Keeping PACE with the NASA Plankton, Aerosol, Cloud, ocean Ecosystem mission


8 Feb 2024
06:33 UTC
Day 210 !

NASA Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) mission

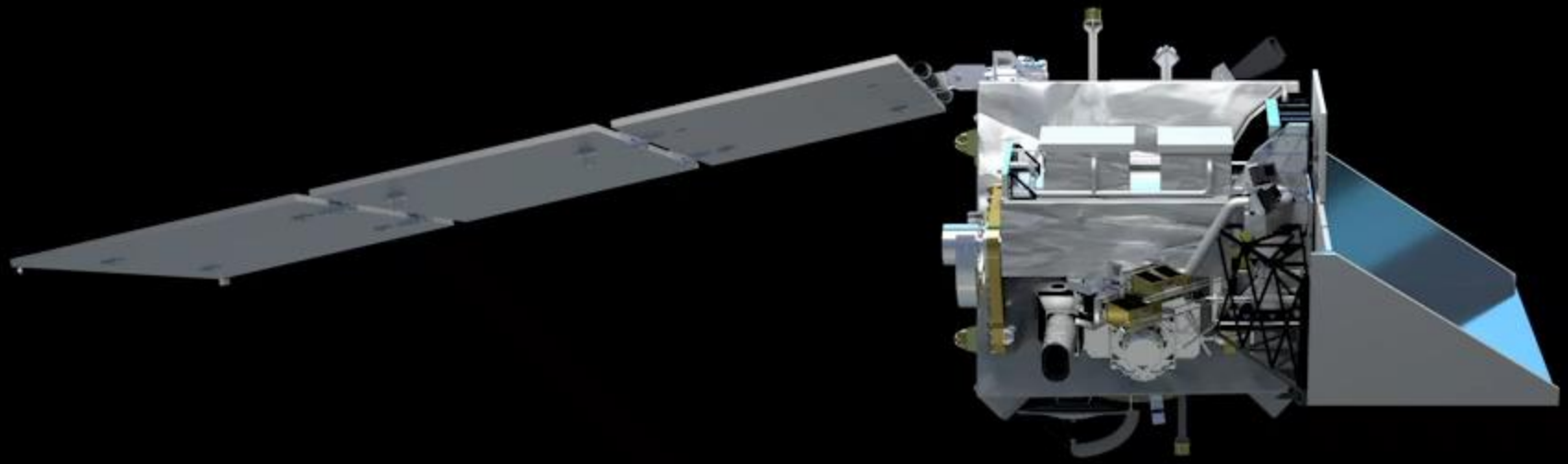
PACE will extend **key systematic ocean color, aerosol, & cloud (& land) climate data records**.

PACE will reveal the **diversity of organisms fueling marine food webs** & how ecosystems respond to change.

Looking at the ocean, clouds, and aerosols together will improve knowledge of the roles each plays in our planet.

Key mission characteristics:

- Polar, ascending, Sun synchronous orbit; 98° inclination
- 13:00 local Equatorial crossing
- 676.5 km altitude
- 6 – 9 hr data latency
- Managed by NASA Goddard Space Flight Center
- *All data & software free for public use*



The PACE Ocean Color Instrument (OCI):

- 340-890 nm @ 5 nm resolution in 2.5 nm spectral steps
- Plus 940, 1038, 1250, 1378, 1615, 2130, & 2250 nm
- 2-day global coverage; 1-km^2 @ nadir; ±20° fore/aft tilt
- *Performance driven by ocean color science requirements*

https://pace.gsfc.nasa.gov
@NASAOcean

2 contributed multi-angle polarimeters:

- **HARP-2 (UMBC)**
  4 visible-NIR bands
  Wide swath; 2.5 km @ nadir
  Hyper-angular
  Cloud capabilities beyond OCI
- **SPEXone (SRON/Airbus)**
  Hyperspectral UV-NIR
  Narrow swath; 3 km @ nadir
  5 angles
  Aerosol capabilities beyond OCI

data (re)processing & release status

Initial data release on 11 April 2024

- Level-1 radiometry from all 3 instruments
- Heritage suite of ocean color products from OCI (all “provisional” -> EDS, OB.DAAC/OBPG)

