8R.3 WSR-88D OPEN RADAR DATA ACQUISITION (ORDA) BASE DATA QUALITY

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1. INTRODUCTION

The ORDA will replace the current (Legacy) WSR-88D Radar Data Acquisition (RDA) subsystem in 2005-2006 to improve: 1) receiver and signal processing hardware; 2) user interface; 3) signal processing and diagnostic software; and 4) system reliability, maintainability, availability. Even though improving data quality was not an originally stated objective of the ORDA project, this paper illustrates how ORDA data quality meets and exceeds Legacy data quality. Previous publications describe many aspects of the ORDA project: Belville et.al. (1997), Cate and Hall (2005); Cate et al. (2003); Crum and Reed (1998); Free et al. (2005); Ice et al. (2004); Ice et al. (2005); Lee (2005), Patel et al. (2005); Patel and Macemon (2004); Reed and Cate (1999); Saffel et al. (2002); Zahrai et al. (2002).

Since January 2004, a team of 17 radar engineers and meteorologists from the Radar Operations Center (ROC), RS Information Systems, and the Cooperative Institute for Mesoscale Meteorological Studies at the University of Oklahoma have met weekly to evaluate base reflectivity, velocity, and spectrum width products generated by the ORDA system. More than 3,000 hours of ORDA data were collected and evaluated.

Base data products from ORDA and Legacy systems were compared using two different procedures. First, products were qualitatively compared between two adjacent radar systems. Open RDA data were collected using the KCRI antenna located on the University of Oklahoma North Campus in Norman, Oklahoma. Legacy radar data were collected using the KTLX radar located near Oklahoma City, Oklahoma, approximately 20 km northeast of the KCRI antenna. Second, base data were quantitatively compared by switching the KCRI system back and forth between ORDA and Legacy configurations.

The ORDA data quality team adopted three criteria against which to judge ORDA base data quality. First, the team considered whether or not reflectivity, velocity, and spectrum width data and products were meteorologically consistent and adequate for use by trained meteorologists as well as untrained users and automated systems. Second, the team assessed differences between ORDA base products and Legacy base products. Third, Legacy and ORDA base data were statistically compared.

This paper demonstrates how ORDA data meets and exceeds the base data quality criteria and documents how the data quality team has ensured that ORDA data is ready for operational use.

2. BASE PRODUCTS ACCEPTABLE FOR USE

First and foremost, the ORDA base data must be deemed acceptable for operational use. Open RDA base data should be able to be used like Legacy base data, with no special interpretation needed, despite the fact that the data is now generated from a different signal processor. See Patel and Macemon (2004); for a description of the ORDA RVP8 signal processor. There should be no discernible degradation of product functionality. Throughout the data evaluation period, 6 September 2004 – 30 June 2005, committee members used these criteria to guide data quality assessments.

Figures 1 and 2 are images of reflectivity products that contain a tornadic supercell located southwest of the ORDA and Legacy radars. Figures 3 and 4 are velocity products from the same storm. Both ORDA and Legacy products look similar.

During the data evaluation period, the data quality committee had the opportunity to compare data from stratiform precipitation, non-severe storms, scattered showers, clear air, anomalous propagation, and tornadic super cells. In each case, all three base radar moments were evaluated. By the end of June 2005 the base data were judged acceptable for operational use.

Another guideline used to assess data quality was whether or not trained experts could tell the difference between ORDA and Legacy products. Figures 5 and 6 document velocity products from ORDA and Legacy radar systems. Which is which? The answer is given at the end of the paper in the acknowledgement section.

Data quality committee members counted and classified velocity dealiasing errors from over 20,000 individual velocity products from all tilts of all possible volume coverage patterns. The velocity dealiasing error rate for all data sets combined was approximately 3%, comparable to that of the Legacy system.

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3. UNDERSTANDING ORDA AND LEGACY DIFFERENCES

There are many differences between the ORDA and Legacy systems. Several examples follow.

First, ORDA uses a different clutter filtering technique than Legacy. GMAP (Gaussian Model Adaptive Processing) is not a notch-width filter as used in the Legacy system, but removes clutter associated spectral coefficients in the frequency domain. GMAP is able to restore signal spectral coefficients. Additional information can be found in Ice et al. (2004).

