The relationship between electron density variations and gravity wavesbased on the MF radar observations

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We, National Institute of Information and Communications Technology (NICT), have three MF radars at Poker Flat, Wakkanai, and Yamagawa. These radars continuously observe wind velocity and electron density in the MLT region, which is corresponding to the ionospheric D region. The main source of the ionization is NO in this region, and the major ion above the ~80 km altitude is NO+. It is known that chemical reactions are important below 80 km altitude and that hydrated ions are major species at the bottom of the D region.

Electron density (Ne) fluctuations with temporal scales of hours and vertical phase progression can be observed in the D region [Trost, 1979; Fukuyama, 1981; Sugiyama, 1988]. Normalized amplitude Ne'/Ne is sometimes or the order of a couple of 10%, which is much larger than expected from NO variation. A model cauculation by Sugiyama et al. [1988] suggested that these variations can be caused by a gravity wave, where the ion-chemical reaction involving ion hydrates are very sensitive to temperature fluctuations as small as gravity wave-indeuced ones even of a few percent.

In the Poke Flat MF radar observation in 18-22 UT on February 28, 1999, electron density fluctuations can be found with a period of 2 hours at about 80 km altitude, where the wave phase propagated upward. Wind velocity flucutations simultaneously showed a gravity wave structure with the similar time scale and phase progression. Amplitudes of this wind fluctuation was about 8 m/s in the wave propagation direction, and about 4m/s in the perpendicular direction. The amplitude of temperature fluctuations of the gravity wave is roughly estimated to be about 3%, whch gives the Ne'/Ne amplitude of about 50% according to the model of Sugiyama et al. The qualitative agreement bweteen the estimated Ne'/Ne and the observed suggests that in the case of February 28, 1999, the observed Ne fluctuations are caused by the chemical reaction responsible for the D-region electron density which is controled by gravity wave-induced temperature perturbations.