NOAA TECHNICAL MEMORANDUM NWS NSSFC-18

VERIFICATION OF SEVERE LOCAL STORM FORECASTS ISSUED BY THE NATIONAL SEVERE STORMS FORECAST CENTER: 1986

Preston W. Leftwich, Jr.
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September 1987

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

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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 1986.

For the first full calendar year, convective outlooks covering a second-day were issued. 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. Ability in delineating the threat of tornadoes by tornado watches was observed. High percentages of tornado-related fatalities (80%) and injuries (63%) occurred within valid severe local storm watches. Greater skill was shown in forecasting the more intense tornadoes.

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. A second-day outlook for the 24-h period beginning at 1200 UTC on the next day is issued at 0800 UTC and updated at 1800 UTC each 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) summarized verification of watches and outlooks issued by the NSSFC during 1984 and 1985, respectively. This report documents verification of convective outlooks and severe local storm watches issued by the NSSFC during 1986.

2. VERIFICATION PROCEDURES

The first step in verification of any forecast is collection of both the forecasts issued and reports of events that occurred during the forecast period. Collection of watch and outlook forecast messages is accomplished in real-time as they are disseminated at the NSSFC. They are automatically encoded for processing via electronic computer. Although reports of severe local storm occurrences are received from many sources, most are extracted from statements, warnings, observations, local storm reports, state weather summaries, etc., received via the Automation of Field Operations and Services (AFOS) system. Other reports are received from telephone conversations, letters, and newspaper reports. Finally, monthly summaries entitled "Storm Data and Unusual Weather Phenomena" (Form F-8) are consulted. To qualify as a valid severe local storm event that is used for convective outlook and watch verification, reports must satisfy one of the criteria listed in Table 1. Multiple reports (Table 1) occurring within 10 statute miles and 15 minutes of each other, and in the same county, are recorded as one event. However, all tornado reports are included. Preliminary data are reviewed at a later time, and a "smooth log" is compiled for use in official verification. Grenier and Halmstad (1986) provide details of these preliminary procedures.

Once data have been compiled, various verification statistics are computed. Primary statistics are the Probability of Detection (POD), False Alarm Ratio (FAR) and Critical Success Index (CSI) that 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).

