



# Introduction to PACE Hyperspectral Observations for Water Quality Monitoring

Part 2: Overview, Access, and Analysis of PACE Ocean Color Data Products

ARSET Host: Amita Mehta (NASA-GSFC & UMBC-GESTAR II)

Guest Instructor: Morgaine McKibben (PACE Applications Lead, NASA-GSFC)

October 2, 2024

# Training Outline

## Part 1

Introduction to  
PACE (Plankton  
Aerosol, Cloud,  
ocean, Ecosystem)  
Mission for Water  
Quality Monitoring

September 25, 2024  
10:00-11:30 AM

## Part 2

Overview, Access,  
and Analysis of  
PACE Ocean Color  
Data Products

October 2, 2024  
10:00-11:30 AM

## Part 3

Access and  
Visualization of  
PACE/OCI Data  
using  
Python/Jupyter  
Notebook Software

October 9, 2024  
10:00-11:30 AM

## Homework

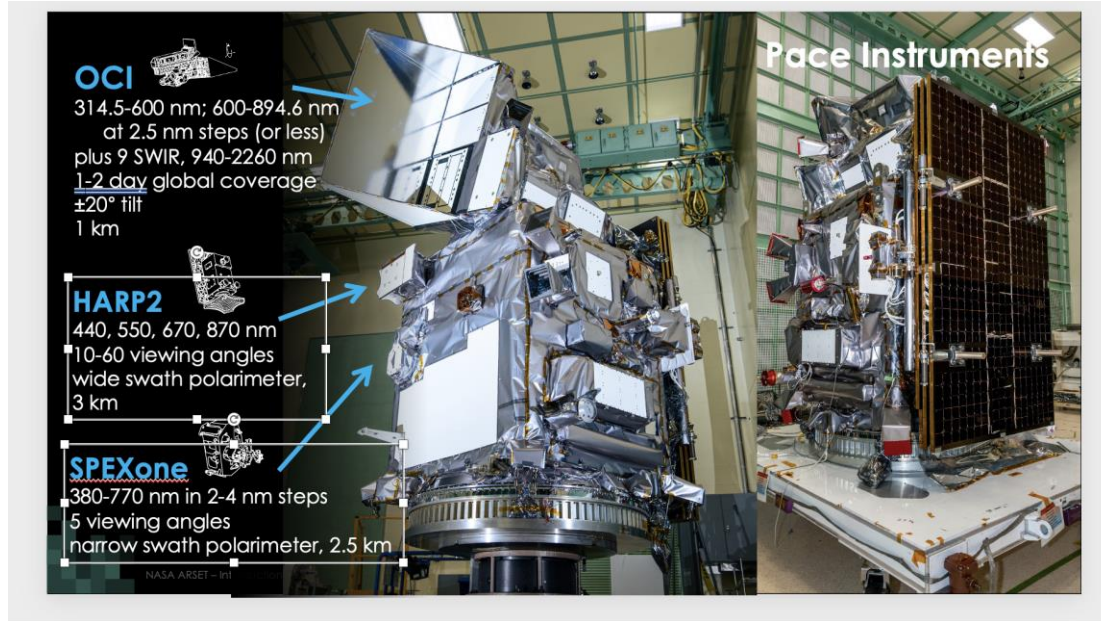
Opens October 9 – Due October 24 – Posted on Training Webpage

A certificate of completion will be awarded to those who attend all live sessions and complete the homework assignment(s) before the given due date.

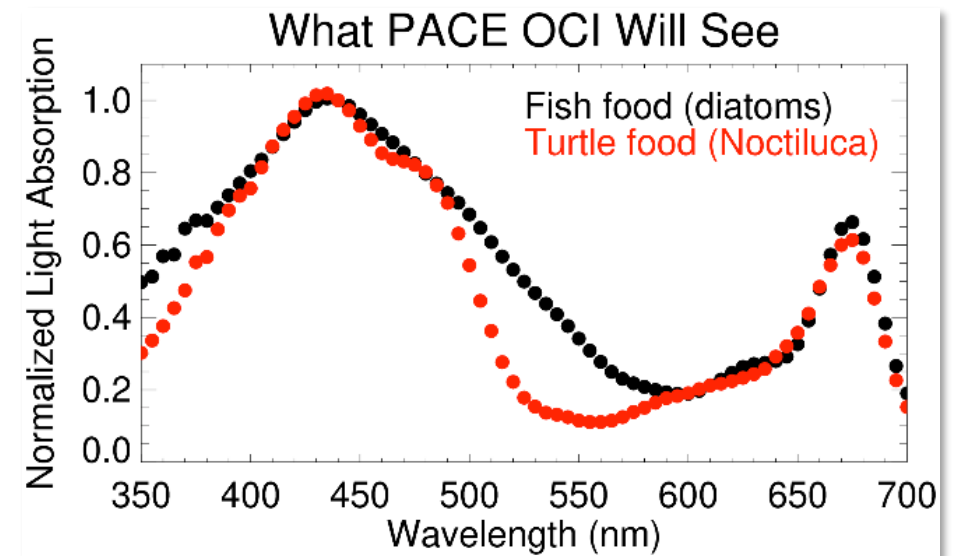
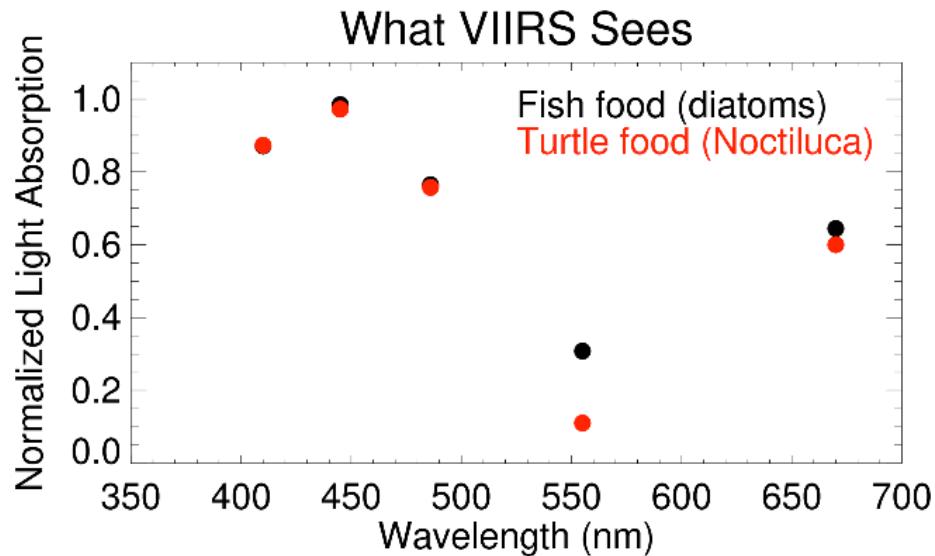


# Part 1 Review: Instruments

Description of PACE – OCI, HARP2, and SPEXone: Spectral, Spatial, and Temporal Resolutions

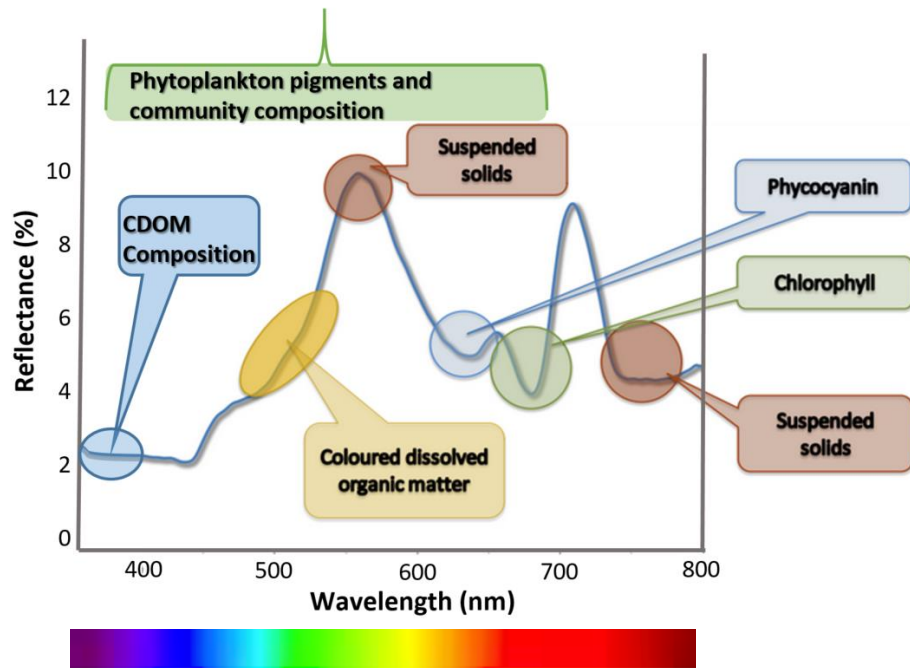


Signals from the ocean are small. Differentiating between constituents requires additional information relative to what we have today.

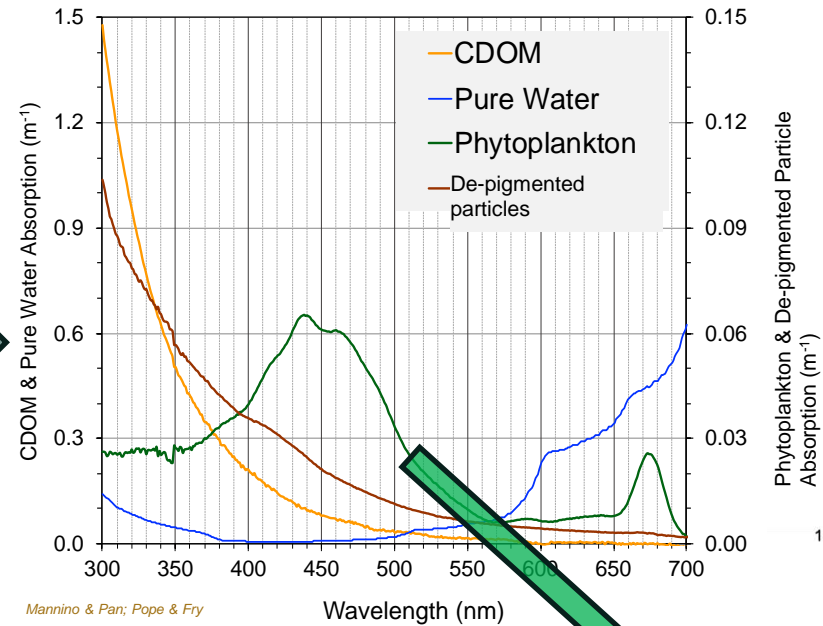


# Part 1 Review: Hyperspectral Observations Enable Separation of Aquatic Constituents

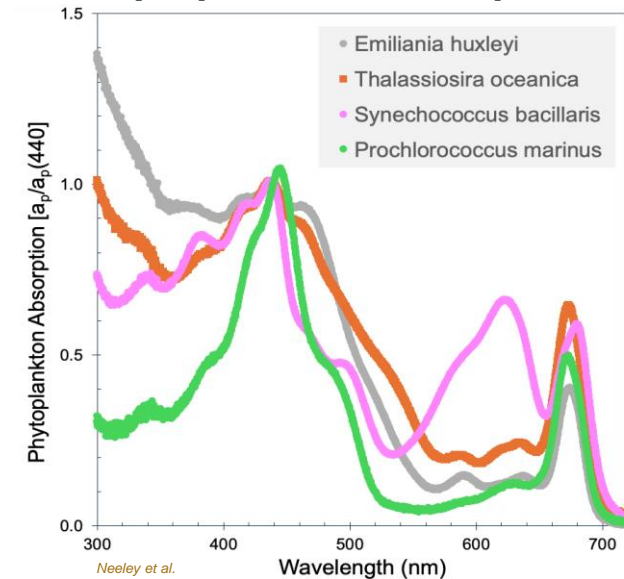
## Water-Leaving Reflectance



## Absorption of In-Water Constituents



## Phytoplankton Composition



Figures adapted from *Diersen et al. 2023*;  
*JGR Biogeosciences*

Reflectance (%) = Percent of sunlight (radiance) leaving the ocean surface from the sunlight (irradiance) entering through the ocean surface.

