January-February 2016
Vol. 20/No. 1

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

Coyote UAS Improvements Advance Hurricane Research Technology

The successful test flight of a newly-enhanced version of the Coyote unmanned aerial system aircraft improves its potential for becoming an operational component of NOAA's fleet of hurricane technologies.

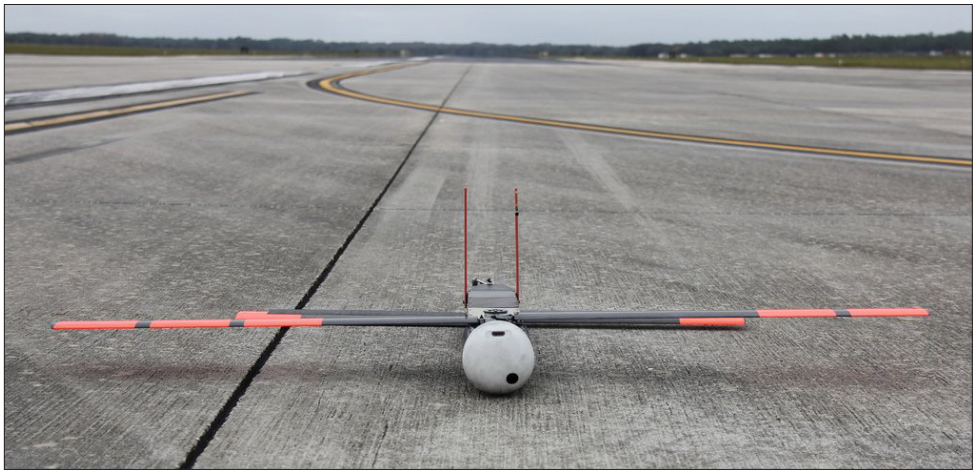
Dr. Joe Cione, an AOML hurricane researcher who serves as the lead for NOAA's Coyote Unmanned Aircraft System research, holds a Coyote while standing in front of NOAA's P-3 hurricane hunter aircraft at MacDill Air Force Base in Tampa, Florida.

On January 7th, a science team from NOAA and Raytheon jointly conducted a test flight of a recently upgraded Coyote, an unmanned aircraft system (UAS). The successful flight verified new technology that improves the Coyote's ability to collect vital weather data in the lowest reaches of the hurricane environment, a region off limits for manned aircraft due to the powerful winds and extreme turbulence found near the ocean surface.

The Coyote was launched from NOAA's P-3 hurricane hunter aircraft and flew over the Avon Park Air Force Range in Avon Park, Florida, to measure the transmission range of its upgraded technologies. The unmanned aircraft set a new distance record for flight control and data transmission to the P-3, providing NOAA hurricane forecasters with real-time data on atmospheric air pressure, temperature, moisture, wind speed, wind direction, and sea surface temperature.

"NOAA is investing in unmanned aircraft and other technologies to increase weather observations designed to improve the accuracy of our hurricane forecasts," said Dr. Joe Cione, a hurricane researcher at AOML who serves as the lead for NOAA's Coyote UAS research. "This successful flight gives us additional confidence that we will be able to use this unique platform to collect critical, continuous observations at altitudes in the lower part of a hurricane, an area that would otherwise be impossible to reach with manned aircraft."

The Coyote is a small, expendable aircraft deployed from the belly of the P-3 through a free-fall chute. Once released, a parachute opens to slow the 13-pound Coyote's descent through the atmosphere until its five-foot wings open and rear propeller engages. The Coyote has a cruising air speed of 60 knots and flies with the wind currents due to its light-weight design, but can be directed by scientists aboard the P-3 to navigate specific flight patterns. In spite of its diminutive size, the Coyote has proven its ability to maneuver in the (***cont. page 2***)



The Coyote on the tarmac at Avon Park after its successful demonstration flight on January 7, 2016.

Continued from page 1

most violent regions of a hurricane. Because hurricanes are fueled by warm ocean water, information collected at the interface of the ocean and atmosphere is vital to understanding and predicting a storm's strength.

The platform was first tested during the 2014 Atlantic hurricane season. On September 16th as Hurricane Edouard churned in the Atlantic with 115 mph winds, researchers flew multiple Coyote missions into the major hurricane at controlled altitudes as low as 400 feet, providing NOAA with real-time data on the storm's structure. After these successful hurricane flights, scientists and engineers went to work to upgrade the Coyote technology with the goal of improving its operational capacity.

One of the keys to the future utility of the platform was improving its ability to fly farther from the P-3 launch aircraft while still providing continuous data from its array of sensors. Engineers at NOAA's Aircraft Operations Center and Raytheon successfully developed and equipped the Coyote with a new antenna and radio, enabling operators to stay in communication with the UAS as it flew away from the P-3 hurricane hunter aircraft during its January 7th test flight.

"We've made significant improvements to Coyote. It can now fly for up to an hour and 50 miles away from the launch aircraft," said Dr. Thomas R. Bussing, vice president of the Advanced Missile Systems product line at Raytheon. "Raytheon technology is playing a key role in enhancing safety for hurricane researchers and helping to deliver vital information about potentially deadly storms to the American people."

The Coyote UAS before deployment from NOAA's P-3 hurricane hunter aircraft.

The upgraded Coyote UAS flies over the Avon Park Air Force Range in Avon Park, Florida during a demonstration flight on January 7, 2016.

During the Hurricane Edouard Coyote missions, the P-3 was constrained to flying within a range of five to seven miles of the Coyote so as to pick up its signal. The increased flight range, as well as enhanced antenna, now enables the P-3 to deploy the Coyote and continue on its own flight pattern at a higher altitude while monitoring the Coyote's position relative to a storm and the hurricane hunter aircraft.

