Atmospheric Chemistry and Physics Discussions

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Comment on acp-2021-741

Anonymous Referee #2

Referee comment on "Mexican agricultural soil dust as a source of ice nucleating particles" by Diana L. Pereira et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-741-RC1, 2022

Review:

Mexican agricultural soil dust as a source of ice nucleating particles

Summary:

In their manuscript, Pereira and colleagues studied the ice-nucleating ability of dust aerosols originated from different agricultural fields at four sites in Mexico. They collected soils from different croplands that were later aerosolized and analysed in the laboratory and compared the lab data set to aerosol samples collected in-situ in the field. The ice nucleation activity (INA) of aerosols was measured in immersion freezing mode which is relevant to ice formation in mixed-phase clouds. The authors draw conclusions on the extent to which organic carbon and certain minerals contribute to the freezing activity of dust particles and discuss the importance of particle chemical composition and size for efficient ice nucleation.

The Introduction is very well written and represents the current scientific knowledge in this field. The methods and sampling design used in this study both in the field and in the laboratory are adequate and the presented results are of general interest to the INP community. Overall, the work presented merits publication in Atmospheric Chemistry and Physics after minor revisions.

General comments:

One conclusion reached by the authors is that agricultural soil dust contributes to the formation of mixed-phase clouds (line 368). However, the data presented in this manuscript do not fully support this conclusion. Specifically, transport measurements were not part of this study and consequently, the influence of the sampled aerosol on cloud formation can only be assumed. Indeed, it could be that these soil dusts are transported to altitudes where mixed-phase clouds appear and the INP concentrations from this study match with literature data, however more data is needed to proof this hypothesis in this context. Therefore, I propose to weaken the according argument in the conclusion. The manuscript could be improved if the authors deepened the discussion of possible transport processes of soil from fields to high altitudes.

The authors use freezing curves to depict the INA of their aerosol samples. However, in the discussion the authors focus the interpretation rather on T50 values than the freezing curves themselves. T50 values have been used in the scientific community to represent a sample's INA. For pure ice nuclei that freeze immediately at a given temperature, T50 is a good parameter for comparison studies. However, if one sample consist of more than one ice nucleus (e.g. OC and K-feldspar), freezing curves may show steps in the spectrum (see e.g. onion (F), wheat (F) in Figure 3). Consequently, the T50 values does not fully represent such samples. Have the authors considered also taking T10 and T90 into consideration or include a more detailed discussion about the spectra?

Specific comments:

Abstract:

Line 32: The authors state that T50 values and aerosol particle size are correlated. There is no mention of what exactly is meant by particle size. I assume aerodynamic diameter? I would recommend mentioning this in the text.

Line 33: Please indicate precisely which efficiency is meant. Ice nucleation efficiency?

Introduction:

Line 61: not all bacteria and fungi are ice nucleation active. I would recommend to add 'certain' to the sentence: '[…] (e.g. certain bacteria, fungi) […]'

Methods:

Line 111: I was wondering what the weather conditions were like during the campaign? Did the authors record any data on the meteorological conditions?

Line 111: '[…] samples collected at the ground level.' How much distance was between the instruments and the ground? Did they actually stand on the ground or were the instrument mounted onto something?

Line 116: Is there a specific reason why aerosol and soil samples were stored at different temperatures?

Figure 2: I was wondering if the 'OPC sign' shouldn't be indicated before the 'aerosol collector sign'? Or was the OPC attached after the impactor/MiniVol?

Line 115 and line 123: For how long did you collect your aerosols? Was the time period in the field the same as in the laboratory?

Line 130: Did the authors collect the aerosol samples for the ice nucleation and mineral analysis in parallel or were the measurements performed sequentially?

Line 146: Are the authors referring to the diameter of the droplets (d=170 um) as the size?

Line 147: I would recommend writing 'dry nitrogen', rather than dry air.

Line 147: I assume that the droplets were not evaporated completely but rather reduced

to the desired size? Please clarify.

Line 152: Could the authors give a little bit of insight into the statistics of their setup? How many droplets/particles per glass slide were analyzed for one sample?

Line 181: This sentence is incomplete. What is meant by 'at 0.85%'? Does that refer to a concentration of the buffer? Further, could the authors specify which sterile solution they used? In addition, was the cultivation performed at room temperature? Maybe the authors could mention that in the text.

Results and Discussion:

Figure 3: For clarification to the reader, I would suggest to mention the aerodynamic diameter as the size in the caption.

Figure S1: It is not clear to me how the particle size distribution was recorded for the field measurements. Could the authors please state in the 'Method' section how the measurement was performed?

Line 212: I was impressed that the type of crop which previously grew on the field influenced the ice nucleation ability of the soil. Do you think field treatments (e.g., pesticides, fertilizer or no artificial treatments that could promote biodiversity and possibly ice-active microbes) could affect the INA of the soil? In addition, do you think that freeze tolerant plants (see e.g. Marcellos and Single, 1979) may leach ice nuclei into the soil?

Figure 5: I would recommend to add the temperature and duration of the heat treatment to the caption.

Figure 3 and 5: When printing out the manuscript the lines of Corn 2 (L), Bean (L) and Onion (L) are hard to distinguish. The authors may consider changing the colours.

Line 281: I recommend to also cite Zolles et al. (2015) here, as they showed that the INA of e.g. microcline decreased by 2 degrees after the sample was heated to 250°C.

Technical remarks:

Line 45: INP should be in plural (INPs)

Line 145: Missing the letter s: ‘Afterwards, […]’

Line 640: The micrometre symbol is in a different style

References:

Marcellos, H., & Single, W. V. (1979). Supercooling and heterogeneous nucleation of freezing in tissues of tender plants. Cryobiology, 16(1), 74-77.

Zolles, T., Burkart, J., HaÌusler, T., Pummer, B., Hitzenberger, R., & Grothe, H. (2015). Identification of ice nucleation active sites on feldspar dust particles. The Journal of Physical Chemistry A, 119(11), 2692-2700.