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Interactive comment on "Sensitivity of the WRF-Chem (V3.6.1) model to different dust emission parametrisation: Assessment in the broader Mediterranean region" *by* Emmanouil Flaounas et al.

Anonymous Referee #1

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General Comments:

The authors evaluated the performance and biases of three different dust emission schemes (GOCART, AFWA, and UoC) available in WRF-Chem. For each scheme, they conducted four different experiments by multiplying various coefficients to the dust emission flux. They also conducted two additional sensitivity experiments, one adding finer dust-size bins and the other changing the mass fraction of each bin, using the GOCART scheme. For each experiment the model was integrated for six months and during the integration the simulation was nudged toward reanalysis. Dust was treated

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as passive tracer and thus all simulations use the same meteorological conditions. Model results were evaluated through comparison with observations from MODIS AOD, AERONET AOD, and airborne lidar-derived extinction coefficients. Their evaluation focused on three regions: North Africa and the Arabian Peninsula for dust emission and the eastern Mediterranean for dust transport.

The results show that compared to observations all three schemes perform differently with different multiplication coefficients over dust source regions versus over ocean after transport. However, for the same dust emission scheme, simulations with different multiplication coefficients have similar correlation coefficients with MODIS observations. Results at the simulation domain, regional scale, and local scale (vertical profiles) were also evaluated. They concluded that among the three schemes evaluated none is optimal. However, the multiplication coefficient of 0.5 gave the most reasonable trade-off option between model AOD at both the source regions and transport regions. This work is interesting and the results can be useful to dust modeling and forecasts. The control of the same meteorological conditions, with the use of FDDA, is a good strategy for the evaluation of the dust schemes. The manuscript could be published in GMD after a major revision.

Specific comments:

1. For each dust emission scheme, the differences in performance over the three regions evaluated may not only be due to the scheme itself (i.e., mass fraction, sizes, etc.) but also the quality of observations that are used for comparison. There are common patterns of biases over land versus over ocean and over desert versus over non-desert regions. These systematic biases over different regions might be related to the quality or bias of observations, in addition to the emission schemes themselves. Thus, the authors need to compare observations from different sources and evaluate AOD retrievals from different algorithms (i.e., the deep blue versus dark target algorithms) using another observation (e.g., AERONET). Then observation analyses should be used to help interpret model results with different multiplication coefficients.

2. Sedimentation and wet scavenging are other potential factors that can impact model performance, in particular for the evaluation of dust transport results. The former seems to be included but not the latter. The wet scavenging should be included in model simulations since it has an impact on long-range dust transport.

3. Does the inclusion of additional finer dust-size bins improve the background values (AOD=0.2)?

4. Figure 14a shows that the dust concentration using GOCART-0.5 has a higher value than that in EXP1 near ground. Since EXP1 includes finer bins (thus smaller sedimentation), one would expect to have more dust suspended in the air. If that is the case then results at a higher level, where more dust is expected in EXP1, should be presented as well.

Technical corrections:

1. Line 415: "all models seem to capture..." should read "all experiments seem to capture . . ." since there is only one model (WRF-Chem) used.

2. Line 522: Delete "13" in front of "each".

3. Line 523: Should 0.25 be 0.225?

4. Caption 14 needs attention. (should be (a), (b), . . ., instead of A, B, . . .)

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