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Interactive comment on "Grid-independent High Resolution Dust Emissions (v1.0) for Chemical Transport Models: Application to GEOS-Chem (version 12.5.0)" *by* Jun Meng et al.

Anonymous Referee #1

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General comments:

In this paper, Meng et al. proposed a grid-independent dust emissions module for CTMs (GEOS-Chem in this case), where dust flux is being calculated a priori and offline within the emissions module (HEMCO in this case). In essence, this approach seems to be replacing the error due to interpolating meteorological fields with those due to interpolating the final dust flux. Considering nonlinear relations between meteorological fields and calculated dust fluxes, I am concerned about using this interpolated dust flux together with the interpolated meteorological fields later in a CTM to represent dust transport, diffusion, deposition, etc. The benefit of an online approach (other

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than the aerosol feedback) is a physical consistency between wind, relative humidity, temperature, soil moisture, etc. representing both dust emissions and other phenomena such as dust transport and deposition, and I am not convinced that the offline approach provides the same faithfulness. Along that line, I found a number of major issues both with the proposed approach as well as its evaluation as summarized in the next section.

Specific comments:

1/ If the only major benefit of the offline approach is a better resolution, simulations should be conducted with various grid resolutions rather than just contrasting the two extremes (2deg x 2.5deg vs. 0.25deg x 0.3125deg). Specifically, comparisons should be conducted to ensure that the online and offline techniques indeed give the exact same dust flux with the same grid resolution.

2/ The soil moisture (another important meteorological factor) was not mentioned when using the offline approach. Wind and soil moisture are dynamically linked and should be represented and discussed.

3/ Based on the scatterplots in figures 3 and 4, the offline model seems to almost always give higher dust emissions, but figure 2(f) shows considerably lower values from the offline model over the Sahara and Sahel. Please discuss this inconsistency. Also, along that line, figure 3 should include a comparison between spatial distributions of online vs offline (overlaid with the AERONET obs) AOD. Perhaps replace the DOD/AOD column and move it to the Supplement?

4/ Throughout the abstract, main text, and conclusion sections, the offline model is argued to better resolve weak dust source regions, but no evaluations are provided for these regions.

5/ I see no connection (and in fact no scientific merit from the physics point of view) between the scaling factor and the offline approach. The scaling is not an advantage

of the offline model as described in sec. 3.3. An online model can also be scaled using the parameter “C” in Eq. (1) of the Supplement. Additionally, the paper misses the justification behind the chosen scaling factors as well as a detailed evaluation.

6/ Additional computational time required for calculating dust fluxes in HEMCO when using the offline approach should be presented and discussed.

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