Reply to Richard Leaitch's comments

This paper examines aerosol size distributions measured in the high Arctic from the Swedish icebreaker Oden during four summers. Back trajectory cluster analyses are used in combination with the size distribution information and ice cover data to examine the regions associated with features of the size distributions up to 10 days prior to the distribution measurements. Before application to the aerosol particles, the cluster analysis is tested using measured DMS, which reasonably shows higher concentrations of DMS tracing back to known DMS source regions. Clearly a lot of effort has been put into the analyses making this a valuable piece of work.
Thank you for the encouraging review.

A few specific comments follow:

1) Concerning section 7
a. In section 7, you say that "Previously reported results from Alert in spring, (Leaitch et al., 2013), and on Mt. Zeppelin, Spitsbergen in early summer, (Engvall et al., 2008), showed nucleation events followed by subsequent prototypical "banana growth" (e.g., c.f. Kulmala et al., 2001), which the authors explained by solar radiation in concert with the presences of precursor gases and attendant low condensational sinks." The Alert data in the Leaitch et al paper referred to focused on the period June, July, August and September. It was summer not spring. Also, there was no mention of a banana growth in Leaitch et al because none was observed. Please correct.
Sorry about the seasonal confusion which we corrected. The text now reads: "Previously reported results from Alert in summer, (Leaitch et al., 2013), and on Mt. Zeppelin, Spitsbergen in spring, (Engvall et al., 2008), showed nucleation events. On Spitsbergen they were followed by prototypical "banana growth" (e.g., c.f. Kulmala et al., 2001). The nucleation events at both Alert and Zeppelin are explained by a conventional nucleation mechanism involving solar radiation in concert with the presences of precursor gases and attendant low condensational sinks."

b. Later in section 7, you say that "Possible reasons for the inconsistency with the data collected during the four icebreaker expeditions could be that the DMS source and photochemical sink generating the precursor gases for nucleation and early growth is both seasonal and temperature dependent (Leck and Persson, 1996a, b; Kerminen and Leck, 2001; Karl et al., 2007, 2012). Given that, perhaps the main difference between the studies concerns how efficiently nucleation and growth of particles resulting from DMS oxidation are predicted by the choice of model and lack of observations to constrain the model assumptions." You have not demonstrated an inconsistency among the datasets. It is quite the opposite. Your analysis shows that all measurements you have used are relatively consistent. Even the trajectory analysis for the Alert data included in Leaitch et al showed the central Arctic (as well as air off Greenland) to be potential source regions, and your results, including those associated with Zeppelin as well as with Alert, indicate the presence of smaller particles when the condensation sink is reduced. Where there is an inconsistency is in the interpretation of "Trajectories connected with high concentrations of newly formed small particles, however, experienced more open 15 water during the last four days before arrival in heavy ice conditions at Oden." There seem to be two possible explanations to the presence of the newly formed particles. Your interpretation is that it is due to the fragmentation of microgels connected with cloud processing. The other (more conventional) interpretation is that it is due to nucleation of new particles for situations of very low concentrations of precursor gases that is facilitated by a low condensation sink. However, at the moment the

real interpretation seems to be that we do not know which answer is correct, if either, and I hope the authors will consider adjusting section 7 to reflect that lack of knowledge.
We hope the reviewer can live with the following revised text: "A major difference between the two land stations and the inner Arctic lies in the different DMS levels. To our best knowledge (Karl et al., 2013) the extremely low DMS concentrations, (Leck and Persson, 1996a, b), in the inner Arctic are not sufficient for the conventional nucleation mechanism. Given that, perhaps the main difference between the studies concerns how efficiently nucleation and growth of particles resulting from DMS oxidation are predicted by the choice of model and lack of observations to constrain the model assumptions."

2) Page 8433, line 22 – "occasionally TO as few as. . ."
Yes, thanks

3) Page 8436, lines 5-7 – I do not understand this sentence: "As compared to the 1271 hourly DMS values. . .a total of 2035 h of DMS data were available. . ."
One, DMS measurements had been taken at times when the DMPS instrument was not operating. Two, because of the stringent contamination criteria applied to the DMPS data, some aerosol data were rejected while DMS data could be accepted.

4) Page 8443, line 21 – week.
Yes, of course, thanks.

5) Page 8447, lines 7-9 – I don't see how these number concentrations, which are really quite modest (130/cc) are an indication of polluted air. The sizes of these particles are mostly below 50 nm diameter and almost all smaller than 100 nm diameter, which means that the associated mass concentrations are very small. Why could this not be an indicator for new particle formation with modest growth over the Greenland ice cap?
Thanks for the suggestion. We corrected the sentence to "This monomodal distribution may be the result of very long aging of polluted air in the free troposphere (e.g., Leaitch and Isaac, 1991; Parungo et al., 1990) or may indicate new particle formation with modest growth over the Greenland ice cap."

6) Page 8447, line 22 – "strongly reminds of the. . ."
Changed to: "strongly reminds us of the"

7) Page 8455, line 15 (acknowledgements) – Richard not Robert.
We are sorry, Richard.

Literature

A.-C. Engvall *et al.*, Changes in aerosol properties during spring-summer period in the Arctic troposphere, *Atmos. Chem. Phys.* **8**(2008), 445-462.

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W.R. Leaitch *et al.*, Dimethyl sulfide control of the clean summertime Arctic aerosol and cloud, *Elem. Sci. Anth.* **1**(2013), 000017.

C. Leck and C. Persson, The central Arctic Ocean as a source of dimethyl sulfide: Seasonal variability in relation to biological activity, *Tellus* **48B**(1996a), 156-177.
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F.P. Parungo, C.T. Nagamoto, P.J. Sheridan and R.C. Schnell, Aerosol characteristics of Arctic haze sampled during AGASP-II, *Atmos. Environ.* **21A**(1990), 937-949.