**Atmospheric
Chemistry
and Physics
Discussions**

Interactive comment on "Satellite observations of aerosol transport from East Asia to the Arctic: three case studies" *by* M. Di Pierro et al.

Anonymous Referee #1

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The authors describe three aerosol transport events from East Asia to the Arctic in 2007. CALIOP aerosol layers are compared with the GEOS-Chem model in the context of regional meteorological conditions. This manuscript provides a nice description of these events and the transport phenomena, however the larger context is somewhat absent. The transport of aerosols from mid-latitudes to the Arctic is well-known– these basic model/CALIOP comparisons do not further our understanding of this process. If the authors could re-frame these results to generalize aerosol transport to the Arctic from Asia (i.e. how frequent? at what altitudes? how important compared to climatological aerosol loading from local sources?), this study would be more compelling. Some additional comments are included below.

Major comments:

1. Figures 1, 5 and 8: The left-hand panels are very difficult to read. Even zoomed in with the online pdf version, I had difficultly discerning back trajectories from political boundaries (both in black). The CALIOP orbits are almost impossible to see. The size of these figures needs to be increased considerably, and/or the authors might consider only showing 4 panels for each.

2. I am somewhat concerned that v2 of the CALIOP retrievals were used for this study. This data was labeled as "provisional" and did not include the suite of QA flags available in the v3 products, which can be used to filter observations as per the recommendations of the CALIOP team. While it may be impractical to repeat the entire analysis with the new data products at this time, I suggest that you do so for one event (and examine the uncertainties in the v3 retrieval). You can thus comment in the text about the robustness of your results to the use of an early data product.

3. GEOS-Chem reproduces the plume placement observed with CALIOP remarkably well. However in all cases, it does not seem to reproduce the intensity of the observed plumes in Fig 2a, 2b, 7, 10, particularly in the later two cases. It would be preferable to compare these at the same spatial resolution (ie. grid the CALIOP observations to the GEOS-Chem grid) to properly compare these features. Similarly, it was not clear if the total AOD comparisons were made over just the extent of the observed plume (i.e. GEOS-Chem sampled only for where aerosol extinction > 0 was reported with CALIOP) or throughout the model feature/column, compensating for plume diffusion in the model. I suspect the later, given the good agreement between the magnitude of AOD, if so it should be made clear that these are not exact comparisons.

4. The text indicates that all three events are associated with precipitation during transport according to the backtrajectories. You showed GEOS-5 precipitation maps, but do not comment on whether these reproduce the regions of precipitation in the backtrajectories. What fraction of aerosols were scavenged in the model as a result?

5. Why is NCEP-NCAR re-analysis shown to describe the meteorological conditions

rather than the GEOS-5 product used in GEOS-Chem?

6. The importance of accounting for the CALIOP sensitivity threshold is discussed in 3.1.3 and Figure 2b, but it is unclear if this threshold is therefore applied to all model extinction values in what follows. Please clarify this in the text.

7. Can you comment on how the CALIOP lidar ratio employed matches with the simulated aerosol types for these events?

8. The discussion of scavenging efficiency on page 25407 is quite interesting. Could you say more about this in your analysis of each event?

Minor comments:

1. Page 25390, line 14: grammar: replace "at daytime" with "during daytime"

2. Section 2.1: It would be useful to include some information on the aerosol optical properties used in GEOS-Chem.

3. Page 25395, line 14: how can the vertical range extend to negative values (-0.5 to 20.2 km)?

4. Figure 2a & 7: why are multiple overpasses during the same day shown here when the transport events extend over several days with many CAlIOP intercepts? i.e. why not match Fig2a to Fig1?

5. Figure 3 is discussed in the text prior to the discussion of Figure 2b - these should be re-ordered.

6. Page 25406, line 27: these AOD values in the plumes are quite small (ie. 0.022, and 0.038) are they significantly different from background or climatological conditions?

7. Page 25407, line 7: you indicate precipitation occurs primarily in the "initial phase" but in your description of the 3rd event you indicated that "precipitation occurred during most of the transport" (page 25406, line 13). Correct inconsistency of phrasing.

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8. Page 25409, discussion of Figure 11: similar to my point above about the earlier figures, it is very difficult to distinguish the two poles of action on the figure. I had to zoom into the pdf figure.

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