



EarthCARE 2026 Science and Validation workshop

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EarthCARE MSI/ATLID aerosol products, development and validation: a step forward (EVID-36, EVID-38)

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- MSI
 - M-AOT processor overview (AOT = AOD)
 - AOD products
 - Visual inspection
 - Validation with AERONET
 - Analysis of the outliers
- ATLID

M-AOT processor overview

- M-AOT retrieval based on **optimal estimation** using pre-calculated **LUTs** for ocean and land.
- **Microphysical properties** used for LUT calculations are based on **HETEAC*** aerosol classification
- LUTs calculated for **25 different aerosol component mixing ratios**
- Only for **cloud-free** (confident clear) conditions

Input:

- MSI L1 RGR VIS, NIR, SWIR-1, SWIR-2 radiances
- M-CM cloud mask and surface classification
- X-MET, ECMWF meteorological state

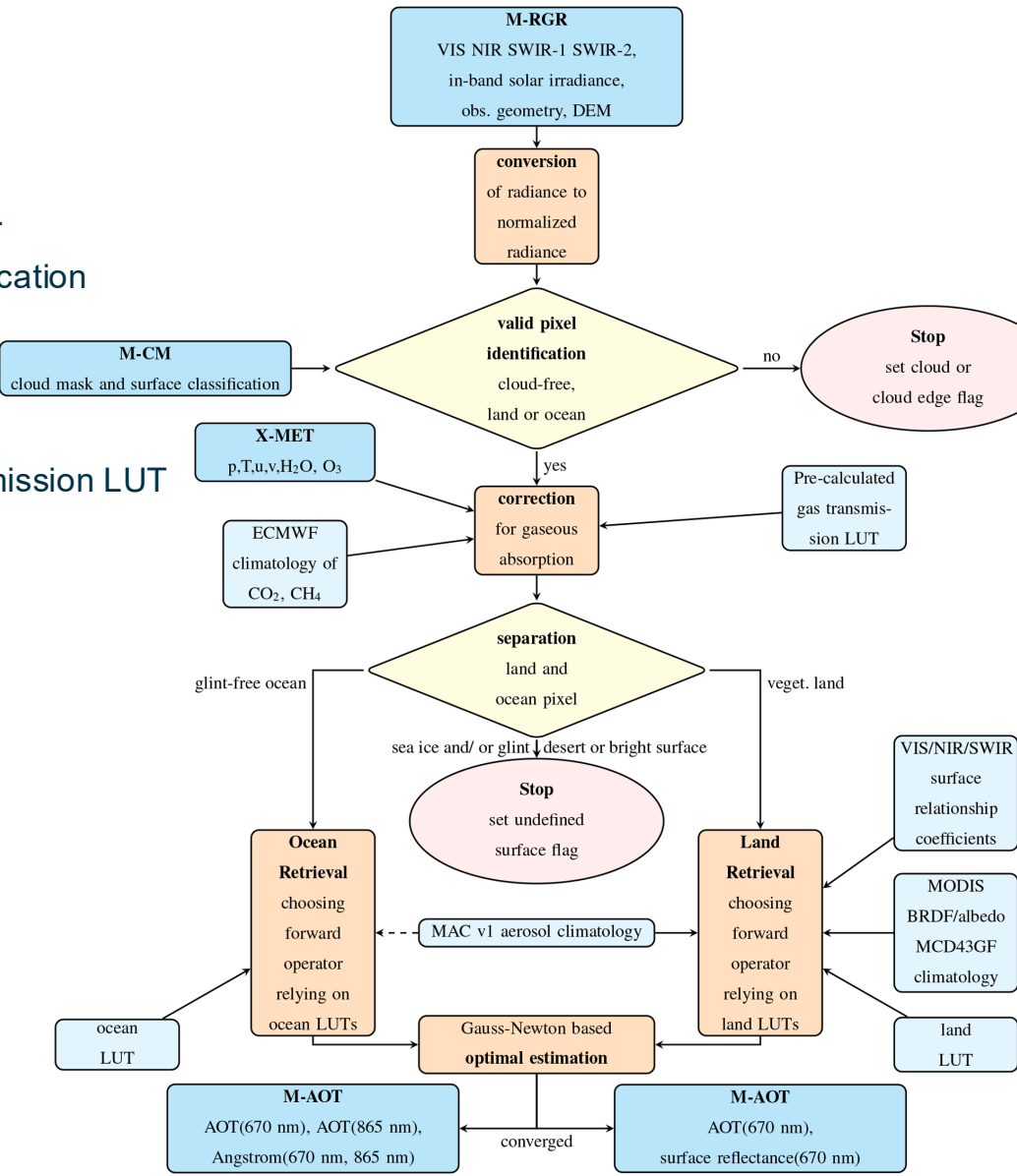
- MODIS BRDF/albedo
- Pre-calculated gas transmission LUT
- Land LUT <-> ocean LUT

Output:

- **AOT at 670nm over the ocean** and, where possible, **land + error (uncertainty)**
- **AOT at 865nm only for the ocean + error (uncertainty)**
- **Angstrom parameter (670nm,865nm)** calculated based on AOT retrievals

Baseline Evolution

Base-line	Start Date (Frame)	Stop Date	Most important Updates
BC	23 Apr 2026 (10804C)		MSI L1 RGR SWIR1 maintenance gain update; CCDB v16
BC	18 Nov 2025 (08374A)	23 Apr 2026 (10804B)	Increase of pixel allowed close to cloud edges (now 5 instead of 10).
BA	27 May 2025 (05651C)	18 Nov 2025 (08376)	MSI VNS maintenance gain update and usage of theoretical solar (spectral) irradiances; CCDB v15. Reprocessed!

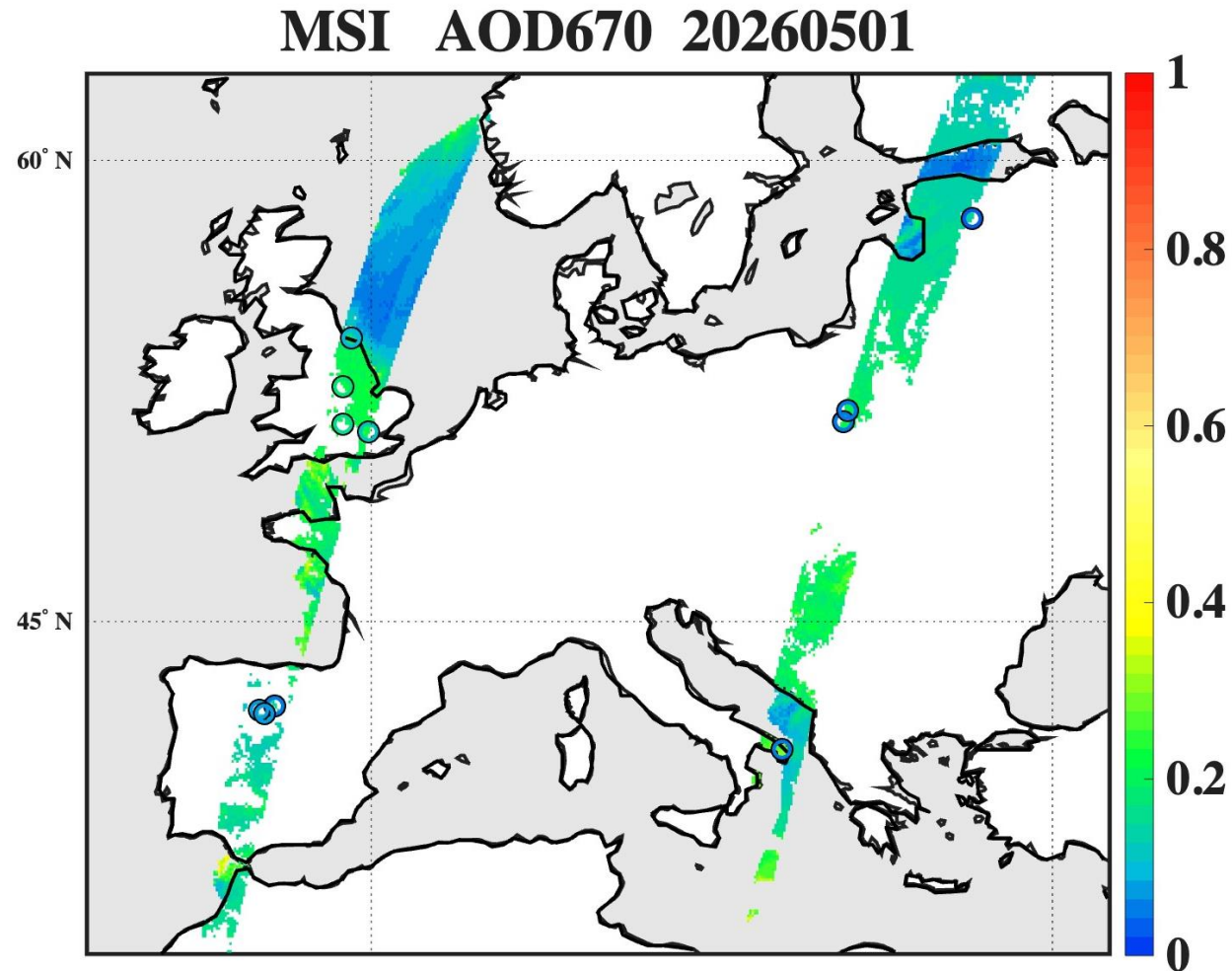


Docter, N., et al., <https://doi.org/10.5194/amt-16-3437-2023>, 2023.
Docter, N., et al., <https://doi.org/10.5194/amt-17-2507-2024>, 2024.
Wandinger, U., et al. <https://doi.org/10.5194/amt-16-2485-2023>, 2023.

