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HIGH-LATITUDE DAYTIME MAGNETIC BAYS IN THE SEPTEMBER 2017 STRONG MAGNETIC STORM

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Abstract. We present a study of magnetic bays occurred in the dayside sector of the polar geomagnetic latitudes during the initial and recovery phases of the magnetic storm on 07-08 September 2017. Typically, high-latitude daytime magnetic bay-like disturbances are observed under the positive *Bz* component of IMF. But during the initial phase of the storm on 07 September, the dayside magnetic bay was registered at high-latitude IMAGE stations NAL, LYR, HOR when intensive rapid fluctuations (15-20 min) of the IMF components stabilized to 09 UT (12 MLT) under the predominantly negative IMF *Bz*. At the storm recovery phase on 08 September, during the same UT-time period (08-11 UT), the IMF *Bz* was steady positive that led to development of a typical dayside (11-14 MLT) polar magnetic bays which was observed at the IMAGE chain as well. It was shown when the IMF conditions have been stabilized under the southern IMF *Bz* component, the dayside polar bay-like disturbances were accompanied by substorm activity in the night side sector of the high latitudes. Contrary to that, when the IMF *Bz* was positive and stable, there were no night side magnetic disturbances. In the both cases, the IMF *By* component was greater than the IMF *Bz* one (|*By*|/|*Bz*| > 1), and the polar electrojets caused appearance of high-latitude daytime negative or positive bays in accordance with the sign of the IMF *By* component.

06 – 08 September 2017

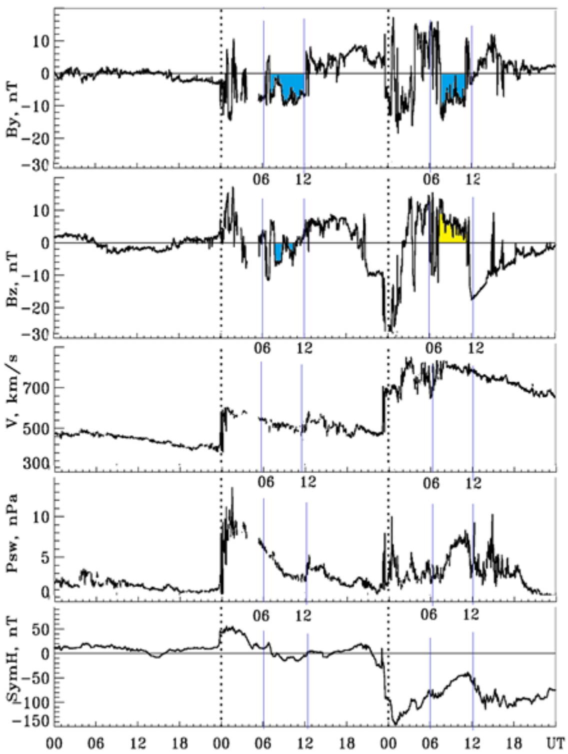

Figure 1. Variations of the IMF components and the Solar Wind parameters in 06-08 September 2017 [*https://omniweb.gsfc.nasa.gov/*]. Time interval under consideration are marked by blue time lable.

Introduction

In our previous papers [*Kleimenova et al.*, 2015*; Levitin et al.*, 2015*; Gromova et al.*, 2016, 2017], we studied the high-latitude bay-like magnetic disturbances which are observed near the local magnetic noon. Disturbances of the geomagnetic field in the dayside sector of the high latitudes could be caused by electrical currents in the ionospheric termed the polar electrojet [*Aakjær*, 2016]. Similar disturbances have been previously reported by [*Iwasaki*, 1971*; Friis-Christensen and Wilhjem*, 1975*; Feldstein*, 1976, 2006]. It was shown that dayside high-latitude magnetic bays are frequently observed under the positive *Bz* component of IMF. The sign of these bays was mainly controlled by the IMF *By* one.

Dayside high-latitude magnetic bays could be recorded both during a storm recovery phase characterized by the positive IMF *Bz* and in the initial phase of magnetic storms if the IMF *Bz* component was variable positive or weakly negative.

The aim of our investigation is to study dayside magnetic bays observed at high-latitude magnetometer stations on 07 and 08 September 2017 in the initial phase and the recovery one of the strong magnetic storm.

The solar wind and IMF variations in strong magnetic storm on 07-08 September 2017

The magnetic storm on 07-08 September 2017 was one of the greatest storm in the decleaning phase of the 24 solar cycle. It was produced by the coronal mass ejection associated with 06 September 2B/X9.3 flare (*www.izmiran.ru/services/saf/archive/*).