# Part 1 Review

- HARP2 and SPEXone will aid in atmospheric correction.
- Relatively low spatial resolution (1 km) constrains use within inland and nearshore waters.
- Hyperspectral algorithms need verification and require hyperspectral field measurements.
- Overview of available PACE Data products and issues in Level-2 data products.
  - Not completely calibrated, limited validation



## Part 2 Objectives

By the end of Part 1, participants will be able to:

- Explore the current and planned PACE data products for water quality monitoring.
- Identify how to access PACE/OCI Level-1, -2, and -3 data.
- Identify applications and the usability of PACE data for monitoring water quality.
- Analyze and visualize available OCI Remote Sensing Reflectances, Level-2 and -3 water quality parameters using NASA's open source SeaDAS.



# How to Ask Questions

- Please put your questions in the Questions box and we will address them at the end of the webinar.
- Feel free to enter your questions as we go. We will try to get to all of the questions during the Q&A session after the webinar.
- The remainder of the questions will be answered in the Q&A document, which will be posted to the training website about a week after the training.



# Part 1 – Trainers

**Amita Mehta**

ARSET Instructor

NASA-GSFC & UMBC-GESTAR II



**Morgaine McKibben**

PACE Applications Lead

(NASA-GSFC)





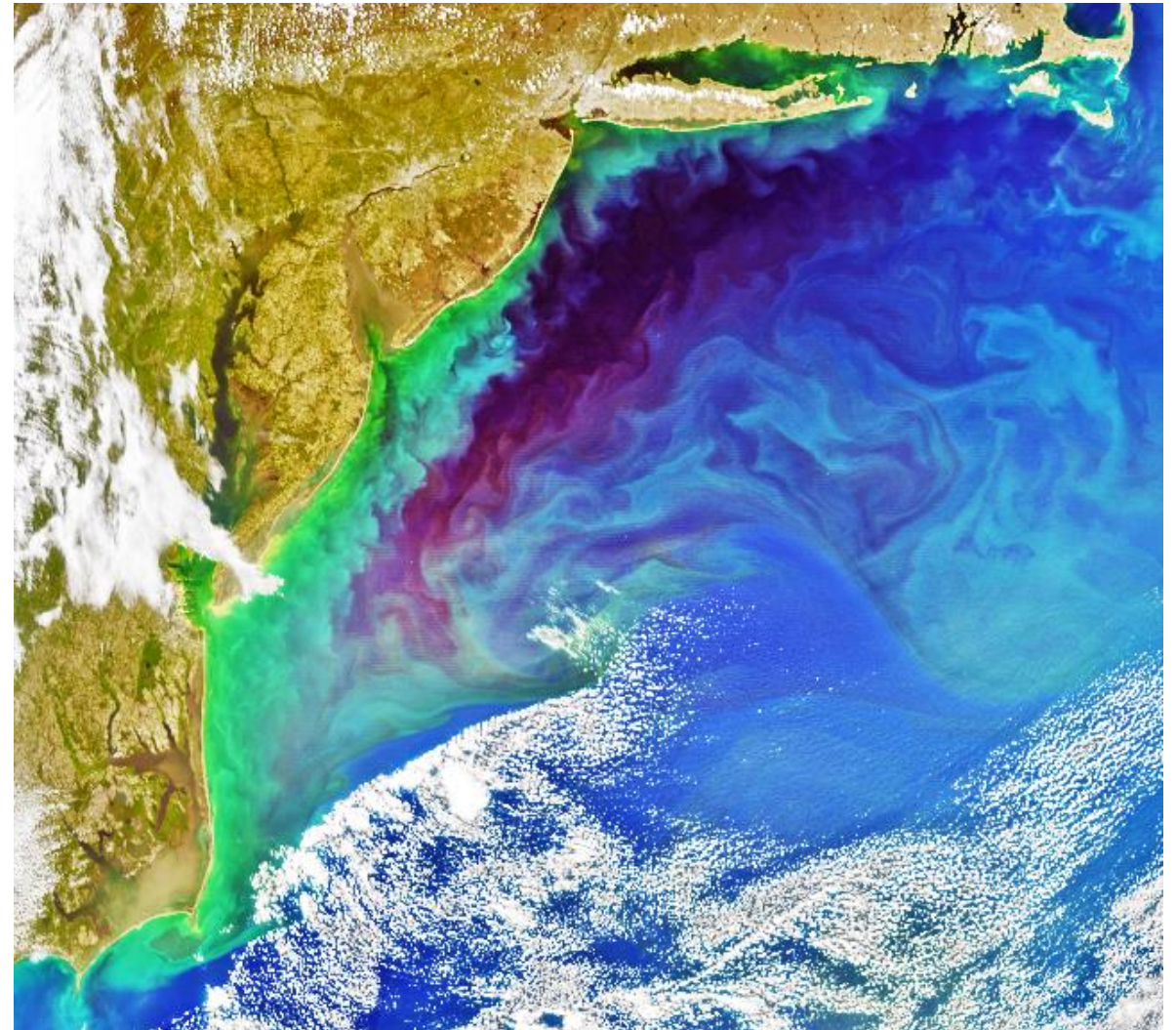


## Overview, Access, and Analysis of PACE Ocean Color Data Products

# Overview

Today we'll explore...

- PACE applications program & use case examples
- Where to access PACE ocean color data products available now
- Resources & support available to work with PACE data



PACE Enhanced RGB, US East Coast, April 26, 2024. Credit: Joseph Knuble



# PACE: Leading a New Era of Global Imaging Spectroscopy



**Science Goals:** PACE is NASA's next great investment to **advance** and **extend** ocean biological, ecological, and biogeochemical data records, as well as cloud, aerosol, and terrestrial data records. **PACE is the most advanced global ocean color mission to date.**



# PACE: About the Instruments



- Global, 13:00 local equatorial crossing
- 3yr mission (at least 10yrs of propellant)
- **Data products are free & open to all**

## Ocean Color Instrument (OCI):

- **Hyperspectral** 340-890nm (UV-NIR) 5nm bandwidth, 2.5nm steps; 7 SWIR bands
- 1-2 day global; 1.2 km<sup>2</sup> at nadir

## Two Multi-Angle Polarimeters:

- **HARP-2:**  
Wide-swath, **hyper-angular**, 4 bands; 2-day global; 3 km<sup>2</sup> nadir
- **SPEXone:**  
Narrow-swath, **hyperspectral from UV-NIR**, 5 viewing angles, >30-day global, 2.5 km<sup>2</sup> nadir





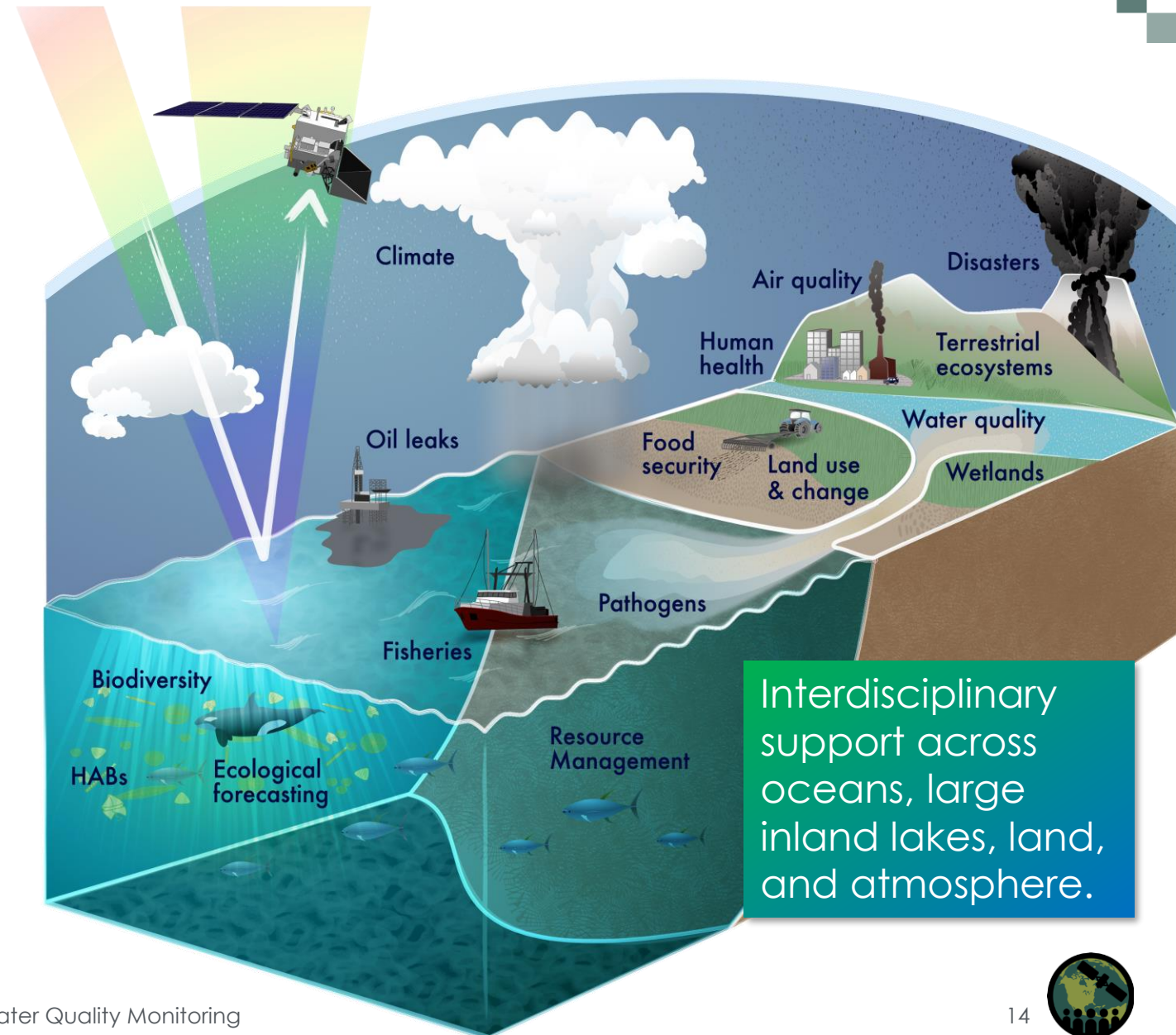
# PACE Applications Program & Water Quality Use Cases

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# PACE Applications: Putting PACE Data to Work Across the Earth System

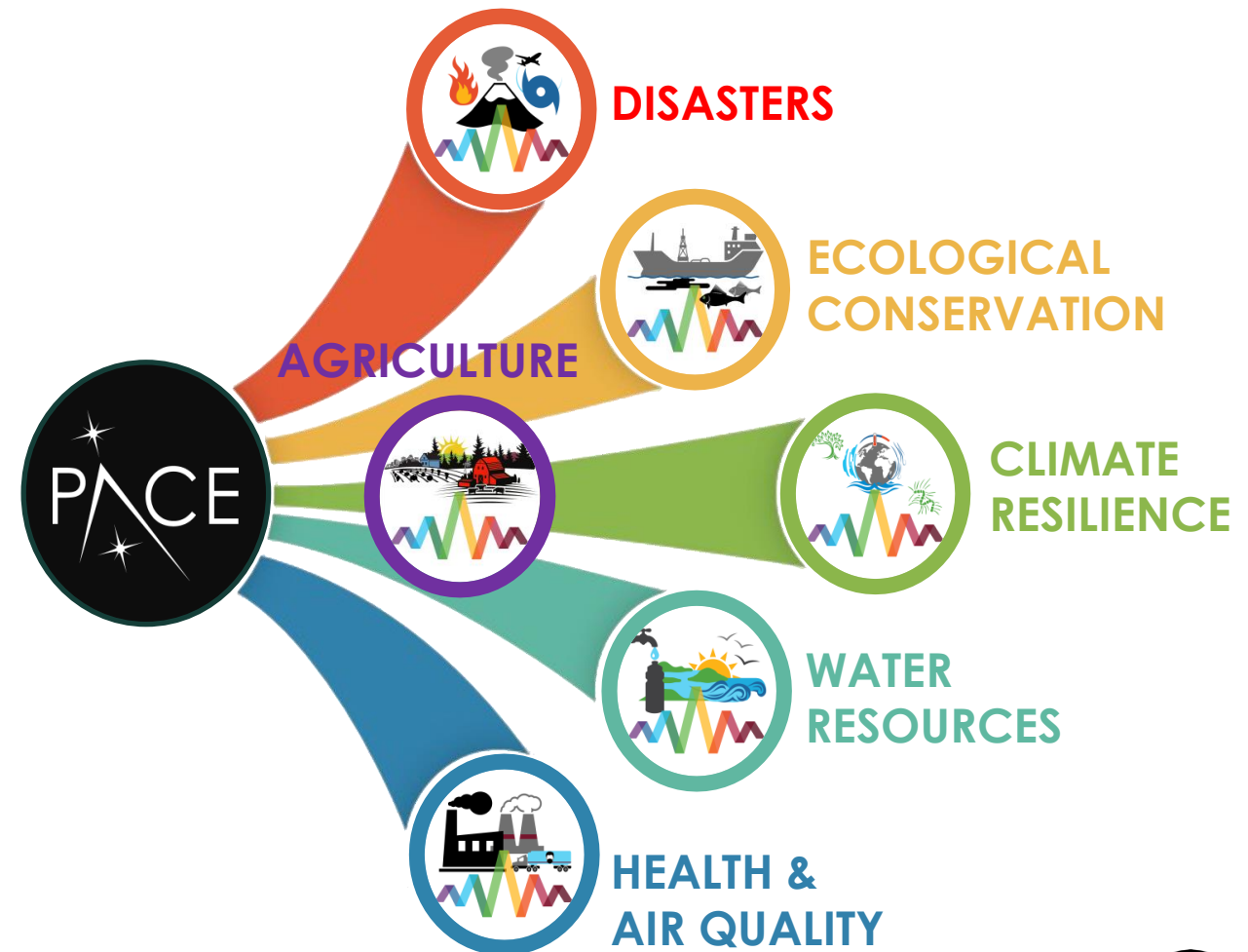
- **Applications:** Innovative uses of NASA PACE data products to improve **decision-making activities & help provide practical solutions to meet societal needs.**
- **Applied Research** bridges PACE data & applications. Provides fundamental knowledge of how to **scale & integrate** PACE data products into **users'** policy, business & management activities.
- **End-User Communities** Include:
  - Individuals & groups
  - Public, private, & academic sectors
  - National & international orgs
  - Local & global scales



