5.4A CAPABILITIES AND LIMITATIONS OF EXISTING MST RADARS: COLORADO WIND PROFILERS

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The Wave Propagation Laboratory (WPL) is developing a ground-based remote-sensing system called PROFILER (HOGG et al., 1983) to measure tropospheric parameters currently measured in operational meteorology by radiosondes. The prototype PROFILER uses two radars for wind sounding: a 6-m radar located at Platteville, Colorado, and a 33-cm radar located at Denver's Stapleton International Airport. The Platteville radar was originally developed by NOAA's Aeronomy Laboratory (AL) and is being operated jointly by WPL and AL. In addition, a network of three 6-m wind-profiling radars is being installed in Colorado, and a fourth site is planned. Figure 1 shows the location of the five radars. Their characteristics and limitations are described in this paper.

1. The 6-m radar at Platteville -- This radar is described by ECKLUND et al. (1979). It has been operating continuously and unattended since about mid-1981, except for brief periods of downtime caused by computer problems. Since January 1982 data have been tape-recorded routinely.

The radar alternates between two modes of operation: one mode is for measuring vertical profiles of the horizontal wind, and the other is optimized for zenith-pointing observations. Each mode is used every 5 min. The data-processing scheme is described in another paper (STRAUCH, 1983). Data are transmitted by telephone to the central PROFILER computer in Denver as well as recorded on magnetic tape at Platteville. There are three antennas, transmitters, and receivers so data are obtained simultaneously in the three viewing directions. Table 1 summarizes the radar characteristics and operating parameters.

The major limitations are caused by the data system. A minicomputer performs all the time-domain integration in software, and this restricts the maximum pulse repetition frequency, the minimum spacing of range gates, and the number of range gates allowed. As a result the radar is operated with coarse range resolution and relatively poor minimum height coverage ($\sim$2 km above ground). The data system also limits sensitivity by restricting the duty cycle. There are 13 range cells for monitoring winds in the troposphere and 10 range cells for monitoring mesospheric echoes. Present plans are to replace the data system with a more versatile system that includes a preprocessor (used with the four radars described below) and to replace the two off-zenith antennas. A minicomputer will still be used for data processing (including spectral analysis), so the number of range cells would be restricted to about 40 to keep the data-processing time small compared with the acquisition time. Range resolution would then be limited by the bandwidth authorized (400 kHz).

2. The 33-cm radar at Denver -- This radar is used only for tropospheric wind measurements. It has a 10-m offset paraboloidal reflector antenna with offset feeds to generate the same three beam-pointing positions as the radar at Platteville (EARNSHAW et al., 1982). For this radar the viewing directions are not observed simulatenously; a single transmitter and receiver are switched to the desired direction. The transmitter is solid state and is capable of up to 25% duty cycle. The T/R function is accomplished by a circulator with a diode limiter providing additional protection for the low-noise r-f preamplifier. The radar operates in three resolution modes: a 1-μs pulse width for high

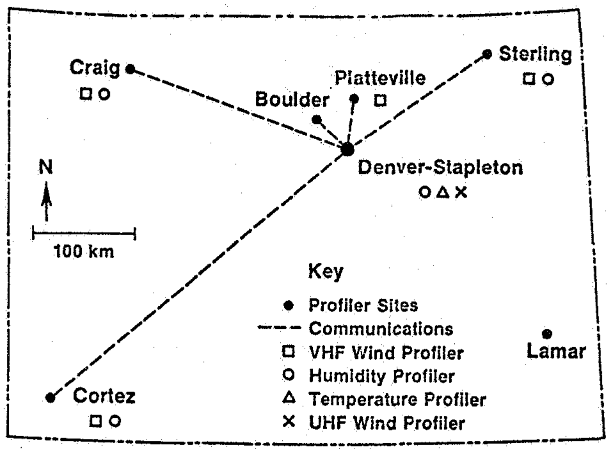

Figure 1. Colorado Profiler Network. A UHF (915 MHz) radar is located at Denver's Stapleton International Airport; VHF (50 MHz) radars are at Craig, Sterling, Cortez, and Platteville. Lamar is a possible future site for a VHF radar.

