AOML Keynotes

NOAA'S ATLANTIC OCEANOGRAPHIC AND METEOROLOGICAL LABORATORY

April-June 2021

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

Scientists at AOML Prepare for the 2021 Hurricane Season with New Technology

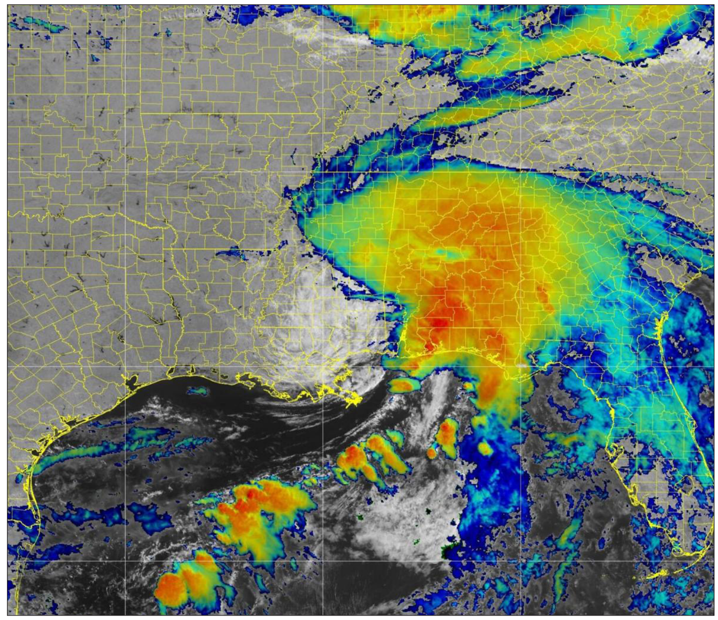
It's back! June 1 marked the beginning of the 2021 Atlantic hurricane season, and NOAA is forecasting another busy year. With an estimated 13-20 named storms predicted to form, hurricane scientists at AOML will continue their efforts to provide NOAA's National Hurricane Center and Environmental Modeling Center with vital data needed to prepare the public for severe weather.

In collaboration with numerous partners, this summer they'll introduce a variety of new observing instruments, modeling techniques, and field campaigns aimed at improving track and intensity forecasts. Some of these new instruments will be deployed for the first time during NOAA's 2021 Hurricane Field Program (see page 2 for more information).

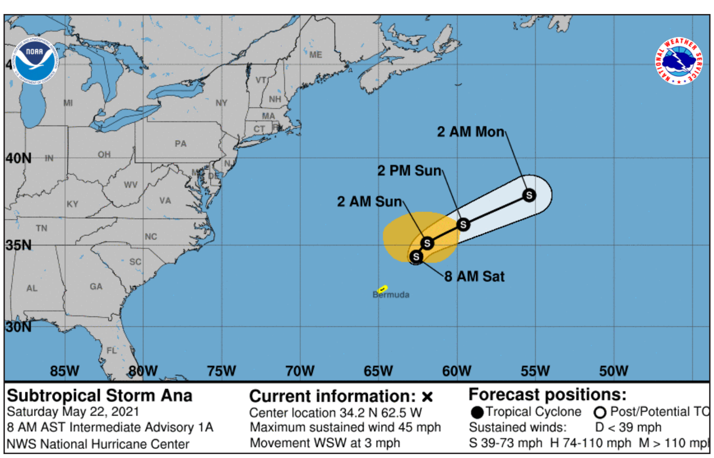
ALAMO floats, surface drifters, saildrones, hurricane gliders, and other instruments will gather ocean observations from the sea surface to depths of half a mile. These data will contribute critical information to forecast models, advancing the knowledge of how ocean conditions impact tropical cyclone intensity.

New this season will also be the Altius-600, a small uncrewed aerial system launched from NOAA's Hurricane Hunter P-3 aircraft. The Altius-600 will collect high quality measurements in the atmospheric layers just above the ocean surface. This turbulent region, chronically undersampled, will help reveal how heat, moisture, and momentum move between the ocean and atmosphere, fueling hurricane development and leaps in storm intensity.

Additionally, a compact rotational Raman Lidar will use a laser to measure temperature, moisture, and Saharan dust in the atmosphere from the aircraft down to the ocean surface, a Terrestrial High-energy Observations of Radiation instrument will measure gamma radiation associated with lightning, and a Wide Swath Radar Altimeter will measure waves at the ocean surface.



NOAA GOES-East infrared satellite image of Tropical Storm Claudette on June 19. Claudette became the first named storm of the 2021 Atlantic hurricane season to make landfall in the US, bringing copious amounts of rainfall to Gulf coast and inland communities.



Subtropical Storm Ana, the first named storm of the 2021 Atlantic hurricane season, formed northeast of Bermuda on May 22 and dissipated the following day. Although short-lived, Ana's development marked the seventh consecutive year the Atlantic hurricane season has begun earlier than its official June 1 start.

Alongside these instruments, hurricane scientists will collaborate with colleagues at the National Weather Service to run a high resolution, moving nested version of the Hurricane Analysis and Forecast System (HAFS), NOAA's next-generation numerical modeling and data assimilation platform. This updated version of HAFS, developed at AOML, is an advance that will enable the inner core region of tropical cyclones to be tracked at 1-2 km resolution.

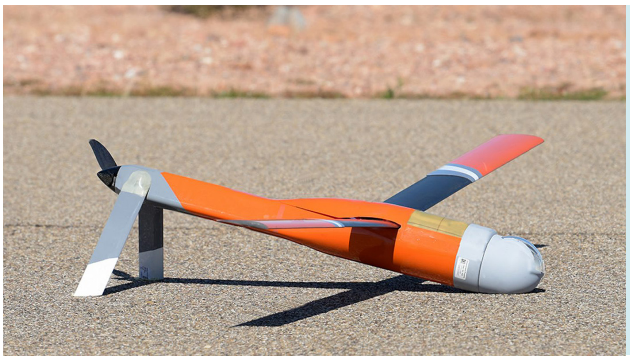
HAFS will provide skilled guidance on track, intensity, and storm structure during the 2021 Hurricane Field Program. A major focus for field operations this year is NOAA's Advancing the Prediction of Hurricanes Experiment (APHEX) to be conducted with multiple partners and focused on all stages of the tropical cyclone lifecycle. Field campaigns will also be conducted with NASA and the Office of Naval Research in support of APHEX.

Equipped with new observing instruments and cutting-edge modeling capabilities this summer, hurricane scientists at AOML will work with their partners to collect and quality control data to help vulnerable communities plan and prepare for severe weather, supporting NOAA's mission of building a more weather-ready nation.

2021 Hurricane Season to Feature an Array of New Technology

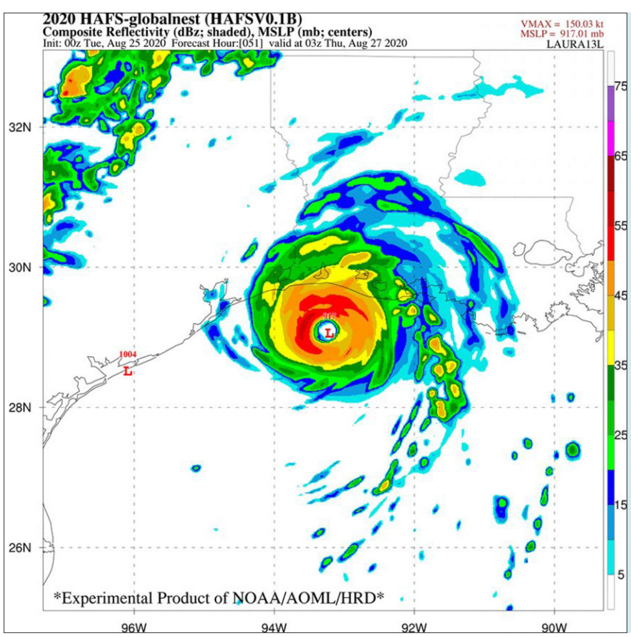
This hurricane season scientists at AOML will deploy an assortment of new air- and water-based uncrewed systems to improve predictions of track and intensity, as well as use a state-of-the-art model to improve forecasts. These capabilities will additionally aid in furthering understanding of the complex processes of how and why tropical cyclones form, strengthen (or fail to strengthen), and dissipate.

Saildrones: AOML will deploy five saildrones in the Atlantic in partnership with NOAA's Pacific Marine Environmental Laboratory (PMEL) in regions where tropical cyclones typically pass. AOML and PMEL researchers will remotely pilot these solar-powered, uncrewed surface vehicles directly into tropical cyclones to gather upper ocean and atmospheric data. Observations from this region of wind-whipped seas and raging winds will help scientists better understand the physical processes for how heat is exchanged between the ocean and atmosphere, providing energy for storms to intensify. These data will be aligned with data from other observing instruments, e.g., hurricane gliders, to improve forecasts.



Altius-600: The Altius-600 uncrewed aerial system will be launched from NOAA's Hurricane Hunter P-3 aircraft to sample the lowest, most turbulent layers of the atmosphere just hundreds of feet above the ocean surface, a region too dangerous for crewed aircraft. This diminutive drone, only 40 inches in length and weighing roughly 25 pounds, can cruise the inner core and eye of tropical cyclones for up to 4 hours and at distances up to 265 miles from its point of launch. The data gathered are expected to help fill gaps in the understanding of how tropical cyclones quickly intensity, as well as advance the ability of forecasters to predict their strength.

ALAMO Floats: Air-Launched Autonomous Micro Observer, or ALAMO, floats will be deployed from NOAA's Hurricane Hunter P-3 aircraft to sample ocean conditions before, during, and after the passage of tropical cyclones. The floats will parachute into the ocean to provide sustained observations of upper ocean temperature and salinity, both factors that contribute to intensification. ALAMO observations will be automatically processed and transmitted in real-time to improve the ocean's representation in ocean-atmosphere coupled forecast models. It is hoped this new technology will ultimately improve predictions of track and intensity, as well as help researchers better detect changes in intensity and overall storm structure.



Hurricane Analysis and Forecast System (HAFS): Scientists at AOML have created the first-ever moving nest for the Unified Forecast System, the foundation of NOAA's weather applications. HAFS is NOAA's next-generation numerical model and data assimilation platform developed within the framework of the Uniform Forecast System. Central to the development of HAFS has been the FV3 dynamical core with an embedded moving nest to enable tracking of the inner core region of tropical cyclones at 1-2 km resolution, key for improving hurricane structure and intensity predictions. HAFS aims to provide reliable and skilled guidance on tropical cyclone track, intensity, and structure, including rapid intensity changes, genesis, and storm size. A set of new, advanced moving nest algorithms have been developed within the Unified Forecast System for HAFS by a team of AOML and University of Miami-Cooperative Institute scientists and software engineers. These algorithms lay the foundation for next-generation advancements in hurricane forecasting beyond NOAA's current Hurricane Weather Research and Forecasting system. HAFS is the first global weather prediction model in the world to feature a movable nest.

