 2011. One of the major concerns about global warming is related to the impacts on vulnerable populations living in urban areas. The all-cause mortality rate of elderly

people in São Paulo presents a seasonal pattern shaped by climate variations where the highest mortality rates are observed in winter and the lowest in summer. Since previous studies involving regional climate model projections for this region points to a warming trend scenario the following question arise: The expected global climate change impacts on the elderly population are going to be exclusively bad? Or there may be something positive about it? A preliminary data analysis indicate that all-cause mortality rates for both elderly men and women are decreasing while the mean annual temperatures are increasing. It is also notice that this mortality decrease is more pronounced in winter months. An observed/expected analysis of the daily mortality rate was also conducted from 1996 to 2011 period. Mortality data was associated with maximum, mean and minimum temperatures (Tmax, Tmea and Tmin respectively) obtained from a meteorological weather station. It is shown that excessive deaths per day significantly increases when Tmax ≥ 30ºC, Tmea ≥ 24ºC and when 14ºC > Tmin ≥ 21ºC. On the other hand a decrease in mortality rate is perceived when Tmax < 15ºC, Tmea < 11ºC and when 14ºC ≤ Tmin < 20ºC. It is also shown that the deficit or excess in daily mortality rates are mainly conditioned by low frequency temperature intervals, i.e., those represented by temperatures that are not common to be recorded in this region. These are key intervals regarding the impacts of climate change over the elderly people.

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URBAN HEAT ISLAND IN WARSAW (POLAND) AND ITS BIOCLIMATIC CONSEQUENCES

Posters

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Urban heat island (UHI) is microclimatic phenomenon that occurs in urbanised areas. It is manifested in significant increase of air temperature in urban area in relation to the surrounding rural neighbourhoods. UHI is effect of: - physical characteristics of the surfaces: materials composing urban surfaces, such as concrete and asphalt, absorb rather than reflecting solar radiation, - lack of natural evaporative surfaces (vegetation) that, in rural areas, contribute to maintain a stable energy balance, - augmentation of the vertical surface that both provide an increased surface absorbing and reflecting solar radiation as well as block winds that contribute to the lowering of the temperature (canyon effect), - human activities that mainly consists in heat produced by heating and cooling plants, industrial activities, vehicles, etc. Therefore during the day large quantities of heat accumulate in the city. At night heat is gradually released into the atmosphere, making it warmer than outside the city. A commonly used measure of UHI is a difference of the minimum air temperature between urban and rural areas. In Warsaw Agglomeration the UHI in particular days can be up to 10-12°C. Medium, long-term UHI values in dense urban or industrial areas can reach 2.5°C. However, warming effect in the city is weakly observed on open areas inside the city, in residential suburban estates with no-dense settlements. UHI is not observed inside the forest growing within the city border. In spite of the growing of the city UHI in Warsaw did not change significantly during the period 1981-2010. UHI phenomenon is also seen when considering thermal conditions felt by urban population. While classic UHI approach is best observed in nights and early morning hours then in bioclimatic considerations daytime surplus of heat in the city centre is more crucial for people living in the city. To present spatial distribution of bioclimatic UHI in Warsaw the GIS methods were used. The research was carried out with support of Central Europe Programme of EU in the frame of UHI project “Development and application of mitigation and adaptation strategies and measures for counteracting the global Urban Heat Islands phenomenon (UHI)”.

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Outdoor heat stress and ultraviolet-induced erythema by months in Florence: useful information for the local population and tourists

Posters

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Solar radiation affects human beings in different ways with direct effects occurring when people are exposed outdoors during working or leisure/sport activities. Erythema is the most familiar short-term symptom of human skin associated with overexposure to unperceivable ultraviolet radiation (UV). In this study the newly developed Universal Thermal Climate Index (UTCI) will be used for the first time to investigate whether the perceived outdoor heat stress might represent a valuable proxy for the unperceivable effect of UV-induced risk of erythema in a Mediterranean city, Florence, Tuscany (Central Italy). The aim of this study is therefore to propose a real approach to link solar UV radiation and thermal factors by means of the application of two internationally recognized indices, in order to estimate their reciprocal interaction and the potential impact on human health. Meteorological data and UVB (280-320 nm) measurements were obtained for the 2004-2012 period by a weather station located in the municipality of Florence. The UTCI was assessed and continuous measurements of erythemally effective UV (UVEry) were performed by means of broadband temperature-corrected radiometers with the spectral response close to the erythemal action spectrum. Hourly UVEry doses were expressed as Standard Erythemal Doses (SEDs). Descriptive analyses of the hourly distribution per month of the frequencies of days with heat stress and UVEry exceeding 2.0, 3.0, 4.5 and 6.0 SEDs were carried out based on the general skin-type characteristics. The association between UVEry and UTCI was analyzed by a two-way contingency table approach. The probability of UVEry exceeding specific SED thresholds when heat stress occurs was often significantly higher than the same probability when no heat stress is perceived. However, during several months, too many days occur without any signs of heat discomfort, even when people may be exposed to relevant doses of harmful UVEry for the skin of various phototypes. These findings underlie the need for public health authorities to provide differentiated advice per month in relation to potential UV skin damage in the city of Florence. Such specific UV information is fundamental for educating the local population and tourists and making them aware of sun exposure.

