Combined Aerosol and Cloud optical thickness from SLSTR observations

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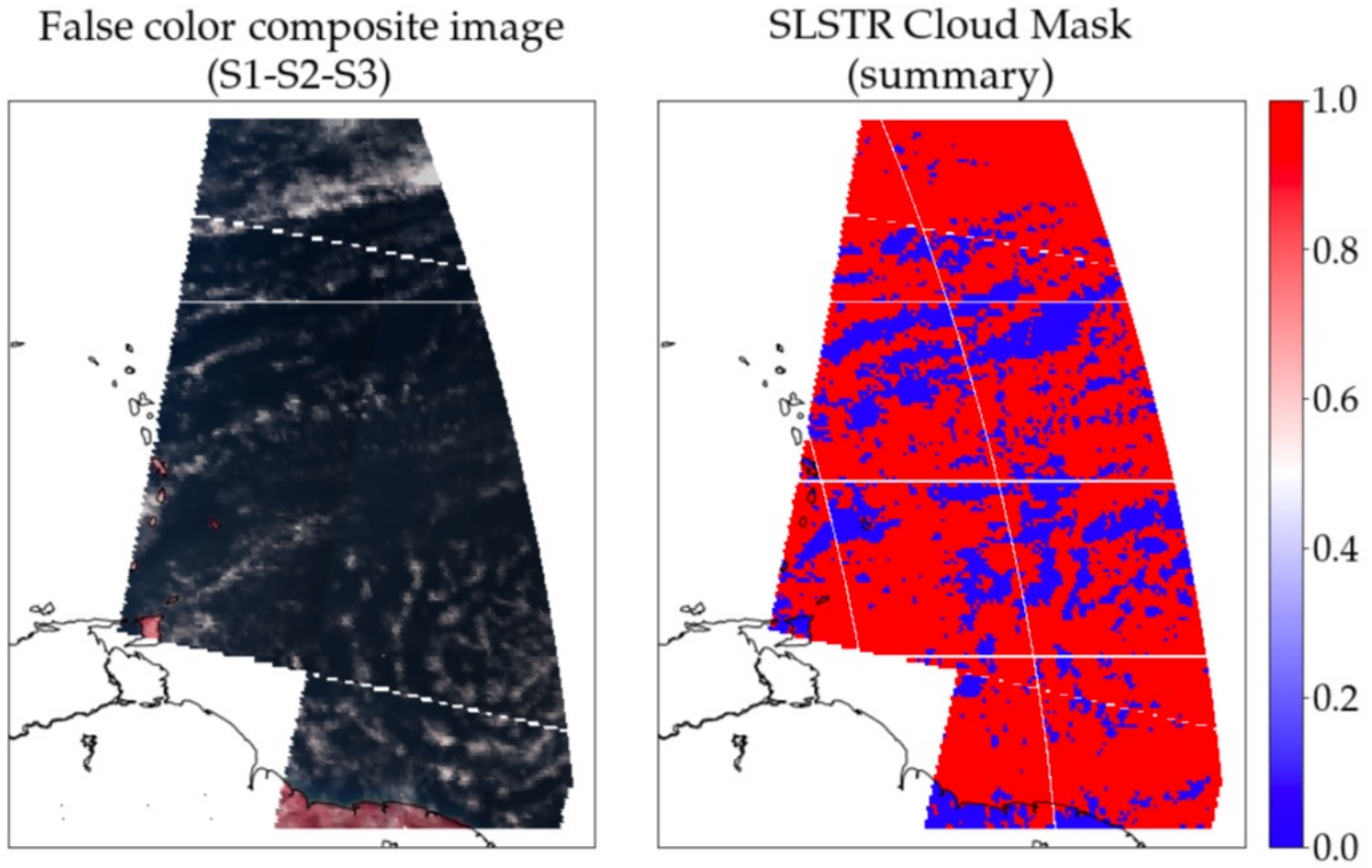
Cloud's role in Aerosol Retrieval

Traditional aerosol retrieval algorithms only process clear sky observation.

Broken, undetected or near clouds can cause an overestimation of the AOT retrieved from satellite.

