A Two-Dimensional Velocity Dealiasing Algorithm for the WSR-88D

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Outline

- WSR-88D Velocity Dealiasing Algorithms – Strengths/Weaknesses
  – Baseline Velocity Dealiasing Algorithm (VDA)
  – Baseline Multiple PRF Dealiasing Algorithm (MPDA)
  – New 2-Dimensional Dealiasing Algorithm (VDEAL)
- ROC evaluation results & hurricane examples
- NSSL VCP 31 results & clear-air example
- Field test summer & fall 2011

Baseline Velocity Dealiasing Algorithm (VDA)

Strengths

- Fast
- Requires minimal amount of computer resources
- Works well in most situations
- Works with all Volume Coverage Patterns (VCPs) except VCP 121

Weaknesses

- Does not handle strong shears well
- Errors can be propagated azimuthally and radially
- Fails in moving clutter environments
- Fails in regions with weak signal and noisy velocities
- Fails in long-pulse clear air velocity data (VCP 31)

Multiple PRF Dealiasing Algorithm (MPDA) with VCP 121

Strengths

- Provides robust velocity dealiasing where more than one velocity estimate is available
- Provides nearly complete velocity coverage out to 125 n mi (230 km)
- Removes range folding at the start of second trip

Weaknesses

- Not well suited for fast moving, rapidly evolving storm systems
- Requires multiple scans of velocity data at same elevation angle
  - Limits number of unique elevation scans to 9
  - Lengthens volume scan time
- May have errors where only one velocity estimate is available, esp. at long range

2-Dimensional Velocity Dealiasing Algorithm (VDEAL)

Strengths

- Provides robust velocity dealiasing solutions for all VCPs except VCP 121 which uses MPDA
- Works well at all ranges
- Works much better in long-pulse clear air (VCP 31) than Baseline VDA

Weaknesses

- Isolated regions may not be dealiased correctly if different from global environmental wind solution
- Requires substantial computer resources
- Does not work with sectorized PRFs

ROC Data Analyzed

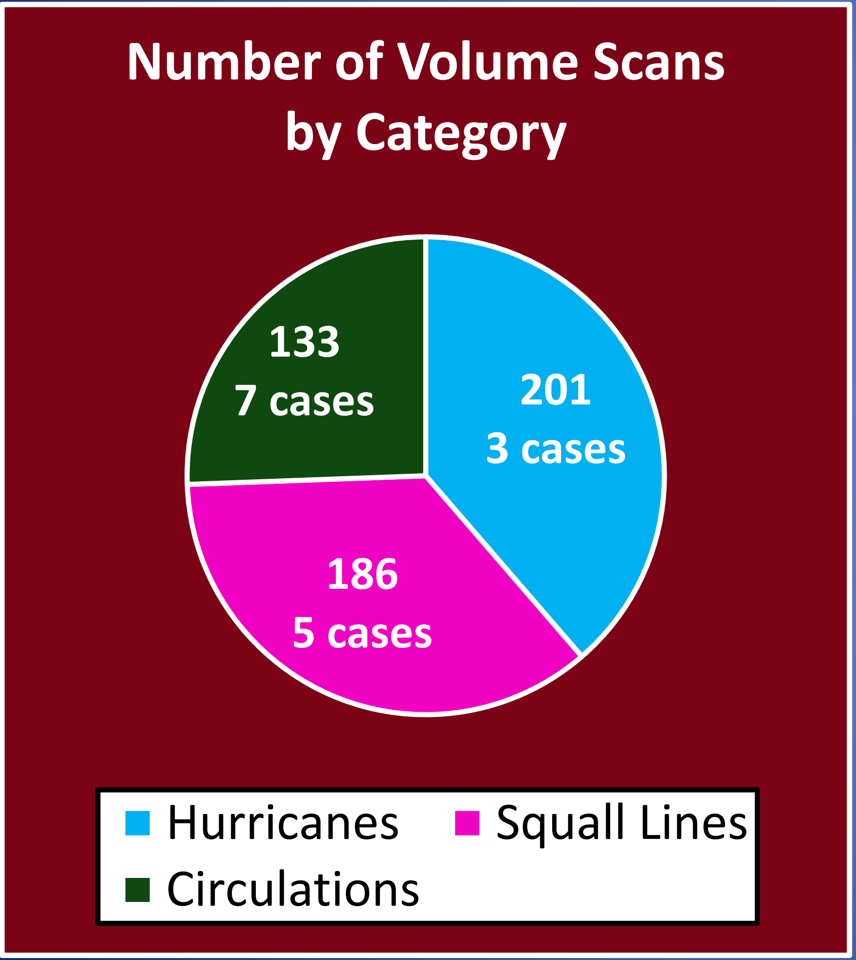
- 15 precipitation events
  - 3 hurricanes
  - 5 squall lines
  - 7 circulations in ground clutter
- 520 velocity products
  - 0.5 deg elevation angle
  - 1 deg azimuthal resolution
- VCPs 11, 12, 21, & 212

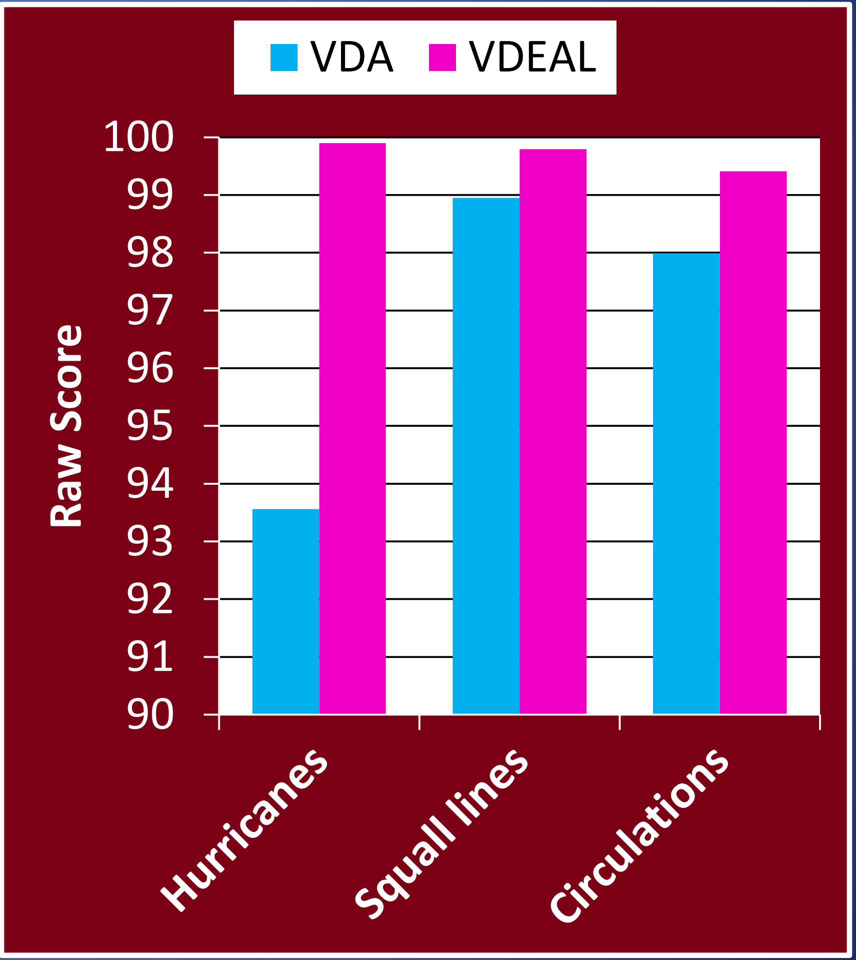
Scoring Methodology Used by NSSL and ROC

Each velocity product image starts with a score of 100 from which points are subtracted as follows:

Description of Error	Penalty
Single gate or 2 adjacent gates	–1
Small radial spike (<3 km in length)	–2
Very small patch	–2 to –3
Small patch	–4 to –8
Large patch	–8 to –12
Swath of ~20°	–12 to –16
Swath of ~40°	–26 to –30
Swath of ~60°	–32 to –38
Swath of ~90° or larger	–40 to –50

