



WESTERN REGION TECHNICAL ATTACHMENT

NO. 01-04

April 3, 2001

DISPLAY OF THE WSR-88D PPS HYBRID SCAN BIN HEIGHTS ON AWIPS

Steve Vasiloff - NSSL - WRH-SSD, Salt Lake City, UT

[Note: Because of the large number of figures, only the text will be published in hard copy. The figures can be accessed on the Web version at <http://www.wrh.noaa.gov> under Technical Attachments.

Introduction

A major consideration of interpreting radar quantitative precipitation estimates (QPE) is the location of the radar beam in relation to the 0 deg C level. Melting ice produces exaggerated reflectivity values resulting in the nearly horizontally-uniform "bright band." Radar QPE from the bright band area will be greatly overestimated. This Technical Attachment describes an application that displays hybrid scan bin (HSB) heights used by the WSR-88D Precipitation Processing Subsystem (PPS; Fulton et al. 1998). Operation guidance is also provided with real examples. An accompanying AWIPS Technical Note gives instructions on how to install this application as an AWIPS Local Application.

What is a Hybrid Scan?

The term "hybrid" refers to the use of different elevation angles to derive QPE in an attempt to minimize ground clutter contamination and data voids caused by obstacles. A "bin" is the standard 1 km by 1 degree reflectivity value. In 1998, the WSR-88D Radar Operations Center (ROC) created new hybrid scan files with rules that differed slightly from those in Fulton et al. (1998). The new "terrain-based" hybrid scans are described by O'Bannon (1997). Figures 1 and 2 show the differences between the original and new hybrid scans. Most notable is the use of only the lowest elevation angle in the new hybrid scan. Briefly, the new rules for determining which elevation angle to use are:

- Use the HSB closest to the ground (formerly the HSB closest to 1 km AGL);
- If the bottom of the HSB is within 150 m of the ground, the next higher tilt is used;
- Beyond the obstacle, a lower tilt can be used if the blockage was less than 51 percent with the correction factors shown in Table 1. Note the discrepancy that a correction of 4 dBZ will never be applied since beams blocked by more than 50 percent are never used.

Bright Band Examples

The Perl/tk application for AWIPS application is intended to be used for shallow cool season storms. Figure 3 shows a schematic diagram of how the 0.5 deg elevation angle might scan through a storm that has a bright band caused by the melting ice aloft. Based on microphysical considerations, the HSB location determines the reliability of QPE.

The KMTX data from 3 May 1999 are used to show what a bright band looks like on radar. Figure 4 shows a 0.5 deg horizontal PPI scan. Note the large area of reflectivity greater than ~32 dBZ (yellow areas). These are exaggerated reflectivity values caused by melting snow and QPE will be overestimated. A vertical cross-section through the yellow area is shown in Fig. 5. Because the bright band is less than 1000 m wide, its vertical extent can be accurately sampled only close to the radar. At farther ranges, the wider beam smooths out the bright band. The result is that estimates are reliable only close to the radar. Another example of a bright band can be seen in data from a vertically-pointing S-band radar. Figure 6 shows a bright band from a case in northern Arizona. The solid lines indicate the vertical extent of the bright band (700 - 1000 m). Note that the bright band descends toward the ground. Thus, the height of the 0 C level may need to be updated periodically. Also note that the bright band is not perfectly uniform.

Perl/tk Application

The PPI in Fig. 4 shows data from only the 0.5 deg tilt (tilt 1). Figure 7 shows how an image of PPS bin heights, relative to the 0 C level, is created. At the left of the schematic, the 0.5 deg elevation angle is unobstructed. Ranges where the height of the HSB is between -500 and 0 m below the 0 C level are colored red. Ranges where the HSB is less than -500 m below the 0 C level are colored green. On the right, the PPS uses the 0.5 deg HSB until it hits the obstacle. At that range, the second tilt (1.4 deg) is used. The ranges where the second tilt is used are colored blue since the 1.4 deg HSB height is between 1500 and 2000 m above the 0 C level. Note the sliver of purple where the 1.4 deg HSB height is between 1000 and 1500 m above the 0 C level.