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Effect of atmospheric conditions on clinical, physiological, and biologic parameters of asthma

Posters

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Asthma is a complex heterogeneous disease that is driven by genetic susceptibility and environmental factors [1, 2]. Published literature has established that changes in atmospheric conditions such as temperature, relative humidity and barometric pressure affect disease activity [3, 4]. Meanwhile, the effects of these fluctuations on the molecular signals associated with asthma are unknown. Therefore, this study explored the effect that atmospheric changes have on molecular signals that has been measured in the sputum and circulation of individuals with asthma. The atmospheric variables were retrieved from National Climatic Data Center (NCDC), which performs

measurements at eight airport weather stations around the state of Connecticut. Our research team at the Yale Center for Asthma and Airway Diseases (YCAAD) has been accumulating data on clinical phenotype and gene expression in the airway from individuals with asthma that reside in the state of Connecticut. Patients were clustered by the weather stations associated with their zip codes. Difference in temperature (T), relative humidity (RH), and barometric pressure (BP) between day of the visit of the individual to the clinic (T0, RH0, BP0), one day (T1, RH1, BP1), and two days (T2, RH2, BP2) prior were selected as the atmospheric variables. Weather parameters were correlated with the clinical, physiological, and biologic parameters of asthma. The atmospheric conditions that influenced the most number of disease phenotypes were the barometric pressure and temperature values one day prior to the visit date. Correlation results indicate that clinical phenotypes such as shortness of breath (r=- 0.207, p = 0.020), chest tightness (r=- 0.202, p = 0.024), and social activity (r=- 0.214, p = 0.017), were negatively correlated with barometric pressure one day prior to the visit. Lung function variables post FEV1 (r= 0.164, p = 0.033), and pre FEV1(r= 0.154, p = 0.047), were positively associated with the temperature value one day prior to the individuals visit. The sputum NOGO (Neurite outgrowth inhibitory protein) levels were significantly correlated with T0 (r= 0.217, p = 0.016), T1 (r= 0.208, p = 0.021), and T2 (r= 0.233, p = 0.010); temperature values on the visit day, one day prior and two days prior respectively. The number of disease parameters influenced by the change in temperature (T0-T1 and T1-T2), barometric pressure (BP0-BP1, BP1-BP2), and relative humidity (RH0-RH1 and RH1-RH2) were low compared to the atmospheric conditions one day prior to the visit. Conclusions: Above mentioned preliminary correlation studies suggest association of atmospheric conditions days before and on the day of the visit with clinical and molecular signals of asthma. The presence of statistically significant association of temperature values with sputum NOGO levels and the lack of significant association with serum NOGO levels need further investigation. In addition, the association of atmospheric conditions on the gene expression in the circulation and airway in asthma will be investigated to better understand the role of environmental conditions in the progression of the disease. References: 1. Duffy, D.L., et al., Genetics of asthma and hay fever in Australian twins. Am Rev Respir Dis, 1990. 142(6 Pt 1): p. 1351-8. 2. Palmer, L.J., et al., Independent inheritance of serum immunoglobulin E concentrations and airway responsiveness. Am J Respir Crit Care Med, 2000. 161(6): p. 1836-43. 3. Mireku, N., et al., Changes in weather and the effects on pediatric asthma exacerbations. Ann Allergy Asthma Immunol, 2009. 103(3): p. 220-4. 4. Beard, J.D., et al., Winter temperature inversions and emergency department visits for asthma in Salt Lake County, Utah, 2003-2008. Environ Health Perspect, 2012. 120(10): p. 1385-90. This abstract is funded by: R01HL118346-02

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Thermoregulation and periodically forced SEIR model: Understanding asthma seasonality in South Florida