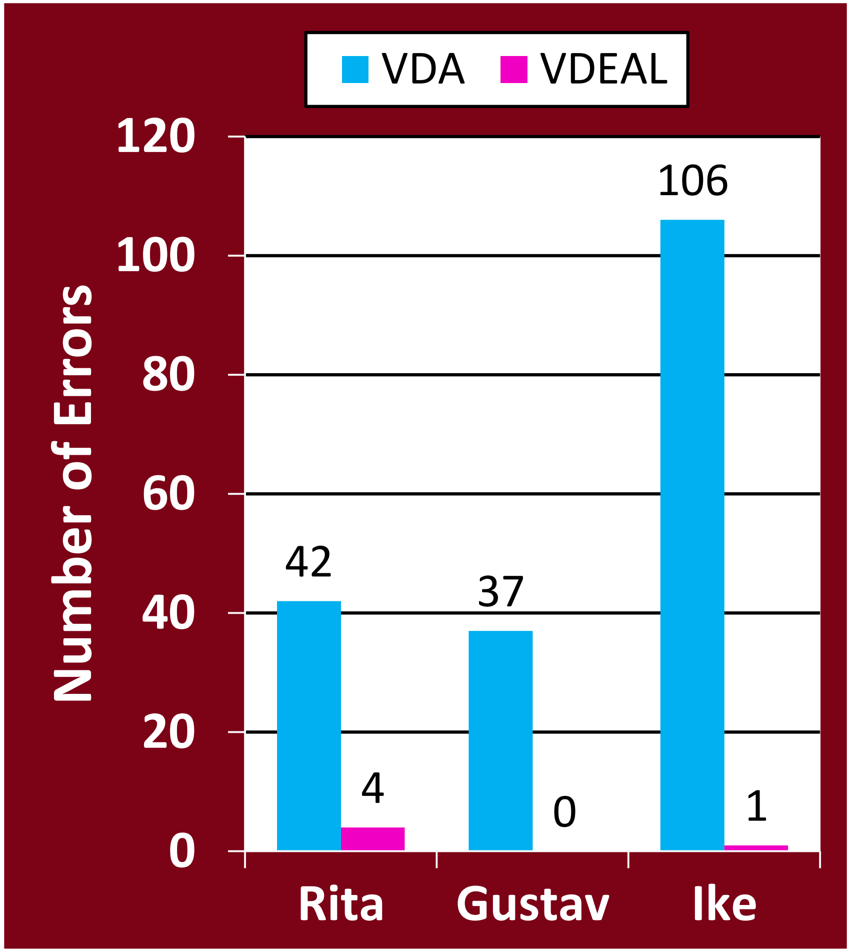
ROC Results


Number of Volume Scans
by Category
133
7 cases
201
3 cases
186
5 cases
Hurricanes
Squall Lines
Circulations


VDA
VDEAL
100
99
98
97
96
95
94
93
92
91
90
Raw Score
Hurricanes
Squall lines
Circulations

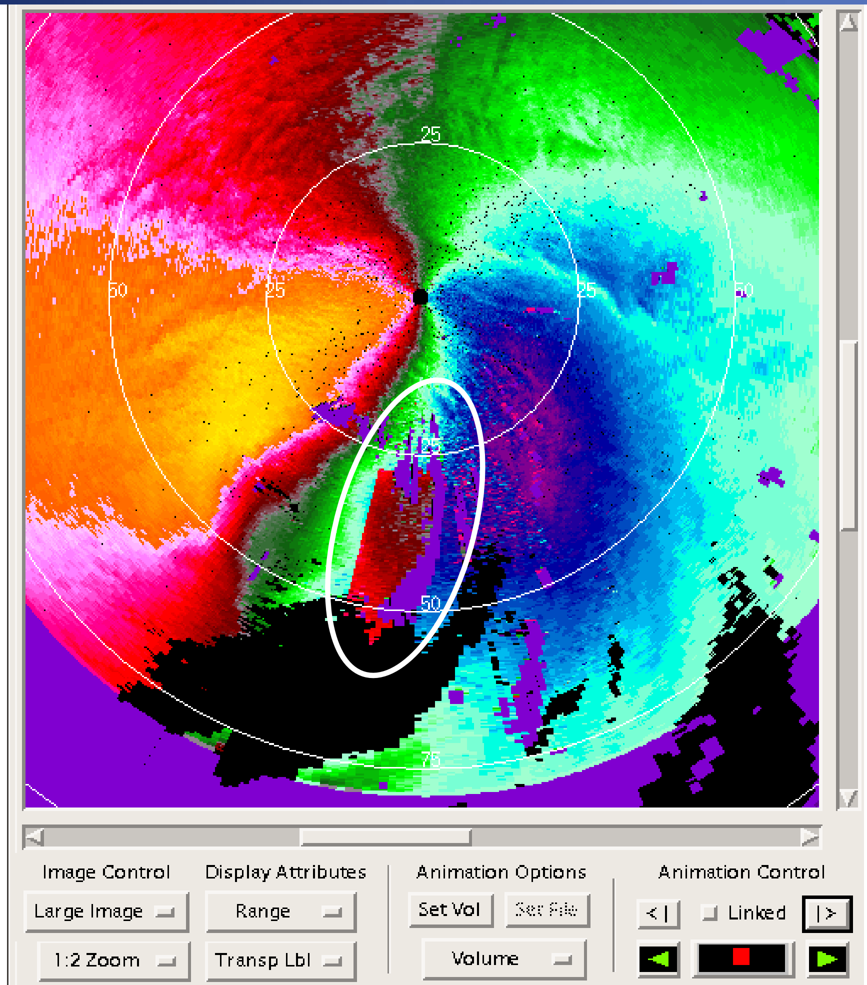
ROC Results (Cont'd)
Hurricane Analysis

- Hurricane Rita (KLCH)
  - 24 September 2005
  - 62 Volumes
  - VCP 21
- Hurricane Gustav (KLIX)
  - 1 September 2008
  - 39 Volumes
  - VCP 212
- Hurricane Ike (KHGX)
  - 13 September 2008
  - 100 Volumes
  - VCP 212

