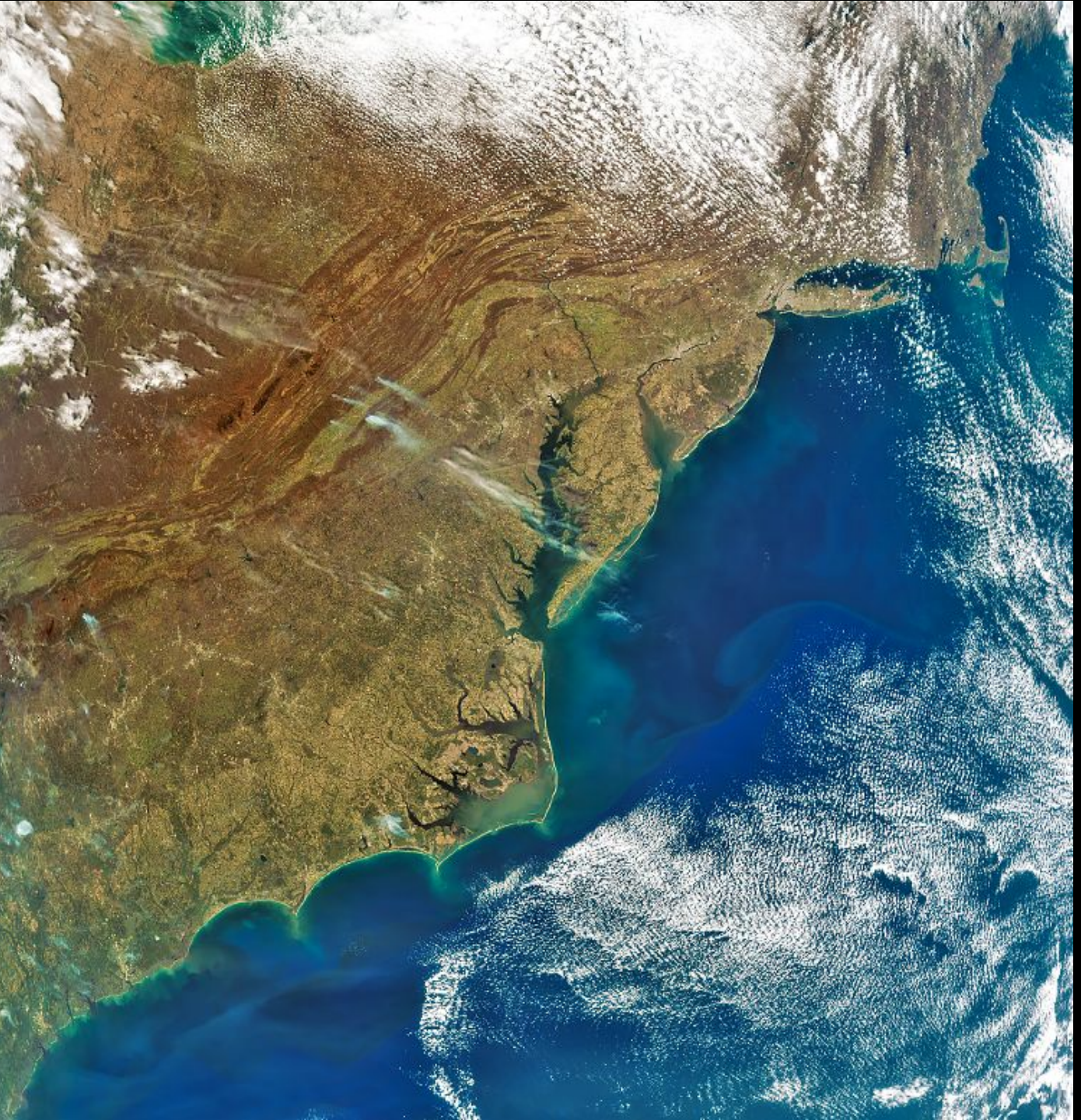
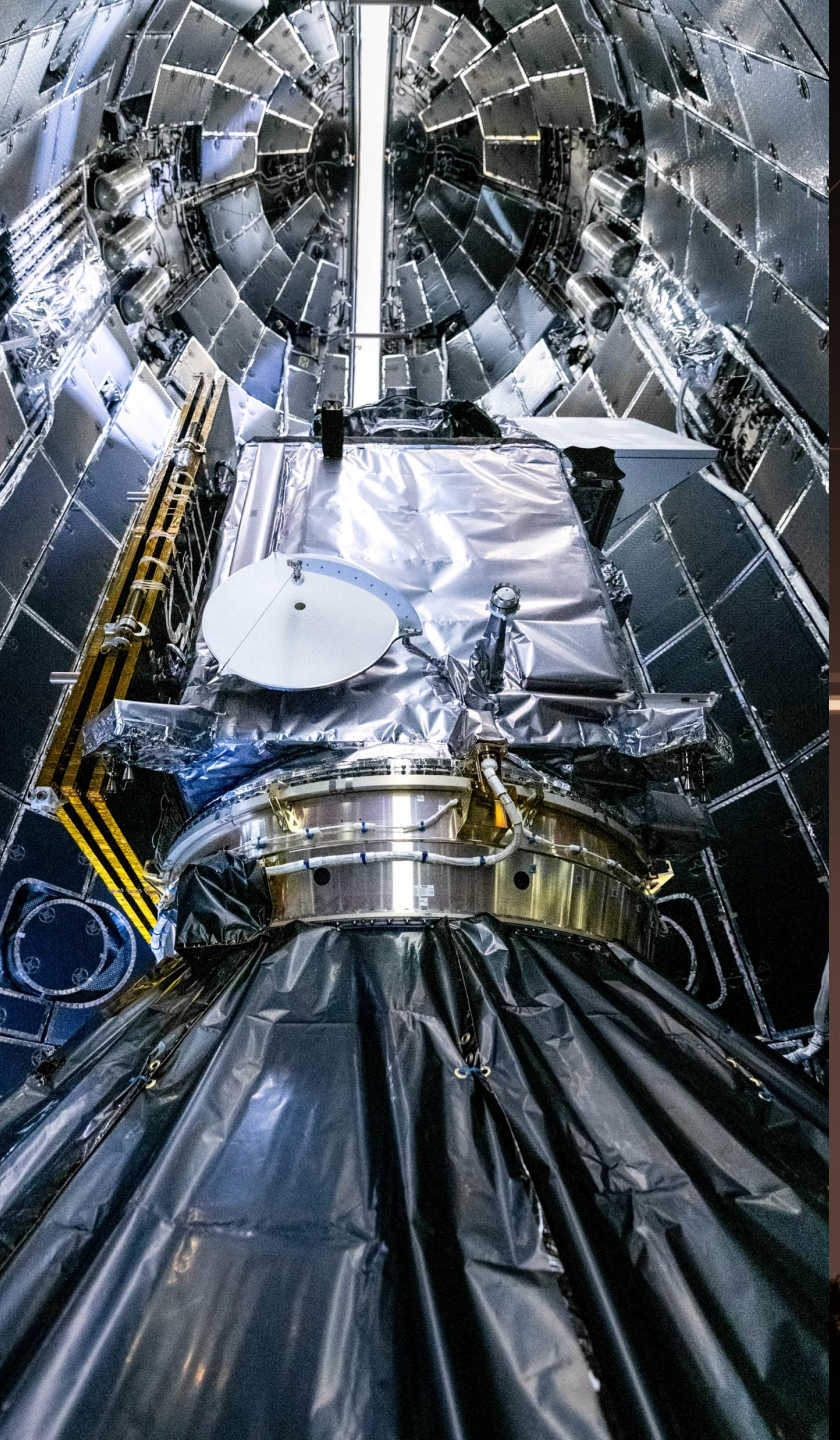


Can We Even Observe Microphysics? Experience from PACE polarimeter retrievals

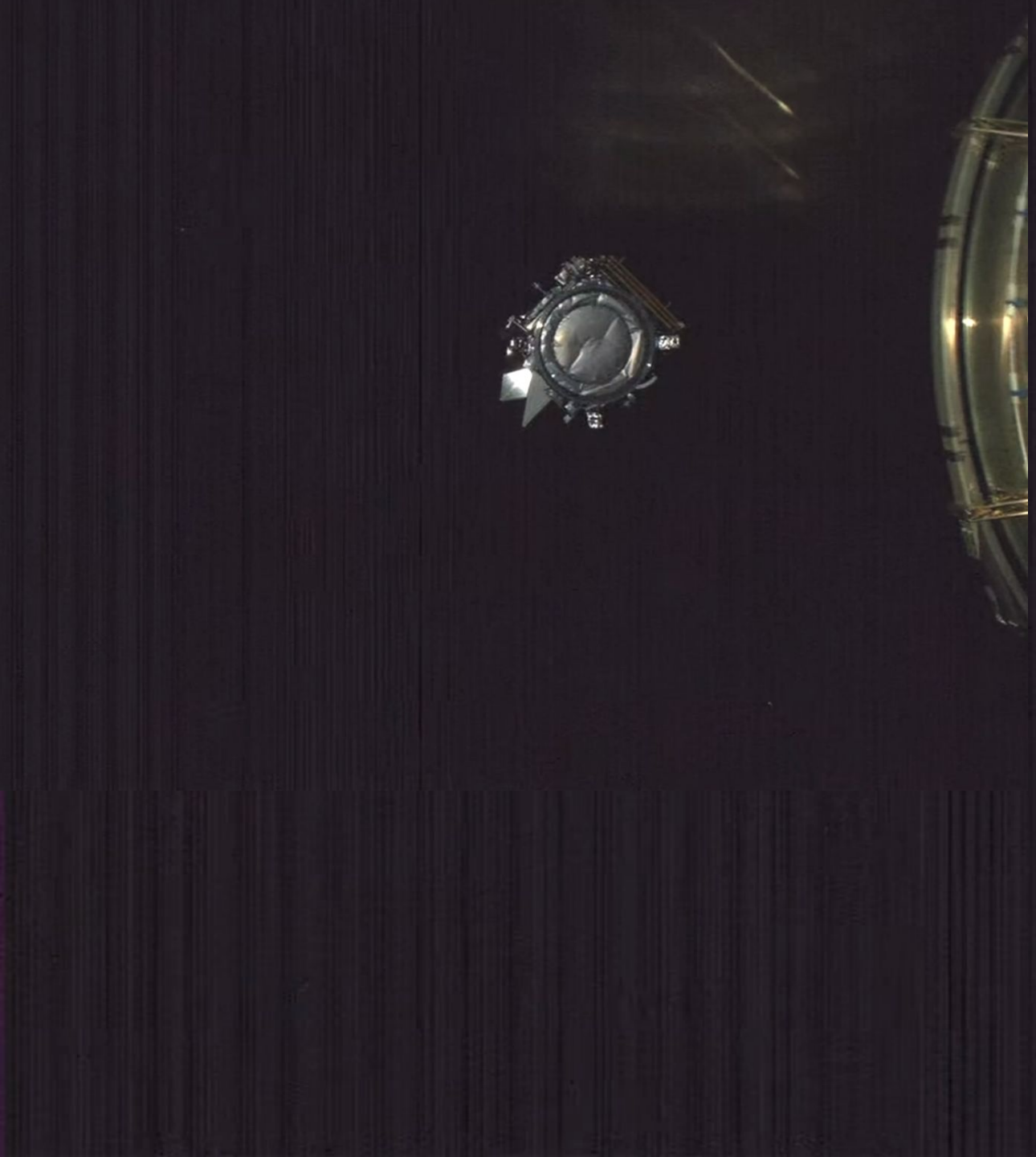
Meng Gao (SSAI/NASA GSFC)
on behalf of the PACE team
(Kirk Knobelspiesse, Bryan Franz, Pengwang Zhai, Kamal Aryal, Jeremy Werdell, Morgaine McKibben, et al)

US CLIVAR Micro2Macro: Origins of Climate Change Uncertainty Workshop, Oct 28-30, 2024

