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Open Access Earth System Science Data Discussions

Interactive comment on "Southern Ocean Cloud and Aerosol data: a compilation of measurements from the 2018 Southern Ocean Ross Sea Marine Ecosystems and Environment voyage" *by* Stefanie Kremser et al.

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Reviewers:

The reviewers of this manuscript are a research group in atmospheric chemistry at the University of British Columbia led by Dr. Nadine Borduas-Dedekind. The group met twice for a combined time of 3 h to review and discuss the manuscript, the instrumentation, the data and the data visualization. The discussion was led by undergraduate student Max Aragon Cerecedes and this report was compiled and edited by Dr.

Borduas-Dedekind. Additional graduate and undergraduate student co-authors of this review include (in alphabetic order): Ayomide Akande, Sophie Bogler, Isabelle Lao, Rickey Lee, Madri Jayakody and Jon Went.

General overview:

First and foremost, we congratulate the authors for the extraordinary team effort in collecting valuable cloud, aerosol and seawater data in the Southern Ocean. This paper presents an open access data set shared on Zenodo, and describes the instrumentation deployed and the data collected during the voyage of R/V Tangoroa in February-March 2018 from New Zealand to the Ross Sea, off the coast of Antarctica. As it stands, the data is presented at different processing levels depending on the instrumentation and will be undeniably useful for evaluating aerosol-cloud interactions in weather and climate models, including the biogeochemical cycling of sulfur compounds.

To help the authors have their data used more quickly, easily and efficiently, we have compiled a list of recommendations, clarifications and critical comments.

Our critical feedback on the structure of the paper includes working on the flow of the manuscript. Leading a large collaborative effort such as this manuscript has its challenges, including producing a unifying storyline of all the measurements undertaken during the voyage. In general, presenting the data by instrument is a useful and efficient way to categorise and present the data, and we command the authors for this structure. Nonetheless, even if multiple authors wrote different sections, we encourage the authors to ensure each section addresses all the information listed below, and we can suggest this type of format: (for example, we thought section 3.3. was particularly well written and structured)

1. Describe why this parameter was measured and what it will (or could) be used for in the future.

2. Describe the instrument operation in detail (ESSD serves as supplementary information, so every detail for operation should be included).

3. Comment on why the instrument was chosen over other alternatives or models.

4. Describe how the data was collected and, when applicable, processed

5. Show the data in figures/tables.

6. End each section by relating which goal is being addressed (from the list in pages 5-6, which can be numbered in order to refer to easily)

7. Avoid data interpretation, as required by the ESSD format. Note that some sections have added data interpretation (ex: 4.2.4) which should be removed.

To further help with the readability of the manuscript, a table of contents would be really useful as a reference for the future reader.

Furthermore, the authors describe instruments which were taken onboard, but which didn't collect data due to malfunctions or errors. The goal in relating this instrument information can be to further instruct scientists of lessons learned, and we think these instrument descriptions are worthwhile additions to the manuscript. However, we suggest that comments faulting inexperienced controllers should be omitted (in the spirit of sportsmanship) (for example lines 196-197). We also suggest to the authors to group "unused" instrumentation to a separate section called "lessons learned" or more objectively, "instrument malfunctions". Nevertheless, we appreciated the transparency offered by the authors of the instrumentation malfunctions. We wondered whether the authors may have one or two suggestions to add to these sections in order for future readers to be better prepared for their own voyage (Figure 18 - is it useful if the data will not be used? Perhaps not worth plotting?)

Specific manuscript comments:

Line 4: Could the authors comment on the direction of the "persistent biases"? An

added qualification such as bias low or high would be more precise.

Line 8: According to the Earth System Science Data manuscript preparation and file submission: Ship names are italic, but their prefixes are roman (e.g. RV Polarstern).

Line 52. Reference format is different from the rest of the paper and should be double checked.

Line 77-78 Which cruise was the first to probe OCS concentrations and sources? Could the authors add the reference? Or indicate it in the table 1?

Table 1: Very useful for context and for future readers and data users! The authors could also add their own ship campaign at the bottom of the table with a "this work" reference.

Line 86. Could the authors briefly explain their motivation for spending most of the voyage's time (30 days) south of 60°S? Does 60°S represent a reference point for some measurements for example?

Lines 92-93. The authors mention the characterisation of radiation but list only the lidar, ceilometer and sky cameras. How was this parameter measured? Wasn't there a radiometer or pyranometer on board which should be added to this list?

Lines 92-101. The authors mention seven research objectives (line 88) but only list six (92-101). Is there a goal missing? In addition, was there a priority within these goals?

Lines 92-101: Give each goal a number to refer to these goals in each instrument section throughout the manuscript.

Table 2: Can the authors ensure that all the items in the column "location on the ship" in Table 2 are also written in Figure 3? For example, where is the fantail located?

Line 117. How did the authors correct the wind speed according to the ship heading and speed? Also with (Popinet et al., 2004)? Please clarify and/or refer to the appropriate section.

Line 166. Wind speed accuracy is stated as 5%. Can the authors comment on whether this accuracy is typical for this instrument? What was the wind direction accuracy?

Line 180-185. The authors' UAV's battery was drastically reduced due to low atmospheric temperatures. Which UAV model was used, which battery?

Section 3.3 – Particularly well written and structured section (see our comment on general flow and structure at the beginning of this review).