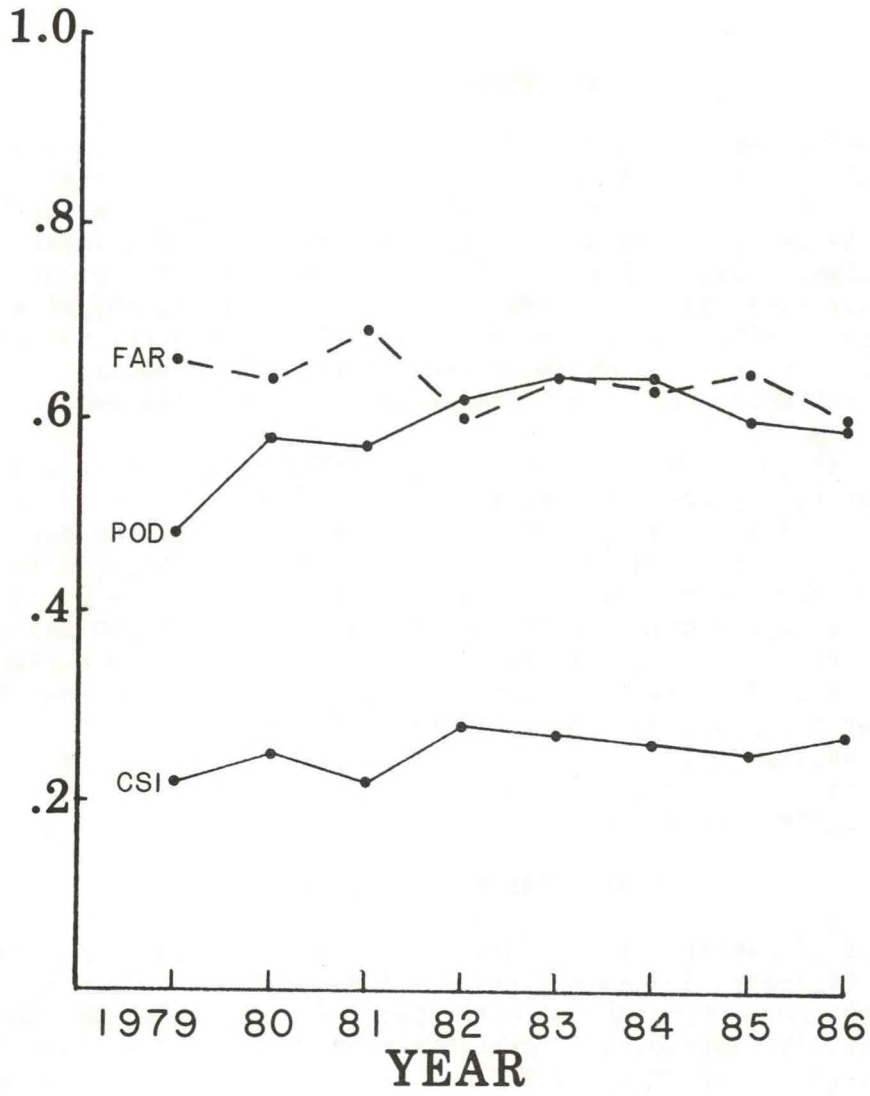

Figure 1. Convective outlook verification for the years 1979-1986.

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.

3. CONVECTIVE OUTLOOKS

During 1986 a total of 584 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 1986 to those of the past seven years.

In the first full year of issuance, 159 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 and/or retained in 155 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 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.

4. SEVERE LOCAL STORM WATCHES

A total of 560 severe local storm watches were issued by the NSSFC during 1986. Of these, 197 were tornado watches and 363 were severe thunderstorm watches. 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 43% of the tornado watches, only 16% of the severe thunderstorm watches contained tornadoes. Tornado watches also reflected an increased threat of severe weather as only 22% of them did not contain any reported severe local storm events.

Intensities of tornadoes are indicated by F-scale (Fujita, 1981) values ranging from "0" (weakest) to "5" (most violent). The POD for various intensities of tornadoes relative to valid severe local storm watches is given in Table 4. During 1986, 41% of the weak (F0-F1) tornadoes occurred in valid watches, while 67% of the violent (F4-F5) tornadoes occurred in valid watches. For strong and violent tornadoes, which caused all tornado-related fatalities during 1986, the probability of detection was 0.55. The POD for all tornadoes was 0.44. These results continue to be consistent with the findings of Ostby and Higginbotham (1982) that SELS forecasters are more successful in predicting strong and violent tornadoes than weak ones.

Table 2
Verification scores for convective outlooks during 1986

A. First-Day

Issue Time (UTC)	Number Issued	POD	FAR	CSI
0700	197	.55	.62	.25
1500	195	.59	.60	.27
1900	192	.64	.60	.29
All	584	.59	.60	.27

B. Second-Day

Issue Time (UTC)	Number Issued	POD	FAR	CSI
0800	159	.34	.63	.18
1800	155	.43	.63	.22
All	314	.38	.63	.20

Table 3
Frequency of severe local storm types in valid watches, 1986

Watch Type	Number Issued	Observed Tornado	Only Other Severe Types	No Severe
Tornado	197	43%	35%	22%
Severe Thunderstorm	363	16%	63%	21%

Table 4
Probability of detection (POD) for various intensities (F-scale) of tornadoes relative to valid severe local storm watches during 1986

Weak (F0-F1)	Strong (F2-F3)	Violent (F4-F5)	Strong/Violent (F2-F5)	All (F0-F5)
0.410	.547	0.670	0.550	0.437

