PACE
Plankton, Aerosol, Cloud, ocean Ecosystem advancing global and coastal ocean color science and applications

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2021 2030 United Nations Decade of Ocean Science for Sustainable Development

CEOS WGCV IVOS 34 – 30 August 2022

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

Primary hyperspectral radiometer:

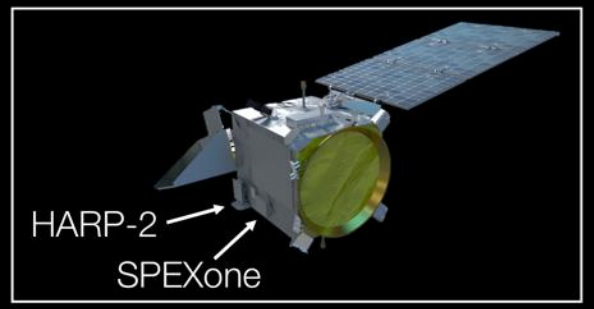
- Ocean Color Instrument (OCI) (GSFC)

2 contributed multi-angle polarimeters:

- HARP2 (UMBC)
- SPEXone (SRON/Airbus)

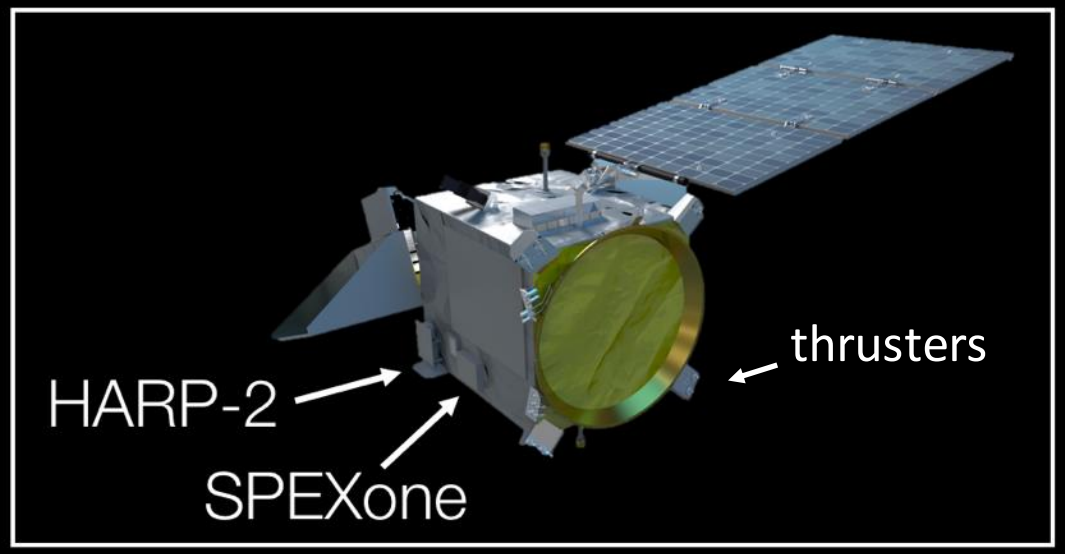
Key characteristics:

- 9 January 2024 launch
- 676.5 km altitude
- Polar, ascending, Sun synchronous orbit; 98° inclination
- 13:00 local Equatorial crossing
- 3-yr design life; 10-yr propellant
- Ka-band downlink rate 600 Mbps; avg Observatory 40 Mbps



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

Additional beauty shots of the PACE observatory can be found at: https://svs.gsfc.nasa.gov/12469



solar array

S-band antenna

star trackers

OCI

We are here.
(Launch – 16 mos.)