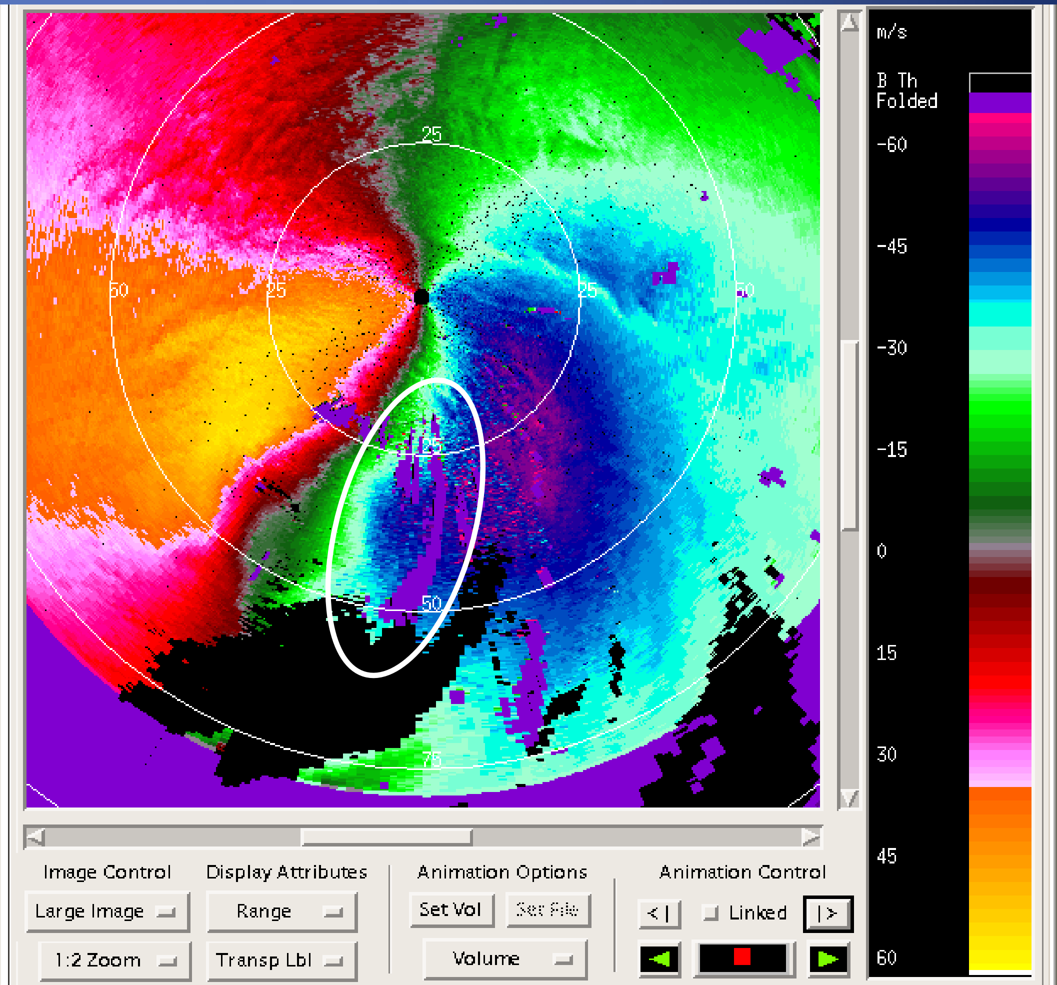


KLCH Hurricane Rita
24 Sep 2005, 06:33Z, VCP 212

Baseline VDA

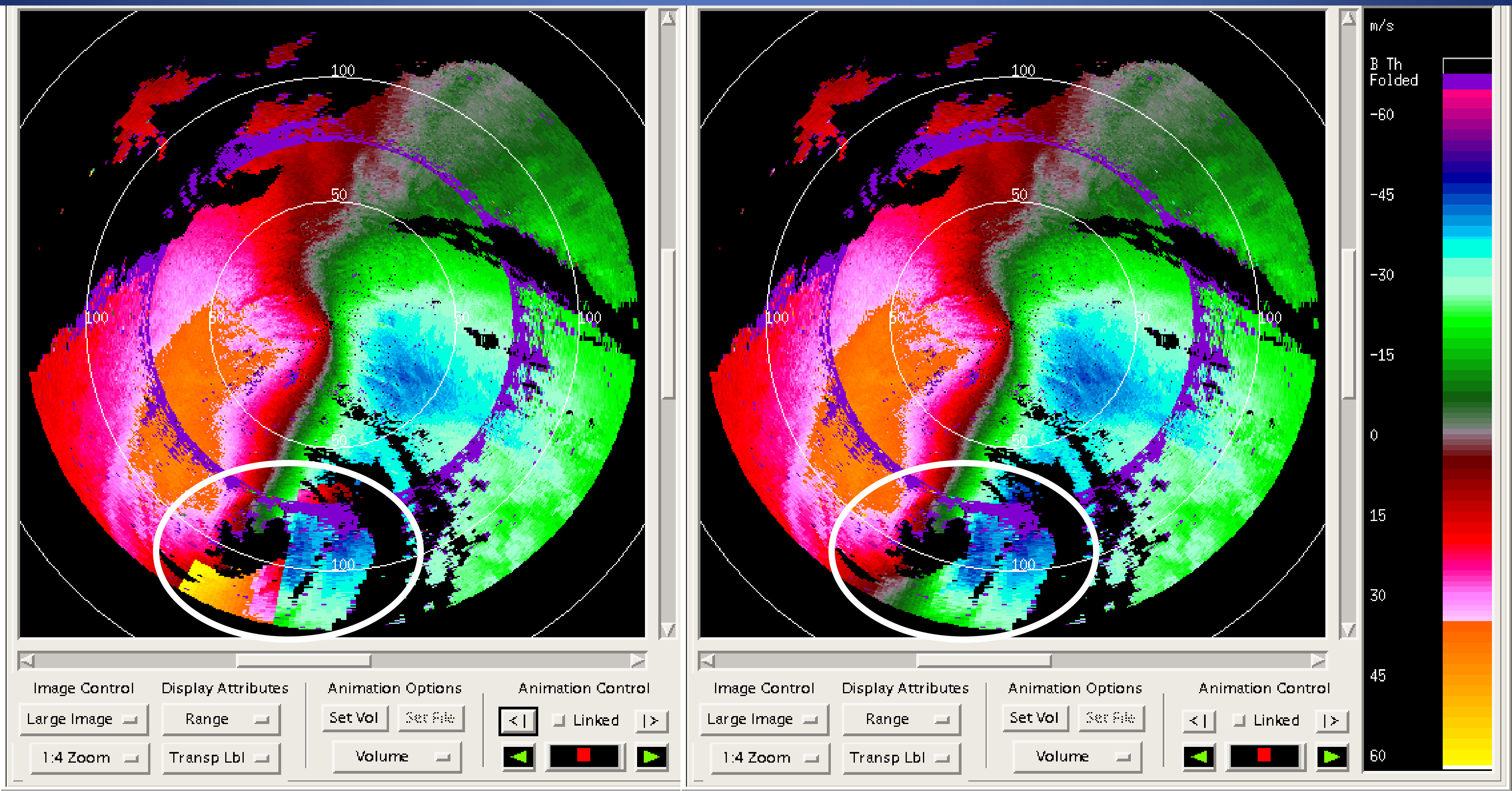


2-D VDEAL



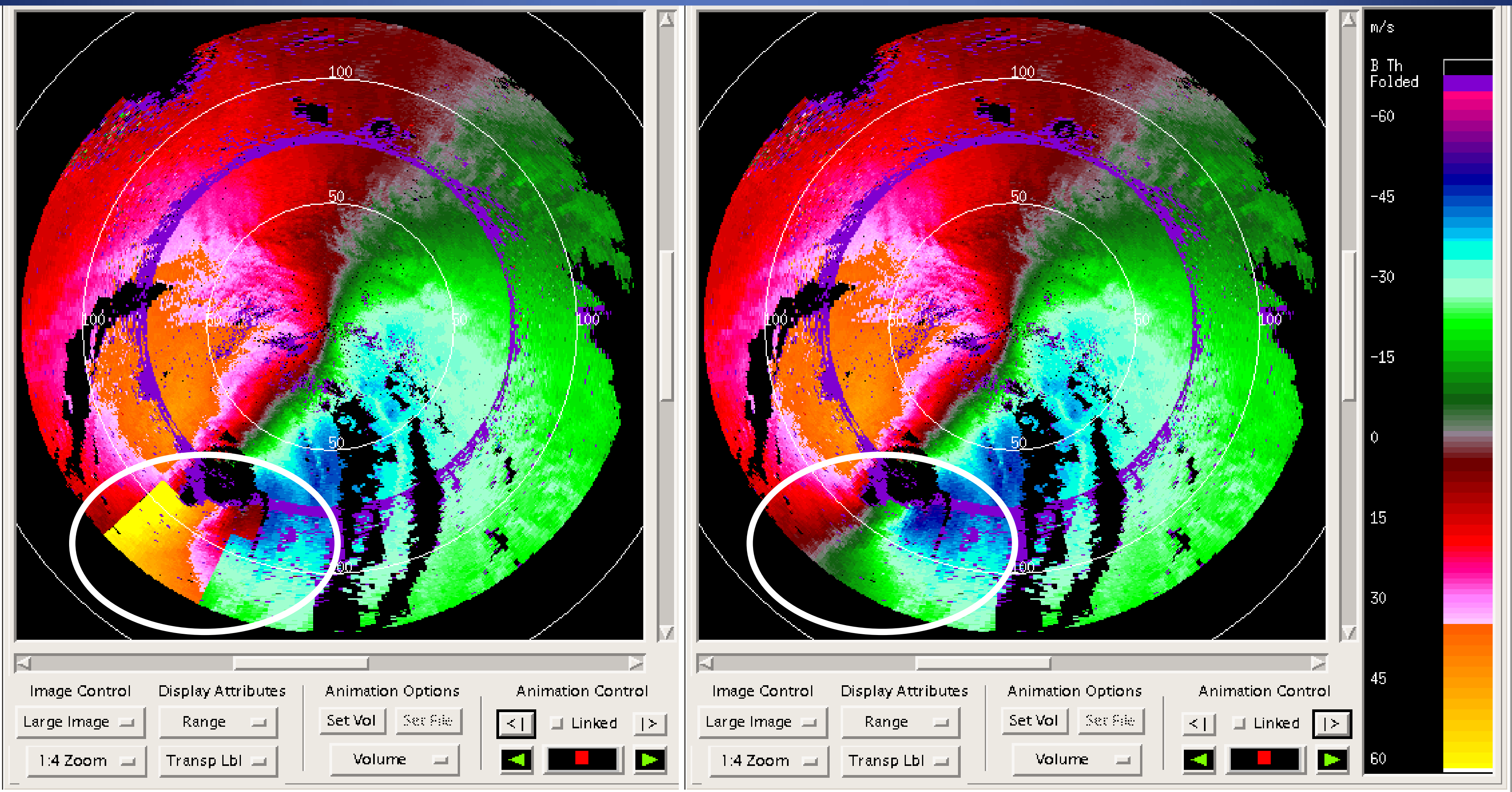
KLIX Hurricane Gustav
1 Sep 2008, 13:17Z, VCP 212

