

## ***Interactive comment on “The Horizontal Ice Nucleation Chamber HINC: INP measurements at Conditions Relevant for Mixed-Phase Clouds at the High Altitude Research Station Jungfraujoch” by Larissa Lacher et al.***

**Anonymous Referee #2**

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Review of “The Horizontal ice nucleation . . .” By Lacher et al.

Larcher et al. describe and characterize a new instrument (HINC) for detecting ice nucleating particles (INPs) in the atmosphere. They then use the instrument to quantify INP concentrations in the deposition mode and immersion mode at a high altitude research station. Concentrations of INPs during two winters are reported and two case studies during high concentrations of INPs are discussed. Since INPs play an important role in climate and the hydrological cycle this topic is well suited for ACP. The paper is well written, and in most cases the results support the conclusions. The

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experiments and analyze are also laudable. However, I do have a few major concerns that need to be addressed before I recommend publication.

Major concerns:

Page 12, Line 11-12. The authors suggest that liquid droplets are not detected in the OPC channel > 5 micrometers because they settle out of the aerosol flow and hence are not sampled by the OPC. Is it possible that some of the ice crystals > 5 micrometers also settle out of the aerosol flow and are not sampled by the OPC? If so, does this mean that HINC only measures a lower limit to INP concentrations?

Page 18, Line 8-9: particle loss for 2 micrometer particles is large (44%). What is the transmission efficiency of unactivated particles > 5 micrometers (i.e. 6-10 micrometer particles)? Could a small percentage of unactivated 6-10 micrometer particles be detected as INPs in your experiments and cause experimental artifacts? As an example, would the conclusions in the paper change, if 1% of the 6-10 micrometer particles are unactivated in the HINC and are detected in the OPC channel > 5 micrometers. Could large (6 to 10 micrometers in diameter) primary biological particles cause experimental artifacts by making it through the HINC unactivated and being detected in the OPC channel > 5 micrometers?

Page 33, line 11-12: Here the authors indicate that HINC avoids particle losses due to gravitational settling in the horizontally oriented chamber. What size of particles are the authors referring to at this point? I find this statement confusing since earlier they indicated that liquid droplets > 5 micrometers settle out and the transmission efficiency of 2 micrometer particles is low.

Page 13, line 4-6: I appreciate that the authors have carried out several systematic studies to determine the upper RH limit for ice crystal detection in the immersion mode. However, I am not completely convinced that at  $T=242\text{K}$  and  $RH_w < 104\%$  the OPC size channel > 5 micrometers is well-suited to reliably detect ice crystals in ambient conditions without experimental artifacts. The authors suggest that these experimen-

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tal conditions are appropriate based on measurements with 200 nm sulfuric acid and 200 nm ammonium sulfate particles, as well as ambient particles. However, perhaps the results from these test cases are not applicable for all air masses encountered at Jungfraujoch. For example, do the results from the test cases apply to 50 nm secondary organic aerosol and 50 nm sea spray particles? What about 800 nm particles? Since the authors have not investigated the effect of particle size or chemical composition (other than sulfuric acid, ammonium sulfate and one ambient situation), I do not know the answer to this question. Also, how representative were the measurements with the ambient particles shown in Figure 4? Were the ambient measurements shown in Figure 5 only carried out on one day or one type of air mass? At  $T=242\text{K}$  and  $RH_w < 104\%$  perhaps the OPC size channel  $> 5$  micrometers is not well-suited to reliably detect ice crystals in air masses influenced by marine origin. Additional discussion and possibly additional results are needed to address these questions.

Minor comments:

Abstract, Page 2, Line 17-19: The evidence for marine aerosol acting as INPs is circumstantial. Hence, I think “indicating” should be replaced by “possibly indicating” or “consistent with”. In the abstract, the authors should also point out that during the event influenced by marine air, they cannot rule out contributions from anthropogenic or other sources.

Page 4, Line 6-8: This sentence refers to reports more than five decades ago, but then references a paper published in 2014. Either remove the 2014 reference or modify the sentence for consistency.

Figure 2: Indicate in the figure caption that the legend on the right hand side refers to different size channels of the OPC.

Page 20, Line 18: please indicate the purity of the nitric acid solution.

Page 23, Line 29: The authors state that the median concentrations are less than or

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equal to  $0.2 \text{ stdL}^{-1}$  during winters 2015 and 2016. This statement appears to contradict Fig. 8, where the median values are greater than  $0.5 \text{ stdL}^{-1}$  for winter 2015. Am I missing something here?

Page 27, line 19-21: Could primary biological particles also be important for land not covered by snow.

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Interactive comment on Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2017-474>, 2017.

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