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NSSL WSR-88D ACTIVITIES ASSOCIATED WITH SWAMP

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Introduction

The National Severe Storms Laboratory (NSSL) has worked with the Salt River Project (SRP) and the National Weather Service (NWS) for the past several years in an effort to understand the monsoon forecasting problems of the Southwest. The Southwest Area Monsoon Project (SWAMP) was created to formalize these studies. During the SWAMP activities this year at the Phoenix NWS office, a new system was introduced for evaluating improved Doppler radar-based algorithms, data integration techniques, and AWIPS-like display capabilities. This demonstration system is called the Warning Decision Support System (WDSS). The portion of the system used by the forecasters to manipulate these new data techniques is called the Radar Analysis and Display Software (RADS). This Technical Attachment describes both the new WSR-88D algorithms under development at the NSSL and how RADS presents this information to the forecaster.

Algorithm Enhancements

Five primary algorithms are implemented in the WDSS: (1) storm cell identification and tracking, (2) hail detection, (3) damaging winds, (4) mesocyclone detection, and (5) tornado detection. The first three algorithms were used during SWAMP this year and were noticeably superior to their WSR-88D counterparts. The mesocyclone and tornado detection algorithms had little use due to the lack of this storm type during the evaluation period. Two secondary algorithms are also available: (1) lightning strike association and (2) precipitation. These algorithms all differ from the WSR-88D Storm Series Algorithms as described in the remainder of this section.

The storm cell identification and tracking algorithm is designed to identify, track, and calculate attributes of individual storm cells, even if in lines or clusters. The existing WSR-88D counterpart only tracks areas of 30 dBZ or higher, without regard to how the storms are organized. This new algorithm can catalog one hundred cells for a single scan, with information on the strongest 20 cells available to the user.

The hail detection algorithm improves on the WSR-88D by providing: (1) probability of any size hail, (2) probability of severe hail (greater than 3/4 inch) and (3) the maximum hail size expected. In contrast, the WSR-88D hail detection algorithm provides only negative, probable or positive categories for any hail size. As is readily apparent, this new hail algorithm better supports the needs of a forecaster making a warning decision.

The damaging winds algorithm does not exist on the WSR-88D and was developed in response to past SWAMP activities. This algorithm attempts to detect and predict (in the very short-term) divergent outflow patterns associated with downbursts, and to detect convergent patterns accompanying gust fronts. In the western United States, this algorithm could have a significant impact on warning operations. The downburst portion of the algorithm correlates: storm top convergence, movement of the storm reflectivity core, maximum divergence below 3 km, and other parameters to provide the user downburst severity and location information.

The remaining two primary algorithms were not used extensively in SWAMP this summer, but are presented here for completeness. The mesocyclone algorithm detects significant rotations within storms using a set criteria. The WDSS algorithm differs from the WSR-88D in four areas: (1) the WDSS provides a movement forecast, (2) the WDSS requires time continuity for detection, (3) the NSSL version has a minimum depth criteria, and (4) this newer version provides more output parameters for diagnostic use than the WSR-88D algorithm. The changes associated with the tornado detection algorithm attempt to detect both the weak circulations associated with the High-Plains type of tornados and the more violent supercell tornados, while keeping the false alarm ratio low.

Two other important techniques are present in the WDSS which affect the algorithms: real-time lightning data correlated to storm cells and clutter residue editing maps (CREMS). Real-time lightning strike data is available for overlay onto any of the radar fields, and an algorithm associates strikes with cells being tracked. Both positive and negative strike information are available. Thus, lightning activity is effectively merged with radar data to aid in determining the intensity of a storm. The clutter residue editing maps provide high resolution blockage and ground clutter information for adjusting the base data. CREMS allows for easier tracking of weak features over an RDA (e.g., gust fronts), while providing higher quality input data to the more reflectivity sensitive algorithms (e.g., precipitation).

New Display Techniques

The Radar Analysis and Display Software (RADS) was developed on UNIX-based workstations running X Window. Thus, the display techniques used are similar to what will exist on AWIPS. This software package is still in a developmental state, so several major features required for operations are missing. However, RADS does provide significant advantages in some areas over what the WSR-88D Principal User Processor (PUP) provides.

The most important advantage of RADS is the cell table. The storm identification and tracking algorithm catalogs up to 100 storm cells. Of these 100 cells, the strongest 20 cells are presented in a table for the user to scan and scroll (see Figure 1). This cell table contains: cell identification, storm location with respect to the RDA, circulation within the storm, surface wind intensity, hail (of any size) probability, probability of severe hail, size of hail expected, maximum dBZ of cell, height of maximum reflectivity, cell base, cell top, cell movement, and lightning characteristics. The blocks of the cell table are color coded with red indicating severe conditions, yellow for moderate, and green for lower intensity conditions. The color coding is extremely useful in drawing the forecaster's attention to the most important storms. During periods with numerous convective storms in an area, the cell table is invaluable for optimizing a forecaster's time when warnings are needed.

Rather than using the full screen or quadrants of a screen, like the PUP, volume scan information is displayed in image windows. Each image window has options for overlaying algorithm products, displaying different map backgrounds, zooming in on an area, getting values of the raw data, or displaying trends of a specific storm. Detailed storm history is available through the trends option. When this option is selected, a trends window is displayed. The trends window provides a graphic look at many parameters internal to the algorithms. For example, center of mass height, maximum reflectivity, VIL, storm aspect ratio, lightning activity and about 60 other parameters. Thus, a detailed examination of a storm is easily and quickly performed.

