A Tool for Empirical Forecasting of Major Flares, Coronal Mass Ejections, and Solar Particle Events from a Proxy of Active-Region Free Magnetic Energy

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This presentation describes a new forecasting tool developed for and is currently being tested by NASA's Space Radiation Analysis Group (SRAG) at JSC, which is responsible for the monitoring and forecasting of radiation exposure levels of astronauts. The new software tool is designed for the empirical forecasting of M and X-class flares, coronal mass ejections, as well as solar energetic particle events. Its algorithm is based on an empirical relationship between the various types of events rates and a proxy of the active region's free magnetic energy, determined from a data set of ~40,000 active-region magnetograms from ~1,300 active regions observed by SOHO/MDI that have known histories of flare, coronal mass ejection, and solar energetic particle event production. The new tool automatically extracts each strong-field magnetic areas from an MDI full-disk magnetogram, identifies each as an NOAA active region, and measures a proxy of the active region's free magnetic energy from the extracted magnetogram. For each active region, the empirical relationship is then used to convert the free magnetic energy proxy into an expected event rate. The expected event rate in turn can be readily converted into the probability that the active region will produce such an event in a given forward time window. Descriptions of the datasets, algorithm, and software in addition to sample applications and a validation test are presented. Further development and transition of the new tool in anticipation of SDO/HMI is briefly discussed.