OCI & Spacecraft I&T

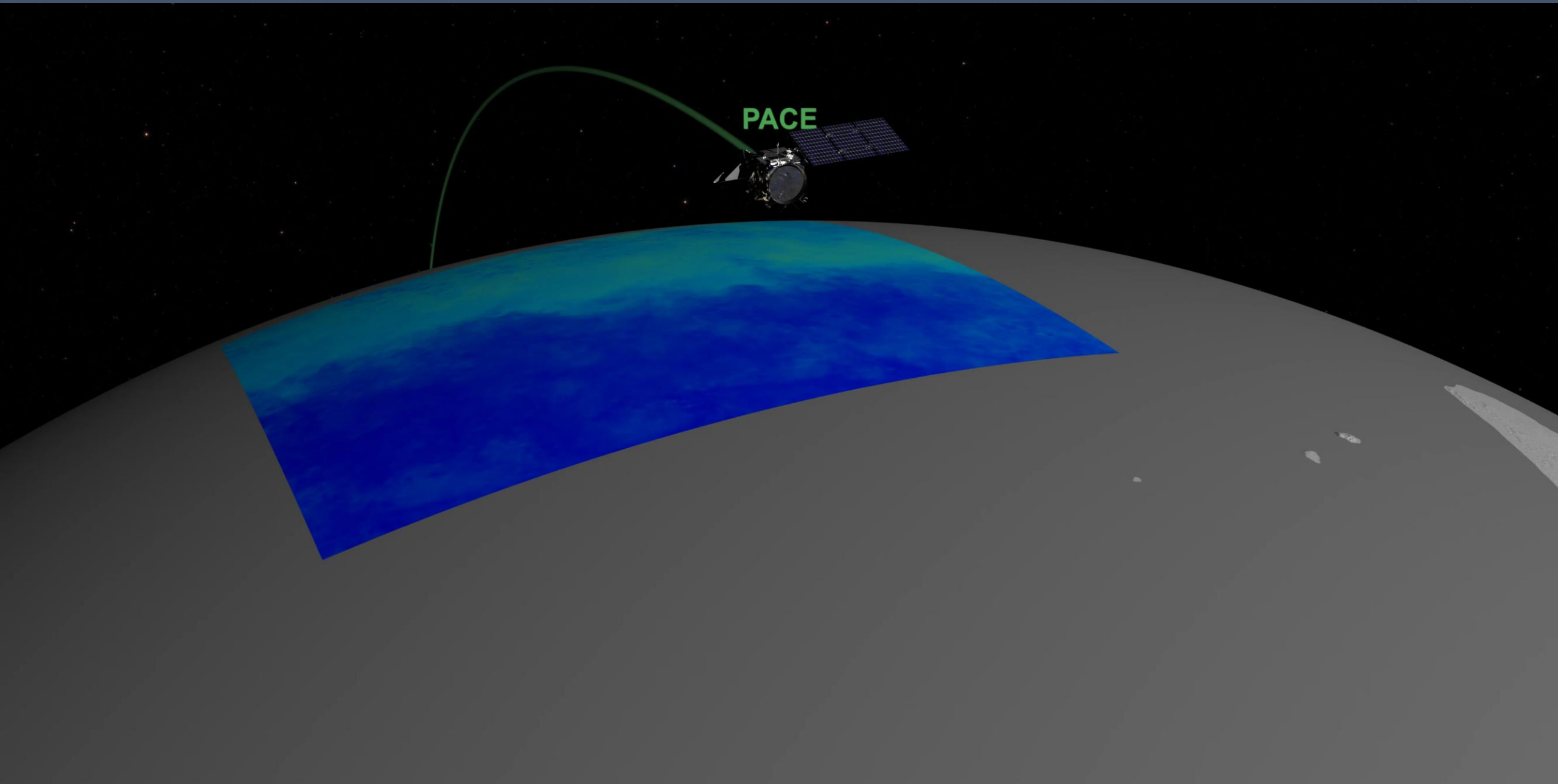
Observatory I&T

Launch Readiness Date (LRD) Jan. 9, 2024

Decommission

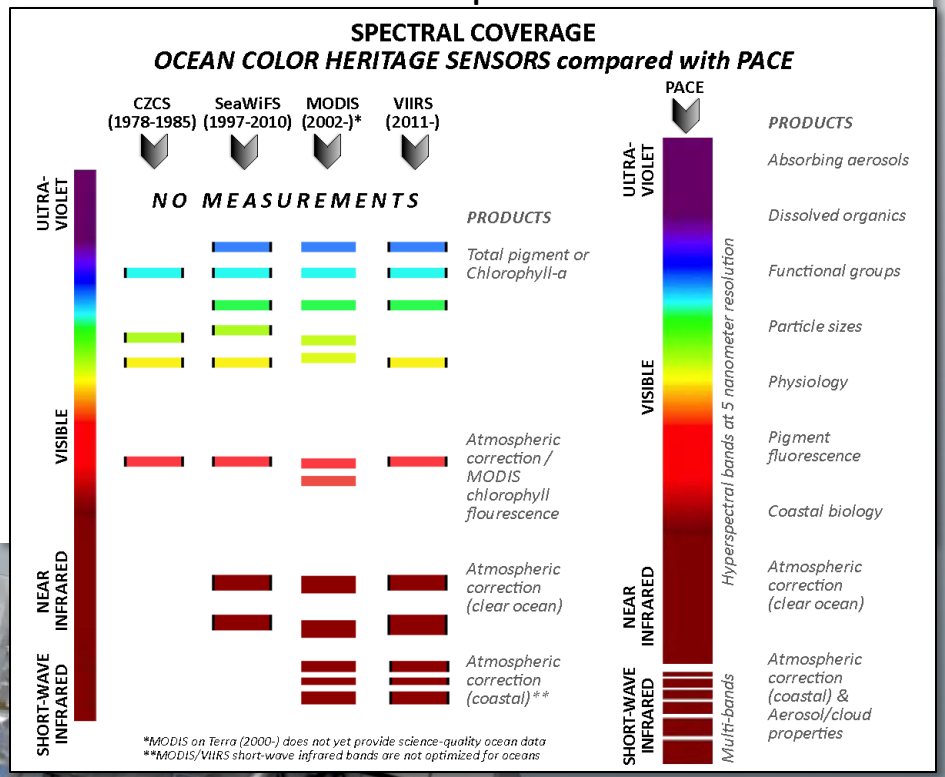
CY21	CY22	CY23	CY24	CY25	CY26	CY27
Phase C		Phase D	Phase E			Phase F

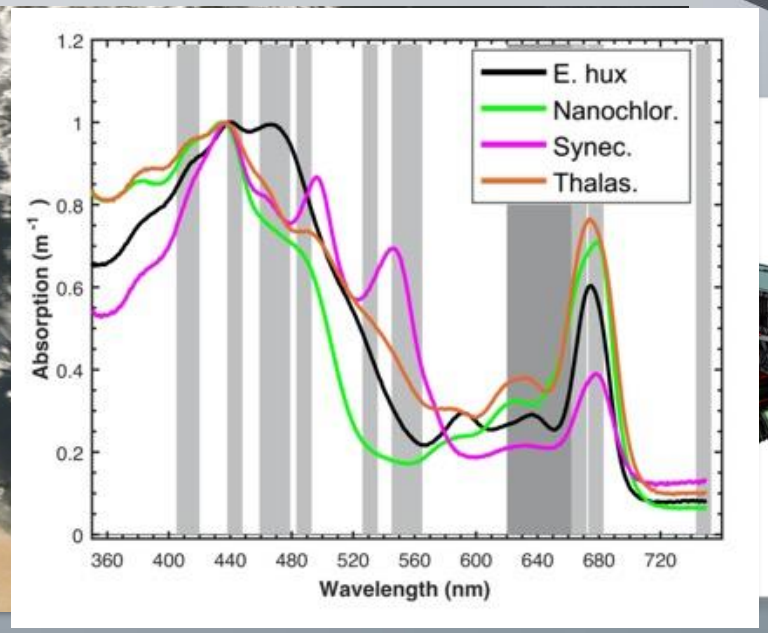
PACE Science Objectives

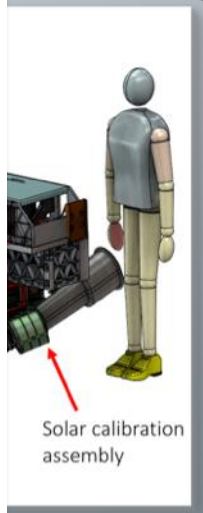


Key OCI Advances

- Hyperspectral scanning radiometer
- 5 nm resolution (320) 340-890 nm
  - Data at 2.5 nm steps







Credit: NASA's Conceptual Image Laboratory

Designed and built at NASA Goddard Space Flight Center

UMBC Hyper Angular Rainbow Polarimeter (HARP-2)

Update

- Flight unit undergoing environmental testing
- Delivery to GSFC for I&T in Fall 2022

	HARP-2	SPEXone
UV-NIR range	440, 550, 670, 870 nm	Continuous from 385-770 nm in 5 nm steps
SWIR range	None	None
Polarized bands	All	Continuous from 385-770 nm in 15-45 nm steps
Number of viewing angles [degrees]	10 for 440, 550, 870 nm; 60 for 670 nm [spaced over 114°]	5 [-57°, -20°, 0°, 20°, 57°]
Swath width	±47° [1556 km at nadir]	±4.5° [106 km at nadir]
Global coverage	2 days	30+ days
Ground pixel	3 km	2.5 km
Heritage	AirHARP, Cubesat	AirSPEX

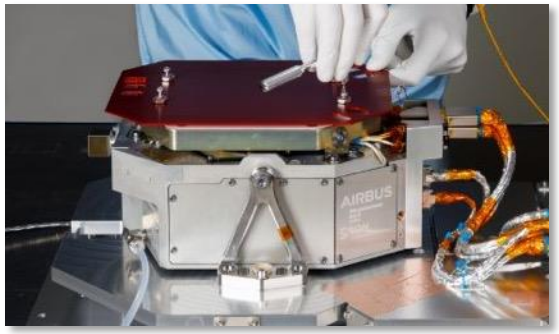
- Excellent for cloud droplet size and ice particle shape/roughness retrievals
- *Provides cloud capabilities beyond those required of OCI*
- *Wide swath matches OCI, offering potentially improved atmos. correction*

- Excellent for aerosol characterization
- *Addresses aerosol climate objectives beyond those required of OCI*

OCI + SPEXone + HARP2

- Greater information content than any current instrument suite for ocean color, aerosol, & cloud observations
- New data products: ocean color from multi-angle polarimetry, wind speed, etc.

