September-October 2015
Vol. 19/No. 5

AOML Keynotes

ATLANTIC OCEANOGRAPHIC AND METEOROLOGICAL LABORATORY

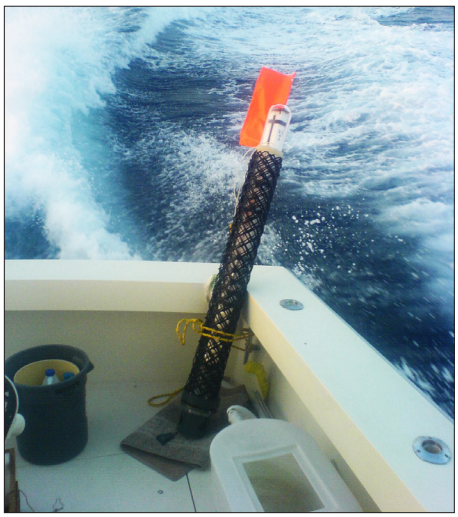
AOML is an environmental laboratory of NOAA's Office of Oceanic and Atmospheric Research located on Virginia Key in Miami, Florida

Western Boundary Time Series Project Celebrates Milestone

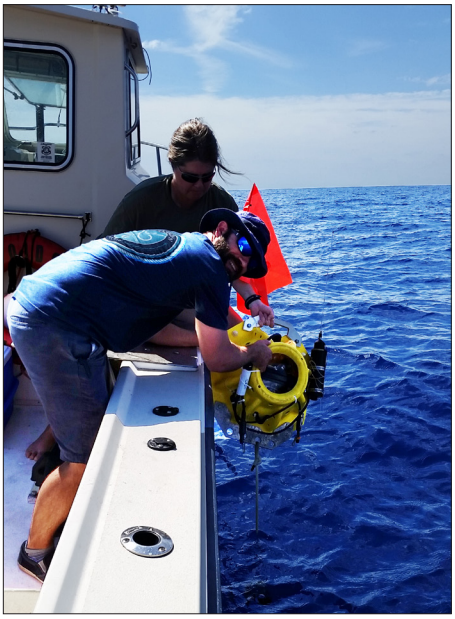
On October 15, 2015, the scientists, technicians, and engineers involved in the AOML-Physical Oceanography Division's (PhOD) Western Boundary Time Series (WBTS) project marked a milestone with the completion of the 100th successful dropsonde cruise in the Florida Current since the project began in the year 2000.

NOAA research into the Florida Current at 27ºN dates back to the early 1980s, and many outstanding scientific results were obtained by the study throughout the 1980s and 1990s. In 1998, however, this Florida Current observing project, which had been jointly run by AOML and NOAA's Pacific Marine Environmental Laboratory, came to an end.

After significant outcry from the scientific community regarding the value of this long-time data series, a new group of PhOD scientists restarted the Florida Current observations as part of the WBTS project in the year 2000. A cornerstone of the project is the continuous observations of the Florida Current volume transport via a submarine cable, which provided daily estimates from 1982 to 1998 in the earlier NOAA projects, and has produced similar daily estimates since the WBTS project started in 2000.



An earlier version of the dropsonde, developed at AOML in the mid 1990s and regularly improved by the engineering team until it was replaced in the mid-2000s by the modern generation of dropsonde.



Andy Stefanick of PhOD and a ship crew member deploy a dropsonde at a monitoring site in the Straits of Florida.

Another crucial part of the program has been regular ship observations of the Florida Current velocity using a free-falling float called a dropsonde at nine sites across the Straits of Florida at 27ºN. These ship sections are used to monitor the calibration of the cable measurements, and they have been critical tests that have helped researchers identify and fix a number of problems in the cable data over the years.

The ocean instrument called a dropsonde (not to be confused with the atmospheric dropsonde) has been used since the 1960s, but the modern version was pioneered at AOML in the mid-1990s via the introduction of a Global Positioning System (GPS) receiver inside the dropsonde. Further improvements over the years have led to a very robust instrument that provides highly accurate estimates of depth-averaged ocean velocity.

Deploying and collecting 100 dropsondes from cruises over the past 15 years in support of the WBTS project has been a collaborative effort of many individuals, from the engineers who build the dropsondes, to the technicians who process the data, to the numerous engineers and technicians who go to sea to collect the data on small boats every year.

These engineers and technicians include Doug Anderson, David Bitterman, Paul Dammann, Pedro DiNezio, Shaun Dolk, Craig Engler, Rigo Garcia, Ben Kates, Jeff Kelley, Nelson Melo, Jose Ochoa, Pedro Pena, Grant Rawson, Uli Rivero, Robert Roddy, Kyle Seaton, Tom Sevilla, and Andy Stefanick.

Although some of these individuals are no longer at AOML, the contributions they made to the WBTS project have helped build this great time series and enabled the project to reach this milestone.

Dropsondes sink to the ocean floor at a constant rate, drop a weight when they reach the bottom, and then rise to the surface at a constant rate under their own buoyancy. By knowing the elapsed time of a completed cast (i.e., the subsurface time interval), and the initial start and end position of the dropsonde on the ocean surface, researchers can calculate the vertically averaged horizontal velocity of the flow of water as the total distance traveled divided by the time required for the cast.

AOML Leads Research Efforts Across Caribbean to Improve Bleaching Predictions

New research techniques include genetic sampling to predict coral bleaching

Across the Caribbean, AOML scientists and their partners are conducting multi-disciplinary research projects to monitor the potential for coral bleaching, measure specific indicators of coral resilience, and improve bleaching prediction capabilities. This ongoing research encompasses multiple levels of the reef ecosystem, from the community level down to the microorganism level, with the goal of providing predictive insights to inform reef managers and support coral reef conservation efforts.

Coral bleaching occurs when zooxanthellae, the colorful algae that live in coral limestone, are ejected from the coral due to stress factors such as warm water temperatures. With the algae expelled, corals appear colorless or "bleached."

AOML coral researcher Renee Carlton uses a photo mosaic image to locate a bleached coral head on a reef in the Florida Keys.

Refining the scope of bleaching forecasts

In the Cayman Islands, researchers with AOML's Coral Health and Monitoring Program (CHAMP) are measuring sub-surface water temperatures at coral reef sites around Little Cayman to improve water temperature estimates in regional bleaching models. These models currently rely heavily on global satellite measurements of sea surface temperatures, which are used as a proxy to represent temperatures below the surface where corals reside. There is great variability between surface and subsurface water temperatures, depending on local oceanographic conditions.

The water temperature data collected from the sites at Little Cayman are being compared to data from a nearby established monitoring buoy to provide more precise temperature comparisons across different reef environments. This insight can be used to refine the scope of NOAA's bleaching forecasts from region-wide to reef-specific, allowing coral reef managers to better target their monitoring and recovery efforts.

Monitoring bleaching impacts along the Florida reef tract

In response to the seventh mass coral bleaching event to impact the Florida Keys since 1983 due to warmer than average sea temperatures, members of AOML's Acidification, Climate, and Coral Reef Ecosystems Team (ACCRETE) deployed pH, temperature, and light sensors at paired inshore/offshore coral reef sites in September. They also collected 200 tissue samples from the Endangered Species Act-listed coral species *Orbicella faveolata* for genetic and lipid analysis.

