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Extending CME predictions and impact from Earth to other planets

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There are several limitations to our ability to predict the timing and impact of coronal mass ejections on Earth and near-Earth space. With respect to timing, there are difficulties in properly assessing CME speed and direction, the heliospheric connectivity from the Sun to Earth, and the impact of the CME's interaction with the ambient solar wind. In predicting the impact, we have difficulty assessing the magnetic structure impacting Earth, including the size, variation, and whether the eruption forms a shock, and we are limited in our understanding of the CME's ability to produce solar energetic particles.

Upcoming observations and the commensurate development of models will continue our progress in improving the predictions at Earth. However, the outer planets pose greater challenges. Although the CME speed approaches the speed of the solar wind by the time it reaches 1 AU, therefore improving the predictability, the heliosphere's structure becomes pervaded with shocked regions (CIRs), CME interaction with the ambient solar wind can similarly produce interplanetary shocks, and the magnetic field structure from point-to-point becomes very difficult to trace.

We first discuss the "current" state of predictions, and the expected impact of future observations, of Earth-impacting coronal mass ejections. We then examine the state of CME models and assess the errors and limitations in predicting Earth-impacting activity. The models are then used to understand the expected prediction needs at

other planets, and to estimate the errors involved in developing predictions in the near future. We conclude with a discussion of an optimal (within reason) observing and modeling network enabling predictions for other planets.