Aerosol data from NASA's PACE mission

Andrew M. Sayer (UMBC and NASA GSFC) / andrew.sayer@nasa.gov

on behalf of the PACE mission team and many others, including but not limited to:

Project Science: Jeremy Werdell (Project Scientist), James Allen, Brian Cairns, Meng Gao, Kirk Knobelspiesse

Unified Aerosol Algorithm: Lorraine Remer, Hiren Jethva, Shana Mattoo, Omar Torres, Rob Levy, N. Christina Hsu, Vinay Kayetha, Woogyung Vincent Kim, Yingxi Rona Shi

HARP2: Vanderlei Martins, Brent McBride, Anin Puthukkudy, Richard Xu

SPEXone: Otto Hasekamp, Guangliang Fu, Zihao Yuan

Launched Feb 2024, First Light March 2024

10+ years of fuel

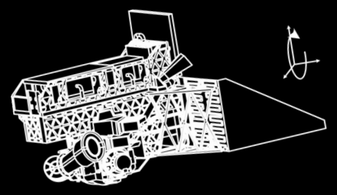
Sun-synchronous polar orbit

1 pm Equatorial crossing time for ascending node

All instruments daytime only observations

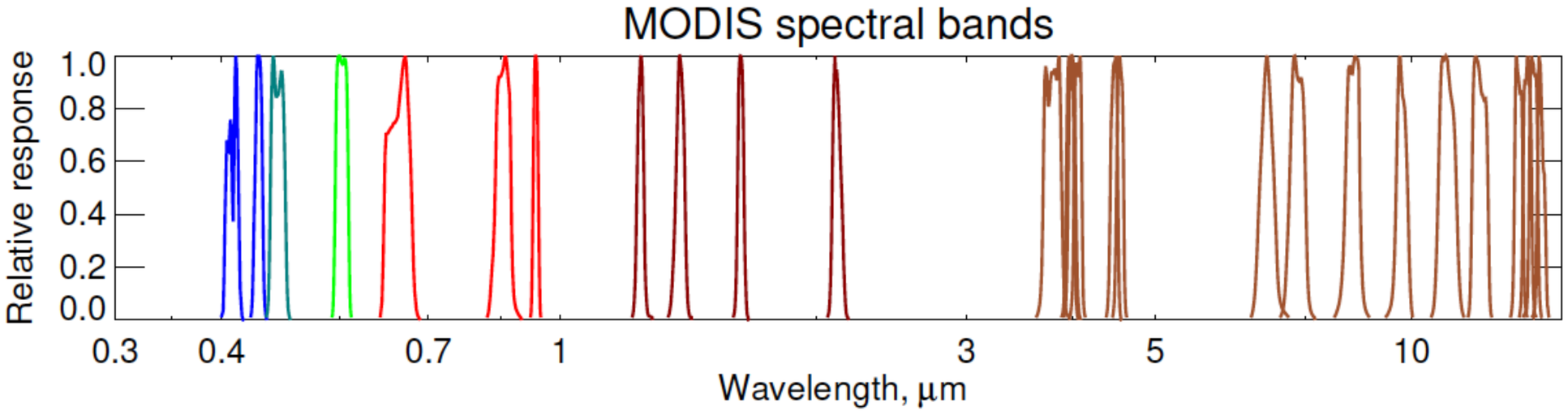
NASA/Kim Shiflett

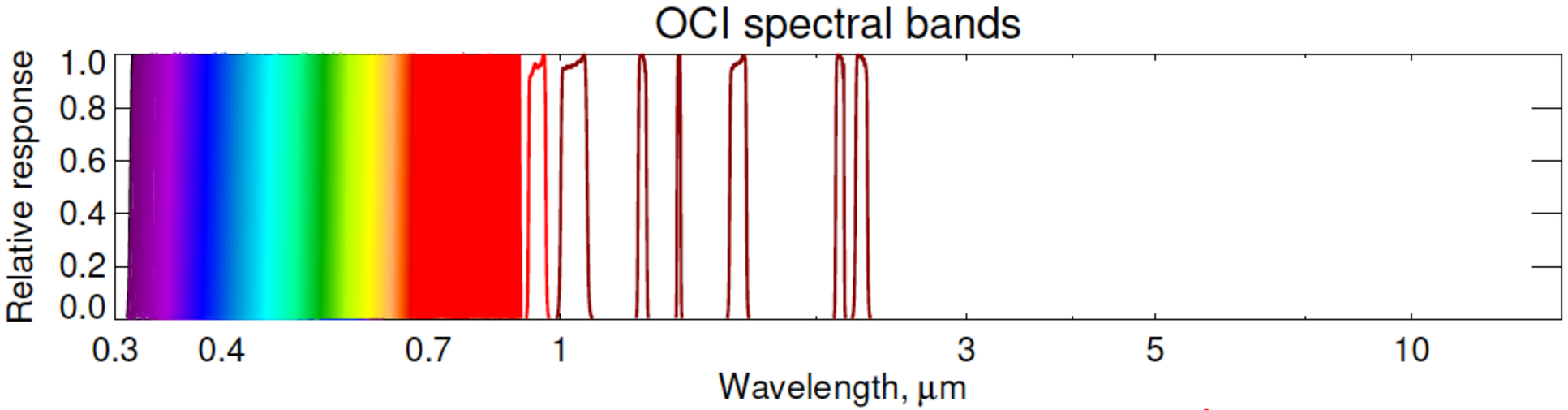
Plankton, Aerosol, Cloud, ocean Ecosystem (PACE)



Ocean Color Instrument (OCI)
340-890 nm at 5 nm FWHM in 2.5 nm steps
7 SWIR bands, 940-2260 nm
2,600 km swath, 1.2 km nominal pixel size
±20° tilt

What's our hyperspectral coverage like?



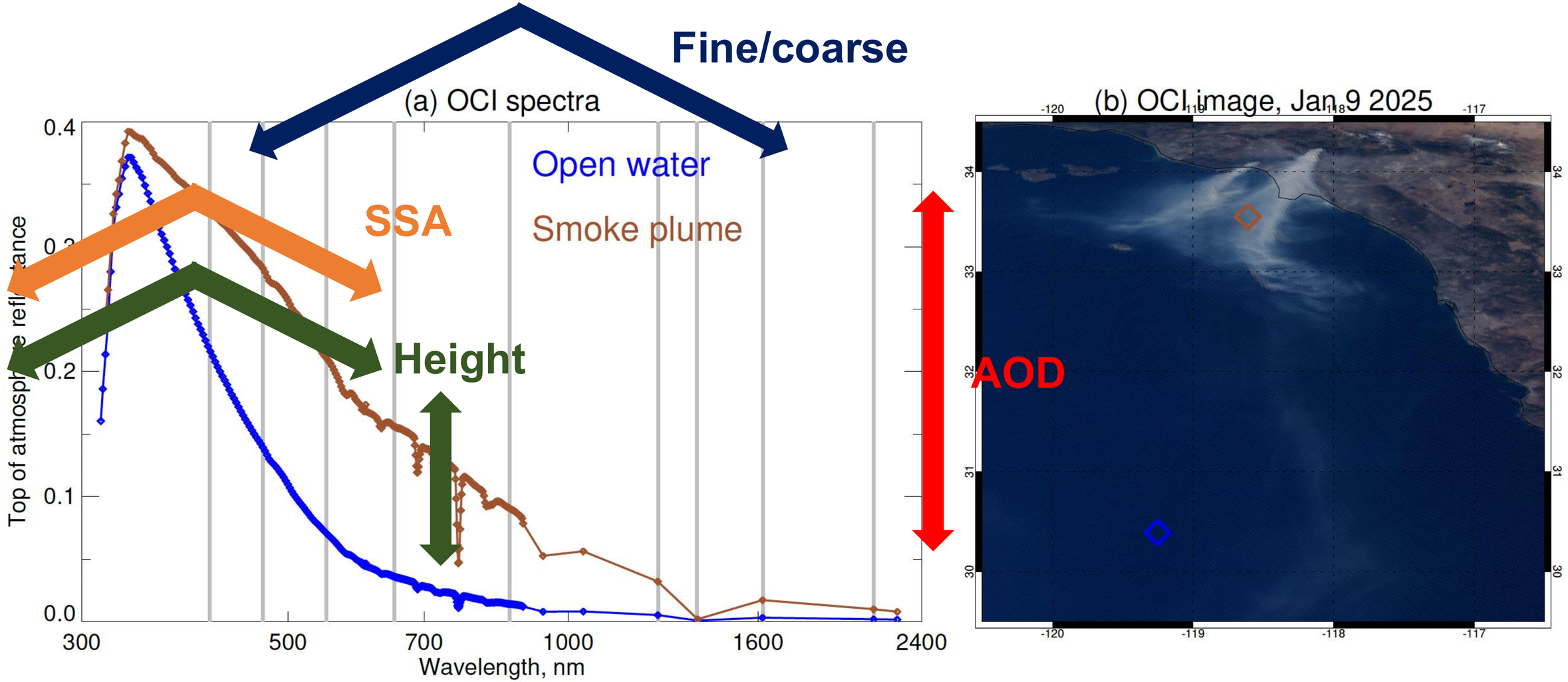


Solar

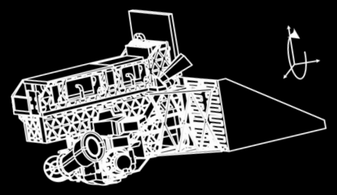
Mixed

Thermal

OCI's benefits for aerosols



Plankton, Aerosol, Cloud, ocean Ecosystem (PACE)



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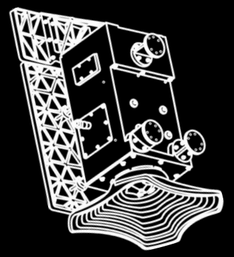
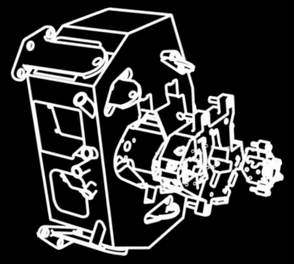
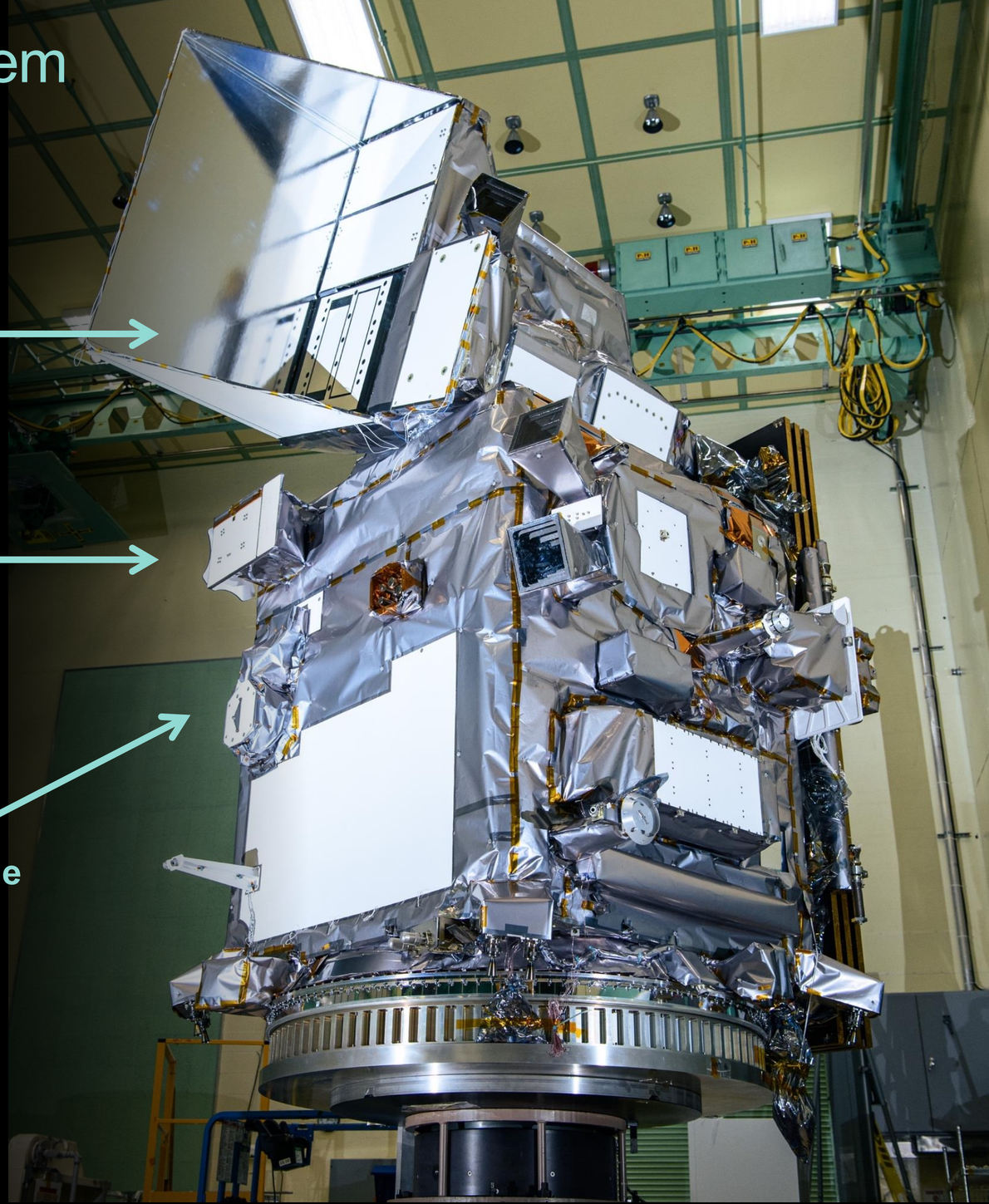


