



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

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RECIPIENT ORGANIZATION	
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22. Recipient UEI: NPU8ULVAAS23	23. Recipient EIN: 526002033

## ACCOMPLISHMENTS

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

- Advance and refine the use of satellite information to operationally derive accurate measures of the Earth System components and develop long-term quality assurance of satellite observations that can be included in future reanalysis projects;
- Research and design best practices for management and stewardship of big data sets;
- Provide cutting-edge, end-to-end research and development services to assist the NOAA science enterprise in transforming raw data received from satellites and other sources into valuable information about the environment;
- Deliver innovative research products, education, training, and outreach to enhance the understanding and utility of that information for respective constituencies and engage with diverse stakeholders of such information;

#### Satellite Obs. Systems

Goal: To develop and implement NOAA GEO and LEO satellite systems, particularly through support for GOES-R series, JPSS, and SmallSat developments. This support will include gathering end-user requirements, developing products, and ensuring the quality, accessibility, and usability of end products.

#### Sensor Cal/Val

Goal: To perform calibration of Earth-observing satellite sensors, including the calibration of visible, infrared, microwave, ozone, and lightning sensors flown aboard NOAA's next-generation JPSS and GOES-R, other platforms, and inter-satellite integration.

#### Algorithm and New Product Development, Data Fusion, and Blended Products

Goal: To develop satellite-based algorithms for Earth System monitoring and validation strategies for derived products, and new applications ranging from weather to climate scales.

#### Components of the Earth System

Goal: To detect and understand changes in the components of the Earth System: atmosphere, oceans, land, biosphere, and human systems. Key focus areas will cover air quality, atmospheric gases and particles, vegetation, land surface properties, the changing cryosphere, the global oceans, and terrestrial and marine ecosystems.

#### Surface Obs. Networks

Goal: To improve the integration of additional data sources and collection methods of global observing climate networks and identify new pertinent climate variables to better characterize Earth's near-surface climate at relevant spatial and temporal time scales.

#### Data Stewardship and Climate Data Records

Goal: To develop systems that provide stewardship and data access for the Federal Government's billion-dollar investment in high-quality environmental data. The focus will be on developing and providing authoritative satellite Climate Data Records (CDRs) for the ~~atmosphere, oceans, cryosphere, and land~~

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

Under this project, the following performance metrics were accomplished during this period of performance.

Number of new or improved products developed that became or may become operational: 178

Number of peer reviewed papers: 117

Number of books and book chapters: 31

Number of invited presentations: 9

Number of presentations: 252

Number of graduate students supported by a CISESS task: 2

Number of graduate students formally advised: 9

Number of undergraduate students mentored during the year: 22

Number of consortium students: 43

A detailed description of accomplishments is provided in the annexes "Q25\_CISESS\_MD\_Expanded.pdf" and "CISESS\_NC\_Answers.pdf".

## ACCOMPLISHMENTS (*cont'd*)

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

Opportunities for our scientists to develop mentoring skills and train students.

The Summer Intern Program for Graduate and Undergraduate students (and High School Seniors) paired students with mentors according to shared interests. All interns were supported for 12 weeks, at 20 hrs/week. At the end of the season, interns write reports and present their results at a students' workshop. During the summer of 2021, we mentored twenty-two interns. Some of them continued through the fall (and spring) with support from the mentors' tasks.

CISESS offered seed funding grants to young scientists to develop new ideas. A new seed funding grants program was created to encourage new techniques to use satellite products, instruments, and models that may make a tangible contribution to advancing NOAA's mission. The program was open to all CISESS Task Leaders or Primary Scientists affiliated with the University of Maryland. Four one-year were awarded, with the option for a second year. Amount: \$30,000 (+\$15,000 in 2nd year)

Education and training materials to support the effective usage of JPSS microwave products. A Remote Sensing Laboratory was created to develop a low-cost microwave radiometer operating at Ka band (18-22GHz). This instrument will provide end-to-end demonstration and education for students and the remote sensing user community, from principles of instrument observations to EDR product retrieval algorithms. This project provides opportunities for younger researchers to participate in the satellite microwave product development and learn how we tailor our products to the research and operational community.

Student training. The project supported training for high school, undergraduate, and graduate students through the Summer Intern Program. The program's objective was to acquaint students with NOAA's mission and science activities.

