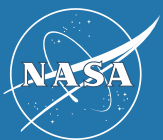
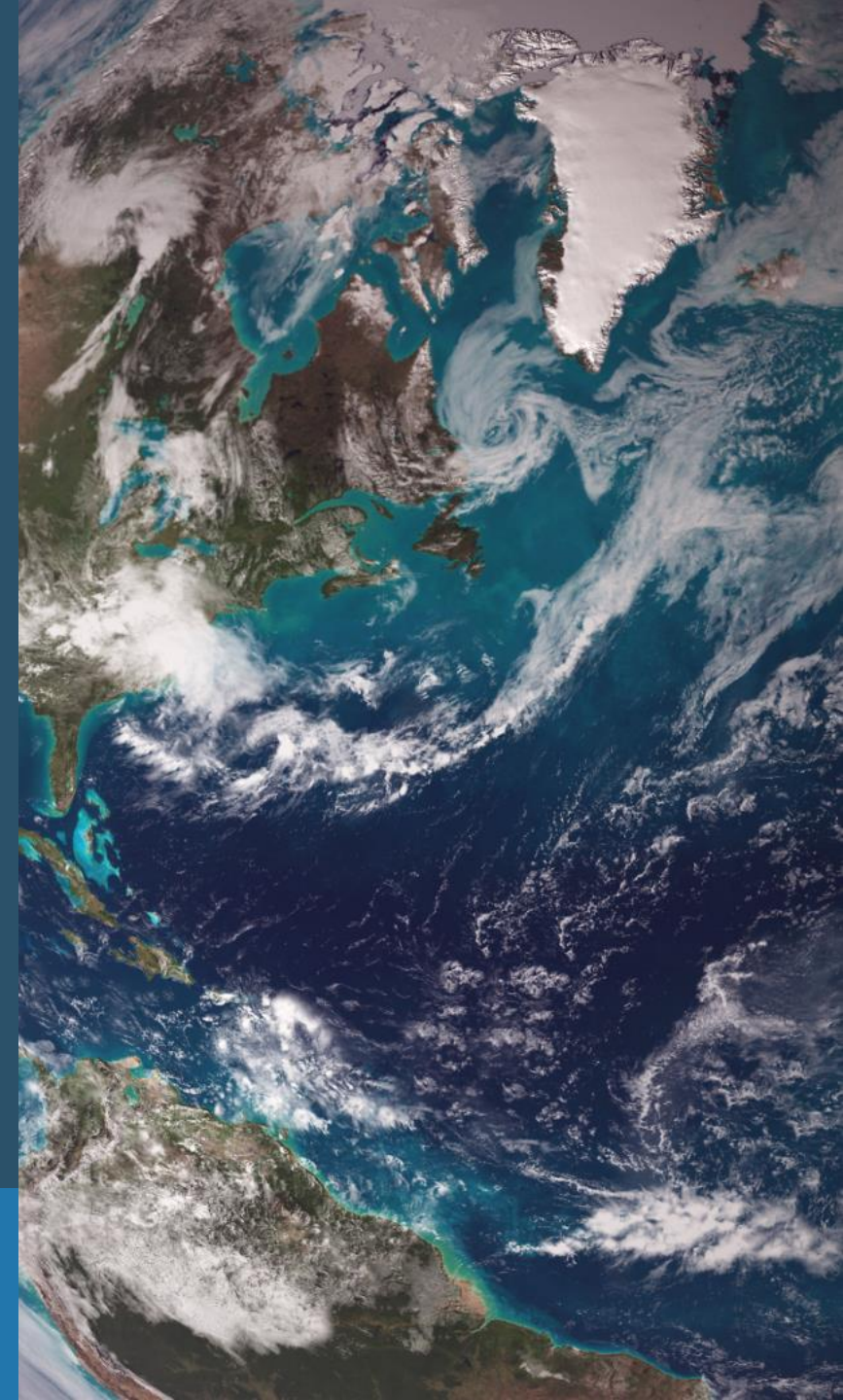


Keeping PACE

Introduction to the Plankton, Aerosol, Cloud,
ocean Ecosystem mission, its products, and discovering data
at OB.DAAC

March 27, 2024

Alicia Scott, Deputy Manager at OB.DAAC



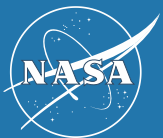
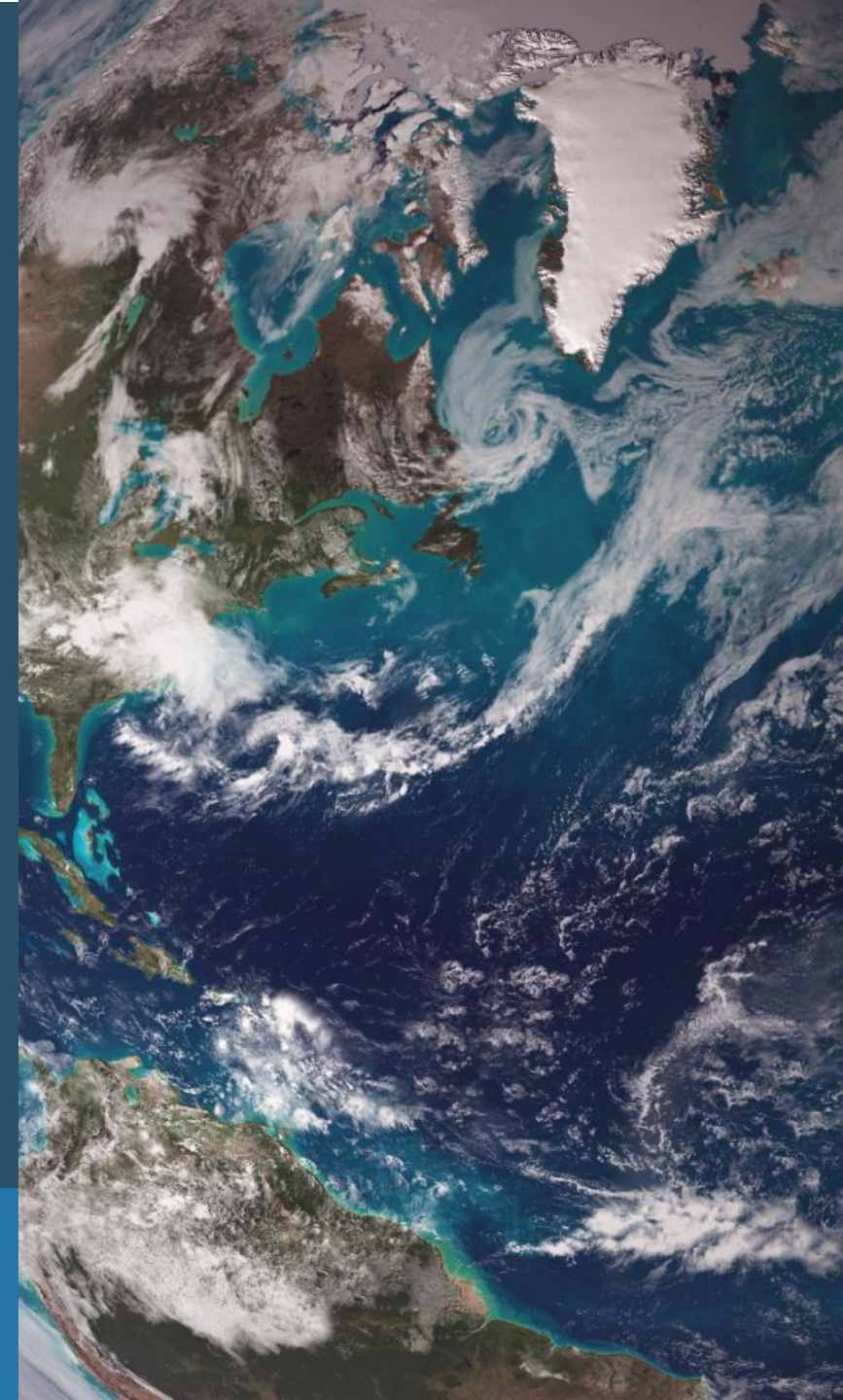
EARTHDATA
OPEN ACCESS FOR OPEN SCIENCE

