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Magnetohydrodynamic drag simulations for a coronal mass ejection

Interplanetary coronal mass ejections (ICMEs) are known to drive the most intense geomagnetic storms. The fastest ICMEs can travel from the Sun to 1 AU in less than 24 hours. In order to have fast and reliable time-of-arrival predictions, it is crucial to develop models that are both physically accurate and computationally efficient. A paramount example is the drag-based model (DBM), which describes an ICME as a rigid body subject to an aerodynamic drag exerted by the background solar wind. However, as already hinted by early simulations, such a drag process has a magnetohydrodynamic nature and the aerodynamic DBM might not be the most accurate description. We present results of numerical experiments using high-resolution 2.5D MHD simulations of an ICME moving in different solar wind environments, aimed at improving such model. We focus on studying the resulting drag force both dynamically and parametrically. Thanks to a semi-Lagrangian approach (Expanding Box Model) and its resulting high resolution, we are able to include the effects of expansion, erosion (magnetic reconnection), and turbulence. We present preliminary results on the ICME tracking, deceleration, and drag estimates, and discuss their implications in the context of space weather.

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