

# NOAA Ocean Color Science and Applications

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NOAA/STAR Ocean Color Science Team & CoastWatch

NOAA/NESDIS Center for Satellite Applications and Research (STAR)

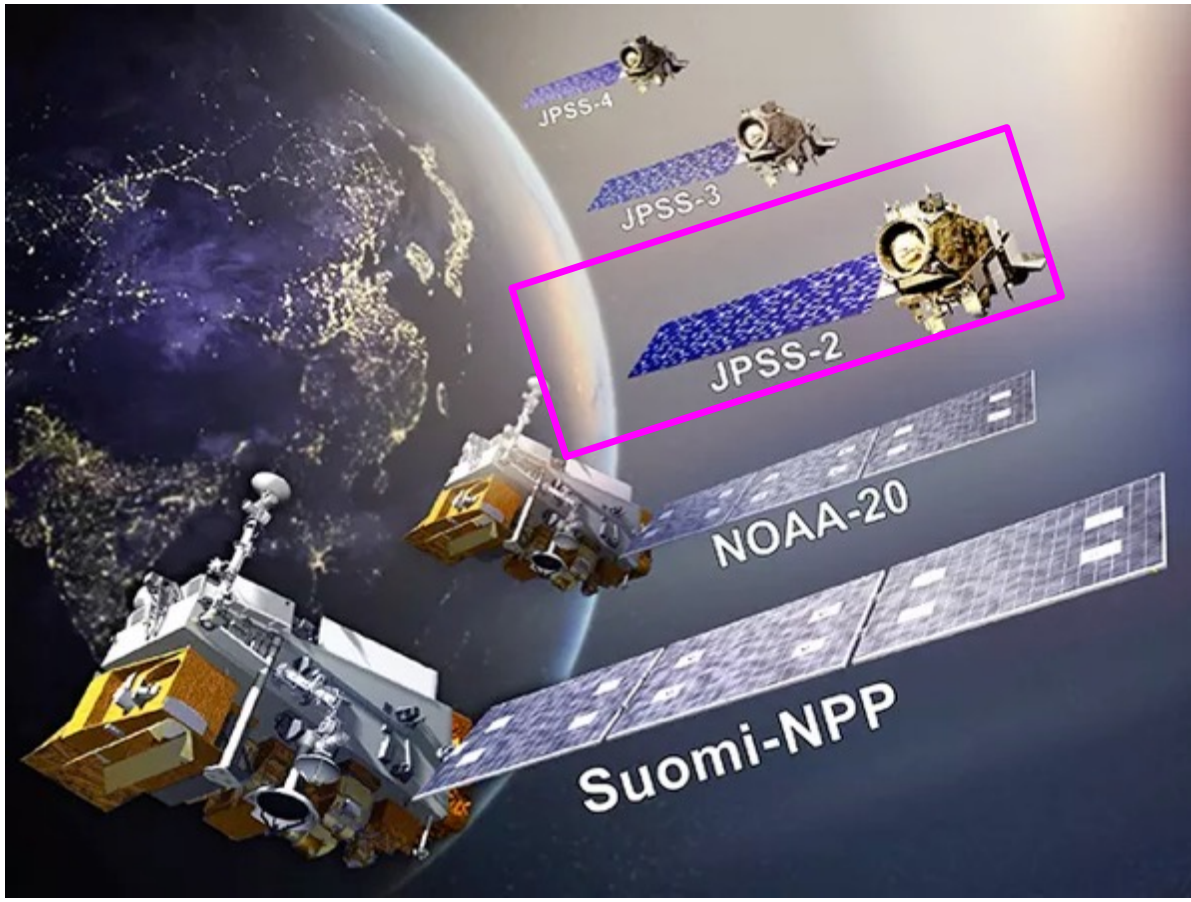
E/RA3, 5830 University Research Ct.

College Park, MD 20740, USA

*International Ocean Color Science Meeting, St. Petersburg, FL, USA, November 14-17, 2023*



# VIIRS NOAA-21 Status



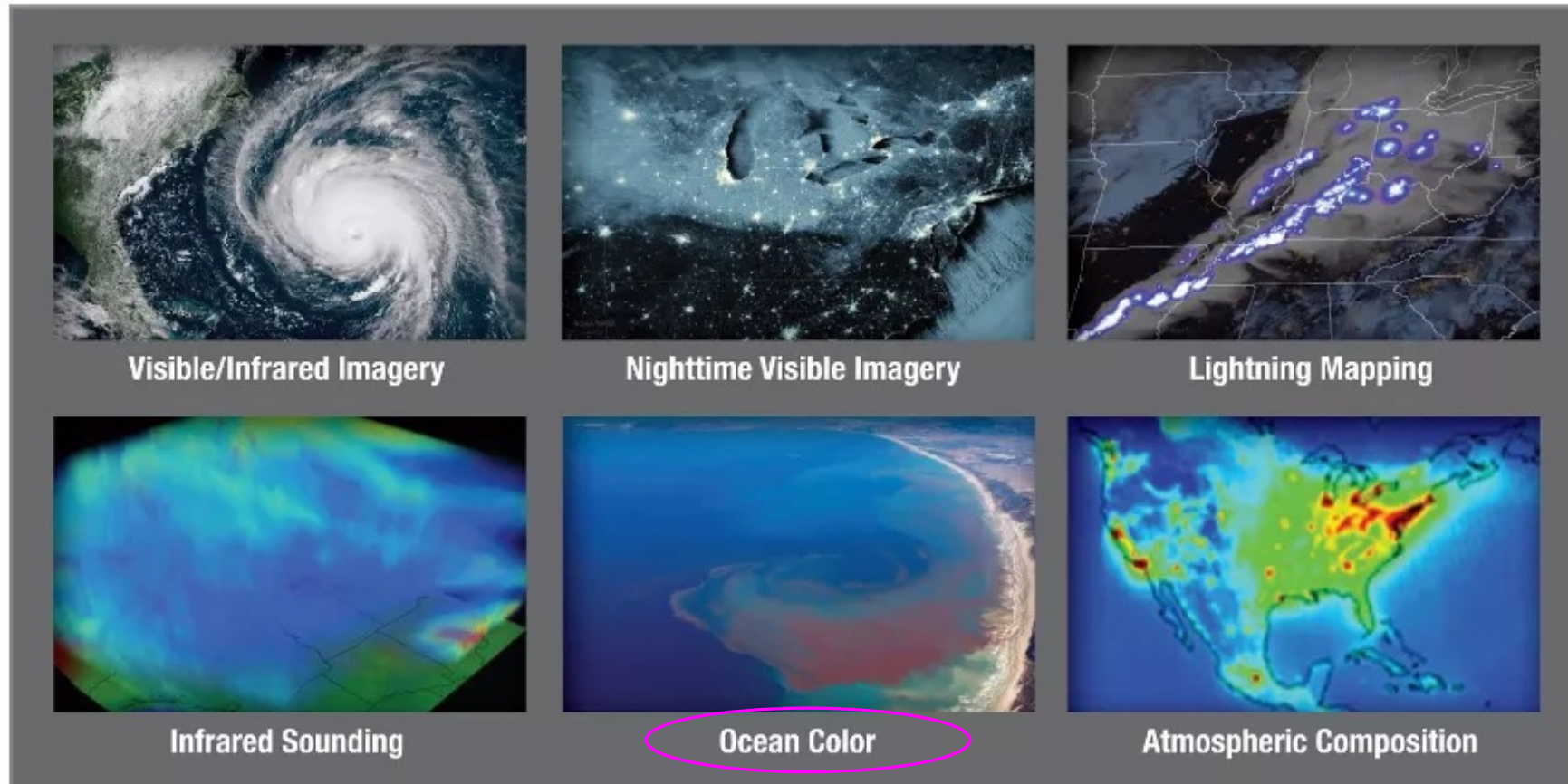
- NOAA-21 satellite was successfully launched on November 10, 2022, at the 1:49 AM (PST) at the Vandenberg Space Force Base (VSFB) in California.
- VIIRS-NOAA-21 data started on December 5, 2022, and global true color image was generated on December 6, 2022.
- After getting the VIIRS-NOAA-21 SDR, we were able to immediately generating global ocean color products.
- NOAA-21 was fully operational in NOAA's fleet of polar-orbiting satellites on November 8, 2023.

<https://www.nesdis.noaa.gov/our-satellites/currently-flying/joint-polar-satellite-system>



# Geostationary Extended Observations

- The Department of Commerce **formally approved** NOAA's next-generation geostationary satellite program, Geostationary Extended Observations (GeoXO), on **December 14, 2022**. GeoXO will now enter the development phase of the mission and start awarding industry contracts to build the spacecraft and instruments.
- NOAA plans for GeoXO to improve on GOES-R's visible/infrared **imagery** and **lightning mapping** capabilities and add **nighttime visible imagery**, **hyperspectral sounding**, **atmospheric composition**, and **ocean color** observations.
- GeoXO is a collaborative mission between NOAA and NASA. NOAA and NASA are working with commercial partners to design and build the GeoXO spacecraft and instruments.



