The authors are grateful to the editor and referees for their careful reading and constructive suggestions that substantially help to raise the quality of our manuscript. Below we address each of the comments listed in blue font. Our answer is listed in black font and revised text is listed in green font. The number of lines in our answers is based on the revised manuscript, and the amendments were marked with a highlight in the revised version.

Referee #1:

Chen et al. present a laboratory investigation of the immersion freezing ice nucleation ability of filter-collected ambient Asian dust particles collected in Beijing.

Overall, I find that the topic of the manuscript fits well within the scope of ACP. This study extends previous studies on the immersion freezing ice nucleation ability of mineral dust particles to size-resolved measurements, and the experimental procedures and analysis are straight forward and sound. Based on the presented measurements a set of new parametrizations are developed that can predict the ice nucleation active surface site density of differently sized mineral dust particles at mixed-phase cloud conditions. While the results are mostly well presented and clear, the discussion of the parametrizations and comparison to previous parametrizations remains partly speculative. Therefore, I suggest the authors to address the below comments fore this manuscript is published in ACP.

We appreciate the referee's affirmation and comments on our work. The comments were responded point-by-point in the following contents, and the manuscript was revised. We have made direct responses and substantial revisions which we believe properly address the referee's concerns.

General comments:

1. The discussion in Sect. 3.5 (in particular L321-335) to me reads somewhat confusing and in parts remains speculative. The present study does not present analysis of the mineralogical composition of the samples investigated. This makes it hard to follow the argumentation why the newly presented parametrizations

should or should not follow previous parametrizations of desert dust samples that are based on samples of different but distinct mineralogical composition, but mostly on polydisperse aerosol particles (see Fig. 7b). Overall, it remains unclear whether the authors attribute the ice nucleation activity observed in the present study to particle composition or to particle size, when comparing to previous parametrizations. This section needs to be revised and more clearly structured upon revision.

We thank the referee for this comment.

We did not investigate the quantitative mineralogical composition in this study, so that there is no solid evidence to explain the discrepancy in terms of mineral composition. Combining the comments of the two referees, we chose to be cautious in explaining the differences with other studies and to focus on the results determined by our experiment. This section was thoroughly rephrased in the revised manuscript:

"Figure 7 (b) compares our size-resolved parameterizations with those from previous studies, based on desert dust (Niemand et al., 2012;Reicher et al., 2019) and single mineral dust components (Atkinson et al., 2013;Niedermeier et al., 2015;Harrison et al., 2019). Niemand et al. (2012) measured surface-collected dust samples (less than 5 µm) to derive the parameterization (solid purple line), which is consistent with our 5.6 µm-fit line (solid red line), and is close to the 1.0 - 3.2 µm-fit line (solid dark green line) for temperatures higher than -17 °C. For different K-feldspar content predictions, an overlap of the new fit lines with previous studies is observed in the temperature range from -25 to -15 °C, particularly for large size particles (5.6 µm and 1.0 - 3.2 µm). At temperatures below -29 °C, the submicron-fit line coincides with the 12% quartz parameterization by Harrison et al. (2019), but is 1 to 2 orders of magnitude higher above this temperature. The supermicron and submicron parameterizations developed by R19 agree within an order of magnitude with our three parameterizations in the lower temperature range (< -23 °C). These two parameterizations underestimate the nucleation activity of large size particles (5.6 µm and 1.0 - 3.2 µm), and fit for the submicron particles for temperatures higher than -20 °C.

