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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 located on Virginia Key in Miami, Florida

Ocean Temperatures May Hold Key to Predicting Tornado Outbreaks

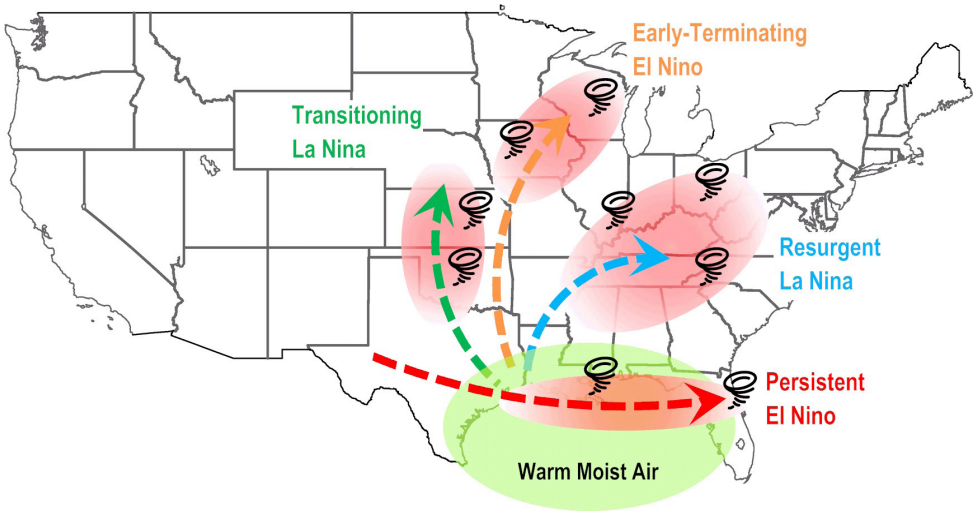
Tornadoes are one of nature's most destructive forces. Widespread tornado outbreaks in the US, such as occurred in the spring of 2011, cause a significant loss of life and property. The capacity to predict these violent storms curently does not extend beyond 7 days. Without long-range outlooks for severe weather, it is difficult for emergency managers, businesses, and the public to prepare the resources needed to prevent economic losses and protect vulnerable communities.

In a paper published in the April issue of *Environmental Research Letters*,* scientists from AOML and the University of Miami identified patterns in the spring phases of the El Niño-Southern Oscillation (ENSO), coupled with variability in North Atlantic sea surface temperatures, that can be used to predict US regional tornado outbreaks.

"This is the first study to show that the most frequently occurring spring sea surface temperature patterns in the tropical Pacific and North Atlantic are linked to distinctive spatial patterns of the probability of US regional tornado outbreaks," said lead author Dr. Sang-Ki Lee, an AOML oceanographer.

The team investigated the spatial patterns of springtime US regional tornado outbreaks from 1950-2014 and their connection to the springtime phases of ENSO. ENSO, or the El Niño-La Niña cycle, is a natural climate pattern in the Pacific Ocean. During an El Niño event, warm sea surface temperatures spread across the tropics. In a La Niña year, the opposite happens: cool sea surface temperatures dominate in the eastern tropical Pacific. These temperature shifts have a ripple effect on large-scale atmospheric processes that are conducive to tornado outbreaks across the US.

Four variations of ENSO events were examined: strong winter events that persist well into spring and weak events that dissipate soon after their winter peak. The team found that weak El Niños led to tornado outbreaks in May throughout the Upper Midwest, while strong El Niños led to outbreaks in February across Central Florida and the Gulf Coast. In contrast, weak La Niñas led to April outbreaks throughout the South, particularly in Oklahoma and Kansas, while strong La Niñas led to April outbreaks along the Ohio Valley and in the southeast and upper Midwest.



Four dominant spring ENSO variations are linked to distinct and significant regional patterns of tornado outbreak probability. Red ellipses indicate the regions of increased risk, while arrows show the associated wind anomalies that produce atmospheric conditions conducive to tornado outbreaks, such as increased wind shear and the convergence of warm, moist air originating from the Gulf of Mexico.

The results suggest that each of the four dominant spring ENSO variations is linked to distinct and significant US regional patterns of outbreak probability. The greatest tornado connection is with strong, persistent La Niñas, consistent with the Super Outbreak of 1974 and the record-shattering tornado outbreaks of 2011, both of which occurred during strong La Niña events.

The team plans to incorporate the spring ENSO state and North Atlantic sea surface temperature variability into a forecast model to predict 1-3 months in advance which regions are more likely to experience widespread tornado outbreaks. By extending NOAA's ability to predict tornado outbreaks, federal, state, and local agencies can plan early and strategically pre-position resources to better prepare for an emergency response.

It is important to remember that a regional tornado outbreak may occur in any season and almost anywhere in the US, regardless of ENSO state. Even during an overall quiet season, one outbreak event could cause significant loss of life and property. Therefore, communities routinely exposed to severe weather systems should be ready for every severe weather season regardless of what a seasonal outlook may predict.

A 3-minute video summary of the paper can be viewed at:

www.youtube.com/watch?v=nOZhWaKy0uw

*Lee, S.-K., A.T. Wittenberg, D.B. Enfield, S.J. Weaver, C. Wang, and R. Atlas, 2016: US regional tornado outbreaks and their links to the springtime ENSO phases and North Atlantic SST variability. *Environmental Research Letters,* 11(4):044008 (doi:10.1088/1748-9326/11/4/044008).

Underwater Glider Science Team Wins Department of Commerce Bronze Medal

AOML oceanographers Francis Bringas, Gustavo Goni, and George Halliwell, along with Richard Bouchard of NOAA's National Weather Service, received a Department of Commerce Bronze Medal in March for their work to deploy a pair of underwater gliders in support of tropical cyclone research. Specifically, the team was recognized for "the rapid and successful implementation of an array of underwater gliders geared towards Caribbean Sea and tropical Atlantic Ocean hurricane research and forecasts."

