P20.4 USER FEEDBACK ON THE EVOLUTION OF WSR-88D ALGORITHMS AND PRODUCTS

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1. INTRODUCTION

In March 1998, NEXRAD OSF personnel polled Weather Surveillance Radar - 1988, Doppler (WSR-88D) users to assess Software Build 9.0, in use since winter 1996. Survey results were used to evaluate perceptions of algorithm performance to gather anecdotal information about perceived problems, to determine algorithm frequency of use, to appraise field use of certain adaptable parameters, and to evaluate the effectiveness of new algorithms and products.

A special effort was made to simplify the polling process. Forecasters returned survey responses by regular-mail, fax, e-mail, and an automated web page form. Lee (1994) and Steadham and Lee (1995) document previous WSR-88D surveys.

2. SURVEY DESIGN

The 1998 OSF algorithm survey asked forecasters to strongly agree, agree, disagree, or strongly disagree with the following statements:

1) "The algorithm or product is used often."
2) "The algorithm or product usually provides accurate and reliable information."
3) "The algorithm or product is important when needed."
4) "Some algorithms and products have not changed between Build 8 and Build 9. Through experience, forecasters have become comfortable using a radar algorithm or product."

This survey format allowed respondents to quickly evaluate 21 WSR-88D products listed in Table 1. The survey also included additional questions not addressed in this preliminary report.

Survey forms were mailed to the following NEXRAD users: 1) Department of Defense (DOD); 2) Federal Aviation Administration (FAA) Center Weather Service Units (CWSU); 3) National Weather Service (NWS) River Forecast Centers (RFC); and 4) NWS forecast offices. Results presented here are based on responses from 19 DOD sites, 4 FAA sites, 2 NWSRFC sites, and 45 NWS sites, often with multiple responses from a given site. At the time of this writing, 122 surveys were processed. The conference poster associated with this paper will update survey findings.

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3. THE GOOD (GETTING THE JOB DONE)

A majority of the respondents agreed or strongly agreed with the four survey statements and the average score was near the mean of 2.5 (Total System Average - last row in Table 1). Ten of the twenty-one products listed in Table 1 were judged reliable and accurate by 75% or more of the respondents. The following algorithms were judged accurate and reliable by more than 90% of the returned surveys: Velocity Azimuth Display (VAD) Wind Profile (VWP), Vertically Integrated Liquid (VIL), Storm Cell Identification and Tracking (SCIT), and Cell Trends (CT).

More than 75% of all respondents often used Hail Detection Algorithm (HDA), One Hour Precipitation (OHP), Storm Total Precipitation (STP), Mesocyclone (M), SCIT, and CT. More than ninety percent of the forecasters responding to the survey used VWP and VIL often.

Layer Composite Reflectivity Maximum (LRM) was judged important and accurate by more than 75% of the forecasters, but 39% disagreed LRM was used often. It is possible the opportunity to use LRM does not occur very often or this product is under used by some offices. Past surveys revealed forecasters use LRM to judge the severity of pulsing thunderstorms and to observe first echoes.

Cell Trends, a new product in Build 9, was deemed to be important (87%), accurate (92%), and used often by 84% of the respondents. Howard *et al.* (1997) discuss limitations associated with WSR-88D's accuracy and capability to depict certain aspects of storm height (life cycle) evolution. Results showed that radar-determined trends are often substantially different from those of a vertical reflectivity structure model for the life cycle of a simple, "single-pulse" thunderstorm.

4. THE BAD (MORE WORK NEEDED)

More than 25% of all respondents considered the following algorithms and products inaccurate and unreliable: Severe Weather Probability (SWP), Combined Shear (CS), Hail Detection Algorithm (HDA), and Tornadic Vortex Signature (TVS). The following paragraphs address each algorithm.

Severe Weather Probability and CS are not used often by 83% and 89% of the forecasters, respectively. The survey questionnaire did not reveal the reasons these algorithms go unused. Forecasters wishing to become more informed about SWP are referred to Alaka *et al.* (1979), Elvander (1977), and Kitzmiller *et al.* (1992). The NWS science and operations officer at Little Rock, AR has found some utility in using CS to help detect tornadic circulations (Wilken 1998). Harris *et al.* 1985 document original research on CS.

Eighty-one percent of the survey respondents judged the new build 9 hail detection algorithm (HDA) to be important when needed; however, HDA was also judged inaccurate by 32% of the forecasters. Ninety-six percent of the responding forecasters commented, in a survey question not addressed in Table 1, the new algorithm over-predicts probability of severe hail and over estimates hail size. Personnel at a few NWS sites conducted detailed case studies, but most forecasters based their comments on general impressions and informal correlations between algorithm output and ground truth reports. Scientists at NSSL developed an adaptable parameter modification to improves HDA performance at high elevation sites and in low shear situations. In April 1998, the OSF issued instructions to field offices to implement the change.

