

Forecasting the Solar Drivers of Severe Space Weather from Active-Region Magnetograms

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Large flares and fast CMEs are the drivers of the most severe space weather including Solar Energetic Particle Events (SEP Events). Large flares and their co-produced CMEs are powered by the explosive release of free magnetic energy stored in non-potential magnetic fields of sunspot active regions. The free energy is stored in and released from the low-beta regime of the active region's magnetic field above the photosphere, in the chromosphere and low corona. From our work over the past decade and from similar work of several other groups, it is now well established that (1) a proxy of the free magnetic energy stored above the photosphere can be measured from photospheric magnetograms, and (2) an active region's rate of production of major CME/flare eruptions in the coming day or so is strongly correlated with its present measured value of the free-energy proxy. These results have led us to use the large database of SOHO/MDI full-disk magnetograms spanning Solar Cycle 23 to obtain empirical forecasting curves that from an active region's present measured value of the free-energy proxy give the active region's expected rates of production of major flares, CMEs, fast CMEs, and SEP Events in the coming day or so (Falconer et al 2011, Space Weather, 9, S04003). We will present these forecasting curves and demonstrate the accuracy of their forecasts. In addition, we will show that the forecasts for major flares and fast CMEs can be made significantly more accurate by taking into account not only the value of the free energy proxy but also the active region's recent productivity of major flares; specifically, whether the active region has produced a major flare (GOES class M or X) during the past 24 hours before the time of the measured magnetogram.

By empirically determining the conversion of the value of free-energy proxy measured from a GONG or HMI magnetogram to that which would be measured from an MDI magnetogram, we have made GONG and HMI magnetograms useable with our MDI-based forecasting curves to forecast event rates.

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