

Aerosol Product from GEO orbit with MTG/FCI – coming development and perspective for a GEO-ring

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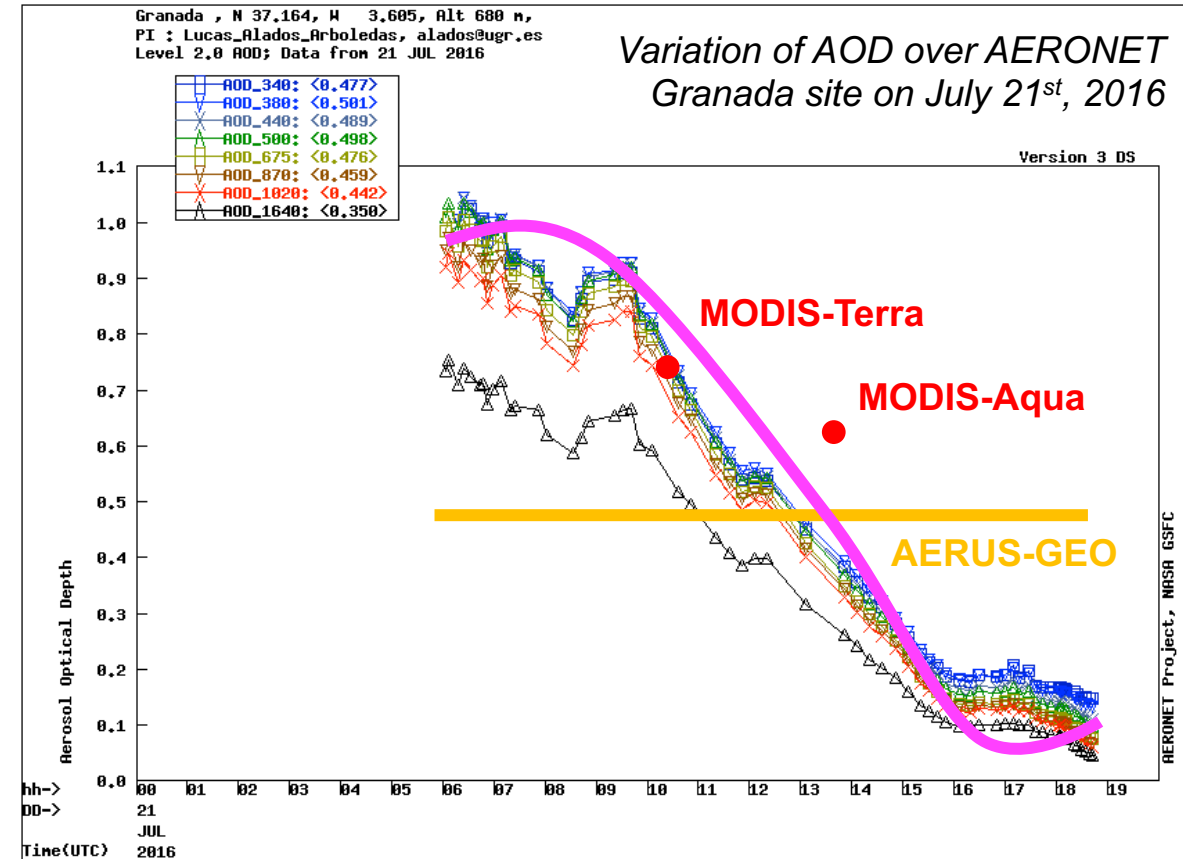


- Need for an aerosol product from GEO
- Heritage from MSG/SEVIRI and Aerus
- Development for MTG/FCI
- Perspective for a GEO-ring



Why aerosol from GEO?

- Specificity from GEO orbits
 - Far orbit: more demanding in geometry and radiometry
 - Visibility limited to a “disk”
 - But a very high-temporal revisit is accessible
- Aerosol content may evolve quickly with time (e.g. volcanic eruptions, wildfire smoke, dust storms, event in general) and is often related to a diurnal cycle (desert dust, urban pollution)
 - useful for many applications
- But for limited diurnal variation, allows maximization of the revisit (clear observation)
 - useful for many applications



Need for high-temporal-frequency aerosol observations (*Zhang et al., 2012; Xu et al., 2016; Plu et al., 2021; etc.*)

Unavailable from LEO (or very difficult) !



