Correlated temporal variations of SCW, AKR and global Pi 2

Teiji Uozumi[1]; Akimasa Yoshikawa[2]; Shinichi Ohtani[3]; Shun Imajo[4]; Dmitry Baishev[5]; Alexey Moiseev[5]; Boris Shevtsov[6]

[1] ICSWSE, Kyushu Univ.; [2] ICSWSE/Kyushu Univ.; [3] The Johns Hopkins University Applied Physics Laboratory; [4] Earth and Planetary Sci., Kyushu Univ.; [5] IKFIA, SB, RAS; [6] IKIR

A transient geomagnetic pulsation Pi 2 is well known to occur at every auroral breakup [e.g. *Sakurai and Saito*, 1976], and is accepted as an onset indicator of the magnetospheric substorm [e.g. *Saito*, 1969; *Rostoker et al.*, 1980]. The formation of the substorm current wedge (SCW) [e.g. *McPherron et al.*, 1973; *Nagai*, 1982] and the breakup of the auroral kilometric radiation (AKR) [e.g. *Gurnett*, 1974, *Morioka et al.*, 2008] are also enumerated as other essential manifestations of the substorm expansion onset. Past studies addressed the timing relations among the onsets of these phenomena [e.g., *Sakurai and McPherron*, 1983; *Liou et al.*, 2000a, 2000b; *Morioka et al.*, 2008]. However, the relation of temporal variations between Pi 2 and other phenomena have not yet been clarified. In this study we investigate a temporal relationship between AKR / SCW modulation and global Pi 2 oscillations. We present some typical events, which revealed highly correlated modulations/oscillations of AKR, SCW and global Pi 2. It is confirmed that the height-integrated AKR power (P_{AKR}) tended to increase/decrease during the interval when the D component Pi 2 (dB_D) deviated in the same/opposite sense as the D- component bay of the SCW. This result suggests that the time derivative of the height-integrated AKR power was modulated coherently with the D component Pi 2 oscillation. This result is consistent with the finding of *Uozumi et al.* [2011]. We reexamined Pi 2 oscillations by applying the Hilbert transform method. The Hilbert transform is the integral transform in the time domain, and shifts the original phase 90deg behind for all the frequency components. We found that the Hilbert-transformed Pi 2 period range oscillations in the D component, HT(dB_D), shows temporal variation similar to $d\log_{10}P_{AKR}$ without lag time. This result supports the aforementioned time-derivative relation between Pi 2 oscillation and AKR modulation. We also analyzed global Pi 2s, which were observed from low- to high-latitude region with highly correlated waveforms (global high-correlation Pi 2 [*Uozumi et al.*, 2009, 2011, 2016]). The result shows that the middle- and high-latitude D component Pi 2 oscillated without any significant time lag, whereas the middle- and high-latitude Pi 2 in the H component oscillations revealed some time lags due to the propagation delay of the Pi 2 waves. The azimuth of the initial deflection of the middle- and high-latitude duskward Pi 2s are consistently explained by the development of an upward field-aligned current that is assumed to be located at the center of the auroral breakup region. These results suggest that the middle- and high-latitude D component Pi 2 oscillations can be treated as a proxy of the modulation of the SCW (dB_D ~ dB_{SCW}), and therefore, the time derivative of the height-integrated AKR power was modulated coherently with the SCW oscillations. It is also found that the H component of the low-latitude Pi 2, which is a manifestation of the fast wave propagated from nightside magnetosphere (dB_{FW}), and dB_{SCW} are highly correlated without any significant time lags ($|dT| <$~ 10 s). The high-correlation signature between dB_{FW} and dB_{SCW} suggests that the driving sources of these wave elements in global high-correlation Pi 2 are closely coupled with each other.