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AOML Keynotes

ATLANTIC OCEANOGRAPHIC AND METEOROLOGICAL LABORATORY

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

Cracking the Code of a Long-Distance Swimmer

Research sheds light on eel migration from the subtropics to European rivers

Born in the Sargasso Sea, that Atlantic Ocean gyre east of Bermuda, baby European eels will travel 4,000 miles to the freshwater rivers of Europe. Now scientists might have answered a century-old question of how these young eels accomplish such vast oceanic migrations: they use a GPS, but not like the one in your car or smartphone.

European eels have a sort of internal GPS or global positioning system tuned to the Earth's magnetic field, according to research appearing in the journal *Current Biology*.*

"With this study, we show for the first time how eels actually use Earth's magnetic field as a map to orient themselves during their long ocean journeys," said Dr. Nathan Putman, co-first author and scientist with AOML's Physical Oceanography Division and the University of Miami's Cooperative Institute for Marine and Atmospheric Studies.

The findings may help improve management of this commercially and culturally important species of eel, as well as similar species, such as the American and Japanese eel. All of these eel populations are considered depleted due to fishing pressure, loss of habitat because of dams that block their passage, pollution, and changes in ocean conditions.

Dr. Putman and an international team of scientists tested the European eels' mapping skills in a laboratory by exposing juveniles—known as elvers—to a series of magnetic fields that mirrored the various magnetic conditions found along the eels' migration route. They found that the eels' orientation differed depending upon the magnetic conditions but, in each case, they headed into what would have been the Gulf Stream—a powerful current that is thought to propel young eels from the Sargasso Sea toward Europe.

A scientist holds juvenile American eels. Almost indistinguishable from the European eel, the American eel is also born in the Sargasso Sea. It makes a similar long-distance migration to North American freshwater rivers. Researchers of the new study on European eels theorize the American eel might also tune into the magnetic field to assist its migration.

European, Japanese, and American eels have been fished for centuries to support valuable commercial, recreational, and subsistence fisheries. Juvenile eels just entering freshwater can fetch staggering prices—in some years more than $2,000 per pound for eels caught in Maine. In 2014, total U.S. commercial eel landings were valued at approximately $9.8 million.

Dr. Putman's earlier research has shown many marine animals, such as Pacific salmon and sea turtles, also use Earth's magnetic field as a large-scale map. By learning what environmental cues animals use to guide their movements, scientists can better predict changes in their migratory routes and distribution.

Additional research is likely to also contribute to better management of other valuable fisheries for migratory species such as tunas, sailfish, swordfish, and sharks.

In April, Dr. Putman made an invited presentation about this research at the European Brain Research Institute in Rome, Italy as part of a distinguished panel of navigation experts that included Edvard Moser, the 2014 Nobel Laureate, and Wolfgang Wiltschko, who in 1965 discovered the magnetic sense in animals.

This article is adapted from a NOAA news feature by Monica Allen.

*Naisbett-Jones, L.C., N.F. Putman, J.F. Stephenson, S. Ladak, and K.A. Young, 2017: A magnetic map leads juvenile European eels to the Gulf Stream. *Current Biology,* 27(8):1236-1240, doi:10.1016/j.cub.2017.03.015.

Galapagos Islands: A Telling Study Site for Coral Reef Scientists

AOML coral scientists recently traveled to the Galapagos Islands to document coral reef health following the 2016-17 El Niño-Southern Oscillation event (ENSO), which bathed the region in abnormally warm waters. Historically, these events have triggered coral bleaching and large-scale mortality, as observed in response to ENSO events of 1982-83 and 1997-98. Interestingly, these same reefs exhibited minimal bleaching in response to this most recent event. Scientists are determining whether this response is due to differing levels of heat stress or an increased tolerance to warm water in the remnant coral communities.

"We are hoping to find evidence of increased heat tolerance, which would be a positive step forward for coral ecosystems facing increased stress from warmer waters globally," said Dr. Ian Enochs, an AOML coral ecologist.

The economic value of increasing reef resistance to global stressors is important to consider. Enochs and colleagues will compare results from the Galapagos to coral ecosystem studies in the Florida Keys, where coral reefs are the foundation of a $2.3 billion economy that supports more than 33,000 jobs.

There is a natural carbon dioxide (CO_2) gradient between the northern and southern islands of the Galapagos, created as a result of coastal upwelling in the southern islands. Upwelling is caused when surface waters are displaced offshore and replaced by deeper, colder waters rich in CO_2 and nutrients. Higher concentrations of CO_2 lower seawater pH and lead to more acidic conditions. This depressed pH, combined with mass coral die off as a result of past ENSO events, has led to a disappearance of reefs in the southern islands. The persistence of reefs differs across the CO_2 gradient, such that the reefs in the northern islands have been able to recover from ENSO-related warming, partly due to environmental conditions more favorable for coral growth. This unique, natural acidification gradient, combined with periodic ENSO warming events, makes the Galapagos an ideal site for comparative studies to determine the potential response of coral reefs to future ocean warming and acidification projections.

