WSR-88D DOPPLER RADAR ADAPTABLE PARAMETER OPTIMIZATION OF THE MESO/TVS ALGORITHM

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Abstract

A collection of recent Arkansas tornadic events are examined within 60 nm of the KLZK WSR-88D radar data acquisition (RDA) site, located at the National Weather Service Forecast Office in Little Rock, to evaluate the performance of the MESO / TVS detection algorithm (MTA) for Tornadic Vortex Signatures (TVS). The data is replayed using Archive Level II data on the WSR-88D Algorithm Testing and Display Systems (WATADS 9) software system for each tornadic scenario including a lead time window of at least 30 minutes and up to 30 minutes after tornadoes were on the ground. TVS detections are first scored with MTA adaptable parameters [Threshold Pattern Vector (TPV) and Threshold TVS Shear (TTS)] at default values (TPV=10 and TTS=72 h^{-1}). A statistical evaluation indicates that limited and spurious TVS information resulted. As a result, MTA adaptable parameter adjustment is performed to see if algorithm performance can be improved. A significant increase in skillful TVS detections occurred when MTA values were lowered to optimal values (TPV=7 and TTS=45 h^{-1}), objectively determined by the critical success index (CSI) statistic. At the MTA optimal settings, average lead time for TVS detections increased from 3 to 6 minutes over defaulted values. As a result of the MTA TPV change from 10 to 7, vertically correlated WSR-88D mesocyclone features identifying tornadoes beyond 60 nm, with no range thresholding for lead hits, increased nearly 13%. Furthermore, the TVS optimization will provide radar operators with more frequent (and skillful) TVS detections, as will be the case when WSR-88D Build 10 is installed at field sites in the fall of 1998.

1. Introduction

An important mission of the National Weather Service (NWS) is to provide advance notification of severe weather to the public. This goal is achieved, in part, by using the Weather Surveillance Radar - 1988 Doppler (WSR-88D) to evaluate the potential for tornadogenesis. Doppler velocity fields are evaluated by the MESO/TVS (Mesocyclone/Tornadic Vortex Signature) algorithm (MTA) to produce decision aids for radar operators who identify areas primed for tornadic formation.

Several Arkansas tornadic episodes (F0 - F4, some of which contained multiple track events) that affected the NWS Forecast Office Little Rock (NWSFO LIT) county warning area (CWA) are collectively studied with the aim to improve MTA-generated TVS recognition relative to ground truth. WSR-88D base data produced by the signal processor at the full spatial and temporal resolution of the system, recorded as Archive Level II data (Crum et al. 1993) at the KLZK (Little Rock) radar data acquisition (RDA) site, is replayed using the WSR-88D Algorithm Testing and Display Systems (WATADS 9) software system (NOAA 1996). Archive Level II data was acquired from the NOAA/National Climatic Data Center (NCDC). Times and locations of tornadoes were established from local storm damage surveys and Storm Data (NOAA 1995-97).

Algorithm performance statistics tests are calculated for various combinations of two adaptable parameters: Threshold Pattern Vector (TPV) and Threshold TVS Shear (TTS). The goal of this study is to see if algorithm performance can be increased by decreasing these two parameters from their default values (10 and 72 h^{-1}, respectively). This study concentrates on the MTA's ability to detect a TVS within 60 nm of the KLZK RDA site due to radar horizon and beam broadening problems. Tornado circulations are difficult to detect at longer ranges. These circulations are frequently low-level events, and at far ranges the beam may overshoot the circulation. In addition, the one-degree beam widens with range (approximately 1 nm wide at a range of 57 nm). This can significantly decrease the range of detection, particularly for small circulations. Considering that many F0 or F1 tornadoes are less than 300 feet wide, the expected range of detection might be less than 3 nm. Luckily, the parent circulation of even these small tornadoes is larger than the tornado itself (and may ascend higher into the storm than the tornado), so the radar has a chance to detect some of these circulations at farther ranges. If this study shows that the current algorithm performance can be increased by changing the TPV and TTS parameters, the KLZK WSR-88D site can take advantage of a Unit Radar Committee's (URC's) level of change authority to implement an improvement. Beyond 60 nm (excluding lead hits), the skill of the MTA's vertically correlated mesocyclone features in detecting tornadoes out to a range of 120 nm is presented as a function of TPV settings. Lastly, with consideration to pending changes in related algorithms that will be part of the WSR-88D Build 10 Radar Products Generator (RPG) software implementation to field sites in the fall of 1998, this TVS optimization study will prepare radar operators with more frequent and skillful diagnostic information regarding potentially tornadic vortices. Fundamental differences exist between the NOAA/National Severe Storms Laboratory (NSSL) tornadic detection algorithm (TDA) in WSR-88D Build 10 to generate a TVS relative to the current WSR-88D TVS (Mitchell 1997; Stumpf et al. 1997). The most fundamental difference between the two algorithms is that the NSSL TDA examines gate-to-gate (azimuthally adjacent and constant in range) velocity differences where the current TVS algorithm examines shear between maximum and minimum velocities within an MTA-generated MESO (i.e., NSSL TDA works independently from the Mesocyclone algorithm). Comparative performance levels between the TDA-derived TVS and the TVS optimization sought in this study are addressed in section 6.