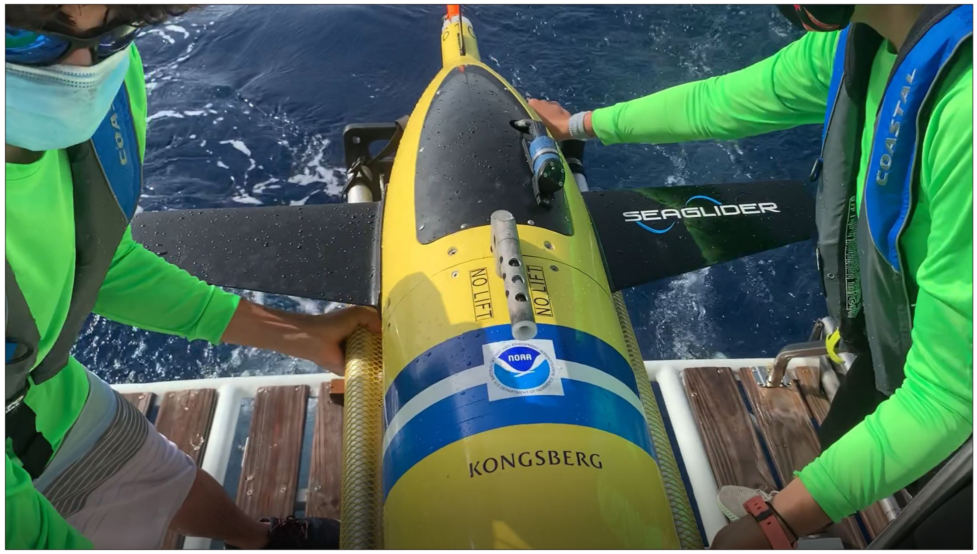
AOML Deploys Gliders in Support of Hurricane Forecasts and Research

In June, scientists at AOML and their partners deployed five gliders in the coastal waters off Puerto Rico and the Dominican Republic. Their deployment marked the eighth year of continuous glider operations in the Caribbean Sea and tropical-subtropical North Atlantic during the Atlantic hurricane season.

The gliders will monitor water mass properties of key ocean features that are linked to hurricane intensification as tropical cyclones travel through these regions. A sixth glider will be deployed later in the summer off of the Bahamas.

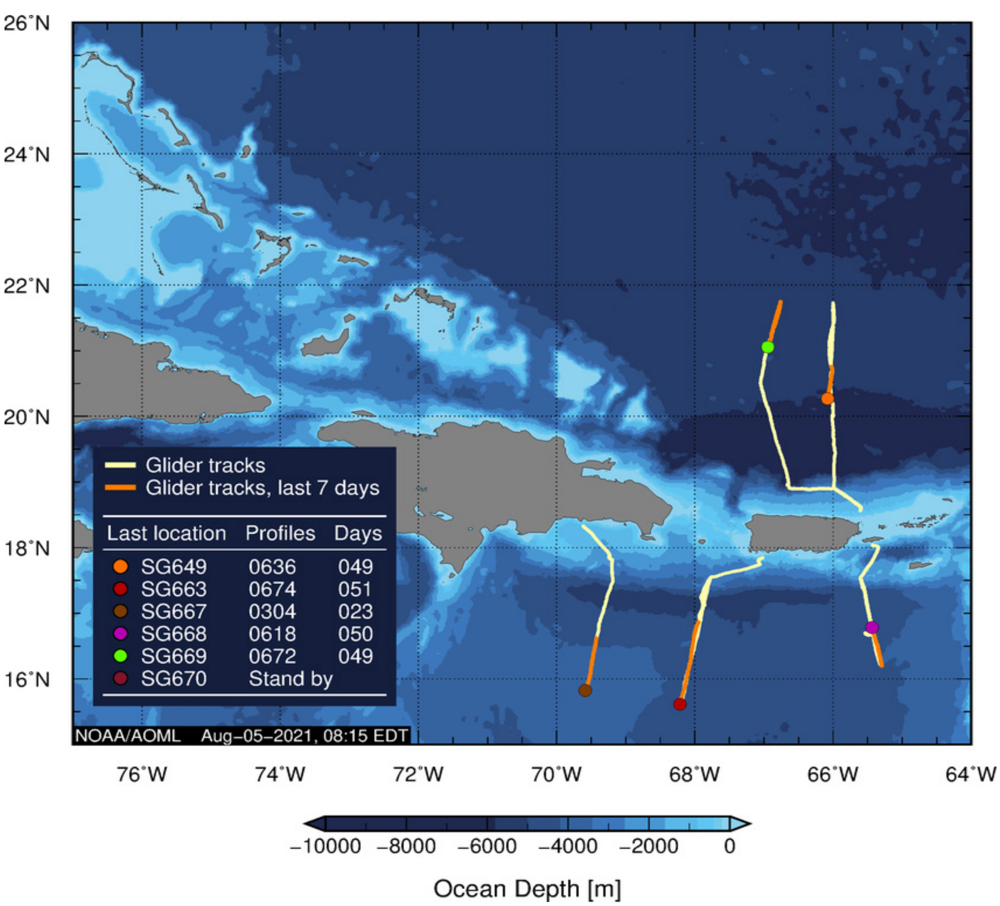
AOML gliders collect temperature, salinity, and dissolved oxygen profile observations to depths of 1000 m while advancing approximately 20 km per day along predetermined transects where tropical cyclones often travel and intensify. Their missions are expected to last 4-5 months, making them some of the longest single glider missions ever.

They were deployed and are being remotely piloted by a team of AOML and University of Miami-Cooperative Institute scientists, science support technicians, and engineers.



An AOML glider before its deployment into the coastal waters of Puerto Rico where it will spend the next 4-5 months gathering temperature, salinity, and dissolved oxygen data to depths of 1000 meters. For more information about AOML's glider operations, visit https://www.aoml.noaa.gov/hurricane-glider-project/.

Glider data are transmitted in real-time to AOML where they are quality controlled before being transferred to data distribution centers. The data are then assimilated into ocean and coupled ocean-atmospheric forecast models. Their inclusion enables the ocean's changing dynamic state to be better represented, which has been shown to improve intensity forecasts. Scientists at AOML have published several studies showing that ocean observations are critical for improving extreme weather forecasts, with glider profile data making one of the biggest contributions to this improvement.



Map that shows the location of where gliders are currently gathering data in the tropical-subtropical North Atlantic Ocean (SG649, SG669) and Caribbean Sea (SG663, SG667, SG668) along fixed transects.

Deployment and recovery operations of the gliders are conducted by scientists at AOML in collaboration with partners of the Integrated Ocean Observing System's (IOOS) Regional Association for the Caribbean (CARICOOS), ANAMAR (the Maritime Authority of the Dominican Republic), and the Cape Eleuthera Institute of the Island School in the Bahamas. Approximately 7,000 salinity and temperature profiles are expected to be obtained from the six AOML missions this year. AOML is also contributing to glider operations led by the US Navy and CARICOOS.

Additionally, some glider missions this summer will be coordinated with the operation of specially-designed saildrones to be deployed in July, which will mostly collect atmospheric observations. This joint endeavor with NOAA's Pacific Marine Environmental Laboratory and Saildrone, Inc. will produce the first fully autonomous and uncrewed collocated, simultaneous observations of the ocean and atmosphere for hurricane research and forecasts.

AOML's glider operations are partially funded from Hurricane Supplemental funds, with additional support from NOAA's Office of Oceanic and Atmospheric Research and AOML.

Ocean Conditions Played Major Role in the Intensification of Hurricane Michael

In a study published in the *Journal of Geophysical Research–Oceans,** scientists at AOML identified key ocean features that supported the rapid intensification of Hurricane Michael (2018), in spite of unfavorable atmospheric conditions for development. The study demonstrates the importance of using realistic ocean conditions for coupled, i.e., ocean-atmosphere, hurricane models to achieve the most accurate intensity forecasts.

Hurricane Michael formed on October 7, 2018 in the northwestern Caribbean Sea and quickly traveled northward through the Gulf of Mexico, making landfall along the Florida Panhandle as a Category-5 hurricane only 3 days later. Michael was the most intense tropical cyclone of the 2018 Atlantic hurricane season and the first Category-5 hurricane to strike the continental US since Hurricane Andrew in 1992. Michael's hurricane-force winds, storm surge, and rainfall led to the deaths of 74 people and caused approximately $25 billion in damages.

Early in its development, Hurricane Michael was exposed to vertical wind shear in the Caribbean Sea and southeastern Gulf of Mexico, which usually prevents hurricane formation or at least limits intensification. In spite of this unfavorable environment, Michael spent most of its trajectory prior to landfall undergoing several stages of rapid intensification, indicating the ocean played an important role in sustaining Michael's strength.

Satellite true-color image that shows the murky brown water of the Mississippi River plume mixing with the dark blue water of the Gulf of Mexico two days after a rainstorm. Image Credit: NASA.

Using ocean observations, scientists were able to characterize key features encountered by Michael along its track that are known for favoring hurricane intensification: high sea surface temperatures, high heat content in the Loop Current and its associated eddies (the main current flowing through the Gulf of Mexico), and the Mississippi River plume.

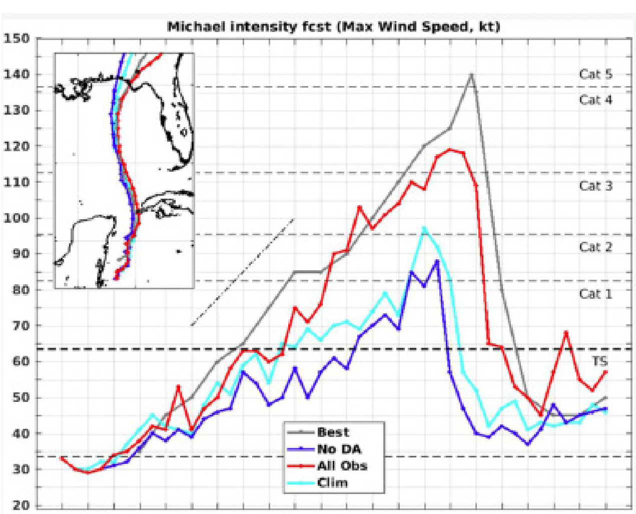
Two hurricane gliders were ideally positioned in the northeastern Gulf of Mexico, and one of them observed the brackish water within the Mississippi River plume (above image). The very intense density gradient between the fresher river water in the surface layer and the saltier ocean water below inhibited the mixing of these two water masses.

