Modeling Study on Predictability of Solar Eruption and Space Weather

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Solar eruption, which manifests as solar flares and coronal mass ejections (CME), is one of the most important phenomena for space weather, because it is the primary source of space weather disturbance. The large scale numerical simulations have played a crucial role for the understanding of that. However, neither the trigger mechanism of the eruption nor the physical condition for the onset of that are well understood yet. Based on the Creative Scientific Research, The Basic Study of Space Weather Prediction, we are aiming to develop a new modeling framework of the sun-earth system. Our numerical model is constituted of the several sub-models, each of which can handle the simulation of different part of the sun-earth system. The solar active region model is designed to simulate the onset of flare based on photospheric magnetic field data observed by Hinode satellite.

In this paper, we present the basic algorithm of our model as well as show the several results of the modeling experiments, in which the X-class flare occurred in the active region NOAA10930 on Dec. 13, 2006 is chosen as a target event. The data-driven simulations, which were carried out in terms of vector magnetograph observed by Solar Optical Telescope (SOT) aboard Hinode satellite, successfully reproduced the observed eruptive event, in which highly twisted magnetic flux was formed with magnetic reconnection and ejected into the interplanetary space. The numerical experiments, which were virtually triggered using data observed on different times, indicated that the size of flux rope might increase as the virtual onset approaches to the onset time of the real event. Based on the results, we discuss about the predictability of solar eruption as well as about the potency of data-driven simulation for space weather prediction.