2. MESO/TVS Algorithm (MTA)

In many tornadic storms, an important precursor of tornadogenesis is the mesocyclone, tersely defined as an area of thunderstorm-scale rotation (usually cyclonic) associated with deep moist convection. On average, nearly 30% of mesocyclones produce tornadoes while around 90% are associated with some type of severe weather. The MTA is modeled after a Rankine-combined vortex which assumes solid body rotation, tangential velocities increase linearly with distance from the center, surrounded by a region of potential flow in which velocities fall off with distance from the center of circulation. The MTA identifies mesocyclones by finding three dimensional cyclonic shear regions that also meet a momentum criteria.

a. How the MTA works

MTA processing utilizes base Doppler velocity data sampled at high resolution segments or "gates" (.13 nm). For clockwise antenna rotation, the algorithm searches for an increase in azimuthal Doppler velocities at a fixed range that pass shear and momentum (equations 1 and 2) thresholds, producing pattern vectors. For a set of areal pattern vectors in close proximity (2D processing), a 2D feature is identified by the MTA if a minimum number of pattern vectors are present. For example, at TPV=10 (default), a circulation with 10 or more pattern vectors will be identified as uncorrelated shear, at least, by the MTA. Next, a symmetry evaluation is performed on all 2D features. If this condition is passed, the feature is identified as correlated shear. In the MTA's 3D processing stage, if two or more symmetric features are closely aligned in the vertical, the feature is identified as a Mesocyclone (MESO). When the symmetry condition applies to only one elevation angle in a 3D feature, it is categorized as 3D correlated (3DC) shear.

$$\text{SHEAR} = \Delta V / L \qquad (1)$$

$$\text{MOMENTUM} = \Delta V * L \qquad (2)$$

where ΔV is defined as the change in Doppler velocities and L is the length of ΔV

If a MESO is detected by the MTA, the algorithm checks to see if a Tornadic Vortex is present. The TVS algorithm calculates shear values affiliated with the maximum and minimum Doppler velocities (not necessarily gate-to-gate) at each elevation in the MESO or within a specified search percentage around it (by default, an additional 5% areal coverage). If the shear value is greater than the TTS setting at a given elevation, a potential TVS is identified. If two or more potential TVSs are vertically linked, a TVS is then generated.

b. The significance of TPV and TTS change

Lowering the value of TPV allows the MTA to recognize smaller scale circulations and, therefore, increases the number of potential TVS identifications. Lowering the value of TTS increases the number of TVS identifications.

3. Methodology

In this MTA performance evaluation, TVS scoring statistics include the use of probability of detection (POD), false alarm ratio (FAR) and critical success index (CSI), defined in equations 3-5. Algorithm output are evaluated for volume scans: (1) that contained tornadic circulations within 60 nm; (2) that occurred at least 30 minutes before tornadoes were on the ground; and (3) that occurred up to 30 minutes after tornadoes were on the ground. An algorithm hit is counted if a TVS is identified with a confirmed tornadic circulation and when a TVS detection occurred upstream of tornadoes (lead hit), even if beyond 60 nm. An algorithm miss is counted if a tornadic circulation is not accompanied during archive data playback by a TVS detection. A false alarm is counted when the MTA identified a TVS on a nontornadic cell.

