# AOML Keynotes

NOAA'S ATLANTIC OCEANOGRAPHIC AND METEOROLOGICAL LABORATORY

October-December 2023

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

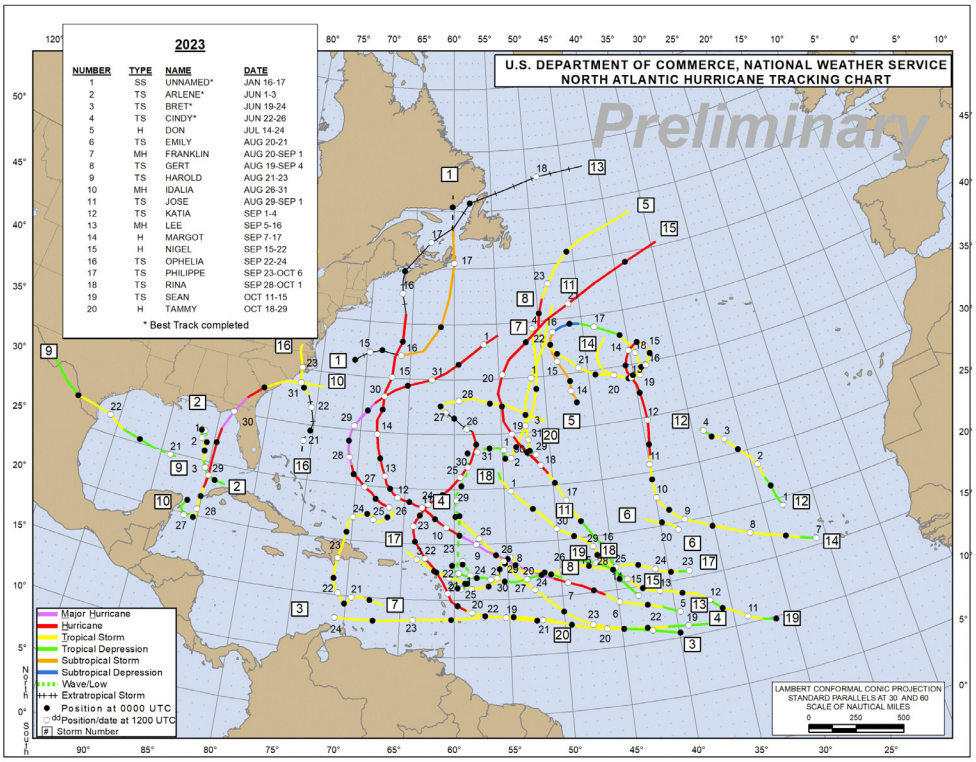

## NOAA Pioneers New Ways to Advance Hurricane Forecasting

***"Our scientists have shown exceptional dedication in advancing new technologies and research this hurricane season, investing weeks of work to gather crucial data. Their efforts stand as a testament to NOAA's commitment to safeguarding lives and property."***

**John Cortinas, PhD**
**AOML Director**

### In This Issue






**National Weather Service map that shows the path of all 20 tropical cyclones that formed in the Atlantic basin during the 2023 hurricane season. Image credit: NWS-NHC**

November 30 marked the official end to the active 2023 Atlantic hurricane season. Throughout the 6-month season, scientists and forecasters from across NOAA pushed boundaries as they worked to conduct crucial research to better forecast future tropical cyclone development and protect those most affected.

Scientists at AOML and colleagues with NOAA's Aircraft Operations Center partnered to fly 54 research and operational missions on NOAA's Hurricane Hunter aircraft into seven tropical disturbances, with five of those systems becoming hurricanes (sustained winds of 74 mph or higher) and three developing into major hurricanes (sustained winds of 111 mph or higher).

Research missions were conducted in collaboration with NOAA's Office of Marine and Aviation Operations (OMAO) and the Office of Naval Research's rapid intensification and moisture and aerosol programs. Operational missions were requested by NOAA's National Hurricane Center and Environmental Modeling Center to collect observations that are critical for improving track and intensity forecasts. The crews provided 188 tail Doppler radar analyses, released 1,274 dropsondes, and continued experimenting with cutting-edge drone technologies.

In addition to sampling the atmosphere, ocean observations were also gathered to better understand the ocean's impact on storms. AOML and partners ***cont. page 2***

*Cont. from page 1*

operated eight underwater gliders in the tropical Atlantic basin that collected temperature and salinity data to depths of 900 meters. NOAA also partnered with Saildrone, Inc. to deploy 12 saildrone uncrewed surface vehicles that collected observations from the air-sea interface.

During their time at sea, the saildrones intercepted storms 19 times for a total of 144 hours in tropical storm conditions, providing near-real time data on pressure, wind speed, temperature, and more. The National Hurricane Center cited saildrone data in their forecast discussions 20 times in 2023.

In mid-October, AOML hurricane researchers successfully deployed a new uncrewed aircraft system (UAS) into Tropical Storm Tammy to measure the lower atmosphere, a region too turbulent for crewed aircraft. The Black Swift Technologies S0™ UAS was launched from NOAA's P-3 aircraft during missions into the storm as it strengthened and approached the Leeward Islands.

The Hurricane Tammy research missions additionally resulted in the first successful coordination of the P-3 aircraft with an assortment of instruments, including Anduril's Altius-600 UAS, a saildrone, dropsondes, and airborne expendable bathythermographs (AXBTs). Together, these instruments collected vital data in the lower levels of storms that have historically been too challenging to sample.

Data collected by the dropsondes were used to validate the wind speed, pressure, humidity, and sea surface temperature observations measured by the Altius-600, saildrone, and AXBTs. This information was crucial for modeling efforts and for better understanding the situational awareness of storms.


