

Analysis of Y -component of Geomagnetic Field and $SYM-H$ Index Using Wavelet Multiresolution Analysis

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Abstract—Electrodynamical coupling between the solar wind's plasma and the Earth's magnetosphere creates geomagnetic disturbances recorded on the ground. This work analyzes the Y -component of the geomagnetic field during two geomagnetic storms and compares it to the solar quiet days. The magnetogram data recorded on low latitude stations are used for the study. We investigated the correlation of the Y -component with geomagnetic index $SYM-H$ using wavelet multiresolution analysis. We have used solar wind velocity, pressure, and interplanetary magnetic fields (B_y and B_z) to know the interplanetary structure for the selected duration. We found a positive correlation between Y -component and the $SYM-H$ index for both events. The magnitude of the Y -component was significantly reduced during the main phase in comparison to the quiet days. Further, variation of solar wind parameters indicated geomagnetic storms are guided by the prolonged southward IMF- B_z component and highly fluctuated IMF- B_y component. This work connects the interplanetary plasma parameters to the storm-time geomagnetic variations.

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1. INTRODUCTION

Solar-surface magnetic variability, solar flares, sunspots, coronal activities, and their interplanetary transients can be related to the appearance of solar activity (Tsurutani et al., 2006). Space storms are global geomagnetic disturbances that result from the interaction between magnetized plasma that propagates from the Sun and plasma and magnetic fields in the near-Earth space plasma environment (Wanliss and Showalter, 2006). According to Gonzalez et al. (1994), moderate geomagnetic storms are characterized by the thresholds of -50 nT, -5 nT, and 2 hours for the Dst index, IMF- B_z , and interval, respectively. Regarding the geomagnetic field, Chapman (1918) pointed out that the net mean changes in the horizontal component during the first half-hour or so of a geomagnetic storm is an increase. This is followed by a decrease of much greater amplitude, which lasts for several hours. A period of recovery then follows and lasts for several days. Thus, the average storm-time effect on the horizontal force should decrease the daily mean during the disturbance. For lower and middle latitude stations, Chapman (1927) concluded that the

average characteristics of slight and intense disturbances are similar in type. This work analyzes the phenomena related to the presence of the solar wind and the resultant distortion of the Y -component of the geomagnetic field at low latitudes during moderate geomagnetic storms. Generally, two usual systems can represent the geomagnetic field: the XYZ and the HDZ systems. The X , Y , and Z stand for northward, eastward, and vertical into the Earth directions, the H , D , and Z stand for horizontal declination (angular direction of the horizontal component related to the geographical north), and vertical (into the Earth) components. In this sense, the $SYM-H$ index surveys the level of geomagnetic activity related to the ring current variations according to the H -component measurements of the geomagnetic field in low and medium latitudes, and this 1-min resolution index is essentially the same as the hourly Dst index.

The increase in solar wind pressure is responsible for the energy injections, and it has global effects on the magnetosphere. Luna-1 was the first Soviet spacecraft to reach the vicinity of Earth's magnetosphere at an altitude of 100000 km and its scintillator made