Review Hamzehpour et al. (2022): The Urmia Playa as source of airborne dust and ice nucleating particles – Part 2: Unraveling the relationship between soil dust composition and ice-nucleation activity

Summary

The manuscript submitted by Nikou Hamzehpour and co-authors provides a detailed insight into the potential driving factors of the ice-nucleation (IN) ability of dust particles from a dried lakebed. Due to an increase in desertification, it is expected that such sources for airborne dust particles are becoming more abundant, and might therefore impact cloud microphysical processes such as the initiation of ice crystal formation.

Soil dust particles can have distinct IN abilities related to their mineralogical composition, and they can contain organic matter and soluble salts. Here, the authors investigate the impact of each component on the ice nucleation ability of the dust sample. The bio-organic matter is found to determine the onset temperature for ice nucleation, and the removal of soluble salts and carbonates leads to an increase in the IN activity. After the removal of the constituents, the IN activity is determined by the clay mineral fraction, and to a lesser extent to quartz and microcline.

The paper is well written and I only have minor comments and suggestions. More of such systematic investigations of driving factors for the ice nucleation ability of natural soil samples are needed to improve our understanding in this field.

General comments

- Please consider shortening the abstract.
- I recommend moving some figures in the appendix and only showing key figures in the manuscript (e.g., figures 3, 4, 10).
- In some cases, the mentioned publications are examples and do not represent all existing literature. Please check and make use of "e.g." in such cases or complete the cited literature.
- What is the atmospheric relevance regarding the size of the samples collected with the high-volume samplers and the ground-collected samples? Supermicron particles are typically not transported over longer distances, such that they could be lofted into levels in the atmosphere where they could impact cloud microphysics by their ice nucleation ability. Please elaborate on this.
- Is it possible to give a temperature-dependent F_{het}? This might allow comparing the nucleation efficiency of the organic INPs and the dust INPs in the sample.
- What is the temperature uncertainty of the DSC experiments? E.g., in line 284, you state a value of -0.2 K for ΔT_{het} which could be within the uncertainty of the experiment. What are significant changes in values for ΔT_{het} and rF_{het}?
- Are there studies investigating the impact of carbonate removal and salt removal on the ice nucleation ability of dust particles, or is your study the first one investigating this?
- Lines 336 – 337: It might be interesting to the reader to compare your results in a more quantitative way to these studies.
- Line 533: The heterogeneous freezing temperature range of 236 – 248 K is very broad and includes not only the freezing temperatures of clay minerals but also other mineral types.

Technical comments

- Title: Should it not be „… as ***a*** source…“?
- Line 163: It should be mentioned in the table header that it is taken from the first part of this work (Hamzehpour et al., 2022).
- Line 251: Abbreviation „rF_{het}“ is not explained.

- Line 310: I recommend increasing the marker size and to indicate the dust and soil samples with different markers.
- Figure 11: I assume that the blue dashed line corresponds to T_{het} and F_{het} of the pure minerals, as described in Figure 12?
- Figure A is not specifically mentioned in the text. Also, the labels are too small.