AOML Keynotes

NOAA'S ATLANTIC OCEANOGRAPHIC AND METEOROLOGICAL LABORATORY

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

Environmental DNA Sampler Transitions to New Open-Source Technology

Scientists at AOML have engineered a new instrument that provides valuable information about the biodiversity of aquatic ecosystems. A paper published recently in *Hardware X** describes the low-cost, open-source Subsurface Automated Environmental DNA (eDNA) Sampler, or SASe.

Building on the success of the Subsurface Automated Sampler, or SAS, a first-of-its-kind instrument created at AOML in 2015, the original technology has been re-tooled to include eDNA sampling. eDNA enables scientists to non-invasively assess marine biodiversity, detect cryptic or invasive species, and monitor groups of organisms in ways that are more thorough than visual surveys.

The SASe filters water to collect eDNA and preserves the samples at room temperature to prevent them from decay. This is vital for 'omics research, as samples must be well preserved to extract and identify their DNA. Because they are automatically preserved, scientists need not be physically present, reducing the time and resources spent in gathering samples in the field.

The SASe is a milestone for AOML as one of the first instances of technology to undergo the rigorous transition process from the desks of scientists, through organizational approval channels, to the wider scientific community. As a result, anyone can freely access the instructions to build and use the SASe.

An official SASe transition plan was developed and executed that documented the transition process, including the project's purpose, research background, its benefits and impacts, implementation, cost, and alignment with NOAA's goals and strategic plan. The transition plan served as a road map to shift the SASe to the public via open-source technology, providing a more affordable option for the automatic collection and preservation of eDNA at precise times, weeks, and months.

The Subsurface Automated Environmental DNA Sampler designed at AOML provides the science community with a low-cost option for filtering and collecting DNA from water samples.

"The benefit of the SASe as a low-cost automated eDNA sampling tool is that researchers can take a more complete snapshot of a site's biological profile. Replicate SASe units can perform synchronized sampling across and between study sites, as well as collect a temporal suite of samples to better understand our study areas. Time constraints and the inconvenience of retrieving same-day samples are not a concern when using the SASe," said Nathan Formel, a University of Miami-Cooperative Institute coral ecologist at AOML and lead author of the paper.

The SASe is waterproof to a depth of 55 meters, 40 meters greater than the 2015 SAS model. It uses a peristaltic pump system to filter a pre-programmable volume of water up to 2 liters and automatically preserves the eDNA sample. Additionally, its low build cost of roughly $280 U.S. dollars makes eDNA sampling both viable and accessible for smaller research and biomonitoring groups.

The SASe's open-source code and design make it an instrument that is adaptable for a range of future eDNA research applications, supporting NOAA's goal to innovate and leverage emerging environmental technology to observe and better understand the ocean and Earth systems. This novel technology is the result of a collaborative effort of scientists at AOML, the University of Miami's Cooperative Institute and Rosenstiel School, and the Northern Gulf Institute at Mississippi State University.

The SASe has transitioned from a research capacity within NOAA's Office of Oceanic and Atmospheric Research to become a commercially-available, open-source instrument via NOAA's Technology Partnership Office, making the capability readily available to the eDNA community.

*Formel, N., I.C. Enochs, C. Sinigalliano, S.R. Anderson, and L.R. Thompson, 2021: Subsurface Automated Samplers for eDNA (SASe) for biological monitoring and research. *HardwareX,* 10:e00239, https://doi.org/10.1016/j.ohx.2021.e00239.

New Laboratory to Facilitate Collaboration between Researchers and Forecasters

The new William M. Lapenta Laboratory on the grounds of NOAA's National Hurricane Center in Miami, Florida will provide researchers and forecasters with a shared space to collaborate in transitioning research and development projects to operations through the Hurricane and Ocean Testbed.

A state-of-the-art facility opened on the grounds of NOAA's National Hurricane Center in mid-December 2021. The new William M. Lapenta Laboratory, named for the late director of the National Centers for Environmental Prediction, provides a place for research meteorologists and forecasters, as well as oceanographers, to collaborate in transitioning the latest research into operational products through the Hurricane and Ocean Testbed.

With the rise of more intense storms and damage to populated coastal areas, improving forecast accuracy and the speed of transitioning hurricane and ocean research to operations have become more urgent. The Hurricane and Ocean Testbed will focus on integrating research from both the oceanic and atmospheric domains to improve forecasts, including predictions of hurricane intensity, rapid intensification, and dangerous ocean conditions.

Using the testbed, AOML researchers and National Hurricane Center forecasters will collaborate to integrate data from an array of observing systems. Developing the capability of forecasters to view and use data in real-time from aircraft-based instruments and uncrewed systems such as flying drones, hurricane gliders, and saildrones will be a key focus of AOML's efforts to aid forecasters.

The new facility provides a physical and virtual meeting space to share real-time observations and model forecasts during storm events. It will also enable researchers and forecasters to jointly explore and find solutions to common forecast challenges to produce better analyses and forecasts of high-impact tropical weather and ocean conditions. The goal is for the Hurricane and Ocean Testbed to become an end-to-end process for warnings and responses that optimizes the path from prediction to warning to action.

Participants will also work to convey the hazards associated with extreme tropical weather and dangerous ocean conditions, as well as their expected impacts. Effectively communicating these hazards and impacts are crucial for helping emergency managers, government officials, the private sector, and society as a whole better prepare to protect life and property.

Dr. William "Bill" Lapenta (right), former director of NOAA's National Centers for Environmental Prediction, and hurricane specialist Dr. Mike Brennan discuss the potential impacts of Hurricane Harvey on August 24, 2017.

The Hurricane and Ocean Testbed mimics an operational environment while minimizing the technological barriers for readying a project for operational use. An initial project will focus on improving estimates of wind speed by integrating dropsonde and three-dimensional surface wind images from tail Doppler radar observations obtained by NOAA's Hurricane Hunter aircraft.

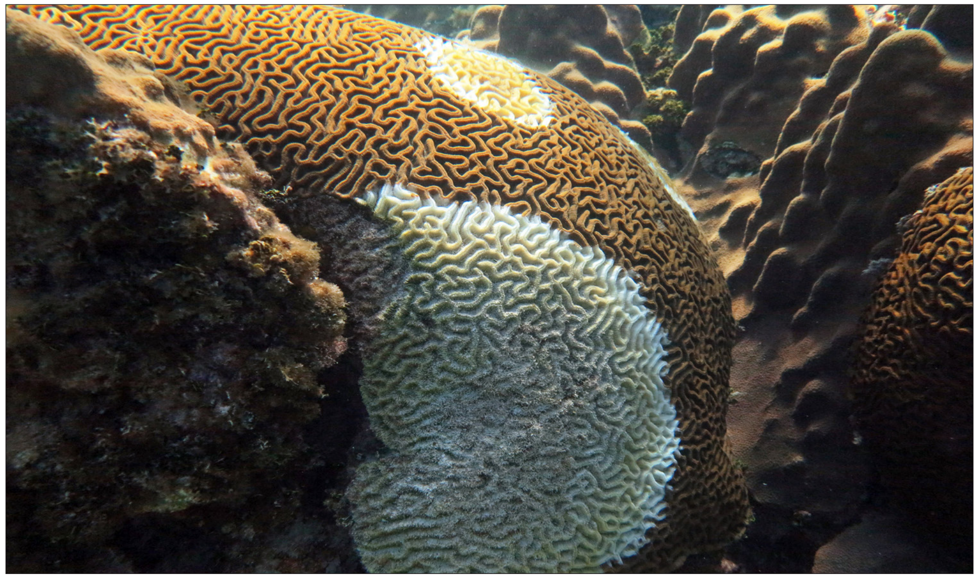
With a newly revitalized transition process and the resources of the Hurricane and Ocean Testbed, AOML hopes to provide more end-to-end solutions that match research applications to operational needs that significantly increase end-state transitions for research focused on creating a more Weather-Ready Nation.

Looking to the future, the Hurricane and Ocean Testbed will improve communications and engagement across NOAA laboratories, government agencies, and academic institutions through grassroots collaborations. By strengthening the interactions between NOAA Research and the National Weather Service, scientists can consider how their research might be transitioned to operations and showcase solutions to forecasters to better evaluate their merit through the Hurricane Ocean Testbed.

AOML and the National Hurricane Center look forward to supporting the success of the Hurricane and Ocean Testbed and are ready to work with other NOAA offices to bring more value to the operational forecast community.