Figure 7 shows an example of what Legacy clutter filtering looks like. Black patches represent areas where the Legacy notch width clutter filter removed clutter and weather signal.

Figure 8 shows how the GMAP clutter filter takes away clutter but not weather signal. A patch of good velocity values associated with weather moved over the black clutter filtered area to the southwest of the radar. In this situation, ORDA improves data quality over Legacy.

A second difference between ORDA and Legacy systems is that a long standing computational problem with spectrum width was fixed. The fix to spectrum width was a known difference that showed up in statistical comparisons. Because of known differences, it was not possible to simply guarantee that ORDA and Legacy systems were EXACTLY identical. Committee members worked to make sure the ORDA provided data suitable for operational use. Again, ORDA data quality exceeds that of Legacy.

Additional differences showed up in the statistical comparison between ORDA and Legacy clutter map performance. Statistical differences are discussed in the next section and illustrated in Figures 9 and 10.

4. STATISTICAL COMPARISON

In addition to comparing the two radar systems qualitatively by examining base data products from adjacent radars, committee members quantitatively compared data from all three base moments from surveillance cuts, batch cuts, and contiguous Doppler cuts from the same radar. The KCRI test bed radar was operated first in Legacy mode and then in ORDA mode. Clutter filtering was turned off, then on everywhere, then on only in the clutter map region. Tests were performed on days in which the weather was uniform and not changing within the study region.

One statistical comparison resulted in a good difference. The Legacy system implemented the old, erroneous spectrum width computation while ORDA implemented the corrected version. Figure 9 displays a histogram and scatter plots comparing ORDA with GMAP on bins, O21A, and Legacy clutter filtering applied to all bins between 3 km and 40 km collected with VCP 21. Legacy filtering is represented by both high, L21Ah, and medium, L21Am, settings. Data was collected at 2.4º elevation angle.

Figure 10 illustrates another desirable difference. The ORDA GMAP filter removes fewer data points from the region around 0 m/s. In this instance, ORDA filtering was most like Legacy medium clutter filtering.

5. SUMMARY

The data quality evaluation committee collected many examples of radar base data products that show ORDA and Legacy systems generate operationally useful data. Base reflectivity, velocity, and spectrum width data and products were meteorologically consistent and judged adequate for use by trained meteorologists as well as untrained users and automated systems.

All qualitative and quantitative data comparisons show there are no unknown problems causing differences between ORDA and Legacy radar systems. As best as can be determined, both ORDA and Legacy radars generate similar and compatible base data moments.

6. ACKNOWLEDGMENT

Numerous ROC government and contract employees unselfishly contributed toward the base data evaluation. The author thanks members of the ORDA evaluation committee who attended many weekly meetings, evaluated base data, diagnosed problems, recommended solutions, performed analyses, standardized data collection procedures, developed test procedures, supplied expertise, and provided valuable guidance. The author also thanks ROC Applications Branch student research assistants for organizing base data files and creating data archive appendices.

Answer to question in Section 2: Figure 5 is ORDA and Figure 6 is Legacy.

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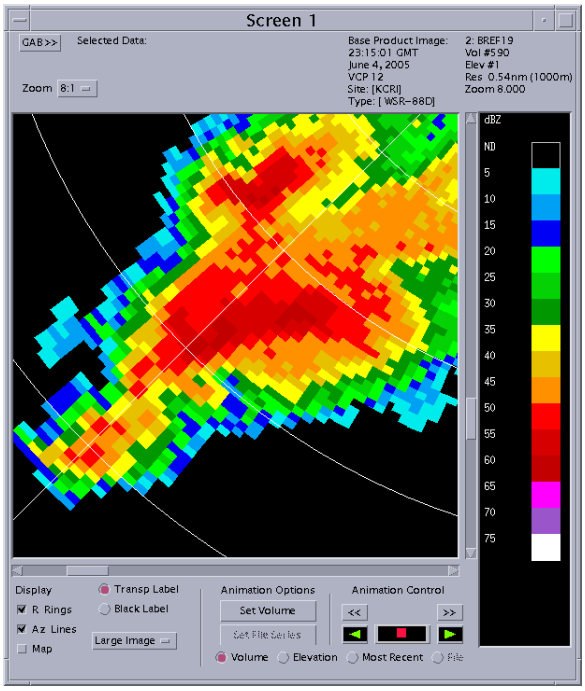

Figure 1 – ORDA Reflectivity Product 4 June 2005.

