

Interactive
Comment

Interactive comment on “Estimating aerosol emissions by assimilating observed aerosol optical depth in a global aerosol model” by N. Huneus et al.

N. Huneus et al.

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Response to Reviewer #1

We greatly appreciate the reviewer comments that helped to improve the quality of the paper. We have addressed each one of the comments below.

General Comments:

Detailed knowledge on the spatial and temporal distribution of aerosol emissions is required to quantify their impact on climate. The present work estimates the monthly mean emission fluxes of several aerosol species (i.e. black carbon, organic matter,

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sea salt and desert dust) and one aerosol precursor for predefined regions on a global scale for a time period of one year. This is accomplished by assimilating daily total (over land and ocean) and fine mode (ocean only) MODIS aerosol optical depth (AOD) in the global aerosol model of Huneus et al. (2009). In contrast to previous studies, this work is the first one to estimate the emissions of several aerosol species simultaneously. A validation is done by comparing the model AOD with (i) the assimilated MODIS AOD and (ii) independent measurements of the AERONET network. The scientific approach and methods applied to verify the results are well described and sound. The overall presentation is clear and well structured. The study focuses on the ACP subject area aerosol physics and covers the ACP research activities Atmospheric Modelling and Remote Sensing. I therefore fully recommend publication of the manuscript in ACP after some minor modifications.

Specific Comments:

Reviewer: L84: The authors mention that Zhang et al. (2005) assimilate AI and TOMS AI. Please clarify where the first AI comes from.

Answer: The error has been corrected and the sentence reads now “. . .by assimilating TOMS AI”.

R: L185: Concerning the paragraph on the a priori aerosol emission fluxes, I find it a bit inconsistent to repeat the references for most emissions but not for the terpene emissions and the conversion factors (7,1.4 and 1.6, 11%) used. Beside, I suggest to define the term ‘organic matter’ first. Then it is easier to understand why a conversion is needed and applied.

A: The text has been modified to include the references for the conversion factors and the terpene emissions and to explain the term ‘organic matter’.

R: L245: Who provided the MODIS level 3 data? In addition, the reference of Hubanks et al. (2008) should already be mentioned here.

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A: Data were downloaded from the “Level 1 and Atmosphere Archive and Distribution System” (<http://ladsweb.nascom.nasa.gov/data/search.html>). The reference has been added on line 245 as suggested.

R: L253: What is the global coverage of the MOD08_D3 data? Does MOD08_D3 contain daytime data only? What is the reason for the data gaps in the northern latitudes which can be seen in the figures showing MODIS AOD (e.g. Figure 3, left).

A: The product level 3 data cover approximately 10% of the globe daily. The reviewer is right that only daytime observations are used to derive the AOD. The data gaps in the northern latitudes correspond to regions without data due to cloud contamination. The limit of this region varies with the month of the year because of variations in the solar zenith angle at the time of the satellite overpass, with largest coverage up north in summer and the lowest coverage in winter.

R: L253: Is the information on MOD08_E3 and MOD08_M3 needed? If not, please remove.

A: No, the information is not needed. We have removed the text as suggested.

R: L274: Could you provide a reference for the known AOD overestimation, please?

A: A reference to Zhang and Reid (2006) was added.

R: L276: How is the thinning done?

A: We have considered different ways to do it, based on random sampling or averaging. For this study, we sample one satellite pixel each day for each model grid box, among the ones contained within this grid-box.

R:L415: How many AERONET stations were selected?

A: A total of 125 stations were selected. This has been added in the text at the end of the paragraph.

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R: L592: Could you give the exact number of AERONET stations, please?

A: The exact number of stations (125) was added to the text.

R: L626: I suggest to use the same numbers as given in Table 5 or vice versa (14.5 vs. 15).

A: Changed as suggested, the same numbers as given in Table 5 were used.

R: L638: I suggest to use either POM (text) or OM (figure caption) here and throughout the text, e.g. in Table 1.

A: We have used POM throughout the text (and figure caption).

R: L718: Do studies on the difference between MODIS and AERONET AOD exist? If yes, they should be mentioned and discussed here.

A: Several studies comparing MODIS to AERONET exist (e.g., Kahn et al., 2007; Levy et al., 2005; Remer et al., 2005 and Remer et al., 2009). All of these studies however, compare MODIS level 2 data against the observations and not the level 3 data we use in this study. The impact of aggregating 10 x 10 km² level 2 data into 1°x1° level 3 data on reproducing AERONET AOD has yet not been published (to our knowledge). We prefer to omit the discussion on the ability of MODIS level 2 to reproduce AERONET data since it does not reflect exactly the product we use and therefore does not contribute to the evaluation we conduct in the study.

R: L750: I suggest to give the flux values of Lamarque et al. (2010) either here or before when discussing Figure 10.

A: The flux values of Lamarque et al. (2010) were added to table 5. A reference to this table has been added in the text (sect. 4).

R: L1110: I suggest to refer to Figure 2 in order to clarify which AERONET stations are used here.

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A: The sentence “Selected stations are illustrated in Figure 2” has been added.

R: L1130: Please explain, here or in the text, what the station indicated with the black and coloured circles are used for.

A: The sentence “AERONET stations are grouped geographically into North American (brown), South America (orange), Europe (pink), Africa (blue), Asia (green), Middle East (yellow) and Australia (purple). Oceanic AERONET stations are illustrated by black circles.” has been added to explain the coloured circles.

R: L1134/1140: Maybe the year (2002) could be given in the figure captions.

A: The year was added in the figure caption.

Technical Corrections:

R: L106: Bold full stop. Please correct.

A: Changed as suggested.

R: L176: Replace ‘causedby’ with ‘caused by’, please.

A: Changed as suggested.

R: L446: Please remove full stop

A: Changed as suggested.

R: L461: Do you mean ‘Central’ instead of ‘South’ Africa (see L477) ?

A: Indeed the region of Central Africa is meant in this section. The text has been changed.

R: L514: ‘The comparison of the analysis OF total and fine : : :’ ?

A: Changed as suggested.

R: L536: ‘in all regions AS illustrated in Fig.2’ ?

A: Figure 2 illustrates the regions as used in the study and therefore the change suggested by the reviewer is not appropriate. To clarify the reference to Figure 2 in the sentence we have replaced “in all regions AS illustrated in Fig.2 for total and fine mode AOD” with “in all regions (see Fig.2 for definition of regions) for total and fine mode AOD”.

R: L606/607: I might have missed something, but do you want to refer to Table 2 (gridbox-by-gridbox) and Table 3 (station-to-station) here instead?

A: Indeed and we thank the reviewer for pointing this out. The text has been corrected.

R:L880: Please correct typing error

A: Error has been corrected.

R:L1127: ‘DefinED regions ..’ or ‘Definition OF regions..’ ?

A: ‘Defined regions ...’ was used to replace ‘Definition regions ...’

R:L1162: Please remove ‘for’

A: Changed as suggested.

R:L1167: Please correct the spelling of deviation

A: Spelling has been corrected.

R: L1184: Add a/b/c which are mentioned in the text (L226), please.

A: Changed as suggested.

R: Whole text: Please refer to the ‘Textual and Visual Conventions’ on the ACP web page (Submission – Manuscript Preparation) for the favoured use of abbreviations (Sect., Fig.,...), capitalisation and the usage of non-english words and phrases (et al., cf., e.g., a priori, in situ, .., should not be italicized).

A: Changed as suggested. Abbreviations, capitalisations and usage of non-english

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words and phrases follow now the indications part of the Text and Visual Convention.

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