Day and night time retrieval of vertical profiles of aerosol properties using a multi-temporal and multi-instrumental approach

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Retrieving estimations of vertical profiles of aerosol absorption affecting aerosol-cloud interactions and aerosol radiative forcing is challenging but demanded task by atmospheric and climatological scientific communities. Such estimations could be performed using a state-of-the-art GRASP algorithm applied to a combination of elastic backscatter lidar and sun-photometer observations [1]. However, detailed information about aerosol scattering properties provided by the sun-photometer is not available at night. The possibility to perform Raman shifted aerosol extinction measurements during night-time provides additional information on aerosol extinction profile. However, both elastic and Raman lidars combined are still incapable of providing detailed information on aerosol scattering properties, which renders the retrieval of aerosol absorption properties during night-time impossible.

A new approach of combination of sun-photometer measurements together with elastic and RAMAN lidar to retrieve vertical profiles of aerosol absorption, including night-time measurements using multi-temporal approach of GRASP algorithm [2] is proposed. Described method retrieves an extended set of aerosol characteristics, describing both columnar (size distribution, complex refractive index and spherical particles fraction) and vertical distribution of fine and coarse aerosol modes for several consequent moments of time, each corresponding to a different set of measurements. Additional constraints on derivative of time variability of these parameters are introduced in order to stabilize the retrieval of columnar properties at night when no sun-photometer measurements are available. The approach realized on the base of GRASP [3] algorithm allows versatile usage of arbitrary sets of observations, including AOD measurements from sun-, star- and lunar-photometers, almucantar measurements using sun-photometers, elastic and Raman lidar attenuated backscatter profiles with different sets of available wavelengths without strict limitations on measurements synchronism.

The performance of the proposed approach is tested on the synthetic dataset of multi-instrumental multi-temporal measurements including sun photometric measurements of sun and sky radiances at 440, 670, 870 and 1020 nm combined with elastic (355, 532 and 1064 nm) lidars performed in the evening and in the morning supplemented with combined elastic/Raman (387 and 607 nm) lidar measurements made at night.

Further testing of the proposed approach in application to real multi-instrumental multi-temporal measurements performed during SHADOW campaigns together with inclusion of day-time Raman lidar sounding [4] and depolarization measurements is planned.

References: