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P.8 OBSERVATIONS OF GRAVITY WAVES IN THE MESOSPHERE WITH THE MU RADAR

T. Tsuda, S. Kato, T. Inoue, T. Yokoi, M. Yamamoto, S. Fukao, and T. Sato

Radio Atmospheric Science Center,
Kyoto University, Uji, Kyoto 611, Japan

We have observed wind motions at 60 - 90 km altitudes with the MU radar during daylight hours (0800 - 1600 LT) from 13 to 31 October 1986. Quasi-monochromatic gravity waves were evident on 16 of the 19 days of observations. They were characterized by typical vertical wavelength of 5 to 15 km and intrinsic periods centered at about 9 hours. The propagation direction of the gravity waves, determined by the gravity wave dispersion relation, was mostly equatorward.

The vertical wave number spectra of the horizontal components of the mesoscale wind fluctuations are explained well by saturated gravity wave theory. the frequency spectrum of vertical wind component has a slope of + 1/3, while the oblique spectra have a slope of – 5/3 up to 4 x 10^{-3} (c/s); these agree fairly well with model gravity wave spectra. Doppler shift effects on the frequency spectra are recognized at higher frequencies.

We also determined upward flux of horizontal momentum flux induced by waves with periods from 10 min to 8 hours, and we estimated westward and northward body forces of 5.1 and 4.0 m/s/day, respectively.

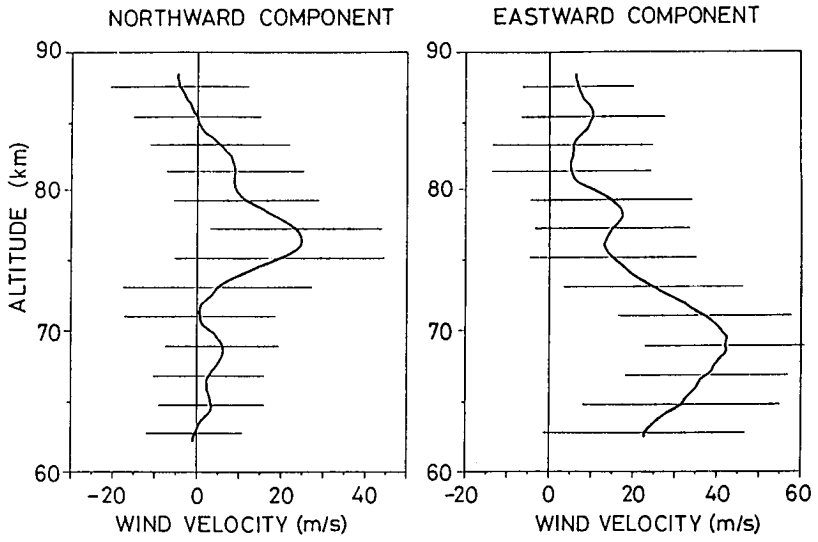

Figure 1. Mean northward (left) and eastward (right) horizontal wind velocity profiles determined from MU radar observations 13 - 31 October 1986. A running average for 2 km altitude is applied. The error bars indicate standard deviations of fluctuating wind components.

