

## ***Interactive comment on “Estimating the influence of the secondary organic aerosols on present climate using ECHAM5-HAM” by D. O’Donnell et al.***

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We would like to thank the Reviewer for these helpful remarks.

We address each of the comments below.

1. The current title emphasises "influence on climate", not comparison to other models/ observations or model evaluation. However, the manuscript only includes chapters 3.7 and 5.7 on radiative forcings. Maybe the current title can be rephrased to better match with MS content. You could also go a bit beyond your current end-result (radiative forcings), and sum up your findings with a few sentences of real climate impacts (effects to temperature, precipitation). With the current model setup (nudging) you don't see

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change in model climate, but maybe some hypotheses can be made.

Response: Aerosol-climate studies generally restrict themselves to direct and indirect effects, these effects being widely accepted. This is also a convenient means of comparing the global significance of different elements of the aerosol population. In this paper, our ambition level does not go any further than that. We will change the title accordingly.

2. It is not explicitly stated if the calculated indirect effect is due to cloud albedo effect only, or can the changes in CDNC also change cloud lifetime. The latter is assumed, but this could be mentioned in chapter 2.7. While nudging pushes the model towards a prescribed state, it can still allow changes in cloud lifetime to some degree (depending on nudging coefficients). However, the indirect effect here is not necessarily the same as more often used fixed-SST radiative flux perturbation. You should use nudged simulations for comparison to observations, but I would suggest 5-year fixed-SST simulations for the forcing calculations to better take into account changes in cloud properties. Averaging over 5 years might also help reduce the noise in Figs. 11 and 12.

Response: Firstly, the Reviewer is correct in assuming that the model does allow some change in cloud lifetime. Secondly, in principle, while we agree that the 5-year fixed-SST simulations are a better way to study climate impacts, we are limited when trying to isolate the impact of one particular set of aerosol species. Ideally, in such a setup, to obtain estimates of the radiative effects of SOA one should calculate the instantaneous forcing due to SOA. The model can do this only for the whole aerosol population.

3. Excluding SOA from nucleation mode is mentioned for the first time in chapter 3.5. Model description should be more clear on what tracers are added for the model and why is nucleation mode SOA neglected. This becomes more clear later in the paper, but should be in chapter 2.3.

Response: Comment accepted.

4. Some material in model description, especially in chapter 2.3, could be left out or placed in appendix.

Response: We will move most of Chapter 2.3 to the Appendix as suggested.

5. Since it is emphasized that the model is designed with computational cost-efficiency in mind, some estimate of added computational cost should be given (relative to original ECHAM5-HAM). This would give the reader some idea of the usability of the model in long-term climate runs.

Response: Estimate of additional CPU requirements will be added to Chapter 2.

6. Figures should be redrawn with a more consistent outlook. Distinct colors (as in Fig.6) are better than interpolated colors (as in Fig.4). The text above figures in Fig. 7 (and 8) is too small to read: phrases like "annual mean accumulation mode number concentration" and "zonal mean" could be put in the figure caption. Figure 15 has no horizontal lines, as in Figs 13-14.

Response: Unfortunately the software used to produce the longitude-latitude plots does not support either distinct colours or zonal mean, hence the different styles. We agree that there is too much text (which is too small) in figures 7 and 8 and will re-plot these figures. We will also harmonise the styles of Figures 13 and 14.

7. Chapter 3.7: I would like to see changes in CDNC presented before the indirect effect, since the change in CDNC leads to indirect effect.

Response: The results regarding CDNC changes will be moved as suggested.

8. Page 2436, last paragraph: opical -> optical

Response: Corrected.

9. Figure 11: text inside figure says all-sky radiative effect, should be cloudy-sky radiative effect

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Response: Corrected.

10. Table 3: missing footnote 1.

Response: Actually a superfluous footnote reference. Corrected.

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