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A Multi-Viewpoint Validation of CME Propagation Through a New MHD Turbulence Solar Wind Model

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On March 2011 March 7, a fast CME (> 2000 km/s) erupted in NOAA 11164. We present a multi-spacecraft validation study of a numerical simulation for this event as well as for the related ambient solar wind Carrington rotation 2107 using a new Alfven-wave turbulence solar wind model. We compare the simulated multi-wavelength EUV images with the SDO/AIA observations, differential emission measure tomography and in-situ measurements at 1 AU. The results are compared to remote as well as in-situ observation from SOHO, STEREOA/B, ACE, and WIND. Our result shows that the new model can reproduce most of the observed features near the Sun and in the heliosphere.

Our new global solar wind model is developed within the Space Weather Modeling Framework (SWMF) and accounts for the different electron and ion temperatures. This model can simulate from the upper chromosphere up to 1AU. The realistic 3D magnetic field is simulated using the data from the photospheric magnetic field measurements. The solar wind is driven by the outward propagating Poynting flux emerging from the lower chromosphere that is carried by low frequency MHD waves. This turbulence and its non-linear dissipation is the only momentum and energy source for heating the coronal plasma and driving the solar wind. The model includes wave-energy injection, transmission, reflection due to large-scale plasma inhomogeneities and dissipation. The wave reflection leads to low-frequency cascade of Alfven waves due to small-scale nonlinearities. In closed field line regions, the dissipation is enhanced since different wave polarities can interact with equal amplitude, resulting in elevated temperatures. The electron heat conduction can subsequently transport this excess of energy deposition down to the chromosphere where it is lost by radiative cooling. The model does not impose open-closed magnetic field boundaries, those naturally develop from the photospheric magnetic fields.