R010-P05
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Forecast of CIR-driven geomagnetic storms using the deep neural networks

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The magnetospheric disturbances is one of the essential indicators for the space weather forecast. The condition in the Earth's magnetosphere strongly depends on the solar wind variation associated with, for example, coronal mass ejection (CME) and/or co-rotating interaction region (CIR). Here, we focus on CIR-driven geomagnetic storms, which are originated from high-speed plasma flow from coronal holes. It is known that the solar wind variation mainly depends on the location and scale of coronal holes. In particular, the solar wind emitted from coronal holes near the solar equatorial region are likely to cause a drastic change of ring current, resulting a geomagnetic storm that can be detected as a global change of magnetic field both in space and on the ground. One of the difficulties for the geomagnetic storm forecast is that the interaction between solar wind and magnetosphere includes nonlinear processes. In addition, different characteristics for each storm event make it difficult to predict geomagnetic storms only using physically based simulations. In this study, we aim to develop the machine learning model for the prediction of CIR-driven geomagnetic storms.

We have developed a regression prediction model of solar wind that have been applied from the solar flare prediction model using deep neural networks (DeFN). First, the database of coronal holes (location coordinates, area) and solar wind (speed (Vsw), plasma density (Nsw), IMF Bz, IMF magnitude (IMF Bt)) is made from the observation data in 2017-2021 for learning. The parameters for coronal holes are derived from by SDO spacecraft data, while solar wind parameters are derived from DSCOVR spacecraft. In addition, we make the database without CME-driven storm events to forecast pure CIR-driven storm events. The magnetic storm list is provided from Kakioka Magnetic Observatory. Based on the magnetic storm list, CME-driven storm events are defined as that CME is observed by SOHO/LASCO at a few days before the onset of magnetic storm. We exclude the data from 1-day before to 3-days after the onset from the database.

We perform the 1-day, 2-days, and 3-days forecasts for the solar wind variations in 2022. The model can tentatively forecast Vsw, Nsw, and IMF Bt, with the root-mean-square errors (RMSEs) for 1-day forecast of ~60 km/s, ~8 /cc, and ~3.5 nT, respectively. The accuracy for 2-days and 3-days forecasts is ~25-60 % worse than 1-day forecast. On the other hand, IMF Bz cannot be forecasted because the related parameters of coronal holes (i.e., magnetic field of solar surface) are not included in the current database. We also find that the forecast accuracy using the database without CME events is almost the same as that using the database with CME events, which is due to a small number of relatively large-scale CME events in 2022.

We are now improving the model to forecast solar wind parameters (in particular IMF Bz) with a fine accuracy.