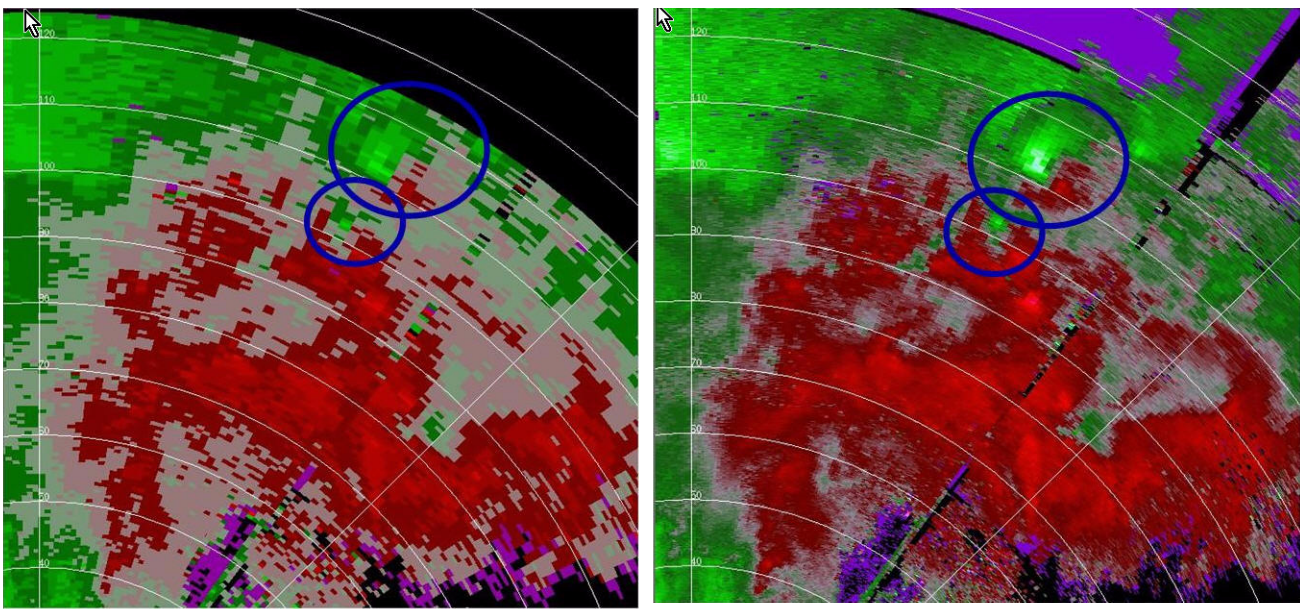
RDA/RPG Build 10.0

Training



Presented by the

Warning Decision Training Branch

Version: 0804

Overview

RDA/RPG Build 10.0 is a software upgrade at both the RDA and RPG. This document will present a summary of the operational impacts of Build 10 from the RDA and RPG perspective. The most significant impact is Super Resolution processing and base products, which will be presented first. The Build 10.0 changes at both the RDA and the RPG may impact Unit Radar Committee (URC) decision making. Coordination among URC members with respect to Build 10.0 URC impacts is encouraged.

The on-line component of the RDA/RPG Build 10 training is presented in three parts. Part 1 focuses on the RDA and RPG changes that produce Super Resolution base data and the new base products. Part 2 presents the remaining Build 10 impacts from the RDA and the RPG. Part 3 focuses on the impacts of using super resolution base products at AWIPS. This document presents the material from Part 1 and Part 2.

The information presented in this document and the on-line materials all reflect the pre-deployment state of knowledge of the operational impacts of Build 10.

Electronic Performance Support System (EPSS)

The Electronic Performance Support System (EPSS) has been updated to support the Build 10.0 changes that are apparent at the RPG Human Computer Interface (HCI). In addition, launching the EPSS at the HCI will now display an initial selection screen that allows operators to choose either the RPG EPSS or a new RDA EPSS. The RDA EPSS, like its RPG counterpart, provides HCI navigation assistance and specific guidance on selected (RDA) task completion.

RDA/RPG Build 10.0 Operational Impacts: Super Resolution

Objectives

1. Identify the RDA processing techniques used to produce super resolution base data.
2. Identify the data quality impact of RDA super resolution processing.
3. Identify differences between super resolution and legacy resolution base products.
4. Identify the purpose of the Recombination Algorithm.

Reference

Initial Implementation of Super Resolution Data on the Nexrad Network; S. Torres and C. Curtis

This reference paper is recommended reading for users wanting to learn more about both Super Resolution and Recombination algorithm execution.

Super Resolution and Recombination

Super Resolution (SR) base data are processed with a range resolution of .25 km (.13 nm) ***and*** an azimuthal resolution of .5°. The display range for SR velocity and spectrum width products is extended from 230 km (124 nm) to 300 km (162 nm). The display range for SR reflectivity products is 460 km (248 nm).

SR requires software changes at both the RDA and the RPG. SR base data are processed at the RDA, while the RPG generates the SR base products. The RPG ***also*** uses a Recombination Algorithm to convert the SR data to the resolution required for the ***legacy*** base products and the algorithms that generate the derived products.

SR processing is available ***only*** for the Base Products and ***only*** for the Split Cut elevations. Initially, SR is intended for visual interrogation using base products and is ***not*** used for generation of derived products.

Why Super Resolution?

Super Resolution products are expected to increase the range where forecasters can visually detect hazards such as mesocyclones and tornadic vortex signatures. In Figure 1, the same data are depicted in a reflectivity product with 4 bit legacy resolution on the left and 8 bit SR on the right. The corresponding velocity products are depicted in Figure 2. Note the finer detail with SR in both reflectivity and velocity. Though this example is using Base Velocity, SR SRMs can be generated at AWIPS, further improving the visual detection of circulations.

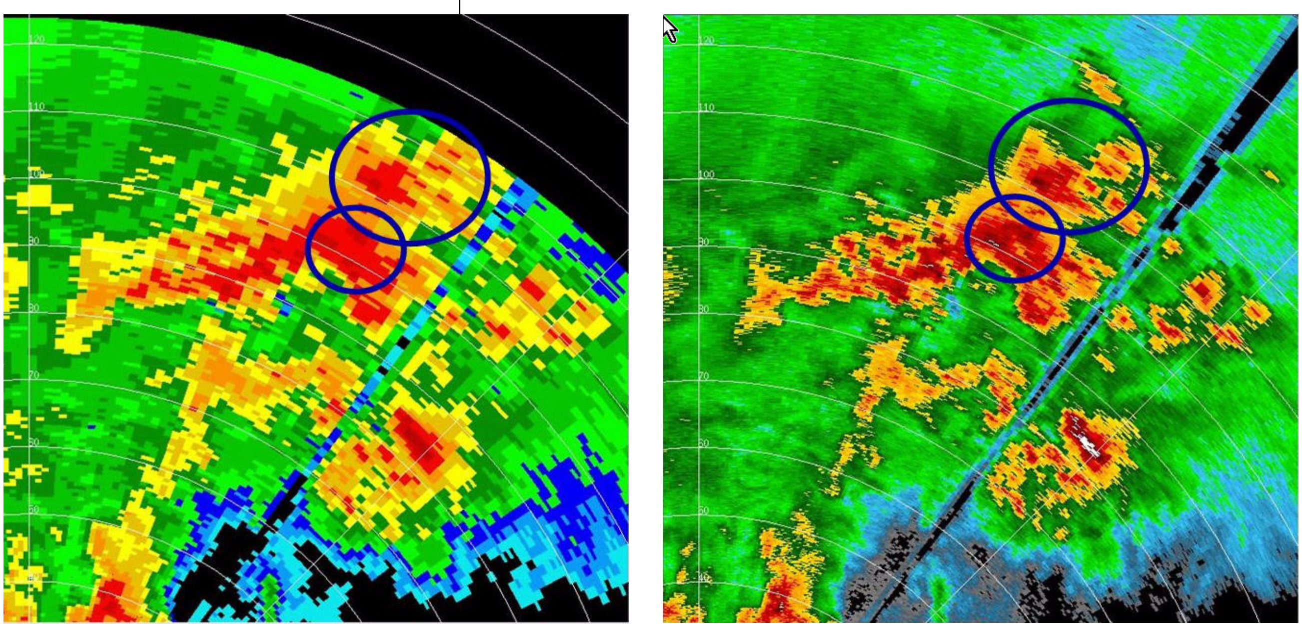


Figure 1. Reflectivity products with 4 bit legacy resolution (left) and 8 bit super resolution (right).

Super Resolution vs. Legacy Resolution

Since the original deployment of the WSR-88D, all base products have had an azimuthal resolution of 1°. The best range resolution available for Base Reflectivity products has been 1 km (.54 nm). Although returned power is available at .25 km

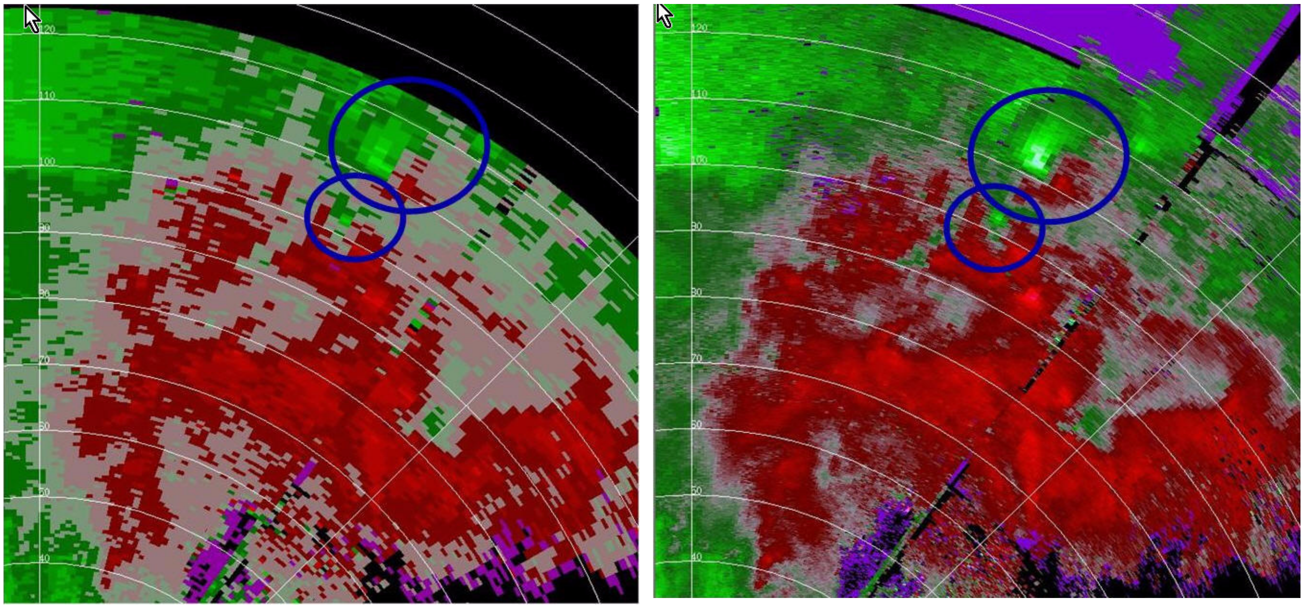


Figure 2. Velocity products with 4 bit legacy resolution (left) and 8 bit super resolution (right).

(.13 nm) resolution, the average power for 4 consecutive .25 km bins is used to convert to Reflectivity at 1 km resolution. The best range resolution available for Base Velocity and Spectrum Width products has always been .25 km (.13 nm). In this document, these base data resolution values will be referred to as the legacy resolutions.

SR processing narrows the azimuthal resolution from 1° to .5° for all 3 ***Base*** products. It also increases the range resolution for Reflectivity from 1 km (.54 nm) to .25 km (.13 nm), which is the same as the legacy range resolution for Velocity and Spectrum Width. With respect to data levels, the SR base products are all 8 bit.

Potential for Higher Data Values

Since SR processing no longer averages returned power and the azimuthal resolution is narrower, there is potential for higher reflectivity values. Since the azimuthal resolution for SR products is one half of legacy, there is also potential for higher velocity values.

Example SR Products in D2D

The following are examples of SR base products presented next to legacy resolution base products in D2D. In each case, the SR products have a slightly noisier appearance than the legacy products. This is a consequence of the techniques used for SR processing at the RDA, which are presented beginning on page 9.

The SR version of Base Reflectivity at the RPG is product #153 and product ID SDR. See Figure 3 to compare the appearance of 8 bit SR (left) and 8 bit legacy resolution (right) for Base Reflectivity as they appear in AWIPS D2D. The upper left legend information identifies SR by including both the range resolution (0.25 km) and the azimuthal resolution (0.5dAz) under VCP 12.