Twenty-five percent of the survey respondents felt the WSR-88D TVS algorithm is not accurate and 34 % of the forecasters do not use it often. OSF personnel conducted adaptable parameter studies in 1994 and 1995 and discovered that TVS algorithm performance increased when mesocyclone and TVS adaptable parameters were optimized. In 1996, the OSF issued a memorandum to field personnel to lower two parameters to optimize TVS performance (Lee 1997). Most sites have followed the OSF recommendation; however, survey respondents still using default adaptable parameter values were contacted and advised to modify mesocyclone and TVS adaptable parameters to improve TVS performance. A new tornado detection algorithm is scheduled to be deployed as part of WSR-88D build 10 in the fall of 1998 (Mitchell 1997, Mitchell *et al.* 1998).

More than 80% of all survey respondents indicated they do not often use CS, Layer Composite Reflectivity Average (LRA), SWP, Spectrum Width (SW), and Echo Tops Contour (ETC). The new build 9 User Selectable Precipitaiton (USP) product is not used by 63% of forecasters. This is somewhat surprising, considering USP was added in response to requests from field personnel.

5. **THE UGLY (INTERPRETING RESULTS)**

Of the 122 responses received, 2 individuals commented the survey format was hard to understand. A relatively high percentage of forecasters failed to comment about the accuracy of the following algorithms: SWP (25%), LRA (29%), CS (32%), and Severe Weather Analysis (SWA) (29%).

Some survey respondents seemed confused with the second statement, “The algorithm or product is important when needed.” Some forecasters assumed if an algorithm was needed, then it was automatically important and they strongly agreed with the statement for all algorithms and products. On the other hand, more than 40% of the survey respondents judged the following to be not important, even when needed: ETC, SW, SWP, LRA, CS, and SWA. More than 40% of the respondents were uncomfortable with these same algorithms and did not use them often.

Table 1 clearly shows some of the algorithms and products used the least (LRA, SWP, CS, ETC) were rated, subjectively, less accurate and less important. Forecasters did not add additional comments to explain their reasoning and the current survey did not investigate this aspect of algorithm use.

6.0 **SUMMARY**

Forecasters are comfortable with most WSR-88D algorithms and products, find them accurate and reliable, and use them often. Algorithms and products new to build 9, (SCIT, HDA, CT) are used often by a majority of forecasters. USP, also a new product, is not used often by most of the survey respondents.

Forecasters used SWA, VAD, CS, LRA, SWP, SW, and ETC less often. Of these underused algorithms and products, SW probably holds the greatest untapped potential for forecasters. In recent years, this poorly understood third Doppler moment has been used to find turbulent regions associated with deep convergence zones (Lemon and Parker 1996); thunderstorm inflow, updraft, and downdraft; three body scattering due to large hail; tornadoes associated with tropical storms; depth of orographic turbulence, the eye wall of deepening or filling hurricanes; gust fronts; quality of velocity data; and, radar signal to noise ratio (Lemon, personal communication).

Results from the 1998 survey are very similar to past surveys, Survey results will allow OSF personnel to monitor algorithms use, to identify opportunities to optimize algorithm adaptable parameters, and to improve field support.

7.0 **ACKNOWLEDGMENT**

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8.0 **REFERENCES**

Alaka, M.A., R.C. Elvander, and R.E. Saffle, 1979: Nowcasts and short-range (0-2 hour) forecasts of thunderstorms and sever convective eather for use in air traffic control. Dept. of Trans. Report No. FAA-RD-79-98, 31 pp.

Elvander, R.C., 1977: Relationships between radar parameters observed with objectively defined echoes and reported severe weather occurrences. Preprints, *10th Conference on*

Severe Local Storms, Omaha, Amer. Meteor. Soc., 73-76.

Harris, F.I., K.M. Glover, and G.R. Smythe, 1985: Gust front detection and prediction. Preprints, *14th Conference on Severe Local Storms*, Boston, Amer. Meteor. Soc., 342-345.

Howard, K.H., J.J. Gourley, R.A. Maddox, 1997: Uncertainties in WSR-88D measurements and their impacts on monitoring life cycles. *Wea. Forecasting*, **12**, 166-174.

Kitzmiller, D.E., W.E. McGovern, R.E. Saffle, 1992: The NEXRAD severe weather potential algorithm. Techniques Development Laboratory, NOAA Technical Memorandum TM TDA-9202 APP, 76 pp.

