Final report on the FY 2010 NSSL-ROC MOU Task 3: Velocity Dealiasing Improvement

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1. INTRODUCTION

Over the past three years, the new 2D Velocity Dealiasing Algorithm (VDA) has been refined as testing of its performance has occurred on a variety of archived data sets, along with some real-time qualitative evaluation by the ROC. The project report presented here gives results from the latest round of testing done by NSSL on several archived WSR-88D data sets. Half of these test cases are new, with the other half being previously evaluated on earlier versions of the new 2D VDA (this was done to measure the extend of improvement in the new 2D VDA over the past year). The focus this year was more on severe weather cases versus previous emphasis on difficult VCP-31 cases. As before, the performance of the latest version of new 2D VDA was compared to the current baseline WSR-88D VDA, using the same quantitative scoring procedure as in previous testing.

2. METHODS

The most recent version of the RPG (Build12.1) was used for testing. This included the most up-to-date version of the new 2D VDA. Differences between this latest version of the 2D VDA and the one evaluated during last year's project were:

1) In the process of estimating the background wind field for use in dealiasing an elevation scan, the last and first radials of the scan are connected in the azimuthal direction. This improves the background wind estimate significantly.

2) Spectrum width weighting is now used in the algorithm. This generally improves the background wind estimate in high-vertical shear/low-PRF events.

3) Filtering of side-lobe ground clutter bins has been added. This data typically has near-zero velocities. The data are temporarily removed prior to the dealiasing process and then added back in afterward.

4) In situations where two larger regions of velocity data on an elevation scan are connected via a single channel of gates (e.g., one radial) and the data in this narrow channel are determined to be unreliable (e.g., overly noisy), then the two regions are dealiased separately.

Six test cases were used to compare the performance of the latest version of the new 2D VDA to the current baseline WSR-88D VDA (Table 1). Three of these cases were the same as used in last year's project, which also allows us to measure the extend of improvement in the new 2D VDA over the past year. The non-VCP-31 test cases were selected to provide a range of convective weather types when the WSR-88D site was operating in either of the two most commonly used precipitation-based scanning strategies (VCP-12 or VCP-212).

Base velocity data files (in netCDF format) were generated for both dealiasing algorithms using a specialized, off-line version of Build-12.1 of the WSR-88D RPG. Although only ~1 hour of data were used for the algorithm comparison in each test case, each RPG “run” was started earlier (usually several hours before the beginning of the comparison time period) in order to allow for the VAD-generated vertical wind profile in the RPG to become fully established. For those test cases where “super-resolution” data was available, both the super-resolution and “recombined” (i.e., legacy resolution) elevation scans were compared. NSSL’s WDSS-II display was used to view and analyze the base velocity data files.

The scoring procedure was quantitative in nature and similar to that used in several other recent projects evaluating the accuracy of WSR-88D velocity dealiasing. Each elevation scan analyzed was given an initial score of 100, and “points” were subtracted for each dealiasing error observed (Table 2). In difficult situations where it was not obvious whether or not an error had occurred, or what the correct solution was, then no points were subtracted (for that particular area of the elevation scan). Although the maximum penalty for a single error was –50 points, there was no limit on the number of separate errors that could be tabulated for the entire elevation scan. Hence, numerous small errors could ultimately add up to a sizable penalty.

3. TEST RESULTS

Based on the scoring methodology presented above, the latest version of the new 2D VDA consistently outperformed the current baseline VDA (Table 3), and was also substantially better than the previous version of the 2D VDA for the VCP-31 case (e.g., Fig. 1). For the three new severe weather cases in this year's data set, the degree of improvement was greatest for the KDDC tornado outbreak case, particularly for the SR scans. And although the overall degree of improvement for the other tornado case (11 Feb 2009) wasn't all that large, the improvements were primarily focused on the tornadic supercell (versus the broader elevation scan; e.g., Fig. 2).

4. DISCUSSION AND CONCLUSIONS

Previous test results for the new 2D VDA indicate that it offers the potential for improved dealiasing of the base velocity data, particularly when the WSR-88D is operating in VCP-31. Continued adjustments/improvements to the 2D VDA have led to a new round of testing, with a greater focus on severe weather (versus clear-air VCP-31) cases. Although several severe weather cases were evaluated during the previous round of testing, the degree of improvement for the new 2D VDA was quite small versus the baseline WSR-88D VDA. However, for the three new cases in this year's data set, the latest version of the 2D VDA did substantially better than the baseline WSR-88D VDA, particularly for the super-resolution elevation scans, which are those now used most often for diagnosing important, low-altitude, severe weather signatures (e.g., mesocyclones). Another noteworthy feature of the new 2D VDA (based primarily on SR data from the KDDC case), is that when the velocity data are unusually noisy (and difficult to properly interpret), the 2D VDA will often simply leave the velocity data in its original state (i.e., within the Nyquist interval) versus the baseline VDA, which will often generate sizable regions of velocities set to the upper or lower limit (±64 m/s).

