

Towards an Operational Aerosol and Surface Retrieval from CO2M/MAP: Development and Evaluation of a GRASP-Based L2 Processor

Christian Matar¹, Pavel Lytvynov¹, Oleg Dubovik², David Fuertes¹, Siyao Zhai¹, Marcos Herreras-Giralda¹, Juan Carlos Antuña Sánchez¹, Anton Lopatin¹, Pepe Phillips³, Ruediger Lang³, Sruthy Sasy³, Leonid Butenko³, Bertrand Fournier³

1. GRASP SAS, Remote Sensing Developments, Lille, France
2. Laboratoire d'Optique Atmosphérique, CNRS/University of Lille, France
3. EUMETSAT, Darmstadt, Germany

The Copernicus CO2M mission introduces a new generation of atmospheric observations aimed at quantifying anthropogenic CO₂ emissions with unprecedented accuracy. A critical component of this system is the Multi-Angle Polarimeter (MAP), designed to characterize aerosol properties and constrain light-path effects impacting greenhouse gas retrievals. Accurate aerosol characterization is essential, as uncertainties in aerosol scattering and absorption directly propagate into CO₂ column retrieval errors.

In this work, we present the development and implementation of an operational Level-2 aerosol processor based on the GRASP algorithm. The processor builds upon the GRASP inversion framework, which enables simultaneous retrieval of aerosol and surface properties through multi-angular, multi-spectral, and polarimetric measurements. The algorithm configuration is specifically adapted to the CO2M/MAP observation geometry and spectral characteristics, leveraging heritage from multi-angular polarimeter missions, from POLDER to 3MI.

We describe the end-to-end processing chain, including ingestion of MAP Level-1C data, harmonization with auxiliary datasets (e.g., surface BRDF/BPDF), and a scalable implementation suitable for operational environments. The functional and qualitative performance of the processor is evaluated using realistic synthetic datasets generated from CO2M/MAP proxy observations, covering a wide range of aerosol types, surface conditions, and viewing geometries. The results demonstrate robust retrieval of key aerosol optical and microphysical properties, with improved accuracy under enhanced angular sampling. The impact of surface characterization and observation geometry on retrieval stability is also quantified. Finally, we discuss the role of the CO2M/MAP aerosol processor within the broader CO2M processing chain and its contribution to reducing systematic errors in CO₂ retrievals.

This work highlights the readiness of GRASP-based approaches for operational exploitation of next-generation polarimetric missions and contributes to ongoing efforts in harmonizing aerosol products across multi-mission frameworks.