2024

ATLANTIC OCEANOGRAPHIC AND METEOROLOGICAL LABORATORY

Accomplishments Report

Office of Oceanic and Atmospheric Research | National Oceanic and Atmospheric Administration

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Expanding Our Reach Through Partnerships

We are especially grateful for our Cooperative Institute partners—the Cooperative Institute for Marine and Atmospheric Studies (CIMAS) and the Northern Gulf Institute (NGI)—who work closely with us as a cohesive unit to execute our mission and advance scientific discovery.

UNIVERSITY OF MIAMI
COOPERATIVE INSTITUTE for MARINE & ATMOSPHERIC STUDIES

NORTHERN GULF INSTITUTE
a NOAA cooperative institute

We also appreciate numerous other research partners and funders who support our work around the world and make so much of our research possible. The following accomplishments are supported by NOAA's Global Ocean Monitoring and Observing Program, Ocean Acidification Program, Hurricane Forecast Improvement Project, Weather Program Office, Office of Ocean Exploration and Research, Geophysical Fluid Dynamics Laboratory, Office of the Chief Information Officer, Office of Marine and Aviation Operations, Southeast Fisheries Science Center, Center for Satellite Applications and Research, US Integrated Ocean Observing System, National Centers for Coastal Ocean Science, Coral Reef Conservation Program, as well as NASA, the US Army Corps of Engineers, and more.

Letter from the Director

It is with great honor that I present this document as a testament to what has been achieved at NOAA's Atlantic Oceanographic and Meteorological Laboratory (AOML) in Fiscal Year 2024 (FY24). As an institution at the forefront of investigating the Earth system, severe weather, and the impacts of a changing climate, AOML has played a pivotal role in furthering NOAA's mission to protect lives and property through scientific advancement, and FY24 was no exception.

The achievements highlighted in the following pages are due to the dedication and relentless work ethic of the scientists, technicians, administrative staff, information professionals, and communications and facility management teams that comprise AOML. Their collective knowledge, experience, and collaborative interactions enable our laboratory to excel, pushing the envelope to further understand the vast environmental threats that challenge communities across the globe.

We find ourselves at a critical juncture where clear and accurately presented scientific findings are paramount to addressing how environmental stressors and climate change impact our communities and economy. NOAA and AOML must advance research that will protect against extreme weather events and environmental hazards, as well as support healthy ecosystems.

With research focused on the Atlantic region, AOML continues with rigorous laboratory experiments and analysis, extensive fieldwork, often in rough seas and turbulent storms, month-long research cruises, and hard-won advances in modeling and engineering capabilties. We create and manufacture new technologies in-house to facilitate our research in physical oceanography and examine ecosystems such as coral reefs. Additionally we work with partners to deploy state-of-the-art instrumentation in tropical storms and hurricanes, assimilate the data, and build cutting-edge models that enhance forecasting skill and protect vulnerable communities.

While ensuring AOML's research continued fluidly, we seemlessly adjusted to several leadership changes in FY24. Congratulations to AOML Director John Cortinas who was selected as the new Deputy Assistant Administrator for Science at NOAA Research. In his place, I am honored to serve as the Acting AOML Director and appreciate the support of Christopher Kelble and Rick Lumpkin, both of whom served as Acting AOML Deputy Director. Shirley Murillo, Jasmin John, and Renellys Perez additionally stepped forward to serve as Acting Division Directors, while many other individuals officially and unofficially assumed leadership roles in this year of change. We are pleased to announce that Ghassan "Gus" Alaka has become the new Director of AOML's Hurricane Research Division (HRD) following the retirement of long-term former HRD director Frank Marks. We also welcomed CAPT Wendy Lewis as AOML's new Associate Director and Alisha Warren as our new Administrative Officer.

The achievements highlighted in this document demonstrate our pursuit of excellence in providing our South Florida community, our nation, and partners around the world with trusted scientific data and knowledge, furthering our role as a leader in Earth system science.

Sincerely,

M. Mid Baringer

Molly Baringer, Acting Director

Preface

NOAA's Atlantic Oceanographic and Meteorological Laboratory (AOML) leads and performs pivotal research to investigate the Earth system with an emphasis on the Atlantic region. Our lab plays a crucial role in modeling and forecasting severe weather, managing natural resources and key ecosystems in the face of growing environmental stressors, and understanding the societal impacts of climate change on local, national, and global scales.

We conduct groundbreaking atmospheric, coastal, and oceanographic research that provides key insights to predict changes in weather, climate, our oceans, and marine ecosystems as outlined in our FY-2022-2026 Strategic Plan. This research supports NOAA's overarching mission of protecting lives, property.

NOAA Research's vision is to center our science done by our laboratories and research programs on the following four societal challenges, noted below, to help the nation. AOML's research adheres to these specific goals, as demonstrated by one or more icons displayed next to its respective accomplishment in the following pages.

- Confronting Challenges from our Changing Climate
- Protecting Against Extreme Weather Events and Environmental Hazards
- Managing Too Much and Too Little Water
- Sustaining a Healthy Environment and Economy

Scientists at AOML traverse whole oceans, fly through hurricanes, deploy instruments, some thousands of meters deep, model Earth systems, investigate marine microorganisms, and monitor large swaths of key marine ecosystems using innovative technologies. These efforts provide more accurate scientific findings that enable effective decision-making.

