6.2 AWIPS LOCAL APPLICATION FOR VISUALIZING WSR–88D PPS HYBRID SCAN BIN HEIGHTS

Steven V. Vasiloff*
NOAA/National Severe Storms Laboratory, Norman, Oklahoma

1. INTRODUCTION

A major consideration for 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 paper 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.

2. CONCEPT OF A HYBRID SCAB

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 area of reflectivity. In 1998, the WSR-88D Radar Operations Center (ROC) created new hybrid scan files created 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.

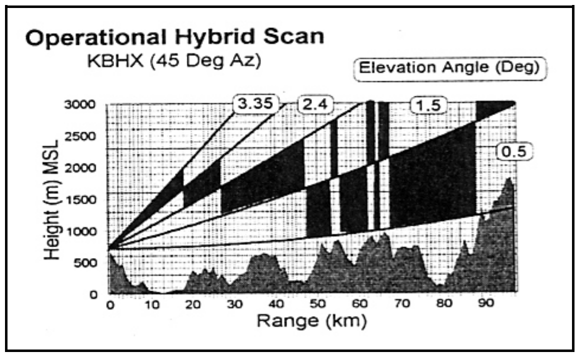

Figure 1. Schematic depicting the structure of the operation hybrid scan file at Eureka, CA (KBHX) along the 45 deg azimuth. Within 50 km, the tilts change because of the "optimal height" requirement. Beyond 50 km, the tilts change due to terrain considerations. (From O'Bannon 1997)

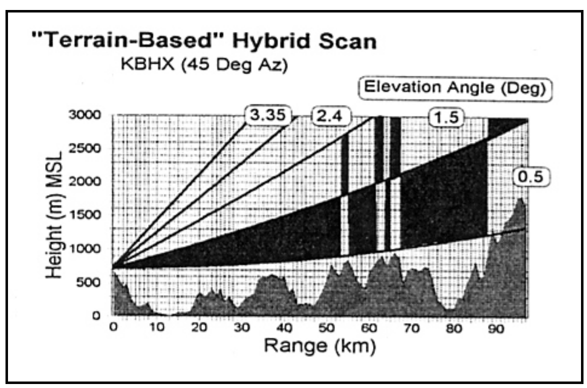

Figure 2. Schematic of a terrain based hybrid scan for KBHX. Note that the lowest tilt is used at closer ranges. (From O'Bannon 1997)

* Corresponding author's address: Steve Vasiloff, NWS, WR Hq, 125 S. State Street Room 1210, SLC, UT 84138; e-mail:steven.vasiloff@noaa.gov

Table 1. Partial blockage corrections (from Fulton et al. 1998)	
Blockage (%)	Reflectivity correction (dBZ)
0 - 10	0
11 - 29	1
30 - 43	2
44 - 55	3
56 - 60	4

Each hybrid scan file is arranged by azimuth and range (360 deg by 230 km). A section of the hybrid scan file for KMTX (northern UT) is shown in Table 2. The 4th tilt is used immediately because of the 150 m clearance requirement. Beyond 7 km range, most of the bins use tilt 1. Note that for the 336 deg azimuth, tilt 2 is used beyond 7 km range indicating the presence of a mountain peak.

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.

		Range ---------->
Azimuth		41141211111111111111111111111111
		41141211111111111111111111112111
	330	41142211111111111111111111222111
		41132311111111111111111111122111
		41133311111112111111111111122111
	333	41133311111112111111111111111111
		41134311111112122111111111111111
		41134411111112222111111112211122
	336	4113442222222223222222222222222

3. BRIGHT BAND EXAMPLE

The 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.

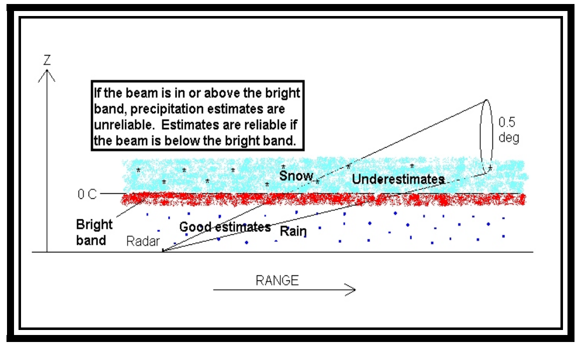

Figure 3. Schematic of a beam passing through a bright band. Under- and over-estimates refer to radar QPE.

