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Comparison of algorithms for the retrieval of aerosol and trace gas vertical profiles using synthetic MAX-DOAS data

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The retrieval of vertical profiles of aerosol extinction and trace gas concentrations using Multi-Axis DOAS has found a growing number of applications during recent years. However, the assessment of the ability of individual profile retrieval algorithms to reconstruct the state of the atmosphere and the determination of their accuracy remains a challenging task owing to the limited information content of scattered light measurements and the variety of conceptual approaches on which the retrieval algorithms are based.
Here we present results from a round-robin intercomparison exercise performed in the framework of the FRM4DOAS (Fiducial reference measurements for ground-based DOAS air quality observations) project. One of the main objectives of this 2-years ESA activity is the demonstration of a centralised NRT processing system for MAXDOAS instruments, which will include both a DOAS analysis and profile retrieval algorithm processor. The round-robin has the aim to select an appropriate retrieval algorithm for the centralised processing system. The comparison is based on a set of synthetic slant column densities from an ensemble of radiative transfer models that comprises more than 20,000 scenarios from a combination of different trace gas and aerosol profiles, wavelengths, and viewing geometries. Target species are aerosol extinction at 360 and 477 nm, formaldehyde, and nitrogen dioxide. By comparing true and retrieved aerosol and trace gas profiles, this approach allows for the first time for a detailed quantitative assessment of the different retrieval algorithms in terms of the information content they retrieve, their numerical stability, and their ability to reproduce the atmospheric state under a large range of different conditions. The standardised comparison procedure developed in the framework of these studies can serve as a benchmark for existing and future MAX-DOAS profile retrieval algorithms based either on optimal estimation or on parametrised approaches.