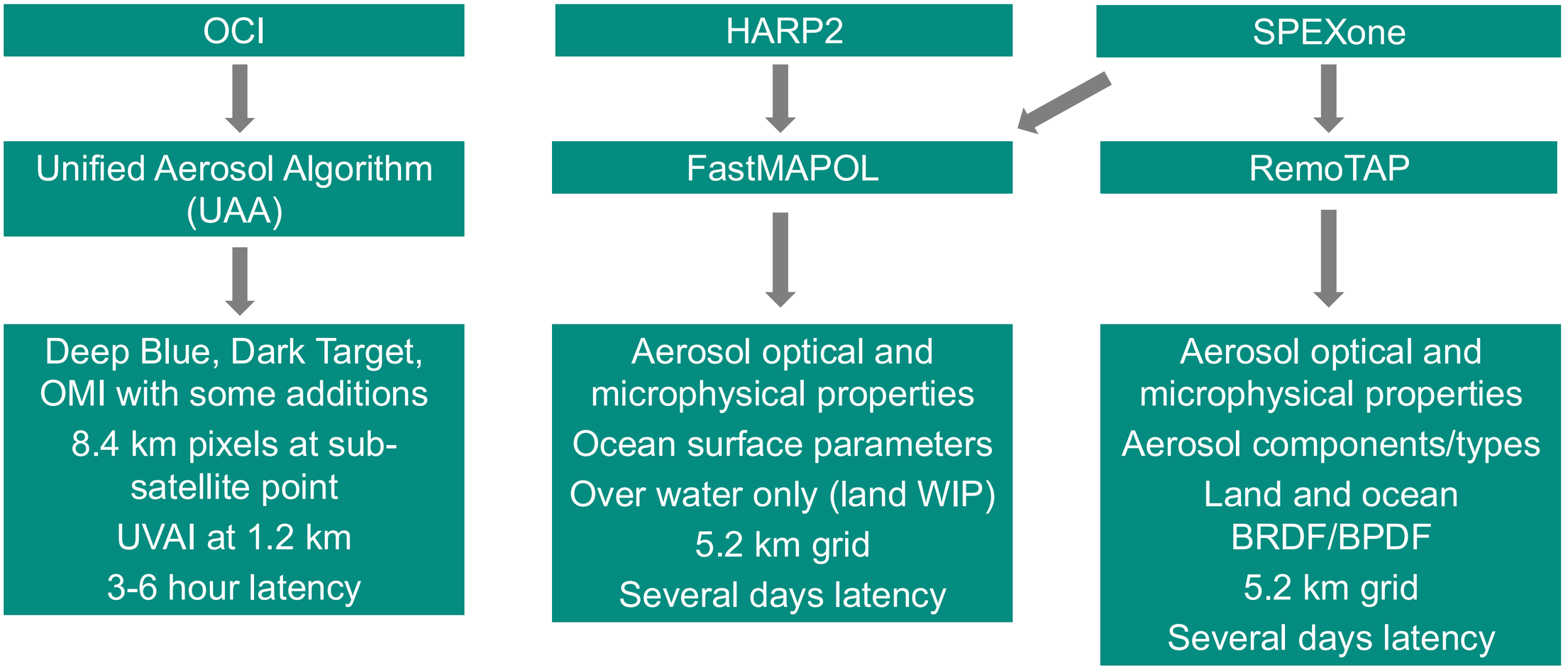
HyperAngular Rainbow Polarimeter 2 (HARP2) contributed by UMBC
440, 550, 670, 870 nm
10-60 viewing angles
Broad swath (1,500 km common)
5.2 km level 1C common grid



Spectropolarimeter for Planetary Exploration one (SPEXone) contributed by SRON
380-770 nm in 2-5 nm steps (I), 10-40 nm (DOLP)
5 viewing angles
Narrow swath (100 km)
5.2 km level 1C common grid



Current aerosol data streams from PACE



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Aerosol properties in the files

Quantity	UAA	FastMAPOL	RemoTAP
Spectral AOD	UV-NIR (land), UV-SWIR (water)	UV-NIR (water)	UV-NIR
UVAI	Yes	No	No
Above-cloud aerosols	OMI-like	No	In development
Fine/coarse split	Over water	Over water	Yes
Absorption	Two methods, high AOD only	Over water	Yes
Optical centroid height	Two methods, high AOD only	Over water	Yes
Surface parameters	No	Remote sensing reflectance	BRDF/BRDF kernels
Size distributions	No	Over water	Yes
Composition	No	No	Yes
Screened corrected TOA reflectances	Yes	No	No
Pixel level uncertainties	No	Coming soon	Yes

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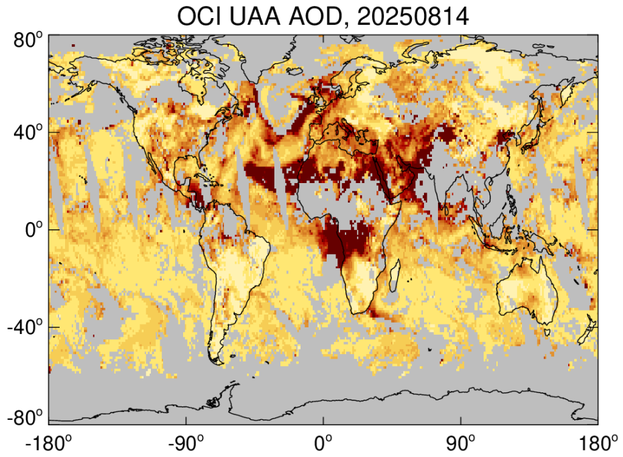
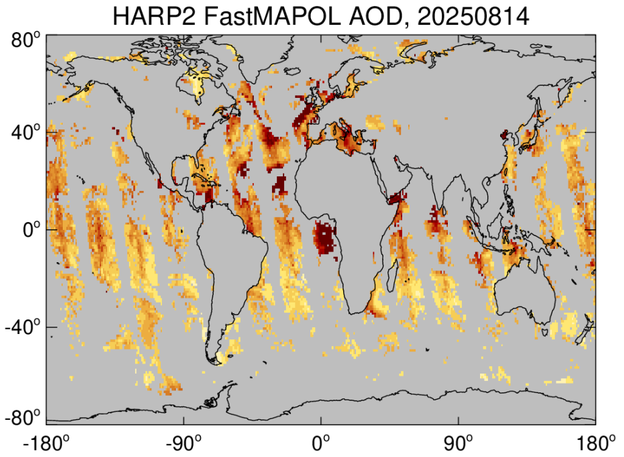
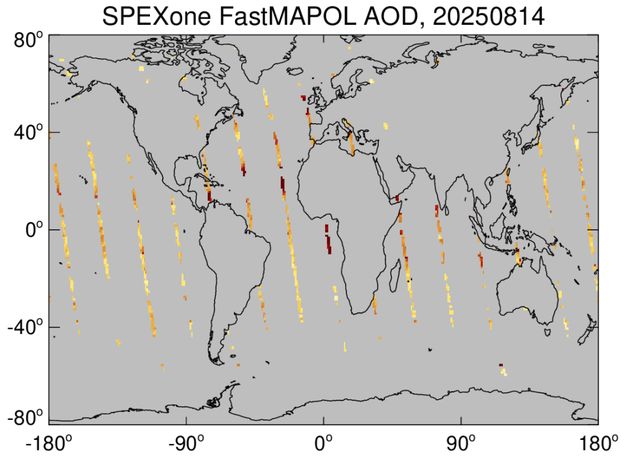
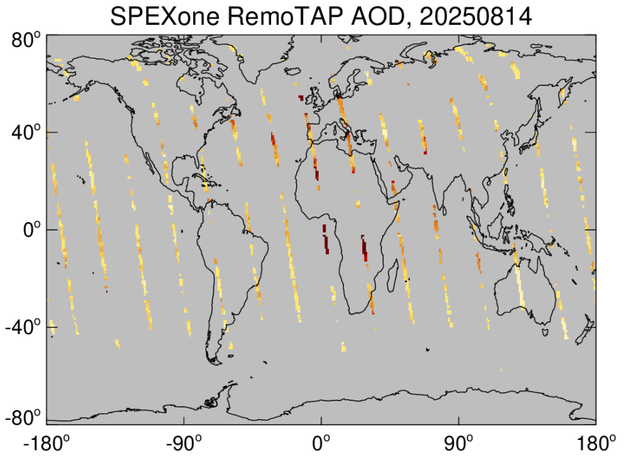
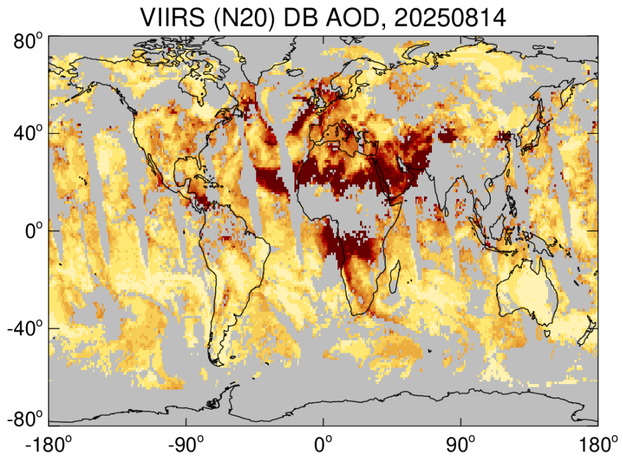
What does it look like? One day