AOML scientists have published previous studies demonstrating slower coral calcification rates in the southern Galapagos islands in response to increased acidification; however, this most recent trip was an opportunity for a two-fold continuation study focused on the impacts of ocean acidification on both the ability of corals to calcify or build their skeleton and rates of bioerosion. Bioerosion is caused by the activities of aquatic plants and animals who bore into and erode the coral skeleton for a variety of reasons, including food and habitat provisioning.

School of scalloped hammerhead sharks encountered by scientists during the research dives. Other species of sharks, pods of dolphins, manta rays, and curious moray eels were also present.

Surveys in this region have indicated that ocean acidification may also increase rates of bioerosion. NOAA scientists collected several coral cores during this most recent research cruise, which are currently being analyzed to quantify the rates of both coral growth and bioerosion. Corals, much like trees, have banded growth rings, which can be used to determine growth rates, while bioerosion can be quantified by looking at how much of the cores have been eaten away. This is the first time internal bioerosion will be directly measured at this site.

The implications of these findings will be helpful in determining the response of coral growth rates and bioerosion rates under predicted increases in both sea surface temperature and ocean acidification. The research was co-funded by the National Science Foundation, National Geographic, and NOAA's Coral Reef Conservation Program. AOML scientists worked with colleagues from the University of California, Columbia University, the University of Miami, and the University of the Virgin Islands.

AOML coral ecologist Ian Enochs obtains a coral core sample to quantify the rates of both coral growth and bioerosion.

University of Miami-Rosenstiel School doctoral student Ana Palacio observes a passing hammerhead shark.

Underwater Glider Data Improved Intensity Forecasts of Hurricane Gonzalo

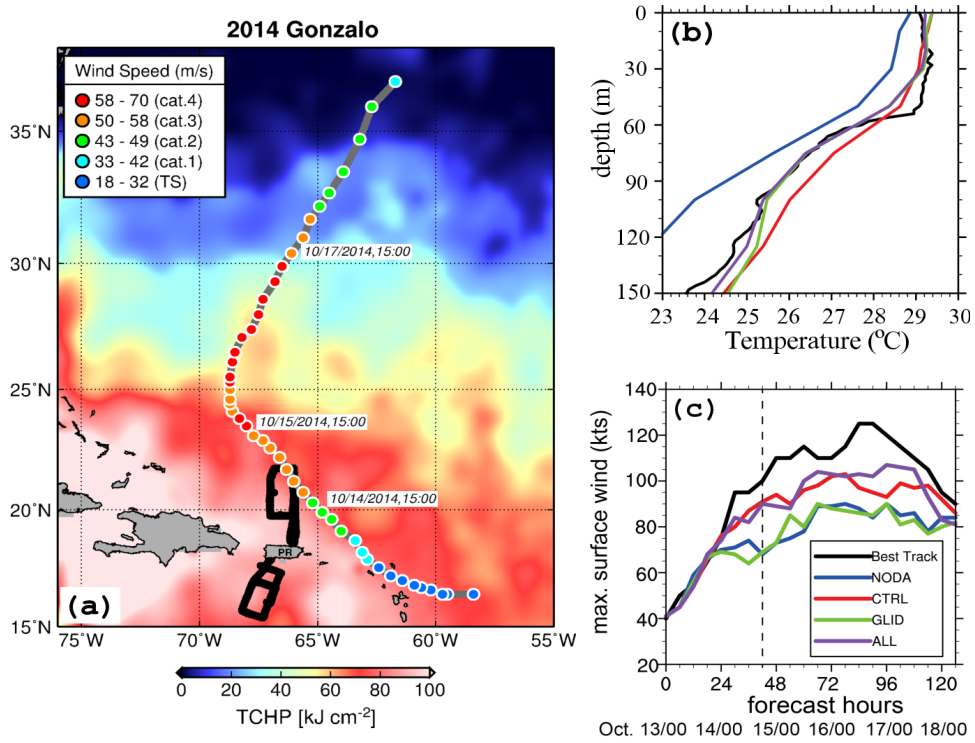
In a recent study published in *Weather and Forecasting,** AOML researchers and their colleagues used NOAA's HWRF-HYCOM operational hurricane forecast model to quantify the impact of assimilating underwater glider data and other ocean observations into the intensity forecasts of Hurricane Gonzalo (2014). Gonzalo formed in the tropical North Atlantic east of the Lesser Antilles on October 12, 2014 (panel *a* at right). On October 14, Gonzalo traveled northeast of Puerto Rico to within 85 km of an underwater glider.

In their previous study of Hurricane Gonzalo (Domingues *et al.,* 2015), the team reported that ocean conditions were characterized by the presence of a layer of low salinity close to the surface, which caused strong vertical density gradients. This near-surface layer, often called a barrier layer by oceanographers, may have likely contributed to the further intensification of Hurricane Gonzalo. Gonzalo reached Category-4 hurricane status on October 15, 2014, making it the most intense Atlantic hurricane during 2011-2014.

