Remote sensing of atmospheric aerosols with the spectropolarimeter SPEX

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Remote sensing of atmospheric aerosols is still an underdeveloped technique, despite the significant influence of aerosols on public health, climate and economy. Current methods are local, time consuming, expensive, and cannot determine macro- and microphysical aerosol properties simultaneously. Spectropolarimetry is a promising remote sensing method for the detection and characterization of aerosols. It is unique in its capability to unambiguously retrieve microphysical aerosol parameters such as size distribution, chemical composition and shape. Existing polarimetric instrumentation either uses a few broad spectral bands, a limited number of viewing angles, or is not accurate enough to fully exploit the polarization measurements.

SPEX, the Spectropolarimeter for Planetary EXploration, is designed to characterize aerosol and cloud particles in the atmospheres of Solar System planets from orbiting satellites, by measuring both the flux and the degree and direction of linear polarization across the visible spectrum with a spectral resolution of 2 nm (flux) to 20 nm (polarization). SPEX measures the polarization using the spectral modulation technique by Snik et al. (2009), which allows both the flux and the full linear polarization information to be measured simultaneously, across all wavelengths. Thanks to this technique, SPEX has no moving components, except for pointing purposes, is very robust and small, and also accurate.

This study aims at testing whether a ground-based version of SPEX is able to characterize aerosols by reaching a high polarimetric accuracy. It furthermore aims at assessing how SPEX would function autonomously within an air quality network. The ground-based SPEX instrument measures the polarized spectrum of the sky across the visible at a range of scattering angles.

The wavelength dependent intensity and degree of linear polarization for different scattering angles offer a large data dimensionality in a SPEX measurement, which is needed to retrieve all free parameters of our atmospheric aerosol models. The algorithm we use for retrieval of the aerosol properties is based on the POLDER retrieval code of Hasekamp et al. (2011). This algorithm fits intensity and polarization spectra computed with a radiative transfer model for an atmosphere containing gas molecules and aerosols to measured spectra, using a range of aerosol properties (e.g. size distribution, aerosol optical depth, refractive index).

The instrument is stationed at CESAR, the Cabauw Experimental Site for Atmospheric Research. Measuring at this location allows us to compare our measurements with the aerosol optical depth provided by the AERONET sun photometer, and our size distributions with the in-situ aerosol measurements performed at CESAR. Aerosol height distributions are provided by (Raman) lidar measurements.

We will present the concept and design of SPEX, the first blue sky observations, the retrieved aerosol properties and a comparison with aerosol properties derived from simultaneous measurements by other instruments.

References

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