Winter 2012
Issue 21

Early Experiences with Dual Polarization at WFO Pittsburgh

On July 15, 2011, the WSR-88D co-located with the Weather Forecast Office (WFO) in Pittsburgh, PA (PBZ) became the fifth WSR-88D nationally, and the second in NWS Eastern Region, to receive the dual polarization (dual-pol) radar upgrade. In the months since PBZ received the dual-pol upgrade, several types of weather phenomena have been viewed with the dual-pol products. This article highlights three particular areas for study: hail detection, the Hydrometeor Classification Algorithm (HCA), and Quantitative Precipitation Estimation (QPE).

One area where dual polarization variables add value to the warning process is hail detection. With legacy (single-pol) radar, a Three Body Scatter Spike (TBSS) is observed as a spike of weak reflectivity extending out from a thunderstorm and away from the radar site. This spike indicates hail in a thunderstorm. With dual-pol radar, the TBSS can be observed as a down-radial spike of lower Correlation Coefficient (CC), in addition to the spike of lower reflectivity (Figures 1 and 2). Dual-pol has also indicated lowered CC

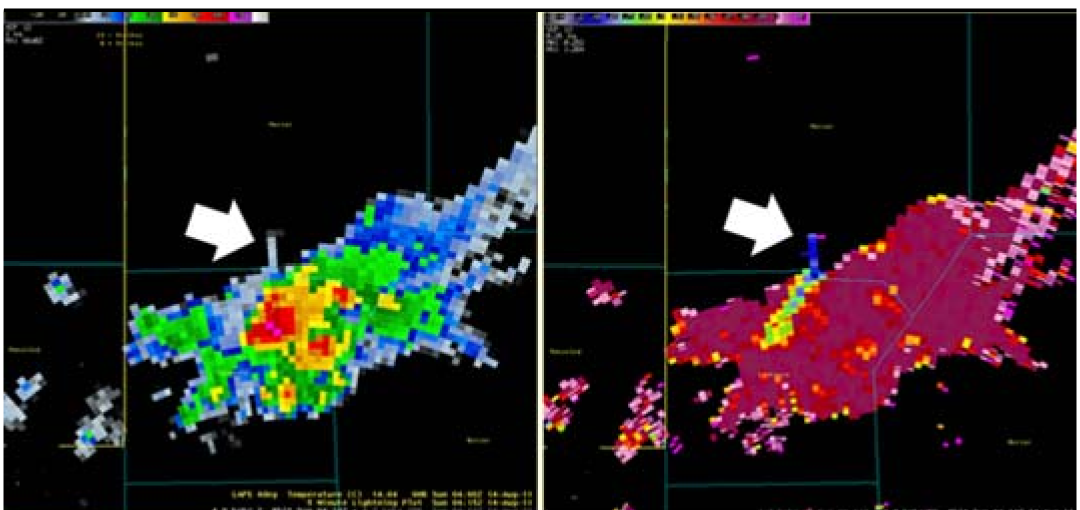

Figure 1: Reflectivity (Z) (left) and CC (right) at 4.3° from 0414Z on August 14. Note the spike of reflectivity on Z (left), and the corresponding spike of low CC (right). This storm produced half inch hail.

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What's Inside?

Dual Polarization at WFO Pittsburgh

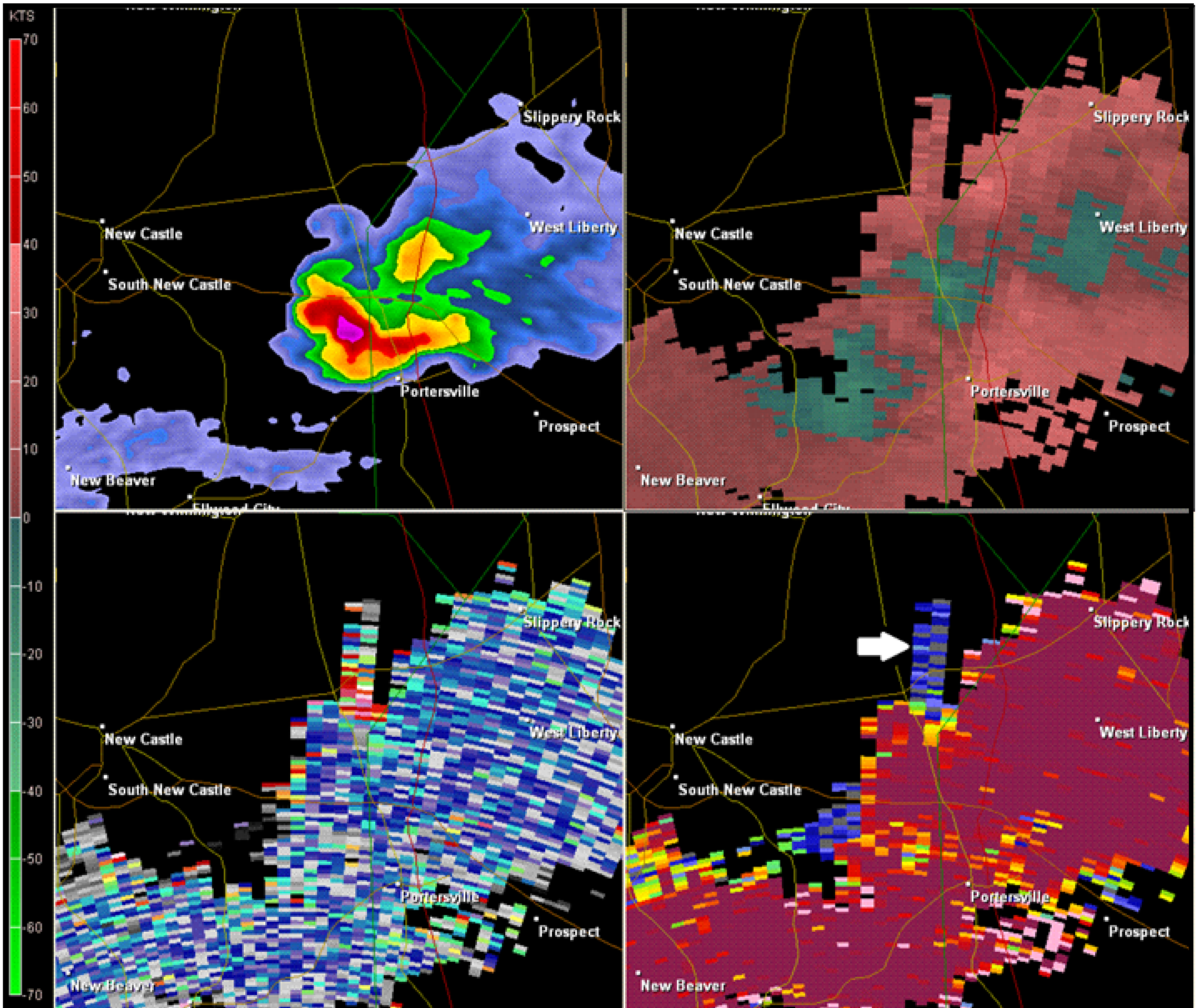

Figure 2: Clockwise from top-left: Z; Storm-Relative Motion (SRM); CC; and Differential Reflectivity (ZDR) at 8° from 1754Z on August 21. Note the spike in CC. This storm produced half-dollar size (1.5”) hail.

Continued from Page 1

values corresponding with both severe and sub-severe hail and in locations where the reflectivity’s TBSS is more difficult to detect in surrounding areas of light reflectivity (Figure 3). Dual polarization may also suggest an area of hail by showing a local minimum in CC, indicating size and shape variation in hydrometeors (Figure 4). At this point, dual-pol data increases confidence that hail is present in a storm. However, at this time there is no definite way to correlate a dual-pol signal to a particular hail size. This is a topic for future research.

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Dual Polarization at WFO Pittsburgh

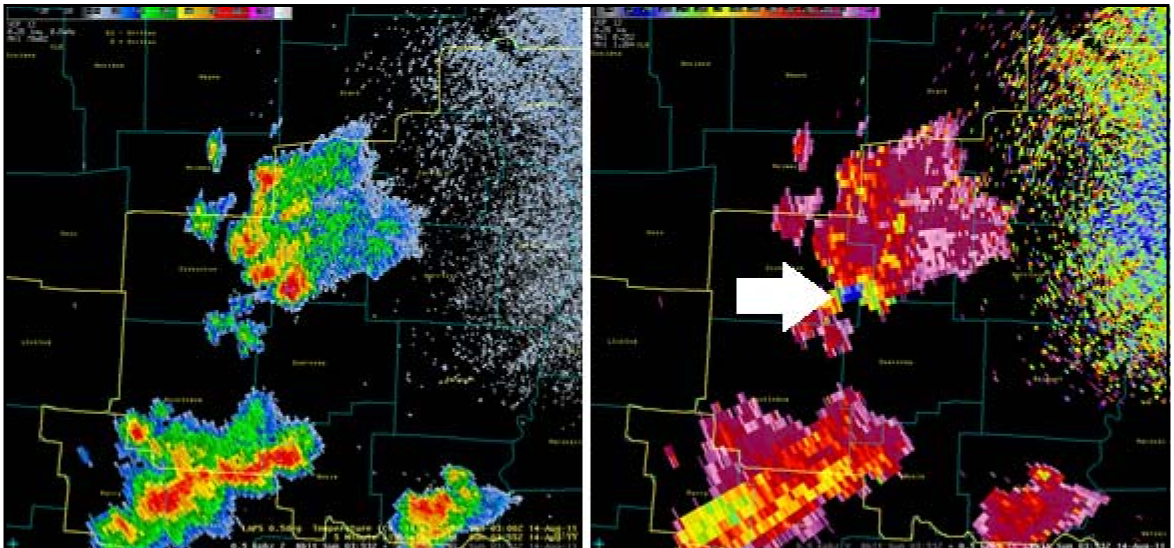

Figure 3: Reflectivity (Z, left) and CC (right) at 0.5^{o} from 0353Z on August 14. This storm produced half inch hail.

