

Interactive comment on “Polar substorm on 7 December 2015: pre-onset phenomena and features of auroral breakup” by Vladimir V. Safargaleev et al.

Anonymous Referee #2

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Reviewer report on “Polar substorm on 07 December 2015: pre-onset phenomena and features of auroral breakup” by Safargaleev et al.

Summary: The paper discusses in great detail one substorm event that took place in the evening sector at high latitudes. Data from several instruments have been utilized. The most interesting result is presented in Figure 9, which shows 15-min magnetic oscillations at ground stations from OJJ to NAL, spanning roughly 13 deg in latitude. Obviously some auroral behavior show the 15-min periodicity, too. However, the paper contains a lot of unclear reasoning, in specific when the solar wind driving and possible dayside reconnection is discussed. The authors overinterpret the data, claiming that

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two southward turnings of IMF Bz, separated roughly by 15 min, make IMF behaviour periodic and cause PERIODIC reconnection, which excites cavity oscillations in the magnetosphere. In addition, several timings must be checked. Therefore, the paper needs a major revision. However, I wish that finally the paper can be published because of these 15-min magnetic oscillations on the ground lasting at least for one hour and probably affecting substorm dynamics.

Major comments:

Section “Introduction” is focused on publications from 1990’s and older, only some recent Russian papers are referred to. Why poleward boundary intensifications (PBIs) are not discussed here?

Section 3.1: Why AE index is not shown anywhere? It would help to put the event into global context, since the local magnetic time in Scandinavia is evening and not close to magnetic midnight.

I. 170: “The substorm was preceded by two negative variations in the H-component at KIL and SOD with repetition period of about 15 minutes (see Fig.2a middle panel).” (1) Give the times in the text. (2) If two events are separated by 15 min, this shouldn’t be called repetition period.

Discussion of SuperDarn data in Section 3.2. is deficient. “...enhancement of the plasma flow in polar cap started at 17:04 UT, reached maximum at 17:08-17:10 UT (diagram d in Fig.4) and lasted until T0. One more flow enhancement took place at 16:52 UT, i.e. 15 minutes before the first one”. If the intention is to make the readers confirmed that 15-min periodicity exists in SuperDarn data, then there should be either time series of velocities or all the panels, not just a few selected ones. Furthermore, it is not explained if the vectors represent l-o-s velocities or mapped velocities. In addition, typically IMF data is shown before discussing ionospheric responses. Now IMF data comes only in Figure 6.

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I. 192: “The increase of F-region electron density at about T0 looks like a signature of the polar patch associated with the reconnected flux tubes drifting across the polar cap from the cusp to the magnetotail”. – If the polar cap patch is formed on the dayside, near cusp, it takes a long time for this patch to drift over the polar cap to ESR. Please make that estimate.

I. 204: “Thus, the southward turning of IMF Bz could reach the magnetopause 20 min after registration onboard THC, and the ionospheric convection is expected to respond in ~ 20 min after that (Hairson and Heelis, 1995).” – 20 min sounds a long time. Previous estimates of a global response have ranged from just seconds [Ridley et al., 1998] to 10 –15 min [e.g. Cowley and Lockwood, 1992]. However, if we use these numbers, they amount to 40-min delay, and then IMF variations at 16:15 and 16:30 UT correspond to 16:55 and 17:10 UT on the ground. I didn’t see these numbers used in later discussion.

L. 294: “on the observation of the 15-minutes periodicity.” Some features are obviously separated by 15 min, some 12 min.

Section 4.1, Figure 5. While the apparent vortices in equivalent current (which may be artefacts of data analysis in regions where they are no magnetometers) may only tentatively be associated with up- or downward FACs, why not the AMPERE data shown in Figure 5c is not discussed here?

I. 412: “The convection enhancements were caused by negative deviations of IMF Bz component” – This needs more convincing discussion in the paper, see my comments above.

I. 413: “Two weak variations in H-component might be the ground signature of global oscillations of the magnetospheric cavity excited by periodic erosion of the dayside magnetopause in the course of periodic reconnection” – Very unclear and hypothetical claim. Firstly, high- or low-latitude H-component? Secondly, I have not found any evidence in the data of PERIODIC reconnection. Two southward turnings of IMF Bz,

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separated roughly by 15 min, doesn’t make the IMF behaviour periodic. The claim is repeated in Conclusions, on I. 436.

I. 447: “The onset was accompanied by disruption of the dawn-to-dusk current in the plasma sheet around (X, Y) ~ (-16, 16) RE” – With one single satellite showing an increase in the absolute value of the Bx component, one can only conclude that dipolarization has taken place, but it is not possible to pinpoint the location of current sheet disruption.

Minor comments:

I. 27: “The question is solving on the base of satellite observations” – Difficult to understand

I. 59: “Multiple onsets occur often.” – Give a reference.

I. 78: “Samsonov et al. (2017) showed that the typical time for a southward interplanetary magnetic field turning to propagate across the magnetosheath is 14 min.” – Dayside magnetosheath to subsolar magnetopause?

I. 103: “Fourth, we present GEOTAIL satellite data to investigate what process in plasma sheet – current disruption or neutral line formation – is responsible for the substorm onset (section 4.2).” – One satellite cannot give this information (was aim of Themis multi-satellite mission).

I. 111 BFN coordinates and elsewhere: Please specify if you use geographic or geomagnetic coordinates. Geomagnetic should be used.

I. 115 “footprints of localized downward (upward) field-aligned current (FAC) are manifested by quasi-circular clockwise (counterclockwise) equivalent current vortices around location of the upward (downward) FAC (e.g. Palin et al., 2016).” - This is a hypothesis and only valid for certain assumptions.

I. 201: “Assuming the nose of the bow shock at 14 RE” – Where is this estimate based

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on?

l. 235: "At this moment the structure was stretched approximately along geomagnetic meridian and had dimension of 170x170 km." – A bit unclear description.

l. 260: "decrease in Bx component (indicated by gray shadow) while" - Actually the figure shows increase of Bx. However, the absolute value is decreased.

l. 265-267: Clarify the discussion, and make clear when dayside and when nightside low-latitude H is referred to.

l. 356: Spell out IPCL

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