MSI AOD670: visual inspection (1)



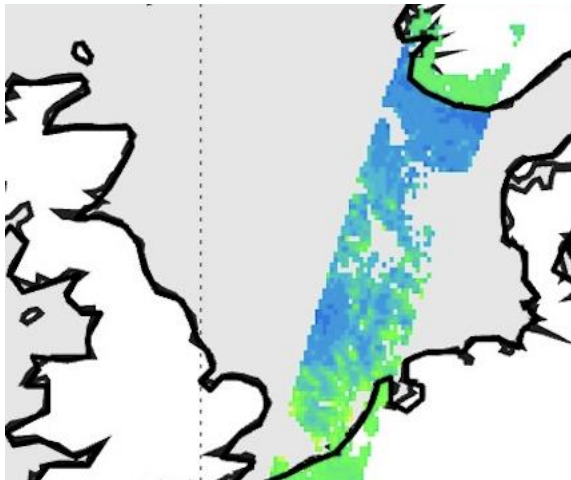
- GOOD retrievals
- Low AOD slightly overestimated
- Ocean/land discontinuity
 - MAC climatology over land
 - dynamically derived aerosol model over the ocean



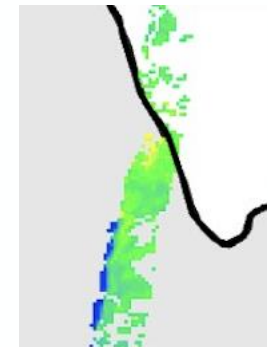
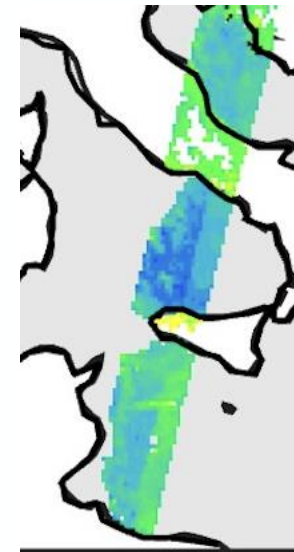
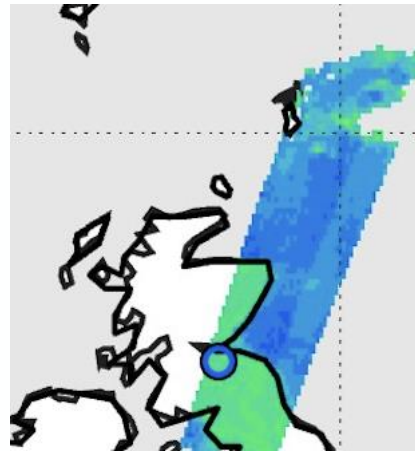
MSI AOD670: visual inspection (2) ocean



Nice variation over ocean



Vertical stripes?

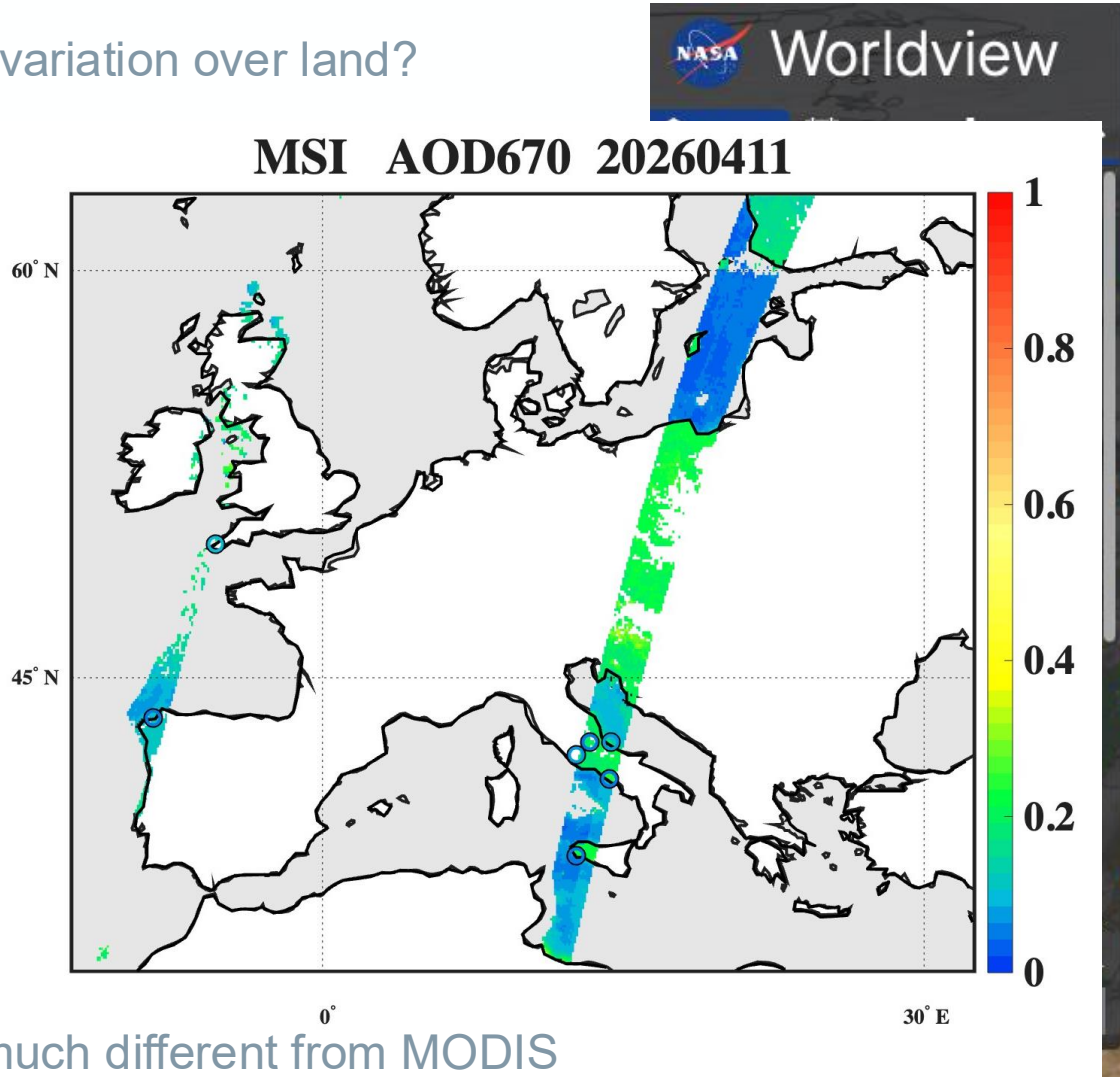


- Possible reason
 - dynamical selection of Aerosol model over Ocean
- Possible solution
 - A better characterization of the SMILE in the LUTs in future baselines might reduce the striping (TROPOS)