Line 221. "The maximum range is 30km but the effective range was lower than that". Can the authors specific the effective range?

Line 273: Can the authors link the use of the sky camera to one of their objectives?

Line 280. Is the technique HDR? Mertens 2009 explicitly proposed exposure fusion as an alternative to HDR to produce a highâĂŘquality, low dynamic range image. Did they authors use the correct reference here?

Line 282. The ELIFAN algorithm crops the sky pictures to remove the distortion before estimating cloud fraction. Did the authors remove the distortion of the allskypi pictures? What was the field of view of the fisheye lens? Could the authors comment on the cloud cover uncertainty (for example in Figure 7)?

Line 291: Can the authors specify how rare clear-sky conditions were on their voyage? If the authors' goals were to study aerosol-cloud interactions, could the authors briefly comment on the value of the sun photometer measurement?

Line 459: In section 3.10.1 title, the word chromatograth is misspelled.

Line 552. How was the % of cloud types calculated? Was this calculation performed by human observations, sky camera pictures and the ceilometer? Did the authors use an automatic algorithm to derive cloud types? Additional information would be useful to understand the data presented.

Section 4.2.4 (lines 673-693) has too much interpretation (not in the realm of ESSD's

scope) and can be rewritten to specify the sample collection details, the operating procedure of the instrument, why this instrument was chosen and the data collected. The data collected should include the frozen fractions as well as the INP concentrations.

Comments on Figures:

During the discussion of this manuscript as a group, we gathered images of each instrument and found this process to be very helpful in visualizing the instruments. We can recommend to the authors to do the same, by adding pictures for each instrument to each section. (The authors can also contact us for these pictures (bord-uas@chem.ubc.ca and aragon@gamma.ttk.pte.hu , as we've gathered them already for our discussion.)

Figure 2: The figure design can be improved for clarity by identifying the level of data analysis (raw vs calculated). The boxes can also be aligned for a cleaner figure.

Figure 3: Do the authors want to further describe the aerosol container lab? Or alternatively show a picture of the inside? The ship's exhaust should be highlighted as it is a big part of the discussion and of the data interpretation. The authors could also add a real picture of the ship (we had to google for a picture) for improved visualization.

Figure 5: Along the left panel, the mean values can be added for clarity and readability. The numbering can be rethought, for example labels (b, d, f, h, i, l) could be removed.

Figure 6: This data is useful to highlight how the tropopause is shallower closer to the pole. With that point in mind, could the authors arrange the panels as a function of latitude instead of as a function of time of the voyage?

Figure 8: Can the authors add the number of points included in each boxplot? Can the authors also specify the values of the whiskers? We weren't sure where the 0.86 coefficient for the atmospheric transmission coefficient came from; could the authors add a description and a reference? Finally, how do the authors explain values above one?

Figure 9: We struggled to understand this figure and perhaps it can be made clearer. What are the bins representing? Could they be better depicted as a histogram/bar graph? Could the percentage and cumulative occurrences be displayed on two graphs? The x-axis at the top and bottom of the plot for percentage is different, maybe color coding the axis labels to the plot line could help. One of the plot lines doesn't show up in the legend.

Figure 11. It would be worth adding a title to each plot to clarify the graph. The letter a of the plot a) has a smaller size than the other ones and Y-axis titles aren't aligned well. The colour bars should avoid white, otherwise the information cannot be seen (particularly true for the vertical velocity plot (b)).

Figure 12: Small note that there is a blue dot on at x=0 value. Could the authors double check? Can the authors comment on how realistic a value of 520ppm of CO2 from an exhaust is?

Figure 13: Could the authors remove the graph lines to help clarity?

Figure 14. In the figure caption, the figures should be labelled a, b, c, d and e. We can also recommend to the authors to add the name of each instrument along each panel for better readability. We recommend plotting the CCN data on a separate graph.

Figure 15: We appreciated this figure to visualise the merger of the datasets on particle diameters and numbers. Thank you!

Figure 17: Nice!

Figure 21: It would be useful to have titles on the plots themselves.

Figure 22: This figure contains a lot of information and additional panels would help the clarity of this data.

Dataset and code availability comments

We recommend to the authors to add photographs of each one of their instruments for

improved visualization of the equipment used in this voyage.

Weather_obs_level_0 → What are the codes of weather types (1-4)?

The automatic weather station data appear to be complete and all information is available.

Line 299. Why is the sun photometer data only found in the Maritime Aerosol Network? Is it possible to add it to the authors' Zenodo data set too?

Line 780. ALCF tool was downloaded, checked and confirmed after communication with one of the authors, Peter Kuma. The script now worked well. Thank you for sharing this resource!

Line 783. The authors provide the website for COARE gas exchange algorithm but in Table A1 in the "das" Data Acquisition System ReadMe_file the authors also provide the Matlab script to calculate fluxes. It might be worth mentioning this script in the Code Availability.

We would also encourage the authors to explore the possibility of providing their data as an open API through https://developers.zenodo.org/

We end this review by once again commanding the authors and scientists for their hard work and effort in gathering this dataset. We wish the authors all the best with their future data analyses and with addressing their scientific research goals.

Interactive comment on Earth Syst. Sci. Data Discuss., https://doi.org/10.5194/essd-2020-321, 2020.