

RPG Build 13.0 Training

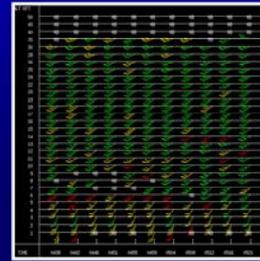
*Presented by the
Warning Decision Training Branch*



Welcome to the RPG Build 13.0 operator training.

RPG Build 13.0 & Your RDA

- Features not active until RDA upgraded Dual-Pol (aka RDA 12.3)
 - Adjustments to Dual-Pol RPG Algorithms
 - CMD & AVSET go away!
- New feature irrespective of RDA Build
 - Enhanced VAD Wind Profile

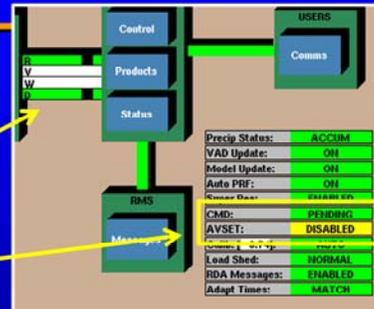


This training presents several features that will not be apparent until your RDA has been upgraded to Dual-Pol, which is RDA Build 12.3. For example, RPG Build 13.0 has adjustments to the Dual-Pol RPG algorithms, which aren't operational until you have Dual-Pol. Also, CMD & AVSET both go away with RDA Build 12.3, but are expected to return beginning in late Summer 2012.

There is one new feature with RPG Build 13.0 that is independent of the RDA Build. It is called the Enhanced VAD Wind Profile (VWP). This is not a replacement for or an addition to the VWP product. Changes are made at the RPG that improve the quality and quantity of available winds "barbs" on this product.

Dual Pol RDA Upgrades

- RDA 12.3 is Dual Pol
 - No CMD or AVSET
- RDA Build 13.0 summer 2012
 - CMD & AVSET return
- Summer 2012: RDA 12.3, shortly (a few weeks) followed by RDA 13.0



Since the Dual Pol upgrade to the WSR-88D fleet is so significant, the updates to both the RPG and the RDA will be more complicated than usual at least through 2013. All of this information applies to WSR-88D Single Thread (not Redundant) sites.

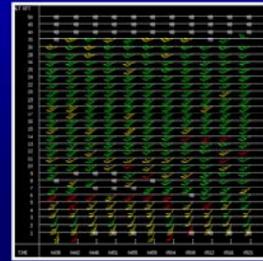
The initial Dual Pol upgrade is RDA Build 12.3, which does not have Clutter Mitigation and Decision (CMD) or Automated Volume Scan Evaluation and Termination (AVSET). As of this writing, both CMD and AVSET return with RDA Build 13.0, which is scheduled to be deployed August 2012.

RPG Build 13.0 / RDA 12.3 Highlights

- RPG status messages related to Dual Pol
- Minor adjustments to RPG algorithms



- CMD & AVSET gone til Summer 2012
- Enhanced VAD Wind Profile



Here are the highlights of the RPG Build 13.0 features for an RDA that has been upgraded to Dual Pol, but not yet to RDA Build 13.0. There are new status messages related to Dual Pol on the RPG Status window. There are a number of minor adjustments to the RPG algorithms, especially the new Dual Pol RPG algorithms. RPG Build 13.0 will not bring back CMD and AVSET. RDA Build 13.0 is needed for that, and it is expected to be deployed Summer 2012.

The one feature of RPG Build 13.0 that has nothing to do with Dual Pol is the Enhanced VAD Wind Profile (EVWP) product. The EVWP will increase both the availability and the accuracy of the WSR-88D calculated winds aloft.

