



## DEPARTMENT OF COMMERCE RESEARCH PERFORMANCE PROGRESS REPORT (RPPR)

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<b>AWARD INFORMATION</b>	
1. Federal Agency: Department of Commerce / NOAA	2. Federal Award Number: NA20OAR4320472
3. Project Title: Cooperative Institute for Marine and Atmospheric Studies (CIMAS)- Innovative Science, Service and Stewardship	
4. Award Period of Performance Start Date: 10/01/2020	5. Award Period of Performance End Date: 09/30/2025
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Signature of Submitting Official: Samuel Collinson	
16. Submission Date and Time Stamp: 07/13/2022	17. Reporting Period End Date: 06/30/2022
18. Reporting Frequency:  <input checked="" type="radio"/> Annual <input type="radio"/> Semi-Annual <input type="radio"/> Quarterly	19. Report Type:  <input checked="" type="radio"/> Not Final <input type="radio"/> Final
<b>RECIPIENT ORGANIZATION</b>	
20. Recipient Name: UNIVERSITY OF MIAMI	
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22. Recipient UEI: KXN7HGCF6K91	23. Recipient EIN: 590624458

## ACCOMPLISHMENTS

### 24. What were the major goals and objectives of this project?

The response to the COVID-19 pandemic limited some of our field work, this is noted where appropriate. CIMAS is structured into four themes - our accomplishments are organized under these themes as follows:  
Tropical Weather Observations, Analysis and Prediction (TW): CIMAS's goal is to collaborate with NOAA scientists to develop and implement a comprehensive hurricane field program that is used to improve operational forecasts. We seek to quantitatively assess the utility of existing observing systems and the design of future observing system through the Quantitative Observing System Assessment Program (QOSAP) and perform cutting edge analyses of a range of tropical weather observations and model simulations. CIMAS scientists goals include the development of NOAA's next-generation hurricane prediction system and continually work to improve NOAA's existing operational prediction systems.

Ocean and Climate Observations, Analysis and Prediction (OC): CIMAS scientists seek to collaborate with NOAA scientists on the design, optimization, and maintenance of key ocean observing systems. Our goal is examine how ocean changes affect climate and marine ecosystems, and build on the current state of knowledge by maintaining valuable, long-term datasets of ocean changes over time. CIMAS scientists goals include assessing the utility of these observations with observing system experiments and observing system simulation experiments. We also seek to support the implementation of multi-model global coupled prediction systems that support NOAA operational needs in sub-seasonal to seasonal prediction.

Ecosystem Observations, Modeling, Forecasting and Management (EOM): CIMAS scientists goals include improved forecasting capabilities and studied the structure and function of marine ecosystems with the aim of assessing marine ecosystem services, particularly in the Southeast U.S. coastal ocean, the Caribbean Sea, and Gulf of Mexico Large Marine Ecosystems. Research and forecasting projects have included those related to human health, fishery resource productivity, and conservation and enhancement of selected habitats (e.g. reefs and mangroves). These projects seek to improve understanding of how climate variability and change, and other anthropogenic threats impact ecosystems. Our objectives include studies focused on promoting sustainable coastal development and facilitating community resiliency, recognizing the interconnections between the marine ecosystem and the adjacent watershed.

Protection and Restoration of Marine Resources (PR): CIMAS seeks to develop technology, research tools, statistical models, mathematical methods, and scientific approaches for the effective rebuilding of harvested species and management of protected species. This includes biogeographical characterization of populations and habitats, and improvements in defining, observing, forecasting, and protecting ecological components of marine protected areas and underwater cultural resources. Studies of essential fish habitats have contributed to restoring habitats and populations to healthier levels. Much of this research goal focuses on the Southeast U.S. coastal ocean, the Caribbean Sea, the Gulf of Mexico marine ecosystems and the Atlantic high seas.

### 25. What was accomplished under these goals?

TW: Assessed deep circulation sensitivity to variations in meltwater fluxes from the AIS. Assimilation capability of dropwindsonde obs. Parallel DA cycles with and without CYGNSS data were compared. The GEFSv12 calibration of WAVEWATCHIII was investigated. Methods for situational awareness of TC vortex and precipitation structure. Ran global-nested HAFS in real-time as part of the HFIP in 2021. Developed a hybrid forecast model for U.S. rainfall. Built an experimental model based on ML to predict TC intensity changes. During the 2021 TC Season, 6 underwater gliders were deployed and operated. The microphysics obs collected in 2020 are analyzed. Implemented nest motion for physics and surface variables with help from NOAA/EMC. Created a set of idealized simulations for early developments of the moving nest in HAFS. A metric for wind field asymmetry using NHC Best Track wind radii information has been developed and is currently undergoing testing. Analysis of existing sUAS and crewed aircraft data. Understanding physical mechanism of driving U.S. rainfall in warm season. Understanding physical mechanism of subseasonal tornado activity and MJO. OSA uses of OSEs and OSSEs to assess the impacts of current and new obs. Develop seasonal forecast for warm-season U.S. rainfall.