First reprocessing (tagged V2) completed in early July

- First use of on-orbit (= solar diffuser) calibrations for all 3 instruments
- Second wave of OCI products (all “TEST” -> OB.DAAC)
  - Terrestrial and aquatic surface reflectances (every 10 nm)
  - Terrestrial vegetation indices (~10 products)
  - Cloud optical properties and altitude
- https://oceancolor.gsfc.nasa.gov/data/reprocessing/V2.0/pace/

Second reprocessing (V3) to be conducted in coming months

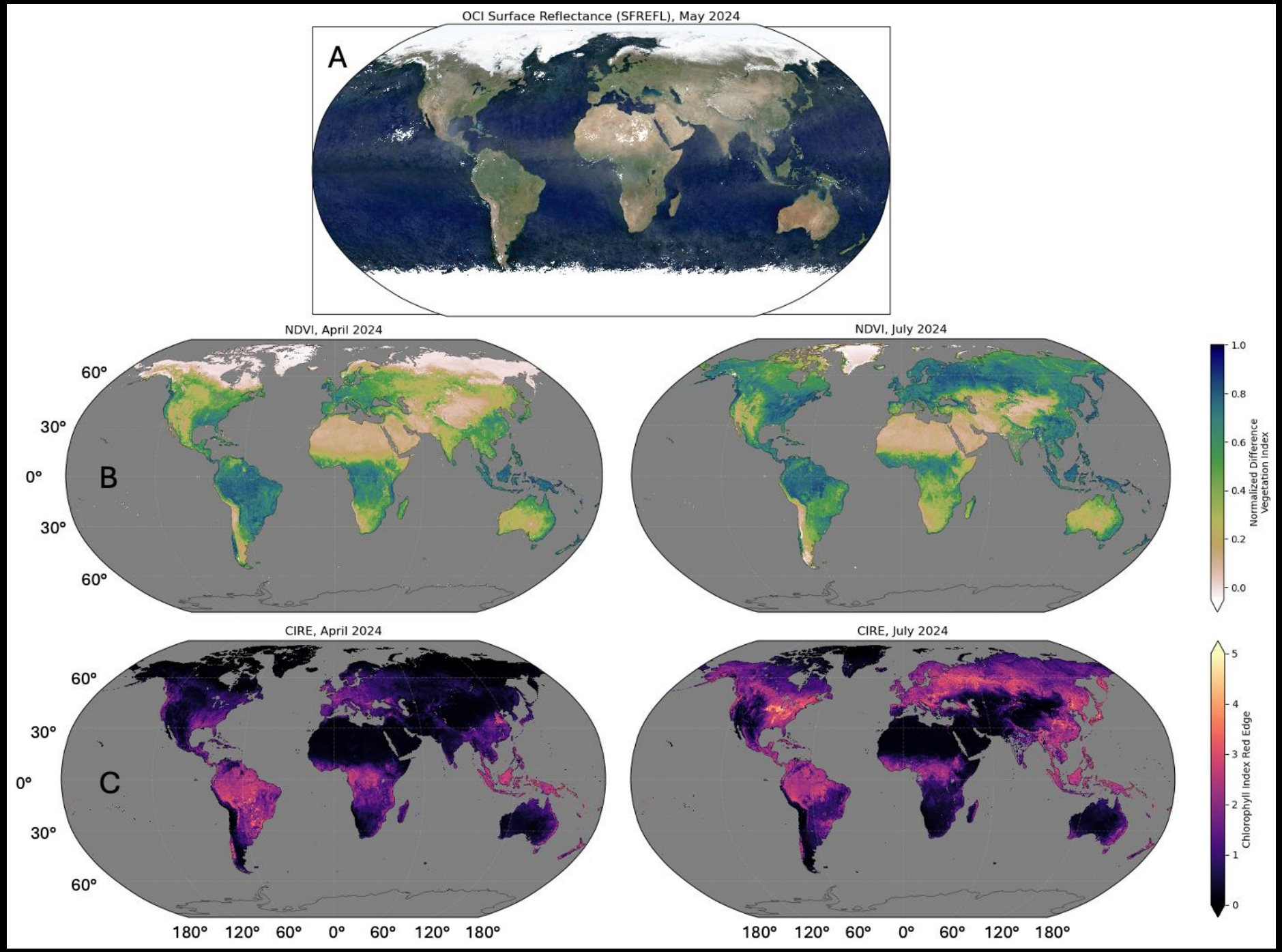
- First system vicarious calibration (HyperNAV)
- TBD wave of products (all “TEST” -> OB.DAAC)