RPG Status Messages

- RPG status messages related to Dual Pol
 - RDA CAL, RDA CAL(DP) & ZDR Stats entries
- For engineering & RPG algorithm analysis
 - Not for operational use



```
Aug 22, 11 [13:12:16] >> MSE STATUS: 5165km2 > 30.0dBZ in VCP 212 recommended  
Aug 22, 11 [13:10:18] >> RDA CAL: T=739; N=-80.76; NT=224; dBZ0=-43.11; I0=-114.87  
Aug 22, 11 [13:10:18] >> RDA CAL (DP): ZDRB= -0.1294, VN=-81.13, VNT=230, VdBZ0=-4  
Aug 22, 11 [13:10:18] >> Vol: 38 (Seg: 2838) RDA Clock:08/22/11 13:10:15 VCP: 212  
Aug 22, 11 [13:10:08] >> ZDR Stats:-0.1/ 0.19, 0.19, 0.19, 0.25, 0.31, 0.44/5841/0  
Aug 22, 11 [13:10:06] >> LDH Stats: Ver: 6, VCP: 212, Last Elev: 19.5 deg, Dur: 27  
Aug 22, 11 [13:07:40] >> RDA ACKNOWLEDGMENT: Remote VCP Received at RDA  
Aug 22, 11 [13:07:38] >> MSE STATUS: 5165km2 > 30.0dBZ in VCP 212 recommended
```

Here are the new status messages at the RPG Status window that are related to Dual Pol. There are three entries, which are generated every volume scan. The first two start with “RDA CAL” and the third starts with “ZDR Stats”. The RDA CAL information is used for engineering analysis. The ZDR Stats information is also used for engineering analysis, as well as research to “fine tune” the RPG algorithms. These numbers are experimental in nature and not for operational use. For those of you upgrading from previous Dual Pol builds, these messages have not changed.

RPG Algorithm Adjustments

- New VCP121 (aka MPDA) parameters
- MLDA for cold season, low melting layer events
- QPE difference products manual reset
- Preprocessor: reduce radial spikes in ZDR
- Preprocessor & QPE: reduce impact of NBF



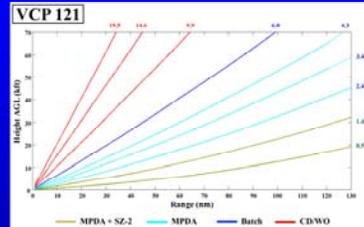
Acronym definitions coming up



Here's a list of the RPG algorithm adjustments that are part of RPG Build 13.0. The following slides will discuss these in detail, including spelling out all these acronyms!

Adjustment to VCP 121 (MPDA) Parameters

- Additional URC parameters
- Eliminates noisy velocity data



Algorithms - (FAA:2 Active/Controlling)

Close Save Undo Baseline: Restore Update

Adaptation Item: Velocity Dealiasing - Multi-PRF ✓ Descriptions

Name	Value	Range
Threshold (Range Unfold Power Difference)	5.0	0.0 <= x <= 20.0, dB
Threshold (Fix Trip Minimum Bin)	-5	-16 <= x <= 16, bins
Threshold (Fix Trip Maximum Bin)	2	-16 <= x <= 16, bins
Threshold (Tight Overlap Size)	2	2 <= x <= 8, m/s
Threshold (Loose Overlap Size)	2	2 <= x <= 12, m/s

There are two additional URC threshold parameters supporting VCP 121, which uses the Multiple PRF Dealiasing Algorithm (MPDA). They are “Tight Overlap Size” and “Loose Overlap Size”. Though the names may not be intuitive, these settings eliminate some occasional noisy velocity data that have been noticed in the past. If noisy velocity data are observed with VCP 121, contact the Hotline for guidance on changing the values.

MLDA in Cold Environments

- MLDA
 - Uses 4° to 10° for search
 - Overlay product
- MLDA can be “cold season challenged”



The Melting Layer Detection Algorithm (MLDA) is one of the new Dual Pol RPG algorithms. It uses data (legacy and Dual Pol) from 4 to 10 degrees to identify the melting layer. These higher elevations are necessary to avoid clutter and other low level data quality problems. An overlay product is generated for each elevation angle that depicts where that elevation angle would intersect the computed melting layer.

