Multi-Angle Polarimeter (MAP) in the Context of Atmospheric Correction for CO2 Retrievals

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The Copernicus carbon dioxide monitoring (CO2M) mission is the space component of the European integrated monitoring and verification support capacity dedicated to monitoring anthropogenic CO2 emissions. Due to the high accuracy requirements of this measurement, it is critical to measure and characterise aerosol in support of the CO2 retrieval. The Multi-Angle Polarimeter (MAP) is therefore included as a payload on the CO2M mission and the measured aerosol properties are used to correct for aerosol scattering and transmission in the downstream greenhouse gas (GHG) retrieval. The instrument itself is a multi-angle (45 views) multi spectral (6 polarised bands, 400-900nm) polarimeter, similar in terms of information content to the heritage instruments POLDER, or the forthcoming 3MI. However, it uses a novel design with micropolarisers and filters directly glued to the focal plane detector. A dedicated resampling approach is therefore needed to co-register all views to the CO2M spectrometer grid in a dedicated MAP L1C product to support the downstream GHG retrieval. For CO2M, three independent GHG retrieval algorithms will used downstream for the XCO:

- Fusional-P [1], which uses MAP L2 as a-priori aerosol information and can either simultaneously retrieve CO2 and aerosol, or CO2 only.
- Fast atmospheric trace gas retrieval (FOCAL) [2][3], which uses MAP L2 for the bias correction in the post-processing stage.
- RemoTAP [4] which ingests MAP L1C and can simultaneously retrieve aerosol and CO2.

The MAP L1B product provides multi-angle polarised radiances, acquired natively at 0.8×0.8 km² which are subsequently co-registered and re-gridded to the main CO2 spectrometer instrument grid at MAP L1C stage. The L1C product contains multi-angle observations co-registered at surface altitude with respect to the WGS84 ellipsoid using a digital elevation model. In this contribution we will describe in detail our specific co-registration approach based on an inverse geolocation algorithm that allows us to seamlessly take parallax correction from surface roughness and potentially cloud height into account. First results from GRASP (Generalized Retrieval of Aerosol and Surface Properties)[5] retrievals of both aerosol and surface properties from simulated MAP L1C product will be presented showing the impact of co-registration error on the downstream aerosol products.

GRASP is a state-of-the-art algorithm developed to achieve complete and accurate characterisation of aerosol and surface properties using full radiative transfer calculations and a highly elaborated statistically optimised fitting. In the case of MAP, the aerosol retrieval performed in the VNIR, is used for an atmospheric correction in the SWIR for the CO2 retrieval. To improve the representation of the aerosol for this spectral region, in particular the characterisation of larger dust particles which scatter predominantly at these wavelengths, a "synergistic retrieval" is used which incorporates (single-view) SWIR channels at 1.6µm and 2µm from the CO2 spectrometer. As a result, GRASP will be used in a new configuration using radiances from two independent instruments and some enhancements have been made to the models used to represent aerosol, particularly in the SWIR, to ensure consistency throughout the entire processing chain encompassing both aerosol and downstream GHG retrievals.

References

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