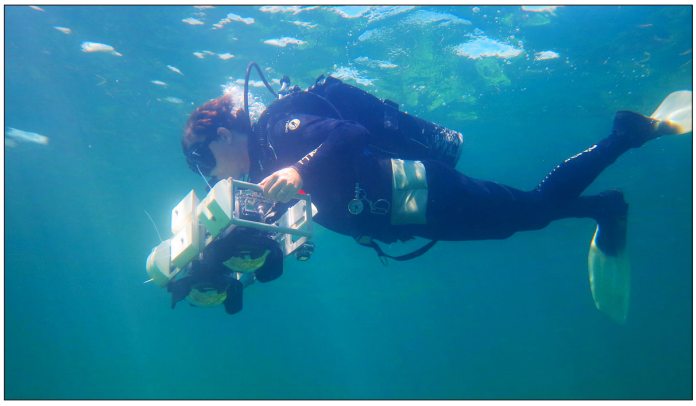
Additionally, an ACCRETE colleague with the University of Miami's Rosenstiel School photographed the reefs using a high-resolution camera to measure the extent of the bleaching impacts. By compiling the photographs into mosaic images, researchers can more accurately document community-wide changes in reef health.

ACCRETE will continue to monitor the impacts of the current bleaching event to determine the extent of coral mortality and to isolate the factors that might serve as indicators for future bleaching events.

Offshore reefs in the Florida Keys have deteriorated dramatically since the late 1970s, while inshore reefs have remained resilient and continue to maintain high coral cover. Ongoing field studies are leveraging the current bleaching event to determine why inshore reefs have survived and are more resistant to bleaching.

How do Florida reefs compare to other reefs in the region?

Other locally-driven stressors to the Florida reef tract, including sediment from coastal construction, pollution from land-based nutrients and fertilizers, physical damage from divers and boaters, and overfishing, all further impact reefs by compounding the stress from global changes, such as warming oceans and ocean acidification. To separate the effects of local anthropogenic stressors from global changes, CHAMP researchers, along with scientists from the Central Caribbean Marine Institute, are monitoring the pristine reefs along Little Cayman. Experiments at this site are designed to contrast them with populated coastal reefs and determine why reefs around this remote island are thriving despite wide-spread bleaching across the region.



Art Gleason, a University of Miami Rosenstiel School scientist collaborating with AOML's ACCRETE group, uses a high-resolution camera to photograph reefs in the Florida Keys. By compiling the photographs into photo mosaic images, researchers are able to more accurately document community-wide changes in reef health.

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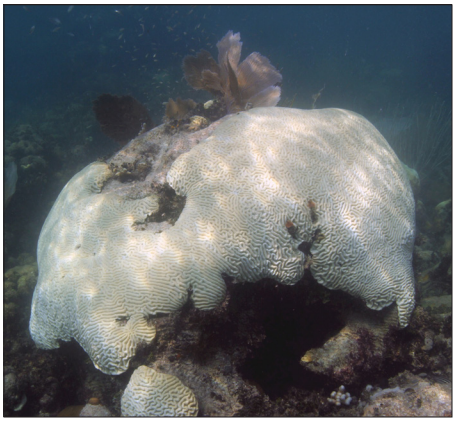
What makes Little Cayman's reefs special?

With an estimated population of only 150 people, Little Cayman lacks a significant human presence. Combined with the island's relative isolation and protection from overfishing, as well as coastal pollution, coral communities have thrived. Ongoing studies of the reefs surrounding Little Cayman have been designed to document globally-driven changes to the reef ecosystem, from studies of specific species to ecosystem-wide shifts.

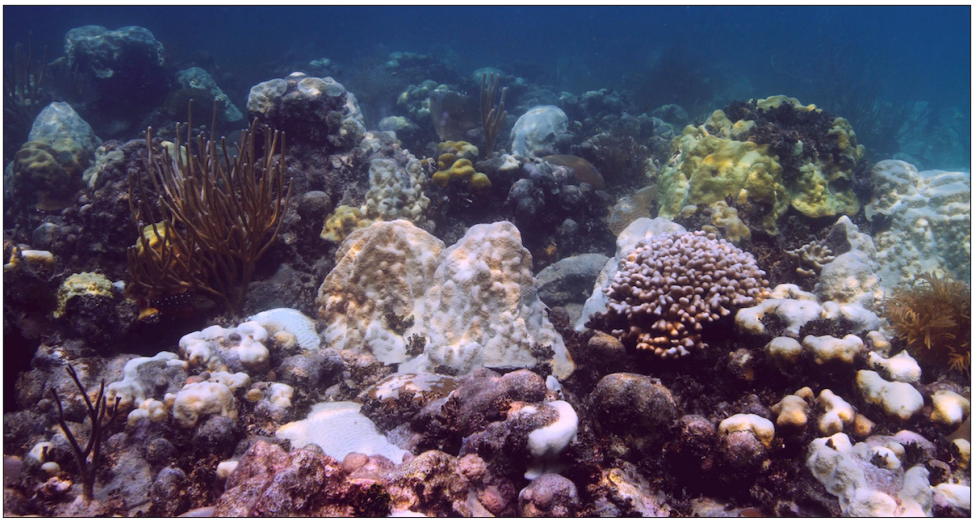
Established monitoring sites equipped with data-collecting buoys have provided a baseline of environmental data at key coral reef sites around the island before the most recent mass bleaching. Current studies will observe environmental conditions at Little Cayman, and samples of coral polyp tissue will correlate changes at the organism and microorganism level, with a goal of noting specific changes that allow these corals to become more resilient. The resulting insights could be adapted to inform protection plans for vulnerable coral reef ecosystems in other parts of the world.

Genetic sampling to predict resilience

At Little Cayman, as well as at sites along the Florida reef tract, researchers are concentrating their efforts at even smaller scales to explain differences in coral susceptibility and resilience to bleaching. With a focus on two species of rare and endangered coral, they are collecting and studying tissue from individual coral polyps. The goal is to identify the genetic makeup of the polyp's "microbiome," the consortium of algae, bacteria, viruses, and fungi all living in dynamic equilibrium with the coral animal. The differences in genetic makeup within these microbiomes can be used as a key indicator of adaptation in specific corals over time. This genetic variability may explain how some corals are able to survive exposure to a variety of stressors, including warmer ocean temperatures.



A bleached brain coral at Cheeca Rocks in the Florida Keys.



Coral bleaching at Cheeca Rocks, a NOAA-designated climate and ocean acidification sentinel monitoring site in the Florida Keys.

Can genetic sampling predict a coral's response to bleaching?

When faced with changing environmental conditions, the microbiome community is the most genetically adaptable part of the coral. A coral's resilience to ocean warming depends on the combined response of its microbiome. Researchers with AOML's Environmental Microbiology Laboratory have sequenced DNA associated with these microbiome communities before, during, and after the current bleaching event to identify changes in specific genes associated with bleaching.

Genetic sampling performed by researchers with AOML's Environmental Microbiology Laboratory will enable reef managers to identify coral species that are more resilient to bleaching and other stressors, such as high levels of nutrients.

