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NSSL Briefings

A newsletter about the people and activities of the National Severe Storms Laboratory and Cooperative Institute for Mesoscale Meteorological Studies collaborative researchers

JPOLE: An operational test of weather radar polarimetry

Accurately estimating precipitation type and accumulation has been a long-standing problem for operational meteorologists and hydrologists. When the estimates are obtained by weather radar, inaccuracies can result from radar miscalibration, attenuation of the signal in heavy precipitation, and the presence of non-meteorological scatterers such as ground returns, birds, and insects. Natural variations in the size, shape, and ice density of cloud and precipitation particles can also result in estimation uncertainties. Fortunately, many of these problems may be at least partially mitigated through the use of radar polarimetry.

Photo by Paul Griffin

As part of the evolution and future enhancement of the WSR-88D, the National Severe Storms Laboratory recently upgraded the KOUN WSR-88D radar to include polarimetric capabilities. These capabilities are now being tested as part of the Joint Polarization Experiment (JPOLE) operational demonstration, which began in the Spring of 2002. The overarching goals of JPOLE are to test the engineering design and data quality of the polarimetric KOUN WSR-88D radar, demonstrate the utility and feasibility of the radar to operational users, and collect data and information for a cost/benefit analysis. Another long-term goal is to transfer polarimetric radar technology to an operational setting. Therefore, real-time data collection during JPOLE will be conducted in collaboration with operational hydrologists, meteorologists, and aviation users, whose insight will be of vital importance to the evaluation of WSR-88D radar products.

Engineering Design and Data Quality

Most research polarimetric radars employ an ***alternate*** horizontal/vertical transmission scheme. In contrast, the polarimetric KOUN WSR-88D radar employs a ***simultaneous*** horizontal/vertical transmission scheme. While simultaneous transmission is expected to have practical advantages over the more common alternate transmission scheme, it remains largely untested. JPOLE will provide an opportunity to evaluate critical engineering and data quality issues. For example, radar data quality must be assessed through a detailed comparison with verification data sets and the radar scanning strategy evaluated to assess compatibility with requirements of the existing WSR-88D radar system.

Benefits to Operational Users

The operational benefits of polarimetric radar data will be examined by conducting an evaluation of polarimetric rainfall rate and hydrometeor classification product performance. Much of this evaluation will be completed in real-time in collaboration with meteorologists from the National Weather Service Forecast Office in Norman, OK and hydrologists from the Arkansas Basin River Forecast Center in Tulsa, OK. The polarimetric KOUN WSR-88D radar data and products will be delivered to operational users by the NSSL Warning Decision Support System – Integrated Information (WDSS-II) software package. During the Spring and Summer of 2002, the hydrometeor classification algorithm will provide detailed information on rain-rate intensity, the occurrence of severe hail, location of anomalous propagation, and presence of biological (birds and insects) scatterers. Winter precipitation products are being introduced in the Fall of 2002.

Given the long-term prospect of a future network of polarimetric WSR-88D radars, JPOLE has the potential to have a far-reaching impact for operational meteorologists, hydrologists, and aviation users at a national scale. More information on JPOLE can be found at www.nssl.noaa.gov/JPOLE.◆

by Terry Schuur

IHOP Update

IHOP, an NCAR-led experiment took place in May and June over the Southern Great Plains. In one of the largest-ever field experiments in North America, scientists from the U.S. and several foreign countries teamed to improve characterization of the four-dimensional distribution of water vapor and its application to improving the understanding and prediction of thunderstorms. Airflow, temperature, and humidity data were collected with a large armada of aircraft and ground-based mobile sensors and fixed-base remote and in-situ sensors. NSSL's contribution to the armada included a SMART Radar, a mobile CLASS ballooning vehicle, a camera vehicle, 9 mobile mesonets, an NSSL field coordination vehicle, an NSSL scout vehicle, and a technicians vehicle to provide in-field maintenance.

