NEXRAD Now

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Use CFC to Optimize Performance of WSR-88D

WSR-88D data quality is a high priority issue and ***appropriate*** clutter suppression is an easy and effective way to maintain data quality and integrity. The Clutter Filter Control (CFC) product was introduced in Build 9 to give you an effective way to ensure that appropriate clutter filtering is being performed by your radar system. When used correctly, this product can instantly give you a graphical depiction of what kind of clutter suppression is being applied, allowing you to proactively apply clutter suppression as changes are warranted, and thereby improving the quality of the data obtained from your system.

To get the current CFC product, enter "D,G,CFC" at the PUP Applications Terminal. Observe which Slice (Elevation Segment 1 or 2) and Param 1 (**D**oppler Channel or **S**urveillance Channel) appears when the edit screen is shown. Make changes to these parameters to request the channel and elevation segment you want to request. Leave the "RPG" column blank and enter an asterisk (*) in the time column. Pressing "<Return>" will force generation of the most recent product for the channel and elevation segment you specified. (Note: the generation process may take several minutes, so be patient.)

If the resulting product depicts the clutter suppression regions definition that adequately addresses the clutter problem at hand, then you're finished.

If, however, you get a pattern that is in no way representative of the clutter problem you are currently experiencing, then the clutter suppression definition needs to be modified (i.e., editing the appropriate clutter suppression regions file).

For a discussion on how to effectively apply clutter suppression and an easy-to-understand explanation on how clutter suppression works and how it should be applied, read the paper "WSR-88D Clutter Suppression and Its Impact On Meteorological Data Interpretation" (Chrisman, et. al.). This paper is on the OSF Homepage: (http://www.osf.noaa.gov/ops/hotline.htm).

Capt Tony Ray
OSF Operations Branch

Use Of Microwave For Narrowband Communications

In the past, the narrowband telecommunications service to the NEXRAD site at San Juan, PR was provided by overhead telephone lines from the Puerto Rico Telephone Company (PRTC). This service has proven to be unreliable because overhead lines to the remote RDA shelter are subject to breakage during storms, and the repair time is very lengthy.

To counter the obstacles to uninterrupted telephone service to the RDA site, the FAA and NWS have agreed to use a different system to transmit radar product data from the RPG to the users. The FAA proposed the use of a Low Density Radio Communications Link (LDRCL) to provide a link between the NEXRAD site and the Combined Enroute and Radar Approach Control (CERAP), the FAA's user site in San Juan. All other narrowband users for this site will connect their commercial telephone company service to the LDRCL at the CERAP instead of connecting to the RPG at the remote location. In this manner, the telephone company will have an easier time maintaining line service to the CERAP. A test of the service supplied by LDRCL as compared to the telephone company line service is planned before the NWS users are switched over to use the LDRCL on a full time basis.

The LDRCL system is an FAA owned digital 1.8 GHz link line-of-sight application, providing transmission/reception of narrowband data between the CERAP, located in town, and the RDA/RPG shelter, located on the mountain side. The LDRCL uses one 8' parabolic grid antenna for transmission up to 35 miles. It has 4 DS1 terminals equipped with 2 DS1 channel banks each with 24 ports. The antenna sits on a 100' (to the platform) 4 leg, tubular

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Inside This Edition

Optimizing the WSR-88D Radar System During Tropical Cyclone Landfall Events

With the 1998 northern hemisphere tropical cyclone (TC) season rapidly approaching, now is the time for coastal, as well as inland, radar sites to begin reviewing those operational items which will help optimize the WSR-88D radar system for both operational and research purposes. Several minor changes in routine operations can significantly affect how your system performs during a tropical cyclone event. The following listing is a compilation of some of the “lessons learned” concerning landfalling TCs over the past 5 years.

PROPER CHOICE OF VOLUME COVERAGE PATTERN (VCP) - - In most instances, the WSR-88D should be operated in VCP 11 (14 elevation slices in 5 minutes) which will provide the best spatial and temporal data sampling. Many short-lived, convective-scale features such as eyewall and outer band mesocyclones, as well as maximum Doppler velocity values, may be missed or poorly sampled when operating in VCP 21.

MESOCYCLONE THRESHOLD PATTERN VECTORS (TPV) - - Since most convective-scale circulations associated with TCs tend to be much smaller than their mid-latitude counterparts, the Mesocyclone Detection Algorithm (MDA) will need to be adjusted to better detect these smaller features which tend to be “squashed” radially and stretched azimuthally. Case studies at the OSF indicate that the Threshold Pattern Vectors (TPV) parameter should be lowered from the default value of 10 down to 6 (see Chapter 6 of “Guidance on Adaptable Parameters Handbook, RPG”) for optimal MDA performance.

