Current Status of Data-driven Space Weather Modeling

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Short-term influence on the space environment (space weather) is made by explosive phenomena such as solar flares and coronal mass ejections (CMEs). Solar flares are transient and strong emissions in sometimes very wide wavelength from radio to γ-ray, and therefore their influence reaches to the Earth with the light speed. On the other hand, though CMEs take a few days for reach to the Earth, southward pointing magnetic field within them makes large influence to the magnetosphere. The prediction of their magnetic field configuration after interaction with the interplanetary solar wind is important to estimate the magnitude of their influence. Therefore, the prediction of not only their occurrence and also timing and condition of their arrival are significant for achievement of the space weather forecast.

Both solar flares and CMEs are believed to be caused by a release process of magnetic energy stored in coronal magnetic field, i.e., magnetic reconnection. Nevertheless, the detail processes in flares and CMEs (e.g. how is the storage of free energy, and what is the trigger of their onset) remains still not well understood. One of the reasons for the difficulty is because magnetic field configuration in the solar corona is much more complex than model field used in theoretical studies.

In order to overcome the difficulty, we have recently developed a suite of data-driven numerical simulations for different phases of solar eruptions. They are the models of the onset of solar flares [Kusnao et al. in prep.], the formation and acceleration of CME in the solar corona [Shiota et al. submitted to ApJ], the propagation of ICME in the interplanetary [Kataoka et al. 2009], and particle acceleration on the CME driven shock [Shiota et al. in prep.]. In this lecture, we demonstrate the capability of data-driven simulation, which were performed based on high resolution observations of a solar eruption event occurred on December 13, 2006. Based on these results, we discuss the recent progress of the understanding solar eruptions and the predictability of space weather.

Keywords: space weather; solar magnetic field; solar flares; coronal mass ejection; solar wind; solar energetic particles

References

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