An actual image of hybrid scan bin heights relative to the 0 C height for KMTX is shown in Fig. 8. Color scales are different from the schematic example. The image is the product of a Perl/tk script that can run as an AWIPS local application (see ATN 42.69 for installation instructions). The colors illustrate the height of each HSB relative to the 0 C height. Each color represents data within certain distances of the 0 C level. A vertical interval of 1000 m is used. For example, if the HSB height is within +/- 500 m of the 0 C level, they are colored red. Pink wedges are areas where the HSB heights are well above the 0 C level (and may be above the storm top). Note that the pink wedges are adjacent to areas where the HSBs are in or just above the 0 C level. Thus, there is the potential for large discontinuities along those boundaries. It is recommended that the forecaster have an idea of the vertical extent of the storm (done with multiple panels or vertical cross sections) in order to understand how the PPS QPE is being affected.

Operational Guidance

This application is perhaps best used as a briefing tool and allows the following operational general guidance (again, with the 0 C level aloft). The reader is cautioned that this guidance does not account for other effects on the character of the precipitation such as sub-cloud evaporation and horizontal advection. Of course, the operational Z-S in use also greatly affects QPE (see Vasiloff 2001).

- If the HSB is below the bright band, QPE is reliable.
- If the HSB is in the bright band, QPE is unreliable and will be greatly overestimated.
- If the HSB is near the bright band, QPE may be unreliable
- If the HSB is above the bright band (i.e., in the snow), QPE is underestimated (especially if the HSB is near or above the storm top).

Application Features

This section describes various features of the user interface. (Installation and start-up instructions are described in ATN 42.69.)

- Several radars can be selected from the "Radar" pull-down menu.
- The "tilt1" radio button allows display of data void areas on the 0.5 deg elevation tilt (i.e., where the beam is blocked). "None" means to show the 0.5 deg tilt heights only with no blockage. "PPS" will revert back to the display of the HSB heights.
- Examples/guidance shown in this TA can be selected from the "Examples" pull-down menu.
- The height of the 0 C level can be adjusted (if it's set to the radar height, HSBs will be relative to the radar).
- Moving the cursor over the color scales creates pop-up windows that describes reliability of data from those areas.
- Clicking the right-mouse on the color image outputs the azimuth, range, and height of the 0.5 deg elevation angle.
- Units can be switched between km and n mi.

Summary

The accuracy of radar precipitation estimates depend on the location in a storm that the

radar is sampling. Because of complex terrain, range/azimuth bins from different tilts at different ranges (HSBs) are used for QPE. For example, QPE is overestimated if the HSB is in or near the 0 deg C level in stratiform precipitation, i.e., near the bright band. This TA gave examples of a bright band and described a PERL/tk local application for AWIPS that provides insight as to potential problems with QPE depending on where the radar HSB is relative to different parts of a storm with a bright band.

List of Tables

Table 1. Partial blockage corrections (from Fulton et al. 1998).

Table 2. Subset of the ASCII version of the KMTX PPS hybrid scan file. The file is arranged by azimuth and range with each azimuth a whole deg and each range bin 1 km beginning at 300 m from the radar. Numbers tell the PPS which tilt to use at the bin location. The origin is 238 deg azimuth and 300 m range.

List of Figures

Figure 1. Schematic of the original PPS hybrid scan structure for the Eureka, CA WSR-88D (KBHX) along the 45 deg azimuth. Within 50 km, different tilts are used because of the “optimal height” criterion (from O’Bannon 1997).

Figure 2. As in Fig. 1 except for the new “terrain-based” hybrid scan (from O’Bannon 1997).

Figure 3. Schematic diagram illustrating the path of the 0.5 deg elevation angle beam through a bright band.

Figure 4. 0.5 deg reflectivity field from KMTX at 0027 UTC on 3 May 1999. While line indicates location of the vertical cross section shown in Fig. 5.

Figure 5. Reflectivity vertical cross section along line shown in Fig. 4.

Figure 6. Reflectivity data from a vertically-pointing S-band radar showing a bright band. Solid lines indicate the vertical extent of the bright band determined from the NSSL bright band algorithm (courtesy of J. J. Gourley).

Figure 7. Schematic diagram showing how the hybrid bin height image is created.

Figure 8. Image showing user interface for the Perl/tk script. “Terrain-based” hybrid scan bin heights, relative to the 0 C level, are shown for the Salt Lake City WSR-88D (KMTX).