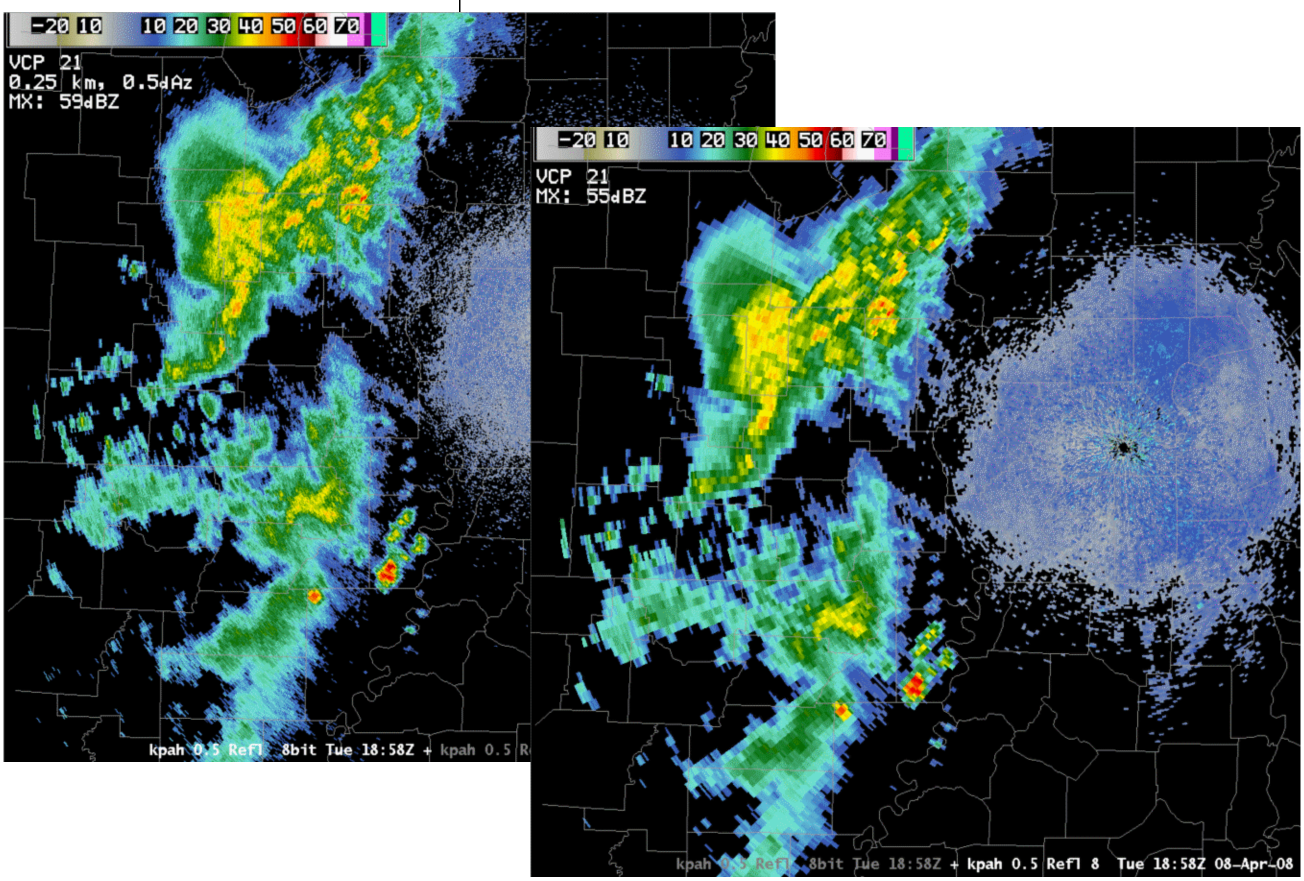


Figure 3. 8 bit super resolution (left) vs. 8 bit legacy resolution (right) for base reflectivity.

The SR Velocity product at the RPG is product #154 and product ID SDV. See Figure 4 for a comparison of the appearance of 8 bit SR (left) and 8 bit legacy resolution (right) for Base Velocity as they appear in AWIPS D2D. As with SDR, the upper left legend information identifies SR by including both the range resolution (0.25 km) and the azimuthal resolution (0.5dAz) under VCP 12.

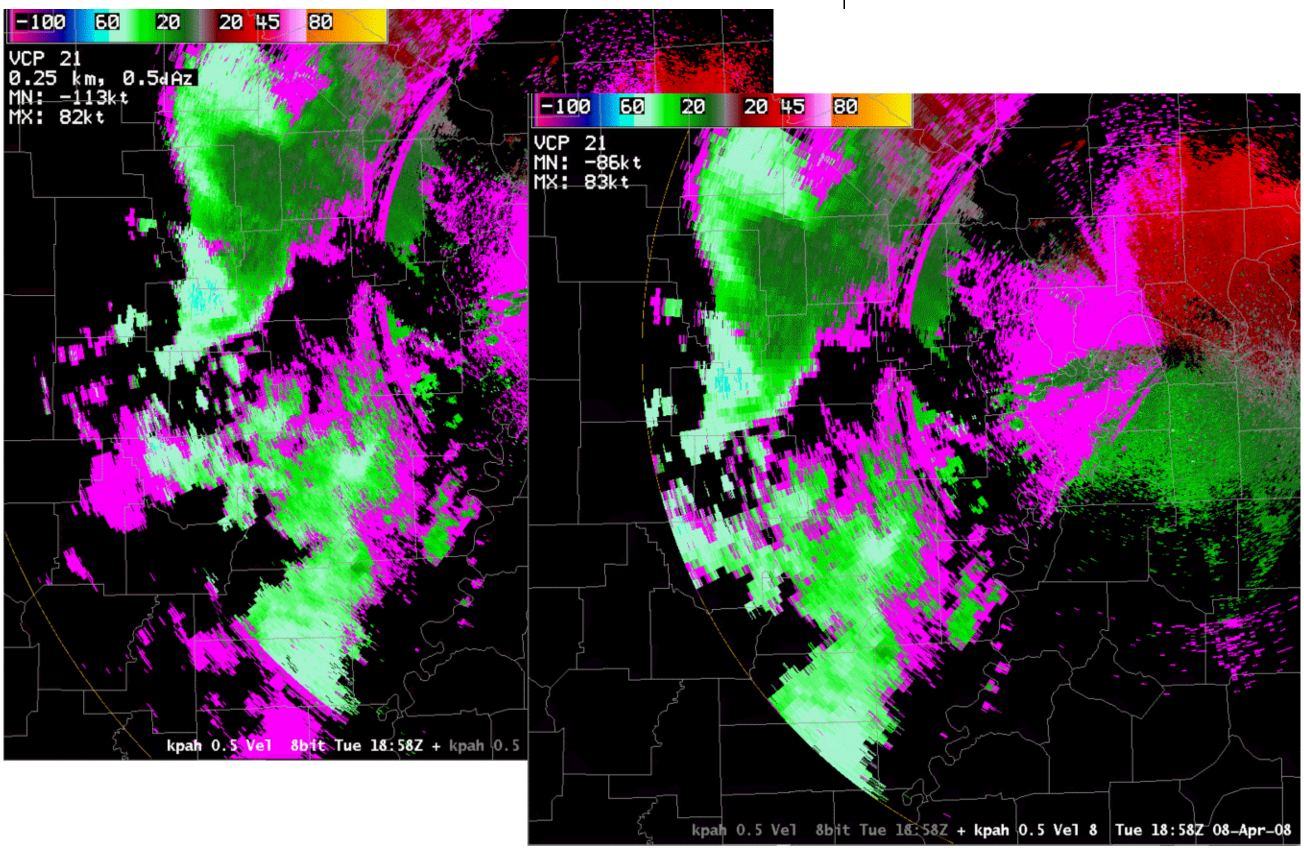


Figure 4. 8 bit super resolution (left) vs. 8 bit legacy resolution (right) for base velocity.

The SR Spectrum Width product at the RPG is product #155 and product ID SDW. See Figure 5 to compare the appearance of 8 bit SR (left) and 3 bit legacy resolution (right) for Spectrum Width as they will appear in AWIPS D2D. As with SDR and SDV, the upper left legend information identifies SR by including both the range resolution (0.25 km) and the azimuthal resolution (0.5dAz) under VCP 12. The SR Spectrum Width product is the only version with 8 bit data levels. Note on the SR

Spectrum Width product, the exact value is presented on the cursor readout, as with the other 8 bit base products. Also the maximum value in the upper left legend is listed as 19 kts, although the cursor readout value in this example is almost 35 kts. The max value in the legend will be corrected with Build 11.

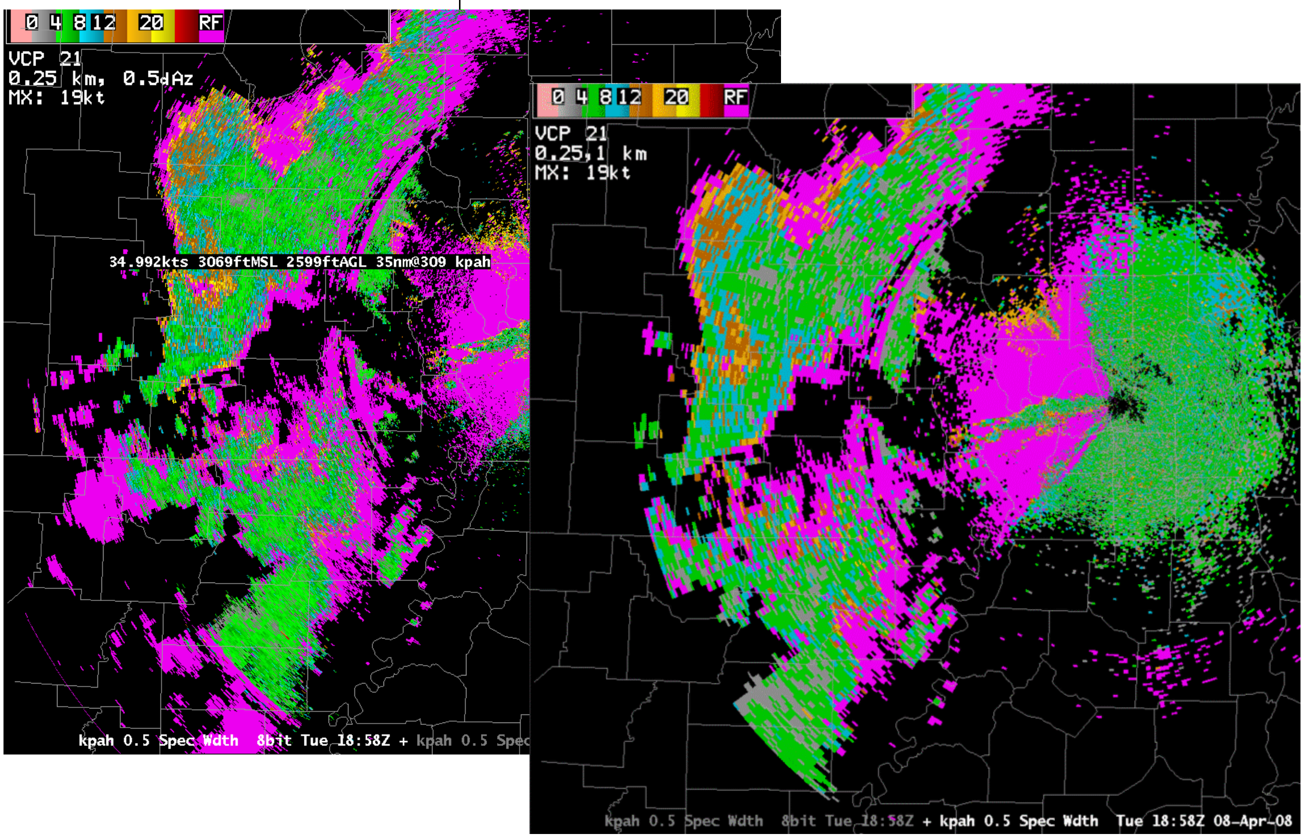


Figure 5. 8 bit super resolution (left) vs. 3 bit legacy resolution (right) for base spectrum width.

Note that for Spectrum Width in D2D, there is a distinctive color associated with a spectrum width equal to zero. If the spectrum width calculation is unable to assign a meaningful value, zero is assigned to that range bin. Since SR base data are slightly noisier than legacy resolution, there may be an increased number of zero bins with SR spectrum width products, as compared to the legacy resolution.

Extended Display Range

For both SR Velocity and Spectrum Width products, SR processing has extended the display range from 230 km (124 nm) to 300 km (162 nm). See Figure 6 for an example of the difference in display range for SR (left) and legacy (right) on Base Velocity. Depending on the VCP and the Doppler PRF used, some portion of the 3rd trip of the velocity data may be displayed. In the example in Figure 6, VCP 21 with PRF #8 was used, resulting in the 1st trip ending at 63 nm, the 2nd trip ending at 126 nm, and the 3rd trip between 126 and 162 nm. In this case, echoes are sufficiently widespread that transitions from the 1st to 2nd trip and from the 2nd to 3rd trip are apparent.

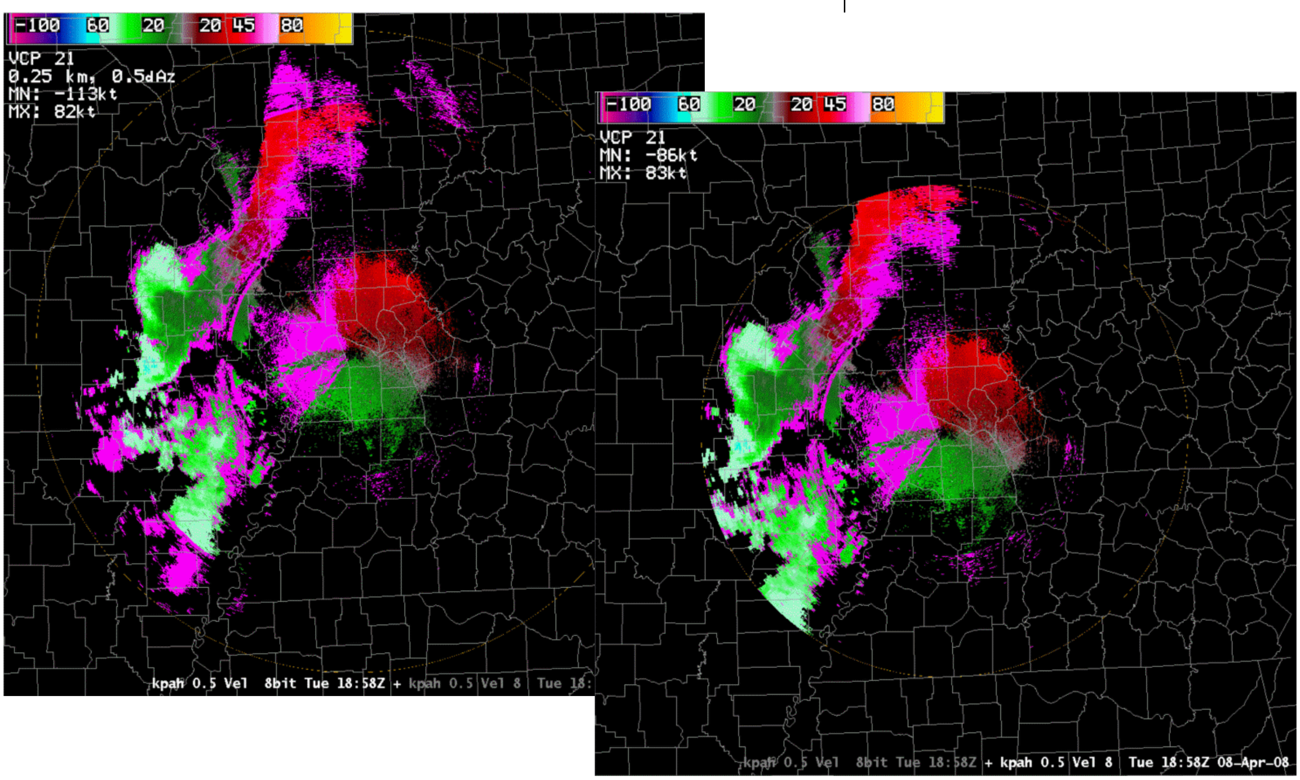


Figure 6. Display range for legacy resolution (left) vs. super resolution (right) for base velocity.

