



Hyperspectral & polarimetric ocean observations from space!

How the NASA PACE Mission will advance environmental & societal applications in disaster management

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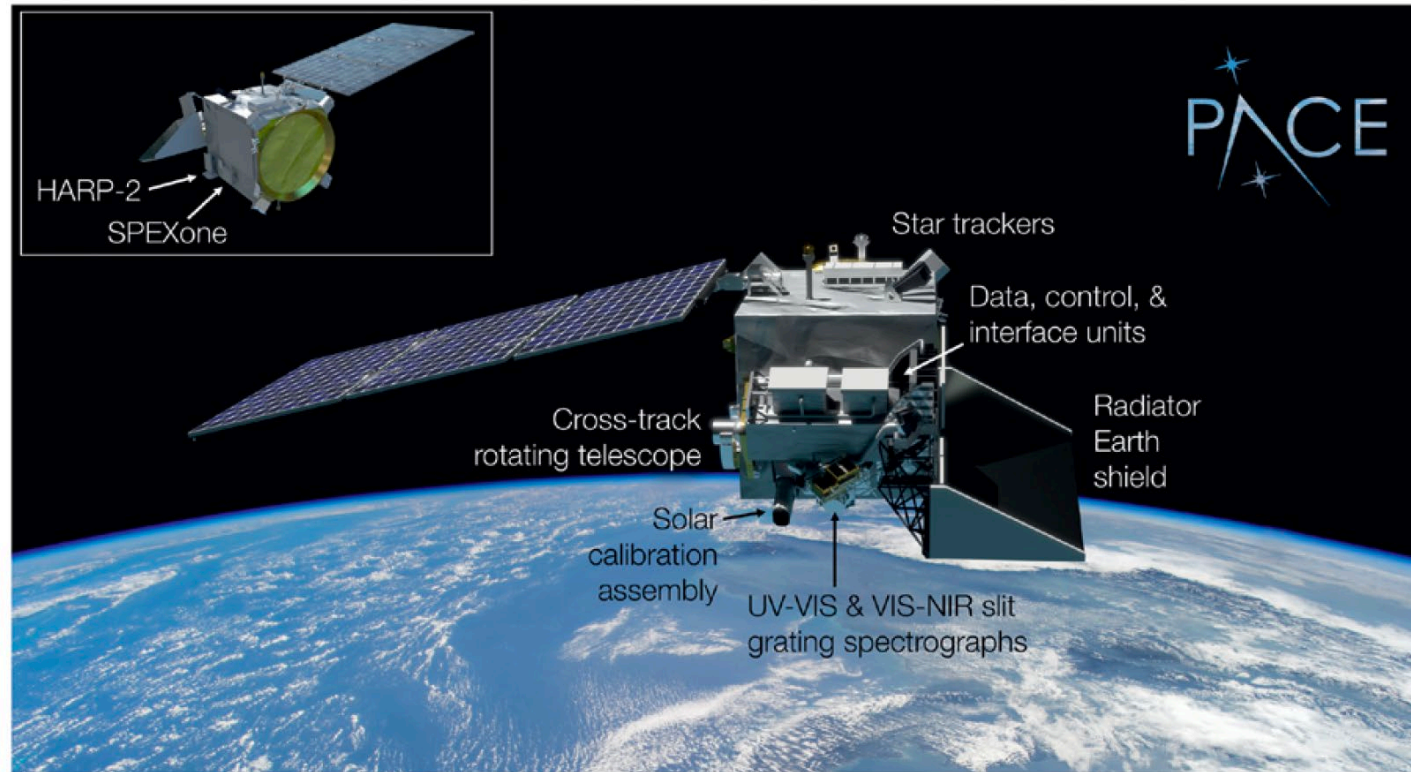
Annual Climate Prediction Applications Science Workshop

May 11, 2023



- Anticipated Launch: **January 9, 2024**
- 13:00 local Equatorial crossing; Global
- 3yr mission, BUT at least 10yrs of propellant
- **Instruments:**
 - Hyperspectral imager: **Ocean Color Instrument (OCI)**- 5 nm for 340-890 nm at 2.5 nm steps
 - 2-day global coverage
 - 1 km² at nadir
 - Two multi-angle polarimeters:
 - **HARP-2** (wide-swath, hyper-angular, 4 bands; 3km² nadir)
 - **SPEXone** (Narrow swath, 5 viewing angles, hyperspectral (UV-NIR), 2.5km² nadir)
- **Data will be free & open to all**
 - All products will be hosted at the GSFC Ocean Biology Distributed Active Archive Center (OB.DAAC) and be available via other portals such as NASA Worldview

PACE is NASA's next great investment to extend ocean biological, ecological, & biogeochemical data records, as well as cloud & aerosol data records!



Extend key systematic **ocean biological, ecological, & biogeochemical climate data records**, as well as **cloud & aerosol climate data records**

Make **new global measurements of ocean color** that are essential for understanding the global carbon cycle & ocean ecosystem responses to a changing climate

Collect **global observations of aerosol & cloud properties**, focusing on reducing the largest uncertainties in climate & radiative forcing models of the Earth system