Other opportunities for training and professional development included: (a) Tutorials and training on standard tools (Python; AWIPS, MATLAB programming as well as ArcGIS software advancements); and (b) Participation in professional domestic and international conferences/meetings/workshops.

Our scientists were assisted in getting familiar with data assimilation techniques and forcing data sources used in the National Water Model.

CISESS staff held numerous small group training sessions to promote data management best practices and to provide guidance to key stakeholders on submitting data to NCEI. The CISESS team has developed multiple guides related to how to use the NCEI submission tools and make publications accessible to meet PARR (Public Access to Research and Results) requirements. Finally, NCEI adopted many of the training practices we piloted on our project to bring new staff up to speed on archiving practices as part of a larger training program to onboard new data managers within NCEI.

~~One CISESS scientist was trained as a Sample Data Manager to participate in sea-going missions. This initiative was part of the~~

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

Dissemination activities at CISESS follow multiple paths expanded in questions 29-32. Here we present a summary and specific examples of dissemination activities.

Publications in scientific journals. Poster and oral presentations (some invited) at national and international conferences, including AMS, AGU, and EGU. Participation in specialized workshops and working groups. Development of training material. Teaching courses focused on NOAA's mission to serve the community. Dissemination to the public was also done through our website (cisess.umd.edu) and social media. Other results are disseminated directly through STAR websites. CISESS provides weekly reports to STAR with the most recent advances and news that took place at the institute. Different CISESS teams reported at weekly or biweekly meetings, and others prepared quarterly reports. The frequency and form of reporting information depend on a given activity's specific needs.

The satellite data water quality training module. This module was taught as part of the CoastWatch satellite data training class by the West Coast and Polarwatch regional nodes of CoastWatch in January 2022.

The NOAA's CoastWatch/OceanWatch/PolarWatch Annual Science Meeting was co-organized and run by a CISESS scientist. The meeting was a chance for all CW/OW/PW regional nodes and the central operations team to convene with satellite data users and scientists on the user community's needs.

Work was shared with communities of interest using a quarterly newsletter and highlighted on the Coral Reef Information System (CoRIS) and Coral Reef Conservation Program (CRCP) websites through various feature stories. CRCP and NCEI social media channels were used to promote feature stories to a broader audience of stakeholders and those with a general interest in coral ecosystems. Finally, project work was presented at various working groups and meetings with stakeholders.

Other scientists are involved in direct conversations with the forecasters at Ocean Prediction Center and Weather Prediction Center and their respective developers at the NCWCP building. In this way, CISESS learns of their needs and develops products to address them. Then, the developers add the products to AWIPS-II, and the forecasters are trained to retrieve them.

CISESS scientists work closely with the NCEI Ocean Exploration Data Stewardship project. A CISESS scientist was invited to speak at the Environmental Data Manager's Workshop (EDMW) on project-based data management planning and gave numerous presentations at local and international conferences. Additionally, the CISESS researcher meets regularly with Federally-Funded Organizations to discuss data management procedures and statuses and was asked to serve as a subject matter expert on a NOAA-wide initiative.

~~CISESS Staff working for the Coral Reef Watch broadly continued its timely provision of all data products, datasets, and supporting~~

*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?

CISESS will continue to conduct collaborative research, education, and outreach programs aligned with NOAA's strategic goals to achieve the following objectives:

- Advance and refine the use of satellite information to operationally derive accurate measures of the Earth System components and develop long-term quality assurance of satellite observations that can be included in future reanalysis projects;
- Research and design best practices for management and stewardship of big data sets;
- Provide cutting-edge, end-to-end research and development services to assist the NOAA science enterprise in transforming raw data received from satellites and other sources into valuable information about the environment;
- Deliver innovative research products, education, training, and outreach to enhance the understanding and utility of that information for respective constituencies and engage with diverse stakeholders of such information;
- Design information products and systems to monitor changes in the Earth System: atmosphere, oceans, land, cryosphere, ecosystems, socioeconomics, and other components of the anthroposphere;
- Develop experimental virtual reality tools for use in forecasting environments; and
- Strengthen overall NOAA-related research capabilities and capacity at CISESS institutions to complement and contribute to NOAA's ability to reach its mission goals.

**PRODUCTS**

29. Publications, conference papers, and presentations

CISESS produced a total of 179 peer-reviewed publications and two NOAA technical reports during this reporting period. A list of CISESS Publications is provided as an attachment to this RPPR.