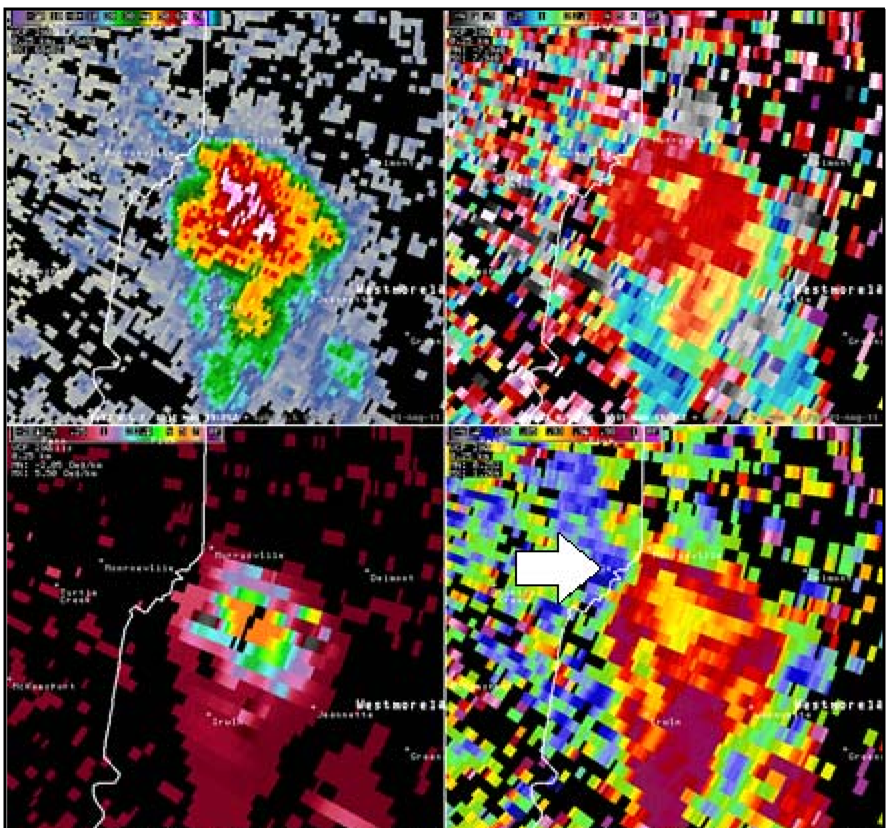

Figure 4: Clockwise from top-left: Z, ZDR, CC, and Specific Differential Phase (KDP) at 0.5^{o} from 1925Z on August 1. This storm produced quarter size (1") hail.

Dual Polarization at WFO Pittsburgh

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A derived product from the base data is the HCA, created by the National Severe Storms Laboratory (NSSL). Using a fuzzy logic system, the HCA identifies particles as one of 12 echo types. The echo types are mostly, but not all, meteorological in nature. Although the HCA performs poorly for cold season classifications (Elmore 2011), the HCA does have some utility; the HCA can help distinguish hail. It was used to show emergency managers the location of a hail core relative to a large outdoor venue during a post-event briefing (Figure 5). The HCA identified a flock of birds at sunrise as biological scatterers (Figure 6). On the other hand, the HCA identified a wind farm as several classifications, including ground clutter, biological, and wet snow (Figure 7). Wind farms are especially difficult for radar algorithms, due to the combination of moving (turbine blade) and stationary turbine blade and mast) targets.

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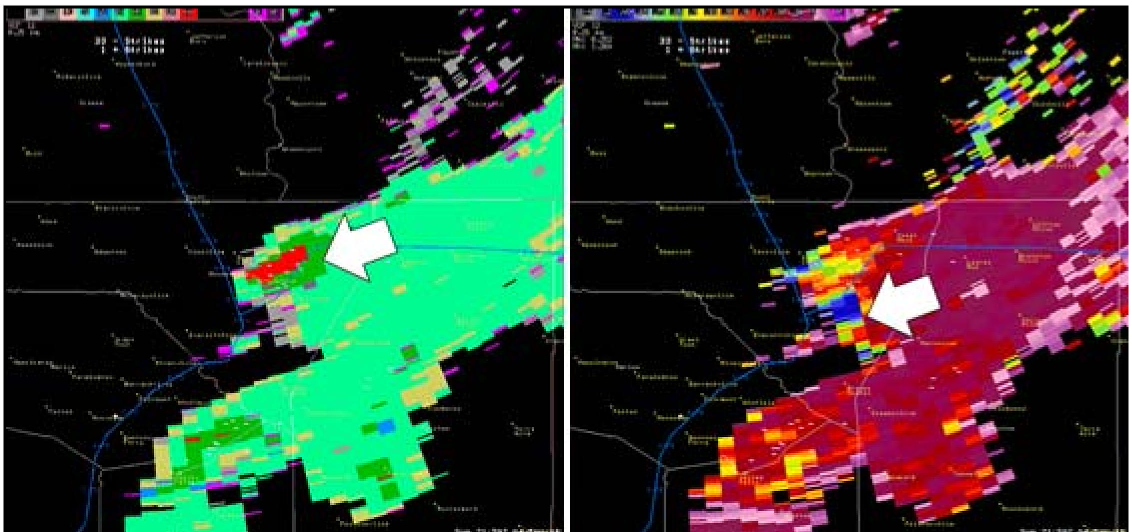

Figure 5: The Hydrometeorological Classification Algorithm (HCA, left) and Correlation Coefficient (CC, right) at 0.5° from 2195Z on September 4. Note how the HCA (left) indicates a rain-hail mix relative to the location of low CC (right).

Figure 6: 0.5° HCA 08/04/11 - 1202Z

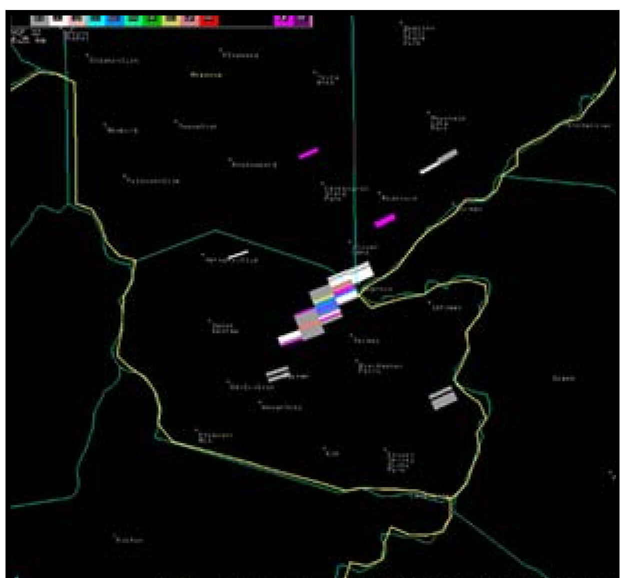

Figure 7: 0.5° HCA 07/26/11 - 1331Z

Dual Polarization at WFO Pittsburgh

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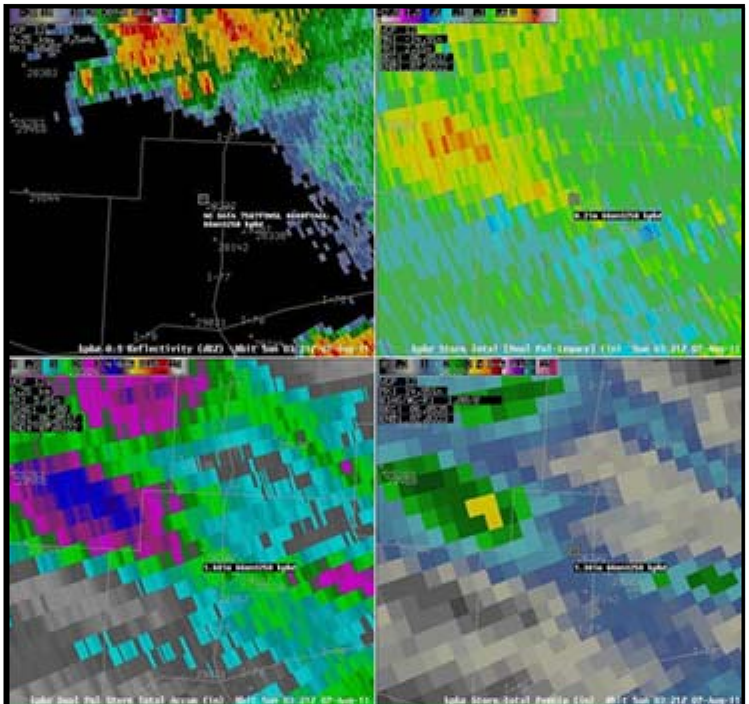

Figure 8: Clockwise from top-left: Base reflectivity; Difference between Dual-Pol and Legacy storm total accumulation; Dual-Pol storm total accumulation; Legacy storm total accumulation.

