An Initial Assessment of EarthCARE ATLID and MSI ESA L2a Uncertainties (NEVAR, EVID38)

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& results from EVID-36, Larisa Sogacheva, FMI, Finland

2nd ESA-JAXA EarthCARE In-Orbit Validation Workshop

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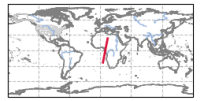
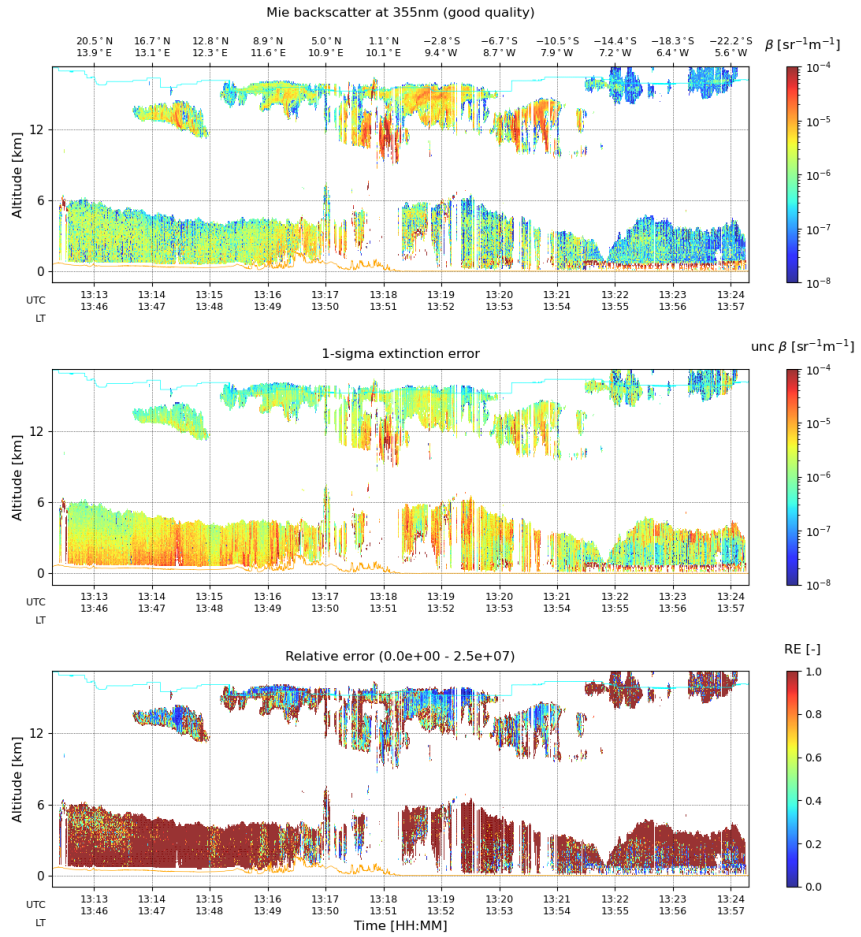
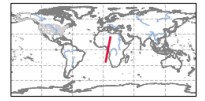
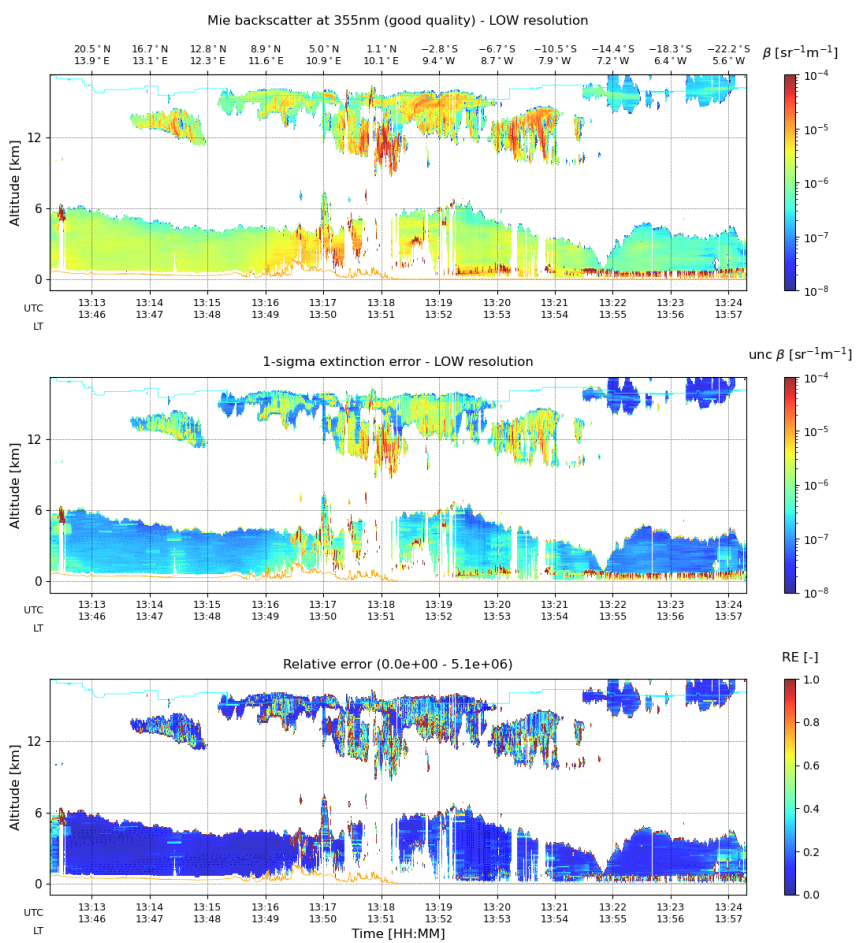
Example of EarthCARE uncertainties: ATL-EBD

