M. T. Könemann (Referee #2)

For clarity, the referee's comments are copied in black and our responses are offset in blue.

Synopsis (Crawford et al.)

-Accept, minor revision-

The manuscript by Crawford et al. entitled "Real Time Detection of Airborne Bioparticles in Antarctica" presents the results of short-term measurements with a Wideband Integrated Bioaerosol Sensor (WIBS, Model 3D) at the Halley Base Clean Air Sector Laboratory (CASLab) during Antarctic Summer in 2015. Data were collected within a three-week period and subsequently analysed using a proven pre-processing- and data clustering approach specified in Crawford et al., 2015, 2016. Additionally, geospatial and meteorological analyses were performed for back- and source-tracking of potential primary biological aerosol particles (PBAPs) and non-biological particles like dust. The authors state the following major findings:

I. On average, fluorescent particles comprise 1.9 % out of the total aerosol concentration (in a size range between 0.8 and 20 µm).

II. Two clusters were classified as dust particles (Cl3) and pollen (Cl4). Cluster Cl1 and Cl2 remain unclassified.

III. For some events, the fluorescent particle concentration seems to be strongly correlated to wind speed and/or wind direction.

IV. Pollen may undergo long-range transport from the coast of Southern America.

Even if commercially available instruments for laser/light-induced fluorescence detection (e.g. WIBS, UV-APS) are commonly used in the bioaerosol community for over 10 years, assessment of physical and technical instrument properties, data analyses and interpretation are still quite challenging. The current manuscript is well written and represents a useful data set out of a unique environment and, therefore, contributes an additional "piece in the puzzle" for a better understanding of aerosol dynamics and data analyses in the future. However, I have some comments/suggestions regarding data acquisition and interpretation which I will explain in detail in the following sections.

We thank the reviewer for their helpful comments and recommendations which we address below.

Specific Comments:

I. Short-term measurements with a single instrument in a complex environment with rather unknown atmospheric Dynamics As stated above, the use of LIF instruments is highly challenging and we're currently not even able to clearly explain (bio)aerosol dynamics in environmental systems right on our own doorstep. Especially therefore, measurements over a duration of roughly one month in Antarctica, with it's very low particle concentrations, will most likely lack statistical relevance to some extent. Additionally, only a single instrument was used for data acquisition without a point of reference in the form of other on- (e.g. an Optical Particle Sizer, OPS) or off-line (e.g. impactor) techniques to countercheck derived data from the WIBS-3D to i.) verify data accuracy and ii.) support results out of the cluster classification approach. Even if the authors refer to measurements with the same device prior to the campaign in Antarctica (page 15, line 24), the reader has to "trust" the measurement accuracy of the WIBS-3D used in this study. A simple, e.g., glass slide impactor for some quick microscopic analyses would have had improved the overall quality, especially by supporting cluster classifications.

> This was an opportunistic pilot study in the region to assess the utility of the technique as part of a larger airborne experimental campaign which had very different scientific goals and objectives (Microphysics of Antarctic Clouds, MAC). As such, while other online aerosol instrumentation was running at the site, they were configured to detect nucleation burst events at much smaller sizes to support the cloud microphysics measurements. We agree that glass slide/impactor samples would have been of great benefit to the analysis and filter samples were taken during airborne operations from 01/12/15 onwards, however, no such samples were taken during wind event A where the majority of PBAP/pollen was observed.

II. Wind speed and inlet kinetics

Wind speeds on site ranging from 8.62 to 14.12 ms-1 (table 2, page 8). At such high rates, inlet kinetics becomes serious business. However, the flow rate of the bypass used (flow fan) is not stated, which becomes a critical factor for concentration- and size cutoffs. In general, the whole inlet system may need to be described a bit more in detail (e.g. was a diffusion or Nafion dryer used in between?). To me, figure 4, page 10 serves as an indicator for a potential sampling cutoff, where particle concentrations are decreasing above ∼ 14 ms-1. Therefore, it seems to me that the flow rate of the bypass was too low to force particles onto a bow-trajectory at such high wind speeds. Long story short: I think that particles at such wind speeds just flew over the inlet horizontally, not reaching the WIBS.

> We thank the referee for their useful comments. We will include more detail on the sampling arrangement used and we will include a short discussion on the potential for reduced sampling efficiencies at high wind speeds in the revised manuscript.

