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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Anthropogenic influence on SOA and the resulting radiative forcing" *by* C. R. Hoyle et al.

C. R. Hoyle et al.

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Reply to reviewer 2

We would like to thank the reviewer for their helpful comments and suggestions for the improvement of this manuscript. The changes we have made are described below.

General comments: The reviewer expresses some doubt about the usefulness of making radiative forcing estimates for SOA, given the current standard of the models. We disagree however. The magnitude of the radiative impact of SOA can not be estimated simply from the globally averaged burdens, therefore to get an estimate of the forcing from the modelled SOA field, a thorough calculation must be performed. Despite the uncertainties in the SOA burdens, such a calculation is valuable as, once

it has been done by several different modelling groups, it will give an indication of the range of the likely SOA effect. It will help to constrain the relevance of SOA for the Earth's climate, as well as regional climate. This is important information when prioritising research on SOA formation processes. Further, assessments of the radiative impact of organic aerosol, including secondary organic aerosol, have already been published in the peer-reviewed literature[1].

1) The radiative forcing of the direct aerosol effect is related to anthropogenic aerosols. Anthropogenic aerosols are all the aerosols from human activity, and not strictly related to anthropogenic emission of aerosols or precursors. All anthropogenic activity causing more aerosols is included, also effects of change in the oxidation (that could also influence sulphate aerosols) and the background aerosol abundance. We have included a paragraph in the introduction about the definition of the radiative forcing of the direct aerosol effect.

2) We have clarified in the text that we assume the whole of the change in biomass burning emissions since pre-industrial times to be an anthropogenic effect. We have not added this to the abstract as neither the title nor the abstract specifically mention biomass burning emissions.

3) We have added a statement in the abstract that it is "The effect of chemical changes in the atmosphere since the pre-industrial period" that are being investigated. We have also clarified further in the model description section that no climate or meteorological changes are taken into account, and that the " analysis is restricted to the chemical changes in the atmosphere between the pre-industrial times and the present". Thus it will be clear to the reader what is meant by the terms such as "pre-industrial

[1]For example: Chung, S. H., and J. H. Seinfeld, Global distribution and climate forcing of carbonaceous aerosols, J. Geophys. Res., 107(D19),4407, doi:10.1029/2001JD001397, 2002.

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atmosphere" we use later in the manuscript. in referring to the modelled atmosphere.

4) Some more details of the SOA model have been included in Section 2.0.

5) We agree that more information about the optical properties should have been included. The issue of hygroscopic growth of organic and inorganic mixtures is important and we thank the reviewer for raising this issue. We have included several sentences with more information of optical properties and the issue of hygroscopic growth.

6) We have added an explanation of the use of ammonium sulphate aerosol as a partitioning medium in our modelling work, near the end of the Oslo CTM2 section. We have removed the sentence stating that the experiments where partitioning to sulphate was allowed are the main focus of the paper, as the discussion of the two cases is actually similar, and this sentence was therefore misleading.

7) A new section has been added addressing possible reasons for the differences in modelled SOA production and burden between several recent studies. Additionally the issue of the larger change in SOA in the present study has been addressed in the section where table 4 (now table 5) is discussed. Basically, the most likely reason is the model resolution in Liao and Seinfeld 2005 is much lower than that used in the Oslo CTM2 (4x5 degrees and 9 vertical layers between the surface and 10mbar, vs 2.8x2.8 degrees and 40 layers between the surface and 10 mbar). The partitioning of semi-volatile species depends on the concentration of the species in the gas phase and the amount of mass available for partitioning. A higher concentration can be maintained with a higher model resolution. A coarser model grid will lead to faster diffusion of POA from the source areas, a lower concentration, and less partitioning of SOA.

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Technical corrections

1) The references for these values have been included. The values themselves have not been included as this would involve the reproduction of a table from Hoyle et al 2007.

2) Labels have been corrected.

3) Unfortunately it is not possible to extract the exact contribution of the anthropogenic SOA precursors to the present day SOA burden, but based on the difference in emissions between biogenic VOC and anthropogenic VOC it is certainly very minor. We have added a paragraph discussing this point to the results section.