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Interactive comment on "Contribution of pollen to atmospheric ice nuclei concentrations" *by* J. D. Hader et al.

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Comment by Bernhard Pummer, Stefanie Augustin, Heike Wex, and Hinrich Grothe:

This paper describes field experiments regarding the contribution of pollen to atmospheric ice nuclei concentrations. We would like to emphasise that we highly appreciate that the authors have performed this field study and have tested our laboratory experiments and our hypothesis regarding pollen IN in the field (made in Pummer 2012 and Augustin 2013). However, we have detected some experimental details and some measurement strategies, which we think have to be described in more detail and there are some conclusions which we think are too strict.

The region of investigation is Raleigh, North Carolina, USA situated 35° 49âĂš N,

78° 39âĂš W, which is several thousand kilometres away from the northern timberline, where we have assumed to find tree pollen with ice nucleation activity (Pummer 2012). Already then, we found different IN activities between pollen samples from the same genus: 4 K between 2 juniper and 3 K between 2 Thuja samples. However, the main trees of North Carolina are conifers, which in principle might be counted into the group of IN active trees. Nevertheless, we found in our experiments that the down-washable molecular IN from pine pollen is several orders of magnitude smaller in mass than from birch pollen. Therefore, we think that the conclusions might be restricted to the region and the trees of this region.

The authors have distinguished between dry particles and wet particles after rainfall. Obviously, among the dry particles IN are either inactive or low in numbers, but the rainfall is activating the particles and IN activity is 30 times increased afterwards (see fig. 7: 4/11 vs. 4/19). The contribution of these particles is most likely the sum over all kind of biological particles and this conclusion cannot be restricted to a particular sort. Therefore, filtration and analysis are extremely important issues. Here, we have not understood the filtration procedure described in the paper:

a) The rain water has been filtered but the dry particles have not been filtered (p.31679, 19). Why?

b) Filtered and non-filtered rain water has been compared. The filtered one has been corrected by an efficiency factor of 0.2 (p.31694). Why?

c) Why has the filtrate not been analysed? This would have been of particular interest since it would include the molecular IN fraction.

In general, we stated the hypothesis that macromolecules can be released from pollen grains, which then can be distributed further independently from the mother grains, and thus, are not directly interconnects with pollen grain concentrations. In principle, the results of this paper do not contradict this idea. Therefore, the sentence "However, Pummer et al. (2012) suggest that the impact of pollen on atmospheric clouds might

have been underestimated due to the ejection of IN active macromolecules from the pollen sac. Our results do not support this hypothesis" seems much too general.

Some specific remarks:

Abstract, line 23-25: "Some pollen species contain some fraction of grains that induce freezing at temperatures as low as -9° C (Diehl et al., 2002)." It should be mentioned here that these high freezing tempeatures might also orignate in the fact that the particles examined in this study contained a large number of pollen, which, as shown in Augustin et al. (2013) and also Hartmann et al. (2013) increases the freezing temperature.

Abstract, line 28: "associated with the grain" The ice nucleating entitiy of pollen grains does not have to be assiciated with a grain, as it can be washed off (Pummer et al. 2012 and Augustin et al. (2013)).

Ad Fig. 6: Please indicate which data set of Pummer et al. 2012 you have used. This is important, since high concentration (100% freezing) used in the equation of Vali et al. is underestimating the number of IN significantly. We may offer to support you with our latest data from pine and birch.

Ad Fig. 7: Were there no IN concentration measurements carried out during some rainfalls? Why are there some data holes? Since dry bioaerosols (including the pollen) are less likely to fragment, it is not so surprising that during the dry seasons IN concentrations are lower (and probably barely exceed whole-cell concentrations) than during rainfall. This is in good agreement with the paper by Huffman et al. 2013.

Interactive comment on Atmos. Chem. Phys. Discuss., 13, 31673, 2013.