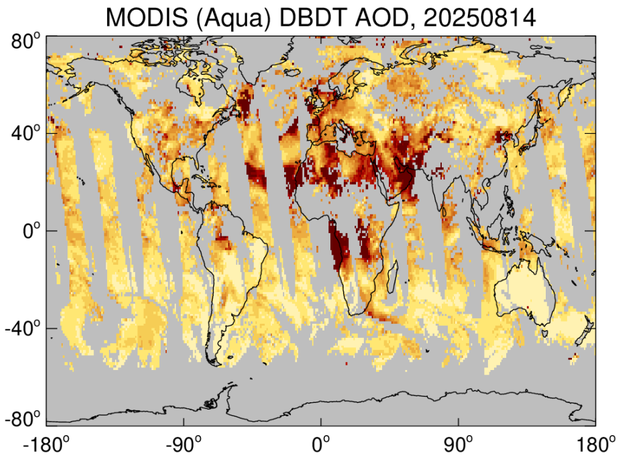


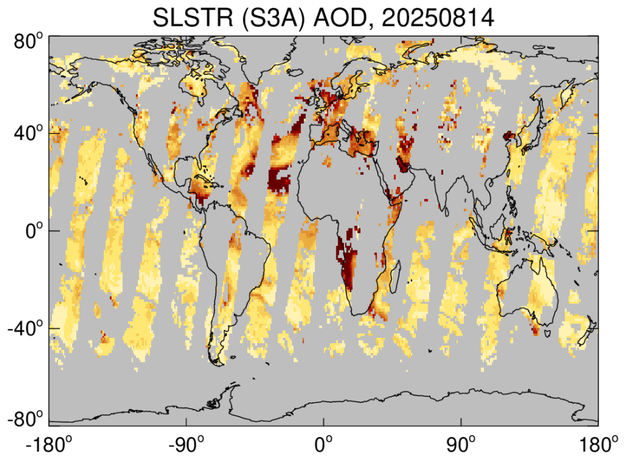


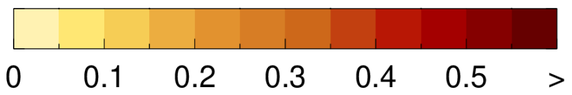












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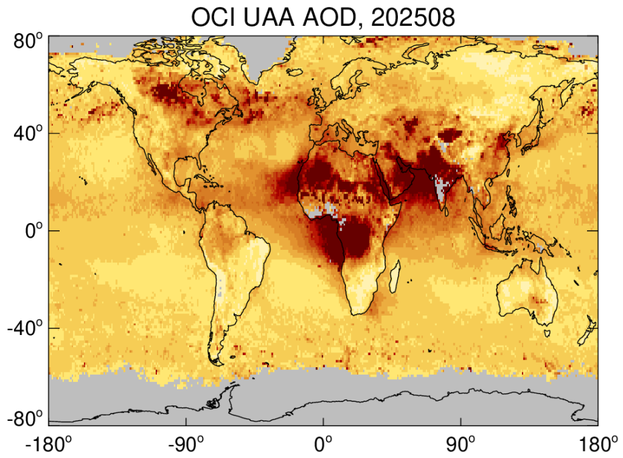
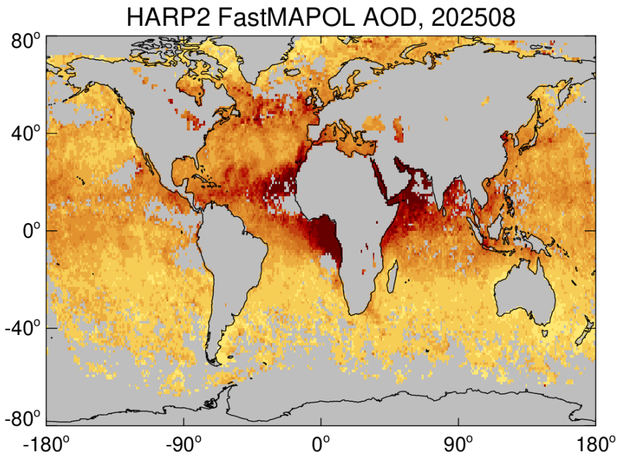
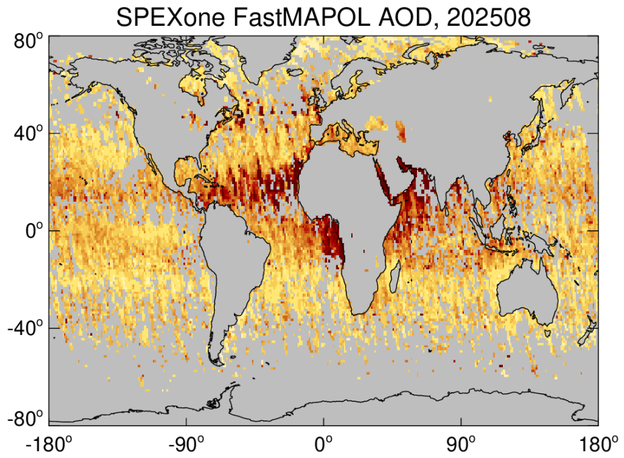
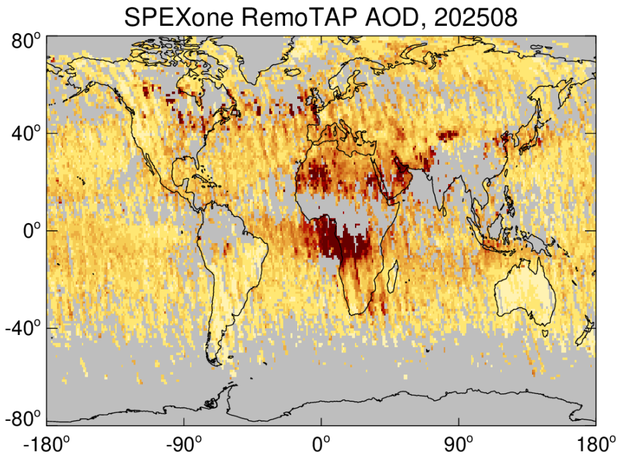
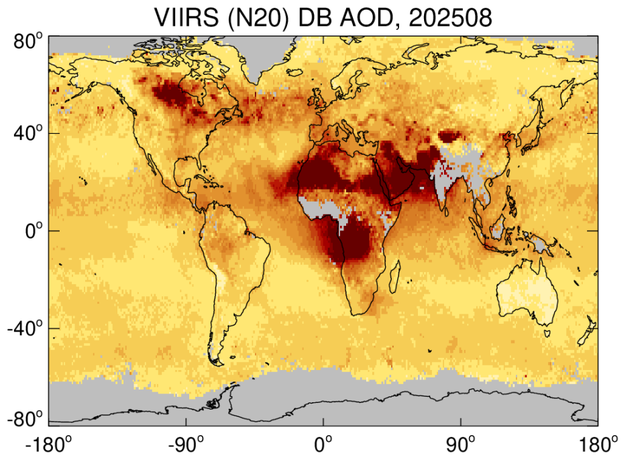
What does it look like? One month

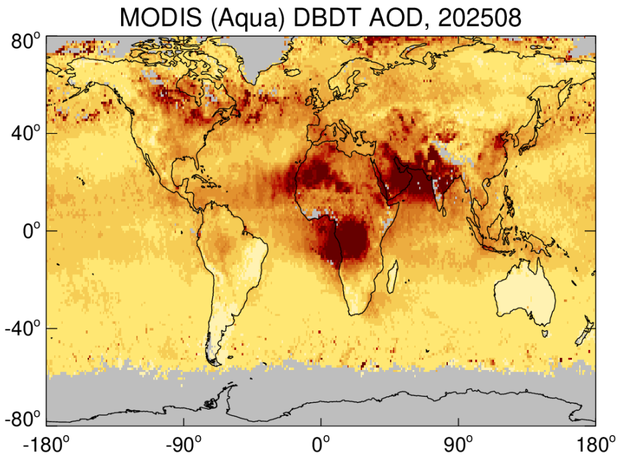


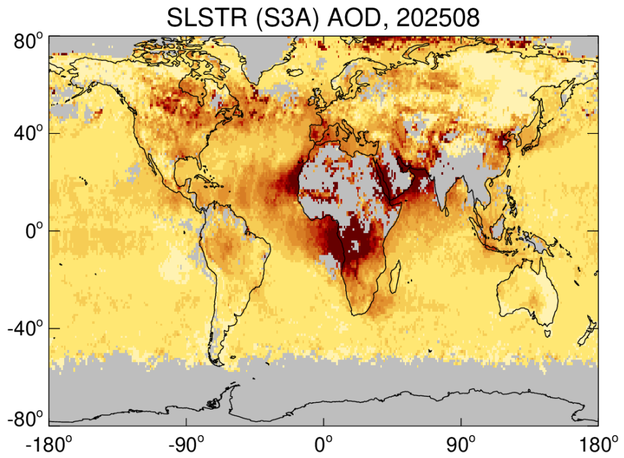


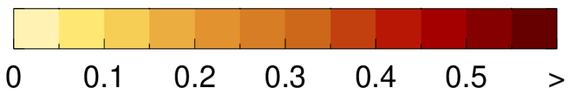












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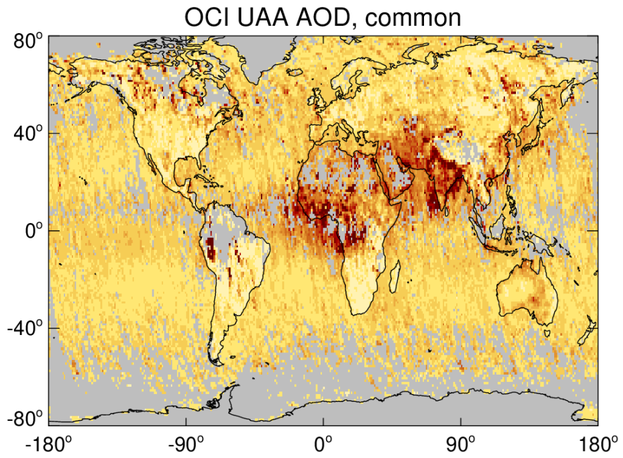
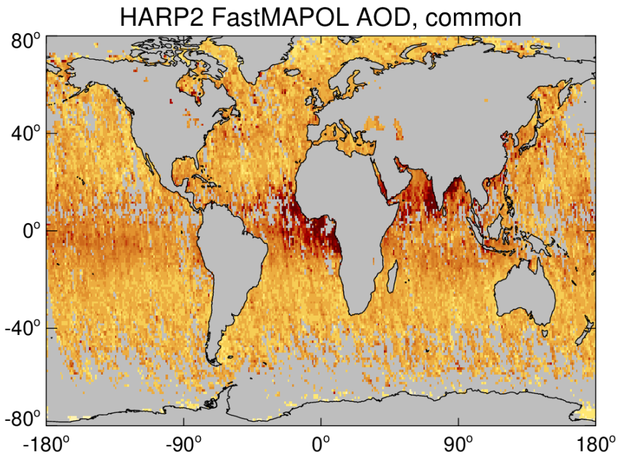
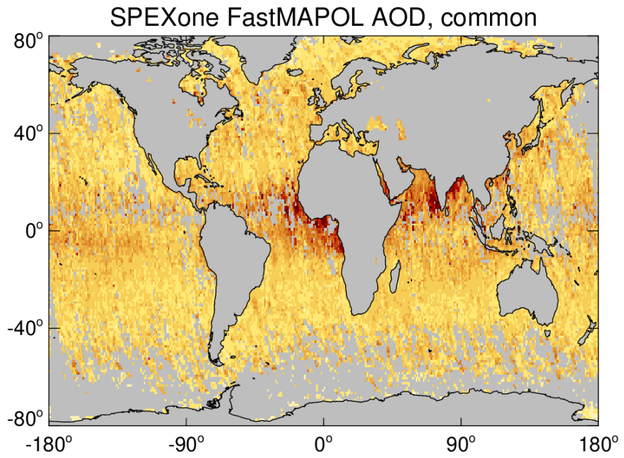
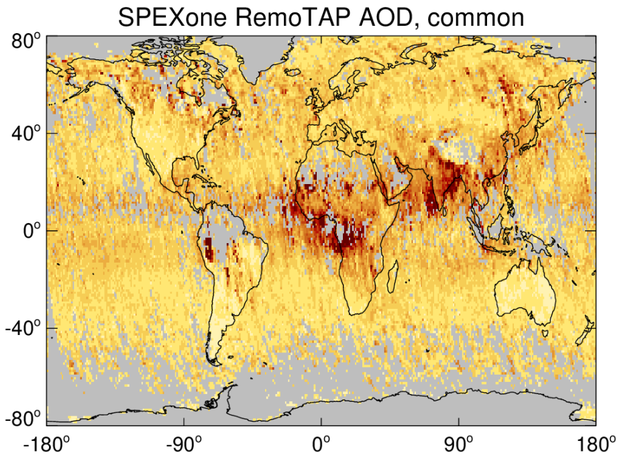
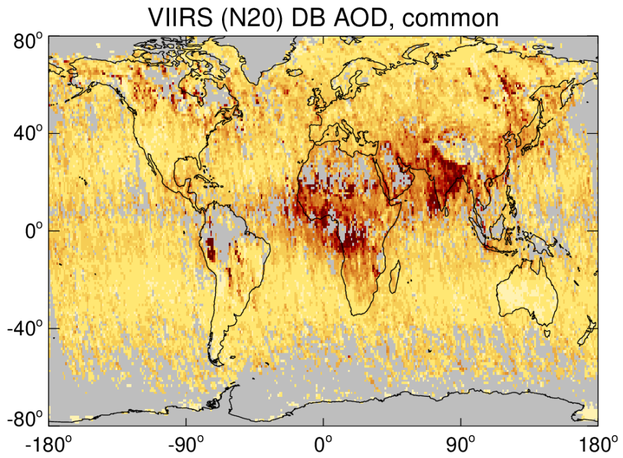
What does it look like? Common sampling

