Author response to referee comments

Measurement Report: Understanding the seasonal cycle of Southern Ocean aerosols

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Response to Anonymous Referee #1

We would like to thank referee #1 for the time taken and the thoughtful suggestions on our manuscript. We detail the improvements made to the paper in response to the reviewer's suggestions below:

- Minor suggestions – we agree that the inclusion of particle size distribution data at Macquarie Island is an important observation in this region and the authors of this study are working towards the establishment of these, together with other complementary measurements, at this remote location. Unfortunately, the scope of the described campaign only extended to the inclusion of CN_{10} and CCN.
- L25 – we have updated this sentence to be along the lines of what the referee has suggested.
- L26-27 – this suggestion changes the meaning of the sentence. We have kept it as is.
- L27-28 – we have updated this sentence to better acknowledge that this region is not completely pollution free, but is the closest we have.
- L55 – we thank the authors for alerting us to this important study. We have included the published version of the paper in the citation list.
- L300 – while we agree that back trajectories are a useful tool in many cases, for this particular question, observations of radon concentrations are a better tool because they are a direct tracer of continental influence and don't suffer from the same high uncertainties that are present in back trajectory calculations in this region (which are driven by a paucity of observations feeding into the reanalysis datasets that drive the trajectory calculations).
- L319-320 – we have added several references to justify this statement.

Response to Anonymous Referee #2

We would like to thank reviewer 2 for their considered comments. They have been an asset to the study and have led to an improved manuscript. We have responded below to each:

Restructuring comments:

While we understand the reviewer's comments about restructuring the results section separate it by measured parameter, we feel that the structure present, where we have separated it by seasonal and latitudinal discussions, is equally valid. Referee #1 confirmed that the manuscript in the current form "follows a logical structure", and this has also been reviewed and agreed upon by all co-authors prior to submission. With regards to the seemingly contradictory conclusions, the examples that are provided by the referee have been addressed in response to specific comments below, so don't

present a potential contraction anymore. Consequent to these points, we have left the overall structure as is.

Specific comments:

- P4 Methods – we agree that a summary of the data availability would be a useful addition to the manuscript, but we extend this to beyond the referees suggestion of just Macquarie Island, and have added a table summarising the data availability from all stations and campaigns. An additional two sentences have been added at the conclusion of the first paragraph of the methods section to complement and introduce the new table.
- P6, L150-151 – this has been clarified in the text.
- P7-8, L195-198 – this is an excellent suggestion to help the reader understand the data availability and complements the addition of the table added to the methods in response to a previous comment. We have added a sentence at the end of section 2.2 that describes the baseline frequency.
- P8, L200-201 – this sentence has been reworded to improve clarity.
- P10, L271 – nice catch! We have updated CAPRICORN2 to CAPRICORN1 as per the referee's astute observation.
- P11 – Results and Discussion, general comments
    - Tempering the interpretation of certain observations by taking into account variability.
        - L344 – replaced "substantially" with "noticeably"
        - L467 – removed "significantly"
        - L504 – removed "substantially"
        - L516 – this instance is justified given the high sample number (both stations are in the thousands of hours of available data) and the obvious difference between the two stations. The text has been left as is.
        - L519 – this instance is justified given the difference between bins is over double, with tight distributions for all voyage data. In addition, the following sentence acknowledges the limited number of observations. The text has been left as is.
    - Discussion of various points:
        1. The difference of the length of the datasets is discussed briefly in the methods section. The choice of approximately 10 years of data was done "to enable a climatological comparison with the MQI data".
        2. The time lags between some datasets aren't of major impact on the results here because we are looking at data in a climatological sense, and campaign data are presented as individual data points on any figures. The years of long-term data utilised from SYO and KCG were chosen so as to overlap as much as possible with campaign data so as to minimize any long-term changes.
- P11, L309 – Corrected the typo by changing the second "is" to "as".
- P11, L310 – We have modified this sentence to clarify that KCG doesn't observe the highest concentrations all year around, but instead "for most of the year".
- P11, L315-316 – changed "September" to "August"
- P11, L315-316 – we have changed "although" to "while" to improve the clarity of the sentence.
- P13, L348-349 – we have reworded this part of the sentence to improve clarity.

- P11-14 – a further analysis of data from each year, in comparison with the 10 year climatology shown in the paper, shows that these features are consistent across almost all individual years. This is shown in the figure below. This figure hasn't been reproduced in the manuscript, however, we have added a sentence in the first paragraph of section 3.1 describing these results.

