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Retrieval of Vertical Profiles of Trace Gases and Aerosols using the HEIPRO Algorithm: An Overview

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During recent years, Multi-Axis Differential Optical Absorption Spectroscopy (MAX-DOAS) has found a growing number of applications for the retrieval of vertical profile information of atmospheric constituents. MAX-DOAS instruments measure the differential slant column density (dSCD) of trace gases along several lines of sight between the zenith and the horizon using spectroscopic techniques. The conversion of dSCDs to vertical profiles of aerosols and trace gases represents an inverse problem which can be solved using appropriate retrieval algorithms in conjunction with radiative transfer models. Usually, the retrieval is performed in a two-step process where aerosol extinction profiles (and potentially also aerosol optical or microphysical properties) are retrieved from the dSCDs of an absorber with known vertical profiles (usually the oxygen collision complex O_4) in a first step, and in a second step trace gas vertical profiles are retrieved using the observed trace gas dSCDs together with the aerosol profiles from the first step.

Here we present the Heidelberg profile retrieval algorithm (HEIPRO) for the retrieval of trace gas and aerosol vertical profiles from MAX-DOAS measurements. HEIPRO is based on the well-established optimal estimation technique with the SCIATRAN radiative transfer scheme as forward model. The versatility of the algorithm will be demonstrated on the basis of ground-based and airborne data from several campaigns (EUCAARI, CINDI, OASIS-IPY, Bromex, and others) reaching from mid-latitudes to Polar Regions, and the vertical sensitivity and information content will be discussed. The vertical profiles retrieved from MAX-DOAS will be compared to co-located aerosol and trace gas instrumentation, such as LIDAR, sun photometer, nephelometer and in situ trace gas measurements. Finally, an outlook on possible future improvements in the retrieval methods and the instrumentation will be provided.