# PACE Applications Program

**Goal:** Accelerate and support translation of PACE's advanced data into **societal action**.

- **Build partnerships** between PACE data producers & users
- **Increase accessibility & actionability** of PACE data
- **Demonstrate the societal value & utility** of PACE



# PACE Applications: Community Engagement

**Community of Practice:** Anyone interested in staying up-to-date on the PACE mission, data, and applications.

## Join us!!

1. Send an email to **\*with 'join' in the subject line\*** to [pace-community-join@lists.nasa.gov](mailto:pace-community-join@lists.nasa.gov)
2. Look for confirmation email → confirm!

**Science & Applications Team:** NASA-funded scientists working on algorithm development, applications, validation, etc.

**Early Adopters:** Researchers and others with applied projects/needs teamed with stakeholders to develop and apply advanced PACE applications

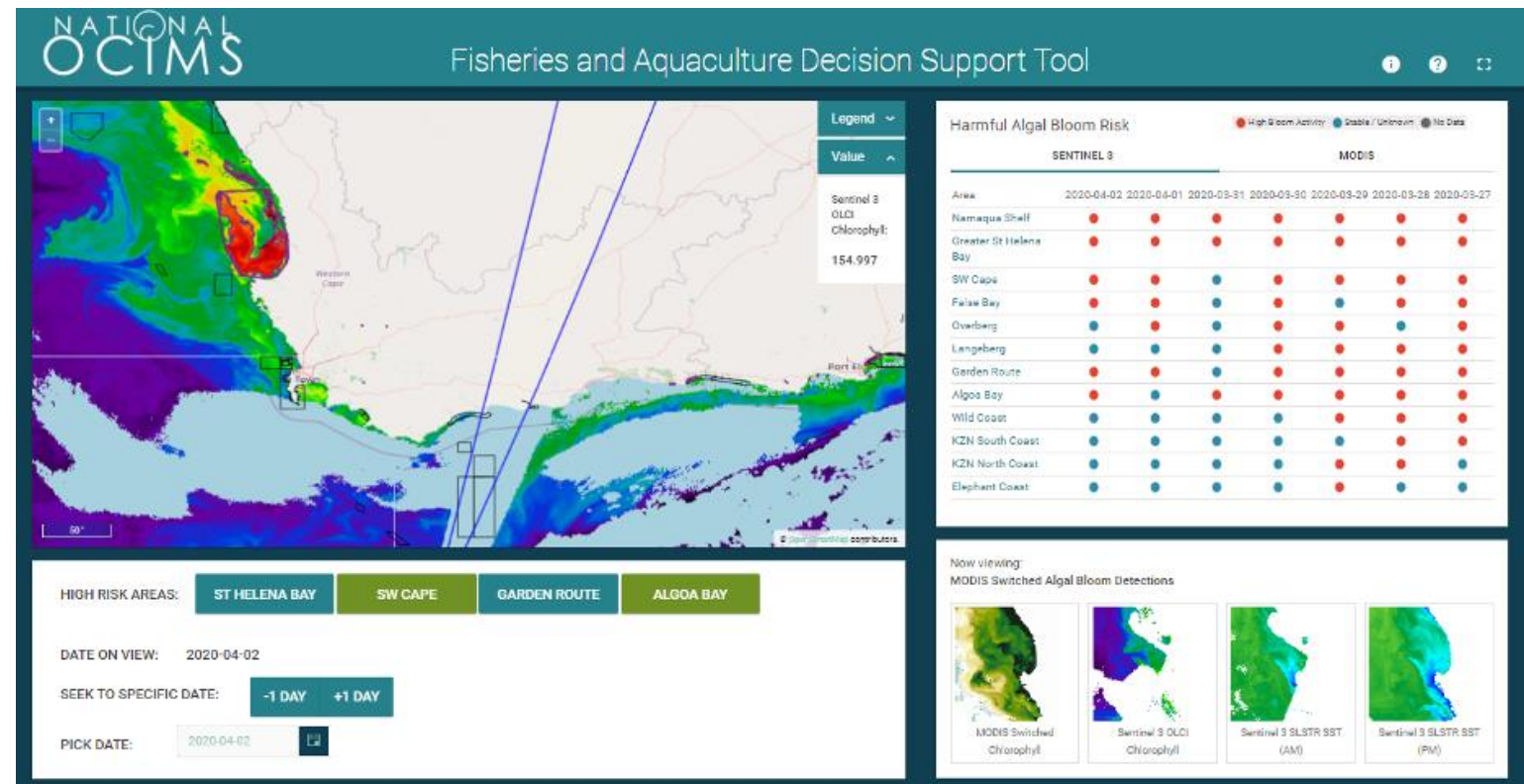




# PACE Applications – Water Resources & Water Quality Examples

New, hyperspectral-based PACE ocean color data products, such as hyperspectral chlorophyll-a, phytoplankton community composition, and pigments, will advance water quality management and understanding of aquatic ecosystems by improving:

- Identification & tracking of harmful algal blooms (HABs)
- Assessment of fisheries & aquaculture health
- Evaluating & maintaining ecosystem health
- Identification of oil spills
- Post-disaster water quality impacts (e.g., high suspended solids, HABs after floods, fires, or hurricanes)



**Top:** The National Oceans and Coastal Information Management System (OCIMS) Fisheries and Aquaculture Decision Support Tool will incorporate phytoplankton community composition from PACE.



# PACE Early Adopter: Brady Aquaculture Site Prospecting



**Damian Brady**

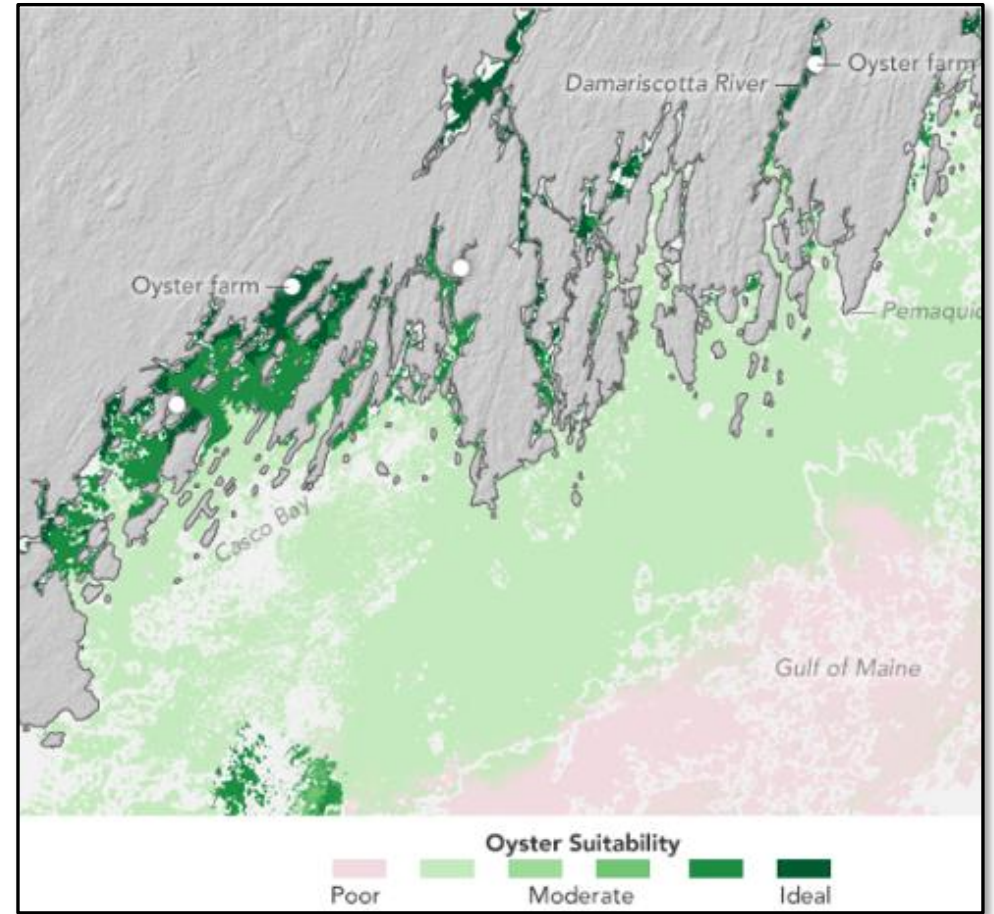
Aquaculture site prospecting:  
Applying PACE products to  
sustainable aquaculture site  
selection »

**Application** Aquaculture Site Prospecting: Applying PACE Products to Sustainable Aquaculture Site Selection

**Significance:** Choosing optimal aquaculture sites with the best available information could save prospective oyster, mussel, and scallop growers money and time.

**How PACE Can Help:** PACE's spectral resolution could help optimize site selection tools by relating phytoplankton size to oyster feeding rates.

**Stakeholders:** End-users change each year with over 600 Limited Purpose Aquaculture License holders in the state of Maine.



Example map from oyster farm site selection tool:  
[https://pace.oceansciences.org/people\\_ea.htm?id=52](https://pace.oceansciences.org/people_ea.htm?id=52)



# PACE Early Adopter: Enhanced Cholera Risk Models

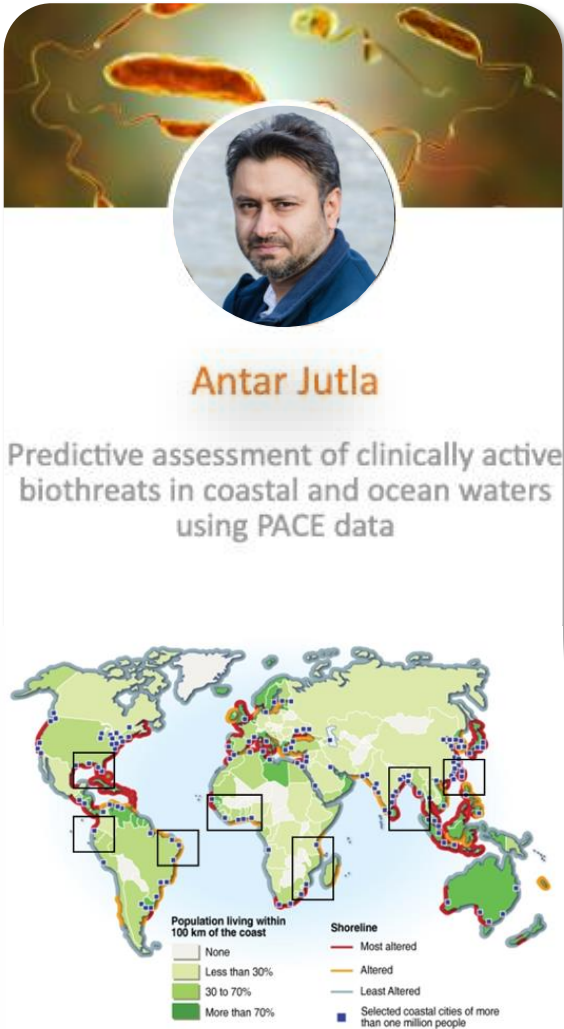


Figure 1: Population distribution and water-borne disease outbreak. Rectangles represent regions with reported disease epidemics.