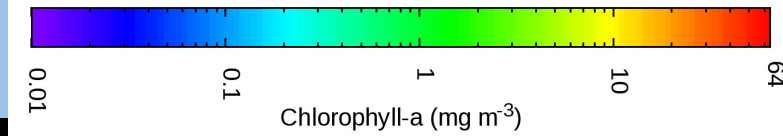
# GeoXO Constellation



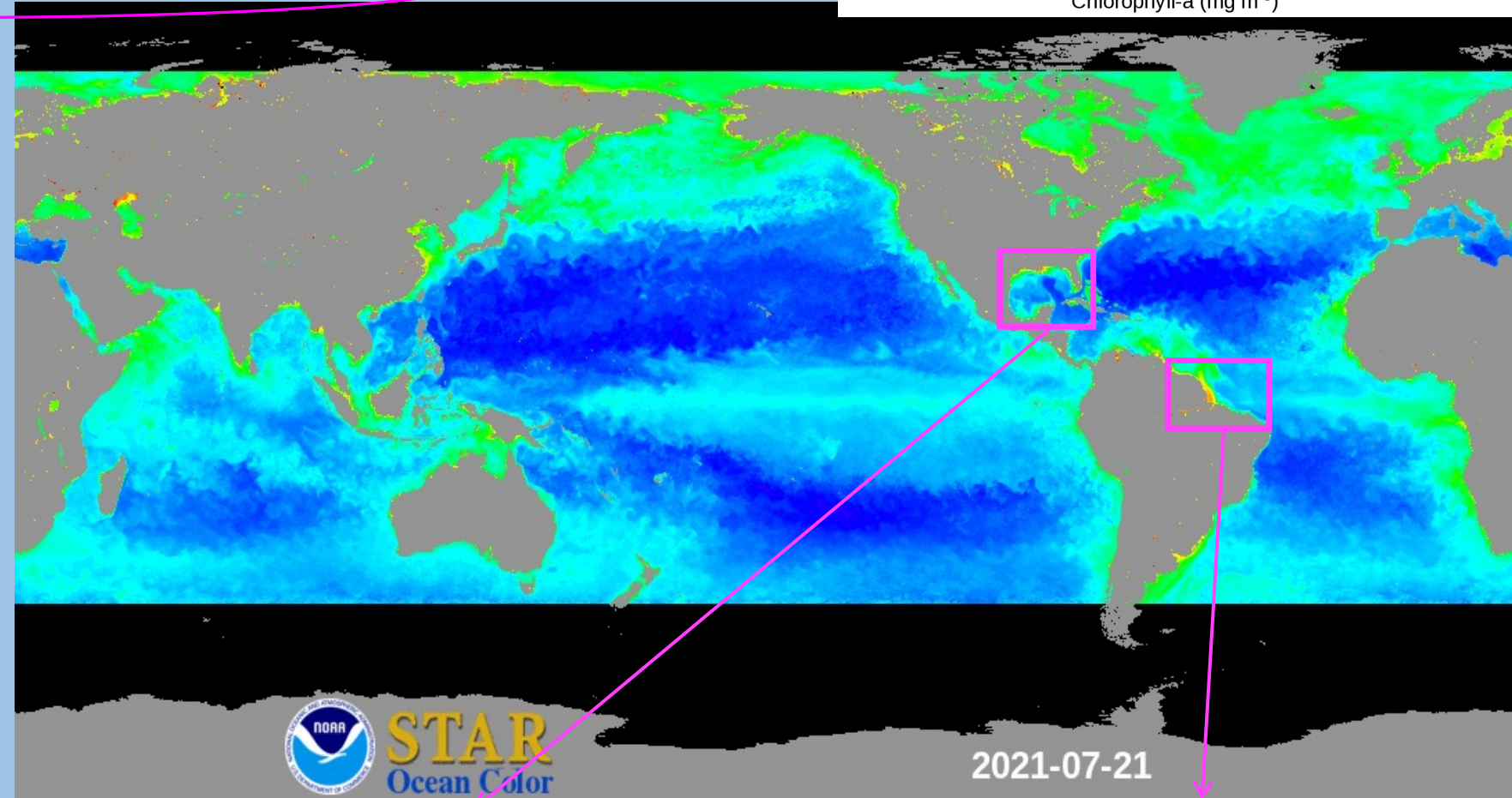
- Spacecraft in the current **GOES-East** and **GOES-West** positions will carry an **imager**, **lightning mapper**, and **ocean color** instrument, and a **centrally-located spacecraft** will carry a **sounder** and **atmospheric composition** instrument.
- On September 5, 2023, a final request for proposal (RFP) for the GeoXO Ocean Color (OCX) Instrument Implementation is being released to industry. Therefore, from Sep. 5, 2023, we are in the “**blackout**” period.
- The resulting contract will provide **a hyperspectral, ultraviolet through near-infrared passive imaging radiometer** that analyzes ocean data and is planned to fly on the NOAA GeoXO program series of geostationary satellites.
- GeoXO will begin operating in the early **2030s** as the GOES-R Series nears the end of its operational lifetime.

# Three-Sensor Global Gap-Free Chl-a Data

(VIIRS-SNPP, VIIRS-NOAA-20, and OLCI-Sentinel-3A)



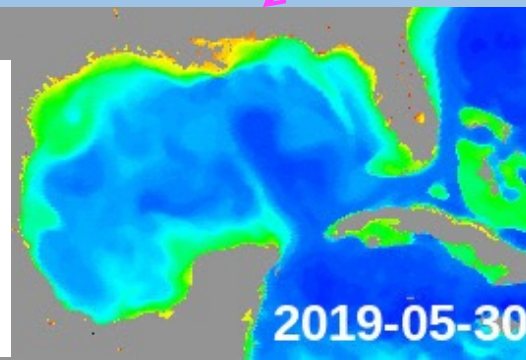
- **Three-sensor** (VIIRS-SNPP, VIIRS-NOAA-20, and OLCI-S3A) global data are merged to produce improved data coverage.
- The Data Interpolating Empirical Orthogonal Function (**DINEOF**) is used to producing global daily gap-free products.
- Routinely global daily gap-free **Chl-a**,  $K_d(490)$ , and **SPM** products and images (in both 2- and 9-km).
- Gap-free products are distributed through NOAA CoastWatch.



Meso-scale ocean features in the gap-free Chl-a data (two examples shown in the right)

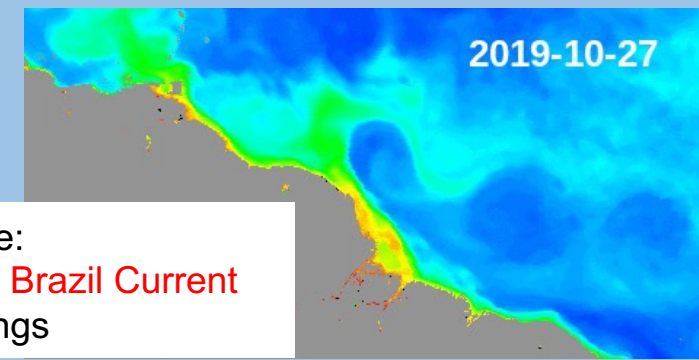
In the movie:

- Formation of **Loop Current Eddy** (LCE): a LCE shedding from the Loop Current around 7/10/2019



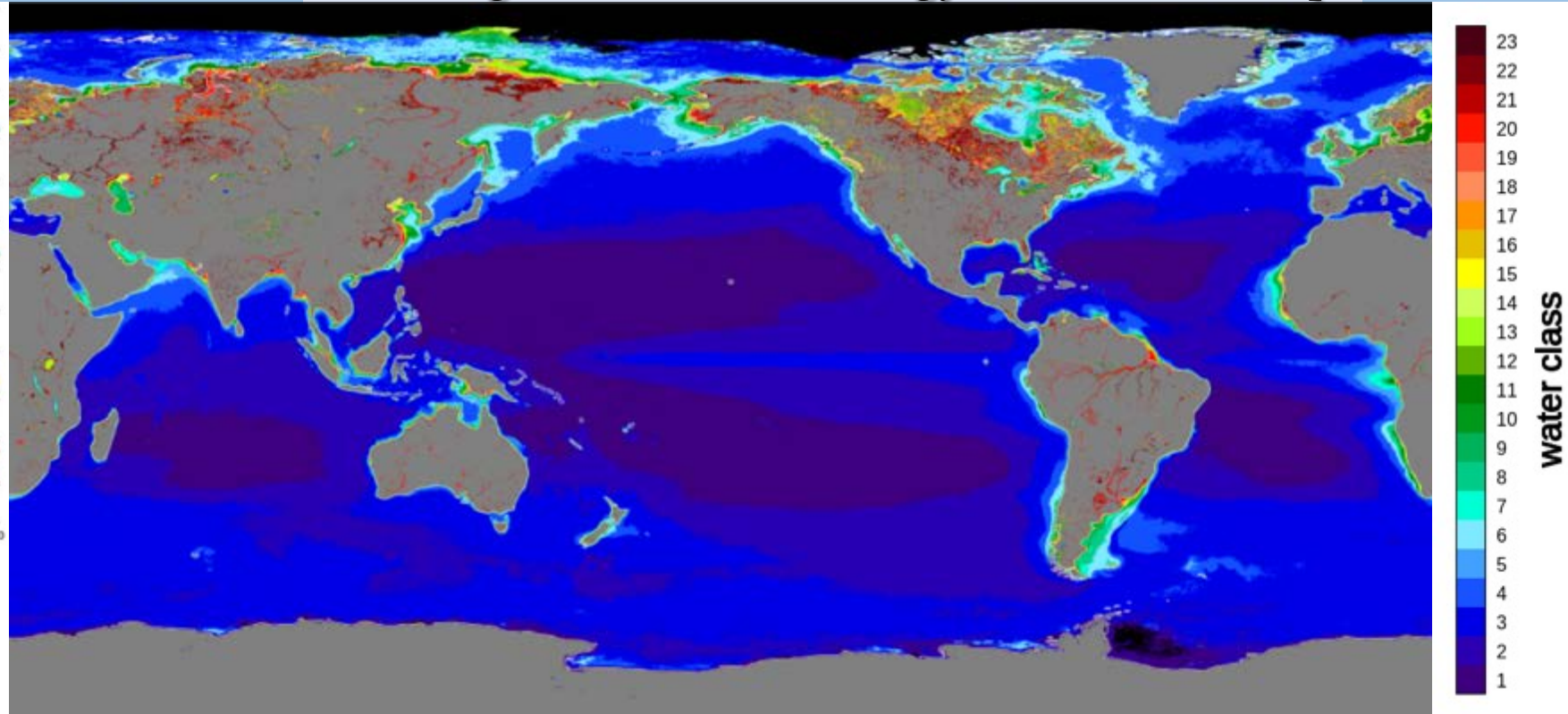
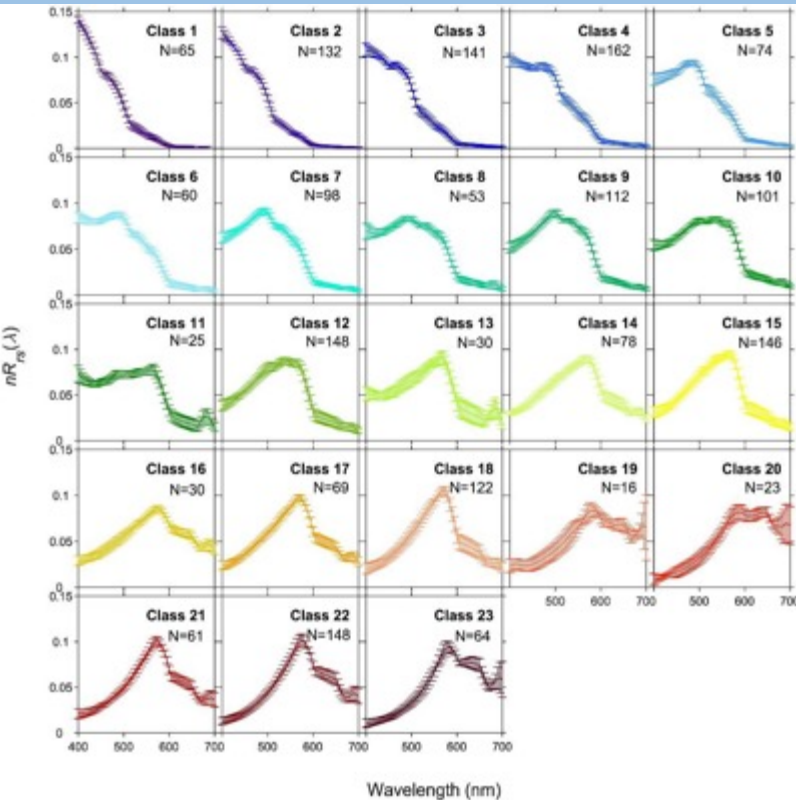
In the movie:

