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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Site representativity of AERONET and GAW remotely sensed AOT and AAOT observations" *by* Nick A. J. Schutgens

Anonymous Referee #4

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The author uses a two year (June 2005 to May 2007), atmosphere-only (prescribed sea surface temperatures), free-running (not nudged), global high-resolution (0.0625 degree) simulation (GEOS5 Nature Run) to conduct an Observing System Simulation Experiment (OSSE) with which the representativeness of aerosol observations (aerosol optical thickness, AOT, and absorbing aerosol optical thickness, AAOT) at AERONET and GAW sites is assessed with regard to space (from 0.0625 to 4.0 degrees) and time (from hourly to annual means).

AOT and AAOT are an important facet of historical and current climate. Their modeling remains challenging, as does comparison of simulation results and observations (from in-situ to satellite). The paper deals with an associated, critical aspect: the spatial and temporal representativeness of in-situ observations of AOT and AAOT on a global

scale. Specifically, monthly representation errors are found to be correlated, implying that annual means offer only a moderate gain in representativeness. Moreover, the global representation bias of AAOT (relevant for model evaluation) is estimated below 10%, showing at the same time that the corresponding 30% estimate by Wang et al. (2018) can be attributed to too coarse model data used in that study.

Recent years have seen a few studies dealing with the topic of representativeness in general and for aerosol observations in particular, yet consensus has not yet been reached. The present paper with its quantitative, objective, and global perspective is a substantial, high-quality contribution to the discussion. I recommend publication in ACP after some revisions.

Specific comments:

page 3, line 9: It would be good to add a bit more information on the simulation data, notably that it is a free running (not nudged) simulation, possibly also a word on vertical resolution and output frequency (hourly or even less?; how 'high-resolution' is the model data with regard to time?).

page 3, line 24: Replace AOD with AOT, here and throughout the manuscript; likewise for AAOD and AAOT.

page 4, line 8: What do you mean by "here we will assume a potentially remotely sensed columnar product ... and consider its representation errors"?

page 4, line 11: Given that various definitions of "representation error" exist in the literature, it would be helpful if the author could provide the exact definition he uses in this paper (e.g. reference to another paper; formula; description).

page 4, line 14: Here it is said that this work deals mostly with yearly and some monthly averages, yet many figures show hourly data. Please clarify.

page 6, line 19: What do you mean by the sing-less error? Absolute error or root-

mean-square?

page 7, line 4: I assume that by 'correlation' you mean R, not R^2. It may be helpful for the reader to explicitly say so.

page 8, line 22: When it is said that G5NR seems capable to realistically simulate the spatial variation of AOT and AAOT, "spatial" here seems to refer to different sites. It is not shown, it seems to me, how realistically G5NR captures the spatial variability of AOT and AAOT around a single site, including the adopted averaging distances between 0.5 and 4 degrees. It may be worthwhile to clarify this point.

page 8, line 31: As grid box sizes are reduced, hourly collocation errors are reduced. Could this be because the physical connection (same cause, exchange of signal) between two hourly time series at two distant points decreases with distance? Could the author comment on why the reported finding is (or is not) physically plausible?

page 9, line 5: Can something be said as to the (physical?) causes of the found east-west (North America) and north-south (Europe) gradient in representativeness?

page 9, line 21: Apart from the shorter atmospheric column, could it also matter that high lying mountain sites are often in the 'free troposphere', i.e., (somewhat) decoupled from the sources of (short lived) aerosols in the boundary layer?

page 11, line 9: Does it matter here, how missing values are treated when computing the annual mean?

page 12, line 23: The author mentions once more the calculated meteorology. Overall, he seems to claim / find that meteorology is not that important for representativeness. Is this indeed what he means to say? And, if so, how about phenomena like ENSO? Could, for example, the comparatively bad performance of South America be related to the presence / absence of ENSO in the model data?

page 13, lines 13 and 20: Does this imply that meteorology is not that important for representativeness?

page 13, line 24: It is not clear where the error of typically 20% globally comes from, I do not see this in the main text of the paper.

Figure 1: One may add in the caption what the different line-styles in the lower row mean.

Figure 5: Any idea why there is an overall bias towards negative values? It seems unlikely that the (few) high lying GAW sites (and their shorter atmospheric column) alone can serve as an explanation.

Figure 6: Any idea what the (physical?) reason is behind the found spatial gradients?

Figure 8: Any idea why Europe is so good and South America rather bad? Geography? ENSO? Number of sites? Other?

Figure 12: Maybe refer in the caption to table 6 (explanation of r). Also, the figure seems to suggest that there is no connection between "r" from Kinne et al. and the relative representation error from this paper; the bars in the plot look pretty much the same for "all", "r=0", "r=1", and even "r>1" for yearly data. Please comment.

Figure 16: What are the dashed lines?

Specific comments:

page 1, line 16: due *to* methodological choices

page 2, line 14: remove S16b

page 10, line 20: "for for" should read "for"

page 11, line 6: "Fig.??" should be properly referenced

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