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Comment on acp-2020-1246

Anonymous Referee #2

Referee comment on "Southern Ocean latitudinal gradients of cloud condensation nuclei" by Ruhi S. Humphries et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2020-1246-RC2, 2021

This paper, by Humphries et al., analyzed data for Cloud Condensation Nuclei and Condensation Nuclei in the Southern Ocean (SO) during MARCUS and CAPRICORN campaigns covering late autumn-early spring. The results show that there are three distinct regions in the Southern Ocean near the East Antarctic coastline based on the aerosol composition and CCN abundance. Continental and anthropogenic pollution mostly affected the northern most sector. Mid-latitude CCN number concentrations and sources were influenced mostly by biogenic and sea salt aerosols in the boundary layer, and southern most sector was influenced by phytoplankton emissions. The classification of these regions is further supplemented by HYSPLIT back trajectory analysis. The results from this study clarify several questions about the sources of aerosol and CCN composition in the SO. The scop of this study is relevant to climate models for understanding the radiation and compositional biases in the SO. The paper is well constructed, methodology and measurement techniques are clearly illustrated. The content is appropriate for the context of the ACPD journal.

A few areas of the manuscript need minor revisions:

1. Figure 3. Along with the violin plots, it would be useful to plot a histogram of the number of observations for each case.

2. Figure 4. and discussion: For the southern-most sector, would it be possible to extend the back trajectory analysis to longer time period, say 15 days? Why was the back trajectory constructed only for 5 days? The authors find that aerosols and CCN in this sector are affected by aerosol species that spend significant time in the free troposphere. This explains that these fine particles have a longer lifetime and can be transported from longer distances. Therefore, extending the back trajectory analysis to longer time periods can be useful to understand their sources.

3. Figure A3 and A4. Add y-axis labels for all figures or move the y-axis label farther with larger fonts so it is common to all figures.

4. Figure A8. Is it possible to add the number of data points considered for analysis along the track? Besides , sea spray production from ship tracks can also affect the sources of aerosols due to whitecap generation. Is there a way to eliminate the amount of sea spray from ship tracks ?

5. Line 252 - Expand ERA-5. Add a few sentenced on ERA-5 data used in this study. Does the total precipitation used here refer to the model variable in the entire column? What are the spatial and temporal resolution of the data used?

6. Line 404 - Authors note that Atmospheric Compositional Front of Antarctica (ACFA) can be affected by the synoptic meteorology. What are the various synoptic meteorological processes in this region that can potentially affect ACFA and how will the sources and trajectory change? This is important for future field campaigns and interpreting data from other campaigns/seasons.

7. For the southern-most sector, would it be useful to plot a probability density / two-dimensional histogram map for chl-a Vs CCN number concentrations similar to Figure A9? This can help understand the sources of phytoplankton emissions in a better way.

Minor errors:

1. Line 1 - "The Southern Ocean region is one of the most pristine in the world" - missing word. "one of the most pristine regions in the world." Similarly, in line 29, "one of the most pristine regions of the planet".

2. Line 9" Rephrase to "where continental and anthropogenic aerosol sources coexist with the background marine aerosol population"

3. Line 37 - "impact global cloud" to impact of global cloud and carbon-cycle feedbacks.

4. Lines 42-53: Field campaign abbreviations need to be expanded.

5. Line 62: Expand on the biological processes and rephrase the sentence.

6. Line 64: "emitted from phytoplankton, into tertiary" to "emitted from phytoplankton, transforms into tertiary"

7. Line 73: "aerosol sulfur" to "sulfur aerosol"

8. Line 76 - expand abbreviation "CLAW"

9. Line 76 - "significant in CCN production" to "significant to CCN production"

10. Line 92 - A setence on the major conclusion from Alroe et al., would be useful to the context.

11. Line 263: Remove commas “for all parameters are unsurprisingly observed”

12. Line 335: Rephrase - change "-' to ','

13. Line 337: Explain air-mass fetch.