Active members of the group include Grant Rawson, Ricardo Domingues, Sang-Ki Lee, and Jili Dong, all University of Miami-Cooperative Institute researchers at AOML, Walter McCall of NOAA's National Data Buoy Center, and Hyun-Sook Kim of NOAA's Environmental Modeling Center. Julio Morell and Luis Pomales of the Caribbean Coastal Ocean Observing System (CariCOOS) and University of Puerto Rico at Mayaguez have also played key roles in the success of the project. Additionally, Ulises Rivero and Thomas Sevilla of AOML recently joined the underwater glider team.

AOML and CariCOOS researchers led the multi-institutional, international project to deploy the underwater gliders off Puerto Rico in 2014 as a cost-effective and efficient means for gathering profile data of ocean parameters such as temperature, salinity, oxygen, and current velocity. The gliders have successfully completed three missions since 2014, gathering more than 10,000 temperature and salinity profiles. These data have enabled researchers to improve their understanding of ocean variability and the effects of hurricane-force winds on the upper ocean. The data have also enabled researchers to observe the impact of glider data on tropical cyclone intensity forecasts, as a result of the data being assimilated into coupled ocean-atmosphere hurricane models

During the 2014 Atlantic hurricane season, powerful Hurricane Gonzalo traveled within close proximity of the glider gathering data in the Atlantic Ocean. Preliminary results from their interaction indicate that assimilation of the glider's data into the HYCOM-HWRF model being tested at AOML and NOAA's Environmental Modeling Center noticeably improved pre-storm ocean thermal and saline structures.

A subsequent study published in *Geophysical Research Letters* (Domingues *et al.,* 2015) based on glider observations revealed that assimilation of ocean salinity conditions may be particularly critical for hurricanes that travel in the North Atlantic Ocean north of Puerto Rico. Results from the study showed that salinity likely played an important role in suppressing the cooling of the upper ocean that would normally have occurred from the passage of Gonzalo. The cooling of surface waters forced by Gonzalo was small compared to cooling forced by other Atlantic hurricanes of similar strength, possibly contributing to the further strengthening of Gonzalo. An additional study that explores the impact of improved ocean initial conditions using assimilated glider data on the forecast of Hurricane Gonzalo is currently underway.

Members of the underwater glider team at AOML include (standing) Tom Sevilla, Sang-Ki Lee, George Halliwell, Grant Rawson, and Francis Bringas and (kneeling) Jili Dong, Ulises Rivero, Ricardo Domingues, and Gustavo Goni.

The underwater glider project was originally funded by the Sandy Supplemental, but is now supported by AOML, CariCOOS, and the University of Puerto Rico, as well as the collaboration of NOAA's National Data Buoy Center. Additional information about the project can be found at www.aoml.noaa.gov/phod/goos/gliders/index.php. Congratulations to the underwater glider science team and to the many glider team members who have contributed to the success of the project.

Underwater Gliders Begin Fourth Mission

In March, AOML's two underwater gliders were deployed in the Caribbean Sea south of Puerto Rico for the start of their fourth mission. Both gliders are now equipped with temperature, salinity, oxygen, chlorophyll, and colored dissolved organic matter sensors. One of the gliders will gather profile data along a repeat transect, while the second will gather targeted observations of mesoscale ocean features to help researchers better understand the role of eddies in transporting nutrient-rich water into the Caribbean Sea. During their two-to-three-month deployment, the gliders are expected to gather an estimated 2500 ocean profiles. Several experiments are also planned to assess the accuracy of the gliders' sensors and current data. The fifth mission for the gliders is scheduled to begin in June 2016 in support of tropical cyclone intensity forecasts.

AOML's two underwater gliders aboard the RV *La Sultana*, a research vessel of the University of Puerto Rico-Mayaguez.

Researchers Sample Indian Ocean along GO-SHIP IO9N Transect

AOML researchers joined an international team of 31 scientists aboard the RV *Roger Revelle* in March and April to sample the physical, chemical, and biological parameters of the Indian Ocean. The cruise was undertaken in support of the Global Ocean Ship-Based Hydrographic Investigation Program (GO-SHIP), an international initiative to decadally sample all ocean basins. By regularly resampling ocean transects, researchers can quantify changes in the ocean's storage and transport of heat, freshwater, salinity, carbon, nutrients, oxygen, and trace gases, providing insights into how a changing climate is impacting the physics, chemistry, and biology of the world's oceans.

Leticia Barbero, a University of Miami-Cooperative Institute scientist with AOML's Ocean Carbon Group, served as chief scientist, while Robert Castle of AOML led the effort for dissolved inorganic carbon (DIC) measurements. The current IO9N survey represented the third occupation of an Indian Ocean transect previously sampled in 1995 and 2007.

The IO9N line began northwest of Freemantle, Australia at 28°S and ended in the Bay of Bengal at 18°N, a distance of more than 4000 miles. Along the cruise track, the research team sampled the full water column at 113 stations. Ship-based hydrography is essential for documenting changes in the water column, especially the deep ocean below 2 kilometers. These deeper levels make up roughly 52% of the ocean's volume and cannot currently be measured by autonomous instruments.