The cloud mask is chosen to be conservative.

One of the consequences of traditional approaches is a large percentage of "lost pixels" (Schwarz et al., 2017).



The CISAR algorithm

The CISAR algorithm is an innovative aerosol retrieval algorithm based the **continuous variations** of the state variables in the solution space to secure consistency within an **Optimal Estimation** retrieval framework.

Atmos. Meas. Tech., 11, 6589–6603, 2018
https://doi.org/10.5194/amt-11-6589-2018

Atmospheric Measurement Techniques Open Access EGU

Atmos. Meas. Tech., 12, 791–809, 2019
https://doi.org/10.5194/amt-12-791-2019

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Joint retrieval of surface reflectance and aerosol properties with continuous variation of the state variables in the solution space – Part 1: theoretical concept

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Joint retrieval of surface reflectance and aerosol properties with continuous variation of the state variables in the solution space – Part 2: application to geostationary and polar-orbiting satellite observations

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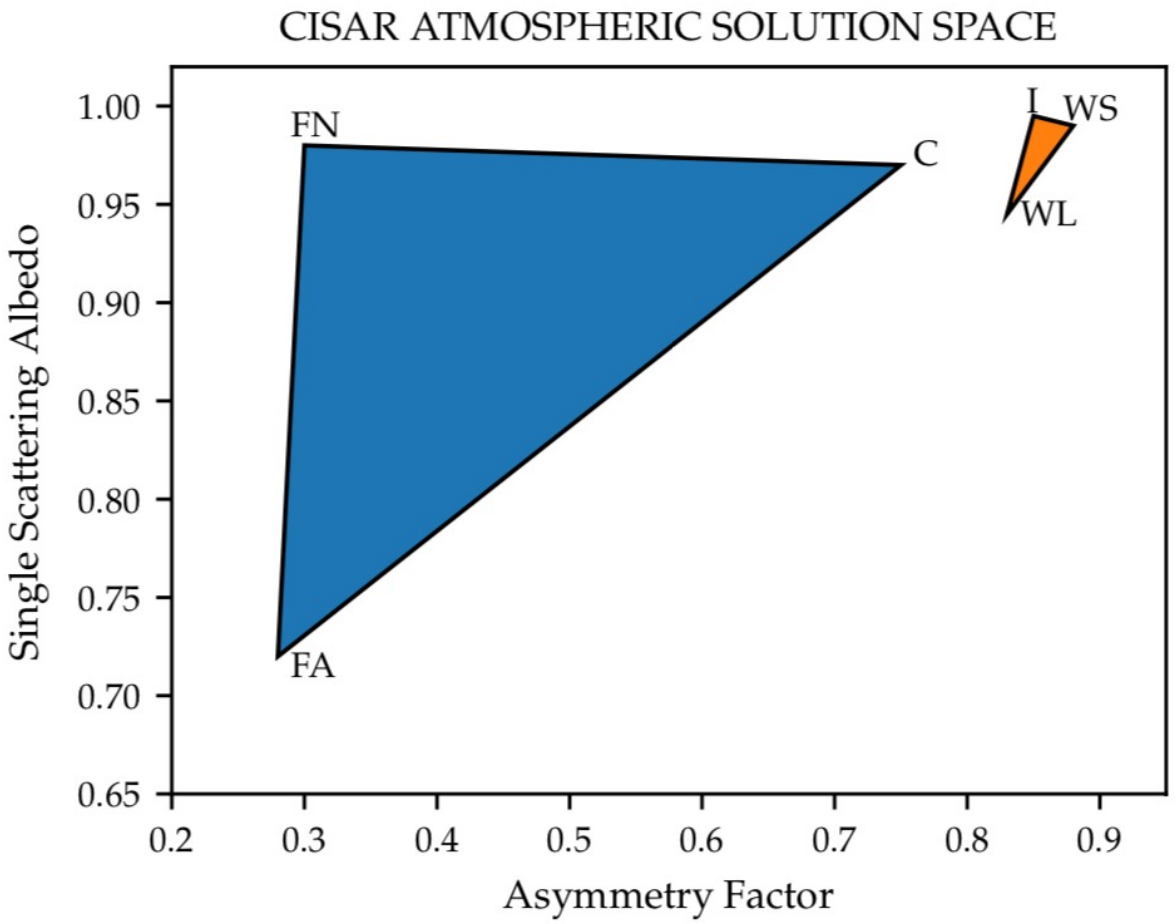
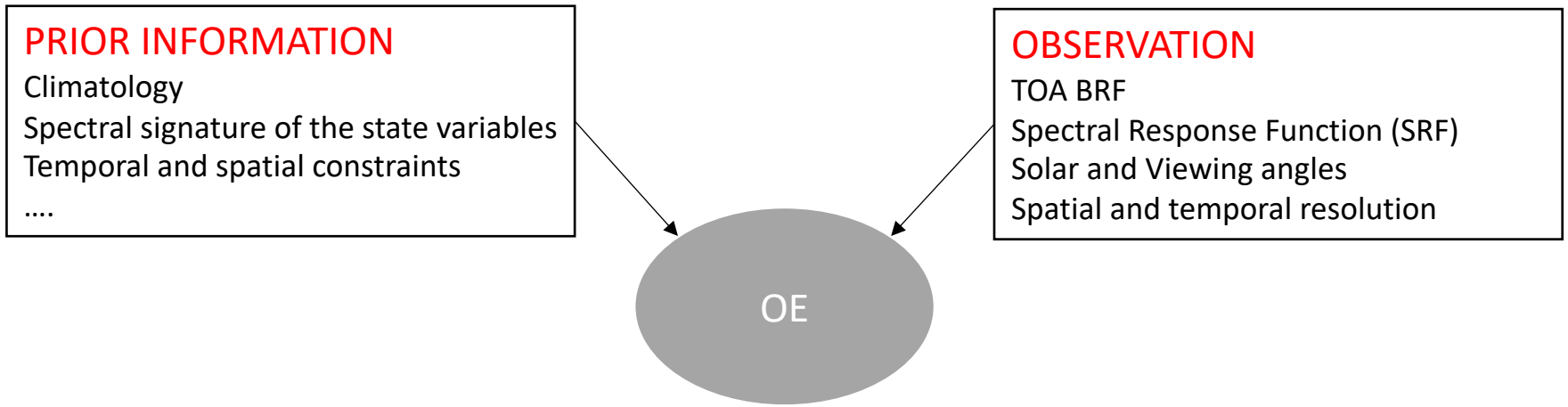
Atmospheric Solution Space