MLDA works best with widespread returns that are deep enough for the 4 to 10 degree search to be successful. MLDA can be “cold season challenged”, in the sense that the true melting layer can be too close to the ground for the algorithm to find it.

MLDA in Cold Environments

- “Use MLDA Heights”
 - Yes: Use MLDA generated melting layer heights
 - No: Use RPG Environmental Data 0° C height for melting layer
- 0° C height is top of ML; bottom is 500 m below



The MLDA has one adaptable parameter, called “Use MLDA Heights”. The Default setting is Yes, which means use the data from 4 to 10 degrees to attempt to find a melting layer.

Sometimes, often during the cold season, there may not be enough data from 4 to 10 degrees for MLDA to find a melting layer. In that situation, setting “Use MLDA Heights” to No uses the 0° C height from the RPG Environmental Data to build the ML products and for ingest to the QPE algorithm.

When the single 0° C height is used, that height is assumed to be the top of the melting layer, while the bottom is assumed to be 500 m below the 0° C height. Thus there is an assumed depth of the melting layer when the 0° C height from the RPG Environmental Data is used.

MLDA in Cold Environments

- MLDA detects melting layer top <1km ARL, or RUC data has 0° C height <1 km ARL
- MLDA then uses RUC 0° C height
 - “Use MLDA Heights” setting bypassed
 - Volume scan by volume scan



RPG Build 13.0 has a change that is applied when the MLDA detects a melting layer top of < 1 km ARL (a rare event!) or the RUC data has a 0° C height < 1 km ARL. If either of these conditions occur for a volume scan, the RUC 0° C height is used for the melting layer. The software essentially bypasses the setting of “Use MLDA Heights” for that volume scan.

QPE Difference Product Reset

- DOD & DSD auto reset when both QPE & PPS auto reset
- Manual reset at RPG
 - New difference reset



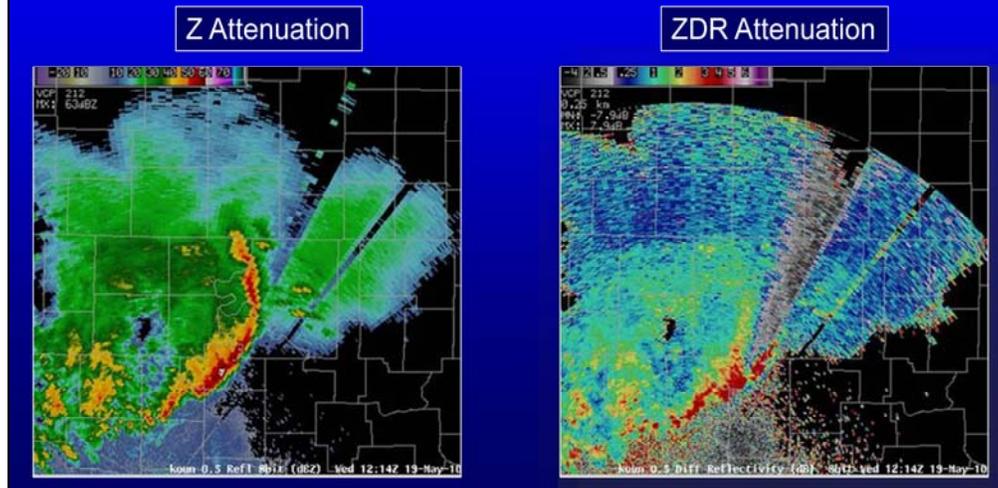
The Dual Pol Quantitative Precipitation Estimation (QPE) product suite includes two difference products, Digital One Hour Difference (DOD), and Digital Storm Total Difference. In each case, the product reflects the QPE accumulations minus the legacy PPS accumulations. Independent of one another, the QPE and PPS storm total accumulations automatically reset to zero after a one hour period with conditions below their respective thresholds.

The QPE difference products also automatically reset to zero when both the QPE and PPS accumulations have automatically reset.