Precipitation estimation is expected to improve with the addition of dual-pol technology. Through the use of dual-pol base data and the HCA, several different precipitation rates will be used by precipitation algorithms, which should allow for more accurate rainfall estimates.

On the evening of August 6, 2011, scattered thunderstorms moved across Ohio into southwestern Pennsylvania and northern West Virginia. Real-time data from the Integrated Flood Observing and Warning System (IFLOWS) precipitation gages in Ohio showed that dual-pol rainfall estimates were more accurate than legacy rainfall estimates (QPE), with legacy estimates underestimating rainfall (Figures 8 and 9). Unfortunately, the IFLOWS gages in West Virginia were not working, so little ground truth was available in real-time as the thunderstorms continued moving to the southeast during the early morning hours of August 7. In this case, 24-hour precipitation amounts from cooperative observers indicated that dual-pol also outperformed Legacy estimates in these locations (Figure 10). That morning, dual-pol data was used to help forecasters make the decision to issue four flash flood warnings, all of which verified.

Rainfall estimates from dual-pol data have not always proven to be more accurate. During the afternoon of August 19, 2011, thunderstorms with heavy rain moved across urban areas of Pittsburgh and

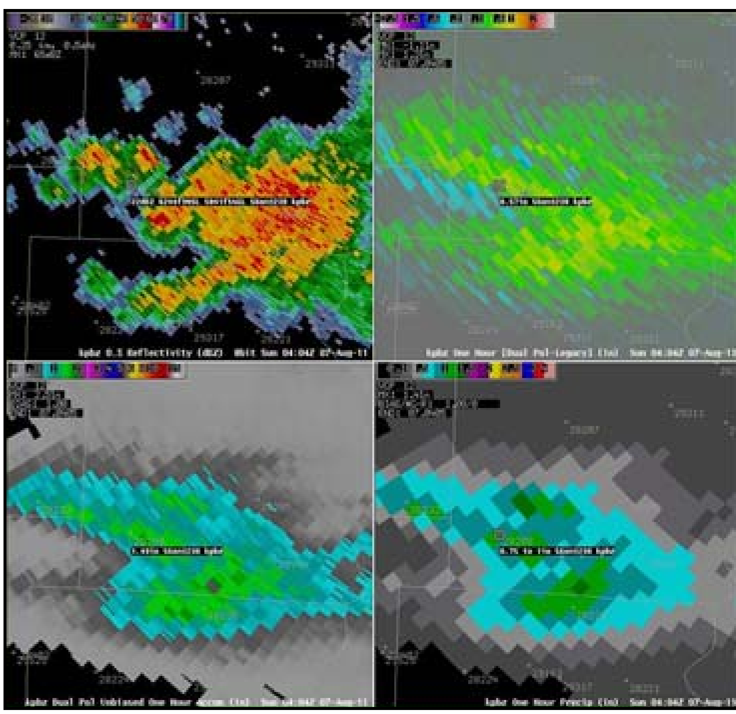

Figure 9: Clockwise from top-left: Base reflectivity; Difference between Dual-Pol and Legacy one-hour accumulation; Dual-Pol one-hour accumulation; Legacy one hour accumulation.

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Dual Polarization at WFO Pittsburgh

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Site	Gage	Legacy	Dual-Pol	Legacy (% Gage)	Dual-Pol (% Gage)
Canaan Valley	1.29	1.20	1.68	93	130
Davis	1.32	1.08	1.56	82	118
Fairmont	3.42	2.20	3.37	64	99
Fellowsville	3.75	2.50	4.00	67	107
Morgantown	1.97	1.60	2.03	81	103
Rowlesburg	2.8	1.70	2.71	61	97
Terra Alta	1.07	0.48	0.78	45	73

Figure 10: Rainfall comparison for sites receiving ≥ 1 inch of rain from 8/6/11 12Z to 8/7/11 12Z.

dropped two to three inches of rain in one hour. Drainage problems in a backed-up sewer system led to four fatalities approximately three miles northeast of downtown Pittsburgh. For this case, dual-pol underestimated the three hour precipitation by 1.0 to 1.5 inches, with legacy radar underestimating the three hour precipitation by 0.5 to 1.0 inches (Figure 11).

Overall, new dual-pol variables such as CC can be used as additional evidence that hail (both severe and sub-severe) is present in an updraft. However, at this point, dual-pol variables have not been as useful for detecting severe winds. Many more wind reports were observed than hail since the dual-pol upgrade. Thus, there were limited opportunities to evaluate rain-

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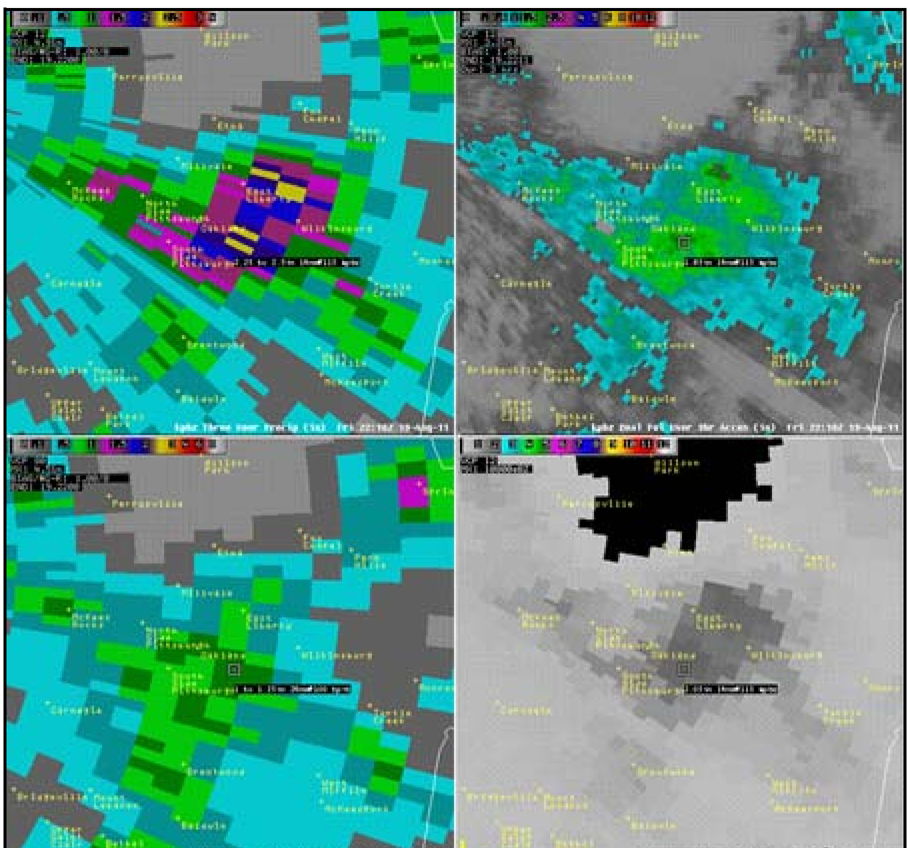

Figure 11: Clockwise from top-left: 3-hr precipitation estimations from KPBZ legacy; KPBZ Dual-Pol; KPBZ AMBER; and TPIT ending at 22Z on August 19.

Dual Polarization at WFO Pittsburgh

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Motorists were forced to abandon their vehicles on Washington Boulevard as flash flood waters quickly submerged their vehicles. Photo Courtesy of Chris Langer/ Pittsburgh Tribune-Review.

fall estimates for storms with possible hail contamination. Through the use of the HCA, areas classified as a rain-hail mix will have precipitation estimates reduced rather than classifying the location of high reflectivity as very heavy rain. Dual-pol rainfall estimates have generally (but not always, as observed in the Pittsburgh flash flooding event) been more reliable than legacy rainfall estimates. Since dual-pol rain rate equations (using dual-pol base variables) are based on research from central Oklahoma, these values may need to be adjusted for other regions of the country. This will be an area for additional research at WFO PBZ and other sites as dual-pol installations continue across the country.

References

Elmore, Kimberly L., 2011: The NSSL Hydrometeor Classification Algorithm in Winter Surface Precipitation: Evaluation and Future Development. *Wea. Forecasting*, **26**, 756–765.

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The Innovative Techniques Working Group

A small working group has been formed to provide a forum where ideas for new/improved data acquisition and processing techniques can be shared and vetted. The Innovative Techniques Working Group (ITWG) was formed because often times a new look at an old problem can result in a creative solution to improve operation and performance (e.g., AVSET, Mode Selection Function, etc.). Even though the membership is intentionally limited, the ITWG has the support of the WSR-88D stakeholder agencies to recruit temporary expert members to address specific problems/topics.