**Jack Elston, the CEO and founder of Black Swift Technologies, and Joe Cione, the NOAA-AOML Lead Meteorologist for Emerging Technologies (holding a Black Swift S0 model), in front of the NOAA P-3 Hurricane Hunter aircraft. Image credit: NOAA-AOML**

These types of coordinated efforts were a primary focus of NOAA's research endeavors throughout the 2023 hurricane season. Scientists, crew members, and private industry partners planned and executed these intricate coordinated efforts to sample multiple levels of the atmosphere and ocean. Observations of how the atmosphere and ocean interacted inside tropical cyclones provided data on storm dynamics that were previously unobtainable by scientists, enabling NOAA to continuously learn more about how storms form and intensify.

Observations gathered throughout the season—from the upper atmosphere to the depths of the ocean—were incorporated into NOAA's state-of-the-art analysis and forecast models to help vulnerable communities better prepare, as well as help improve the understanding of tropical cyclone genesis, intensification, and dissipation.

AOML's hurricane researchers also helped with the successful transition a new hurricane model, the Hurricane Analysis and Forecast System (HAFS), into operations at NOAA's National Weather Service, which showed skill in predicting rapid intensification. Two versions of HAFS, HAFS-A and HAFS-B, began producing operational forecasts for tropical cyclones across the globe on June 27, 2023 after 4 years of development in collaboration with NOAA's Environmental Modeling Center. HAFS helped forecasters predict days in advance that Hurricane Idalia would impact the Gulf coast of Florida as a dangerous major hurricane.

HAFS products were made available in real-time on the AOML Hurricane Model Viewer web site, providing situational awareness and guidance for Hurricane Hunter missions. AOML scientists also evaluated an advanced, experimental version of HAFS as part of the Hurricane Forecast Improvement Program's Real-time Experiment (HREx). The research will be considered in the next HAFS upgrade to version 2, expected next year.

The dedicated scientists, flight crews, and staff that supported the 2023 Hurricane Field Program spent weeks of long hours diligently working to gather data to advance the understanding of storms and improve forecasts with the ever-present goal of protecting lives and property.

| 2023 Atlantic Hurricane Season by the Numbers | | |
|---|---|---|
| Tropical cyclones and tropical disturbances studied: **7** | Dropsondes released: **1,274** | Tail Doppler radar analyses transmitted to EMC and NHC: **188** |
| Airborne research and operational missions: **54** | APHEX P-3 research experiments and modules conducted: **14** | StreamSondes deployed from the NOAA P-3s: **12** |
| Lockheed WP-3D (P-3) Orion missions: **37** | Airborne bathythermographs (AXBTs) released: **90** | Gliders deployed: **8** operated by AOML |
| Gulfstream IV-SP (G-IV) missions: **17** | Small Uncrewed Aircraft Systems (sUAS) deployed from the NOAA P-3s: **5** | A-Sized wave drifters deployed from the NOAA P-3s: **5** |

# New Black Swift Drone Deployed in Tropical Storm Tammy

***"We appreciate the dedication of our partnership with Black Swift Technologies in advancing our mission of improving future hurricane forecasts and protecting lives and property."***

**Joe Cione, PhD**
**NOAA-AOML Lead Meteorologist for Emerging Technologies**

**Hurricane researchers and the Black Swift Technologies team celebrate aboard NOAA's P-3 Hurricane Hunter aircraft after the successful launch and mission of the S0 into Tropical Storm Tammy. Image credit: NOAA-AOML.**

NOAA hurricane researchers successfully deployed a new uncrewed aircraft system (UAS) into Tropical Storm Tammy on October 19, 2023, measuring parts of the storm too dangerous for humans to go. The Black Swift Technologies S0™ UAS was launched from NOAA's P-3 Hurricane Hunter aircraft by scientists from AOML during missions into the storm as it strengthened and headed closer to the Leeward Islands in the Caribbean.

NOAA partnered with Black Swift to develop an instrument robust enough to withstand the punishing conditions found tropical cyclones. The S0 UAS can operate in low- to medium-altitude maritime environments, gathering atmospheric profiles from as low as 50 feet above the ocean surface to as high as 15,000 feet in the atmosphere.

At 2.7 pounds, the S0 is the lightest UAS platform ever used to successfully sample a tropical cyclone. It features various payload instruments that measure air temperature, wind speed and direction, moisture, and atmospheric pressure. These observations are gathered through onboard programming and/or by aircraft-based operators.

AOML's hurricane hunters sampled Tropical Storm Tammy with tail Doppler radar to obtain three-dimensional profiles of the wind and areas of heaviest precipitation, as well as with GPS dropsondes deployed along the flight track. The successful launch of the S0 additionally provided observations from the lowest, rarely sampled, most turbulent levels of the storm. Flying as low as 100 feet above the ocean surface, the S0 completed a 1-hour and 11-minute mission, the second longest air-deployed mission by a UAS.

The goal is to continue to deploy the Black Swift S0 UAS alongside other uncrewed aircraft, such as the Altius-600, into active tropical cyclones during operational P-3 missions, providing NOAA scientists with real-time, near-surface atmospheric data. These observations will one day be integrated into forecast models to improve the understanding of a storm's track, intensity, and structure.

"Black Swift strives to solve some of the most difficult problems required to expand the use of UAS," said Jack Elston, the CEO and founder of Black Swift Technologies. "It's been amazing working with Dr. Cione, the P-3 team, and NOAA to build and deploy a platform that can gather data previously unavailable to forecasters from a critical part of the storm."

The S0 launch into Tropical Storm Tammy shows how uncrewed systems can help NOAA improve tropical cyclone forecasts by filling a vital gap in observations.

### NOAA Conducts First Collocated Drone Mission into a Hurricane

Dozens of dedicated NOAA scientists and crew members, along with private industry partners, collaborated to plan and successfully execute the first-ever collocated drone mission on October 25. The mission collected vital data in the lower altitudes of a hurricane, a region historically difficult to sample–until now.