References

Fulton, R. A., J. P. Breidenbach, D.-J. Seo, D. A. Miller, and T. O'Bannon, 1998: The WSR-88D rainfall algorithm. *Wea. Forecasting*, **13**, 388-395.

O'Bannon, T, 1997: Using a 'Terrain-Based' Hybrid Scan to Improve WSR-88D Precipitation Estimates. *Preprints*, 28th Conf. on Radar Meteorology, AMS, Austin, pp. 506-507.

Vasiloff, S. V., 2001: WSR-88D performance in northern Utah during the winter of 1998-1999. Part-I: Adjustments to precipitation estimates. Western Region Technical Attachment TA 01-02.

Operational Hybrid Scan KBHX (45 Deg Az)

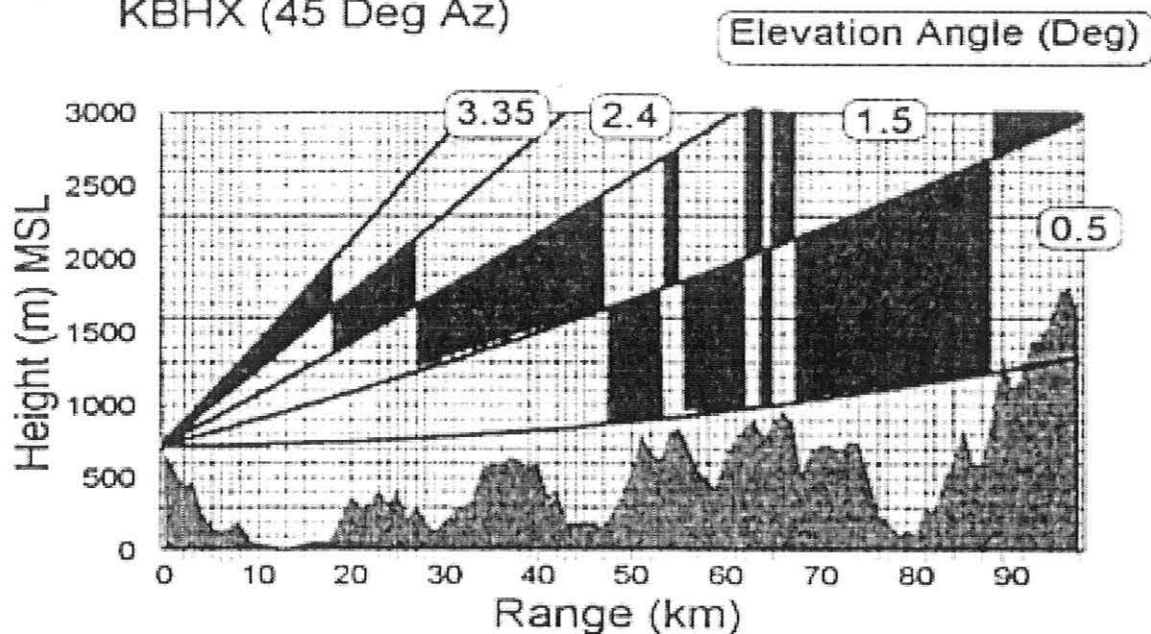


Figure 1. Schematic depicting the structure of the operational Hybrid Scan file at Eureka, CA (KBHX) along the 45 degree azimuth (northeast). Within 50 km, the tilts change because of the "optimal height." Beyond 50 km, the tilts change because of the proximity of the bottom of the beam to the terrain or as a result of blockage.

"Terrain-Based" Hybrid Scan

KBHX (45 Deg Az)