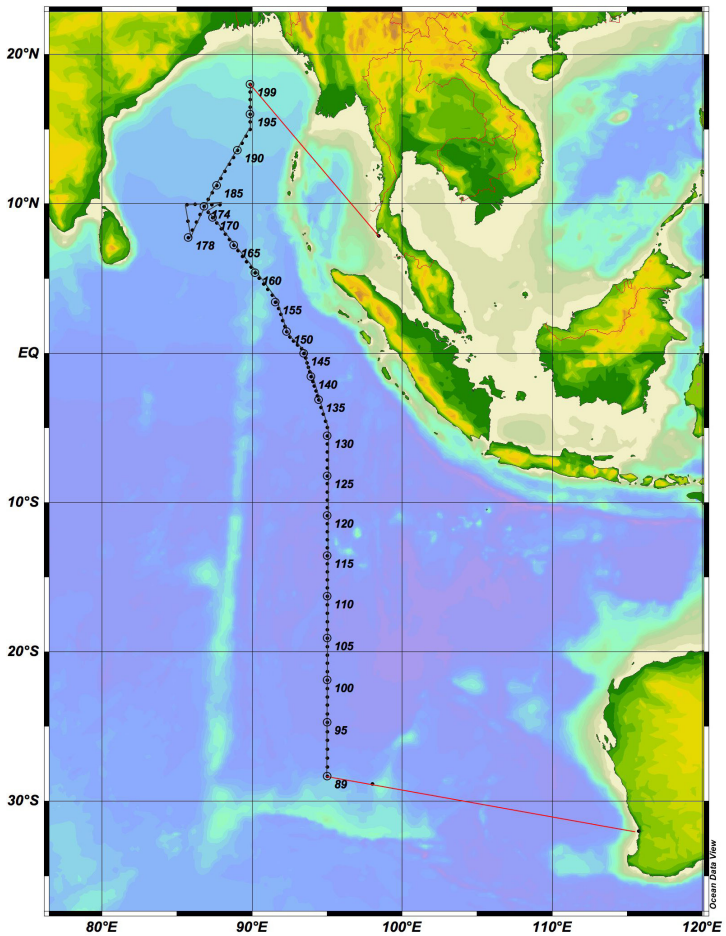
Conductivity-temperature-depth and oxygen (CTD-O_2) sensors connected to a water-sampling package generally called the rosette, CTD, or simply "the package," were used at each station to collect samples at 36 depths. These samples provided precise measurements of salinity, temperature, and oxygen down to 6000 meters, more than 3.5 miles below the ocean surface. Water collected at each depth was also used to determine total DIC, pH, nutrient concentrations, chlorophyll levels, and a variety of other parameters.

Robert Castle of AOML (far left) waits his turn to obtain water samples from the CTD for dissolved inorganic carbon analysis.

Great care was taken to measure a number of high priority, level 1 core parameters such as carbon, nutrients, salinity, temperature, etc. In addition to these core parameters, however, a number of level 2 (highly desirable factors) and level 3 (ancillary measurements) parameters were gathered as well. As an example, trace metals, which are metals such as iron found in extremely small concentrations in the ocean, were measured at 24 locations along the cruise track. At the same locations, water samples were gathered to perform incubation experiments to determine nutrient uptake rates, as well as the phytoplankton community and genomic composition of surface waters.

The science plan also included a number of activities to assist other research programs. For example, an optics cast was performed daily, timed to the passage of the MODIS-AQUA satellite that provides images of ocean color. These optics casts will be used to calibrate the MODIS-AQUA satellite images. Additionally, eight Argo profiling floats were deployed at select locations along the cruise track in support of the ARGO program.

After more than a month at sea spent diligently gathering an array of data around the clock, the intensive IO9N sampling effort ended with a port call in Phuket, Thailand. The survey along the IO9N GO-SHIP transect supports global ocean observational efforts by providing critical data that will serve as a baseline to assess changes in the ocean's biogeochemical cycle in response to natural and anthropogenic activities. These collective observations are needed to improve knowledge of the complex interaction between the oceans and global climate.



Cruise track of the 2016 IO9N GO-SHIP Indian Ocean transect from Freemantle, Australia northward into the Bay of Bengal (28°S to 18°N).

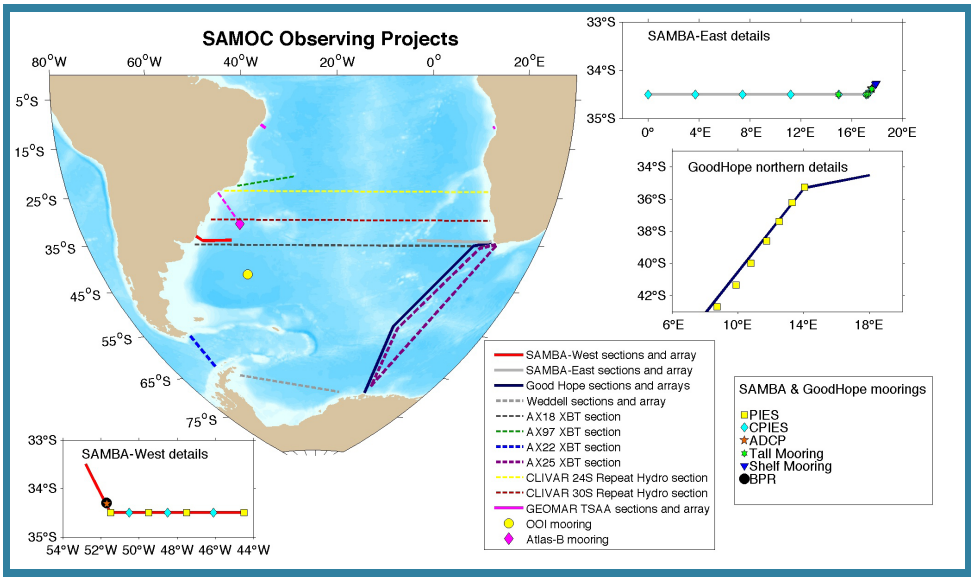
- **GO-SHIP Program—http://www.go-ship.org/**
- **US Repeat Hydrography Program—http://ushydro.ucsd.edu/**
- **The RV *Roger Revelle*—https://scripps.ucsd.edu/ships/revelle**

AOML Scientists Lead and Participate in Workshop on South Atlantic Circulation

Drs. Christopher Meinen and Renellys Perez of AOML's Physical Oceanography Division led a one-day workshop for the international South Atlantic Meridional Overturning Circulation ("SAMOC") initiative on February 21st in New Orleans, Louisiana. AOML scientists Drs. Shenfu Dong, Silvia Garzoli, Sudip Majumder, and Claudia Schmid also participated in the workshop, which was the sixth in a series held since 2007 to coordinate international efforts to study important SAMOC-related science issues.