Baseline VDA | **2-D VDEAL**



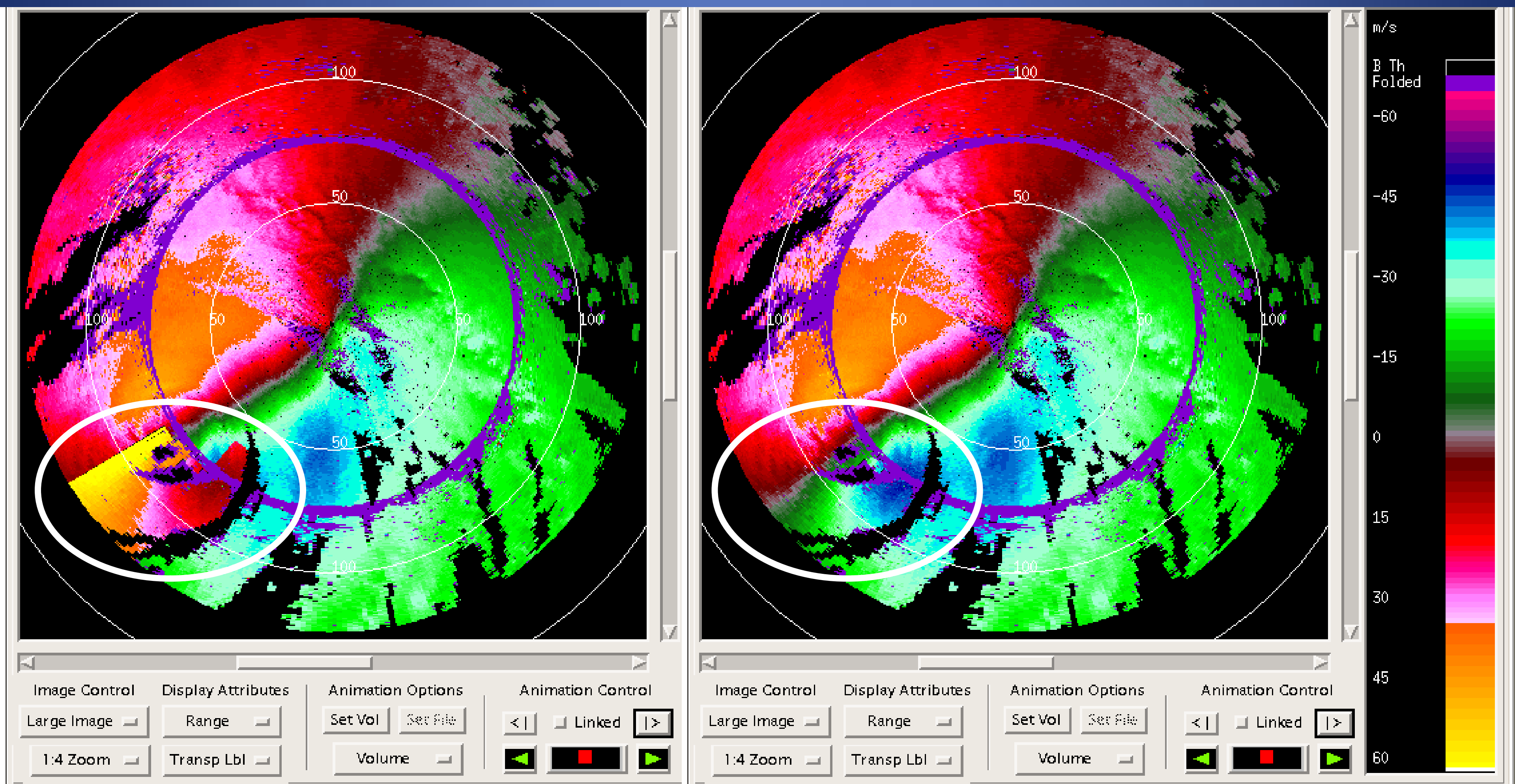
KLIX Hurricane Gustav
1 Sep 2008, 15:16Z, VCP 212

Baseline VDA **2-D VDEAL**



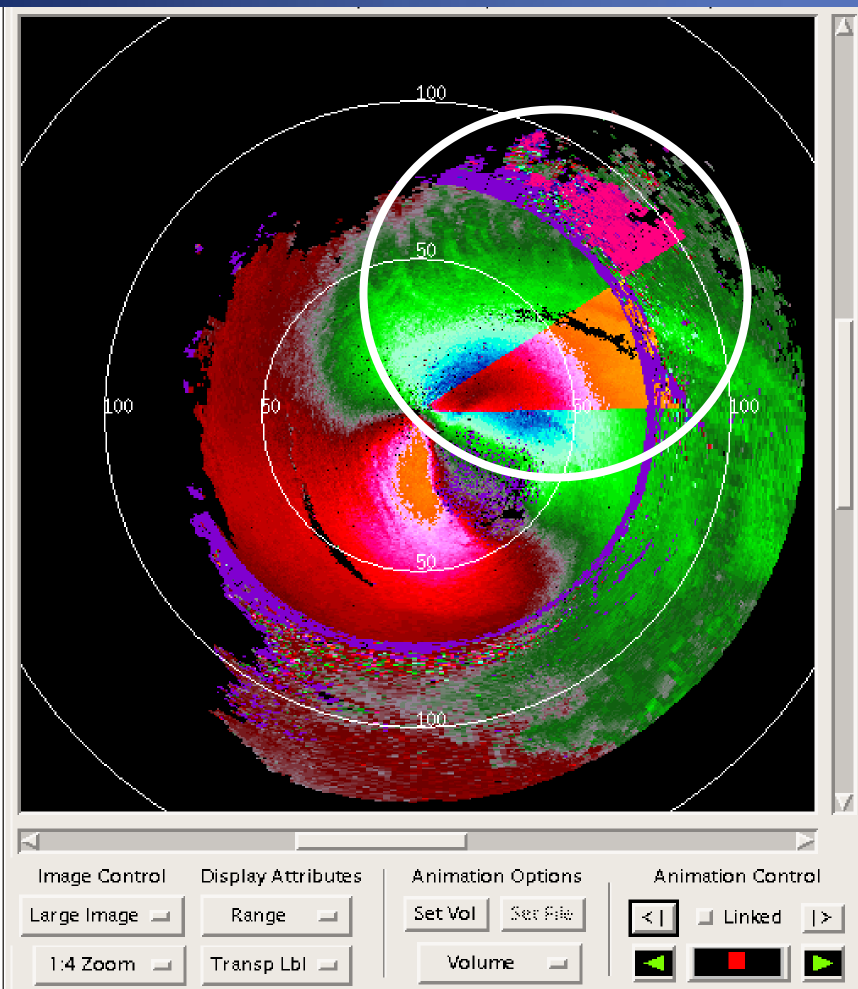
KLIX Hurricane Gustav
1 Sep 2008, 16:47Z, VCP 212

