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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

Scientists Gather Data in Catastrophic Hurricane Dorian

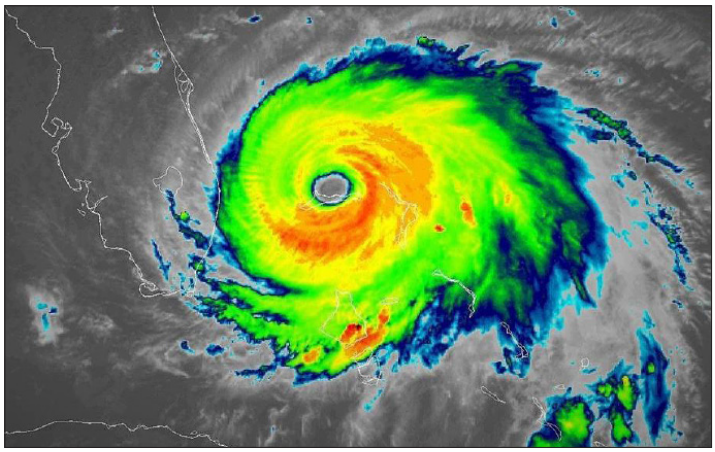
AOML's hurricane scientists began airborne missions into Hurricane Dorian in August to aid NOAA's efforts to prepare the public for severe weather. The catastrophic, Category-5 storm will long be remembered as one of the Atlantic basin's most powerful landfalling hurricanes. Dorian decimated the northwest Bahamas as it roared ashore on September 1, becoming the strongest hurricane to strike the island nation since records began in 1851.

Tropical Storm Dorian developed southeast of the Lesser Antilles on August 24. The poorly-organized system strengthened slowly on its path across the Caribbean Sea before moving into the western Atlantic, a more favorable region for development marked by low wind shear and warm ocean temperatures.

Airborne missions to sample Dorian began on August 26. Using instruments and technology aboard NOAA's Hurricane Hunter P-3 aircraft, AOML's hurricane scientists gathered observations from Dorian's inner core to assess changes in the storm's structure and intensity. Missions conducted by NOAA's Gulfstream-IV jet additionally sampled the regions above and around the periphery of Dorian to monitor how atmospheric steering currents impacted the storm's movement.

Tail Doppler radar enabled AOML's hurricane scientists to pinpoint Dorian's strongest winds, how far they extended outward, and the regions of heaviest rainfall. Dropsondes deployed along the flight track provided critical information about the atmosphere, generating vertical profiles of pressure, temperature, and humidity. These data, quality controlled aboard the P-3 and G-IV, were transmitted in real-time for assimilation into NOAA's Hurricane Weather Research and Forecasting model and used by the National Hurricane Center to generate up-to-date track and intensity forecasts.

View of Dorian's eyewall from aboard NOAA's P-3 Hurricane Hunter aircraft on September 1 as the Category-5 storm approached the northwest Bahamas.



NOAA GOES satellite image of Hurricane Dorian in the western Atlantic on September 3. Dorian stayed perched atop the northwest Bahamas for more than 48 hours after atmospheric steering currents became stationary, battering the Abaco Islands and Grand Bahama Island with devastating consequences.

Missions aboard the P-3 continued as Dorian made landfall over the Abaco Islands in the Bahamas, with several passes through the eyewall measuring peak sustained winds of 185 mph and gusts greater than 200 mph. After landfall along Grand Bahama Island, Dorian's forward speed slowed to a crawl before completely stalling due to a collapse of the steering currents.

For more than 48 hours the region was battered by Dorian's ferocious winds and a 20+ foot storm surge that caused severe widespread flooding. The catastrophic storm's extreme economic and human impacts to the Bahamas will be long lasting, as communities struggle to recover from the devastation and account for thousands of individuals still missing.

Missions ended on September 5 as Dorian gradually weakened and swept up the U.S. eastern seaboard, bringing blustery winds, rain, and flooding to communities from central Florida to the Carolinas. After passing over Cape Hatteras, Dorian headed out to sea, accelerating toward the Canadian Maritimes. The tenacious system made one last landfall near Halifax, Nova Scotia as a post-tropical storm before finally dissipating above the icy waters of the Labrador Sea.

During 15 P-3 missions conducted over an 11-day period—the most flown into a single storm since missions began in 1975—AOML's hurricane scientists measured Dorian's intensification from a weak tropical storm in the Caribbean to one of the Atlantic's fiercest hurricanes. The data they gathered were vital to protecting life and property, supporting NOAA's efforts to warn vulnerable communities of approaching severe weather through accurate forecasts.

NOAA Increases Chances for Above Normal Hurricane Activity in the Atlantic

"El Niño typically suppresses Atlantic hurricane activity but now that it's gone, we could see a busier season ahead. This evolution, combined with the more conducive conditions associated with the ongoing high-activity era for Atlantic hurricanes that began in 1995, increases the likelihood of above-normal activity this year."

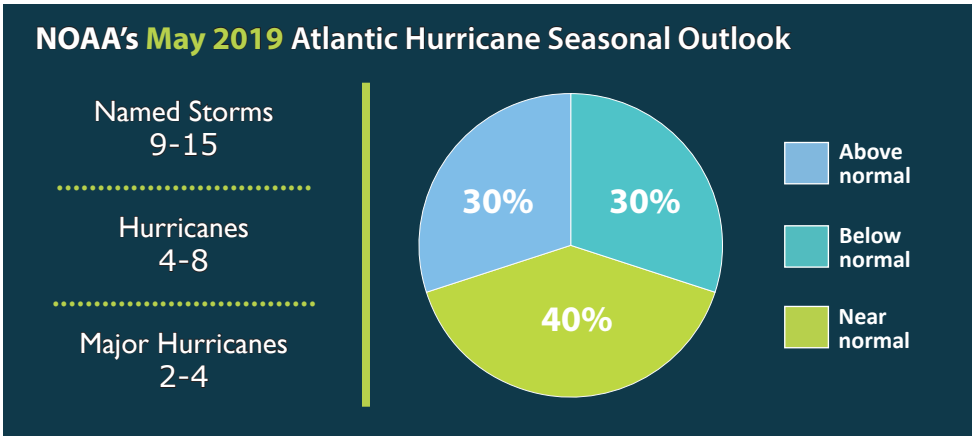
Dr. Gerry Bell, Lead Forecaster
NOAA-Climate Prediction Center