- **Northern Brazil Current** (NBC) rings



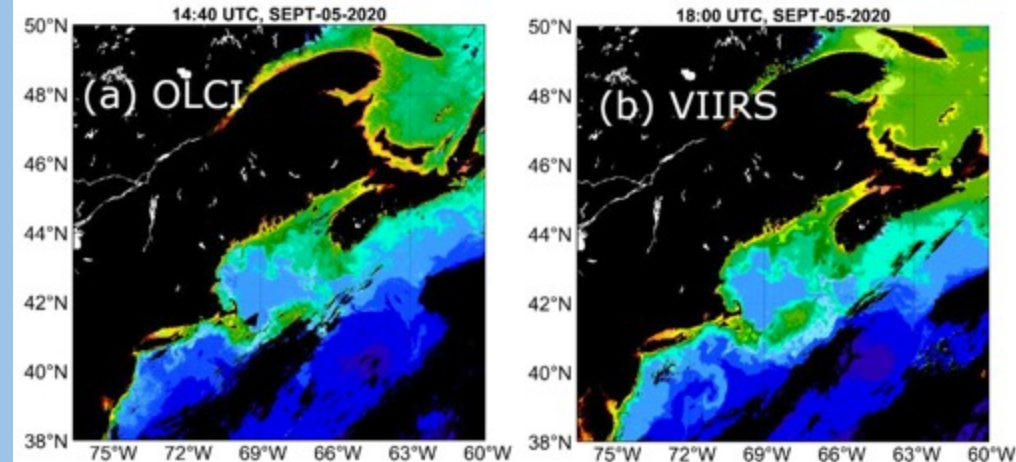
# Global Water Class Product

## VIIRS-generated Climatology Water Class Map

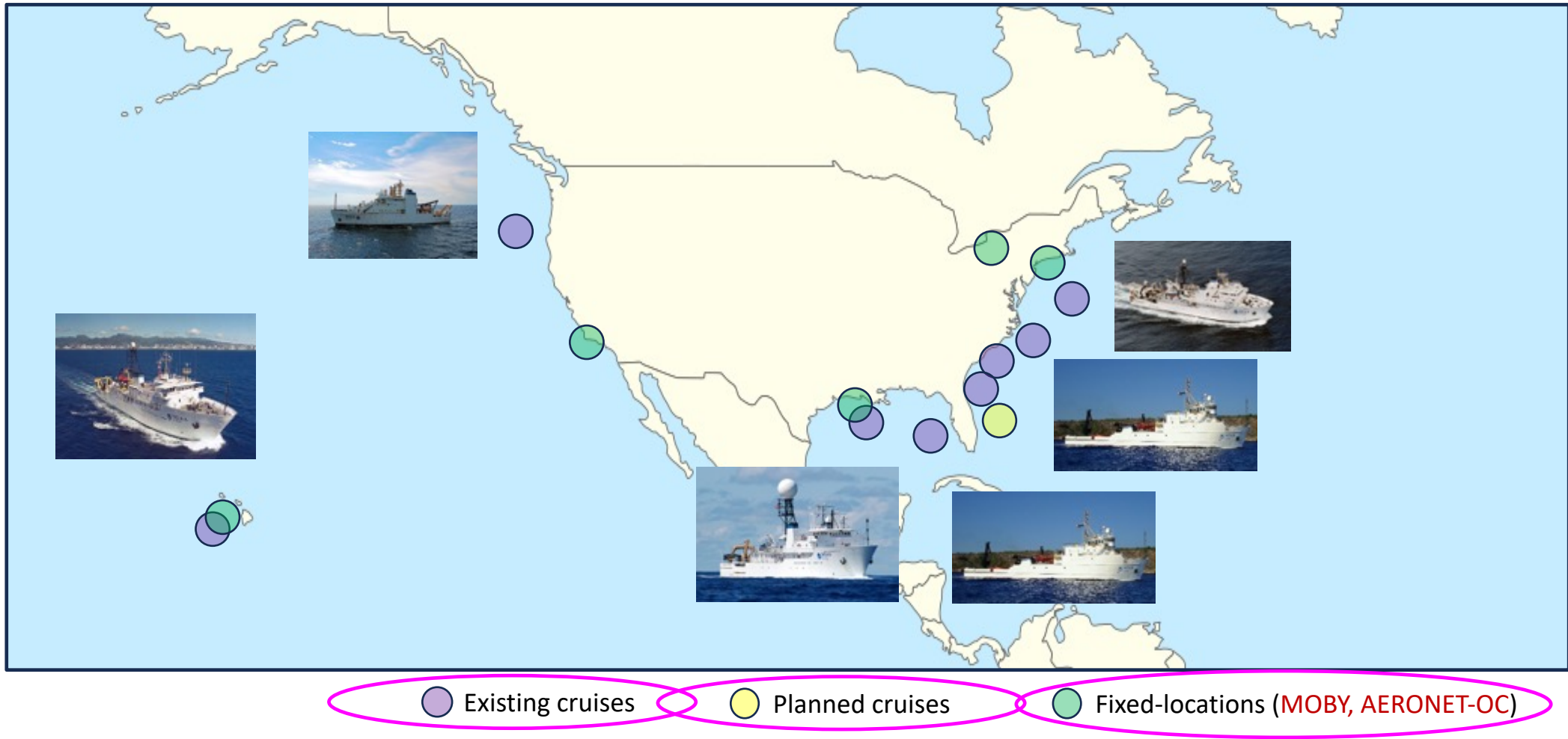


- Global partitioning of satellite ocean color data is needed to decipher the optical complexity and unravel the diversity of natural waters.
- The ocean science community needs a representative water classification scheme to produce distinct and consistent water classes from different satellite sensors.
- A new water class product has been developed with total of 23 water classes.
- Global water class products have been routinely produced using MSL12 for VIIRS-SNPP, VIIRS-NOAA-20, OLCI-S3A, OLCI-S3B, and SGLI-GCOM-C.

