

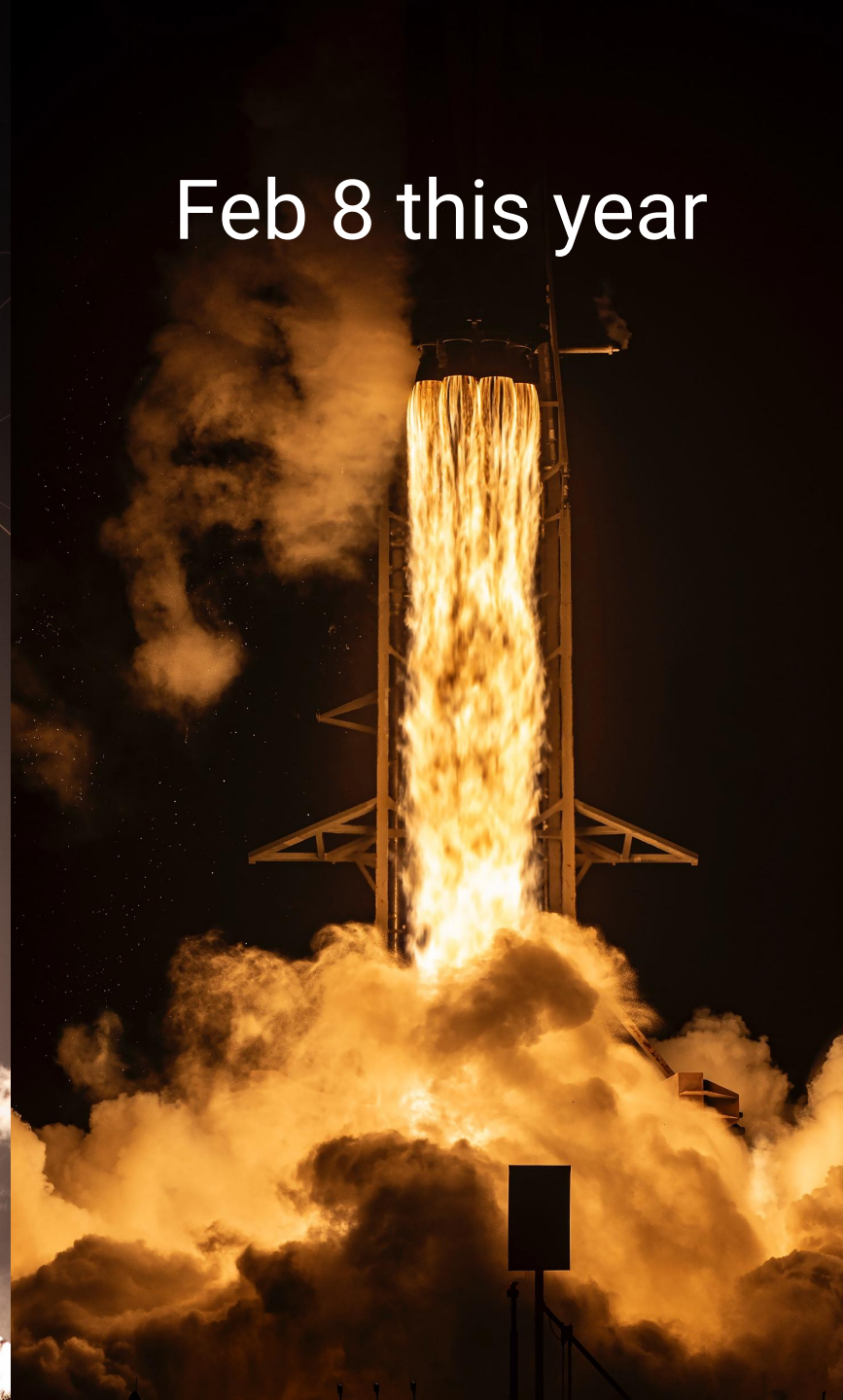


Can We Even Observe Microphysics? Experience from PACE polarimeter retrievals

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



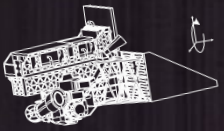


Feb 8 this year



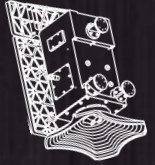
Feb 8 this year





OCI

340-890 nm in 2.5 nm steps
7 discrete SWIR, 940-2260 nm
1-2 day coverage $\pm 20^\circ$ tilt, 1.2km



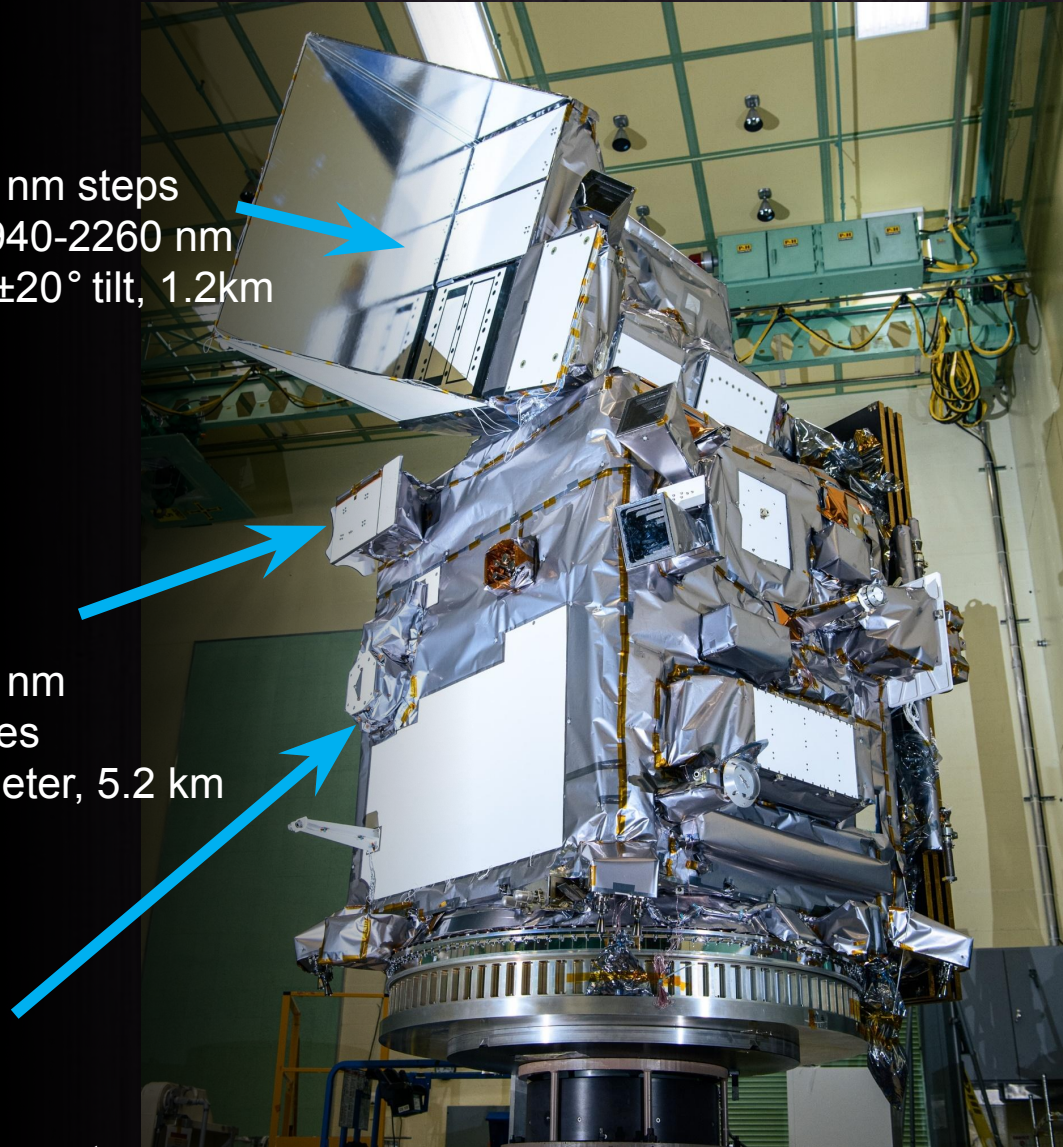
HARP2 (UMBC)