NSSL's ground-based platforms focused on mesoscale boundaries and convection initiation on a total of 12 mission days. Of these 12 cases, cumulonimbus clouds developed within the intensive observing region along a boundary on 2 days, towering cumuli on 5 days, and no significant convection on 5 days. An additional 3 days were spent sampling boundary layer evolution from sunrise to early afternoon around a cluster of fixed IHOP sensors in the Oklahoma Panhandle. The 24 May case featured the first known observed evolution of a dryline, cold front, and their triple point intersection using high-resolution mobile sensors. Valuable data were also collected on sharply defined drylines, slow moving cold fronts, and the triple point intersection of an outflow boundary and a convergence line. ◆

by Conrad Ziegler

Spotlight on: Dave Stensrud

Thousands of pink flamingos in the spring, and as many pumpkins in the fall covered Bascom Hill in Madison, Wisconsin. The Statue of Liberty (appearing to be mostly submerged) rested on the ice of Lake Mendota in the winter. Huge Halloween, Oktoberfest, and toga parties--all funded with student fees--this was the era of the infamous "Pail and Shovel" party that ran the student government during Dave Stensrud's years at the University of Wisconsin, Madison. He says it was a fun and diverse school, and with all the distractions he still managed to graduate with his B.A. in Meteorology and Math in four years.

His journey from his home in Minnesota to his current residence in Oklahoma took him through Madison, WI for undergraduate work, Salt Lake City, UT for an internship at the NWS-Western Region, then to Penn State for his M.S. in meteorology. Dave came to Oklahoma when he was hired by Ed Kessler in 1986 to pursue numerical weather prediction--a new direction for the mostly radar-based NSSL. Dave valued the independence and support offered by NSSL to lead his own career, pursue his own research agenda, and continue his education. After a few years at NSSL, he returned to Penn State for one year to start his Ph.D. and completed it in 1992 while working at NSSL. He was one of the first modelers at the lab.

Dave now leads the Models and Assimilation Team at NSSL. His work includes investigating the potential uses of short-range model ensembles in forecasting severe weather events. The public service aspect of his work--knowing that his work will benefit severe weather forecasting--is very important to Dave. He feels his biggest success has been to help emphasize the necessity of model diversity in ensemble forecasting. What he didn't mention as his biggest success was the prestigious "White House Presidential Early Career Award for Scientists and Engineers" he received in 1996. It is the highest honor bestowed by the U.S. Government upon outstanding scientists and engineers at the beginning of their careers. Dave is also adjunct faculty at OU, teaching a graduate level mesoscale modeling course once every two years. He particularly enjoys interacting with the students on their research topics.

Growing up as a Boy Scout, and achieving Eagle Scout rank, Dave braved Minnesota weather to go "winter camping" (I didn't know people did that!); he had always loved the outdoors and was especially fascinated by the weather. He enjoys jazz music and reading. He stays busy with his family: his wife Audrey, and children Matthew (15) and Caitlin (11). He is an assistant scoutmaster with Boy Scout Troop 792 and an elder in the Presbyterian Church where he teaches middle school youth. Dave believes vacations are good for the soul. He and his family go "anywhere interesting", and rarely to the same place twice. ◆ *by Susan Cobb*

NSSL researcher is awarded DOC Silver Medal

Harold Brooks is a 2002 recipient of the Department of Commerce Silver Medal for developing the first ever, highly-accurate and accessible estimates of long-term threats from tornadoes, thunderstorm winds and large hail on any day anywhere in the contiguous USA.

Brooks took raw reports put onto a regularly-spaced grid by Mike Kay (CIMMS), and applied statistical techniques to provide estimates of the occurrence of severe thunderstorms for any location in the contiguous United States on any day of the year. Working with Daphne Zaras (CIMMS), Brooks also developed applications to make interactive animations of the probability of severe thunderstorms around the country through the year.

The severe weather hazard estimates Brooks developed are available in user-friendly formats at: http://www.nssl.noaa.gov/hazard. ◆

News briefs

Comings and goings

Michael Buban (CIMMS) is working with Conrad Ziegler to analyze multiple mobile ground-based Doppler radar and in-situ data obtained during the IHOP field phase this past May and June. He is working towards his master's degree at the University of Oklahoma (OU).

Melissa Bukovsky will be working with Jack Kain on convective parameterization as she pursues her master's degree at OU.

Kevin Manross is a new CIMMS Research Associate working with the Severe Weather Warning and Applications Technology Transfer Group - NWS group within the Warning Research and Development Division.

Nusrat Yussouf (CIMMS) is working for Forecast Research and Development / Models and Assimilation Team as a Research Associate on the NOAA New England Forecasting Pilot Program: High Resolution Temperature and Air Quality.

Janelle Janish (CIMMS) has moved to Houston. Janelle's research led to improved severe weather detection algorithms and applications for the WSR-88D.

