Solar Magnetic Flux Rope Eruption Simulated by a Data-driven Magnetohydrodynamic Model

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The combination of magnetohydrodynamic (MHD) simulation and multi-wavelength observations is an effective way to study the mechanisms of magnetic flux rope eruption. We develop a data-driven MHD model using the zero-beta approximation. The initial condition is provided by a nonlinear force-free field derived from the magnetofrictional method based on vector magnetic field observed by the Helioseismic and Magnetic Imager on board the Solar Dynamics Observatory. The bottom boundary uses observed time series of the vector magnetic field and the vector velocity derived by the Differential Affine Velocity Estimator for Vector Magnetograms. We apply the data driven model to active region 11123 observed from 06:00 UT on 2010 November 11 to about 2 hr later. The evolution of the magnetic field topology coincides with the flare ribbons observed in the 304 and 1600 angstrom wavebands by the Atmospheric Imaging Assembly. The morphology, propagation path, and propagation range of the flux rope are comparable with the observations in 304 Å. We also find that a data constrained boundary condition, where the bottom boundary is fixed to the initial values, reproduces a similar simulation result. This model can reproduce the evolution of a magnetic flux rope in its dynamic eruptive phase.

References

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