Substorm current wedge model for Pi 2 pulsation revisited with middle-latitude MAGDAS and the Polar UVI data

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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 Pi2 phenomenon, and developed a model to estimate the SCW location from the middle-latitude Pi2 polarization pattern (referred to as the SCW model for Pi2). *Lester et al.* [1983] assumed that the middle-latitude Pi2 was directly associated with the substorm current system, or Pi2 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 Pi2 oscillations similar to the model by *McPherron et al.* [1973]. *Lester et al.* [1983] examined their model with 16 Pi2 events, which were observed with longitudinal magnetometer chain of middle-latitude (GMLAT ˜55deg), and presented the result that the longitudinal change of the Pi 2 azimuth (orientation of the major axis of the Pi2 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 Pi2 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 Pi2 hodograph, although the model predictions are based on a simplification of the currents at substorm onsets. At present, the SCW model for Pi2 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 Pi2. One of the issue is the aforementioned inconsistency on the prediction of the center of the SCW. The discrepancy between the model prediction and observation has not been solved yet.

We revisited at the open question on the SCW model for Pi 2 by analyzing over 100 middle-latitude Pi2 events with referring the auroral breakup locations, which were determined by the Polar UVI data [Liou, 2010]. We selected Pi2 events with the following criterion, (1) middle-latitude station (ZYK, GMLAT=59.9deg) was located nightside and duskward of the auroral breakup location, (2) the power of the magnetic perturbation just before the onset of the auroral breakup was below a threshold level. In this study, we assumed that the ionospheric foot point of the upward FAC was located at the position of the auroral breakup. Then we estimated the signature of the magnetic variation at ZYK generated by the upward FAC. The direction of the initial deflection of the Pi 2 (Theta$_{id}$) and the major axis of the Pi2 hodograph (Theta$_{hod}$) were compared with the estimated direction of the magnetic variation by the upward FAC (Theta$_{FAC}$). The deviation of Theta$_{id}$ and Theta$_{hod}$ from Theta$_{FAC}$ are defined as DeltaTheta$_{id}$ and DeltaTheta$_{hod}$, respectively. We found that |DeltaTheta$_{id}$|tended to be smaller than |DeltaTheta$_{hod}$|, and the average value of |DeltaT$_{id}$|and |DeltaTheta$_{hod}$|were 34deg and 46deg, respectively. We also found that ˜60% (˜40%) of events exhibited |DeltaTheta$_{id}$|<= 30deg (15deg). The present result suggests that the initial deflection of the middle-latitude Pi2 is a manifestation of the evolution of the upward FAC at the onset. We will present the detail in the session.