Report #1, Submitted on 08 Oct 2024 by Anonymous referee #3

Dear Authors,
Thank you for your hard work. I have some questions that you should address before accepting the manuscript. Please, find them in the attached doc.
All the best.

Thank you very much for reviewing our manuscript again.
Please note the authors' comments on the review highlighted in green.

Attached file with this report:

Dear Authors,
Thank you very much for your detailed answers and the notable improvement of your manuscript. The new version shows a better organization of your Research and provide more curated information about your findings.
Please find below my new comments, some of them appeared from your previous answers (which are marked in bold and between quotation marks):

"We would like to point out that the lightning jump algorithm in use was adapted to the GEO lightning sensor and is described in detail in Erdmann and Poelman (2023). It does not use the same configuration as the LJ algorithms for terrestrial lightning location systems (LLSs). The commonly used algorithms was developed for lightning mapping array (LMA) with radar-based storm tracking. Erdmann and Poelman (2023) tuned the algorithm parameters to be used with GLM lightning observations and satellite-based storm cell tracking."
I fully understand your comment, but after carefully reading the two manuscripts (the presented one and the 2023 one), I think that you should include a graphic which could help the reader understand the differences between the original and the proposed version of the algorithm. This scheme should present the life cycle of a thunderstorm from the point of view of the lightning activity and how you transform in the sigma variable and when a jump or a dive occurs.

Please see below a time series showing one thunderstorm trajectory with LJs identified using the original 2σ and our adapted FRarea LJ algorithm (Figure R1). The figure also includes the flash rate and algorithm flash rate (FR, blue) and σ-level thresholds (grey), as dashed line for the original 2σ LJ algorithm, and as solid lines for our FRarea LJ algorithm. Detected LJs are shown as red markers as indicated in the legend. The time evolution of the cell area with 10-minute updates is plotted in the 2 row of Figure R1.
The FRarea LJ algorithm of this study considers the cell area when calculating σ-levels. Hence, the solid and dashed lines for the σ-levels of our and the 2σ LJ algorithm, respectively, differ especially at times when the cell area is changing. This behavior is evident during the start of the trajectory, where the cell grows, and more flashes can be matched to the larger footprint. The original 2σ LJ algorithm detected a LJ, whereas our LJ algorithm didn't as the FR per area did not increase sufficiently and σ(area) remained close to 0. Note also the decreasing σ(area)-level for the increase in FR at about 40 minutes, happening with a simultaneous jump in the cell area likely due to merging of cells. The raw σ-level increased at this time. The opposite behavior can be seen towards the end of the life cycle (at about 94 min): The σ(area)-level exceeds the raw σ-level as the FR increased within a shrinking, soon decaying cell. At 36 min, only

our FRarea LJ algorithm could detect the LJ that actually led to maximum FR of 93 flashes/min. The lower σ-level threshold of our FRarea algorithm of 1 compared to the original 2σ algorithm helped to detect this LJ that should not be missed. After 64 min of the cell lifetime, both algorithms detected a LJ.