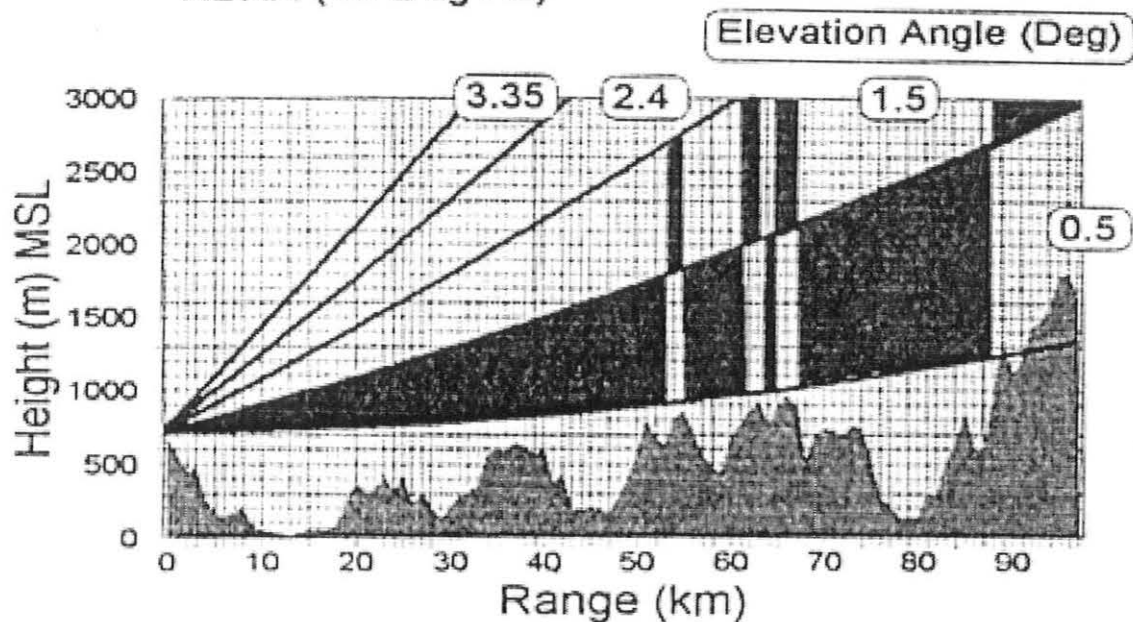


Figure 2. Schematic showing the structure of the 'terrain-based' Hybrid Scan for KBHX. Within 50 km, the lowest tilt is used nearly to the radar site.