Fig. 1 shows the development of the magnetic storm on 07-08 September 2017. The initial phase of the storm started on 07 September was characterized by intensive rapid fluctuations (15-20 min) of the IMF components in 06 - 12 UT which stabilized to 09 UT under the predominantly negative IMF *Bz* component and the negative IMF *By* one. Similar IMF situation was observed at the same UT time, during the storm recovery phase, on 08 September. On 08 September, as on 07 September, the intensive rapid fluctuations of the IMF components (06-07 UT) stopped at 08 UT, and the IMF *Bz* became stable. But contrary to the storm intial phase during the recovery phase, the IMF *Bz* changed to positive values under the negative IMF *By*.

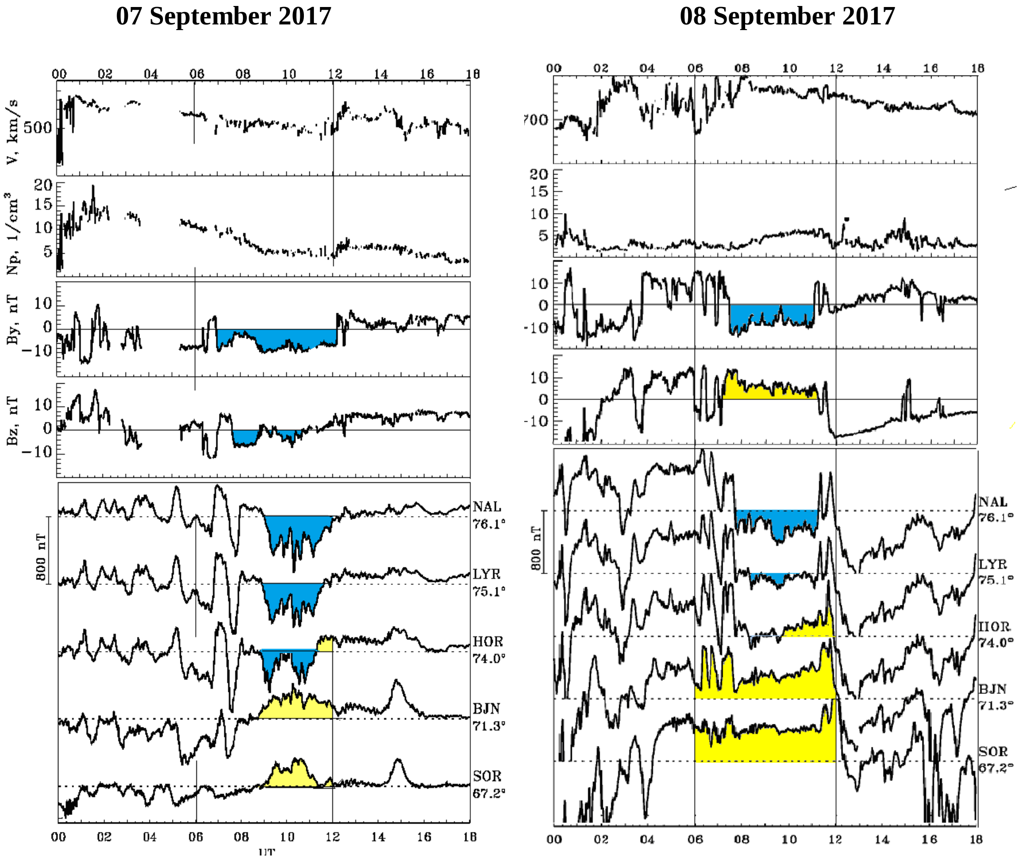

Figure 2. The velocity (*V*), the density (*N*p) of the solar wind and the IMF *By*, *Bz*, and magnetograms of high-latitude IMAGE stations on 07 September (***a***) and on 08 September (***b***) 2017.

Data

Our study of the geomagnetic disturbances is based on (i) the data collected from the Scandinavian IMAGE magnetometer chain [*http://space.fmi.fi/MIRACLE/*] and from the global network of stations INTERMAGNET [*http://www.intermagnet.org/*]; (ii) modelling of equivalent currents by European Clauster Assimilation technology ECLAT [*http://www.space.fmi.fi/MIRACLE/ECLATandMIRACLE/*]; (iii) geomagnetic index data from World Data Center for Geomagnetism, Kyoto [*http://wdc.kugi.kyoto-u.ac.jp*].

