Review of "Aerosol Effects on Electrification and Lightning Discharges in a Multicell Thunderstorm Simulated by the WRF-ELEC Model", Mengyu Sun et al.

The authors present a concise study of aerosol (acting as CCN) impacts on electrification and lightning activity in a case study simulation of severe deep convection over Beijing. Regional simulations are performed using the WRF model with a lightning parametrization. Two simulations are performed: a''polluted' (P) case with CCN concentrations consistent with those observed in the Beijing area, and a 'continental' (C) case with CCN concentrations that represent standard continental conditions (but which still remain high compared to e.g. clean oceanic conditions). The model reproduces the convective event relatively well, with convection occurring slightly earlier in the model than observed. When adjusted for timing of convection, the polluted case has a similar flash count and evolution of the flash count variability to observations while the continental case has a completely different intensity and evolution of lightning flashes, with the onset of lightning occurring earlier than the polluted case but the lightning intensity being much weaker throughout the duration of convection. The authors assess the differences in the lightning activity between the two cases in terms of the cloud microphysics and show that the polluted case has increased amounts of cloud water, suppressed amounts of graupel and increased amounts of cloud ice compared to the continental case and that there are stronger updrafts and downdrafts in the polluted case. The differences in the cloud charge structure are then related to these morphological differences in the cloud microphysical structure, which is used to explain the differences in lightning evolution and intensity between the two cases.

The paper is mostly well structured with informative and clear figures, however much of the discussion of the aerosol impacts on microphysical development and processes is speculative rather than supported by thorough analysis. This is a major weakness of the study which should be addressed in a revised version of the paper before it is suitable for publication.

General comments:

1. The manuscript is in need of careful English language editing throughout, particularly in the abstract and introduction. There are too many for a reviewer to spend time providing a full list of typos and language corrections.

2. The paper would benefit from an explanation of inductive vs non-inductive charging mechanisms for the reader familiar with cloud microphysics but not charging mechanisms and lightning. Similarly, discussion of the dipole/tripole charge structure needs more explanation and placing in context of which is more likely to have occurred in the observed case.

3. The authors make many statements about microphysical process differences between the two cases, but do not provide any analysis of these processes or comparison to what would be expected to have occurred in the real observed case.

4. The authors state that certain sections of the model domain are excluded from the analysis, but then show many figures in which the microphysical structure of the two simulations are averaged horizontally. Details of this horizontal averaging process need to

be given to ensure that they are consistent across all the analysis and appropriate for the particular scientific questions being addressed.

Specific comments:

Section 3 (Model overview): the model setup up and boundary forcing should be described (with appropriate references) in the body of the text as well as summarized in a table. More information on the model setup is required: what is the simulation start time, how much spin-up time is discarded from the analysis (if at all), are both nests run without a convection scheme (I believe this is the case?), how do the authors downscale from 1-degree global data to their 6 km nest, what is the geographical coverage of the two model nests and the placement of the 2km nest inside the 6 km nest (a map would help)?

L154: “grids for short” - grids usually refers to the entire set of model grids (nested), not points. I suggest using ‘points’, or just ‘grid points’.

L171: “The average value of the observed aerosol concentration before thunderstorm initiation is much higher in the Beijing area” - higher than what? And how does this compare to the two CCN concentrations you have selected as your polluted and continental values?

L200-215 (and Fig 4): Does light/heavy/moderate etc refer to lightning density (flashes occurring in terms of number of grid points)? Clarify this in the wording.

L233: Is the horizontal averaging performed over the entire model domain or excluding the region in the NW where the convection was different from the observed case?

Fig 5: The polluted case has an extra cell (at approx. 09:45 UTC) that doesn’t develop in the continental case. Can you explain why this is and what impact this has on the results? Given that you are forcing both simulations with the same boundary data, this may affect the subsequent development of convection in the P-case compared to the C-case.

L336: “microphysical and electrical processes” - do the authors mean the CCN have a direct electrical impact on the charging, and not just through the impact on microphysics?

L350: discussion on convective strength - at the start of this section you say there is no significant difference in convective strength between the two cases, but it was stated in L320 that the P-case has stronger updrafts and downdrafts than the C case. This contradicts saying “vertical convective strength did not vary significantly under different aerosol conditions”. Similarly at the end of this section you then say there is increased latent heating at upper levels that strengthens convection and enhances lightning activity (L364), which contradicts the first sentence which says there is no difference in convective strength.

L445: The authors note here that their study only considers aerosol impacts on this case of convection through perturbations to the liquid phase development of the cloud. One question might then be what are the dominant aerosol sources observed in the case study region, particularly at the time of this event, and whether they are more effective CCN or IN?

Technical corrections:

Fig 3b and Fig 6 captions: the colours should be noted as well as linestyle. In fact, it would be better to use one of either (a) colour or (b) linestyle to denote the two cases, not a combination of both.