For the current study, it was found that the barrier layer observed prior to the passage of Hurricane Gonzalo and its associated sharp density gradients were only successfully represented in the ocean initial conditions with the inclusion of underwater glider data.

An analysis of the observations gathered during Gonzalo's passage revealed that the ocean was better represented in the operational model with the assimilation of underwater glider data. Results show that the pre-storm thermal (panel *b*) and saline structures of the upper ocean, used as initial conditions for the hurricane forecasts, were substantially improved when compared to numerical experiments that did not include underwater glider data and other ocean observations.

A NOAA/AOML-CARICOOS underwater glider ready for deployment in the Caribbean Sea. The gliders are remotely operated and navigate under harsh ocean conditions, including hurricane-force winds.



(*a*) Track of Hurricane Gonzalo overlaid on a tropical cyclone heat potential map for October 10, 2014. (*b*) Temperature profile (black line) at the location of the glider on October 13, 2014 (00:00 GMT) before the passage of Gonzalo for the simulations developed in the study (colored lines) compared with the observations (black line). (*c*) Maximum wind forecasts, along with the best track for the different numerical experiments, compared with the observed best track data (black line) made available by NOAA's National Hurricane Center. Numerical experiments were developed with no assimilation of ocean observations (NODA), assimilation of all ocean observations excluding gliders (CTRL), assimilation of underwater glider data only (GLID), and assimilation of all ocean observations available (ALL). Panels (b) and (c) are adapted from Dong *et al.,* 2017.

Results from the coupled model simulations developed for Hurricane Gonzalo showed that the largest improvement in hurricane intensity forecasts occurred when all upper-ocean observations were assimilated into the ocean component of the model (panel *c*). The assimilation of ocean observations and underwater glider data reduced intensity forecasts errors by as much as 50% when compared to experiments that did not include ocean observations.

This work represents the first study of its kind to quantify the impact of assimilating underwater glider data and other ocean observations into NOAA's ocean-atmosphere coupled operational model.

AOML scientists and their colleagues with the Caribbean Coastal Ocean Observing System (CARICOOS) and the National Data Buoy Center (NOAA/NDBC) implemented the NOAA/AOML-CARICOOS Hurricane Underwater Glider network in 2014 to improve observational coverage of the ocean in areas where hurricanes commonly travel and intensify. The remotely operated gliders collect targeted and sustained ocean measurements.

The Hurricane Underwater Glider network will collect ocean observations during the upcoming 2017 Atlantic hurricane season as part of NOAA's Hurricane Field Program. The effort has already gathered and distributed large, unique datasets of upper-ocean observations in real-time from the Caribbean and tropical North Atlantic. To date, the gliders have produced more than 14,000 profiles from these regions of parameters that include temperature, salinity, dissolved oxygen, chlorophyll-*a*, and backscatter.

More information about the NOAA/AOML-CARICOOS glider project can be found at http://www.aoml.noaa.gov/phod/goos/gliders/index.php.

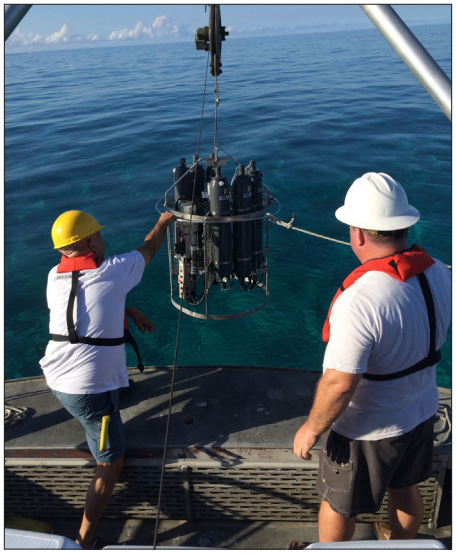
*Dong, J., R. Domingues, G. Goni, G. Halliwell, H.-S. Kim, S.-K. Lee, M. Mehari, F. Bringas, J. Morell, and L. Pomales, 2017: Impact of assimilating underwater glider data on Hurricane Gonzalo (2014) forecast. *Weather and Forecasting,* doi:10.1175/WAF-D-16-0182.1.

Coastal Ocean Pathogens Impact South Florida's Coral Reefs

A variety of land-based pollutants, among them sewage, pesticides, pharmaceuticals, and nutrients, regularly pass into the ocean, with concerns that this may compromise water quality and endanger coral reefs. A new study by AOML scientists and their colleagues suggests that land-based pollutants released into the ocean can reach southeast Florida's coral reefs and influence the microbes found in the water and in the corals themselves. The research, published in *Applied and Environmental Microbiology*,* reveals that coastal inlets and ocean outfalls that transport treated wastewater convey contaminants to reefs offshore of Miami-Dade and Broward counties.

