Autumn 2014
Issue 23

What's the Pink Fringe?

The Radar Operations Center (ROC) in conjunction with the National Severe Storms Laboratory (NSSL) has been researching the challenge presented by the overestimation of noise power at certain WSR-88D sites.

Prior to Build 14.0, the NEXRAD system utilized calibration procedure (executed in between volume scans) to obtain the default system noise power value from the noise power estimate acquired at the highest antenna elevation (a.k.a. blue sky noise) normalized at lower elevations for each cut in the volume scan for radar variable calculations.

The method for determining the noise power normalization scaling factors causes an overestimation of the noise power at sites with presence of targets that produce high noise power estimates at some azimuths (e.g., mountains or other strong clutter). At azimuth positions that do not have the strong clutter targets, an excessive noise power value is used for radar variable computations. In some cases, the default noise power value can be too low, but this behavior is seen infrequently.

Inaccuracies in noise power estimates impact signal power estimates in both the horizontal and vertical channel. Radar variable calculations are affected when using inaccurate noise. The Correlation Coefficient (CC) and Spectrum Width are impacted most directly. To address these inaccuracies, RDA Build 14.0 has incorporated a new algorithm dubbed Radial by Radial Noise (RxRN), which was developed at NSSL by Igor Ivic of the Cooperative Institute for Mesoscale Meteorological Studies. The algorithm provides real-time noise power estimates at each radial and is thus capable of capturing noise power variations in time, elevation, and azimuth. The result is more accurate noise power estimates used to compute radar variables.

RxRN works by examining each range bin along a radial and determining whether the data in that bin meets the algorithm's criteria for noise. If the criteria is met, that noise value and the values from other "noise-like" bins are averaged together to produce a noise value unique to that radial. This value is then used for the various data calculations along the radial. In

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Pink Fringe *(Cont.)*

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some cases, such as when there are weather echoes along most or all of a radial, the algorithm will not have enough noise-like bins with which to calculate a new noise. When this happens, the algorithm fails and the default system noise power estimate is used. This will happen rarely, because the failure rate for RxRN is estimated at 0.025%.

How will this impact the data? Much of the effects will not be noticeable to the user, but will impact the algorithms that use the data. However, there are three cases where the operator might notice the results yielded by the application of RxRN. First, for sites that typically use an inflated system noise power, the user may notice that the CC values are more accurate than before. Second, for sites that have interference, some interference and sun strobes may be removed from the data. Third, there will be an increase in low-signal values at sites which originally used inflated system noise powers before the implementation of RxRN.

Figure 1(a) is an image of the Kauai, HI (PHKI) radar display when the default noise

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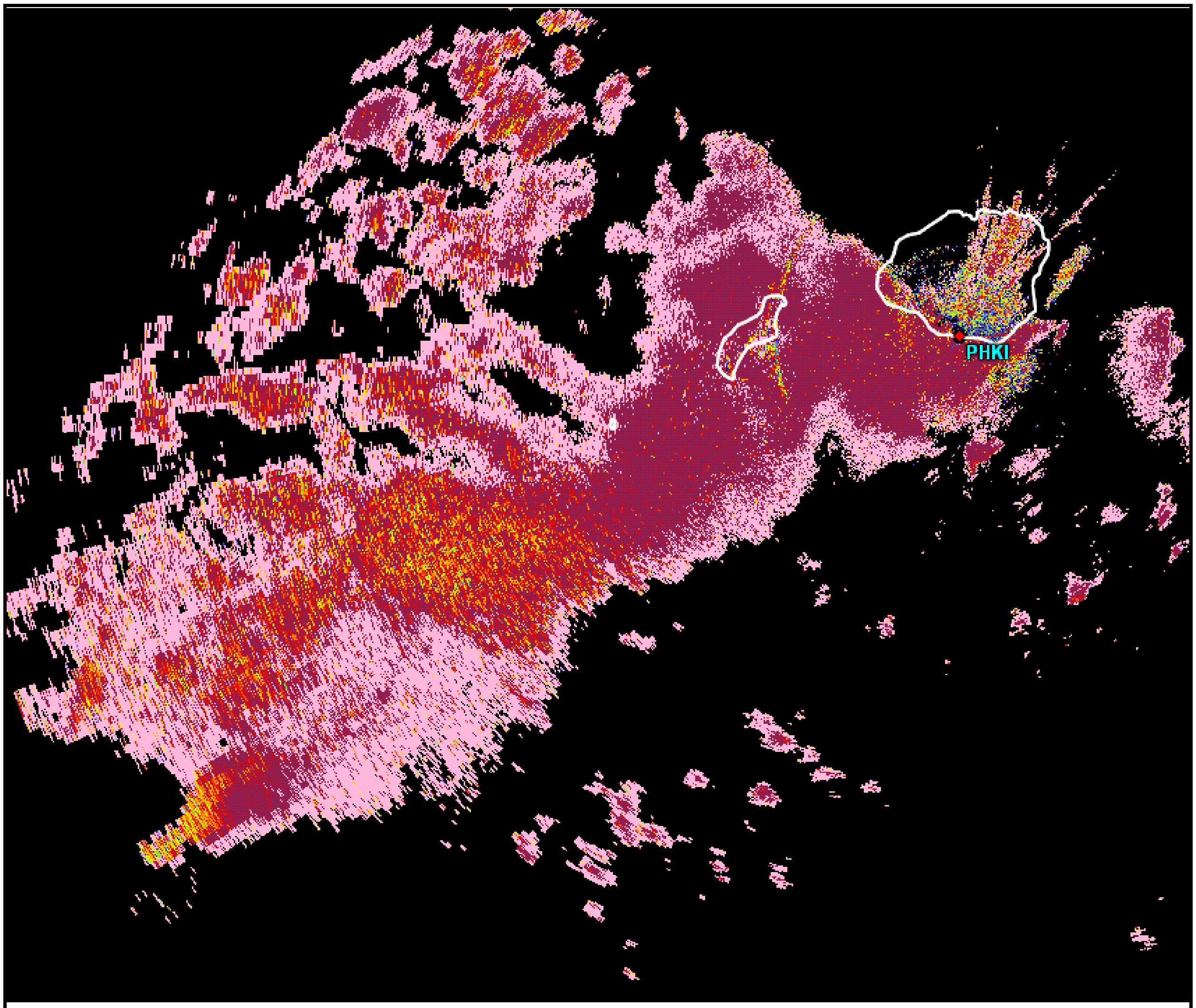

Figure 1(a): Correlation Coefficient data from PHKI using the default noise power value.