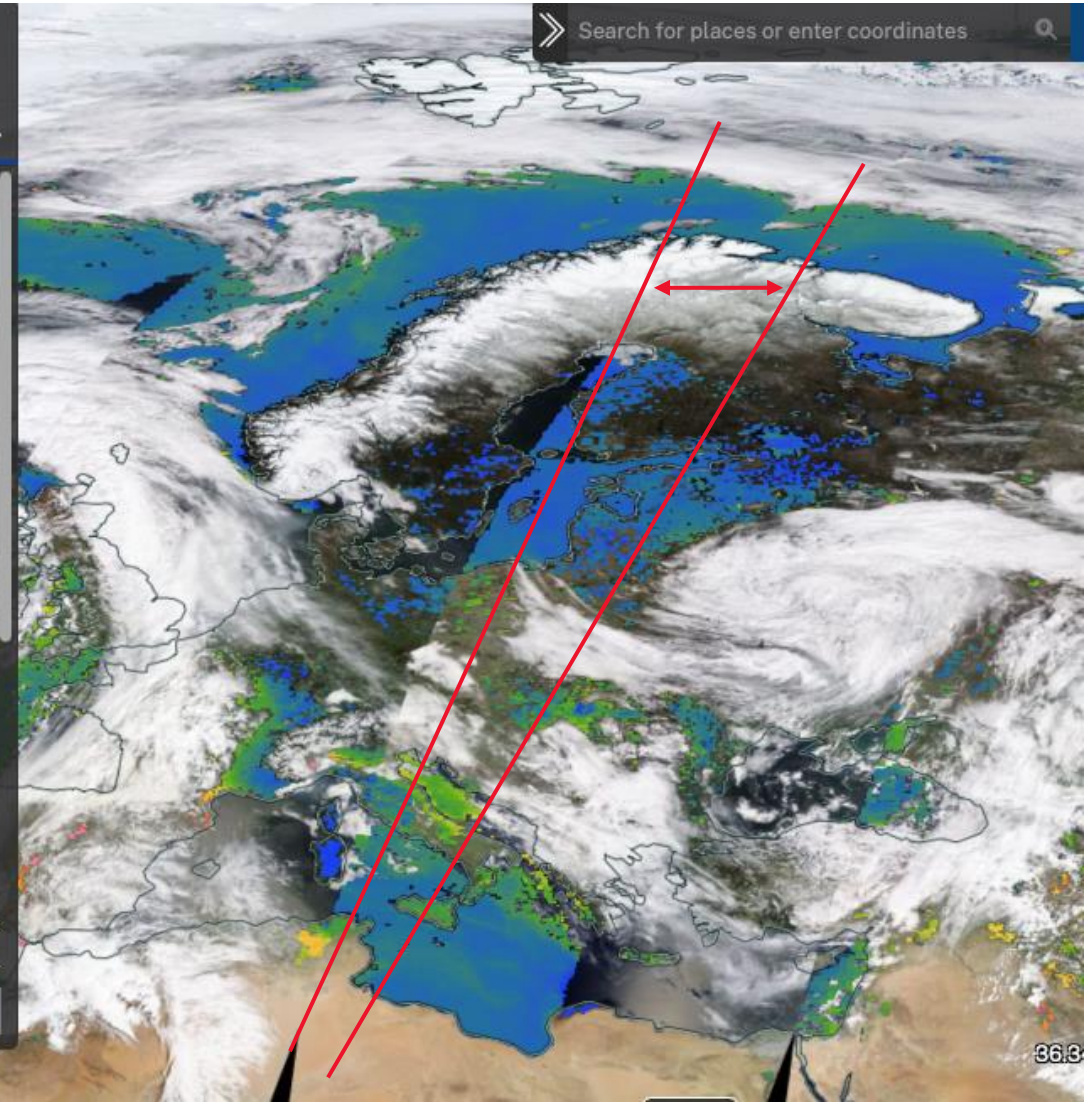
MSI AOD670: visual inspection (2) land



Too little variation over land?



