D39

N85-32505

4.3A USE OF THE VAD TECHNIQUE AND MEASUREMENTS OF MOMENTUM FLUX IN THE STRATOSPHERE AT ARECIBO

C. R. Cornish and M. F. Larsen

School of Electrical Engineering
Cornell University
Ithaca, NY 14853

The Arecibo 430-MHz radar was used in the velocity-azimuth display (VAD) mode to obtain radial velocity measurements at 16 azimuth directions from which the three-dimensional wind field and momentum flux can be calculated. The radar was operated on a nearly continuous basis for a seven-day period in May of 1982 and the elapsed time between start and finish of a VAD scan was approximately 35 minutes. Radial velocities were measured in the upper troposphere and lower stratosphere (6-24 km) with at height resolution of 150 meters at a zenith angle of 15 deg.

Vertical and horizontal velocities are calculated from the sums and differences, respectively, of radial velocity pairs, i.e., at azimuth directions AZ and AZ + 180 degrees. Momentum flux at a particular azimuth is calculated by taking the difference between the square of radial velocities at AZ and AZ + 180 degrees in a manner first described by VINCENT and REID (1983). It should be noted that measurements of radial velocity pairs are not simultaneous but are time delayed by approximately 15-25 minutes. This period, the time required to rotate the antenna feed and take measurements at AZ and AZ + 180°, effectively limits sampling of velocities and momentum fluxes to longer period gravity waves and planetary waves. In the following presentation only the radial velocities in the principal (zonal and meridional) directions have been used. Future analysis will utilize the full 16-direction VAD from which the velocities and momentum fluxes are calculated by a least squares fit method.

Using the aforementioned technique velocities and momentum fluxes have been calculated and spectrally analyzed. Shown in Figures 1, 2 and 3 are the time series over the seven-day period and calculated spectra of the horizontal (U = zonal, V = meridional) velocities, vertical velocity (W = vertical), and momentum fluxes (Z = zonal, M = meridional), respectively, at an altitude of 14.49 km. Because of the gapped and unevenly spaced nature of the velocity time series, a DFT routine was used to calculate the spectra. To obtain an estimate of the error introduced by the uneven spacing, a sinusoidal signal composed of three sine waves with periods of 38.1, 70 and 130 hours was spectrally analyzed at the same uneven time spacing and is displayed in Figures 1-3 by the dotted curve labeled "F". The 38.1-hour period corresponds to the inertial period at Arecibo (18 deg , 21 min N). The two longer periods correspond to oscillations identified in the zonal and meridional velocities, most likely planetary wave modes. The effect of the uneven spacing is to introduce significant errors into the high frequencies (periods < 20 hours), while lower frequencies are credible.

Examination of the spectra in Figure 3 reveals that momentum flux can be identified with certain wave modes. In particular, the zonal momentum flux is significant at the inertial period with noticeable contributions at longer planetary wave periods. So far, only relative amplitudes of the spectral components of the waves have been determined; the uneven weighting of the gapped data series makes absolute values difficult to estimate until the weighting function is determined and deconvolved.

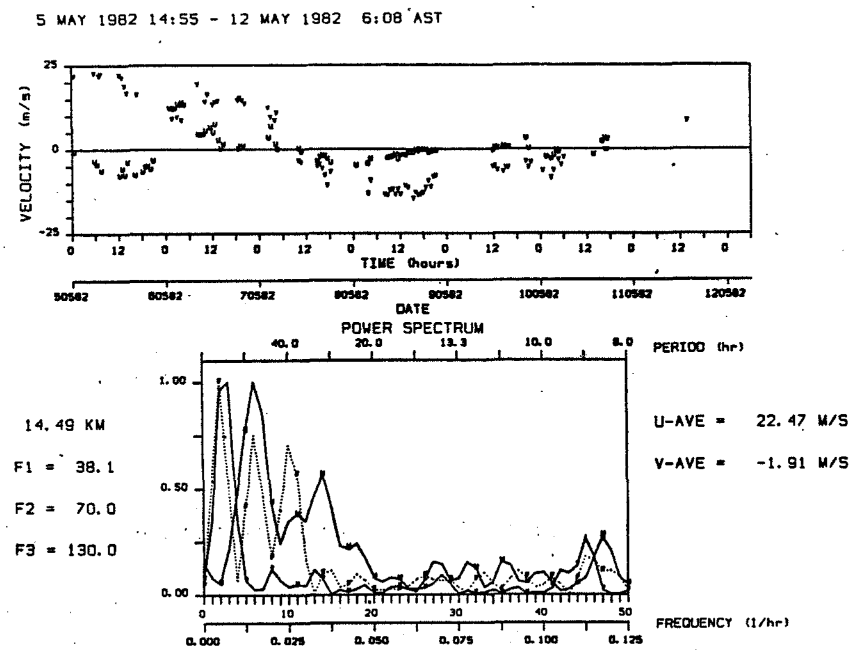

Figure 1. Zonal (U) and meridional (V) velocity time series and spectra at 14.49 km.