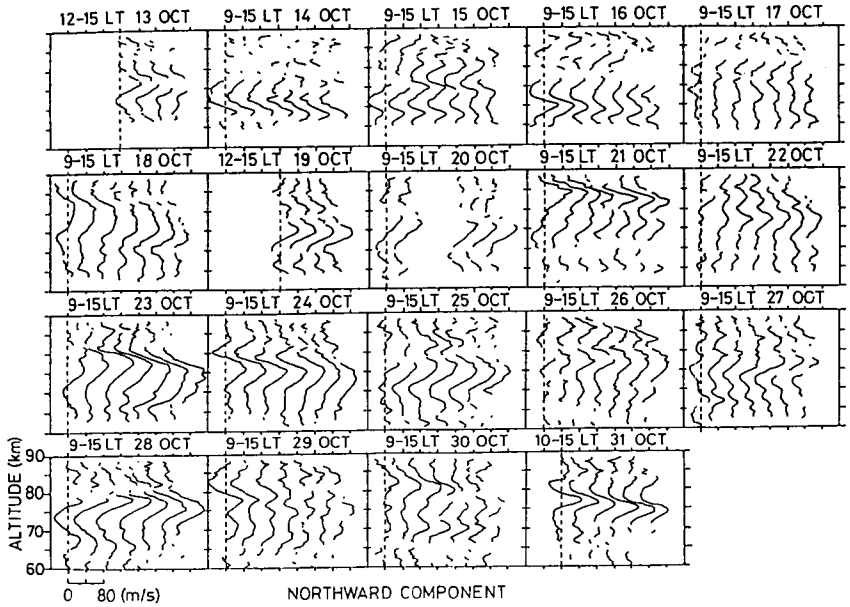

Figure 2. The northward component of wind velocity profiles. Data are averaged for 2 hours by shifting the averaging period by one hour. The dashed line indicates 0 m/s for the first profile, and other profiles are successively shifted by 40 m/s.

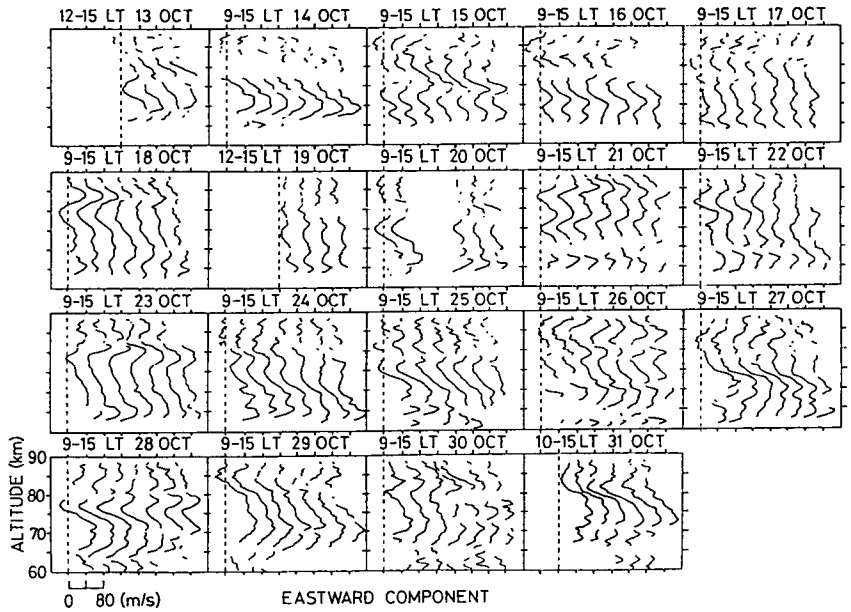

Figure 3. The same as Figure 2 except for the eastward component.

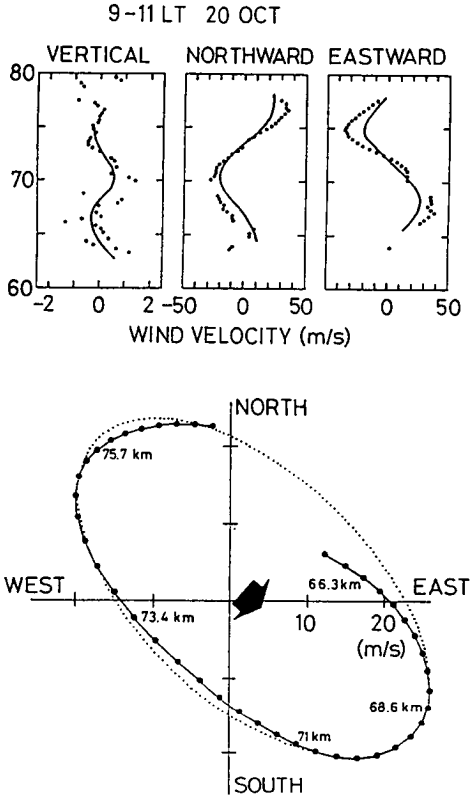

Figure 4. Vertical profiles of the three wind components observed at 9 - 11 LT on 20 October 1986 (top) and the corresponding hodograph (bottom). Dots in the top panels show original data, while the solid curves correspond to the profiles after band-pass filtering with cutoffs at 6 and 24 km. The solid curve in the bottom panel is the hodograph of the filtered wind velocities, and the dotted curve is a least-squares fit of an ellipse to the hodograph, from which the intrinsic wave period was estimated to be 10.9 hours. The thick arrow indicates the propagation direction of this wave.