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

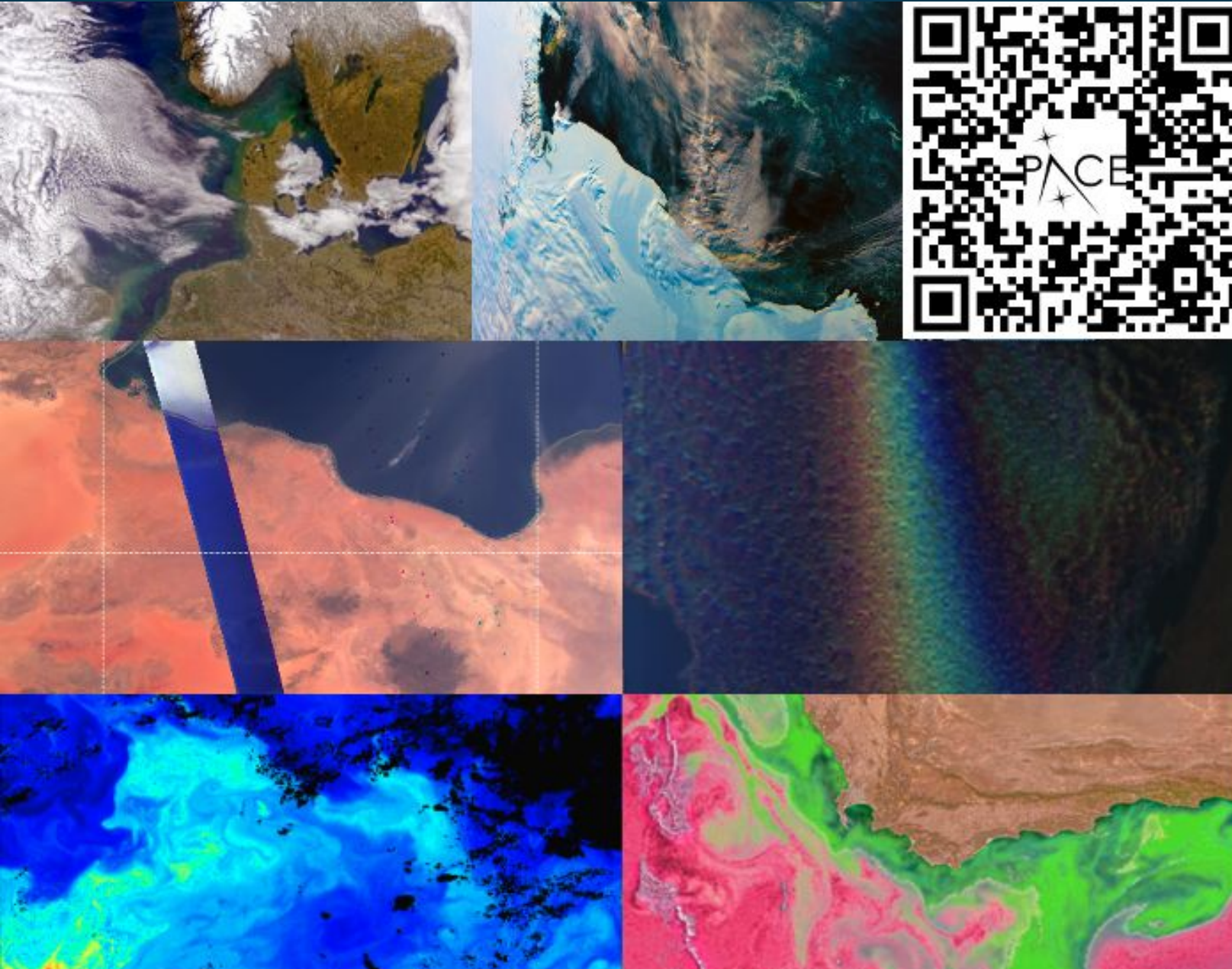


SPEXone (SRON)

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



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

 **WORLDVIEW**

Layers Events Data

REFERENCE

- Coastlines
© OpenStreetMap contributors

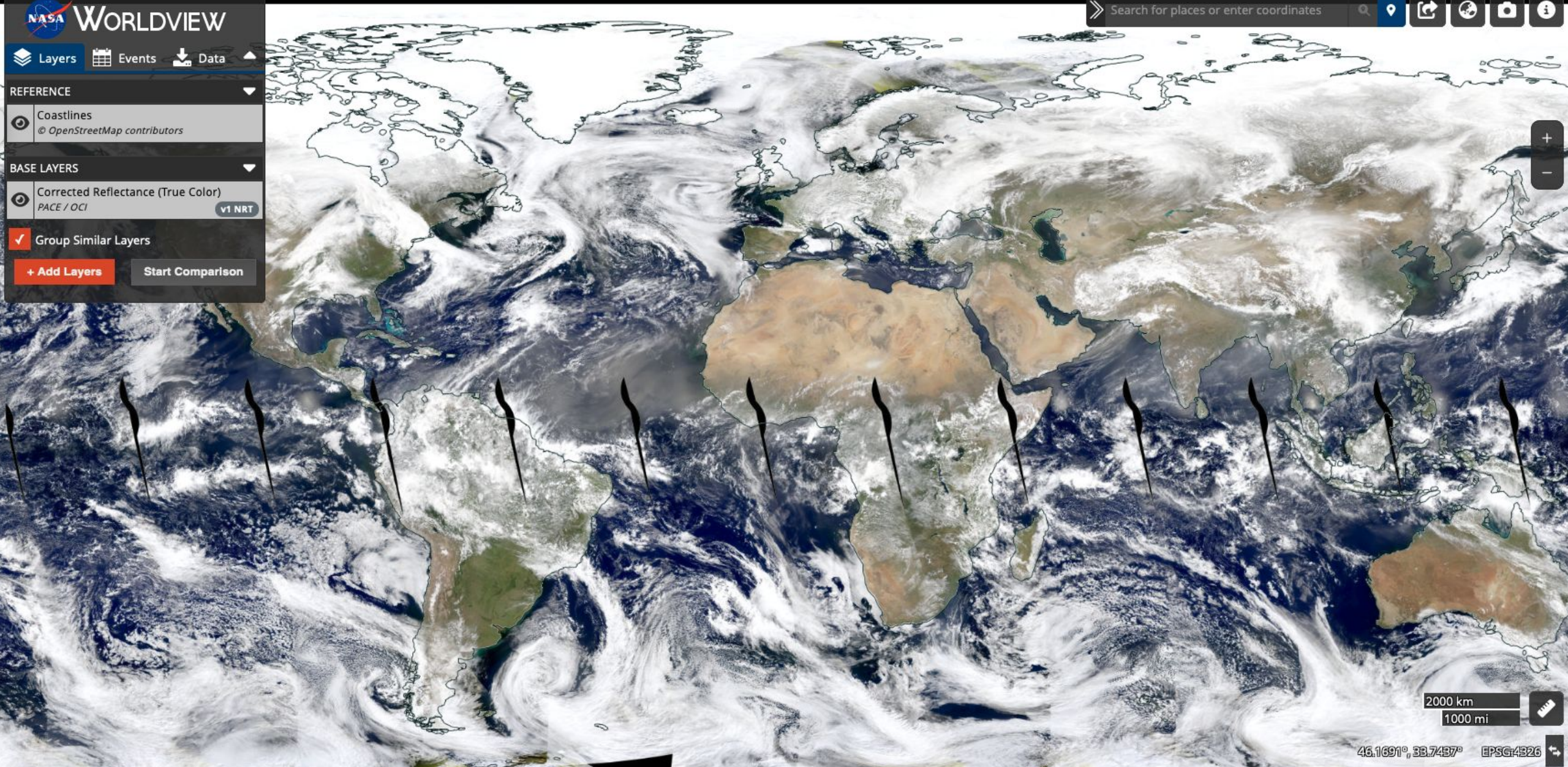
BASE LAYERS

- Corrected Reflectance (True Color)
PACE / OCI v1 NRT

Group Similar Layers

[+ Add Layers](#) [Start Comparison](#)

Search for places or enter coordinates



2000 km
1000 mi

46.1691°, 33.7437° EPSG:4326

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)

Data Products Table

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

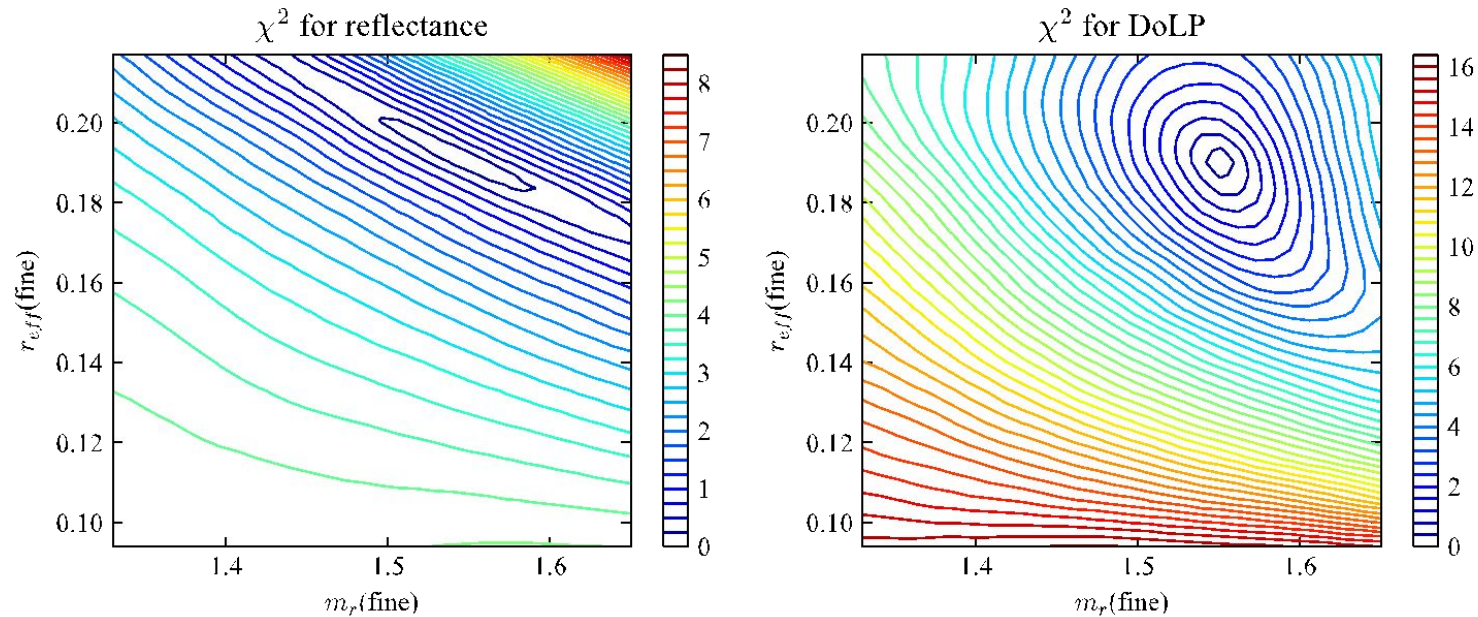
Coming soon!