While RADS offers many new display techniques useful to the operational meteorologist, several vital features are lacking. For example, these PUP features are not present: linked cursors, cross sections, cursor home, VAD wind profiles, and four-panel displays. Dissecting a storm without a multi-panel display is cumbersome. However, since RADS is still in a state of development, these features will likely be added over time.

Summary

NSSL is taking several steps to improve the algorithms in the WSR-88D, and the base data quality. Much of this work directly affects common problems seen in the western United States. Their display system, Radar Analysis and Display Software (RADS), offers many excellent techniques and ideas for optimizing a forecaster's time in a warning situation. Therefore, RADS is extremely useful for supplementing a PUP in an operational setting. As RADS matures, it may eventually be able to replace the PUP.

References Used and Acknowledgments

Much of the algorithm information presented here is contained in the "1994 Phoenix Severe Weather Warning Technology Beta-Test Planning Document". Information in the "New Display Techniques" section was obtained from conversations with NSSL personnel (Mike Eilts, Arthur Witt, Kurt Hondl and Ken Howard), and from personal experience in using the RADS. Special thanks to J. T. Johnson of NSSL for providing a color copy of the RADS windows depicted in Figure 1.

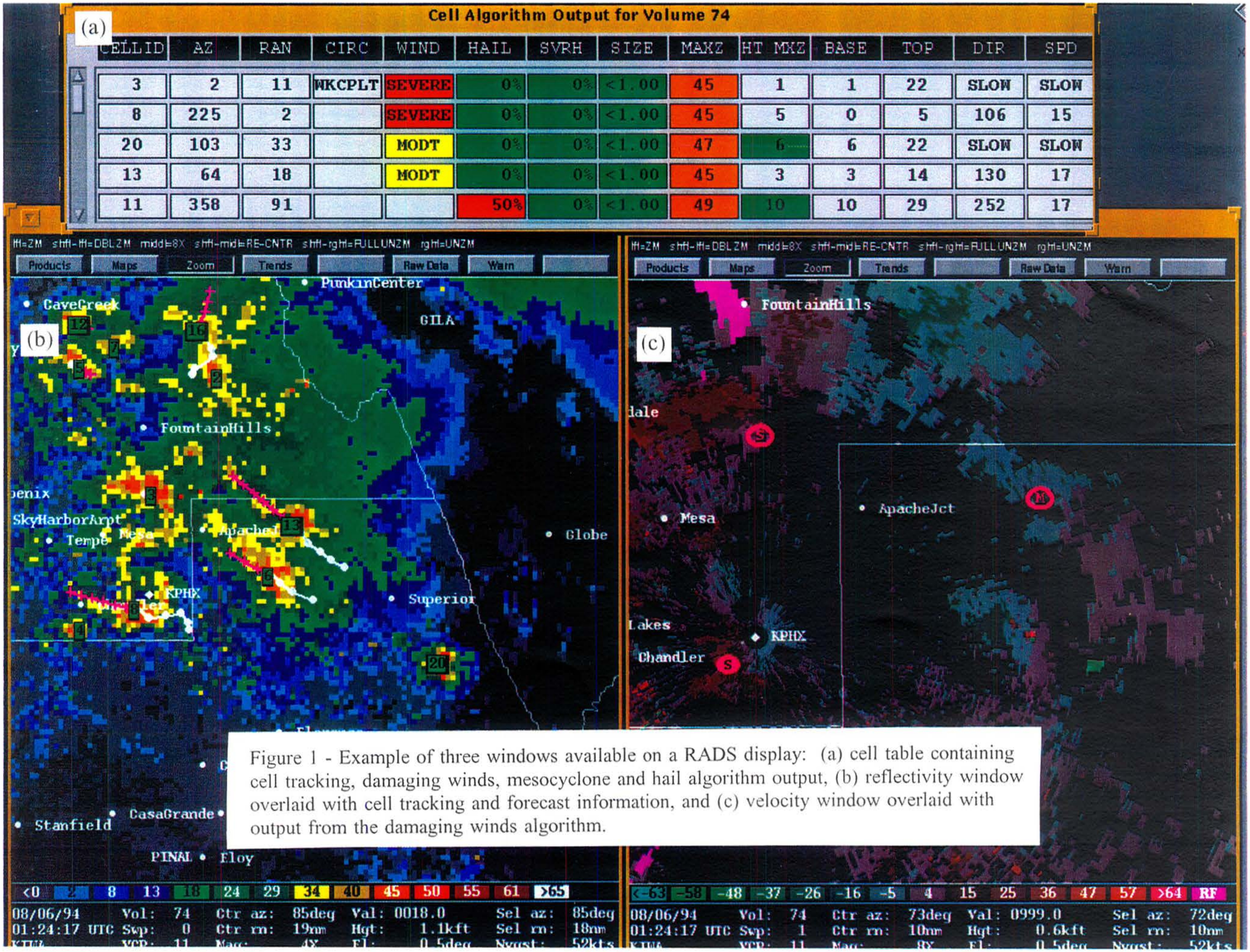

Figure 1 - Example of three windows available on a RADS display: (a) cell table containing cell tracking, damaging winds, mesocyclone and hail algorithm output, (b) reflectivity window overlaid with cell tracking and forecast information, and (c) velocity window overlaid with output from the damaging winds algorithm.