To identify operational problem areas, the ITWG will review comments included on WSR-88D questionnaire responses, Hotline call tickets, and inquiries/suggestions received via the WSR-88D feedback system. Initial topics for discussion include reducing Volume Coverage Pattern (VCP) update times, more frequent low-level updates, optimizing pulse repetition frequency (PRF) selection, reviewing VCP specifications, and other issues that may improve data availability and/or quality.

The ITWG will focus on operational problems with the goal of finding creative methodologies and implementing field-deployable solutions. (See the SAILS article in this publication for a look at the first ITWG project.) Members will leverage existing agency processes (e.g., TAC, SREC, OSIP, etc.) to reduce the time required to move from the drawing board to deployment.

Once an idea is fleshed out and deemed viable by the ITWG, a formal project will be initiated using the standard WSR-88D change process. Project information and updates will be posted on the Radar Operations Center web page under the "New Radar Technology" banner (http://www.roc.noaa.gov/WSR88D/NewRadarTechnology/NewTechDefault.aspx). In addition, articles outlining ongoing and planned proposals will be published in future editions of *NEXRAD Now.*

Joe N Chrisman
ROC Engineering Branch

Information "Tid Bits" for Improved WSR-88D Operations

These "tid bits" on operational topics are too short for separate articles. We hope you will find this information beneficial.

New WSR-88D in Western Washington State Operational

On 29 September 2011, Senator Cantwell, presided over the Dedication Ceremony of the new WSR-88D, KLGX, Langley Hill, WA. The radar has been modified with the Dual Polarization technology. The key WSR-88D assets for this project (pedestal, transmitter, and Radar Data Acquisition (RDA)) were transferred to the National Weather Service (NWS) from the Keesler AFB, MS maintenance training facility. This enabled cost savings of the installation; operations and maintenance; and ease of keeping the radar on the same upgrade path as the rest of the WSR-88D network. The installation was complete one year earlier than the initial plan to buy a commercial S-Band Doppler and Dual Polarization radar to meet WSR-88D specifications/requirements.

WSR-88D Level II Archive Data Users and Usage

A question frequently received at the Radar Operations Center (ROC) is, "Does anyone use archived Level II data and how often?" This is a fair question because many people at field sites, the National Climatic Data Center (NCDC), the ROC, Top Tier sites, NWS HQ, Unidata and others have invested a lot of time and effort to advance the data collection of these data. In addition, the NWS NEXRAD Program has invested funding for the data collection, distribution, and archive. The following summaries are monthly averages for 2011.

User Email Domain	
.gov	30%
.edu	24%
.mil	1%
Other	46%

Data Archive Usage	
#Requests	3,883
#Files Requested	274,548
GB FTP'd	5,750

Conducting Semi-Annual Unit Radar Committee (URC) Meetings? If Not, Now is a Great Time to Start

In the last issue of *NEXRAD Now* we reminded operators that Chapter 4 of the Memorandum of Agreement among the DOC, DoD, and DOT for Interagency Operation of the WSR-88D (http://www.roc.noaa.gov/WSR88D/) requires all WSR-88D sites with two or more NEXRAD agencies connected must have semi-annual URC meetings, which can be conducted via phone. All but four overseas WSR-88Ds should have an active URC. As the installation of Dual Polarization technology continues (20 installed, 140 to go as of the end of 2011), coordination of the installation dates and the 12-day radar outage is essential. Also, it would be a great idea for sites to invite the maintenance staff of a TDWR in their coverage area to participate in the URC meetings. Please contact the WSR-88D Hotline with questions on how to start/restart your local WSR-88D URC. The Hotline will also gladly participate in future URC telecons to answer

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Tid Bits

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questions or address system-wide topics on the agenda.

WSR-88D Volume Coverage Pattern (VCP) Usage

In the last issue of *NEXRAD Now* we published graphs of monthly and annual VCP usage. Figure 1 is an update of the annual average VCP usage, which includes 2010 and 2011 information. The ROC believes the steadily increasing use of VCPs 212 and 12 is a good sign that operators are recognizing the benefits of the faster updates and more scans at the lower elevation angles during severe weather and other situations.

Tim Crum
ROC Director's Office

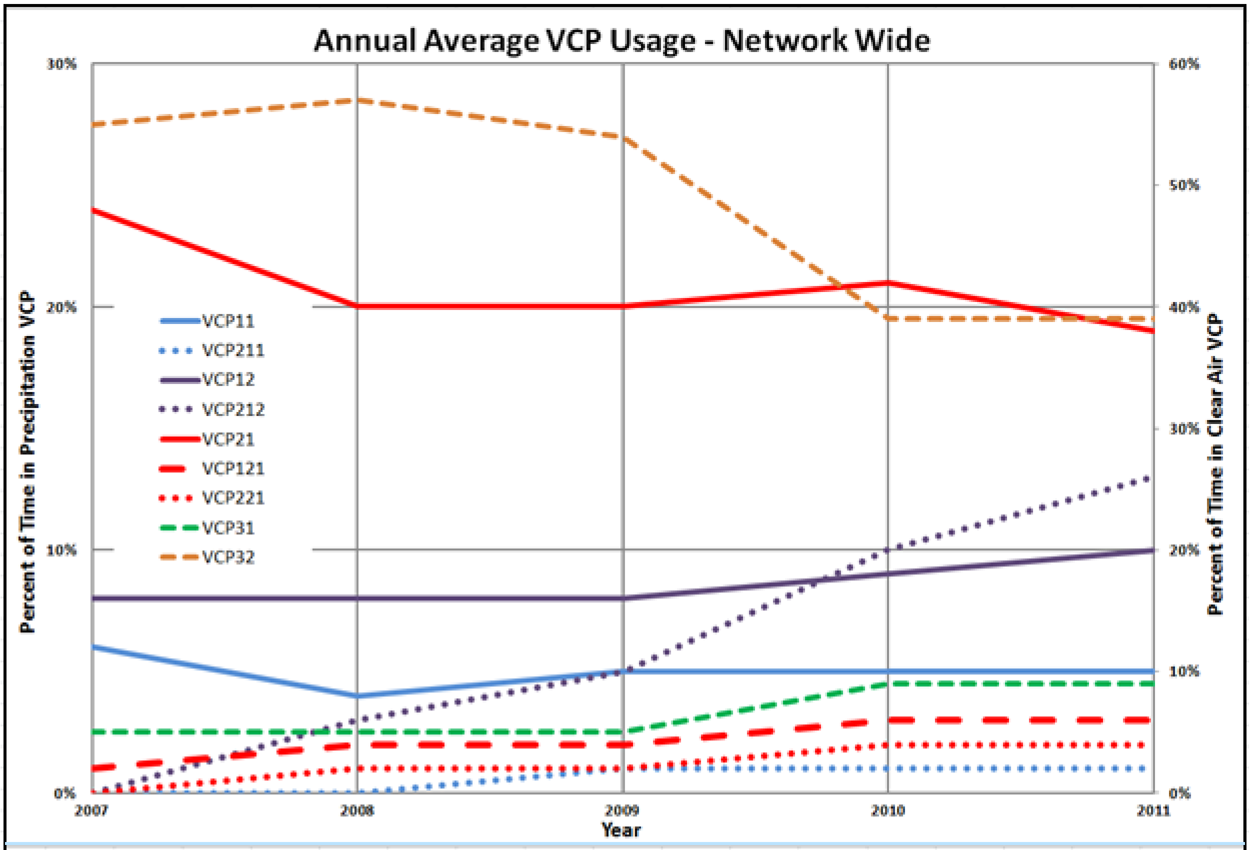

Figure 1: Annual VCP Usage (2007-2011).

Setting SAILS for New Split Cut Scan

According to respondents to the 2007 Radar Operations Center (ROC) Applications Branch Field Survey, faster Volume Coverage Pattern (VCP) updates and more frequent low elevation updates are the two "most important VCP improvements" the ROC could make to the WSR-88D. The Automated Volume Scan Evaluation and Termination (AVSET) function was a good first step in meeting these stated operational needs. However, when storms are close to a Radar Data Acquisition (RDA), AVSET does not reduce VCP completion times and therefore, does not provide more frequent low-level updates. A proposed remedy for this limitation, the Supplemental Adaptive Intra-Volume Low-Level Scan (SAILS) scheme, is being explored by the Innovative Techniques Working Group (ITWG).

The concept of SAILS is to add a supplemental 0.5º split cut* scan to the existing severe weather VCPs – 12 and 212. This new split cut scan will be inserted into the "middle" of the volume scan to evenly space the intervals between 0.5º data updates. The "middle" of the volume scan is adaptive and determined in real-time, because volume scan completion times vary due to the change in termination angle determined by AVSET (see Table 1).

**Split cut is a term used to describe the technique of scanning a particular elevation two or*

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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
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: Insert Angle as a Function of Termination Angle.

SAILS

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more times using a different pulse repetition frequency (PRF) for each full scan. This technique is used to accurately place targets in range using a low PRF and to collect accurate velocity data using a high PRF.