Posters

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The impact of changing weather and air quality conditions on cardio-respiratory diseases is very important. Epidemiological as well as biometeorology studies have documented the existence of exacerbating factors for asthma, different from often cited allergens. Economic conditions, educational backgrounds, stress, diets, along with weather and air quality conditions appear to compete and complement the allergen hypothesis. Motivated by these facts and aimed at understanding the inner working of asthma, time series of Emergency Department (ED) visits due to asthma in Miami Dade and Broward Counties were provided by the Florida Asthma Coalition for six years (2005-2011) with daily temporal resolution. They show a peak of attendance between the months of November and January and a minimum between the months of April and June every year. Such seasonality represents an increase (decrease) about 38 % above (below) the mean number of visits per day during this period. Weekends appear to be the most common time for ED visits, leading us to think about the influence of the exposition time to pollutants, cultural and socio-economic impacts, as well as possible lagging effects. Besides that, the spatial distribution of cases (Zip code breakdown) revealed that the proximity to highways or heavy-loaded transportation routes increases the occurrence of cases. The time series of weather parameters (Temperature, Humidity, Wind Speed and direction, Pressure, Diurnal range of both temperature and humidity, and extreme of both, temperature and humidity) were obtained from the Weatherbug mesonet in South Florida. Surface ozone, and particulate matter were obtained from EPA registered stations. Time series and correlation analyses between weather variables and the number of cases resulted in weak to moderate associations mainly with the minimum and mean temperature, the mean humidity, and some derived thermal indexes. Lagging effects were analyzed up to seven days previous to ED visit. A General Additive Model (GAM) for Multilinear regression (MLR) was implemented based on the most sensitive lags. Thermal homeostasis seems to explain variance in the number of cases no more than a 30 %. When air quality (Ozone and particulate matter) time series is used, direct associations are less evident. It is noteworthy that large levels of allergens and surface ozone tend to occur in spring and early summer due to the release of pollens, the end of the dry season, which produces many wildfires, and the sun activated photolysis. Both, ozone and particulate matter peak after the “winter asthma season” and the location of measuring stations might play a role underestimating the amount of ozone that really impacts communities nearby highways. Indirect associations with temperature and humidity might result also from the sensitivity of prospective patients to upper and lower respiratory tract infections due to rhinoviruses and syncytial viruses. From a synoptic point of view, this seasonal peak is registered in Canada first in late August and then, as first cold air masses reach southern portions of US the position in time of this seasonal effect shifts to December and January. Weather conditions in South Florida are favorable for these viruses to proliferate during the later fall and early winter. In this end, a periodically forced SEIR model is considered to account for the periodic outbreaks of respiratory infections as triggers of asthma and its further exacerbation. The time series resulting from such a model follows very closely the time series of recorded cases, showing additionally a lagging effect between 3 and 7 days after the cold temperatures are established. Clear winter skies combined with low temperatures may produce temperature inversions and shallow boundary layers effects. This combination may inhibit the atmospheric mixing both vertically (convection) and horizontally (advection) and the concentration of pollutants near the surface increases. Persistent low temperatures and dry conditions together are factor-stimulating molds and viruses spreading, which combined with moderate levels of ozone appears as the primary triggering mechanisms. A combined effect of thermoregulation and “flu season” seems to polarize the immune system in the direction of an inflammatory response that ignites the asthma attack.

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Burning and its Effects on Cardiovascular and Respiratory Health of the Population of the eastern Region of the Brazilian Legal Amazon

Posters

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Air pollution represents one of the greatest public health problems, even when at levels considered safe by the environmental legislation (Castro et al., 2003; Bakonyi et al., 2004). In the Brazilian Amazon region air pollution is caused mainly due to the burning of forest biomass. The main current outbreaks burned in the Amazon are associated with farming in scale family and livestock, corresponding, respectively, to the practice of land preparation for planting used for centuries by farmers of the Amazon and various tropical regions, known as itinerant agriculture, migratory or slash-and-burn (slash-and-burn agriculture), and the burning of pastures infested with invasive plants for its renewal. This study aims at verifying the association between outbreaks of fires combined with meteorological variable air temperature and hospitalizations for cardiovascular and respiratory diseases in eastern Legal Amazon. Monthly data were used from hospitalizations, burnings and air temperature. Hospitalizations data were obtained from the database of the computer department of the Unified Health System (DATASUS) the list of morbidity of the International Classification of Diseases ICD-10, the circulatory system (Acute Myocardial Infarction diseases, Other diseases Ischemic Heart disorders, Driving and Cardiac Arrhythmias, Heart Failure, Other heart diseases) and respiratory diseases (Acute pharyngitis and tonsillitis, laryngitis and tracheitis Acute, other Acute upper airway Infections, Influenza, acute bronchitis and Bronchiolitis, Other diseases of the Upper Respiratory Tract, Asthma, Bronchiectasis); data from burned of Portal Monitoring burnings and fire satellite in near real time by the National Institute for Space Research (INPE), and air temperature data from the Bank of Meteorological Data for Education and Research of the National Institute of Meteorology (INMET) of the localities situated in the Eastern Region of the Amazon (Capital of the State of Tocantins and Pará), municipalities located near the region known as the deforestation arc. To detect the association between the variables under study was done using the generalized linear models introduced by Nelder and Wedderburn (1972) which correspond to a flexible generalization of ordinary least squares regression. Relates to random distribution of the dependent variable (the distribution function) with the systematic part (non-random) through the link function. The computer program used for this analysis was the free software R (2.15.0). The results showed increased cardiovascular disease, higher than the increase of respiratory diseases in the study period and 1% statistical association of significance between the fires and the air temperature with cardiovascular disease and 5% significance with respiratory diseases. We conclude that in this Amazon region the effects of fires, combined with the air temperature possibly influence the number of hospitalizations for heart disease with greater statistical significance that for respiratory diseases. It is expected to contribute to the planning of public policies both locally and for the other regions with similar weather conditions.