Currently implementing and evaluating

No approach currently identified

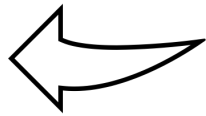
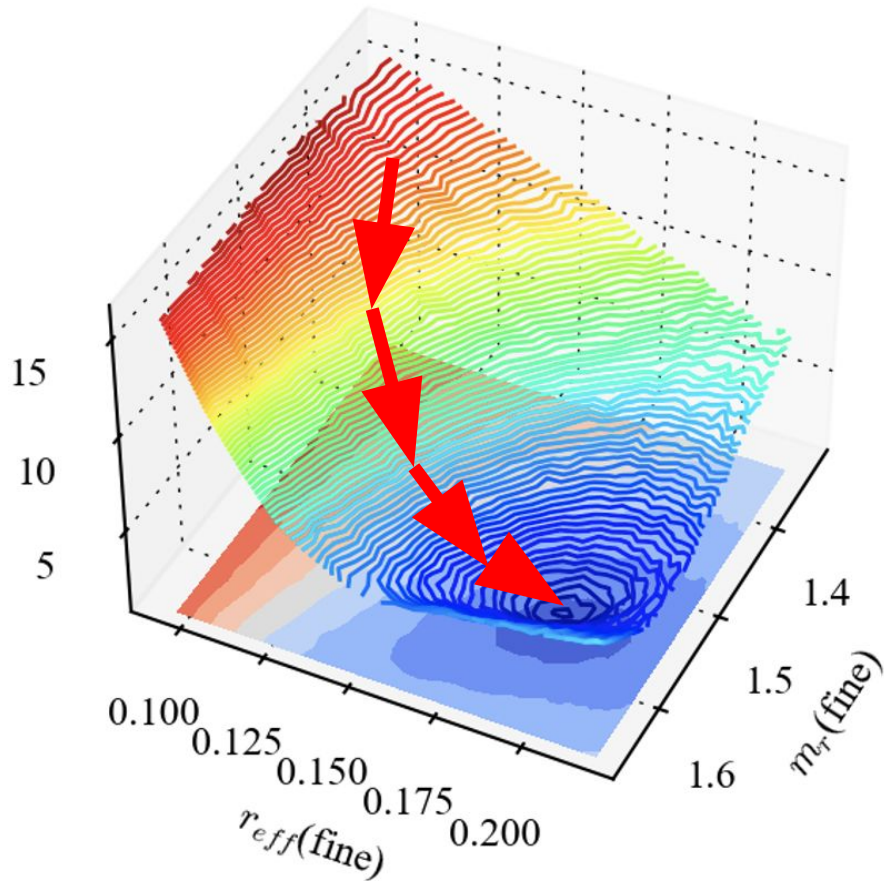
https://pace.oceansciences.org/data_table.htm

- Improve aerosol optical and microphysical property retrievals

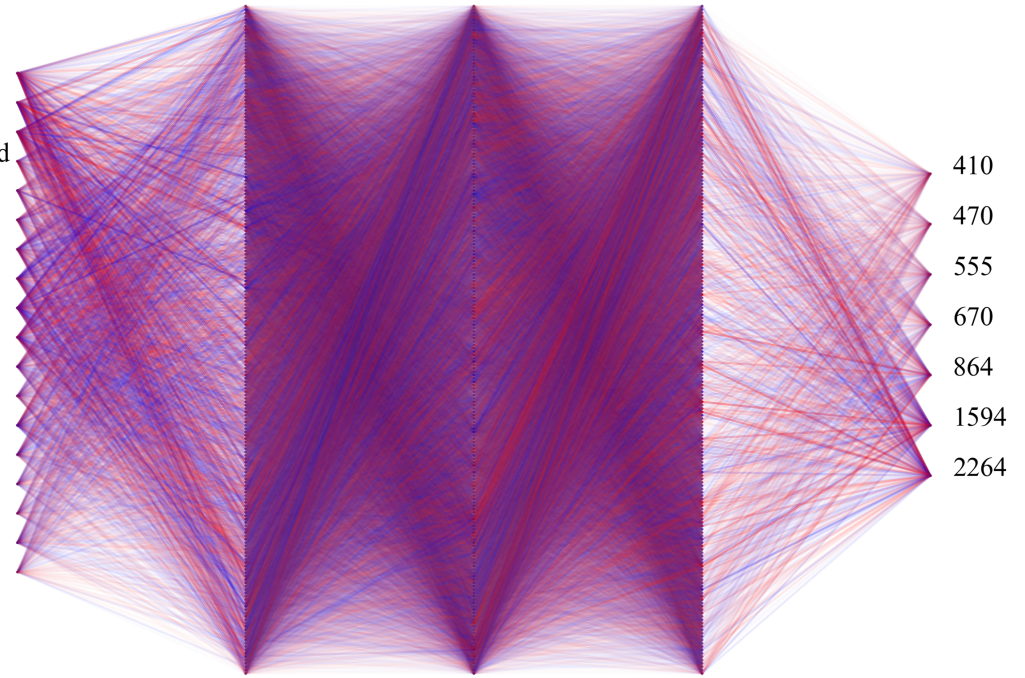


- **Inherent assumptions in aerosol models (ongoing, welcome feedback)**
 - Aerosol size distribution optimized through observations (Gao et al 2018)
 - Pre-defined aerosol types with size and refractive index dependency (Aryal et al 2023)
 - Assumptions in aerosol shape: spheres, spheroid (Dubovik et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

FastMAPOL as a testbed for PACE polarimeter retrievals



zen
phi
solzen
wndspd
chla
vdv1
vdv2
vdv3
vdv4
vdv5
pfr1
pfr2
pcr1
pcr2
pfi1
pfi2
pci1
pci2



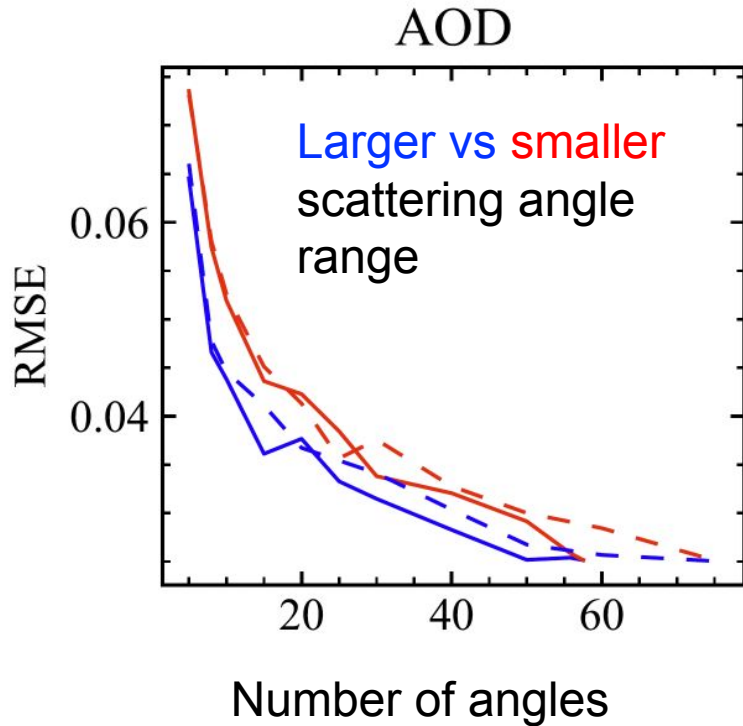
- Coupled atmosphere and ocean radiative transfer model (Zhai et al 2022)
- Fast and accurate forward model and Jacobians with neural networks
- Simultaneous aerosol and ocean property retrieval (Gao et al 2021-2023, Aryal et al