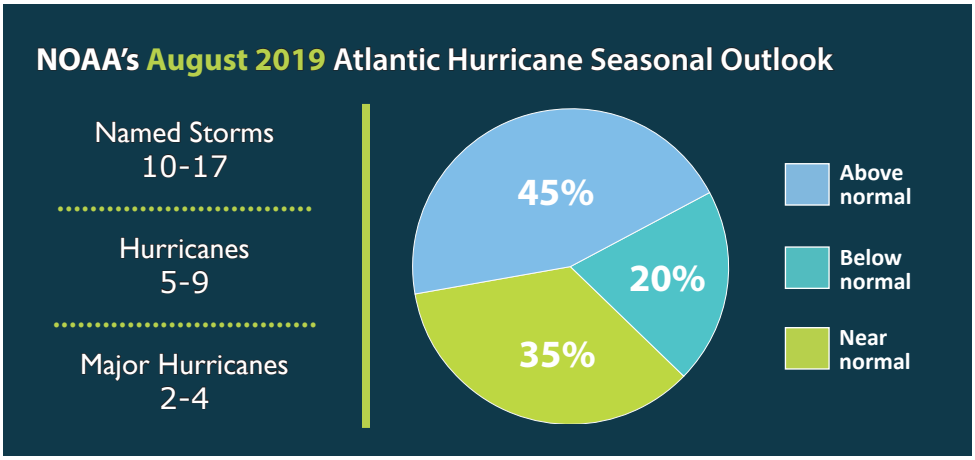
NOAA issued an updated hurricane outlook for the Atlantic basin on August 8, increasing the likelihood that the 2019 hurricane season, which officially ends November 30, will have above-normal overall activity.

As the Atlantic enters its climatological peak months for hurricane activity, i.e., August through October, NOAA's seasonal forecasters have determined that oceanic and atmospheric patterns are now more conducive for above-normal hurricane activity than expected when the May pre-seasonal hurricane outlook was issued.

In particular, the unpredicted ending of the 2018/2019 El Niño event prompted the forecasters to increase the probability of above-average activity. El Niño is a periodic weather phenomenon that warms sea surface temperatures across the tropical Pacific Ocean. It tends to suppress hurricane activity across the Atlantic by increasing wind shear.

NOAA has increased the likelihood to 45% for above-normal Atlantic hurricane season activity, up from only 30% in NOAA's May outlook (see graphics, above right). The likelihood of near-normal activity has decreased to 35% (down from 40%), while the chance of below-normal hurricane activity has decreased to only 20% (down from 30%).





The August seasonal outlook also slightly increases the number of storms expected to develop, now predicting 10-17 named storms (winds above 39 mph), with 5-9 of those reaching hurricane strength (winds of 74 mph or greater, and 2-4 hurricanes expected to strengthen into major hurricanes (winds of 111 mph or greater, i.e., categories 3-5).

This updated outlook is for the entire hurricane season, which began on June 1. On average, the Atlantic season produces 12 named storms, of which six become hurricanes with three reaching major hurricane strength.

NOAA's August seasonal outlook provides a general guide to the expected overall activity during hurricane season. It does not imply levels of storm activity for any particular region or predict how many storms will make landfall. Landfalls are largely determined by short-term weather patterns, which are only predictable within about a week of a storm potentially reaching a coastline.

It only takes one storm to devastate a community. Therefore, coastal communities that are potentially impacted by landfalling storms and flooding are urged to remain vigilant, have preparedness plans ready and in place should the need arise to activate them, and monitor the tropics by visiting www.hurricanes.gov, the official site for the National Hurricane Center.

NOAA's seasonal outlooks are an official product of its Climate Prediction Center, produced in collaboration with the National Hurricane Center and AOML's Hurricane Research Division.

2019 Atlantic Storm Names

Andrea	Humberto	Olga
Barry	Imelda	Pablo
Chantal	Jerry	Rebekah
Dorian	Karen	Sebastien
Erin	Lorenzo	Tanya
Fernand	Melissa	Van
Gabrielle	Nestor	Wendy

What's Happening in the Tropics?

Join AOML scientists for daily tropical weather discussions in the AOML first-floor conference room at 12:30 pm in support of NOAA's 2019 Hurricane Field Program. Everyone is welcome to attend, either in person or remotely.

For GoToMeeting access:
https://www2.gotomeeting.com/join/151354330

For audio access:
Dial +1 (872) 240-3212
Access Code: 151-354-330
Audio PIN: shown after joining the meeting

Underwater Gliders to Capture Key Ocean Data during Hurricane Season

AOML's underwater glider missions began in July in support of NOAA's 2019 Hurricane Field Program. As the Atlantic hurricane season enters its peak months—August-September-October—the gliders will gather key ocean data while patrolling the Caribbean Sea and North Atlantic in areas where hurricanes typically develop and intensify.

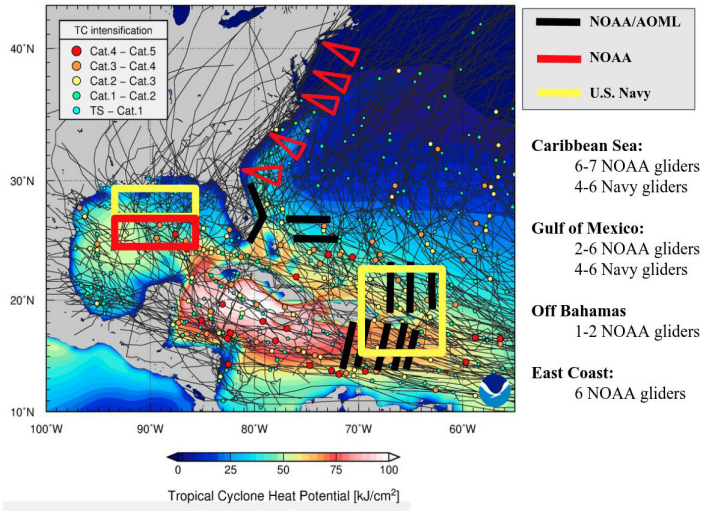
This year a fleet of six gliders was deployed to expand coverage in regions where ocean data can provide the most value to hurricane models, with four gliders patrolling the Caribbean Sea off the US Virgin Islands, Puerto Rico, and the Dominican Republic, and two in the North Atlantic Ocean north of Puerto Rico. Two additional gliders are planned for deployment later in the season—one in the coastal waters of the Bahamas and the other off the Florida Straits.

The gliders measure the upper ocean's properties, with an emphasis on temperature and salinity, to depths as great as half a mile along predetermined tracks. Heat content plays a crucial role in hurricane development, with warm sea surface temperatures generally increasing the likelihood for intensification. Salinity also plays an important role. Lower concentrations of salt in surface waters help fuel intensification by preventing deeper, cooler waters from rising to the surface.

The data collected by the gliders enable researchers to assess the thermal structure of the upper ocean, as well as dynamic features that may contribute to hurricane formation, intensification, and weakening. Representing the ocean accurately in hurricane forecast models is an emerging priority for improving intensity forecasts. On their return to the surface, the data are transmitted in real-time to the Global Telecommunications System for assimilation into NOAA's operational and experimental hurricane models.

AOML's glider deployments are part of a multi-institutional, international effort funded by NOAA through the 2019 Supplemental Appropriations Act of Congress. NOAA is supporting the mission with the objective of deploying 15-20 hurricane gliders specifically in support of hurricane forecasts and studies.

These deployments are based on partnerships that include the Integrated Ocean Observing System (IOOS), regional associations for ocean observing systems in the Caribbean (CARICOOS), southeast (SECORA), and Mid-Atlantic (MARACOOS), as well as academic partners at the University of Puerto Rico-Mayaguez, University of Miami, Rutgers University, University of Delaware,



Map of planned hurricane glider deployment sites for 2019, selected to expand ocean data coverage in regions were hurricanes typically develop, intensify, and dissipate.

AOML staff and partners from the University of Puerto Rico-Mayaguez aboard the R/V *La Sultana* before setting off to deploy two underwater gliders in the coastal waters of Puerto Rico.

the Maritime Authority of the Dominican Republic, University of the Virgin Islands, and Cape Eleuthera Institute of the Bahamas.

These partnerships have enabled AOML scientists to establish three new ports in La Parguera (Puerto Rico), Santo Domingo (Dominican Republic), and Charlotte Amalie (Virgin Islands). The gliders are expected to generate approximately 8,000 temperature, salinity, and dissolved oxygen profiles from the ocean surface to a depth of 1 km before their retrieval in November near the end of hurricane season.

Hurricane Glider Links

AOML's hurricane glider web pages feature several newly-developed auxiliary near-real-time ocean products in support of hurricane intensity forecasts.

For the latest hurricane glider observations:

https://www.aoml.noaa.gov/phod/goos/gliders/observations.php

For products that display ocean areas with favorable conditions for hurricane intensification based on satellite-derived observations of sea surface temperatures, upper ocean heat content, and sea surface salinity—all key factors in the transfer of energy from the ocean into the hurricane environment:

https://www.aoml.noaa.gov/phod/goos/gliders/oc_monitoring.php

For AOML's Hurricane Ocean Viewer that displays real-time ocean conditions based on satellite and in situ observations derived from products for the last 10 to 30 days:

https://cwcgom.aoml.noaa.gov/cgom/OceanViewer/index_hrd.html

To view an 8-minute video about AOML's glider operations entitled *Gliding into Hurricane Intensity Forecasts*:

https://www.youtube.com/watch?v=FXF3iuR8zAY&feature=youtu.be

Nutrients entering Biscayne Bay Signal Shift in Water Quality

Research shows Biscayne Bay's water quality has been declining over the past 20 years and may be reaching a "tipping point" due to human activity.

Home to protected species, seagrass meadows, coral reefs, valued recreational/commercial fish species, and a host of other marine life, Biscayne Bay lies adjacent to the Miami metropolitan area, one of Florida's most populated urban centers. The bay's historically clear waters are increasingly threatened by human activities.

An analysis of 20 years of water quality data shows that Biscayne Bay, a NOAA Habitat Focus Area off southeast Florida, is degrading, as scientists have identified early warning signs that could help managers prevent a regime shift of the bay's ecosystem.

In a recent study published in *Estuaries and Coasts,** AOML scientists and collaborators from the Northern Gulf Institute detected an increasing trend in chlorophyll and nutrient levels from 48 monitoring stations located throughout the bay, despite most of the bay having clear waters and low nutrient concentrations. The study included samples collected over a 20-year period from 1995-2014, a time frame that coincided with a rapid increase in the human population at the study site.

The data show that Biscayne Bay—home to endangered species, coral reefs, seagrass meadows, and a number of valued commercial and recreational fish species—is becoming more nutrient rich as chlorophyll and phosphate levels have steadily increased over the past 20 years. This increase is greater in the nearshore and semi-enclosed areas of Biscayne Bay, indicating the decline in water quality is due to land-based sources of pollution.

"If current management practices continue, it could lead to a regime shift in Biscayne Bay from one with clear water and lush seagrass meadows to a murky system dominated by phytoplankton," said Dr. Chris Kelble, an AOML coastal oceanographer and co-author on the study. "This would alter the ecosystem and the species that live in the bay."

Phytoplankton—microscopic plants that need sunlight and nutrients to grow—live in the water column. Their numbers increase as nutrients like phosphorus and nitrogen enter the water. With increasing levels of phytoplankton comes the potential for algal blooms that damage seagrass beds and other marine life by reducing the amount of light available to them.

The upper region of the bay has already experienced seagrass die-off, a likely early impact from this change in water quality. Scientists are now working with local municipalities, resource managers, and non-profits to use the results from the study to target reductions in nutrients via coastal management and human behavior to prevent further increases in chlorophyll and inorganic nutrient levels.