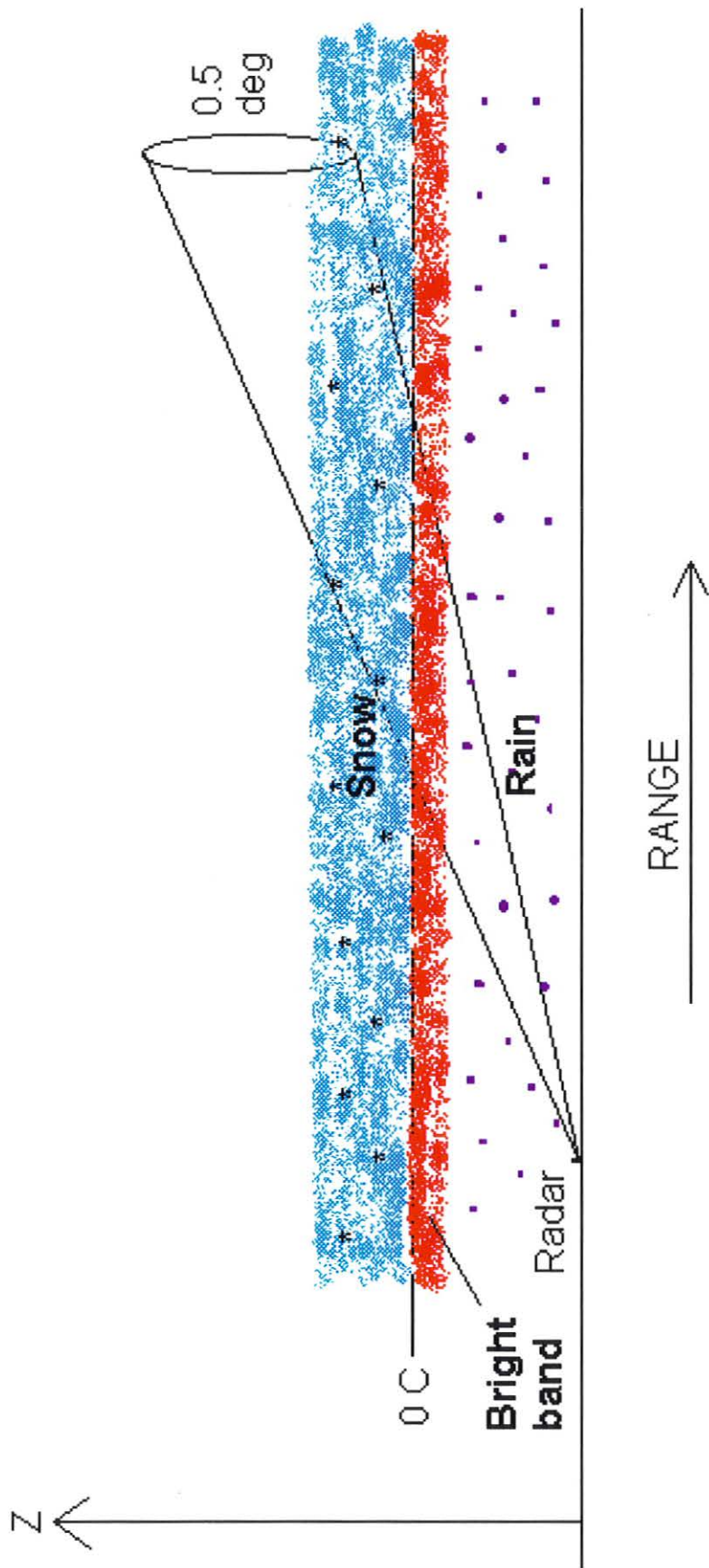


Figure 3

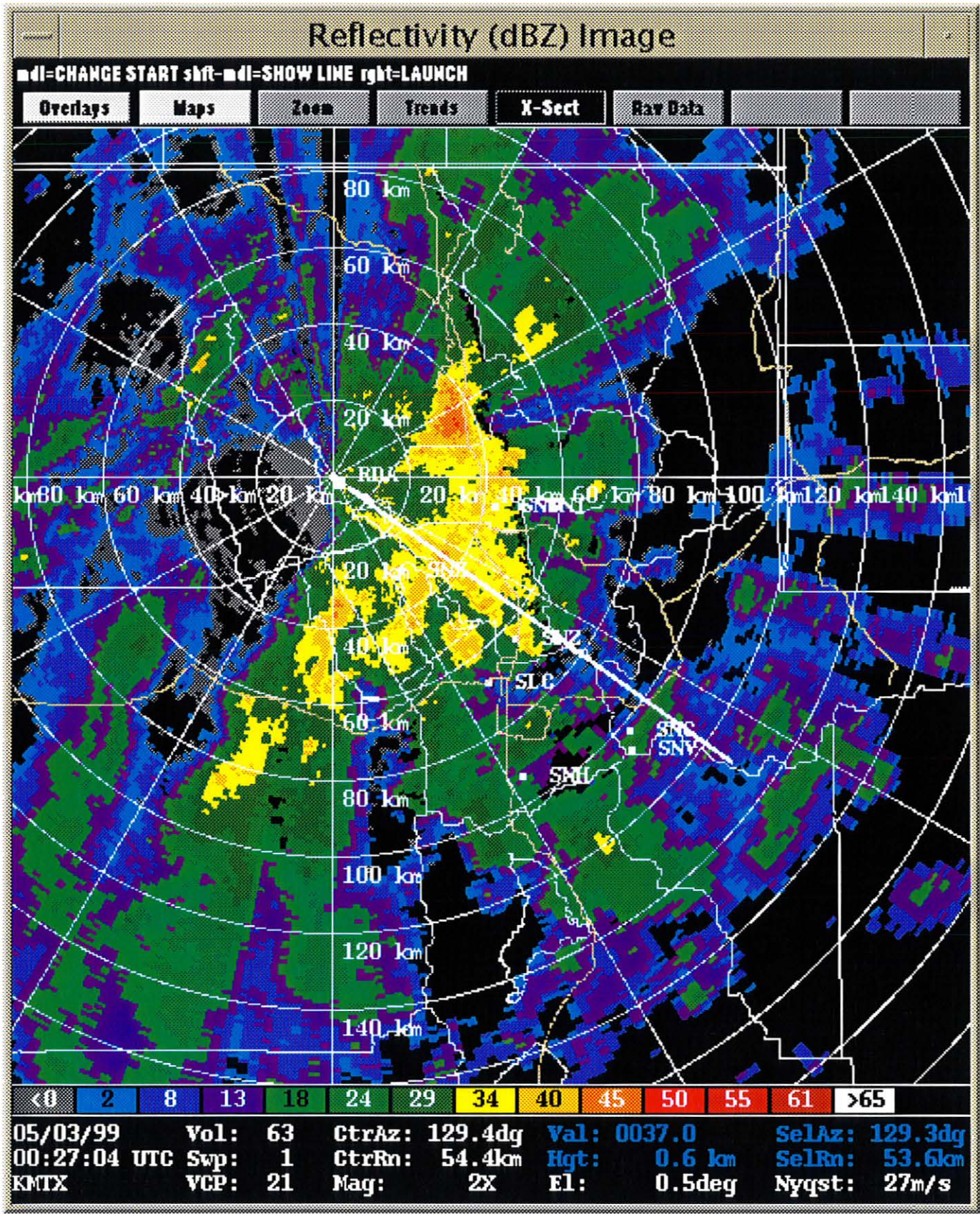


