

Prediction of sunspot number and latitude distribution using machine learning

*Kento Michiwaki¹, Shinsuke Imada¹, Yoshizumi Miyoshi¹

1. Institute for Space-Earth Environmental Research, Nagoya University

For space weather study, it is important to estimate the solar activity in near future. Recently, it is believed that the polar magnetic field at the solar minimum is one of the indicators for the next solar activity. Therefore, many studies try to estimate the solar polar magnetic field for the cycle prediction. The temporal variation of the polar magnetic field can be reproduced by using the surface magnetic flux transport calculation model (SFT model). The SFT model consists of advection term due to differential rotation and meridional circulation, magnetic diffusion term, and flux emergence term. The advection and the diffusion coefficients are estimated by modern observations. On the other hand, estimation of future flux emergence is still very difficult. Therefore, estimating when and where the sunspots will be emerge is crucial for cycle prediction study.

In this study, we predicted the sunspot number using RNN (Recurrent Neural Network), which is one of the machine learning technique. Also, the latitude distribution (butterfly diagram) was predicted using CNN (Convolutional Neural Network). As a result, for the prediction of the number of sunspots, by using the sunspot number of former half of the cycle as the input data, we succeeded to predict the sunspot number of latter half of the cycle. For the prediction of the appearance latitude, the transition and the periodicity of the appearance of the sunspot from the middle latitude to the low latitude were able to be reproduced.

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