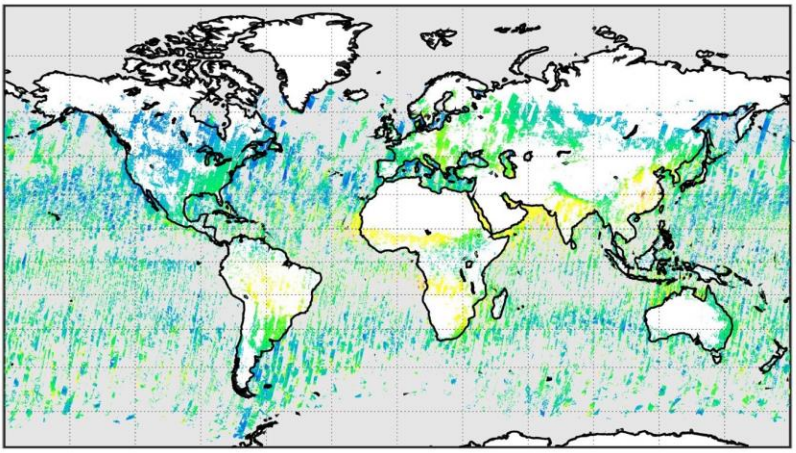
Not much different from MODIS



MSI AOD670: visual inspection (3) monthly AOD

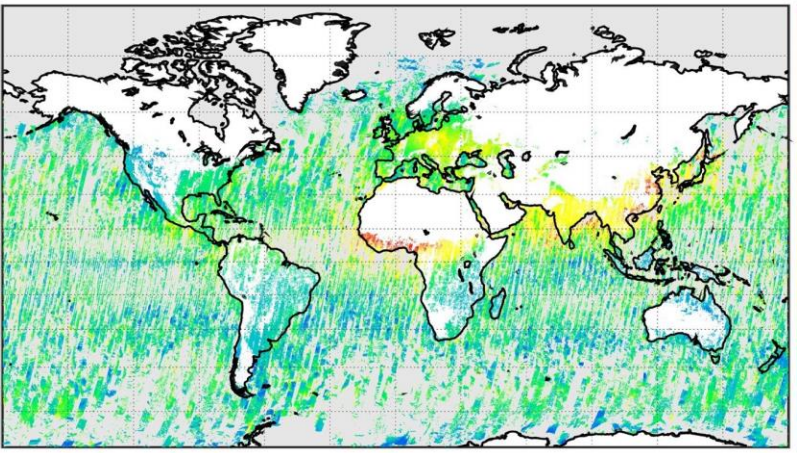
BA

MSI AOD670 202510



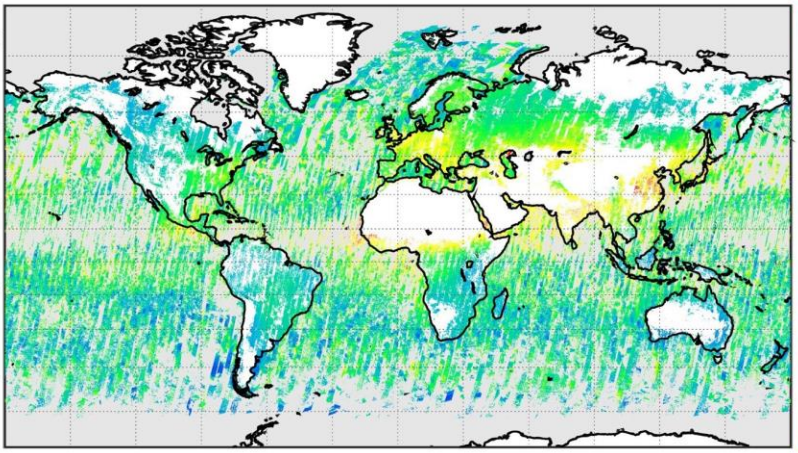
BC

MSI AOD670 202603

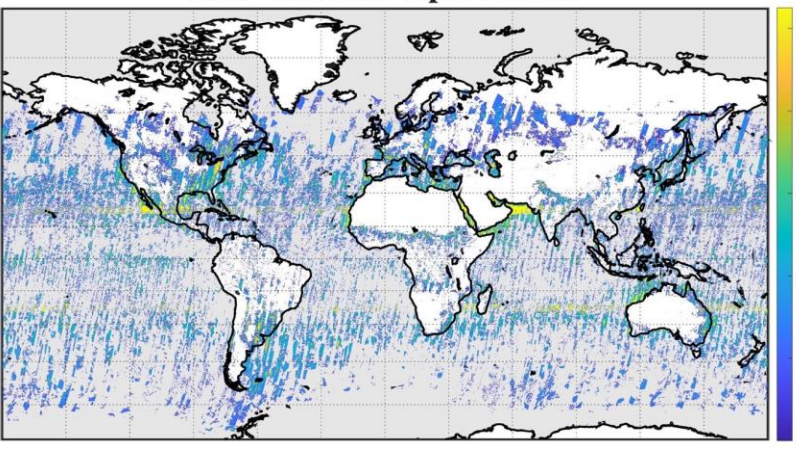


BC_{SWIR1}

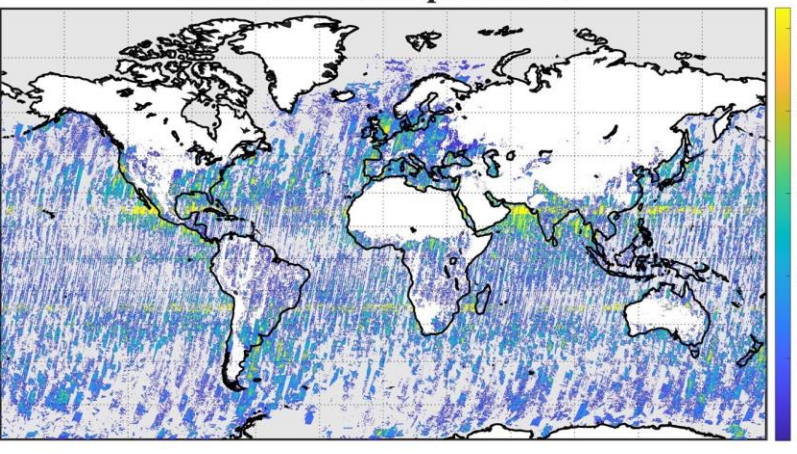
MSI AOD670 202605



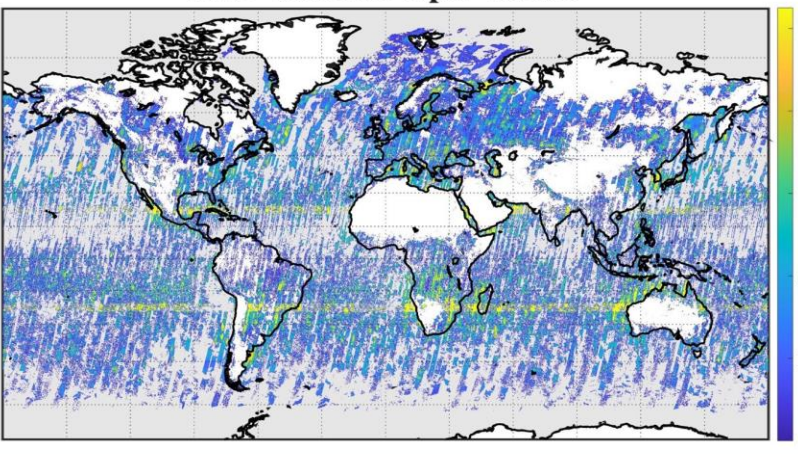
MSI AOD670 Npix 202510



MSI AOD670 Npix 202603



MSI AOD670 Npix 202605



MSI AOD₆₇₀, 865: Validation with AERONET

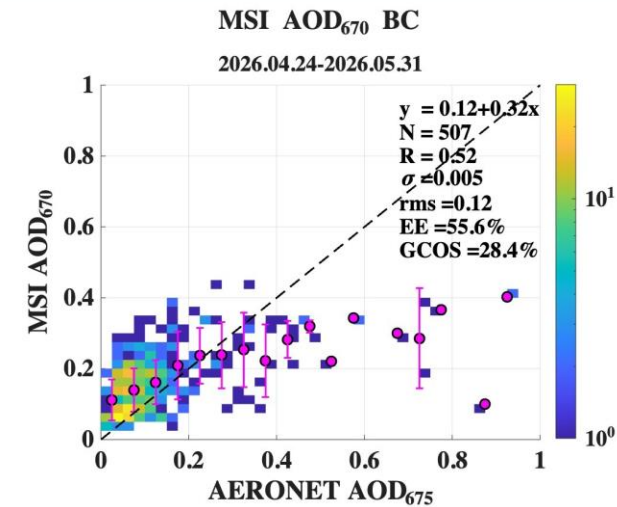
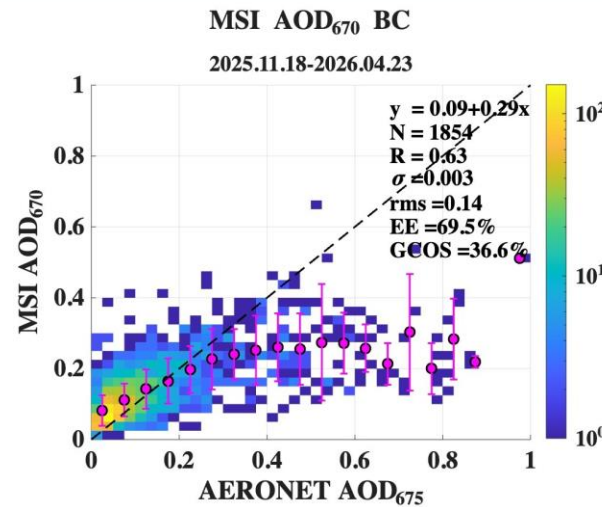
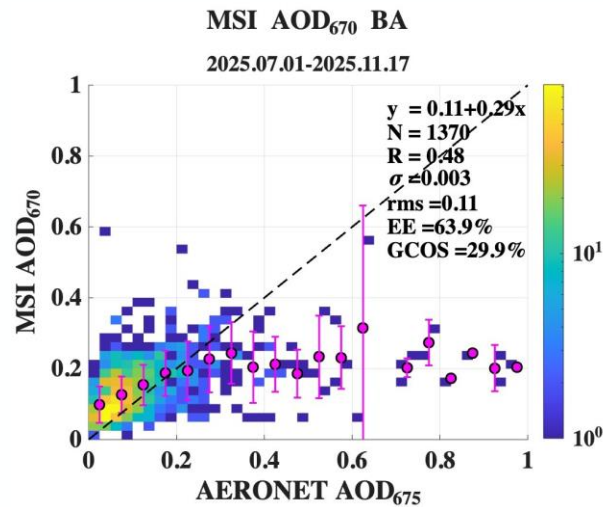


BA

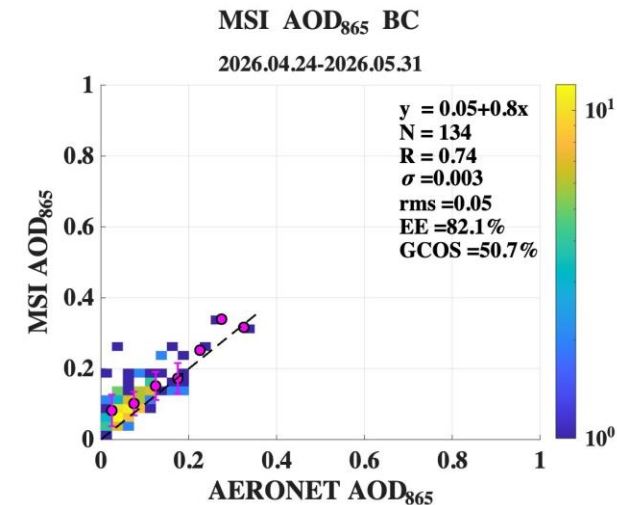
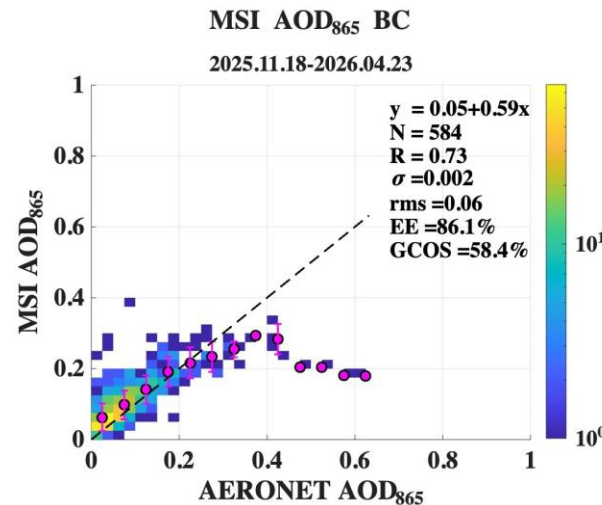
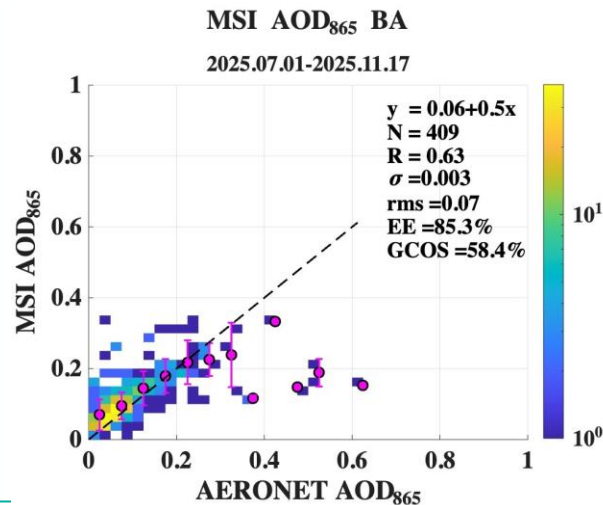
BC

