ベクトル磁場と彩層発光を用いた機械学習による太陽フレア予測
Solar Flare Prediction with Vector Magnetogram and Chromospheric Brightening using Machine-learning

*西塚 直人[1]、久保 勇樹[1]、杉浦 孔明[1]、田 光江[1]、亘 慎一[1]、石井 守[1]
*Naoto Nishizuka[1], Yuki Kubo[1], Komei Sugiura[1], Mitsue Den[1], Shinichi Watari[1], Mamoru Ishii[1]

1.国立研究開発法人　情報通信研究機構
1.National Institute of Information and Communications Technology

Solar flares have been empirically predicted based on the solar surface observations. Before large class of flares, photospheric magnetic field in the active region becomes complex and sharp magnetic neutral lines are formed. It is also known that chromospheric brightening recurrently occurs at around the neutral lines. In NICT, solar flares occurring in the next 24 hours have been predicted by scientists in the daily forecast operations, but the flare mechanism has not been well revealed and we still have a difficulty in predicting flares with high accuracy and good confidence. Currently, we can access huge amount of observation data, so we developed a system to automatically predict flares using the near real-time observation data by satellites and the machine-learning technique.
We used observation data sets taken by SDO and GOES satellites during 2010-2015: (1) line-of-sight direction magnetogram and vector magnetogram data by HMI/SDO, (2) lower chromospheric brightening data by AIA 1600 Angstrom filter/SDO, and (3) soft X-ray emission by GOES. Firstly, we automatically detect active regions using full-disk images of magnetogram every 1 hour, to predict a flare class occurring in the region in the next 24 hours. Secondly, we extract solar features for each region, i.e., the maximum magnetic field strength, the maximum gradient of magnetic field in the line-of-sight direction, the number of magnetic neutral lines, the maximum length of neutral lines, the magnetic free energy, the shear angle, the time variations of magnetic field configurations, the history of X/M-class flares, the background GOES X-ray emission, and the activity of chromospheric brightening. Thirdly, we apply the machine-learning technique to the dataset of solar features to predict flares. We divided the total data set into two for training and test. We adopted three machine-learning techniques for comparison: the support vector machine (SVM), the k-nearest neighbor (k-NN) and the extra random trees (ERT). As a result, we succeeded in achieving good prediction of X-class flares, as verified by the True Skill Score (TSS) larger than 0.7, which is better than human forecast operations (TSS~0.5). In this presentation, we would like to introduce our flare predictions model and to discuss flare triggering mechanism.

キーワード：宇宙天気予報、太陽フレア、統計解析、機械学習、光球ベクトル磁場、彩層
Keywords: Space Weather Forecast, Solar Flare, Statistical Analysis, Machine-Learning, Photospheric vector Magnetic field, Chromosphere