SYNERGETIC RETRIEVAL OF AEROSOL PROPERTIES FROM METOP

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Abstract

At the Earth Observation Center (EOC) of the German Aerospace Center (DLR) an upgrade of the synergetic aerosol retrieval method SYNAER which exploits GOME-2 and AVHRR data was made. SYNAER combines the use of an automatic dark field technique for AVHRR visible reflectances with a least square fit of simulated radiance spectra to GOME-2 measurements in order to retrieve aerosol optical depth and type in the boundary layer. This combination of two instruments allows retrieving aerosol optical depth at 550 nm and aerosol speciation from a choice of 40 pre-defined aerosol types.
This method was firstly developed with the sensor pairs ATSR-2 & GOME on board ERS-2 and AATSR & SCIAMACHY on board ENVISAT. However, due to instrumental limitations the coverage of SYNAER/ERS-2 and SYNAER/ENVISAT is very sparse. Therefore, SYNAER was transferred to similar sensors AVHRR and GOME-2 onboard MetOp. While transferring to the new sensor pair a thorough evaluation of the synergetic methodology and its information content has been conducted, which led to significant improvements in the methodology.
The first ongoing goal is the production of a 1-year tropospheric aerosol dataset and its thorough error characterization as input to Aerosol_CCI, MACC and PASODOBLE projects. The work shows exemplary results obtained with SYNAER applied to METOP sensors.

SYNAER/MetOp with APOLLO

At DLR (DFD-AT) a SYNergetic AErosol Retrieval method (SYNAER) was developed for ERS-2 and ENVISAT [Holzer-Popp, et al., 2002a and 2002b, 2008], which exploits the complementary information content of a radiometer and a spectrometer; the method has now been transferred to AVHRR and GOME-2, both onboard MetOp. This combination of two instruments allows to retrieve several parameters of the atmospheric aerosol loading:

- **aerosol optical depth at 550 nm**
- **aerosol speciation from a choice of pre-defined aerosol types**
- **near-surface aerosol mass concentration (PM10, PM2.5, PM0.5) assuming a fixed boundary layer height**

Fig.1: APOLLO algorithm applied for one 2048x2048 km^2 MetOp frame over Europe on 01.09.2008. Left frame corresponds to the reflectances from AVHRR/MetOp Channel 3 without cloud correction. Middle frame represents land-sea mask and sun glint mask derived from APOLLO. Right slide shows cloud mask with 1 km^2 resolution, which later is used in SYNAER/MetOp retrieval in order to eliminate and discern between cloudy pixels and pixels with aerosol load.

Accurate cloud detection is an important prerequisite for each aerosol retrieval. The well established APOLLO (AVHRR Processing Scheme Over CLoud Land and Ocean; Kriebel et al. 2003) software was applied to MetOp-AVHRR data. The capability of retrieving cloud cover in boxes of 1 km^2 means a significant strength of SYNAER because it reduces the erroneous aerosol detection due to the presence of sub pixel clouds significantly.

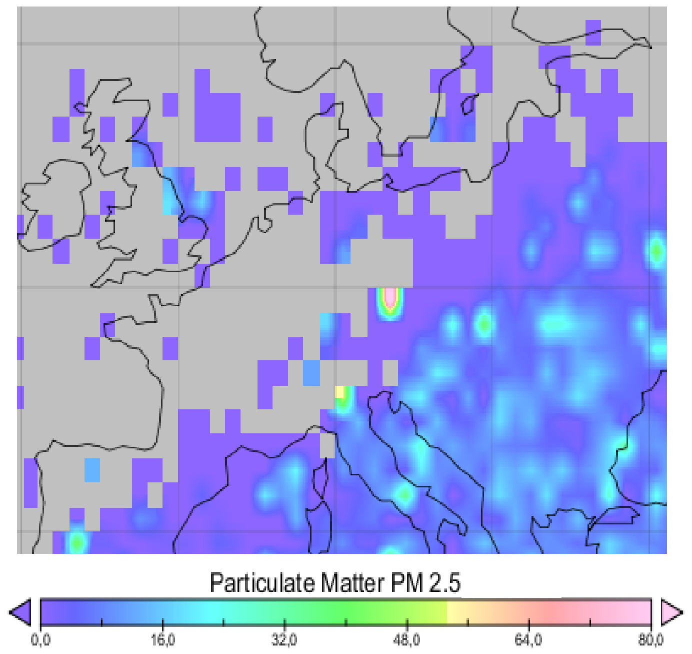

Fig.2: PM2.5 map over Europe based on SYNAER observations of the period 1 – 6 September 2008.

