Solar surface flow around the cycle 24 minimum

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Solar flares have significant impacts on the Earth’s environment. Flares are now believed to be associated with sunspot’s activities. Therefore the 11-year variability in sunspot numbers is one of the major origins of the decadal variability in the solar environment. Predicting sunspot number in next solar cycle is very important for space weather. Building the next solar cycle prediction scheme is the key to long-term space weather research. Recently, it is believed that the polar magnetic field during the minimum period is one of the good indicator for the next solar cycle activity. Surface flux transport (SFT) models are often used to estimate polar magnetic fields. On the other hand, the SFT model requires several parameters, such as meridional circulation, rotational difference, and turbulent diffusion. These parameters are not fully understood, and especially their temporal variation is still unclear.

In this study, we focused on two typical solar surface flows, differential rotation and meridional circulation. We apply a magnetic element tracking (MET) module to SDO/HMI magnetic field data to obtain solar surface velocities. Because HMI has been available since 2010, we calculated solar surface flow using ten years data. We can capture more than 5,000,000 elements and average for each latitude. As a result, we obtain the latitudinal profile of the meridional flow and differential rotation speed. We also studied the temporal variations of the meridional flow and differential rotation speed in cycle 24. We find that the differential rotation/meridional flow speed is faster/slower at the latitude where the sunspots frequently emerge, respectively.

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