NOAA Technical Memorandum
NWS FCST 32

NWS WATCH/WARNING VERIFICATION FLASH FLOOD, WINTER STORM, AND HIGH WIND JANUARY 1980-JUNE 1986

National Weather Service
Silver Spring, Md.
July 1987

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

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(Continued on inside back cover)

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Robert E. LaPlante
Program Requirements and Development Division
Office of Meteorology

National Weather Service
Silver Spring, Md.
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UNITED STATES
DEPARTMENT OF COMMERCE
Malcolm Baldrige, Secretary

National Oceanic and
Atmospheric Administration
Anthony J. Calio
Under Secretary

National Weather Service
Richard E. Hallgren,
Assistant Administrator

TABLE OF CONTENTS

ABSTRACT

This study presents flash flood, winter storm, and high wind watch and warning statistics of lead time, probability of detection, false alarm ratio, and critical success index. The period of record is 1980 through 1985 for flash floods and 1980 through June 1986 for winter storms and high winds. Several years of data that were obtained under similar procedures are presented so that trends in watch/warning performance can be established. Two years of detailed statistics, not previously published, of flash floods, winter storms, and high winds are contained in an appendix.

1. INTRODUCTION

In January 1979, the National Weather Service (NWS) implemented a new program to verify flash floods, winter storms, and high winds. The Weather Service Forecast Offices (WSFO) listed in Appendix I were required to enter verification data on standardized logs each month for flash flood watches and warnings; winter storm watches and warnings, specifying if the warning is for blizzard, heavy snow or freezing rain; and high wind and duststorm/sandstorm warnings. The focus of this report is to present together several years of data that were obtained under similar procedures and analyzed by NWS Headquarters (WSH) so that trends in watch/warning performance can be established. Some of the information presented here has already been documented by Campbell (1981, 1982, and 1985) and Thompson (1985a and 1985b). In addition, two years of detailed statistics, not previously published, of flash floods, winter storms, and high winds will be presented in Appendix II.

This document is not intended to explain variation in trends, but simply to present in a general format the results of a basic statistical summary. This report will be the last in a series with a similar format that began with data from 1980. The results from 1979, the first year of the flash flood, winter storm, and high wind watch/warning program, were limited and therefore, not included in this report.

Beginning in January 1986 for flash floods and July 1986 for winter storms and high winds, an improved, highly automated program of watch/warning verification was begun at the National Severe Storms Forecast Center (NSSFC). The increased automation of the NSSFC verification system will permit more opportunities to stratify the data to better address specific issues. Additionally, the new system will be more timely and consistent with other severe weather verification.

2. SCORES

A brief description of some of the watch/warning verification terms follows.

Probability of Detection (POD). The POD is the fraction of total events that were warned and can be expressed as:

$$\text{POD} = \frac{\text{number of warned events}}{\text{total number of events}} .$$

False Alarm Ratio (FAR). The FAR is a measure of overwarning and is the fraction of warnings that did not verify. It can be expressed as:

$$\text{FAR} = \frac{\text{number of unverified warnings}}{\text{number of warnings issued}} .$$

Critical Success Index (CSI). The CSI is a threat score defined by the fraction of time that the severe (threat) event was correctly forecast when either the severe (threat) event occurred and/or was forecast. The CSI can have a value between 0 (worst possible value) and 1 (best possible value) and can be expressed in terms of the POD and the FAR as follows:

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

Percent Verified (PV). The percent verified is the percent of warnings issued that verified and can be expressed as:

$$\text{Percent Verified} = \frac{\text{number of verified warnings}}{\text{number of warnings issued}} \times 100$$

Also, the PV is equivalent to 100(1 - FAR).

Lead Time. Lead time is the difference (usually expressed in hours or minutes) between the time a warning or a watch was issued and the time the verifying event first occurs in the warned area. An event in progress when a warning is issued has a zero lead time.

Average Lead Time. Average lead time is simply the average of a set of lead times.

3. PROBLEMS

The following is a partial list of problems and inconsistencies of the data that should be kept in mind when using the findings of this report.

1. In 1980, each forecast office was given the option of entering all watches, warnings, and events or a subset that could consist of one or several zones, the only exception being all flash flood warnings and events had to be entered. Beginning in January 1981, forecast offices were instructed to choose one zone to verify for flash flood watches, winter storm watches and warnings and high wind warnings. The purpose was to provide a more consistent verification program. Consequently, the number of reported flash flood events with a watch decreased substantially. Since the probability of detecting a flash flood event with a watch decreased significantly, the POD and the CSI for flash flood watches were omitted from this report.

2. Verifying individual warnings versus verifying for a zone or counties can make a difference in lead time distribution. If a warning is issued for several counties and the event begins at a different time in each county, only the earliest known time would be used as the lead time for the warning, while each county's earliest known time would be used as its own lead time. This is mainly a problem for flash flood warnings since all winter weather and high wind warnings are verified strictly on a zone basis.

3. There is a problem with the definition of the duration of a flash flood as stated in WSOM Chapter E-13 when the flooding event exceeds the stated valid period of four hours. Some aspects of this problem are:

a) Warnings are extended often and the majority of these extensions have a built-in zero lead time. Since the extensions are counted as separate warnings, the overall warning lead time is reduced.

b) There may be some exaggeration in the number of events because of the subjective analysis of the watch/warning logs. It is often difficult to tell whether an event used to verify a warning is new or the continuation of an event.

c) A few offices issue flash flood warnings that are in effect for an unusually long period of time (over 18 hours is considered unusual). While this practice eliminates the extension problem, it conflicts with the definition of a flash flood as a short term event.

4. For winter storms and high winds there is a break and a realignment of the data. From 1980 through 1983, the data are grouped by calendar year. The data from January 1984 to July 1984 are not included. From July 1984 through June 1986, the data are divided into two one-year seasons that run from July of one year through June of the next year. All flash flood data are grouped by calendar year.

5. Occasionally the logs are incomplete or are filled out incorrectly with contradictory information included in remarks. In these cases the tabulation calls for judgment and is, therefore, subjective and to some degree inconsistent from year to year. Instructions for filling out the logs require all flash flood warnings to be verified and all flash flood events without a watch or warning to be entered on the log. For the remainder of watch/warning issuances and events, each forecast office preselects one zone to verify for flash flood watches and one zone to verify for winter weather and high wind.

4. FLASH FLOOD

A flash flood is defined by WSOM Chapter E-13 as follows: "A flood which follows within a few hours of heavy or excessive rainfall, dam or levee failure, or a sudden release of water impounded by an ice jam." A wall of water rushing through a narrow channel is not the only type of flash flood; water may rise rapidly due to poor drainage. Ponding of water is especially common in low lying coastal regions.

Appendix II contains detailed flash flood statistics for the calendar years 1984 and 1985; refer to Campbell (1981, 1982, and 1985) for detailed statistics for 1980 through 1983.

Figure 1 shows the 6-year average (1980-1985) of the annual number of flash flood events by WSFO management area and the percentage of these events in each region. The Southern Region had the largest percentage, 57 percent, followed by the Central Region with 17 percent. The annual variability of the regional percentage of events is rather small.

Some of the figures to follow contain regional breakdowns of average lead time, probability of detection, false alarm ratio, and critical success index of watches and warnings. Note, if in any one year a region had insufficient data, its score was omitted and a "▲" was plotted instead.

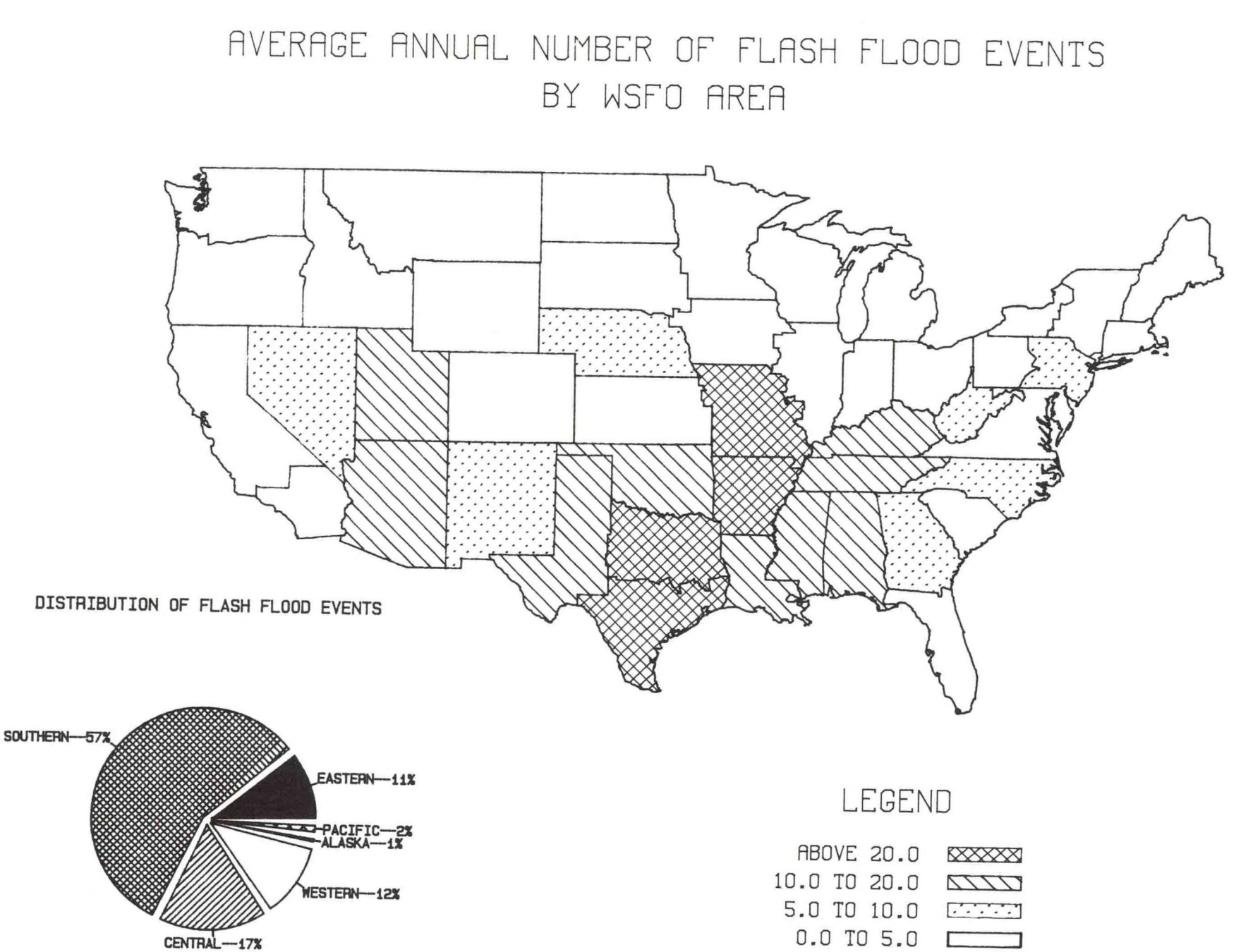

Figure 1. For the years 1980 - 1985.