$$\text{POD} = \Sigma \text{ Hits} / \{\Sigma \text{ Hits} + \Sigma \text{ Misses}\} \qquad (3)$$

$$\text{FAR} = \Sigma \text{ False Alarms} / \{\Sigma \text{ Hits} + \Sigma \text{ False Alarms}\} \qquad (4)$$

$$\text{CSI} = \Sigma \text{ Hits} / \{\Sigma \text{ Hits} + \Sigma \text{ Misses} + \Sigma \text{ False Alarms}\} \qquad (5)$$

The Archive Level II data sets used in this study for TVS detections are determined by the tornadoes listed in Table 1. The highest multiple track tornadic event (15) producing the highest fatality count (25), appropriately referred to as the 1 March Tornadic Outbreak (1997), is the largest subset in Table 1. For this scenario, TVS statistics are computed from Tornado Tracks #1-5 and #10 within a 60 nm radial boundary from the RDA site in Fig. 1. TPV values are lowered (from TPV=10) to 4 in increments of 3. Following suit, the TTS default threshold is reduced to 45, 30 and 20 h^{-1} at each TPV setting. A larger range of TPV and TTS and a greater spread between successive values are used in this study than those used in a TVS optimization study by Margraf et al. (1997). Results for the 1 March Tornadic Outbreak are presented in section 4a. Tornado Tracks #6-9 and #11-15 are part of the data set used for MESO/3DC shear detections in section 4c. More information pertaining to this specific event can be accessed via the Internet from the NWSFO LIT home

Table 1. ARKANSAS TORNADO TABLE FOR TVS STATISTICS

DATE	ARKANSAS COUNTY (CITY), DISTANCE IN MILES (TRACK # FOR 1 MARCH TORNADIC OUTBREAK IN FIG. 1).	TIME (UTC)	HIGHEST F-SCALE MAGNITUDE	LARGEST PATH WIDTH (YARDS)	PATH LENGTH (MILES	DEFAULT MTA HITS / MISSES / FALSE ALARMS
10/27/95	SALINE (SARDIS)	0622-0624	F2	50	0.5	0 / 1 / 0
11/11/95	PRAIRIE TO WOODRUFF (4 NNW DES ARC TO 3 SW McCLELLAND)	0502-0512	F2	100	8.5	0 / 2 / 2
03/06/96	GARLAND (PERCY TO PLEASANT HILL)	0150-0202	F1	50	8	1 / 2 / 0
05/27/96	DALLAS (1.3 SSW DALARK TO 2 SE TULIP)	2015-2040	F3	440	15	0 / 5 / 0
05/27/96	SALINE (1 E BENTON) SALINE (BRYANT)	2035-2036 2041-2042	F0 F0	20 20	0.1 0.1	0 / 1 / 0 0 / 1 / 1
03/01/97	LONOKE TO WHITE (5.5 NW CABOT TO 8 SW SEARCY) [# 4]	2037-2055	F3	100	18	1 / 3 / 0
03/01/97	CLARK TO HOT SPRING (3.5 NE ARKADELPHIA TO 6.5 E MALVERN) [# 1]	2050-2110	F4	600	24	0 / 4 / 0
03/01/97	WHITE (10 NE SEARCY TO NEAR VELVET RIDGE) [# 5]	2115-2130	F2	150	13	0 / 3 / 0
03/01/97	SALINE TO PULASKI (5 SE BENTON TO 1 S PROTHO JUNCTION) [#2]	2125-2150	F4	1408	17	2 / 6 / 0
03/01/97	POPE TO VAN BUREN (1 S OAK GROVE TO THE OZARK NATIONAL FOREST) [#10]	2130-2150	F2	880	15	0 / 4 / 0
03/01/97	LONOKE (NEAR FURLOW) [#3]	2202-2204	F2	100	2.3	0 / 1 / 0

page (http://www.srh.noaa.gov/ftproot/LZK/HTML). For all tornadic data sets listed in Table 1, the optimal MTA performance is determined objectively by the highest CSI value obtained from default and non-default values of TPV and TTS in section 4b, using the reduction scheme mentioned above.