Super Resolution Processing at the RDA

SR base data are generated at the signal processor at the RDA for ***only*** the Split Cut elevations of the VCPs. Increasing the range resolution for Reflectivity from 1 km (.54 nm) to .25 km (.13 nm) is done by simply eliminating the step that averages 4 consecutive power values used for the legacy resolution.

Effective Beamwidth

Increasing the azimuthal resolution for all three base moments from 1° to .5° is more complicated. An important concept that supports understanding of SR processing is “effective beamwidth”. The physical beamwidth ***for any single pulse*** is slightly less than 1°. This would also apply if the WSR-88D antenna were stationary. However, the antenna moves as pulses are transmitted and received. For base data assigned to a particular radial, the pulses identified for base data processing are those transmitted as the beam centerline passes through that radial.

Figure 7 shows an example of 11 pulses used to generate base data for the radial between 0° and 1°. Though in operations the actual number of pulses per radial would be higher, 11 was chosen in this example for simplicity. The black dots represent pulses whose beam centerline is within the radial. Note that ***except*** for the pulse centered on this radial (at 0.5°), the beam position associated with the remaining pulses will capture scatterers ***outside*** this particular radial.

The process of sampling as an antenna rotates results in what is known as the effective beamwidth. With legacy resolution, the effective beamwidth is about 1.4°. This effective beamwidth can be narrowed by using techniques known as overlapping radials and data windowing.

Overlapping Radials

Overlapping radials is achieved by changing the defined center of each radial from 0.5°, 1.5°, 2.5°, etc. (legacy) to 0.25°, 0.75°, 1.25°, 1.75°, etc. (SR). Figure 8 depicts this concept, where the base data are processed for the radials between

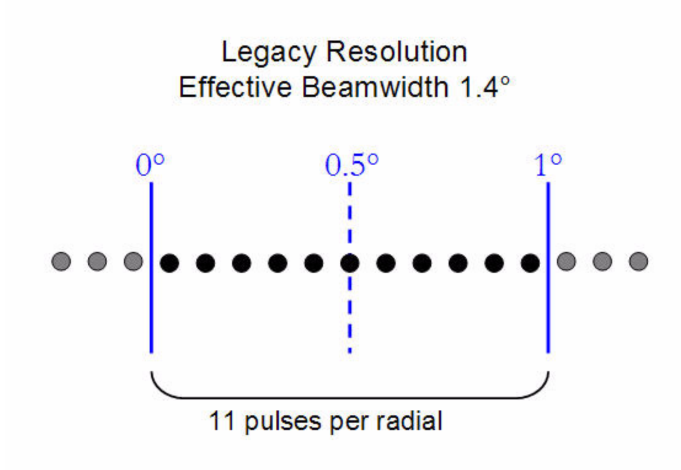


Figure 7. Effective beamwidth of legacy resolution.

0° and 0.5° and between 0.5° and 1°. The center of the first radial is 0.25° and the pulses that comprise the base data estimate come from 359.75° to 0.75°. The center of the second radial is 0.75° and the pulses that comprise the base data estimate come from 0.25° to 1.25°. The result is 1° radials that overlap.

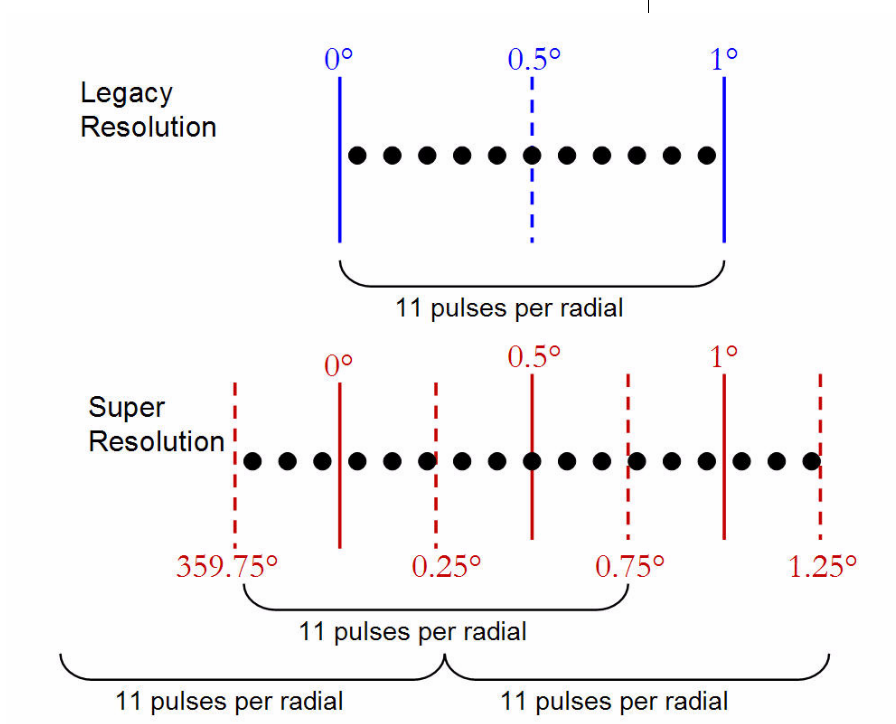


Figure 8. Overlapping radials for super resolution.

Data Windowing

Overlapping radials is not sufficient for Super Resolution because the number of pulses per radial cannot be decreased and the effective beamwidth for each 0.5° radial is ***still*** 1.4°. Thus there is a need for data windowing. Data windowing is a weighting technique that affects the impact of individual pulses on the base data estimate. For example, if all the pulses have the same weight, each pulse has the same contribution to the estimate. This case, where all the pulses have equal weight, is called a Rectangular window. See Figure 9 for an example of a Rectangular window, which is one of the many windowing techniques used in signal processing.

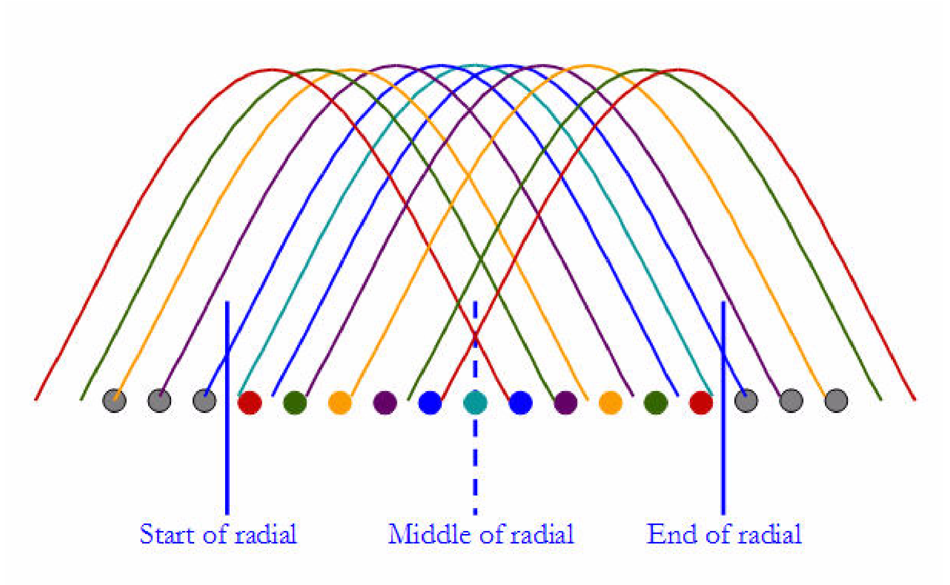


Figure 9. Rectangular window, where all the pulses have equal weight.

Other windowing techniques give the pulses closest to the center of the radial more weight and the pulses away from the center of the radial progressively less weight. There are windowing techniques in signal processing that use this weighting scheme to narrow the effective beamwidth. Figure 10 depicts a simplified version of this concept, using the same set of pulses from Figure 9.

Though this successfully narrows the effective beamwidth to about 1°, there is some data loss since the pulses furthest away from the center have lower weight. This increases the variance (error) of the base data estimate.

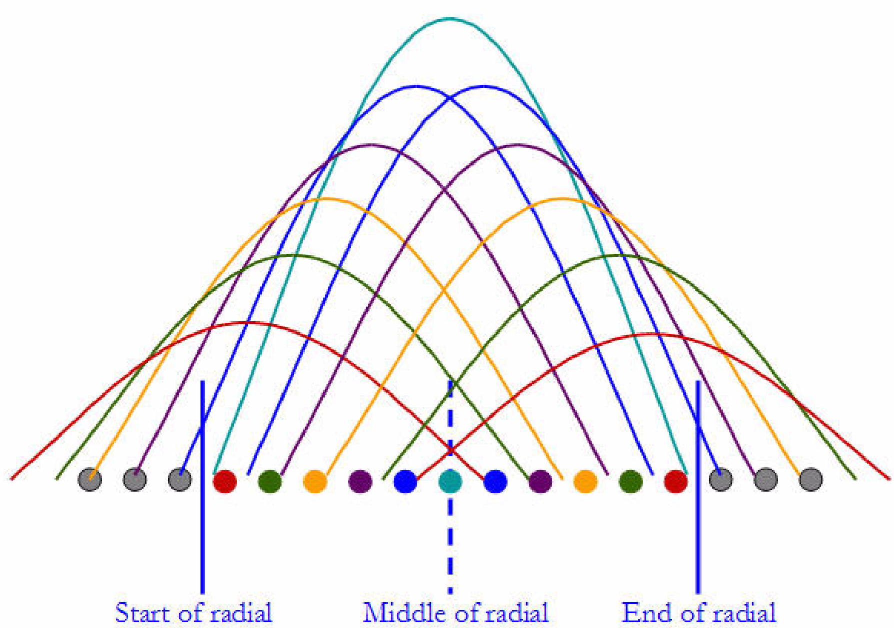


Figure 10. Windowing technique which narrows the effective beamwidth.

Operational Impacts of Super Resolution

Noisier Data

The combination of overlapping radials and windowing is sufficient for products with an azimuthal resolution of .5°, though the resultant SR base data have higher variance than the legacy resolution. The SR products are visually noisier, but the noisiness is expected to be an acceptable trade off for the benefits of visually detecting smaller scale features at longer ranges. Additional signal processing techniques may be provided in the future to reduce this noisiness enough to allow SR base data to be used for input into at least some of the legacy algorithms.

Transitioning Through Multiple Elevations

A significant operational adjustment in the usage of SR products will involve viewing data through multiple elevations, whether using All Tilts or 4-panel displays. Since the SR products are limited to the Split Cut elevations, the products from angles above will be at the legacy resolution. Visually transitioning from SR to the legacy resolution as you view higher angles may be initially distracting and will require some familiarization. See Figure 11 for an example of a 4-panel Reflectivity display with 2 panels from the Split Cut elevations (SR for 0.5° and 1.5°) and 2 panels from higher elevations (legacy resolution for 2.4° and 3.4°).

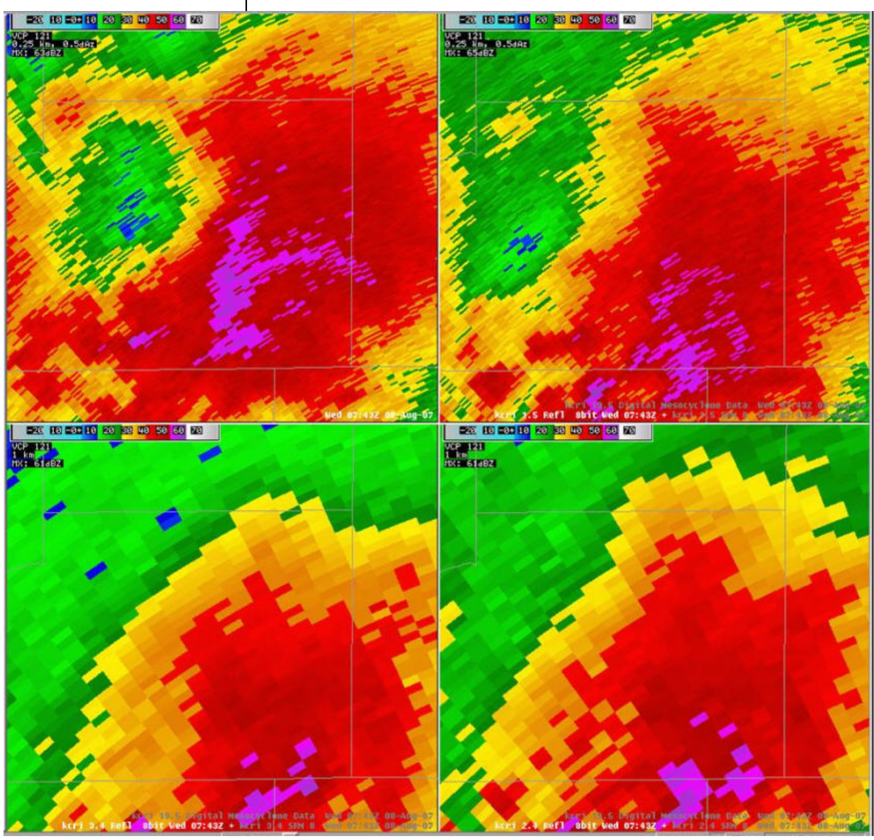


Figure 11. Four panel reflectivity with SR products on Split Cut elevations (0.5° and 1.5°) and legacy resolution for the higher elevations (2.4° and 3.4°).

