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Gravity wave analysis using Tromsoe meteor radar

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Results of atmospheric gravity wave analysis using the Nippon/Norway Tromsoe Meteor Radar (NTMR) are presented. This is the first comprehensive gravity wave analysis of this kind using a small meteor radar, and which has hitherto only been possible with a powerful system such as an MST radar.

The targets of the radar are ionized meteor trails produced at 70-110 km altitude by meteor bodies, which impinge onto Earth's atmosphere, collide with atmospheric molecules and ionize them along their paths. After its formation, the meteor trail follows the motion of the ambient neutral atmosphere, that is, winds. The trail also expands rapidly due to molecular diffusion, which is a function of atmospheric temperature and density. Wind velocity and diffusion coefficient are estimated from Doppler frequency shift and echo power decay characterizing the observed radar meteor echoes, respectively. Atmospheric temperature fluctuation due to gravity waves can be further estimated from the diffusion coefficient under an assumption called the Boussinesq approximation, which is known to be mostly valid for waves with relatively short vertical scales such as gravity waves.

NTMR has been in continuous operation since November 2003 in Tromsoe (69N). One of the major advantages of the present meteor radar system is its very high echo rate (6000-20000 echoes a day) despite the relatively small transmitting power (7.5kW peak). Horizontal winds and temperature fluctuations can be measured with time and height resolutions better than 1 hour and 2km, high enough for the study of inertial gravity waves in the mesopause region. Using a theoretical phase relation between the horizontal winds and temperature fluctuation, horizontal propagation characteristics of gravity waves are studied. The estimated propagation directions are mostly opposite to those of background mean winds below 90 km. This shows good agreement with results based on powerful radar systems that gravity waves generated in the lower atmosphere carry wave energy and momentum flux high into the mesosphere and then

release them so that they decelerate and reverse the prevailing winds in the mesosphere and, above 90km, close the mesospheric jet in summer. More detailed gravity wave analyses focusing on the relation of gravity waves with short-term background wind variations, planetary scale waves and tidal waves are to be conducted by fully utilizing the continuous data set.