SRON/Airbus Spectro-polarimeter for Planetary Exploration (SPEXone)

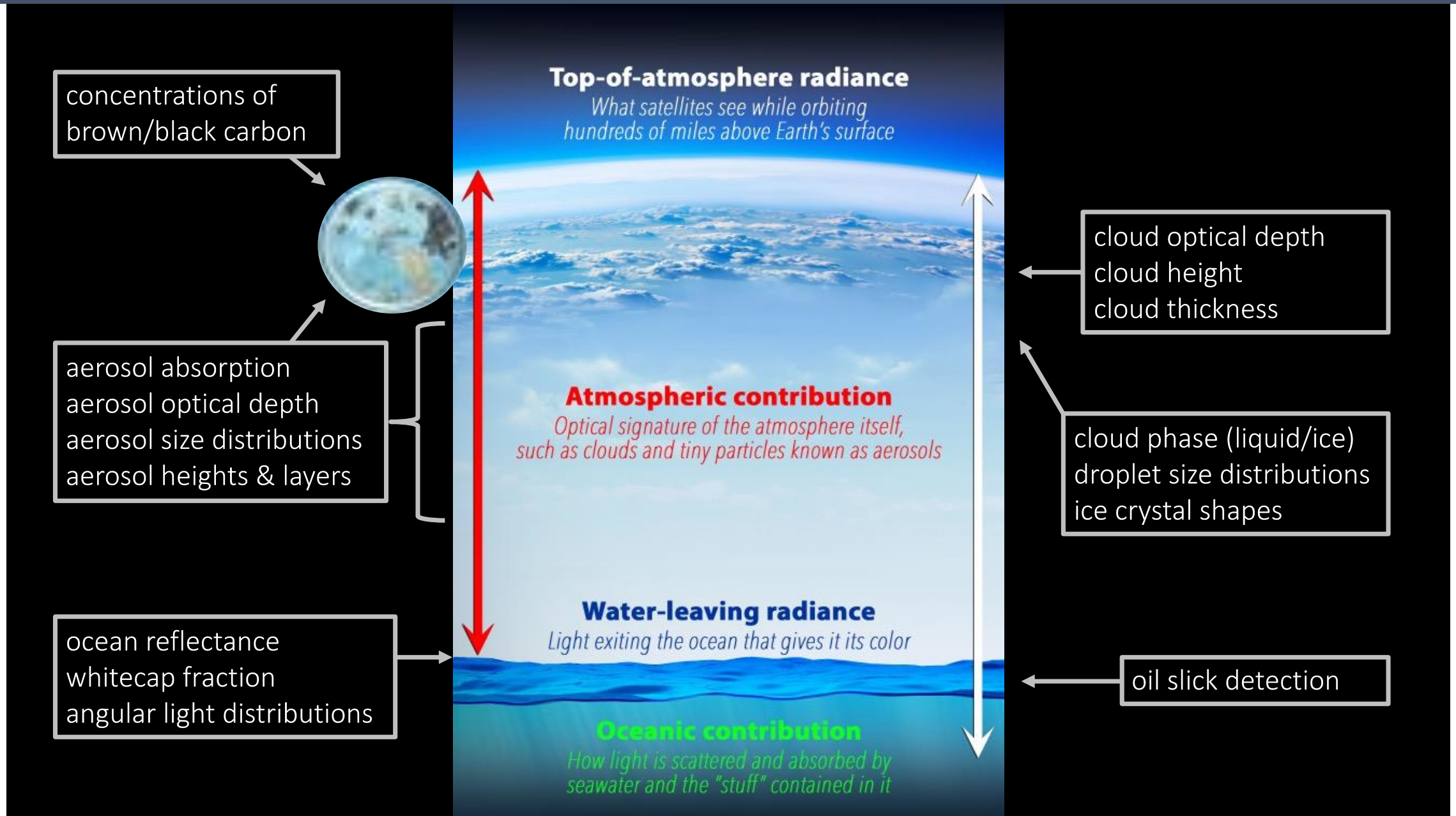


Update

- SPEXone flight unit delivered to GSFC; integrated to spacecraft
- 16 orbits of simulated data available online

