

Interactive comment on “Parametrization of convective transport in the boundary layer and its impact on the representation of diurnal cycle of wind and dust emissions” by F. Hourdin et al.

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Answer to reviewer 3

We would like to thank the anonymous referee #3 for his/her very positive comments on the manuscript. You will find enclosed a point to point answer the minor remarks. The pdf showing the modifications of the paper itself is also available for control.

C12268

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We have to add in introduction to this answer that we found a small error in the computation of the Weibull distribution. A normalizing factor was missing, which was systematically lowering the emissions. We thus updated all the figures with the new simulations. No conclusion is affected especially because we are focusing on the sensitivity to parameterizations more than on the realism of the simulated dust distribution. Comparison with observation is now better for the dust (surface concentration and AOT) but we insist (as in the first draft) on the fact that this good agreement may be more a question of chance, since a number of parameters which were not explored here may affect emission. In particular, taking into account an a priori subgrid scale variability through Weibull distribution strongly enhances dust emission, and may be seen as a trick to compensate our inability to account for sub-grid scale turbulent or mesoscale processes. To simplify a little bit the discussion on this subgrid scale distribution, the W^* term in the emission was omitted in the new set of simulations. All the figures were redone with those new simulations that rely on a somewhat upgraded version of the LMDZ model, which also marginally affects the wind but without changing any of the conclusion or comment.

The Reviewer comments are reproduce in "script" font together with the answers.

Hoping you will find our answer appropriate,

with best regards,

Frédéric Hourdin

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27431, 18-19: define theta and theta_th here
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Added: *"where θ is the mean potential temperature in the grid box and θ_{th} the potential temperature within the thermal plume at the same model level."*

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27432, 1: define TKE
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Modified: "is based on a steady-state solution of the evolution equation of the Turbulent Kinetic Energy (TKE) "

27433, 6-7: please give more details about the use of the Weibull parameterization

Added to the text: " In order to account for sub-grid scale variability of the mean wind speed, a Weibull distribution is used (Cakmur et al., 2004) with the following probability density function:"

$$p(u) = \frac{k}{A} \left(\frac{u}{A}\right)^{k-1} \exp \left[- \left(\frac{u}{A}\right)^k \right] \quad (1)$$

" where u is the sub-grid wind speed, the shape parameter k is set to $k = 3$ and A is calculated in order to fit the first moment of the Weibull distribution with the mean wind, i. e., $U = A\Gamma(1 + 1/k)$ with Γ the Gamma function. "

27433, 14: what is the size range of the 12 bins?

Added to the text: " The boundaries for the 12 dust bins used here are 0.09, 0.19, 0.67,1.49,2.27, 3.46,4.81,5.58,6.79,12.99,26.64 ,41.60 and 63.0 μm ."

27433, 16-17: settling and dry deposition -- briefly report if e.g. a series of resistances model etc.

Added to the text: " Settling of dust particles and dry deposition are computed as in CHIMERE (Menut et. al., 2013)"

27435, 4: change to ``interactive``

Done

27437, 11-12: I would say they are rather similar actually

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Yes, I agree. The comment on differences was removed.

27437, 29–30: Have you considered comparing to the Tamanrasset station as well? It should be closer to the dust sources and have data for the study period. Also, please briefly describe how the AERONET data were treated to get the daily cycle.

We intend to make direct comparison with Tamanrasset observations in the future but did not have the observations when we did the work. We compared AOT at another station in the Sahel, showing a similar underestimation. We do not show daily cycle for the AERONET data but only the day-to-day variations.

27442, 3: change to ``at their first stage``

The sentence was modified: *"In the model, this peak is due to the rapid downward transport of momentum by the compensating subsidences when the thermal plumes reach the height of the low-level jet"*

27443, 5: here (and earlier in the text) you are implicitly assuming that AOD is representative of dust emissions, and that model AOD is indicating underestimation when compared to remote sensing retrievals -- maybe just put in somewhere what are the assumptions behind this, involving particle size and optical properties

Added to the text: *"Despite a reasonable representation of the near surface winds (at least at the stations available, which unfortunately are not in the main emission zones), and despite the use of a Weibull distribution to account for the effect of spatial inhomogeneities of wind speed within a grid mesh, the model underestimates the observed dust, typically by 20-50% for the NP48 simulation that shows the strongest emissions. The underestimation is similar when considering either AOD or PM10 concentrations. AOD is sensitive to the atmospheric column with a stronger contribution of small particle while the PM10 concentration is a direct measurement of the mass concentration close to the surface. The fact that both indicate a similar underestimation suggest a general underestimation of emissions rather than a size distribution effect."*

27443, 10: change to ``the same observations are``

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This section of the conclusion has been rewritten and extended.

Figure 3: what is the black solid line in the upper panel?

Added: *"The horizontal line in the upper panel corresponds to a wind of 7 ms^{-1} above which emissions start to be significant."*

Figure 7: how does this compare to Figure 4?

Added: *"As was already seen in Fig. 4, the mean value is somewhat overestimated at Cinzana and underestimated at Banizoumbou for the three LMDZ simulations."*

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