RPG Build 13.0 offers the new option to do a direct manual reset of the Difference products, both the one hour and the storm total durations.

Adjustment for Attenuation & NBF

- Squall line



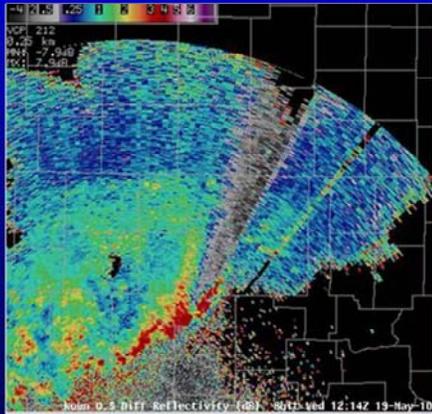
Attenuation and Non-uniform Beam Filling (NBF) each have a unique impact on Dual Pol products. They often occur at the same time, as with this intense squall line that is oriented parallel to several radials. There is significant attenuation of Z, which is just the horizontal part of the transmitted pulse. There is also significant differential attenuation in the ZDR product. The beam is passing through numerous large raindrops, which have a much larger horizontal extent compared to the vertical. There is more attenuation loss in the horizontal compared to vertical, resulting in a significant underestimate of ZDR down radial from the squall line.

Non-uniform beam filling is also affecting the CC product for this case, which is presented on the next slide.

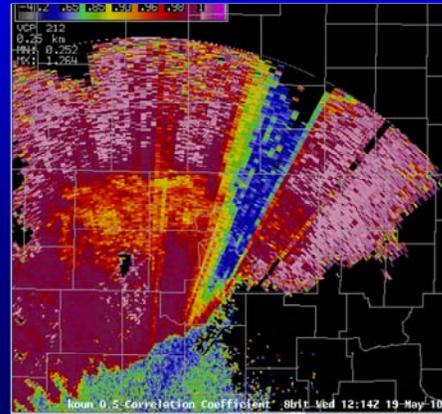
Adjustment for Attenuation & NBF

- Squall line

ZDR Attenuation

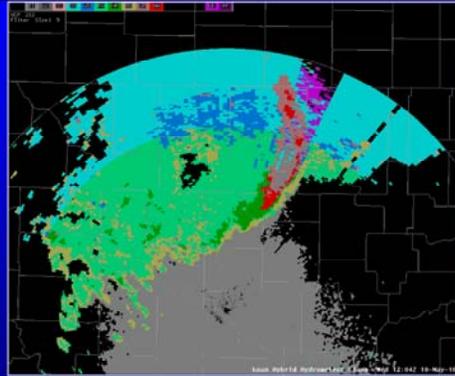


CC Non-uniform Beam Filling



For this case, there is also an extreme underestimate of CC down radial from the squall line. This is the impact of NBF, where there is a gradient of precipitation types and thus a gradient of PhiDP within the beam.

Adjustment for Attenuation & NBF

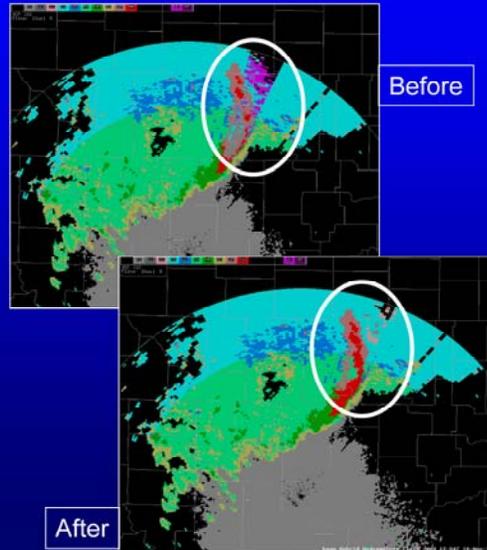


- Unrealistic CC & ZDR down radial
- HCA errors
 - Biological, unknown, etc. instead of precipitation

Attenuation and non-uniform beam filling result in underestimations of both ZDR and CC. The Hydrometeor Classification Algorithm (HCA) doesn't know any better (it's an algorithm) and often misclassifies echo in these areas. For example, instead of rain, heavy rain, wet snow or dry snow, many of the bins in this "swath" are identified as clutter, biological, or unknown. This significantly affects the performance of the QPE in estimating rainfall.

