NOAA TECHNICAL MEMORANDUM NWS NSSFC-21

VERIFICATION OF SEVERE LOCAL STORM FORECASTS ISSUED BY THE NATIONAL SEVERE STORMS FORECAST CENTER: 1987

Preston W. Leftwich, Jr.
National Severe Storms Forecast Center
Kansas City, Missouri 64106

December 1988

U.S. DEPARTMENT OF COMMERCE / National Oceanic and Atmospheric Administration / National Weather Service

National Weather Service
National Severe Storms Forecast Center

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VERIFICATION OF SEVERE LOCAL STORM FORECASTS ISSUED BY THE NATIONAL SEVERE STORMS FORECAST CENTER: 1987

by

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ABSTRACT. The SELS Unit of the National Severe Storms Forecast Center routinely issues convective outlooks and severe local storm watches to delineate areas that are favorable for development of severe local storms. This report summarizes verification of those forecasts that were issued during 1987.

The threat of severe local storms was identified well via the second-day outlooks. Prediction of the location of subsequent events improved in the first-day outlooks. Greater skill was shown in forecasting the more intense tornadoes. High percentages of tornado-related fatalities (89%) and injuries (92%) occurred within valid severe local storm watches.

1. INTRODUCTION

The Severe Local Storms (SELS) Unit at the National Severe Storms Forecast Center (NSSFC) has responsibility for issuing convective outlooks, severe thunderstorm watches and tornado watches for the contiguous United States. Convective outlooks, which depict expected areas and densities of severe local storms in a preliminary sense, are issued daily at 0700, 1500, and 1900 UTC. Forecast periods begin at 1200, 1500, and 1900 UTC, respectively, and continue until 1200 UTC the following day. An initial second-day outlook is issued at 0800 UTC and updated at 1800 UTC each day. Both outlooks are valid for the 24-hr period beginning at 1200 UTC the next day. Severe thunderstorm and tornado watches are issued, as needed, to delineate areas in which conditions have become favorable for severe local storms to occur within the next few hours.

Various forms of verification of products issued by the SELS Unit have long been an important aspect of operations. Such data not only aid the assessment of the quality of forecasts but also provide helpful feedback concerning the progression of events during specific severe weather episodes. Results of these verification efforts have been published by Galway (1967), Galway (1975) and Pearson and Weiss (1979).

In 1982 the National Weather Service (NWS) formulated a National Verification Plan (NWS, 1982) to provide guidelines for verification of the various products that are issued to the public. Verification at the NSSFC is now an integral part of this national program. Leftwich (1985, 1986, 1987) summarized verification of watches and outlooks issued by the NSSFC during 1984, 1985 and 1986, respectively. This report documents verification of convective outlooks and severe local storm watches issued by the NSSFC during 1987.

2. VERIFICATION PROCEDURES

The first step in verification of any forecast is collection of both the issued messages and reports of events that occurred during the forecast period. Collection of watch and outlook messages is accomplished in real-time as they are disseminated at the NSSFC. They are automatically encoded for processing via electronic computer. To qualify as a valid severe local storm event that is used in watch and convective outlook verification, reports must satisfy one of the criteria listed in Table 1. Extreme turbulence reports from aircraft are collected in near real-time via the Automation of Field Operations and Services (AFOS) system. Then, they are manually entered into the NSSFC severe local storm event database. Otherwise, the sole source of severe local storm reports used for official (final) verification is the monthly summary entitled "Storm Data and Unusual Weather Phenomena" (Form F-8) that is submitted for each state by the various National Weather Service Forecast Offices (WSFO's). These reports are manually entered into the NSSFC event database. Further restrictions are applied before any event data are included in the verification procedure. Multiple reports of the same event occurring within both 10 statute miles and 15 minutes of each other, and in the same county, are considered as one event. However, all tornado reports appearing in the F-8 report are included. Additional information regarding processing of severe local storm reports is given by Grenier and Halmstad (1986).

