Atmos. Chem. Phys. Discuss.,
doi:10.5194/acp-2016-385-AC2, 2016

Atmospheric Chemistry and Physics Discussions

Interactive comment on "An observationally-constrained estimate of global dust aerosol optical depth" *by* David A. Ridley et al.

David A. Ridley et al.

daridley@mit.edu

Received and published: 27 October 2016

Response to Reviewers

We would like to thank all reviewers for their helpful comments and criticism on this work. We believe we have addressed the comments and made changes to the methodology and manuscript where possible. We now include supplementary figures and several of the figures in the manuscript have been updated.

Key changes include: âĂć Analysis and statistics generated for log(AOD) rather than AOD âĂć Instrument uncertainty included in the estimate âĂć Regional bias correction of satellite data by AERONET âĂć Uncertainty in bias correction propagated through

analysis âĂć Marine Aerosol Network (MAN) data included âĂć Supplementary figures of AERONET and satellite AOD histograms âĂć Comparison of model AOD with daily AOD from MAN âĂć Supplementary comparison with deposition flux

The key changes are that the global dust AOD is decreased from 0.033 to 0.030 and the uncertainty increased from 0.006 to 0.011 (2σ) as a result of considering instrument uncertainty and the uncertainty on the updated AERONET bias correction of the satellite retrievals. The observational estimate is hence closer to the AEROCOM model estimate. We believe that this better corrects for regional biases in the satellite retrievals while representing the inherent uncertainty in using limited in-situ measurements to apply correction factors over large regions. The regional estimates of seasonal dust AOD from the different satellite instruments are generally in closer agreement. The observational estimate is also brought closer to the MERRAero dust AOD; the previous discrepancy was of some concern because MERRAero assimilates MODIS AOD and may be expected to represent the dust AOD better than models without assimilation. The agreement between model and observational estimate improves over the mid-Atlantic, reducing (but not eliminating) the potential for systematically high dust removal in the models. While many of the quoted numbers change as a result of our reanalysis, all other conclusions remain essentially the same.

Please find the reviewer-specific comments and responses (blue italics) listed below.

Kind regards, David Ridley

Anonymous Referee #4 The study combines estimates of AOD from satellite and sun-photometer (AERONET) observations. The authors evaluate the statistical uncertainty of dust AOD calculated from model simulations against in-situ observations. The manuscript is well written and scientifically sound. Thank you for your comments, we hope to have covered your concerns below.

———————-

General comment: Why do you scale the model AOD from regional to global (page 8 & 9, Eqn 3)? The general scaling approach does not consider the regional variability in soil properties (determining dust emission fluxes), meteorological drivers, size distributions (affecting AOD and life time), etc. What is the motivation for ignoring these factors despite knowing that they affect on dust concentrations and dust properties? Are the results after scaling still representative? Please consider including some words on how meaningful the scaling approach is.

The scaling to global dust AOD does rely on the global distribution of dust aerosol in the four models used, and will represent the regional variability in soil properties, meteorological drivers and size distributions to the extent that those models reproduce those properties. We are unable to account for potential biases that exist in all the models; however, the purpose of using four models is to both reduce the impact of these biases and to propagate their effect on the uncertainty in the DAOD by providing a range of scaling factors.

We derive the dust AOD over regions in which dust aerosol makes up a significant fraction of the total AOD to minimize errors from both retrieval uncertainty and model representation of non-dust AOD. Ideally we would derive the dust AOD in all regions to eliminate the need to use the models; however, the uncertainties prevent meaningful results in remote regions. We found that comparison of satellite retrievals of AOD with the Marine Aerosol Network (MAN) showed poor correlation and bias in remote locations. We have added the following text to clarify this in the manuscript (pg 8):

"We focus on regions in which the dust AOD often dominates to reduce potential errors from biases in modeled non-dust AOD."

This is followed by examples of key uncertainties in the non-dust AOD (e.g. regions influenced by biomass burning).

———————-

Related to that, can global averages of dust AODs considered as an appropriate measure for model skills with regard to dust distribution? Regional errors may equal out and thus a global average may be misleading. As also pointed out in the result section, dust varies strongly with regions and depends on the model skills for the regions. Furthermore, on the one side you are arguing with global averages of AOD (i.e. abstract and conclusion), on the other side you are suggesting that regional means are the more appropriate measure. It sounds somewhat inconsistent. Please clarify.

We agree that there is limited use for global dust AOD. However, this is a common metric used to assess models and is presented here to allow comparison with model estimates. Because of the limited use we have provided specific information on the seasonality and the magnitude of the dust AOD in different regions. We believe that including both the global dust AOD and the more detailed regional interpretation of the results is a reasonable framework. We address this in opening paragraph of the Section 3.4 on regional dust AOD and have added the following statement to the conclusions:

"...it is essential to evaluate models on regional and seasonal scales, at which we find considerable differences."

Specific comments:

———————-

p4 l11 remove parenthesis for reference Kok et al. Done

———————-

p4 l24 remove parenthesis for reference Albani et al. Done

———————-

p5 l7 remove parenthesis for reference Gong, 2003 Done

———————-

p5 l14 remove parenthesis for reference Fast et al., 2006 Done

———————-

p5 l14 remove parenthesis for reference Barnard et al., 2010 Done

———————-

p7 l4 "man" should be "main" p7 l19 should be MERRAero to be consistent Done

———————-

p9 l14 It appears a bit odd to me to have one of the co-authors cited as "personal communications". Changed

———————-

Maybe omit the "personal communication" part and only provide the "manuscript in preparation" part? Done

———————-

p9 l23 "Eqn. 3" to be consistent Done

———————-

p9 l27 "Eqn. 1" to be consistent Done

———————-

p11 l30 As the naming of the regions are erroneous on the figures (see below), please check if it's correct in the text. Thank you, these have been corrected throughout the text.

———————-

p13 l1 Please consider shifting "(the Gulf of Oman)" to line 26 where the Kyzyl Kum region was mentioned first. Here we are discussing the Gulf of Oman as the region be-

tween the Southern Middle East and Kyzyl Kum desert regions. Therefore, we believe the reference to the Gulf of Oman should stay in its current location.

———————-

Fig. 1 something went wrong with assigning geographical names to the numbering of the areas. Area number 5 is definitely not the Atlas Mountain region. Maybe confound with the Adrar des Iforas Mountain region? Similarly, the Bodele Depression covers the Sudan, too. Please clarify. Thank you, the Atlas mountains region was mis-labelled and has been corrected to Mali/Niger

———————-

Fig. 7, 9, 10 Base on the numbering issue appearing in Fig. 5, there may be a consequent mis-naming of the Atlas region. Please check. Fig. 7, 9, 10 Taklamakan

———————-

These have been corrected to better represent the regions: Mali/Niger and Bodele/Sudan, and the Taklamakan spelling used throughout.

Interactive comment on Atmos. Chem. Phys. Discuss., doi:10.5194/acp-2016-385, 2016.