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Atmospheric Measurement Techniques Discussions

Interactive comment on "Analysis of lightning outliers in the EUCLID network" *by* Dieter R. Poelman et al.

Anonymous Referee #1

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The paper describes a method to distinguish lightning outliers from the typical EUCLID cloud-to-ground and intra-cloud lightning dataset based on radar-based 5-min precipitation product. The methodology consists in merging the lightning data to the radar-based precipitation data and to study the properties of the lightning outliers located in a non precipitating region based on a spatial criterion. The properties are then discussed according to different information available from the lightning observations.

I think the methodology needs a bit more description, and more specifically on the way the advection is taken into account in the lightning dataset and on the beginning and ending times of the 5-min period used to categorize the different EUCLID lightning records.

The sensibility and accuracy of the radar-based precipitation products should also be

discussed as it is served as reference and limitation should be identified and taken into account during the analysis. I also wonder if rain field is the proper radar-based parameter to investigate. I would have also looked at the radar reflectivity composite as lightning flashes can propagate outside the rain field. Looking only the rain field suggests implicitly that you are considering that EUCLID records are predominantly located in the cores or closed to the convective cores. Using the radar reflectivity composite would help you to identify outliers in cloud-free regions to outliers in cloud regions.

What is also missing is some information on when during the flashes the different outliers are detected. Are they detected during the preliminary breakdown or latter during the life of the flashes? And to which processes do they correspond? I believe that such question can only be investigated by comparing EUCLID data to LMA-type observations. Note that a comparison with LMA-type observations might also require looking at the raw LMA data recorded by each station.

Note that the Authors do not exploit the value of rain accumulation that is provided by the radar-based product. I would have added some statistics on that parameter according to the properties of outliers and non-outliers.

Finally, no discussions are given by the Authors on how they could improve their algorithm based on the present analysis but maybe it is already planned or under way.

The manuscript is well written even if some clarifications are required. I think some additional parameters should be inserted in the figures. Please find below some specific comments.

Line 19. One should not forget that the 3D structure of the flashes might be different in winter compared to the one in summer.

Line 38. Is there a missing word after "more"?

Lines 64-67. Why only these two regions? And not a larger domain covered by both

EUCLID and the European radars?

Line 98. Please provide some physical and/or technological explanations on your statement that “timing only sensors often increase the number of outliers”.

Line 108. What do you mean by “overshooting beams”? Please rephrase.

Lines 108-113. I suspect the precipitation product you have been using has been validated. It might be relevant to provide some references on such validation in your paper.

Line 109. Is the Marshall-Palmer relationship valid whatever the precipitation regime? I suspect in your case you are more interested in low precipitation amount where potentially you might find the lightning outliers. So do you think that the radar product used here is sensitive enough to deliver a reliable and accurate product for your investigation? Why did you choose a radar-based precipitation product and not for example the reflectivity composite? Discharges are not only propagating where precipitation occurs (e.g. spider lightning). So I wonder if your choice to use the radar-based precipitation product does not lead to a larger uncertainty. Do you have any comment?

Lines 116-127. How is the advection taken into account as a 5-min precipitation product is generated? And how do you take into account the advection in your lightning data? At which altitude does the radar-based precipitation product correspond?

Lines 130-143. Same questions as for lines 116-127. How is the advection taken into account? At which altitude does the radar-based precipitation product correspond? Is the precipitation product comparable in terms of accuracy for both domains of interest?

Line 146. How is the radar-based precipitation distributed in those two domains? Are they geographically uniformly distributed? In Figure 4, you are giving the spatial distribution of the % of outliers. I would have added with iso-contours (in white) the actual lightning distribution from where you computed the %.

Lines 148-149. Again how did you take into account the advection of the precipitation

and of the lightning activity? The radar product is provided per 5-min period. How did you select the lightning data within that 5 min period and how does it fit with the way the radar product is built?

Lines 151-152. Again this suggests that precipitation at the ground is required to verify the lightning data. How are we sure that precipitation is always required where lightning flashes occur? Please provide some arguments to strengthen your methodology. I think a similar analysis using the reflectivity composite should be performed in order to identify cloud-free outliers to in-cloud non-precipitation outliers. At which stage of the lightning flash do the lightning outliers correspond?

Line 153. I suspect you have projected the lightning data on the same temporal and spatial grid as the radar data, right?

Figure 3. Could you please plot as well the number of CG strokes and IC pulses in order to see how your dataset spreads over the years?

Lines 161-163. Am I correct when I say that you did not try to associate the outliers with “correct” events based on a time criteria for example? I wonder if a time criteria should not be added to your analysis in order to dissociate isolated events to outliers mis-located from a group of events.

Line 185. See comment on Line 146 for Figure 4.

Lines 194-196 Could not we say as well that the October-to-April flashes might have different vertical and horizontal structures that make them detected by EULCID sensors with more difficulties? One should not only criticize the radar sensibility or the sensor upgrade.

Lines 203- 204. I understood that the two geographical domains you have been studying should not really suffer of any long range issue. Am I right?

Line 208. “which” instead of “wich”.

Lines 212-214. I agree with you on the climatology point of view, but then it depends on the application you want to do with your outliers data.

Lines 217-219. This confirms the interest of considering a temporal criterion in your analysis in order to discriminate isolated (in time and space) outliers to isolated in space only outliers. What do you think?

Figure 6. Without the actual number of events considered for each year, it is difficult to identify how statistically representative is the dataset you are studied in Figure 6. Could you please add that information?

Line 228. What the % of outliers with an absolute current above 20 kA?

Line 238. I would add “positive current outliers” instead of “positive outliers”.

Lines 228-238. I have a question about all those low current events. How confident are you in their detection and on their classification not only in terms of IC or CG but also in terms of polarity?

Lines 238-253. How accurate are the event locations when two lightning sensors are only used? Do you usually keep flashes detected with only two EUCLID sensors? Have you plotted the same parameter but by range of current? I would like to see how the number of lightning sensors influences the detection of the outliers according to their estimated current. You could plot it with 2D cumulative distribution.

Line 257. Do you see any difference between IC and CG outliers separately?

Lines 256-259. Do you have a way to get the number of events that were rejected by the central processor for the period of data you have studied?

Figure 8. The number of samples per SMA range would provide an idea on the statically representativeness of the dataset used here. Please add that parameter in Figure 8.

Figure 8 (continued). Similarly to what I suggested for Lines 238-253, have you looked

on how the SMA is distributed according to the number of lightning sensors used to locate the different event categories? If yes, what are your main conclusions? If not, please take a look on that plot and provide some information in response to the present comment.

Lines 265-267. I do not understand your statement. Please explain it.

Lines 280-281. I would insert the actual numbers, i.e. outliers and total number of samples.

%%% End of review

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