International Visitors

Three visitors from Paraguay, two from Bolivia and two from Peru are working to prepare a document that describes aspects of the weather and climate of the Chaco and Altiplano regions of South America as part of a USAID funded activity.

Dr. Milton Speer, from the Australian Bureau of Meteorology, is visiting NSSL via a National Research Council (NRC) post-doctoral appointment. For the next several months he will be working with Dave Stensrud on ensemble forecasting applications to heavy rainfall events.

Awards and honors

NSSL's **John Daugherty** was made a Fellow of the National Association of Environmental Professionals (NAEP) at the end of June. This was the third Fellow award in the 27-year history of the NAEP.

Zhongqi Jing (CIMMS) was the NOAA Team Member of the Month in September. His research and work were a crucial contribution to the ORPG (Open System Radar Products Generator) Project. Jing's team was responsible for establishing the software architecture and design of the ORPG to replace a component of the WSR-88D system designed in the mid-1980's.

Kevin Scharfenberg, a former graduate student and now full time employee as a CIMMS Research Associate was awarded "Outstanding student poster presentation" at the Severe Local Storms Conference for his poster entitled "Polarimetric radar observations of a downburst-producing thunderstorms

(continued on next page)

News briefs, continued

during STEPS." **Valerie McCoy** (CIMMS) received Honorable Mention for her student poster presentation entitled "Using a GIS to Compare the May 3, 1999 Oklahoma City Tornado Damage Path to WSR-88D Signatures."

NSSL sponsors European Conference on Severe Storms

NSSL was an official sponsor of the third annual European Conference on Severe Storms (ECSS), held from August 26-30 in Prague, Czechoslovakia. Eight scientists from NSSL/CIMMS spoke at the conference. Three scientists from NSSL/CIMMS conducted a workshop the week before the conference for operational forecasters on eastern European convective weather.

AUITI (Acronyms Used In This Issue)

CIMMS - Cooperative Institute for Mesoscale Meteorological Studies
KOUN - Norman, Oklahoma
NCAR - National Center for Atmospheric Research
NOAA - National Oceanic and Atmospheric Administration
NSF - National Science Foundation
NSSL- National Severe Storms Laboratory
NWS - National Weather Service
OU - University of Oklahoma
REU - Research Experience for Undergraduates
SMART-R - Shared Mobile Atmospheric Research and Teaching Radars
SPC - Storm Prediction Center
WSR-88D - Weather Surveillance Radar - 88 Doppler, same as NEXRAD

NSSL's web site is: http://www.nssl.noaa.gov

NSSL Briefings *is a publication from the National Severe Storms Laboratory intended to provide federal managers, staff, and other colleagues in the meteorological community with timely information on our activities. Since most of these activities involve collaborations with scientists at the University of Oklahoma's Cooperative Institute for Mesoscale Meteorological Studies, this publication also contains information about CIMMS employees and various NSSL/CIMMS activities. If you would like to be added to the NSSL Briefings mailing list, or have a change in your address, please forward requests to Kelly Lynn, NSSL, 1313 Halley Circle, Norman OK, 73069; by phone: (405) 360-3620; or by email: kelly.lynn@noaa.gov.*

Damaging winds associated with low-altitude mesovortices within bow echoes

It is well established that squall lines with outward-bowing segments--bow echoes--often produce damaging "straight-line" winds at the ground. Some recent results from a study of low-altitude "mesovortices" within bow echoes suggest an unexpected and new paradigm for the production of such winds, as well as an equally surprising mechanism for the formation of mesovortices.

The well-known conceptual model attributed to T.T. Fujita shows damaging winds forced by intense downdrafts just behind the apex of the bow echo. Results from Morris Weisman's (NCAR) and my numerical cloud model similarly show a narrow strip of strong winds at the apex. But, given model environments of moderate to strong vertical wind shear, the most damaging winds--quantified in terms of duration and areal extent--are actually associated with low-altitude mesovortices located more than 20 km to the northwest of the apex. Moreover, the swath of these winds expands with time, as individual mesovortices merge to form fewer, though larger, vortices.