A study team of researchers from AOML, the University of Miami, and University of Minnesota used next-generation DNA sequencing to characterize the microbial communities of potential contaminant sources, namely, coastal inlets and wastewater ocean outfalls. The genetic signatures from these sources were compared to those of microbial communities of coral reef waters and tissue using specialized bioinformatic software. Analysis showed that land-based discharges influenced the microbiomes of reef communities and coastal receiving waters.

Coral reefs are unique, highly diverse ecosystems that play a crucial role in maintaining marine biodiversity, providing a habitat for an estimated one-quarter of all marine life. They also provide coastal protection and serve as a source of food and recreation for millions globally. Due to a host of environmental stressors, they face an uncertain future and are generally endangered.



Jack Stamates and Charles Featherstone of AOML deploy a CTD instrument with Niskin water sampling bottles to measure physical ocean parameters and collect water for nutrient, microbial, and metagenomic analyses.

NOAA Corps diver Ben VanDine collects a sample of coral tissue and mucus for genetic microbial source tracking and microbial community metagenomic analysis using a syringe biopsy method. This sampling technique does minimal damage to the coral and usually heals within a few weeks.

Over a 2-year period, water samples were regularly gathered from coastal inlets, ocean outfalls, and treated wastewater effluent, as well as from 16 coral reef sites in the study area. Coral polyp and mucus tissue samples were also gathered from two commonly-occurring reef species in the area—*Porites asteroids* (mustard hill coral) and *Siderastrea siderea* (starlet coral).

Previous studies have reported that wastewater discharge plumes from ocean outfalls generally rise to the sea surface where they dilute outward to within a few kilometers of the outfall site. The plumes typically disperse at the surface rather than descend towards the reefs. Through the genetic sequencing methods used in the study, however, the study team found that pathogens in treated wastewater did reach south Florida's offshore coral reefs.

The study results suggest that treated wastewater discharged from ocean outfalls had the greatest influence on the native microbial community structure of reef water and coral tissues as compared to the other input sources of microbial contaminants investigated. Microbes in coastal inlet waters also appeared to reach and impact coral reefs.

Municipal treatment plants chemically disinfect wastewater effluent prior to its discharge to kill or render dormant a variety of pathogenic microorganisms that may be found in sewage. However, many types of bacteria can take up and use DNA from other bacteria in the environment, even if the donor bacteria are no longer alive. In spite of wastewater treatment protocols, a large enough output of genetic material survives to impact the community structure of reef microbiota.

"Microbial contaminants from land-based sources of pollution pose a major threat to coral reef ecosystems," said Dr Chris Sinigalliano, a microbiologist with AOML's Ocean Chemistry and Ecosystems Division and study coauthor. "Our study was undertaken to better assess the microbial loading of such contaminants on the coastal waters of coral reefs, as well as develop cost-effective mitigation strategies."

This genomic-based research sheds light on how microbial communities from land-based pollution sources impact coral reefs in southeast Florida, as well as how native coral populations may be reacting to land-based pollution exposure. It also contributes to the development of new methods for measuring and tracking microbial pollution in coastal ecosystems. Additionally, the research will help guide contaminant mitigation and ecosystem management efforts.

Funding for the study was provided by NOAA's Coral Reef Conservation Program.

*Staley, C., T. Kaiser, M.L. Gidley, I.C. Enochs, P.R. Jones, K.D. Goodwin, C.D. Sinigalliano, M.J. Sadowsky, and C.L. Chun, 2017: A next-generation sequencing approach to characterize the impacts of land-based sources of pollution on the microbiota of southeast Florida coral reefs. *Applied and Environmental Microbiology,* 83(10):e03378-16, doi:10.1128/AEM.03378-16.

University of Miami CIMAS Contractor at AOML Awarded 2016 Denny Medal

Dr. Joaquin Trinanes, a University of Miami-Cooperative Institute for Marine and Atmospheric Studies contractor at AOML, is the recipient of a 2016 Denny Medal from the Institute of Marine Engineering, Science, and Technology (IMarEST). Dr. Trinanes received the award during a ceremony at IMarEST headquarters in London, England on March 27. The Denny Medal is bestowed annually to the authors of the best paper published over the course of a year in the *Journal of Operational Oceanography*.

Dr. Trinanes is the primary author of a paper that explored the potential sites for where Malaysian Airlines flight MH370 might have entered the ocean.* The aircraft went missing on March 8, 2014 during a flight from Kuala Lumpur, Malaysia, to Beijing, China with 239 people on board.

In July 2015, a wing flaperon that washed ashore along the coast of Reunion Island was confirmed as being from flight MH370. This single piece of debris provided the first evidence that the aircraft crashed in the Indian Ocean. Other pieces of debris linked to the aircraft have also since been found in the southwest Indian Ocean.