Additional data products to be released pending review by Project + PIs

- No predefined deadlines

current data availability

Product	Level 1/2	Level 3	EDS (cloud)	OB.DAAC
OCI				
TOA	x		x	
AOPs (Rrs, AVW, …)	x	x	x	x
IOPs (a,bb,Kd)	x	x	x	x
BGC (Chl, phytoC, …)	x	x	x	x
PAR	x	x	x	x
surface reflectance		x		x
vegetation indices		x		x
cloud properties		x		x
HARP2				
TOA	x		x	
SPEXone				
TOA	x		x	


OCI Surface Reflectance (SFREFL), May 2024
A
NDVI, April 2024
NDVI, July 2024
B
60°
30°
0°
30°
60°
Normalized Difference Vegetation Index
1.0
0.8
0.6
0.4
0.2
0.0
CIRE, April 2024
CIRE, July 2024
C
Chlorophyll Index Red Edge
5
4
3
2
1
0
180° 120° 60° 0° 60° 120° 180°

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

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

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

What do colors in the "Availability" column mean?

Available	Coming soon!	Currently implementing and evaluating	No approach currently identified

Calibrated Radiometry and Polarimetry

Calibrated and geolocated radiometry and polarimetry as observed at sensor.

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

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	Provisional	ATBD SAT members: Boss, Zhai, Krotkov, Chowdhary, Stamnes, Zhang In situ measurement protocols
Apparent visible wavelength	An optical water classification index reported as the weighted harmonic mean of visible-range Rrs wavelengths (400-700 nm)	nm	Level-2 1-km at nadir; daily - Level-3 4-km; daily, 8-day, monthly, annual	Test	ATBD
Spectral diffuse attenuation coefficients	Spectral diffuse attenuation of downwelling irradiance at multiple wavelengths between 350 and 700 nm. Provides indices of water clarity and light penetration.	m^{-1}	Level-2 1-km at nadir; daily - Level-3 4-km; daily, 8-day, monthly, annual	Test	ATBD SAT members: Boss, Stramski, Odermatt In situ measurement protocols

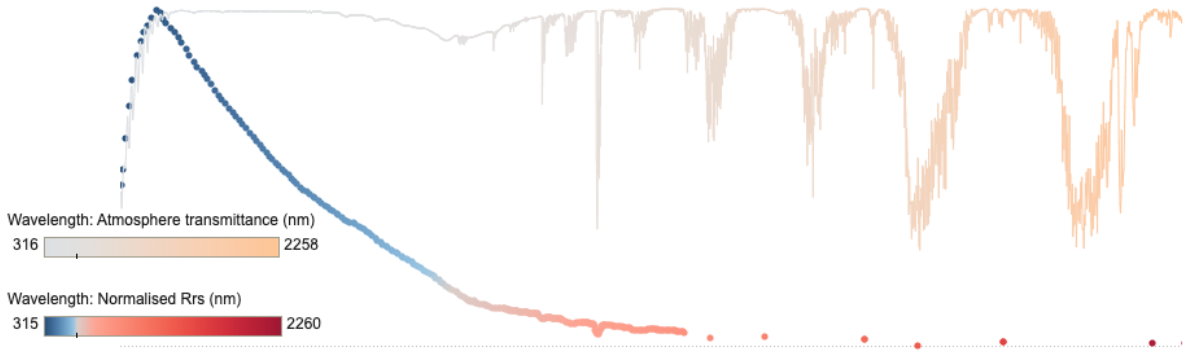
“ What you should know about PACE data”

