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Using Data-driven time-dependent Magnetofrictional modeling to initiate Magnetohydrodynamic simulations of coronal active regions

The data-driven time-dependent magnetofrictional method (TMFM) has proven to be a powerful tool for studying solar coronal eruptive events. Coupling data-driven TMFM with magnetohydrodynamic (MHD) simulations potentially provides a robust and efficient approach to study such events in more detail.

As has been shown by a number of studies, TMFM is capable of incorporating observational data directly. Additionally, it is significantly faster to compute compared to MHD, due to the simplifications of the model. The main aim of this work is to utilize the data-driven TMFM, initiated with observational data, close to the time of the expected eruptive event, and transfer the magnetic field evolved with TMFM to initiate an MHD simulation, providing a more realistic initial condition for the MHD simulation. The goal is to leverage the lower computational cost of TMFM while simulating the fast and more dynamic evolution of eruptive events with the more complete MHD model.

As an example case for our approach, we simulated NOAA active region 12673, with the linked data-driven TMFM and ideal zero-β MHD simulation. The main twisted flux system in our simulation was rising during the MHD simulation, however, the final height of the flux system depended on how close to eruption the transformation of the model from TMFM to MHD was performed. Our simulations showed the primary factors in the eruptive event are the torus instability and presence of the slip-running reconnection.

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