National Aeronautics and Space Administration

IOCS 2025: NASA agency update

Laura Lorenzoni, Kelsey Bisson
NASA HQ

Dec. 2, 2025

MOON to MARS

Focused on human deep space exploration, using the Moon as testbed to develop the technologies and capabilities needed for future human missions to Mars.

Artemis I (2022) was the first step - uncrewed test flight Upcoming Missions

Artemis II (NET spring 2026): first crewed mission for a lunar flyby.

Moon to Mars is **objectives-based**, which puts the **what** and **why** before the how. These objectives hinge on science, including Earth science.

ARTEMIS

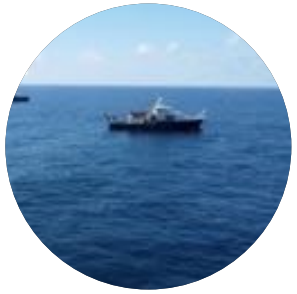
NASA remains committed to understanding aquatic BGC, biodiversity and ecosystems, on Earth and beyond

NASA's **Ocean Biology and Biogeochemistry program** aims to understand and predict changes in biology and biogeochemistry of the upper ocean, including marine ecosystems, the carbon cycle, and the impacts of natural and human induced long-term changes on aquatic ecology through remote sensing observations, in situ data, and modeling.

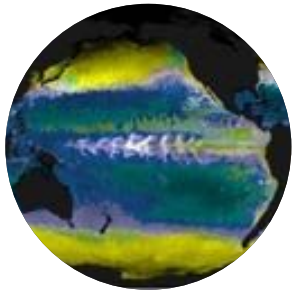
OBB works closely with the **Biodiversity program** with a focus on characterizing aquatic biodiversity.

Satellite, airborne, in situ, and modeling assets are critical. The combination of passive and active measurements is essential to our scientific advancement.

Explore the development of new biological, ecological, and biogeochemical observations from space-based assets.



Understand and quantifying the impacts and feedbacks of Earth System processes.



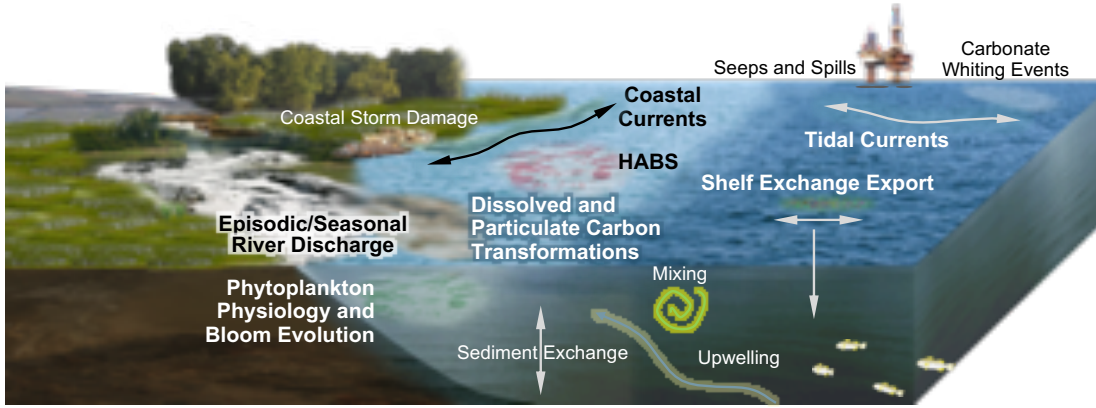
Modeling, predictive understanding of changes in aquatic ecosystems carbon, on Earth and beyond.

GLIMR – Geostationary Littoral Imaging and Monitoring Radiometer

NASA EVI-5 Managed by UNH: Joseph Salisbury (PI), Antonio Mannino (Deputy PI); Instrument by Raytheon

Hyperspectral (350-1040 nm) ocean color sensor in Geostationary orbit

- Targeting Gulf of Mexico and other coastal/ocean waters of N. and S. America
- **Hourly imaging** frequency; spatial resolution of 300 m (nadir)
- Spectral sampling and resolution: ~7 nm and 10 nm; SNR: ~600 to >1000



Short Term Coastal Processes: Investigate how high frequency fluxes of organic matter, sediments, and other materials between and within coastal ecosystems regulate the productivity and health of coastal ecosystems.

Luce – Cloud Aerosol LIdar for Global scale Observation of the ocean-Land-Atmosphere System

ASI, Universita degli Studi di Basilicata, Leonardo, NASA

- Space-based Raman LIDAR mission with a primary focus on the atmosphere, and priorities in further studying the Ocean. Has applications relevant to cryospheric and terrestrial sciences.
- NASA plans to contribute the detectors; currently being considered 8 channels.

RECENT MISSIONS

EMIT (EVI-4)

Launched aboard SpaceX CRS-25 on July 14, 2022. Imaging spectrometer focused on analyzing airborne dust impact on climate, and aquatic changes (extended mission).