Table 1
Criteria for severe local storm events

a.	Tornado - a rotating circulation touching the ground and associated with a thunderstorm.
b.	Hail equal to or greater than 3/4 inch (1.9 cm) in diameter.
c.	Thunderstorm wind gust of at least 50 knots (93 km/h).
d.	Thunderstorm wind damage.
e.	Extreme turbulence (reported by aircraft) associated with thunderstorm.

Once data have been compiled, various verification statistics are computed. Primary statistics are Percent Verified (PV), Probability of Detection (POD), False Alarm Ratio (FAR) and Critical Success Index (CSI). The latter three statistics were adapted from those described by Donaldson et al. (1975). Adaptations were necessary because the statistics described by Donaldson et al. considered point forecasts, and both watches and outlooks are area forecasts. Modifications and the computational procedures that are currently followed are discussed in detail by Weiss et al. (1980).

3. CONVECTIVE OUTLOOKS

During 1987 a total of 549 convective outlooks specified a threat of severe local storms for the current, or first, day. Verification statistics stratified by the three issuance times are given in Section A of Table 2. The two later outlooks, which are based on additional diagnostic analysis and a later run of the National Meteorological Center (NMC) numerical guidance, generally contained a higher percentage of reports (higher POD). An increase in the CSI was observed for these later outlooks. Figure 1 shows the relationship of the overall verification statistics for 1987 to those of the previous eight years.

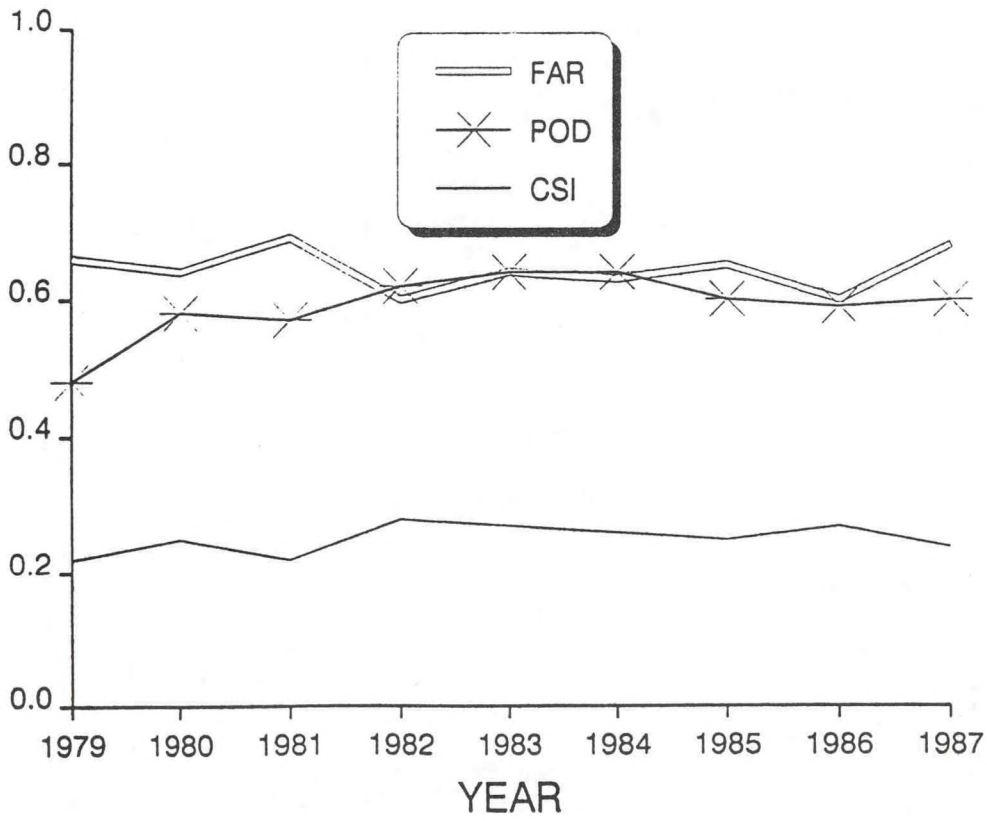

Figure 1. Convective outlook verification for the years 1979-1987.