Dr. Trinanes and his coauthors analyzed the possible pathways to link the location of aircraft debris found in the southwest Indian Ocean with potential crash sites. The research team used data from NOAA's Global Drifter Program and the University of Hawaii's SCUD (Surface Currents from Diagnostic) model to track various pieces of aircraft debris backward in time, enabling them to identify areas with a higher and lower probability of being the crash site.

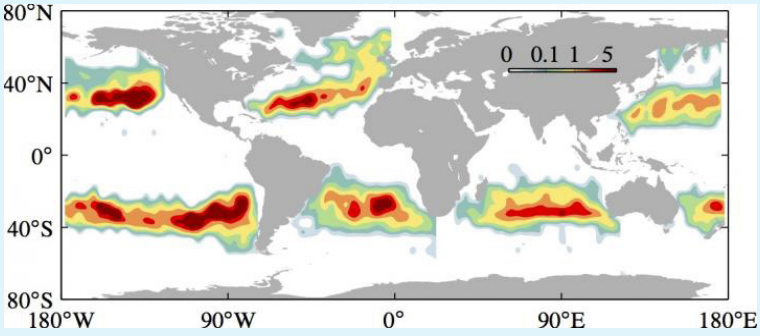
Dr. Joaquin Trinanes accepts a 2016 Denny Medal from Dr. Jane Smallman, the immediate past president of the Institute of Marine Engineering, Science, and Technology.

Their analysis indicated that the official search area in the southeastern Indian Ocean fell within a region of high probability as being the crash site. However, a large extension in the southeastern Indian Ocean south of 30°S and along the east coast of Australia was potentially the most probable site of the crash of flight MH370.

Subsequent discoveries of debris linked to flight MH370 that have been found along the coasts of Mozambique, South Africa, Mauritius, and Tanzania support the results presented in the study and confirm the general westward drift and travel time of debris from the search area.

Results of the study also include the development and implementation of a new methodology that can be used to assess the source of marine debris, potentially improving future search strategies and general debris tracking assessments.

*Trinanes, J.A., M.J. Olascoaga, G.J. Goni, N.A. Maximenko, D.A. Griffin, and J. Hafner, 2016: Analysis of flight MH370 potential debris trajectories using ocean observations and numerical model results. *Journal of Operational Oceanography*, 9(2):126-138, doi:10.1080/1755876X.2016.1248149.



Researchers found that undrogued (i.e., unanchored) satellite-tracked drifting buoys accumulated in the world's five oceanic subtropical gyres (orange and red tones) in much the same manner as plastic debris.

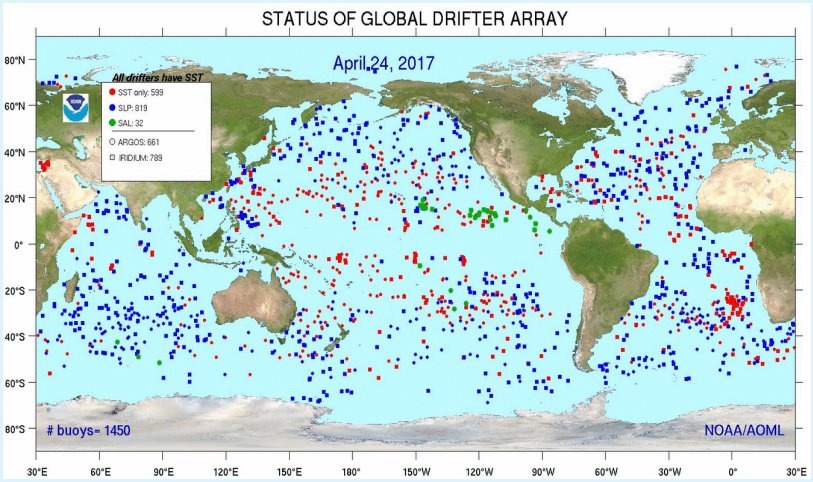
*Beron-Vera, F.J., M.J. Olascoaga, and R. Lumpkin, 2016: Inertia-induced accumulation of flotsam in the subtropical gyres. *Geophysical Research Letters,* 43(23):12,228-12,233, doi:10.1002/2016GL071443.

Research Hints at How Marine Debris Accumulates in the Ocean

AOML oceanographer Rick Lumpkin, along with researchers from the University of Miami's Rosenstiel School, have developed a model that simulates the trajectory of floating marine debris at the ocean surface. The team compared the model's simulated results against a 20+ year database of satellite-tracked surface drifting buoys from NOAA's Global Drifter Program.* They found that undrogued or unanchored (i.e., with lost sea anchor) buoys accumulated in the world's five oceanic subtropical gyres in much the same manner as plastic debris, shedding light on how floatsam accumulates into massive garbage patches in the ocean. The speed at which the undrogued buoys accumulated in the gyres precluded attributing the effect to wind-driven currents alone. Instead, the study atrributes the accumulation to finite-size and buoyancy (i.e., inertial) effects on the motion of the undrogued drifters exposed to ocean currents and wind drags. The authors infer marine plastic debris and flotsam are similarly impacted.

