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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Abundance of fluorescent biological aerosol particles at temperatures conducive to the formation of mixed-phase and cirrus clouds" *by* C. H. Twohy et al.

Anonymous Referee #1

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Reviewer Comments: "Abundance of fluorescent biological aerosol particles at temperatures conducive to the formation of mixed-phase and cirrus clouds" by C. H. Twohy et al.

Summary and general comments

In this manuscript, the vertical distribution of biological particles and ice nucleating particle (INP) concentrations over the U. S. western plains in autumn are discussed. Measurements from the boundary layer and from the free troposphere were compared. A decrease in the concentration of fluorescent biological aerosol particles (FBAP) with

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Discussion paper

height was observed with the largest variations occurring in the temperature regime of mixed-phase clouds. The vertical distribution of INPs based on the observed FBAP concentrations was derived using existing parameterizations. In addition, FBAP concentrations were compared to model results of different bioaerosol particles using the global chemistry-climate model EMAC in the sample domain.

The authors address the interest in biological aerosol particles as INPs in the atmosphere by measuring their occurrence at temperatures (altitudes) which are relevant for ice nucleation and include a comparison to atmospheric parameterizations and model results. To my knowledge, similar measurements, in particular on the vertical distribution of FBAP, have not been reported so far. The content of this paper is timely and contributes to the understanding of biological aerosol particles as INPs in the atmosphere. The manuscript is suitable for publication and its content fits well in the context of Atmospheric Chemistry and Physics. Specific reviewer comments to be addressed are given in the following.

Specific comments

Line 78-89: This paragraph is rather detailed. The reader has the impression that the properties of the field site are presented. Thus, I would rather move this paragraph to section 2 (properties of the field site) or else adapt by reducing the details in the general introduction.

Line 106: I suggest to mention earlier literature for small ice nucleation active macromolecules (INMs) from pollen rather than the given reference. Please see Pummer et al., 2012, ACP, http://www.atmos-chem-phys.net/12/2541/2012/ as an appropriate reference.

Line 115: Can the WIBS instrument be referred to as “new” device? This type of instrument has been used in a number of campaigns with published data (e.g. Toprak et al., 2013, ACP, http://www.atmos-chem-phys.net/13/225/2013/)

Line 163: Please include if your statement includes also e.g. mineral dust particles coated with biological material. Wouldn't they fluoresce, too?

Line 326ff: It is not intuitive why the blank samples are treated like they are. For two tests of blank filters rather the average of the blanks should be subtracted (including the variability by presenting error bars).

Line 336: Please add a statement on the decrease of total aerosol number concentration. A lower INP concentration is also expected with a general decrease in total aerosol number with height and the resulting change of the aerosol size distribution.

Line 341ff: Data from this study is compared to Tobo et al. (2013). Please make clear whether the conservative or liberal approach was used by Tobo et al. (2013) when comparing to this study.

Line 345/346: "INP concentrations estimated from the WIBS data are shown" is misleading. I suggest to rephrase this part along the lines: "...the INP concentration derived with the parameterization by Tobo et al. (2013) and the estimated FBAP concentration are shown..."

Line 383: The high variability of the data is not visible "at any given temperature". Consider to change and indicate that this is particularly visible in Figure 5b and the warm temperature regime.

Line 408: The authors refer to a "variability in concentration at the same altitude throughout the region" in the model data. It is not clear what is meant by "region". Please state if it is referred to different days (panels) and rephrase accordingly. Each of the flight shows that the variability in the modeled data is not always on the same altitude throughout the measurements days.

Line 423ff: This sentence is misleading. "Large biological particles" would include e.g. pollen which are of diameters of 20 μm or larger. Earlier in the paper it has been discussed that only a small fraction of these large particles reach high altitudes relevant

for ice nucleation. Specify the size by replacing “large” by the WIBS size thresholds used.

Line 456ff: The authors state that the extrapolated data have “no basis in existing measurements”. I recommend to remove these data as the scientific basis for these data points is not given.

Technical comments and language

Line 96: Replace “Fluorescent biological particle” by “FBAP”

Line 116: Hyphenation in “real time” missing. Please add to be consistent within the manuscript.

Line 120: No need in introducing FBAP again here.

Line 128: Replace “portion” by “region”.

Line 229: Missing “cm” in unit “MâĎę cm” for resistivity.

Line 335: Please add “(6B)” after “boundary layer filter” to make it more clear which sample location you are referring to.

Line 343: Remove “WIBS” before “FBAP” for consistency.

Line 381: Replace “microbial” with “biological”.

Line 383: Delete “particle” in “FBAP particle concentration” for consistency.

Line 457: Replace “this” by the specific temperature range referred to.

Line 461: “Expected” concentration is unclear. I recommend to rephrase with something along the lines: “. . .are well below concentrations derived with the parameterization for primary ice in clouds.”

Line 485: Please be more quantitative what the term “quite close” means.

General technical remarks: Check text and figures for consistency in naming

(FBAP/FBAP particles, WIBS/WIBS-4A, ALT/Altitude Above Ground, Particle Concentration/Concentration).

Figures

Figure 3:

- Consider splitting in two figures for better readability (3a, 3b+c).

- Please label panels with a), b) and c) according to the figure caption.

- 3c: Typo in legend: It should read “INP-FBAP” instead of INP-FPAB”.

- 3c: The grey data points are hardly visible (both on the screen and on print-out). Please re-color.

- 3c: Dashed lines: Please indicate in the legend what the difference makes in the two lines (low and high FBAP measurements)

- Figure caption (line 917): “.” missing after “Tobo et al”.

Figure 4, caption: Hyphenation of “clear-air” is missing – please add for consistency.

Figure 5: X-axis label is not consistent with the text. Delete “particle” in “FBAP Particle Conc.”.

Figure 6, caption: Delete “particles” after “FBAP”.

Figure 7: The legend covers the y-axis labels in all subplots. Please change.

Figure 8: The color “magenta” appears different compared to other plots and is rather purple. Please re-color to magenta to be consistent with other figures, the figure caption and text.

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