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Interactive comment on "New particle formation events observed at King Sejong Station, Antarctic Peninsula – Part 1: Physical characteristics and contribution to cloud condensation nuclei" *by* Jaeseok Kim et al.

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Review comment on "New particle formation events observed at King Sejong Station, Antarctic Peninsula – Part 1: Physical characteristics and contribution to cloud condensation nuclei" by Jaeseok Kim et al.

This manuscript presents new particle formation (NPF) and its impact on CCN ability at Korean Antarctic research Station (King Sejong) located in the Antarctic Peninsula. This study is based on long-term aerosol measurements for several years. To our knowledge, the long-term SMPS measurements through the years in the Antarctic regions are very limited. Actually, results in the manuscript are important and interesting

to understand NPF and aerosol science in the Antarctic regions. As a whole, the topic of the manuscript is relevant and suitable for the scope of the "Atmos. Chem. Phys.". However, there are several points which require some careful revision and corrections before publication.

Major points

1. Authors showed NPF occurrence and frequency in Section of 3.1.1. However, time series of CN concentrations and SMPS results (i.e. contour plots of variations of aerosol size distributions) should be shown and add explanation before analysis/discussion of NPF occurrence and frequency. The plots of the typical examples can provide important information for us.

2. It is true that emission of aerosol precursors from oceanic bioactivity and atmospheric photochemical reactions are associated with NPF in the Antarctic coasts during summer. Unlike to other Antarctic coastal regions, however, anthropogenic impacts (local contamination) can be larger around the Antarctic Peninsula particularly in the summer because of activity in many stations and ship-borne tourism. Therefore, influence of anthropogenic activity and local contamination should be analyzed and discussed before discussion on contribution of condensable vapors originated from oceanic bioactivity. The following works are useful references.

Shirsat, S. V. and Graf, H. F.: An emission inventory of sulfur from anthropogenic sources in Antarctica, Atmospheric Chemistry and Physics, 9(10), 3397–3408, 2009.

Graf, H.-F., Shirsat, S. V., Oppenheimer, C., Jarvis, M. J., Podzun, R., and Jacob, D.: Continental scale Antarctic deposition of sulphur and black carbon from anthropogenic and volcanic sources, Atmospheric Chemistry and Physics, doi:10.5194/acp-10-2457-2010, 2010.

Furthermore, air masses in the Antarctic Peninsula were transported frequently from south America. This transport pathway can lead to high aerosol number concentrations

and BC concentrations at Ferraz Station located in the Antarctic Peninsula (Pereira et al., 2004, 2006). In other words, these studies implied that anthropogenic aerosol precursors and land-origin aerosol precursors such as organics can be transported and supplied to the Antarctic Peninsula. Thus, I recommend strongly comparison of number concentrations, NPF frequency, and FR in each air mass origin.

Pereira, K., Evanhelista, H., Pereira, E., Simões, J., Johnson, E., and Melo, L.: Transport of crustal microparticles from Chilean Patagonia to the Antarctic Peninsula by SEMâĂŘEDS analysis, Tellus B, 56(3), 262–275, doi:10.1111/j.1600-0889.2004.00105.x, 2004.

Pereira, E., Evangelista, H., Pereira, K., Cavalcanti, I., and Setzer, A.: Apportionment of black carbon in the South Shetland Islands, Antarctic Peninsula, Journal of Geophysical Research: Atmospheres (1984–2012), 111(D3), doi:10.1029/2005JD006086, 2006.

