Annales Geophysicae Discussions

Ann. Geophys. Discuss., referee comment RC1
https://doi.org/10.5194/angeo-2022-14-RC1, 2022

Comment on angeo-2022-14

Anonymous Referee #1

Referee comment on "Multi-instrument observations of polar cap patches and traveling ionospheric disturbances generated by solar wind Alfvén waves coupling to the dayside magnetosphere" by Paul Prikryl et al., Ann. Geophys. Discuss., https://doi.org/10.5194/angeo-2022-14-RC1, 2022

Reviewer's report on the manuscript by Prykryl et al. titled "Multi-instrument observations of polar cap patches and traveling ionospheric disturbances generated by solar wind Alfvén waves coupling to the dayside magnetosphere" (manuscript #: angeo-2022-14)

In this manuscript, the authors try to show a close relationship between the solar wind Alfvén waves and the polar cap patches / traveling ionospheric disturbances, using multiple events based on the observation by the RISR IS radar, ground-based magnetometers, GNSS receivers, and SuperDARN radars. The topic itself is scientifically interesting, although several points should be improved. I consider that the following points should be addressed and revised before the manuscript is ready for publication in the Annales Geophysicae journal.

Overall comments:

- Interpretation of the data. The authors demonstrate that the TIDs are generated only by the Joule Heating due to the dayside ionospheric currents. These days it is not a

generally accepted idea. The TIDs are highly correlated with the lower atmospheric disturbances (e.g., Frissell et al., 2016). I am also surprised to see that the manuscript includes minimal discussion. The authors should add the discussion section, cite the related papers such as those mentioned in this report, and discuss the differences between the current events and the previous studies.

Recent progress of the TID studies using the SuperDARN is summarized in the review paper by Nishitani et al. (2019). I recommend that the authors check this paper.

- Definition of the LSTID / MSTID. The manuscript states that the LSTIDs have greater than 10000 km. I am not certain how the authors can distinguish between LSTIDs and MSTIDs in Figure 9. The authors need to add a more detailed description. In addition, I am not sure whether the LSTIDs observed by the SuperDARN radar and pointed out in the text are actually LSTIDs. Lines 261-262 state, "Figs. 9a-d show TIDs observed in the detrended vertical vTEC and the radar ground-scatter power focused and defocused by TIDs moving equatorward." The LSTID wavelength greater than 1000 km cannot produce focusing / defocusing of the radar waves. LSTIDs are supposed to be observed in the Doppler velocities of the ground scatter data. For example, Hayashi et al. (2010) showed that the SuperDARN Doppler velocities changes in the ground scatter data are consistent with the GNSS TEC data in the framework of the propagation of atmospheric gravity waves.

- Lines 144-145 say, "Fig. 3 shows the ionospheric currents (EICs) mapped in geographic coordinates…." It is strange that later in the manuscript, Figures 16-18 are plotted in AACGM (geomagnetic coordinates). I do not understand why the authors plot the same (e.g., EIC) data in different coordinates in one manuscript. It will cause serious confusion among the readers. I strongly recommend plotting the data in the same coordinate system.

Individual comments:

Lines 128-129 and Figure 2: Please describe the RISR-C and RISR-N field of views (beam positions). Otherwise, the readers cannot understand what the authors mean.

Lines 138-140: "The first few patches (enhancements in Ne) that were observed by RISR-N between 16:00 and 17:00 UT were not detected by RISR-C (Fig. 2a). This implies that the cusp was in the RISR-C FoV since polar patches are known to be produced by flow channels in the cusp." I do not understand these sentences. Maybe something is wrong. Please check.

Lines 146-147: "The GPS ionospheric pierce points (IPPs) at 110 km shown as circles scaled by the CHAIN GPS phase variation values, σΦ, are discussed in Section 3.3.3." – I wonder why the authors set the pierce points at 110 km. Obviously, the electron density is higher in the F-region than in the E-region, and so is the amplitude of scintillations. By the way, I cannot find section 3.3.3.

Line 185: "were" – is it "which were"?

Figure 9 and Lines 266-267 (as well as other corresponding lines): Are the ground scatter ranges plotted the same way as the ionospheric scatter? If so, it will cause a severe misunderstanding among the readers. If the ground scatter comes from a 1-hop propagation mode, then the focusing / defocusing point should be the mid-point between the radar and the backscatter region (for 2+ hops the geometry becomes more complicated). It is not appropriate to plot the SuperDARN echo data with the range set to the backscatter point, together with the GNSS TEC data with the same range.

Figure 4 caption: There is no description of the SuperDARN convection map.

References:

Frissell NA, Baker JBH, Ruohoniemi JM, Greenwald RA, Gerrard AJ, Miller ES, West ML (2016) Sources and characteristics of medium-scale traveling ionospheric disturbances observed by high-frequency radars in the North American sector. J Geophys Res Space Physics 121:3722–3739. https://doi.org/10.1002/2015JA022168

Hayashi H, Nishitani N, Ogawa T, Otsuka Y, Tsugawa T, Hosokawa K, Saito A (2010) Large-scale traveling ionospheric disturbance observed by SuperDARN Hokkaido HF radar and GPS networks on 15 December 2006. J Geophys Res 115:A06309. https://doi.org/10.1029/2009JA014297

Nishitani, N., Ruohoniemi, J.M., Lester, M. et al. Review of the accomplishments of mid-latitude Super Dual Auroral Radar Network (SuperDARN) HF radars. Prog Earth Planet Sci 6, 27 (2019). https://doi.org/10.1186/s40645-019-0270-5