

## ***Interactive comment on “Improved estimate of global dust radiative forcing using a coupled chemical transport-radiative transfer model” by L. Zhang et al.***

### **Anonymous Referee #1**

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In this study, by online coupling the GEOS-Chem global three-dimensional chemical transport model (3-D CTM) with the Fu-Liou-Gu (FLG) radiative transfer code, the more realistic dust vertical profiles can be directly provided to FLG besides the “climatological” one (i.e., FLG vertical profile). And then the authors fully investigated the important roles of vertical profiles in the dust direct radiative forcings and heating rates, along with the differences between these two dust vertical profiles. They found out that using the GEOS-Chem vertical profile can reflect the differences of vertical structure of AOD between dust and non-dust source regions, while this is missed if the FLG vertical profile is used. The obvious differences in radiative forcings and heating rates due to different dust vertical profiles used emphasize the importance of vertical

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profiles in radiative forcing calculations, and hence in modulating regional circulation. The manuscript overall is well written, although I felt more clarifications are needed. I suggest that this manuscript will be able to be published if the authors address the minor revisions indicated below.

1. In page 2422, Line 15-20, the authors have mentioned that the spatial variations of solar zenith angle are not taken into account and the cosine of the solar zenith angle of 0.5 is used in the calculations. I feel confused that whether the constant value of 0.5 is globally used? And how about the temporal resolution for radiation calculations? Is 6-h used? If so, any temporal variations of solar zenith angle are considered? If no temporal and spatial variations of solar zenith angle are included into the radiation calculations, the global estimate for monthly mean results can't be taken as the true representations for the global monthly-mean effects of the dust vertical profiles. More explanations about this are suggested to better support the authors' conclusions.

2. There are some inconsistencies among Fig.4 and Fig.5. For example, in Fig.5, over 5°W-60°E, below 800hPa, for all dust sizes over both Africa and Asia dust belts, all the differences are positive, however, in Fig.4, the corresponding differences are negative. Please double check these two plots.

3. In section 4.2, in order to study the differences of solar radiative forcing over dust source regions and downwind areas, the (10°E, 20°N) and (140°E, 40°N) are selected to represent the dust source region of Sahara desert and downwind area of Eastern Asia, respectively. I just feel confused why the authors don't choose the downwind area that is adjacent to each dust source region. For example, why don't use the Africa dust belt with the Arabian Sea, or the Asian dust belt with Eastern Asian? Any explanations are appreciated.

4. In section 4.1, the explanations on the values listed in Table 1 are generally accompanied with Figs.3, 4 and 5. However, there exist some inconsistencies among these table and figures: the Sahara and Gobi used in Table 1 have narrower latitude spans

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than the African and Asian dust belts used in Fig.3, 4, and 5. So I just wonder why not the same latitude domains used for both Table 1 and Fig.3, 4, and 5. Are there any special considerations taken for these?

5. In Page 2428, some analyses are needed to explain the conclusion listed at Line 7-9.

Other minor comments:

1. It's better to include the units in the figure captions for Fig.1 (dust emission), Fig.6-Fig.14.

2. In abstract, Line 15-18, this sentence should be for TOA, and the Infrared radiative forcing decreases over African dust belt, while increases over Asian dust belt, when the GEOS-Chem vertical profile is used. Clearly the more accurate description here is suggested.

3. In Page 2417, Line 19-20, "The vertical distribution of dust also plays an important role in serving as cloud condensation nuclei." I just wonder whether the dust instead of the vertical distribution serves as cloud condensation nuclei. So it seems that the writing needs to be modified.

4. Typo error: li.zhang@colorado.edu.edu, duplicated ".edu".

5. In Page 2425, Line 7, "from the distribution from gravitational settling", it's better to use "by gravitational settling".

6. In Page 2426, Line 24, it's better to add the unit [ $\text{Wm}^{-2}$ ] after "0 ~ 1".

7. In Page 2427, Line 14, "A possible reason for" should be "A possible reason".

8. In Page 2430, Line 16-18, "the warming effect with GEOS-Chem vertical profile is  $0.44 \text{ Wm}^{-2}$  and  $0.06 \text{ Wm}^{-2}$  higher than that of FLG vertical profile over the downwind area of Eastern Asia due to more dust particles in the free troposphere". There are two values (0.44 and 0.06), however, only one corresponding area is listed, i.e., the

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downwind area of Eastern Asia. Clearly, one more area is missed. Please modify.

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