Sediments a Likely Culprit in Spread of Deadly Disease on Florida's Coral Reef

Stony coral tissue loss disease was first observed in 2014 and has since extended its reach throughout Florida's Coral Reef and wider Caribbean. New findings show that sediments spread the disease through indirect exposure between infected and healthy corals.



A brain coral in the Florida Keys displays multiple white lesions on its surface, indicative of infection with stony coral tissue loss disease.

New research published in the journal *Frontiers in Marine Science** has found that seafloor sediments have the potential to transmit a deadly pathogen to local corals and hypothesizes that sediments have played a key role in the persistence of a devastating coral disease outbreak throughout Florida and the Caribbean.

These new findings, the result of a collaborative effort between researchers with AOML, the University of Miami's Cooperative Institute for Marine and Atmospheric Studies, and Louisiana State University, could help mitigate the spread of the deadly disease known as stony coral tissue loss disease. The disease causes white lesions and a rapid loss of tissue in reef-building corals.

Since first appearing in the coastal waters off Miami in 2014, stony coral tissue loss disease has spread throughout all of Florida's Coral Reef, as well as to the wider Caribbean, affecting more than 20 coral species and likely killing millions of coral colonies. To date the microbe, or suite of microbes, that causes the disease has not been identified, making it difficult to manage and treat.

"Our findings indicate that disease-associated microbes may reside in sediments, which can help explain how this disease outbreak has been able to spread and persist largely unabated for the last 7 years," said the study's lead author Michael Studivan, a University of Miami-Cooperative Institute scientist at AOML.

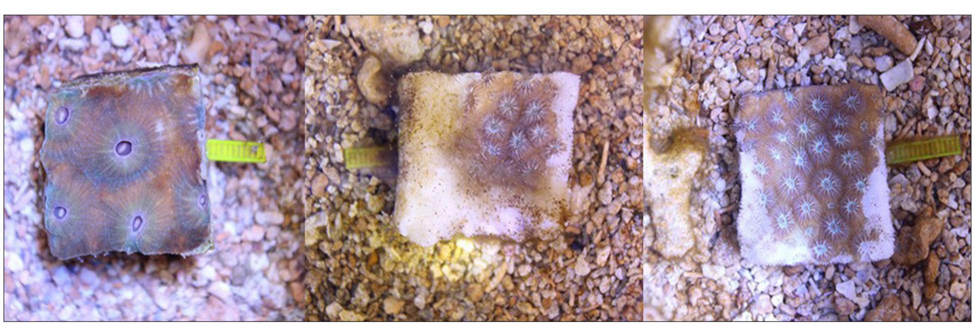
To study the spread of the disease, the science team built a disease transmission apparatus in the Experimental Reef Lab on the campus of the University of Miami's Rosenstiel School to test and identify possible disease vectors and sources. They inoculated reef sediments with stony coral tissue loss disease from diseased corals and exposed these sediments to healthy corals.

Over a period of 4 weeks, the corals were monitored daily for signs of the disease's characteristic white lesions to determine how many individual corals developed lesions and how quickly the disease progressed. It was found that disease-inoculated sediments were able to transmit stony coral tissue loss disease pathogens, resulting in visible signs of the disease in as little as 24 hours.

Additionally, DNA extracted from sediments exposed to stony coral tissue loss disease was compared to DNA from sediments not exposed to the disease to identify several known pathogens that are found on reef environments near diseased corals, including the *Vibrio* spp. group of bacteria. This suggests that some stony coral tissue loss disease-associated microbes can be found in sediments.

"We hope this new information will provide managers with critical information needed to respond to the stony coral tissue loss disease outbreak, especially in the context of mitigating further disease spread with coastal construction activities like dredging and beach renourishment," said study coauthor Ian Enochs, a research ecologist at AOML and principal investigator for AOML's Coral Program.

This research, funded by NOAA's Coral Reef Conservation Program and NOAA Research's 'Omics Program, emphasizes the need to better understand the roles played by sediment microbial communities and coastal development activities in transmitting the disease. It also adds weight to the assertion that disease transmission occurs via an infectious agent or agents.



Examples of coral fragments used in the stony coral tissue loss disease sediment transmission experiment: *Left—Montastraea cavernosa* (great star coral) shows marginal tissue necrosis; *Center—Orbicella faveolata* (mountainous star coral) shows rapid necrosis and tissue loss after 24 hours; *Right—Orbicella faveolata* with white lesions appearing along the fragment's margins.

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*Studivan, M.S., A.M. Rossin, E. Rubin, N. Soderberg, D.M. Holstein, and I.C. Enochs, 2022: Reef sediments can act as a stony coral tissue loss disease vector. *Frontiers in Marine Science*, 8:815698, https://doi.org/10.3389/fmars.2021.815698.

This article is adapted from an article originally published by the University of Miami

Hurricane Model that Follows Multiple Storms Improves Intensity Forecasts

Warning the public of the damaging winds in tropical cyclones is critical for safeguarding communities in harm's way. A new study by hurricane scientists at AOML is the first to quantify the value added to tropical cyclone intensity forecasts by storm-following nests. The research, published in the *Bulletin of the American Meteorological Society**, demonstrates that storm-following nests applied to multiple hurricanes in the same forecast cycle can improve intensity predictions by as much as 30%.

Accurate tropical cyclone intensity forecasts made by computer models require that the locations being forecast, called a grid, be close together. The distance between points on the grid, or the resolution, must be equal to or less than 3 kilometers to achieve what is referred to as "high resolution." High-resolution models like NOAA's Hurricane Weather Research and Forecasting (HWRF) model enable the tropical cyclone eye and eyewall, and the clouds and thunderstorms making up the eyewall and rainbands, to be forecast with accuracy.

These models usually "nest" high-resolution grids around the tropical cyclone inside larger grids with lower resolution to conserve the use of valuable computer resources. This seamless technology saves millions of hours of computational time and keeps computing costs viable.

In the current operational version of HWRF, these nests, or regions of high resolution, follow the tropical cyclone during the forecast. However, HWRF can only follow one tropical cyclone at a time with moving telescopic nests around that one storm. As a result, the effects that all active tropical cyclones have on one another are not always well predicted, and forecasts are not as accurate.

Recent advances to HWRF have enabled multiple sets of moving telescopic nests to follow more than one tropical cyclone at a time. To test whether having storm-following nests around all active tropical cyclones at the same time produced more accurate forecasts, scientists at AOML developed an experimental version of HWRF with moving nests around all active storms instead of just one.

They ran more than 400 forecasts of two versions, i.e., a single-storm version versus a multi-storm version, to observe if moving nests around more than one tropical cyclone improved forecasts. The only difference between the two sets of forecasts was the number of storms that had telescopic moving nests.

When it came to moving nests, the more the merrier! Intensity forecasts improved as more tropical cyclones and, consequently, more moving nests were added to the model, with gains of up to 30%. This study marks the first time the value added to tropical cyclone forecasts by storm-following nests has been directly measured, with intensity forecast improvements observed simply by adding nests to more than one tropical cyclone. The results will play a pivotal role in the development of storm-following nests for NOAA's next-generation tropical cyclone modeling system, the Hurricane Analysis and Forecast System or HAFS.

HAFS is based on the framework of NOAA's Unified Forecast System, an Earth modeling system that serves as the foundation for all of NOAA's forecast applications. It incorporates concepts from both the current operational and experimental versions of HWRF and will be used during the 2022 hurricane season and beyond to provide forecast guidance on tropical cyclone track, intensity, and structure to NOAA's National Hurricane Center.