Legacy Resolution Base Products Still Available for Split Cuts

Though the SR base products are generated only for the Split Cut elevations, legacy resolution base products (3 bit, 4 bit, and 8 bit) are ***also*** generated for these ***same*** elevations. They are generated from SR base data that has been “recombined” into the legacy resolution. The legacy resolution base products from this recombined data will be less noisy than the SR base products. The Recombination Algorithm is presented beginning on page 16.

Agency Access to SR Products

Thanks to the high speed AWIPS lan-to-lan connection, NWS WFOs will have access to the SR base products generated from their dedicated RPG(s). Bandwidth is also sufficient for WFOs to receive SR products from FAA RPGs, dedicated supplemental connections, and WAN-based product requests. WFOs that have high speed frame relay connections from AWIPS to DoD RPGs will also be able to access SR base products from DoD radars. However, due to bandwidth limitations the DoD staff at those associated base weather offices will ***not*** be able to see those same SR products! This difference in agency access is something that staff at both the NWS and DoD offices must keep in mind.

SR products will not be displayed on the NWS radar web pages for the near future. The products displayed on these pages come from the Radar Product Central Collection Dissemination Service (RPCCDS). Additional bandwidth is required to add SR products to the RPCCDS.

RPS Lists

WFOs will need to adjust RPS lists to allow for SR products from the Split Cut elevations of each VCP. RPS lists for adjacent radars with dedicated connections also will need to be adjusted. To determine if an adjacent radar has SR processing, the Nexrad Unit Status product will have an S next to the elevations with SR products.

Recombination Algorithm at the RPG

The derived products are generated from algorithms that were designed to process base data at the ***legacy*** resolution. Examples include the Mesocyclone Detection Algorithm (MDA), the Precipitation Processing System (PPS) and many others. Currently, ***none*** of these algorithms can ingest SR base data.

Though the signal processor ***could*** generate both legacy and SR base data for the Split Cut elevations, it is not possible for the wideband communications link to accommodate ***both*** data streams. Therefore, the SR base data must be "recombined" at the RPG to produce legacy resolution data for the legacy base products (3 bit, 4 bit and 8 bit) as well as for ingest into the algorithms that generate the derived products.

Figure 12 depicts the recombination process for base reflectivity data. There are eight SR bins for the corresponding legacy resolution bin. The conversion to legacy resolution for this case is a linear average of the eight SR values. Note that averaged values are Z, not dBZ, improving the quality of the estimate. The legacy Z value is then converted to dBZ for product generation.

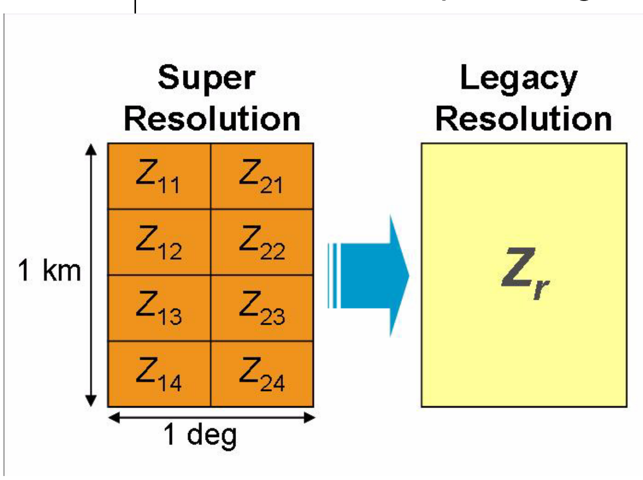


Figure 12. Recombination process for base reflectivity. Blue arrow depicts the linear average of all 8 bins.

Figure 13 depicts the recombination process for base velocity and base spectrum width. There are two SR bins for the corresponding legacy resolution bin. For velocity, the average is power weighted. For spectrum width, the average is also power weighted, but there is an additional step to account for the variance of the two velocity estimates that generated the two spectrum widths.

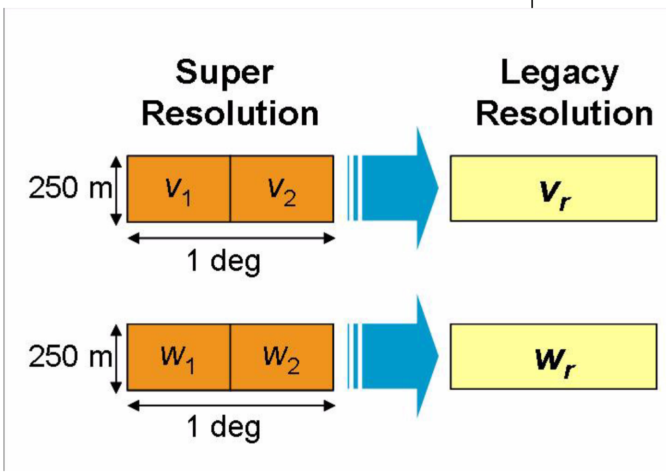


Figure 13. Recombination process for base velocity and spectrum width. Blue arrow depicts power weighted averaging for velocity and spectrum width (also accounts for variance of velocity for spectrum width calculation).

Recombination With Incomplete Data

When one or more of the SR bins contain No Data, the Recombination Algorithm uses different methods depending on the data type. For reflectivity, No Data means that the returned power was too low for display purposes, but it does not mean ***zero*** power. A power value is estimated using the system noise value (transmitted from the RDA) and the signal to noise ratio threshold. Though this individual power value would be too low for display, its estimated Z value is included in the average.

For velocity and spectrum width, the two available SR bins may contain valid data, No Data, or RF. If ***both*** SR bins contain No Data or RF, the resultant legacy bin will also contain No Data or RF, respectively. If one of the SR bins contains a valid velocity or spectrum width, it is used for the legacy bin.

Recombined Data and Legacy Algorithms

Extensive testing was performed to ensure that the recombined base data were operationally equivalent to the legacy base data with respect to algorithm performance. The testing was conducted for SCIT, ET/EET, VIL/DVIL, VWP, MDA, TDA, and STP. No significant differences in algorithm performance were discovered.

MDA Detections

Recall that MDA is particularly sensitive to low power and/or noisy velocity data. Operationally insignificant MDA detections occur in these areas. Though SR base data are noisier than legacy, SR base data are ***not*** used by the MDA. Operationally insignificant MDA detections are ***not*** affected by SR processing.

Disabling SR Processing

SR data processing is expected to be operational at all times. However, there is an option to disable SR if there are wideband communications (or other) problems that cannot support SR data transfer from the RDA to the RPG. When SR data processing is disabled, legacy base data are processed at the RDA for the Split Cut elevations instead.

RDA Build 10.0 Operational Impacts

The following impacts are the result of Build 10 changes to the RDA software:

1. Bypass Map Generation SNR and Clutter threshold default values changed

2. Changes to clutter censoring settings to reduce the number of “No Data” bins

3. Maximum number of clutter regions increased from 15 to 25

4. RDA HCI changes

Objectives

1. Identify the impact of changes to the clutter censoring settings.
2. Identify the relationship between the number of clutter filter elevation segments and the maximum number of clutter regions per file.

1. Bypass Map Generation Default Values Changed

There are two editable thresholds used in the Bypass Map Generation process: SNR and Clutter. Investigations by the ROC have found that the preferred default values for these thresholds are 24 and 3, respectively. Build 10 RDA software makes these values the default. Figure 14 depicts the Generate Clutter Map window with the Build 10.0 default values.

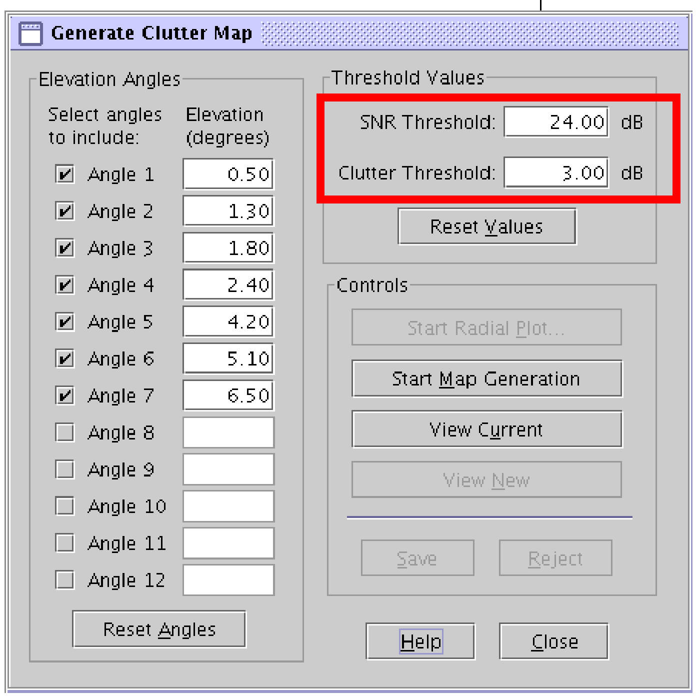


Figure 14. Generate Clutter Map window with Build 10 defaults for the thresholds.

2. Changes to Clutter Censoring Settings

Clutter censoring is a part of the Gaussian Model Adaptive Processing (GMAP) clutter filtering technique. For range bins which return only signal from hard targets (no meteorological returns), censoring is designed to assign No Data to those bins. The previous settings for the censoring process were too aggressive and had the potential to assign No

Data to bins with some meteorological return. The Build 10.0 settings are adjusted such that there are fewer range bins assigned No Data within an area of ground clutter return. This results in more bins with data available within areas of terrain clutter than previously.

3. Maximum Number of Clutter Regions Increased

RDA/RPG Build 9.0 (deployed Summer 2007) had a significant change to the implementation of clutter filtering by increasing the number of elevation segments from 2 to 5 (Figure 15). This increased the vertical resolution of clutter filtering and reduced unnecessary suppression on higher elevation angles. This change did require the development of appropriate clutter suppression regions for ***each*** of the 5 segments. However, there was a limit of 15 regions in total for the 5 segments. For sites where this may be prohibitive, Build 10.0 increases the limit from 15 to 25 regions per file distributed over all 5 segments.

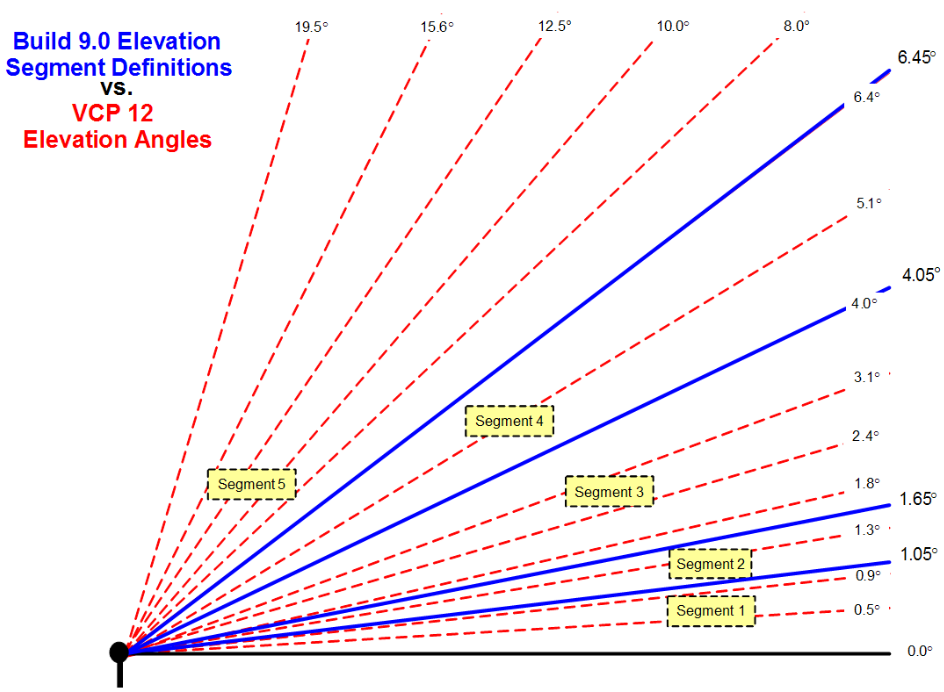


Figure 15. Five clutter filtering elevation segments deployed Summer 2007.

4. RDA HCI Changes

The RDA HCI (Figure 16) provides more information, without requiring a password, than previous builds. Performance Data, Log Data, and Adaptation Data are all available without providing a password.

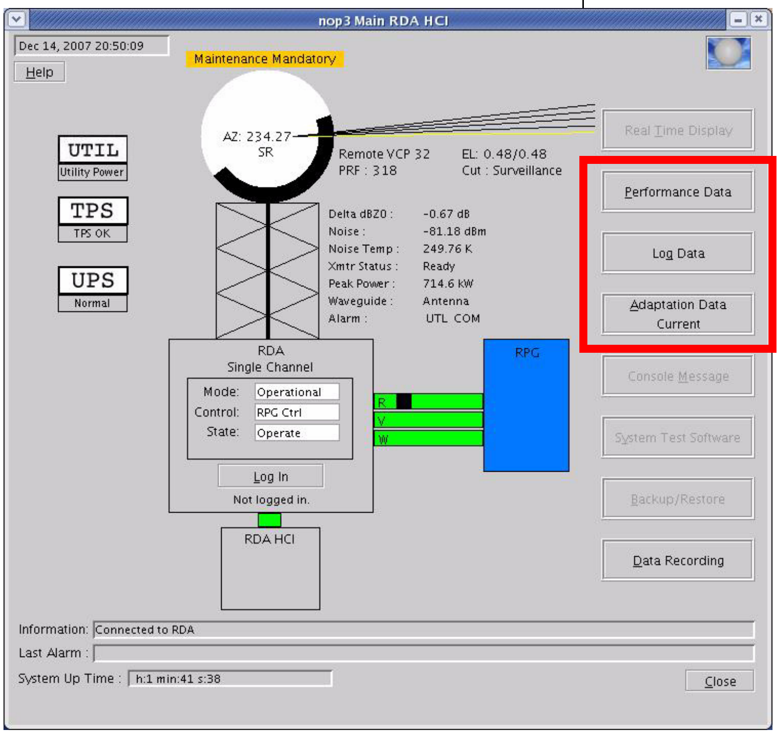


Figure 16. RDA HCI without password.