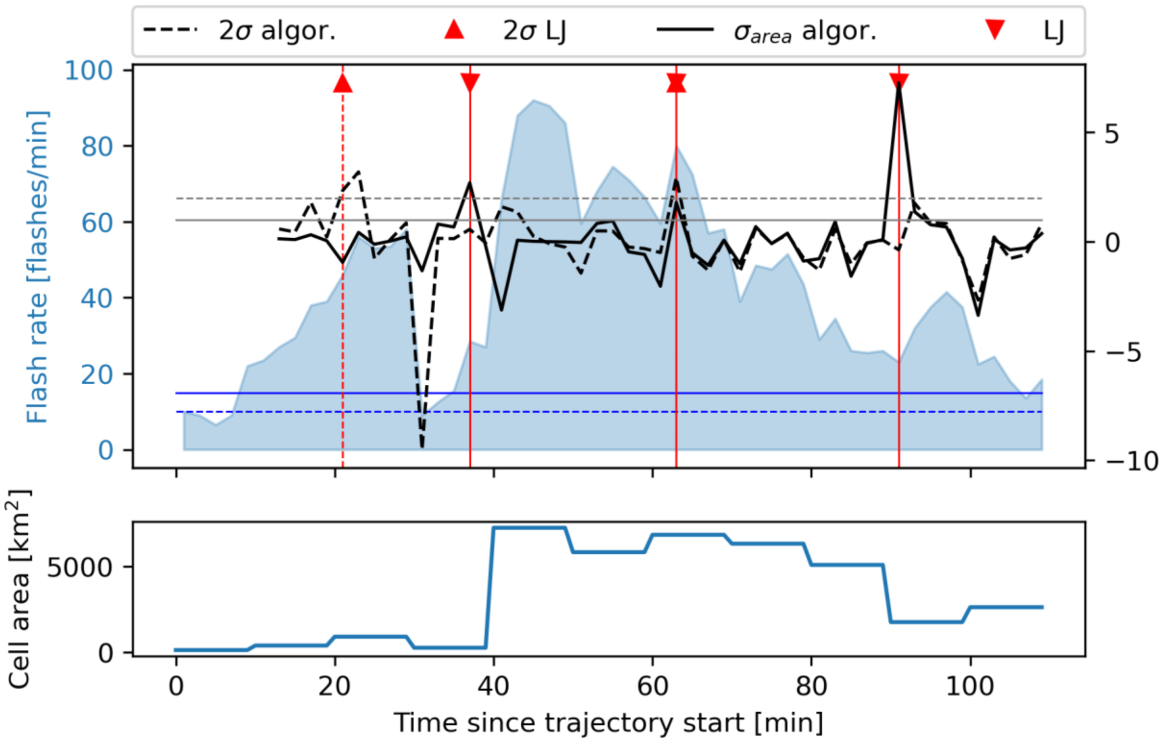

Figure R1: LJ algorithm comparison for a thunderstorm trajectory on 10 Jun. 2020

We decided that we won't use this exact Figure in the manuscript. The 2-sigma algorithm is not explained and not part of this work so it would rather confuse the reader. Instead, we add a figure showing the time series with LJs and LDs and the parameters as obtained from the applied algorithms to identify LJs and LDs. The following paragraph and figure were added to Section 2.6:

""

Figure 2 illustrates the application of the LJ and LD detection algorithms for one thunderstorm trajectory starting on 06 Feb. 2020 at 0520 UTC and lasting almost 90 minutes. The thunderstorm reached a maximum FR of 48 flashes per minute about 75 minutes after the cell had been identified, with a second FR peak observed 54 minutes after the start. In total, 2 LJs and 3 LDs were detected as indicated by the red markers. The detection algorithm thresholds are also shown as horizontal lines, in blue for the FR threshold and in grey for the σ -level threshold. The flash rate must be greater than the FR threshold to detect a LJ or LD. At the same time, the σ-level should exceed the threshold for the LJ algorithm, and be more negative than the threshold for the LD algorithm. The σ -level peaked during the first LJ. Although the raw FR increased more rapidly during the second than during the first LJ, the simultaneous growth of the cell led to a smaller σ -level than in the first LJ, as the LJ algorithm accounts for cell area by dividing FR by the cloud cell area.