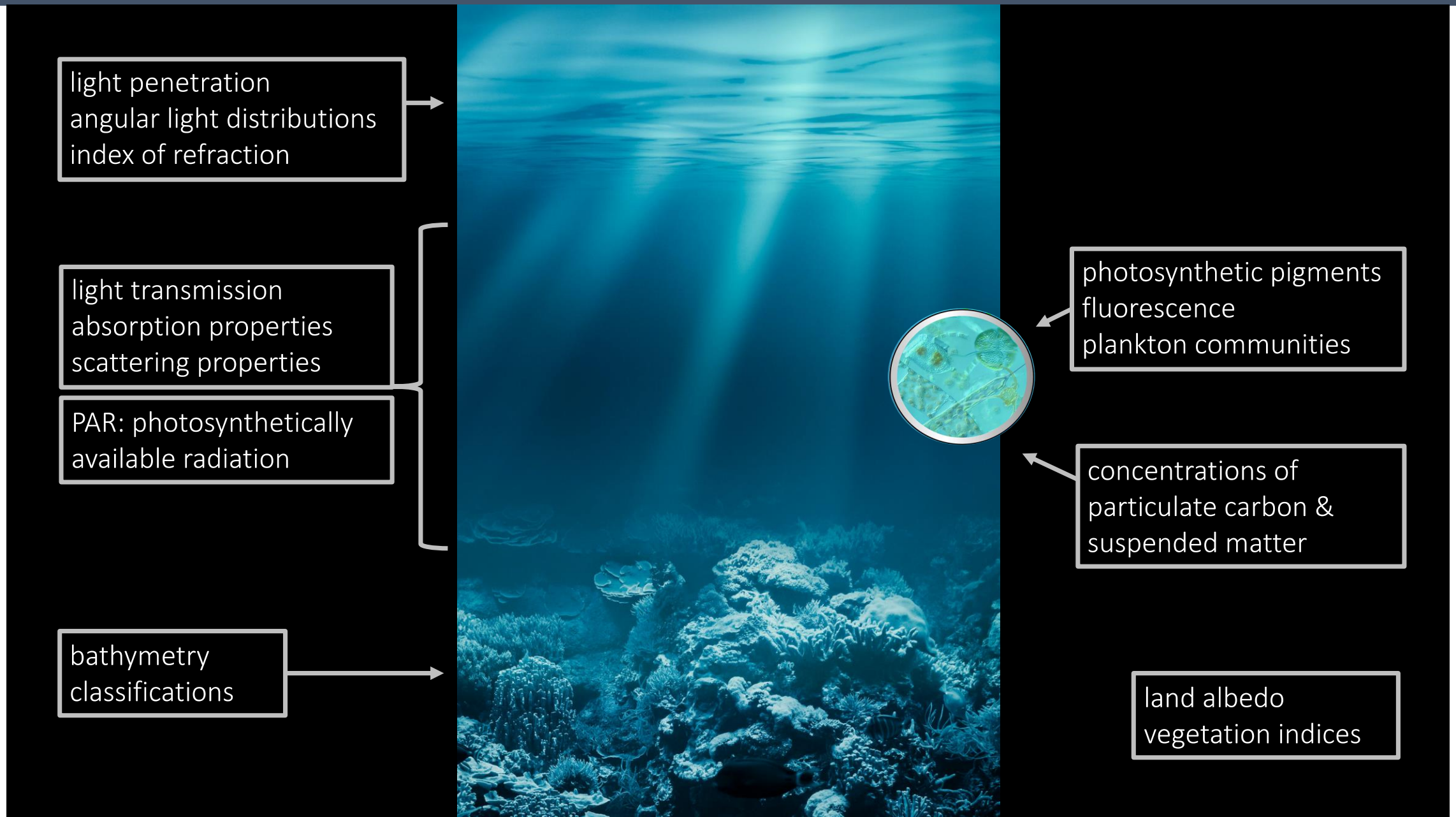
PACE Data Products – Atmospheric

DATA PRODUCTS



PACE – Ocean Color (plus Terrestrial)

