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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 #2

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General comments: Overall, the work presented in this paper does attempt to address a fundamental question regarding aerosol interactions in the free troposphere and their impact on cloud development. However, I agree with many of the points brought up by Reviewer 1 in that there was a lack of adequate discussion of the results and implications of this work. Additionally, while the data generated in this study is interesting and substantial, there are a few improvements that could be made on the analyses that would help strengthen some of the claims made in the conclusion. I will discuss below the areas that I think could use more attention.

Specific comments: As one of the main points of this paper was to investigate the rela-

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tionship between aerosol particle concentrations and cloud microphysical properties, I suggest that the following be considered and discussed in more detail:

1. Cluster 3 is classified as biological material based on similar fluorescence described in a previous paper (Crawford et. al. 2014). In Crawford et. al. 2014, a more detailed list of airborne bacterial phyla and families as well as a few groups of fungal spores were identified as likely representatives of the fluorescent PBAPs. However, the current paper only discusses the implications of the results under the assumption that cluster 3 represents Pseudomonas syringae (Mohler 2008 and Lloyd 2015). While it is true that the ice-active fraction of P. syringae is low in the environment, is there a possibility that cluster 3 may also represent other ice-active microorganisms found in higher concentrations?

2. The effect of PBAPs on meteorological processes presents an area of research where there are still many uncertainties. As such, the results presented herein on aerosol concentrations in the free troposphere are significantâĂŤhowever the implications of the results are only covered briefly, and would benefit from a more detailed discussion. It's concluded that such low concentrations of PBAPs and their estimated ice-active fraction would have negligible influence on cloud properties, with only two papers (Mohler 2008 and Lloyd 2015) referenced. In fact, there exists a body of literature that specifically addresses how similarly low concentrations of INPs may still influence cloud glaciation and precipitation development via secondary ice formation mechanisms (a few of which I have listed below). In particular, I encourage looking through Korolev 2007, which outlines conditions conducive to rapid glaciation of mixed-phase clouds through the Wegener-Bergeron-Findeisen mechanism. These conditions may be similar to those of the clouds sampled at Jungfraujoch. These papers also address the discrepancy between ice crystal and ice nuclei concentrations in mixed-phase clouds, which is a point used in this current study to back the claim that the fluorescent PBAP concentrations detected are too low to affect nucleation processes (pg. 26076 lines 1-2).

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References:

Korolev, A. (2007). Limitations of the Wegener-Bergeron-Findeisen mechanism in the evolution of mixed-phase clouds. Journal of the Atmospheric Sciences, 64(9), 3372-3375.

Phillips, V. T. J., Choularton, T. W., Illingworth, A. J., Hogan, R. J., Field, P. R. (2003). Simulations of the glaciation of a frontal mixedâĂŘphase cloud with the Explicit Microphysics Model. Quarterly Journal of the Royal Meteorological Society, 129(590), 1351-1371.

Diehl, K., Wurzler, S. (2010). Air parcel model simulations of a convective cloud: Bacteria acting as immersion ice nuclei. Atmospheric Environment, 44(36), 4622-4628.

Zeng, X., Tao, W. K., Zhang, M., Hou, A. Y., Xie, S., Lang, S., ... Simpson, J. (2009). An indirect effect of ice nuclei on atmospheric radiation. Journal of the Atmospheric Sciences, 66(1), 41-61.

Pratt, K. A., DeMott, P. J., French, J. R., Wang, Z., Westphal, D. L., Heymsfield, A. J., ... Prather, K. A. (2009). In situ detection of biological particles in cloud ice-crystals. Nature Geoscience, 2(6), 398-401.

Cantrell, W., Heymsfield, A. (2005). Production of ice in tropospheric clouds: A review. Bulletin of the American Meteorological Society, 86(6), 795-807.

Mossop, S. C. (1985). The origin and concentration of ice crystals in clouds. Bulletin of the American Meteorological Society, 66(3), 264-273.

3. It is stated that “no apparent trend is observed between mean fluorescent aerosol fractions and contemporaneous mean meteorological or cloud microphysical parameters, suggesting that particle fluorescence does not impact cloud evolution or formation (pg. 26074 lines 14-17),” and again later it is concluded that there is “no apparent link between the fluorescent aerosol fraction and observed cloud microphysical parameters and meteorology, suggesting that aerosol fluorescence does not influence cloud

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formation/evolution at the site. (pg. 26076 and lines 10-12)." For the reader, it may be difficult to see any trend or lack thereof in this data based solely on figure 5. A statistical analysis on the meteorological/microphysical and fluorescence data (i.e., regression) and including a test statistic and accompanying p-value to back claims that there is no relationship would be helpful.

Technical corrections:

Pg. 26068 Line 25: What are "modest" concentrations?

Pg 26073 Line. 6: "Discussion of the SDE's will be described elsewhere." While you do mention the companion paper to this study in the introduction, it should be clarified here again where there SDE discussions will be taking place.

Pg. 26074 Line 8: What test is used to determine whether there is any statistical significance? Eyeballing standard deviations is not always sufficient for determining significance.

Pg. 26074 Line 14: You bring up a point that may be worth discussing in detail further, in that certain cloud events had large fluctuations of fluorescent aerosol fractions while some do not.

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