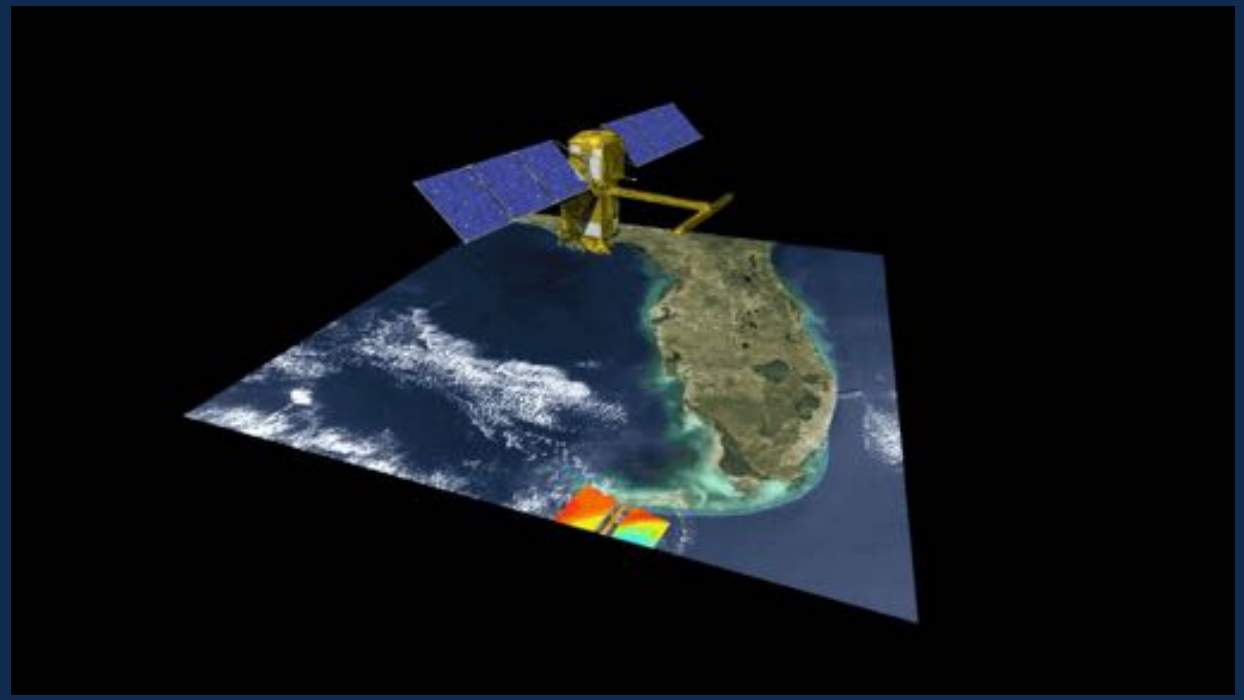
NISAR (NASA-ISRO)

Launched July 30, 2025. Radar imaging focused on land and ice-covered surfaces

Launched November 17, 2025, altimetry measurements focused on global sea level rise, atm. and ocean conditions

Sentinel 6B

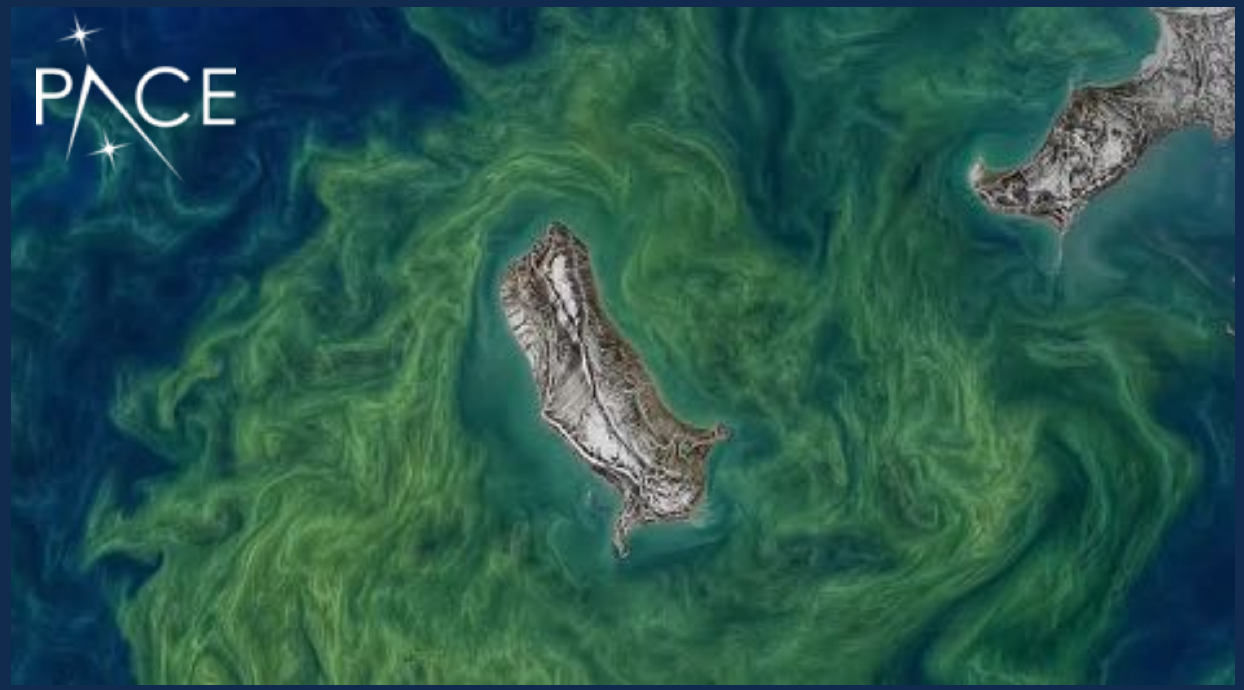
(ESA/EUMETSAT,NASA, NOAA)



SWOT
SURFACE WATER & OCEAN TOPOGRAPHY

Launched Dec. 16, 2022
- Ka-band Radar Interferometer (KaRIn)

Unprecedented Detail:
- Measures height of nearly all water on Earth's surface
- 10x better resolution