Agenda/Table of Contents

1. Mission Introduction
2. Data Products
3. Finding PACE Data
4. How to Prepare
5. Training and Tutorials

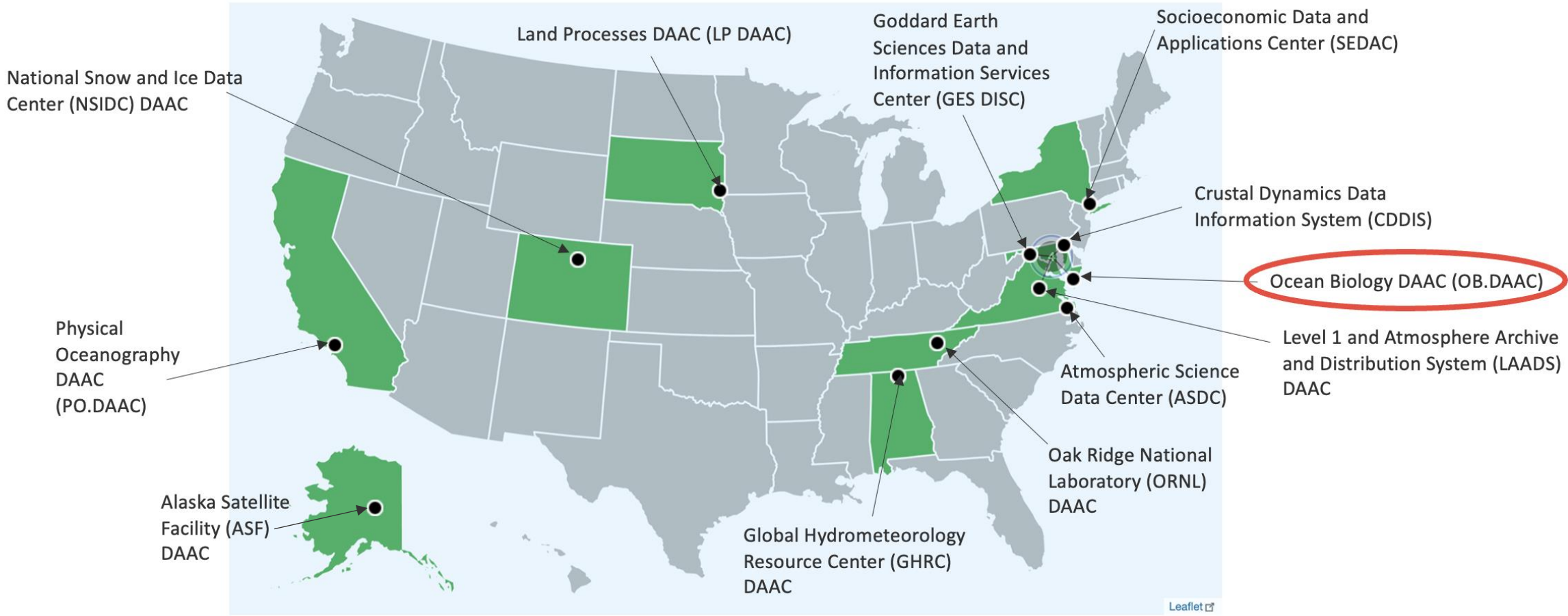
Mission Introduction

An overview of the PACE mission and it's data archive center.



EARTHDATA
OPEN ACCESS FOR OPEN SCIENCE

NASA DAACs



Who is OB.DAAC

The Ocean Biology Distributed Active Archive Center (OB.DAAC) joined the NASA DAACs in 2013. It is located at NASAs Goddard Space Flight Center in Greenbelt, MD and is co-located with its data provider, the Ocean Biology Processing Group (OBPG).

Mission Overview

The Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) mission will extend the high-quality ocean ecological, ocean biogeochemical, cloud, and aerosol particle data records begun by NASA from heritage missions such as SeaWiFS, MODIS, MISR, and VIIRS.

Mission Overview

Key characteristics:

- Launched on February 8, 2024 on a Falcon 9 from Kennedy Space Center in Florida.
- 676.5 km Altitude
- Polar, Ascending, Sun-Synchronous Orbit; 98-degree inclination
- 13:00 UTC Local Equatorial Crossing
- 3-yr design life; 10-yr propellant
- 9-12 hrs latency (on average; full range ~3-24 hrs)

Mission Management:

NASA Goddard Space Flight Center, UMBC Earth and Space Institute, and SRON/Airbus (Netherlands)

Data Summary:

- Expected Data Delivery: April 2024
- L0-L3 Science Data*
- Data Volume: 1.5PB (over mission lifetime based on current heritage products)

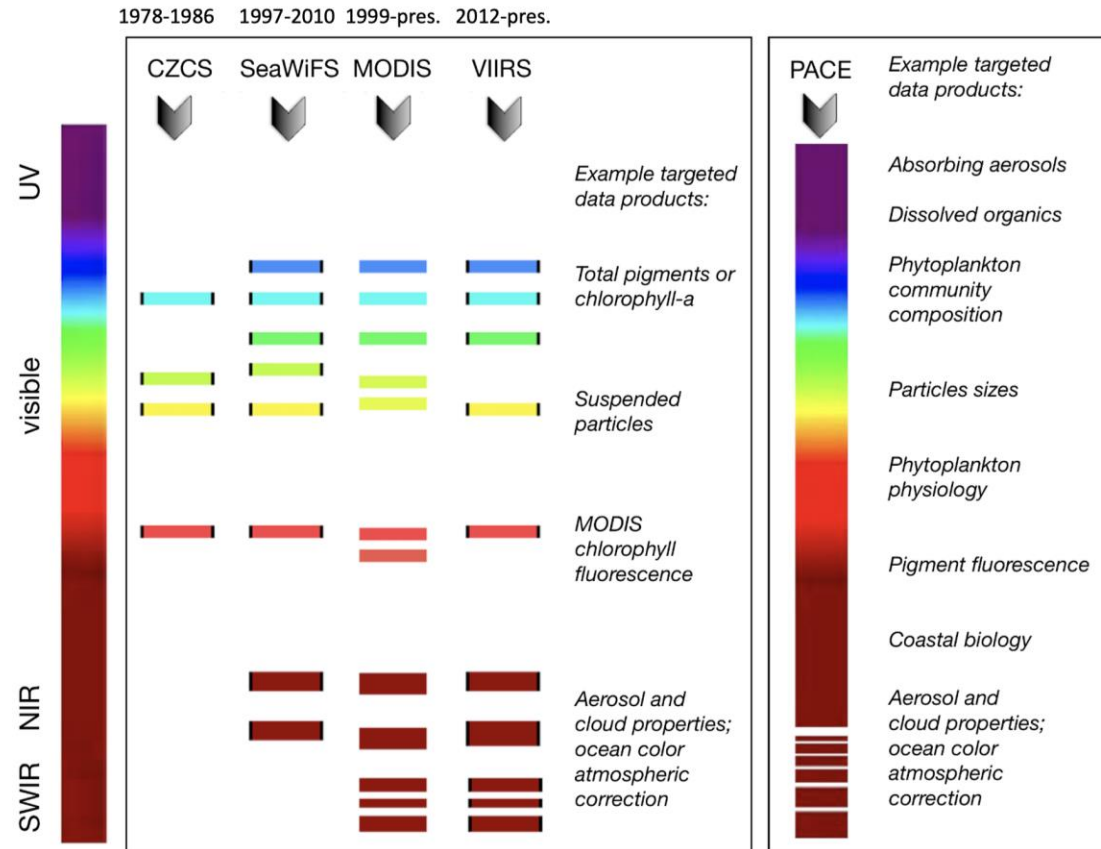
Instruments

- PACE's primary sensor, the Ocean Color Instrument (OCI), is an advanced global, hyperspectral imaging radiometer with a continuous spectral range from the ultraviolet to near-infrared, plus 7 shortwave infrared bands.
- The Spectro-Polarimeter for Planetary Exploration (SPEXone) is a narrow swath, ultraviolet to near-infrared hyperspectral, multi-angle polarimeter built by a consortium in the Netherlands (SRON, Airbus DS Netherlands).
- The Hyper Angular Rainbow Polarimeter (HARP2) is a wide swath, visible to near-infrared multispectral, hyperangular polarimeter built and contributed by the University of Maryland Baltimore County.

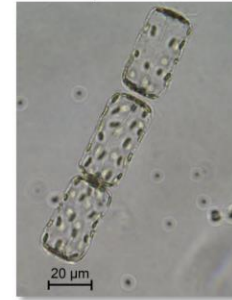
Societal Benefit

- PACE will extend **key systematic ocean color, aerosol, cloud & land climate data records**.
- PACE will reveal the **diversity of organisms fueling marine food webs** & how ecosystems respond to change.
- **Looking at the ocean, clouds, land & aerosols together** will improve knowledge of the roles each plays in our planet.

Science Capabilities – OCI

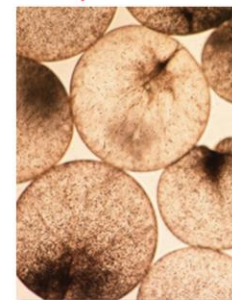


Example diatom



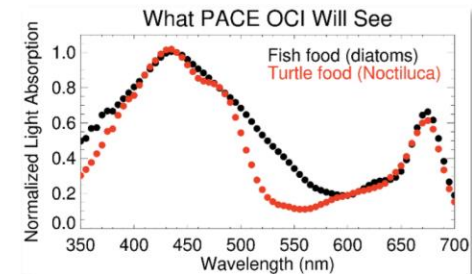
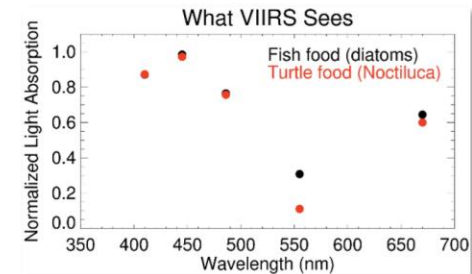
Linda Armbrrecht, abc.com.au

Example Noctiluca



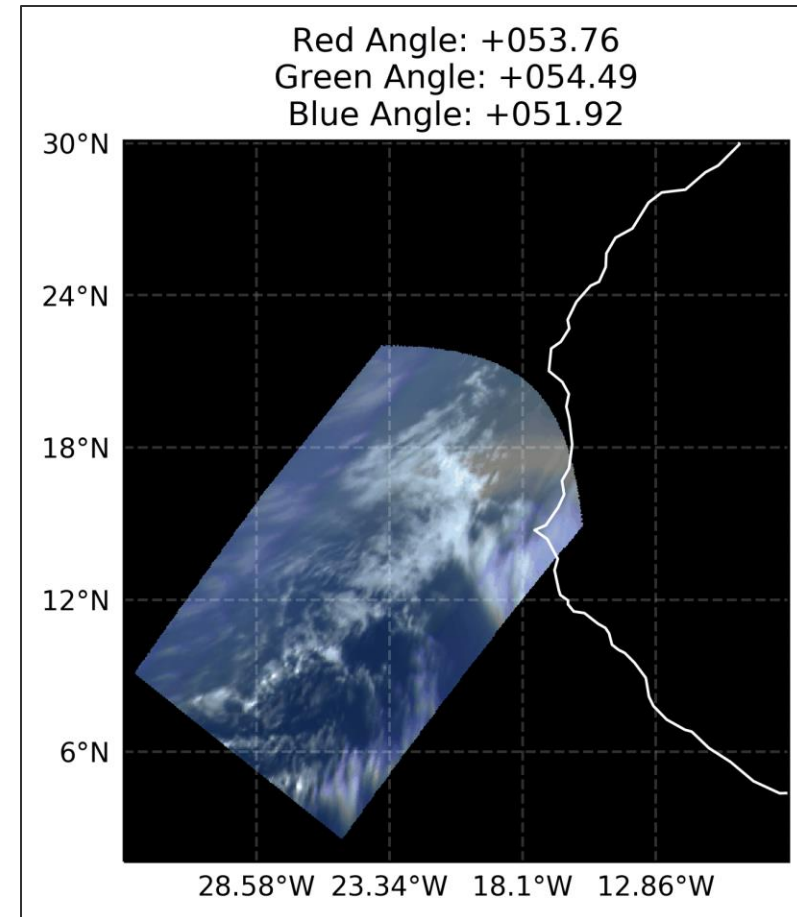
● 1 mm ●
Joaquim Goes, LDEO

signals from the ocean are small & differentiating between constituents requires additional information relative to what we have today

