



NOAA CoastWatch/OceanWatch/PolarWatch: Aiding Value-Chain Transitions from Data to Applications

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And the

NOAA CoastWatch/OceanWatch/PolarWatch Team

NOAA/NESDIS/STAR

Seminar Series

20 November 2019

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NOAA CoastWatch/OceanWatch/PolarWatch Program*



Questions

- Where are the gaps in operational satellite ocean/coast/water data or data products?
- What barriers to access and use are perceived by stakeholders?
- How do we fill these gaps and bridge these barriers?
- Where are the opportunities for expanding the number and types of applications that could benefit from satellite data?



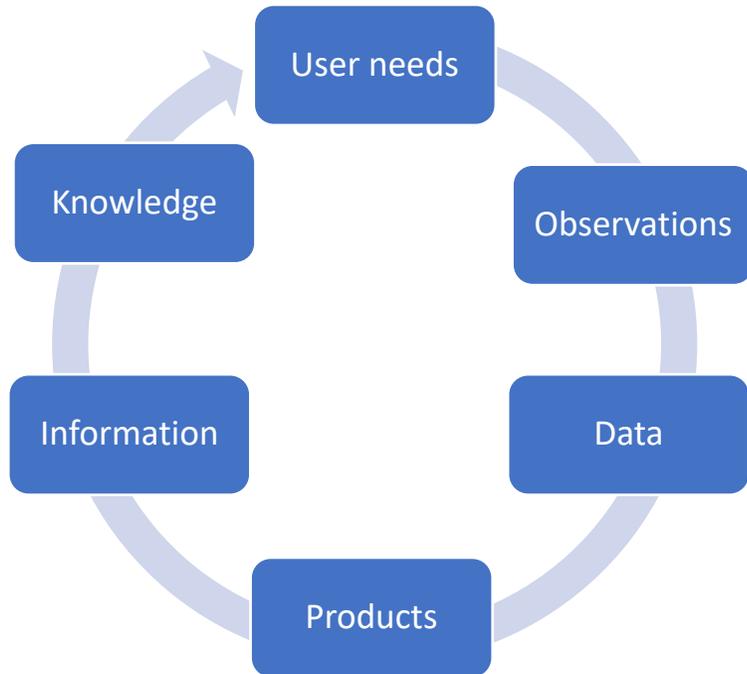
Outline

- What is the “value chain”?
- What is “moderate assurance” operational satellite oceanography?
- What ocean/coastal/inland water observations can we get from satellites?
- What is NOAA CoastWatch/OceanWatch/PolarWatch
- What are our future directions, challenges, and opportunities?
- How are we aiding in the use of satellite data for applications, decisions and social benefit?

STAR scientists have roles as both
“users” and “providers”



Value Chain of Data, Products, Information, Knowledge



Data (~from bytes to geophysical parameters)

Data Products (~from swath/granule to merged, mapped, anomalies, etc.)

Information (such as combine data types, outside information, get the full picture)

Knowledge (*to inform actions*)

There are gaps

Expanding the “operational” paradigm

- Routine and sustained provision of accurate, consistent, mature and fit for purpose, well-described, discoverable and accessible oceanographic satellite observations spanning different time-scales (i.e., NRT to climate) for multiple uses (e.g., research, applications and services) that lead to decisions and actions.
- Can be high assurance/high-service, or **moderate assurance/moderate-service**



Expanding the “operational” paradigm

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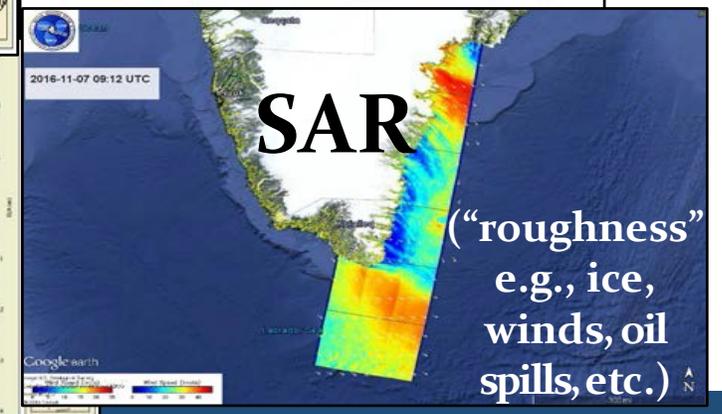
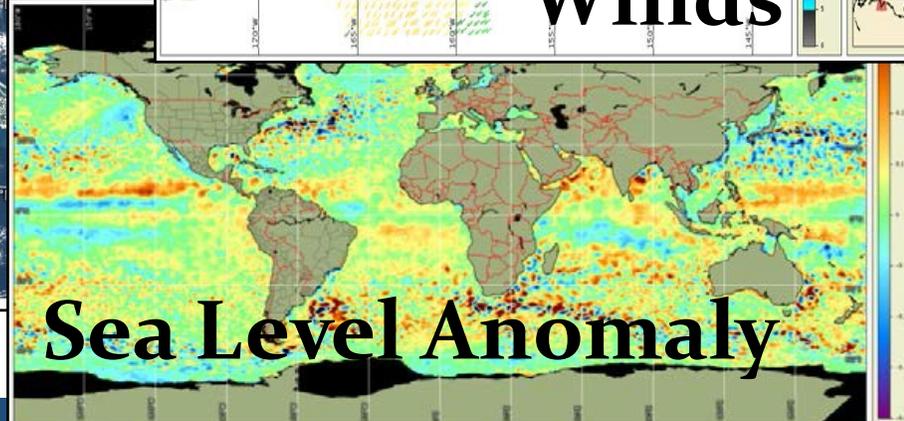
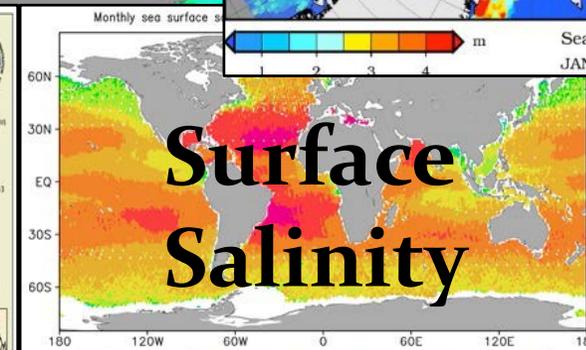
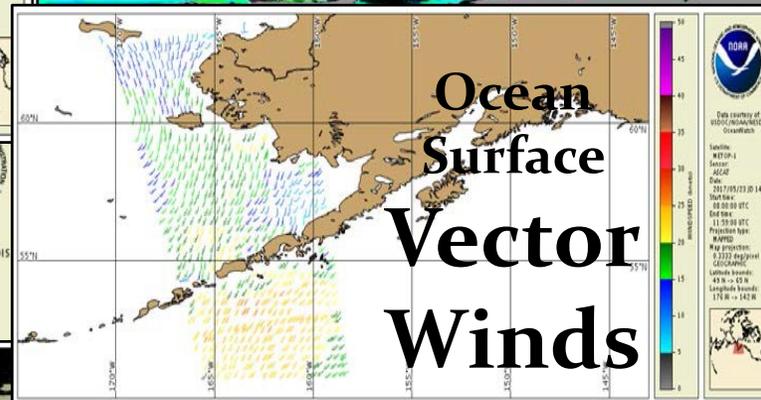
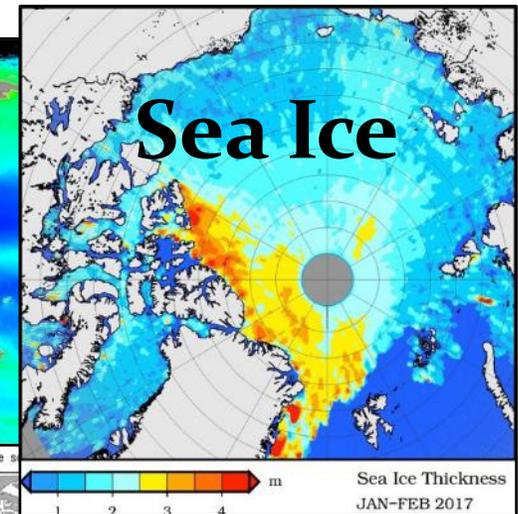
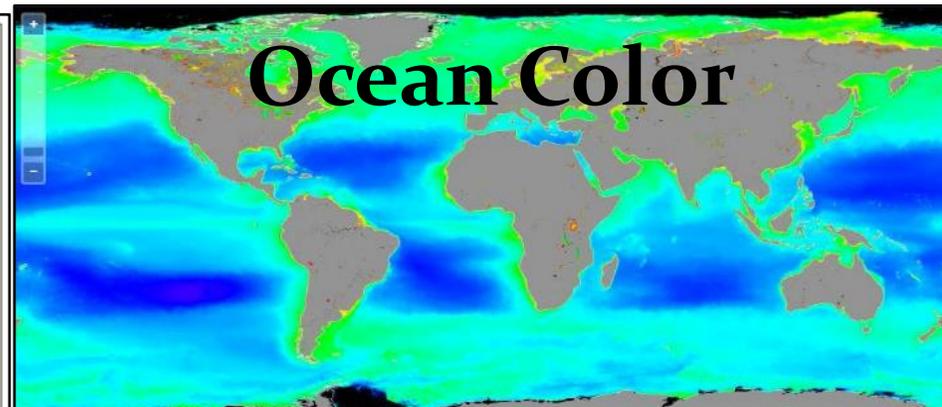
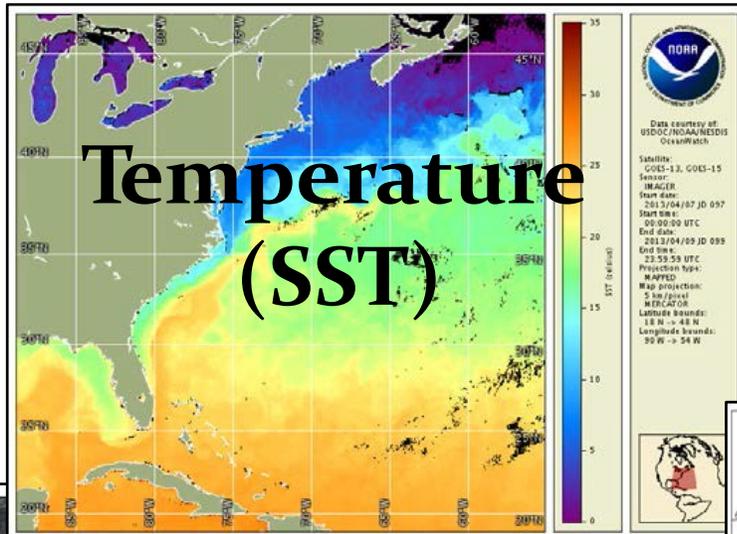
“Fit for Purpose”

