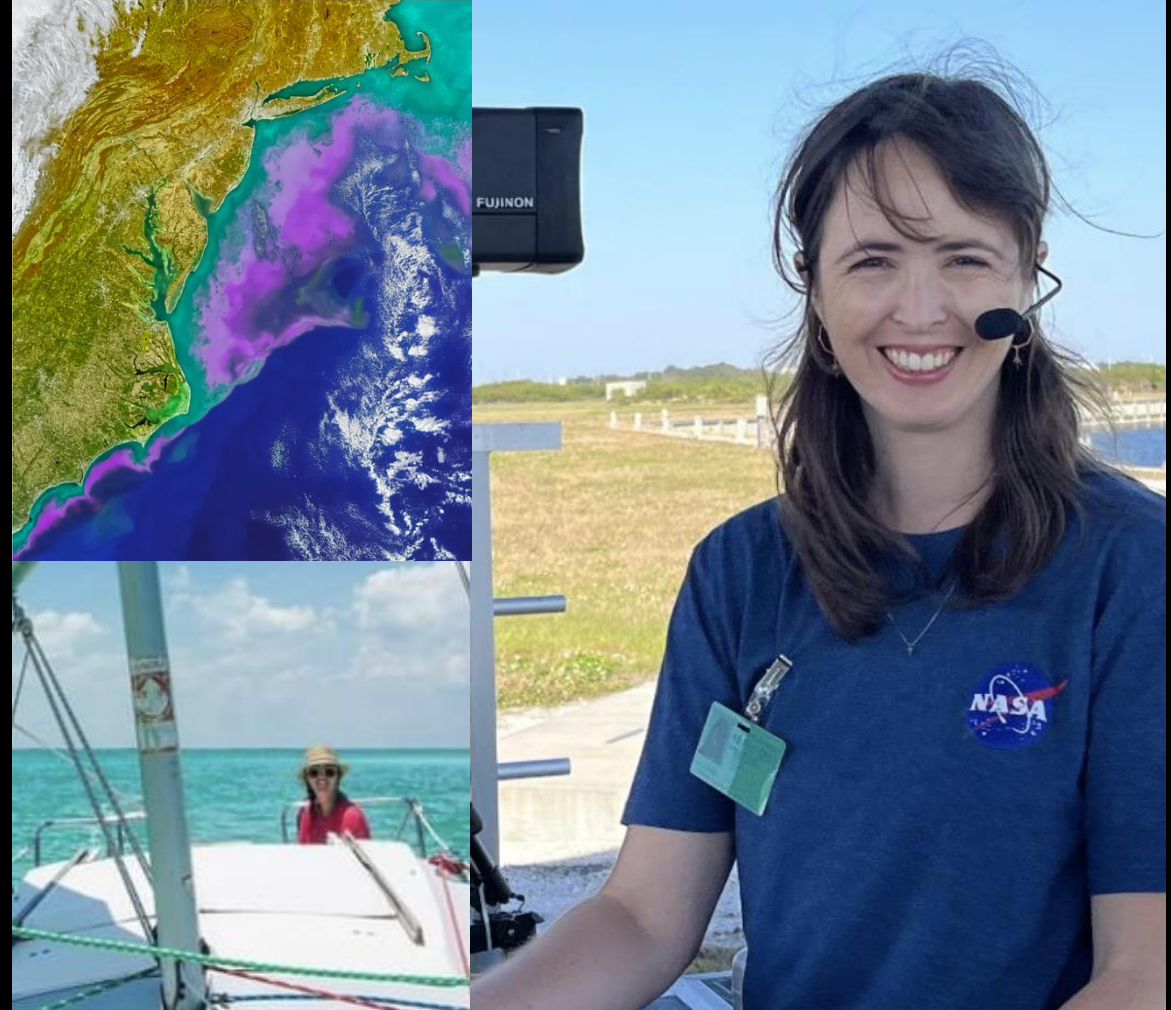


Carina Poulin

Scientific Designer

SSAI - The Ocean Ecology Laboratory at NASA GSFC
carina.poulin@nasa.gov

Developing tutorials, educational content, creating science visualizations, image processing and designing swag!





Background:

Université de Sherbrooke, Québec, Canada

- B.Sc. – Ecology, internships for Parks Canada
- M.Env. – Impact of light pollution on cyanobacteria
- Ph.D. Remote Sensing – Optical properties of phytoplankton cultures

Postdoc University of Southern Mississippi – Stennis Space Center – Plankton optics

Postdoc Florida Atlantic University – Bioluminescence





The Ocean Ecology Laboratory (OEL) advances Earth System Science by producing and distributing ocean and atmospheric satellite climate data records, developing new remote sensing, field, laboratory, and modeling methods, and by conducting innovative research in ocean Biogeochemistry and atmospheric composition and processes.

PAST MISSIONS

SeaWiFS · Aquarius · CZCS · GOCI · HICO · MERIS · OCTS

Ocean remote sensing revolutionized our understanding of our planet's oceans; SeaWiFS provided the first global view of the biosphere (right), which showed how chlorophyll concentrations over the world varied over time, and how that influenced the global carbon cycle.

The data records from these past missions, which OEL continues to maintain, are the foundation on which the current and future land, atmosphere, and ocean observation operations are built.

CURRENT SATELLITE MISSIONS

VIIRS-NOAA20 | SNPP · MODIS-Aqua | Terra · NOAA21 · OLCI-S3A | S3B · HawkEye

Building on the knowledge acquired by the OEL's earlier missions and together with our field and data support teams, our current satellite fleet is producing state-of-the-art observations from the Earth's lands, oceans, lakes, coasts, estuaries, and atmosphere that allow us to gain a better understanding of its global processes and dynamics.

Decision-makers use data produced by the OEL from these missions, in combination with earth system models, to make choices that will impact the future of the planet.

SATELLITE AND FIELD DATA SUPPORT

**OB.DAAC · OBPB · Field Support Group · EXPORTS · PACE-PAX
SeaBASS · SeaDAS · CyAN · HPLC pigments**

Our data support teams engage in activities that ensure the quality of NASA's ocean and aquatic field datasets used in the development of Ocean Color satellite algorithms and in the validation of satellite products and models.

NASA's Ocean Ecology Lab, with its global network of partners, has organized and participated in numerous sea and air expeditions. Field measurements provide essential support to ocean remote sensing missions.

The OEL develops and maintains the systems and tools for processing, archiving, distributing, and visualizing a wealth of the satellite and field data products in use by the research community.

PACE - PLANKTON, AEROSOL, CLOUD AND OCEAN ECOSYSTEM OCEAN COLOR - POLARIMETRY

Our most recent satellite mission, PACE, with its hyperspectral Ocean Color Instrument (OCI), will provide an unprecedented view of the diversity and distribution of the types of plankton in our oceans, with its measurements ranging from ultraviolet to shortwave infrared. This will allow us to study the processes that govern plankton dynamics, help identify harmful algal blooms, and assist resource managers, policymakers, and industry professionals.

PACE will also be equipped with two multi-angle polarimeters, SPExone and HARP2, which will give us information on oceanic and atmospheric particle size and composition. For example, studying cloudbows in Degree of Linear Polarization images from PACE will tell us about the particle size distribution of the droplets in the clouds, as shown on an image of the Atlantic Ocean, off the coast of Newfoundland, from the HARP Cubesat mission of the Earth Space Institute at UMBC (left).

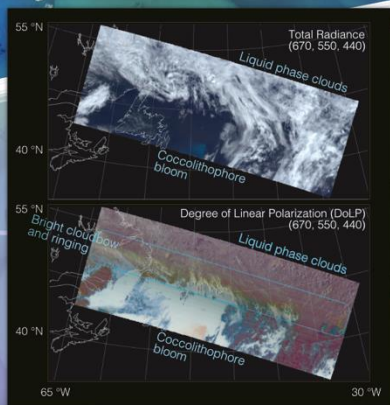
Together, PACE's three instruments will give us an unparalleled global outlook on the interactions between the Earth's oceans and atmosphere.

FUTURE MISSIONS

AOS · GLIMR · AND BEYOND

The OEL will continue to expand the boundaries of our knowledge further, with satellites in geostationary orbit, and more satellites that will observe the planet's atmosphere. GLIMR will take multiple measurements of the same area on the same day, giving us a unique window into the short-term changes that happen in the ocean. Another satellite mission, the Atmosphere Observing System, will be taking key, groundbreaking measurements of the vertical structure of the atmosphere.

The OEL will persist in building on the learnings of our past and present and developing markedly innovative missions that will further deepen our understanding of our planet's oceanic and atmospheric systems.





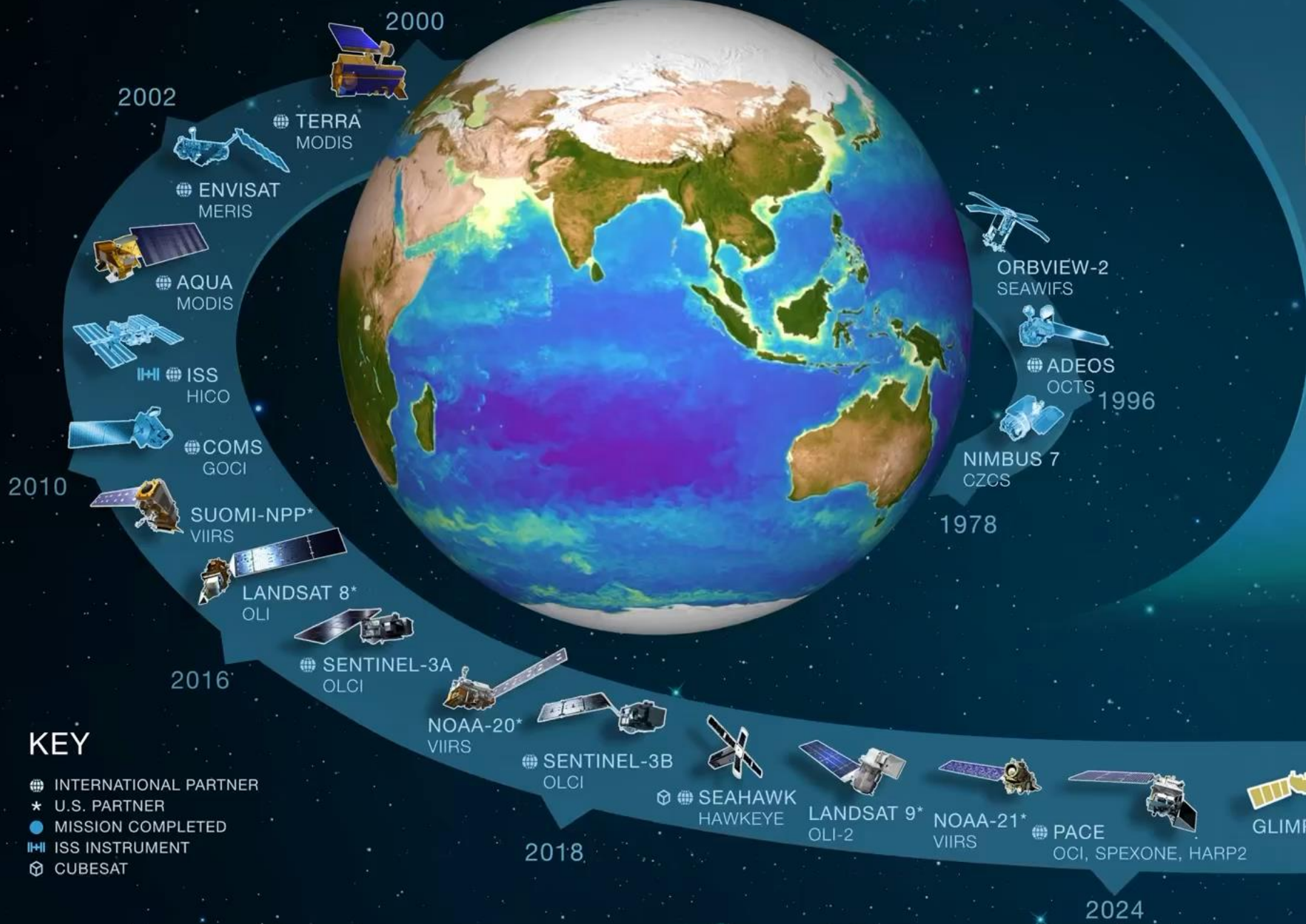
PACE comes after a long legacy of Earth observatories

National Aeronautics and
Space Administration



EARTH FLEET Ocean Color

This image from NASA's Scientific Visualization Studio shows the Global Biosphere. It represents the chlorophyll concentration on the ocean and earth's surface, as measured primarily by the SUOMI-SNPP/VIIRS sensor. Both on land and in the sea, a high chlorophyll concentration indicates an abundance of life.



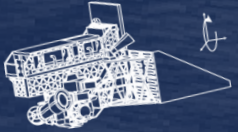
KEY

- INTERNATIONAL PARTNER
- * U.S. PARTNER
- MISSION COMPLETED
- ISS INSTRUMENT
- CUBESAT

MISSIONS

PACE INSTRUMENTS

OCI



340-890 nm in 2.5 nm steps
7 discrete SWIR: 940-2260 nm
1-2 day coverage; $\pm 20^\circ$ tilt; 1 km

HARP2



440, 550, 670, 870 nm
10-60 viewing angles
wide swath polarimeter; 3 km

SPEXone



380-770 nm in 2-4 nm steps
5 viewing angles
narrow swath polarimeter; 2.5 km



direction of flight

**PACE fills niches not currently
addressed at home or abroad**

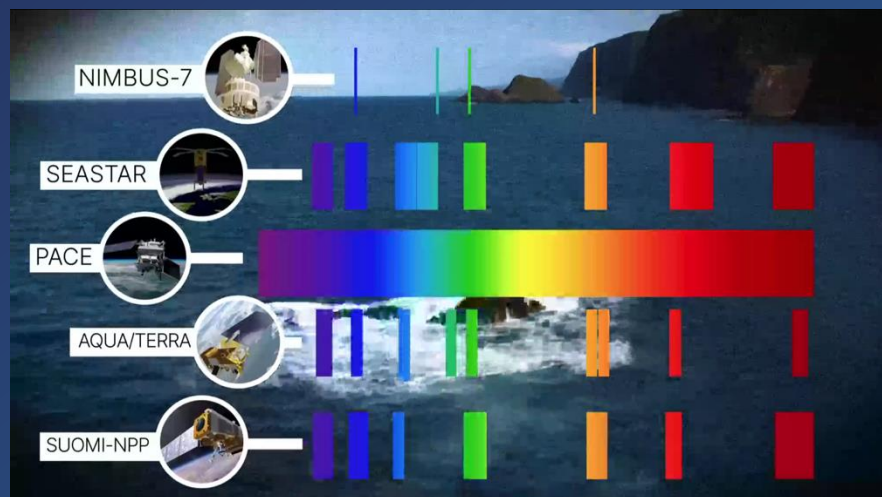
Moving from multi- to hyper-spectral

UV & two 2- μ m bands realize
atmospheric improvements over
heritage instruments

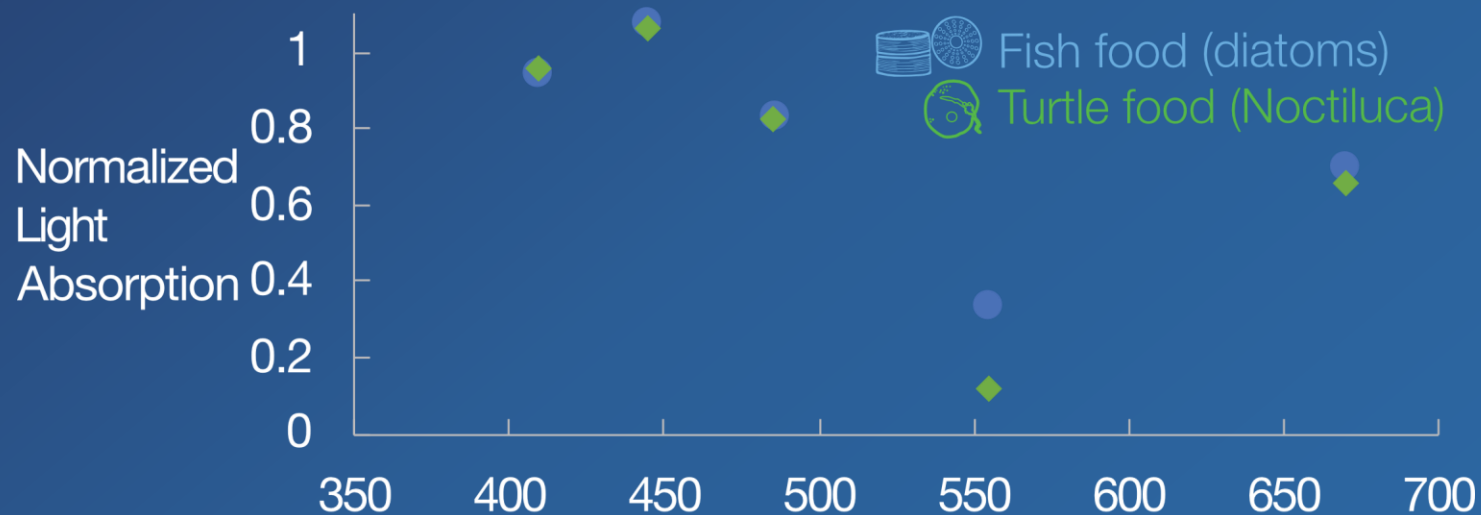
Multi-angle polarimetry adds
dimensions of information

Tilt is essential for capturing marine
system dynamics

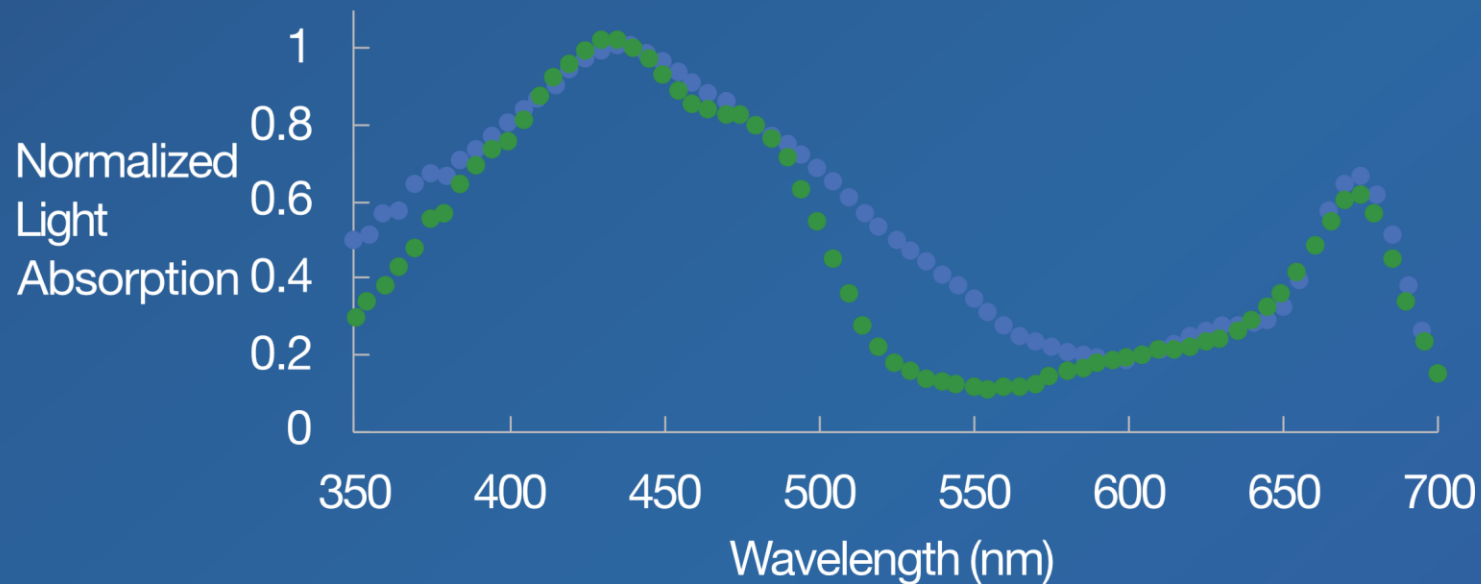
PACE-OCI takes hyperspectral measurements



