Data-constrained Simulation of CME Initiation and Propagation: Comparison with Observations

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We perform the first global data-constrained MHD simulation of a CME with the Space Weather Modeling Framework (SWMF). This code has fully developed state-of-the-art steady state solar wind driven by Alfvén wave turbulence, in which disturbances can be propagated using ideal or resistive MHD, full thermodynamics, and various other physics. The CME can be propagated to 1AU and the interaction with the magnetosphere can be studied. The initial condition for the simulation is the best-fit 3D non-linear force free field (NLFFF) model obtained with the flux rope insertion method of the active region CME on April 08, 2010. The boundary condition is a synoptic magnetogram from SOLIS, with a high resolution HMI piece around the active region. We discuss the capabilities built-in into SWMF for producing fully data-constrained models of CMEs. We show the initiation and propagation of the CME within 10 Rsun. The stability of the region has already been analyzed in our previous studies, which justifies the use of unstable models as initial conditions. We discuss the effect of the different initial conditions on the propagation of the CME. We compare simulated LASCO and STEREO white light original, running and base difference images with the actual observations and demonstrate the power of using data to constrain the initial and boundary conditions of such a simulation. We compare the velocity profiles, height-time plots, and deflections of different realizations of the simulations with those derived from the observations. In addition, we simulate the EUV corona of the pre-eruption configuration in several AIA filters and compare to AIA observations of the sigmoidal regions before the eruption. EUV images during the eruptions are compared with the images of the EUV wave observed in the vicinity of this region.