The statistical relationship between the photospheric magnetic parameters and the flare productivity of active regions

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Using line-of-sight Michelson Doppler Imager(MDI) magnetograms of 89 active regions and Solar Geophysical Data (SGD) flare reports, we explored, for the first time, the magnitude scaling correlation between three magnetic parameters and the flare productivity of solar active regions. These parameters are: (1) the average value of spatial gradients of the magnetic field on the magnetic neutral line $(\overline{\nabla B_z})_{NL}$, (2) the length of magnetic neutral line with strong magnetic gradient L_{GNL}, and (3) total magnetic energy $\int \epsilon(B_z)dA$ dissipated in a layer of 1m during 1 second over the active region's area. The MDI magnetograms of active regions used for our analysis are close to the solar central meridian (within $\pm 10^{\circ}$). The flare productivity of active regions was quantified by the soft X-ray flare index for different time windows: from the time interval of the disk passage down to +1 day from the magnetogram recording. Our results explicitly indicate a positive correlation between the parameters and the overall flare productivity of active regions, and imminent flare production as well. The correlations of three parameters with flare productivity confirm, respectively, the dependence of flare productivity on (1) complexity of magnetic field, (2) the degree of nonpotentiality of active regions, and (3) intensity of turbulent motions of magnetic flux tubes in the photosphere. The parameters might usefully complement each other in flare forecasting.