NASA Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) mission aerosol data expectations

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1: UMBC; 2: NASA GSFC; 3: NASA GISS

Mission summary and status

Spacecraft
Assembly nearing completion at GSFC!

OCI
Undergoing thermal vacuum testing!

SPEXone
Integrated onto spacecraft June 2022!

HARP-2
Delivery October 2022!

Launch
January 2024!

- 1 pm polar orbit
- 3 year design life; 10 years propellant
- All products CF-compliant NetCDF4
- Distributed by OB DAAC & Langley ASDC

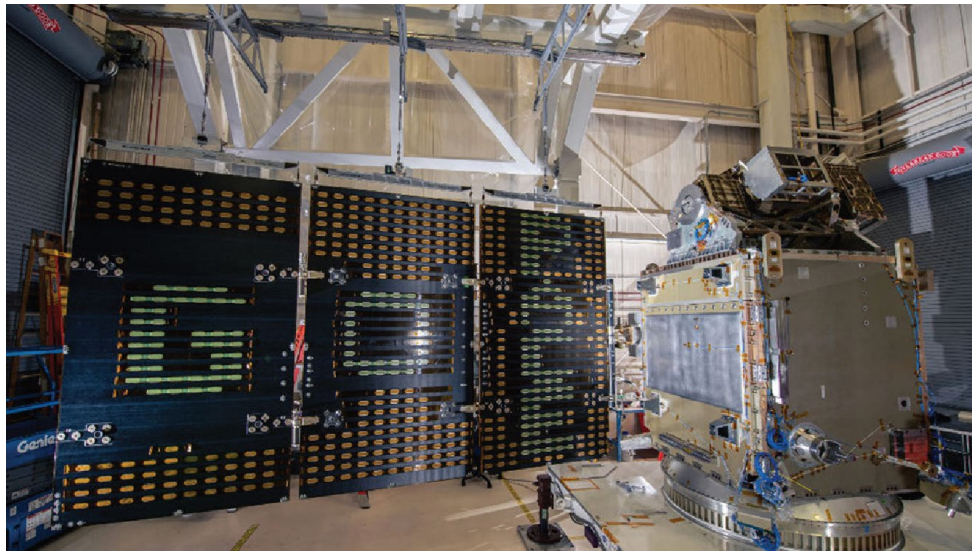


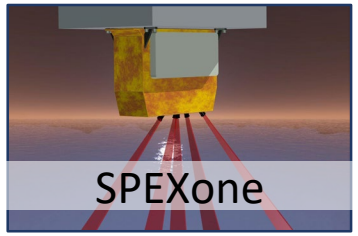
Photo by B. Lambert (NASA GSFC)

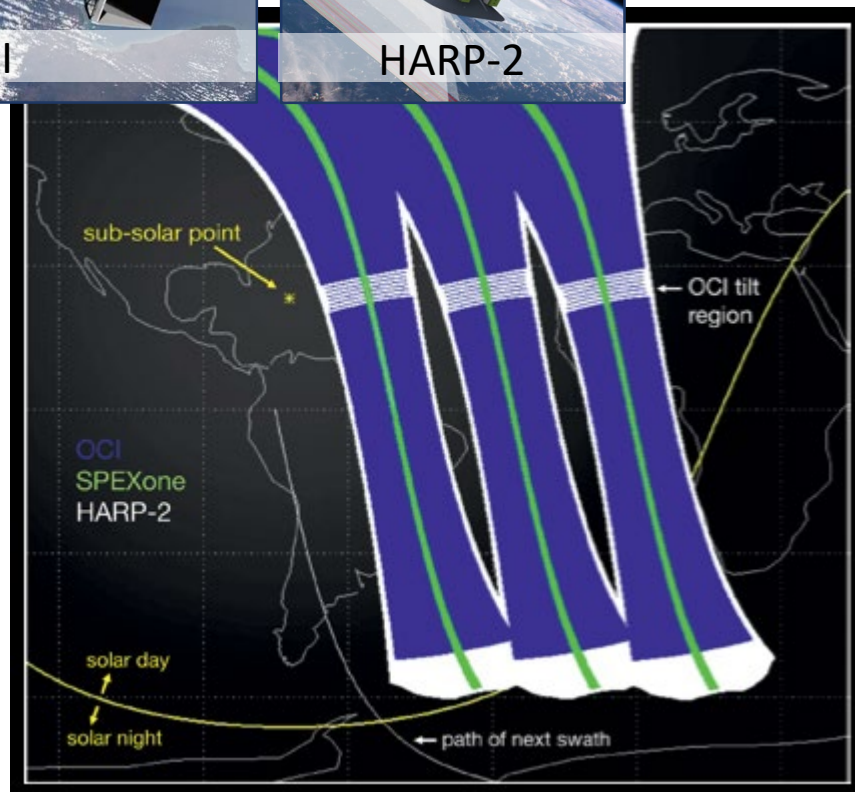
P.J. Werdell, *et al.,* (2019). The Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) mission: Status, science, advances, *Bulletin of the American Meteorological Society*, 100 (9), https://doi.org/10.1175/BAMS-D-18-0056.1