**Application:** Enhanced **cholera risk models** through integration of hyperspectral remotely sensed plankton & plankton health data into algorithms for Florida & the Chesapeake Bay.

**Significance:** Water-borne pathogens pose a significant threat to human and environmental health. Better understanding of the relationship between plankton and *Vibrio cholerae* will **improve risk assessment and improve human health advisories**. This work can be used to make real-time decisions of when and where to initiate cholera relief and mitigation activities, as well as, for decision-making for safe water and sanitation.

**How PACE Can Help:** The hyperspectral capabilities of PACE OCI will enhance existing prediction models (for *Vibrio cholerae*) by **integrating phytoplankton type and phytoplankton health metrics into algorithms**. It is anticipated that PACE will enhance such activities to support public health, policy analysis, and decision-making.

**Stakeholders:** United Nations Office for Coordinator of Humanitarian Affairs (UNOCHA); World Health Organization (WHO); UNICEF

[https://pace.oceansciences.org/people\\_ea.htm?id=68](https://pace.oceansciences.org/people_ea.htm?id=68)



# PACE Early Adopter: Northern Gulf of Mexico Water Quality



**Bingqing Liu**

Assessing the potential impact of a changing climate on the water quality of northern Gulf of Mexico »

**Application:** Assessing the potential impact of a changing climate on the water quality of Northern Gulf of Mexico, including advancing harmful algal bloom identification & forecasting for oyster farms in the Gulf region.

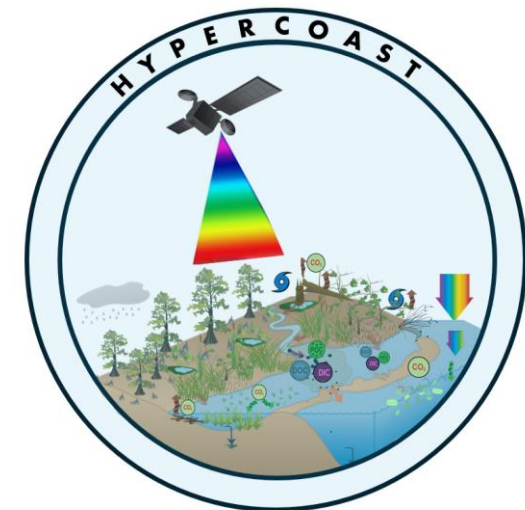
Recently released the HyperCoast Data Visualization Tool:

<https://hypercoast.org/>  
[PACE Notebook](#)

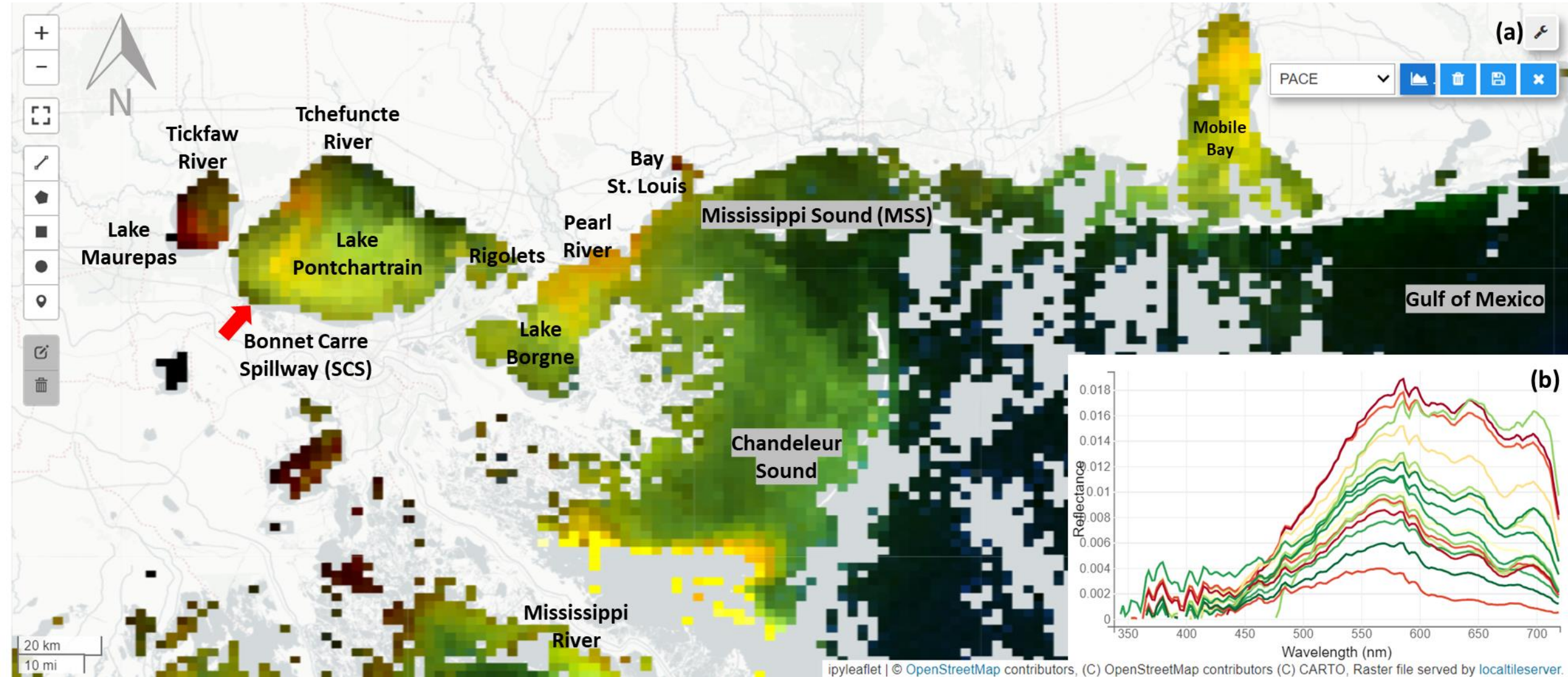
**Next Step:** Using these PACE spectra and in situ data in machine learning for characterization of water and phytoplankton types.

## Stakeholders:

- Barataria-Terrebonne National Estuary Program (BTNEP)
- Oyster Program Manager at Louisiana Department of Wildlife and Fisheries (LDWF)
- Louisiana Department of Environmental Quality (LDEQ)
- Pontchartrain Conservancy



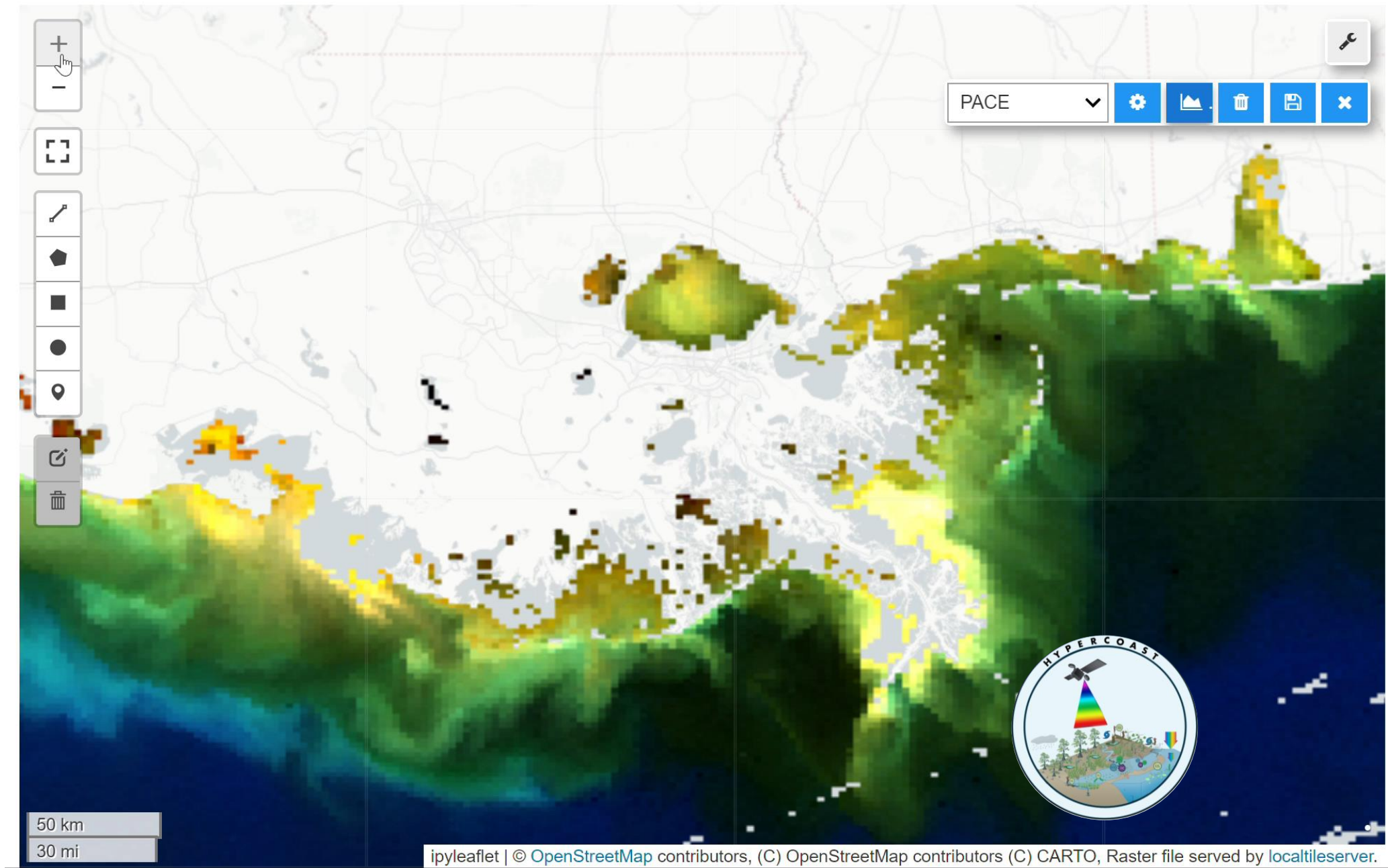
# HyperCoast: PACE's Application in Lakes and Estuaries



Diverse water types observed from PACE in the Northern Gulf of Mexico.

# HyperCoast Demo: Spectra Extraction

Diverse water  
types observed  
from PACE in the  
Northern Gulf of  
Mexico



ipyleaflet | © OpenStreetMap contributors, (C) OpenStreetMap contributors (C) CARTO, Raster file served by localtileservers.