RPG Build 10.0 Operational Impacts

The following impacts are the result of Build 10 changes to the RPG software:

1. Numerous RPG HCI changes
2. Enhanced version of the Multiple PRF Dealiasing Algorithm (MPDA) invoked with VCP 121
3. Bias value source added to PPS products
4. Threshold number of gage-radar pairs is URC editable

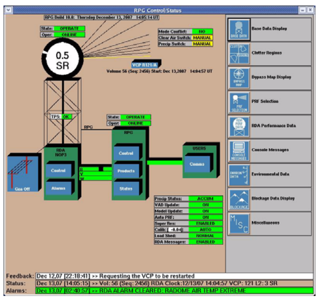
Objectives

1. Identify the purposes of the two RPG HCI main page changes related to super resolution.
2. Identify the design change and resultant improvement to the Build 10.0 VCP 121.

3. Identify the operational considerations for the use of the Build 10.0 VCP 121.

1. Numerous RPG HCI Changes

RPG HCI Main Page and Super Resolution



There are two changes to the RPG HCI main page related to Super Resolution (SR). When SR base data are being processed, “SR” will be displayed on the radome just under the elevation angle number. Since SR base data are only available on the Split Cuts, the SR label will be limited to Split Cut elevations (Figure 17).

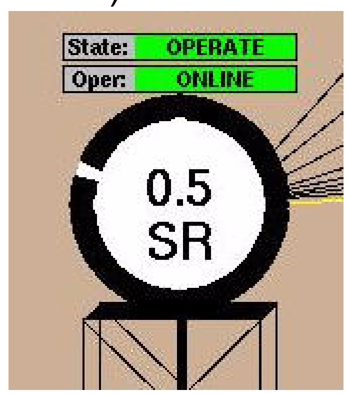


Figure 17. SR label on radome for a SR elevation.

Among the cluster of toggle buttons located beneath the Users box, there is a Super Res button to allow for disabling or enabling SR processing ***at the RDA*** (Figure 18). The decision for having SR enabled or disabled is not expected to be based on meteorological conditions. SR base data requires significant bandwidth from the RDA to the RPG. Existing wideband speeds and data compression will support SR base data transfer, even during significant weather. The option to disable SR processing is available should unexpected problems develop, such as reduced capacity of the RDA or wideband connection, or a problem with the recombined base data. If there appears to be a problem with the quality of the SR or recombined data, the local technicians or the Hotline can assist to determine if it is necessary to disable SR processing.

The four possible status values are ENABLED, ENABLING (transitioning from disabled to enabled), DISABLED, DISABLING (transitioning from enabled to disabled). When SR base data are disabled, only legacy resolution base data are processed at the RDA and SR products will not be generated at the RPG.

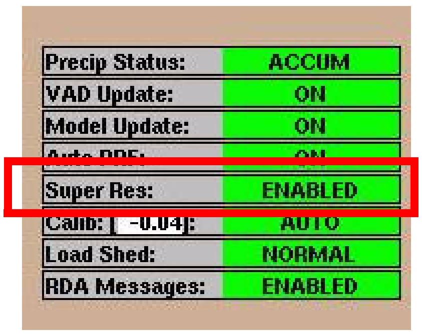


Figure 18. SR toggle button.

RDA Performance Data

The RDA Performance Data button on the RPG HCI accesses the same type of information as before, but with a different format. It actually displays the RDA Performance Data window (Figure 19) that is part of the RDA HCI.

The Missing BDDS Box

A particularly obvious change to the RPG HCI main page is the absence of the BDDS box below the RPG box (Figure 20). This reflects the redesign of the RPG software infrastructure. The RPG Refresh, part of RDA/RPG Build 9.0, provided two processors, RPGA and RPGB.

RPGB runs the Local Data Manager (LDM), which performs the Archive II function. RPGB also runs the Base Data Distribution System (BDDS) and 2 FAA sponsored algorithms: the Machine Intelligent Gust Front Algorithm (MIGFA) and the NEXRAD

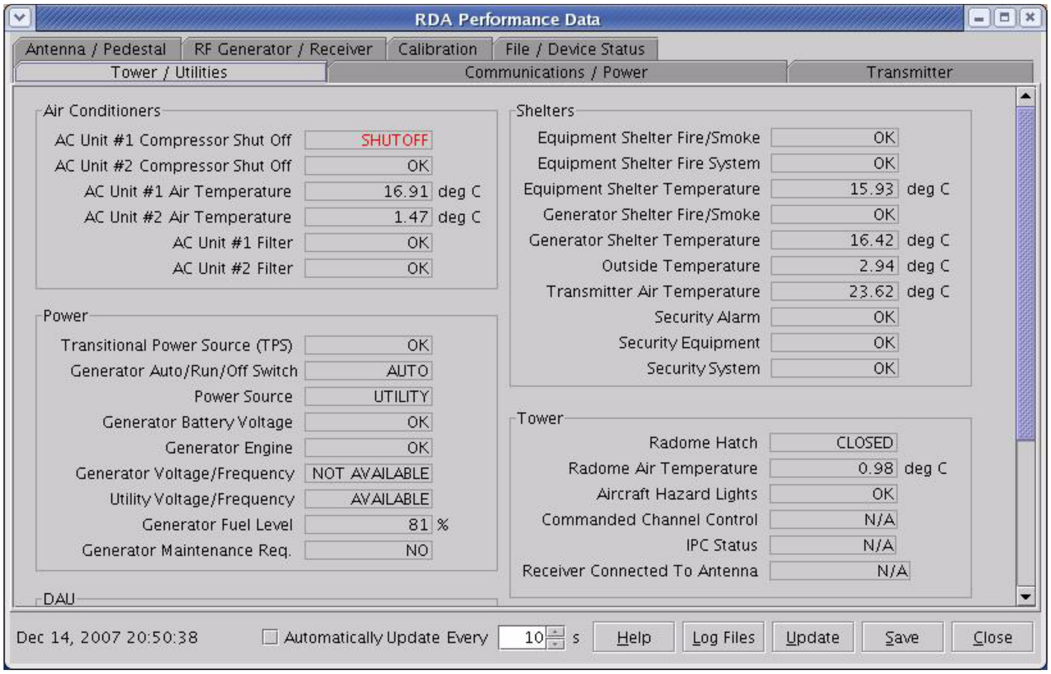


Figure 19. RDA Performance Data window.

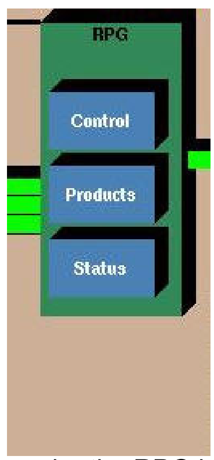


Figure 20. No BDDS box under the RPG box!

Turbulence Detection Algorithm (NTDA), which is new to Build 10.0. RPGA manages the overall RPG software execution and also generates the base and derived products familiar to NWS users.

BDDS and Archive II Management

The RPG Control window (Figure 21) has buttons for BDDS and Archive II, each accessing their respective windows.

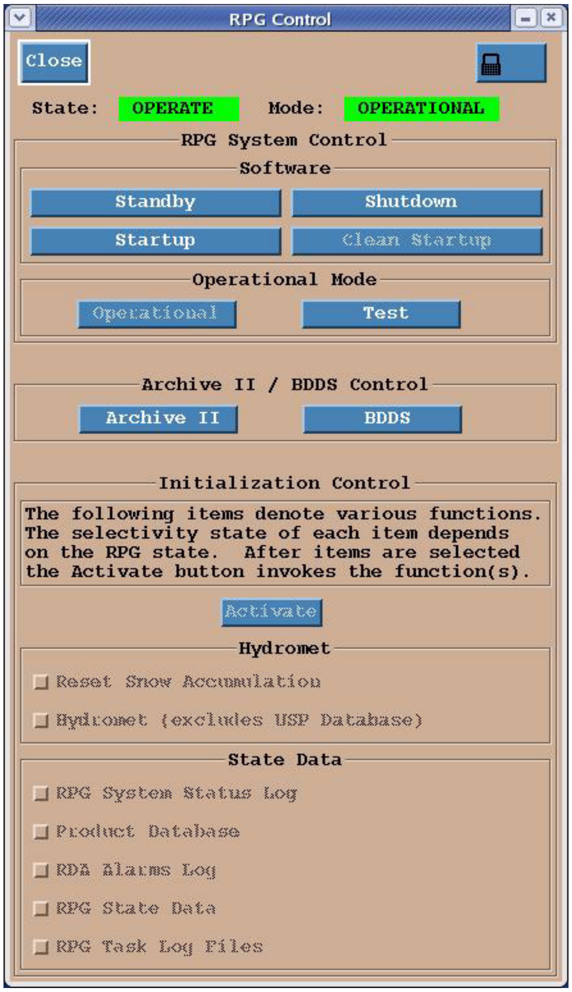


Figure 21. RPG Control window.

BDDS Window

The BDDS is a process used at a few locations that passes base data directly to end user “clients” through a hardwire or T1 connection. The BDDS window (Figure 22) shows the current client list. Since the BDDS is part of the RPG software, the BDDS is shut down and restarted only when the RPG is shut down and restarted.

Archive II Window

Archive II is the term that describes the routing of Level II data using the Local Data Manager (LDM) software and Internet 2. For an overview of this distribution network, see

http://www.roc.noaa.gov/NWS_Level_2/FOC_LDM_Architecture_V5.pdf

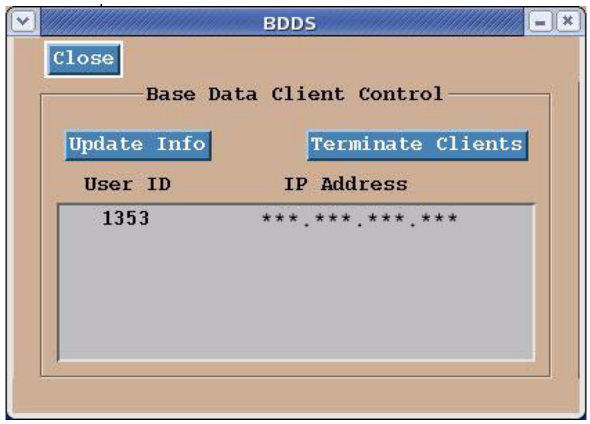


Figure 22. BDDS window.

The Archive II window (Figure 23) has two functions of interest, Transmit Data and Reinitialize. In rare cases, operators could be asked by Hotline, Telecommunication Operations Center (TOC), or Regional staff to use one of these options to restore Archive II data distribution. For more information on the TOC, see
http://www.nws.noaa.gov/tg/

Transmit Data vs. Reinitialize

Transmit Data on or off is used to start or stop the LDM data flow. This is intended to correct short term data flow interruptions. The Reinitialize button first brings down the LDM software, then clears data buffers and restarts the LDM software. A new feature with the Archive II window is a listing of clients.

Level II Transmission of SR or Recombined Base Data

Due to the additional communications bandwidth required to distribute SR Level II data from an RPG, some sites will ***not*** be able to support the transmission of SR Level II data upon installation of Build 10.0.

For systems whose bandwidth will not support the SR Level II data stream, the ***Recombined*** Level II data stream will be distributed ***instead***. This will be the case for the foreseeable future for DoD RPGs.

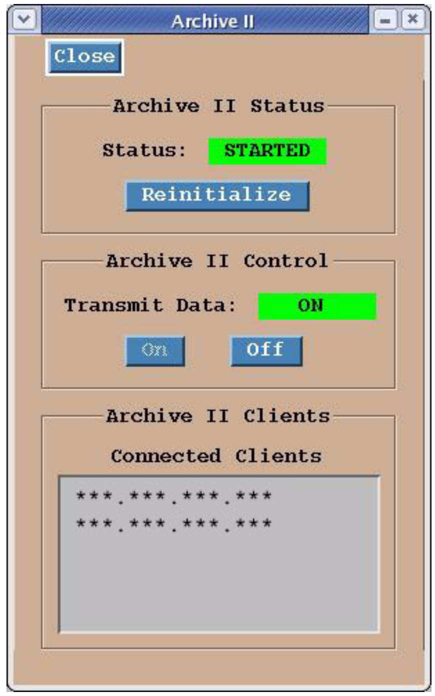


Figure 23. Archive II window.

For NWS RPGs, the ability to transmit SR Level II data will be dependent on a communications upgrade known as NOAAnet. As of this writing, most NWS offices are expected to have NOAAnet communications in place before the Build 10.0 installation. NWS sites will know when NOAAnet is installed because the ESA and/or the ITO has to activate the service at the office.

To control which Level II data stream is distributed, there is a new entry on the Algorithms window (accessed by selecting "RPG Products"). Once the Algorithms window (Figure 24) is opened, the first entry is Archive II. The parameter options are Yes (distribute the SR Level II data stream) or No (distribute the Recombined Level II data stream). The default setting is No.

SR Level II Distribution

Once the appropriate communications are in place (NOAAnet for NWS), SR Archive II can be set for data distribution by changing the Archive II param-

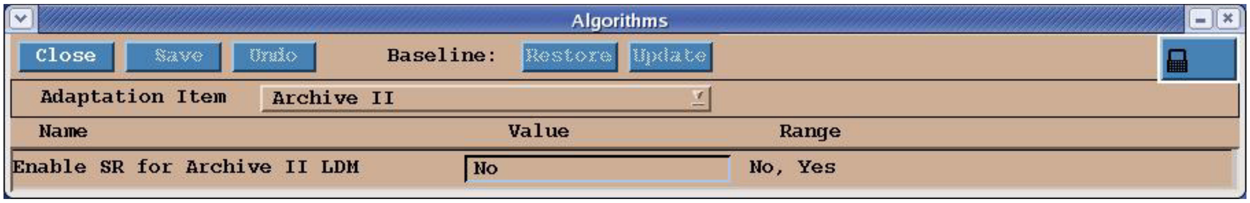


Figure 24. Algorithms window with Archive II parameters.

eter to Yes and executing the Reinitialize process on the Archive II window.

Once the distribution of SR Level II data is in place, private vendors will have access to it. Local media and/or emergency managers may see the SR products, depending on the vendors that they use.

Changes to VCP and Mode Control Window

There are a few changes to the VCP and Mode Control window (Figure 25), specifically regarding the buttons along the bottom of the window.