- Can be high assurance/high-service, or moderate assurance/moderate-service

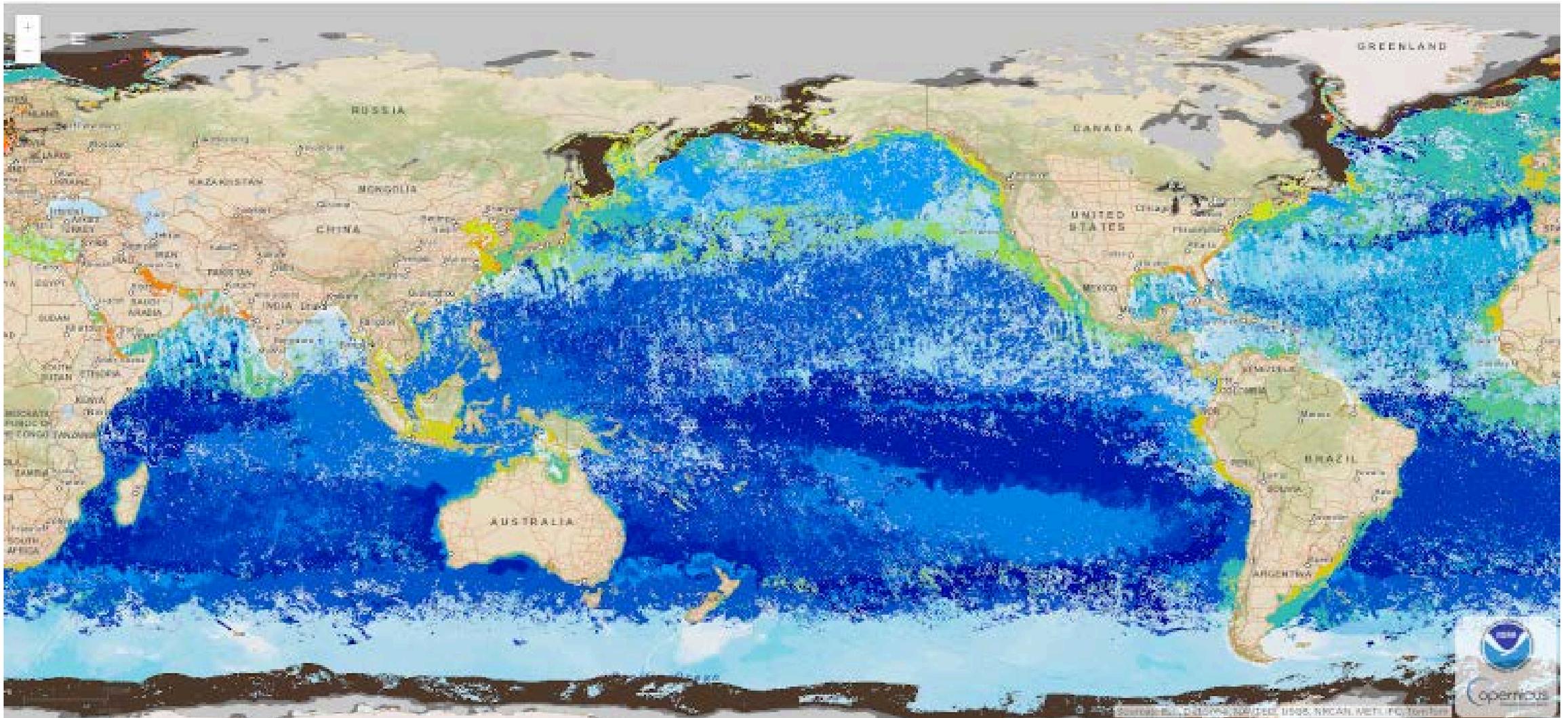
Moderate Assurance



Ocean (Water) Parameters from SPACE



Satellite input - Model output: e.g., Seascapes Product



<https://coastwatch.noaa.gov/cw/satellite-data-products/multi-parameter-models/seascape-pelagic-habitat-classification.html>



Satellite input - Model output: e.g., Seascapes Product

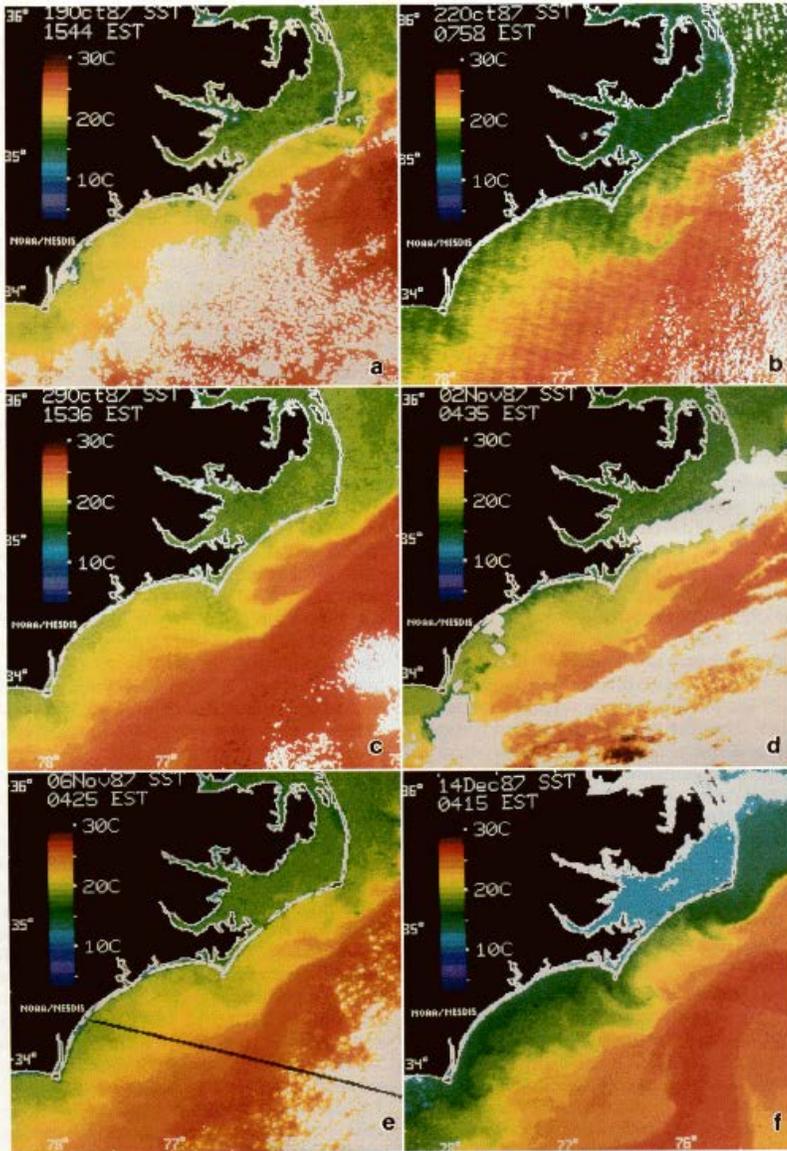
US and global Marine Biodiversity Observation Network (MBON) scientists (Kavanaugh, Muller-Karger and others) partnered with US Integrated Ocean Observation System (IOOS), NOAA/OAR/AOML and NOAA/NESDIS/STAR (NOAA CoastWatch/OceanWatch)



<https://coastwatch.noaa.gov/cw/satellite-data-products/multi-parameter-models/seascape-pelagic-habitat-classification.html>



History of CoastWatch



1987, Unprecedented HAB in NC. Satellite SST points to likely source.

Fig. 2. Satellite image of sea-surface temperature of Raleigh and Onslow Bays. The advanced, very high-resolution radiometer (AVHRR) was flown on the NOAA-9 and NOAA-10 polar-orbiting weather satellites. White areas are cloud cover. Black line in panel e covers missing data. Note the filament of Gulf Stream water (24°–25°C) near Cape Lookout that remained intact from the 19 October to 6 November images. All from NOAA-9 except panel b from NOAA-10.

Limnol. Oceanogr., 36(5), 1991, 1053–1061
© 1991, by the American Society of Limnology and Oceanography, Inc.

An expatriate red tide bloom: Transport, distribution, and persistence

Abstract—In November 1987, the toxic dinoflagellate *Gymnodinium breve* bloomed in North Carolina nearshore waters. This occurrence was the first record of *G. breve* north of Florida, a range extension of > 800 km. We propose the (Gulf of Mexico) Loop Current-Florida Current-Gulf Stream system as the transport mechanism for *G. breve* cells from a late summer bloom off the southwest coast of Florida (Charlotte Harbor–Sarasota). The estimated transit time for cells around the peninsula and northward to the continental shelf off North Carolina is 22–54 d.

About 30 d after the Charlotte Harbor–Sara-

sota bloom, satellite images of sea-surface temperature substantiated the shoreward movement of a filament of Gulf Stream water onto the narrow continental shelf between Cape Hatteras and Cape Lookout. This filament, the likely source of *G. breve* cells, remained in nearshore waters and was identifiable in satellite images for >19 d. Once the bloom was inshore, both windspeed and direction were important in determining its distribution.

