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Atmospheric Measurement Techniques Discussions

Interactive comment on "Implications of satellite swath width on global aerosol optical thickness statistics" *by* P. R. Colarco et al.

Anonymous Referee #1

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The paper aims at evaluating the impact of satellite swath width on global aerosol optical thickness statistics. In general, it is an important question what the importance is of satellite coverage and sampling for a given scientific application, in this case aerosol direct radiative forcing estimation. It is also a very complicated question. Any orbiting satellite aiming at aerosol remote sensing faces a sampling bias, as it is impossible to measure aerosol properties at all times and at all locations. Therefore, in order to use the satellite remote sensing data to come to an estimate of the direct radiative forcing a combination with other data and models is required to fill the gap in the sampling pattern. Direct aerosol radiative forcing depends on mostly the spectral optical thickness (i.e. not just at one wavelength), single scattering albedo, and asymmetry factor. These parameters inherently depend on the aerosol microphysics. For the different properties different sampling/coverage may be needed to add information to the auxil-

iary measurements and models with which the satellite data is to be combined to come to a direct radiative forcing estimate. Performing an investigation of sampling/coverage importance for AOT at a single wavelength is only a small first step in the complicated process of coming to a conclusion what it means for the direct aerosol radiative forcing. Nevertheless it is an important step definitely worth the investigation. However, concerning the present study I have 2 major caveats:

1) The authors use the MODIS full swath AOT as a reference. This is not a good reference for the following reasons: a) The MODIS full swath AOT also has a sampling bias itself, as it does not cover the temporal domain, and the retrievals are heavily filtered for e.g. clouds which yields an unevenly distributed spatial AOT field (i.e. some regions are persistently more cloudy than other regions). b) The MODIS AOT dataset itself is not of sufficient accuracy to do the investigation. Even after correction for the peculiar viewing dependent AOT error, it is evident from e.g. figure 2 that there is a remaining AOT error varying from angle to angle by as much as 0.03 (even for the 2003-2008 mean). This makes the dataset unsuitable to identify effects at the 0.01 AOT level, as is done in the paper. Given these problems with the MODIS dataset it is hard to tell if we are looking at MODIS retrieval artifacts or real sampling effects. It seems the results show at least some peculiar behavior, especially since the Caliop sub-samples seem to reproduce the full swath values better than the much larger MISR sub-samples. Therefore, the least the authors should do to draw conclusions on the impact of satellite swath width on global aerosol optical thickness statistics, is to extend the study with model data that cover the full spatial and temporal domain (so also the sampling bias of the MODIS full swath AOT can be estimated). The authors indicate this as future work but I find it an essential step to substantiate any conclusions on this topic. Including the different sampling strategies in an Observing System Simulation Experiment (OSSE) would really be the thing to do but I see this would be beyond the scope of this paper.

2) I have major problems with the conclusion: "These results suggest that future

aerosol satellite missions having only narrow swath views may not sample the true AOT distribution sufficiently to reduce significantly the uncertainty in aerosol direct forcing of climate.". As indicated above the situation is much more complicated than this and direct forcing estimates require combination of different data sources with models. Whether satellite missions are able to significantly reduce the uncertainty of aerosol direct climate forcing estimates depends not only on sampling but (probably more important) also on the accuracy of the data and number of parameters (i.e. microphysics, single scattering albedo) that are being measured. An instrument that provides accurate microphysics and single scattering albedo with narrow swath is likely to learn us more on direct aerosol radiative forcing than a full swath instrument providing only AOT. I agree that it is best to combine both characteristics but it is definitely not as black and white as the authors state. In particular the statement undermines the importance of an important satellite instrument like CALIOP and planned missions like Earthcare and (possibly) APS that will provide a wealth of new information highly relevant to the aerosol forcing problem. Even when the study is extended by model data to come to a substantiated conclusion (see 1) the authors should refrain from such statements.

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