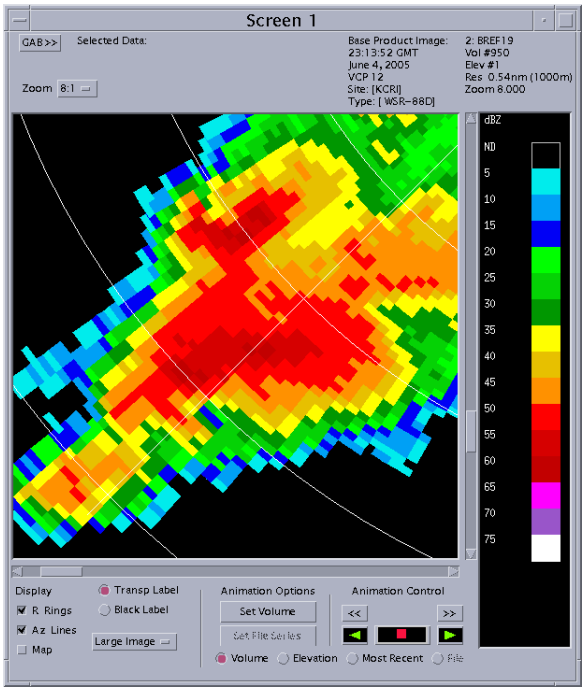

Figure 2 – Legacy Reflectivity Product 4 June 2005.

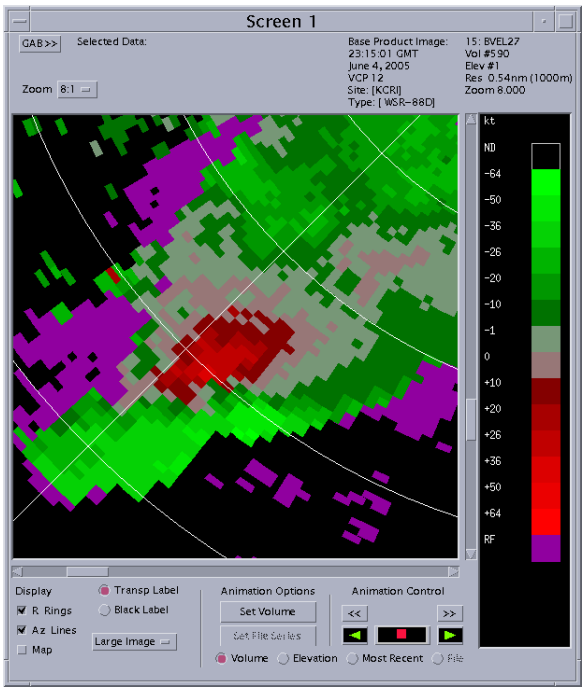

Figure 3 – ORDA Velocity Product 4 June 2005.

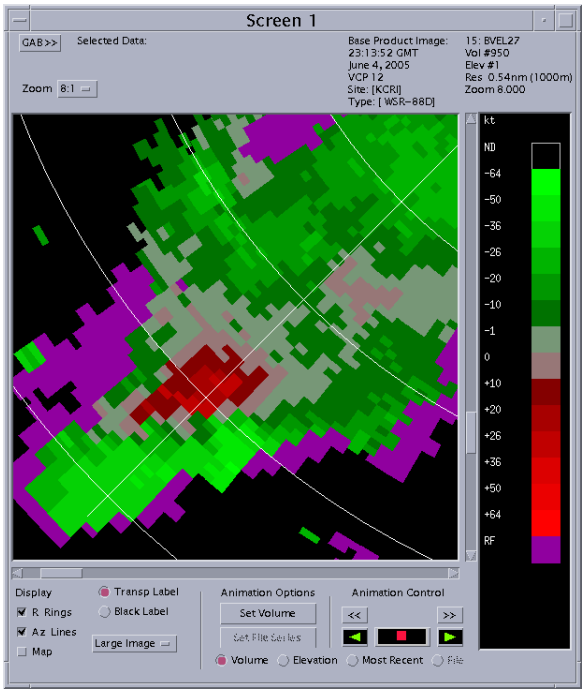

Figure 4 – Legacy Velocity Product 4 June 2005.