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[1]). These are exaggerated

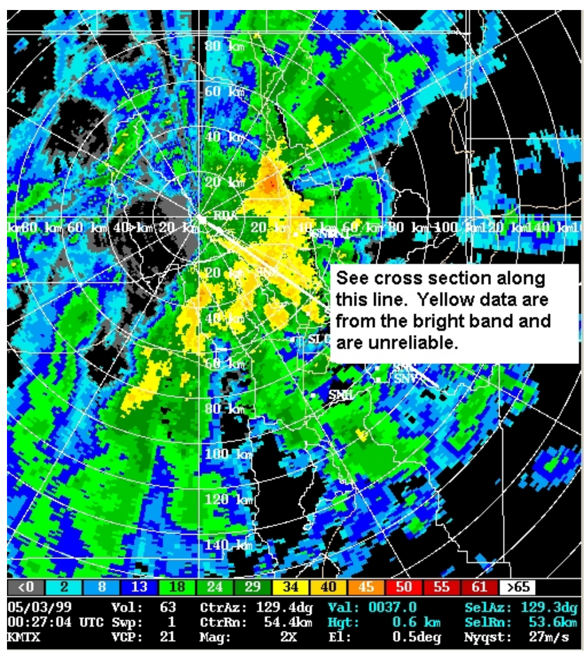

Figure 4. Reflectivity from the 0.5 deg sweep at 0027 UTC on 5/3/99.

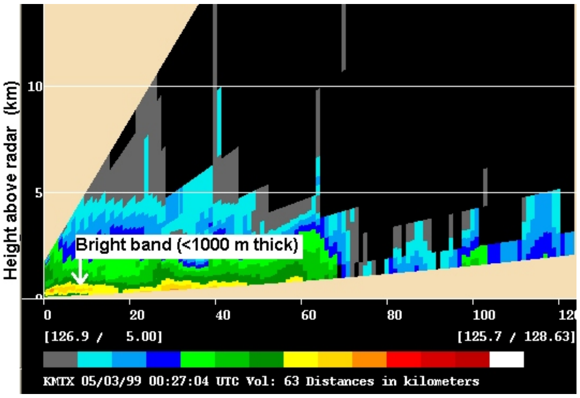

Figure 5. Vertical cross section through a bright band along the line in Fig. 4.

reflectivity values caused by melting snow and QPE will be overestimated. A vertical cross-section through the bright band area is shown in Fig. 5 . Because the bright band is less than 1000 m deep, 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 where the beam is beneath the bright band. 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.

4. PERL/TK APPLICATION

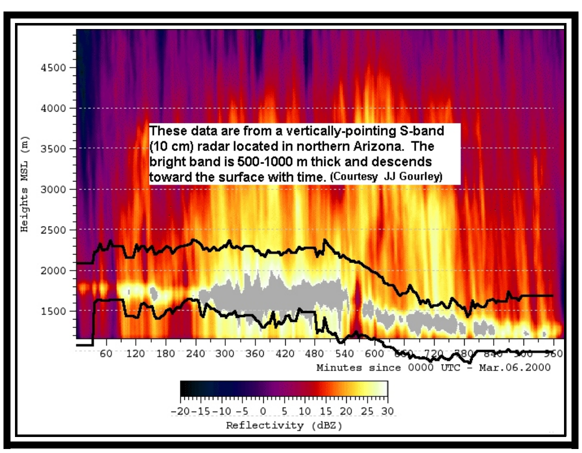

Figure 6. Descending bright band in northern Arizona. (Courtesy of JJ Gourley)

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. To 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 tilt 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

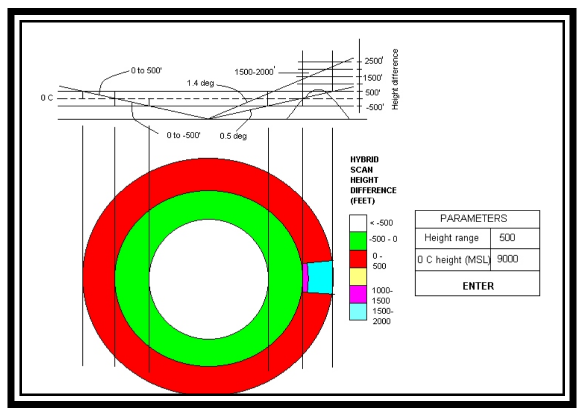

Figure 7. Schematic showing how a hybrid scan is constructed and converted into a plan view. The heights of the different tilts are color-coded. The actual AWIPS product is shown in Fig. 8.

example. The image is the product of a Perl/tk script that can run as an AWIPS local application (see WR ATN 42.69 for installation instructions). The colors (shades) 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