Sensitivity experiments show that significant low-altitude mesovortices develop in simulated squall lines and bow echoes only when the environmental vertical wind shear is within a relatively narrow range of values and, surprisingly, when the Coriolis force term in the model is nonzero. Mesovortex-genesis is initiated by the tilting, in downdrafts, of initially crosswise horizontal baroclinic vorticity. Over a period of less than an hour, the resultant vortex couplet gives way to a dominant cyclonic vortex as the relative, and more notably planetary vorticity is stretched vertically; hence, the Coriolis force plays a direct role in the genesis of low-altitude mesovortices!

This research was presented at the AMS Conference on Severe Local Storms in August 2002, and helps motivate objectives of an upcoming field program known as the Bow echo and Mesoscale Convective Vortex (MCV) Experiment (see companion article on page four). ◆ *by Jeff Trapp*

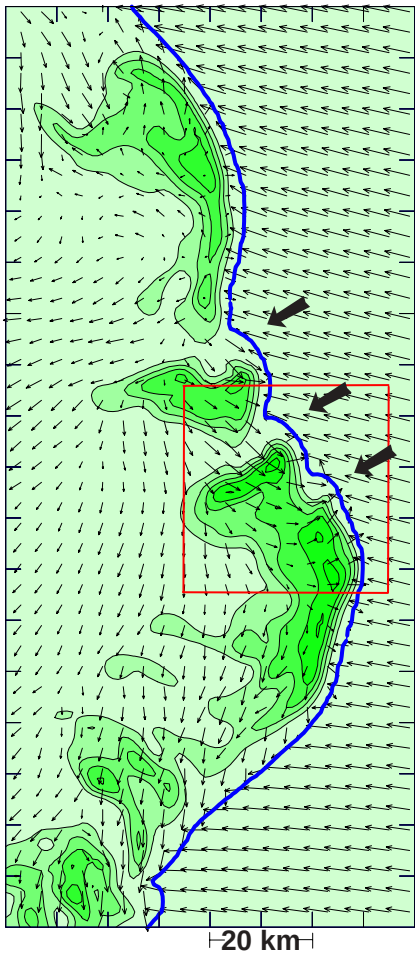


Figure 1: Horizontal cross-section, at z=0.25km of rainwater mixing ratio (color-filled and contoured at 1 g kg^{-1} increments), storm-relative horizontal velocity vectors, and the -1 K perturbation temperature isotherm (bold blue line), valid at t = 5h. Bold arrows point to low-altitude mesovortices. Red box indicates 40X40-km portion of the domain plotted in Fig. 2. Tick marks are plotted every 10 km.

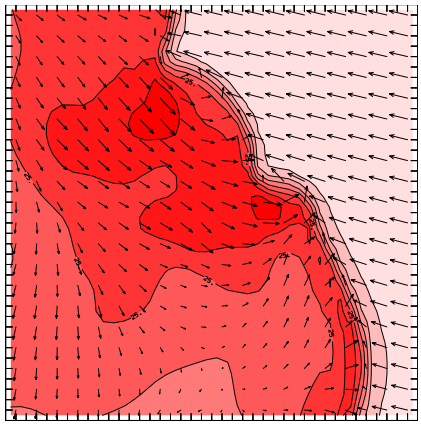
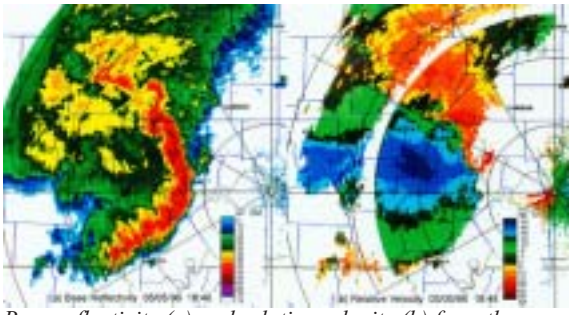


Figure 2: Horizontal cross-section, at z=0.127 km of ground-relative horizontal wind magnitude (color-filled and contoured at 5 m s^{-1} increments) and storm-relative horizontal velocity vectors, valid at t=5 h.



Base reflectivity (a) and relative velocity (b) from the Paducah, KY WSR-88D radar at 18:48 GMT for 5 May 1996. Velocities are presented relative to a storm motion of 33 kts from 280 degrees.

NSSL scientists to explore "bow echoes" in BAMEX: The Bow Echo and MCV EXperiment

Each year in the United States, damaging winds from thunderstorms pose a significant hazard to life and property. According to "Storm Data," from January 1995 to July 2000 over $1.4 billion in property damage, 72 deaths and 1,008 injuries were reported to the National Weather Service (NWS) as having been caused by such wind events. Particularly hazardous is a type of organized convective system popularly referred to as a "bow echo" (so named due to its characteristic bow shape on weather radar displays). First described in detail by Ted Fujita, bow echoes now represent one of the best-known modes of convective organization associated with severe weather events, especially for high surface winds.