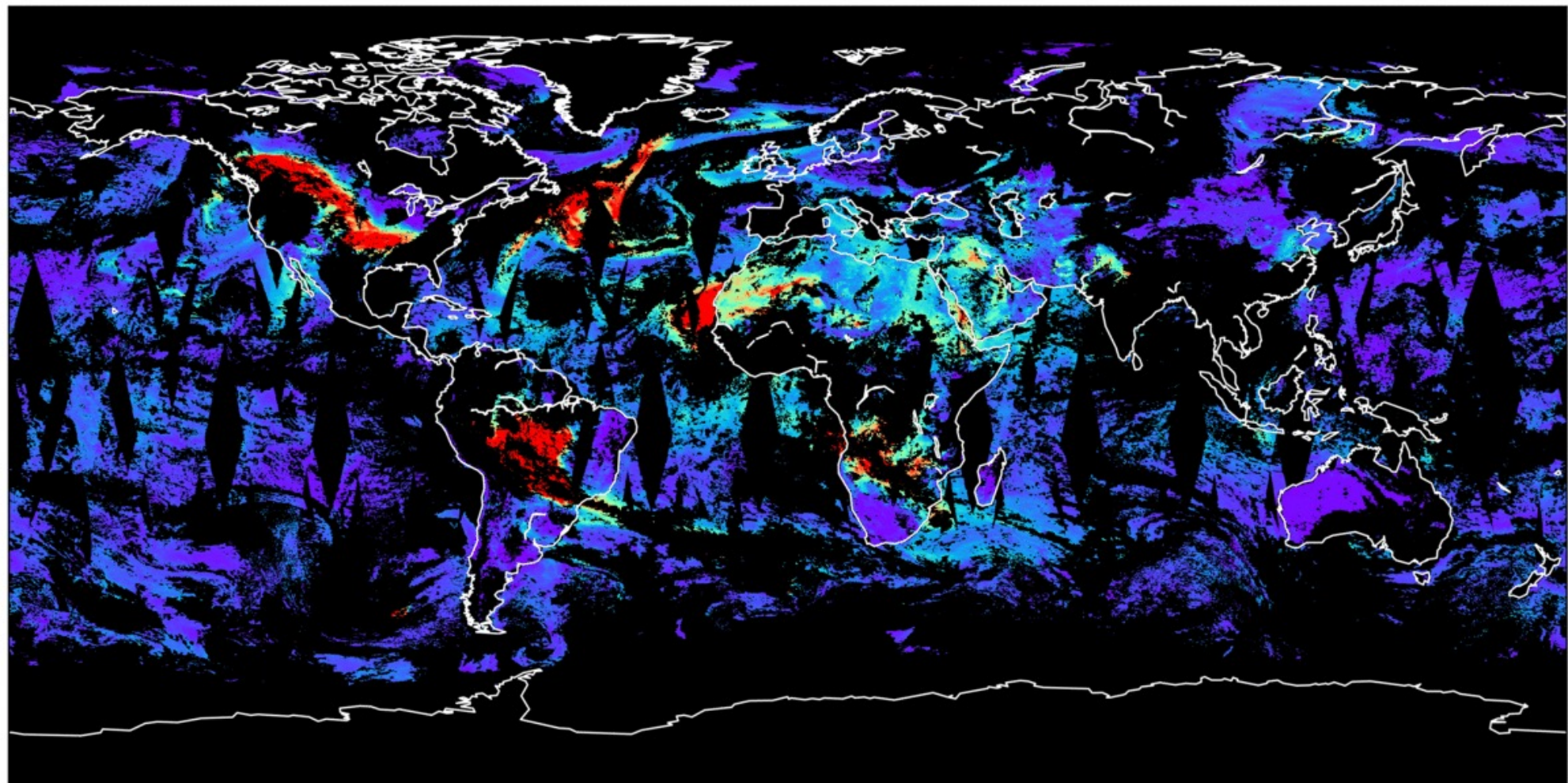
Why aerosol from GEO?

Animation
switching from

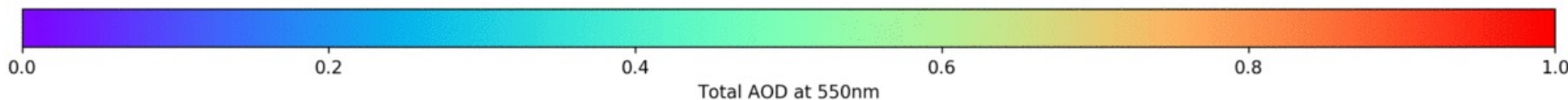
LEO AOD
(from MODIS
with DT/DB)

to

GEO AOD
(from GEO-ring
with AERUS-GEO)



Ceamanos et al., 2021



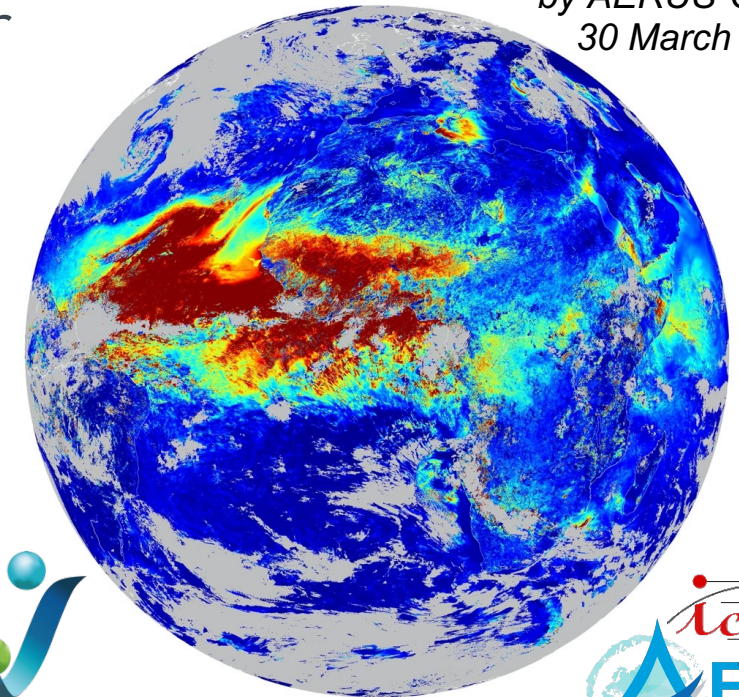
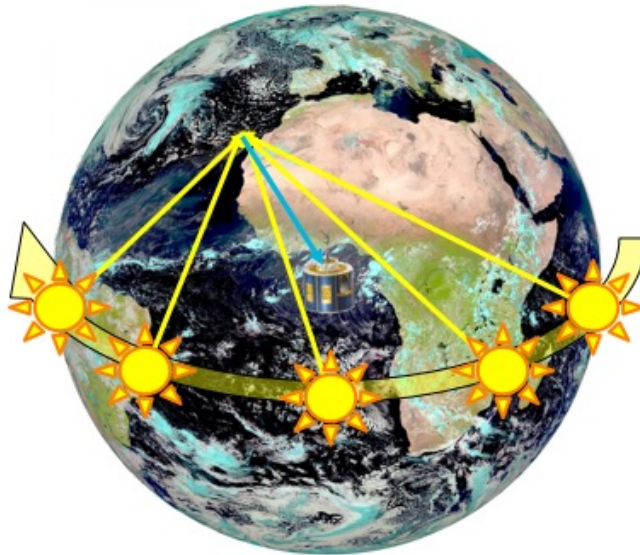
GEO-ring provides **greater spatial and temporal coverage** than LEO

