General Description of the Dugway FM/CW Boundary Layer Radar
7 February 2012

The FMCW radar is a portable system consisting of two trailers, one for the data processing and radio frequency electronics equipment, and the other for the two antennas. Two identical 10-foot-diameter parabolic antennas, one for transmitting and one for receiving, are positioned on a fully steerable mount. The antennas are typically directed vertically (approximately 4 degrees of vertical to shed rain or snowmelt) for high-resolution backscatter'profiling. The radar uses a phased-locked-loop digital frequency synthesizer to obtain a highly linear, very low noise 200-MHz bandwidth sawtooth 50-ms sweep centered at 2.9 GHz. The final amplifier is a solid state amplifier with a continuous output of approximately 250 W. The received signal is homodyned, amplified and filtered, and then sampled with a 16-bit analog-to-digital converter. The digitized data is then sent to an array processor for integration and fast Fourier transform (FFT). A true real-time computer controls the hardware and data acquisition cycle as well as the data flow. High resolution color images are created and stored on the local hard drive. Live visualization of the data is shown as a continuous time-height display of the relative amplitude of the returned signal.

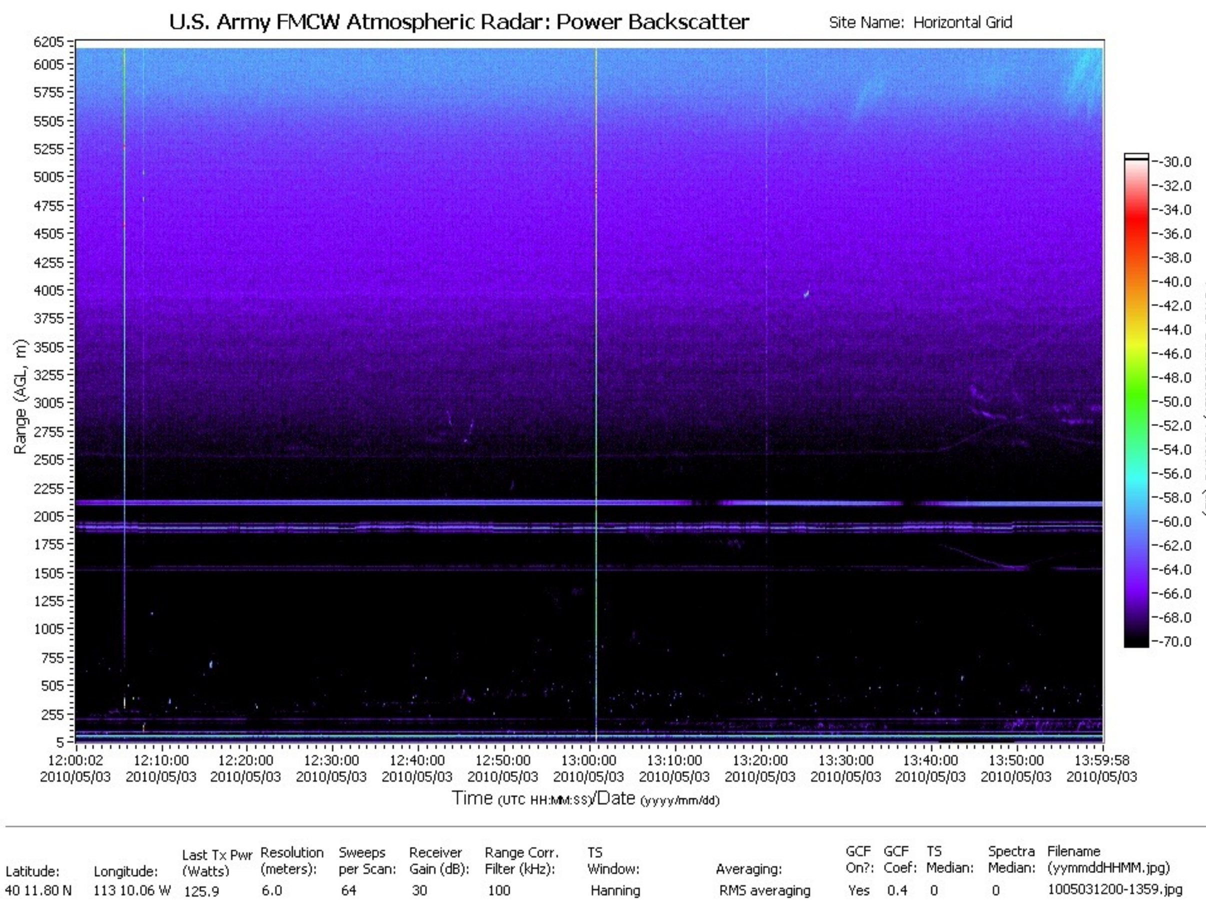
Dugway FMCW Radar Specifications

Characteristic	Value
Operating frequency	2.9 GHz ± 100 MHz
Spatial resolution	Typically 4-6 m but varies with height coverage
Height coverage	Typically 4-6 km
Temporal resolution	6 to 12 s per profile
Number of range gates	1024
Antenna type	Bistatic Parabolic
Antenna 3-dB beam width	2.7 Degrees
Transmitter type	Solid State
Transmitter power	250 W Continuous
Minimum detectable signal	Less than -165 dBm