Managers can apply this understanding to monitoring programs, looking for these genetic changes as a predictive marker for potential coral bleaching. Additionally, acquiring the ability to identify specific microbiome combinations that are more resilient to bleaching than others may help the efforts of reef-rebuilding organizations as they select species to grow in nurseries and identify reef locations to outplant corals.

Coupling insights on the diversity of corals and their microbes with bleaching forecast models can also provide valuable guidance to reef managers' mitigation activities. Using a similar approach, selecting corals that are more resilient to high levels of nutrients, such as nitrates and phosphates, may eventually provide stability to coral reefs threatened by land-based sources of pollution.

"The research being performed to characterize these communities will eventually assist reef managers and coral conservation groups by providing them with information to help choose the best species and regions to focus their efforts," said AOML coral ecologist Jim Hendee. "Today's corals have a lot to contend with, and we want to give managers every possible advantage to succeed in preserving and maintaining these valuable ecosystems."

These research activities are a multi-institutional effort conducted by NOAA and its partners with the University of Miami's Rosenstiel School and Cooperative Institute for Marine and Atmospheric Studies, the Central Caribbean Marine Institute's Little Cayman Research Centre, Nova Southeastern University's National Coral Reef Institute, the University of Wisconsin, and the Smithsonian Institution.

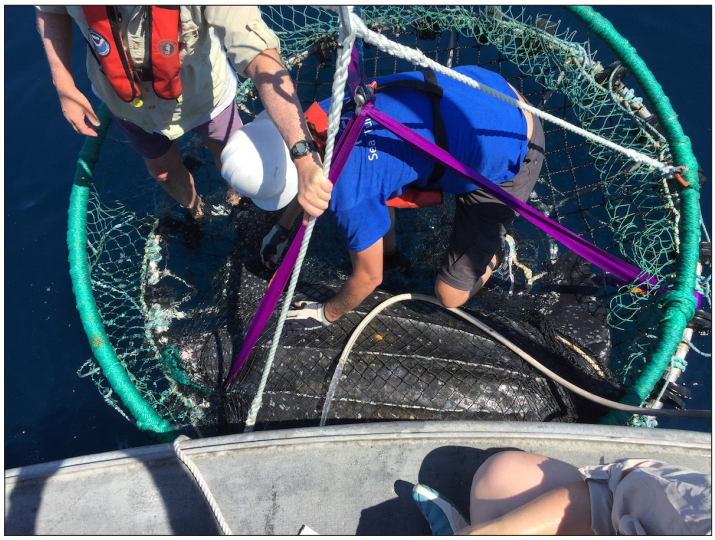
NOAA Partners Collaborate on First Gulf of Mexico Leatherback Tagging Cruise

In September, a team of NOAA partners collaborated on a project to locate, capture, tag, and release endangered leatherback sea turtles (*Dermochelys coriacea*) in the northeastern Gulf of Mexico. The survey was conducted off the coast of the Florida Panhandle near Destin, Florida, and marked the first research focused on leatherback turtles in Gulf waters.

National Marine Fisheries Service (NMFS) scientists Chris Sasso, Karin Forney, Scott Benson, and Brian Stacy successfully applied satellite-tracked GPS transmitters to six leatherback turtles during the 7-day survey from September 19-25. Their efforts were made possible due to the aid of a NOAA Twin Otter aircraft piloted by Matt Nardi and Alex Johnston of NOAA's Office of Marine and Aviation Operations (OMAO) and the NOAA R/V *Hildebrand* captained by Joe Bishop, LTJG Ben Vandine, and LT Marc Weekley of AOML.

After each turtle was located by spotters aboard the Twin Otter aircraft, it was secured within a net and brought to the R/V *Hildebrand* where it was measured and fitted with a satellite-tracked GPS transmitter. Researchers hope to gain a better understanding of the leatherbacks' use of habitat, migratory patterns, and distribution in the region by tracking their location, dive patterns, and long-term movements.

A 608-pound female leatherback turtle swims in a rehabilitation pool at the Gulfarium Marine Adventure Park in Fort Walton Beach, Florida, after being rescued from a Florida Panhandle beach. Her release into the Gulf of Mexico from aboard the R/V *Hildebrand* was made possible through a collaborative effort between NOAA and Gulfarium staff. A video of her release can be viewed at http://www.youtube.com/watch?v=hywB2J4T-sM&sns=em.



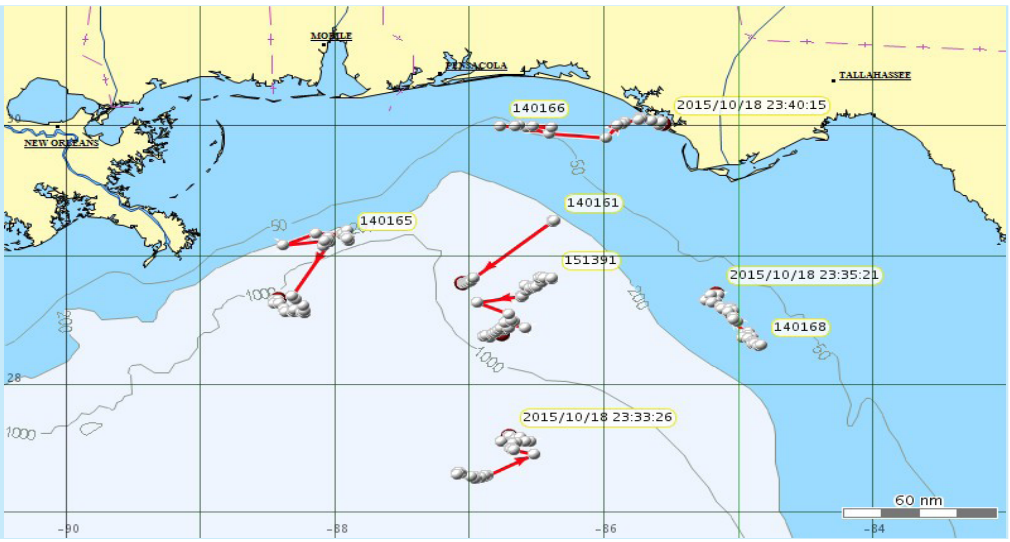
NOAA scientists secure a leatherback turtle in a net off the stern of the R/V *Hildebrand* before equipping it with a satellite-tracked GPS transmitter.

Leatherback turtles are the largest sea turtle species on Earth, growing to lengths in excess of 7 feet and weights in excess of 2,000 pounds. Although they inhabit the tropical and temperate waters of the Atlantic, Pacific, and Indian oceans, as well as Mediterranean Sea, little is known about their presence in the Gulf of Mexico.

In addition to the planned leatherback research, the NOAA team also assisted in the release of a female leatherback turtle stranded earlier in September on Pensacola Beach. After treatment and rehabilitation at the Gulfarium Marine Adventure Park in Fort Walton Beach, the turtle was brought aboard the R/V *Hildebrand* in Destin, Florida and released off the coast of Pensacola in an area where the crew had spotted other leatherback turtles foraging for jellyfish. Without NOAA's assistance, Gulfarium staff would have had to release the leatherback on the beach, a less than ideal reentry site, given that other leatherbacks were foraging about 20 miles offshore from the beach.

The NMFS leatherback turtle study was a great success due to the collaboration with OMAO and AOML. OMAO's Twin Otter crew were crucial in spotting leatherbacks from above, while AOML's vessel and captains ensured success on the water after the leatherbacks were located.

