

4.2B GRAVITY-WAVE SPECTRA IN THE ATMOSPHERE OBSERVED BY MST RADAR

A. O. Scheffler and C. H. Liu

Department of Electrical and Computer Engineering
University of Illinois
Urbana, IL 61801

Recently, based on data from radiosonde, Doppler navigation, hot-wire anemometer and Jimsphere balloon, VANZANDT (1982) proposed a universal spectrum of atmospheric buoyancy waves. The possible existence of such a universal spectrum clearly will have significant impact on several areas in the study of the middle atmosphere dynamics such as the parameterization of sub-grid-scale gravity waves in global circulation models; the transport of trace constituents and heat in the middle atmosphere, etc. Therefore, it is important to examine more global wind data with temporal and spatial resolutions suitable for the investigation of the wave spectra. MST radar observations offer an excellent opportunity for such studies (BALSLEY and CARTER, 1982).

In using wind velocities measured from MST radars to investigate the gravity-wave spectra, it is important to realize that radar measures the line-of-sight velocity which, in general, contains the combination of the vertical and horizontal components of the wave-associated particle velocity. Starting from a general oblique radar observation configuration, applying the dispersion relation for the gravity waves, we relate the spectrum for the observed fluctuations in the line-of-sight gravity-wave spectrum through a filter function (SCHEFFLER and LIU, 1984). The consequence of the filter function on data analysis will be discussed. Because of the good range resolution in many existing MST radars, it is possible to obtain two-dimensional spectra from observed data. The interpretation is, however, complicated by the fact that most observations were carried out in the oblique mode. Transformation formulae will be presented to relate the observed two-dimensional k_z/ω spectra to the $k_z-\omega$ spectra, where k_z' is the wave number along the radar beam direction while k_z is the wave number along the vertical direction. Some observational results are presented in Figures 1, 2, 3, and 4.

REFERENCES

- Balsley, B. B. and D. A. Carter (1982), The spectrum of atmospheric velocity fluctuations at 8 km and 86 km, Geophys. Res. Lett., 9, 465-468.
Scheffler, A. O. and C. H. Liu (1984), Observations of gravity wave spectra in the atmosphere by MST radar, submitted to Geophys. Res. Lett.
VanZandt, T. E. (1982), A universal spectrum of buoyancy waves in the atmosphere, Geophys. Res. Lett., 9, 575-578.

OBSERVED RADIAL VELOCITY POWER SPECTRUM
 1981 MAR 20 18:40 TO MAR 22 7:59 AST
 AZ = 90.00, ZA = 10.00, F = 430.00, TCDH = 1: 0
 FROM 7.31 TO 24.00 KM AT 150.00M RES. N = 114
 NOMISS = 113, NPTS = 120, NINCOH = 29, NAV = 126

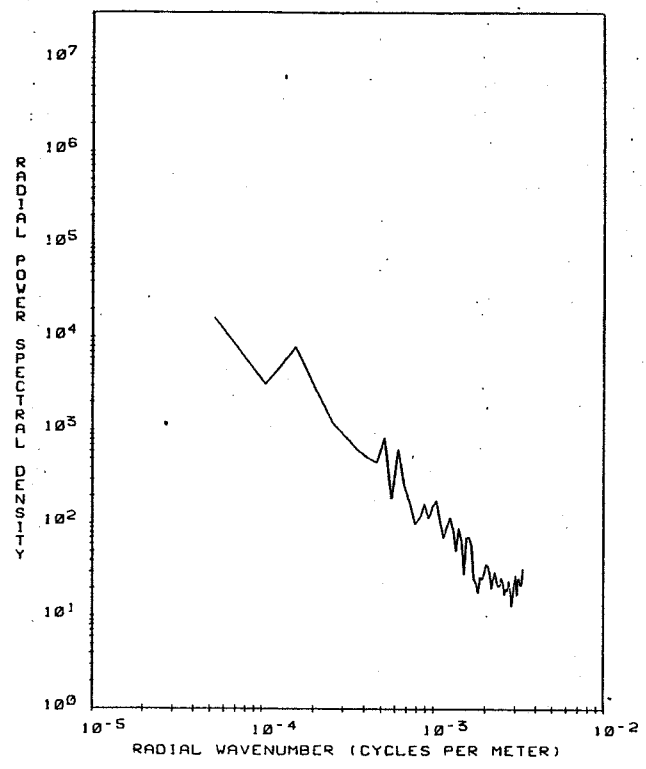


Figure 1. Wind fluctuation spectra observed by a radar operating obliquely assuming the wave-associated spectrum behaves as $f^{-5/3}$. The solid curve corresponds to $\theta_B = 15^\circ$. The dotted curve corresponds to $\theta_B = 5^\circ$.