Split cut data collection was chosen because it provides the required number of samples to ensure effective clutter filtering; provides range unambiguous reflectivity data, which is the basis to range unfold velocity data; and supports Super Resolution data processing. Using split cut scanning to collect the supplemental 0.5° scan adds approximately 35 seconds to the volume scan duration. This results in VCP 12 completion times of approximately 282 seconds when AVSET does not terminate the VCP early, and a completion time of approximately 218 seconds when AVSET terminates the volume coverage pattern after collection of the 6.4° scan.

SAILS will significantly reduce low level scan update rates, especially when storms are displaced from the RDA location. The standard VCP 12 scans 0.5° every ~195 to ~260 seconds, depending on the AVSET's VCP termination angle, which provides 14 to 19 updates per hour. VCP 12 with SAILS will scan 0.5° every ~110 to ~142 seconds, depending on AVSET, providing 0.5° scans at a rate of 25 to 32 scans per hour. These additional low level "looks" during severe weather operations will enhance WSR-88D forecast and warning support.

The ITWG is still exploring the implementation options for SAILS. However, to speed the approval process, initial thoughts are to segregate this new 0.5° data from the algorithm data processing stream and to limit its availability to only the base product (Reflectivity, Velocity, Spectrum Width) and dual polarization (dual-pol) product (Differential Reflectivity, Correlation Coefficient, and Specific Differential Phase) generation tasks within the Radar Product Generator (RPG). However, the base moments and dual-pol variables from this supplemental scan will be included in the Level II base data stream.

The concept to initially segregate this new data from the algorithm data processing stream is to ensure the field deployment of SAILS will not be delayed awaiting algorithm development required to incorporate this new data. However, by including this new scan in the Level II data stream, algorithm developers who wish to use the new data input can enhance/correct/modify their algorithms without delaying SAILS field implementation. Any algorithm updates and enhancements will be included in future RPG software builds.

The SAILS project is still in its infancy but initial investigations and analysis have not uncovered any technical issues with the WSR-88D, and ITWG members do not foresee any irreconcilable issues with WSR-88D stakeholder agencies user display systems. The preliminary control software has been compiled and is available for testing on the ROC testbed, as radar time becomes available. Look for project updates and information, which will be posted on the ROC web page, under the "New Radar Technology" banner (http://www.roc.noaa.gov/WSR88D/NewRadarTechnology/NewTechDefault.aspx).

Joe N Chrisman
ROC Engineering Branch

Is There a Community-Scale Wind Project Near You?

The Radar Operations Center (ROC) has been working with field sites since 2006 to understand and estimate the potential impact of large, utility-scale wind farms. However, we are now beginning to learn (mostly from WFOs) of planned community-scale projects, which are defined by the American Wind Energy Association (AWEA) as less than 20 Megawatts, but typically much less and with only one turbine installed. Many of these single-turbine projects support school districts, commercial parks, farmers, etc.

While these projects may not seem as likely to impact WSR-88D data/products and resulting forecasts and warnings as utility-scale wind farms, if the turbine(s) is located within ~3km of the radar and blade tips extend above the deck of the WSR-88D tower, the impacts can be large. For example, the hub (nacelle) of a single large turbine in the radar's line-of-sight at 3km can significantly block the radar beam and cause a data shadow through the entire range of a radial (1 deg).

Please notify the ROC at wind.energy.matters@noaa.gov if you become aware of a proposal to install this type of wind project close to your WSR-88D. As with larger wind farm projects, we will assess the potential impacts on the radar/operations and work with the developer, if needed. The ROC will increase our outreach efforts to the community wind developers to increase their awareness of WSR-88D locations and potential impacts.

Tim Crum
ROC Director's Office

ROC Stars

The Radar Operations Center (ROC) employs dedicated professionals working for the betterment of the WSR-88D program. We are proud of our employees, many of whom have been recognized for their efforts. Please join us in congratulating the following ROC award recipients:

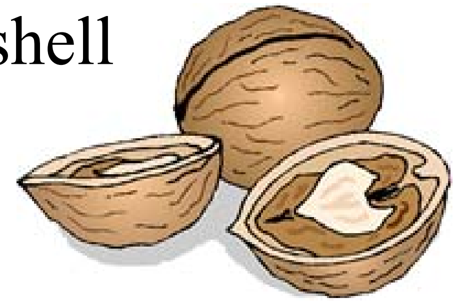
- 2010 Oklahoma Federal Executive Board Employee of the Year Nominees:
  - Technical, Professional & Admin. GS-9 & Above, (Civilian) - Chris Calvert
  - Clerical/Admin. Assistant (Civilian) - Cindy Laffoon
  - Supervisory (Civilian) - Marty Williams
  - Outstanding Team Effort - Greg Cate, Lt.Col. Stephen Cocks, Richard Murnan, Dave Zittel, Joe Chrisman, Darcy Saxion, Richard Ice, Steven Smith, Michelle Collier and Stephen Castleberry

- ROC Employee of the Quarter - FY11
  - 1st Quarter - Ray Gonzalez, Program Branch
  - 2nd Quarter - Jerrod Walker, Program Branch
  - 3rd Quarter - Dan Hoffman, Program Branch
  - 4th Quarter - Bob Heelan, Operations Branch

- ROC Team Member of the Quarter - FY11
  - 1st Quarter - Mark Roper, Director's Office
  - 2nd Quarter - Jason Close, Engineer Branch
  - 3rd Quarter - Gail Grimes, Program Branch
  - 4th Quarter - Brandy Bauer, Program Branch

Nancy Beck
ROC Director's Office

RDA Clutter Suppression in a Nutshell



As a quick refresher the following is a reprint of an article that was first published in the Autumn 2007 edition of *NEXRAD Now.*

Definitions:

GMAP - Gaussian Model Adaptive Processing (GMAP) is the algorithm that performs clutter suppression in ORDA. The fundamental tenet of GMAP is that clutter targets produce a Gaussian frequency distribution around zero velocity with a known, narrow spectrum width. The starting spectrum width (seed) value used in the WSR-88D is 0.4 m/s. For each range bin, GMAP processes the frequency spectrum to identify the power centered on zero velocity. Using this power value, GMAP calculates a clutter Gaussian having a 0.4 m/s (seed value) spectrum width. GMAP then applies this initial clutter Gaussian to the frequency spectrum. If needed, GMAP iteratively recalculates the clutter Gaussian using successively narrower spectrum width values until only clutter power is defined within the clutter Gaussian. All power within the final resultant clutter Gaussian are assumed to be from clutter and are removed from the spectrum.

If there is sufficient meteorological-like power return (return with velocity) available after the clutter coefficients are removed, GMAP will construct a Gaussian curve from that remaining power spectrum and "rebuild" the meteorological signal power (see, http://www.wdtb.noaa.gov/buildTraining/ORDA/PDFs/Final_Chrisman_Ray.pdf).

Bypass Map - A special map generated for each Elevation Segment that identifies the geographic location of clutter targets (targets with near-zero radial velocity and a narrow spectrum width) present within the radar's viewing horizon at the time the map was generated.

Elevation Segment - An Elevation Segment is the grouping of contiguous data collection elevation angles. For the purpose of applying clutter suppression, each grouping (elevation segment) is treated as an individual entity. For more information go to http://www.wdtb.noaa.gov/buildTraining/Build9/pdfs/Joe_AMS_clutter_segments.pdf.

AP - Anomalous Propagation is the nonstandard bending of the radar beam, either more or less steeply than expected. AP may result in the beam being trapped in the boundary layer for long distances resulting in significantly more return on the product displays.

Clutter - The broad definition of "clutter" is, "Any return that interferes with the observation of desired signatures on a radar display."

However, we define "clutter" as stationary, hard (highly reflective), ground-based, nonmeteorological targets. Unlike the first definition, this more restrictive clutter definition does not include return from biological targets (insects, birds, etc.), non-precipitable aerosols, and changes in refractive index, which may be implied in the broader definition, above. We use this more restrictive definition to distinguish ground-based "clutter" targets

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Nutshell

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from those targets that can and do provide valuable boundary layer information.

From the radar's signal processing point of view, yet another definition needs to be introduced here. Because of the nature of the clutter filtering process, the radar considers ALL returns that have a near-zero radial velocity and a narrow spectrum width as clutter. This definition is important because, when clutter suppression is invoked, the radar performs suppression on all returns that have these characteristics (near-zero radial velocity and a narrow spectrum width).

Clutter Suppression:

GMAP ONLY operates where the operator, via the Clutter Regions window, tells it there is clutter. Within each defined region either the Bypass Map or All Bins can be selected.

Bypass Map - with the Bypass Map selection, ONLY those gates identified on the Bypass Map (within the defined region) will be processed by GMAP. ***Use the Bypass Map selection to address routine, non-transient clutter.***

All Bins - with All Bins selected, EVERY gate within the defined region will be processed by GMAP. ***Use operator-defined Clutter (Suppression) Regions with the All Bins selection to address transient clutter return caused by AP.***

Joe N Chrisman
ROC Engineering Branch

The New WSR-88D Wind Energy Evaluation Scheme

The Radar Operation Center's interaction with the wind energy industry has continued to increase as that industry continues to grow and installs more wind farms near WSR-88D sites. At the same time, the emphasis has grown on cooperative efforts to ensure the growing renewable energy industry can coexist beneficially with the WSR-88D network. One of the results arising from those interactions was the desire for a more easily understood schema to identify areas of potential wind farm impacts on the WSR-88D.