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Relationship Between Temperature and Influenza: Case Study for the month of March

Posters

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Influenza, commonly referred to as the 'flu', is a respiratory virus that causes significant mortality and morbidity during annual epidemics, and is capable of affecting nearly half of the global population during severe pandemics (e.g., the 1918–1920 'Spanish Flu' (Potter, 2001). Shortly after the detection of the H1N1 influenza outbreak, a virus infection that started in Mexico in late March and early April 2009. The disease subsequently spread quickly to the United States and other countries and formed the first infectious pandemic of the 21st century (Moghadami, 2012). Patients with high-risk conditions such as diabetes, asthma, pregnancy, cardiovascular diseases, immune suppressive status, obesity, and sickle disease suffered more from this pandemic (Miller, 2009). This study aims at verifying the tendency of the H1N1 influenza in São Paulo city (Brazil) during the period of 2000 to 2004 for march. Monthly data were used from hospitalizations. Hospitalizations data of influenza were obtained from the database of the computer department of the Unified Health System (DATASUS) the list of morbidity of the International Classification of Diseases ICD-10. The trend will be verified through the Mann Kendall test, that is nonparametric trend test. The computer program used for this analysis was the free software R (2.15.0). The Mann-Kendall, initially proposed by Sneyers (1975), considers that, if stability a time series, the succession of values occurs independently, and the probability distribution should always remain the same (simple random number). The p-value associated with the Mann-Kendall test is statistically significant, suggesting the presence of a statistically significant upward trend in in the number of hospitalizations from H1N1 influenza. This fact can be associated with the transition season (summer to autumn), which means that there is an increase in the temperature range. The temperature variation affects humans, since most species is not adapted to the occurrence of major temperature variations.

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Cold Spell Impacts on Daily Mortality in 6 Metropolitan Cities in Korea (1991-2010) : using Spatial Synoptic Classification

Posters

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This study examines cold spell effects on cause-related mortality in Korean 6 metropolitan cities during 1991-2010.

To classify the cold stressful days, synoptic climatological approach, Spatial Synoptic Classification (SSC) has utilized to sub-dividing the offensive days.

As a result, Dry Polar (DP) weather type has successfully represented the typical cold and dry weather influenced by the continental Siberian High activity with showing the highest frequency during the winter period.

To explore more cold stressful days, we set DP (-) and DP (--) days which characterized by lower temperature and humidity, and stronger westerly.

Mortality data has classified by age and cause of death by whole disease, cardiovascular, and respiratory diseases according to the International Classification of Disease-10th revision.

Standardization considered inter-annual changes by yearly mean level of winter mortality has applied to regression model.

And the linear trend has used as a baseline mortality. Excess mortality net increasing by cold-stressful DP subsets were estimated.

Health effects of cause-specific excess mortality showed more critical severity on elderly group on DP (-) days.

In addition, the strongest net increase of health effects were estimated under DP (--) days significantly.

All the results demonstrates SSC could be suitable synoptic climatological approach for diagnosis of the link and effects between the weather condition and human health in Korean large cities.

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Heat- and cold-related cardiovascular mortality and morbidity in urban and rural populations in the Czech Republic

Posters

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Several studies have examined relationships of high and low air temperatures to excess cardiovascular mortality in the Czech Republic (central Europe). Much less attention has been devoted to application of thermal indices in evaluating heat- and cold-related mortality in this region. The present study compares differences in the impacts of warm and cold days on excess deaths and hospital admissions for cardiovascular diseases (CVDs) among urban (Prague) and rural population (southern Bohemia) over the 1994–2009 period. These differences are compared between selected population groups (men and women; <65 and 65+ years). Values of the 90% (10%) percentile of daily mean air temperature, Apparent Temperature (AT), Physiologically Equivalent Temperature (PET) and Universal Thermal Climate Index (UTCI) in summer (winter) were used for the definition of warm (cold) days for each region separately. Excess mortality/morbidity is represented by the number of deaths/hospital admissions above expected daily values, the latter being adjusted for long-term changes, annual and weekly cycles, and epidemics of influenza/acute respiratory infections.

Generally higher relative excess CVD mortality on warm days was identified in Prague, while for cold days we found higher excess mortality in the rural region of southern Bohemia. In contrast to mortality, excess CVD morbidity was not observed on either warm or cold days. While heat stress increases mortality especially due to chronic CVDs, the effects of cold stress are most pronounced on acute CVDs (myocardial infarction). We found air temperature, as the most widely used proxy for ambient thermal conditions in environmental epidemiology, comparable to thermal indices in assessing heat-related mortality. On the other hand, air temperature provides a weak cold effect in comparison with the thermal indices in both regions and its application may underestimate the magnitude of cold-related mortality. These findings are important when possible climate change effects on heat- and cold-related mortality are estimated.

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Lack of Association between Barometric Pressure and Completed Suicide

Posters

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Background: We have previously performed a study in which we have found that emergency psychiatric visits increase when barometric pressure is low. In that same study we also found that violent crimes increase when the barometric pressure is low. We investigated suicides in that study, and found no effect but our suicide sample was underpowered. Methods: We obtained barometric pressure data for Jefferson County, Kentucky, from the NOAA Midwestern Regional Climate Center. We obtained suicide data for Jefferson County from the Jefferson County Coroner's office. We performed a regression analysis between pressure information and suicides. We investigated the time period between January 2002 through August 2010. Results: There was no relationship between the average daily barometric pressure and the likelihood of suicide. Discussion: While previous work revealed that there was a relationship between impulsive violence, and impulsive behaviors resulting in emergency psychiatric visits. The current study suggests that there is no relationship between barometric pressure and completed suicide.