We note that the quantitative mineralogical composition was not investigated in this study, so that we cannot explain the discrepancy accurately in terms of mineral composition. On the other hand, while relatively minor, measurement and calculation uncertainties should be borne in mind when comparing our parameterizations with other curves as well. First, different experimental methods introduce measurement errors. A cold stage-based technique was applied in this study, while cloud simulation chamber (Niemand et al., 2012), laminar flow tube (Niedermeier et al., 2015) and many other cold-stage instruments (with varying size/volume droplets; Atkinson et al., 2013;Harrison et al., 2019;Reicher et al., 2019) were used to measure the activated fractions of tested particles/droplets at a given temperature. Then, the investigated particles came from various sources and underwent different processing, including airborne-collected, surface-collected (sieved or milled) samples, and single mineral dust components. Next, the calculation of $n_s(T)$ depends on a key parameter, particle surface area, which refers to the surface area of dust particles in laboratory studies, while refers to the surface area of total aerosol particles in this study and in R19. Furthermore, we adopted aerodynamic diameter to obtain $n_s(T)$, which underestimated the result (0.42 to 0.93 times) compared with that determined by the converted geometric diameter.

These airborne dust particles are composed of a complex mixture of various mineral components (e.g. feldspar, quartz, clay, and calcite), varying particle sizes, biological materials, and anthropogenic fine particulate matter. Its ice nucleation activity was determined by all factors, and dominated by the most active substance. Despite the uncertainties, it is certain that there is an explicit size dependent freezing efficiency over a large temperature range, and the contribution of biological materials to nucleation activity at T > -15 °C is highlighted. Compared with mineral composition-based parameterizations, the advantage of particle size-based curves is that we do not need to know the complex mineralogical composition of dust. Only the particle size distribution, a widely monitored parameter, is required in size-based prediction. Furthermore, there is a vertical distribution of mineral dust in the atmosphere (Maki et al., 2019), implying potentially different contributions of these various size particles in cloud formation. Our size dependent parameterizations can provide more refined simulation and prediction in theory, which needs to be confirmed in further model studies." (L336-368)

2. The authors suggest that the results help to understand the effect of chemical aging (e.g. L66, L73). However, specific aging mechanisms and or effects on the ice nucleation activity of the collected dust particles are not presented. I therefore suggest to remove the discussion of aging from the manuscript, unless a more comprehensive discussion of this topic is provided.

   We thank the referee for this suggestion. Specific measurements and analysis of chemical aging of the collected Asian dust particles are indeed not presented in the manuscript. We deleted the discussion of chemical aging to make the topic clearer. The sentences were rephrased:

   "In fact, reference single mineral dust and surface-collected particles do not fully represent the actual dust transport process in the troposphere due to gravitational dust sedimentation, adsorption of biological materials, and other factors." (L64-66)

   "…the role of Asian dust, especially after long-range transport, …" (L74)

Specific comments:

1. L17: Replace "warm" by "high".

   Replaced (L17, L79, L292, L387).

2. L24: Why is the upper limit -6 °C and not -5 °C, i.e. the upper limit of the presented immersion freezing experiments?

   The upper limit temperature was based on our experimental results. As you can see in Fig. 2(a), Fig. 3(b), Fig. 4(a), Fig. 6(a) and Fig. 7(a), few samples froze at -5 °C, whereas most samples nucleated from -6 °C. So that we define the upper limit of the valid temperature range in this study is -6 °C, as given in Table 3.

3. L35: Delete “in-situ”.

   Deleted as suggested.

4. L38: Change to: “... affects ice particle formation”

   Replaced (L38).

5. L38-40: “simplified parametrizations” and “to accurately predict” seems contradictory; I suggest rephrasing this statement.

   The common goal of cloud studies is to accurately simulate and predict the occurrence and evolution of clouds in models. At the same time, concise and elegant parameterizations are also the pursuit of scientific researchers.

   This sentence was rephrased for clarity:

   “However, parameterizations characterizing INP activity are required to predict the occurrence and evolution of clouds, suggesting that there is a need for measurements of ice formation on different INP types.” (L38-41)

6. L41: I suggest replacing “efficiency” by “ability”, as the former implies some sort of time-dependence.

   Replaced (L41).

7. L43: Add space before parenthesis here and on L44.

   Added. Thanks for the referee’s careful reading, and the full text has been checked.

8. L46: Replace “and so on” by “such as”

   This sentence was rephrased (L45-46):

   “Dust particles are mainly composed of clay minerals (including illite, kaolinite, chlorite, etc.), quartz, feldspar, calcite, and other mineral components.”

