General Comments

Pérez-Invernón et al. utilized the Lightning Imaging Sensor to develop different Long-Continuing-Current (LCC) parameterizations and compared the simulations with observations. This new parameterization could benefit both LCC simulations and lightning NOx studies.

Specific Comments

1. L12: What is the meaning of typical lightning? It should be typical total lightning according to the main text. If I am wrong, please correct me.

2. L66-69: It is necessary to explain why do you only mention LCC (>9 ms) and LCC (>18 ms). How about the longer LCC?

3. L77: If I understand correctly, it is the total lightning distribution which agrees with that derived in Blakeslee et al. (2020). Please rephrase the sentence to make it clear and connect with the peak flash density and land-ocean contrast mentioned later.

4. L81-92: It would be interesting to see more discussion about the meaning of the ratios between LCC and total lightning flashes. While the introduction section has explained why the ocean has a larger ratio, how about the cause and meaning of the maximums over land? Are these also weak convection?

5. L94-95: It seems the ratio of LCC (>18 ms) to total lightning usually exists over the cells with large ratio of LCC (> 9ms) to total lightning. This indicates that LCC (>18 ms) is the subset of LCC (>9 ms) and explains the smaller number of LCC (>18 ms).

6. L113: As discussed in [Romps, D. M. (2019)] (https://doi.org/10.1029/2019GL085748), "the mixed-phase cloud region is bounded by the 273-K isotherm (where ice can first form) and the 240-K isotherm (where liquid drops freeze homogeneously)". They use IFluxT, defined to be the convective ice flux on the 260-K isotherm, which lies within the mixed-phase regions of clouds and is close to the 440-mbar isobar in a modern-day tropical sounding. I know it is a large work to do the sensitivity test, could authors point the importance of isotherm?

7. L127-L128: Shouldn't the tropospheric and middle atmosphere processes include the effects of anthropogenic emissions? maybe authors want to emphasize the meteorological atmosphere processes?

8. L143: How did the authors re-grid the updraft? It is better to use the maximum updraft in the grid according to the updraft references.

9. L159: Does "the possible relationship" stands for the relationship between ratio and updraught mass flux?

10. L171: It seems there are few points when the updraught mass flux larger than 0.3. Could this affect the regression?

11. L185: Did the authors get some model grids with updraught mass flux larger than 0.5? If so, the uncertainty of LNOx will also be large. If the authors have written some other manuscript implementing this parameterization, please tell readers the limitation.

12. L235-L236: As mentioned in Luhar et al. (2021), their marine parameterisation yields flash rates that are approximately an order of magnitude smaller than the PR92. Why the authors get the larger difference (5:1 and 1:1)? Is it caused by the model resolution?

13. L268: Are "maximum values" compared with both land and ocean data?

14. L282-L284: Interesting results of seasonal correlation. Do authors have any explanations?

15. L315-L316: Are extreme values of updraft from reanalysis or simulation? If they only exists in one dataset, that may explain the bad agreement.

16. In the Discussion section, authors usually use "good agreement", "higher", "lower" to explain the figures. They need to come up with a better way like putting some figures in the Supplements and add use some indexes to judge "good or bad" and "higher or lower".

Technical Corrections

1. L11: to find a global parameterization → to develop a global parameterization

2. L13: It is better to give the full name of EMAC in the Abstract

3. L31, L37: LSS are → LLS is

4. L42: Add a space between degree symbol and N(S)

5. L47: the process of separation of electrical charges → the process of electric charge separation

6. L51: could be helpful to ..... and (to) ....

7. L63: lightning with ... and (with) ...

8. L71: The TRMM-LIS ended in 2015 and a similar instrument onboard the ISS replaced it for a
4 years mission ...

9. L76, L81, L93: It would be better to use a,b,c instead of first/second panel to point out the subplot. Please also check other figures.

10. L82: are also regions with →coincide with

11. L84: is clearer shown ... showing the ratio of →is more clearly shown by the ratio of .... in Fig 1c.

12. L89: between 35◦ N and 35◦ S latitude →between 35◦ N and 35◦ S

13. L90: All these regions are well-known regions for →All these regions are well-known for

14. L120: "section" →"Section"

15. L129: "by using" →"by"

16. L134: "a novel combination .... suggested by us" →"our novel combination"

17. L138: What is the definition of the "scaling factor" in Table 1? Because I do not see the same numbers in these references, authors may have their own definition.

18. L142: "prepare" →"process"

19. L143: The sentence can be simplified into "the global 1-hourly averaged values of the vertical velocity at the 450 hPa level between March 2017 and March 2018 are re-gridded onto a 2.50◦ × 2.50◦ latitude and longitude grid, which it is similar to that typically used in global chemistry climate models."

20. L197-L199: This is duplicated with L195-L196. If I misunderstand, please correct me.

21. L206: "with a quadratic Gaussian grid of 2.8◦ × 2.8◦ in latitude and longitude"
→"with a .8◦ × 2.8◦ quadratic Gaussian grid"

22. L216: Please rephrase the sentence. The grammar is wrong.

23. L231-L232: "figure 4" → "Fig. 4"

24. L263: "Figure 7 and 8" →"Fig 7. and 8."

25. L264-L265: "Figures 9-12" →"Fig. 9-12"

26. L276: "off" → "of"

27. L300-L301: Please add the references.

28. L305: Which ratio?

29. L310: "suggests" → "suggest"

30. L317: "season" → "seasons"

31. L319: "parameterization" → "parameterizations"

32. L342: "entail" → "entails"

33. L375: "entail" → "entails"

34. L386: "that will serve to complement" → "that can complement"

35. L386: "will serve to improve the" → "will improve"

36. L387: "will serve to improve" → "is needed to improve"

37. L391: Too many "serve to" are used in the Conclusion. Please polish it.

38. Fig 13. "Each point represents a different season." It is better to use different opacity (or other symbols) for each point. Otherwise, readers do not know which point is which season.