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Risk Populations for Temperature-associated Myocardial Infarction Admissions in South Korea

Posters

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Background: A number of studies have reported the relationship between environmental temperature and the incidence of myocardial infarction (MI) according to gender, age, and location. The incidence of temperature-associated episodes of MI may increase with aggravated climate conditions, especially in older people, patients with underlying cardiovascular diseases, and those who are poor, uneducated, or isolated. However, scientific evidence is still insufficient especially regarding the risk of low socio-economic status population for temperature-associated MI admissions.

Objectives: In the present study, we evaluated hospital admissions for temperature-associated MI according to gender, age (<75 or ≥75 years), insurance type (National health Insurance (NHI) for the general population, or medical care (Medicaid) for the poor), and location (urban or rural) to compare the risks among these subpopulations. We also evaluated changes in threshold temperatures in summer and winter and correlated the findings with the risks of temperature-associated MI in the subpopulations.

Methods: We used National Health Insurance Service data for daily hospital admissions of MI, meteorological data from the Korea Meteorological Administration, and air pollution data from the National Institute of Environmental Research from 1 January 2004 to 31 December 2012. The generalized models analysis (GAM) was used to assess the short-term effects of temperature (mean, maximum and minimum thresholds) associated with MI admissions when temperatures increased above or decreased below the threshold temperature. The relationships were adjusted by humidity, barometric pressure at sea level, composition and amount of air pollutants (PM10, NO2, O3), day of the week, and duration of the heat wave or cold wave. We defined the threshold temperature as the

change point detected using piecewise regression analysis with increased risk based on the relationship between temperature and MI admissions.

Results: An increased risk for hospital admission due to MI for several subpopulations was found when temperatures rose above or dropped below threshold temperatures. The threshold temperature and relative risks (RR) for MI were different according to subpopulations and season. In the summer, the threshold of mean temperatures ranged between 23.5°C to 28.5°C and the RRs ranged from 1.01 to 1.16 among the following subgroups: 1.16 (95% CI: 1.01-1.33) for the ≥75 years age group and 1.01 (95% CI: 0.96-1.05) for the <75 years age group, and 1.10 (95% CI: 1.02-1.20) for the urban population and 1.03 (95% CI: 0.95-1.12) for the rural population. The maximum temperature threshold ranged from 33.5°C to 34.5°C and the RRs ranged from 1.02 to 1.15 among the following subgroups: 1.08 RR (95% CI: 1.02-1.14) for the female group, 1.12 (95% CI: 1.01-1.24) for the ≥75 years age group, and 1.15 (95% CI: 1.04-1.28) for the Medicaid group. During winter, the RR of the Medicaid group was 1.05 (95% CI: 0.98-1.12) when the mean temperature dropped below threshold by -0.5°C. The RR was 1.11 (95% CI: 1.04-1.20) at temperatures below the minimum temperature threshold (-13.5°C). The RR of the urban population was 1.16 (95% CI: 1.02-1.32) and that of rural population was 1.04(95% CI: 1.00-1.08) when temperatures dropped below the minimum temperature threshold.

Conclusions: Significant increases in MI risk for several subgroups were associated with temperatures above or below the temperature threshold during summer and winter, respectively. In the summer, the female group, the ≥75 years age group, the Medicaid group, and the urban population showed the highest risk for MI when temperatures exceeded the mean and maximum temperature threshold. During winter, the Medicaid group and the urban population showed the highest risk for MI when temperatures dropped below the minimum temperature threshold. These findings identify vulnerable groups who are at increased risk for hospital admission due to MI that is related to climate change. The data can be used to establish climate change adaptation strategies for susceptible populations.

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Increase of the Cutaneous Vitamin D3 Synthesis for a Person Wearing UV Transparent Clothes: A Model Study

Posters

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Humans should avoid prolonged exposure to the Sun during the warm subperiod of the year with naturally high solar UV level. One of the known recommendations to reduce excessive UV radiation is to wear clothes with UV protection additives. The level of the UV protection by clothing fabrics is measured as the Ultraviolet Protection Factor (UPF) which is usually calculated from spectral measurements of UV radiation transmittance through a selected fabric. Thus UPF is obtained as the ratio between UV intensity before and after passing through the fabric. The European Standard for sun-protective clothing (EN13758) states that fabrics with UPF larger than 40 could be labeled as UV-protective. However there is an important question: how to get adequate solar UV doses to keep a healthy status of vitamin D without overexposure risks?

Experiments with the artificial (emitted by fluorescent tubes) and solar radiation passing through various garments show that some kind of 100% cotton knitted fabric, used as normal daily clothing, has UPF~10. Model studies using UV exposure data typical for central Poland show that a garment made of this fabric allows larger synthesis of vitamin D3 in human body without the skin redness. Thus the adequate level of vitamin D could be attained safely by a person exposing only small part of his body (face, palms) during the warm sub-period (May-August) of the year with naturally high intensity of solar radiation. Wearing UV transparent garments is an option to keep adequate vitamin D level for persons with traditional way of clothing covering almost the whole body.