National average lead times of flash flood watches and warnings are presented in figure 2. Except for 1980, when the WSFO's had the option of reporting all the flash flood watches, only watches from the preselected zone of each forecast office were verified. The average lead time for warnings was 40 minutes and remained fairly constant from year to year. The average lead time for watches was 5.3 hours, but exhibited more annual variability, and had a very slight increase with time. Figure 3 and figure 4 show the regional breakdown of the average lead time of flash flood watches and warnings, respectively.

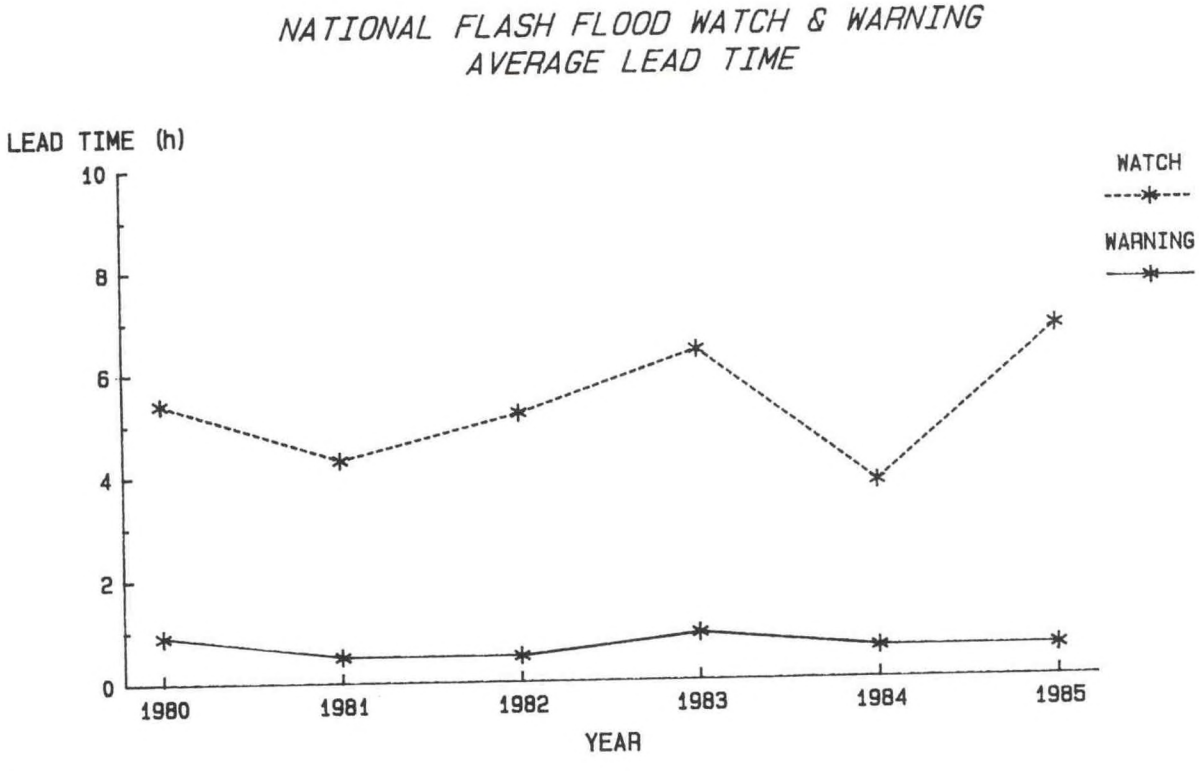

Figure 2.

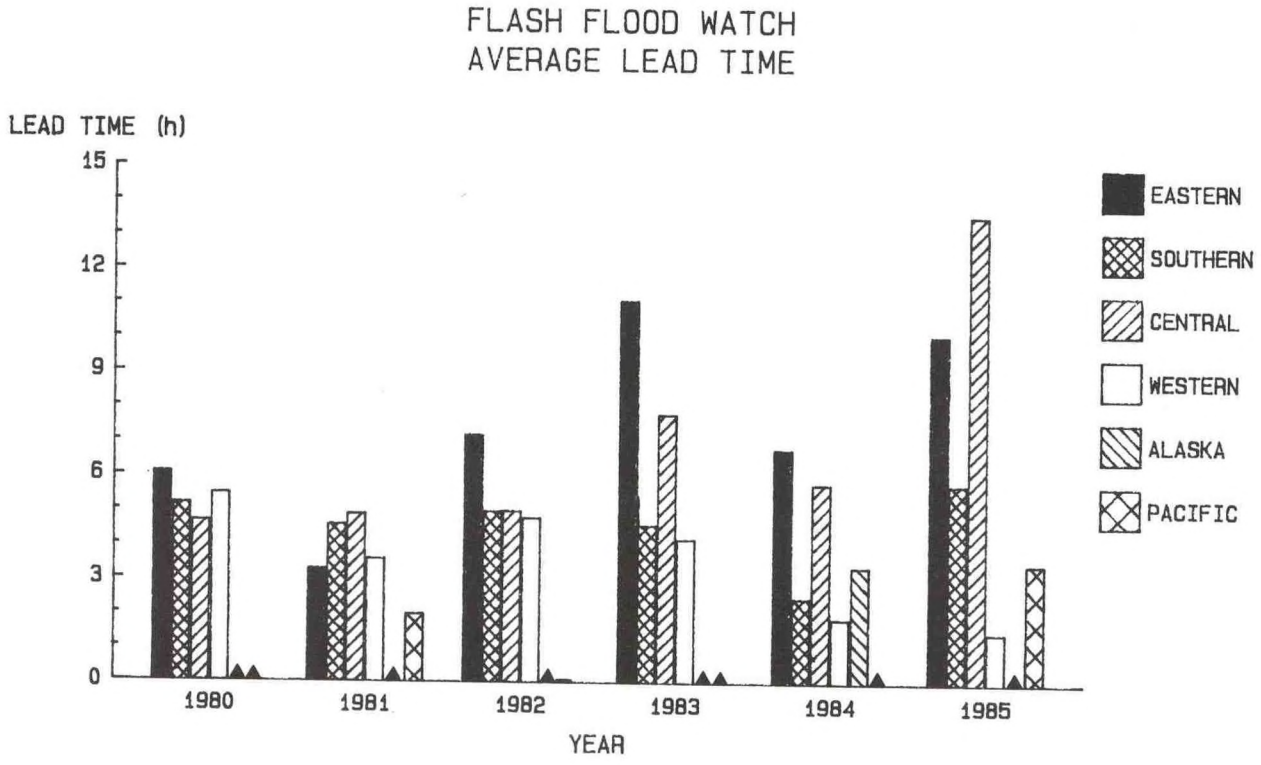

Figure 3. Regional breakdown of average lead time. Regions not plotted had insufficient data and are denoted by a "▲".

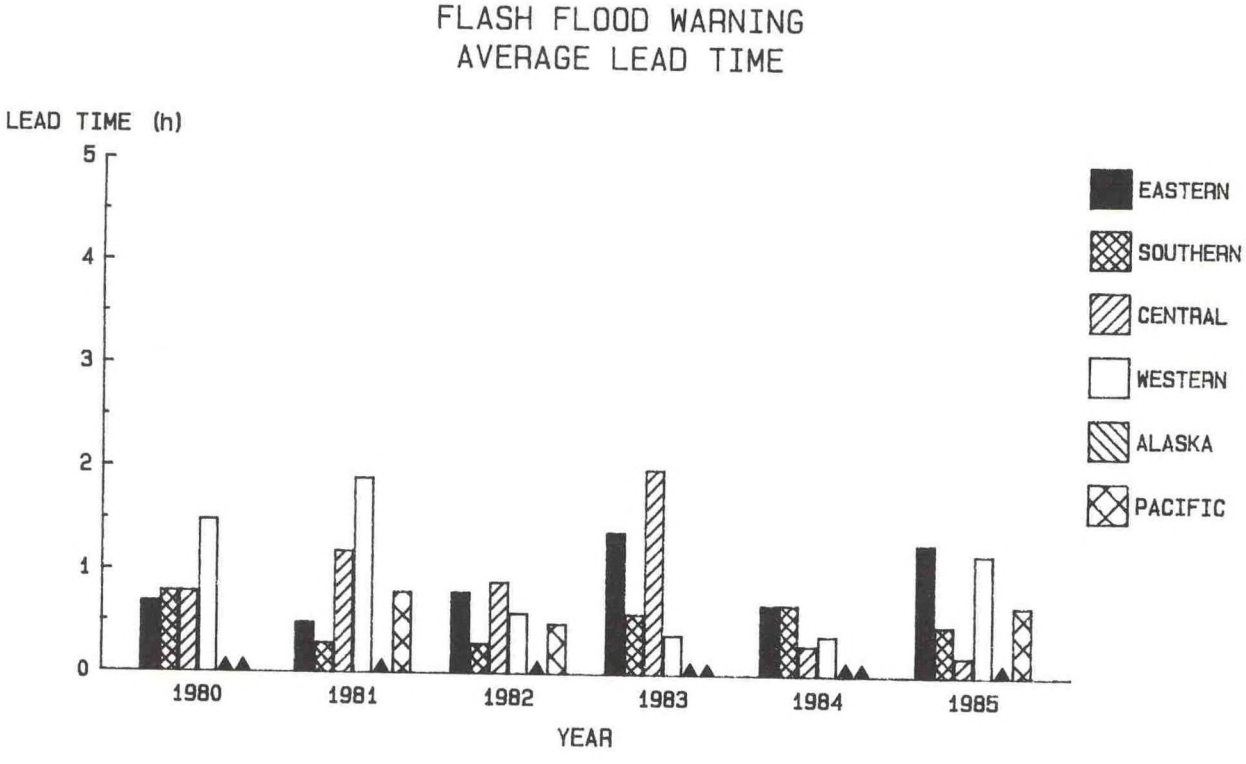

Figure 4. Same as Fig. 3, except for flash flood warning.

