

Geosci. Model Dev. Discuss., referee comment RC2  
<https://doi.org/10.5194/gmd-2021-337-RC2>, 2022  
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## Comment on gmd-2021-337

Anonymous Referee #2

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Referee comment on "Weaknesses in dust emission modelling hidden by tuning to dust in the atmosphere" by Adrian Chappell et al., Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2021-337-RC2>, 2022

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### General Comments

This study introduced a novel method based on dynamic land cover change (albedo or earth's shadow) to quantify dust emission with grid precision and thus overcomes the biases from the traditional approach that estimated dust emissions based on constant spatial vegetation distribution from bare soil assumptions. The aim is to investigate point source emission detected by satellites observation varying with time and space. They found that both approaches/models overestimated the occurrence of dusty days, which is mainly from soil wind friction velocity. The more the model overestimates the soil wind friction velocity, the more it entrains high sediment flux once the threshold is exceeded. Therefore, the albedo-based model generates lower emissions than the traditional model due to the new formulation of soil wind friction velocity obtained as function albedo, roughness and horizontal wind velocity. This newly developed albedo-based model suggested to mimic the soil bareness and vegetation cover before and after dust emissions, and the results proved moderately good performance. This study is important and has potential impact for modelling community especially in quantifying effective emission of dust. Some questions for the experiment design and results are need to be addressed prior to the publication.

### Specific Comments

- Dust Point Source locations are only shown on a small-domain map in Figure 1; Later, the authors described the roughness, wind speed, and dust flux in Figure 5 over a larger-domain map, would the authors show the DPS over a larger-domain map, such as the continental US (CONUS)? And, if possible, a map of North America is preferred

to display district boundaries, deserts, vegetation and etc.

- AOD represents the total aerosol burden in the atmosphere. DOD is meant for detecting dust particles in the atmosphere. In this study, the authors preferred to employ a threshold of 0.2 for DOD ( $DOD > 0.2$ ) as from previous study of Ginoux et al (2012) to separate dust from background over North America during spring season. However, Ginoux et al (2012) used the threshold  $DOD > 0.25$  for most of the regions, and the threshold from this previous study is retrieved from the MODIS-DB L2 product at the 10 km x10 km grid resolution that is much finer than 1 degree resolution used in this study. Given that the authors in this study overestimated the frequency (Figure 3) even with the lower DOD threshold of 0.2 without quality control, why didn't the authors sample DOD with quality flag at higher resolution and then average over one degree resolution? Otherwise, is 0.2/0.25 reasonable for one-degree resolution? Over such a large grid, smaller value may be preferred? please clarify.
- The results showed that high dust emissions were generated mainly from the Great Plains extending from Montana, Wyoming, Dakota, Colorado, New Mexico, and Texas, and slight dust emission were from the semi-arid and arid regions of the western deserts (Sonoran, Chihuahuahua, Mohave and great basin deserts). Therefore, I think the authors should also explain why those semi-arid and arid regions did not have any DPS.
- How does the study incorporate the soil texture/ soil type especially particle size threshold for starting the dust saltation? More explanation is preferred.

### **Minor Comments**

- The paragraph from 231-237 describes Figure 2a for the albedo-based model. It seems that the results from the smooth and rough cases overlap. Please clarify if they are identical.
- In Figure 5 and 6,  $U_h$  should be replaced by  $U_{10}$ . Please also correct others if any.