PACE

## **PACE Data Access:** Roadmap for Getting Started

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# Accessing PACE Ocean Color Products

## Knowledge & experience level of this presentation:

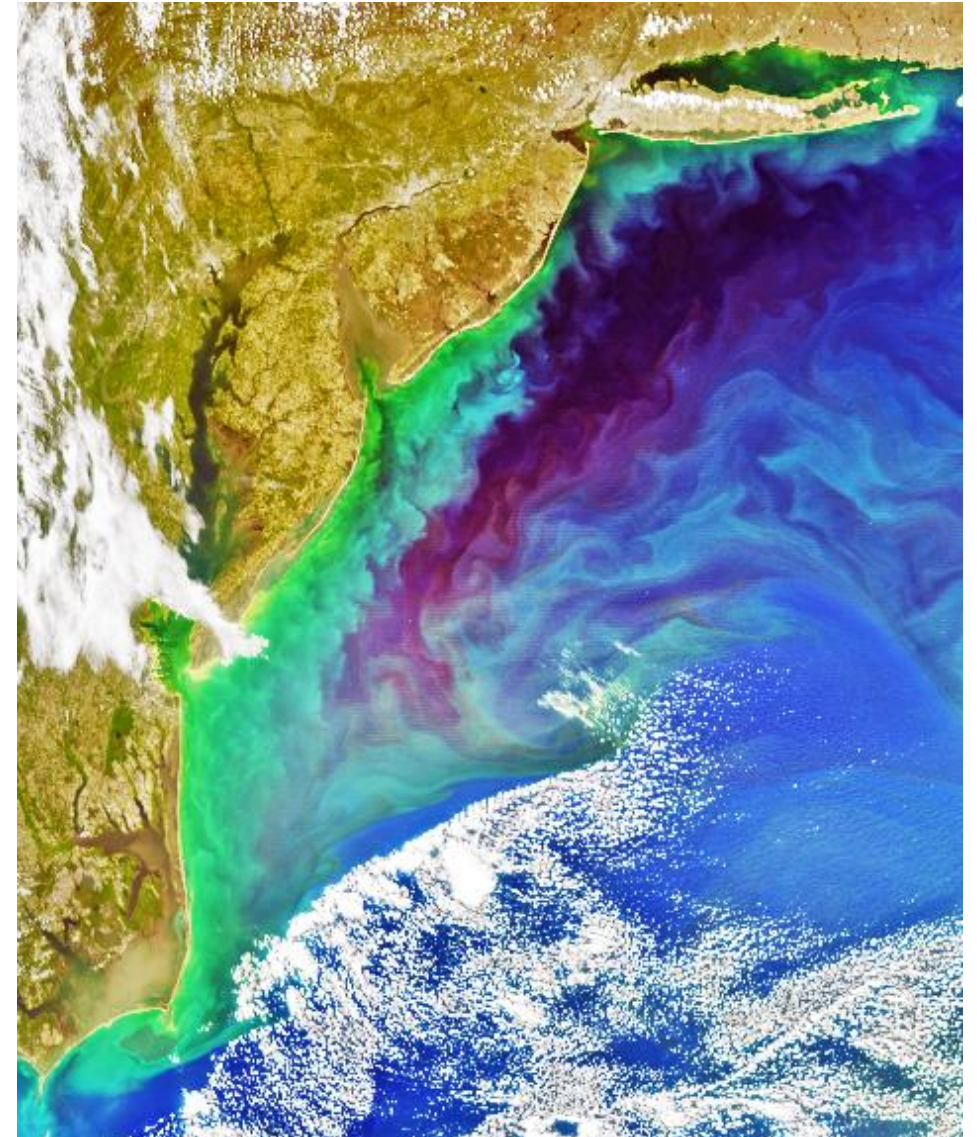
Familiar with downloading, visualizing, and interpreting ocean color satellite data products

## Information is current as of July 2024.

Data versions, access points, resources will evolve!

## By the end of this section, you will:

- Know which NASA tools provide access to PACE data
- Know where to find resources available to utilize PACE data (software, Python notebooks, tutorials)
- Know how to stay up to date with data access and resources over time



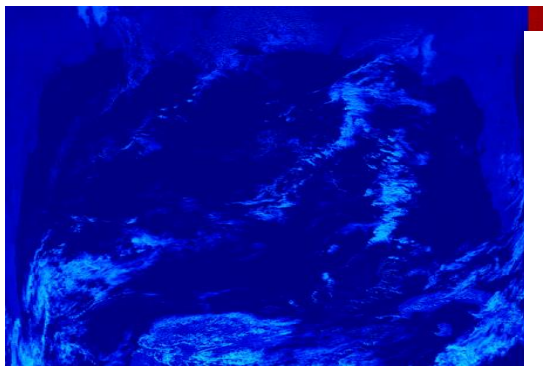
PACE Enhanced RGB, US East Coast, April 26, 2024. Credit: Joseph Knuble



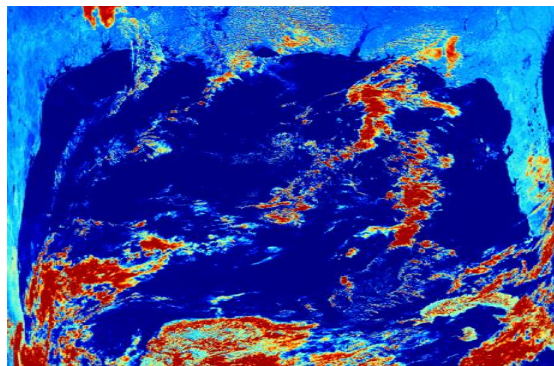


# Definition of Terms: Data Level

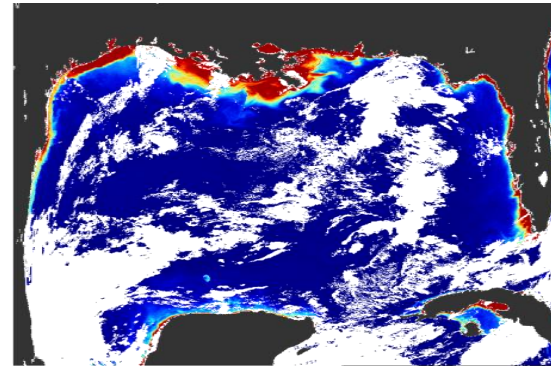
Data Level	Description	Format
Level 1A	Raw instrument data & spacecraft telemetry, reformatted to netCDF4	NetCDF4
Level 1B	Calibrated & geolocated instrument data	NetCDF4
Level 1C	Calibrated, geolocated, and co-registered to a common grid	NetCDF4
Level 2	Derived geophysical science data products	NetCDF4
Level 3	Temporally and spatially composited (binned and mapped) products	NetCDF4
Level 4	Geophysical products derived from combined Level-3 inputs and/or models	NetCDF4



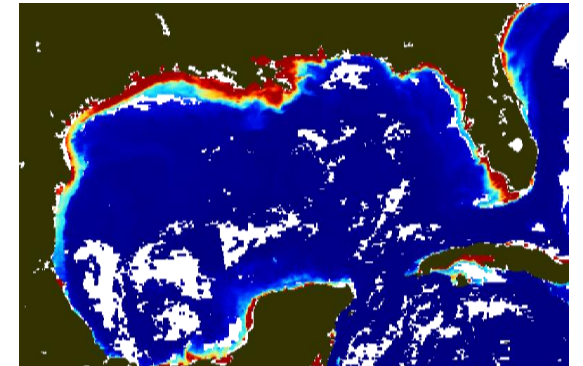
**Level-1A** – Uncalibrated  
859 nm Band



**Level-1B** – Calibrated  
Top-Of-Atmosphere Radiance at 859 nm



**Level-2** – Remote Sensing  
Reflectance at 645 nm




**Level-3** – Mapped 4km  
8-day Chlorophyll-a



# Definition of Terms: Data Status

**Data Status:** Descriptor of data maturity. Diagnostic is the least & Standard is the most mature.





All currently available PACE data products are **Diagnostic**, **Test**, or **Provisional** status.

Data Status	Description	Maturity
<b>Diagnostic</b>	Products that support analysis of algorithm behavior, but are not intended for science.	<b>Least Mature</b>  <b>Most Mature</b>
<b>Test</b>	Have not yet been reviewed by algorithm developers an/or may have known errors under investigation.	
<b>Provisional</b>	Results have been reviewed and are within expectations, but have not yet been validated and may still contain significant errors.	
<b>Standard (Science Quality)</b>	Products produced by an algorithm that has community consensus and have been validated.	



# Definition of Terms: Level-2 Ocean Data Product Suites

**Data Product Suites:** Related data products that are packaged together in one file.

 <p><b>OC_AOP</b></p> <p><b>APPARENT OPTICAL PROPERTIES</b></p> <ul style="list-style-type: none"> <li>• Remote Sensing Reflectance</li> <li>• Rrs uncertainty</li> <li>• AOT</li> <li>• Angstrom</li> <li>• <del>Incident Photosynthesis Available Radiation</del></li> <li>• <del>Normalized Fluorescence Line Height</del></li> <li>• Apparent Visible Wavelength</li> </ul>	 <p><b>OC_IOP</b></p> <p><b>INHERENT OPTICAL PROPERTIES</b></p> <ul style="list-style-type: none"> <li>• Spectral phytoplankton absorption coefficients</li> <li>• Spectral non-algal particle plus dissolved organic matter absorption coefficients</li> <li>• Spectral chromophoric dissolved organic matter absorption coefficients</li> <li>• Spectral non-algal particle matter absorption</li> <li>• Spectral particulate matter absorption coefficients</li> <li>• Spectral slope coefficients of chromophoric dissolved organic matter absorption</li> <li>• Spectral particle backscattering coefficients</li> <li>• Total spectral backscattering coefficients</li> <li>• Total absorption coefficients</li> <li>• Backscattering Slope</li> <li>• Non-algal particle matter absorption Slope</li> <li>• Uncertainties (for some listed above)</li> <li>• Diffuse attenuation coefficient (Kd_Lee)</li> <li>• Kd_Lee uncertainties</li> </ul>	 <p><b>OC_BGC</b></p> <p><b>BIOGEOCHEMISTRY</b></p> <ul style="list-style-type: none"> <li>• Concentration Of Chlorophyll-a</li> <li>• Concentration Of Particulate Organic Carbon</li> <li>• <del>Concentration Of Particulate Inorganic Carbon</del></li> <li>• Concentration Of Phytoplankton Carbon</li> </ul>	 <p><b>OC_PAR</b></p> <p><b>PHOTOSYNTHETICALLY AVAILABLE RADIATION</b></p> <ul style="list-style-type: none"> <li>• Daily PAR scalar 0-</li> <li>• Daily PAR planar 0+</li> <li>• Daily PAR planar 0-</li> <li>• Instantaneous PAR planar 0+</li> <li>• Instantaneous PAR planar 0-</li> </ul>	<p><b>More to Come:</b></p> <p>Phytoplankton Community Composition Suite</p> <p>Net Primary Production Suite</p> <p>And more...</p>
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Adapted from slide by Ivona Cetinic (EGU 2024). Data products that are crossed out are planned for the data suite but not yet available.  
 NASA ARSET – Introduction to PACE Hyperspectral Observations for Water Quality Monitoring

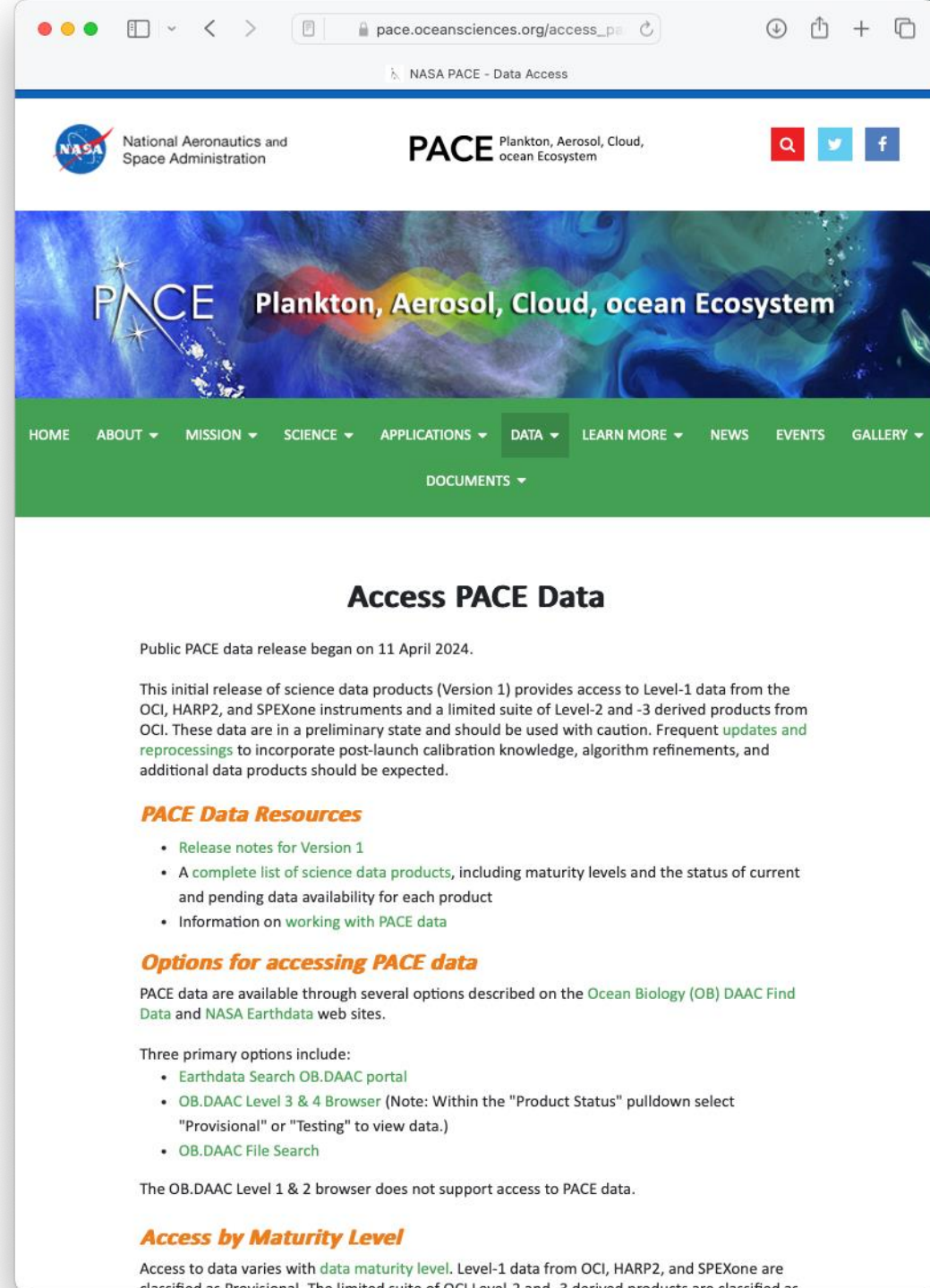


# Access PACE Data: Getting Started

## PACE Data Access Landing Page

→ Go-to-source for current information.