To learn more about AOML's efforts to develop and advance NOAA's hurricane research and forecast modeling systems, visit **https://www.aoml.noaa.gov/hurricane-modeling-prediction/.** For experimental and tropical cyclone model guidance from HWRF, HAFS, and other numerical weather prediction models, visit **https://storm.aoml.noaa.gov/viewer.**

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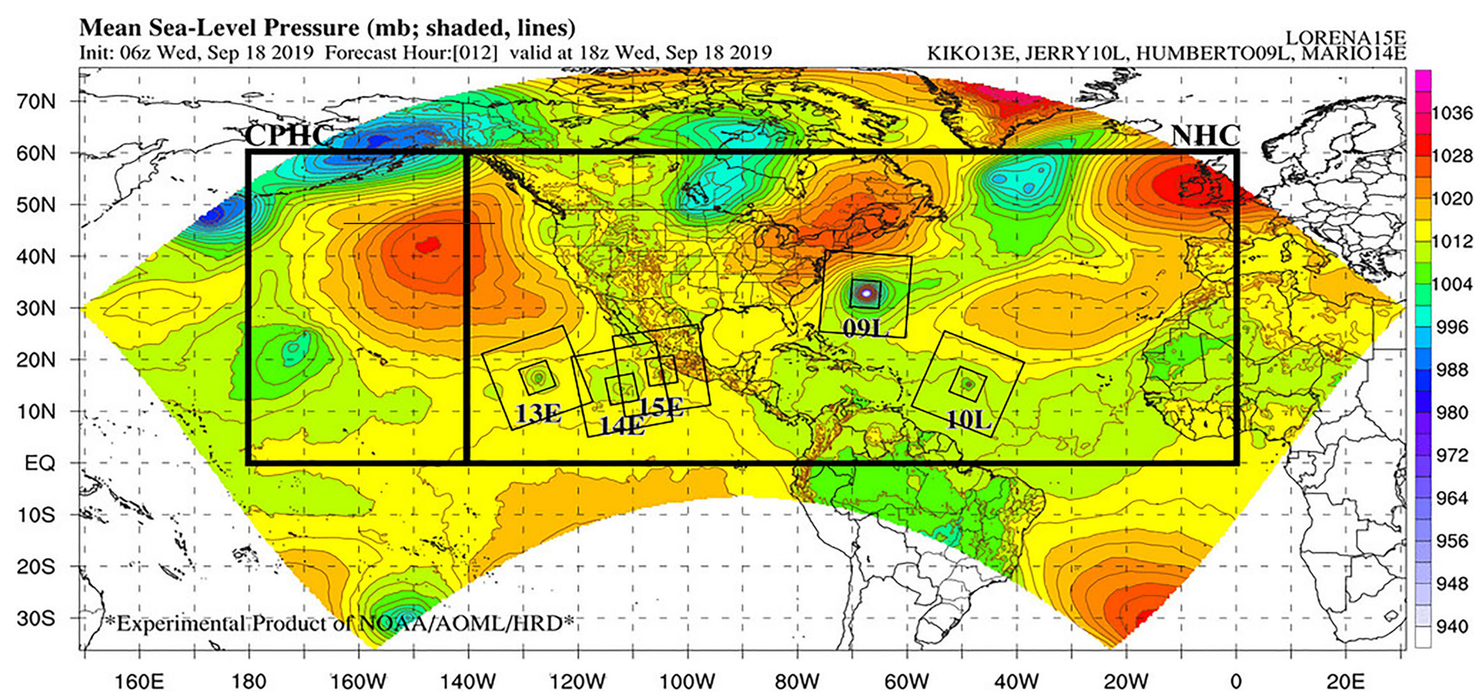
*Alaka, G.J. Jr., X. Zhang, and S.G. Gopalakrishnan, 2022: High-definition hurricanes: Improving forecasts with storm-following nests. *Bulletin of the American Meteorological Society,* 103(3): E680-E703, https://doi.org/10.1175/BAMS-D-20-0134.1.

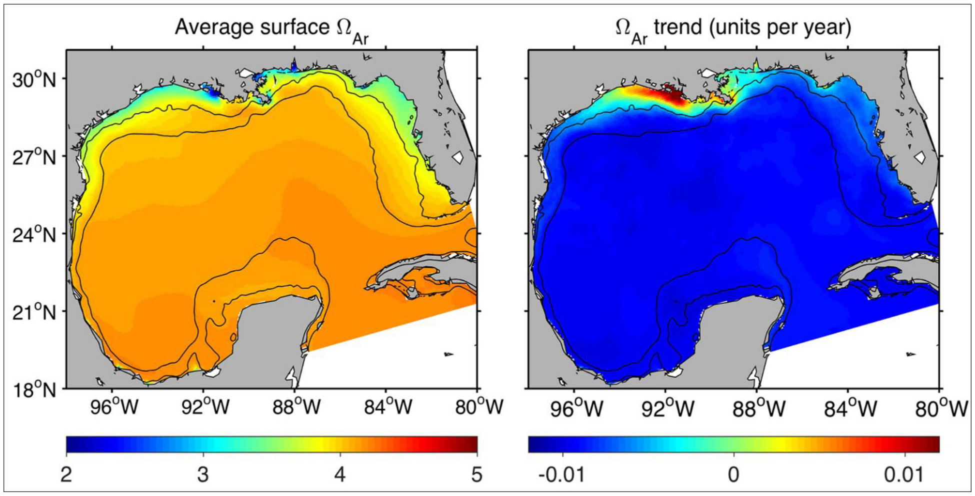


Storm-following nests (thin black boxes) are shown for five tropical cyclones in an experimental version of the NOAA's Hurricane Weather Research and Forecasting model. The Central Pacific Hurricane Center (CPHC) and National Hurricane Center (NHC) areas of responsibility are shown by thick black boxes to demonstrate how tropical cyclone interactions are captured over short and long distances. The characters 13E, 14E, 15E, 09L, and 10L refer to the individual tropical cyclones in this forecast, i.e., Kiko, Mario, and Lorena in the eastern North Pacific and Humberto and Jerry in the North Atlantic, respectively.

River Runoff Creates a Buffer Zone for Ocean Acidification in the Gulf of Mexico

A new study by scientists at AOML, the University of Miami, and Northern Gulf Institute has revealed that the alkalinity of river runoff is a crucial factor for slowing the pace of ocean acidification along the Gulf of Mexico's northern coast. This valuable, first-time finding may also be indicative of ocean carbon chemistry patterns for other U.S. coastal areas significantly connected to rivers.

The research, published in *Geophysical Research Letters*,* used models to identify the main drivers of ocean acidification for different regions of the gulf. The models provided evidence that river alkalinity has counteracted the progression of ocean acidification for coastal areas along the gulf.



Maps that show the average surface aragonite saturation state (Ω_{Ar}) (left) and its long-term trend (right) across the Gulf of Mexico. Positive aragonite saturation state trend values over the northern coastal areas of the Gulf of Mexico imply a progression to less acidic conditions. This ocean acidification buffer has been caused by the Mississippi-Atchafalaya River's alkaline water mixing and neutralizing the seawater in that area.

Ocean acidification refers to a reduction in seawater pH over time, mainly caused by increased levels of carbon dioxide in the atmosphere being absorbed into the ocean. Seawater chemically reacts with carbon dioxide to form carbonic acid, causing the ocean to become more acidic.

These changes in ocean chemistry negatively impact marine species such as corals and shellfish by impairing their ability to grow and persist. As the ocean's pH level decreases, there is also a reduction in the aragonite saturation state, i.e., the water conditions that will more likely dissolve calcium carbonate, one of the materials used by shells and coral skeletons to form their structure.

Corals and shellfish need a higher aragonite saturation state and less acidic waters, i.e., higher levels on the pH scale, to thrive. If seawater becomes too acidic, less coral reef habitat is available for fish and other reef dwelling animals that ultimately diminishes biodiversity and marine ecosystem health.

For a freshwater body, the Mississippi River has a relatively high level of alkalinity. Over recent decades, agricultural practices such as liming, i.e., adding materials to lower soil acidity, and water quality improvements have both contributed to increased levels of water alkalinity in the Mississippi River system. Alkalinity acts as a neutralizing factor that makes a solution less acidic and more basic or alkaline.

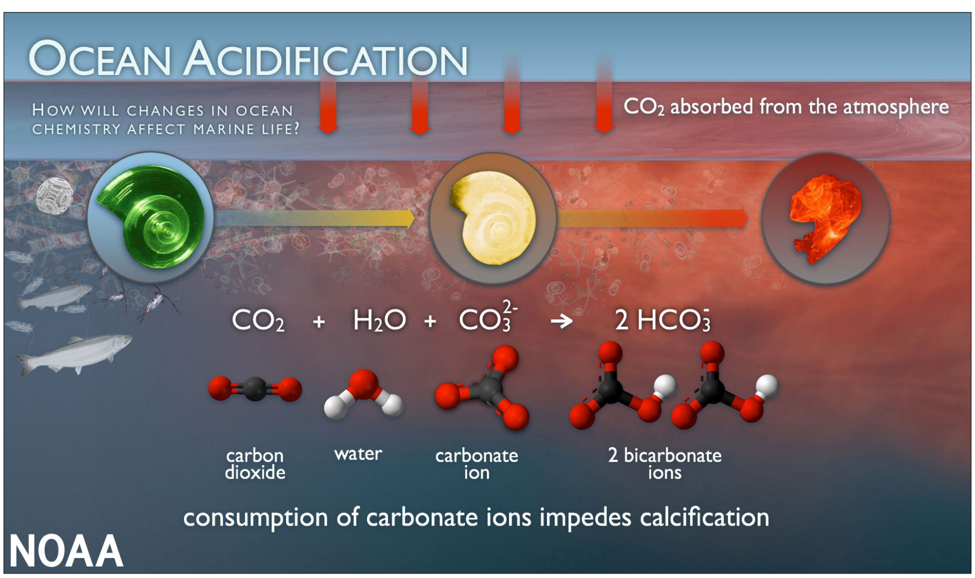


Diagram that shows how a pteropod shell dissolves over time due to ocean acidification. When atmospheric carbon dioxide is absorbed by the ocean, the chemistry of the seawater is altered and conditions become more acidic. Lower pH levels challenge the ability of corals and shellfish to build their structure.

