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Development of unified retrieval algorithm for aerosol remote sensing

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Here we present an attempt to develop unified algorithm for retrieving aerosol properties from different remote sensing observations. It is expected to develop a single retrieval algorithm that can be applied with minor modifications to a variety of both satellite and ground-based remote sensing observations. The idea of such development has appeared during efforts on developing and improving the inversion algorithms for deriving detailed aerosol properties from observations by AERONET ground-based radiometers, PARASOL satellite multi-angle polarimeter and their combinations with lidar measurements.

Commonly, the developments of retrieval algorithms for deriving aerosol from ground-based and satellite observations have always been considered as completely independent and, most importantly, different efforts. At the same time, there are evident fundamental similarities in contents and structures of many aerosol retrieval algorithms. For example, accurate modeling of solar radiances both observed from ground and space, requires rather similar calculations of gaseous absorption, light scattering by aerosol particles, surface reflection, as well as, full transfer of radiation in the atmosphere. In addition, the principles used for optimizing the performance of numerical inversion are very similar and even identical in most of inversion algorithms. During our efforts on developing aerosol retrievals for AERONET and PARASOL, the clear benefits of emphasizing the similarities in different retrievals became evident. First, using the same blocks of programs for forward modeling and inversion assures consistency of the different algorithms and the resulting aerosol products. Second, any improvement achieved for one application can be easily transferred and implemented for another related application. For example, an approach for accounting for effect of particle non-sphericity developed for AERONET has been adapted to the last version of PARASOL retrieval. Contrariwise, the vector radiative transfer originally developed for PARASOL retrieval has been included in the latest version of AERONET algorithm inverting polarized observations. Third, and probably most promising aspect is a possibility of relatively straightforward adaptation of the developed code/algorithm to a multi-instrument inversion. For example, the present version of the algorithm can be applied either to PARASOL or AERONET data, or their combination if the data coexist. In addition, the algorithm can include the lidar data if available. Moreover, in the last version of PARASOL algorithm the retrieval is organized as a simultaneous fitting of a large group of pixels under additional constraints liming time variability of surface and spatial variability of aerosol properties. This principle provides a possibility to benefit from multi-instrument inversion even if the observations by different instruments are not exactly co-incident or co-located. Such synergetic multi-instrument retrievals are expected to result in higher consistency and accuracy of aerosol products.

The first version of the unified algorithm will be described and illustrated by advanced applications to PARASOL and AERONET data, as well as to a combination of AERONET and lidar data. The perspective of adaptation of the algorithm to observations by other instruments and releasing public version of the unified retrieval will be discussed.