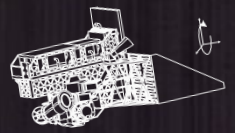
PACE | NASA | GODDARD EARTH SCIENCES



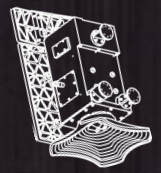

Feb 8 this year



Feb 8 this year

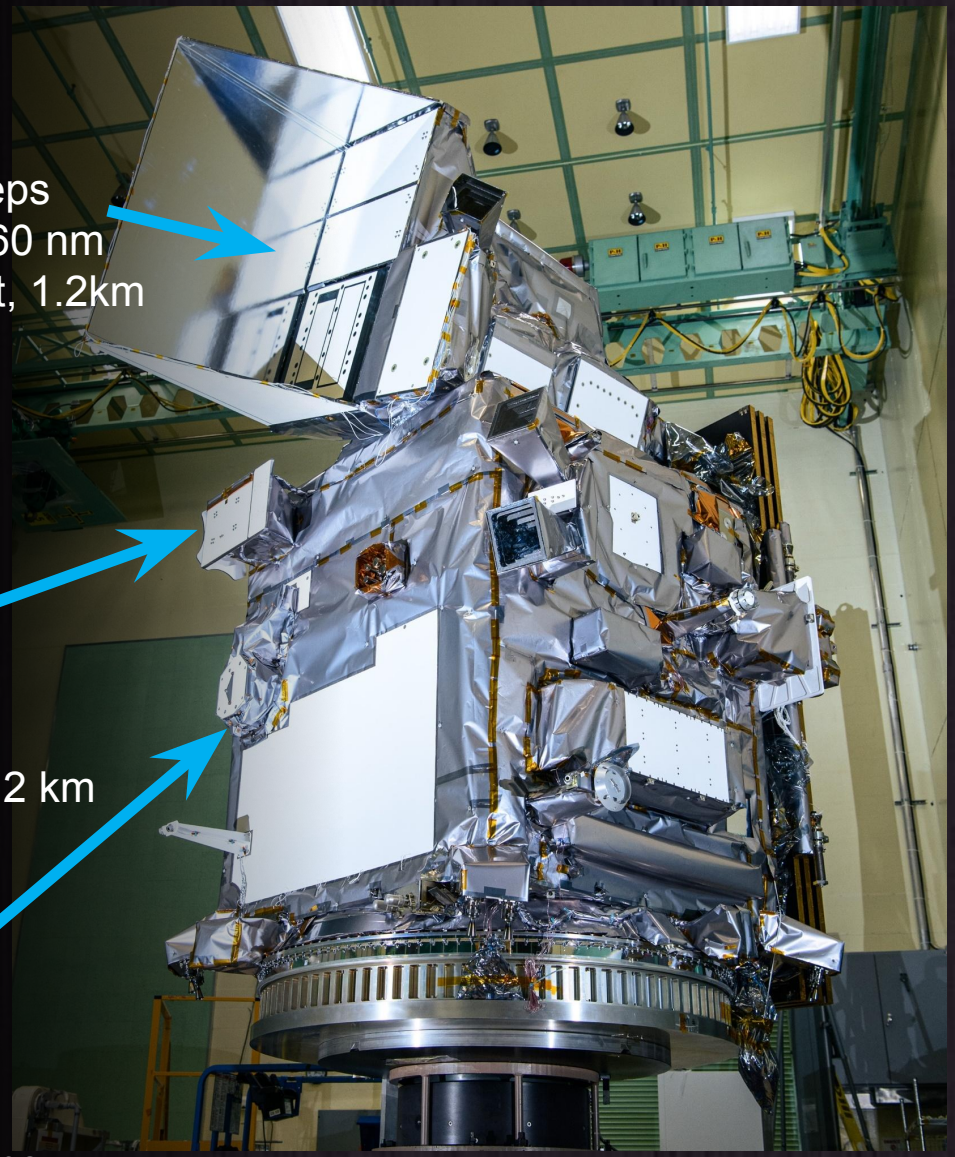


OCI
340-890 nm in 2.5 nm steps
7 discrete SWIR, 940-2260 nm
1-2 day coverage ±20° tilt, 1.2km

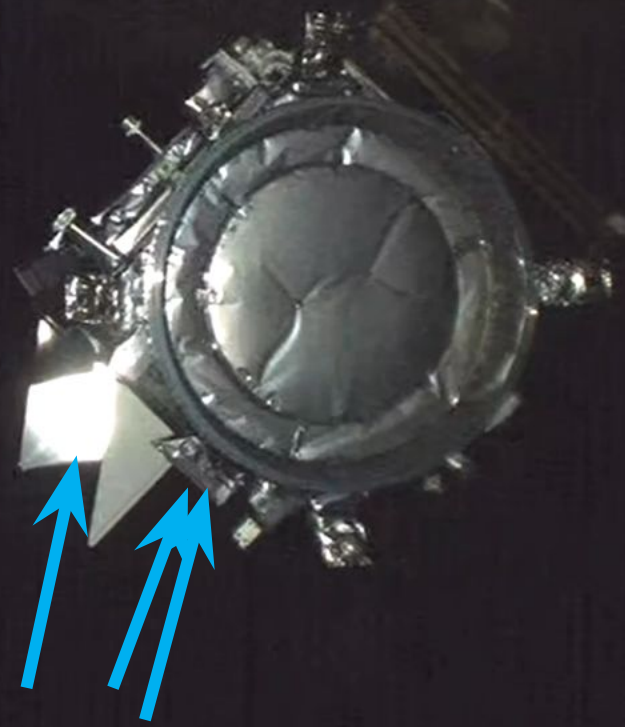


HARP2 (UMBC)
440, 550, 670, 870 nm
10-60 viewing angles
wide swath polarimeter, 5.2 km

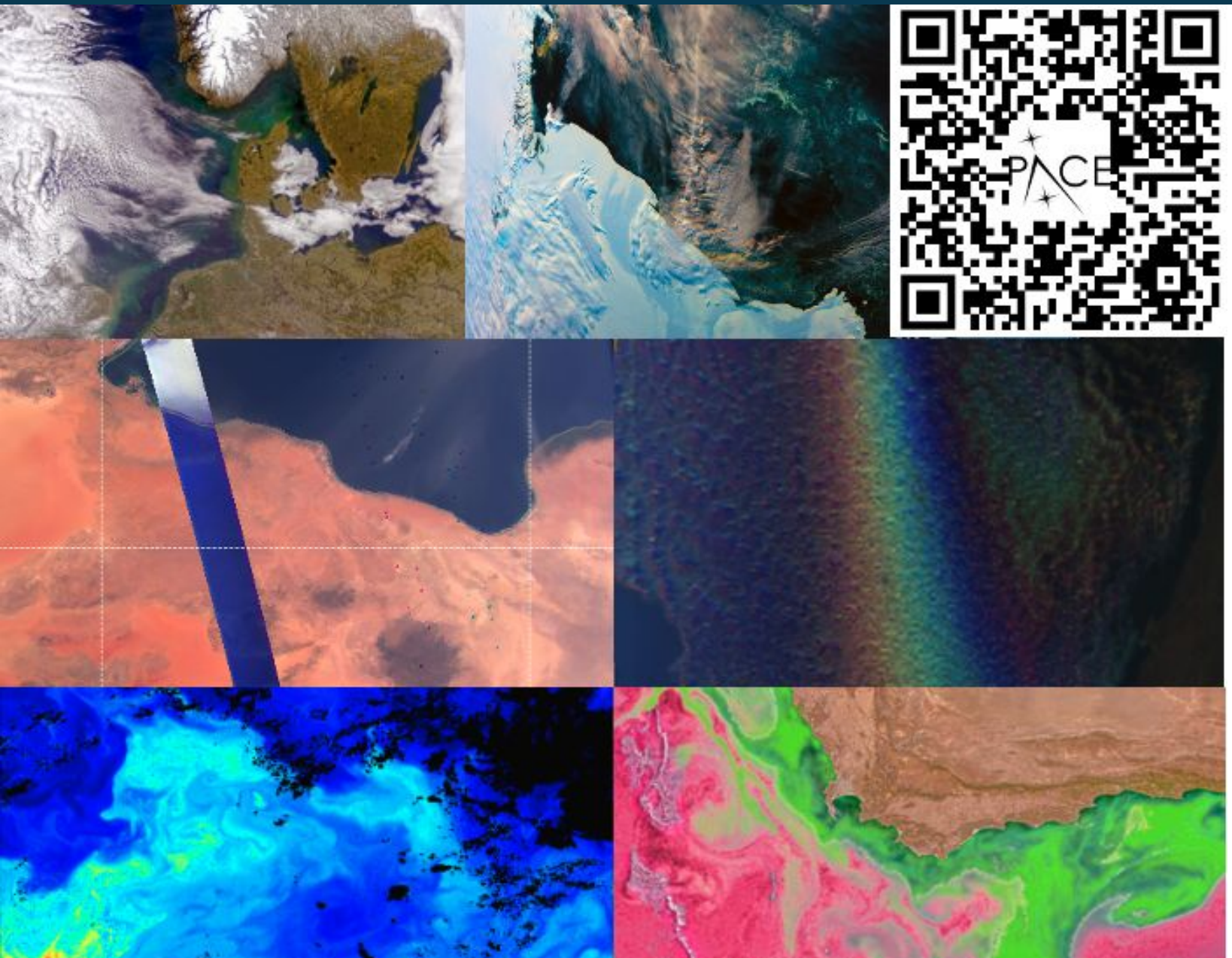
SPEXone (SRON)
380-770 nm in 2-4 nm steps
5 viewing angles
narrow swath polarimeter, 5.2 km



Feb 8 this year



Initial data released on 11 Apr 2024



V1 initial release

- Level-1 (radiometry) from all 3 instruments
- Heritage suite of Ocean Color products from OCI

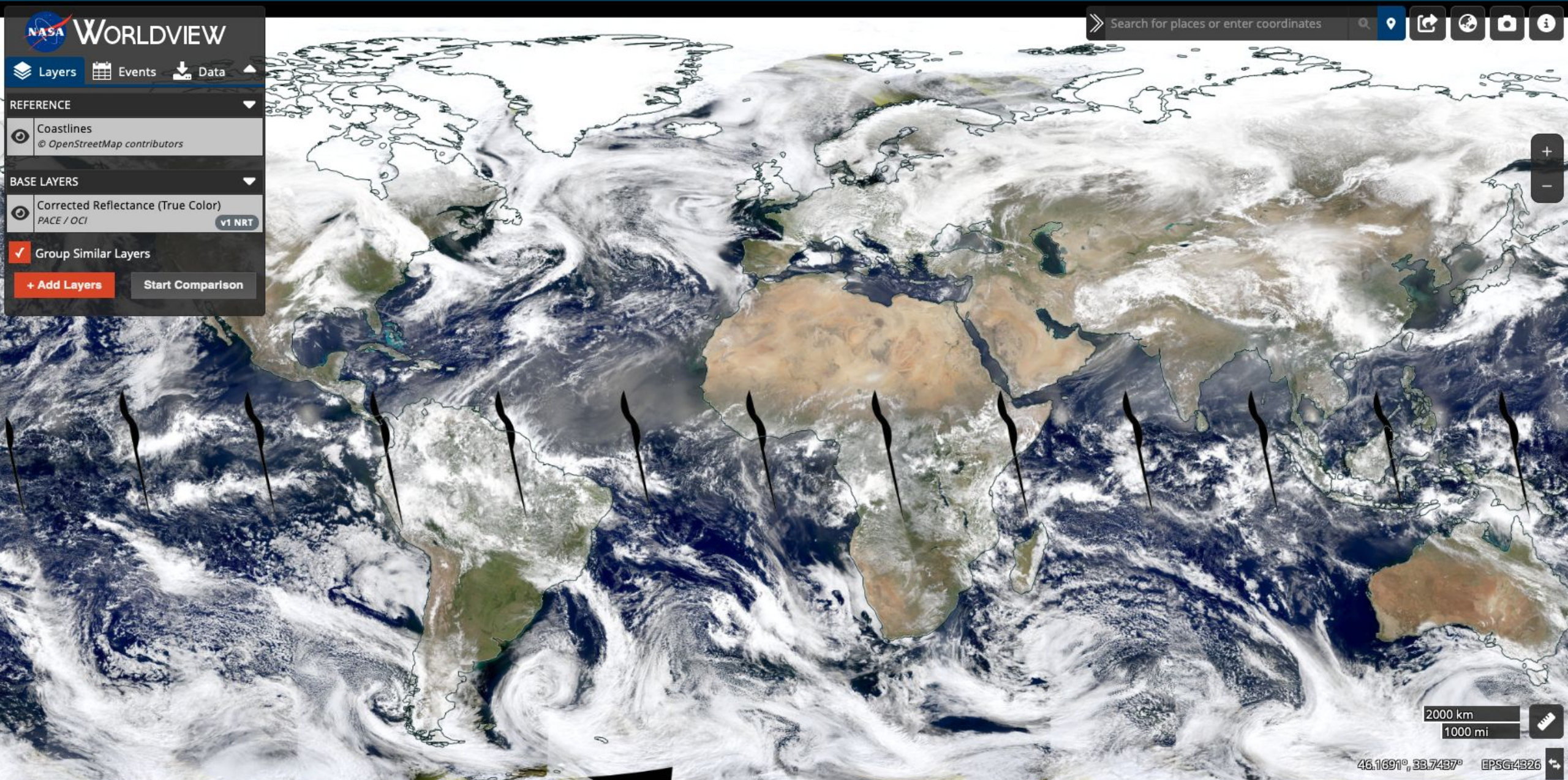
V2 reprocessing

- Use on-orbit calibration information
- Provide science mode data collected during commissioning
- Additional science products from OCI (Land and Clouds)

