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ORIGINAL ARTICLE

On the existence of a long range correlation in the Geomagnetic Disturbance storm time (Dst) index

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Abstract The Dst (Disturbance storm time) index is a measurement of earth geomagnetic activity and is widely used to characterize the geomagnetic storm. It is calculated on the basis of the average value of the horizontal component of the earth's magnetic field at four observatories, namely, Hermanus (33.3° south, 80.3° in magnetic dipole latitude and longitude), Kakioka (26.0° north, 206.0°), Honolulu (21.0° north, 266.4°), and San Juan (29.9° north, 3.2°) and is expressed in nano-Teslas. The strength of the low-latitude surface magnetic field is inversely proportional to the energy content of the ring current around earth caused by solar protons and electrons, which increases during geomagnetic storms. Thus a negative Dst index value indicates that the earth's magnetic field is weakened which is specifically the case during solar storms. Predicting Dst index is a difficult task due to its structural complexity involving a variety of underlying plasma mechanism. For characterizing and forecasting this complex time series, a formal model must be established to identify the specific pattern of the series. Persistent demand for a fool proof model of Geomagnetic Dst index prompted us to investigate the Dst Time Series mechanism with a very recent technique called Visibility Algorithm and it is observed that the Dst time series follows the same model that of a Stochastic Fractional Brownian motion having long range correlation.

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1 Introduction

The Dst (Disturbance storm-time) index represents the axially symmetric disturbance of the magnetic field at the dipole equator on the Earth's surface (Sugiura 1964). It is calculated as an hourly index from the horizontal magnetic field component at four observatories, namely, Hermanus (33.3° south, 80.3° in magnetic dipole latitude and longitude), Kakioka (26.0° north, 206.0°), Honolulu (21.0° north, 266.4°), and San Juan (29.9° north, 3.2°). These four observatories were selected because they are close enough to the magnetic equator, thus are not strongly influenced by auroral current systems. Also, they are far enough away from the magnetic equator so that they are not significantly influenced by the equatorial electrojet current that flows in the ionosphere. They are also relatively evenly spaced in longitude. Convolution of their magnetic variations forms the Dst index, measured in nanoTesla (Wanliss and Showalter 2006). It is widely used to define the occurrence, duration and magnitude of a geomagnetic storm. More severe storms are expressed with higher negative-value Dst indices. An intense geomagnetic storm is defined as any event with a Dst of less than −500 nanoTeslas (nT).

In recent years, a higher resolution version of Dst index, namely SYM-H index was formed. The SYM-H index uses six ground-based magnetometer stations to calculate the symmetric portion of the horizontal component magnetic field near the equator. The main difference between the 1 min SYM-H and the Dst index is the time resolution and the effects of the solar wind dynamic pressure variations are more clearly seen in the SYM-H than in the Dst