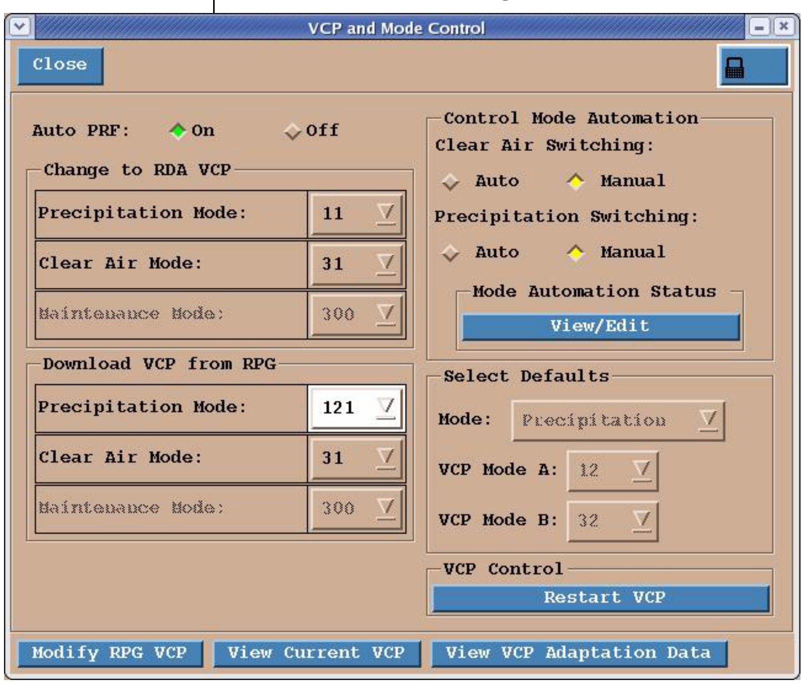
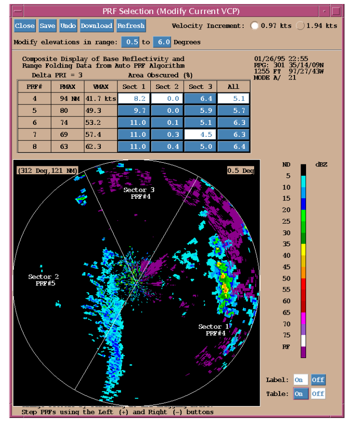


Figure 25. VCP and Mode Control window.

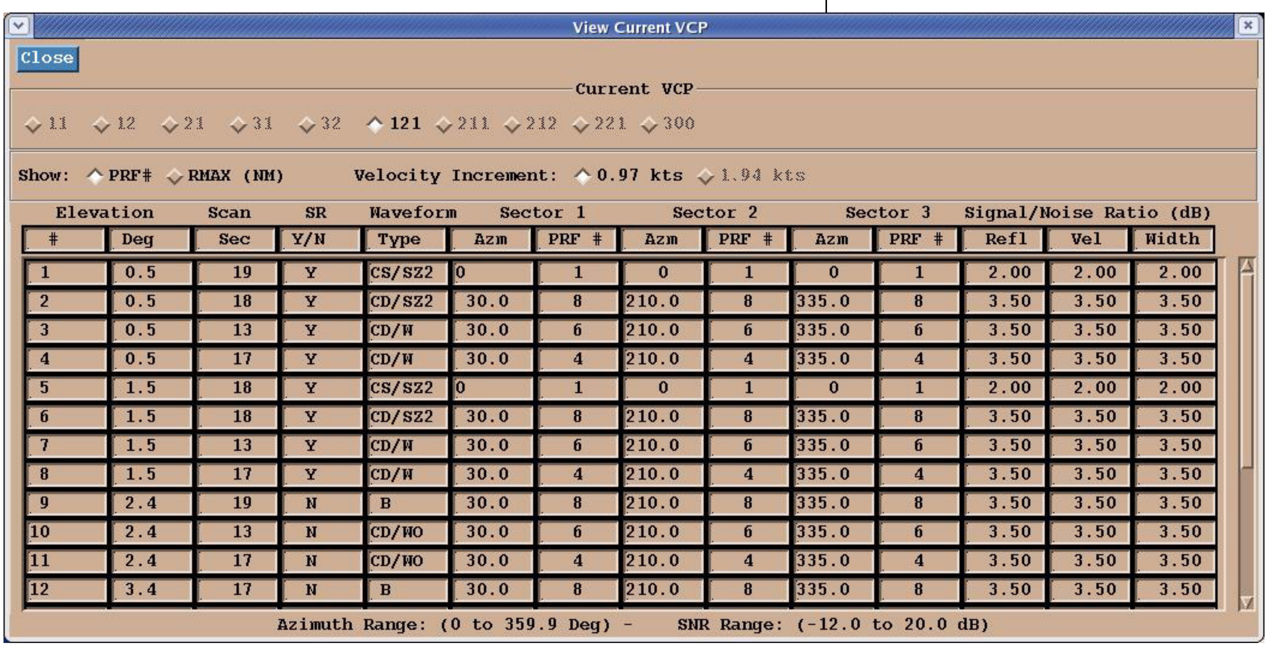
Modify RPG VCP

A button that was previously called Modify Current VCP is now called Modify RPG VCP. This button opens the PRF Selection window, which is used to modify the Doppler PRF. The first step in the process of editing the Doppler PRF is to turn Auto PRF off, which can be done from the VCP and Mode Control window. Then the PRF Selection window is easily accessed using the button called Modify RPG VCP.



View Current VCP

The View Current VCP button is new. Selecting it opens the View Current VCP window (Figure 26), which displays the current VCP. This can be used as a reference only, as it does not allow for editing the current VCP.



View Current VCP

Close

Current VCP

◇ 11 ◇ 12 ◇ 21 ◇ 31 ◇ 32 ◆ 121 ◇ 211 ◇ 212 ◇ 221 ◇ 300

Show: ◆ PRF# ◇ RMAX (NM) Velocity Increment: ◆ 0.97 kts ◇ 1.94 kts

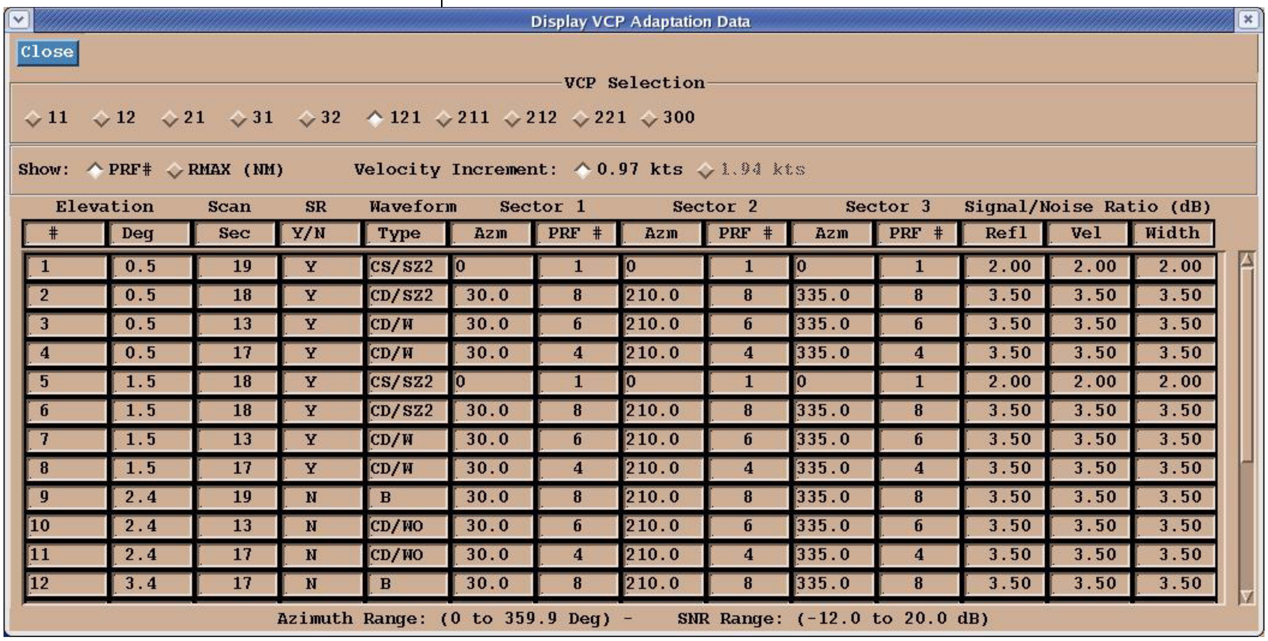
Elevation		Scan	SR	Waveform	Sector 1		Sector 2		Sector 3		Signal/Noise Ratio (dB)		
#	Deg	Sec	Y/N	Type	Azm	PRF #	Azm	PRF #	Azm	PRF #	Refl	Vel	Width
1	0.5	19	Y	CS/SZ2	0	1	0	1	0	1	2.00	2.00	2.00
2	0.5	18	Y	CD/SZ2	30.0	8	210.0	8	335.0	8	3.50	3.50	3.50
3	0.5	13	Y	CD/W	30.0	6	210.0	6	335.0	6	3.50	3.50	3.50
4	0.5	17	Y	CD/W	30.0	4	210.0	4	335.0	4	3.50	3.50	3.50
5	1.5	18	Y	CS/SZ2	0	1	0	1	0	1	2.00	2.00	2.00
6	1.5	18	Y	CD/SZ2	30.0	8	210.0	8	335.0	8	3.50	3.50	3.50
7	1.5	13	Y	CD/W	30.0	6	210.0	6	335.0	6	3.50	3.50	3.50
8	1.5	17	Y	CD/W	30.0	4	210.0	4	335.0	4	3.50	3.50	3.50
9	2.4	19	N	B	30.0	8	210.0	8	335.0	8	3.50	3.50	3.50
10	2.4	13	N	CD/WO	30.0	6	210.0	6	335.0	6	3.50	3.50	3.50
11	2.4	17	N	CD/WO	30.0	4	210.0	4	335.0	4	3.50	3.50	3.50
12	3.4	17	N	B	30.0	8	210.0	8	335.0	8	3.50	3.50	3.50

Azimuth Range: (0 to 359.9 Deg) - SNR Range: (-12.0 to 20.0 dB)

Figure 26. View Current VCP window.

View VCP Adaptation Data

The last button of interest on the VCP and Mode Control window is View VCP Adaptation Data, previously called Display Adaptation. This brings up the Display VCP Adaptation Data window (Figure 27). This window depicts all of the VCPs that are stored at the RPG and available for download to the RDA. This window can be used as a reference for the data collection techniques and angles used for the RPG VCPs.



Display VCP Adaptation Data

Close

VCP Selection

11 12 21 31 32 121 211 212 221 300

Show: PRF# RMAX (NM) Velocity Increment: 0.97 kts 1.94 kts

Elevation		Scan	SR	Waveform	Sector 1		Sector 2		Sector 3		Signal/Noise Ratio (dB)		
#	Deg	Sec	Y/N	Type	Azm	PRF #	Azm	PRF #	Azm	PRF #	Refl	Vel	Width
1	0.5	19	Y	CS/SZ2	0	1	0	1	0	1	2.00	2.00	2.00
2	0.5	18	Y	CD/SZ2	30.0	8	210.0	8	335.0	8	3.50	3.50	3.50
3	0.5	13	Y	CD/W	30.0	6	210.0	6	335.0	6	3.50	3.50	3.50
4	0.5	17	Y	CD/W	30.0	4	210.0	4	335.0	4	3.50	3.50	3.50
5	1.5	18	Y	CS/SZ2	0	1	0	1	0	1	2.00	2.00	2.00
6	1.5	18	Y	CD/SZ2	30.0	8	210.0	8	335.0	8	3.50	3.50	3.50
7	1.5	13	Y	CD/W	30.0	6	210.0	6	335.0	6	3.50	3.50	3.50
8	1.5	17	Y	CD/W	30.0	4	210.0	4	335.0	4	3.50	3.50	3.50
9	2.4	19	N	B	30.0	8	210.0	8	335.0	8	3.50	3.50	3.50
10	2.4	13	N	CD/WO	30.0	6	210.0	6	335.0	6	3.50	3.50	3.50
11	2.4	17	N	CD/WO	30.0	4	210.0	4	335.0	4	3.50	3.50	3.50
12	3.4	17	N	B	30.0	8	210.0	8	335.0	8	3.50	3.50	3.50

Azimuth Range: (0 to 359.9 Deg) - SNR Range: (-12.0 to 20.0 dB)

Figure 27. Display VCP Adaptation Data window.

Base Data Display Window

The Base Data Display window (Figure 28) has been changed to accommodate Super Resolution data. Assuming that SR is enabled, it can ***only*** be viewed in Scan mode. When a SR elevation is being displayed in Scan mode, there will be a SR label at the top of the window next to the product elevation. If specific elevation angles are selected, only the recombined legacy resolution data will be displayed.

