Atmospheric Chemistry and Physics Discussions

Atmos. Chem. Phys. Discuss., referee comment RC1
https://doi.org/10.5194/acp-2020-1280-RC1, 2021

Comment on acp-2020-1280

Anonymous Referee #3

Referee comment on "Lightning occurrences and intensity over the Indian region: long-term trends and future projections" by Rohit Chakraborty et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2020-1280-RC1, 2021

General Comments: This paper studies lightning trends and related meteorological drivers in India, where future population and urbanization growth rates make this an interesting and societally relevant problem. The study also adds to the scientific discussion on the importance of aerosols on lightning. It is also one of few studies that looks at lightning radiance, though as mentioned below, more description will be needed to clarify this quantity's importance. In general, the paper doesn't suffer from any major methodological flaws, though it could benefit from better explanations and clarifications in both the text and in the figures. While I have noted that this manuscript should undergo major revisions, it is probably more like in between minor and major.

Specific Comments:

pg 2, line 11: Are the authors suggesting that at higher latitudes the inductive mechanism is found to be the major factor? I am not aware of studies showing this. However, others, e.g., Saunders (1992), have claimed that the noninductive mechanism may be more responsible for early electrification and the inductive mechanism more so for later on during the thunderstorm development process. Please clarify.

pg 3, line 95-97: As the authors say, lightning radiance is generally not investigated. Some more background should be presented as to why this variable, which is probably less familiar to readers, is more connected with physical processes (e.g., lightning nitrogen oxide (LNOx) production), as well as why it is not directly correlated with flash frequency (along similar lines, why "radiance is far more dependent on the local hydrometeor concentrations" than is flash rate, as mentioned on line 286). Lastly, provide some context as to why policymakers should care about radiance. From a possibly naive

point of view, deaths are likely to be related to the number of flashes, regardless of the flash radiance.

pg 4, line 129: Are the units for "radiance" not J/m2/steradian/micrometer? I believe the GOES-R GLM documentation notes that this quantity is actually a solid angle averaged spectral energy (and I think LIS outputs the same thing). Please double-check the units from the downloaded data files.

pg 4, line 152-153: I am not familiar with Kumar and Kamra (2012); could the land-sea frequency contrast be due to different aerosol amounts? Perhaps a map of AOD could be helpful for the reader.

pg 9, lines 330-333: The authors mention ozone depletion as the primary cause for increasing CAPE. Without thinking about ozone, CAPE would be expected to increase with global warming due to upper-level changes in buoyancy. In the tropics the free-tropospheric lapse rate is set by entraining clouds (the zero buoyancy model of Singh and O'Gorman (2013)). Thus, undilute buoyancy increases with warming because of the larger saturation deficit between an undilute parcel and the environment, which scales with saturation specific humidity. As per Seeley et al. (2015), the resulting difference in saturated moist static energy is dominated by the latent enthalpy term at lower altitudes with more water vapor, but by the sensible heat term at higher altitudes. Have the authors considered this?

Figure 7 is quite unclear. Please provide units for both y-axes. For the top row, what is "variability"? Please also clarify the meaning of the percentages in the legends in the top row of plots.

Where do the percentages in Figure 8 come from? I do not see them in the main text. Please also clarify over what time period the changes represent, i.e., last decade minus first decade, last decade minus 2010-2020, 2100-1950, etc.

It would probably also be nice to put frequency and radiance units on all pertinent figures (Figures 3, 5, and 7) so that they are not confused with percentages by readers.

Technical Corrections: There are quite a few grammatical fixes that could be made; I have pointed out two below.

pg 7, line 250: descent —> decent

pg 18, line 366: fairs —> fares

References

Saunders, C. P. R. (1993). A review of thunderstorm electrification processes. *Journal of Applied Meteorology and Climatology*, *32*(4), 642-655.

Singh, M. S., & O'Gorman, P. A. (2013). Influence of entrainment on the thermal stratification in simulations of radiativeâ□□convective equilibrium. *Geophysical Research Letters*, *40*(16), 4398-4403.

Seeley, J. T., & Romps, D. M. (2015). Why does tropical convective available potential energy (CAPE) increase with warming?. *Geophysical Research Letters*, *42*(23), 10-429.