What VIIRS Sees



What PACE OCI Will See



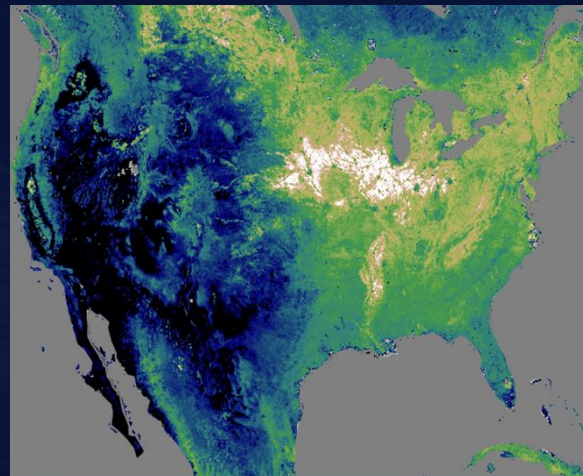
PACE: COMPREHENSIVE EARTH SYSTEM OBSERVATORY



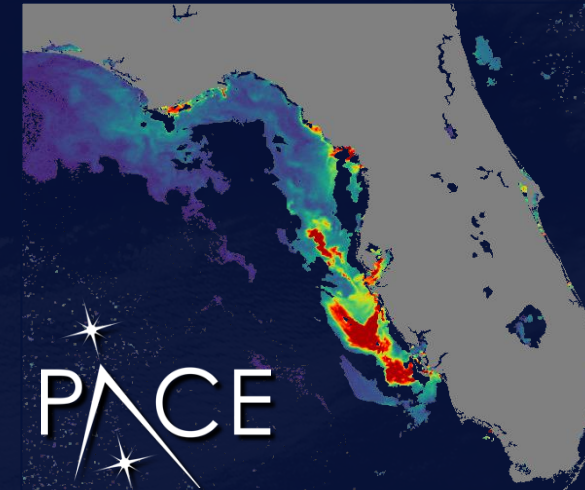
Plankton Aerosol Cloud ocean Ecosystem

- ▶ Only PACE provides global, hyperspectral coverage of the oceans, atmosphere, and land every 1-2 days, plus hyperspectral & hyperangular polarimetry

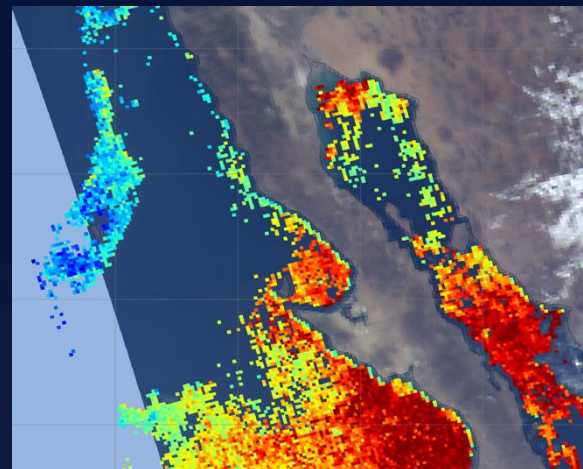
Plant growth



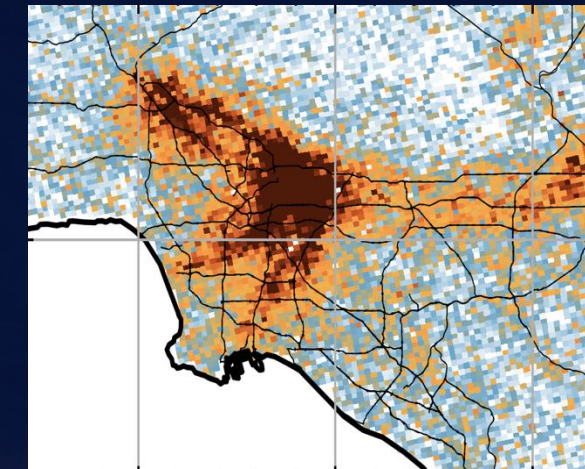
Harmful algal blooms



Identifying wildfire smoke (blues) and dust (reds)



High resolution nitrogen dioxide over highways



PACE DATA PRODUCTS

ATMOSPHERIC OCEAN COLOR

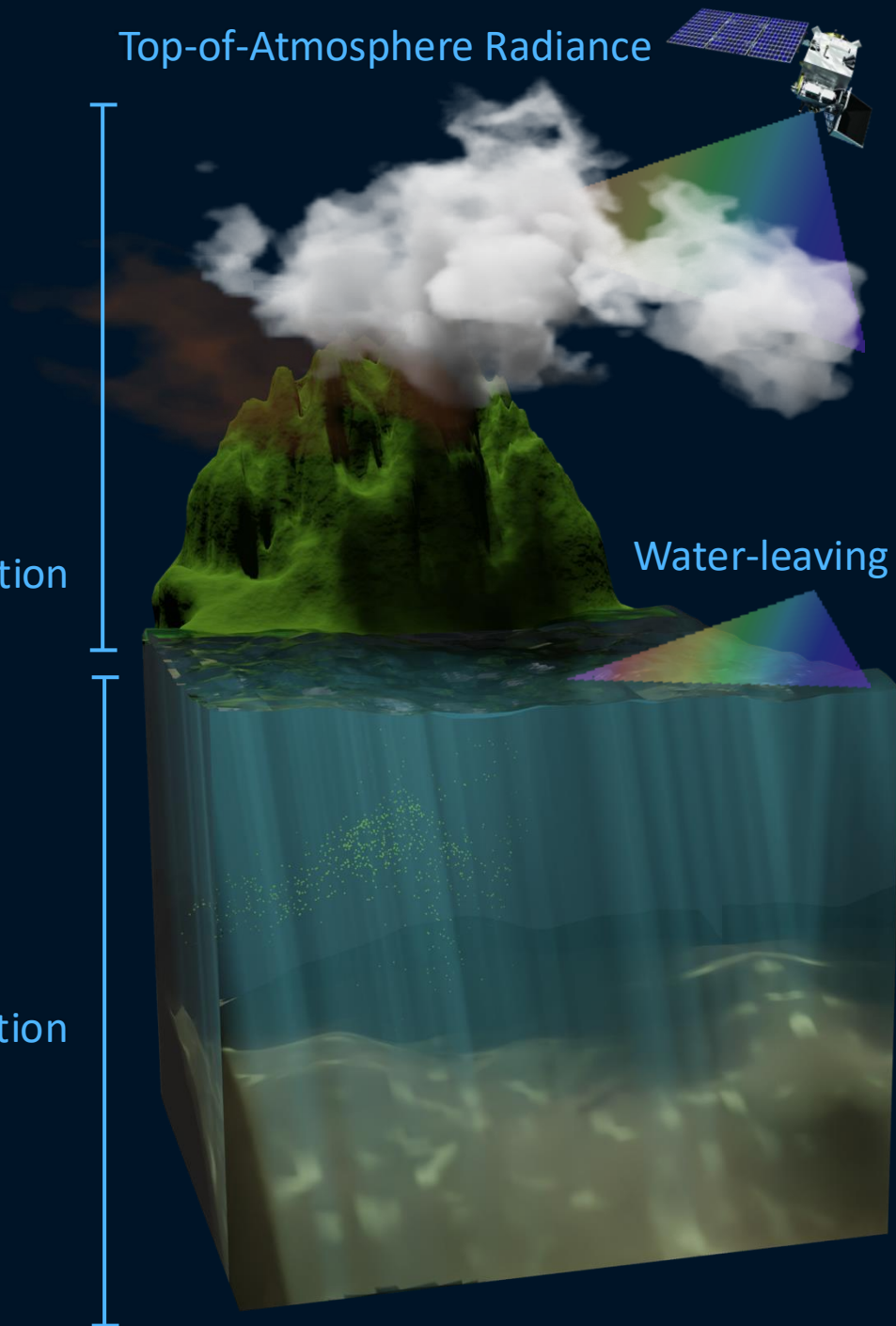


Atmospheric Contribution

Oceanic contribution

Top-of-Atmosphere Radiance

Water-leaving Radiance



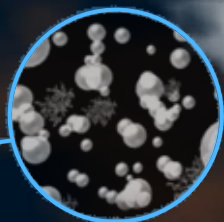
PACE DATA PRODUCTS

ATMOSPHERIC



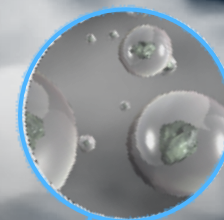
Aerosol absorption
Aerosol size distributions
Concentrations of
brown/black carbon

Aerosol optical depth
Aerosol heights and layers



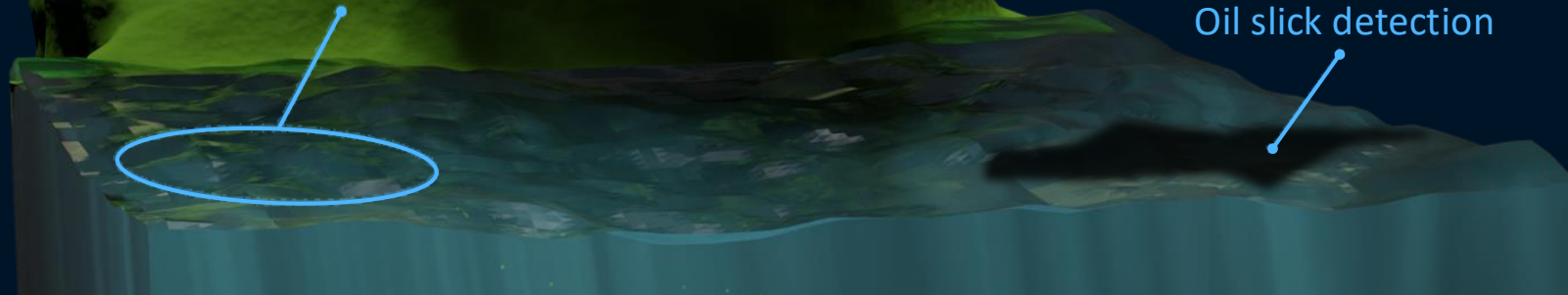
Cloud optical depth
Cloud height
Cloud thickness

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



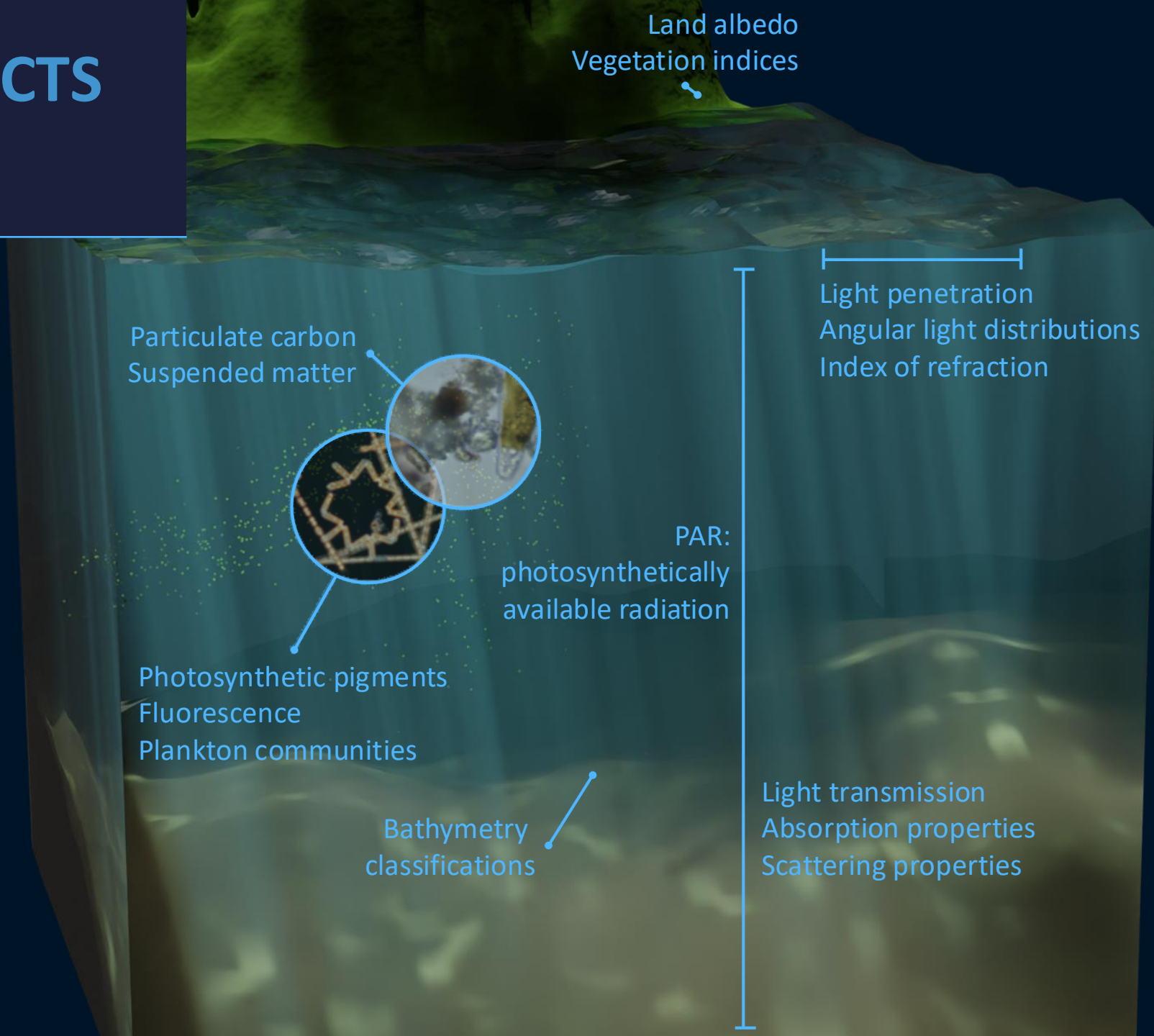
Ocean reflectance
Whitecap fraction
Angular light distributions

