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Atmospheric Chemistry and Physics Discussions



# *Interactive comment on* "Rainfall drives atmospheric ice nucleating particles in the maritime climate of Southern Norway" *by* Franz Conen et al.

**Anonymous Referee #1**

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The authors show the results of monitoring of ice nucleating particles (INPs) active at a relatively warm temperature (-8°C) in PM10 and PM2.5 at a coastal site in southern Norway. They also discuss possible linkages of INPs and local meteorological events. Despite low time resolution and limitation of available temperature (weekly INP data at -8°C), this work provides rare and very valuable datasets, since there are few studies that have reported seasonal variations of atmospheric INPs based on continuous long-term monitoring. However, I thought that more detailed discussion is necessary to suggest that INPs active at -8°C may consist largely of fungal spores. I would therefore recommend this manuscript be published after several revisions.

Specific comments:



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Discussion paper

1) The wording “maritime climate (e.g., title)” may not be appropriate. This work is based on the measurements at a coastal site, but I didn’t think that the measurements have been conducted in remote marine boundary layer. For example, the authors described that “probably, INP-8 were aerosolised locally by the impact of raindrops on plant, litter and soil surfaces (Page 1, Lines 10-11)”. This obviously indicates the influence of terrestrial origin and not marine origin. To avoid misleading, I would strongly suggest avoiding the use of the wording “maritime climate” in the main text and considering a more appropriate title.

2) It is a little difficult to understand the motivation of measurements of arabitol and mannitol. Although there is the description of “fungal markers arabitol and mannitol (Page 1, Line 15)” in the abstract, the authors should clearly explain why arabitol and mannitol can be regarded as fungal biomarkers in Section 2.4. In addition, in the first paragraph of Section 3.4, the authors may need to briefly describe the reason why they decided to use arabitol and mannitol data.

3) The results of measurements of INPs after heating to 90°C should be presented more clearly. The authors conclude that “sensitivity to heat treatment (90°C) suggests bacterial or fungal sources, not pollen (Page 7, Lines 22-23)”. For this results, however, there is only a very short description that “exposure to 90 °C deactivated on average > 93% of INP-8 in our assays (Page 6, Line 16)”. If “the punches from 10 filters in each size fraction were tested a second time after they had been immersed for 10 min in a water bath at 90 °C (Page 3, Line 10-11)”, it is probably important to show the results in a figure and/or table (and seasonal variations of INP-8 after heat treatment if possible).

4) It is hard to understand why the authors consider that “INP-8 may consist largely of fungal spores during the warm part of the year (Page 1, Line 15)” and “bacterial contributions may be more important than fungal sources during the colder part of the year (Page 7, Line 25, 26)”. I assume that this is only based on the results that “from mid-May to mid-September, INP-8 correlated positively with the fungal markers arabitol and mannitol (Page 1, Line 15; Page 6, Lines 26-27)”. This result may suggest that fungal

spores are a potential important source of INPs from mid-May to mid-September, but I think that it is still impossible to rule out the possibility that the contribution of bacteria and soil organic particles were also significant. Did you try any other approaches to support the authors' hypothesis? For example, did you evaluate the relationship of INP-8 with other markers (e.g., bacteria, soil organic particles) from mid-May to mid-September?

5) It is a little hard to understand that "from mid-May to mid-September, INP-8 correlated positively with the fungal markers arabitol and mannitol (Page 1, Line 15)" only based on Figure 5. For example, could you show the results (additional figures like Figure 4 or tables) comparing INP-8 with arabitol and mannitol measured in different seasons (e.g., the period of mid-May to mid-September vs. other periods; spring vs. summer vs. autumn vs. winter)?

Technical corrections:

6) Page 2, Line 5: [f]ollow-up => follow-up?

7) Please explain the definition of INP-8 more clearly. Is it ice nucleating particles "active at -8°C or warmer (Page 1, Line 25)" or "active at -8°C"?

8) It is a little difficult to see the data on precipitation and/or snow depth in Figures 2 and 5. I would like to suggest that the values would increase from bottom to top if there are no special reasons.

9) What is the value of 0.47 in Figure 4 (r or r2)? In addition, I would like to suggest that the authors would indicate the equation of the regression line, since they noted that "in PM2.5 we found consistently about half as many INP-8 as in PM10 (Page 1, Line 14)".

10) Is Figure 3 FLEXPART output? If so, please describe it in Section 3.2 and/or the caption of Figure 3. In addition, I would like to suggest including the explanation of why the unit of potential emission sensitivity is seconds (Page 4, Lines 3-4).

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