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# AOML Keynotes

ATLANTIC OCEANOGRAPHIC AND METEOROLOGICAL LABORATORY

*AOML is an environmental laboratory of NOAA's Office of Oceanic and Atmospheric Research on Virginia Key in Miami, Florida*

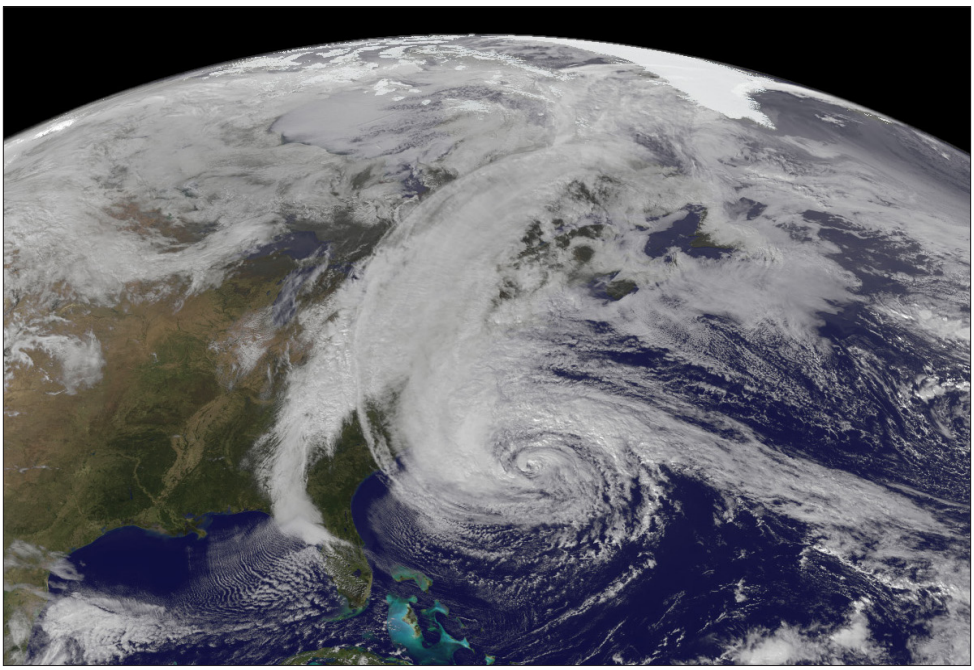
## NOAA's Airborne Data Vital in Forecasting Hurricane Sandy

AOML's hurricane researchers spent four hectic days in October gathering data as part of the effort to provide accurate forecasts about Hurricane Sandy. The late season Atlantic storm swept up the eastern seaboard, imperiling an estimated 50 million people, after leaving a trail of death and destruction throughout portions of the Caribbean and pelting Florida with tropical storm-force winds and rain.

Hurricane Research Division (HRD) scientists gathered observations from within the inner core of Sandy aboard one of NOAA's P-3 aircraft, while NOAA's Gulfstream-IV high altitude jet sampled the regions above and surrounding Sandy, including the mid-latitude weather systems to the north and west of Sandy's center that interacted with the storm and determined its unusual track.

GPS dropwinsondes measured Sandy's atmospheric pressure, humidity, winds, and temperature. Tail Doppler radar observations enabled HRD researchers to obtain three-dimensional depictions of Sandy's powerful winds and the regions of heaviest precipitation.

These highly-accurate, real-time data were assimilated into numerical models and used by the National Hurricane Center to keep government officials, emergency managers, the media, and the public informed with up-to-date forecasts, days in advance of Sandy's landfall. They provided vital information about the thermodynamic structure found within the turbulent environment of Sandy, the strength and direction of Sandy's damaging winds, and the atmospheric steering currents that would influence Sandy's track and landfall location.



**GOES-13 satellite image of Hurricane Sandy on October 28th. The massive storm covered much of the U.S. eastern seaboard as it churned offshore of the Carolinas and began interacting with a cold front located to its west (the elongated mass of clouds). Sandy posed a threat to more than 50 million people as it moved northward towards the densely-populated mid-Atlantic and northeastern states.**

**Hurricane researchers Lisa Bucci and Frank Marks monitor Sandy's winds aboard NOAA's P-3 aircraft.**

Sandy grew to massive proportions after merging with cold Arctic air, as it barreled eastward across the U.S (see satellite image above). Hurricane-force winds increased outward to as much as 175 miles, while tropical storm-force winds expanded to about 520 miles, making Sandy one of the largest systems ever observed in the Atlantic.

