

Observing the horizontal divergent flow of the sun as a precursor of sunspot emergence

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Solar active regions including sunspots are the origins of flare activities and CMEs. It is widely accepted that active regions are the consequence of the rising magnetic flux from the deep convection zone, i.e., flux emergence.

In this study, we report the detection of the horizontal divergent flow (HDF) at the solar photosphere, prior to the magnetic field appearance in NOAA AR 11081 on 2010 June 11. The HDF has been predicted theoretically through our recent numerical simulations on the flux emergence. The mechanism of the HDF is that the plasma on the rising magnetic flux escapes horizontally around the solar surface.

For the observation, we used the SDO/HMI Dopplergrams and magnetograms, and investigated the differences of each (Doppler and magnetic) profile of this region from that of the quiet Sun. We determined the appearance times of the HDF and the flux emergence as the times when each difference exceeds one standard deviation level (one-sigma) of the reference quiet-Sun profile. As a result, we found that the HDF occurs about 100 min before the associated flux emergence. That is, the HDF can be thought as a precursor of the flux emergence and the sunspot formation. The HDF observation may allow us to predict the flux emergence in the nearest future, which may contribute the space weather study.

Keywords: sun, magnetic field, solar interior, photosphere, space weather