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Evolution of the critical instability height and CME likelihood in solar active regions

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Working towards improved space weather predictions, we aim to quantify how the critical height at which the torus instability drives coronal mass ejections (CMEs) varies over time in a sample of solar active regions. We model the coronal magnetic fields of 37 bipolar active regions and quantify the critical height at their central polarity inversion lines throughout their lifetimes. We then compare these heights to the changing magnetic flux at the photospheric boundary and identify CMEs in these regions. When the magnetic flux of an active region increases due to the continuous emergence of a single bipole, the critical height tends to increase, whereas the emergence of a new bipole into an existing active region or quiet Sun environment often causes the critical height to decrease sharply. A similar invesitgation of periods of decreasing magnetic flux indicates that the critical height rises when magnetic concentrations disperse, and falls when polarities converge and cancel at their inversion line. These results support and extend previous studies by showing that the average critical height is generally proportional to the separation between active region sunspots through time. We find higher rates of CMEs at times when the critical height is falling rather than rising, and when magnetic flux is increasing rather than decreasing. With continued work to also study multipolar regions, we may be able to identify conditions that are more conducive to producing eruptions, and determine the relative likelihood of active regions producing CMEs using readily-available observational proxies.

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