NOAA TECHNICAL MEMORANDUM NWS NSSFC-35

VERIFICATION OF SEVERE LOCAL STORMS FORECASTS ISSUED BY THE NATIONAL SEVERE STORMS FORECAST CENTER: 1992

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June 1993

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: 1992

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 1992.

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. During 1992 the SELS Unit issued 940 severe local storm watches. Of these, 348 were tornado watches. The total of 940 was the most watches issued in one year, exceeding the previous high of 836 in 1991. There were 13416 severe local storm events during 1992. Of these, 1297 were tornadoes. In terms of the total number of both tornadoes and all events, this was the most active season on record.

1. INTRODUCTION

The Severe Local Storms (SELS) Unit of the National Severe Storms Forecast Center (NSSFC) has responsibility for issuing convective outlooks, tornado watches and severe thunderstorm 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. Although convective outlooks include forecasts for all thunderstorms, only forecasts of severe local storms are addressed in this report. An initial second-day severe local storm 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. Tornado and severe thunderstorm watches are issued, as needed, to delineate areas in which conditions will 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 aid the assessment of forecast quality, identify possible areas of improvement, and provide helpful feedback concerning the progression of events during specific severe local storm episodes.

Results of these earlier verification efforts have been published by Galway (1967), Galway (1975) and Pearson and Weiss (1979) and Anthony and Leftwich (1992a). In 1982, the National Weather Service (NWS) formulated a National Verification Plan (NWS 1982) to provide guidelines for verification of the various products. As an integral part of the national program, the NSSFC publishes verification summaries each year. For example, Anthony and Leftwich (1992b) summarized verification of watches and outlooks issued by the NSSFC during 1991. This report documents verification of severe local storm watches and convective outlooks issued during 1992.

2. VERIFICATION PROCEDURES

The first step in verification of any forecast is collection of both the issued forecast 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. Although severe local storm reports are collected at the NSSFC as a part of operational procedures, reports of tornadoes, large hail and thunderstorm wind events are not retained for use in official (final) verification. All other reports are obtained via "Storm Data and Unusual Weather Phenomena". This monthly report, also known as Form F-8, is prepared for each state by the various NWS Forecast Offices. Further restrictions are applied before any event is included in the verification procedure. Multiple reports of hail and/or wind 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 summary are included as separate events. 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 convective cloud.
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 a 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, whereas 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 1992 a total of 696 convective outlooks specified a threat of severe local storms for the current, or first, day. Figure 1 shows overall convective outlook verification statistics for the ten-year period 1983-1992. Verification statistics for 1992, 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 later National Meteorological Center (NMC) numerical model guidance, contained progressively higher percentages of reports (higher POD). Increases in CSI were also observed for these later outlooks.

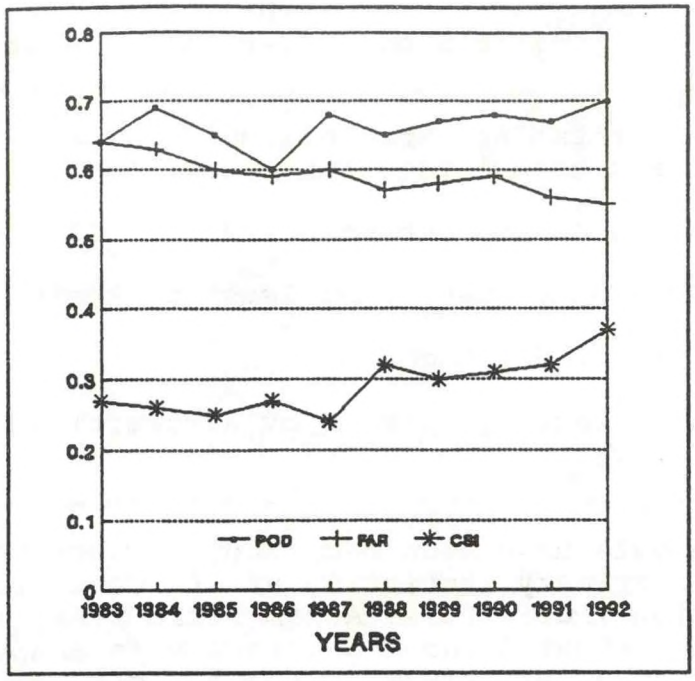

Figure 1. Convective outlook verification for the years 1983-1992.

There were 206 initial (issued at 0800 UTC) second-day outlooks that specified a threat of severe local storms for the following day. A threat of severe local storms was initiated or retained in 222 updated outlooks issued at 1800 UTC. Verification of these outlooks is given in Section B of Table 2. Updates improved the initial outlooks in terms of POD.

