NOAA TECHNICAL MEMORANDUM NWS NSSFC-9

VERIFICATION OF SEVERE LOCAL STORM FORECASTS ISSUED BY THE NATIONAL SEVERE STORMS FORECAST CENTER: 1984

Preston W. Leftwich, Jr.
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Kansas City, Missouri 64106

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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 that delineate areas that are favorable for development of severe local storms. This report summarizes verification of those forecasts that were issued during 1984.

Convective outlooks benefitted from later diagnostic analysis and additional numerical guidance. The highest degree of forecast skill was observed during the active months of spring. Skill in distinguishing the added threat of tornadoes in tornado watches was observed. High percentages of tornado-related fatalities (87%) and injuries (88%) were covered by 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 0800, 1500, and 1930 GMT. Forecast periods begin at 1200, 1500, and 2000 GMT, respectively, and last until 1200 GMT the following day. Severe thunderstorm and tornado watches are issued, as needed, to delineate areas in which conditions have become favorable for severe local storms to develop within the next several 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, relative to the forecasts, 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. This report documents verification of the convective outlooks and severe local storm watches issued by the NSSFC during 1984.

2. VERIFICATION PROCEDURES

The first step in verification of any forecast is collection of both the forecasts issued and reports of events that will verify the forecast. Collection of watch and outlook forecast messages is accomplished in real-time as they are disseminated at the NSSFC. They are then 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 Automated Field Operations System (AFOS). 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 clearly satisfy one of the criteria listed in Table 1. Multiple reports of the same type (Table 1) occurring within 10 statute miles and 15 minutes of each other, and in the same county, are recorded as one event. All tornadoes are retained. Preliminary data are reviewed at a later time, and a "smooth log" is compiled for use in official verification.

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).

3. CONVECTIVE OUTLOOKS

During 1984 a total of 563 Convective Outlooks were issued. Verification statistics stratified by the three issuance times are given in Table 2. The two later outlooks, which are based on more diagnostic analysis and a later run of the National Meteorological Center (NMC) numerical guidance generally contained a higher percentage of reports (higher POD). Overforecasting, as reflected in the FAR, decreased for the later forecasts. An increase in the CSI resulted.

As has been observed in past years, there was an annual variation in verification scores during 1984. Figure 1 depicts this variation. The combination of a high POD and the lowest FAR of the year produced the highest CSI in April. Verification scores are best in the spring

TABLE 1
Criteria for Severe Local Storm Events

a. Tornado - a funnel or rotating circulation touching the ground and associated with a thunderstorm.

b. Hail equal or greater than 3/4 inch (1.9 cm) in diameter.

c. Convective wind gust of at least 50 knots (93 km/h).

d. Significant convective wind damage.

e. Extreme turbulence reported by aircraft.

TABLE 2
Verification Scores for Convective Outlooks During 1984

Issue Time (GMT)	Number Issued	POD	FAR	CSI
0800	183	.67	.65	.24
1500	186	.70	.63	.26
1930	194	.70	.61	.27
All	563	.69	.63	.26

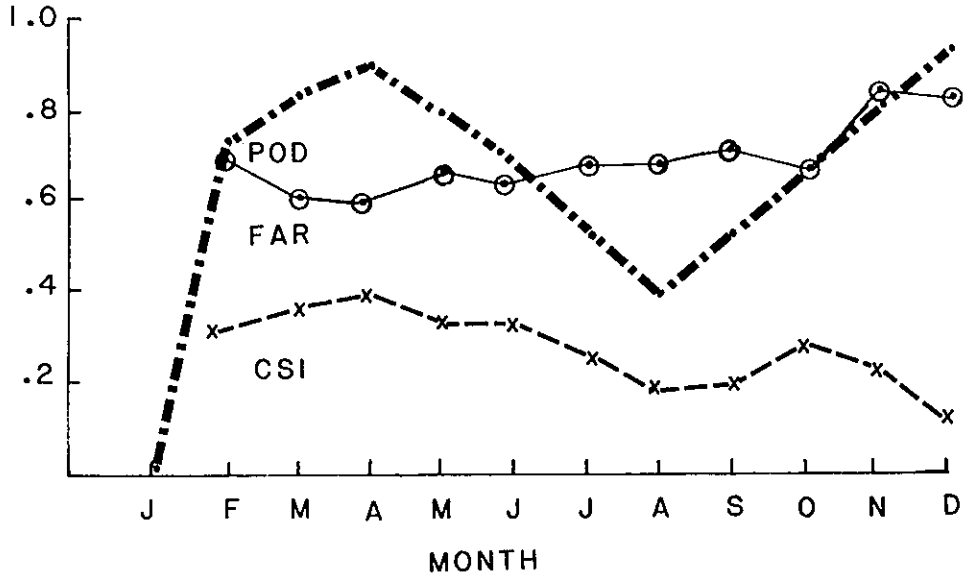

Figure 1. Annual variation of verification scores for convective outlooks during 1984.

months when synoptic-scale systems are better defined. In contrast, the POD was lowest in August - a time when severe storms are most affected by local meteorological conditions. Figure 2 shows the relationship of the overall verification statistics for 1984 to those of the past five years.