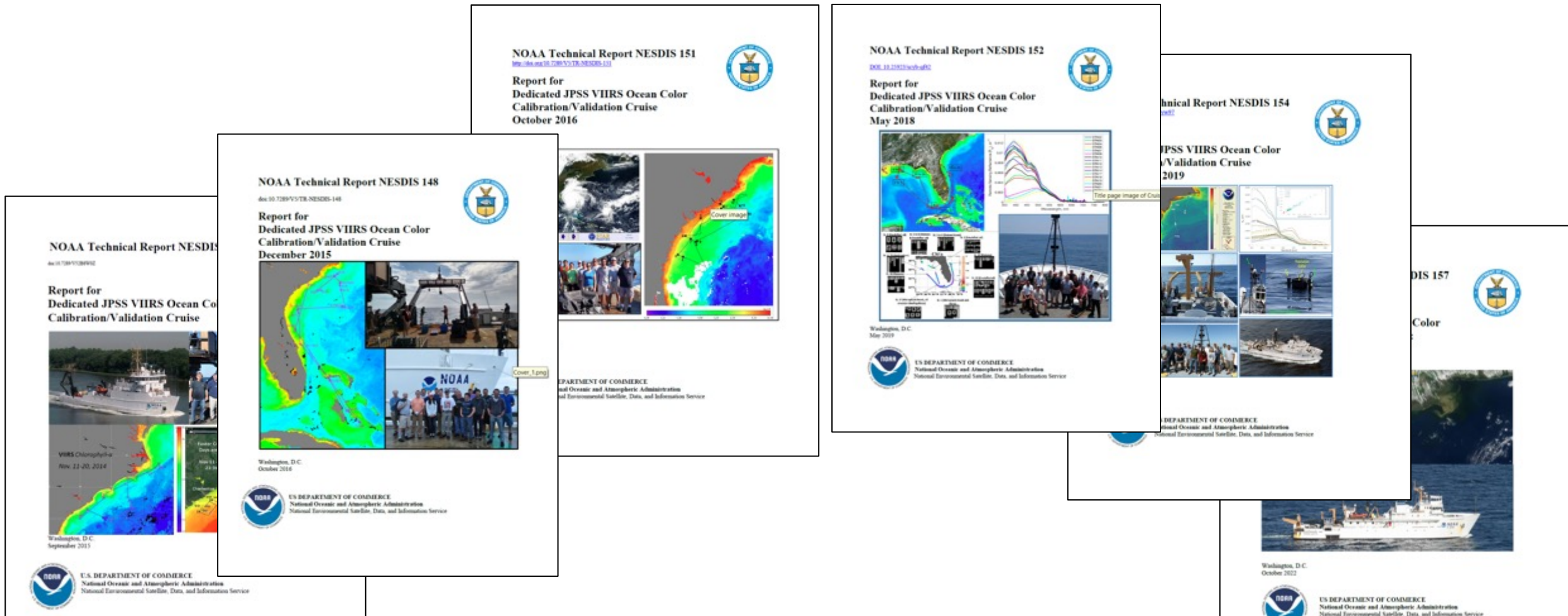
Wei, J., M. Wang, K. Mielsons, L. Jiang, S. Kratzer, Z. Lee, T. Moore, H. M. Sosik, and D. V. Zande, "Global satellite water classification data products over oceanic, coastal, and inland waters," *Remote Sens. Environ.*, **282**, 113233, 2022. <https://doi.org/10.1016/j.rse.2022.113233>



# NOAA-Dedicated VIIRS Ocean Color Cal/Val Activities (2011–present)



# Reports of the NOAA Dedicated Ocean Color Cal/Val Cruises



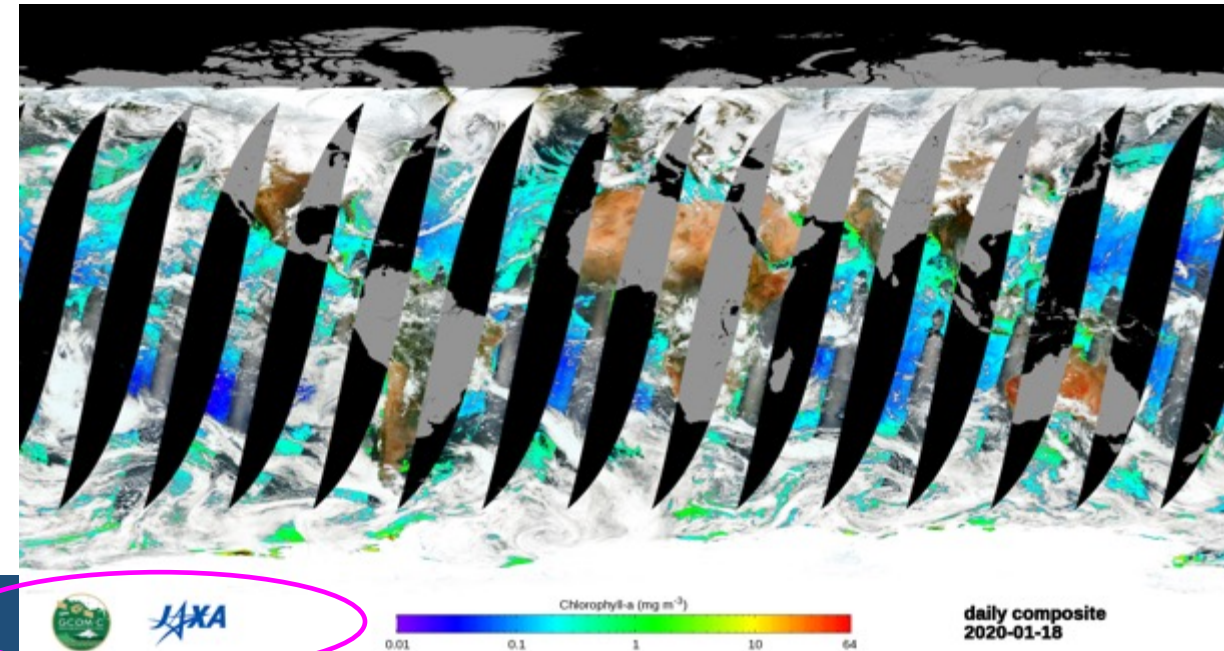
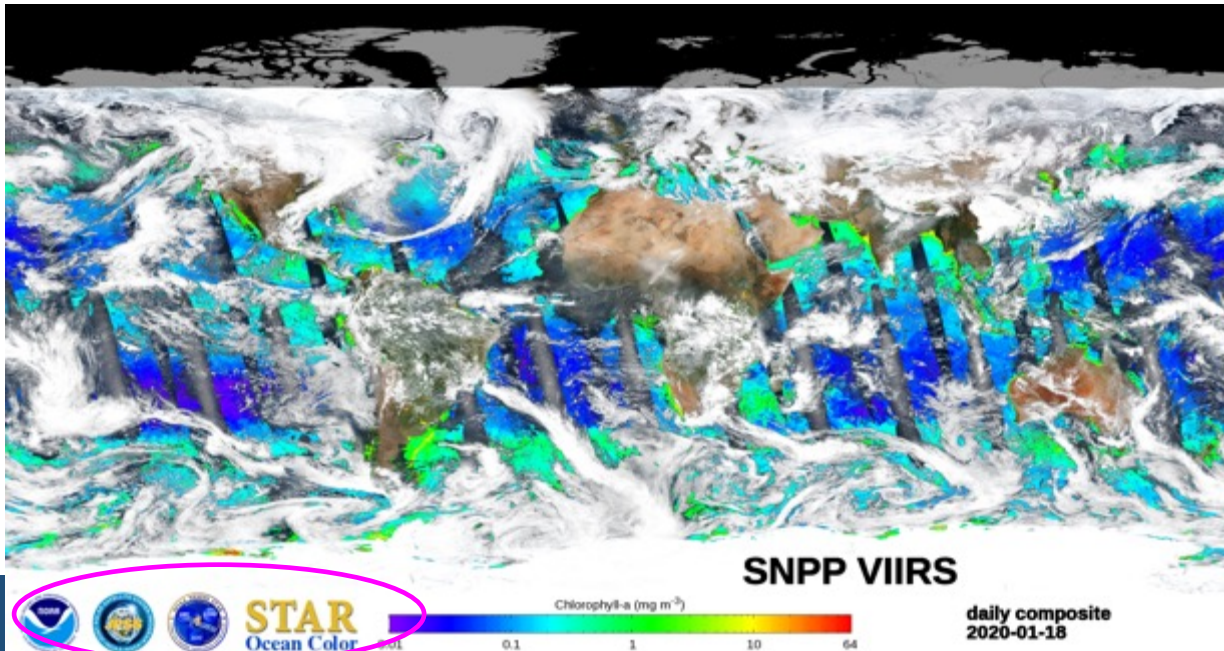
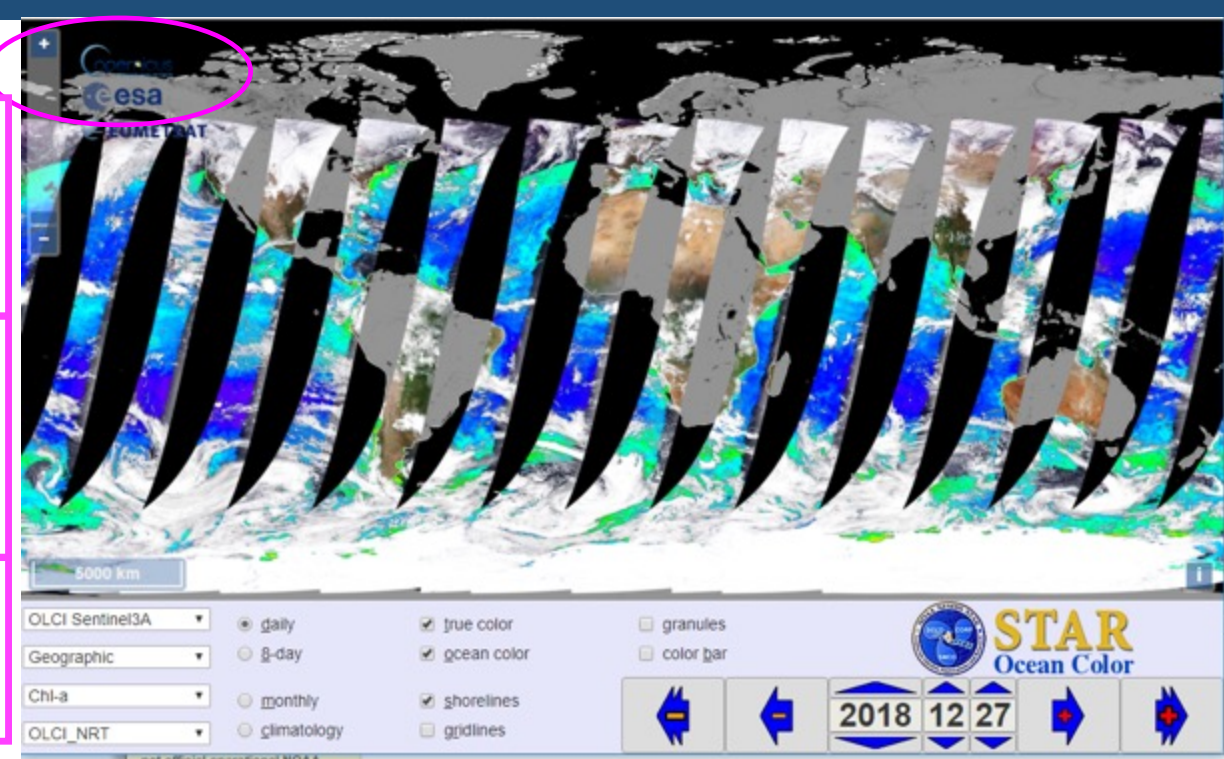
- Ondrusek, M., M. Wang, E. Stengel, C. Kovach, A. Gilerson, E. Herrera, M. Malinowski, J. I. Goes, H. do R. Gomes, K. McKee, C. Hu, J. Cannizzaro, D. English, S. Ladner, W. Goode, N. Tuffillaro, and I. Lalovic, “Report for Dedicated JPSS VIIRS Ocean Color Calibration/Validation Cruise: Gulf of Mexico in April 2021,” *NOAA Technical Report NESDIS 157*, J. Wei (ed.), NOAA National Environmental Satellite, Data, and Information Service, Silver Spring, Maryland, October 2022. <https://doi.org/10.25923/x2q6-9418>



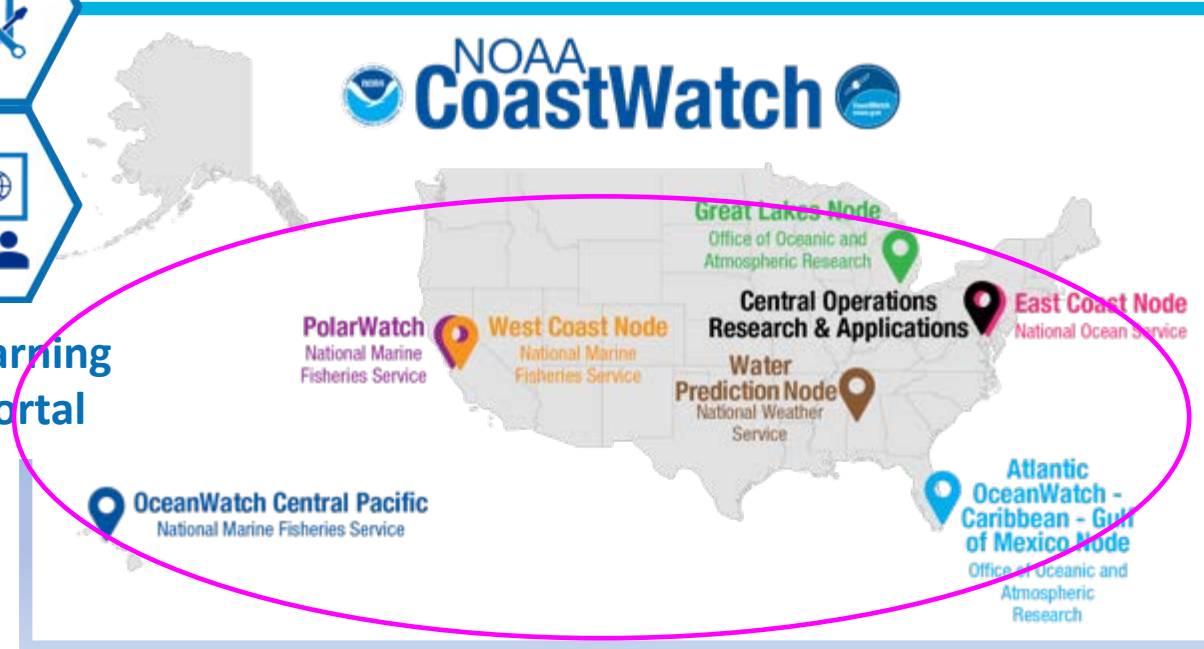
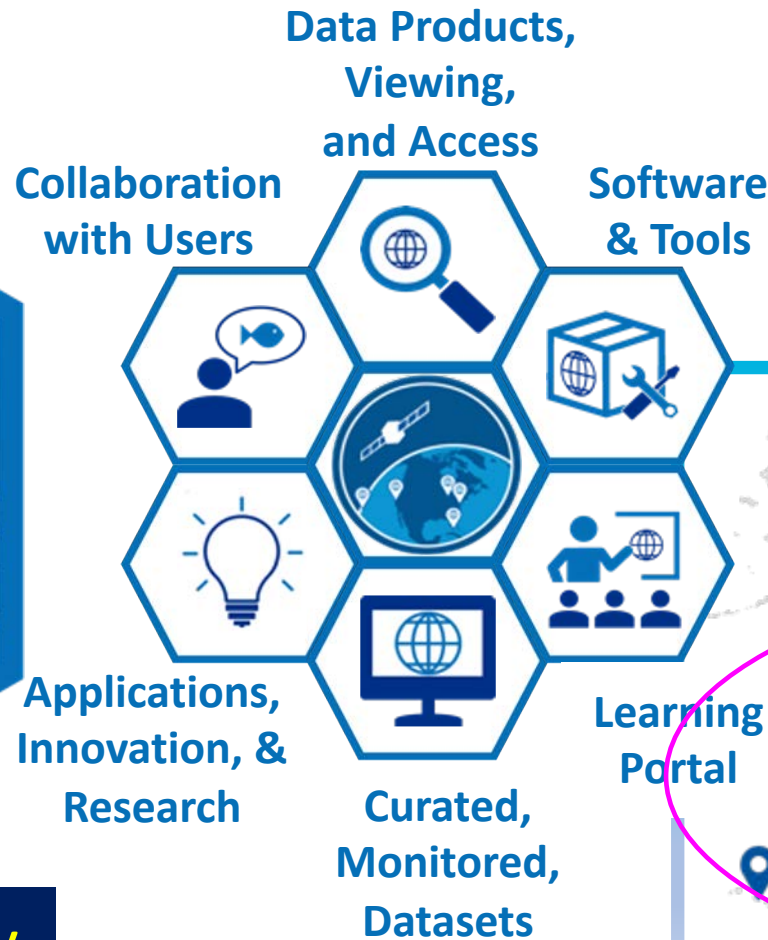
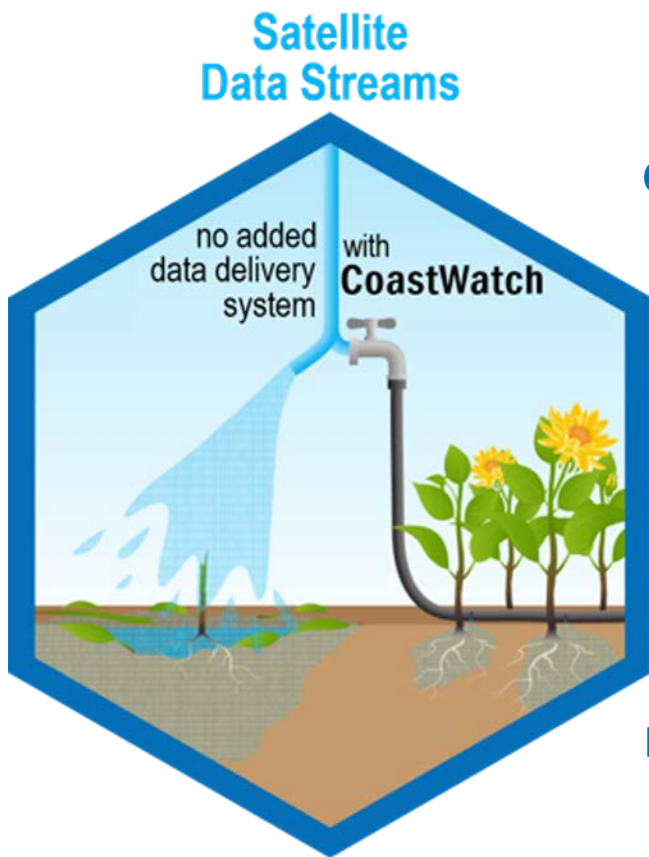


# International Collaborations

- Leveraging international data and services for mutual benefits:
- NOAA is primary US distributor for Copernicus Marine Data from Sentinels
- Actively involving various ocean color related activities with NASA, EUMETSAT, ESA, JAXA, JRC, KIOST, KHOA, and other international space agencies and organizations
- **NOAA OCView**
  - OLCI (EUMETSAT) and SGLI (JAXA) ocean color & true color imageries
  - Routine ocean color data/images of VIIRS SNPP, NOAA-20, VIIRS-NOAA-21, OLCI-S3A/S3B, SGLI-GCOM-C, and GOCI
  - Routine Cal/Val results and performance monitoring for VIIRS, OLCI, SGLI, GOCI, etc.
- **NOAA CoastWatch**
  - Produces routine L3 for Mediterranean for EUMETSAT operational use
  - Hosts several satellite ocean color and true color imageries/data
  - Satellite data distributions