NOAA hurricane researchers deployed a new uncrewed aircraft system (UAS) into Hurricane Tammy near a saildrone uncrewed surface vehicle to measure parts of the storm too turbulent for crewed aircraft to venture. The low-flying Altius-600 UAS, launched from NOAA's P-3 Hurricane Hunter aircraft, collected observations at altitudes below 5,000 feet, while the saildrone collected observations at and below the ocean surface.

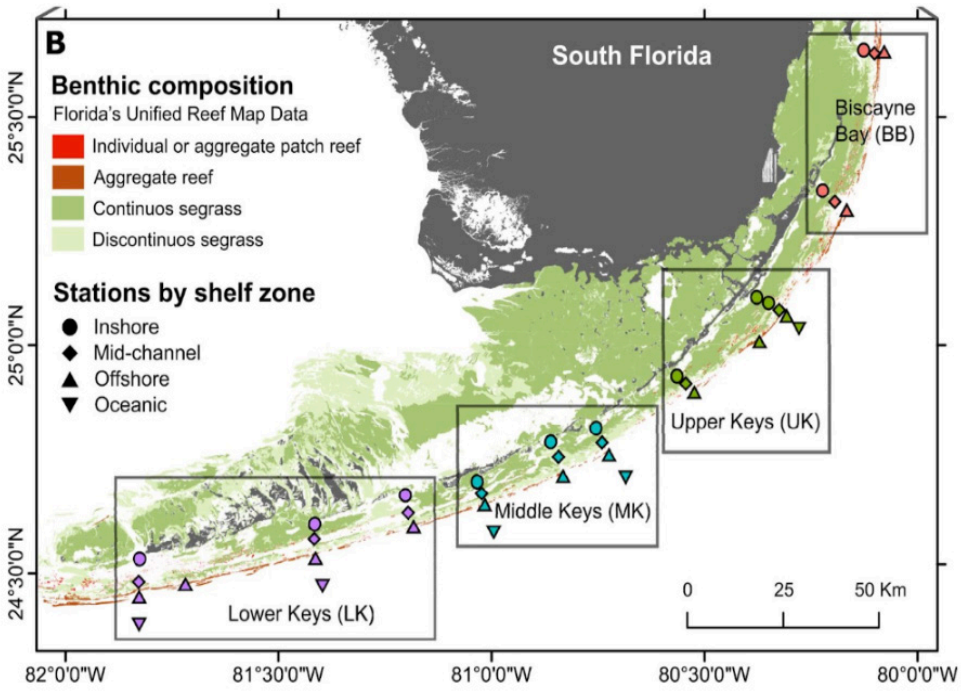
Data gathered from the mission will help advance the understanding of the complex interactions that occur at the air-sea interface, enabling storms to form and develop, as well as rapidly intensify.


**The Altius-600 UAS (foreground) was deployed from NOAA's P-3 aircraft (background), transmitting data from Tammy at altitudes as low as 940 feet above the ocean surface. Image credit: NOAA-AOML**

# Study Demonstrates Buffering of some Florida Reefs against Ocean Acidification

***"Understanding the local impacts of ocean acidification is essential for predicting potential economic losses from eroding coastal ecosystems. If we are able to pinpoint the regions that are more and less affected by ocean acidification, we can employ more effective and targeted strategies to conserve coral reef ecosystems."***

**Ana Palacio-Castro, PhD**
**AOML Coral Scientist**




**Map that shows where water samples were collected for more than decade at the 38 field stations within the Florida Coral Reef. The stations represent inshore, mid-channel, and offshore reefs from different regions, including Biscayne Bay and the Upper, Middle, and Lower Florida Keys. Image Credit: Palacio-Castro *et al.* (2023).**

A groundbreaking new study* spanning more than a decade and hundreds of miles of the Florida Coral Reef demonstrates the key role benthic communities play in reducing the impacts of climate change on coral reef ecosystems, specifically ocean acidification.

As the ocean accumulates more carbon from the atmosphere, it becomes more acidic, a process known as ocean acidification. A more acidic ocean makes it harder for corals and other marine organisms to build their calcium carbonate skeletons and shells. However, scientists at AOML and the Cooperative Institute for Marine and Atmospheric Studies (CIMAS) have found that ocean acidification near the Florida Coral Reef varies both geographically and over time, resulting in reef areas that may be less affected by acidification compared to reefs in the open ocean.

In many regions globally, the effects of ocean acidification on coastal ecosystems are compounded by localized changes in water chemistry that are harmful to key marine ecosystems. While the southernmost reefs in the Florida Coral Reef were identified as hotspots for ocean acidification, inshore reefs, particularly in the Upper Keys, proved less vulnerable due to increasing water alkalinity (the opposite of acidity) and the presence of seagrass beds.

From 2010 to 2021, researchers monitored 38 stations at inshore, mid-channel, and offshore reefs within the different regions of the Florida Coral Reef, from Biscayne Bay in the north through the upper, middle, and lower Florida Keys in the south. As part of NOAA's National Coral Reef Monitoring Program, water samples were collected every 2 months at each station and analyzed for changes in key water chemistry parameters used to calculate pH, helping identify how ocean acidification varies among inshore and offshore reefs, across different regions, and over time from seasons to years.

While mid-channel and offshore reefs in the Florida Coral Reef are more exposed to ocean currents and global ocean acidification trends, the study found shallow inshore reefs were less impacted. In the Upper Keys specifically, their greater seasonality, increasing water alkalinity (known to neutralize acidification), and variety of benthic communities such as seagrass beds significantly influence the carbonate chemistry, providing a buffer against ocean acidification.

