

The Relation between Time-Series Characteristics of Solar Active Region Magnetic Field Properties and Flare Activity

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Solar flares suddenly release an immense amount of energy mainly in the form of electromagnetic radiation, and consequently they can cause major disturbances in the Sun-Earth environment. An accurate prediction of flares is therefore crucial for protecting our space assets and the safety of astronauts and navigation systems. In this study, we investigated a statistical data set of 8-day time series of 18 magnetic field parameters in 94 flaring solar active regions (ARs) in 2010 to 2016. The time series data were derived from 12-min cadence photospheric vector magnetograms observed by SDO/HMI. For each AR under investigation, we calculated the mean values of the magnetic parameters from their corresponding time series data, as well as the fluctuations using detrended fluctuation analysis. Then, the mean values and fluctuations were compared with the sum of peak soft X-ray intensities of flares produced in the investigated AR (called flare index) during the eight days. As a result, we find the mean of time series of parameters measuring magnetic non-potentiality of ARs, such as vertical current, current helicity and free magnetic energy density, have a good correlation with the flare index: i.e., their correlation coefficients (CCs) are higher than 0.58. Especially, the mean of AR vertical current time series has a fairly good correlation with the flare index (CC=0.64). It is also found that the fluctuation of AR current helicity time series is well correlated with the flare index (CC=0.68). These results show that the mean and fluctuation of time series of AR non-potential magnetic parameters can be considered as a useful measure for estimating AR's flaring activity over the entire time series. Moreover, it is expected that further time series analysis can help improve flare prediction.

Keywords: Sun, Solar Flares, Time Series Analysis