

Reply to Referee #1, Dr. David Knudsen

Manuscript Number: egusphere-2024-3277

Manuscript Title: Leaping and vortex motion of the shock aurora toward the late evening sector observed on 26 February 2023

Thank you for your valuable comments. We have revised the manuscript, following your comments. The **added** sentences are colored red and deleted sentences are ~~crossed-out~~ in the manuscript. The replies to your comments are as follows:

#### **Overall comments:**

Shock aurora is scientifically interesting because it results from a very specific driving impulse in the solar wind. While primary effects appear on the dayside of the Earth, this paper documents nightside signatures, which are rare and difficult to detect. The information gained is useful in understanding the magnetospheric mechanisms involved in the generation of shock aurora. This paper is a clear presentation of relevant observations including some newly-discovered phenomena. I believe it will be a valuable contribution to the literature. I have only a few minor technical/grammatical comments:

Thank you for your positive comments on the manuscript. We made revisions according to your suggestion. Below is a one-to-one response to each of your comments.

Lines 7, 18, 86, and 150:  
We corrected.

Line 289, "stational folding": not sure what's meant here. Do you mean spatial folding?  
We wanted to convey that the aurora exhibits a leaping motion, followed by a swirling movement in place without changing location. As you pointed out, the original expression did not effectively explain this, so we have revised the description.

Thank you very much again for the valuable and careful comments.

March 14th, 2025  
Sota Nanjo

## Reply to Referee #2

Manuscript Number: egusphere-2024-3277

Manuscript Title: Leaping and vortex motion of the shock aurora toward the late evening sector observed on 26 February 2023

Thank you for your valuable comments. We have revised the manuscript, following your comments. The **added** sentences are colored red and deleted sentences are ~~crossed-out~~ in the manuscript. The replies to your comments are as follows:

### Overall comments:

This paper examines a shock aurora event on 26 February 2023 in northern Scandinavia, marking the first time such nightside auroral features have been captured by ground-based cameras. Using high-resolution all-sky imagery and magnetometer data, the study identifies three distinct auroral forms—a pre-existing green arc, a red diffuse aurora, and a secondary discrete arc exhibiting unique leaping and vortex-like motions. These observations are correlated with geomagnetic sudden commencement and field-aligned current signatures, offering new insights into solar wind interactions with the nightside ionosphere. The manuscript is well written and is recommended for prompt publication after minor suggested changes.

Thank you for your kind feedback on the manuscript. We have made revisions based on your suggestions. Below, you will find a detailed response to each of your comments.

Apart from the suggestions from Reviewer 1, I recommend that the authors provide an introduction to ionospheric equivalent currents, as these are crucial for the analyses in Figures 5 and 6. An explanation of how equivalent currents relate to field-aligned currents (in terms of strength and direction, for example) would enhance the clarity of the discussion.

Thank you for your comment. We agree that it is important to include an explanation of the equivalent current in the introduction. We have added the explanation in lines 79–88 of the revised manuscript with tracked changes.

A minor question on Figure 1: the negative  $B_z$  and sudden increase in  $P_{dyn}$  appear roughly 50 minutes before the SC, as shown in the H component. Does this time difference arise from the solar wind's propagation from L1 to Earth? Normally, a propagation algorithm is used to remove for that delay.

Yes, the time difference is indeed due to the discrepancy between the observations at L1 and those on the ground, as you pointed out. While it is common to apply a time shift, this study directly plots the DSCOVR data rather than using the OMNI database, and we wanted to present the data to the readers without any modifications to avoid any

potential misunderstandings or arbitrary adjustments. However, as you pointed out, this could cause confusion for the readers, so we have added an explanation in lines 147–149 and the caption of Figure 1.

Thank you very much again for the valuable and careful comments.

March 14th, 2025

Sota Nanjo