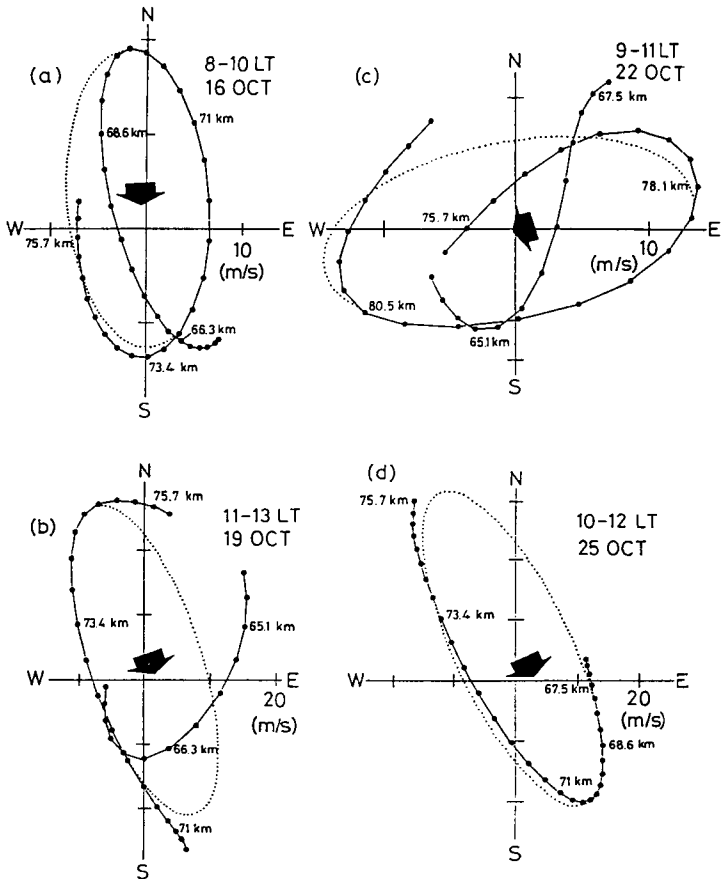

Figure 5. Four examples of the hodographs and the propagation direction.

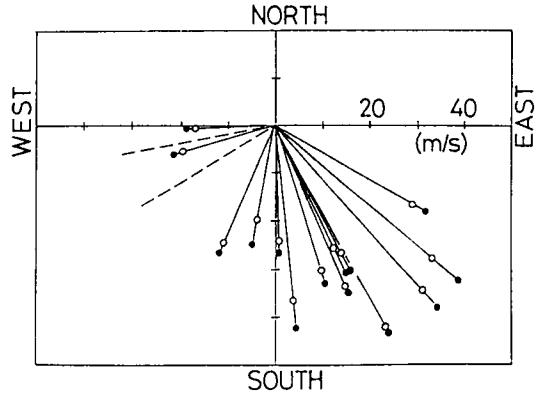

Figure 6. Distribution of horizontal phase (full circle) and group (open circle) velocities. Only the propagation direction was determined for two cases indicated by a dashed line. The mean amplitudes of the horizontal phase and group velocities were 35.3 and 31.6 m/s, respectively.

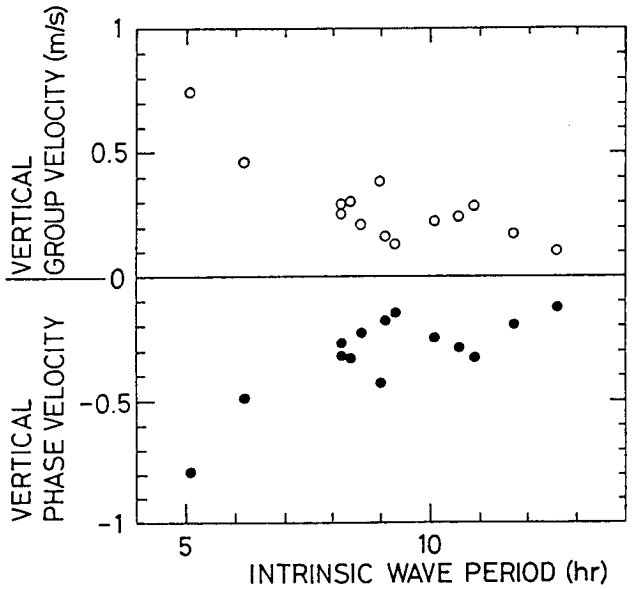

Figure 7. Distribution of the intrinsic period and vertical group (open circle) and phase (full circle) velocities. The mean intrinsic period was 8.6 hours, and the mean vertical group and phase velocities were 0.31 and – 0.28 m/s, respectively.

