Atmospheric
Chemistry
and Physics
Discussions

Interactive comment on "Tagged tracer simulations of black carbon in the Arctic: Transport, source contributions, and budget" *by* Kohei Ikeda et al.

Anonymous Referee #2

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This is an interesting study investigating the source Black Carbon (BC) to the Arctic using GEOS-CHEM, a global chemical transport model (CTM). Ikeda et al. used a tagged tracer method to quantify the contributions of emission source the Arctic BC. The authors also discussed the seasonality of transport pathways of BC to the Arctic. In general, the paper is well-written and easy to follow, and the literature review is cohesive and complete.

Overall, I would like to recommend this manuscript for publication; however, I have few major comments and some minor comments and suggestions, that should be addressed before the paper is published.

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Major Comments:

In this paper, the authors claim that using the new scheme "the model reproducibility of the seasonal variations is increased" or " the simulated seasonal variations were improved".

However, based on figure 2 this claim is only correct for Alert and Tiksi sites. I believe this needs further clarifications. For example, for Zeppelin site, the above claims are not true at all and the standard scheme shows significantly better performance in capturing both values and seasonality of BC. For Barrow, the standard scheme captures the summer, fall, and winter-time BC concentration better than the new scheme and we only see the improvement in the simulations for spring. Also for Tiksi, although the new scheme values are closer to observations, they are still under predicting BC very significantly. I would recommend adding some statistical analysis and more discussion for backing up this claim.

I would highly recommend comparing the results of the new scheme vs. the standard scheme for the vertical distributions along the ARCTAS flight path. Also, did you make any comparisons for each flight? Have you checked the performance of you model for the ARCTAS flights below 66N? Finally, I would recommend adding more description on the transport mechanisms from each sector and the reasons behind the seasonality. The paper shows interesting results, but it needs more discussion on how the transport pathways change in different seasons.

Minor Comments:

Page 6, Lines 17-20: Please add a reference or citations for the observation data used for this section.

Page 6, Lines 30-31: I would recommend removing the "expect in summer" phrase from the following sentence and add further clarifications to it. "This is mainly because the new scheme yielded an increase in BC concentrations except in summer with max-

imum effects in winter at the all four Arctic sites." Based on figure2 the new scheme shows higher values for summer as well, but the increase is smaller than other seasons.

Page 7, Line 13: What would be the possible reasons for "a too effective transport to Zeppelin"?! I would recommend adding more clarifications on why the model overestimated BC in Zeppelin.

Page 7, Lines 15-23: What would be the possible reasons for underestimation below 3k and overestimation in mid-troposphere? Adding more discussion and statistical analysis in this section will help. Also please add the standard scheme results to this analysis and figure3.

Page 7, Line 17: Please add the dates of flights used for this analysis.

Page 7, Lines 28-30: I would recommend adding references here or in page 6-lines17-20. Please see the above comment. Also please add a map with the locations of the sites that are selected for this study.

Page 7, Lines 25-30: Adding discussion on possible reasons on why the model underestimates the observations over Europe and East Asia. Also, please add the results of new scheme vs. standard scheme. How was the performance of the standard scheme for these selected sites?

Page 8, Lines 15-30: Please add some description on how you calculated meridional fluxes for these plots.

Page 9, Lines 15-32: I would recommend adding more discussions here and summarize some previous studies on Transport pathways and why there is a strong aloft meridional flux. (For example adding more discussions on location of polar dome and relative vertical mixing in different seasons).

Page 12, Lines 17-20: I have found the following sentence very confusing. Please modify this sentence. "Although the efficiency of the EAS-AN BC transport to the Arctic

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was lower than that of the other anthropogenic sources (EUR-AN, RUS-AN and NAM-AN) due to the effective wet removal (Fig. 9), the inflow flux was the largest among the four major 20 sources. "

Page 13, Line 24: The second largest what? Maybe "The second largest contribution" -> "The second largest contributor to the Arctic BC was"?

Page 15, Lines11:15: Please add the % contributions of BB emission from Siberia and Alaska and Canada during summer.

Figure 1-a: The plot would be easier to read if you mark the whole East Asia as well, maybe adding a zoomed map for that section to show the East Asian regions (i.e. Korean Peninsula, South China, etc.) It was difficult to locate the region of East Asia and its sub-regions in the emission plot.

Figure 3: Please add the standard scheme vs new scheme comparison with observation in Figure 3. Also, it would be nice, if you can add the error bars and NMB (or RMSE).

Figure 4: It would be great to add the locations of the observations site on a map. For example, it is not obvious which IMPROVE sites were chosen for plotting and this comparison.

Figure 5 and Figure 6: I would recommend removing wet scavenging lines from these plots or export the plots at a higher resolution. The font of these plots was very small and very hard to follow. What do the numbers in the white squares represent? The numbers are very hard to read.

Figure 8 and Figure 9: Please add a description if this is the area average concentration for the Arctic or the concentration at a specified location in the Arctic?

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