National probability of detection (POD), false alarm ratio (FAR), and critical success index (CSI) for flash flood warnings and FAR for flash flood watches are shown in figure 5. The POD and CSI for watches are not presented because the number of events covered by a watch was highly biased as a result of only logging watches from preselected zones. The FAR for warnings has averaged .15, and shows a very slight increase over the period. The POD and CSI for warnings have held steady near .80 and .70, respectively. The FAR for watches, after increasing in 1981 and 1982, settled near .55. Regional FAR scores for watches and warnings are shown in figures 6 and 7, respectively; regional POD and CSI scores for warnings are shown in figures 8 and 9, respectively.

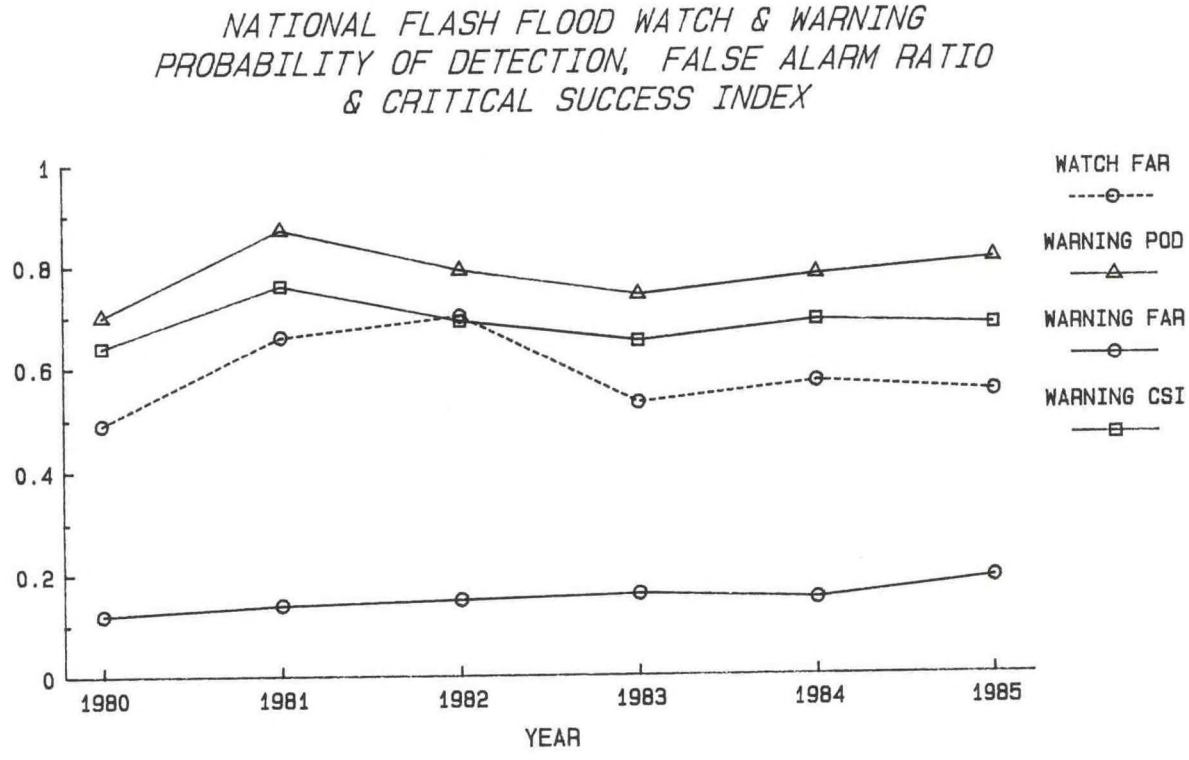

Figure 5.

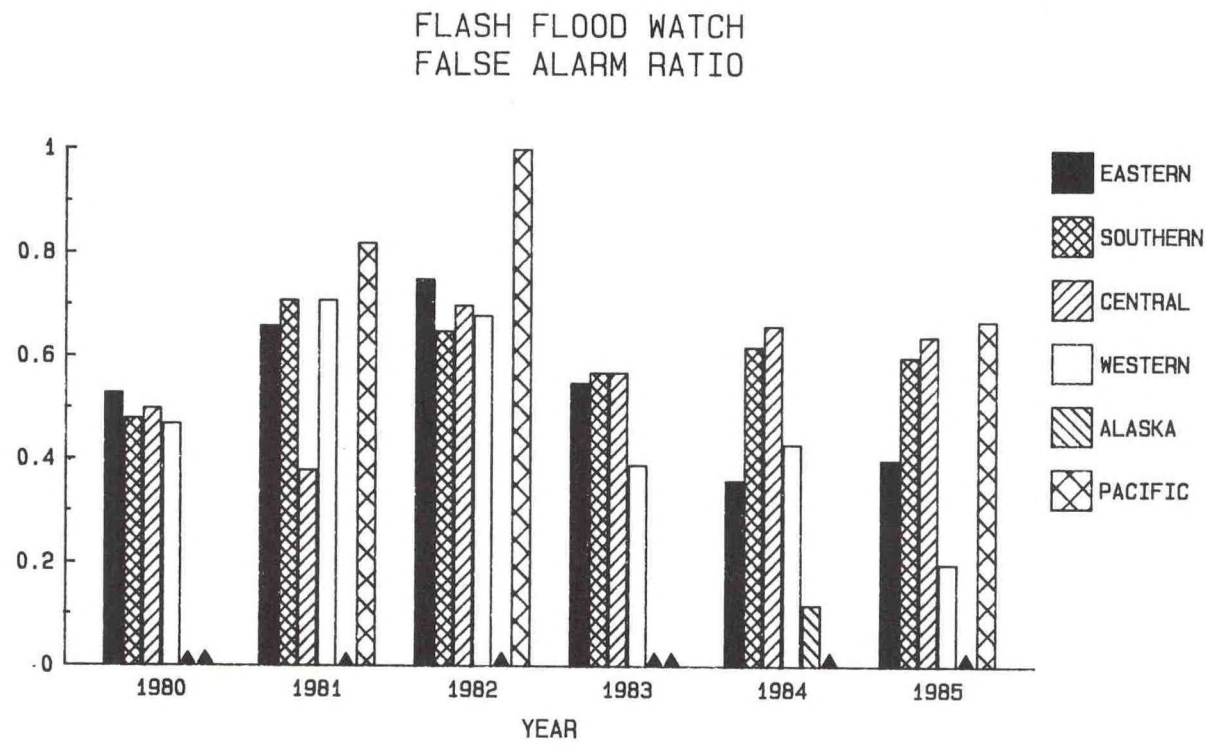

Figure 6. Regional breakdown of flash flood watch false alarm ratio.

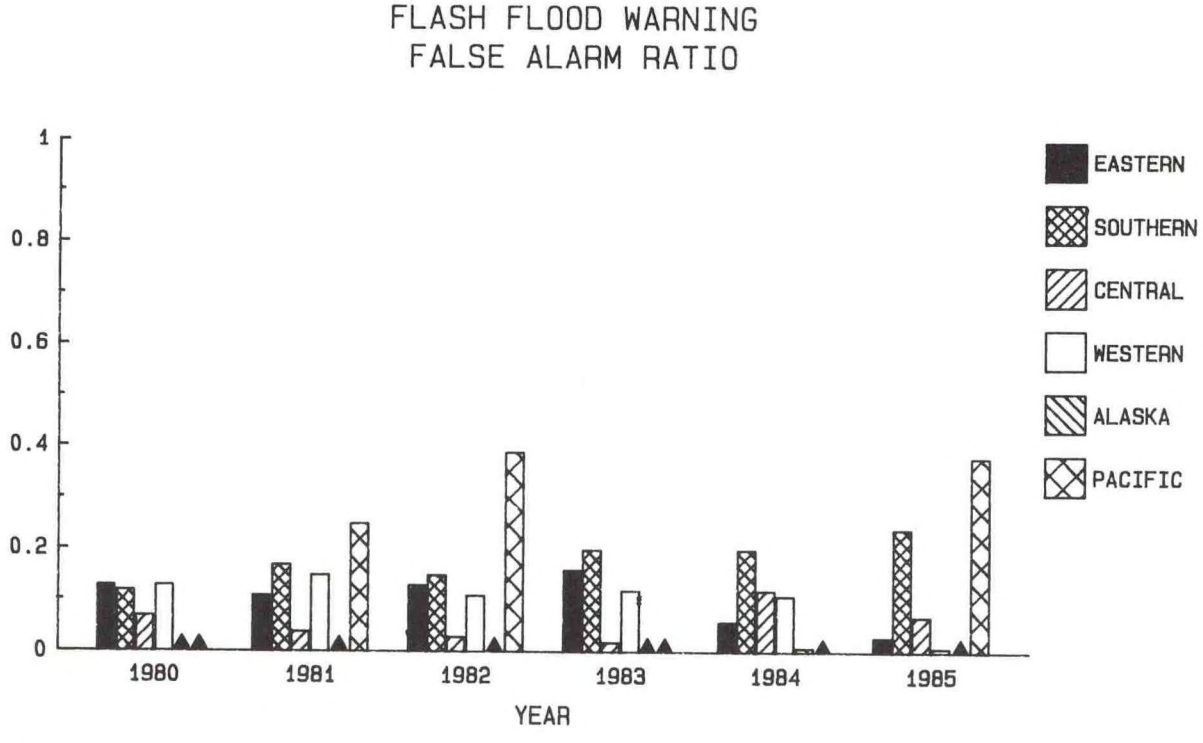

Figure 7. Regional breakdown of flash flood warning false alarm ratio.