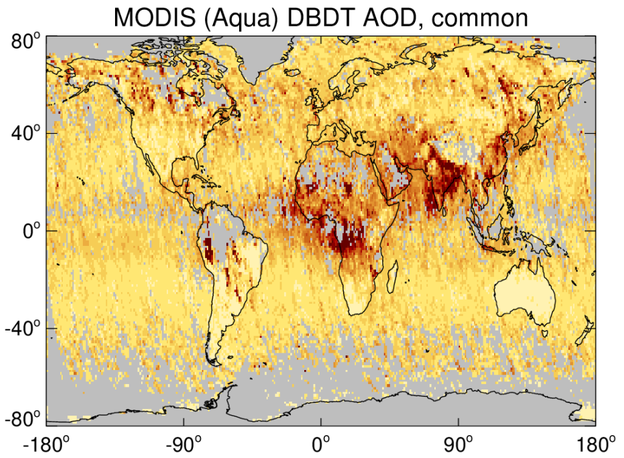


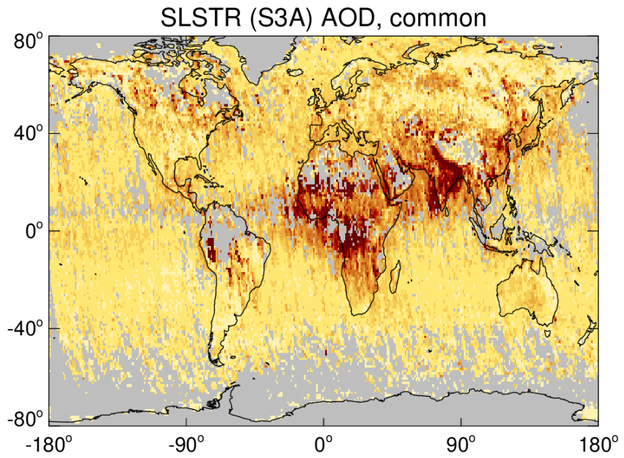


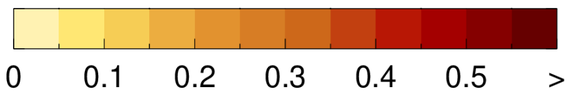












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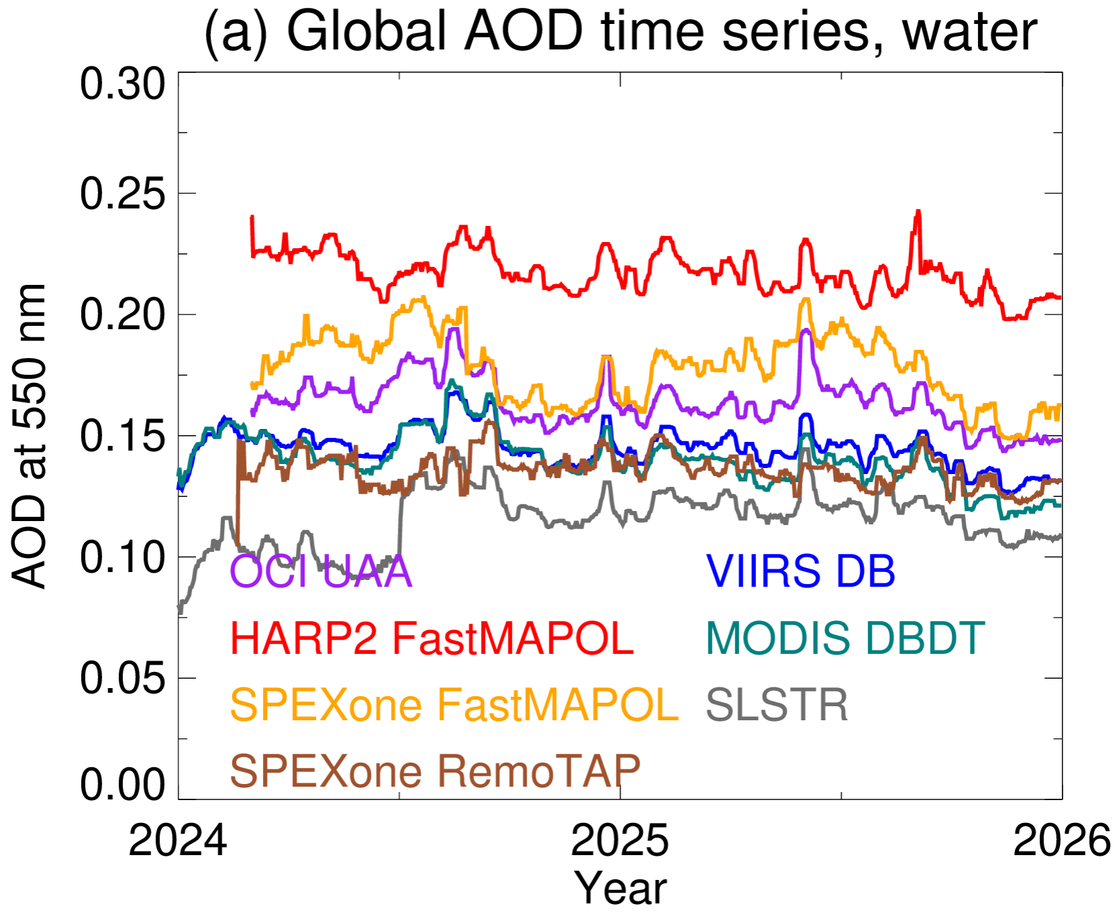
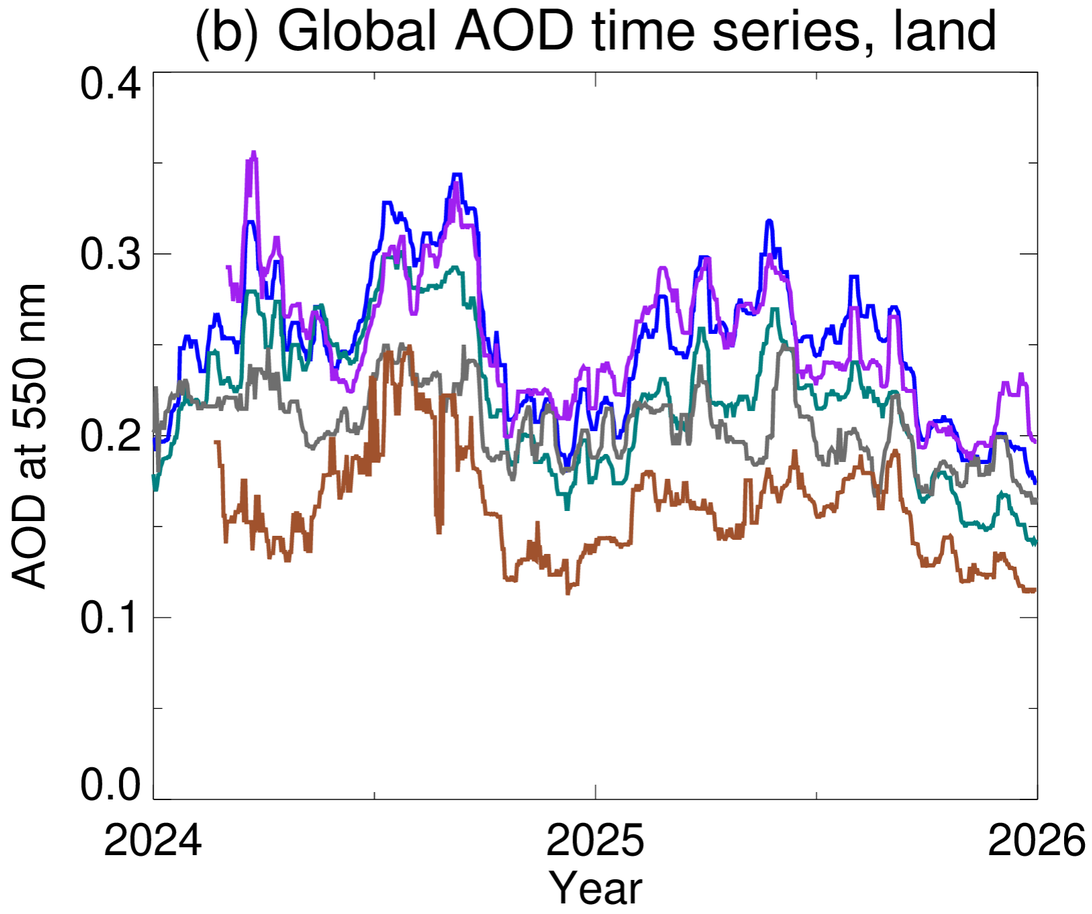
What does it look like? Time series





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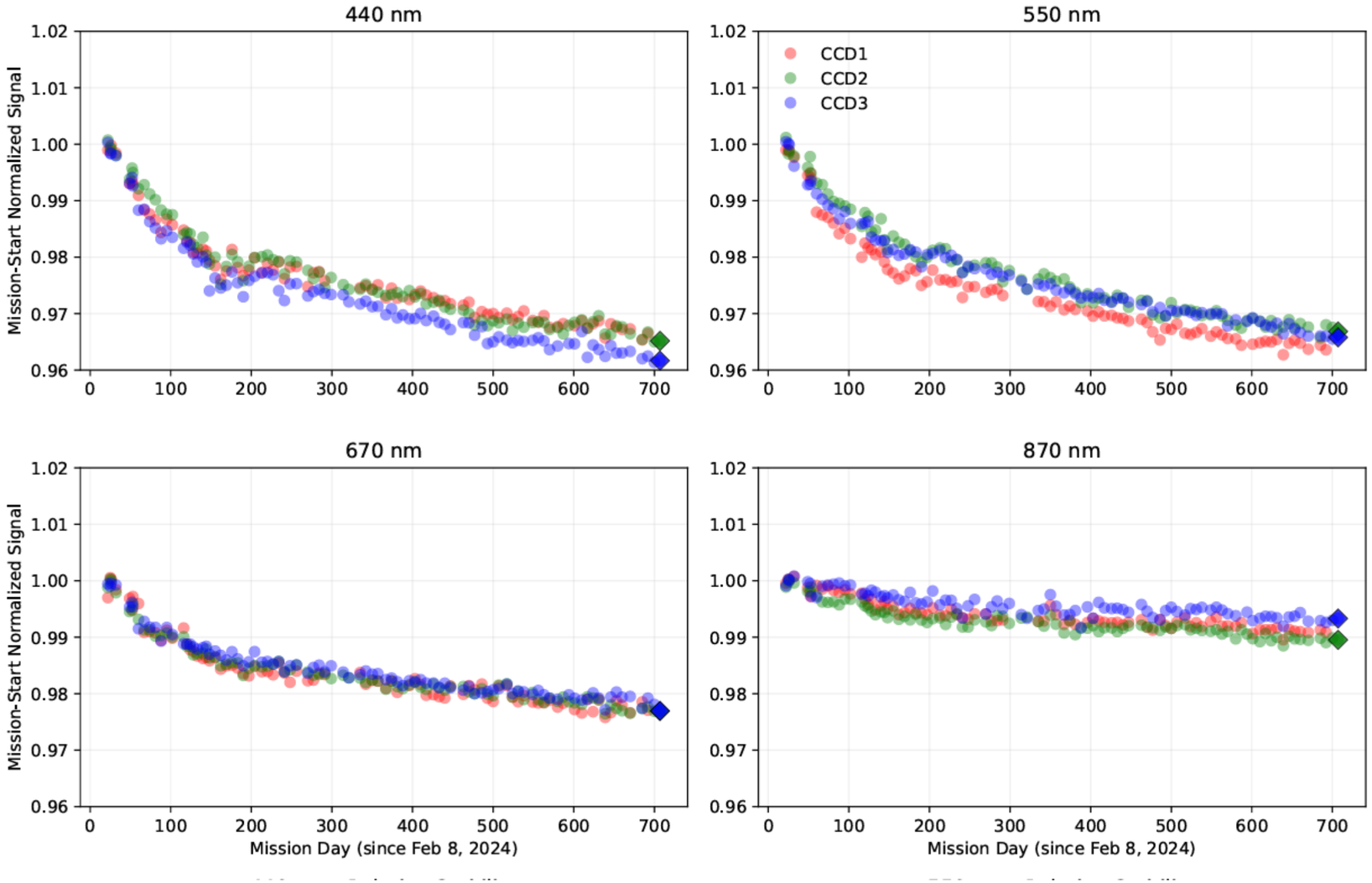
HARP2 calibration reprocessing is happening now



