Implications of the equinoctial effect for semi-annual variation in geomagnetic activity

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The semi-annual variation in geomagnetic activity which magnetic disturbance tends to be higher at equinoxes than at solstices has been known for more than 150 years. Although the Russell and McPherron hypothesis (Russell and McPherron, 1973), which is based on the recognition that the interplanetary magnetic field in the solar equatorial plane tends to have the largest southward component in geocentric solar magnetospheric coordinates in early April and October, had been widely accepted as the explanation of the phenomenon for many years, recent detailed studies have clearly shown that the RM effect accounts for only a subordinate proportion of the semi-annual variation of geomagnetic activity, and that the larger part of the phenomenon is attributable to the equinoctial effect (Bartels, 1932; McIntosh, 1959) in which the angle between the solar wind flow and the dipole axis of the Earth plays an essential role (Cliver, Kamide and Ling, 2000; Cliver, Kamide, Ling and Yokoyama, 2001; O'Brien and McPherron, 2002). However, the mechanism how the equinoctial effect modulates geomagnetic activity semi-annually has been an enigma.

In this paper, we show that the emergence of the geomagnetic disturbance in sub-auroral zone is regulated by the component of the solar wind velocity perpendicular to the dipole axis of the geomagnetic field. This finding solves the long-lasted enigma, for the magnitude of the perpendicular velocity component that is related to the angle between the solar wind flow and the dipole axis varies semi-annually even if the solar wind velocity remains constant. We further show that the equinoctial effect also works in the geomagnetic activity in the boreal auroral zone represented by the AE index.

Some implications of the equinoctial effect in the dayside magnetic reconnection are discussed.