4. SEVERE LOCAL STORM WATCHES

A total of 402 severe local storm watches were issued during 1984. Of these, 223 were tornado watches and 179 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 53% of the tornado watches, only 21% of the severe thunderstorm watches contained tornadoes. Tornado watches also reflected an increased threat of severe weather as only 16% 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 probability of detection (POD) for various intensities of tornadoes relative to valid severe local storm watches is given in Table 4. During 1984, 39% of the weak (F0-F1) tornadoes occurred in valid watches. All of the observed violent (F4-F5) tornadoes occurred in valid watches. For strong and violent tornadoes, which caused 96% of tornado-related fatalities during 1984, the probability of detection was 0.61. The POD for all tornadoes was 0.45. These results are consistent with the findings of Ostby and Higginbotham (1982) that SELS forecasters are more successful in predicting strong and violent tornadoes than weak ones.

Statistics concerning severe local storm events resulting in fatalities and injuries are given in Table 5. During 1984, tornadoes caused 122 fatalities in the United States. Severe thunderstorm winds caused 36 additional fatalities. In regard to tornado-related fatalities, 106 of 122 (87%) were covered by valid watches. Thirteen (36%) of the 36 fatalities resulting from thunderstorm wind gusts occurred within valid watches. The increased threat suggested by tornado watches is reflected by eleven of these thirteen fatalities having occurred during valid tornado watches. Valid severe local storm watches covered 88% of tornado-related injuries and 44% of injuries attributable to other severe thunderstorms.

Trends in verification statistics for all severe local storm watches, as depicted in Figure 3, reflect gradual improvement over the past 10 years. The same statistics for tornado watches are shown in Figure 4. A sharp rise in these scores is noted between 1981-1982. This sharp rise coincides with the implementation of the Centralized Storm Information System (CSIS) at the NSSFC (Ostby, 1984). Scores for the past three years have remained at these higher levels.

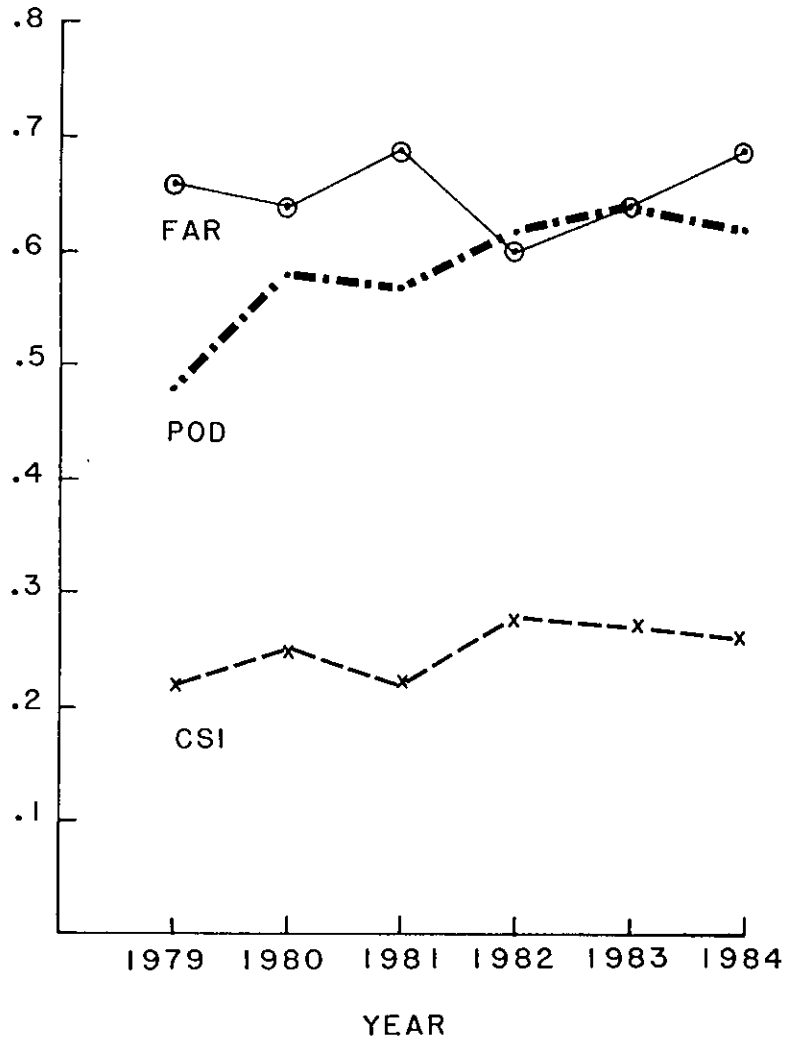

Figure 2. Convective outlook verification for the years 1979-1984.

