NOAA TECHNICAL MEMORANDUM NWS NSSFC-13

# VERIFICATION OF SEVERE LOCAL STORM FORECASTS ISSUED BY THE NATIONAL SEVERE STORMS FORECAST CENTER: 1985

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

November 1986

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

NOAA TECHNICAL MEMORANDA

National Weather Service
National Severe Storms Forecast Center

The National Severe Storms Forecast Center (NSSFC) has the responsibility for the issuance of severe thunderstorm and tornado watches for the contiguous 48 states. Watches are issued for those areas where thunderstorms are forecast to produce one or more of the following: (1) hailstones of 3/4 inch diameter or greater, (2) surface wind gusts of 50 knots or greater, or (3) tornadoes.

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UNITED STATES
DEPARTMENT OF COMMERCE
Malcolm Baldrige, Secretary

National Oceanic and
Atmospheric Administration
Anthony Calio, Administrator

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Assistant Administrator

TABLE OF CONTENTS

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) summarized verification of watches and outlooks issued by the NSSFC during 1984. This report documents verification of convective outlooks and severe local storm watches issued by the NSSFC during 1985.

## 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 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. 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).

# VERIFICATION OF SEVERE LOCAL STORM FORECASTS ISSUED BY THE NATIONAL SEVERE STORMS FORECAST CENTER: 1985

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 that delineate areas that are favorable for development of severe local storms. This report summarizes verification of those forecasts that were issued during 1985.

Convective outlooks exhibited the best forecast skill during the active months of spring. Ability in delineating the threat of tornadoes by tornado watches was observed. High percentages of tornado-related fatalities (83%) and injuries (76%) 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, were issued daily at 0800, 1500, and 1930 UCT.[1] Forecast periods began at 1200, 1500, and 2000 UCT, respectively, and lasted until 1200 UCT 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 occur within the next several hours.

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[1]Beginning in 1986, convective outlooks are issued at 0700, 1500 and 1900 UCT. Also, an outlook for the following 24-h period (beginning at 1200 UCT on the next day) is now issued at 0800 UCT and updated at 1800 UCT each day.

## 3. CONVECTIVE OUTLOOKS

During 1985 a total of 565 Convective Outlooks that specified a threat of severe thunderstorms were issued. Verification statistics stratified by the three issuance times are given in 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.

As has been observed in past years, there was an annual variation in verification scores during 1985. 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 months when synoptic-scale systems are better defined. In contrast, the POD was lowest in August. The highest FAR and lowest CSI occurred in July. Both July and August are months when severe storms are most affected by local meteorological conditions. Figure 2 shows the relationship of the overall verification statistics for 1985 to those of the past six years.

## 4. SEVERE LOCAL STORM WATCHES

A total of 477 severe local storm watches were issued by the NSSFC during 1985.[2] Of these, 207 were tornado watches and 270 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 47% 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 14% 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 1985, 46% of the weak (F0-F1) tornadoes occurred in valid watches, while 86% of the violent (F4-F5) tornadoes occurred in valid watches. For strong and violent tornadoes, which caused 99% of tornado-related fatalities during 1985, the probability of detection was 0.66. The POD for all tornadoes was 0.49. 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.

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[2] Three watches were issued by the U.S. Air Force Global Weather Central (AFGWC) operating as a backup to the NSSFC. Verification of these three watches is not included in this report.

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

d. Significant convective wind damage.

e. Extreme turbulence reported by aircraft.

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Table 2
Verification scores for convective outlooks during 1985

| Issue Time (UCT) | Number Issued | POD | FAR | CSI |
|---|---|---|---|---|
| 0800 | 182 | .54 | .66 | .23 |
| 1500 | 194 | .61 | .63 | .26 |
| 1930 | 189 | .66 | .66 | .26 |
| All | 565 | .60 | .65 | .25 |