Adjustment for Attenuation & NBF

- Adjustments to 2 RPG parameters
- HCA result is
 - More precipitation bins identified
 - Fewer unknown bins

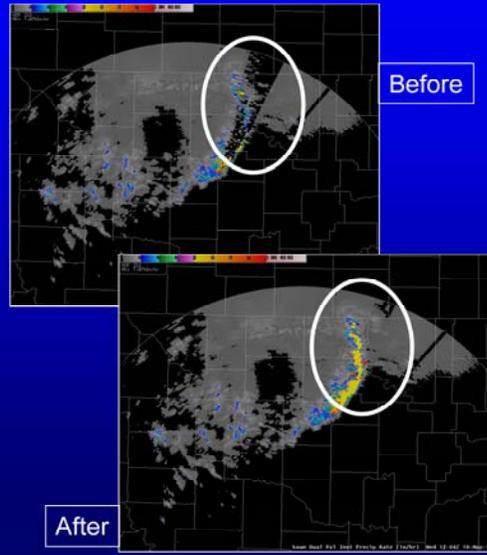


Some testing was conducted regarding the “sensitivity” of the RPG Dual Pol algorithms to non-uniform beam filling. Adjustments were made to mitigate the affects of non-uniform beam filling and attenuation for events like squall lines. For this squall line case, the HC product is shown with the pre-Build 13.0 parameter settings at the top, and the Build 13.0 parameter setting at the bottom.

Since QPE performance is directly dependent on the HCA output, the next slide shows how these parameter adjustments can improve QPE.

Adjustment for Attenuation & NBF

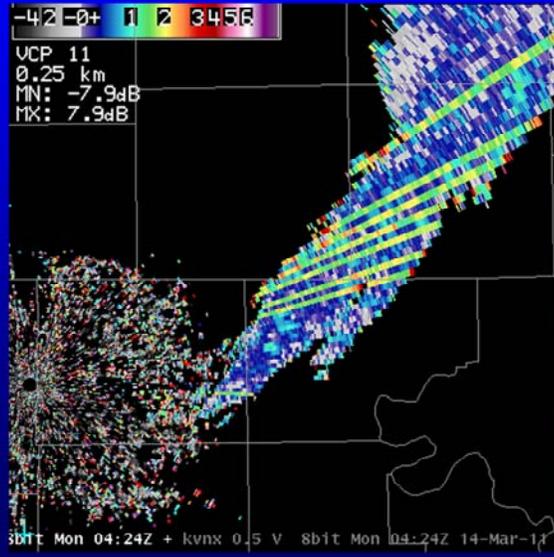
- QPE rate product
- Clutter & bio not converted to precipitation
- RPG adjustments improve QPE rain rates



Since QPE performance is directly dependent on HCA output, mitigating the impacts of attenuation and non-uniform beam filling ultimately improves rainfall estimation. Without the adjustments, zero rain rates show up in a large area down radial from the squall line on the top image. With the RPG Build 13.0 adjustments on the lower image, the QPE rain rate product looks much more realistic.

RPG Preprocessor Spikes in ZDR

- ZDR spikes known artifact
- Preprocessor adjustment



These “ZDR spikes” are known artifacts from the Dual Pol RPG Preprocessor algorithm. The frequency of occurrence is highly variable. Some of you may have seen this rarely, while others may have seen it more often. An RPG Build 13.0 adjustment to the Preprocessor is expected to reduce the frequency of these ZDR spikes.