A ridge of high pressure south of Greenland prevented Sandy from being swept out to sea. Instead, the megastorm was steered inland, coming ashore south of Atlantic City, New Jersey on October 29th with 80 mph winds, torrential rains, and a storm surge that flooded low-lying regions from the Carolinas to Maine with particularly devastating consequences for portions of New York and New Jersey.

Sandy's impacts upon the densely-populated mid-Atlantic and northeastern states will likely be long lasting, as communities struggle to recover. With preliminary estimates of damages already soaring into the billions, the storm is destined to become one of the costliest in U.S. history.

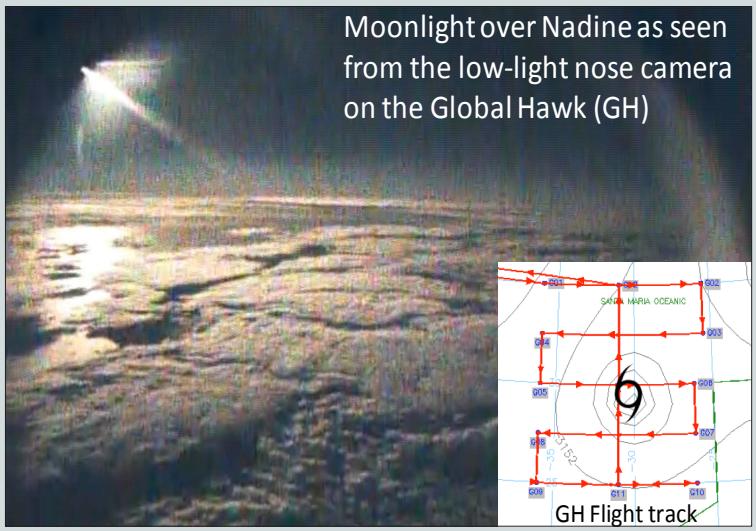
HRD researchers spent close to 60 hours aboard NOAA aircraft observing Sandy from October 25-28 in seven back-to-back missions. The data they gathered were critical to protecting both life and property as Sandy moved northward up the eastern seaboard. The massive storm nevertheless claimed more than 110 lives in the U.S., with close to 70 lives lost throughout the Caribbean.

Dr. Sundararaman Gopalakrishnan of AOML's Hurricane Research Division (aka Gopal) made an invited presentation about tropical cyclones at the NOAA Science Day event on September 12th in Washington, DC. Gopal's presentation, *The NOAA-HWRF System: Advances, Promises, and Challenges in Tropical Cyclone Structure and Intensity Predictions,* emphasized the critical use of observations obtained from NOAA's P-3 aircraft in improving HWRF forecasts.

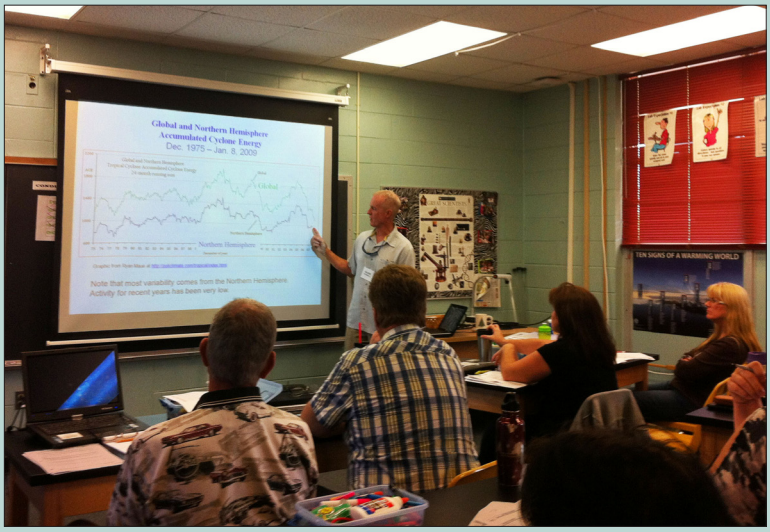
On September 13th, Gopal made two briefings to Congressional House and Senate members and their staff on Capitol Hill. His presentation entitled *NOAA's High-Resolution Hurricane Modeling System (HWRF): Improving our Nation's Hurricane Track, Structure, and Intensity Forecasts* was well attended by members from the House Committee on Science, the Senate Committee on Commerce, and staff from various offices of representatives and senators. Many in the audience had an advanced understanding of weather, weather models, and the data used for improving the models.