Geomagnetic activity at the high latitudes

As a rule, high-latitude daytime magnetic bay-like disturbances are observed under the positive *Bz* component of IMF. However, during the initial phase of the storm, 07 September 2017, the dayside polar magnetic bay was recorded at the high-latitude IMAGE observatories at 09-11 UT (12-14 MLT), when the IMF *Bz* component was slightly negative (Fig. 2a). At the same time, the high-latitude IMAGE stations showed a sequence of irregular short-term alternating bay-like disturbances. Around 09 UT, the IMF *Bz* changed from negative to positive values modifying between -5 nT and +2 nT, the IMF *By* component was negative and more intensive than the IMF *Bz* one (|*By*|/|*Bz*| > 1). In this time (near local noon), at the high-latitude IMAGE stations NAL, LYR, HOR there was the negative polar magnetic bay occurred with the amplitude of ~400 nT.

At the first storm recovery phase (08 September, 08-11 UT), the steady positive IMF *Bz* led to development of a typical dayside polar magnetic bays-which was observed at the IMAGE chain (11-14 MLT). At the polar IMAGE stations NAL and LYR these bays were negative due to the negative IMF *By* component predominance over the IMF *Bz* one (|*By*|/|*Bz*| > 1).

Fig. 3 shows the ionospheric equivalent currents modeled by of European Cluster Assimilation Technology (ECLAT) for UT-time intervals (06 - 12 UT) under consideration for 07 September (a) and 08 September (b). Red colors (positive numbers) mean eastward equivalent currents, blue colors (negative numbers) mean westward currents.

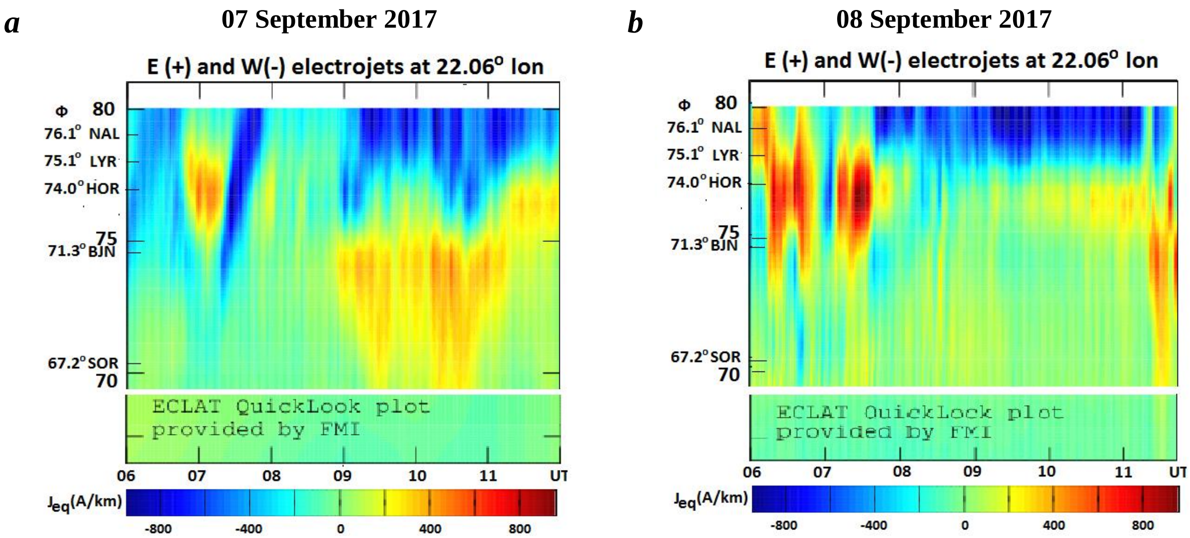

Figure 3. Ionospheric equivalent currents calculated from IMAGE magnetometers data on 07 September (***a***) and on 08 September (***b***). Red colours (positive numbers) mean eastward equivalent currents, blue colours (negative numbers) mean westward currents.