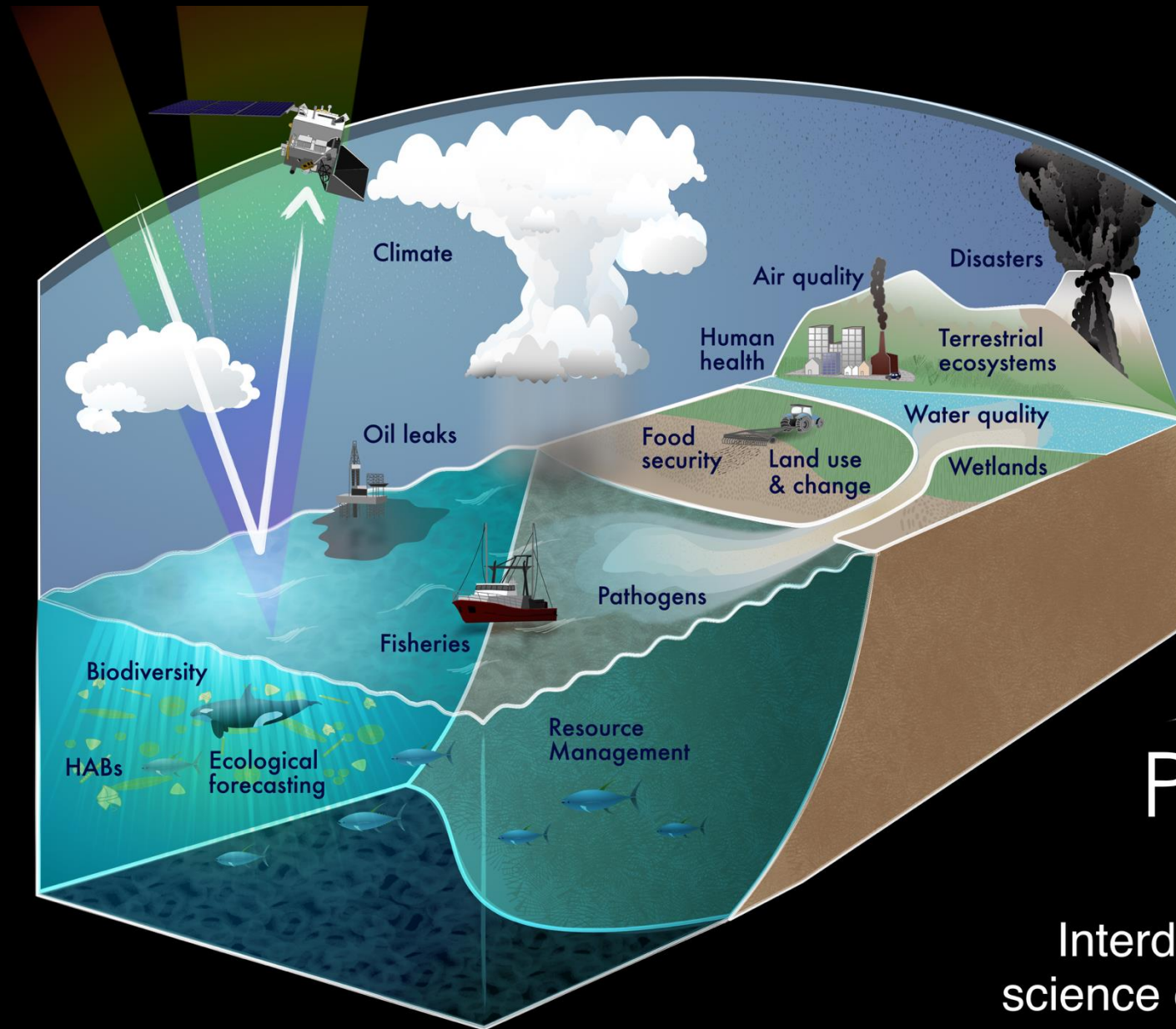
Oil slick detection



PACE DATA PRODUCTS

OCEAN COLOR





PACE

Interdisciplinary
science objectives

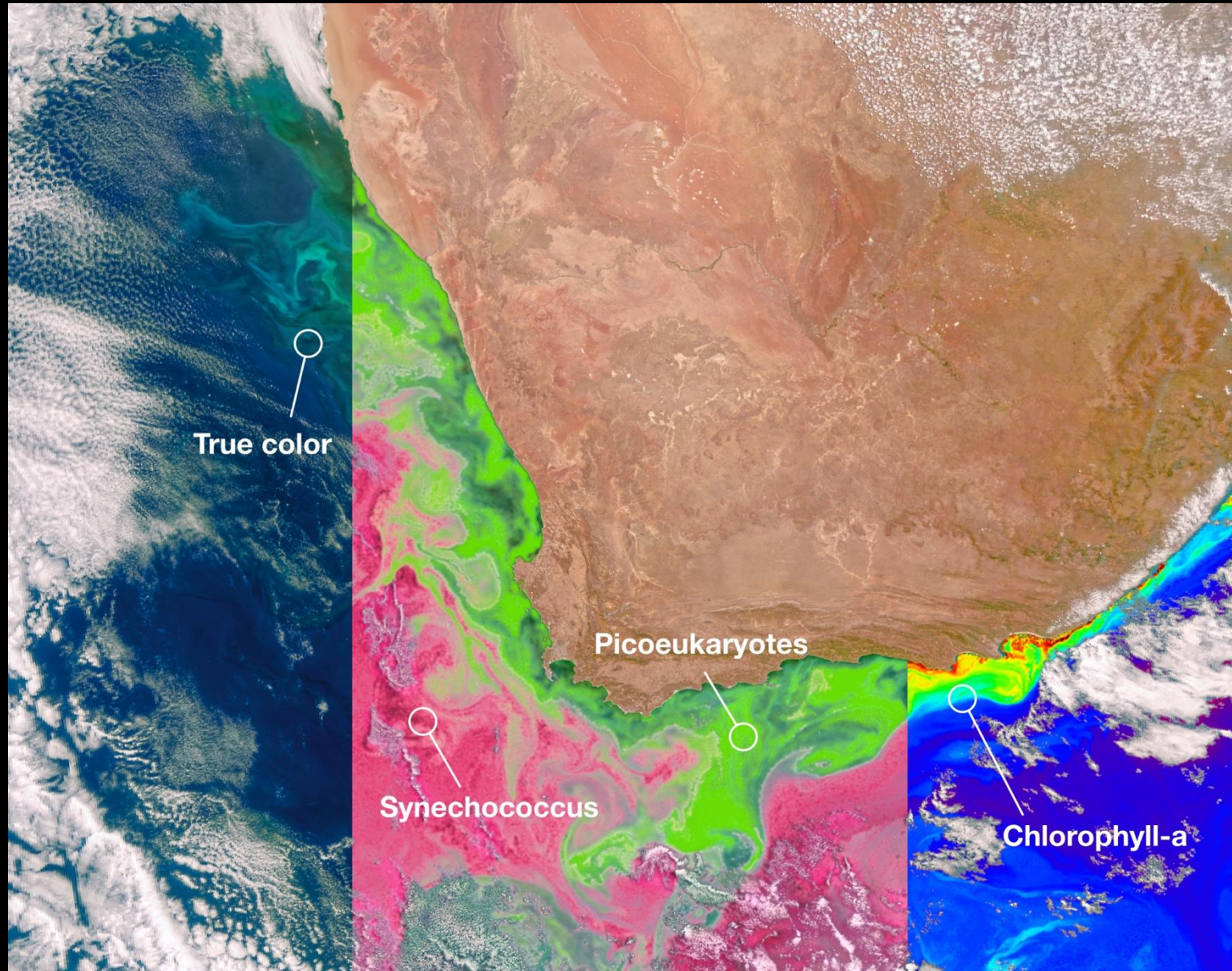
PACE Launch Feb. 8th 2024 1:33 AM EST

Space Launch Complex 40 at Cape Canaveral Space Force Station Space in Florida

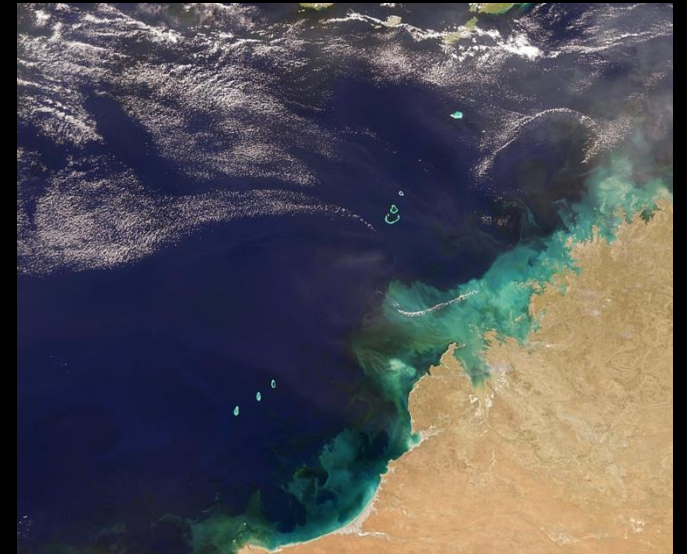
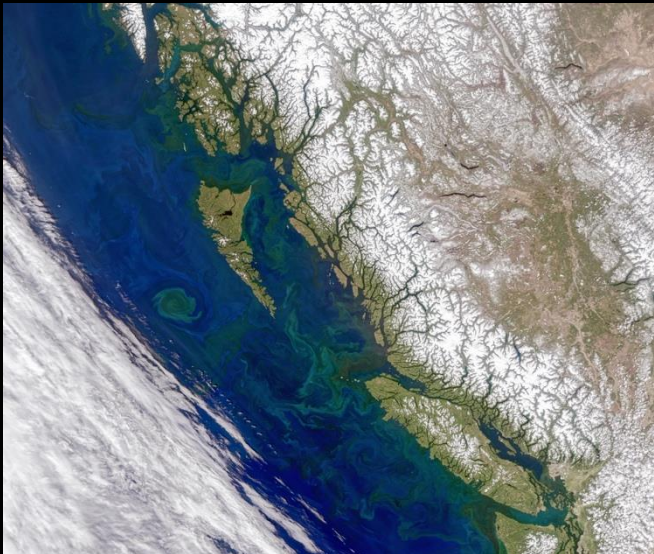
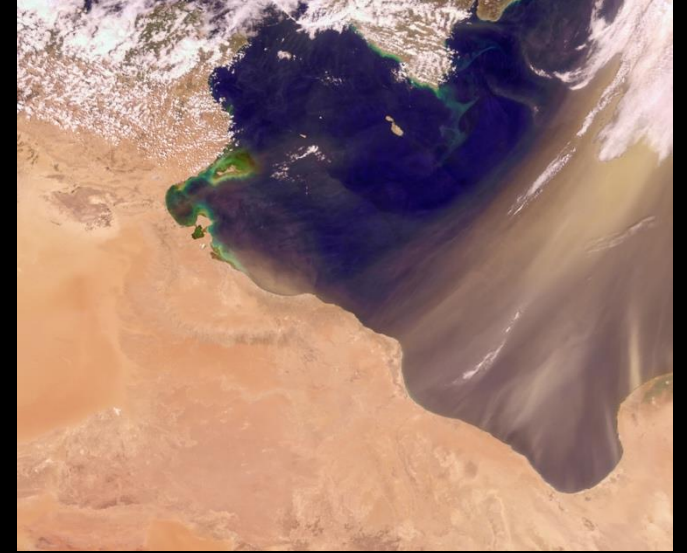
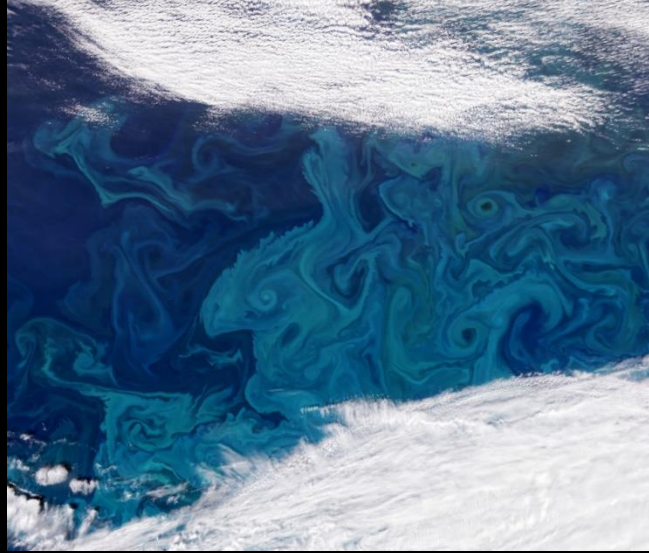
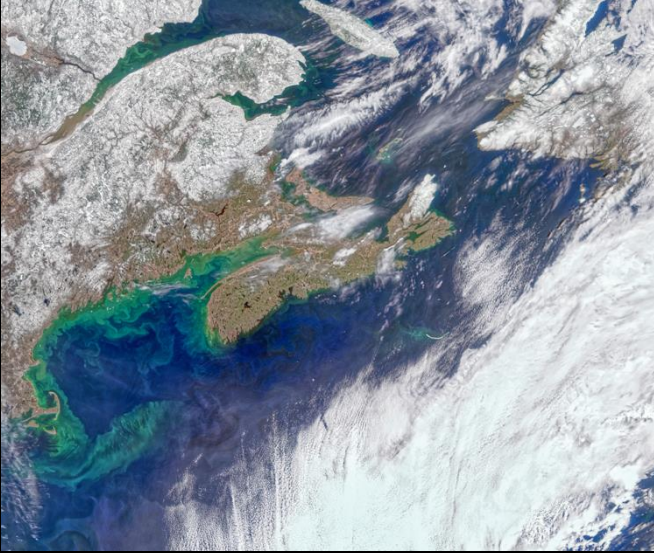


PACE Hawaiian shirts

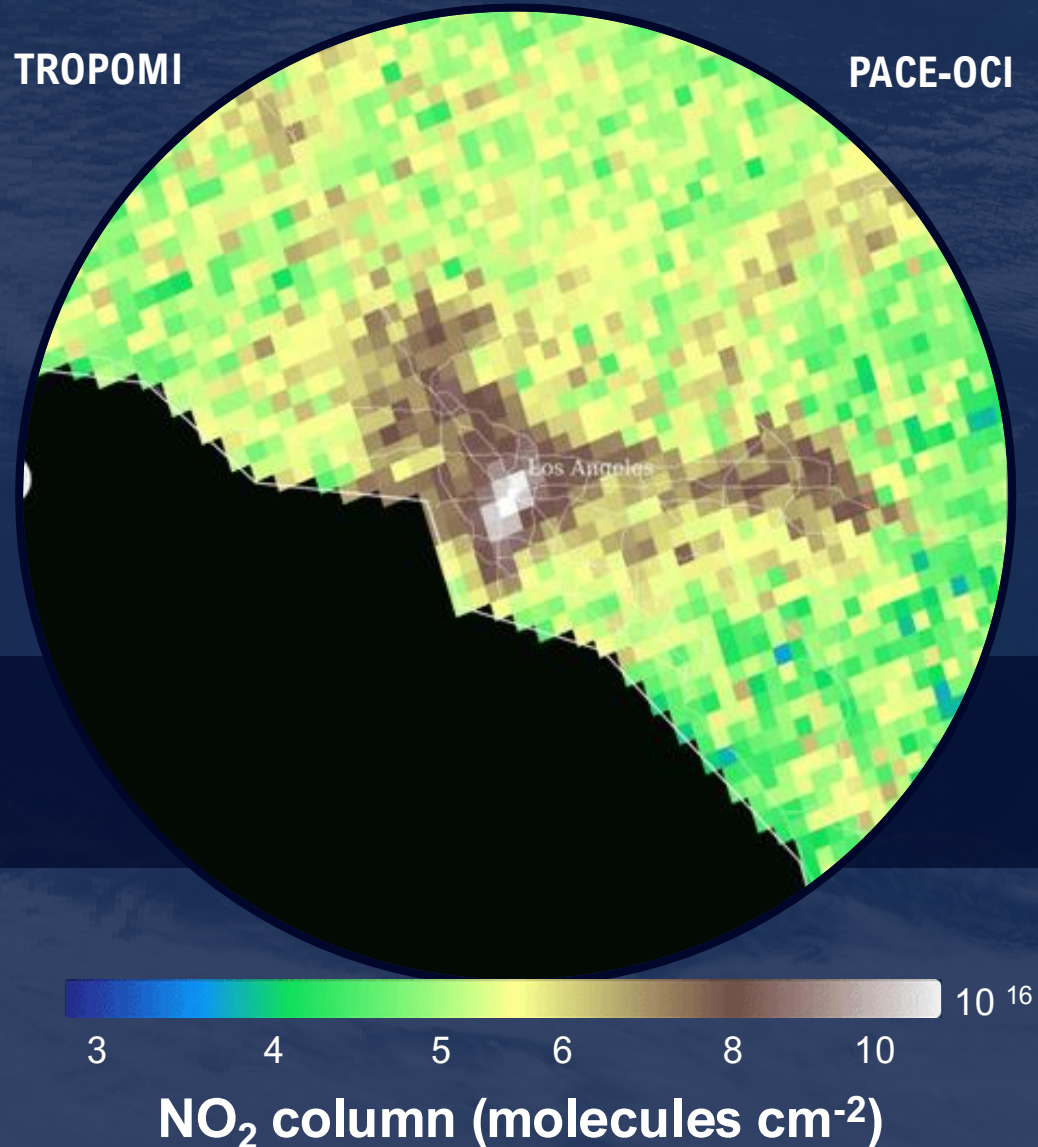
First Light Image



PACE RGB Imagery

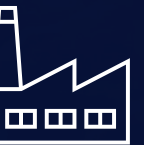


RETRIEVING TRACE GASES IN HIGH RESOLUTION



- **Ground-breaking, high spatial resolution NO₂ retrievals from PACE OCI** reveal finer-scale details of NO₂ sources, such as vehicular emissions and power plants, compared to TROPOMI & TEMPO
- Enabled by neural network training with TROPOMI data

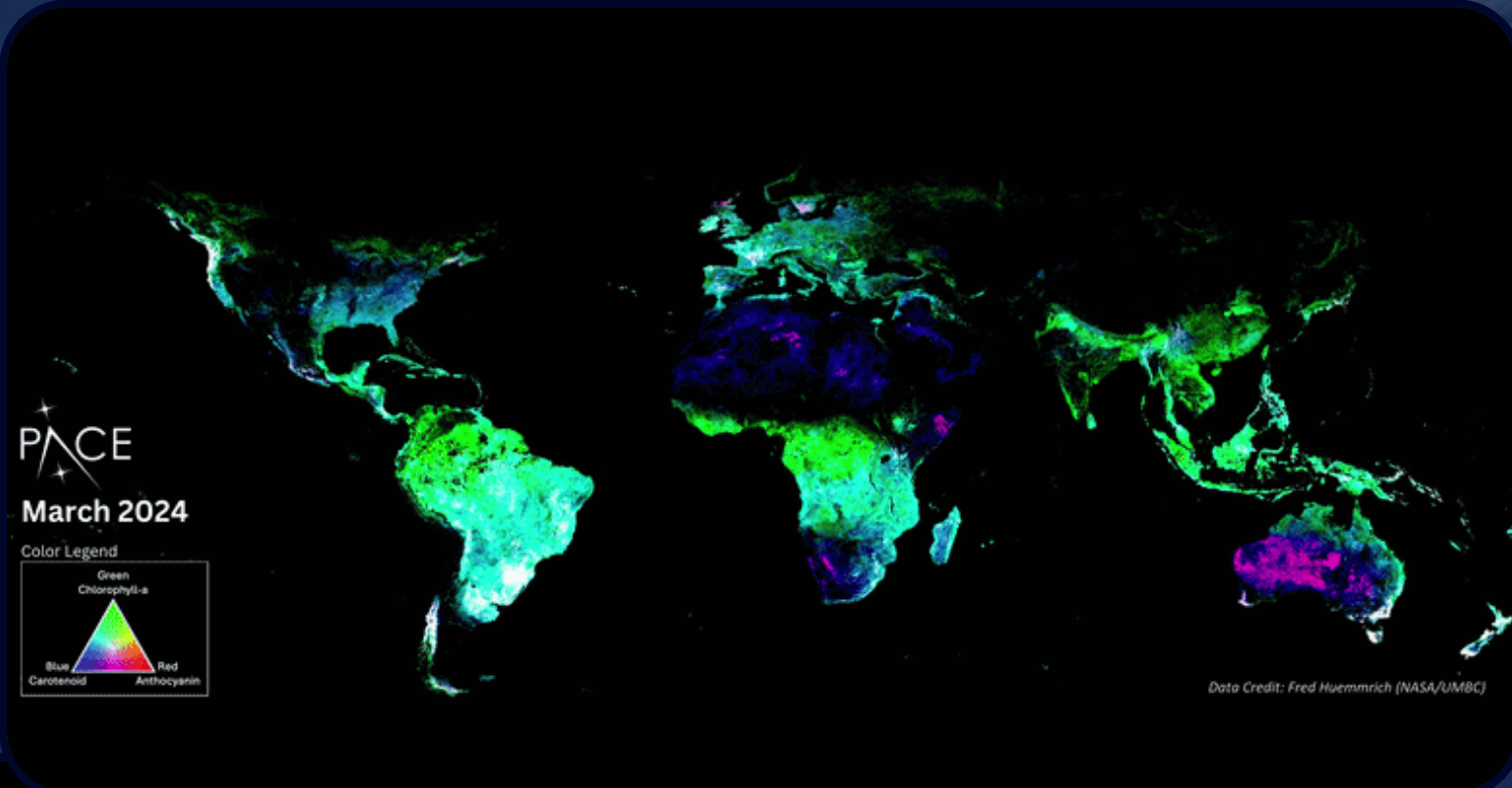
**WILL ENHANCE LOCAL AIR QUALITY MONITORING
AND IMPROVE REGIONAL CHEMISTRY MODELING**



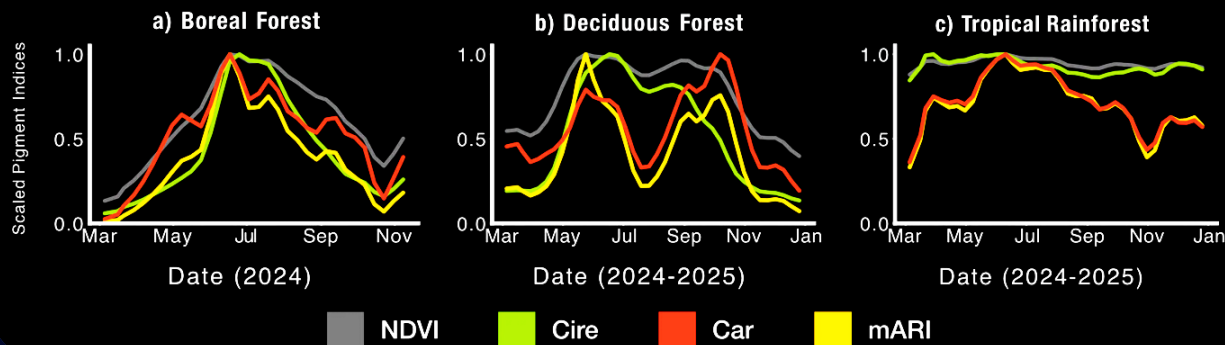
#9: SIMULTANEOUSLY RETRIEVING 10 VEGETATION INDICES

PACE's vegetation indices provide first-ever simultaneous information from space about vegetation type, health status, productivity and leaf area.

Only PACE can provide this information globally, every 1-2 days.



