Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2017-590-RC1, 2017

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Size distribution and ionic composition of marine summer aerosol at the continental Antarctic site Kohnen" *by* Rolf Weller et al.

Anonymous Referee #2

Received and published: 20 November 2017

General comments:

The authors investigated the impact of different weather situations on the physical and chemical properties of the aerosols using measurements of aerosol number concentration, size distribution and size segregated aerosol sampling. They conclude that the marine aerosol is mostly transported and deposited through long-range transport during clear sky conditions. In addition, they report observation of formation and subsequent growth of aerosol particles traceable for 4-5 days and up to around 40-50 nm in size. This study is of particular interest for two reasons: i) papers comparing aerosols to larger scale meteorology in Antarctica are scarce and ii) this is the first

paper showing results of aerosol measurements from Kohnen. While this paper gives more insight into the aerosol processes in the Antarctica, at present it is lacking i) a better comparison to already existing papers, ii) more complete comparison to data from Neumayer and iii) throughout discussion and explanation of the NPF events observed during 17.-19.1.2015. These major issues need to be addressed before the publication in ACP. With these inclusions, this manuscript will be an important addition to the papers describing the aerosol chemical and physical properties and transport to Antarctica. Also, I am concerned about the coherency of the paper – binding the chapters (and maybe reconsidering their order and adding some new ones suggested in the specific comments) better together would make this manuscript more readable. Finally, and partly linked with the previous issue, the results, discussion and conclusions seem quite separate from each other. The authors need to find a way to build a story that is easier to follow and stress the importance of their findings.

Specific comments:

1. At page 3 in the last paragraph you refer to the summer concentration peak of biogenic sulphur aerosol but don't give an explanation. Please, add a short explanation for the clarity.

2. In chapter 2.2.3 you explain how you tried to validate the consistency of the HYSPLIT trajectories. Your second approach – varying the starting height between 10 and 100 m is not to my understanding very good approach due to the limited vertical representation of the model in such a small scale (at which height is Kohnen? And how well is the topography represented in HYSPLIT? The difference between 10 and 100 m might just not be visible at all in the model). Rather, use heights e.g. 100 m, 250 m, 500 m. However, HYSPLIT offers two easy, physically more justified ways to check the accuracy of the trajectories: ensemble and matrix trajectories. Due to the small number of days you could easily run those or one of the options to see whether there are discrepancies in the trajectory paths or not. Also, show somehow (give comparison values, example figure or so) how does the GDAS data differ from the isentropic

approximation?

3. Please include time labels (by 6 or 12 hours, or e.g. bigger labels by 12 hours and smaller by 6 hours) into your trajectories e.g. in Fig. 13A, S6A and S7A.

4. The authors are now mainly comparing their data with the meteorological conditions and to previous publications. It would be beneficial if you would include a small chapter of more throughout comparison of the aerosol chemical + physical composition between the different years (2015 and 2016). This is done already partly for the chemical composition but please, give some overall median / mean physical parameters for both years as well (e.g. particle number concentration, aerosol chemistry, ...). You could make a comparison table including both the chemical and physical properties (e.g. for 2015 and 2016 overall and 2015 and 2016 LPS separately).

5. The second last paragraph of 4.1.1 is not easy to understand. Please, clarify.

6. The last paragraph in chapter 4.1.1 deals with comparison to Neumayer. This part is very important part, yet it is only 6 rows of text. You should do a more throughout comparison since the instrumentation in both Kohnen and Neumayer is very similar and one of the stations is much closer to the sea (N) while the other is further up on the continent (K). Please, extend your comparison as much as you can and also discuss on the meaning of the findings. How does the data from Neumayer support your conclusions?

7. In section 4.1.2, page 9, 1st paragraph, I think that the 20 hours needed for the particle growth is a slight overestimation or at least an upper limit. First of all, from the figure it seems that the NPF started at 10 nm or at lower sizes (if you look at the smallest observable size). Assuming that the particles would have reached e.g. 2 nm at the formation site (–> 10-2 = 8 nm of growth with advection), and assuming constant 8 m/s wind speed (from Figure 3), the time needed for the growth would be about 13 hours and the distance to the onset of formation less than 400 km. If the particle growth was even faster in the beginning (the authors note that organic vapors are needed to

explain the growth) and the particles would reach already 5 nm at the formation site, these values would reduce to 8.3 hours and 240 km. In either case, the formation must have taken place above the continent. Although it is important to compare the studies also to those made at the Antarctic plateau (the next paragraph), it would be needed to compare the results first to other Antarctic summer studies closer to the sea ice since the NPF and growth reported in this study compares better to those (see above and also those already included into the manuscript) and the airmasses according to the trajectories are not originated from the plateau.

8. The authors responded to the earlier comments that they included more references to the manuscript. I am however, concerned still about the discussion part of the manuscript and the references. They have referred very well to different studies of size segregated aerosol samplings around Antarctica but lack many major studies of aerosol physical properties close to Kohnen. Currently there are already quite a number of papers published from different stations around Dronning Maud Land (DML), close or further away from the coastline, under different meteorological conditions and in both marine or continental airmasses. All those papers draw their own part of the picture in the Antarctic aerosol. How do the authors of this manuscript relate their work and findings to the other papers? Below are listed few (not yet included) studies that this study could be compared with:

-Virkkula et al., JGR, 2006, doi:10.1029/2004JD004958 (Chemical aerosol NSD, Atlantic Ocean, Southern Ocean and Dronning Maud Land)

-Virkkula et al., Boreal Environ. Res., 2007, (PSD and NPF at Dronning Maud Land)