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

Known data issues

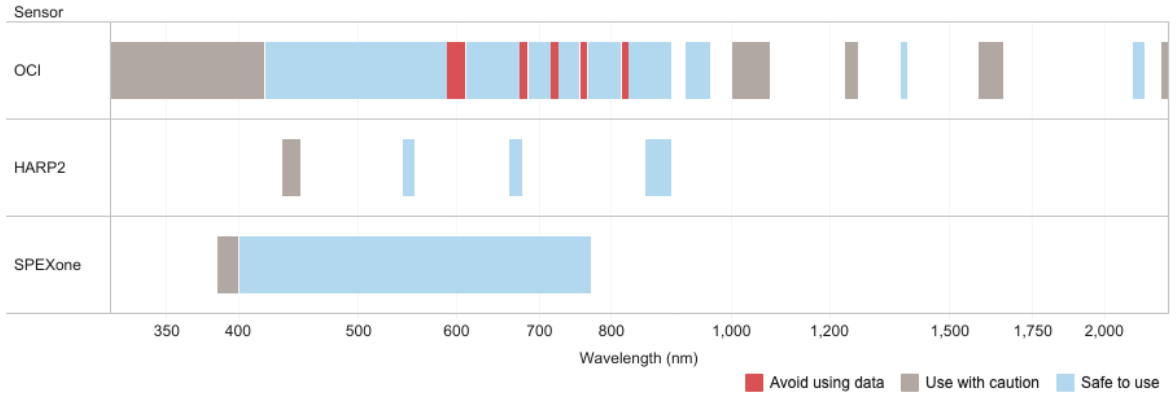
PACE is already providing high-quality data. However, some issues have to be noted before using it. Some particular bands, influenced by instrument or atmospheric characteristics, should be avoided for the moment.
Other issues affect the entire dataset, and some events affect data availability. See below for details.

Reference spectra (for indicative purposes)