"We were able to suggest specific regions within Biscayne Bay to target coastal management efforts in order to have the greatest impact on improving water quality," said Nicole Millette, a post-doctoral scientist at Woods Hole Oceanographic Institute and the lead author on the study. Millette conducted the study while she worked as a post-doctoral researcher at the Northern Gulf Institute in collaboration with Dr. Kelble at AOML.

The authors hope their findings will be used to affect these changes before the impending regime shift is realized throughout much of the bay. Once an ecosystem has shifted it is far more difficult to restore than it is to prevent the shift from occurring. Scientists are hopeful this regime shift can be prevented and plan to track potential improvements after new management measures and actions are implemented to stem the flow of nutrient loading into Biscayne Bay.

*Millette, N.C., C. Kelble, A. Linhoss, S. Ashby, and L. Visser, 2019: Using spatial variability in the rate of change of chlorophyll-*a* to improve water quality management in a subtropical oligotrophic estuary. *Estuaries and Coasts,* doi:10.1007/s12237-019-00610-5.

Biscayne Bay—A NOAA Habitat Focus Area

Biscayne Bay was selected as a NOAA Habitat Focus Area in 2015, one of ten such NOAA-designated areas in the nation. Together with local management and environmental partners, NOAA scientists are working to improve Biscayne Bay's water quality, prevent habitat degradation, and support the recovery of protected species and sustainability of fish species. Work is also proceeding to curb the impact of human activities by increasing the public's awareness and understanding of the ecological, economic, and societal benefits of the Biscayne Bay ecosystem.

Google image of the Biscayne Bay Habitat Focus Area (white outline) showing Biscayne Bay and the Florida reef tract (image from *NOAA's 2015-2020 Biscayne Bay Habitat Focus Area Implementation Plan*).

AOML and Norwegian Scientists Use eDNA to Survey Mesopelagic Fishes

Dr. Luke Thompson, a Northern Gulf Institute Assistant Research Professor at AOML, sailed aboard the Norwegian icebreaker RV *Kronprins Haakon* in May as part of a research effort focused on characterizing species that dwell in the mesopelagic zone—the region of the ocean 200–1000 meters below the surface. The cruise was undertaken to explore the potential for developing a new fishery based on mesopelagic fish.

Recent estimates of the fish biomass in the dimly-lit mesopelagic "twilight" zone range from between 2–50 billion tonnes, making fish in this layer the most abundant in the global ocean. This untapped resource has attracted the attention and interest of the commercial fishing industry, as well as marine fish feed producers. However, research is needed to better understand the ecological impacts and consequences to the mesopelagic ecosystem (and broader ocean) from harvesting its resources.

Scientists aboard the *Kronprins Haakon* conducted the month–long survey to study the mesopelagic ecosystem, with an emphasis on quantifying the abundance, diversity, and biomass of mesopelagic species in both nutrient poor and nutrient rich waters. The cruise began in Mindelo, Cape Verde off the west coast of Africa and passed through the Canary Islands and northeast Atlantic before arriving in Oslo, Norway. Data gathered along the cruise track measured the physical, chemical, and biological properties of the ocean, while acoustics and trawling operations focused on gathering mesopelagic specimens for taxonomic identification of fish, cephalopods, and crustaceans.

A macroplankton trawl equipped with Deep Vision, a camera system that gathers continuous images of passing organisms, is brought on deck after gathering fish from the mesopelagic zone, a region of the ocean approximately 200-1000 meters beneath the surface.

Dr. Thompson participated in the cruise as part of a bilateral US–Norway project to use environmental DNA, or eDNA, to study the mesopelagic environment. The joint project resulted from meetings of a US–Norway intergovernmental group on eDNA implementation for fisheries stock assessments and management led by AOML molecular biologist Dr. Kelly Goodwin and representatives from the Norwegian Institute of Marine Research.

The NOAA–Institute of Marine Research team tested the use of eDNA to characterize a potential new fishery in the mesopelagic layer. Their objective was to identify as many species as possible from the water column using eDNA sequencing and to compare the taxonomic distribution and abundance of fish species in the eDNA data with those from the traditional trawl and acoustics data collected during the cruise.

Dr. Thompson and his Norway-based Institute of Marine Research counterpart, Dr. Lotta Lindblom, filtered eDNA from water taken from depths with strong acoustic signatures (scattering layers). Mindful of the importance of expanding eDNA reference databases, they also collected fish specimens for mitochondrial DNA sequencing. Samples from 122 fish species were frozen or stored in ethanol for later DNA sequencing analysis.

The eDNA species tables will be compared with species composition tables derived from the fish and macroplankton trawls. The high-quality taxonomic identifications from the trawl data make this a valuable dataset for comparison with eDNA data. Additionally, acoustic data were used to determine the fish groups that travel upward through the water column after dusk to feed on plankton, while eDNA data were, in turn, used to identify the scattering layers of migrating fish in the acoustics data.

Analysis of the eDNA samples will be conducted through NOAA's Omics Program. Drs. Thompson and Goodwin and their Norwegian colleagues are excited to see how eDNA can be used to benefit fisheries investigations in the coming years.

The scientific crew aboard the RV *Kronprins Haakon* sorts and identifies fish from a pelagic fish trawl.