AERUS-GEO algorithm

- *Basis.* Aerosol and surface simultaneous retrieval from one full day of SEVIRI observations based on their distinct angular and temporal features (Carrer *et al.* 2010, 2014)
- *Main outputs.* Daily-averaged AOD and surface BRDF at 0.64 μm
- *Validation.* Good agreement with AERONET ($r \cong 0.7$)
- *Production:* implemented in ICARE data & services center
 - Operated in « NRT mode » since 2014 + Reanalyses

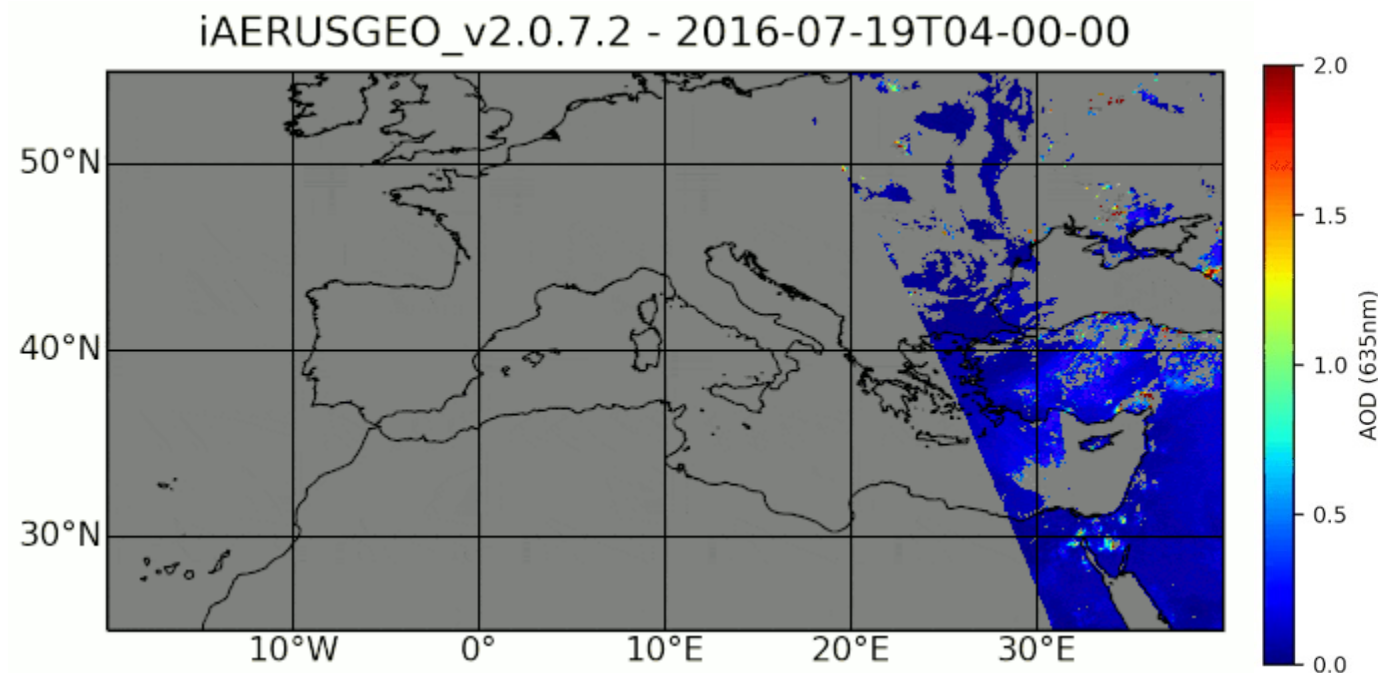
Daily AOD retrieved
by AERUS-GEO on
30 March 2010

SEVIRI:
GEO at 0° longitude
640, 865, and 1650nm
3km every 15 mins



i-AERUS-GEO algorithm

- *Main outputs.* Instantaneous AOD every 15mins (daily surface BRDF at $0.64 \mu\text{m}$)
- *Basis.* Surface estimated at the end of the day (using all valid observations), then propagated using a Kalman filter - Aerosol can be estimated the day after for each observations (Caemanos *et al.* AMT 2023)