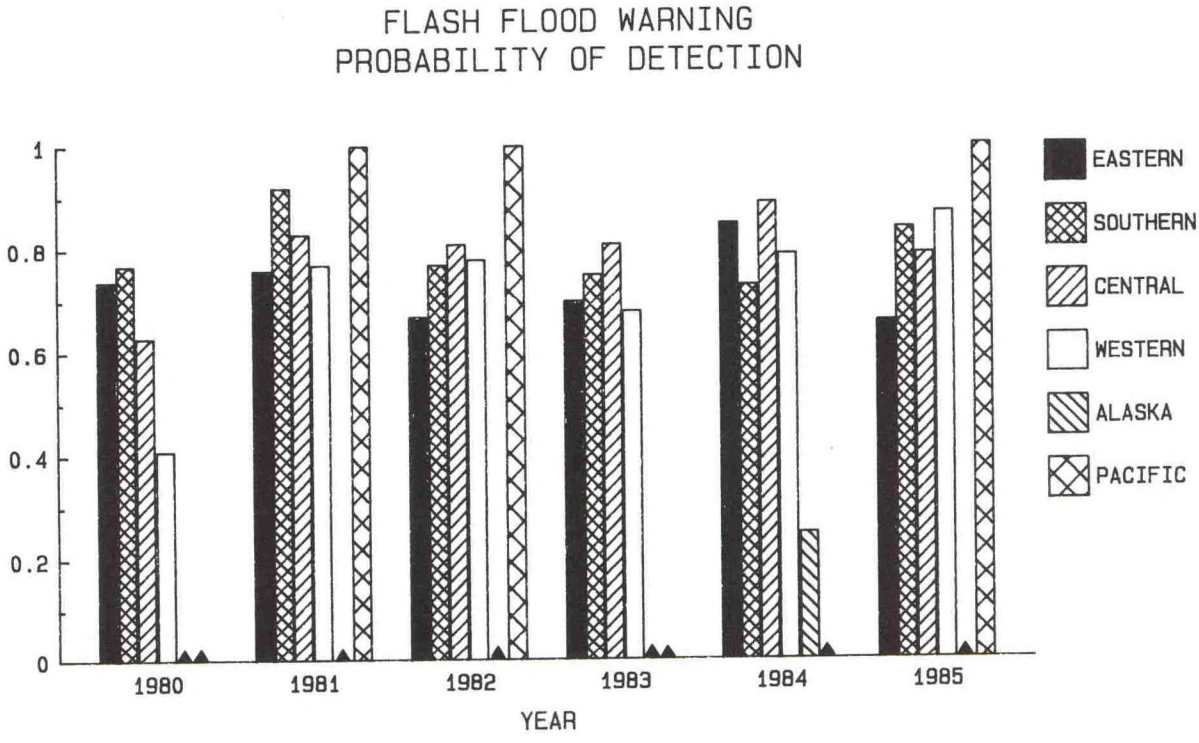

Figure 8. Regional breakdown of flash flood warning probability of detection.

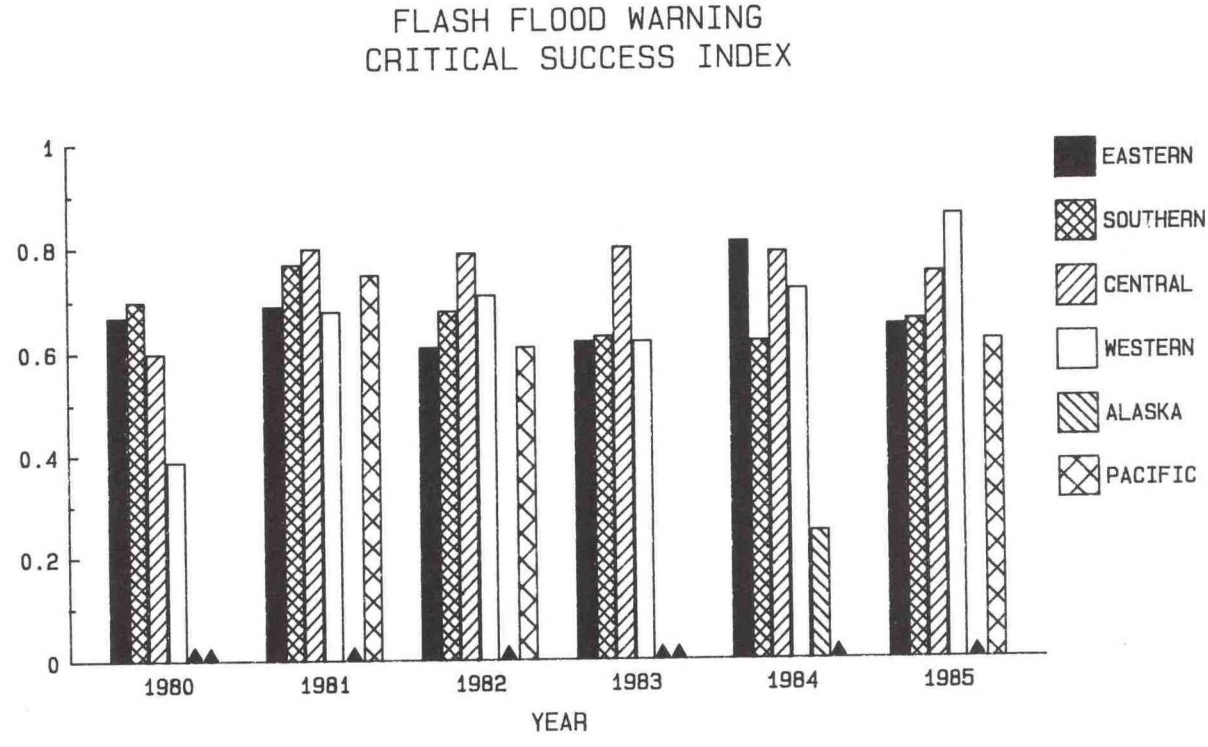

Figure 9. Regional breakdown of flash flood warning critical success index.

5. WINTER STORM

For winter storms there is a break and a realignment of the data. For the four years 1980 through 1983, the data are grouped by calendar year. The data from January 1984 to July 1984 is not included. From July 1984 through June 1986, the data are divided into two 1-year seasons that run from July of one year through June of the next.

To provide consistency to the data, what were previously referred to as group winter storm warnings and events from 1980 through 1983 (which consisted of winter storm, blizzard, heavy snow, and freezing rain warnings and events) are now simply referred to as winter storm warnings and events. This reclassification will provide homogeneity with the two seasons, 1984-85 and 1985-86, that are presented in detail in Appendix II. Definitions, as stated in WSOM Chapter C-42, for winter storm watch and warnings and the various winter events can be found in Appendix III.

Figure 10 shows the 6-year average of the annual number of winter storm events by WSFO management area and the percentage of these events in each region. When interpreting this figure, please keep in mind the first problem stated in the Problems section of this report. That is, during 1980 each office was given the option of entering all winter storm issuances and events or a subset that could consist of one or several zones; while after 1980, only those issuances and events that occurred in the preselected zone were logged. Consequently, for some forecast offices the number of winter storm events reported in 1980 is higher than in the succeeding years. Since this happened in only one of six years of data, the overall six year average of the annual number of events is not significantly affected. The largest percentage of events, 32%, occurred in the Central Region, followed by the Western Region with 27%.

As with flash floods, in the figures that show regional statistics, a "▲" indicates that insufficient data were reported by a region. Because of operational procedures, the Alaskan Region's winter storm warnings are not normally preceded by a watch. As a result, the Alaskan Region's lead time, POD, FAR, and CSI scores have been omitted from the winter storm watch figures.

National average lead times of winter storm watches and warnings are presented in figure 11. The average lead time for watches exhibits a steady increase from 18.2 hours in 1980 to 23.9 hours in the 1985-86 winter season. The average lead time for warnings has increased, but not steadily, from 5.1 hours to 7.6 hours over the same period. Figures 12 and 13 show the regional breakdowns for watches and warnings, respectively.

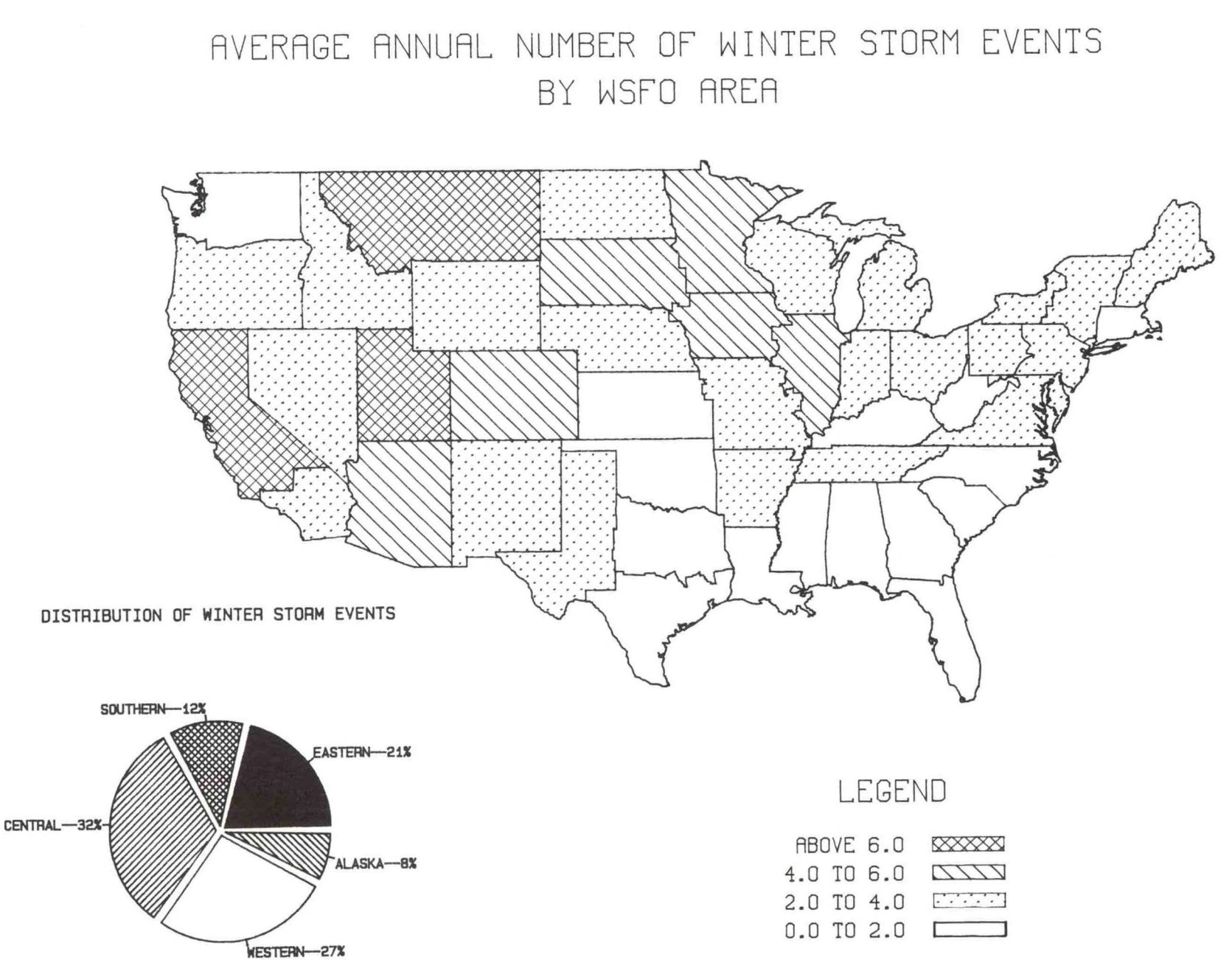

Figure 10. For the years 1980-83 and the seasons 1984-85 and 1985-86.