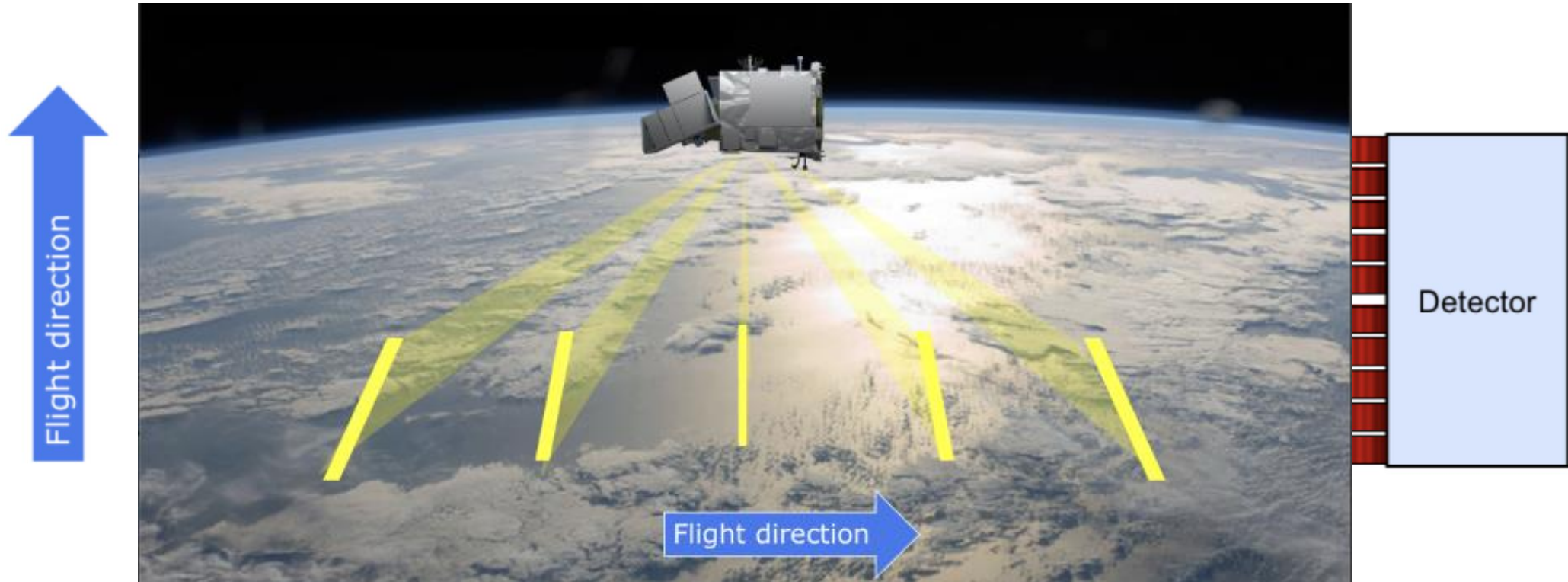


Science Capabilities – HARP2

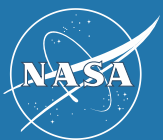
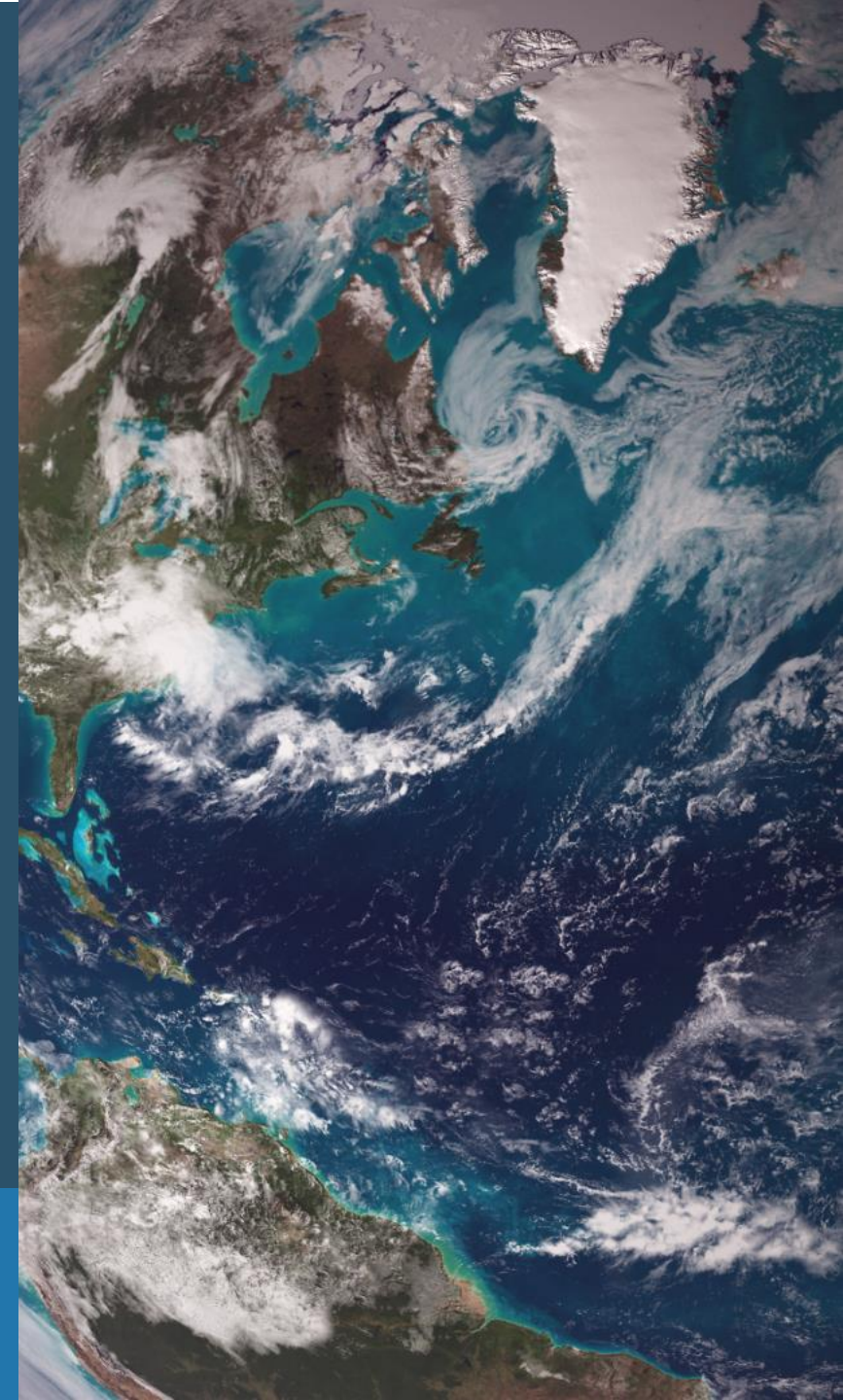
HARP Cubesat RGB imagery,
West Africa with Saharan dust,
glint, clouds 2020 / 06 / 13



Science Capabilities – SPEXone



PACE Data Products



EARTHDATA
OPEN ACCESS FOR OPEN SCIENCE

PACE DATA PRODUCTS

ATMOSPHERIC OCEAN COLOR

Top-of-Atmosphere Radiance



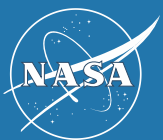
Atmospheric Contribution

Water-leaving Radiance comprises 5-15% of the total Top-of-Atmosphere Radiance signal ...