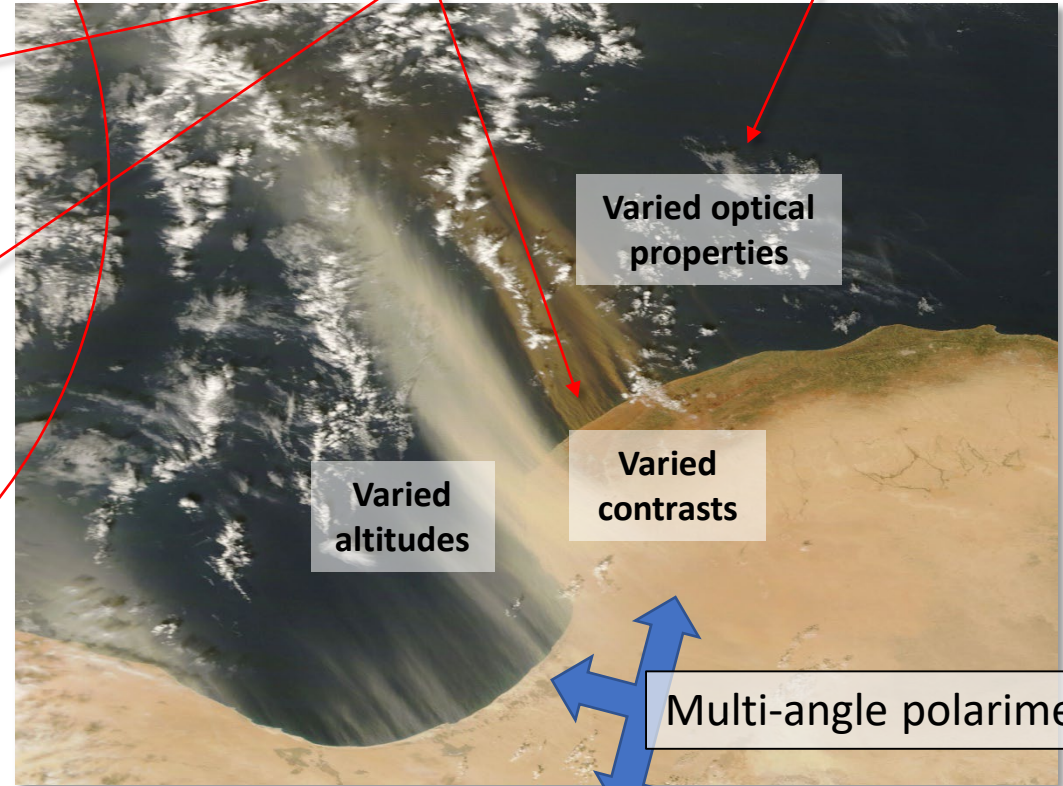
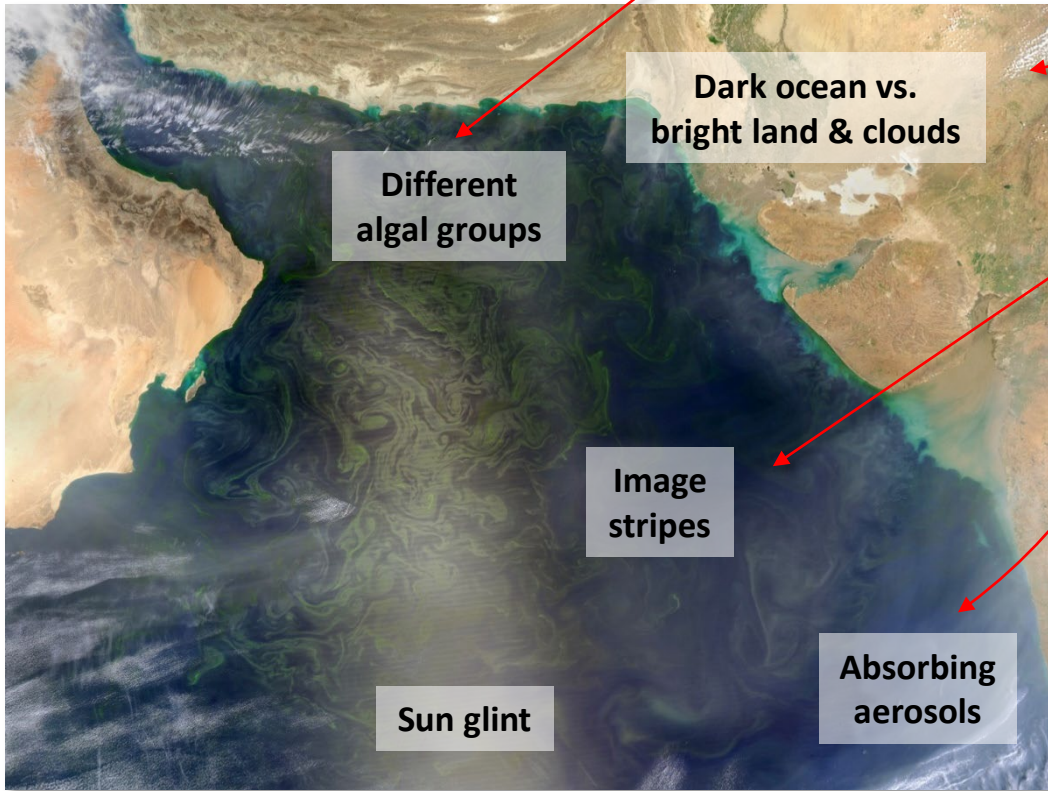
GSD of $1 \pm 0.1 \text{ km}^2$ at nadir

Spectral range from $\leq 340\text{-}890 \text{ @ } \leq 5 \text{ nm}$

940, 1038, 1250, 1378, 1615, 2130, 2260 nm

Twice-monthly lunar calibration & onboard solar calibration (daily, monthly, dim)

