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The extremely strong photospheric electric currents of active region NOAA 13664

Active region NOAA 13664 has been so far the most flare-prolific active region of the present solar cycle, producing eight X- and several M- and C-class flares, causing the strongest geomagnetic storm since 2003. In this study, the evolution of the non-neutralized (net) electric currents is examined, along with that of the emerging flux. The net currents were calculated using a method based on image segmentation and error analysis of the photospheric vector magnetograms provided by the Helioseismic and Magnetic Imager (HMI). At its full extent NOAA 13664 became the second largest in area since 2010, second only to NOAA 12192. The region was already an evolving δ -type region when it rotated into view. A series of strong magnetic flux emergence events in its vicinity led to an extremely complex magnetic configuration, with intense shearing motions over almost the entire area of the region. In comparison to the most extended and the most flare prolific regions observed since the beginning of HMI observations, NOAA 13664 had by far the strongest net electric currents. The development of these currents is attributed to a unique case of interaction between a complex δ -type region, which already contained strong net currents, and new highly-deformed flux systems.

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