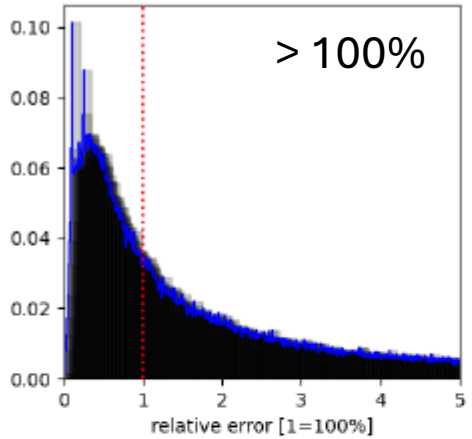




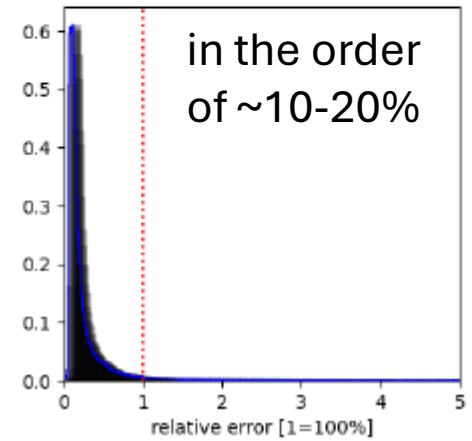




Uncertainties



high res.

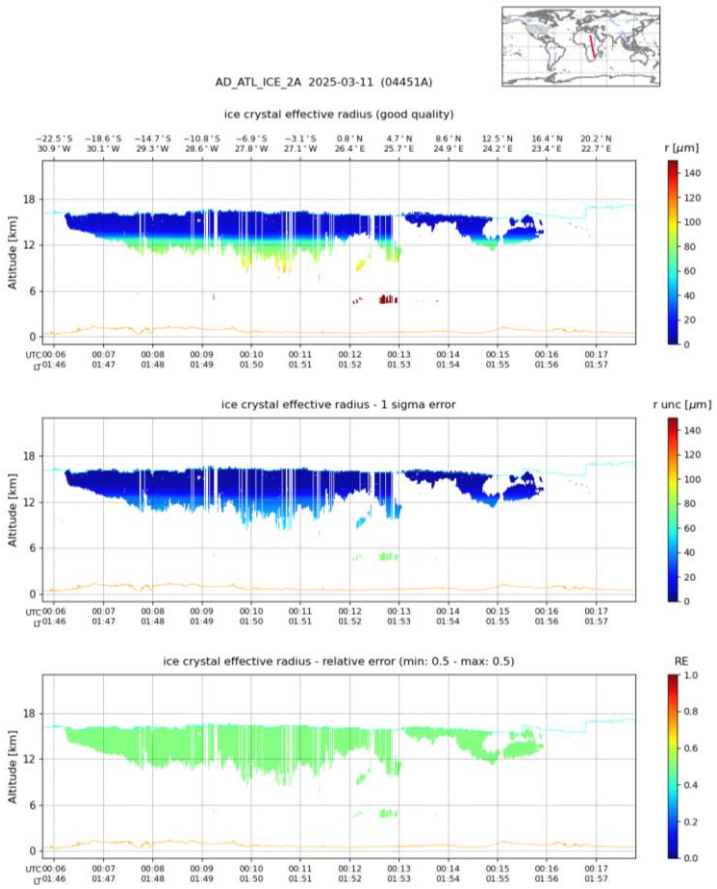


low res.

Mie backscatter - **high resolution** **low resolution**

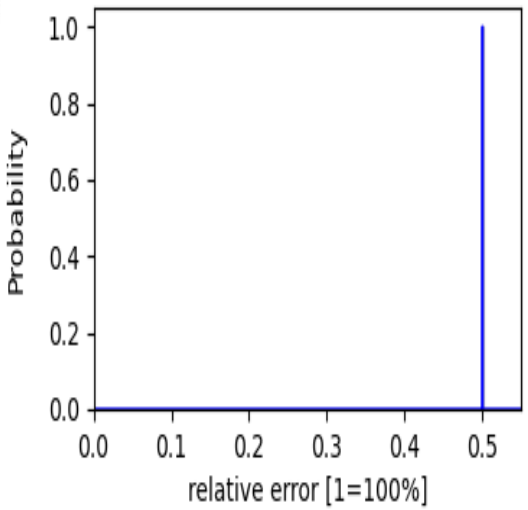
Example of EarthCARE uncertainties: ATL-ICE