HARP2 Version 4 is cross-calibrated against OCI

1-4% calibration gain decrease

Non-negligible trending

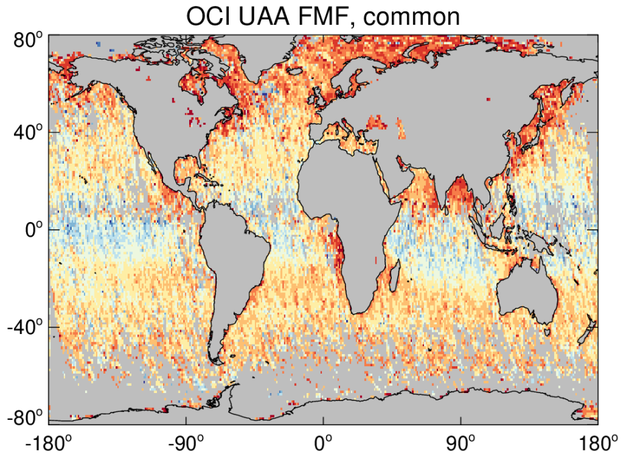
Updates to **geolocation**, **flatfielding** etc as well

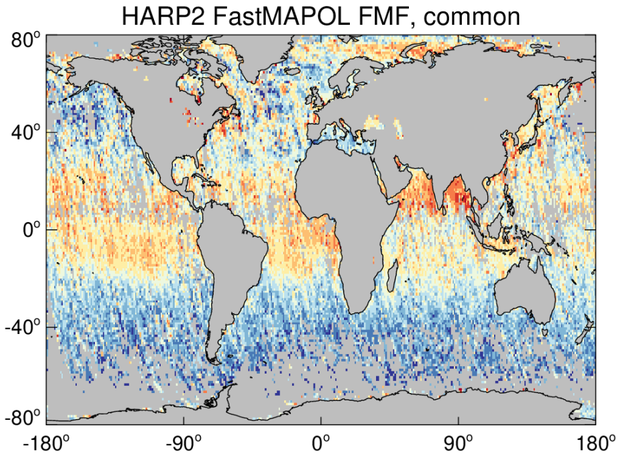
Tests show significant **drop in AOD**, more **complicated changes to FMF and SSA**

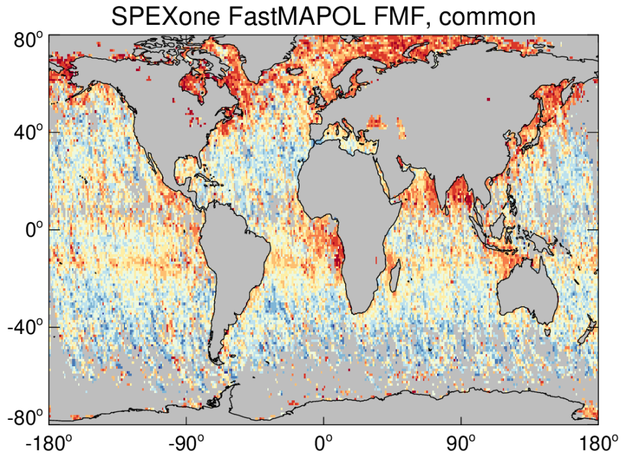
(Sorry we couldn't finish the reprocessing in time for this!)

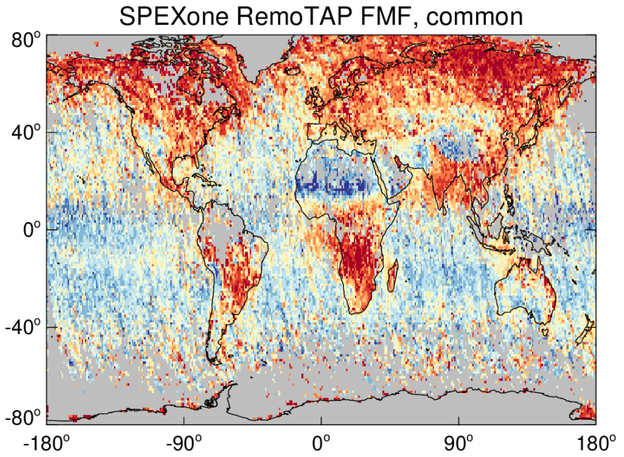
Vanderlei Martins, Richard Xu, Anin Puthukkudy, Brent McBride
Earth and Space Institute, UMBC

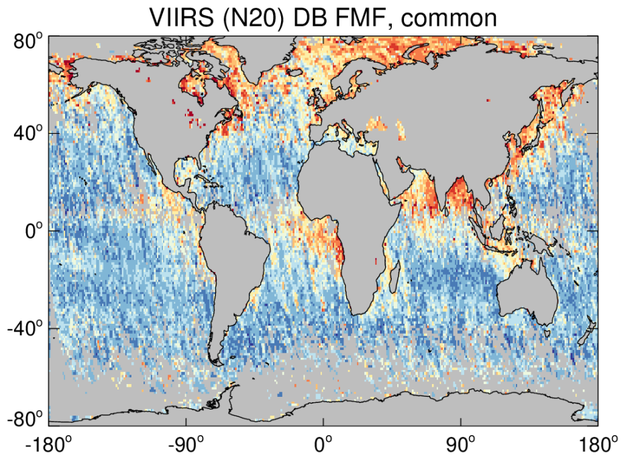
What does it look like? Common sampling

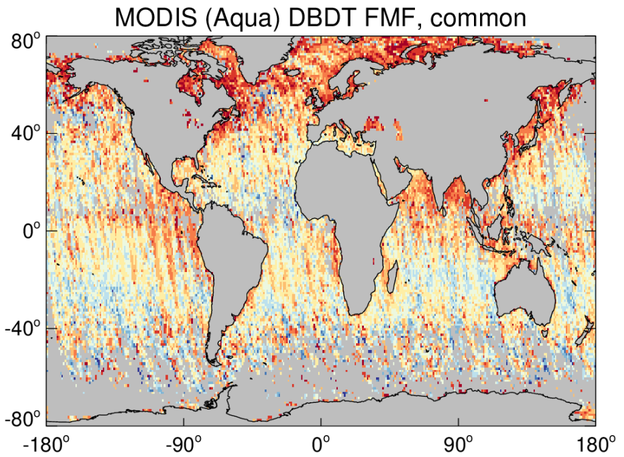


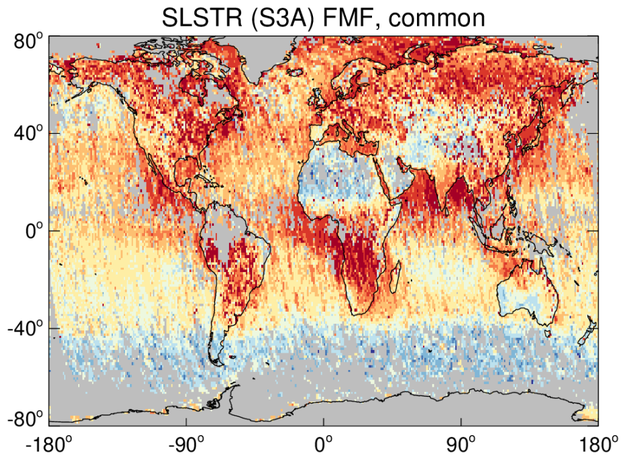


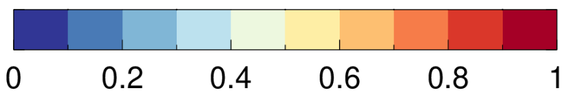












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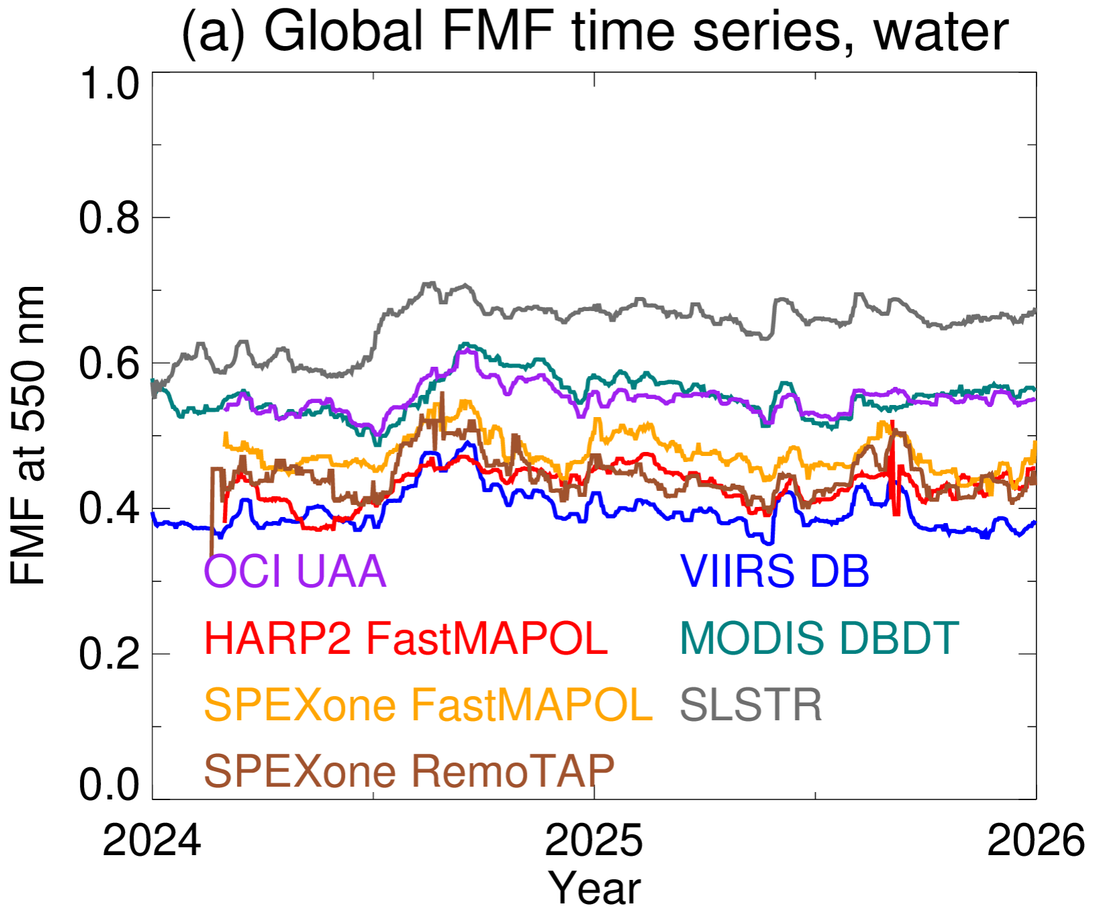
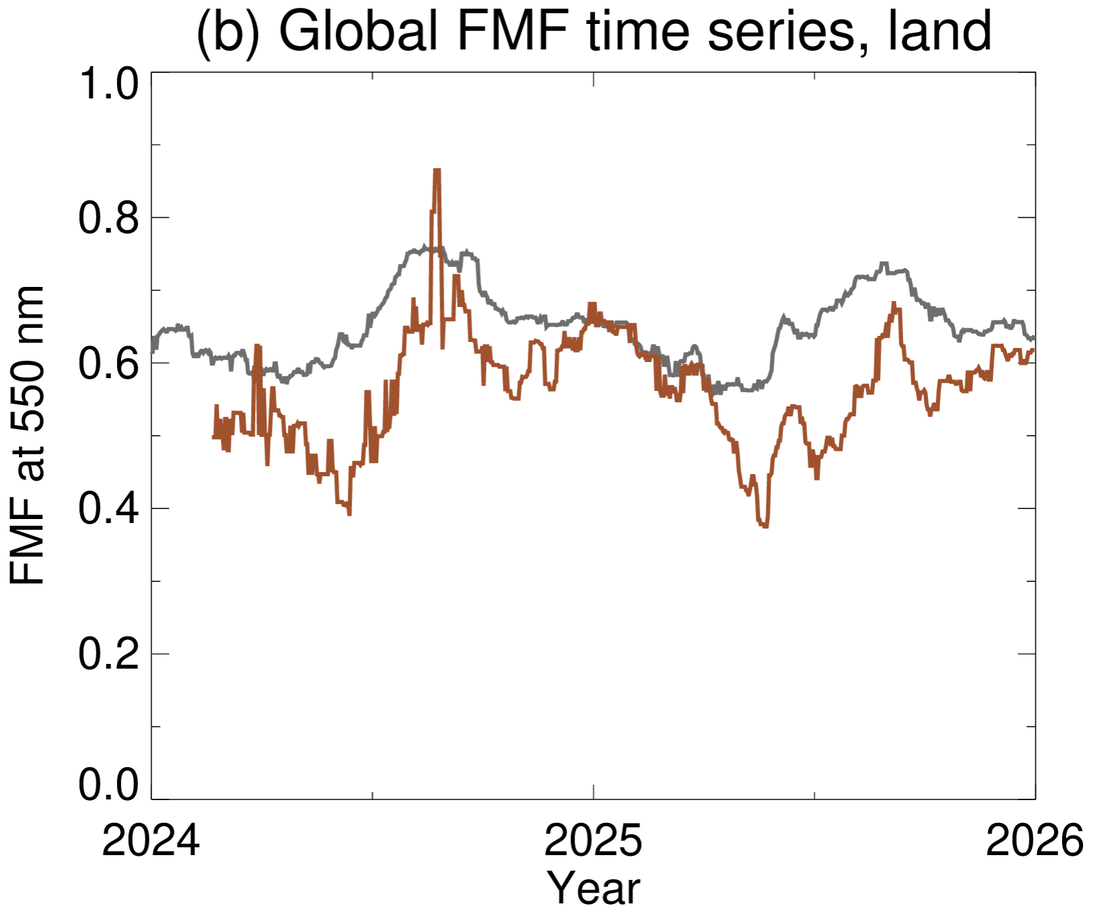
What does it look like? Time series





