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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The effect of sea ice loss on sea salt aerosol concentrations and the radiative balance in the Arctic" *by* H. Struthers et al.

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We thank the reviewer for their effort in reviewing this paper. Their comments and corrections have significantly improved the manuscript.

Referee #2 Specific comments:

1. Section 2-The authors when describing the CAM-Oslo Model briefly discuss the comprehensive evaluation of the model through the Aerocom initiative but give no specific examples. It would be useful to provide a more detailed description of the models performance in the polar regions particularly.

Response: The CAM-Oslo (and its predecessor CCM-Oslo) modeled aerosol fields and radiative forcings are, for the most part, within the range of the other AeroCom models (Kinne et al. 2006, Schultz et al. 2006, Quaas et al. 2009). Globally, the total anthropogenic aerosol direct effect is smaller in magnitude than most of the models due to a relatively large contribution from anthropogenic black carbon (Schultz et al. 2006). The cloud albedo effect is close to the AeroCom median, again on a global scale. There are no comprehensive AeroCom intercomparison results specifically for the Arctic. A more specific description of the characteristics of CAM-Oslo has been added.

Section 2 (CAM-Oslo model), paragraph two:-

'... evaluated through the AeroCom (Aerosol Comparisons between Observations and Models) international aerosol modeling initiative (references). See also Kirkevåg et al. (2008a,b). On global scales, the general characteristics of the aerosol fields and radiative forcings simulated by CAM-Oslo and its predecessor CCM-Oslo are within the range of the other models included in the AeroCom project (Kinne et al. 2006, Schultz et al. 2006, Quaas et a. 2009) although the model tends to underestimate the concentration of mineral dust away from major source regions (Seland et al. 2008). While displaying a mid-range direct radiative forcing (DRF) at the ground surface, Schultz et al. (2006) found that the total 'top-of-the-atmosphere' (TOA) anthropogenic aerosol DRF in CCM-Oslo was relatively high i.e. more positive (-0.01 Wm-2) when compared with eight other models and the AeroCom average. The same holds true for CAM-Oslo, where the TOA DRF is 0.03 Wm-2 (Seland et al. 2008). Despite this slightly positive DRF, the total aerosol absorption was found to be in relatively good agreement with ground based remote sensing retrievals (AERONET), where most AeroCom models have a clear negative bias (see http://nansen.ipsl.jussieu.fr/AEROCOM/data.html). The version of CAM-Oslo ....'

2. Section 4-The labelling and description of the simulations is confusing and requires some clarification. It would help if the meteorology fields of each run were explicitly

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declared at this point. Reading further into the paper its stated that the P1-ICE and P2- ICE-SALT simulations use identical met fields while CTRL does not despite being described as identical to P1 in this section. It would be clearer if all differences between the runs was discussed in more detail here rather then throughout the results sections.

Response: The beginning of Section 4 (Model simulations) including the description of the simulations has been rewritten to clarify the model setup used. The abbreviations used for the different model simulations have also been changed. See response to Referee #1, point 4.

3. In section 5.1 its stated that the meteorological fields in P1-ICE and P2-ICE-SALT are identical to each other but not to the control run, is this the reason for the consistent increase in sea salt number flux seen in figure 7(a,c,e) between the control and P1-ICE?

Response: No, the increase is primarily (but not exclusively) due to the difference in prescribed sea ice in the CAM-Oslo aerosol module.

If this is the case can the authors justify there statement in section 5.2.1 that the difference in aerosol direct forcing between P1-ICE and CTRL is entirely attributable to change in surface albedo. Although it is stated that the the sea-salt emissions in both runs are essentially the same it would be good to see the results from a control run with 'nudged' meteorological fields to confirm this conclusion. It would also be interesting to separate the change in sea spray resulting from larger open ocean area from the change caused by differing wind speeds.

Response: The reviewer points out that the change in the aerosol direct forcing between the CTL and the P1 simulations cannot be entirely attributed to the change in surface albedo. The modeled meteorology is different between these two model simulations and this in turn alters the Arctic sea salt aerosol burden and AOD, along with a number of meteorological parameters. On the other hand, Figures 7-11 demonstrate that the emissions, atmospheric burden and AOD of the sea salt aerosol for the CTL

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and P1 simulations are very similar. It is therefore reasonable to conclude that the difference in aerosol direct forcing between these two simulations is primarily (but not entirely) due to the change in surface albedo. We have examined the possible role of relative humidity altering the hygroscopic growth of sea salt particles, however when comparing the CTL and the P1 simulations, the change in radii was found to be less than 10% resulting in a negligible change in the aerosol direct effect over the summer months. Since the aerosol module is run off-line, the P1 and P2 simulations have identical meteorology (hopefully better explained now in Section 4 - see point 2 above).

Comparing the emissions from these two simulations then gives us some idea of the change in sea spray in isolation from changes in wind speed, albeit for 2100 ice fields in the CAM3 model.

Text in Section 5.2.1 (Natural aerosol direct radiative forcing) has been altered:-

'The difference in the natural aerosol direct forcing between the P1 and CTL simulations can primarily be attributed to the change in surface albedo since the sea salt aerosol emissions, column burdens and the natural AOD are very similar in the two simulations (see Figures 7-11).'

Technical comments

4. section 5 Line 19- sentence begins The 21:00 SST believe this should be 2100?

Response: The text has been corrected.

5. Simulation names are not used consistently throughout paper with P1-ICE described as P1 etc

Response: The nomenclature has been changed:

CTL -> CTL

P1-ICE -> P1

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P2-ICE-SALT -> P2

P3-ICE/SST-SALT -> P3

This nomenclature has been applied consistently throughout the paper.

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 28859, 2010.

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