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Interactive Comment

# *Interactive comment on* "Quantifying the impact of sub-grid surface wind variability on sea salt and dust emissions in CAM5" *by* K. Zhang et al.

**Anonymous Referee #1**

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Review of "Quantifying the impact of sub-grid surface wind variability on sea salt and dust emissions in CAM5" by K. Zhang et al.

This manuscript describes a method to estimate subgridscale variability of surface winds in the global model CAM5 to improve the computation of dust and sea salt emission fluxes. The approach builds upon previous work by various authors. The authors describe a method to quantify wind variability due to small-scale processes like turbulence, and describe the surface wind speeds in terms of a Weibull probability distribution. The global model is modified accordingly and changes in sea salt and dust emissions and distributions are compared to the standard setup.

Parameterization of subgridscale variability for modelling wind-driven emission of primary aerosol particles is a relevant topic, and the authors present an interesting



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method how a quantification of the such processes can be achieved. They find that while sea salt aerosol emissions are not substantially changed by subgridscale wind variability, the changes in dust emission can be important. However, the authors should address several issues in a revised version.

A major problem is the lack of an appropriate evaluation of the model results using the new wind parameterization used for computing primary aerosol emissions. In section 5.2 a comparison of averaged model results with MISR optical thickness retrievals is shown as sole evaluation of the model results. While the MISR aerosol product is certainly well established and useful, there are undoubtedly more observations that should be used for the model evaluation. E.g., Huneeus et al. (2011, ACP) the results from global dust models are compared to standard dust datasets. Evaluation of dust model results with AOD from the AERONET sunphotometer network, in particular the 'coarse mode' aerosol, is a standard method even for global models. Not only annual mean values of model results and observations should be compared, but also time series for different locations. Even if no 1:1 relationship can be expected between model results and observations given the difficulties comparing a model grid value with a point measurement, at least such comparisons can indicate if the new results (e.g. EXP4 vs. Control) improve the model agreement with observations, e.g. in terms of seasonality and regional differences.

In section 5.2 also the impact of the emission changes due to subgriscale wind variability on radiative forcing is shown. This part is unnecessary and misleading, since the 'best' model version would be EXP 4, which is not shown. Radiative forcing by dust aerosol depends not only on dust AOD but also on optical properties of the particles, which add considerable uncertainties. Given these uncertainties and the lack of new information, this part (including Figure 16) should be removed from the paper. Instead more attention should be given to evaluation of the model changes.

A more important result is provided later in section 5.2. The shift of the frequency of dust events towards smaller but more numerous dust emission events when including



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the subgridscale parameterisation is quite significant. While it is true that the temporal coverage of aerosol retrievals by polar orbiting satellite instruments provide too little temporal coverage to evaluate the dust emission frequencies, note that are results from geostationary satellites that can provide useful information. E.g., the infrared dust index data for Saharan dust retrieved from the Meteosat SEVIRI instrument provides dust information at 15min intervals (see e.g. Schepanski et al., 2007, GRL) Figure 17 is interesting, here it would be nice if the results could also be shown for larger areas, e.g. for the whole Sahara.

Another major concern is that the results of the effects of the subgridscale wind parameterisation are mostly shown by maps of relative changes, particularly in figures 13 and 14. Showing absolute changes would be better at least exemplary, since it would show where the wind modifications actually play an important role for the emissions and AODs. And at least for EXP4 maps of emissions and AOD (not differences) should be shown together with the results of the Control simulation to show how emission and AOD patterns change when using the new parameterization.

Minor comments:

Section 2.4: In the description of the dust emission scheme, please state what the threshold for dust emission is based upon in the scheme (topography, soil type, texture, or anything else?)

Figure 4: not much can be learned from this figure. The differences might be better illustrated by frequency distributions.

Section 4: For the purpose of getting an overview in which area which processes play a role it would be interesting to show maps of $\sigma$d, $\sigma$U,t, $\sigma$U,m, $\sigma$U,l.

Section 4.2.3.: Using WRF results, the authors test if the subgridscale variability for the ECMWF 15-km wind fields is appropriate to represent the ‘real’ variability. The WRF model is used at 3 km resolution where usually convection does not need to be



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parameterized. To test the oceanic surface winds, a test was performed at a location in the southern Pacific. The authors mention that they did not perform such a test in the tropical ocean where major differences can be expected due to strong convective activity. They argue that the sea salt emissions from that regions would weak so that it is not important to test the performance of the 15-km fields there. However this is an implication from computations that neglect subgridscale wind variability, and not necessarily confirmed by Fig. 2. This problem should be should be discussed

Section 4.2.4, Figure 10: Since the $\sigma$U,l is inversely related to the coefficient C, Figure 1 should depict 1/C rather than C, since this would provide a measure of the subgridscale variability. Also, in Figure 10 the letters indicating the locations of the time series shown in Figure 11 should be indicated next to the appropriate boxes.

Section 4.2.4 : As above for the ocean, the applicability of the 15-km ECMWF wind fields to offer a good measure of wind speed variabilities used to compute dust emissions are tested for a location in the Taklamakan region with a few days of a 3-km WRF simulation. The authors find a good agreement in that region and argue that the differences in the flatter terrain in the Sahara are expected to be minor since the orography would have a small effect. However, note that e.g. Marsham et al. (2011) found considerable subgridscale wind activity during summer conditions in the Sahara due to wet convective activity using regional model study at 4 km grid resolution. Neglecting this process will cause an underestimate of subgriscale surface winds, which should be discussed in the text.

Section 4.3: To illustrate the implementation of the subgridscale processes in the model a flowchart would be helpful

References:

Schepanski, K., I. Tegen, B. Laurent, B. Heinold, and A. Macke (2007), A new Saharan dust source activation frequency map derived from MSG-SEVIRI IR-channels, Geophys. Res. Lett., 34, L18803, doi: 10.1029/2007GL030168



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Marsham, J, Knippertz P; Dixon N; Parker DJ; Lister GMS (2011): The importance of deep convection for summertime dust uplift over West Africa, Geophysical Research Letters, 38, . doi: 10.1029/2011GL048368

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