BC_{SWIR1}

AOD₆₇₀
land, coastal



AOD₈₆₅
coastal



MSI AOD670: Validation with AERONET, outliers



BA

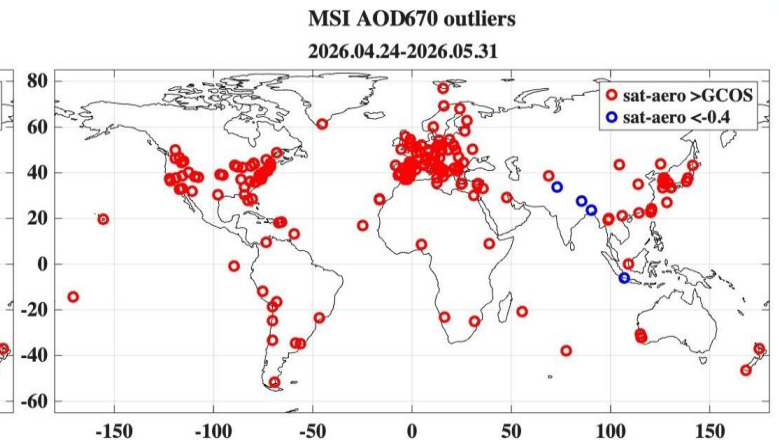
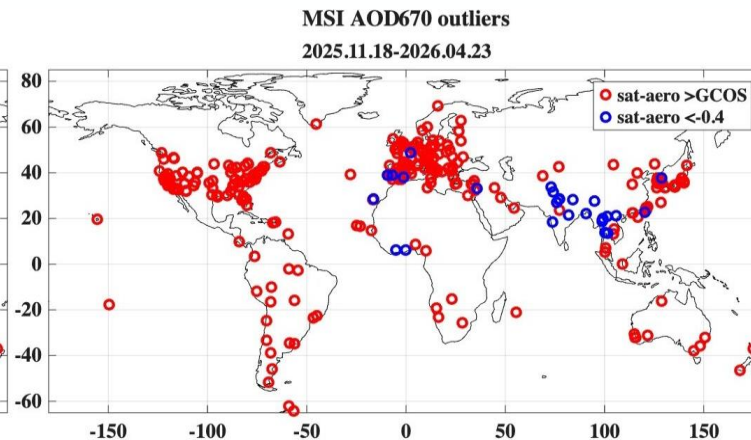
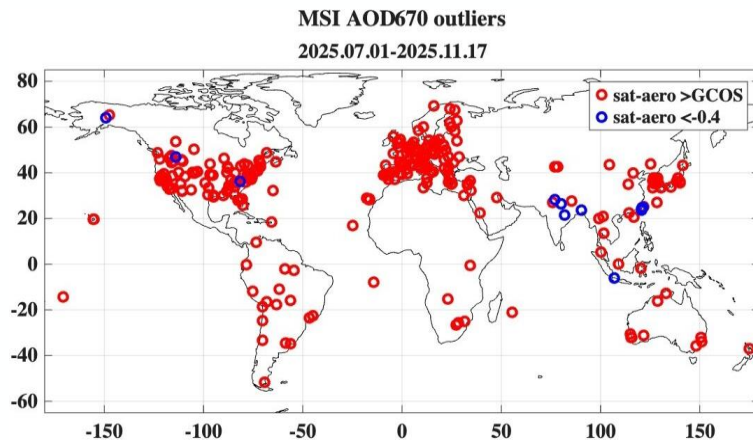
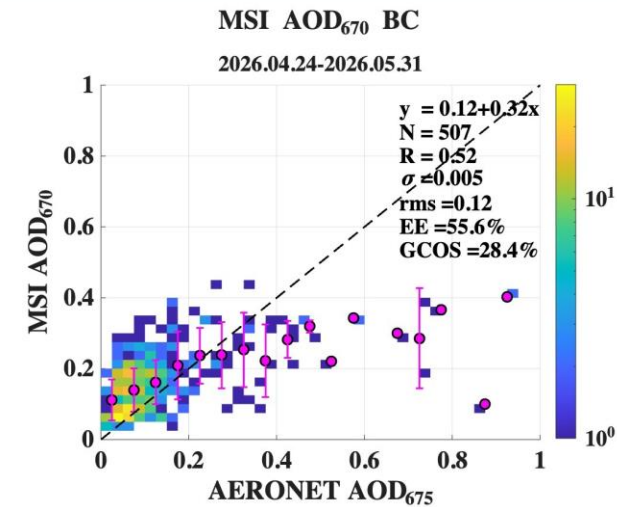
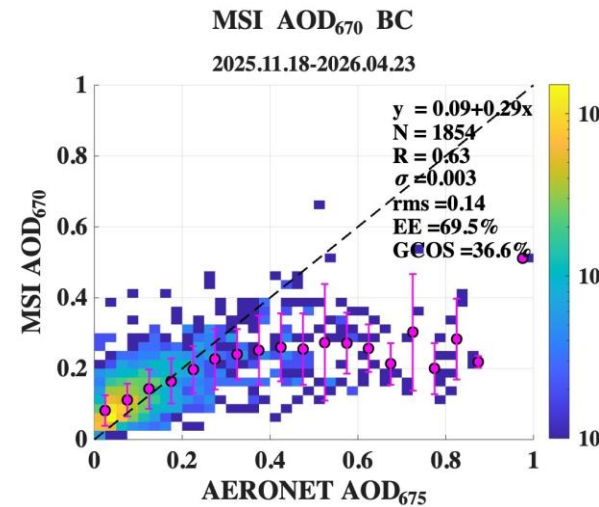
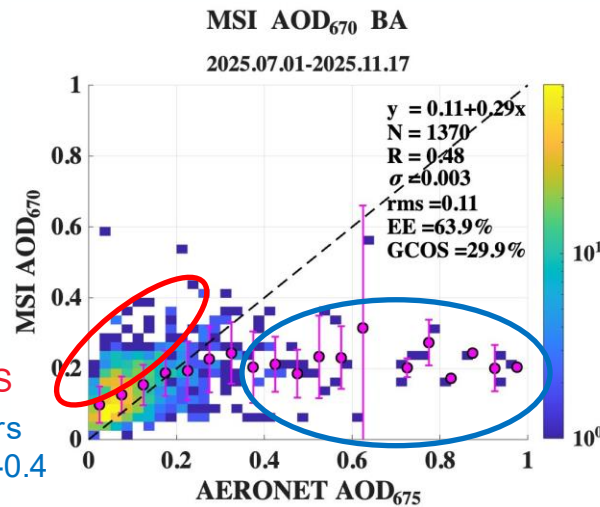
BC

