NOAA TECHNICAL MEMORANDUM NWS NSSFC-37

SEVERE LOCAL STORM WARNING VERIFICATION: 1992

Hugh C. Crowther and John T. Halmstad
National Severe Storms Forecast Center
Kansas City, Missouri 64106-2877

May 1993

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

National Weather Service
National Severe Storms Forecast Center

The National Severe Storms Forecast Center (NSSFC) has the responsibility for the issuance of tornado and severe thunderstorm 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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No. 5 The Operational Meteorology of Convective Weather Volume I: Operational Mesoanalysis. Charles A. Doswell III, November 1982, 160 p., (PB83 162321).

No. 6 Severe Local Storm Warning and Event Summaries Available in AFOS. Preston W. Leftwich, Jr. and Lawrence C. Lee, January 1984, 10 p., (PB84 150291).

No. 7 Severe Thunderstorm Cases of 1984. John E. Hales, Jr. and Hugh G. Crowther, May 1985, 88 p., (PB85 210748/AS).

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TABLE OF CONTENTS

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ABSTRACT

Tornado and severe thunderstorm warnings are issued by local offices of the National Weather Service. Routine verification of these warnings is accomplished at the National Severe Storms Forecast Center. This report highlights verification procedures and summarizes national, regional and local verification results for the year 1992.

In the past, offices in Southern Region and Central Region have issued most of the warnings and experienced most of the severe local storm events. In 1992, local offices in those two regions accounted for more than 80 percent of the warnings and severe local storm events.

Verification scores for 1992 showed significant improvement for the nation as a whole. In fact, improvement in scores for the Probability of Detection (POD) of severe local storm events, the Critical Success Index (CSI), and the Verification Efficiency (VE), were the greatest in eight years of records, and improvement in the False Alarm Ratio (FAR) and Percentage of Verified Warnings (PV) was equal to the rather marked changes between 1984 and 1985, and between 1985 and 1986.

INTRODUCTION

Severe local storm warnings are issued to the public by more than 200 local offices of the National Weather Service (NWS). These warnings, which are typically based on radar information and/or storm spotter reports, alert the public to an imminent or existing severe thunderstorm or tornado.

Each designated area of warning responsibility is composed of counties in the vicinity of the local office. Locations of these offices are contained in "National Weather Service Offices and Stations" (NWS 1990). Areas of responsibility are defined in Chapter C-47 of the "Weather Service Operations Manual" (1986), with included revisions by the Office of Meteorology (OM).

Routine verification of all tornado and severe thunderstorm warnings issued by offices is accomplished at the National Severe Storms Forecast Center (NSSFC) in Kansas City, Missouri. This report summarizes these verification results for the year 1992. Detailed evaluation of the results, such as comparisons among individual offices, is beyond the scope of this report.

VERIFICATION PROCEDURES

Severe local storm warning verification began in 1979. Pearson and David (1979), and Kelly and Schaefer (1982), analyzed warning verification statistics back to 1976, and in 1982 a National Verification Plan (NWS 1982) was formulated to provide guidelines for verification of all products issued to the public. The severe local storm warning verification effort at NSSFC is an integral part of this national program. Monthly and year-to-date summaries are routinely provided to national headquarters, regional headquarters, and local offices.

The two elements necessary for verification are: (1) issued warnings, and (2) event reports. Initially, both warnings and event reports are collected in real time from the Automation of Field Operations and Services (AFOS) computer system. Event information is extracted from surface observations, warning messages, local storm reports (LSR'S), statements, pilot reports, and state weather summaries. Additional reports may be received via newspaper articles and telephone conversations. These reports form a "rough log" of severe local storm events.

Each week, listings of warnings that have been logged and processed at the National Severe Storms Forecast Center, and the "rough log", are transmitted via the AFOS system to local offices for review. The role of these warning and event summaries in the verification process is discussed in detail by Leftwich and Lee (1984), and updated by Grenier and Halmstad (1986).

After reviewing warning lists, local offices send any warning corrections to the Verification Section. The "rough log" is an aid for the Warning Coordination Meteorologist (WCM), Warning Preparedness Meteorologist (WPM), or severe weather focal point at each forecast office to use in preparing "Storm Data and Unusual Weather Phenomena" (FORM F-8). These F-8 reports are the sole source of event reports used in the "smooth log" for official verification. There is one exception in that real-time surface aviation observations (SAO) containing severe weather reports are retained in the "smooth log" even though they may not appear in the F-8 report. After all sources of information have been compiled, the resulting "smooth log" and warning file become the data bases for official verification.

To qualify as a severe local storm event, a report must satisfy one of the criteria listed in Table 1. General guidelines on event reporting may be found in Grenier and Halmstad (1986). For verification purposes, multiple reports of severe local storm events occurring within ten statute miles and fifteen minutes of each other, and in the same county, are recorded as one event, with the following exceptions:

(1) all distinct tornadoes are retained as separate events

(2) all wind events of 65 knots or greater are retained

(3) all reports of hail with a diameter of two inches or greater are retained

(4) all reports containing deaths, injuries, or more than half a million dollars damage are retained (Damage Category 6, or above)

Originally, a severe event was identified as a duplicate if it met the following criteria: (1) it was in the same county, (2) it was within ten statute miles and/or fifteen minutes of another report, and (3) it was the same type of non-tornadic phenomena, i.e. wind or hail (Leftwich and Lee, 1984). It was later noted that a severe wind and severe hail report from the same thunderstorm caused the storm to be counted twice. In an effort to focus on the thunderstorm cell, the "same type" requirement was dropped at the start of the 1986 severe weather year (Grenier and Halmstad, 1986).

CRITERIA FOR SEVERE LOCAL STORM EVENTS USED IN WARNING VERIFICATION

A. TORNADO - a rotating circulation touching the ground and associated with a convective cloud.

B. HAIL equal or greater than 3/4 inch (1.9 cm) in diameter.

C. THUNDERSTORM WIND GUST of 50 knots (93 km/h) or greater.

D. THUNDERSTORM WIND DAMAGE which implies the occurrence of a severe thunderstorm.

Any event that occurs within a county for which a warning was issued, and during the valid period of the warning, is considered a "warned event". Thus there can be multiple "warned events" during the valid time of a given warning. Also, any type of severe event can verify either a tornado warning or a severe thunderstorm warning.

In current verification procedures, the county is the basic unit of area. A warning in effect for three counties is counted as three "warned counties". At least one severe local storm event occurring during the valid period of a warning in a warned county produces a "verified county warning". In order to obtain perfect verification, at least one severe local storm event must occur in each warned county.

Sparseness of population can decrease the chances that a severe weather event is reported. Schaefer and Galway (1982) addressed biases reflected in the tornado climatology across the United States, and Hales and Kelly (1985) discussed possible effects of variations in reporting of hail and thunderstorm wind gust events upon verification results. More recently, Doswell and Burgess (1988) noted several problems relating to the F-scale tornado intensity rating system and the occurrence of very long track tornado events. Results of these studies demand that caution be exercised in comparing verification results among local offices, and among regions that have different population densities or different meteorological regimes.

