Geophysical Research Abstracts
Vol. 14, EGU2012-13517, 2012
EGU General Assembly 2012

Assessment of diverse algorithms applied on MODIS Aqua and Terra data over land surfaces in Europe

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Beside an increase of greenhouse gases (e.g., carbon dioxide, methane and nitrous oxide) human activities (for instance fossil fuel and biomass burning) have lead to perturbation of the atmospheric content of aerosol particles. Aerosols exhibits high spatial and temporal variability in the atmosphere. Therefore, aerosol investigation for climate research and environmental control require the identification of source regions, their strength and aerosol type, which can be retrieved based on space-borne observations. The aim of the present study is to validate and evaluate AOT (aerosol optical thickness) and Ångström exponent, obtained with the SAER (Satellite AErosol Retrieval) algorithm for MODIS (MODerate resolution Imaging Spectroradiometer) Aqua and Terra calibrated level 1 data (1 km horizontal resolution at ground), against AERONET (AErosol RObotic NETwork) observations and MODIS Collection 5 (c005) standard product retrievals (10 km), respectively, over land surfaces in Europe for the seasons; early spring (period 1), mid spring (period 2) and summer (period 3). For several of the cases analyzed here the Aqua and Terra satellites passed the investigation area twice during a day. Thus, beside a variation in the sun elevation the satellite aerosol retrievals have also on a daily basis been performed with a significant variation in the satellite-viewing geometry. An inter-comparison of the two algorithms has also been performed.

The validation with AERONET shows that the MODIS c005 retrieved AOT is, for the wavelengths 0.469 and 0.500 nm, on the whole within the expected uncertainty for one standard deviation of the MODIS retrievals over Europe ($\Delta\tau = \pm 0.05 \pm 0.15\tau$). The SAER estimated AOT for the wavelength 0.443 nm also agree reasonable well with AERONET. Thus, the majority of the SAER AOT values are within the MODIS expected uncertainty range, although somewhat larger RMSD (root mean square deviation) occurs compared to the results obtained with the MODIS c005 algorithm. The discrepancy between SAERand AERONET AOT is, however, substantially larger for the wavelength 488 nm, which means that several of the AOT values are without the MODIS expected uncertainty range. Both algorithms are unable to estimate Ångström exponent accurately, although the MODIS c005 algorithm performs a better job. Based on the inter-comparison of the SAER and MODIS c005 algorithms it was found here that the former estimation of AOT is for values up to 1on the whole within the expected uncertainties for one standard deviation of the MODIS retrievals, considering both Aqua and Terra and periods 1 and 3. The latter also occurs for Aqua and period 2, while then for AOT values lower than 0.5.

The present algorithms were, beside aerosols emitted from clean sources and continental sources in Europe, also applied with favor on aerosol particles transported from agricultural fires in Russia and Ukraine. The latter events were associated with high aerosol loadings, although probably with similar single scattering albedo as the days classified as clean. We also present observations performed with space borne and ground-based lidars in the area investigated. From the latter platforms the vertical distribution of aerosol extinction in the atmosphere can be measured. This study suggests that the present satellite retrievals of AOT, particularly obtained with the MODIS c005 algorithm, will, in combination with the lidar measurements, be very useful in validation of regional and climate models over Europe.