In September, a NOAA research team successfully captured and released six endangered leatherback sea turtles in the Gulf of Mexico after equipping them with GPS transmitters. The team hopes to gain a better understanding of the turtles' use of habitat, migratory routes, and distribution in the Gulf by tracking their location, dive patterns, and long-term movements.



Map showing the location and movement of six endangered leatherback sea turtles in the Gulf of Mexico shortly after being equipped with satellite-tracked GPS transmitters.

AOML Establishes New Ocean Acidification Monitoring Sites in the Gulf of Mexico

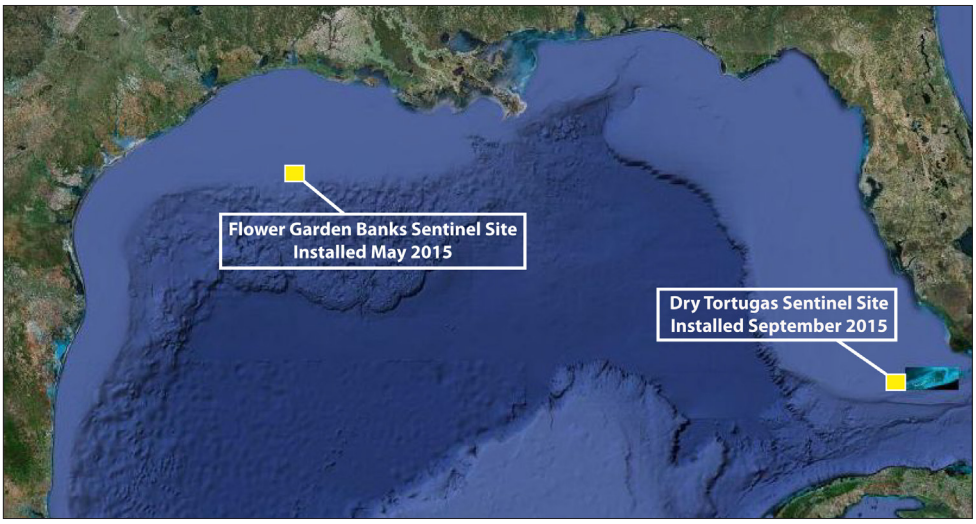
Members of the Acidification, Climate, and Coral Reef Ecosystems Team (ACCRETE) at AOML—Derek Manzello, Ian Enochs, Renee Carlton, Lauren Valentino, and Graham Kolodziej—recently traveled to two remote reef locations to expand the National Coral Reef Monitoring Program's (NCRMP) network of sentinel climate and ocean acidification monitoring sites.

The newly established sites, located in the Flower Garden Banks National Marine Sanctuary and the Dry Tortugas, will provide researchers with additional data and insights into the ocean's changing chemistry and the progression of ocean acidification, as well as the ecological impacts of these variables across the Caribbean basin and Gulf of Mexico.

Both sentinel sites are located in remote regions of the Gulf of Mexico that experience few impacts from man-made stressors such as overfishing and pollution from land. ACCRETE will monitor the physical and chemical conditions at the two sites over time, as well as closely monitor ecosystem impacts to the reefs due to ocean acidification such as species-specific calcification rates, calcium carbonate budgets, and rates of bioerosion, i.e., the removal of calcium carbonate structures by living organisms.

ACCRETE partnered with researchers from NOAA's Office of National Marine Sanctuaries and academic colleagues in May to establish a sentinel site in the Flower Garden Banks National Marine Sanctuary. Located approximately 120 miles southeast of Galveston, Texas, the Flower Garden Banks include the northernmost coral reefs on the continental shelf of North America and contain some of the most pristine reefs in the Atlantic.

From aboard the NOAA R/V *Manta*, ACCRETE and Sanctuary researchers conducted benthic surveys to measure ecosystem productivity and deployed monitoring units to measure calcium carbonate cycling, subsurface ocean temperatures, and rates of bioerosion. To measure historical growth rates, they collected coral cores, which are being analyzed at AOML by a state-of-the-art CT (computed tomography) scanner.



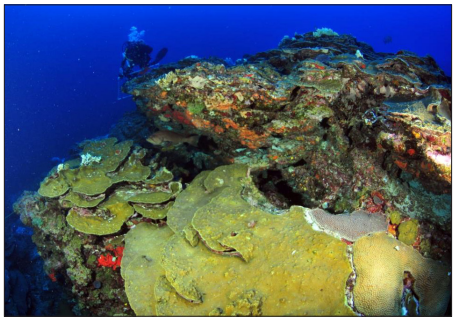
AOML coral researchers recently established sentinel sites to monitor ocean acidification and its subsequent impacts on marine ecosystems in the Flower Garden Banks National Marine Sanctuary and the Dry Tortugas.

In September, ACCRETE researchers established a monitoring site in the Dry Tortugas, there creating transects for long-term monitoring and deploying monitoring units to track ecosystem impacts. The Dry Tortugas are a small group of islands located 70 miles west of Key West, Florida that constitute the southwestern tip of the Florida Reef Tract.

The Dry Tortugas site provides a unique opportunity to compare ocean chemistry changes and ecological impacts with data gathered from Cheeca Rocks, an ocean acidification sentinel site located farther north along the Florida Reef Tract that was previously established by ACCRETE researchers.

In addition to the Flower Garden Banks and Cheeca Rocks sentinel sites, ACCRETE researchers also monitor and gather data from the La Parguera sentinel site in Puerto Rico. Sentinel sites in the Pacific are located in Oahu's Kaneohe Bay, Hawaii, American Samoa, and Saipan in the Commonwealth of the Northern Mariana Islands. Data from these sentinel sites all contribute to the NCRMP's goal of providing sustained and long-term measurements of key variables to gauge the status and trends in coral reef health.

Aside from leading the in-situ climate change and ocean acidification monitoring effort for the Atlantic Ocean, ACCRETE researchers also collaborate with NOAA's Pacific Marine Environmental Laboratory in Seattle, Washington, and the Coral Reef Ecosystems Division of the Pacific Islands Fisheries Science Center in Honolulu, Hawaii, to ensure that monitoring efforts in the Atlantic and Pacific are aligned.



A flourishing reef in the Flower Garden Banks National Marine Sanctuary.

AOML coral researchers Paul Jones and Renee Carlton work to extract a core sample from a coral colony in the Gulf of Mexico's Flower Garden Banks National Marine Sanctuary. Core samples from the newly established ocean acidification sentinel site are being analyzed at AOML with a state-of-the-art computed tomography (CT) scanner to assess the effects of ocean acidification on historical growth rates of various coral species.