VERIFICATION MEASURES

FALSE ALARM RATIO

The False Alarm Ratio **(FAR)** is the number of unverified county warnings **(UCW)** divided by the total number of county warnings issued **(TCW)**.

$$\frac{\text{UNVERIFIED COUNTY WARNINGS}}{\text{TOTAL COUNTY WARNINGS}}$$

PROBABILITY OF DETECTION

The Probability of Detection **(POD)** is the number of warned severe local storm events **(WSE)** divided by the total number of severe local storm events reported **(TSE)**.

$$\frac{\text{WARNED SEVERE EVENTS}}{\text{TOTAL SEVERE EVENTS}}$$

CRITICAL SUCCESS INDEX

The Critical Success Index **(CSI)** is the number of warned severe local storm events **(WSE)** divided by the sum of the total number of severe local storm events **(TSE)** and the number of unverified county warnings **(UCW)**.

$$\frac{\text{WARNED SEVERE EVENTS}}{\text{TOTAL SEVERE EVENTS + UNVERIFIED COUNTY WARNINGS}}$$

NOTE: The values in the annual printouts may differ slightly from those listed in the tables to follow due to round-off error. The values in the annual printouts were computed according to the following formula:

$$CSI = [\ POD^{-1} + (1 - FAR)^{-1} - 1]^{-1}$$

VERIFICATION EFFICIENCY

The Verification Efficiency **(VE)** is the sum of the verified county warnings **(VCW)** and the number of warned severe local storm events **(WSE)**, divided by the sum of the total number of county warnings **(TCW)** and the total number of severe local storm events **(TSE)**.

$$\frac{\text{VERIFIED COUNTY WARNINGS + WARNED SEVERE EVENTS}}{\text{TOTAL COUNTY WARNINGS + TOTAL SEVERE EVENTS}}$$

PERCENTAGE OF VERIFIED COUNTY WARNINGS

The Percentage of Verified county warnings **(PV)** is the number of verified county warnings **(VCW)** divided by the total number of county warnings issued **(TCW)**. The sum of the False Alarm Ratio **(FAR)** and the Percentage of Verified county warnings **(PV)** is equal to one.

$$\frac{\text{VERIFIED COUNTY WARNINGS}}{\text{TOTAL COUNTY WARNINGS}}$$

NATIONAL VERIFICATION STATISTICS FOR 1992

There were 13,534 severe local storm events reported across the contiguous United States in 1992. The previous highest total for the nation since records began in 1979 was 12,534 reports, in 1991.

The total of 13,534 severe local storm events was more than one thousand (1011) greater than that for 1991 (an eight percent increase), and marked the fourth consecutive year with an increase in the total number of severe local storm events reported across the nation. Nearly half of the severe local storm events in 1992 were in the Southern Region states, and nearly a third were in the Central Region states.

The total of 15,124 county warnings was slightly greater than the previous record of 14,920, which was established in 1991, and also marked the fourth consecutive year with an increase.

There were 8168 verified county warnings across the nation in 1992, compared to the previous record of 7097 in 1991, which was an increase of 1071 verified warnings (15 percent).

As a result, there was a marked improvement in verification for the nation as a whole. The False Alarm Ratio (FAR) dropped from .52 to .46, the Probability of Detection (POD) jumped from .67 to .72, the Critical Success Index (CSI) jumped from .39 to .48, and the Verification Efficiency increased from .56 to .62.

Not only were the verification scores for 1992 the best since records began in 1979, the improvement in the scores between 1991 and 1992 was also the greatest of record.

Figure 1 shows the steady improvement in scores for the False Alarm Ratio, the Probability of Detection, the Critical Success Index and the Verification Efficiency between 1979 and 1992.

The False Alarm Ratio has gradually dropped from nearly .90 to less than .50 over the past 13 years, while the Probability of Detection has increased from below .40 to above .70, the Critical Success Index has improved from around .10 to nearly .50, and the Verification Efficiency scores has improved from just slightly over .20 to above .60.

National Statistics
1979 Through 1992

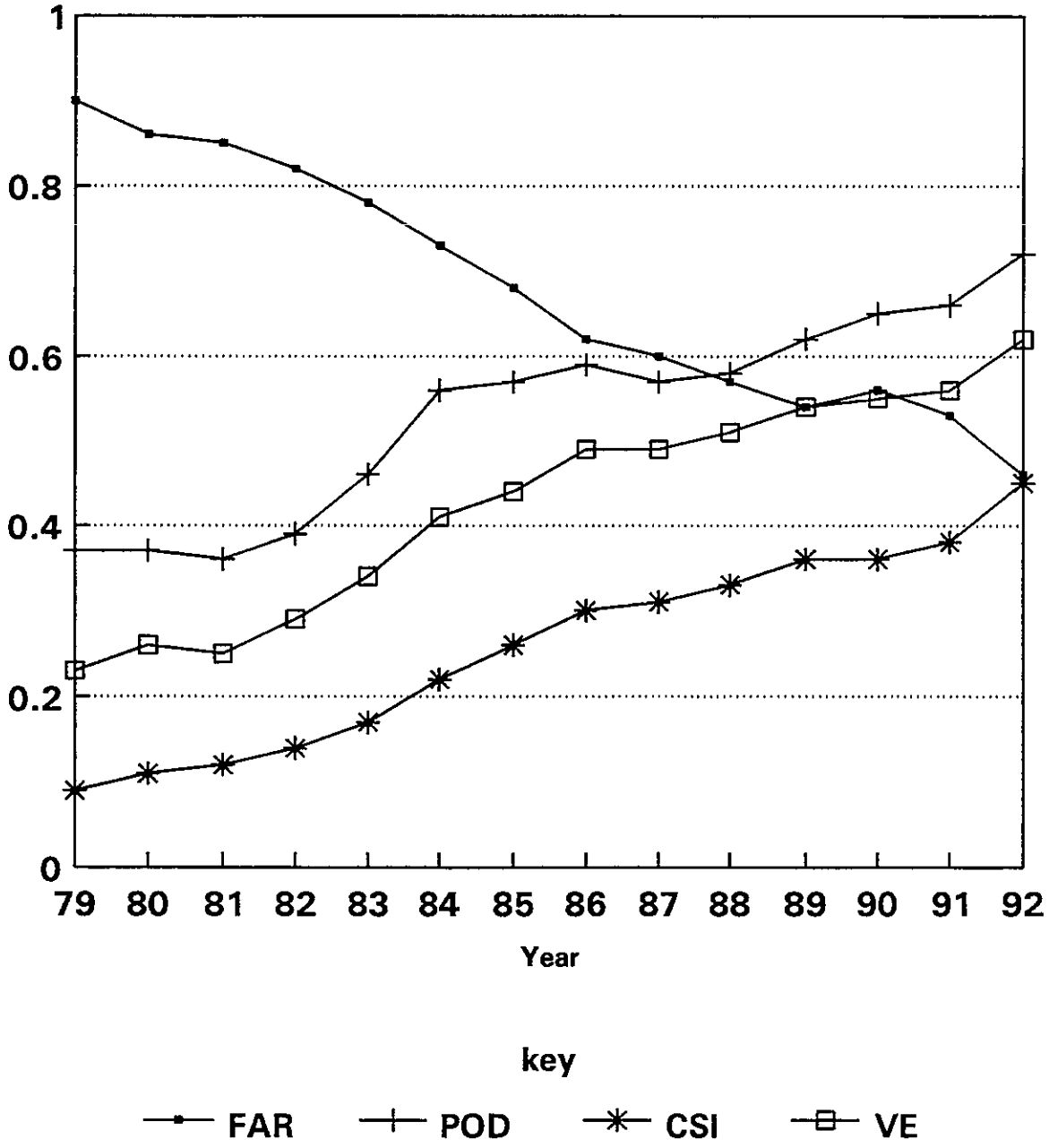

Figure 1.

