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WAVELET COMPONENT MANIFESTATION OF SOLAR WIND PARAMETER DISTURBANCES WHICH CORRESPONDING TO THE PLASMA FLOWS AT THE DYNAMICS OF MAGNETIC DISTURBANCE SPECTRUMS ALONG THE GEOMAGNETIC MERIDIAN

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Abstract. The study a parallel analysis of the results of the post-processing of the wavelet components for low frequency (LF) disturbed parameters of the Solar Wind plasma flows and disturbances of the horizontal component of the geomagnetic field (range of hydromagnetic waves) recorded along the meridional chain of stations in different strength of geomagnetic storms is devoted. The dynamics of the components of the spectrum of perturbations of the Solar wind meeting the Solar flux in the low-frequency (2-8 MHz) spectrum of magnetic disturbances at high-latitude stations is shown and as a diagnostic tool of the plasma flow can be used.

1. Introduction

Previously, that the LF oscillations of Solar Wind parameters are shown in the records of magnetograms on ground-based observatories was observed [*Gul'el'mi and Troickaja, 1973*]. The main objective of the study is to test the possibility of establishing type approached to the magnetosphere disturbed flows Solar Wind on basis of analysis of the components of the wavelet spectra of the near-Earth space environment parameters and components of geomagnetic field along the high-latitude part of the meridional chain of stations is consist [*Barkhatov et al., 2011*]. This approach to test the hypothesis, that in period geomagnetic storms, created Solar plasma flows, some of the magnetic LF disturbance on the Earth surface associated with MHD disturbances in these flows and penetrates into the magnetosphere from the Solar Wind is used. In this special attention spares to high-latitude regions, where the configuration of the geomagnetic field of LF oscillations of the Solar Wind into the Earth's magnetosphere may allow direct penetration.

2. The data used and processing techniques

In study minutes data for geomagnetic field components from a grid of stations IMAGE (http://www.geo.fmi.fi/image) and the data for parameters of Solar Wind (PSW) and the interplanetary magnetic field (IMF): Bz, N, P и VBz (http://cdaweb.gsfc.nasa.gov) was used. Data intervals to 12 daytime intervals magnetospheric storms of varying intensity on the index Dst indication (http://spidr.ngdc.noaa.gov/spidr/) are correspond and between 2000 and 2003 are recorded [*Barkhatov et al., 2011*].

Solution to the problem of identifying the type who approached magnetosphere disturbed Solar Wind on its expression in the records of magnetograms on ground-based observatories difficult in obtaining quantitative estimates of consistency studied spectrums. To successfully assess the consistency spectral pattern only the key features should contain [*Astafieva, 1996*]. This aim by calculating the corresponding wavelet skeletons and further matching can be achieved. In this study the algorithm for this approach was suggested. The conclusion for the consistency of any pair of skeletons on minimizing the mean square deviation on the registration of the local maxima of the spectrum (representing skeletons) is based. To do this, the coordinates of points on the x-axis (time) determine $X = [x_1\ x_2\ \dots x_n]$ and y-axis (frequency) $Y = [y_1\ y_2\ \dots y_n]$, for skeleton in his frame is forming. For each pair of skeletons the standard deviation is calculates like this

$$Dx = \sqrt{\frac{1}{n}\sum_{i=1}^{n}\left(x_i^{s1} - x_i^{s2}\right)^2}$$

where n – the number of points that form the skeleton (in our experiments n = 23), s1, s2 – indexes of belonging to the skeleton of the selected pair. Then the deviation of convenience by the total maximum value of the sample is normalized.

$$Dxn_i = \left(1 - \frac{Dx_i}{\max(Dx)}\right)\cdot 100\%$$

As a basic wavelet in numerical experiments Daubechies waves of fourth order is selected. Note that the observed spacing between together skeleton (excluding first and last, the occurrence of which is caused by edge effects) (see Fig. 1) to the characteristic time scale for the test frequency range is points. The wavelet scale factor of 4 to 15 (2-8 mHz), it averages ~ 25-30 minutes. This means that with such interval in this frequency range the entire vibrating system is changing. Therefore, the sample skeletons for latitude to calculate *Dxn* within a half-hour time window are formed. Consistent skeletons only those for which the value *Dxn* exceeded 70% was accepted. In Fig. 1 an example of calculating *Dxn* couples skeletons one of which always meets PSW or IMF are shows.