Plankton, Aerosol, Cloud, ocean Ecosystem

Ocean Color Instrument (OCI)

- UV to NIR (340-890 nm) hyperspectral, 2.5 nm steps with 5 nm FWHM
- NIR/SWIR bands at 940, 1038, 1250, 1378, 1615, 2130, & 2250 nm
- 5 nm FWHM for 340-890 nm, 2.5 nm steps
- ~daily revisit (2,660 km swath)
- 1 km^2 footprint at nadir
- Tilts to decrease Sun glint



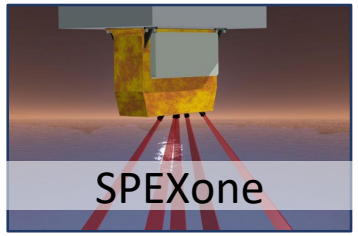


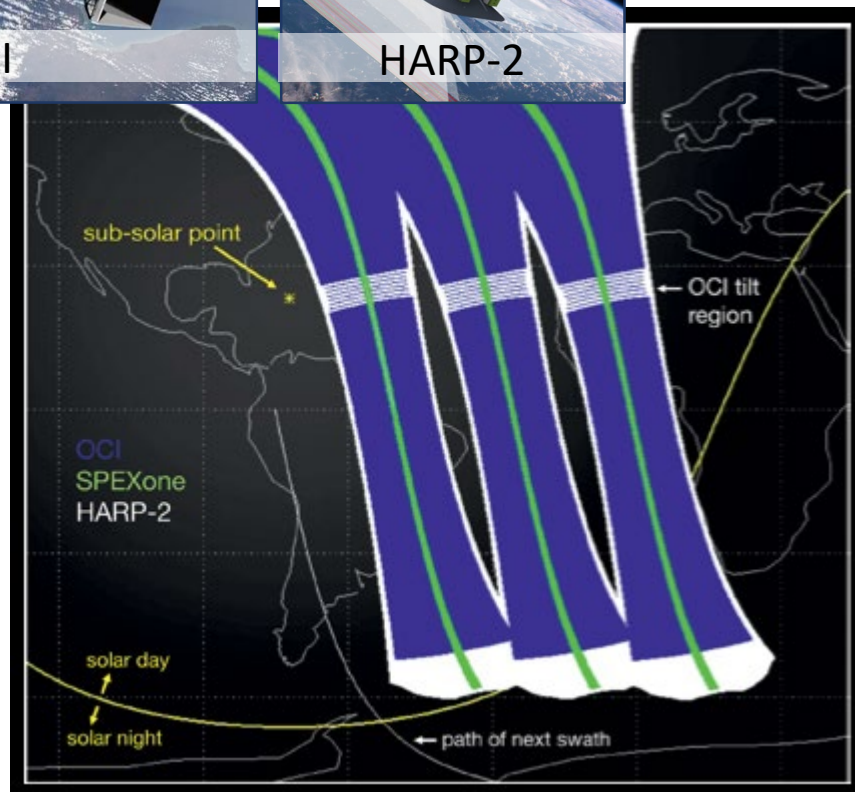
HARP-2 (UMBC)