Based on these newest test results, it appears warranted that the latest version of the 2D VDA as it currently is implemented in RPG Build12.1 move to the next level of broader operational testing (i.e., limited field testing at several volunteer NWS sites).

Table 1. List of the test cases. All times are in UTC, and the date corresponds to the start time. Acronyms: VCP = Volume Coverage Pattern; LP = Light precipitation; FB = frontal boundary; SL = Squall-line.

Radar site	Date	Analysis period Start Time	End Time	VCP	Weather situation
KDMX	03 Dec 2008	13:04	14:01	31	Light precipitation and frontal boundary
KLIX	01 Sep 2008	16:03	17:15	212	Hurricane Ike
KTLX	12 Apr 2009	05:31	06:26	12	General thunderstorms (null case)
KDDC	24 May 2008	01:59	03:03	212	Tornado outbreak
KDGX	03 Aug 2008	04:58	06:03	12	Westward propagating squall-line
KTLX	11 Feb 2009	00:58	01:57	12	EF4 tornado

Table 2. Penalties for different types of dealiasing errors.

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

Table 3. Average performance scores for the current baseline (Cur) and latest version of the new 2D Velocity Dealiasing Algorithm (VDA) for each test case. Acronyms: LR = legacy resolution; SR = super resolution; Pv 2D = Previous version of the 2D VDA; Lv 2D = Latest version of the 2D VDA.

Date	All elevation scans			LR elevation scans			SR elevation scans		
	Cur	Pv 2D	Lv 2D	Cur	Pv 2D	Lv 2D	Cur	Pv 2D	Lv 2D
03 Dec 2008	24.5	57.3	74.1	47.1	70.5	82.9	–32.0	24.2	52.2
01 Sep 2008	94.6	99.98	99.95	95.7	99.97	99.93	89.4	100	100
12 Apr 2009	98.7	99.9	99.9	98.7	99.9	99.9	95.4	99.0	99.0
24 May 2008	88.7		97.9	89.9		98.1	83.2		96.6
03 Aug 2008	94.7		98.3	96.5		99.0	86.5		95.0
11 Feb 2009	96.3		99.7	97.2		99.8	92.5		99.0