In the second full year of issuance, 147 initial (issued at 0800 UTC) second-day convective outlooks specified a threat of severe local storms for the following day. A threat of severe local storms was initiated or retained in 158 updated outlooks issued at 1800 UTC. Verification of these outlooks is given in Section B of Table 2. In general, updates improved the initial outlooks in terms of POD and CSI. Comparison of second-day outlooks with the 0800 UTC first-day outlook, addressing the same forecast period, showed a noteworthy improvement in the POD for the first-day outlook. Values of FAR showed little change. These results continue to suggest that the threat of severe local storms can frequently be identified well in advance, and later guidance and diagnostic analysis improve the prediction of the area of occurrence.

Table 2
Verification scores for convective outlooks during 1987

A. First-Day

Issue Time (UTC)	Number Issued	POD	FAR	CSI
0700	183	.57	.69	.23
1500	182	.60	.66	.25
1900	184	.65	.67	.25
All	549	.60	.68	.24

B. Second-Day

Issue Time (UTC)	Number Issued	POD	FAR	CSI
0800	147	.39	.70	.17
1800	158	.45	.70	.19
All	305	.42	.70	.18

4. SEVERE LOCAL STORM WATCHES

A total of 574 severe local storm watches were issued by the NSSFC during 1987. Of these, 156 were tornado watches and 418 were severe thunderstorm watches. Standard verification statistics are routinely computed for severe local storm watches. Trends in some of these statistics are shown in Figure 2 for the years 1978-1987. Issuance of both types of watches denotes the threat of severe thunderstorms. Tornado watches emphasize an additional threat of tornadoes. As shown by Table 3, skill in distinguishing such a difference in threat was exhibited during the year. While at least one tornado occurred in 37% of the tornado watches, only 18% of the severe thunderstorm watches contained tornadoes. Tornado watches also reflected an increased threat of severe weather as only 18% of them did not contain any reported severe local storm events.