Seagrass beds alter water chemistry as they grow through metabolic processes such as photosynthesis, calcification, and respiration. Through photosynthesis specifically, seagrass absorbs carbon dioxide from seawater, providing more favorable conditions for the formation of calcium carbonate by reducing acidity.

The study's crucial finding is that well-distributed beds of seagrass coexisting with inshore reefs in the Upper Keys are a buffer against ocean acidification. As ocean acidification is expected to worsen with climate change, these regions may act as refugia for marine organisms where reef structures are likely to persist. It also demonstrates the crucial role seagrass beds and other benthic communities play in safeguarding coral reefs and how they should be prioritized in ongoing and future coral restoration efforts.

This study is unique in both its spatial and temporal scope as scientists monitored hundreds of miles of the Florida Coral Reef for more than a decade. Beyond its scale, the findings emphasize the need to examine localized impacts of global environmental stressors brought on by climate change to establish effective management strategies to both conserve and restore key ecosystems.

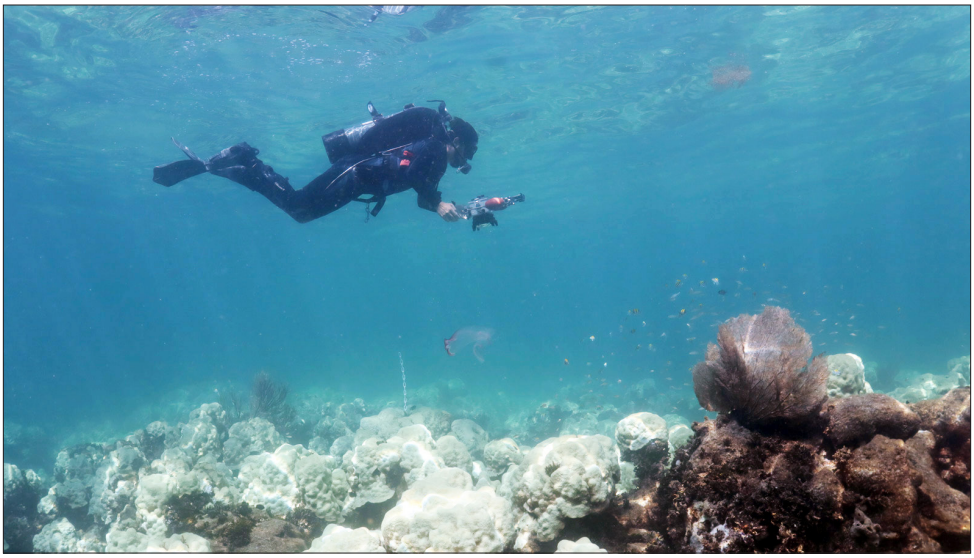
Funding for the study was provided by NOAA's Ocean Acidification Program, as well as NOAA's Coral Reef Conservation Program.

*Palacio-Castro, A.M., I.C. Enochs, N. Besemer, A. Boyd, M. Jankulak, G. Kolodziej, H.K. Hirsh, A.E. Webb, E.K. Towle, C. Kelble, I. Smith, and D.P. Manzello, 2023: Coral reef carbonate chemistry reveals interannual, seasonal, and spatial impacts on ocean acidification off Florida. *Global Biogeochemical Cycles*, 37(12):e2023GB007789, https://doi.org/10.1029/2023GB007789

# A Bold, Unprecedented Effort Tackles the Vast Threats to Marine Ecosystems

***"A key goal of this multi-stressor project is to show how climate change will impact the seven "Mission: Iconic Reef" sites and how changing water quality parameters associated with the Comprehensive Everglades Restoration Plan may influence them. The ability to target resiliency will allow scientists to evaluate different coral restoration strategies to help ensure habitat protection under various climate scenarios."***

**Ian Enochs, PhD**
**AOML Research Ecologist**



**Ian Enochs captures images of a bleached coral reef structure following an extreme marine heatwave that impacted reefs across South Florida during the summer of 2023. Image credit: NOAA-AOML**

NOAA announced in November 2023 that $4.2 million in funding had been awarded to a collaborative project entitled "*Florida Regional Ecosystem Stressors Collaborative Assessment*" or FRESCA, co-led by AOML and the University of Miami and involving seven academic and research institutions.

The announcement marks the beginning of a crucial effort among experts across vastly different fields to understand the holistic effects of climate change, as well as unlock key insights to inform ongoing and future restoration strategies.

The launch of FRESCA comes at a critical juncture, as it will provide essential information for the management and restoration of South Florida's marine ecosystems through the Comprehensive Everglades Restoration Plan. FRESCA will also provide for the management of the Florida Keys National Marine Sanctuary and the Mission: Iconic Reefs project to restore seven ecologically and culturally significant reefs within the sanctuary.

In the wake of an extreme mass coral bleaching event brought on by a marine heatwave that impacted South Florida, the Gulf of Mexico, and greater Caribbean region during the summer of 2023, AOML scientists are leading this unprecedented effort to tackle the numerous threats faced by marine ecosystems.

Preparing for the future of climate change requires an understanding of the breadth of environmental stressors attributed to Earth's warming and rising global carbon emissions. FRESCA aims to assess the current and future impacts of five key marine ecosystem stressors under climate change: ocean acidification, hypoxia, ocean warming, eutrophication, and harmful algal blooms.

However, these are not isolated issues. From marine heatwaves and greater ocean warming to acidification and hypoxia, these stressors are exacerbated by their counterparts with varying intensities in different regions and across complex, yet interconnected marine ecosystems.

Over a 4-year period, coral ecologist Ian Enochs of AOML and Ana Palacio-Castro, PhD, a Cooperative Institute scientist at AOML through the University of Miami, will co-lead this multi-institutional effort. The goal is to determine the current distribution and impact of the five stressors across the southwest Florida Shelf and Florida Keys National Marine Sanctuary, respectively.