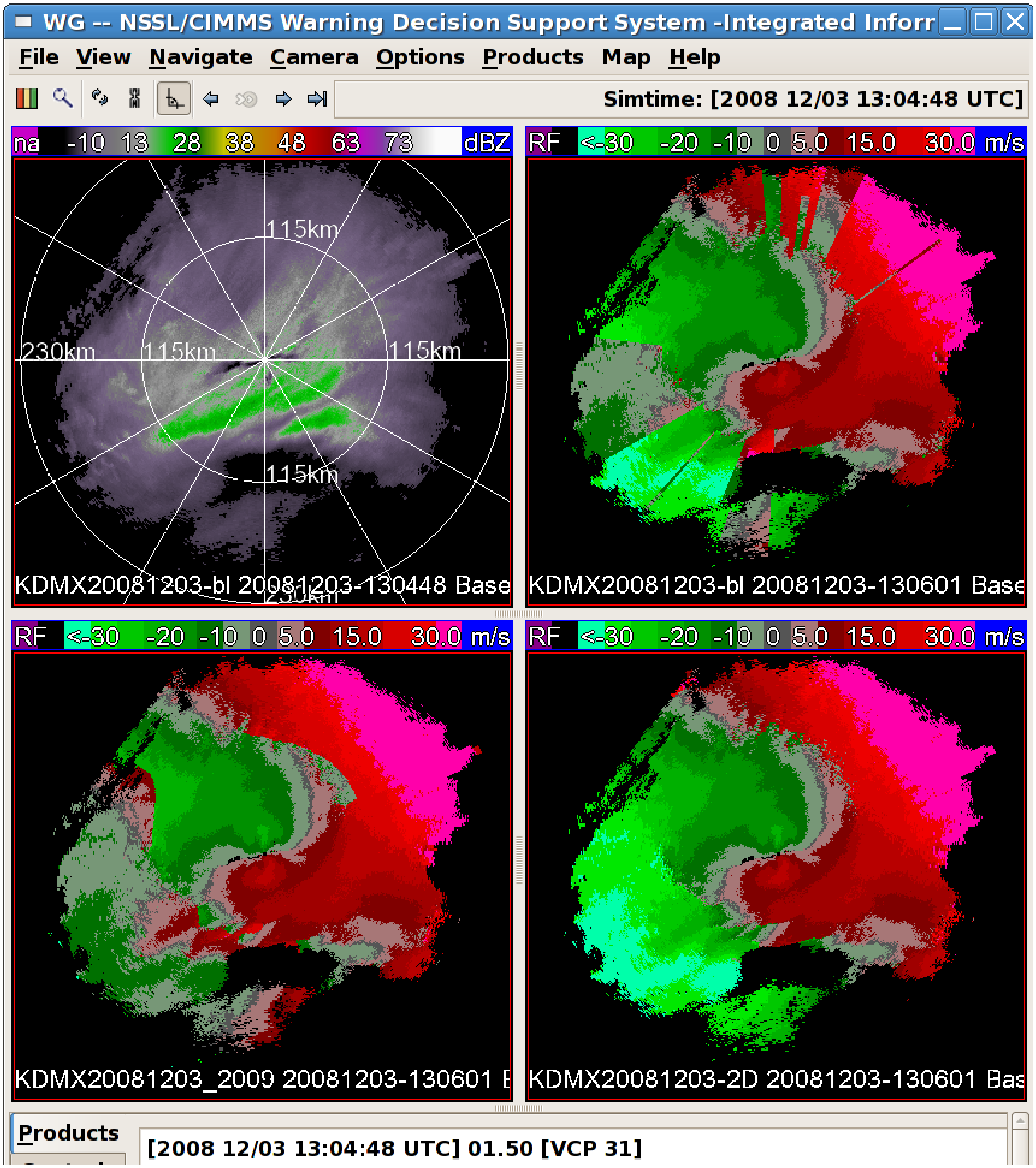

Fig. 1. Example of differences in velocity dealiasing between the current baseline VDA (upper right), the previous version of the new 2D VDA (lower left), and the latest version of the new 2D VDA (lower right). The base reflectivity corresponding to the velocity images is shown in the upper left. The data shown come from the KDMX 1.5° elevation scans on 3 Dec 2008 at 13:04:48 UTC for reflectivity and 13:06:01 UTC for velocity.

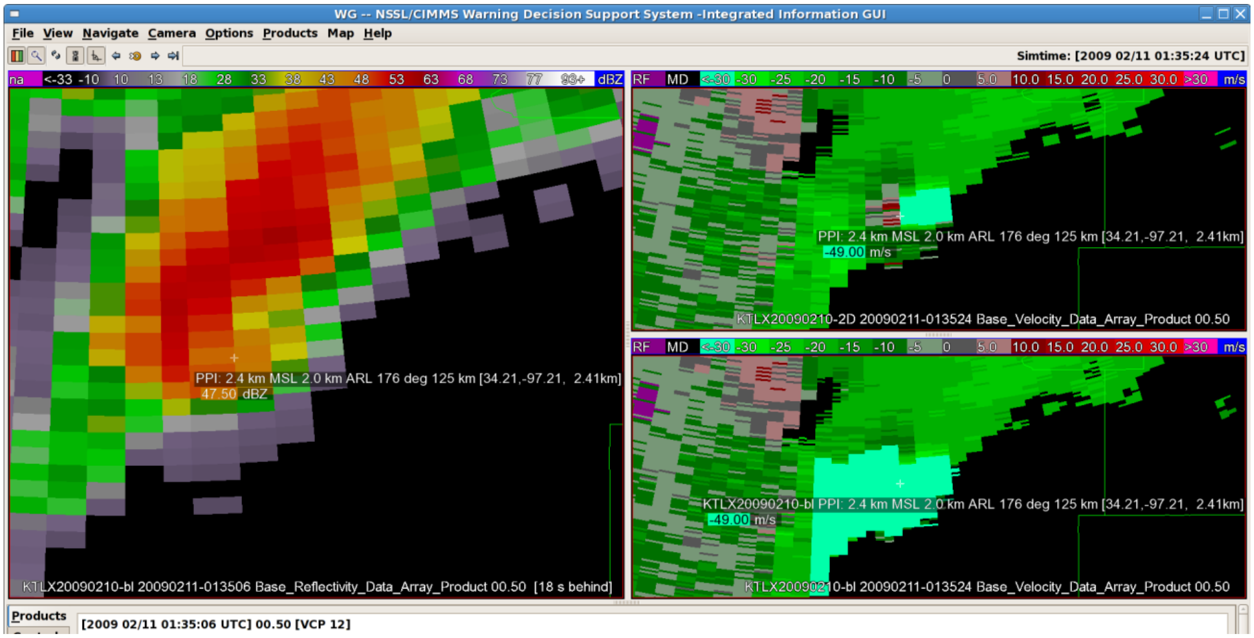

Fig. 2. Example of differences in velocity dealiasing from the current baseline VDA (lower right) and latest version of the new 2D VDA (upper right). The data shown come from the KTLX 0.5° elevation scan on 11 Feb 2009 at 01:35:06 UTC.