An account is also kept for MESO/3DC shear hits beyond 60 nm from the RDA site to see if MTA TPV adaptable parameter change increases MESO/3DC POD. Scoring of MESO/3DC shear POD uses the same time window for TVS detections, including lead time hits generally up to 30 minutes before tornadoes (even if $\leq$ 60 nm), listed in Table 2.

4. Results

a. TVS statistics for 1 March Tornadic Outbreak

Algorithm performance statistics (POD, FAR and CSI) for the 1 March Tornadic Outbreak are presented in Fig. 2. As TTS is lowered at a fixed TPV, POD increased. However, so did FAR in most cases. The best MTA performance for this particular event is objectively determined at the CSI maximum (50%) at TPV=4 and TTS=30 h^{-1}. These settings produce significantly different performance statistics (especially for FAR) than in a WSR-88D TVS optimal mode study reported by Mitchell (1997). In Mitchell (1997), TVS optimization differences from this study include a less stringent threshold for TTS (18 h^{-1}), reduced shear thresholding for MESOs, and used a larger sample size in producing POD, FAR, and CSI values of 42%, 76%, and 18%, respectively. Differences between time window scoring methods may also account for some of the deviation. In addition, many of the hits for the 1 March Tornadic Outbreak in Table 1 were associated with Tornado Tracks #2 and #4 (see Fig. 1), well within 40 nm of the RDA site where the radar's beam width is more likely to resolve and adequately sample vortices capable of producing tornado-like shear.

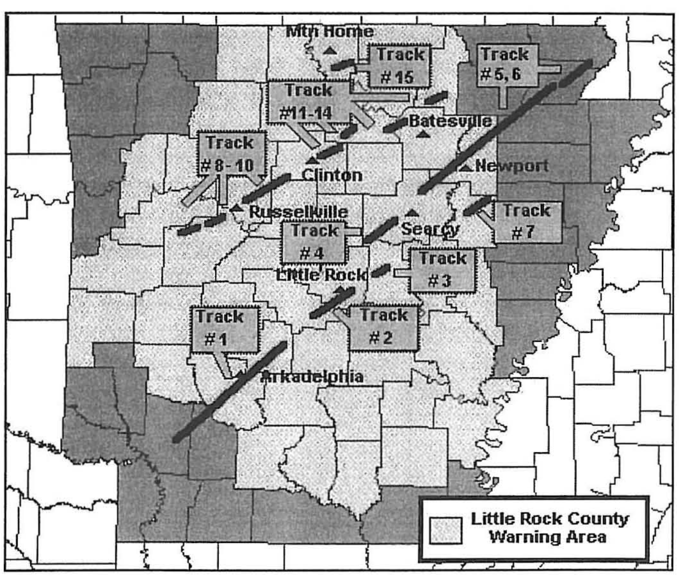

Fig. 1. 1 March Tornadic Outbreak in tracks (1997).

b. TVS statistics for all cases combined

Performance statistics, for all cases combined in Table 1, are shown in Fig. 3. POD statistics reveal comparable skill levels to those in the 1 March Tornadic Outbreak in Fig. 2. In sharp contrast, the performance of the MTA is compromised by significant increases in the FAR, narrowing the FAR gap between the 1 March Tornadic Outbreak and the findings reported in Mitchell (1997). Values of CSI in Fig. 3 indicate that a maximum around 37% occurs at TPV=7 and TTS= 45 h^{-1}. Therefore, the optimal MTA adaptable parameter combination for all tornadic cases combined is TPV=7 and TTS= 45 h^{-1}. This result is in close agreement to "local" TPV and TTS settings for more skillful TVS detections suggested in Lee (1997).

A potential benefit in more TVS hits, specifically lead hits, is an increase in average lead time, shown in Fig. 4 as a function of TPV and TTS. Compared to MTA default settings, TPV=4 and TTS=20 h^{-1} provide the best average lead time (slightly greater than 12 minutes). However, this adaptable parameter combination had the highest FAR in Fig. 3. CSI values suggest that the combination of TPV=7 and TTS=45 h^{-1} provided the best performance with an average lead time of 6 minutes (a 3 minute increase from default TPV and TTS).

