7R5 Improvements in RPG Clutter/Precipitation Discrimination for the WSR-88D

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1. Abstract

The goal of the AP Ground Clutter Mitigation Scheme is the elimination of ground clutter echoes that occur during anomalous propagation (AP) conditions in the atmosphere. The AP Ground Clutter Mitigation Scheme is being deployed in stages within the Weather Surveillance Radar-1988 Doppler (WSR-88D) network. Once fully deployed, this scheme will improve the quality of the radar base data by identification and removal of AP ground clutter echoes. The AP Ground Clutter Mitigation Scheme consists of two parts: the Radar Echo Classifier (REC) that is partially deployed within the Radar Product Generator (RPG) and the Clutter Mitigation Decision (CMD) that is under development for the Open Radar Data Acquisition (ORDA). The CMD is discussed in Dixon et al. (2005) at this conference.

The Radar Echo Classifier (REC) (Kessinger et al, 2003) is a data fusion system that uses fuzzy-logic techniques to estimate the type of scatterer measured by the WSR-88D. The REC consists of three algorithms: the AP Detection Algorithm (APDA) classifies AP ground clutter return, the Precipitation Detection Algorithm (PDA) classifies precipitation regions, and the Sea Clutter Detection Algorithm (SCDA) classifies return from the ocean surface. The APDA is deployed within the RPG.

Currently, the APDA is used as a quality control flag for the Enhanced Precipitation Preprocessing (EPRE) hydrological algorithm (O'Bannon and Ding, 2003) to remove ground clutter contamination during construction of the Hybrid Scan Reflectivity (HSR). The HSR is input into the radar-derived rainfall calculation. The PDA has been ported to the RPG Common Operating Development Environment (CODE) and modifications have been made to EPRE. The CODE-version of EPRE now uses outputs from both the APDA and the PDA to better discriminate between precipitation and clutter return. Preliminary results show that, with these modifications, the HSR has higher quality and contains less clutter contamination.

2. Case Study

One example is shown from the St. Louis, MO WSR-88D (KSLX) on 1 November 2004 to compare the new versus the old methodology for construction of the HSR. Figure 1 shows the base moment fields and the outputs from the APDA and the PDA. As can be seen, several regions of AP ground clutter have formed in response to the squall line moving over the radar and cooling the environment, causing AP conditions. Both the APDA and the PDA perform well at detecting AP ground clutter or precipitation, respectively.

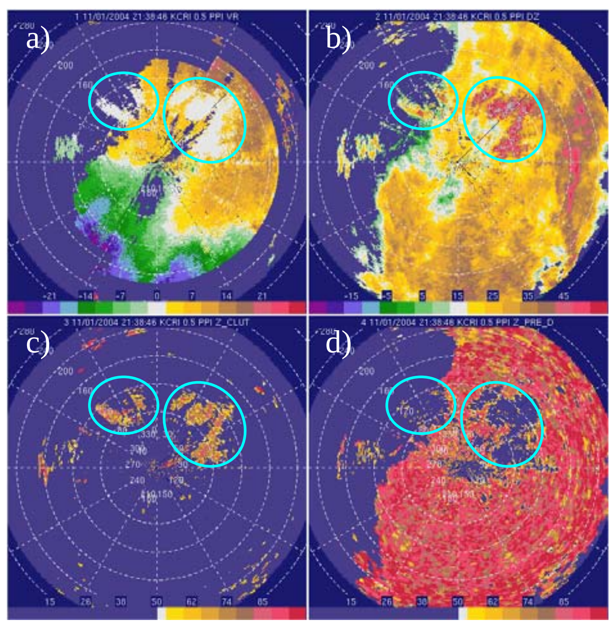

Figure 1. Radar Echo Classifier results are shown from the St. Louis, MO WSR-88D (KLSX). Fields shown include a) radial velocity (m/s), b) reflectivity (dBZ), c) APDA output thresholded on 0.5 interest, and d) PDA output thresholded on 0.5 interest. Encircled regions contain AP ground clutter.

A closer look at the results shown in Figure 1 reveals additional notable performance characteristics of the APDA and the PDA. Figure 2 contains the same data as in Figure 1, but with a higher magnification and centered on the northeast quadrant. Notice that both the APDA and the PDA perform well at detecting both clutter and precipitation, respectively. The encircled regions shown in Figure 2 are regions of mixed ground clutter and precipitation returns. Notice that in these mixed regions, neither the APDA nor the PDA has a positive detection, in general.