In addition to these improvements, the Coyote is now equipped with an upgraded instrument package that includes an infrared sensor for measuring sea surface temperature. Observations from the infrared sensor should help scientists better understand how a hurricane extracts energy from the ocean and how this energy enables a hurricane to intensify or change. The team is also currently working to optimize the longevity of the Coyote's battery, which should facilitate longer periods of flight during future data-gathering missions.

The January 7th demonstration flight verified the Coyote's ability to transmit data from its instrument package to operators aboard the P-3, as well as to forecasters at NOAA's National Hurricane Center (NHC) in Miami. Data from future Coyote flights will provide NHC with an additional source of real-time measurements to assist forecasters in developing more accurate estimates of a storm's intensity. These measurements will eventually be incorporated into hurricane models to fill the data gap created by a lack of spatial coverage in the lower portions of a storm.

"Here at the National Hurricane Center, we are keenly interested in obtaining measurements from the Coyote of the strongest winds near the center of the storm," said Dr. Chris Landsea, the science operations officer at NHC. "Coyote could help us paint a better picture of current storm intensity for our storm updates."

NOAA first adopted the Coyote UAS for hurricane research in 2009. The platform was originally developed by the Navy for maritime surveillance and is manufactured by Raytheon of Waltham, Massachusetts. NOAA's mission for Coyote is to improve forecasts of hurricane intensity at levels where it will directly impact people and property.

With the potential for becoming an operational component of NOAA's fleet of hurricane technologies, researchers will continue to upgrade components of the Coyote to improve its data collection capabilities and reduce its per unit cost. These improvements could expand the Coyote's application to other aspects of NOAA's portfolio where remote access and observations are essential.

NOAA/Unmanned Aircraft Systems Program
uas.noaa.gov

AOML/Hurricane Research Division
www.aoml.noaa.gov/hrd

National Hurricane Center
www.nhc.noaa.gov

AOML-led Carbon Dioxide Sampling Effort Helps Quantify the Ocean's Role in Global Carbon Budget

Researchers with the Global Carbon Project released their annual update for the global carbon budget in December 2015, revealing carbon dioxide (CO_2) emissions from fossil fuels increased slightly in 2014 (+0.6%), but are projected to decline slightly (by est. -0.6%) in 2015. The global oceans serve as a natural buffer, offsetting increased emissions by absorbing an estimated 27% of human-produced CO_2 from the atmosphere in 2014. Data collected, in part, from long-term surface ocean CO_2 monitoring efforts, funded by NOAA's Climate Program Office and the Ocean Acidification Program, indicate that the oceans removed about 10.7 billion tons of CO_2 from the atmosphere in 2015.

NOAA's Ship of Opportunity Program coordinates a fleet of vessels that globally collect surface ocean carbon dioxide measurements.

CO_2 is a greenhouse gas whose concentration in the atmosphere increases from the burning of fossil fuels and cement production, and from deforestation and other land-use changes. To understand the total amount of CO_2 on our planet, researchers must look at the places where this carbon is absorbed and stored: the atmosphere, land, and ocean.

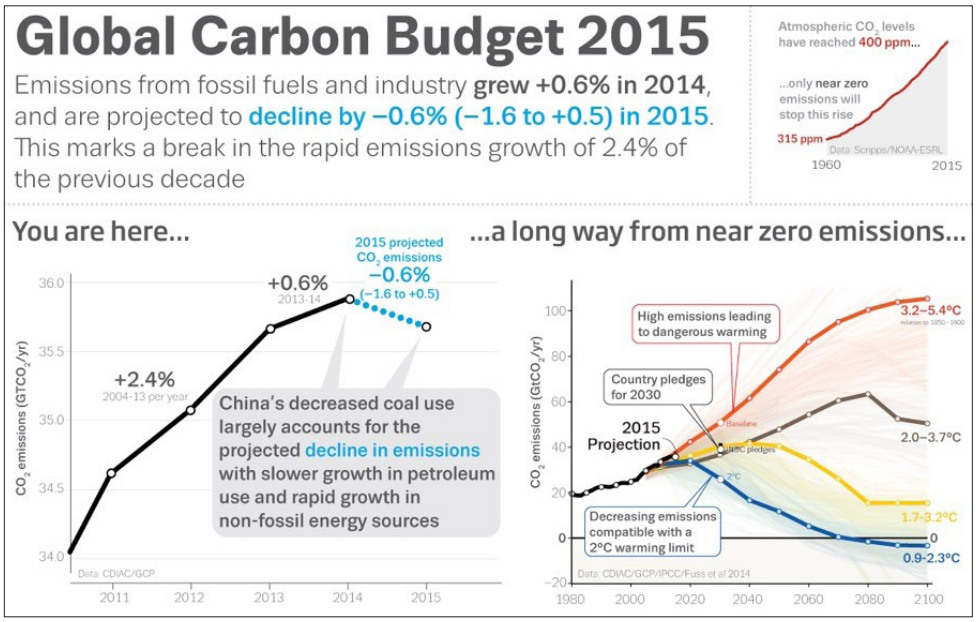
Across the global ocean there is a continual flux of CO_2 in surface waters as it equilibrates with CO_2 in the atmosphere. Natural cycles in weather, climate, and ocean currents alter the rate at which the ocean takes up and releases CO_2 from the atmosphere. These cycles take place across various time and geographic scales and include phenomena such as El Niño, which increases the rate of CO_2 uptake in equatorial regions, as well as changes in temperature and the upwelling of deep ocean water.

To determine and record these changes, it is important to have a sustained, long-term ocean monitoring effort in place. The Surface Ocean CO_2 Atlas (SOCAT) is a combined international effort that provides a comprehensive record of 14.7 million surface water CO_2 measurements for the world's oceans and coastal seas. These measurements, collected from ships, moorings, and drifters, provide researchers with a means to calculate the total amount of CO_2 the oceans are taking up. This, in turn, contributes to the estimation of the overall change in the ocean carbon sink and can be used to measure changes in processes such as ocean acidification.

