Geoscientific Model Development Discussions

Geosci. Model Dev. Discuss., referee comment RC1
https://doi.org/10.5194/gmd-2022-232-RC1, 2022

Comment on gmd-2022-232

Anonymous Referee #1

Referee comment on "Data-driven aeolian dust emission scheme for climate modelling evaluated with EMAC 2.55.2" by Klaus Klingmüller and Jos Lelieveld, Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2022-232-RC1, 2022

This manuscript from Klingmüller and Lelieveld presents a dust scheme that leverages techniques from machine learning (ML) to help represent dust emitted from arid and semi-arid regions. The model setup is well described and the comparison with observations is sufficiently clear to appreciate regions where ML improves upon the classical representation of dust emission that is currently used in the EMAC model used by this group. The paper is sufficiently well written to warrant publication but I would like to see minor questions answered that can improve on it and help the reader follow the choices that have been made in this work.

A first thing that should be explained since it is can be seen as both a wise or a curious choice is why the authors choose to compare the model results to the dust aerosol optical depth at 10 mm instead of the more classical comparison at a wavelength of 550nm.

Lines 73-75: please explain to the reader why you need to normalize surface friction velocity, soil moisture, snow depth, KAI, geopotential and clay fraction, is it inherent to the way the ML technique is used? It is hard for the reader to guess.

Line 109: you imply that the dust emissions are injected in the first 4 lowest layers of the model, if that is the case, please give the rational of why you chose to do that instead of injecting dust in the lowest model layer and what are the averaged heights of these first 4 layers.

Line 123: the text seems to indicate that aerosol wet scavenging is a function of total precipitation in a model gridbox. Physically, this is not the choice since aerosols are scavenged as a function of the amount of precipitation formed in the aerosol layer and is also dependent on the rate of precipitation coming from above. Please explain better the choice made here.

Line 143: this is the first time you mention f_loss which is defined below in line 155. You should at least introduce what f_loss represents before this line.

Lines 177-178: "The temporal correlation coefficients of the observed and predicted hourly DAOD values within each grid cell are typically greater than 0.5 over the regions affected by desert dust (Fig. 3)." You give the impression to the reader that the correlation coefficients are always above 0.5, as you describe later on in the paper it might be the case for spring and summer and it is not the case for the 2 other seasons.

Caption of Figure 1: Please spell out that MAE stands for mean absolute error and RMSE stands for random means square error.

Color chart in Figure 3: the use of red and saturated red make it difficult to appreciate the differences between regions that have a correlation coefficient of 0.5 compare to 0.7 or even 0.9. Please take a color scale that allows to appreciate this differences more accurately.

Line 198: To appreciate an annual mean emission of 4.3 Gt/yr it would be informative to give the fraction of this emission that are particles below a diameter of 1mm since they will influence much more the shortwave and Kok et al., (2017) have established a constraint on this fraction as well as on the total emission. Please indicate what is the cutoff of the dust size distribution in your model for comparison with other models. It would be of interest to know how much you emit for the larges regions emitting dust (see paper by Kok et al 2021)

Line 219: When you explain how EMAC DAOD is obtained when dust and seasalt are present, you should indicate the assumptions made for the density of dust and of seasalt to allow other researchers to make a comparable evaluation.

Color bar of Figure 7: you should extend this color bar as the AOD scales of 0.0, 0.1,... 0.8 are too close one another to be legible.

You could have pushed further the comparison with observations by comparing yearly mean dust deposition over the globe, this is done et Checa-Garcia et al., (2021) for instance.

Thank you for this interesting contribution.

References:

Kok et al., 2017, Smaller desert dust cooling effect estimated from analysis of dust size and abundance, Nat com., doi: 10.1038/ngeo2912

Kok, J. F., Adebiyi, A. A., Albani, et al., 2021: Contribution of the world's main dust source regions to the global cycle of desert dust, Atmos. Chem. Phys., 21, 8169–8193, https://doi.org/10.5194/acp-21-8169-2021.

Checa-Garcia, R., Balkanski, Y., Albani, S., et al.: Evaluation of natural aerosols in CRESCENDO Earth system models (ESMs): mineral dust, Atmos. Chem. Phys., 21, 10295–10335, https://doi.org/10.5194/acp-21-10295-2021, 2021.