SIMULTANEOUS RADAR, OPTICAL AND GPS OBSERVATION OF E-REGION IRREGULARITIES AND F-REGION TRAVELING IONOSPHERIC DISTURBANCES

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On the night of August 6, 2002, typical quasi-periodic (QP) echoes from field-aligned electron density irregularities in the ionospheric E-region were observed in a mode of 5-beam Doppler observations with the powerful 46.5-MHz middle and upper atmosphere (MU) radar at Shigaraki, Japan. The QP echoes exhibited a wavy structure that propagated southwestward at 100 m/s with a wavelength of 30 km. During this QP event, a 630.0 nm all-sky CCD imager at the MU radar site detected medium-scale traveling ionospheric disturbances (TID) at altitudes of around 250 km in the F-region. The TID also propagated southwestward at 80 m/s with relative fluctuation amplitudes of 30-50% and a wavelength of 300 km. This propagation direction is very similar to the direction of the QP echoes movement. Also, a 630.0 nm Fabry-Perot interferometer at the radar site detected neutral winds (U) of 106 m/s that generates an electric field of 4.5 mV/m through UxB, where B is the geomagnetic field. From these observed values and average F-region electric field of 1.0 mV/m that is derived from previous MU radar observations in summer under high solar activity conditions, we estimate polarization electric fields associated with TID are 1.2-2.0 mV/m toward the northeast. When these polarization fields are mapped down along B without attenuation, ExB plasma drift velocities of 28-47 m/s are induced in the E-region. In actual, drift velocities in the QP echoes observed with the MU radar was 42 m/s, which is very consistent with the values (28-47 m/s) estimated above. Moreover, the direction of the ExB drift estimated is almost identical to that of the plasma drift in the QP echoes observed with the MU radar. Thus, the electric fields associated with the F-region TID seem to be closely coupled to those that generate QP echoes in the E-region.