10B.3

IMPROVING SHORT-TERM WARNINGS THROUGH RAPID UPDATE OF RADAR-DETECTED SEVERE WEATHER FEATURES

Christopher W. Porter*
Cooperative Institute for Mesoscale Meteorological Studies/ National Severe Storms Laboratory

1. INTRODUCTION

The National Severe Storms Laboratory (NSSL) has developed a Severe Storm Analysis Package (SSAP) containing a suite of algorithms for radar detection of severe weather features such as mesocyclones and tornadoes. Algorithmic output is displayed at the end of a volume scan although critical information on hazards features is available after just one elevation scan. Thus, a time lag exists between the initial identification of severe weather features and the dissemination of that information to a user.

A new version of NSSL's SSAP code contains a rapid update system (Wyatt et al. 1998) allowing users access to severe weather feature information after each elevation scan. Rapid dissemination of information could potentially allow access to vital severe weather information as much as five minutes earlier than currently available, thus improving the warning decision processes of the National Weather Service and Federal Aviation Administration.

Four algorithms within SSAP have been modified to contain the rapid update system: the Storm Cell Identification and Tracking (SCIT) algorithm (Johnson et al. 1998), including the Hail Detection Algorithm (HDA; Witt et al. 1998); the Tornado Detection Algorithm (TDA; Mitchell et al. 1998); and the Mesocyclone Detection Algorithm (MDA; Stumpf et al. 1998). SCIT, HDA, and TDA have been implemented within the WSR-88D Open System (Saffle and Johnson 1998). MDA is slated for a future build of the ORPG while the rapid update system is currently planned for release within ORPG Build 5.0.

2. RAPID UPDATE SYSTEM

2.1 *Methodology*

The rapid update system is initiated after the first elevation scan of radar data is received. Two-dimensional components are identified by examining horizontal runs of adjacent reflectivity gates above a specified threshold (SCIT) and regions of horizontal shear above a specified threshold (MDA and TDA). The location of the 2D features are compared with forecasted tracks of 3D features from the previous volume scan. Features closest to one another are time associated. Time association after the initial elevation scan allows the range and azimuth of severe weather features to be updated within a feature attribute table in addition to updating the location of the icon representing the severe weather feature on the radar display.

In addition, the 2D feature of the current volume scan inherits all feature attributes of the time-associated 3D feature. In this way, all feature attribute information from the previous volume scan is coasted to the current volume scan. For example, for a tornadic vortex signature detection within TDA, the 2D feature in the current volume scan inherits the following attributes: identification number (ID), circulation type, mesocyclone ID and storm cell ID the TDA feature is associated with, top height, depth, maximum velocity difference, maximum shear, and propagation speed and direction. Base height, low-level velocity difference across azimuths, and low-level shear are calculated using data from the initial, lowest-level elevation scan. A list of feature attributes that are passed from a 3D feature within the previous volume scan to a new 2D detection in the current volume scan for each SSAP algorithm is given in Table 1.

As each additional elevation scan of data is made available within the current volume scan, vertically adjacent 2D features are associated to produce a 3D feature (Johnson et al. 1998; Witt et al. 1998; Mitchell et al. 1998; Stumpf et al. 1998). Once the 3D feature is completely built (or topped), which can occur prior to the end of the volume scan, the attributes of the 3D feature in the current volume scan are updated.

Attributes of 3D features can also be updated prior to the feature being topped. If a severe weather feature has become more severe since the previous volume scan, appropriate feature attribute information is immediately disseminated to the user. For example, if the maximum velocity difference within a TDA vortex detection has become greater than the same attribute within the 3D detection in the previous volume scan, then the attribute information within the current volume scan is updated immediately. In this way, 3D feature attributes can be updated in the current volume scan even before the 3D feature is completely built.

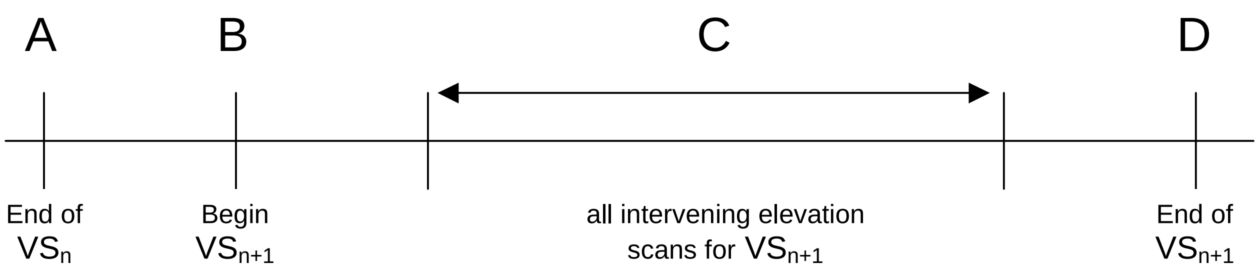
Of course, new 3D features in the current volume scan can also be identified that do not have a time-associated counterpart in the previous volume scan. For these features, an icon will appear on the display once there is enough information to determine a new 3D feature exists. Thus, an icon will appear once information from

