Variations in cloud amount with a cycle of solar rotation in western-Pacific warm pool and relationship to the 11-year solar cycle

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Linkages between solar activity and the earth's climate have been suggested in previous studies. The 11-year cycle in solar activity evident in sunspot numbers is the most examined example of periodicity, and it is clearly recognized in variations in the thermal structure and dynamical motion of the stratospheric atmosphere [Haigh, 1994; Kodera, 1995; Shindell and Rind, 1999]. Synchronization between the flux of galactic cosmic rays and cloud amount has also been reported in terms of the 11-year solar cycle [Svensmark, 1998]. Variations in the stratosphere related to the period of apparent solar rotation (27-day) have also been suggested [Nastrom and Belmont, 1978; Hood, 1984]; however, for such a short period, no decisive evidence exists to indicate a relationship between solar activity and tropospheric phenomena have been reported.

One example which suggests a connection between solar activity and tropospheric phenomena in such a short timescale is a 28-day periodicity in the global lightning activity deduced by the spectral intensity of the Schumann resonance [Sato and Fukunishi, 2006]. However, the solar parameter responsible for the 28-day periodicity has not been determined yet. On the other hand, it is found that there is a relatively good correlation between the global lightning activity and the cloud amount in the equatorial region. This indicates that the cloud amount has the 27-day periodicity, that is, it can be expected that a variation in the cloud amount is influenced by the solar activity in such a short period. Then we have analyzed Outgoing Longwave Radiation (OLR) data as a proxy for the cloud amount. We have conducted a spectral analysis to investigate the periodicity in detail.

In this presentation we clearly demonstrate a 27-day variation in the cloud amount in the region of the western-Pacific warm pool, which is only seen in the solar maximum years of the 11-year cycle. Moreover, a ˜50-day periodicity is strongly enhanced in years when the 27-day variation is prominent. This result suggests that the tropospheric atmosphere is strongly influenced by solar activity. The apparent correlation between the 27-day variation and the longer ˜50-day phenomenon indicates a physical connection between the two cycles. Our preliminary examination is based on the fact that the cloud amount in the region of the western-Pacific warm pool always shows clear 27-day variations in solar maximum years; however, the 27-day variations may lead to global change via the modulation of the eastward propagation of cloud systems known as MJO (Madden-Julian Oscillation) [McPhaden, 1999; Takayabu et al., 1999] with periodicity of 30-80 days. Long-term variations in tropospheric phenomena, including the 11-year cycle, are generally investigated based on yearly averaged data, but the present results suggest an alternative possibility: short-period variations modulate longer periodic phenomena as a structure of the time hierarchy.