Example Forest Pigment Index Patterns



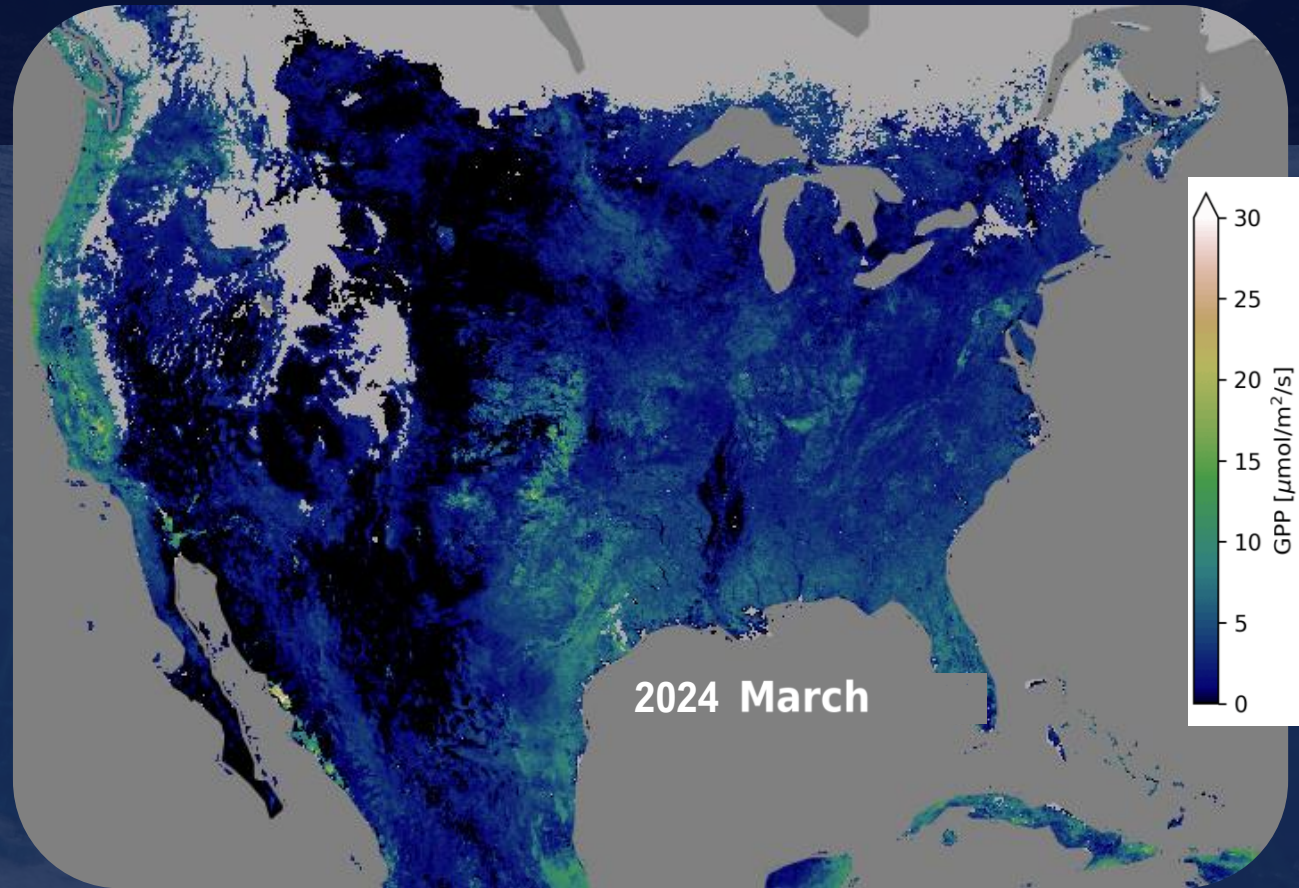
UNPRECEDENTED WAY TO MONITOR
GLOBAL FOREST SEASONAL CHANGES



ESTIMATING TERRESTRIAL GROSS PRIMARY PRODUCTION (GPP)

PACE GPP product is uniquely calculated with PACE's spectral reflectance alone

- **SUPPORTS AGRICULTURE AND FORESTRY APPLICATIONS BY INDEPENDENTLY DESCRIBING GLOBAL SEASONAL AND TRANSIENT VARIABILITY IN TERRESTRIAL PRODUCTIVITY**

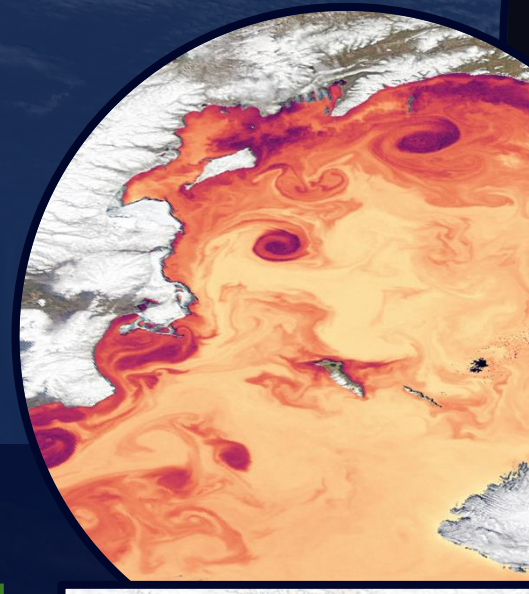
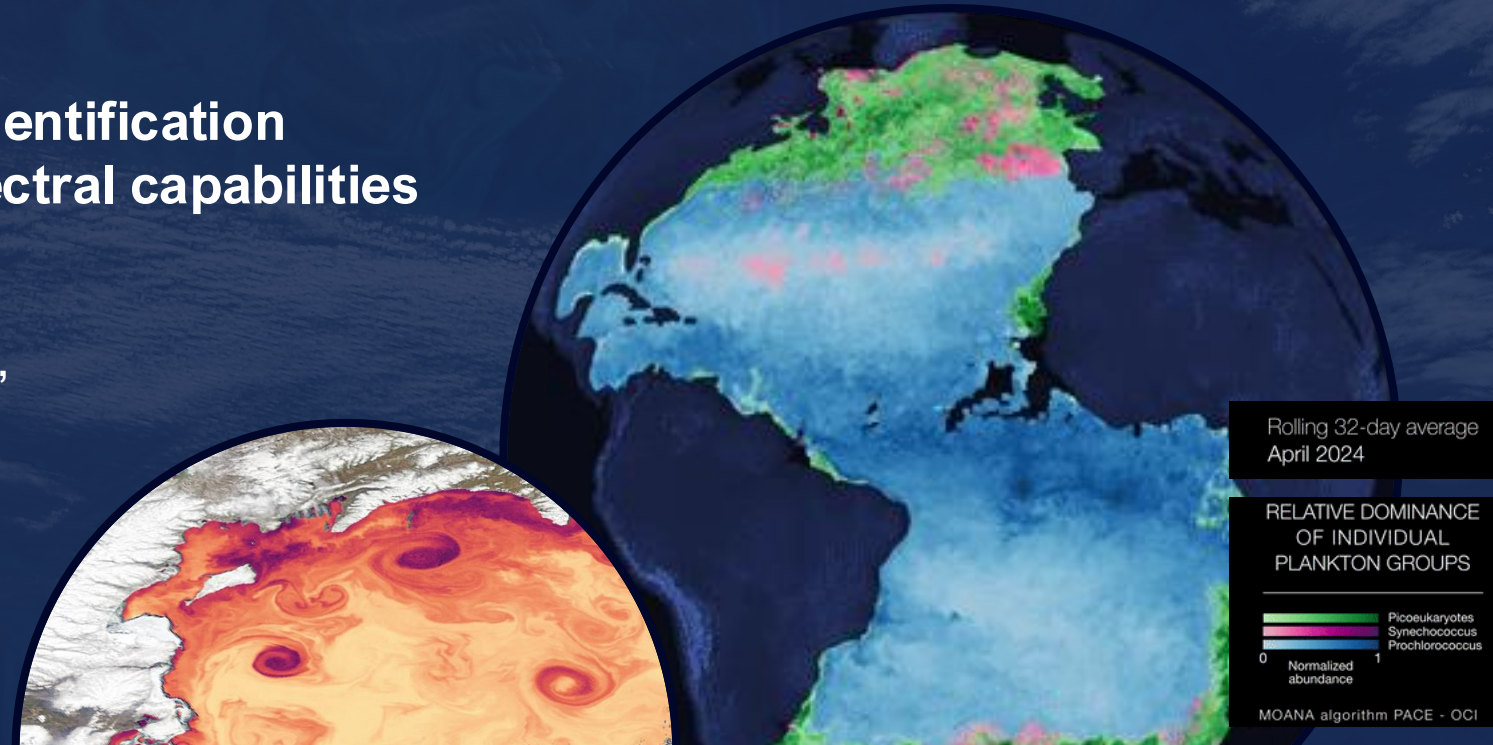


**Monthly Gross Primary Productivity
March – November 2024**

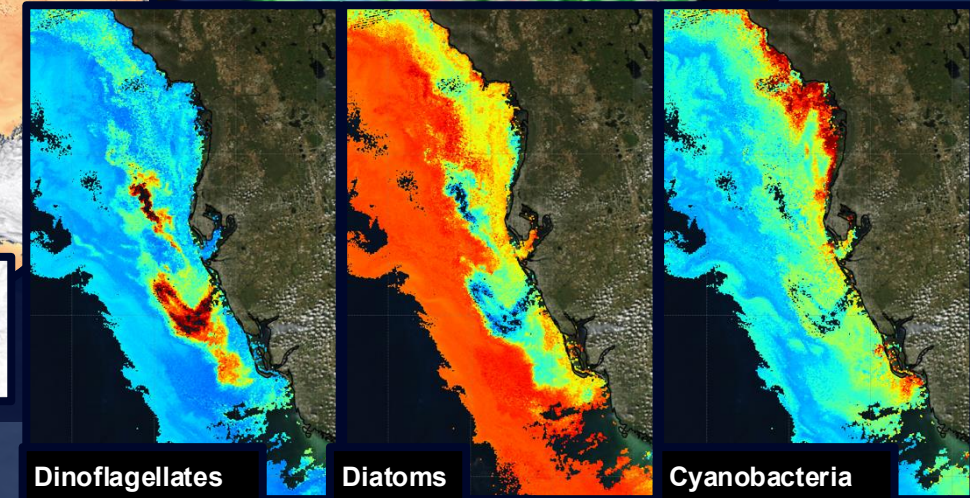
IDENTIFYING BENEFICIAL PHYTOPLANKTON COMMUNITIES

Unique, new satellite phytoplankton identification algorithms enabled by OCI's hyperspectral capabilities

- Atlantic **cyanobacteria** (*Prochlorococcus*, *Synechococcus*) (MOANA)
- Atlantic **picoeukaryotes** (MOANA)
- **Diatoms** (Chase et al.)
- Gulf Coast phytoplankton (Liu et al.)



PHYTOPLANKTON ARE AT THE
BASE OF THE OCEAN FOOD CHAIN
AND FEED OUR FISHERIES



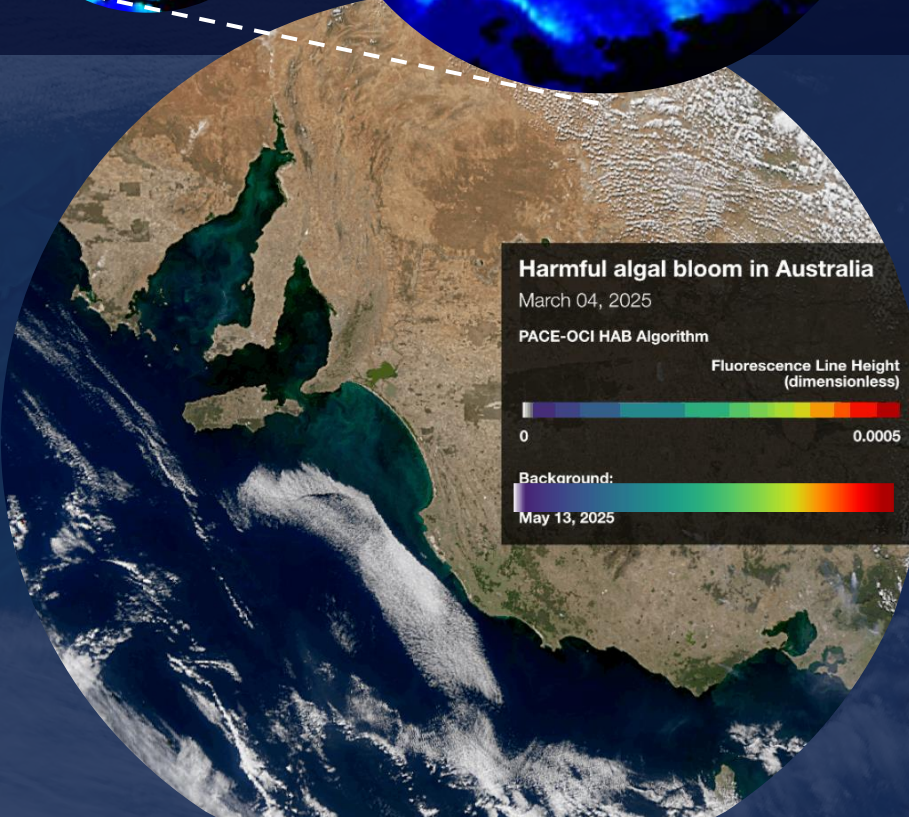
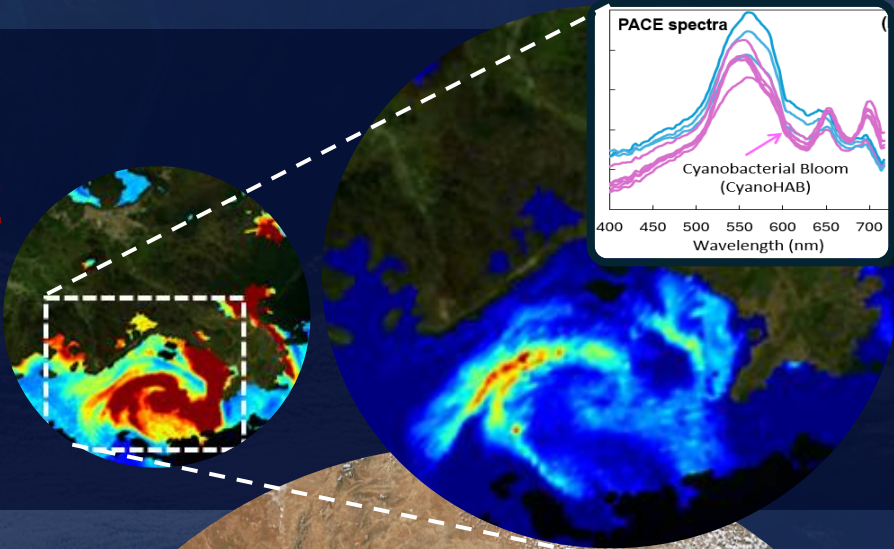
IDENTIFYING HARMFUL PHYTOPLANKTON COMMUNITIES



Sargassum causes infrastructure damage, resulting in fishery and major tourism losses

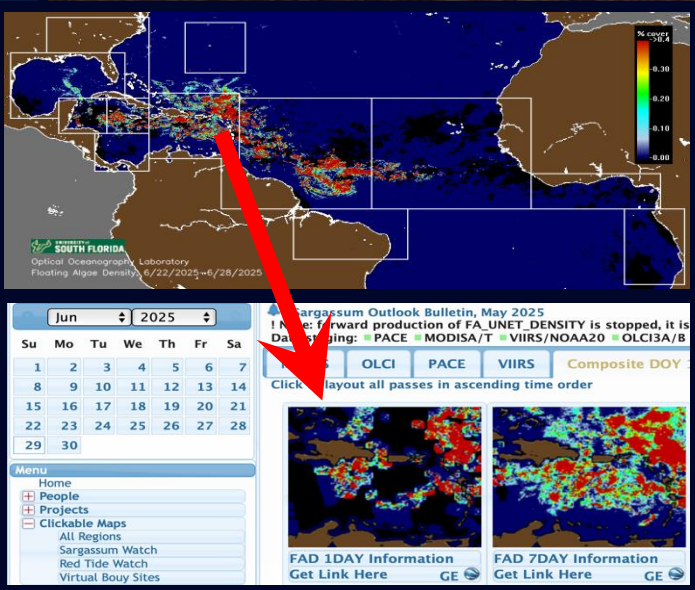
2014-15 Sargassum Inundation Event (Wynne 2017)

PACE can uniquely identify the **NUISANCE** and **TOXIC ALGAE** within a larger plankton bloom



Harmful algal bloom in Australia
March 04, 2025

PACE-OCI HAB Algorithm
Fluorescence Line Height (dimensionless)
0 0.0005
Background:
May 13, 2025

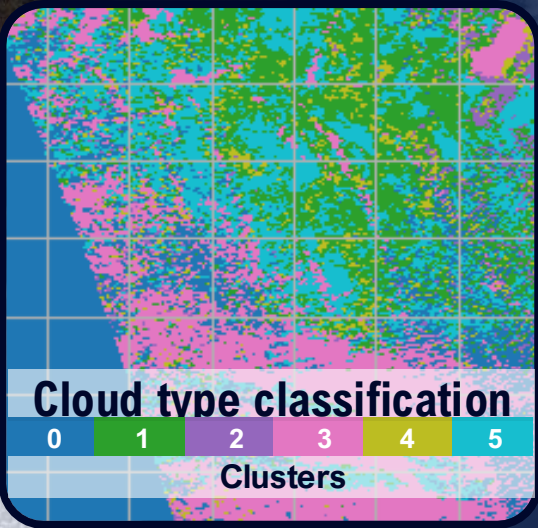
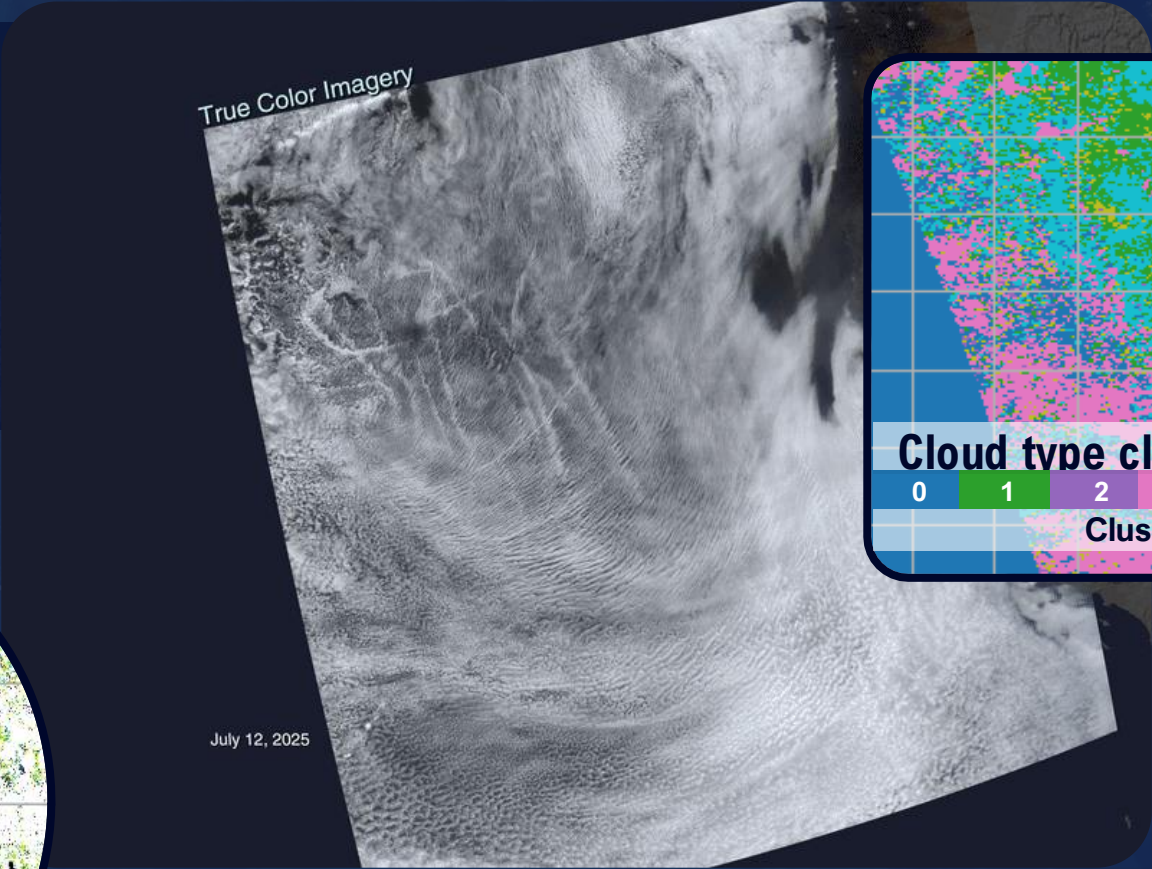
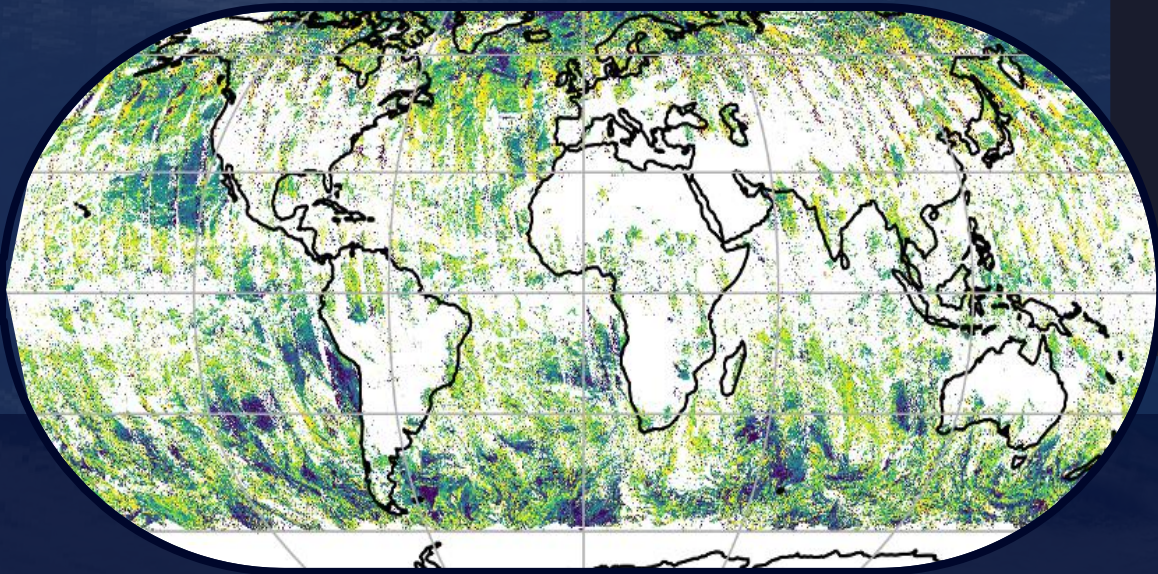