As a result, the water in the surface layer remained warm, even under hurricane conditions, maintaining the high sea surface temperatures that enabled Michael to intensify.

Numerical experiments demonstrated that the integration of satellite and in-situ observations into the ocean model led to a more realistic forecast from the coupled hurricane model (bottom left image). In particular, it led to a 56% error reduction in the wind intensity forecast prior to Michael's landfall.

Scientists found that sea surface temperature data and vertical profiles assimilated into the ocean model were the main contributors to the intensity error reduction in the coupled model. The coupled hurricane-ocean forecasts showed that upper ocean conditions, especially high sea surface temperatures in the northeastern Gulf, played a critical role in the intensification of Michael.

The study reveals that achieving realistic ocean conditions requires the combined assimilation of both in-situ and satellite observations. Moreover, it shows the importance of ocean observations from gliders, expendable bathythermographs, Argo profiling floats, and other instruments for improving the real-time analyses of ocean conditions. Operational models that provide guidance to forecasters are thus improved, enabling them to better warn the public of severe weather.



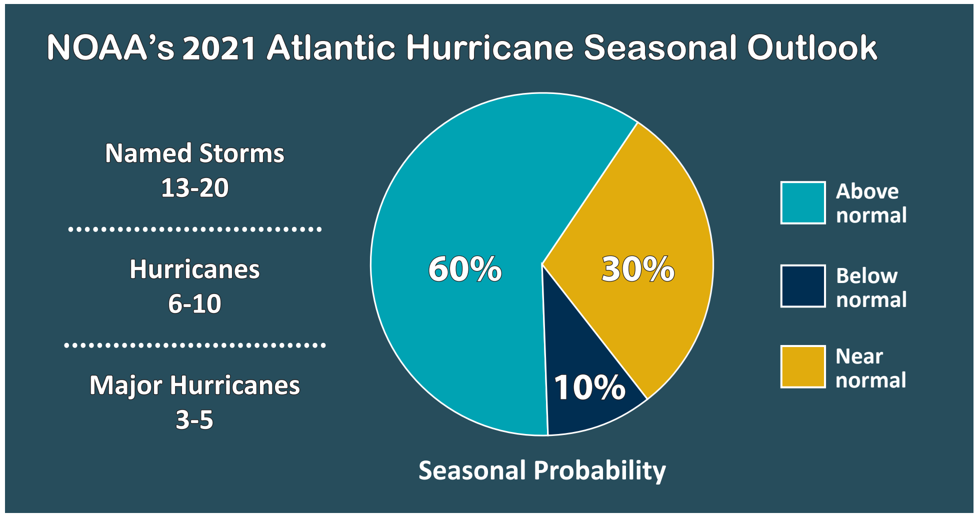
Plot that shows the intensity of Hurricane Michael based on observations and as forecasted by three coupled hurricane simulations starting on October 6, 2018 (observations = gray line; no ocean data assimilation = dark blue line; climatological ocean = cyan line; and all ocean observations assimilated = red line). The black dashed-dotted line to the left of the wind intensity indicates the slope of tropical cyclone rapid intensification (30 kts in 24 h). The simulation that included all ocean observations (red line) mostly closely matched Michael's observed intensity (gray line).

*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,* e2020JC016969, https://doi.org/10.1029/2020JC016969.

NOAA Predicts Another Active Atlantic Hurricane Season

"Although NOAA scientists don't expect this season to be as busy as last year, it only takes one storm to devastate a community. The forecasters at the National Hurricane Center are well-prepared with significant upgrades to our computer models, emerging observation techniques, and the expertise to deliver the life-saving forecasts we all depend on during this, and every, hurricane season."

Ben Friedman
Acting NOAA Administrator



NOAA's Climate Prediction Center is calling for another above-normal Atlantic hurricane season. Forecasters predict a 60% chance of an above-normal season, a 30% chance of a near-normal season, and a 10% chance of a below-normal season. However, the historic level of storm activity seen in 2020 is not anticipated.

For 2021, a likely range of 13–20 named storms (39 mph winds or higher), are predicted to form, of which 6–10 could become hurricanes (74 mph winds or higher), including 3–5 major hurricanes (categories 3, 4 or 5; with 111 mph winds or higher). NOAA provides these ranges with a 70% confidence level. The Atlantic hurricane season stretches from June 1 through November 30.

NOAA recently updated the statistics that are used to determine when hurricane seasons are above-, near-, or below-average relative to the latest climate record. Based on this update, an average hurricane season now produces 14 named storms, of which 7 become hurricanes, including 3 major hurricanes.

El Niño-Southern Oscillation (ENSO) conditions are currently in the neutral phase, with the possibility of the return of La Niña later in the hurricane season. "ENSO-neutral and La Niña support the conditions associated with the ongoing high tropical cyclone activity era," said Matthew Rosencrans, the lead seasonal hurricane forecaster at NOAA's Climate Prediction Center. "Predicted warmer-than-average sea surface temperatures in the tropical Atlantic Ocean and Caribbean Sea, weaker tropical Atlantic trade winds, and an enhanced west African monsoon will likely be factors in this year's overall activity."

Scientists at NOAA also continue to study how climate change is impacting the strength and frequency of tropical cyclones. In an effort to continuously enhance hurricane forecasting, NOAA has made several updates to products and services that will improve hurricane forecasting during the 2021 season.

In March, NOAA upgraded its flagship Global Forecast System (GFS) to improve hurricane genesis forecasting. It coupled the GFS with a wave model that extends ocean wave forecasts from 10 days to 16 days. Global Positioning Satellite Radio Occultation (GPS-RO) data are also now included in the GFS model, providing an additional source of observations to strengthen its overall model performance.

Forecasters at the National Hurricane Center are now using an upgraded probabilistic storm surge model, known as P-Surge, that includes improved tropical cyclone wind structure and storm size information that offers better predictability and accuracy. This upgrade extends the lead time of P-Surge forecast guidance from 48 to 60 hours in situations where there is high confidence.

This hurricane season, AOML will deploy its largest array of air and water uncrewed systems to gather data designed to improve hurricane intensity forecasts and forecast models. New drones will be launched from NOAA's Hurricane Hunter aircraft that will fly into the lowest levels of the hurricane environment, a turbulent region known as the boundary layer. In the ocean, saildrones, hurricane underwater gliders, global drifters, and ALAMO floats, an air-deployable technology, will track various parts of the life cycle of tropical systems.

Last year's record-breaking season serves as a reminder to all residents in coastal regions or areas prone to inland flooding from rainfall to monitor the tropics, examine preparedness plans, and be ready to activate those plans if needed. "With hurricane season starting on June 1, now is the time to get ready to advance disaster resilience in our communities," said FEMA Administrator Deanne Criswell. "Visit Ready.gov and Listo.gov to learn and take the steps to prepare yourself and others in your household."

The Atlantic hurricane outlooks are an official product of NOAA's Climate Prediction Center, produced in collaboration with the National Hurricane Center and AOML.

NOAA will provide an update to its Atlantic outlook in early August, just prior to the peak of the season.

This article is modified from a May 20, 2021 web story on www.noaa.gov

2021 Atlantic Storm Names

Ana	Henri	Odette
Bill	Ida	Peter
Claudette	Julian	Rose
Danny	Kate	Sam
Elsa	Larry	Teresa
Fred	Mindy	Victor
Grace	Nicholas	Wanda

AOML to Use Ship of Opportunity Data in Support of Extreme Weather Forecasts and Sea Level Studies

In June, AOML began a new collaboration with ships of opportunity to collect temperature profiles along the US Atlantic continental shelf from New York to Florida. Expendable bathythermographs or XBTs, probes that measure heat in the upper ocean, will be deployed by the crews of cargo vessels at a spatial distance of approximately 130 km following established logistics for regularly sampled XBT transects.

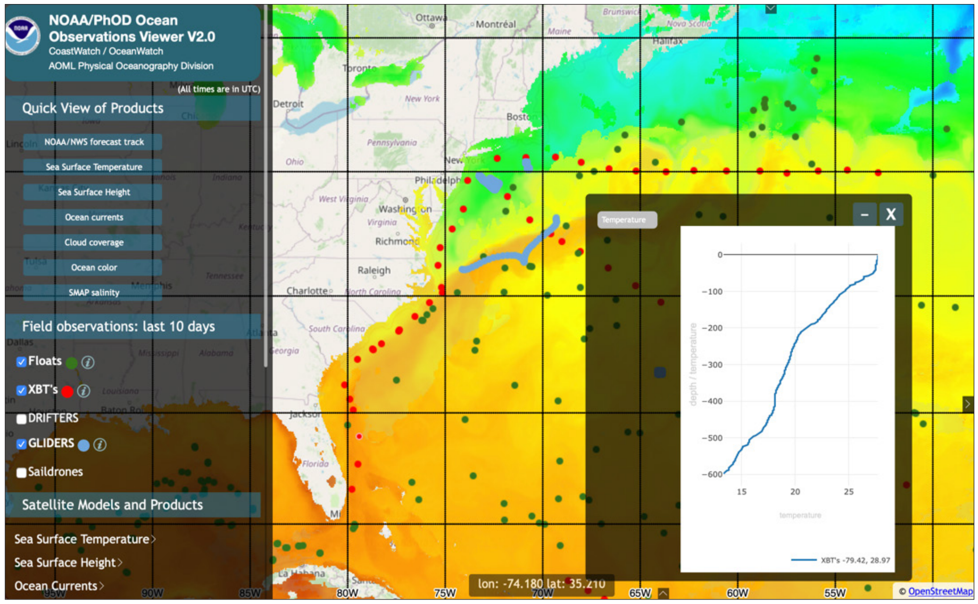
The ships currently contributing to this effort include the Hapag Lloyd vessels *Chicago Express* and *Bremen Express*. In July, the *Maersk Vilnius* and *Maersk Visby* will also join the effort, currently used to obtain XBT data along the AX07 (Miami to Gibraltar) and AX08 (Cape Town to New York) transects, respectively.

XBT data are transmitted in real-time to the Global Telecommunication System to provide temperature observations in regions known to contribute to hurricane intensity changes and where ocean water mass properties contribute to sea level changes. These observations are assimilated into NOAA's operational ocean models to better characterize the upper ocean's thermal structure in shelf waters that are normally undersampled.

