RC2: 'Comment on angeo-2022-14', Anonymous Referee #2, 29 Jun 2022

Replies to Reviewer 2

Review of "Multi-instrument observations of polar cap patches and traveling ionospheric disturbances generated by solar wind Alfven waves coupling to the dayside magnetosphere" by Prikryl, Gillies, Themens, Weygard, Thomas and Chakraborty

The paper is well written, contains interesting new results and should be published in Annales Geophysicae after suitable revision.

Reply: *We appreciate your comments and suggestions. They helped us to clarify the points are trying to make, to improve referencing relevant papers, and hopefully to improve the manuscript in general. Below we provide our replies (in italics) to individual points. The manuscript is revised accordingly.*

Main Comments

There are two distinct parts to solar wind high speed streams. At the leading edge where the high speed stream interacts with the upstream slow speed stream, a "corotating interaction region" or CIR (GRL 3, 3, 137-140, 1976; JGR 100, A11, 21717-21733, 1995) forms. CIRs have both high magnetic fields and high plasma densities, higher than the following high speed stream proper. The Alfven wave amplitudes are also higher inside the CIR due to the compression (GRL, 22, 23, 3397-3400, 1995). It will be interesting for the AG readership to know where your effects are strongest, associated with the CIR or the high speed stream proper. Also since the plasma densities inside the CIR are high, can this play a role in magnetic reconnection and the tongues of ionization?

Reply: *Yes, we agree that the effect should be stronger for CIRs, which we focus on in the manuscript. We now discuss this in the Introduction and introductory paragraph of Section 3 and provide relevant references.*

Introduction Section. I doubt that Jim Dungey (1961) intended to imply that the interplanetary magnetic field remained southward and there occurred a steady state of energy input into the magnetosphere. This statement should be reworded a bit to remove this implication.

Reply: *The reference to Dungey (1961) is replaced by appropriate references (Russell and Elphic, 1978, 1979).*

Short duration (~30 min to 1 hr) southward magnetic fields causes substorms (PSS, 12, 273-282, 1964; JGR, 77, 16, 2970, 1972; JGR, 78, 4, 617-629, 1973). Longer duration (hrs) southward fields cause magnetic storms (JGR, 99, A4, 5771-5792, 1994; JGR 113, A05221, doi:10.1029/2007JA012744, 2008). Southward component interplanetary fields associated with Alfven waves in either CIRs or high speed streams have been shown to do the same, cause substorms and DP2 events (JGR, 73, 11, 5549-5559, 1958; JGR, 95, A3, 2241-2252, 1990; JGR 100, A11, 21717-21733, 1995; JASTP 66, 167-176, 2004). In the JGR 2000 paper it was noted that southward IMFs with durations less than 15 min were not geoeffective. Can you please mention (roughly) the duration of the southward components of the Alfven waves?

Reply: *Your references mostly point to causes of substorms and magnetic storms. Although the events we describe in the manuscript occurred during the growth phase of geomagnetic storms, we focus on the solar wind coupling on the dayside. The durations of the southward component of the Alfven waves, as can be seen in Fig. 9, varied from a few minutes to a few hours. We believe that the southward turnings, as well as the IMF By duskward deflections, play a role in the onset of flows in the cusp. Of course, the anti-sunward flows will intensify, and last longer, when Bz remain southward longer. This will certainly influence the geo-effectiveness, and on the substorm and magnetic storm developments, as more and more newly opened magnetic flux is carried over to the nightside. But we are focussing on the immediate response in the cusp and ionospheric signatures of FTEs. We have added these sentences in the Introduction:*

"Solar wind Alfvén waves (Belcher and Davis, 1971) that couple to the magnetosphere-ionosphere system are associated with high-intensity long-duration continuous auroral activity (HILDCAA) (Tsurutani and Gonzalez, 1987; Tsurutani et al., 1990). Spacecraft observations of the polar cap and auroral zone noted auroral patches during HILDCAA intervals due to the southward component of Alfvén waves causing reconnection (Guernieri et al., 2004; Guernieri 2006). The durations of the southward component of Alfvén waves have an impact on the geo-effectiveness, and on the substorm and magnetic storm developments. However, in this paper we focus on the immediate dayside ionospheric response to the IMF during the impact of corotating interaction regions at the leading edge of high-speed streams."

The ionospheric currents that you mention most certainly must be DP2 currents. Please quote and discuss.

Reply: *Thank you for this important comment. In the new Section 4 Discussion we quote relevant papers and briefly discuss the currents, including DP2.*

Line 52. It should be noted that spacecraft observations of the polar cap and auroral zone noted auroral patches during HILDCAA intervals (southward component of Alfven waves in solar wind high speed streams causing reconnection). Please see p235-243 in AGU mon. 167, 2006; Substorms 7: Proceedings of the 7th International Conference on Substorms,edited by N. Ganushkina and T.I. Pulkkinen, 1, 67, 2004. These papers should be quoted.

Reply: *The sentence is modified, and the references are added.*

Line 113. The reference to the HCS discovery should be quoted here. It is JGR 83, 717, 1978.

Reply: *The reference is included. Thank you.*