- The solution space is defined by the vertices of selected aerosol/cloud targets in each processed band.
- The solution space is divided into 2 sub-space for aerosols and cloud properties respectively.
- The total ω and *phase function* are computed considering a linear behaviour in the solution space.

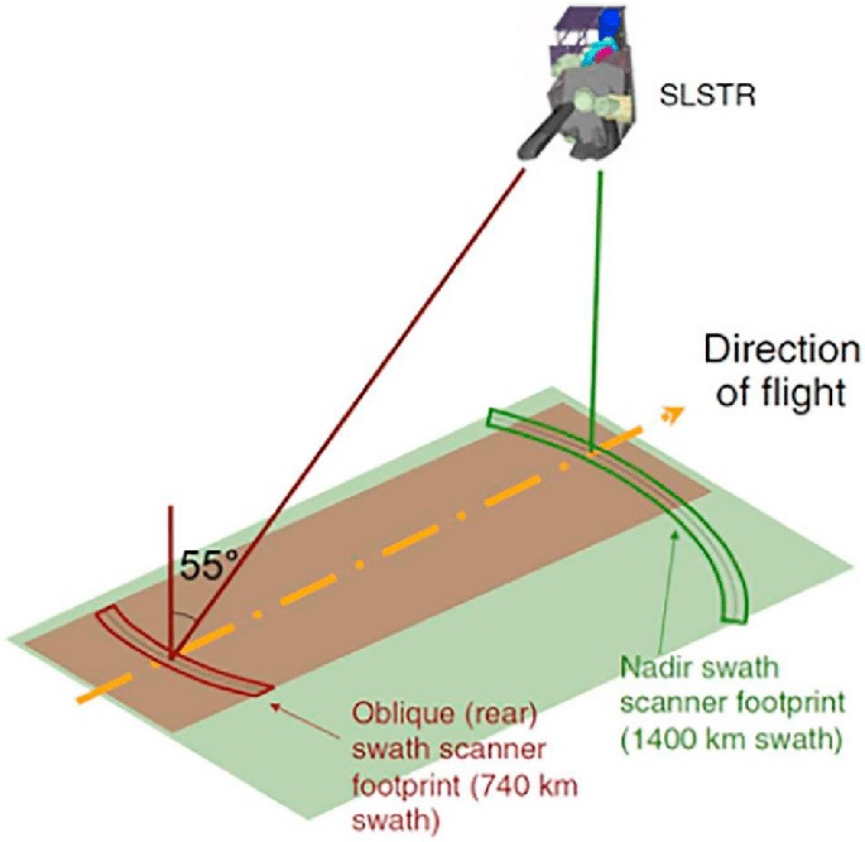
Inversion

- The inversion is based on the Optimal Estimation (OE) theory, which seeks for the best balance between the prior information and the observation:

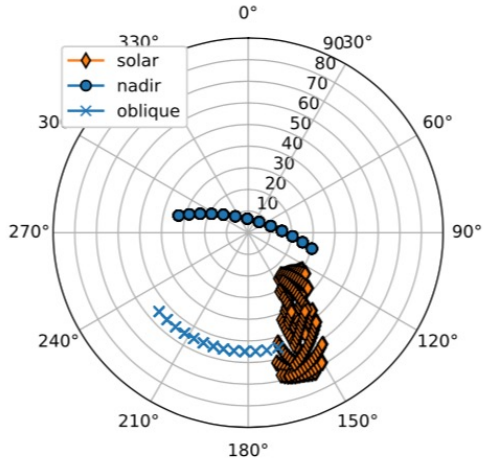


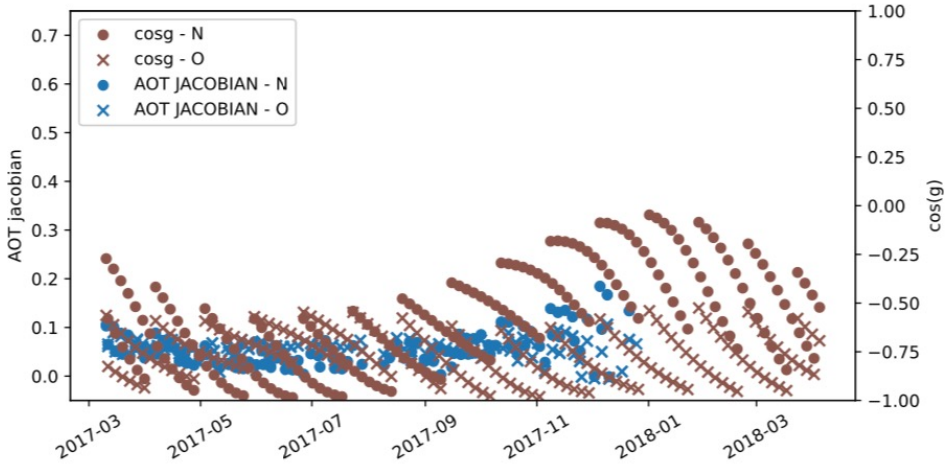
- SLSTR observations are accumulated during 16 days, the inversion takes place at the end of the accumulation period
- During the first 2 accumulation periods only clear-sky observations are processed, in order to build a good prior on the surface reflectance
- Afterwards, no external cloud mask is used and all observations are processed.