BC_{SWIR1}

AOD670
land, coastal

pos_outliers
sat-aero > GCOS

neg_outliers
sat-aero < -0.4



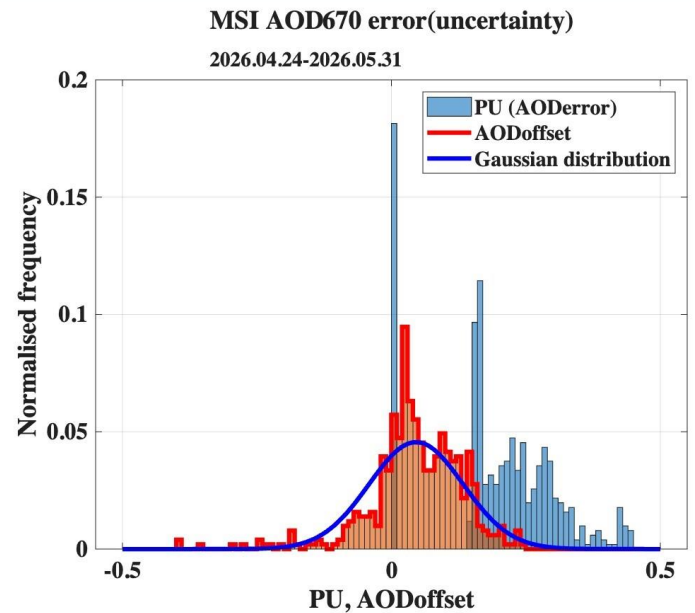
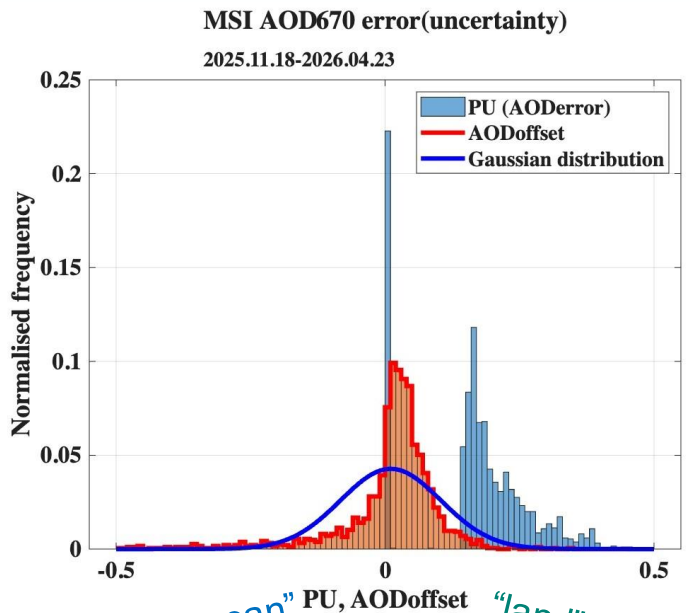
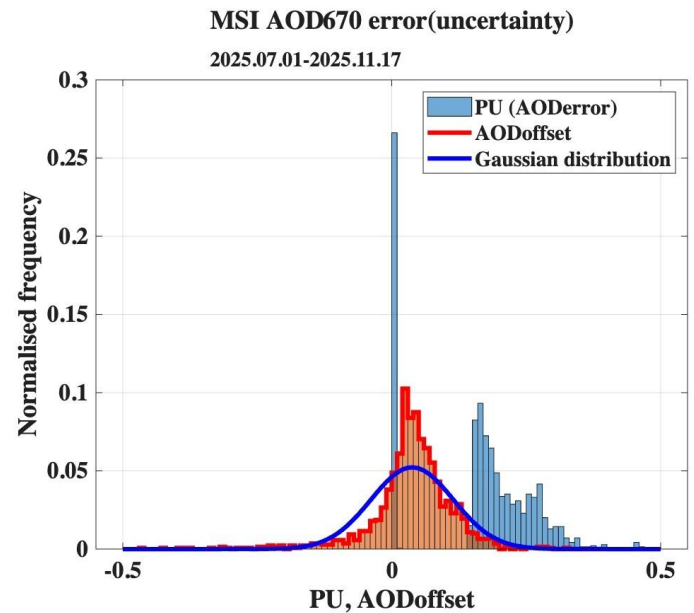
MSI AOD670: Validation of uncertainties with AERONET



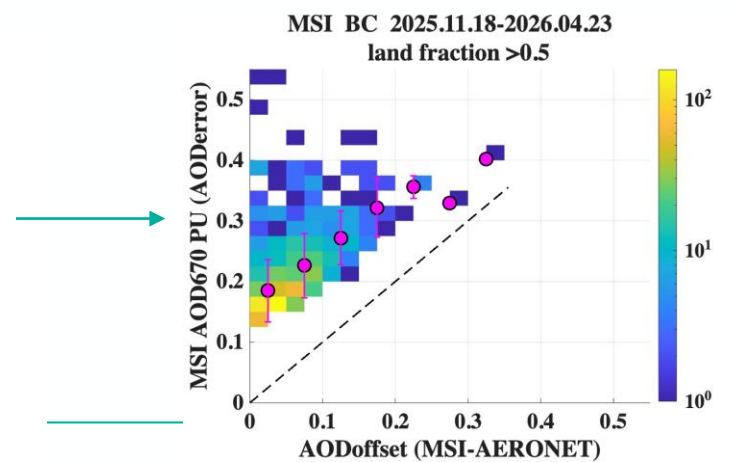
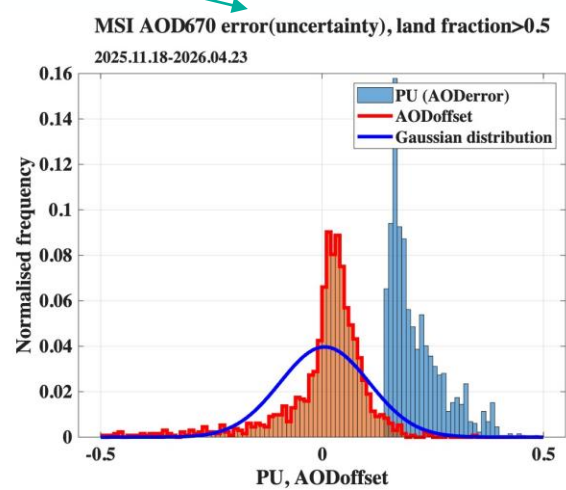
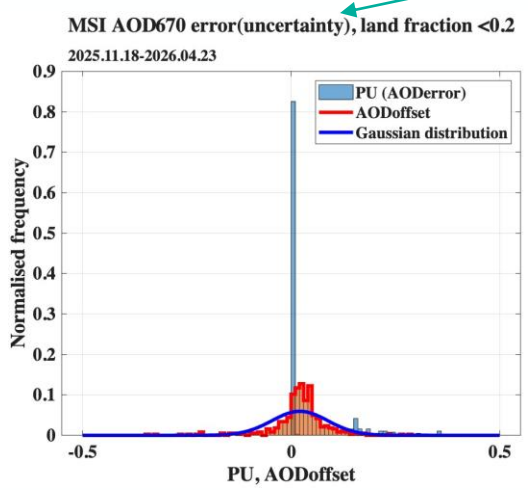
BA

BC

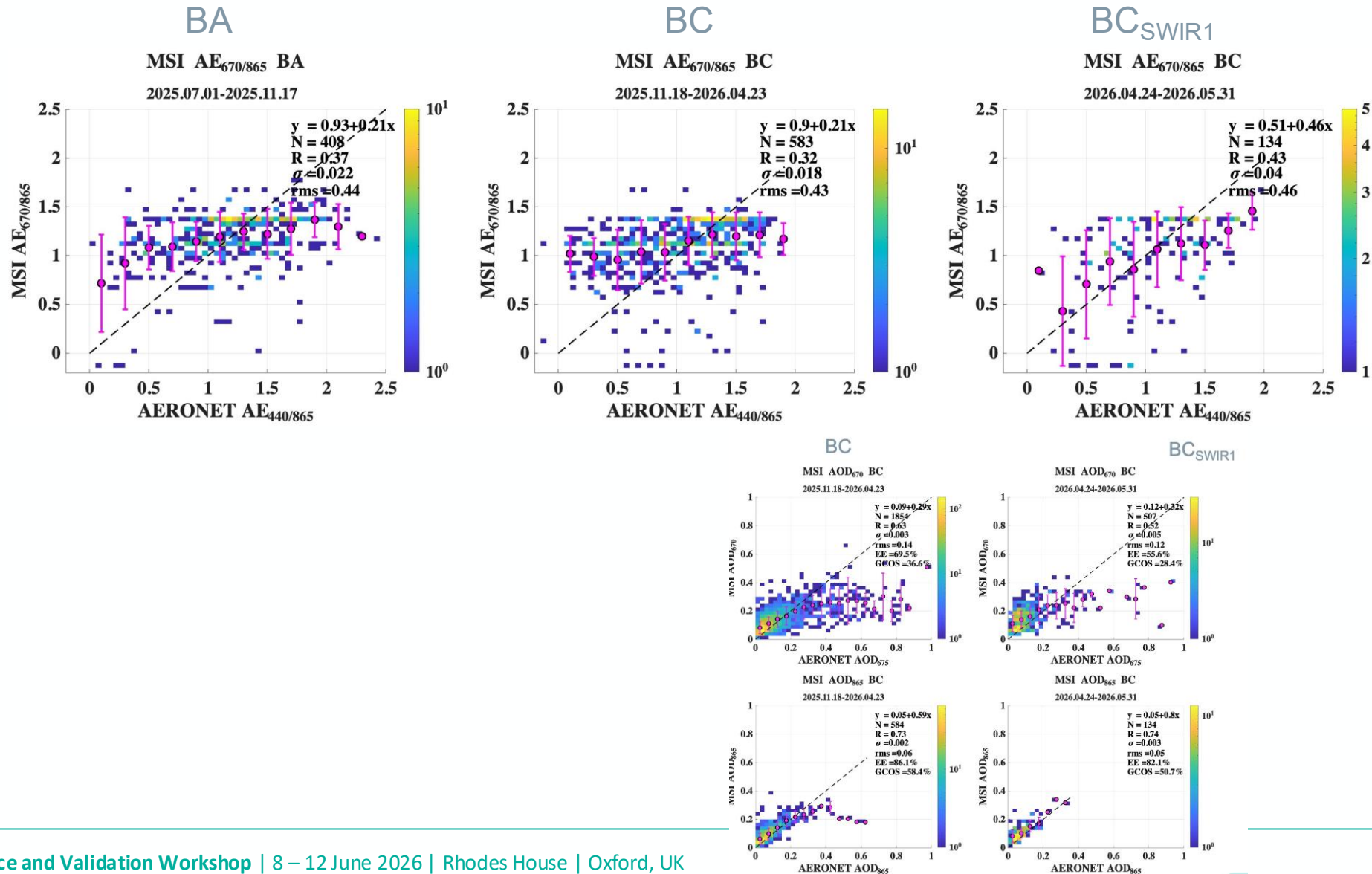
BC_{SWIR1}



“ocean” PU, AODOffset “land”