OC: Systems installed on three NOAA ships close to 180,000 datapoints. The fourth GOMECC-4 cruise was successfully executed. Argo DAC automatic system for decoding, QC, and distribution of data. Maintained the transects AX04, AX07, AX10, AX25, AX32, AX97, AXCOAST. Continuous submarine cable measurements of the Florida Current transport. Investigation of WAVEWATCHIII physics and numerical scheme, for average and extreme conditions. UN Ocean Decade Satellite Activity- Outcome: A Safe Ocean. Training on Glider recoveries with partners at Cape Eleuthera Institute. Constrain regional CO2 fluxes using automated pCO2 systems. Understand air-sea interaction processes during TC events. Deploy TC underwater gliders to monitor upper ocean on path of TCs. Implement monitoring network for ocean acidification. Monitor ocean parameters in upper 2,000m through US Argo  
EOM: Sequenced fish trawl samples for a metabarcoding project, analyze genetic data from bottlenose dolphins in Texas and North Carolina for population genetics studies, and for bottlenose dolphins in the western North Atlantic and Gulf of Mexico for a taxonomy study. All commercial fishery-dependent data extractions have been standardized, documented, and are being used by CIMAS and SEFSC staff for SEDAR assessments. Developed a Marine protected area model for the eastern Mediterranean.

PR: Applied new detectors for identifying GOM Bryde's whales within the ocean soundscape to historical acoustic data from 2010-2018. Assisted surveys of the GOM Marine Assessment Program for Protected Species and completed Biscayne Bay mammal surveys. Conducted genetic analyses to determine stock structure within Galveston Bay, along the Texas coast, and off North Carolina. Participated in June 2021 aerial and ship-based surveys of marine mammals. Monitored spawning of seven coral species in wild, outplanted, and nursery stocked colonies and collected gametes from some species including *D. labyrinthiformis*, not previously reported to be spawning in Florida. Continued enhancements of novel methods for gamete collection, gamete fertilization, and maximizing larval and recruit survivorship.

*Attach a separate document if more space is needed for #6-10, or #24-50.*

**ACCOMPLISHMENTS (cont'd)**

**26. What opportunities for training and professional development has the project provided?**

CIMAS invests in being part of the training pipeline for NOAA. CIMAS provides for many training activities including:

- 1) collaborative research teams of faculty, NOAA and CIMAS scientists and graduate students;
- 2) funding of graduate students with the support of NOAA fellowships and graduate research Assistantships
- 3) participation of NOAA scientists in student mentoring training and teaching of graduate level courses
- 4) promoting Post-doc opportunities within NOAA labs and
- 5) funding students to participate in professional experiences attending scientific meetings, including those of the US fishery councils and Regional Fishery Management Organizations (RFMOs) such as ICCAT.

The PI and others on the project were also able to attend the UFS Users' workshop, AMS Annual Meeting, and AMS Hurricane Conference to collaborate with other scientists virtually and learn more about ongoing work.

Opportunities for staff: NMME model, deterministic and probability forecast skills, operate the operational data assimilation and forecast systems, develop new techniques to process microbiome data, working in the wet lab performing a multi-stressor experiment, field work, bioinformatics, AWIPS2 software training provided by an expert from National Hurricane Center (NHC), training in glider deployment and refurbishment, tutorial on how to set up and run.

Support for several Rosenstiel graduate students, postdocs, and CIMAS staff: creation of the *A. cervicornis* physiological database, assessing disease transmission; experiment on LBSP and genotype resilience, to study observational data from hurricane field experiments and analyze hurricane model outputs, analyze WBTS data. Three Ph.D. students have obtained extensive training in molecular biology and physiology pipelines for corals and sponges.

CIMAS scientists were trained in survey design, database management (with SQL and ORACLE) and the use of statistical software (R and SAS), agent-based modelling platforms (JAVA) and ecosystem models (EWE). CIMAS scientists attended the "Machine Learning in Python for Environmental Science: Hackathon" short course in the AMS100 and participated in ML related courses in the Electrical and Computer Engineering (ECE) Department at UM.

CIMAS scientists received skill-based training in scientific diving, at sea survey design, drone surveys, coral spawn collection, fish ageing, larval rearing, Seascape genetic analysis ecosystem and connectivity modeling. They have also been trained in, structured decision making, leadership, project management, GIS, statistical and database programming (R and SQL/ORACLE) and cybersecurity. Scientists received training through attendance of national and international workshops and conferences, some hosted by CIMAS, by accessing UM employee training resources (ULEARN, LinkedIn training, Commerce Learning Center) and by taking advantage of resources available at the local NOAA labs (e.g. SEFSC Coding Study Group.). CIMAS staff have trained staff from other agencies on the use of the GulfMAP database and trained SEFSC scientists on new methods for computing complexity metrics from remote-sensed mapping data.

