If Pi2 is onset indicator of substorms, what triggers Pi2s?

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Close analyses of substorm onset using data from all-sky imagers, ground magnetometers, and plasma and magnetic field measurements at geosynchronous orbit obtained in the Global Aurora Dynamics Campaign (1985-1995) revealed that equatorial Pi2s can pick up in statistical base as well as for case studies the onset of individual field line dipolarization of substorms [Saka et al., 2010; Saka and Hayashi, 2017]. The analyses also show that field-aligned flows towards the equatorial plane (inflow) intensified radial inhomogeneity of plasma pressure in the pre-onset intervals, which initiated slow magnetoacoustic wave through Ballooning instability. The excited slow magnetoacoustic wave would smooth out the radial inhomogeneity by the associated azimuthal expansion of the flux tubes. The smoothing of the radial inhomogeneity is consisted of oscillating transition of flux tubes (at Pi2 periodicity) from one stable geometry with smaller curvature radius to the other of larger curvature radius of geomagnetic field lines, which will be referred to as field line dipolarization [Saka, 2019b].
The analyses also showed that flux tubes linked to negative and positive bays at higher and lower latitudes, respectively, oscillated coherently at Pi2 periods [Saka et al., 2012; Saka, 2019b]. Oscillating flux tubes associated with positive bay may trigger cavity/waveguide mode in low latitudes [Allan et al., 1996; Li et al., 1998], while flux tubes for negative bay yields convection surge in the midnight magnetosphere [Saka, 2019b]. Electromotive force generated in the auroral ionosphere by the convection surge produced field-aligned currents in it [Saka, 2019a].

In the dip-equator, a singular latitude of the cavity/waveguide mode [Allan et al., 1996], only isotropic mode can be excited. This leads us to suppose that a very large propagation velocity (or large wavelength exceeding whole circle of the Earth) of Pi2s in the nightside sector [Kitamura et al., 1988] would be caused by the dawn-dusk asymmetry of non-propagating compressions. This contrasts with the high-latitude Pi2s that propagated typically at 20km/s eastward and westward in the sector east and west of the substorm center, respectively [Samson and Harrold, 1985].

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