Comparison of second-day outlooks with first-day outlooks shows noteworthy improvement in values of POD with little change in FAR. This results in higher values of CSI for successive outlooks. Improvement in POD and little change in FAR results from second-day outlooks being, on the average, smaller in area than first-day outlooks. Second-day outlooks are based almost entirely on indications derived from numerical model guidance, which emphasizes synoptic-scale features. For the first-day outlooks important information is obtained from mesoscale analysis as well as later runs of numerical guidance. Generally, a larger area of threat is evident in mesoscale analyses than in numerical guidance alone. Also, such subsynoptic-scale analysis leads to better placement of outlook areas. Increased area and better placement of outlook areas combine to produce similar values of FAR and higher values of POD and CSI.

Table 2

Verification scores for severe local storm outlooks during 1992

A. First-Day

Issue Time (UTC)	Number Issued	POD	FAR	CSI
0700	229	.63	.55	.34
1500	234	.71	.53	.38
1900	233	.77	.55	.38
All	696	.70	.55	.37

B. Second-Day

Issue Time (UTC)	Number Issued	POD	FAR	CSI
0800	206	.43	.59	.26
1800	222	.51	.58	.28
All	428	.47	.59	.27

4. SEVERE LOCAL STORM WATCHES

During 1992 the SELS Unit issued 940 severe local storm watches. Of these, 348 were tornado watches and 592 were severe thunderstorm watches. The total of 940 was the most watches issued in one year, exceeding the previous high of 836 in 1991. There were 13416 severe local storm events during 1992. Of these, 1297 were tornadoes. In terms of the total number of both tornadoes and all events, this was the most active season on record (Grenier and Halmstad 1992). Also, the mean area contained in severe local storm watches in 1992 was 22952 square nautical miles, the smallest on record.

Issuance of either a tornado watch or a severe thunderstorm watch denotes the threat of severe local storms. Analysis of the overall forecasting of severe local storms is obtained via verification of all watches and all severe local storm events considered together. Trends in some of these statistics for the period 1983-1992 are shown in Figure 2.

Issuance of tornado watches emphasizes the threat of tornadoes. To assess this aspect of tornado watches separately, additional verification of tornado watches is done considering tornadoes only. That is, a tornado watch is considered to be verified only when a tornado occurs during the valid time period and within the watch area. Statistics computed in this manner are shown in Figure 3 for the period 1983-1992.

As shown by Table 3, skill was shown during 1992 in distinguishing severe local storm situations which have a greater threat of tornadoes from situations when tornado development is not likely. While at least one tornado occurred in 49% of the tornado watches, only 17% of the severe thunderstorm watches contained tornadoes. Tornado watches also reflected an increased threat of severe local storms as only 12% of them did not contain any reported events.

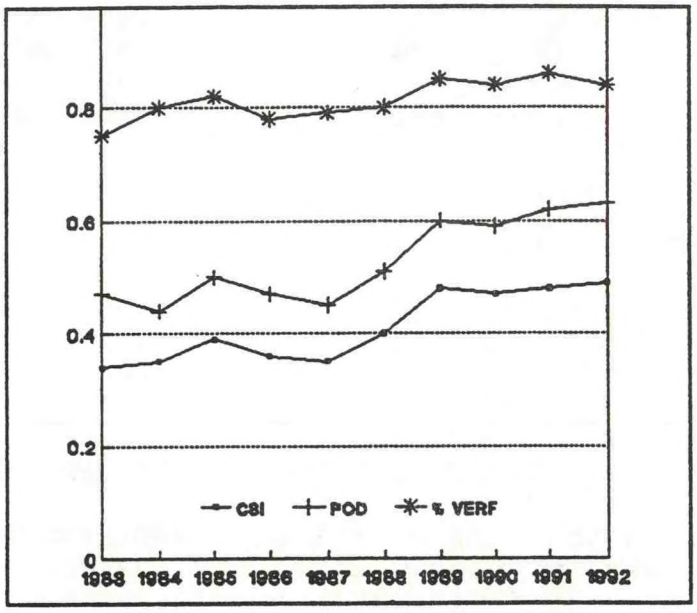

Figure 2. Verification for all severe local storm watches issued during the period 1983-1992.

Values of POD for various intensities of tornadoes during 1992 relative to valid severe local storm watches are given in Table 4. A tornado is considered to have occurred within a valid watch if any portion of its track occurred within a valid watch area. Intensities of tornadoes are indicated by F-scale (Fujita 1981) values ranging from "0" (weakest) to "5" (most violent). During 1992, 64% of the weak (F0-F1) tornadoes occurred in valid watches, while 93% of the violent (F4-F5) tornadoes occurred in valid watches. For strong and violent tornadoes, which caused 92% of the tornado-related fatalities during 1992, the Probability of Detection was 0.89. The POD for all tornadoes was 0.67.