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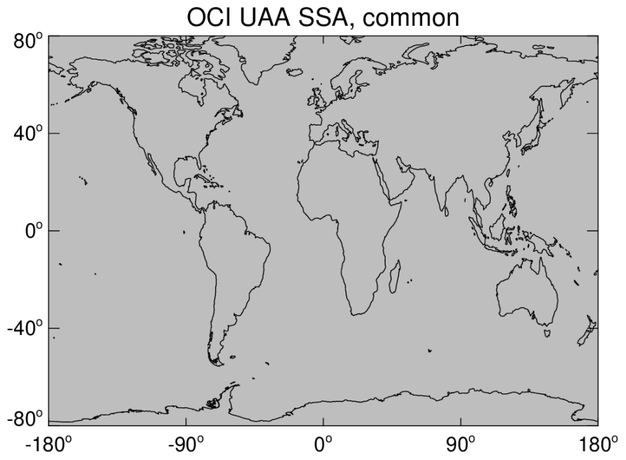

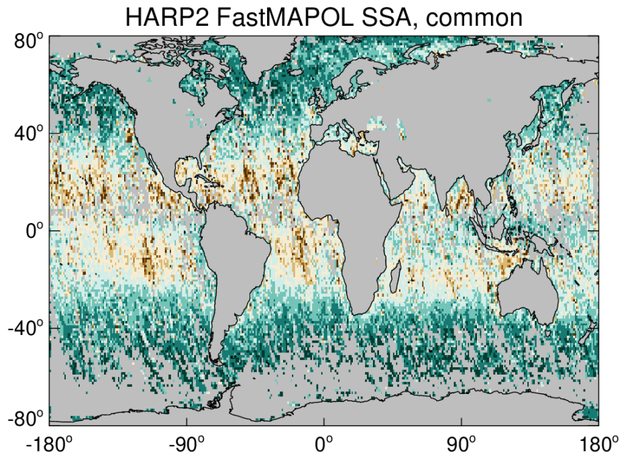

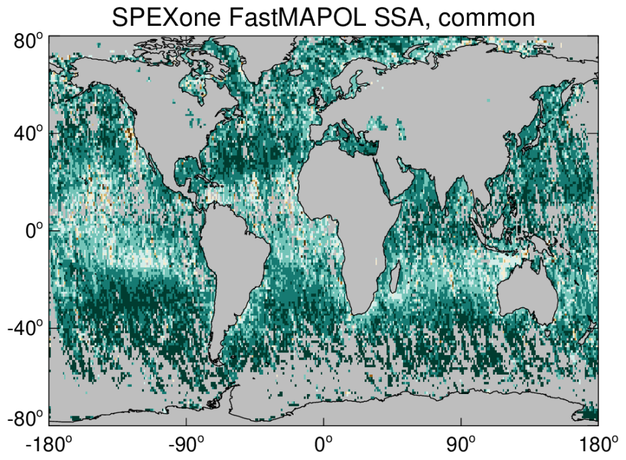

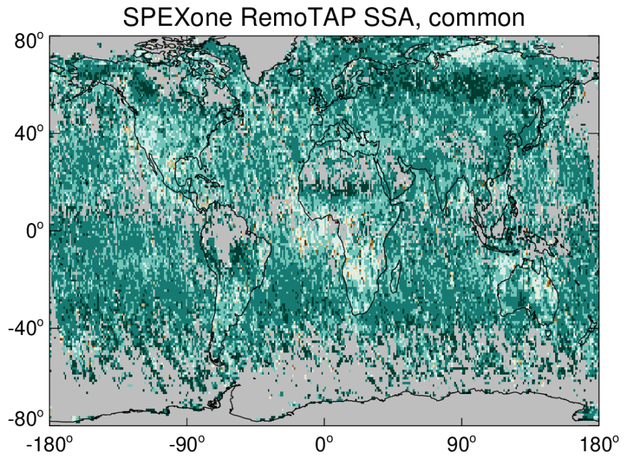

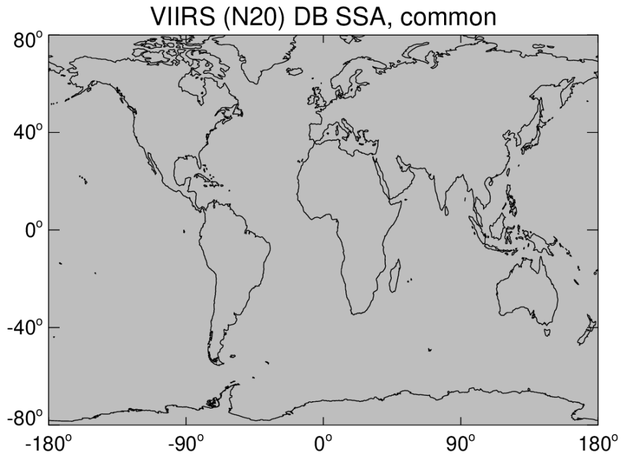

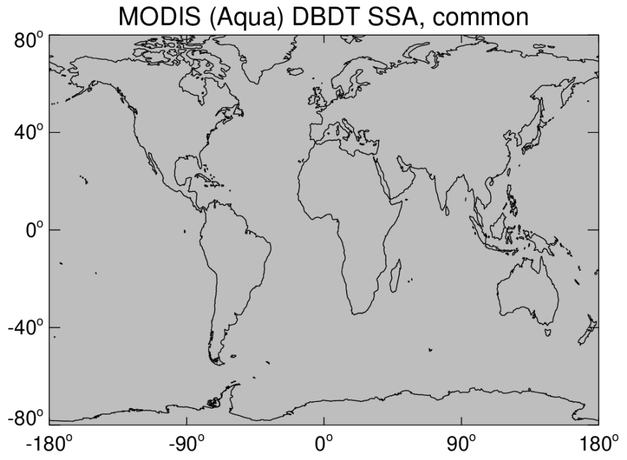