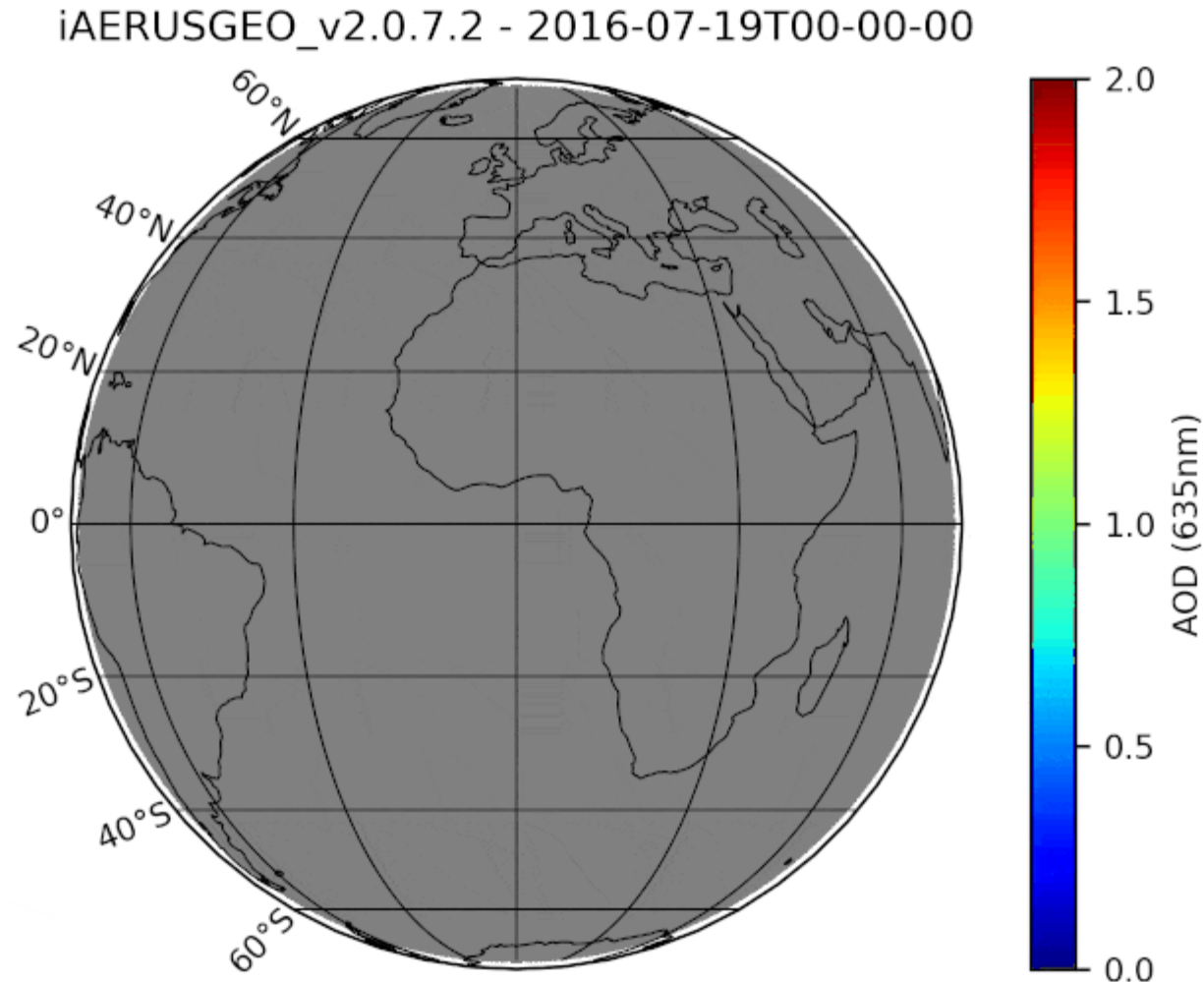
**Animation
showing diurnal
evolution of AOD
from July 19th to
22nd, 2016, as
retrieved by
iAERUS-GEO
(CM>1)**