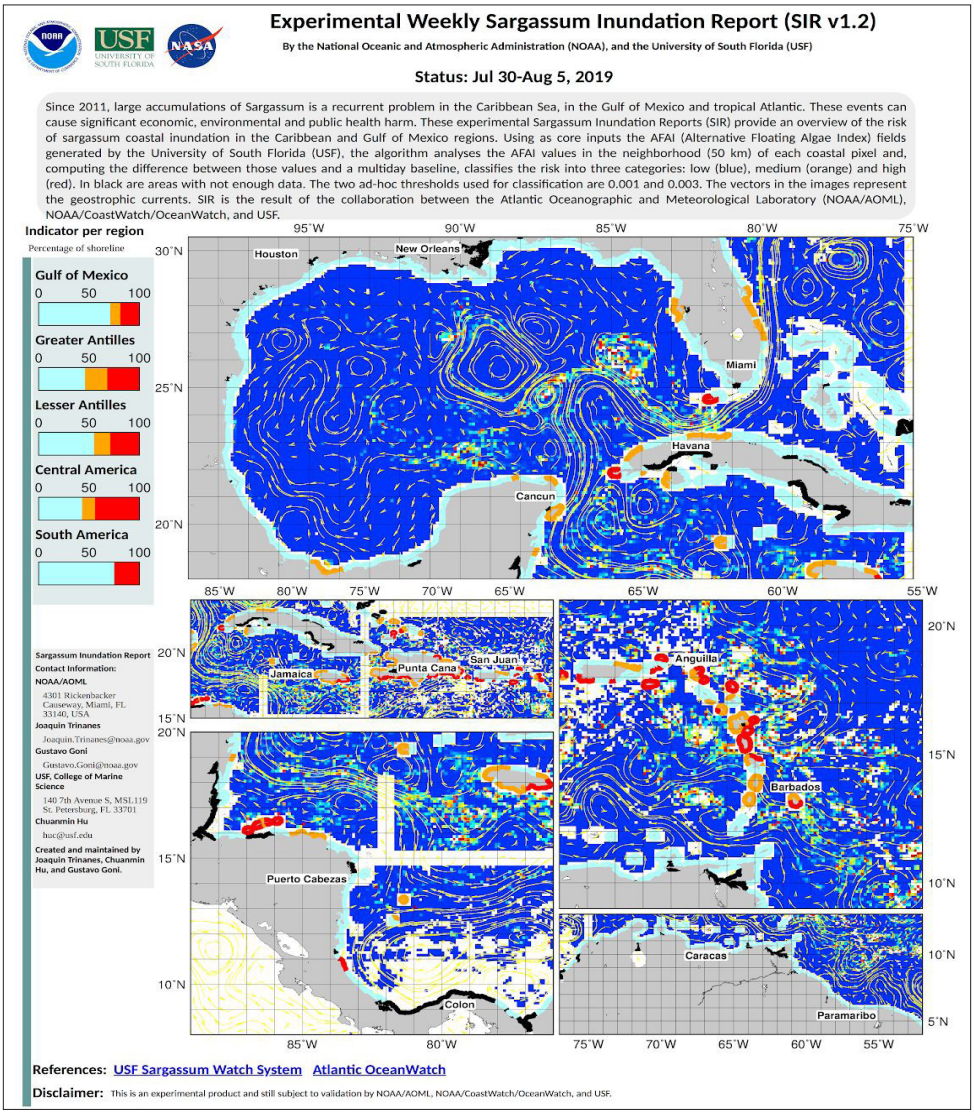
Tracking Sargassum in the Atlantic, Caribbean, and Gulf of Mexico

The unprecedented arrival of massive amounts of Sargassum—brown seaweed that floats in dense mats along the ocean surface—to the Caribbean Sea and Gulf of Mexico represents a materialized risk to the environment, society, and economy of these regions. Frequent reports link Sargassum to beach inundation, coral reef degradation, tourism industry disruption, coastal erosion, and sea turtle nesting, among other multiple and mostly negative impacts.

A regime shift occurred in 2011, when large amounts of Sargassum were detected in the central Atlantic Ocean. This extensive mat of Sargassum stretched from the coast of Africa to the Caribbean Sea during the summer and washed ashore in the Lesser Antilles. Before 2011, the largest mats of Sargassum were usually found in the Gulf of Mexico and Sargasso Sea.

This regime change has been recently attributed to factors such as unusual large-scale ocean circulation and wind patterns, an increasing presence of nutrients in the Amazon River's discharge due to expanding deforestation and fertilizer use, and to nutrients provided by the winter upwelling on the west African coast and along the boundaries between equatorial currents. Other factors, such as moderate temperatures, the presence of a Sargassum seed population, and falling Saharan dust might also be behind the shift.

Ocean circulation and wind patterns are ultimately the factors that govern the downstream distribution of Sargassum, which has presently reached and is negatively affecting coastal south Florida. The key to forecasting the movement of Sargassum is in understanding the impact of surface currents and winds on its trajectories.



An example of a Sargassum Inundation Report that shows conditions in the Caribbean Sea and Gulf of Mexico for July 30-August 5, 2019. Colors along the coast refer to the level of risk for Sargassum inundation (i.e., high risk—red; medium risk—orange; low risk—cyan). The report also provides information on the percentage of shoreline potentially affected by Sargassum.

AOML researchers created and deployed GPS tracked Sargassum-simulating drifters in the tropical Atlantic Ocean and Caribbean Sea in 2018. These experiments provided valuable information on how wind and ocean currents affect the transport and distribution of Sargassum.

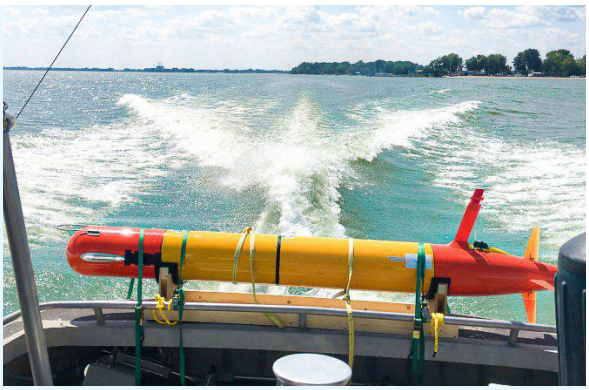
In 2018, AOML researchers released an assortment of drifters into the tropical Atlantic Ocean and Caribbean Sea, including Sargassum-simulating drifters (image at left), to study the impact of varying currents and winds on Sargassum translation velocities. These experiments enabled a better understanding of how the size and buoyancy of the different types of drifters affected their movement, leading to an improvement in trajectory models.

Building on this knowledge and with the aid of the satellite-derived Alternative Floating Algae Index developed by Dr. C. Hu at the University of South Florida, AOML researchers have recently started distributing weekly experimental Sargassum Index Reports that estimate the risk of Sargassum to various coastal areas (image above). The risks are quantified based on the presence of Sargassum in the neighborhood of each coastal pixel (i.e., 50 km), using as a reference the mean floating algae density during the previous 7 days. The reports are posted at https://www.aoml.noaa.gov/phod/sargassum_inundation_report/.