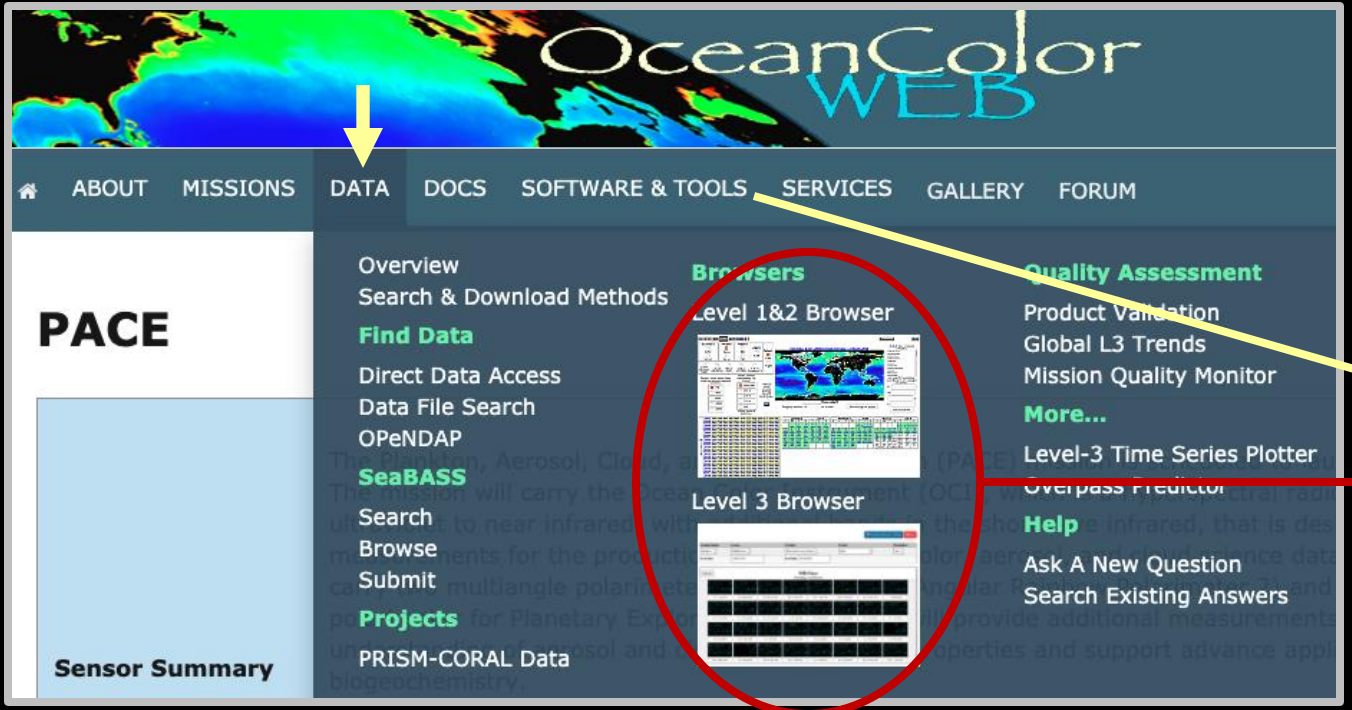
DATA PRODUCTS

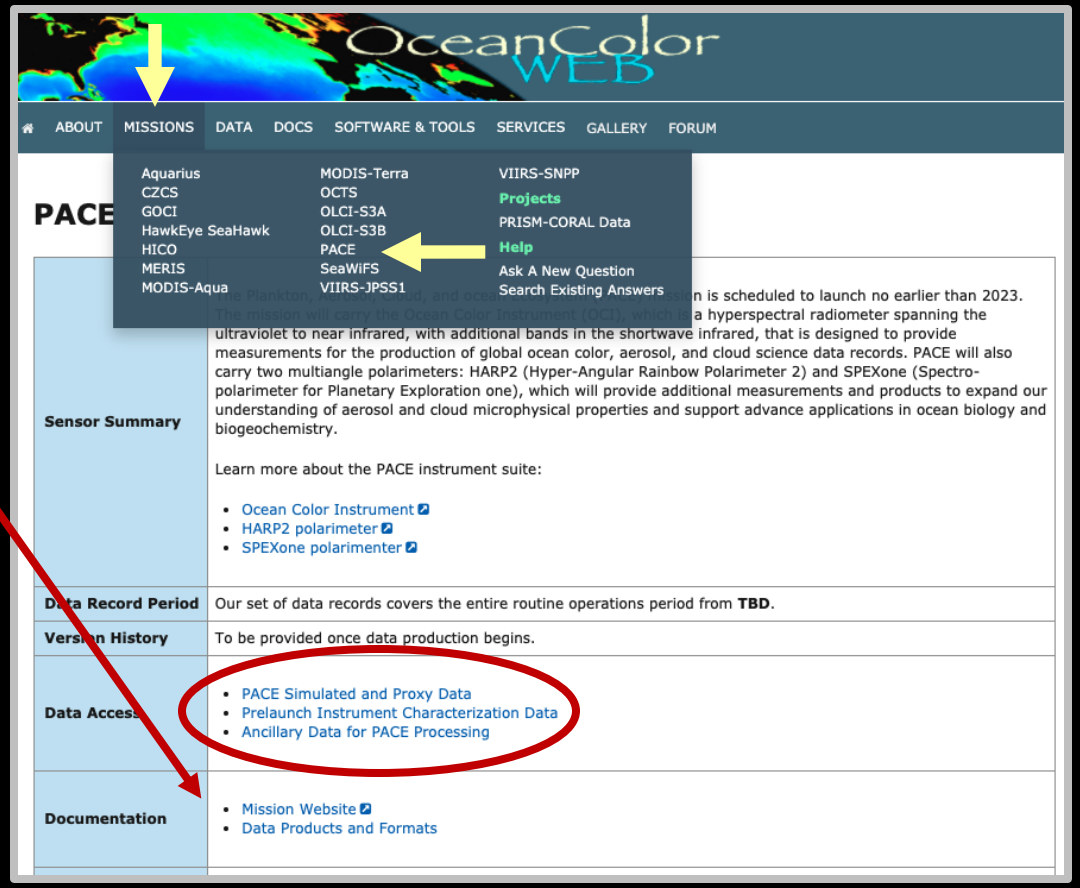


PACE data availability, formats & software

Data Level	Description	Format
Level 0	Lowest level science data (Raw Data; Consultative Committee for Space Data Systems (CCSDS) packets - https://public.ccsds.org/Pubs/133x0b2.pdf)	CCSDS
Level 1A	Uncalibrated science data in self–describing archive format	netCDF4
Level 1B	Calibrated radiances, geo-located science data as observed	netCDF4
Level 1C	Calibrated radiances, geo-located, co-registered (resampled) science data	netCDF4
Level 2	Science products derived from Level-1B/C	netCDF4
Level 3	Temporally and spatially composited science products	netCDF4