Product Generation List

The Product Generation List (Figure 29) has several new entries. There are the three new SR base products:

1. Super Res Reflectivity Data Array Product: SDR, #153
2. Super Res Velocity Data Array Product: SDV, #154

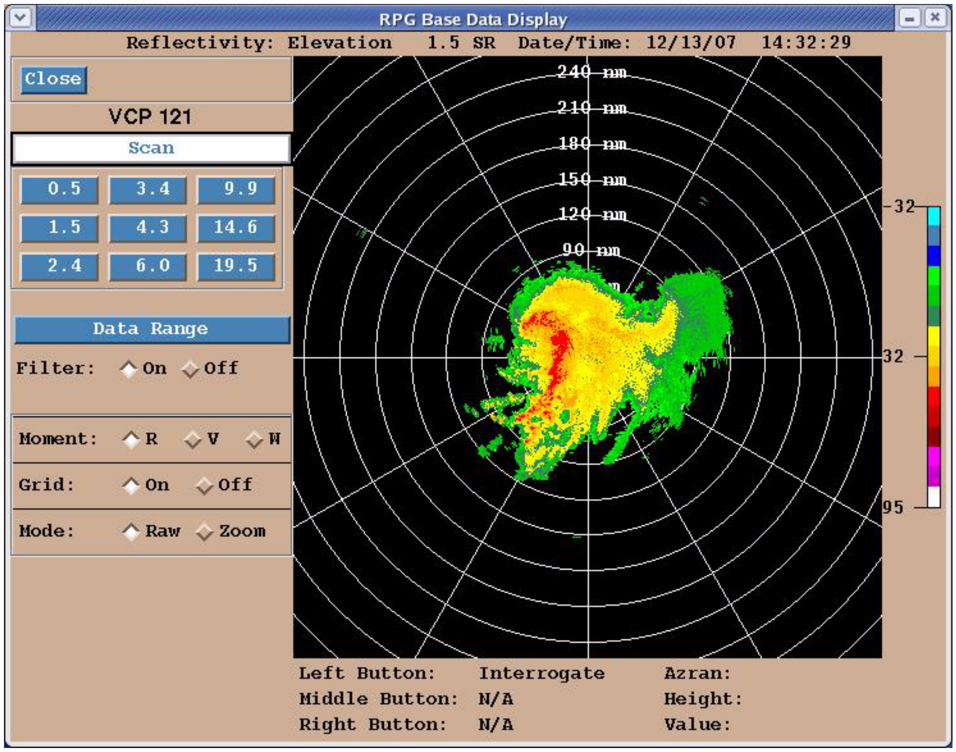


Figure 28. Base Data Display window.

3. Super Res Spectrum Width Data Array Product: SDW, #155

There are also two products generated by the NEXRAD Turbulence Detection Algorithm (NTDA). This is an FAA sponsored algorithm and AWIPS display of NTDA products is not currently scheduled for any upcoming build. The only indication of the NTDA products for NWS users would be their presence on the Product Generation List:

SDR	153	1	30	<=	1.8	Super Res Reflectivity Data Array Product: 256 level/0.13 nm
SDV	154	1	30	<=	1.8	Super Res Velocity Data Array Product: 256 level/0.13 nm
SDW	155	1	30	<=	1.8	Super Res Spectrum Width Data Array Product: 256 level/0.13 nm
EDR	156	0	0	<=	0	NTDA EDR Final Product
EDC	157	0	0	<=	0	NTDA CONF Final Product

Figure 29. New entries in Generation List.

1. NTDA EDR Final Product: EDR, #156 (EDR is Eddy Dispersion Rate)
2. NTDA CONF Final Product: EDC, # 157 (EDC is Eddy Dispersion Confidence)

2. Enhanced Version of MPDA/VCP 121

References

Concept of Operations for the Enhanced VCP 121 to Mitigate Range Aliasing; D. Zittel, ROC

*Combined WSR-88D Technique to Reduce Range Aliasing Using Phase Coding and Multiple Doppler Scan*s; D. Zittel, ROC; D. Saxion and R. Rhoton, RS Information Systems; D. Crauder, Earlham College

Combining Two Techniques

VCP 121 was originally fielded in the Spring of 2004. It utilized the Multiple PRF Dealiasing Algorithm (MPDA). Using the VCP 21 angles and additional Doppler rotations at the lower elevations, VCP 121 significantly reduced RF data on velocity and spectrum width products, while performing velocity dealiasing as well.

Another significant improvement in the reduction of RF data is the recently fielded (Build 9.0, Summer 2007) SZ-2 Range Unfolding Algorithm. SZ-2 is implemented using VCPs 211, 221, or 212.

The Build 10.0 enhanced version of VCP 121 combines the benefits of MPDA and the SZ-2 Range Unfolding technique. SZ-2 is used for one of the additional Doppler rotations for the lowest two (Split Cut) elevations, significantly increasing the availability of velocity and spectrum width data. The waveform definition for these two rotations is CD/SZ2. For the non-SZ-2 elevations, the waveform is listed as either CD/W or CD/WO. CD/W means that Doppler mode is used and range unfolding is performed at the RDA. CD/WO means that Doppler mode is used and range unfolding is performed at the RPG. Figure 30 presents the Build 9.0 vs. the Build 10.0 design of VCP 121.

Elev.	Waveform	No. of Pulses	PRF No.	Waveform	No. of Pulses
0.5	CS	15	1	***CS/SZ2***	***17***
0.5	CD/W	43	8	***CD/SZ2***	***64***
0.5	CD/WO	40	6	***CD/W***	40
0.5	CD/WO	40	4	***CD/W***	40
1.5	CS	15	1	***CS/SZ2***	***17***
1.5	CD/W	43	8	***CD/SZ2***	***64***
1.5	CD/WO	40	6	***CD/W***	40
1.5	CD/WO	40	4	***CD/W***	40
2.4	B	6,40	1,8	B	6,40
2.4	CD/WO	40	6	CD/WO	40
2.4	CD/WO	40	4	CD/WO	40
3.4	B	6,40	2,8	B	6,40
3.4	CD/WO	40	6	CD/WO	40
3.4	CD/WO	40	4	CD/WO	40
4.3	B	6,40	2,4	B	6,40
4.3	CD/WO	40	7	CD/WO	40
6.0	B	6,40	3,5	B	6,40
9.9	CD/WO	40	7	CD/WO	40
14.6	CD/WO	43	8	CD/WO	43
19.5	CD/WO	43	8	CD/WO	43

Figure 30. Build 9.0 (left) vs. Build 10.0 (right) VCP 121 design.

Build 9.0 vs. Build 10.0 VCP 121 Examples

Combining the benefits of MPDA processing and SZ-2 is expected to provide up to 98 percent of velocity data out to 124 nm for events with widespread returns. One of the cases used during testing was a winter storm event with widespread coverage. Figure 31 depicts legacy resolution reflectivity products for this event, with the Build 9.0 VCP 121 on the left and the Build 10.0 VCP 121 on the right. This case was collected using two different antennas which are about 10 miles apart. There is no significant difference in the two reflectivity products, except for the slight displacement of echoes due to the use of two antennas.

The significant advantage of enhanced VCP 121 with respect to velocity data is depicted in Figure 32. The legacy resolution Build 9.0 VCP 121 is on the left and the legacy resolution Build 10.0 VCP 121 is on the right. With the Build 9.0 VCP 121, velocities were often not available in widespread

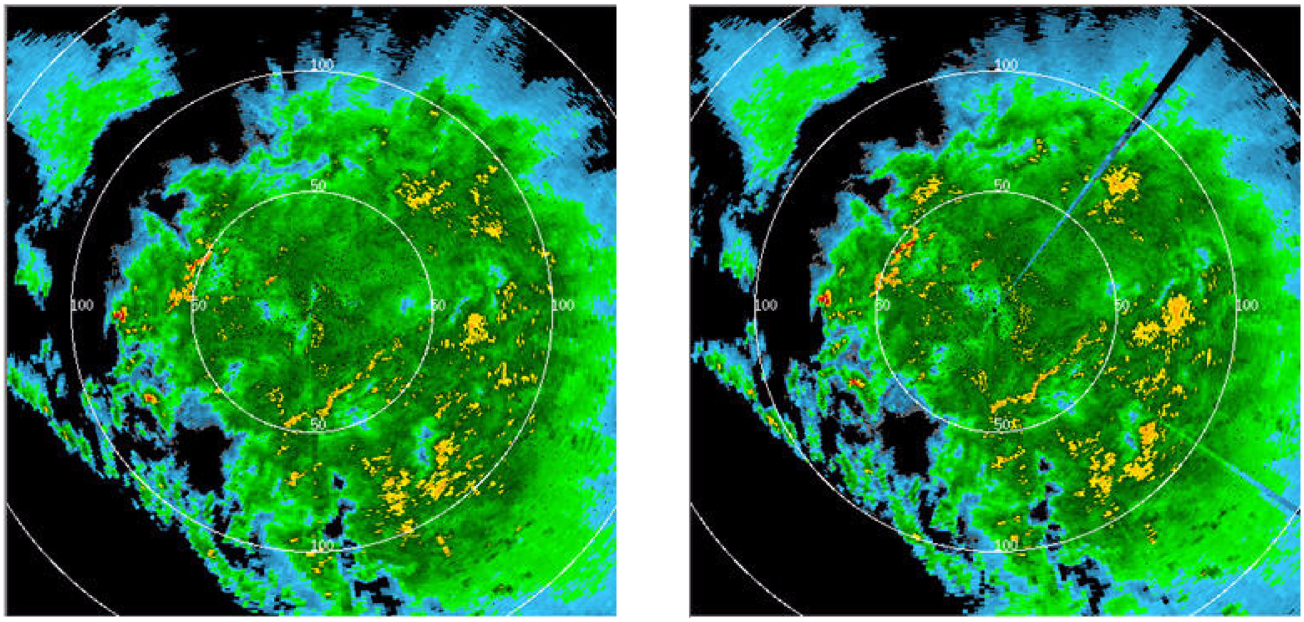


Figure 31. Reflectivity products for Build 9.0 VCP 121 (left) and Build 10.0 VCP 121 (right).

events beyond 95 nm, which is the longest R_{max} among the Doppler PRFs. The addition of SZ-2 data as part of the Build 10.0 VCP 121 makes these data available beyond that range.

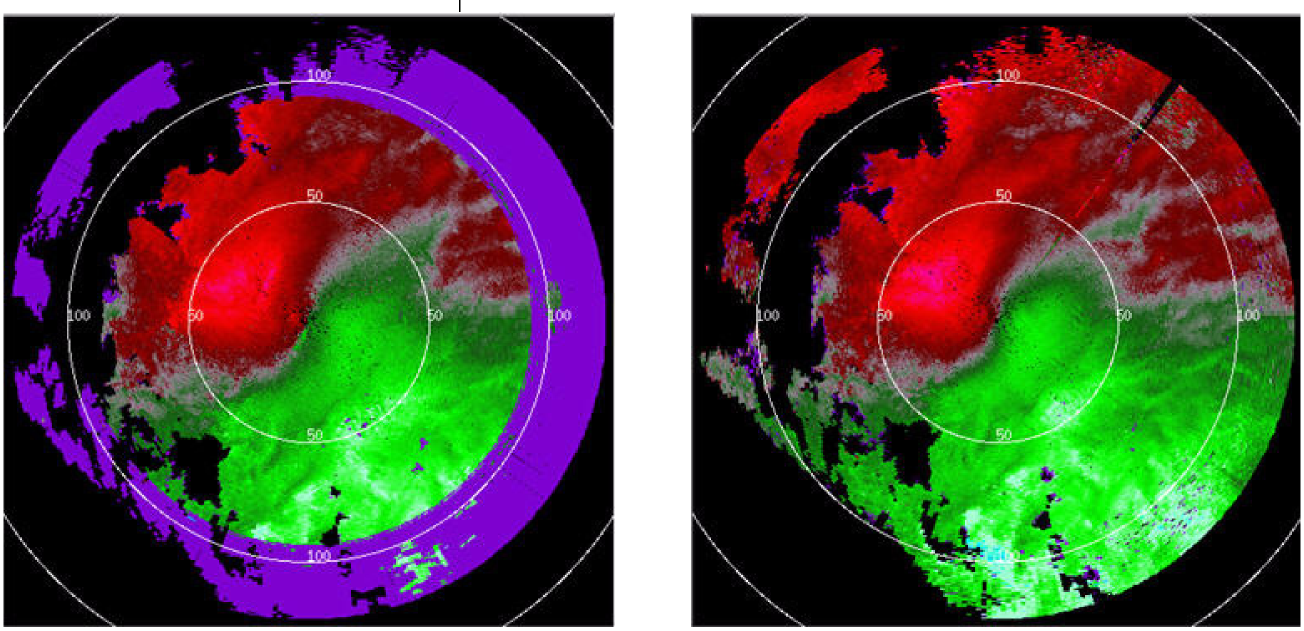


Figure 32. Velocity products for Build 9.0 VCP 121 (left) and Build 10.0 (not SR) VCP 121 (right).

Operational Considerations

The Build 10.0 VCP 121 is intended for the same applications as the Build 9.0 VCP 121. It is best used for events with widespread echo coverage, such as tropical cyclones, mesoscale convective complexes, or extensive squall lines. It is ***not*** the best choice for rapidly evolving deep, moist convection.

The volume scan update rate for the Build 9.0 VCP 121 was about 5 minutes and 30 seconds. The volume scan update rate for the Build 10.0 VCP 121 is slightly longer, about 5 minutes and 45 seconds. This is because SZ-2 requires 64 pulses per radial.

As always with VCP 121, the Doppler PRFs are held constant. There is no option to edit the Doppler PRF.

Additionally, because the SZ-2 Range Unfolding Algorithm is part of the Build 10.0 VCP 121, All Bins clutter filtering needs to be avoided. Since extensive precipitation and extensive AP are rarely co-existent, Bypass Map clutter filtering should be adequate for operations while using the enhanced VCP 121.

MPDA Adaptable Parameters

MPDA has always had two adaptable parameters (Figure 33) designed to address the potential for a ring of noisy velocity values along the interface between the 1st and 2nd trip. These parameters and their Build 10.0 default values are

- “Threshold (Fix Trip Minimum Bin)”: default setting of -3
- “Threshold (Fix Trip Maximum Bin)”: default setting of +6

VCP 121 SR Base Velocity

Testing using these default values has thus far been limited to a single WSR-88D. These settings

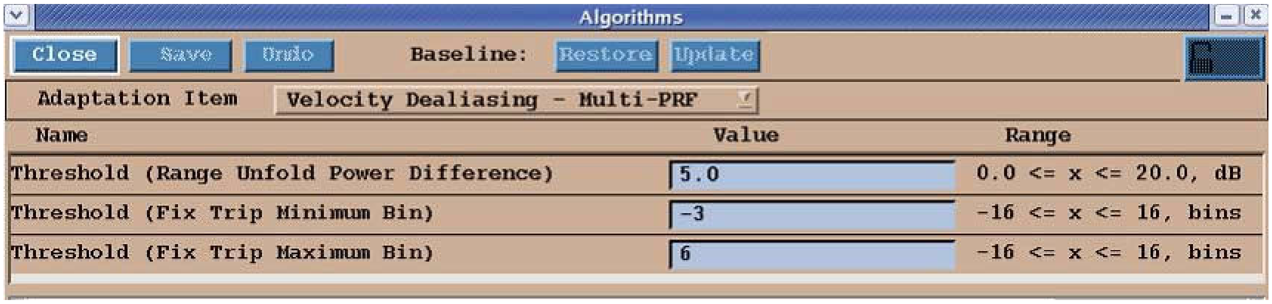


Figure 33. MPDA adaptable parameter default settings for Build 10.0.

have been sufficient to remove the noisy ring. However, for SR velocity products generated using VCP 121, there is a ring of ***missing*** data at 230 km (124 nm), which is the start of the extended range (Figure 34). If this ring is of concern, it can be mitigated by changing “Threshold (Fix Trip Minimum Bin)” from -3 to +2, while keeping “Threshold (Fix Trip Maximum Bin)” set to +6.

