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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Real Time Detection of Airborne Bioparticles in Antarctica" *by* Ian Crawford et al.

Anonymous Referee #3

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This manuscript presents measurements of fluorescent aerosol made in Antarctica over a period of weeks using a WIBS. Although the authors find that fluorescent particles are a minor component (a few %) of total aerosol, there are some interesting features in the data worthy of publication. WIBS data is analyzed using a clustering method previously published by this group and 4 component populations are identified. Two of these clusters (together accounting for >97% of the fluorescent aerosol) are only weakly fluorescent and are hypothesized to be non-biological fluorescent aerosol, possibly dust. The other two clusters have more fluorescent intensity, are hypothesized to be biological and one of these is very similar to a cluster identified from laboratory samples of various pollen. Fluorescent loadings are analyzed as a function of wind speed for specific periods of interest and the authors state that high levels of fluores-

cent aerosols were primarily (though not always) associated with flow from the NE. Back trajectories are also analyzed and the authors posit that fluorescent aerosol (and thus pollen) arrives at the site as a result of long range transport from as far away as South America.

Comments:

This paper presents the first fluorescent aerosol observations reported for Antarctica and, as such, it is a worthy contribution to the literature. However I found portions confusing and also recommend including more information in certain places. Much of my discomfort arises from the fact that the 5 periods of interest seem rather arbitrary, at least given the information presented. As such, I don't know how to interpret observed differences between these periods or what they mean for fluorescent aerosol in Antarctica more generally. Specific suggestions for improvement are included below.

1. With any discussion of intensity of fluorescent signals the question of calibration arises. I appreciate that there is, as yet, no widely-accepted calibration for fluorescence in the WIBS and it seems that this instrument has been used in numerous laboratory and field studies without significant intentional modification. There is some discussion of this in the discussion of pollen identification (i.e. that the same instrument was used to look at pollen samples and they look very similar in intensity to Cl4) however it would be appropriate to include a more thorough related discussion in the methods section. Do the authors have any information regarding the stability of fluorescent intensity measurements over time? Are the instrument gains used here the same as those used in previously published work from this group? Can you comment on whether or how changes or instability in fluorescent sensitivity would affect the clustering algorithm? Can the authors comment on what kinds of laboratory-generated particles they have observed to fall into the weakly, moderately, medium and highly fluorescent populations? Those categories seem arbitrary and are used only minimally in the subsequent analysis.

2. On a related note, it would be good to include the numbers of particles sampled that fell in each cluster and also the number of particles that saturated the detector. Do the detectors for this WIBS saturate around 2000 counts? If so, given that the stated average intensity in the pollen population is ∼1800+/-300 after exclusion of saturating particles, it seems that a substantial fraction of pollen particles would saturate and you might be underestimating the contribution of that population.

3. A relatively minor point but, in your discussion of asymmetry factor, I believe dust is typically quite fractal (e.g. Bi, Huang et al, ACP 2016 or Yu, Zhu, et al, ACP 2015) yet your dust cluster AF indicates relatively sphere-like. Can the authors provide information to bolster confidence in the retrieved AF from the WIBS? (i.e. any data from calibrations with known aspherical particles or any corroborating reports of relatively spherical dust?)

4. I am confused by the discussion surrounding the wind events. First, the authors define a level above which they consider fluorescent concentrations elevated and imply that they are going to look at periods where that happened. Then, however, two of the five periods in table 2 don't have elevated fluorescent concentrations (the 2nd and the 4th) while there are periods that seem to have elevated fluorescent concentrations that are not included in the analysis (i.e. early on in the project and on 11/29). Is the selection driven mainly by wind speed and direction? Why include the 5th period and not periods from 20-21 and 29 Nov? Are these just meant to be case studies of the different combinations of wind and aerosol loadings observed? Please clarify how these 5 periods of interest were chosen. It would also be helpful if these periods were marked in Figure 2 so that the reader doesn't have to mentally combine the table and the figure.

5. In the text, the authors state that high levels of fluorescent aerosols were primarily associated with flow from the NE but I don't think this statement is supported by the data presented. To me it seems that there was one period of fluorescent enhancement from the NE and one from the W. There are possibly even two instances of high

loadings with westerly flow if you consider the noisy but relatively elevated concentrations at the beginning of the project in addition to what was seen in the 5th highlighted period. Other instances of flow from either direction don't necessarily bring elevated concentrations and I don't know what the explanation is for this behavior but I don't think it's as clean as currently presented.

6. The authors also state that they see enhancements in the ratio of fluorescent to total aerosol at particular times. It is nearly impossible to assess this ratio from the graph presented. I recommend adding a panel or a figure to show a time series of the fluorescent fraction, possibly showing two traces where one shows the "dust-like" fluorescent fraction and one shows the PBAP fluorescent fraction. 7. I don't fully understand Figure 3. Was this made from the average of all periods when the wind was from the NE and, if so, how was this average calculated? How is it that the plot for total fluorescent particles has a component in the SW quadrant but the other two do not? In panel b, it is labeled as dust but also as Cl1. I thought dust was Cl3 and Cl1 was unclassified. Either way, why show the plot for one but not the other? 8. In the caption of Fig 4 it is stated that these plots are only for the NE wind event with the highest fluorescent loadings however the text on lines 1-3 of the same page implies that it is for all of the selected events. Please make these consistent. If the graphs are really only for a single event, it would be interesting to know whether similar behavior was observed during other periods. What does it look like if similar graphs are made for the westerly event that had relatively high fluorescent loadings?

9. I am not well-versed in calculations of flux, and I cannot speak to the validity of the method used here. In any case, I don't really see the point of calculating a flux under the present circumstances. If the elevated concentrations are episodic and not systematically associated with a particular flow direction or meteorological context, then it doesn't seem that this is likely to represent flux from sea ice or the ocean or any other dispersed source but, rather, will represent flux from a particular but unidentified bioaerosol source at an unknown location and I don't see the utility. Flux from the local

environment might be better assessed by looking at wind events without elevated fluorescent concentrations but, again, I don't know enough about flux to know if this would be robust or even possible.

10. With regard to the airmass trajectory analysis, it would be nice to see maps for all of the events discussed. Was event A the only time that flow arrived from S. America or was there a time with similar back trajectories but little fluorescent aerosol enhancement?

11. As stated above, much of my discomfort with this paper arises from the fact that so much of the discussion centers on analysis of 5 events (and of those 5, only one or two get much attention) and the selection of these events is unclear to me. It is therefore difficult to develop a sense for how representative they might be, how to interpret the variability between them or what they mean in a larger context. The text is often written as though systematic relationships have been found which I find a bit misleading given that the study duration was relatively short and these "relationships" are extrapolated from single events. I recommend rephrasing these statements and revisiting the data analysis to more clearly delineate the observations themselves, the generalizations made based on the observations and the limitations to these generalizations imposed by the short duration of the study and the episodic nature of the environment.

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