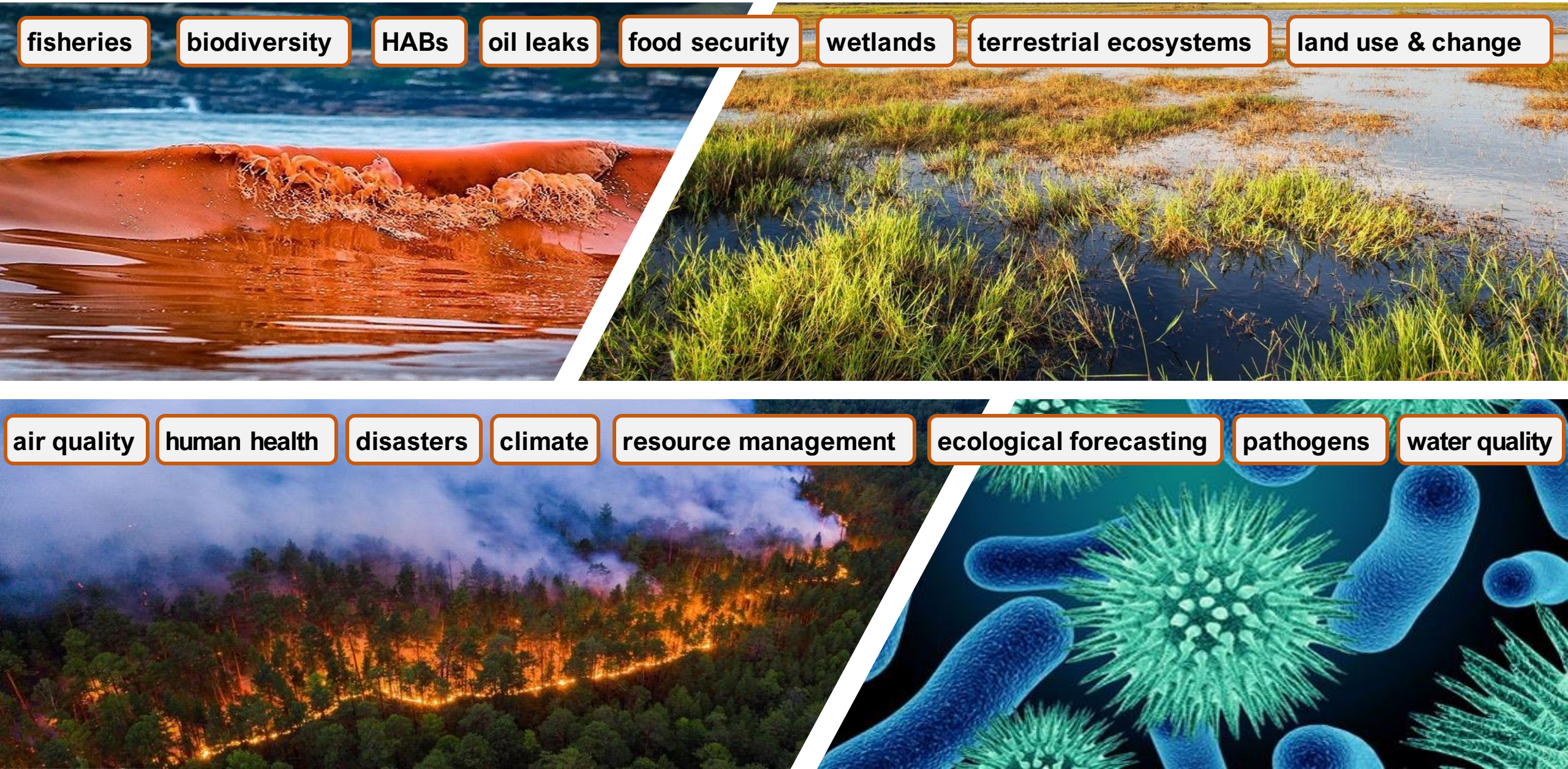
https://oceancolor.gsfc.nasa.gov





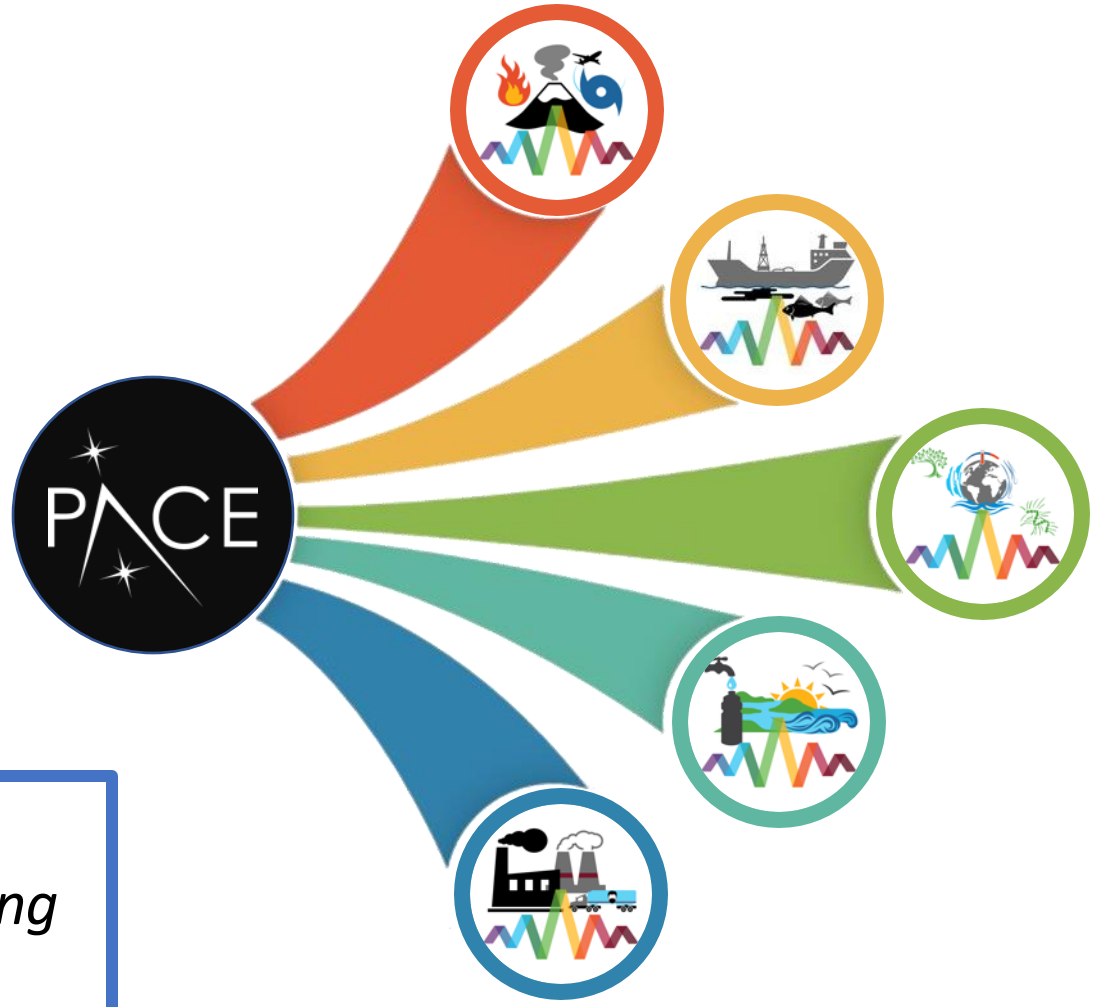
https://seadas.gsfc.nasa.gov

PACE: Interdisciplinary applied science objectives



PACE Applications Program

- *Addressing community user needs* & concerns with PACE data products
- *Grow relevance* & sustainability of PACE
- *Demonstrate the societal value* & utility of PACE



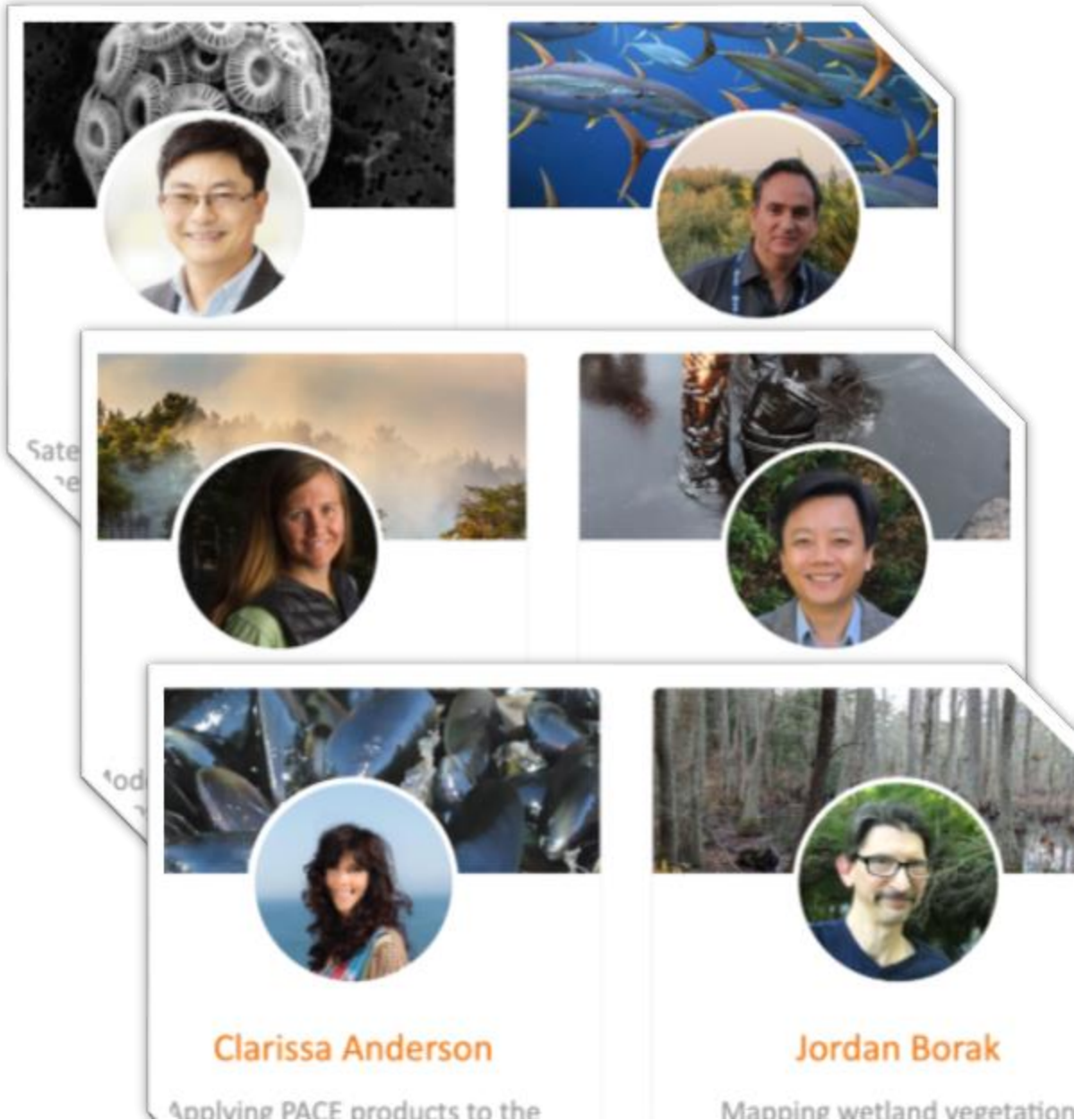
The goal of the PACE Applications Program is to foster new partnerships and out-of-the-box thinking that will generate inventive solutions that aid society.

