Sheath-Accumulating Propagation of Interplanetary Coronal Mass Ejection

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Fast interplanetary coronal mass ejections (interplanetary CMEs, or ICMEs) are the drivers of strongest space weather storms such as solar energetic particle events and geomagnetic storms. The connection between space weather impacting solar wind disturbances associated with fast ICMEs at Earth and the characteristics of energetic CMEs observed near the Sun is a key question in the study of space weather storms as well as in the development of practical space weather prediction. Such shock-driving fast ICMEs usually expand at supersonic speed during the propagation, resulting in the continuous accumulation of shocked sheath plasma ahead. In this paper, we propose the “sheath-accumulating propagation" (SAP) model that describe the coevolution of the interplanetary sheath and decelerating ICME ejecta by taking into account the process of upstream solar wind plasma accumulation within the sheath region. On the basis of the SAP model, we discussed (1) ICME deceleration characteristics, (2) the fundamental condition for fast ICME at Earth, (3) thickness of interplanetary sheath, (4) arrival time prediction and (5) the super-intense geomagnetic storms associated with huge solar flares. We quantitatively show that not only speed but also mass of the CME are crucial in discussing the above five points. The similarities and differences between the SAP model and the drag-based model are also discussed.

Keywords: coronal mass ejections, solar wind, space weather