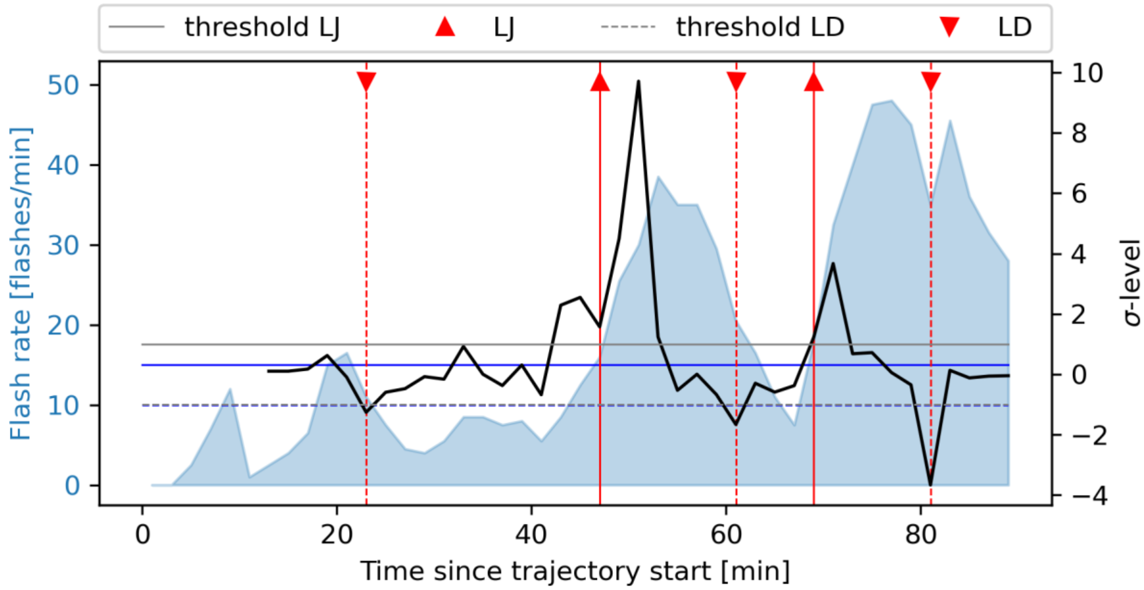

Figure 2. Flash rate (blue shading), σ-level (black) and detected LJs and LDs (red triangles) for one thunderstorm trajectory starting 06 Feb. 2020, 0520 UTC. The FR-thresholds (blue) and σ-level thresholds (grey) of the LJ (solid) and LD (dashed) detection algorithms are shown as horizontal lines (dashed lines superimposed).
“””

“Why is the size of the storms important?”
The difference in size between supercells or normal cells is quite evident and is an indicator of the intensity and wide of the updraft. This is only one example, but there are many more. For example, large squall lines or MCS tend to last more and to produce more severe weather reports, because the organization is higher and helps to extend the duration. These are two examples of the importance of the size. For sure, there are cases where the size does not provide any relevant information, but these examples are less associated with convection.
In fact, you say in your manuscript that: “the mean cell areas in Table 4 confirm the previous finding. On average, severe thunderstorm cells covered an area of 12,812 km2 (median 4,089 km2). Storms with LJs had an average area of 15,780 km2 (median 6,995 km2), whereas while non-severe thunderstorms and those without LJs typically covered about 2,000 km2 on average, with medians around 550 km2).”
We agree with the referee that different storm types such as supercells, single cell storms, or MCSs are known to have different sizes. We found that the thunderstorms with LJ and the severe storms feature larger footprint areas than the no-LJ and non-severe storms. Hence, this could mean that more organized storm types prevail in these 2 categories.
We added this aspect to the discussions (section 3.1.1):
“The fact that thunderstorms with LJs, LDs and the severe storms covered larger areas than the average area of all thunderstorms may indicate an above-average fraction of well-organized thunderstorm types like supercells, multi-cell storms, or MCSs that are known for larger footprint areas than the ordinary single cell thunderstorms.”

However, we did not analyze or separate different storm types. The study analyzes almost 25k storm trajectories, and would take a lot of time to evaluate those trajectories by hand for the thunderstorm type. We may look into this aspect in the future for certain selected trajectories.

About the list of acronyms, I know that is not mandatory, but in your case can result very helpful to the reader, because the large number of items. It is your choice.
We didn't add a list since we think it is uncommon in journal articles.

