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Sun-To-Earth MHD Simulation of the 14 JULY 2000 "Bastille Day" Eruption

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Solar eruptions are the main driver of space-weather disturbances at the Earth. Extreme events are of particular interest, not only because of the scientific challenges they pose, but also because of their possible societal consequences. Here we present a magnetohydrodynamic (MHD) simulation of the 14 July 2000 "Bastille Day" eruption, which produced a very strong geomagnetic storm. After constructing a "thermodynamic" MHD model of the corona and solar wind, we insert a magnetically stable flux rope along the polarity inversion line of the eruption's source region and initiate the eruption by boundary flows. More than 10^{33} ergs of magnetic energy are released in the eruption within a few minutes, driving a flare, an EUV wave, and a coronal mass ejection (CME) that travels in the outer corona at $\approx 1500\,\mathrm{km\,s^{-1}}$, close to the observed speed. We then propagate the CME to Earth, using a heliospheric MHD code. Our simulation thus provides the opportunity to test how well *in situ* observations of extreme events are matched if the eruption is initiated from a stable magnetic-equilibrium state. We find that the flux-rope center is very similar in character to the observed magnetic cloud, but arrives ≈ 8.5 hours later and ≈ 15 too far to the North, with field strengths that are too weak by a factor of ≈ 1.6. The front of the flux rope is highly distorted, exhibiting localized magnetic-field concentrations as it passes 1 AU. We discuss these properties with regard to the development of space-weather predictions based on MHD simulations of solar eruptions.