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Comment on acp-2021-827

Anonymous Referee #2

Referee comment on "Lightning activity in northern Europe during a stormy winter: disruptions of weather patterns originating in global climate phenomena" by Ivana Kolmašová et al., Atmos. Chem. Phys. Discuss.,
<https://doi.org/10.5194/acp-2021-827-RC3>, 2022

Review of the manuscript "Lightning activity in Northern Europe during a stormy winter: disruptions of weather patterns originating in global climate phenomena" by Ivana Kolmašová, Ondřej Santolík, and Kateřina Rosická (acp-2021-827).

General comments.

The manuscript analyses the lightning activity, detected by WWLLN, during the 2014/2015 colder season over the northern Atlantic. The period of time analyzed was chosen given that this season presented an unusually high lightning activity with more than 5 thunderstorm days per month.

The analysis shows that lightning occurs predominantly above the ocean and along the western coastal areas with a nearly uniform (local) time occurrence and a flash multiplicity between 1 and 12 but with an 86% of the strokes detected by WWLLN as a single-stroke flashes.

On the other hand, the analysis of the superbolts (defined as lightning strokes with energies above 1 MJ) shows that this type of lightning strokes occurs above seawater on the western coastline of British Islands, Norway and Denmark, with the majority of the superbolts occurring during the three coldest months in the middle of the winter season. The (local) time distribution of the superbolts shows a preference to occur at night and morning hours. The analysis of the superbolts multiplicity showed that 86% of the superbolts are single-stroke flash and superbolts only present multiplicity up to 3. The analysis of the energy of successive strokes forming a flash shows that, after a very energetic strokes (superbolt), the subsequent strokes have a three orders weaker energy magnitude.

Finally, the unusually high lightning activity detected during the 2014/2015 winter is discuss in term of the North Atlantic Oscillation and the variation of the NAO monthly index.

The manuscript present a novelty analysis of the lightning activity produced by winter

thunderstorm and on an area where the lightning activity is rare. The analysis provides a new insight on the distribution of high energy strokes which seem to be related with the SST anomalies reported on the northern Atlantic.

The manuscript is well written and the presentation is well structured and clear. The figures are adequate and support the analysis and results presented on the study.

However, the authors should discuss some issues before the manuscript is ready for publication.

Major comments.

1. Lines 162-165. The authors indicated that they used the WWLLN data between 2010 and 2020 on the area under study. According to the authors, the WWLLN annual amount of detections varied through this period with a peak on the lightning strokes detected during the winter season 2014/2015. However, the WWLLN detection efficiency has changed through the years caused by the buildout of the network. As showed by Kaplan and Lau (2021), the amount of strokes detected by WWLLN had increased since 2005 until 2014 when the network seems to reach a stable detection amount of strokes. Had been the amount of lightning strokes, reported by the authors, corrected by the network efficiency?

If not, perhaps the peak observed on the winter season 2014/2015 is not so high as the study suggest given the detection efficiency time variation.

On lines 165-167, the authors also reported that "The average and median values of the yearly number of North-European winter strokes calculated over the last decade are respectively 35 and 24 thousand strokes."

Has been these average and median values calculated with the raw data reported by WWLLN?

If the average and median values were calculated with the raw data reported by WWLLN, the results will have a bias given the low detection amount of lightning strokes during the first part of the decade.

The detection efficiency variation of the WWLLN needs to be discussed on the manuscript.

Kaplan, J. O., & Lau, K. H. K. (2021). The WGLC global gridded lightning climatology and timeseries. *Earth System Science Data Discussions*, 1-25.

2. Lines 177-182. The authors reported that the strokes occurred during DJF were ten times stronger than the strokes occurred during ONM. This conclusion is based on the values of the mean and median of the energy distribution for these two periods of time. However, the strokes energy presents a nearly log-normal distribution and the mean and median are not the best way to compare these type of energy distributions. Please show the energy distribution of the lightning strokes for both periods of time in the same graph to compare and discuss the differences.

3. Lines 228-229. Please discuss how was decided the grouping criteria chosen to define a

multi-stroke flash. Were these criteria based on the literature or sensitivity tests were made to define its?

4. Lines 272-273. The authors asseverated that the relative efficiency of the network did not change during the analyzed period. Is this an assumption or is based on an analysis of the efficiency reported by the network? Please clarify.

5. Lines 299-301. The authors refer to a global SST anomaly map available at NASA web page. The link shows a video for a long timeline and it is not easy to see the SST anomaly for the norther Atlantic for the 2014/2015 winter season. Please consider to present a new figure showing the SST anomaly for the period and area of interest.

6. Lines 305 and Figure 6. It is reported the winter season numbers of lighting strokes detected by WWLLN as a function of the NOA index. However, as I mention before (see comment 1), the WWLLN detection efficiency varies through the years. Therefore, the high amount of lightning activity observed in the 2014/2015 winter could have a bias given the low detection efficiency during the first part of the decade.

Minor corrections:

1. Lines 174-175. "...months (7, 9, 13, 11, 5, and 6, respectively). To create...". Please clarifies the meaning of the number between the parenthesis.

2. Line 194. Please indicate how was obtained the values of 1 strokes per 3.3 km² reported.

3. Lines 194-195. "...There was nearly no lightning activity detected above the continent." Please report the percentage of the amount of the strokes detected over the ocean and the continent.

4. Figure 3 b, c and d and Figure 4 b, c and d. Please considerer to use the same vertical axis in the graphics.

5. Figure 5 a. The sum of the percentage reported on the first bins is 100%. What percentage represent the other bins reported (multiplicity higher than 4)?

Please also note the supplement to this comment:

<https://acp.copernicus.org/preprints/acp-2021-827/acp-2021-827-RC3-supplement.pdf>