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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Atmospheric inversion of SO_2 and primary aerosol emissions for the year 2010" *by* N. Huneeus et al.

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We greatly appreciate the reviewer comments that helped to improve the quality of the paper. We have addressed each one of the comments below. In addition, an error in the computation of the annual uncertainties was corrected. However, this correction has no consequences on the general conclusions of our work, which is based on uncertainties at the monthly scale. Only the magnitude of the global annual mean uncertainty is affected.

Specific Comments:

Referee : p6166, l9: I recommend the use of either Pg or Tg for all species.

Answer: The unit for sea salt was changed from Pg to Tg.

R: p6169, l21: Since the instrument details (i.e. MODIS) are given for GFAS, it should be mentioned which satellite instrument(s) GFED is based on.

A: The satellite instrument used for GFED has been specified and the text changed accordingly.

R: p6171, l1: On page 6168 the large diversity in dust and sea-salt emission is mentioned. Could you state out more clearly why the sensitivity study on the a priori inventories only covers fossil fuel and biomass burning?

A: Contrary to fossil fuel and biomass emissions, no equivalent reference emission inventory exist for desert dust and sea salt, therefore the same sensitivity analysis cannot be applied to them. Since their emissions are parameterised and are calculated as a function of local surface and atmospheric variables, one would need to test the sensitivity of the emissions to parametric and structural uncertainties of the parameterizations. Such a study, although interesting, is outside the scope of this work. To clarify this we have added the following sentence to the text: “No sensitivity analysis is conducted on natural emissions of DD and SS given the absence of a reference emission inventory on one hand and the physical nature of their emissions on the other hand”.

R: p6171, l20: Add a general literature reference where the equations can be found.

A: The reference Rodgers (2000) was added to the text. Rodgers, C. D.: Inverse Methods for Atmospheric Sounding: Theory and Practice, World Sci., Tokyo, Japan, 240 pp., 2000.

R: p6173, l6: How is the fine mode defined?

A: The MODIS algorithm uses different fine mode aerosol models in the retrieval. It has five different aerosol models varying in physical and optical properties. The choice of the model varies from region to region and even throughout the year depending on the dominant source. A thorough description of the aerosol model used in the algorithm

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can be found in Remer et al. (2005). Indeed this is an important point since the fine mode aerosols used in the inversion are not the same as used in the MODIS algorithm. This issue is mentioned as possible source of the bias degradation in Section 4.1.

R: p6178, l25: What does EPA stand for?

A: EPA stands for Environmental Protection Agency. The acronym has been defined in the text.

R: p6179, l25: For the DD and SS emissions the reader is referred to HCB12. This makes the remaining part of the paragraph obsolete. Otherwise, the information about how the DD emissions are obtained from the wind speed should be added.

A: The first phrase of the paragraph was removed and the reference was added at the end of the paragraph.

R: p6180, l1: How do the emission of the inventories differ? Which one is supposed to be 'better'? Mention if this is discussed elsewhere in the paper or in another publication.

A: A sentence indicating the publications where the differences between the inventories are discussed was added. The sentence added is "The differences between the biomass burning inventories and the anthropogenic emissions of SO2, BC and POM are analysed in Kaiser et al (2012) and Diehl et al. (2012), respectively."

R: p6181, l3-8: Are the abbreviations like ACCMIP used in this publication only or are they more general terms used elsewhere? If yes, where? What about moving this paragraph to the end of Section 3 where the emission studies are introduced?

A: ACCMIP is the abbreviation used to refer to the emission inventory that combines the estimates from Lamarque et al (2010) for the period 1850-2000 and the projected emissions from the RCP8.5 scenario. This abbreviation is used in Granier et al. (2011) and Diehl et al. (2012). The former was added in the text. The paragraph presenting the abbreviations used to refer to each combination of emission inventories was moved to the end of Section 3 as suggested but the sentence indicating that the analysis will

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be centred on the results from ACFED was added to the first paragraph of Section 4.

R: p6183, l10-11: Does this mean that GFAS is more realistic?