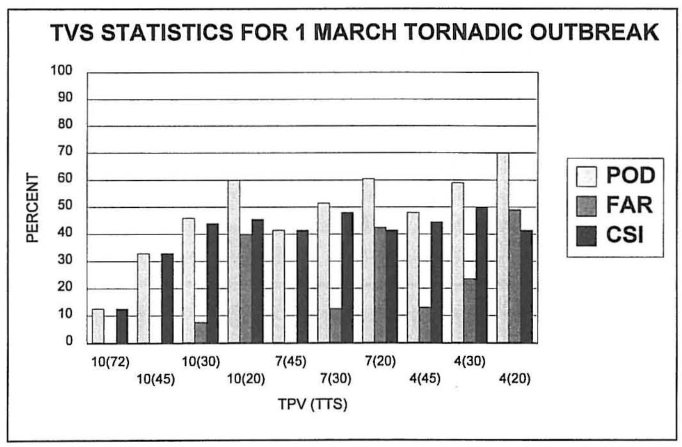

Fig. 2. TVS statistics (POD, FAR and CSI) for 1 March Tornadic Outbreak as a function of TPV (TTS) settings.

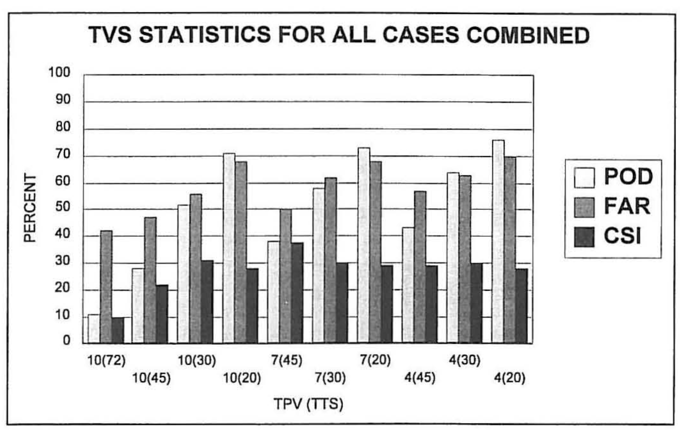

Fig. 3. TVS statistics (POD, FAR and CSI) for all cases combined as a function of TPV (TTS) settings.

Table 2. ARKANSAS TORNADO EVENTS FOR MESO/3DC SHEAR POD

DATE	ARKANSAS COUNTY (CITY), DISTANCE IN MILES (TRACK # FOR 1MARCH TORNADIC OUTBREAK IN FIG. 1).	TIME (UTC)	HIGHEST F-SCALE MAGNITUDE	LARGEST PATH WIDTH (YARDS)	PATH LENGTH (MILES	DEFAULT MTA TVP HITS / MISSES
03/06/96	IZARD TO SHARP (7 SW) MELBOURNE TO 2.8 ENE CALAMINE	0145 - 0245	F3	150	35.5	10 / 3
04/15/96	STONE TO IZARD (4 NW FOX TO 2 NE HORSESHOE BEND)	0010 - 0122	F4	880	44	10 / 5
05/27/96	CLARK TO DALLAS (2.5 SSW OKOLONA TO 2 SE TULIP)	1925 - 2040	F3	440	41	10 / 2
03/01/97	HEMPSTEAD TO CLARK (NEAR HOPE TO 3.5 NE ARKADELPHIA) [#1]	1950 - 2050	F4	1056	38	6 / 6
03/01/97	BAXTER (3 N NORFOLK TO 3 N JORDAN [#15]	2010 - 2020	F1	200	0.5	0 / 2
03/01/97	YELL (NEAR BELLEVILLE) [#8]	2050 - 2100	F1	50	1	1 / 1
03/01/97	YELL (NEAR CHICKALAH) [#9]	2105 - 2115	F1	50	1	2 / 2
03/01/97	WHITE TO GREENE (NEAR VELVET RIDGE TO NEAR PARAGOULD) [#5]	2130 - 2310	F2	150	65	15 / 12
03/01/97	VAN BUREN (4 SW SHIRLEY TO THE OZARK NATURAL FOREST) [#11]	2212 - 2214	F0	20	2.5	2 / 1
03/01/97	STONE (0.5 E RUSHING) [#12]	2222 - 2223	F0	20	0.5	0 / 1
03/01/97	STONE TO INDEPENDENCE (NEAR MARCELLO TO NEAR BETHESDA) [#13]	2250 - 2255	F1	25	5	8 / 1
03/01/97	WOODRUFF TO POINSETT (1.5 W PATTERSON TO 5 NE HICKORY RIDGE) [#7]	2255 - 2330	F2	880	20	12 / 1
03/01/97	SHARP (NEAR CAVE CITY) [#14]	2315 - 2316	F1	40	1	1 / 1