AOML leads an effort that contributes about one-third of the data to the SOCAT record. These data are collected from a fleet of about 14 ships managed by investigators at AOML, its sister labs, the Pacific Marine Environmental Lab and Earth System Research Lab, and four academic partners. This fleet, known as the Ship Of Opportunity Program (SOOP-CO_2), is the world's largest coordinated CO_2 sampling operation and is made up of a network of cargo vessels, cruise ships, and research vessels.

While underway, these vessels collect about 20 surface ocean measurements per hour, equating to about 500 data points per day. AOML pioneered the development of the technology used to autonomously measure CO_2 in the surface ocean. This technology, now part of a commercial enterprise, is considered the gold standard for obtaining surface ocean CO_2 measurements around the world.

The Global Carbon Project (GCP) assists scientists in establishing the knowledge base for supporting policy debate and action to slow the rate of increase of greenhouse gases in the atmosphere. More information about the GCP can be found at http://www.globalcarbonproject.org/index.htm.



Global CO_2 emissions from fossil fuels increased in 2014, and the uptake of CO_2 by the oceans was 10% greater than the 2005-2014 decadal average. As denoted in the chart above, however, several factors are projected to slightly decrease global fossil fuel emissions for 2015.

New Antenna System Improves Reliability While Drastically Cutting Costs

Scientists and engineers with AOML's Physical Oceanography Division have successfully designed, built, and tested a new antenna system that dramatically increases data transmission reliability while drastically reducing operating costs. The new Iridium-based transmission system has no restrictions on data format or size, allowing data from various ocean and land-based observation platforms to be transmitted more securely and at a fraction of the cost as the older Inmarsat-C platform. Since its completion, PhOD researchers have adopted the system on a number of expendable bathythermograph (XBT) transects, as well as simultaneously tested and implemented it on other AOML observing systems.

Development of the system involved creating new transmission hardware and software. The system includes state-of-the-art technologies combined with advanced algorithms to allow for the fast and stable transmission of digital data.

Results from initial tests carried out in 2013 were used to optimize the system and to reduce or eliminate connection drops and data loss. It began its transition to operational capacity in 2015 and is currently being used on all cargo ships with XBT transects operated by AOML and the Scripps Oceanographic Institution.

Use of the new Iridium system has resulted in a 95 percent reduction in the average transmission cost for an XBT profile, with an estimated savings to NOAA of more than $200,000 annually.

Closeup view of the new Iridium antenna and its housing designed and constructed at AOML.

An Iridium antenna (inside in the red circle) was installed aboard the container ship CMA CGM *Racine* by PhOD scientific rider Ricardo Domingues in January before it embarked upon the AX07 transect. During the 3-week transatlantic crossing from Miami, Florida and Gibraltar, Ricardo deployed approximately 270 XBT probes.

NOAA deploys approximately 12,000 XBTs per year as part of its contribution to the global XBT network, a component of the Global Ocean Observing System. The network consists of approximately 50 fixed transects that are repeated several times every year.

XBTs are probes launched from cargo and research vessels in all ocean basins that measure ocean temperature to depths of 800 m. Data from the probes enable scientists to assess the transport of meridional heat in the ocean, as well as the meridional overturning circulation. The data also enable them to monitor key boundary, surface, and subsurface currents and account for almost 20 percent of all upper ocean temperature profiles obtained globally each year.

Since the early 2000s, XBT data have been processed and transmitted in real-time using the Inmarsat-C satellite network consisting of 12 geostationary telecommunication satellites. The data are then distributed into the Global Telecommunications System and used worldwide for climate research and weather and climate forecasts. However, the Inmarsat-C satellite network is costlier and does not allow for the transmission of different data types.

Although the new Iridium-based transmission system was originally developed for XBT observations, it is capable of transmitting additional forms and amounts of data. Its applicability has since been expanded to include thermosalinograph (TSG) and pCO_2 systems, which measure underway temperature, salinity, and dissolved carbon dioxide in surface waters, respectively.

Other global oceanographic observation platforms such as Argo floats and drifting buoys also use the Iridium network for data transmission; however, these platforms use a protocol only suitable for smaller amounts of data. With the application of the new antenna system, which can transmit files of arbitrary size, these data can be transmitted at a lower cost and at a faster rate.

In addition to Iridium transmissions, the new system can be also be configured to transmit data over telephone landlines or computer networks, potentially decreasing many other operational costs. Plans for the system include increasing its use along XBT transects run by other XBT partner institutions, as well as its application to other types of real-time environmental data transmissions.

The concept and implementation for the Iridium-based system developed at AOML is the work of a team that included Pedro Pena, Caridad Gonzalez, Ulises Rivero, Francis Bringas, and Gustavo Goni. Funding for the project was provided by AOML and the Climate Observations Division of NOAA's Climate Program Office.

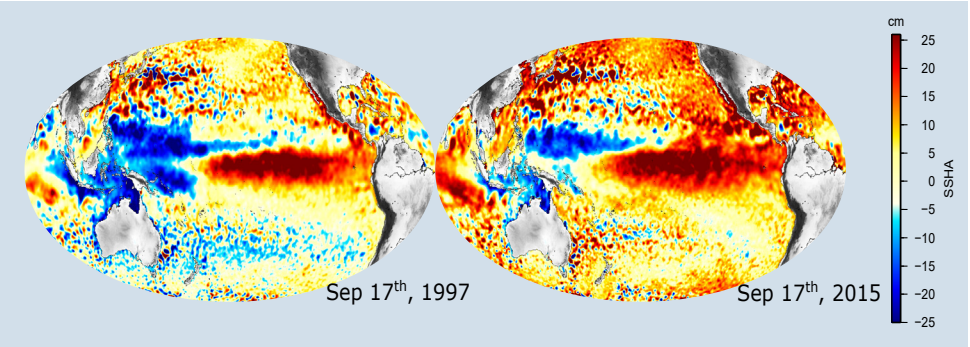
Study Explores Role of El Niño in Transport of Waterborne Disease

A new study published in the journal *Nature Microbiology** highlights how emerging, devastating outbreaks of *Vibrio* infection in Latin America might be linked to El Niño, a climate pattern that periodically causes surface temperatures to warm throughout the equatorial Pacific Ocean. An international research team that included Dr. Joaquin Trinanes, a University of Miami-Cooperative Institute scientist with AOML's Physical Oceanography Division, used microbiological, genomic, and bioinformatic tools to demonstrate how El Niño provides a mechanism for the transport of disease from Asia into the Americas.