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EXPERIMENTAL STUDY OF THERMAL COMFORT IN HUMAN HOSPITAL WARDS UNIVERSITY HOSPITAL OF THE FEDERAL UNIVERSITY OF ALAGOAS, NORTHEAST BRAZIL

Posters

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Thermal comfort studies aim to establish methods of assessment of the conditions needed for a suitable thermal environment and human occupation activities, based mainly in the of thermal satisfaction of man with the environment activities and occupation thermal environment conditions. Considering this necessity, it is important to obtain a more accurate knowledge of the physical factors associated with the occurrence of an episode of discomfort (Fanger, 1970). This study aimed to evaluate the degree of comfort in two wards of the to assess the degree of comfort in two wards of the University Hospital of the Federal University of Alagoas, locate in the Maceió city (AL), Brazil, with its coordinates (09 ° 40'S, 035 ° 42'W and 110m altitude). The study period was 2006, for 30 days in the rainy season (19/07/06 to 19/08/06), and the dry season (19/11/06 to 19/12/06) with measurements in both periods, totaling 1440 hours of data collected. Two floors for analysis of environments, the second and fifth floor were selected. The wards consist of a non-air-conditioned room, with windows and accommodation capacity for eight patients.Data of Air Temperature and Relative Humidity recorded at Thermohygrograph instrument, were used equation Anderson (1965) cited by Rosenberg (1983), allowing to calcute the Human Comfort Index (HCI) for each ward. The results signaled that there are differences in the microclimate inside the wards, both in temporal variation (rainy and dry season), between floors (2nd and 5th floor) and between day and night, and that the position of the building construction influence on variations in comfort due to the daily cycle of the apparent motion of the Sun.The thermal comfort index ranked "discomfort bearable" was observed exclusively on 5th floor; Temperatures on the 2nd floor, in most times, higher than the 5th floor in both seasons. During the dry period, after noon until end of the afternoon, with the sunset, hourly situations occurred in air temperatures in the wards of the 5° floor were higher. It is concluded that the study may point to the second floor, and the environment in general more uncomfortable for patients. It is hoped that this study can contribute to the formulation of public policies in the health area that incorporates sociocultural aspects operating in the health disease process favoring the development of new research.

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STUDY OF HUMAN DISCOMFORT IN SALVADOR– BAHIA

Posters

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Human biological cycles are highly interfered by climate and weather. The way one works, gets exhausted, and recovers is affected by meteorological variables, such as air temperature, relative humidity, solar radiation and wind speed. Sometimes those activity cycles are affected by harsh

climatic conditions, producing body and mind discomfort, affecting the sleeping cycle, and in extreme cases, may even cause detrimental health effects. During the last decade, interest in the assessment of thermal comfort has increased because of climate changes and increased heat stress in cities. Thermal comfort is the condition of mind that expresses satisfaction with the thermal environment and is assessed by subjective evaluation. Maintaining the standard thermal comfort for occupants of buildings or other enclosures is one of the important goals of design engineers (ANSI, 2010). This article is an attempt to quantifying the thermal comfort of a city located in a transition area in Salvador city (BA), Northeastern of Brazil, showing that the thermal sensation for the inhabitants of this region during this period. Nastos (2006) says that the knowledge of human discomfort conditions is necessary because many people particularly those who live in large cities have greater risk to morbidity and mortality due to higher air temperature than the surrounding countryside. For this the Temperature Effective Index (TE) by modified Thom's Discomfort Index [DI] (THOM, 1959; GILES et al., 1990) which uses temperature in degrees Celsius. Monthly means of temperature and relative humidity, obtained from the National Institute of meteorology (INMET) during the period 1961-2010 were used for calculating the index. Thom's discomfort index was the first index created to asses levels of human discomfort related to meteorological variables. Results indicated during summer (November to February) several months that are uncomfortable regarding heat because there was ID values above 24 º C. Already during winter (May-August) on most days less than 50% of the population has a slight discomfort (ID between 21 and 24 ° C) values of this index are smaller, indicating a lower heat stress during this period. When you combine high temperatures with low humidity it produces high values of ID. It was noted also that the ID has become uncomfortable with greater frequency in the last 10 years, and in some summer months the ID reached 28 º C indicating that the majority of the population has a relative discomfort and significant deterioration of the psychophysical condition. In any month was observed a situation of welfare (comfortable) according to the methodology of Thom (1959), because the ID was never less than 21°, in our study. There is a true and close relationship between urban thermal environments and city size, presence of industrial areas and motor– vehicle traffic, urban density, like in Salvador, because changes of environmental conditions in big cities are due to the greenhouse effect, high rate of pollution in addition to urban heat island effect, increasing the thermal discomfort. With this study expected to contribute to the planning of public policies for regions with similar weather conditions.

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Study on the modification of heat balance model by observed mean radiant temperature and mean skin temperature