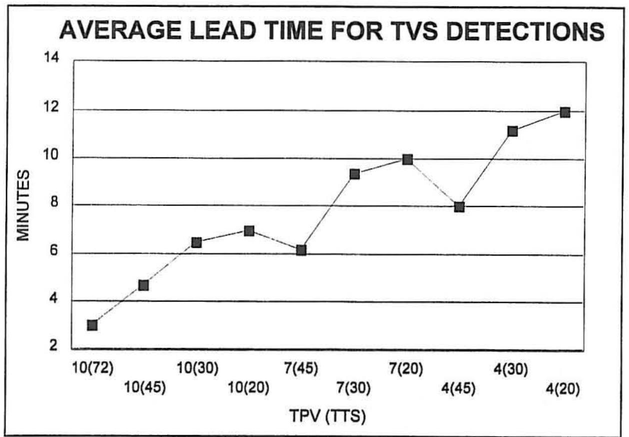

Fig. 4. Average lead time (minutes) for TVS detections as a function of TPV (TTS) settings.

c. MESO / 3DC shear POD

MDA-generated MESO and 3DC shear hits and misses are used to measure tornadic skill performance beyond 60 nm from tornadic data in Table 2. Here, lead hits are not constrained by range if reasonably positioned upstream of tornadoes under study. Values of POD as a function of TPV are shown in Fig. 5, revealing that TPV=7 offers the largest TPV increase (ΔTPV=3; from TPV=10), matching the optimal TPV setting for TVS detections. The net increases in TPV=7 (TPV=4) POD from the default TPV threshold were found to be 12.9% (15.8%).

5. Operational impacts

As a result of lowering the MTA adaptable parameter thresholds for the KLZK WSR-88D, more TVSs will be identified in an operational mode. That is, smaller and weaker circulations from mini-supercells, bow echoes, bookend vortices, lateral shear zones, etc., will be subject to TVS identification, whether tornadic or not. This limitation stems from the fact that the current algorithm cannot distinguish between highly sheared rotational signatures and tornadoes. The MTA optimization will amplify the skill level for TVS identified tornadic circulations yet increase the realization of false alarms. Thus, where MTA-generated products identify areas of concern, an increased emphasis is placed upon the radar/warning meteorologist to analyze for traditional storm structures and evolutions using WSR-88D reflectivity products, storm-relative velocity products, alphanumeric mesocyclone products at the Principal User Processor Applications Terminal (displays mesocyclone features and classifications such as depth, diameter, and shear), etc., as follow up steps in the decision to warn process for tornadoes. A non-conventional WSR-88D derived product, combined shear, may provide some insight into echo pattern configurations and shear strength in weakly sheared events (Wilken 1997).

Furthermore, the optimal MTA setting in this study implies a twofold increase in average lead time for a TVS to tornado (from 3 to 6 minutes). As a result, the difference may provide a "real" lead time for tornado warning notification to the public factoring in dissemination time lag effects. Beyond 60 nm, it is of additive benefit that the optimized MTA TPV adaptable parameter will identify more vertically correlated features in tornadic circulations.