Originally we provided maps depicting the area of radar coverage at or below 130 meters above ground level (AGL) and 200 meters AGL. The original yellow gold coverage maps were then enhanced at the request of many of the wind energy developers with an additional coverage depiction, the blue layer, for 160 meter AGL coverage. These heights were originally selected as they best represented the state of the wind turbine architecture in the United States, and accommodated the expected increases in turbine heights.

The assessments for many of the wind energy proposals falling in these original color-coded areas were either negative or nominal impacts. The maps only indicated if the turbines were in or out of the radar line of sight (RLOS). Our desire to provide a more definitive first-look evaluation, more clearly qualify the levels of impact, and communicate where mitigation of those impacts might be requested, led to a new scheme.

To provide that more definitive evaluation, we considered additional radar characteristics when determining the new coverage zones. In Figure 2 we depict those zones for the same radar as in Figure 1.

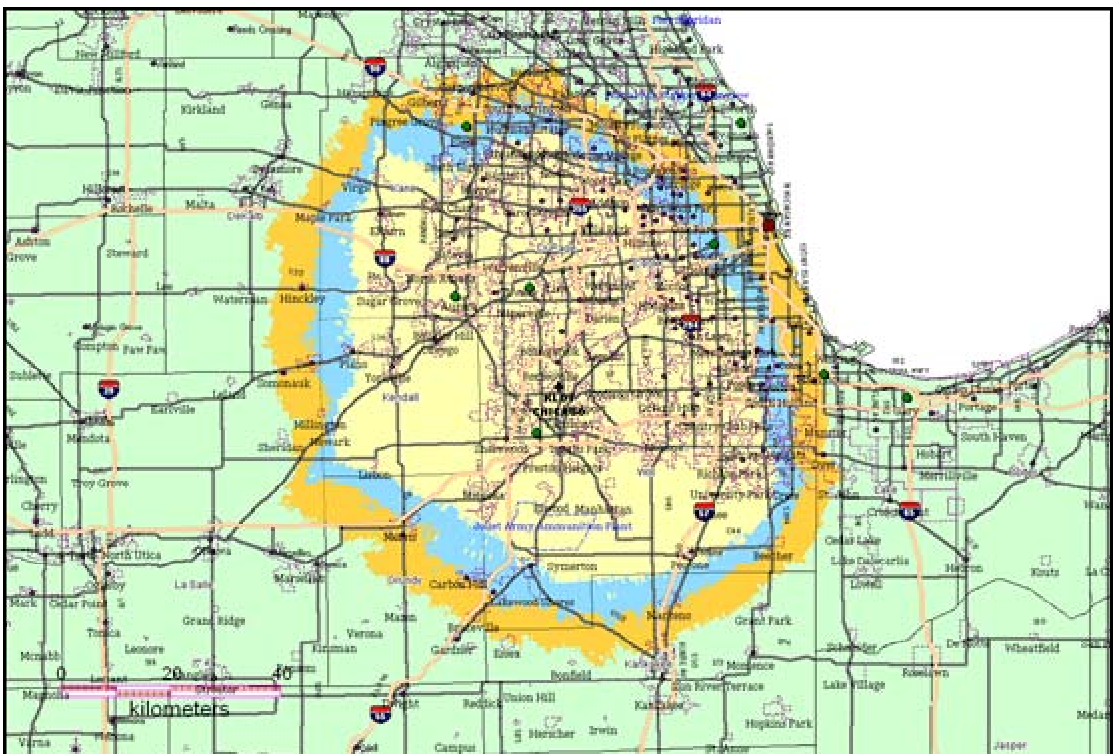

Figure 1: KLOT (Chicago, IL) 130, 160, & 200m AGL Coverage to 230km.

The most noticeable difference is that there appears to be less area in the RLOS. This is the result of limiting the RLOS coverage to turbines no taller than 160 meters AGL as opposed to the 200 meters AGL as in the previous scheme. To differentiate the

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potential impacts and communicate our desired action to the wind farm developers, we created new color-coded zones within the new RLOS area.

There are four different color zones. The first, the RED zone, is a 3km area around the radar that is a preferred *No Build Zone*. Within this zone, large turbines have the potential to damage the radar receiver, cause partial or complete azimuthal data loss throughout the entire radar coverage range, and eliminate feasible work-arounds by radar end-users.

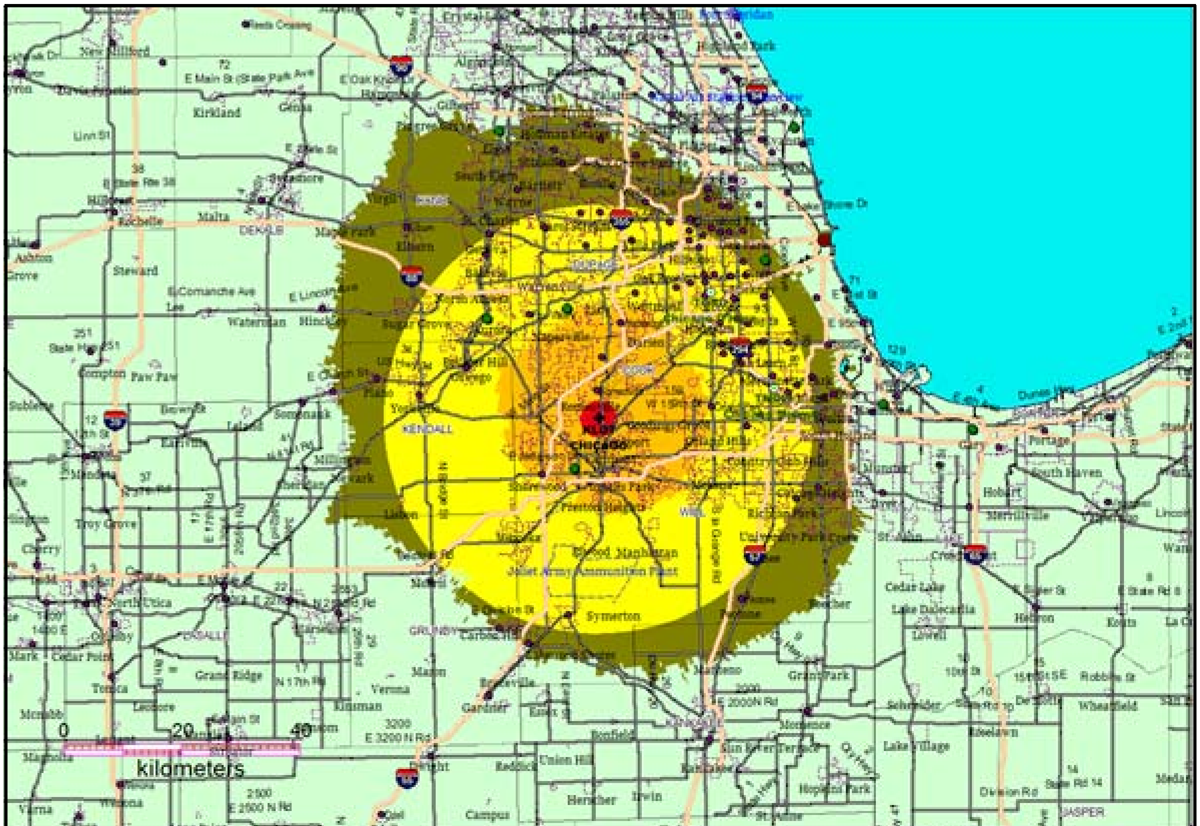

Figure 2: KLOT Operational Impact Zones.

The next zone, the *Mitigation Zone*, is depicted in AMBER. It extends from 3km to as much as 36km from the radar, and indicates where a 160-meter tall turbine tip will penetrate the first two WSR-88D elevation angles (VCPs 12 and 212). As the name suggests, the potential results of wind turbine-radar interaction in this area are significant and require mitigation. We suggest options that can mitigate the impact of wind turbines on the radar's ability to provide warning information necessary for protecting lives and property.

The third zone, the *Consultation Zone*, is depicted in YELLOW. This zone extends from as close as 3km, depending on terrain, to 60km from the radar. For an area to be included in this zone it must meet one of two criteria. The first criterion is potential wind turbine penetration of the first elevation angle in the area from 3km up to 36km from the radar. The second criterion includes areas where penetration of the first two elevation angles occurs from 36km to 60km from the radar. We request ongoing consultation with the developer to ensure that we document

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the final turbine configuration and that it still permits the critical warning mission to be accomplished.

The fourth zone, the *Notification Zone*, is depicted in OLIVE-GREEN. This zone contains areas from 36km extending outward to 230km. The potential penetration need only be in the first elevation angle. We request that developers advise NOAA of development in these areas. A turbine configured in these areas will be routinely visible on the radar, but will typically have limited impact on the warning operations.

