Polarimetric Missions in the context of Operational Aerosol Products

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Satellite observations of aerosol properties are of critical importance for a number of established and emerging applications that serve a wide user community such as the Copernicus Atmosphere Monitoring Service (CAMS), the National Weather Prediction (NWP), the World Meteorological Organisation Sand and Dust Storm Warning Advisory and Assessment System (SDS-WAS), the Volcanic Ash Advisory Centers (VACC), and the climate analysis with the Copernicus Climate Change Service (C3S). The provision of operational aerosol products implies a sufficient level of quality, a documented and monitored performance, a near real-time data dissemination, a reliability in term of data distribution, but also a retrieval optimized with respect to the user needs.

To support these NRT operational needs, EUMETSAT is currently operating two aerosol processors providing aerosol optical depth (AOD) as well as some other aerosol parameters: the Polar Multi-Sensor Aerosol product (PMAp) from the Metop platforms [1], and the Optimised Simultaneous Surface Aerosol Retrieval with Copernicus Sentinel-3 (OSSAR-CS3) from the Sentinel-3 platforms [2]. If the particularity of PMAp is to be the first NRT operational aerosol product being based on a synergy between 3 instruments (GOME-2, AVHRR, and IASI), OSSAR-CS3 efficiently combines the spectral information provided by SLSTR from a dual-view acquisition. Both algorithms have recently made good progress, especially by a better understanding of the measurement itself. Both products are assimilated (currently PMAp over ocean) or will be assimilated soon by CAMS for the need of air quality monitoring.

A significant breakthrough will be done with the polarimeter 3MI on-board Metop-SG coming end 2025 [3]. 3MI is a heritage of the POLDER instruments, with improved capabilities: the spectral range covers from 410 to 2200 nm, 9 channels being polarized (-60°, 0°, and +60°), the spatial resolution is 4 km nadir, and the swath 2200 × 2200 km^2. The operational aerosol retrieval will rely on the GRASP framework under implementation and optimisation to the 3MI information content [5] [6]. A performance at least similar to PARASOL and MODIS combined is expected for the standard AOD parameter. In addition, the polarimetric capabilities open the door to many more parameters allowing a description of the aerosol model (fine/coarse) or type, aerosol chemical component, size, layer height, and shape. The Copernicus CO2M mission will also carry a Multi-Angle Polarimeter (MAP) for which operational aerosol products will also be generated based on the GRASP framework. This will require a specific optimisation for the

need of atmospheric correction in the SWIR domain supporting the retrieval of carbon dioxide and methane.

Another important step forward will be to pursue the development of synergistic products. Combining the information content from different sensors, the set of aerosol parameters, and/or their associated performance, can be significantly enhanced. A Multi-Aerosol Product (EPS-SG/MAP) will be proposed, as a follow-on of PMAp, combining the instruments from the Metop-SG platform, i.e. 3MI, METimage, Sentinel-5/UVNS, and IASI-NG. The synergy will be also developed for other platform, especially for Sentinel-3 for which the spectral information can be enriched by combining SLSTR with OLCI, and by extension to Sentinel-3 Next Generation. In a longer term perspective, the synergy developed for EPS-SG could also be implemented for Meteosat Third Generation, combining FCI, Sentinel-4/UVN, and IRS instruments.

These developments based on various space systems have nevertheless a similar goal of generating and disseminating operational aerosol products. This requires a level of standardisation in term of methodology. For instance, the information content analysis will be generalized as a prerequisite to any optimisation of the retrieval, and the Cal/Val approaches and methodologies relying on operational reference measurements such as Aeronet – but not only- will also be communalized as much as possible.

The presentation will overview all these aspects, with a special focus on polarimetric missions.

References

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[3] Fougnie et al., "The Multi-Viewing Multi-Channel Multi-Polarisation Imager – Overview of the 3MI polarimetric mission for aerosol and cloud characterization," *J. Quant. Spectrosc. Rad. Transf*., APOLO special issue, No. 219, pp. 23-32, 2018.

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[6] Dubovik et al., "Comprehensive Description of Multi- Term LSM for Applying Multiple a Priori Constraints in Problems of Atmospheric Remote Sensing: GRASP Algorithm, Concept, and Applications", Front. Remote Sens. 2:706851. doi: 10.3389/frsen.2021.706851, 2021.

Preferred mode of presentation ☒ Oral ☐ Poster ☐ Either

Topic *(check all that apply)*

☐ Advances in the theory of polarimetric remote sensing
☐ Scattering of light by terrestrial aerosols, clouds, oceans, and land surfaces
☐ Polarimetric applications in astrophysics and planetary science
☒ Improvement of polarimetric instrumentation quality and information content
☒ Development of advanced retrieval algorithms and data processing
☒ Upcoming and current satellite missions and field campaigns
☐ Long-term calibration and validation
☐ Discussions on the life and legacy of Michael I. Mishchenko
☐ Other: *if checked, enter description here*