ice crystal effective radius

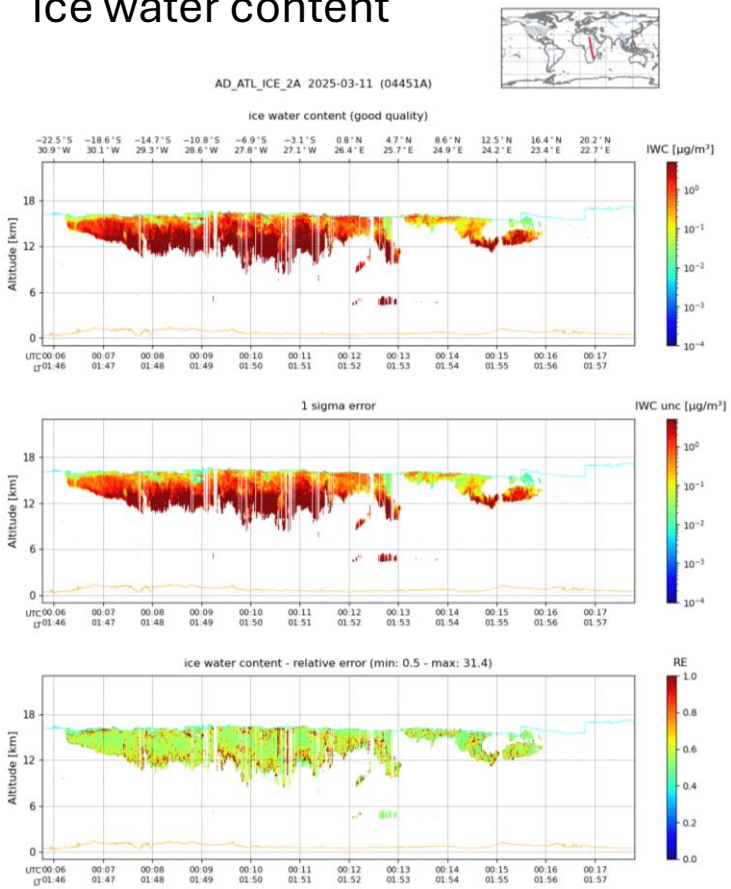


Uncertainties

50% relative error

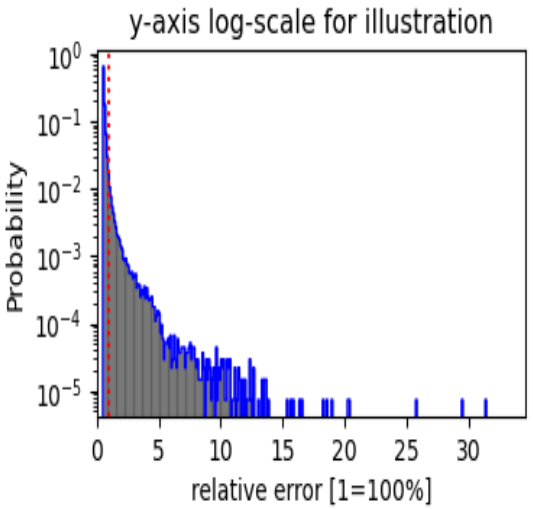


ice water content



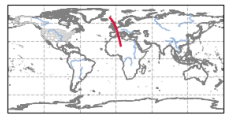
Uncertainties

50% - x *100 %

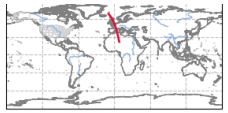


ATL-ALD quality status, mask, and uncertainties

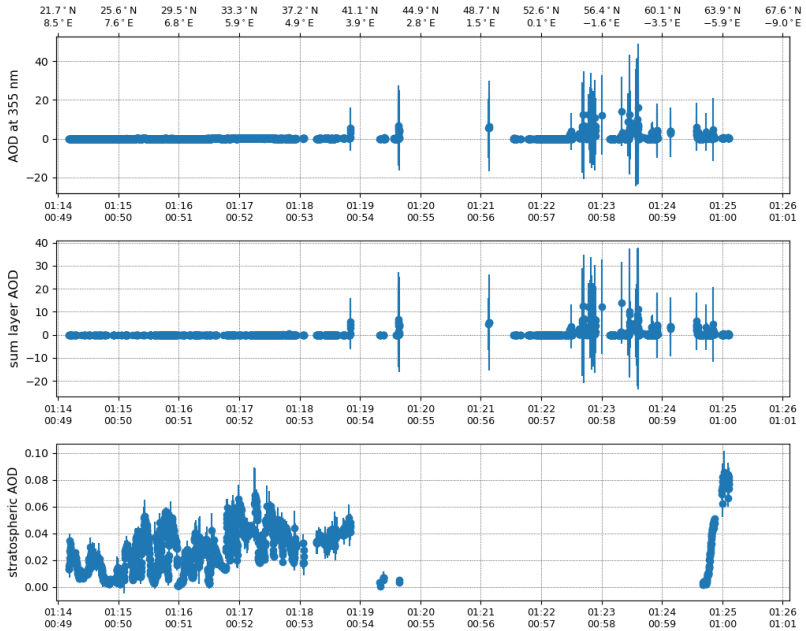
AOT's at 355 nm

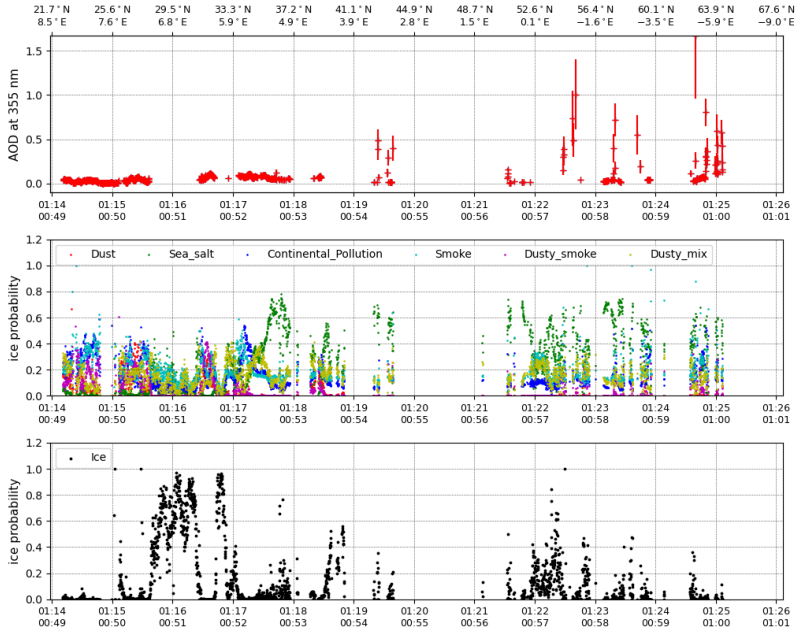


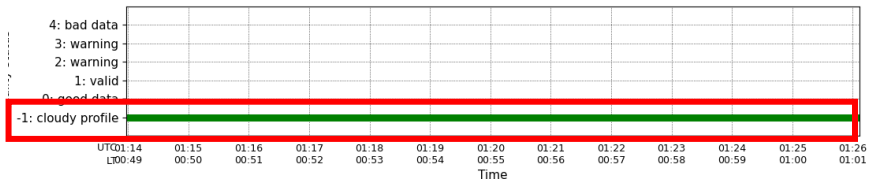
AC ATL_ALD_2A 2025-01-10 (03518B)