- Wide swath
- ~2.5 km at nadir
- Hyperangular
- 4 bands across the VIS & NIR
- Intensity and linear polarization components

SPEXone (SRON/Airbus)

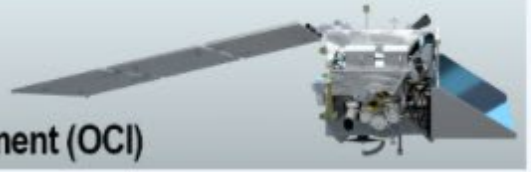
- Narrow swath
- 5.2 km resolution
- Hyperspectral (UV-NIR)
- 5 view angles
- Intensity and linear polarization at different spectral resolutions



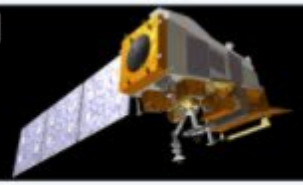


Plankton, Aerosol, Cloud, ocean Ecosystem

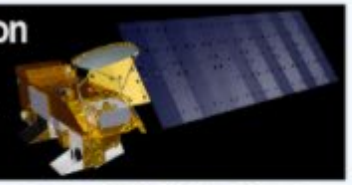
PACE Ocean Color Instrument (OCI)



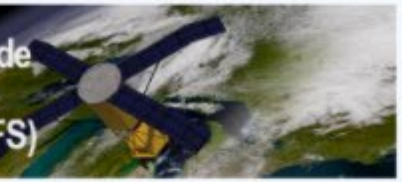
Visible Infrared Imaging Radiometer Suite (VIIRS)



Moderate Resolution Imaging Spectroradiometer (MODIS)



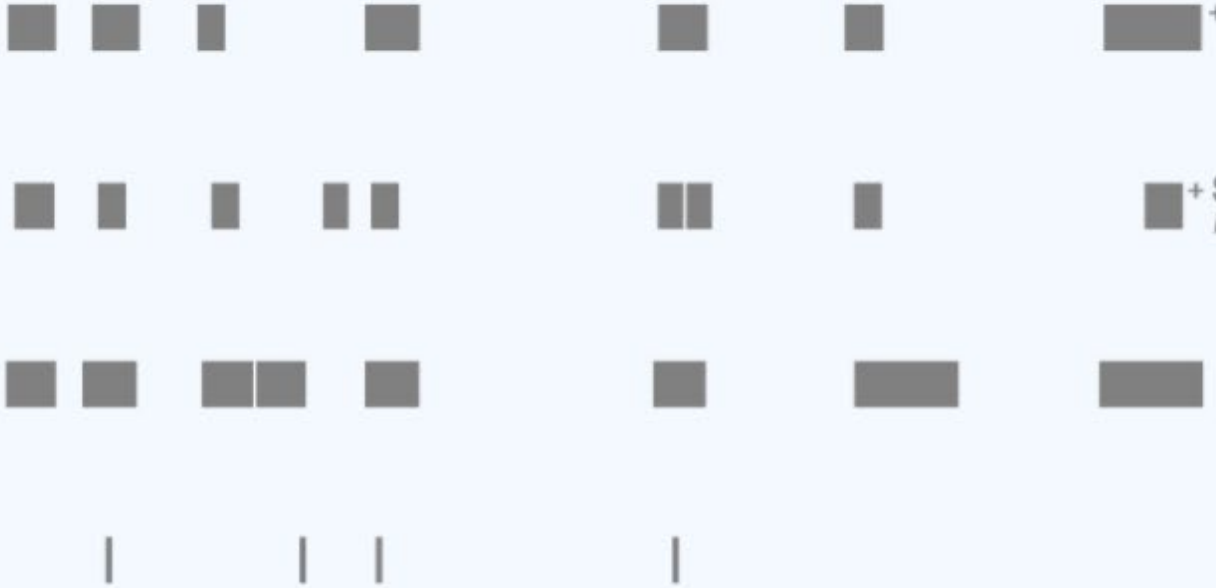
Sea-viewing Wide Field-of-view Sensor (SeaWiFS)



Coastal Zone Color Scanner (CZCS)