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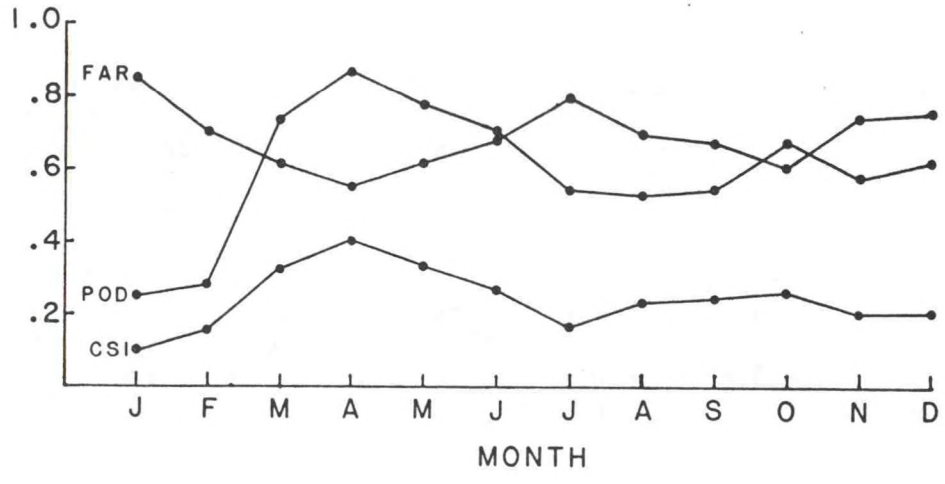


Figure 1. Annual variation of verification scores for convective outlooks during 1985.

Statistics concerning severe local storm events resulting in fatalities and injuries are given in Table 5. During 1985, tornadoes caused 94 fatalities in the United States. Severe thunderstorm winds caused 16 additional fatalities. In regard to tornado-related fatalities, 78 of 94 (83%) occurred within valid watches. Seven (44%) of the 16 fatalities resulting from thunderstorm wind gusts occurred within valid watches. Valid severe local storm watches contained 76% of tornado-related injuries and 40% of injuries attributable to other severe thunderstorms.

Trends in verification statistics for all severe local storm watches are depicted in Figure 3. The same statistics for tornado watches are shown in Figure 4.

## 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.

Overall success of the convective outlooks during 1985 was best during the active months of spring. Outlooks issued during early afternoon contained the highest percentage of severe local storm events.

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 (83%) and injuries (76%) occurred within valid severe local storm watches. Also, greater ability was shown in forecasting the more intense tornadoes.

## 6. ACKNOWLEDGMENTS

The author thanks Virginia L. Rich for her technical assistance in preparation of this report. Steven J. Weiss provided some of the verification data.