The SAMOC VI workshop, held the day before the start of the American Geophysical Union's (AGU) 2016 Ocean Sciences conference, brought together 25 scientists representing institutions from the four continents that border the Atlantic Ocean. Participants discussed logistical updates related to ongoing and future field programs, including plans for joint cruises and field work, collaborative research studies and publications, data analysis challenges and data sharing policies, and the future leadership of this important science initiative.

Dr. Garzoli stepped down as chair of the SAMOC Executive Committee, taking a "member emeritus" position, and Dr. Meinen was appointed to serve as a new member of the Executive Committee. The participants also agreed upon procedures for creating a new SAMOC Science Team that will help direct science in this area moving forward.



Map illustrating many of the major field projects that collect data related to South Atlantic Meridional Overturning Circulation (SAMOC), including several important NOAA-led projects.

A SAMOC-related science session entitled "Observing and Modeling the Meridional Overturning Circulation in the South Atlantic: Causes of Variability and Impacts on Climate, Weather, and Ecosystems" was held on the first day of the AGU Ocean Sciences meeting. This session updated the broader scientific community on recent SAMOC scientific advances, and Dr. Perez was one of the four conveners.

These important discussions will help NOAA and its partners better understand the structure and variability of the Meridional Overturning Circulation in the South Atlantic, which is one of the key near-term goals of the US interagency Ocean Research Priorities Plan.

New Virtual Stations Enhance Coral Monitoring Efforts in the Caribbean

Coral researchers with NOAA's Coral Health and Monitoring Program (CHAMP) at AOML recently added two new sites to its collection of western Caribbean virtual stations. The new virtual station at Banco de San Antonio is in a commercially important fisheries region and serves as a sister sanctuary to NOAA's Flower Garden Banks National Marine Sanctuary in the Gulf of Mexico. The new virtual station in Cabo San Antonio, part of the Guanahacabibes National Park, is a sister sanctuary to NOAA's Florida Keys National Marine Sanctuary. By monitoring conditions at these comparable sister sanctuary sites, CHAMP researchers will be able to evaluate ecosystem function and changes occurring across the Straits of Florida.

CHAMP researchers at AOML are now able to remotely monitor environmental conditions in the Guanahacabibes National Park.

Virtual stations are locations of interest for which there is no in-situ monitoring, but for which remotely-sensed and modeled parameters such as sea temperature, wind speed, and ocean currents are available. CHAMP researchers actively monitor and provide data on coral reef ecosystems through CHAMP's Portal tool. In addition to remotely-sensed observations, a network of buoys established at reef sites throughout the Caribbean and Florida also provide data for CHAMP. The CHAMP Portal currently includes oceanographic and meteorological observations from 152 sites around the globe. Of these 152 sites, 17 report environmental parameters from in-situ instruments and 135 are virtual stations. Data from the CHAMP network serve as an invaluable blueprint for guiding coral reef management practices and restoration efforts throughout the Caribbean.

CHAMP data also inform ecological forecasts that alert resource managers of possible coral bleaching conditions and other environmental impacts, providing them with the needed information for conservation and local management decisions. The CHAMP Portal data, with links to ecological forecasts at individual sites, can be found at http://www.coral.noaa.gov/champportal.

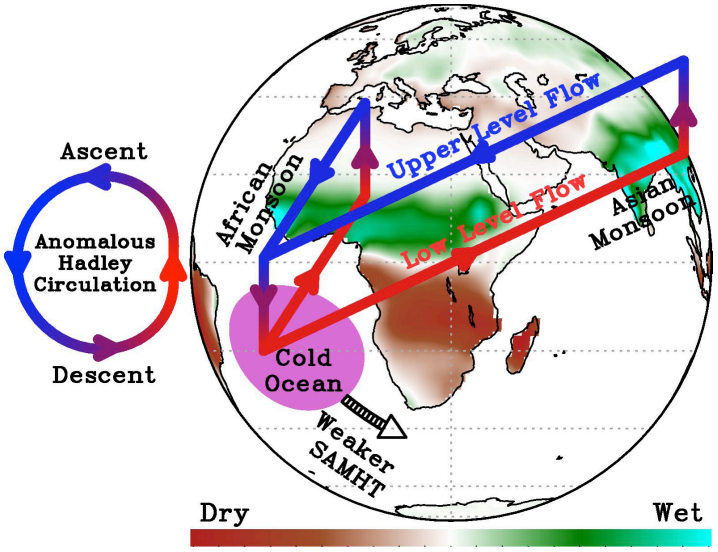
Study Describes Link Between South Atlantic Ocean and Global Rainfall Variability

A recent paper published in the *Journal of Climate** identifies how ocean circulation variability in the South Atlantic Ocean may influence global rainfall and climate patterns. The study by researchers with AOML's Physical Oceanography Division and the University of Miami's Cooperative Institute for Marine and Atmospheric Studies suggests that the South Atlantic's circulation is a potential predictor of global rainfall variability with a lead-time of approximately 20 years. This link between the South Atlantic Ocean and climate and weather could provide, for example, critical information to managers and decision makers by obtaining significant long-term insights for water management on a global scale.