Vibrios are rod-shaped bacteria present in the marine environment that proliferate in warm and low-salinity seawater. In the U.S. alone, *Vibrio* infections cause an estimated 80,000 illnesses and 100 deaths annually. There are many species of *Vibrio*, the best known being *V. cholerae*, *V. vulnificus*, and *V. parahaemolyticus*.

During the last three more significant El Niño episodes (1990-1991, 1997-1998 and 2010), new Asian variants of pathogenic *Vibrio* have emerged in Latin America. They include a variant of *V. cholerae*, which resulted in more than 13,000 deaths in Peru in 1990, and two variants of *V. parahaemolyticus*, which triggered widespread gastrointestinal illness associated with contaminated shellfish in 1997 and 2010.

The authors observed that declared illnesses caused by waterborne bacteria reported in Latin America moved in tandem with where and when warm El Niño waters made contact with the land. Whole-genome sequencing of bacterial strains suggest there may indeed be a link between organisms that cause illness in Asia and those that emerge in Latin America, in particular, Peru and Chile.



Comparison of sea surface height anomalies during the 1997-1998 and 2015-2016 El Niño episodes in the Pacific Ocean. El Niño events impact weather patterns globally scale and may facilitate the transport of waterborne disease from the equatorial Pacific into the Americas.

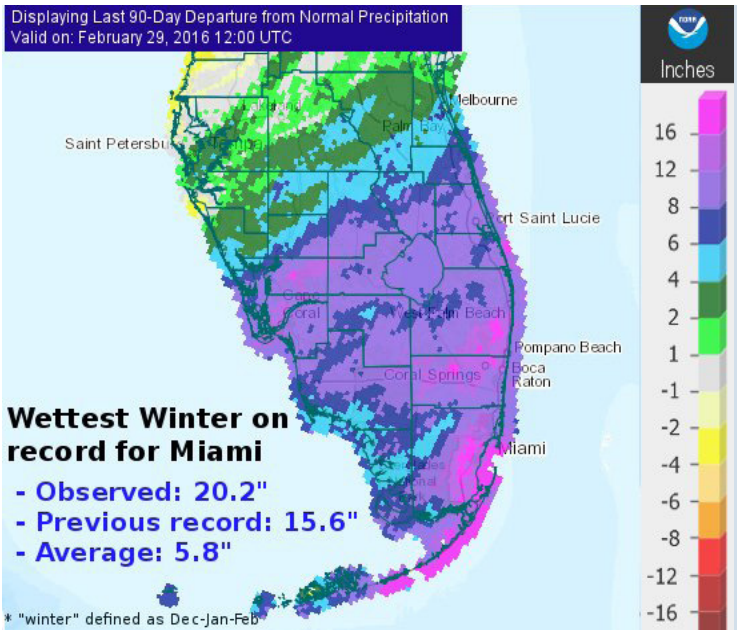
In addition, these strains have been identified in environmental sources, providing further evidence that El Niño waters may be responsible for the transport and spread of these emergent pathogens across thousands of miles of ocean. But how can this happen?

The authors argue that *Vibrio* can attach to larger organisms, such as zooplankton. In numerous studies, *Vibrios* have been shown to bind to and use these larger organisms as an energy source. Driven by ocean currents, an El Niño event could, therefore, represent an efficient, long-distance "biological corridor," enabling the displacement of marine organisms from distant areas. This process could provide both a periodic and unique source of new pathogens into Latin America with serious public health implications for the spread and control of disease.

The cause of sudden outbreaks of *Vibrio* infection in Latin America has long been a a source of mystery. The authors hope their study will assist coastal communities better prepare for the threat of disease outbreaks posed by El Niño episodes.

Other authors involved in the study include Drs. Jaime Martinez-Urtaza of the UK's University of Bath, Narjol Gonzalez-Escalona of the US Food and Drug Administration, and Craig Baker-Austin of the UK's Centre for Environment, Fisheries and Aquaculture Science.

*Martinez-Urtaza, J., J. Trinanes, N. Gonzalez-Escalona, and C. Baker-Austin, 2016: Is El Niño a long distance corridor for waterborne disease? *Nature Microbiology,* 1(3): 16018, doi:10.1038/nmicrobiol.2016.18.

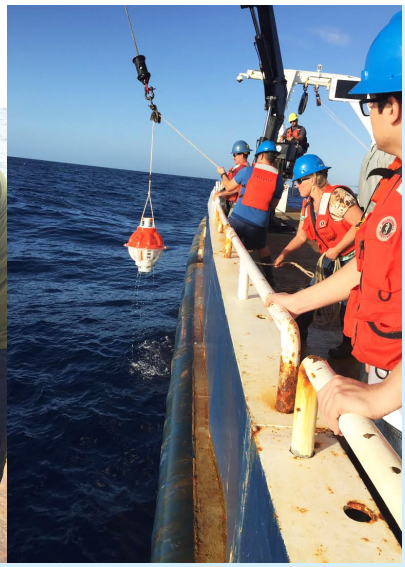


Rain, Rain, Go Away...

NOAA's National Weather Service announced at the end of February that Miami and Miami Beach had just experienced their rainiest winters on record. Both cities shattered their previous precipitation records due to the abundant amount of rain that fell between the months of December, January, and February.