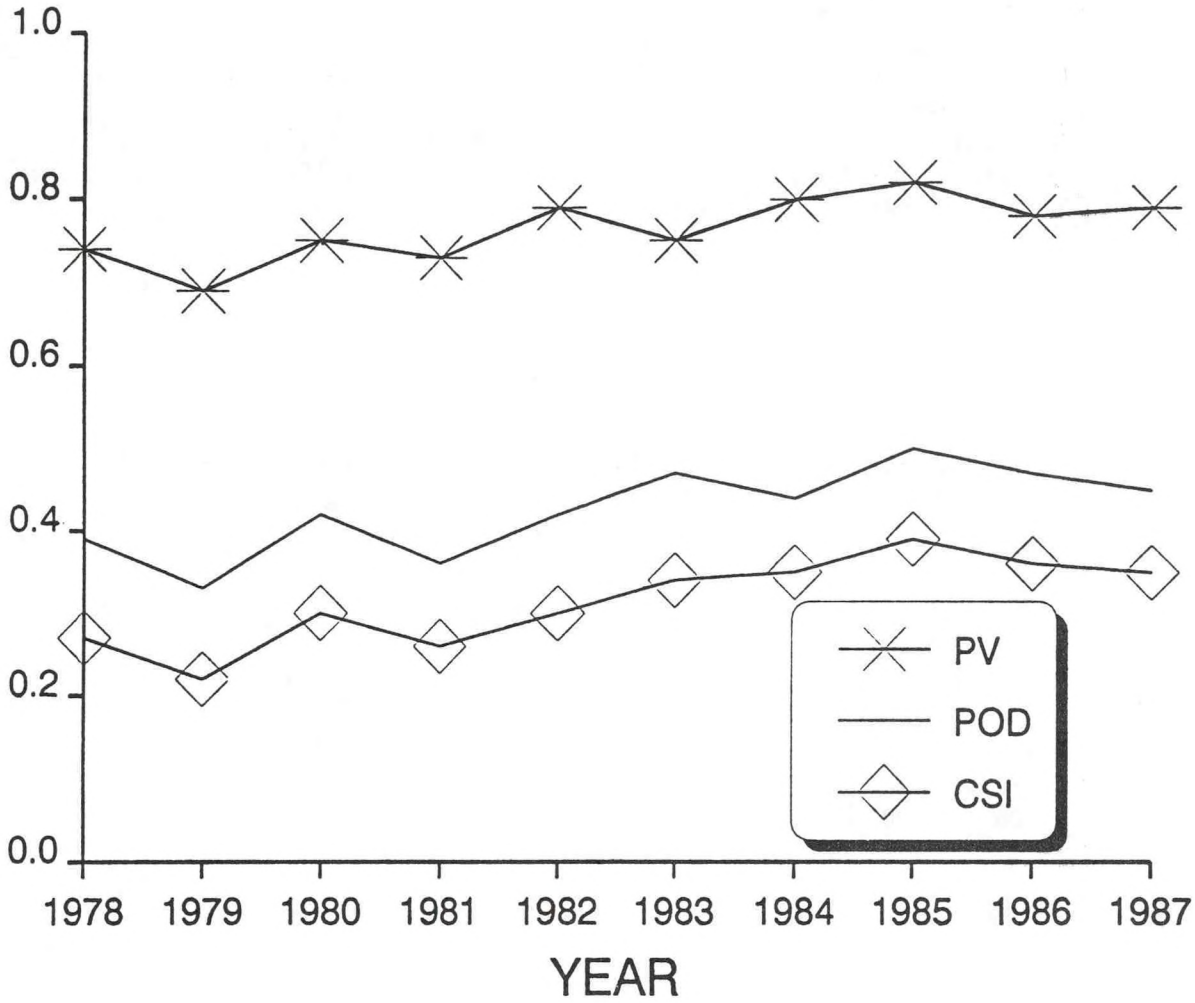

Figure 2. Verification for all severe local storm watches issued during the period 1978-1987.

Table 3
Frequency of severe local storm types in valid watches, 1987

Watch Type	Number Issued	Observed Tornado	Only Other Severe Types	No Severe
Tornado	156	37%	45%	18%
Severe Thunderstorm	418	18%	61%	21%

Intensities of tornadoes are indicated by F-scale (Fujita, 1981) values ranging from "0" (weakest) to "5" (most violent). Values of POD for various intensities of tornadoes during 1987 relative to valid severe local storm watches are given in Table 4. During this year, 45% of the weak (F0-F1) tornadoes occurred in valid watches, while all of the violent (F4-F5) tornadoes occurred in valid watches. For strong and violent tornadoes, which caused 97% of the tornado-related fatalities during 1987, the probability of detection was 0.69. The POD for all tornadoes was 0.47.

Table 4
Probability of detection (POD) for various intensities (F-scale) of tornadoes relative to valid severe local storm watches during 1987

	Weak (F0-F1)	Strong (F2-F3)	Violent (F4-F5)	Strong/Violent (F2-F5)	All (F0-F5)
Total	579	74	3	77	656
In WW	259	50	3	53	312
POD	0.45	0.68	1.00	0.69	0.47

Strong and violent (F2-F5) tornadoes consistently pose an increased threat to life and property. When a severe local storm watch precedes such events, an enhanced service has been provided to the public. Values of POD for all, weak (F0-F1) and strong/violent tornadoes for the period 1978-1987 are shown in Figure 3. The closeness of the POD for all tornadoes to the POD for weak tornadoes reflects the high percentage of weak tornadoes. POD values for strong/violent tornadoes are consistently higher than values for weak tornadoes and have remained near 0.7 for the last four years. Results for the past several years have been consistent with the earlier findings of Ostby and Higginbotham (1982) that SELS forecasters are more successful predicting strong/violent tornadoes than predicting weak tornadoes.

