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Retrieval of Vertical Aerosol and Trace Gas Distributions from Polarization Sensitive Multi-Axis Differential Optical Absorption Spectroscopy (MAX-DOAS)

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An accurate knowledge of the vertical distribution of trace gases and aerosols is crucial for our understanding of the chemical and dynamical processes in the lower troposphere. Their accurate determination is typically only possible by means of laborious and expensive airborne in-situ measurements but in the recent decades, numerous promising ground-based remote sensing approaches have been developed. One of them is to infer vertical distributions from "Differential Optical Absorption Spectroscopy" (DOAS) measurements. DOAS is a technique to analyze UV- and visible radiation spectra of direct or scattered sunlight, which delivers information on different atmospheric parameters, integrated over the light path from space to the instrument. An appropriate set of DOAS measurements, recorded under different viewing directions (Multi-Axis DOAS) and thus different light path geometries, provides information on the atmospheric state. The vertical profiles of aerosol properties and trace gas concentrations can be retrieved from such a set by numerical inversion techniques, incorporating radiative transfer models.
The information content of measured data is rarely sufficient for a well-constrained retrieval, particularly for atmospheric layers above 1 km. We showed in first simulations that, apart from spectral properties, the polarization state of skylight is likely to provide a significant amount of additional information on the atmospheric state and thus to enhance retrieval quality. We present first simulations, expectations and ideas on how to implement and characterize a polarization sensitive Multi-Axis DOAS instrument and a corresponding profile retrieval algorithm.