- Full-disk maps of instantaneous AOD

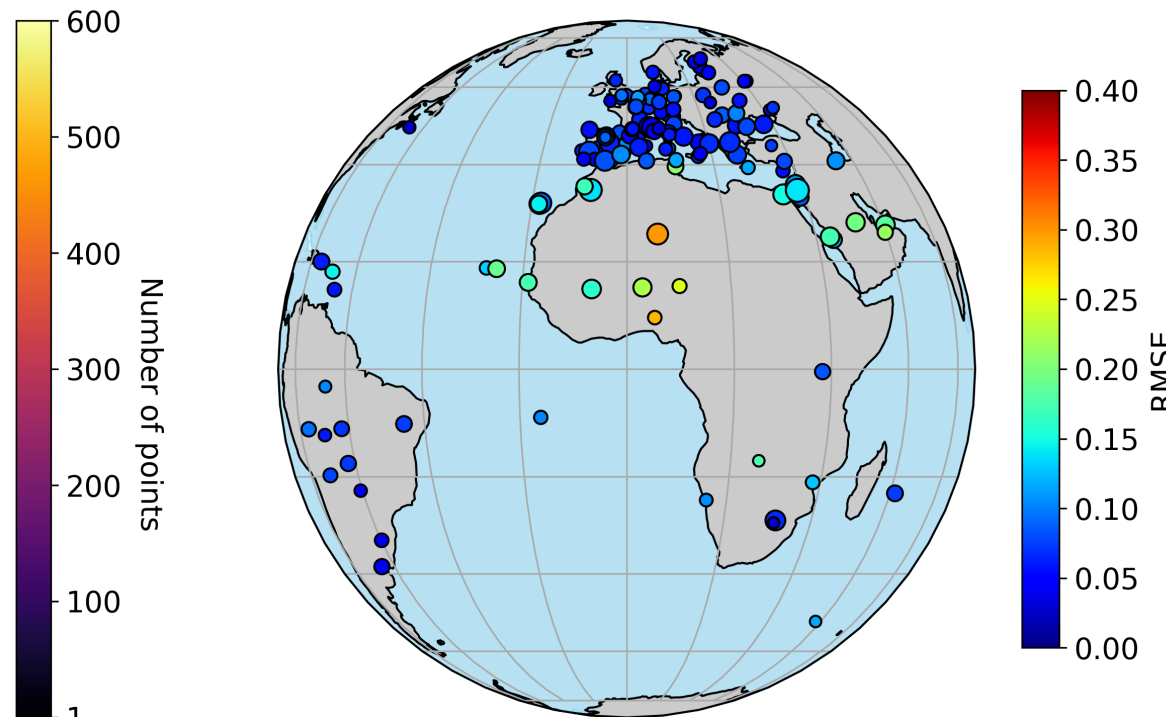
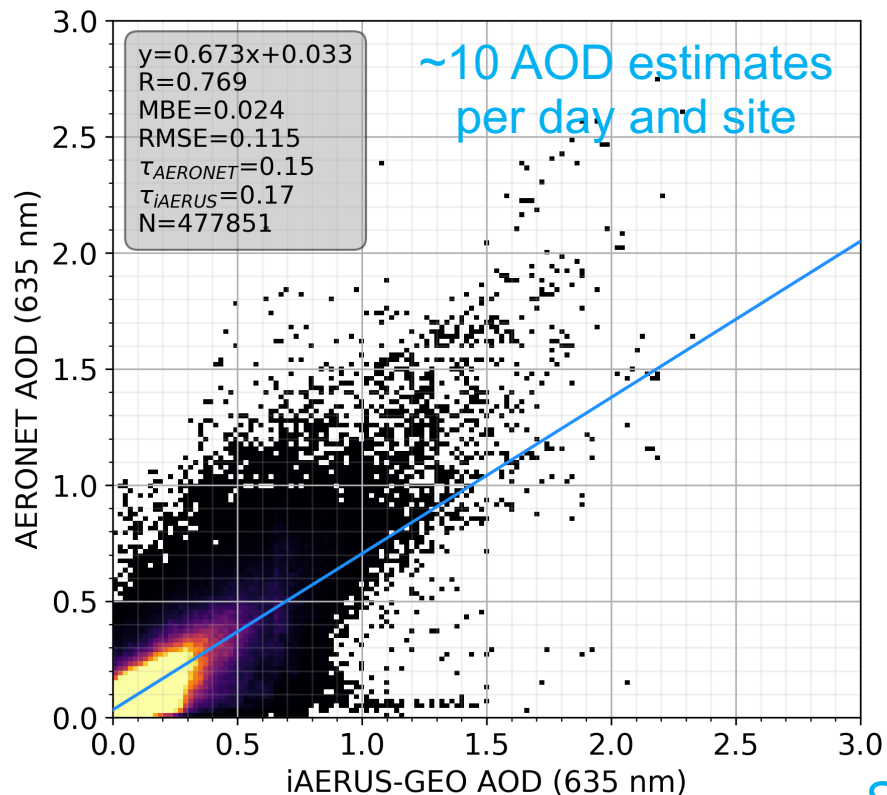
Fine temporal monitoring of aerosols is made possible over land and ocean

Higher bias over bright surfaces and some residual cloud contamination



Animation showing diurnal evolution of AOD from July 19th to 22nd, 2016, as retrieved by iAERUS-GEO (CM>1)