SLSTR observations



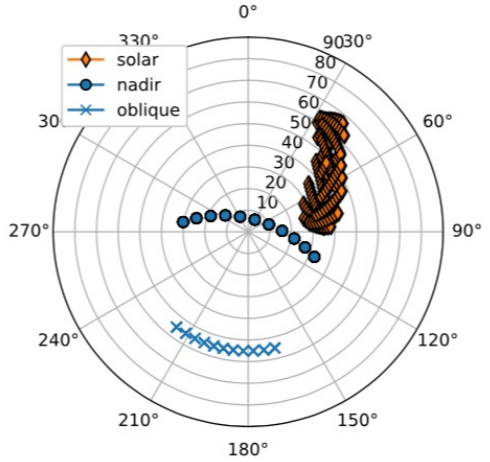
MetObs Lindenberg

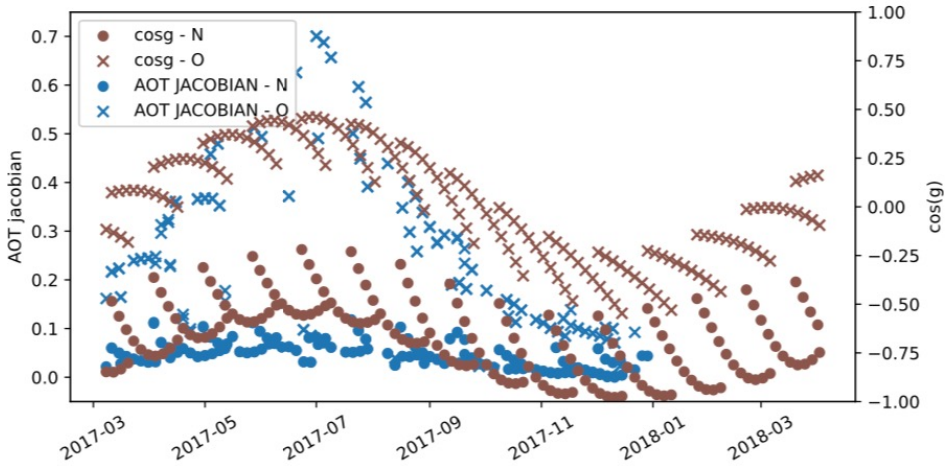




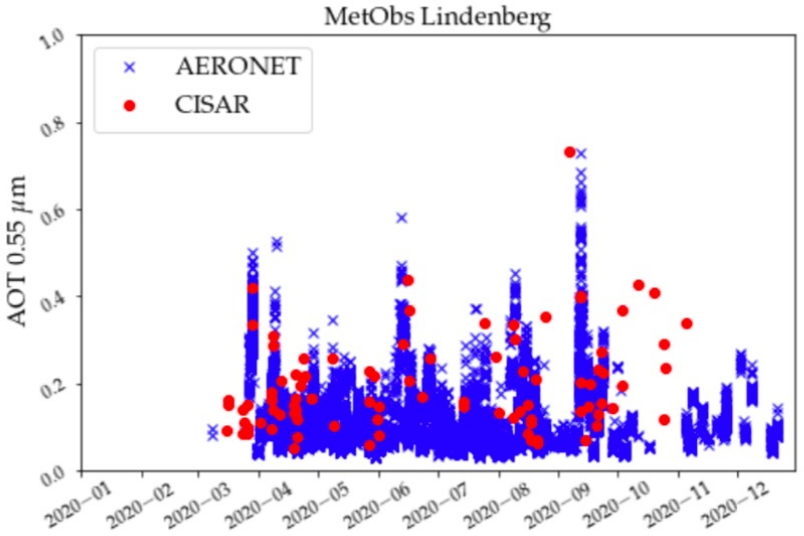
(a) a

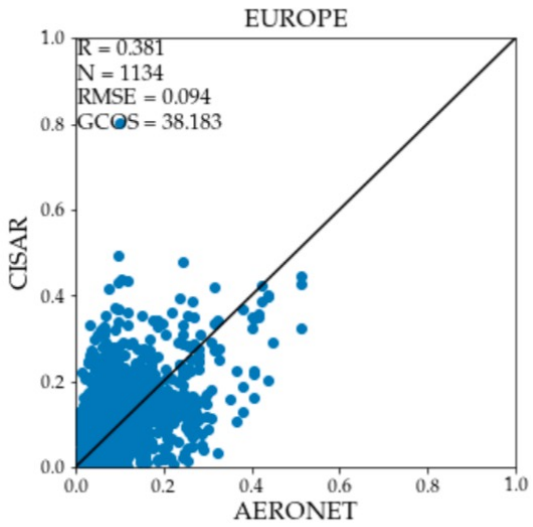
Bandung

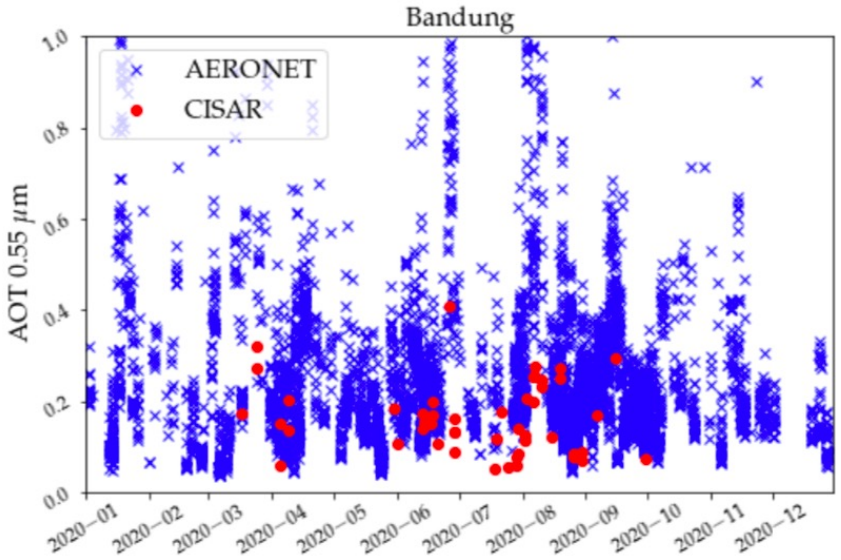