-Asmi et al., ACP, 2010, doi:10.5194/acp-10-4253-2010 (Aerosol hygroscopicity, chemical composition and NPF at Dronning Maud Land)

-Pant et al., JGR, 2010, http://dx.doi.org/10.1029/2009JD013481 (Aerosols during passage of cyclonic storms at Maitri)

-Yu and Luo, Atmosphere, 2010, doi:10.3390/atmos1010034 (Modelling study and comparisons to measurements, oceanic DMS and NPF around coastal Antarctica)

-Kyrö et al. ACP, 2013, doi:10.5194/acp-13-3527-2013 (NPF from continental biogenic precursors at Dronning Maud Land)

-Fiebig et al., ACP, 2014, doi:10.5194/acp-14-3083-2014 (Antarctic aerosol annual cycle at Dronning Maud Land)

-Chen et al., ACP, 2017, doi.org/10.5194/acp-17-13783-2017 (Air ion measurements at Dome C, including NPF event analysis, not from DML but since the authors compare their studies with an earlier paper from this station, this is included also)

9. Continuing the previous comment, Kyrö et al., 2013 presented very strong new particle formation events from Aboa, Dronning Maud Land (DML) and conclued that those events were associated with meltwater over the nunataks. Your trajectories during the NPF seem to come from the same direction as where they located the formation events to take place in NPF events that grew over several hours and it seems that some of the events they saw appeared during low pressure as well. Can you comment on this, how does your study compare with theirs? Also, the sulphuric acid concentration needed to explain the growth (1.4x10ˆ7) compares surprisingly well to those concentrations reported in their study. I suggest that the authors read this study and comment on whether it is possible that the NPF observed at Kohnen is similar to what was reported by Kyrö et al.

10. From Figure 7 it looks like instead of one, you have observed 3 NPF events during consecutive days and every time there's first some local NPF during noon which disappears after couple of hours and then a new mode appears at around 10 nm at midnight. This is extremely interesting yet the authors don't seem to have fully noticed this or they are not discussing about this (the observation of two – not three – local NPF events is reported in chapter 3.2 but the discussion is completely missing). Please, explain this observation. And for the clarity it would be good if instead of Fig. 7 you have one figure

of particle NSD 17-21.1. so that the fine features of the SD evolution described above would be seen better, and one figure showing how the contamination at the station looks like (not needed). Also, your log-scale in the color code is not very clear. Instead of 0, 1, 2,. . . you could have 10ˆ0 or 1, 10ˆ1 or 10, 10ˆ2 or 100 and so on.

11. Furthermore, calculate GR, J3, J10, CS and CoagS for all of the 3 local (J3) and regional (J10) events.

12. How does the evolution of the aerosol size segregated chemistry during NPF event and subsequent growth support your conclusions?

13. It would be better if you combine figures 11 and S5 so that you have the medians for both 2015 and 2016 with very thick lines (e.g. 2015 with solid and 2016 with dashed lines) and then with thin solid and dashed lines with different colors the individual measurements. This way one would see the difference between the years easier; it is not very easy to compare the values or two figures when they are in different files. The days with particular interest (LPS) you could have with slightly thicker lines to stand out.

14. Please check the English in your manuscript – there are some inconsistencies or wrong words that change the meaning of the sentence completely (see detailed comments in "Technical corrections" –chapter) .

15. Finally, I think your manuscript is lacking a "storyline" – currently it is a set of chapters and paragraphs of results and discussion after each other but please, think how to glue and fit them together to make it an attractive story. Since your manuscript is rather short, you could consider combining the Results and Discussion sections together to make it more fluent to read. Please, stress the importance of your findings more. Right now the discussion is mostly concentrated on comparing to previous studies and it is not clearly stated what new your results bring to the understanding of the Antarctic atmosphere.

Technical corrections:

Page 1, Row 10: ”an outstanding low pressure system” – as per Oxford English dictionary, oustanding means either ”exceptionally good” or ”not yet resolved”. Neither of these meanings fit very well to a low pressure system. How about changing it to remarkable / striking / notable / exceptional?

Page 1, Row 21: ”aerosol characterized by an usually mono-modal. . .” Do you mean ”by unusually mono-modal. . .” or ”by usually mono-modal. . .”

Page 2, Row 7: ”under predict” to ”underpredict”

Page 2, Row 13: Your reference to Raes et al., 2000 is already rather old. Consider adding also more references.

Page 4, Row 23: ”all up” do you mean ”in total”?

Page 4, Row 27: ”we have to”, is in present tense while your previous sentence is in imperfect. Change to ”we had to”

Page 6, Row 17: “provoked by local combustion were” –> “provoked by local combustion are”

Page 7, Row 9: “outstanding Na+”, consider changing to “exceptionally high Na+”. Also, again in Page 7, Row 17, some other word would fit better than “outstanding”.

Page 7, Row 33: Difficult sentence. Change to e.g. “In Dronning Maud Land, cyclone driven marine air intrusions are infrequent, sporadic events that are often associated with high-precipitation rates (refs)”.

Page 8, Row 22: as well as –> and; short stormy period –> a short stormy period

Page 8, Row 30: Verisimilar –> Very similar

Page 8, Row 38: “weather situation had influenced transport of marine aerosol. . .” –> “weather situation transported marine aerosol. . .”

Page 9, Row 10: “magnitude to high” to “magnitude too high”

Page 11, Row 5: Condition written two times; “clear sky condition conditions” –> “clear sky condition”

Page 11, Row 13: “understand the role biogenic aerosol. . .” –> “understand the role of biogenic aerosol. . .”

Interactive comment on Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2017-590, 2017.