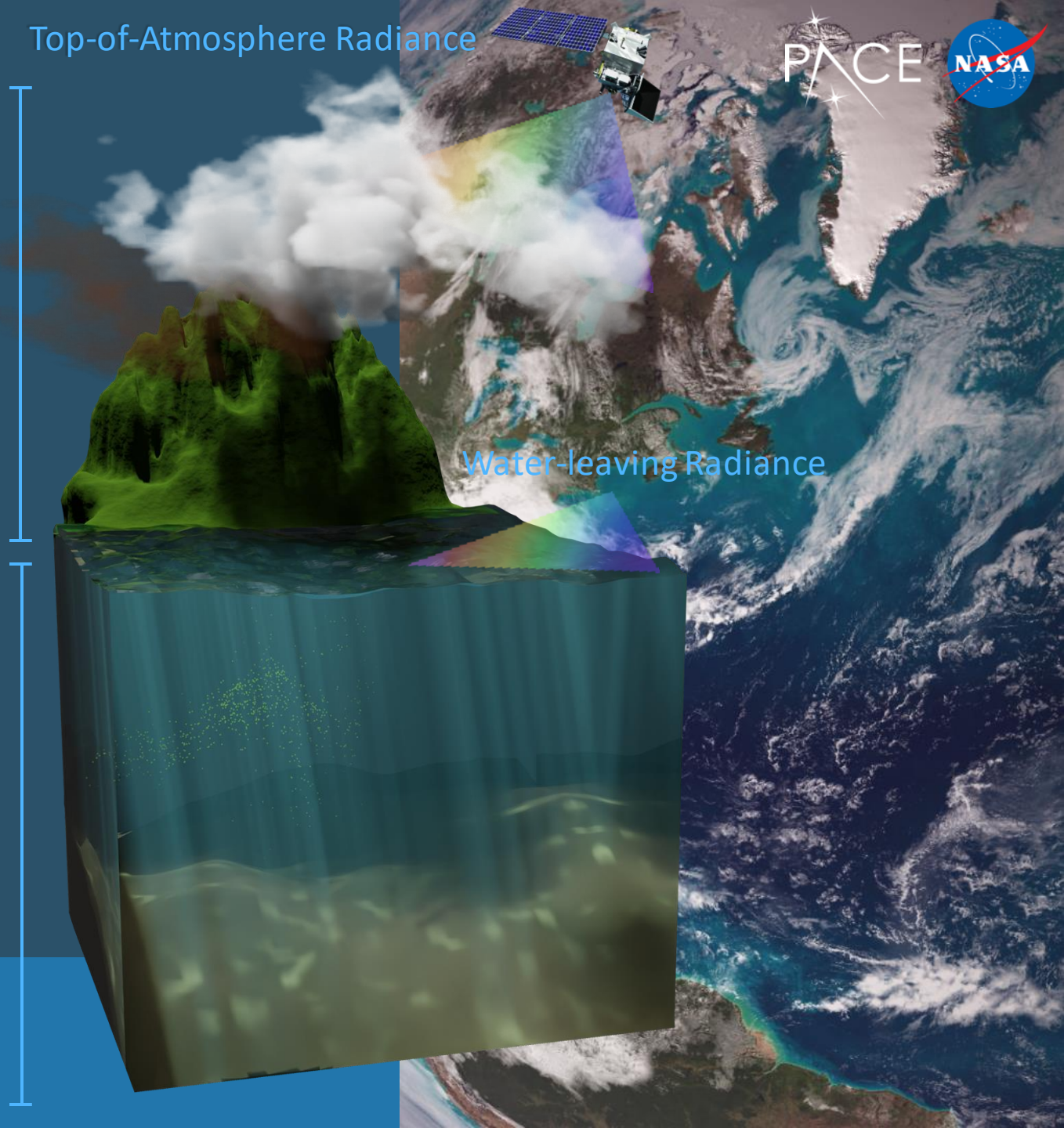
Coupling the communities is essential!

Oceanic contribution

Water-leaving Radiance



EARTHDATA
OPEN ACCESS FOR OPEN SCIENCE



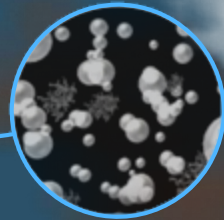
PACE DATA PRODUCTS

ATMOSPHERIC



Cloud optical depth
Cloud height
Cloud thickness

Aerosol absorption
Aerosol size distributions
Concentrations of brown/black carbon

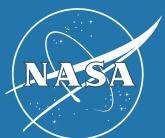


Aerosol optical depth
Aerosol heights and layers

Ocean reflectance
Whitecap fraction
Angular light distributions

Cloud phase (liquid/ice)
Droplet size distributions
Ice crystal shapes

Oil slick detection



EARTHDATA
OPEN ACCESS FOR OPEN SCIENCE

PACE DATA PRODUCTS

OCEAN COLOR

Land albedo
Vegetation indices



Mission is actively engaging the terrestrial science community (best effort basis)

Particulate carbon
Suspended matter



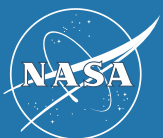
Photosynthetic pigments
Fluorescence
Plankton communities

Bathymetry
classifications

PAR:
photosynthetically
available radiation

Light penetration
Angular light distributions
Index of refraction

Light transmission
Absorption properties
Scattering properties



EARTHDATA
OPEN ACCESS FOR OPEN SCIENCE

Data Products

Land

- Surface Reflectance
- Enhanced Vegetation Index
- Photochemical Reflective Index
- Aerosol optical depth in the near infrared
- BRDF/albedo and model parameters

Atmospheric

- Spectral aerosol optical depth
- Aerosol size distribution
- Aerosol complex refractive index
- Aerosol layer height
- Cloud Mask
- Optical thickness of liquid and ice clouds

Ocean

- Spectral remote sensing reflectances
- Spectral particulate matter absorption coefficients
- Phytoplankton community composition
- Spectral phytoplankton absorption coefficients
- Net Primary Production
- Apparent visible wavelength

Data Products - Availability

Available at launch

1-3 months post-launch

Currently implementing and evaluating

No approach currently identified

Calibrated Radiometry and Polarimetry

Calibrated and geolocated radiometry and polarimetry as observed at sensor.

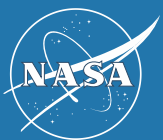
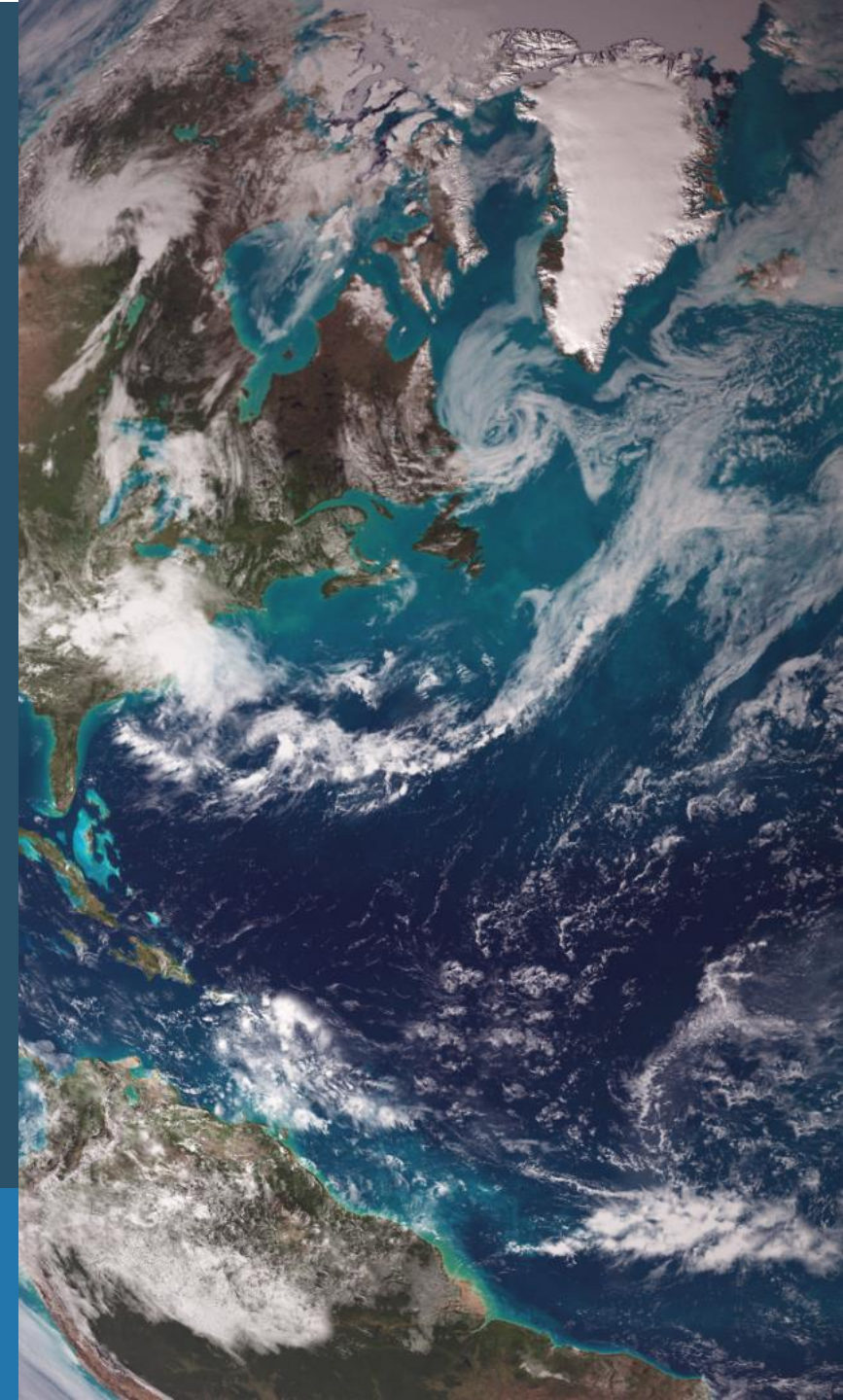
Product	Description and Use	Units	Availability	Status	Additional Info
Spectral top-of-atmosphere radiances from OCI	Spectral radiance observed at the top of the atmosphere.	$W m^{-2} um^{-1} sr^{-1}$	Level-1B 1-km at nadir; daily - Level-1C TBD; daily	Standard product	Level-1C draft data format and examples
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 TBD; daily	Standard product	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 TBD; daily	Standard product	Level-1C draft data format and examples

Ocean Properties to be Produced by OCI

Bio-optical and biogeochemical properties of seawater constituents in the sunlit upper ocean.