V3 reprocessing planned

- Further **calibration** updates
- More data products to be released pending review by Project and PIs

PACE data on NASA Worldview



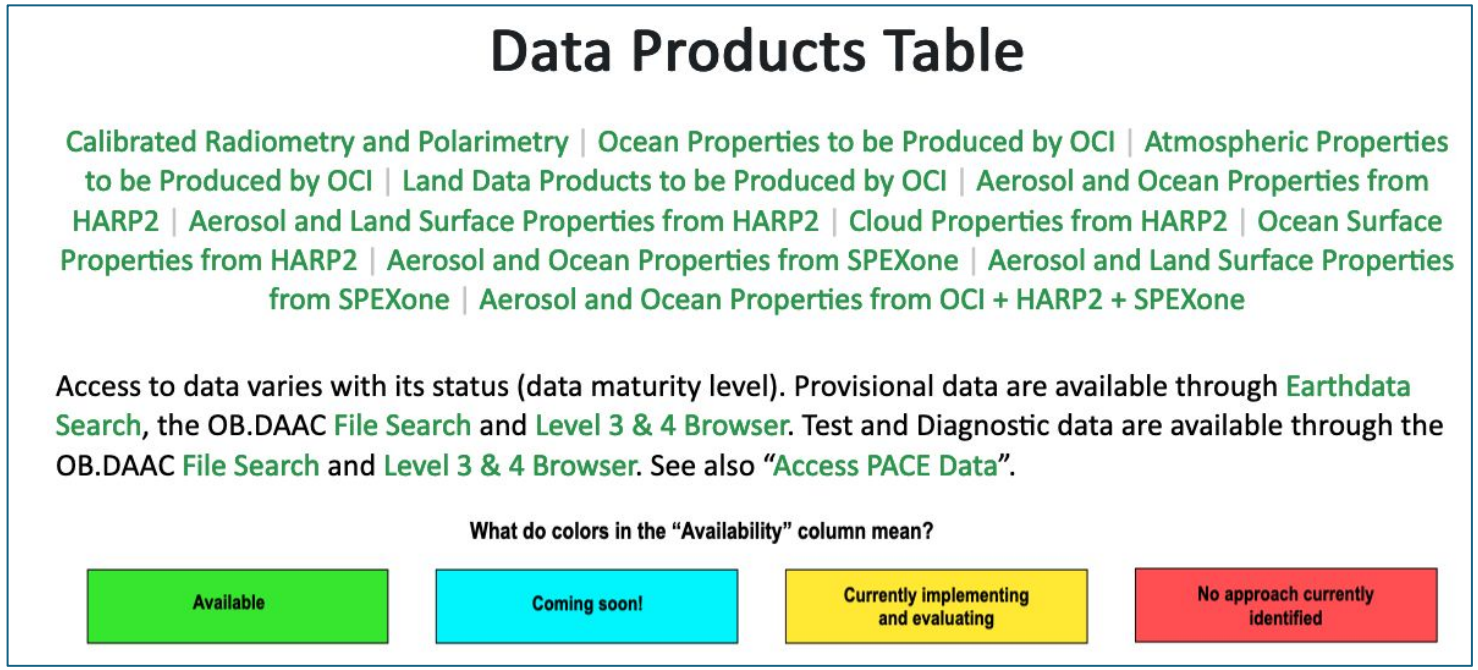
PACE polarimeter Level 2 aerosol data processing

Data product (coming soon):

- Fine/coarse mode AOD, SSA, etc
- Fine/coarse mode size, complex refractive index, etc
- Aerosol layer height
- Surface properties

Processing algorithms:

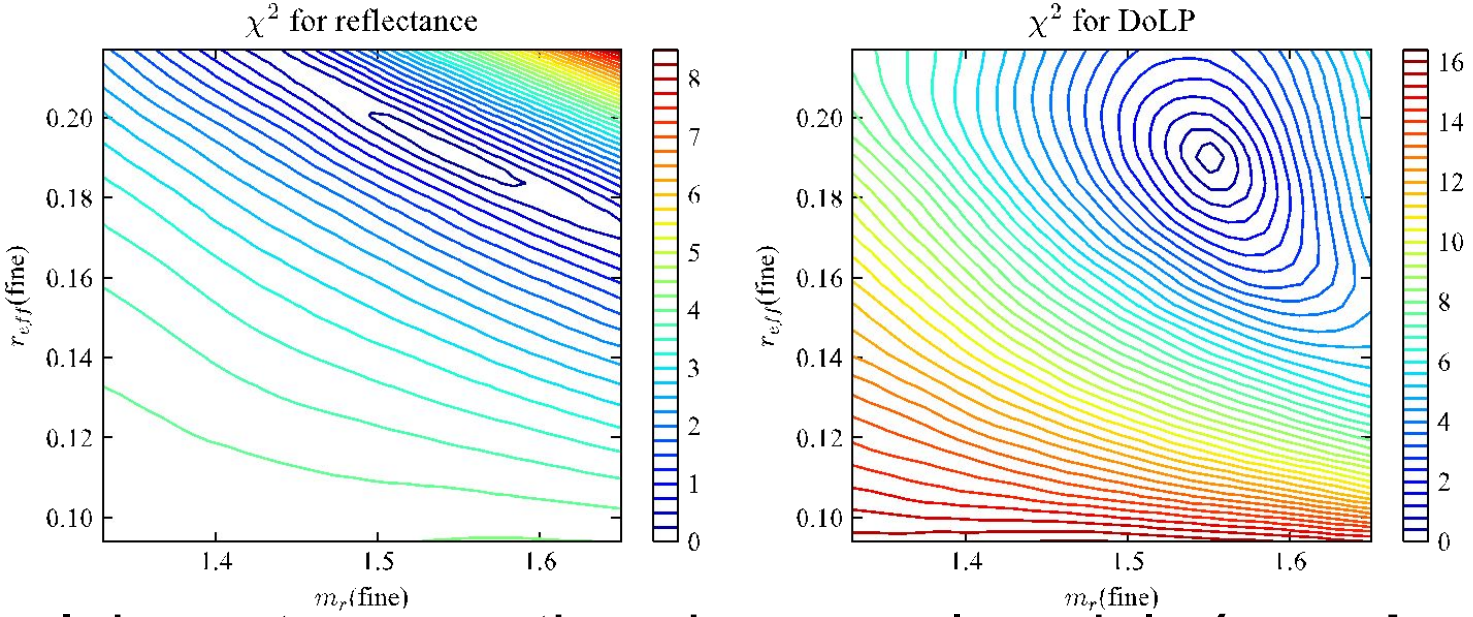
- RemoTAP (SRON)
- MAPP (LaRC)
- GRASP (UMBC)
- FastMAPOL (GSFC)



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

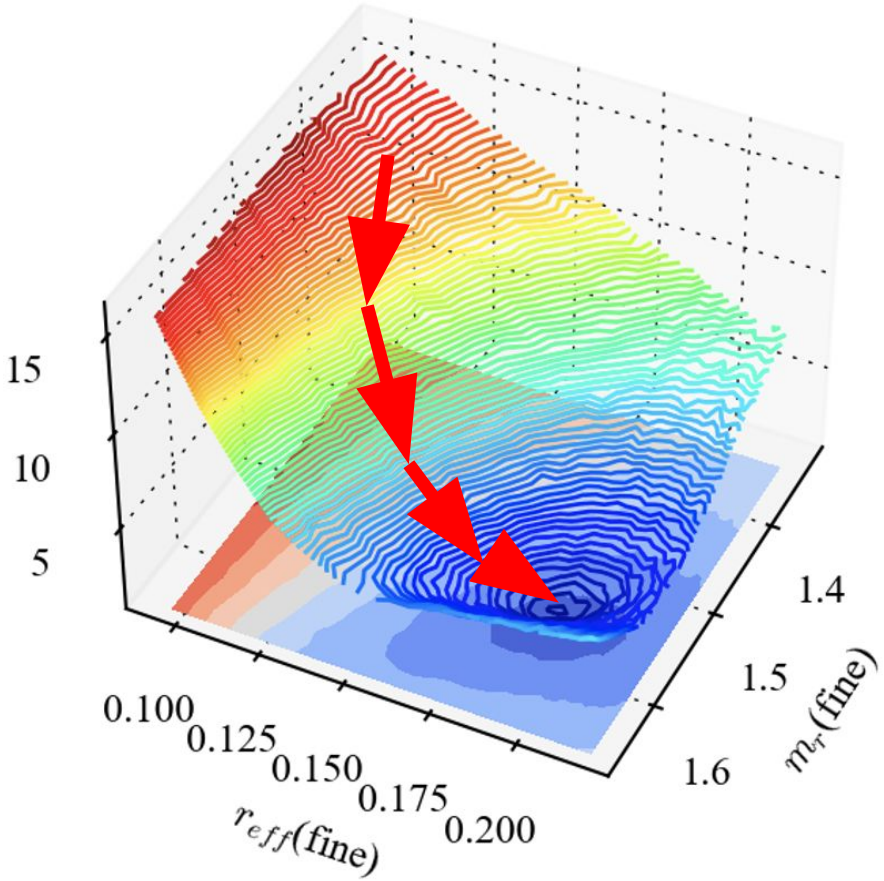
Promises and challenges of polarimetric retrievals

