Propagating directions of atmospheric gravity waves observed by the MF radar

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In this study, we investigate the relationship between atmospheric gravity waves and electron density fluctuations in the mesosphere and lower thermosphere, where correspond to the ionospheric D region. Using the relationship between them, the propagating directions of gravity waves can be determined. The statistical feature of gravity wave propagation using MF radars will be presented.

In the past, some electron density (Ne) observations in the ionospheric D region showed signatures of fluctuations with temporal scales of hours with clear vertical phase progressions [Trost, 1979; Fukuyama, 1981]. Amplitudes of their normalized fluctuations (Ne'/Ne) are sometimes found of the order of 20-50%, which however have been difficult to be quantitatively explained by atmospheric waves. Sugiyama [1988] proposed a theoretical model of chemical reaction involving ion hydrates, which suggested a possibility that these Ne fluctuations might be caused by gravity wave-induced small temperature variations through ion-chemical reactions. The main source of the ionization in this region is NO, and the major ion species above ˜80 km altitude is NO+. It is known that chemical reactions are important in this region and that hydrated ions are major species at the bottom of the D region. Because the dissociative recombination rate between electrons and hydrated ions is much faster than the ionization of NO, Ne is depressed below ˜80 km altitude. Sugiyama [1988] suggested that the ion-chemical reaction coefficient for the production of ion hydrate was very sensitive to temperature variations at about 80 km altitude, and gravity wave-induced small temperature variations could produce the ion hydrate fluctuations which led to Ne fluctuations. In the Poke Flat MF radar observation at 18-22 UT on February 28, 1999, Ne fluctuations can be seen with phase propagating upward at about 80 km altitude. Simultaneously, a gravity wave whose period is about 5 hours and the vertical wave length is about 14 km is found from the wind velocity data. Ne'/Ne is about 59%, and this value is quantitatively agreed with the estimated one based on Sugiyama model. The correlation coefficients between Ne and the wind velocity (zonal and meridional components) can give us some information on where, when, and how often Ne variations caused by the gravity waves are observed. High correlation coefficients are often found in the MLT region. We can determine the propagating directions of gravity waves from the relation between Ne and wind velocity variations. The statistical feature of gravity wave propagation using MF radars will be presented.