

Atmos. Chem. Phys. Discuss., referee comment RC1
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Comment on acp-2022-489

Anonymous Referee #1

Referee comment on "Comparing the ice nucleation properties of the kaolin minerals kaolinite and halloysite" by Kristian Klumpp et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2022-489-RC1>, 2022

Summary:

In the presented study the ice nucleation properties of two types of kaolin minerals are investigated, which are chemically identical but have different morphologies. While kaolinite forms flat platelets and has a more constrained ice nucleation behaviour (e.g., freezing onset temperature in the range of 243.3 K to 244 K using freshly prepared samples), halloysite has a variety of different morphologies, e.g. tubes, and shows a more diverse ice nucleation activity with ice onset temperatures ranging from 238.2 K to 244.9 K. To better understand the role of morphology, the samples are milled and reveal a clear decrease in the ice nucleation ability of halloysite, while kaolinite samples are rather unaffected. By determining the pore size distributions and pore volumes of the samples before and after milling, it is shown that the halloysite tubes are destroyed, and thus it is suggested that they are likely involved in ice nucleation processes. The authors provide a detailed discussion about the surface type of the mineral causing the ice formation and conclude that hydroxylated particle edges are the most likely location for ice nucleation.

The study is well conceived and I enjoyed reading the manuscript which is generally very well written. I only have minor comments.

General comments:

Do you have suggestions for further studies to test your hypothesis that the hydroxylated edges of the kaolin minerals are causing the ice nucleation, e.g., molecular dynamics studies, or other laboratory studies?

Abstract: You might want to consider mentioning that the milling leads to an increase in

specific surface area.

Line 63: An early study by Vonnegut (1947) should be referenced here as well.

Section 2.: It might be helpful to include a figure showing the structure of kaolinite and halloysite.

Lines 175 and 189: Shouldn't other studies next to Klumpp et al. (2022) be referenced here as well?

Lines 201 to 202: Is there a reason why those halloysite samples were chosen for milling (e.g., the content of impurities)?

Lines 208 to 210: Can you explain in more detail this equation, and also provide uncertainty estimates for your measurements for pore volume distributions?

Line 277: The description of the experiments using ammonia/ammonium is missing in the methods.

Line 357 and following: You might want to consider referencing Fig. 1 here.

Section 4.3: I recommend naming this section slightly differently, to indicate that this is a discussion and not a results section (e.g., "likely location of ice nucleation").

Figs 6, 7, 10 and 11: Could you indicate the uncertainties in your measurements by error bars?

Technical comments:

Line 3: "1" is missing in the authors' name for their affiliation.

Figs. 3 and 4: While in Fig. 3 the untreated samples are labeled "pure", there are not

specifically labeled in Fig. 4.

Lines 421 and 423: A bracket is missing at the end of the sentence.

Reference

Vonnegut, B.: The Nucleation of Ice Formation by Silver Iodide, *J. Appl. Phys.*, 18, 593-595, 10.1063/1.1697813, 1947.