Global Drifter Program Marks Iridium Milestone

On March 13, the Global Drifter Program (GDP) at AOML marked a milestone in its transition from Service Argos to Iridium for its array of surface drifting buoys: more than 50% of the array is now being tracked with the Iridium satellite system. The Iridium transition plan, announced by GDP principal investigators Rick Lumpkin (AOML) and Luca Centurioni (Scripps Institution of Oceanography) in November 2014, aims for the array to be 80% Iridium by mid-2019. Meeting this milestone will result in substantial cost savings for NOAA and faster access to data worldwide. Surface drifting buoys measure sea surface temperature and near-surface currents. The data are used in weather forecasts, seasonal to interannual climate predictions, and climate research.



Map of the global drifter array on April 24, 2017.

PIRATA/AEROSE Cruise Surveys the Tropical Atlantic

Scientists with AOML's Physical Oceanography Division participated in the 2017 Prediction and Research Moored Array in the Atlantic (PIRATA) Northeast Extension/ Saharan Dust AERosols and Ocean Science Expeditions (AEROSE) cruise aboard the NOAA Ship *Ronald H. Brown* from February 19-March 25. During the 35 day, nearly 7,500 nautical mile journey from Montevideo, Uruguay to Charleston, South Carolina, the science team measured the upper ocean and near-surface atmosphere of the tropical Atlantic. The region is known for its strong climate variations and the generation of Atlantic hurricanes, with impacts on rainfall rates and storm strikes for the surrounding continents of Africa and the Americas. PIRATA is supported by Brazil, France, and the US. AEROSE is an internationally recognized series of field campaigns led by scientists at Howard University and NOAA to explore African air mass outflows and their impacts on climate, weather, and environmental health.

Scientists prepare a conductivity-temperature-depth frame to measure water properties.

Researchers Deploy Surface Drifters at Gulf of Mexico Oil Leak Site

In April, scientists from Water Mapping LLC, AOML/Cooperative Institute for Marine and Atmospheric Studies (CIMAS), and the University of Miami conducted a field experiment at the Taylor Energy oil leak site approximately 12 miles off the Mississippi Delta. The scientists deployed several types of drifting buoys to test their ability to follow oil at the ocean surface under the influence of river waters. The Taylor Energy oil leak occurred in 2004 after the destruction of a rig by Hurricane Ivan. Since then, small quantities of oil have consistently spread at the surface of the Gulf. The experiment was undertaken in support of the Gulf of Mexico Research Initiative project entitled *Influence of river induced fronts on hydrocarbon transport*, in collaboration with the CARTHE Consortium.

Dr. Matthieu Le Hénaff of AOML/CIMAS deploys a drifter in thin oil.

Local AMS Chapter Meets at AOML

The Great Miami Chapter of the American Meteorological Society hosted a meeting at AOML on April 26. There were 37 members and guests at the event, including a large contingent from AOML's Hurricane Research Division (HRD). Concurrent with the event was a display of research posters in the AOML lobby from recent meteorological meetings to familiarize guests with AOML's hurricane research. The lecturer/speaker for the meeting was HRD director Dr. Frank Marks, who gave a presentation entitled *Landfalling Tropical Cyclone Rainfall Distributions.*

Participants of the AMS meeting at AOML.

Members of the NASA-NOAA Working Group for Space-based Lidar Winds in Newport News, Virginia.

Science Team Meets to Assess Space-Based Lidar Winds

AOML Director Dr. Bob Atlas attended a meeting of the NASA-NOAA Working Group for Space-based Lidar Winds in Newport News, Virginia on March 21-23. At the meeting, Bob presented an overview of NOAA's Quantitative Observing System Assessment Program (QOSAP) and reported on Observing System Simulation Experiments to evaluate the potential impact of Doppler lidar wind observations on numerical weather prediction.

Performance Measure Developed at AOML Transitions to Operational Use

In 2000, Congress authorized funding for the Comprehensive Everglades Restoration Plan (CERP) to "restore, preserve, and protect the south Florida ecosystem while providing for other water-related needs of the region, including water supply and flood protection." These "water-related needs" also included restoring freshwater flows to downstream estuaries.

This large scale restoration project served as the inspiration for researchers with AOML's Ocean Chemistry and Ecosystems Division to develop and implement a model that assesses the effects of Everglades Restoration efforts on south Florida's sport fish populations. Sport fish are an important part of the south Florida economy and ecology and are the species most often targeted by recreational fishers. The majority of south Florida sport fish species are dependent upon healthy estuaries with natural freshwater runoff.

The US Army Corps of Engineers and state agencies are using an AOML-developed model to predict how juvenile sport fish will respond to changes in their habitat during Everglades restoration efforts.