Plankton, Aerosol, Cloud, ocean Ecosystem

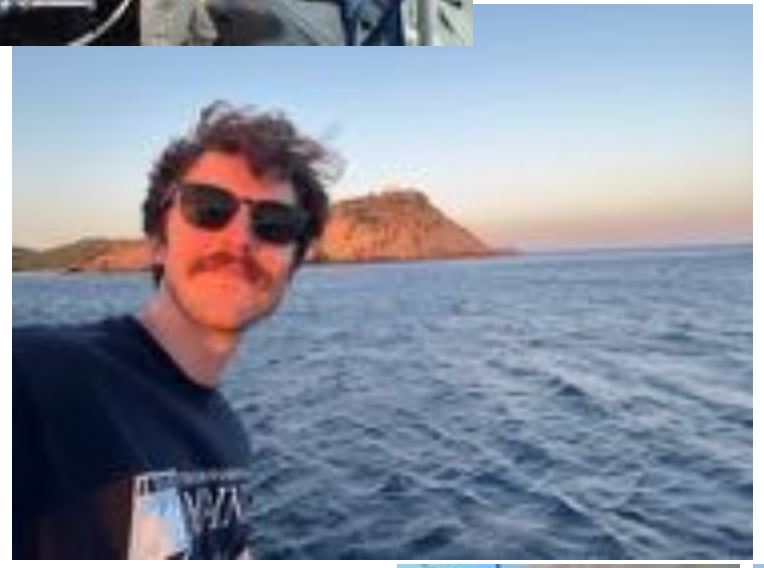
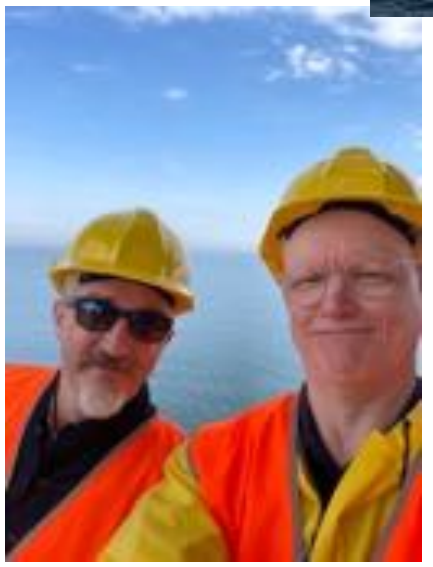
Launched Feb. 8, 2024
- OCI – Hyperspectral global mapping imaging spectrometer
- 2 complementary polarimeters (HARP-2 and SPEXOne)

Unprecedented knowledge:
- Insight into primary production of the ocean







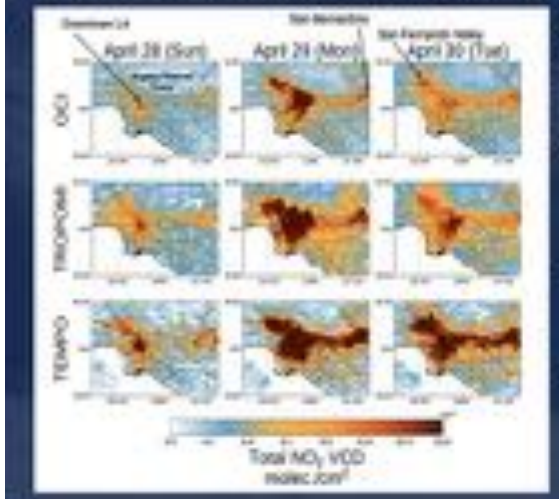







PACE: Groundbreaking Science

NEW PUBLICATION: RETRIEVING TRACE GASES FROM PACE OCI WITH MACHINE LEARNING

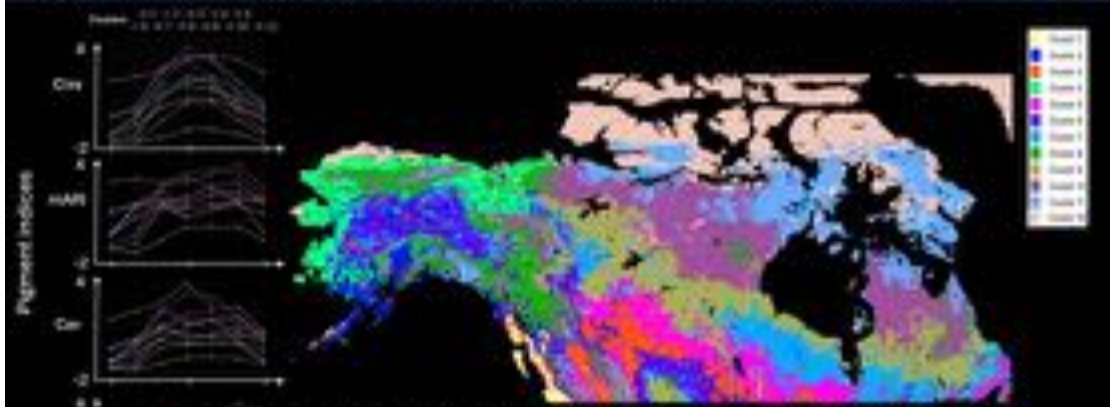


PACE OCI spectra are leveraged to retrieve nitrogen dioxide (NO_2) at higher spatial resolution than other satellite platforms. Enabled by neural network training with European Sentinel 5 Precursor (TROPOMI) data.

- **Ground-breaking, high spatial resolution NO_2 data products only from PACE OCI** reveal more fine details of NO_2 sources such as vehicular emissions and power plants compared to TROPOMI & TEMPO
- **PACE-OCI NO_2 products can enhance local air quality monitoring and improve regional chemistry modeling**
- **Citation:** Fasnacht, Zachary, Joanna Joiner, Eric Bucsela, Matthew Bandel, Fei Liu, Lok Lamsal, and Nickolay Krotkov (2025). Utilizing machine learning for high resolution NO_2 total columns from PACE OCI." Environmental Research Letters. https://doi.org/10.1088/1748-9326/adf8bf

GODDARD PACE

PACE OBSERVATIONS OF NORTHERN NORTH AMERICA
CLASSIFYING ECOSYSTEMS USING HYPERSPECTRAL OCI VEGETATION INDICES



Unsupervised isodata classification for NDVI, Chlorophyll Index (Cire), Carotenoid Index (Car), Anthocyanin Index (mARI), and Photochemical Reflectance Index (PRI) for April through October (left). The colored regions (above) represent areas with similar pigment index seasonality.