A total of 294 talks and posters were presented at national conferences. Of these, two were invited presentations.

**PRODUCTS (cont'd)**

**30. Technologies or techniques**

Please see Question 32 for a complete list

Algorithm refinements and database updates are a priority for CISESS and have significantly improved retrieval quality and spatial coverage of satellite products.

Development of datasets:

Development of weekly, monthly, seasonal, and annual averages of Chlorophyll and light attenuation (turbidity) for the U.S. east coast for the entire mission of the VIIRS instrument on the Suomi-NPP satellite (2012-present) to allow environmental resource managers to understand long-term variability and change and to provide the basis for new decision-making applications, e.g., such as those involving long-term climatologies.

Global daily surface blue-sky albedo climatology datasets: at spatial resolutions of 500 m, 0.05 degrees and 0.5 degrees. (<https://doi.org/10.5281/zenodo.6359686>, <https://doi.org/10.5281/zenodo.6350821>)

A new North American coastal synthesis data product called "Coastal Ocean Data Analysis Product in North America (CODAP-NA, Version 2021): <https://www.ncei.noaa.gov/data/oceans/ncei/ocads/metadata/0219960.html>

Updated Global Ocean Data Analysis Project Version 2 (GLODAPv2.2021): [https://www.ncei.noaa.gov/access/ocean-carbon-data-system/oceans/GLODAPv2\\_2021/](https://www.ncei.noaa.gov/access/ocean-carbon-data-system/oceans/GLODAPv2_2021/)

Updated Surface Ocean CO2 Atlas Database Version 2021 (SOCATv2021) <https://www.ncei.noaa.gov/data/oceans/ncei/ocads/metadata/0235360.html>

Developed Soil Moisture Operational Product System (SMOPS) climate data records from 2002 to generate a long-term database of 1 km satellite soil moisture and their anomalies.

Developed real-time full disk 2x2km gridded satellite lightning data from both GLM16 and GLM17 for 2019-2021.

A monthly surface pCO2 product for the California Current Large Marine Ecosystem (Version v1.0.1) that is used to measure ocean heat.. <https://doi.org/10.5281/zenodo.5523389> (Sharp, J.D., Fassbender, A.J., Carter, B.R., Lavin, P.D., Sutton, A.J., 2021. RFR-CCS)

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

Nothing to Report

**PRODUCTS (cont'd)**

**32. Other products**

**DATASETS**

Blended Sea Surface Winds for Resolving Hurricane Winds dataset  
Coastal Ocean Data Analysis Product for North America (CODAP-NA)  
GLOBal Ocean Data Analysis Project Version 2.2021 (GLODAP)  
Surface Ocean CO2 Atlas Database Version 2021 (SOCATv2021)

Mapped Observation-Based Oceanic Dissolved Inorganic Carbon (DIC)  
Compilation of Dissolved Organic Matter (DOM) data from Global Ocean Surveys  
MetOp-A/B/C IASI HIRS Radiance datasets  
1 km Soil Moisture Products and their Anomalies CDRs from 2002 to present  
AERONET Based Surface Reflectance Dataset from April 2021 to present  
Weekly, Monthly, Seasonal & Annual Average Chlorophyll & Turbidity 2012 to present  
Gridded DC Lightning Mapping Array dataset  
Global Daily Surface Blue-sky Albedo Climatology dataset  
Global Daily Surface Blue-sky Land Cover Climatology dataset  
Global Land Surface Temperature climatology (in development)  
NOAA Atlas 14 Volume 12  
International Comprehensive Ocean-Atmosphere Data Set (ICOADS) R3.0.2  
SBUV/2 & OMPS Ozone Profile Climate Data Records  
World Ocean Database – Quarterly Updates and Releases  
Gridded Pentadal, Annual, Seasonal, & Monthly Ocean Temperature & Salinity Anomalies  
Gulf of Mexico Regional Climatology, Ver. 2.  
AVHRR Pathfinder SST v. 5.3  
Coral Reef Temperature Anomaly Database (CoRTAD)  
Sentinel 3A & B OLCI Chlorophyll and Total Suspended Matter at 300m