III. Wind speed and snow/ice Crystals

Temperatures mostly below zero and high wind speed rates lead me to the thought in how far ice crystals from local sources may contribute to the measured data set. To me, it seems to be reasonable that, at least, a minor portion of particle concentrations counted, may be ice crystals. Furthermore, crystal structures on particle surfaces may also affect the asymmetry factor (and also sizing) by changing light scattering patterns detected by the Quad-PMT. However, the occurrence of ice crystals depends on the overall inlet system which needs, as stated above, a more detailed description.

> While the aerosol inlet stack is not heated, CASLab is heated to a regular room temperature (~20 to 25 °C), thus we feel it is unlikely that an ice particle would make it to the sensing region of the instrument without melting or evaporating in the sample line between the inlet stack and the instrument. Furthermore the majority of the air sampled by the WIBS is used as a filtered sheath flow which has a longer residence time in the instrument, effectively heating and drying the air, which would further act to melt/evaporate any ice crystals before they could be detected. As such we believe the influence of ice crystals on the measurements to be negligible.

IV. Vessels as potential emission sources

Even if the marine traffic in this particular area is considered to be rather low, vessels as a potential particle emission source has to be kept in mind though. Attached is a link showing a traffic density map from 2015 (Click on density map button on left):

https://www.marinetraffic.com/en/ais/home/centerx:-59.2/centery:-64.6/zoom:4

As you can see in here, there is a main traffic route in NW direction including mostly tankers, cargo- and fishing vessels. Compared to the back-trajectory analyses in figure 7 (page 14), all wind events (except for E) crossed or brushed the main traffic route for which I think that it has to be considered as a potential emission source to some extent.

> We thank the referee for the useful suggestion and we will include a short discussion of marine vessels as a potential source in the revised manuscript.

V. Geospatial analyses

The data processing of figure 6 (page 12) is unclear to me and needs some further explanation. How were the land class types in combination with back-trajectories processed? Was the trajectory length used? Or was the trajectory "footprint" put onto a, e.g., raster map and blanked out?

> The method to determine time spent over each land class followed three procedural steps:
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> 1) The land class types were obtained from the sea ice fractional coverage (at 25 km resolution) maps, obtained from the product *Near-Real-Time DMSP SSMIS Daily Polar Gridded Sea Ice Concentrations* (Maslanik, J. and J. Stroeve. 1999), Available from the National Snow and Ice Data Center. In this dataset, sea ice, and land (continent/coast) was marked. Open water was deduced from areas where sea ice <5%. In practice this upper limit could be set to 1% or 10% without impacting the conclusions.
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> 2) Back trajectory analysis performed using HYSPLIT (Stein et al., 2015); five-day back trajectories (one hour time step) were calculated using the National Centers for Environmental Prediction (NCEP) reanalysis meteorological field. (Stein et al., 2015).
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> 3) At each time-step (hour) we determine the type of land for the lat/lon point of the back trajectory. We do this for all (hourly) back trajectories. Then the ratio of the occurrences of lat/lon over each type of land divided by the total number of points is derived for the last 12h, 48, 72h, etc.

Technical corrections: Single trajectory plots in figure 7 (page 14) need captions for better allocation.

> We include text in each plot describing the period/wind event it covers to improve clarity in the revised manuscript.

Final comment: The current manuscript provides an interesting data set and will be useful for the whole bioaerosol community and should, therefore, be published. However, the authors need to state the general "case study-nature" of the manuscript more clearly and discuss effects and potential interferences which might occur in this complex environment (e.g. snow and ice, vessels) more detailed. Furthermore, the inlet system used in this study needs some further description.

> We will reiterate the case study nature of the work presented in the final paragraph of the manuscript and we will suggest that further long term studies with accompanying supporting measurements are needed to build up a climatology of bioaerosol events. The other suggestions are dealt with in previous responses to this review.

References

Maslanik, J., and J. C. Stroeve (1999), Near-Real-Time DMSP SSMIS Daily Polar Gridded Sea Ice Concentrations, Version 1 [December 2015–January 2016]. Boulder, Colo.: NASA DAAC at the Natl. Snow and Ice Data Cent., doi:10.5067/u8c09dwvx9lm.

Stein, A. F., Draxler, R. R., Rolph, G. D., Stunder, B. J. B., Cohen,M. D., and Ngan, F.: NOAA's HYSPLIT atmospheric transport and dispersion modeling system, B. Am. Meteorol. Soc., 2015, 2059–2077, doi:10.1175/BAMS-D-14-00110.1, 2015