9. L47: "High content" and "increasing ratio" of what? Please specify.

   "High content" and "increasing ratio" of the clay minerals.

   The statement was modified (L47-49):

   "Clay minerals were widely investigated in ice nucleation studies (Mason, 1960;Eastwood et al., 2008;Pinti et al., 2012;Wex et al., 2014;Kumar et al., 2019a) due to their high abundance in mineral dust composition (Murray et al., 2012), especially after long-range transport (Leinen et al., 1994;Uno et al., 2009)."

10. L49: Add Kumar et al. (2019)

    Added as suggested (L48).

11. L53: Add Kumar et al. (2019a), Zolles et al. (2015)

    Added (L53).

12. L55: Larger particles often… add Welti et al. (2009)

    Added (L56).

13. L61: Do you mean "enhance the ice nucleation ability to higher temperatures"?

    We followed the comment and rephrased the statement:

    "… extend the ice nucleation ability to higher temperatures" (L61-62)

14. L64-67: How does gravitational settling affect the dust transport and/or ice nucleation activity? Rephrase this statement.

    We followed the comment and added more details:

    "During dust transport, larger particles settle faster due to gravity, while smaller particles can remain lifted for longer period, thus possibly playing a different role in cloud formation (Kramer et al., 2020;Maki et al., 2019)." (L66-68)

15. L69: Change to: "…in differently sized particles…"

    Changed (L70).

16. L71: Change to: "…activity of different…"

    Changed (L72).

17. L75: Change to: "…efficiency of Asian dust and its sensitivity to particle size, airborne…"

    Changed (L76).

18. L77: Change to: "…INP number concentration…"

    Changed (L78).

19. L78: Change "warm" to "high"

    Changed (L79).

20. L81: Climate models? Please specify.

    The $n_s(T)$ parameterizations can be applied in regional and/or global climate models, such as the Single-column version of the Community Atmospheric Model version 5 (SCAM5, Neale et al., 2010), the Consortium for Small-scale Modeling (COSMO, Baldauf et al., 2011), and the global chemical transport model GEOS-Chem (Schill et al., 2020)

References:

- Baldauf, M., Seifert, A., Förstner, J., Majewski, D., Raschendorfer, M., and Reinhardt, T.: Operational convective-scale numerical weather prediction with the COSMO model: Description and sensitivities, Mon. Weather Rev., 139, 12, 3887–3905, doi:10.1175/MWR-D-10-05013.1, 2011.
- Neale, R. B., Chen, C-.C., Gettelman , A., Lauritzen, P. H., Park, S., Williamson, D. L., Conley, A. J., Garcia, R., Kinnison, D., Lamarque, J-.F., Marsh, D., Mills, M., Smith, A. K., Tilmes, S., Vitt, F., Morrison, H., Cameron-Smith, P., Collins, W. D., Iacono, M. J., Easter, R. C., Ghan, S. J., Liu, X., Rasch, P. J., and Taylor, M. A.: Description of the NCAR Community Atmosphere Model (CAM5.0), Tech. Rep. NCAR/TN-486-STR, NCAR, available at: http://www.cesm.ucar.edu/models/cesm1.0/cam/, 2010

- Schill, G. P., DeMott, P. J., Emerson, E. W., Rauker, A. M. C., Kodros, J. K., Suski, K. J., Hill, T. C. J., Levin, E. J. T., Pierce, J. R., Farmer, D. K., and Kreidenweis, S. M.: The contribution of black carbon to global ice nucleating particle concentrations relevant to mixed-phase clouds, Proceedings of the National Academy of Sciences, 117, 22705, 10.1073/pnas.2001674117, 2020.

21. L86: Please specify the time resolution.

    Changed to "…minute-level temporal resolution meteorological parameters…" (L87).

22. L89: "A 8-stage…"

    Changed to "An eight-stage…" (L90).

23. L90: Change to: "We used stages 1 to 8 of the…at a flow rate of 30 L/min in this study." Move reference of Marple et al. (1991) to L89.