Miami's new winter rainfall record now stands at 20.26 inches, easily topping the old record of 15.06 inches established in 1905. In an average year, Miami usually experiences about 5.8 inches of rain during the winter months. The new record for Miami Beach is now 19.15 inches, which beat the previous record of 16.47 inches set in 1983. Other cities across South Florida that also set new winter precipitation records include Fort Myers, Naples, Moore Haven, and Vero Beach.

South Florida's wetter than normal winter season is linked to the strong El Niño currently occurring in the Pacific Ocean, which causes the subtropical jet stream to dip farther south, steering low-pressure systems in the direction of the Sunshine State.



Left: AOML oceanographer Jay Hooper works on the CTD between deployments. Right: Crew members deploy a pressure inverted echo sounder instrument to measure the average sound speed in the water column.

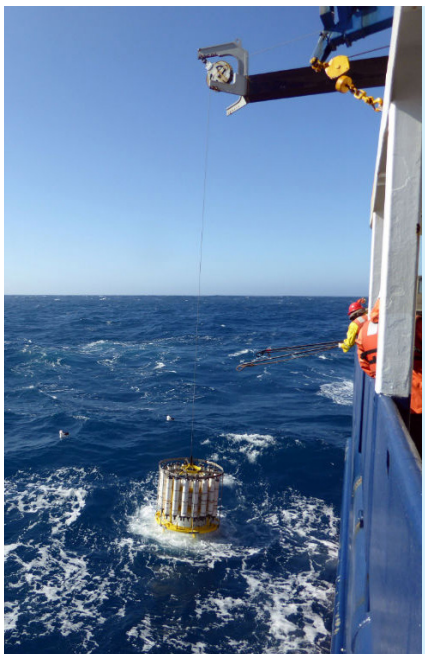
Western Boundary Time Series Cruise Successfully Completed

Researchers with AOML's Physical Oceanography Division completed a Western Boundary Times Series cruise in February aboard the UNOLS Ship R/V *Endeavor*. AOML oceanographer Molly Baringer served as the chief scientist with technical support provided by Pedro Pena, Andy Stefanick, Jay Hooper, Grant Rawson, and Tom Sevilla, all of AOML. Three graduate students from the University of Puerto Rico-Mayaguez also participated in the sampling effort along a transect from San Juan, Puerto Rico to Port Everglades in Fort Lauderdale, Florida. During their 2 weeks at sea, the science team gathered full water column values of salinity, temperature, and oxygen with a CTD (conductivity-temperture-depth) instrument, as well as deployed three pressure inverted echo sounder (PIES) moorings. The PIES moorings will measure the strength of the Atlantic meridional overturning circulation at 26°N in support of the RAPID (Rapid Research and Response) program, a joint effort of NOAA and the National Science Foundation.

AOML Participates in El Niño Rapid Response Field Campaign

AOML hurricane researcher Jason Dunion participated in NOAA's El Niño Rapid Response Field Campaign, a comprehensive land-sea-air sampling effort in the tropical Pacific, to study the current El Niño and improve weather forecasts thousands of miles away. Jason was part of the team of NOAA scientists and partners that deployed NASA's Global Hawk unmanned aircraft, a key asset for the Sensing Hazards with Operational Unmanned Technology (SHOUT) project led by researchers with NOAA's Unmanned Aircraft System Program. The Global Hawk carried a suite of meteorological sensors and dropped parachuted weather instruments during four research flights in February in the eastern Pacific, near the US west coast. Data from the flights will help improve the models that are used to support weather forecasts. The data will also provide insights that researchers hope will improve year-to-year El Niño forecasts, as well as the accuracy of the models predicting the longer-term effects of climate change.

El Niño Rapid Response project members, including AOML's Jason Dunion (second from right) in front of the Global Hawk unmanned aircraft at NASA's Armstrong Flight Research Center at Edwards Air Force Base in California.



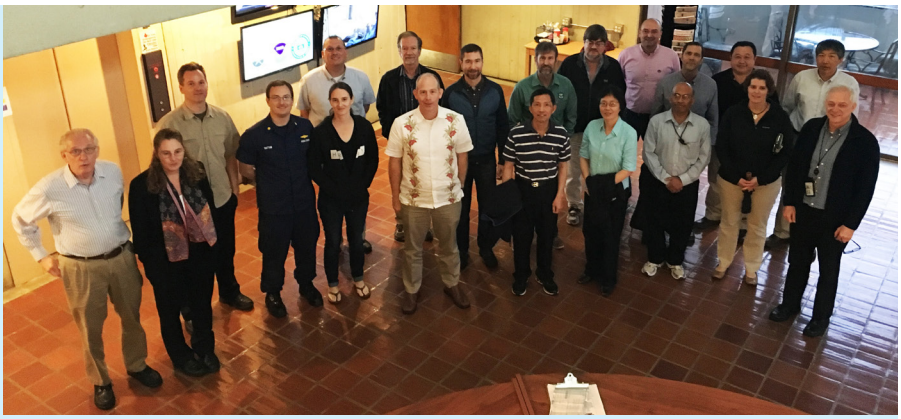
GO-SHIP Repeat Hydrography Cruise Explores Decadal Changes in Southern and Indian Oceans

AOML oceanographer Chuck Featherstone was aboard the R/V *Roger Revelle* when it departed Freemantle, Australia on February 8th for the start of the GO-SHIP (Global Ocean Ship-based Hydrographic Investigations Program) IO8S Repeat Hydrography Cruise in the remote Indian Ocean. During the month-long sampling effort from the Antarctic Circle to 28°S, researchers aboard the *Revelle* will be repeating a hydrographic transect last occupied in 2007. The cruise is part of an international effort to decadally quantify changes in the global ocean's storage and transport of heat, fresh water, carbon, nutrients, oxygen, and trace gases. Chuck will be analyzing seawater samples for dissolved inorganic carbon concentrations obtained by a CTD (conductivity-temperature-depth) instrument equipped with a rosette and bottle sampling system.