The majority of efforts to understand the dynamics of the Atlantic Ocean circulation system and its climate impact have focused primarily on the North Atlantic. Only in recent years has the research community started investigating and assessing the South Atlantic and its role in climate and weather. The ocean circulation in this region is unique, since it is the only major ocean basin that transports heat from the poles towards the equator, thus playing an important role in the global distribution of ocean and atmospheric heat.

The study illustrates that multi-decadal variability in the South Atlantic's circulation modulates global atmospheric circulation by influencing the transfer of momentum, heat, and moisture between the two hemispheres. This link is based on the movement of heat in the South Atlantic known as the South Atlantic meridional heat transport. The study indicates that a weaker transport yields cooler upper ocean temperatures in the South Atlantic about 20 years later. This impacts global rainfall patterns, including seasonal monsoons, by driving atmospheric heat from the Northern Hemisphere to the Southern Hemisphere and moisture from the Southern Hemisphere to the Northern Hemisphere, a process known as the inter-hemispheric Hadley circulation.

Changes in monsoonal rainfall have vital socioeconomic impacts, as the majority of the world's population lives in countries that rely on the regular return of the monsoon rains. These countries often have semi-arid climates that are highly vulnerable to climate variability and change, particularly in terms of water availability and food security. It is, therefore, critical to improve our skill to reliably predict future changes in the monsoons. From the time researchers monitor changes in the South Atlantic, it will take 20 years, according to the study, to observe a response in monsoonal precipitation. This 20-year predictability could provide vital information for governments seeking to allocate resources accordingly.



An illustration of the role of a weaker-than-normal South Atlantic meridional heat transport in the atmospheric circulation at 20 years lead-time. This results in a cooler than normal South Atlantic Ocean, which produces an anomalous inter-hemispheric Hadley circulation labeled by counterclockwise circulation. The lower branch of this circulation (red arrow) brings warm and moist air from the Southern Hemisphere to the Northern Hemisphere. The increased moist transport to the Northern Hemisphere increases precipitation in the Northern Hemisphere, thus enhancing monsoons.

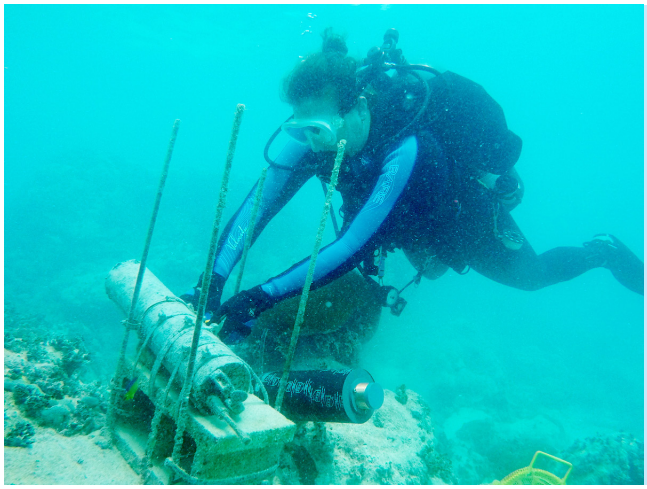
As the seasonal march of the monsoons dominates the global circulation in summer, the influence of monsoons reaches far beyond their immediate geographic domain. The anomalous circulation pattern associated with variability in the South Atlantic may also have important implications for long-term climate variability over the entire globe. For example, it could bring drier and warmer summer conditions over North America and Europe, exacerbating droughts.

Although some monsoon regions feature abundant rains, the strong seasonality in rainfall means that understanding the timing, duration, and intensity of monsoons is vital. The results presented in this study also highlight the value of sustained ocean observational efforts, combined with theoretical and numerical model outputs, which are important to improve our knowledge of the complex interaction between the South Atlantic Ocean and global climate variability and monsoons.

*Lopez, H., S. Dong, S.-K. Lee, and G. Goni, 2016: Decadal modulations of inter-hemispheric global atmospheric circulations and monsoons by the South Atlantic Meridional Overturning Circulation. *Journal of Climate,* 29(5):1831-1851.

AOML Wins Energy and Environmental Stewardship Award

In March, AOML received a Department of Commerce (DOC) Energy and Environmental Stewardship Award for negotiating a Utility Energy Service Contract with Florida Power and Light to replace its 30-year old chiller, upgrade the HVAC control system, and decommission the failing thermal energy storage system. Former Associate Director CDR Stephen Meador, along with Administrative Officer Dalynne Julmiste and Deputy Director Molly Baringer, were members of a DOC Energy Savings Performance Contract Team that contributed to a larger DOC effort. The team won the "Lean, Clean, and Green" award category for successfully developing and awarding over $138M in alternatively-financed energy contracts, avoiding more than $5M in annual utility costs across several NOAA sites. The chiller project at AOML took 2 years to complete; it is expected to reduce AOML's overall annual energy consumption by about 24%, resulting in a cost savings of about $75K per year over the first 5 years.



Coral Scientists Replace Instruments for Ongoing Coral Bleaching Study

AOML coral researchers visited reefs in the Upper and Lower Florida Keys in early March to swap out instruments that are part of an ongoing coral bleaching study. pH and light logger sensors were removed and new instruments deployed at both inshore and offshore study sites. The pH loggers, know as SeaFETS, provide accurate measurements of seawater pH over extended periods of time, while ECO-PAR sensors for light intensity record highly accurate measurements of photosynthetically active radiation, or PAR. PAR represents the spectral range of solar radiation from 400-700 nanometers used by photosynthetic organisms for photosynthesis, the process of converting sunlight into energy.

AOML coral scientist Renee Carlton prepares to swap out the ECO-PAR instrument at a dive site in the Upper Florida Keys.