    Corrected.

    "We used stages 1 to 8 of the MOUDI with cut-points (D_{50}) ranging from 10 to 0.18 μm in aerodynamic diameters at a flow rate of 30 L min^{-1} in this study." (L92-93)

24. L93: Delete "text"

    Deleted.

25. L104: Delete: "operated after careful temperature calibration"

    Deleted.

26. L108: How did the authors ensure that everything was washed of the filters? Was there any evidence from more sticky aerosol components, such as secondary organic material associated with the mineral dust particles?

    We thank the referee for this comment, and added related information.

    We did an experiment of particle washing removal efficiency to ensure that particles were washed off the filters, as depicted in Fig. R1.1. The tested filter was collected from a dust event in 2018, and all the extraction processes were the same as those described in the manuscript except for the extraction time. This Nuclepore filter was completely submerged in 20 mL double-distilled water (resistivity of 18.2 MΩ·cm at 25 °C) and was extracted by an ultrasonic shaker for 15 minutes to get the sample called “15 min - 1st” in Fig. R1.1. Then the filter was removed from the washed suspension and was immersed in a fresh 20 mL double-distilled water for a second extraction cycle to obtain the sample called “15 min - 2nd”. The sample “15 min - 3rd” was produced similarly in a third extraction cycle.

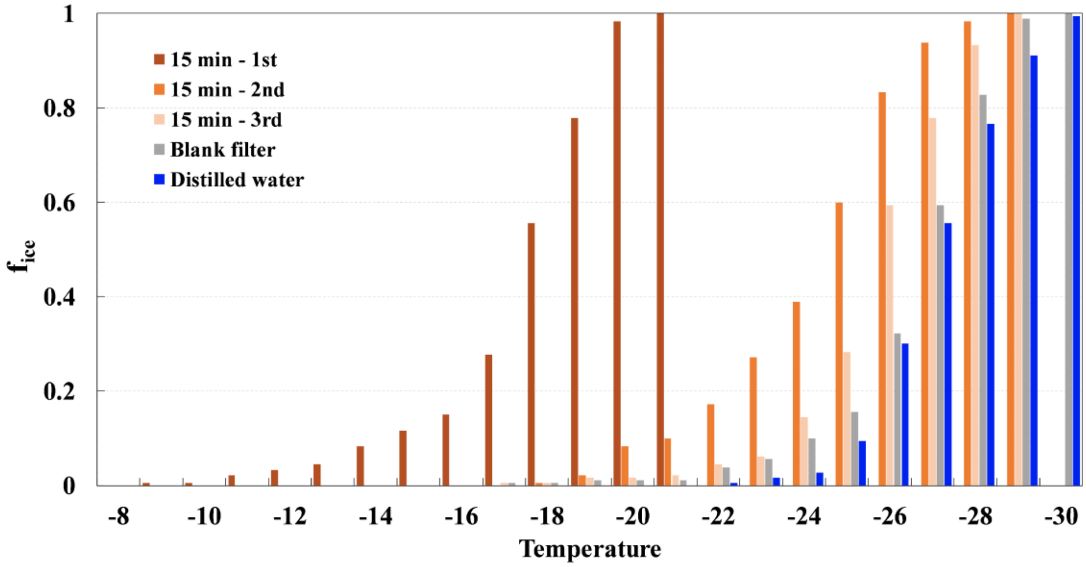

Figure R1.1. Particle washing removal efficiency experiments. The brown, orange and light orange bars represent the frozen fraction (f_{ice}) of the solution at different temperatures after the first, second, and third ultrasonic treatment, respectively. As comparisons, the grey and blue bars are the droplet freezing experiments for blank filter and distilled water, respectively.

The freezing of the three samples indicated that most of the particles were extracted efficiently in the first cycle, which had higher frozen fractions at higher temperatures than rest of the samples. Indeed, some of the particles remained over the filter, but a longer extraction periods would not impact the freezing results, since there was only minor overlap between their freezing temperatures. Therefore, 15-minute ultrasound treatments for twice (i.e., 30 minutes) can wash all ice active materials off the filters. As for the more sticky aerosol components, we think they were also eluted into the aqueous solution according to our results.