**PRODUCTS**

GOES Aerosol/Smoke products (GASP) product  
GOES-16/17 Evapotranspiration and Drought Monitoring product  
GOES ABI Snow Cover products  
GOES GLM Gridded Lightning products  
Subseasonal Soil Moisture Prediction products  
JPSS River Basin Ice Map products  
JPSS ATMS Snowfall Rate products

**PARTICIPANTS & OTHER COLLABORATING ORGANIZATIONS**

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

Name: Ellen Williams  
Role: PD/PI

Number of months (calendar) on project: 3

Contribution to the project: Dr. Williams is tasked with overall responsibility of the Cooperative Institute, including managing the relationship between Consortium members, and between the overall Consortium and NOAA. She serves as the primary point-of-contact of the CI with NOAA. She provides overall CI scientific and operational leadership, working with NOAA and Consortium team members. She reports to the CISESS Executive Council.

Residence: State of Maryland

Name: E. Hugo Berbery Role: PD/PI

Number of months (calendar) on project: 12

Contribution to the project: As Deputy Director of CISESS, Dr. Berbery also acts as Director for the campus in MD: tasked with supporting management of the overall Consortium, as well as management of the MD campus of CISESS, with scientific and financial responsibility over all research, education, and outreach/engagement activities taking place in this campus. In the role of CISESS Deputy Director and Director of the Maryland Campus, he supports the Director in managing the Consortium. He oversees scientific research, education, and outreach/engagement activities taking place in the Maryland campus as well as financial operations. At CISESS, Dr. Berbery has worked on advancing the Institute's scientific profile, improving its visibility, and developing best management practices.

Residence: State of Maryland

Name: Otis B. Brown Role: Co-PD/PI

Number of months (calendar) on project: 12

Contribution to the project: Dr. Brown is responsible for the campus of CISESS in NC, tasked with overall management, scientific and financial responsibility over all research, education, and outreach/engagement activities taking place in this campus.

Residence: State of North Carolina

The attachment "FY21 RPPR Scientist List.pdf" lists task leaders and primary scientists and their specific research topics.

**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?

Nothing to Report

35. What other organizations have been involved as partners?

The CISESS Consortium consists of UMD and NCSU as lead institutions and the University of North Carolina System (17 campuses, including NCSU); the University of Maryland, Baltimore County (UMBC); the University of Alabama (UA); the University of Alabama in Huntsville (UAH); the City University of New York (CUNY); George Mason University (GMU); Oregon State University (OSU); Howard University (HU); the University of Michigan (UM); the University of South Carolina (USC); the University of Georgia (UGA); the University of California, Irvine (UCI); South Dakota State University (SDSU); Florida International University (FIU); and the University of Nebraska Medical Center (UNMC) as academic institutions. Nonacademic institutions of the CISESS Consortium are the Pacific Northwest National Laboratory (PNNL), the University Corporation for Atmospheric Research (UCAR), The Nature Conservancy (TNC), and the Research Triangle Institute (RTI).

FY20 Consortium Contributions:

Consortium Partner	Location	Tasks
CESSRST, City College of New York	New York, NY	10
George Mason University	Fairfax, VA	6
RSC, University of Alabama	Tuscaloosa, AL	3
University of Maryland Baltimore County	Baltimore, MD	2
Howard University	Washington, DC	1
Oregon State University	Corvallis, OR	1
GSCE, South Dakota State University	Brookings, SD	1
University of New Hampshire	Durham, NH	1

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

36. Have other collaborators or contacts been involved?

FY20 Contributions (Non-Consortium):

Partner Location Tasks

University of Colorado at Boulder Boulder, CO 1

Kansas University Lawrence, KS 1

Texas Technical University Lubbock, TX 1

ReefSense Townsville, Australia 1

Jet Propulsion Laboratory Pasadena, CA 1

**IMPACT**

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

Data Stewardship

The Ocean Carbon and Acidification Data System (OCADS) project plays an instrumental role in the research of global climate change and ocean acidification. CISESS scientists provide critical data management support, developing relevant data products, and data standards. Understanding the carbon cycling in the ocean and ocean acidification is critical to help guide our society's mitigation and adaptation efforts.

We are developing long time series of the Soil Moisture Operational Products System (SMOPS) 1 km soil moisture products from the JPSS satellite observations, and reducing the soil moisture simulation uncertainties. The tremendous advantages include but are not limited to generating high-quality, consistent, fine resolution, long-term, and high spatial coverage soil moisture records.