Similar to data from other observing platforms, these XBT data will be evaluated for their impact to better represent ocean water mass properties linked to hurricane weakening or intensification. They will also complement Argo float measurements, which provide a broader scale of sampling but often miss boundary currents, as well as hurricane gliders, whose sampling is geared toward obtaining observations with high horizontal spatial resolution along fixed tracks.

Approximately 700 XBTs are expected to be deployed annually along the US eastern seaboard. These deployments can be tracked online by visiting the Ocean Observations Viewer web page of the Physical Oceanography Division (see blue link in the caption above).

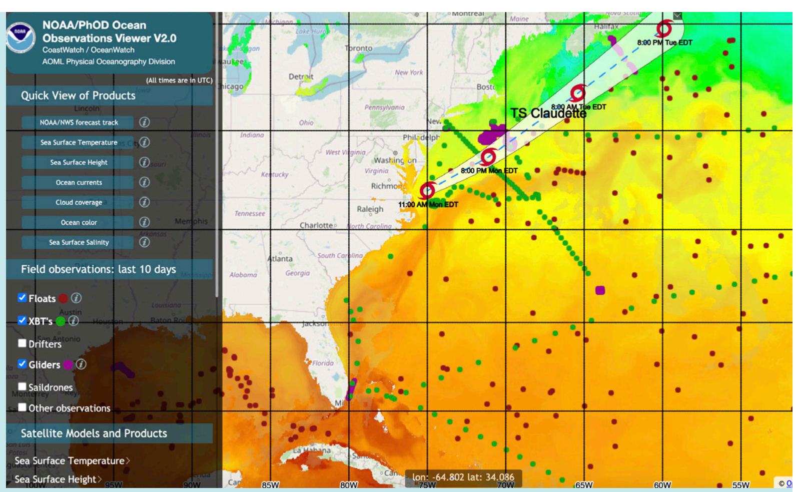
AOML's ship of opportunity XBT network is funded by NOAA's Global Ocean Monitoring and Observing Program and AOML.



Map of the Atlantic basin with the location of XBT temperature observations (red circles) obtained by the Hapag Lloyd cargo vessel *Chicago Express* during its transit from New York to Florida after completing the AX07 XBT transect (Gibraltar–New York, May-30-June 9, 2021). Background colors represent sea surface temperatures in the Atlantic on June 8, 2021. Green circles show the location of Argo float observations, while blue circles show the location hurricane glider observations. The panel insert depicts an XBT temperature profile obtained off the coast of Georgia. The source of this image is the AOML-Physical Oceaonography Division's Ocean Observations Viewer: https://cwcgom.aoml.noaa.gov/cgom/OceanViewer/index_phod.html.

Ocean Observations Collected Ahead of Tropical Storm Claudette

In June, Tropical Storm Claudette passed directly over areas in the Atlantic Ocean that were being surveyed by three ocean observing platforms: hurricane gliders, Argo floats, and expendable bathythermographs (XBTs). The forecasted track of Claudette is superimposed on the map to the right, showing how these observing platforms measured ocean water mass properties off the US northeast coast and across the Gulf Stream ahead of Claudette's projected path. The use of multiple observing platforms that collect targeted and sustained ocean observations enable the ocean's thermal structure to be more accurately characterized in ocean and hurricane forecast models. Data from these three platforms were assimilated into the Real-Time Ocean Forecast System at NOAA's Environmental Modeling Center. They demonstrate how different components of the observing system all contribute key upper ocean profile data to better represent the ocean during extreme weather events.

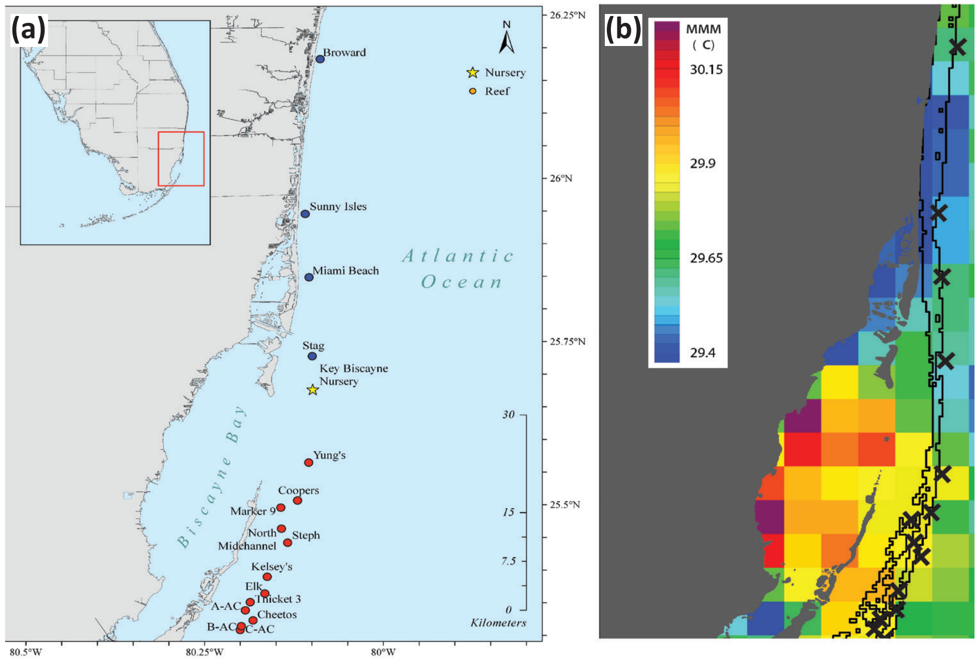


Map showing sea surface conditions in the Atlantic Ocean on June 21, 2021, the projected path of Tropical Storm Claudette, and the location of in-situ observations that generate temperature profiles: Argo floats (dark red), XBTs (green), and hurricane gliders (purple).

Heat Tolerant Corals May Be the Key to Improving Restoration Efforts

A new study* by researchers at the University of Miami's Rosenstiel School of Marine and Atmospheric Science and AOML suggests that outplanting corals, specifically staghorn coral (*Acropora cervicornis*) from higher temperature waters to cooler waters, may be a better strategy to help corals recover from certain stressors. The researchers found that corals from reefs with higher average water temperatures showed greater healing than corals from cooler waters when exposed to heat stress.

Researchers collected 18 coral genotypes from the University of Miami's coral nursery that were originally sourced from different reefs along Florida's east coast (image at right) and monitored them for recovery after exposure to heat stress. They found that corals exposed to increasingly warm temperatures did not heal as successfully as those corals that were kept at a constant temperature, but that being from a warmer donor reef increased the likelihood of healing for corals exposed to increased temperatures (image below).



(a) Key Biscayne nursery and donor reef locations. Colored circles correspond with donor reef 4-km resolution maximum monthly mean (MMM) sea surface temperature data in which red circles indicate an MMM>29.9°C and blue circles indicate an MMM<29.9°C. (b) MMM sea surface temperatures derived from harmonic analysis of the Advanced Very High-Resolution Radiometer (AVHRR) Pathfinder Version 5.0 from 1982-2008. The Florida Reef Tract is outlined in black, and donor reef locations are indicated by black x's

The results from the study suggest that sourcing corals from warmer reefs and outplanting them into cooler environments that may likely experience temperature increases in the future increases their chances of recovery under heat stress. "We know to avoid fragmenting corals in areas with warmer water temperatures," said Ruben van Hooidonk, PhD, a University of Miami-Cooperative Institute coral researcher at AOML and study coauthor. "Wound recovery rates are reduced in these areas, and the corals won't be able to heal as quickly or as efficiently."

By identifying genotypes that are more resilient to certain stressors, restoration specialists will be able to incorporate this knowledge into their practices to increase the likelihood of recovery and survival for corals during outplanting. "We now have additional evidence that coral colonies can maintain certain characteristics and attributes even after they are relocated to a nursery," said Madeline Kaufman, a coral researcher with the University of Miami and lead author of the study. "This information provides opportunities for restoration practitioners to optimize their efforts by prioritizing genotypes with specific beneficial characteristics."

There has been a noted decline in the health of coral reefs around the world, caused by stressors such as pollution, overfishing, disease outbreaks, and climate change. Increasing sea water temperatures have also caused coral bleaching events to occur more frequently and last for longer periods.

Reef restoration techniques have become a common tool used to help restore coral reefs and their associated ecosystem services. Through the coral gardening process, corals are fragmented to promote growth; however, this often leaves corals with lesions, making them more vulnerable to pathogens that can lead to mortality. In addition, thermal stress can slow or suppress wound recovery.

There is a pressing need for coral researchers and restoration specialists to identify coral genotypes with greater recovery potential and to assess the effect that increasing sea temperatures have on lesion repair. This will help scientists better understand how outplanted corals will be affected both seasonally and under ocean warming conditions.

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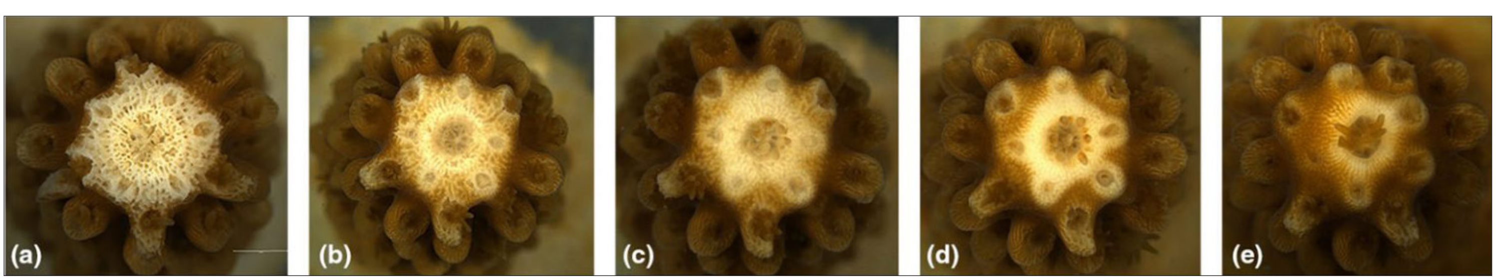
*Kaufman, M.L., E. Watkins, R. van Hooidonk, A.C. Baker, and D. Lirman, 2021: Thermal history influences lesion recovery of the threatened Caribbean staghorn coral *Acropora cervicornis* under heat stress. *Coral Reefs,* 40(2):289-293, https://doi.org/10.1007/s00338-020-02025-2.



Researchers assessed wound healing rates for coral fragments on a scale of 0-100%: (a) 0% healed; (b) 25% healed; (c) 50% healed; (d) 75% healed; and (e) 100% healed.