The above content was detailed in the revised manuscript and supplementary information.

"The extraction process lasted 30 minutes, … (see Supplementary Information, referred to as SI from here on, for more details)." (L110)

27. L120: Change to: "…concentration of ice active sites above…"

    Changed (L123).

28. L123: Change to: "is calculated as: …"

    Changed (L127).

29. L125: Change to: "…activity of samples with different aerosol particle size…"

    Changed (L129).

30. L127: Change to: "…(Vali et al. 2015) is calculated from the INP concentration as:…"

    Changed (L131).

31. L128: "and per droplet"?

    We gratefully thank the referee for the careful reading.

    In Eq. (3), parameter *A* should be the total surface area of the particles per unit volume of sampled air. The error in the text has been corrected. We make sure the calculations and results are correct.

    "where *A* is the total surface area of the particles per unit volume of sampled air, …" (L132)

32. L128: Delete "based on the particulate matter information"

Deleted.

33. L130: I do not follow this statement, please expand.

    We followed the comment and added some detailed explanations.

    A principal source of uncertainty in the experiments stems from the representativeness of testing droplets for the total suspension, especially for the scenario that only a minor fraction of droplets contains ice active particles. We added more discussion about this statement as follows:

    "The INPs are scarce in the air, thus their number presented in the washing suspension is usually small. These small volume droplets (1 µL) may not contain a representative number of particles, and the number of examined droplets is limited (90 droplets)." (L136-138)

34. L131: Delete "population"

    Deleted.

35. L133: Rephrase to. "Following the method of O'Sullivan et al. (2018)…"

    This statement has been reworded to "Following the method of O'Sullivan et al. (2018) and Barker (2002), …" (L139)

36. L137: Add "each particle size class"

    Added (L143).

37. L143: Change to: "ultrafine condensation... »

    Changed (L150).

38. L184: Change to: «…indicating different ice nucleating…"

    Changed (L193).

39. L193 vs. L195: Please write out "2" as "two" for consistency

It was uniformly written as “2” (L202). The same question was reworded as “2 orders of magnitude” in Line 372 for consistency.

40. L227: Change “efficiency” to “ability”

Changed (L241).

41. L230: “The higher…” Do the authors have any particle data to support this claim? Are there other studies that suggest the northwest pathway to be associated with a higher feldspar content?

We did not measure the mineral compositions in this study and no reliable evidence to support this view. Combined with other comments from the two referees, we decided to downplay the mineral fractions and focus on biological materials, which has been confirmed by reliable measurement results.

Here, the sentences have been modified:

“On the one hand, previous studies have shown that Chinese deserts have distinct zoning characteristics; The north-western deserts are characterized by relatively higher amount of feldspars, while in the northern sandy lands, quartz mineral is more common (Zhao, 2015). The two dust sources in this study are consistent with these two desert regions. On the other hand, the high ice nucleation activity above -15 °C may be attributed to the attached biological materials on the dust particles (Tang et al., 2018). The reasons for the different INP activity of two pathway samples are discussed in detail below.” (L241-246).

42. L233: Change to “Figures 4 (a) and (b) compare…”

Changed (L248).

43. L236: Add a sentence along the lines: “The ns values of this study are compared to literature values.”

Added (Line 252).

44. L237: Change to "…desert in Africa"

    Changed (L253).

45. L243: Change to: "The difference in the temperature range between this study (…) add R19 (…) is due to the droplet volume…"

    Changed (L258-259):

    "The difference in the temperature range between this study (-25 to -5 °C) and R19 (-35 to -20 °C) is due to the droplet volume (0.5 nL in R19, in contrast to 1 μL in the present study)."

46. L246: Change to: "…demonstrate that despite different origins of the dust samples investigated here and in R19, as well as the varying atmospheric transport..."