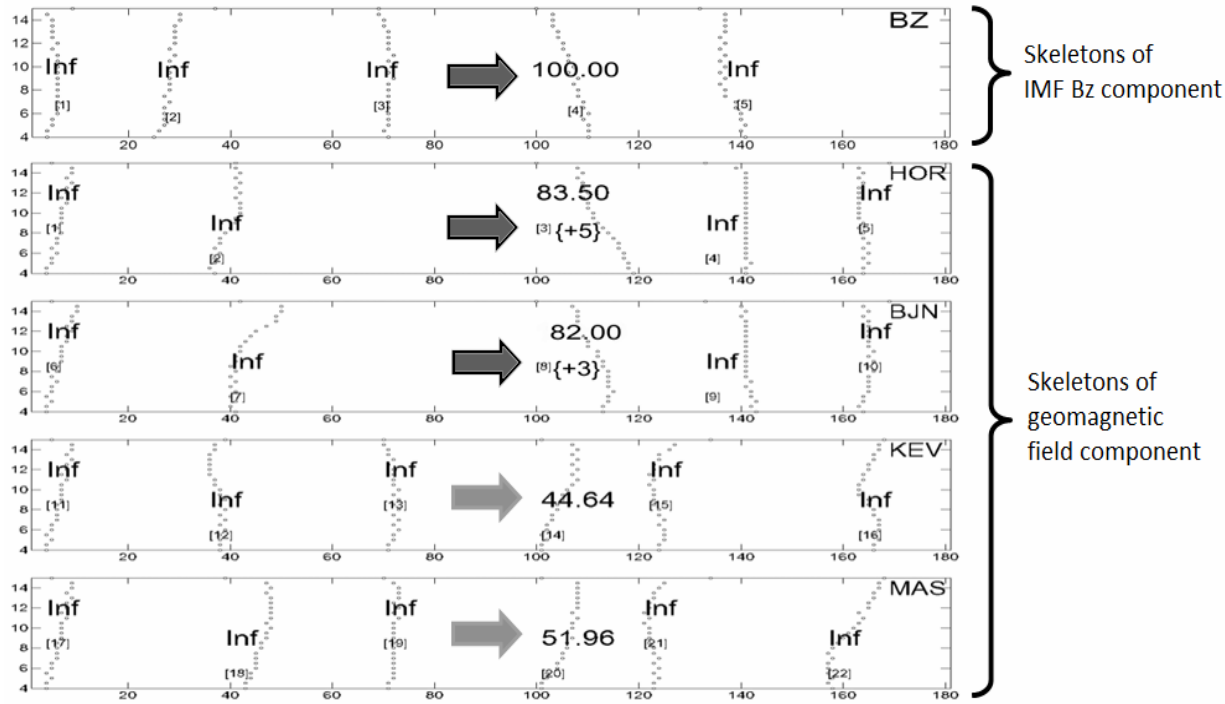

Fig. 1. Example calculation of *Dxn* couples skeletons marked with arrows. Braces contain a time shift. Skeletons, which were not included in the sample are marked «Inf». The abscissa is time in minutes, vertical axis - the value of large-scale wavelet coefficients corresponding to the frequency range of 2-8 mHz. A fragment of the data corresponds to the main phase of the storm 24.11.2001 1500 -1800 UT, Dst = -240 nT.

3. Improvement type of geoeffective Solar Flow with its spectral characteristics and the response time of the magnetosphere

Application of technology to the analysis of skeletons of basic parameters of the interplanetary medium of the magnetosphere in the oscillations of the horizontal component of the geomagnetic field at different latitudes to come up to her indignation allowed us to estimate the response time. Experimental research the following pattern has shown.

1) Before storm time response of the magnetosphere in the perturbations of the geomagnetic field at coming up parameters of the Solar flow response in quick reaction in high latitudes and delayed reaction in sub-auroral zone is consist. Fig. 2 an example of registration of similar delayed skeletons is Shown. Indeed, the region of the polar cap and the auroral oval to the direct effects of disturbance leading edge of the solar flow is subject, while the sub-auroral region emerging with intomagnitosphere source caused by the action of the solar wind is registered.

2) The response time of the magnetosphere in the disturbances of the geomagnetic field at the initial phase of the storm at all latitudes considered equally poor was displayed. Fig. 3 an example of simultaneous registration of similar skeletons at different latitudes is shown. This is possible, if all stations the data being analyzed in this phase stay in the polar cap and the disturbances of the flow of the Solar Wind are registered.