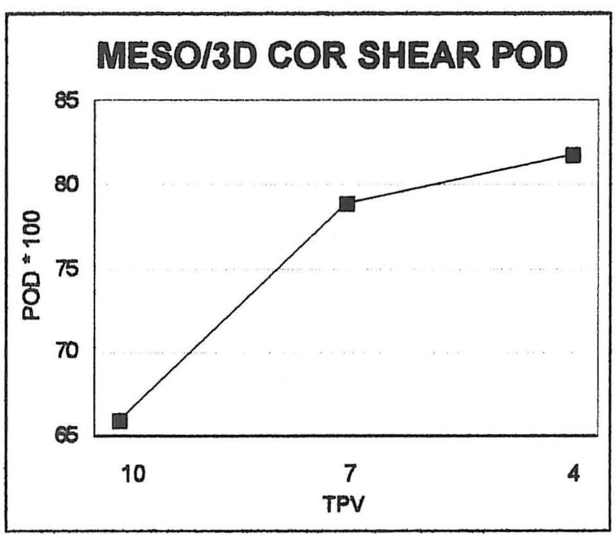

Fig. 5. MTA MESA/3DC shear POD as a function of TPV settings. Hits and misses were associated with tornadoes greater than 60 nm from the RDA site. Lead hits may be, and occasionally were, closer in.

6. The NSSL TDA in Build 10

a. Algorithm description

The NSSL TDA is designed to examine velocity differences between adjacent velocity gates at a constant range at each elevation angle. If a minimum velocity difference threshold is surpassed for three or more consecutive gate-to-gate pairs, a 2D circulation is constructed. A process of multiple thresholding is then applied to the isolated core vortices, discarding elongated azimuthal shear zones (i.e., frontal boundaries) from further processing. If core vortices are vertically linked with sufficient depth and strength, the feature will be identified as a TVS or Elevated TVS (ETVS). A TVS requires the base of the circulation to extend down to the lowest elevation angle (0.5°) or a prescribed low-level altitude above radar level (ARL). For more information regarding the NSSL TDA, see Mitchell et al. (1998).

b. Performance level differences between the NSSL TDA and optimized TVS

A preliminary evaluation of the NSSL TDA-derived TVS, part of the WSR-88D Build 10 RPG software implementation at field sites in the fall of 1998, using Archive Level II data for all tornadic cases combined in Table 1 was replayed in WATADS 9 at default settings. Comparing its performance to the optimized TVS algorithm, increases are observed in POD and CSI (41% and almost 37%, respectively) with a significant reduction in FAR (around 14%), consistent with findings reported in Mitchell (1997).

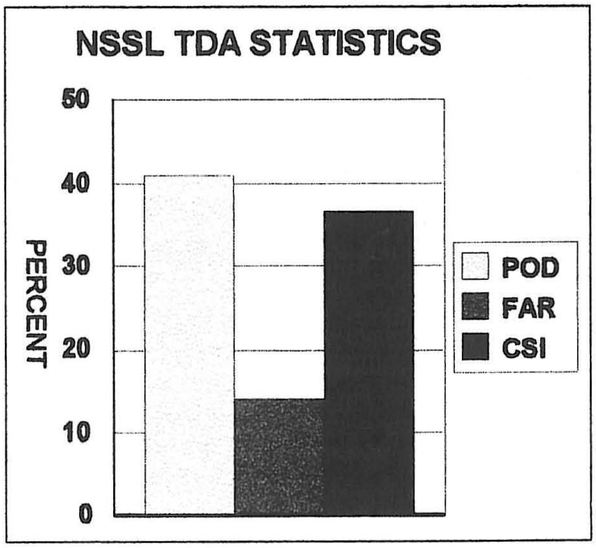

Fig. 6. NSSL TDA-derived TVS statistics (POD, FAR and CSI) for all cases combined.

7. Summary and Conclusions

In this MTA performance evaluation for tornadic data sets from the KLZK WSR-88D Archive Level II database using WATADS 9, POD, FAR and CSI statistics for TVS detections are generated as a function of various TPV and TTS combinations. The paradigm that the default MTA settings for TVSs produce a good basis for tornado warnings is not substantiated in the composited analysis (POD ~ 11% and FAR ~ 42%, Fig. 3), further motivating the need for a MTA adjustment. This is likely the result of selecting short-lived and lower end F-scale magnitude tornadoes as part of the data compositing mix. Indeed, on a case by case basis, a measure of statistical variability will occur, as demonstrated with the 1 March Tornadic Outbreak (Fig. 2).