A: It means that for our model of intermediate complexity, the AOD computed using GFAS as first guess are closer to the observations in terms of root mean square error. However, this cannot be generalised to say that GFAS is more realistic. One would need to test with models of increased complexity whether the same is observed.

R: p6185, l1: I can only identify four regions, namely NOAM, EURO, INDIA and SEAS.

A: The sentence in question refers to the regions where the original difference to the RCP8.5 emissions is reduced, i.e. the difference between the FG and RCP8.5. Therefore EAAS is also included since the difference between the AN and RCP8.5 is smaller than the FG even though the emissions are larger than both RCP8.5 and FG. The formulation of the sentence was changed to clarify this and avoid confusion.

R: p6185, l7: Do you want to refer to Figure 3 instead? Figure 4 is dealing with SO2 emissions.

A: Indeed, Figure 3 is meant. The text was changed accordingly.

R: p6186, l1: Maybe you could use a term like 'both BB inventories' instead of 'both inventories' to clearly differentiate from the four anthropogenic inventories (ACFED,..).

A: Changed as suggested.

R: p6186, l3: I suppose Fig. 8 is meant.

A: Yes, Figure 8 is meant, the text was corrected accordingly.

R: p6186, l19: I do not understand the phrase 'distinctive time series ..'. Please clarify.

A: What is meant here is that AN emissions of BB are grouped according to the BB inventory used and not the anthropogenic inventory used. The AN using GFED have distinctive time series from those using GFAS. The phrase was replaced by the follow-

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ing “the AN emission time series of the experiments based on GFED have distinguishing features from those based on GFAS”. In addition the description of the Figure was corrected. The phrase “Finally, in SSAM all four AN present. . .” was replaced with “Finally, in SSAM all four AN present magnitudes closer to GFED for the months of April to September, the ACFAS and AEFAS are closer to GFAS for the months of January, March, October and December and the magnitudes of all four AN are between GFED and GFAS for November.”

R: p6186, l22: Refer to Table 6 and maybe add ’(ACFED)’ after ’reference setup’.

A: Changes as suggested.

R: p6187, l18: Could you specify what this information is, please?

A: This information refers to the fact that over ocean the fine mode AOD is assimilated in addition to the total AOD. The sentence was modified to clarify this.

R: p6188, l22/23: What would be needed to do so?

A: To do so one would need to conduct the inversion for the year 2000 to assess whether the AN falls within the uncertainties of the FG in that year and then extend the study to each year till 2010.

R: p6201/6202: Both, Table 1 and 2 are part of Table 3 and 4. Avoiding this repetition should be possible with additional explanations.

A: Tables 1 and 2 were removed and the text was changed accordingly.

R: p6203: AERONET could be mentioned in the caption, too.

A: Changed as suggested.

R: p6205/6206: Table 5 is not needed, since the results are part of Table 6.

A: Table 5 was removed and the text changed accordingly.

Technical Corrections:

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R: p6172, l 10: The equation numbers appears twice. Please remove one.

A: The word document submitted to ACPD had only one equation number. Special attention will be given at the proof reading step to avoid this kind of repetition.

R: p6182, l14: 'errors ... are' or 'error ...is'

A: The combination 'error . . .is' was chosen.

R: p6185, l26: add a comma or 'and' between CEAF and SOAF

A: A 'and' was added between CEAF and SOAF

R: p6210: A thick horizontal line at 0 would help to read the figures.

A: Changed as suggested.

R: p6211: Increase the range of the y-axis to avoid that the top of the POM AN-ACFED bar does not coincide with the plot frame.

A: Changed as suggested.

R: p6211/6214: replace OM with POM in the x-axis description

A: Changed as suggested.

R: p6217: use identical terms in figure title (e.g. ACCMIP-GFED) and caption (ACFED).

A: Changed as suggested.

R: Explain the terms DDF and DDC.

A: The phrase "DDF and DDC correspond to the fine and coarse mode of DD, respectively." to the caption of Figure 9.

Interactive comment on Atmos. Chem. Phys. Discuss., 13, 6165, 2013.