TABLE 3
Frequency of Severe Local Storm Types in Valid Watches, 1984

Watch Type	Number Issued	Observed Tornado	Only Other Severe Types	No Severe
Tornado	223	53%	31%	16%
Severe Thunderstorm	179	21%	55%	24%

TABLE 4
Probability of Detection (POD) for Various Intensities (F-Scale) of Tornadoes Relative to Valid Severe Local Storm Watches During 1984

Weak (F0-F1)	Strong (F2-F3)	Violent (F4-F5)	Strong/Violent (F2-F5)	All (F0-F5)
0.39	0.58	1.00	0.61	0.45

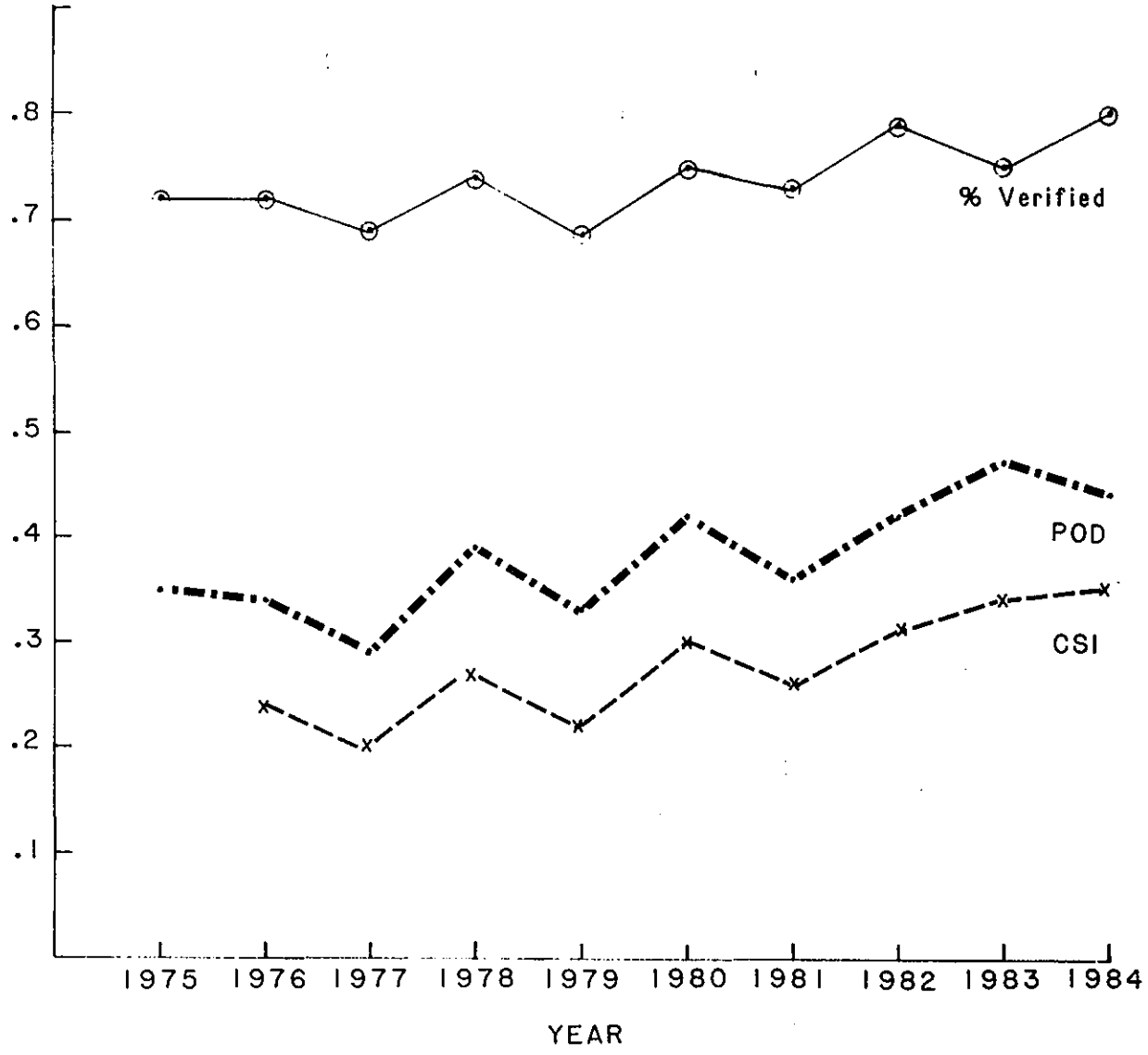

Figure 3. Verification for all severe local storm watches issued during the period 1975-1984.

