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NOAA Predicts Another Active Hurricane Season

Coastal communities were urged to prepare for an active hurricane season as NOAA released its 2004 outlook for the Atlantic basin on May 17th. Speaking at a news conference in Houston, Texas, hurricane specialists predicted the June 1st-November 30th season would likely be marked by above-normal levels of storm activity. Twelve to 15 tropical storms are predicted to form, with six to eight of these storms developing into hurricanes. Two to four hurricanes are predicted to become major hurricanes with sustained wind speeds of at least 115 mph.

Climate conditions contributing to the above-normal forecast include the active phase of the Atlantic multi-decadal signal and a continuation of warmer than normal ocean temperatures in the tropical Atlantic Ocean and Caribbean Sea. The active phase of the Atlantic multi-decadal signal, which began in 1995, has been a primary factor in the increased amount of hurricane activity observed since that time. Many of the tropical storms and hurricanes in 2004 are likely to form during August-October, the peak months of the season, over the tropical Atlantic and Caribbean Sea between 9°N-21.5°N.

The 2004 hurricane outlook represents the combined expertise of a panel of scientists from NOAA's Climate Prediction Center, National Hurricane Center, and AOML's Hurricane Research Division (Stanley Goldenberg and Christopher Landsea). An updated forecast will be issued in early August 2004.

"Targeted Observations" Technique Improves Accuracy of NOAA's Hurricane Track Forecasts

A relatively new sampling technique known as "targeted observations" has enabled AOML's Hurricane Research Division (HRD) to increase the accuracy of the models that NOAA's National Hurricane Center uses to issue its official hurricane track forecasts. The targeted observations technique represents the culmination of two decades of research and collaborations with academic colleagues and within NOAA (*i.e.,* NOAA Research, Aircraft Operations Center, and National Weather Service), as well as improvements to hurricane models and instrument technology, advanced high speed computing capabilities, and the acquisition of NOAA's Gulfstream-IV jet aircraft. On average, a 25% improvement in the five-day forecast period has been achieved.

NOAA's Gulfstream-IV jet aircraft.

The targeted observations technique evolved from the need to make optimal use of the limited flight time aboard the Gulfstream-IV. HRD researchers developed strategies for identifying areas in the tropical cyclone environment where small changes in atmospheric conditions produced the greatest variance in model simulations. By focusing sampling efforts in these "target" areas, errors were reduced, leading to greater accuracy in the final track forecasts. "Targeted observation strategies support one of NOAA's primary mission goals—to serve society's needs for weather and water information—since they will enable both coastal residents and emergency personnel to more effectively prepare for hurricanes, thus saving lives and minimizing property damage," said Frank Marks, HRD Director.

During the 2002 and 2003 hurricane seasons, a total of 32 missions—mainly in major Hurricanes Isidore, Lili, and Isabel—utilized the targeted observation sampling strategy. By incorporating the data into NOAA's high performance forecast models, the accuracy of the five-day hurricane track forecasts increased by an average of 25%. Consistently achieving this level of improvement in future hurricane track forecasts (36- to 60-hour forecast intervals) will greatly assist in the decision-making process used to issue official hurricane watches and warnings. Analysis of the last five years of missions suggests that the Global Positioning System (GPS) dropwindsondes are also an especially useful tool in forecasting the track of strong (categories 4 and 5 on the Saffir-Simpson Hurricane Scale) and rapidly intensifying hurricanes (*e.g.,* Hurricane Opal in 1995).

As a hurricane approaches land, successful evacuation and damage mitigation measures, based on the most accurate landfall forecasts available, can greatly (*continued on page 2*)

(*continued from page 1*)

reduce loss of life and property. It has been recently estimated to cost close to $1 million (depending upon the amount of development) to prepare each mile of coastline within a hurricane warning area. Significant value can be realized if forecasters avoid calling for unnecessary preparation when a hurricane comes close to, but does not strike, a large coastal community. One complete Gulfstream-IV flight of eight hours and the required dropwindsondes costs about $40,000, much less than the average cost of preparing just one mile of coastline for a hurricane landfall.

Furthermore, according to the recently released 2004 NOAA Statistics Book, National Weather Service forecasts, warnings, and associated emergency responses result in a $3 billion dollar savings during a typical hurricane season. Two-thirds of this savings ($2 billion) is attributed to a reduction in hurricane-related deaths, and one-third of this savings ($1 billion) is attributed to a reduction in property-related damage because of preparedness actions.

