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Atmospheric Chemistry and Physics Discussions

# *Interactive comment on* "The distribution of sea-salt aerosol in the global troposphere" *by* Daniel M. Murphy et al.

**Anonymous Referee #1**

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The authors present observations of sea-salt aerosol concentrations collected with the Particle Analysis by Laser Spectrometry (PALMS) instrument on the ATom aircraft campaign in July-August 2016 and January-February 2017 as well as one flight in October 2017. These observations afford a global view of sea salt aerosol size distribution over a large range of latitudes (85N-80S) and altitudes (surface to 12 km). The measured diameter range is from 0.18 to 3 micrometers. The authors find a strong altitude dependence of the sea salt concentrations and a strong correlation with water vapor, reflecting wet scavenging of sea salt in the atmosphere. The authors report a source of sea salt aerosol over sea ice, with a different chemical composition than over the open ocean. The authors also compare these observations with results from chemical transport models.



The paper presents a very unique and interesting dataset of sea salt aerosol mass concentrations. The uniqueness comes from the systematic observations with the same instrument over a large of altitudes, latitudes, and for different seasons. The study is within the scope of ACP and represents a new contribution to the field of sea salt aerosol spatial distribution and scavenging. The paper is well written and well organized. I have a few comments that I would like to see the authors address.

1) Page 5 line 26. The authors mention that the details of the normalization are provided in a manuscript that's in preparation. It would be useful to include a bit more detail on this normalization in the present manuscript. For example, how large are the normalization factors that are applied to the PALMS instrument? How do these factors vary with particle size? Is there a dependence on altitude?

2) Figure 2. The text states that the filter samples indicate more sea-salt mass, as expected from sampling larger particles than PALMS. However, when looking at the figure it looks like PALMS is systematically larger than the filter Na+ measurements: nearly all the points appears to fall above the 1:1 line and PALMS observations of sea salt mass are larger than Filter Na+. Am I misreading the chart? It would be useful to give the statistics of the slope and correlation coefficient associated with the dashed line on the plot. Also, the figure has a box "if PALMS 2/3 of filter..." This statement is unclear, can the authors please explain in the figure legend that the error bars correspond to?

3) The distinct composition of sea salt aerosol over Arctic sea ice is an interesting result, consistent with a sea ice origin. Can the authors elaborate on the size distribution of these sea salt particles? Does it also look distinct from open ocean sea salt? For example, if these sea salt particles originate from frost flowers, one might expect larger particles. If they originate from blowing snow, then these is a possibility that submicron particles would be present, depending on the size of the snow particles and the numbers of sea salt particles produced per snowflake that sublimates.

4) The authors interpret the sea salt –water vapor correlation plots in Figure 6 as indicators of scavenging of water vapor and sea salt, and effectively vertical profiles of sea salt. However, one confounding factor in terms of the seasonal differences seem between ATom1 (summer) and Atom2 (winter) is the different temperature profiles. Based on Clausius-Clapeyron, I assume that a similar water vapor mixing ratio – say 1000 ppmv – corresponds to different altitudes for winter and summer in the northern hemisphere as well as for the tropics (15S-15N panel) as the temperature profiles are likely quite different. To provide further support the statement “In both hemispheres the winter data show more sea-salt aerosol in the upper troposphere than either the summer hemisphere or the tropics.”, the authors would have to plot sea salt concentrations as a function of latitude for different seasons above a certain altitude. Alternatively, the authors could show the mean or median vertical profiles of sea salt aerosol mass concentrations for different seasons and latitude bands. Are the values shown in Figure 6 means or medians of sea salt concentrations for each water vapor bin? Having a sense of the variability for the blue and black lines in the various panels of Figure 6 would be useful. This could be done by showing an envelope of the sea salt concentrations (25th and 75th percentile for example).

Additional minor comments

- page 8 line 11-12. Is “one” missing from “a rage of more than per second”?

- page 10 line24. Remove extra “particles”

- page 12. Line 10. Do the authors mean Figure 6 instead of 5?

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