REGION	ERN	SRN	CEN	WRN	U.S.
NUMBER OF OFFICES	51	58	67	35	211
TOTAL COUNTY WARNINGS	2394	7304	5029	397	15,124
PERCENTAGE OF TOTAL	15.8	48.3	33.3	2.6	100.0
AVERAGE PER OFFICE	47	126	75	11	72
VERIFIED COUNTY WARNINGS	1376	4360	2352	80	8,168
PERCENTAGE OF TOTAL	16.8	53.4	28.8	1.0	100.0
AVERAGE PER OFFICE	27	75	35	2	39
UNVERIFIED WARNINGS	1018	2944	2677	317	6,956
PERCENTAGE OF TOTAL	14.6	42.3	38.5	4.6	100.0
AVERAGE PER OFFICE	20	51	40	9	33
TOTAL SEVERE EVENTS	2320	6602	4266	346	13,534
PERCENTAGE OF TOTAL	17.1	48.8	31.5	2.6	100.0
AVERAGE PER OFFICE	45	114	64	10	64
WARNED SEVERE EVENTS	1621	5169	2849	91	9,730
PERCENTAGE OF TOTAL	16.7	53.1	29.3	0.9	100.0
AVERAGE PER OFFICE	32	89	43	3	46
FALSE ALARM RATIO	.425	.403	.532	.798	.460
PROBABILITY OF DETECTION	.699	.783	.668	.263	.719
CRITICAL SUCCESS INDEX	.486	.542	.410	.137	.475
VERIFICATION EFFICIENCY	.636	.685	.560	.230	.624
PERCENT VERIFIED	.575	.597	.468	.202	.540

NATIONAL AND REGIONAL VERIFICATION STATISTICS

(1984-1992)

YEAR	TCW	VCW	TSE	WSE	FAR	POD	CSI	VE	PV
1984	12498	3316	7357	4095	.730	.560	.220	.410	.270
1985	10957	3607	7997	4555	.670	.570	.260	.450	.330
1986	10789	4155	8725	5118	.610	.590	.300	.490	.390
1987	9409	3739	7367	4228	.600	.570	.310	.490	.400
1988	8593	3675	7253	4232	.570	.580	.330	.510	.430
1989	11956	5459	10408	6468	.530	.620	.370	.550	.470
1990	13696	6085	10956	7085	.560	.650	.360	.550	.440
1991	14920	7097	12523	8358	.520	.670	.390	.560	.480
1992	15124	8168	13534	9730	.460	.719	.475	.624	.540
TOTAL	107942	45301	86120	53869					
AVERAGE	11994	5033	9569	5985	.580	.626	.362	.511	.420

KEY TO ABBREVIATIONS

ST = STATE
WSO = WEATHER SERVICE OFFICE
TCW = TOTAL COUNTY WARNINGS
VCW = VERIFIED COUNTY WARNINGS
UCW = UNVERIFIED COUNTY WARNINGS
TSE = TOTAL SEVERE (LOCAL STORM) EVENTS
WSE = WARNED SEVERE (LOCAL STORM) EVENTS
FAR = FALSE ALARM RATIO
POD = PROBABILITY OF DETECTION
CSI = CRITICAL SUCCESS INDEX
VE = VERIFICATION EFFICIENCY
PV = PERCENTAGE OF VERIFIED COUNTY WARNINGS

*** EASTERN REGION ***

YEAR	TCW	VCW	TSE	WSE	FAR	POD	CSI	VE	PV
1984	1022	344	988	505	.660	.510	.250	.420	.340
1985	1387	658	1528	906	.530	.590	.360	.530	.470
1986	1445	793	1627	952	.450	.590	.400	.570	.550
1987	1029	611	1291	722	.410	.560	.400	.580	.590
1988	1452	861	1752	1082	.410	.620	.430	.610	.590
1989	1983	1004	2171	1261	.490	.580	.370	.540	.510
1990	2488	1319	2412	1568	.470	.650	.410	.590	.530
1991	2046	1162	2237	1475	.432	.659	.439	.616	.568
1992	2377	1359	2314	1609	.425	.699	.486	.636	.575
TOTAL	15229	8111	16320	10080					
AVERAGE	1692	901	1813	1120	.467	.618	.430	.575	.533

*** SOUTHERN REGION ***

YEAR	TCW	VCW	TSE	WSE	FAR	POD	CSI	VE	PV
1984	5938	1628	3272	2005	.730	.610	.230	.440	.270
1985	4625	1596	3361	2066	.660	.600	.280	.470	.340
1986	4212	1715	3494	2195	.590	.630	.330	.520	.410
1987	3883	1486	2712	1630	.620	.600	.310	.490	.380
1988	4007	1848	3019	2040	.540	.680	.380	.570	.460
1989	6057	3088	5173	3608	.490	.700	.420	.600	.510
1990	5839	3062	4938	3552	.480	.720	.440	.620	.520
1991	6735	3476	5406	3978	.484	.736	.435	.614	.516
1992	7304	4360	6602	5169	.403	.783	.542	.685	.597
TOTAL	48600	22259	37977	26243					
AVERAGE	5400	2473	4220	2916	.542	.691	.408	.560	.458

*** CENTRAL REGION ***

YEAR	TCW	VCW	TSE	WSE	FAR	POD	CSI	VE	PV
1984	5293	1319	2908	1553	.750	.530	.200	.390	.250
1985	4794	1324	2975	1612	.720	.540	.220	.410	.280
1986	4868	1623	3427	1948	.670	.570	.270	.450	.330
1987	4331	1614	3156	1847	.630	.590	.300	.480	.370
1988	2862	928	2235	1069	.680	.480	.240	.400	.320
1989	3694	1321	2845	1551	.640	.550	.280	.450	.360
1990	4987	1645	3375	1902	.670	.560	.260	.450	.330
1991	5690	2387	4558	2837	.580	.623	.334	.510	.420
1992	5029	2352	4266	2849	.532	.668	.410	.560	.468
TOTAL	41458	14513	29745	17168					
AVERAGE	4606	1613	3305	1908	.651	.577	.302	.444	.349