**27. How were the results disseminated to communities of interest?**

Disseminated results from the project to CIMAS collaborators, resource managers, and the public through a variety of media, including scientific publications, technical reports (including NOAA Technical memoranda), conference presentations, training workshops, web content, other public media and outreach activities.

TW & OC: Research results were published in the peer-reviewed journals (e.g., AMS, AGU, Science, Nature, Climate Dynamics). Presentations include: AVAPS user group meeting, NOAA HFIP Annual Meeting, AMS Annual Meeting, AMS Conference on Hurricanes and Tropical Meteorology, NOAA Modeling Fair, NOAA Tropical Cyclone Operations and Research Forum, The Disease Advisory Committee (DAC) of Stony Coral Tissue Loss Disease (SCTLD) sub team, at the NOAA Bioinformatics Super Group meeting, the American Society of Microbiology (ASM) conference, All-Atlantic Data and Policy Forum, PIRATA24/TAV Meeting. Data sharing efforts include: Data sets are posted to HRD website and ftp site. These data are submitted to a communal, online NOAA data portal accessible to the public. Leveraged social media, the AOML website, and the CIMAS website platforms to increase our education and outreach capabilities to the general public. The underwater glider observations data were made publicly available in real time through the Global Telecommunication System (GTS), and through the AOML website. The data is distributed via Global Data Assembly Centers (GDACs) and the Global Telecommunication System (GTS) and is open to the public and scientific community working on climate models and oceanographic data analysis. The project's python software is currently being housed in a private Github repository where the NOAA JHT facilitator can access it and provide feedback. AMS Annual Meeting, AGU Fall Meeting, AMS TC Conference, HFIP annual meeting, HAFS bi-weekly teleconferences.

EOM: Provided estimates of status and trends for a suite of indicators for the Florida Keys National Marine Sanctuary through a live web tool at [https://www.aoml.noaa.gov/esr\\_fknms](https://www.aoml.noaa.gov/esr_fknms). Presented Acropora coral genotyping information to resource managers and coral restoration agencies. Provided a technical report of the GOM Integrated Ecosystem Assessment workshop to the Louisiana Trustee Implementation Group. Provided input to fisheries stock assessments for ICCAT, SEDAR and SERO processes and internally to NOAA leadership of SEFSC, including estimates of fishery discards. Presentations at NOS-OAR joint meeting, eDNA technical workshop, NOAA Genetics Journal Club.

PR: Contributed to stock Assessment and Fishery Evaluation (SAFE) reports for marine mammal stocks. Provided annual summary reports of marine mammal strandings to database users and resource managers. Used data on genetic of marine mammals in multiple outreach presentations to middle and high school kids and adults in local communities in Louisiana and the CARMMA consortium. Provided results of genetic analyses of marine mammals from the U.S. Atlantic and Gulf of Mexico through marine mammal stock assessment reports. NOAA publishes these reports and post them in NMFS websites and in the NOAA Institutional Repository. The status and trends of the developed indicator suite for the Florida Keys National Marine Sanctuary are accessible for all stakeholders and communities of interest on a live web tool. Project updates and recommendations have been given to the NOAA OAR Omics group, NOAA OER, and Coral Disease Advisory Committee.

*Attach a separate document if more space is needed for #6-10, or #24-50.*

**ACCOMPLISHMENTS (cont'd)**

**28. What do you plan to do during the next reporting period to accomplish the goals and objectives?**

TW: Further HAFS developments. TROPICS/CyGNSS OSE study with HAFS model; OSEs assimilating CyGNSS. Multivariate assessment of the wave reforecast and its predictability at time scales beyond 10 days. Satellite architecture project addressing the impacts of satellite wind-field obs. Cloud-based AWIPS platform: remote visualization development will be possible. Test HAFS during real-time in 2022, work with EMC on initial operational implementation in 2023. Improve prediction skill using EOF analysis, ML. Lead weekly tornado outlook from May to June. Quantify TC surface wind field characteristics.

OC: Study effects of increasing ice sheet melting on deep ocean circulation. Recruit new vessels across the Atlantic. Atlantic Ocean transect A16N and the Indian Ocean transect I05. We will participate in the third East Coast Ocean Acidification (ECO3) cruise. The US Argo DAC will continue adding new floats to the processing stream. Developments related to model physics, ocean coupling, and nesting strategies. Develop MOM6 for regional, apply JEDI SOCA to provide realistic ocean initial conditions, coupling MOM6 to HAFS. Maintain and enhance underwater glider obs. Publish results from the VAST model vetting. Deploy the buoy and seafloor sensor package at the Port Everglades. Maintain High Density XBT Network. Document outcomes of sensitivity analyses and results of simulations using PCoMS model.