Fred Huemmrich, UMBC/NASA GSFC

GODDARD PACE

NASA'S PACE MISSION:
MULTI-PLATFORM VIEW OF CALIFORNIA RED TIDES

RED TIDES RESULT IN MILLIONS OF DOLLARS IN U.S. ECONOMIC LOSSES ANNUALLY

A red tide was observed on September 27th, 2024 in Monterey Bay, California from an aircraft as part of "PACE-PAX" satellite validation efforts (below)

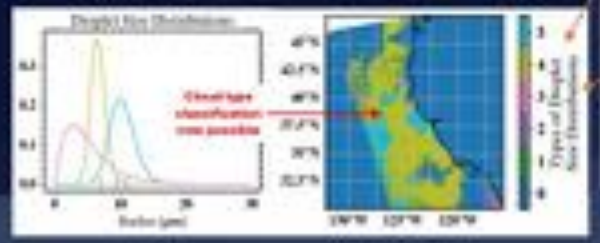
The red tide was confirmed using in-water images of red tide cells (circle above) from a PACE Validation Team led by Clarissa Anderson (Scripps Institution of Oceanography)

Using **PACE**-OCI's unique hyperspectral, visible and ultraviolet data, **the red tide bloom was detected** in the area of the PACE-PAX observations (Kahru et al. 2021)

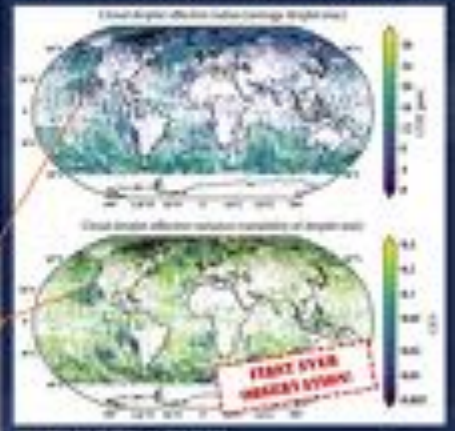
NEW CLOUD PROPERTY PRODUCTS PACE HARP-2 POLARIMETER

Cloud droplet size from PACE -

- Cloud droplet sizes are determined from multi-angle, polarization-sensitive measurements by HARP-2
- **Cloud droplet effective radius** (average droplet size) is observed by other sensors (including PACE OCI) using a spectral technique. This polarization approach promises fewer artifacts.
- **Cloud droplet effective variance** (variability of droplet size) observations from space have never been made at this (1.2km) resolution
- Both offer new insight into cloud properties, precipitation, aerosol-cloud interactions, and the Earth's energy balance



Global 3-day Average PACE CLOUD_OPC Product
July 3-5, 2025*



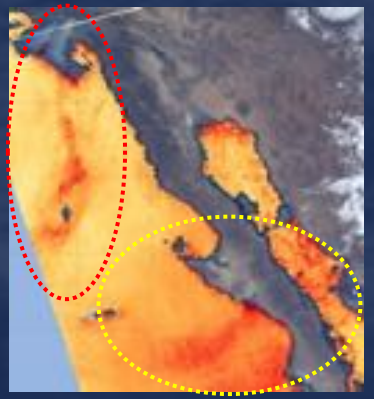
GODDARD PACE

PACE'S MULTI-DISCIPLINARY VIEW OF THE JANUARY 2025 LOS ANGELES WILDFIRES

THE PACE/HARP2 MULTI ANGLE POLARIMETER MONITORS SMOKE

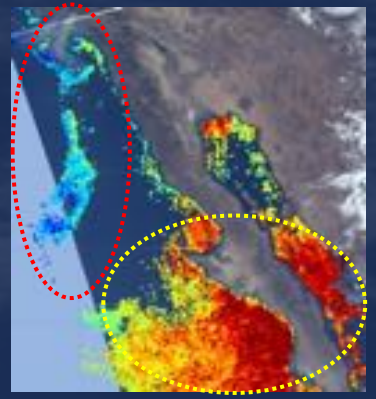
By applying the NASA-developed FastMAPOL algorithm to HARP2's advanced data, we can distinguish between smoke and other types of atmospheric particulate pollution like dust

Aerosol optical depth (550nm)
(Aerosol quantity)



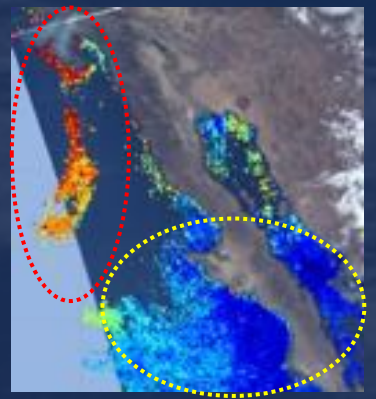
Less aerosols — *More aerosols*

Single scattering albedo (550nm)
(Aerosol light absorption)

