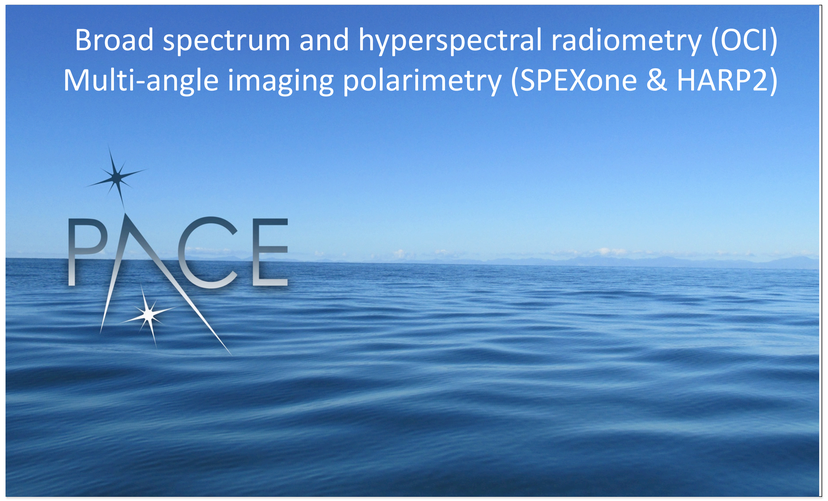
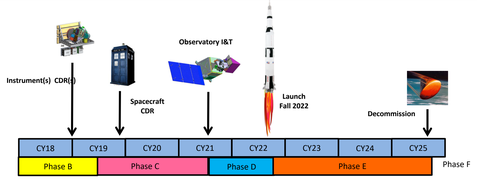
The PACE mission: New measurements for ocean and atmospheric science: Focus on aerosols and particulates

Lorraine A. Remer (UMBC JCET), Emmanuel Boss (U. Maine), Olga Kalashnikova (NASA JPL), Feng Xu (NASA JPL), Anthony Davis (NASA JPL), J. Vanderlei Martins (UMBC), Otto Hasekamp (SRON), Ali Omar (NASA Langley) , Maria Tzortziou (CUNY)



The Plankton, Aerosol, Cloud, ocean Ecosystem Mission

Key Mission Elements	
Mission management	NASA Goddard SFC
Ocean Color Instrument	NASA Goddard SFC
HARP2 polarimeter	U. Maryland Baltimore County
SPEXone polarimeter	SRON (Netherlands)
Spacecraft/Mission Ops	NASA Goddard SFC
Science data processing	Ocean Biology Processing Group
Competed science teams	NASA Earth Sciences Division



Key Mission Features	
Cost	Directed, DTC, $805M
Life	3-yr, Class C, 10-yr fuel
Orbit	676.5 km, Sun sync, 1-pm MLT AN
Coverage (OCI)	2-day global
RF Communication	Ka direct to ground, 600Mbps

Key Mission Science Requirements

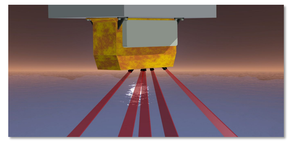
- Ground sample distance of 1 ± 0.1 km^2 at nadir
- Sun glint mitigation (OCI tilt ± 20^o)
- OCI spectral range from (320) 350-865 nm @ 5 nm resolution
- OCI with 940, 1038, 1250, 1378, 1615, 2130, 2260 nm bands
- Twice-monthly lunar calibration
- Onboard solar calibration (daily, monthly, dim)
- A vicarious calibration system
- Core data products, uncertainties, & a validation program

Two small contributed polarimeters

Spectro-Polarimeter for Planetary Exploration (SPEXone)

Contribution from the Netherlands (SRON, NSO, Airbus; TNO optics)

POC: Otto Hasekamp

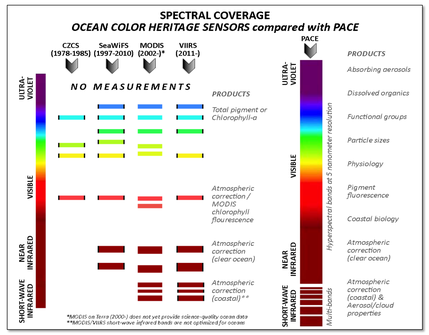


Hyper Angular Rainbow Polarimeter (HARP-2)

Contribution from University of Maryland Baltimore County

POC: Vanderlei Martins

Broad spectrum and hyperspectral radiometry



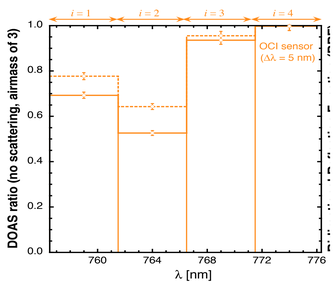
OCI (Ocean Color Instrument)

- Wide swath
- 1 km resolution
- Hyperspectral (5 nm resolution)
- UV through the nearIR
- 8 discrete channels in the SWIR.
- Both 2130 and 2250 nm.

