

Atmos. Chem. Phys. Discuss., referee comment RC1
<https://doi.org/10.5194/acp-2020-1284-RC1>, 2021
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Comment on acp-2020-1284

Anonymous Referee #1

Referee comment on "Aerosol effects on electrification and lightning discharges in a multicell thunderstorm simulated by the WRF-ELEC model" by Mengyu Sun et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2020-1284-RC1>, 2021

Re:

Aerosol Effects on Electrification and Lightning Discharges in a Multicell Thunderstorm Simulated by the WRF-ELEC Model

Mengyu Sun et al.

This work uses an advanced microphysical scheme coupled with a charging and discharge model to study the effect of pollution on microphysical and charging processes. The subject is of interest to readers of the Journal.

Yet, there is much work to be done to clarify the reasons for the differences between the continental and polluted case. I am also concerned that the results are not realistic in regard to how the cloud and rain water forms as the background conditions are changed. The authors offer explanations for why they do not, but they contradict themselves within the text.

I highlighted areas of text that were not grammatically correct or were unclear (in attachment). I also listed my comments here that are mentioned within bubbles in the attached text. Words are used describing results that require further explanation (e.g., what is a domain average? The authors stated that they did not use some of their results because they were not realistic). There is a lack of quantitative comparison.

There are many highlighted areas and many comments.

I suggest the authors step back and ask themselves if the microphysical response to changes in aerosol concentration are consistent with other studies, including spectral (bin) micrphysics studies, as well as observation!

They need to more clearly explain model simulation differences and add details where needed (see comments).

I do not see why Section 4.5 (Delay of First Flash) is its own section, coming well after the previous results that followed the storms through their different developmental phases.

120: No reference provided.

125: What is the context for stating "The maximum total lightning frequency even exceeded $1600 \text{ flashes} \cdot (6 \text{ min})^{-1}$ at the mature stage." How does the reader know this is a large number, considering system sensitivity varies from region to region.

130: Where is the description of the model physics used, the domain grid spacing, etc? How long were the simulations run. How soon after the start of the simulations did the convection of interest occur?

135: Why are processes related to graupel growth the only ones mentioned? I was expecting to read more details about diffusional growth, interactions among particles, freezing, etc.

170: higher in the Beijing area than where else?

180: should be: "should effectively delay..." There is no certainty here.

185: There are quite large differences in the simulated radar compared to the observed radar in terms of spatial coverage. The authors should say why, and explain why these large differences do not affect their results/conclusions. Also, can the authors hypothesize why the simulated storm occurred 1.5 earlier than observed? This is quite a significant time difference.

205: How is the variation of flashed in the P-Case better (more) consistent with the observations. No statistics are presented to prove this point.

240: In previous simulation studies, the authors note that more aerosols could be activated into cloud drops ... leading to larger cloud drop concentration. They claim that in this study no more cloud droplets could be created -- suggesting that the supply of moisture was limiting. However, this could be an artifact of the scheme, rather than physical reality. Moreover, in 255, the authors claim that warm rain process was delayed -- yet why should it be, since the cloud concentration (mass/) was just mentioned to be the same.

265: Moreover, latent heating profiles are similar in areas of cloud mass, again suggesting that warm processes were not delayed.

260: Please add more up to date references.

270: They state that the mass mixing ratio of graupel was relatively less in the P-case. This is contrary to the mentioned studies (more references could be added). They suggest that reduced raindrop freezing explains this, but previously mentioned that latent heating was the same. How can this be since latent heat is released from droplet condensation? Were the drop sizes smaller? Was there more snow?

280: The authors then note that the maximum amount of graupel in the mature stage is higher in P versus C, but don't explain why the results have changed.

280+ It is incorrect to claim that there are any appreciable differences in the dissipating stage, based on the numbers given.

295: The short paragraph is a conclusion, rather than a result.

305: How is dipolar charge structure more consistent with previous observations. Please tell the reader the difference between dipolar and simple dipoles/tripoles.

310: negative charge region in which simulation?

320: Why do graupel and hail particles charge negatively?

340: Very hard to understand the sentence structure.

350: More recent references needed.

355:

"Considering that both cases have rather high CCN concentration, there would not be much difference between them in condensation." So, then what makes them difference. (By the way, I am not sure I believe this; more information is needed comparing mass, not just concentrations -- but we're still left with the question of why?).

365: Section 4.5: Why is it a separate section and not integrated within the text?

370: "In the meanwhile" refers to when?

390: what simulation becomes much larger at 9:30 UTC?

405: Please discuss what are the microphysical processes affected.

415: Is that heat of fusion rather than latent heat?

425: The paragraph beginning with "Compared to C-case" has a contradiction. Shouldn't ice and graupel grow more quickly due to coalescence? You just pointed out that "it was not noted."

675: Figure 5: How are these vertical profiles calculated -- over what volume?

685: Please better define "domain" in the figure caption of Figure 6.

695/705: Figure 7 and 8: the word "main" is not clearly defined.

Might differences also be shown?

710: What is "the location shown in Fig. 2?"

Please also note the supplement to this comment:

<https://acp.copernicus.org/preprints/acp-2020-1284/acp-2020-1284-RC1-supplement.pdf>