

## ***Interactive comment on “Birch and conifer pollen are efficient atmospheric ice nuclei” by B. G. Pummer et al.***

**C. Morris (Referee)**

cindy.morris@avignon.inra.fr

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The major contribution of the work described in this manuscript is to provide insight into the chemical nature of the ice nucleation active material associated with pollen. The results presented here show that the ice nucleation active material associated with pollen can be solubilised and hence transferred from the pollen grain itself to the surrounding aqueous environment. Furthermore, based on experiments to test the resistance of the ice nucleation activity to various heat and chemical treatments, the authors present strong evidence that the active principle is not proteinaceous; it is likely a polysaccharide or perhaps an oxidized organic polymer.

In order to make this message more clear to the reader and eliminate various other extraneous and perhaps unfounded claims about the ice nucleation activity of pollen,  
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the authors need to make some major changes in the organization and writing style of the manuscript.

1) I was not sure where the Materials and Methods were presented in the manuscript. They seem to be dispersed throughout the manuscript and interwoven with the Results. A more classical presentation would be very useful.

2) There is also not a clear statement of the objectives. In the Introduction section the authors state that no research has been carried out to describe the nature of pollen ice nucleation activity. This leads the reader to suspect that the objective targets describing this nature. However, the paper deviates quite a bit towards efficiency of pollen as ice nuclei (and this is re-enforced by explicit use of the word “efficient” in the title), but the data presented in the manuscript in its current state are not sufficient to address the question of efficiency.

3) The bulk of the methods and results are written in the present or present perfect tenses. This makes it very difficult to differentiate accepted fact or regular practice from the methods and results specifically contributed by this work. For methods and results, the verb tense should be simple past tense. Present tense is used for accepted facts or to indicate a regular practice.

Overall, the manuscript needs numerous corrections for proper English grammar and vocabulary, and verification that sentences are complete.

In addition the authors should note that all Latin names should be in italics.

Concerning other scientific findings in this manuscript I have the following remarks and questions:

4) How do the authors define efficiency of ice nucleation activity? The ice nucleation activity reported here occurs well below  $-15^{\circ}\text{C}$ . Admittedly it occurs at temperatures above the homogenous freezing temperature of water, but it does not seem to be effective at temperatures remarkably warmer than those for mineral dust. And clearly it

does not approximate the activity of certain ice nucleation active bacteria. For the ice nucleation activity characterized for intact pollen grains in suspension, the authors do not give any information about the activity per pollen grain or per mass of pollen. Is it comparable to that of mineral dust on a per-weight or a per-particle basis? How do the different pollen species compare to each other on a per-pollen grain basis in terms of INA? Overall, it was very surprising that there was no information about the total numbers of pollen grains tested in the freezing tests and if the numbers tested were comparable among the different species of pollen.

5) Did the authors check the purity of their pollen to verify that it was not transporting contaminants such as bacteria or fungi? Pollen must be collected from plants (probably field-grown plants to assure sufficient production) and cannot be propagated under aseptic conditions as can certain micro-organisms. One way to verify this might be to place a given number of pollen grains on sterile microbiological media (for cultivating bacteria or fungi) to see if any microbial colonies develop.

6) In the Discussion, the authors suggest that the ice nucleation active material from pollen, once separated from the pollen grain, could be transported to altitudes much higher than the pollen grains themselves can be transported. I wondered about the mechanisms that would be involved in this transportation. Under what natural conditions would the ice nucleation active material be removed from the pollen? – I suppose that this would involve free moisture, but would this be in a wet aerosol, or on plants or elsewhere? And then what would be the conditions that would favour the separation of the pollen from this water that would also lead to continued dissemination of the ice nucleation active material?

7) I appreciated the speculations made in this manuscript particularly about the mechanisms involved in ice nucleation activity and the possible link between life history of the plant species (adaptation to colder climates) and the rate of ice nucleation activity of its pollen. However, I think that the authors should be careful to make a very balanced and objective evaluation of the potential importance of pollen in atmospheric ice

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nucleation given the relatively cold temperature of its activity.

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