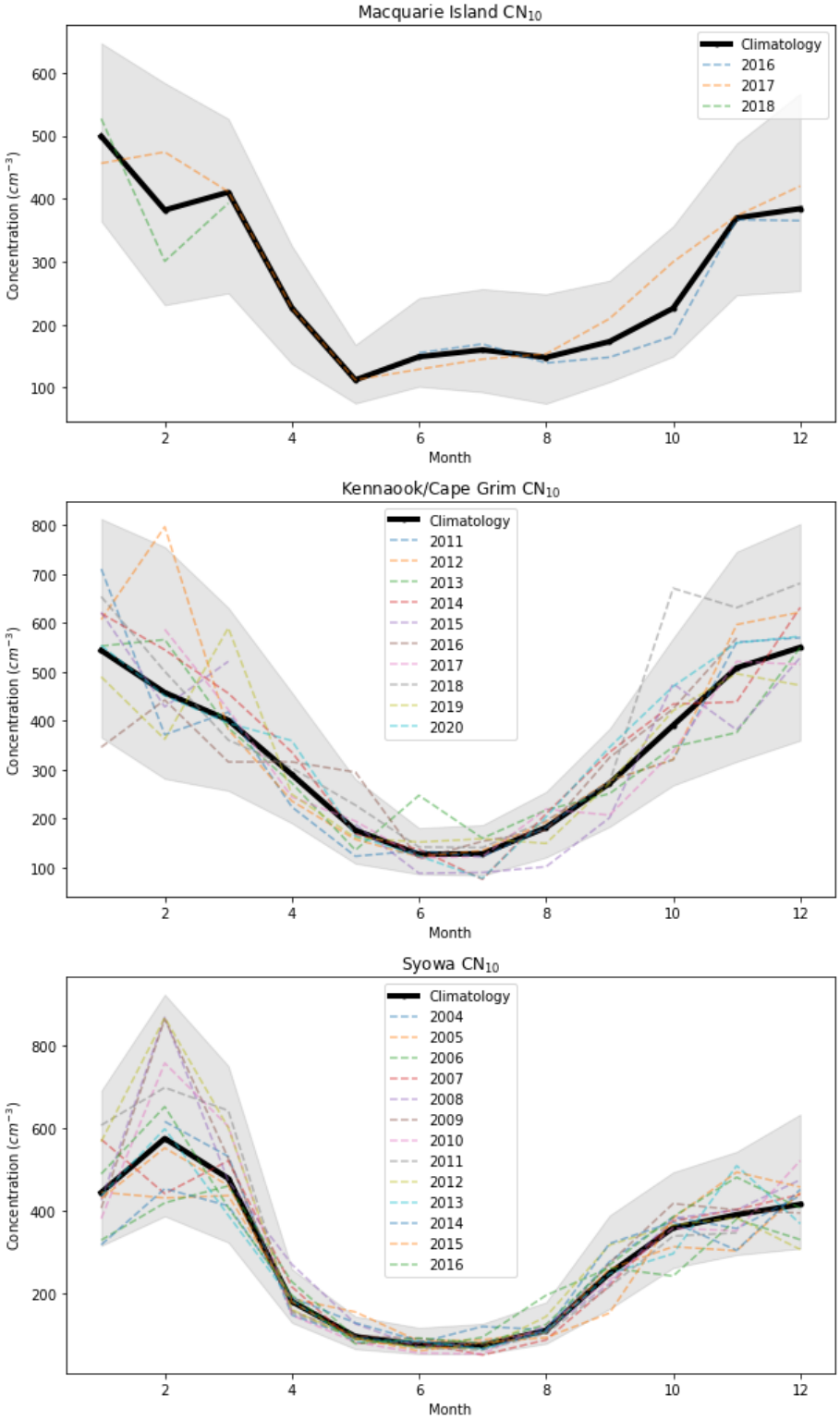

Figure 1: Seasonal cycles of CN10 calculated from all available data at each station, plotted together with individual years. Monthly medians are shown in all cases, with the shading of the climatology representing the interquartile range.

- P15, L394-395 – we agree that the majority of the peak is definitely in June, however we included May because the 75th percentile of the May data shows an increase in several parameters. We have altered the first sentence of this paragraph to reflect this, such that it now reads "… the significant spike in CCN0.5 concentrations at MQI, beginning in May, and peaking in June."
- P15, L424-426 – we have modified the sentence to include the importance of considering supersaturation in the discussion, and have explicitly outlined that we have utilised CCN measured at 0.5% supersaturation in the calculation of the ratio.
- P16, L445 – we have weakened this language, making it more quantitative, changing it from "many" to "around half".
- P16, L446 – while we agree that trajectories could add strength to this hypothesis, the authors feel that this is not a major result of this paper, and as such, is out of the scope of the current study. However, this is in line with previous studies that have utilised trajectory studies to analyse similar data. We have edited the sentence to add these citations to support this hypothesis.
- P17, L461-463 – we have reworded the sentence to improve wording.
- P19, L512-513 – We have added a few sentences in the previous paragraph to describe the difference between voyage and KCG data during the summer period, and also expanded the explanation of the autumn difference in the following paragraph.
- P20, L527, 528 – the improvements to previous discussions made in response to earlier comments by the referee improve the accuracy of this statement. However, we have edited this sentence acknowledge the difference.
- P20-21 – while we can see how these two sentences could be included in the conclusions, we feel that to discuss the points in the detail required, they are more suited to the discussion section where we can discuss in a more expansive form.