

Statistical study for electromagnetic coupling between E- and F-region ionosphere over Japan

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During the FERIX (F- and E-Region Coupling Study) campaign observation in 2004, we succeeded in observing direct evidence of electromagnetic coupling process between the mid-latitude E- and F- region FAIs (Field Aligned Irregularities). In 2005, we conducted continuous observations of E-region FAIs (E-FAIs) with LTPR (Lower Thermosphere Profiler Radar) located at Shigaraki. Data from the experiment were compared with GPS-TEC data from the GEONET for statistical study for the E- and F-region coupling processes. At first, we determined the position where the E-FAIs echoes were often observed with LTPR, and mapped it to the F-region (300 km altitude) along the geomagnetic field line. Perturbation of the GPS-TEC (pTEC) at that point was compared with E-FAIs activity determined from the LTPR echo power. Within 64 samples, in 34 cases, there were clear correlation between the E-FAIs occurrence and large fluctuation of pTEC (case A). In 13 cases, there were no pTEC fluctuations and E-FAI occurrence. In 7 cases, though the E-FAIs were observed, pTEC fluctuations were very weak (case B). In 10 cases, E-FAI was very weak, but pTEC fluctuations were strong and 7 of these 10 case, Sporadic-E (Es) layer was observed with ionosonde at Shigaraki (case C). Both case A and C showed large pTEC fluctuations; but no E-FAIs were found in case C. We investigated the F-region plasma structure such as azimuth-dependent structure of MSTID (Medium-Scale Traveling Ionospheric Disturbance) between the case A and C. The result showed that the angle distribution of pTEC horizontal structure for case A had a prominent angle distribution of about -50 to -20 degree compared with relatively broader distribution for case C. We discussed that this shows developed MSTIDs exist when E- and F-region coupling occurred. We analyzed pTEC data of SEEK-2 (Sporadic E Experiment over Kyushu -2) rocket observation period, when strong QP echoes were observed. We found no MSTID structure or prominent azimuth angle in the F-region plasma. This case can be categorized as case B. The plausible source of the QP structure in SEEK-2 can be attributed to structures of the neutral atmosphere owing to gravity waves or KHI.