Through ecosystem modeling and experimentation, researchers will identify thresholds of key habitat-altering species, from corals to pelagic fish, in response to greater temperatures, ocean acidification, hypoxia, and nutrient levels.

FRESCA is funded by the NOAA-National Centers for Coastal Ocean Science's Competitive Research Program, NOAA's Climate Program Office and Ocean Acidification Program, and the US Integrated Ocean Observing System in collaboration with NOAA's Office of National Marine Sanctuaries.

**Ana Palacio-Castro preserves a seawater sample to study ocean acidification near a coral reef. Image credit: Sean Mattson/STRI**

# Failing Upwards: Developing an Autonomous Surface Vehicle for 'Omics Research

***"Sometimes its gotta fail to move forward. You tweak it and then take it out to the field again, thinking it's going to work. You keep trying, going back to the drawing board until it does."***

**Kelly Goodwin, PhD, AOML Scientist**
**Chair, NOAA's 'Omics Working Group**

**The solar-powered SeaTrac autonomous surface vehicle, roughly the shape of a stand up paddle board, successfully sampled the shallow waters of western Lake Erie. Image credit: NOAA-GLERL**

On August 5, 2023, scientists from NOAA's Great Lakes Environmental Research Laboratory (GLERL), AOML, and the Monterey Bay Aquarium Research Institute (MBARI) watched as a new solar powered surface vehicle, the SeaTrac, sailed off across the Great Lakes. For 2 weeks, the autonomous vessel navigated the shallow waters of western Lake Erie equipped with state-of-the-art technology, unlocking advancements in 'omics research and the ability to monitor harmful algal blooms.

A team of engineers and scientists at MBARI, along with NOAA scientists, first successfully deployed a long-range autonomous underwater vehicle (LRAUV) in the California Current that could dive hundreds of meters to collect samples for genetic analyses. However, the shallower waters of the Great Lakes proved too challenging for the LRAUV to operate, forcing the team to search for a vehicle better suited for shallow waters.

The goal was to develop an autonomous underwater vehicle to collect, process, analyze, and transmit data in near-real time while withstanding the harsh conditions of both the open ocean and Great Lakes. Their search eventually led to the mission with the SeaTrac platform.

Watching the SeaTrac successfully navigate Lake Erie brought celebration. "Until you get the whole system out there on the water you don't really know what's going to happen; it shows how complicated the engineering process actually is," said Goodwin.

While the SeaTrac differs from the LRAUV in its ability to navigate only along the water's surface, the two vehicles both collect biological samples via the 3G ESP, or 3rd Generation Environmental Sampler Processor. The instrument was developed by MBARI to collect water samples without human intervention for 'omics analyses.

NOAA 'omics, a growing science and technology focus area, uses fields such as metagenomics, metatranscriptomics, and proteomics to examine genetic material (DNA, RNA, proteins) from an array of species, from microscopic organisms to large fish and even marine mammals. The autonomously collected samples are analyzed for environmental DNA (eDNA), the genetic material left by organisms in the environment. eDNA allows researchers to monitor and better understand aquatic life, including organisms that cause harmful algal blooms in the Great Lakes.

The SeaTrac's ability to collect eDNA autonomously has a variety of perks such as monitoring during weather conditions too dangerous for crewed missions, which it accomplished while deployed. However, the instrument did more than just collect and preserve samples for later analysis of eDNA—it also autonomously processed and analyzed samples for harmful algal bloom toxin while cruising on the lake.

A new sensor developed at MBARI and NOAA's National Centers for Coastal Ocean Science (NCCOS) enabled the SeaTrac to measure harmful algal bloom toxin concentrations on-the-fly and transmit the data to shore-based operators. This quick delivery of toxin data to resource managers will allow for informed decisions to better protect public health.

The successful deployment of the SeaTrac with the 3G ESP instrument and toxin sensor was a major milestone, but work remains to develop and use this coupled technology on a larger scale. To this end, AOML developed a transition plan—"*Advancing NOAA Autonomous 'Omics Capabilities*"—that outlined the collaborative effort between GLERL, AOML, MBARI, and NCCOS.

Signed by NOAA leadership in April 2023, the plan provides a roadmap to describe how the project will mature over time with ongoing research, development, and testing. The strides made to advance this technology and unlock new means of performing critical environmental research demonstrate the importance of embracing risk and failing upwards.

**NOAA-GLERL marine engineer Kyle Beadle and scientist Reagan Errera, PhD, remove MBARI's 3G ESP sampling instrument from the inside of the SeaTrac autonomous platform. Image credit: NOAA-AOML.**

# AOML Scientist Contributes to Fifth National Climate Assessment Report

Emily Osborne, PhD, a physical scientist at AOML, served as the Coordinating Lead Author for the "Ocean Ecosystems and Marine Resources" chapter of the *Fifth National Climate Assessment* report. This fifth iteration of the report finds that the impacts of weather extremes, exacerbated by climate change, are far-reaching across every region of the United States. However, the report also finds that rapidly reducing greenhouse gas emissions and accelerating adaptation can limit further warming and protect lives and property from many climate risks.

When asked about the importance of this work, key challenges discussed in the chapter, and what drove her to lead a team of cross-disciplinary authors to produce the nation's most up-to-date and authoritative report on climate change in the United States, Emily stated, "it was a way to connect science to decision-makers and the general public. Climate communication tools like the *National Climate Assessment* ensure the public has access to the latest information in a digestible way."

Here are some of the findings from the chapter:

***Key messages:*** There is overwhelming evidence that climate change, through ocean warming, changes in oxygen and pH, extreme events, and other human-caused effects, has and will continue to have significant impacts on United States marine ecosystems. Climate change poses an array of substantial risks to ocean-related industries such as fisheries, tourism, recreation, transportation, and energy. What we do today to reduce carbon emissions, mitigate carbon dioxide, and adapt by building more resilient communities and economies will determine how climate change impacts the ocean and many people, businesses, and communities.