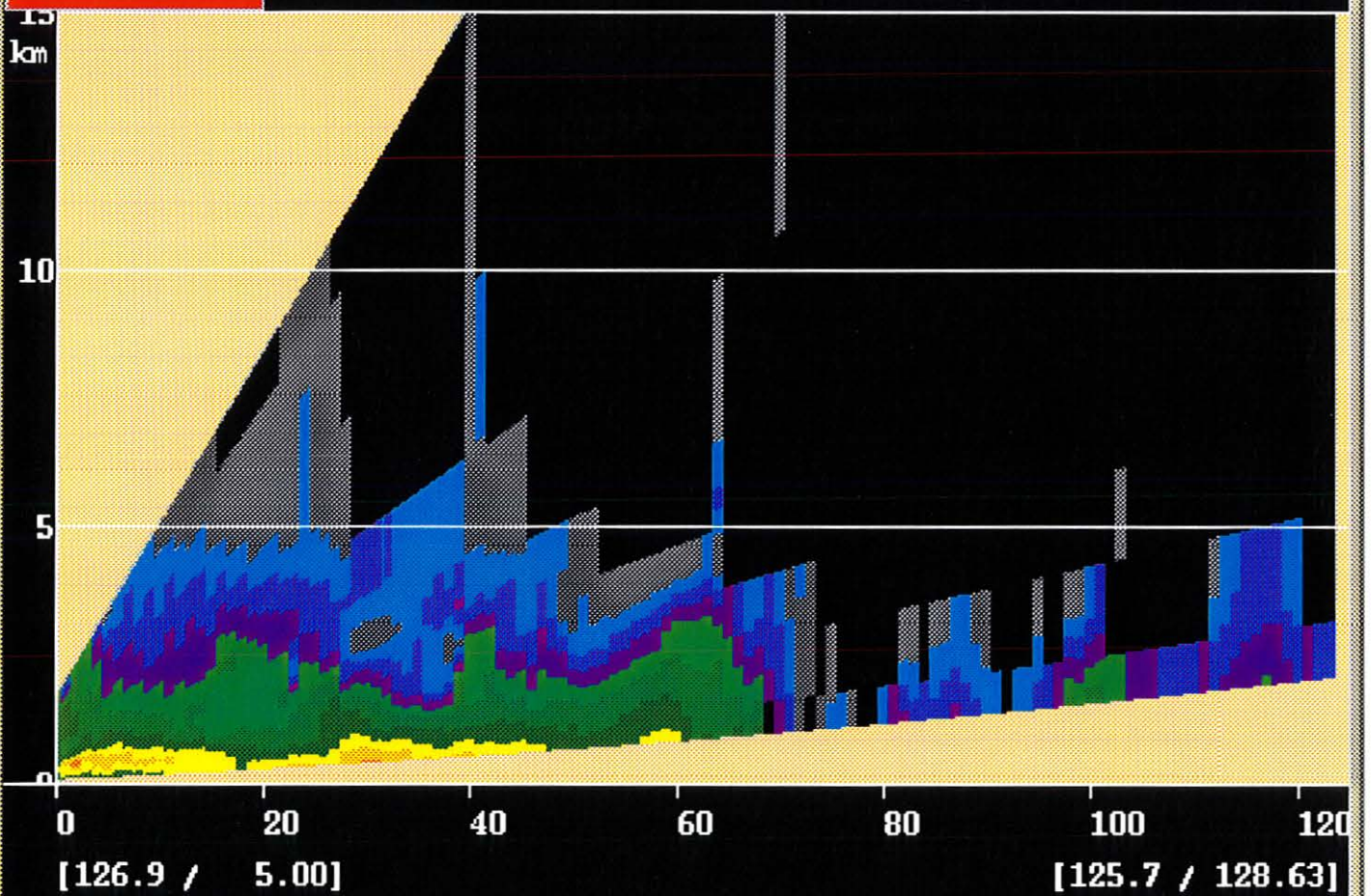
Figure 4

Cross-section (Reflectivity)