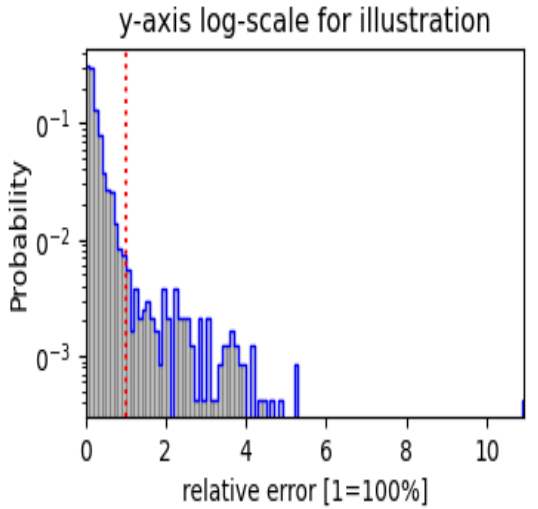
AC ATL_ALD_2A 2025-01-10 (03518B)



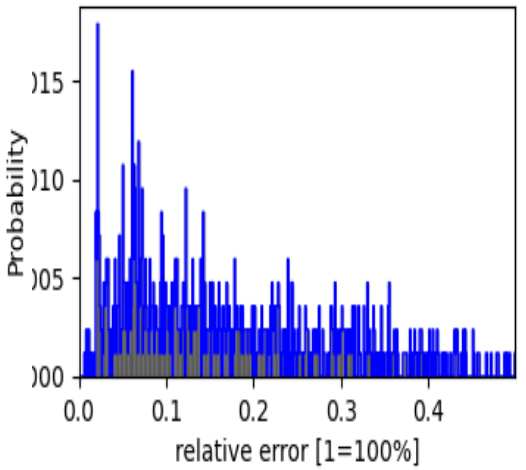




for the intermediate use filtering:
AOT < 3, **ice probability < 0-01,**
relative error < 50%



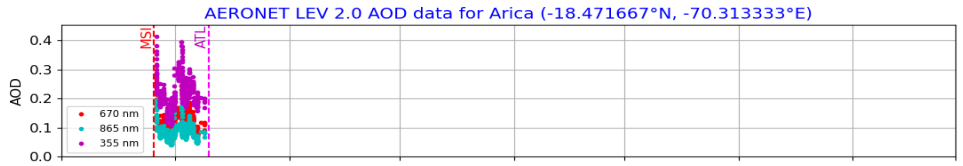
large uncertainties, mainly related to unfiltered cloud

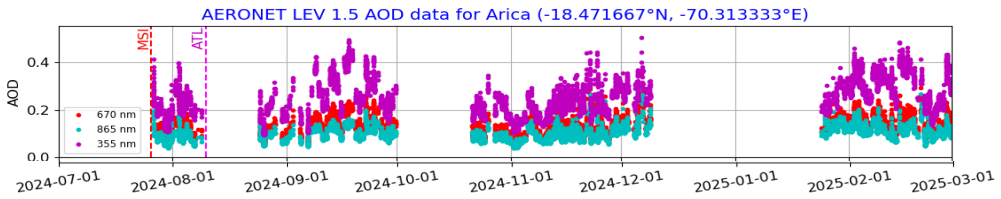


after filtering: uncertainty distribution after filtering

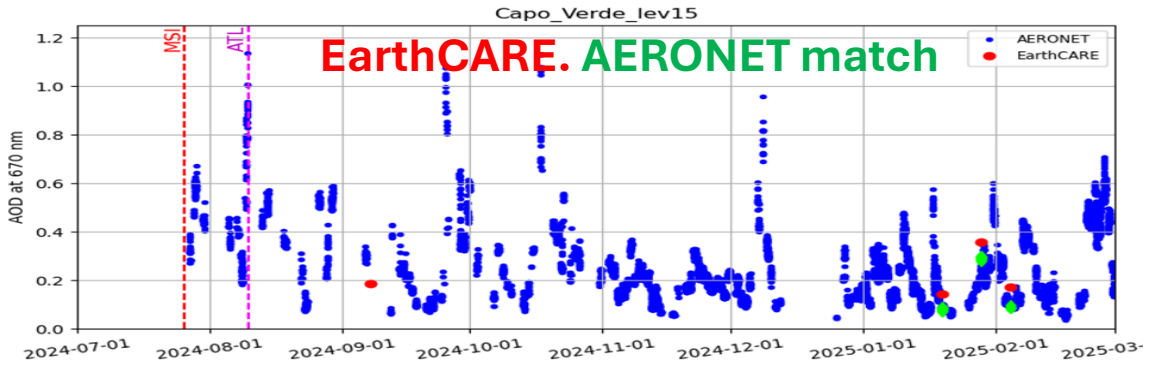
Evaluation approach I/II

Validation using global AERONET data – Level 2.0, Level 1.5 and Lunar observations (all points)





Log-log interpol. to 355, 670 and 865 nm (using all data up 870 nm)



only few matches per station

- Use Level 1.5, Level 2 still little coverage, lunar data
- Data download until 2025/03/01
- Spatial-temporal correlation: **50 km, 30 minutes**

  1. Useful: python oads_download.py A-ALD --radius_search 50000 79.990278 -85.939167 -st 2024-09-28 -et 2024-12-14 by Leonard König (TROPOS) for EarthCARE time series at station location

  2. Temporal correlation in second step

- Note_ MSI-AOT with quality status 4: no retrieval attempt due to bad or missing input data (input data not available or out of bounds) -> user perspective, remove “empty” data ?