Ocean Acidification Buoy to be Installed in American Samoa

In March, NOAA's Ocean Acidification Program funded the installation of a new MAP CO_2 buoy for Fagatele Bay National Marine Sanctuary in American Samoa. This new site will establish the second of three planned class III sentinel climate and ocean acidification monitoring sites in the Pacific. The other site in the Pacific is in Kaneohe Bay, Hawaii, while the final planned Pacific site is for Saipan in the Mariana Islands. AOML coral researchers Drs. Derek Manzello and Ian Enochs will lead installation efforts of the buoy in 2017 with staff from the Pacific Islands Fisheries Science Center in Honolulu and NOAA's Pacific Marine Environmental Laboratory in Seattle. Drs. Manzello and Enochs visited American Samoa in February 2014 and identified four candidate sites in Fagatele Bay for the new ocean acidification buoy; ongoing discussions will determine the most ideal location. In addition to the Pacific sites, there are currently two class III sentinel sites operating in the Atlantic at La Parguera, Puerto Rico and Cheeca Rocks in the Florida Keys. A third Atlantic site is planned for the Flower Garden Banks in the Gulf of Mexico.

Acroporid corals in Fagatele Bay, American Samoa.

Left: **The fully instrumented CREWS station in La Parguera, Puerto Rico.** ***Right:*** **The La Parguera station pylon dismantled and being towed away.**

La Parguera, Puerto Rico Coral Monitoring Station Dismantled

During the last week of March, the Coral Reef Early Warning System (CREWS) station in the coastal waters off La Parguera, Puerto Rico was dismantled and removed from service. Prior to its decommissioning, the station experienced several extended power outages caused by damaged underwater instruments. In spite of replacing failed instruments and other components, as well as devoting considerable time to troubleshooting the source of its problems, the station continued to languish. With a complete overhaul of the station no longer considered viable, researchers with NOAA's Coral Health and Monitoring Program (CHAMP) at AOML made the decision to remove it from service.

John Halas of Environmental Moorings International, Inc. and staff from the University of Puerto Rico completed the work to dismantle the station's pylon. However, the station's base plate and eight outer anchors were left in place for the possible future deployment of a monitoring buoy or stand-alone instruments.

AOML's CHAMP team installed the La Parguera CREWS station in late 2005, with data transmissions beginning in January 2006. The station reliably transmitted data for an estimated 7.5 years.

Hurricane Researchers Complete Aviation Water Safety and Survival Training

Staff with AOML's Hurricane Research Division completed a 2-day Aviation Water Safety and Survival training course in March. Classroom instruction included cold weather survival skills such as injury treatment, sheltering, signaling, and fire starting; water safety and survival training was held at the Opa Locka Coast Guard station pool. Participants practiced survival swimming techniques and use of the Windslow life raft. They also learned how to evacuate the aircraft using the Shallow Water Egress Trainer (SWET) chair. Additionally, those who chose to learned how to use the Helicopter Emergency Egress Device System (HEEDS) bottle. Each participant experienced wearing a cold weather immersion suit and successfully demonstrated their ability to exit the SWET chair while upside down, under water. NOAA aircraft mission participants complete this training every 5 years to improve their survival chances in the unlikely event of an emergency situation or crash landing.

Robert Black prepares to be flipped upside down in the SWET chair.

NOAA Miami Regional Library Administratively Organized under OAR

The NOAA Miami Regional librarians are pleased to announce that the NOAA Central Library in Silver Spring, Maryland and its branches at AOML, the National Hurricane Center, and Pacific Marine Environmental Laboratory are now administratively organized under the Office of Oceanic and Atmospheric Research. This is a move from the National Centers for Environmental Information (formerly NESDIS, NODC). The Miami library's services and products continue to be available and include: specialized bibliographies on demand, interlibrary loans, NOAA-wide e-journals, e-books, science literature databases, book ordering, reference services, creation of regional online environmental literature databases, digitization and archiving of documents, issuance of DOI's for NOAA publications, assistance with the new NOAA Institutional Repository resources and processes, advice on Data Management Plans, cited citation and author studies, and other special projects. The NOAALinc online catalog continues to be available. Visit the Miami Regional library website and catalog at www.aoml.noaa.gov/general/lib.

NOAA Miami Regional librarians Gloria Aversano, Linda Pikula, and Ashley Jefferson.

Student Volunteers Aid Marine Ecosystem Restoration Efforts in Nicaragua

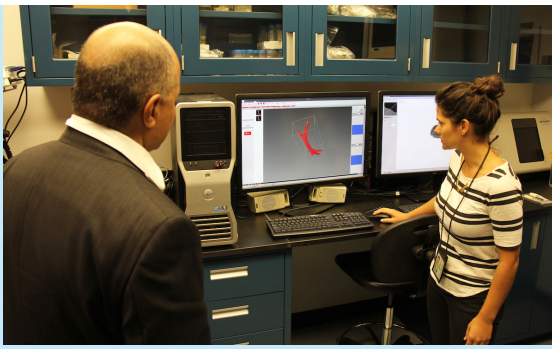
In March, Dr. Pamela Fletcher, a researcher with AOML's Ocean Chemistry and Ecosystems Division and a University of Florida/Florida Sea Grant Regional Extension Coordinator, led students from the University of Florida (UF) to the Pacific coast of Nicaragua for a week-long trip focused on marine ecology and conservation. In lieu of spring break vacation, nine UF students volunteered to assist at the Isla Juan Venado Nature Reserve through the Florida Alternative Breaks program. All actively participated in mangrove reforestation and monitoring efforts, sea turtle conservation activities, and community engagement.

Dr. Pamela Fletcher (left foreground wearing hat) with University of Florida students and students and staff from the Universidad Nacional Autónoma de Nicaragua at a tour of the Jardin Botanico Ambiental.