OCI covers a broad spectrum with no gaps, making it *hyperspectral*

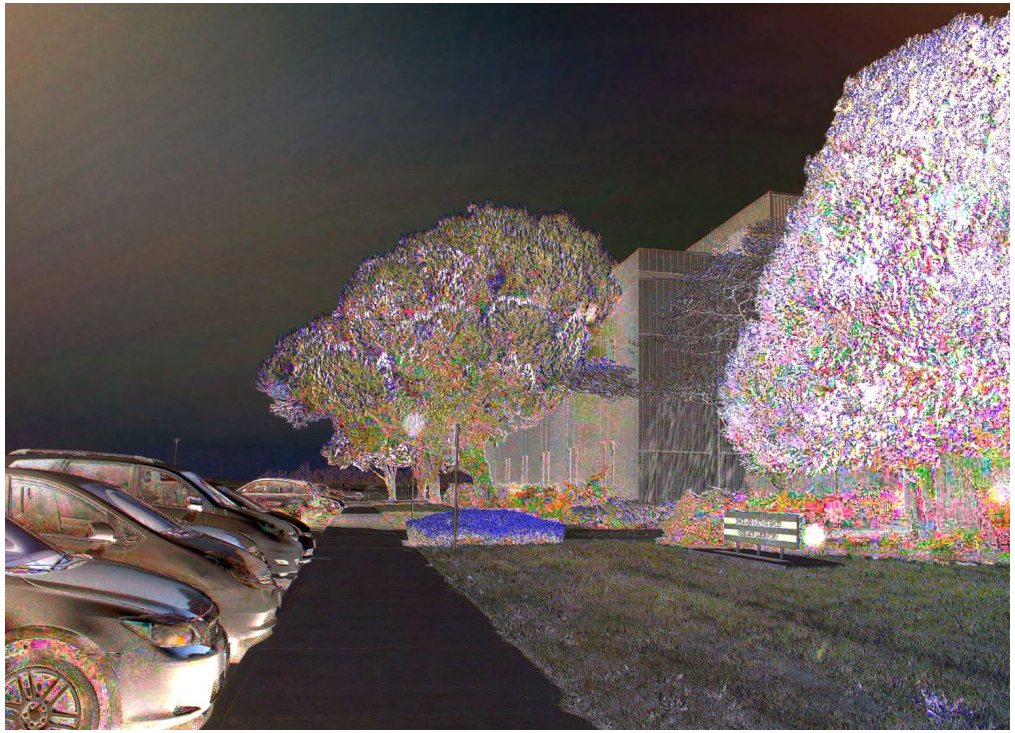
+ 6 more shortwave infrared (IR) bands that are optimized for ocean science



+ Shortwave IR bands that are *not* optimized for ocean science

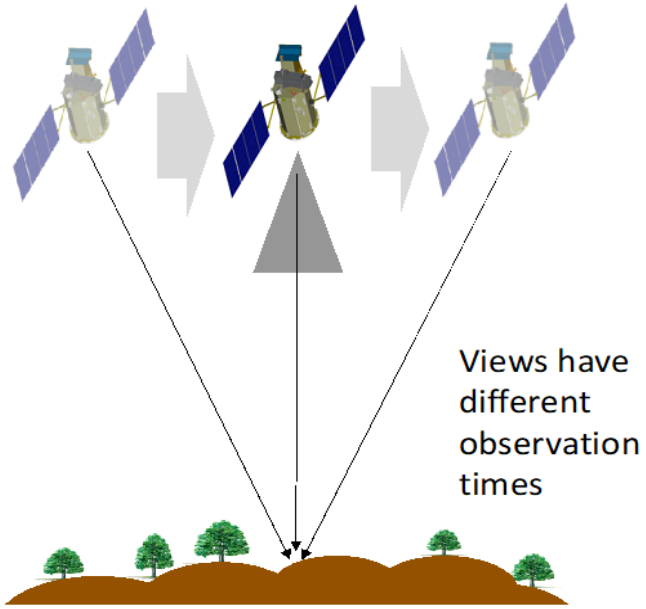
+ Shortwave IR bands that are *not* optimized for ocean science

