Review of nhess-2021-14 manuscript:

Global ground strike point characteristics in negative downward lightning flashes – part 2: Algorithm validation

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This is well-written and very interesting work that is relevant to all areas associated with ground-based lightning risk and protection. This second paper in the sequence follows nicely after the first paper that describes cloud-to-ground (CG) ground strike-point (GSP) behavior in terms of "ground truth" using high-speed video observations in many different locations. The specific questions in this second contribution are "how well can existing LLS networks capture the strike-point behavior, and is there a 'best' algorithm for doing this?".

This work is a real contribution to these questions, but there is room for improvement, as indicated below. Some of these issues are important concerns that the authors need to address before I can recommend this work for publication. Some further suggestions/comments would be easy to address and would improve the contribution. Others may require additional effort that the authors may see as "future work." This is followed by a few technical corrections and suggestions.

Concerns

1. An important issue with multiple ground contacts is the closely-spaced strike locations resulting from forked lightning and a fraction of the sequential strokes. It seems that the authors may have the information available to specifically determine the fraction of such strike points that at not properly classified by each LLS in the study, possibly as a function of distance projected into the plane of the camera. It may be that a detailed assessment of this is beyond the reasonable scope of this current work, but some discussion of this issue would be important to include, at least in the discussion section.

2. All three GSP algorithms rely heavily on the error ellipse parameters, so the accuracy of these parameters is essential. The rather large disagreement between the measured LA and estimated SMA values in Table 1, at least for the BR LLS, call this into question. Helpful insight about the accuracy of the ellipse parameters for each LLS can be provided by the distribution of Ch-square values. Even just knowing the mean and standard deviation of the Chi-square values for each LLS (for the flashes included in the study) would be helpful.

3. The phrase "semi-major axis" is used on line 73, with no earlier definition or explanation. Since Location error estimates are central to this work, the authors need to

precede this with a discussion of what an error ellipse is and what an SMA is, either in a short section of its own or through references to earlier work. A number of LLS's do not have these parameters, and this should probably be mentioned. In those cases, GSPs would probably be determined solely by some prescribed separation distance.

4. The findings in both papers indicate that ground strike point statistics differ in different regions. This is worth mentioning.

5. All the regions exhibited higher percentages of single stroke flashes than any of the seven studies cited in the 2013 CIGRE Brochure 549 (Table 2.1), which is relevant but not cited. The authors should address this apparent discrepancy.

Suggestions/Comments/Questions

6. Have the authors collected information about stroke order, SMA, separation distance to closest GSP, or nearest-sensor risetimes for the mis-classified strokes? As noted by Stall et al. (2009) and Cummins (2012), stroke order and risetime information might be helpful in resolving strokes (PEC/NGC) that create new ground contacts. Maybe this is future work?

7. Is there an explanation for the unusual GSP statistics for SA (sorry if I missed it) (maybe distance-to-camera?) Are flashes that interacted with towers in the SA dataset excluded from the analysis?

8. Is there an explanation for the uniformly-low peak current for the ES LLS, for all stroke types? This does not need to go into the manuscript, unless the authors find it particularly relevant.

9. The distance information in Table 1 is a "treasure trove" of observations that are not explored in this work. First, the very large maximum distances for most LLS's are much larger than what was reported in the past, which is at-odds with the authors' statement on lines 152-153. Maybe these are caused by individual location errors? Do these values match with the video, and with the logical definition of a flash? Also, knowing the fraction of separation distance near the spatial accuracy of the LLS data (below 500m) would be interesting and helpful information. Maybe this is future work?

Technical Corrections/Suggestions

10. Throughout the manuscript, the term “amount” is used when talking about the number of strokes or sensors. The same is true in paper 1. English usage typically employs “number” to quantify integer values like these.
11. Line 33: suggest “should not” rather than “cannot”
12. Line 35: suggest “nature and society” rather than “human safety”
13. Line 46: suggest adding Koshak et al. (2015) along with the existing Yair (2018) reference
14. Line 57: suggest changing “…relate Ng to…” to “…infer Ng from…”
15. Line 59: suggest changing “…flash is…” to “…flash has historically been…”
16. Line 87: the acronym “CC” is used before it is defined
17. Line 102: suggest adding “flash” before “detection efficiencies”
18. Line 104: should clarify what is meant be a “downward event”
19. Line 111: suggest adding Zhu et al. (2020) as a good reference for tower-based LA estimates
20. Line 126: the phrase “one can find” leaves the reader hanging. It seems like this should refer back to the references in section 2
21. Line 127: remove “can” ?
22. Line 128: suggest adding “and are described in the text that follows” after “data set”
23. Line 132: suggest replacing “LA” with “random location errors”, since this method does not quantify local mean (bias) errors.
24. Line 160: suggest adding “waveshape information derived from” before “IMPACT”
25. Line 162: suggest adding “directly” after “applied”
26. Lines 182-184: The use of “so-called spherical threshold” makes the algorithm seem rather mysterious. I think that it behaves simply as an Euclidian distance at this point in the algorithm.
27. Line 200: should clarify what is meant by “pre-existing GSPs.”

Suggested References

Koshak, W.J., Cummins K.L., Beuchler D.E., and other (2015), Variability of CONUS Lightning in 2003–12 and Associated Impacts, j. Appl. Met. & Clim., v54, pp 15-41, dio: 10.1175/JAMC-D-14-0072.1, 2015.

Zhu, Y., Lyu, W., Cramer, J., Rakov, V., Bitzer, P., & Ding, Z. (2020). Analysis of location errors of the U.S. National Lightning Detection Network using lightning strikes to towers. Journal of Geophysical Research: Atmospheres, 125, e2020JD032530. https://doi.org/10.1029/2020JD032530

Kenneth Cummins, March 2021