Posters

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This study proposed a applied heat balance model customized to Korea's climate and physiological characteristic. Our model based on heat balance model proposed by Huang (2007) and ASHRAE (2005), but with improvements that, reflect observed data such as mean radiation temperature and mean skin temperature. The proposed model calculates the expected temperature for thermal comfort, depending on changes in relative humidity, wind speed, mean radiant temperature, metabolic rates, and clothing insulation. The earlier model assumed the same outdoor temperature and mean radiant temperature but we found that the difference between the two temperature by observation. Changes in expected temperature according to changes in mean radiant temperature were examined. It was found that, as outdoor exposure grows longer, the outdoor temperature needs to be lowered to maintain thermal comfort. The expected temperature for thermal comfort was lower at a metabolic rate of 4 Met than at 1 Met. In terms of wind speed, the expected temperature is not affected by a rise in wind speed when mean radiant temperature is low. However, as mean radiant temperature rises higher, the expected temperature varies more according to different wind speeds. And the discrepancy in expected temperatures was measured between calculations of skin temperature according to the formula of the model and mean skin temperature as measured in this study. The results showed that the latter case yielded higher expected temperatures. As examined thus far, this study considered only mean radiant temperature and mean skin temperature among the diverse variables of the model, and showed the discrepancy in expected temperatures by the difference in the two variables. A variety of heat balance models developed in previous studies, both at home and abroad, have been introduced in Korea, and they need to be tested and improved with actual experiments to yield more accurate outcomes, tailored to Korea's particular environment.

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Increasing in mean temperature affects mortality by stroke in a Tropical environment

Posters

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BACKGROUND In 2008 more than 9 million people died prematurely from cardiovascular disease (CVD). About 8 million of these deaths occurred in peripheral countries (World Atlas of Cardiovascular Diseases, 2011). In Brazil, non-communicable chronic diseases are responsible for the largest percentage of all deaths among men and women. In 2010, the leading cause of death in the country were diseases of the circulatory system, which mainly affected the age group above 60 years, with 320,000 deaths, accounting for 29% of total deaths. Among cardiovascular diseases, stroke is the leading cause of death, accounting for 10% of total deaths (Ministry of Health, 2012). Stroke is a serious public health issue as it is a major cause of death worldwide and is the leading cause of disability and second in deaths after coronary heart disease (WANG et al, 2009). Several studies have shown the influence of climatic variables on hospital admissions and deaths from stroke. However, this effect is not fully understood. In temperate locations in the United States and Taiwan, relations between hospital admissions and deaths from stroke and atmospheric variables (minimum or maximum temperature, atmospheric pressure, relative humidity) were found (EBI et al, 2004; LEE et al, 2008). However, other studies conducted in temperate locations, as Brussels, UK and Canada, found no association between atmospheric variables on the incidence of stroke (CAPON et al, 1992; FIELD, 2000; COWPERTHWAITE; BURNETT, 2011). In subtropical and tropical climates, where people are acclimated to the hot weather, few data are available on the relationship between temperature and stroke (WANG et al., 2009). In São Paulo, with a population of more than 11 million people in 2013, located at the latitude 23º32'52" S, where normal mean, minimum and maximum temperatures are 19,4º, 15,2º, 25,4ºC, these relationships were not investigated so far. Thus, the aim of this study was to investigate the influence of temperature on stroke mortality in São Paulo. METHODS Daily mortality for stroke, meteorological variables and air pollution data were obtained for the period of January 2002 to December 2011. The percentage increase of mortality for total stroke, hemorrhagic, and ischemic were estimated with endpoint-specific generalized additive Poisson regression models. Nonparametric smooth function was used to control seasonality and an indicator of holidays was adopted to control short-time trend. Effects of mean temperature, humidity, thermal amplitude, barometric pressure and air pollutants were assessed using specific third-degree polynomial distributed lag models for a time window of eight days. The models were controlled for humidity, atmospheric pressure, thermal amplitude and pollutants. The use of Generalized Additive Models (GAM) is an alternative that allows, in a simple way, the control of these

confounding factors, since this type of model eliminates the need to specify a parametric form for the association between predictors and response. The R (R Development Core Team 2014) software was used for all analyses. RESULTS From GAM results we observed an estimated increase of 6.2% in total stroke mortality for each interquartile range increase in mean temperature in the first two days. For women, the risk is 5.7%, and 4.8% for males. For people over 65 years, the percentage increases 1.3, 7.8 and 1.1% for women and males, respectively(Table 1). Ischemic stroke (IS) mortality also increased 12% for each interquartile range. For female gender the increase was 5% on the second day of exposure of the mean temperature (Table 2). For men no significant results were found. For the higher age of 65 the percentage increases to 14.1% and remains similar to the female gender (4.7%) For hemorrhagic stroke no significative association was observed with mean temperature. CONCLUSION The increase of mean temperature affects total stroke mortality and, in especial, the ischemic subgroup in this city in a Tropical area. This reinforces the concept that the subgroups of stroke, ischemic and hemorrhagic, may present different pathophysiologic mechanisms and, hence, different risk factors.

Table 1: Percentage increase of mortality by stroke for an increase of 1 ° C in mean temperature.

Outcome by group	Percentage increase	Confidence Interval
stroke	6.2%	3.3 - 9.0%
stroke female	5.7%	2 - 9.6%
stroke male	4.8%	1.6 - 8.2%
stroke > 65 years	1.3%	0.6 - 2%
stroke > 65 anos female	7.8%	3.1 - 12.7%
stroke > 65 anos male	1.1%	0.1 - 8.5%

Table 2: Percentage increase for mortality by Ischemic stroke for an increase of 1 ° C in mean temperature.