Instrument performance requirements

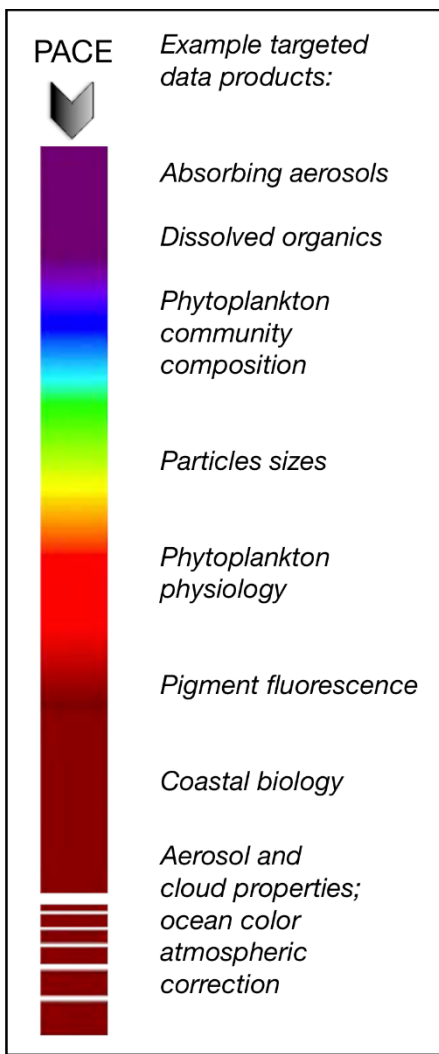
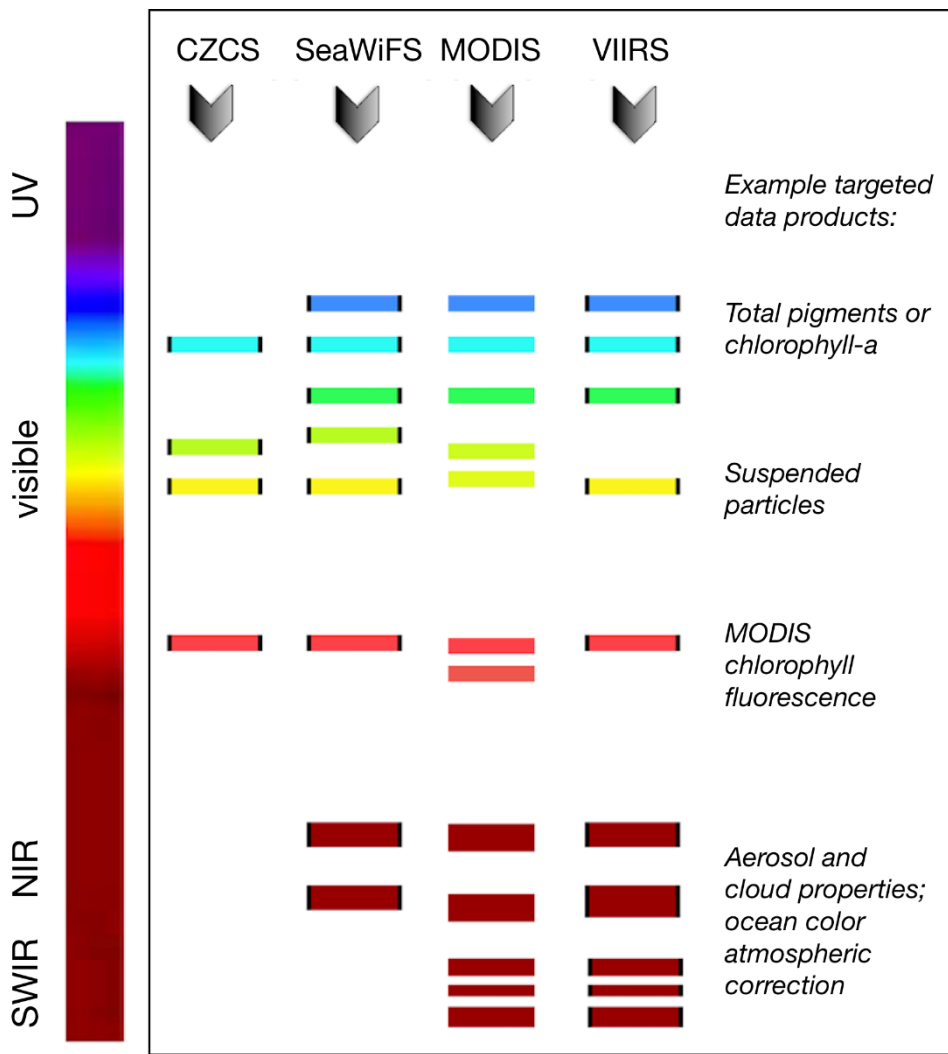


Tilt $\pm 20^\circ$

Improve our understanding of how **aerosols influence ocean ecosystems & biogeochemical cycles** and how **ocean biological & photochemical processes affect the atmosphere**

Moving from multi-spectral radiometry to spectroscopy

1978-1986 1997-2010 1999-pres. 2012-pres.

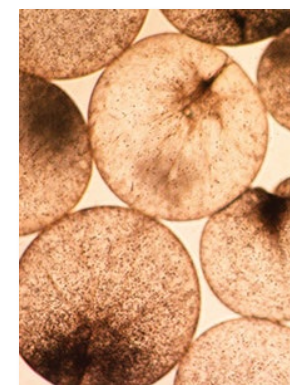


Example diatom



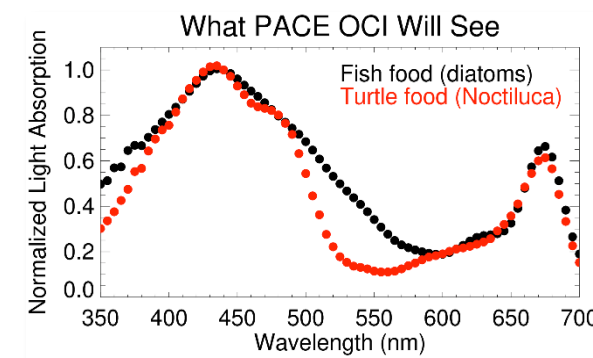
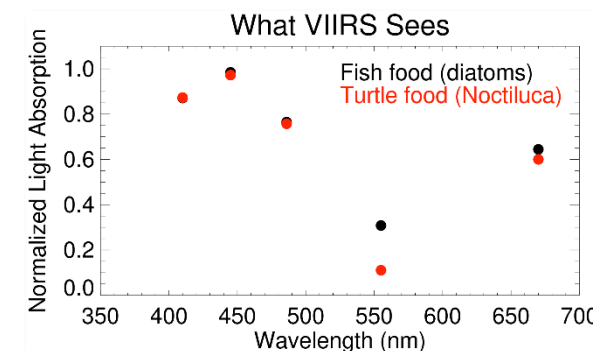
Linda Ambrecht, abc.com.au

Example Noctiluca



1 mm
Joaquim Goes, LDEO

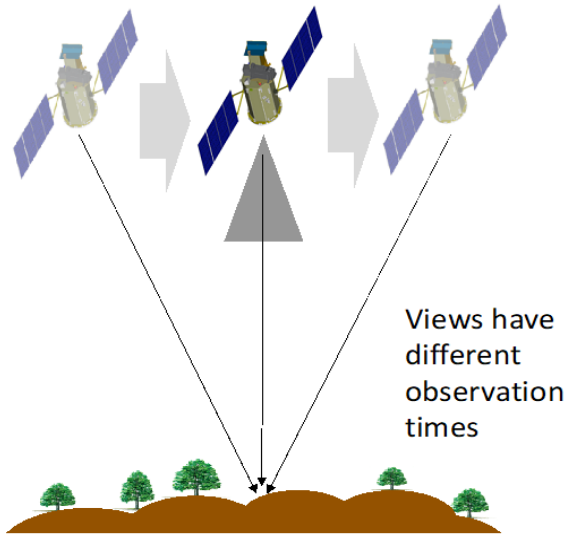
Signals from the water are small & differentiating between constituents requires additional information relative to what we have today