Reading file: ECA_EXAB_MSI_AOT_2A_20250117T054729Z_20250117T082614Z_03630A Number of valid AOD: 0
Reading file: ECA_EXAB_MSI_AOT_2A_20250117T072002Z_20250117T082142Z_03631A Number of valid AOD: 0
Reading file: ECA_EXAB_MSI_AOT_2A_20250126T054336Z_20250126T082410Z_03770A Number of valid AOD: 0
Reading file: ECA_EXAB_MSI_AOT_2A_20250126T071609Z_20250126T082454Z_03771A Number of valid AOD: 0
Reading file: ECA_EXAB_MSI_AOT_2A_20250131T173559Z_20250131T223734Z_03855E Number of valid AOD: 0
Reading file: ECA_EXAB_MSI_AOT_2A_20250204T053919Z_20250204T081919Z_03910A Number of valid AOD: 0

Evaluation approach II/II

MSI-AOT (AB, AC):

AOT at 670 nm – land and ocean, AOT error

AOT at 865 nm – ocean, AOT error

AE (355/670, 670/865), no error

ATL-ALD (AC, AD, AE):

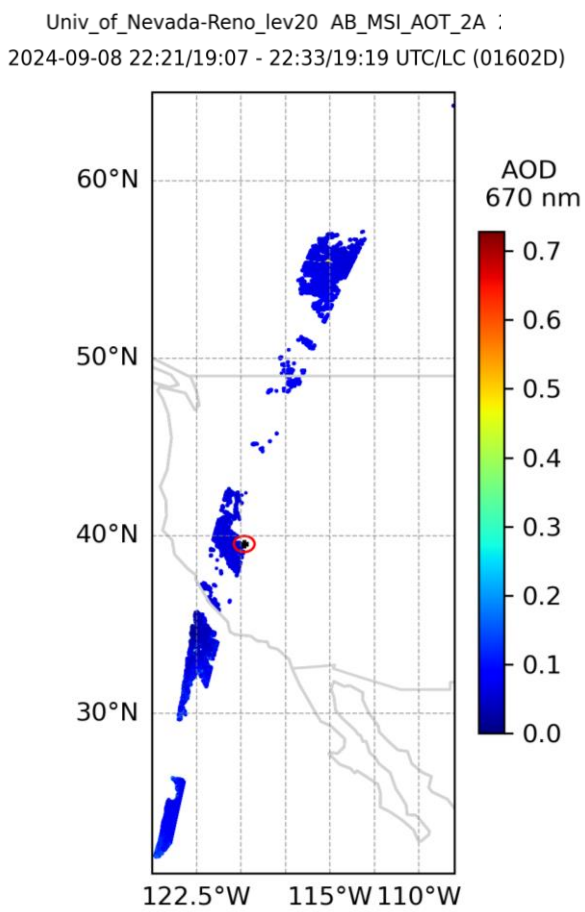
AOT at 355 nm, AOT error

AM-ACD (AB, AC): fewer datasets