2024 By the Numbers

~3,000

Person hours supporting tropical cyclone

~4,500

'Omics samples processed to monitor and understand marine ecosystems

111

Peer-reviewed publications

~2000

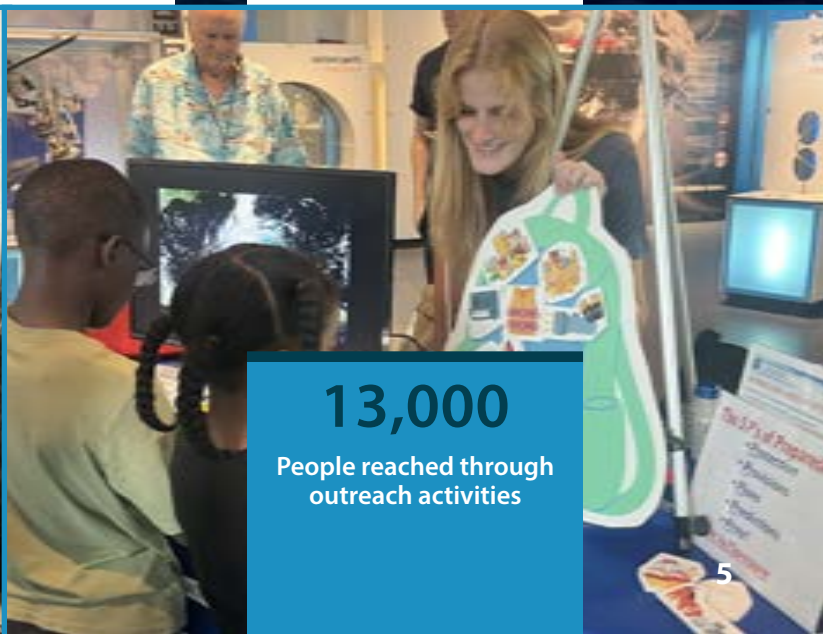
Person at sea days

~1,300

Drifters managed or deployed to maintain the array of global ocean observations.

26

Award winners



13,000

People reached through outreach activities

Goal #1: Empower our Team

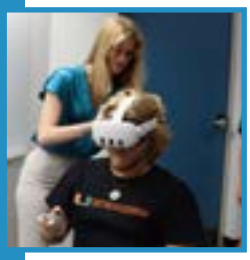
Create a cutting-edge environment that fosters discovery, exploration, and success.

Equipping the next generation of hurricane model scientists

In June 2024, NOAA's Hurricane Forecast Improvement Program and partner organizations hosted a summer colloquium at Howard University to train graduate and doctoral students in hurricane modeling. Participants learned about the Hurricane Analysis and Forecast System (HAFS), NOAA's newest numerical model, through lectures and hands-on sessions. The event aimed to enhance skills in numerical weather prediction, broaden the use of HAFS, and prepare the next generation of hurricane model scientists.

Scientists engage communities in outreach events nationwide

AOML staff and partners reached over 13,000 people through in-person community events, hands-on activities, and virtual presentations during FY24. These events included the Deering Seafood Festival, Museum of Discovery and Science's Eye of the Storm Hurricane Awareness Day, Miami-Dade County Youth Fair, NOAA's Hurricane Awareness Tour, and numerous classroom presentations. Our dedicated scientists also presented to over 1,000 students and teachers through virtual education programs such as Skype-a-Scientist and Scientists in Every Florida School to inspire the next generation of scientists and environmental stewards.

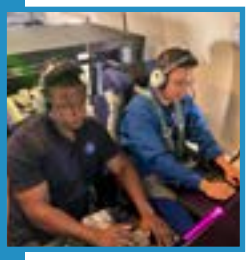


Join a research mission from home: Unveiling AOML's virtual reality experience

Virtual reality (VR) technology represents a new frontier in science communication, and AOML is using it to invite everyone on a research mission alongside their scientists. Join us on a hurricane flight, a research cruise, or a dive on a coral reef through a VR headset, computer, or even a phone.

Immersing students in hands-on experiences

During FY24, AOML hosted more than 40 interns, ranging from high school students to post-doctoral fellows, including NOAA-William Lapenta interns, NOAA-Experiential Research and Training Opportunities interns, and a Knauss Fellow. Through these summer and year-long opportunities, our interns aided in assessing the effectiveness of hurricane models, investigating disease transmission among corals, assisting engineers, and developing virtual reality experiences.

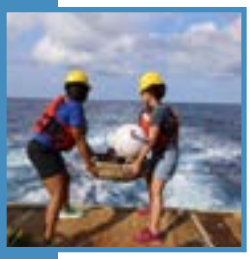


LANTERN employees enhance our science and community

AOML welcomed three exceptional employees through temporary positions as part of NOAA's Leveraging Abilities, Needs, Talents, Energies, and Resources Network (LANTERN) development program in FY24. While on these details, they advanced NOAA's use of uncrewed systems technology for hurricane research, helped with AOML's stakeholder assessments, and transitioned research to operations.

Ocean Sciences meeting: AOML & PMEL townhall

AOML partnered with NOAA's Pacific Marine Environmental Laboratory in February 2024 to co-host a town hall panel discussion during the Ocean Sciences Meeting in New Orleans, Louisiana. Panelists reflected on the past 50 years of the innovative science conducted at both labs to better understand the Earth system from the depths of the ocean to upper atmosphere, as well as the trajectory of continued collaborative science for the next 50 years.