EM: Improve performance of visual survey for estimation of population size-structured population abundance of coral reef fish communities, with a focus on South Florida. Progress work pertaining the Gulf of Mexico IEA project, including research on the Barataria Basin IEA project. Improve the GOM IEA Status Report by emphasizing aspects of Human Dimensions, developing a Results Chains for adaptive management, and creating a Decision Support Framework for providing objective science for regulatory decision making and commenting. Research on isotopic signatures on fish larvae, ageing and gut analysis from previously collected samples will be completed to develop an inverse trophic-web dynamics model. Develop statistical tools for quantifying habitat use of reef fishes, and then use these results to refine fishery-independent sampling designs.

PR: Analyze additional years of data from the latest deployments of passive acoustic recorders used to detect Bryde's whale presence. Supplement photo-ID fieldwork on bottlenose dolphin by collaborating with FIU. Estimate abundance based and characterize scars and skin lesions on the audited photo ID data for the Biscayne Bay bottlenose dolphin population. Continue to audit and curate marine mammal stranding data submitted to NOAA. Collect, manage and analyze broad-scale data on the seasonal distribution and abundance of cetaceans and marine turtles from aerial and ship-based surveys. Process, analyze and distribute data collected in past surveys. Use coral recruits produced in 2020 and 2021 in hypothesis driven restoration research. Continue to document spawning and collect gametes for the three ESA listed coral species, *A. palmata*, *A. cervicornis* and *O. faveolata* and for *D. labyrinthiformis*. Resume surveys of the long-term demographic monitoring of *Acropora* and collect additional genotype sampling from new monitoring sites.

**PRODUCTS**

**29. Publications, conference papers, and presentations**

See attached Exhibit A.

**PRODUCTS (cont'd)**

**30. Technologies or techniques**

Under this award a number of technologies and techniques have been developed. These include:

Parameterization techniques that represent ice sheet melting in coupled models.

Developed code to QC and format the CYGNSS data in prebufr. Configured the operational model to assimilated CyGNSS.

General Oceanics model 8050 underway pCO2 system. WAVEWATCHIII tools.

The Wind Hazard Recommender Software tool.

Satellite simulators for Aircraft, AMV, Conventional, GPS-RO and Radiance obs.

An objective TC center-finding method has been developed.

Techniques to estimate oceanic flow using acoustic obs and bottom pressure data.

Continuously improving OceanViewer, Ocean Obs Viewer and the OBIS interface.

eDNA analysis with 16S amplicon sequencing. ML approaches to analyzing sequence data. Assembling eukaryotic genomes.

We displayed real-time graphics from HAFS and other experimental models on the AOML TC Model Viewer.

Python tools and shell scripts for diagnostics.

An experimental ensemble machine learning model, specialized for RI forecasts.

Software for delayed time scientific quality control of underwater glider data; new python script that analyzes sea glider log files to scan for errors and check mission parameters; python script automated a aspect of glider piloting.

Online web tool for red tide.

Online web tool for interactive indicators of Florida Keys sanctuary condition.

Published dataset on the online NOAA Oral Histories Archive, VOICES.

~~A History of Red Tide Events on the west coast of FL~~

**31. Inventions, patent applications, and/or licenses**

None

## **PRODUCTS (cont'd)**

### 32. Other products

Gridded Surface wind analyses.

Dataset from A20/A22 cruise submitted to public repositories: <https://cchdo.ucsd.edu/cruise/325020210316> and <https://cchdo.ucsd.edu/cruise/325020210420>

The US Argo DAC maintains a website that provides documentation and information about the operations as well as statistics and graphics presenting the collected data

The SAM project is producing full-water-column daily estimates of temperature and salinity at each mooring site in the array. These data are served via the project web page.

AMSR-2 Daily Products: [https://cwcgom.aoml.noaa.gov/erddap/griddap/RSS\\_AMSR2\\_AOML.graph](https://cwcgom.aoml.noaa.gov/erddap/griddap/RSS_AMSR2_AOML.graph)

Argo BGC AOML: <https://cwcgom.aoml.noaa.gov/erddap/search/index.html?page=1&itemsPerPage=1000&searchFor=bgc>

METOP-C ASCAT Daily winds: [https://cwcgom.aoml.noaa.gov/erddap/griddap/ASCAT\\_WINDS\\_METOP\\_C\\_AOML.graph](https://cwcgom.aoml.noaa.gov/erddap/griddap/ASCAT_WINDS_METOP_C_AOML.graph)

3 hour AOT forecast from GEFS-Aerosols:

[https://oceanwatch.aoml.noaa.gov/erddap/griddap/GEFS\\_Aerosols\\_bfd8\\_ee31\\_ed8b.graph](https://oceanwatch.aoml.noaa.gov/erddap/griddap/GEFS_Aerosols_bfd8_ee31_ed8b.graph)