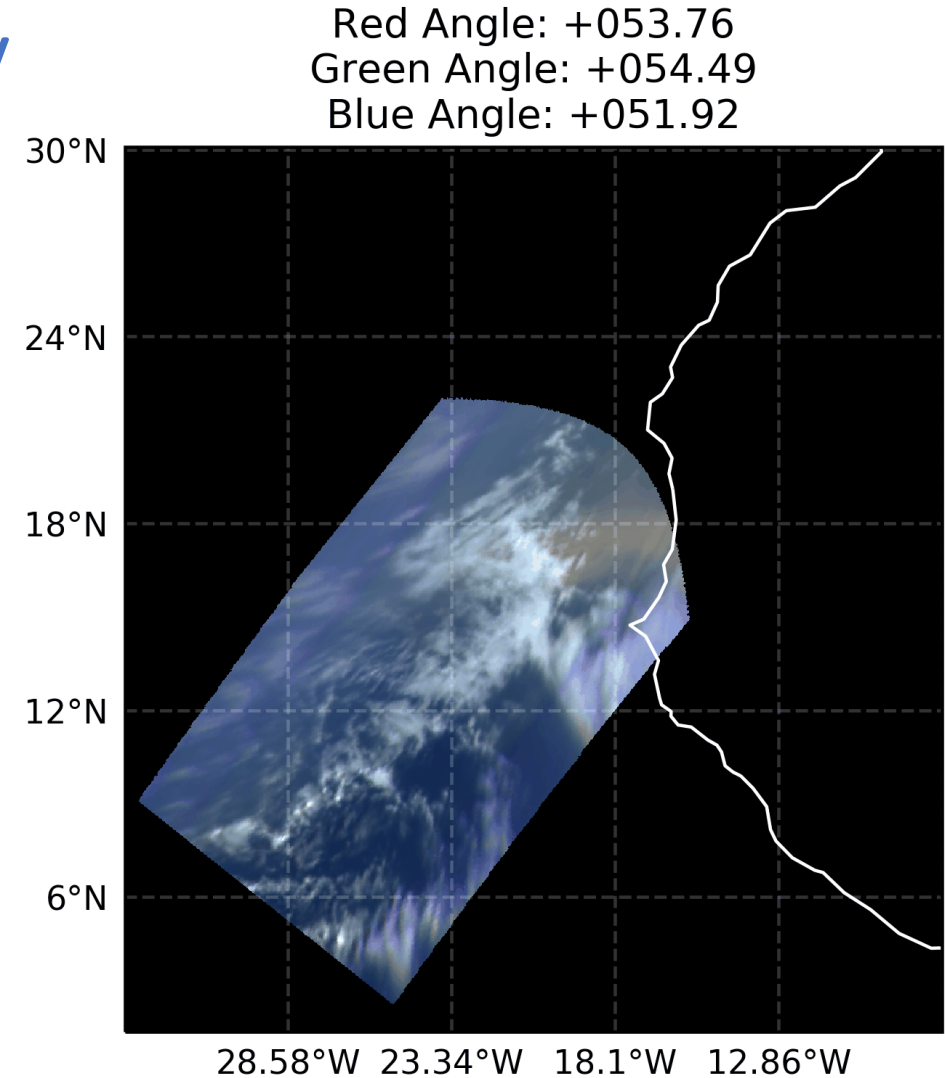
Similarly, *polarization* provides another dimension of information.



The *multi-angle* aspect of PACE's polarimetry further improves characterization of aerosol particles, clouds, and surface cover.



HARP Cubesat RGB image
J. V. Martins (UMBC) and team



New PACE Technology = Interdisciplinary Applied Science Objectives



fisheries

biodiversity

HABs

oil leaks

food security

wetlands

terrestrial ecosystems

land use & change



air quality

human health

disasters

climate

resource management

ecological forecasting

pathogens

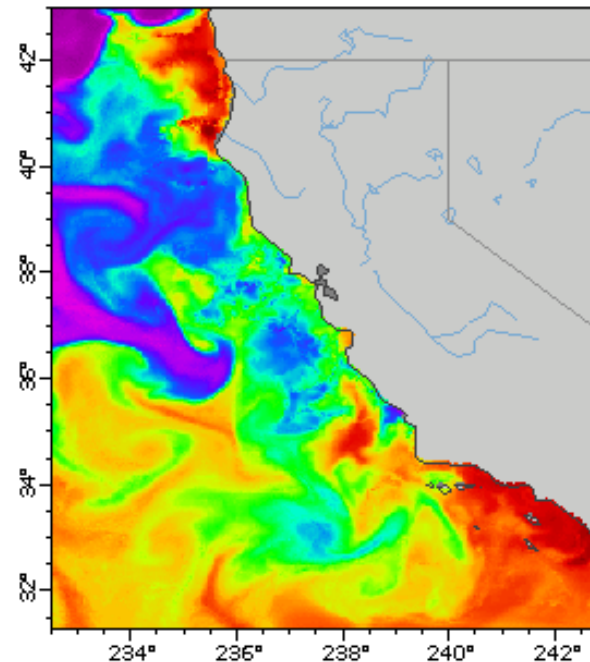
water quality



Informing Applications with PACE Data: Monitoring and Managing Disasters

Applicable across application areas, PACE will provide data on that can inform disaster risk management, including reduction, mitigation, and response of disasters such as:

- Wildfire smoke (aerosol data)
- Volcanic ash emissions pre- or post-eruption (aerosol, SO₂ data)
- Harmful algal blooms and fish kills/hypoxia (phytoplankton, chlorophyll data)
- Oil seeps and spills (optical properties, reflectance)
- Hurricane/weather monitoring (cloud data)



0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1
Probability of Particulate Domoic Acid > 500 nanograms/L (1)
C-HARM 3-Day Advanced Forecast: Pseudo-Nitzschia, cellular domoic acid, and particulate domoic acid probability, California and Southern Oregon coast (2019-11-01T12:00:00Z)
Data courtesy of UCSC, UCSD



Left: Smoke plume rising over Reno, Nevada.