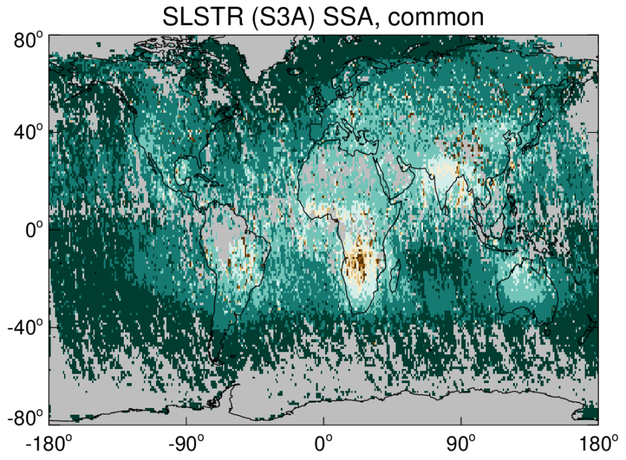

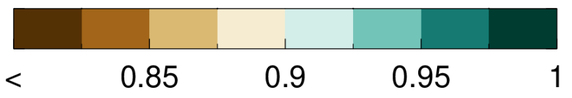

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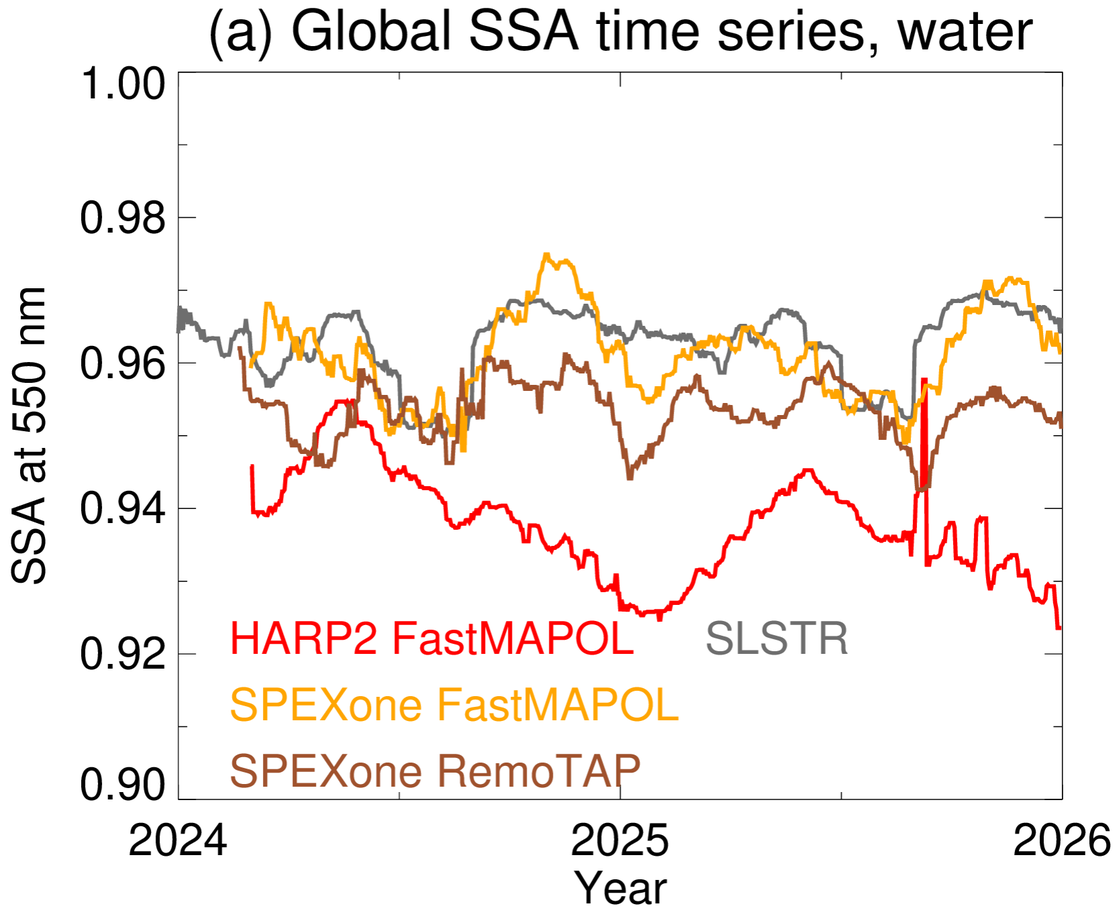
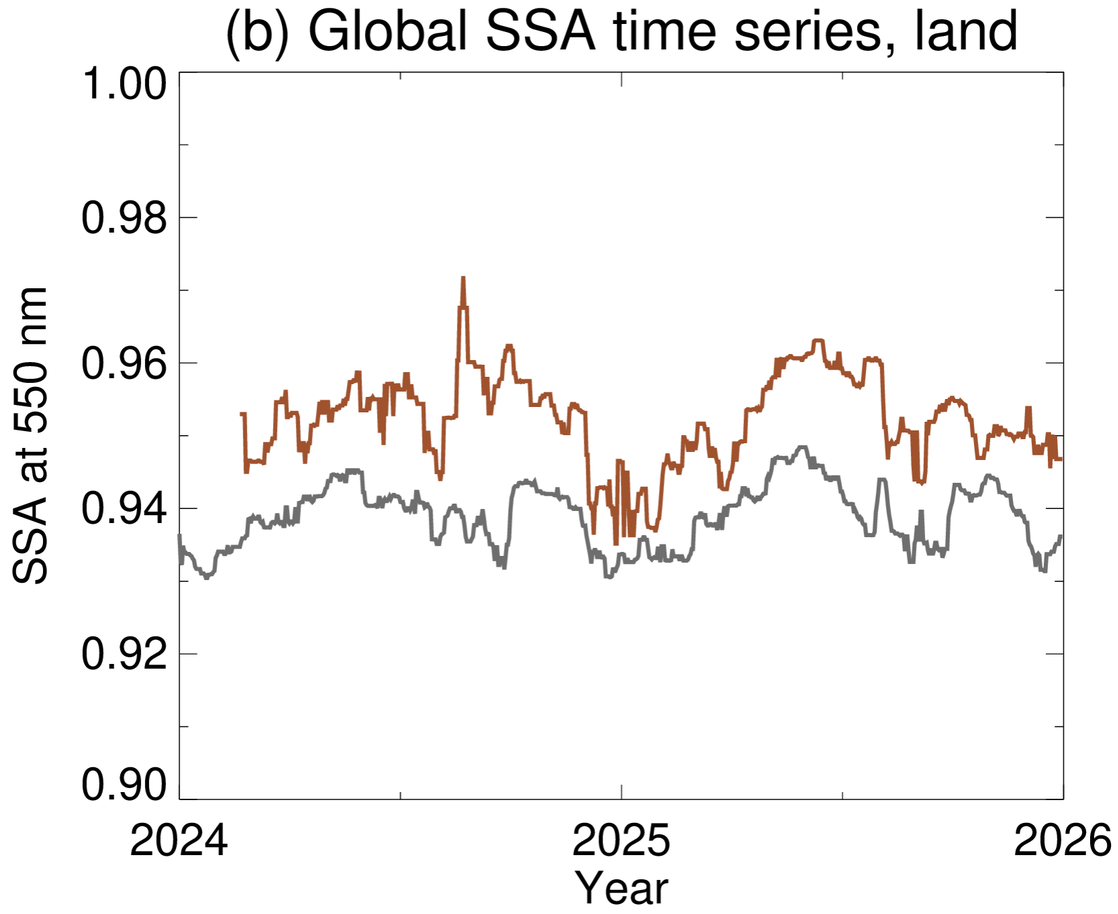
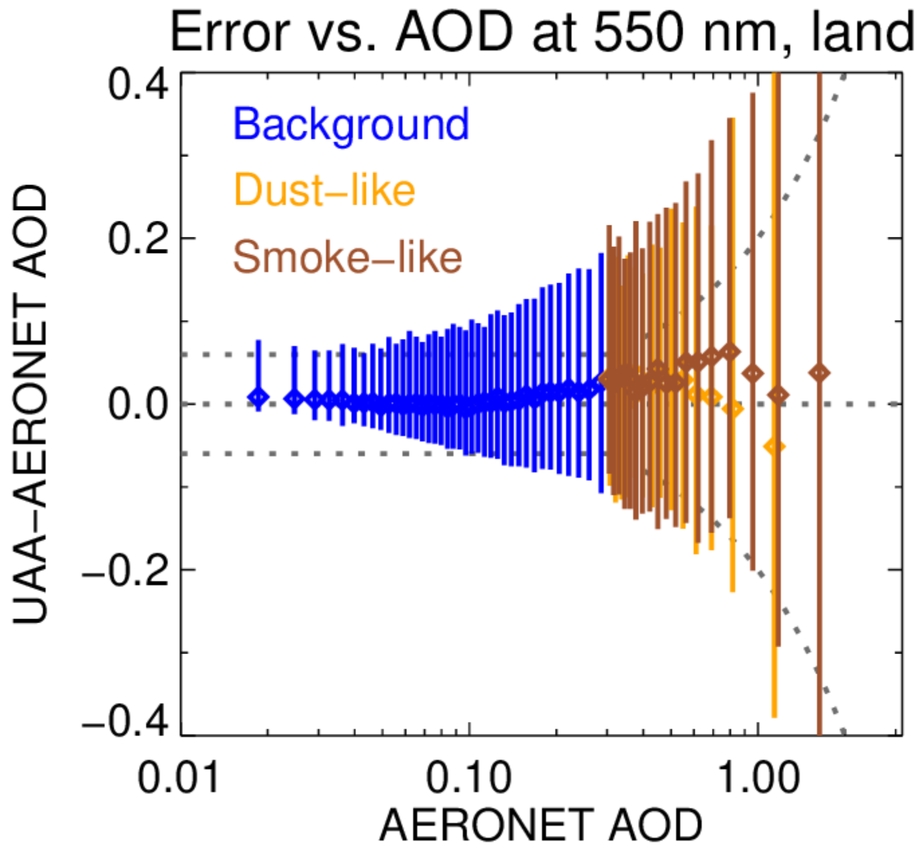
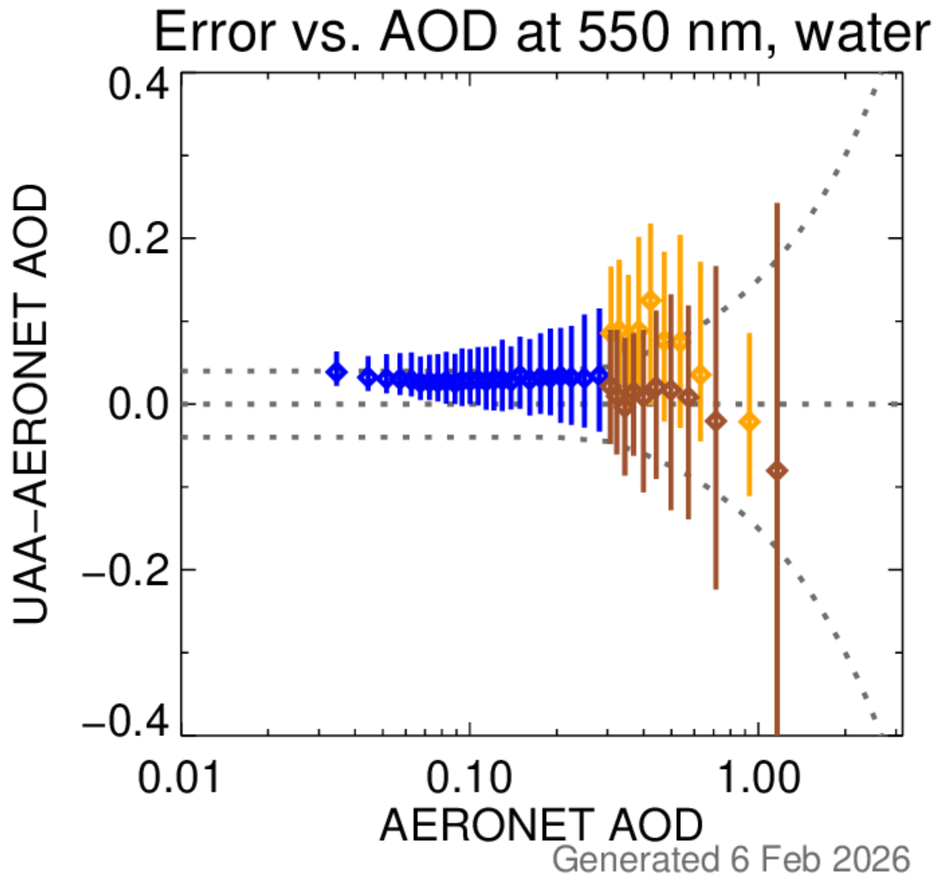