The toxic dinoflagellate *Gymnodinium breve* (Davis 1948) (formerly *Ptychodiscus*

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Morehead City 28557

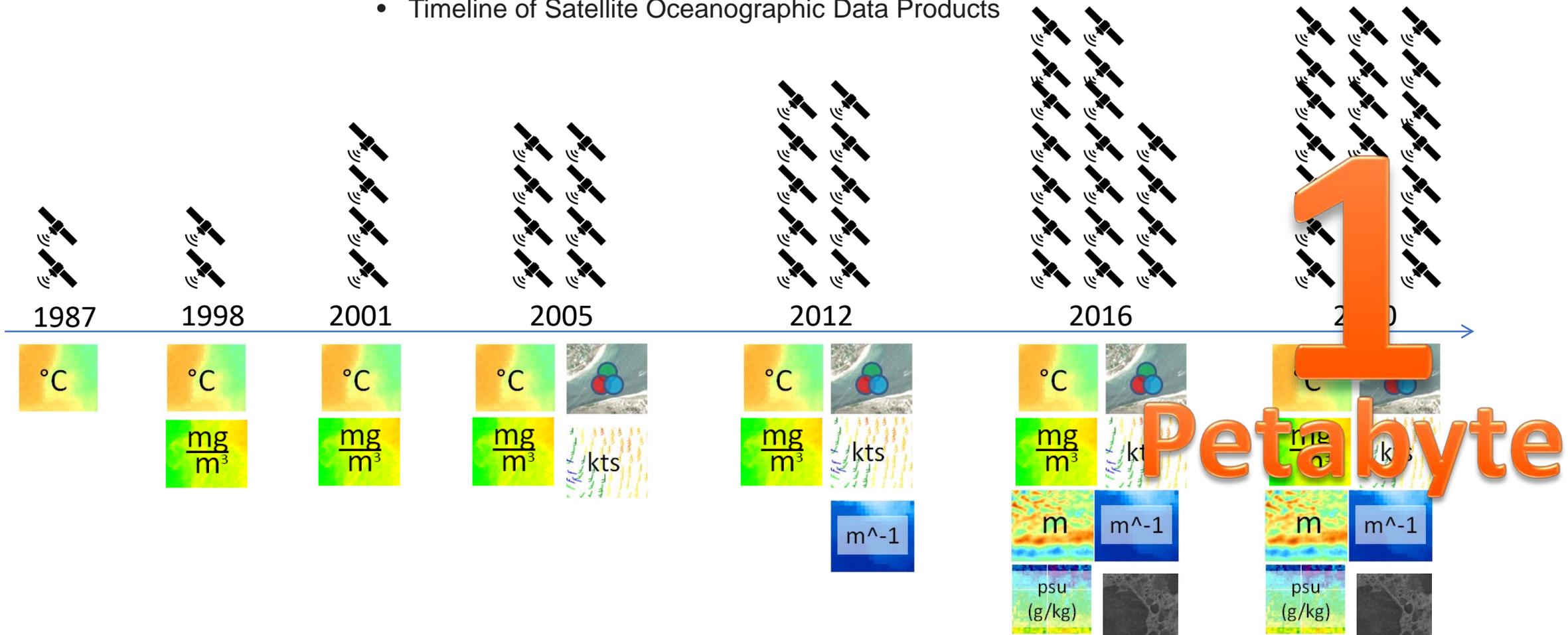
Jefferson T. Turner

Biology Department
Southern Massachusetts University
North Dartmouth 02747



CoastWatch/OceanWatch Data

- Timeline of Satellite Oceanographic Data Products



NOAA CoastWatch/OceanWatch/PolarWatch Free and Open Data/Products

Aid in the use of ocean /aquatic satellite data along the value chain from observations to decision-making

- Data Search and Access
- Product Descriptions
- Value added product development and distribution
- Data monitoring (quality/quantity)
- Transition new products
- Outreach, training, education
- User engagement
- Feedback to satellite science

The screenshot shows the NOAA CoastWatch website. At the top, there is a navigation menu with links for Home, Satellite Data Products, Field Observations, Data Quality, Nodes, User Resources, Stories, and About. Below the menu is the NOAA logo and the text 'The National Oceanic and Atmospheric Administration'. To the right, there is a search bar and a dropdown menu for 'NOAA CoastWatch • OceanWatch' with radio buttons for 'CoastWatch' and 'NOAA', and a 'Submit' button. Below the search bar, there is a link to 'Need Help? Contact the Help Desk:' with an email address '(301) 683-3335'. The main content area features a large satellite data visualization of the world's oceans, with a 'Latest News' box on the right containing a notice about the '1st International Operational Satellite Oceanography Symposium' on June 18-19, 2019. Below the main visualization, there is a section titled 'Satellite data products for understanding and managing our oceans and coasts' with three smaller images: a satellite view of a hurricane, a map of the Atlantic Ocean with the text '18-19 June 2019' and '1st International Operational Satellite Oceanography Symposium', and a coastal map of Florida with various locations marked.

CoastWatch.NOAA.gov



CoastWatch mission is to help users access and use satellite data



Provide access to datasets with data servers

Develop tools and tutorials to help users access and use data

Provide training and hands-on assistance

Find or create products in response to users needs

Work directly with users on projects

The CoastWatch Nodes are Value Added Providers



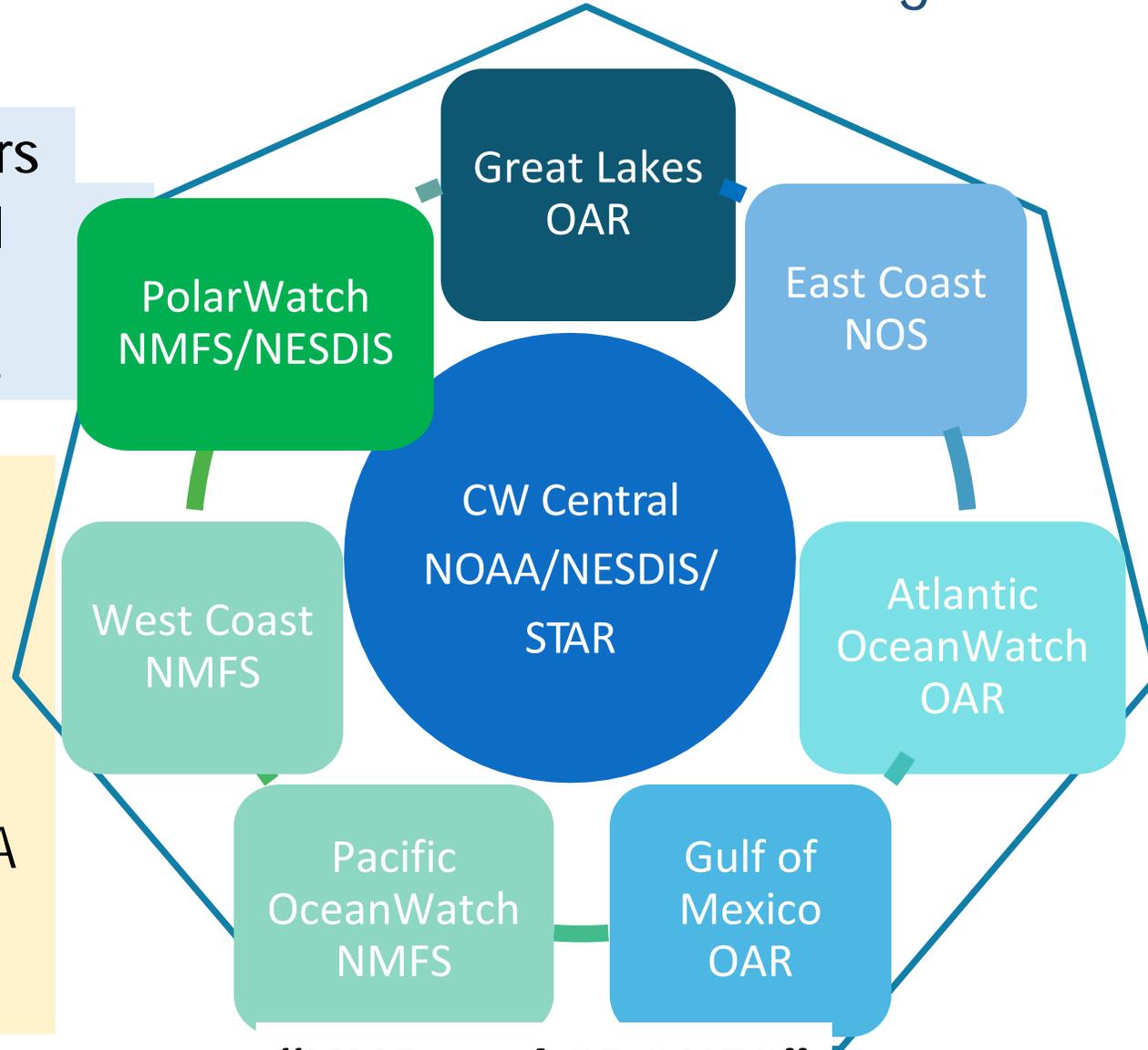
NOAA CoastWatch/OceanWatch/PolarWatch Program

NOAA Data Providers

- SOCD
- STAR
- OSPO
- NCEI
- OAR
- NWS

External Data Providers

- USGS
- NASA
- Copernicus; EUMETSAT; ESA (Sentinels)
- JAXA



“HUB and SPOKES”

NOAA Users

- OAR
- NESDIS
- NOS
- NMFS
- NWS
- OMAO

External Users

- Federal Agencies
- State Agencies
- Commercial
- Academia
- International
- General Public



Contact information for the nodes, central office and program



CoastWatch Central

Contact email and helpdesk
coastwatch.info@noaa.gov

Website
coastwatch.noaa.gov

CoastWatch/OceanWatch/PolarWatch Program

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Node Manager
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Great Lakes

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Node Manager
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Website
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Caribbean/Gulf of Mexico, Atlantic OceanWatch

Ops Manager
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Node Manager
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Node Manager
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East Coast

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coastwatch.info@noaa.gov

Node Manager
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coastwatch.info@noaa.gov

Website
eastcoast.coastwatch.noaa.gov

PolarWatch

Ops Manager
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jennifer.sevadjian@noaa.gov