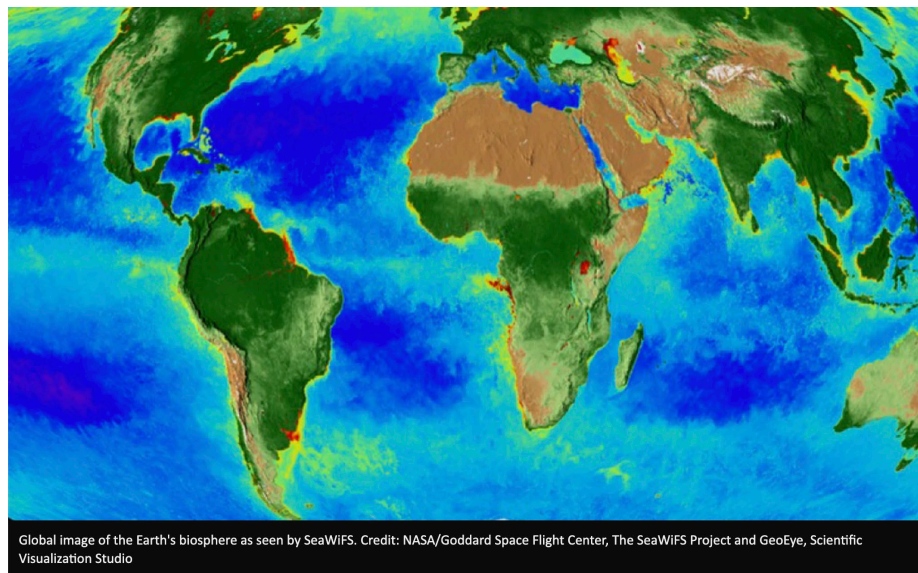
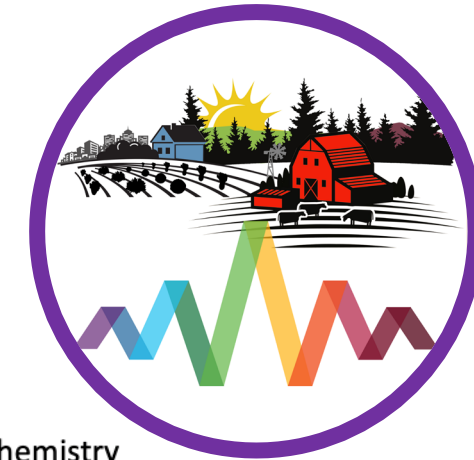
*Middle: Thick blooms of green *Noctiluca scintillans* threaten water quality, public health, tourism, and the operations of many coastal industries in Oman.*

Right: Animation showing the probability of particulate Domoic Acid concentration greater than 500 nanograms per liter in seawater off the U.S. west coast during Nov 2019. Reds and oranges indicate higher probabilities while purples and blues show lower probabilities.

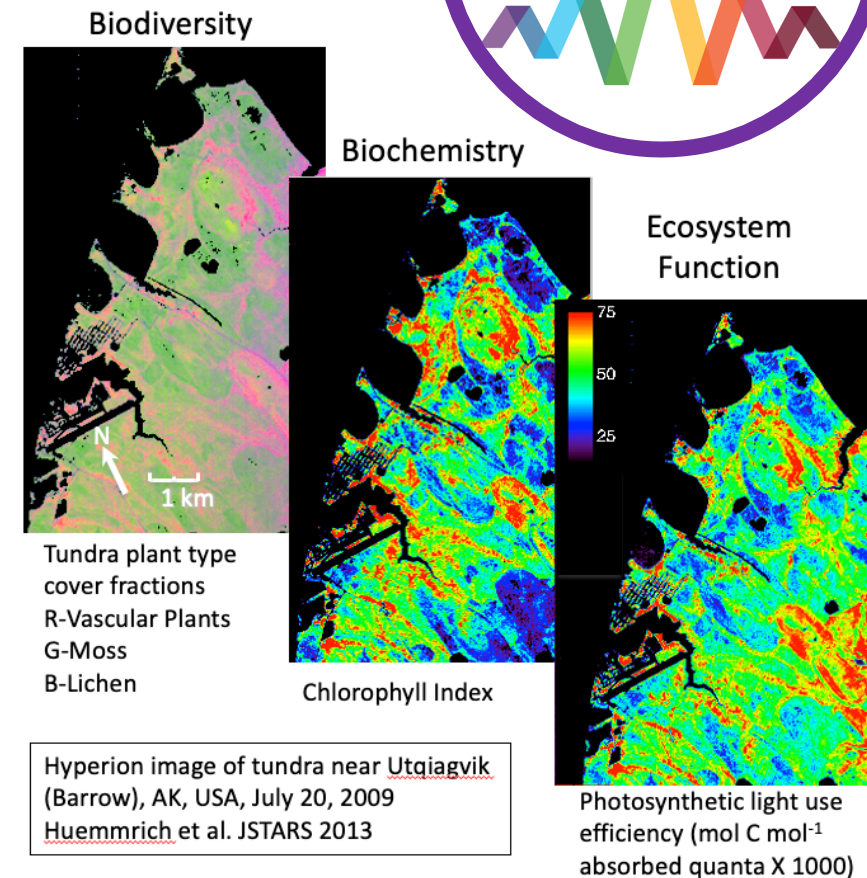
Informing Applications with PACE Data: Monitoring and Managing Terrestrial/Land Ecosystems

PACE will provide data on surface vegetation, including surface reflectance, BRDF, NDVI, and other indices, which can describe dynamics of key terrestrial vegetation biochemical and functional characteristics. This can benefit, inform, or improve:

- Monitoring watershed health for best management practices, including impacts to wetlands, forests (cover and type), and other ecosystems from insect outbreaks, fires, seasonal changes, or other land use changes or stressors
- Monitoring agricultural practices, cover, and crop health
- Understanding impacts from land to coastal or aquatic environments



Above: Bald Cypress Swamp, First Landing State Park, Virginia Beach, VA.



