

On the predictability of solar flares

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Solar flares are catastrophic eruptions in the solar corona and sometimes impact the terrestrial environment and our infrastructure. However, what triggers their onset is not yet well understood; this severely limits our capacity to predict flare occurrence. In this study, on the basis of a systematic survey of three-dimensional magnetohydrodynamics simulations, we show how small emerging magnetic flux can trigger solar flares. We find two different processes for the onset of solar flares and furthermore find that their occurrence can be controlled by the orientation of emerging magnetic flux. In addition, it is shown that the two major flares observed by the Hinode satellite are consistent with our simulations. Our findings suggest that forecasting large flares is possible with sophisticated observations of solar surface magnetic field. However, the lead time of deterministic flare forecasts is limited by the growth time of flux emergence, which might be less than several hours. Presumably, flare forecasts for longer duration might be difficult and may be possible only in a probabilistic manner.

Keywords: solar flares, solar corona, magnetohydrodynamics, simulation, Hinode, prediction