Anonymous Referee #1

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We would like to thank the referee for a set of very thoughtful comments which eventually helped to improve the quality of the manuscript. In the following, we will respond to each comment line-by-line.

General comments

This study examines the performance of three well-known dust emission schemes in a box model environment constrained by observations from the DO4Models field campaign in Botswana during July-October 2011. Modeling the atmospheric desert dust cycle has improved the past two decades but the remaining challenges and uncertainties are still significant. The most important aspect of this problem is the lack of detailed measurements of the dust vertical flux emitted from the soil in a variety of arid areas worldwide. Such measurements could help the modelers improve the emission parameterization schemes and take the leap towards more robust simulations and predictions of the dust cycle. The paper is well written and concise. In terms of scientific significance, I believe that the knowledge gained from the sensitivity model experiments as they are compared to measurements is an important addition to current knowledge and practices. My comments concern mostly some obscure parts of the manuscript where clarifications are necessary to improve the quality of the narrative. The only omission I found in this work was a discussion on the errors in the measurements that might have influenced the results. I am in favor of publishing this paper with Geoscientific Model Development, after carefully addressing the minor comments that follow.

Since the originally submitted version of the manuscript was heavily relying on the input of a companion paper by Wiggs et al. regarding the treatment of measurement errors and uncertainty, we are happy to report that the Background chapter has been entirely rewritten, covering all relevant aspects of measurement errors and potential implications. Moreover, ambiguities and/or unsupported claims have been removed or reformulated, particularly in the heavily revised Chapters 4.2 and 4.3.

Note that all figures have been re-plotted to reflect very late changes in the soil size distribution data which also led to a change of the values in Table 1. For the soil moisture correction, gravimetric soil moisture content ("GSMC") rather than volumetric soil moisture content ("VSMC") - as indicated in the first version of the manuscript - has been used throughout.

Specific comments

Introduction
1. Page 5740, line 25: "from a remote sensing"
2. Page 5741, line 17: "In this paper we report..."

Amended.

Background
1. Why did the authors choose Sua Pan for the field campaign? What characteristics of the soil surface make this location unique and at the same time common to a large number of soil types in desert areas worldwide? In other words, are the conclusions transferrable to other arid regions as well or they are limited to the specific crusted type of surface? Please include the information in the text.

It's mainly because Sua Pan is situated away from major North African dust sources which tend to have high background dust aerosol concentrations. Down south, background concentrations are no major concern which is why we think it's an ideal place to study the emission process (for more information, see Chapter 2 in the revised manuscript, lines 149ff**).
2. Page 5743, line 21: "anemometers at heights of".

Amended.

3. Page 5743, lines 18-29: The description and differences between the measuring sites is not clear in the text (i.e. the dust sensors are included in all 11 sites?). Please make a distinct description of the AWS and MET sites as to the differences between them.

More detail has been added.

Box model development
1. The correction factor 2.61 used in the MB95 scheme was set to 1 in later publications (Marticorena et al. 1997, Laurent et al. 2006, Darmenova et al. 2009). Why did the authors choose to include the value that originates from the experiment of White (1979)?

We actually used 1.0 as correction factor as well. We have added more detail to make that clear in the manuscript (lines 331-335**)

2. Page 5747, line 21: How do you calculate the grain size velocity ws?

Information added (function of particle mass, diameter and the drag coefficient in consideration of different possible Reynolds regimes).

3. What is the difference between minimally and fully disturbed soil size distributions? This is important to put the discussion on the findings in the right context.

Described in more detail in the manuscript now (see Chapter 2, lines 188ff**): [Surface sediment] was used in "wet" fully dispersed mode (assumed to represent the dust in suspension), and also in "dry" minimally dispersed mode using an air dispersion unit (which maintains and measures any particle agglomerates which might be assumed to comprise the saltation flux).

4. Table 2 is confusing. Sensitivity experiments (a) to (d) occurred for all model setups? If yes, then I suggest reordering the rows by leaving the experiments a-d last and inclusive of all setups.

Amended and further simplified.

Results and discussion
1. Figures 2-4 contain a large number of sub-plots that make the reading of the figure very difficult. The plots are an important part for this work. I would suggest to either make the subplots bigger or cut each figure in two.

We are afraid that this is the only point we have concerns with. While certainly filled with plenty of information, we can't really see how splitting the panels into several sub-plots would make it easier to interpret. We do admit, that we have seen much smaller plots elsewhere and are therefore a bit surprised that Figs. 2-4 cause issues. While we are certainly able to cut the plots, we would like to ask the editor to make a final judgment. For the time being, we have left them as they were before.

2. Figure 1 could be improved from the indication of the measuring sites in their respective location.

Fig 1 has been re-done completely. We hope that helps to facilitate the reading.

3. A discussion on the possible sampling errors/uncertainties in the measured quantities is essential. Inclusion of quantitative values is desirable, if possible.

As pointed out earlier, Chapter 2 now contains several paragraph which are dealing with measurement uncertainties in all detail.

** The page numbers refer to the revised manuscript which I uploaded as supplement.