Table 1. Platteville radar characteristics and operating parameters

Radar		
Frequency	49.92 mHz	
Authorized bandwidth	0.4 mHz	
Peak power	27 kW (maximum ≈60 kW)	
Average power	180 W (maximum ≈1 kW)	
Pulse width	16 μs	
Pulse repetition period	2400 μs	
Antenna aperture	100 m x 100 m	
Antenna pointing	zenith, 15° off-zenith to north and east (3 antennas)	
Antenna type	fixed phased array of colinear-coaxial dipoles	
Two-way beamwidth	2.5°	
Data Processing	**Vertical Mode**	**Horizontal-Wind Mode**
Time domain averaging	256 pulses	32 pulses
Spectral averaging	2	16
Maximum radial velocity	$\pm$2.44 m/s	$\pm$19.55 m/s
Spectral resolution (64 points)	0.076 m/s	0.61 m/s
Tropospheric sampling		
1st height	1.85 km	2.5 km
Height spacing	1.5 km	1.45 km
Number of heights	13	13
Mesospheric sampling		
1st height	67.5	66 km
Height spacing	3.6 km	3.48 km
Number of heights	10	10

resolution in the lowest 2 km, a 4-μs pulse width to measure winds to about 7-km altitude, and a 16-μs pulse to measure winds to the highest altitude possible. Time-domain integration is performed in a laboratory-built preprocessor that also operates the radar under computer control. The main PROFILER computer performs the data processing; it has an array processor so that spectral-processing overhead time is small compared with data acquisition time. (The rate at which power spectra must be calculated is much higher for a 33-cm radar than for a 6-m radar.) Radar characteristics and the anticipated operating parameters are shown in Table 2. Radar hardware is complete, and tests have been made to ensure that the system will operate properly. Software for automated operation is not complete. Limitations of this radar will not be known until it has been in continuous operation for some time. Operation should start early in 1983. It is expected that a major limitation will be that the maximum height coverage will not extend to the tropopause routinely. Future plans are to add pulse coding so that longer pulses can be used to take advantage of the high duty cycle available.

3. The 6-m radar network — These three radars are similar to the Platteville, radar, but they will not have zenith-pointing antennas. The antenna apertures are 1/4 that of the Platteville antennas. These radars are designed for tropospheric wind measurements. They observe the north and east wind components simultaneously, perform all required data analysis at the radar site, and send hourly wind profiles to Denver by telephone. They use the same preprocessor and radar-computer interface as the 33-cm radar. Two resolution

Table 2. Stapleton radar characteristics and operating parameters

Radar			
Frequency	915 mHz		
Maximum bandwidth	2 mHz		
Peak power	5.6 kW		
Duty cycle	≤25%		
Antenna aperture	≈10 m x 10 m		
Antenna pointing	zenith, 15° off-zenith to north and east		
Antenna type	offset paraboloidal reflector with offset horn feeds		
Two-way beam width	1.7°		
System noise temperature	240 K		
Data Processing	1	2	3
Pulse width	1 μs	3 μs	9 μs
Pulse repetition period	50 μs	64 μs	110 μs
Average power	110 W	260 W	450 W
Time domain averaging	136 pulses	80 pulses	46 pulses
Spectral averaging	8 spectra	32 spectra	32 spectra
Maximum radial velocity	———	12.02 m/s	———
Spectral resolution (64 points)	———	0.375 m/s	———
Height sampling			
1st height	1.06 km	1.64 km	2.7 km
Height spacing	100 m	290 m	870 m
Number of heights	24	24	18

Table 3. Sterling radar characteristics and operating parameters

Radar				
Frequency	49.8 mHz			
Authorized bandwidth	0.4 mHz			
Peak power	30 kW (maximum ≈60 kW)			
Average power	400 W (maximum ≈1 kW)			
Pulse width	4, 16 μs (3, 9)			
Pulse repetition period	300, 1200 μs (225, 675)			
Antenna aperture	50 m x 50 m			
Antenna pointing	15° off-zenith to north and east (2 antennas)			
Antenna type	fixed phased array of colinear-coaxial dipoles			
Two-way beam width	5°			
Data Processing	4-μs pulse	(3)	16-μs pulse	(9)
Time domain averaging	320 pulses	(426)	64 pulses	(113)
Spectral averages	8		16	
Maximum radial velocity	±15.7 m/s		±19.6 m/s	
Spectral resolution (64 points)	0.49 m/s		0.31 m/s	
Height sampling				
1st height	1.4 km	(0.6)	3.0 km	(3.0)
Height spacing	290 m	(290)	1.160 km	(.870)
Number of heights	20	(22)	14	(18)

( ) -- new values as of 5/1/83.

modes are used: a 4-μs pulse width for low and midlevels and a 16-μs pulse width to extend the height coverage as high as possible. Table 3 lists the characteristics and anticipated operating parameters. These radars are to be installed by January 1983 and in operation in early 1983.

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