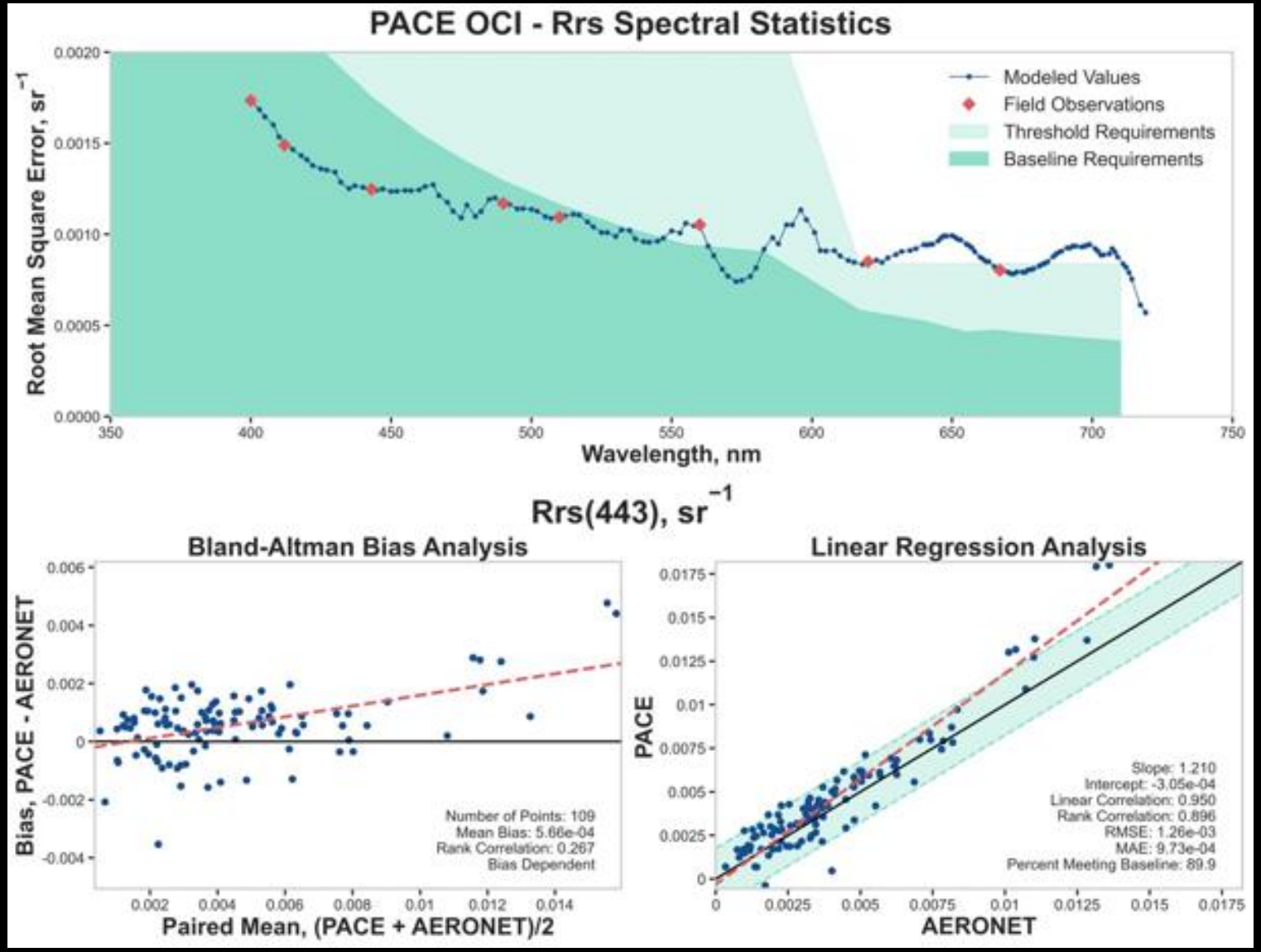
Problematic bands

Hover over the bands to get more information about the issues. The ocean normalized surface reflectance (rhos) and atmosphere transmittance spectra are shown as a reference.

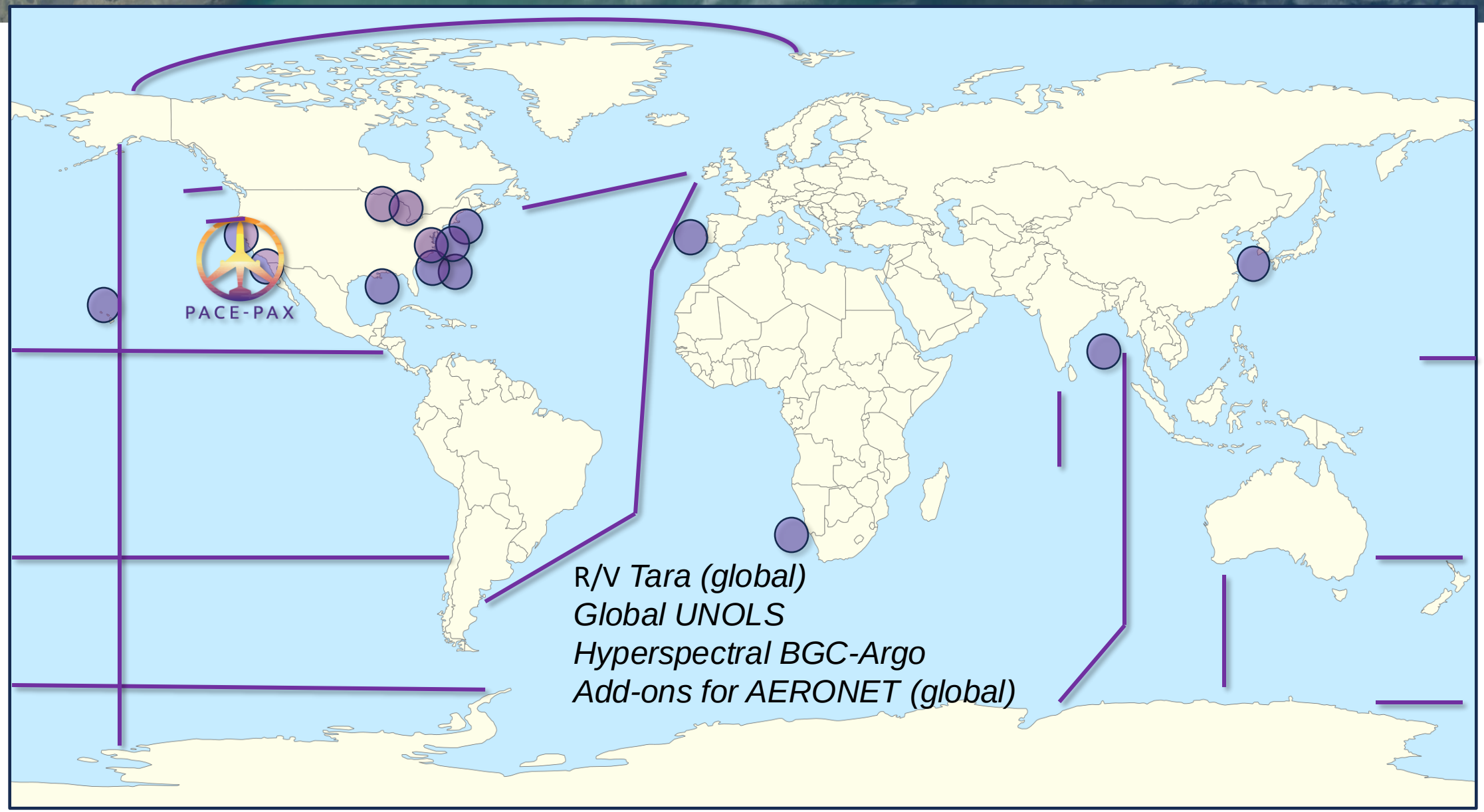


Preliminary performance assessments (Rrs only for the moment)