Figure 3 below provides examples of terrain's influence upon the areal extents of the second through fourth zones. Rising terrains, as well as terrain blockage create a complex geometry for the zones. To the east of the KIWA (Phoenix, AZ) radar, the mitigation zone extends to 36km and the consultation zone to 60km. The areas in the northeast, south, and west clearly demonstrate the influence of complex terrain.

For additional information on the potential impacts, actions requested, and other information related to this scheme, please see the article at http://www.roc.noaa.gov/WSR88D/Publicdocs/WINDPOWER2011_Final.pdf.

Ron Guenther
ROC Engineering Branch

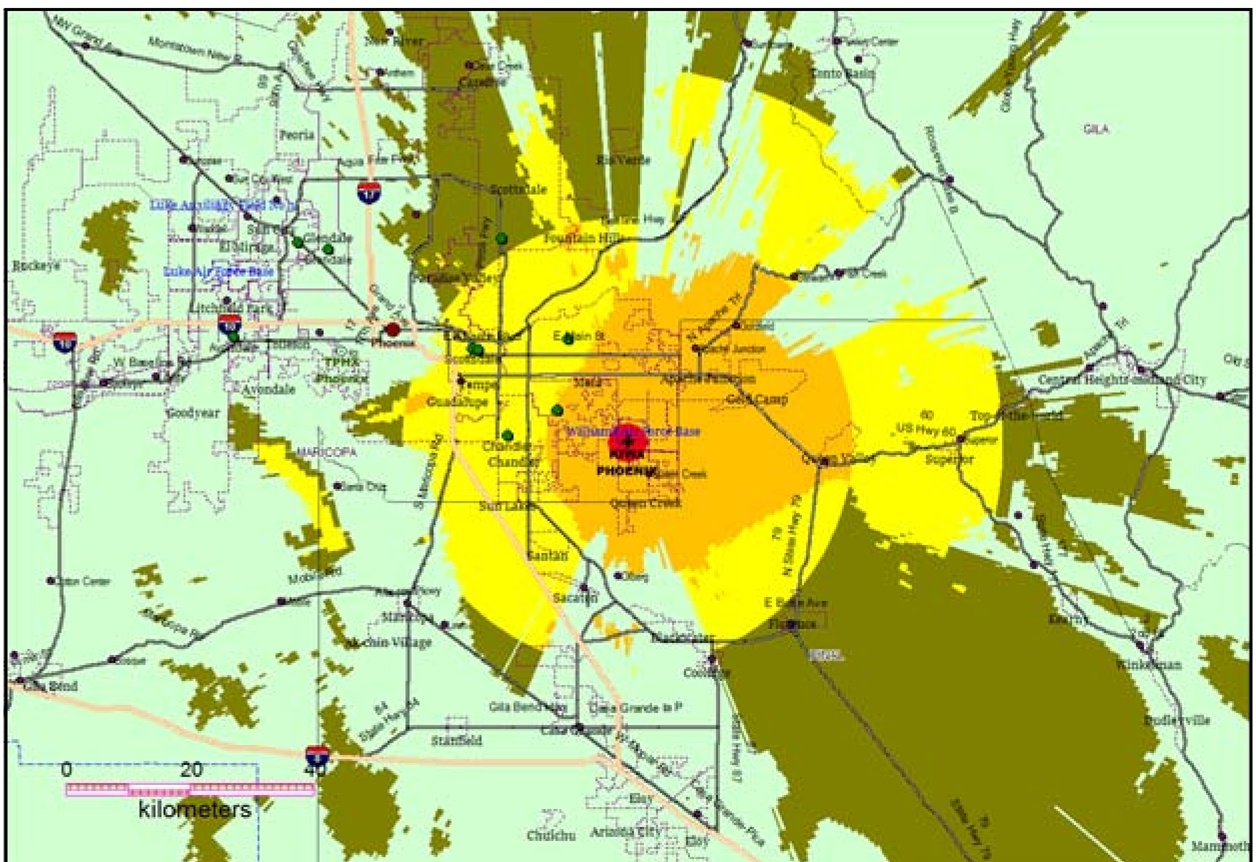

Figure 3: KIWA Terrain Influence upon Operation Impact Zones

Manual Clutter Suppression Management - Its Back Or, Oh! How I Miss CMD

Do to the particular timing of the development and testing of the Clutter Mitigation Decision (CMD) algorithm, and the realities of contracts, the CMD algorithm is not included in the initial Dual Polarization baseline software suite. The good news is that CMD will return in Build 13.0. The bad news is that when a radar is upgraded to Dual Polarization, CMD will not be available and manual clutter suppression management will be required until Build 13.0 is deployed (Summer 2012).

A quick look at the National Radar Mosaic reaffirms the concern that maybe some of the knowledge and ability required to effectively apply clutter suppression might be a little bit fuzzy after three years of not worrying about it. As a review, the following is a slightly modified reprint of an article that was first published in the Summer 2006 edition of *NEXRAD Now.*

Improved Capability:

Clutter filtering in the Radar Data Acquisition (RDA) is accomplished using a WSR-88D-tuned version of the SIGMET Gaussian Model Adaptive Processing (GMAP) clutter filtering technique. GMAP provides the capability to "rebuild" the power spectrum of any removed meteorological return, thereby significantly reducing clutter filter-induced bias in the base data estimates. (For additional information, refer to "A First Look at the Operational (Data Quality) Improvements Provided by the Open Radar Data Acquisition (ORDA) System," Chrisman and Ray, 2005 at http://www.wdtb.noaa.gov/buildTraining/ORDA/PDFs/Final_Chrisman_Ray.pdf).

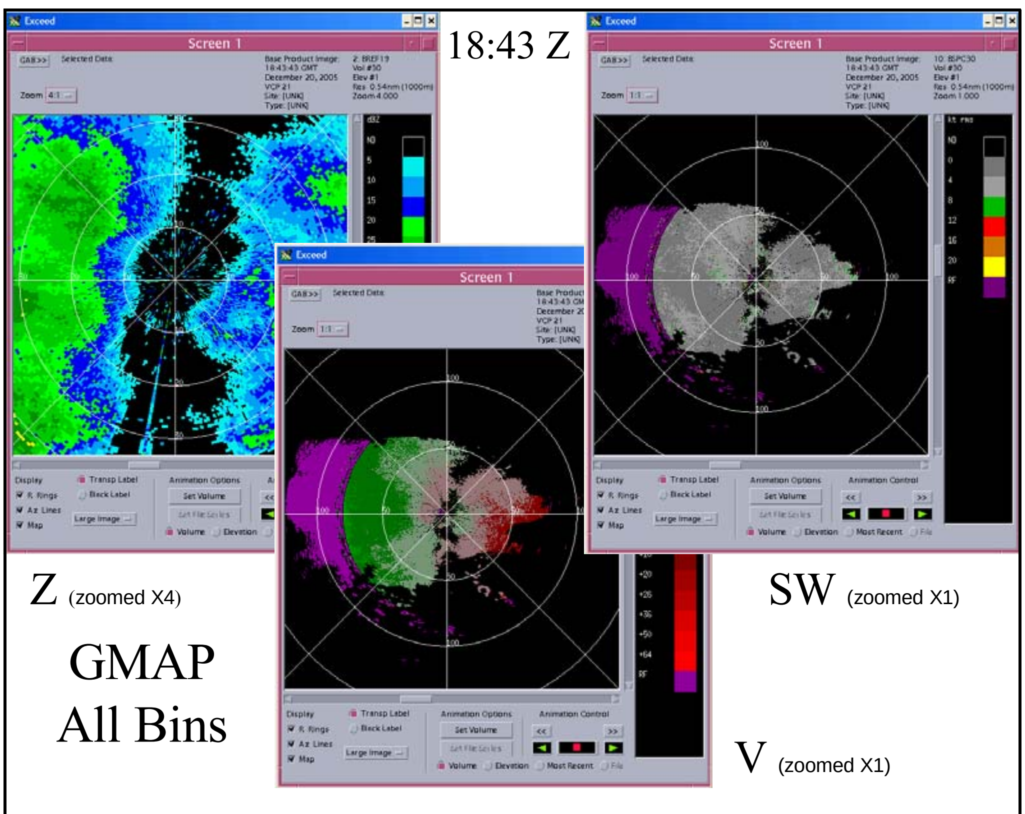

Figure 1: GMAP applied to All Bins

Even though GMAP can "rebuild" a portion of the power spectrum from meteorological return, improper application of GMAP can have a detrimental affect on the base data estimates.

Better Suppression Through Proper Application:

Generally speaking, use the Bypass Map to address the normal ground clutter pattern and only invoke All Bins clutter suppression when and where there is clutter return caused by Anomalous Propagation (AP).

Using clutter suppression regions in areas where there

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Manual Clutter Suppression

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is no clutter return can still result in significant degradation of meteorological return. Even though GMAP attempts to "rebuild" the power spectrum of any removed meteorological return, it can only do this when some power for meteorological return survives the initial filter process. In weakly forced laminar flow, GMAP suppresses (removes) all power with near zero-velocity. In this environment there may not be any power left to initiate the "rebuilding" process. Figure 1 clearly illustrates this situation.

Compare the data coverage area in Figure 1 with that of Figure 2. It is easy to see the reduction in meteorological data coverage caused by clutter suppression.

