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The uncertainty of MODIS C6 aerosol optical depth product over land

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Aerosol Optical Depth (AOD) has an important impact on climate change and air quality. A number of AOD satellite data products have been released, like Moderate Resolution Imaging Spectroradiometer (MODIS) AOD product, which are further applied for monitoring PM2.5, for long-term aerosol trend analysis, and for estimating aerosol radiative forcing. However, the accuracy of MODIS AOD product with ± 0.03 or 15-20% of global mean value over land is still low for extensive scientific research.

To investigate the accuracy of the product, a synthetic experiment was designed where the errors introduced by both radiometry and algorithm, e.g. instrument calibration, gas correction and cloud mask, and some assumptions on aerosol properties can be removed.

Through analysis of the mean value of retrieved AOD over 1520 observational configurations, the algorithm performs very well with small errors (up to 0.2%) for most cases, while for some extreme cases (eg., AOD=5.0), it performs less accurately (> 3%). The uncertainty also shows a trend related to the geometry of observations (e.g., scattering angle). The results suggest higher accuracy at large scattering angles, and lower accuracy at small scattering angles.

The main reason for the uncertainty is an inappropriate assumption on surface reflectance, where surface reflectance is regarded as a function of aerosol loading and mixing ratio. Therefore, a more accurate representation of the surface reflectance will increase the accuracy of the MODIS AOD product.