NRT AOD 4 hour composite created from ABI L2 data from GOES-16:

[https://oceanwatch.aoml.noaa.gov/erddap/griddap/ABI\\_AOD\\_G16\\_4H.graph](https://oceanwatch.aoml.noaa.gov/erddap/griddap/ABI_AOD_G16_4H.graph)

Sentinal-2 MSI bands: [https://oceanwatch.aoml.noaa.gov/erddap/griddap/AREA1\\_51d0\\_6ac6\\_7407.graph](https://oceanwatch.aoml.noaa.gov/erddap/griddap/AREA1_51d0_6ac6_7407.graph)

New international collaboration with CNRS (France) and EMBL (Germany) as part of AtlantECO partnership.

We provided ATCF track files for HAFS to the National TC Center through an ftp server.

Hybrid forecast systems for U.S. warm-season rainfall

Seasonal tornado forecast system (SPOTter); subseasonal tornado forecast system (weekly reported)

Updates to National Marine Ecosystem Status Website ([ecowatch.noaa.gov](http://ecowatch.noaa.gov))

The data collected by the gliders were made publicly available in near-real time through GTS and on AOML website and distributed

## **PARTICIPANTS & OTHER COLLABORATING ORGANIZATIONS**

### 33. What individuals have worked on this project?

See attached Exhibit B.

**PARTICIPANTS & OTHER COLLABORATING ORGANIZATIONS (cont'd)**

34. Has there been a change in the active other support of the PD/PI(s) or senior/key personnel since the last reporting period?

Personnel who joined CIMAS:

Wilton Aguiar  
Elizabeth Bevan  
Julie Brown  
Erin Cain  
Ricardo Campos  
Samantha Camposano  
Rachel Cohn  
Zachary Daugherty  
Katherine Eaton  
Carissa Gervasi  
Kathryn Grazioso  
Steven Johnson  
Willem Klajbor  
Jessica Leonard  
Jiangang Luo  
Nicholas MacKnight  
Emily Milton  
Enrique Montes  
Ana Palacio Castro  
Isabel Porto da Silveira  
Walter Rogers  
Aurpita Saha  
Ore Solanke  
Benjamin Young  
Breanna Zavadoff

Personnel who left CIMAS:

Debra Abercrombie  
~~Daniella Alvarez~~

35. What other organizations have been involved as partners?

See attached Exhibit C.

**PARTICIPANTS & OTHER COLLABORATING ORGANIZATIONS (cont'd)**

36. Have other collaborators or contacts been involved?

- A. Abdolali
- C. Accardo
- A. Acosta
- J. Adams
- M. Alexander
- S. Alin
- V. Anantharaj
- L. Anderson
- M. Applegate
- J. Ault
- H. Baertlein
- A. Baker
- D. Bakker
- M. Baran
- M. Baringer
- H. Barkley
- J. Bartzick
- N. Bates
- J. Bazelais
- J. Beal
- L. Beerkircher
- S. Beggerly
- J. Bell
- M. Bernardi Bif
- D. Berry
- M. Beverly
- J. Bishop
- E. Biton
- R. Black
- J. Blondeau
- J. Bohnsack
- C. Bowler
- A. Brame
- M. B...

**IMPACT**

37. What was the impact on the development of the principal discipline(s) of the project?

See attachment Exhibit D



**IMPACT (cont'd)**

**38. What was the impact on other disciplines?**

Assessing the impacts of AIS melting in climate system will make an important contribution to atmospheric and cryospheric sciences.

Data leads to improved forecasting skill for oceans and global climate.

The methods of model validation and forecast assessment have been organized into Python scripts and functions that extrapolate the wave modeling application.

Some software components of the Wind Hazard Recommender could impact other meteorological disciplines

Improved obs of the MOC and of the western boundary currents will allow for better testing of research and predictive models used for weather, climate, ecosystem, and coastal resilience planning.

Understanding of the interactions between nutrient loading and FIB presence in inland waterways during seasonal variations.

OceanViewer supports operational, climate and research oceanography, and TC research. Saharan dust monitoring supports the development of an early warning system of synoptic air quality events

Improvement of plankton community surveys provide data on prey and larval communities linked to fisheries. These surveys may be used to regularly complement/augment fishery surveys in the future.

Improved TC forecasts from HAFS will be useful for emergency managers and other planners/officials when TCs threaten.

Data used by this project was actively used by forecasters during the 2021 TC Season. Also, the project led to increase the knowledge of the role played by the ocean in TC intensity changes.

Measurements along the newly introduced transect AXCOAST provided data ahead of TC Henri

Implications for coral restoration management.

Improved tropical Atlantic measurements impact weather prediction and DA, satellite calibration and validation, and ecosystem and biogeochemistry monitoring and research.