At the completion of sampling operations in March, the *Revelle* will return to port for a swap out of the science team and the start the IO9N Repeat Hydrography Cruise from Freemantle, Australia to Phuket, Thailand. AOML-University of Miami Cooperative Institute scientist Leticia Barbero will serve as the co-chief scientist, and Bob Castle of AOML will assume responsibility for dissolved inorganic carbon sampling and surface CO_2 measurements. The IO9N transect will bring the *Revelle* northward through the Indian Ocean and into the Bay of Bengal, with more than 100 planned sampling stations from 28°S-18°N.

Researchers aboard the R/V *Roger Revelle* recover a CTD instrument from the chilly waters of the Southern Ocean after completing a full water column cast.

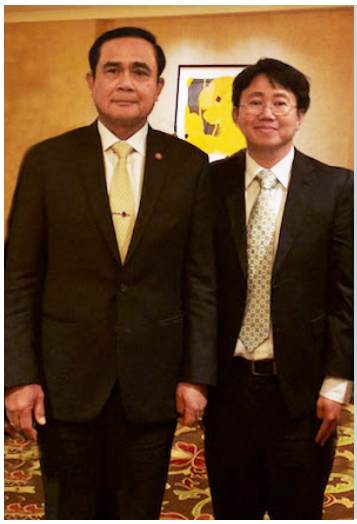
Coast Watch/Ocean Watch Managers Meet at AOML



Coast Watch/Ocean Watch managers met at AOML in January for their annual meeting.

AOML hosted the 17th CoastWatch/OceanWatch Science Workshop on January 27-29. Presentations highlighted the large suite of products distributed by the CW/OW programs, while subsequent discussions brought greater awareness of the robust frameworks and methodologies for satellite data processing, and of robust approaches to identify, understand, support, and meet user needs and requirements. Paul DiGiacomo, manager of the CW program at NOAA's National Environmental Satellite, Data, and Information Service (NESDIS), expressed the importance of regular, direct interaction between node managers to improve the program's objectives and quality of its products, as well as provide a common ground for sharing expertise and knowledge. Presenters and remote participants also recognized AOML's role in organizing and leading the workshop; they expressed confidence in meeting the challenges posed by a new generation of satellites, the advent of new technologies for data management and processing, and an increasing need for international cooperation and compulsory data quality requirements.

The CW/OW programs share similar principles and practices, providing portals for remotely-sensed data and data products. AOML has managed the CW Caribbean regional node since 2000; it serves as a pathway for accessing near-real-time and science-quality data and products such as sea surface temperatures, ocean color, winds, and sea surface height anomalies. The node was expanded several years ago to include the Gulf of Mexico. In 2015, an Atlantic OceanWatch node was created at AOML, with Gustavo Goni and Joaquin Trinanes of AOML serving as node manager and operations manager, respectively. The new framework expands the capabilities of the CW Caribbean node, as well as the range of its products, to include larger areas, focusing on both near-real-time and historical datasets and developing new technologies for data sharing and visualization.



AOML Researcher Meets with the Prime Minister of Thailand

Natchanon Amornthammarong, a native of Thailand and a University of Miami-Cooperative Institute scientist with AOML's Ocean Chemistry and Ecosystems Division, met Prayut Chan-O-Cha, the Prime Minister of Thailand, on February 14th. The Prime Minister was visiting the US in February to attend the ASEAN (Association of Southeast Asian Nations) Summit at the invitation of President Obama. ASEAN was established in 1967 to promote cooperation and regional stability amongst its member states, which currently include Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Vietnam. While in California for the 2-day summit, the Prime Minister arranged to meet with Thai individuals working in the US that are involved in various fields of research. Natchanon was one of 10 individuals chosen for the honor. As a result of his meeting with Prayut Chan-O-Cha, Natchanon has been invited to make several presentations in Thailand about his work to design, construct, and deploy portable instruments in coastal waters that analyze inorganic chemical species such as ammonium and dissolved inorganic carbon.

Prayut Chan-O-Cha, the Prime Minister of Thailand, and Dr. Natchanon Amornthammarong of AOML.

HRD Goes the Extra 3.1 Miles

On February 27th, staff with AOML's Hurricane Research Division (HRD) participated in a PurpleStride 5K race to honor former colleague Paul Willis. The event, sponsored by the Pancreatic Cancer Action Network, raised funds for pancreatic cancer research and awareness. Sadly, Paul passed away in October 2015 after battling the disease for more than a year. When his HRD colleagues first learned of his illness, they supported him by becoming involved with PurpleStride and its mission to "Wage Hope." This was the second year Team Paul Willis has participated in PurpleStride, but the first time the event has included a timed race. This year's team—Lisa Bucci, Frank Marks, Kathryn Sellwood, and Rob and Matthew Rogers—completed the 5K race with the help of many of their HRD coworkers, raising $500 in support of pancreatic cancer research. The speediest team member was Lisa Bucci, who finished second in the women's division with a time of 24:47, less than 8 minutes per mile! The rest of the team, although slower, enjoyed the beautiful, sunny, cool day and the camaraderie of joining together for a good cause.

Team Paul Willis: Frank and Anita Marks, Kathryn Sellwood, Lisa Bucci, and Rob and Matthew Rogers. Anita Marks was also one of the main organizers of the PurpleStride Miami event.

Researchers Continue Monitoring and Sampling Efforts of Tropical Atlantic

Scientists with AOML's Physical Oceanography Division participated in a PIRATA Northeast Extension (PNE) cruise this past November-December 2015. They were joined aboard the NATO ship NRV *Alliance* by scientists with NOAA's Pacific Marine Environmental Laboratory (PMEL) and the Aerosols and Ocean Science Expeditions (AEROSE) team from NOAA's Center for Atmospheric Sciences. The research effort aboard the *Alliance* was undertaken to service moorings and to collect a wide range of oceanographic and atmospheric data (see cruise track below).

