Novel flare forecasting in 3D solar active regions

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Abstract

In this presentation, we address newly discovered pre-flare behavioural patterns in typical sunspot groups by focusing on their evolution as a function of height above the solar surface in a 3-dimensional solar AR. Here, we further probe and apply the concept of the pre-flare behavioural patterns using a magneto-hydrodynamic (MHD) simulation generating solar-like flares.

We introduce and discuss the relevant properties and the capability of pre-flare tracking of ARs to improve Space Weather forecasting by focusing on the evolution from the photosphere towards the chromosphere, Transition Region and low corona. The basis of a proxy measure of our approach is the so-called weighted horizontal gradient of magnetic field (W_GM) defined between spots of opposite polarities closer to the polarity inversion line(s) of an AR. The value and the temporal variation of W_GM is found to possess novel and potentially important diagnostic information about (i) the intensity of expected flares and (ii) the accuracy of onset time prediction.

Next, we will demonstrate how, by tracking the temporal evolution of W_GM, distance between opposite polarity spots and the associated net flux at various heights in the lower solar atmosphere evolves as function of height. We show that this latter temporal behaviour across the chromosphere-low corona has fundamentally new forecast capabilities. We found, that at a certain height the converging of opposite polarities begins much earlier than at the photosphere or at other heights. Therefore, we present a tool to identify the optimum height in the solar atmosphere for flare forecasting that may considerably increase the capability of the time prediction.