*** WESTERN REGION ***

YEAR	TCW	VCW	TSE	WSE	FAR	POD	CSI	VE	PV
1984	245	25	189	32	.900	.170	.070	.140	.100
1985	151	29	133	31	.810	.230	.210	.120	.190
1986	264	24	177	23	.910	.130	.060	.110	.090
1987	166	28	208	29	.830	.140	.080	.150	.170
1988	272	38	245	41	.860	.170	.080	.150	.140
1989	222	46	218	48	.790	.220	.120	.210	.210
1990	382	59	231	63	.850	.270	.110	.210	.150
1991	449	72	324	68	.840	.210	.100	.181	.160
1992	397	80	346	91	.798	.263	.137	.230	.202
TOTAL	2548	401	2071	426					
AVERAGE	283	45	230	47	.843	.206	.101	.179	.157

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APPENDIX A

1992 VERIFICATION STATISTICS FOR EASTERN REGION

WSO	ST	TCW	VCW	UCW	TSE	WSE	FAR	POD	CSI	VE	PV
ABE	PA	45	36	9	44	35	.200	.795	.660	.798	.800
ACY	NJ	32	17	15	26	20	.469	.769	.488	.638	.531
ALB	NY	125	92	33	142	117	.264	.824	.669	.783	.736
AVL	NC	15	1	14	13	1	.933	.077	.037	.071	.067
AVP	PA	20	17	3	33	20	.150	.606	.556	.698	.850
BDL	CT	38	31	7	43	39	.184	.907	.780	.864	.816
BDR	CT	12	9	3	18	12	.250	.667	.571	.700	.750
BGM	NY	40	29	11	51	39	.275	.765	.629	.747	.725
BKW	WV	22	16	6	22	18	.273	.818	.643	.773	.727
BOS	MA	5	0	5	0	0	1.000	.000	.000	.000	.000
BTV	VT	20	17	3	24	23	.150	.958	.852	.909	.850
BUF	NY	47	20	27	27	21	.574	.778	.389	.554	.426
BWI	MD	47	24	23	57	24	.489	.421	.300	.462	.511
CAE	SC	78	49	29	74	55	.372	.743	.534	.684	.628
CAK	OH	67	23	44	37	25	.657	.676	.309	.462	.343
CAR	ME	0	0	0	1	0	.000	.000	.000	.000	.000
CHS	SC	32	22	10	36	29	.312	.806	.630	.750	.688
CLE	OH	89	53	36	70	52	.404	.743	.491	.660	.596
CLT	NC	54	33	21	61	34	.389	.557	.415	.583	.611
CMH	OH	71	44	27	60	45	.380	.750	.517	.679	.620
CON	NH	8	3	5	8	3	.625	.375	.231	.375	.375
CRW	WV	37	21	16	27	22	.432	.815	.512	.672	.568
CVG	OH	97	75	22	101	80	.227	.792	.650	.783	.773
DAY	OH	80	49	31	74	56	.387	.757	.533	.682	.613
EKN	WV	42	33	9	39	33	.214	.846	.688	.815	.786
ERI	PA	49	41	8	60	50	.163	.833	.735	.835	.837
GSO	NC	61	28	33	55	32	.541	.582	.364	.517	.459
GSP	SC	61	41	20	70	47	.328	.671	.522	.672	.672
HAR	PA	55	30	25	63	38	.455	.603	.432	.576	.546
HAT	NC	43	10	33	29	11	.767	.379	.177	.292	.233
HTS	WV	28	17	11	24	17	.393	.708	.486	.654	.607
ILG	DE	28	11	17	23	11	.607	.478	.275	.431	.393
ILM	NC	30	14	16	28	18	.533	.643	.409	.552	.467
IPT	PA	10	9	1	24	16	.100	.667	.640	.735	.900
LYH	VA	7	0	7	8	0	1.000	.000	.000	.000	.000
MFD	OH	37	12	25	23	16	.676	.696	.333	.467	.324
NYC	NY	82	44	38	85	60	.463	.706	.488	.623	.537
ORF	VA	72	31	41	51	34	.569	.667	.370	.528	.431
ORH	MA	10	5	5	13	6	.500	.462	.333	.478	.500

1992 VERIFICATION STATISTICS FOR EASTERN REGION

WSO	ST	TCW	VCW	UCW	TSE	WSE	FAR	POD	CSI	VE	PV
PHL	PA	63	26	37	57	37	.587	.649	.394	.525	.413
PIT	PA	137	63	74	108	89	.540	.824	.489	.620	.460
PVD	RI	10	3	7	4	4	.700	1.000	.364	.500	.300
PWM	ME	28	20	8	37	25	.286	.676	.556	.692	.714
RDU	NC	157	78	79	131	84	.503	.641	.400	.562	.497
RIC	VA	27	10	17	39	14	.630	.359	.250	.364	.370
ROA	VA	2	1	1	3	1	.500	.333	.250	.400	.500
ROC	NY	7	3	4	6	3	.571	.500	.300	.462	.429
SYR	NY	21	16	5	31	28	.238	.903	.778	.846	.762
TOL	OH	74	52	22	79	63	.297	.797	.624	.752	.703
WBC	DC	122	77	45	148	93	.369	.628	.482	.630	.631
YNG	OH	50	20	30	33	21	.600	.636	.333	.494	.400
RGNL	AVG	47	27	20	45	32	.425	.699	.486	.636	.575
U.S.	AVG	72	39	33	64	46	.460	.719	.475	.624	.540

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CSI = CRITICAL SUCCESS INDEX
VE = VERIFICATION EFFICIENCY
PV = PERCENTAGE OF VERIFIED COUNTY WARNINGS