Mitchell, E.D. 1997: A performance evaluation and comparison of the NSSL tornado detection algorithm and the WSR-88D tornadic vortex signature algorithm. Preprints, *28th Intl. Conf. on Radar Meteorology*, Austin, Amer. Metor. Soc., 351-352.

————, M.A. Fresch, R.R. Lee, T.M. Smith, W.D. Zittel, 1998: The new NSSL tornado detection algorithm for the WSR-88D. Preprints, *14th Intl. Conf. on Interactive Information and Processing Systems for Meteorology, Oceanography, and Hydrology*, Phoenix, Amer. Metor. Soc., 271-274.

Lee, R.R., 1994: Survey results of WSR-88D field sites: meteorological algorithm performance. *First WSR-88D Users' Conference*, Norman, NEXRAD OSF, 1-8.

————, 1997: Regional adaptation of NEXRAD mesocyclone and TVS algorithms. Preprints, *28th Intl. Conf. on Radar Meteorology*, Austin, Amer. Metor. Soc., 347-348.

Lemon, L.R. and S. Parker, 1996: The Lahoma storm deep convection zone: its characteristics and role in storm dynamics and severity. Preprints, *18th Conf. Severe Local Storms*, San Franciso, Amer. Metor. Soc., 70-75.

Steadham, R. and R.R. Lee: 1995, Perceptions of the WSR-88D performance. Preprints, *27th Conf. on Radar Meteorology*, Vail, Amer. Meteor. Soc., 173-175.

Wilken, G.R., 1998: Using WSR-88D shear products during severe storm events, *Southern Region Topics*, National Weather Service, Southern Region.

TABLE 1. Table of responses to 4 survey statements. For each statement, the two numbers represent the percent of respondents that agreed and strongly agreed (excluding those with no opinion) and the average score from the respondents (scale from Strongly Disagree = 1.0 to Strongly Agree = 4.0). The products are ranked by the statement "used often". Forecasters were not asked to evaluate "Comfort of Use" for the new build 9 algorithms, CT and USP.

Product ID - Name	Used Often		Accurate & Reliable		Important when needed		Comfort of Use	
	%	(Avg)	%	(Avg)	%	(Avg)	%	(Avg)
VIL - Vertically Integrated Liquid	94	(3.6)	98	(3.3)	94	(3.5)	93	(3.3)
VWP - Velocity Wind Profile	93	(3.6)	94	(3.2)	91	(3.4)	92	(3.2)
SCIT - Storm Cell ID & Tracking	89	(3.3)	93	(3.1)	89	(3.2)	84	(2.9)
M - Mesocyclone	85	(3.3)	79	(2.8)	83	(3.3)	85	(3.0)
CT - Cell Trends	84	(3.2)	92	(3.2)	87	(3.2)	NA	(NA)
STP - Storm Total Precipitation	81	(3.2)	75	(2.8)	89	(3.2)	86	(3.0)
OHP - One Hour Precipitation	78	(3.2)	81	(2.8)	88	(3.2)	85	(3.0)
HDA - Hail Detection Algorithm	78	(3.1)	62	(2.6)	81	(3.1)	76	(2.7)
ET - Echo Tops	68	(2.9)	86	(3.0)	82	(3.0)	84	(3.0)
TVS - Tornadic Vortex Signature	66	(2.9)	63	(2.5)	78	(3.0)	70	(2.7)
LRM - Layer Composite Refl Max	61	(2.7)	84	(2.8)	76	(2.8)	72	(2.7)
THP - Three Hour Precipitation	57	(2.6)	76	(2.7)	84	(3.0)	77	(2.8)
SS - Storm Structure	50	(2.4)	71	(2.5)	66	(2.4)	54	(2.2)
USP - User Selectable Precip	35	(2.2)	70	(2.6)	69	(2.6)	NA	(NA)
SWA - Severe Weather Analysis	20	(1.8)	51	(2.0)	47	(2.0)	33	(1.8)
VAD - Velocity Azimuth Display	20	(1.8)	67	(2.5)	43	(2.1)	39	(2.0)
SW - Spectrum Width	16	(1.8)	65	(2.4)	51	(2.1)	39	(2.0)
SWP - Severe Weather Probability	16	(1.6)	37	(1.8)	32	(1.8)	29	(1.7)
LRA - Layer Composite Refl Avg	15	(1.6)	53	(1.9)	34	(1.8)	33	(1.8)
CS - Combined Shear	11	(1.5)	34	(1.6)	23	(1.6)	20	(1.6)
ETC - Echo Top Contour	8	(1.5)	62	(2.3)	27	(1.8)	36	(1.9)
Total System Average	53	(2.6)	71	(2.6)	67	(2.7)	59	(2.4)