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Scaling Analysis and Model estimation of Solar Corona Index

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Abstract

A monthly average solar green coronal index time series for the period from January, 1939 to December, 2008 collected from NOAA (The National Oceanic and Atmospheric Administration) has been analysed in this paper in perspective of scaling analysis and modelling. Smoothed and de-noising have been done using suitable mother wavelet as a pre-requisite. The Finite Variance Scaling Method (FVSM), Higuchi method, rescaled range (R/S) and a generalized method have been applied to calculate the scaling exponents and fractal dimensions of the time series. Autocorrelation function (ACF) is used to find autoregressive (AR) process and Partial autocorrelation function (PACF) has been used to get the order of AR model. Finally a best fit model has been proposed using Yule-Walker Method with supporting results of goodness of fit and wavelet spectrum. The results reveal an anti-persistent, Short Range Dependent (SRD), self-similar property with signatures of non-causality, non-stationarity and nonlinearity in the data series. The model shows the best fit to the data under observation.

Keywords – Corona, solar, Hurst, FVSM, fractal, Higuchi, autocorrelation, wavelets, PACF, Yule-walker.

1. Introduction

The entire heliosphere as well as our Earth is being governed in every instant of time by different solar activity. The terrestrial lives are heavily influenced by solar activities. On the other hand terrestrial activities are seriously dependent on modern technology which in turn mostly influenced by satellites. Different solar activities which in turn affect the space weather have a great negative impact. Sensitive electronics in satellites may get damaged. It is also been unveiled that the Earth's atmosphere, magnetosphere, and the earth's surface disturbed by solar coronal mass ejections, solar flares, and high-speed solar wind streams. It is shown that the cyclic solar activity has chaotic characteristics. It becomes important to analyse solar activity and suggest a statistical model which can be a useful tool for engineers and designers interested in space weather prediction and its applications. The coronal index (CI) of solar activity is one of the important indices and it represents the total irradiance of the green corona emitted by the Sun's visible hemisphere. Using homogenized Fe XIV 530.3 nm coronal emission line, CI is calculated (Rybanský, 1975a) (Rybanský, Rušin, Minarovjeh, & Gaspar, 1994) (Rybanský, Rušin, & Minarovjeh, 2001) (Xanthakis, Petropoulos, Banos, & Sarris, 1990). There are a number of physical processes that take place

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