Pink Fringe *(Cont.)*

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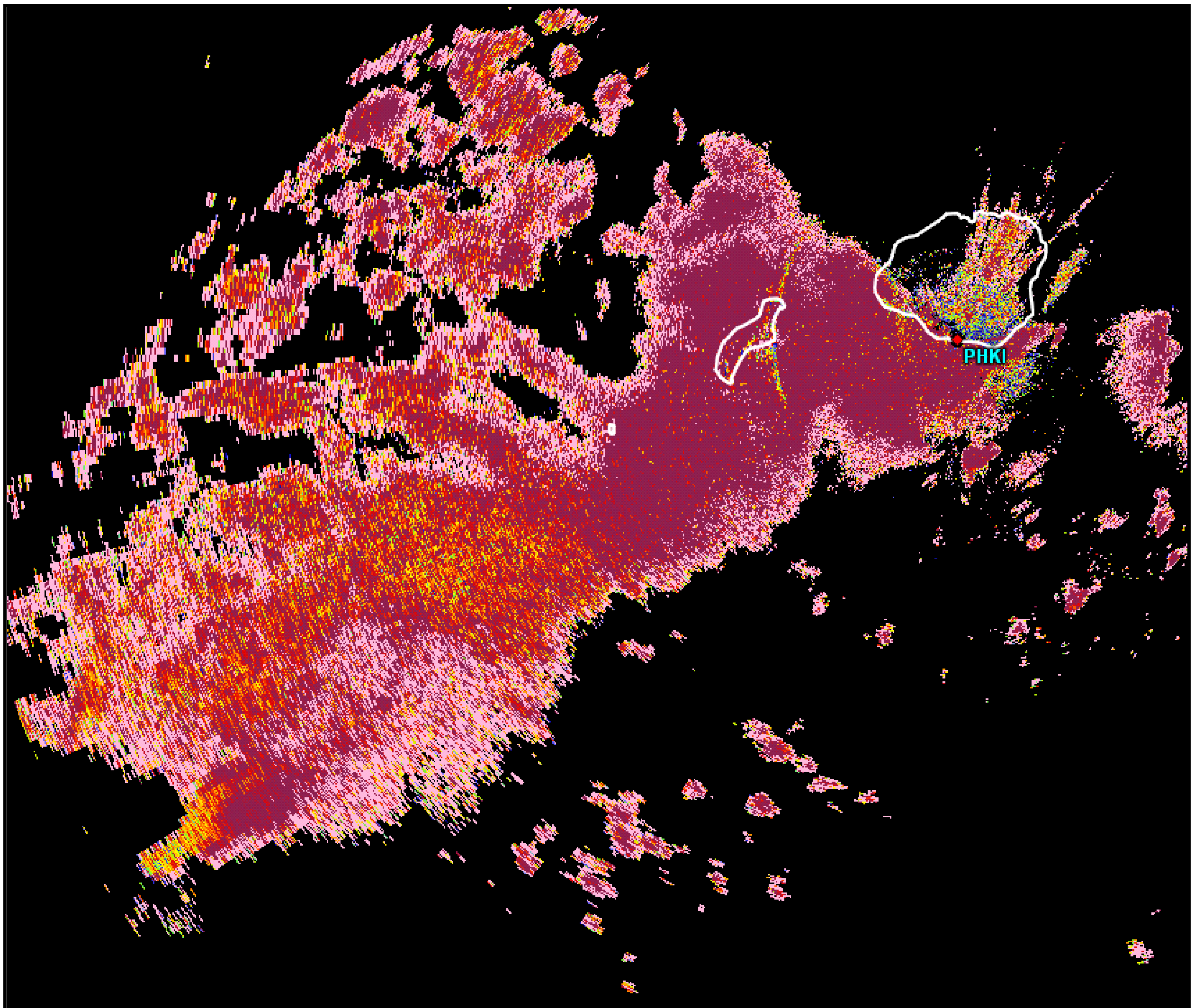

Figure 1(b): Correlation Coefficient data from PHKI using noise power values generated by the RxRN algorithm.

power value is used. This site has a high default noise power due to the adjacent mountain. Figure 1(b) provides an example of improved CC values for PHKI. When using RxRN for the noise values, the CC values decrease and fewer values greater than one (that appear light pink on the display) are seen. When comparing the two figures, there is much less “pink fringe” along the edges of precipitation in the image where RxRN is applied.

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Pink Fringe *(Cont.)*

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Figure 2(a) is an example of image reflectivity generated using the default noise power value, and interference that has been removed from a cut of Norman, OK (KOUN) test radar data. Three of the interference strobes are suppressed while one is not, and the pulsed interference also remains after RxRN application (Figure 2(b)). Whether or not interference is removed depends upon whether the

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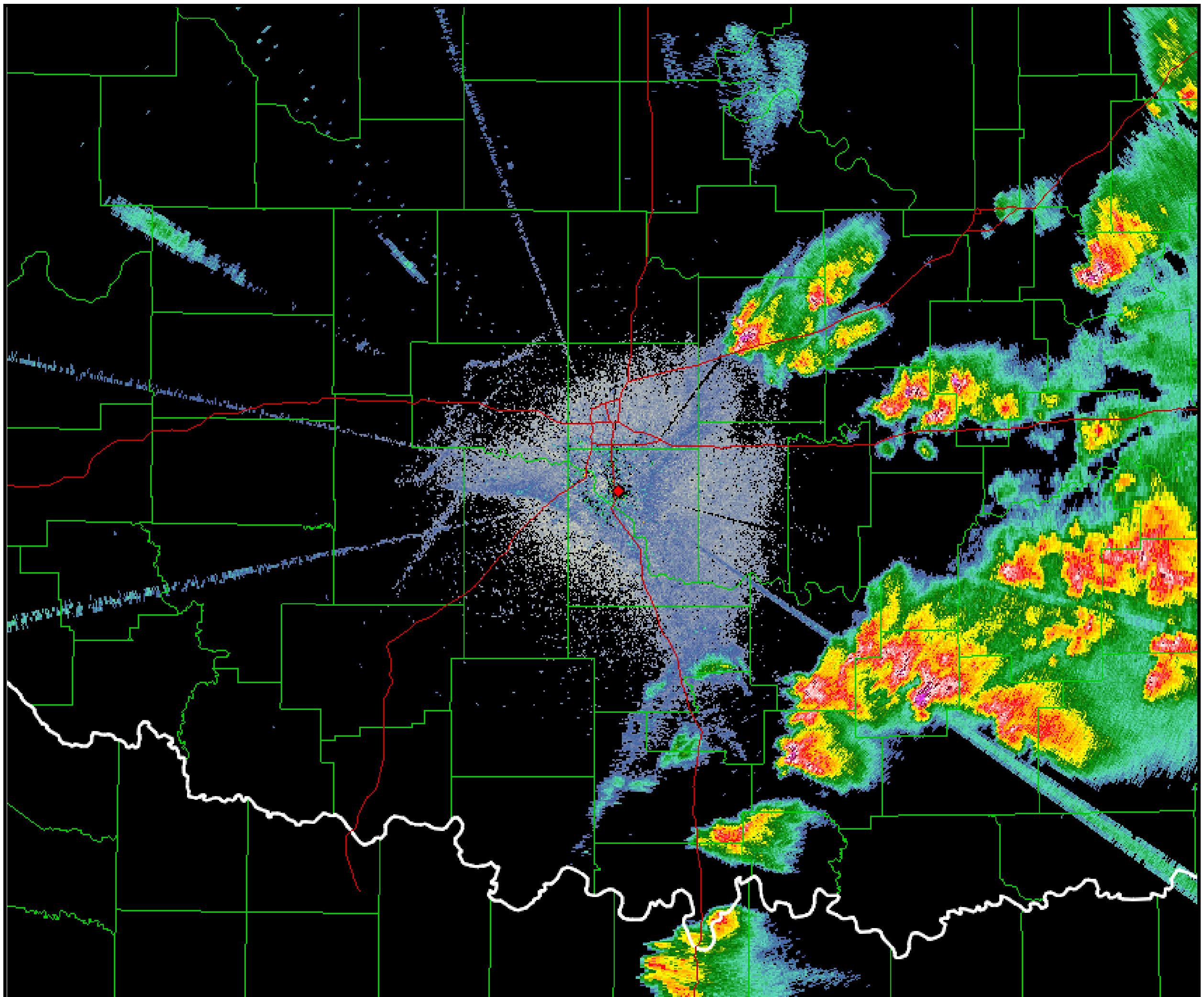

Figure 2(a): KOUN reflectivity using the default noise power value.