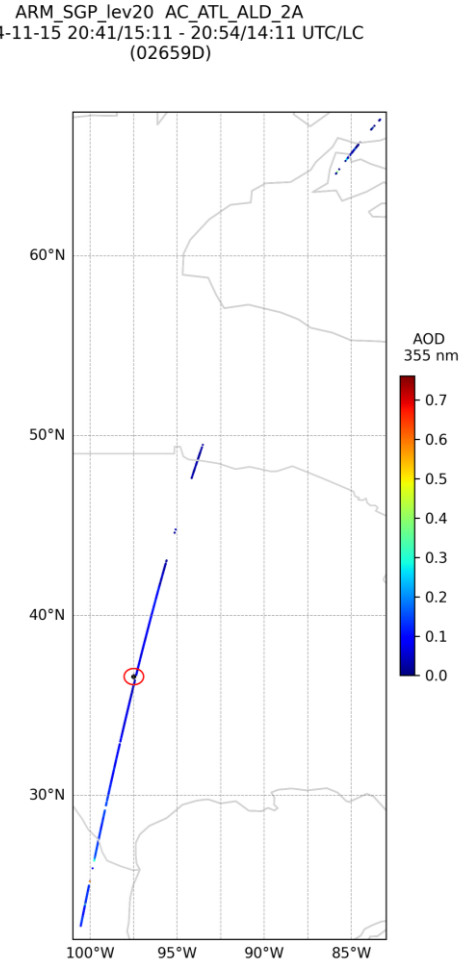
AOT at 355, 650, 865 nm incl. error

AE (355/670, 670/865), errors are given

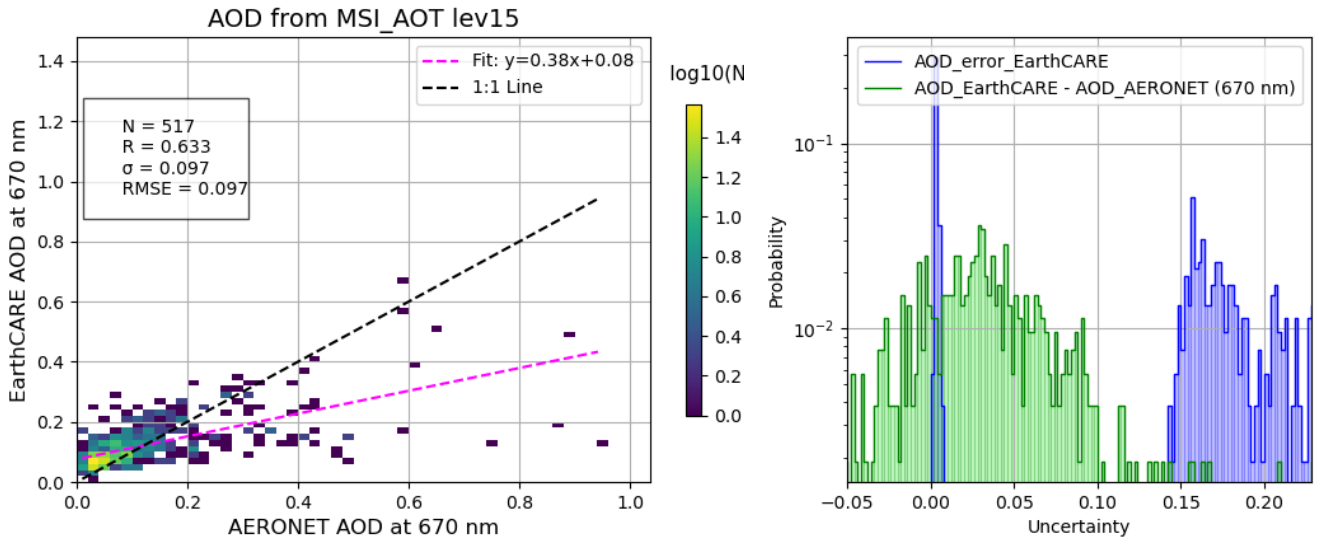
MSI – AOT

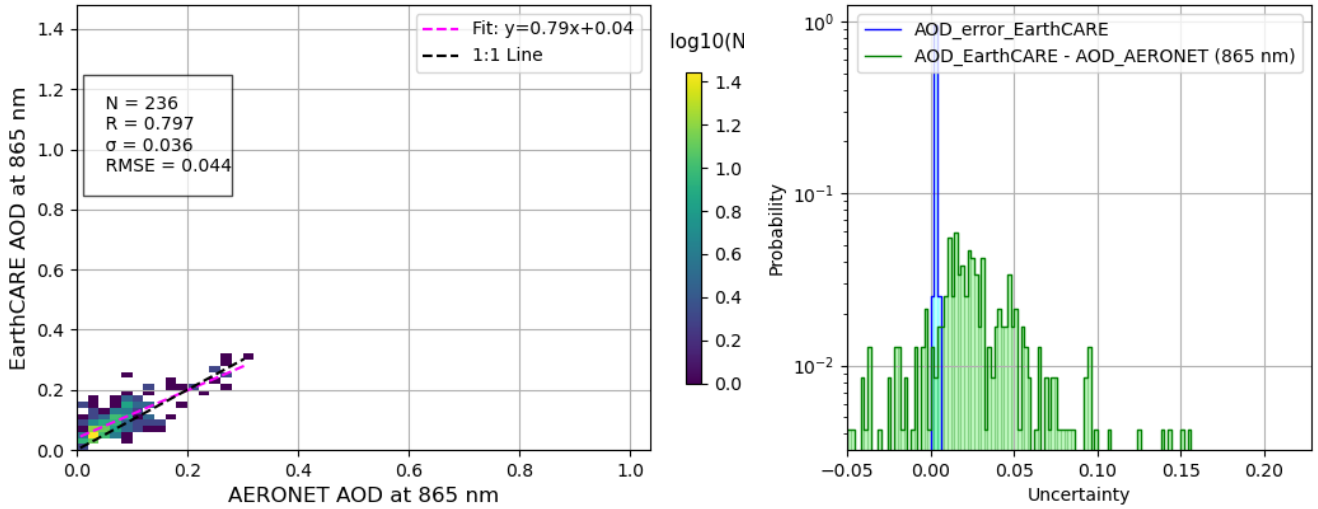


ATL - ALD



MSI-ATL AOT at 670 & 865 nm and uncertainties





Correlation EarthCARE AOD vs. AERONET AOD lev 1.5

AOT 670 nm

- N= 517 colocations, **R = 0.63**
- **low bias at AOT above ~0.2**
- EC uncertainties
  - small compared to t = $AOT_{EarthCARE} - AOD_{AERONET}$
  - higher uncertainties (land ?)

AOT 865 nm

- N= 236 colocations, **R = 0.8**
- EarthCARE uncertainties are smaller compared to t

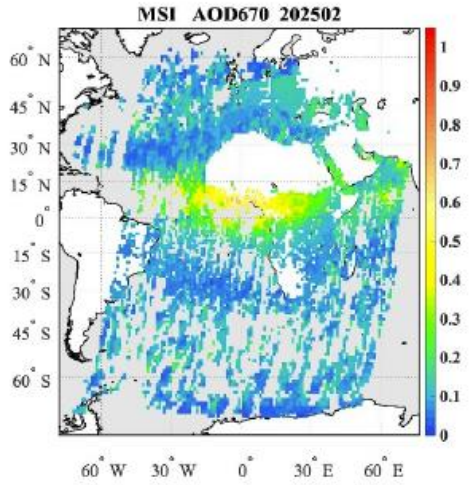
AERONET Level 2:
only 7 matches

AERONET Lunar:
no match within 30 min,
comparison within 10 hours give correlation > 0.6

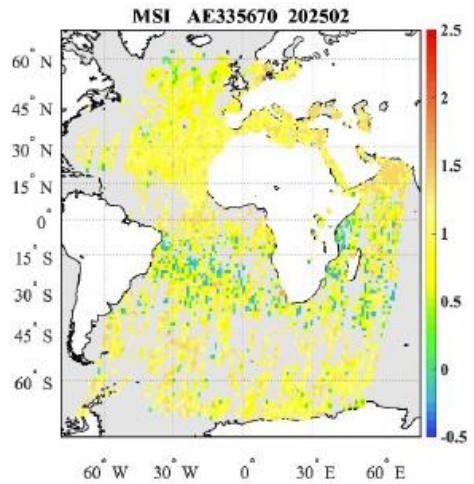
from Larisa Sogacheva, FMI (EVID-36), see poster 34