→ Bookmark this page!



The screenshot shows the NASA PACE Data Access landing page. At the top, there is a navigation bar with the NASA logo, the text "National Aeronautics and Space Administration", the PACE logo, and the text "Plankton, Aerosol, Cloud, ocean Ecosystem". There are also social media icons for search, Twitter, and Facebook. Below the navigation bar is a large banner image with the PACE logo and the text "Plankton, Aerosol, Cloud, ocean Ecosystem". Underneath the banner is a green navigation menu with the following items: HOME, ABOUT, MISSION, SCIENCE, APPLICATIONS, DATA, LEARN MORE, NEWS, EVENTS, GALLERY, and DOCUMENTS. The main content area has a heading "Access PACE Data" and a paragraph stating "Public PACE data release began on 11 April 2024." Below this is a paragraph explaining the initial release of science data products (Version 1) and the limited suite of Level-2 and -3 derived products from OCI, HARP2, and SPEXone instruments. There is a section titled "PACE Data Resources" with a bulleted list of links: "Release notes for Version 1", "A complete list of science data products, including maturity levels and the status of current and pending data availability for each product", and "Information on working with PACE data". Another section titled "Options for accessing PACE data" explains that PACE data are available through several options described on the Ocean Biology (OB) DAAC Find Data and NASA Earthdata web sites. It lists three primary options: "Earthdata Search OB.DAAC portal", "OB.DAAC Level 3 & 4 Browser (Note: Within the 'Product Status' pulldown select 'Provisional' or 'Testing' to view data.)", and "OB.DAAC File Search". A note states "The OB.DAAC Level 1 & 2 browser does not support access to PACE data." At the bottom, there is a section titled "Access by Maturity Level" which explains that access to data varies with data maturity level and that Level-1 data from OCI, HARP2, and SPEXone are classified as Provisional.

# Access PACE Data: Getting Started

[Data Products Table Webpage](#): Current & future data products, availability, and status.

Always up-to-date. → **Bookmark this page!** ←

## Data Products Table

Calibrated Radiometry and Polarimetry | Ocean Properties to be Produced by OCI | Atmospheric Properties to be Produced by OCI | Land Data Products to be Produced by OCI | Aerosol and Ocean Properties from HARP2 | Aerosol and Land Surface Properties from HARP2 | Cloud Properties from HARP2 | Ocean Surface Properties from HARP2 | Aerosol and Ocean Properties from SPEXone | Aerosol and Land Surface Properties from SPEXone | Aerosol and Ocean Properties from OCI + HARP2 + SPEXone

Access to data varies with its status (data maturity level). Provisional data are available through [Earthdata Search](#), the [OB.DAAC File Search](#) and [Level 3 & 4 Browser](#). Test and Diagnostic data are available through the [OB.DAAC File Search](#) and [Level 3 & 4 Browser](#). See also "[Access PACE Data](#)".

### What do colors in the "Availability" column mean?

Available

Coming soon!

Currently implementing and evaluating

No approach currently identified

### Calibrated Radiometry and Polarimetry

Calibrated and geolocated radiometry and polarimetry as observed at sensor.

Product	Description and Use	Units	Availability	Status	Additional Info
Spectral top-of-atmosphere radiances from OCI	Spectral radiance observed at the top of the atmosphere.	$W m^{-2} \mu m^{-1} sr^{-1}$	Level-1B 1-km at nadir; daily - Level-1C; daily	Provisional	Level-1C draft data format and examples
Spectral top-of-atmosphere radiances and polarimetry from SPEXone	Spectral radiance and polarimetry observed at the top of the atmosphere, for all sensor viewing angles.	Various	Level-1B TBD; daily - Level-1C; daily	Provisional	Level-1C draft data format and examples
Spectral top-of-atmosphere radiances and polarimetry from HARP2	Spectral radiance and polarimetry observed at the top of the atmosphere, for all sensor viewing angles.	Various	Level-1B TBD; daily - Level-1C; daily	Provisional	Level-1C draft data format and examples

# Access PACE Data: Getting Started

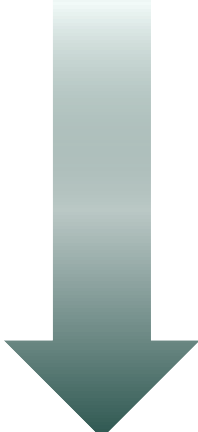
I am accustomed to getting ocean color data from OB.DAAC (Ocean Biology Distributed Active Archive Center) via the Level 1,2 and Level 3,4 browsers on the Ocean Color Website. **Is accessing PACE data different?**

Yes!

- Access varies with **data level & data status** (data maturity).  
For example:
  - Provisional Level-1 & -2 data available through Earthdata Search
  - Provisional, Test, and Diagnostic data available from the OB.DAAC File Search & OB.DAAC Level-3 & -4 Browser

## What is available today?

- **Level-1 Provisional** data from **OCI, HARP2, & SPEXone**
- Limited suite of **OCI Level-2 & Level-3** derived products
- **Version-2 Release**. Preliminary data, use with caution. Frequent updates & reprocessing should be expected.

Data Status	Maturity
Diagnostic	<b>Least Mature</b>  <b>Most Mature</b>
Test	
Provisional	
Standard (Science Quality)	



# Access PACE Data: Where to Find Data Products



## NASA Worldview

Data visualization. Quickly outputs images & videos.

← Currently OCI Level-2, Chl-a & True Color



WORLDVIEW

<https://worldview.nasa.gov>



## NASA Earthdata

Comprehensive: download data from \*all\* NASA Distributed Active Archive Centers (DAACs). Cloud-based.

← Level-1 & -2, Provisional: OCI, SPEXone, HARP2 data



EARTHDATA  
OPEN ACCESS FOR OPEN SCIENCE

<https://earthdata.nasa.gov>

## NASA OB.DAAC (Ocean Biology DAAC) Website

“File Search” & “Level 3 & 4 Browser” Search Tools

- **Provisional, Test, and Diagnostic** data
- Level/maturity available varies by instrument/product



OCEAN COLOR  
OB.DAAC | OBPG

<https://oceancolor.gsfc.nasa.gov>



# Access PACE Data: Where to Find Data Products



## NASA Worldview

Data visualization. Quickly outputs images & videos.

← Currently OCI Level-2, Chl-a & True Color

**WORLDVIEW**

<https://worldview.nasa.gov>





# NASA WORLDVIEW

Layers Events Data

## OVERLAYS

- Place Labels  
© OpenStreetMap contributors, Natural Earth
- Coastlines / Borders / Roads  
© OpenStreetMap contributors
- Coastlines  
© OpenStreetMap contributors
- Chlorophyll a (L2)  
PACE / OCI v1 NRT  
  
< 0.0100 mg/m<sup>3</sup> >= 20.000 mg/m<sup>3</sup>

## BASE LAYERS

- Corrected Reflectance (True Color)  
PACE / OCI v1 NRT

Group Similar Layers

[+ Add Layers](#) [Start Comparison](#)

Search for places or enter coordinates

Zoom out view

2000 km  
1000 mi

77.7890°, -139.3775° EPSG:4326

1 DAY

2024 APR 20



024

APR 2024

MAY 2024

JUN

DAY



# Access PACE Data: Where to Find Data Products



## NASA Worldview

Data visualization. Quickly outputs images & videos.

← Currently OCI Level-2, Chl-a & True Color

**WORLDVIEW**

<https://worldview.nasa.gov>



## NASA Earthdata

Comprehensive: download data from \*all\* NASA Distributed Active Archive Centers (DAACs). Cloud-based.

← Level-1 & -2, Provisional: OCI, SPEXone, HARP2 data

**EARTHDATA**  
OPEN ACCESS FOR OPEN SCIENCE

<https://earthdata.nasa.gov>



EARTHDATA SEARCH

OBDAAC (Ocean Biology Distributed ... Leave Portal

Search for collections or topics



PACE x

Filter Granules Clear Filters

Granule Search

Granule ID(s) Search Single or Multiple Granule IDs...

Temporal Start YYYY-MM-DD HH:mm:ss

End YYYY-MM-DD HH:mm:ss Recurring?

Day/Night Find granules captured during the day, night or anytime. Anytime

Data Access Find only granules that have browse images Find only granules that are available online

Search Results (32 Collections)

