



EGUsphere, referee comment RC2  
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## **Comment on egusphere-2022-296**

Anonymous Referee #2

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Referee comment on "Morphological evolution and spatial profile changes of poleward moving auroral forms" by Anton Goertz et al., EGU sphere,  
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Reviewer report of "The Morphology of Poleward Moving Auroral Forms" by Anton Goertz, Noora Partamies, Daniel Whiter, and Lisa Baddeley

In this study, the authors observed carefully the spatial and temporal morphological profiles of poleward moving auroral forms (PMAFs) based on the data obtained from the scanning photometer and all-sky camera image data and found new feature on PMAFs; the merging of auroral patches into a singular arc-like structure, which can be considered that auroral structures with the order of  $\sim 100$  kilometers can be led to form a PMAF within a large-scale physics. This merging might be addressed by the localized dayside magnetopause reconnection.

This reviewer considers that some new features previously unrevealed can be explained by this study, but this paper does not yet reach the publication level in a present form because of following reasons.

### **Major comments:**

1) On the use of terminology of "morphology";

This reviewer considers that this terminology is frequently used to point out "form" and "shape" of thing in our field. If you say, "the morphology of Poleward Moving Auroral Forms", readers may think that PMAFs have various kinds of shape or form. However, the authors discuss that PMAFs, which temporally and spatially changed, in this paper. The implication of "morphology" used in this study seems to be wrong. Then, this reviewer suggests replacing "morphology" with the other word, such as "temporal and spatial (profile) changes". In particular, this reviewer strongly felt that this section did state

“temporal and spatial changes of auroral arcs (or PMAFs, but it actually remains question whether or not the whole process as shown in Figure 2 is “PMAFs”). The title should also be changed. This reviewer’s candidate is “Temporal and Spatial (Profile) Changes of Poleward Moving Aurora Forms: Observations Based on All-sky Camera and Scanning Photometer (at Svalbard)”.

## 2) The database compiling;

In this study, the authors promote the discussion on the PMAFs using two databases; one is the statistical database of PMAFs which were detected from 2003 to 2008, and another is the unusual and multiple PMAF events occurred on 18<sup>th</sup> December 2017.

The 1<sup>st</sup> database includes each individual PMAF event occurred in a day from 2003 to 2008? If only one PMAF event usually occurs in a day, the 2<sup>nd</sup> database should be identified as “anomalous” event. If so, can the authors discuss these two databased within the same work frame? The physics, such as formation mechanism, IMF conditions, and background magnetic field/plasma characteristics during the 2<sup>nd</sup> PMAF event might be different from the usual PMAFs (the 1<sup>st</sup> PMAF database)?

## 3) The data structure;

“Depending on the exact lifetime of each individual PMAF we used 1-2 minute time bins of the arciness data for the SEA. This corresponds to 3-4 time bins per event lifetime with about 5-10 data points per bin per PMAF.” The relation between the time resolution of PMAF all-sky image data and arciness time bins is unclear and so complicated. Please explain more clearly with an illustration or rewrite this sentence more detailed.

## 4) Dayside reconnection evidence;

The authors assert through this study that PMAFs can closely be connected (linked) with dayside reconnection based on the previous studies. However, in this study, you do not show any clear observational evidence for the occurrence of dayside magnetic reconnection associated with PMAFs. The reconnection evidence can be obtained from in-situ space-based and remotely ground-based observations, such as the HF radar arrays (SuperDARN radars). At least, the authors should show some examples (data) of dayside reconnection evidence, if the PMAFs are associated with the dayside magnetospheric processes.

## 5) Statistics of arciness;

The tendency as shown in Figure 6 is varied depending on the IMF and solar wind conditions? Although the authors show the average profiles of IMF and solar wind plasma, actually, the PMAF events should occur under various solar wind conditions. If the authors try to examine statistical characteristics of arciness, the PMAF data under the specific or average IMF-By and -Bz and solar wind plasma conditions (as seen in Table 1) were used? Although the authors tell that "SEA was employed to analyze the behavior of narrow-band arciness during the 23 PMAFs in the first event list." and "the same analysis was conducted with the second event list, which includes 18 events that occurred on a single day", these PMAFs (23 events in first event list and 18 events in the second list) were occurring under the similar solar wind and IMF conditions or average solar wind conditions as shown in Table 1?