1992 VERIFICATION STATISTICS FOR SOUTHERN REGION

WSO	ST	TCW	VCW	UCW	TSE	WSE	FAR	POD	CSI	VE	PV
ABI	TX	125	58	67	96	71	.536	.740	.436	.584	.464
ABQ	NM	62	20	42	26	11	.677	.423	.162	.352	.323
ACT	TX	78	43	35	93	69	.449	.742	.539	.655	.551
AGS	GA	55	16	39	31	14	.709	.452	.200	.349	.291
AHN	GA	63	25	38	43	27	.603	.628	.333	.491	.397
AMA	TX	393	250	143	335	292	.364	.872	.611	.745	.636
AQQ	FL	21	7	14	13	8	.667	.615	.296	.441	.333
ATL	GA	180	47	133	120	50	.739	.417	.198	.323	.261
AUS	TX	126	73	53	116	92	.421	.793	.544	.682	.579
BHM	AL	207	70	137	121	78	.662	.645	.302	.451	.338
BNA	TN	65	46	19	73	51	.292	.699	.554	.703	.708
BPT	TX	54	20	34	39	25	.630	.641	.342	.484	.370
BRO	TX	29	8	21	15	10	.724	.667	.278	.409	.276
BTR	LA	98	27	71	56	34	.724	.607	.268	.396	.276
CHA	TN	45	36	9	59	41	.200	.695	.603	.740	.800
CRP	TX	30	16	14	25	17	.467	.680	.436	.600	.533
CSG	GA	70	43	27	81	45	.386	.556	.417	.583	.614
DAB	FL	41	10	31	20	12	.756	.600	.235	.361	.244
DRT	TX	8	4	4	9	6	.500	.667	.462	.588	.500
ELP	TX	24	5	19	25	6	.792	.240	.136	.224	.208
ESF	LA	0	0	0	1	1	.000	1.000	1.000	1.000	.000
EYW	FL	1	0	1	1	0	1.000	.000	.000	.000	.000
FMY	FL	0	0	0	19	13	.000	.684	.684	.684	.000
FSM	AR	130	76	54	109	93	.415	.853	.571	.707	.585
FTW	TX	489	358	131	632	511	.268	.809	.670	.775	.732
GLS	TX	30	14	16	18	16	.533	.889	.471	.625	.467
HOU	TX	125	52	73	104	75	.584	.721	.424	.555	.416
HSV	AL	71	53	18	72	61	.254	.847	.678	.797	.746
JAN	MS	265	159	106	207	171	.400	.826	.546	.699	.600
JAX	FL	58	11	47	40	12	.810	.300	.138	.235	.190
LBB	TX	138	116	22	136	124	.159	.912	.785	.876	.841
LCH	LA	161	63	98	93	71	.609	.763	.372	.528	.391
LIT	AR	263	212	51	299	254	.194	.849	.726	.829	.806
MAF	TX	275	137	138	197	158	.502	.802	.472	.625	.498
MCN	GA	58	43	15	75	46	.259	.613	.511	.669	.741
MEI	MS	109	65	44	81	68	.404	.840	.544	.700	.596
MEM	TN	66	28	38	69	34	.576	.493	.318	.459	.424
MGM	AL	99	52	47	100	68	.475	.680	.463	.603	.525
MIA	FL	14	2	12	13	2	.857	.154	.080	.148	.143
MLB	FL	80	38	42	66	45	.525	.682	.417	.568	.475
MOB	AL	76	24	52	52	27	.684	.519	.260	.398	.316
NEW	LA	163	26	137	47	21	.840	.447	.114	.224	.160
OKC	OK	967	825	142	1016	909	.147	.895	.785	.874	.853
PBI	FL	31	1	30	9	1	.968	.111	.026	.050	.032
PNS	FL	24	14	10	31	12	.417	.387	.293	.473	.583

1992 VERIFICATION STATISTICS FOR SOUTHERN REGION

WSO	ST	TCW	VCW	UCW	TSE	WSE	FAR	POD	CSI	VE	PV
ROW	NM	36	16	20	52	34	.556	.654	.472	.568	.444
SAT	TX	103	25	78	40	23	.757	.575	.195	.336	.243
SAV	GA	44	14	30	34	16	.682	.471	.250	.385	.318
SHV	LA	690	559	131	760	718	.190	.945	.806	.881	.810
SJT	TX	105	38	67	61	45	.638	.738	.352	.500	.362
SPS	TX	105	52	53	98	71	.505	.724	.470	.606	.495
TBW	FL	195	85	110	132	83	.564	.629	.343	.514	.436
TLH	FL	24	11	13	28	12	.542	.429	.293	.442	.458
TRI	TN	4	0	4	5	0	1.000	.000	.000	.000	.000
TUL	OK	363	297	66	398	343	.182	.862	.739	.841	.818
TUP	MS	119	49	70	75	49	.588	.653	.338	.505	.412
TYS	TN	30	13	17	24	15	.567	.625	.366	.519	.433
VCT	TX	19	8	11	12	8	.579	.667	.348	.516	.421
RGNL	AVG	126	75	51	114	89	.403	.783	.541	.685	.597
U.S.	AVG	72	39	33	64	46	.460	.719	.475	.624	.540

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1992 VERIFICATION STATISTICS FOR CENTRAL REGION

WSO	ST	TCW	VCW	UCW	TSE	WSE	FAR	POD	CSI	VE	PV
ABR	SD	78	53	25	74	66	.321	.892	.667	.783	.679
ALO	IA	40	24	16	45	29	.400	.644	.475	.624	.600
ALS	CO	0	0	0	1	0	.000	.000	.000	.000	.000
APN	MI	14	9	5	21	17	.357	.810	.472	.743	.643
BFF	NE	176	33	143	56	35	.812	.625	.176	.293	.188
BIS	ND	65	28	37	40	29	.569	.725	.377	.543	.431
CNK	KS	226	172	54	245	219	.239	.894	.732	.830	.761
COS	CO	37	19	18	68	30	.486	.441	.349	.467	.514
COU	MO	157	78	79	111	85	.503	.766	.447	.608	.497
CPR	WY	15	3	12	14	7	.800	.500	.269	.345	.200
CYS	WY	34	10	24	48	15	.706	.312	.208	.305	.294
DBQ	IA	27	14	13	27	18	.481	.667	.450	.593	.519
DDC	KS	223	137	86	194	167	.386	.861	.596	.729	.614
DEN	CO	234	72	162	150	82	.692	.547	.263	.401	.308
DLH	MN	41	16	25	39	29	.610	.744	.453	.562	.390
DSM	IA	124	37	87	129	46	.702	.357	.213	.328	.298
DTW	MI	39	16	23	35	23	.590	.657	.397	.527	.410
DTX	MI	1	1	0	0	0	.000	.000	.000	1.000	1.000
EVV	IN	62	47	15	62	50	.242	.806	.649	.782	.758
FAR	ND	68	29	39	57	41	.574	.719	.427	.560	.427
FNT	MI	36	22	14	50	31	.389	.620	.484	.616	.611
FSD	SD	118	53	65	134	69	.551	.515	.347	.484	.449
FWA	IN	60	37	23	67	40	.383	.597	.444	.606	.617
GJT	CO	1	0	1	8	0	1.000	.000	.000	.000	.000
GLD	KS	125	104	21	164	138	.168	.841	.746	.837	.832
GRB	MI	43	15	28	34	15	.651	.441	.242	.390	.349
GRI	NE	232	74	158	131	79	.681	.603	.273	.421	.319
GRR	MI	10	10	0	33	22	.000	.667	.667	.744	1.000
HON	SD	81	26	55	68	36	.679	.529	.293	.416	.321
HTL	MI	15	8	7	10	6	.467	.600	.353	.560	.533
ICT	KS	203	113	90	174	140	.443	.805	.530	.671	.557
IND	IN	196	73	123	171	82	.628	.480	.279	.422	.372
INL	MN	33	10	23	12	7	.697	.583	.200	.378	.303
ISN	ND	7	3	4	5	3	.571	.600	.333	.500	.429
JKL	KY	15	8	7	13	9	.467	.692	.450	.607	.533
LAN	MI	24	12	12	30	15	.500	.500	.357	.500	.500
LBF	NE	124	49	75	91	60	.605	.659	.361	.507	.395
LEX	KY	36	16	20	27	19	.556	.704	.404	.556	.444
LND	WY	3	0	3	5	0	1.000	.000	.000	.000	.000
LNK	NE	56	20	36	39	22	.643	.564	.293	.442	.357
LOT	IL	61	47	14	80	57	.230	.712	.606	.738	.771
LSE	WI	24	15	9	26	19	.375	.731	.543	.680	.625