Pink Fringe *(Cont.)*

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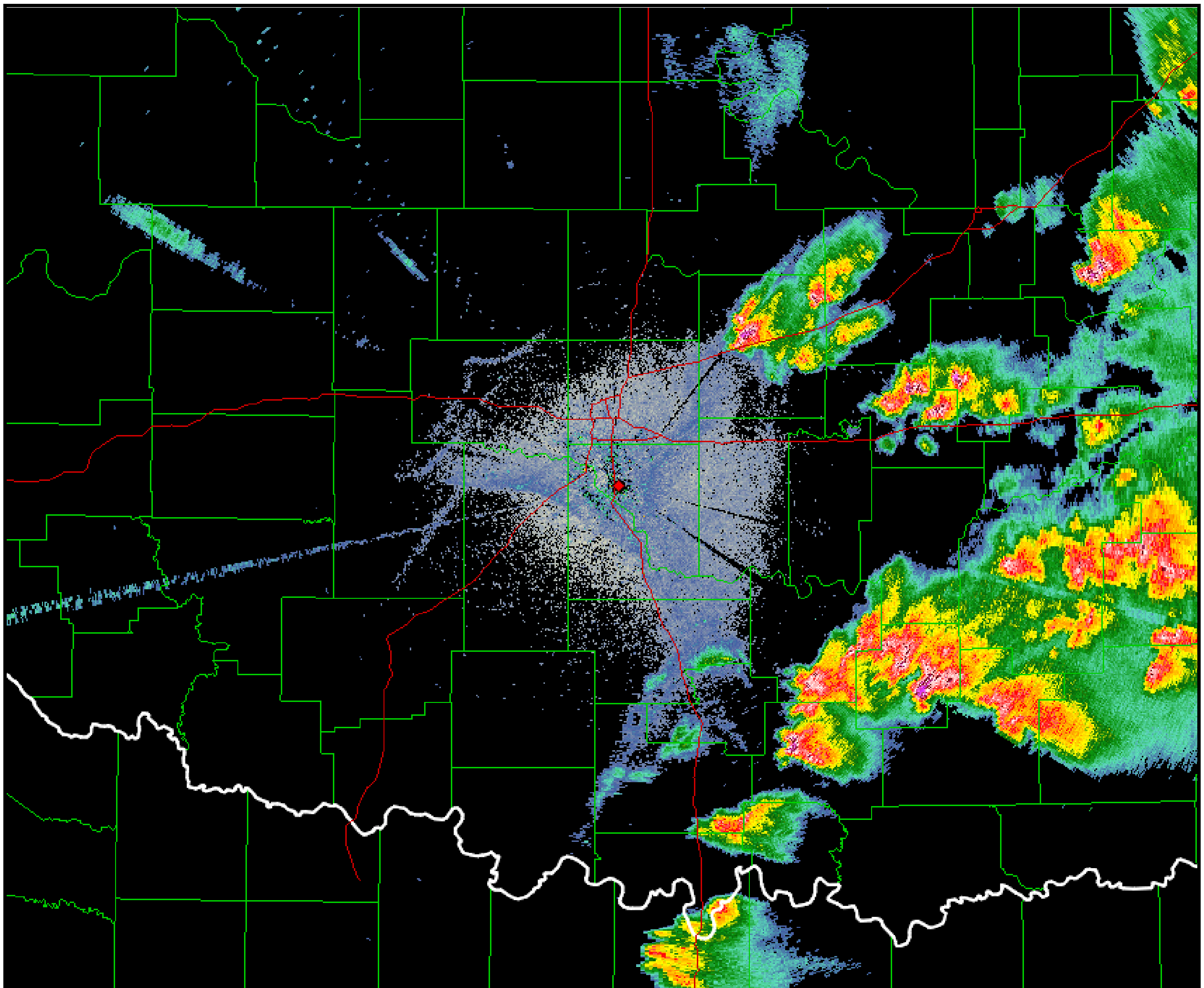

Figure 2(b): KOUN data using noise power values generated by the RxRN algorithm.

signal level is strong enough to raise the noise floor high enough to remove the strobe, and also whether the signal itself meets the criteria for noise. Interference that has a sufficiently coherent signal and/or is not strong enough will likely remain in the data. There are also two reflections to the northwest that are not affected by the RxRN algorithm.

The display shown in Figure 3(a) demonstrates reflectivity data using the default noise value from the Duluth, MN (KDLH) WSR-88D.

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Pink Fringe *(Cont.)*

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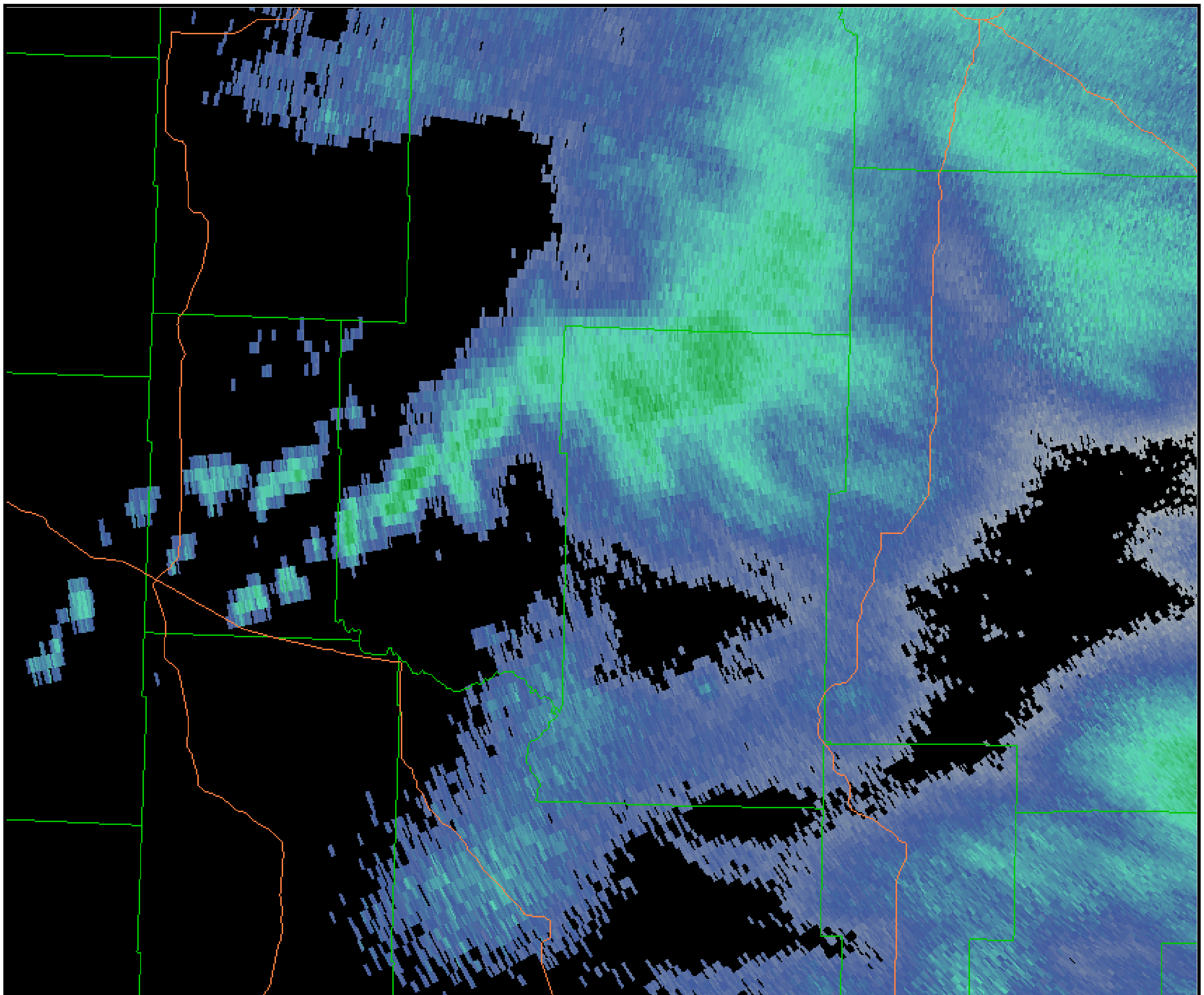

Figure 3(a): Reflectivity data from KDLH using the default noise value.

Figure 3(b) provides an example of the increased reflectivity coverage for a case of very light precipitation at the Duluth site. The application of RxRN noise power values results in a lower noise power threshold and yields more lower-value reflectivity returns.