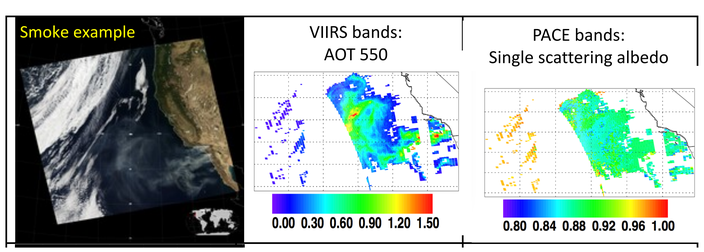
For aerosol retrievals… MODIS/VIIRS plus OMI at 1 km resolution.

New aerosol capabilities:

- Aerosol absorption when over ocean.
- Layer height from Oxygen-A band



Davis and Kalashnikova

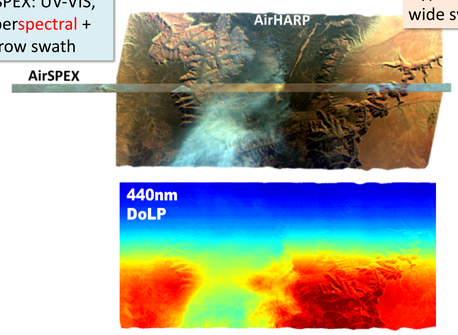


Mattoo and Remer

Synergistic polarimetric measurements

AirSPEX: UV-VIS, Hyperspectral + narrow swath

AirHARP: VIS-NIR, Hyperangular + wide swath



RGB image from instrument-measured intensity. Narrow AirSPEX image along center line of wide swath AirHARP.

Corresponding AirHARP of DoLP for the same scene. Note smoke creates pertubation from background Rayleigh signature in the polarization field.

Co-located imagery from airborne versions of SPEX and HARP flying on the NASA ER-2
Courtesy of J. Vanderlei Martins (UMBC)

PACE will provide better air quality info

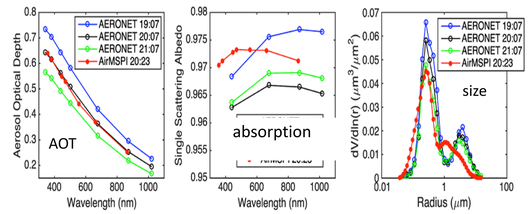
- Air quality is one of six identified PACE applications areas
- Enhanced capabilities from all three PACE sensors will better characterize aerosol particles from space
- New characterization includes quantified particle absorption, size, shape and layer height
- At 1-5 km spatial resolution across a broad swath (nearly daily coverage).
- PM derivations from PACE data will be much better constrained than is currently possible from MODIS or VIIRS
- PACE encourages collaboration between atmospheric and oceanic communities
- Because most of the world's population lives in coastal areas, better understanding and characterization of the near-shore ocean optical properties possible with PACE will also improve aerosol retrievals near these population centers.
- The PACE applications team (Ali Omar and Maria Tzortziou) have prepared materials addressing PACE's role in air quality.

- https://pace.oceansciences.org/applications.htm

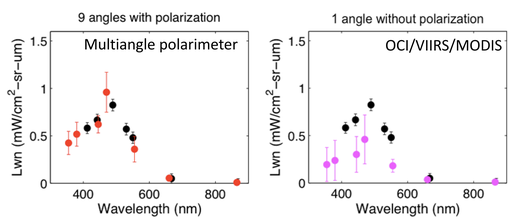
Why polarimetry?

Multi-angle polarimetry allows expanded characterization and better accuracy of aerosol and cloud retrievals.

Red line is polarimeter retrieval. Other colors are AERONET ground-truth



…. And more accurate atmospheric correction



Black dots: ground truth
Colored dots: retrieval

Absorption retrievals with these wavelengths require polarimetry. Angles alone are insufficient.

All polarimeter retrievals in this section are from AirMSPI, a precursor to the MAIA mission. They are provided by the JPL team: D. Diner, O. Kalashnikova, F. Xu, M. Garay