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Comment on acp-2022-551

Anonymous Referee #1

Referee comment on "Role of K-feldspar and quartz in global ice nucleation by mineral dust in mixed-phase clouds" by Marios Chatziparaschos et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-551-RC1, 2022

Review of "Role of K-feldspar and quartz in global ice nucleation by mineral dust in mixed-phase clouds" by Chatziparaschos et al.

General comment:

The present study evaluated the importance of K-feldspar and quartz in ice nucleation and mixed-phase cloud formation. To do so, the authors used the global 3-dimensional chemistry-transport model TM4-ECPL where different parametrizations were added to fulfill the proposed objectives. The performance of the model was found to be satisfactory taking into account the associated uncertainties. The author found that besides K-feldspar, quartz can be a good source of INPs at specific locations, altitudes and temperatures with a good potential to impact mixed-phase and cirrus clouds. The present study provides new evidence on the importance of mineral dust particles in cloud formation. Additionally, the used approach can open future studies in the cloud physics community. Although the Introduction and Methodology sections are well written, this is not the case for Results and Discussion section. Therefore, the present manuscript can be accepted after the following comments are properly addressed.

Major comments:

- There are several parts where the same information is repeated. I invite the authors to avoid redundancy.
- Figures are called in a random way making very difficult to follow the manuscript. Although most of the text is well written, the way Figures are incorporated into the text is not appropriate and needs to be fixed to improve de readability of the manuscript.
- Section 4 is very confusing and needs to be deeply edited.
- The figures and Tables added to the Supplementary material need to be used in a better way to support the discussions on the main text. Most of them are just briefly mentioned with a lack of a scientific discussion.

Minor comments:

Lines 24-26: "Mineral dust emitted from arid regions, particularly potassium-containing feldspar (K-feldspar), has been shown to be the most efficient INP through immersion freezing in mixed-phase clouds." This is not completely true, as the most efficient INPs, in terms of the freezing temperature, are biological particles.

Line 34 and along the manuscript: "(low-level clouds)". With low-level clouds the authors mean liquid clouds? If yes, this sentence is not correct as the CCN abilities were not evaluated in the present study.

Lines 48-49: "Ice nucleation in clouds proceeds by homogeneous freezing of liquid droplets at temperatures lower than −37°C" How about RHi?

Lines 49-50: "triggered by INP at warmer temperatures" How about RHi?

Line 64: "(e.g., Georgakaki et al., 2022; Sotiropoulou et al., 2021)". I suggest to cite older/pioneering studies.

Line 78: "have been proposed to act as INP". The word "proposed" is incorrect as there is very clear evidence that they can act as INP.

Line 108: I suggest to add a brief description about the immersion freezing definition.

Lines 151-153: How about the particle' density?

Lines 178-180 and along the manuscript: Either use "parametrization" or "parametrisation"

Line 231 and along the manuscript: Figures need to be called chronologically, starting with Figure S1.

Lines 310-311: "4b). As shown in Figure 4a, these points correspond to measurement temperatures around -20oC and -25oC." I do not get this.

Line 351 and Figure 1: "to activate and form INP". An aerosol particles has the capability or not to act as INP but INPs do not form.

Line 368: I suggest to replace "there are quartz INP sources" to "could be quartz INP sources"

Lines 373-379: I suggest to merge this lines with lines 362-365.

Line 383: "600hPa" Why not at 800 hPa as in previous sections?

Lines 388-389: "Total INP ([INP]total) maximizes approximately at 600-500hPa (Figure 8a)". I do not get this. At what latitude and temperature do the authors refer to?

Line 389: "where K-feldspar derived INP is the largest fraction of INP concentration". Again, at what latitude and temperature do the authors refer to?

Lines 391-392: "are calculated at lower altitudes". Please indicate the temperature range.

Line 391: "quartz's high number concentration". Please cite literature indicating that the Gobi Desert is a good source of quartz.

Lines 394-395: “At temperatures below −25°C, the quartz contribution becomes increasingly important with decreases in temperature at high INP concentrations” I do not get this.

Lines 400-401: “and is far from emission sources.” It is unclear to me.

Line 401: “Figure S5 for Eurasia”. This is the only mention for this Figure and it deserves to be deeper discussed

Lines 423-424: “Consideration of quartz-derived INP is improving the comparison with observations for high INP concentrations at low temperatures and relatively low INP concentrations at temperatures around -20oC”. I do not get this.

Line 434: The H-M mechanism usually takes place around -5°C, therefore, it may not be of high importance for the temperatures evaluated here.

Figure 3: From the figure caption my understanding is that panel (a) should have two colors only.

Figure 4: “[INP]T” and “m-3”. Fix this.

Figure 6 and along the manuscript. Are the authors referring to K-feldspar or all types of feldspar?

Figure S3: The Figure legend covers some sampling sites

Figure S7: Should “This figure is related to Fig 3.” Be “This figure is related to Fig 4.”?

Table S3: This is not mentioned in the main text

Technical comments:

Line 17: It should be Switzerland

Line 57: Add a reference after “forcing”

Line 82: I suggest to replace Hoose et al. (2010a) by Hoose and Mohler (2012).

Line 92: Add a reference after “density”

Line 109: “(Westbrook and Illingworth, 2013)”I suggest to add a more appropriate reference here, and additionally, it is out of place.

Line 124: Add a reference after “scavenging”

Line 166: Add a reference after “sieving”

Line 180: Replace “as ice nuclei particles” with “INP”

Line 190: Add a reference after “surfaces”

Line 245: Replace “3.2” with “Section 3.2”

Line 278: “2022) _databases” Fix this.

Line 314: “low temperatures”. Specify low temperatures.

Line 337: “see also Supplementary Figure S8)” There is not Figure S8 in the supplementary material.

Line 379: “concertation”. Fix this.

Line 396: Should “(Figure 8a)” be “(Figure 8b)”?

Lines 399, 416, 417: Add a reference after “K-feldspar”

Line 414: “k-feldspar”. Fix this.

Line 419: What do the authors mean with “global atmosphere”?