Provided opportunities for sample and data collection, and also for calibration of satellite technologies.

**39. What was the impact on the development of human resources?**

CIMAS has continued to be an effective pipeline for the development of human resources. This continues to be accomplished by recruiting students and staff for completion of graduate degrees, and by immersing them into collaborative research teams. Graduating students and outgoing CIMAS staff take positions in academia, NGOs, private industry and all levels of government, including local, county, state and federal. Many find permanent employment in NOAA, in particular with the AOML and SEFSC laboratories. Most staff and students are working at NOAA lab facilities to improve their networking with federal scientists and to learn about the environment of federal research institutions.

CIMAS graduating students often get jobs at AOML and SEFSC labs, sometimes as FTEs other times as employees of contracting NOAA collaborators, including CIMAS.

The number of students who graduated at UM and other CIMAS partners institutions and are now working at NOAA and state agencies is a statement to the effectiveness of the workforce pipeline supported by this cooperative institute. A graduate student is being mentored through the William Lapenta scholars program.

**IMPACT (cont'd)**

**40. What was the impact on teaching and educational experiences?**

Undergraduate and graduate student education are an integral part of the work facilitated by CIMAS. NOAA scientists and CIMAS staff participate in the educational programs at the UM, as instructors, advisors, academic committee members, mentors and scientific collaborators in student's research projects. CIMAS provides substantial funding including salary, research and tuition expenses for research assistants who are pursuing graduate degrees at UM and other partner institutions as part of CIMAS funded research projects. CIMAS also provides a few fellowships in support of independent research projects developed by graduate students. CIMAS supports workshops aimed at increasing the skill set of students, CIMAS staff and NOAA scientist. This included workshops on statistical and modelling techniques, database management and scientific communication. In collaboration with Miami-Dade College (MDC), CIMAS developed and implemented a summer internship program where MDC students were embedded with CIMAS scientists in the lab.

Students participated on educational experiences related to photo-identification of marine mammals during surveys, design of field campaigns and research cruise implementation. Students were also trained in stable isotope analysis of skin biopsies. A graduate student is being mentored through the William Lapenta scholars program.

Organized, hosted and participated in UN Ocean Decade Satellite Activity: "Satellite Monitoring of Pelagic Sargassum". Speakers: NOAA CoastWatch Seminar, SECOORA December Meeting, UNEP Webinar of the Sargassum Series on The Sargassum Challenge, BRA-USA Workshop on Oil Spill.

Response and Restoration. Panel: SEMTSI 2022: One Health. OSM2022: 1 poster and 4 oral sessions.

A metagenomic tutorial video was produced and posted on the AOML YouTube channel. This and other presentations are helping to train NOAA staff on eDNA and Omics tools.

Data from the marine mammal projects was used in multiple outreach presentations to kids (K-12) and adults (college and beyond).

**41. What was the impact on physical, institutional, and information resources that form infrastructure?**

This project used computational resources to simulate the climate system. We used 9.8 Tb of storage on the HERA supercomputer from NOAA.

Both the validation/data-mining packages and post-processing machine learning models have been designed to work operationally at NCEP/NOAA. The probabilistic tools and neural networks are components to be implemented in the operational ensemble wave forecasts during the last year of this project.

New computing resources were allocated to support the project's goals, aimed to provide processing, storage and data distribution capabilities. The data & products & applications generated by this project integrate within the organization infrastructure. A new ERDDAP/TDS computer was installed for supporting data distribution.

Aforementioned tutorial video and a subsequent interactive work flow are new resources for bioinformatics training.

Improved TC forecasts form a critical part of information infrastructure, and also serve to protect physical infrastructure from TC hazards.

The data collected by the gliders were made publicly available in near-real time through the Global Telecommunication System, and on NOAA/AOML website.

It has supported the improvement of Mote Marine Lab facilities, including the purchase of an ex situ spawning system to facilitate coral genotype propagation and restoration activities.

The 'Omics Initiative has facilitated use of molecular lab spaces at NOAA-AOML and has improved wet lab infrastructure in the CIMAS Experimental Reef Lab through the purchase of supplies.

Audited and completed photo identification library for Biscayne Bay GulfMAP and provided it to GulfMAP.

**IMPACT (cont'd)**

**42. What was the impact on technology transfer?**

The results of this research will help guide model developers on how to better represent meltwater fluxes from AIS in models that do not actively simulate ice sheet melting. This is likely to have a broad impact on the techniques used to model polar regions - especially since most climate models do not have interactive ice shelves.

The impact has been significant, including technology transfer through NOAA centers as well as to the general public. The entire research has been done publicly available.

Working with one of the NOAA 'Omics Working Groups subcommittees, the educational videos will help transfer 'omics technologies to new users.