"Our study showed that river alkalinity inputs from the Mississippi River can offset the progression of ocean acidification in northern coastal areas of the Gulf of Mexico. We can expect river alkalinity to have a similar counteracting effect on ocean acidification in other U.S. coastal regions, since the dominant pattern for U.S. rivers is alkalinization," said Fabian Gomez, lead author of the study and a Northern Gulf Institute research scientist at AOML.

Ocean acidification is a major environmental stress factor that contributes to the degradation of valuable marine resources in the gulf. A recent report by NOAA's Office of Coastal Management highlighted the economic value of the Gulf of Mexico's coastal and marine ecosystems: they support approximately 598,000 workers and are the largest contributor to America's blue economy, with an estimated $104 billion dollars coming from oil and gas production, marine shipping, and the fishing industry.

This research, supported by NOAA's Ocean Acidification Program, will help preserve and manage coral reefs and other marine species that gulf coastal communities depend on for fishing, tourism, and other economic drivers in the region.

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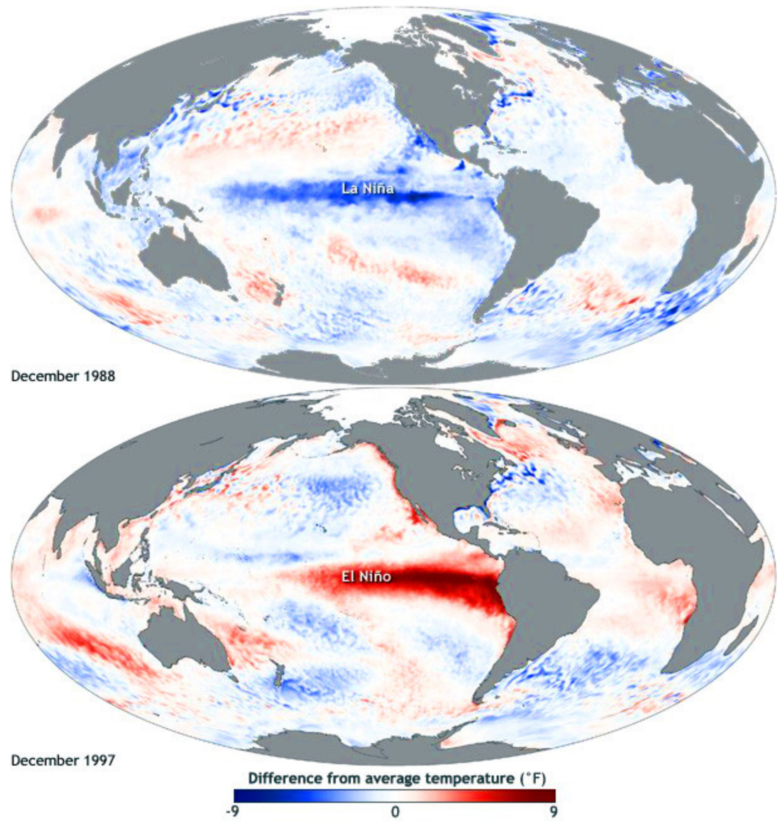
*Gomez, F.A., R. Wanninkhof, L. Barbero, and S.-K. Lee, 2021: Increasing river alkalinity slows ocean acidification in the northern Gulf of Mexico. *Geophysical Research Letters*, 48(24):e2021GL096521, https://doi.org/10.1029/2021GL096521.

New Research Showing Link between Florida Current and Pacific Ocean could Improve Sea Level, Climate Prediction

New research* by scientists at AOML shows that sea surface temperature changes in the equatorial Pacific Ocean, part of a weather phenomenon known as the El Niño-Southern Oscillation (ENSO), can help predict changes in the Florida Current that occur three months later. The ENSO's influence on the Florida Current was also found to affect sea levels along the eastern side of the Florida Straits.



Maps of sea surface temperature anomaly in the Pacific Ocean during a strong La Niña (top, December 1988) and El Niño (bottom, December 1997). Maps by NOAA Climate.gov, based on data provided by NOAA View.

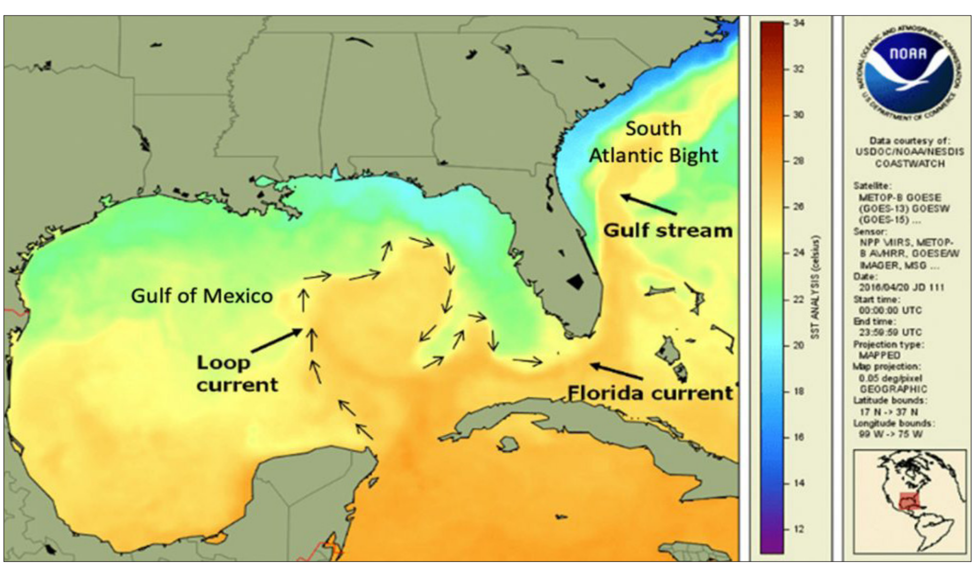
El Niño and La Niña are the warm and cool phases of the ENSO recurring climate pattern across the tropical Pacific. ENSO is one of the most important drivers of global climate because of its ability to influence temperatures and precipitation across the globe, affecting ecosystems and economies worldwide.

The Florida Current is a strong oceanic current that flows northward along the eastern coast of Florida through the Florida Straits. It carries warm tropical waters that eventually feed the Gulf Stream (see image below). Scientists monitor the Florida Current due to its influence on weather, climate, and society, including changes in coastal sea levels and flooding events. Previous studies have investigated drivers of variability in the Florida Current transport, but it is not yet fully understood.

According to Shenfu Dong, an AOML oceanographer and lead author of the study, "The Florida Current is a critical component of the Meridional Overturning Circulation (MOC) that plays a substantial role in climate and weather. Establishing this strong relationship between the Florida Current and ENSO not only benefits coastal communities for sea level prediction, but also helps us better predict extreme weather events and climate."

Analyzing in-situ and satellite observations from 1993 to 2020, AOML scientists found warming conditions in the Pacific (El Niño) that resulted in low pressure anomalies in the Gulf of Mexico, and high pressure anomalies that extended into the Caribbean Sea from the tropical Atlantic. This pressure pattern is associated with anticyclonic winds over the Caribbean Sea and the Bahamas that drive abnormal oceanic convergence, which causes higher sea levels in those regions. Oceanic convergence refers to the process of water particles flowing into and accumulating in an area.