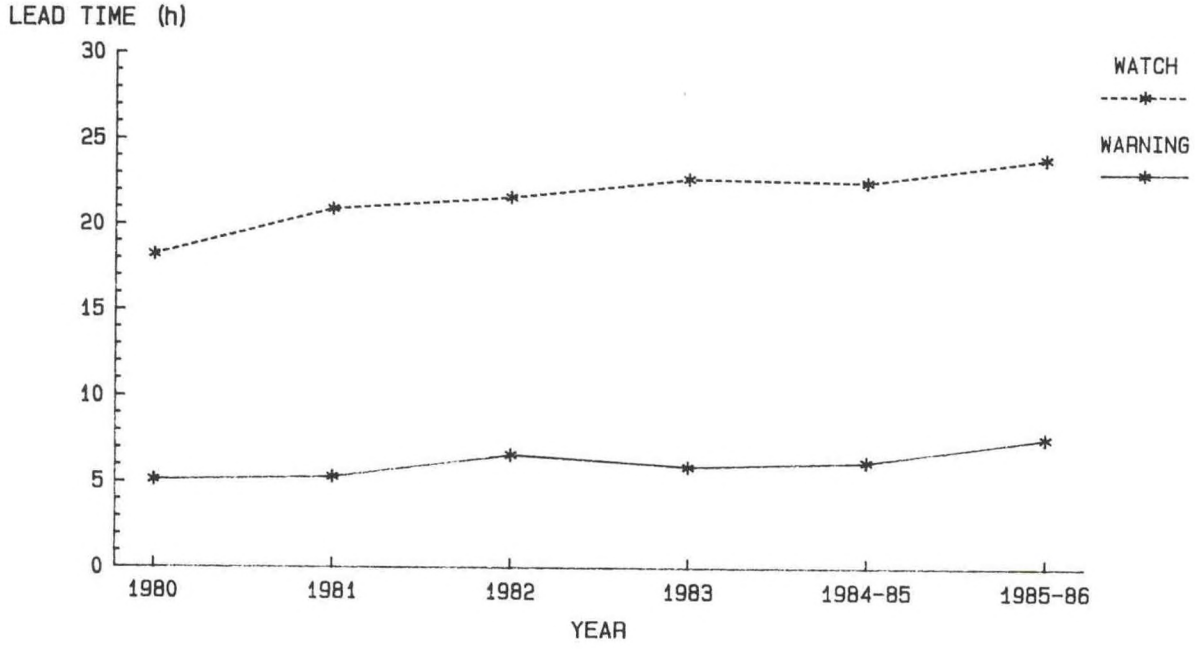
NATIONAL WINTER STORM WATCH & WARNING
AVERAGE LEAD TIME
LEAD TIME (h)
30
25
20
15
10
5
0
1980
1981
1982
1983
1984-85
1985-86
YEAR
WATCH
WARNING

Figure 11.

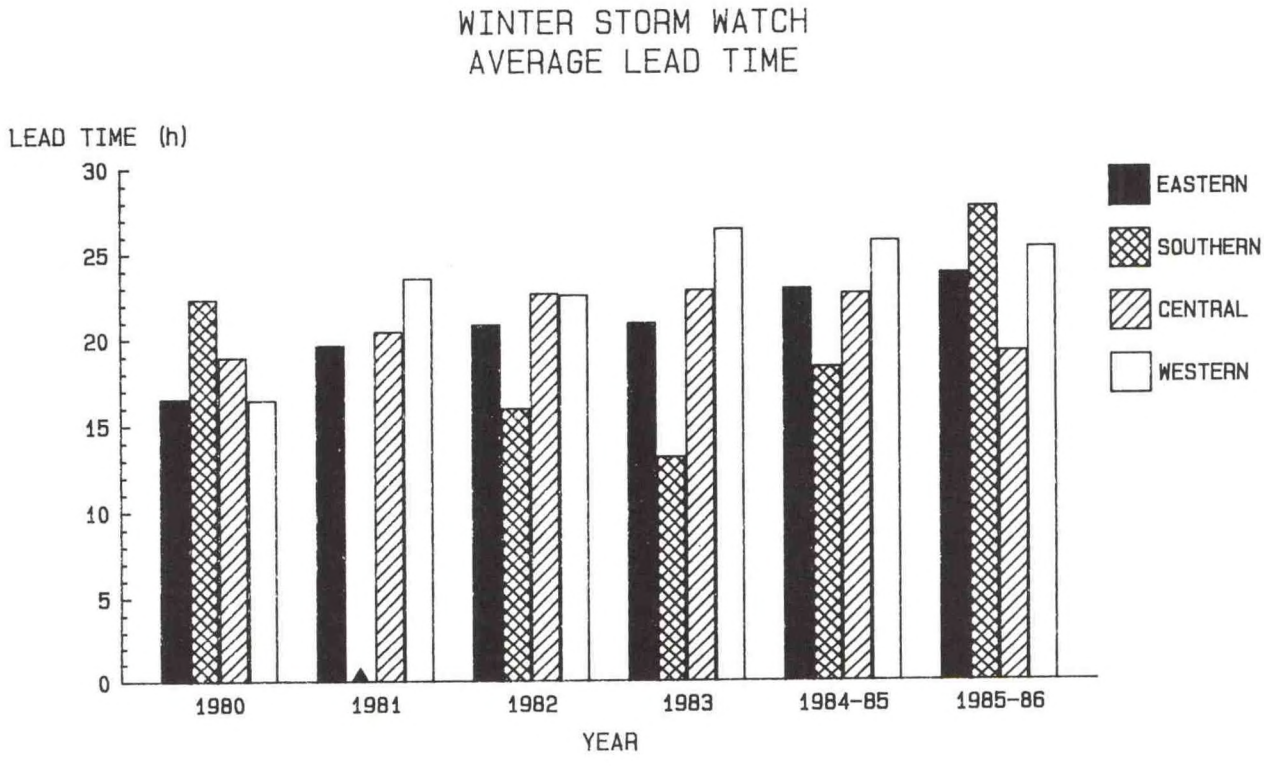

Figure 12. Regional breakdown of average lead time. Regions not plotted had insufficient data and are denoted by a "▲".

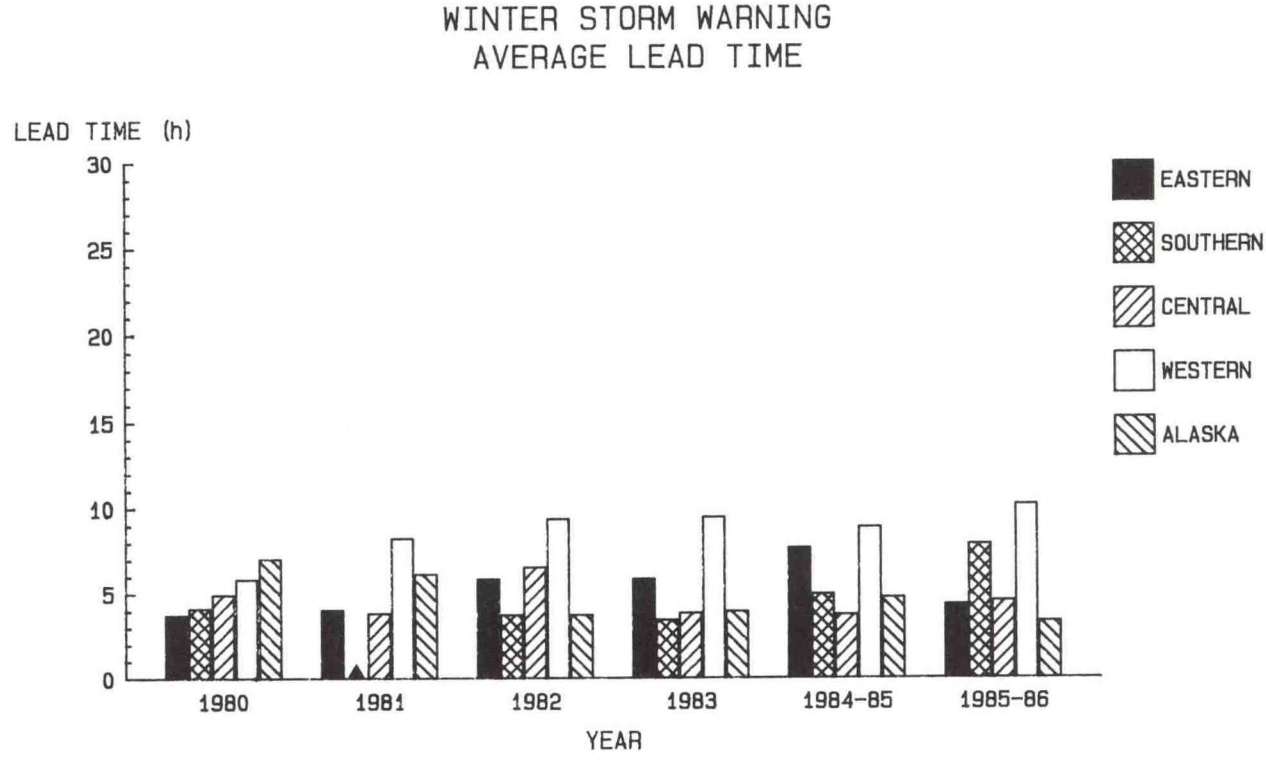

Figure 13. Same as Fig. 12, except for winter storm warning.