Product	Description and Use	Units	Availability	Status	Additional Info
Spectral remote sensing reflectances	Spectral color of the ocean in the ultraviolet-to-near infrared spectral range. Used as input into algorithms to retrieve information about colored dissolved organic matter, phytoplankton, non-algal particles, and other aquatic constituents. Provided in continuous 2.5-nm steps from 350 to 717.5-nm with a resolution (bandwidth) of 5-nm.	sr^{-1}	Level-2 1-km at nadir; daily - Level-3 4-km; daily, 8-day, monthly, annual	Standard product	ATBD SAT members: Boss, Zhai, Krotkov, Chowdhary, Stamnes, Zhang In situ measurement protocols

Finding PACE Data

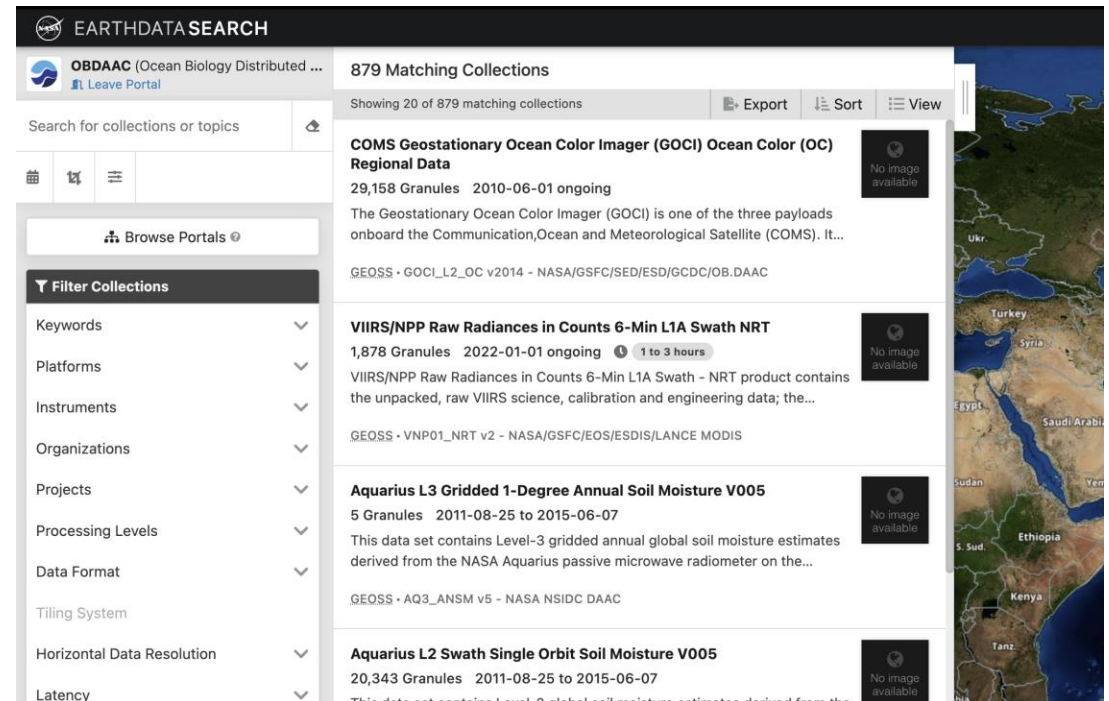


EARTHDATA
OPEN ACCESS FOR OPEN SCIENCE

Data Access

Earthdata Search Client

- Find data from any NASA DAAC and filter by various search parameters
- OB.DAAC Portal



The screenshot displays the Earthdata Search interface. At the top, the header reads "EARTHDATA SEARCH" and "OBDAAC (Ocean Biology Distributed ...)" with a "Leave Portal" link. A search bar contains the text "Search for collections or topics". Below the search bar is a "Browse Portals" button and a "Filter Collections" sidebar with expandable categories: Keywords, Platforms, Instruments, Organizations, Projects, Processing Levels, Data Format, Tiling System, Horizontal Data Resolution, and Latency. The main content area shows "879 Matching Collections" and "Showing 20 of 879 matching collections". Three collection entries are visible, each with a "No image available" placeholder and a map thumbnail on the right. The first entry is "COMS Geostationary Ocean Color Imager (GOCI) Ocean Color (OC) Regional Data" with 29,158 granules and a date range of 2010-06-01 to ongoing. The second entry is "VIIRS/NPP Raw Radiances in Counts 6-Min L1A Swath NRT" with 1,878 granules and a date range of 2022-01-01 to ongoing. The third entry is "Aquarius L3 Gridded 1-Degree Annual Soil Moisture V005" with 5 granules and a date range of 2011-08-25 to 2015-06-07. The fourth entry is "Aquarius L2 Swath Single Orbit Soil Moisture V005" with 20,343 granules and a date range of 2011-08-25 to 2015-06-07. A map on the right side of the interface shows the Eastern Mediterranean and surrounding regions, including Turkey, Syria, Saudi Arabia, Egypt, Sudan, Ethiopia, Kenya, and Tanzania.

Data Access

Python API Library: earthaccess

```
1 import earthaccess
2
3 earthaccess.login(strategy="netrc")
4
5 results = earthaccess.search_data(
6     count=2,
7     short_name="ATL08",
8     bounding_box=(-92.86, 16.26, -91.58, 16.97),
9 )
10
11 earthaccess.download(results, "./research/")
12
```

- Line 3: earthaccess handles authentication with NASA EDL.
- Line 5: earthaccess abstracts NASA's search API (CMR) into a *pythonic* module.
- Line 11: earthaccess can download or open data for both cloud and on-prem hosted datasets.

Data Access

The screenshot shows the top navigation bar of the Ocean Color website. The 'Quick Links' menu item is circled in red. A dropdown menu is open, listing several data access options. Red arrows point from the dropdown items to the main content area.

OCEAN COLOR
OB.DAAC | OBPG

ABOUT ▾ DATA ▾ RESOURCES ▾ TOOLS ▾ COMMUNITY ▾ GALLERY FORUM **Quick Links ▾**

- Direct Data Access
- File Search
- OpenDAP
- Level 1 & 2 Browser
- Level 3 & 4 Browser
- CyAN Data Browser
- PRISM-CORAL Browser
- Mission Quality Monitor
- Create an AppKey
- Data Dashboard

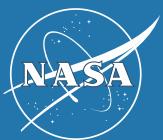
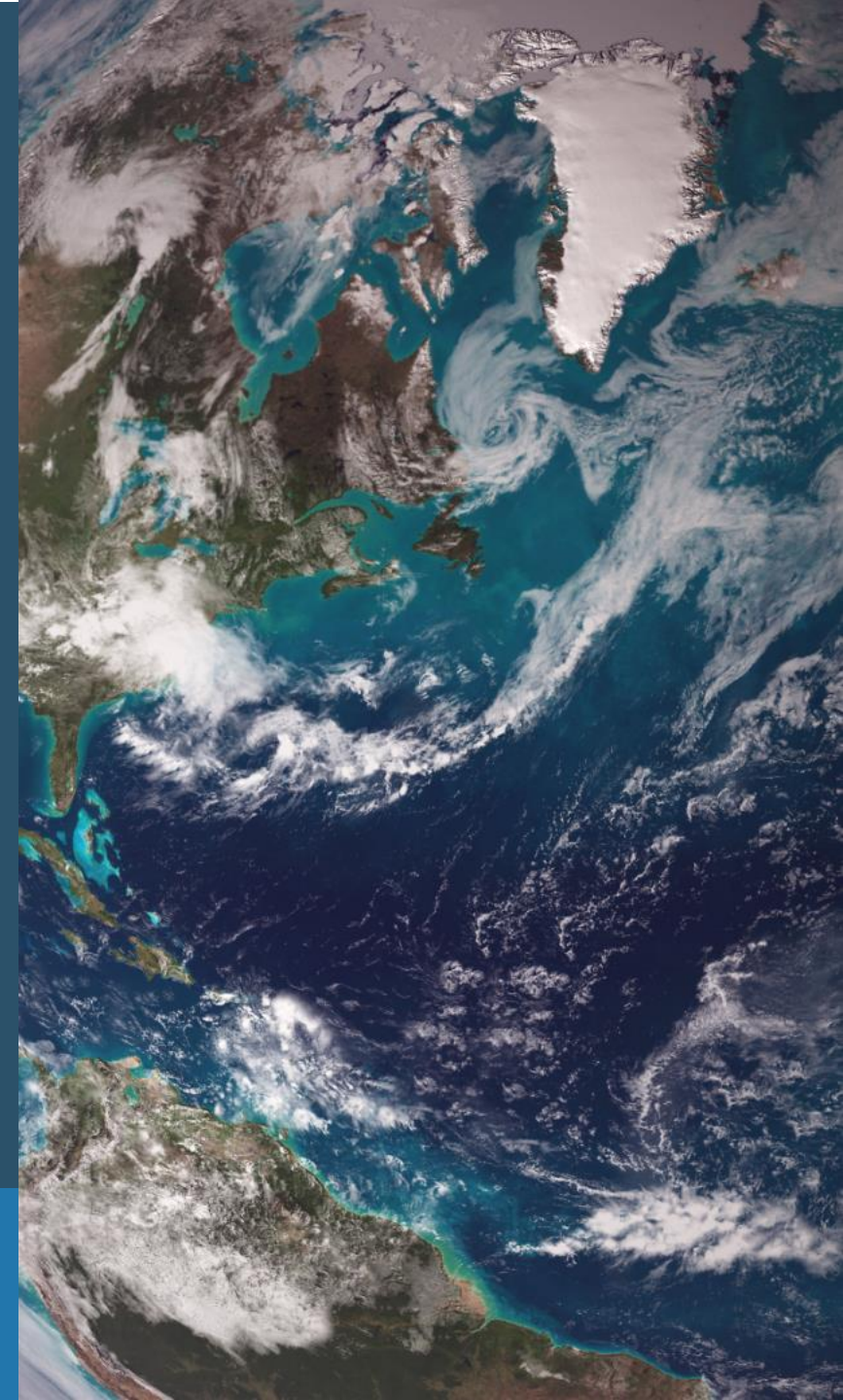
Ocean Color Feature
A Complex System

Phytoplankton in the waters off the coast of Mauritania bloom year-long, because of a resurgence of nutrient-rich water being pulled from the depths of the ocean to the surface by the strong trade winds that push surface waters from the African continent towards the west.