2023)
<https://doi.org/10.5194/amt-14-4083-2021>

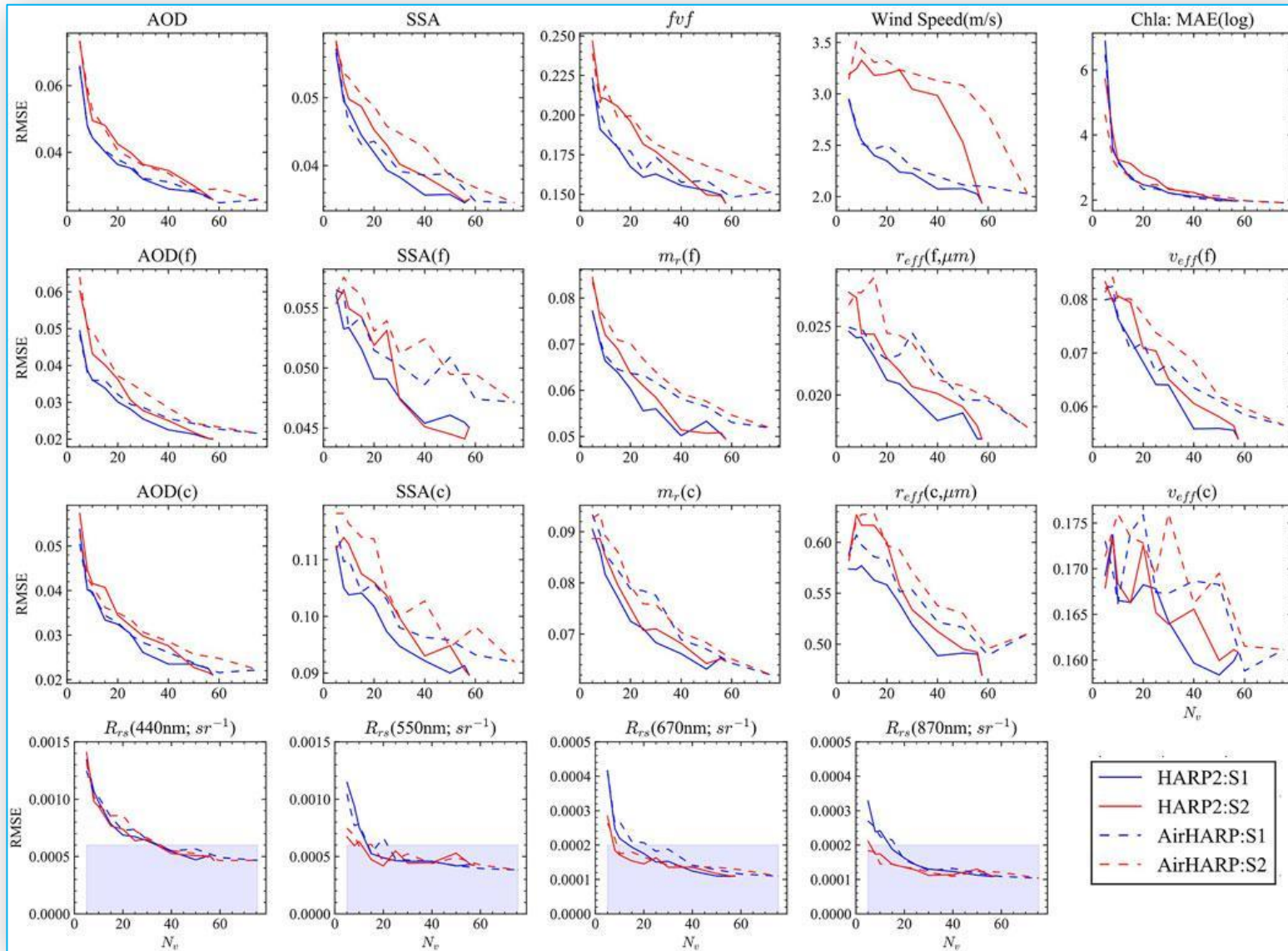


FastMAPOL

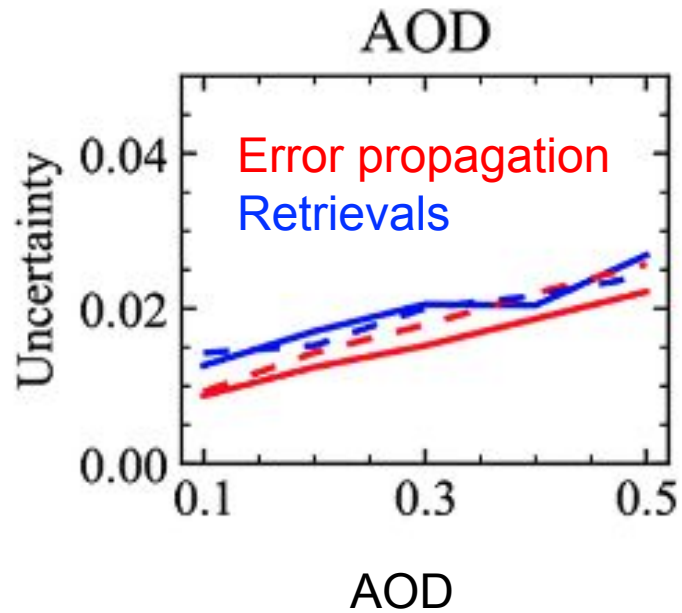
Retrieval uncertainty vs number of input angles



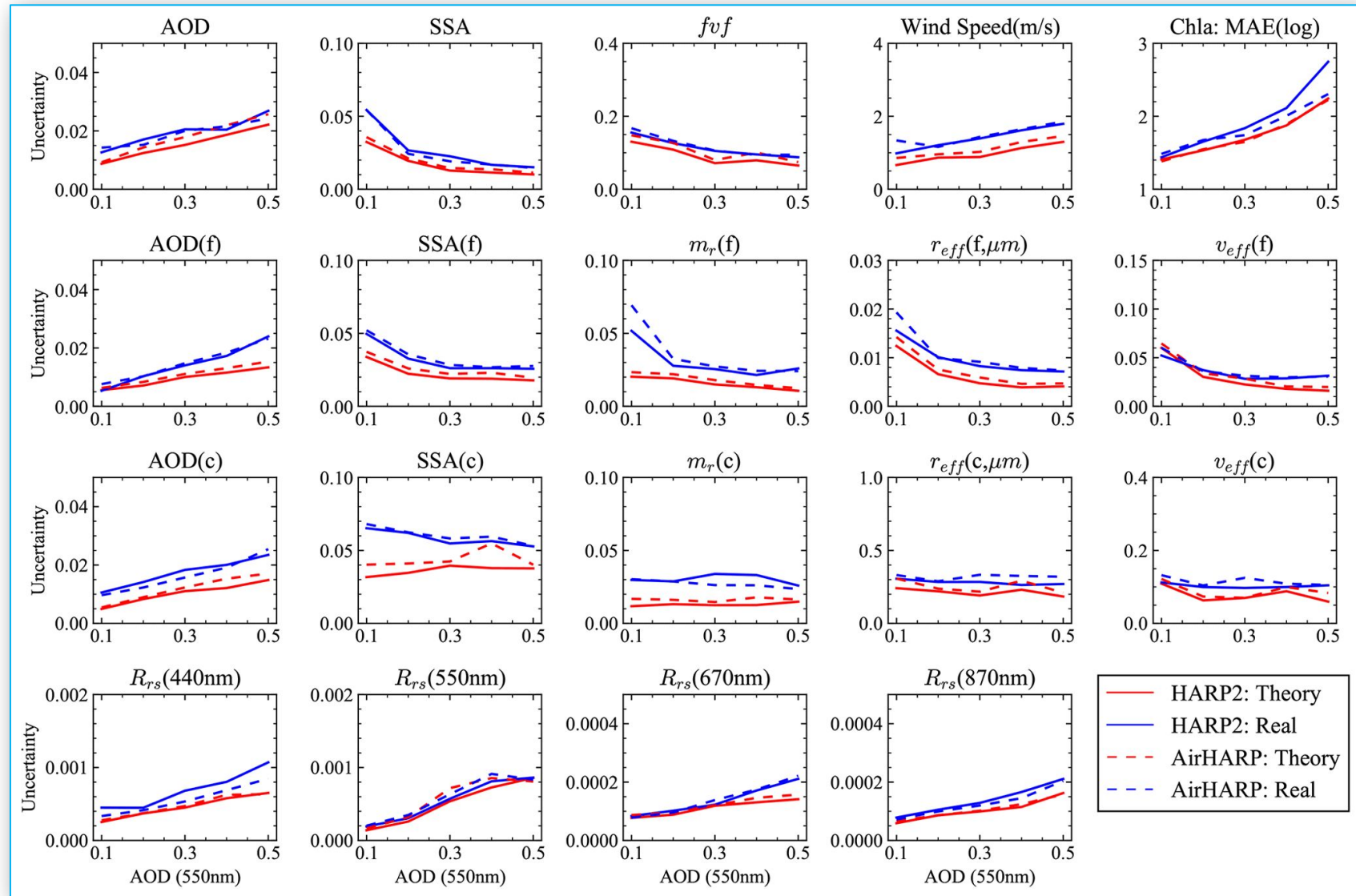
Adaptive multi-angle data screening based on fitting performance.



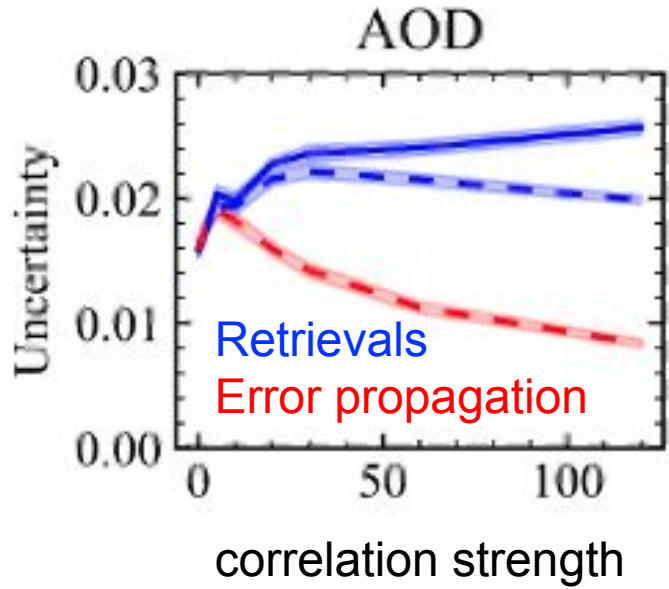
Retrieval uncertainty vs aerosol loadings



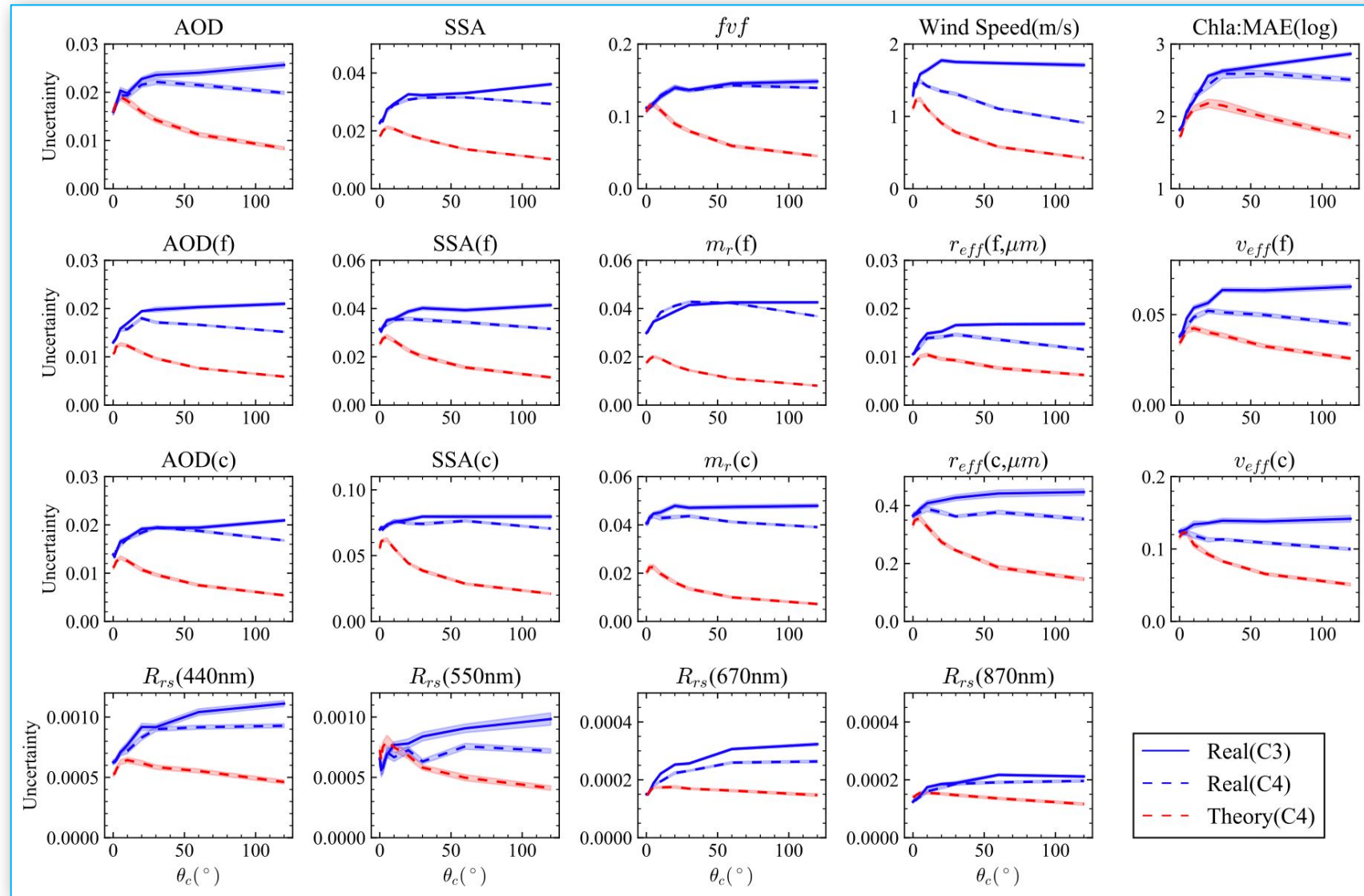
Pixel-wise retrieval uncertainties can be well described by error propagation.