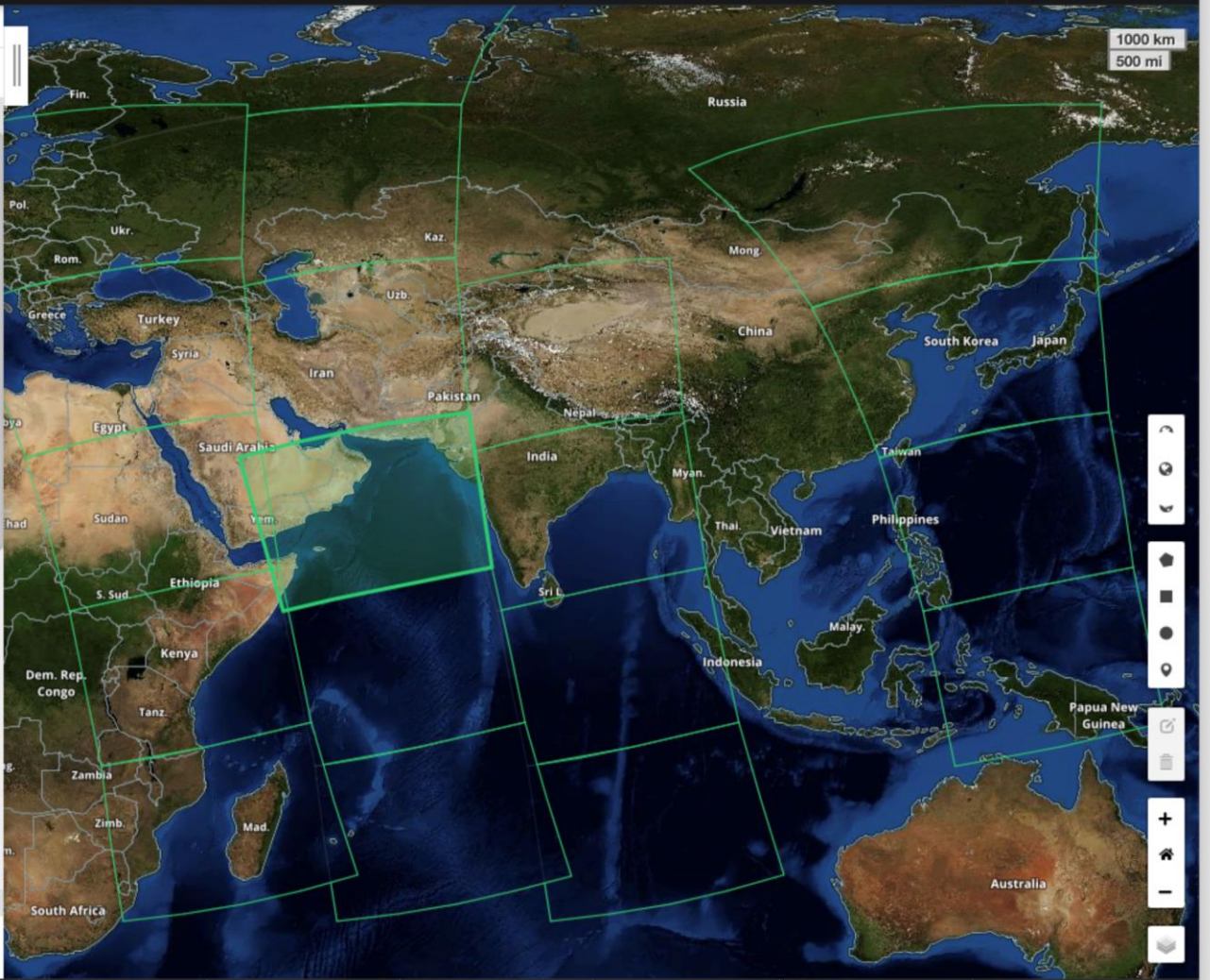
PACE OCI Level-1C Science Data, V1.0

Showing 20 of 7,096 matching granules Sort View

PACE_OCI.20240607T103610.L1C.5 km.nc START 2024-06-07 10:36:10 END 2024-06-07 10:41:09 + Download	PACE_OCI.20240607T103110.L1C.5k m.nc START 2024-06-07 10:31:10 END 2024-06-07 10:36:09 + Download
PACE_OCI.20240607T102610.L1C.5 km.nc START 2024-06-07 10:26:10 END 2024-06-07 10:31:09 + Download	PACE_OCI.20240607T102110.L1C.5k m.nc START 2024-06-07 10:21:10 END 2024-06-07 10:26:09 + Download
PACE_OCI.20240607T101610.L1C.5k m.nc START 2024-06-07 10:16:10 END 2024-06-07 10:21:09 + Download	PACE_OCI.20240607T090751.L1C.5 km.nc START 2024-06-07 09:07:51 END 2024-06-07 09:10:56 + Download
PACE_OCI.20240607T090251.L1C.5 km.nc START 2024-06-07 09:02:51 END 2024-06-07 09:07:50 + Download	PACE_OCI.20240607T085751.L1C.5 km.nc START 2024-06-07 08:57:51 END 2024-06-07 09:02:50 + Download

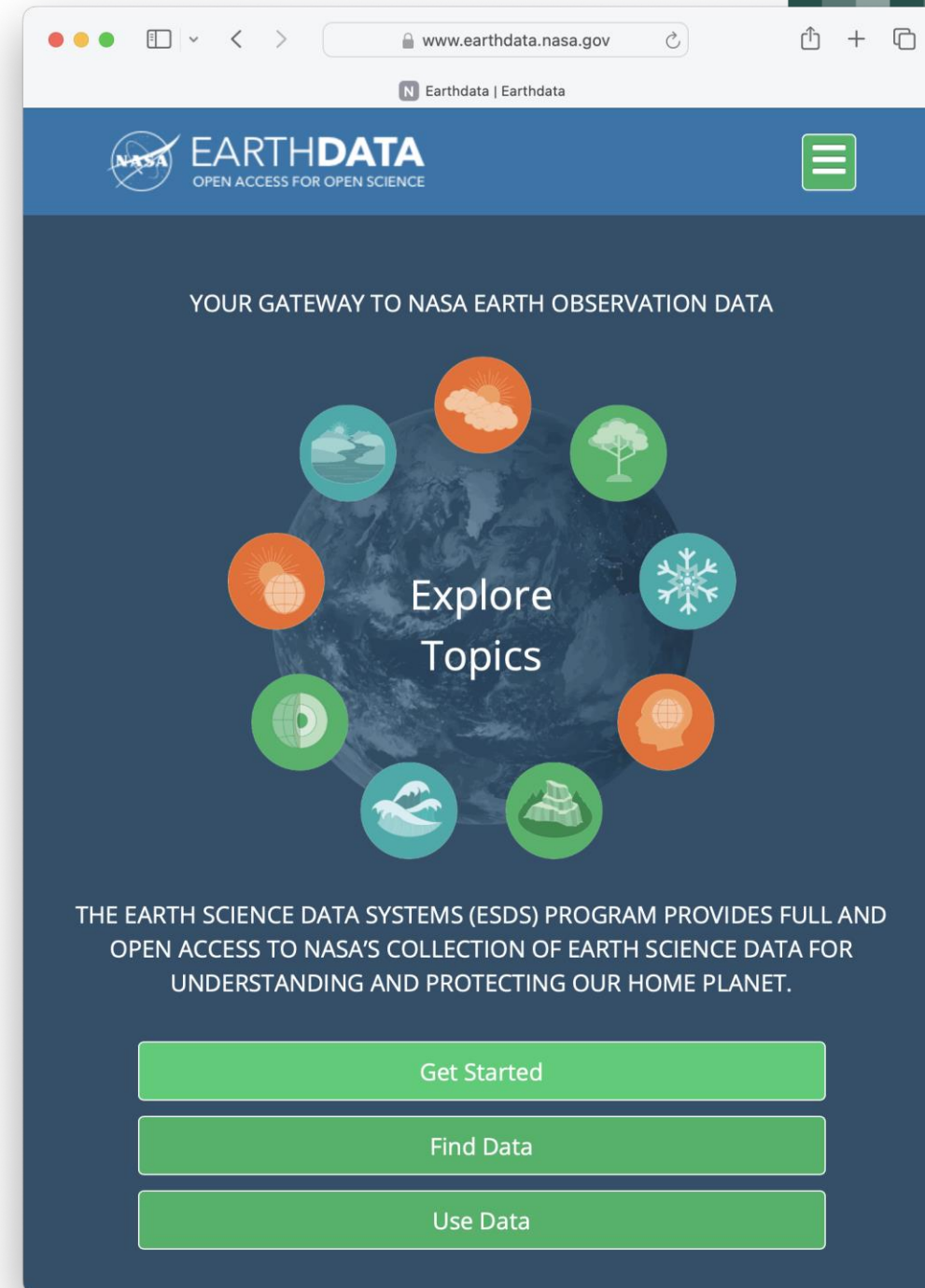
Search Time: 0.7s

Download All 7,096



# Access PACE Data: EarthData

- [Create an Earthdata Account](#)
  - A login is required to download data.
- [Earthdata Getting Started](#)
  - Link to guidance for using Earthdata
- [Keep PACE: Introduction to the PACE Mission, Products and Data Discovery](#)
  - Recent PACE OB.DAAC Tutorial
  - Includes Earthdata (& OB.DAAC) data search details



# Access PACE Data: Where to Find Data Products



## NASA Worldview

Data visualization. Quickly outputs images & videos.

← Currently OCI Level-2, Chl-a & True Color



WORLDVIEW

<https://worldview.nasa.gov>



## NASA Earthdata

Comprehensive: download data from \*all\* NASA Distributed Active Archive Centers (DAACs). Cloud-based.

← Level-1 & -2, Provisional: OCI, SPEXone, HARP2 data



EARTHDATA  
OPEN ACCESS FOR OPEN SCIENCE

<https://earthdata.nasa.gov>

## NASA OB.DAAC (Ocean Biology DAAC) Website

“File Search” & “Level 3 & 4 Browser” Search Tools

- **Provisional, Test, and Diagnostic** data
- Level/maturity available varies by instrument/product



OCEAN COLOR  
OB.DAAC | OBPG

<https://oceancolor.gsfc.nasa.gov>



# Access PACE Data: NASA OB.DAAC

## OB.DAAC Level 3 & 4 Browser Tool

Visualize, extract, and download select Level 3 PACE data products

### User Note:

- (1) First, in the “Product Status” menu, select “Provisional” or “Test”; (2) then select PACE instrument options in the “Instrument” menu; and (3) select your product, period, & resolution.
- Includes useful help feature (red button to right)
- Downloads require a NASA Earthdata account (<https://urs.earthdata.nasa.gov>).

oceancolor.gsfc.nasa.gov/l3

NASA Ocean Color

## Level 3 & 4 Browser

Extract or Download Data Help

Product Status	Instrument	Product	Period	Resolution
Provisional	PACE-OCI	Chlorophyll concentratio	Daily	0.1-deg

Start Date: 2024-02-25 End Date: 2024-06-07

Previous

PACE-OCI  
Chlorophyll concentration

Tue, 30 Apr 2024 (L3) Wed, 1 May 2024 (L3) Thu, 2 May 2024 (L3) Fri, 3 May 2024 (L3)

Sat, 4 May 2024 (L3) Sun, 5 May 2024 (L3) Mon, 6 May 2024 (L3) Tue, 7 May 2024 (L3)

Wed, 8 May 2024 Thu, 9 May 2024 Fri, 10 May 2024 Sat, 11 May 2024

# Access PACE Data: NASA OB.DAAC

## OB.DAAC File Search Tool

Search currently available for Provisional, Diagnostic, and Test data

### User Notes:

- Has a useful help feature (red button on left) that details and useful search features (e.g., wget & curl text generation for data of interest, advanced search, etc.).
- Downloads require a NASA Earthdata account (<https://urs.earthdata.nasa.gov>).

The screenshot shows the NASA Ocean Color File Search tool interface. At the top, there is a browser address bar with the URL "oceandata.sci.gsfc.nasa.gov/api" and a "NASA Ocean Color" header. Below the header, there is a "LOGIN" button with a right-pointing arrow. The main heading is "File Search", followed by a red "Help" button. A navigation bar contains four tabs: "Basic" (selected), "Advanced", "Search Ancillary", and "Search by Subscription". The "Instrument:" field is set to "PACE-OCI". The "Data Class:" section has three radio buttons: "Show All" (selected), "Level-0", and "Level-1C". The "Data Type:" section has three radio buttons: "PACE-OCI level-1C at SPEXone width" (selected), "All", "Refined Only", and "Quicklook Only". Under "Additional Options", there are three unchecked checkboxes: "Display results as text, one file name per line", "Prepend URL prefix to file name", and "Include checksum with file name". A code block contains the following commands:

```
wget -q --post-data="results_as_file=1&sensor_id=42&dtid=1355&sdate=2024-02-25 00:00:00&edate=2024-06-07 03:34:54&subType=1" -O - https://oceandata.sci.gsfc.nasa.gov/api/file_search
curl -d "results_as_file=1&sensor_id=42&dtid=1355&sdate=2024-02-25 00:00:00&edate=2024-06-07 03:34:54&subType=1" https://oceandata.sci.gsfc.nasa.gov/api/file_search
```

A "Submit" button is located at the bottom of the form.

# Resources to Work With PACE Data: Python

## [PACE Jupyter Notebook Tutorials](#)

### Learn with OCI Tutorial Notebooks:

- Data Access
- File Structure at Three Processing Levels
- OCSSW: Installing & Running Command-line Tools
- OCSSW: Processing with Command-line Tools
- (Also Learn with HARP2: Data Visualization)
- More to come...





# Resources to Work With PACE Data: Cloud, Github

## NASA Cloud Support

**Earthaccess**, a Python application programming interface (API) to search for and download or stream data from the Earthdata cloud.

- [Earthaccess Information](#)
- [Download Earthaccess](#)

## NASA Openscapes Earthdata Cloud Cookbook

- [Vital resource to understanding Earthdata & the Cloud](#)



## Github

**nasa-pace**

Want to share your PACE-relevant code on a Github repository with the Community? Tag it with “nasa-pace”.