The two features of the aerosol properties, naimly retrieved AOD550 and derived aerosol type, can be used to calculate a systematic conversion of AOD values into aerosol mass concentrations (PM10, PM2.5, PM0.5) and their speciation. However, the vertical profile structure is an essential additional input for deriving accurate PM values under all cirumstances. This can in principle be derived from operational chemistry transport models, e.g. the POLYPHEMUS-DLR/SIREAM model, or from auxiliary measurements by ground-based (e.g. EARLINET) or spaceborne (e.g. CALIPSO) lidar systems.

These profiles and the SYNAER output allow a systematic conversion of AOD into PM values [Holzer-Popp, et al., 2004]. This approach holds the potential to enable a global all-year application in comparison to experimental statistical correlations which have been demonstrated for several sensors but generally are restricted to a certain region or season.

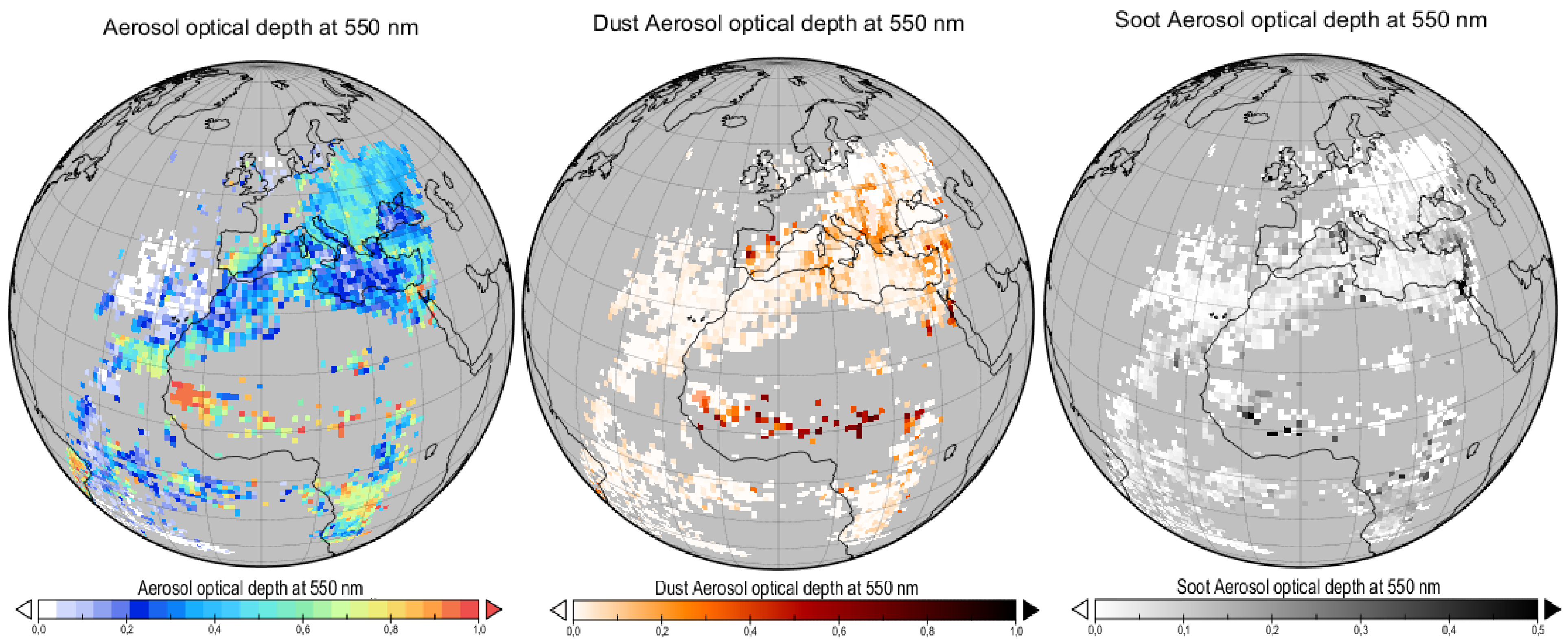

Fig.3: Aerosol maps over Europe. Aerosol optical depth at 550 nm for daytime MetOp orbits acquired over Europe and Africa during the period 1.-6. September 2006. Left plot shows total AOD for this time period. Middle plot corresponds to mineral dust aerosol load. Right picture shows the AOD due to the soot.