Figure 5

CLOSE

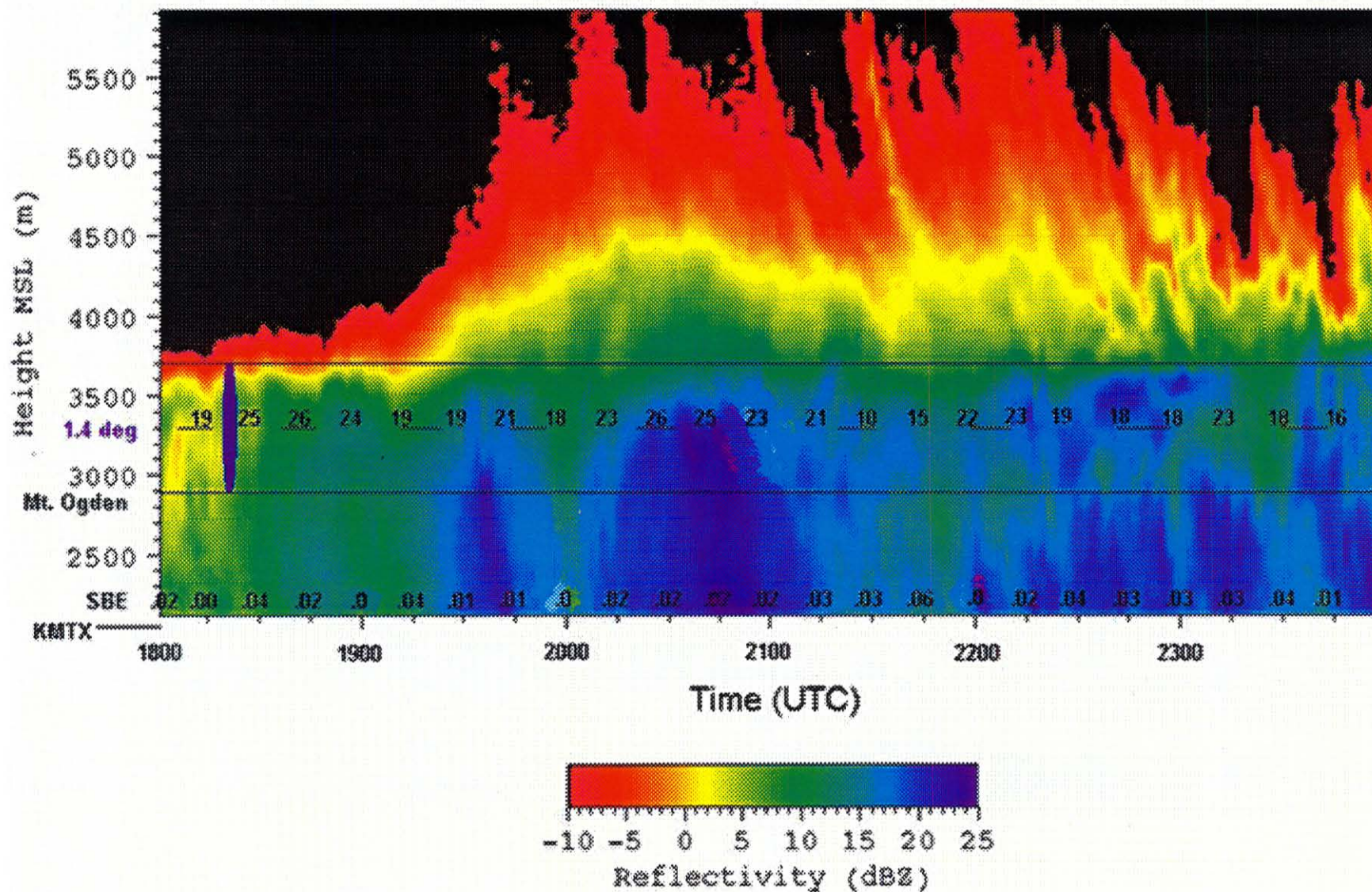
Cross-section (Reflectivity)