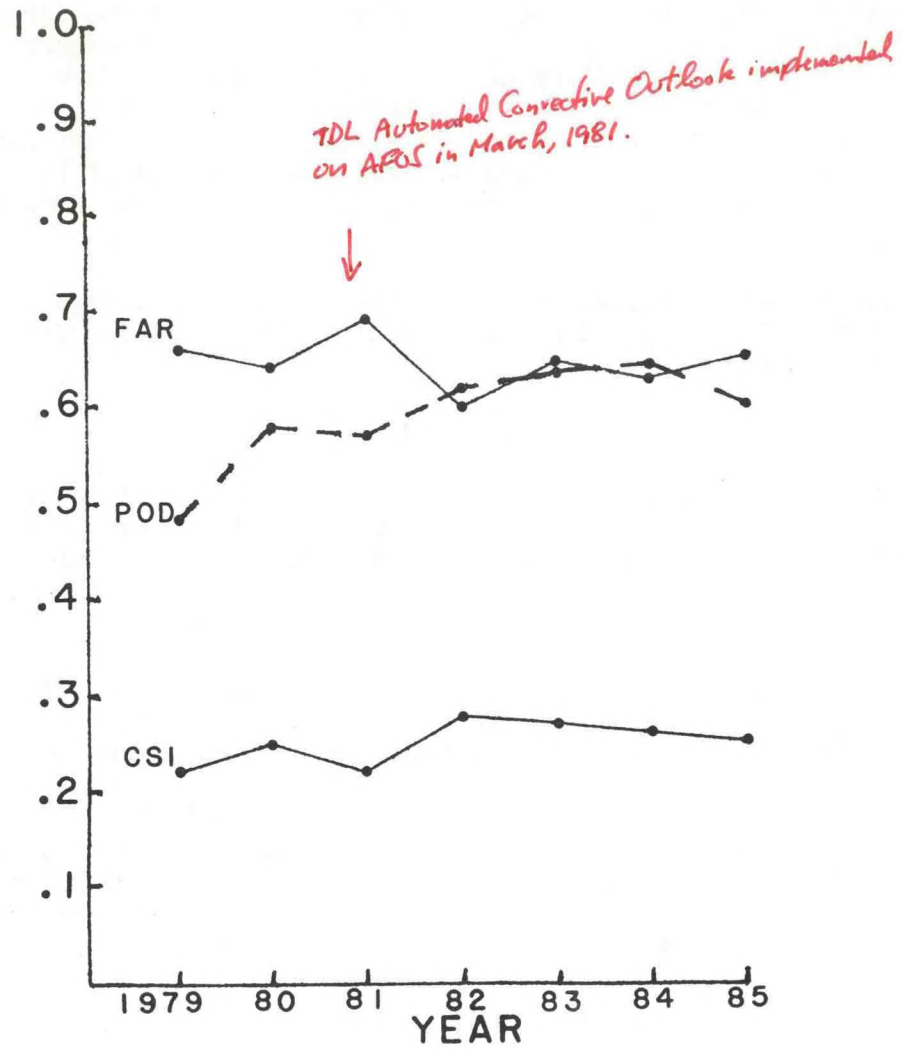


Figure 2. Convective outlook verification for the years 1979-1985.

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Table 3
Frequency of severe local storm types in valid watches, 1985

| Watch Type | Number Issued | Observed Tornado | Only Other Severe Types | No Severe |
|---|---|---|---|---|
| Tornado | 207 | 47% | 39% | 14% |
| Severe Thunderstorm | 270 | 16% | 65% | 19% |

Table 4
Probability of detection (POD) for various intensities (F-scale) of tornadoes relative to valid severe local storm watches during 1985

| Weak (F0-F1) | Strong (F2-F3) | Violent (F4-F5) | Strong/Violent (F2-F5) | All (F0-F5) |
|---|---|---|---|---|
| 0.46 | 0.64 | 0.86 | 0.66 | 0.49 |