The model was used as part of the Central Everglades Planning Project (CEPP) to predict how proposed project configurations would affect juvenile sport fish habitat in Florida Bay (see http://www.saj.usace.army.mil/Missions/Environmental/Ecosystem-Restoration/Central-Everglades-Planning-Project/). It model performed well and enabled staff with the US Army Corps of Engineers and South Florida Water Management District to design the final project for CEPP.

As a result of the model's success, a performance measured developed by AOML scientists was approved in April by the US Army Corps of Engineers, South Florida Water Management District, and their partners for operational use. The performance measure will apply the same model to assess the extent to which the Everglades restoration efforts have succeeded in restoring estuarine sport fish habitat and evaluate how potential Everglades Restoration projects are likely to affect estuarine sport fish habitat.

Attendees of the IOC-IODE 24th Session held between March 28-31, 2017 in Kuala Lumpur, Malaysia.

NOAA-AOML Librarian Attends 24th Session of the IOC-IODE

In March, NOAA-AOML librarian Linda Pikula attended the 24th Session of the IOC (Intergovernmental Oceanographic Commission) Committee on International Oceanographic Data and Information Exchange (IODE) in Kuala Lumpur, Malaysia. Linda represented NOAA as the US National Coordinator for Information Management. She also served as a member of the Working Group on the Restructure of the IODE and as chairperson of the Group of Experts on Marine Information Management. The IODE program was established by UNESCO (United Nations Educational, Scientific, and Cultural Organization) in 1961 to enhance marine research by facilitating the exchange of oceanographic data and information between participating Member States and by meeting the needs of users for data and information products. The IODE network has collected, quality controlled, and archived millions of ocean observations and makes these data available to Member States. The 24th IODE Session was attended by 67 participants from 31 IOC Member States and five international organizations.

AOML Supports WFO-NHC Open House

On Saturday, March 18, AOML staff participated in an Open House event jointly hosted by the National Weather Service's Miami-South Florida Forecast Office and National Hurricane Center (NHC). The public was invited to tour the facility located on the grounds of Florida International University to learn how forecasters track and predict tropical weather systems. Visitors also had the chance to watch the launch of a weather balloon. Kathryn Sellwood, Neal Dorst, Marlos Goes, and Frank Marks of AOML manned a table that highlighted oceanographic and meteorological research at AOML that supports weather forecasts and NOAA's goal of building a weather-ready nation. Throughout the 4-hour event, they interacted with hundreds of people, many of them school-age children, explaining AOML's role in the sciences and the community.

Marlos Goes, Frank Marks, and Neal Dorst at the WFO-NHC open house.

AOML meteorologist Stanley Goldenberg mans the NOAA booth at the Youth Fair.

NOAA Shines at the Miami-Dade County Fair and Exposition

Volunteers from all of NOAA's Miami-based line offices took turns staffing a booth at the Miami-Dade County Fair and Exposition (aka "Youth Fair") in March-April to showcase NOAA and its positive impact on the south Florida community. The annual 3-week event draws massive crowds—more than half a million—many of whom pass by the NOAA booth. Employees from AOML's Hurricane Research Division, the Southeast Fisheries Science Center, Miami-South Florida Forecast Office, and the National Hurricane Center all contributed to speaking with the thousands of fair-goers on a variety topics such as hurricanes and hurricane preparedness, weather forecasts, coral reefs, marine mammals, sea turtles, sport fish, invasive and endangered marine species, habitat conservation, and more. The NOAA booth featured several large displays that highlighted the research and services of the different line offices, a special weather-themed photo-op, plus a robust assortment of posters, flyers, and pamphlets free for the taking.

Team NOAA Competes in Annual Miami Corporate Run

Team NOAA competed in the 2017 Mercedes-Benz 5K Corporate Run on April 27. This year's 12-member group was comprised of NOAA employees from the Miami-South Florida Forecast Office, National Hurricane Center, and AOML. The weather was warm and humid but failed to discourage a record crowd from showing up: more than 28,000 competitors from 846 local businesses, government agencies, and non-profits flocked to downtown Miami's Bayfront Park for the event. Overall, team member Greg Foltz (AOML) placed 163rd out of a field of 13,016 male competitors, while team member Lisa Bucci (AOML) placed 600th out of a field of 15,088 female competitors. Additionally, the coed team of Lisa Bucci-Laura Paulik-Greg Foltz-Dave Zelinsky placed first in the Government-State-Federal category and 21st out of a total of 192 coed teams. Besides the camaraderie of the team and a fun evening focused on health and wellness, the race also supported a worthy cause: a portion of the proceeds were donated to the United Way.

Members of Team NOAA before the start of the 2017 Miami Corporate Run.

Congratulations

Bradley Klotz, a University of Miami-Cooperative Institute for Marine and Atmospheric Studies scientist with AOML's Hurricane Research Division, earned a PhD in geosciences from Florida International University in March. Brad's dissertation, *Evaluation and predictability of observation-based surface wind asymmetric structure in tropical cyclones,* explored the changes in the tropical cyclone surface wind structure that occur in response to vertical wind shear and storm motion using a global satellite dataset. He also explained the differences in wind structure that occur during intensifying or weakening periods of the tropical cyclone life cycle and discussed the utility of his results, especially in the absence of aircraft data.