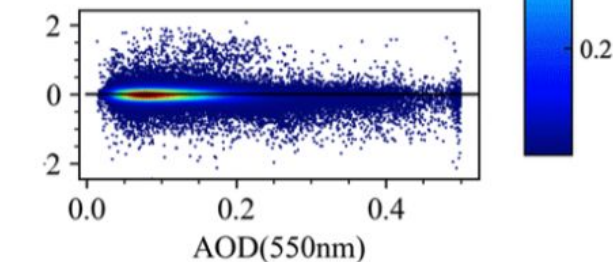
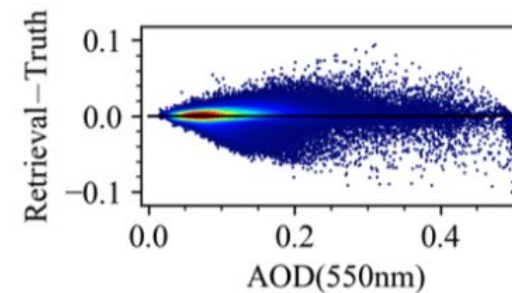
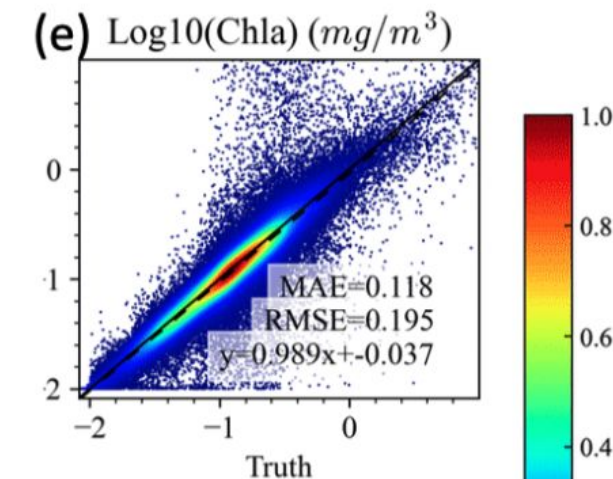
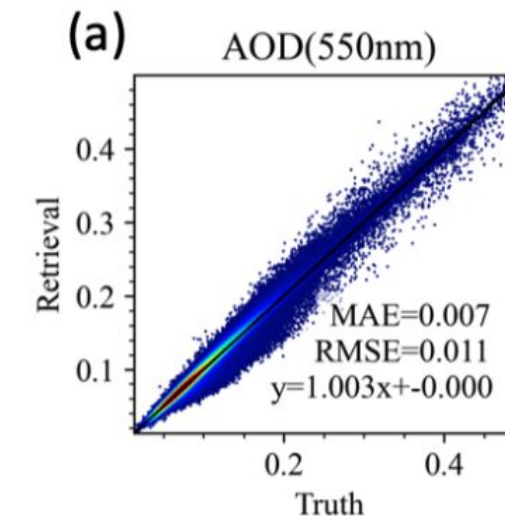
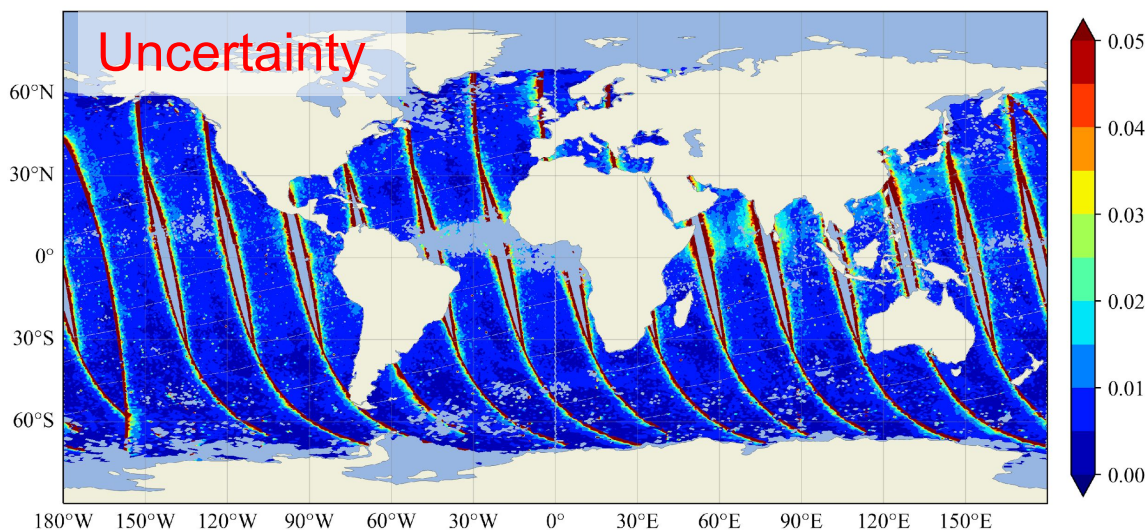
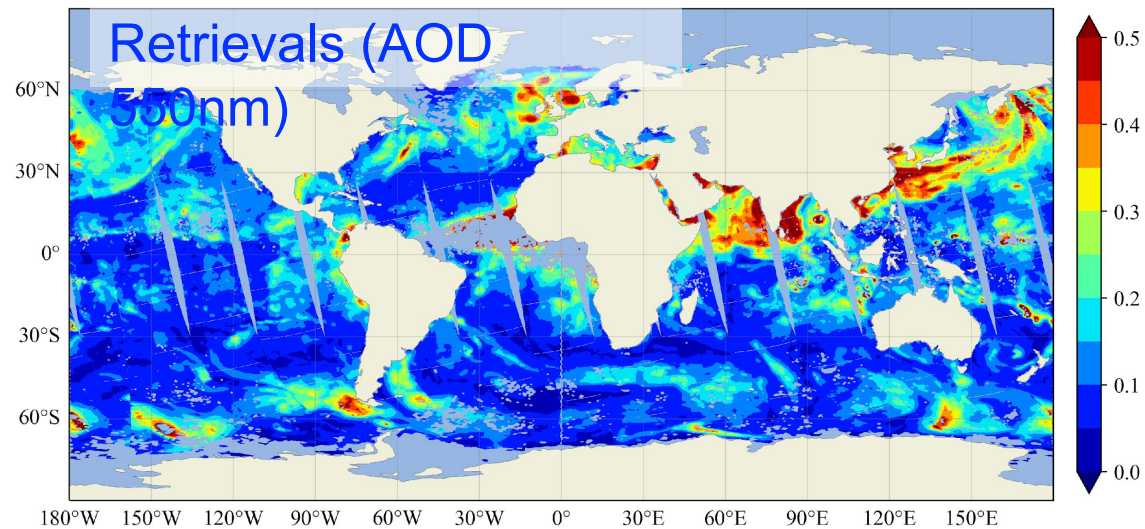
Retrieval uncertainty vs angular noise correlations



