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

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The current Weather Surveillance Radar-1988 Doppler (WSR-88D) utilizes two velocity dealiasing schemes, the Velocity Dealiasing Algorithm (VDA) and the Multiple Pulse Repetition Frequency (PRF) Velocity Dealiasing Algorithm (MPDA). The VDA remains virtually unchanged since the deployment of the legacy WSR-88Ds. The VDA primarily uses radial continuity, an average of nearby velocity neighbors, or an Environmental Wind Table (EWT) to help resolve winds exceeding the maximum unambiguous velocity (Nyquist Velocity, V_N) which for the WSR-88D is between 21 and 35 m s^{-1} for the following precipitation Volume Coverage Patterns (VCPs): VCPs 11, 12, 21, 211, 212, & 221 and the clear air VCP 32. The long-pulse clear air VCP 31 has a Nyquist velocity of about 8 m s^{-1}. While generally reliable, the VDA can fail: 1) under strong shear conditions; 2) in velocity data with moving clutter; 3) in areas with weak echoes; 4) when the Nyquist velocity is much lower than the prevailing winds; or 5) where the values in the EWT are not representative of the local storm winds. The MPDA, fielded in 2004 as VCP 121, takes multiple scans of velocity data at the same elevation using up to three different PRFs. It can dealias velocity with a high degree of reliability where there is more than one velocity estimate available. However, the utility of the MPDA in VCP 121 is limited during rapidly changing weather events because the additional scans required increases the volume scan time to nearly 6 minutes. VCP 121's utility is further diminished because it has only 9 unique elevation angles with which to interrogate storm structure.

The Radar Operations Center (ROC) tested a two-dimensional velocity dealiasing scheme (VDEAL) that is more robust than the current VDA. It works by simultaneously dealiasing all gates in an elevation scan using a least-squares approach to minimize the discontinuity caused by aliasing. Greater weight is given to velocity differences near zero or at multiples of $2V_N$ as well as velocity differences where the corresponding spectrum width values are low. VDEAL can be used by all VCPs except VCP 121 with no perceptible delay in product availability.

This paper presents the test results of VDEAL on historical WSR-88D data sets collected during hurricanes, tornadic storms, and storms with outflow boundaries. For this test, velocity products were scored qualitatively. Of 520 low-level velocity products evaluated, the VDA had 252 with dealiasing errors while VDEAL had only 71 with dealiasing errors. More striking was the reduction in velocity dealiasing errors and improved data quality of the VDEAL over the VDA in hurricanes. Of 201 velocity products evaluated, VDA had 185 total dealiasing errors while VDEAL had only 5 dealiasing errors. Based on these results and independent testing by scientists at the National Severe Storms Laboratory, the ROC plans to conduct a field test during the summer and fall of 2011.

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