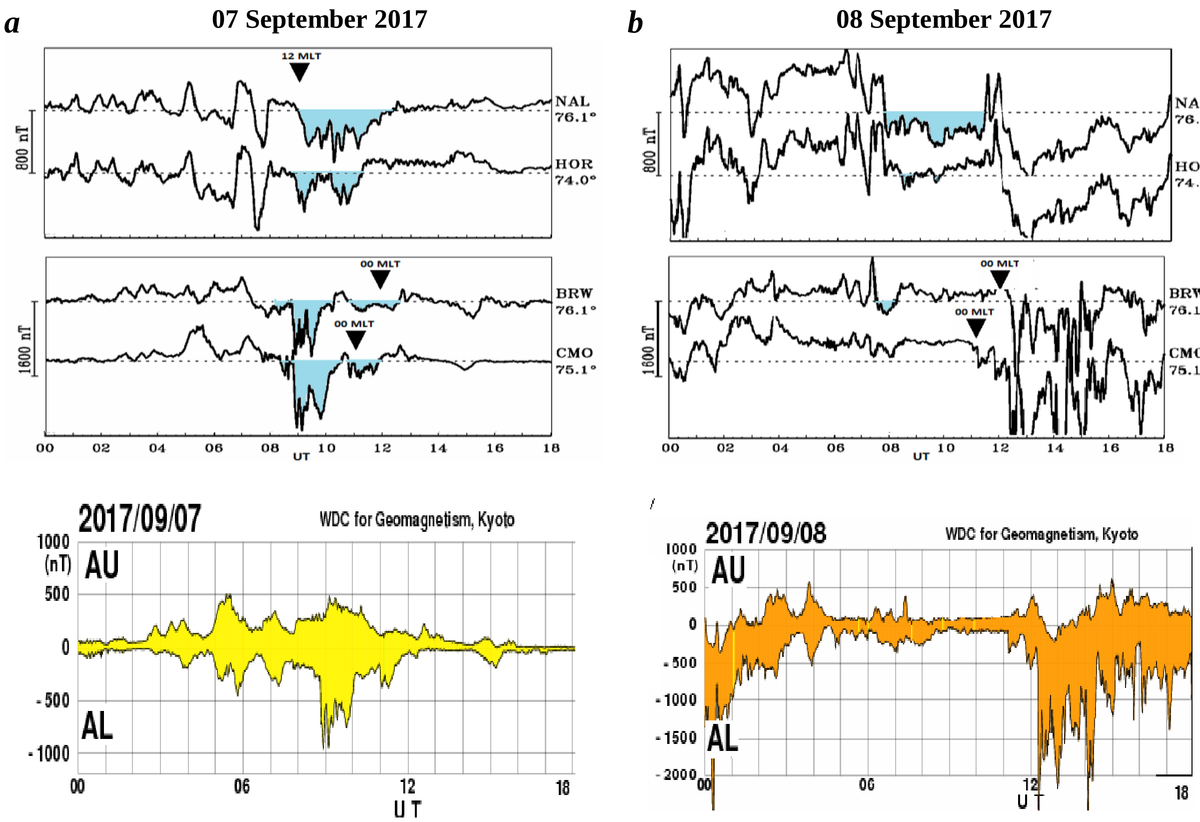

Figure 4. Magnetograms of the polar IMAGE stations in the dayside sector of the high-latitudes, North American stations in the night side sector and the auroral indicies of the geomagnetic activity on 07 September (***a***) and on 08 September (***b***).

The equivalent ionospheric currents demonstrated the time evolution of the equivalent currents along a north-south profile. According to this the ground-based observed magnetic data showed that dayside geomagnetic disturbances changed from quasi-periodic variations to dayside polar bays. Their signs varied with latitude.

Auroral activity

On 07 September, around 09 UT, the IMF Bz became stable and weakly changed near zero, the night substorm activity enhanced at the BRW and CMO stations (-800 nT) simultaneously with negative polar magnetic bays near local noon, at the high-latitude IMAGE stations NAL, LYR, HOR (Fig. 4a). The appearance of these bays was preceded by a long interval (~1,5 hours) when the IMF *Bz* was negative and rather stable.

Contrary to that, at the same UT time on 08 September (08-11 UT), the IMF *Bz* was stable positive, the negative magnetic bays at the IMAGE stations was less intensive, and there were no night side magnetic disturbances as, for example, at BRW and CMO. Geomagnetic activity in the auroral zone was low, AL< -100 nT (Fig. 4b).

Summary

Intensive rapid fluctuations (15-20 min) of IMF components caused quasiperiodical geomagnetic variations in the daytime sector of the high latitudes which were incoherent with the IMF fluctuations.

When the IMF conditions have been stabilized under the southern IMF *Bz* component, the dayside polar bay-like disturbances accompanied by substorm activity in the night side sector of the high latitudes. Contrary to that, when the IMF *Bz* was positive and stable, there were no night side magnetic disturbances.

The predominance of the negative IMF *By* component over the IMF *Bz* one ($|By|/|Bz| > 1$) caused the polar electrojet generation and appearance of daytime negative bays at the high latitude stations of IMAGE chain.

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