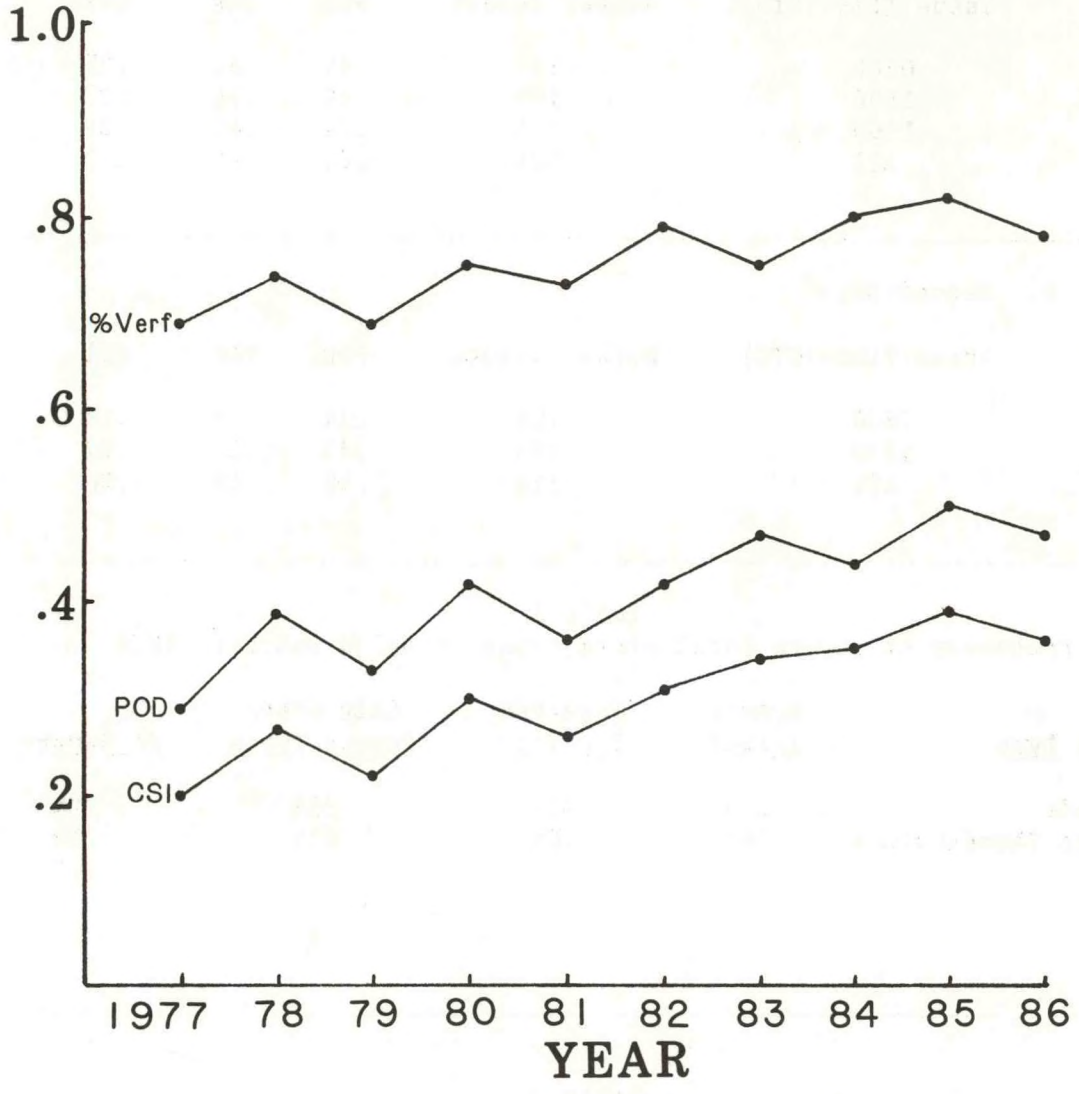

Figure 2. Verification for all severe local storm watches issued during the period 1977-1986.

Statistics concerning severe local storm events resulting in fatalities and injuries are given in Table 5. During 1986, tornadoes caused 15 fatalities in the United States. Severe thunderstorm winds caused 36 additional fatalities. In regard to tornado-related fatalities, 12 of 15 (80%) occurred within valid watches. Eighteen (50%) of the 36 fatalities resulting from thunderstorm wind gusts occurred within valid watches. Valid severe local storm watches contained 63% of tornado-related injuries and 52% of injuries attributable to other severe thunderstorms.

In order to verify a tornado watch, a tornado must occur within the forecast area and time period. Occurrence of any severe local storm event (Table 1) verifies a severe thunderstorm watch. Standard verification statistics based on these criteria are routinely computed by the NSSFC. Trends in some of these statistics for all severe local storm watches are shown in Figure 2. Statistics pertaining to tornado watches only are shown in Figure 3. For example, values of POD depicted in Figure 3 reflect the percentage of tornadoes that occurred within valid tornado watches during each year.

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 (80%) and injuries (63%) occurred within valid severe local storm watches. Also, greater ability was shown in forecasting the more intense tornadoes.