HAFS technology (PBL physics and moving nest implementations) have been transitioned into the main HAFS code for real-time testing and future operational implementation. The AOML model viewer website continues to serve as a portal for display of graphics for comparison of experimental and observational models. Transfer of ftp files to NHC allows the forecasters to evaluate HAFS prior to implementation.

Regional MOM6 at level 4

CIMAS employees, with their AOML colleagues, continued training in glider deployment, refurbishment, and piloting for CIMAS, CARICOOS, ANAMAR, and CEI personnel including the piloting of gliders outfitted with a new ARM processor.

We developed multiple web tools to visualize and access data.

Ad hoc software and open-source programming script for biodiversity data management, visualization, curation, and sharing has been made publicly available.

Technological advances, both in terms of software and hardware, are made available to partner institutions at no cost, as follows: AMVER-SEAS, AOML's proprietary data recording software is made freely available to users at: <https://www.aoml.noaa.gov/phod/goos/seas/>, and is used by the following partner institutions: UFRJ, Brazilian Navy, University of Cape Town, and Scripps Institute of Oceanography; AOML's XBT Auto-Launcher system permanently installed in the NOAA Research Vessel Okeanos Explorer; AOML's Iridium-based data transmission system provided to partner institutions: UFRJ, Brazilian Navy, Scripps, and Argentinian Coast Guard. A meteorological station has been donated to the Federal University of Rio de Janeiro to be used along the AX97 XBT transect.

**43. What was the impact on society beyond science and technology?**

The knowledge and improvements of wave forecasts beyond 10 days have an enormous impact on the maritime industry, offshore operations, and coastal safety.

Some of our products are of interest for individual and institutional users (e.g. Vibrio fields, Sargassum monitoring products, altimetry for off-shore oil platforms). Many of our operational products have real applications in different areas: fisheries, air quality, water quality, maritime traffic, etc.

Blog posts were written about the Antarctica expedition to share field experience with the lay public. An eDNA presentation was given at the AOML Open House for non-scientist attendees.

We collaborated with interdisciplinary teams and provide information to policy and decision makers.

Marine biodiversity data from the Americas is now being shared through public repositories and thus available for management and decision-making of marine living resources throughout the world.

Maintain a long-term record of ocean obs along fixed transects in support of improved weather forecasts, and long-term climate and sea-level predictions

PIRATA produces a long-term (>20 year) publicly available time series of surface atmospheric and oceanic measurements that are used to improve weather and climate forecasts, and are used for ocean, climate and ecosystem studies.

Understand and quantify the impacts of red tide on human health, fisheries, and continued ecosystem functions.

The identification of stress-resilient coral genotypes, and resolution of the SCTL outbreak, is critical to the future protection of coral reef ecosystems and the socio-economic resources they provide.

These data can be used as means of educating the public on environmental health and to inform policy decisions and public forums.

Our work on coral 'Omics has direct implications for how we ensure that coral reefs maintain their resilience in the face of climate change and more localized stressors.

These data will likely inform the management of critical reef resources in Florida.

*Attach a separate document if more space is needed for #6-10, or #24-50.*

**IMPACT (cont'd)**

44. What percentage of the award's budget was spent in foreign country(ies)?

2 , 1.63% represents payments to foreign entities: Universidad de Compostela in Spain and Bermuda Institute of Ocean Science in Bermuda. There were also payments to Consultants: Iscale and Cape Eleuthera Island. Travel expenses for CIMAS employees to participate in international meetings and also to participate in research cruises. These activities took place this year as opposed to last year during COVID-19 when there were no foreign activities.

**CHANGES/PROBLEMS**

45. Changes in approach and reasons for change

The systems installed on Royal Caribbean ships Equinox, Allure of the Seas and Flora have not collected any data because the ships were not sailing due to impacts of the pandemic on the cruising industry. All three are expected to return to normal operations in the near future.

Mechanical issues and an outbreak of covid among the ship's crew caused the cancellation of the A13.5 cruise for a second time. None of the CIMAS personnel contracted the virus and all were able to return home safely. Conversations are ongoing about the possibility to reschedule the cruise a third time.

Recent changes to the Bahamas EEZ requests made it impossible to obtain permission to work in the waters. The requirement from Cuban authorities to embark two Cuban nationals amid the pandemic restrictions were unfeasible and we had to abandon the plan to sample in Cuban waters.

The code COSS has been updated with optimized techniques that make better use of CPU allocations on NOAA supercomputers, addressing an issue that came up in simulation.

Due to the ongoing pandemic, this project has shifted its focus toward using a cloud-based AWIPS platform, which is still being developed at the National TC Center, rather than using an AWIPS-dedicated workstation in person.

Timing and location of certain samples were altered due to difficulty obtaining water samples. Certain 'bottom' samples were dropped due to shallow depth.

Due to issues with supply chain and COVID-19 restrictions the deployment of the buoy and sensor package has been delayed by several weeks.