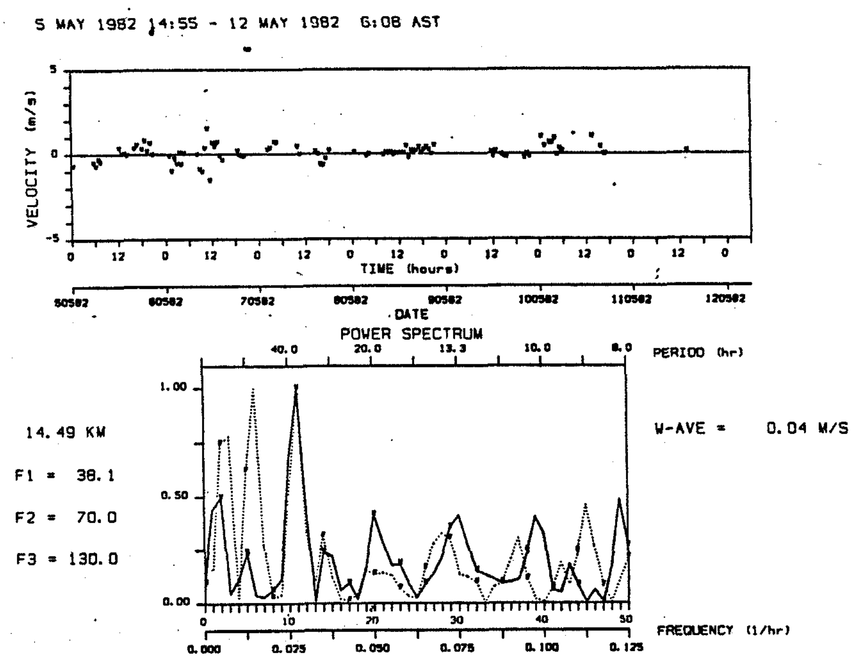

Figure 2. Vertical velocity (W) time series and spectra at 14.49 km.

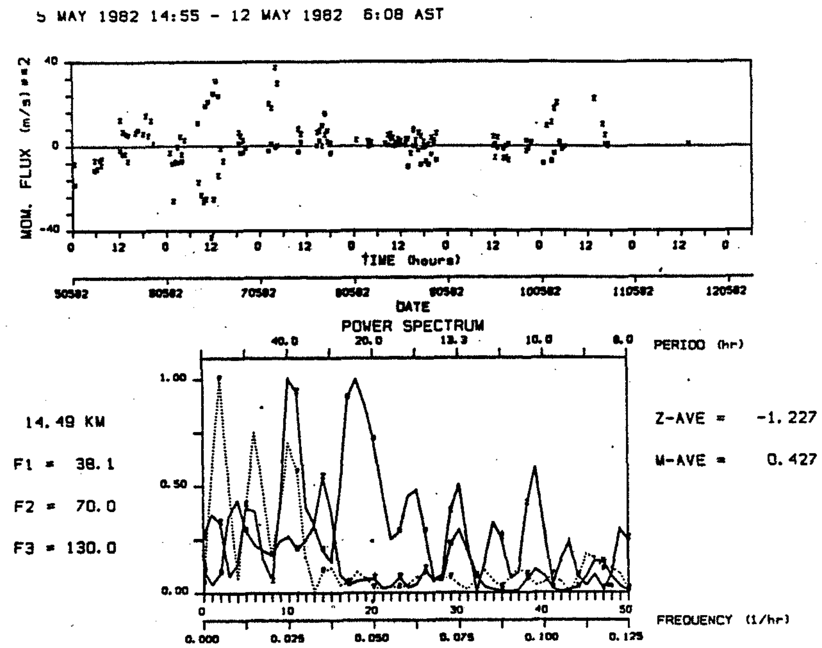

Figure 3. Zonal (Z) and meridional (M) momentum fluxes at 14.49 km.

Ongoing analysis of this data set includes determination of the various wave modes by means of identification of period, polarization of the horizontal wind, and vertical and horizontal wavelengths. Estimates of the magnitude of momentum flux at these longer periods and comparison to momentum fluxes at shorter gravity wave periods obtained after high pass filtering will provide insight into the relative contributions by the various modes. Studies of the variation of momentum flux with height at various periods will demonstrate which modes are depositing momentum into the stratosphere and which are relatively transparent to the stratosphere.

REFERENCE

Vincent, R. A. and I. M. Reid (1983), HF Doppler measurements of mesospheric gravity wave momentum fluxes, J. Atmos. Sci., 40, 1321-1333.