* Corresponding Author Address: Christopher W. Porter, NSSL, 1313 Halley Circle, Norman, OK, 73069; e-mail: Chris.Porter@nssl.noaa.gov

TABLE 1: Attributes for SSAP algorithmic features that can be updated after each elevation scan within the rapid update system.

ALGORITHM	Attributes updated after initial elevation scan	Attributes that can be updated after each elevation scan
SCIT	Base Height	Top Height Maximum Reflectivity Height of Maximum Reflectivity VIL
MDA	Base Height Low-Level Diameter Low-Level Rotational Velocity Low-Level Shear Maximum Shear Low-Level Gate-to-Gate Velocity Difference	Circulation type Top Height Depth Maximum Diameter Maximum Rotational Velocity Maximum Shear Maximum Gate-to-Gate Velocity Difference Mesocyclone Strength Rank Mesocyclone Strength Index Probability of Tornado Probability of Severe Weather
TDA	Base Height Low-Level Velocity Difference Low-Level Shear	Circulation type Top Height Depth Maximum Velocity Difference Maximum shear
HDA	(none)	Probability of Hail Probability of Severe Hail Hail Size

FIGURE 1: Rapid Update timeline summarizing the methodology.



A – 3D features from previous volume scan (time=n) are finalized

B – 2D features in current volume scan (time=n+1) are time associated with 3D features from previous volume scan (time=n) and feature attributes are coasted

C – New 3D features are built. Feature attributes updated if:
1) 3D feature is topped
2) Feature attributes are intensifying (becoming more severe)

D – All 3D features have been topped and attributes updated in volume scan at time=n+1 two different elevation scans is available rather than waiting until the new 3D feature is completely built.

A timeline of the rapid update system methodology is given in Figure 1.

2.2 *Time Association Errors and Elevated Features*

The rapid update system also accounts for potential time association errors and elevated features. A time association error can occur when a 3D feature from the previous volume scan is time associated with a 2D feature in the current volume scan that is not part of a 3D feature. Occasionally, the SSAP algorithms identify 2D features in the lowest elevation scan that do not have corresponding 2D features in elevation scans further aloft. When this occurs, the time association made between the prior 3D feature and the current 2D feature is broken. Then, the 3D feature from the previous volume scan is free to time associate with another 2D or 3D feature in the current volume scan.

The original rapid update methodology did not coast information for elevated features such as elevated TVS signatures once the initial elevation scan of the current volume scan is completed. Elevated features from the previous volume scan do not necessarily have a 2D feature within the lowest elevation scan of the current volume scan with which to time associate. Thus, elevated feature information would not be coasted to the current volume scan. Currently, after a code change, all elevated feature attribute information is coasted to the current volume scan after the first elevation scan is complete even if a time association has not been made with a 2D feature. Once a time association can be made, the icon position and feature attribute table information is updated.

3. EVALUATION OF THE RAPID UPDATE SYSTEM

The rapid update system is being tested for robustness and accuracy at this time. Radar data from a variety of severe weather events are being used. End of volume scan information will be examined to ensure that algorithm accuracy in identifying severe weather features has not decreased with the implementation of the rapid update system. Algorithmic output at the end of the volume scan should be nearly identical in both the rapid update and non-rapid update modes.

The benefit of providing users with severe weather feature information in a more timely fashion will be examined once it is known that algorithm accuracy has not been compromised. The average increase in time that severe weather feature information is made available to a user will be determined. Attribute information can be disseminated to users approximately 4 to 5 minutes earlier in the rapid update system for severe weather features identified at the lowest elevation scan.

In addition, time association errors will be noted. A time association failure rate will be determined for each algorithm.

Display graphics of the rapid update system can be viewed at http://www.nssl.noaa.gov/~porter/rapidupdate.

4. REFERENCES

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