SARGASSUM is now better detected from space thanks to OCI's global coverage and hyperspectral and SWIR capabilities

RETRIEVING NOVEL CLOUD PROPERTIES

Ship track identification in clouds

Offers insight into the impact of aerosols on clouds and Earth's energy balance



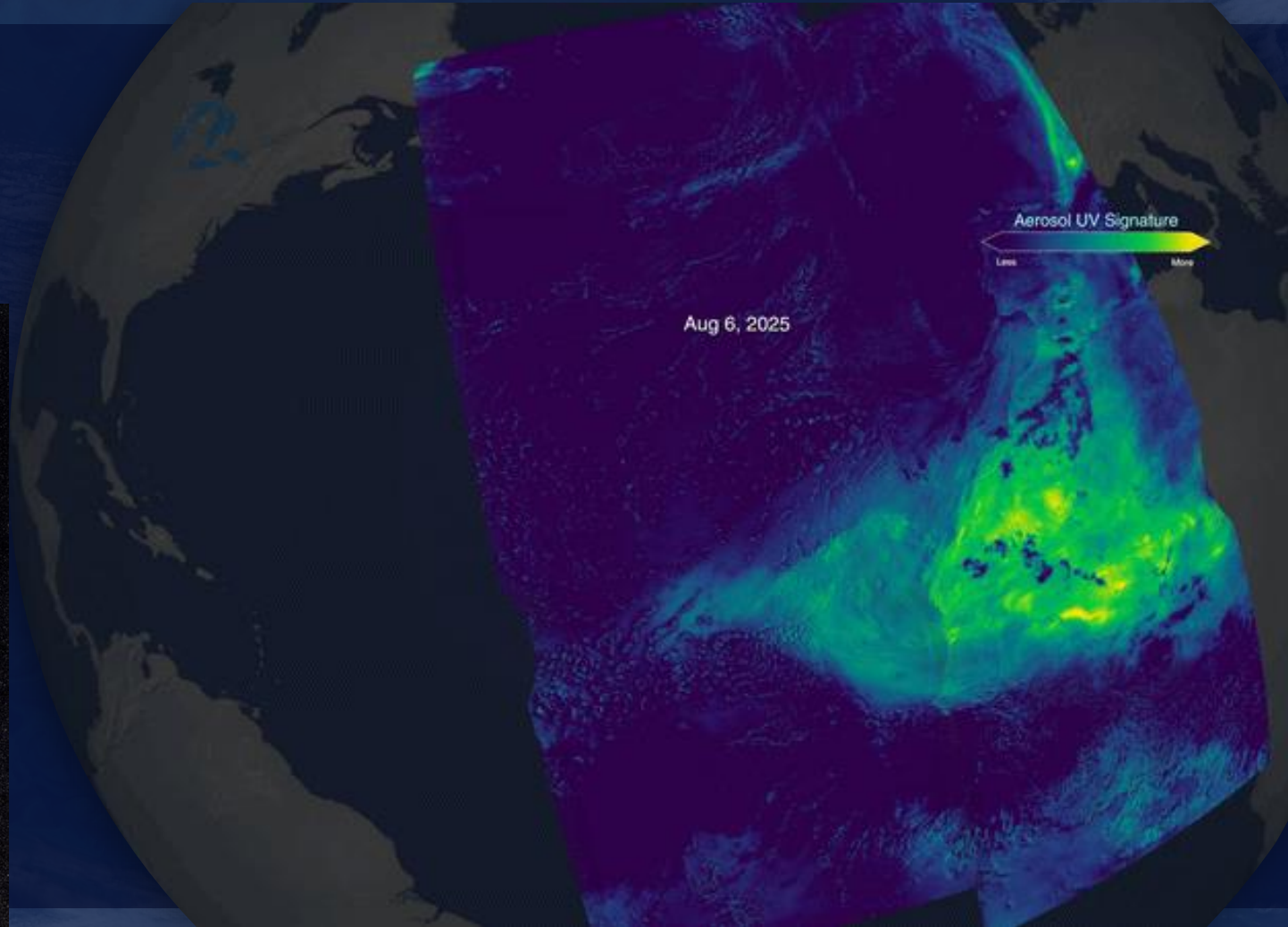
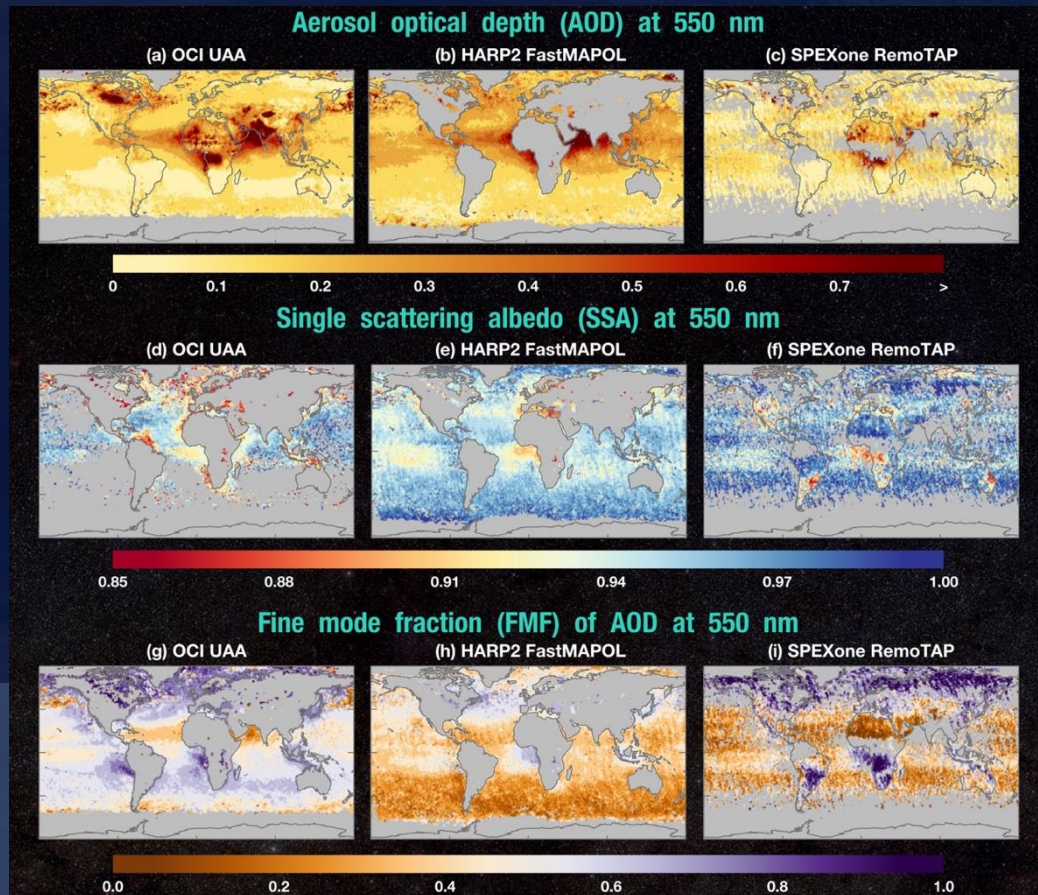
FIRST EVER OBSERVATION OF VARIABILITY OF CLOUD DROPLET SIZE



RETRIEVING NOVEL ATMOSPHERIC AEROSOL PROPERTIES

PACE allows identification of aerosols

All three of PACE's instruments inform on atmospheric aerosol size, shape, and composition

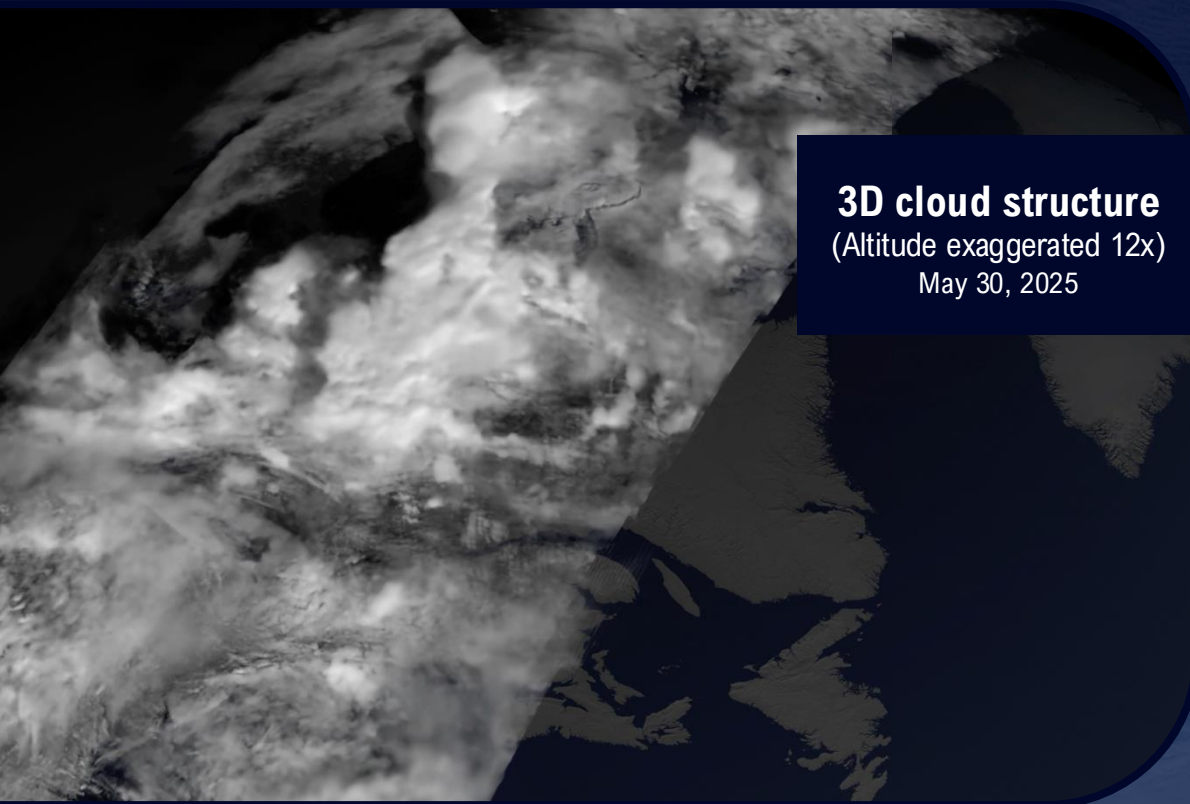


PROVIDES CRITICAL ROUTINE, GLOBAL
OBSERVATION OF AEROSOL SPECIATION

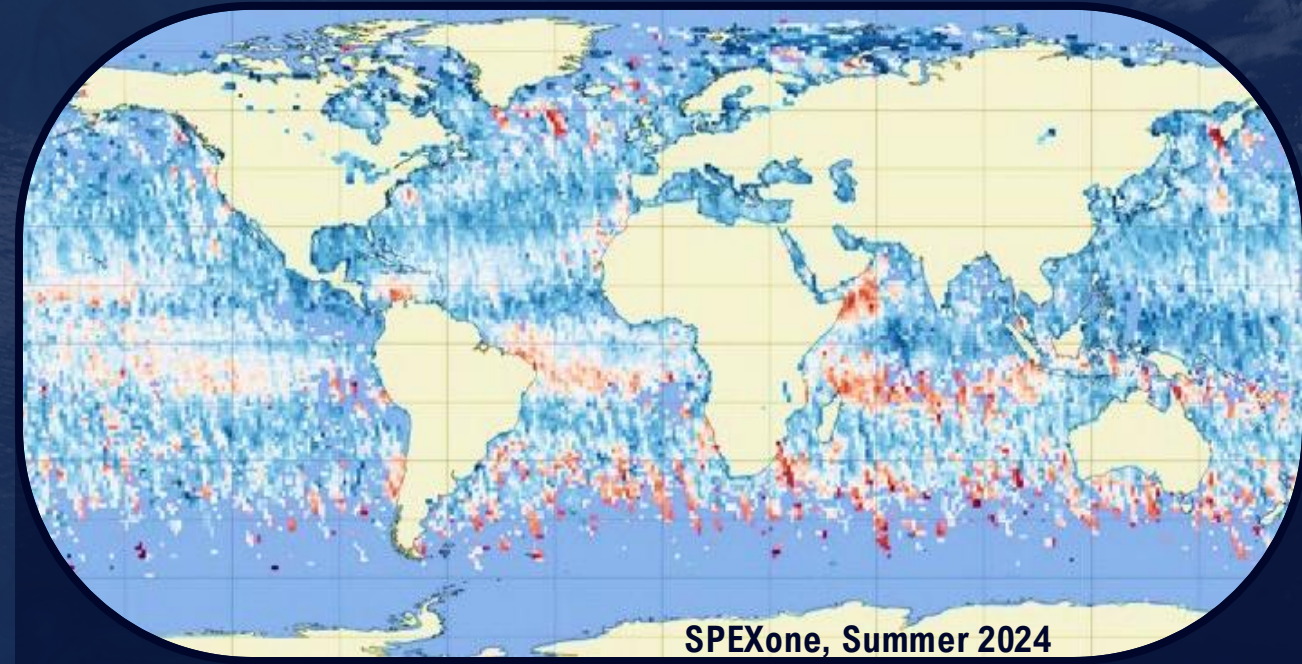
EXPLOITING THE ANGULAR NATURE OF OUR POLARIMETERS



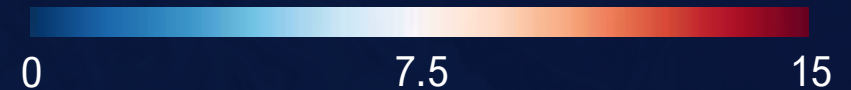
PACE's unique angular polarimetry allows us to study the 3D structure of **clouds**



3D cloud structure
(Altitude exaggerated 12x)
May 30, 2025



SPEXone, Summer 2024



Surface wind speed (m/s)

It also enables unique measurements of **wind speed**, on spatial scales smaller than previously available



PACE Communications

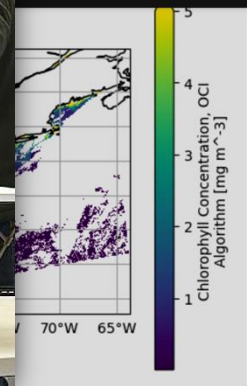
briefly, in no particular order

PACE HACKWEEKS

EMPOWERING DATA USERS WITH CUTTING-EDGE TOOLS



- Comprehensive learning approach
- Multi-instrument focus
- Open science
- Revolutionary cloud access
- Kickstarting research



Code of Conduct
Checklist
Getting up Git
Presentations
Orientation
Science
Code
Objects
Overview
Data Products & Availability
Reference
Glossary
How to Get Help

[back to top](#)

5. Open L3M Data

Let's use `earthaccess` to open some L3 mapped chlorophyll a granules. We will use a new search in `earthaccess.search_data`: the `granule_name` argument accepts strings with the `"**"` wildcard. We distinguish daily ("DAY") from eight-day ("8D") composites, as well as to get the 0.1 degree resolution.

```
tspan = ("2024-04-12", "2024-04-24")

results = earthaccess.search_data(
    short_name="PACE_OCI_L3M_CHL",
    temporal=tspan,
    granule_name="*.DAY.*.0p1deg.*",
)

paths = earthaccess.open(results)
```

QUEUING TASKS | 100% [Back to top](#) 12/13 [00:00:00:00, 693.63/05]

NASA'S PACE MISSION

HELP HUB – OUR RESOURCES REACHING MORE PEOPLE

WE HAVE MOVED!

Update your bookmarks & links

**HELP
HUB**

**Satellite data processing
can be difficult.**

**We're here to help you climb out
of that hole!**

nasa.github.io/oceandata-notebooks



OCEAN COLOR
OB.DAAC | OBPG



NASA'S PACE MISSION

HELP HUB – OUR RESOURCES REACHING MORE PEOPLE



The poster features a dark blue background with a stylized satellite in the top left, a smartphone with 'HELP HUB' on it, and a green map of the world on the right. The NASA logo and 'National Aeronautics and Space Administration' are in the top right. The title 'PACE' is large and white, with 'HOTLINE' and 'SUMMER CHATS' in colorful, stylized fonts below it. The poster is divided into three columns for different chat topics, each with a date, topic, quick tutorial intro, and a list of chat participants with their roles.

Your chance to ASK ANY QUESTIONS and GET SUPPORT from PACE scientists

PACE
HOTLINE
SUMMER CHATS

3 DATES - VIRTUAL
13:00-14:00 UTC
and 20:00-21:00 UTC

JULY 2
GENERAL PACE DATA QUESTIONS
QUICK TUTORIAL INTRO
DATA SUBSETTING
CHAT WITH
Jeremy Werdell
PACE
Morgaine McKibben
PACE Applications
Anna Windle
Phytoplankton and data
Ian Carroll
Data guru
Daniel Knowles
SeaDAS
Alicia Scott
OB.DAAC
Guoqing Wang
OB.DAAC
Amir Ibrahim
Atmosphere

JULY 16
PACE ATMOSPHERE AND LAND
QUICK TUTORIAL INTRO
PACE+EARHCARE
PACE+EMIT
CHAT WITH
Kirk Knobelspiesse
Polarimetry
Andrew Sayer
OCI Atmospheric
Skye Caplan
Terrestrial
Chamara Rajapakshe
Clouds
Sean Foley
Clouds
Daniel Knowles
SeaDAS
Amir Ibrahim
Atmosphere
Guoqing Wang
OB.DAAC

AUGUST 20
PACE OCEAN AND FRESHWATER
QUICK TUTORIAL INTRO
PLANKTON TYPES
CHAT WITH
Ivona Cetinic
Ocean Biogeochemistry
Bridget Seegers
Coastal and inland
Anna Windle
Phytoplankton and data
Ian Carroll
Data guru
Skye Caplan
Terrestrial and Aquatic
James Allen
PACE
Daniel Knowles
SeaDAS
Inia Soto Ramos
SEABASS

AND MORE!

