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Interactive comment

Interactive comment on "Quantifying local-scale dust emission from the Arabian Red Sea coastal plain" *by* Anatolii Anisimov et al.

Anonymous Referee #2

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The manuscript presents an analysis of dust emission from the coastal plain of the Arabian Peninsula at the Red Sea over the time period 2009-2011. This region is an important local dust source with frequent dust events, for which a systematic study of dust emission has been lacking so far. The analysis is done based on off-line simulations with a high resolution land model that includes a dust emission scheme. Thus, feedbacks with meteorological variables are not taken into consideration. The study includes evaluation of the results against observation derived variables. Sensitivity analysis is carried out to study the dependence of the results on the horizontal model resolution, resolution of vegetation and soil data set, and the applied source function. The analysis of dust emission is then done using the model version with 1$\times$1 km resolution. A total value of the dust emission from the region is provided as well as geographical and temporal patterns, and estimates for the amount of annually emitted iron oxides and phosphorus.

The study presents new and scientifically interesting results. It is generally well structured and well written. Some points should be addressed before publication, though, which are listed below:

1. **Abstract, main part, and conclusions:** The amount $7.5\,\mathrm{Mt\,a^{-1}}$ of total dust emission as presented in the abstract, the successively derived magnitude of dust emission from different locations, and the quantification of the amount of iron oxides and phosphorus are all predetermined by the calibration of the model. For the lack of measured dust emission rates, the calibration is done by assuming the same emitted dust amount in the land model as in the MERRAero reanalysis over the investigated time period, which is not based on measured values, but calculated using a dust module.

   This approach rests on the assumption that the magnitude of the dust emission in MERRAero is a reliable estimate of the true dust emission from this region. To my knowledge, no evaluation has been published with respect to the dust emission from this region in MERRAero. The authors themselves acknowledge that the resolution of the reanalysis is too low to provide reliable estimates of the dust emission from this region, and they show with their own analysis that the magnitude of dust emission increases with refinement of the horizontal resolution.

   Thus, this suggest the conclusion that the magnitude of the presented total dust emission, the emission amount from individual locations, and the amount of iron oxides and phosphorus are highly uncertain. This uncertainty should be addressed. Perhaps, one could use the variability of the emission in MERRAero from the whole time period 2003-2015, which already has been used in the manuscript by the authors, to provide a first estimate of the lower and upper range of the emission related quantities presented in the paper, especially for the ones presented in the abstract, even though that still wouldn't address any possible bias in the MERRAero dust emission. The issue of the uncertainty and its sources for the estimates provided in the paper should also be thoroughly discussed in the conclusions. Also, when providing the absolute quantities in the abstract, it should be pointed out that the values are just first estimates that are still highly uncertain.

2. **Page 4, lines 10–13:** The assumption that the mineral composition of dust aerosols and the mineral composition of the soils in *Claquin et al.* (1999) and *Nickovic et al.* (2012) were close does not (always) hold just because of changes during the life cycle of dust from emission to deposition, even more importantly, it does not hold because the measurements of the soil mineral fractions were done for soils that had been wet-sieved. Wet sieving is a technique that strongly disperses soil aggregates (*Shao*, 2001), which is not realistic for dust emission from the parent soils of the dust sources. This caveat to the assumption made by the authors should be added to the manuscript.

   Having said this, the authors are mainly interested in the amount of iron oxides and phosphorus. *Nickovic et al.* assume the same iron oxide fraction in the clay and silt size range, and phosphorus is provided only for the clay and the silt-size range together. Therefore, the fractions of these minerals are less affected by the wet-sieving problem, based on these assumptions. Also, in the present manuscript, only the integrated amount over all size bins defined in the dust module is presented. Thus, other sources of uncertainty probably affect the calculated iron oxide and phosphorus amount more than the wet-sieving problem. The wet-sieving issue still may be are more relevant source of error for the other minerals presented in Figure. 9, though.

3. **Page 7, lines 4–7:** How the choice for the threshold value for the statistical source function was made should be explained in detail. It is not clear for the

reader from simply stating, “The threshold value is chosen with respect to the temporal frequency of the SEVIRI instrument”.

4. **Page 15, line 5:** Do not say “Dust emission climatology”, since the analysis is done only for three simulates years. Name the section “Multi-year dust emission” or similar.

5. **Page 14, line 23:** The unit of the total dust emission in the text should be the same as in Fig. 4a, i.e., $\mathrm{g\,m^{-2}\,a^{-1}}$.

6. **Page 17, line 29:** “All of the quantities have a pronounced diurnal cycle, ...” should be phrased more precisely as “Total dust generation, frequency, and maximum emission rate have a pronounced diurnal cycle, ...”. The authors themselves discuss the exception for the intensity further below.

7. **Page 18, line 20:** Add *Scanza et al.* (2015).

8. **Page 31, Table 1:** The used individual components of the WRF model configuration should be presented in a way that is friendly to the reader who is not an insider of the WRF model. That is, not just by using acronyms, but fully spelled out, with references added and information how these components can be accessed.

References

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