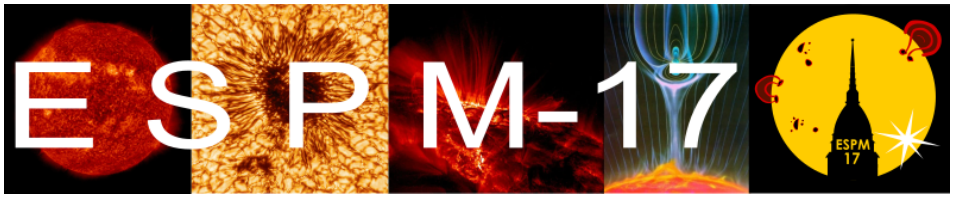

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Solar cycle variation in the properties of photospheric magnetic concentrations

It is widely accepted that eruptive phenomena on the Sun are related to the solar magnetic field, which is closely tied to the observed magnetic concentrations (MCs). Therefore, studying MCs is critical in order to understand the origin and evolution of all forms of solar activity. In this paper, we investigate the statistics of characteristic physical parameters of MCs during a whole solar cycle by analyzing magnetograms from 2011 to 2023 observed by the Helioseismic and Magnetic Imager (HMI) on board the Solar Dynamics Observatory (SDO). We discover that there are differences between large- and small-scale MCs in different phases of the solar cycle. By analyzing the distributions of the magnetic flux, area, and magnetic energy of MCs, we find that the small-scale MCs obey a power-law distribution, and that the power indices vary very little with the phases of the solar cycle. However, for the large-scale MCs, although they also obey the power-law distribution, the power indices are clearly modulated by the different phases of the solar cycle. We also investigate the relation between the maximum magnetic field strength (Bmax) and the area of MCs (S) and find the same property. The relation for the large-scale MCs is modulated by the phases of the solar cycle, while it is still independent of the phases of the solar cycle for the small-scale MCs. Our results suggest that small- and large-scale MCs could be generated by different physical mechanisms.

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