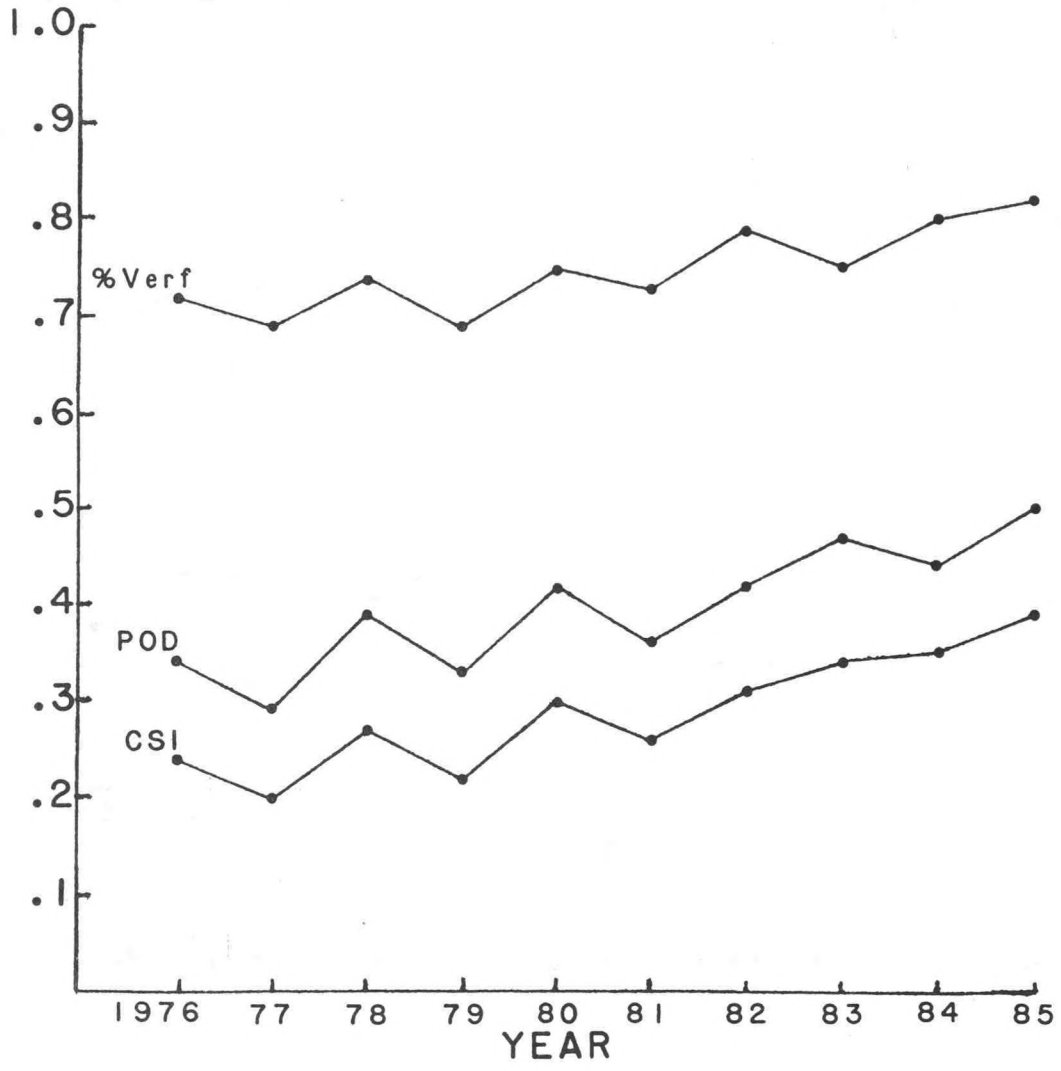


Figure 3. Verification for all severe local storm watches issued during the period 1976-1985.

Table 5
Severe local storm-related fatalities and injuries in 1985

| | Tornado | | Severe Thunderstorm | |
|---|---|---|---|---|
| | Fatalities | Injuries | Fatalities | Injuries |
| Total Number | 94 | 1299 | 16 | 214 |
| Occurring within valid watches | 78 | 985 | 7 | 85 |
| Percent within valid watches | 83 | 76 | 44 | 40 |

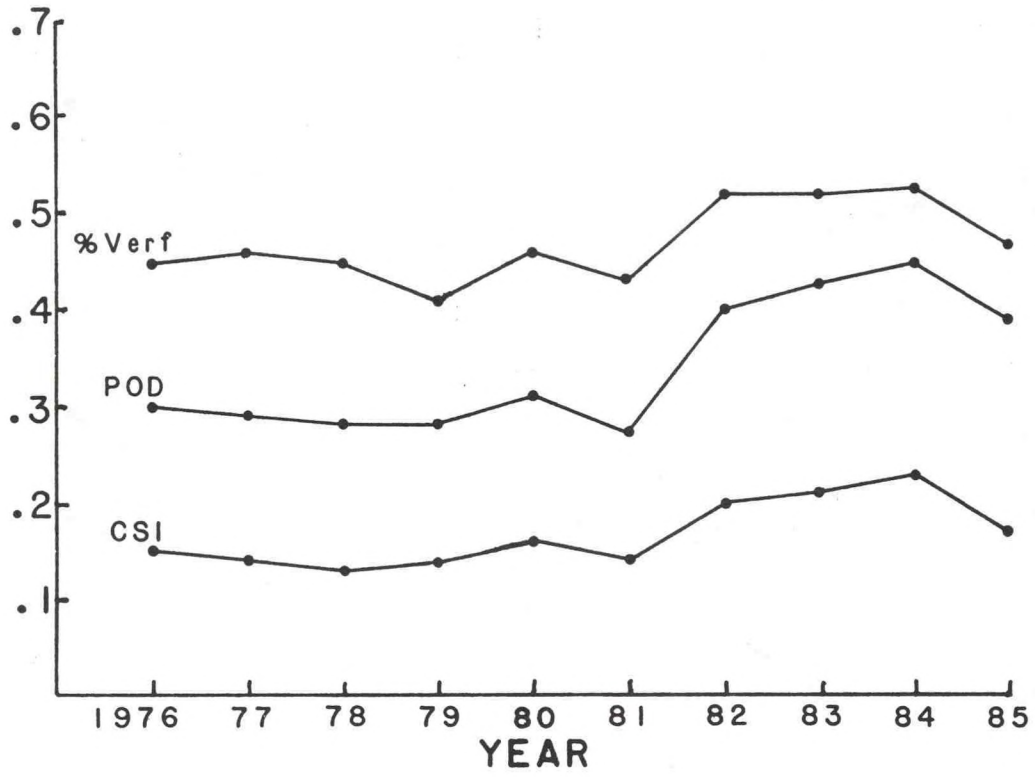


Figure 4. Tornado watch verification for the years 1976-1985.

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No. 11 Severe Thunderstorm Cases of 1985. John E. Hales, Jr. and Hugh G. Crowther, February 1986, 51 p., (PB86 164340/AS).

No. 12 Severe Local Storm Warning Verification Preliminary Procedures. Leo A. Grenier and John T. Halmstad, April 1986, 10 p.

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