Underwater Glider Observations Reveal Impact of Salinity on Hurricane Gonzalo

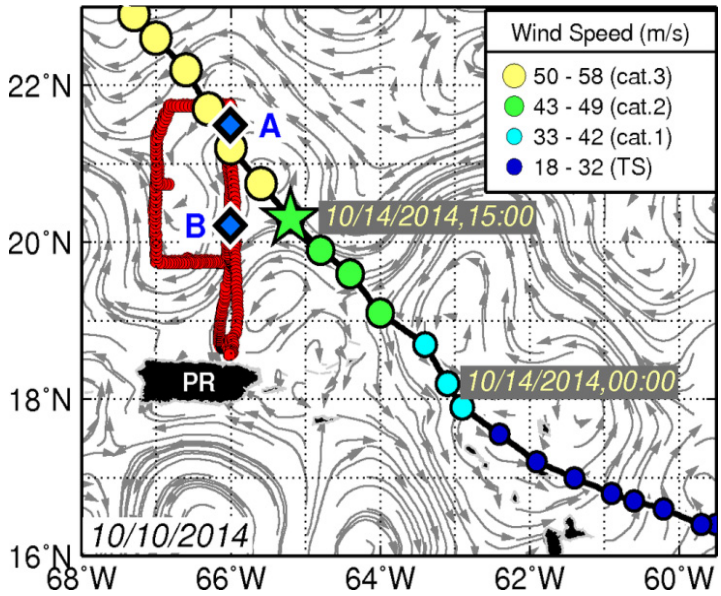
Hurricanes are known to cool surface waters as they travel over the ocean, leaving a swath of colder water behind them where they pass. This cooling is mostly caused by a hurricane's strong winds mixing warm surface water with colder water from depths as great as 100 meters. Sea surface cooling forced by a hurricane can ultimately cause a negative feedback mechanism to occur, leading to the potential reduction of a hurricane's intensity.

Understanding the processes behind these air-sea interactions is one of the goals of AOML's underwater glider project begun in 2014 in support of hurricane research. Underwater gliders are remotely-operated vehicles that dive and ascend through the upper 1000 meters of the ocean. They collect and transmit data in real time for periods up to several months in specific areas of interest.

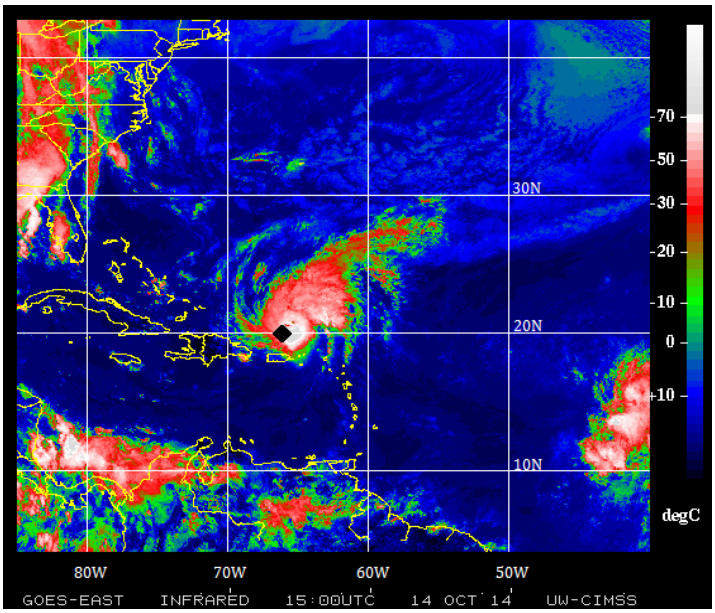
A recent study published in *Geophysical Research Letters** by AOML scientists and their colleagues with the University of Miami's Cooperative Institute for Marine and Atmospheric Studies (CIMAS), the University of Puerto Rico-Mayaguez, and NOAA's Environmental Modeling Center used observations from one of AOML's underwater gliders to identify the importance of salinity in reducing the upper ocean's cooling due to the passage of a hurricane. Lead author Ricardo Domingues, a CIMAS researcher with AOML's Physical Oceanography Division, and his science team examined observations of Hurricane Gonzalo (2014) before, during, and after the storm traveled to within 85 kilometers of the glider's position north of Puerto Rico on October 14th.

Hurricane Gonzalo formed on October 12, 2014 and intensified into a major category-3 hurricane with maximum sustained winds of 115 mph by October 14th. Gonzalo's close proximity to the glider enabled the science team to analyze the upper ocean's response to Gonzalo's powerful winds, as well as gauge the ocean's recovery following Gonzalo's passage through the region.

The study revealed that salinity conditions below the ocean surface created a barrier against Gonzalo's strong winds. In oceanographic terms, this barrier is called a "barrier layer." The presence of the barrier layer prevented the mixing of surface and deeper waters. As a result, sea surface cooling in Gonzalo was small compared to sea surface cooling forced by other hurricanes of similar strength in areas without a barrier layer. This minimal cooling of surface waters may have favored the intensification of Gonzalo, which continued to strengthen as it traveled over the region where the glider was located.



Track followed by one of AOML's underwater gliders (red points) north of Puerto Rico (PR) during July–November 2014, overlaid on altimetry-derived geostrophic currents. During October 8-28, 2014, the glider sampled ocean conditions between sites A and B (blue diamonds). The track of Hurricane Gonzalo is shown by colored circles (every 3 hours). The star highlights the closest location of the hurricane with respect to the glider.



Black diamond shows the approximate location of the glider superimposed on an infrared image of Hurricane Gonzalo on October 14, 2014 at 1500 UTC when Gonzalo was at its closest location to the glider. The image was obtained from the Cooperative Institute for Meteorological Satellite Studies (http://tropic.ssec.wisc.edu/).

The study further revealed that salinity effects observed in the real ocean were not being properly represented in one of the ocean models used for hurricane forecasts—the HYbrid Coordinate Ocean Model (HYCOM)—coupled to the Hurricane Weather Research and Forecasting model (HWRF), i.e., HWRF-HYCOM. As a consequence, HWRF-HYCOM overestimated the sea surface cooling forced by Hurricane Gonzalo's winds, which ultimately caused an underestimation in the intensity forecasts of Gonzalo.

The ability to identify such discrepancies and understand the mechanisms behind them is critical for improving tropical cyclone intensity forecasts. The science team concluded that "a better model representation of salinity conditions may improve simulations of the ocean's response and benefit future hurricane forecasts in the region, given the importance of salinity as suggested by the observations analyzed in this study."

Results from the study emphasize the value of underwater glider observations for improving the knowledge of how the ocean responds to a tropical cyclone's winds. The results also emphasize how underwater glider observations can be used to improve tropical cyclone intensity forecasts and studies.