Polarization provides another dimension of information

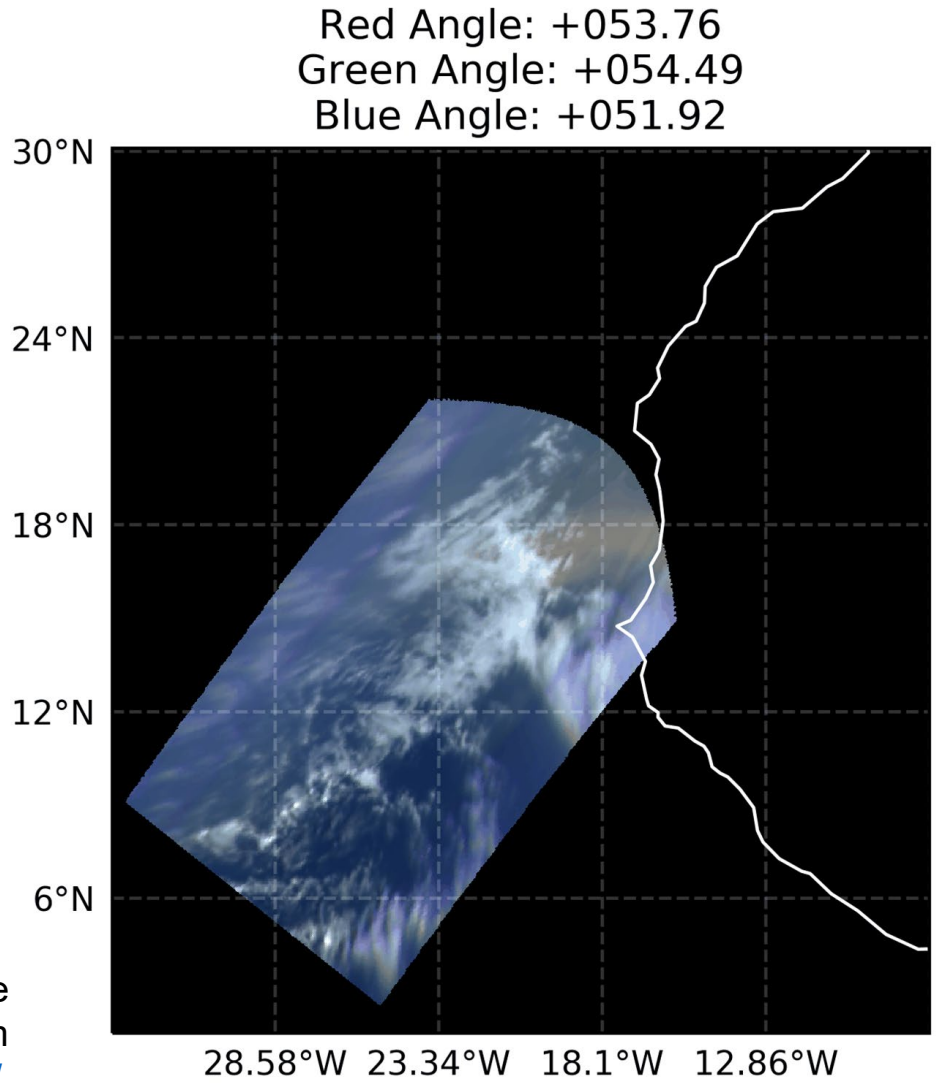


Photos by K. Knobelspiesse
(NASA GSFC)

The multi-angle nature of PACE's polarimetry further improves characterization of the Earth's surface and atmosphere



HARP Cubesat RGB image
J. V. Martins (UMBC) and team
https://esi.umbc.edu/harp -presentations/



