Geophysical Research Abstracts
Vol. 16, EGU2014-2192-2, 2014
EGU General Assembly 2014

Intercomparison of satellite aerosol retrieval algorithms based on the simulated measurements of the intensity and polarization of reflected solar light for various types of underlying surfaces

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Atmospheric aerosol has a profound influence on climate, the global cloud field, and human health. Therefore, the microphysical (size and shape of particles, chemical composition, and concentration) and optical (optical thickness, single scattering albedo) properties of atmospheric aerosol have been thoroughly studied using the ground-based and satellite observation systems. The main optical parameter is aerosol optical thickness (AOT). AOT can be derived from measurements of direct solar light by a sun-photometer positioned on the ground, a ship, or an aircraft. Simultaneously, AOT can be derived using an optical instrument orbiting the planet. The ground measurements provide the most accurate values of the AOT, as they provide a direct measure of the attenuation of solar radiation. Satellite measurements require the development of the complex retrieval software, because the satellite signal contains both contribution from the surface and atmospheric aerosol. The contributions of molecular scattering and absorption must be accounted for as well. There have been numerous attempts to compare the spectral AOT derived from the ground and satellite measurements, with the accuracy of satellite retrievals is usually checked against ground measurements collocated in time and space. However, such inter-comparisons cannot be perfect because the direct solar light beam attenuation measurements from the ground and reflected solar light measurements provide different spatial sampling of atmosphere. This is not a big issue in the ideal case of a cloudless sky with homogeneously distributed aerosol particles. However, in practice, some residual clouds (e.g., Cirrus) or contrails can influence the signal measured on the ground and also from orbit. Moreover, atmospheric aerosol is not always homogeneously distributed in space. This will make the direct inter-comparison of both techniques difficult. Yet another possibility is to compare results of retrievals from different instruments/algorithms using simulated data. Such retrievals should give the same AOT, although in practice, this is often not the case. Then there is a problem with the selection of the best performing algorithm/instrument for lack of a single reference measurement. In this presentation, we inter-compare several aerosol retrieval algorithms using synthetic radiative transfer calculations for a given (and known) atmospheric state for an assumed spectral surface reflectance. In particular, the retrievals are performed using synthetic double-view AATSR and multi-view MISR radiometric observations, and multi-view POLDER radio-polarimetric observations. It is found that other things being equal the most accurate retrievals are achieved, if not only the intensity but also the polarization of the reflected solar light is measured at several angles and spectral channels. This finding strongly endorses the launch of multi-angular polarimeters such as the planned 3MI instrument to be developed by European Space Agency for the EUMETSAT Polar System Second Generation (EPS-SG).