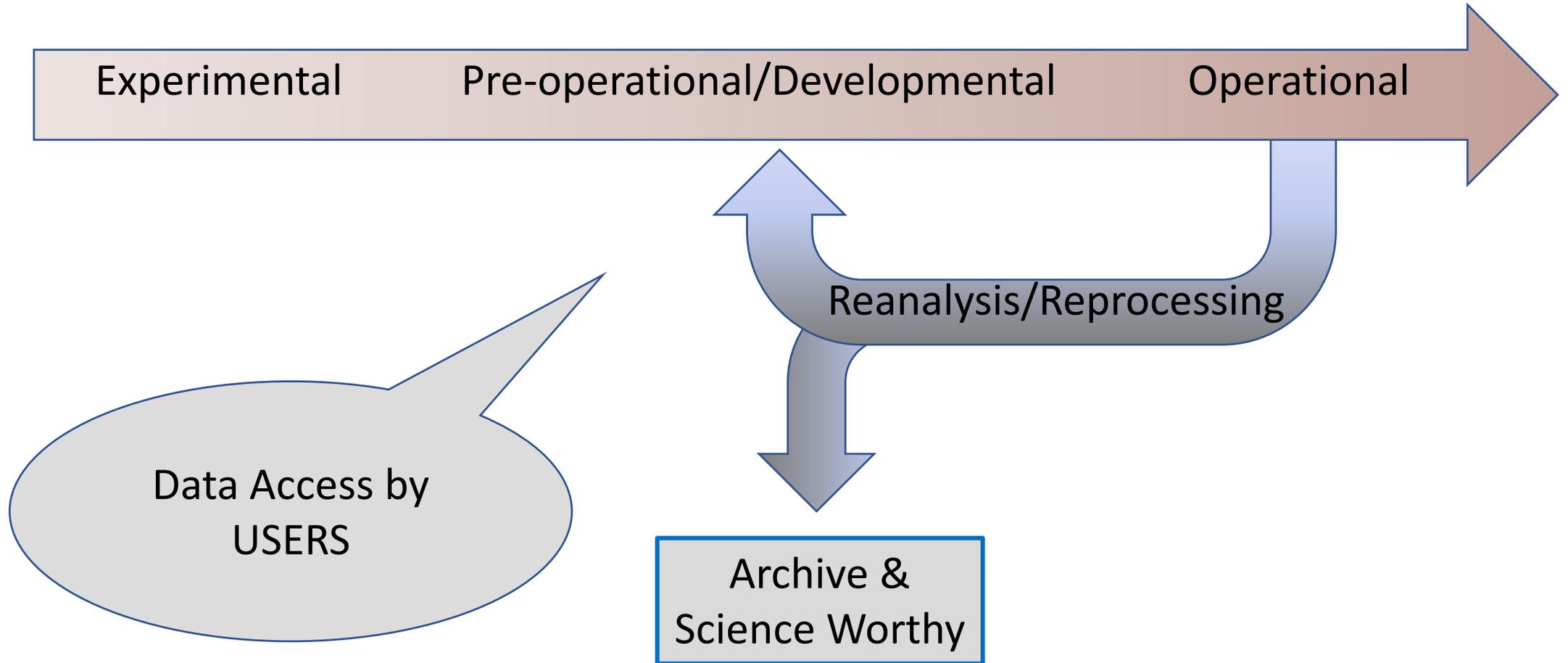
Node Manager
Cara Wilson

Node Manager
Dale Robinson

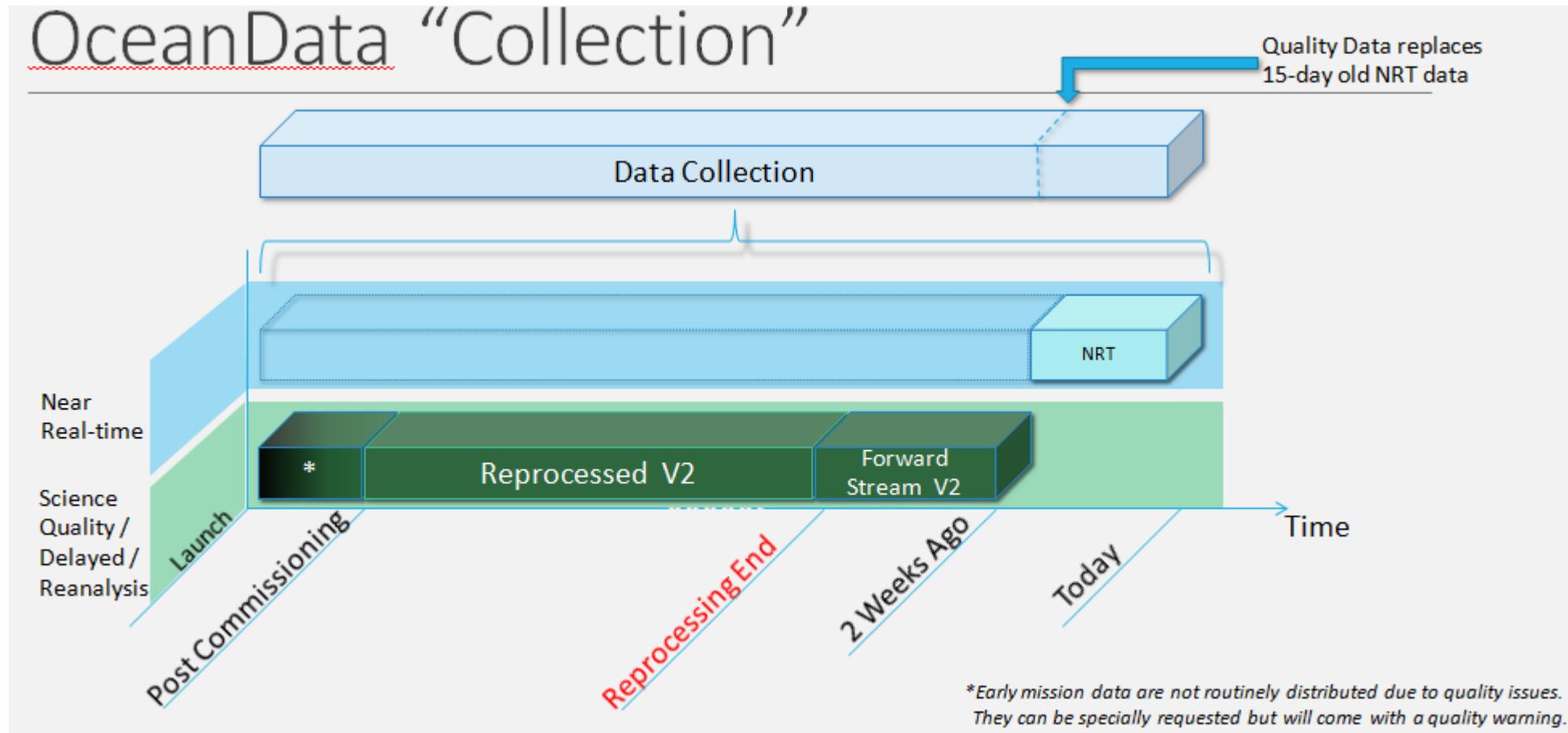
Website
polarwatch.noaa.gov



Typical Product Lifecycle



Collections



Consistent NRT & Science Quality Datasets

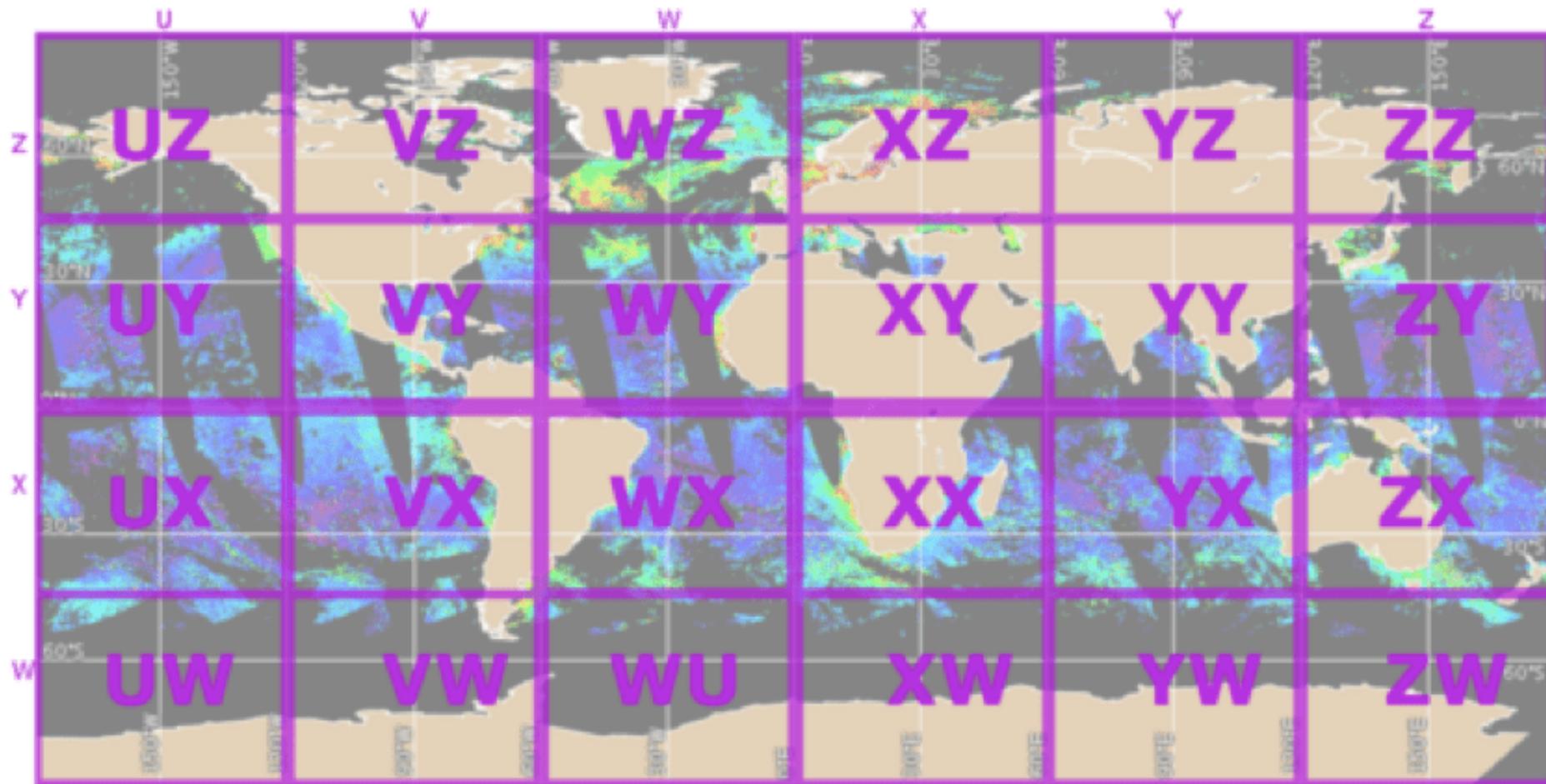
Example from NOAA MSL12 VIIRS Ocean Color

Attribute	Near-Real Time	Delayed-Mode/Science-Quality
Latency:	Best effort, as soon as possible (~12-24h)	Best effort, on a 2-week delay
Processing System:	MSL12 (v1.01; will transition to v1.2x)	MSL12 (v1.2x)
SDR:	IDPS Operational SDR	OC-improved SDR
Ancillary Data:	Global Forecast System (GFS) Model	Science quality (assimilated; GDAS) from NCEP
Spatial Coverage:	May be gaps due to various issues	Complete global coverage
Processed by:	OSPO (operational)	NOAA/STAR
Distributed by:	CoastWatch , OSPO	CoastWatch, NCEI
Archive Plans:	Yes, from OSPO to NCEI	Yes, from CoastWatch to NCEI
Full Mission Reprocessing:	No	Yes, every ~2-3 years or as needed



