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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Improving the simulation of global aerosol with size-segregated anthropogenic number emissions" *by* Filippo Xausa et al.

Anonymous Referee #1

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The authors compare aerosol size distributions simulated using an emission inventory with explicit size-resolved aerosol number emissions (GAINS) with the AeroCom mass-only emission inventory. The authors generally find better agreement in accumulation-mode number concentration at 11 measurement sites with GAINS relative to the previous model assumptions. Size-resolved aerosol number emissions is an important uncertainty in studying aerosol-cloud interactions (e.g. Lee et al., 2013). Using emission inventories with explicit aerosol size distribution information is a useful step forward. This study is a useful contribution to the field and fits well in ACP; however, I have a number of comments for the authors to address before I can suggest publication.

Main Comments

1. It is unclear how the authors convert from the sectional emission size distributions in GAINS to the modal scheme of the model. (e.g. Do you fit the GAINS size distribution to lognormal modes? If that is the case how do the median radii from GAINS compare with the assumptions in ECHAM-HAM? Or do you take the total particle number in the defined Aitken and accumulation modes and emit them using the same median radii as in the previous assumption?)

2. I think the authors should be careful when claiming this as a comparison between number concentration in AeroCom and GAINS. Different models convert aerosol mass to number differently. For instance, a different assumed count median radius for organic aerosol would result in a different number concentration. Really, the comparison is between aerosol number in GAINS and the default assumptions in ECHAM-HAM.

3. Considering points 1 and 2, it is unclear to me if the differences in the simulations result from different total aerosol number concentrations or different emission sizes (or both). For instance, POM from biomass burning and biofuel is often emitted with a larger count median radius. How much of the observed differences in aerosol number between the 2 simulations could be accounted for by changing the assumed emissions count median radius and standard deviation in the ECHAM-HAM model (and thereby changing number)? Or is the regional variability in size distributions from various technologies in GAINS that is important?

4. The comparison to the observation sites is not very quantitative. A linear regression (or something similar) could provide quantifiable metrics to compare the 2 simulations.

Specific Comments

1. The title is perhaps misleading, as the GAINS model only improves accumulation mode number concentration.

2. Lines 91-96: What is meant by "input"?

3. Lines 206-209: What is the relationship between the GAINS inventory and the ECLIPSE inventory?

4. Sections 2.1 and 2.2: Given the importance of modeled representation of size-resolved aerosol to this paper, I think the discussion of aerosol schemes should be its own section. Section 2.1 starts with discussing aerosol representation and Section 2.2 ends discussing shipping and biogenic emissions.

5. Lines 305-308: Are the emission sectors in GAINS different from those in AeroCom? How does this impact the comparison between the simulations?

6. Lines 324-334: I was a little confused by this section. Doesn't the GAINS (or ECLIPSE) inventory have mass concentrations?

7. Are "Rtot" and "Rattot" different (perhaps a typo? I cant find the definition)?

8. Is Rgrid weighted by surface area of the gridcell?

9. Lines 399-400: I thought the composition between the 2 simulations was held fixed (though as in Main point 5 I found this unclear)?

10. Lines 544-545: Is it possible to calculate CCN0.2 from the same measurements sites used to compare in Figure 4 in order to provide a more quantitative comparison? Or a comparison to the number of particles with diameters greater than 60 nm (as a proxy for CCN)?

11. Was Figure 3 discussed anywhere in the main text?

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