Some new comments:
- Typo in caption of table 4: "Torndao" should be "Tornado"
OK
- I suggest merging subsections 3.1.2 and 3.1.3, reducing part of the text. There a lot of results and I suggest you that focus on the main items.
We merged the sections and shortened parts of the text.
- You say that "It should be mentioned that severe weather is observed in storms without LJs, and that there are non-severe storms that had GLM LJs". Fortunately, there is not an algorithm able to reproduce the exact behavior of a thunderstorm. Furthermore, as you also indicate in the manuscript (and we previously discussed), there are limitations on the direct ground observations of severe weather. Because of this, I suggest that you replace "Hence, the GLM LJs should not be used as standalone severe weather warning tool but in combination with other data." By "We recommend the algorithm users to consider its limitations, in special at the time of applying for operational purposes. The algorithm can indicate the occurrence of severe weather in a thunderstorm but, as occurs with all the real-time tools, the user must consider many other elements, such as signatures observed in radar imagery, satellite data or terrestrial lightning detection networks."
Thank you for the suggestion, we changed the text accordingly and added a slightly modified sentence to the manuscript: "Users of the algorithm are advised to be aware of its limitations, especially when using it for operational purposes. The algorithm can indicate the occurrence of severe weather in a thunderstorm, but as with all real-time tools, the user must take into account many other elements, such as signatures observed in radar images, satellite data or terrestrial lightning detection networks."

Report #2, Submitted on 09 Oct 2024 by Anonymous referee #1

The revised paper is much improved. I think the paper can be published after additional minor corrections.

We thank the referee for his effort to review our manuscript and to help improve it. We appreciate the positive feedback. The new comments will be included in the text as stated in our answers to the comments highlighted in green.

Line 5: and/or severe weather
OK
Line 9: in the non-severe storms
OK
Line 13: Is 26.4 mm/h significantly different from 20 mm/hr?
These are average values. We can have a look at Figure 3b [new: Figure 4b]: The IQR of the withNCEI storm as severe storms, with average CRR of 19.5 mm/h (rounded to 20 mm/h in the abstract), ranges from 9 to 28 mm/h. Hence, it includes the 26.4 mm/h value. CRRs show a wide range of values and the category IQRs approximate 20 mm/h. We added this aspect to the discussion (Section 3.1.4 [new: 3.1.3]): "However, one needs to consider the high variability of CRRs in each TS category expressed as IQRs of about 20 mm/h.".
We are convinced that 26.4 mm/h means a significant increase to 19.5 mm/h as (i) it's a relative increase of about 35% (=(26.4-19.5)/19.5), and (ii) 26.4 mm/h is almost as high as the 75% of the severe storms' distribution (28 mm/h).
The impact of 6.9 mm/h rainfall for events like flash floods depends on additional criteria like storm moving speed, the surface characteristics, and terrain.
Line 27: In addition
OK
Line 80: data are ingested
OK
Line 166: Why these specific 14 parameters? Are these all the parameters provided, or did you choose a subset?
As you may see in the peer review process. initially, we used all parameters that our nowcasting software provides us. We reduced the number of parameters in the paper to improve the readability. These remaining 14 parameters mean a trade-off between as much information as possible about the storm cells and the most important findings.
Line 236: How do you measure pressure? Is this an independent parameter, or derived from the brightness temperature? Table 4 should have independently observed or calculated parameters.
The NWCSAF nowcasting software takes ECMWF NWP as an additional input. Pressure measures are based on the NWP data taking the brightness temperatures and NWP temperature profiles into account. The NWCSAF software provides pressure as an output.
Line 257: Where do we see these results for withHail and withTornado?
We decided that we would not show the results for the individual severe weather types (they were included in a previous submission of the manuscript), and neither to discuss them in detail.
We think it is worth mentioning the results here as they differ from all severe storms. We added "(not shown)" to the text so that it is clear that this is an additional information.
Line 305: "colder" and "lower" than what?
We added that storms with LDs are the reference for the comparison.
Line 336: optical storms?

A mistake resulting from the last revision. We corrected the sentence: “For the first time, thunderstorms with GEO LJs and/or LDs detected from optical lightning observations are characterized in detail.”