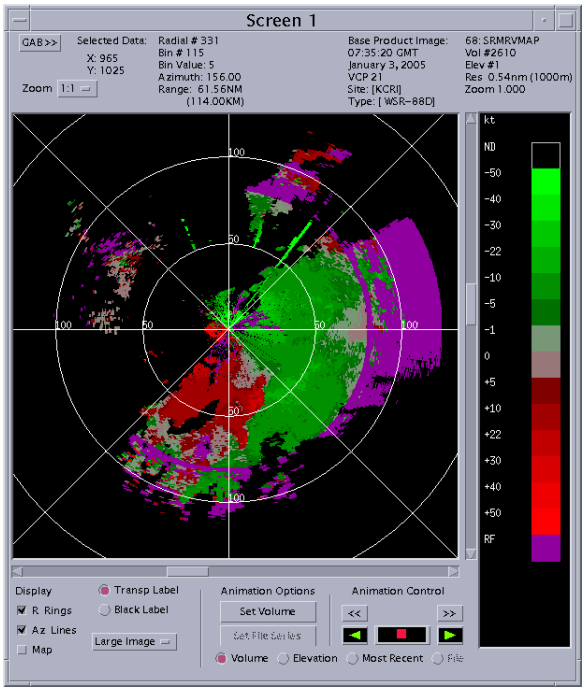

Figure 5 – ORDA or Legacy Velocity Product?

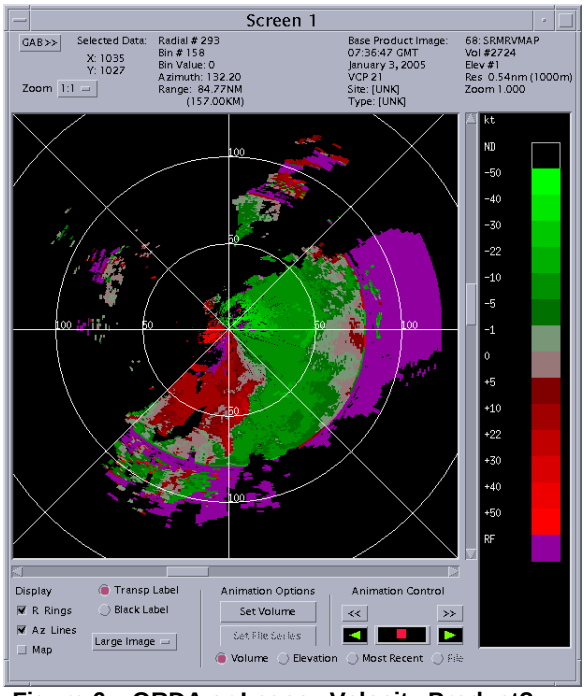

Figure 6 – ORDA or Legacy Velocity Product?

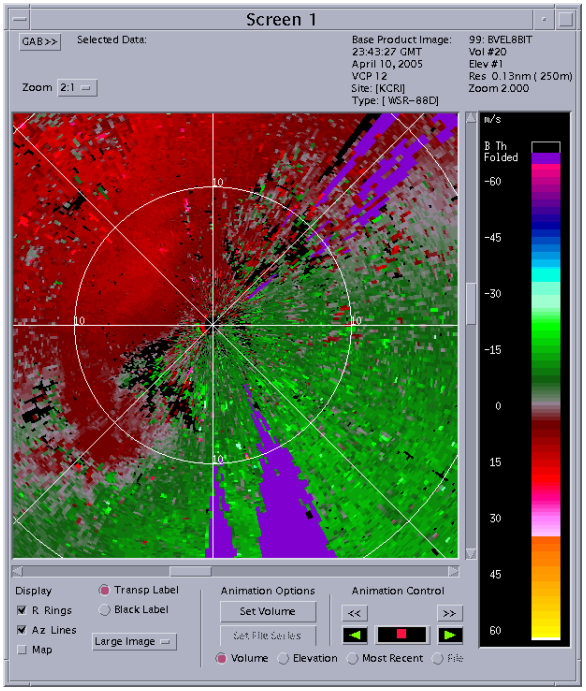

Figure 7 – Legacy like clutter filtering.

