Review of *Geosci. Model Dev. Disc.* Manuscript #gmd-2011-71

"Importance of the surface size distribution of erodible material: an improvement of the Dust Entrainment And Deposition DEAD"

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Recommendation: Major Revisions required

I have voluntarily disclosed my identity in all manuscript reviews since 2004 for many of the reasons discussed here (http://www.agu.org/fora/eos/2006/10/22/anonymous-review-pros-and-cons.html). The authors are free to contact me at zender@uci.edu.

General Comments

The manuscript describes improvements to the dust aerosol parameterizations employed by the atmospheric model ALADIN. One strength of the manuscript is that it conveniently offers, in one place, a rather complete description of the dust mobilization. This suits the mandate of GMD to enhance the reproducibility of geoscientific models. The primary flaw of the model is its neglect of prior literature and recent developments by Kok. This recent theory has important implications for the mechanisms (like role of parent soil size distribution) analysed and interpreted by this manuscript. Revisions to address the questions that arise would be correspondingly major, yet feasible. On the other hand, the manuscript's revised version of DEAD is clearly an advance within the previous theoretical framework and I congratulate the authors on this progress.

Specific Comments

1. The title does not parse well in English. Adding "model" near the end should suffice, i.e., "Importance of the surface size distribution of erodible material: an improvement of the Dust Entrainment And Deposition (DEAD) Model"
2. *Shannon and Lunt* (2011) is a (non-cited) previous GMD article (also reviewed by me) which presents a complete description of the LPJ dust model, and thus the mobilization portion of that paper re-capitulates some of the same parameterizations presented here. This overlap of material between the two papers should at least be noted, possibly used to shorten the present manuscript, and also examined for any ways in which the present manuscript illuminates questions highlighted in *Shannon and Lunt* (2011). That said,

in this age of electronic publications the convenience of having a complete description of a model in one place deserves real weight, and perhaps outweighs the goal of maximal conciseness.

3. Alf Grini implemented the *Alfaro and Gomes* (2001) sandblasting theory in DEAD c. 2004 *Grini and Zender* (2004), so there are version of DEAD (e.g., the U. Oslo GCM) which have long had soil-particle size/texture-dependence and sandblasting. Perhaps this should be noted somewhere, with the disclaimer that this manuscript refers, unless otherwise noted, to the original version of DEAD.
4. The sandblasting scheme employed is based on *Alfaro and Gomes* (2001). This theory holds that faster winds produce (i.e., sandblast) relatively more small particles than slower winds. Hence the sandblasted size distribution depends strongly on the wind speed at emission.

   The authors are probably aware of recent challenges by Kok to the sandblasting theory of Alfaro and Gomes. *Kok* (2010) introduced a new conceptual model where the sandblasting portion of dust generation is treated as the fracturing of brittle materials. Moreover, *Kok* (2011) argued, based on many published measurements of size-distributed dust flux (not concentration), that the size distribution of mineral dust emissions is independent of the wind speed. Furthermore, *Kok* (2011) found little sensitivity of the emitted dust size distribution to soil characteristics. Those papers specifically discuss the significance of the differences among size-resolved dust emissions observations and theories.

   The sensitivity of dust emissions to wind speed and soil texture is at the heart of this manuscript which makes no mention of Kok's theory. Many assertions made in the manuscript are questionable in light of Kok's work, e.g., fxm

   Readers will wonder the extent to which Kok's theory would improve or degrade the dust processes in ALADIN.

   (a) Can the authors explain how sensitive their results are to the specific sandblasting formulation utilized?

   (b) Would uniform soil textures, coupled to the *Kok* (2010) size distribution, improve or degrade ALADIN's agreement with AMMA and AERONET measurements? Could this be performed as Experiment 5?

5. The finding (whether one believes it or not) by *Kok* (2011) that dust emitted size distribution is nearly independent of the source soil texture presents an opportunity for this study to emphasize all the reasons source soil texture *is* important for dust mobilization besides dust size distribution. For examples, fractional coverage by non-erodible pebbles, susceptibility to moisture-inhibition effects, total mass sandblasting efficiency (α). The revised manuscript should emphasize this point so that readers appreciate the oft-neglected subtleties of soil texture which are easier for those (like the authors) with field experience to appreciate.

6. Page 2902 Line 4: This sentence illustrates the manuscript's often poor English translation (of course it's vastly better than my translation of English into French would be), including subject number disagreement with the verb and with adjectives. Please ask a more fluent writer of English to revise the manuscript.
7. Page 2903 Line 19: wind velocity or wind friction velocity?
8. Page 2905 Line 7: We found the same thing. Perhaps this is because *Fécan et al.* (1999) is more accurate for in situ than for spatially averaged soil moistures?

Technical Corrections

1. Throughout: "developed" as in "the developed [DEAD, model, version, etc.]" does not translate well into English. Alternatives closer to the intended meaning might be "new", "improved", "updated", "modified", or "revised", as appropriate.
2. Page 2895 Line 5: "emissions and transport"
3. Page 2895 Line 24: eliminate "it's important to specify"
4. Page 2896 Line 1: suggest "... 75 μm, the optimal size for saltation"
5. Page 2896 Line 8: "ignored in the original version of DEAD"
6. Page 2901 Line 3: Place in preceding paragraph. Use "... soil particle bins with relative surface areas shown ...".
7. Page 2901 Line 3: disambiguate with "... of the suspended dust particles ..."
8. Page 2902 Line 16: "erodible"
9. Page 2902 Line 21: "shown"
10. Page 2903 Line 17: omit "African"

References

Alfaro, S. C., and L. Gomes (2001), Modeling mineral aerosol production by wind erosion: Emission intensities and aerosol size distributions in source areas, *J. Geophys. Res.*, *106*(D16), 18,075–18,084. 3, 4

Fécan, F., B. Marticorena, and G. Bergametti (1999), Parametrization of the increase of the aeolian erosion threshold wind friction velocity due to soil moisture for arid and semi-arid areas, *Annales Geophysicae*, *17*, 149–157. 8

Grini, A., and C. S. Zender (2004), Roles of saltation, sandblasting, and wind speed variability on mineral dust aerosol size distribution during the Puerto Rican Dust Experiment (PRIDE), *J. Geophys. Res.*, *109*(D7), D07,202, doi:10.1029/2003JD004,233. 3

Kok, J. (2010), A scaling theory for the size distribution of emitted dust aerosols indicates that climate models overestimate dust radiative forcing, *Proc. Natl. Acad. Sci.* 4, 4b

Kok, J. (2011), Does the size distribution of mineral dust aerosols depend on the wind speed at emission?, *Atmos. Chem. Phys.*, *11*, 10,149–10,156, doi:10.5194/acp-11-10149-2011. 4, 5

Mokhtari, M., L. Gomes, P. Tulet, , and T. Rezoug (2011), Importance of the surface size distribution of erodible material: an improvement of the Dust Entrainment And Deposition DEAD, *Geosci. Model Dev. Disc.*

Shannon, S., and D. J. Lunt (2011), A new dust cycle model with dynamic vegetation: LPJ-dust version 1.0, *Geosci. Model Dev.*, *4*(2), 85–105, doi:10.5194/gmd-4-85-2011. 2