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



PACE Validation Science Team (PVST)



PACE Postlaunch Airborne eXperiment: PACE-PAX

An airborne field mission devoted to validation of NASA PACE observations

Deploying two aircraft, each flying out of their home base:

- CIRPAS Twin Otter (Marina, CA) – Direct (in situ) aerosol, cloud measurements
- NASA ER-2 (Palmdale, CA) – Remote and PACE Proxy measurements

Added 20+ hours (80+ total) to support EarthCare collaboration and underflights

3-27 September 2024, ~~60 flight hours~~

PACE-PAX validation objectives
1. Validate new retrieval properties
2. Assess spatial and temporal scale impact on validation
3. Validate in a narrow swath
4. Validate radiometric and polarimetric properties
5. Target specific geometries, season, and time of day
6. Focus on specific processes or phenomena

Instrument/Team	Aircraft	Role	Lead PI	Institution
AirHARP	ER-2	PACE/HARP2 polarimetry proxy	J. Vanderlei Martins	UMBC
HSRL-2	ER-2	Aerosol/cloud/ocean Lidar	T. Shingler / J. Hair	NASA LaRC
PICARD ARC	ER-2	PACE/OCI spectrometer proxy	James Jacobson	NASA ARC
PICARD GSFC	ER-2	PACE/OCI spectrometer proxy	Kerry Meyer	NASA GSFC
PRISM	ER-2	PACE/OCI spectrometer proxy	David R. Thompson	JPL
RSP	ER-2	Multi-angle polarimeter reference	B. Cairns / K. Sinclair	NASA GISS
SPEX Airborne	ER-2	PACE/SPEXone polarimetry proxy	Otto Hasekamp	SRON
Twin Otter	TO	Aerosol/cloud in situ instruments	Anthony Bucholtz	NPS
LARGE	TO	Aerosol/cloud in situ instruments	Luke Ziemba	NASA LaRC
ISARA	TO	In situ instrument synergy activity	Snorre Stamnes	NASA LaRC
LI-Nephelometer	TO	Aerosol phase functions	Adam Ahern	NOAA
Weather team		Weather & aerosol, cloud forecasting	Rei Ueyama	NASA ARC
ESPO		Earth Science Project Office	Erin Czech	NASA ARC

Leadership team:

Kirk Knobelspiesse, Mission Scientist, NASA GSFC
Brian Cairns, Deputy Mission Scientist, NASA GISS
Ivona Cetinić, Deputy Mission Scientist, NASA GSFC

pace.oceansciences.org/campaigns.htm

Ocean Carbon & Biogeochemistry

Studying marine ecosystems and biogeochemical cycles in the face of environmental change

Home | About OCB | Activities | Science Support | Publications | Science Highlights | News

The NASA Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) Project and Ocean Carbon & Biogeochemistry (OCB) Program are hosting a one-week social coding event (a.k.a hackweek or hackathon). The event will include a combination of lectures, tutorials, and working (coding) activities that will kick-start research using new Earth science data streams generated by the OCI, SPEXone, and HARP2 instruments. Participants will gain behind-the-scenes access to all aspects of the PACE mission.

- Data and compute resources will be provided on a cloud platform, and coding activities will be conducted in Python. **Participants must have some experience (i.e. able to work independently) with Python in order to benefit from this hackweek.** *We will also consider applicants who are more proficient in a different coding language but are interested in learning how to transition to Python*
- The target audience is a diverse array of individuals from various backgrounds and career stages (students to professionals).
- All lectures will be recorded, and lecture materials and recordings will be made available on the course web page.