CISESS has been actively processing multiple satellite data to document ocean surface winds for resolving hurricane structures. NOAA/NCEI Blended Seawinds (NBS) version 2.0 is the only gap-free Global Ocean surface wind product that can resolve very high winds, associated with Hurricanes Tropical Cyclones, etc.

Algorithm development and calibration/validation efforts

The radiative transfer model (RTM) is a critical tool for remote sensing and numerical forecast systems. We employed Artificial intelligence to develop a new-era RTM using simple statistical methods instead of the complex radiative physical theory, of the traditional RTMs. The new RTM demonstrates high efficiency and high accuracy. Its processing speeds are around an order of magnitude faster than the traditional method, an issue critically needed in operational models.

Downscaling of Geostationary Lightning Mapper (GLM) Observations Using International Space Station-Lightning Imaging Sensor (ISS-LIS) Data: The method builds a foundation for future GEO and LEO lightning sensors on a global scale. The project facilitates space-based lightning detection, real-time lightning observation, and severe weather forecasting and nowcasting.

CISESS JSTAR SDR CrIS: Scientific Support for Joint Polar Satellite System (JPSS) Cross-Track Infrared Sounder (CrIS) Calibration and Validation: The primary impact of this project has been the continued preservation of high-quality calibration and validation of the JPSS CrIS sensors, and the provided readiness to the launch of the JPSS-2 and JPSS-3 CrIS instruments.



**IMPACT (cont'd)**

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

Advancing the Effectiveness and Efficiency of GLDAS Assimilation of JPSS Land Data Products for NCEP NWP and Drought Monitoring Operations.

Better weather and climate forecasts are required for weather- and climate-ready nation. Better drought monitoring capability will benefit agricultural management and production forecasts.

The research and development support provided by CISESS staff for science mission areas at the Office of Water Prediction and the National Water Center will aid and enhance calibration of the National Water Model and therefore help improve forecast results by the model.

CISESS Operational Calibration, Validation, and Monitoring of JSTAR SDR VIIRS, and algorithm updates. The high-quality NOAA reprocessed VIIRS products calibrated in this project assure their application in social-economic and disaster monitoring studies. The high-quality VIIRS Day-Night Band data calibrated in this project assures its application in social-economic and disaster monitoring related studies. The VIIRS imagery SDRs were demonstrated to detect shipping containers at ports under clear sky conditions opening up to other possible uses.

Downscaling of GLM Lightning Observations facilitates the understanding of lightning physics and detection in a broader area in atmospheric science, remote sensing, electrical engineering, and education. The data product under development will also make a great contribution to the Earth Science machine learning applications.

A CISESS scientist working as OceanWatch Operations Manager assists stakeholders across a wide range of disciplines and applications: fisheries researchers, marine biologists, protected species managers, commercial fishermen, etc.

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

CISESS has supported NOAA's commitment to developing a future diverse workforce, and to this end, it is led by a Minority-Serving Institution (UMD is a MSI) and has significant participation from other MSIs. CISESS supports K-12, undergraduate, graduate, and postdoctoral education through mentoring early career staff, advising, teaching students, supporting student research activities, enabling student internships and fellowships, and advancing research collaborations. At least 4 CISESS scientists have transitioned to civil servant positions.

Specific impacts on the development of Human Resources include:

- Established an annual CISESS summer intern initiative, a mentoring program for high-school, undergraduate, and graduate students to work on NOAA-related research. The 2021 summer group consisted of 22 interns; CISESS supported them by paying hourly wages for 20 hrs/week during 12 weeks. Other interns were hired through the fall and winter.
- Established annual CISESS Science Meetings for sharing knowledge and stimulating collaborative opportunity discussions.
- Promoted early-career scientists by establishing a Seed Funding program that encourages the development of new research ideas that can contribute to NOAA's priorities.
- Provided training on the use of ocean satellite data to over 300 workshop participants to ensure NOAA satellite products are utilized by stakeholders and that stakeholders use application-appropriate products. Participants were NOAA staff, university researchers, students, local government employees, and others. This project ensures the availability of ocean satellite data to users in the Pacific Islands Region. Products are curated and centered on the dateline to facilitate downloads and data extraction across the dateline.