National POD, FAR, and CSI scores for watches are shown in figure 14. For watches, the POD has increased slightly over the period; the FAR and the CSI have remained essentially constant. National POD, FAR, and CSI scores for warnings are shown in figure 15. The general improvement in the CSI is related to the slight increase in the POD and slight decrease in the FAR. Figures 16 and 17 show the regional values of POD and FAR for watches, respectively; figures 18 and 19 show the regional values of POD and FAR for warnings, respectively. Figures 20 and 21 show the regional CSI scores for watches and warnings, respectively.

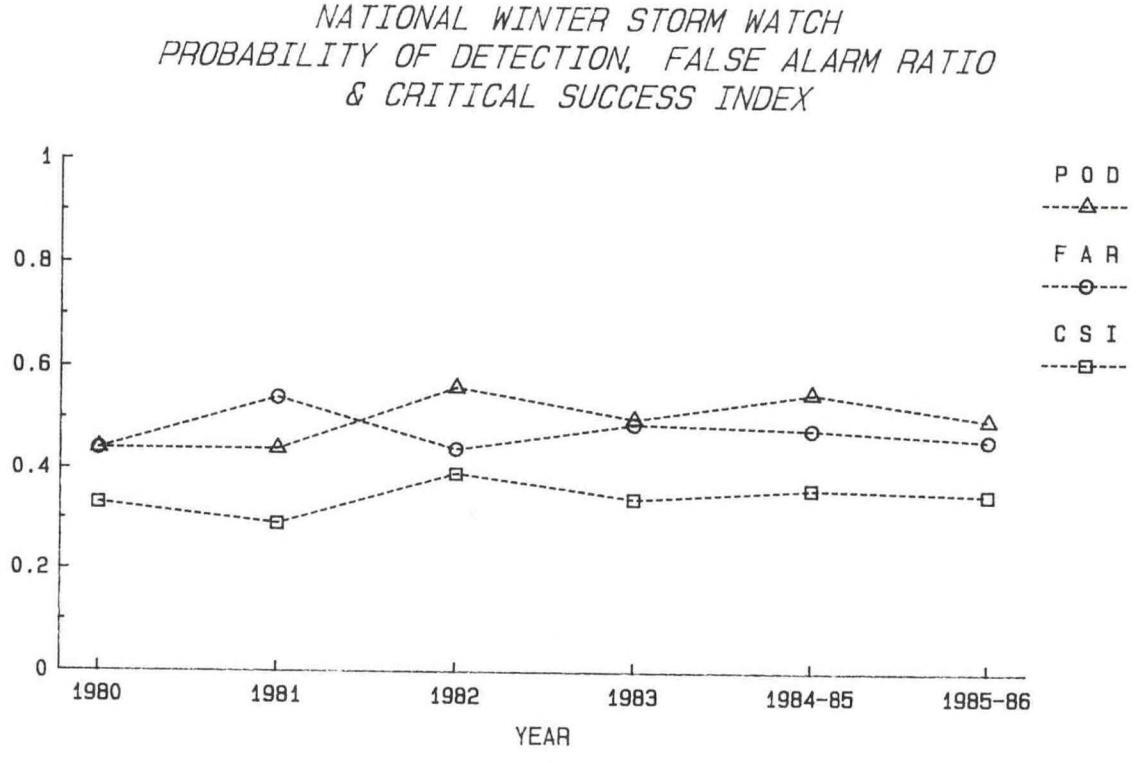

Figure 14.

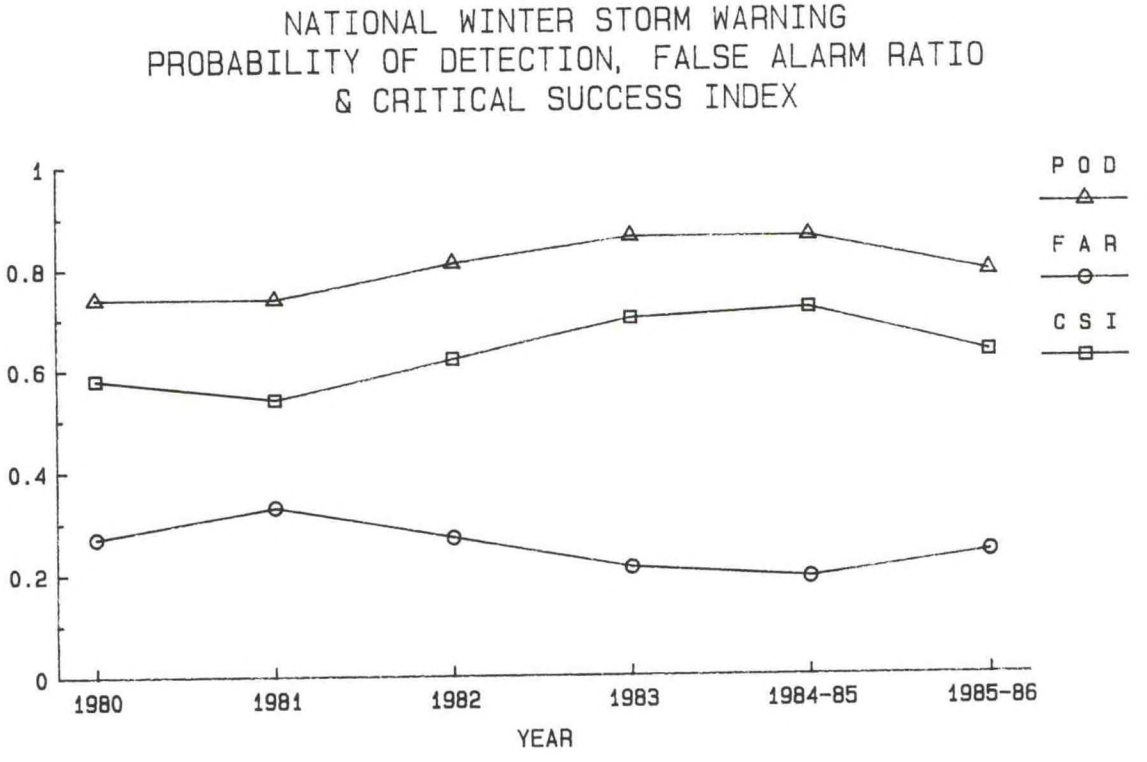
NATIONAL WINTER STORM WARNING
PROBABILITY OF DETECTION, FALSE ALARM RATIO
& CRITICAL SUCCESS INDEX
1
0.8
0.6
0.4
0.2
0
1980
1981
1982
1983
1984-85
1985-86
YEAR
P O D
F A R
C S I

Figure 15.

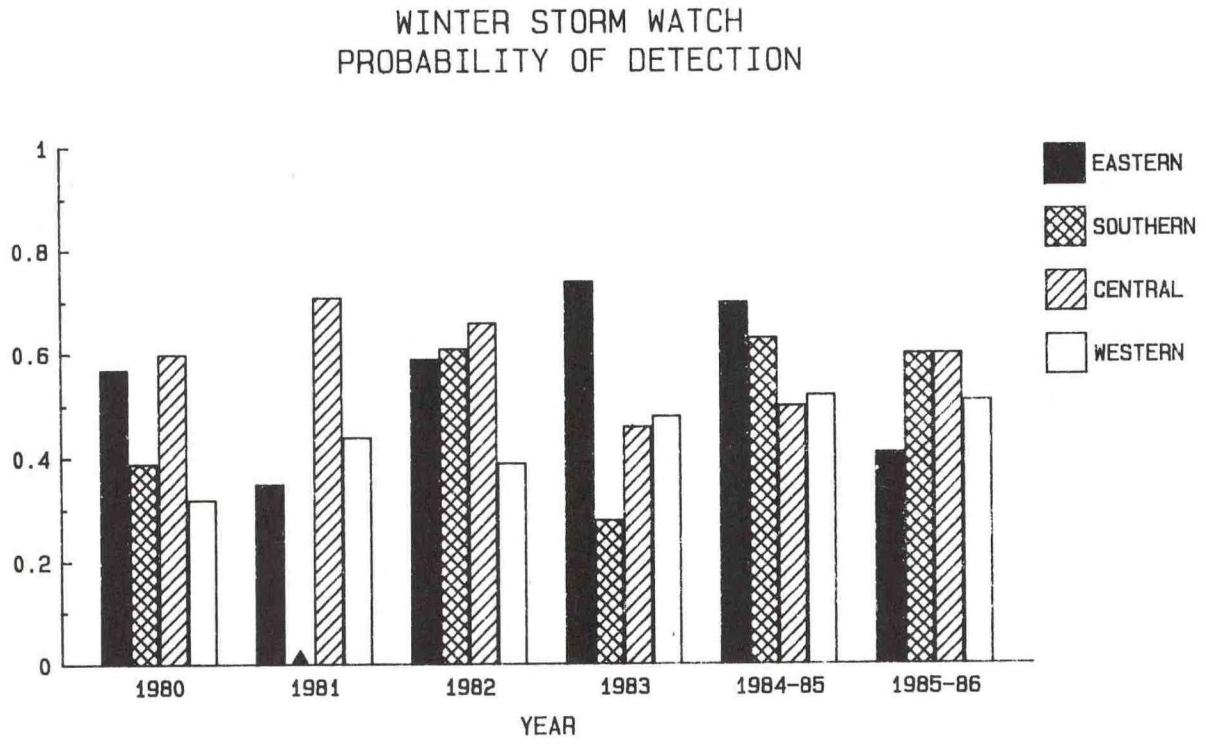

Figure 16. Regional breakdown of winter storm watch probability of detection.