AOML Scientist Collects eDNA to Make Connections in Marine Food Webs

Nastassia Patin, PhD, a University of Miami-Cooperative Institute scientist at AOML, spent 3 weeks in May aboard the NOAA ship *Reuben Lasker* collecting environmental DNA or eDNA from water samples in support of the Rockfish Recruitment and Ecosystem Assessment Survey.

In collaboration with scientists from the National Marine Fisheries Service, Dr. Patin collected 339 samples at transect stations along the coast of California from Point Reyes to San Diego.

Environmental DNA refers to DNA collected directly from habitats like soil, freshwater, or the ocean. It contains the DNA of organisms that live in or have passed through that habitat, including rare, invasive, and endangered species.

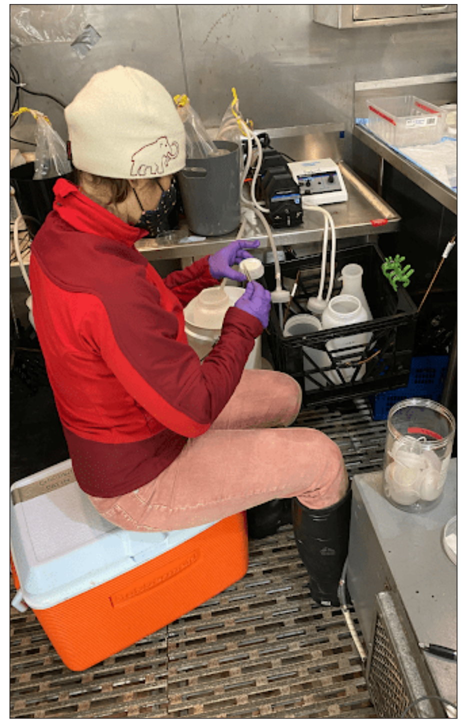
The eDNA gathered during the survey will be used for marker gene sequencing, i.e., “metabarcoding,” for organisms at different trophic levels from microbes to whales. Trophic level refers to the position of an organism in a food chain, based on the amount of consumption steps that separates it from the original energy source, such as the sun. Interactions between organisms in different trophic levels cause the energy flow to be more complex than a linear chain (food chain), and is better represented as a food web.

The eDNA will additionally be analyzed for information on microbial genomes and biochemical function, which are not attained through metabarcoding. “Marine eDNA research has lagged behind that of terrestrial and aquatic environments,” said Dr. Patin, “largely due to challenges with field sampling and sequence data analysis.”

As part of NOAA’s efforts to develop eDNA methods, Dr. Patin worked to optimize sampling protocols aboard the *Reuben Lasker*, a challenging project considering the ship was not designed for sensitive molecular work. Advancements in eDNA sampling and analysis methods will improve the detection of rare, invasive, and endangered species that may not be comprehensively assessed with visual surveys.

According to Dr. Patin, “expanding macrofaunal assessments beyond visual surveys will provide more precise information on areas of predator/prey overlap than is currently possible with visual surveys. Further, linking multiple trophic levels will contribute to our understanding of coastal marine food webs, whose foundation is microbial and the highest levels of which include blue whales.”

Environmental DNA data generated from the survey will be sequenced and analyzed with trawl catch information, along with other ecological metrics, to provide a better understanding of marine food webs, organism interconnectivity in the California Current, and predator/prey coexistence in these areas.

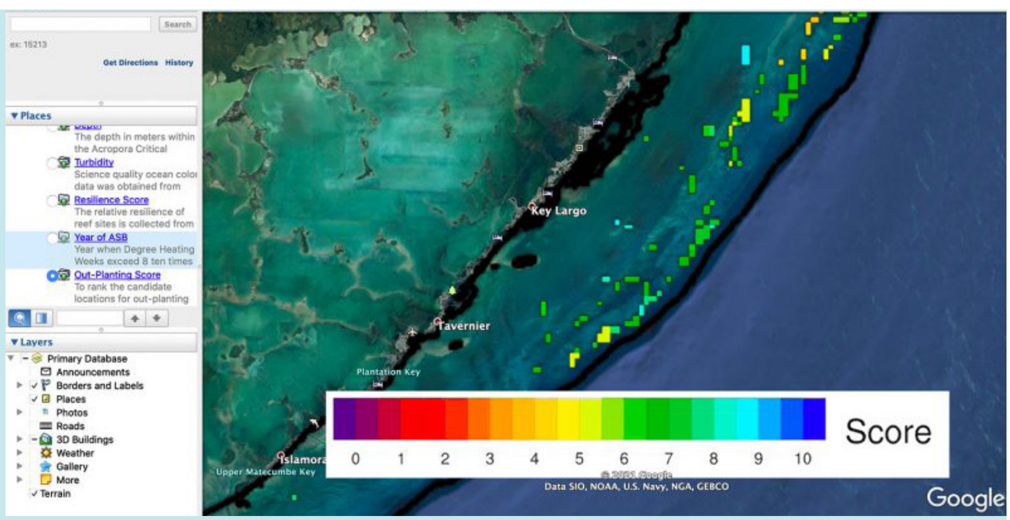


Nastassia Patin aboard the NOAA Ship *Reuben Lasker* assembles a filter to capture eDNA from a water sample.

Experimental Mapping Tool Shows Potential for Improving Restoration Efforts for Coral Reefs

To help improve the long-term survival of nursery-raised staghorn coral (*Acropora cervicornis*), Ruben van Hooidonk, a University of Miami-Cooperative Institute coral scientist at AOML, has developed an experimental mapping tool that ranks suitable outplant locations. There are currently at least seven coral nurseries in Florida that cultivate staghorn coral, representing the best opportunity to maintain resilient populations of this species.

The tool ranks candidate outplanting sites based on binary (yes/no) and continues criteria. The binary criteria include *Acropora* critical habitat, depth, coral hard bottom, and turbidity, while continues criteria consider the relative resilience of the location and the projected climate change impact, i.e., the year of onset for annual severe bleaching conditions. “Raising and outplanting corals can cost millions of dollars,” according to van Hooidonk. “This tool is designed to help guide outplanting strategies for nursery-raised staghorn coral to maximize their long-term survival, which could, in turn, increase the effectiveness of the nurseries and promote the presence of staghorn coral along the Florida reef tract.”



Screenshot of a new mapping tool that shows the outplanting score for corals in the vicinity of Key Largo, Florida.

Coral Growth in Flower Garden Banks Approaches Threshold as Sea Temperatures Rise

Brain corals in the Gulf of Mexico's Flower Garden Banks National Marine Sanctuary.

A recent study* by scientists at AOML and the Cooperative Institute for Marine and Atmospheric Studies shows that the growth observed in two coral species, symmetrical brain corals (*Pseudodiploria strigosa*) and mountainous star corals (*Orbicella faveolata*), in the Gulf of Mexico's Flower Garden Banks National Marine Sanctuary is linked to warming sea surface temperatures.

Coral reefs in many areas of the world are declining, with the western Atlantic showing some of the greatest losses. Despite this trend, coral coverage for the high latitude, remote reefs in Flower Garden Banks has remained at 50% or greater since 1989. Based on data collected by NOAA's National Coral Reef Monitoring Program, Flower Garden Banks is the only Atlantic coral reef site under US jurisdiction to be scored as being in "good" condition.

"Coral reef ecosystems in the Flower Garden Banks are outliers because the top of the reef cap starts at 17 m and continues down to 50 m," said Nicole Besemer, a coral researcher at AOML. "These deeper corals don't often experience the warm temperatures that the majority of shallow Caribbean corals are exposed to. The increased temperatures at these deeper sites actually assist coral growth where they might have caused bleaching at a shallow reef site."

Scientists obtained coral cores from symmetrical brain corals and mountainous star corals and analyzed their growth record, coral calcification, and skeletal density for the past 45-57 years (see image below). These measurements were used to determine whether any trends over time showed a connection to changes in the environment, such as sea temperature and/or river discharge.

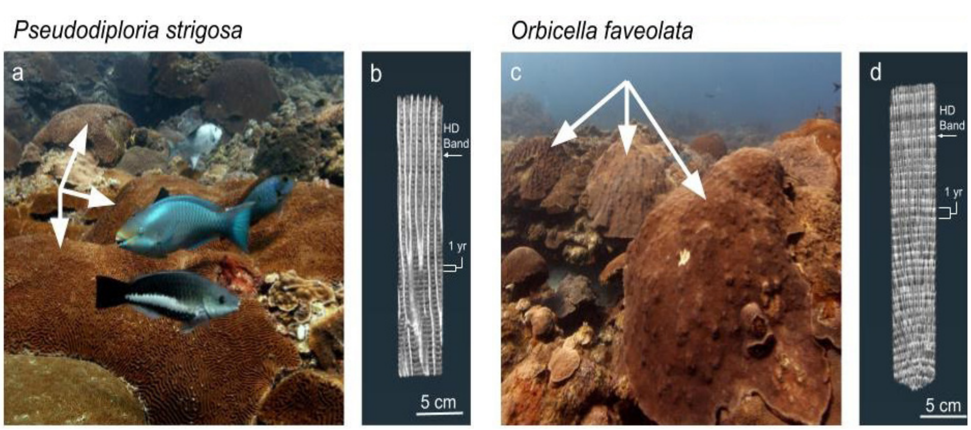
The study found that coral extension and calcification for both species have increased over the past 4-5 decades, providing evidence that some high latitude, cooler reef sites may experience enhanced coral growth due to ocean warming.

However, while the warming ocean may promote growth in some corals, over time rising temperatures may lead to more frequent and harmful coral bleaching events. Notably, the reefs in Flower Garden Banks experienced the most severe bleaching event ever recorded in 2016. This indicates the region may be approaching a warming threshold that, if crossed, could likely have detrimental consequences for the growth and overall health of coral reef ecosystems in this area.

"The observed increase in coral growth is not expected to continue, as sea temperatures have now warmed to where the upper thermal limits for the corals at Flower Garden Banks are being exceeded and coral bleaching events are occurring more frequently," said Derek Manzello, PhD, lead author of the study and the coordinator for NOAA's Coral Reef Watch program.

Cooler water, the lack of land-based pollution sources, and greater depths are all factors that have enabled Flower Garden Banks reefs to retain their coral coverage compared to other regions that are more directly impacted by human activity, storm damage, changes in water temperature and salinity, and coral bleaching.

Understanding how coral reefs at high latitudes and cooler temperatures respond to changes in the environment over time may help scientists better predict how these reef-building coral species will fare when exposed to warming sea surface temperatures and the imminent threat of coral bleaching.



Photos of coral colonies at east Flower Garden Banks, along with computerized tomography (CT) images of cores, for (a,b) brain coral and (c,d) mountainous star coral. The CT images illustrate clear annual banding, showing their growth over time.

