

## Reviewer 1)

The article demonstrates a high level of quality overall, with no issues identified in its structure, methodology, or results.

Only a few minor technical corrections are recommended, as outlined below:

- Figure 2 contains a labeling error: the panel for Iron fraction in arid soils should be labeled (I) instead of (j), and the caption should also indicate 'iron (I)' for consistency.
- It would be beneficial to provide a brief justification for the selection of the specific physical schemes listed in Table 2. Explaining why these parameterizations were chosen, particularly in relation to the model's objectives, the study region, or their known performance in similar configurations, would strengthen the methodological transparency and scientific rationale of the work.

We would like to thank the reviewer for his comments and recommendations. Specifically:

- 1) The Figure 2 labeling error, along with the caption, has been corrected.
- 2) A brief justification of the selected physical schemes has been provided, and the pertinent publications have been added. More specifically the following paragraph has been included after Table 2: The physical parameterizations schemes chosen are selected due to their previous performance in similar studies. For instance, the same configuration was used in Solomos et al., 2023 for the sensitivity simulations for the METAL-WRF development. Additionally, the same parameterizations were used in Spyrou et al., 2022 where a dust source map was created for the Saharan desert (excluding the use of a newer cumulus scheme in this work) and other similar works (i.e. Drakaki et al., 2022). For the microphysics, surface and radiative transfer schemes specifically, the choices made are also suggested by the WRF-ARW user setup guide (Skamarock et al., 2021) and have been successfully used in a number of other publications (Kampouri et al., 2021; Varlas et al., 2021 and others)

## Reviewer 2)

The overall quality of this article is very high, and I have no objections regarding its structure, methodology, or results.

A few minor technical corrections are suggested below:

- Lines 137 & 141: the "index" subscript in the equation is not correctly formatted.
- Lines 148-150: the list could be rewritten to make it more symmetrical and consistent, e.g.: "[...] **(i) in the first simulation**, the dust and associated minerals are treated [...]; **(ii) in the second set** of simulations [...]"
- Line 396: "[...] for each mineral-dust type **using the METAL-WRF model**.";
- Line 401: "[...] calculations, and [...]"

We would like to thank the reviewer for his comments and recommendations. For the technical corrections:

- 1) The "index" subscript in the equation has been corrected.
- 2) The list in Lines 148 – 150 has been rewritten as per the reviewer suggestions.
- 3) Changed the text according to the reviewer suggestions.
- 4) Changed the text according to the reviewer suggestions.