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Numerical Study of Solar Storms from the Sun to Earth

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As solar storms are sweeping the Earth, adverse changes occur in geospace environment. How human can mitigate and avoid destructive damages caused by solar storms becomes an important frontier issue that we must face in the high-tech times. It is of both scientific significance to understand the dynamic process during solar storm's propagation in interplanetary space and realistic value to conduct physics-based numerical researches on the three-dimensional process of solar storms in interplanetary space with the aid of powerful computing capacity to predict the arrival times, intensities, and probable geoeffectiveness of solar storms at the Earth. So far, numerical studies based on magnetohydrodynamics (MHD) have gone through the transition from the initial qualitative principle researches to systematic quantitative studies on concrete events and numerical predictions. Numerical modeling community has a common goal to develop an end-to-end physics-based modeling system for forecasting the Sun-Earth relationship. It is hoped that the transition of these models to operational use depends on the availability of computational resources at reasonable cost and that the models' prediction capabilities may be improved by incorporating the observational findings and constraints into physics-based models, combining the observations, empirical models and MHD simulations in organic ways.

In this talk, we briefly focus on our recent progress in using solar observations to produce realistic magnetic configurations of CMEs as they leave the Sun, and coupling data-driven simulations of CMEs to heliospheric simulations that then propagate the CME configuration to 1AU, and outlook the important numerical issues and their possible solutions in numerical space weather modeling from the Sun to Earth for future research.