3) The main phase of the storm under the action of the type of areas of interaction speed Solar Wind with slow flows (CIR), the reaction of the magnetosphere as a disturbances of the geomagnetic field at the disturbed parameters of the Solar flow by fast response at high latitudes and delayed in the subauroral zone is characterized. But under the influence of flow type as magnetic cloud with turbulent cover and/or with a shock wave the reaction time at all latitudes equally poor is considered. Difference as different geometries curving lines of the magnetosphere under the influence of different flows is due. Fig. 4 an example of registration of similar skeletons at different latitudes on the main phase of the storm under the influence of flow type magnetic cloud is shown.

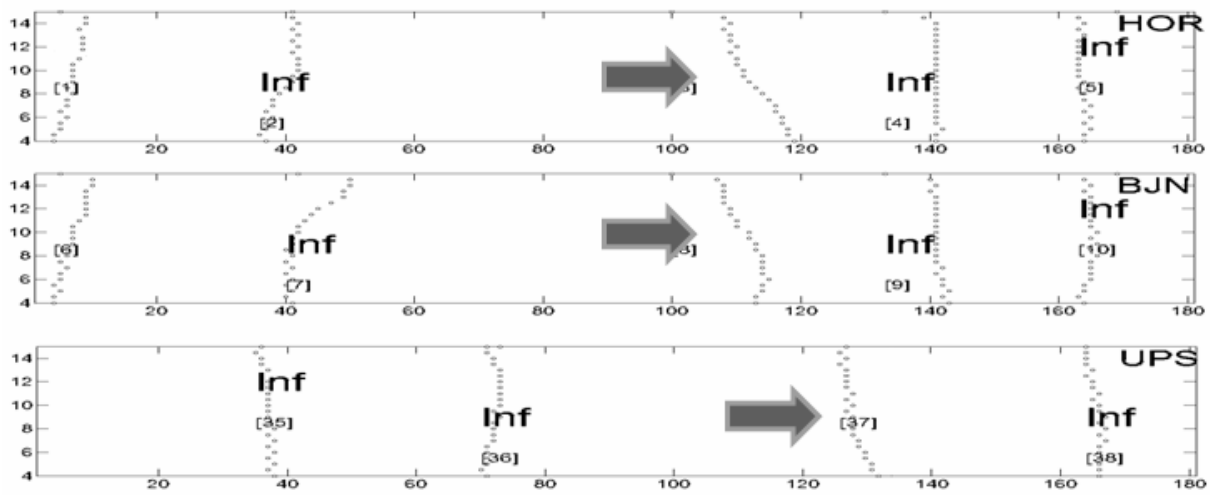

Fig. 2. Example of registering skeletons marked with arrows before the storm. The abscissa is time in minutes, vertical axis - the value of large-scale wavelet coefficients corresponding to the frequency range of 2-8 mHz. A fragment of the data corresponds to the undisturbed interval before the storm 02.09.2002 1100 -1400 UT, Dst = -10 nT.