Renellys Perez, a University of Miami-Cooperative Institute for Marine and Atmospheric Studies scientist with AOML's Physical Oceanography Division, is the guest editor for the 2017 spring edition of the US CLIVAR *Variations* newsletter focused on observing the deep ocean. The *Variations* newsletter is written for the US CLIVAR community and offers the opportunity to showcase research, present interesting findings, and make a case for future research directions. The issue was released on April 26 and can be accessed at https://usclivar.org/.

NOAA Corps Officer LTJG Benjamin VanDine received a NOAA Corps Achievement Medal in April for his "exemplary service and exceptional efforts" while serving as the Research Support Coordinator for AOML's Ocean Chemistry and Ecosystems Division. Ben routinely serves as a coxswain and diver for field projects in support of the Coral Health and Monitoring Program, as well as assists with ocean current surveys and water quality monitoring efforts. He also provides research and logistical support for AOML's Environmental Microbiology Laboratory. In addition to these duties, Ben supports AOML's Office of the Director with property audits and the maintenance of AOML's small fleet of government vehicles.

Welcome Aboard

Dr. Lidia Cucurull joined AOML's Hurricane Research Division in February to serve as the Deputy Director of NOAA's Quantitative Observing System Assessment Program (QOSAP) led by AOML director Dr. Bob Atlas. Lidia will focus on research to improve the forecast skill of NOAA's numerical weather prediction models through the assimilation of current and new global observing systems, including the use of radio occultation observations. A major component of this research involves conducting Observing System Experiments and Observing System Simulation Experiments in support of the QOSAP. As part of her duties, Lidia will continue to lead the Global Observing Systems Analysis Group at NOAA's Earth System Research Laboratory in Boulder, Colorado. She holds a PhD in physics, with a speciality in atmospheric sciences, from the University of Barcelona.

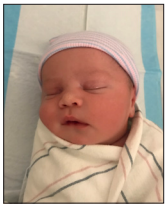
Dr. Alexandra Gronholz joined the staff of AOML's Physical Oceanography Division in April as a post-doctoral scientist with the University of Miami's Cooperative Institute for Marine and Atmospheric Studies. Alexandra will conduct research to study the variability of the meridional overturning circulation in the South Atlantic and its link to eddy processes. Her research will directly contribute to NOAA's long-term goal of improving the scientific understanding of the changing climate system and its impacts. She recently earned her PhD from the University of Bremen in Bremen, Germany.

Dr. Jonathan Poterjoy joined the staff of AOML's Hurricane Research Division in March as a National Research Council postdoctoral scientist. Jonathan will be working with several scientists within AOML on data assimilation, modeling, and observing-system design for tropical cyclones. In particular, his work focuses on the development and application of nonlinear Bayesian filtering approaches for data assimilation in high-dimensional geophysical systems. He holds a PhD in meteorology from Pennsylvania State University.

Sierra Sarkis joined the Office of the Director in March as the new communications intern at AOML. Sierra will be writing science summaries for the AOML web page and maintaining (and growing) the AOML Twitter account. She has conducted coral reef and sea grass field work in Belize and marine resource management in Turks and Caicos. Sierra earned her undergraduate degree in marine science at Boston University and is currently a graduate student at the University of Miami's Rosenstiel School in the Masters of Professional Studies program.

Ian Smith joined AOML's Ocean Chemistry and Ecosystems Division (OCED) in March as a new technician working through the University of Miami's Cooperative Institute for Marine and Atmospheric Studies. Ian is a graduate of the University of Washington's School of Oceanography. During the summer of 2016, he worked with Dr. Chris Kelble as a student intern who participated in field studies of Florida Bay. As an OCED technician, Ian will support research related to Florida Bay water quality, coral microbiome genetics, and juvenile fisheries ecology. He will also undergo training to analyze nutrient samples and will participate in the upcoming Gulf of Mexico Ecosystems and Carbon Cruise (GOMECC-3) this summer as a nutrient analyst.

Baby Makes Three



Ryan Smith, an oceanographer with AOML's Physical Oceanography Division, and his wife Simone are the proud parents of their first child, a daughter. Lucy Elaine Smith was born on April 6 and weighed in at 8 pounds, 10 ounces. Mom, Dad, and baby Lucy are all healthy, happy, and doing well.

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

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

Christiansen, F., **N.F. PUTMAN,** R. Farman, D.M. Parker, M.R. Rice, J.J. Polovina, G.H. Balazs, and G.C. Hays, 2016: Spatial variation in directional swimming enables juvenile sea turtles to reach and remain in productive waters. *Marine Ecology Progress Series,* 557: 247-259.

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