AOML scientists will continue their efforts to conduct additional field experiments, as well as collaborate with research partners on theoretical and computer modeling studies, to better understand and forecast the transport of Sargassum.

Underwater Robots Map, Measure Toxicity of Great Lakes Algal Blooms

Two underwater robots were deployed in the western basin of Lake Erie in August as part of a field test by NOAA researchers and partners at the Monterey Bay Aquarium Research Institute to monitor and measure the toxicity of harmful algal blooms in the Great Lakes. The robots—known as long-range autonomous underwater vehicles—roamed Lake Erie to detect toxic algae patches and measure microcystin, a potent neurotoxin produced by Cyanobacteria that poses health risks to both humans and animals. The vehicles also collected information on the genetic composition of the Cyanobacteria, a project spearheaded by AOML scientists. NOAA hopes to transition these tools into part of its permanent efforts to track algal blooms in the Great Lakes. Once fully vetted, the vehicles will provide the ability to detect, monitor, and map harmful algal blooms and their toxicity on a 24/7 basis in all weather conditions.



A long range autonomous underwater vehicle is ferried to the western basin of Lake Erie to test its ability to detect and measure toxic algal blooms.

Coral Researchers Monitor Impacts of Climate Change in the Florida Keys

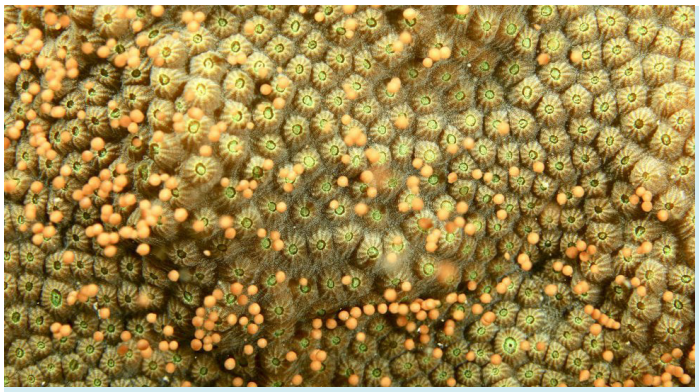
AOML coral researchers visited Cheeca Rocks reef in Islamorada, Florida for a few days in July as part of their efforts to track biological trends occurring on the reef due to ocean acidification and other climate change impacts. The data and tissue samples gathered were in support of NOAA's National Coral Reef Monitoring Program led by AOML for US coral reefs in the Atlantic Ocean. The team conducted calcium carbonate budget surveys and collected photomosaics of the various reef sites. These were the first surveys conducted at Cheeca Rocks reef since the 2014 outbreak of the stony coral tissue loss disease event in the Florida Keys. It was anticipated that potential impacts from the disease event might be observed in the tissue samples from this year's surveys.

AOML coral researcher Graham Kolodziej confirms the identify of a tagged coral colony at Cheeca Rocks.

AOML Premieres State-of-the-Art Engineering Work Space

AOML's new engineering space features nine offices on the periphery of a large, well-lit work area.

AOML premiered its new, state-of-the-art engineering space on August 5 after more than a year of renovation. The updated 3,500 square foot area features nine offices, two large storage rooms, multiple well-lit work stations, and a meeting room. The spacious redesign will better serve the needs of AOML's wide-ranging programs and projects. Engineering staff will use the area to repair and maintain an assortment of instruments—data pods, expendable bathythermographs, inverted echo sounders, underwater gliders, and more—in support of oceans and climate, microbiology, and south Florida marine ecosystem research. The space will additionally support the design, development, and construction of new instruments and sensors to meet NOAA's emerging technological needs.



A colony of *Orbicella faveolata* synchronously releases gamete bundles (i.e., small yellow spheres) a few hours after sunset.

Coral Spawning Event to Shed Light on Coral Resilience in the Florida Keys

In August, AOML's coral researchers collected tiny gamete bundles being released from the protected mountainous star coral, *Orbicella faveolata*, at Cheeca Rocks reef in the upper Florida Keys. Taking place shortly after moonrise, the spawning process is a visually beautiful part of the circle of life for corals, releasing gametes into the water to be fertilized and eventually settle to create new stony coral colonies. The collected gametes support AOML's 'Omics research, conducted with partners from NOAA's Southeast Fisheries Science Center, to better understand the molecular basis of coral resilience to high ocean temperatures and to develop the technological capacity to predict the coral species more likely to bleach.

AOML Scientists Attend in International Workshop on South Atlantic MOC

Several scientists from AOML participated in a one-day workshop on the South Atlantic Meridional Overturning Circulation in Montreal, Canada on July 15. Variations in the overturning circulation in the South Atlantic have been tied to changes in precipitation patterns, extreme weather, and coastal sea levels. NOAA is the lead agency tasked with advancing understanding on this topic under the US Interagency Ocean Research Priorities Plan. Drs. Chris Meinen and Renellys Perez of AOML chaired sessions discussing recent additions and updates to the South Atlantic Meridional Overturning Circulation observing systems, as well as future funding and logistics planning going forward on this decade-long international initiative. Workshop participants hailed from Argentina, Brazil, Germany, Ireland, South Africa, Spain, the United Kingdom, and the United States.

Participants of the SAMOC VIII workshop in Montreal, Canada. AOML and University of Miami-Cooperative Institute participants included Marion Kersalé, Chris Meinen, Renellys Perez, and Denis Volkov (not in picture). Photo credit: Manuel Gutierrez-Villanueva.