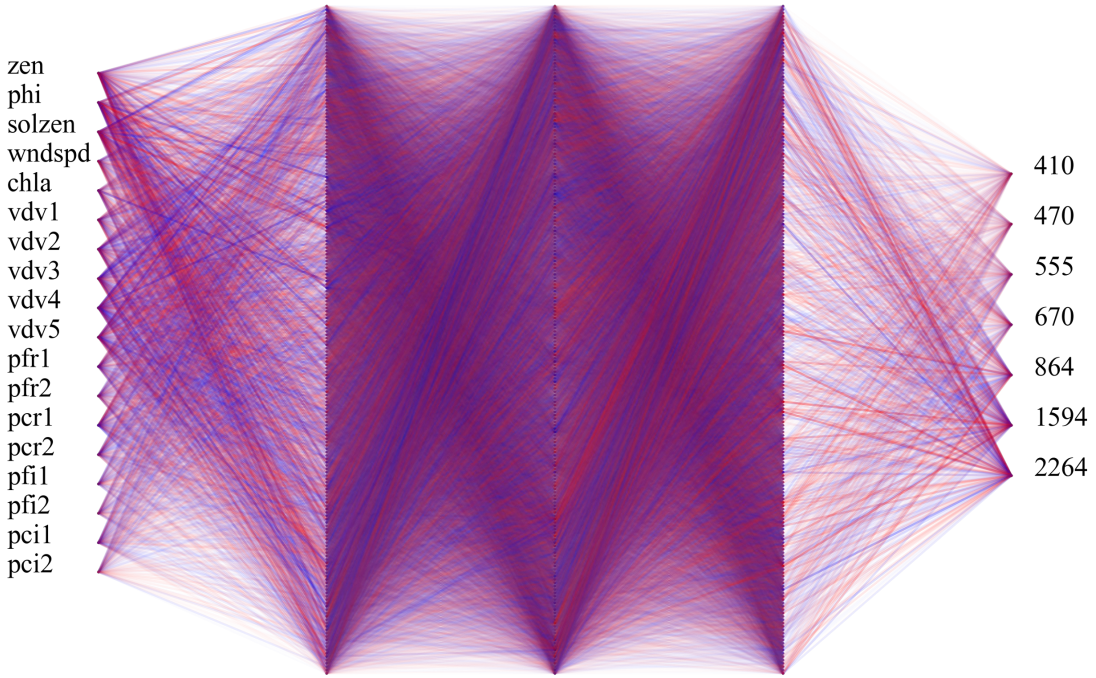
- Improve aerosol optical and microphysical property retrievals



- Inherent assumptions in aerosol models **(ongoing, welcome feedback)**
  - Aerosol size distribution optimized through observations (Gao et al 2018)
  - Pre-defined aerosol types with size and refractive index dependency (Aryal et al 2023)
  - Assumptions in aerosol shape: spheres, spheroid (Dubovik et al 2006), irregular hexahedron (Saito et al 2021)
- **Challenges in retrieval speed, accuracy & uncertainty analysis**

FastMAPOL as a testbed for PACE polarimeter retrievals



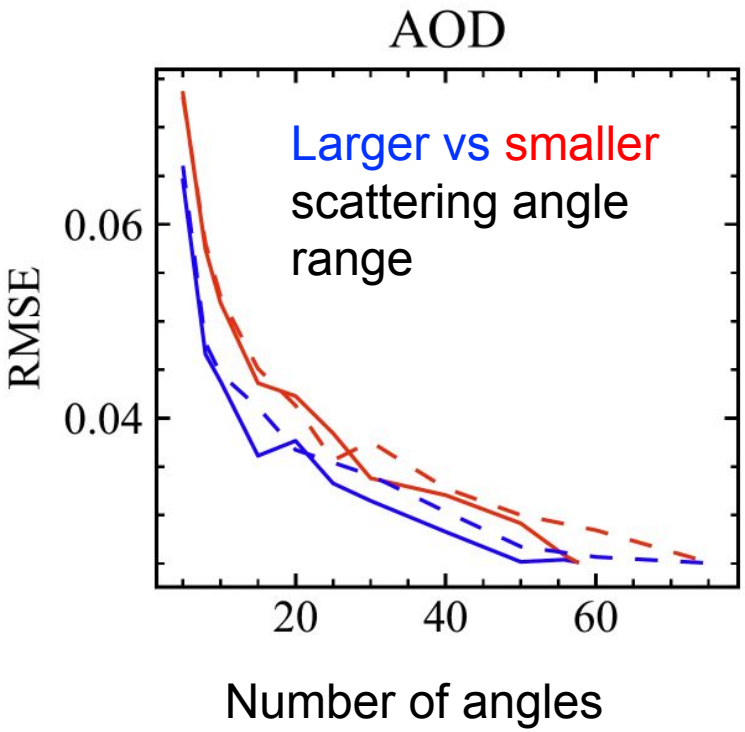


- Coupled atmosphere and ocean radiative transfer model (Zhai et al 2022)
- Fast and accurate forward model and Jacobians with neural networks
- Simultaneous aerosol and ocean property retrieval (Gao et al 2021-2023, Aryal et al 2023)

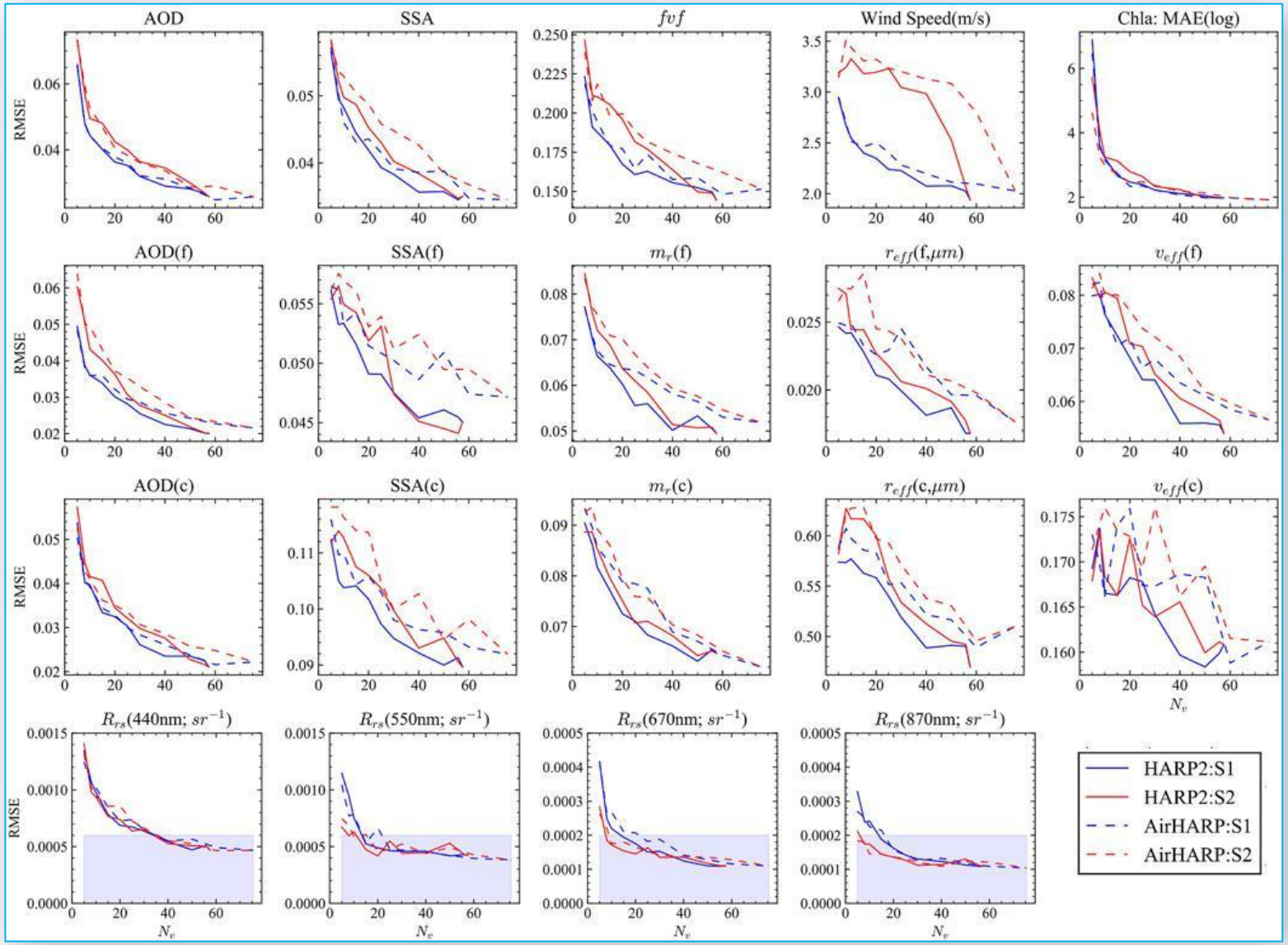
https://doi.org/10.5194/amt-14-4083-2021

FastMAPOL

Retrieval uncertainty vs number of input angles

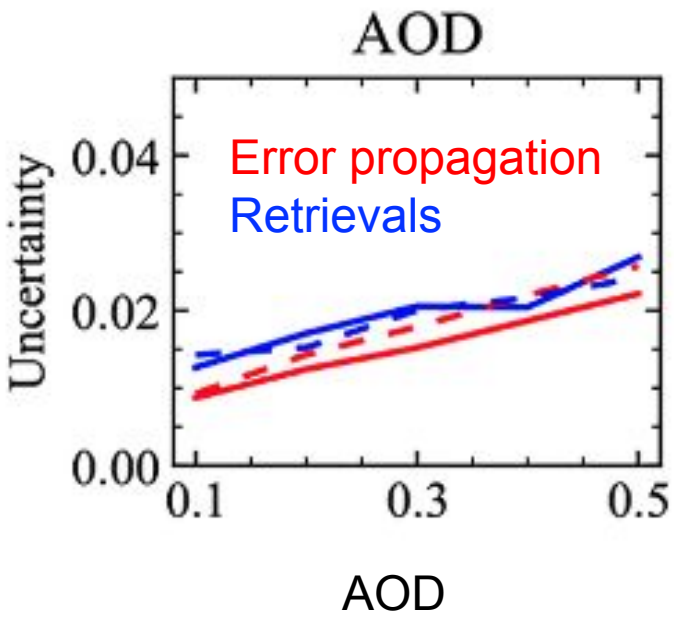


Adaptive multi-angle data screening based on fitting performance.

