Review of "Advancing global aerosol simulations with size-segregated anthropogenic particle number emissions"

In this revised manuscript, the authors compare simulated particle number concentrations using anthropogenic aerosol mass emissions from AeroCom and compare this to a simulation using size-segregated particle number concentrations from the GAINS inventory. Emissions of size-segregated particle number concentrations may improve aerosol models. The approach used in this paper is a useful first step. The authors have responded to my initial comments; however, I have additional minor comments that should be addressed prior to publication.

Main Comment

1. I found Section 2.3 difficult to follow. As this section is really the central point of this study, I think it is important for the method to be explained as clearly as possible. As I understand it now, the authors replace the emitted particle number in the ECHAM-HAM defined Aitken mode with the number of particles from a corresponding size range in the GAINS inventory (and then the same for the accumulation mode). This is alluded to in lines 309-311; however, I think this needs to be more clear. For example, "in the defined Aitken and accumulation modes" should be more specific - is this referring to the ECHAM-HAM definitions? Further, the authors should state explicitly that they are using the total particle number in these modes from GAINS, but not using the mode diameters from GAINS (they use the mode diameters for ECHAM-HAM). Thus, there may be some artificial shift from the size distributions in GAINS to the simulations in ECHAM-HAM.

I had been under the impression that the use of the AeroCom mass-to-number conversion implied that total emitted mass was held fixed between the AeroCom and GAINS simulations; however, considering the Supplemental plots and the response to Reviewer 2, I see I am mistaken. I agree mass concentrations are not the focus of this study; however, the possible difference in mass concentration should be stated.

To be clear, I am not criticizing this approach, but recommending a more clear description of the method and discussion of the implications.

2. The authors attribute the lower simulated Aitken particle number concentration in GAINS relative to AeroCom to the increased condensation sink from the higher accumulation-mode particle emissions in GAINS. A feedback process between increased accumulation-mode number, CS, and Aitken mode number is certainly expected here. However, in Table 3, it appears that GAINS also has lower Aitken mode emissions when computing by the median of gridded ratios. How much does the lower emitted Aitken mode number impact the comparisons in Figure 4 as opposed to increased CS?

Minor and technical comments

1. Lines 312-319 are repeated 324-330.
2. AeroCom and GAINS are referred to as "data" and "datasets". Would it be more accurate to refer to them as inventories (as in "...the AeroCom inventory")?
3. Line 55 - Should "anthropogenic aerosol particle" be changed to "particles" or "particle concentrations"? Similar note for "accumulation mode particle" in Line 47 and elsewhere in the text.
4. Is the use of the word "input" in lines 92-93 referring to emissions? If so I think it would be more clear to write this sentence as "...exhaustive module for emitted particle number size distributions" or something similar. The use of "model-input" is vague.
5. Lines 94-96, I agree that almost all past inventories only provide bulk mass aerosol emissions; however, a fair amount of aerosol models don't track size-resolved mass and number concentration either.
6. Equation 4 should have some equal sign.
7. Condensation sink is sometimes abbreviated as CS and sometimes the entire word is written out. The use of CS should be consistent throughout (for instance in the paragraph starting at Line 498).
8. Line 524-525 - I do not think the results in this section support the statement "as well as other climate models". I agree that nucleation and growth are important uncertainties and other models likely need improvement. I think this statement should be left for the Conclusions section.
9. Line 628 - I do not agree with the sentence "the particle size distribution in the Aitken mode and the accumulation mode". As I understand the methods, the emitted median diameter for both emission inventories are the same for the Aitken and accumulation mode. The difference is in the number concentration in each mode.