

Study of coupling processes between mid-latitude ionospheric E and F regions based on the FERIX-2 experiment

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In the ionosphere, conductivity parallel to the geomagnetic field is so high that such polarization electric fields are easily mapped along the field line for several hundred kilometers. Therefore, it had been expected that FAIs in the E- and F- regions are geomagnetically coupled.

FERIX (F- and E- Region Ionosphere Coupling Study) observation campaign was carried out in 2004. We located LTPR (Lower Thermosphere Profiler Radar) at Sakata to observe E-region FAI, and with the MU radar, observed F-region FAI from Shigaraki. By the observations, E- and F- region FAIs were found at the same time along the same geomagnetic field lines. However, important problem was left unsolved, i.e., which region contributes to the generation of the electric fields. We then conducted the similar experiment FERIX-2 from May to September 2007. For FERIX-2 experiment, we applied the radar imaging technique for both radars, and studied the horizontal structures of both E- and F- regions FAIs in more detail. We also operated a bistatic receiving site at Maze, Niigata to expand observation region of the LTPR. Observations of Doppler velocity of the echoes from both Sakata and Maze would reveal two dimensional motion of the E-FAI.

From these observations, we found that the F-FAI shows northwest-southeast wavefront with small structures of 20-30 km. The small structures had wavefront various Doppler speed, and propagated to the northwest. On the other hand, E-FAI distributed zonally elongated, or showed northwest-southeast structures. Although the difference of the scale was pointed out in E-layer and F-layer, close structure between E-FAI and F-FAI was discovered. We found that E-FAI were enhanced and showed northwest-southwest wavefront structures when F-FAI echoes were observed by the MU radar. The overall horizontal motions of the F-FAI and E-FAI echoes are similar and westward, as originally reported from FERIX-1. The radar imaging observations, however, revealed that smaller echo patches of E-FAI tend to appear at the edge or around the F-FAI echoes.

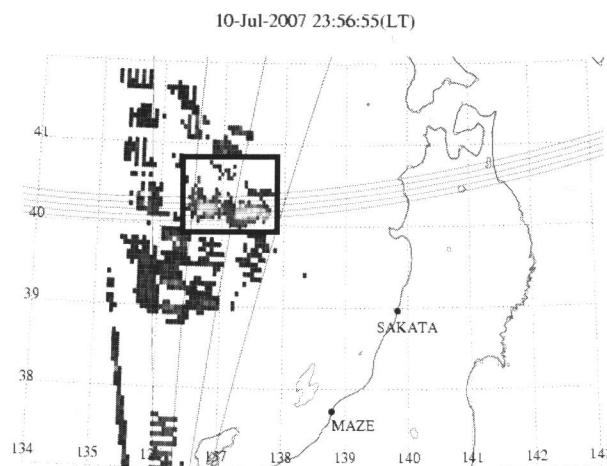


Figure: Horizontal distribution of F-region FAI echoes observed with the MU radar. The echoes are obtained by the MU radar multibeam imaging observations. The F-region FAI echoes are found at 250-300 km altitudes, but in this figure, they are mapped down to 100 km altitude along the geomagnetic field line. Shown in the square area is the E-region FAI echo distribution observed by the LTPR located in Sakata. Close comparison between F- and E-region observations revealed that E-region FAI echoes tend to appear at the edge of the F-region FAI echoes.