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*Manzello, D.P., G. Kolodziej, A. Kirkland, N. Besemer, and I.C. Enochs, 2021: Increasing coral calcification in *Orbicella faveolata* and *Pseudodiploria strigosa* at Flower Garden Banks, Gulf of Mexico. *Coral Reefs*, 40(4): 1097-1111, https://doi.org/10.1007/s00338-021-02108-8.

New Tool Tracks Sargassum Inundation Potential for Coastal Communities

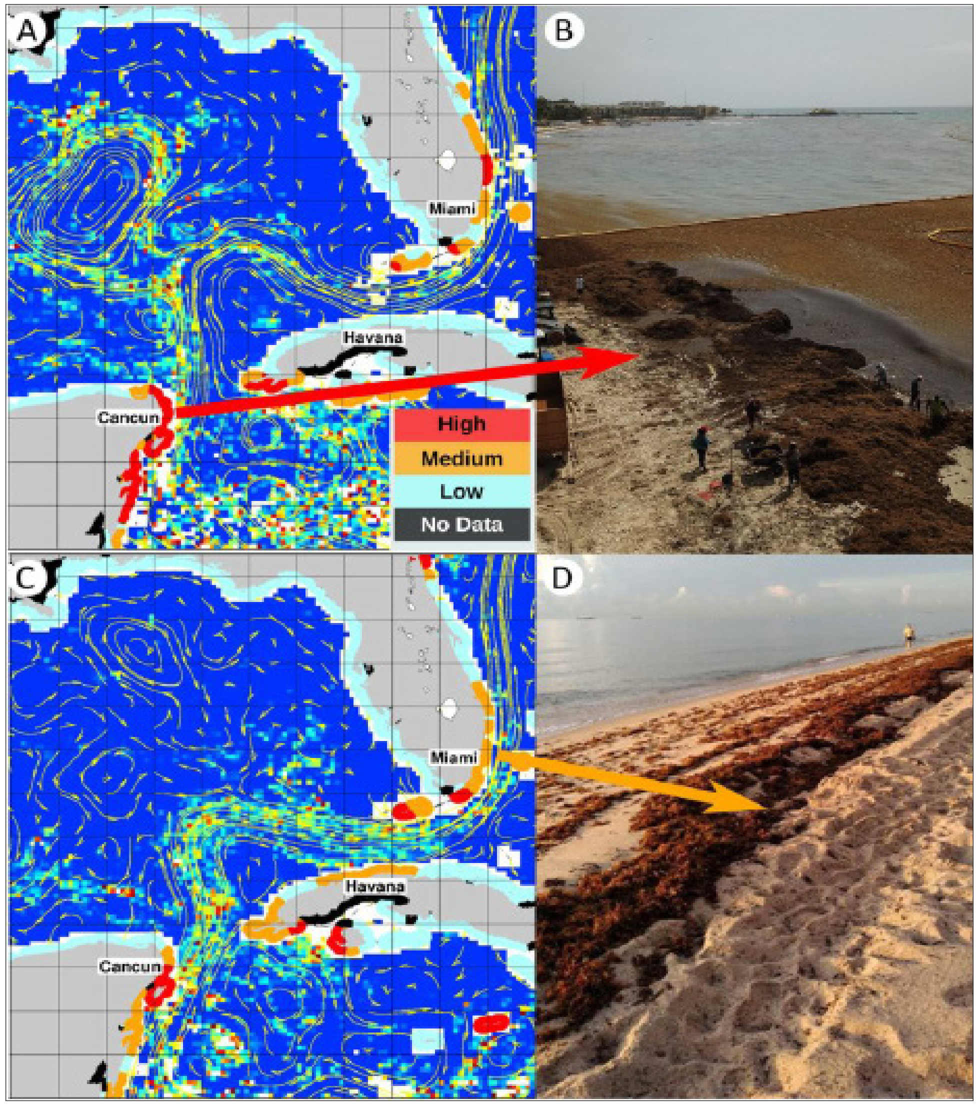
A recently published paper* presents the Sargassum Inundation Report (SIR), a new tool that uses a satellite-based methodology to remotely monitor areas with coastal inundations of Sargassum. SIR was created to quantify, predict, and better manage Sargassum influxes, which have major economic, social, environmental, and public health impacts for communities that border the Caribbean Sea, tropical Atlantic Ocean, and Gulf of Mexico.

Sargassum is a type of floating brown alga commonly called "seaweed." These alga float at the sea surface, where they often aggregate to form large mats on the open ocean. Historically, Sargassum was found within the Gulf of Mexico and western North Atlantic, with the majority of it aggregating in the Sargasso Sea. In 2011 its geographic range expanded, and massive quantities of Sargassum began washing ashore along islands throughout the Caribbean Sea.

The study presents the results of an analysis carried out with SIRs; the fields presented in these reports show promise as a platform that can incorporate new data sources and integrate them with forecast models as they develop. These fields also provide a long-term time series to identify trends and variability, detect extreme events, and facilitate cross-validation with other datasets.

SIR is made up of weekly fields derived from satellite-based observations that estimate the abundance of Sargassum in the open ocean and forecast its potential to reach coastlines for five regions: the Gulf of Mexico, Central America, the Greater Antilles, the Lesser Antilles, and South America. This product provides information about the presence of Sargassum within the vicinity of coastlines, although other coastal processes, such as winds, waves, and currents, ultimately determine how much Sargassum washes ashore.

The SIR algorithm uses 7-day Floating Algae density fields to estimate the potential for Sargassum to wash ashore. These satellite-derived Sargassum density estimates are analyzed for a radius of 50 km from the coastline; the inundation potential is then categorized into three levels: low, medium, and high. Coastlines are color coded according to the potential for Sargassum reaching the coast



(A) SIR for July 2–8, 2019 indicating a high (red) Sargassum inundation potential for Cancun, and (B) a photo showing severe coastal inundation of Sargassum in Cancun, Quintana Roo, Mexico on July 12, 2019 (Source: Isaac Esquivel/Cuartooscuro.com). (C) SIR for July 7–13, 2020 indicating a medium (orange) inundation potential for Miami, Florida, and (D) a photo showing moderate levels of Sargassum along the beach in Miami on July 8, 2020 (Source: Marine Macroalgae Research Lab–Florida International University). SIRs can be accessed at https://www.aoml.noaa.gov/phod/sargassum_inundation_report/index.php?dtrange=SIR_20210726.

In addition to satellite observations, in-situ observations in the form of images and descriptions are being added to an in-house database. The availability of satellite-derived Sargassum estimates and fields of coastal inundation potential that can be combined with other data types also provides the opportunity for machine learning algorithms to automatically detect and quantify the amount of Sargassum from webcams and photographs.

This work is a collaborative research effort between scientists at AOML, NOAA's National Environmental Satellite, Data, and Information Service (NESDIS), NOAA's CoastWatch Program, the University of South Florida, University of Miami, and LGL Ecological Research Associates, Inc.

It is anticipated SIR reports will be produced daily and distributed by NESDIS and NOAA's National Ocean Service in support of regional efforts to monitor Sargassum extreme events and their impact on coastal regions and regional economies.

The research also supports the AtlantOS program's efforts to foster cooperation, align interests, and implement an integrated all-Atlantic Ocean observing and information system that will link a number of existing and future ocean observing activities to meet user needs.

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*Trinanes J., N.F. Putman, G. Goni, C. Hu, and M. Wang, 2021: Monitoring pelagic Sargassum inundation potential for coastal communities. *Journal of Operational Oceanography,* https://doi.org/10.1080/1755876X.2021.1902682.

Scientists at AOML Develop First-ever Daily Estimates of Heat Transport in the South Atlantic Ocean

In a study published recently in the *Journal of Geophysical Research-Oceans*,* scientists at AOML, the Cooperative Institute for Marine and Atmospheric Studies, and abroad used data from moored instruments to produce a daily, continuous time series of the volume and heat transports in the South Atlantic along 34.5°S. This is the first time data from a moored array have been analyzed to create a full-depth, daily heat transport time series at this key location for inter-ocean exchange.

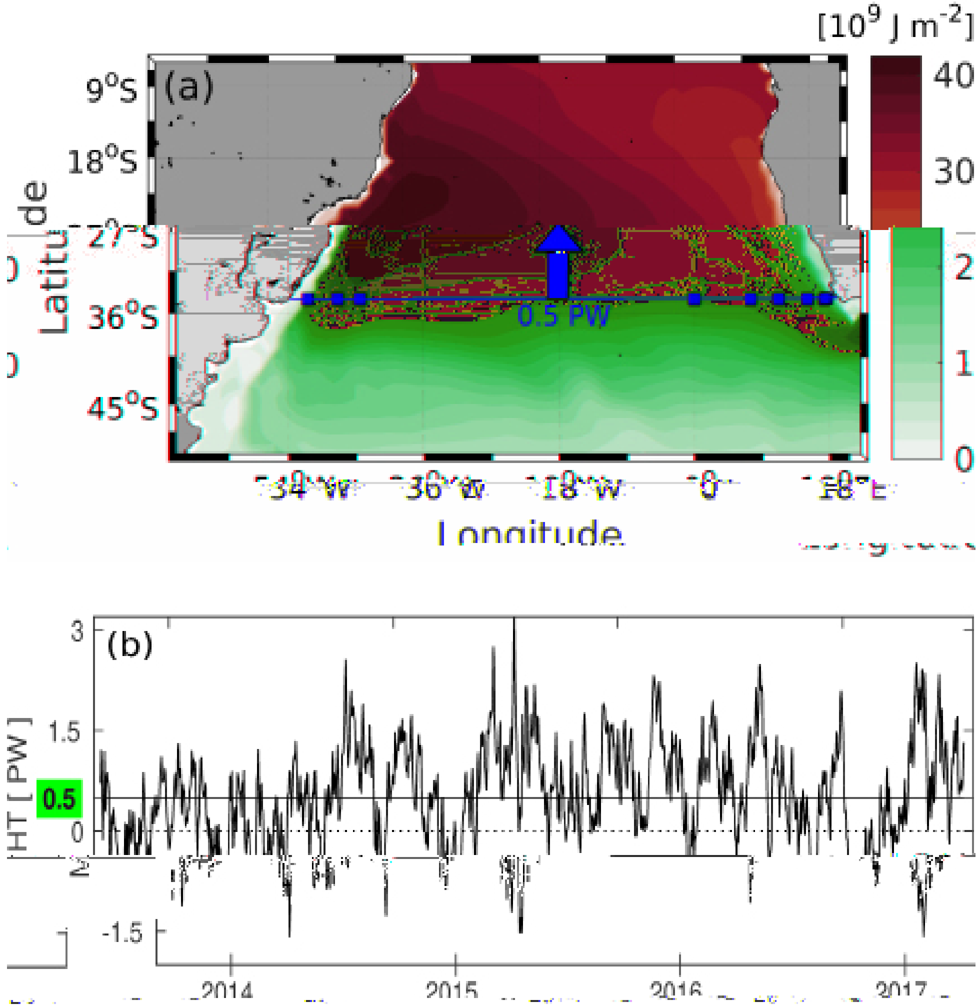
Flow patterns in the South Atlantic are thought to control the stability of the entire meridional overturning circulation (MOC), a component of the global ocean circulation that plays a major role in redistributing heat, salt, dissolved oxygen, and carbon. Variations of the MOC, particularly the transport of heat, have important societal impacts on coastal sea levels, marine heat waves, extreme weather events, and shifts in regional surface temperature and precipitation patterns, all of which impact human resources (i.e., agriculture, fisheries, infrastructure, and more), as well as health around the globe.