**Emily Osborne with seawater samples during a research cruise in the Santa Barbara Channel to study ocean acidification. Image credit: NOAA-AOML**

***Key challenges:*** Additional scientific observations are required to deliver robust early warnings and improved longer term projections. Climate change disproportionately impacts historically underserved groups, including Black, Indigenous, and people of color, which emphasizes the need to ensure that climate information is equitably shared and accessible. Enduring and equitable outcomes will be achieved when all are at the table to develop adaptation and resilience plans.

***Promising adaptations:*** Development of fisheries management approaches that use ocean climate projections to assess risks; measures to protect and restore marine ecosystems that capture and store carbon, such as mangroves, seagrass, and kelp forests; decarbonization of the maritime transport sector, investment in research, and expansion of ocean-based solutions for marine carbon dioxide removal.

The *Fifth National Climate Assessment* report and the "Ocean Ecosystems and Marine Resources" chapter can be viewed at the following links:

Full report:
https://nca2023.globalchange.gov/

"Ocean Ecosystems and Marine Resources" chapter:
https://nca2023.globalchange.gov/chapter/10/

## Global Carbon Budget Report Stresses Reduction of Greenhouse Gas Emissions

Anthropogenic carbon dioxide ($CO_2$) emissions continue to rise worldwide, according to the latest global carbon budget report published in December 2023.* Prepared annually in support of the Global Carbon Project, the report emphasizes the need to significantly reduce emissions to meet global climate targets so as to avoid detrimental environmental impacts. Atmospheric $CO_2$ concentrations in 2023 were projected to reach 419.2 parts per million, an estimated 51% increase above pre-industrial levels, with 36.8 billion metric tons of greenhouse gas emissions produced by the end of the year.

AOML-Ocean Carbon Cycle scientists Leticia Barbero, Denis Pierrot, and Rik Wanninkhof were part of the international team that examined global emissions for key greenhouse gases—$CO_2$, methane, and nitrous oxide. "As we work towards achieving net zero emissions, we have been expecting natural sinks to behave the way they have in the past," explained Wanninkhof. "If they don't, we'll have to decrease emissions even more than expected." The report was led by the University of Exeter's Global Systems Institute and included contributions from 70 research and academic institutions globally.

*Friedlingstein *et al.*, 2023: Global carbon budget for 2023. *Earth System Science Data*, 15(12):5301-5369, https://doi.org/10.5194/essd-15-5301-2023

# AOML Oceanographer Gustavo Goni Retires from Federal Service

Gustavo Goni, PhD, an oceanographer at AOML and the former director of the Physical Oceanography Division, retired in October 2023 after 26 years of federal service to NOAA and the nation.

Gustavo's passion for oceanography began as a student in Argentina in the mid-1970s, motivating him to earn a BS degree in Ocean Engineering from the Buenos Aires Institute of Technology. He later received an MS degree in Acoustics at The Pennsylvania State University, followed by a PhD in Applied Marine Physics from the University of Miami.

He began his career at AOML in 1991 as a Research Associate with the University of Miami's Cooperative Institute for Marine and Atmospheric Studies. In 1997 Gustavo became as federal oceanographer, and in 2009 became the Director of the Physical Oceanography Division, a position he held until 2021.

During his years at AOML, Gustavo conducted research on ocean dynamics, studied the impact ocean variability on fisheries, weather, and climate, and investigated several aspects of the recent Sargassum blooms, while also leading observational efforts with underwater gliders and expendable bathythermographs.

"I am extremely happy to have worked at NOAA," said Gustavo. "I cannot imagine a better place to conduct oceanographic research. The opportunity to motivate talent and scientific curiosity by allowing scientists the freedom to conduct original research that leads to societal benefits, is among the most important aspects of the work at AOML."

Other areas of Gustavo's research focused on the variability of boundary currents using combined hydrographic observations and satellite data analysis. He was also involved in assessing changes in the Meridional Overturning Circulation in the South Atlantic using satellite altimetry data and observations from the Global Ocean Observing System collected by an assortment of instruments.

Gustavo was a leader who organized national and international meetings, as well as represented NOAA and the United States on several national and international panels that coordinate a wide range of global and regional oceanographic activities.

He also served as the Chairman of the Ship Of Opportunity Program, whose main objective is to fulfill upper ocean observational requirements as established by the Global Climate Observing System and Global Ocean Observing System. Additionally, Gustavo published more than 200 science articles and led and/or participated in numerous funded research proposals.

When asked what he will miss most about working for NOAA, Gustavo said, "The opportunity to continue growing personal and professional relationships. Working for NOAA gave me the opportunity to experience highlights that I would otherwise had never lived, such as interacting with Desmond Tutu, a Nobel Peace Prize winner, during a research cruise to South Africa; meeting the Emperor of Japan in person during a meeting in Sapporo; or simply doing a high five with the Prince of Monaco and

Miss France at the finish line during a marathon in Nice, where I was attending a science meeting."

Throughout his career, Gustavo received numerous awards and honors. Most recently, he received both Department of Commerce Gold and Bronze Medals in recognition of his contributions to the Saildrone and Hurricane Glider projects.