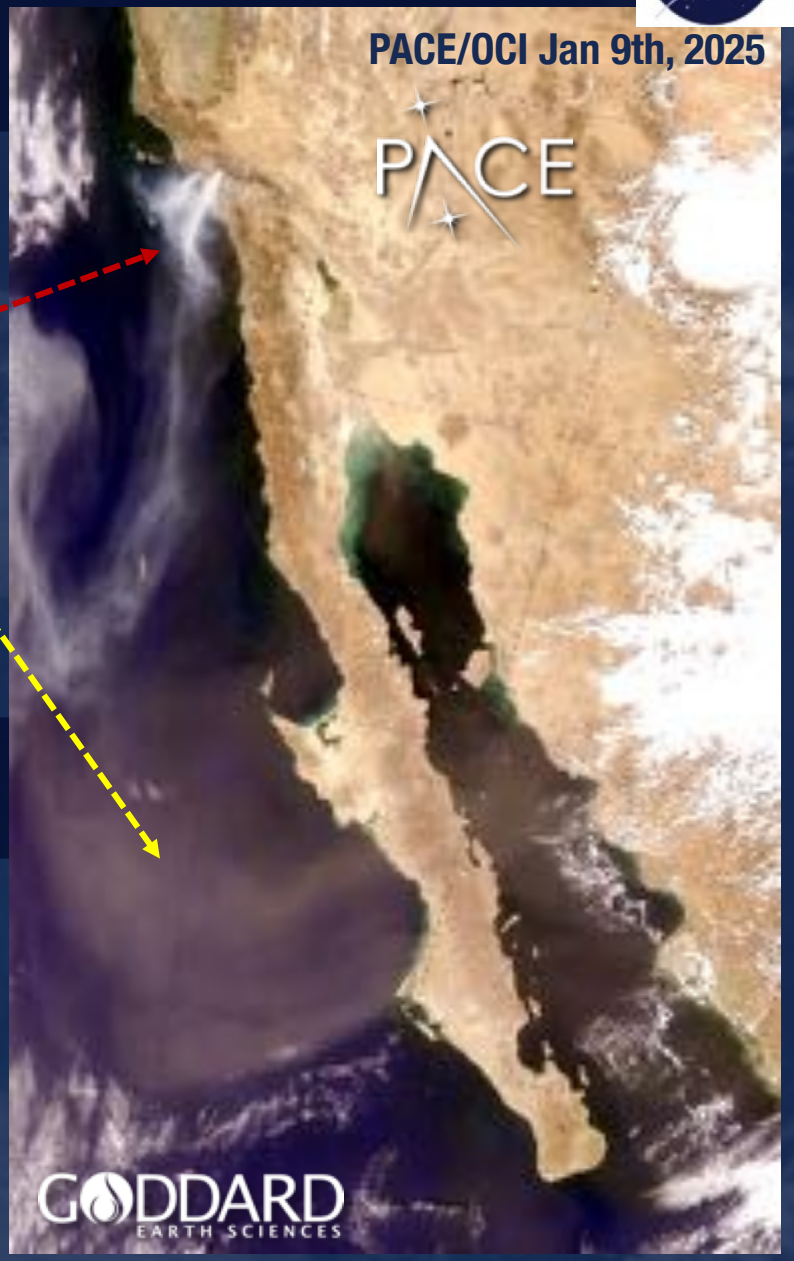


Scattering aerosols — *Absorbing aerosols*

Fine mode fraction
(Dominant aerosol size)

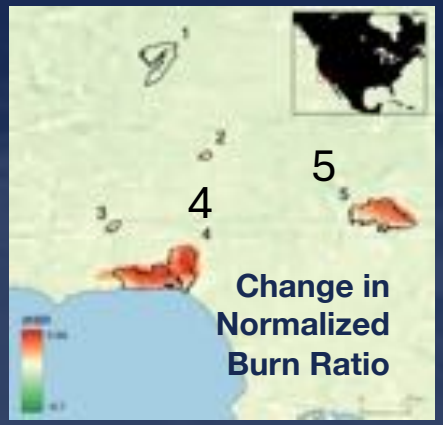


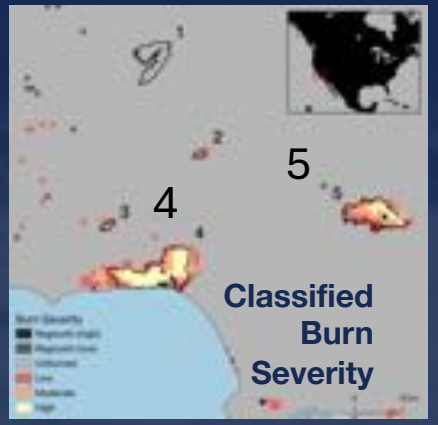
Small aerosols — *Large aerosols*



THE PACE/OCI HYPERSPECTRAL IMAGER MONITORS BURN SEVERITY

Change in Normalized Burn Ratio (dNBR) indicates burn severity. Due to PACE/OCI's global coverage and high temporal revisit, dNBR can be assessed rapidly following a fire.





4. Palisades Fire (1/07/2025)

5. Eaton Fire (1/07/2025)

PACE LAUNCH!

PLAR

YEAR 1

YEAR 2

REPROCESSING 1

in-orbit cals
OCI land surface refl.
OCI vegetation indices
OCI cloud properties

RELEASED

OCI atmospheric aerosols;
SPEXone atmos, oceans
HARP2 atmos, oceans

J F M A M J J A S O N D J F M A M J J A S O N

2024

2025

FIRST LIGHT

Level-1 radiometry
OCI heritage ocean color

REPROCESSING 2

OCI vicarious cal.
OCI phyto. communities (Atl.)
Level-1 req. achieved

within the next 3 mos.

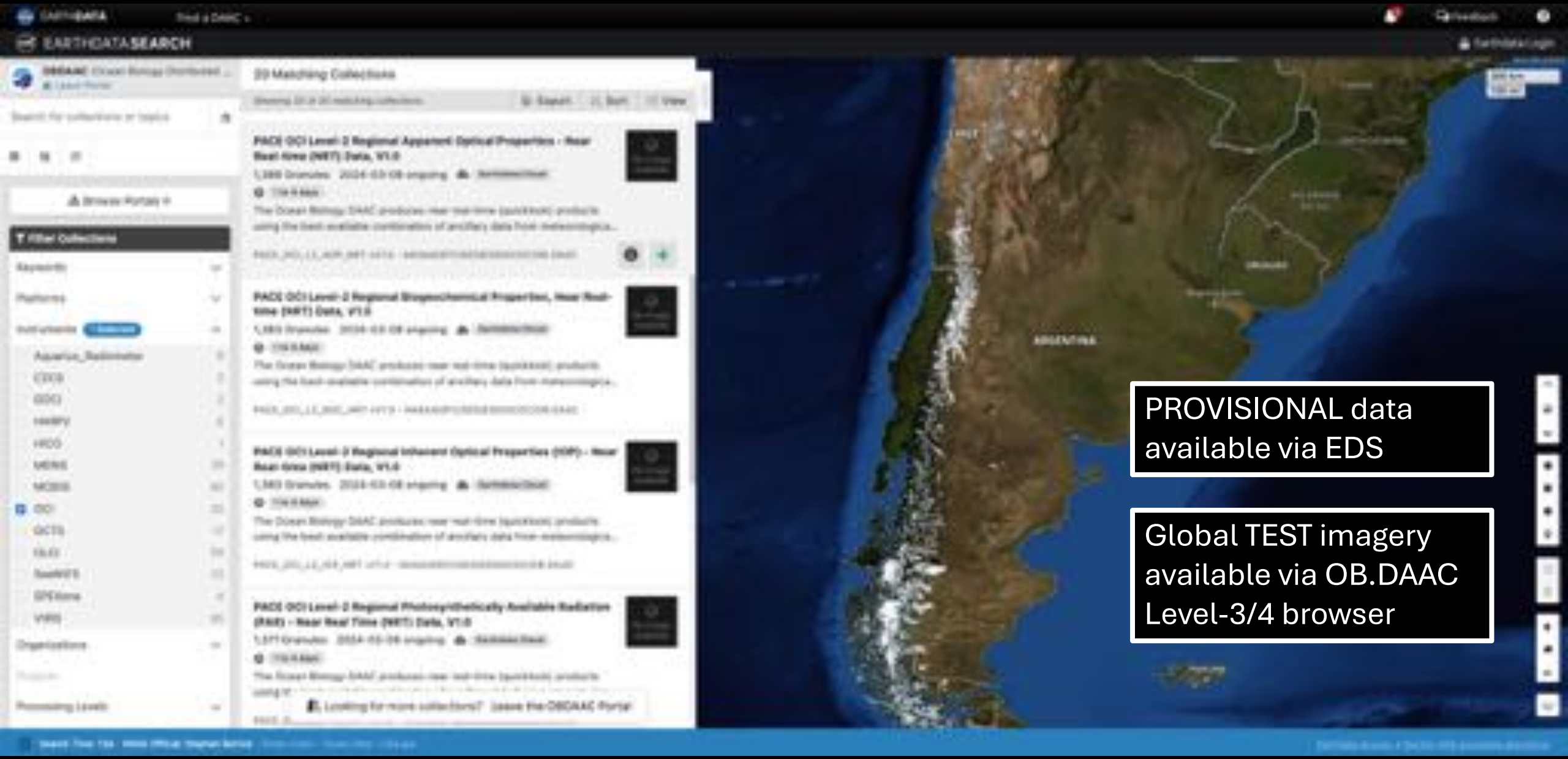
OCI phyto. communities (global)
additional polarimeter products
first multi-instrument products