The southern end of the South Atlantic Ocean serves as the gateway for water masses formed in the Pacific, Indian, and Southern oceans to exchange, mix, and flow into the Atlantic Ocean. Due to the difficulty in observing the MOC and its heat transport, however, many questions remain about these key oceanic flows.

"The South Atlantic plays a unique role in the overturning circulation, as the only basin transporting heat towards the equator and connecting the North Atlantic to the other oceans basins," said Marion Kersalé, a Cooperative Institute scientist at AOML and lead author of the study.

The research team used a dataset from an array of moored sensors across the Atlantic along 34.5°S—the South Atlantic MOC Basin-wide Array or SAMBA—to develop a new technique for estimating full-depth temperature profiles. Because these instruments are widely-spaced and therefore miss key details of the interior heat structure of the MOC, satellite, CTD (conductivity-temperature-depth), and Argo profiling float observations were used to fill data gaps.

This technique produced ~4 years of daily estimates of heat transport in the South Atlantic Ocean, revealing seasonal and interannual changes of these important oceanic flows with strong variations on time scales of a few days to a few weeks. For example, during this 4-year period the amount of heat transported northward was several times its mean value on multiple occasions. These observations also showed that volume and heat transports varied in a consistent manner with one another.



(a) SAMBA mooring locations used in this study (green squares) and mean meridional heat transport in the South Atlantic. (b) Temporal variability of the total meridional heat transport at 34.5°S.

"This allowed us to use earlier moored observations from a pilot version of the SAMBA array, extending the record farther back in time and producing ~6 years of daily estimates of heat transport," said Renellys Perez, an AOML oceanographer. "To do so, MOC volume transport was used as a proxy for heat transport. Going forward, we can use the MOC volume transport to estimate heat transport operationally until a more detailed and accurate heat transport calculation can be made."

The new dataset is valuable for validating and improving ocean and climate models, both at NOAA and around the globe. These improved models will enable scientists to make more accurate forecasts of Earth's changing climate.

This research supports the vision of the AtlantOS Program to deliver an advanced framework for the development of an integrated Atlantic Ocean observing system.

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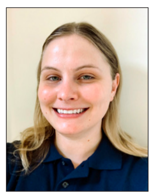
*Kersalé, M., C.S. Meinen, R.C. Perez, A.R. Piola, S. Speich, E.J.D. Campos, S.L. Garzoli, I. Ansorge, D.L. Volkov, M. Le Hénaff, S. Dong, T. Lamont, O.T. Sato, and M. van den Berg, 2021: Multi-year estimates of daily heat transport by the Atlantic Meridional Overturning Circulation at 34.5°S. *Journal of Geophysical Research–Oceans,* 126(5):e2020JC016947, https://doi.org/10.1029/2020JC016947.

AOML Welcomes Summer Interns...Virtually!

AOML welcomed a small but talented group of summer interns to its ranks in June. Guided by seasoned career professionals, they began tackling a variety of research projects in support of the lab's three science divisions. It is hoped the skills and relationships they develop, as well as their acquaintance with NOAA, will better prepare them for future educational and career opportunities.

"It has been amazing meeting scientists from a variety of backgrounds and experiences, and especially learning about NOAA as an organization." Shelby Gibson

Erica Bower is a third year PhD student attending Stony Brook University as an atmospheric science major. She joined AOML's Physical Oceanography Division as a NOAA-William M. Lapenta intern to work with Drs. Hyun-Sook Kim and Matthieu Le Hénaff. Erica's research project is focused on the effects of hurricanes Laura and Marco (2020) on the upper ocean environment in the Gulf of Mexico. She is studying barrier layer formation, maintenance, and destruction due to the passage of Laura and Marco's wind and precipitation fields. She will also compare the representation of these processes in the NCODA dataset with the HWRF-POM and HYCOM hurricane models.

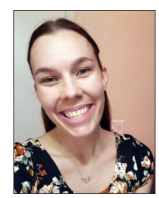


Shelby Gibson is an undergraduate student (senior) at the University of California-Berkeley majoring in geophysics and marine science. She joined AOML's Physical Oceanography Division as a NOAA-Ernest F. Hollings Scholar to work with Dr. Sang-Ki Lee. Shelby is quantifying and analyzing marine heatwave and cold-spell events off the US Gulf coast during 1982-2020. Using statistical methods, she is exploring the relationships between these anomalous events with other key climate modes of variability such as the El Niño-Southern Oscillation, North Atlantic Oscillation, North Atlantic tripole, and Pacific-North American teleconnection patterns.

Sophie Grimsley is an undergraduate student at the University of South Carolina Honors College, majoring in environmental science. Sophie joined AOML's Hurricane Research Division as a NOAA-William P. Lapenta intern to work with Drs. Jun Zhang and Frank Marks. She is researching the relationship between boundary layer structures and intensity change in hurricanes by analyzing dropsonde and tail Doppler radar data. Using Hurricane Irene (2011) as a case study, Sophie is examining the height of the boundary layer, its recovery, and linkage to convective structure.

Nicole Luchau is an undergraduate student (rising junior) at New York University majoring is environmental studies and public policy. She joined AOML's Ocean Chemistry and Ecosystems Division to work with Drs. Sean Anderson and Luke Thompson. Nicole is helping to process environmental DNA (eDNA) samples collected from the Rosenstiel School dock using the Submersible Automated Sampler. Her project involves learning the latest bioinformatics tools (QIIME 2 and Tourmaline), analyzing eDNA data using the coding software R, and developing interactive visualizations to better inform eDNA results.

Nicholas Mesa is an undergraduate student (rising junior) at the University of Florida majoring in civil engineering. He joined AOML's Hurricane Research Division as a NOAA-William P. Lapenta intern to work with Drs. Jonathan Zawislak and Robert Rogers. Nicholas is analyzing near-coincident satellite and aircraft observations to develop diagnostics for assessing the distribution of precipitation around storms and the relationship of that distribution to the humidity in the environment and near-environment of the tropical cyclone.



Michelle Spencer is a graduate student at the University of Wisconsin-Milwaukee soon to be entering her last semester before obtaining an MS degree in atmospheric sciences. She joined AOML's Physical Oceanography Division as a NOAA-William P. Lapenta intern to work with Drs. Renellys Perez and Greg Foltz. Michelle is using in-situ data collected from moorings in the North Atlantic Ocean, via the PIRATA project, to study the effects of tropical cyclones on the upper ocean. Her goals are to determine the primary storm factor(s) controlling surface and subsurface temperature, salinity, and velocity responses to tropical cyclones by analyzing nine storms that passed within two degrees of the mooring sites.

AOML Senior Scientist Contributes to UNESCO Report

"This integrated ocean carbon research (IOC-R) report emphasizes the need for research to meet three key challenges of the UN Ocean Decade: unlocking ocean-based solutions to climate change, expanding the global ocean observing system, and delivering data, knowledge, and technology to all."

Rik Wanninkhof, AOML Senior Scientist and lead editor for the *IOC-R* Report

In April, the United Nations Educational, Scientific and Cultural Organization's (UNESCO) Intergovernmental Oceanographic Commission published a report highlighting the ocean's critical role in regulating climate through the uptake of carbon dioxide. *Integrated Ocean Carbon Research: A Summary of Ocean Carbon Knowledge and a Vision for Coordinated Ocean Carbon Research and Observations for the Next Decade* presents a synthesis of current knowledge about the ocean carbon cycle. It also provides a plan for future ocean carbon research to help decision-makers better prepare for climate change mitigation and adaptation policies in the coming decade. The full report can be accessed at **https://unesdoc.unesco.org/ark:/48223/pf0000376708**.

AOML Hosts First Virtual Open House

AOML hosted its first virtual open house in April in celebration of Earth Day with a series of hour-long webinars that aired nightly from Tuesday, April 20, to Friday, April 23.

The week-long event showcased presenters from AOML's three science divisions – Physical Oceanography, Hurricane Research, and Ocean Chemistry and Ecosystems – who spoke about their recent research and answered questions from the audience.

Eyes on our Ocean focused on how the ocean changes over time and some of the instruments scientists use to monitor these changes, the ocean's role in extreme weather events, and how natural and human activities impact marine resources.

Hunting Hurricanes explored what it's like to fly into the eye of the storm, some of the new technology scientists at AOML are using to better understand the workings of tropical cyclones, and how to be better prepared for hurricane season.

Coasts and Corals examined a few of the stressors that challenge the health of coral reefs and other marine ecosystems, pathogens that cause disease and harmful algal blooms, and molecular methods being used to genetically identify a wide range of marine organisms.

Ask AOML Q&A enabled audience members to listen in on a lively panel discussion that featured a hurricane scientist, coral researcher, IT specialist, oceanographer, and a technical engineer. These panelists answered questions from the audience and spoke about their backgrounds, education, career paths, and working for NOAA.

AOML's virtual open house was organized and hosted by Heidi Van Buskirk, an AOML communications specialist, with assistance from the AOML Comms Team.

