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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Coherent uncertainty analysis of aerosol measurements from multiple satellite sensors" *by* M. Petrenko and C. Ichoku

Anonymous Referee #2

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Review of paper:

Coherent uncertainty analysis of aerosol measurements from multiple satellite sensors. by M.Petrenko and C.Ichouku

Positives - Exploring retrieval products at the level 2 (before aggregation) - Taking advantage of parallel products during the overlapping CALIPSO/SeaWiFS period - Being aware of outlier driven biases (and errors) and efforts to remove outlier impacts

Concerns - 50km spatial average goes in the direction of level 3 (unclear about requirement for central values) - The generally successful outlier filtering cannot be applied to level 3 products - Data-volume as other (than accuracy) element on data-use is left out of recommendation - AVHRR data (offering links to the past over oceans) are not in-

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Interactive Discussion
Discussion Paper

cluded in the inter-comparison - POLDER fine-mode AOD data should not be evaluated over dust dominated regions

General comments

The paper explores and compares retrieval capabilities of available global level2 AOD data-sets from different satellite sensors against trusted AERONET ground observations. Hereby a time-period is selected that includes both retrievals from SeaWiFS and CALIPSO, aside from retrievals by MODIS, MISR, OMI and POLDER. Standard statistical measures (mainly linear-fits, correlation-coefficients and root-mean-square error) are determined with stratifications into season and surface conditions (e.g. vegetation-type, ocean-type). Also explored are reduced datasets, where upper-end outlier data were been removed. The results demonstrate that (1) there is no single dominant retrieval (although the maturity of AOD retrievals by MODIS and MISR often leads to a general superior performance) and (2) that the removal of outliers in most cases improves the retrieval performance. This study gives interesting insights in strengths and limitations of different satellite sensors and their associated retrievals. Particular appealing are increased data-sets capabilities with upper end outlier data removed (while surrendering about 5 to 10% of the data). Hereby the chosen method linked to the local median seems a sensible approach. Unfortunately, such data-set improvement is not possible for externally aggregated level 3 data-sets, which begs the question, if - in an additional step - these improved level 2 products could be aggregated into improved level 3 products, as level 3 prodcuts will continue to be the primary evalution choice in global modeling (due to their compactness and similarity in scale). Another issue, which did not get much attention, is the difference in data-sampling, mainly due to sensor swath capabilities. While data accuracy is desirable, accuracy without coverage is less interesting. Thus often lower accuracy is acceptable, if in turn better spatial and temporal context can be provided. Even though this analysis works with (multi-?) seasonal data, the co-locations and the volume offered by CALIPSO will be much lower than that of MISR and that of MISR in turn will be much lower than MODIS. Fewer

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13, C1740–C1744, 2013

samples mean fewer coincidences with AERONET references, so statistics based on a different number of sites and a different number of samples at those sites are not (strictly) comparable (when deciding on the regional/seasonal best retrieval). There is some disappointment that AVHRR data-sets are not included in this inter-comparison. Despite their algorithm simplicity AVHRR offers competitive data over oceans and a link back in time. Another issue is the use of POLDER fine-mode AOD data which should not be compared to the total AOD (except over urban and wildfire seasons, where fine-mode AOD contributions dominate. Thus, the large biases over regions affected by dust and the overall low (-est) correlation coefficients put POLDER in a rather poor light. In that context also there are little to no discussion on CALIPSO data and its poor correlation (there may too few CALIPSO data to perform a confident evaluation) This brings me to the question of bias (as CALISPO data tend to be biased low). Any evaluator wants to know first if the (satellite) reference is biased – in what direction and by how much, as function of region, season and AOD. In this contribution there is only limited information given. I do not like the generality of linear fits and the scatter plots often remain discouraging, even with outliers removed. In addition, there is almost no info on biases for low AOD (0-0.2) or for median AOD (0.2-0.5), as scatter plots are offered only for the large 0-5 AOD range. There are nice elements, but I wonder a bit on how much the paper offers to data-set users. It confirms the general sense of complexity and limitations by satellite remote sensing of aerosol properties, but recommendations remain vage also somewhat ignoring the data volume aspect, which is also an element for a decision on data use.

Minor comments

4642/20 using the 50km mean value may help in the comparison among different sensor products but goes in the direction of level 3 comparisons. We really learn about the satellite products more from comparisons of the central value to the ground reference data. It also remains unclear, if the central value was a requirement in matched to AERONET. If comparison involve satellite data without its central value, then the 50km

ACPD
13, C1740–C1744, 2013

evaluation is less meaningful. Having a central value also would give insights into the central value's regional representation (and hereby helping to address a site's regional representation)

4643/8 the AOD (via Angstrom) interpolation (and especially the extrapolation into the UV) is only sensible for AERONET AOD data, but not for satellite retrieved AOD data (with a-priori absorption assumptions). This complicates any combination of different satellite data products (e.g OMI in the context of MISR or MODIS)

4649/19 the outlier detection - if simply based on the retrieval - is interesting and important (and calls for the developing of associated level3 prodcuts). However, here (if not, state so) the outliers are based on regression line deviation, thus seem to involve a reference data. If this reference data is AERONET, then it will be really difficult to create an outlier removed global data-set.

4650/3 the five times above median values only finds the upper-end outliers

Table 2 the applied quality criteria are not quite clear for cases where more than one QA criterium is listed

Table 3 almost all slopes are below 1.0 . . . this is surprising to me as on an event basis I would have expected the opposite. This is probably related to some satellite retrievals inability to catch high AOD events, also since almost all intercepts are positive! Also considering regional differences the presentation of comparisons via linear fit lines is somewhat misleading. Also some slopes of POLDER are very low - apparently related to the use of fine-mode AOD POLDER data. I would leave then POLDER data out of the table or would only compare to the AERONET fine-mode AOD. Also the low slopes of CALIPSO need some explanations.

Table 4 please separate between spatial and temporal correlations, and hereby differentiate between seasonal and inter-annual correlation, if possible (also try rank-correlations as a few outliers can dominate the result). Also the correlations do not

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13, C1740–C1744, 2013

address the bias.

Table 5 RMS is a mixture of bias error and variability error. Such an error distinction could be insightful. I appreciate the filtering of outliers prior to the analysis (as along as the filtering can be easily applied to the standard data).

Figure 4 I am not clear about the colors: to me it looks as if it indicates an event frequency. The 'red' linear fit lines are too meaningful (as Table 3) and even surprising for OMI. I also suggest different plots for OMI and MODIS (also as AOD values at shorter OMI wavelengths are generally larger) and would use the extra space to show in the lower three panels a scatter plots enlargement only for the 0.0 to 0.5 AOD regions.

Figure 5 This plot is rather small and loaded with info. Give am explanation why some errors for particular days are only one-directional and otherwise symmetric?

Figure 6/7/8 . . . too small to detect detail

Figure 9 POLDER outliers (no surprise) are related to areas where corase mode aerosol dominates. . . it also might be nice to indicate (possibly by different symbol shapes) if outliers are high or low with respect to AERONET (to demonstrate potential aerosol type biases)

Figure 10 the impact from the removal of outliers is convincing. However, if is it based on comparisons to AERONET then this extra filter is of less use, as then an outlier removal in non-AERONET country will be difficult to achieve.

Figure 11 I assume these are temporal correlations at each site (still there may be biases to considered)

Interactive comment on Atmos. Chem. Phys. Discuss., 13, 4637, 2013.