Substorm current wedge model for Pi 2 pulsation revisited with the morphology of the global high-correlation Pi 2

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The formation and the development of a substorm current wedge (SCW) is one of the fundamental processes in the expansion phase of the magnetospheric substorm [e.g. *McPherron et al.*, 1973; *Nagai*, 1982]. *McPherron et al.* [1973] described the three-dimensional substorm current wedge, and located the center of the wedge at the longitude where there is a change in sign of the east-west (D component) magnetic bay. *Lester et al.* [1983] applied this idea to the Pi 2 phenomenon and developed a model to estimate the SCW location from the middle-latitude Pi 2 polarization pattern (referred to as the SCW model for Pi 2). *Lester et al.* [1983] assumed that the middle-latitude Pi 2 was directly associated with the substorm current system, or Pi 2 polarization was a resultant of the oscillating SCW, then predicted polarization pattern across the current wedge. The SCW model predicts the center of the wedge at the longitude where is a change in sign of the D component Pi 2 oscillations similar to the model by *McPherron et al.* [1973]. *Lester et al.* [1983] examined their model with 16 Pi 2 events, which were observed with longitudinal magnetometer chain of middle-latitude (GMLAT ˜55N), and presented the result that the longitudinal change of the Pi 2 azimuth (orientation of the major axis of the Pi 2 hodograph) for all the events were basically consistent with the expected changes of the model prediction, though the center of the SCW, which were estimated from the Pi 2 azimuth pattern, were not always collocated with that of the estimation by the *McPherron* [1973] model (˜65% agreement).

According to *Lester et al.* [1984], the SCW models has had considerable success explaining middle-latitude magnetic bay structure and orientation of the major axis of the Pi 2 hodograph, although the model predictions are based on an oversimplification of the currents at substorm onsets. At present, the SCW model for Pi 2 is recognized as a useful tool to estimate an approximate location of the upward/downward field aligned current of the SCW system [e.g. *Kitamura et al.*, 2005; *Kim et al.*, 2005]. However there remain some open questions on the SCW model for Pi 2. One of the issue is that ideally the ellipticity of the Pi 2 hodograph should be linear ($|\text{epsilon}|<0.1$, *Lester et al.*, 1984), if the middle-latitude Pi 2 was directly associated with the substorm current system. However, *Lester et al.*, [1983, 1984] presented that a majority of Pi 2 events exhibited not linear but rather circular shape of the hodograph. The discrepancy between the model prediction and observation has not been solved yet. *Uozumi et al.* [2009, 2011] studied Pi 2 propagation in the magnetosphere by analyzing global high-correlation Pi 2 events. They showed that the D component of the high- and middle-latitude Pi 2s oscillated without significant time delay in the entire nighttime sector. In contrast, the H (north-south) component of the Pi 2s showed an MLT (magnetic local time) dependence of the time difference. *Uozumi et al.* [2009, 2011] explained the time difference with three-dimensional Pi 2 propagation model in the magnetosphere. They presented that the time differences were due to delayed arrival of the driven-Alfvenic wave, which was forcedly generated by the fast mode wave propagated from Pi 2 source in the magnetosphere. We revisited at the aforementioned open question on the SCW model for Pi 2 with the morphology of the global high-correlation Pi 2, and then found a possible solution to the issue. The driven-Alfvenic wave is a key element to solve the issue on the SCW model. We will present the detail of the solution at the meeting with observational results of the high-correlation Pi 2 events, which were observed at a middle-latitude MAGDAS/CPMN station ZYK (GMLAT=59.6N, GMLON 216.8) and the ETS-VIII geosynchronous satellite (GMLON.=217.5).