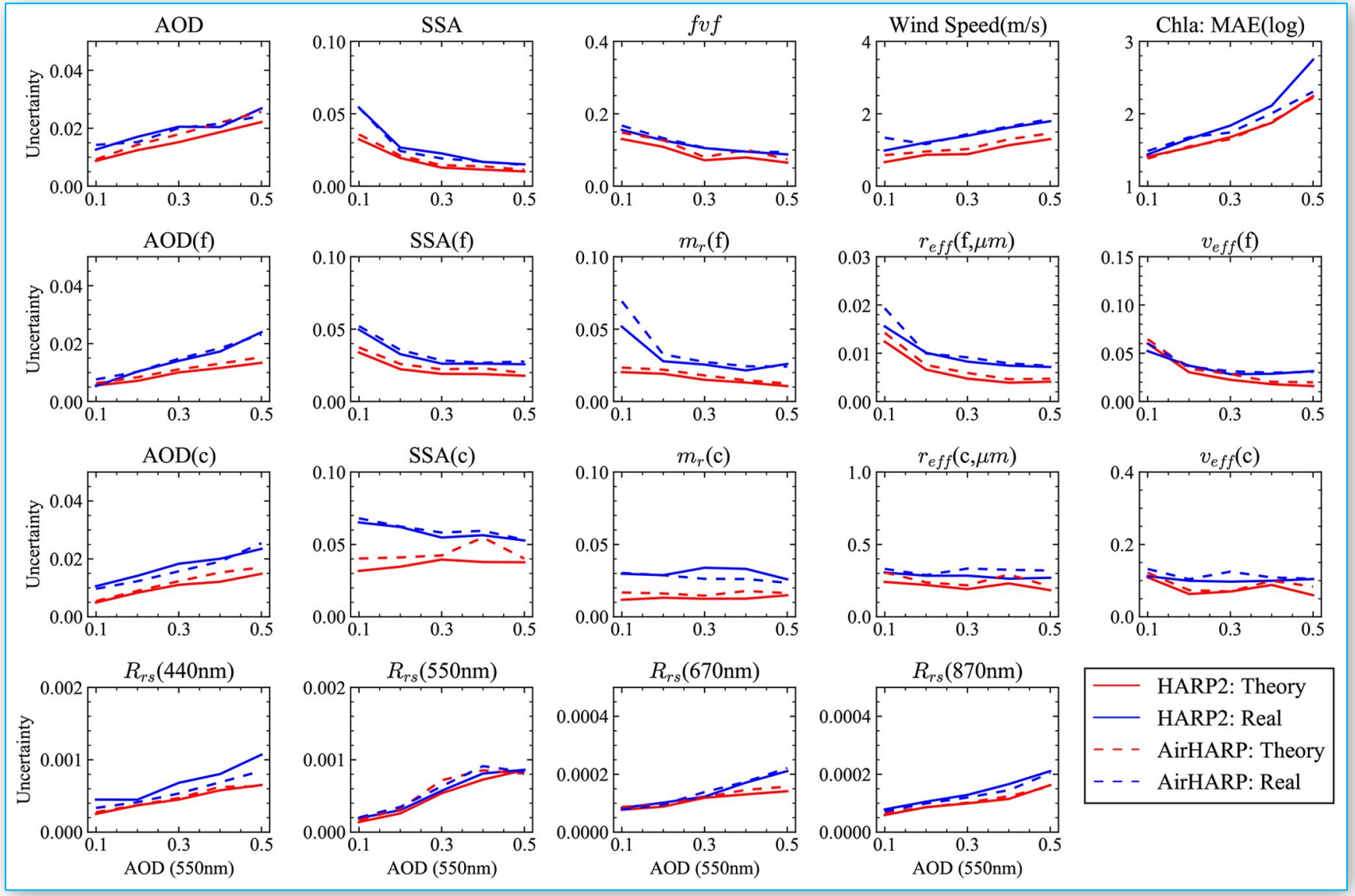


https://doi.org/10.3389/frsen.2021.757832

Retrieval uncertainty vs aerosol loadings

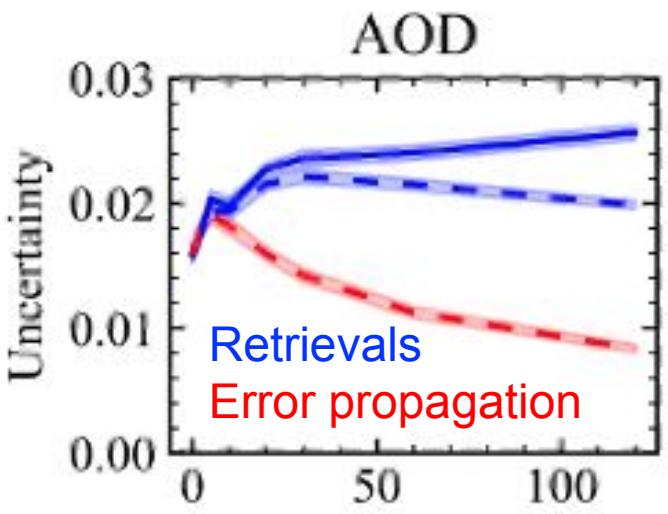


Pixel-wise retrieval uncertainties can be well described by error –propagation.



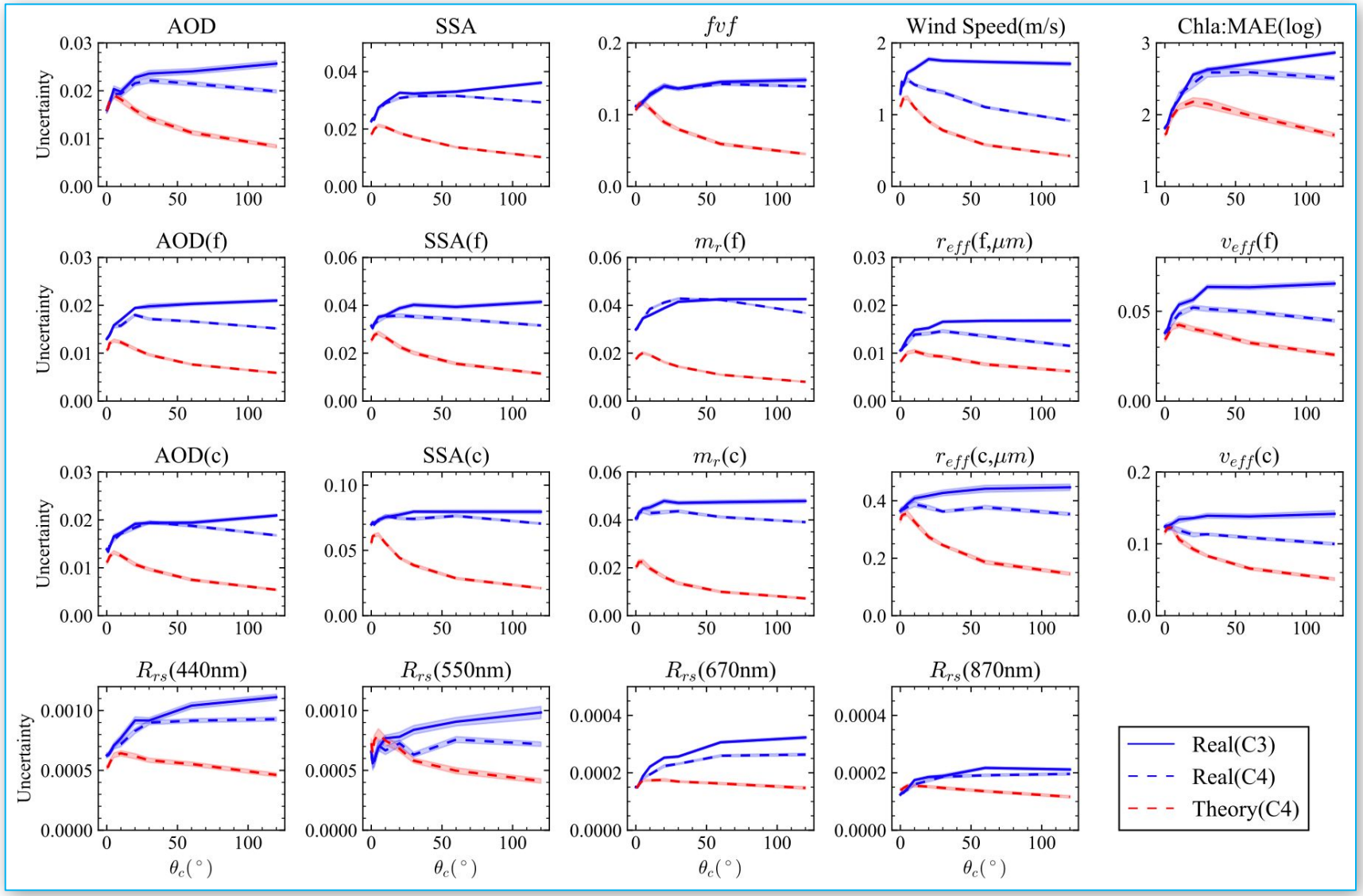
https://doi.org/10.5194/amt-15-4859-2022

Retrieval uncertainty vs angular noise correlations



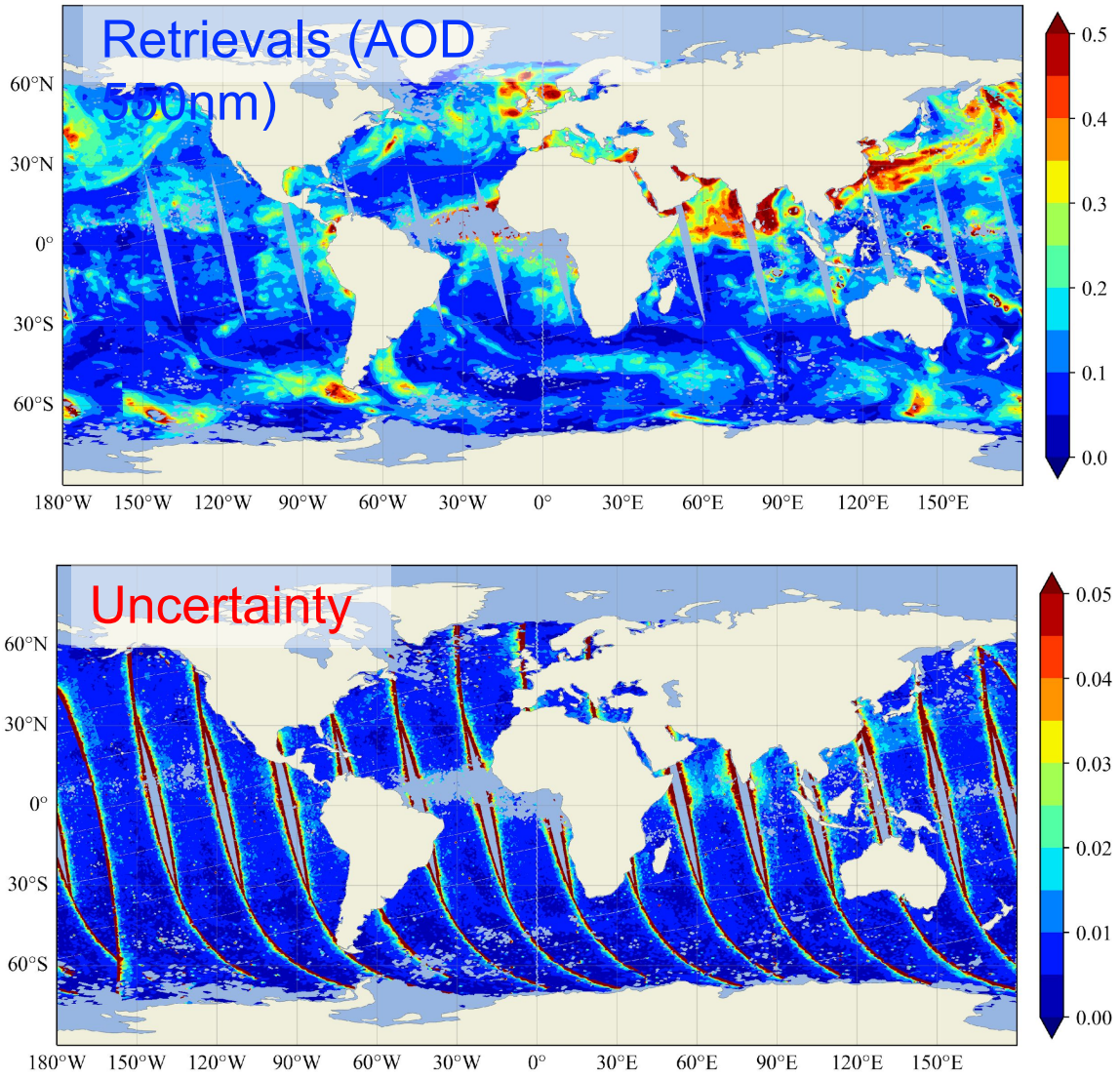
correlation strength

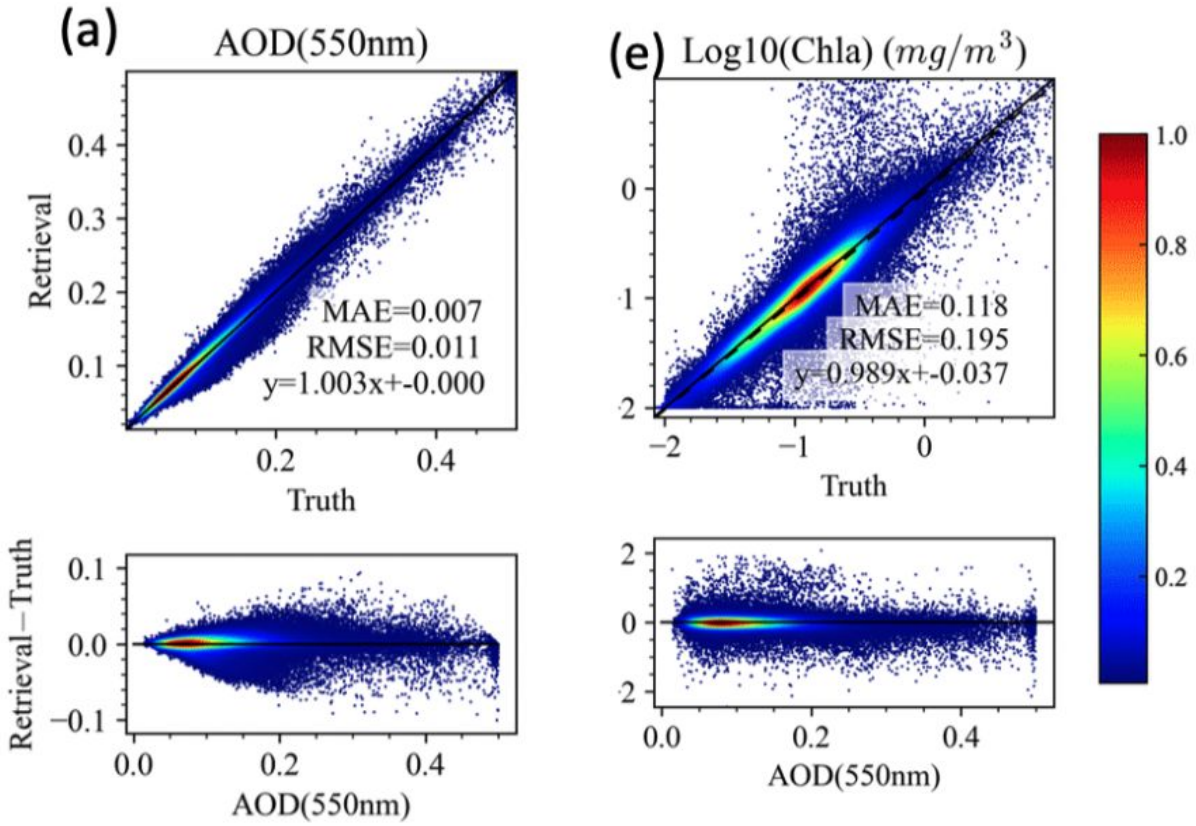
Optimal performance requires full error covariance matrix including angular noise correlations.