AOML hurricane researchers were involved in the first year of field work for the NASA Hurricane and Severe Storm Sentinel (HS3) field campaign. This experiment, involving two unmanned Global Hawk (GH) aircraft, is aimed at improving the understanding of environmental and inner-core processes on tropical cyclone genesis, intensification, and extratropical transition. Robert Rogers and Jason Dunion are members of the HS3 Science Team, where they played a key role in developing and executing flight plans to satisfy various HS3 objectives and analyzed the data that were collected. Michael Black was instrumental in designing the sampling strategies and processing the data collected using the GPS dropsonde system on one of the GHs.

During the 2012 field campaign, six GH missions were conducted, including five to sample Nadine, an Atlantic basin storm, during the three-week period as she developed into a tropical storm, maintained tropical storm intensity despite adverse environmental conditions, redeveloped from a post-tropical cyclone to a tropical storm and, ultimately, strengthened into a hurricane.




**Photograph of Nadine, the 14th named storm of the Atlantic hurricane season, as viewed from above by the nose camera on a Global Hawk unmanned aircraft. The inset image shows the flight track used to sample the storm over a 26-hour period from September 26-27.**




**AOML meteorologist Mark Powell during a lecture to help sixth-grade science teachers better understand climate change.**

AOML meteorologist Mark Powell was a guest lecturer for an ASK (Advancing Student Knowledge) Florida Climate Workshop in Daytona Beach on October 3-5th. The program is funded by NASA to improve middle school teachers' understanding of climate science. Participants in the program attend both summer and school-year training workshops with the goal of developing and teaching at least one climate lesson.

Throughout the training, teachers work individually with coaches and interact with other teachers, science educators, and researchers and agree to share their new knowledge and skills with peers who did not participate in the program.

Mark trained 20 sixth-grade science teachers from Volusia and Flagler counties through lectures about sea level rise, hurricanes, and the El Niño-Southern Oscillation phenomenon. The training also included several lab experiments and a game of Hurricane Jeopardy.

# Western Boundary Time Series Data Collection Efforts Continue

NOAA has been one of the leading players in research on the Meridional Overturning Circulation (MOC) for the past three decades, dating back to 1982 when scientists with AOML's Physical Oceanography Division (PhOD) joined with partners at NOAA's Pacific Marine Environmental Laboratory and the University of Miami's Rosenstiel School of Marine and Atmospheric Science (RSMAS) on a new program to monitor key western boundary components of the Atlantic MOC (AMOC) at 27°N east of Florida.

AOML took over sole direction of this program, presently called the Western Boundary Time Series (WBTS) project, in 2000. The program represents the cornerstone of a major international initiative between the United States and the United Kingdom that started in 2004.

This collaboration, denoted as MOCHA (Meridional Overturning Circulation Heat-flux Array) by U.S. contributors and RAPID-MOC (Rapid-Meridional Overturning Circulation) by U.K. contributors, is designed to measure temporal variations of the complete AMOC along 26.5°N. It is important to quantify AMOC variability and understand the processes that govern that variability as AMOC variations have been shown to be correlated to important climate changes such as variations in surface air temperatures and precipitation.