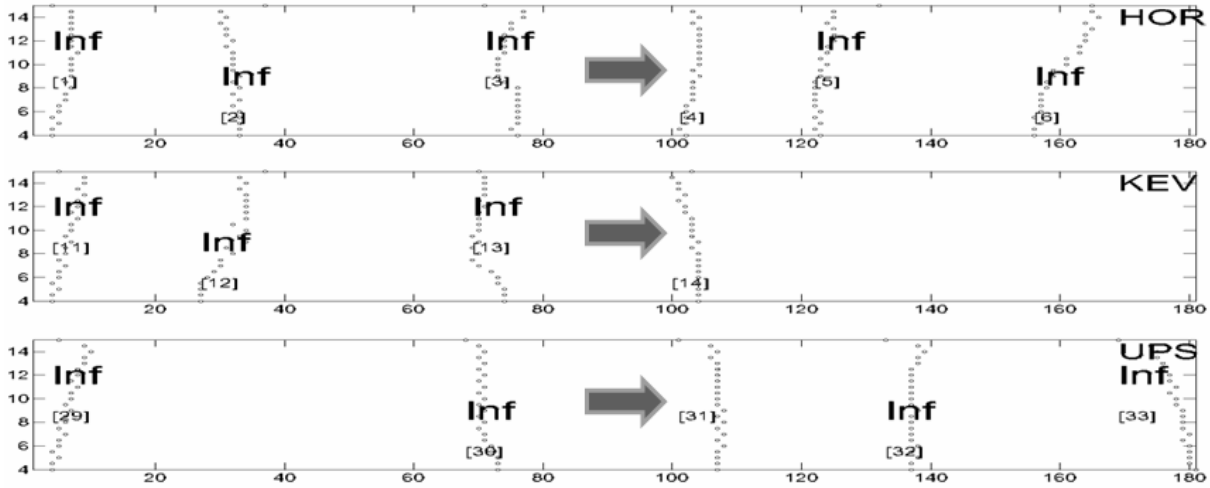

Fig. 3. Example of registering skeletons marked with arrows in the initial phase of the storm. The abscissa is time in minutes, vertical axis - the value of large-scale wavelet coefficients corresponding to the frequency range of 2-8 mHz. A fragment of the data corresponds to the initial phase of the storm 15.07.2000 1400 -1300 UT, Dst = 10 nT

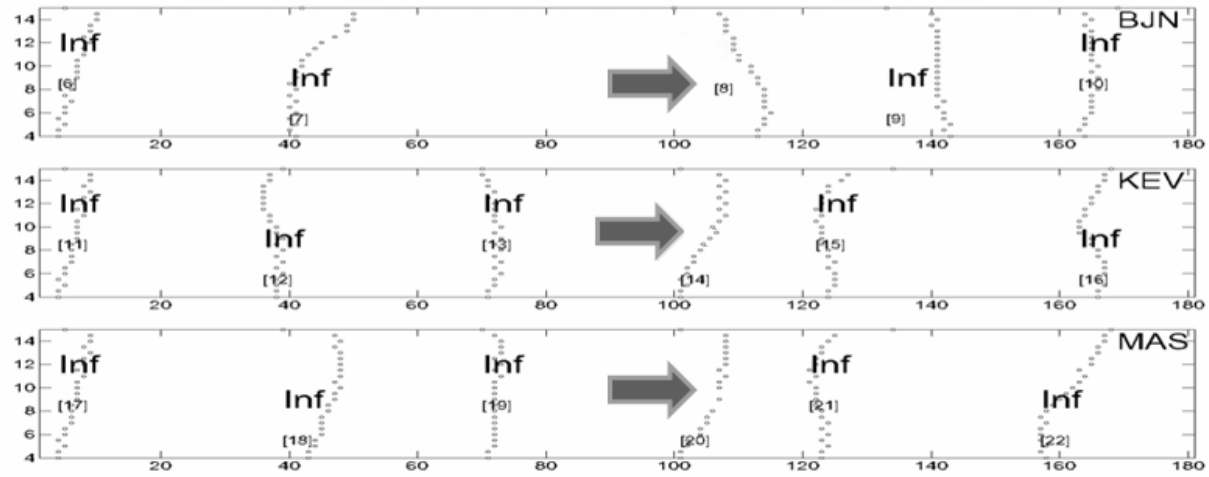

Fig. 4. Example of registering skeletons marked with arrows on the main phase of the storm. The abscissa is time in minutes, vertical axis - the value of large-scale wavelet coefficients corresponding to the frequency range of 2-8 mHz. A fragment of the data corresponds to the main phase of the storm 24.11.2001 1500 -1800 UT, Dst = -240 nT.

Conclusion

This paper the ability of determining the type who approached magnetosphere disturbed Solar Wind stream by analyzing the components of the wavelet spectra of the near-Earth space environment parameters and the geomagnetic field along the meridional chain stations is tests. The dynamics of the components of the spectrum of disturbances of the Solar Wind correspond to the Solar flux in the low-frequency (2-8 mHz) spectrum of magnetic disturbances at high-latitude stations is shown and can be used as a diagnostic tool of the plasma flow. The possibility of refinement of the plasma of the Solar Wind on the results of comparison of the spectral characteristics of disturbances PSW, IMF and the geomagnetic field is demonstrate. It is shown that the energy spectrum of the oscillations of these parameters reflects the internal structure of the corresponding plasma formation. Resulting conclusion of the fact that during geomagnetic storms caused by Solar plasma flows, some of the geomagnetic low disturbance on the surface associated with MHD disturbances in these flows and penetrates into the magnetosphere from the solar wind is indicative.

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