The Florida Current strength is proportional to the sea level difference between the Bahamas and Florida. Rising sea levels near the Bahamas increase the sea level slope across the Florida Straits, and hence, a stronger Florida Current. Cooling conditions (La Niña) in the equatorial Pacific will have the opposite effect, resulting in reduced Florida Current transport and lower sea levels near the Bahamas.



The Gulf of Mexico Loop Current on April 20, 2016, as shown by the CoastWatch GOES-Polar Operational Environmental Satellite Global Sea Surface Temperature product.

*Dong, S., D.L. Volkov, G. Goni, K. Pujiana, F. Tagklis, and M. Baringer, 2022: Remote impact of the equatorial Pacific on Florida Current transport. *Geophysical Research Letters,* 49(4): e2021GL096944, https://doi.org/10.1029/2021GL096944).

Oceanographic Discovery and International Cooperation Live on Aboard *Tara*

This guest post by Nastassia Patin, a University of Miami-Cooperative Institute microbial ecologist and bioinformatician at AOML, provides a personal reminiscence of her time at sea in the Southern Ocean aboard the schooner Tara as a member of the Mission Microbiomes research cruise.

Scientists and crew members aboard the *Tara* on a calm day in Antarctica (photo credit: Maéva Bardy).

In January and February 2022, I was fortunate to take part in the Antarctic leg of Mission Microbiomes aboard the schooner *Tara*. My participation was part of a partnership between NOAA and AtlantECO, a European-led consortium to characterize, quantify, and model Atlantic Ocean ecosystems. The science conducted under AtlantECO includes studies on a wide of range biological, chemical, and physical oceanographic processes. *Tara* is the platform for Mission Microbiomes, an ambitious effort to apply standardized sampling protocols across multiple voyage legs over 2 years across the Atlantic and Southern Oceans.

Like most marine microbiologists, I first heard about *Tara* when papers started appearing using DNA sequence data from something called "Tara Oceans." These datasets included environmental DNA from sites covering the world's oceans. They were produced using a method called shotgun metagenomic sequencing, which encompasses all of the DNA from a sampled community; it is the most powerful way of characterizing the microscopic life contained in a drop (or in *Tara's* case, 20 liters) of water.

Nastassia Patin collects water samples from the Southern Ocean (photo credit: Léa Olivier).

Bioinformaticians like myself can use metagenomes to reconstruct whole genomes without first isolating organisms in culture, an enormously valuable tool given that >99% of marine microbes have not been cultured. Genome sequences tell us not only who the microbes are but what they are doing; for example, whether they perform photosynthesis or recycle organic matter to fuel the eukaryotic plankton communities (a process known as the "biological pump"). The production and public release of these data have been a wonderful service to the marine science community and have resulted in hundreds of publications (and counting) that have greatly expanded our understanding of critical oceanographic processes.

When I was given the opportunity to join one of the legs of Mission Microbiomes, I immediately jumped at it. I knew very little about the boat itself or its storied history. *Tara* is a 36-meter (118 foot) schooner (a term I had to look up; it means there are two masts). It was built in 1989 for an Arctic drift, a journey that involves trapping a boat in the polar ice pack, transporting it around the North Pole via the ice drift, and releasing it in the spring.

Ironically, it was named *Antarctica* and didn't perform the intended journey under its first owner. In 2000 it was purchased by Sir Peter Blake, the celebrated yachtsman who used it to promote environmental awareness and the impacts of climate change, and renamed *Seamaster*. Sir Peter was tragically killed by river pirates in the Amazon in 2001, and the boat was subsequently bought by the Tara Oceans Foundation. Tara Oceans was only one project facilitated by the foundation. Other voyages included Tara Pacific, which sampled tropical coral reefs in the Pacific Ocean, and Tara Arctic, an 18-month expedition which fulfilled the original vision of the boat for an Arctic drift (only the second boat to ever do so, after Fridtjof Nansen completed a drift on the *Fram* in 1896).

Mission Microbiomes is perhaps the most scientifically ambitious of all these projects. Along with protocols for sampling environmental DNA and RNA, which were the core of Tara Oceans, under the AtlantECO protocols we also measured biogeochemical parameters (including nutrients and oxygen and nitrogen isotopes), deployed plankton nets to characterize the phyto- and zooplankton communities, and even used a custom-built rosette to analyze trace metals. The latter was an important component of our work in the Southern Ocean which, unlike all other oceans, is limited primarily by iron rather than macronutrients like nitrate and phosphate. It was also a massive challenge as trace metal sampling is extremely susceptible to contamination from instruments, rust, and careless handling.

The sampling was governed by a set of standardized protocols, developed by AtlantECO and distributed ***cont. page 8*** *cont. from page 7*

among five different “operators.” We were lucky to have a sixth person, chief scientist Alessandro Tagliabue from the University of Liverpool, who could help wherever he was most needed because a full station with four depths sampled with two rosettes was a very heavy workload.

The sampling schedule was never unbearable, however, in large part because every person aboard *Tara* is expected to work as an equal member of the team. Sailors and scientists share all the cleaning duties, and scientists even participate in night watches. On any given day, a PhD student might clean toilets with the captain, the chief scientist might label a hundred tubes, and the cook might help deploy the rosette. As a result of this egalitarian approach, there is a very strong sense of camaraderie aboard the boat. I can personally say I have never felt such a strong team dynamic in any of my previous field work. It was a spirit that kept everyone smiling even on days when work on deck was being done in the snow with 40-knot winds.

Of course, the experience was elevated to another level by our surroundings. It was my first time in Antarctica, and I was overwhelmed by the majesty of the icebergs, the ever-changing light, the grace of the birds and mammals in the sea, and their charming clumsiness on land. We were lucky enough to go ashore several times, including one day on the Antarctic continent itself.

It was near the end of the fledgling season and we saw flocks of young penguins, barely out of their downy coats, make their first dive into the frigid waters. We also visited Deception Island, a horseshoe-shaped volcanic island whose interior is devoid of charismatic megafauna, likely due to the geothermal activity. I convinced the chief scientist to allow a half-day of sampling at Deception and am intrigued to see what kinds of microbes thrive in these polar vents.

The Deception Island sampling is one example of the unique scientific capabilities aboard *Tara*. Its small size and maneuverability compared to most oceanographic research vessels allows it to approach physical features for very precise sampling. For example, one of our scientific objectives was to sample gradients around an iceberg, and we were able to do so by getting very close to the source of the freshwater plume with *Tara*. In addition, with a maximum of six scientists in one team aboard, it was easier to adjust sampling plans and accommodate schedule changes.

The laboratory capacities are, of course, more limited than those of a larger vessel; nevertheless, the capabilities for sampling and filtering water are supported by a 12-bottle rosette and CTD, a wet lab with high-throughput filtration setups, a dry lab for smaller-scale filtrations, and a new trace metal rosette and glove box following protocols of the GEOTRACES program. It is a truly remarkable floating laboratory with massive potential for comprehensive physical, biological, and chemical characterization of the world’s oceans.

My time aboard *Tara* showed me how much science can be accomplished with limited resources and a strong sense of purpose. Mission Microbiomes is performed in the same spirit of exploration and determination that characterizes the schooner’s history, which is detailed in the rich library onboard. I feel privileged to have been a part of one leg of the mission, and I look forward to the resulting scientific revelations which will doubtless unfold over many years.

Building on the success of Tara Oceans, Mission Microbiomes and AtlantECO are helping to unravel the microbial drivers of global oceanographic processes, which are crucial not only to understanding the present but also predicting the future of our seas. American-European collaborations of this scale are rare but incredibly valuable, and NOAA should continue to capitalize on this extraordinary opportunity as a partner in AtlantECO.

Tara **anchored in the central bay of Deception Island, a horseshoe-shaped volcanic island, to sample microbiomes and discover the forms of life that thrive in the water’s polar vents.**

Nastassia Patin encounters a fledgling penguin while ashore in Antarctica (photo credit: Maéva Bardy).

Coyote Small Uncrewed Aircraft System Data Improved Hurricane Maria Forecasts

AOML meteorologist Joe Cione holds one of several Coyote small Uncrewed Aircraft Systems deployed from NOAA's P-3 Hurricane Hunter aircraft (background) during missions into Hurricane Maria.

Observations obtained by the Coyote small Uncrewed Aircraft System led to a significant improvement in the analyses of Hurricane Maria's (2017) position, intensity, and structure, according to new research published in the journal *Monthly Weather Review**. The study by AOML and University of Miami-Cooperative Institute scientists highlights how the Coyote's novel near-surface measurements helped more accurately depict Hurricane Maria's inner core, demonstrating their ability to improve forecasts.

