Investigation of the Relation Between Magnetospheric Activity and Solar Wind Parameters Based on Potential Learning

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Nowadays, it is so important in saving our economic activity and evading the disasters caused by terrestrial electromagnetic effects to predict both temporal and spatial scales of the geomagnetic disturbances based on in-situ solar wind observations. Recently, Neural Network (NN) is one of the notable techniques for the predictions of the magnetospheric activities. However, NN has a problem referred to as ‘black box’, which is difficult to extract which solar wind parameters are the most important for prediction. In this study, we examine a significant relationship between K_p index, which represents the magnetospheric activity, and the solar wind conditions based on an interpretable neural network: ‘Potential Learning (PL)’. A feature of the PL is to make a network that can understand the input variables by learning the “input potentialities”, which are indices calculated using the variances of the solar wind parameters as input variables.
In this study, we investigate the magnetospheric activity profile when the Interplanetary Magnetic Field (IMF) oriented southward ($B_z < 0$). As the input solar wind data, we utilize the two components of the magnetic field (B_x, B_y) in GSE, and solar wind flow speed, and number density during 20 years between 1999 and 2018. Furthermore, we divide the associated values of K_p into two groups (targets): ‘K_p = 6- to 9 (positive target)’ and ‘K_p = 0 to 1+ (negative target)’. Because the data number of positive target was smaller than that of negative target, the negative target samples are randomly selected so that the data numbers of both targets become equal. Based on the PL neural network, we obtain two important results; 1) the solar wind plasma flow speed might have the most influential in the increase of the K_p index, and 2) as the secondary influential parameter for the K_p increase, the solar wind proton density is considered. In the presentation, we will discuss feasibility of the application to the prediction of the magnetospheric activity based on the solar wind parameters.

Keywords: Space Weather Modeling, Magnetospheric Activity and Solar Wind, Neural Network (Potential Learning)

