

We thank the reviewer for the additional, thoughtful comments on the revised manuscript. Our responses are provided below.

Thanks the authors for the clarification of their objective of this study and detailed responses. I have several comments to follow.

#### General Comments

1. As the author responded in the general comments, the focus of their study is the interannual variability instead of absolute dust emission fluxes. I recommend modifying the title accordingly to add “interannual variability of windblown dust emissions” to avoid confusion.

Response: Thank you for the suggestion. The manuscript title has been revised to “The relative importance of wind and hydroclimate drivers in modulating the **interannual variability** of dust emissions in Earth system models”.

2. As a general comment for the focus of this study, if it is argued that there is no observational data available for the evaluation of dust emissions, the discussion of the interannual variability of dust emissions in this study is purely inter-model comparisons. Then the analyses are the simulated explainability of wind and hydroclimate parameters from different models, which could be the real relative importance or simply model failure. Then what would be the significance, or informative guidance from this study?

Response: A significant aspect of this study is comparing multi-model dust simulations through the lens of the relative importance of dust emission drivers, which reflects the inherent nature (i.e., unobservable, highly model-specific) of simulated dust emission fluxes. This presents a new framework for diagnosing model behaviors and biases. While our analysis is based on inter-model comparison, it reveals potential biases in how models represent the physical coupling between dust emissions and their driving factors. For instance, GFDL-ESM4 and CESM2-CAM-Kok are found to overestimate the hydroclimate influence and underestimate the wind influence over hyperarid regions.

3. As the relative importance of wind and hydroclimate parameters is the focus of this study, and wind speed is especially sensitive to model resolution. I recommend recognize the importance of model resolution for careful interpretation of the relative importance of wind and hydroclimate parameters. Their importance could be swapped at different spatial resolutions.

Response: We agree that model resolution plays an important role in simulating near-surface wind strength and total dust emission fluxes. But, because most models tune the threshold wind velocity or soil erodibility maps to produce reasonable dust emission patterns, we expect the model resolution to have small effects on the *temporal covariability between wind speed and dust emissions*. This is supported by our results

over the hyperarid climate zone, where dust emission is predominantly controlled by wind speed in most ESMs, regardless of the model resolution. Models with finer resolutions (e.g., CESM and GFDL-ESM4) do not necessarily capture the dominant wind control in the hyperarid zone, compared to coarser-resolution models.