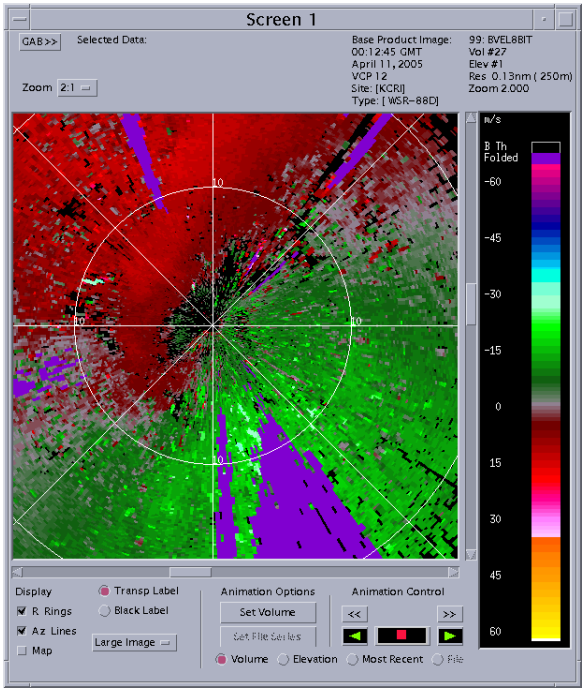

Figure 8 – GMAP clutter filtering.

