# 2.1F MESOSPHERIC SCATTER AND ITS MICROSTRUCTURE

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The difference in character between mesospheric returns from about 70 and about 80 km has been remarked on by a number of workers. This note gives some further examples. Figure 1 (GIBBS and BOWHILL, 1983) shows simultaneous fading curves from 69 and 82.5 km altitude, and Figure 2 shows their Fourier spectra. The 69-km echo is characterized by a single return with about .1 Hz width, while the 82.5 km return extends over more than 3 Hz bandwidth; this difference is also perceptible, but to a lesser degree, on the fading curves. The conclusion seems inescapable that internal random velocities of a few m/s are present within the scattering volume for the 82.5-km echo. The most likely source for these rather large velocities is convective instability arising from deformations of the temperature profile by breaking gravity waves.

The distinction between the two types of scatter at these altitudes probably accounts for the behavior with frequency of the nighttime fading period at low and very low frequencies. BOWHILL (1957) found that the fading period of D-region reflections at night was constant at about 7 min from 16 to 43 kHz, but that at frequencies of 70 kHz and above, the fading period decreased in such a way as to indicate the presence of irregularities smaller than about 1 km in size. This suggests that frequencies of 48 kHz and below were reflected primarily from the region below 80 km where the narrow spectral irregularities of Figure 1 dominate.

Figure 3 (GIBBS and BOWHILL, 1983) shows another interesting type of behavior often seen in the spectra at the lower altitudes. The upper and lower portions of the diagram are spectra at altitudes separated by only 1.5 km compared with the 3 km vertical resolution corresponding to the 20-μsec transmitter pulse width. Two well-defined echoes are seen, each appearing at the same frequency on both plots with the different relative amplitudes. These different amplitudes are ascribed to the presence of two distinct Fresnel-type scatter regions within the scattering volume. Knowing the pulse shape, it is possible to determine the altitude at which those echoes occur, and the Doppler frequency associated with each.

Figure 4 (GIBBS and BOWHILL, 1983) shows an example of this kind of analysis; the hollow circles indicate velocities toward the radar, shaded circles indicate velocities away from it, and the diameters of the circles are proportional to the magnitudes of the velocities. This kind of plot gives the possibility of determining the location of individual scatterers with much higher precision (better than 100 m) than is normally possible with the pulse width used.

## ACKNOWLEDGMENTS

The work described was supported in part by the National Aeronautics and Space Administration under grant NSG 7506 and in part by the National Science Foundation under grant ATM 81-20371.

## REFERENCES

Bowhill, S. A. (1957), Ionospheric irregularities causing random fading of very low frequencies, J. Atmos. Terr. Phys., 11, 91.

**Gibbs, K. P. and S. A. Bowhill (1983), An investigation of turbulent scatter from the mesosphere as observed by coherent-scatter radar, Aeron. Rep. 110, Aeron. Lab., Univ. Ill., Urbana-Champaign.**

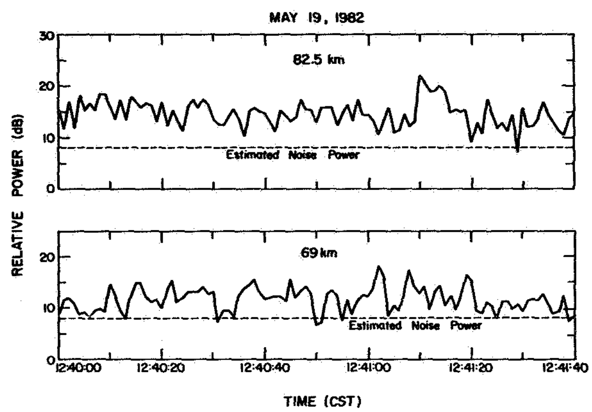


Figure 1. Power data at 1-second intervals on May 19, 1982.

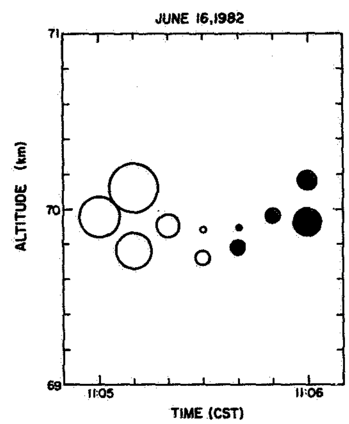


Figure 4. Scattering on June 16, 1982.

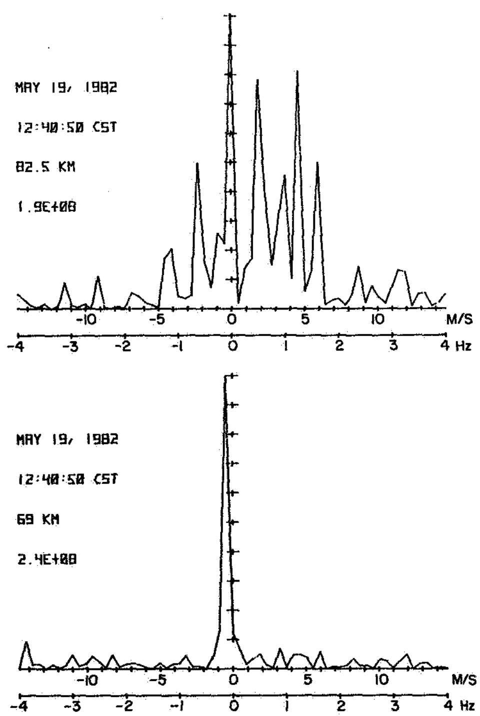


Figure 2. Spectral variation with altitude on May 19, 1982.

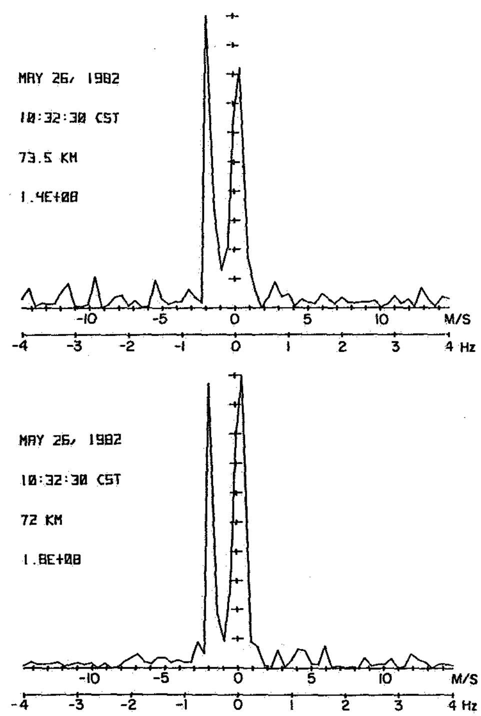


Figure 3. Comparison of spectra at adjacent altitudes.