Validation with AERONET - UAA

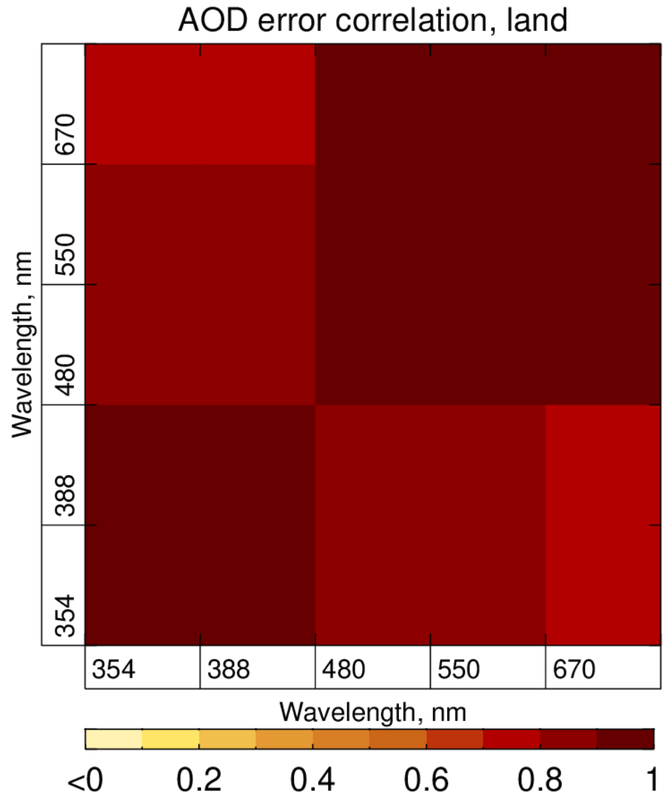


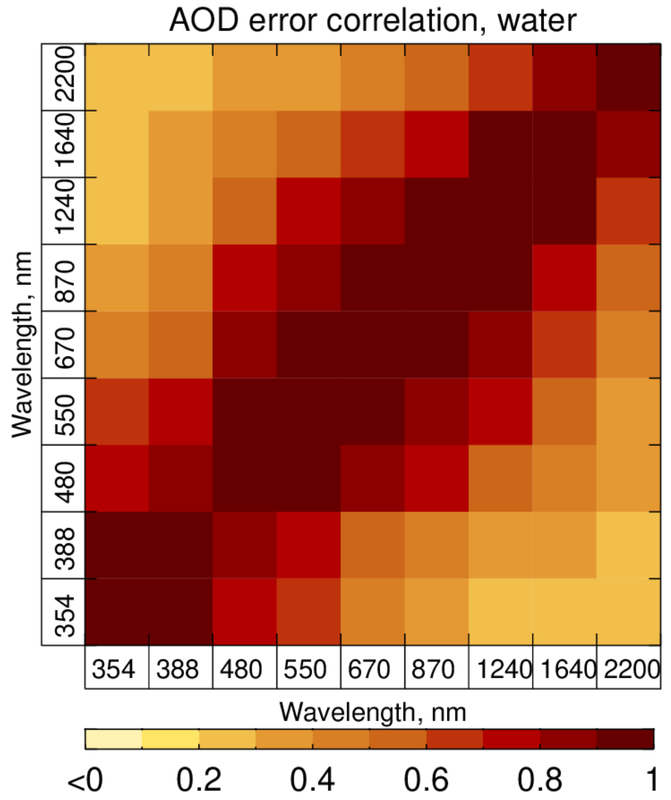


Roughly 70k matchups over land, 18k over water

Categorisations based on AERONET AOD and Ångström exponent

Validation with AERONET - UAA



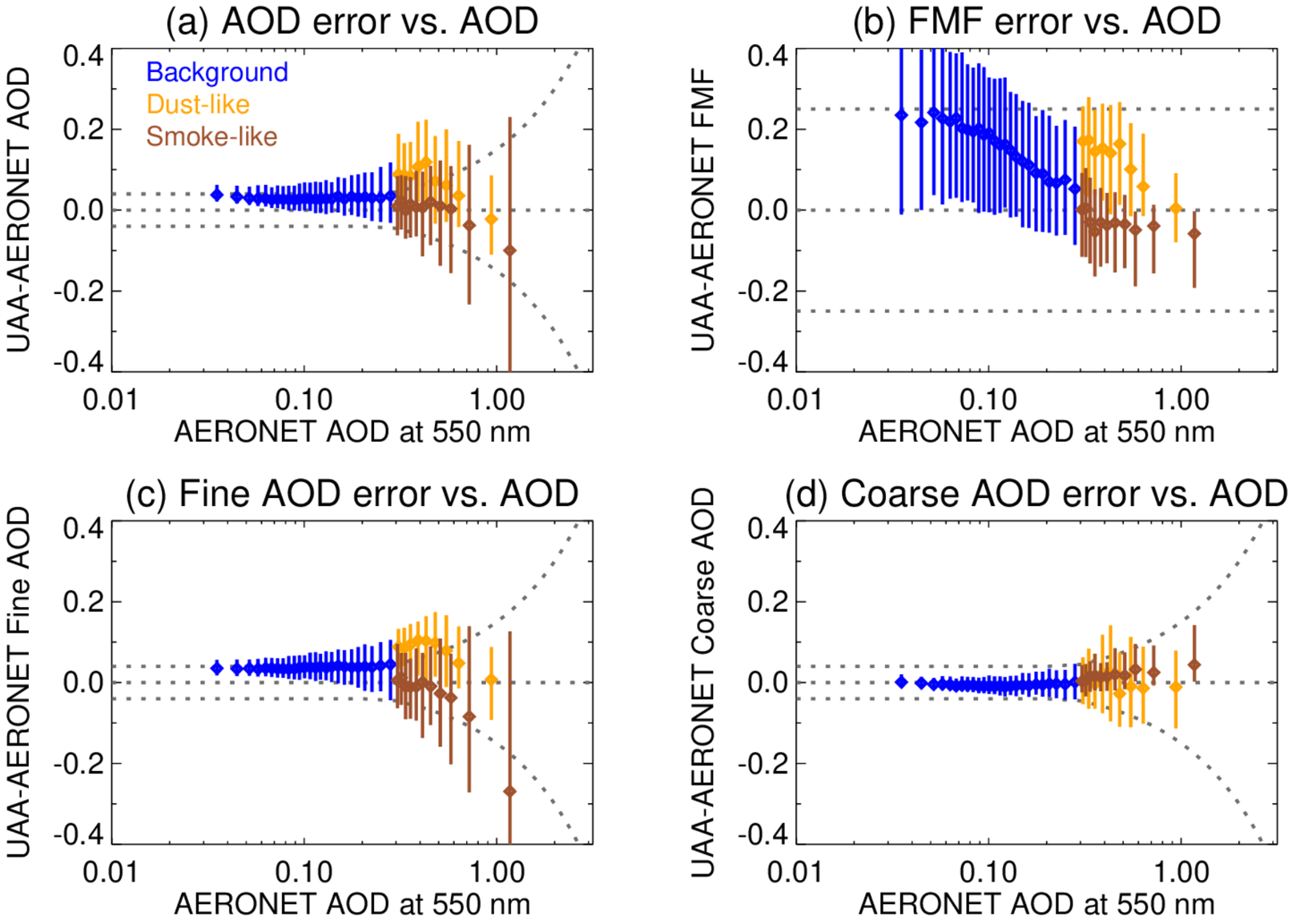


Strong positive correlations between AOD error at different wavelengths: not independent information for assimilation

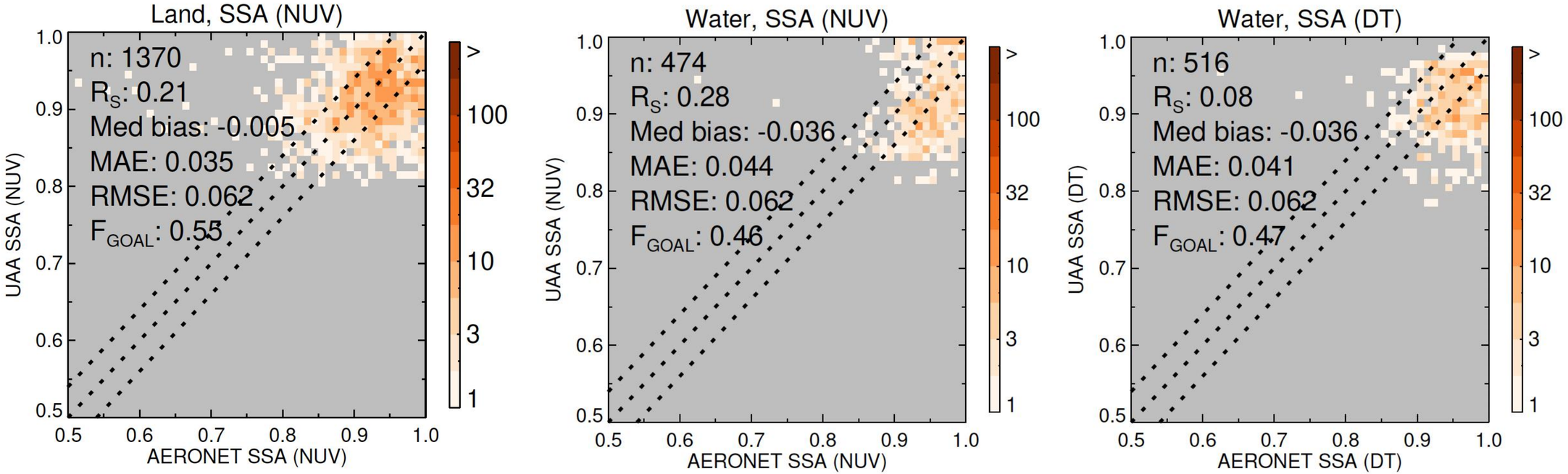
Validation with AERONET SDA - UAA

UAA AOD biases over water are mostly driven by too much fine mode

Similar behaviour shown in ~200 MAN matchups



Validation with AERONET inversions - UAA



SSA matchups **fairly limited** at time of analysis

Uncertainty of AERONET and satellite SSA **not small** compared to range

What's the **best metric** to look at? SSA or AAOD?

Planning to look at **UV** SSA (AERONET, MFRSR) soon

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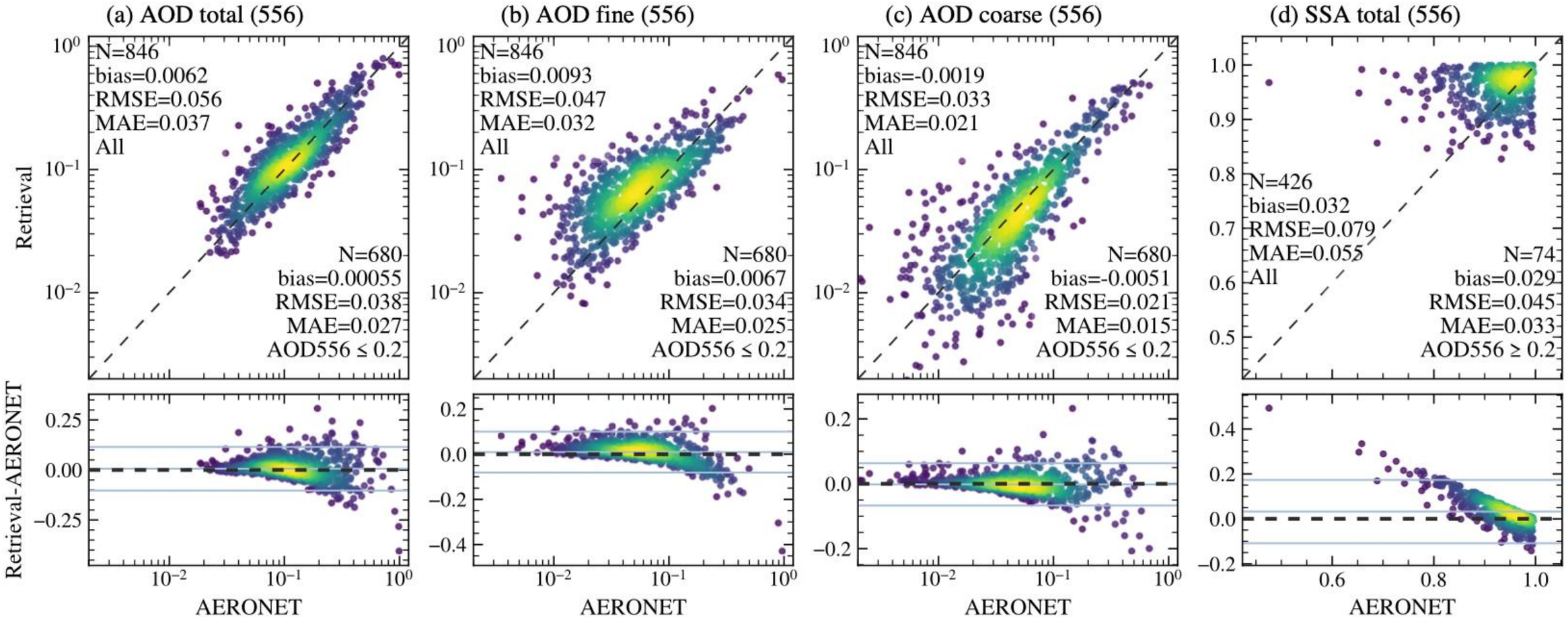
Validation with AERONET – FastMAPOL (SPEXone)



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

Validation of aerosol height – all products

Working on it…

Is optical centroid height even useful for assimilation?

Some closing thoughts

OCI **continues heritage aerosol products** with (hopefully) sufficient latency for assimilation

PACE polarimeter latency too high for assimilation but hopefully **pathfinders** for testing operational 3MI?

At a minimum, polarimetry should give **lower-error AOD** for assimilation (but it would be a shame if that's all your community gets from it)

Evaluation of properties **beyond AOD is challenging**, especially away from AERONET sites – some are not yet mature

EarthCARE **orbit makes it difficult** to use as a validation resource

Sorry that there are **still biases** you need to take care of

Where should we focus our attentions to help the data be more suitable for assimilation?

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AeroCom

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25th AeroCom / 14th AeroSat workshop

Kyushu University, Fukuoka, Japan

12–16 October 2026

Abstract submission extended to **June 15** 2026!

Joint session on **PACE**, **EarthCARE**, and **3MI**!

https://aerocom.met.no/events/aerocom2026