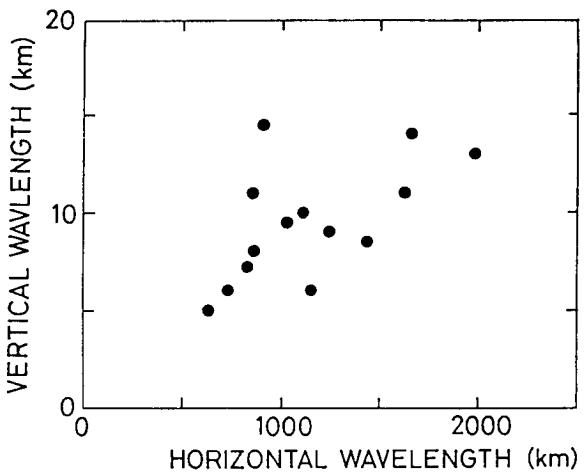

Figure 8. Distribution of the horizontal and vertical wavelength. The mean values were 1100 and 9.5 km.

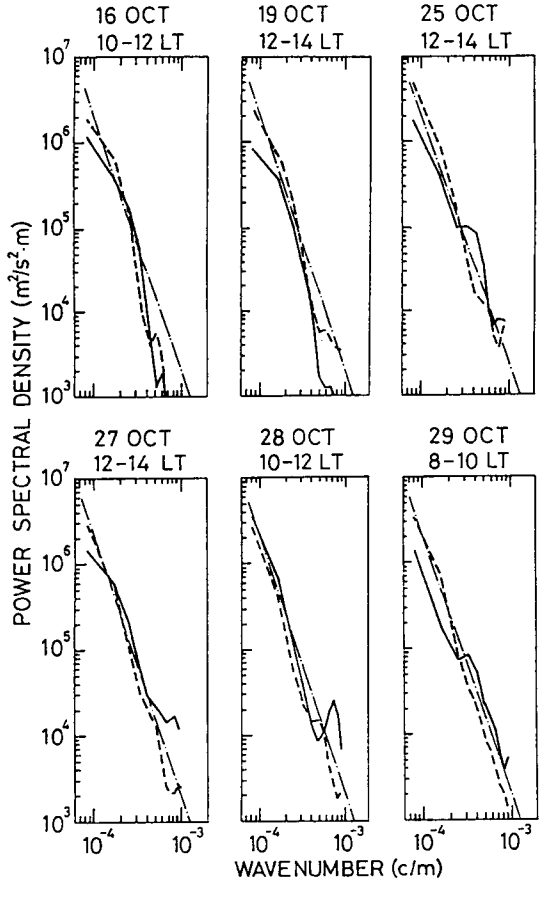

Figure 9. Vertical wave number spectra. The solid and dashed lines show the zonal and meridional components, respectively. The chained line corresponds to the model spectrum predicted by saturated gravity wave theory [Smith et al., 1987].

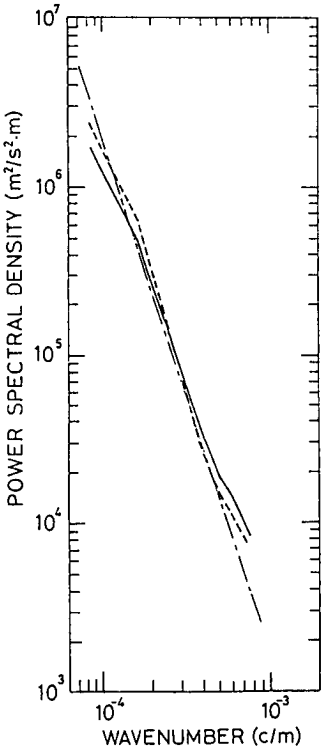

Figure 10. The same as Figure 9 except for a mean spectrum averaged for 13 - 31 October 1986.

