

This study developed and implemented a sub-grid parameterization for dusty cirrus over Europe in ICON-D2-ART model. The authors tested the parameterization during six Saharan dust episodes over Europe. It turns out that this sub-grid parameterization performs remarkably well in two of the selected cases. Overall, this is an innovative and interesting study. It fits well within the scope of ACP. However, I have concerns regarding the representativeness of the selected six cases. Also, there are too many figures in the main text. I have some specific comments as well.

#### General comments

1. Why are these six cases selected? How do the first three cases in Table 1 represent the dusty cirrus phenomena in Europe? More importantly, how do the last three cases represent the dust events with no occurrence of dusty cirrus? Specifically, how many dust episodes occur in one year in Europe? How many of these dust events have dusty cirrus and how many of them does not?
2. Analysis in Section 3.4 is performed using the six selected dust events, half of which are dusty cirrus cases. Following the above questions, I have concerns on the representativeness of the six cases for the yearly dust events in Europe. Dusty cirrus occurs in half of the six cases. However, it seems dusty cirrus is a rare phenomenon in Europe and thus, presumably, there are much more dust events that do not accompany with dusty cirrus. Therefore, it is not fair to evaluate the overall performance based on the six selected cases. Ideally, the authors should analyze all the dust events in one year. Or at least, the authors should analyze the cases with dusty cirrus and without dusty cirrus separately. More no dusty cirrus cases will be needed to increase the representativeness of such cases.
3. There are too many figures (22 figures) in the main text. Please consider move some to the supplement. For example, you may shorten Section 3.2 and move the related figures to the supplement because this case has similar results to the first one.

#### Specific comments

1. Figures 1, 3-5, 11-13, and 15-17. To help readers better identify the regions of these maps, please add latitude and longitude tick markers.
2. Section 2.1 and 2.2. It is not clear enough until I read the first paragraph of Section 3 that the ICON-D2-ART model includes dust-cloud interaction on grid scale, and the dusty cirrus parameterization is a sub-grid parameterization. Please clarify it. For example, reword the title of section 2.2 to "A sub-grid parameterization of dusty cirrus".

3. Line 68-69. Please explain which mode has the smallest size and which one has the largest size here. If possible, please give a rough estimate of the size range for each mode.
4. Eq (3) and Line 144-147. DeMott et al. (2010 and 2015) parameterizes ice nucleating ability using aerosol/dust number concentrations. Some other studies describe INP concentration based on dust surface area (e.g., Ulrich et al. 2017). By using dust mass concentrations in this study, the increased ice nucleating ability of dustC mode is already naturally considered, because coarser dust particles contribute more to total mass. I have no problem with further doubling the weight for dustC, but please explain it more clearly.
5. Table 2. How is dust treated in the no dust simulation? What does climatological dust mean? If it does include dust representation, the name “no dust” may be misleading.
6. Line 279 and Line 281: “ice condensation nuclei”. Should be “INPs”.
7. Line 322. What is microphysical aging and how does it contribute to the bias?
8. Figure 6. Please explain the differences between bias and MAE. It can be included either in the figure caption or the main text.
9. Line 381-382: “dusty cirrus formation is the dominant aerosol-cloud-radiative effect of mineral dust over Europe”, and same statement appearing in the abstract. Still related to the representativeness issue mentioned in my general comments, it is not safe to make such statement, because it is very likely that you do not include all the dust-cloud interaction cases.
10. Line 380-385: “The fact that... very weak in ICON-D2-ART”. This part is not clear to me. Figures 21 and 22 show model biases as a function of dust optical depth. I agree that the sub-grid parameterization reduces model biases over all the dust loading. But it seems the absolute radiation fluxes (colors of the scatters) do decrease with dust optical depth. Then, why is it concluded that the new parameterization removes aerosol sensitivity?
11. Figures S3, S4, and S7. Are these two figures identical to Figures 6, 14 and 18, respectively? If so, please remove these two figures in the supplement. If there is any other duplicate figure in the supplement, please remove them as well.
12. Figure S61: caption. Please confirm whether it is May 15 or May 5.