    Changed (L261-262):

    "…demonstrate that despite different origins of the dust samples investigated here and in R19, as well as the varying atmospheric transport processes, …"

47. L248: Delete "great" (it seems also a bit contradictory with the statement on L250).

    Deleted (L262)

    We also qualified the "similarity" into "within 1 or 2 orders of magnitude" (L262) and rephrased the statement in L265:

    "However, some samples in this study were more active than the measurements in the above two studies. Three hypothesizes are proposed to explain the possible reasons."

48. L253-255: Is this known? This statement should be supported by appropriate references

    We have rephrased the statement:

    "Some efficient samples in this study were mainly from northwest China (see Sect. 3.2), and we cannot exclude the effect of feldspar content on ice nucleation activity when comparing dust particles from different deserts. Note that this is only a possible conjecture based on very limited evidence, and more further studies are needed." (L268-271)

49. L258: "The near-surface…" This is unclear, here you compare ns, which is normalized to particle size/surface area, or am I misunderstanding you here?

In light of the difference in the vertical distributions of dust particles, we believe that there may be more large particles in the near-surface-collected samples than that collected in an aircraft. An explicit size dependence of surface ice active site density has been confirmed in this study. Hence, near-surface-collected samples may show higher $n_s(T)$ than the aircraft measurements.

The statement has been modified:

"…, the concentration of larger particles near the ground is higher (Maki et al., 2019), suggesting that the n_s (T) values of near-surface-collected samples may be higher, i.e., they may show more efficient INP activity than the aircraft measurements." (L272-274)

50. L260: "…to be more active INPs" compared to dust?

The statement is not clear and it has been rephrased:

"…which are considered to be more active INPs than dust particles…" (L275)

51. L262: Delete "green"

Deleted.

52. L264-265: Can be reduced to 2-3 main references, as you detail these studies in Sect. 3.4.

We followed the comment and reduced the number of references (L279).

53. L270: Replace "population" by "number concentration"

Replaced (L285).

54. L272: Add: "…ice nucleation"

    Added (L287)

55. L274: Delete space in front of D50

    Deleted (L289).

56. L275: "and" should not be italicized

    We followed the comment and reset the font (L290).

57. L277: Replace "warm" by "high"

    Replaced (L292).

58. L280: Do the indicated uncertainties correspond to standard deviations for the 12 samples? Please specify here and in the caption of Fig. 5.

    We followed the comment and added a related definition and introduction in the revised manuscript and supplement information.

    The indicated uncertainties correspond to the standard deviation of 12 samples at each temperature. Related information was added in L297 of the revised manuscript and in the caption of Table S3 of SI. There was no uncertainty information in Fig. 5. Thus, we didn't add more about it.

    "The above uncertainties correspond to the standard deviation of 12 samples at each temperature." (L296-297)

59. L290-293: This contradicts your hypothesis presented in Sect. 3.3. that different feldspar content contributes to different freezing abilities." There is not sufficient evidence provided to claim/suggest a difference in mineralogical composition between the two transport pathways. I suggest to completely leave this out and focus on the aspect of the biological fraction, where direct measurements and support is provided by your data. Please see my main comment above.

    We thank the referee for this kind suggestion and partly followed the comment.

In the revised version, we replotted the figure and added detailed comparison between two pathways, emphasizing the contribution of biological materials. However, the nucleation activity of all northwest samples was higher than that of the north samples, so that we think the possibility of mineral composition should not be completely ignored.

"However, it should be noted that the nucleation activity of all northwest samples was higher than that of the north samples, suggesting that there might be a difference in mineral composition (e.g., feldspar content), although it was far less important than the contribution of biological materials." (L311-313)

60. L296: Change "can't" to "cannot"

    Changed (L316).

61. L304: Replace "Where" by "Here"

    Replaced (L325).

62. L313: Replace "the first two lines" by "…between the lines of D50 = 5.6 μm and the ns curve for submicron particles."