Adopt-A-Drifter program

This year, AOML led the charge to revamp the Adopt a Drifter Program (ADP), an affiliate program of NOAA's Global Drifter Program. The ADP team overhauled the adoption process and ADP website, including new resources and new *Track a Drifter* pages resulting in 15 new adoptions this year. Additionally, ADP hosted their first summer intern in collaboration with NOAA's Global Ocean Monitoring and Observing Program and SciJinks. The intern designed and developed Ocean Odyssey: Tracking Marine Debris, a NOAA SciJinks web game suitable for K-12 audiences, that incorporates historic drifter data and helps middle school audiences understand how ocean surface currents transport marine debris.

Social media engagement

AOML continues to reach hundreds of thousands of social media accounts with series such as *Darwin Explains AOML Research*, *Hands On with AOML Research*, *and 12 Days of Research*, in addition to sharing real-time science endeavors. Through engaging content, AOML has observed a tremendous growth in its outreach, including a 112% increase in Instagram followers in FY24 and an average engagement rate of 10.5%.

Take-Action photography contest

AOML hosted a "Take Action" photography contest in which staff submitted their best research or nature photos. As the winner of the contest, Dr. Michael Studivan's "Looking for Eggs" photograph is proudly displayed on the cover of this report. It features a scientist in Port Miami during a coral spawning event. The contest is a showcase of the meaningful science at AOML and a testament to the creative people who support AOML's mission.

Black History Month tour of Virginia Key Beach Park

Our neighbors at Historic Virginia Key Beach Park Trust led us on an informative tour of the park during Black History month to share the rich history of this beach, formerly known as "Virginia Beach, a Dade County Park for the exclusive use of Negroes." Virginia Key Beach was, and still is, a place for celebrations, community gatherings, and merriment, and we are honored to have been invited to tour such a special place in our community.

AOML awarded for exceptional science and communications accomplishments

In FY24, 26 scientists, staff, and team members received 9 prestigious awards for their outstanding contributions and dedication to NOAA's mission. These awards included Department of Commerce Gold and Silver Medals, NOAA Administrator's Award, NOAA Silver Sherman Award, NOAA Research Dr. Daniel L. Albritton Outstanding Scientific Communicator Award, NOAA Research Employee of the Year Award, NOAA Research Team Member of the Year awards (leadership, outreach and education, and personal and professional excellence categories), an American Meteorological Society Editor's Award, and the National Tropical Weather Conference's Robert and Joanne Simpson Award.

Goal #2: Observe the Earth System

Collect and evaluate ocean, atmosphere, and marine ecosystem observations that contribute to the body of scientific knowledge of the Atlantic Ocean region to improve the ability to better assess and predict the Earth system.

The term 'hurricanes' will be used throughout this report to generally refer to all forms of tropical cyclones (intense low pressure wind systems that form over tropical oceans).

Hurricane season 2024: Studying storms from sea, sky, and space

During the 2024 hurricane season, scientists collected data from the air, sea surface, and underwater to enhance forecasts and increase scientific knowledge. AOML is the only science organization in the world to regularly fly directly into hurricanes to observe their environment, giving researchers the unique opportunity to collect real-time data to assimilate into forecast models. AOML researchers and partners flew 8 tropical cyclones this season with flights starting in late June with Hurricane Beryl as it rapidly intensified and became the Atlantic's earliest Category 5 hurricane on record. The Hurricane Field Program continued through Hurricane Helene and Hurricane Milton in October, with researchers both in the air and on the ground supporting a total of 67 missions and 521 flight hours to gather and process real-time storm data during the 2024 hurricane season.

Investigating storm dynamics from above

The instruments deployed in tropical cyclones provide data for advancing hurricane forecasting and investigating storm dynamics. This season, researchers successfully deployed 17 Blackswift S0 drones, breaking records in flight time, communications range, and maximum wind speed. In Hurricane Helene, the S0 flew for 105 minutes and communicated with the P-3 for 169 miles. Inside Hurricane Milton, the S0 recorded record-breaking wind speeds of 209 kt (240 mph) at 500 meters (1640 feet) altitude. These sUAS (Small Uncrewed Aircraft System) were used in tandem with Skyfora Streamsondes, which researchers hope will transform the way we study and understand the lower levels of a tropical cyclone.

Deploying instruments below the storm

Below the hurricane, drifters, gliders, AXBTs, profiling floats, buoys, and saildrones monitored the effects of the storm on the ocean. Researchers deployed 12 wave drifters from the P-3 while 6 gliders monitored the deep-sea mixing that occurs beneath the storm. At the sea surface, 12 saildrones were deployed with the task of gathering data from the boundary layer, providing researchers with observations from previously inaccessible regions of the storm. These instruments are critical for developing a better understanding of the air-sea interactions that fuel tropical cyclone formation and intensification.