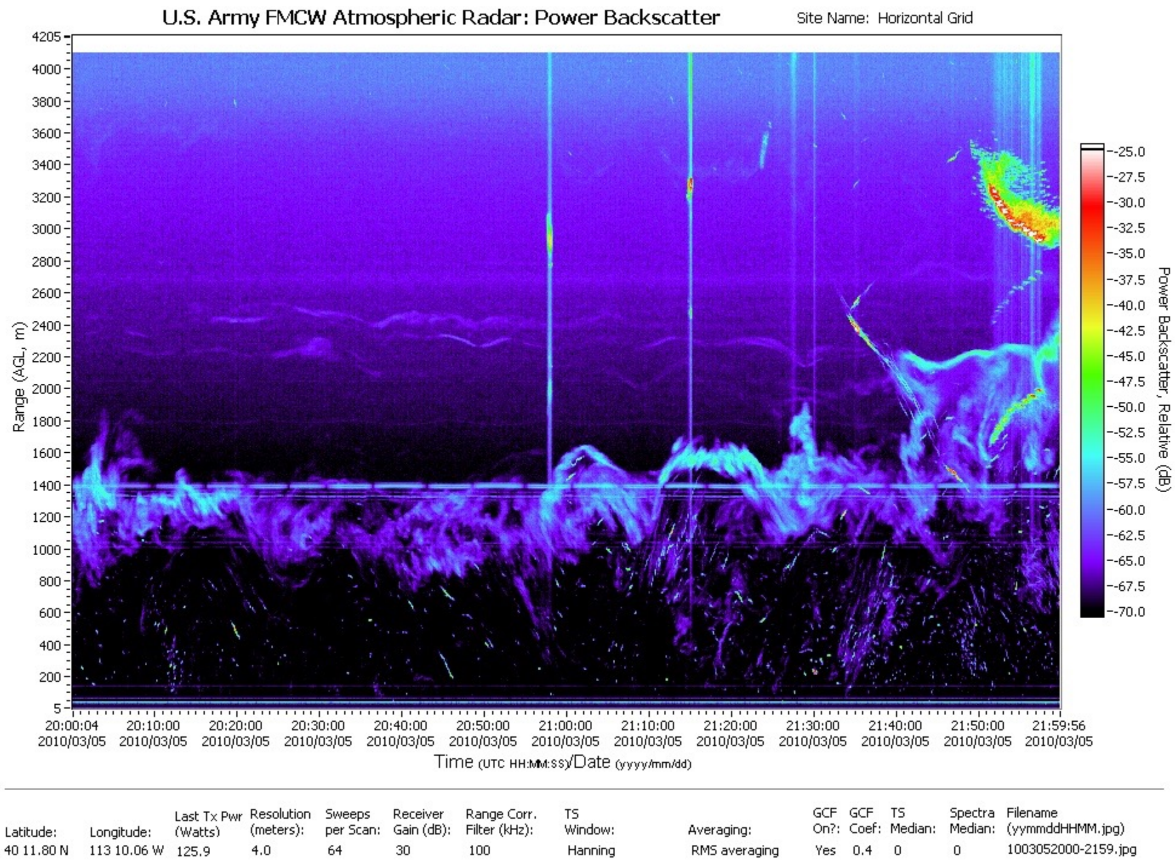
Examples of FM/CW Radar Data Imagery

Results shown were taken from the FMCW radar with the system set up for vertical sensing of the boundary layer at Horizontal Grid. Several types of atmospheric features are displayed and discussed: wave activity and its influence on boundary layer dynamics, fine structure of weather fronts, morphology of the convective boundary layer, and the morphology of a weak winter storm.