    Replaced:

    "…between the fit lines of D_{50}= 5.6 μm and submicron particles." (L334)

63. L317: "1.0 ~ 3.2 μm" I assume this line corresponds to the average of the D50 = 3.2, 1.8 and 1.0 μm lines which overlap in Fig. 7a, right? This should be specified in the text. I also suggest to replace "~" by "-" and chose a color that is distinctively different to any color used for the individual lines to avoid confusion.

    We followed the comments and rephrased the statement for clarity:

    "… the $D_{50} = 3.2, 1.8$ *and* 1.0 μm lines were averaged into one, 1.0 - 3.2 μm-fit line, as shown in Fig. 7 (b)." (L335)

    The "~" in "1.0 ~ 3.2 μm" has been replaced by "-" throughout the paper.

    And the color of the "1.0 - 3.2 μm-fit line" is changed to dark green in Figure R1.2.

(Modified Fig. 7).

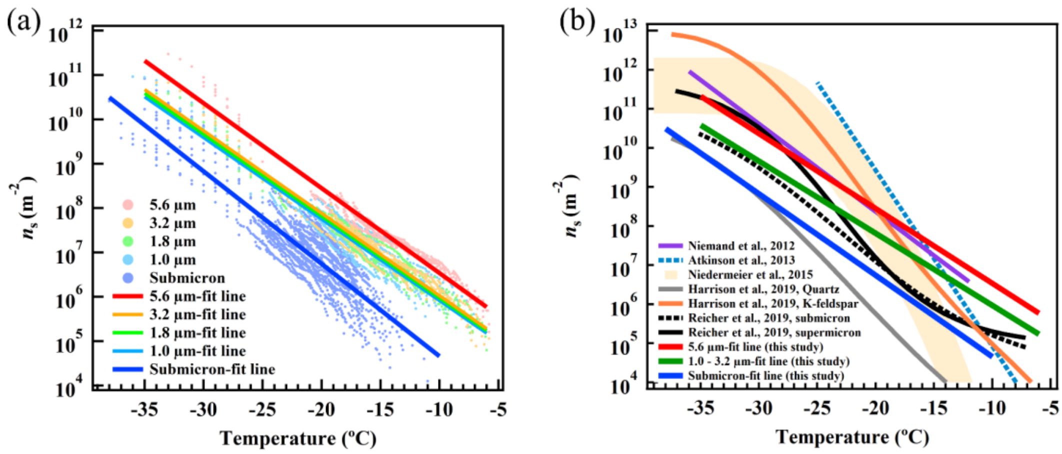

Figure R1.2. Modified Fig. 7

64. L319: "was less than 1 to 5 µm": Do you mean "below 5 µm"?

Rephrased.

"…less than 5 µm" (L338)

65. L322: contain more highly ice active minerals"

Sect. 3.5 was reorganized and this sentence was deleted.

66. L323: Delete "exactly"

Deleted.

67. L324: "-25 °C". From the figure it appears to be more likely "-29 °C".

We followed the referee's comment and corrected it.

"At temperatures below -29 °C, ..." (L342)

68. L324-325: "This phenomenon can…" If this was the case, why does your submicron parametrization deviate strongly from the quartz parametrization of Harrison et al. (2019) at higher temperatures? Is this because feldspar ice nucleation activity dominates at higher temperatures? This should be specified.

The ice nucleation activity at higher temperatures might be attributed to feldspar and biological materials. However, we cannot tell how much these factors contributed based on available results. We pointed out existing uncertainties and interpreted the difference cautiously:

"At temperatures below -29 °C, the submicron-fit line coincides with the 12% quartz parameterization by Harrison et al. (2019), but is 1 to 2 orders of magnitude higher above this temperature." (L342-343)

69. L333: Replace "components" by "factors"

    Replaced (L362).

70. L334-335: "…are more active…" Compared to what? The Atkinson et al. (2013) K-feldspar line?

    Sect. 3.5 was thoroughly reorganized and this sentence was deleted.

71. L335: « Overall… » This statement seems misplaced and should be moved to Sect. 4

    Corrected.