GODDARD EARTH SCIENCES

Image credit of Jeremy Werdell/Carina Poulin

Data product availability

Algorithm suite	Instrument	Products	ATBD	L2/L3 status
OCI Clouds [CLD]	OCI	Cloud mask, optical thickness, effective radius, liquid water path, top height, top temperature, top pressure [multiple permutations]	In development	Provisional (L2 and L3)
Unified aerosol algorithm [UAA]	OCI	Spectral aerosol optical depth, fine mode fraction (ocean only), near-UV single scattering albedo (for high AOD), UV aerosol index	In development	Provisional (L2 and L3)
Multiangle Implementation of Atmospheric Correction [MAIAC]	OCI	Aerosol and surface properties, exact list TBC	In development	In implementation
Apparent Optical Properties [AOP]	OCI	Spectral remote sensing reflectances (and standard uncertainties), apparent visible wavelength, fluorescence line height	Completed (nFLH in development)	Provisional (L2 and L3)
BGC	OCI	Chlorophyll-a (uncertainty), phytoplankton carbon, particulate organic carbon	Completed	Provisional (L2 and L3)
IOP	OCI	Spectral absorption and backscattering coefficients and their components (and standard uncertainties), spectral diffuse attenuation coefficients	Completed	Provisional (L2 and L3)
PAR	OCI	Daily mean and instantaneous photosynthetically available radiation, above and below surface, scalar and planar	In development	Provisional (L2 and L3)
MOANA	OCI	Distribution of three phytoplankton populations in the Atlantic Ocean (cells mL-1 of Prochlorococcus, Synechococcus, and autotrophic picoeukaryotes)	Completed	Provisional (L3)
Surface reflectance [SFREFL]	OCI	Spectral surface reflectance @122 wavelengths	Completed	Provisional (L2 and L3)
Land vegetation indices [LANDVI]	OCI	NDVI, EVI, CCI, NDSI, PRI, CIRE, MARI, CAR, NDWI, NDII	Completed	Provisional (L2 and L3)
Ocean Surface	HARP2	Ocean surface refractive index, NIR AOD	Development paused	Development paused
Polarimetric cloud [GPC]	HARP2	Cloud liquid index, liquid cloud droplet effective radius and variance	In development	Provisiona, (L2 and L3)
FastMAPOL	HARP2	Aerosol and ocean properties	In development	Provisional (L2 and L3)
GRASP	HARP2	Aerosol, ocean and land properties	In development	In implementation
RemoTAP	SPEXone	Aerosol, ocean and land properties	Completed	Provisional (L2 and L3)
Microphysical Aerosol Properties from Polarimeters (MAPP)	OCI + HARP2 + SPEXone	Aerosol and ocean properties	In development	In implementation

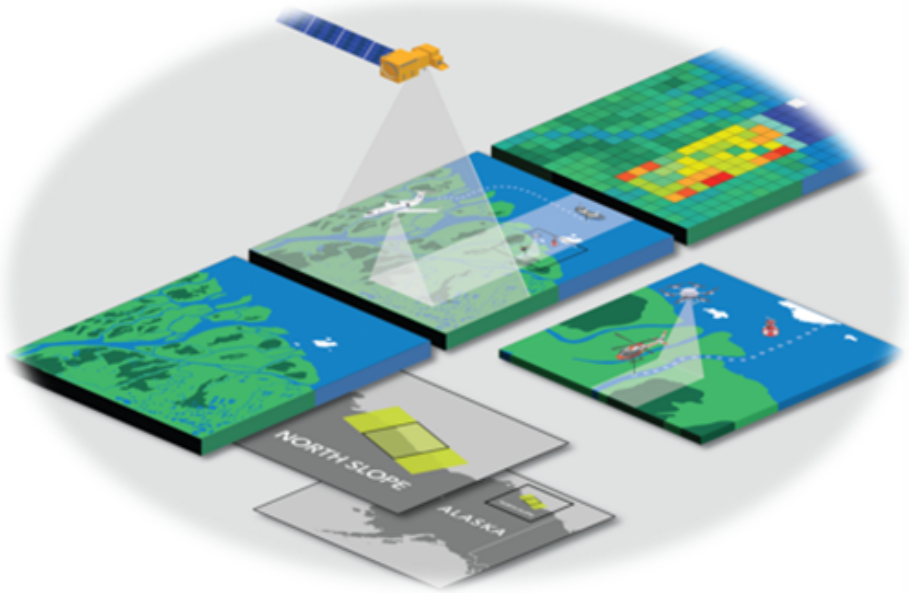

EARTHDATA SEARCH
20 Matching Collections
PACE OCI Level-2 Regional Apparent Optical Properties - Near Real-time (NRT) Data, V1.0
PACE OCI Level-2 Regional Biogeochemical Properties, Near Real-time (NRT) Data, V1.0
PACE OCI Level-2 Regional Inherent Optical Properties (IOP) - Near Real-time (NRT) Data, V1.0
PACE OCI Level-2 Regional Photosynthetically Available Radiation (PAR) - Near Real Time (NRT) Data, V1.0
ARGENTINA
PROVISIONAL data available via EDS
Global TEST imagery available via OB.DAAC Level-3/4 browser