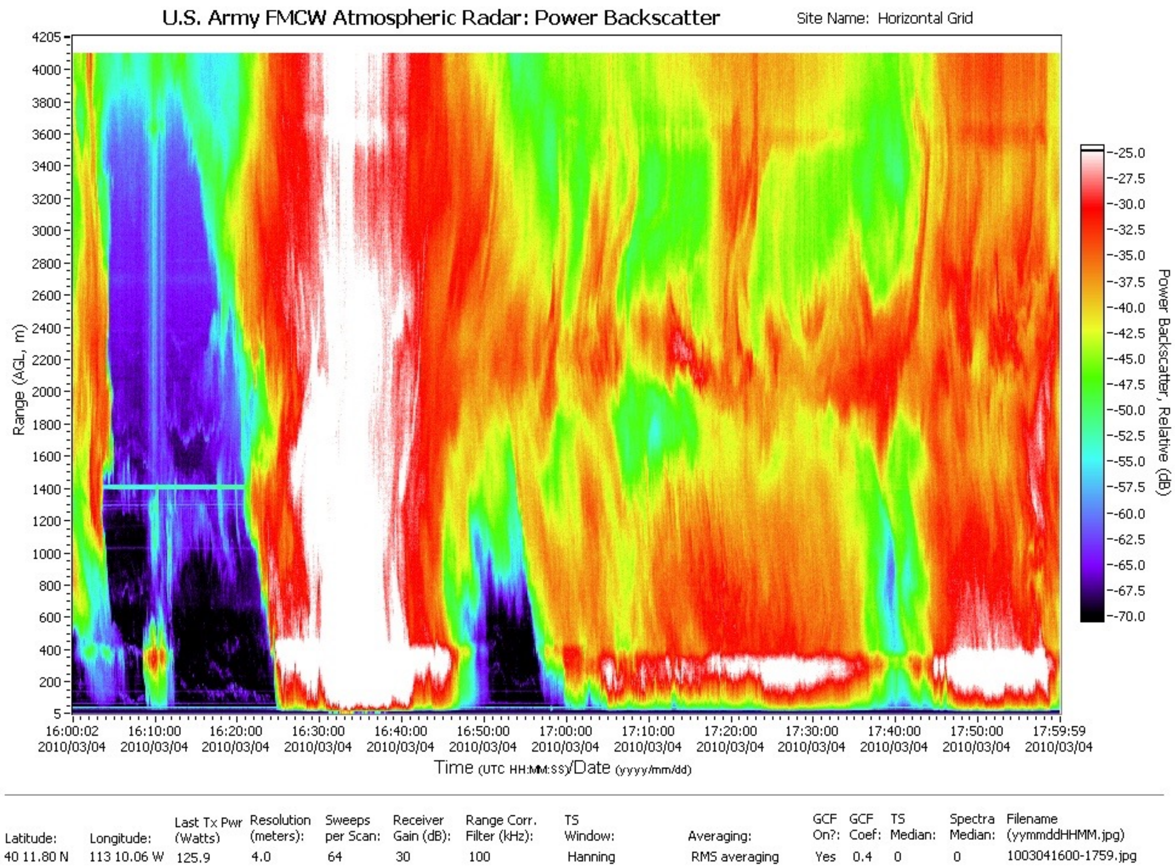
In each of these images, the y-axis represents altitude above ground level in meters and the x-axis represents time. A two hour time period is shown in each of these figures. The color scale represents the relative received backscatter power. The color assignments in the figures show a color range in a "rainbow" fashion from black and darker blues representing a very weak relative backscatter power return through greens, yellows, and finally red, with white representing the highest relative return power.



The first image is of the time period (12 UTC to 14 UTC) just prior to sunrise (1404 UTC) on 3 March 2010. The image shows a very quiet atmosphere as would be expected under quiescent synoptic conditions with a stable atmosphere. There are very few scattering elements in this figure. However, the start of the development of the daytime boundary layer can be seen after 1330Z. A weak signature of a residual boundary can be seen near 3 km from 1340Z to 1400Z.



This image depicts the boundary layer over the radar on 3 March 2010 from 20 UTC to 22 UTC. The boundary layer is clearly evident as cyan curves in the image. The boundary layer starts the time period at around 1 km AGL and rises to nearly 2.3 km AGL by 22 UTC. The streaks of higher relative backscatter power below the boundary layer are most likely birds, although there are a few “point objects” that are most likely insects. The strong signal between 3 km and 3.6 km at 2155 UTC most likely represent man-made scatterers being dropped from an airplane.



The last image shows a precipitation event occurring at least from 1625 UTC to 1800 UTC on 4 March 2010. The white colors represent the strongest return signal and represent precipitation. The radar bright band is clearly evident on this image as the enhanced backscatter signal at approximately 400 m AGL. This represents the 0°C level where snow if falling at higher altitudes and rain is falling at lower altitudes. Clearly the precipitation masks any clear-air atmospheric signal such as the boundary layer or residual layers.

The FMCW radar technique, with its ultra-sensitivity and unequalled range resolution, is ideal for examining fine detail of the development and decay of the atmospheric boundary layer.