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Interactive comment on "Electrostatic forces alter particle size distributions in atmospheric dust" *by* Joseph R. Toth III et al.

Anonymous Referee #1

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The article presents a valuable contribution to the discussion of the influence of atmospheric electric fields on dust transport, on the basis of both lab measurements and modelling. Particularly interesting is the comparison of the modelling to the campaign data collected by Maring et al. (2003).

However, some improvement to the presentation is needed.

P.4 line 138 and following: the model description is cryptic and confusing, with the same symbols used for the mean values and standard deviations of three different quantities, diameter, charge density and initial vertical velocity. E.g. the variable described first as the standard deviation of the size distribution has the dimension of surface charge density (line 187). This makes it unnecessarily difficult to assess the methodology.

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Discussion paper

Another potential confusion occurs in section 5: on p.7 lines 211-212 it is stated that the electrostatic forces were calculated as the product of the electric field and the surface charge density, meant here to be the same charge density as that on the particle surfaces. Taken at face value, this might be understood to imply that the atmospheric system is treated as a parallel capacitor, with the charge density equal to that found on particle surfaces (or on bulk quartz surfaces, as in one cited reference, Miura and Arakawa, 2007). This is misleading at best, and could potentially hide a basic error made by the authors - which is presumably not the case, judging from equation 2, which is correct.

Having said that, there is some justification for employing the field-density product, as both these parameters are unknown and the electrostatic force does depend on their product. So it should be explained clearly what is meant.

My main objection concerns the discussion of the results. It is concluded that even the fair weather electric could maintain large dust particles aloft. However, this is assuming extreme value of surface charge densities, 220 $\mu C\,m^{-2}$, found in lab studies of bulk quartz surfaces (Miura and Arakawa, 2007), and untypically large (compare e.g. the values cited in Angus and Greber, 2018). More realistic values, especially for particulate matter rather than bulk material, should be cited from literature (which is not as sparse as the discussion implies, if spatial charge density measurements are included) and used in these conclusions. The authors own lab results point to charge densities two orders of magnitude lower than the above number, and similar values were found by Waitukaitis et al. (2014). So it should be concluded that electric fields exceeding the normal fair weather value are probably needed, as suggested previously by some authors. For example, it was estimated on the assumption of realistic spatial charge densities that fields of 2 kV/m would be required to maintain dust in suspension (Ulanowski et al., 2007). While such high values exceed the fair weather field, extensive literature suggests that they are not uncommon during dust episodes.

These unsupported conclusions are made prominent in Fig. 6 and 7, where the earlier convention to use the field-density product (as in Fig. 5) is unaccountably abandoned in favour of citing just the electric field. The hidden assumption, not mentioned in the figure captions, is the extreme, and probably unrealistic, value of the surface charge density. This is misleading, as all that can be said is that the field-density product has a certain value. So the labeling of both figures should be changed.

Small points and typos:

P.1 line 30: for completeness, dust also interacts via the semi-direct effect, whereby dust enhances cloud evaporation.

P. 8 line 257: presumably what is meant is that particles "would remain aloft", not "would be lofted"?

Fig. 5: the year cited should be 2003.

Fig. 7: In my view, the cumulative distribution shown is less clear than the alternative form of a differential distribution, and should be changed.

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