PIRATA, Prediction and Research Moored Array in the Atlantic, is an international program jointly administered by Brazil, France, and the US. Begun in 1997, its goal is to monitor the upper ocean and near surface atmosphere of the tropical Atlantic through the deployment and maintenance of an array of moored buoys and automated meteorological stations. The PIRATA array is a critical component of the climate observing system that enables researchers to better understand and predict climate fluctuations, as well as their impacts, on the countries bordering the tropical Atlantic basin. The PNE project is a joint endeavor of AOML and PMEL to expand the PIRATA array of ATLAS moorings into the northern and northeastern sections of the tropical Atlantic Ocean.

During the cruise, the PMEL team and deck crew replaced four PNE buoys that are a crucial part of the PIRATA array and recovered a mooring that was part of the T-FLEX validation near the PNE mooring site at 4°N, 23°W. They also serviced the PIRATA backbone mooring on the equator at 23°W. Additionally, they recovered an experimental shortwave radiation sensor with a rinsing system.

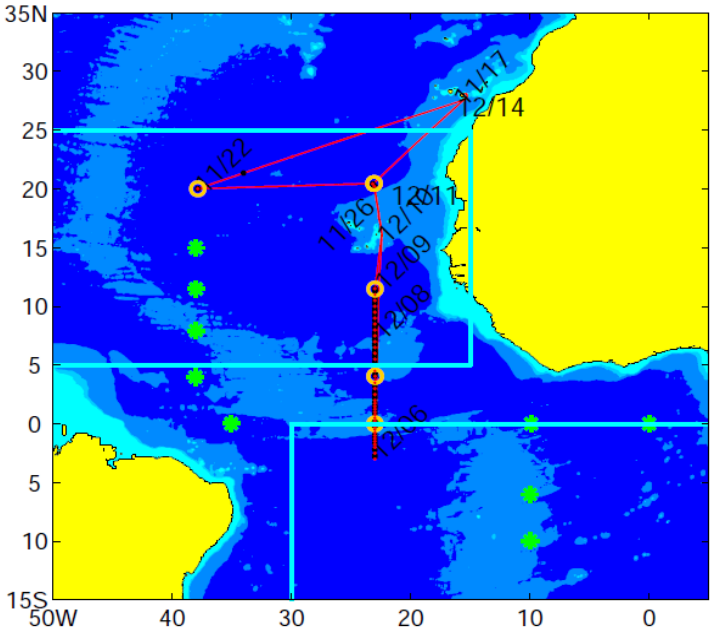
The AEROSE team gathered atmospheric samples throughout the cruise. The goal of their research is to assess the impact of aerosols, specifically Saharan dust and sub-Saharan smoke, on the ocean and atmosphere during their transport across the tropical Atlantic Ocean.

The AOML team gathered profiles of pressure, temperature, salinity, oxygen, and velocity at 41 stations with a CTD/O_2/LADCP system (see bottom right image); water samples were obtained to analyze their salinity and oxygen content. These data are, in part, used to study the oxygen minimum zone, tropical instability waves, and the tropical/subtropical cells system.

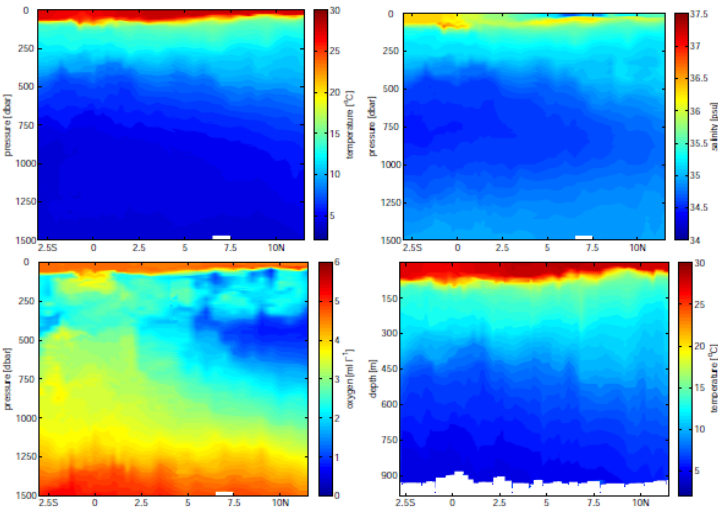
The AOML, PMEL, and AEROSE teams aboard the NRV *Alliance* during the PIRATA PNE cruise this past November 15-December 14, 2015. Dr. Claudia Schmid of AOML, sitting cross-legged on the deck, served as chief scientist.

The cruise was also used to perform two XBT (expendable bathythermograph) experiments targeted at improving the quality of XBT data. The first experiment was a test of enhanced Deep Blue XBTs, which were deployed as part of a joint project with Sippican to improve the quality of measured temperatures. For this purpose, multiple XBTs were dropped during CTD casts. The second experiment focused on determining the impact of the fall height on XBT profiles by dropping two probes simultaneously from different heights (a section of these data is shown below).

Claudia Schmid of AOML served as chief scientist during the month-long cruise, with technical support provided by Shaun Dolk, Erik Valdes, and Thomas Sevilla, all AOML-University of Miami Cooperative Institute researchers. The PMEL team included Steven Kunze and Bill Higley, while the 10-member AEROSE team was led by Vernon Morris. A student from the University of Miami's Rosenstiel School, Michael Cohen, and a volunteer, Vera Schmid-Dannert, also participated (see group photo above).



Red line denotes the cruise track of the November-December 2015 PIRATA Northeast Extension (PNE) cruise off western Africa. Circles denote PNE recovery and deployment sites, red dots denote CTD stations, and black dots denotes XBT profile sites. Green stars are PIRATA backbone moorings.