**IMPACT (cont'd)**

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

CISESS scientists involve students in earth science and enable students and teachers to explore and understand the large volumes of climate data that NOAA collects about the Earth. Working collaboratively with other academic and public partners, stakeholders, and the private sector, CISESS supports and engages in various educational and outreach-related activities to advance the following areas:

- i. Increase awareness of climate science and changes in the climate system
- ii. Grow the understanding of how climate data is collected, observed, analyzed, and used in research purposes
- iii. Increase awareness of climate datasets and products, and how educational teachers/professors can make use of climate data products for teaching climate science
- iv. Demonstrate capacity building on the various impacts of climate change across public, private, and academic arenas
- v. Increase private sector understanding and use of climate data and information for their strategic and operational use

Specific examples:

Coral Reef Watch (CRW) staff broadly communicates critical product information (including summaries & analyses of satellite- and model-based products) to users worldwide via CRW's email networks, social media accounts, regular partner and monitoring network reports, numerous presentations, and other outreach materials. Staff also provides training opportunities on CRW's decision support tools for coral reef management and their appropriate applications and garners feedback to improve management tools. CRW aims at improving understanding of climate change threats to coral reefs and establishes sound practices for the use of NOAA products to enhance resilience-based coral reef management.

CISESS staff has made it a priority to continue outreach to students and educators by posting educational content on the CoRIS site and by working closely with internal and external organizations to promote coral reef-based educational content on websites and social media.

With the satellite data water quality training module, the CoastWatch program is now able to meet the needs of specific satellite data users interested in water quality variability, such as aquaculture farmers or environmental managers.

Datasets for education: The VIIRS SR product data is publicly released for teaching and education use.

A website to display the Blended Products and Validation Coordination is under development with the help of an undergraduate intern (part-time, full year) from the University of Maryland. The webpage provides an opportunity for teachers and educators to freely access a research-quality validation product linking NOAA's satellite research and operations.

CISESS scientists contribute to the documentation of the HYSPLIT model, and part of the outcome has been integrated into HYSPLIT workshop tutorial materials.

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

Nothing to Report

**IMPACT (cont'd)**

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

An improved VIIRS verified RDR algorithm developed in this project has been transitioned to operation in the Community Satellite Processing Package (CPSS) to support direct broadcast users. We also submitted a refined version of the code change package to IDPS for transition to operation for the NOAA operational processing.

An updated GCOM AMSR2 precipitation retrieval – GPROF will be transitioning to NOAA operations shortly after its scheduled delivery to NOAA GCOM-W1 AMSR2 Algorithm Software Processor (GAASP) team.

Products within the CRW decision support system for coral reef management, which CISESS staff have conceptualized, researched, developed, and tested in close collaboration with partners all over the world, help marine resource managers, scientists, elected officials, monitoring networks, and the public monitor climate impacts to reef ecosystems worldwide.

In response to CRW products and communications from staff, users have reduced local stressors during periods of high oceanic heat stress (e.g., closing scuba diving and fishing areas), rescued rare corals, and shaded/cooled key nursery reefs. Staff also publishes regularly in the scientific literature, including co-authoring papers involving applications and analyses of CRW products, algorithms, and methodologies, and contributes to national and international assessments of coral reef conditions. All of these are archived, in a 508-compliant format, with NOAA CoRIS and the NOAA IR. We are interviewed frequently about our work and products for features by different NOAA offices, UMD/ESSIC, and the U.S. and international press.

Continued work with data managers to optimize data submissions from Principal Investigators to data centers, and between data centers. A CISESS scientist works as part of the science and technology division which seeks to explore innovative ways for collecting, analyzing, and accessing data.

GOES-R Proving Ground Satellite Liaison for the National Weather Service serves the forecasters at WPC and OPC who do not have dedicated time to bring new satellite products from R2O. Otherwise, the operations would move very slowly (or not at all) to acquire new cutting-edge satellite data produced by NOAA, NASA, academia, and other space/met agencies worldwide.

To benefit the National Water Model of NWS OWP and the NWP models and climate analysis of NWS NCEP with a long time series of 1km resolution satellite soil moisture data product. The long time series of 1 km soil moisture products and their anomalies will be developed using observations from JPSS, MetOps, GOES, GCOM, and other soil moisture-relevant satellite platforms. The new products are enhancements of existing soil moisture data that closely couple with the needs of the NWS and other societal end users.

Work on the Satellite Oceanography and Ocean Surface Data Stewardship, Production, and Services.

blended TAC and BUFR data into one product, with duplicates removed. This was developed at NCEI over the course of years and was put into operations in March 2022. This is a significant update to the surface marine climate record.