OPERATIONAL PULSE REPETITION FREQUENCY (PRF) - - Although the WSR-88D will automatically choose the PRF that will produce the least amount of purple range folded (RF) data, there may be times when the PRF will need to be changed to eliminate areas of RF echoes in the eyewall of a TC. By extending the maximum unambiguous range (R_{max}), obscuration of maximum Doppler velocities can be minimized and sometimes eliminated completely. When operating in AUTO PRF mode, the WSR-88D will choose from among 4 Doppler PRFs - - 5, 6, 7, and 8 - - which have R_{max} of 80 nm, 74 nm, 69 nm, and 63 nm, respectively. With Build 9, an additional Doppler PRF (4) was made accessible to the UCP operator. PRF 4 has a R_{max} of 96 nm and a maximum unambiguous velocity (V_{max}) of 43 kt. Although PRF 4 has a much lower V_{max} as compared to PRF 8 (64 kt), velocity dealiasing should not be a problem in those areas where fairly continuous echo coverage exists.

It is important to remember that when selecting PRF 4, the WSR-88D must remain in MANUAL PRF mode (i.e., leave AUTO PRF off). If the UCP operator selects PRF 4, and then switches back to AUTO PRF, the radar will not use PRF 4. Instead, the WSR-88D will default to one of the other Doppler PRFs (5, 6, 7, or 8). PRF 4 is for manual selection *only*.

BASE VELOCITY DISPLAY INTERVALS - - There are eight Base Velocity code tables that can be edited by the UCP operator - - four in Mode A (Precipitation) and four in Mode B (Clear Air). Given the primarily convective nature of TCs, only the Mode A velocity products will be discussed. The WSR-88D can be operated using 1 of 2 Velocity Measurement Increments {VMI} (0.97 kt/0.5 ms^{-1} or 1.94 kt/1.0 ms^{-1}) to produce 8-data level and 16-data level velocity products. The velocity intervals displayed on Base Velocity products are not fixed or tied to any specific PRF, and can be changed by the UCP operator to display any desired values from +/- 1 kt to +/- 246 kt for velocity product code IDs 6 and 7, but only up to +/- 123 kt for velocity product code IDs 4 and 5 (to access the UCP velocity ID code files, press Function Key **F1**, then on the COMMAND: line, enter: **SE, {password#1}, VE <Return>**).

The velocity intervals chosen for display should be determined by the strength of the approaching TC. Maximum displayable values should be based on the current and predicted strength of a TC as indicated in National Hurricane Center (NHC) warnings. Having maximum displayable velocity values of 64 kt for a 100 kt system would provide only limited information. Also remember that NHC’s wind forecasts are for sustained 1-minute surface wind speeds. Higher wind speeds usually lie at altitudes between 3,000 and 10,000 ft ASL so your maximum displayable velocity will generally need to be 10-15 kt higher than the official forecast wind speeds. Coordination with the NHC may help to determine what velocity intervals would best serve their needs as well as your local office’s operations.

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Tropical Cyclone Landfall Events

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VELOCITY MEASUREMENT INCREMENTS (VMI) - - As mentioned in the above topic, the WSR-88D can operate using 2 different Velocity Measurement Increments - - 0.97 kt/0.5 ms^{-1} or 1.94 kt/1.0 ms^{-1}. The range of maximum displayable velocity values can be extended to 246 kt by operating with a VMI of 1.94 kt (e.g., velocity product code IDs 6 and 7). This can be very important when an approaching tropical cyclone is expected to possess winds greater than 123 kt. To implement this VMI change at the UCP, press Function Key **F1**, then on the COMMAND: line, enter: **V,V,1.94 <Return>**, then **E** (to End) **<Return>**. Additionally, AUTO PRF must be off to successfully download the modified VCP (i.e., the new VMI). AUTO PRF may be used after the successful VMI change has been executed (see Chapter 4 of "Guidance on Adaptable Parameters Handbook, RPG").

There is an additional "hidden" benefit to operating the WSR-88D with a 1.94 kt VMI - - the Storm Relative Mean Radial Velocity Map (SRM) product will default to the same velocity intervals used to generate the Base Velocity product. That means the SRM product is no longer locked into the non-adaptable maximum default velocity values of +/- 50 kt and can display storm-relative velocity values up to 246 kt. There will be little or no degradation of the displayed velocity data.