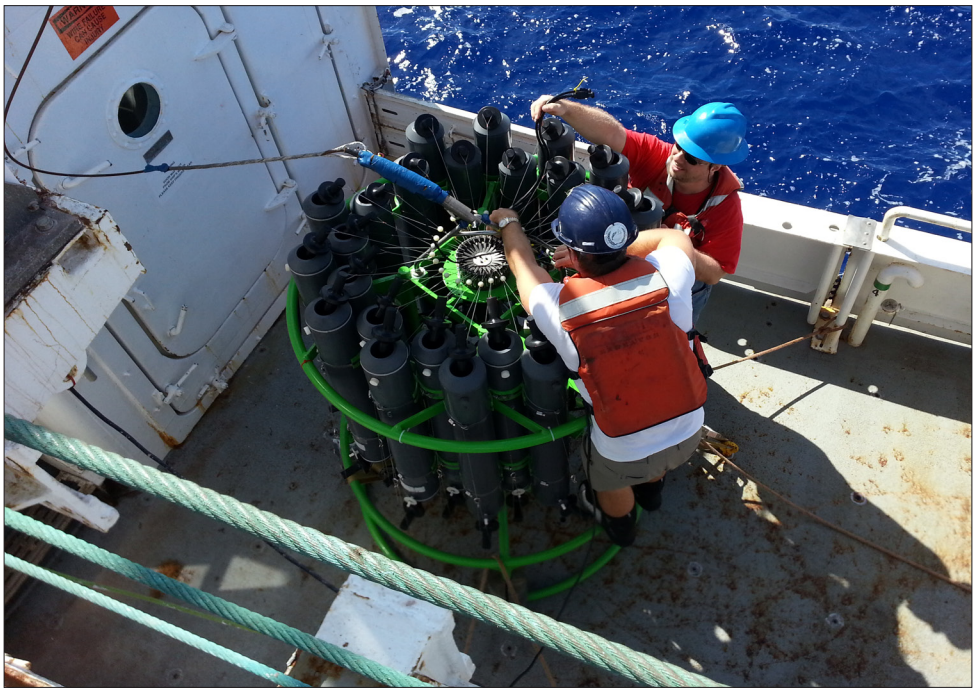
In the latest expedition in support of these collaborative projects, six PhOD scientists and engineers—Dr. Christopher Meinen, Mr. Jay Hooper, Mr. Pedro Peña, Dr. Renellys Perez, Mr. Kyle Seaton, and Mr. Andrew Stefanick—joined with colleagues from RSMAS on a very successful research cruise aboard the University of Rhode Island's RV *Endeavor* from September 24th to October 10th.

**The science party for the September-October 2012 WBTS-MOCHA cruise aboard the RV *Endeavor.***

Researchers collected more than 40 high quality conductivity-temperature-depth (CTD) profiles, collected data acoustically from four pressure-equipped inverted echo sounder (PIES) moorings, deployed two PIES moorings and recovered one PIES, and recovered and deployed five short and tall moorings of various types. This cruise was also used to opportunistically deploy 10 satellite-tracked drifting buoys for the Global Drifter Program.

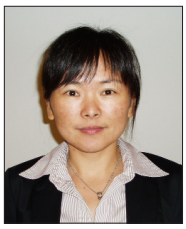
The continuing success of these joint programs has extended the long time-series of Gulf Stream/Florida Current and Deep Western Boundary Current observations that are crucial for the study of climate time-scale ocean processes, for which few long records are available. These measurements are used by the scientific community to assess the realism of state-of-the-art ocean and coupled climate simulations.

**An AOML researcher and RSMAS graduate student deploy a drifting buoy from the deck of the RV *Endeavor* in support of the Global Drifter Program.**

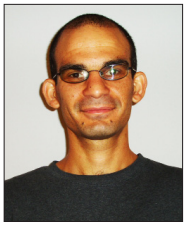


**A conductivity-temperature-depth (CTD) instrument is prepared for deployment from aboard the RV *Endeavor.***

## Welcome Aboard



Dr. Hua Chen joined the staff of the Hurricane Research Division (HRD) in September as a post-doctoral scientist with the National Research Council. Hua will be working with HRD's modeling group on the intensification problem in tropical cyclones with an emphasis on the physics and diagnostics of the high-resolution HWRF model. She recently received her Ph.D. in atmospheric sciences from the University of Maryland.



Dr. Javier Delgado joined the staff of the Hurricane Research Division (HRD) in September as a senior research associate of the University of Miami's Cooperative Institute for Marine and Atmospheric Studies. Javier will work with HRD's Modeling Group on the scalability and improvement of the performance of the HWRF modeling system. He will also collaborate with HRD's Data Assimilation Group to configure the OSSE (observing system simulation experiment) system and assist in improving the performance of the coupled HWRF-OSSE system. Javier recently earned a Ph.D. in electrical engineering from Florida International University's College of Engineering and Computing.

Combined Federal Campaign

November 1-28, 2012

AOML's 2012 CFC coordinators:

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## Congratulations

Howie Friedman of AOML and Teresa Gulotta-Powers, Chairperson of the South Florida Federal Executive Board.