CISESS scientists working on GOES-R ABI Calibration and Validation Support cooperate with scientists and engineers from government agencies, universities, and companies and share the technologies used by different people.

With the rigorous development and evaluation of the multiple SAR FIM algorithms, we are near forming a single SAR FIM algorithm that will provide the best operational SAR FIM products. The CMS merging algorithm is written in Python, and is ready to demonstrate the merged VIIRS/SAR FIM products.

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

Scientific Support for Joint Polar Satellite System (JPSS) CrIS Calibration and Validation. Because high-quality hyperspectral infrared data has a large impact on weather and climate forecasting, these products have a broad downstream socio-economic impact in the United States, as societies and businesses can make better decisions based on having more precise information at hand.

Bioavailable mercury in the environment is one of the premier public health concerns due to its link to human congenital disabilities. While a complete understanding of mercury transport and chemistry in the atmosphere is still a distant goal, making long-term measurements of global background atmospheric mercury is vital to understanding trends and achieving NOAA's vision of a healthy, resilient ecosystem. CISESS scientists work on improving these measurements by developing a R.M. difference system which is crucial to understanding our changing environment.

Global climate change impacts all aspects of our lives through rising sea levels, stronger hurricanes, melting permafrost, intensified wildfires, disrupted fresh water and food supply, etc. The rapid change in the Ocean's chemistry is jeopardizing the Ocean's role in providing important ecosystem goods and services, including food security, fisheries, and aquaculture industry, recreational opportunities, carbon sequestration and storage, and other Blue Economy related activities, to billions of people, especially those in the coastal communities. CISESS scientists are playing a critical role by making data available, facilitating data product developments, and supporting the research on ocean carbon and ocean acidification, thus helping guide our society's mitigation and adaptation efforts.

Knowledge of real-time lightning production in thunderstorms has proven to be valuable information for weather forecasting. Total lightning observations, or observations of intra-cloud and cloud-to-ground lightning, are the most useful for storm warning and public safety applications.

Products resulting from the CISESS activity "Processing Multiple Satellite Data - Ocean Surface Winds for Resolving Hurricane Structures" have a usage in the insurance industry, especially in risk management prediction for people dependent on Ocean for their livelihood. They are also a valuable product for Ocean Vessel tracking, where it is of substantial commercial importance. This project can support the USA's important offshore power generation project.

CISESS provided scientific support to the CoastWatch Satellite Data Products, Applications, and User Engagement for Water Quality, Fisheries, and Climate Decision-Making for the U.S. East Coast. The project improved decision-making in ecosystem-based fisheries management by providing specific applications about environmental variability needed by fishery biologists to combine physical information with biological variability. For instance, seasonal temperature anomaly maps are incorporated into the Chesapeake Bay Seasonal Environmental Conditions Summary Reports and the Mid-Atlantic State of the Ecosystem Reports, which

*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)?

1 , In FY21, we worked with ReefSense, an Australia-based subcontractor who provide services to Coral Reef Watch and its CISESS staff. This is about 1.2% of the total budget in FY20. (The web page would not allow us to enter a decimal number in the box, so we reported the closest integer.)

**CHANGES/PROBLEMS**

45. Changes in approach and reasons for change

Nothing to Report

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

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

Nothing to Report

47. Changes that had a significant impact on expenditures

Nothing to Report

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

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

Nothing to Report

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

Nothing to Report

**PROJECT OUTCOMES**

**50. What were the outcomes of the award?**

Outcomes of CISESS are the following:

Through this year's tasks, CISESS:

- harnessed expertise in satellite and in situ observing systems required to produce reliable and authoritative data, and provide project management and data stewardship skills necessary for making these data usable and available;
- contributed to NOAA mission-directed research that will utilize these observing systems and lead to an understanding of the Earth System at regional to global scales and from minutes to decades;
- provided educational and outreach opportunities in NOAA-related research on applications of satellite data and information, supporting students' participation in areas that will contribute to the development of a diverse workforce in NOAA;
- engaged with stakeholders, offer the communication expertise required to understand user needs, and deliver actionable information about the Earth System;
- identified emerging science needs requiring satellite and other Earth observations that will contribute to effectively and efficiently meeting NOAA's mission.

**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.*