There are some significant and important operational differences between the SRM and Base Velocity products. Recall that the SRM displayed velocity values are obtained by using the highest of 4 successive 0.13 nm velocity range bins, whereas the Base Velocity product uses the first of 4 successive range bins. The result is that the SRM will always display the highest detected Doppler velocity, whereas the same maximum velocity value may be missed on the Base Velocity product.

When using a user-defined storm-relative motion (e.g., the NHC track motion and speed from the advisory) to generate SRMs, significant velocity asymmetries may become apparent that could provide additional useful information to field forecasters, NHC personnel, and various in-situ researchers. Finally, if a storm-relative motion of 0 kt/ 0° direction (i.e., 0/0 SRM) is used, then the "extended SRM" product becomes a "maximum" Base Velocity product with the same velocity intervals.

If you have any questions, please contact the OSF Hotline at 1-800-643-3363 or feel free to contact me by e-mail at sstewart@osf.noaa.gov or by phone at 405-366-6560 ext. 4280.

Stacy Stewart
OSF Operations Training Branch

WSR-88D Precipitation Algorithm Validation

Editor's Note: Below is a summary of a paper submitted to the *Journal of Atmospheric and Oceanic Technology* titled "A COMPARISON OF RADAR ESTIMATES OF RAINFALL ACCUMULATION FROM THE WSR-88D PRECIPITATION ALGORITHM WITH RAIN GAUGE DATA"

Radar-estimated rainfall amounts from the NEXRAD Weather Surveillance Radar Precipitation Accumulation Algorithm were compared with measurements from numerous rain gauges. Sixty- five rain events from 12 radar sites were analyzed. These rain events covered a wide variety of precipitation types from tropical and convective storms to widespread stratiform events, over various climatic regions of the United States. The radar slightly overestimated rainfall accumulations for intense convection cases and significantly underestimated accumulations for stratiform and tropical cases. Varying degrees of range effects were observed for different types of precipitation. For convection cases, the radar underestimated rainfall at the nearest and farthest ranges and slightly overestimated at the middle ranges. A much stronger range bias was evident for stratiform cases. The radar underestimated rainfall substantially in the nearest and farthest ranges and to a somewhat lesser extent at other ranges. The radar also underestimated rainfall for all other types of precipitation, especially at the nearest range, but generally less substantially than for stratiform systems.

Gerald Klazura,
Argonne National Laboratory, Argonne, IL

Jessica M. Thomale,
University of Oklahoma, Norman, OK

D. Scott Kelly,
National Weather Service, Silver Spring , MD

James McCullough

"Our WSR-88D ALWAYS Underestimates Precipitation Accumulation. WHY???"

A common cause of underestimation is the failure of the accumulation algorithms to be activated by the Precipitation Detection Function (PDF) because the Nominal Clutter Area (NCA) is set much too high.

So your next question is: ***How can this be, we always operate in VCP 11 or 21 when rain is within our radar umbrella?***

Let's take a quick look at the Precipitation Detection Function (PDF) to clear up any misconception about precipitation accumulation and volume coverage pattern selection.

The PDF is designed to automatically determine if precipitation is occurring within 124 nm of the radar. After computing the areal coverage of reflectivities above a certain intensity (the Precipitation Rate Threshold), the PDF compares this coverage to the Area Threshold which is the sum of the Precipitation Area Threshold and the Nominal Clutter Area Threshold. The PDF does not discern between a ground return and a real precipitation target. The NCA is intended to account for the areal coverage of residual clutter.

PRECIPITATION DETECTION Pg 1 of 1

COMMAND: AD,*****,M,*****,P,
FEEDBACK: OPER B/R 32

(M)odify, {LINE#} (E)nd (C)ancel (D)elete, {LINE#}

N	Tilt Domain		Precip Rate Thresh (dBR)	Nominal Clutter Area (Km2)	Precip Area Thresh (Km2)	Precip Cat.
	-					
1	0.0	2.0	-2.0	100	20	2
2	0.0	4.0	1.0	150	10	1
3	2.0	4.0	-2.0	80	20	2

Figure 1

One of the following three Precipitation Categories is assigned to each volume scan depending on which combination of thresholds are met or exceeded (See Figure 1):

Category 0 - No precipitation detected. The total area of reflectivities $\geq$ 22 dBZ ($\geq$ 30 dBZ) ***did not*** meet or exceed the Area threshold for Category 2 (Category 1).