1992 VERIFICATION STATISTICS FOR CENTRAL REGION

WSO	ST	TCW	VCW	UCW	TSE	WSE	FAR	POD	CSI	VE	PV
MCI	MO	155	55	100	105	59	.645	.562	.288	.438	.355
MKX	WI	57	28	29	60	40	.509	.667	.449	.581	.491
MKG	MI	11	9	2	22	18	.182	.818	.750	.818	.818
MLI	IL	38	20	18	39	24	.474	.615	.421	.571	.526
MQT	MI	15	5	10	12	5	.667	.417	.227	.370	.333
MSN	WI	47	30	17	45	34	.362	.756	.548	.696	.638
MSP	MN	54	23	31	49	37	.574	.755	.463	.583	.426
OFK	NE	94	54	40	98	71	.426	.724	.514	.651	.575
OMA	NE	134	41	93	65	44	.694	.677	.279	.427	.306
PAH	KY	48	22	26	48	24	.542	.500	.324	.479	.458
PIA	IL	87	56	31	90	71	.356	.789	.587	.718	.644
PUB	CO	78	15	63	39	16	.808	.410	.157	.265	.192
RAP	SD	80	12	68	48	16	.850	.333	.138	.219	.150
RFD	IL	32	5	27	21	5	.844	.238	.104	.189	.156
RST	MN	61	14	47	33	14	.770	.424	.175	.298	.230
SBN	IN	45	29	16	46	33	.356	.717	.532	.681	.644
SDF	KY	84	39	45	61	37	.536	.607	.349	.524	.464
SGF	MO	210	93	117	130	106	.557	.815	.429	.585	.443
SHR	WY	6	2	4	7	2	.667	.286	.182	.308	.333
SPI	IL	75	38	37	80	43	.493	.538	.368	.523	.507
STC	MN	41	19	22	42	26	.537	.619	.406	.542	.463
STL	MO	194	122	72	171	144	.371	.842	.593	.729	.629
SUX	IA	35	23	12	43	30	.343	.698	.546	.679	.657
TOP	KS	178	85	93	122	93	.522	.762	.433	.593	.478
VTN	NE	6	0	6	2	0	1.000	.000	.000	.000	.000
RGNL	AVG	75	35	40	64	43	.532	.668	.410	.560	.468
U.S.	AVG	72	39	33	64	46	.460	.719	.475	.624	.540

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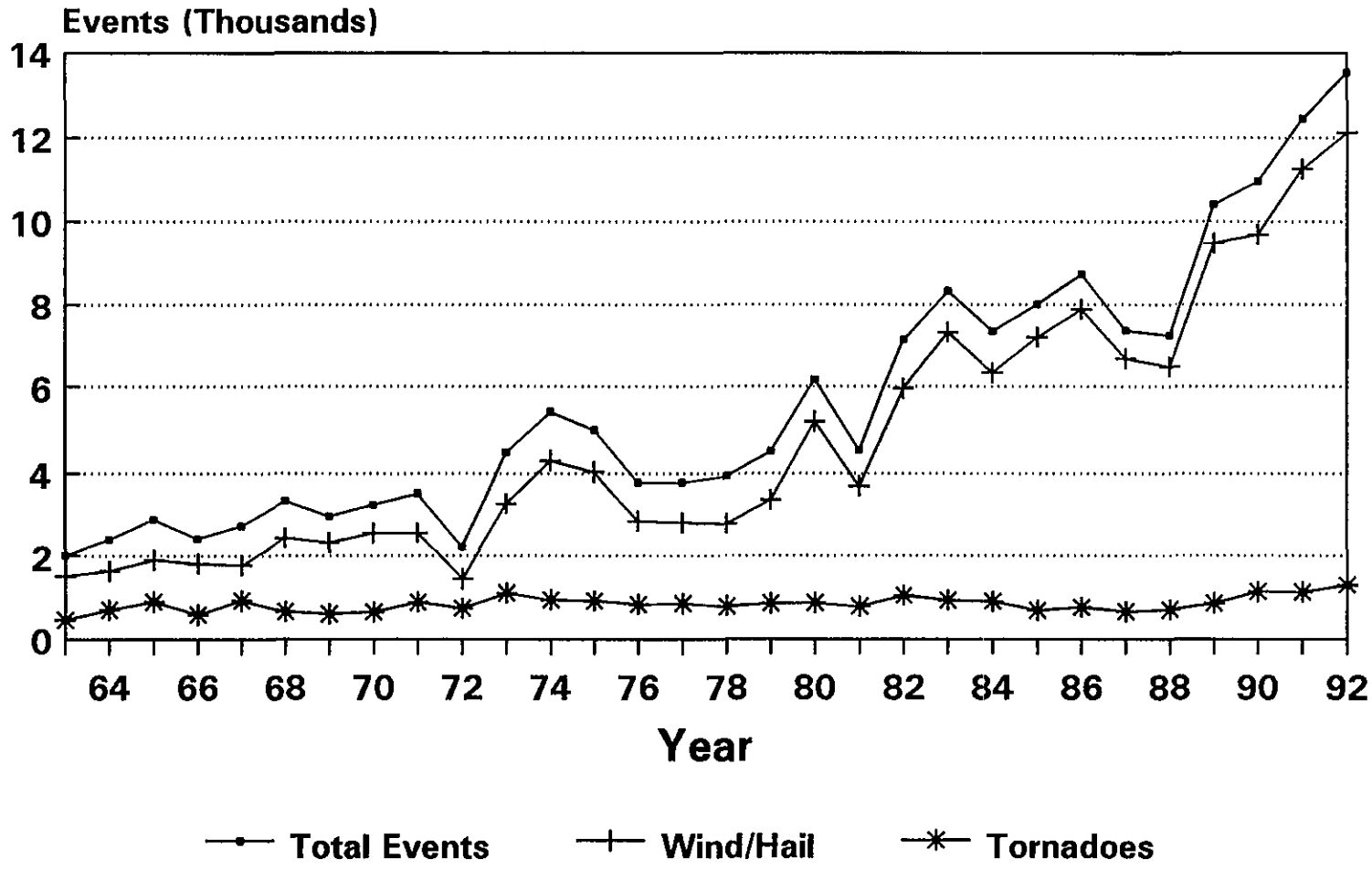
1992 VERIFICATION STATISTICS FOR WESTERN REGION