RDA Build 14.0 has been deployed with the RxRN algorithm turned on. At sites with noise values that are too high, this will improve the CC values and yield more coverage. For sites with interference strobes, some of the strobes may be suppressed. While the impact of RxRN may not

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Pink Fringe *(Cont.)*

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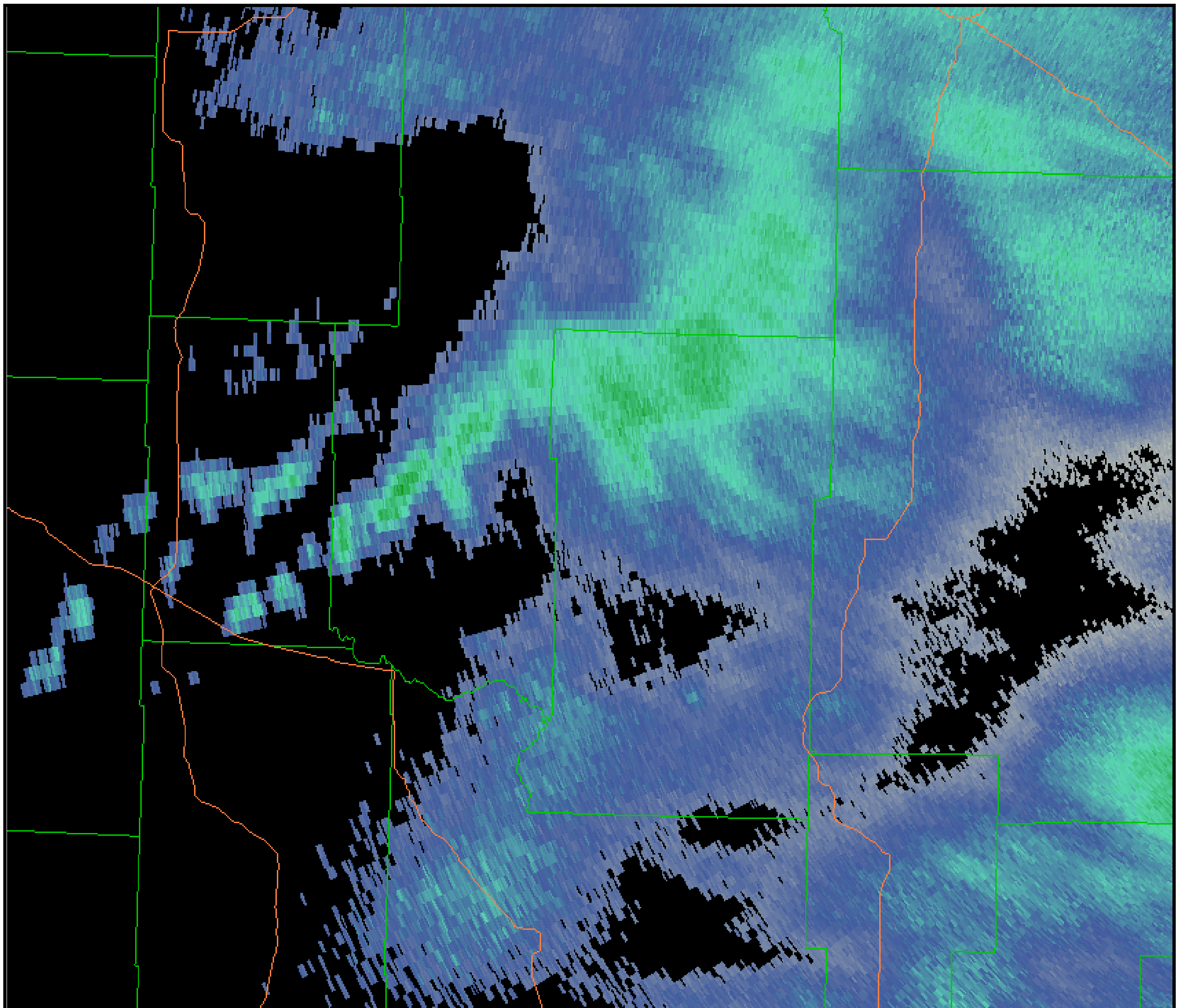

Figure 3(b): Reflectivity data from KDLH using noise values generated by the RxRN algorithm.

be directly noticeable by the user, the more accurate data will be used by the operator and systems that use the Level II data from it. With the implementation of this algorithm, the ROC continues to improve the data accuracy from the RDA, yielding better results for its users.

Jane Krause
ROC Engineering Branch

The Continuing Evolution of Dynamic Scanning

Over the past few years the Radar Operations Center (ROC) has dedicated a significant amount of effort to reduce volume scan completion times and provide for faster low-level elevation updates. The first action was the implementation of VCP 12, which reduced the volume scan completion time to less than 4 1/2 minutes. With the desire for near continuous vertical elevation sampling (especially at low elevations), required volume coverage, data quality constraints and hardware rotational limitations, VCP 12 embodies the limit of rigid VCP definitions. Many thought VCP 12 would provide the most frequent low-level updates possible with a rotating dish radar.

Then the idea of dynamic scanning began to evolve. The concept of dynamic scanning is to tailor the data collection scheme based on the current weather situation. The goal is to provide fast low level updates without sacrificing dense vertical sampling, base data quality, or the products that require the completion of an entire volume scan. The first step toward this paradigm change came

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SAILS 0.5° Elevation Insertion Point Based on VCP Termination Angle							
Elevation Angles (VCP 12)	VCP 12 Elevation Duration	Termination Angle = 19.5	AVSET Termination Angle = 15.6	AVSET Termination Angle = 12.5	AVSET Termination Angle = 10.0	AVSET Termination Angle = 8.0	AVSET Termination Angle = 6.4
0.5°	31 Sec	31 Sec	31 Sec	31 Sec	31 Sec	31 Sec	31 Sec
0.9°	31 Sec	31 Sec	31 Sec	31 Sec	31 Sec	31 Sec	31 Sec
1.3°	31 Sec	31 Sec	31 Sec	31 Sec	31 Sec	31 Sec	31 Sec
1.8°	15 Sec	15 Sec	15 Sec	15 Sec	15 Sec	15 Sec	15 Sec
0.5°						31 Sec	31 Sec
2.4°	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec
0.5°				31 Sec	31 Sec		
3.1°	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec
0.5°		31 Sec	31 Sec				
4.0°	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec
5.1°	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec
6.4°	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec
8.0°	13 Sec	13 Sec	13 Sec	13 Sec	13 Sec	13 Sec	
10.0°	13 Sec	13 Sec	13 Sec	13 Sec	13 Sec		
12.5°	13 Sec	13 Sec	13 Sec	13 Sec			
15.6°	13 Sec	13 Sec	13 Sec				
19.5°	13 Sec	13 Sec					
Duration	243 Sec	274 Sec	261 Sec	248 Sec	235 Sec	222 Sec	209 Sec
0.5 Elevation Update Times	243 Sec*	136 Sec and 138 Sec *	136 Sec and 125 Sec *	122 Sec and 126 Sec *	122 Sec and 113 Sec *	108 Sec and 114 Sec *	108 Sec and 101 Sec *
* Plus Retrace Time							

Table 1: SAILS Elevation Insert Points.

Dynamic Scanning *(Cont.)*

Continued from Page 8

with the introduction of the Automated Volume Scan Evaluation and Termination (AVSET) function (http://www.roc.noaa.gov/WSR88D/NewRadarTechnology/NewTechDefault.aspx), deployed fleet-wide in RDA Build 13.0. By looking at the strength and coverage of the available reflectivity return, AVSET dynamically terminates each volume scan based on the detected weather return. Depending on the location of storms, AVSET can provide volume scan updates as fast as every 190 seconds.

The next step along this evolutionary path was the introduction of the Supplemental Adaptive Intra-Volume Low-Level Scan (SAILS), which was deployed fleet-wide in Build 14.0. SAILS inserts one supplemental low-level elevation split cut scan into the existing severe weather VCPs 12 and 212. This new split cut scan is inserted into the "middle" of the volume scan to evenly space, as closely as possible, the time intervals between low-level elevation data updates. The "middle" of the volume scan is adaptive and determined on a volume scan-to-volume scan basis based on the termination angle determined by AVSET (the SAILS scans are highlighted in Table 1).