As one can see, GMAP filtering can be very aggressive under certain circumstances (Figure 1). It is important to remember, however, that with the Bypass Map in control (Figure 2) the impact of GMAP filtering can also cause data loss along the zero isodop in areas where it was invoked.

Suggested Clutter Suppression Management Items:

The following items are provided as general guidance to assist in local Clutter Suppression management.

1. Use the Bypass Map to address routine, non-transient clutter.

2. Generate a new Bypass Map when seasonal conditions change (when the current Bypass Map no longer addresses the routine clutter). Bypass Map generation can be accomplished at the MSCF via the RDA HCI. A technician working with a meteorologist can generate a new Bypass Map in about 10 minutes. Refer to the document "Bypass Map Generation Guidance" at http://www.wdtb.noaa.gov/buildTraining/ORDA/PDFs/Bypass.pdf for additional information. To discuss questions concerning the validity of the Bypass Map, contact the Radar Operations Center (ROC) Hotline.

3. Define at least two Clutter Suppression Regions files and name them accordingly.

- One of these files should invoke the Bypass Map for both elevation segments.

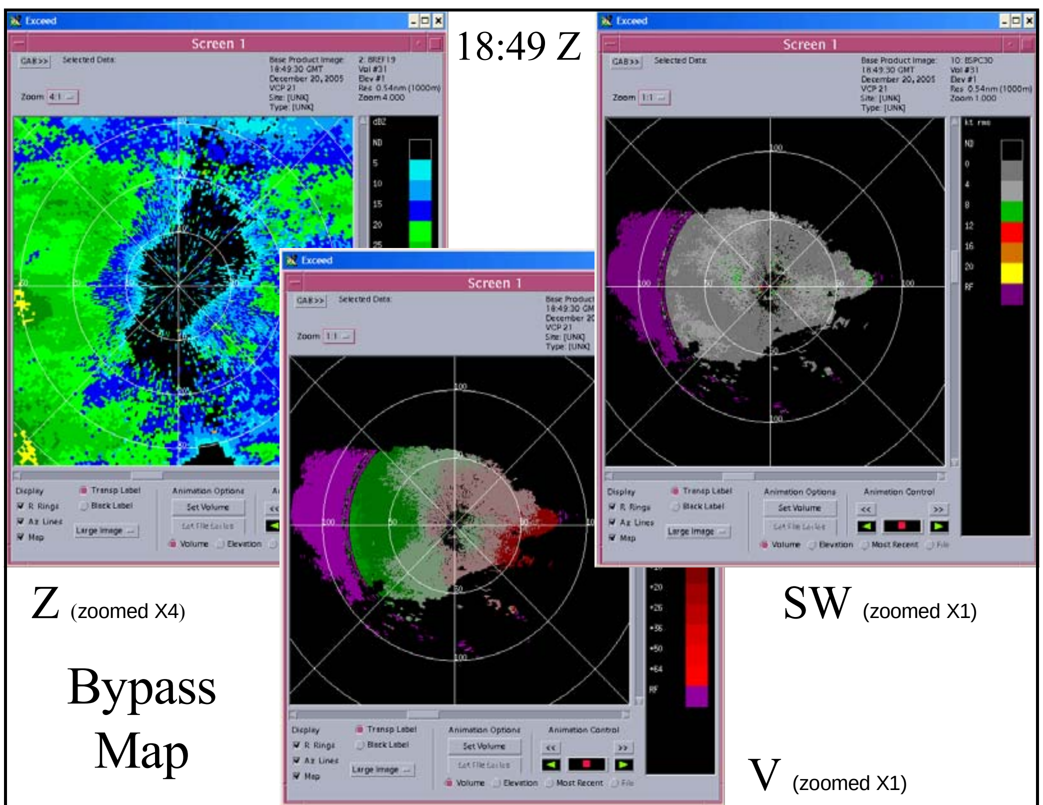

Figure 2: Bypass Map-Controlled GMAP clutter suppression applied

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- One file should invoke All Bins filtering for the low elevation segment and the Bypass Map for the high elevation segment.
  (*Note:* The Radar Operations Center does not recommend using forced suppression on the high elevation segment except under extreme AP conditions when the 2.4 degree elevation cut is intersecting the ground. These extreme conditions are rare for most sites. At sites where these conditions do occur, create another file that invokes All Bins filtering for both elevation segments.)
- If appropriate at your location, define a file (or files) to address predictable transient clutter caused by local geography (e.g., small scale AP return caused by a large body of water, etc.).

4. Under AP conditions, invoke the appropriate clutter suppression regions file to address transient clutter return caused by AP. When the conditions causing the AP event subside, download the predefined file that invokes the Bypass Map.

Joe N Chrisman
ROC Engineering Branch

Picture This...

In 2008 *NEXRAD Now* held a photo contest of scenic NEXRAD sites, and received some wonderful photos. The photos received such positive feedback that we have decided to expand upon the theme. We will now be featuring a scenic photo of an RDA in each edition of *NEXRAD Now.*

Keep your camera (or cell phone) handy and snap a few pictures of your site when your RDA is looking particularly scenic. Send the photos to Ruth.E.Jackson@noaa.gov and look for them in the next edition of *NEXRAD Now.*

Below is a lovely picture of the Glasgow, MT RDA site at dawn. However, the photo belies the temperature -- at the time it was -37° F. Thanks to Bill Martin, Glasgow WFO Science and Operations Officer, for braving the cold to capture the photo.

Ruth Jackson
Editor, *NEXRAD Now*

Glasgow, MT RDA at dawn.

Radome Maintenance Issues

New Radome Contracts

In January 2012, NOAA's Western Acquisition Division awarded separate contracts to L-3 Communications ESSCO, Inc. and Radome Services LLC. These contracts give the Radar Operations Center (ROC) authority to task these contractors to perform inspections and to provide maintenance services such as washing and painting radomes and replacing panels. Now is a good time to discuss three radome issues the ROC has recently encountered: Tedlar peeling, panel-to-panel bolt tightness, and contractor access to RDA sites.

Tedlar Peeling

Tedlar® is a DuPont™ polyvinyl fluoride film that is used as a skin in many types of composite moldings such as commercial aircraft cabin panels, awnings, signs, and radome panels. The Tedlar helps release the parts from their molds and then later protects them from ultraviolet damage in the field. The Tedlar film used in NEXRD radome panels is the same thickness as a standard sandwich bag and does not provide structural strength.

While it is common for small patches of Tedlar to peel over the years, a few radomes such as Mobile, AL; Tampa, FL; and Melbourne, FL have experienced peeling in areas as large as three feet across (see Figures 1 and 2). We suspect that the humid, salt air and occasional hurricane force winds have accelerated radome aging at these sites.

Peeling does not affect the radome's structural integrity or indicate the need for a panel replacement, but it does expose the panel's fiberglass to ultraviolet light. Please report peeling to

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Figure 1: Radome with peeling Tedlar film.

Figure 2: Peeling Tedlar film. Note the peeling is not centralized to one location.

Radome Maintenance

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the ROC Hotline, so your radome can be scheduled for inspection and repainting if necessary. Full ultraviolet protection will be restored with the next coat of paint. See http://www.roc.noaa.gov/WSR88D/PublicDocs/RadomeMaintenanceSchedule.pdf for the radome maintenance schedule. The posted dates are tentative and the contractor will coordinate the actual date directly with the sites.

NEXRAD radomes are designed to withstand winds of 134 miles/hour, and some have survived even higher velocities in Typhoons. In the rare case of a catastrophic failure, the ROC keeps an entire radome in a ready-to-ship steel container and will replace the old radome as soon as possible.

Panel-to-Panel Bolt Tightness

NWS EHB 6-503-2 Card 2-043 calls for annual torque testing of panel-to-panel bolts and notification of the Hotline if the test fails. So far in NEXRAD's 20-year history, no test failures have merited further action. Nevertheless, it is important to report test failures to allow early detection of any downward trends which may develop in the future.

"Spinners" are those embedded panel nuts that have broken their bond to the sandwich panel allowing them to rotate without ever tightening. Due to the spinning, the torque of the nut-bolt assembly cannot be measured. Although the tendency is to assume that spinners are loose (i.e., under-torqued), the fact is that spinners are often caused by over-torqueing and thus are more likely to be over-torqued. The site ETs should circle spinners with a marker and point them out to the next radome inspection crew so they can be repaired.

Contractor Access to RDA Sites

The government is contractually obligated to pay its contractors for direct and indirect costs of work the government directs them to perform. If the contracting officer issues a task order for contractor travel to a site to inspect or repair its radome and if the site denies access, then the contractor is entitled to file a claim for its wasted labor, rental equipment, and travel costs. We recently had to reimburse one contractor over $8000 because the site denied weekend access to avoid paying overtime to send an ET to the site. We realize that sometimes there are extenuating last minute circumstances such as weather, ET illness, etc. However, please contact the ROC Hotline so we can try to quickly reschedule and minimize costs.

Call the Hotline

If you have questions/concerns about your radome's need for maintenance or about a contract crew scheduled to perform maintenance at your site, contact the ROC Hotline.

Vance Mansur
ROC Program Branch