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

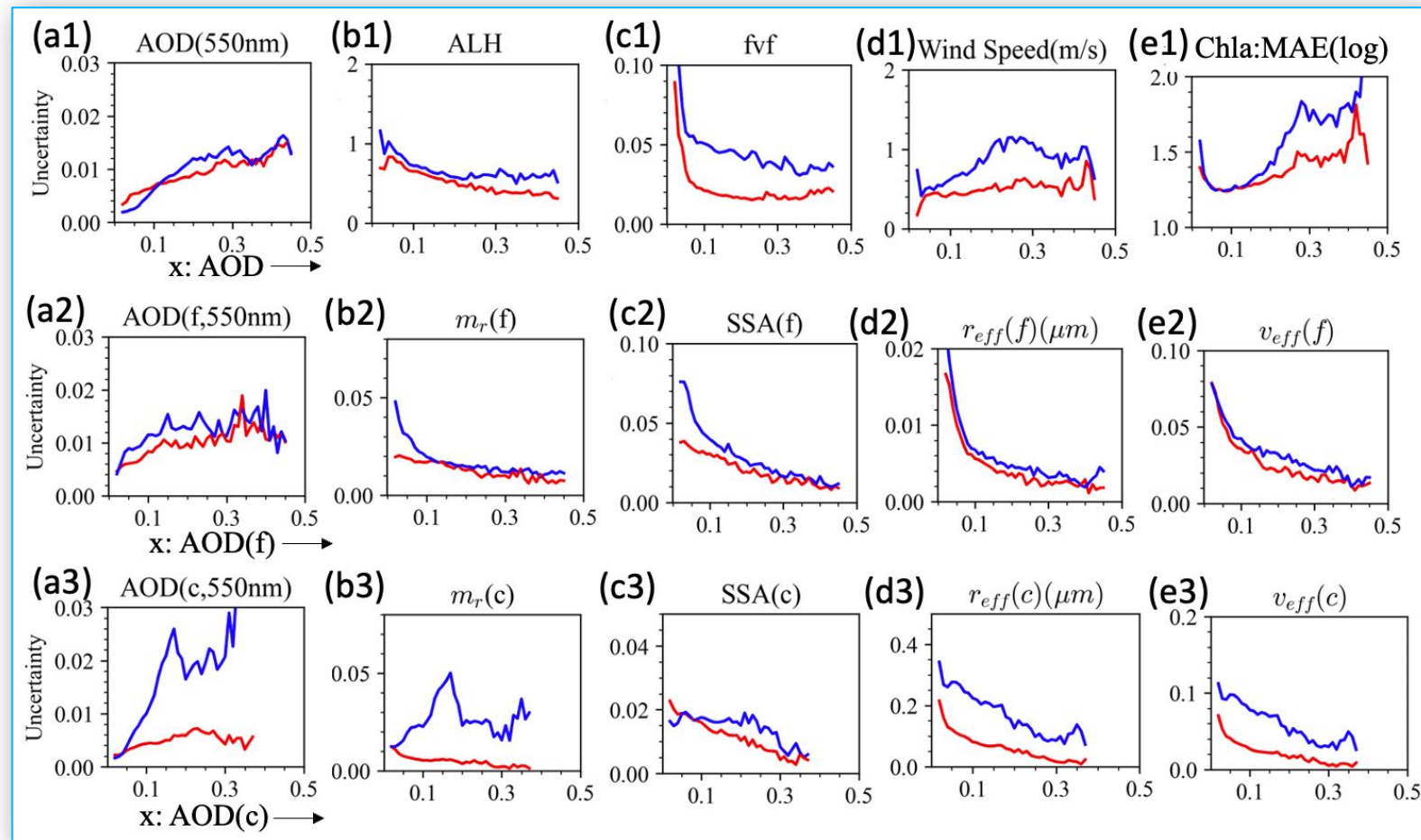
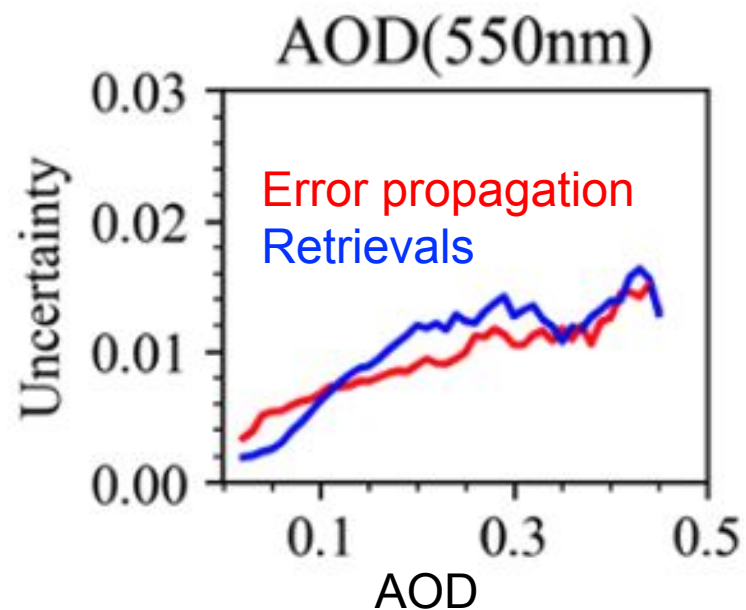


Uncertainty analysis based on global simulation



Data available from NASA OB.DAAC.

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



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

HARP2 AOD retrieval time lapse



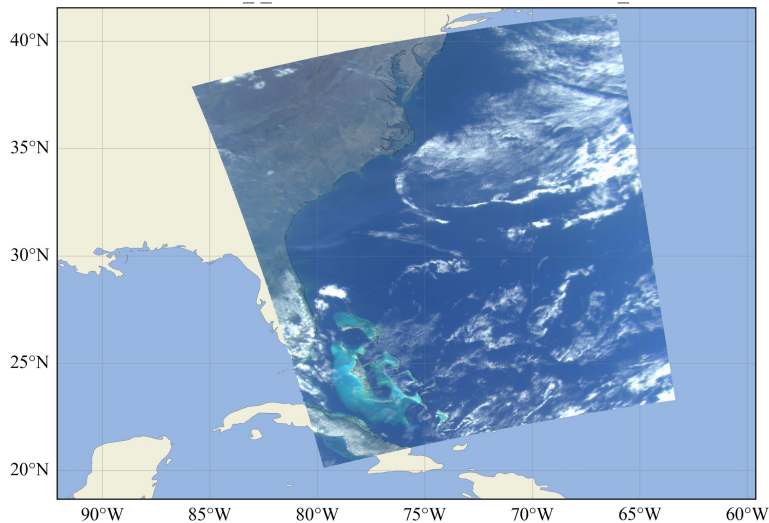
AOD(550nm) from April-May 2024

Optical and microphysical retrievals

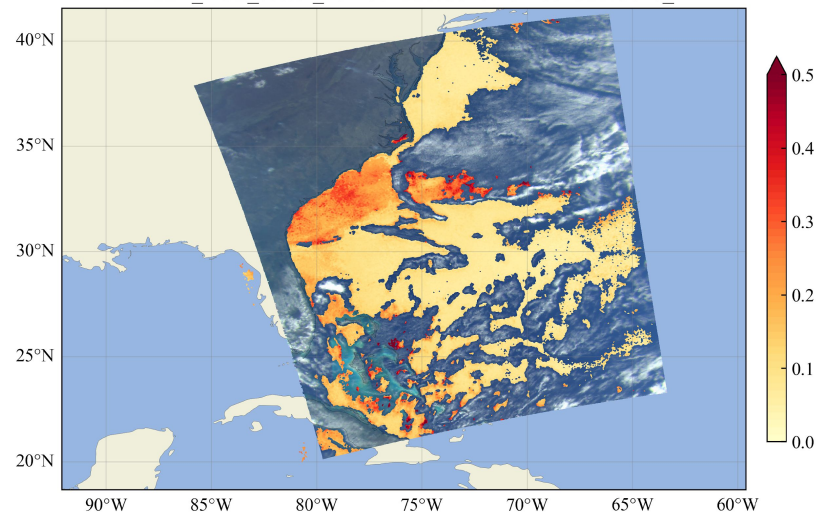
AOD(550nm)

FVF

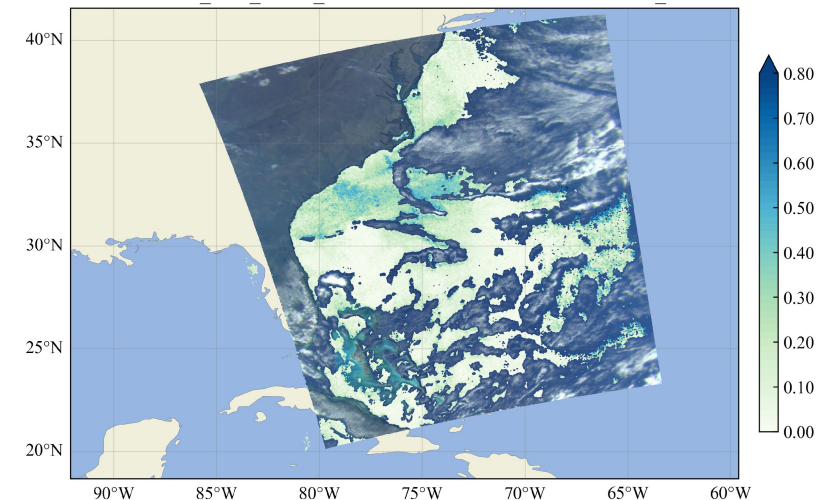
HARP2_i_20240321T173720-20240321T173720_3



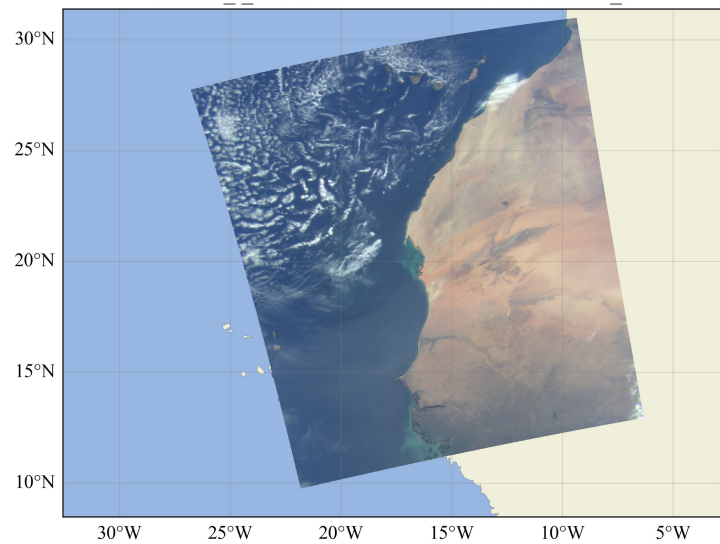
HARP2_AOT_v3.6.2_20240321T173720-20240321T173720_4