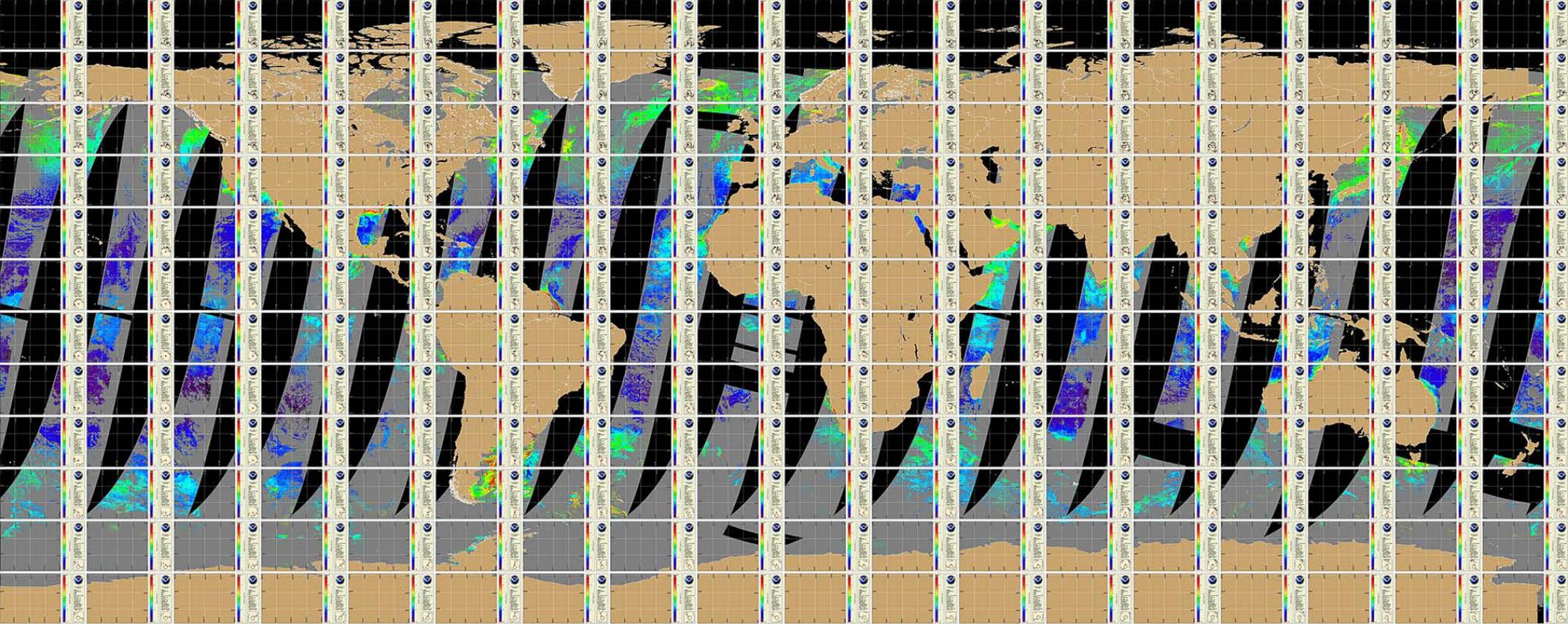
CoastWatch "Value Added" Products

Example: VIIRS Hi-Res Sectors Co-Located for Ocean Color and SST



CoastWatch "Value Added" Products

Example: : Hi-Res Sectors for OLCI S3 (=VIIRS x9)



Satellite Data Products Pages

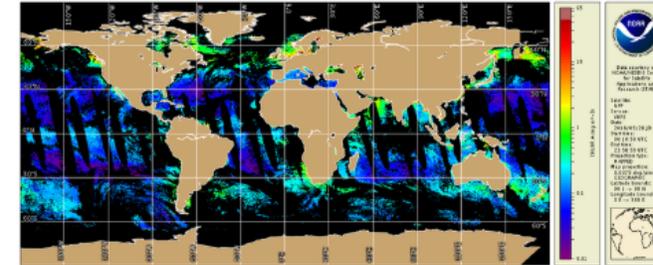
- Data Access
 - ERDDAP
 - THREDS
 - FTP
 - NRT
 - Science Quality, RAN or Delayed Mode
- Description text
- Standardized tabular product information
- Documentation

NOAA MSL12 Ocean Color - Science Quality - VIIRS

Satellite Data Products / Ocean Color (Chlorophyll, radiances, etc.) / Science quality / NOAA MSL12 Ocean Color - Science Quality

Updated: October 8, 2019

Data Access Description Information Documentation



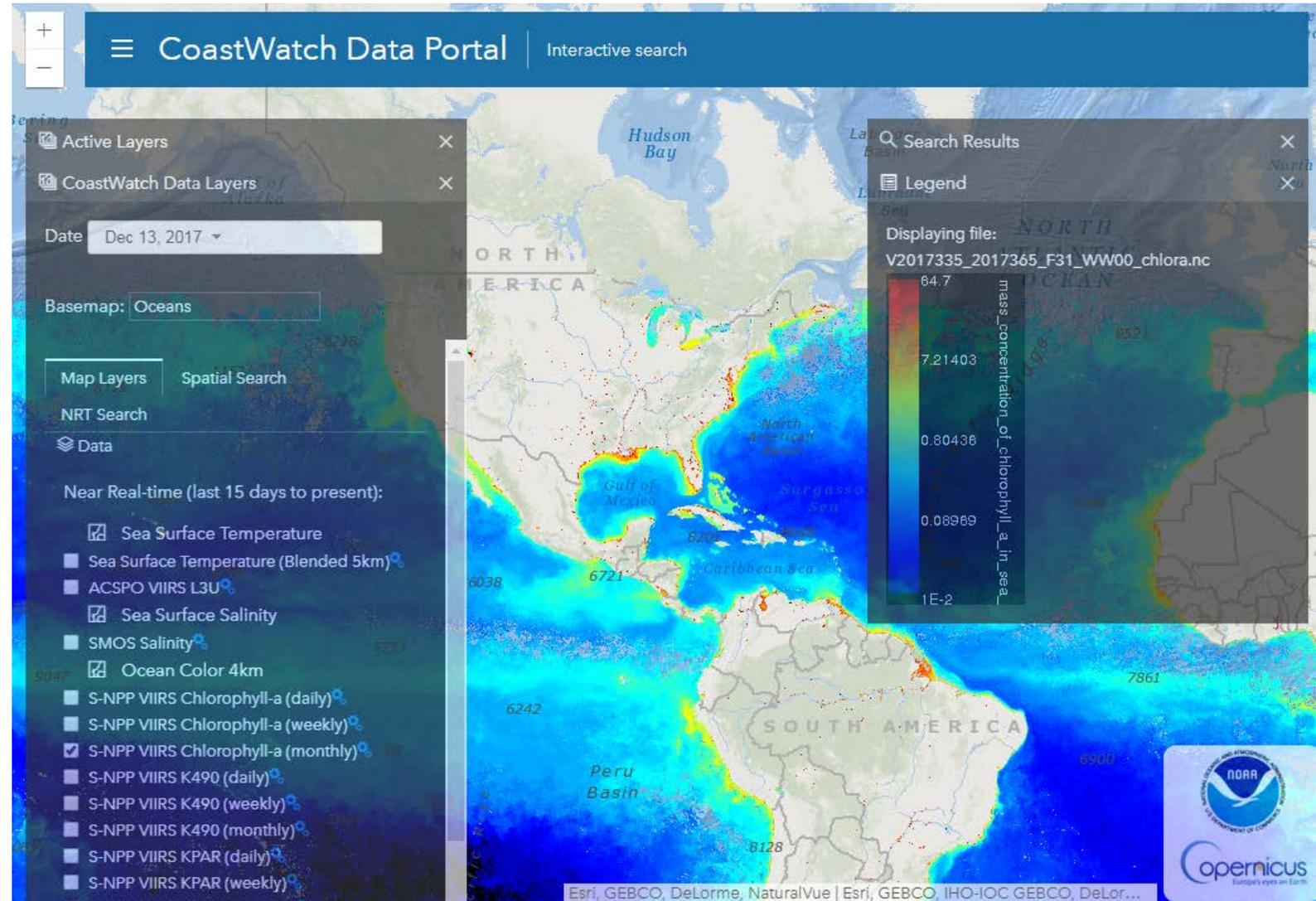
Data are available through the following servers:

Service	Resource Locator
HTTPS Search Tools	Daily, global granule/swath data access from: Granule selector tool (Level 2): https://coastwatch.noaa.gov/cw_html/cw_granule_selector.html Time and space search tool (Levels 1b and 2): https://coastwatch.noaa.gov/cw_html/cw_polygon_search.html
FTP	Daily, global, Level 2 granule/swath (nominal 750 m) ftp://ftpcoastwatch.noaa.gov/pub/sood1/mecb/coastwatch/viirs/science/L2/ Global, Level 3 merged single file, ~4 km <ul style="list-style-type: none">• Chlorophyll-a: Daily Weekly Monthly• Diffuse Attenuation Coefficient ($K_d(490)$ and $K_d(\text{PAR})$): Daily Weekly Monthly• Normalized Water Leaving Radiances (nLw's, all bands): Daily Weekly Monthly
THREDDS	Top Level of Science Quality, Life of Mission THREDDS catalog Daily, global, Level 2 granule/swath (nominal 750 m)THREDDS Catalog Global, Level 3 merged single file, ~4 km <ul style="list-style-type: none">• Chlorophyll-a: Daily Weekly Monthly• Diffuse Attenuation Coefficient ($K_d(490)$ and $K_d(\text{PAR})$): Daily Weekly Monthly• Normalized Water Leaving Radiances (nLw's, all bands): Daily Weekly Monthly Global, Level 3 merged sectorized files, ~750 m (see sector map under description tab) <ul style="list-style-type: none">• Chlorophyll-a: Daily Weekly Monthly• Diffuse Attenuation Coefficient ($K_d(490)$ and $K_d(\text{PAR})$): Daily Weekly Monthly• Normalized Water Leaving Radiances (nLw's, all bands): Daily Weekly Monthly <p><i>*Note, CW sector 750 m merge files are currently available through ~early January 2019 and are filling in as processing is completed.</i></p>

Please acknowledge "NOAA CoastWatch/OceanWatch" when you use data from our site and cite the particular dataset DOI as appropriate.