Radar beam curvature and beam width spreading are considered to limit TVS detections out to 60 nm from the KLZK WSR-88D RDA site. TVS hits for all tornado cases combined, as well as false alarms, increased when TPV and TTS defaulted values were lowered. Thus, to objectively determine an optimal combination of MTA adaptable parameters, CSI was used. KLZK's WSR-88D MTA adaptable parameters for TVS detections were optimized at TPV=7 and TTS=45 h^{-1} where the CSI maximum occurred. Tornado detection lead time increased from 3 to 6 minutes when adaptable parameters under study were optimized.

Beyond the 60 nm limit and up to the radar's maximum unambiguous range, tornado detections were compared to MESO/3DC shear hits and misses. At the optimized TPV setting for TVS detections (TPV=7), a 12.9% increase in POD occurred from TPV=10 (default).

The optimized MTA adaptable parameters will provide added utility for the radar/warning meteorologist in the operational setting by: (1) producing more information on tornadic storms across the F-scale spectrum; and (2) contributing more skillful TVS detections that will also occur when WSR-88D Build 10 RPG is installed in the fall of 1998. However, since the MTA (or TDA in Build 10) does not factor in synoptic and mesoscale conditions, radar reflectivity signatures, convective-scale interactions (such as boundary enhancement and collisions) that may affect storms with tornadic potential, it is paramount for the radar/warning meteorologist anticipating or working a tornadic event to be knowledgeable of the environment and keep alert to changing conditions.

Acknowledgments

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Author

David Matson received the B.S. and M.S. degrees in Meteorology from Texas A&M University in 1991 and 1993, respectively. He became a Meteorological Intern with the National Weather Service late in 1993 and is currently positioned at the Little Rock forecast office. His meteorological interests vary from large-scale phenomenon such as Blocking, El Niño, and PNA to thunderstorm-scale convective storms that produce flash flooding, large hail, and tornadoes. An article for a future *Monthly Weather Review* publication is currently being pursued by David that emphasizes the role of synoptic-scale forcing during a central continental U.S. block during the latter half of May 1995.

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MEETING NEWS

• **Pacific Northwest Weather Workshop will be held at the NOAA Western Regional Center campus at Sand Point in Seattle, Washington on 26-27 February 1999.** This annual conference, sponsored by the National Weather Service, the University of Washington, and the Puget Sound Chapter of the American Meteorological Society, reviews recent developments in weather forecasting and observational technologies affecting the West Coast, major weather events of the past year, and other topics dealing with the meteorology of the region. A major theme of this year's meeting will be the hydrometeorology of western North America including high resolution atmospheric/hydrological modeling, river and streamflow prediction, and studies of major flooding and heavy precipitation events.

Abstracts for presentations (including title, authors, and a short description of the presentation) should be sent to the organizers by 1 December 1998. For further information on registration or presentations, contact Clifford Mass, Dept. of Atmospheric Sciences, Box 351640, University of Washington, Seattle, WA 98195 (206-685-0190, cliff@atmos.washington.edu) or Brad Colman/Chris Hill, NWS Forecast Office, 7600 Sand Point Way NE, Seattle, WA 98115 (206-526-6095 x224 or x222, colman@seawfo.noaa.gov or chris.hill@noaa.gov).

• **Third Annual Central Iowa NWA Chapter Severe Storms and Doppler Radar Conference will be held 26-28 March 1999 at the University Park Holiday Inn, West Des Moines, Iowa.** It will begin on Friday, 26 March at 1:30 PM and conclude on Sunday, 28 March at noon. Last year's event attracted 318 meteorologists, weathercasters, storm chasers and emergency management officials from the U.S. and Canada. Presentations related to all aspects of severe weather and operational use of Doppler radar are encouraged. Special emphasis is being placed on the use of Build 10 WSR-88D algorithms and implications for NWS and media forecasters. The program committee is also seeking success stories on the implementation of EMWIN and other cooperative ventures involving the public and private sector. The annual Friday night storm chase video session will also return for 1999. Bring video and photos of your latest chase!

Anyone wishing to make a presentation, please e-mail an abstract or one paragraph description of your proposed talk to: johnmc49@ecity.net or by postal mail to: John McLaughlin, KCCI-TV, 888 Ninth Street, Des Moines, IA 50309.

Registration details will be posted on the Internet at http://www.ecity.net/~iowanwa/ You can also link to this website from the NWA home page at http://www.nwas.org