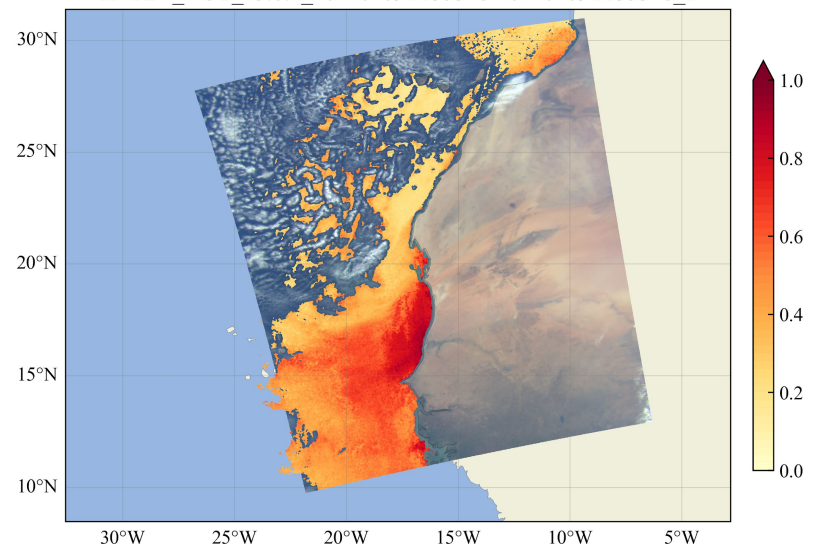
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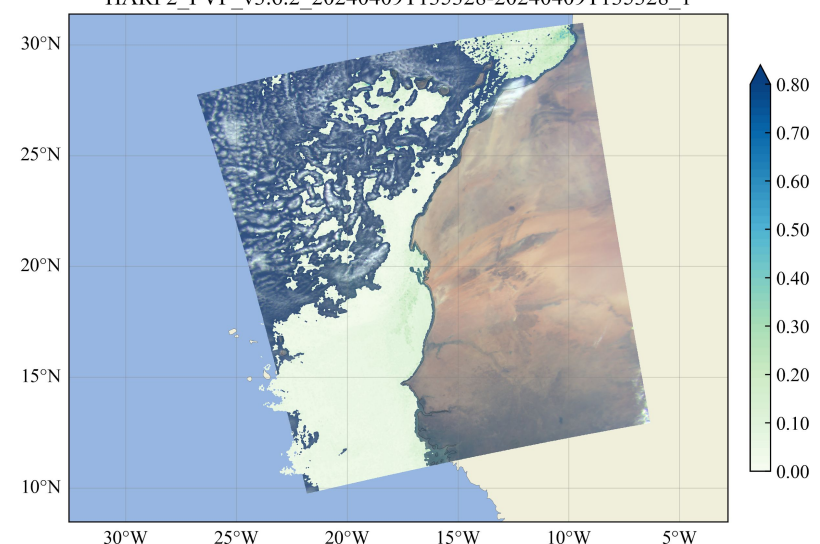
HARP2_i_20240409T135328-20240409T135328_1



HARP2_AOT_v3.6.2_20240409T135328-20240409T135328_1



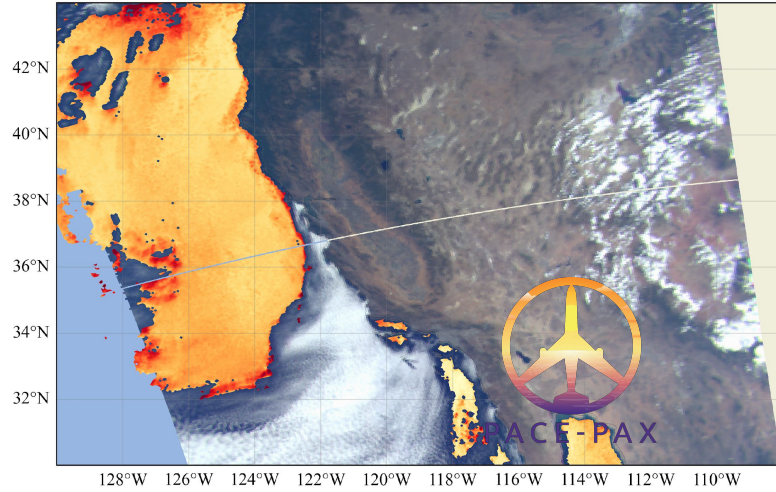
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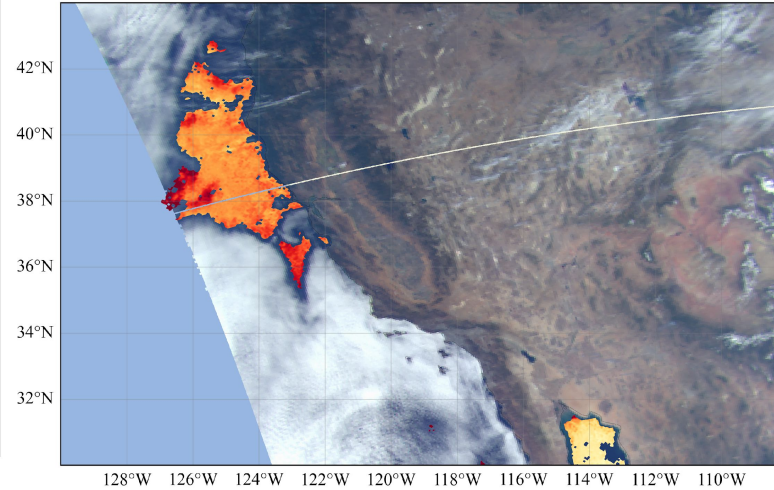
Support PACE-PAX field campaign



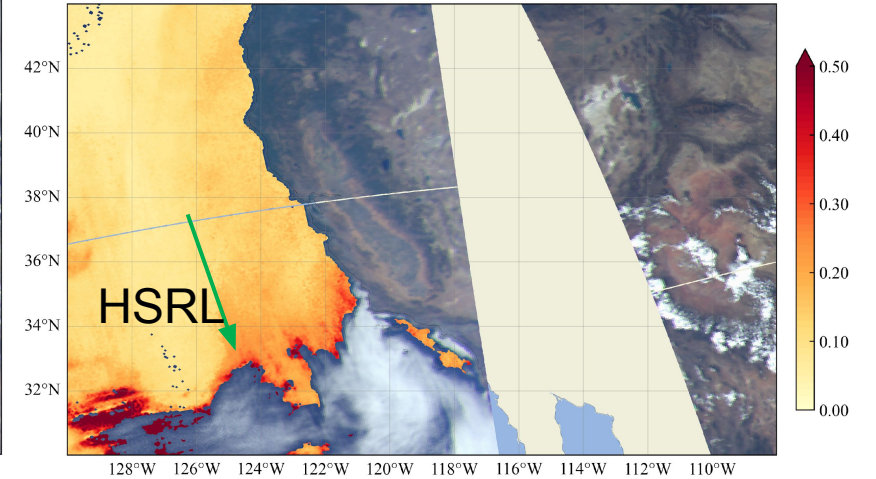
HARP2_AOT_v3.7.5_20240929T185124-20240929T221259_6



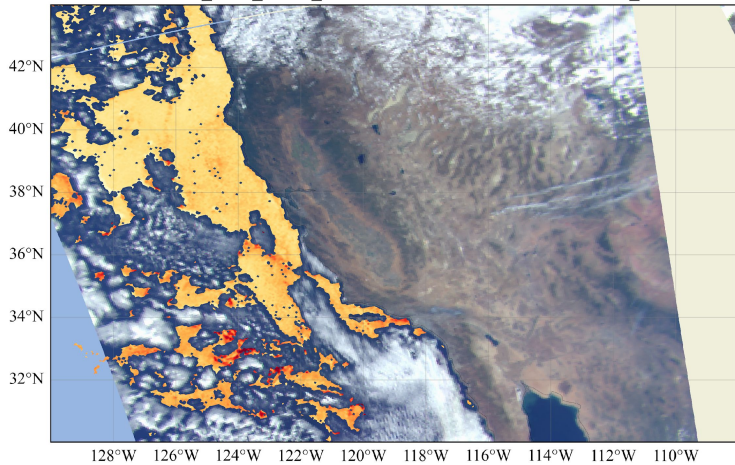
HARP2_AOT_v3.7.5_20240923T184221-20240923T220356_6



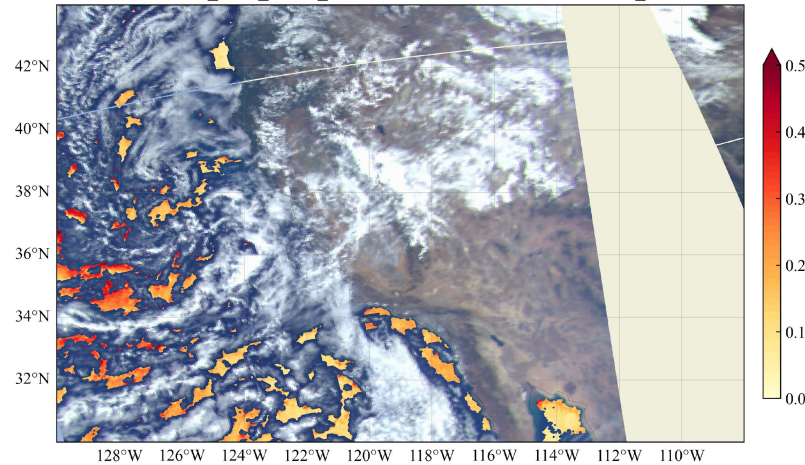
HARP2_AOT_v3.7.5_20240930T192540-20240930T210857_4