KMTX 05/03/99 00:27:04 UTC Vol: 63 Distances in kilometers

S-Band Radar Reflectivity

Figure 6



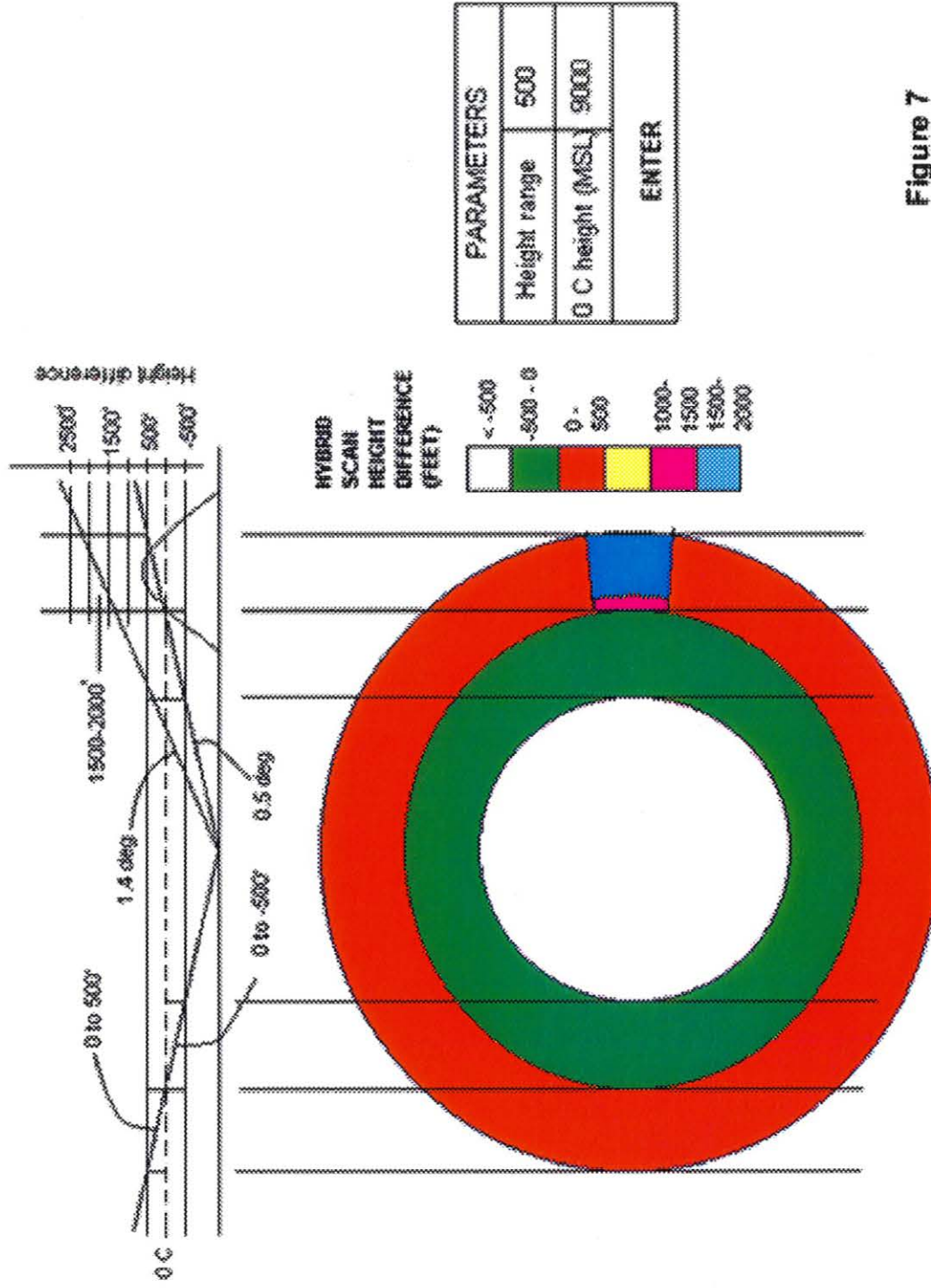


Figure 7

Figure 8