CMD, AVSET & Dual Pol

- RDA software used to develop Dual Pol did not have AVSET or CMD
- Once upgraded to Dual Pol (RDA Build 12.3)
 - CMD & AVSET unavailable til RDA Build 13.0
 - Default status is
 - AVSET DISABLED
 - CMD PENDING

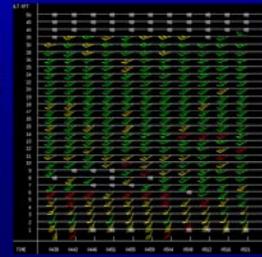
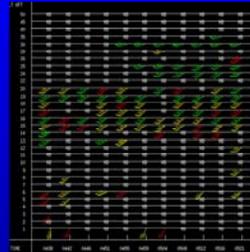
Precip Status:	ACCUM
VAD Update:	ON
Model Update:	ON
Auto PRF:	ON
Sensor Data:	ENABLED
CMD:	PENDING
AVSET:	DISABLED
Load Shed:	NORMAL
RDA Messages:	ENABLED
Adapt Times:	MATCH

The fielding of AVSET and Dual Polarization are related to one another, in the same way as CMD and Dual Pol. The RDA software that was used to develop Dual Pol did not have AVSET or CMD. When your RDA is initially upgraded to Dual Pol (RDA Build 12.3), CMD and AVSET will not work until RDA Build 13.0 is installed. RDA Build 13.0 is currently scheduled to begin deployment during the Summer of 2012.

While CMD and AVSET are unavailable, their default status on the RPG will be PENDING and DISABLED, respectively.

Enhanced VAD Wind Profile

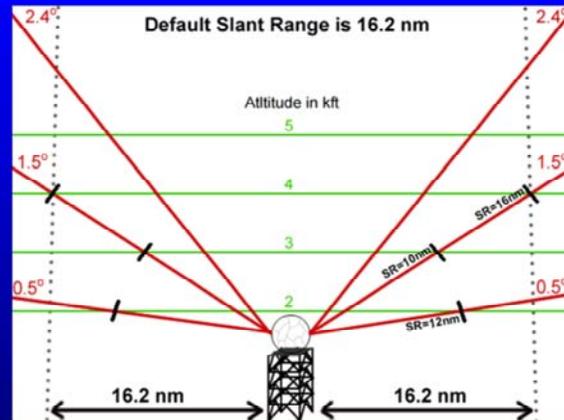
- Old VWP design:
 - For each height, 1 wind computed from 1 slant range
- EVWP design:
 - For each height, multiple winds computed from multiple slant ranges
 - Best wind chosen



RPG Build 13.0 has one new feature that is independent of Dual Polarization. It is an improved way of generating the Velocity Azimuth Display (VAD) Wind Profile (VWP) product. The result is a greater availability and accuracy of the WSR-88D calculated winds on the VWP product. The original VWP design uses a single wind estimate derived from a radar elevation angle closest to a particular slant range value. The Enhanced VWP design computes multiple wind estimates from radar elevation angles closest to multiple slant ranges. The underlying VAD processing for each wind estimate has not changed. For each height, the “best” wind is chosen if there is more than one available.

Original VWP Design

- Single wind computed for each height
 - Angle closest to given slant range



The original VWP design uses a single wind speed and direction estimate for each height. The radar elevation angle closest to the slant range, an adaptable parameter, was used to calculate the VAD wind for that height. If there was sufficient radar return at that elevation angle for an estimate, a single wind for that height was calculated and used on the VWP product.

Enhanced VWP Design

- For given VAD height
 - Calculate 1st wind as before
 - Calculate supplemental winds based on other slant ranges & elevations
 - Must meet constraints for accuracy



The Enhanced VWP has a more robust design, allowing for multiple winds to be calculated for each VAD height. In addition to the one wind estimate calculated using the original method, other slant ranges and elevation angles are used to calculate supplemental wind estimates for each height. There are a number of constraints to keep these “possible” winds sufficiently accurate.