While the threat posed by tropical storms and hurricanes remains undiminished, the new targeted observations technique developed by HRD researchers will assist forecasters to more accurately identify and warn coastal communities of approaching weather systems. With continued research into strategies to locate and sample specifically targeted regions during hurricane surveillance missions, as well as better methods to assimilate the data into NOAA's hurricane models, additional improvements in the hurricane track forecast models are anticipated.

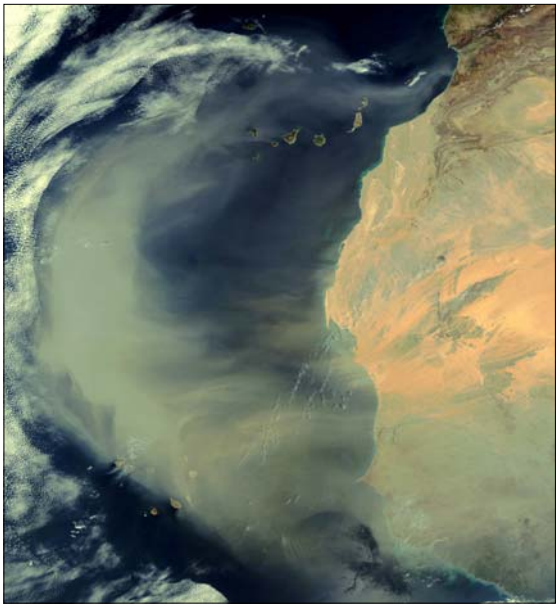
(Adapted from a May 17, 2004 article appearing on the NOAA web site)

2004 ATLANTIC STORM NAMES

ALEX	HERMINE	OTTO
BONNIE	IVAN	PAULA
CHARLEY	JEANNE	RICHARD
DANIELLE	KARL	SHARY
EARL	LISA	TOMAS
FRANCES	MATTHEW	VIRGINIE
GASTON	NICOLE	WALTER

Saharan Air Layer Impacts Atlantic Tropical Cyclone Activity

A recent study indicates that a dry layer of dust-laden air that drifts across the Atlantic seasonally from the northwest African coast may play a major role in suppressing tropical cyclone activity in the North Atlantic. The new findings about this air mass, the Saharan Air Layer (SAL), appeared in the March 2004 issue of the *Bulletin of the American Meteorological Society,*[1] co-authored by Jason Dunion, a senior research associate with the University of Miami's Cooperative Institute of Marine and Atmospheric Studies and AOML's Hurricane Research Division, and Christopher Velden of the University of Wisconsin's Cooperative Institute for Meteorological Satellite Studies.



A massive duststorm, the Saharan Air Layer, moves off the northwest African coast, blanketing thousands of square miles of the eastern Atlantic Ocean.

The SAL forms over the Sahara Desert and Sahel regions of northern Africa during the late spring and early fall. Large amounts of mineral dust lift off the arid desert surface and mix with the hot, dry air above. As this air layer moves westward and emerges from the coast, it is undercut by cool, moist, low-level air and becomes the SAL. Throughout its depth, the SAL generally retains its dryness and dustiness as it is carried thousands of miles across the ocean. During the Atlantic hurricane season (June 1-November 30), the SAL often blankets large portions of the North Atlantic. In fact, satellite imagery reveals that the SAL can sometimes encompass an area of the Atlantic larger than the contiguous United States.

While the SAL has been studied for several decades, its link to Atlantic hurricane activity has never been fully examined due to limitations in consistently detecting it with the visible and infrared channels found on most geostationary and polar-orbiting environmental satellites. Dunion and Velden performed their research utilizing a new split-window infrared imagery technique developed using the Geostationary Operational Environmental Satellites (GOES-8 and, subsequently, GOES-12). The GOES multispectral technique enabled them to continuously detect and monitor the SAL.

Using archived GOES satellite imagery, they tracked the movement of the SAL as it drifted westwards across the North Atlantic, Caribbean, and Gulf of Mexico during several recent hurricane seasons. The imagery showed that when the SAL encountered and subsequently engulfed tropical waves, tropical disturbances, or pre-existing tropical cyclones, its dry air, temperature inversion, and strong vertical wind shear tended to inhibit their intensification. As a result, these tropical circulations lost a major portion of their strength while still over the warm tropical waters of the Atlantic. Tropical circulations that emerged from the SAL's influence were sometimes able to regain their strength and rapidly intensify.

