Project for Solar-Terrestrial Environment Prediction: Predicting Solar Cycle 25

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It is thought that the longer-term variations of the solar activity may affect the Earth's climate. Therefore, predicting the next solar cycle is crucial for the forecast of the "solar-terrestrial environment". To build prediction schemes for the next solar cycle is a key for the long-term space weather study. At the beginning of the talk, we will briefly review how to predict the next solar cycle.

Recently, the relationship between polar magnetic field at the solar minimum and next solar activity is intensively discussed. Because we can determine the polar magnetic field at the solar minimum roughly 3 years before the next solar maximum, we may discuss the next solar cycle 3years before. Further, the longer term (~5 years) prediction might be achieved by estimating the polar magnetic field with the Surface Flux Transport (SFT) model. Now, we are developing a prediction scheme by SFT model as a part of the PSTEP (Project for Solar-Terrestrial Environment Prediction) and adapting to the Cycle 25 prediction. We find that the observed axial dipole moment becomes approximately constant during the period of several years before each cycle minimum, which we call the axial dipole moment plateau. The cross-equatorial magnetic flux transport is found to be small during the period, although a significant number of sunspots are still emerging. The results indicate that the newly emerged magnetic flux does not contribute to the build up of the axial dipole moment near the end of each cycle. This is confirmed by showing that the time variation of the observed axial dipole moment agrees well with that predicted by the SFT model without introducing new emergence of magnetic flux. These results allow us to predict the axial dipole moment at the Cycle 24/25 minimum using the SFT model without introducing new flux emergence. The predicted axial dipole moment at the Cycle 24/25 minimum is 60–80 percent of Cycle 23/24 result suggests that the amplitude of Cycle 25 is weaker than the current cycle (Figure 1). We also discuss about the grand minimum.

We also try to obtain the meridional flow, differential rotation, and turbulent diffusivity from recent modern observations (*Hinode* and *Solar Dynamics Observatory*). These parameters will be used in the SFT models to predict the polar magnetic fields strength at the solar minimum. In this presentation, we will explain the outline of our strategy to predict the next solar cycle and discuss the initial results for Cycle 25 prediction.

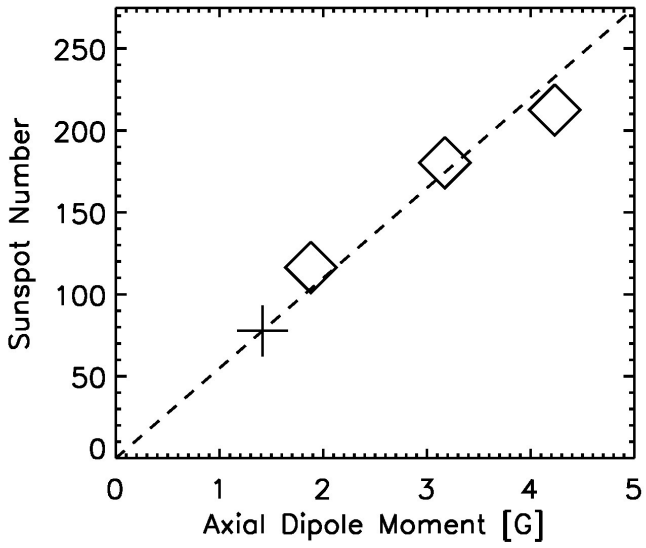

Figure 1. Maximum value of the 13-month smoothed monthly total sunspot number in each sunspot cycle (Cycle 22, 23, and 24; diamond) and the predicted cycle amplitude in Cycle 25 (cross) as a function of the axial dipole moment at the previous minimum predicted from the magnetogram observed three years before the minimum. The least-square fit for Cycles 22, 23, and 24 that crosses the point of origin is shown as the dashed line. The correlation coefficient for Cycles 22, 23, and 24 is 0.99.

References

Iijima, H. et al., Improvement of solar-cycle prediction: Plateau of solar axial dipole moment, Astronomy & Astrophysics, 607, L2 , 2017.