SAILS will significantly reduce low-level scan update rates, especially when used in conjunction with AVSET and storms are displaced from the RDA location. Table 2 (below) provides a breakdown of the expected low-level elevation scan update times with SAILS based on AVSET termination angles.

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Elevation Angles (VCP 12)	VCP 12 Elevation Duration	Standard Termination Angle = 19.5	AVSET Termination Angle = 15.6	AVSET Termination Angle = 12.5	AVSET Termination Angle = 10.0	AVSET Termination Angle = 8.0	AVSET Termination Angle = 6.4
Duration	243 Sec	274 Sec	261 Sec	248 Sec	235 Sec	222 Sec	209 Sec
0.5 Elevation Update Times	253 Sec *	136 Sec and 148 Sec *	136 Sec and 135 Sec *	122 Sec and 136 Sec *	122 Sec and 123 Sec *	108 Sec and 124 Sec *	108 Sec and 111 Sec *
		Avg 147 Sec	Avg 140 Sec	Avg 134 Sec	Avg 127 Sec	Avg 121 Sec	Avg 114 Sec
* 10 Seconds Added to Account for Retrace Time. Avg estimate includes 10 additional seconds to account for elevation transition times							

Table 2: Low-Level Update Timing with SAILS and AVSET

Dynamic Scanning *(Cont.)*

Continued from Page 9

With low-level data update times under 2 1/2 minutes (under 2 with ideal conditions), the question was raised, "Are more frequent low-level scan updates possible with the WSR-88D?" The answer to this question is "YES."

During the summer of 2013, several tests were conducted to quantify the acceleration required to transition the antenna to 0.5° multiple times during the execution of a standard volume scan. The results from these tests showed that the antenna drive assembly was designed for three times the acceleration/deceleration required to achieve the desired elevation angle transitions. (The test report is available at http://www.roc.noaa.gov/WSR88D/NewRadarTechnology/NewTechDefault.aspx). Based on these findings, the idea for implementing multiple SAILS scans began to take shape.

Building on the concept of SAILS, MESO-SAILS (Multiple Elevation Scan Option for SAILS) allows the operator to select either one, two, or three supplemental low-level elevation scans (verses only one supplemental scan allowed in the initial SAILS implementation) per VCP (for VCP 12 and 212). Like the initial SAILS concept, these additional supplemental low-level elevation scans are evenly spaced, in time (as close as possible given the defined VCP rotation rates), throughout the volume scan. The new MESO-SAILS options will result in two, three, or four low-level elevation scan updates per volume scan, at the operator's discretion. The tables below show the insertion points for SAILSx2 (Table 3) and SAILSx3 (Table 4) for each of the available AVSET termination angles for VCP 12. (NOTE: The SAILS elevation scans are RED in the tables.) Additionally, the low-level product update times are also provided for each AVSET termination angle.

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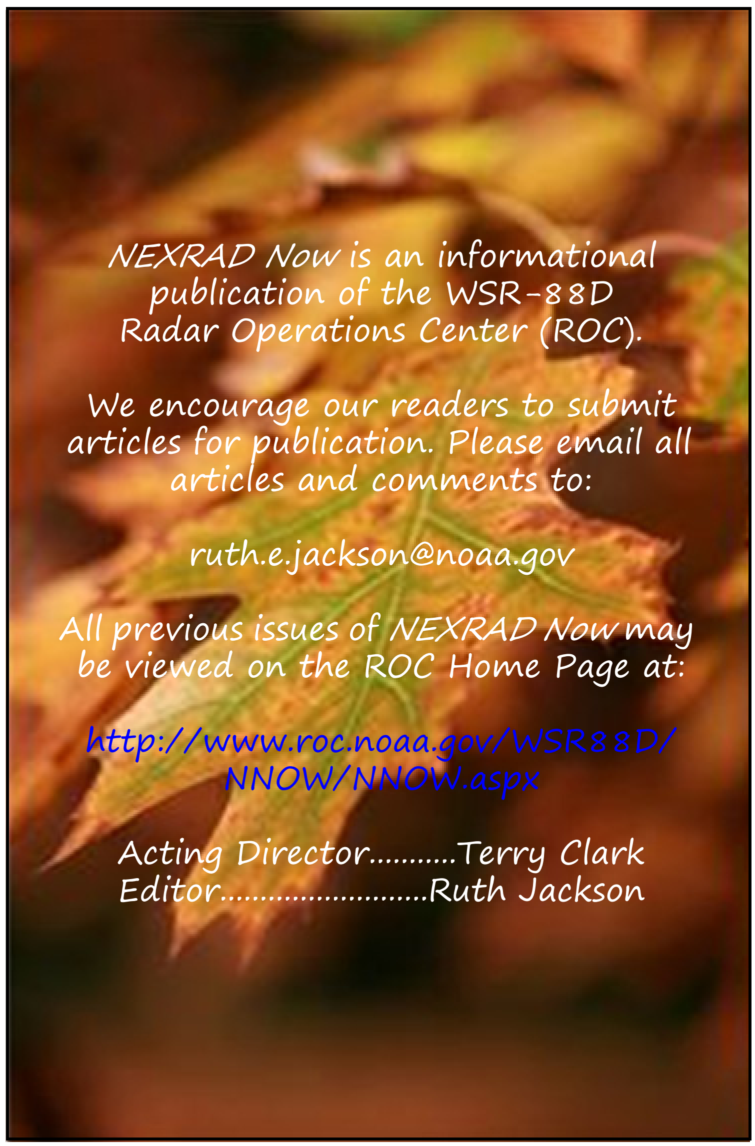

Dynamic Scanning *(Cont.)*

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Elevation Angles (VCP 12)	VCP 12 Elevation Duration	Term Angle 19.5	AVSET Term Angle 15.6	AVSET Term Angle 12.5	AVSET Term Angle 10.0	AVSET Term Angle 8.0	AVSET Term Angle 6.4
0.5°	31 Sec	31 Sec	31 Sec	31 Sec	31 Sec	31 Sec	31 Sec
0.9°	31 Sec	31 Sec	31 Sec	31 Sec	31 Sec	31 Sec	31 Sec
0.5°							31 Sec
1.3°	31 Sec	31 Sec	31 Sec	31 Sec	31 Sec	31 Sec	31 Sec
0.5°		31 Sec	31 Sec	31 Sec	31 Sec	31 Sec	
1.8°	15 Sec	15 Sec	15 Sec	15 Sec	15 Sec	15 Sec	15 Sec
2.4°	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec
0.5°							31 Sec
3.1°	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec
0.5°						31 Sec	
4.0°	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec
0.5°				31 Sec	31 Sec		
5.1°	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec
0.5°			31 Sec				
6.4°	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec
0.5°		31 Sec					
8.0°	13 Sec	13 Sec	13 Sec	13 Sec	13 Sec	13 Sec	
10.0°	13 Sec	13 Sec	13 Sec	13 Sec	13 Sec		
12.5°	13 Sec	13 Sec	13 Sec	13 Sec			
15.6°	13 Sec	13 Sec	13 Sec				
19.5°	13 Sec	13 Sec					
Duration	245 Sec	305 Sec	292 Sec	279 Sec	266 Sec	253 Sec	240 Sec
0.5 Elevation Update Times	243 Sec	93 Sec, 116 Sec, and 106 Sec*	93 Sec, 102 Sec and 107 Sec*	93 Sec, 88 and 108 Sec*	93 Sec, 88 Sec and 95 Sec*	93 Sec, 74 Sec and 96 Sec*	62 Sec, 91 Sec and 97 Sec*
		Avg 108 Sec	Avg 104 Sec	Avg 100 Sec	Avg 96 Sec	Avg 90 Sec	Avg 84 Sec
* 10 Seconds Added to Account for Retrace Time. Avg estimate includes 10 additional seconds to account for elevation transition time							