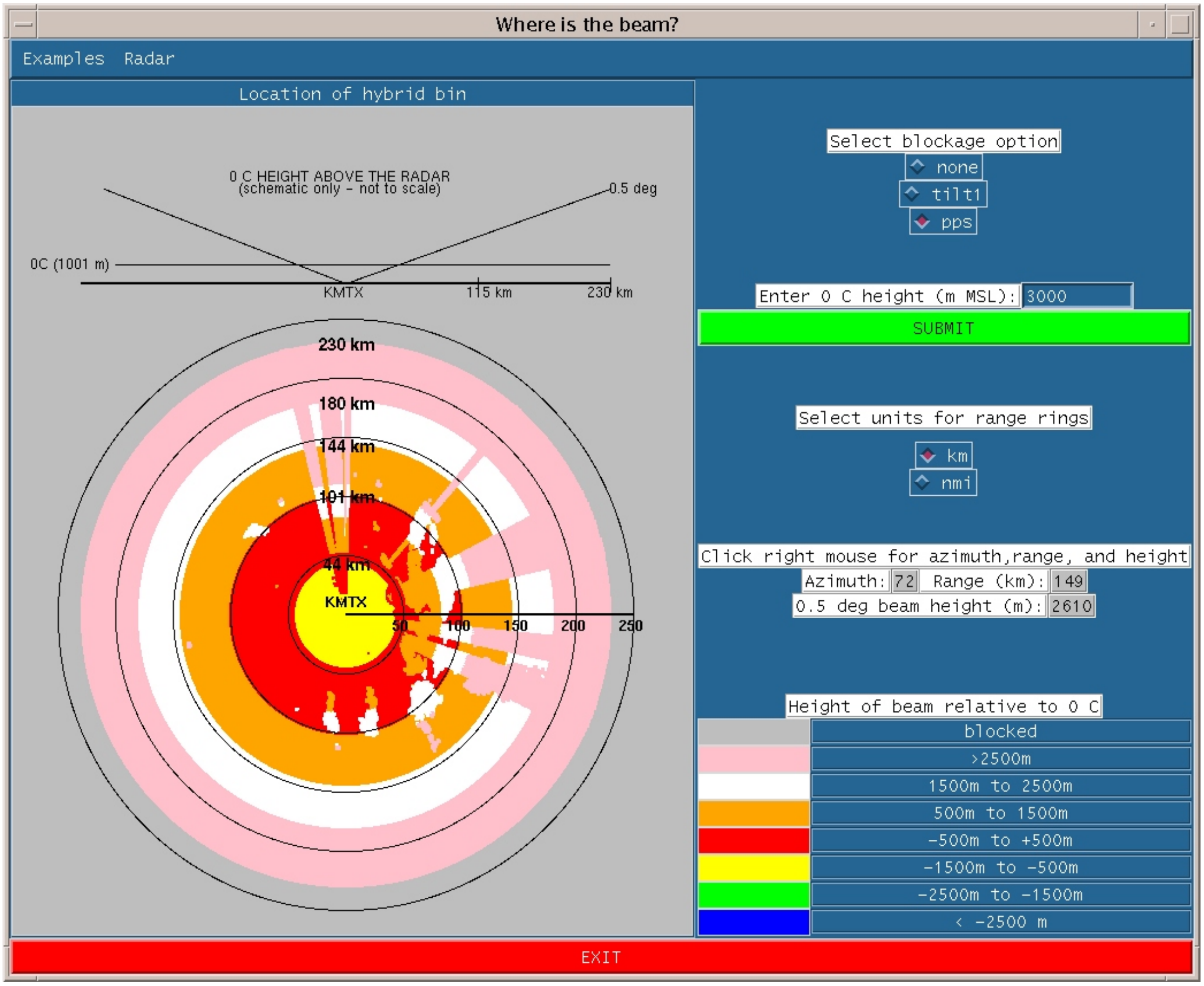

Figure 8. Perl/Tk graphical user interface showing hybrid scan heights for the KMTX PPS hybrid scan file. Note that the 1.4 deg beam is used the the north, east, and south of the radar in mountainous areas.

the storm (done with multiple panels or vertical cross sections) in order to understand how the PPS QPE is being affected.

5. 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).

6. APPLICATION FEATURES

This section describes various features of the user interface. (Installation and start-up instructions are described in WR 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, HSB heights 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.

7. SUMMARY

The accuracy of radar precipitation estimates depends on the location in a storm that the radar is sampling. Because of complex terrain, range/azimuth bins from different tilts at different ranges 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 paper 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.

8. ACKNOWLEDGMENTS

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9. REFERENCES

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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. www.wrh.noaa.gov/wrhq/01TAs/0104/index.html

Western Region AWIPS Technical Note 4.2-69: awips.wrh.noaa.gov/build4_2/atn42-69.htm[1]

[1]Please see the web document for color figures which appear in grey shades here..