Bow echoes can be quite extensive in length (over 300 km), last for several hours, and generate mid-level cyclonic vortices of diameters ~10-50 km (see also the companion article). Such mesovortices often consolidate and grow in scale to become a mesoscale convective vortex (MCV) with diameters ~100-200 km that persist long after the parent convective system has dissipated. Some MCV's re-initiate convective storms for several days thereafter as they travel distances of 1000 km or more. BAMEX, the Bow Echo and MCV EXperiment, seeks to understand both of these related mesoscale phenomena.

NSSL scientists Dave Jorgensen, Jeff Trapp (CIMMS), Brad Smull and Conrad Ziegler are joining with NCAR, NWS and University scientists as Principal Investigators (PI's) of BAMEX. One of the main goals of BAMEX, according to one of the PI's, Morris Weisman of NCAR, is to "understand the processes and improve prediction of systems that produce severe winds, through special data sets that can be used to initiate and validate numerical simulations." This and other goals can best be achieved through a highly mobile field experiment, given the fact that such systems are long-lived, affect extensive geographical areas, and can occur anywhere within a broad latitudinal band during the early warm season. Consequently, BAMEX observations will be collected via an airborne and a ground-based armada that will be deployed into several convective systems during May-July of 2003, the period bow echoes and MCV's occur most frequently. The proposed base of operations is St. Louis, Missouri. For more information contact Dave Jorgensen or Jeff Trapp at: davej@ucar.edu or jeff.trapp@nssl.noaa.gov. ◆

NSSL works with Taiwanese agencies to develop a Hydrometeorological Decision Support System for Taiwan

NSSL and NOAA's Forecast Systems Laboratory (FSL) are collaborating with the Central Weather Bureau and Water Resources Agency of Taiwan to develop a Hydrometeorological Decision Support System (HDSS) for Taiwan. The two agencies are hoping to improve the country's capabilities to issue flash flood and flood warnings and to improve their river and reservoir water management. The project will run from 2002-2005. The first year's accomplishments include: establishing infrastructure for real-time radar, rain gage, model and sounding data ingest, completing basic infrastructure and configuration of the HDSS for Taiwan, initial deployment of the HDSS with a Web-based product display system, and generating a suite of radar analysis and quantitative precipitation estimation products in real-time.◆

Research Experience for Undergraduates

Every summer NSSL/CIMMS hosts undergraduate college students through the National Science Foundation's (NSF) Research Experience for Undergraduates (REU). Daphne Zaras, CIMMS, is Lead Principal Investigator on the NSF grant and coordinates the REU activities. A summary of the REU students' research topics and mentors are listed below:

Erik Crosman - (University of Northern Colorado) - "Modeling Oklahoma City Rainfall Occurrence Using a First-Order Markov Chain" Mentor Harold Brooks (NSSL)

Stephanie Nordin - (St. Cloud State University) - "Significant Severe Thunderstorm Proximity Soundings" Mentor Harold Brooks (NSSL)

Addison Sears-Collins - (University of Virginia) - "A Climatology of Drizzle for North America" Mentor Bob Johns (CIMMS), Dave Schultz (CIMMS)

Shanna Sampson - (Millersville University) - "The Influence of Initial Conditions on the SPC 2001 Ensemble Cloud Model Forecasts" Mentor Kim Elmore (CIMMS) ◆

NSSL/SPC mutually benefit from collaborations

NSSL and CIMMS researchers, and SPC meteorologists are mutually benefitting from being located in the same building. Nine papers/posters authored by both NSSL, CIMMS, and SPC staff were presented at the recent Severe Local Storms Conference in San Antonio, TX. Topics included the annual NSSL/SPC Spring Program, "Operational Ensemble Cloud Model Forecasts: Some Preliminary Results," "Evaluation of ETA Model Forecasts of Mesoscale Convective Systems" and "A Database of Proximity Soundings for Significant Severe Thunderstorms, 1957-1993."

Another way co-location benefits both groups is through daily map discussions where current weather is discussed as well as operationally-relevant research topics, results, problems, and work in progress. ◆