6. ACKNOWLEDGEMENTS

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Table 5
Severe local storm-related fatalities and injuries in 1986

	Tornado		Severe Thunderstorm	
	Fatalities	Injuries	Fatalities	Injuries
Total Number	15	536	36	379
Occurring within valid watches	12	335	18	198
% Within Watches	80	63	50	52

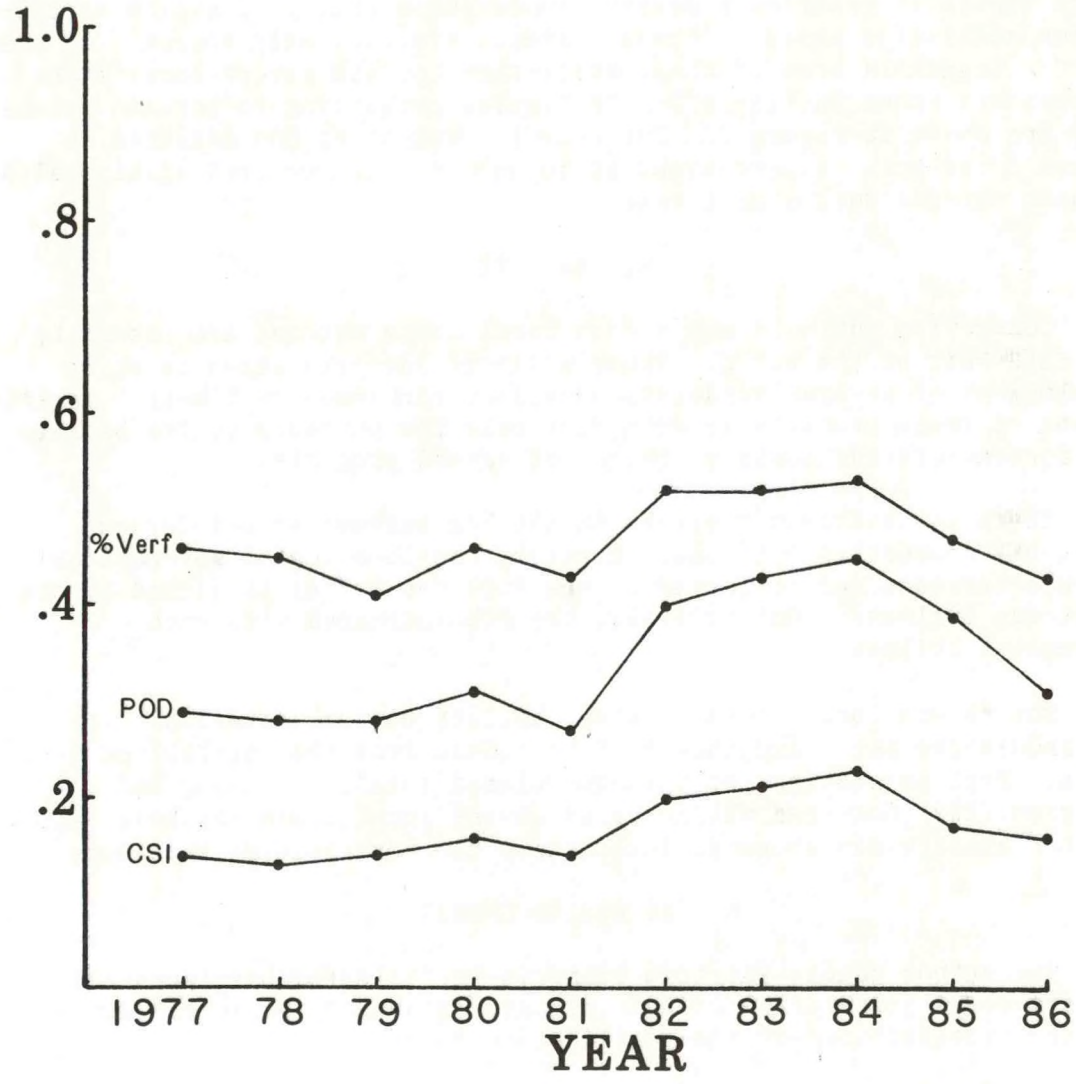

Figure 3. Tornado watch verification for the years 1977-1986.

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