Enhanced VWP Design

- Slant range increases with elevation angle
 - 0.5° slant range is 60 km (32 nm)
 - 1.5° slant range is 80 km (43 nm), etc.
- All estimates must pass “error test” to be valid
- How to choose?
 - Wind with best “validity weight” used



In order to calculate more than one wind, additional slant ranges are used. There is a formula that increases the slant range as the elevation angle increases. In order for any wind from any elevation to be considered, there is an “error test” requirement that ensures that any error in the estimate is sufficiently low.

Since EVWP calculates more than one possible wind for any given height, how is a single wind chosen? A validity weight or validity index is calculated, which takes into account the error, the wind speed, and the number of points used to generate the wind estimate.

Enhanced VWP Design

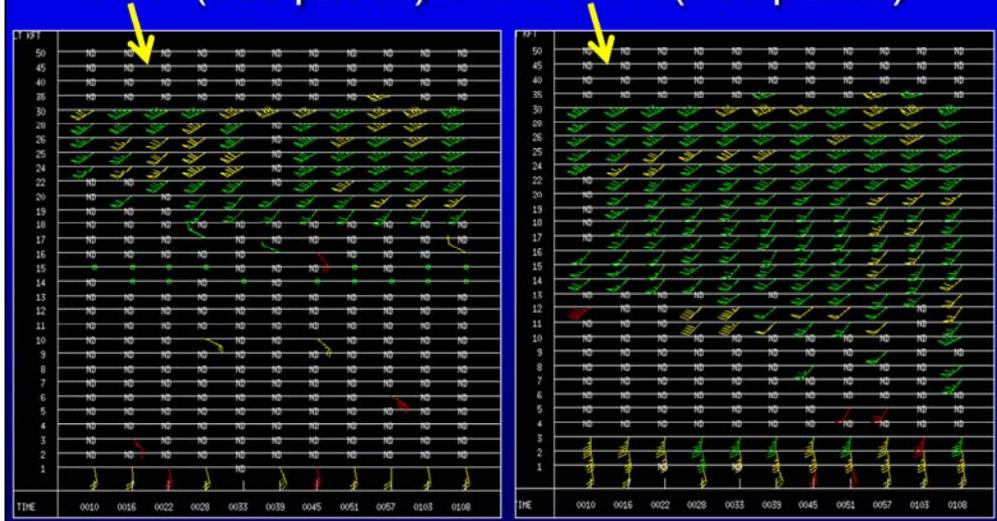
Original VAD Estimate Available?	Valid Supplemental VAD Estimate(s) Available?	VWP Wind Plot
NO	NO	ND (No Data)
YES	NO	Original VAD Estimate
NO	YES	Supplemental VAD Estimate with Lowest Validity Index
YES	YES	VAD Estimate (either Original or Supplemental) with Lowest Validity Index

- EVWP Result? More winds with higher validity

This table summarizes how the original VAD wind estimate is used along with supplemental winds. The result (examples on the next few slides) is a VWP product with a larger number of wind estimates available and an overall higher validity of the estimates.

VWP vs. EVWP

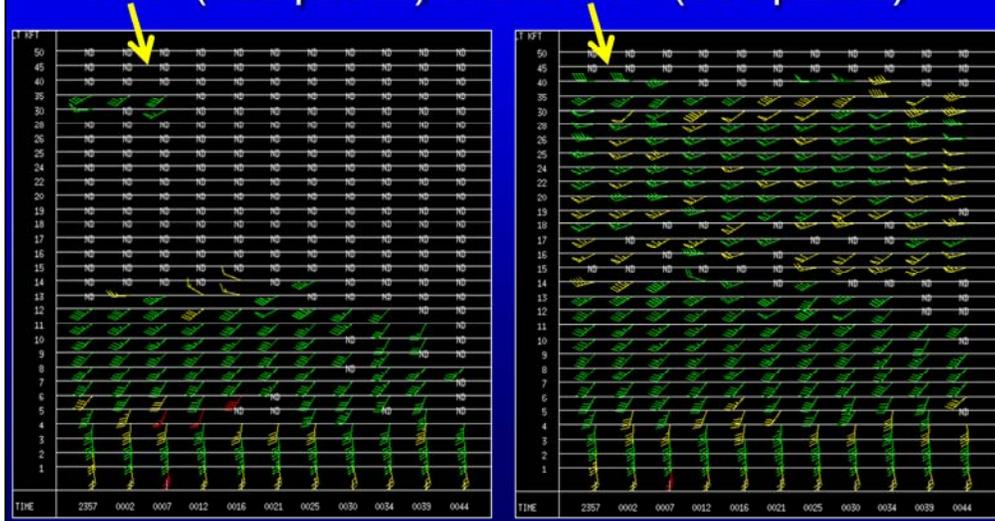
- VWP (109 points) and EVWP (200 points)