3. Authors stated definition and classification of NPF in Section of 2.2.1 and 2.2.2. Because SMPS measured size distributions of aerosol particles with size range of D>10 nm, authors tried likely to identify NPF using the difference of CN concentrations (e.g., CN2.5-CN10). Criteria values of 500 cm-3 were used for the NPF identification. What is the procedure to decide the criteria values? This criteria is very important basic in this study. I think that authors were in accordance of procedures shown by Humphrires et al. (2016). Considering that measuring site and conditions were different to sea-ice area (Humphrires et al., 2016), authors should show example plots of time series of CN2.5-CN10 and discuss the suitable criteria values. In addition, classification of NPF in accordance with previous works (Dal Maso et al., 2005; Yli-Juuti et al., 2009) requires information about particle growth after NPF. However, the difference of CN concentrations cannot provide information on particle growth. How did you identify particle growth of nucleation mode (D<10 nm)?

4. FR was estimated from CN data with 1 sec resolution in this study. What is values

of variability? In general, 1 sec CN data can be varied greatly. The large variability engender the large error of the estimated FR. CN data with longer time resolution (e.g., one minute) is better to estimate FR. Also, statistical analysis and error estimation are required for CN2.5-CN10 and the estimated FR.

5. GR was estimated from GMD. How did you calculate GMD? Did you have log-normal fitting analysis or identify diameter of mode maximum? Some explanation is needed in Section of 2.2.3.

6. To identify origins and pathway of air masses with NPF, some trajectory was shown in Figure 1. Although trajectory can provide us important information of transport processes of air masses, Fig.1 showed only some cases. I suggest all trajectories in NPF at each height are plotted in Figure 1 (e.g., trajectory density map) to identify origins and pathway of air masses with NPF.

7. CCN concentrations were discussed in Section of 3.3. Long-term CCN records provide important knowledge to us. In this study, aerosol size distributions were measured simultaneously by SMPS. Nevertheless, aerosol size distributions did not compare to CCN data. I understand that critical diameter was estimated hardly in this study. However, aerosol size distributions must be useful and important data to elucidate features of CCN concentrations. The critical diameter of the Antarctic aerosols during summer was discussed by Kyrö et al. (2013). Comparison between size distributions and CCN should be shown and discussed.

Minor points

1. Introduction: Page 2 Line 20 Aerosol particles with size larger than several tens nm are not "new".

2. Introduction: Page 3 Line 3

"Dall'osto" is correct.

3. Introduction: Page 3 Line 10-12

Asmi et al. (2010) presented hygroscopicity of ultrafine particles measured at the coastal Antarctic station (Aboa). They showed and discussed hygroscopic growth factor and CCN activity, although they did not measure directly CCN. This should be mentioned in introduction.

4. Section 2.1 Measuring periods should be mentioned in Methods section, although the periods was shown in the section of Results and discussion.

5. Page 8 Line 14-18 Kyrö et al. (2013) showed emission of aerosol precursors from melt pond, not from oceanic bio-activity. This description should be modified.

"∼biota activities in the Antarctica" is correct.

6. Page 8 line 24-25 In this study, the NPF was observed in May in spite of only one case. If NPF occurred actually in the Antarctica in May, this is important to understand aerosol science in the Antarctic troposphere. Some explanation and discussion such as FR and air mass origin should be added.

7. Figures 3 and 4 Both figures can be merged. That is easy to compare among each other.

8. Page 9 Line 22-24 GRs in September-October were not shown in Fig. 4. Does it mean no particle growth in September-October? Some explanation should be added.

9. Page 10 Line 9-10 Higher CS values were obtained at King Sejong Station. The high CS might result from high aerosol number concentrations, although high CN related also to aerosol size distributions. If so (high aerosol concentrations), supply and transport of aerosols and aerosol precursors should be taken into account. This must be associated with FR, GR, and CCN ability. Details were already shown in the major comment.

10. Page 11 Line 19-22 Are air mass origins (Case I-IV) corresponding to Fig.1a-d?

11. Section of 3.4 CS values were used for discussion. I suggest that CS values and

aerosol number concentrations obtained in previous works at stations (e.g., Neumayer and Aboa) around Weddle Sea should be compared to data in this study. As mentioned in major comment, anthropogenic and local impact should be discussed. Such impacts are analyzed hardly only by trajectory.

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