Annual Report Highlights Global Weather and Climate in 2018

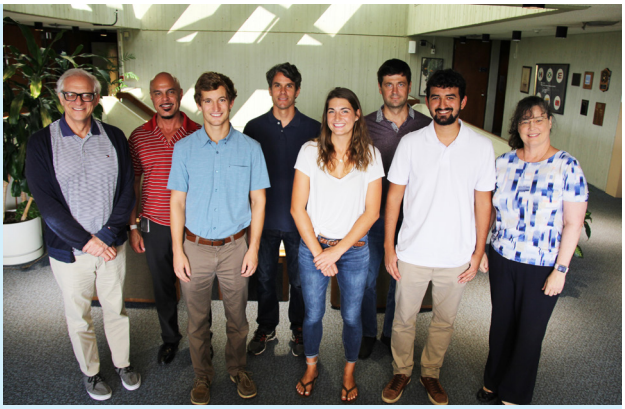
The 29th in a series of annual reports to document planet Earth's global weather and climate was published recently as a supplement to the September 2019 issue of the *Bulletin of the American Meteorological Society*. The report, *State of the Climate in 2018,* describes and analyzes the weather and climatic events that occurred in 2018 based on the contributions of more than 450 scientists. NIne AOML researchers contributed to the international effort who served as coauthors on the following sections of the report:

- *Global oceans: Global ocean carbon cycle*—Rik Wanninkhof and Joaquin Trinanes
- *Global oceans: Surface currents*—Rick Lumpkin and Gustavo Goni
- *Global oceans: Salinity*—Claudia Schmid
- *Global oceans: 2018 Florida red tide bloom*—Christopher Kelble and Gustavo Goni
- *Tropical cyclones: Atlantic basin*—Stanley Goldenberg
- *Tropical cyclones: Tropical cyclone heat potential*—Ricardo Domingues, Gustavo Goni, and Francis Bringas
- *Tropical cyclones: Upper-ocean conditions in the Gulf of Mexico during Hurricane Michael*—Gustavo Goni and Ricardo Domingues

The full report can be found at https://www.ametsoc.net/sotc2018/Socin2018_lowres.pdf.

University of Miami PhD Students to Work With AOML Scientists

AOML welcomed three University of Miami-Rosenstiel School PhD students in August, who began classes this fall semester as part of a new partnership between AOML and the University of Miami's Cooperative Institute for Marine and Atmospheric Studies. The partnership supports the formation of a new generation of oceanographers, who from the early stages of their studies will become familiar with NOAA-oriented research. The students will be primarily situated on the Rosenstiel School campus during the first two semesters of classes. During their third semester they will start their research with AOML scientists, with a shift more to dissertation work in the summer of 2020. AOML is pleased to introduce them:



AOML leaders and University of Miami-Rosenstiel School PhD students. From left to right: Gustavo Goni (AOML), John Cortinas (AOML), Lev Looney (Rosenstiel School), Greg Foltz (AOML), Leah Chomiak (Rosenstiel School), Denis Volkov (AOML), Ivenis Pita (Rosenstiel School), and Molly Baringer (AOML).

Leah Chomiak received a BS degree in Marine and Atmospheric Science with a major in Marine Chemistry from the University of Miami. During her undergraduate studies, Leah conducted a biogeochemical analysis of the subtropical convergence zone east of New Zealand. Until recently, Leah worked as a University of Miami-Cooperative Institute research associate with AOML's Ocean Chemistry and Ecosystems Division where she studied the effects of ocean acidification on coral reefs and participated in several research cruises. Leah will work with Denis Volkov and Molly Baringer on the variability of the meridional overturning circulation and its associated property transports, as well as its impacts on weather and climate.

Lev Looney received a BS degree in Marine Science (emphasis in Physical Oceanography) and Geography from the University of South Carolina. As an undergraduate, Lev conducted research on a variety of topics, including Atlantic hurricanes and wind-driven upwelling in eastern boundary current regions. He will work with Greg Foltz to study the interactions between ocean stratification and tropical cyclone intensification.

Ivenis Pita received a BS degree in Oceanography and Meteorology from the University of Bahia and an MS from the Federal University of Rio de Janeiro. During 2014-2015, he worked as an exchange student at the University of Perth. Ivenis has already conducted research using hydrographic data to study the link between sea surface variability and the upper thermal structure of the Brazil Current using NOAA expendable bathythermograph observations. He will work with Gustavo Goni and other AOML scientists on the assessment of boundary currents and coastal sea level rise.

Student Intern Highlight

Kelly Nunez Ocasio, a graduate student at Pennsylvania State University, interned this summer at AOML with Dr. Sim Aberson of the Hurricane Research Division. She was recently featured in the student edition of NOAA Research's EEO newsletter. Here is Kelly's story.

Born in Chicago, Illinois but raised on the beautiful island of Puerto Rico, Kelly's passion for weather began at a young age when the island was hit by Hurricane Georges in 1998. Although only a young child, Kelly still remembers hearing the walls wooing from the strong winds. What started as a fear of hurricanes and extreme weather became her passion as an adult.

Kelly is currently a NOAA-Center for Atmospheric Sciences and Meteorology Fellow. As part of her fellowship, she was required to complete a NOAA Experiential Research and Training Opportunity project. The project Kelly pursued at AOML continued her PhD studies at Penn State on African easterly waves and the role of convection in tropical cyclogenesis. "I am very grateful to have had the opportunity to work at a NOAA lab and receive incredible input and mentoring from research scientists," Kelly said of her time at AOML. However, Kelly is no stranger to the lab—she interned in 2014 as an undergraduate student through NOAA's Educational Partnership Program.

After earning her PhD, Kelly plans to continue studying tropical meteorology at a science agency and considers NOAA Research laboratories as a viable option. Of the educational opportunities provided by NOAA, Kelly had this to say: "I would definitely recommend these types of opportunities to both undergraduate and graduate students of all cultural and all academic STEM backgrounds, as it is in these types of experiences one gains professional skills such as leadership, team work, and communicating science, skills that aren't necessarily learned in a classroom or from sitting behind a computer."

AOML Commends Outgoing Summer Interns

In August, AOML began bidding farewell to its 2019 summer interns—a small, but motivated group of high school, undergraduate, and graduate students—who completed 4-10 week internships at the lab. Each intern was paired with one or two mentors, all career scientists, who challenged them to learn new skills, improve knowledge, and gain practical work experience in a research environment.

Under the tutelage of their mentors, interns gathered data in the field, conducted research, and completed an assortment of technical assignments in support of the lab's science programs. They also learned about NOAA, the agency's mission, and the various opportunities available throught NOAA for those wishing to pursue careers in the marine and atmospheric sciences.