Example 1: Old VWP is on the left and (for the same data) EVWP on the right. Also included are the number of wind estimates available for the VWP vs. the EVWP.

VWP vs. EVWP

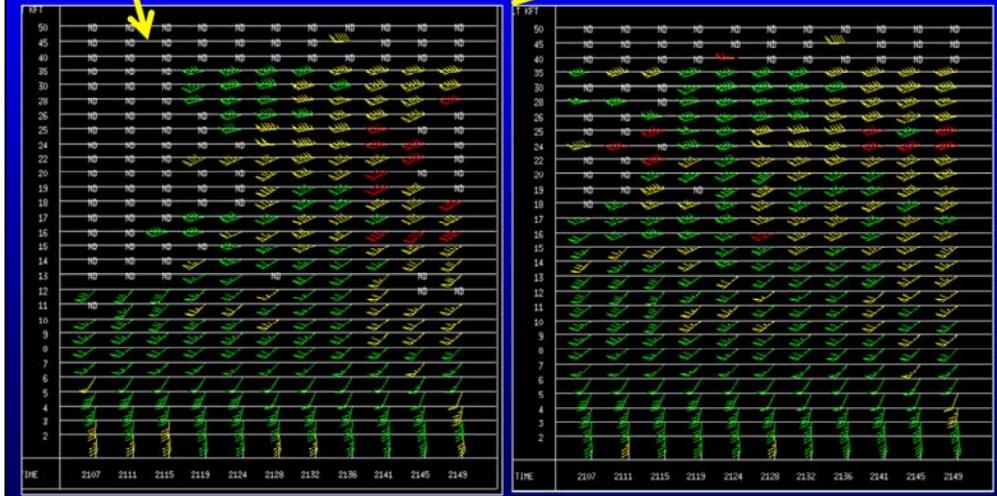
- VWP (155 points) and EVWP (284 points)



Example 2: Old VWP is on the left and (for the same data) EVWP on the right. Also included are the number of wind estimates available for the VWP vs. the EVWP.

VWP vs. EVWP

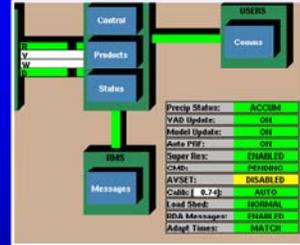
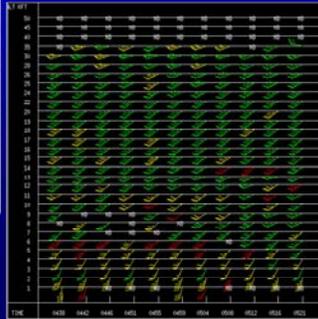
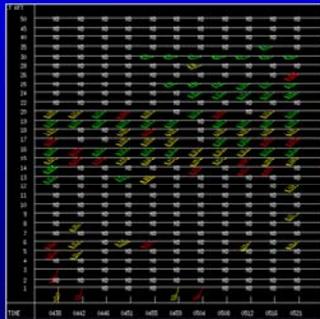
- VWP and EVWP



Example 3: Old VWP is on the left and (for the same data) EVWP on the right (no wind estimate numbers for this example).

Thank You For Your Time

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Thank you for your time and please let me know if you have any questions.