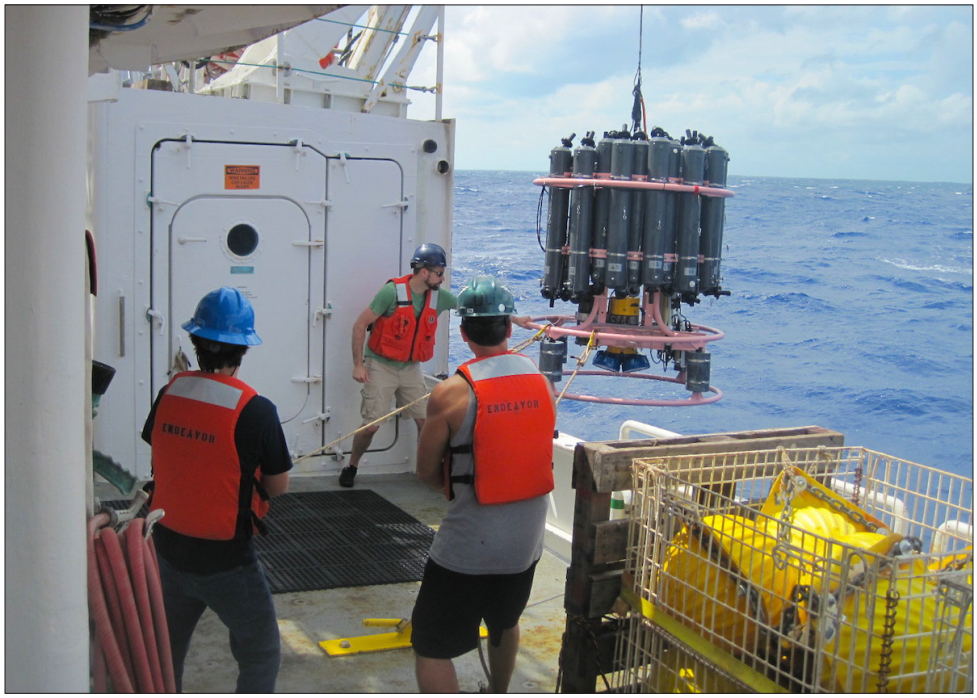
*Domingues, R., G. Goni, F. Bringas, S.-K. Lee, H.-S. Kim, G. Halliwell, J. Dong, J. Morell, and L. Pomales, 2015: Upper-ocean response to Hurricane Gonzalo (2014): Salinity effects revealed by targeted and sustained underwater glider observations. *Geophysical Research Letters,* 42(17):7131-7138 (doi:10.1002/2015GL065378).

Researchers Gather Data in Support of Western Boundary Time Series Project

Changes in the Meridional Overturning Circulation (MOC) have been shown to correlate with changes in surface air temperatures, hurricane intensification, and precipitation patterns across much of the globe. NOAA/AOML scientists continue to play a leadership role in MOC research, and one location where they have particularly focused is at 26ºN. AOML began studying MOC-related flows at this location in 1982 and, to date, more than 30 years of important ocean transport and water mass data have been collected at this latitude in the Florida Straits and east of the Bahamas Islands.

NOAA/AOML's Western Boundary Time Series (WBTS) project has, since the year 2000, been studying the Florida Current and the Deep Western Boundary Current, two key limbs of the MOC system in this region. The Florida Current transport time series maintained by the WBTS project is one of the longest time series of ocean transport measurements in the world. Furthermore, in 2004 it became the cornerstone for a major international initiative between the United Kingdom and the United States to study the basin-wide MOC flow across 26ºN in the Atlantic. NOAA, the US-National Science Foundation (NSF) and the UK-National Environment Research Council (NERC) jointly fund this international array.

For the latest cruise in support of the NOAA-funded WBTS and NSF-funded MOCHA projects, six scientists with AOML's Physical Oceanography Division—Chris Meinen, Ulises Rivero, Pedro Peña, Grant Rawson, Jay Hooper, and Tom Sevilla—joined with colleagues from the University of Miami's Rosenstiel School aboard the R/V *Endeavor* for a 17 day research cruise from October 3-19, 2015.



AOML cruise members Tom Sevilla and Ulises Rivero (forefront) work with the ship survey technician aboard the R/V *Endeavor* to recover the CTD (conductivity-temperature-depth) instrument package.

During the cruise, 44 high-quality conductivity-temperature-depth (CTD) and lowered acoustic Doppler current profiles were collected, data from five pressure-equipped inverted echo sounder (PIES) moorings were acoustically downloaded, one new PIES mooring was deployed, and one prototype PIES-datapod system was also deployed. Additionally, three tall current meter/dynamic height moorings and one short bottom-pressure mooring were recovered and deployed.

The partnership between AOML and the University of Miami's Rosenstiel School has now resulted in more than 20 successful cruises since the year 2000, continuing a long history of fruitful collaboration between the two groups. The success of this cruise, together with a British cruise taking place later in October-November, will provide the data needed to extend the basinwide MOC dataset to 11.5 years.

These measurements are crucial for the study of the climate system and the impact of the ocean on socially important quantities such as sea-level rise and fresh water management. Maintaining these long-term measurement projects remains a key task for the international scientific community.

Finally, in addition to providing crucial data for understanding the climate system, the data collected on these cruises represent crucial validation tools for improving state-of-the-art ocean and coupled climate model simulations.

The science team for the October 2015 MOCHA-WBTS cruise aboard the R/V *Endeavor.*

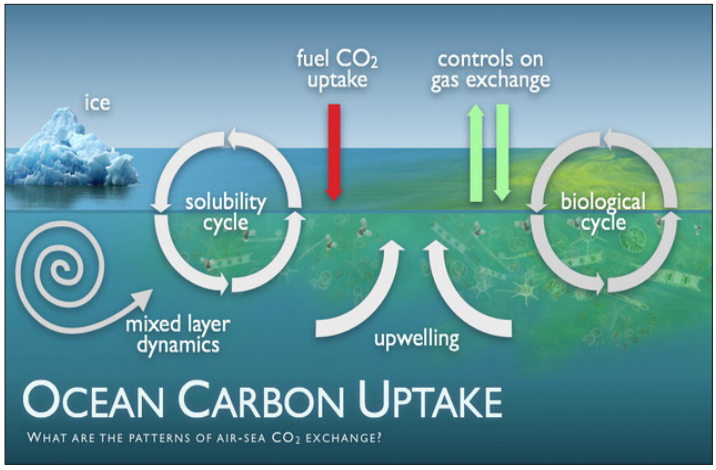
AOML Oceanographer Rik Wanninkhof Selected as Senior Technical Scientist

NOAA selected AOML oceanographer Dr. Rik Wanninkhof in October 2015 to become a Senior Technical Scientist, the highest attainable level for federal research scientists within NOAA. Rik is an internationally recognized authority on air-sea gas transfer with close to 25 years of experience studying the effects of atmospheric carbon dioxide (CO_2) on the ocean. Senior Technical Scientist positions are held by individuals who achieve national and/or international distinction in their field through their high-level research.

Rik began his career at AOML in 1991 as an oceanographer with the Ocean Chemistry and Ecosystems Division (OCED). Since then he has conducted research on the inorganic carbon cycle, focusing on the uptake of anthropogenic CO_2 by the oceans and the effects of increasing CO_2 levels on ocean biogeochemical cycles and ecology. Much of this research has involved decadal resampling of hydrographic sections throughout the global ocean to quantify changes in the storage and transport of CO_2, nutrients, fresh water, and heat. He currently leads OCED's Ocean Carbon Group, which researches the transport and transformation of carbon in the ocean.

As a principal investigator, Rik's work has stimulated the development of entirely new field techniques for quantifying air-sea gas transfer velocity, as well as multi-investigator, international field experiments to test and apply these methods in different oceanic environments. He co-led the development of the global surface ocean observing system for the partial pressure of CO_2 (pCO_2) within NOAA, and his Ocean Carbon Group has been one of the most important contributors to the global pCO_2 databases.