Table 3: MESO-SAILS x2 with AVSET

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Dynamic Scanning *(Cont.)*

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Elevation Angles (VCP 12)	VCP 12 Elevation Duration	Term Angle 19.5	AVSET Term Angle 15.6	AVSET Term Angle 12.5	AVSET Term Angle 10.0	AVSET Term Angle 8.0	AVSET Term Angle 6.4
0.5°	31 Sec	31 Sec	31 Sec	31 Sec	31 Sec	31 Sec	31 Sec
0.9°	31 Sec	31 Sec	31 Sec	31 Sec	31 Sec	31 Sec	31 Sec
0.5°				31 Sec	31 Sec	31 Sec	31 Sec
1.3°	31 Sec	31 Sec	31 Sec	31 Sec	31 Sec	31 Sec	31 Sec
0.5°		31 Sec	31 Sec				31 Sec
1.8°	15 Sec	15 Sec	15 Sec	15 Sec	15 Sec	15 Sec	15 Sec
0.5°						31 Sec	
2.4°	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec
0.5°			31 Sec	31 Sec	31 Sec		
3.1°	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec
0.5°		31 Sec					31 Sec
4.0°	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec
0.5°						31 Sec	
5.1°	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec
0.5°				31 Sec	31 Sec		
6.4°	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec	14 Sec
0.5°			31 Sec				
8.0°	13 Sec	13 Sec	13 Sec	13 Sec	13 Sec	13 Sec	
0.5°		31 Sec					
10.0°	13 Sec	13 Sec	13 Sec	13 Sec	13 Sec		
12.5°	13 Sec	13 Sec	13 Sec	13 Sec			
15.6°	13 Sec	13 Sec	13 Sec				
19.5°	13 Sec	13 Sec					
Duration	243 Sec	336 Sec	323 Sec	310 Sec	297 Sec	284 Sec	271 Sec
0.5 Elevation Update Times	243 Sec	93 Sec, 74 Sec, 86 Sec and 93 Sec*	93 Sec, 60 Sec, 87 Sec and 93 Sec*	62 Sec, 91 Sec, 73 Sec and 94 Sec*	62 Sec, 91 Sec, 73 Sec and 81 Sec*	62 Sec, 77 Sec, 73 Sec and 82 Sec*	62 Sec, 62 Sec, 74 Sec and 83 Sec*
		Avg 89 Sec	Avg 86 Sec	Avg 83 Sec	Avg 79 Sec	Avg 76 Sec	Avg 73 Sec

* 10 Seconds Added to Account for Retrace Time. Avg estimate includes 10 additional seconds to account for elevation transition time

Table 4: MESO-SAILS x3 with AVSET

Continued on Page 13

Dynamic Scanning *(Cont.)*

Continued from Page 12

The Multiple Elevation Scan Option for SAILS provides the operator with the flexibility to select either 1 (SAILS off), 2, 3 or 4 low-level data updates per volume scan. This flexibility combined with the option to enable AVSET results in significant improvement in low-level data availability. The table below provides the expected frequency of low-level scan updates per hour when AVSET, SAILS, MESO-SAILS, or a combination of those techniques are employed.

The Benefits of Dynamic Scanning

AVSET and SAILS/MESO-SAILS

Product Availability Comparison

VCP 12	Number of 0.5° Base Product Updates per Hour	Volume Product Updates per Hour
Standard Operation	14	14
AVSET	14 - 19	14 - 19
SAILS	24	12
AVSET and SAILS	24 - 32	12 - 16
AVSET and MESO-SAILS	40 - 50	10 - 13

Table 5: Dynamic Scanning Product Availability

(NOTE: As the frequency of low-level scans increases, the number of full volume updates per hour decreases.)

Initial testing of MESO-SAILS, using the ROC testbed radar, began in earnest with the start of the spring convective season. This testing includes measuring bandwidth usage, product evaluation and hardware impact analysis. So far, testing has provided very positive results. Testing will continue throughout the summer months and the results will be presented to the tri-agency partners for consideration in the decision as whether or not to move forward with this concept.

Joe Chrisman
ROC Software Engineering

We're ROC-ing Social Media

On March 24, 2014 the ROC launched accounts on social media sites Facebook, Twitter, and YouTube. Our target audience is the weather enterprise including federal/state/local government users, research, academia, private sector, and the media. Expect to find information about software builds, new radar technology and development, tests and deployments, informational videos, and much more!

Follow us at:

www.facebook.com/NEXRADROC

www.twitter.com/NEXRADROC

www.youtube.com/NEXRADROC

New Coherency Based Thresholding (CBT) Algorithm

When the WSR-88D radar was upgraded to a Dual Polarimetry, the splitting of the transmitted signal reduced the sensitivity of the radar by approximately 3.5 dB. The result of this sensitivity decrease is to lose low-power signals from the data field. To help compensate for this sensitivity reduction, RDA Build 14.0 offers an algorithm called Coherency Based Thresholding (CBT), which was developed at the National Severe Storms Laboratory by Igor Ivic of the Cooperative Institute for Mesoscale Meteorological Studies.