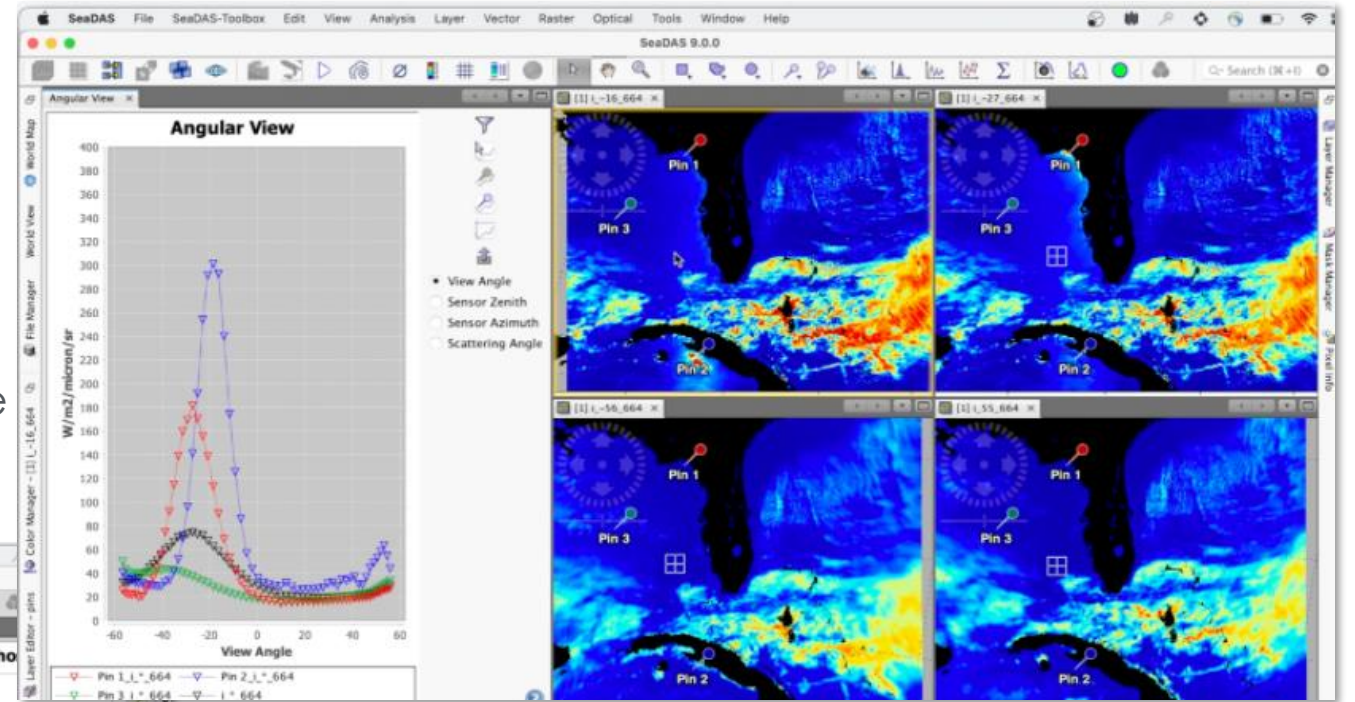
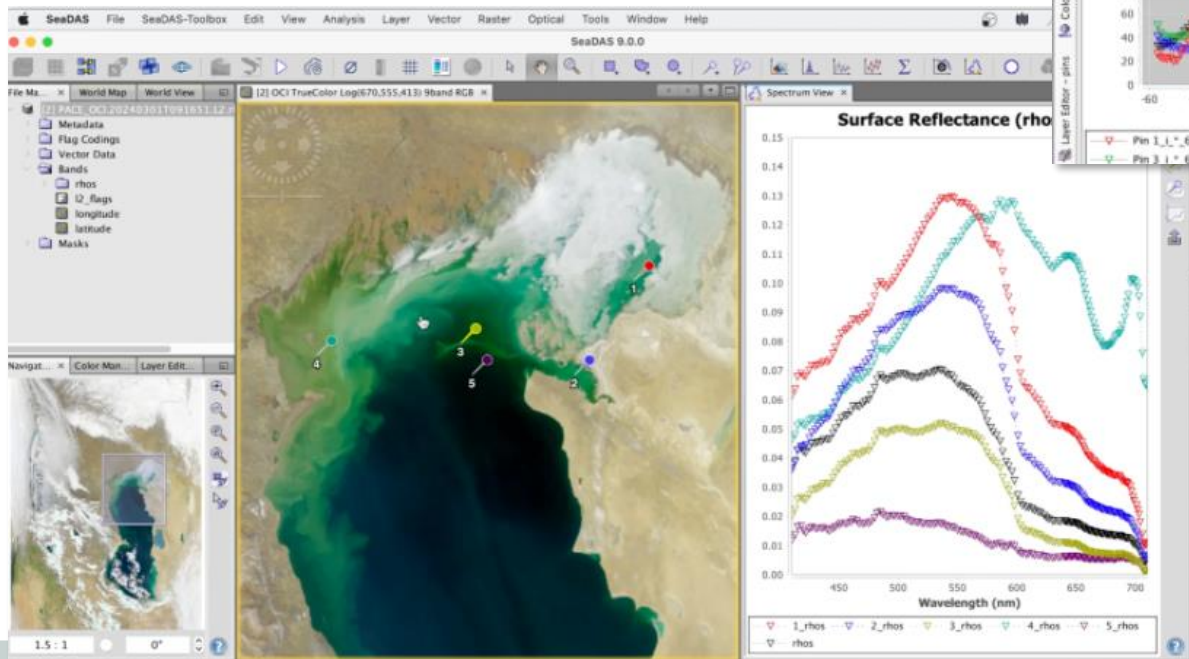


# Resources to Work With PACE Data: SeaDAS

## NASA/OB.DAAC Data Analysis and Visualization Software

[Download SeaDAS](#)

- Newest Version: 9.0.1, May 2024
- Version 9.x supports PACE data.
- Operating Systems: Mac, Linux, Windows
- Exports to formats including **GeoTIFF** (readable by GIS), **KML** (readable by Google Earth), & others.



## [Tutorial Video on SeaDAS 9.0](#)

Includes OCI hyperspectral (left) and polarimeter (above) data examples.

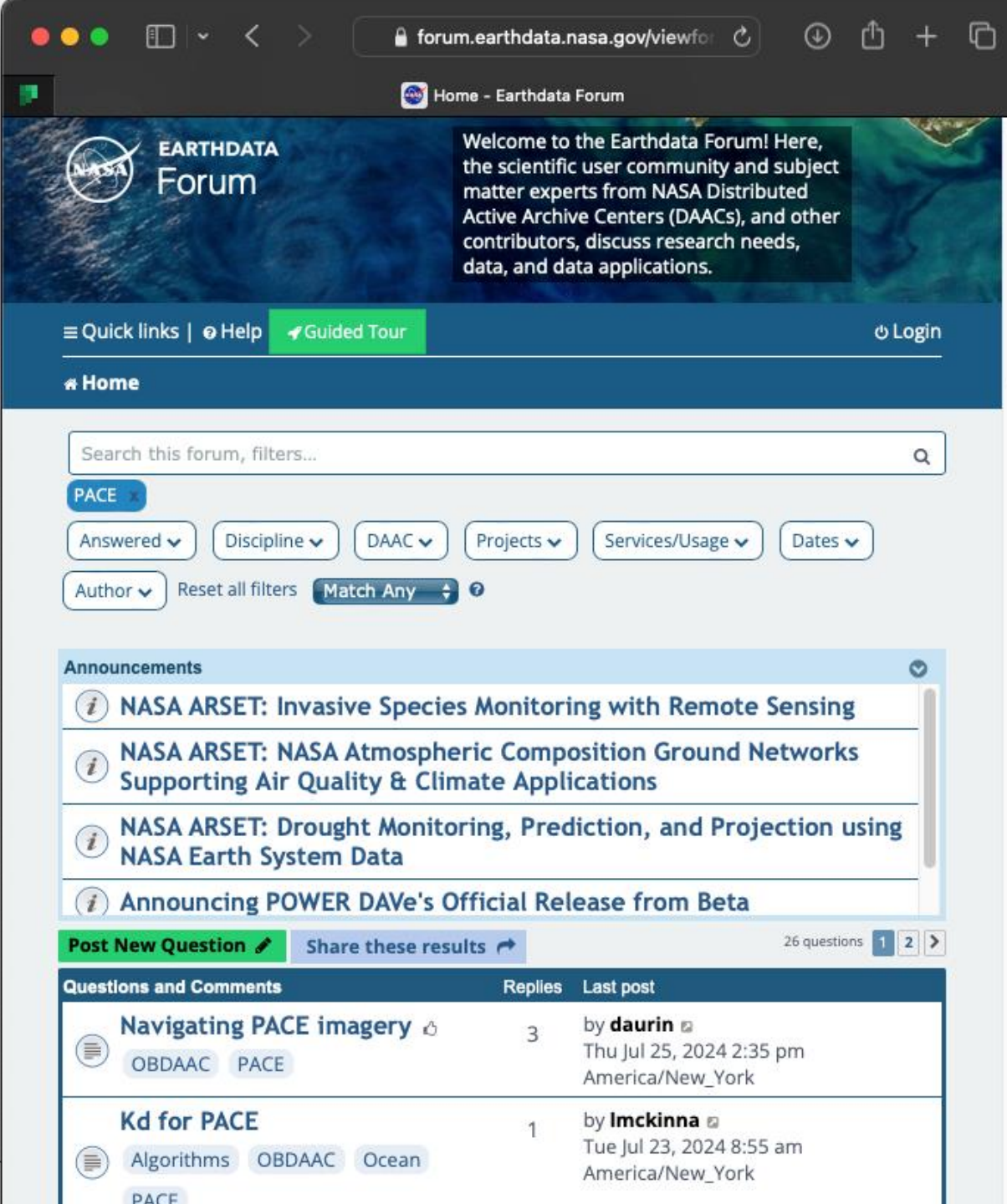


# Resources: Questions

## Data Questions:

- [Earthdata Forum Main Webpage](#)
- [Earthdata Forum for PACE-Tagged Questions](#)

Questions are answered by NASA-affiliated personnel.



## Summary



<https://pace.gsfc.nasa.gov>

Follow us: @NASAOcean



Speaker email:  
[morgaine.mckibben@nasa.gov](mailto:morgaine.mckibben@nasa.gov)

- PACE is leading the next generation of water quality science and applications.
- On ramp to future hyperspectral missions (e.g., NOAA GeoXO, NASA GLIMR, & SBG).

### Stay up-to-date with all things PACE:

- PACE-Community Email List
- [PACE Website](#)
  - Data Access & Data Product Table Webpages
  - News & Events Sections





## Demonstration

Examine OCI Level-2 Remote Sensing Reflectances and Level-3 Water Quality Parameters using SeaDAS

# About SeaDAS

- [ARSET Training: Overview of SeaDAS 8.4.1 for the Processing, Analysis, and Visualization of Optical Remote Sensing Data for Water Quality Monitoring](#)
- [Tutorial Video on SeaDAS 9.0](#)



# Access PACE Data: Where to Find Data Products



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Data visualization. Quickly outputs images & videos.

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OCEAN COLOR  
OB.DAAC | OBPG

<https://oceancolor.gsfc.nasa.gov>





Part 2:  
**Summary**



# Summary

- Applications Program: Inform decision making activities in water resources, fisheries, ecosystem areas.
- Examples of PACE Early Adopters: Aquaculture site selection, enhanced cholera risk models, [Hypercoast](#) water quality monitoring for lakes and estuaries.
- Description and access to multiple levels of PACE data: [PACE Data Access Landing Page](#)
- Data Access: Through [OB.DAAC](#) and [Earthdata](#).
- [NASA Worldview](#): Useful for near real-time PACE true-color images and Chlorophyll-a concentration data visualization.
- Demonstration of SeaDAS: Useful for PACE data analysis and visualization.



## Looking Ahead to Part 3

- Access and visualize OCI Remote Sensing Reflectances and Level 2 and 3 Water Quality Parameters from Earthdata using open-source Python software/Jupyter Notebooks.
- Identify steps to customize the provided Jupyter Notebook software for other areas of interest and timeframes.



# Homework and Certificates

- **Homework:**
  - One homework assignment
  - Opens on 9/10/2024
  - Access from the [training webpage](#)
  - Answers must be submitted via Google Forms
  - **Due by 24/10/2024**
- **Certificate of Completion:**
  - Attend all three live webinars (attendance is recorded automatically)
  - Complete the homework assignment by the deadline
  - You will receive a certificate via email approximately two months after completion of the course.



# Contact Information

## Trainers:

- Morgaine McKibben
  - [morgaine.mckibben@nasa.gov](mailto:morgaine.mckibben@nasa.gov)
- Amita Mehta
  - [Amita.v.mehta@nasa.gov](mailto:Amita.v.mehta@nasa.gov)

- [ARSET Website](#)
- Follow us on Twitter!
  - [@NASAARSET](#)
- [ARSET YouTube](#)

## Visit our Sister Programs:

-  [DEVELOP](#)
-  [SERVIR](#)



# Resources

- [Earthdata Forum Main Webpage](#)
- [Earthdata Forum for PACE-Tagged Questions](#)
- [PACE Data Access Landing Page](#)





**Thank You!**