Baseline VDA **2-D VDEAL**

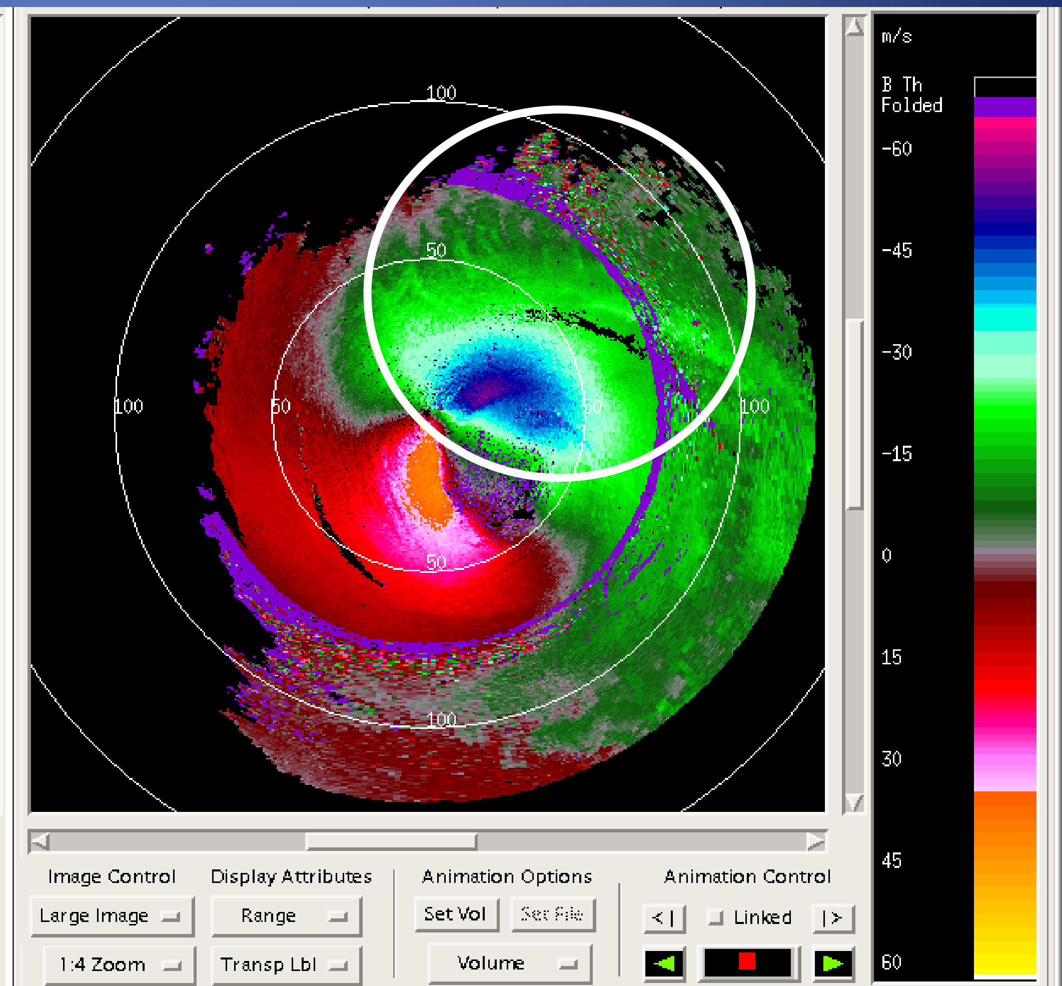


KHGX Hurricane Ike
13 Sep 2008, 06:12Z, VCP 212

Baseline VDA

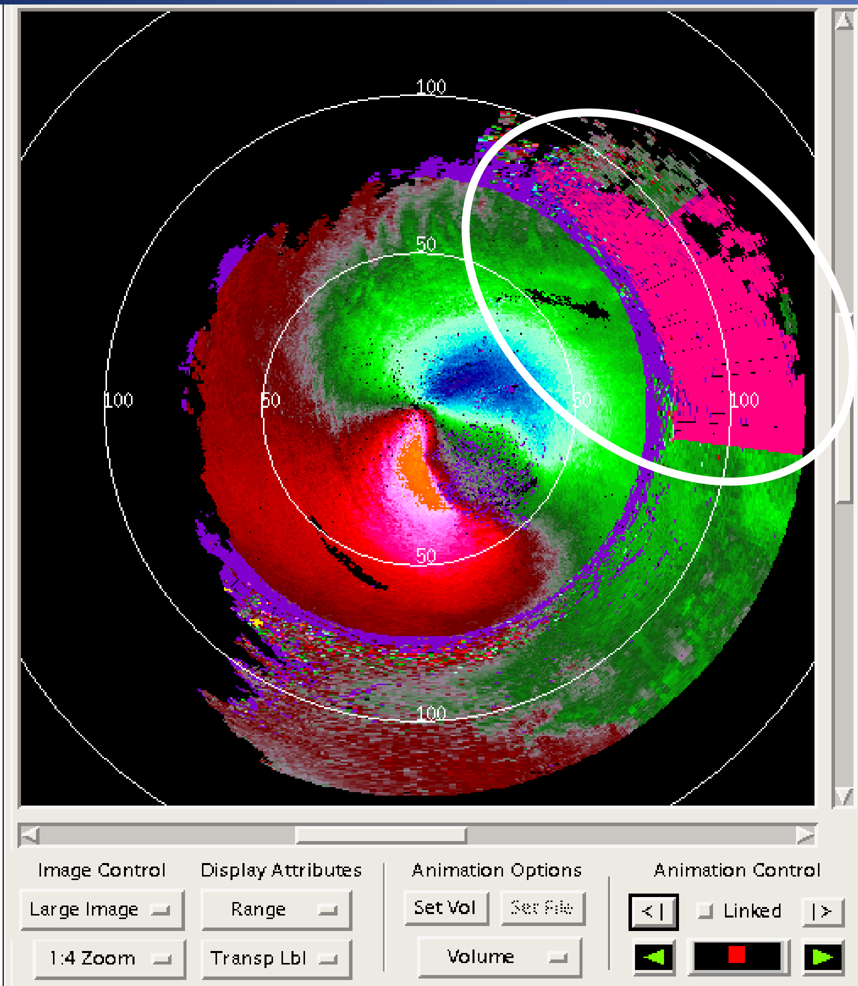


2-D VDEAL

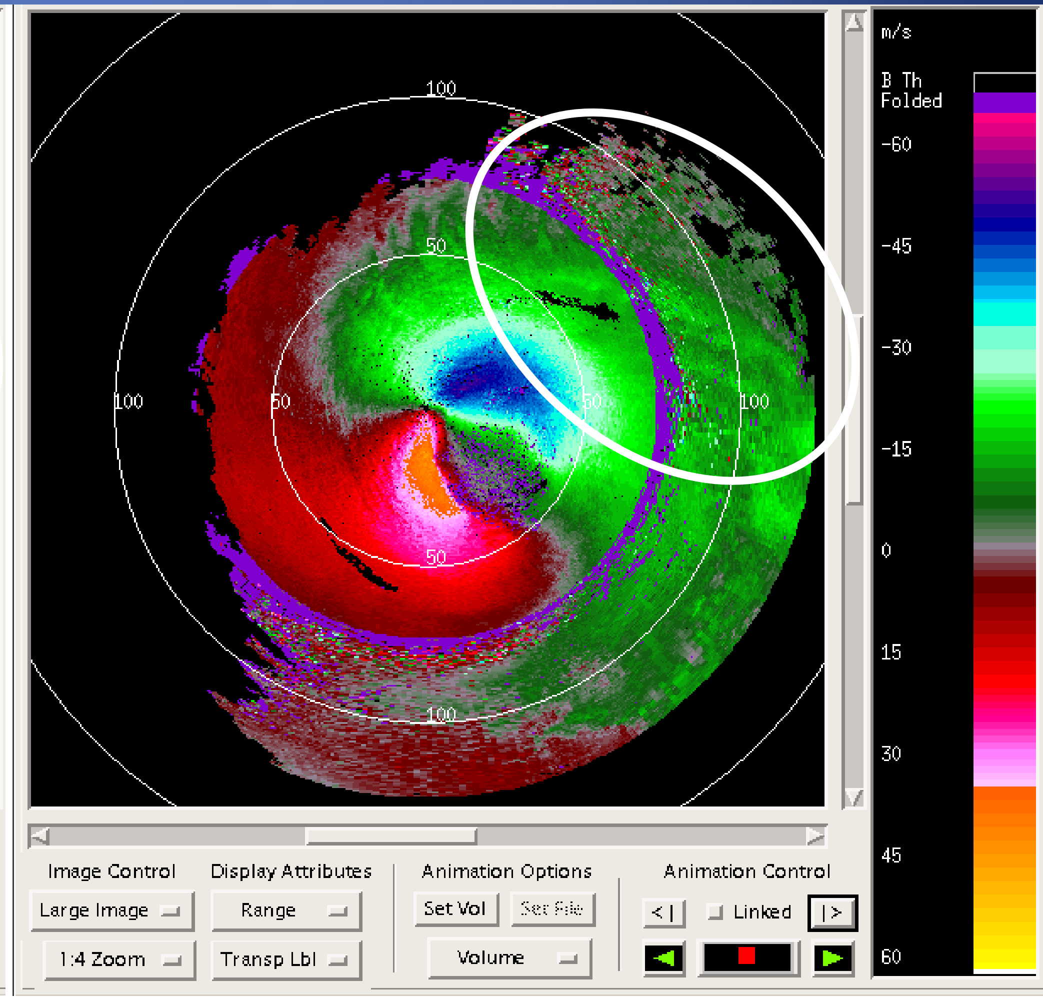


KHGX Hurricane Ike
13 Sep 2008, 06:21Z, VCP 212

Baseline VDA



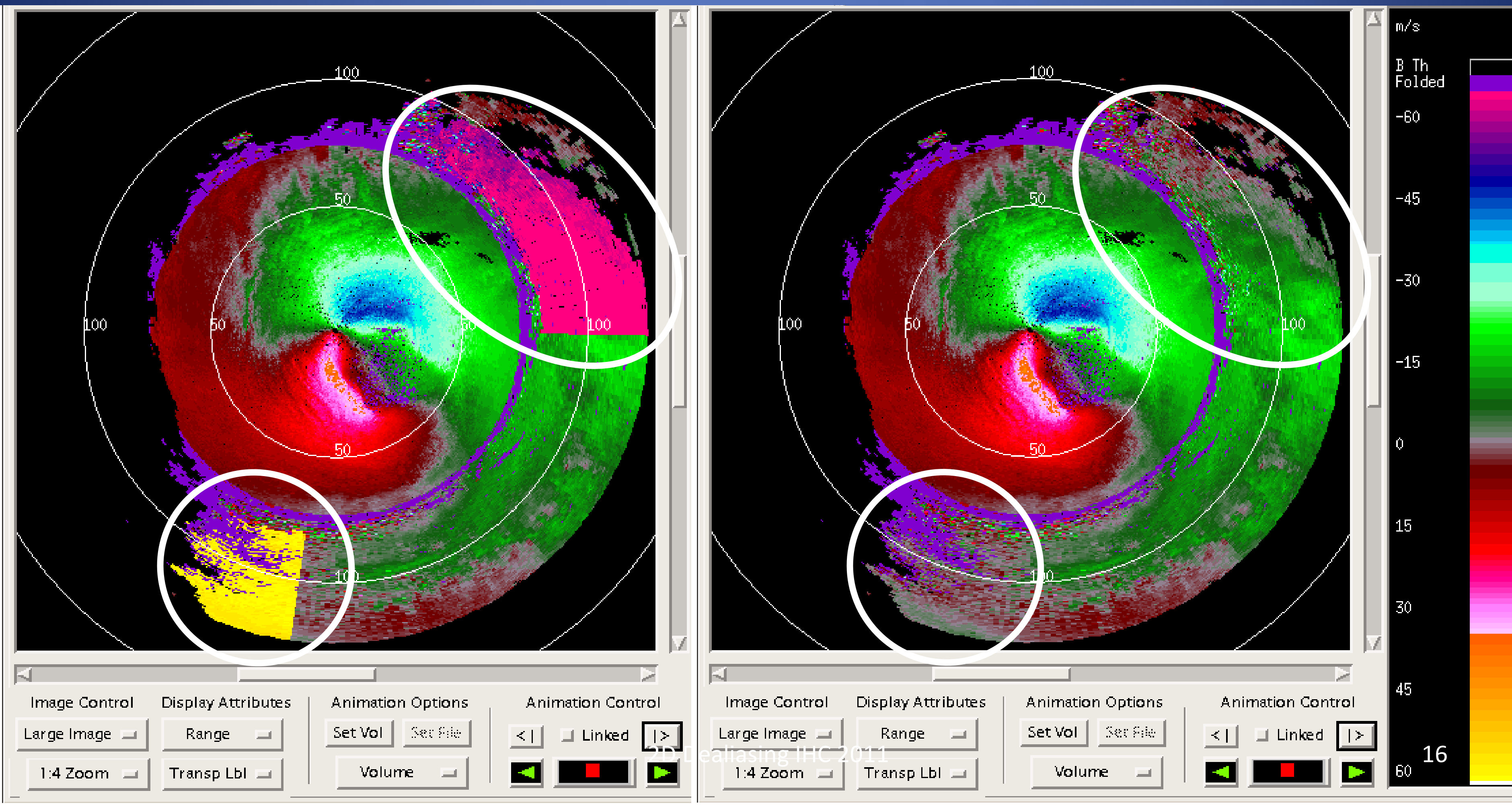
2-D VDEAL



KHGX Hurricane Ike
13 Sep 2008, 06:45Z, VCP 212

Baseline VDA

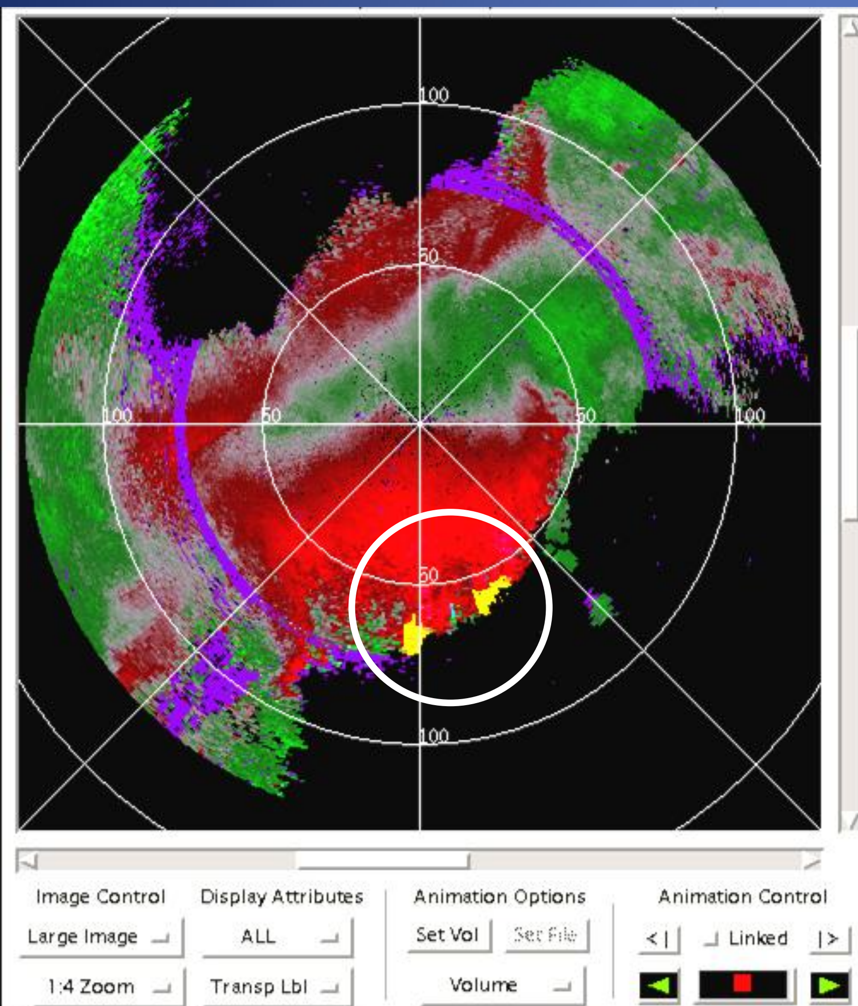
2-D VDEAL

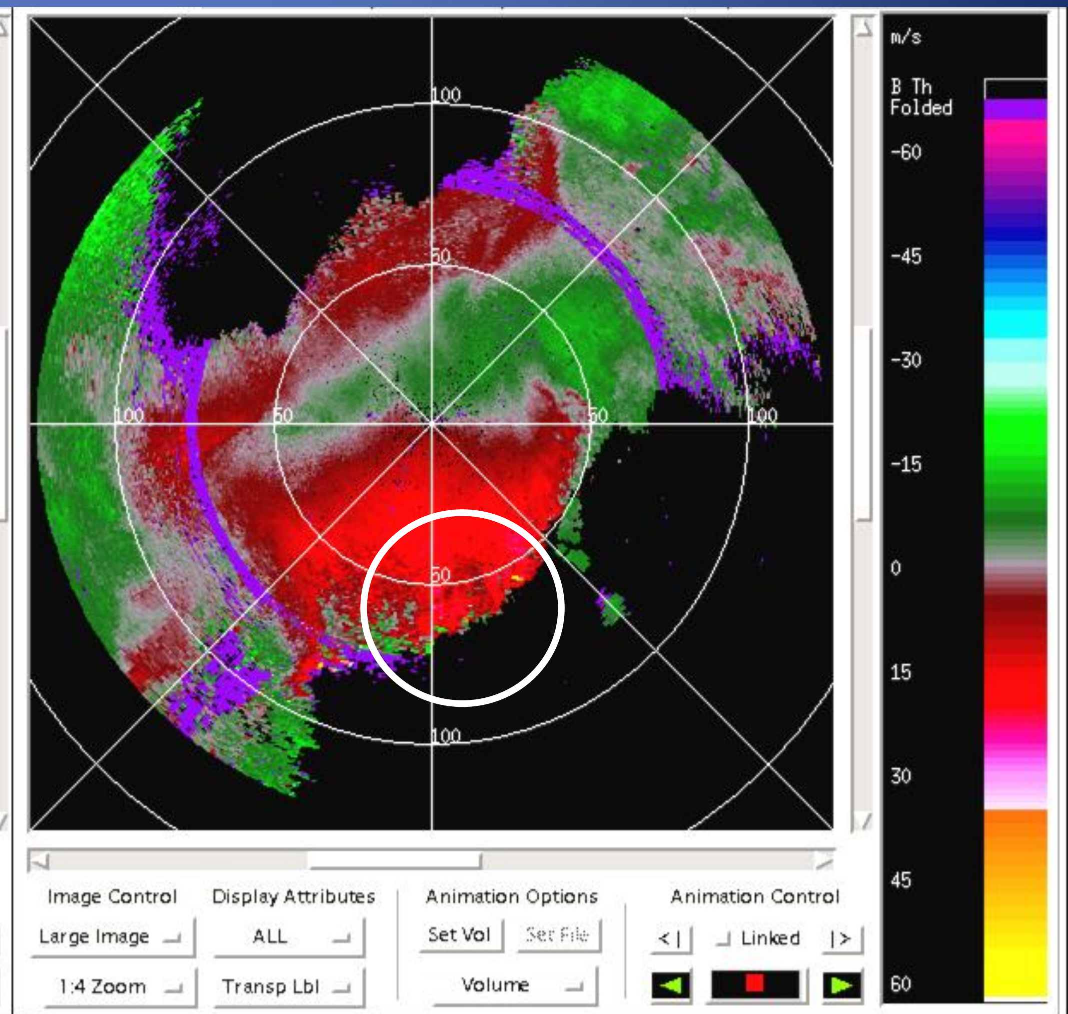


Outflow Boundary, Norman, OK

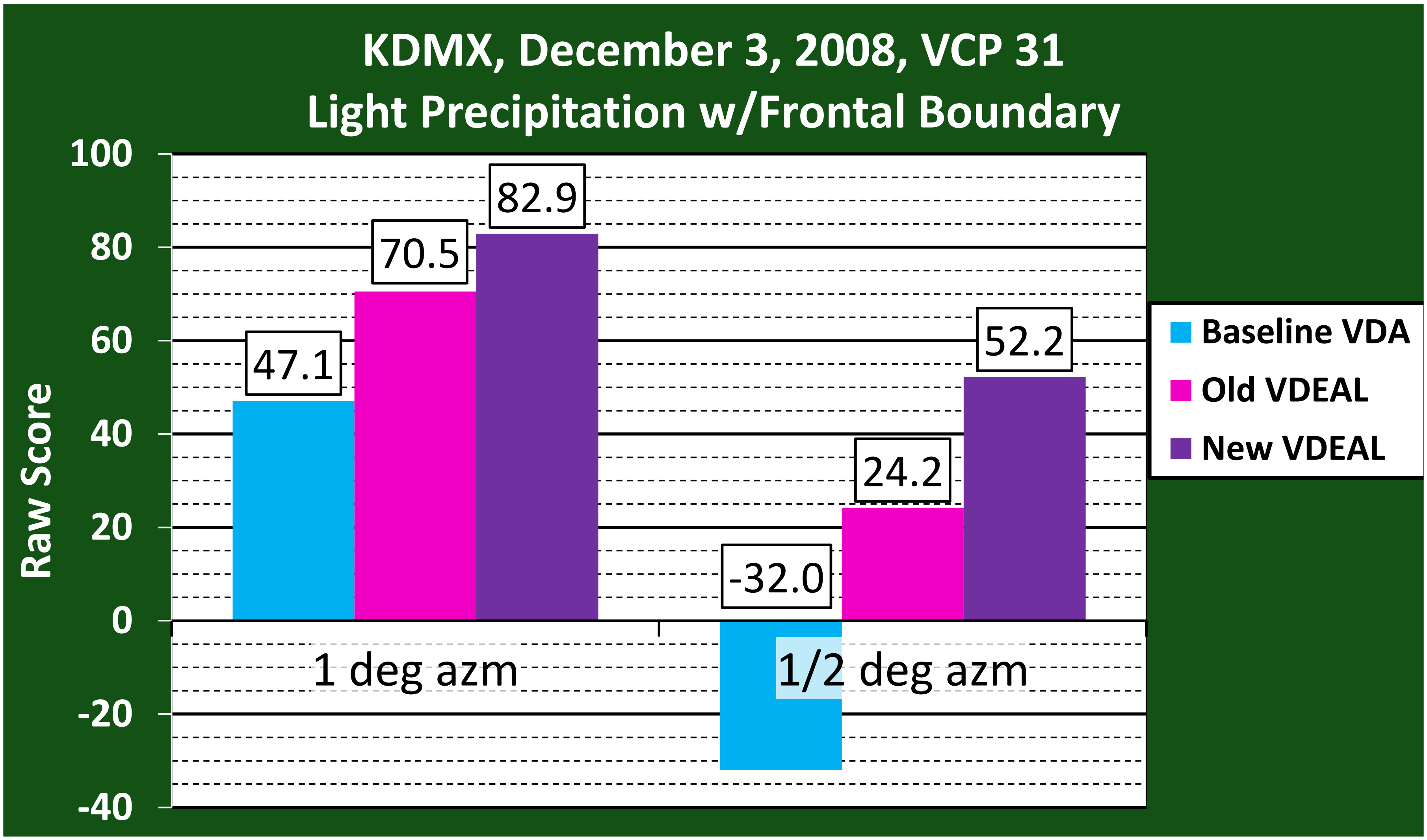
Baseline VDA

2-D VDEAL





NSSL Results for VCP 31

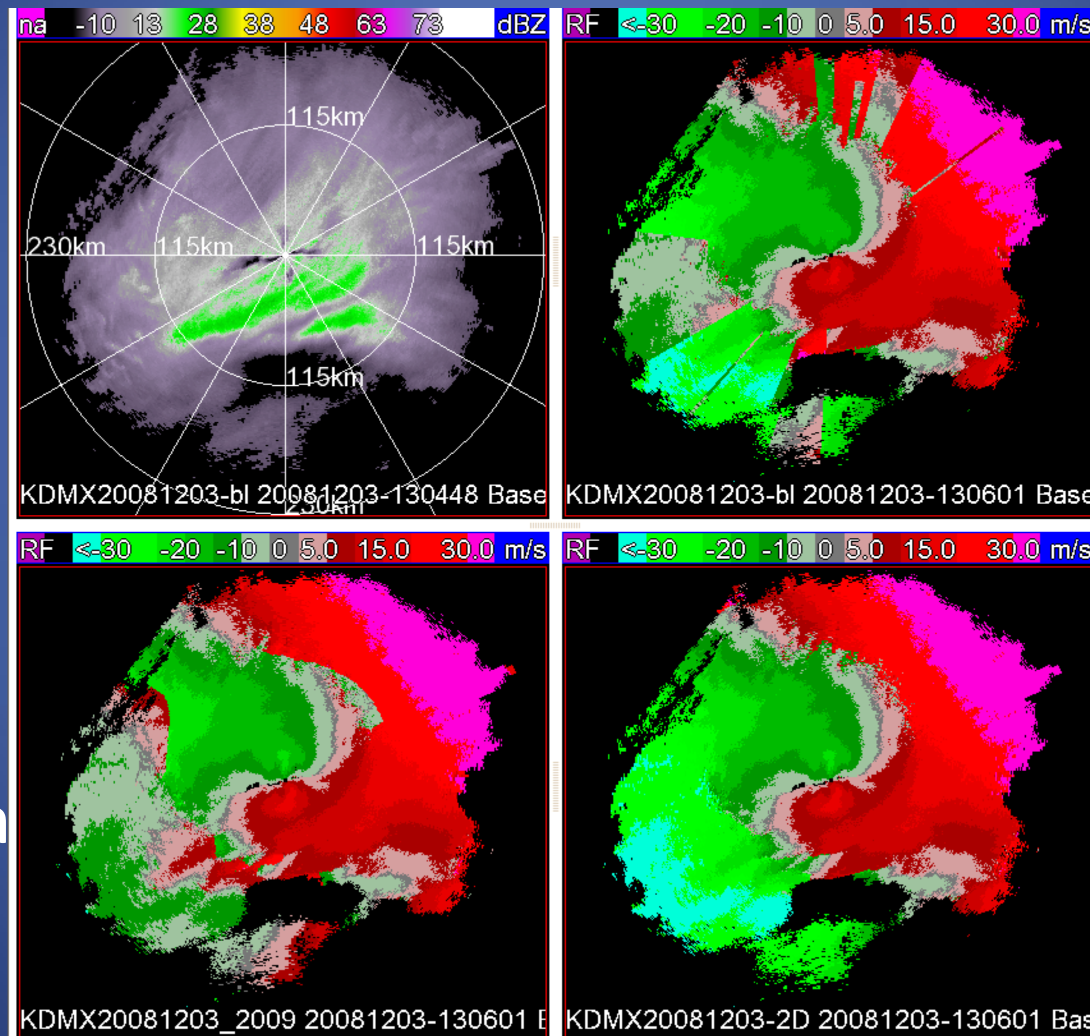


KDMX, 3 Dec '08, 13:02Z, VCP 31, 1.5° Elev

Frontal Boundary South of Radar

Reflectivity image

Velocity image from Baseline VDA



Velocity image from early version 2-D VDEAL

Velocity image from new version 2-D VDEAL

Field Test of VDEAL

- Field test to run 1 June to 1 December, 2011
  - Coincide with hurricane season
  - Toggle will allow sites to switch between baseline VDA and new 2-D VDEAL
  - Looking for participation from 8+ sites
    - 4+ coastal
    - 2 mountainous
    - 2 other interior sites

