Atmos. Chem. Phys. Discuss., 15, C8313–C8319, 2015
www.atmos-chem-phys-discuss.net/15/C8313/2015/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Observations of fluorescent aerosol–cloud interactions in the free troposphere at the Sphinx high Alpine research station, Jungfraujoch" *by* I. Crawford et al.

Anonymous Referee #1

Received and published: 21 October 2015

Summary: The manuscript by Crawford et al. (2015) presents results from 12 days of fluorescent aerosol measurement during winter time at the Jungfraujoch, Switzerland, an observatory at 3580 m altitude. Measurements were conducted with the wide-band integrated bioaerosol spectrometer (WIBS-4). A recently introduced cluster algorithm (Crawford et al. 2015) was applied for the statistical analysis of fluorescent particles. The analysis revealed that almost all fluorescent particles measured were mineral dust and only a minority of biological origin. Based on the low number concentration of primary biological aerosol particles (PBAP) observed in this study, a maximum ice active fraction of 0.5% at -9.7°C reported by Mohler et al. (2008) for a common bacterial

strain, Pseudomonas syringae, and the several order of magnitude larger ice crystal concentrations observed at Jungfraujoch, it is concluded that PBAP do not significantly contribute to ice crystal concentrations at this site during winter time.

The paper is significant in that there are currently only few observations of biological aerosol particles and cloud interactions during winter time and it represents an additional application of the new clustering algorithm introduced by Crawford et al. (2015). However, the current manuscript shows several deficiencies. The discussion of the observations, their uncertainty and shortcoming, and the implication of the results are often kept at a minimum. There are several incidents were related work is not cited sufficiently and assumptions being made without discussion of their validity. The general structure of the manuscript is good, however, long sentences make it hard for the reader to follow. Overall, the manuscript gives the impression that the authors did not invest much effort in preparing it. This is a pity because the measurements and results themselves would certainly be of interest to the readers of ACP.

Therefore, I only suggest publication of the manuscript in ACP if major revisions are undertaken and the following remarks are taken into consideration.

General remarks:

The title stresses that the measurements were conducted and are representative for free tropospheric conditions. However, the manuscript completely lacks a confirmation and discussion of this truly being the case. The rather old publication (Baltensperger et al. 1998) which is given as reference already states that “during winter the site represents the free troposphere most of the time”, but not all the time, as the current manuscript suggests. A recent study by Herrmann et al. (2015) showed that this is the case “over 60 % in January”. I advise the authors to be more careful with the claim of measuring in the free troposphere and investigate if this is applicable for their measurement period.

The manuscript claims to have measured a representative time period of the typical

ACPD
15, C8313–C8319, 2015

background aerosol concentrations at the Jungfraujoch during wintertime. Which indicators have been used to support this claim? Has a comparison been done to long term measurements at the same site during winter time using other instrumentation? Considering the short measurement period of only 12 days and the rather uniform origin of air masses from over the Atlantic ocean, as mentioned in the manuscript, the representativeness of the measurements for "typical background aerosol concentrations" are questionable. Supportive data needs to be presented in the manuscript. How does the statement in the introduction "even modest concentrations of primary ice can result in the rapid glaciation and subsequently cause precipitation. . ." and the conclusions at the end of Section 4, "such low concentrations of PBAP are unlikely to have any significant impact on cloud evolution through ice nucleation (. . .) IN concentrations of only 5x10-4 L-1"? This can only go together if you clearly define "modest" and give typical number concentrations of ice nuclei found to impact cloud evolution.

In the part about the cluster analysis and its interpretation it is almost impossible for the reader to follow as the cluster algorithm is not described nor are details given about the interpretation of the fluorescence analysis. What are physical differences between particles in cluster 1 and 2? How likely is it that cluster 3 is representative for Pseudomonas syringae?

A general technical comment: It is not specified if the presented concentrations are given at local conditions or if they have been normalized to standard temperature and pressure conditions. The latter would be recommended. Please clarify.

Specific remarks:

p 26068 l25: define "modest", otherwise this appears as a contradiction to your own results

p26069 l8ff: What kind of coatings are you referring to? Not all coating necessarily increase the saturation ratio required for ice nucleation. Please provide citations to studies you are referring to

ACPD
15, C8313–C8319, 2015

p26070 l6: reference to some of these campaigns?

p26071 l8-26: References for the description of the WIBS-4 are completely missing in the paragraph. Please cite them appropriately.

p26072 l11: Please give a brief summary of the agglomerative data processing method you are using in the current manuscript. The reader should be able to understand and follow your method without reading another paper.

p26073 l16: A description of the surrounding of the Jungfraujoch is necessary for readers not being familiar with the local terrain (e.g. Aletsch glacier). Even a topographical map could be added. Figure 3: Indicate the in cloud and out of cloud periods in this figure since you are referring to it when talking about average in cloud and out of cloud Nfl and Ntot

p26074 l4ff: Which role does the total inlet play here? Were differences expected between in cloud and out of cloud cases? Which implication does the observed temperature dependence of the fluorescent aerosol fraction have? Please discuss your results more.