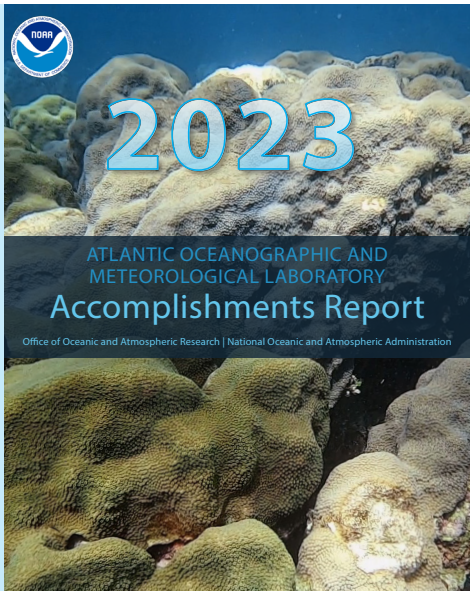
Gustavo is excited for the time to catch up and reconnect with friends and family in Argentina and around the world after so many years in the United States. However, he will be cheering from the sidelines for the success of everybody at AOML and NOAA.

"I am grateful to all of my colleagues for the help, interaction, and support they gave me over the years. The teamwork at AOML is central to accomplish the world class research conducted by NOAA."

### AOML Report Highlights Research Accomplishments for Fiscal Year 2023

In December AOML published a summary of accomplishments for fiscal year 2023, the time frame from October 1, 2022 to September 30, 2023. The report highlights AOML's research throughout the fiscal year and how it addressed four societal challenges identified by NOAA Research: (1) confronting challenges from our changing climate; (2) protecting against extreme weather events and environmental hazards; (3) managing too much and too little water; and (4) sustaining a healthy environment and economy. The report also provides highlights of AOML's efforts to build a more inclusive, diverse, equitable, and accessible workplace.

Observations of the Earth system by a variety of instruments and methods—from the upper levels of hurricanes to the depths of the ocean—enabled AOML researchers to track changes across a variety of ecosystems to monitor the impacts of climate change, helping advance the understanding of this global threat. Whether analyzing samples, enhancing models, flying directly into storms, crossing entire oceans, or conducting new experiments, AOML's research assisted decision-makers, emergency managers, scientists, and communities both nationally and globally. The report is available for viewing from NOAA's Institutional Repository.



# Awards Ceremony Celebrates 2023 Staff Achievements

AOML staff were recognized for their outstanding achievements throughout 2023 during an awards ceremony in December. The following individuals and teams are the recipients of a host of prestigious awards in support of NOAA's mission.

### *Department of Commerce*

Greg Foltz, Gustavo Goni, and Francis Bringas, along with colleagues from NOAA's Pacific Marine Environmental Laboratory and with support from affiliates Jun Zhang and Joaquin Trinanes, received a 2023 Department of Commerce Gold Medal for pioneering the application of uncrewed surface vehicles, i.e., saildrones, to observe hurricanes and tropical storms.

### *NOAA*

Ian Enochs received NOAA's 2023 Dr. Daniel L. Albritton Outstanding Scientific Communicator Award for his outstanding leadership and communication of NOAA's coral reef research and its relevance to the American public during an extreme marine heatwave and subsequent bleaching event across South Florida.

Nicole Besemer was named NOAA's Employee of the Month for February 2023 for successfully orchestrating field missions in support of the National Coral Reef Monitoring Program despite the heightened operational complexity and travel risks due to the COVID pandemic.

Elizabeth Perez received NOAA's 2023 Silver Sherman Award for outstanding service by going above and beyond in support of AOML's contract activities.

Lidia Cucurull received the NOAA Boulder Outreach's Gold Star Award for recording the NOAA Boulder tour in Spanish to help reach thousands of Spanish speakers across the nation.

### *NOAA-Office of Oceanic and Atmospheric Research (OAR)*

Emily Osborne received OAR's 2023 Employee of the Year Award for Personal and Professional Excellence for her promotion and advocacy of safety to prevent sexual assault and sexual harassment across NOAA and the broader scientific community.

Ben Chomitz, Kenzie Cooke, Allyson DeMerlis, Katie Eaton, Taylor Gill, Thia Griffin-Elliott, Patrick Kiel, Graham Kolodziej, Christopher Malanuk, Ana Palacio-Castro, Marike Pinsonneault, Rayne Sabatello, Nash Soderberg, and Michael Studivan received OAR's 2023 Team Member(s) of the Year Award for Outreach and Education for their exemplary response to the unexpected and unprecedented 2023 coral bleaching event in South Florida and their efforts to communicate the event to the American public. Federal team members who supported the effort included Nicole Besemer, Laura Chaibongsai, Ian Enochs, Emy Rodriguez, and Kayelyn Simmons.

Jason Dunion received OAR's 2023 Team Member of the Year Award for Leadership in advancing NOAA's Hurricane Field Program through innovative, inclusive leadership; strong partnerships with key stakeholders; and capacity-building among early-career staff and external teams.

Sarah Ditchek received OAR's 2023 Team Member of the Year Award for Personal and Professional Excellence for leading the most comprehensive assessments ever undertaken of the impacts of reconnaissance data and observing strategies on numerical weather prediction forecasts of tropical cyclones.

Andrew Hazelton received OAR's 2023 Team Member of the Year Award for Personal and Professional Excellence for advancing operational hurricane forecasts by leading the development, evaluation, and operational readiness of the Hurricane Analysis and Forecast System's "B" configuration.

William Ramstrom received OAR's 2023 Team Member of the Year Award for Personal and Professional Excellence for helping develop the first ever high-resolution, cloud-allowing, storm-following moving nest capability in NOAA's Hurricane Analysis and Forecast System and transitioning it to operations.

### *South Florida Federal Executive Board*

Hosmay Lopez received the South Florida Federal Executive Board's Federal Employee of the Year award for Science for his groundbreaking contributions to the understanding of how El Niño-Southern Oscillation events will evolve with global warming, with significant implications for how residents of South Florida will experience climate change over the next several decades.