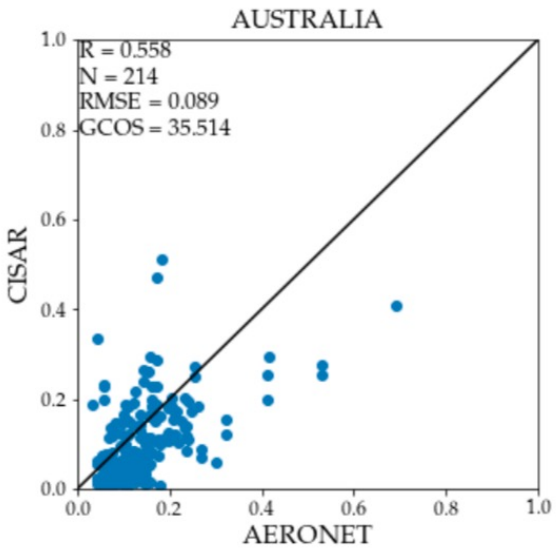


Evaluation against AERONET

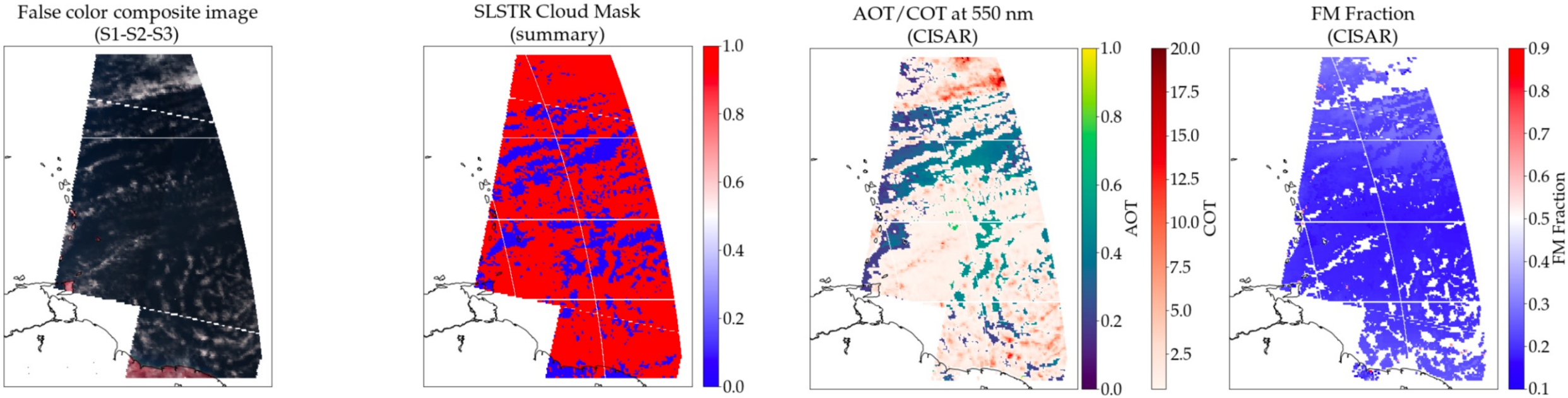






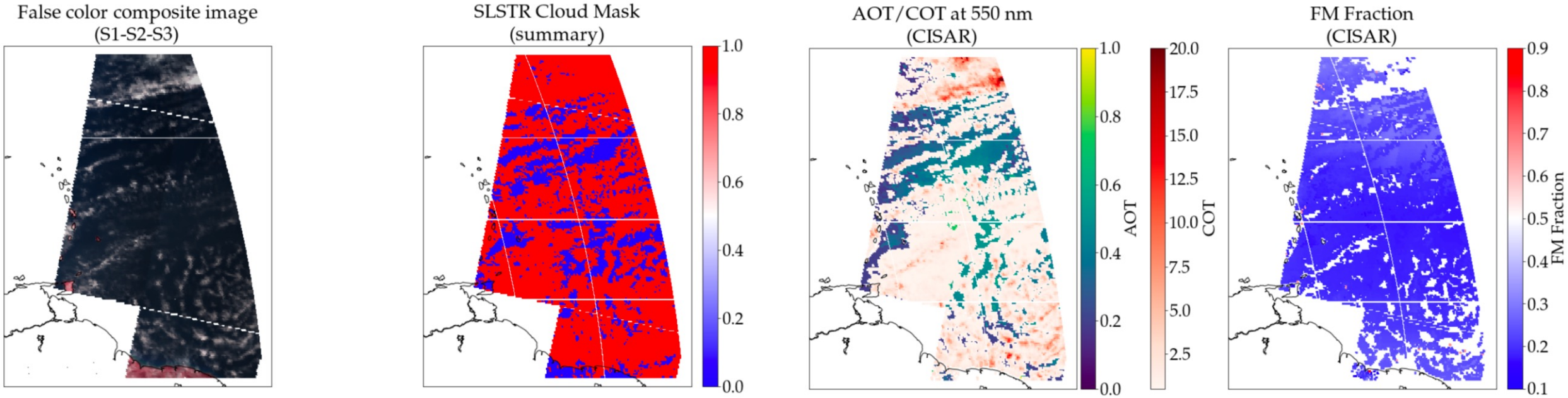


Case study: Barbados



February 1st, 2020. The ground measurements during the Eurec4a campaign measured high dust AOT.

Case study: Barbados



February 1st, 2020. The ground measurements during the Eurec4a campaign measured high dust AOT.

More than 70% pixels flagged as cloudy! But CISAR retrieval is present over 76% of pixels.
Spatial coverage improved by 46%!