### **Minor comments:**

1) In Abstract and everywhere: What is the definition of "open-closed boundary"? Is it the same region as the poleward edge of the main aurora oval?

2) Table 1; Why don't the authors show the average value of plasma number density ( $N_p$ )? This reviewer considers that the solar wind density is more effective parameter in auroral phenomena than the solar wind temperature ( $T_{sw}$ ).

3) Section 4.1; Here, the authors tried to state the profile changes of PMAFs, but this reviewer feels just like reading several sentences as written in the research note. In these items, there are some PMAF signatures that have already well-known. The reviewer recommends re-organizing or re-structuring this section. In order to concisely and shortly show these series of spatial and temporal PMAF change flows, how about illustrating these using the block diagrams?

4) "The merging of auroral patches into a singular structure is interpreted in two different ways depending on the scale of the auroral patches." "Patches on the order of tens of kilometers separated by similarly sized regions devoid of 557.7nm aurora may be the ionospheric manifestation of inhomogeneities in the spatial distribution of solar wind particles."

Can you provide the associated references? Or these are your considerations? If the latter case, why can you consider these?

5) What is "PMAF1 category" and "PMAF2 category"? What do PMAFs 1 and 2 have the

significant characteristics?

6) What is the definition of "re-brightening events"? Please explain these phenomena more clearly.

7) Figures 2, 3 and 4; The explanations of these two figures are complicated. The author should show the time on the top of each panel, such as "(a) 6:15:13 UT (b) 6:15:35 UT...". In particular, in Figures 2 and 3, the title should be put. For example, "ASC images on 18<sup>th</sup> December 2017". In relation to this, this reviewer recommends that the authors should put a movie of ASC during the time intervals when you are discussing here (18<sup>th</sup> December 2017) as "supplementary information".

8) Figure 4; What is (are) the color code (colored regions and curves) assigned? The highness of arciness index? If so, please put a color bar to easily understand what color shows. Please explain more clearly how the colored region shown in the center column, and colored curves in the right column were calculated.

9) Figure 5; This reviewer cannot find the red part. Maybe you changed the color from red to black?

10) Figure 6; What do the labels from (a) to (f) seen in Figures 6 mean? This reviewer cannot find the explanations (notations) on these labels in the manuscript. Maybe, these labels are related to Figure 7?

11) In relation to 10) and Figure 7; Why do the authors need to independently show the PMAF's images here? Readers must become confused. If the authors want to discuss the arciness index variations associated with the PMAF's evolution, they should discuss this with a combination of Figure 6 with Figure 7. This reviewer recommends re-organizing these figures and associated sentences (paragraphs).

12) Section 5 (pp.13, L5 and L11); morphological evolution of PMAFs --> temporal and spatial profile changes of PMAFs.

PMAF morphology --> A series of temporal and spatial PMAF changes

13) Section 5 (pp.13, L12); which --> where or that

14) Section 4.2 (pp.12, L16) and Section 5 (pp.13, Ls 28 – 31); This reviewer considers that the automation of PMAF detection might have already been started to be developed based on machine learning technique (e.g., Convolutional Neural Network; CNN). Do you have any opinions on the event search using machine learning? If yes, you also should discuss the relation between your opinion and machine learning technique in the manuscript.

There are several recent reports that, with a help of machine learning technique, the auroras detected by the all-sky camera can automatically be categorized. The corresponding links are shown as follows.

1. <https://www.nature.com/articles/s41598-022-11686-8>

2. <https://tromsoe-ai.cei.uec.ac.jp/#/>

3. <https://www.sciencedirect.com/science/article/pii/S1364682622000797?via%3Dihub#fig1>

This reviewer considers that your research results and principle of the PMAF event search can be implemented to these algorithms. However, on the other hand, independently, will the authors build some system to automatically detect the PMAFs in near future?

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The PDF format version of this reviewer's report was attached. Please also refer to this file.

Please also note the supplement to this comment:

<https://egusphere.copernicus.org/preprints/2022/egusphere-2022-296/egusphere-2022-296-RC2-supplement.pdf>