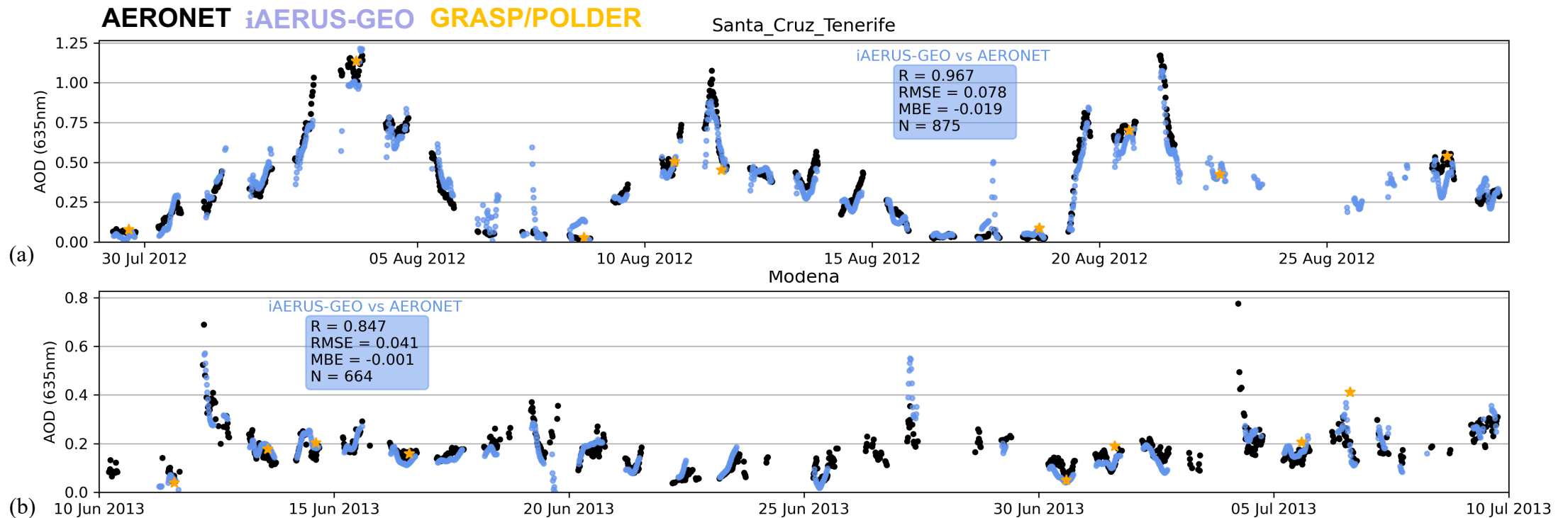
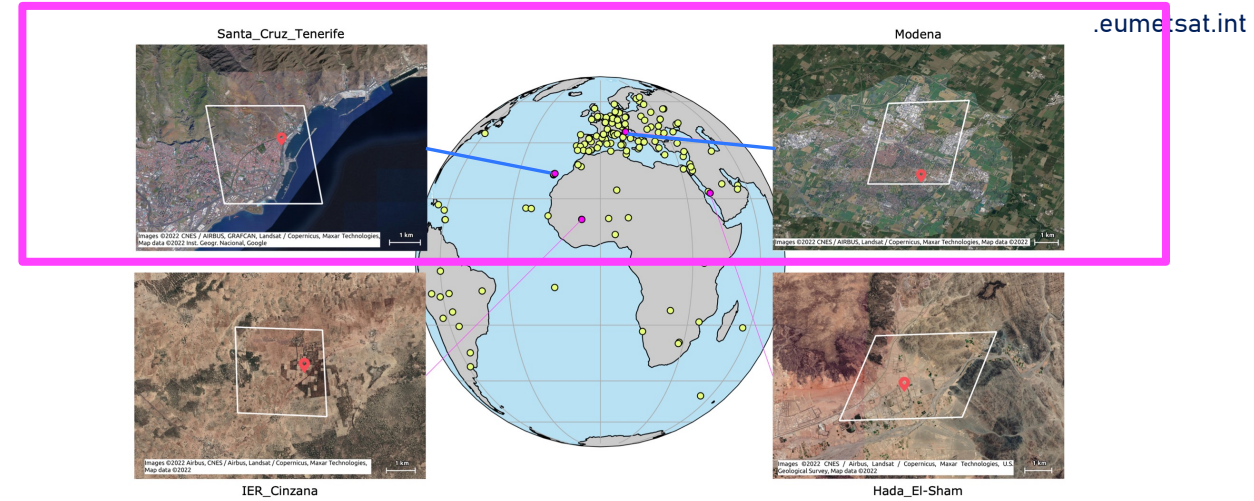
- Assessment of the performance



Satisfactory results despite some limitations including bright surfaces, coastal regions, and recurrently cloudy areas.