Data Portal

- Visualize
- Layer
- Probe
- Subset
 - Time
 - Space
- Download



https://coastwatch.noaa.gov/cw_html/cwViewer.html



Data Portal Tutorial Animation

Downloading and subsetting data

https://coastwatch.noaa.gov/cw_html/cwViewer.html



Ocean Monitor

Ad hoc name : OceanWatch Monitor (OM); to be finalized later

NOAA OceanWatch Monitor (OM)

NOAA National Oceanic and Atmospheric Administration U.S. Department of Commerce

Oceanwatch Monitor (OM) Satellite data products for understanding and managing our oceans and coasts

Oceanwatch Ocean Color Sea Surface Height Sea Surface Salinity **Sea Surface Temperature** Sea Surface Wind About

Oceanwatch OM SST Home

Oceanwatch Monitor

Data and Regions 3

Satellite Products

Reference Data

Regions of Interest

Intra-thematic Plots 4

Inter-thematic Plots 3

Event Media (future)

On-Demand (future)

20-min Quickstart Guide

Partners & collaborators

NASA

EUMETSAT

opernicus

esa

Department of Commerce
National Oceanic & Atmospheric Administration
Center for Satellite Applications and Research

Privacy | Customer Survey | Contact Us
Information Quality

Facebook Twitter Email YouTube

- Maps
- Timeseries
- Hovmöller Diagrams
- Reference Data Sets

<https://www.star.nesdis.noaa.gov/socd/om/>



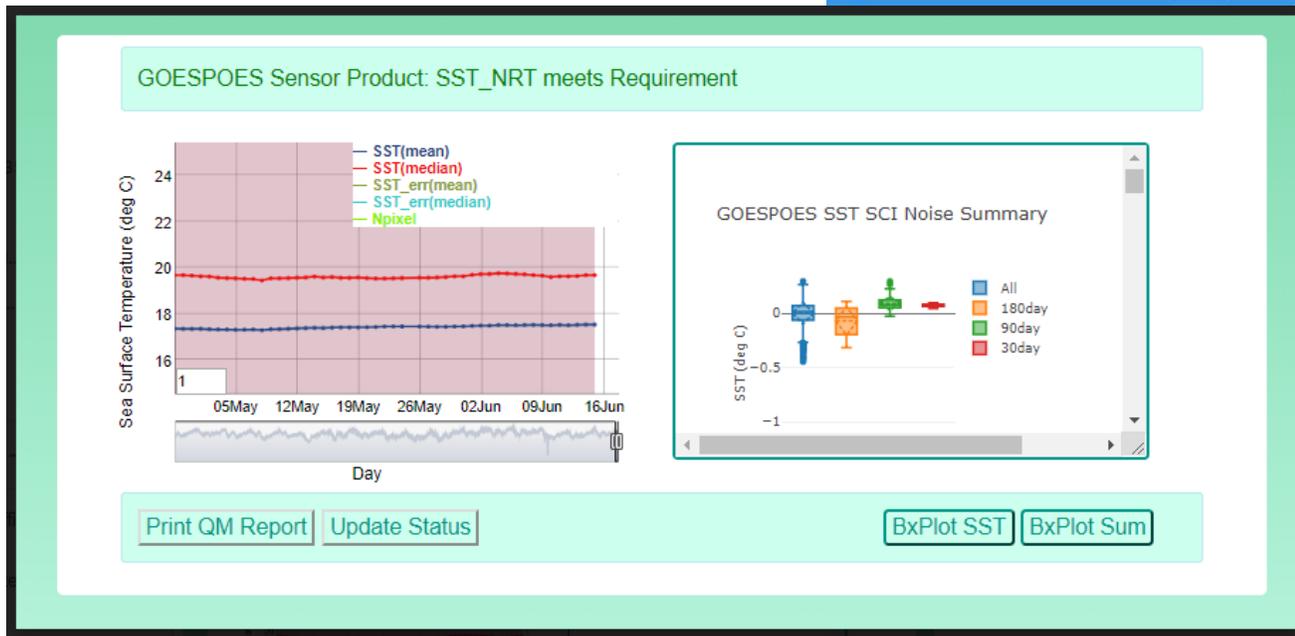
Data Performance Tracking

- Monitors data
 - availability
 - stability
- Quantitative, statistics

Color Latency Summary:

Sensor	Chlor_a	Kd490	KdPAR	nLws	Anomaly	Imagery	L2	L4	QMetric
VIIRS-NPP-NRT-Global	good	good	good	good	N/P	N/P	95 %	good	good
VIIRS-N20-NRT-Global	good	good	good	good	N/P	N/P	good	good	good
OLCI-S3A-NRT-Global	95 %	95 %	N/P	95 %	N/P	N/P	good	N/A	95 %
OLCI-S3B-NRT-Global	good	good	N/P	good	N/P	N/P	good	good	good
VIIRS-NPP-SCI-Global	good	good	good	good	N/T	N/T	93 %	good	good
VIIRS-N20-SCI-Global	N/P	N/P	N/P	N/P	N/P	N/P	TBD	TBD	TBD
	N/P	N/P	N/P	N/P	N/P	N/P	TBD	TBD	TBD
	N/P	N/P	N/P	N/P	N/P	N/P	TBD	TBD	TBD
	7 %	87 %	87 %	TBD	N/T	95 %	good	87 %	
	good	good	N/P	TBD	N/T	good	N/P	92 %	
	6 %	N/P	86 %	TBD	N/T	good	86 %	86 %	
	5 %	N/P	95 %	TBD	N/T	good	95 %	77 %	

ts Requirement :: 100 %



<https://www.star.nesdis.noaa.gov/sod/me cb/coastwatch/NRT-QA/QM Reports.html>



CoastWatch Utilities and CDAT Software

CoastWatch Utilities 3.5.0

User Resources / CoastWatch Utilities 3.5.0

Updated: September 25, 2019

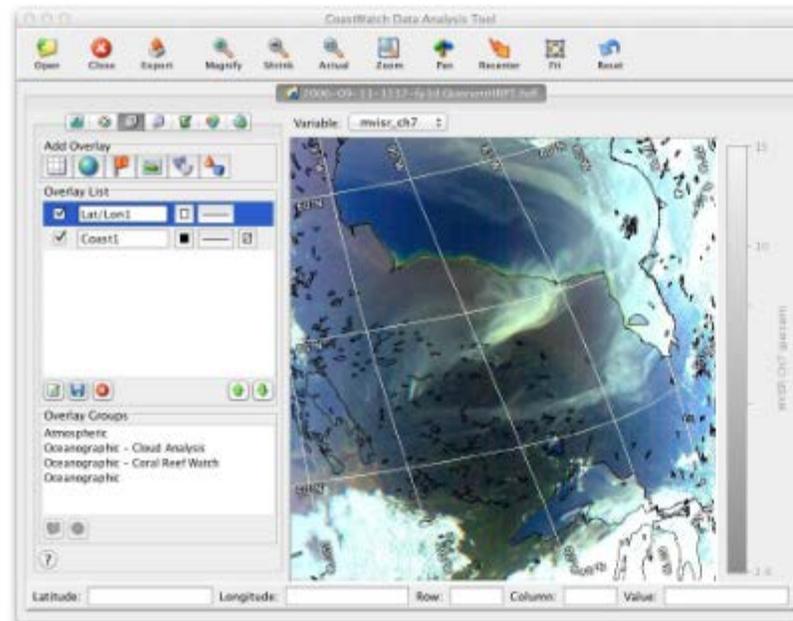


Table of Contents

- Software Features
- New in Version 3.5.0 (build 924)
- Screenshots
- Downloads
- Documentation
- Presentations

<https://coastwatch.noaa.gov/cw/user-resources/coastwatch-utilities.html>



NOAA CoastWatch Satellite Training

Coastwatch.info@noaaa.gov

<https://coastwatch.noaa.gov/cw/user-resources/satellite-data-training-courses.html>

Upcoming full 3-day courses Spring 2020

- **San Juan PR** - 5 to 7 February at the University of Puerto Rico
- **Anchorage, AK** - Tentative dates 7 to 9 April, Alaska Fisheries Science Center
- **Charleston, SC.** – Dates TBD - in association with Hollings Marine Laboratory



NOAA CoastWatch Future Directions

- **Challenges & Opportunities:**
 - Knowing our users (and what they use, how they access, etc.)
 - Fully mine and exploit data access logs (no required “registration” process)
 - Data product database development including key users
 - Proactively and systematically asking permission for users to be identified for specific purposes
 - Establish an online user forum
 - Overcoming language barriers to make satellite data products more understandable
 - Increasing the number of in-person, hands-on training classes
 - Improve online self-learning materials (“Learning Portal”)
 - Develop university (at UMD?) course and/or curriculum
 - Improve user experience on website
 - Data visualization
 - Data searches and access
 - Quality tracking
 - Themed portals
 - Event tracker
 - Develop or identify new value added products, derived products, L4 analysis products, etc.
 - that serve specific or multiple applications
 - transition them to operations
 - In situ databases and satellite matchups
 - Grow the definition and implementation of “moderate assurance”
 - Quantification
 - Infrastructure IT requirements
 - Conveying benefits/limitations of datasets (both content and technical) to users
 - Document history of CoastWatch (pre-proposal submitted to 2019 NOAA Heritage Program)



NOAA CoastWatch Future Directions

- Upcoming CW/STAR presentations:
 - Data Portal – Michael Soracco
 - OceanWatch Monitor – Prasanjit Dash
 - Data Access and Stability Monitor – Sathya Ramachandran
 - Training and Tutorials – Melanie Abecassis
- Recent CW/STAR presentations:
 - PolarWatch – Jenn Sevadjan 8/29/2019 [NOAA Polar Watch](#)
 - ERDDAP – Cara Wilson 8/22/2019 [ERDDAP](#)



Applications and Research Examples



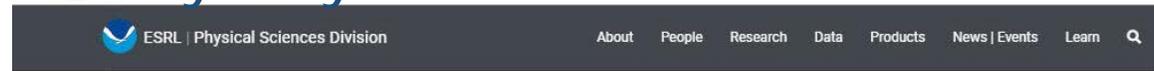
Observation inputs:

- NRT Geo-Polar Blended Day-Night SST
- AMSR-2 sea ice concentration

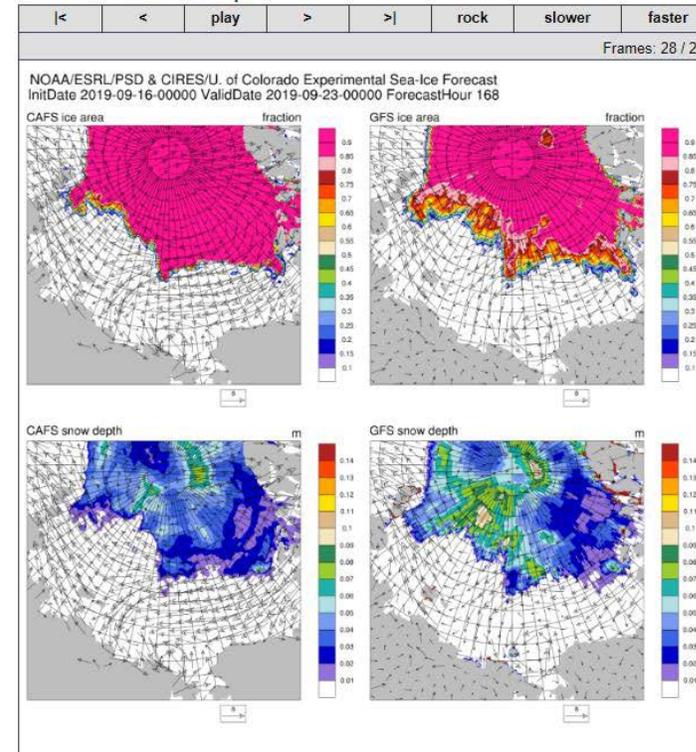
Application:

initialize the Coupled Arctic Forecast Systems (CAFS) model. CAFS will be used during the upcoming Multidisciplinary drifting Observatory for the Study of Arctic Climate (MOSAIC) field campaign.