[See this in the Gallery](#)

How to Prepare

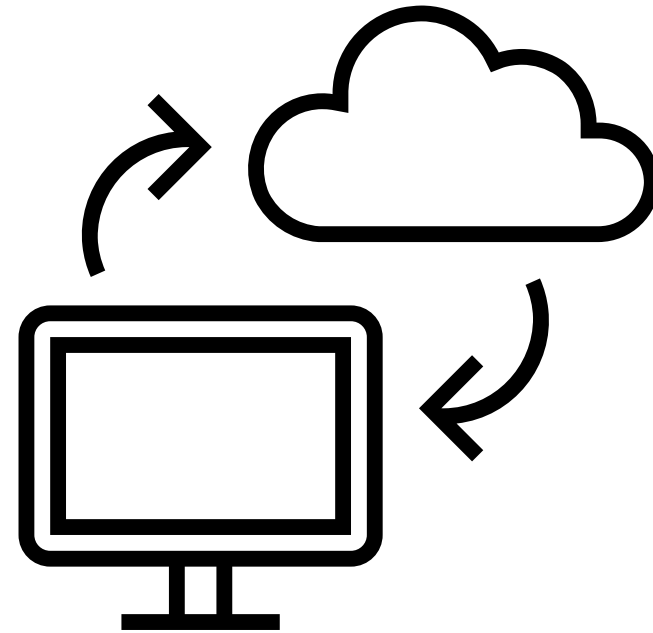
Accessing PACE data in the cloud



EARTHDATA
OPEN ACCESS FOR OPEN SCIENCE

Data Access: PACE in the Cloud

NASA has decided to use **Amazon Web Services** as our cloud provider. All public NASA science data will be available in **us-west-2** region.



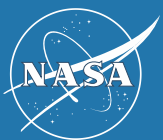
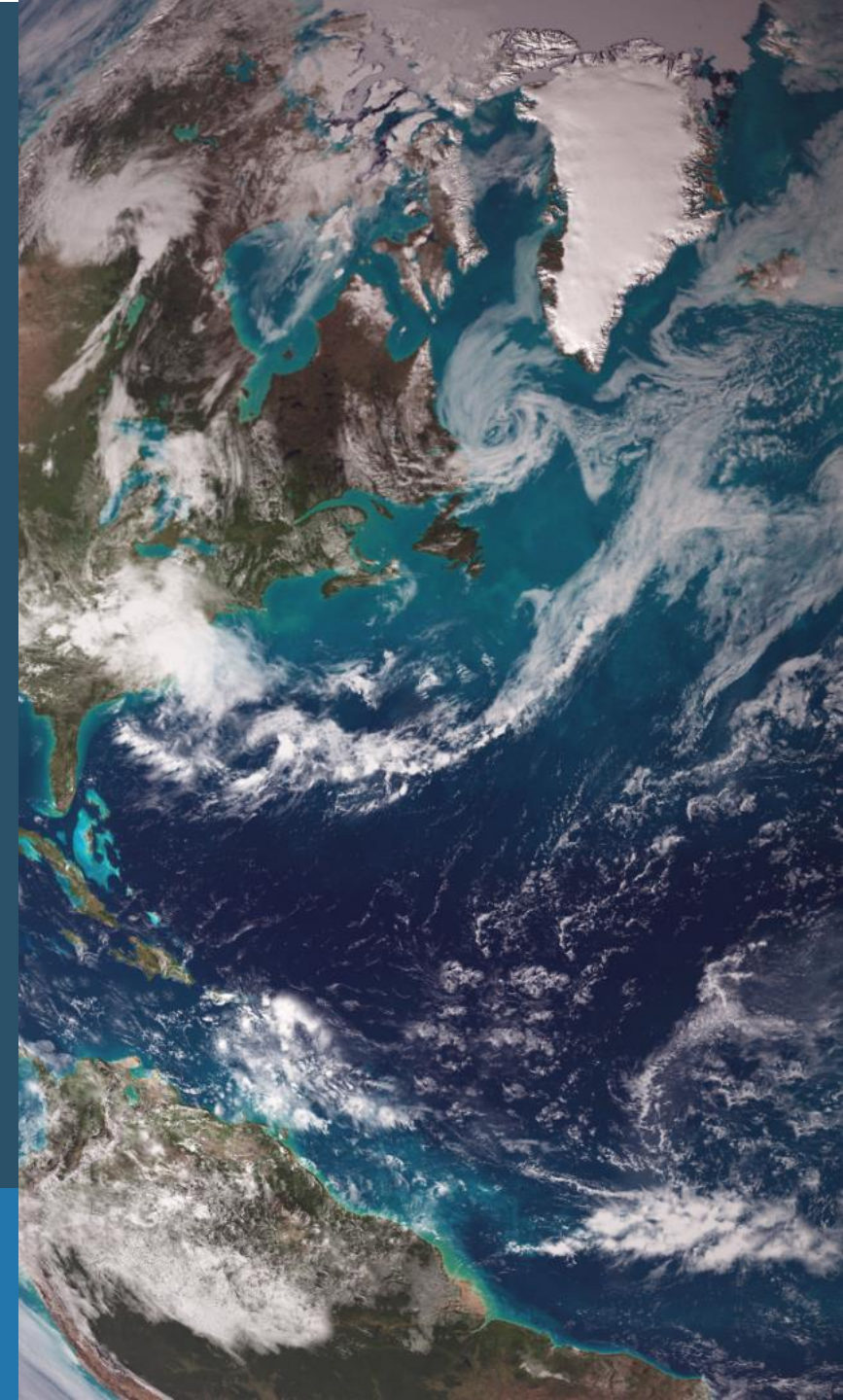
Data Access: PACE in the Cloud

- Create Earthdata Login account:
<https://urs.earthdata.nasa.gov/>
- Create an AWS account in **us-west-2** region
- Community Developed Resources:
- NASA Openscapes Earthdata Cloud Cookbook:
<https://www.youtube.com/watch?v=FcATnW5KJJo>

PACE in the Cloud: Benefits

- Improved performance
- Multiple data access methods
- Multidisciplinary data access
- Analysis next to data
- Expanded services

Trainings and Tutorials



EARTHDATA
OPEN ACCESS FOR OPEN SCIENCE

Cloud Resources

- Earthdata Cloud Primer:
<https://www.earthdata.nasa.gov/learn/webinars-and-tutorials/cloud-primer-amazon-web-services>

Ocean Color Resources

Jupyter Notebooks:

- Read and plot level-2 chlorophyll map
- Download and visualize level-2 products
- Read and plot level-3 files

More to come!