Ocean profiles gathered along 23°W: temperature (top left), salinity (top right), and oxygen (bottom left), all from the CTD/O_2/LADCP system; temperature section from XBT profiles between CTD casts (bottom right).

Bring Your Child To Work Day

AOML welcomed a large group of children to the lab on February 5th in celebration of Bring your Child to Work Day. The program for this year's event centered on the vast network of ocean buoys and drifters that globally gather marine and atmospheric data. The morning began with an introduction by AOML oceanographer Rick Lumpkin on how scientists use buoys and drifters to track the flow of currents, heat, and salt throughout the world's oceans. After examining some of AOML's ocean-observing instruments, the students were broken into teams and given materials to build and test their very own drifter. An additional activity demonstrated how water temperature and salinity content can change the density of seawater and impact ocean circulation. Thanks to Erica Rule and the many volunteers at AOML who made the 2016 Bring your Child to Work Day event a fun learning experience.

February is

Black History Month

2016 Theme:

Hallowed Grounds—Sites of African American Memories

"If a race has no history, if it has no worthwhile tradition, it becomes a negligible factor in the thought of the world, and it stands in danger of being exterminated."

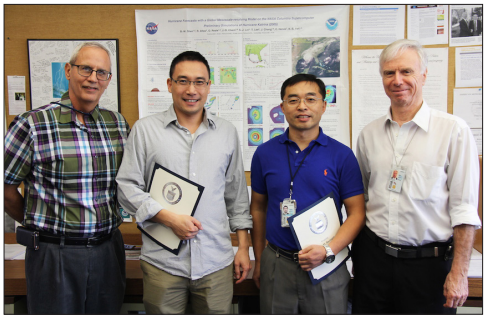
Carter G. Woodson

Dr. Carter G. Woodson, an African-American historian, teacher, and journalist, known as the Father of Black History, initiated the annual February observance of Negro History Week in 1926. He chose the month of February in honor of Abraham Lincoln's February 12th birthday and Frederick Douglass' accepted birthday of February 14th. In 1976, as part of the United States Bicentennial, the informal expansion of Negro History Week to Black History Month was officially recognized by the U.S. government.

2016 Federal Holidays
New Year's Day **Friday, January 1st**
Martin Luther King, Jr. Birthday **Monday, January 18th**
Washington's Birthday **Monday, February 15th**
Memorial Day **Monday, May 30th**
Independence Day **Monday, July 4th**
Labor Day **Monday, September 5th**
Columbus Day **Monday, October 10th**
Veterans Day **Friday, November 11th**
Thanksgiving Day **Thursday, November 24th**
Christmas 2016 **Monday, December 26th**

Congratulations

Howard (Howie) Friedman, a meteorologist and the deputy director of AOML's Hurricane Research Division, is one of the first recipients of NOAA's EEO-Diversity Award for Exemplary Service. Howie received the award in recognition of his long-term efforts to support equal employment opportunity and diversity at AOML. He was also recognized for his long-term support of educational and outreach activities at AOML through his interaction with NOAA's Office of Education (i.e., the Hollings Scholarship, Educational Partnership, and Graduate Sciences programs), as well as extensive activities related to the South Florida Federal Executive Board (FEB). Howie has supported the FEB in many capacities over the years, including serving as its treasurer, a member of its Board of Directors and Federal Employee of the Year Awards Committee, and co-chair of the Mediation Council/Shared Neutrals Alternative Dispute Resolution Program. He has served as the director of AOML's Equal Employment Opportunity Program for more than 35 years.



HRD director Frank Marks, Jun Zhang, Xuejin Zhang, and AOML director Bob Atlas.

Jun Zhang and Xuejin Zhang, both University of Miami-Cooperative Institute for Marine and Atmospheric Studies (CIMAS) scientists with AOML's Hurricane Research Division, were recently awarded CIMAS gold medals for their exemplary work efforts. Jun was recognized for improving the surface layer and vertical-diffusion parameterization within NOAA's Hurricane Weather Research and Forecasting (HWRF) numerical model, enabling HWRF to better forecast intensity and storm structure. Xuejin was recognized for designing and implementing a third, moving nest for HWRF, enabling the model to attain 3-km resolution.

Welcome Aboard

Dr. Fabian Gomez, a post-doctoral research associate at the University of Southern Mississippi, began a one-year visit with AOML's Physical Oceanography Division in February. Dr. Gomez will work with Drs. Sang-Ki Lee, Yanyun Liu, and John Lamkin (of NOAA's Southeast Fisheries Science Center) on a project funded by the Northern Gulf Institute and NOAA. He will use biogeochemical models to study larval transports of multiple fishery species in the Gulf of Mexico and how they are impacted by future climate changes.

NOAA Corps officer LCDR Justin Kibbey joined AOML's Office of the Director in January and will begin his duties as AOML's new Associate Director in March. Prior to his arrival at AOML, Justin served as the Deputy Chief of the Programs and Project Section at NOAA's Aircraft Operations Center in Tampa, Florida. He is a qualified aircraft commander and instructor pilot for the WP-3D hurricane hunter and DHC-6 Twin Otter aircraft. After serving 9 years with the US Navy, including 33 combat missions over Iraq, Justin transferred to the NOAA Corps in 2010. He is a 2001 graduate of the US Naval Academy in Annapolis, Maryland, with a BS degree in political science.

Mr. Masumbuko Semba, a Tanzanian lecturer at the Nelson Mandela African Institute of Science and Technology and a doctoral student at the University of Leuven in Belgium, began an extended visit with AOML's Physical Oceanography Division (PhOD) in January. Masumbuko is being hosted at AOML by Dr. Rick Lumpkin and will be a guest of PhOD until May 2016. During his time at AOML, Masumbuko will become familiar with several aspects of AOML's contributions to the global ocean observing system. He will also complete two oceanography courses at the University of Miami's Rosenstiel School of Marine and Atmospheric Science.

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

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