Ships of Opportunity: Crucial ef orts to measure surface ocean uptake of carbon

As part of AOML's leading role in the international Ships of Opportunity-Carbon Dioxide (SOOP-CO2) program and Surface Ocean CO2 Observing Network (SOCONET), our team successfully installed and maintained partial carbon dioxide (pCO2) measuring systems onboard partnering vessels. In the Arctic, scientists performed key maintenance on the pCO2 system onboard the Compagnie du Ponant's Le Commandant Charcot while reaching the North Pole. A new generation pCO2 system was also installed with NOAA's Global Monitoring Laboratory onboard the USCGC Healy before it sailed for the GO-SHIP ARC01 cruise. In the Galapagos Islands, our team collaborated with the University of Miami's OceanScope program to revive the pCO2 system onboard the M/V Celebrity Flora, which had been inoperable since the COVID pandemic. Scientists and engineers at AOML also frequently participate in cruises on container ships in support of the AOML eXpendable BathyThermograph (XBT) network.

GO-SHIP cruises perform critical research while crossing oceans

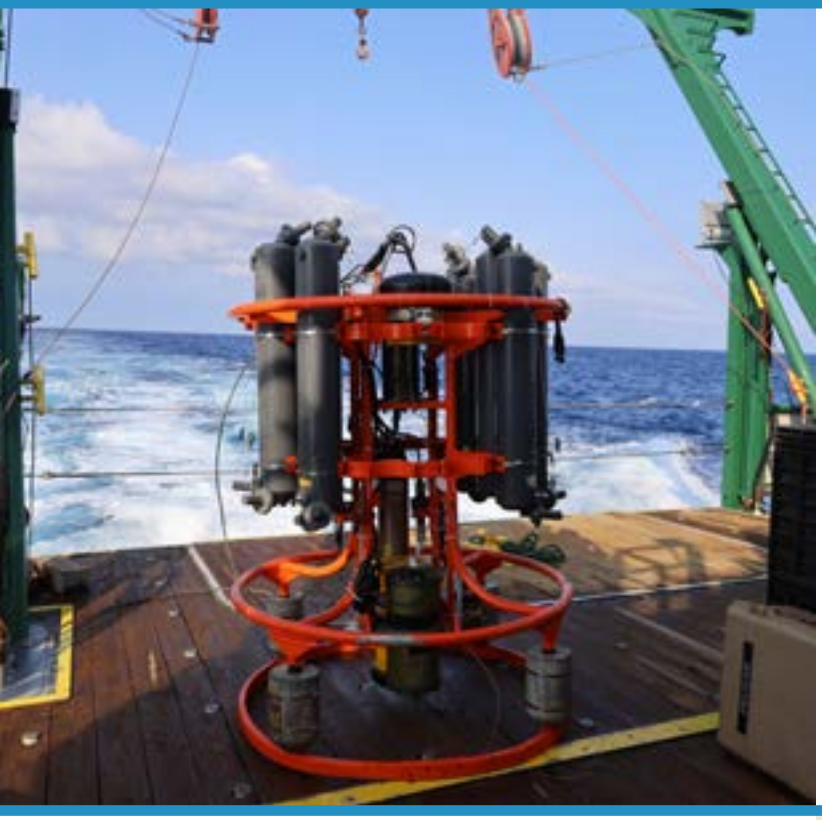
Scientists at AOML led and participated in major research cruises in FY24 as part of the international GO-SHIP program with the mission of advancing our knowledge of ocean carbon uptake at depth, and biological conditions. One team co-led the six-week I08S GO-SHIP cruise from Fremantle, Australia to Antarctica and back. Another group participated in the 52-day A13.5 GO-SHIP cruise across the equator and into the South Atlantic. Completion of the GO-SHIP I08S and A13.5 cruises allows international teams of scientists to track global changes in oceanic carbon uptake from the atmosphere and pelagic planktonic communities using environmental DNA as part of the emerging BIO-GO-SHIP program.

PIRATA cruise supports key tropical Atlantic observing system

Scientists at AOML joined leg 3 of this year's PIRATA cruise to service moorings in the tropical Atlantic and collect oceanographic and atmospheric samples in support of the PIRATA Northeast Extension project. This annual cruise allows for academic and international collaboration to advance the understanding of the ocean and to work towards improved prediction of weather and climate variability. The cruise departed from Pascagoula, Mississippi and returned to the same location over three months later after traveling more than 12,700 nautical miles. The data collected sheds light on changes in ocean temperatures, salinity, dissolved oxygen and currents across the equator, the oxygen minimum zone, and a region responsible for the development of Atlantic hurricanes.

Studies advance understanding of the AMOC

Researchers at AOML made significant progress in understanding the Atlantic Meridional Overturning Circulation (AMOC) in FY24. A study led by a University of Miami PhD student with scientists at AOML is the first to estimate the AMOC's heat transport at 22.5°S in the South Atlantic, highlighting the importance of sustained in situ observations. Using a novel mapping method, the study revealed insights into the seasonal and year-to-year variability of the AMOC. Another study led by a CIMAS researcher found that the AMOC abyssal limb in the North Atlantic has weakened over the past two decades, contributing to an increase in deep sea heat content, and hence, sea level rise in the region.