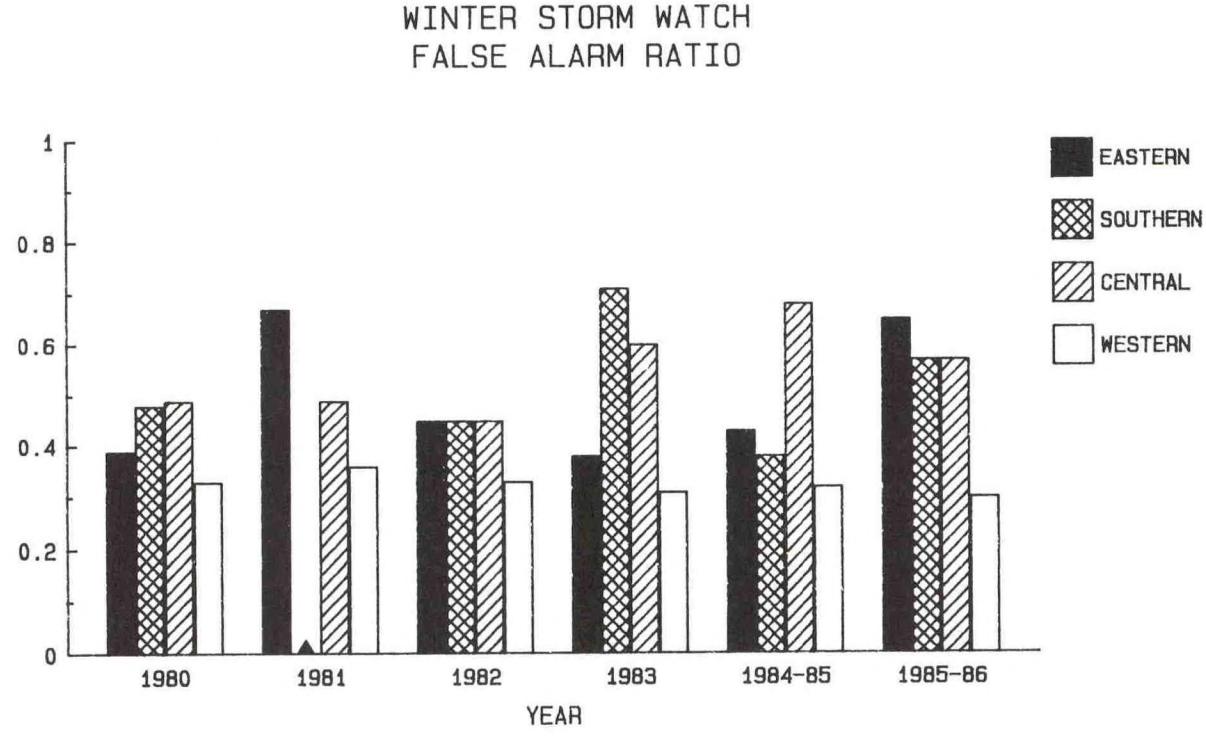

Figure 17. Regional breakdown of winter storm watch false alarm ratio.

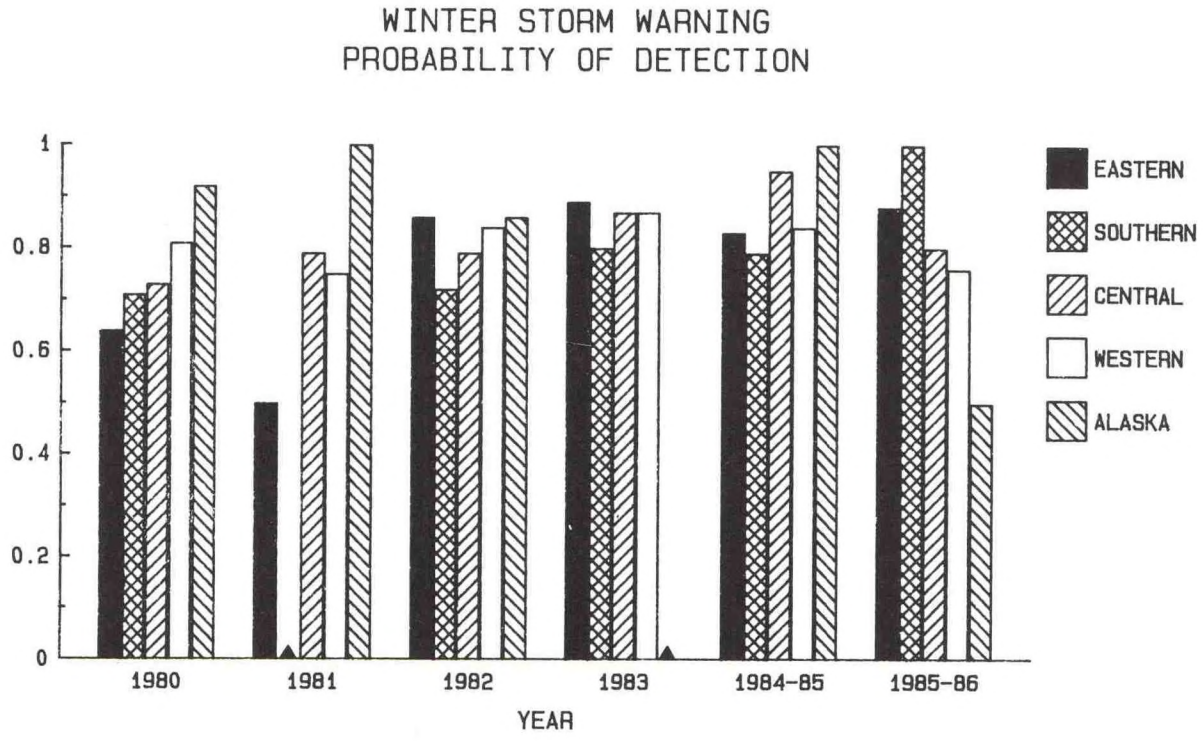

Figure 18. Regional breakdown of winter storm warning probability of detection.

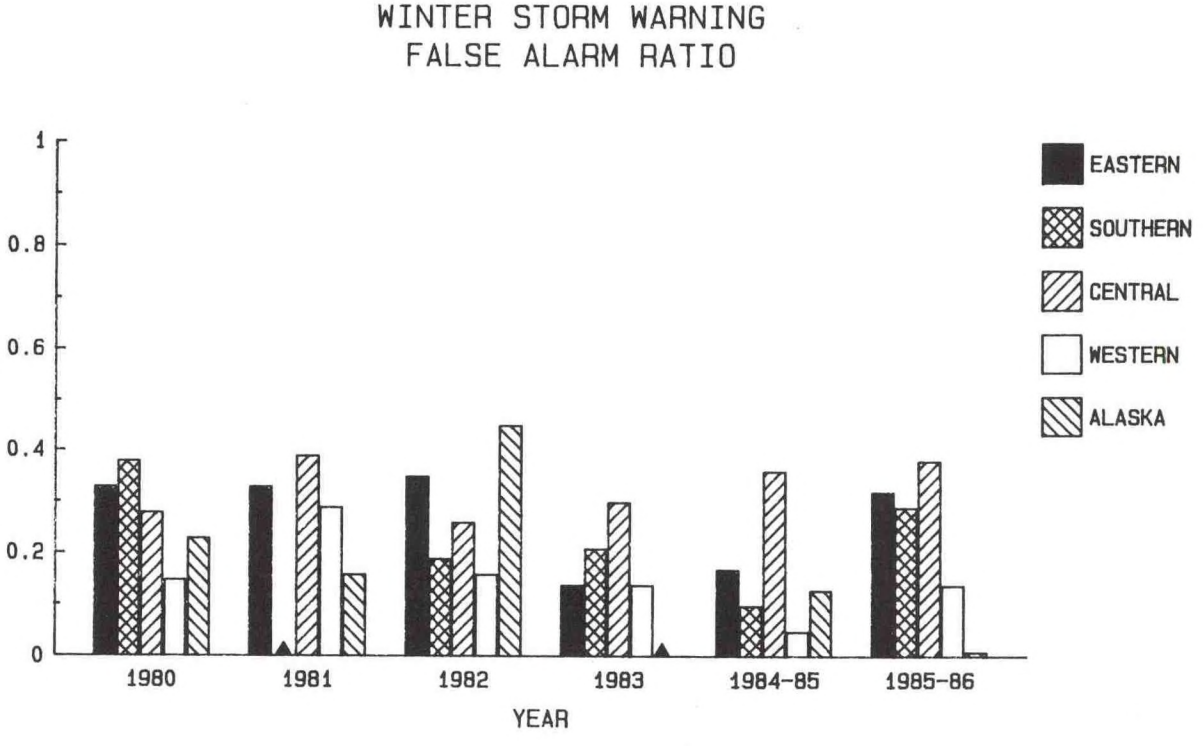

Figure 19. Regional breakdown of winter storm warning false alarm ratio.

