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Topological Changes during Coronal Mass Ejections: New Insight from 3-D Numerical Simulations

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In this paper, we discuss the changes in magnetic topology during Coronal Mass Ejections (CMEs) in the context of two complex events: the Apr 21 and Aug 24 of 2002 CMEs. To study the dynamics of these events in the solar corona, we performed a series of compressible 3-D MHD numerical simulations with an ad-hoc driver for the eruptions. We used SoHO/MDI data to set realistic boundary conditions for the ambient magnetic field of the Sun. In our model, the loss of equilibrium of the coronal magnetic field and subsequent eruption were achieved by stretching the opposite polarity feet of a newly emerged magnetic dipole. The stressed magnetic field reconnects through null points and, in the case of the Aug 24 event, also through a quasi-separator. As a result, magnetic flux and helicity are transferred from the expanding flux system containing the evolving dipole to the nearby flux systems. Another result is the jump-like change in the location of one footprint of the erupting magnetic field. This paper emphasizes on the importance of studying CMEs on a case-by-case basis if we are to understand their dynamics, energetics, and interplanetary consequences.