OBB Highlights and heads up

- 18 selections in 2024 and 2025 focusing on tipping points and episodic events, and their impacts to aquatic ecosystems; advancing the remote detection of floating debris, and refining our predictive understanding of the ocean biological pump.
- We depend on our community for selecting the best science NASA can fund – THANK YOU to all of our reviewers! If you want to review, please don't be shy!
- Research Opportunities in Space and Earth Sciences **http://nspires.nasaprs.com/.** Released in early July 2025.
- Open Science remains a priority at NASA.
- Next Decadal Survey – it is being planned; will be focused on observations we need for Earth system over the next decade.

FORTE (Frontlines Of Rapidly Transforming Ecosystems) – Tzortziou, PI

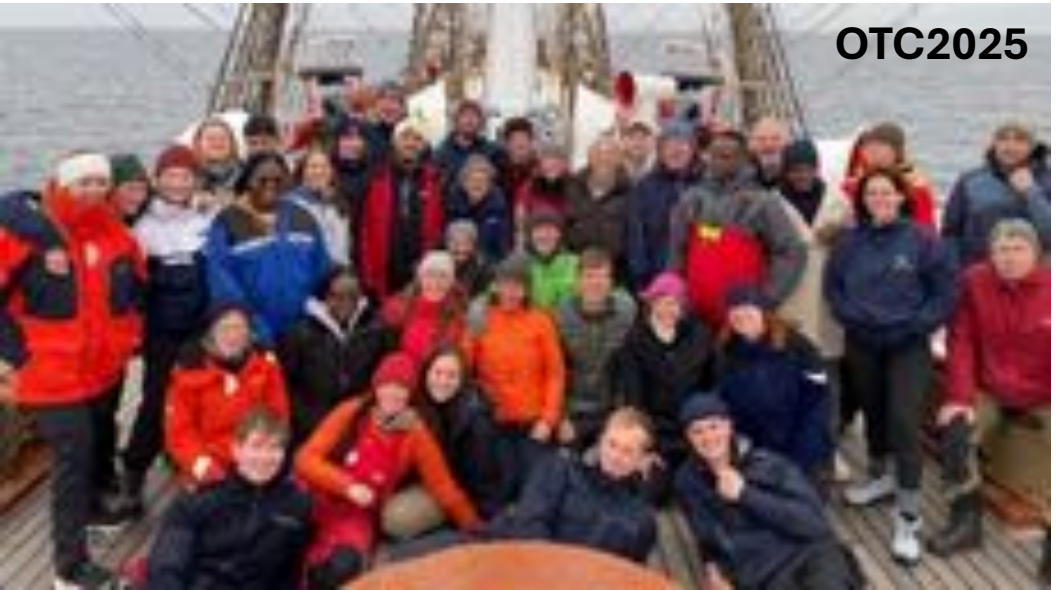
FORTE is a recently selected NASA Earth Venture Suborbital (EVS-4) Mission that will further shed light on how nearshore Arctic ecosystems, from lower watersheds to coastlines and adjacent seas, respond to changes in the mobilization, magnitude, composition, and seasonality in land-ocean fluxes (freshwater, heat, carbon, sediment and nutrients) and what are the implications for larger scale ocean processes and feedbacks.



Alaska Coastlines (Tzortziou, Summer 2022)


Ocean Optics Class 2025


OTC2025


OTC2025


FICE25

System Vicarious Calibration (SVC)

(1) HyperNAV
OSU, SeaBird Scientific, Univ. Maine

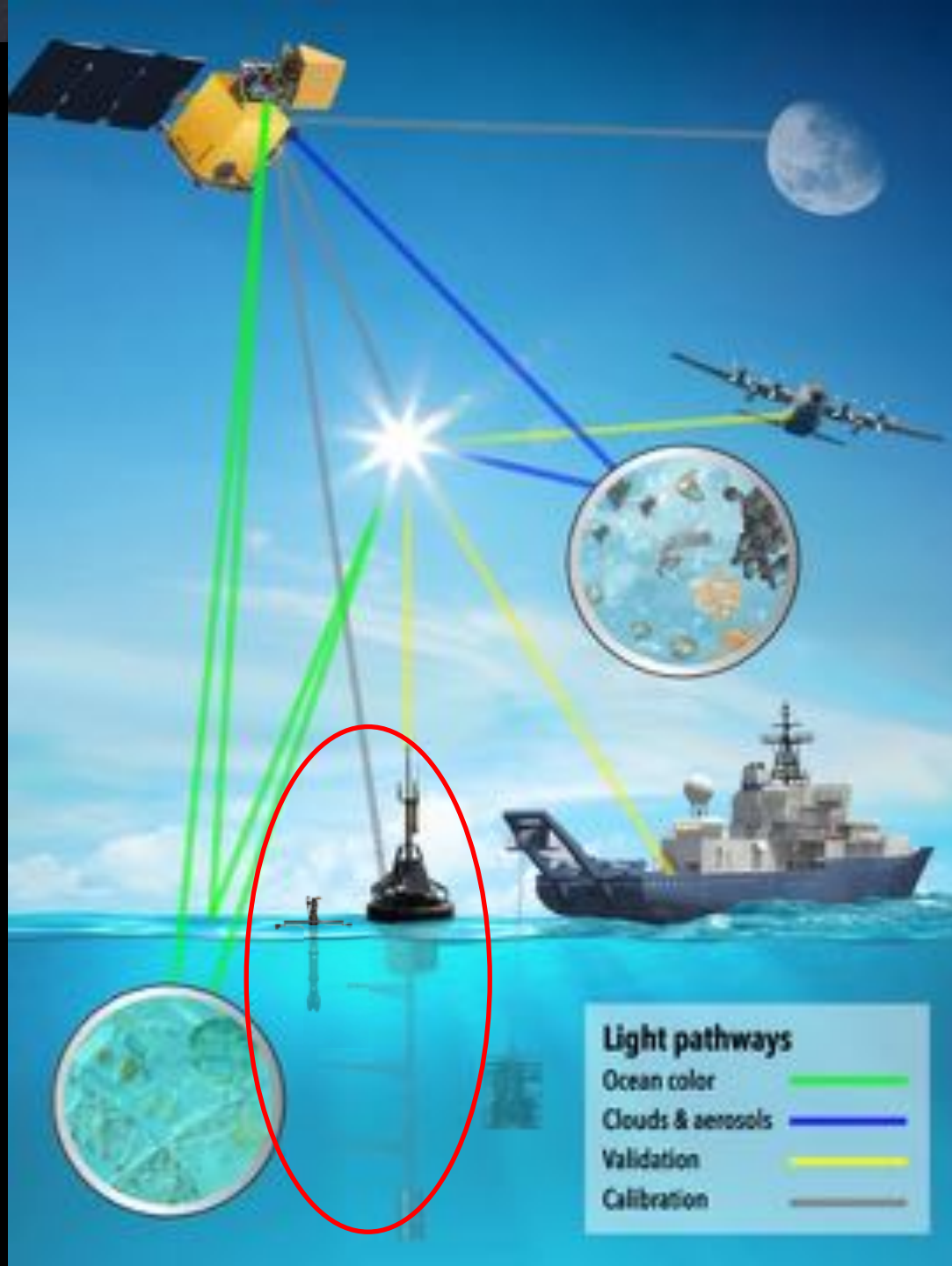
radiometric float
- small, portable
- profiling
- long-duration
- COTS legacies