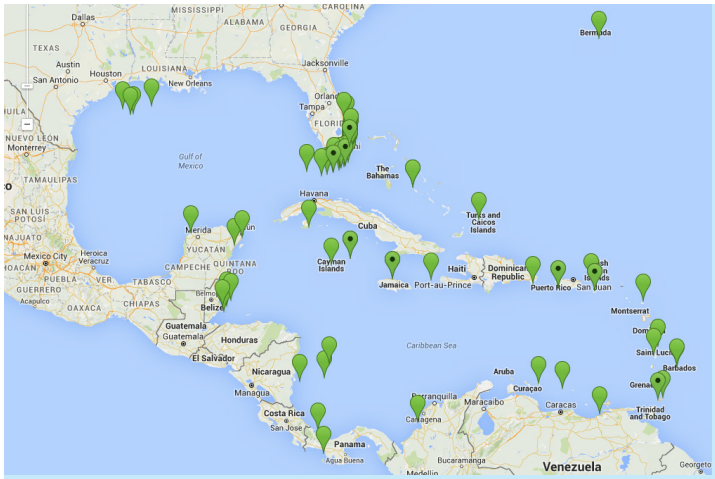
During his years at AOML, Rik has been the recipient of a number of accolades and honors including the John Martin Award from the American Society of Limnology and Oceanography, Gold and Silver Medals from the Department of Commerce, a NOAA Administrator's Award, and several outstanding scientific paper awards from NOAA's Office of Oceanic and Atmospheric Research. In recognition of his exceptional scientific contributions, he was elected a Fellow of the American Geophysical Union in 2009.



Patterns of air-sea carbon dioxide exchange are the focus of AOML's Ocean Carbon Group, led by Dr. Rik Wanninkhof.

Rik holds a PhD from Columbia University, awarded in 1986, and has published more than 200 papers related to the oceanic carbon cycle and air-sea gas exchange.

The Senior Technical Science position recognizes Rik's exceptional understanding of atmospheric and oceanic science; expertise in biogeochemistry, physics, and their linkages; translation of scientific information into decision-support applications; and development of ideas for innovative and transformational science in support of NOAA's mission. These capabilities allow Rik to effectively communicate NOAA's scientific excellence to the outside world.



AOML's Coral Health and Monitoring Program (CHAMP) rolled out a new data source in October as part of its online data query tool. Optimally Interpolated Sea Surface Temperatures, or OISSTs, are data from microwave satellite observation platforms, products that are sourced from Remote Sensing Systems. Whereas other sea surface temperature sources might be missing data due to orbital gaps or non-ideal environmental conditions such as cloud cover or rainfall, the OISST platform corrects for these errors to provide a complete, daily sea surface temperature map that can benefit coral health and monitoring efforts worldwide.

The new data source is loaded from OISST files dating back to January 1, 1998 through the present day. These Remote Sensing Systems data are distinct from longer-term climate data records in that they represent "foundation sea temperature" estimates. These estimates use a one-dimensional model to calculate daytime warming for each region, represented by a pixel in the global dataset, based on local conditions of wind and light penetration. In well-sampled regions this may not impact the final product, but the data sources used in most analyses have large regions where few satellite retrievals exist each month due to persistent cloud cover, making the daytime satellite retrievals of the OISST extremely valuable.

Prior to the integration of the OISST data, the CHAMP portal included 54 sites, 14 of which reported data from on-site instrumentation and the rest of which were termed "virtual stations." Virtual stations are locations of interest throughout the world's coral habitats for which remotely-sensed data products are available. Often, these locations are selected to be virtual forerunners of on-site observation platforms to be deployed at a later date. Integration of the Remote Sensing Systems' OISST data has enabled AOML to add an additional 92 virtual stations for a current total of 146 sites, nearly tripling the amount of coverage across the world's coral habitats.

The CHAMP Portal is a query tool for accessing oceanographic and meteoro- logical data from the CHAMP database, developed by researchers at AOML. New data are loaded into the CHAMP portal's database in near-real time and often available for query within a few minutes of collection, thanks to the immediate and constant access by CHAMP servers to station dataloggers. The CHAMP portal can be accessed at http://www.coral.noaa.gov/champportal/.

Participants of the 31st session of the Data Buoy Cooperation Panel held in Geneva, Switzerland on October 19-23, 2015.

Dr. Rick Lumpkin, Mayra Pazos, Erik Valdes, and Shaun Dolk, all with AOML's Physical Oceanography Division, attended the 31st session of the Data Buoy Cooperation Panel (DBCP) in Geneva, Switzerland, on October 19-23, 2015.

Rick co-chaired the US delegation and the Instruments Best Practice Task Team and presented the Global Drifter Program Report and Tropical Moored Buoy Arrays Report. Mayra chaired the Task Team on Data Management and served as technical coordinator of the International South Atlantic Buoy Program (ISABP). She also presented the report of its activities. Shaun chaired the Buoy Program for the Indian Ocean Action Group and was technical coordinator for the North Pacific Group.

Rick, Erik, and Shaun also gave talks during the Scientific and Technical Workshop on the first day of the meeting. Erik's presentation compared the performance of buoys from different manufacturers; afterward, participants representing those manufacturers approached him with questions that will enable them to improve faults identified in his talk.

During the general meeting, updates of buoy activities were presented by many critical drifter program partners. The AOML drifter team's participation allowed them to consider each member's expertise (science, procurement, ship opportunities, quality control, data management, etc). Many discussions were furthered during coffee and lunch breaks, including a critical annual face-to-face meeting with the Scripps four-person component of the Global Drifter Program covering topics ranging from Iridium data, metadata, and Global Telecommunications System (GTS) actions, to better coordination of deployment opportunities.

Erik and Mayra also had side meetings with Mathieu Ouellet (MEDS, Canada) on data exchange and with Ross Bannister (New Zealand) for one-to-one training on how to check data and track drifters. Ross became AOML's primary drifter contact in New Zealand with little training after his predecessor, Julie Fletcher, passed away suddenly, a loss still mourned in the drifter community.

For several years, the ISABP was semi-dormant, with only Mayra (as technical coordinator) representing the group. At last year's DBCP meeting, a new chair, Luis Santos (Brazil), was elected. Mayra called for a side meeting of the ISABP to be officially included in the DBCP-31 agenda. This side meeting was held with several participants. The ISABP is now revamping the program's web page and promoting involvement from other countries, leveraged via Brazil's presence and involvement.

AOML Holiday Party

Friday, December 11th

Lobby—12 Noon – 2 pm

$10.00 per person

(includes turkey, mashed potatoes, side dishes, and more)

Bring a dish or dessert to share

Raffle drawing and prizes

To register contact:
Ivan Castro—305-361-4420

A group of administrative officers from the National Weather Service (NWS) visited AOML on September 30th while in Miami to attend the annual Operations and Budget Management meeting. While at AOML, the group was given an informal tour of the facility and met with staff from AOML's Admin Office to discuss best practices, benchmarks, and new developments in operations. Staff from AOML's three science divisions met with the group during stops along the tour to share information about the lab's climate, ecosystems, and hurricane research. Thanks to all who welcomed the NWS group to AOML and made their visit a success.

NWS administrative officers listen as Dr. Gustavo Goni (right) explains how researchers use an array of ocean-observing instruments to gather data for climate forecast models and climate studies, as well as weather and marine forecasts.