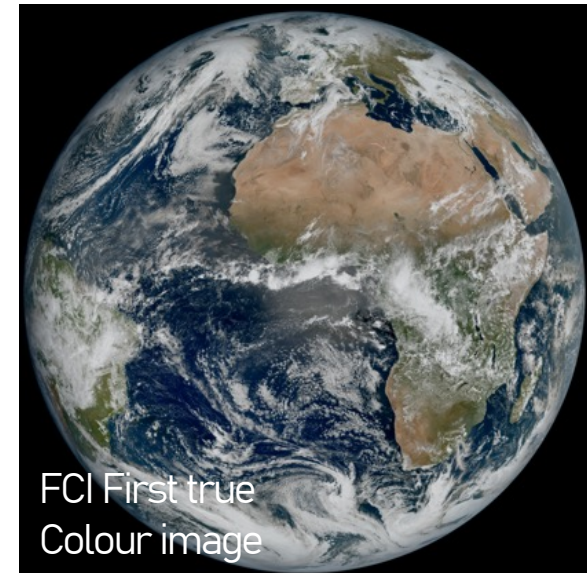
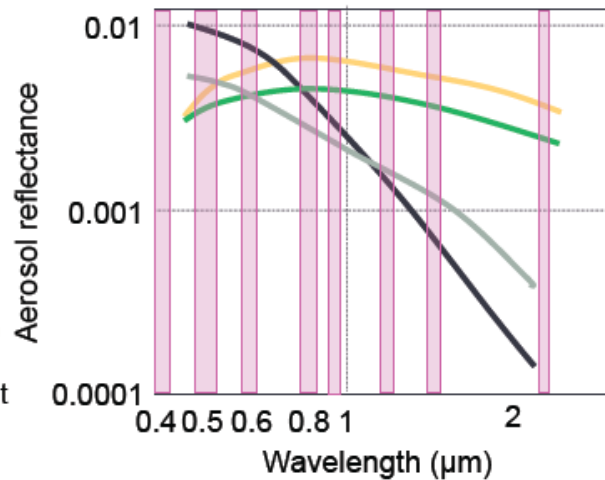
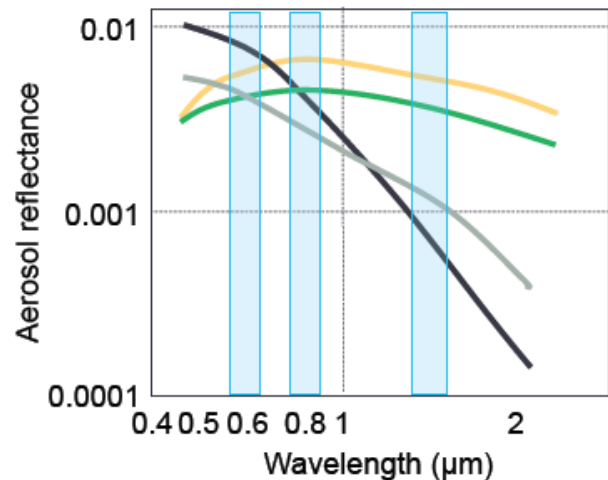
- All available sites from April 2012 to September 2013
- All retrievals (no filtering based on CM)
- Only central pixel is used for validation
- Error increases with:
 - Surface reflectance, due to decreasing aerosol signal
 - Scattering angle, due to decreasing aerosol ref. (& increasing surface ref.)
 - A decreasing AOD Jacobian, due to decreasing sensitivity to aerosols

- Ability to retrieve the diurnal cycle:
 - Based on SEVIRI
 - Very good potential
 - Some limitations to be addressed with FCI





- A number of limitations have been observed with i-AERUS / SEVIRI
- MTG/FCI, now in orbit, provides:
 - More spectral bands: 8 reflective bands (versus 3 for SEVIRI)
 - Better assessment of the aerosol model properties
 - Better disentanglement from the surface
 - Better performance
 - Better spatial resolution (1km@nadir)
 - Better revisit - more observations: 10' (2.5' in rapid scan mode)



24 hours of FCI: Canadian Wildfires reaching the Iberian peninsula (June 2023)

