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Empirical correction of Coll. 5 MODIS AOT and AE over ocean for data-assimilation

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Data-assimilation for aerosol requires global data-sets of unbiased observations with well-characterized random errors. MODIS provides an excellent global dataset of multi-wavelength aerosol AOT (aerosol optical depth) over ocean, but their error characterisation is not complete, in particular for AE (Angstrom exponent). As AE potentially contains information on aerosol size, it is a very interesting observation to assimilate.

We start with a validation study of MODIS Aqua and Terra Coll. 5 level 2 AOT and AE observations over ocean with AERONET. We first apply data-selection procedures to MODIS that discard a substantial number of observations that seem suspicious. We then optimize our co-location criteriums to obtain the highest possible correlation with AERONET. The resulting data-set reveals biases in MODIS AOT due to windspeed and cloud-fraction that can easily be more than 25%. In addition, a lack of responsiveness in MODIS AE is seen, with AERONET AE showing a much larger range of observed values. Furthermore, we find MODIS random errors in AOT to be substantially larger than is usually assumed. For large AOT, we find errors of $\sim$25% as opposed to $\sim$5% (Remer et al. 2005)

Next, we correct the systematic errors in AOT and AE through empirically determined functions. AE correction seems only possible for AOT above a certain threshhold (AOT at 860nm > 0.055). These empirical functions are determined based on one subset of the MODIS-AERONET comparison dataset, while other subsets are used for verification. In this way, we mostly remove the biases in AOT and AE and improve correlations with AERONET. We discuss how representative this correction is for the global MODIS data-set by studying MODIS errors as function of time and space and a preliminary comparison to Marine AERONET data. Due to the correction, AE contrast between land and ocean, and between the North and South hemispheres is increased. Finally, we build simple models for the random error in MODIS AOT and AE. These random errors turn out to depend mostly on AOT itself although small influences from cloud-fraction & windspeed (on AOT random errors) and AE (on AE random errors) are also present. AE random errors are smaller than an error analysis based on AOT values with independent errors suggests.

We will also briefly discuss sampling strategies of MODIS data for assimilation, as there are strong spatial correlations in the observations.