During 2021 and part of 2022, COVID restrictions have negatively impacted deployment of XBTs along some of the repeat transects.

NOAA EMC requested that we extend the moving nest functionality to regional configurations, from the original global cubed sphere configuration. This was implemented and tested from November, 2021 to January, 2022.  
Remote/virtual work due to Covid-19 local caseloads.

*Attach a separate document if more space is needed for #6-10, or #24-50.*

**CHANGES/PROBLEMS (cont'd)**

**46. Actual or anticipated problems or delays and actions or plans to resolve them**

Identifying how AIS melting affects the ocean circulation requires extensive and time-consuming analysis of several aspects of polar dynamics (e.g., buoyancy loss, sea ice production). Contributing authors participate in frequent results discussions to expedite this analytical process.

Reduced number of cruises due to reduced operations of ships during the pandemic. Ships are expected to return to operations in summer 2022.

The GPS-RO module had to be recoded and redesigned in order to fix significant discrepancies on the simulated obs.

There was a delay in molecular analysis of Microbial Source Tracking Markers due to extension of construction timeline in the laboratory spaces. This has been resolved, and all samples have been processed.

Covid-19 issues and staffing shortages continue to be problematic for field work.

Due to COVID-19 travel restrictions, impacts in the underwater glider deployments are still possible. Additional planning is ongoing to minimize or eradicate any impacts to the operations

We have experienced some delays due to issues beyond our control with external partners and weather.

Delivery of training modules have been delayed as a result of travel restrictions and general supply-chain issues related to the pandemic.

Further testing of equipment has been performed in the lab, and additional equipment needed for the project has been procured.

COVID-19 restrictions have had a large impact on XBT cruises. During this report period, some XBT cruises were canceled due to travel restrictions or uncertainties. Current travel restrictions are affecting not only transects from or to the U.S., but also solely international, transects. Until travel restrictions were lifted from the affected countries, some XBT transects were unable to be performed.

Upcoming delays are anticipated as the RVWS will begin engine replacement mid June, we will not know the extent of these delays until work commences. Backup ships and sampling plans are in place.

Work plans were readjusted to be successful while working in an at home setting. Local contractors have been hired to do remote work.

**47. Changes that had a significant impact on expenditures**

An unexpected return from Cabo Verde upon cruise cancellation and during the new year travel meant flights had to be booked on short notice and at higher rates than planned. Overall the impact was minor.

The requirement to quarantine and self isolate prior to embarking on the cruise increased hotel and per diem expenditures compared to other years. However, we had budgeted for this increased expense so there were no budget issues.

There was a delay in molecular analysis of Microbial Source Tracking Markers due to extension of construction timeline in the laboratory spaces. This has been resolved, and all samples have been processed.

Changes in ship routes is a recurrent issue that can negatively impact the realization of planned XBT transects. To overcome this issue, project personnel are constantly seeking alternatives for ship recruitment, coordinating the logistics, and working towards implementing new partnerships with different shipping companies. COVID-19 restrictions have had a large impact on XBT cruises. During this report period, some XBT cruises were canceled due to travel restrictions or uncertainties. Current travel restrictions are affecting not only transects from or to the U.S., but also solely international, transects. Until travel restrictions were lifted from the affected countries, some XBT transects were unable to be performed.

Multiple field efforts were canceled due to Covid 19 Pandemic. Money normally used for travel is being used for contractor work but not all project deliverables can be completed by contractors.

The number of cruises in the Florida Straits was reduced to one, because of the cessation of cruises that go into the Bahamian waters.

**CHANGES/PROBLEMS (cont'd)**

48. Significant changes in use or care of human subjects, vertebrate animals, biohazards, and/or select agents

None

49. Change of primary performance site location from that originally proposed

Most CIMAS staff are currently teleworking due to the guidance provided by UM and NOAA.

Coral larvae experiments in association with collaborators from USC were conducted offsite due to Covid-related travel restrictions.

**PROJECT OUTCOMES**

50. What were the outcomes of the award?

See attached Exhibit E.

**DEMOGRAPHIC INFORMATION FOR SIGNIFICANT CONTRIBUTORS (VOLUNTARY)**

Gender:

- Male
- Female
- Do not wish to provide

Ethnicity:

- Hispanic or Latina/o Not
- Hispanic or Latina/o Do not
- wish to provide

Race:

- American Indian or Alaska Native Asian
- Black or African American
- Native Hawaiian or other Pacific Islander
- White
- Do not wish to provide

Disability Status:

- Yes
  - Deaf or serious difficulty hearing
  - Blind or serious difficulty seeing even when wearing glasses
  - Serious difficulty walking or climbing stairs
  - Other serious disability related to a physical, mental, or emotional condition
- No
- Do not wish to provide

*Attach a separate document if more space is needed for #6-10, or #24-50.*