AOML commends the diligence and commitment of its 2019 summer interns and the mentors who guided their efforts (see table below). It is hoped their time at AOML was rewarding and will better align them with future career and educational opportunities.

AOML's summer interns, along with interns from NOAA's Southeast Fisheries Science Center, met for pizza on July 3 in the NOAA-Miami Regional Library at AOML. In addition to interns having the chance to speak about their summer projects, mentors and other lab managers discussed the many educational opportunities and career paths offered through NOAA.

2019 Summer Interns	AOML Mentors
Addison Alford University of Oklahoma	Jun Zhang Hurricane Research Division
Aden Annane Alonzo and Tracy Mourning Senior High School	Neal Dorst/Jon Zawislak Hurricane Research Division
Rafael de la Cova Archbishop McCarthy High School	Jon Zawislak Hurricane Research Division
Alrick Green San Jose State University	Sundararaman Gopalakrishnan/Gus Alaka Hurricane Research Division
Nicholas Johnson, NOAA Hollings Scholar University of Alabama-Huntsville	Jon Zawislak Hurricane Research Division
Alan Martin University of Miami	Chris Sinigalliano/Maribeth Gidley Ocean Chemistry and Ecosystems Division
Rachel Martin, NOAA Hollings Scholar Ohio University	Chris Kelble Ocean Chemistry and Ecosystems Division
Shannon McCloskey University of Florida	Jon Zawislak Hurricane Research Division
Kelly Nunez-Ocasio Pennsylvania State University	Sim Aberson Hurricane Research Division
Eric Pikula Salem State University	Chris Sinigalliano/Maribeth Gidley Ocean Chemistry and Ecosystems Division
Eduardo Sevilla Miami-Dade College	Claudia Schmid Physical Oceanography Division

Congratulations

AOML Director Dr. John Cortinas has been elected to become a Fellow of the American Meteorological Society. John has been a member of the AMS since 1983, supporting the organization as an associate editor for the journals *Weather and Forecasting* and *Monthly Weather Review*. He has additionally served as the Chairperson of the Minority Scholarship Committee and as a member of both the Board on Women and Minorities and the Weather Analysis and Forecasting Committee. John, who currently serves as an elected member of the AMS Council, will be formally recognized as a Fellow in January 2020 at the Society's 100th annual meeting in Boston, Massachusetts.

AOML coral scientist Ian Enochs has been selected to receive a 2019 Department of Commerce Silver Medal for his leadership in designing and implementing a low-cost, open source subsurface autosampler. The new instrument eliminates barriers to water sampling, increasing the research capacity for all oceanographers. Nathan Formel, a University of Miami-Cooperative Institute research associate at AOML, was also a key collaborator who contributed significantly to the development of the autosampler.

AOML hurricane scientists Jun Zhang and Robert Rogers are the 2020 recipients of the American Meteorological Society's Banner I. Miller Award in recognition of their outstanding contribution to the science of hurricane and tropical weather forecasting published in a journal with international circulation in the 48 months prior to the deadline for nominations. They are joined in the award by David Nolan of the University of Miami and Vijay Tallapragada of NOAA's Environmental Modeling Center. The group was recognized for their paper* that showed a significant improvement in the prediction of tropical cyclones in an operational numerical weather prediction model.

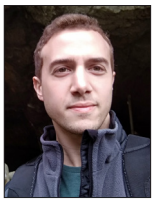
*Zhang, J.A., D.S. Nolan, R.F. Rogers, and V. Tallapragada, 2015: Evaluating the impact of improvements in the boundary layer parameterization on hurricane intensity and structure forecasts in HWRF. *Monthly Weather Review,* 143(8):3136-3155 (doi:10.1175/MWR-D-14-00339.1).

Welcome Aboard

Albert Boyd joined the staff of AOML's Ocean Chemistry and Ecosystems Division in August as a University of Miami-Cooperative Institute research assistant. Albert will work with the Acidification, Climate, and Coral Reef Ecosystems Team on carbonate chemistry analysis, as well as instrument calibration and maintenance, all in support of the National Coral Reef Monitoring Program. He holds a BS degree in Biology from the University of Miami.

Nicole Besemer joined the staff of AOML's Ocean Chemistry and Ecosystems Division in August as a University of Miami-Cooperative Institute senior research associate. Nicole will work with the Acidification, Climate, and Coral Reef Ecosystems Team as the new National Coral Reef Monitoring Program's Caribbean Climate Operations Coordinator. She hold an MS degree in Marine Biology and Fisheries from the University of Miami's Rosenstiel School of Marine and Atmospheric Science.

Paulo Paz joined the staff of AOML's Hurricane Research Division in July as a University of Miami-Cooperative Institute software engineer. Paulo will work with Dr. Lidia Cucurull in support of the Quantitative Observing System Assessment Program, primarily on the validation of nature runs and the development of optimized procedures to verify data denial experiments. He holds a BS degree in Computational Mathematics from the New Jersey Institute of Technology.



Christian Saiz joined the staff of AOML's Physical Oceanography Division in July as a University of Miami-Cooperative Institute electrical engineer. Christian will provide scientific and operational support, participating as a seagoing "rider" aboard research vessels and merchant ships during transect cruises to collect expendable bathythermograph data. He will also work in support of NOAA's hurricane glider project. Christian holds a BS degree in Electrical Engineering from the Universidad Tecnológica Nacional in Buenos Aires, Argentina.

Nash Soderberg joined the staff of AOML's Ocean Chemistry and Ecosystems Division in August as a University of Miami-Cooperative Institute research assistant. Nash will work with the Acidification, Climate, and Coral Reef Ecosystems Team on projects related to coral reef restoration, as well as the maintenance of experiments in the Experimental Reef Laboratory. He holds a BS degree in Marine Science and Biology from the University of Miami.

The women of AOML gathered on July 30 to show their support for NOAA and NOAA Research's efforts to celebrate the contributions of women in the workforce. Although more than 20 women were unavailable for the photo, all of AOML's women scientists, computer specialists, technical experts, and support staff contribute every day to NOAA's mission of science, service, and environmental stewardship.

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

Keynotes editor: Gail Derr

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

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