"The SAL's influence on hurricanes may be a factor in the challenge forecasters face in accurately predicting a tropical cyclone's intensity in the Atlantic," said Dunion. "It also may contribute to this basin's relatively reduced level of hurricane activity compared to other ocean basins." Future SAL research will seek additional validation of the GOES-SAL tracking imagery using Global Positioning System (GPS) dropsondes launched from NOAA hurricane hunter aircraft. Understanding how the SAL impacts hurricane activity in the Atlantic may potentially lead to more skillful forecasts of tropical cyclone intensity change.

[1]Dunion, J.P., and C.S. Velden, 2004: The impact of the Saharan Air Layer on Atlantic tropical cyclone activity. *Bulletin of the American Meteorological Society*, 85(3):353-365.

Researchers Convene to Fine Tune Remote Sensing Requirements

An international workshop to coordinate joint implementation strategies for future remote sensing missions dedicated to obtaining environmental observations was held at AOML on April 20-22, 2004. Drs. Silvia Garzoli and Robert Molinari of AOML's Physical Oceanography Division, members of the Organizing Committee, served as local hosts for the event.

The Joint Science and Implementation Workshop brought together more than 130 researchers to discuss the SMOS, Aquarius/SAC-D, and HYDROS satellite missions. SMOS, scheduled for launch in early 2007, will gather global observations of soil moisture and ocean salinity, as well as monitor vegetation water content and snow cover/ice structure. The Aquarius/SAC-D mission, developed jointly by the United States and Argentina, will begin its three to five-year quest to map global ocean surface salinity in 2008. HYDROS will provide the first global view of the Earth's changing soil moisture and land surface freeze/thaw state after its launch in 2009.

Researchers focused on issues of modeling, data analysis and data requirements, validation, and how to best link the new satellite observations with in-situ salinity observing systems, as well as links to other satellite measurements such as rain, winds, sea surface temperature, and sea surface humidity. General science discussions considered how to apply observations from the missions to study the global hydrological cycle, ocean circulation, climate, carbon dioxide flux, land processes, and the cryosphere.

The SMOS and Aquarius/SAC-D missions are expected to synergistically produce the most accurate and highly resolved global surface salinity measurements possible and help determine the large-scale climate variability of the ocean and its effects on weather. HYDROS observations will improve understanding of how water, energy, and carbon are exchanged between land and the Earth's atmosphere.

Coral Reef Monitoring Network Expands to Jamaica

Scientists with AOML's Ocean Chemistry Division began preliminary operations in June to install a CREWS (Coral Reef Early Warning System) station in Discovery Bay, Jamaica. The new station will augment the existing coral reef monitoring network and is the result of a collaborative agreement reached between NOAA and the MACC (Mainstreaming Adaptation to Climate Change) Project.

A typical Coral Reef Early Warning System (CREWS) station.

The MACC Project seeks to develop greater regional and national capacity for monitoring, assessing, and adapting to the effects of climate change in the Caribbean. Caribbean countries participating in the MACC Project include Antigua and Barbuda, the Bahamas, Barbados, Belize, Dominica, Grenada, Guyana, Jamaica, St. Kitts and Nevis, Saint Lucia, St. Vincent and the Grenadines, and Trinidad and Tobago. The Global Environmental Facility is funding the five-year project.

The steadily growing network of CREWS environmental monitoring stations gathers data from remote coral reef sites throughout the world. CREWS stations consist of a suite of oceanographic and meteorological sensors that measure the following: air temperature, wind speed and gusts, wind direction, dew point, barometric pressure, sea temperature, tide state, salinity, photosynthetically available radiation, and ultraviolet radiation.

An automated system processes the large amount of raw data gathered by the stations and generates near real-time information products about coral reef-related events. This information is distributed via the Internet and through several email listservers to the coral reef research community.

The entire CREWS data collection and processing system is part of NOAA's Coral Reef Watch Program. This program uses remote sensing, computational algorithms, and artificial intelligence tools to monitor, model, and report physical environmental conditions that adversely impact coral reef ecosystems.

The Discovery Bay CREWS station is expected to become fully operational in January 2005. Discussions are also currently underway to develop funding strategies for a CREWS station to be positioned in Belize.