APRIL 19-23, 2021

6P.M.-7 P.M. ET

FLY INTO HURRICANES, EXPLORE OUR OCEAN, AND MORE AT THE #AOMLVIRTUALOPENHOUSE!

fyi

If you missed AOML's Virtual Open House, no worries! The webinars were recorded. Videos of the four virtual sessions can be viewed by clicking on the following links:

Eyes on our Ocean

https://www.youtube.com/watch?v=mhEGqxjPbVo

(featuring Rick Lumpkin, Renellys Perez, Shenfu Dong, and Grant Rawson)

Hunting Hurricanes

https://www.youtube.com/watch?v=K-Sdz-Ajscs

(featuring Jon Zawislak, Rob Rogers, Joe Cione, and Shirley Murillo)

Coasts and Corals

https://www.youtube.com/watch?v=sVIx9SkK33M

(featuring Chris Kelble, Nicole Besemer, Anderson Mayfield, and Nastassia Patin)

Ask AOML Q&A

https://www.youtube.com/watch?v=nYEYkAoLbnc

(featuring Evan Forde, Alejandra Lorenzo, Michael Studivan, Heather Holbach, and Diego Ugaz)

Congratulations

Leticia Barbero, a Cooperative Institute scientist with AOML's Ocean Chemistry and Ecosystems Division, was selected in May to become the new Co-Chair for the Global Ocean Ship-based Hydrographic Investigations Program (GO-SHIP). AOML participates in GO-SHIP as part of an international effort to study decadal changes in ocean carbon, acidification, and stratification. As the GO-SHIP Co-Chair, Leticia will work to align NOAA's priorities with other international stakeholders and partner programs. She succeeds AOML senior scientist Rik Wanninkhof in the position, who served as the Go-SHIP Co-Chair for the past 6 years.

Nicole Besemer, a Cooperative Institute scientist, and Ian Enochs, a research ecologist, both with AOML's Ocean Chemistry and Ecosystems Division, are members of the Working Group for NOAA's Coral Reef Condition Status Reports, that received a 2021 Hermes Creative Platinum Award in May for Outstanding TV Placements and Outstanding Overall Publicity Campaign. The group received the award from the International Association of Marketing and Communication Professionals in recognition of compelling print media exposure created during a pandemic through virtual press events.

Joseph Bishop, a mechanical engineer with AOML's Ocean Chemistry and Ecosystems Division, was named NOAA's Employee of the Month for April 2021. Joe was recognized for his leadership in designing, engineering, and deploying a first-of-its-kind real-time monitoring buoy at Port Everglades in Fort Lauderdale, Florida. The buoy is part of an expert system that will assess oceanographic conditions to protect coral reefs and other marine life during a major expansion project at the port in 2022. Due to Joe's efforts, the buoy is fully functioning and ready to support both dredging operations and coastal ecosystems.

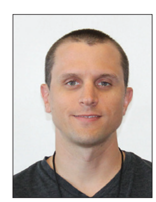
Michael Fischer, a Cooperative Institute scientist with AOML's Hurricane Research Division, was awarded a 2020 Reviewer's Certificate by the Royal Meteorological Society in June. Michael received the award in recognition of the quality and thoroughness of a large number of reviews he completed on tropical cyclone analyses for the *Quarterly Journal of the Royal Meteorological Society*. By bringing his expertise in observations and modeling to the review process, Michael enabled the Royal Meteorological Society to uphold its high standards for papers published in its journals.

Gregory Foltz, an oceanographer with AOML's Physical Oceanography Division, was selected in April as one of the world's 1,000 most influential climate scientists by Thomson Reuters, the company that provides the Web of Science database service. Thomson Reuters created their international listing based on three rankings: (1) how many research papers scientists have published on topics related to climate change; (2) how often those papers are cited by other scientists in similar fields of study, such as biology, chemistry, or physics; and (3) how often those papers are referenced in the lay press, social media, policy papers, and other outlets.

Ramon Hurlockdick, an information technology specialist with AOML's Office of the Director, recently earned a PhD in Information Systems from the College of Computing and Engineering at Nova Southeastern University. His thesis, "*How non-compliance impacts security incidences: A public sector case study of application security and proper data governance,*" explored the critical role of training in preparing staff responsible for implementing security policies and procedures. Ramon began his doctoral studies at Nova Southeastern University, designated a center of excellence by the National Security Agency, through the support of the Graduate Studies Program of NOAA's Office of Oceanic and Atmospheric Research.

Rayne Sabatello, a Cooperative Institute communications intern with AOML's Physical Oceanography Division, earned a Master of Professional Science degree in Climate and Society from the University of Miami's Rosenstiel School in May. Rayne's thesis, *Improving communications quality for the Physical Oceanography Division at NOAA's Atlantic Oceanographic and Meteorological Laboratory*, aimed to enhance the division's communications through the creation and use of five communication mediums—web pages, news stories, social media posts, field journals, and two-page flyers. The project determined the benefits of each communication tool and its effectiveness in reaching AOML's diverse target audiences. The results will assist AOML in developing the lab's FY-2022 communications strategy.

Luke Thompson, a Cooperative Institute bioinformatician with AOML's Ocean Chemistry and Ecosystems Division, accepted an invitation in April to serve as a member of the Scientific Committee for the Earth HoloGenome Initiative (EHI). The EHI, based at the Centre for Evolutionary Hologenomics at the University of Copenhagen in Denmark, is building a collaborative network to generate a standardized collection of fecal/cloacal swabs and tissue samples of wild vertebrates across the globe. The initiative aims to study eco-evolutionary questions related to the spatial, temporal, and phylogenetic patterns of wild animal–microbiota interactions.



Jonathan Zawislak, a Cooperative Institute scientist with AOML's Hurricane Research Division, accepted an invitation in April from the American Geophysical Union to become an Associate Editor of *Journal of Geophysical Research-Atmospheres.* Jon will critically review and assess the quality of research articles submitted to the journal with a focus on tropical cyclones for a term of 3 years. The journal publishes research to advance and improve the understanding of atmospheric properties and processes, including the interaction of the atmosphere with other components of the Earth system, as well as their roles in climate variability and change

Welcome Aboard

Emily Ashe joined AOML's Office of the Director in May as a new University of Miami-Cooperative Institute Communications Intern. Emily will work with the Communications Team to promote the lab's research activities and accomplishments by writing science articles for the AOML website, maintaining and growing the lab's social media platforms, and other duties. She is currently a graduate student with the Coastal Zone Management Program at the University of Miami's Rosenstiel School.

Ben Chomitz joined AOML's Ocean Chemistry and Ecosystems Division in April as a University of Miami-Cooperative Institute Research Associate. Ben will work in the Coral Program's Digital Morphology Lab by using AOML's CT and 3D scanners, and their associated analysis infrastructure and software, to analyze and study various biologic and ecologic metrics on a wide range of scales. He recently earned an MS degree in Biology from the University of Costa Rica.

Megan Deehan joined AOML's Ocean Chemistry and Ecosystems Division in May as a University of Miami-Cooperative Institute Communications Intern. Megan will work to promote the division's research activities and accomplishments by writing science articles for the AOML website, preparing web pages, and other duties as they arise. She is currently a graduate student with the Marine Conservation Program at the University of Miami's Rosenstiel School.

Rayne Sabatello joined AOML's Physical Oceanography Division in May as a University of Miami-Cooperative Institute Communications Specialist. Among her duties, Rayne will work to promote the division's research activities and accomplishments on social media, write science articles for the AOML website, and prepare web pages. She recently earned an MPS degree in Climate and Society from the University of Miami's Rosenstiel School.

Dr. Alice Webb joined AOML's Ocean Chemistry and Ecosystems Division in April as a University of Miami-Cooperative Institute Post-Doctoral Scientist. Alice will work with the Coral Reef Conservation Program's Reef Persistence Evaluator project to translate carbonate budgets into a climate-relevant management tool for forecasting habitat persistence. She holds a PhD from the Department of Ocean Systems at the Royal Netherlands Institute for Sea Research.

Dr. Dan Wu joined AOML's Hurricane Research Division in June as a University of Miami-Cooperative Institute Senior Research Associate. Dan will work with Drs. Altug Aksoy and Jason Sippel on developing the inner-core data assimilation capabilities for NOAA's new Hurricane Analysis and Forecasting System (HAFS). She holds a PhD in Atmospheric Science from the School of Atmospheric Sciences at Nanjing University.

Farewell

NOAA Corps Officer LCDR Andrew Colegrove, AOML's Associate Director for the past 3 years, departed in April to prepare for his next rotational assignment as the Commanding Officer of the NOAA Ship *Gordon Gunter* stationed in Pascagoula, Mississippi. During his tenure as Associate Director, Andrew tended to both safety and security issues at AOML, as well as managed the day-to-day operation and maintenance of the AOML facility. He also spearheaded a long list of repair and improvement projects, helping make the AOML facility a safer, more updated, and aesthetically pleasing work environment.

Ricardo Domingues, an University of Miami-Cooperative Institute Senior Research Associate with the Physical Oceanography Division, resigned in April to accept a position with private industry. During Ricardo's almost 10 years at AOML, his work focused on providing technical and scientific support for a variety of projects within the division, including the XBT network, Western Boundary Time Series project, and hurricane underwater glider operations. Ricardo also led and collaborated with colleagues on numerous science studies, including efforts to improve hurricane intensity forecasts and sea level outlooks and projections.

Rafael Gonçalves, a University of Miami-Cooperative Institute Post-Doctoral Scientist, completed his appointment with the Physical Oceanography Division in April. During Rafael's 2 years at the lab, his research focused on applying deep Gaussian processes to ocean data assimilation to assess the impact of in-situ oceanographic data on hurricane intensity forecasts and on monitoring Atlantic meridional heat transport.

Patrick Halsall, a University of Miami-Cooperative Institute Research Associate with the Physical Oceanography Division, resigned in April to accept a new position with the City of Miami Beach as a Business Intelligence Engineer. During Patrick's 6 years at AOML, he provided technical support for the XBT network and PhOD website, as well as supported the hurricane glider project.

Heidi Van Buskirk, University of Miami-Cooperative Institute Communications Specialist with AOML's Office of the Director, resigned in May. Heidi has accepted a position with the South Florida Public Broadcasting Service (PBS) as an assistant producer for the television program *Changing Seas*. This documentary series gives viewers a first-hand look at how experts study the ocean and how human activities impact ocean resources. During Heidi's 2 years at AOML, she worked to grow the lab's social media presence, primarily with the implementation of an Instagram account. Since its inception in 2020, the account has grown to over 1700 followers and has been an excellent medium for collaboration between AOML, other NOAA labs, and cooperative institute partners.

U.S. Department of Commerce
Ms. Gina M. Raimondo
Secretary of Commerce
www.doc.gov

National Oceanic and Atmospheric Administration
Dr. Richard W. Spinrad
Undersecretary of Commerce for Oceans and Atmosphere and NOAA Administrator
www.noaa.gov

Office of Oceanic and Atmospheric Research
Mr. Craig N. McLean
Assistant Administrator
www.oar.noaa.gov

Atlantic Oceanographic and Meteorological Laboratory

Dr. John V. Cortinas
Director

Dr. Molly O. Baringer
Deputy Director

LTJG Alyssa N. Thompson
Associate Director (Acting)

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

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