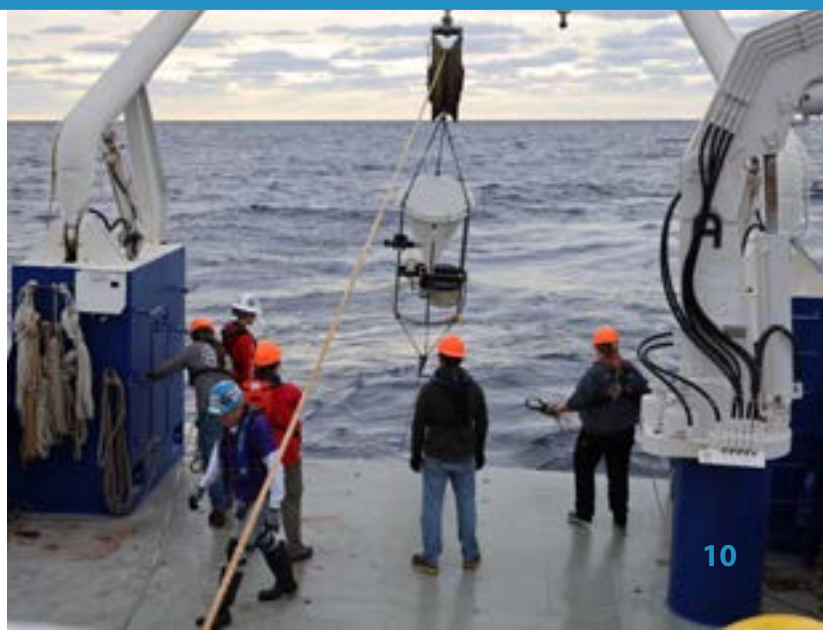


Reassessing the stability of the Florida Current

Scientists at AOML found through observations that the Florida Current, one of the fastest currents in the ocean and an important part of the AMOC, has remained remarkably stable over the past 40 years. In this study, Western Boundary Times Series scientists reassessed the overall trend in the Florida Current transport inferred from submarine cable measurements and found that a correction was needed for the gradual change in the Earth's magnetic field over time. The correction nearly removed a previously reported negative trend in the record, revealing that the Florida Current has remained stable for the past four decades. If the AMOC is slowing down, it has not yet been reflected in the Florida Current, or observational records are still too short to detect the slowdown with confidence. This study demonstrates the value of sustained observations for the AMOC, as existing observational records are just starting to reveal decadal-scale signals relevant to climate variability.

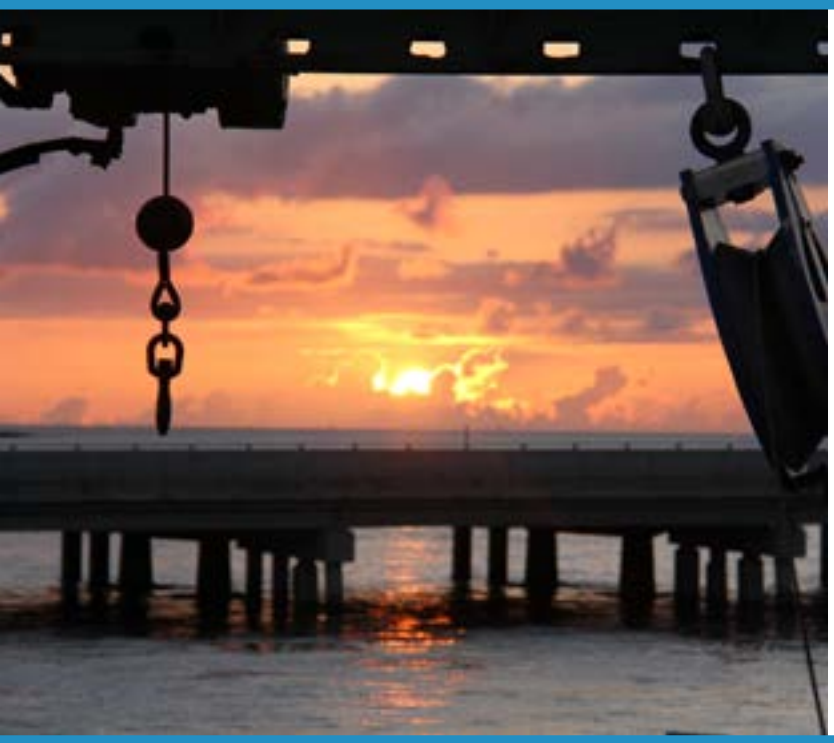
Investigating the biological carbon pump with deep-ocean sediment traps

Traversing 100 nautical miles of ocean, a team of scientists from AOML, the US Geological Survey (USGS), and the University of South Carolina retrieved a moored sediment trap located hundreds of meters below the surface in the Gulf of Mexico. Over the next several months, the team processed and examined the flurry of microscopic shells and eDNA of biological debris collected by the trap, known as "marine snow." This collaborative NOAA–USGS research project is using sediment trap samples to investigate the biological carbon pump, the ocean's role in removing atmospheric carbon, and paleoclimatology.



Major strides to enhance resilience of coral reefs and key marine ecosystems

AOML's Coral team successfully led National Coral Reef Monitoring Program (NCRMP) field operations in FY24 to collect crucial observations, including photomosaic and carbonate budget surveys in the Dry Tortugas, Virgin Islands, and Puerto Rico to monitor major climatic trends on reef ecosystems. This comes alongside a new effort to assess how the impacts of five major environmental stressors vary geographically and temporally across key ecosystems of South Florida. With $4.2 million announced in funding, the Florida Regional Ecosystems Stressors Collaborative Assessment (FRESCA) co-led by AOML and the University of Miami has already made significant strides. In the first year of a four-year project, the team has enhanced ongoing South Florida Ecosystem Restoration (SFER) cruises along the West Florida Shelf, deployed new instrumentation at a key climate monitoring site in the Florida Keys, and renovated our Experimental Reef Lab (ERL) with new capabilities designed entirely in-house in preparation for a series of experiments.