https://doi.org/10.5194/amt-16-2067-2023

Uncertainty analysis based on global simulation

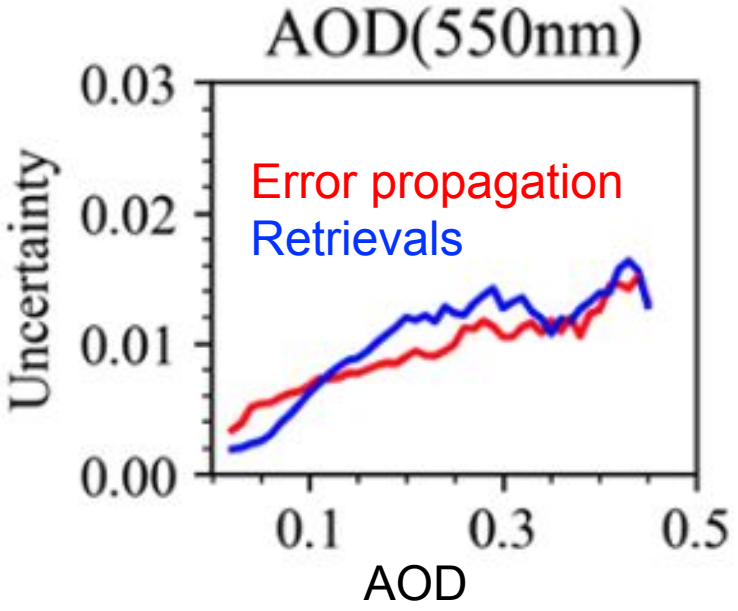




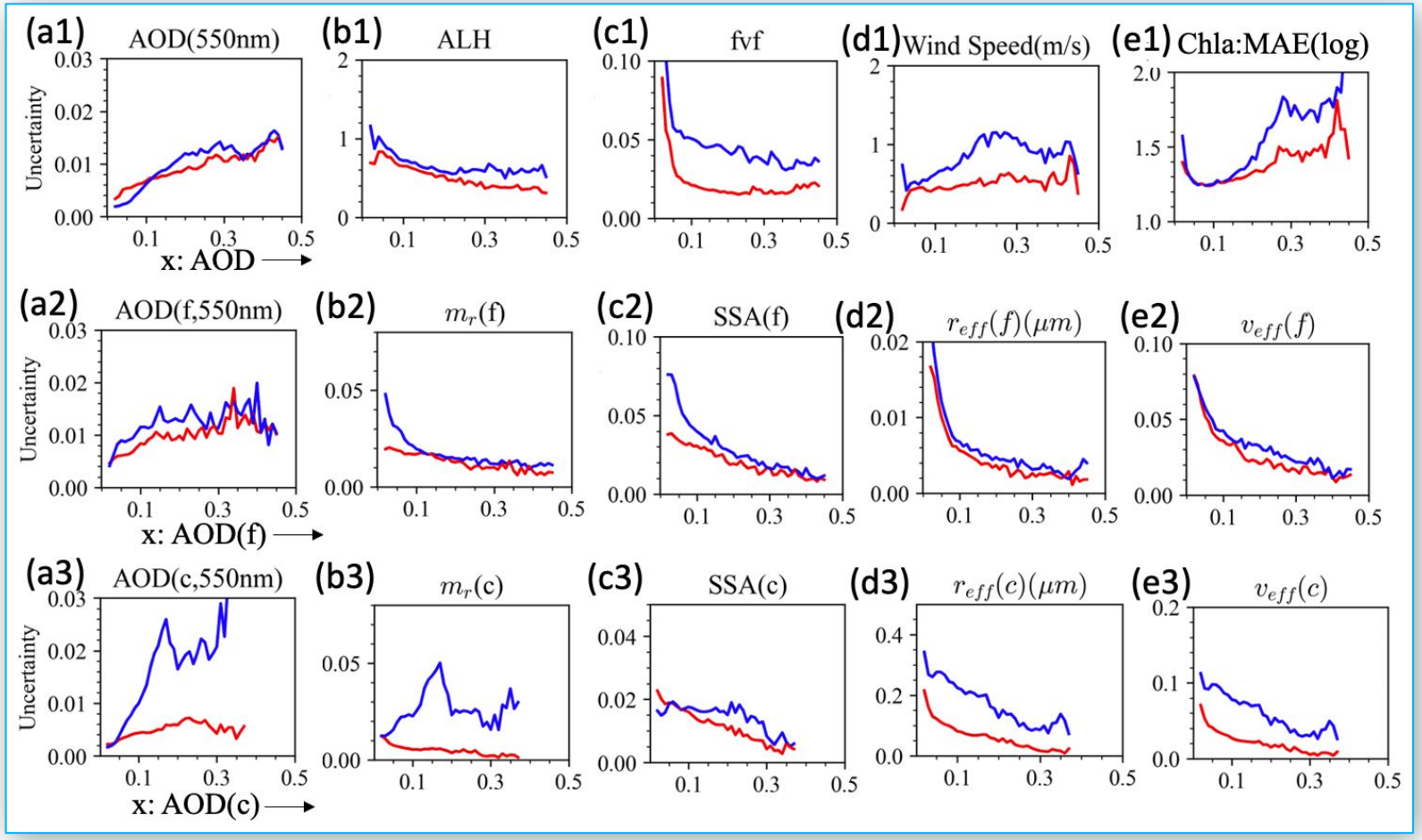
Data available from NASA OB.DAAC.

https://doi.org/10.5194/amt-16-5863-2023

Uncertainty analysis based on global simulation



More realistic uncertainty evaluation based on realistic global simulation using MERRA2 aerosol as inputs.



https://doi.org/10.5194/amt-16-5863-2023

HARP2 AOD retrieval time lapse

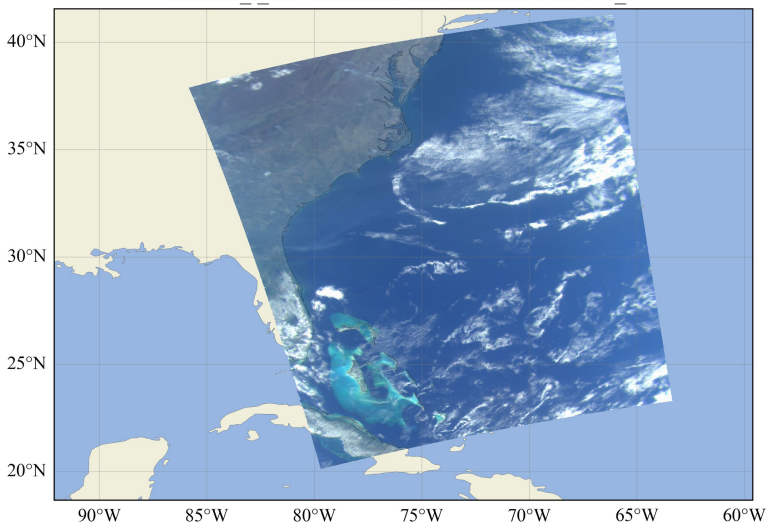
AOD(550nm) from April-May 2024

Optical and microphysical retrievals

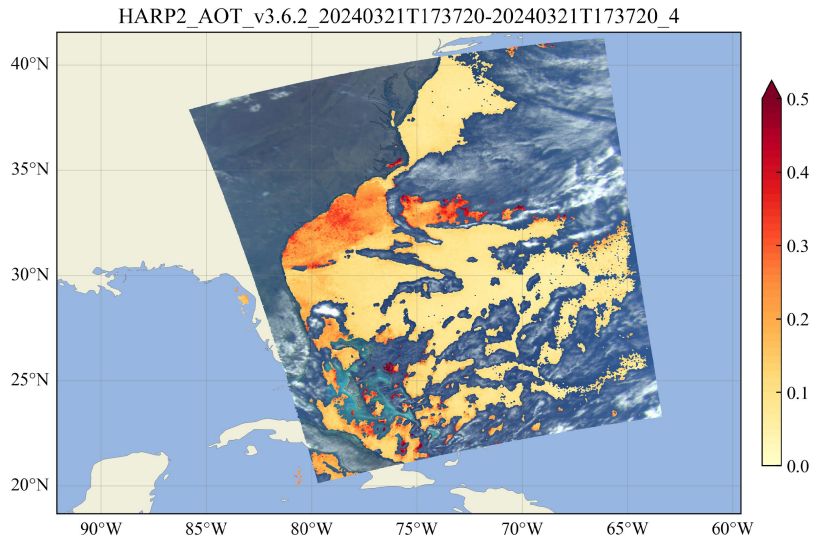
AOD(550nm)

FVF

HARP2_i_20240321T173720-20240321T173720_3



HARP2_AOT_v3.6.2_20240321T173720-20240321T173720_4



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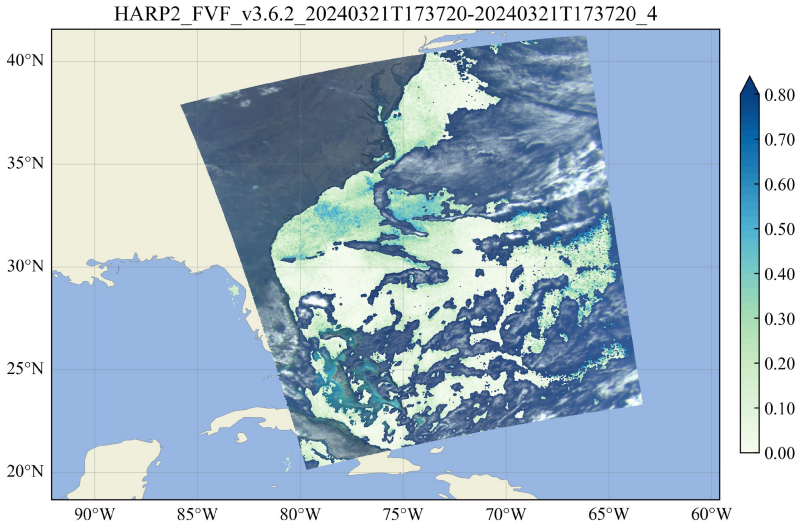