Recent AOML Publications (May-June 2004)*

Coale, K.H., K.S. Johnson, F.P. Chavez, K.O. Buesseler, R.T. Barber, M.A. Brzezinski, W.P. Cochlan, F.J. Millero, P.G. Falkowski, J.E. Bauer, **R.H. WANNINKHOF**, R.M. Kudela, M.A. Altabet, B.E. Hales, T. Takahashi, M.R. Landry, R.R. Bidigare, X. Wang, Z. Chase, P.G. Strutton, G.E. Friederich, M.Y. Gorbunov, V.P. Lance, A.K. Hilting, M.R. Hiscock, M. Demarest, W.T. Hiscock, **K.F. SULLIVAN**, S.J. Tanner, R.M. Gordon, C.N. Hunter, V.A. Elrod, S.E. Fitzwater, J.L. Jones, S. Tozzi, M. Koblizek, A.E. Roberts, J. Herndon, J. Brewster, N. Ladizinsky, G. Smith, D. Cooper, D. Timothy, S.L. Brown, K.E. Selph, C.C. Sheridan, B.S. Twining, and Z.I. Johnson, 2004: Southern Ocean Iron Enrichment Experiment: Carbon cycling in high and low Si waters. *Science,* 304(5669):408-414.

KATSAROS, K.B., and A.V. Soloviev, 2004: Vanishing horizontal sea surface temperature gradients at low wind speeds. *Boundary-Layer Meteorology,* 112(2):381-396.

*Names of AOML authors appear in bolded capital letters.

Farewell

Sara Cotton, a CIMAS Associate with the Ocean Chemistry Division's Environmental Microbiology Laboratory since October 1998, resigned from AOML on April 23, 2004. Sara joins the staff of the Rosenstiel School of Marine and Atmospheric Science's Advancement Office where she will serve as an Alumni Affairs and Outreach Coordinator.

NOAA Corps officer Commander Sean White departed AOML in June 2004 after a four-year assignment with the Hurricane Research Division. Sean's next assignment will be with the National Centers for Environmental Prediction in Camp Springs, Maryland.

Welcome Aboard

Claudia Garcia joins the staff of the Ocean Chemistry Division's Environmental Microbiology Laboratory as a CIMAS research associate. Claudia holds a Bachelor of Science degree in biology from Purdue University. She will assist Dr. Kelly Goodwin in developing molecular biological assays for recreational water quality monitoring.

Jorge Perez joins the staff of the NOAA Miami Regional Library located at AOML as an assistant librarian. Jorge will work with Librarian Linda Pikula and is available for assistance with inter-library loans, reference searches, and web-related services. Jorge recently graduated from the University of South Florida with a Masters degree in library and information science.

Anjali Sardeshmukh joins the staff of the Ocean Chemistry Division's Environmental Microbiology Laboratory as a laboratory technician. Anjali holds a Bachelor of Science degree in biology from the University of Miami and will assist Dr. Kelly Goodwin with culture maintenance and halocarbon degradation research.

AOML Emergency Info cards for the 2004 hurricane season are available from Gladys Medina, Office of the Director:

(305) 361-4300
Gladys.Medina@noaa.gov

Congratulations

James Franklin, Krystal Valde, and Michael Black, recipients of the American Meteorological Society's 2004 Banner I. Miller award.

Michael Black, a meteorologist with AOML's Hurricane Research Division (HRD), Krystal Valde, a University of Miami meteorology student intern with HRD, and James Franklin, a hurricane specialist with the National Hurricane Center (and former HRD research meteorologist), are the recipients of the American Meteorological Society's 2004 Banner I. Miller Award. The award, one of the most prestigious in the field of tropical meteorology, is presented for the best contribution to the science of hurricane and tropical weather forecasting published in a journal with international circulation during the 48 months prior to the presentation of the award. Their research, published in *Weather and Forecasting*, was the first to document the mean vertical profile of wind speed in the hurricane inner core region from the surface to 700-hPA level using global positioning system (GPS) dropsondes. [Franklin, J.L., M.L. Black, and K. Valde, 2003: GPS dropwindsonde wind profiles in hurricanes and their operational implications. *Weather and Forecasting,* 18(1):32-44].

Yeun-Ho Daneshzadeh, Reyna Sabina, and Claudia Schmid of the Physical Oceanography Division's U.S. Argo Data Management Team are the recipients of a 2004 NOAA Administrator's Award. The Team is recognized for their contributions in developing and improving the data management system of the international Argo project, a global network of profiling temperature and salinity floats, and for providing quality controlled oceanic data in real time to the international operational and research oceanographic communities. Elizabeth Forteza and Xiangdong Xia, non-federal members of the Physical Oceanography Division's U.S. Argo Data Management Team, were also recognized for their contributions to the Argo project by Dr. Joseph Prospero, Director of the Cooperative Institute for Marine and Atmospheric Studies (CIMAS).