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:

- Expand the user communities with tangible and potential applications that would benefit from the use of PACE data
- Facilitate feedback on PACE data products pre-launch
- Accelerate the use and integration of PACE products into applications post-launch by providing specific support to Early Adopters who commit to engage in pre-launch applied research



PACE Early Adopters

Aquaculture/Fisheries

Air-sea exchange

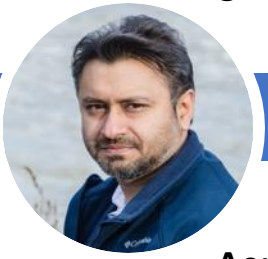
Marine mammals & Climate

Oil Spills

Mapping HABs Risk

Aquaculture/Fisheries

Waterborne Pathogens



Aerosols& Human Health

HABs Detection

Wetland Ecosystems

Data Integration

Food Security

Water Clarity-Waters Resources

Mobile Apps & Decision Making

Water Clarity-Water Resources

Data management

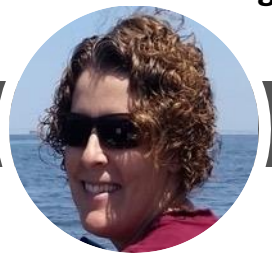
Air Quality & Human Health

Global Carbon Budget

HABs Monitoring

Air Quality & Climate

HABs Monitoring



HABs Monitoring

Water Clarity & Ecosystem Health

Data Integration

https://www.eventbrite.com/e/pace-applications-workshop-2022-tickets-321347487987

Vicarious Calibration and Validation

- System Vicarious Calibration – *ongoing competition*
  - MarONet – Voss/Johnson/Yarbrough et al.
  - HyperNav - Barnard/SeaBird/Boss et al.

- Validation Activities
  - ROSES 2022 PACE Validation Science Team (PVST)
  - PACE Post-launch Airborne eXperiment (PACE-PAX)
  - Rely on existing infrastructure and data resources
    - AERONET-OC (thank you Giuseppe!!!)
    - AERONET
    - FRM4SOC
    - MAN, SKYNET, ARM, MPLNET, EARLINET, etc.
  - Establish new infrastructure (tbd)

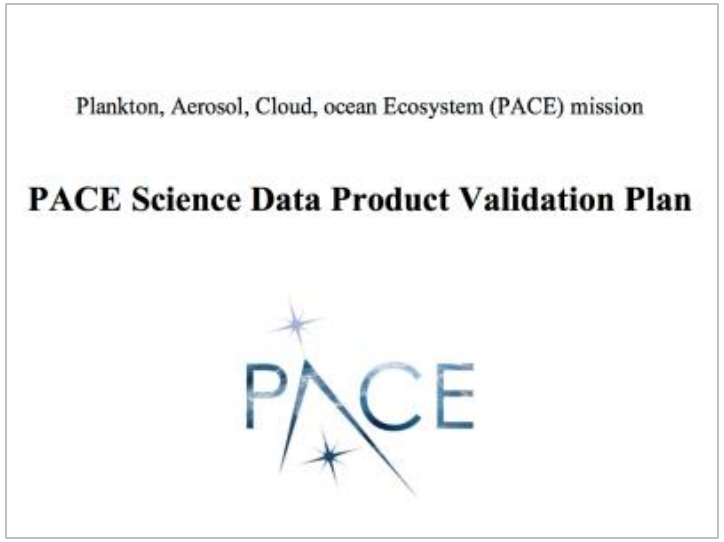
Effective Date: <Date>
Expiration Date: <Date> [as required]

GSFC PACE CMO
<Date>
Released

PACE-SCI-PLAN-0140, Revision -
Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) mission,
Code 427.0

PACE Vicarious Calibration Plan
Draft 1, 26 February 2019

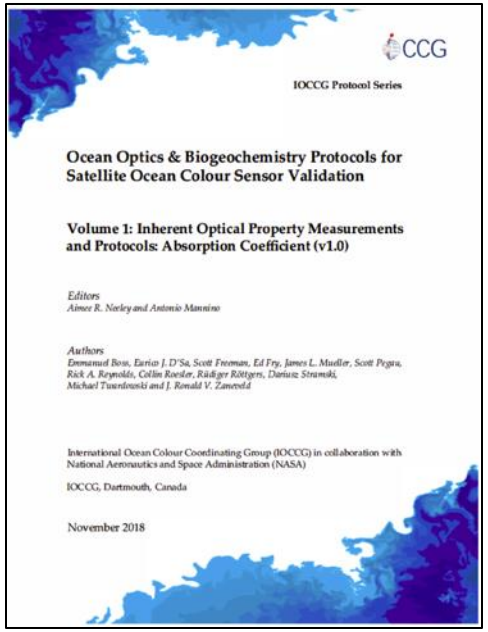
https://pace.oceansciences.org/documents_more.htm?id=1758

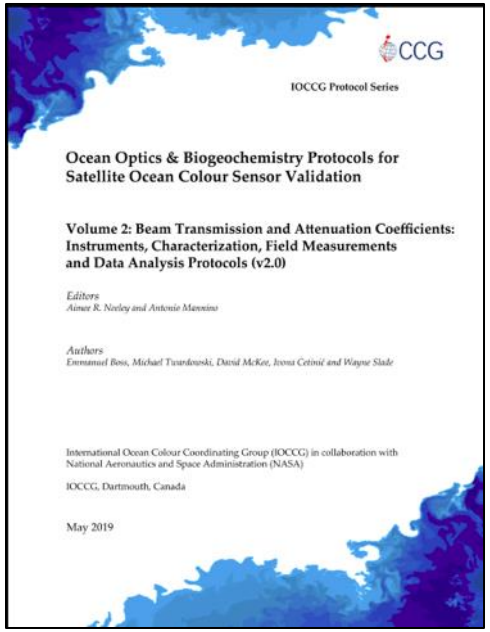

Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) mission

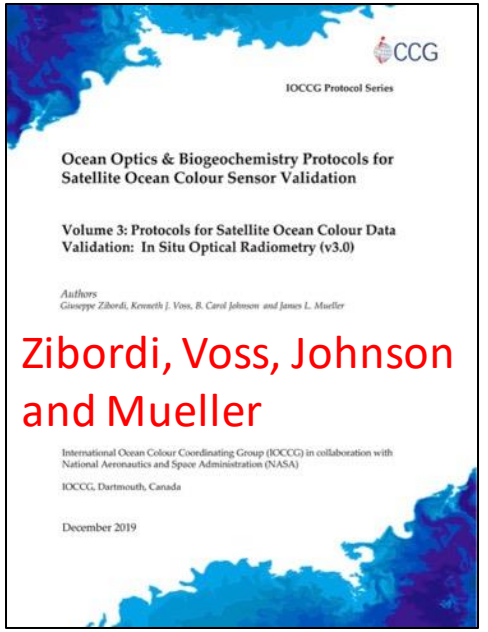
PACE Science Data Product Validation Plan

