A Data-driven MHD Simulation Model for CME Generation and Propagation

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Coronal mass ejections (CMEs) are major drivers of extreme space weather conditions, hence a matter of serious concern for our modern, technologically dependent society. The development of models that simulate CME generation and propagation through the interplanetary space is an important step toward our capability to predict CME arrival times at Earth and their geoeffectiveness. CME generation models of varying complexity and accuracy have been developed for decades from over-pressured plasmoid models to flux rope-based models with or without the necessity of energy build-up before eruption. In almost all cases, they have model parameters that need adjustment from one event to another. In this work, we present an overview of a data-driven MHD simulation model for CMEs extending from lower chromosphere to 1 AU which is currently developed. It is entirely based on first principles with minimum setup effort and free model parameters. It consists of local and global simulation models to be coupled. A schematic of the local and global simulation domains are shown in the attached figure. Our local model driven by vector magnetograms on the photosphere will track the evolution of active regions to obtain formation of flux ropes near polarity inversion lines and eventually their eruptions resulting from ideal and non-ideal instabilities. The propagation of the erupted CME will then be followed up to 1 AU through the global corona and inner heliosphere where the results will be validated with near-Earth spacecraft data. We consider the CME eruption associated with the X2.1 flare that occurred on 6 September 2011 from NOAA AR 11283 in our model.

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