Goals of VDEAL Field Test

- Obtain field experience with VDEAL at new sites under a broad range of meteorological conditions
- Obtain feedback from operational users
- Determine if VDEAL can replace the VDA for most VCPs or simply be an option

Exceptions

  - ***VCP 121 will continue to use the MPDA***
  - ***PRF sectoring will invoke VDA***

Tentative Field Test Schedule

- December 2010/January 2011 obtain approval ✓ to conduct field test
- February to May 2011
  - Assemble test team ✓
  - Formulate test plans/evaluation criteria ✓
  - Solicit participation from field sites
- June 1 to December 1, 2011 – conduct field test and begin data evaluation
- December 2011 to March 2012 – conclude data evaluation, write final report, make recommendation
- If successful, determine when to deploy

Questions

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Supplemental Slides

Baseline Velocity Dealiasing Algorithm (VDA)

- Applies algorithm sequentially on a radial by radial basis
  - Saves a copy of last good dealiased radial
- Uses Environmental Wind Table to provide initial value for dealiasing
- Dealiasing proceeds along a radial using nearby velocity bins or an average of nearby bins that have already bin dealiased
- Checks for and attempts to correct unrealistic radial or azimuthal shears
- Assigns original velocity values to unresolved velocity bins

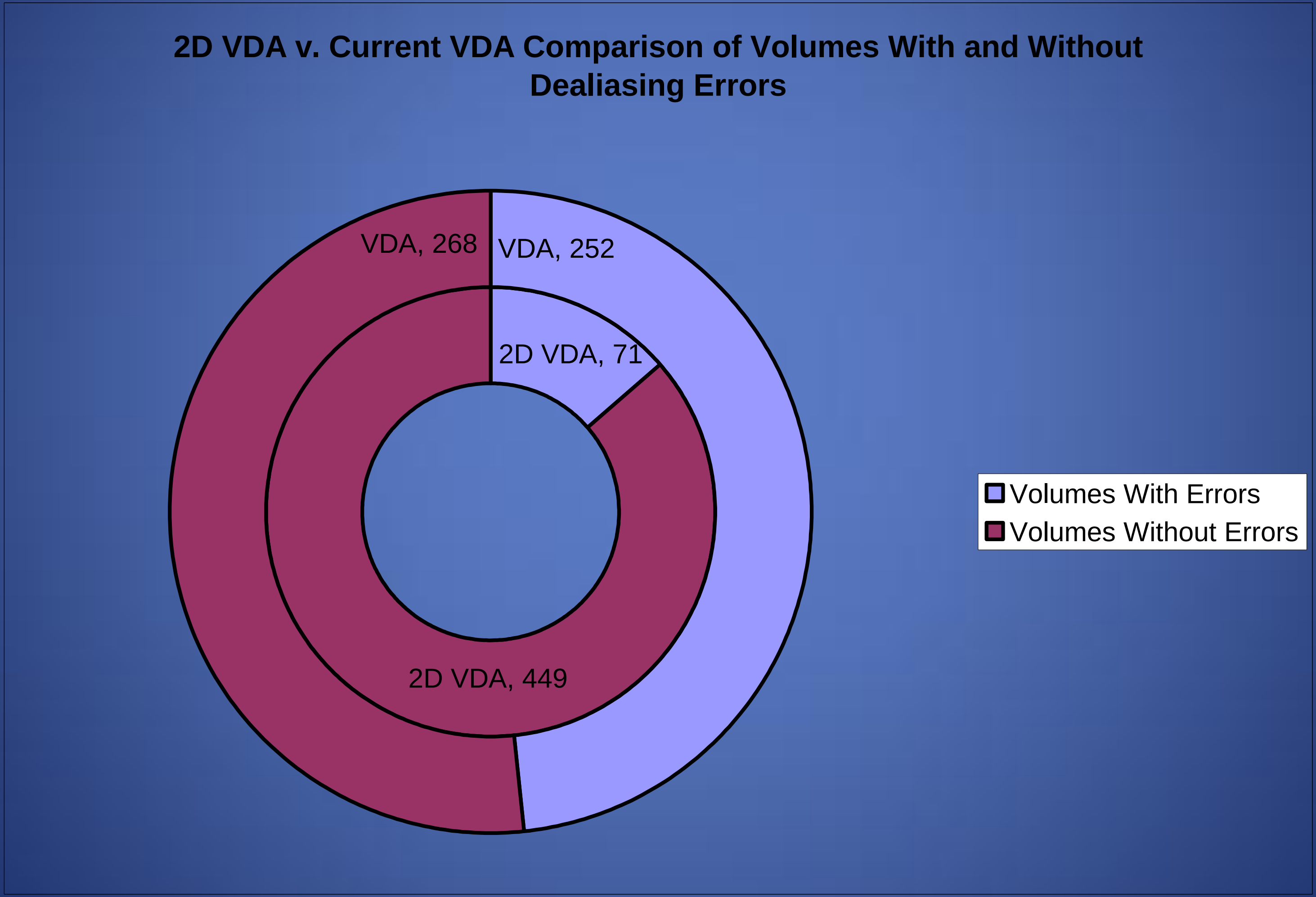
Baseline Multiple PRF Dealiasing Algorithm (MPDA)

- Algorithm sequentially acquires up to 3 velocity scans each with a different Nyquist velocity at the same elevation angle
- Uses environmental wind data to help with dealiasing
- First dealiases 3 velocity values, where available, for the same point in space to find a solution
- If no solution found from previous step, dealiases pairs of velocities from the 3 estimates or if there are only 2 velocities are available
- If no solution found from the previous step, dealiases velocity data where only 1 value is available
- Finally, If no acceptable solution found, puts in the best fitting velocity from any velocity field into the dealiased velocity field
- Checks between steps for unrealistic shears and isolated bins
- Values put in the output velocity field provide reference values for downstream dealiasing

2-Dimensional Velocity Dealiasing Algorithm (VDEAL)

- Uses least-squares approach to dealias velocity discontinuities simultaneously on a full velocity field
- Develops its own wind profile
- Develops a coarse (sub-sampled) global solution and then resolves discontinuities in smaller regions
- Assigns more weight to velocity differences near $\pm 2V_N$
- Assigns more weight to velocity differences in regions with low spectrum width than those with high spectrum width
- Temporarily removes velocity values from side-lobe contamination during dealiasing
- Dealiases separately regions connected by a narrow bridge of noisy data

Bulk Statistics VDA vs VDEAL from Applications Branch Study



Comparison of NSSL and ROC Analyses

NSSL

- All elevation angles
- Examined both 1 deg and ½ deg resolution velocity products
- Evaluated 1 clear-air; 5 precipitation events
  - VCPs 12, 31 & 212
  - Hurricane, squall line, storms, & frontal boundaries
  - ~920 1 deg velocity products
  - ~200 ½ deg velocity products

ROC

- 0.5 deg elevation angle
- Examined only 1 deg resolution velocity products
- Evaluated 15 precipitation events
  - VCPs 11, 12, 21, & 212
  - Hurricanes, squall lines, & tornadic storms
  - 520 velocity products