72. L342-343: Please see my comment above. Your data suggest that the difference is mainly driven by a difference in the biological material present on the dust particles from the two transport pathways.

    We followed the comment and rephrased the statement in the revised version:

    "… dust particles transported from China's northwest and northern deserts have different INP concentrations and ice nucleation efficiencies." (L374-375)

    "And the average concentration proportion of heat-sensitive INPs was higher in northwest than in north pathway, indicating that the most discrepancy in nucleation activity between the two pathways was attributed to the abundance of heat-sensitive INPs, although the presence of different mineral fractions cannot be excluded." (L384-387)

73. L354: Replace "warm" by "high"

Replaced (L387).

74. L355: Are you trying to say that Asian dust has a higher abundance of biological material compared to desert dust?

We rephrased the sentence:

"These results not only explain the higher nucleation activity exhibited by our samples at relatively high temperatures (above -15 °C), but also emphasize the important role of biological materials during the seasonal Asian dust transport process." (L387-389)

75. L362: "…emphasizing the importance…" I suggest to tune this down a little bit: "…potentially suggesting the importance of larger particles for cloud formation."

Corrected. (L394)

76. L363: "as particle size reflects … » This statement should be support by references.

There are clearly different mineral types, contents and assemblages between different-sized fractions, thereby indicating clear grain-size dependence of mineral composition (Krippner et al., 2015; Xie et al., 2020).

However, these discussions are hardly to be found within the field of atmosphere and ice nucleation researches, so that we deleted this sentence.

References:

- Krippner, A., Meinhold, G., Morton, A. C., Russell, E., and von Eynatten, H.: Grain-size dependence of garnet composition revealed by provenance signatures of modern stream sediments from the western Hohe Tauern (Austria), Sedimentary Geology, 321, 25-38, 10.1016/j.sedgeo.2015.03.002, 2015.
- Xie, Y., Liu, L., Kang, C., and Chi, Y.: Sr-Nd isotopic characteristics of the Northeast Sandy Land, China and their implications for tracing sources of regional dust, Catena, 184, 10.1016/j.catena.2019.104303, 2020.

77. L364-365: “Due to the single requirement…” Unclear what you mean, please rephrase.

We rephrased the sentence:

“Since only particle size distribution is required as an input without particle mineralogical compositions, the new particle size-based parametrizations can be widely applied in models, …” (L396-498)

78. Fig. 3: Why are there two blue lines coming from the northwest pathway, i.e. lie on top of the red trajectories?

The blue lines represent the north pathway and consist of three samples (M3, M5, D6). These 72-hour back trajectories were initiated at the beginning of each sampling period, and started a new trajectory every 1 or 2 hours until the end of the sampling period. There were 12 lines in sample M5 (see R1.3), and the 2 (actually was 3) blue lines were part of them, indicating that the wind direction changed during the sampling period. However, most dust particles were originated from the north pathway.

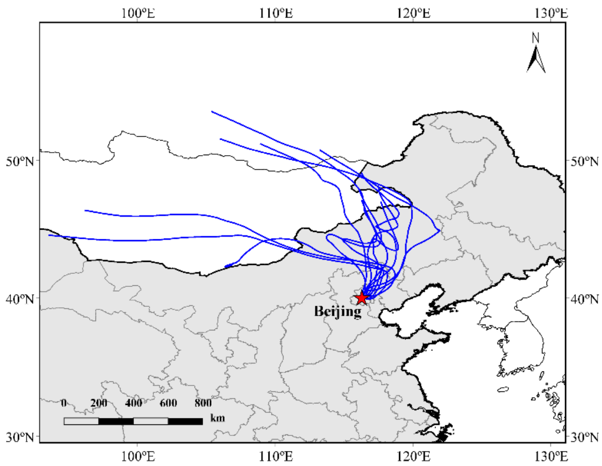

Figure R1.3 Air mass trajectories of sample M5.

79. Fig. 5: Include space between value and unit, i.e. “10 °C”

Corrected.