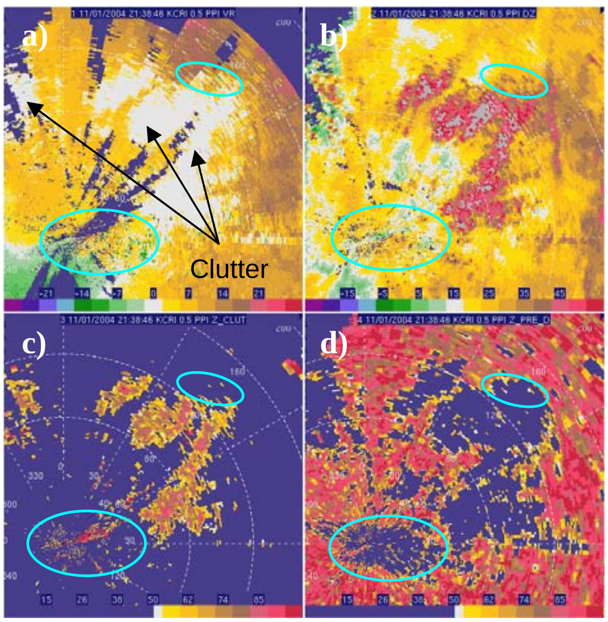

Figure 2. Same as Figure 1 with higher magnification of the region containing AP ground clutter. Cyan ovals contain regions of mixed clutter and precipitation returns.

As discussed in Section 1, the PDA has been added to the RPG CODE and the development version of EPRE modified to use both the APDA and the PDA as quality control thresholds during construction of the HSR. For each radar bin, the output from the APDA and the PDA are examined to determine if that bin should be used within the HSR. A positive test result for input into the HSR is that the radar bin must not be clutter (i.e., APDA is less than 0.5) <u>and</u> must be precipitation (i.e., PDA is greater than 0.5). If a negative test result occurs, then the range bin at the next higher elevation angle is selected for input into the HSR, provided that it also passes the quality control test. Note that in mixed clutter and precipitation cases, such as is shown in the blue ovals within Figure 2, these radar bins will not be input into the HSR since they fail the quality control test (i.e., both the APDA and the PDA values are less than 0.5).

Figure 3 shows the HSR results using only the APDA as the quality control threshold within the EPRE where range bins with APDA greater than 0.5 are not used. This is the methodology currently used by the RPG. Notice, within the magenta circle, that scattered radar bins of ground clutter have been introduced into the HSR with this methodology.

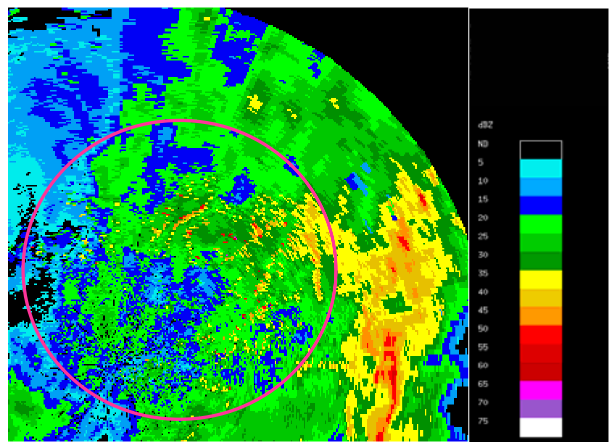

Figure 3. Hybrid Scan Reflectivity (HSR) derived using only the APDA to remove ground clutter.

Figure 4 shows the HSR results with the new quality control methodology that uses both the APDA and the PDA to determine if a radar bin contains clutter or precipitation. Comparison of

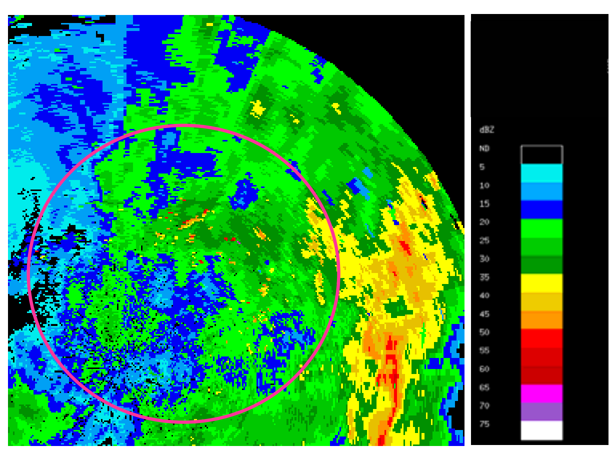

Figure 4. Same as Figure 3 except both the APDA and the PDA are used to construct the HSR.

Figure 4 to Figure 3 shows that the number of radar bins that contain clutter, in error, is significantly reduced. The new quality control methodology results in a significant improvement in the HSR.

3. Summary

Results were shown of a new methodology for construction of the Hybrid Scan Reflectivity (HSR) within the Enhanced Precipitation Preprocessor (EPRE). The Radar Echo Classifier (REC) AP Detection Algorithm (APDA) and the Precipitation Detection Algorithm (PDA) are both used in the quality control process within the RPG development version of the EPRE to discriminate between radar bins that contain clutter versus precipitation. Results from one case study were shown that indicate the new methodology improves the quality of the HSR by having less ground clutter contamination.

4. References

Dixon, M., C. Kessinger**,** C., and J. Hubbert, 2005: Echo classification and spectral processing for the discrimination of clutter from weather. *Preprints-CD, 32nd Conference on Radar Meteorology*, American Meteorological Society, Albuquerque, NM, 24-29 September 2005.

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O'Bannon, T., and F. Ding, 2003: Continuing enhancement of the WSR-88D precipitation pre-processing subsystem. *Preprints, 31st International Conference on Radar Meteorology,* American Meteorological Society, Seattle, 7-12 August 2003.