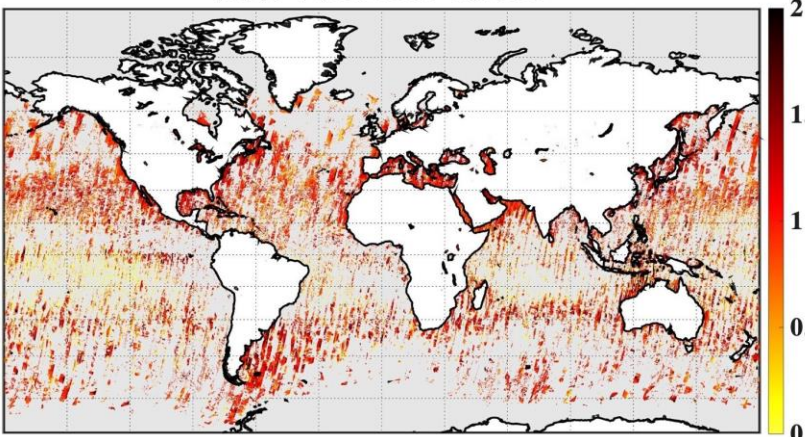


MSI AE 670865: validation with AERONET

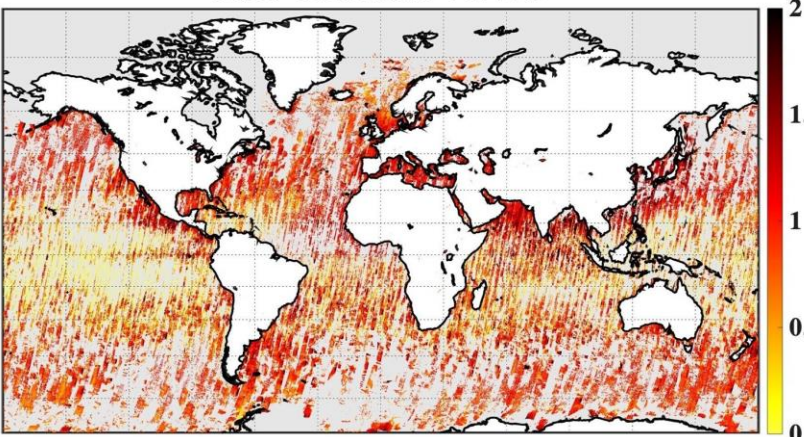


MSI AE 670865: monthly composites

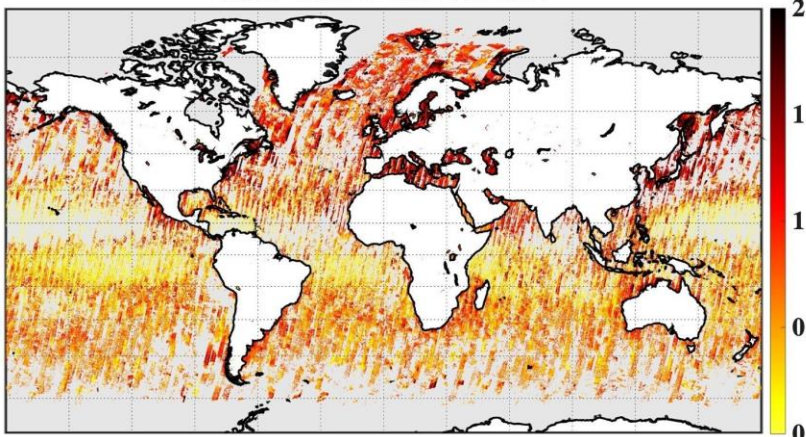
MSI AE670865 202510



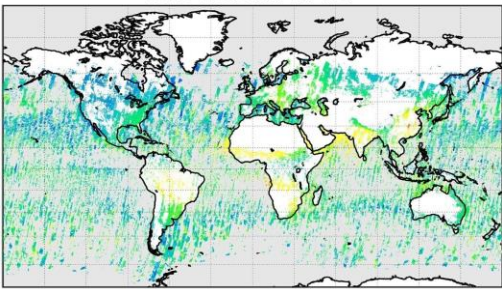
MSI AE670865 202603



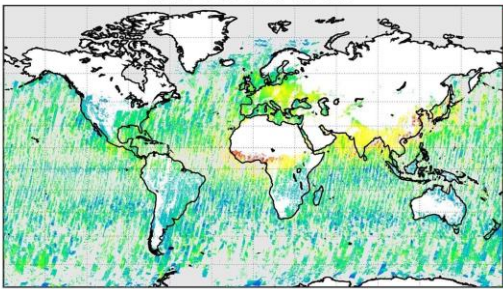
MSI AE670865 202605



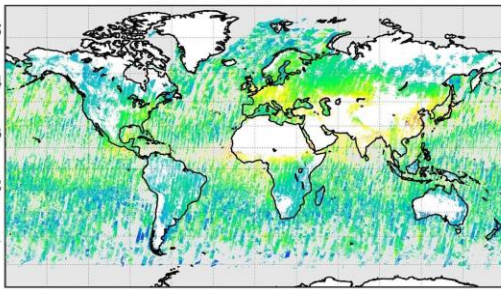
MSI AOD670 202510



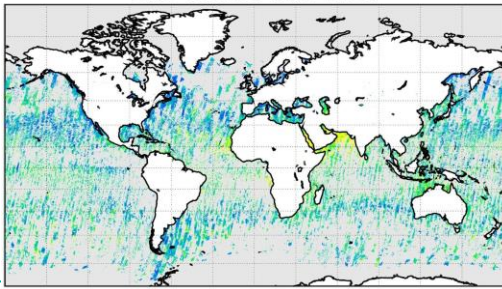
MSI AOD670 202603



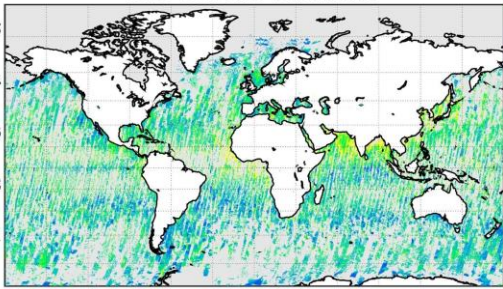
MSI AOD670 202605



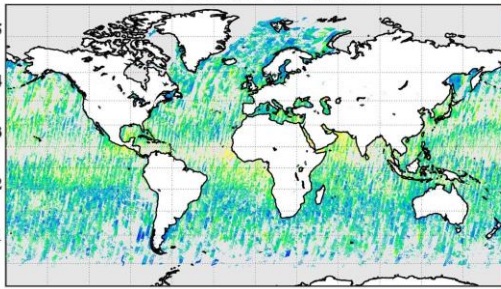
MSI AOD865 aod 202510

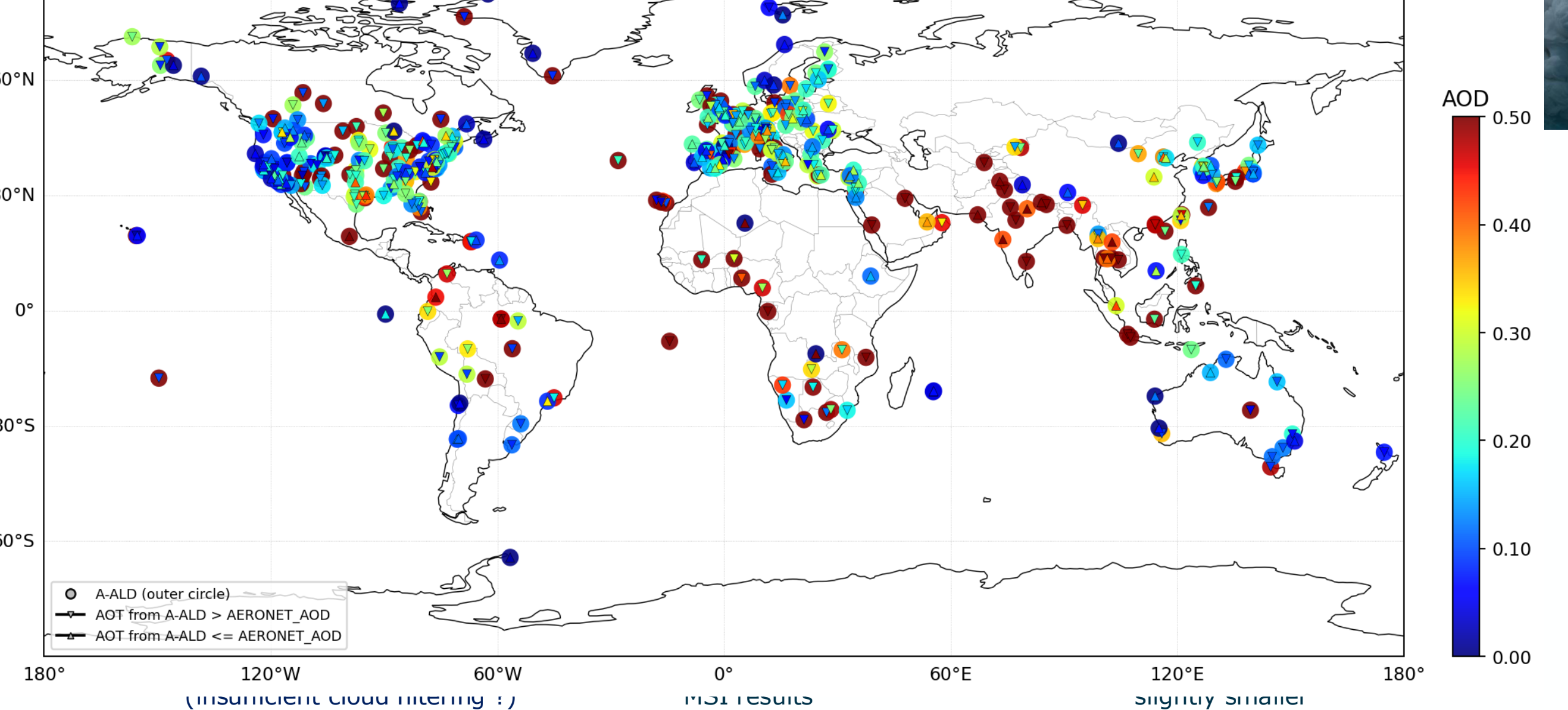


MSI AOD865 aod 202603



MSI AOD865 aod 202605





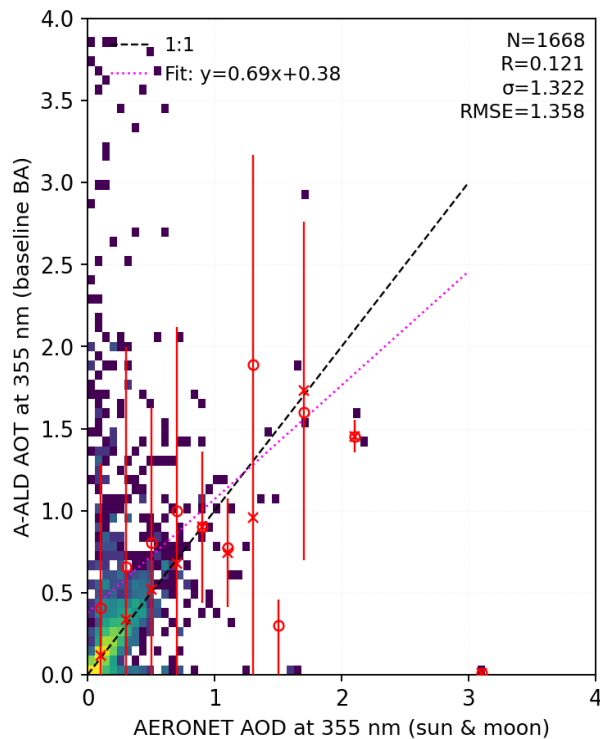
- Note, the median is at the 1x1 line

@Kerstin Stebel

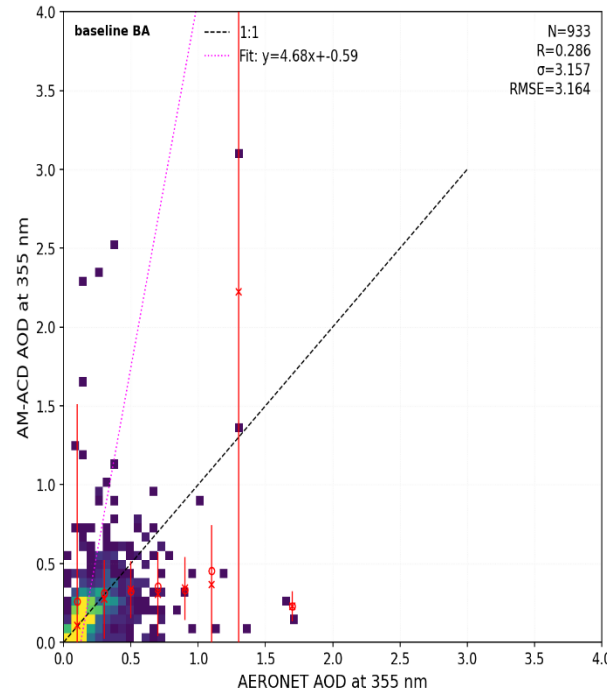
Combined – AOT 355 nm A-ALD, AM-ACD, ACM-CAP



AOT at 355 nm from A-ALD (BA)

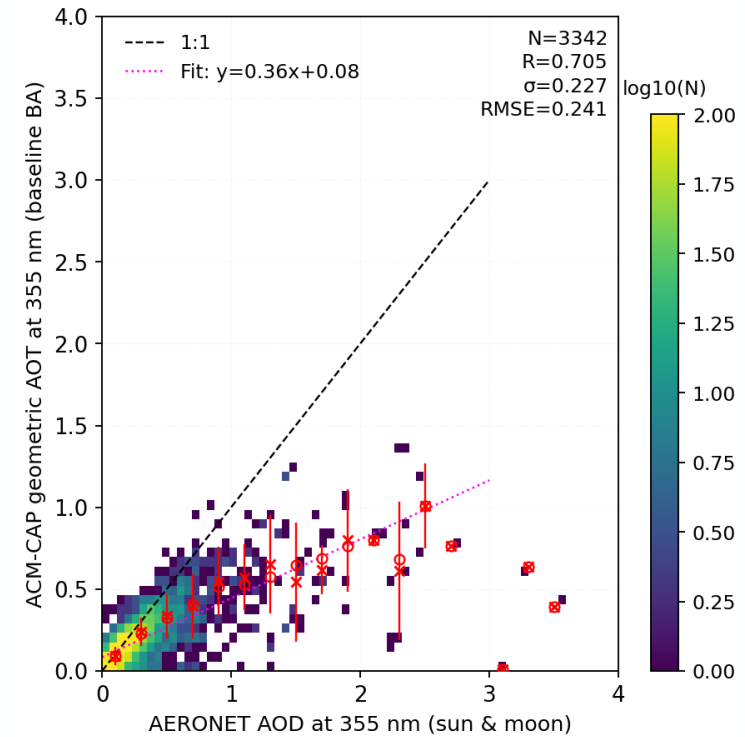


AOT at 355 nm from AM-ACD (BA)



- Lower number of matchups
- Improved correlation
- Few outlier at low AOD
- Underestimation at higher AOD