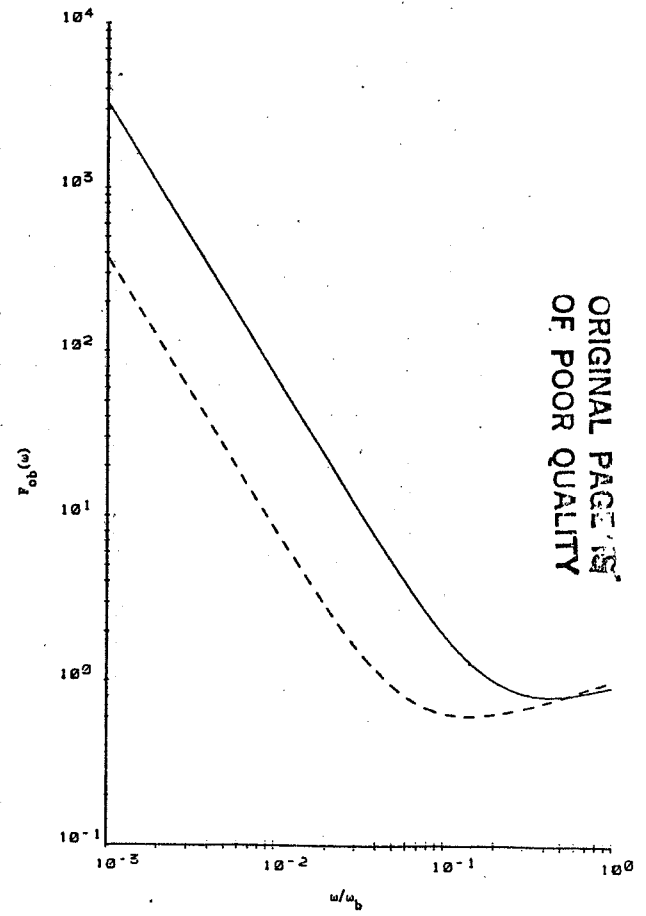


Figure 2. Observed wind fluctuation inverse wavelength spectrum by oblique radar with $\theta_B = 10^\circ$. Spectrum is the average of 29 spectra computed from velocity profiles that were coherently integrated for a period of 1 hour. Total data covered 35 hours.

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OBSERVED RADIAL VELOCITY POWER SPECTRUM
 1981 MAR 20 18:40 TO MAR 22 7:59 AST
 AZ = 90.00, ZA = 10.00, F = 430.00, TCOH = 0:10
 FROM 7.51 TO 24.00 KM AT 150.00M RES. N = 114
 NOMISS = 113, NPTS = 128, NINCOH = 178, NAV = 1277

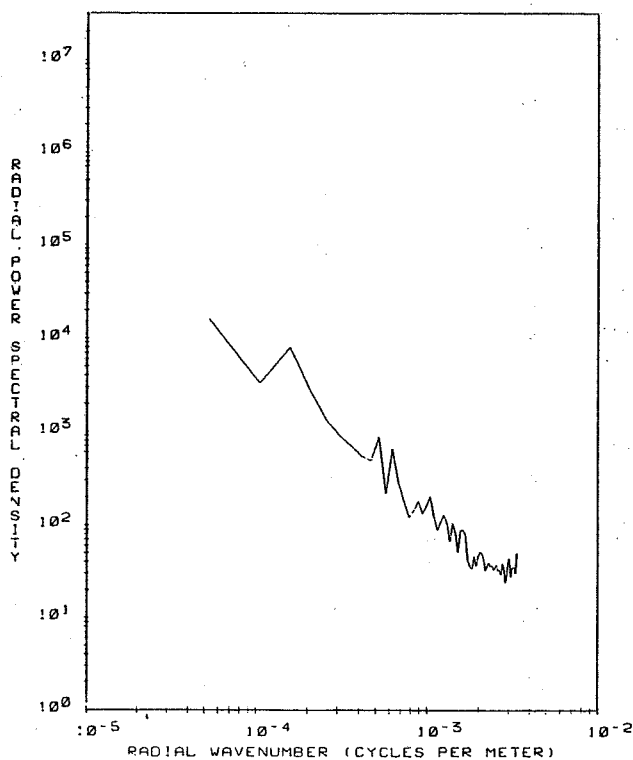


Figure 3. Observed wind fluctuation inverse wavelength spectrum for the same radar data as in Figure 2, except the spectrum is the average of 178 spectra computed from velocity profiles that were coherently integrated for 10 min periods.

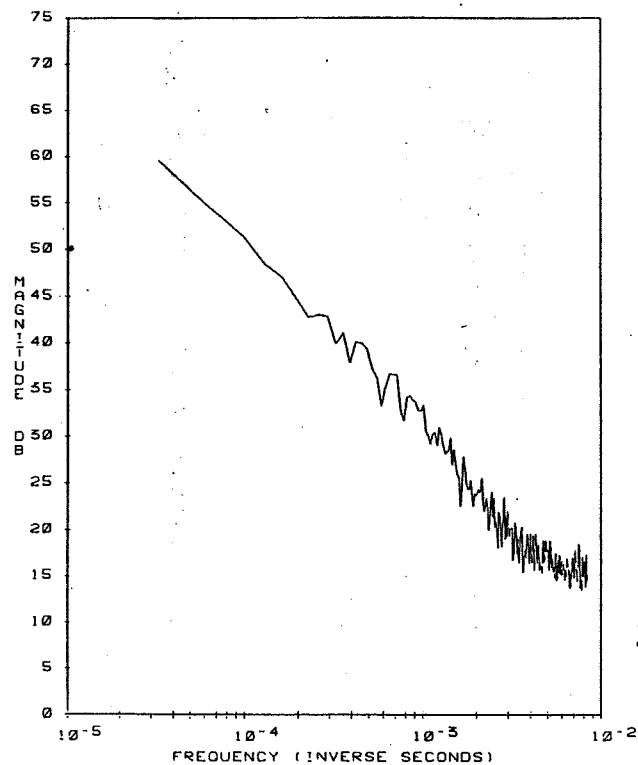


Figure 4. Observed wind fluctuation frequency spectrum by oblique radar with $\theta_B = 10^\circ$. Spectrum is the average over 6 range heights. The spectra at each range height is the average of 4 consecutive spectra in time.

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