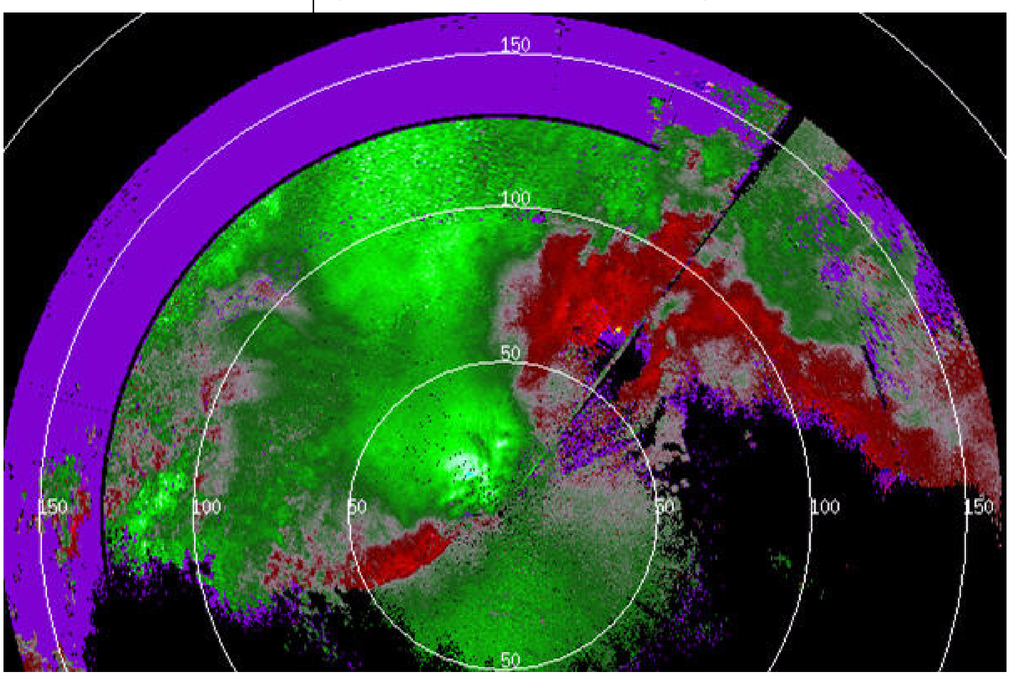


Figure 34. Ring of missing data along edge of extended coverage of SR VCP 121 velocity product.

Also note in Figure 34 that only a portion of the SR extended range velocity data has been recovered. This will be dependent on the distribution of echoes and their respective returned power.

3. Bias Value Source Added to PPS Products

For many years, WFOs have had the option of applying a gage-radar bias to the WSR-88D precipitation estimates. The bias is based on comparing radar estimates to available rain gages. The number of gage-radar pairs is variable, as well as the period of time for the comparison. The radar gage comparison is performed at AWIPS and a bias table is transferred hourly to the RPG. The bias that is used from this table for application to the rainfall estimates is based on a threshold that is discussed beginning on page 38.

With AWIPS OB 8.2, an RFC-generated bias also becomes available for application. The RFC-generated bias will usually be of higher quality due to the extensive Multisensor Precipitation Estimator (MPE) quality control performed by the RFC staff. RFCs will have the option to send this bias information to WFOs with an associated RPG within the RFC's area of responsibility. WFOs will have the option to send the RFC-generated bias to their RPG for application to the rainfall estimates.

Since an applied bias could come from two different sources (WFO or RFC), Build 10.0 includes the source of the bias on the STP, OHP, or THP alphanumeric products. The local AWIPS-generated bias is identified by the AWIPS ID (e.g. OUN). An RFC-generated bias is identified by the 3 letter RFC ID:

- Alaska/Pacific RFC: ACR
- Arkansas-Red Basin RFC: TUA
- California-Nevada RFC: RSA
- Colorado Basin RFC: STR
- Lower Mississippi RFC: ORN

- Middle Atlantic RFC: RHA
- Missouri River Basin RFC: KRF
- Northcentral RFC: MSR
- Northeast RFC: TAR
- Northwest RFC: PTR
- Ohio RFC: TIR
- Southeast RFC: ALR
- West Gulf RFC: FWR

There will be only one RFC-generated bias available at any one time. For WFOs with CWAs that fall within more than one RFC's area of responsibility, only one of the RFC biases can be sent to the RPG for use. This decision will require the judgement of the Service Hydrologist, the radar focal point, the flash flood focal point, or any other staff members that may be appropriate.

The activation of the RFC bias transfer capability requires coordination between the WFO and the RFC. The installation notes and related MPE documentation can be found on the NWS WFO Hydrologic Forecast System (WHFS) Field Support Group Webpage at
https://ocwws.weather.gov/intranet/whfs/

Look for the "RFC Bias Transfer Installation Notes" and the "OB8.2 MPE Editor Users Guide".

4. Threshold Number of Gage-Radar Pairs URC Editable

The gage-radar comparison and generation of a table of bias values is performed as part of the MPE at AWIPS. This table is transferred hourly to the RPG. The table values vary from a bias based on a small number of gage-radar pairs over a short time (less than 1 hour) to a bias based on a large number of gage/radar pairs over a very long time (essentially climatological).

The bias table is displayed as part of the Supplemental Precipitation Data (SPD) product (Figure 35), a text product generated every volume scan. In this example, the first six rows in the table have bias values that imply that the radar is overestimating. These bias values are based on time and the number of gage-radar pairs varying from less than one hour and 1 pair to 10 hours and 7 pairs. The remaining rows of the table have bias values that imply that the radar is underestimating. These bias values are based on time and number of gage-radar pairs varying from 168 hours and 217 pairs to 9999044 hours and 12556 pairs.

```
SUPPLEMENTAL PRECIPITATION DATA - RDA ID   531  12/19/07 16:53

VOLUME COVERAGE PATTERN =  21   MODE = A

          GAGE BIAS APPLIED               -       NO
               BIAS ESTIMATE              -     1.60
               EFFECTIVE # G/R PAIRS      -   217.81
               MEMORY SPAN (HOURS)        -   168.01
               DATE/TIME LAST BIAS UPDATE - 12/19/07 16:25
  TOTAL NO. OF BLOCKAGE BINS REJECTED     -        0
               CLUTTER BINS REJECTED      -     8050
               FINAL BINS SMOOTHED        -        0
   HYBRID SCAN PERCENT BINS FILLED        -    99.87
               HIGHEST ELEV. USED (DEG)   -     2.40
               TOTAL RAIN AREA (KM**2)    -   6580.7

        MISSING PERIOD: 12/15/07 22:00 12/15/07 22:23
                        GAGE-RADAR MEAN FIELD BIAS TABLE

LAST BIAS UPDATE TIME:  12/19/07 16:25                        BIAS APPLIED ?   NO
```

MEMORY SPAN (HOURS)	EFFECTIVE NO. G-R PAIRS	AVG. GAGE VALUE (MM)	AVG. RADAR VALUE (MM)	MEAN FIELD BIAS
0.001	1.000	0.508	0.891	0.570
1.000	3.257	0.418	0.955	0.438
2.000	4.862	0.401	0.956	0.420
3.001	5.667	0.395	0.953	0.415
4.998	6.461	0.390	0.949	0.411
10.004	7.254	0.418	0.956	0.437
168.006	217.808	3.009	1.877	1.603
719.819	739.421	2.928	2.165	1.352
2160.295	2498.883	3.174	2.758	1.151
9999044.000	12556.898	2.973	2.627	1.132

Figure 35. Supplemental Precipitation Data Product with bias table.

Which Bias is Available for Use?

The Hydromet Adjustment Algorithm determines the bias that is available from this table for application to the rainfall estimates and allows the operator the option of applying the bias. The bias is applied by setting the Bias Flag parameter to True (the default setting for the Bias Flag is False). The choice of the bias is based on the adaptable parameter “Threshold Number of Gage/Radar Pairs Needed to Select Bias from Table [NGRPS]”.

With Build 10.0, the NGRPS is editable under URC guidelines (Figure 36). The default value is 10. In the example in Figure 35, the default value of 10 gage/radar pairs would have resulted in a bias value of 1.603, which was based on a long period of time (168 hours) and may not be appropriate for the present event. The option to change the value of NGRPS allows for choosing a bias that seems most appropriate before setting the Bias Flag to True (Figure 36).

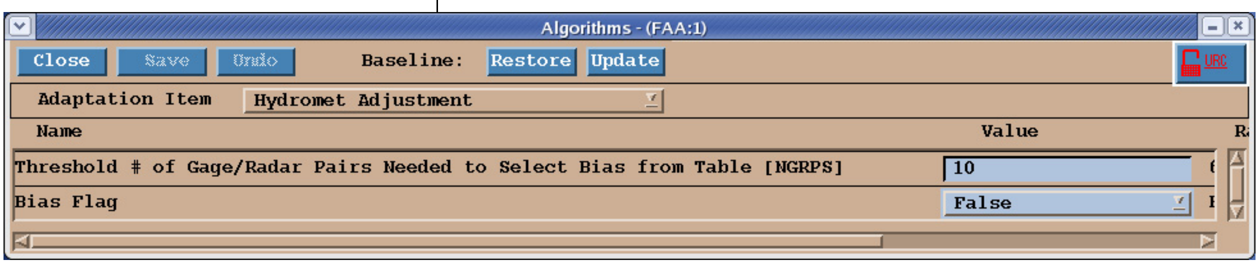


Figure 36. Hydromet Adjustment algorithm parameters editable with Build 10.

VCP Comparison Table

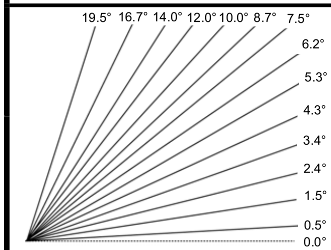
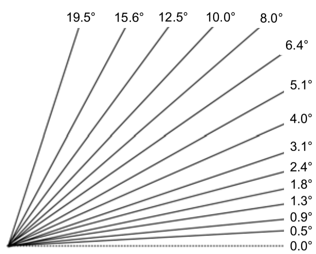
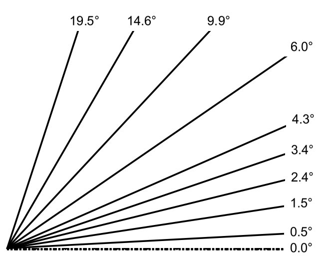
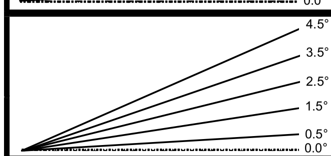
The VCP Comparison Table, first issued Summer of 2007, has been updated to reflect the changes to VCP 121. Please destroy previous copies and replace them with the 2008 version (Figure 37).

Summary

This document presents the pre-deployment state of knowledge of the operational impacts of RDA/RPG Build 10.0. Additional copies of this document, the reference documents, and the training presentations are available at the RDA/RPG Build 10.0 Training page:
http://www.wdtb.noaa.gov/buildTraining/Build 10/

Quick Reference VCP Comparison Table for RPG Operators

February 2008

Slices	Tilts	VCP	Time*	Usage	Limitations
	14	11	5 mins	Severe and non-severe convective events. Local 11 has Rmax=80nm. Remote 11 has Rmax=94nm.	Fewer low elevation angles make this VCP less effective for long-range detection of storm features when compared to VCPs 12 and 212.
		211	5 mins	Widespread precipitation events with embedded, severe convective activity (e.g. MCS, hurricane). Significantly reduces range-obscured V/SW data when compared to VCP 11.	All Bins clutter suppression is NOT recommended. PRFs are not editable for SZ-2 (Split Cut) tilts.
	14	12	4 ½ mins	Severe convective events. Extra low elevation angles increase low-level vertical resolution when compared to VCP 11.	High antenna rotation rates slightly decrease accuracy of the base data estimates.
		212	4½ mins	Rapidly evolving, widespread severe convective events (e.g. squall line, MCS). Increased low-level vertical resolution compared to VCP 11. Significantly reduces range-obscured V/SW data when compared to VCP 12.	All Bins clutter suppression is NOT recommended. PRFs are not editable for SZ-2 (Split Cut) tilts. High antenna rotation rates slightly decrease accuracy of the base data estimates.
	9	21	6 mins	Non-severe convective precipitation events. Local 21 has Rmax=80nm. Remote 21 has Rmax=94nm.	Gaps in coverage above 5°.
		121	6 mins	VCP of choice for hurricanes. Widespread stratiform precipitation events. Significantly reduces range-obscured V/SW data within 230 km when compared to other VCPs.	All Bins clutter suppression is NOT recommended. High antenna rotation rates slightly decrease accuracy of the base data estimates. PRFs are not editable. Gaps in coverage above 5°.
		221	6 mins	Widespread precipitation events with embedded, possibly severe convective activity (e.g. MCS, hurricane). Reduces range-obscured V/SW data out to 300 km when compared to other VCPs.	All Bins clutter suppression is NOT recommended. PRFs are not editable for SZ-2 (Split Cut) tilts. Gaps in coverage above 5°.
	5	31	10 mins	Clear-air, snow, and light stratiform precipitation. Best sensitivity. Detailed boundary layer structure often evident.	Susceptible to velocity dealiasing failures. No coverage above 5°. Rapidly developing convective echoes aloft might be missed.
		32	10 mins	Clear-air, snow, and light stratiform precipitation.	No coverage above 5°. Rapidly developing convective echoes aloft might be missed.

*VCP update times are approximate.

Figure 37. VCP Comparison Table, 2008 version.