Ongoing ecosystem assessments provide vital research on status, health of environments across South Florida

In FY24, six South Florida Ecosystem Restoration cruises successfully collected key oceanographic, biogeochemical, and harmful algal bloom observations, along with planktonic samples and an estimated 900 eDNA samples at ~70 sites throughout the Florida Keys, Florida Bay, and West Florida Shelf. In Florida Bay, the Juvenile Sportfish project supported by the US Army Corps of Engineers conducted six cruises to collect submerged aquatic vegetation and fish density measurements and analyze seawater properties. In northern Biscayne Bay, the Biscayne Bay Water Quality Assessment supported by NOAA's Coral Reef Conservation Program (CRCP) conducted 12 field sampling campaigns at inshore and offshore sites to evaluate land-based sources of pollution affecting benthic habitats in the area.

AOML makes signifcan t contributions to 'Omics and environmental DNA research

AOML led the development and publication of the NOAA 'Omics Data Management Guide, which provides best-practice guidance and tools for managing and sharing 'Omics data in alignment with updated NOAA Data policies. A new bioinformatics tool, edna2obis, was used to publish the first NOAA 'Omics eDNA dataset on the international biodiversity platforms OBIS and GBIF, with eDNA biodiversity observations collected during the fourth Gulf of Mexico Ecosystems and Carbon (GOMECC-4) research cruise.

Goal #3: Assess and Model the Earth System

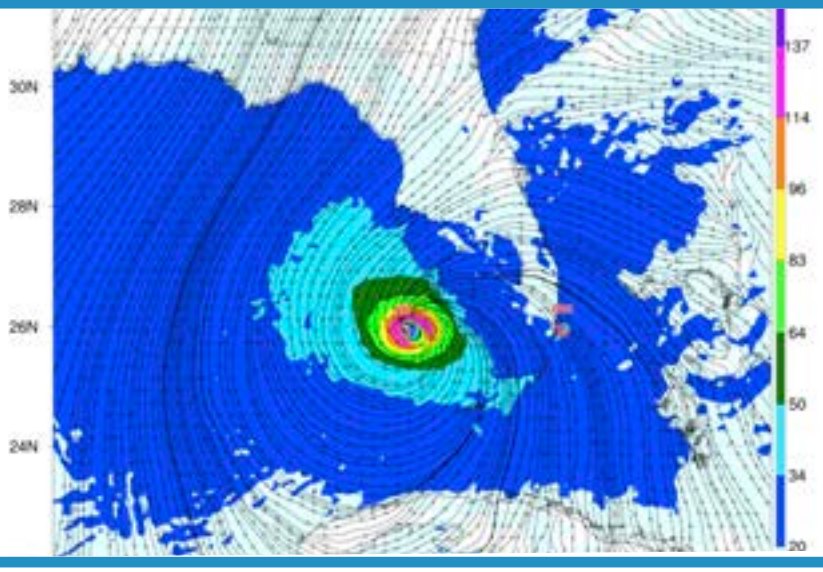
Understand the Earth system by creating accurate, predictive, high-fdelit y models that characterize and assess change and predict future Atlantic Ocean regional and global outcomes.

International partners improve global extreme weather forecasting

Throughout 2024, AOML scientists worked closely with international partners to ensure that improvements in extreme weather forecasting were available to all. A 12-year collaboration between AOML and the Indian Ministry of Earth Sciences (MoES) culminated in the renewal of an Implementing Arrangement (IA) on Technical Cooperation in Development of Tropical Cyclone Numerical Weather Prediction System for the Indian Seas, which paved the way for advances in severe weather modeling. To further expand the reach of AOML's global collaborative science, researchers teamed up with the Republic of Korea to spark new partnerships, share technology and scientific advancements, and brainstorm new ideas. AOML scientists also attended workshops to contibute to ongoing discussions on the Tropical Cyclone Exemplar, especially as it relates to observing and modeling activities in the northwest Pacific Ocean. These workshops served many purposes, but analyzing progress and learning from failures and successes are what propel advancements in understanding ocean-atmosphere observations between AOML and its international partners.

Developments in hurricane model contribute to its lasting legacy

The Hurricane Analysis and Forecast System (HAFS) was formally adopted as NOAA's new flagship forecast model in 2023, building on the success of the Hurricane Weather Research and Forecasting (HWRF) model. HWRF was implemented in 2007, and over a 16-year period underwent extensive developments to become one of the most important and successful ocean-coupled, regional numerical weather prediction models. Its impressive performance has left a lasting legacy that will continue propelling HAFS and future hurricane forecast models to new heights.



Unveiling the innovative advancements in hurricane modeling

HAFS v2.0 features new upgrades that give the model greater precision when mapping storm development. HAFS v2.0 uses improved methods to create a more accurate picture of the storm's starting conditions and the location of the eye based on observations and information from the National Hurricane Center. This creates a more detailed depiction of the storm and leads to better forecasts of the hurricane's overall structure, including the size and extent of hurricane-force winds.

