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Interactive comment on "Size-dependent ice nucleation by airborne particles during dust events in the Eastern Mediterranean" *by* Naama Reicher et al.

Anonymous Referee #2

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General statement

This paper presents results of an experimental investigation of the ice-nucleating properties of aerosol particles sampled from the atmosphere over Israel. Five episodes with mineral dust being transported from the deserts of Northern Africa and the Middle East and one case with clear sky were sampled by MOUDI in six size-classes. Aqueous extracts of the samples were analysed by the droplet freezing devices WISDOM and BINARY.

Atmospheric mineral dust (AMD) is next to sea salt the largest constituent of atmospheric aerosol, and a major ice nucleating agent. Several previous studies have con-

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Discussion paper

ducted size-resolved INP measurements. It is evident since long ago (e.g. Georgii and Kleinjung, Jour. des Recherches Atmosphériques, 145-156, 1967) that ice nucleating particles (INP) are mostly large particles. This is also found here, and no surprise. However, the new size-resolved data allow a much more detailed understanding of ice nucleation by AMD. Supermicron particles are shown to nucleate at warmer temperatures and to contain higher numbers of INP than submicron particles, even if normalized to the aerosol surface (expressed as surface densities ns of INP). The authors conclude from their ns(T) curves of the different events and size classes, as well as from the overlap with published ns data for minerals, that feldspars dominate the freezing induced by supermicron particles. Quartz dominates ice nucleation by submicron particles. From the comparison with published data it is further concluded that current parameterizations of ns(T) overestimate the activity of airborne dust. As a consequence, the authors derive a new, size-dependent parameterization from their data.

The present manuscript is not just another study on ice nucleation by mineral dust. Its size-resolving approach yields substantial and valuable new information. Including the particle size and the modification of mineral dust during transport in the parameterization – such as done here – will help to improve the modelling of cloud glaciation and related effects.

The work as a whole is sound and perfectly suited to the scope of the journal. The advanced experperimental methods are well documented. The data are well presented and convincingly interpreted in the light of current knowledge and literature. The manuscript as a whole is crafted very well. I recommend publication after some minor adjustments described below.

Major comments

Chapters 2.7.1 and 2.7.2 / sonication times: WISDOM sonicates 90 seconds, whereas BINARY does 30 minutes, accompanied by a 20°C warming. I presume the good agreement of both methods suggests that the effect of this different treatment is negligible ?

There are some laboratory studies on ice nucleation of minerals that might be cited. Consider to mention and discuss these where relevant, either in the introduction or among the results: 1) Welti et al., Ice nucleation properties of K-feldspar polymorphs and plagioclase Feldspars, Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2018-1271, 2019

2) Archuleta et al., Ice nucleation by surrogates for atmospheric mineral dust and mineral dust/sulfate particles at cirrus temperatures, Atmos. Chem. Phys., 5, 2617–2634, 2005

3) Lüönd et al., Experimental study on the ice nucleation ability of size-selected kaolinite particles in the immersion mode, J. Geophys. Res., 115, D14201, doi:10.1029/2009JD012959, 2010

Line 161: please spend a few words on how A was derived from primary data.

Line 229: I cannot see from Fig.4 that "SyDS2 has a weaker size dependence in comparison to the other dust events . . ." (smaller spread of curves for a given T), as you state in line 229.

Figures 6 and 7: The clear case CSDS has the highest ns of all data. How is this interpreted? Is the aged tropospheric background aerosol more active than "fresh" mineral dust plumes? Wouldn't that be an interesting result that needs discussion?

Minor comments:

Line 183: maybe add (MDS) after "Another event" ?

Line 184: I believe "west" or "southwest" is better than "south"

Line 211: although it is without consequences, the reader will be interested to know whether the fires are around Rehovot or farther away. Can you say a word on this?

Line 219: maybe add “to ice nucleation” after “supermicron particles”?

Line 234: You write: “.. ranged from 10-3 to almost 1 . . .”; I read exactly 10-1 as upper bound.

Line 322: I believe it is “ice cloud formation” or “formation of ice clouds” , instead of “ice clouds formation”

Line 368: Isn’t it “emphasizes”, because it is related to “overprediction” (singular)?

Technical items

Line 217: Typo: “Ice nucleation is initiated . . .” instead of “initiates”

Figure 6, CSDS: The diagonal line is missing in the graph.

Figure 9a) delete “r” in the graph’s legend, now it says “(subrmicron class)”

Figure 9: add a) and b) to the left and right graphs

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