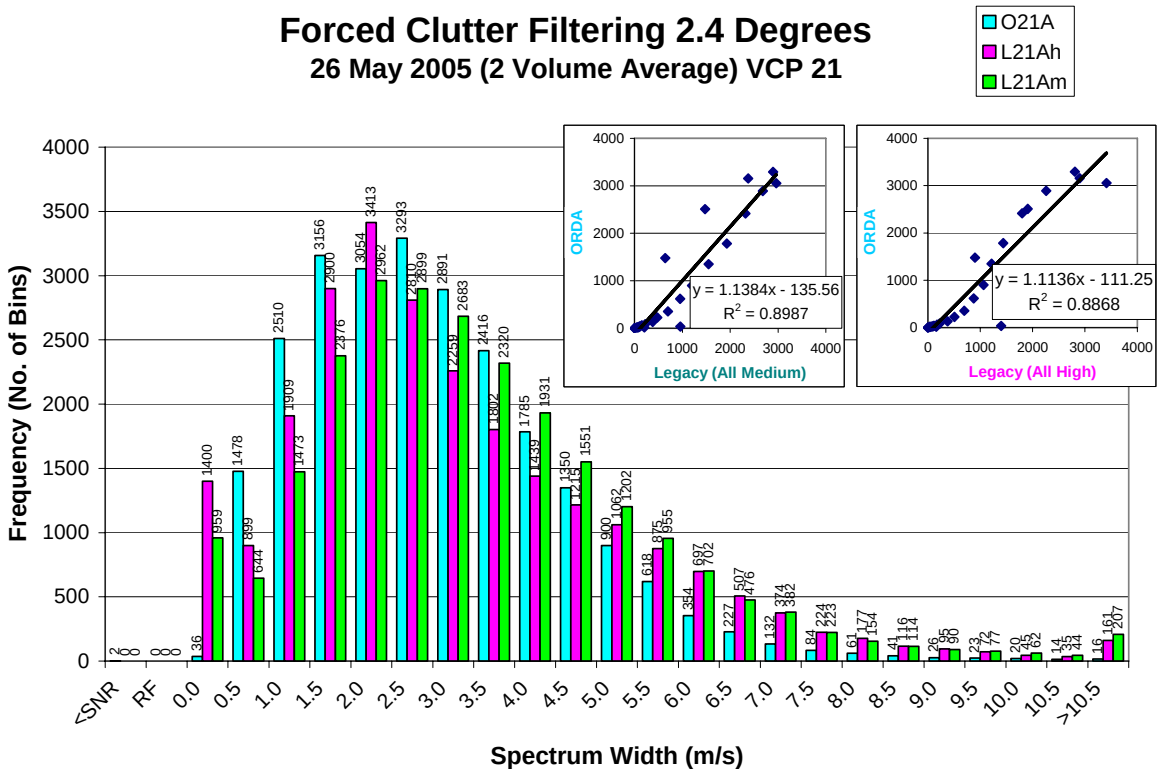

Figure 9. Comparison of ORDA and Legacy spectrum width data.

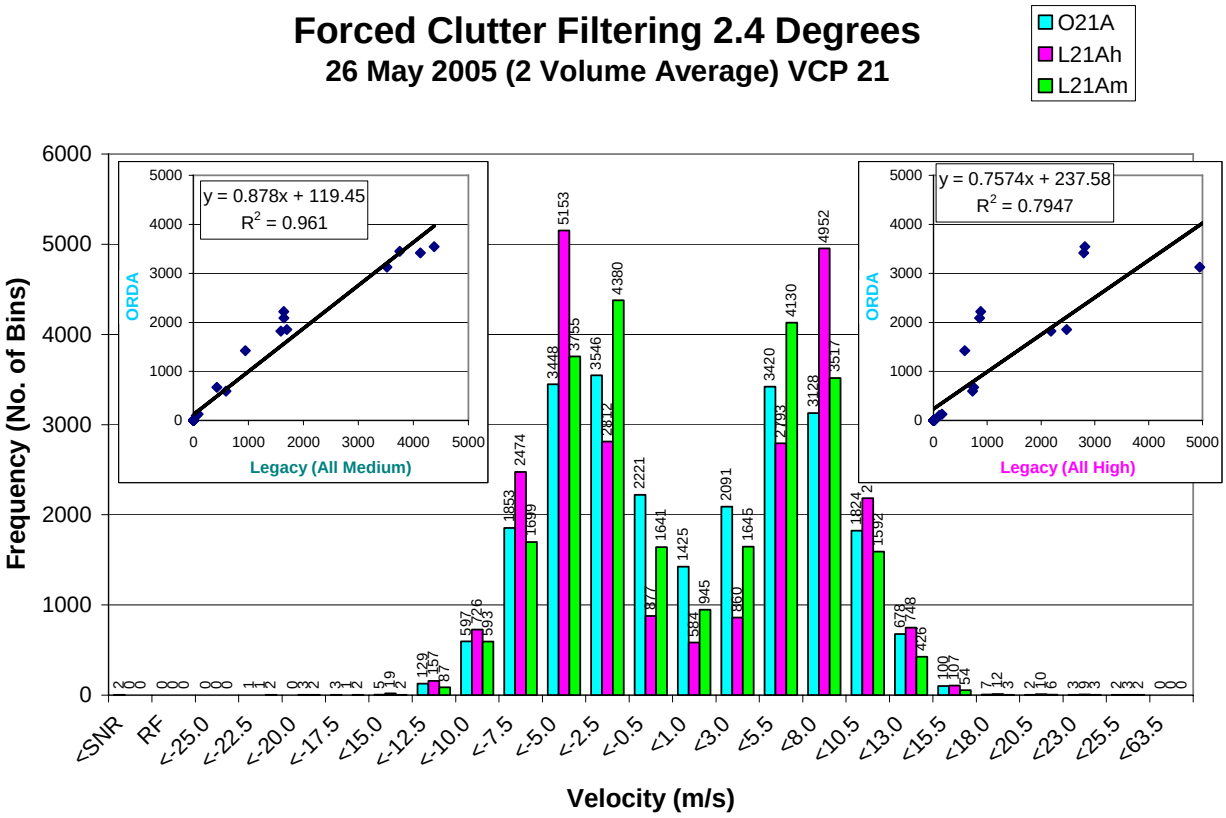

Figure 10. Comparison of ORDA and Legacy velocity data.