Investigating how a changing climate af ects coral reefs

When warm and cold-core eddies separate from the Loop Current system in the Gulf of Mexico, they bring significant changes in ocean temperature and salinity over a series of coral reefs and banks found along the continental shelf-edge in the Gulf of Mexico known as the Flower Garden Banks National Marine Sanctuary. Scientists at AOML, CIMAS, NOAA's Office of National Marine Sanctuaries (ONMS), and National Environmental Satellite, Data, and Information Service (NESDIS) leveraged a dataset from an array of Argo floats deployed in the region from 2003 to 2022 in a study that suggests exposure to these temperature fluctuations may enhance the resilience of these reefs in the face of warming oceans. In the Atlantic, scientists with AOML's Coral Group led a groundbreaking study spanning a decade and hundreds of miles of Florida Coral Reef Tract that demonstrates how ocean acidification may be exacerbated and mitigated in certain areas - with seagrass beds playing a key role.

How Port Miami sediment af ects early coral life stages

A study led by scientists with CIMAS, AOML, and NOAA's National Marine Fisheries Service Habitat Conservation Division indicates significantly lower survival and settlement rates of coral larvae, and ultimately reduced reproductive success, when exposed to suspended sediments from recently dredged areas in the Port Miami. Exposure to suspended sediments and increasing turbidity negatively impact corals through all life stages, but few studies have investigated the effects on coral larvae (i.e. planulae) that eventually settle on a substrate and mature into coral polyps.

Potential predictor identifed f or long-range US tornado forecasts

In December 2021, the most destructive winter tornado outbreak on record, known as the Quad-State Tornado Outbreak, caused 89 fatalities, 672 injuries, and at least $3.9 billion in property damages. Scientists at CIMAS and AOML investigated this outbreak and found that it occurred under an exceptionally strong and prolonged negative Pacific-North American (PNA) pattern, which created favorable conditions for tornadic activity. The PNA may be a potential predictor for US tornado forecasts on the subseasonal (2 weeks to 3 months) timescale. Tornadoes are among the deadliest and costliest natural disasters in the United States and also one of the hardest to predict.

Goal #4: Transition Our Research

Empower end users with research and knowledge that enables decision-making, drives outcomes for operational partners, and advances scientifc k nowledge. AOML's ef orts to accelerate and facilitate the transition of Research and Development (R&D) to operations, applications, commercialization, and other uses (R2X) realized major gains in FY24. Using a streamlined transition planning and tracking process, the lab completed nine full R2X transitions.

Improving next generation hurricane forecast model

AOML collaborated with NOAA partners on the development of version 2.0 of the Hurricane Analysis and Forecast System (HAFS) that transitioned into operations on July 16, 2024. AOML's Hurricane Modeling Group has systematically advanced its hurricane forecasting methods by integrating innovative technology to refine its models. These improvements provide National Hurricane Center forecasters with better guidance on hurricane structure, intensity, and track. Upgrades to HAFS v2.0 equip meteorologists with the tools to make more accurate predictions and reliable forecasts that are crucial for timely preparation and response efforts, improving public safety, and minimizing the impact of tropical cyclones.

Fully signed 'One-NOAA' SOCONET transition plan

The Surface Ocean CO2 Reference Observing Network (SOCONET) is an international collaboration of established operators that provide quality global surface ocean CO2 data. The data are used to quantify global air-sea CO2 fluxes and trends in surface water CO2 levels. The air-sea fluxes are key to assess the global carbon balance, and the trend determines the rate of ocean acidification. Through a collaboration of principal scientists at AOML, PMEL, and GML, and with the assistance of the Office of Research Transition and Application (ORTA), NOAA's contribution to SOCONET was formalized into a 'One-NOAA' Transition Plan that was fully signed in FY24.

Innovations to the Statistical Hurricane Intensity Prediction Scheme (SHIPS)

Despite the notable improvements made to HAFS v2.0, rapid intensification (RI) is difficult to predict, and statistical-dynamical and consensus models still significantly contribute to intensity forecasts. In an effort to improve these forecasts, AOML's Hurricane Modeling Team developed a new model that predicts the probability of hurricane RI. This new model–SDCON-RII–represents a consensus of the SCON-RII and DTOPS-RII model forecasts and was shown to be more accurate than any of the current operational probabilistic RI models used to predict rapid intensification. As a result of its success, SDCON-RII was operationalized at the National Hurricane Center for the 2024 hurricane season. The implementation of SDCON-RII marks a significant milestone in our ability to anticipate and respond to the dynamic nature of tropical cyclones; by learning to predict a storm's intensity changes, forecasters are able to warn at-risk communities with a greater lead time, minimizing loss of life and property.

Seasonal hurricane outlook

AOML marked a significant achievement with the "2024 AOML Contribution to the Climate Prediction Center's Operational Seasonal Hurricane Outlook" transition plan. This is the first Modular Transition Plan of its kind that went through the rigorous National Weather Service's Research to Operations (R2O) review process and was fully approved and signed. This unique plan captures multiple R2O and knowledge transfer transitions, including three separate transitions that occurred in FY24. This type of plan significantly streamlines the documentation and review of several related, and often sequential, model improvements intended to transition and will benefit, and set a precedent, for future transition plans.