(2) MarONet
U.Miami, NIST, Curtin Univ., SJSU

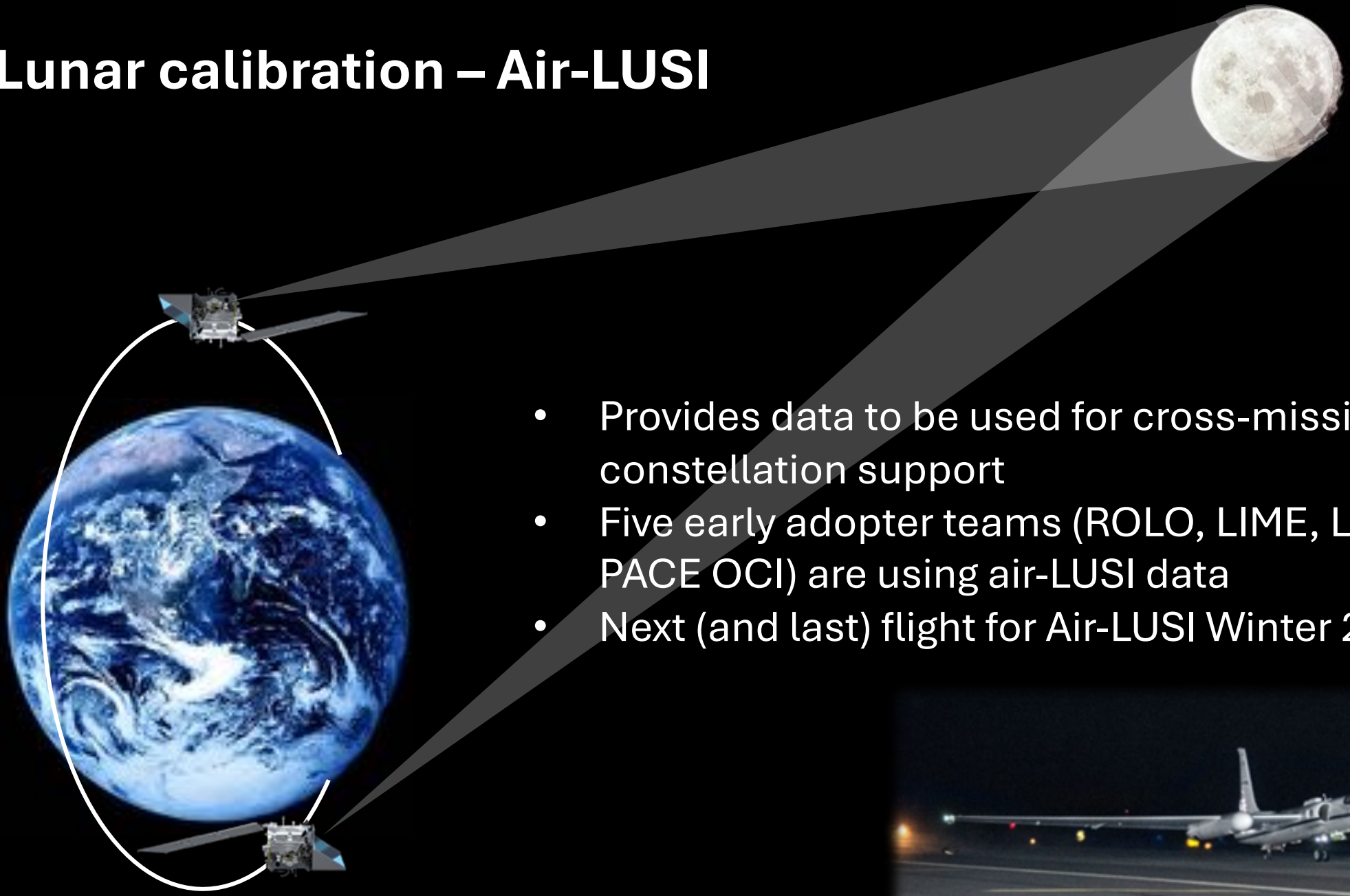
radiometric buoy
- large, 20’ container
- 3 fixed arms
- long-deployment
- MOBY legacy

Multi-site operations globally

Currently deployed off Perth, Australia



Lunar calibration – Air-LUSI



- Provides data to be used for cross-mission/ constellation support
- Five early adopter teams (ROLO, LIME, LESSR, SLIMM, PACE OCI) are using air-LUSI data
- Next (and last) flight for Air-LUSI Winter 2026

We are stronger when
we work together.

Thank you!