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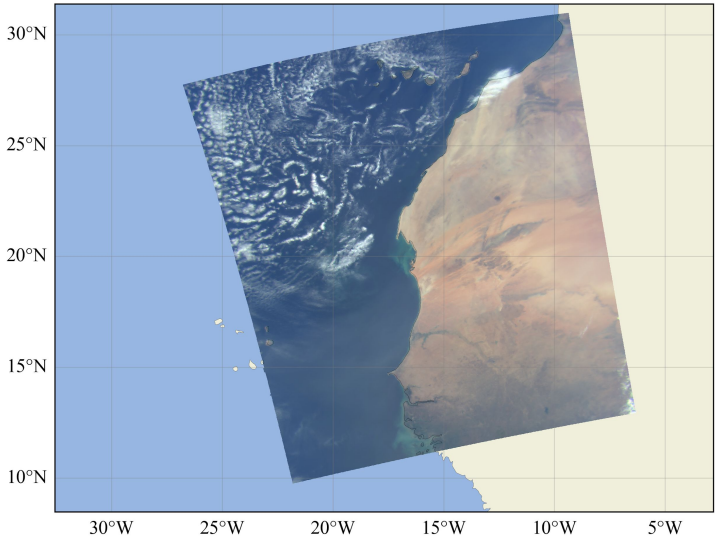

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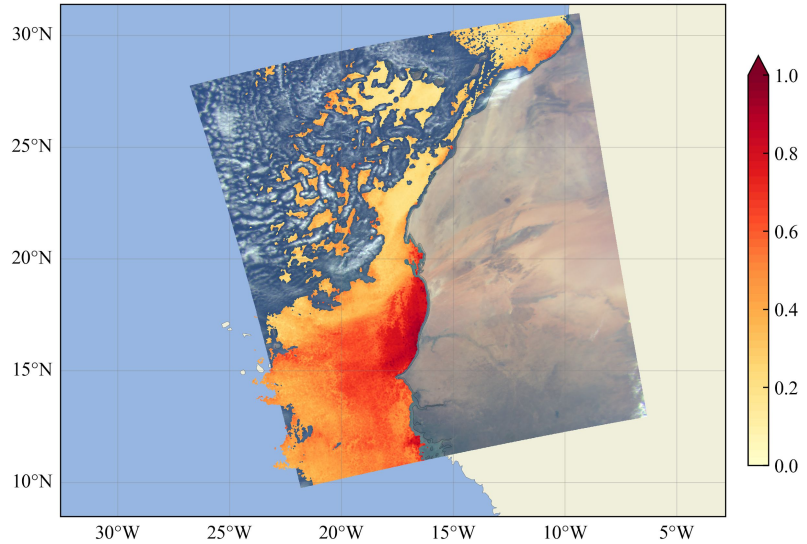
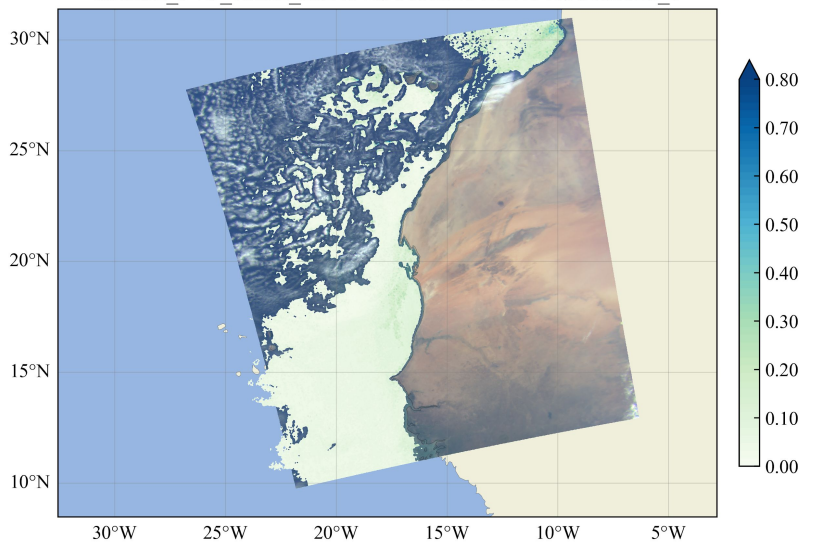
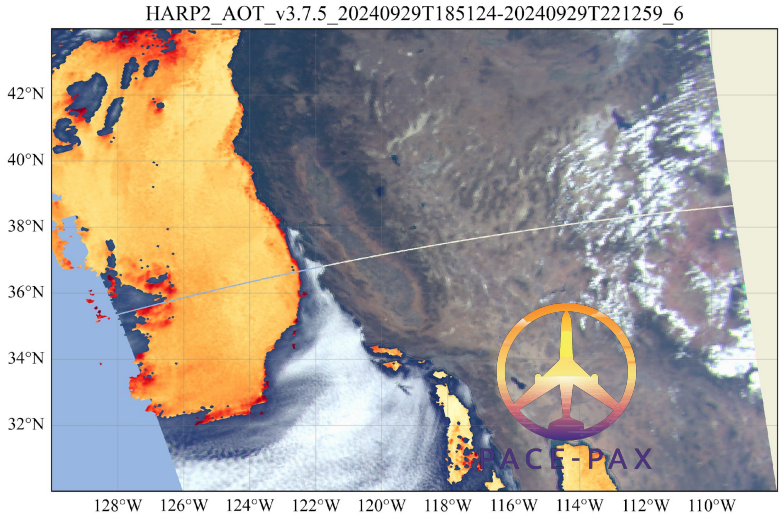
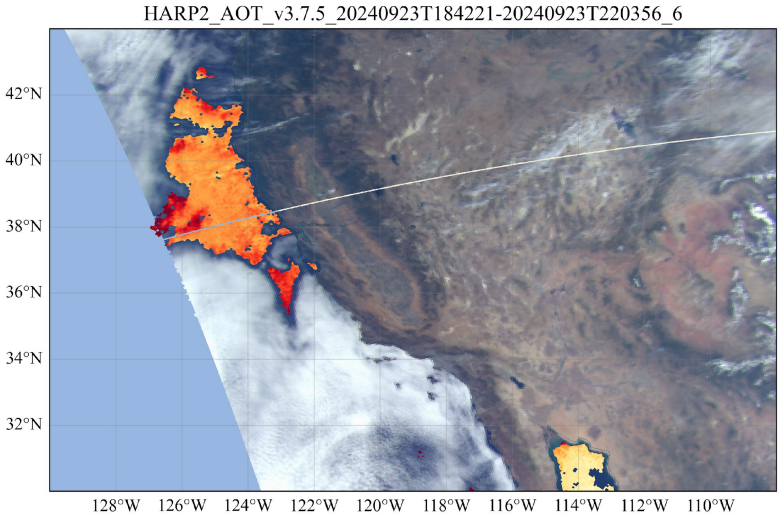


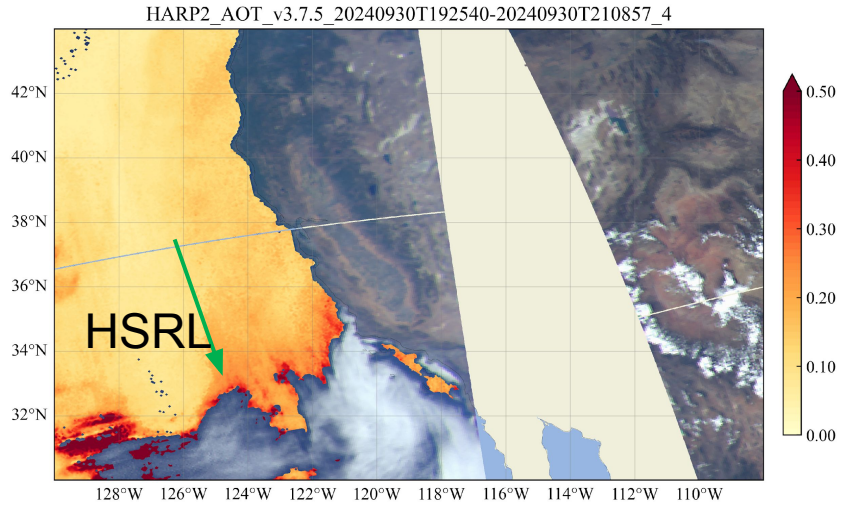
HARP2_FVF_v3.6.2_20240409T135328-20240409T135328_1