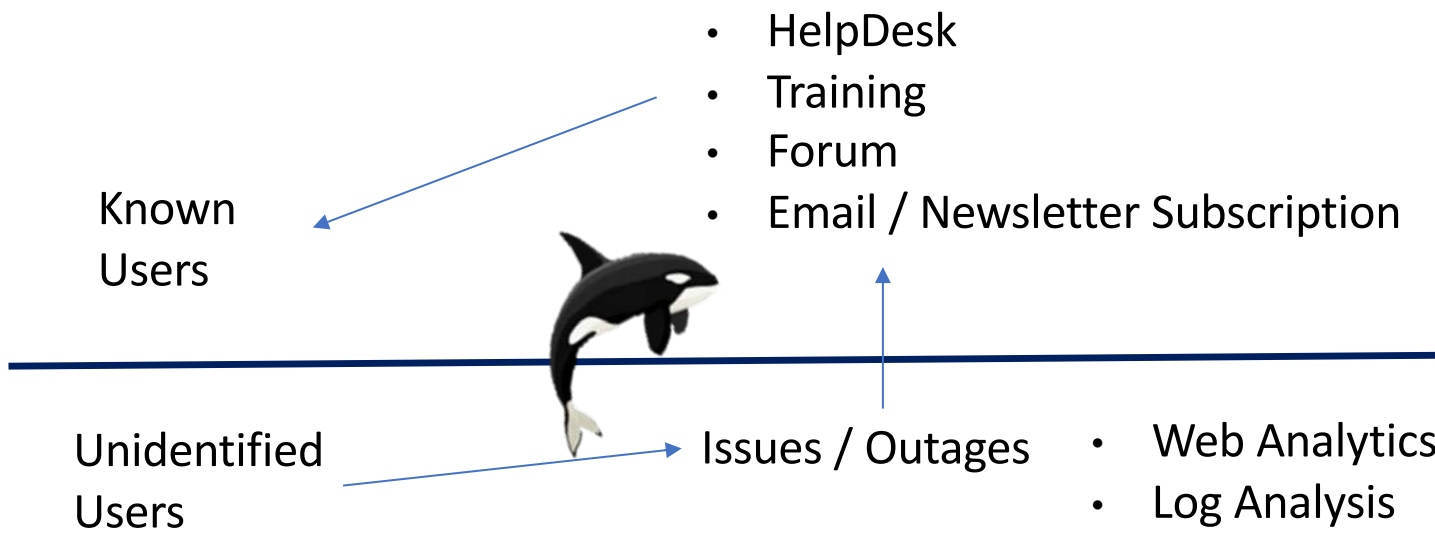


NOAA CoastWatch exists to help people find, choose, access, and use satellite data in applications and decision-making for ocean, coastal, and fresh waters.

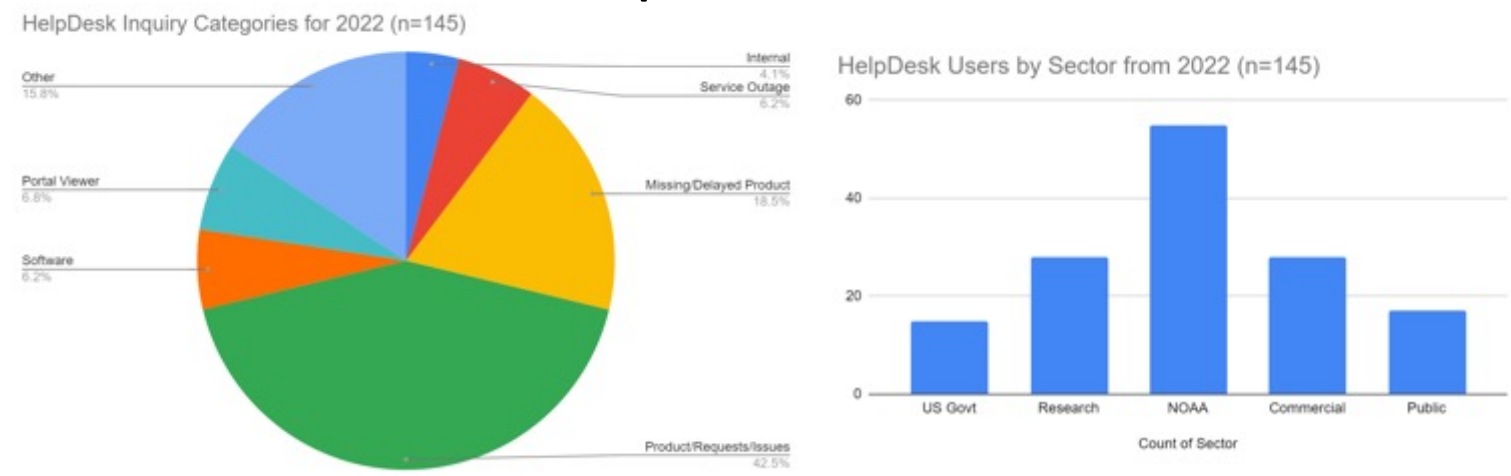


[coastwatch.noaa.gov](https://coastwatch.noaa.gov)





## 2022 Help Desk Statistics



CoastWatch HelpDesk: [CoastWatch.Info@NOAA.gov](mailto:CoastWatch.Info@NOAA.gov)  
 Online public user forum: <https://vlab.ncep.noaa.gov/web/coastwatch>

# CoastWatch water quality data add value to ~\$400M aquaculture industry.

*U.S. marine aquaculture is valued at \$397M, bivalve shellfish (clams, oysters, mussels) production total \$325M<sup>1</sup>.*



### What is an Aquaculture Opportunity Area?

Aquaculture Opportunity Areas show high potential for commercial aquaculture. A science and community-based approach to identifying these areas helps minimize interference with other enterprises, account for current fishing patterns, and protect the ecosystem.

- ADAs will expand important economic opportunities in coastal and rural areas, and increase our nation's seafood security.
- ADAs use the best available science to find appropriate space for sustainable aquaculture. Farms in ADAs will still need to go through the permitting process and environmental reviews.
- ADAs minimize interactions with other users, such as shipping, fishing, and the military.

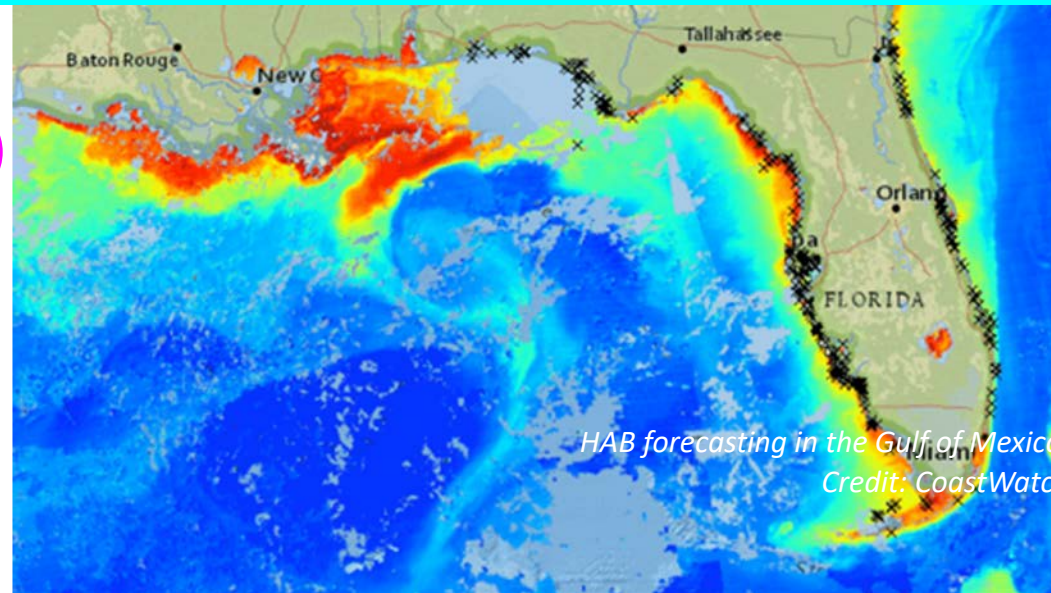
### Assessment and Use of ADAs

Stakeholder input is essential in the design and location of ADAs and NOAA expects these areas will be shaped through a public process that allows constituents to share their community and stewardship goals, as well as critical insights. ADA size, exact location, and farm types will be determined through spatial analysis and public input to expand sustainable domestic seafood production while minimizing potential user conflicts.

Learn more: [fisheries.noaa.gov/topic/aquaculture](https://fisheries.noaa.gov/topic/aquaculture)

**Harmful Algal Blooms (HABs) are estimated to cost the seafood sector ~\$20M annually<sup>2</sup>, particularly impacting the shellfish sector**

Development of **Aquaculture Opportunity Areas (AOAs)** are underway under EO 13921<sup>3</sup>, and CoastWatch satellite data is expected to support increasing needs for **monitoring** and **threat forecasting** for AOAs, as well as informing their **screening** and **siting**.



CoastWatch data currently provide valuable information for **monitoring** and **managing** the effects of HABs on shellfish aquaculture in many parts of the country, as well as informing **siting** of new farm operations. *More applications in slide "notes."*

<sup>1</sup>FUS 2018; <sup>2</sup>Hoagland et al. 2000; <sup>3</sup>EO 13921



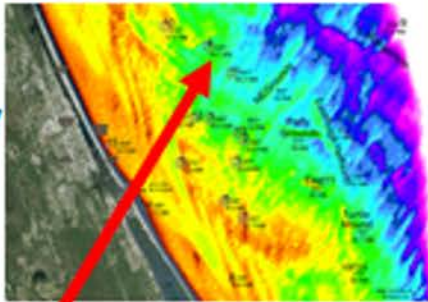


# Florida research divers use daily satellite water clarity for sampling biology at artificial reefs



Artificial reefs constructed to enhance local commercial and recreational fisheries