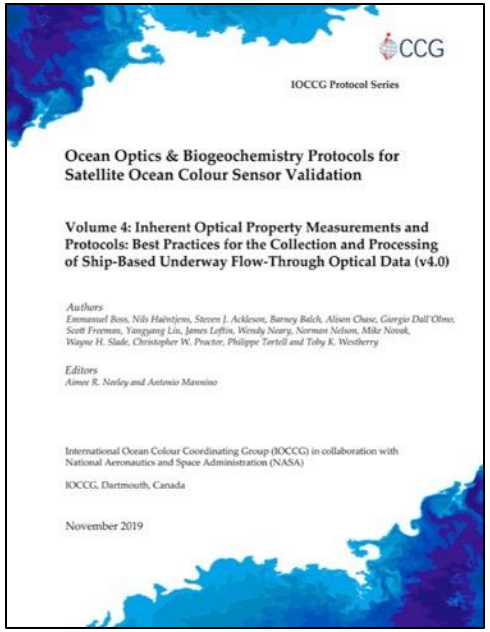
https://pace.oceansciences.org/docs/PACE_Validation_Plan_14July2020.pdf

Field Measurement Protocols - Published









Vol. 1.0 Absorption (particles)

Nov. 2018

Vol. 2.0 Beam Attenuation

April 2019

Vol. 3.0 Radiometry for Validation

Dec. 2019

Vol. 4.0 Inline Flow-Through IOPs

Nov. 2019

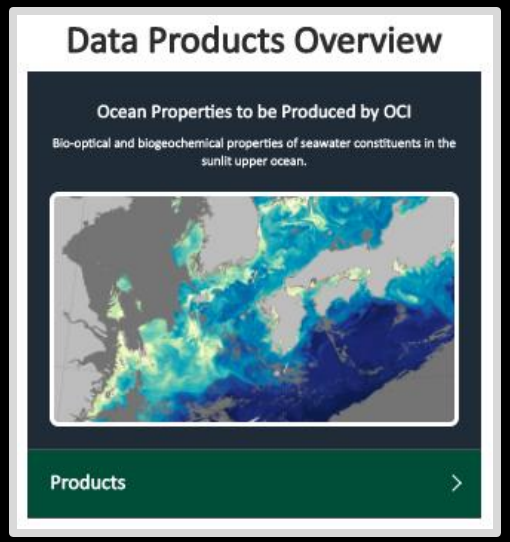
Vol. 6.0 Particulate Organic Carbon

August 2021

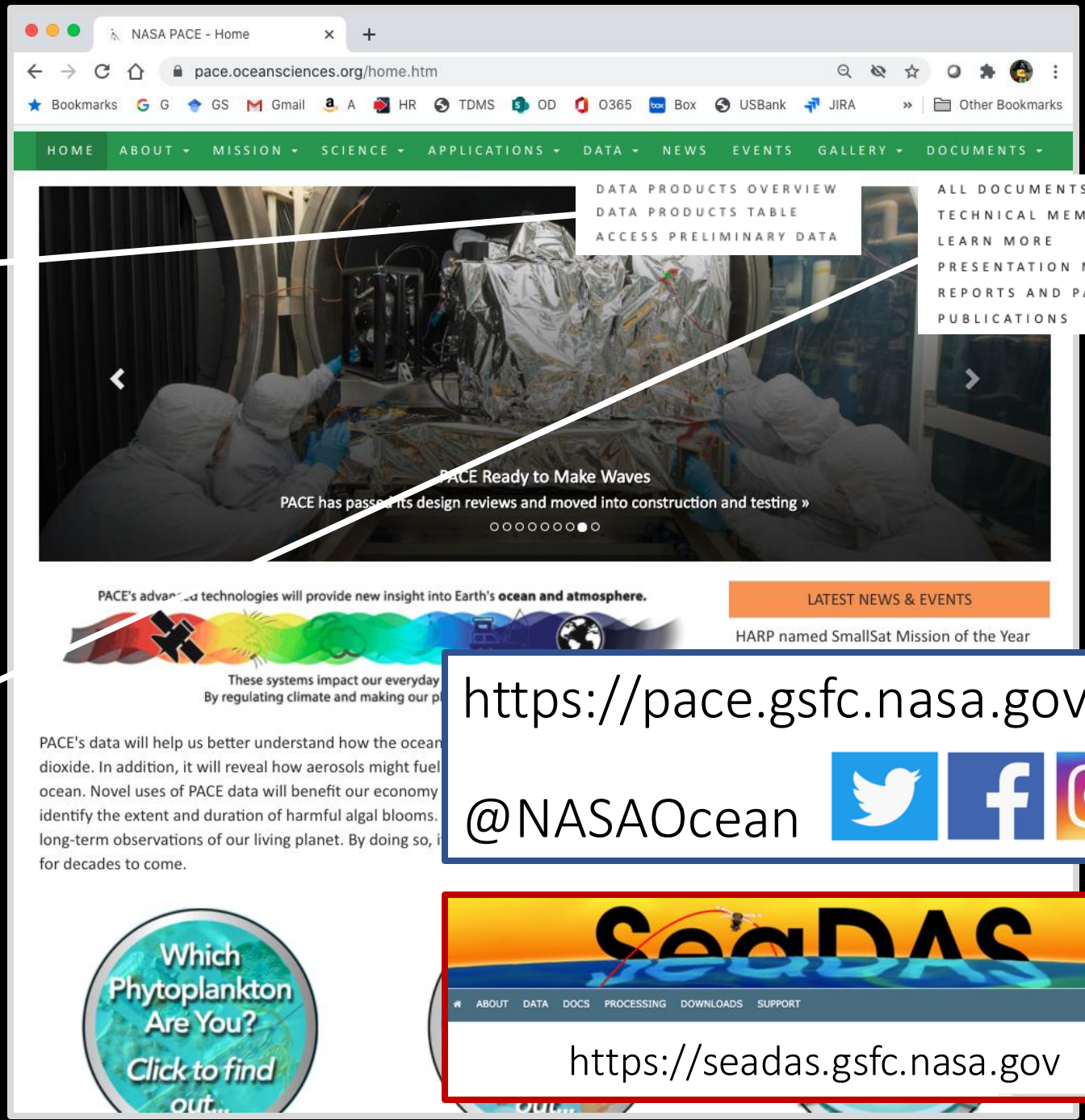
https://ioccg.org/what-we-do/ioccg-publications/ocean-optics-protocols-satellite-ocean-colour-sensor-validation/

resources & useful info

data product descriptions + access to simulated data & characterizations



PACE technical memos & other documents



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