

ORIGINAL ARTICLE

Multifractal cross-correlation analysis between CME and Planetary K-index time series

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Abstract

This research aims to examine the multiscale-multifractal correlation properties between the geomagnetic storm and coronal mass ejection (CME) occurrences by analyzing the CME linear speed and Planetary K-index time series data. The relevant data for both CME and geomagnetic storm occurrences were obtained from the Solar and Heliospheric Observatory mission's LASCO and the NOAA Space Weather Prediction Center, respectively, for the same period (February 1999 to December 2007). We performed MultiFractal cross-correlation Detrended Fluctuation Analysis (MFXDFA) and Multi-fractal cross-correlation Detrending Moving average Analysis (MFXDMA) to investigate and quantify the possible cross-correlation between the two natural events. The MFXDFA technique is also compared to the backward MFXDMA algorithm's performance. The change in the degree of cross-correlation over time has been investigated, and the findings are quantitatively analyzed. The existence of significant power-law cross-correlations has been discovered within all scaling orders. Furthermore, we also find evident persistence of cross-correlation with substantial Hurst exponents. In addition, it has been observed that long-term cross-correlation has a more considerable degree of multifractality and persistence than short-term cross-correlation.

KEYWORDS

coronal mass ejection, multifractal cross-correlation detrended fluctuation analysis, multifractal cross-correlation detrending moving average analysis, Planetary K-index

1 | INTRODUCTION

The Earth's magnetic field might be considered as our planet's only defense against the Sun's high-energy particles and hazardous radiation. According to the scientific community, significant changes in the geomagnetic field generated by different solar activities may jeopardize the operation of crucial infrastructures relying on space-based assets and have terrestrial effects. The fundamental

mechanics, on the other hand, are still not clear. By analyzing CME linear speed and Planetary K-index (Kp-index) data, an attempt has been made to explore the cross-correlations between the Coronal Mass Ejection (CME) and the occurrence of geomagnetic storms. Coronal Mass Ejection (CME) is a sort of severe solar event that occurs when a massive cloud of magnetically charged plasma is released from the Sun's corona and travels at large speeds (thousands of kilometers per second) into