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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Dust emission in farmland caused by aerodynamic entrainment and surface renewal" *by* Hongchao Dun and Ning Huang

Anonymous Referee #1

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Zhang et al., (2016) had put forth the renewal mechanism of fine particles in a soil's top layer, which they think is critical to sustaining dust emission. The work Dun and Huang presented here clearly attempts to build on that study simulating the dust emission process in farmland using a dust emission model with combined aerodynamic entrainment and surface renewal mechanisms previously proposed. They are trying to show that their model is effective to predict dust emission in farmland. In general, however, I think the performed approach and methodology are subject to major deficiencies, and the results are questionable. In many places, the statements drawn by the authors lack sufficient evidence: the readers would appreciate it if the authors could explain some crucial aspects in detail. Some sections also needed to be restructured. So, I regret

that I am unable to recommend publication of this manuscript in its present form in ACP.

P – Page; L – Line (please use continuous line numbering instead of restarting numbering on every page. The current line numbering makes the review process painful!)

Major comments:

As the authors themselves pointed out, the simulated dust emission rate only slightly differs between including and excluding the aerodynamic entrainment and surface renewal mechanisms. I cannot find clear evidence supporting the main conclusion of this study. I have no idea based on what the authors concluded that "the model is an effective method to predict the dust emission rate". I encourage the authors to try to improve the model results, or, if that proves impossible, then learn why the model is not working and write a thoughtful and candid report characterizing the issues and the lessons learned by the attempt. But currently, I am really struggling to find out the scientific merit of this work.

Also, the evaluation of model performance (Section 3.4) relies on only one dust event, and there is no detailed quantitative analysis of the modeled and experimental data. Strictly speaking, a more intensive evaluation is required to put the conclusion on a more solid statistical basis. Event for comparison between the simulated and measured dust flux at the current level, the discussion seems somewhat subjective. The authors divided the field dust event process into three main phases without any justification. What kind of data or sensitivity study is there showing that this kind of phase division is reasonable? How did the authors distinguish the contribution of the dust emission from different mechanisms in each phase? How did they attribute the primary emission mechanism in the first phase to aerodynamic entrainment? Besides, the statement in the model evaluation section is a little bit not more candid. I would not say that the dust emission rate in the first phase, according to the authors' division, is high (the "relatively high" is vague): it is much lower than peak values registered in the second phase. In that short section, the authors mentioned the dust concentration twice. But

I did not see any dust concentration data presented in the manuscript for this event to support those statements.

Also related to the field dust emission event. The authors should have to state where they get the data and how the experiment was set up to obtain the wind velocity and dust emission flux.

The "farmland" only appears in the title and the abstract but is not mentioned anywhere else, which looks weird. The authors need to introduce somewhere in the manuscript the unique property of farmland surface from the dust emission perspective and make it clear why the model presented here is suitable for use to model the dust emission in farmland. It would be more interesting if the authors could quantitatively quantify how big the difference would be on the dust emission rate with and without the surface renew by soil moisture.

The calculation procedure is not very clear to me. I think there would be an update of theta after obtaining the evaporate rate. So, the theta in Eq. 12 is actually at a time step right before the current one. The authors may want to clarify the different time steps the theta is at in the equations to avoid any possible confusion. A flow chart would be helpful too.

I would encourage the authors to construct more sensitivity tests on some key parameters that control the soil moisture prediction to see quantitively how they affect the dust emission rate in farmland.

Many variables are using in the equations without any definition. Values for constant parameters used in the model are also missing (please see detailed comments below). I would encourage the authors to specify those constants such that readers can tell if they are within the reasonable range and reproduce the results.

Minor comments:

P1; L18: please give the size range for “fine particle”.

P1; L25-27: “Their results indicated that, in the initial phase of dust emission from a natural soil surface, aerodynamic entrainment should be the dominant mechanism and dust might be supplied by free grains exposed on soil surface.” This statement seems not really correct. The aerodynamic entrainment could be crucial for dust emission only under certain circumstances. Here, I think that the authors exaggerated the importance of aerodynamic entrainment to dust emission.

P2; L7: how thick the topmost layer is defined?

P3; Section 2: the readers would appreciate a few sentences right after the section heading to explain how Section 2 is organized before diving into the subsections.

P3; Eq. 1: consider adding a plot to Figure 1d to illustrate the vertical profile of the free fine dust coverage. Also, labeling the thickness of the free dust layer in Figure 1c would help readers get the point readily.

P3; Eq. 2: please introduce Fdust in the main text before showing this equation. Also, what is the value of “n” used in this study?

P3: does d in Eq. 3 refer to diameter? What is the size limit in the dust model?

P3; L25: please introduce U*wt first and then U*t. Also, please define AN and gamma, and specify the constants used in the dust model.

P4; L1: please define rou w and rou s.

P4; Eq. 4: what’ the difference between ds and d? ds is the soil grain size, then what does d stand for? It seems to be a typo, as it does not make sense to have d on the right-hand side but ds on the other, and d only comes into play in this lognormal formula. Also, should specify how many modes (“N”) and the lognormal distribution parameters used for calculation.

P4; L7: considering deleting “in lognormal distribution”. This term seems redundant, considering it had been mentioned in the sentence right before. No need to repeat the

information.

P4; L16: Text starting from this line within this subsection is talking about soil moisture distribution, separated from the content of this section. Since the soil moisture distribution is strongly affected by the evaporation rate (in Section 2.4, the authors also cite Eqs. 7 and 8 together with Eq. 9 and so on), it would be better to put it in Section 2.3, where the authors detailed how to predict the soil moisture content. With this adjustment, the authors may want to change the subtitle of 2.3 to "Soil moisture distribution" or any other similar.

P4; L20: specify the value for Dv.

P4; Eq. 8: define lambda and specify the value used.

P5; Eq. 10, 11, and 12: specify Ks, m, a, b, c, and d etc.

P5; Section 2.4: please provide more details about each step: how the initial boundary conditions were set; what's the grid resolution; what's the time step etc. Please specify. Also, see major comments on step 4.

P5; L24-26: is there any cause-and-effect relationship between the two sentences? Please explain.

P5; L26 to P6; L2: sentence difficult to follow. Why a 10-day evaporation process? Is the "soil initial condition" referring to the one right after the 10-day evaporation finished? But under which friction velocity was used as you have three in Fig. 2abc?

P6; L20-21: unclear sentence. What does it mean when saying that the "erosion effect on dry soil layer could hardly be improved"?

P6; Fig. 2: why in the first 0.25 hr, the surface position with U*=0.5 m/s is higher than with U*=0.45 m/s? Why in the first hour the soil moisture content at the newly exposed surface with U*=0.5 m/s is higher than with U*=0.45 m/s, even though the surface position is comparable between the two cases? Another interesting but missing point

is that increasing U* from 0.45 to 0.5 m/s did not lower the surface position in the first 0.5 and 0.75 hrs as much as increasing U* from 0.40 to 0.45 m/s.

P7; Fig. 3: I think it could be interesting to also show the total soil thickness. Fig. 3s: I did not see black lines.

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