Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2019-439-RC2, 2019
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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Effects of three-dimensional electric field on saltation during dust storms: An observational and numerical study" *by* Huan Zhang et al.

Anonymous Referee #2

Received and published: 2 September 2019

Zhang and Zhou presented a 3-D E-field model to study saltation during a severe dust storm observed at the Qingtu Lake Observation Array site. The model was shown to be able to reproduce the mass flux profile from measurements. Their results indicate that the E-field in dust storms is very different from that in pure saltation. In addition, they demonstrated the importance of midair collisions in the exchange of momentum and charge between saluting particles. They also emphasised the necessity to consider 3-D E-field in future dust storm studies. Below are my main comments.

1. The authors used the empirical mode decomposition (EMD) to capture the time-varying features in the measured 3D E-filed data. Similar tools also exist, such as the

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wavelet transformation. Why the authors chose EMD over the wavelet method? EMD is known to likely cause problems at the beginning and end of a time series. How did the authors deal with such issues? The application of EMD is also vulnerable to mode mixing. How was this problem handled in estimating the time-varying mean values?

2. The reduction of height z to the dimensionless z* is dependent on the saltation height, which is determined from measured SPC-91 data. I understood that SPC-91 is a particle counter that gives number size distribution. How was the mass information obtained from this data? What assumptions you made? How do the measurement uncertainties and assumptions influence the estimated saltation height? Does the saltation height vary with time?

It is described in section 4.1 that 'normalized vertical component E3* increases monotonically as height increases in the saltation layer'. However, in fig. 5c, the data points clustering at z* between 0.5 and 1 showed lower E3* than the ones at smaller z*. Therefore, this statement is not valid. It also seems that data points at z*=1-1.5 are always deviated from the trends in Figs. 5a-c. What could be the reason?

The authors used hourly bins in Fig. 5. How will the patterns look like if finer bins are used, e.g. 30 min or 10 min?

3. The authors considered midair particle-particle collisions with a viscoelastic force model in the saltation model to stimulate particle motion. This inclusion of the midair particle-particle interaction is shown to be important. However, during midair particle-particle interaction, particle diameters may change upon collision or frictional contact, e.g. due to cleavage of agglomerates, which may increase the total number of particles in the system and shift the size and charge distributions of the particle population. Have the authors thought about these effects?

4. The authors performed a simple sensitivity study of mass flux on the effects of E-field intensity factors. It is said that the red curve corresponds to the observed dust storm. Where did the authors obtain the intensity factors for the other two cases? Are

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they realistic compared to reported observations in literature?

5. This study is based on one case. It therefore lacks the statistics to reach statements, like 'This 3-D E-field model successfully resolves the discrepancy between the 1-D E-field model (e.g. Kok and Renno, 2008) and the recent measurement (i.e. Esposito et al., 2016).' or 'The DEM implemented by cell-based algorithms is robust enough to detect and evaluate all particle-particle midair collisional dynamics.'Two aspects here:

a) It is weak in reaching conclusions based on a single case study. Also for model validation purpose, it would be important to apply the algorithms to at least another case. It will largely improve the quality and strength of the results, if the authors could add a second case to support. b) The 3-D E-field model indeed shows a good agreement with observations, but the discrepancy between the 1-D E-field model and measurement may not only be due to the exclusion of the two other dimensions of the E-field. It is good that the authors took into consideration of particle-particle midair collisional dynamics in the model, but what the authors implemented in the model certainly do not account for all. I would like to suggest the authors make a revision of the language in sections 5.3, 5.4 and 6 to avoid exaggeration in discussing the methods and results as well as conclusions drawn therefrom.

6. P20 line 26: remove explicitly; 7. P20 line 28: It does not seem to me that the 3-order polynomial curves can capture the patterns well in Fig. 5. Therefore, it is inappropriate to say '. . ., providing a detailed characterisation. . .'

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