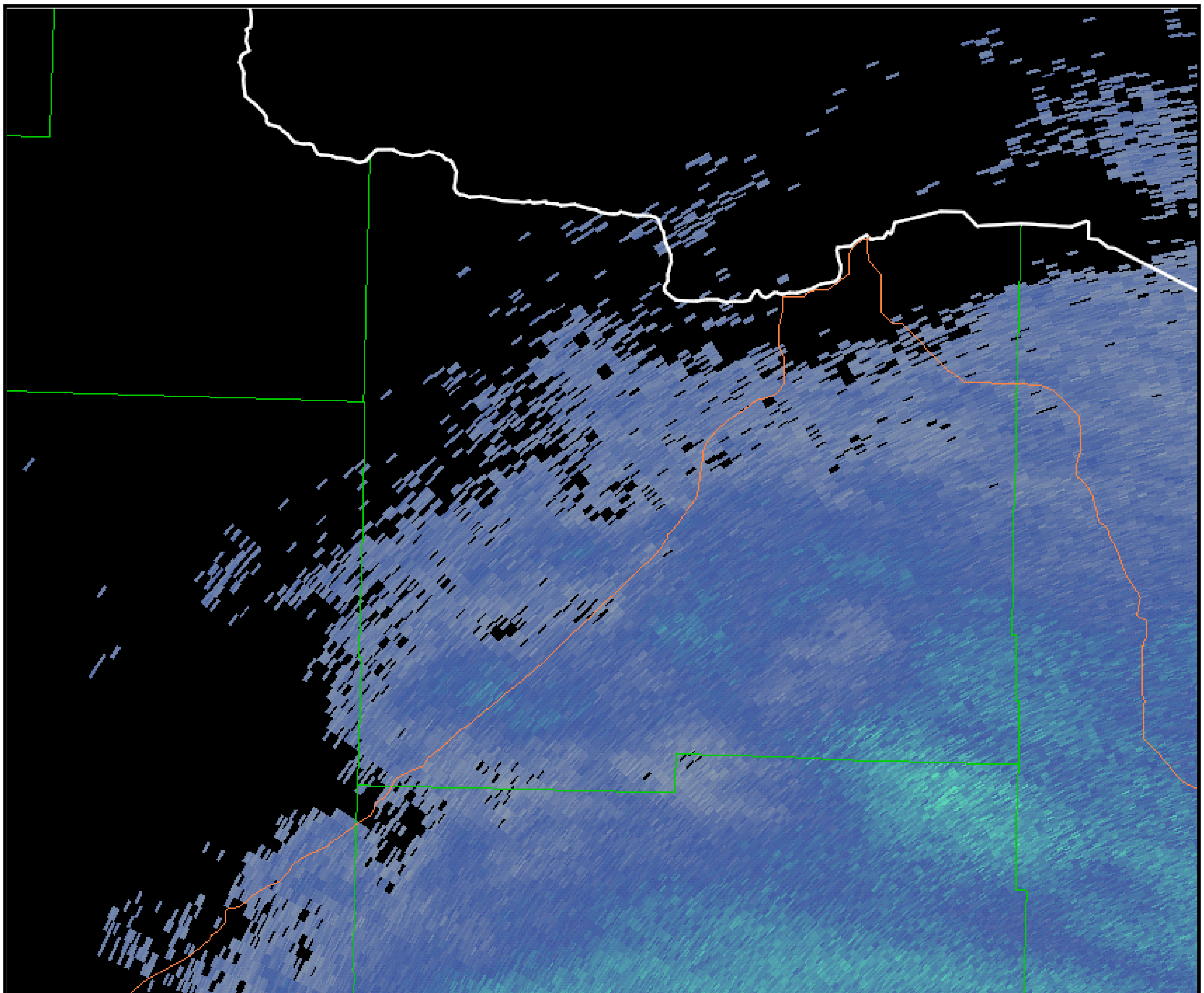

Figure 1(a): Light precipitation at KDLH radar with CBT.

The new algorithm functions alongside the already existing signal-to-noise ratio (SNR) based censoring method. Hence, CBT operates only on data in range bins classified as noise by the standard censoring method. It does so by examining the data in these range bins to determine whether it meets criteria for coherent signal. If it does, the algorithm classifies the data as signal. As a result, bins that were not previously thresholded by the standard censoring are not affected by CBT, but bins with low-power values which are within 3 dB of the SNR threshold, and exhibit coherent signal characteristics, are recovered with CBT. When turned on, CBT is active for all processing modes except for batch cuts.

The impact of CBT on the data fields is that more weak echo data will appear on displays than would

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CBT Algorithm *(Cont.)*

Continued from Page 15

have previously appeared. Unlike when changing algorithms for clutter filtering, where an immediate and discernible impact can be seen, the impact using CBT will be more subtle. For heavier rainfall, some additional returns of weak reflectivity will be observed. The impact will be more noticeable for widespread light precipitation, where many weak echo bins on the outer edges would have been thresholded out of the data field. Likewise, it could also make weak outflow boundaries more visible.

Provided is an example of weak reflectivity returns from Duluth, MN (KDLH) radar. Using Level I data from the site, a data replay system was used to produce a volume with and without CBT applied (Figures 1(a) and (b)). With CBT activated, there are a significant number of weak echo bins

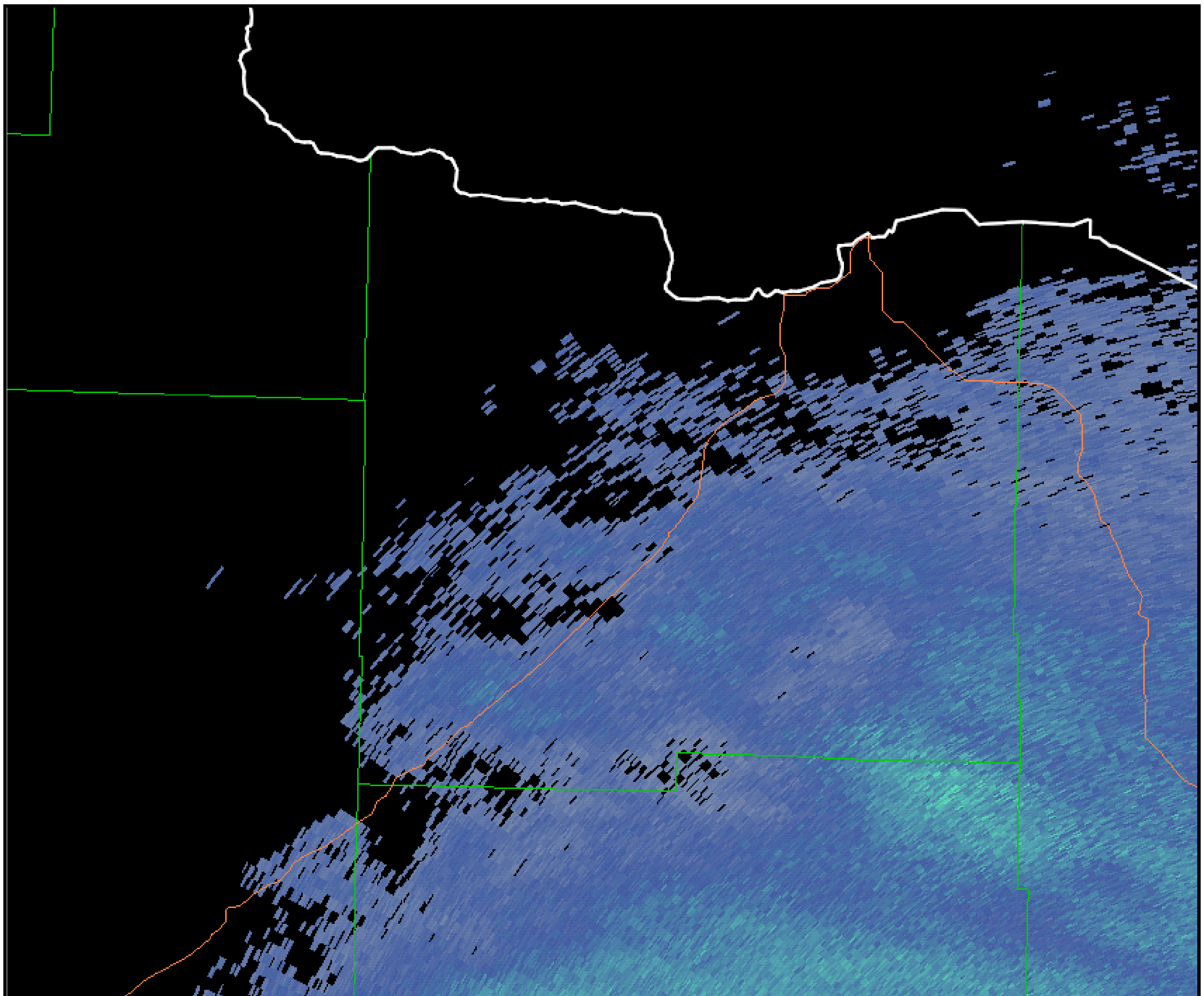

Figure 1(b): Light precipitation at KDLH radar without CBT

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CBT Algorithm *(Cont.)*

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returned to the data field. These bins can provide the forecaster with a more accurate assessment of where precipitation is located across the forecast area.

One important thing to remember when activating CBT is the corresponding values of Correlation Coefficient (CC) of the recovered data. Radar variables estimated from weak echo returns have more variance than those obtained from stronger signals. This is especially true in cases of CC values which are far more likely to stray above one when estimated from weak signals (e.g., echoes recovered by CBT). This accounts for the tendency to see such values along the edges of storms and in other regions of weak echo. This is not a cause for concern, but it is important to remember that when weak signal is returned, its CC values will have more variance than values with strong signal and more CC values that are greater than one will be observed. Figures 2(a) and (b) show the CC field that corresponds to Figures 1(a) and (b).

