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Comment on angeo-2022-6

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Referee comment on "Magnetic local time (MLT) dependence of auroral peak emission height and morphology" by Noora Partamies et al., Ann. Geophys. Discuss., https://doi.org/10.5194/angeo-2022-6-RC1, 2022

This study made statistical analyses of several all-sky images in the Fennoscandian Lapland and Svalbard to estimate the aurora peak emission height. While I am thinking that explanation of the method can be improved by answering comments below, the results seem to be reliable and this study would be the first time to provide the MLT dependence from the large-scale data set. I think it is worthy of publication after revising.

Since the authors have been working for a long time in this field, the scientific motivation and impact of this study should be addressed in the introduction, even briefly, I think. For example, optical data have been applied to estimation of physical parameters, such as precipitating electron energy and ionospheric conductivity, but these applications have not reached the satisfactory level. Then, what progress can be expected by applying knowledge of the peak emission height? In more simple manner, why would you like to know the peak height?

1. There are a few comments on the analysis method. Basically I agree with results from the analysis in this study, but there are several unclear points for me on the method. I hope that these comments will be helpful to make it clearer.

1-1. Section 2: I have a feeling that this section had better say more about the method to decide the peak altitude. Two methods have been presented in Whiter et al. (2013), method 1 (horizontal plane in Section 4.1) and method 2 (magnetic field lines in Section 4.2). Since the method 2 is a new one developed in Whiter et al. (2013), I am supposing that it has been applied on this study, but I am not sure because the text does not explicitly say. The text should address it.

1-2. Section 2: According to the comparison in Whiter et al. (2013), the method 2 is less suitable than the method 1 for auroral arcs wider than 30 km or located along B in one of the images. Could you tell us how to deal with this issue in deriving the peak altitude?

1-3. L98: "When the mapped heights differ less than 20 km and the mapped emission projections show a correlation larger than 0.5 …" I think that this study follows the criteria adopted in Section 4.2 of Whiter et al. (2013). Getting back to Whiter et al. (2013), I can't find the clear reason why these numbers (20 km and 0.5) were acceptable for the peak altitude determination. The text should tell us more about the background of the 20 km. Looking at the upper panel of Figure 2, the median/mean peak altitude seems to vary within 105-120 km, which is shorter than 20 km. If the 20 km is "ambiguity" of individual estimation, I suspect the variation might be dubious. On the other hand, the height difference might be usually smaller than 20 km. The text should mention the procedure of deriving the peak altitude in more detailed manner.

1-4. Related to comment 1-3. Horizontal displacement of the mapped location due to the vertical difference is a function of the elevation angle. It gets larger with smaller elevation angle (e.g., in case of the 20 km vertical difference, 0 km for the elevation angle of 90 degrees but over 100 km for 10 degrees). This means that a large vertical difference may not affect seriously in case of high elevation angles but the vertical difference should be a small value for the low elevation angle. This may suggest that the acceptable vertical difference should not be unique in the camera FOV. Accuracy of the peak height estimation may more rely on the horizontal difference rather than the vertical one, which may be related to the correlation coefficient. Could you tell us more about this point in the text?

1-5. Caption of Figure 1 says that "… excluding angles below 10 degrees." Did this study analyze images by 10 degrees? If yes, that is fine. But if not, the smallest available angle should be applied in Figure 1.

2. Figures 2 and 3: I have been supposing that the peak height of the green line is higher on average than that of the blue line, but these two figures do not clearly show the difference through the night. However, for the 6-7 MLT bin, the blue-line height may be significantly lower than the green one. Could you give us comments in the text on (1) no clear height difference in between for most of the night hours and (2) the difference for the 6-7 MLT bin?

3. L142-: "Similarly to the Lapland height data, most of the height data from the Svalbard ASCs are …" Figure 4 shows the time series of the emission height of the green line in Svalbard, and the text says its similarity with the Lapland result. How about the result of the blue line in Svalbard?

4. L168: "… in Figure 6 we find no notable difference …" As the text says after this part, there is a consistent decrease of the emission height in the dawn sector of the Lapland. So I have a feeling of wrongness on "no notable difference."

5. L179: "… in most bins between 08 and 14 MLT" This should be revised as "in most bins from 14 to 08 MLT", I wonder.

6. Figure 6: The text does not say effects of small data points in the noon sector, which is different from Figure 5. I am thinking that the data point is good enough to make reliable statistical analysis for all time bins, but let me make sure if it is true.

7. Figure 7: Title of the vertical axis is “Arciness” but the figure caption says “numbers of analyzed images”. I am thinking the figure caption is correct.

8. Figure 7: All four panels present a peak in the midnight and decreasing toward morning and afternoon. This pattern relies on number of the dark night (see Figures 2, 3 and 4) along with the event number. So the ratio may be better to capture the feature. Same comments for other later figures.

9. Figure 7. In the right panels for the Lapland result, from 12 to 15 MLT (or may be 16 MLT) and from 10 to 11 MLT, markers are plotted at 0. It means that there is no event, but in reality, no measurement, I wonder. To make it clear, no marker is better, I think. Same comments for other later figures.