Figure 7: uncertainty bands? Since at large sizes only very few particles are counted, the uncertainty must be much larger than at the small sizes I suspect?

p26074 l16: which meteorological and cloud microphysical parameters have you investigated? Please specify. Have you only looked at these time series or done correlation and more in depth analysis of trends?

p26075 l12-16 It's impossible to compare the clusters since only for cluster 3 number concentrations are given. The correlation with Nfl of cl1 and cl2 shows that most of the fluorescent particles were found in these two clusters, however, a simple number concentration provide more insight.

p26075 l18: This is unclear. "lower" than what? Are you saying you expected lower concentrations than you measured or what you measured is what you expected?

ACPD
15, C8313–C8319, 2015

p26075 l21: This goes back to the major comment about the free troposphere claim: if you have any planetary boundary layer influence at all, pure free tropospheric conditions are not given.

p26075 l27: there are more measurements of biological ice nuclei available than Mohler et al. 2008. Please also consider them

p26076 l7-12: Be careful with such general statements. Your measurement period was very short and if at all can be representative for winter time. This should be clarified here.

Technical remarks:

All figures should be made bigger and the font size needs to be larger. The axis labels are just at the edge to be readable.

The official name of the Jungfraujoch observatory is “High Altitude Research Station Jungfraujoch”: please correct this throughout the paper, especially in the title

p26069 l19: be consistent with the spelling of “Primary Biological Aerosol Particles”: in the abstract it is spelled with lower case

p26069 l19: insert “(PBAP)” after “Primary Biological Aerosol Particles”

p26069 l26: the order of citations is not consistent throughout the manuscript. Sort them consistently either chronologically or alphabetically

p26069 l27: Please make at least two sentences out of this very long one

p26070 l5: replace “Alpine” with “altitude”

p26070 l6: insert “-“ between “cloud” and “aerosol”

p26070 l11: replace “D” with “diameter, Dp”

p26070 l20: replace “Alpine” with “altitude”

ACPD

15, C8313–C8319, 2015

p26070 l20: define “a.s.l.”

p26071 l6-7: order of citations?

p26071 l12: insert “to” before “determine”

p26071 l17: rephrase the sentence. “bands (. . .) are (. . .) recorded” sounds odd.

p26071 l19: replace “2nd” by “second”

p26071 l23: delete “to know”

p26072 l1: delete “,” and insert parentheses around “Gabey et al., 2011”

p26072 l17: delete “measurements of”

p26072 l20: insert “)” after 3V-CPI

p26072 l21f: replace “ e.g. Lawson et al. (2015)” with “(e.g. Lawson et al., 2015)”

p26072 l23-24: repetition. Please rephrase the sentence.

p26072 l29: replace “;” with “and”

p26073 l1: replace “Saharan dust events” with “SDE’s”

Figure 4 and 5: What do the whiskers and horizontal lines denote in the different plots?

Figure 6 and Figure 7: replace the x-axis label “size” with “aerodynamic diameter” if it is the aerodynamic diameter which you are showing

Figure 6: caption and title: be consistent: is it “-15°C $\leq$ T < 10°C” or “-15°C < T $\leq$ 10°C”? This also refers to p26074 l 18.

Figure 6: what do the different line colors for the mean size distribution show? They can all be black

p26074 l 21 replace “Figure” with “Fig.”

ACPD

15, C8313–C8319, 2015

p26075 l5 replace “size” with “diameter”

p26075 l5 insert “(AF)” after “asymmetry factors”

p26075 l17 delete “ of” after “reaching”

p26075 l18: either split the sentence into two or delete the second part of the sentence as this is rather a repetition of the first part. “for very little in the way” sounds colloquial.

p26076 l24: split sentence in two

p26076 l25: insert “emissions from “ after “large”

References: Mohler, O., Georgakopoulos, D. G., Morris, C. E., Benz, S., Ebert, V., Hunsmann, S., Saathoff, H., Schnaiter, M., and Wagner, R.: Heterogeneous ice nucleation activity of bacteria: new laboratory experiments at simulated cloud conditions, Biogeosciences, 5, 1425–1435, 2008; doi: 10.5194/bg-5-1425-2008

Baltensperger, U., Schwikowski, M., Jost, D. T., Nyeki, S., Gaggeler, H. W., and Poulida, O.: Scavenging of atmospheric constituents in mixed phase clouds at the high-alpine site Jungfraujoch part I: Basic concept and aerosol scavenging by clouds, Atmos. Environ., 32, 3975–3983, 1998

Crawford, I., Ruske, S., Topping, D.O. and Gallaher, M.W.: Evaluation of hierarchical agglomerative cluster analysis methods for discrimination of primary biological aerosol, Atmos. Meas. Tech. Discuss., 8, 7303–7333, 2015; doi:10.5194/amtd-8-7303-2015

Herrmann, E., Weingartner, E., Henne, S., Vuilleumier, L., Bukowiecki, N., Steinbacher, M., Conen, F., Collaud Coen, M., Hammer, E., Jurányi, Z., Baltensperger, U. and Gysel, M.: Analysis of long-term aerosol size distribution data from Jungfraujoch with emphasis on free tropospheric conditions, cloud influence, and air mass transport, J. Geophys. Res. Atmos., 120, 2015; doi:10.1002/2015JD023660.

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 26067, 2015.