UF's volunteers also contributed to outreach efforts in partnership with students from the Universidad Nacional Autónoma de Nicaragua, to build awareness of natural resource conservation. Additionally, some of the students repaired and maintained buildings on the nature reserve property as part of an eco-tourism project. Through the program, student volunteers learned about marine life conservation, leadership, service, and the culture of Nicaragua, contributing to their personal, academic, and professional development.

For the past three years, the US Embassy staff in Managua have participated in the mangrove planting sessions, sharing their Foreign Service experiences with students and learning about UF's Florida Alternative Breaks program. This year, the US Ambassador to Nicaragua, Laura F. Dogu, hosted the group at her home as a send-off to the week-long program. Ambassador Dogu provided students with an overview of the Department of State, the mission in Managua, and stories about her experience working for the department.

Under the direction of Dr. Fletcher, UF's volunteers have aided marine ecology restoration activities in Nicaragua since 2012. Working alongside nature reserve staff, local youth groups, the Sutiava indigenous community, and others, UF students have helped plant more than 33,000 mangrove seedlings. These reforesting efforts ensure mangroves will continue to provide a habitat for birds, fish, reptiles, and many other species, as well as ensure the resiliency of coastal regions by protecting them from storms and other threats.



NOAA Deputy Administrator VADM Manson Brown Visits Virginia Key Science Labs

AOML and NOAA's Southeast Fisheries Science Center (SEFSC) welcomed VADM Manson Brown, the Deputy Administrator of NOAA, to Virginia Key on March 15th. VADM Brown visited both facilities to meet with leaders, become acquainted with the research conducted at each lab, and attend a review of the science program for SEFSC. During a tour of AOML, VADM Brown learned of AOML's tropical cyclone research and efforts to improve tropical cyclone forecasts and warnings. He also learned of AOML's efforts to observe the changing physical, chemical, and biological properties of the ocean and the impacts of these changes on climate, weather, and marine ecosystems. In the afternoon, VADM Brown hosted an informal all-hands meeting attended by the AOML-SEFSC community.

Above: **Vice Admiral Manson Brown addresses the AOML-SEFSC community at an all-hands meeting.** ***Top right:*** **Lauren Valentino shows a three-dimensional image of a coral;** ***Middle right:*** **Rik Wanninkhof explains how underway surface carbon data are gathered using a thermosalinograph;** ***Bottom right:*** **Gustavo Goni discusses some of the ocean-observing instruments deployed by AOML oceanographers.**

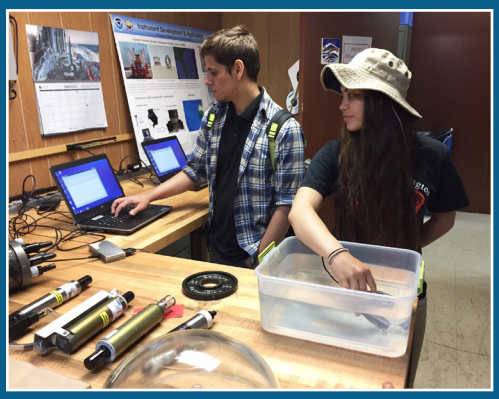
AOML Director and Deputy Director Visit Capitol Hill

Drs. Bob Atlas and Molly Baringer visited Washington, DC in April to meet with South Florida congressional representatives. Bob and Molly highlighted AOML's recent advances in hurricane modeling, observing system simulation experiments, ocean observing system enhancements, and ecosystems research.

Congressional representatives were particularly pleased to learn about the continued improvements in hurricane forecasts and the Hurricane Weather Research and Forecasting (HWRF) modeling effort, as well as new technology advances such as the Coyote unmanned aircraft system and the wind profiling Lidar instrument. Other topics that also met with much interest included AOML's underwater glider observations and their unique roll in assessing the influence of hurricane intensity, a new seasonal tornado outlook experimental product based on ocean observations, and an initiative to assess coral reef resiliency using genomic information.

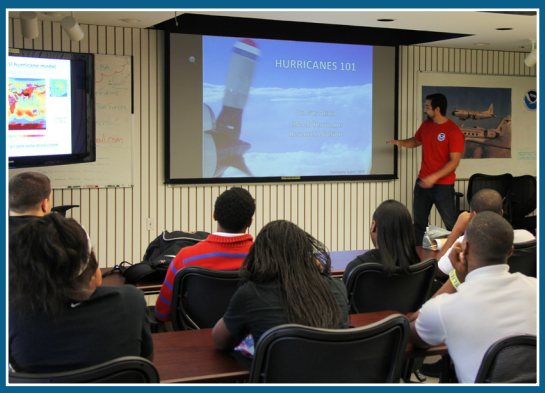
Bob Atlas and Molly Baringer of AOML visited with Congressman Mario Diaz-Balart (upper left), Congresswoman Ileana Ros-Lehtinen and Brittany Marsden of NOAA's Formulation and Congressional Analysis Division (upper right), and Congresswoman Debbie Wasserman Schultz (bottom right).

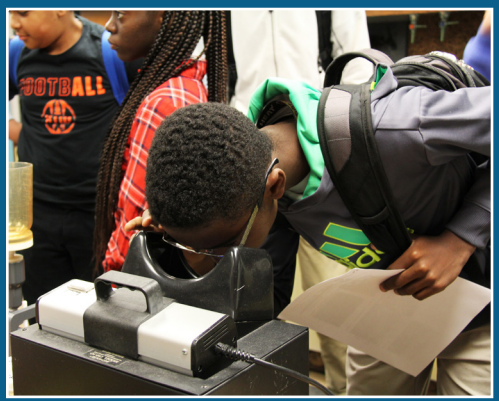
My Brother's Keeper National Labs Week at AOML








On Friday, March 4th, AOML hosted 35 students from Miami's Booker T. Washington High School for the Obama Administration's My Brother's Keeper National Labs Week. This national event is designed to introduce students from communities that are not well represented in STEM (Science, Technology, Engineering, Mathematics) careers to federal employees and lab facilities in the hopes of inspiring interest in these fields. Students from this Title 1 Miami-Dade County public high school soared into a hurricane through the eyes of our hurricane hunter scientists, experienced the challenge of engineering ocean observing technologies, discovered the microorganisms in our coastal beaches, and met the programmers who create the next generation of hurricane models to predict storms. AOML researchers brought their science to within reach of the students as hands-on experiments designed to introduce the concepts of ocean circulation, water properties, and microbial sampling.