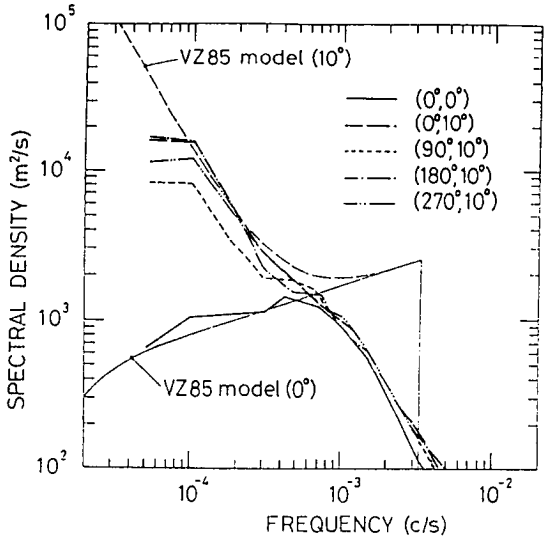

Figure 11. Frequency spectra of vertical and radial (10°) wind velocities observed on 18 - 31 October 1986 compared with a model spectrum proposed by VanZandt [1985] (indicated as VZ85).

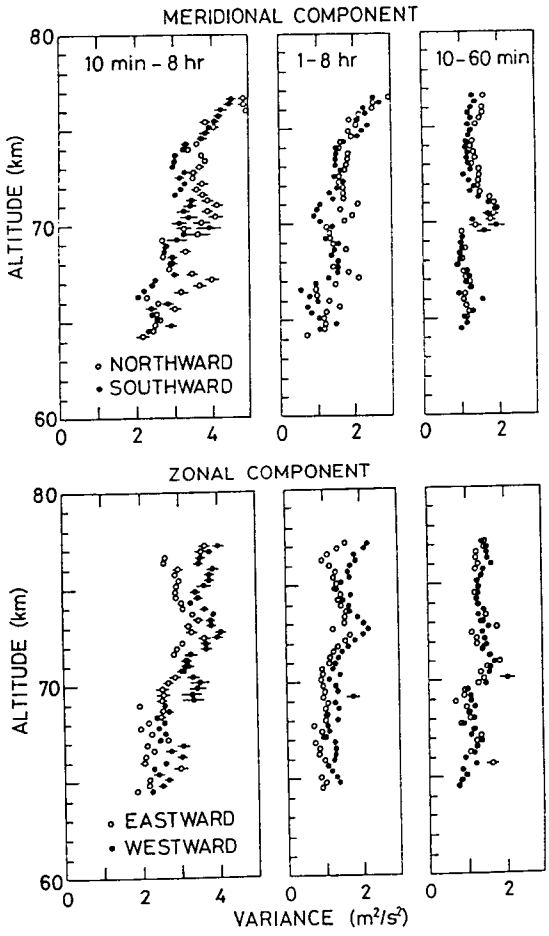

Figure 12. Variance of radial wind velocities for meridional (top) and zonal (bottom) components determined independently at each height. Left, center and right panels correspond to the variance contributed from wave components with periods from 10 min to 8 hours, 1 to 8 hours, and 10 to 60 min, respectively.

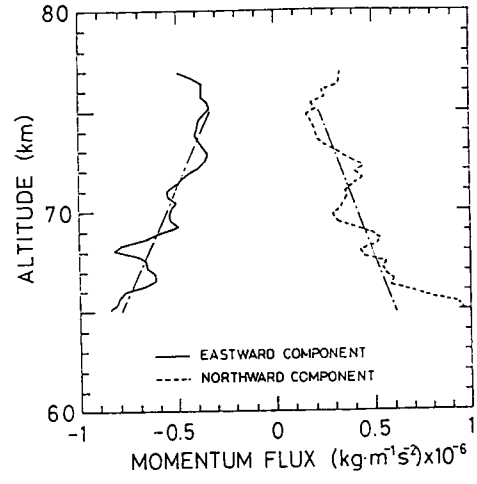

Figure 13. Vertical profiles of the eastward and northward components of momentum flux for wave periods ranging from 10 min to 8 hours. The mean accelerations at 60 - 75 km is 5.1 and 4.0 m/s/day for eastward and northward components, respectively.