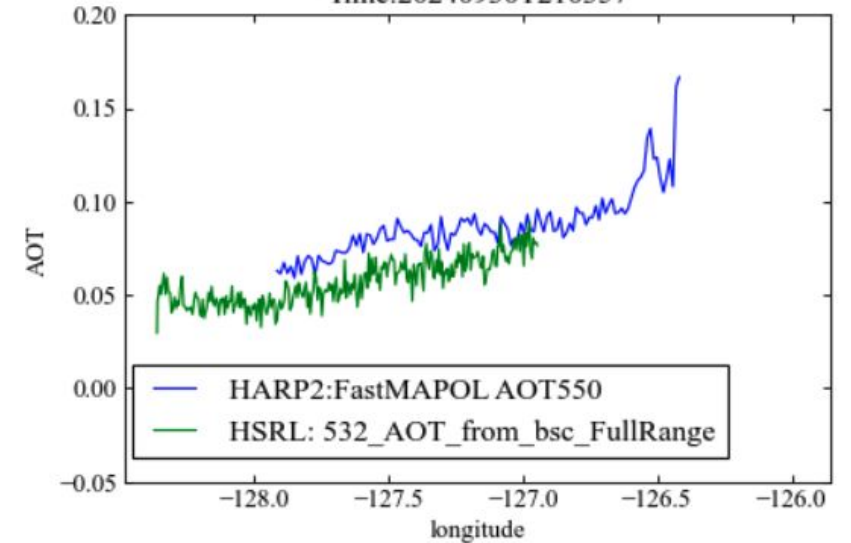
HARP2_AOT_v3.7.4_20240912T204131-20240912T203631_5



HARP2_AOT_v3.7.5_20240918T190729-20240918T205046_4



Time:20240930T210357



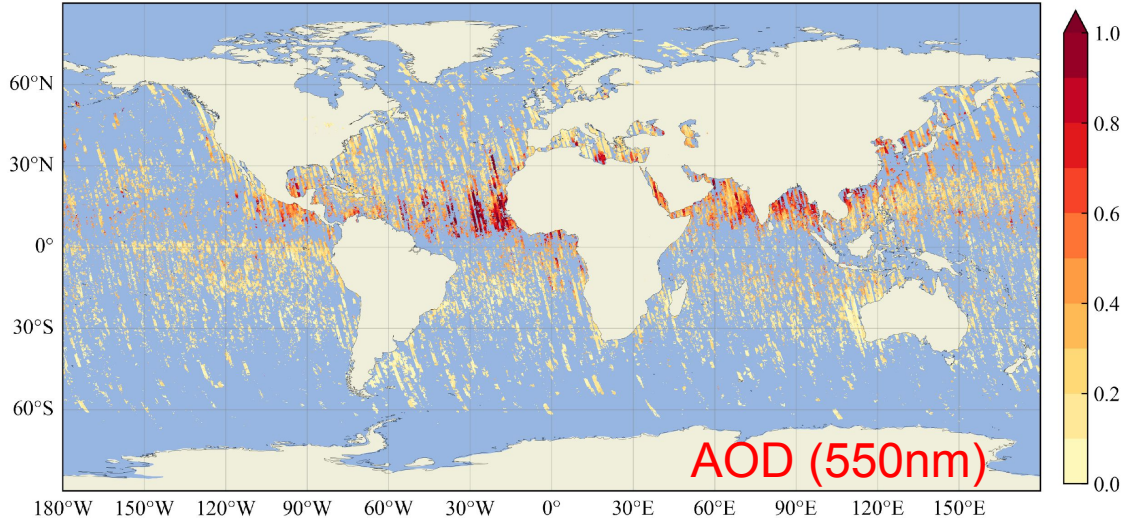
<https://www-air.larc.nasa.gov/missions/pacepax/>

Joint aerosol and ocean color results with SPEXone

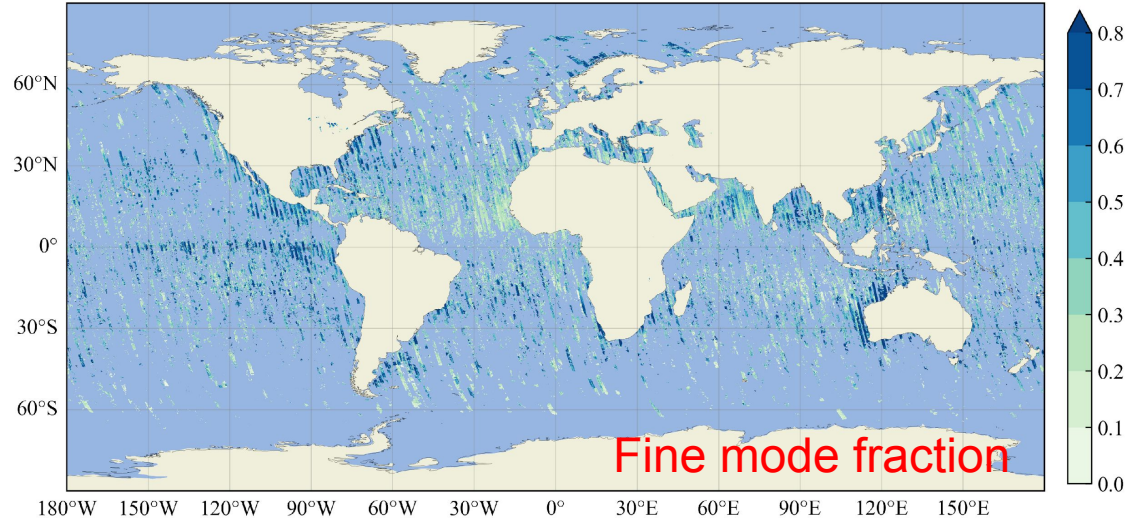


Used for testing HARP2 algorithm, full SPEXone capability is harnessed by RemoTAP @ SRON

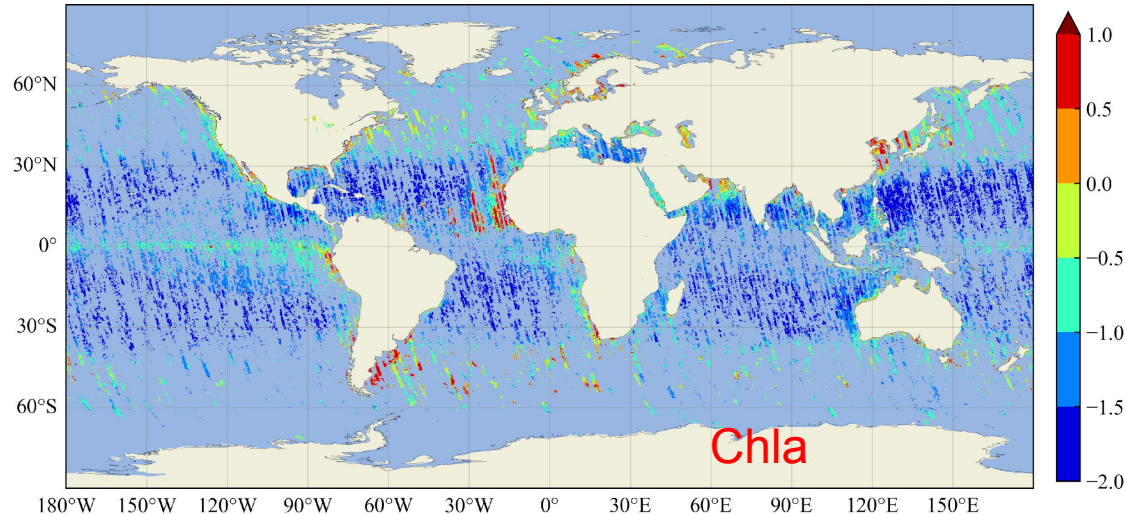
SPEXONE:20240401T003625-20240430T230134 AOT_550 Chi2<3, nv_ref>10, nv_dolp>10



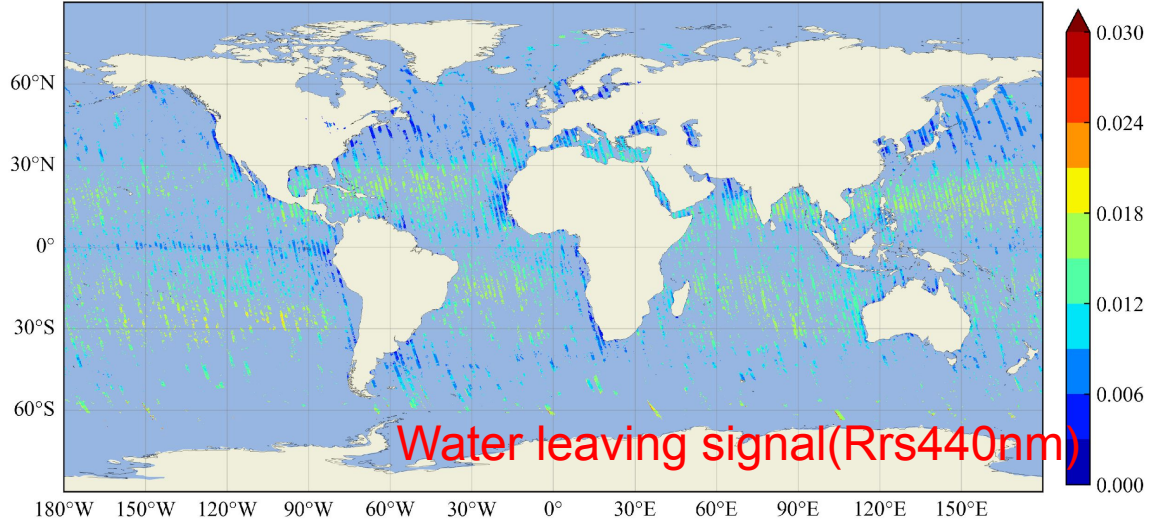
SPEXONE:20240401T003625-20240430T230134 FVF Chi2<None, nv_ref>None, nv_dolp>None



SPEXONE:20240223T210422-20240426T115515 CHLA_LOG10 Chi2<3, nv_ref>10, nv_dolp>10



SPEXONE:20240401T003625-20240416T124838 RRS2_MEAN_440 Chi2<3, nv_ref>10, nv_dolp>10



Get involved!



REGISTRATION



APPLICATIONS WORKSHOP

December 8, 2024

The Westin Washington, D.C. City Center
1400 M St NW, Washington, DC 20005

In person, 9am-5pm

*Held the Sunday prior to the
2024 AGU Fall Meeting in
Washington DC.*

pace.gsfc.nasa.gov



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

HELP HUB

**Satellite data processing
can be difficult.**

**We're here to help you climb out
of that hole!**



OCEAN COLOR
OB.DAAC | OBPG



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