Distributed through: CW Central



Sea Ice Area & Snow Depth



Please contact [Amy Solomon](#) and [Janet Intrieri](#) with questions and comments. We are particularly interested if you find this information useful.

Note, the forecasts are **experimental**. NOAA/ESRL is not responsible for any losses due to their use.

To reference plots, please include: "Plot provided by the NOAA/ESRL Physical Sciences Division, Boulder, CO from their Web site at <https://www.esrl.noaa.gov/psd/>."

Courtesy: Janet Intrieri and Amy Solomon at NOAA/ESRL Physical Sciences Division, Boulder, CO from their Web site <https://www.esrl.noaa.gov/psd/>

EcoCast

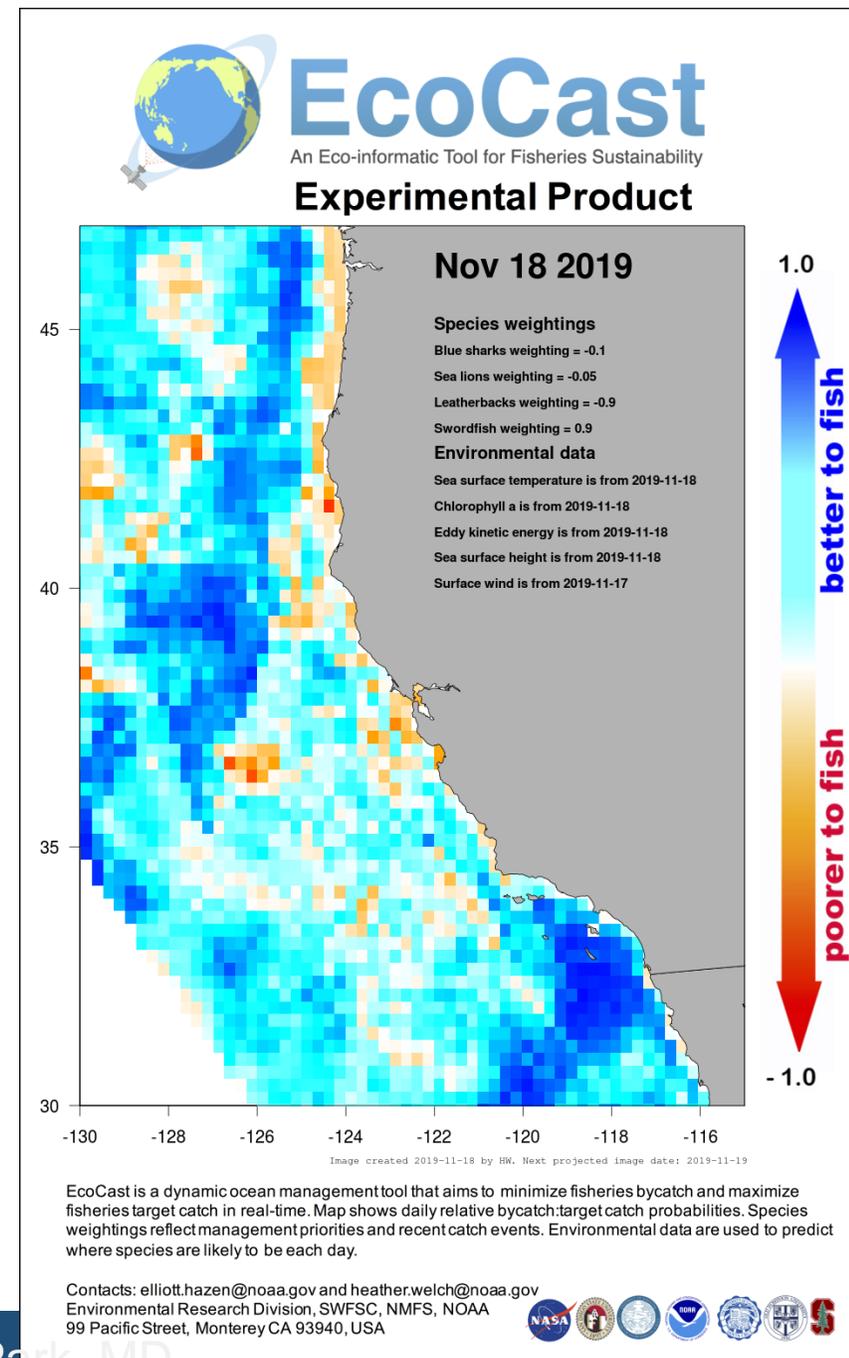
Observations: SST, chl, EKE, SSH, winds

Application: Bycatch avoidance
Distributed through: CW West Coast Node

This project is funded in part through JPSS/PGRR

Courtesy: Elliot Hazen, Heather Welch, NMFS SWFSC developers and Dale Robinson, operations production West Coast Node

https://coastwatch.pfeg.noaa.gov/ecocast/map_product.html



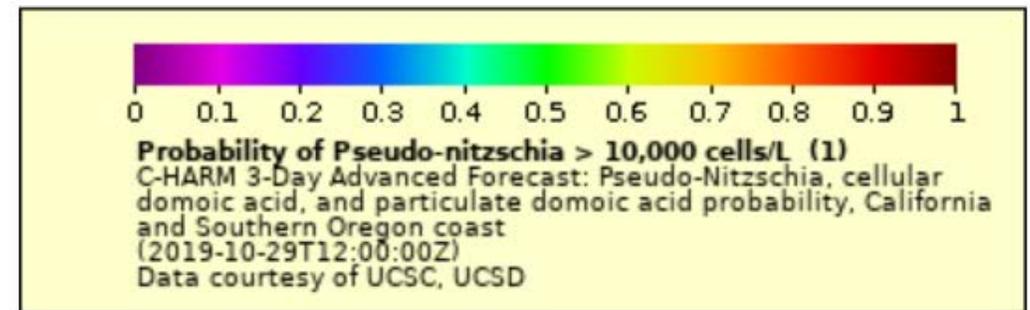
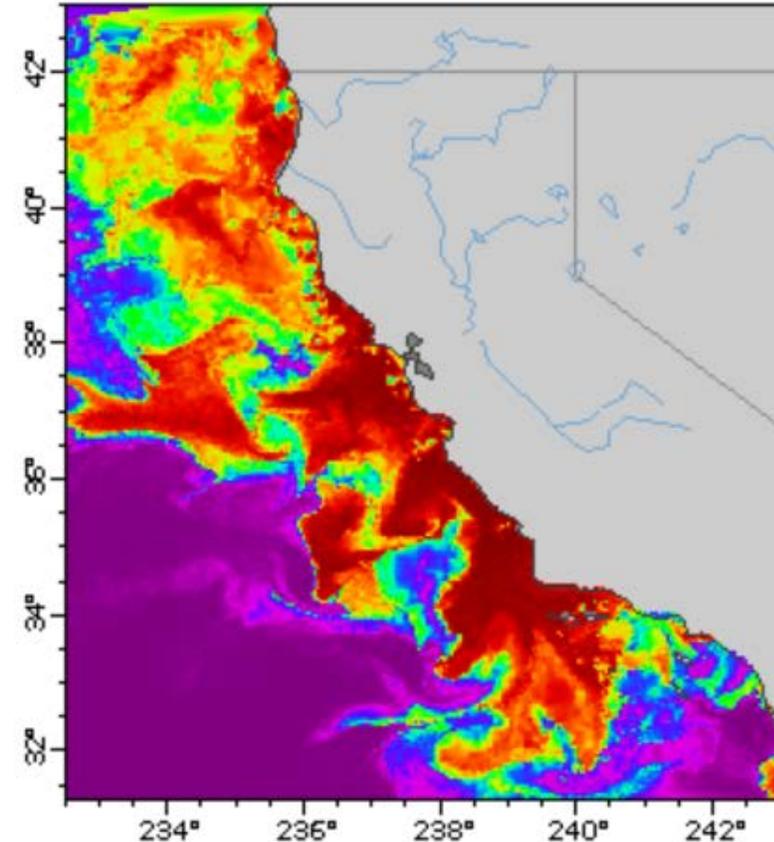
C-HARM 3-Day Advanced Forecast:

Pseudo-nitzschia, cellular domoic acid, and particulate domoic acid probability, California and Southern Oregon coast

Observations: SST and Chlorophyll

Application: Human health, wildlife health, shellfish aquaculture, etc.

*Courtesy: Dale Robinson, West Coast Node;
Developed by Kudela et al.. UC Santa Cruz, etc.*



Local validation of global satellite product for further use. Example Slide from Recent 3-Day CoastWatch Satellite Training Course

Observation: SST

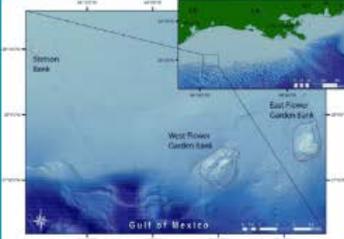
Application:
Management of Flower
Garden Banks National
Marine Sanctuary

Courtesy: Michelle A. Johnston, NOAA

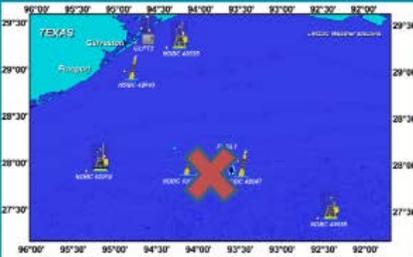
Michelle A. Johnston, Ph.D.
Coral Reef Long-Term Monitoring Project Manager
Flower Garden Banks National Marine Sanctuary
Galveston, TX 77551
michelle.a.johnston@noaa.gov



Flower Garden Banks National Marine Sanctuary, located in the Gulf of Mexico, has conducted long-term coral reef monitoring since 1989 at the East and West Banks. Water quality parameters, such as temperature and salinity are monitored with datasondes on the coral reef, and surface parameters are measured with surface data buoys.

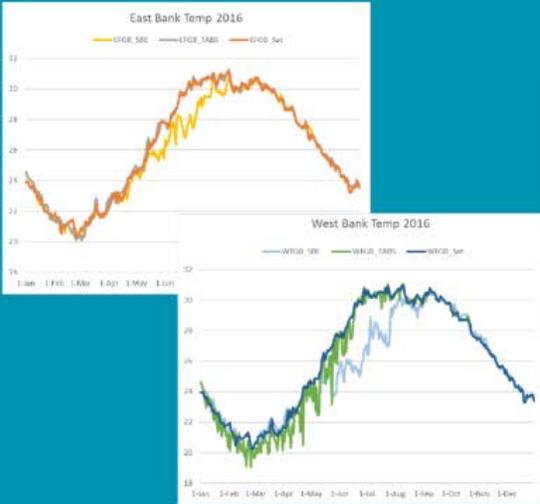


Decommissioned data buoys



Unfortunately, the TABS surface data buoys maintained by TAMU were decommissioned after 2016 due to lack of funding, leaving FGBNMS without important in situ surface data.

