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Atmospheric Measurement Techniques Discussions

Interactive comment on "Polarimetric radar characteristics of lightning initiation and propagating channels" *by* Jordi Figueras i Ventura et al.

Anonymous Referee #1

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GENERAL COMMENT This paper presents a detailed study on lightning strokes in Switzerland, in relation with hydrometeor classification from dual-polarization weather radar. The topic is original and certainly interesting for a wide range of cloud physics applications. The paper is in general well written, with a comprehensive introduction including the scientific background and a proper description of the instrumentation and analysis methods adopted. The data analysis is highly descriptive, including a consistent amount of results organized according to partitions including IC, CG, positive and negative strokes, and finally lightnings originating at lower levels (mixed-phase region). The illustrated results are very interesting and worth to be published on AMT journal. As also detailed in the specific comments below, I found this part (section 3)

not enough fluent due to an overwhelming amount of numbers in the text. For this reason, I suggest making use of tables to organize at least some of these numbers and try to improve the fluency focusing on the relevant qualitative behaviors. In addition, while the introduction is properly developed with many relevant references, in the data analysis I missed references helping to understand whether the results are supported by previous findings or the authors are showing some phenomenological behavior not yet comprehensively studied, lacking physical explanation. This is my only major concern, which I'm sure could be easily addressed by the authors. Providing a better context to these results would help the paper readability, and provide other researchers a more solid background to work with lightning data in association with dual-polarization measurements.

Consider adding a figure showing an example of radar hydrometeor classification. A vertical cut, possibly with lightnings over plotted, would greatly help readers not familiar with radar classification, and may serve as an effective visual introduction to the main topic of the paper.

SPECIFIC COMMENTS AND MINOR CORRECTIONS

- When discussing the hydrometeor type in relation with the lightnings, percentages are given to represent the relative occurrence of given particle types. The first comment I have is that providing these numbers with two decimals accuracy is misleading. We know that hydrometeor classification is subject to many assumptions and uncertainties, so I would recommend providing these percentages with a lower level of accuracy (rounding to integers may be enough in general). The second comment is that there are large portions of the manuscript with a detailed listing of these percentages (e.g. page. 11, lines 3-9) which makes reading a bit hard. I recommend moving as much as possible those numbers to tables and leave in the text only the most relevant ones, focusing on the relevant qualitative behavior.

- P.6, Line 24: "ZPhi" method should read "ZPHI", and the proper reference should be

the Testud paper:

Testud, J., E. Le Bouar, E. Obligis, and M. Ali-Mehenni, 2000: The rain profiling algorithm applied to polarimetric weather radar. J. Atmos. Oceanic Technol., 17, 332–356.

Indeed, Ryzhkov used the ZPHI method for rainfall estimation using the same ZPHI method as in Testud et al., 2000 for deriving specific attenuation.

- P. 7, Lines 9-10: according to Besic et al., 2018, if there is a dominant hydrometeor type, the entropy is low (close to 0), while in case of mixtures, the entropy is higher (up to 1). Please explain and/or correct why it is here stated the opposite ("..within the radar resolution volume there is a clearly dominant hydrometeor type (entropy 1) or if it is an heterogeneous mixture without any dominant hydrometeor type (entropy 0)."). Also check that the values of entropy discussed through the paper are consistent with the correct definition.

- P.7, Line 29. "extend" -> "extent"

- P. 9, L25: "The reflectivity data (topmost panels in Fig. 7) of all sources show a bi-modal distribution" Any idea why? Could there be a relation with the bimodality of lightning data?

- Please check the label for aggregates, sometimes it is referred to as "AG" (P. 6, L. 32), but in fig. captions it is often called "DS".

- P. 13, Lines 11-14. Here the authors hint at a possible relation between the very high proportion of positive lightnings and hail at the ground. Please add proper references.

- P. 15, Lines 3-4: "For our classification we have considered as belonging to the mixed phase or liquid regions flashes the first VHF source of which was located in areas where the dominant hydrometeor. . ." I suggest rewording, i.e. "For our classification we have considered as belonging to the mixed phase or liquid regions flashes whose first VHF source was in areas where the dominant hydrometeor.."

- P. 16, Lines 6-7: have you analysed in detail the "origin" of these 2 deg/km Kdp values (lower-right panel in fig. 18)? Such anomaly in the distribution is quite suspect, could it be due to some artifact in the data processing?

- P.17, Line 2: "flashes with origin in the liquid and mixed phase layers as a proxy for upward lightning". Is there a proper reference to add here? Or is it just a "common sense" expectation?

- P. 17, Lines 20-22: I also suggest considering "riming" (which implies the presence of supercooled water) in addition to particle concentration/size to explain the higher reflectivity.

- Fig. 1. Either add a length scale in the image, or at least mention the size of the domain in the caption. A map with lat, lon axes would be more useful for easier interpretation of fig. 3.

- Fig. 2 Need larger font for the dates.

- Fig. 4 (and all other similar histograms). Please add a legend with the color meaning (in addition to mentioning in the caption), it is sufficient in the first panel.

- Fig. 8, top panels: it may be better to add the hydrometeor type (e.g. "RN",..) directly on the x-axis (so the reader is not forced to keep switching between the number and the label), or at least mark the most relevant hydrometeor types directly on the histogram bars.

- Fig. 9: same as above, please mark the hydrometeor type on the axes, try to avoid using the numeric index. Suggestion: consider using a monochromatic color scale (e.g. gray scale), with light tone for low occurrence and dark tone for higher occurrence. I argue this may improve the readability (this is just a suggestion!). The current dark blue really dominates the visual impact.

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