Main take-aways

1. PACE OCI will **extend and improve** on heritage (e.g. MODIS/VIIRS) aerosol data sets

2. Multi-angle polarimetry offers more **capable, detailed** aerosol characterization

OCI aerosols at launch

Extending **MODIS** and **VIIRS heritage**

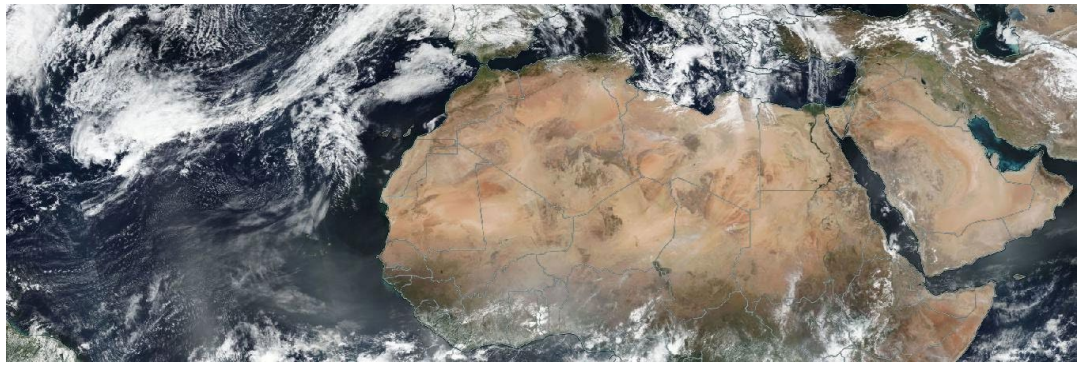
- Spectral aerosol optical depth (AOD)
- Ångström exponent (AE)
- Fine mode AOD fraction (over ocean)

Processed at full (~1 km) resolution, land and ocean

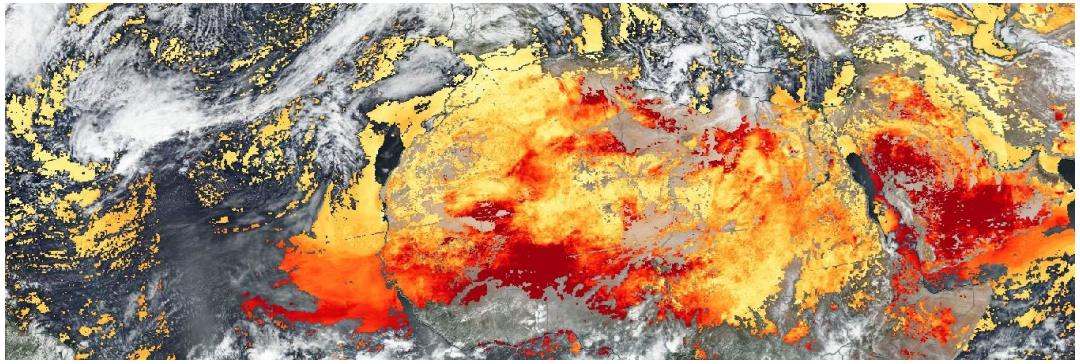
Deep Blue & Dark Target implemented; MAIAC in development

Latency <1 day (likely slower than MODIS/VIIRS)