Farewell

AOML Director Dr. Bob Atlas presents CDR Stephen Meador with a certificate of appreciation honoring his years as AOML's Associate Director.

CDR Stephen Meador, AOML's Associate Director since 2012, retired on April 1st after 20 years of service with the NOAA Corps. As the Associate Director at AOML, Steve coordinated ship time aboard NOAA research vessels, championed both safety and security measures, and managed the day-to-day operation and maintenance of the AOML facility. Steve left AOML in a much improved state due to the phenomenal number of repair and enhancement projects he spearheaded. These projects have resulted in greater energy conservation and compliance with federal mandates, as well as reduced operating costs.

HRD Director Frank Marks, Thiago Quirino, and AOML Deputy Director Molly Baringer.

AOML's Hurricane Research Division bid a fond farewell to Dr. Thiago Quirino, an information technology specialist, on April 15th. Thiago has accepted a position with SAS in Cary, North Carolina. During Thiago's almost 9 years with HRD, he supported the development of NOAA's next generation of numerical models for improved forecasts and warnings of tropical cyclones. He was a member of an HRD team that won a Department of Commerce Gold Medal in 2014 for his role in refining NOAA's high resolution Hurricane Weather Research and Forecasting (HWRF) model that is used operationally by the National Hurricane Center and several international forecast agencies.

Welcome Aboard

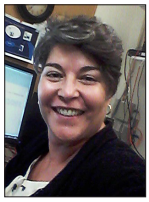
Dr. Leon Nguyen joined the staff of AOML's Hurricane Research Division in March as a National Research Council post-doctoral scientist. Leon will work with Dr. Rob Rogers to better understand how hurricanes respond to vertical shear by using observations and the Hurricane Weather Research and Forecasting (HWRF) numerical model. He recently received his PhD from the Department of Atmospheric and Environmental Sciences of the State University of New York at Albany. His dissertation focused on the impact of environmental vertical wind shear on tropical cyclone structure and intensity.

Dr. Nathan Putman joined AOML's Physical Oceanography Division in April as a University of Miami-Cooperative Institute for Marine and Atmospheric Studies post-doctoral scientist. Nathan's research will focus on interdisciplinary studies, with an emphasis on Lagrangian trajectories in the Gulf of Mexico and eastern US seaboard, as well as comparison of environmental DNA and ocean conditions to assess processes that influence species assemblage composition. He holds a PhD from the University of North Carolina at Chapel Hill.

Congratulations

Ruth Almonte, a senior budget analyst with the Administrative Group of AOML's Office of the Director, completed the South Florida Federal Executive Board's High Performance Leadership Program this past December. Ruth was one of 15 federal employees in the South Florida area selected to participate in the year-long program, geared towards helping participants develop a broader range of managerial and leadership competencies through training, lectures, and mentoring.

Shenfu Dong, a University of Miami-Cooperative Institute scientist with AOML's Physical Oceanography Division since 2007, became a Federal oceanographer on March 7th. Shenfu is an internationally-recognized scientist, and among her credentials are more than 30 peer-reviewed publications. She is a lead principal investigator or co-principal investigator on several NOAA, National Science Foundation, and National Aeronautics and Space Administration (NASA) proposals, as well as a member of several technical and scientific panels, including the NASA science teams for Ocean Surface Topography and Ocean Salinity and the NOAA-AOML XBT Science Team.



Caridad Gonzalez, a University of Miami-Cooperative Institute research associate with AOML's Physical Oceanography Division, was named NOAA's Team Member of the Month for March 2016. Caridad was recognized for being the lead software developer for a project that improved how ocean temperature data from exependable bathythermographs are transmitted by shifting to the Iridium satellite network. She developed the software from the ground up and integrated it with the computer system used by research and commercial vessels worldwide to gather and transmit oceanographic and meteorological observations in real-time. Data transmissions using the new Iridium system are more reliable, plus the system has been expanded to transmit any type or amount of data, all at a fraction of the cost of the older Inmarsat-C system.

Sang-Ki Lee, a University of Miami-Cooperative Institute scientist with AOML's Physical Oceanography Division since 2002, became a Federal oceanographer on March 21st. Sang-Ki is an internationally-recognized scientist with significant contributions in the areas of inter-basin ocean heat transport and the ocean's role in climate and extreme weather. He has more than 60 peer-reviewed publications to his credit and has served as the lead principal or co-principal investigator on several research projects funded by NOAA, the National Science Foundation, and National Aeronautics and Space Administration.

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***Keynotes* is published bimonthly to highlight AOML's recent research activities and staff accomplishments.**

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

ATLAS, R., R.N. HOFFMAN, Z. Ma, G.D. Emmitt, S.A. Wood, S. Greco, S. Tucker, **L. BUCCI, B. ANNANE,** R.M. Hardesty, and **S. MURILLO,** 2015: Observing system simulation experiments (OSSEs) to evaluate the potential impact of an optical autocovariance wind lidar (OAWL) on numerical weather prediction. *Journal of Atmospheric and Oceanic Technology,* 32(9):1593-1613.

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