**Atmospheric
Chemistry
and Physics
Discussions**

Interactive comment on "New parameterization of dust emissions in the global atmospheric chemistry-climate model EMAC" *by* M. Astitha et al.

Anonymous Referee #2

Received and published: 20 July 2012

This manuscript describes the dust schemes implemented into the EMAC model and provides evaluations of the model simulated dust concentrations and AOD by comparing with surface measurements and remote sensing data. Significant amount of effort has been put into the work. The manuscript is well organized.

However I have several major issues with the paper that have to be addressed before the manuscript being considered for publication:

1. "New parameterization" and "two schemes": While I appreciate the detailed description of the dust uplifting processes and parameterization, it is difficult to tell which part of the parameterization is "new" that is unique and has not been published in the liter-

ature. If there is something new, it should be made more explicit. Also, I really don't see "two" schemes; DU1 and DU2 are the same with the only difference in particle size distributions (Table 4).

2. "The need to represent arid regions individually and explicitly...": In contrast, after reading this manuscript, I don't see any need to have Dp that is unique to individual regions. DU1 and DU2 perform very similarly and DU1 is overall better than DU2.

3. The emission and atmospheric loading are significantly different between DU1 and DU2 (Table 5 and 6), yet, the concentration, deposition fluxes, and AOD are very similar between the two? How do you explain and reconcile?

4. My biggest problem with this manuscript is the model evaluation. There are way too many subjective, descriptive words and phrases assessing the model performance, such as "very well", "good agreement", "satisfactory", etc. What are the standards to warrant such satisfactions? It seems that if the differences between model-simulated and observed values are within a factor of 10 (Figure 6, 7, 9, 12), the model is considered to have "good agreement" with observations. However the differences at some locations are more than 100 times! The evaluation should be as objective as possible and the self-praising, subjective words should be avoided.

5. The simulation includes dust, biomass burning, and sea salt, but omits anthropogenic and natural aerosols from volcanoes and terrestrial biosphere. This is not appropriate for comparisons with AERONET or satellite AOD, even at the dust dominated sites unless you screen out the non-dust components. Using AE<1.2 is very ineffective to exclude small particles.

Specific comments:

P13238, Abstract, line 13-14: "The dust outflow from Africa over the Atlantic Ocean is accurately simulated..." what is the standard of "accurately simulated"? Clearly from the figures the differences can be as large as more than 100 times.

P13238, Abstract, line 20-22: As I mentioned earlier, your results do not corroborate with this statement.

P13239, line 1: global models are "less dependent on boundary condition" – global models do not dependent on boundary conditions at all.

P13239, line 3-5: interaction between pollutants and dust is not unique for global models.

P13239, line 10-12: "In many cases models are tuned…" Can you give several examples among the many cases?

P13240, line 5-6: Can you give examples on how regional models are more sophisticated in representing dust emissions? On what regards?

P13240, line 10-11: I don't see how this work can overcome the difficulties listed in the previous paragraphs, one is that the regional model is more sophisticated, and another is the difficulty of directly measuring dust emission fluxes in the source areas. Your work does not deal with these at all.

P13241, line 12-13: If the model covers a complete diurnal cycle in 5 days, how do you get "daily average" from the model and compare with observations?

P13247, line 21: I don't see the use of equation (10) in calculating horizontal fluxes.

P13249, line 6-8: What is the physical justification for the size adjustment?

P13252, line 4: So the data are from various time periods. How appropriate is this to compare with model with only one-year (2000) simulation?

P13252, line 15-18: I disagree that the anthropogenic fraction of aerosol is not relevant. Not having a full chemistry should not be the reason for not including anthropogenic aerosols. Anthropogenic BC and OC are mostly primary aerosols, and not having a full chemistry scheme is no excuse for not including anthropogenic aerosols.

P13252, line 19: In fact, 500 nm is a standard wavelength of AOD sun photometer measurements in AERONET. AOD at 500 nm is available at all AERONET sites. "extracted" – you mean "interpolated".

P13252, line 28: AE 500-870 nm – how do you get AOD at 500 nm if it is "rarely given" (line 19)?

P13252, last line: As I said earlier, AE<1.2 does not exclude most small particles. It is a poor filter for selecting dust.

P13253, line 11-12: "it is not recommended" by whom? What kind of conclusion is a "strong" conclusion?

P13253, The last paragraph: If you plot a diff map (absolute or relative difference) the emission difference will become apparent at different geographic regions.

P13254, line 6-7: Why can't you be sure about the changes of wind speed? Can you simply directly compare the wind speed from free running GCM with the ERA40? How different is the soil moisture between GCM and ERA40?

P13254, line 17: "probably because the wind speeds…" – again, please check the wind speed to be sure, not just guess the differences.

P13254, line 25: How well is "well"? The model just captures the peaks but severely underestimate dust concentrations from Sept to May. The concentration from the model is basically zero.

P13254, line 26 and P13255, line 1: What statistics?

P13255, line 10 and 11: "good agreement", "quite close" – avoid using these judgmental, subjective phrases. Be quantitative.