Full disk is scanned every 10 minutes

EUMETSAT

ESA



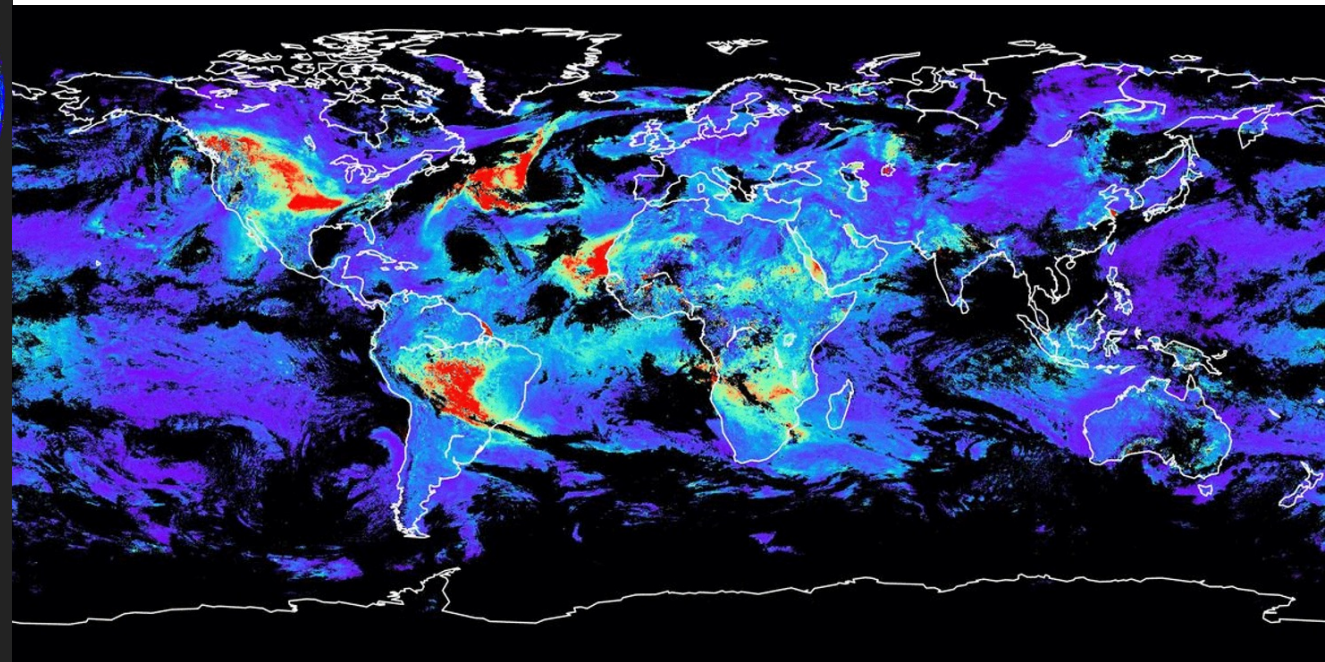
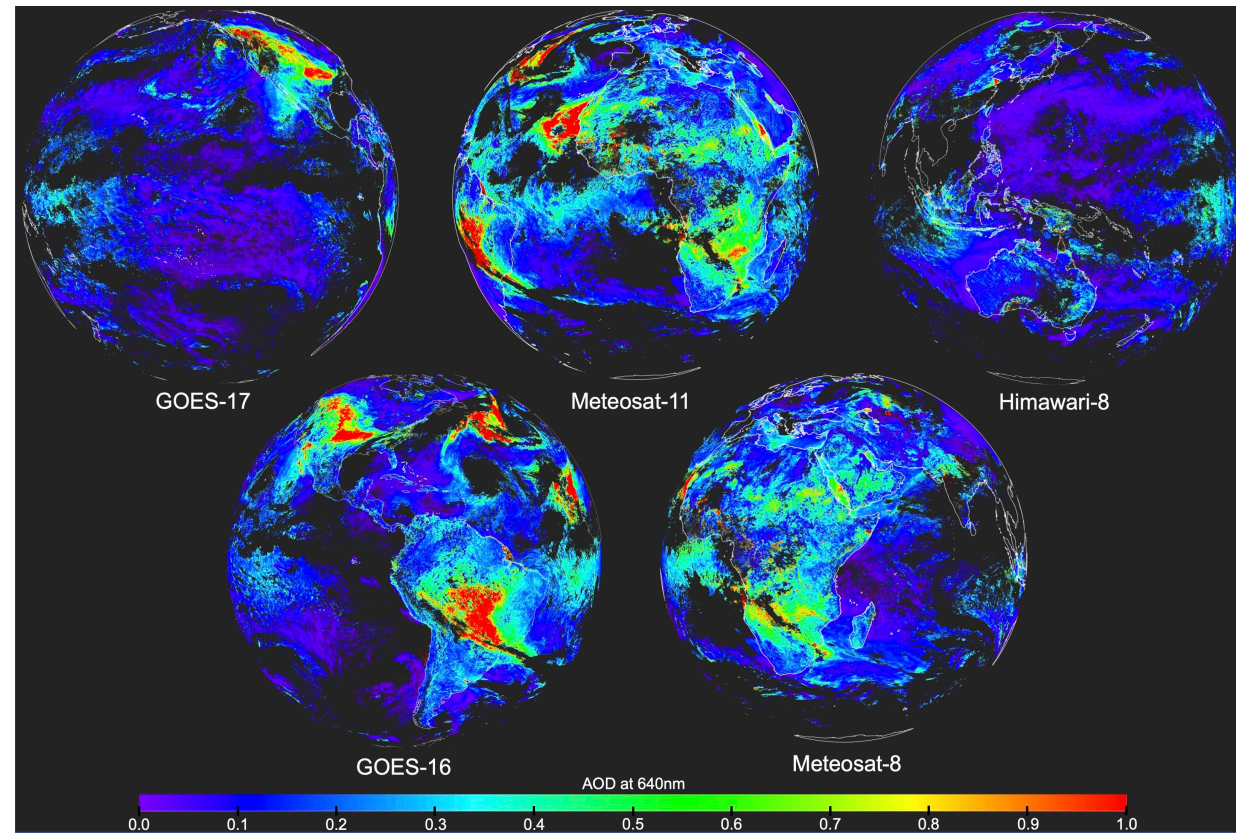


- i-AERUS to be adjusted to FCI data
 - More VIS bands increase sensitivity to AOD over surfaces (esp. bright ones)
 - More bands allows a better determination of the aerosol type
 - Directly impact AOD and reduces variation with geometry
 - More robust estimation
 - Increased number of measurements, in time and space
- On-going effort in Météo-France.
 - Scientific development and improvement of the performance
- In 2024, EUMETSAT will work closely with Météo-France with the following goals:
 - Support the optimisation of i-AERUS for FCI
 - Perform some demonstrational steps of the added-value for assimilation
 - Implement the processor in the EUMETSAT premises
 - Tailored for a NRT processor including dissemination



Perspective for a GEO-ring

- The coming i-AERUS will exploit the capability of MTG/FCI
- Afterward, can be operated on other similar systems: GOES/ABI, Himawari/AHI...
- Using a similar retrieval and product, a full GEO-ring becomes possible
 - Demonstration already done for a “SEVIR-like” version of the product
- A targeted option for such a GEO-ring product would be an implementation in ICARE



- EUMETSAT plans to develop an operational aerosol product based on MTG/FCI – starting early 2024
- It will rely on the heritage from developments done by Météo-France on MSG/SEVIRI data (currently available in ICARE)
- Adaptations are needed to improve the product using the additional information provided by FCI
- By extension, this processor can be applied to a GEO constellation of sensor having similar properties in order to provide a GEO-ring aerosol product
- Such a development can be optimised and tailored to the user needs (parameters, resolution for time and spatial - may differ from needs for LEO)
 - Feedbacks are welcome
- In the future, synergistic products can also be derived from FCI/IRS/S4



Thank you for your attention !