On September 29th, researchers with AOML's Environmental Microbiology Laboratory, along with scientists from Florida International University's Southeast Environmental Research Center, collected water samples on Miami Beach during a king tide event, the highest astronomical tide of the year. Sample sites were located adjacent to pumps installed by the City of Miami Beach to actively pump super-tidal floodwaters out of the streets and back into Biscayne Bay. AOML's team continuously monitored and collected water samples over a 5-hour period at locations in Maurice Gibb Memorial Park, along 14th Street, and at 27th Street and Indian Creek Drive. During sampling, physical water properties such as temperature, salinity, pH, turbidity, and dissolved oxygen content were also measured.

Floodwaters cover portions of Indian Creek Drive on Miami Beach.

AOML researchers aboard the R/V *F.G. Walton Smith* conducted a bimonthly water quality cruise in support of AOML's South Florida Project (SFP) during the week of September 21st. The SFP has enabled scientists and resource managers to keep a watchful eye on the sensitive marine habitats found in the region and has served as a sentinel during periods when the ecosystem has been subjected to extreme events such as hurricanes, harmful algal blooms, and, more recently, potential oil spill contaminants. Researchers with the SFP have recently produced a comprehensive, long-term baseline regarding regional circulation, salinity, water quality, and biology for the ecosystem.

The R/V *F.G. Walton Smith* leaves Miami to monitor water quality in Florida Bay.

Staff with AOML's Hurricane Research Division (HRD) celebrated the last regularly scheduled tropical weather map discussion in support of HRD's Hurricane Field Program on Friday, October 16th. Everyone attending Aloha Friday, an HRD tradition, was encouraged to wear their most colorful Hawaiian garb. Garlands were provided, along with pineapple, pineapple juice, and other tropical treats. HRD hosted the daily tropical weather discussions throughout the summer, led by volunteer discussion leaders from the tropical meteorology science community.

Bidding aloha to HRD's daily tropical weather discussions: Xuejin Zhang, John Gamache, Brian McNoldy, Peter Dodge, Lisa Bucci, Paul Reasor, Robert Rogers, Kelly Ryan, Bachir Annane, Brittany Dahl, Kathryn Sellwood, Eric Uhlhorn, Gus Alaka, Stanley Goldenberg, Frank Marks, and Howard Friedman.

Farewell

Dr. George Soukup, a physicist with AOML's Hurricane Research Division (HRD), retired in October after 30 years of Federal service. George began his career with HRD in 1985 after being hired to work with the late Dr. Katsuyuki (Vic) Ooyama on a new numerical model for hurricane forecasting.

He began work with Dr. Mark Powell in 1997 on the H*Wind project to improve the analysis of surface winds in tropical cyclones. George also helped design the surface wind model used as part of the Florida Public Hurricane Loss Model certified by the State of Florida in 2007.

Over the past few years, George worked with the H*Wind team to develop an improved surface wind analysis scheme that takes advantage of the hurricane's circular geometry and the tendency for a large majority of the azimuthal variance of the surface wind at each radius to be represented by the azimuthal mean and first wavenumber. A paper coauthored by George and Dr. Frank Marks of HRD that describes this new analysis approach is currently in review with the journal *Monthly Weather Review*.

AOML Mourns the Loss of Paul Willis

Paul Willis, a long-time employee of AOML's Hurricane Research Division (HRD), passed away on October 11, 2015 at the Cedar-Sinai Medical Center in Los Angeles, California, where he had been undergoing treatment for pancreatic cancer.

Paul was a cloud physics scientist who specialized in tropical rainfall. He began his career with AOML's Hurricane Research Division as a Federal employee in the early 1970s when the division was still a separate entity from AOML known as the National Hurricane and Experimental Laboratory.

In the summer of 1974, Paul participated in one of the first international efforts to better understand how tropical waves drifting off the west coast of Africa developed into Cape Verde hurricanes. The landmark study, known as the GARP (Global Atmospheric Research Project) Atlantic Tropical Experiment (GATE), brought together scientists from 20 nations, and datasets from the massive experiment are still being used to better understand how the tropical Atlantic is impacted by global climate.

Over the years, Paul participated in other critical studies, including the Florida Area Cumulus Experiment (FACE) and the Tropical Ocean Global Atmosphere Program's Coupled Ocean Atmosphere Response Experiment (TOGA-COARE). He also flew through countless tropical storms and hurricanes aboard C-130 and WP-3D hurricane hunter aircraft in support of HRD's annual Hurricane Field Program.

Paul retired from federal service in 1994 but continued his support for HRD as a research associate with the University of Miami's Cooperative Institute for Marine and Atmospheric Studies (CIMAS). After almost 20 years with CIMAS, he retired (for a second time) in 2014.

On October 27th, Paul's HRD colleagues honored him during a PurpleLight gathering on Miami Beach sponsored by the Pancreatic Cancer Action Network. The event brought together survivors, family, and friends affected by pancreatic cancer.

Paul enjoyed photography, was an avid cyclist, and loved to travel. He is survived by his wife Marie, a son and daughter, and two grandchildren.

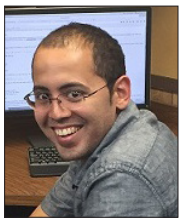
Congratulations

Gustavo Goni, director of AOML's Physical Oceanography Division, accepted an invitation by the American Meteorological Society in September to become an editor of the *Journal of Oceanic and Atmospheric Technology*. Gustavo will serve a 3-year term reviewing manuscripts submitted for publication that describe instruments and methodologies used in atmospheric and oceanic research.

Shaun Dolk, a Cooperative Institute research associate with AOML's Physical Oceanography Division, earned his Master of Professional Science (MPS) degree in Weather, Climate, and Society from the University of Miami's Rosenstiel School in August. Shaun successfully defended his thesis entitled *Projecting oil dispersion in the Gulf of Mexico, Straits of Florida, and Caribbean using climatological data from drifting buoys and surface winds.*

Welcome Aboard

Dr. Lidia Cucurull, chief of the Global Observing Systems Analysis Group at NOAA's Earth System Research Laboratory in Boulder, Colorado, joined AOML's Office of the Director in September. Lidia will share her time between ESRL's Global Systems Division and AOML on research dedicated to improving the forecast skill of NOAA's numerical weather prediction models. A major component of this research involves conducting Observing System Experiments and Observing System Simulation Experiments in support of the Quantitative Observing System Assessment Program led by AOML director Dr. Bob Atlas. Lidia holds a PhD in atmospheric sciences from the University of Barcelona.



Patrick Halsall joined AOML's Physical Oceanography Division in September as a research associate with the University of Miami's Cooperative Institute for Marine and Atmospheric Studies. Patrick will work with researchers on the XBT (expendable bathythermograph) network project, where he will manage, quality control, and distribute XBT data. He holds a BS degree in information technology from Florida International University and has experience in software development, database management, and web applications.

Charline Quenee joined AOML's Ocean Chemistry and Ecosystems Division in September as a research associate with the University of Miami's Cooperative Institute for Marine and Atmospheric Studies. Charline will work with the Ecosystem Assessment and Modeling group to assist with field activities and to examine the relationships between ecosystem status and ecosystem services. She holds a BS degree in marine science and biology from the University of Miami with minors in marine policy, chemistry, and anthropology.

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4301 Rickenbacker Causeway
Miami, FL 33149
www.aoml.noaa.gov

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Keynotes publishing editor: Gail Derr

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

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