WSO	ST	TCW	VCW	UCW	TSE	WSE	FAR	POD	CSI	VE	PV
BIL	MT	46	5	41	25	5	.891	.200	.076	.141	.109
BOI	ID	62	11	51	42	11	.823	.262	.118	.212	.177
EKA	CA	0	0	0	2	0	.000	.000	.000	.000	.000
EKO	NV	0	0	0	2	0	.000	.000	.000	.000	.000
EUG	OR	1	0	1	2	0	1.000	.000	.000	.000	.000
FAT	CA	0	0	0	1	0	.000	.000	.000	.000	.000
FCA	MT	1	0	0	0	0	1.000	.000	.000	.000	.000
FLG	AZ	1	0	1	9	0	1.000	.000	.000	.000	.000
GEG	WA	4	0	4	5	1	1.000	.200	.111	.111	.000
GGW	MT	9	1	8	7	1	.889	.143	.067	.125	.111
GTF	MT	14	6	8	21	7	.571	.333	.241	.371	.429
HLN	MT	2	0	2	6	0	1.000	.000	.000	.000	.000
HVR	MT	13	4	9	6	3	.692	.500	.200	.368	.308
INW	AZ	0	0	0	1	1	.000	1.000	1.000	1.000	.000
LAS	NV	4	1	3	6	2	.750	.333	.222	.250	.250
LAX	CA	12	1	11	7	1	.917	.143	.056	.105	.083
LWS	ID	0	0	0	4	0	.000	.000	.000	.000	.000
MFR	OR	5	0	5	3	0	1.000	.000	.000	.000	.000
MSO	MT	13	1	12	5	1	.923	.200	.059	.111	.077
PDT	OR	3	1	2	5	1	.667	.200	.143	.250	.333
PDX	OR	5	1	4	3	1	.800	.333	.143	.250	.200
PHX	AZ	66	20	46	48	23	.697	.479	.245	.377	.303
PIH	ID	15	2	13	23	2	.867	.087	.056	.105	.133
RDD	CA	8	1	7	6	1	.875	.167	.077	.143	.125
RNO	NV	6	3	3	9	2	.500	.222	.167	.333	.500
SAC	CA	0	0	0	4	2	.000	.500	.500	.500	.000
SAN	CA	5	0	5	5	0	1.000	.000	.000	.000	.000
SEA	WA	20	10	10	4	4	.500	1.000	.286	.583	.500
SFO	CA	0	0	0	7	0	.000	.000	.000	.000	.000
SLC	UT	61	8	53	47	9	.869	.191	.090	.157	.131
SMX	CA	0	0	0	1	0	.000	.000	.000	.000	.000
TUS	AZ	19	3	16	14	3	.842	.214	.100	.182	.158
WMC	NV	0	0	0	1	0	.000	.000	.000	.000	.000
YKM	WA	2	1	1	5	5	.500	1.000	.833	.857	.500
YUM	AZ	0	0	0	10	5	.000	.500	.500	.500	.000
RGNL	AVG	11	2	9	10	3	.798	.263	.137	.230	.202
U.S.	AVG	72	39	33	64	46	.460	.719	.475	.624	.540

SEVERE EVENTS
1963 Through 1992



APPENDIX B

TORNADO STATISTICS FOR 1992

There were a record 1297 tornadoes in 1992, nearly one hundred and seventy more than any previous year. The previous record was 1133 tornadoes, in 1990, followed by 1132 tornadoes in 1991.

Seven states reported record tornado totals for 1992. Tornado totals for Colorado and Louisiana were nearly three times the state average, and the total of 61 tornadoes in Ohio was four times their state average. Sixteen of the record nineteen tornadoes in the state of California occurred during the month of December.

STATE RECORDS FOR 1992

STATE	1992 TOTAL	AVERAGE (1962-1991)	PREVIOUS RECORD & YEAR
CALIFORNIA	20 TORNADOES	5 TORNADOES	16 TORNADOES IN 1991
COLORADO	81 TORNADOES	26 TORNADOES	76 TORNADOES IN 1991
DELAWARE	6 TORNADOES	1 TORNADO	5 TORNADOES IN 1975
LOUISIANA	79 TORNADOES	28 TORNADOES	72 TORNADOES IN 1990
MARYLAND	13 TORNADOES	3 TORNADOES	10 TORNADOES IN 1975
NEW YORK	25 TORNADOES	6 TORNADOES	16 TORNADOES IN 1990
OHIO	61 TORNADOES	15 TORNADOES	43 TORNADOES IN 1973

The 1992 tornado season started off relatively quiet, with just 290 tornadoes the first five months of the year. The total of 53 tornadoes in April was the lowest for that month since 1962.

Then came June and July. There were 399 tornadoes across the nation during the month of June, a record total for any month of the year, and there were another 213 tornadoes in July, a record total for that particular month.

Tornadoes ravaged the central U.S. during the middle of June. There were fifty-six tornadoes on June 15th, and another sixty-seven tornadoes on the 16th. The two day total of 123 tornadoes was second only to the record total of 148 tornadoes during the "Super-Outbreak" of April 3rd-4th, 1974.

There were twenty-nine tornadoes in Kansas on the 15th, and twenty-seven tornadoes in Minnesota on the 16th. Twenty-one of the tornadoes in Minnesota were strong or violent ones, and yet there was just one fatality in the tornado outbreak, and for the month of June as a whole.

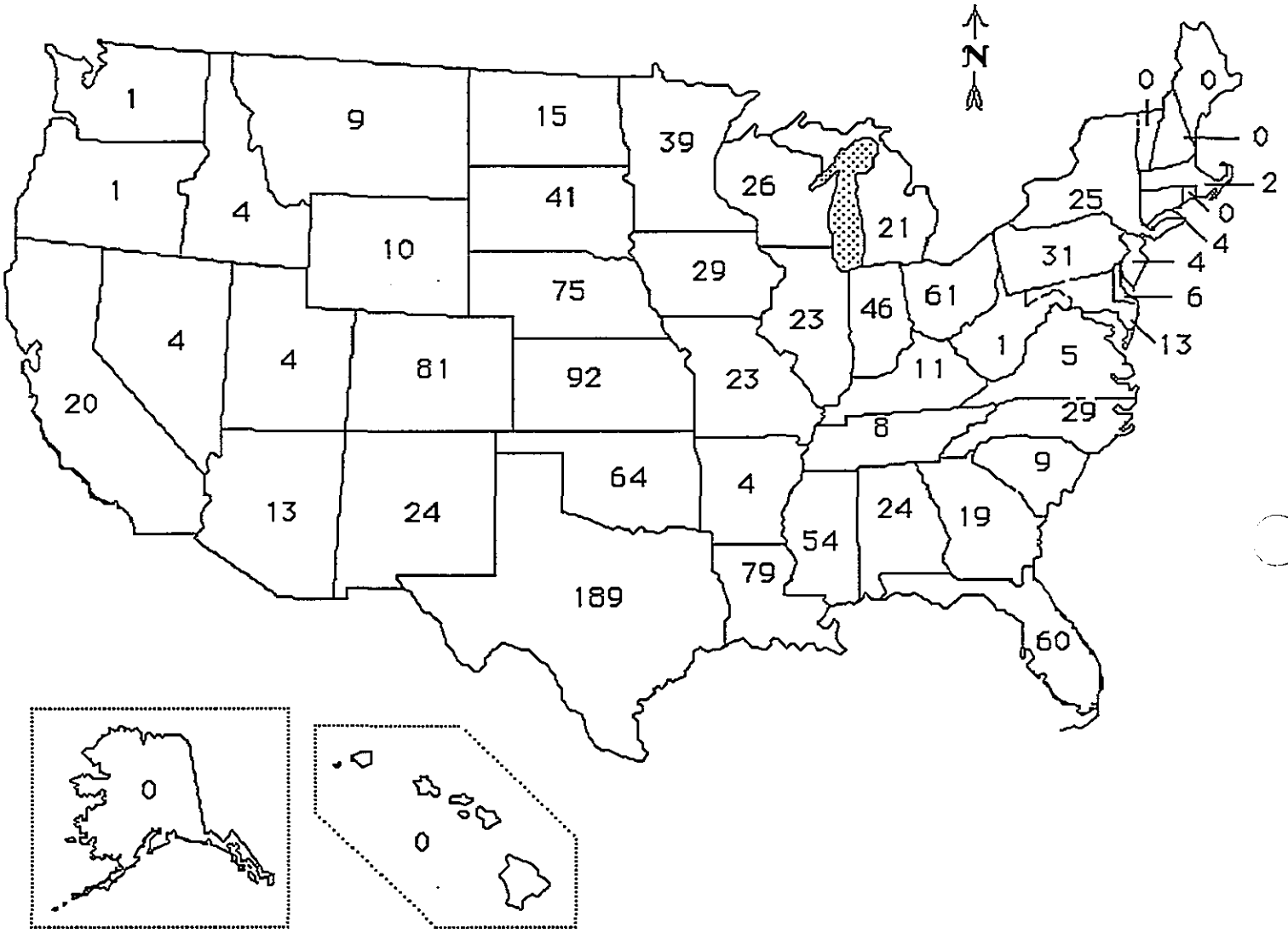
By the end of September nearly 1100 tornadoes had been reported across the nation. Despite the unusually high number of tornadoes for the year there had been just nine tornado related deaths (one death for every 122 tornadoes).