Coastal Bathymetry at Daytona Beach



Old ships sunk to be reefs

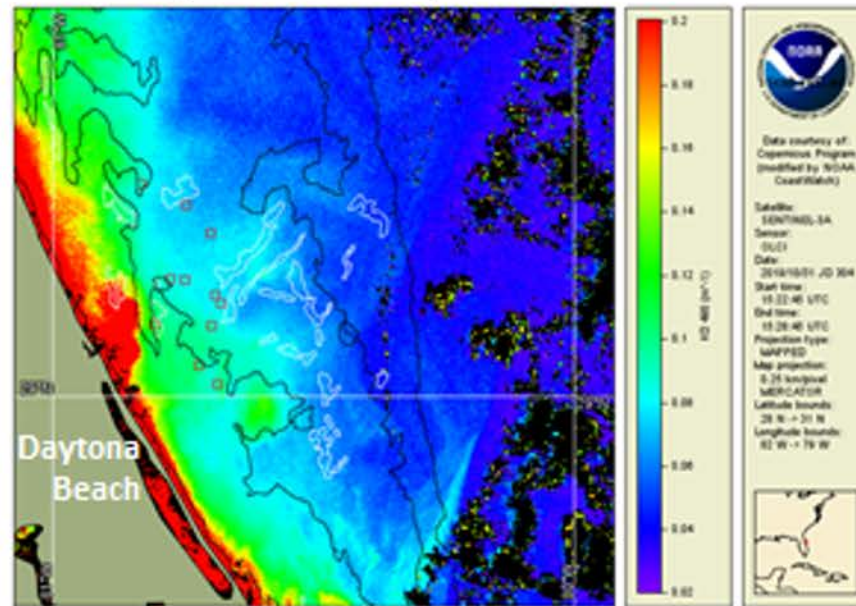
Volunteer divers compare restoration of biological activity at artificial vs. natural reefs



Satellite water clarity provides information for daily go-no-go dive decision

## ScubaViz.us

Science and Technology for Divers



Customized image for divers

Sentinel-3A OLCI Kd490

Oct 31, 2019

Engaged Application Development

NOAA CoastWatch East Coast Node

- Provides water clarity products from multiple sensors: OLCI, VIIRS, MODIS
- Runs experimental algorithms, AM & PM orbits, multiple spatial resolutions
- Works collaboratively to meet latency, accuracy, resolution, coverage needs

CSD Solutions, LLC

- Developed ScubaViz website to support dive planning and operations
  - Latest near real-time satellite Kd490 customized image
- Compares water clarity products from multiple sensors against in-water observations (qualitative assessments)
- Feedback on product improvements



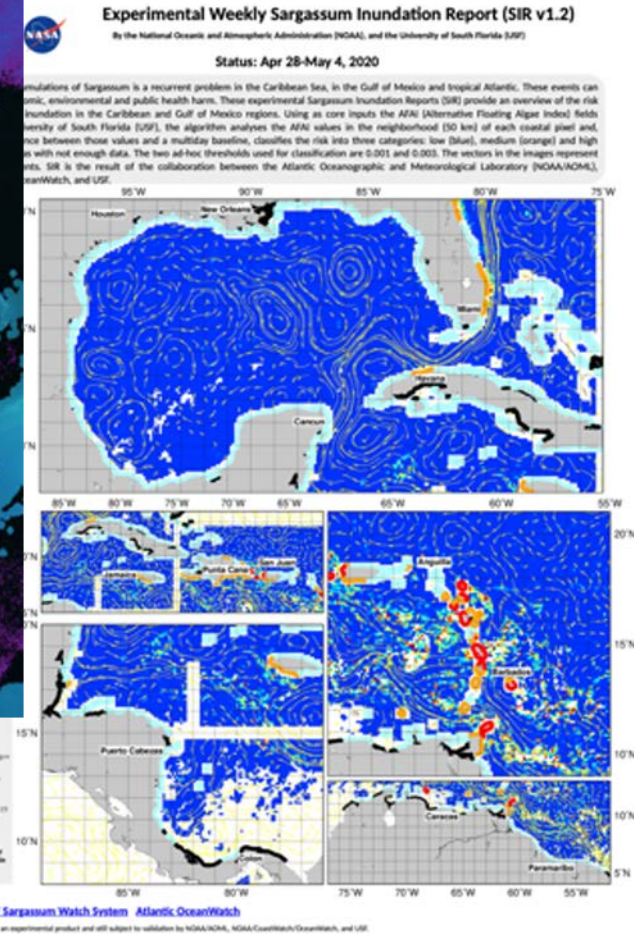
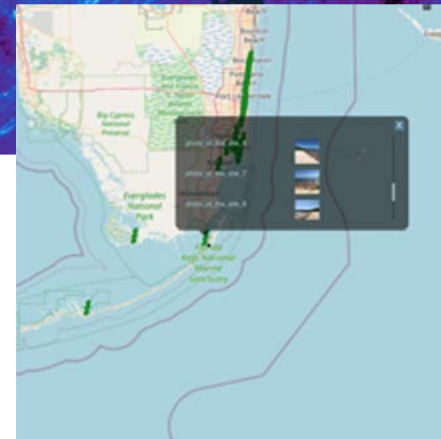
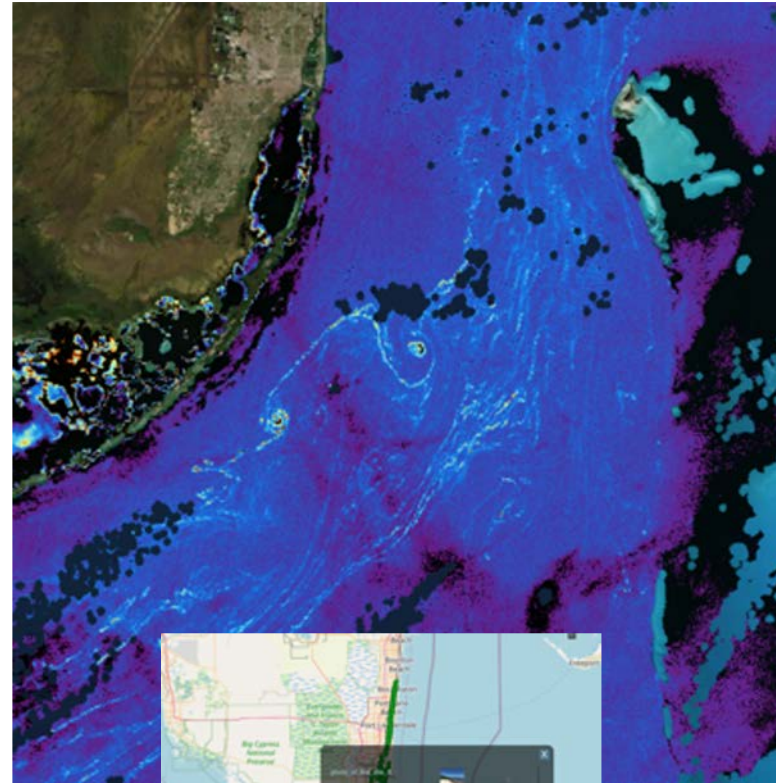
# CGM-AOW monitors, tracks, and reports *Sargassum* inundation for coastal communities.

Caribbean, Gulf of Mexico,  
Atlantic OceanWatch Node  
(CGM-AOW)

**Impact/Importance:** Since 2011, massive amounts of *Sargassum* are arriving to the Caribbean and Gulf of Mexico, and have major economic, social, environmental and public health impacts, disrupting tourism, fishing, shipping and coastal ecosystems.

**Criticality:** CGM-AOW provides unique satellite-based operational capabilities for *Sargassum* detection, an integrated database for ground truth observations based on citizen science, and the *Sargassum* Inundation Reports to evaluate the risk associated with the arrival of *Sargassum* to the coastal area.

Partnership with **CariCOOS, OAR, USF** and **IOCARIBE**



# West Coast Node produces advanced forecasts of harmful algal probability in US West Coast waters.

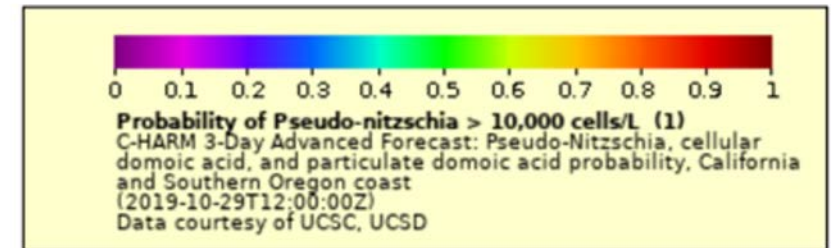
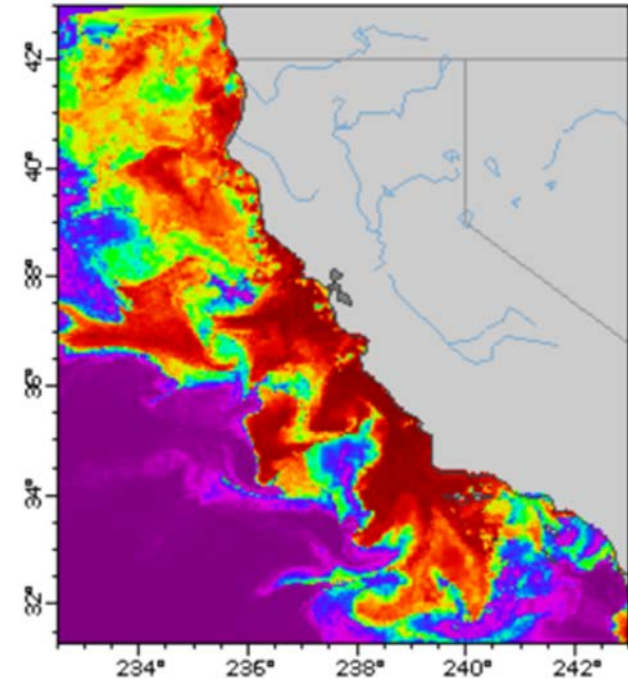
West Coast Node produces a nowcast plus 1-, 2-, and 3-day forecasts from C-HARM<sup>1</sup>, a model that predicts harmful alga (*Pseudo-nitzschia*) and toxin (domoic acid) occurrence in California and Oregon coastal waters. The model uses satellite chlorophyll and remote sensing reflectance data.

