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Identifying biases of Collection 6 MODIS ocean aerosol optical depth retrievals

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Aerosol Optical Depth (AOD) retrievals derived from the MODerate resolution Imaging Spectroradiometer (MODIS), on-board the twin polar satellites Terra (2000-present) and Aqua (2002-present), provide a quantitatively useful information for aerosol monitoring, radiative forcing studies and model evaluation, due to their high accuracy, particularly over oceans, and near-daily global coverage. MODIS AOD retrievals are utilized also in data assimilation (DA) applications, aiming at improving the predictive skills of numerical simulations. Nevertheless, the performance of DA systems is critically affected by the quality of the input satellite data, making thus necessary the identification and the reduction of any possible observational/retrieval bias.

Driven by this necessity, the overarching goals of the present study are: (i) the evaluation of the collection 6 (C006) Level 2 (L2) MODIS-Terra/Aqua ocean AOD observations, at a global scale, over the period 2007-2016, (ii) the identification of factors contributing to AOD biases and (iii) the construction of empirical formulas for "correcting" the raw MODIS AOD retrievals. As reference data, ground-based aerosol observations derived by 120 AERONET stations located in coastal areas and islands are utilized. The intercomparison of MODIS AOD versus AERONET is performed at three wavelengths (550nm, 650nm and 870nm) in the visible spectrum range. According to our preliminary results, for MODIS-Aqua, the correlation coefficient (R) values are higher than 0.86, while positive MODIS-AERONET biases, decreasing from 0.012 to 0.005 for increasing wavelengths, are recorded. For MODIS-Terra, the corresponding biases are almost double and the R values are higher than 0.93. In both platforms and at all wavelengths, the obtained overall results are consistent throughout the AERONET stations with few exceptions.

A detailed analysis reveals that the cloud contamination, the viewing geometry, the microphysical models used in the retrieval algorithm and the wind speed constitute the determinant factors regulating the observed overestimations of AOD derived by MODIS. More specifically, the positive MODIS-AERONET differences are getting more evident for cloud fractions higher than 0.8, for sun-glint angles lower than 50° and for increasing wind speeds, when low AOD conditions (< 0.2) prevail. On the contrary, for intense aerosol loads, the existence of clouds reduces the accuracy of MODIS retrievals whereas the highest overestimations are mainly observed when coarse particles dominate. By taking into account all the aforementioned factors and after applying a series of quality assurance filters, regarding the spatial homogeneity of AOD data and the removal of outliers, empirical correction formulas will be constructed and applied in the raw MODIS retrievals.