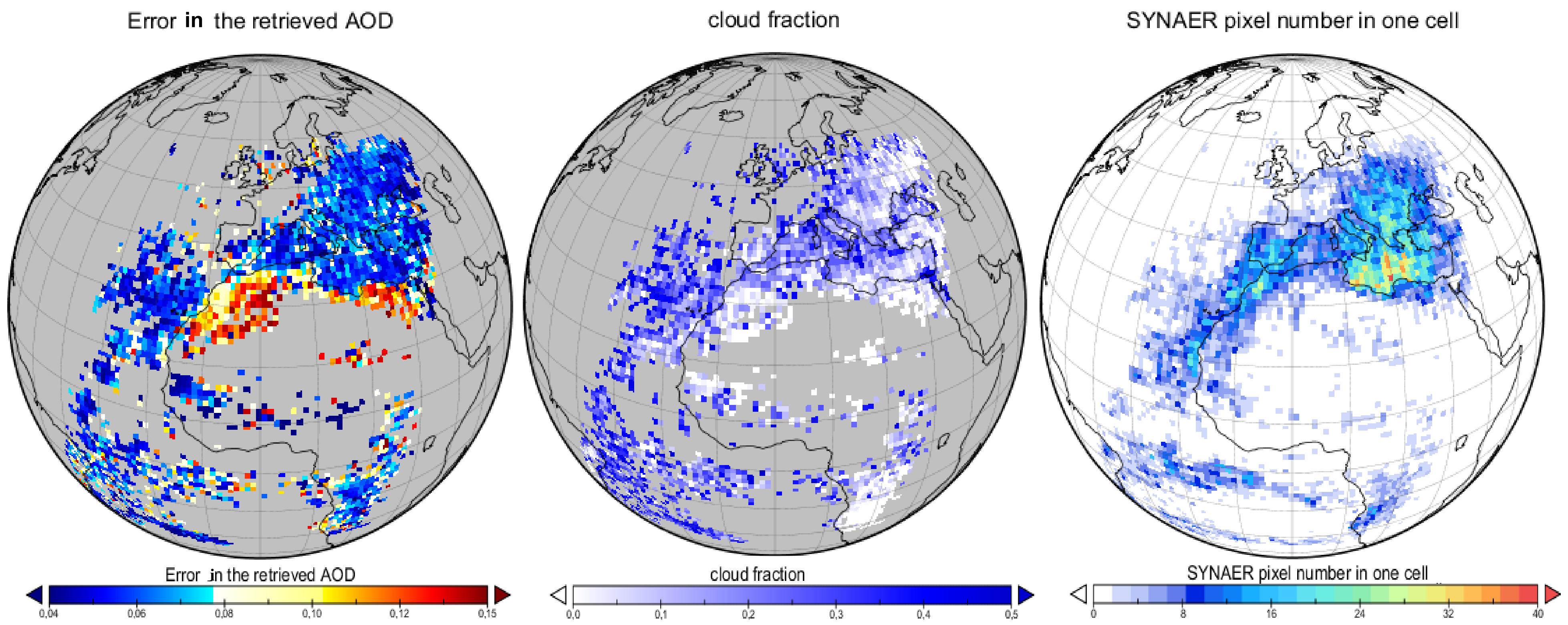

Fig.4: Aerosol maps over Europe. Aerosol optical depth at 550 nm for daytime MetOp orbits acquired over Europe and Africa during the period 1.-6. September 2006. Left plot shows total AOD error due to the surface type retrieval and dark field method assumptions for this time period. Middle plot corresponds to the cloud fraction derived from APOLLO/MetOp. The cloud treshold in 50% is used in order to account partly cloudy pixels. Right picture shows total coverage of the processed orbits over the 6 days.

Several features can be seen on these maps:

✓ Mineral dust AOD over the the Sahel-Soudan belt is well detected
✓ Organic Soot can be also seen over the typical fire areas in Africa
✓ Antropogenic Soot AOD signal can be also observed over Nile Delta and partly in Europe
✓ AOD550 error is quite large over rather bright surfaces, as e.g. in Northern Africa.

Summary and outlook

This poster summarizes results of the AOD retrieval from MetOp and AOD-to-PM conversion. In all examples shown a 2 km fixed homogeneous aerosol layer was assumed; the use of the POLYPHEMUS-DLR/SIREAM vertical profile is one of the next steps to be implemented into the algorithm. A dataset covering Europe, large parts of Africa and the Eastern Atlantic Ocean and extending over several days in September 2008 has been produced with the SYNAER method. Based on the SYNAER retrieved AOD and speciation data in orbit projection daily maps of PM values were produced.

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References

- Holzer-Popp, T., Schroedter, M., and Gesell, G.: Retrieving aerosol optical depth and type in the boundary layer over land and ocean from simultaneous GOME spectrometer and ATSR-2 radiometer measurements, 1, Method description, 2, Case study application and validation J. Geophys. Res., 107(D21), AAC16-1–AAC16-17, 2002a,b.
- Holzer-Popp T., Schroedter-Homscheidt, M., Breitkreuz, H., Klüser, L., Martynenko, D., Improvements of synergetic aerosol retrieval for ENVISAT, Atmospheric Chemistry and Physics, 8, 7651-7672, 2008

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