Hurricane Maria left a trail of destruction on its path through the Caribbean in September 2017 as a deadly major storm. During missions of NOAA's P-3 Hurricane Hunter aircraft, AOML scientists deployed six Coyote drones in the eye and surrounding eyewall of Maria to test their ability to sample the lowest reaches of the hurricane environment.

Measurements from this turbulent region where the ocean and atmosphere collide are critically important but rarely observed, as conditions found there are too dangerous for crewed aircraft. The diminutive Coyote drones, weighing only 13 pounds, collected wind, temperature, humidity, and atmospheric pressure data—typically several times every second for periods up to an hour—at altitudes as low as 300 feet above the ocean surface.

These high-resolution data were added to NOAA's Hurricane Weather Research and Forecasting model, the first ever inclusion of such observations, using the Hurricane Ensemble Data Assimilation System developed at AOML. To improve their impact on model forecasts, the authors devised a quality-control technique to identify and remove outlier observations. Additional improvements to model forecasts were achieved by assimilating Coyote measurements at the high frequency rate of 5 every minutes rather than every 6 hours.

The impact of quality-controlled Coyote data ingested into the model at 5-minute intervals was significant. Error reductions were noted for all observation types based on statistics computed at the locations of both the Coyote and non-Coyote observations.

The Coyote's measurements of the seldom sampled atmosphere closest to the ocean were key to providing more accurate depictions of Hurricane Maria's intensity and structure as the storm passed through the Caribbean. These unique data can help improve future forecasts to warn the public of impending severe weather.

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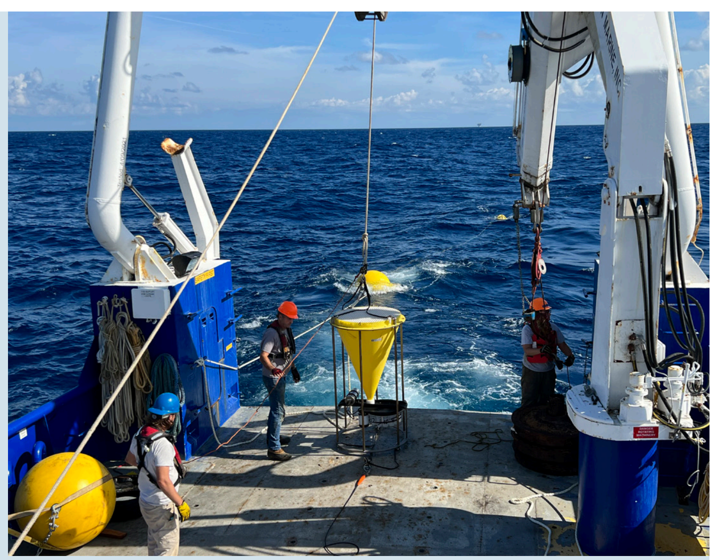
*Aksoy, A., J.J. Cione, B.A. Dahl, and P.D. Reasor, 2022: Tropical cyclone data assimilation with Coyote uncrewed aircraft system observations, very frequent cycling, and a new online quality control technique. *Monthly Weather Review,* 150(4):797-829, https://doi.org/10.1175/MWR-D-0124.1.

New Sediment Trap Time-Series Project Launched in the Northern Gulf of Mexico

In December 2021, the Northern Gulf Institute and AOML collaborated with US Geological Survey researchers to launch a new joint sediment trap time-series in the northern Gulf of Mexico. This mooring, located at a water depth of 1,200 meters (28.24°N, 89.13°W), is suspending two sediment traps at approximately 600 meters that will be collecting ocean particulates for the next 6 months.



Scientists prepare to deploy a sediment trap in the northern Gulf of Mexico from the aft of the R/V *Pelican*.

With a goal of maintaining this mooring for 5 years, the research team will be returning in May to retrieve samples and then redeploy the mooring for another 6 months. The objective of this new project is to quantitatively track particle fluxes to ocean depths and characterize the environmental DNA signatures of collected sediments. By applying new eDNA approaches to particulate fluxes collected by the sediment trap, AOML researchers aim to characterize the biodiversity of sinking ocean particulates and observe changes over seasonal and interannual time-scales. Studying the delivery and transformation of ocean particulates will help researchers better understand how the biological carbon pump, a major carbon cycling pathway, works within this region of the world.

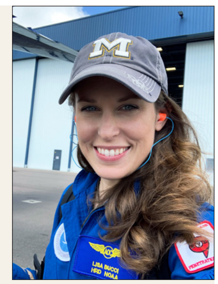
Spotlight On!

AOML is pleased that four of its scientists were profiled on the NOAA Research website in honor of March being Women's History Month. Below are excerpts from their profiles; their full profiles can be accessed at https://research.noaa.gov/News/Scientist-Profile.

***Nicole Besemer** is a marine biologist with AOML's Coral Program focused on investigating the impacts of climate change and ocean acidification on coral reefs. Nicole's role is to manage the program's climate monitoring efforts in support of the National Coral Reef Monitoring Program.*

What drew you to your current career or field? My dad would take me out on his boat before I could walk, so I grew up fishing with him and spending time on the water. We lived in many different places, but one constant was always finding a lake or ocean to take the boat out. This is where I really grew my appreciation for everything the environment had to offer. In high school, I was fortunate to participate in multiple field trips to explore national parks. This included a 2-week trip to Alaska, as well as visits to the Grand Canyon, Zion National Park, Bryce Canyon, and many others. It was from these experiences and inspiration from my science teacher that I was able to realize a career studying the environment, and more specifically marine science, was possible. My two positions before joining NOAA were working for the National Park Service.

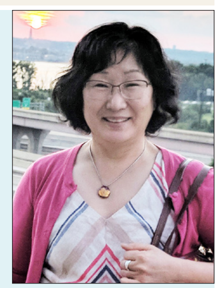
What do you enjoy most about your work? There are two aspects to this question for me. What I love most about my job is it's so versatile. From planning trips, to being in the field, analyzing the data, reporting the data, participating in outreach activities, and mentorship, I never do one thing for too long. What I enjoy the most about our program and our research is that we are contributing to science that can hopefully make our world and environment a better place one day, and I'm thankful for the opportunity to do so.



***Lisa Bucci** is a research scientist with AOML's Hurricane Research Division who flies into hurricanes aboard NOAA's Hurricane Hunter aircraft to gather key storm data.*

What drew you to your current career or field? My initial interest in the weather came from a lack of understanding and a fear of the severe storms I experienced growing up in the Midwest. The boom of thunder would send me under the bed or into a closet. As I grew older, I wanted to understand how to forecast storms and what to do in the event of a severe outbreak in order to feel safe. This research gave me an appreciation for meteorology, and my fear subsided as I learned more about the subject. When choosing a major in college, I jumped at the opportunity to formalize my interest in atmospheric sciences and ended up completing three degrees in the field!

What do you enjoy most about your work? Field work! I love getting on NOAA's Hurricane Hunter aircraft and flying into storms. Each storm has a unique story and teaches me something new. It reignites my passion for understanding storms, how to better observe and forecast them, and to be a part of the process to help my friends and neighbors stay safe in the event of a landfalling hurricane.

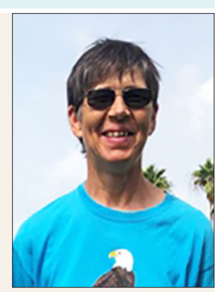


***Hyun-Sook Kim** is a research scientist with AOML's Physical Oceanography Division focused on better understanding the interactions between the ocean and extreme weather events using coupled numerical forecast systems. "Coupled" models bring two or more models together, e.g., ocean and atmospheric models, to build a more comprehensive model.*

What drew you to your current career or field? Science has always been fascinating to me because it is the study of the natural world following theoretical principles. I had the option of pursuing basic physics as a career, but instead chose to study extreme weather events using numerical modeling systems because of the more practical nature of the research and benefit to society.

What do you enjoy most about your work? Discovery! It is rewarding to know the tools I build provide scientific evidence that supports research and contributes to the advancement of physics in modeling.

Do you have a favorite moment or accomplishment in your career? Yes! It is in knowing that coupled modeling systems transitioned to operational numerical models are still providing valuable guidance about typhoons and cyclones to forecasters around the globe.