Course Dates & Location:

4-8 August 2024

University of Maryland, Baltimore County (UMBC)

looking forward

Second reprocessing (V3) to be pursued this (boreal) Fall

- First OCI system vicarious calibration
- Updated OCI atmospheric correction (NO_2, updated gasses, others)
- TBD updates to HARP2 and SPEXone
- TBD new products

PVST data availability in SeaBASS; SVC data availability

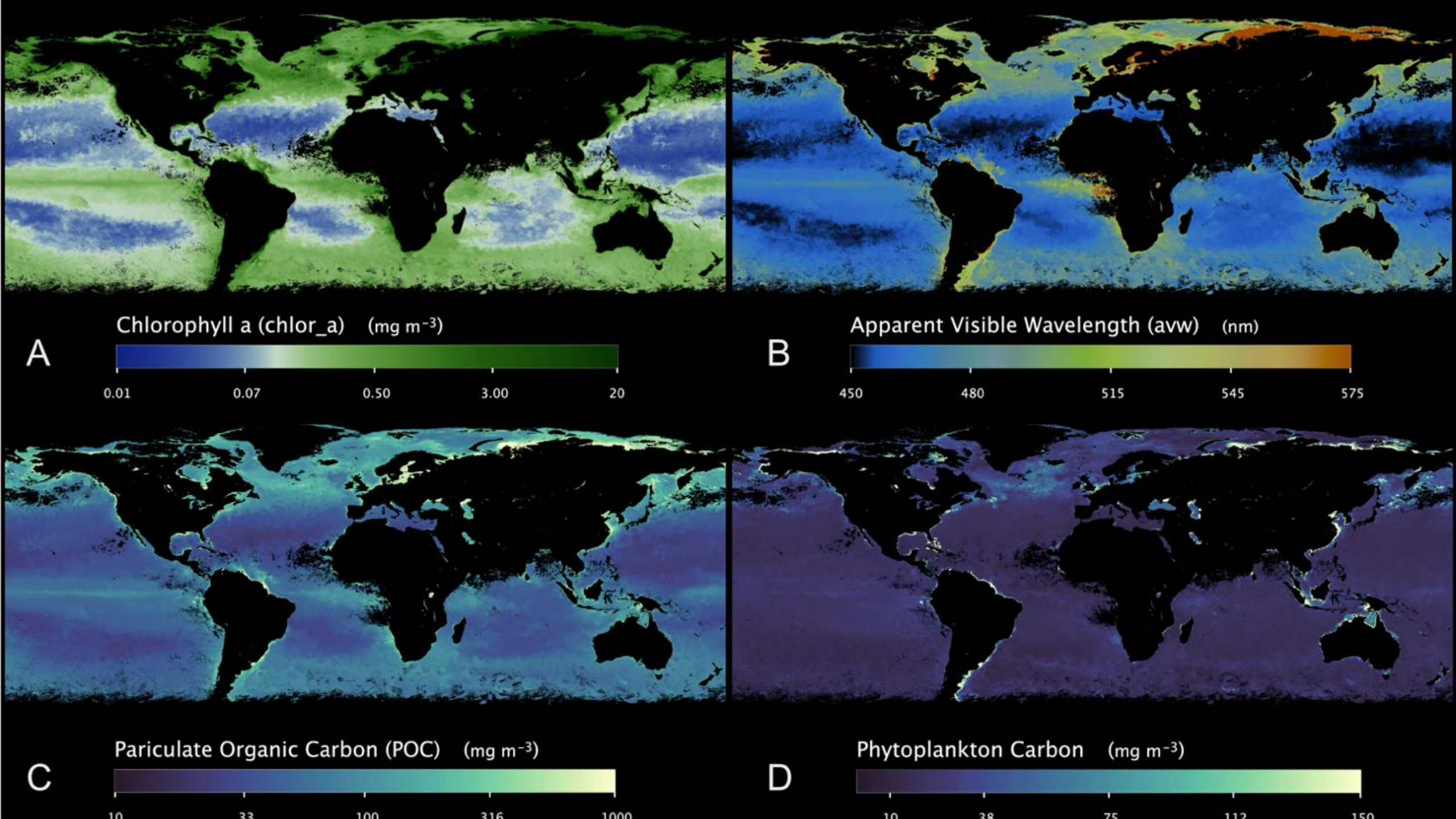
- 60-day submission requirement for PVST

Additional tutorials & trainings

- Hackweek tutorials, ARSET training, in-person training at Ocean Optics, etc.

Meeting presence

- SPIE (UK), Ocean Optics (Spain), WICSIS-3 (Netherlands), Fall AGU (US), others


A
Chlorophyll a (chlor_a) (mg m⁻³)
0.01
0.07
0.50
3.00
20
B
Apparent Visible Wavelength (avw) (nm)
450
480
515
545
575
C
Pariculate Organic Carbon (POC) (mg m⁻³)
10
33
100
316
1000
D
Phytoplankton Carbon (mg m⁻³)
10
38
75
112
150