Characteristics of Pi2 electric and magnetic pulsations observed at the low-latitude CPMN magnetometers and a FM-CW radar

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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 Pi2 magnetic pulsations. Pi2 has been studied with arrays of magnetometers on the ground and with in-situ observation by satellites [e.g. Yumoto, 2001]. However characteristics of Pi2 electric pulsations in the low-latitude ionosphere have not been clearly identified yet. We have focused on measuring the Pi2 electric pulsations by a 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, Fukuoka, Japan (Magnetic Latitude: 23.2 degree, Magnetic Longitude: 199.6 degree) in 2002. The radar provides 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 ExB drift. Thus, using the FM-CW radar we can measure east-west electric fields in the ionosphere. In this study, we also used geomagnetic field data obtained from Circum-pan Pacific Magnetic Network (CPMN) stations.

We found two-types of Pi2 electric and magnetic pulsations at Sasaguri and Kagoshima (M. Lat. 21.9 degree, M. Lon. 200.6 degree). The dominant frequencies of the electric and magnetic field variations were identical, and the cross correlation coefficients of these pulsations were larger than 0.65. One type shows +-40 degree phase lag between the electric and magnetic field oscillations during the Pi2 pulsations, and the other type shows +-90 degree phase lag between the electric and magnetic fields. These two-type Pi2 events can be explained by an earthward propagating compressional oscillation (E_y = -V_z x B_{0x}) and a standing wave mode in radial direction (i.e., E_y and B_x oscillate nearly in quadrature, respectively), as suggested by Takahashi et al. (JGR, 2001).