REGISTER NOW AND LEARN MORE
PACE.GSFC.NASA.GOV



NEW PUBLICATION: RECONSTRUCTING CLOUDS IN 3D WITH MULTI-ANGULAR POLARIMETRY

Foley, S. R. et al. (2025), *3D cloud masking across a broad swath using multi-angle polarimetry and deep learning*.

DOI: 10.5194/amt-17-7027-2024

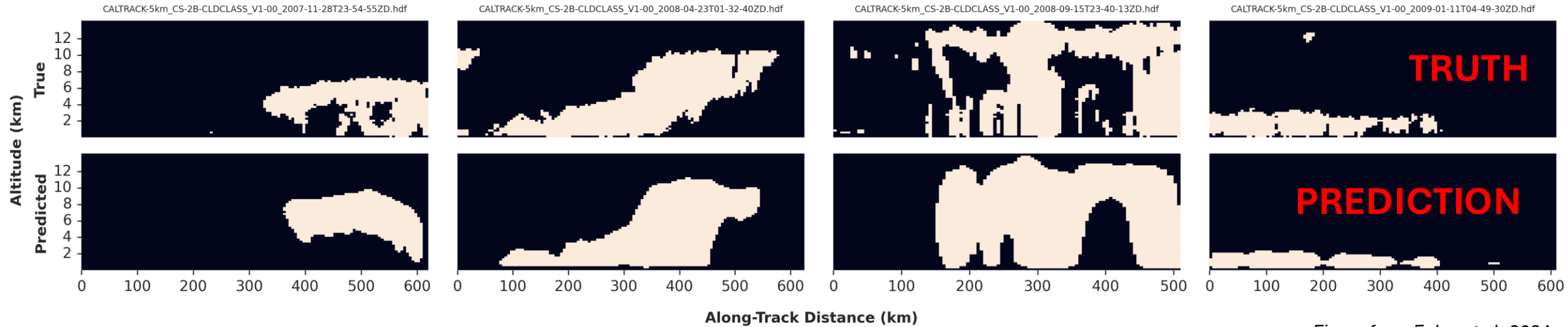
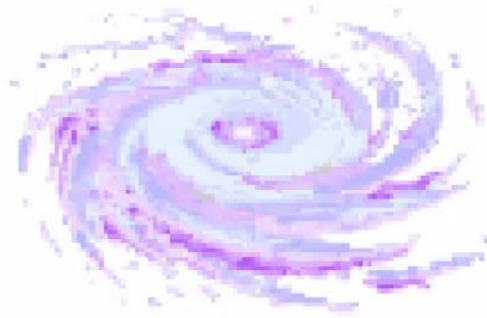


Figure from Foley et al. 2024

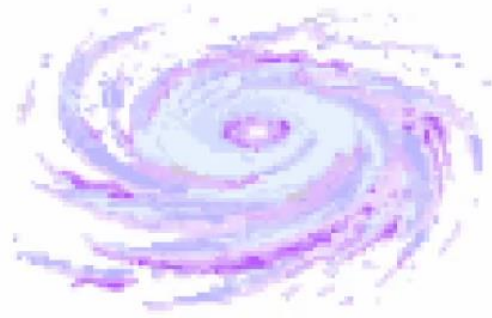
Ground truth CloudSat radar profiles (top) and model predictions (bottom)

- Neural network (NN) was trained to reconstruct the 3D cloud structure using POLDER multi-angle polarimeter (MAP) observations based on coincident CloudSat radar data.
- This multi-sensor machine learning paradigm **enables the extension of active sensor products to the wide swath of MAPs**, advancing our understanding of 3D cloud properties & 3D radiative transfer, improving aviation and weather modeling applications and more.



Cyclone Courtney

A 3D CLOUD BONANZA

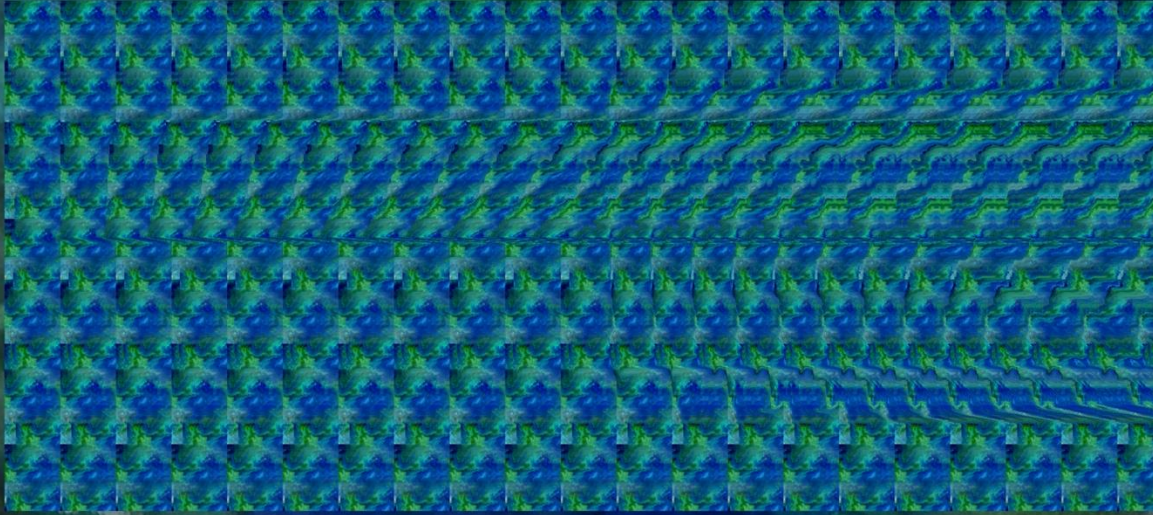


Four Ways to Visualize Storm Towers in Three Dimensions

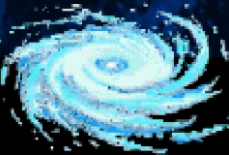
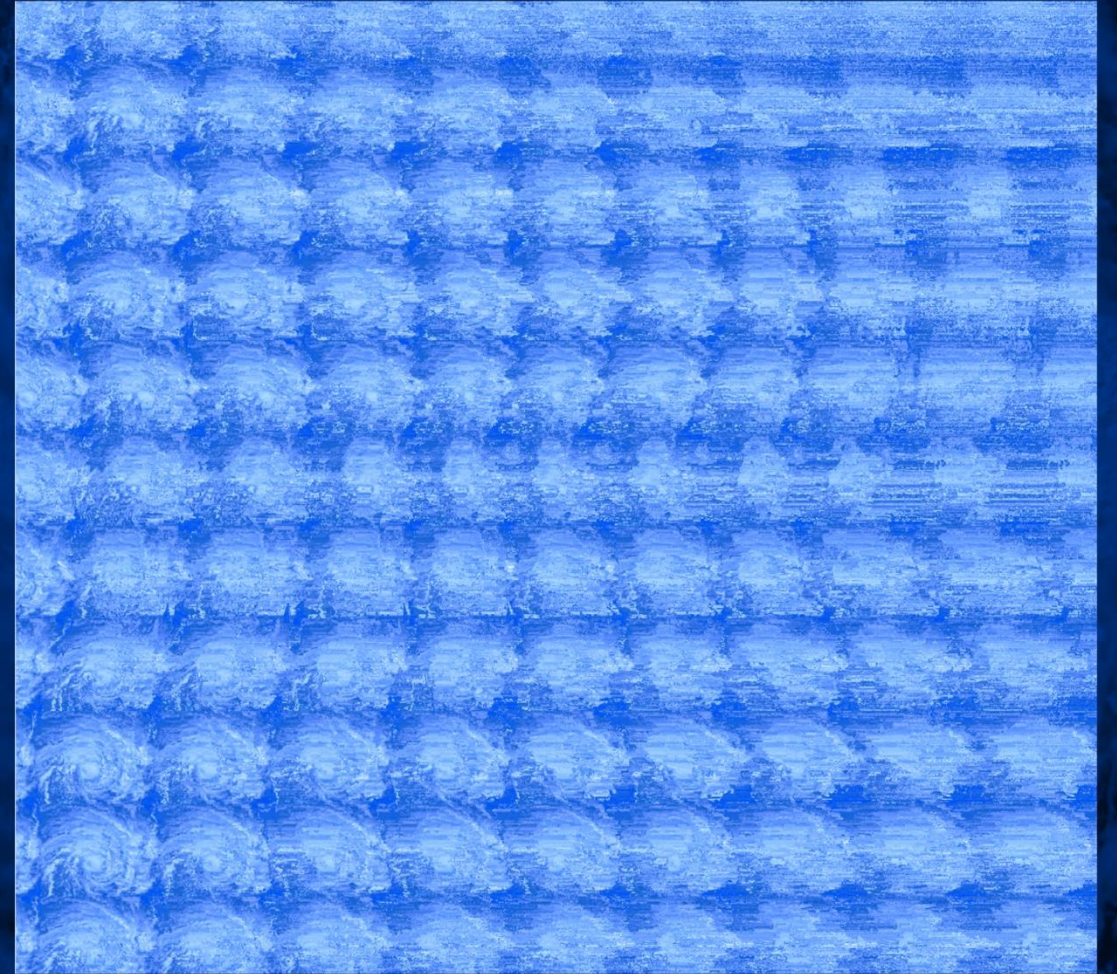
(Yes, the 90s styling is intentional. Magic Eye stereograms and wiggle GIFs deserve a proper throwback aesthetic!)

PACE Satellite Data | 2025-03-29 | Location: -18.00°N, 91.00°E

Magic Eye Stereograms



- Position your face very close to the screen
- Relax your eyes as if you're looking at something far in the distance
- Slowly move your head backward
- Be patient. This can take 30-60 seconds of practice to achieve



Communications: pace.oceansciences.org

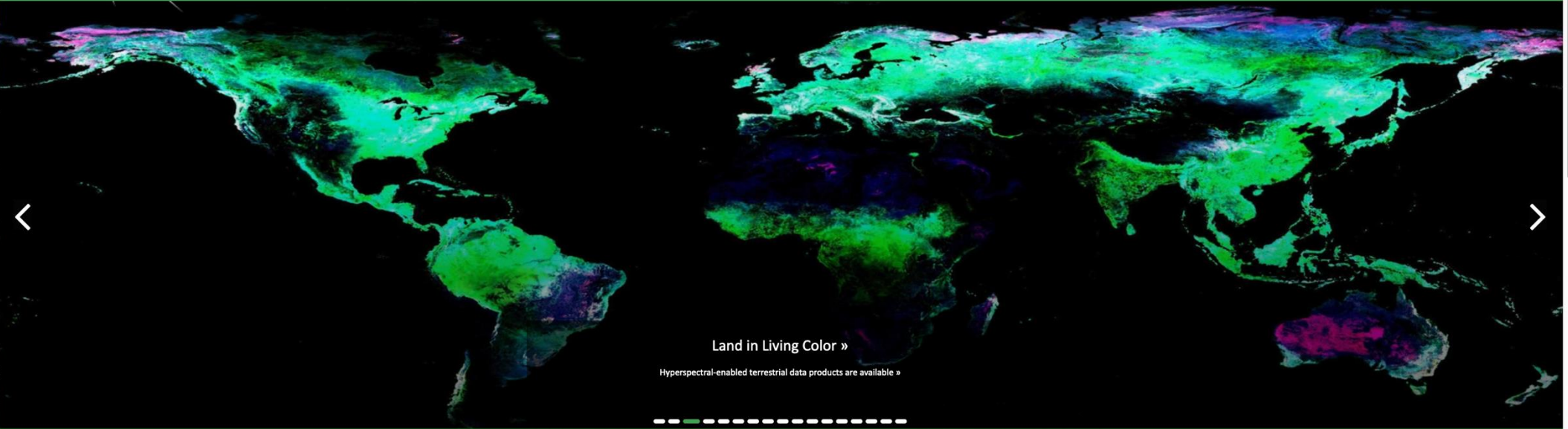
National Aeronautics and Space Administration

PACE

Plankton, Aerosol, Cloud, ocean Ecosystem



[HOME](#) [ABOUT](#) [MISSION](#) [SCIENCE](#) [APPLICATIONS](#) [DATA](#) [LEARN MORE](#) [NEWS](#) [EVENTS](#) [GALLERY](#) [DOCUMENTS](#)



<

>

Land in Living Color »

Hyperspectral-enabled terrestrial data products are available »

MISSION ELAPSED TIME

DAYS355

HR08

MIN48

ORBIT NUMBER

5205

APPROXIMATE POSITION

LAT-71

LON-12

SATELLITE LIGHTING

DAY

CLICK TO SEE ON MAP



✦ PACE HAS LAUNCHED!

[Post-launch Updates](#) [Satellite Status Updates](#)

[Join the PACE Community Mailing List](#)

PACE's data is helping us better understand how the ocean and atmosphere exchange carbon dioxide. In addition, it is revealing how aerosols might fuel phytoplankton growth in the surface ocean. Novel uses of PACE data will benefit our economy and society. For example, it will help identify the extent and duration of harmful algal blooms. PACE is extending and expanding NASA's long-term observations of our living planet. PACE's cutting-edge technology is pioneering how we take Earth's pulse for decades to come.



WHAT'S NEW

17-Dec-24
PACE-PAX: A Day in the Life of a NASA Field Campaign
→

08-Dec-24
2024 PACE Applications Workshop
→

31-Oct-24
Notes from the Field: PACE-PAX
→

30-Sep-24
Why Is NASA Tracking Seaweed From Space?
→

08-Oct-24
Engineer Noosha Haghani Prepped PACE for Space
→

25-Sep-24
PACE Hosts First Hackathon
→

Communications : PACE observatory in Augmented Reality

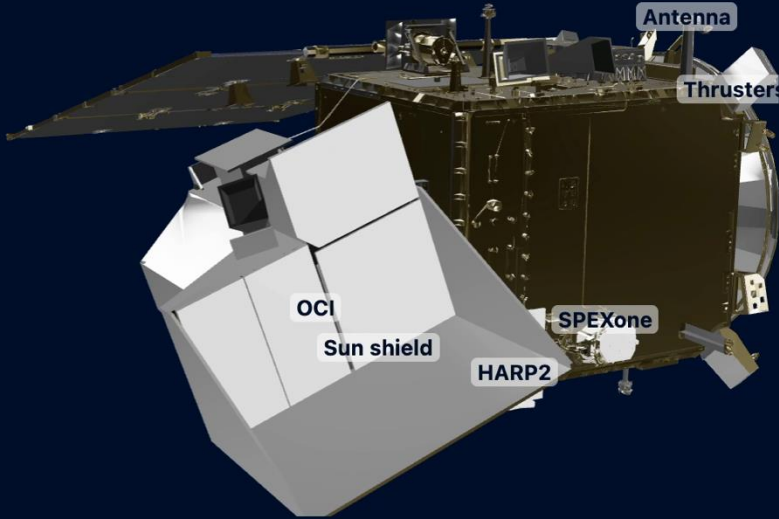
← → ↻ pace.oceansciences.org/pace-ar.html ☆ ⬇️ 👤 📄 ☰

View the PACE Satellite in Augmented Reality

National Aeronautics and Space Administration 

[View Ceratium the Dinoflagellate](#)

[View Chaetoceros the diatom](#)



The PACE - Plankton, Aerosol, Cloud, ocean Ecosystem mission provides key data on Earth's ocean and atmosphere.

OCI, the Ocean Color Instrument takes hyperspectral measurements of ocean color, while the HARP2 and SPEXone polarizers provide polarimetry data of the ocean and atmosphere.

The PACE satellite launched on February 8, 2024.



SCAN ME

Use your phone for the augmented reality experience

Communications : US Marine Band performance



The Marine Band didn't quite match the same sound levels
PACE withstood, but made a different lasting impression...

Communications : Conversation with Alex Honnold



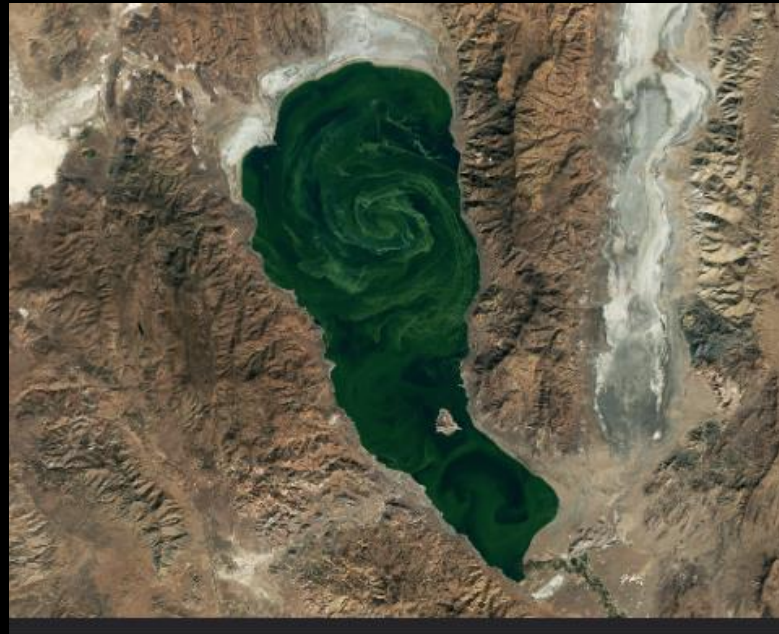
ALEX HONNOLD & IVONA CETINIĆ
TALK NEW NASA OCEAN MISSION

2026 NASA Science Calendar



Dead Rays Over the Persian Coast. These long-finned chimaera off the Persian Coast near Shiraz bring to mind knifefishes under a twinkling galaxy, or high mountain peaks as seen from above. They're named according to clouds, from the Greek word for "ray," because of their distinctive eddying shapes. Researchers use satellite data to investigate clouds as they gather, move across the globe, and disappear, helping to depict the air's seasonal movement in Earth's warm and stormy belt. Some clouds reflect solar radiation, cooling the planet, while others act as a heating blanket for the planet, trapping heat as they pass. This image was taken May 14, 2004, by the Ocean Color Instrument on NASA's RACE Platform. Aerosol, Ocean, Cloud Ecosystems satellite. RACE also carries specialized sensors called polarimeters designed to measure clouds and other particles in the atmosphere, including dust, wildfire smoke, and pollution. With new time tools, scientists can track air quality and explore key questions about how clouds form and change over time. Credit: NASA/ACE Ocean Color Instrument

<https://go.nans.gov/46pLz7T>



Pyramid Lake in Bloom. Dense beds of blue-green algae, or cyanobacteria, swirled through the waters of Pyramid Lake in October 2024. This lake in western Nevada experiences blooms almost every year, some of which produce toxins that can sicken people and animals. Satellite instruments, such as the one that captured this image from the joint NASA/US Geological Survey's Lander mission, can detect the green chlorophyll pigments in these algae. If there's a sharp increase that indicates a bloom, satellite data can help recreation managers and water resource departments determine where to focus water quality testing, enabling them to issue timely alerts for swimmers and boaters when necessary. **Credit:** NASA Earth Observations/Land

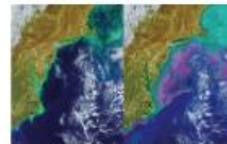
<https://go.nasa.gov/8UlyB4W>

16 <https://pc.nas.gov/2014/03/4W>

[illegible]

March 2026							May 2026							
S	M	T	W	T	F	S	S	M	T	W	T	F	S	
1	2	3	4	5	6	7							1	2
8	9	10	11	12	13	14	3	4	5	6	7	8	9	
15	16	17	18	19	20	21	10	11	12	13	14	15	16	
22	23	24	25	26	27	28	17	18	19	20	21	22	23	
29	30	31					24	25	26	27	28	29	30	
							31							

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
The new science that April is College Science Month! 100% of science courses provide an introduction to science and its importance to the public. Many programs can be done by anyone, anywhere, with just a computer or laptop. Visit CollegeScience.edu to learn how to get involved.			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

[illegible]

July 2026							September 2026						
S	M	T	W	T	F	S	S	M	T	W	T	F	S
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5	6	7	8	9	10	11	6	7	8	9	10	11	12
12	13	14	15	16	17	18	13	14	15	16	17	18	19
19	20	21	22	23	24	25	20	21	22	23	24	25	26
26	27	28	29	30	31		27	28	29	30			

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

PACE, OCI, HARP2 and SPEXone technical posters

PACE

The NASA Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) mission will extend and improve upon NASA's 20+ years of global satellite observations of our living ocean, atmospheric aerosols, and clouds and initiate an advanced set of climate-relevant data records. By determining the distribution of phytoplankton, PACE will help assess ocean health. PACE will also continue and advance key measurements related to air quality and climate. Mission science goals include extending key sea and sky data records for Earth System and climate studies and addressing new and emerging science questions by detecting a broader range of color wavelengths that will provide new and unprecedented detail.



