

## Observations of Pi 2 Ionospheric Electric Fields by FM-CW radars

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At the onset of magnetospheric substorms, impulsive hydromagnetic oscillations occur globally in the magnetosphere with a period range from 40 to 150 seconds [e.g. Saito, 1968]. They are called Pi 2 magnetic pulsations. Pi 2 has been studied with arrays of magnetometers on the ground and with in-situ observation by satellites [e.g. Yumoto, 2001]. However characteristics of Pi 2 electric pulsations in the low-latitude ionosphere have not been clearly identified yet. We have focused on measuring the Pi 2 electric pulsations by an FM-CW (Frequency Modulated Continuous Wave) radar and clarify their characteristics.

In order to detect the ionospheric electric fields, we built a FM-CW (HF) radar at Sasaguri (Magnetic Latitude: 23.2 degree, Magnetic Longitude: 199.6 degree, LT=UT+9 hrs), Fukuoka, Japan in 2002. The radar provides the Doppler shift of launched wave frequencies, which corresponds to the height variation of the ionosphere, with a high-time resolution of 3 sec. When the eastward (westward) electric field penetrates into the low-latitude ionosphere, it drifts upward (downward) through the  $E \times B$  drift. Thus, using the FM-CW radar we can measure east-west electric fields ( $E_y$ ) in the ionosphere [see Ikeda et al., 2008]. In this study, we also used geomagnetic field data BH at Kujyu (KUJ; M. Lat. 23.6 degree, M. Lon. 203.2 degree, LT=UT+9 hrs), a part of Circum-pan Pacific Magnetic Network (CPMN) stations [cf., Yumoto et al., 2001].

The first Pi 2 event was observed at KUJ and Sasaguri simultaneously at 13:32 UT (22:32 LT) on 6 November, 2003. Also positive bay was detected in the H-component (BH) at KUJ. The dominant frequencies of the electric field  $E_y$  and magnetic field BH were identical. From a cross-correlation analysis between the BH at KUJ and  $E_y$  at Sasaguri, we found that the correlation coefficient is 0.80 and phase delay is about -100 degree. Takahashi et al. (JGR, 2001) showed the expected phase relation between magnetic field of cavity-mode Pi 2 and associated electric field. Based on their result, we suggest the phase delay of -100 degree indicates that the first Pi 2 event shows a radial mode structure of cavity-mode Pi 2.

The second Pi 2 event was observed at 14:15 UT (23:15 LT) on the same day 6 November, 2003. The dominant frequency of  $E_y$  and BH were the same and phase delay is -148 or 39 degree. Since the phase delay is almost -180 or 0 degree, this Pi 2 event can be a propagating mode of Pi 2.

Further we analyzed the Pi 2 electric field observed at Paratunka (PTK; Magnetic Latitude: 45.75 degree, Magnetic Longitude: 221.45 degree, LT=UT+11 hrs), Kamchatka, Russia by the FM-CW radar. Also this result will be present in this paper.