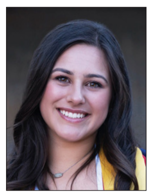
***Claudia Schmid** is a research oceanographer with AOML's Physical Oceanography Division. She spends a large part of her time as the manager of a data center, primarily studying the variability of ocean circulation. Getting a better understanding of such variability is important for ecosystems, weather and climate research, and forecasting.*

What projects or research are you working on now? I currently spend most of my time managing the US Argo Data Assembly Center as one of the principal investigators of the US Argo project. The goal of this project is to monitor the conditions in the ocean using profiling floats, which measure pressure, temperature, and salinity in the upper 2,000 meters of the ocean. Some floats can go to the ocean bottom (6,000 meters limit), while other floats can also measure biogeochemical properties (for example, chlorophyll-a, nitrate, oxygen). The data are distributed 24/7 to the scientific community and operational centers. They are also available to the general public. Currently, seven team members help me with software developments and all other work needed to have a functioning data center.

Do you have a favorite moment or accomplishment in your career? My favorite moments were going to sea to see first-hand how observations are collected. It provides a thorough understanding of the challenges one has to overcome to collect high-quality data. It also teaches one to accomplish the best possible outcome with the available resources. Those experiences continue to be useful in my current role as manager of the US Argo Data Center.

Welcome Aboard

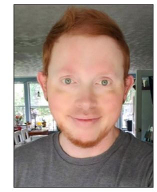
Laura Chaibongsai joined the Office of the Director in January as a Communications Specialist/Physical Scientist to lead communications at AOML. Laura is a science communicator who specializes in program management, citizen science, and community engagement. She most recently served as a Research Development Officer for Florida International University, supporting scientists in the Institute of Environment. Prior to that, Laura spent 13 years at the University of Miami's Rosenstiel School as an outreach manager and then as the program manager of the Consortium for Advanced Research and Transport of Hydrocarbon in the Environment (CARTHE). Throughout her career, Laura has translated ocean and atmospheric science for a wide range of audiences, with a specific focus on reaching underrepresented communities. At AOML, she will manage all aspects of communications to promote the lab's research and science activities. Laura holds an MA degree in Marine Affairs and Policy from the Rosenstiel School.



Morgan Chakraborty joined AOML's Ocean Chemistry and Ecosystems Division in February as a Coral Program intern. Morgan will spend the next year supporting the National Coral Reef Monitoring Program's research efforts and restoration projects. Before coming to AOML, she worked as an intern in the Coral Reproduction Lab at the Mote Marine Laboratory on Summerland Key. At Mote, Morgan was involved in multiple research activities, including coral spawning and daily husbandry, and led her own project entitled "2021 Looe Nursery *Acropora cervicornis* gamete bundle fecundity." Morgan is currently a University of Miami-Rosenstiel School graduate student in the Master of Professional Science program.

Dr. Jorge Guerra joined AOML's Hurricane Research Division in February as a scientist with the University Corporation for Atmospheric Research (UCAR). Jorge will support NOAA's Quantitative Observing System and Assessment Program led by Dr. Lidia Cucurull by quantifying and optimizing the benefits of radio occultation observations from current and proposed satellite missions. Prior to joining AOML, he conducted research through the University of Oklahoma's Cooperative Institute for Severe and High-Impact Weather Research and Operations at NOAA's Global Systems Laboratory. There, he supported the Warn-on-Forecast System to increase lead times for severe weather events. Jorge holds a PhD in Atmospheric Science from the University of California-Davis.

Jasmin John joined AOML's Ocean Chemistry and Ecosystems Division in January as the division's new Deputy Director. Jasmin comes to AOML from NOAA's Geophysical Fluid Dynamics Laboratory (GFDL) in Princeton, New Jersey where, as a physical scientist, she conducted research focused on understanding the legacy effects of climate change on the Earth system, particularly the ocean and marine ecosystems. Jasmin additionally served as the technical lead for the management and development of GFDL's Earth System Models on various high performance computing platforms in support of the Coupled Model Intercomparison Project/Intergovernmental Panel on Climate Change and other science initiatives. At AOML, she will tend to both research and administrative duties for the division's 50+ scientists and support staff. Jasmin holds a BA degree in Applied Mathematics and Physics (double major) from Barnard College and a MA degree in Astronomy from Columbia University.



Paul Johnson joined AOML's Physical Oceanography Division in January as a University of Miami-Cooperative Institute Research Associate. Paul will support the US Argo Data Assembly Center at AOML led by Dr. Claudia Schmid. Specifically, Paul will work to decode and add new information to Network Common Data Form (NetCDF) files such as position errors. These errors are determined by the organization transmitting the data to AOML, together with metadata derived from their system, and are added to the trajectory files used for estimating the velocity at the drift depth of Argo profiling floats. Paul holds a BS degree in Information Technology from Florida International University.

Willem (Will) Klajbor joined AOML's Ocean Chemistry and Ecosystems Division in March as a University of Miami-Cooperative Institute Senior Research Associate. Will just completed a year-long Knauss Fellowship with NOAA's Office of National Marine Sanctuaries. At AOML, he will work to coordinate the activities of the Ecosystem Indicators Working group, a cross-line office team that updates and maintains the National Marine Ecosystem Status website (ecowatch.noaa.gov). He will also lead the effort to use the Integrated Ecosystem Assessment framework to inform wind energy decision-making in the Gulf of Mexico. Will holds a MS degree in Marine Resource Management from Oregon State University.

Jessica Leonard joined AOML's Physical Oceanography Division in January as a University of Miami-Cooperative Institute Research Associate. Jessica will support the US Argo Data Assembly Center at AOML led by Dr. Claudia Schmid, with duties mainly focused on developing quality control software. Part of this work will involve the implementation of new automatic quality control tests approved by the International Argo Data Management Team. Jessica will additionally adapt software to improve performance tracking. She holds BS degrees in both Physics and Marine Sciences from North Carolina State University.

NOAA Corps Officer Commander Tony Perry joined the Office of the Director in January as AOML's new Associate Director. Tony comes to AOML after having just completed 2 years as the Commanding Officer of the NOAA Ship *Oscar Elton Sette* stationed in Honolulu, Hawaii, in support NOAA fisheries assessments, physical and chemical oceanographic research, and marine mammal/marine debris surveys. At AOML, Tony will oversee the daily operation and maintenance of the AOML facility and grounds, tend to safety, security, and preparedness measures, and manage various ongoing and new repair and enhancement projects. Tony holds a BS degree in Marine Sciences from California State University-Monterey Bay.

Welcome Aboard *(continued)*

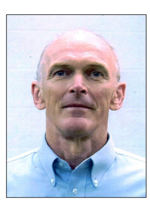
Dr. Isabel Porto da Silveira joined AOML's Physical Oceanography Division in March as a University of Miami-Cooperative Institute Senior Research Associate. Isabel will work with Dr. Shenfu Dong to support AOML's expendable bathythermograph (XBT) and glider projects. Specifically, Isabel will assist with software development, data analysis and management, graphics generation, and product/website development and maintenance. She holds a PhD in Meteorology from the Instituto Nacional de Pesquisas Espaciais, i.e., National Institute for Space Research.

Dr. Franz Philip Tuchen joined AOML's Physical Oceanography Division in January as a new National Research Council post-doctoral scientist. Philip will work with Drs. Renellys Perez and Greg Foltz on a project to study the long-term influence of tropical Atlantic instability waves on climate using observations and numerical models. He received his PhD in Physical Oceanography from GEOMAR and the University of Kiel, Germany in 2020. Philip has studied a variety of topics including equatorial Atlantic deep jets, subtropical cells, subtropical water mass pathways, and the meridional overturning circulation.

Dr. Benjamin Young joined AOML's Ocean Chemistry and Ecosystems Division in February as a University of Miami-Cooperative Institute post-doctoral scientist. Ben will support the Coral Program by working on several projects related to the outbreak of stony coral tissue loss disease; specifically, identifying transmission vectors and treatments and applying 'omics technologies to better understand disease resistance in coral populations. He recently completed his PhD at the University of Miami's Rosenstiel School, where he examined disease dynamics of the endangered coral species *Acropora palmata* using microbial and transcriptomic techniques.

Congratulations

Mu-Chieh "Laura" Ko, a University of Miami-Cooperative Institute Senior Research Associate with AOML's Hurricane Research Division, earned a MS degree in Electrical and Computer Engineering from the University of Miami's College of Engineering in December 2021. At AOML, Laura supports the Hurricane Modeling and Prediction Program by focusing on the use of machine learning applications to improve hurricane forecasts.