**Criticality:** For protection of human health and wildlife health, and for protection and management of shellfish aquaculture

*Courtesy: Dale Robinson, West Coast Node*

*Developed in collaboration with Clarissa Anderson, Raphael Kudela, UC Santa Cruz, Central California Ocean Observations, Southern California Coastal Ocean Observing System:*

<https://coastwatch.pfeg.noaa.gov/erddap/griddap/charmForecast3day.graph>

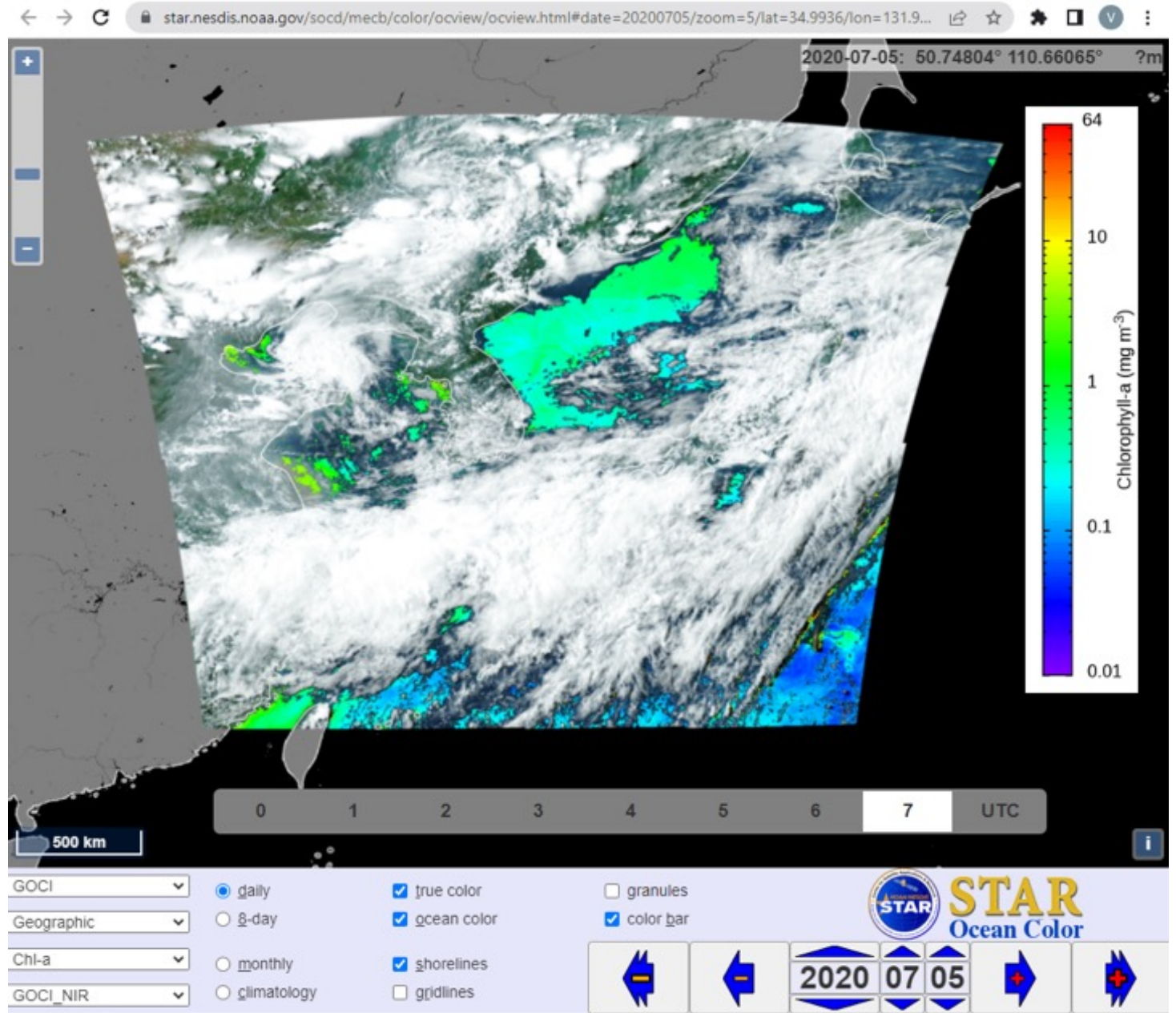


<sup>1</sup>California Harmful Algae Risk Mapping

# OceanWatch Central Pacific Node is using GOCI geostationary data (processed with NOAA-MSL12) for GeoXO Proving Ground/Risk Reduction Pilot Study

**Sensitivity of reef-relevant water-quality indices to satellite data resolution**

Hui Shi<sup>1,2</sup>, Justin Suca<sup>1</sup>, and Ryan Rykaczewski<sup>2,3</sup>





# UN Environment Sustainable Development Goal: Coastal Eutrophication Indicators

## Indicator 14.1.1

Index of coastal eutrophication and floating plastic debris density



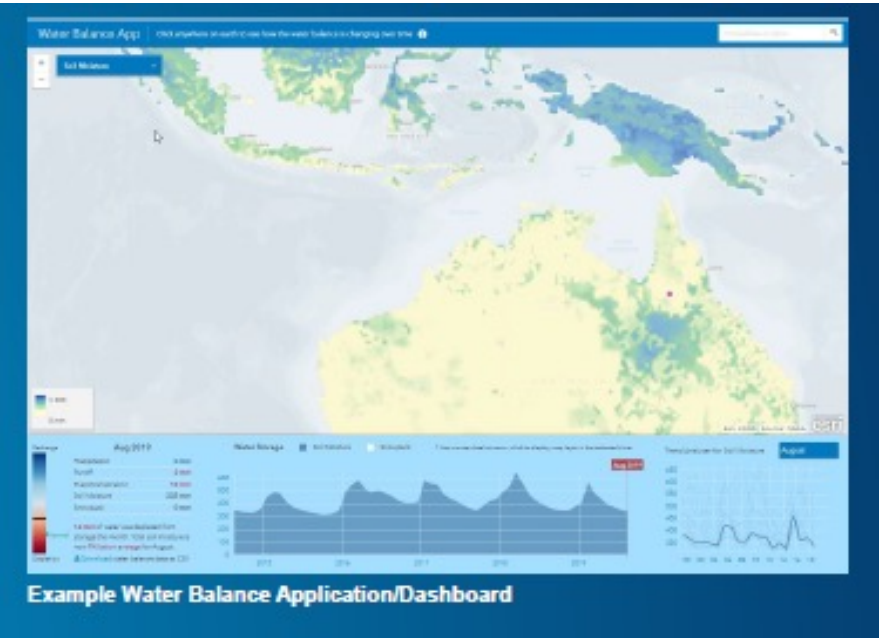
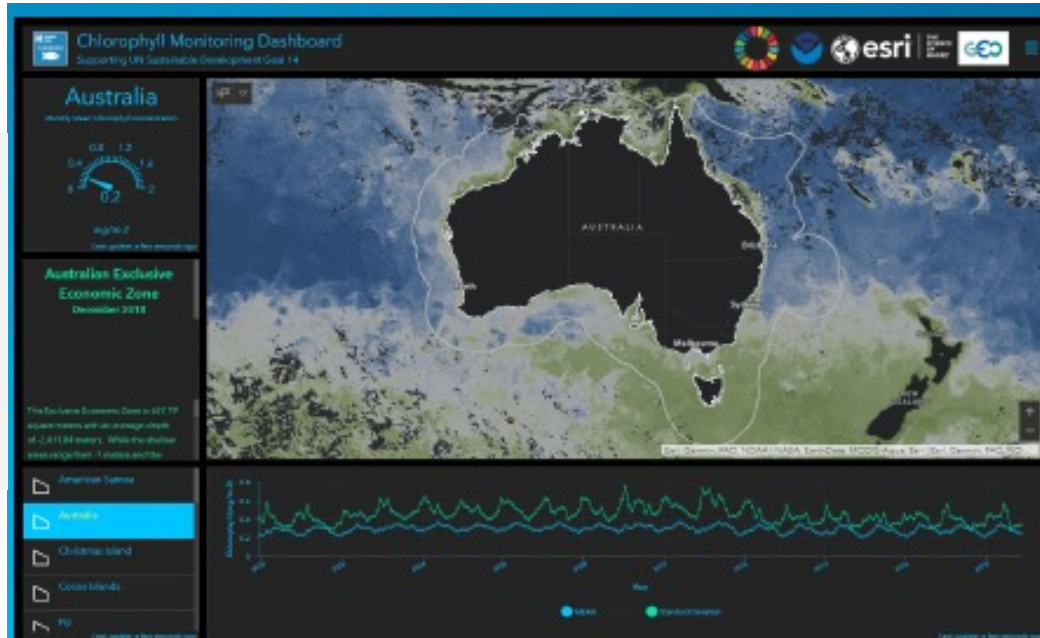
### • 14.1.1a: Index of Coastal Eutrophication (ICEP)

#### 1. Percentage of coastal zone with Chl-a deviations

- ESA Ocean Colour CCI (OC\_CCI) product, led by the Plymouth Marine Laboratory (PML): consistent, merged chlorophyll-a product from SeaWiFS, MODIS, MERIS and VIIRS, spanning 1997 to 2018.

#### 2. Intra-annual coastal zone chlorophyll-A anomalies

- NOAA VIIRS chlorophyll-a anomaly products: 1) the difference anomaly and 2) the anomaly ratio, both calculated using a running 61-day Chl-a median.



**VIIRS, OLCI, and SGLI Global Images and Cal/Val:**  
**<https://www.star.nesdis.noaa.gov/sod/mecb/color/>**



**[CoastWatch.NOAA.gov](https://www.coastwatch.noaa.gov)**

CoastWatch HelpDesk: [CoastWatch.Info@NOAA.gov](mailto:CoastWatch.Info@NOAA.gov)

Online public user forum: <https://vlab.ncep.noaa.gov/web/coastwatch>

***Thank You!***