Category 1 - Significant precipitation detected. The total area of reflectivities $\geq$ 30 dBZ ***did*** meet or exceed the Area threshold for Category 1.

Category 2 - Light precipitation detected. The total area of reflectivities $\geq$ 22 dBZ ***did*** meet or exceed the Area threshold for Category 2 but the total area of reflectivities $\geq$ 30 dBZ ***did not*** meet or exceed the Area threshold for Category 1.

(Note: These dBZ values apply when using Z = $300R^{1.4}$.)

When the assigned Category is 1 or 2, the precipitation accumulation algorithms (PPS) compute rainfall accumulations. When the assigned Category is 0, rainfall products with zero accumulations are generated, regardless of the active VCP.

By setting the NCA to represent the residual clutter, Categories 1 and 2 will be assigned by the PDF when real precipitation is occurring anywhere within 124 nm of the radar. In order to correctly set the NCA, the detected area of reflectivity returns can be checked on the Precipitation Status screen (ST,PRE). For example, on a precipitation-free day with no anomalous propagation (AP), the detected area is a good first guess for a typical NCA setting for your site. This screen provides the results from the PDF for each volume scan, including the currently assigned precipitation category and the time left until the operator may select a Clear Air Mode VCP.

So what about VCP control?

This seems a little tricky at first, so bear with us. When Category 1 has not been detected during the past hour, any VCP can be selected. When the assigned Category is 1, the radar can only be operated in Precipitation Mode (VCP 11 or 21). In either case the precipitation accumulation algorithm will run or not based on the Precipitation Category, ***not the VCP***.

OK - What is the suggested strategy that ensures the precipitation algorithms are active when it is raining but still allows us the flexibility to control the operational mode (VCP)?

The NCA should not generally be used to prevent the radar from switching into Precipitation Mode A due to the presence of AP. AP should be filtered by the application of clutter suppression. If appropriate clutter suppression cannot properly remove all of the AP and the decision is made to increase the NCA to prevent the radar from switching into Precipitation Mode A, then you should ***only*** increase the value of NCA for Category 1 (line 2 in the example menu). Category 1

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Underestimated Precipitation Accumulation

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is the only category that requires a Precipitation Mode VCP. Thus once the residual AP has dissipated, the NCA for Category 1 must be promptly returned to the proper smaller residual clutter value to permit the radar to switch to Precipitation Mode when significant rainfall begins.

Never increase the values of NCA beyond the residual clutter value for Category 2. In the event of AP with NCA for Category 2 set to proper low values, the precipitation algorithms will execute as expected and automatically remove the negative effects of anomalous propagation on the precipitation estimates through quality control logic internal to the algorithms.

At times, precipitation accumulations may be desired while the radar is operating in a Clear Air Mode VCP. This is appropriate for very light rain or snow events. In this case, it is permissible under URC guidelines, to raise the NCA threshold value for Category 1 precipitation, but leave it set relatively low for Category 2 precipitation. If this is done, the Precipitation Rate and Area thresholds will be exceeded for Category 2, but will not be exceeded for Category 1. Any VCP can be invoked, and precipitation products will accumulate rainfall estimates.

You have direct control over the NCA settings which frequently contribute to underestimation, and therefore ***you can fix it!*** Just remember - The bottom line is the ***assigned precipitation category***. When the assigned category is either 1 or 2 the precipitation accumulation algorithms are activated. Regardless of the active VCP, the accumulation algorithms ***do not*** execute until the PDF assigns precipitation Category 1 or 2. Indiscriminately high NCA values prevent the precipitation accumulation algorithms from executing when in fact it is raining, resulting in an unrecoverable loss of rainfall accumulation.

Jami Boettcher
OSF Operations Training Branch

Joe N. Chrisman
OSF Engineering Branch

OU-OSF Combined Research Project

The Operational Support Facility often provides the where-with-all for Oklahoma University Engineering seniors to perform their required Senior Research Project. This has proven to be mutually advantageous to both the seniors, the University, and the OSF. Several useful devices and analyses have been developed over the years. The OSF staff engineers act as mentors to the seniors involved.

At the present time, two groups of seniors are being mentored by OSF engineers, Rich Ice and Bill Urell. The project selected for implementation is the development of a dummy load to be connected to the WSR-88D Modulator. The dummy load must simulate the Pulse Transformer and Klystron cathode circuit. This device will be extremely useful in field applications where it is necessary to isolate faults between the Modulator and the Pulse Transformer/Klystron, especially since the latter components are situated in the Oil Tank and are difficult to access. Previous Weather Radars employed a similar dummy load, but at a much different impedance level so that the old units are not useable on the WSR-88D.