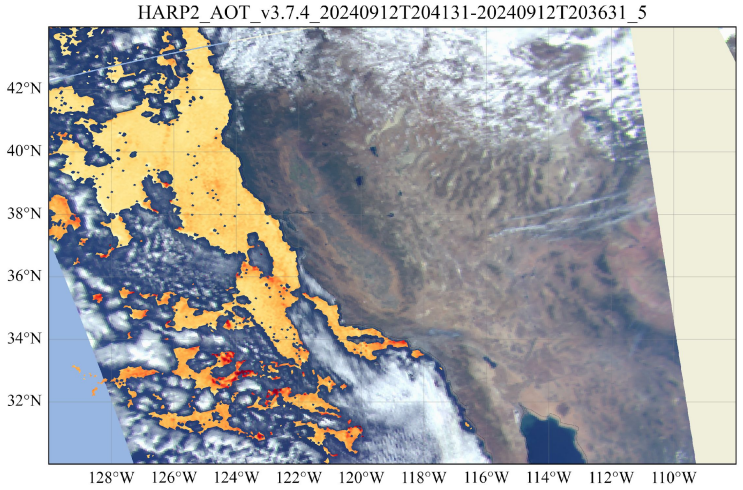


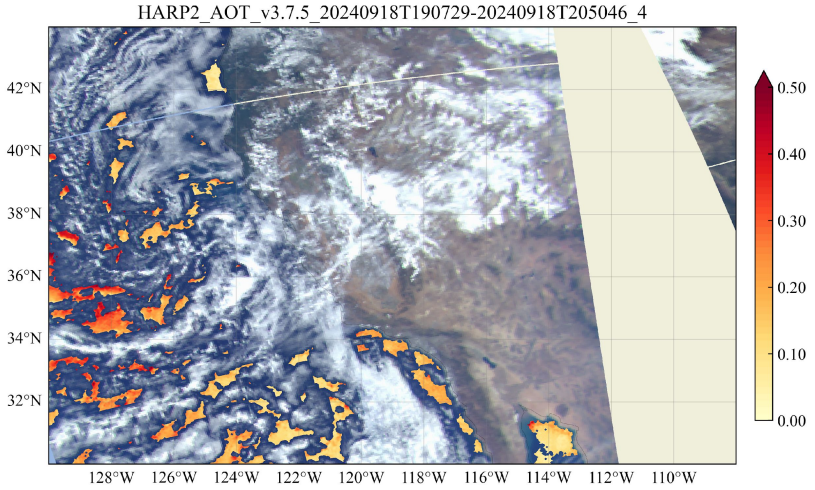
Support PACE-PAX field campaign

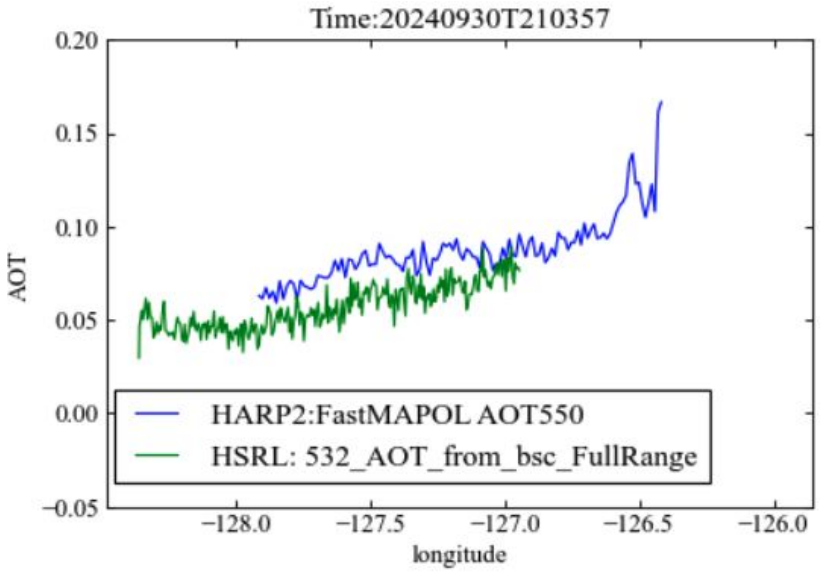








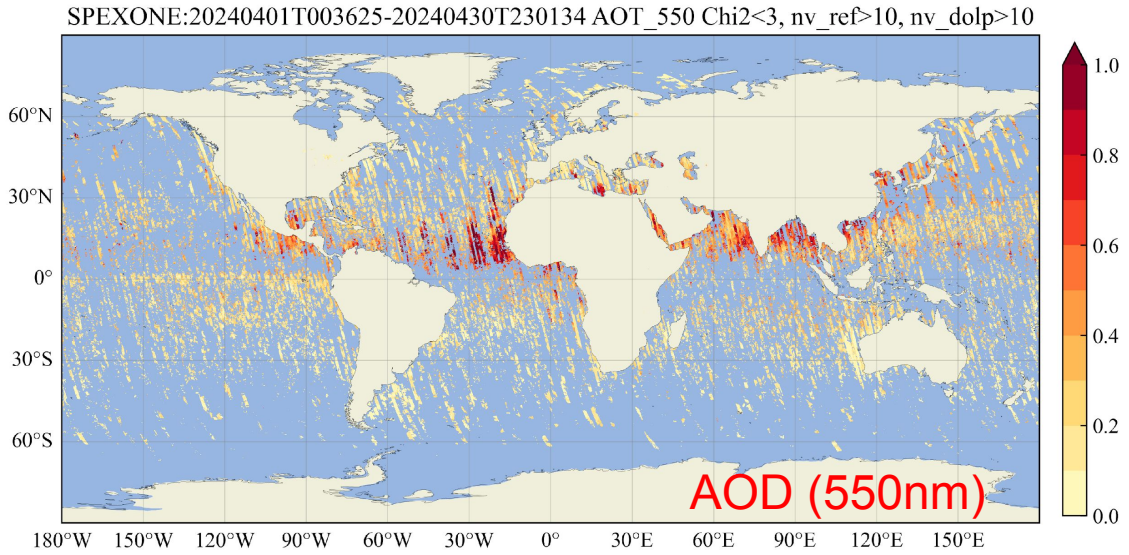


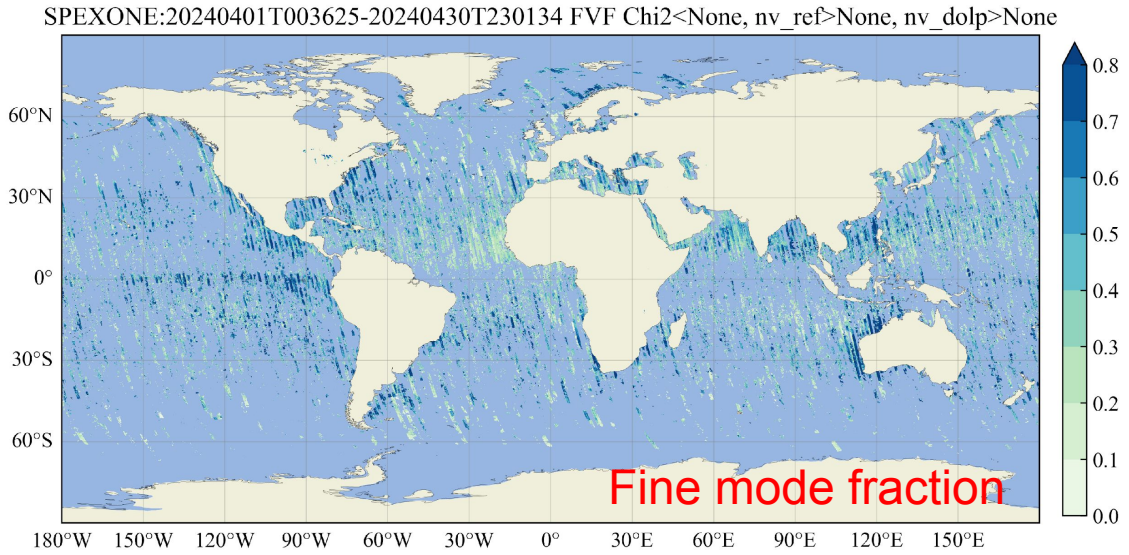


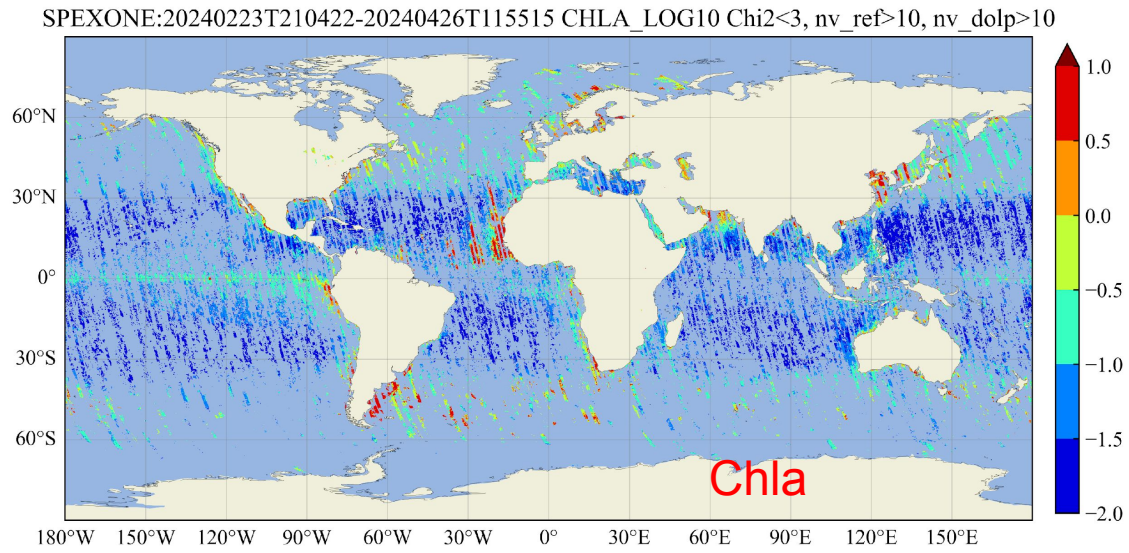
https://www-air.larc.nasa.gov/missions/pacepax/

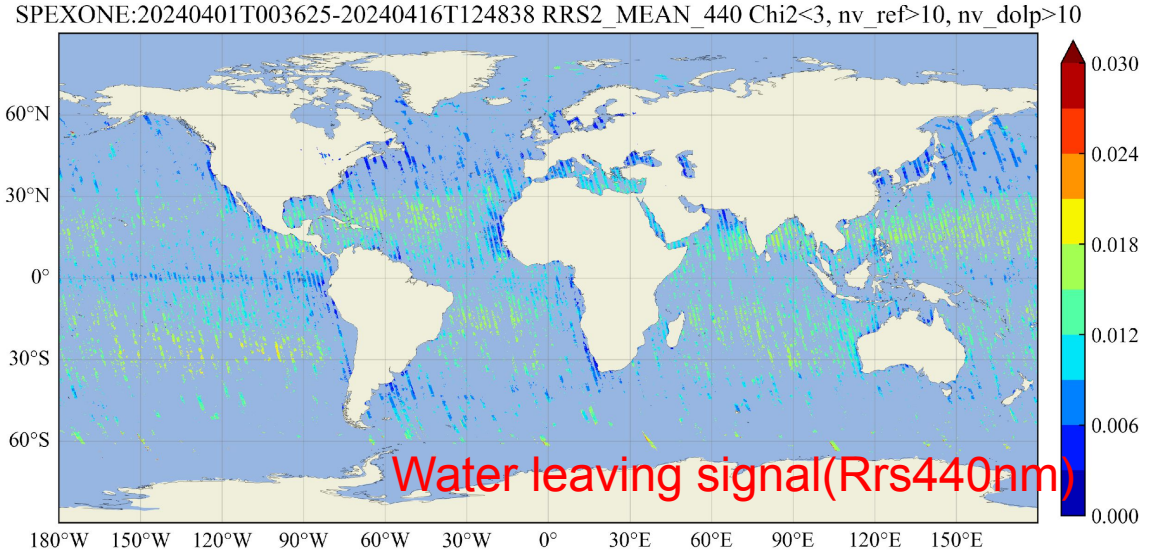
Joint aerosol and ocean color results with SPEXone

Used for testing HARP2 algorithm, full SPEXone capability is harnessed by RemoTAP @ SRON



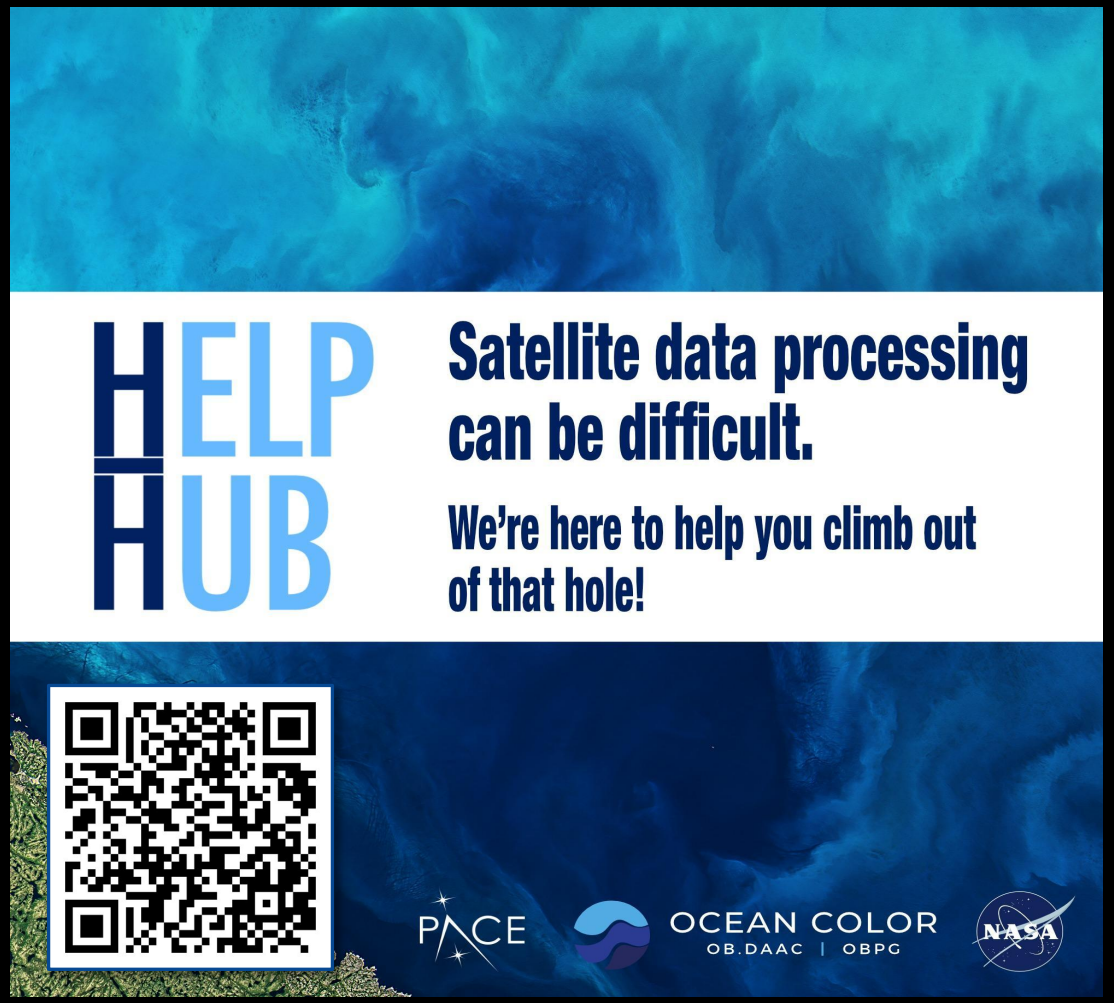






Get involved!

Lead: Morgaine McKibben (morgaine.mckibben@nasa.gov)



Lead: Carina Poulin (carina.poulin@nasa.gov)