

## ***Interactive comment on “Development of a dynamic dust-source map for NMME-DREAM v1.0 model based on MODIS NDVI over the Arabian Peninsula” by Stavros Solomos et al.***

### **Anonymous Referee #3**

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Review for “Development of a dynamic dust-source map for NMME-DREAM v1.0 model based on MODIS 1 NDVI over the Arabian Peninsula” by Stavros et al.

The authors developed a dynamic dust source map based on MODIS Normalized Digital Vegetation Index (NDVI) for the dust emission scheme in the NMME-DREAM v1.0 model over the Arabian Peninsula. Two groups of simulations are conducted for 2016, one with the dynamic source map (NDVI\_run) and the other with the default static source map (CTRL\_run). It was found that when using the dynamic dust source the simulated AOD biases are reduced for dust episodes (i.e., when  $AOD > 1$ ) in comparison with the simulation using default setting. This paper explored the influence of the

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seasonal variation of vegetation coverage on dust emission scheme, which is a very interesting and important topic, and tested their methods over one major dust source regions, Arabian Peninsula. However, the overall presentation needs some improvement, some details need further clarification, and I also have some concerns about the methodology. My comments are listed below.

Major comments:

1. In the introduction part when reviewing previous studies of dust source map, I think it is important to briefly introduce Ginoux et al. (2001), who determined dust source mainly based on topographic depressions. As mentioned in the later part of the paper, this is also the default setting used in the NMME-DREAM model. It is also informative to explain what's new in the method used here compared with previous studies that also used NDVI to develop dust source map in the introduction section. And similarly, in the result section, it is better to discuss current results within the context of previous work that also compared static dust source map with NDVI based source map in this region.

2. Some details regarding the methodology need further clarification, for instance:

a) I think it will be informative to provide the equation of dust emission scheme in the NMME-DREAM model in section 1.1, so readers can see the role of the dust source function.

b) How do you define “# of dust points” in your equation of “Agrid\_box”?

c) How do you define dust efficiency in line 120 and “fractional gross error” and “mean fractional bias” in Table 2?

d) Section 1.2 has a lot of redundant lines, e.g., lines 131-133 are the same as lines 140-142, while lines 128, 135 and 143 repeated the same information.

e) According to lines 183-184, it is not clear if the simulated AOD is purely dust AOD, or it also includes the optical depth contributed by other aerosol particles?

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f) Line 162 seems indicating that the model settings are different for the CTRL\_run and NDVI\_run? Is this true?

g) It is also important to briefly introduce the datasets used for model validation in section 1, e.g., the MODIS AOD, AERONET AOD. What are the spatial and temporal resolutions?

3. Two major differences between Fig. 2a and b are the discrepancies of dust source strength over western Saudi Arabia and over Iran and western Pakistan. I think the authors should discuss these differences in the end of section 1.1 and also correspondingly in the result section. It seems to me that the NDVI source map overestimates the dust source strength over western Saudi Arabia and consequently led to too much AOD in this region in Fig. 3b.

4. Section 2.1 discusses dust transport by atmospheric circulation in August 2006. First of all, it is not clear to me whether information presented here is based on model simulation or reanalysis or observational data. Please clarify. On the other hand, those weekly variations of surface winds and dust transport may not necessarily be revealed in the monthly AOD map in Fig. 3. I'd suggest either adding figures of weekly variations of wind and AOD in this section or adding monthly surface wind vectors in Fig. 3 to discuss how winds affect AOD pattern.

5. As you mentioned in lines 233-236, NDVI mask dose not have much seasonal variations in permanent deserts, but may be important in those semi-arid regions, as also pointed by Kim et al. (2013). I wonder if you can also plot 12-month NDVI map in this region for 2016 to demonstrate the influences of NDVI seasonal cycle and then you can discuss the seasonal variations of AOD in Fig. 5 along with NDVI seasonal cycle.

6. The overall magnitude of AOD in the control run is quite low but does seem to have relatively higher values over the eastern Arabian Peninsula, which is consistent with the pattern of MODIS AOD. I wonder if you tried to tune the model in the CTRL simulation

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to increase the overall magnitude of dust emission and then compare the pattern and seasonal cycle of AOD with the NDVI\_run.

7. Kim et al. (2013) combined both the topographic depression-based dust source and NDVI seasonal masking for dust source map. I wonder if you can combine the dynamic source developed here with the default Ginoux et al. (2001) static source, and see if the model performance is further improved. I think those high AOD over western Saudi Arabia probably will be largely reduced.

8. Here only modeled AOD in the two simulations are compared. I wonder if you also see any improvement in other aspects of dust life cycle such as surface dust concentration, vertical distribution, and deposition.

Minor points:

1. Line 28, add "e.g.," before "Torge et al., 2011"

2. Line 31, add space between "precipitation" and "processes". Please fix all similar occurrences.

3. Line 45, I don't think there is any "feedbacks" on "human health", please consider reorganizing the sentence.

4. Line 63, please add brackets for "2013", and fix all similar occurrences.

5. Line 79, I think the original dust source function developed by Ginoux et al. (2001) did not use "Olson World Ecosystems dataset". Can you explain a bit more here?

6. Line 109, you may want to add a line or two to explain why NDVI of 0.1 is selected instead of 0.15 as used by Kim et al. (2013).

7. Lines 200-201, not clear. Did you use Ångström exponent to mask AOD? In that case, the masked AOD may contain large particles such as dust and sea salt.

8. Fig. 3, it is better to mask out AOD outside the model domain in Fig. 3c for an easy

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comparison among the three plots.

9. Please clarify in Table 1 caption that this is for annual mean. And for correlation, do you use monthly data? Can you also mark whether the correlation coefficients are statistically significant?

10. Table 2, are monthly or daily data used for correlation? Please add significance test as well.

11. Fig. 5, are the time series calculated from single AERONET site (which one?) or averaged over four stations on the Arabian Peninsula?

References:

Ginoux, P., Chin, M., Tegen, I., Prospero, J. M., Holben, B., Dubovik, O., & Lin, S.-J., Sources and distributions of dust aerosols simulated with the GOCART model. *J. Geophys. Res.*, 106(D17), 20, 255–20, 273, <https://doi.org/10.1029/2000JD000053>, 2001

Kim, D., M. Chin, H. Bian, Q. Tan, M. E. Brown, T. Zheng, R. You, T. Diehl, P. Ginoux, and T. Kucsera, The effect of the dynamic surface bareness on dust source function, emission, and distribution, *J. Geophys. Res. Atmos.*, 118, 871–886, doi: 10.1029/2012JD017907, 2013.

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