P13255, line 16: "Cheju" has been changed to "Jeju" since more than 10 years ago.

P13255, line 18: I cannot tell which one is no. 12 in Fig. 3a.

P13255, line 23-24: So it is "good" within a factor of 10??

P13256, line 4-5: Now you are saying that your model is just the same as "many global models". However in several places you seem to distinguish this model from many global models. "have difficulties" – in terms of what? Models are too high? Too low?

P13256, line 10-11: How does the bias calculated? Are they absolute bias? You show high bias (positive) of the model simulations, but from the Figure it is clear the model has an overall low (negative) bias.

P13256, line 18-19: "correlate rather well" – how well? Even if they are "well" correlated, the slop is far away from 1:1, and a lot of these green points are outside of 1:10 line with difference up to 100x!

P13256, line 23-24: Similarly, "agree well" should not be used. I am puzzled about this level of satisfaction given the fact that many of the model points are a factor of 10 too low, and some are as low as a factor 300!!

P13256, line 28: I don't understand how come they all have positive bias (except DU1 ERA40) - the model is definitely much lower than the observations.

P13257, line 1, and Figure 7+Table 8: I just don't see how it is possible to get "a liner regression close to one". It is so obvious from Figure 7 that there are large fraction of points deviated far away from 1:1, the slope should be much higher than 1, and the intercept should be negative in all simulations.

P13257, line 3-5: "This may indicate..." This sentence sounds like a guess. Does the comparison of dust deposition support this statement? Regarding the solubility, can you do sensitivity experiments to reduce the solubility to see the effects?

P13257, line 6-10, Prospero datasets and AERONET data: They all cover multiple years, not just for year 2000. In fact, Prospero's data cover 15-20 years and AERONET more than 10 years.

P13257, line 12: "satisfactory though not ideal": What does it take to make you satisfied? This is very subjective statement.

P13257, line 19-22: "...may be related to the meteorological conditions" – can you pull out the met data to be sure, instead of guessing?

P13258, line 7: "very well" – again, how well is very well?

P13258, line 9: Is a factor of 10x difference considered as "accurate"?

P13258, line 11-12: Can you quantify "substantially improves the simulation"? It is difficult to tell from the Figure how DU2 has substantially improved the simulation.

P13258, line 12-13: It is not just "overestimated at some locations". It is overestimated by a factor of 100 at those locations.

P13258, line 15: "Reasonably well" means within a factor of 10!

P13258, line 15-17, sentence starts with "Only for one location...": It is Hard to see from the Figure. There are many stations that the model systematically either over or underestimates.

P13259, line 8: "satisfactory" - Another subjective words. You have to tell us your standard of being satisfied. Within a factor of 100?

P13259, line 11: Many of the sites are not dominated by dust. Sites in the Mediterranean Sea have significant amount of pollution, so has Jeju.

P13259, line 14: How do you get the daily average from the model if it takes 5 days to complete a diurnal cycle?

P13259, line 20: "all days for the month" – how about the days when no data are available?

P13259, line 23: "reasonably good agreement" – avoid using such subjective phrase.

P13260, line 7-9: Does it mean that the EMAC physics is not quite right to represent

the Bodele dust source? Why is there a risk using a physical representation if you have confidence in EMAC physics?

P13260, line 12: "well"; line 18 – "well"; line 21, "mediocre", and line 23, "good": too many subjective words!

P13260, line 26-17: Why do you think that the modeled dust is right but other aerosols are wrong? You should show some evidence, e.g., by comparing the AE and absorbing AOD.

P13260, paragraph from line 111 to 21: This paragraph is too descriptive, not quantitative. No one can tell which station is which from the figures.

P13260, last paragraph that ends in next page: There are no figures or numbers to look at about these evaluations. Can you supply figures to let the readers know what you are talking about?

P13261, line 26: another "well"!

P13262, line 2: another "good agreement"!

P13262, paragraph starts from line 10: MODIS aerosol mass burden? This is not a MODIS product. Where do you get this product?

P13262, same paragraph as above, and Figure 14: Are you showing dust mass burden from the model, but MODIS "mass burden" of all aerosols?

P13262, line 20: Why is there no data over N Africa if MODIS Deep Blue is used?

P13262, line22: another "well represented"!

P13263, line 2: Would you please provide evidences and examples of "many models apply regionally tuned emission fluxes"?

P13263, line 24-25: I don't understand this claim. AOD of any values, not just in the range of 0.4 to 1.2, can be a mixture of coarse and fine particles.

P13263, last line and P13264, first two lines: Have you evaluated the modeled sea spray aerosols, or it is just a guess?

P13265, line 2-6: Does it mean that you should not concentrate on comparing DU1 and DU2 over N Africa, Middle East, and their downwind regions but focus more on the regions where DU1 and DU2 emissions have large differences? However 15 out of the 19 AERONET sites are located in N Africa, Middle East, and downwinds.

Lastly, I don't see MISR is used anywhere in the manuscript. It is only in the Supplement material. You should either include MISR in the main manuscript, or move MISR related material to supplement.