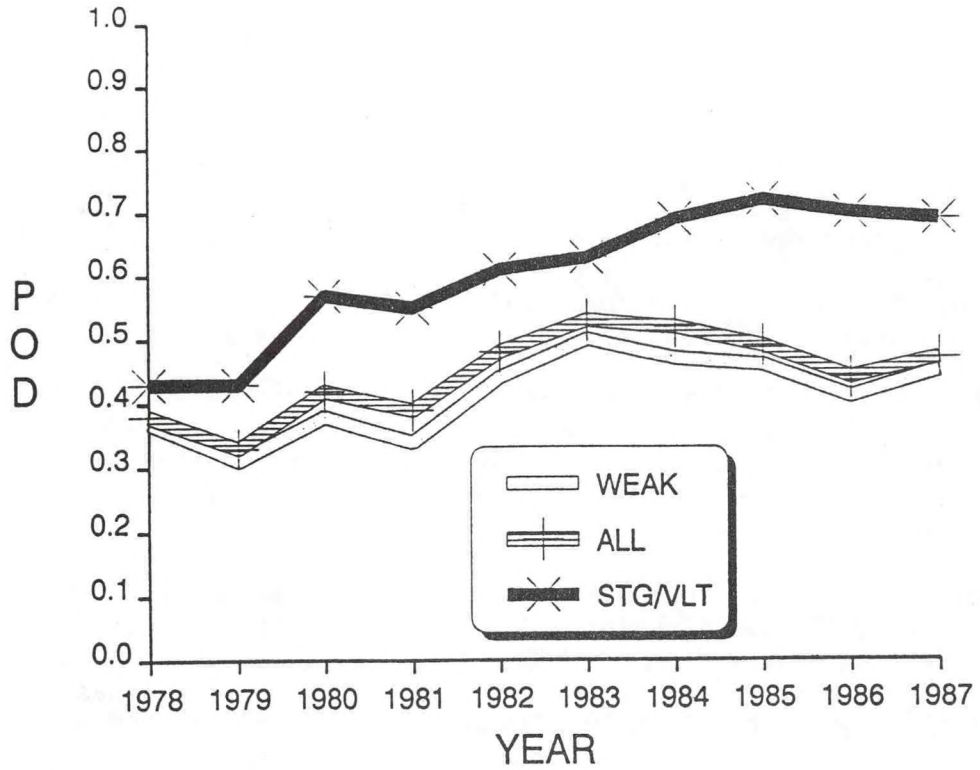

Figure 3. Annual values of Probability of Detection (POD) for weak, strong/violent, and all tornadoes, respectively, for the years 1978-1987.

During 1987 there were 14 tornadoes that caused at least one fatality. Of these 14 "killer" tornadoes, eight occurred within valid severe local storm watches. Further statistics concerning severe local storm events resulting in fatalities and injuries are given in Table 5. During 1987, tornadoes caused 59 fatalities in the United States. Severe thunderstorm winds caused 30 additional fatalities. In regard to tornado-related fatalities, 53 of 59 (89%) occurred within valid watches. Ten (33%) of the 30 fatalities resulting from thunderstorm wind gusts occurred within valid watches. Valid severe local storm watches contained 92% of tornado-related injuries and 57% of injuries attributable to other severe thunderstorms.

Table 5

Severe local storm-related fatalities and injuries in 1987

	Tornado		Severe Thunderstorm	
	Fatalities	Injuries	Fatalities	Injuries
Total	59	1018	30	398
Occurring within valid watches	53	938	10	225
% Within Watches	89	92	33	57

5. SUMMARY

Convective outlooks and severe local storm watches are issued by the SELS Unit of the NSSFC. These products identify areas in which development of severe thunderstorms and/or tornadoes is likely. Verification of these products is done routinely for purposes of feedback to the forecasters and quality control of issued products.

There was little difference in the FAR between second-day and first-day convective outlooks. However, the location of severe local storm occurrence (as reflected in the POD) was better-predicted by the first-day outlooks. Collectively, the POD increased with each successive outlook.

For severe local storm watches, ability was exhibited in distinguishing the added threat of tornadoes from that of hail or wind gusts. High percentages of tornado-related fatalities (89%) and injuries (92%) occurred within valid severe local storm watches. Also, greater ability was shown in forecasting the more intense tornadoes.

6. ACKNOWLEDGEMENTS

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