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Simultaneous retrieval of trace gases, aerosol and cirrus using RemoTAP – the global orbit ensemble study for the CO2M mission

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In the support of the Copernicus Anthropogenic Carbon Dioxide Monitoring (CO2M) mission, SRON Netherlands Institute for Space Research developed the Remote sensing of Trace gas and Aerosol Product (RemoTAP) algorithm. RemoTAP is able to achieve simultaneous retrieval of trace gases, aerosol and cirrus using measurements from the Multi-Angle Polarimeter (MAP) and CO2I Imager aboard the CO2M mission. At the same time, it has the capability to perform the retrieval of trace gas from only CO2I measurements.

This study evaluates the performance of RemoTAP for combined MAP-CO2I and CO2I-only retrievals, respectively. We base our evaluation on synthetic CO2M measurements simulated for realistic atmospheric (aerosol, cirrus), surface, geometry conditions. For the treatment of cirrus, we implemented 2 options: 1) filter our cirrus contaminated pixels based of non-scattering retrievals form CO2I, and 2) include cirrus properties (aspect ratio, roughness, column number, altitude) to the retrieval state vector. Overall, the MAP-CO2I retrieval method is able to reduce the aerosol-induced retrieval error in column-averaged dry-air mole fraction of CO2 (XCO2) in terms of RMSE and bias by more than a factor of 2, compared to CO2I-only retrievals on the filtered pixels. A strong correlation between XCO2 error and surface albedo in CO2I-only retrievals is significantly reduced for MAP-CO2I retrievals. Besides, XCO2 biases in CO2I-only retrievals exhibit a significant spatio-temporal variability caused by a strong dependence on aerosol load. The biases can be up to 2 ppm over some regions, which are much larger than for the global case. It shows that only by the inclusion of MAP measurements, the large aerosol-induced biases can be mitigated, resulting in the retrievals that meet the mission requirement (precision <0.7 ppm and bias <0.5 ppm).

Keywords: RemoTAP retrieval algorithm, aerosol, CO2M, MAP-spectrometer simultaneous retrieval