

9.15A MILLSTONE HILL RADAR: CAPABILITIES FOR S/T OBSERVATIONS

G. B. Loriot
Haystack Observatory
Westford, MA

During the past several years, the 440-MHz radar at Millstone Hill has been modified to detect coherent echoes from clear-air turbulence in the stratosphere/troposphere (S/T) over the altitude range 4-25 km. Two distinct modes of data acquisition have been developed, and data reduction programs have been completed for one of these modes. This mode (I-mode) transmits a 10 microsec (1.5 km) pulse on the fully steerable antenna. Typically, the antenna is set at a low elevation angle (e.g., 15 deg.) to reduce the altitude resolution to ~1 km., and power spectra are collected at some 40 range gates. The antenna may be scanned in azimuth to obtain the total wind vector, held fixed to monitor wave motion, or scanned in elevation to monitor the horizontal extent or the turbulent activity. This steerability gives Millstone a flexible system to focus on localized events, such as lee waves or convective storms. An additional advantage at low elevations is the relatively large Doppler shift of the signal, since the LOS velocity contains a large component of the horizontal velocity. This shift separates the turbulence signal sufficiently far from the ground clutter to allow the spectral moments to be readily inferred. Some 500 hours of S/T I-mode data have been reduced to geophysical parameters, and reside on a data base at Millstone Hill.

The second mode of operation (M-mode) is designed for a fine range resolution (less than 500 m) with adequate signal-to-noise ratio to probe into the stratosphere (up to 25 km altitude). A coded pulse waveform was developed, using complementary codes, and a range resolution of 300 m was achieved. In order to obtain a comparable altitude resolution with no degradation from beam width, the antenna was operated at high elevation angles (75-80 deg). Echoes were obtained up to 23-25 km altitude, but the Doppler shifts were very small, often overlapping the fading ground clutter. Programs to reduce these data will probably require parameterized fitting routines, but such routines have not yet been developed for M-mode data.

The S/T program at Millstone Hill has been dormant since December 1983. All processing programs have been retained, including an option in I-mode to operate with a 2 microsec pulse (with a large reduction in maximum range). The Millstone S/T radar is best suited for focused experiments using the steerable antenna at low elevation, with a 1.5 or 0.3 km range resolution. For example, the radar could monitor the dynamics of storms, or measure turbulence in lee waves above nearby mountains. Plans are being considered for such experiments in the future.

Some operating characteristics of Millstone Hill I-mode operations are given below. Values in parentheses will be valid as of 12/84, due to scheduled transmitter upgrades.

Transmitter frequency	440 MHz
RF pulse width	10 μ s or 2 μ s
Pulse repetition frequency	500 Hz (1000 Hz 12/84)
Peak power	1.4 MW (2.5 MW 12/84)
System temperature	150 K
Antenna	150 ft., fully steerable
Minimum range	10 km (3 km 12/84)
Maximum altitude (10 μ s pulse)	21 km (25 km 12/84)