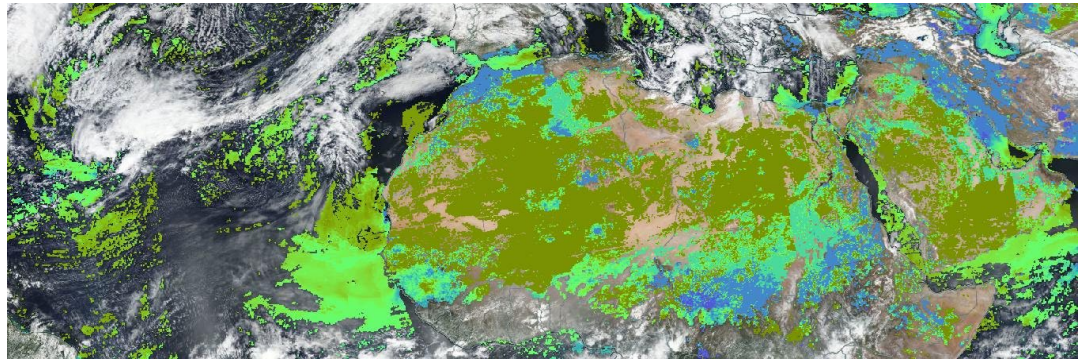
VIIRS
04 Mar 2020



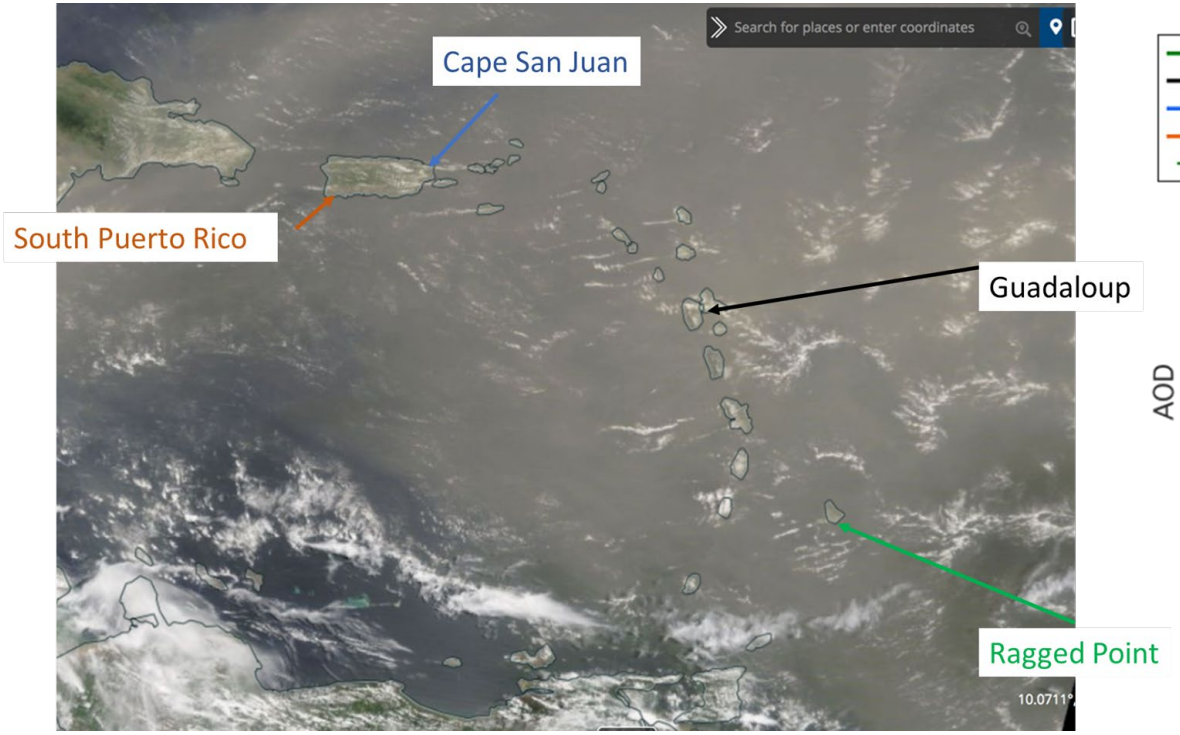
AOD
low high

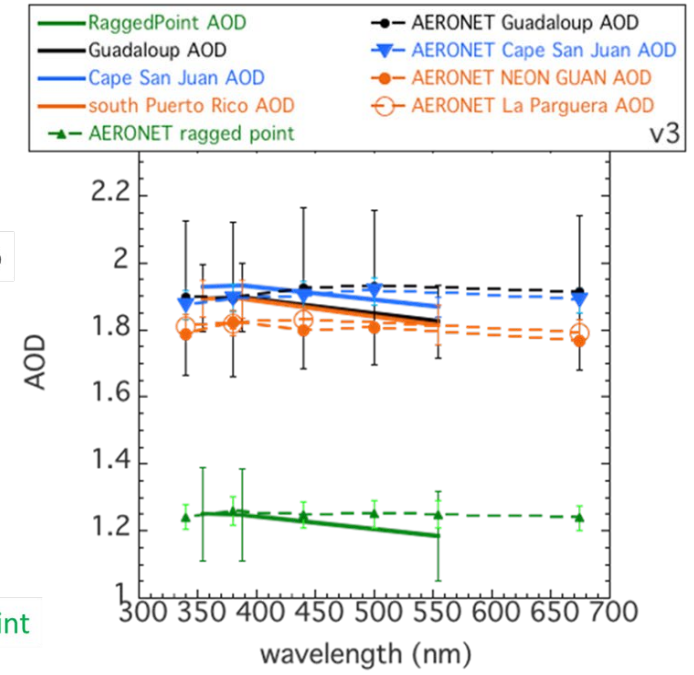


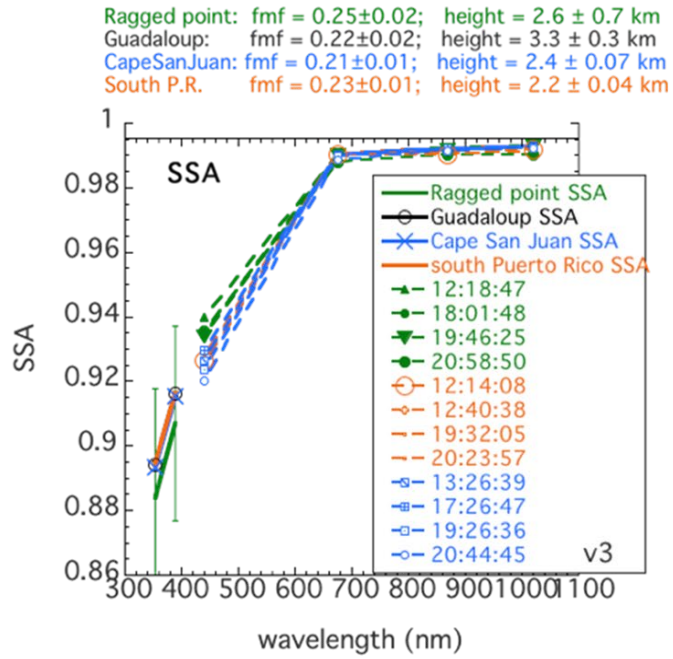
AE
low high



OCI aerosols in development (credit L. Remer et al., UMBC)







Combined UV-VIS observations allow retrieval of **aerosol absorption (SSA)**

Potential retrieval of **aerosol height** from UV-VIS and O_2 absorption channels

Polarimetry in development

- Multi-angle polarimetry provides **detailed aerosol optical** and **microphysical properties**
- Likely ~5 km resolution
- Several algorithms in development
- Processing and latency TBD

PACE Science Data Product Selection Plan
https://pace.oceansciences.org/documents.htm?id=memo

Simulated and proxy data
https://oceancolor.gsfc.nasa.gov/data/pace/test_-data/

Polarimetry in development

Algorithm name	Data source	Products	Coverage	Source	Status	Comments
RemoTAP	SPEXone	Aerosol loading & microphysics Surface properties	Land Ocean Above cloud	SPEXone instrument team, PI: Otto Hasekamp (SRON)	Testing within PACE science data system, simulated datasets	Hasekamp et al. ATBD for SPEXone RemoTAP Aerosol Processing, SRON, Utrecht, The Netherlands, SRON-SPEXoneL1-2020-02, issue: 0.90, 2020
FastMAPOL	HARP2	Aerosol loading & microphysics Ocean properties	Ocean	PACE Project Science, PI: Meng Gao (NASA GSFC)	Testing within PACE science data system, aircraft data	Gao et al, 2021, https://doi.org://10.5194/amt -2020-507
PACE-MAPP	SPEXone + HARP2 together	Aerosol loading & microphysics Ocean properties Cirrus cloud mask	Ocean	PACE Science Team, PI: Snorre Stamnes (NASA Langley)	Aircraft data, initial prototype code delivered	Stamnes et al., 2018, https://doi.org://10.1364/AO.57.002394

All are iterative, optimization-based retrievals of multiple aerosol parameters and byproducts

Computational expense mean that all the above use machine learning

- Forward model emulators, NOT machine learning inversion

1. PACE OCI will **extend and improve** on heritage (e.g. MODIS/VIIRS) aerosol data sets
2. Multi-angle polarimetry offers more **capable, detailed** aerosol characterization

What data latency is acceptable for routine AOD assimilation?

What would it take for additional quantities (spectral AOD, fine fraction, etc) to be assimilated?

How might you use polarimetry-based retrievals and what could we do to facilitate that?

What don't you like about EOS-era aerosol data that we could change?