Lectures

OCB's PACE Mission Training Lectures

https://www.youtube.com/playlist?list=PL2JK_uZ15iZBq7XGAvQIo3NkwVVBMKZZO

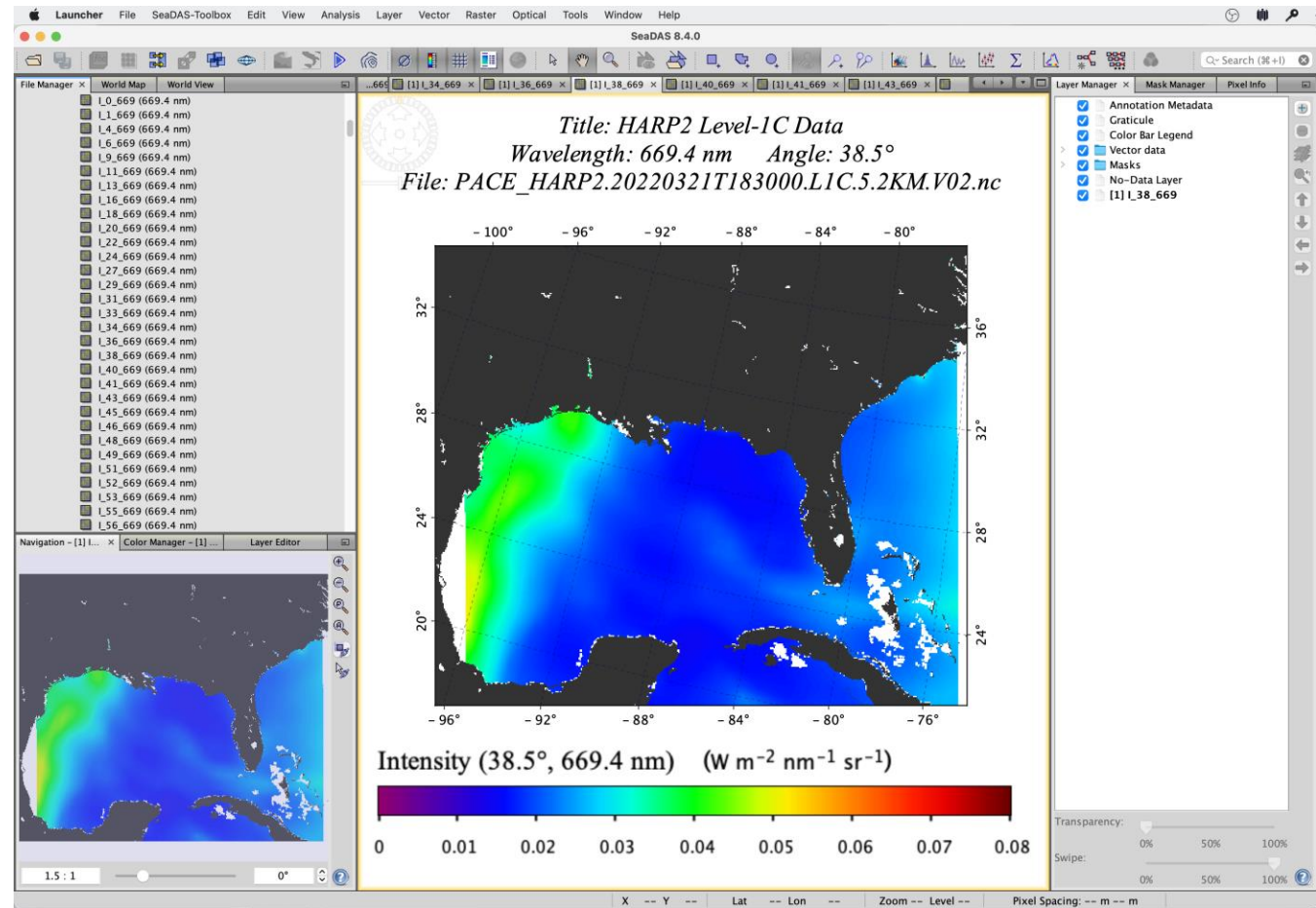
User Engagement

- Pace Hackweek: Aug 4-8
 - Presentations and code will be made publicly available once session is completed.
- Join Ocean Color mailing list

Analysis & Visualization Support

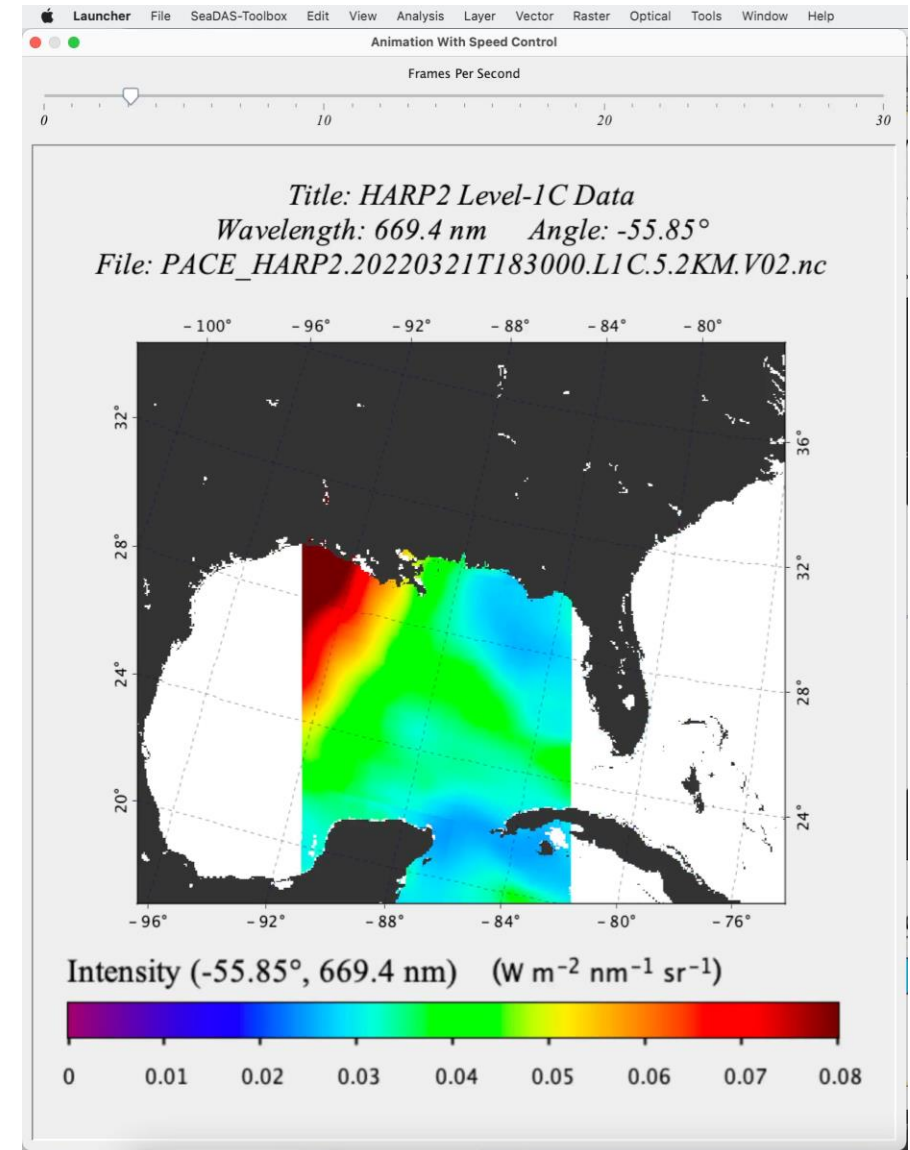
SeaDAS release: April 2024

- support for multi-angle polarimetry data
- data animation feature

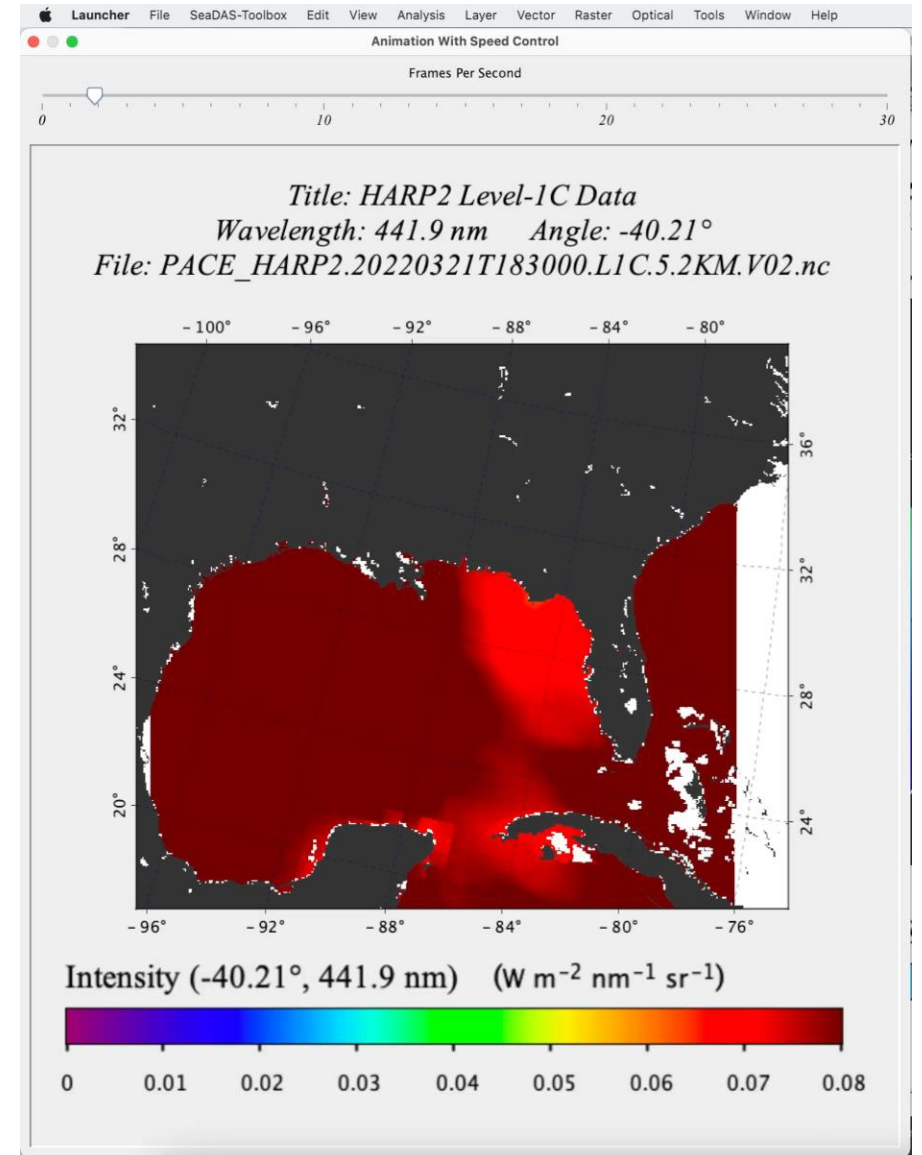
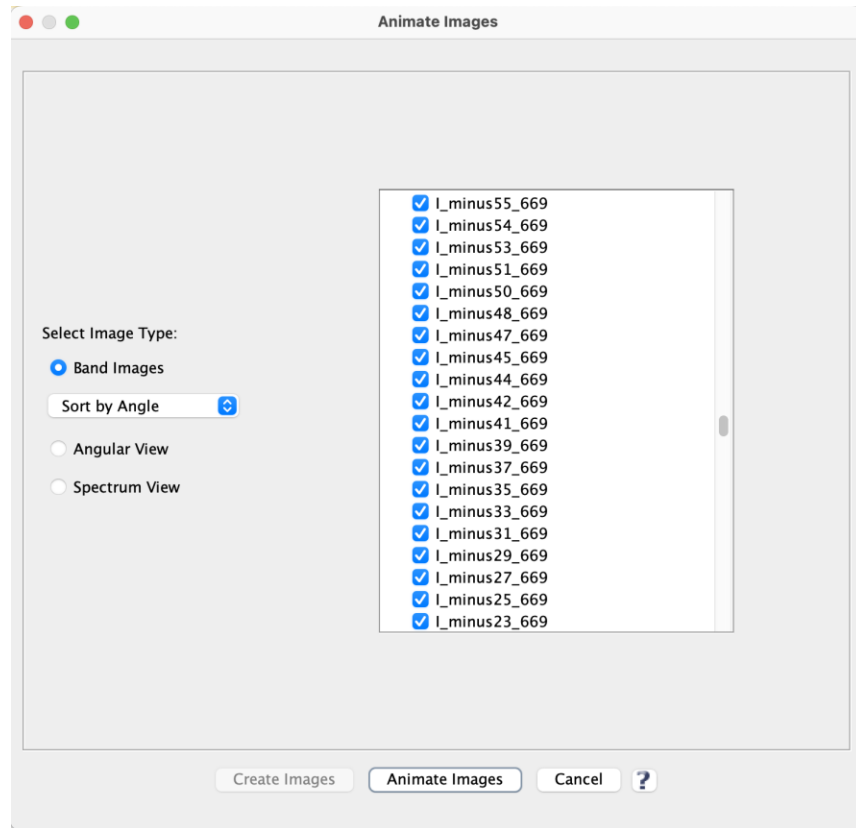


PACE Support in SeaDAS

Animation of PACE simulated
HARP2 Level-1C data: angular
view



PACE Support in SeaDAS



SeaDAS Resources

Find SeaDAS course material,
software feature tutorials and case
studies!

