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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Global cloud condensation nuclei influenced by carbonaceous combustion aerosol" *by* D. V. Spracklen et al.

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Review of "Global cloud condensation nuclei influenced by carbonaceous combustion aerosol", by Spracklen et al.

This paper evaluates (1) GLOMAP model predictions of CCN against observations and (2) the model-predicted sensitivity of CDNC, the aerosol direct effect and the cloud-albedo indirect effect to changes in carbonaceous aerosol. This second point is addresses the important discussion of the efficacy of BC reduction for climate control.

The paper is well written and certainly of interest to the ACP readership. I recommend it being published in ACPD after several minor issues are addressed.

General comment:

1. In my opinion, the most important finding in the paper is the huge sensitivity of the AIE of carbonaceous aerosol due to the emitted size distribution of the carbonaceous aerosol (factor of 3!!). To be fair, the small_CCA sim had very small-sized carbonaceous emissions; however, the sensitivity would still be very large even if the emissions sizes in the small_CCA sim were made a bit larger.

I think that it is unlikely scientists will be able to give policy makers any useful estimate of how a reduction of carbonaceous emissions affects climate until this uncertainty is reduced. Also, it is likely that the emissions size distribution of carbonaceous aerosols would change if control techniques were used to reduce BC, which introduced additional uncertainties beyond those shown here.

It appears that the AIE is more sensitive to uncertainties in carbonaceous primary emissions sizes than it is to uncertainties in nucleation rates (e.g. Wang and Penner, 2010. I tried to deduce a sensitivity from Merikanto et al, 2010, but couldn't quickly.) Yet, in my opinion, the community is focused much more on nucleation. There is no doubt that nucleation is important, but your results here show just how important it is for us to better understand primary emissions size.

I would make this large uncertainty in the carbonaceous AIE due to uncertainties in the emissions size distribution a main point of the paper in both the abstract and the conclusions.

Specific comments:

1. Page 7007, line 12: Why is BLN not used in the default simulation since it was shown in earlier papers to improve GLOMAP results? Wouldn't it be important to have it in the base case as well as the cases where carbonaceous aerosols are turned off in order to better simulate the changing size distribution?

2. Section 4.3.1: To estimate the aerosol direct effect, you use the forcing per mass from AeroCom averages and the global mass burdens predicted in your GLOMAP

simulations. However, forcing per mass is a fairly strong function size (information that you have in GLOMAP) and location (i.e. surface reflectance/cloud cover). I understand that it may be more work than is necessary to do a full rad x-fer calculation on your aerosol fields, but do you have an idea of how similar your aerosol size distributions are to those assumed by the AeroCom models when they calculated the radiative forcing? Do you have an idea of how much uncertainty might be associated with differences in the size distribution?

The main reason that I'm curious about this is because I wonder if uncertainties in the size distribution (e.g. small_CCA) have important effects on the direct effect calculations too. I'm fairly sure they won't be a factor of 3 change in the direct forcing like you saw with the AIE, but they still could be important.

I'm not asking you to recalculate your direct effects, but maybe add a few sentences on these uncertainties. Maybe its something we should try to quantify in the future.

3. Page 7014, Line 24: What are the units for the effective radius in this equation? Since the "100" at the beginning of the right-hand side has no listed units, you can figure out the Re units.

4. Page 7015, Line 2: Can you elaborate more on this perturbation experiment? Did you keep that ratio of drop volumes constant?

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 6999, 2011.