TABLE 5
Severe Local Storm-Related Fatalities and Injuries
Covered by Valid Watches

	Tornado		Severe Thunderstorm	
	Fatalities	Injuries	Fatalities	Injuries
Total Number	122	2181	36	376
Occurring within valid watches	106	1920	13	166
% covered by watches	87	88	36	44

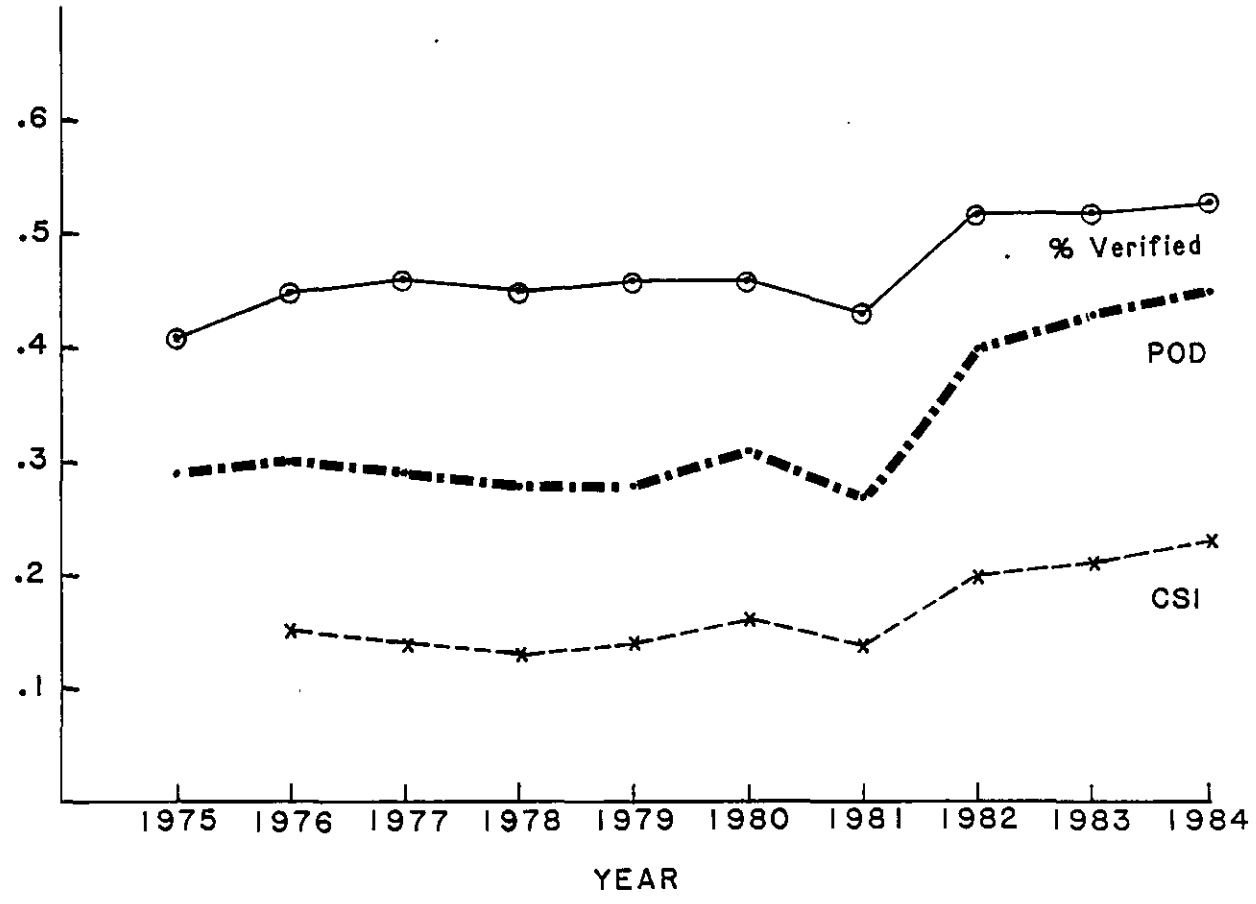

Figure 4. Tornado watch verification for the years 1975-1984.

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.

During 1984, convective outlooks issued later during the morning and afternoon reduced the degree of overforecasting. Overall success, as reflected in the CSI, was best during the active months of spring.

For severe local storm watches, skill was exhibited in distinguishing the added threat of tornadoes from that of hail or wind gusts. High percentages of tornado-related fatalities (87%) and injuries (88%) were covered by valid severe local storm watches. Also, greater skill was shown in forecasting the more intense tornadoes.

6. ACKNOWLEDGEMENTS

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