Case study: Barbados

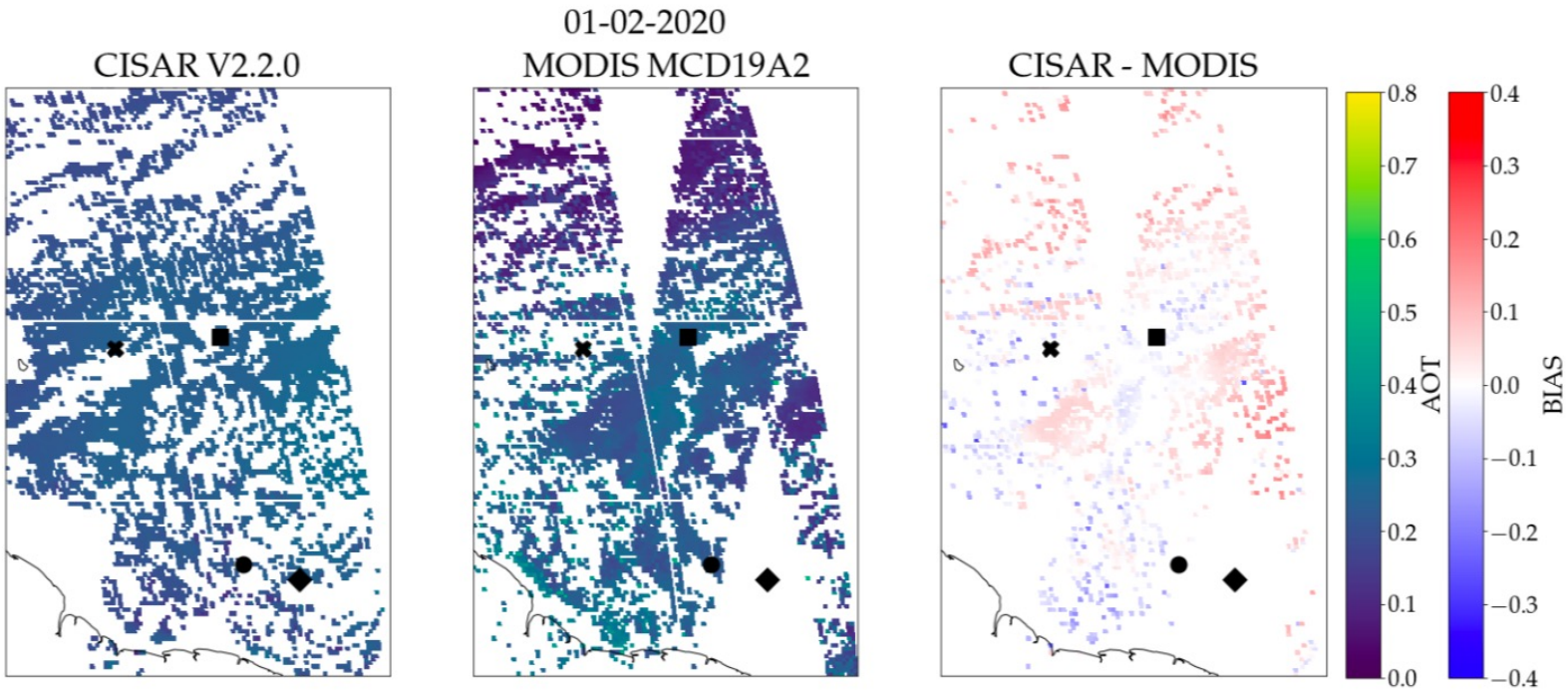


Fig. 10: SLSTR/CISAR (left panel), MODIS/MAIAC (center panel) AOT retrieval at $0.55\mu m$ and the associated bias (right panel) during the 1/2/2020. The black symbols represent the ship measurement acquired during the EUREC4A campaign. The AOT retrieval is equal to 0.43 for RV METEOR (cross), 0.54 for Maria Merian (dot), 0.31 for Atalante (diamond) and 0.55 for Atomic (square) 0.55.

Conclusions

- An innovative approach is proposed to address issues related to clouds in aerosol retrieval.
- CISAR consistently retrieves surface reflectance, aerosol and cloud single scattering properties.
- After a training period, no external cloud mask is applied and all observations are processed.
- The spatial coverage is improved as CISAR retrieves aerosols also in the vicinity of clouds and within thin clouds.
- The evaluation against AERONET shows good temporal evolution agreement and small RMSE, though there is still room for improvement.
- The evaluation against MODIS shows good spatial distribution agreement and no systematic bias.
- In the Barbados case study it is observed as CISAR correctly discriminate between dust and clouds.