Rik Wanninkhof, an oceanographer with AOML's Ocean Chemistry Division, is a co-author on a research article that has won the Office of Oceanic and Atmospheric Research's FY-2003 Outstanding Scientific Paper Award [Feely, R.A., C.L. Sabine, T. Takahashi, and R.H. Wanninkhof, 2001: Uptake and storage of carbon dioxide int he oceans: The global CO_2 survey. *Oceanography*, 14(4):8-32].

Team AOML competed in the 20th Miami Corporate 5K Run at Bayfront Park on the evening of May 6th. Proceeds from the event were donated to the south Florida chapter of the Leukemia and Lymphoma Society. More than 20,000 individuals from 642 companies participated.

Travel

Rick Lumpkin served as a co-convenor for the Global Ocean Circulation session at the European Geophysical Union meeting in Nice, France on April 26-30, 2004.

Kelly Goodwin attended a NOAA workshop on Oceans and Human Health in Silver Spring, Maryland on May 2-4, 2004.

Carlisle Thacker attended the 36th International Liege Colloquium on Ocean Dynamics in Liege, Belgium on May 3-7, 2004.

Rik Wanninkhof attended The Ocean in a High CO_2 World symposium in Paris, France on May 10-12, 2004. He also participated in the Surface Ocean-Lower Atmosphere Study (SOLAS) Implementation Panel meeting in Montreal, Canada on May 17-19, 2004.

Judith Gray attended a CICOR (Cooperative Institute for Climate and Ocean Research) Executive Board meeting in Woods Hole, Massachusetts on May 11, 2004.

James Hendee attended the Coral Reef Ecosystem Integrated Observing System workshop in Boulder, Colorado on May 11-14, 2004.

Jules Craynock and Louis Florit repaired the Coral Reef Early Warning System (CREWS) station in St. Croix, U.S. Virgin Islands on May 24-27, 2004.

Gustavo Goni and Robert Molinari attended the Tropical Atlantic Workshop in De Bilt, the Netherlands on June 7-9, 2004.

Erica Rule attended the Office of Oceanic and Atmospheric Research's annual Outreach Coordinators meeting in Silver Spring, Maryland on June 8-11, 2004.

David Enfield, Silvia Garzoli, Robert Molinari, and Chunzai Wang visited several oceanographic and meteorological institutions in China to meet colleagues and present AOML research on June 11-26, 2004.

James Hendee, Erik Stabenau, and Derek Manzello attended the 10th International Coral Reef Symposium in Okinawa, Japan on June 28-July 2, 2004.

May-June 2004 Informal Research Reports*

May 6 ***Methyl Bromide: Recent Trends and Budget***
Dr. Shari Yvon-Lewis, Ocean Chemistry Division

May 11 ***Deriving a Heat Budget for the Tropical Atlantic***
Dr. Claudia Schmid, Physical Oceanography Division

May 13 ***Uncertainty in Hurricane Winds: What Do New Measurements and Simulations Tell Us About Hurricane Andrew***
Dr. Mark Powell, Hurricane Research Division

May 21 ***Year 1 Results from our Funded JHT Project and Preliminary Analyses of Near-Surface Observations in Hurricane Lili (2002)***
Dr. Joseph Cione, Hurricane Research Division

May 25 ***Upper Ocean Heat Content Estimates from Historical Hydrographic Data***
CDR Sean White, Hurricane Research Division

May 26 ***Retroflections of the North Brazil Current during February 2002***
Dr. Robert Molinari, Physical Oceanography Division

May 27 ***An Overview of Understanding ENSO***
Dr. Chunzai Wang, Physical Oceanography Division

May 27 ***Comparison of Tropical Cyclone Rainfall Forecasts from Operational Model for 1998-2003***
Dr. Robert Rogers, Hurricane Research Division

June 3 ***Precipitation Observational Support During CBLAST: Performance of the DMT CIP Probe***
Mr. Robert Black, Hurricane Research Division

June 22 ***Comparing Sewage Effluent Disposal in Massachusetts Bay and in Southeast Florida***
Dr. John Proni, Ocean Chemistry Division

June 24 ***Analyzing and Disseminating Airborne Doppler Radar Observations in Tropical Cyclones***
Dr. John Gamache, Hurricane Research Division

***Presentations are held in the first-floor conference room.**

View *Keynotes* online: http://www.aoml.noaa.gov/keynotes

Keynotes is published bi-monthly by the Atlantic Oceanographic and Meteorological Laboratory. Contributions and/or comments are welcome and may be submitted via email (Gail.Derr@noaa.gov), fax (305) 361-4449, or mailing address: NOAA/AOML, *Keynotes*, 4301 Rickenbacker Causeway, Miami, FL 33149.

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