**AOML Director John Cortinas (left) and Deputy Director Molly Baringer (right) with Emily Osborne, the recipient of an OAR 2023 Employee of the Year Award for Personal and Professional Excellence for her advocacy to prevent sexual assault and sexual harassment across NOAA and the broader scientific community.**

**AOML Director John Cortinas (standing, left) and Deputy Director Molly Baringer (standing, second from right) with members of a team who received OAR's Team Member(s) of the Year Award for Outreach and Education for their exemplary efforts to communicate an unprecedented coral bleaching event in South Florida to the American public, using social media and other means to reach millions.**

## Welcome Aboard

Dr. Luis Bordin joined AOML's Physical Oceanography Division in December as a Post-Doctoral Associate with Mississippi State University's Northern Gulf Institute. Luis will work with Dr. Fabian Gomez on a project to build a subseasonal-to seasonal warning system for red tide and hypoxia for West Florida Shelf fisheries. He recently earned a PhD in Oceanography from the Federal University of Rio Grande in Brazil.

Anthony Burke joined AOML's Ocean Chemistry and Ecosystems Division in November as a Research Associate with the University of Miami's Cooperative Institute for Marine and Atmospheric Studies. Anthony will support the Coral Program by serving as the manager of the Experimental Reef Laboratory and helping design and manufacture experimental instruments associated with the Florida Regional Ecosystem Stressors Collaborative Assessment project. He holds BS degrees in Chemistry and Marine Science from the University of Miami.

Dr. Heidi Hirsh joined AOML's Ocean Chemistry and Ecosystems Division in September as an Assistant Scientist with the University of Miami's Cooperative Institute for Marine and Atmospheric Studies. Heidi will support the Coral Program with research focused on evaluating how the unique characteristics of an ecosystem drive nearshore biogeochemical variability, and thus the degree of stress exposure a given coral reef experiences. By developing statistical models to predict nearshore carbonate chemistry from these characteristics, sites can be identified that are more resilient to current stressors and future change. She holds a PhD in Earth System Science from Stanford University.

Dr. John Morris joined the Ocean Chemistry and Ecosystem Division in October as a Post-doctoral Associate with the University of Miami's Cooperative Institute for Marine and Atmospheric Studies. John received his PhD from the University of Miami's Rosenstiel School in 2022. His previous research included investigating the effects of ocean acidification on bioeroding sponges, habitat modeling of coral reef ecosystems using benthic and fish survey data, and evaluating coral restoration strategies in response to vessel groundings. John will work with the Coral Program to model reef persistence of Mission: Iconic Reefs as part of the Florida Regional Ecosystem Stressors Collaborative Assessment project.

Dr. Mingming Shao joined AOML's Physical Oceanography Division in October as a Post-doctoral Associate with the University of Miami's Cooperative Institute for Marine and Atmospheric Studies. Ming holds a PhD in Applied Marine Physics from the University of Miami's Rosenstiel School. Prior to joining AOML, he was a post-doctoral researcher at the Woods Hole Oceanographic Institution. His previous research focused on multi-scale air-sea interactions and upper ocean dynamics. Ming will work with Dr. Hyun-Sook Kim and members of the modeling team on wave modeling research and the assimilation of wave observations.

## Farewell

Graham Kolodziej, an AOML Senior Research Associate with the University of Miami's Cooperative Institute for Marine and Atmospheric Studies, resigned in October to accept a position with the Woods Hole Oceanographic Institution in Woods Hole, Massachusetts. Graham began with the Coral Program as a laboratory technician in 2013. During his 10 years at AOML, he supported numerous field sampling efforts and a number of prominent projects for the Coral Program, including be part of the science team that designed and built the state-of-the art Experimental Reef Laboratory to study the genomic mechanisms of coral resiliency against future conditions of thermal stress and ocean acidification. Graham also led the acquisition and protocol development of a Computed Tomography scanner, which has become an essential tool for Coral Program researchers.

Dr. Ruben van Hooidonk, an AOML Assistant Scientist with the University of Miami's Cooperative Institute for Marine and Atmospheric Studies, resigned in December. During Ruben's 13 years at AOML, his research investigated the impacts of climate change on marine ecosystems, particularly coral reefs, and explored ways to improve coral resiliency. Through the use of satellite data and data from global models, Ruben also projected the inherent risk and uncertainty for the persistence of coral reefs under threat from warming ocean temperatures and ocean acidification.

## Congratulations

Lev Looney, a University of Miami graduate student at AOML, recently surpassed his 1,000th student through the Skype a Scientist program. The nonprofit educational organization enables scientists to video conference with students in classrooms around the world to share their knowledge and research. The platform enables students and/or the public to speak with a real scientist and get questions answered straight from the source.

Lev signed up for Skype a Scientist in 2020. After 40 video calls with 57 classes in 22 schools, he reached more than 1,000 students in the United States, Japan, China, Malaysia, and Canada. The schools in the US spanned 11 states and comprised elementary, middle, and high school-aged students.

"I joined Skype a Scientist to help myself get over my fear of public speaking," said Lev. "Not only did it help me improve my communication skills, but Skype a Scientist also helped keep my passion alive for what I do, especially in the tougher times of grad school. Students also teach me things. Joining this platform made me realize I want to continue to include teaching others as part of my career path, something I never thought I would want."

Lev is pursuing a PhD in Meteorology and Physical Oceanography and focuses his talks on weather, climate, and hurricanes. Outside of the Skype a Scientist program, he has also been involved with the Scientists in Every Florida School program, giving similar talks to five classes in Florida. Lev additionally is a pen pal through the Letters to a Pre-Scientist program and is involved in numerous outreach groups at the University of Miami.

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

**ABERSON**, **S.D.**, **J.A. ZHANG**, **J. ZAWISLAK**, **K. SELLWOOD**, **R. ROGERS**, and **J.J. CIONE**, 2023: The NCAR GPS dropwindsonde and its impact on hurricane operations and research. *Bulletin of the American Meteorological Society*, 104(11):E2134-E2154.

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