Therefore, ERDDAP was used to extract daily SST data from the NOAA Coral Reef Watch **Global Coral Bleaching Monitoring Products: Daily 5-km dataset** for East and West Bank buoy locations in 2016.

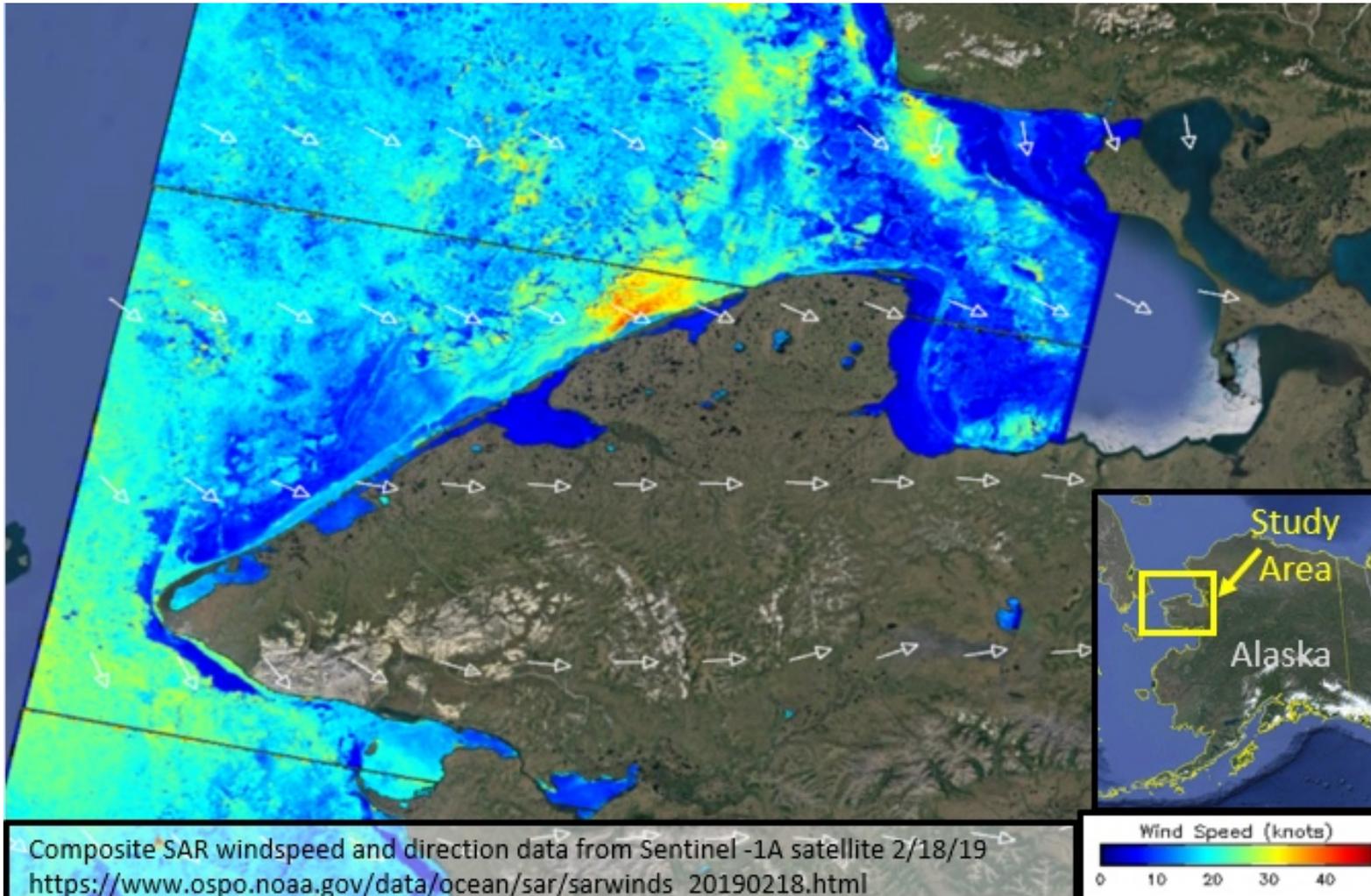


When comparing 2016 satellite data and TABS buoy data, there was no significant difference (t-test in R) between temperature datasets at EFGB. There was a significant difference at WFGB due to issues with the buoy data. In conclusion, FGBNMS can confidently use satellite data for surface measurements to augment the coral monitoring program **1** products.



Participant Slide: SAR data for monitoring coast storm hazards

Tahzay Jones, NPS, 2019 Satellite Course participant (Juneau)



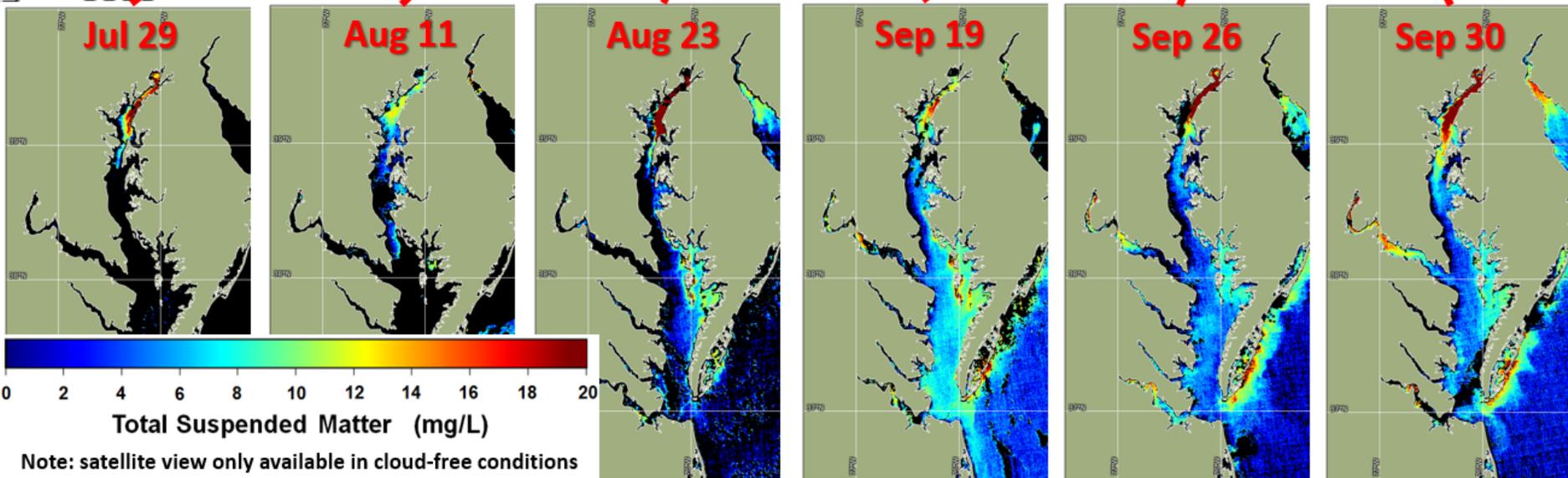
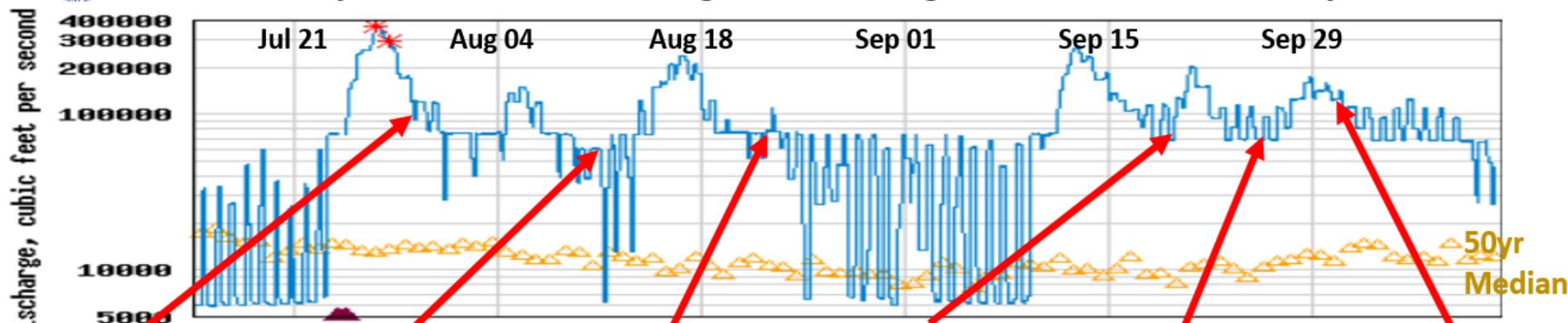
- Seward Peninsula is host to natural and cultural resources significant enough for the majority of the northeast coast to be designated a Natural Preserve.
- Storm activity in ice-free conditions is accelerating erosion.
- Erosion threatens coastal villages, important archeological artifacts and migratory bird habitat.



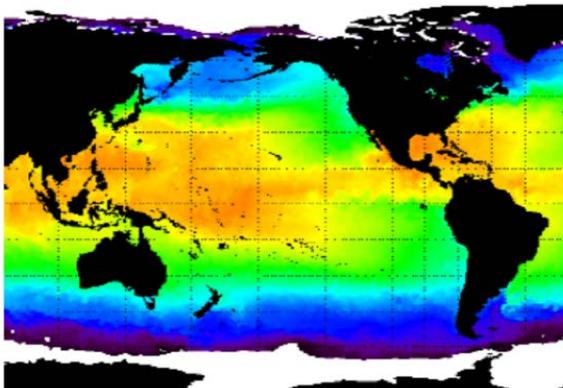
Sediment Plume 2018 Unprecedented Rainfall, Chesapeake Bay



Sediment plumes per peak discharge event – as seen by satellite
USGS Susquehanna River discharge at Conowingo, MD / NOAA Total Suspended Matter



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E-Lightning and Poster Sessions:

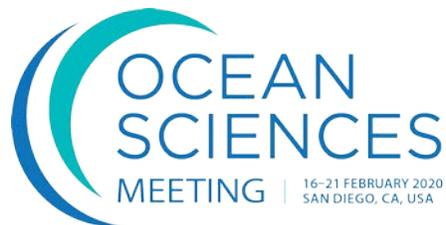
Oceanography from Space: Applications for Satellite-based Ocean Observations

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Town Hall:

NOAA Ocean Satellite Data Products for Science and Applications

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