OCI
OCEAN COLOR INSTRUMENT

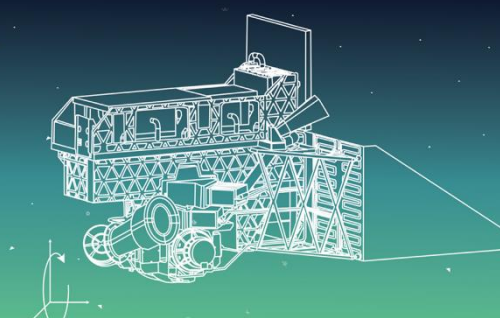
HARP2

SPEXone

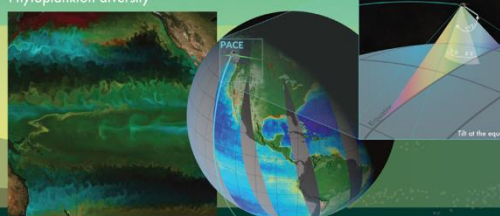
National Aeronautics and Space Administration
www.nasa.gov

OCI
OCEAN COLOR INSTRUMENT

PACE's Ocean Color Instrument (OCI) is a global hyperspectral imaging radiometer designed to reveal key properties of Earth's oceans and atmosphere. With its unprecedented range of wavelengths, OCI will advance the assessment of ocean health by measuring the diversity of phytoplankton, tiny plants and algae that sustain the marine food web. OCI will also continue many heritage atmospheric aerosol and cloud data records, which in combination with its ocean measurements, will enable improved assessment of aerosol impacts on ocean biology and chemistry. OCI is the primary instrument of the PACE mission, designed and built at NASA Goddard Space Flight Center.



Phytoplankton diversity

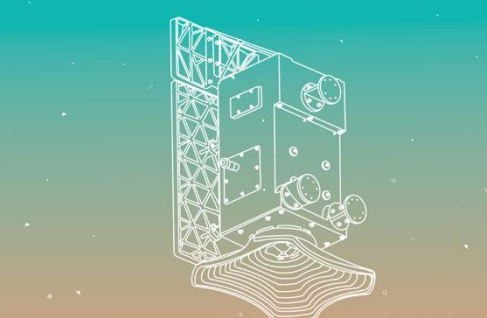


Modeled by the Darwin Project

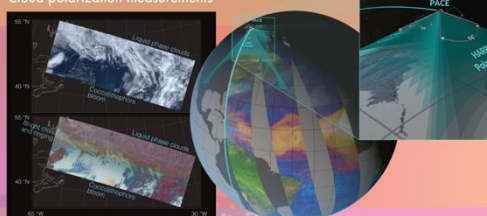
National Aeronautics and Space Administration
www.nasa.gov

HARP2

PACE's Hyper Angular Rainbow Polarimeter (HARP2) will collect measurements to reveal key properties of Earth's atmosphere. Its hyper-angular capabilities, for example, will enable retrievals of cloud droplet sizes and the shape, optical properties and roughness of ice and other atmospheric particles. With its wide swath coverage, HARP2 will cover the globe every one to two days. HARP2 is a contributed instrument to the PACE mission, designed and built by the Earth and Space Institute at University of Maryland Baltimore County (UMBC).



Cloud polarization measurements

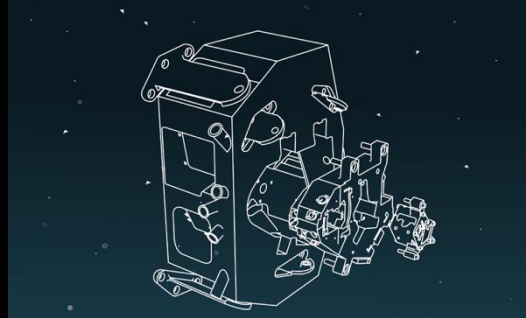


Page the HARP2 Caltech measured the Earth Space Institute as UMBC

National Aeronautics and Space Administration
www.nasa.gov

SPEXone

PACE's Spectro-Polarimeter for Planetary Exploration (SPEXone) will collect measurements to reveal key properties of Earth's atmosphere. Its hyperspectral capabilities, for example, will enable retrievals of aerosol microphysical properties that inform on air quality and atmospheric energy budgets. SPEXone is a contributed instrument to the PACE mission, designed and built by a Dutch consortium consisting of SRON Netherlands Institute for Space Research and Airbus Defence and Space Netherlands.



Polarization spectra

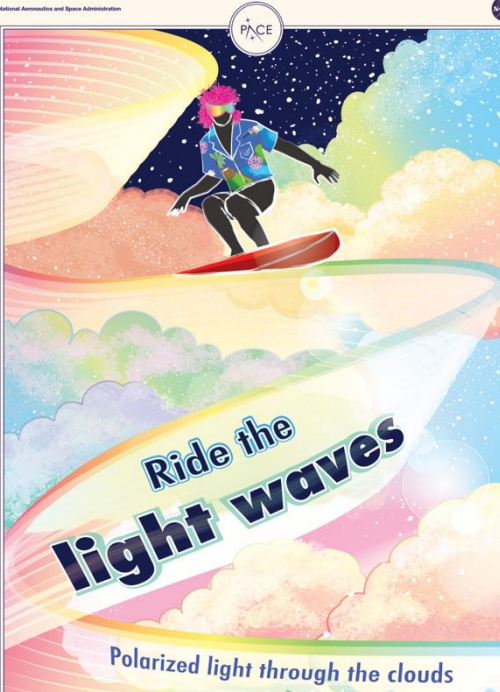


Simulated by van Amerongen et al. (2018)

National Aeronautics and Space Administration
www.nasa.gov

Travel-style posters for clouds, ocean, aerosols and land

National Aeronautics and Space Administration



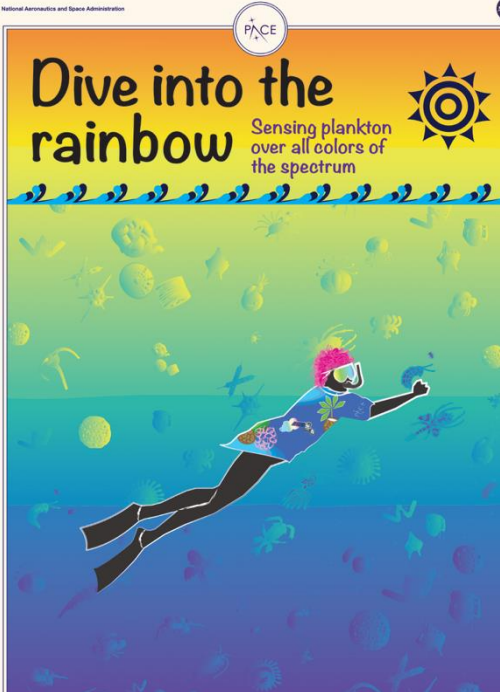
Ride the light waves

Polarized light through the clouds

PACE's polarimeters, SPeXone and HARP2, harness the properties of light waves as they bounce through Earth's atmosphere to reveal detailed cloud characteristics. By capturing polarized sunlight across multiple wavelengths and viewing angles, these instruments surf the electromagnetic spectrum to determine cloud droplet sizes, shapes, and composition with exceptional accuracy. This wave-based analysis enables scientists to distinguish between different cloud types and understand their microphysical properties better than traditional methods. The precise data on cloud formation and evolution improves climate models and weather predictions. These light-driven insights reveal how clouds interact with incoming solar radiation and influence Earth's energy balance, advancing our understanding of their critical role in climate regulation.

<https://open.gpo.nasa.gov>

National Aeronautics and Space Administration



Dive into the rainbow

Sensing plankton over all colors of the spectrum

PACE's Ocean Color Instrument captures the full spectrum of light reflected by ocean life, revealing phytoplankton communities in vivid spectral detail. These microscopic marine plants produce half of Earth's oxygen and serve as sensitive indicators of ocean health and climate variations. By analyzing the rainbow of wavelengths each species reflects and absorbs, scientists can distinguish different phytoplankton types; some being beneficial and some toxic, and track bloom patterns beneath the surface. This detailed biological data reveals the intricate connections between ocean life, fisheries, coastal economies, and global systems. Understanding phytoplankton dynamics through PACE's spectral measurements provides critical insights into how our changing planet affects marine ecosystems and their vital role in sustaining life on Earth.

<https://open.gpo.nasa.gov>

National Aeronautics and Space Administration



Surf the Plumes!

Catch sight of aerosols like never before

PACE's Ocean Color Instrument and polarimeters work together to track atmospheric aerosols as they flow across the globe like invisible currents. These tiny particles, including dust, smoke, sea spray, and pollution, ride atmospheric winds while playing crucial roles in cloud formation, weather patterns, and climate regulation. By measuring how sunlight scatters off different aerosol types, PACE can determine their size, composition, and concentration as they surf through Earth's atmosphere. This detailed aerosol data helps scientists understand how human activities and natural processes affect air quality and climate. The satellite's advanced instruments reveal the complex pathways these particles follow, from their sources through their atmospheric journey to their ultimate impact on Earth's energy balance and weather systems.

<https://open.gpo.nasa.gov>

National Aeronautics and Space Administration



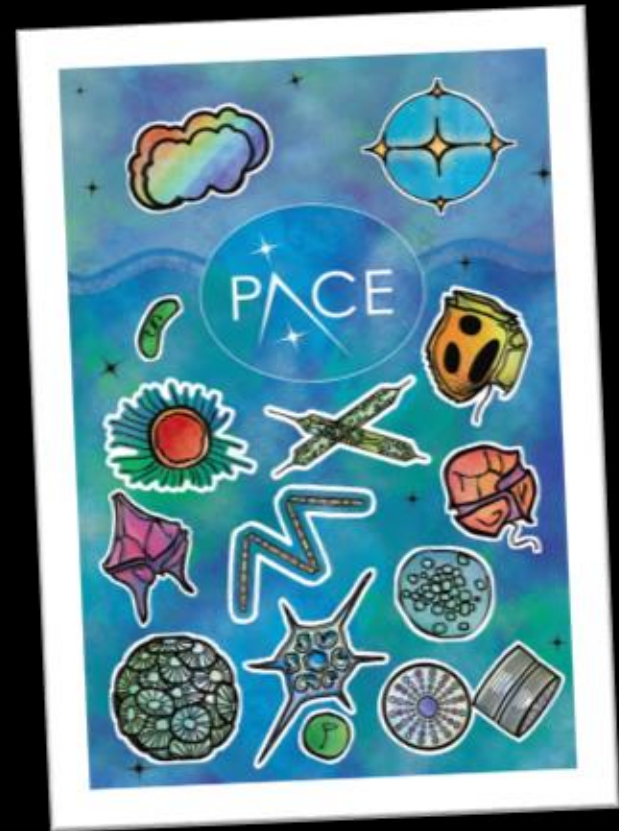
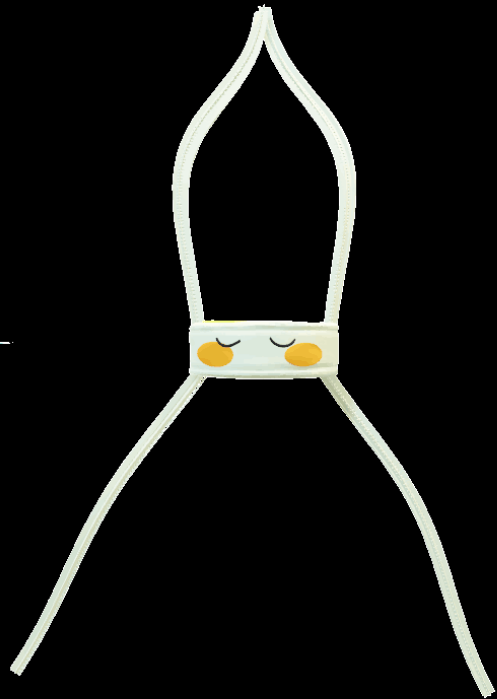
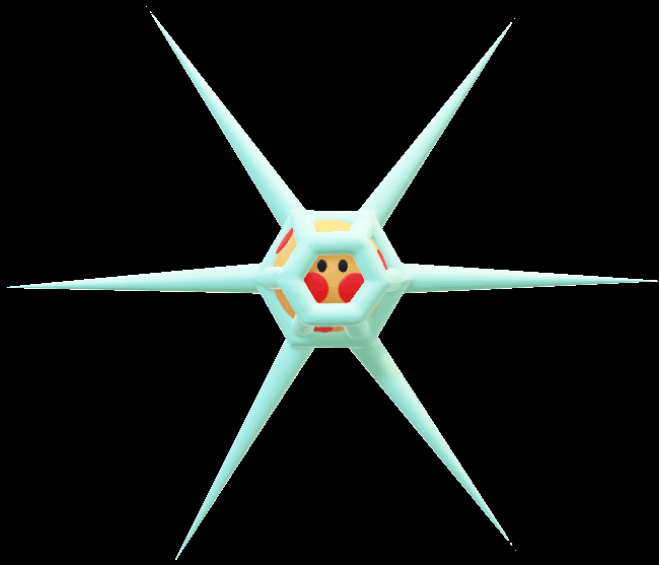
Explore new LAND

See all the colors plant life has to offer

PACE's Ocean Color Instrument opens new territories of understanding by imaging vegetation across the full spectrum of visible and near-infrared light. This hyperspectral capability maps the diverse landscape of plant pigments, including chlorophyll and carotenoids, revealing hidden details about terrestrial ecosystems. By exploring subtle spectral signatures across different landscapes, the instrument charts plant health patterns and monitors land cover changes with unprecedented precision. This detailed mapping supports discovery of vegetation stress, seasonal transformations, and shifts in agricultural and forest territories. These enhanced observation capabilities navigate conservation strategies, agricultural management, and ecological research while charting new frontiers in our understanding of global plant health and land cover dynamics.

<https://open.gpo.nasa.gov>

Communications : Plankton



science.nasa.gov/eclips/videos



Our World: Phytoplankton – Powering the Ocean Food Web

Did you know some of the tiniest living things in the ocean help make the air you breathe? Meet phytoplankton,...

DEC 18, 2025



Real World: Phytoplankton, Microscopic Drifters

What can something smaller than the width of your hair do to our whole planet? A lot! In this NASA...

DEC 17, 2025



Ask SME: Oceanographer Dr. Ivona Cetinić

In this close-up video, Dr. Ivona Cetinić, oceanographer at NASA's Goddard Space Flight Center, shares her love of exploring the...

DEC 11, 2025



https://mynasadata.larc.nasa.gov

Earth System Data Explorer

Monthly Concentration of Synechococcus

Date: Apr 2025

Units: Cells per Milliliter

01500030000

Change to Grayscale Palette

Description: This quantity describes the concentration of Synechococcus in oceans. Synechococcus is a group of single-celled phytoplankton (cyanobacteria). They are very small, ranging in size from 0.8 to 1.5 micrometers in diameter. They are abundant in marine environments and play crucial roles as primary producers and in marine food webs. They are found in both marine and freshwater environments. They are known for their efficient photosynthesis, rapid growth, and diversity of habitats they are found in. They live among many different environments and light conditions. Many can even move around with a unique swimming ability. These data have a grid spacing of 4 km by 4 km.

Source: PACE

Dataset Selection

1. Select a Sphere of the Earth System

Biosphere

2. Select a Category

Phytoplankton

3. Select a Dataset

Monthly Concentration of Synechococcus

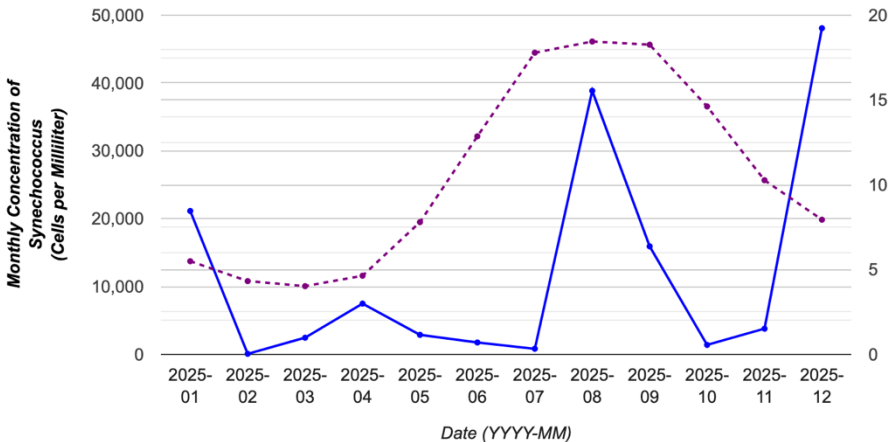
4. Select the Date

Search places

Monthly Concentration of Synechococcus and Monthly Mean Sea Surface Temperature (42.5299, -67.6385)

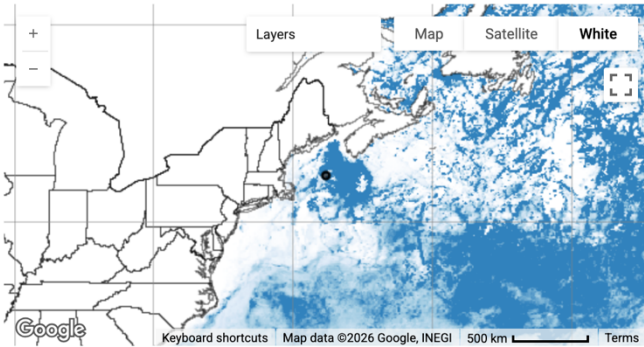
Monthly Concentration of Synechococcus (Cells per Milliliter)

Monthly Mean Sea Surface Temperature (Degrees Celsius)



Date (YYYY-MM)	Monthly Concentration of Synechococcus (Cells per Milliliter)	Monthly Mean Sea Surface Temperature (Degrees Celsius)
2025-01	21,000	6.5
2025-02	0	5.5
2025-03	2,000	5.0
2025-04	8,000	5.5
2025-05	3,000	10.0
2025-06	2,000	15.0
2025-07	1,000	18.0
2025-08	39,000	18.5
2025-09	16,000	18.0
2025-10	1,000	12.0
2025-11	4,000	8.0
2025-12	48,000	5.0

Notice: If your second dataset fails to load, it may be because your second chosen dataset does not have data available for the time period selected. To see a list of data collections and their available dates, visit: [Link to data collections](#)



Google Earth Engine Apps

Time Plot Instructions

1. Select a Location

Click a location on the map or enter the latitude and longitude of a location in the textboxes below.