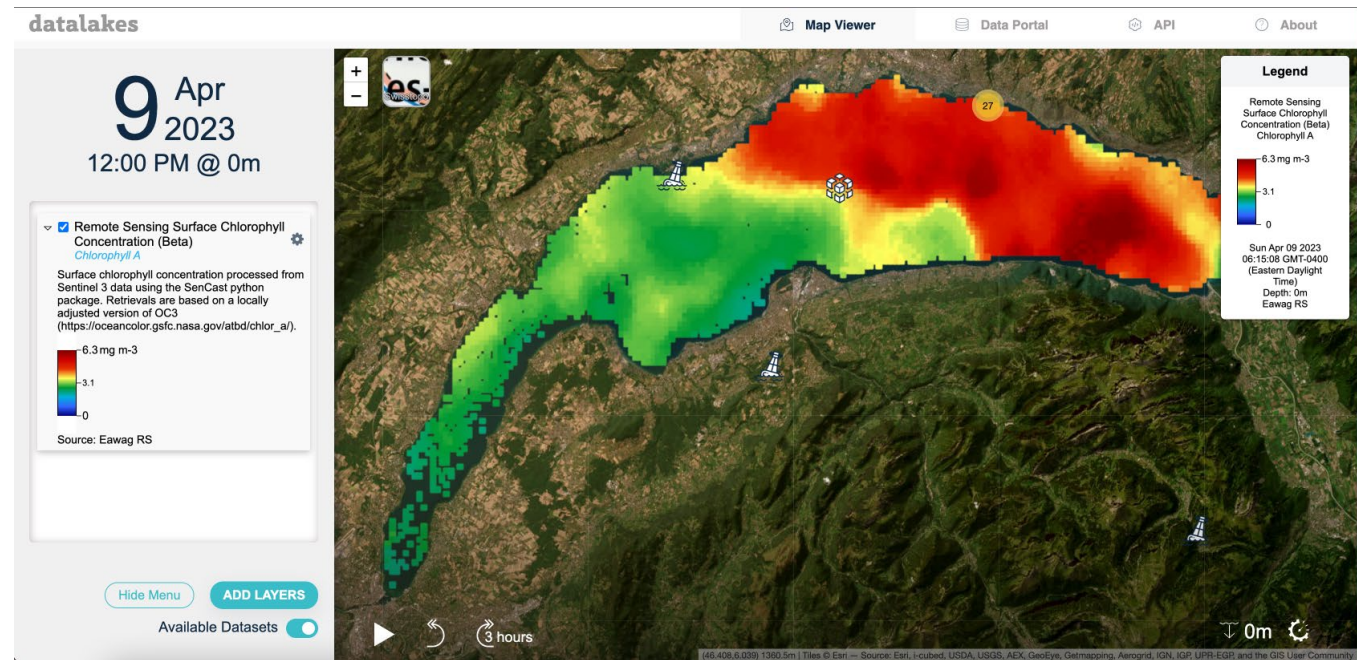
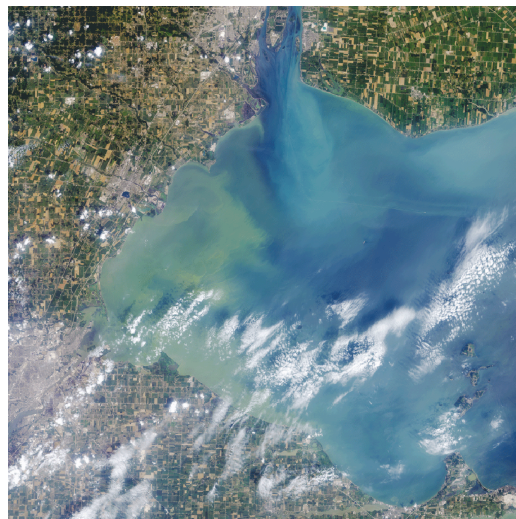
Informing Applications with PACE Data: Monitoring and Managing Aquatic Ecosystems

PACE will provide chlorophyll-a, CDOM, phytoplankton community composition, pigments, reflectance, and other data products for understanding and protecting aquatic ecosystems, which can benefit and/or inform:

- Health and citing of fisheries or aquaculture
- Monitoring food webs, ecosystem health, aquatic biodiversity, and watershed health for best management practices (including based on water clarity and particle size)
- Monitoring of drinking water quality and advising water treatment operators
- Advising local health departments
- Monitoring effects of nutrient/agricultural runoff into large lakes



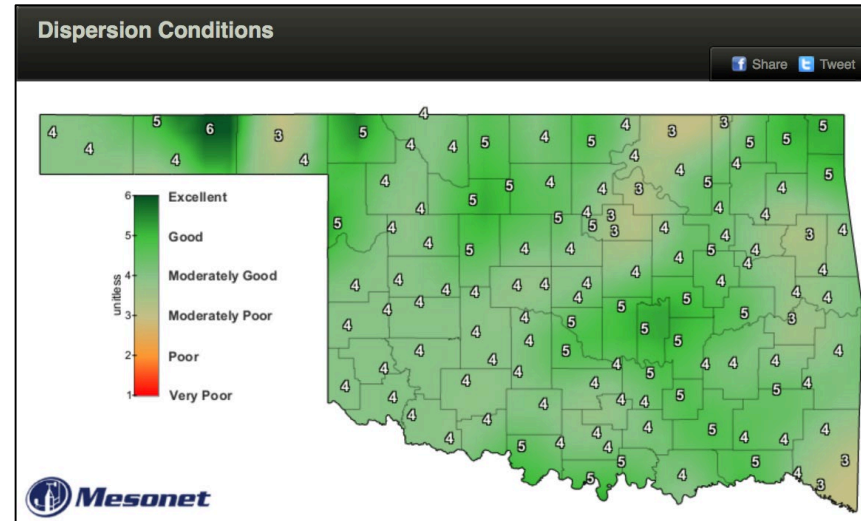
*Left: Landsat natural color image of microcystis bloom in Lake Erie. (Photo courtesy of NASA Earth Observatory)
Right: datalakes Lake Geneva decision support tool that will incorporate Chlorophyll A from PACE.*



Informing Applications with PACE Data: Monitoring and Managing Air Quality

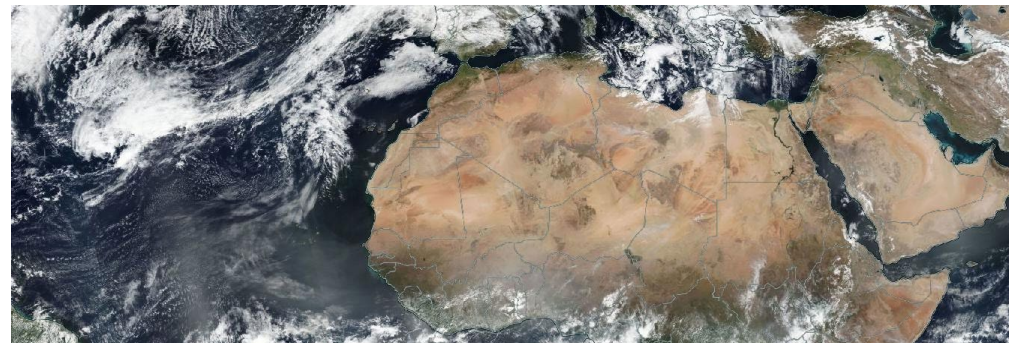
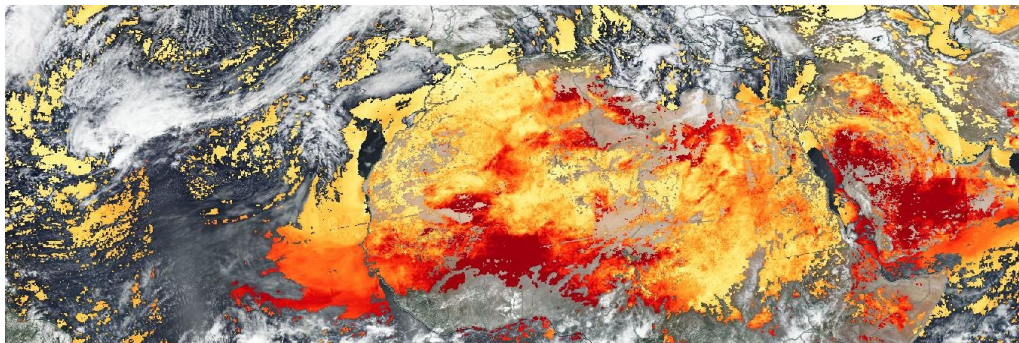
PACE will provide aerosol measurements (such as total column aerosol amount, aerosol layer height, and aerosol optical depth) for understanding air quality and its impacts on human health, which can benefit and/or inform:

- Estimating particulate matter (PM) for air quality advisories
- The impact of aerosols on the climate
- The location, altitude, and magnitude of particulate matter such as wildfire smoke or volcanic ash

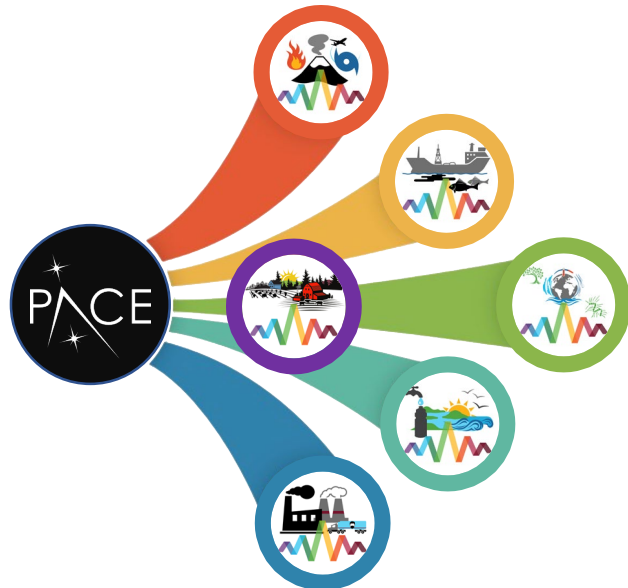


Top: Mesonet map showing dispersion conditions over Oklahoma, or the ability of the atmosphere to dilute airborne particles (i.e. smoke, pollution, pesticides). Higher dispersion means faster atmospheric dilution is likely.

Bottom: PACE will extend MODIS and VIIRS heritage aerosol optical depth retrievals.



The goal of the PACE Applications Program is to foster new partnerships and out-of-the-box thinking that will generate inventive solutions that aid society.



Community of Practice: Those interested in using and applying future PACE data (open to anyone in applications or research)

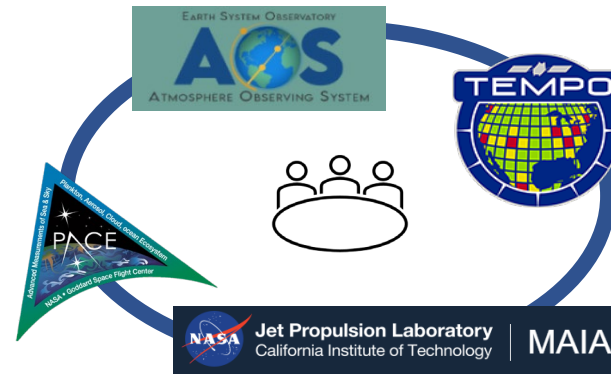
Early Adopters: Select pre-launch applied users of PACE data

Science & Applications Team: Funded scientists working on algorithm development, applications, validation, etc. (depending on solicitation cycle)

Community of Potential: Those unfamiliar with satellite data products and PACE capabilities but interested in leveraging and benefiting from PACE data products

Community Focus Sessions, Community Needs Assessments, Annual Workshops...

This is Tom Occupation: Water Quality Bio/ Backstory: Tom has worked at Florida DEP (DEP) for 15 years. He has a masters in Marine Biology and focuses on Gulf Coast water quality, coral reefs, and kayaking.	This is Julie Occupation: Post-Doctoral Researcher Bio/ Backstory: Julie is a first-year post-doctoral research explorer in Marine Biology. Her research focuses on the effects of climate change on coral reefs, and she is currently working on a grant to study the effects of climate change on coral reefs.	This is Feng Occupation: Senior Engineer Bio/ Backstory: Feng is a Senior Scientist at the University of Florida. He has a Ph.D. in Environmental Engineering and is currently working on a grant to study the effects of climate change on coral reefs.	This is Astrid Occupation: Senior Engineer Bio/ Backstory: Astrid works as an engineer at the University of Florida. She has a Ph.D. in Environmental Engineering and is currently working on a grant to study the effects of climate change on coral reefs.	This is Jake Occupation: Researcher Bio/ Backstory: Jake works at the Gulf of Mexico Research Consortium. He has a Ph.D. in Marine Biology and is currently working on a grant to study the effects of climate change on coral reefs.	This is Claire Occupation: Researcher Bio/ Backstory: Claire leads NOAA's National Community Based Network (NCBN) for the Gulf of Mexico. She has a Ph.D. in Marine Biology and is currently working on a grant to study the effects of climate change on coral reefs.	This is John Occupation: Researcher Bio/ Backstory: John is a researcher at the University of Florida. He has a Ph.D. in Environmental Engineering and is currently working on a grant to study the effects of climate change on coral reefs.	This is Elena Occupation: Ministry of Environment Scientist Bio/ Backstory: Elena is a scientist at the Ministry of Environment where she develops models and supports policy making on good fishing practices. She collects data to produce maps on sea surface temperature, chlorophyll concentration, currents speed and direction, salinity, bathymetry, and the depth of the thermocline. She shares information directly with the local fishing community and with policy-makers who use her data to inform their work. In her free time, she enjoys swimming and surfing.
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PACE Applications Water Quality & Resources Focus Session
July 28th, 2021

PACE Applications 2021 Workshop
Virtual Event
September 15-16, 2021

PACE Air Quality & Applied Atmospheric Sciences Focus Session
Virtual Event
May 11th, 2022

PACE Applications Workshop
September 14-15, 2022
Virtual Event

Virtual Listening Session for Tribes
Join us to learn more about NASA-PACE Program & Provide Feedback on Tribal Data Needs
Thursday, June 23
9:00-10:30am (Pacific & MST)
12:00-1:30pm (Eastern)
Click here to Register
Learn more about NASA-PACE program

PACE Early Adopter Program



The PACE Early Adopter program promotes applied science and applications research designed to scale and integrate PACE data into policy, business, and management activities that benefit society and inform decision making.