<https://seadas.gsfc.nasa.gov/tutorials/>



User Resources

PACE data will be available in the cloud at OB.DAAC starting in April 2024! Stay connected for announcements, updates and learning opportunities.



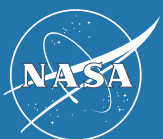
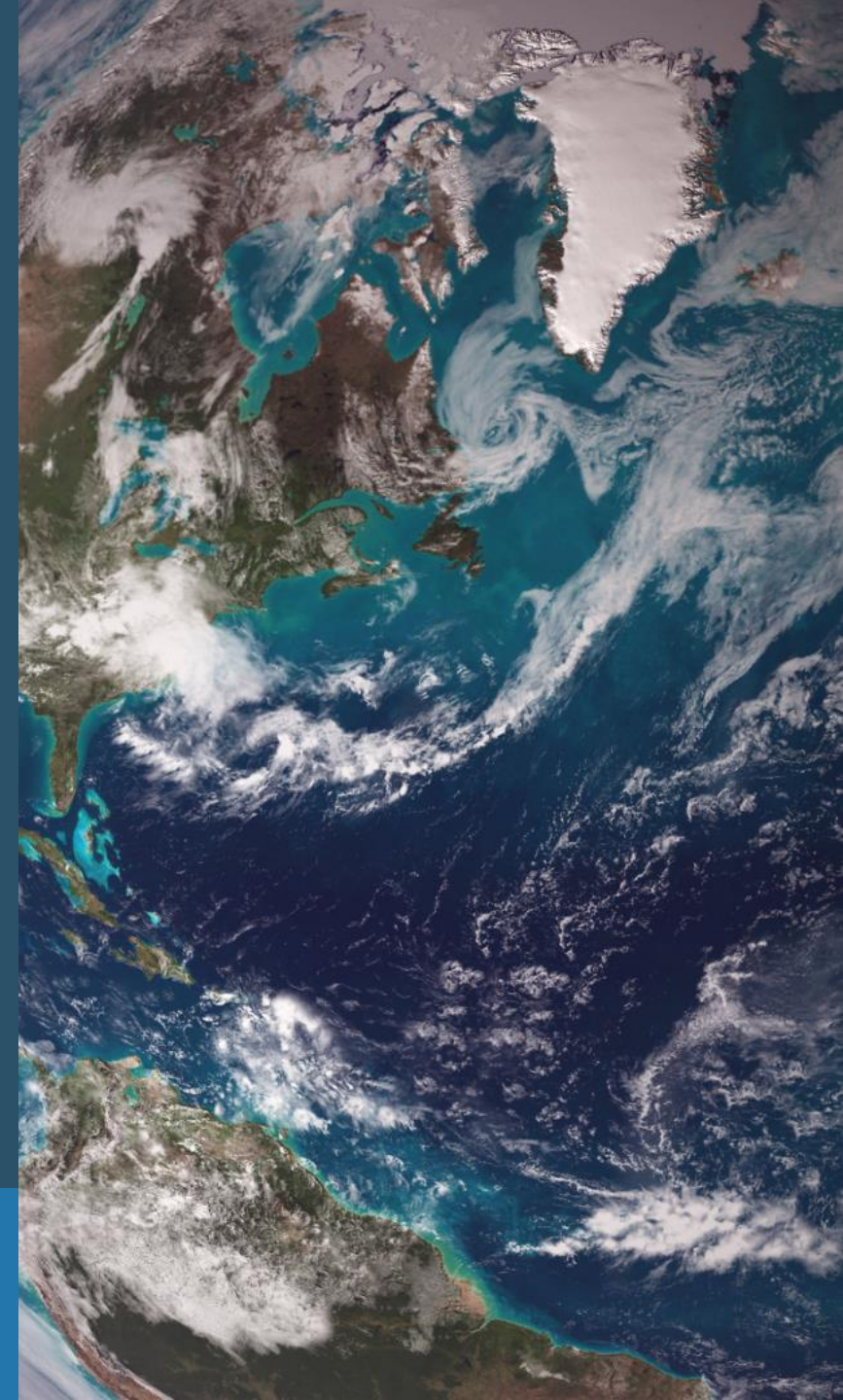
Ocean Color Mailing List:
[Subscribe](#)



Learning:
[Earthdata Cloud
Primer](#)



User Support:
[Earthdata Forum](#)

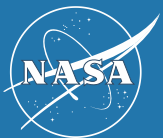
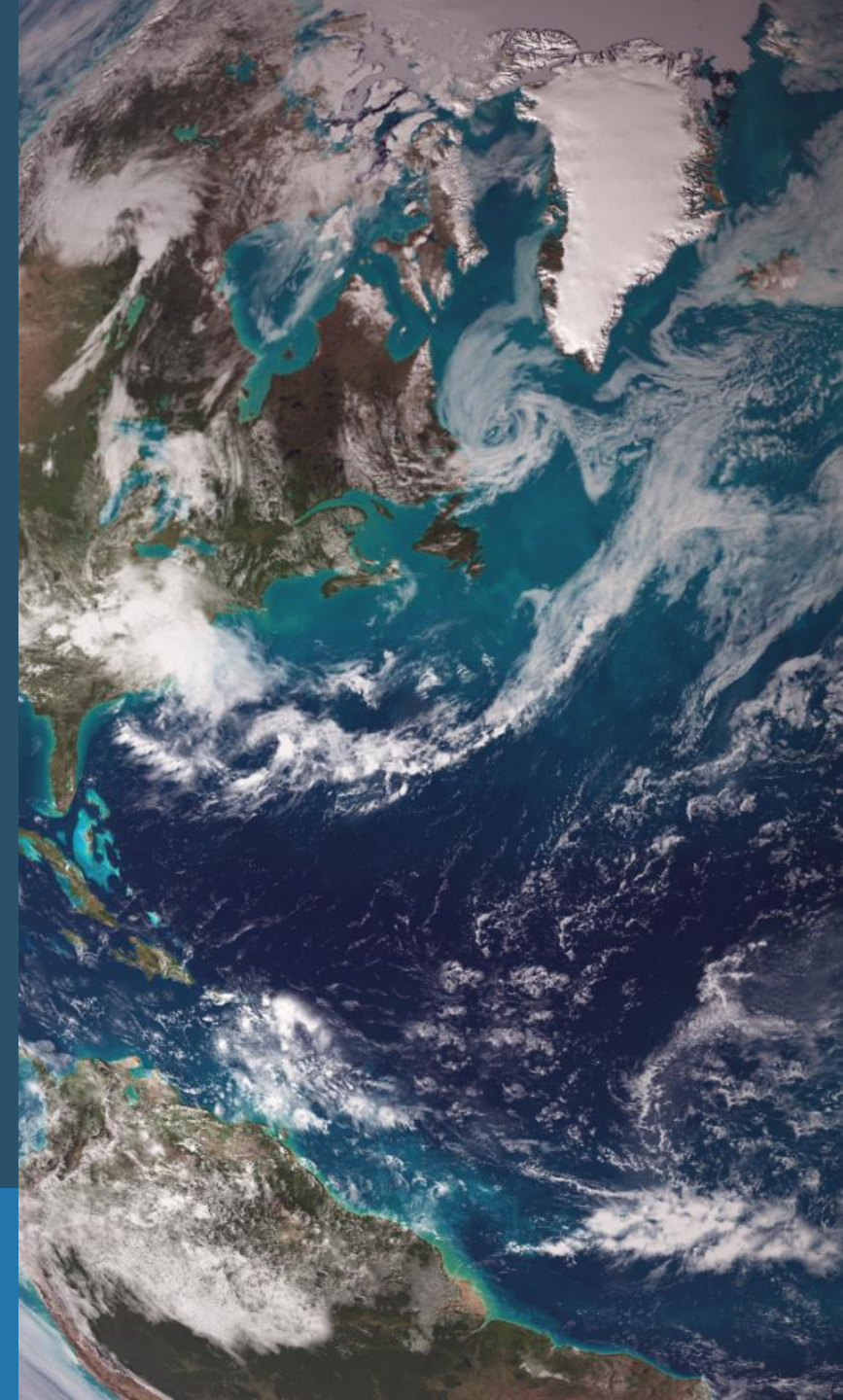


EARTHDATA
OPEN ACCESS FOR OPEN SCIENCE

Learn more about PACE and it's data products

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

<https://pace.oceansciences.org/data.htm>



EARTHDATA
OPEN ACCESS FOR OPEN SCIENCE