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Influence of sky radiance measurement errors on inversion-retrieved aerosol properties

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Remote sensing of the atmospheric aerosol is a well-established technique that is currently used for routine monitoring of this atmospheric component, both from ground-based and satellite. The AERONET program, initiated in the 90's, is the most extended network and the data provided are currently used by a wide community of users for aerosol characterization, satellite and model validation and synergetic use with other instrumentation (lidar, in-situ, etc.). However there are still open issues and inconsistencies in the modeling of the aerosol optical properties. For example, there are known limitations in the inversion of sky radiances, especially related to the large uncertainty of the retrieved products from almucantar scans at low solar zenith angles (SZA) and/or under low aerosol optical thickness conditions. Another topic of special interest is the case of desert dust, which is by far, the most problematic aerosol type regarding adequate modeling of optical properties, mainly due to the complex shape of dust particles.

Within AERONET, sky radiances are acquired in two geometries: almucantar and principal plane. Principal plane inversions were provided together with the almucantar inversion products at the beginning of the AERONET version 2 direct Sun and inversion algorithm, released in 2006. However the principal plane retrievals were later removed from the AERONET database due to discrepancies with the almucantar retrievals, the latter being considered more stable and reliable, although only at large solar zenith angles. Two problems arise from this situation. First, the monitoring of inversion-derived properties such as size distribution, refractive index and single scattering albedo, cannot be retrieved in the middle of the day. Second, there is the need to find out the reasons for the inconsistency between principal plane and almucantar retrievals.

We have investigated to what extent the discrepancies can be a consequence of the measurement procedure. In particular, three systematic errors in the radiance observations were analyzed in order to quantify the effects on the inversion-derived aerosol properties: calibration, pointing accuracy and finite field of view. The aim of this work is to determine how each of these analyzed errors affects aerosol retrievals in both geometries (almucantar and principal plane) and try to provide criteria for quality assurance and product error estimations.

For this purpose, sky radiances were simulated with the forward module of AERONET code (by Dubovik and King, 2000) using several aerosol types, described by the volume size distribution and the complex refractive index. Then the systematic errors were artificially introduced in those modeled radiances to which the inversion module was applied in order to compare the retrieved aerosol properties with the original ones. The typical uncertainty in the analyzed quantities (5% in calibration, 0.2º in pointing and 1.2º field of view) yields to errors in the retrieved parameters that vary depending on the aerosol type and geometry. While calibration and pointing errors have relevant impact on the products, the finite field of view does not produce notable differences.

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