Reliability of Photospheric Eruptive Indicators Using Parametric Flux Emergence Simulations

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Abstract

Flares and CMEs are among the most energetic events in the solar system, impacting the near-Earth environment and thus our technologies. The European H2020 research project Flarecast (Flare Likelihood and Region Eruption Forecasting) aims to develop a fully automated solar flare forecasting system with previous unmatched accuracy. Flarecast will automatically extract various active regions magnetic parameters from solar magnetogram and white-light images to produce accurate predictions using the current state-of-art forecasting techniques based on data-mining and machine learning.

Flare productivity is empirically known to be correlated with the size and the complexity of active regions. Several other parameters, based on magnetic field data from active regions have been tested in the recent years. Solely, none of these parameters have provied a clear eruptivity criterion yet. However, the predictability of these parameters has been only barely tested on numerical simulations.

In this context, we used the MHD numerical simulations of the formation of stable and unstable magnetic flux ropes of Leake et al. (2013) and Leake et al. (2014) to evaluate the predictive potential of the magnetic parameters. These eruptive / non-eruptive simulations only differs by the orientation of the overlying arcade. We used time series of magnetograms from the parametric simulations of stable and unstable flux emergence, in order to compute about 100 different parameters. This parameters list includes both new parameters, such as helicity, and parameters usually used as proxies in actual forecasting methods. Our results indicate that only parameters measuring the total non-potentiality of active regions associated with magnetic inversion line properties present significant preflare signatures, probably making them successful eruptive predictors.