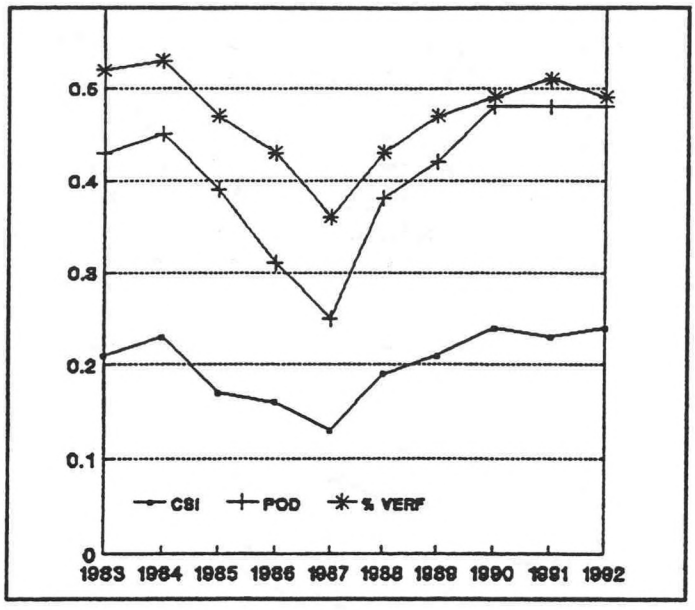

Figure 3. Verification of tornado watches via tornadoes only for the period 1983-1992.

Table 3

Frequencies of severe local storms in valid watches, 1992

Watch Type	Number Issued	Observed Tornado	Only Other Severe Types	No Severe
Tornado	348	49%	39%	12%
Severe Thunderstorm	592	17%	66%	17%

Table 4

Probability of Detection (POD) for various intensities (F-scale) of tornadoes relative to valid severe local storm watches during 1992

	Weak (F0-F1)	Strong (F2-F3)	Violent (F4-F5)	Strong/Violent (F2-F5)	All (F0-F5)
Total	1111	172	14	186	1258
In Watch	709	152	13	165	840
POD	0.64	0.88	0.93	0.89	0.67

Strong and violent (F2-F5) tornadoes consistently pose an increased threat to life and property. Values of POD for all, weak (F0-F1) and strong/violent (F2-F5) tornadoes for the period 1983-1992 are shown in Figure 4. 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. Results for the past several years have been consistent with the earlier findings of Ostby and Higginbotham (1982).

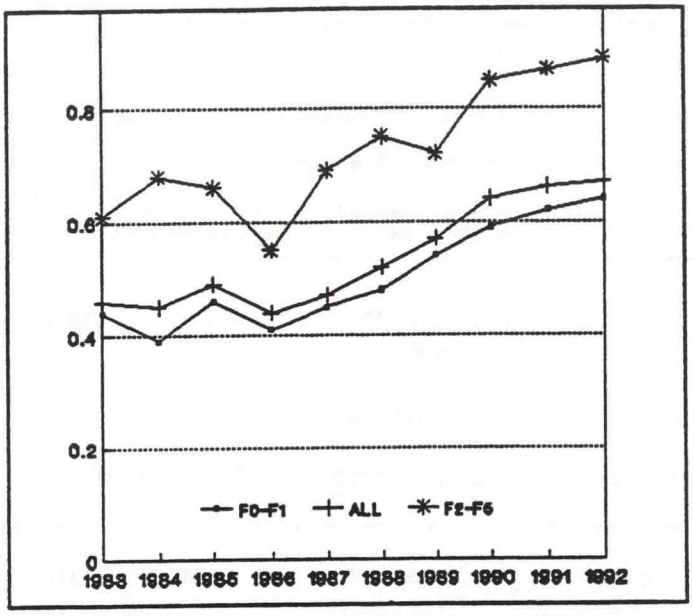

Figure 4. Annual values of Probability of Detection (POD) for weak, strong/violent, and all tornadoes, respectively, for the years 1983-1992.

During 1992, there were 14 tornadoes that caused at least one fatality. Eleven of the 14 "killer" tornadoes 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 1992, tornadoes caused 39 fatalities in the United States. Severe thunderstorm winds caused 14 additional fatalities. Twenty-nine (74%) tornado related fatalities occurred within valid watches. Ten (71%) of the 14 fatalities resulting from thunderstorm wind gusts occurred within valid watches. Valid severe local storm watches contained 78% of tornado-related injuries and 71% of injuries attributable to other severe thunderstorms.

Table 5

Severe local storm-related fatalities and injuries in 1992

	Tornado		Severe Thunderstorm	
	Fatalities	Injuries	Fatalities	Injuries
Total	39	1323	14	431
Occurring within valid watches	29	1027	10	284
% Within Watches	74	78	71	66

5. SUMMARY

Severe local storm outlooks and 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.

In 1992 there was some improvement in FAR between second-day and first-day severe local storm outlooks. However, the location of severe local storm occurrence (as reflected in the POD) was better predicted by the first-day outlooks.

For severe local storm watches, ability was exhibited in distinguishing the added threat of tornadoes from that of hail or thunderstorm wind gusts. During 1992, 74% of the tornado-related fatalities and 78% of the tornado-related injuries occurred within valid severe local storm watches.

6. ACKNOWLEDGEMENTS

The author thanks Denise Vandeloo for her technical assistance in preparation of this report.

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