Monthly composites

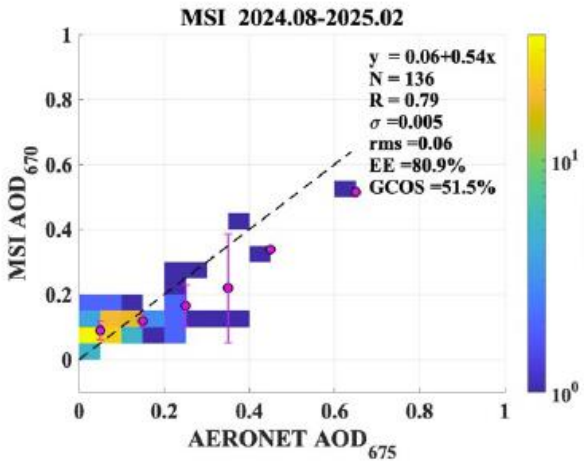
AOD

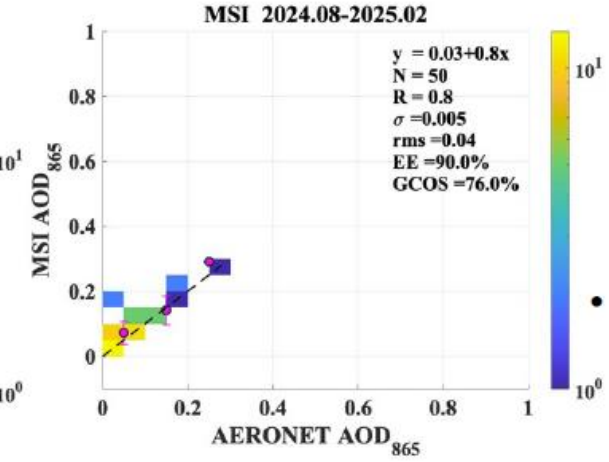


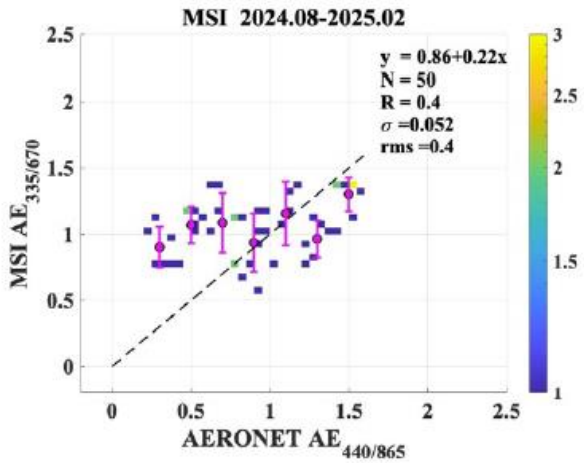
AE

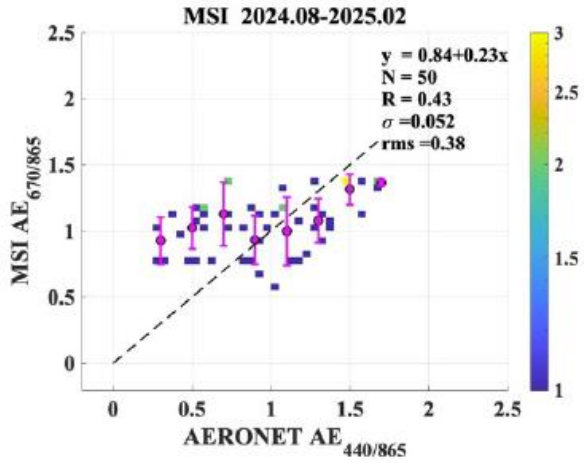


Validation with AERONET









- Correlation between MSI and AERONET lev 1.5

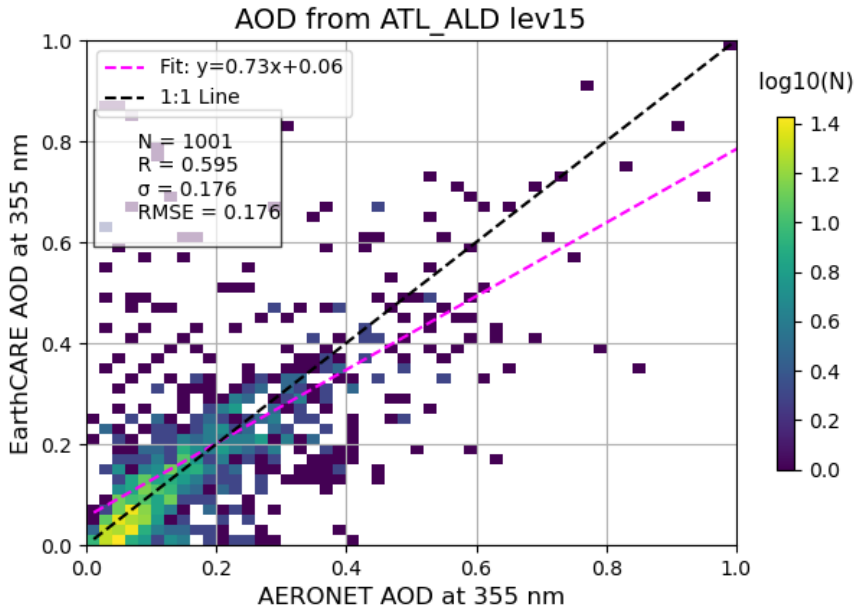
* is high (R = 0.79 (670 nm)
R = 0.80 (865 nm))

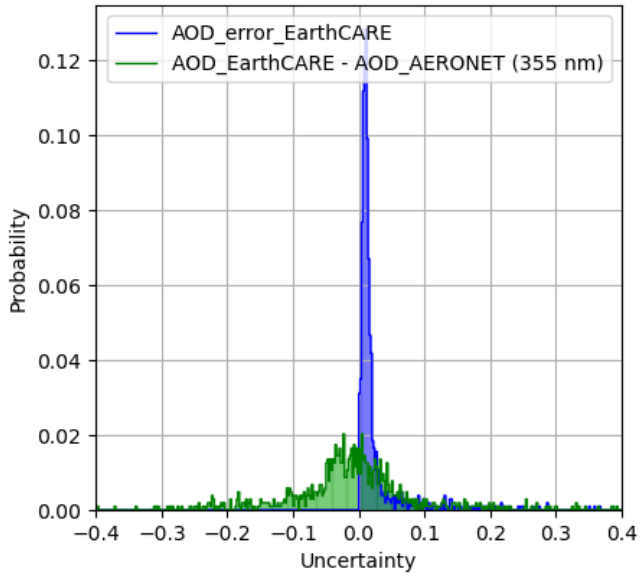
- AOT 670 above 0.2 is biased low
- AOT is not retrieved over the bright surface

- The data shows some spread around the 1:1 regression line, but the relation between MSI AE and AERONET AE is weakly linear.