The most deadly outbreak of tornadoes in the year occurred over the weekend prior to Thanksgiving. Severe thunderstorms in the south central and eastern U.S. spawned ninety-three tornadoes over a forty-eight hour period. The tornadoes claimed twenty-six lives, including fifteen in Mississippi.

Mississippi thus continued their notoriety with respect to both number of tornado deaths per year and number of tornado deaths per square mile. One tornado killed a dozen persons in Rankin County the night of the 21st, including ten persons at Brandon.

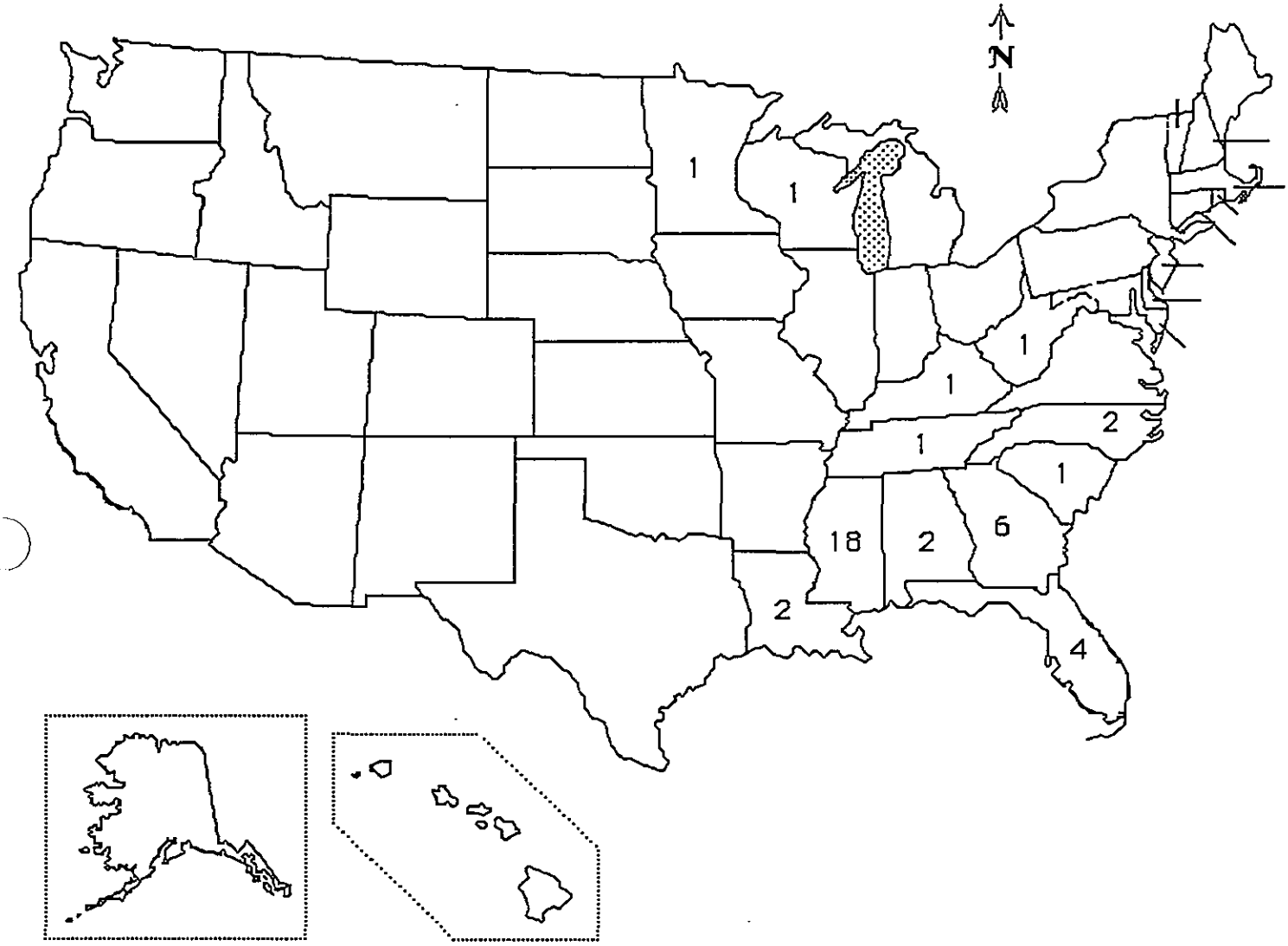
There were a record 146 tornadoes in November, and another twenty tornadoes in December, pushing the total count for the year to the record of 1277 tornadoes.

1992
TORNADOES



U.S. Department of commerce, NOAA
National Severe Storms Forecast Center, Kansas City Mo.

1992
TORNADO FATALITIES



U.S. Department of Commerce, NOOA
National Severe Storms Forecast Center, Kansas City Mo.

No. 8 A Minimum Assumption Tornado Hazard Probability Model. Joseph T. Schaefer, Donald L. Kelly, and Robert F. Abbey, May 1985, 30 p., (PB85 20692/AS).

No. 9 Verification of Severe Local Storm Forecasts Issued by the National Severe Storms Forecast Center: 1984. Preston W. Leftwich, Jr., November 1985, 23 p., (PB86 128105/AS).

No. 10 Severe Local Storm Warning Verification: 1984. Preston W. Leftwich, Jr. and Leo A. Grenier, December 1985, 14 p., (PB86 148244).

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, 16 p., (PB86 194362).

No. 13 Verification of Severe Local Storm Forecasts Issued by the National Severe Storms Forecast Center: 1985. Preston W. Leftwich, Jr., November 1986, 9 p., (PB87 137139/AS).

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