Howie Friedman of AOML's Hurricane Research Division was recognized for his contributions to the South Florida Federal Executive Board (FEB) and south Florida federal community in September at the FEB's quarterly meeting. Howie was presented with a plaque for his dedication and service as the FEB's treasurer during fiscal year 2012. He was also re-elected as the treasurer of the FEB for fiscal year 2013. In addition to his work as the FEB treasurer, Howie has served as a member of the FEB's annual Federal Employee of the Year Awards Committee for more than a decade, and is currently the co-chairperson of the FEB's Mediation/SNAP (Shared Neutrals-ADR [Alternative Dispute Resolution] Program) Committee.

Silvia Garzoli, AOML's chief scientist, received the Premio RAICES a la Cooperación Internacional en Ciencia, Tecnología, e Innovación in September from the Argentine Ministery of Science and Technology. The award recognizes Argentinean researchers living abroad of Argentina who have strengthened scientific cooperation and technological capabilities within the country. Over the past decade, Silvia has worked with the Argentine scientific community on international projects to monitor and study the South Atlantic meridional overturning circulation and the meridional transport of heat in the Atlantic. She will receive the award in Buenos Aires on November 23rd.

Sang-Ki Lee, a University of Miami Cooperative Institute scientist with AOML's Physical Oceanography Division, was selected as NOAA's Team Member of the Month for October 2012. Sang-Ki was recognized for research that has identified a relationship between La Niña conditions in the tropical Pacific and increased tornadic activity in the United States. In April-May 2011, the U.S. experienced one of the deadliest tornado seasons on record, prompting the need to identify long-term climate signals that could potentially provide seasonal predictability for U.S. tornado outbreaks. Sang-Ki and his team members examined the top ten tornado seasons since 1950 and found a link to a climate pattern known as Trans-Niño, which is part of the El Niño-Southern Oscillation climate cycle. Trañs-Nino, which occurs as La Niña conditions are declining in the spring, creates atmospheric conditions throughout the central and eastern U.S. that favor intense tornado outbreaks.

Russell St. Fleur of AOML, Jaqueline Arroyo, Executive Director of the South Florida Federal Executive Board, and Alejandra Lorenzo of AOML.

Alejandra Lorenzo of AOML's Computer Networks and Services Division and Russell St. Fleur of AOML's Hurricane Research Division were recognized for their service to the South Florida Federal Executive Board (FEB) at the FEB's quarterly meeting in September. Alejandra and Russell received Technology Assistance Awards in acknowledgment of their efforts to aid the FEB in updating their web site. Alejandra, a member and co-chair of the FEB's Web Council, was instrumental in developing a memorandum of understanding between AOML and the FEB that has enabled AOML to temporarily host the FEB's website on the AOML server while it awaits migration to a Department of Commerce server. Russell St. Fleur provided the FEB with invaluable technical expertise in facilitating the migration of the FEB's web site to the AOML server.

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Dr. Robert S. Detrick
Assistant Administrator

# Recent Publications *(AOML authors are denoted by bolded capital letters)*

Coddington, O., P. Pilewskie, and **T. VUKICEVIC**, 2012: The Shannon information content of hyperspectral shortwave cloud albedo measurements: Quantification and practical applications. *Journal of Geophysical Research,* 117:D04205, 12 pp.

Enns, A.A., L.J. Vogel, A.M. Abdelzaher, H.M. Solo-Gabriele, L.R.W. Plano, **M.L. GIDLEY,** M.C. Phillips, J.S. Klaus, A.M. Piggot, Z. Feng, A.J.H.M. Reniers, B.K. Haus, S.M. Elmir, Y. Zhang, N.H. Jimenez, N. Abdel-Mottaleb, M.E. Schoor, A. Brown, S.Q. Khan, A.S. Dameron, N.C. Salazar, and L.E. Fleming, 2012: Spatial and temporal variation in indicator microbe sampling is influential in beach management decisions. *Water Research,* 46(7): 2237-2246.

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Nagamani, P.V., M.M. Ali, **G.J. GONI, P.N. DI NEZIO,** J.C. Pezzullo, T.V.S. Udaya Bhaskar, V.V. Gopalakrishna, and N. Kurian, 2012: Validation of satellite-derived tropical cyclone heat potential with in situ observations in the North Indian Ocean. *Remote Sensing Letters,* 3(7):615-620.

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*AOML conducts research to understand the physical, chemical, and biological characteristics and processes of the ocean and the atmosphere, both separately and as a coupled system. The principal focus of these investigations is to provide knowledge that leads to more accurate forecasting of severe storms, better utilization and management of marine resources, better understanding of the factors affecting both climate and environmental quality, and improved ocean and weather services for the nation.*