geom. AOT at 355 nm from ACM-CAP (BA)



- Larger number of matchups
- High correlation ($R = 0.7$)
- No outlier at low AOD
- Underestimation at higher AOD ("MSI feature")

Conclusions



- MSI
 - Visual inspection
 - Land/ocean discontinuity
 - AOD
 - Better coverage in BC/Bcswir
 - The main features of aerosol distribution are being well represented
 - BC quality is better compared to BA and BCswir
 - Low AOD is overestimated (land)
 - High AOD is underestimated in potentially high AOD loadings areas
 - AOD uncertainties
 - Provided uncertainties overestimated
 - AE
 - Better statistics for BCswir (low number of matchups with AERONET)
- ATLID
 - AOT still shows many outliers (cloud filtering ?)
 - Median lies on 1x1 line
 - AOT Uncertainties more realistic, pot. low
- Combined
 - Validation of AOT 355 nm from ATLID compared with AOT 355 nm from AM-ACD, ACM-CAP
 - AM-ACD
 - Lower number of matchups
 - Improved correlation
 - Few outlier at low AOD, Underestimation at higher AOD
 - ACM-CAP
 - Larger number of matchups
 - Good correlation ($R = 0.7$)
 - No outlier at low AOD
 - Underestimation at higher AOD (“MSI feature”)