Outcome by group	Percentage increase	Confidence Interval
IS	12%	4.7 - 19.5%
IS female	5%	1.2 - 8.8%
IS male	NS	NS
IS > 65 years	14.1%	8.1 - 20.4%
IS > 65 anos female	5%	0.6 - 8.9%
IS > 65 anos male	NS	NS

IS = Ischemic Stroke
NS = Not Significant

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Heat-related morbidity and mortality for ischaemic heart disease and cerebrovascular disease in the Czech Republic

Posters

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The study examines effects of hot spells on cardiovascular disease (CVD) morbidity and mortality in the population of the Czech Republic, with emphasis on differences between ischaemic heart disease (IHD) and cerebrovascular disease (CD) and between morbidity and mortality. Daily data on CVD morbidity (hospital admissions) and mortality over 1994–2009 were obtained from national hospitalization and mortality registers and standardized to account for long-term changes as well as seasonal and weekly cycles. Hot spells were defined as periods of at least two consecutive days with average daily air temperature anomalies above the 95% quantile during June to August. Relative deviations of mortality and morbidity from the baseline were evaluated. Hot spells were associated with excess mortality for all examined cardiovascular causes (CVD, IHD and CD). The increases were more pronounced for CD than IHD mortality in most population groups, mainly in males. In the younger population (0–64 years), however, significant excess mortality was observed for IHD while there was no excess mortality for CD. Excess CVD mortality was not accompanied by increases in hospital admissions and below-expected-levels of morbidity prevailed during hot spells, particularly for IHD in the elderly. This suggests that out-of-hospital deaths represent a major part of excess CVD mortality during heat and that for in-hospital excess deaths CVD is a masked comorbid condition rather than the primary diagnosis responsible for hospitalization.

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Association of High and Low Temperature with Hospital Admissions for Subarachnoid Hemorrhage in Susceptible Populations in Korea

Posters

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Background: A number of studies have examined the influence of meteorological factors and seasonal variation on the incidence of cardiovascular disease. An association between temperature and congestive heart failure or ischemic heart disease seems to be fairly robust; however, the relationship between temperature and subarachnoid hemorrhage stroke (SAH) is complex and the findings are contradictory. There has been consistent evidence for the short-term effects of ambient temperature on increased risk of myocardial infarction (MI) and death due to cardiovascular disease. However, the association between environmental temperature and risk of SAH remains controversial. Most research in SAH has concentrated on the relationship between season and incidence of SAH. It is important to include threshold temperatures, temperature lag effects, and nonlinear exposure-response relationships when evaluating the effects of temperature on stroke, MI, and acute coronary syndrome. The aim of this study was to investigate the association between the daily temperature and risk for SAH by analyzing the hospital admission records of 111,316 SAH patients from 2004 to 2012 in Korea.

Methods: We used climate variables from the Korean Meteorological Administration, air pollution data provided by Korea National Institute of Environmental Research, and SAH admission data from the National Health Insurance Service. We estimated the temperature-SAH association by applying generalized additive models (GAMs) with nonparametric smoothing functions (splines) to describe nonlinear relationships. Associations were adjusted according to humidity, barometric pressure at sea level, and air pollutants including PM10 and NO2. We estimated the threshold temperature using the piecewise-defined function. The analysis was performed for the following subgroups: gender (male or female), age (<75 years or ≥75 years), insurance type (National Health Insurance for the general population (NHI) or medical care (Medicaid) for the poor), and area (rural or urban) with climate zones based on cooling degree-days (CDD) for summer and heating degree-days (HDD) for winter. Results: We found a delayed effect, between 22-28 days, on the incidence of SAH due to hot temperature. The maximum threshold temperature during heat exposure was 31.5°C. The maximum temperature increase of 1°C above the threshold temperature was associated with a significant

increase in relative risk (RR) of 1.07 for the >75 years age group, and 1.03 for males, respectively. Apart from longer lasting heat effects, short-term cold effects were observed between 4-7 days. The mean threshold temperature during cold exposure was -3.5°C and the minimum threshold temperature was -13.5°C. A mean temperature decrease of 1°C was associated with a significant increase in RR of 1.03 for the <75 years age group, and 1.02 for females. The increased risk associated with minimum temperature was especially strong for male patients (RR =1.09, CI=1.05-1.14). With regard to heat exposure, the Medicaid group showed RR of 1.11 (lag: 1 day), which was higher than the NHI group who showed RR of 1.02 (lag: 22-28 days). With regard to cold exposure, the RRs in the Medicaid group were 1.05 with the mean temperature lag of 4-7 days, and 1.11 at the minimum temperature with a lag of 15-21 days, respectively. Meanwhile, patients in the NHI group only showed a risk of 1.01 at the mean temperature. The RR due to heat exposure was higher in hot areas with higher cooling degree-days (CDD) than in warm areas with lower cooling degree-days (CDD). Meanwhile, the RR due to cold exposure was higher in cold areas with higher heating degree-days (HDD) than in warm areas with lower heating degree-days (HDD).

Conclusions: This is the first study to find an association between temperature and incidence of SAH related to heat and cold exposure (defined by threshold temperatures). An increase in temperature above the heat temperature threshold or decrease in temperature below the cold temperature threshold correlated with increased risk of SAH in susceptible populations with different lag effects and risks. Our findings provide useful information for identifying the risk of SAH in vulnerable groups that can be used to establish climate change adaptation strategies.

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