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時系列予測機 UFCORIN を利用した GOES X 線ライトカーブにおける太陽フレア予報研究
Prediction Study of Solar Flare Events in GOES X-ray Flux using Time-Series Prediction Engine UFCORIN

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We have been developing UFCORIN, an automated space weather prediction system based on machine-learning technologies. Our aim is twofold: one is to provide real-time space weather forecast that thoroughly utilize the huge amount of solar observation data available today. The other is to discover the observational flare-triggering features, by analyzing the big data with the clear goal of predicting the solar flares.

UFCORIN stands for Universal Forecast Constructor by Optimized Regression of INputs. As the name suggests, UFCORIN is designed as a generic time-series predictor, which can be set to predict arbitrary time series from arbitrary numbers and kinds of input time series.

Using our system we predict maximum of GOES X-ray flux for 24-hour period in the future. As inputs to the predictor, we use wavelet powers of the full disk line-of-sight magnetogram obtained by the Helioseismic and Magnetic Imager (HMI) on board the Solar Dynamic Observatory (SDO). We also use the total magnetic flux data by SDO/HMI, and past data of GOES X-ray flux as inputs. The simulated prediction ran for 2 years (2011-2012) with 1-hour time resolution. To predict X, ≥M and ≥C class flares events, we first predict the real value of the GOES X-ray flux maximum, and then apply different thresholds for different events. These thresholds are part of the prediction parameter subject to optimization.

Following Bloomfield et al. [2012], we use true skill statistics (TSS) to compare the performance of various prediction strategies. Our best TSS values using HMI and GOES data are 0.692, 0.470 and 0.566, respectively, for predicting X, ≥M and ≥C class flares. These TSS values are comparable to previous studies such as those by Song et al. [2009], by Bloomfield et al. [2012], and by Bobra & Couvidat [2014]. We emphasize that we predict flares for the 2-years continuous period, and make no use of active region detection. In contrast, all of the previous studies are based on active region images and selected set of events.

At the annual meeting, we would also like to report the progress of our ongoing research, for example the search of flare features in SDO/AIA ultraviolet images. Also, our techniques can be applied to the prediction of space weather events other than solar flares, such as solar wind, solar energetic particles, and geomagnetic disturbances. We are also trying to quantify the social and economic impacts of the solar flares, in order to provide customized space weather forecast for various human activities.

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