ATL-ALD AOT at 355 nm vs. AERONET lev 1.5

Correlation between AOT at 355 nm from ATL-ALD (filtered) and AERONET lev 1.5





AOT at 355 nm

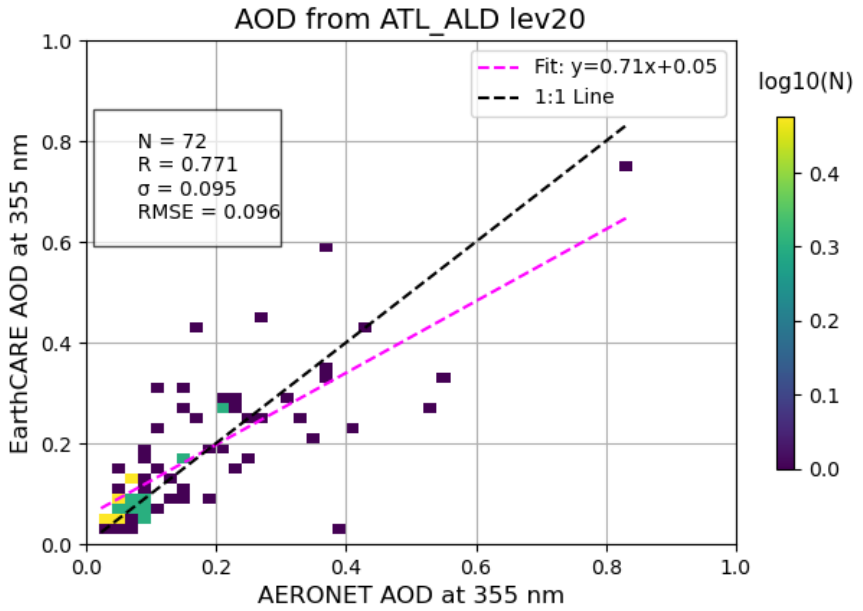
- N = 1001 matches
- **R = 0.6**
- **slightly low bias at AOT above ~0.2**

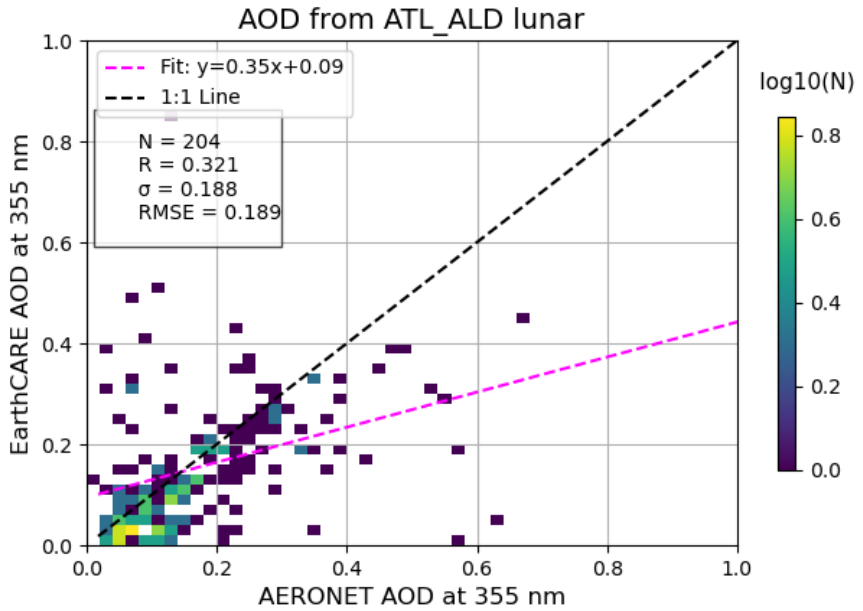
AOT uncertainties

- EarthCARE uncertainties are slightly smaller/comparable to $AOT_{EarthCARE} - AOD_{AERONET}$

ATL-ALD AOT 355 nm vs. AERONET lev 2 & lunar

Correlation between AOT at 355 nm and AERONET lev 2.0 and lunar data





AOT at 355 nm

- N = 72 matches
- **R = 0.77**

AOT at 355 nm

- N = 204 matches
- **R = 0.3**

Summary

- Product specific uncertainty treatments in ATL and MSI datasets
  - ATL-EBD calculated uncertainties, as expected reduced with averaging
  - ATL-ICE effective radius given with fixed 50% relative uncertainty
  - ATL-ALD quality status (-1 cloudy) requires update (“in process next baseline”), preliminary post-processing using ice mask for filtering: high uncertainties related to clouds -> reasonable uncertainty distribution

- Evaluation of MSI-AOT and ATL-ALD AOT using AERONET Level 1.5 (Level 2.0 and Lunar) data
  - Using spatial temporal correlations: 50 km and 30 minutes
  - Empty AOT data in MSI-AOT when quality status 4: no retrieval attempt due to bad or missing input data (user unfriendly ?)

- Initial evaluation of MSI-ATL AOT 670 and 870 nm, Ångström exponent, and uncertainties
  - around 500 matches found, no retrieval over bright surface
  - high correlation, **AOT at 670 nm: R between 0.63 to 0.79, and for AOT 865 nm: R = 0.8**
  - **AOT at 670 nm is low bias above ~0.2**
  - **Ångström exponent: spread around the 1:1, weak correlation**
  - **Uncertainties: 670 nm lower than AOT $_{EarthCARE}$ – AOD $_{AERONET}$ & higher uncertainty values, 865 nm: low values**

- Initial evaluation of ATL-ALD AOT 355 nm and uncertainties
  - around100 matches
  - **R = 0.6, weak low bias**
  - **EarthCARE uncertainties are slightly smaller/comparable to AOT $_{EarthCARE}$ – AOD** $_{AERONET}$