

## ***Interactive comment on “On the annual variability of Antarctic aerosol size distributions at Halley research station” by Thomas Lachlan-Cope et al.***

**Anonymous Referee #3**

Received and published: 11 November 2019

Comments: Lachlan-Cope et al. present a novel study of Antarctic aerosol size distribution collected over a whole year of measurements at Halley research station. By applying the K-means clustering data analysis, eight aerosol categories were characterized. Based on the air mass back trajectory analysis, major sources regions including sea ice, open ocean, snow, and etc. were elucidated. Then, this study concluded that NPF and growth events in the Antarctic atmosphere mainly originated from both the sea ice marginal zone and the Antarctic plateau. The implication for climate and conclusion section is well-written, and in particular, the brief comparison with two other Antarctic stations (Dom C Concordia and King Sejong Station) during the year 2015 is a very useful and insightful section. Overall, the manuscript is generally well-written and interesting to read, with clear structure and sufficient explanations. The manuscript

C1

may be suitable to be published in Atmospheric Chemistry and Physics.

Major Comments: Page 2 and Lines 30: In the present study, cluster “pristine\_160” with a bimodal size distribution (75 nm and 160 nm, respectively) shows the highest WS, but there were no correlations between them. Please clarify the meaning of “strong correlation in the abstract”. Page 11 and Lines 19: New particle formation and growth was observed for the nucleation mode PSC cluster. In addition, the authors mentioned that NPF and growth events originate from both sea ice marginal zone and the Antarctic plateau in the abstract. Please, calculate and suggest the growth rate, which is a critical factor that affects the CCN number concentration in Antarctic regions. Then, the value could be compared according to the air mass origins. Page 15 and line 9. Almost 5 pages were partitioned to discussion section that was overlapped with introduction section. Most of of the discussion section should be moved to introduction section and SI. Page 20 and line 19. The authors compared data from Halley, Dome C, and King Sejong Station. Overall, much higher concentrations are seen at the coastal Antarctic sites relative to continental based Dome C station. The coastal Antarctic stations being a remote location might be not immune to man-made impacts and specific tracers (e.g., black carbon) are necessary to discern those influence. In particular, quite high BC concentration was detected in King Sejong Station, as presented by Kim et al. (2018). Here, the possible sources of NPF and growth due to human activity (anthropogenic influence) could be discussed.

Minor Comments: Page 9 and Line 1: Section 2.3 is missing. Page 10 and Line 1: As mentioned in the manuscript, the difference between spring and autumn at  $D_p > 60$  nm is very interesting. Please, explain possible reasons. Page 2 and Lines 30: Error should be displayed in Figure SI 5. Please, provide the relationships between total particle number concentration and each meteoroidal data (e.g., wind speeds, RH, T, and ozone) according to the different aerosol categories. Page 38 and line 6: What is meant by “Please note that the sea ice extent is the median September extent from 1981-2010” in Figure 7.

C2

Please also note the supplement to this comment:  
<https://www.atmos-chem-phys-discuss.net/acp-2019-847/acp-2019-847-RC3-supplement.pdf>

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Interactive comment on Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2019-847>, 2019.