In order to verify initial calculations of the Pulse Transformer/Klystron impedance, a Low Power simulation of the Modulator was developed using the real Pulse Forming Network. The output of the Charging Transformer was simulated by a +18 V DC power supply, the RBDT stack was simulated with a DPDT toggle switch available from Radio Shack, and the Pulse Transformer/Klystron was simulated by various composition resistors available from the same source! The waveforms derived from the simulation were amazingly similar to those obtained on the real Transmitter. Varying the value of the load impedance had the effect predictable from transmission line theory. Furthermore, the Low Power simulation set-up has direct application at the National Reconditioning Center as a test fixture for testing Pulse Forming Networks.

If all goes well, the WSR-88D Modulator Dummy Load test fixture could be used by OSF repair teams for solving difficult transmitter failures.

Bill Urell,
OSF
Engineering Branch

Clutter Filter Control and the BIG RED BALL

This sounds like the title of a cute bedtime story that will delight the little ones every night into the foreseeable future. In fact, it is an anomaly that diminishes your ability to adequately apply clutter suppression and interpret the resulting WSR-88D data.

The Clutter Filter Control (CFC) Product is designed to depict the clutter suppression scheme currently being applied at the RDA. However, if it displays as a BIG RED BALL pattern (or one that is in no way representative of the suppression that should be occurring based on the last downloaded clutter suppression regions file), then there's a some work that needs to be done to generate a valid CFC product.

a. Some explanation as to why the RPG is not producing a CFC that depicts reality is in order. Whenever the RDA/RPG computers are booted up, the RPG compares the dates of the two files (one at the RDA and one at the RPG) which contain duplicate copies of the Bypass Map. If the RDA file has a more recent date stamp than the RPG file, then the RDA file is requested by the RPG so that the two files match. However, if the RPG file has a more recent date, then the RDA does not send a new Bypass Map to the RPG. The most common way this situation can occur is if the software was loaded on the RDA before it was loaded on the RPG. It is in this situation that we get a BIG RED BALL on the CFC product. This is simply the RPG depiction of the "default" empty file located at the RPG. Two important points should be made here:

(1) The RPG compares the file dates of the RDA Bypass Map and RPG Bypass Map files -- ***not*** the files containing the clutter suppression regions.

(2) When you see a BIG RED BALL on your CFC product, it is an indicator that the Bypass Map at the RDA has not been copied over to the RPG. It is not necessarily representative of what actually is, or is not, being suppressed. The clutter suppression regions file you have downloaded to the RDA is probably operating as advertised. It is just that the CFC product was built using the "empty" Bypass Map from the RPG rather than the "real"one from the RDA.

b. To fix this problem, the RPG file needs to be updated with a copy of the Bypass Map currently in use at the RDA. To make this happen, all you have to do is enter the following command at the UCP; "AD,XXXXX,CL,B,R", then "<Return>". This requests the Bypass Map from the RDA and copies it to the RPG. Do not make any edits on this screen; simply press "<F1>" to exit it.

Now, the RPG file date matches the one at the RDA. After a couple of volume scans, you should be able to request and see a valid CFC product using the steps outlined above.

If you are still unable to obtain a valid CFC product, or if you have any other questions, please feel free to contact the Hotline at 1-800-643-3363.

Capt Tony Ray
OSF Operations Branch

Microwave Narrowband Communications

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steel tower. On February 4th, the FAA transferred both their dedicated and dial-up PUP circuits as well as the UCP circuit onto the microwave link as a test case for reliability and availability of narrowband communications.

The new Microwave Line Of Sight (MLOS) system at San Juan will allow NEXRAD information to be provided to the NWS, FAA and NIDS vendors in a much more reliable means, with relatively low circuit down time, short time to restore the system, and high availability. A similar installation is also deployed at Molokai, HI.

Roger Ngomeni
OSF Engineering Branch

NEXRAD Now is a periodical of the WSR-88D Operational Support Facility.

Director..Jim Belville
Deputy Director...............................Richard Vogt
Editor...Ruth Jackson

The upcoming issue of *NEXRAD Now* is scheduled for release in November, '98. We encourage all our readers to submit articles for publication. Please note that the deadline for submission of articles for the November issue of *NEXRAD Now* is October 2nd.

Please send all comments and articles via e-mail to: rjackson@osf.noaa.gov