Global Carbon Budget 2023 report emphasizes urgent need to reduce global emissions

According to the newest Global Carbon Budget report, global emissions continue to rise and must be significantly reduced to meet global climate targets and avoid severe and deleterious effects of climate change. In 2023, atmospheric carbon dioxide (CO_2) concentrations are expected to reach 419.2 ppm, an estimated 51% above pre-industrial levels, with 36.8 billion metric tons of greenhouse gas emissions being produced by the end of the year. Scientists at AOML with the Ocean Carbon Cycle group were co-authors of the 2023 report, making significant contributions to quantify the exchange of carbon between the ocean and the atmosphere - and how this might be changing.

Contributing to State of the Climate knowledge

AOML contributed to the 2023 State of the Climate report published annually in the Bulletin of the American Meteorological Society to communicate the impacts of the Earth's warming and seasonal-to-decadal climate variability on the global oceans. This transition of knowledge benefits the scientific community through improved understanding of the changing climate system and supports a climate-literate public.

Fifth National Climate Assessment

Nearly 100 NOAA scientists and staff contributed to the Fifth National Climate Assessment published in FY24, finding the impacts of weather extremes exacerbated by climate change are far-reaching across every region of the United States. However, the report also found that by rapidly reducing greenhouse gas emissions and accelerating adaptation can limit further warming, protecting lives and property from multiple climate risks. A scientist at NOAA AOML, served as Coordinating Lead Author on the Oceans and Marine Resources chapter of the report.

National Marine Sanctuaries condition reports

Scientists with AOML's Integrated Ecosystem Assessment effort continue to facilitate indicator selection, analyze status and trends, and author sections of multiple National Marine Sanctuary Condition Reports. Data from AOML monitoring programs were used in multiple indicator analyses for Flower Garden Banks and Grays Reef sanctuaries. These condition reports were drafted in 2023 and are currently in review. In addition, AOML scientists participated as subject matter experts, providing valuable input on indicator vetting, dataset identification, and condition status and trend ratings for the Gray's Reef National Marine Sanctuary in March 2023. AOML scientists are also co-creating interactive infographics, hosted online, to visualize National Marine Sanctuary indicator status and trends, set in an ecosystem context. This effort strives to provide best science information to support resource managers, decision makers, and stakeholders of National Marine Sanctuaries and the resources they protect, and was included as a part of the Florida Keys National Marine Sanctuary's FEIS in October 2022 for their management plan update.

Robotic arms investigate the impacts of climate change on reef-building corals

Scientists at AOML and CIMAS are researching the effects of climate change on reef-building species using the innovative Sequential Treatment Application Robot, or "STAR." Developed by AOML's Coral Group, the open-source robotic arms automate the manipulation of experimental conditions in AOML's Experimental Reef Lab while investigating the combined effects of ocean warming, high nutrients, and Stony Coral Tissue Loss Disease on endangered coral species like *Orbicella faveolata*.

Looking Forward to FY25

At AOML, FY25 will bring major milestones, new and continued projects, and innovation that seeks to further NOAA's mission of providing crucial scientific research for the sake of protecting lives and property. In FY24, we celebrated the completion of a variety of projects behind the scenes. Many of those projects were merely a catalysis for what's to come.

Major strides in the development of the HAFS model over the past year have drastically advanced forecasting capabilities and accelerated the science our Hurricane Research Division (HRD) has planned for FY25. Data collected and assimilated through field exercises on Hurricane Hunter aircraft into major storms, including Category 3 Helene and Category 5 Milton, will be crucial to analyze in the next year to investigate how these storms rapidly intensified. Coordinated efforts with BlackSwift drones, saildrones, dropsondes, and a vast array of atmosphere and oceanic instruments build on our ability to model tropical storm development from the upper atmosphere to greater ocean depths, creating a holistic picture of the entire system.

Our ability to model the Earth system to predict and project future climate and ecosystem changes will be further enhanced by projects in development with joint efforts across our research divisions and partnering institutions. The emerging Climate and Ecosystems Fisheries Initiative will foster collaboration across NOAA laboratories and partners to ultimately provide climate-informed advice for marine resource management and community adaptation. The Florida Regional Ecosystems Stressors Collaborative Assessment will use gigabytes of data collected in both the field and lab to produce high-resolution biogeochemical models to assess future impacts of key environmental stressors exacerbated across South Florida.

AOML's 'Omics team is leading the implementation of new strategies for data management to facilitate the expansion of this quickly emerging field and a major program across NOAA, unleashing new ways of assessing the status and health of marine ecosystems. Newly deployed SOFAR buoys at five of the seven Mission: Iconic Reefs and enhanced South Florida Ecosystem Restoration cruises will enable our Coral and Ecosystems group to observe fluctuations in ocean conditions in near-real time. AOML's Ocean Carbon Cycle group is well positioned to expand collaborative research following the announcement of $200 million in funding to monitor the global ocean's uptake of carbon. This funding will fuel international programs including GO-SHIP and GOMECC to build on decades of research with new instrumentation for climate monitoring and workshops to strengthen national and international partnerships.

These innovative efforts underpin the diverse areas of research that scientists at AOML will pursue across research divisions and institutions at the highest caliber - and on the international stage. These next steps come as our team reflects on all that has been achieved since 2019 in anticipation of AOML's upcoming 5-year lab review in FY25. We feel confident in saying there is much to reflect upon and even more to look forward to as we enter the new year.

NOAA Atlantic Oceanographic & Meteorological Laboratory

Office of Oceanic & Atmospheric Research

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