We thank Dr. Jie Chen and an anonymous reviewer for their comments and time. We have addressed all of Dr. Chen's comments and made changes to the manuscript as advised.

Dr. Chen's report

"In the revised manuscript submitted by Tarn et al., the authors have addressed most of the questions posed by the reviewer. However, I have noted some minor comments that should be considered before its publication in Aerosol Research."

Minor comments:

1. ***This statement is confusing: "Size-resolved INP analysis has demonstrated that ice-nucleating activity during dust events increased with increasing aerosol particle size and concentration, and that the activity of supermicron particles was similar for different dust events, suggesting that common mineral species were controlling ice nucleation"***

   What is meant by "ice nucleating activity"? If it refers to the ice nucleating activity of the dust aerosol, it would be affected by the concentration of aerosol particles. Conversely, if it refers to the ice nucleating activity of individual dust particles, it would not be influenced by concentration. Additionally, what specific chemical components are indicated by "common mineral species"?

Response:

This alludes to the possibility that different parts of the ice nucleation community mean "activity" in different ways, e.g. some might mean it to be concentration. Here, the "ice-nucleating activity" refers to the number of ice active sites per unit [dimension] of material, typically per unit surface area ($n_s(T)$) or per unit mass ($n_m(T)$), i.e. the density of ice active sites together with the activation temperature of those sites (assuming the singular approximation). Normalisation of the INP concentration to surface area or mass provides a means of comparing INPs across materials and locations (where concentrations will vary). Therefore, INP concentration might not necessarily correlate with ice-nucleating activity (in terms of $n_s(T)$), but it did in the stated case. The "common mineral species" comment refers to materials that are common across the regions of interest (i.e. commonality) rather than being "typical" minerals (although this is also the case given that K-feldspar is expected to dominate the INP population given its presence in the region). We have reworded this slightly and hope that it is more clear:

> "*Size-resolved INP analysis has demonstrated that ice-nucleating activity during dust events increased with increasing aerosol particle size and concentration, and that the activity of supermicron particles was similar for different dust events, suggesting that mineral species common across these regions were controlling ice nucleation (Reicher et al., 2018; Reicher et al. 2019).*"

To try to make clear what we mean by "activity" in this case, we have also now added a definition of activity, as opposed to concentration, as being $n_s(T)$ throughout this paper by stating this in the first instance in which "activity" is mentioned in the Introduction.

2. ***Figure 6: The parameterization for fertile soils from O'Sullivan et al. [2014] is not displayed in this Figure.***

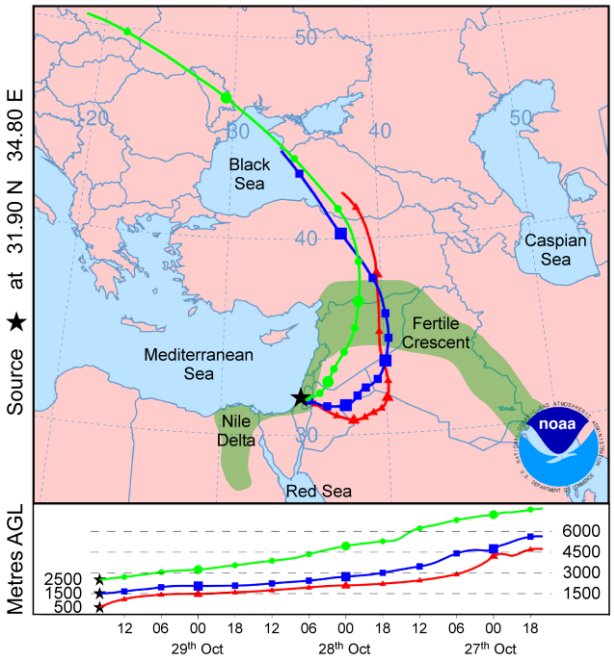
Response:

We apologise for this oversight, O'Sullivan 2014 was shown in the original submitted version of the paper but a slightly different version of the figure was used in the revision and O'Sullivan was unfortunately missing. We have added the O'Sullivan 2014 fertile soil parameterisation back into the plot.

3. ***Can authors mark the Fertile Crescent region in Figure 3 or other places of interest (e.g., black sea)? Alternatively, the authors may consider creating their own plot.***

Response:

We have modified Figure 3 to show land and water more clearly, and have marked important regions discussed in the text such as the relevant seas and the Nile Delta. We have also marked the approximate region of the ancient Fertile Crescent:



4. ***Section 3.5: It seems that samples collected from clean and dust days have comparable ice nucleation activities. Does this suggest that dust particles do not significantly influence the ice nucleation activities of the observed aerosols?***

Response:

On the contrary, the fact that the active site density curves below ~−18 °C are similar, despite the dust surface area varying substantially, is consistent with the dust controlling the INP population in this regime. As we say in the text, it is consistent with about 1 wt% K-feldspar, as per the Harrison et al. (2019) parameterisation.

5. ***The authors claimed that samples have lower ice nucleation activities compared to fertile soils. Does this imply that the contribution of fertile soils is insignificant? Testa et al. [2021] also reported ice nucleating particles from agricultural emission, maybe add these results from comparison. How about other dust sources? Did authors consider other dust sources, for example, anthropogenic dust from cities as indicated in Chen et al. [2024].***

Response:

Testa et al. only provide their data for INP concentrations, which cannot be directly compared to our data given the different locations and environments. We have added the anthropogenic INP parameterisation from Chen et al. to Figure 1c and discuss it briefly in the text but given that this is also in terms of INP concentration, rather than ice-active site density (e.g. $n_s(T)$) (please see response to comment 1), and the environments between the two are very different, we can only suggest that anthropogenic dust could have an influence, although given the $n_s(T)$ values discussed later in the manuscript we believe that the INP population is largely dominated by K-feldspar. We have reworded this addition thus:

> "*The recent parameterisation for anthropogenic INPs of Chen et al. (2024), which uses supermicron aerosol concentrations to estimate heat-resistant INP concentrations from sources*

such as traffic-influenced road dust, sits at the top-end of our INP data below about −15 °C, though the sampling site, being in a ubiquitously dusty environment and prone to air masses from varied locations, was a very different to the metropolis from which the parameterisation was derived. It is therefore difficult to compare the parameterisation directly in terms of INP concentration, but given the presence of mineral dust in the region, particularly of K-feldspar, the influence of anthropogenic dust is not expected to be a dominant source of INPs."

In the later discussion of $n_s(T)$, we have added parameterisations for Wyoming agricultural soil and China loess dust to Figure 6 and brief discussion that our results are lower than would be expected for such soils.