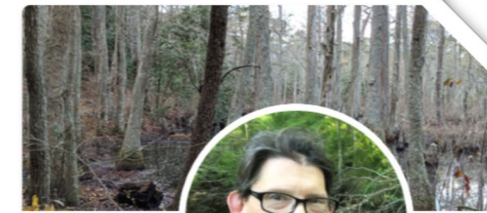
GOALS:

- ✓ PROVIDE OPPORTUNITIES TO PARTNER WITH MISSION SCIENTISTS
- ✓ PROVIDE THE MISSION WITH FEEDBACK ON UTILITY OF DATA
- ✓ SUPPORT EARLY ADOPTERS AND BUILD CAPACITY TO ACCELERATE DATA UPTAKE
- ✓ EXPAND MISSION VISIBILITY AND PARTNERSHIPS WITH NEW USER COMMUNITIES
- ✓ ENHANCE MISSION DATA PRODUCTS AND SERVICES BASED ON USER FEEDBACK



Clarissa Anderson

Applying PACE products to the



Jordan Borak

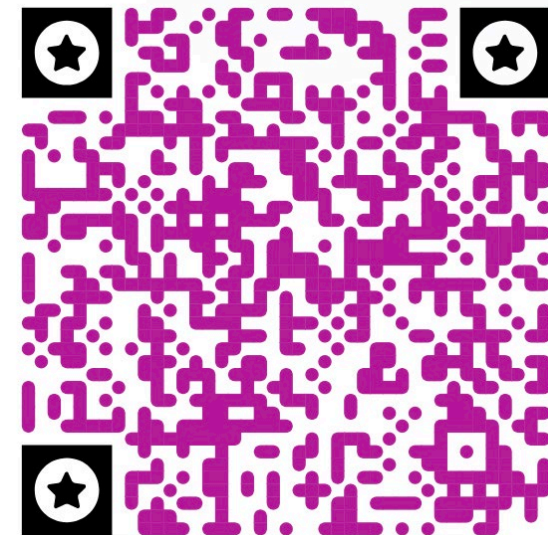
Mapping wetland vegetation

Get Involved in this YEAR OF LAUNCH!



- **Trainings and tutorials** to prepare the PACE community for data access, analysis, and visualization with PACE data
- **Community conversations around thematic areas** to further identify and build out innovative applications areas (and develop white papers and case study documents)
- **End-user engagement** to continue to build out the PACE Community of Practice and prepare for the Community of Potential post-launch

Join the PACE CoP and/or Early Adopters Program!



Thank you!

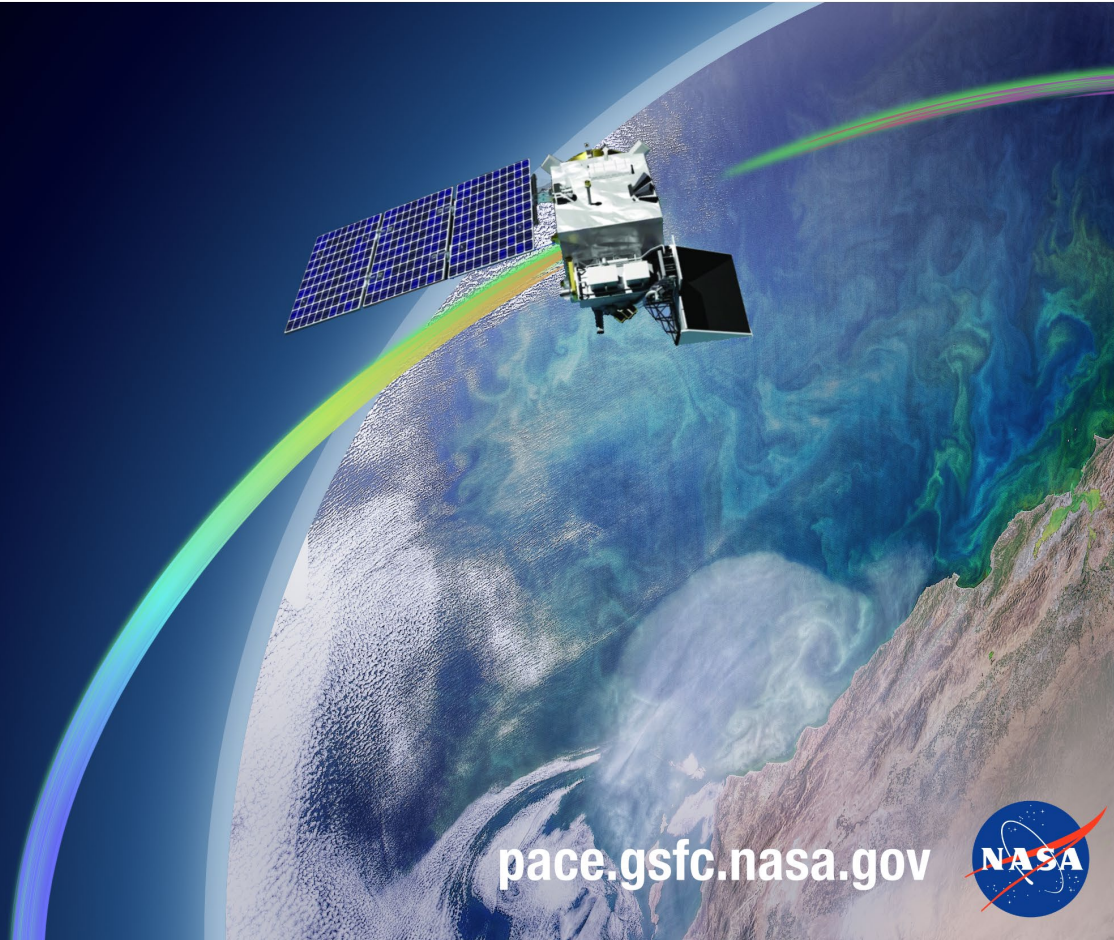


PACE

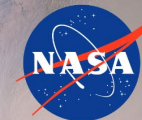
APPLICATIONS WORKSHOP

September 6-7, 2023

Virtual event



pace.gsfc.nasa.gov



Registration
opens June



Erin Urquhart & Natasha Sadoff

PACE-applications@oceancolor.gsfc.nasa.gov

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