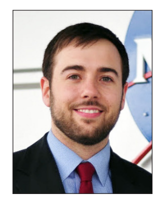


Rik Wanninkhof, AOML's senior scientist and an oceanographer with AOML's Ocean Chemistry and Ecosystems Division, is a coauthor on a paper that received a NOAA Research 2021 Outstanding Scientific Paper Award. "*The oceanic sink for anthropogenic CO_2 from 1994 to 2007*" by Gruber *et al.* (2019) was the top contender in the Oceans and Great Lakes category. Published in the journal *Science*, this research quantified the global ocean's uptake of anthropogenic carbon dioxide for the period 1994-2007. The paper can be accessed at https://doi.org/10.1126/science.aau5153.

Farewell

Dr. Soumi Chakravorty, a University of Miami-Cooperative Institute scientist with AOML's Physical Oceanography Division, completed her 2-year post-doctoral appointment in December. Soumi is now performing research as a post-doctoral scientist at the Imperial College in London. While at AOML, Soumi studied the impact of atmospheric variations in the extratropical Pacific on the development of El Niño events. She also studied the differences in the subsurface build-up and discharge of heat associated with central-Pacific and eastern Pacific El Niño events and the implications of those differences on El Niño predictability. Soumi published three peer-reviewed articles about this research, with two papers appearing in the *Journal of Climate* and one in the *Journal of Geophysical Research-Oceans*.

Kristina Kiest, a digital communications specialist with AOML's Office of the Director, resigned in March to accept a communications position with the Weather Program Office at NOAA Research. Kristina began at AOML as a communications intern in 2018 tasked with writing science articles for the AOML website and other venues, growing AOML's social media presence, and supporting a variety of outreach events. She later supported the Office of the Director as a web developer who spearheaded the total redesign of the AOML's web presence through the use of Google analytics and science communication best practices.



Dr. Peter Marinescu, a Colorado State University-Cooperative Institute scientist with AOML's Hurricane Research Division, completed his 2-year post-doctoral appointment in January. During Peter's time at AOML, he worked with the Quantitative Observing System Assessment Program under the direction of Dr. Lidia Cucurull. Peter's research focused on evaluating the impact of remotely-sensed, three-dimensional wind observations obtained by the Aeolus satellite on hurricane analyses and forecasts using the Hurricane Weather Research and Forecasting (HWRF) model. Peter will continue his affiliation with NOAA as a Colorado State University-Cooperative Institute scientist with NOAA's Global Systems Laboratory in Boulder, Colorado.

Dr. Lakemariam Worku, a University of Miami-Cooperative Institute scientist with AOML's Hurricane Research Division, completed his 2-year post-doctoral appointment in January. While at AOML, Lake facilitated the first ever Hazardous Weather Testbed tropical cyclone experiment in collaboration with colleagues at NOAA's National Weather Service and National Hurricane Center. Lake also conducted an experiment with National Weather Service forecasters to test the tropical cyclone wind recommender technique in the Advanced Weather Interactive Processing System (AWIPS). AWIPS is a processing, display, and telecommunications system that lies at the foundation of the National Weather Service's operations. The results Lake collected will optimize the wind recommender technique for future operational implementation by the National Weather Service.

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

Andrade-Canto, F., F.J. Beron-Vera, **G.J. GONI**, D. Karrasch, M.J. Olascoaga, and **J. TRINANES**, 2022: Carriers of Sargassum and mechanism for coastal inundation in the Caribbean Sea. *Physics of Fluids*, 34(1):016602.

Brown, P.J., E.L. McDonagh, R. Sanders, A.J. Watson, **R. WANNINKHOF**, B.A. King, D.A. Smeed, **M.O. BARINGER**, **C.S. MEINEN**, U. Schuster, A. Yool, and M.-J. Messias, 2021: Circulation-driven variability of Atlantic anthropogenic carbon transport, uptake, and inventory. *Nature Geoscience,* 14(8):571-577.

Campos, E.J.D., M.C. van Caspel, W. Zenk, E.G. Morozov, D.I. Frey, A.R. Piola, **C.S. MEINEN**, O.T. Sato, **R.C. PEREZ**, and **S. DONG**, 2021: Warming trend in Antarctic Bottom Water in the Vema Channel in the South Atlantic. *Geophysical Research Letters,* 48(19):e2021GL094709.

CHAKRAVORTY, **S.**, **R.C. PEREZ**, C. Gnanaseelan, and B.T. Anderson, 2021: Revisiting the recharge and discharge processes for different flavors of El Niño. *Journal of Geophysical Research–Oceans*, 126(11):e2020JC017075.

CHAKRAVORTY, **S.**, **R.C. PEREZ**, B.T. Anderson, S.M. Larson, B.S. Giese, and V. Pivotti, 2021: Ocean dynamics are key to extratropical forcing of El Niño. *Journal of Climate*, 34(21): 8739-8753.

CHEN, **X.**, M. Xue, B. Zhou, J. Feng, **J.A. ZHANG**, and **F.D. MARKS**, 2021: Effect of scale-aware planetary boundary layer schemes on tropical cyclone intensification and structural changes in the gray zone. *Monthly Weather Review,* 149(7):2079-2095.

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ENOCHS, I.C., L.T. Toth, A. Kirkland, **D.P. MANZELLO, G. KOLODZIEJ, J.T. MORRIS**, D.M. Holstein, **A. SCHLENZ**, C.J. Randall, J.L. Maté, J.J. Leichter, and R.B. Aronson, 2021: Upwelling and the persistence of coral-reef frameworks in the eastern tropical Pacific. *Ecological Monographs,* 91(4):e01482.

LE HÉNAFF, **M.**, **R. DOMINGUES**, **G. HALLIWELL**, **J.A. ZHANG**, **H.-S. KIM**, M. Aristizabal, T. Miles, S. Glenn, and **G. GONI**, 2021: The role of the Gulf of Mexico ocean conditions in the intensification of Hurricane Michael (2018). *Journal of Geophysical Research–Oceans,* 126(5):e2020JC016969.

LIM, **S.J.**, and **LR. THOMPSON**, 2021: Mito-helper: A mitochondrial reference sequence analysis tool for fish eDNA studies. *Environmental DNA,* 3(4):706-715.

Lin, I.-I., **R.F. ROGERS**, H.-C. Huang, Y.-C. Liao, D. Herndon, J.-Y. Yu, Y.-T. Chang, **J.A. ZHANG**, C.M. Patricola, I.-F. Pun, and C.-C. Lien, 2021: A tale of two rapidly-intensifying super typhoons: Hagibis (2019) and Haiyan (2013). *Bulletin of the American Meteorological Society,* 102(9): E1645-E1664.

MUELLER, **M.J.**, **B. ANNANE**, S.M. Leidner, and **L. CUCURULL**, 2021: Impact of CYGNSS-derived winds on tropical cyclone forecasts in a global and regional model. *Monthly Weather Review,* 149(10):3433-3447.

Ntaganou, N., V. Kourafalou, **M. LE HÉNAFF**, and Y. Androulidakis, 2022: The role of the West Florida Shelf topography on the Loop Current system variability. *Ocean Dynamics,* 72:49-78.

PALACIO-CASTRO, **A.M.**, C.E. Dennison, **S.M. ROSALES**, and A.C. Baker, 2021: Variation in susceptibility among three Caribbean coral species and their algal symbionts indicate the threatened staghorn coral, *Acropora cervicornis*, is particularly susceptible to elevated nutrients and heat stress. *Coral Reefs,* 40(5):1601-1613.

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Tew, K.S., J. Kuo, J.O. Cheng, F.C. Ko, P.J. Meng, **A.B. MAYFIELD**, and P.J. Liu, 2021: Impacts of seagrass on benthic microalgae and phytoplankton communities in a coral reef ecosystem under experimental warming—A mesocosm study. *Frontiers in Marine Science*, 8:679683.

TRINANES, **J.**, and J. Martinez-Urtaza, 2021: Future scenarios of risk of *Vibrio* infections in a warming planet: A global mapping study. *The Lancet Planetary Health,* 5(7):E426-E435.

WADLER, **J.B.**, D.S. Nolan, **J.A. ZHANG**, and L.K. Shay, 2021: Thermodynamic characteristics of downdrafts in tropical cyclones as seen in idealized simulations of different intensities. *Journal of the Atmospheric Sciences,* 78(11): 3503-3524.

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