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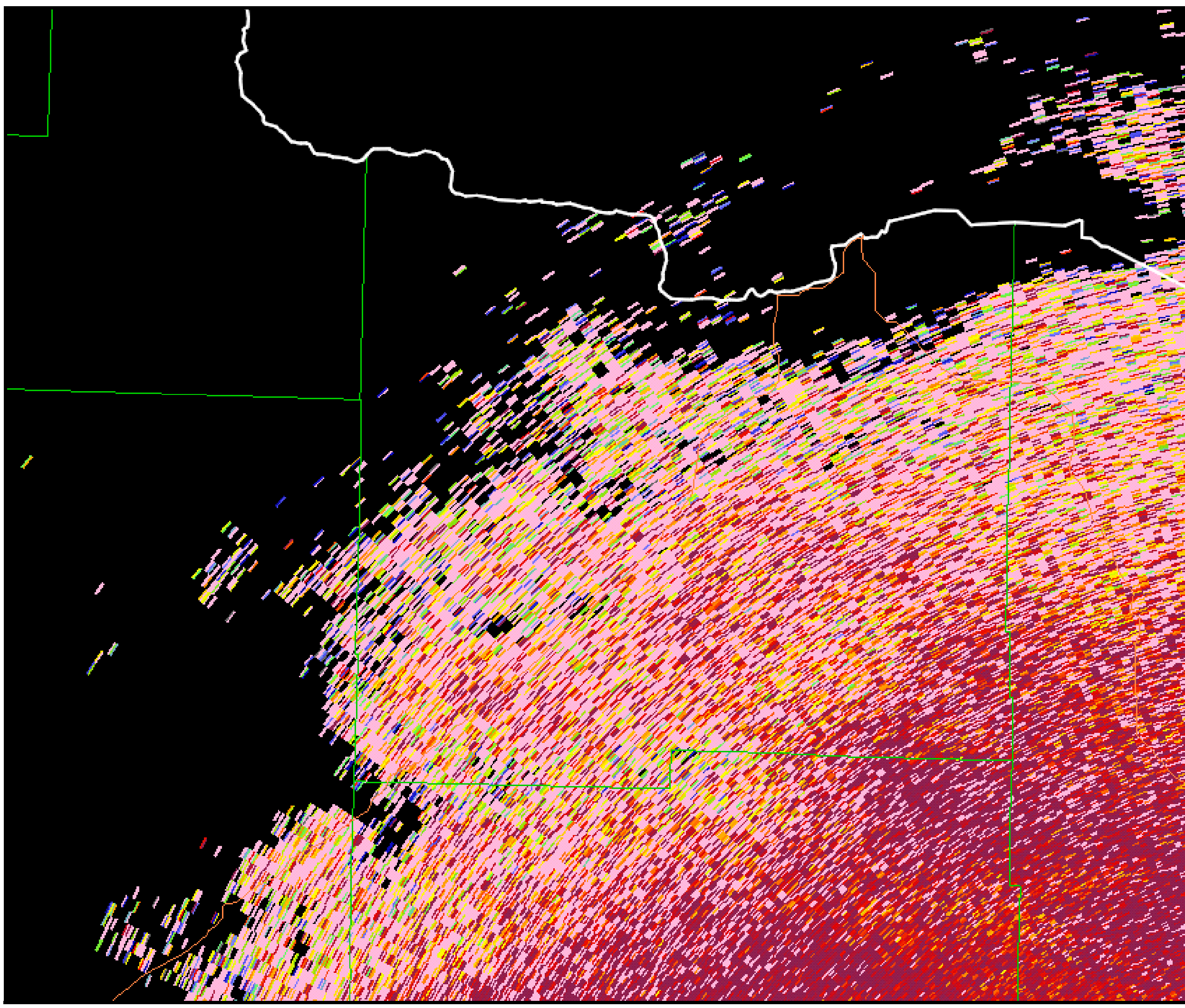

Figure 2(a): Correlation Coefficient for light precipitation at KDLH with CBT.

CBT Algorithm *(Cont.)*

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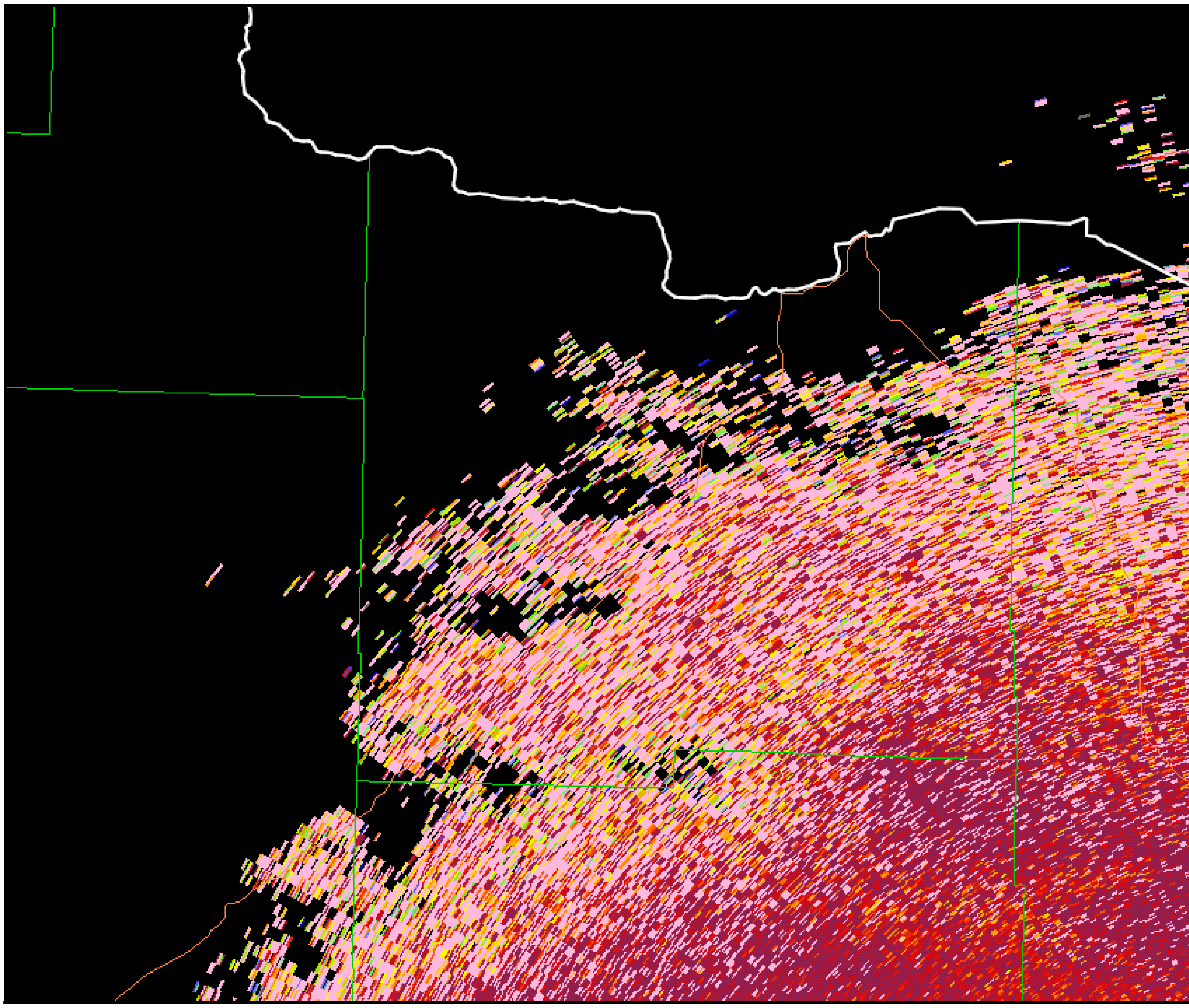

Figure 2(b): Correlation Coefficient for light precipitation at KDLH without CBT.

For Build 14.0, the CBT algorithm is turned off by default. It can be turned on from the RDA HCI. Benefits include a coverage increase in areas of weaker signal and for widespread light stratiform precipitation events, as well as improved returns along weak boundaries. The ROC has made every effort to offer this option to sites in order to alleviate the 3 dB sensitivity loss caused by the Dual Polarimetric upgrade.

Jane Krause
ROC Engineering

Sunset Over Kansas City...

Scott Blair, Lead Forecaster at WFO Kansas City, submitted this vivid photo of the WSR-88D (KEAX) at Pleasant Hill, MO. This colorful sunset occurred prior to a strong cold frontal passage on the evening of January, 26, 2014. Thank you, Scott, for sharing this glimpse of a beautiful Missouri sky.