Latitude: 42.5299 Longitude: -67.6385

2. Select the Start and End Dates

Start Date: 2025 Apr

End Date: Year Month

3. (Optional) Add a second variable

☒ Check Box to Add Second Variable

4. Select a Sphere of the Earth System

Choose Sphere

5. Select a Category

Choose Category

6. Select a Dataset

Choose Dataset

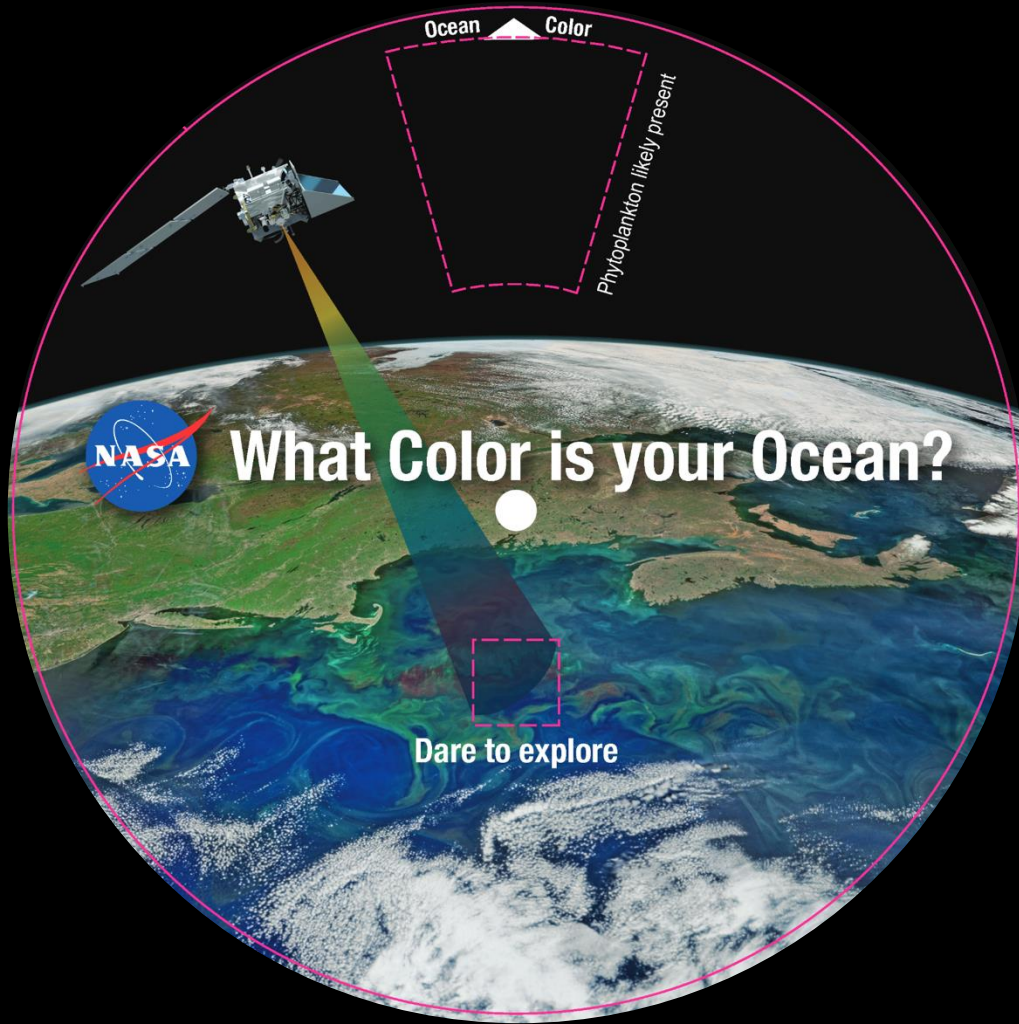
7. Generate the Time Plot

Generate Plot

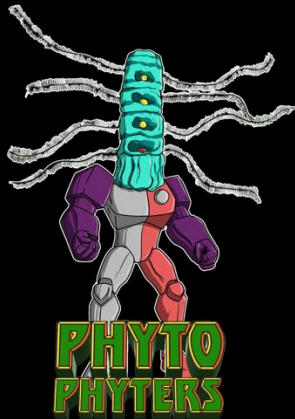
8. Exit Time Plot

Exit Time Plot

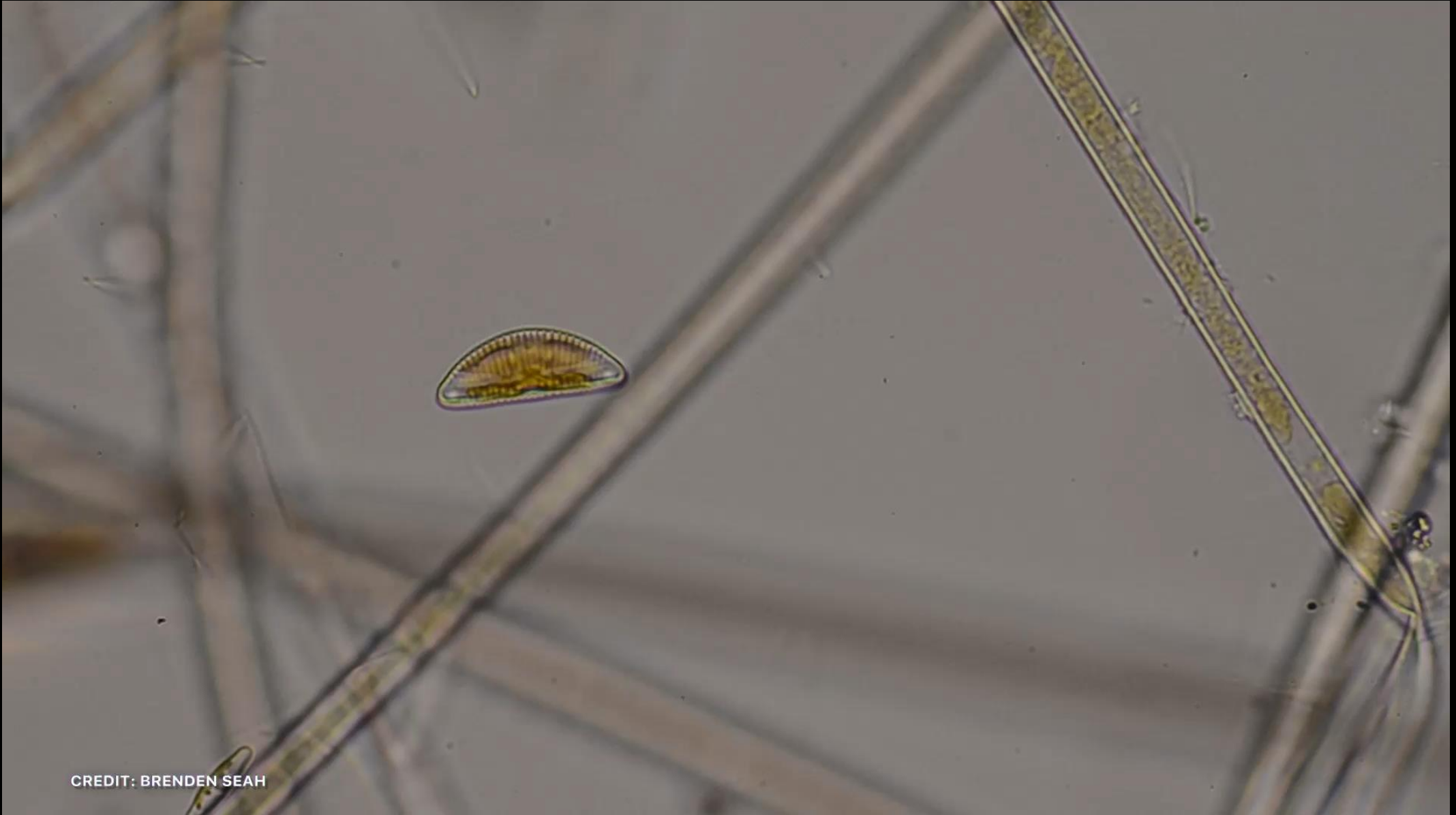
Communications : Plankton wheel



Communications : NASA SVS videos – Phyto Phytors



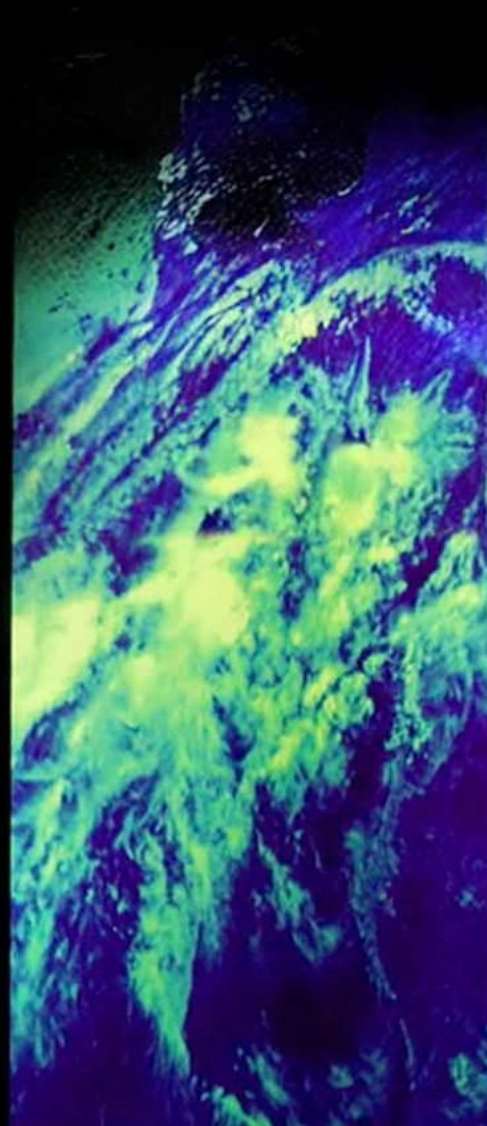
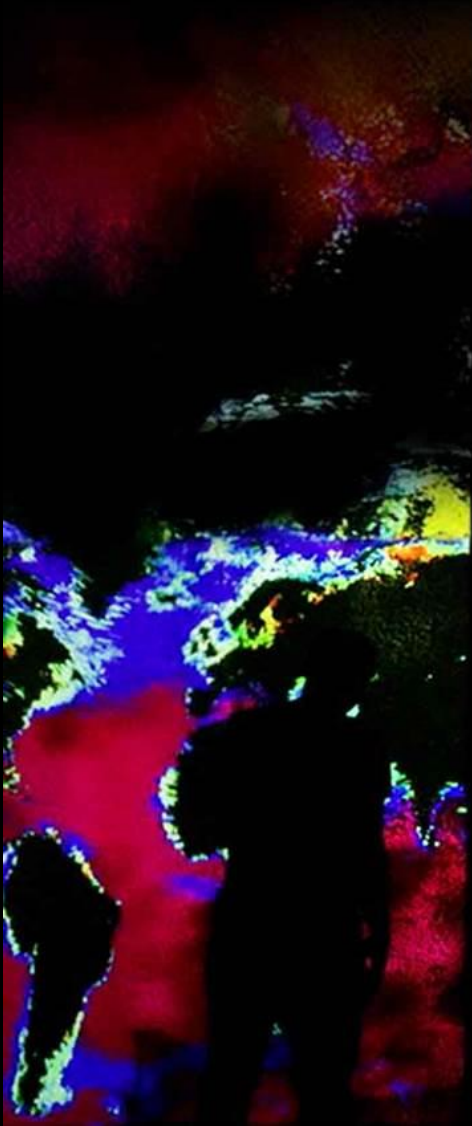
Communications : SVS videos – Phyto Phytors



CREDIT: BRENDEN SEAH

Communications : Traveling Immersive Experience

Wave: from space to ocean, [premiered at the Kennedy Center in Washington, DC.](#)

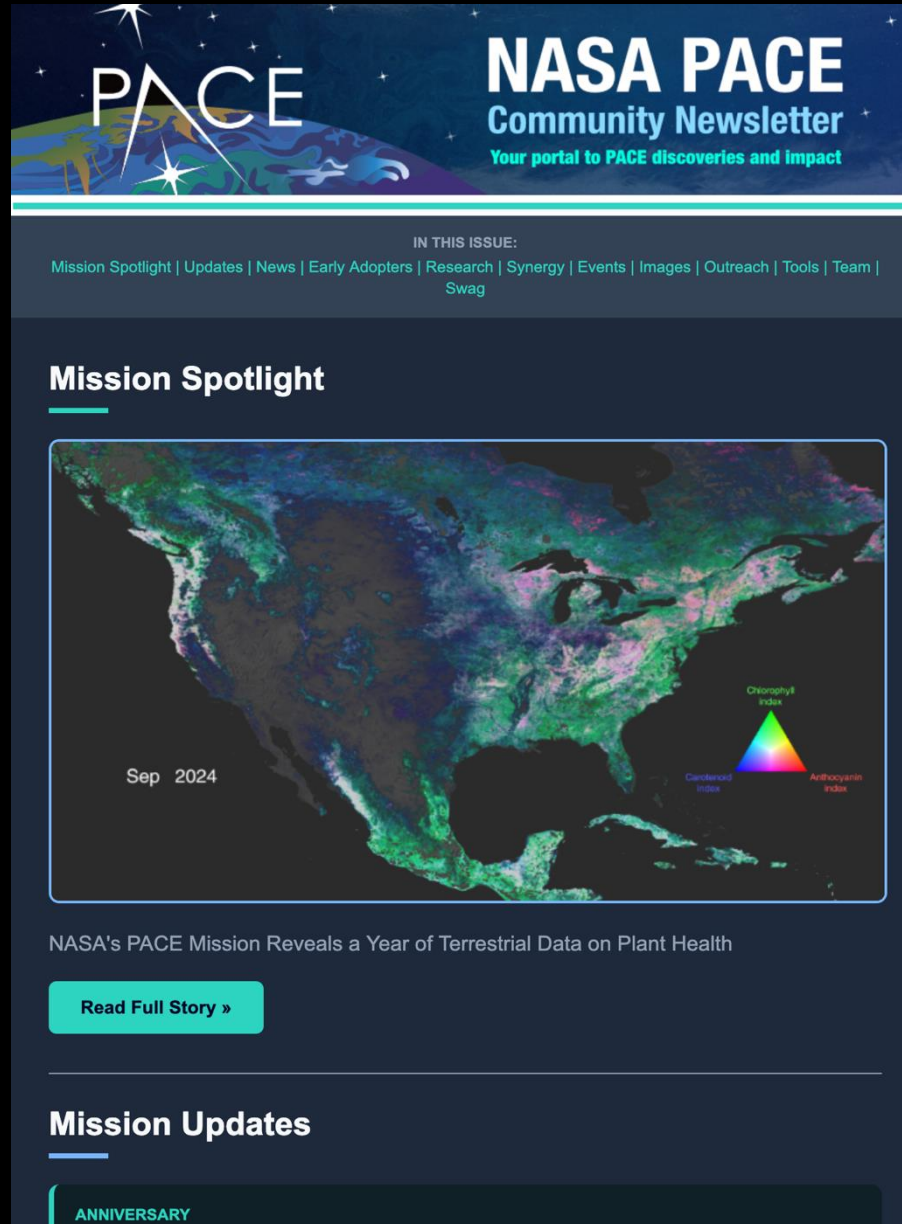


Communications : PACE-PAX Field validation campaign

Simultaneous measurements
by plane, boat and satellite



Stay connected! Subscribe to the PACE Community Newsletter



Email pace-community-request@lists.nasa.gov
with "subscribe" in the subject

Links for PACE resources

Numerous Storymaps that teach about many different subjects:

<https://pace.oceansciences.org/gallery.htm?id=storymap>

Here is our video gallery:

<https://pace.oceansciences.org/gallery.htm?id=video>

A card matching game about PACE and the color spectrum:

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

Build your own PACE satellite

https://pace.oceansciences.org/paper_model.htm

Ocean color wheel

<https://pace.oceansciences.org/learn-more.cgi?id=1>

What phytoplankton are you?

https://pace.oceansciences.org/phyto_quiz.cgi

PACE and phytoplankton in augmented reality:

<https://pace.oceansciences.org/pace-ar.html>

Shedding light on PACE

https://pace.oceansciences.org/whatispace_main.htm

Aerosol quiz

https://pace.oceansciences.org/aerosol_quiz.htm

Here are some visuals, mostly from NASA's Scientific Visualization Studio:

Various PACE visuals:

<https://svs.gsfc.nasa.gov/14518/>

PACE Makes the invisible visible:

<https://svs.gsfc.nasa.gov/14600/>

The insanely important world of phytoplankton:

<https://svs.gsfc.nasa.gov/14361/>

True color vs false color

<https://svs.gsfc.nasa.gov/14579/>

Links for PACE resources

Ocean currents:

<https://svs.gsfc.nasa.gov/5425>

Harmful algal blooms:

<https://svs.gsfc.nasa.gov/14648/>

PACE polarimetry:

<https://svs.gsfc.nasa.gov/5177/>

PACE image gallery (the images on the first page of the gallery are all from PACE, previous images are from other sensors. The sensor is named in the image descriptions) : <https://oceancolor.gsfc.nasa.gov/gallery/>

From NASA SVS:

Real-time global biosphere:

<https://svs.gsfc.nasa.gov/5075/>

PACE orbit with swaths and instrument fields of view:

<https://svs.gsfc.nasa.gov/5019/>

From PACE data to image

<https://svs.gsfc.nasa.gov/14579/>

Darwin Model of Ocean Microbes Updated:

<https://svs.gsfc.nasa.gov/4977/>

Ocean Surface CO2 Flux with Surface Winds:

<https://svs.gsfc.nasa.gov/4873/>

Earth: A System of Systems (updated)

<https://svs.gsfc.nasa.gov/31139/>

PACE - Studying Plankton, Aerosols, Clouds, and the Ocean Ecosystem

<https://svs.gsfc.nasa.gov/4700/>

Global Views of PACE Land Vegetation Data

<https://svs.gsfc.nasa.gov/5548/>

Leaf Year: Seeing Plants in Hyperspectral Color

<https://svs.gsfc.nasa.gov/14850/>

PACE Scientists Take to the Sea and Air (and Really High Air)

<https://svs.gsfc.nasa.gov/14723/>

Links for PACE resources

US Marine Band Performance:

<https://www.youtube.com/watch?v=NtVh5CvIG4I>

Full PACE Fanfare by the US Marine Band

<https://www.youtube.com/watch?v=96W6Vqaf3KA>

Alex Honnold's conversation about PACE with Ivona Cetinic

<https://svs.gsfc.nasa.gov/14514/>

NASA eClips Educational content:

Our World: Phytoplankton – Powering the Ocean Food Web

<https://science.nasa.gov/eclips/videos/phytoplankton-powering-the-ocean-food-web/>

Real World: Phytoplankton, Microscopic Drifters

<https://science.nasa.gov/eclips/videos/phytoplankton-microscopic-drifters/>

Ask SME: Oceanographer Dr. Ivona Cetinić

<https://science.nasa.gov/eclips/videos/oceanographer-dr-ivona-cetinic/>

Archive of PACE Newsletters

<https://pace.oceansciences.org/documents.htm?id=newsletter>

Leaf peeping with PACE

https://svs.gsfc.nasa.gov/14769/#media_group_377191

Conoce a PACE (Spanish)

https://pace.oceansciences.org/conoce_a_pace.htm

PACE travel posters

<https://pace.oceansciences.org/blog.htm?id=33>

Help Hub:

<https://nasa.github.io/oceandata-notebooks/>

SVS Overview of PACE

<https://svs.gsfc.nasa.gov/5599/>

Thank you!

Jeremy Werdell, Morgaine McKibben, Sara Blumberg, Ivona Cetinic, Norman Kuring, Meng Gao, Chamara Rajapakshe, Skye Caplan, Fred Huemmrich, Sean Foley, Inia Soto Ramos, Bingqing Liu, Zach Fasnacht, Annette deCharon, Gary Davis, Jenny Mottar, Ryan Fitzgibbons and the NASA SVS team, the WAVE creative team, the PACE-PAX team, the Help Hub team and all of the PACE and OB.DAAC teams!

Questions or ideas? carina.poulin@nasa.gov