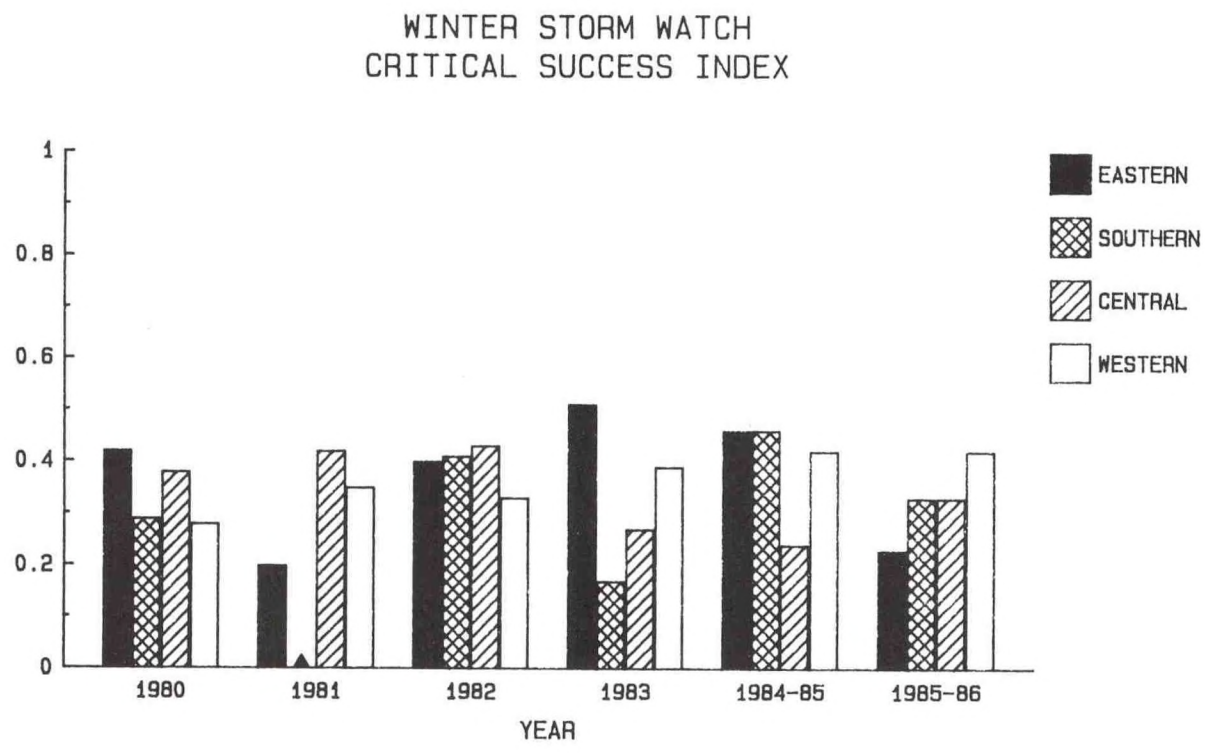

Figure 20. Regional breakdown of winter storm watch critical success index.

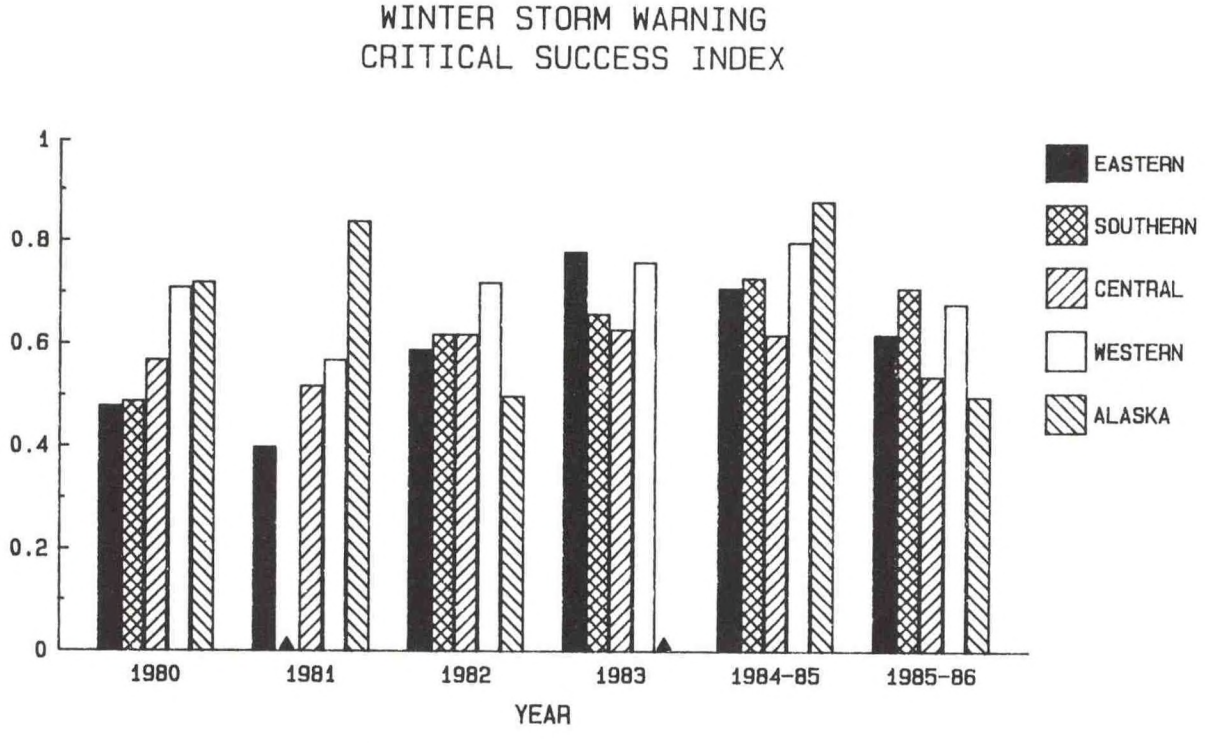

Figure 21. Regional breakdown of winter storm warning critical success index.

6. HIGH WIND

The alignment of the 6-year period of record for the high wind warning data presented here is the same as that for winter storms. Most forecast offices do not issue high wind watches; therefore, they are not included in the verification program. Detailed high wind statistics from the 1984-85 and 1985-86 seasons are presented in Appendix II. No duststorm/sandstorm warnings or events were reported on the verification logs for the 6-year period. Definitions for high wind and duststorm/sandstorm events are given in Appendix III.

Figure 22 shows the 6-year average of the annual number of high wind events by WSFO management area and the percentage of these events in each region. When interpreting this figure, please keep in mind the first problem stated in the Problems section of this report. That is, during 1980 each office was given the option of entering all high wind warnings and events or a subset that could consist of one or several zones; while after 1980, only those warnings and events that occurred in the preselected zone were logged. Consequently, the number of high wind events reported in 1980 is higher than in the succeeding years; however, this is primarily a problem in the western portion of the country and the Alaskan Region. Since this happened in only one of six years of data, the overall six year average of the annual number of events is not significantly affected. The Western Region reported the largest percentage of events, 37%, followed by the Central Region with 22%.

As with flash floods and winter storms, in the figures that show regional statistics, a "▲" indicates that insufficient data were reported by a region.

Figure 23, which shows the national average lead time for high wind warnings, exhibits a considerable amount of annual variability. Regional breakdowns are shown in figure 24.

National POD, FAR, and CSI statistics for high wind warnings are shown in figure 25. The POD score averaged .95 for the period; that is, 19 out of 20 of the reported events were warned. Excluding 1981, the FAR and the CSI have remained stable near .15 and .80, respectively. Figures 26, 27, and 28 show the regional breakdowns for the CSI, POD, and FAR, respectively.

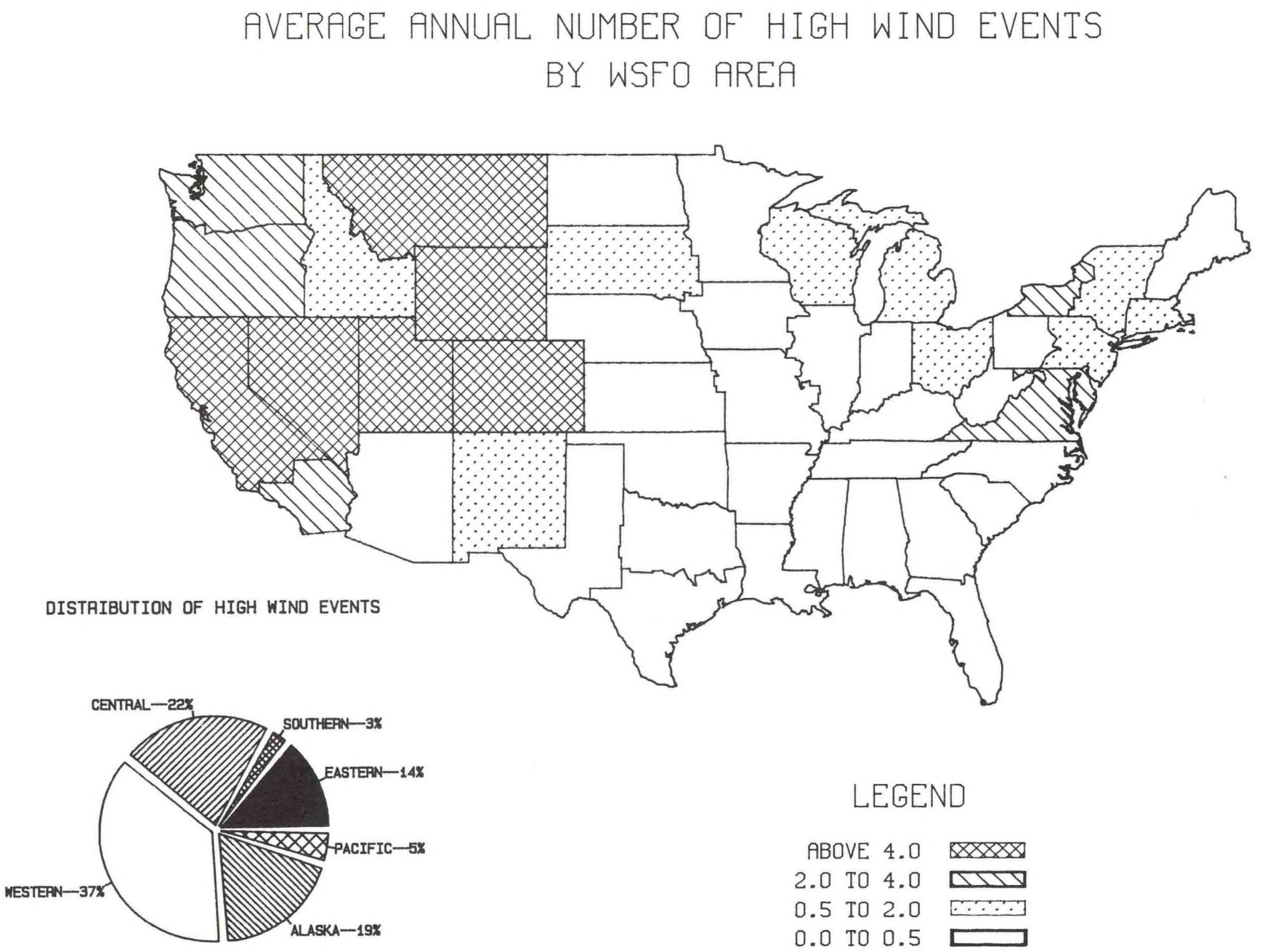

Figure 22. For the years 1980-83 and the seasons 1984-85 and 1985-86.

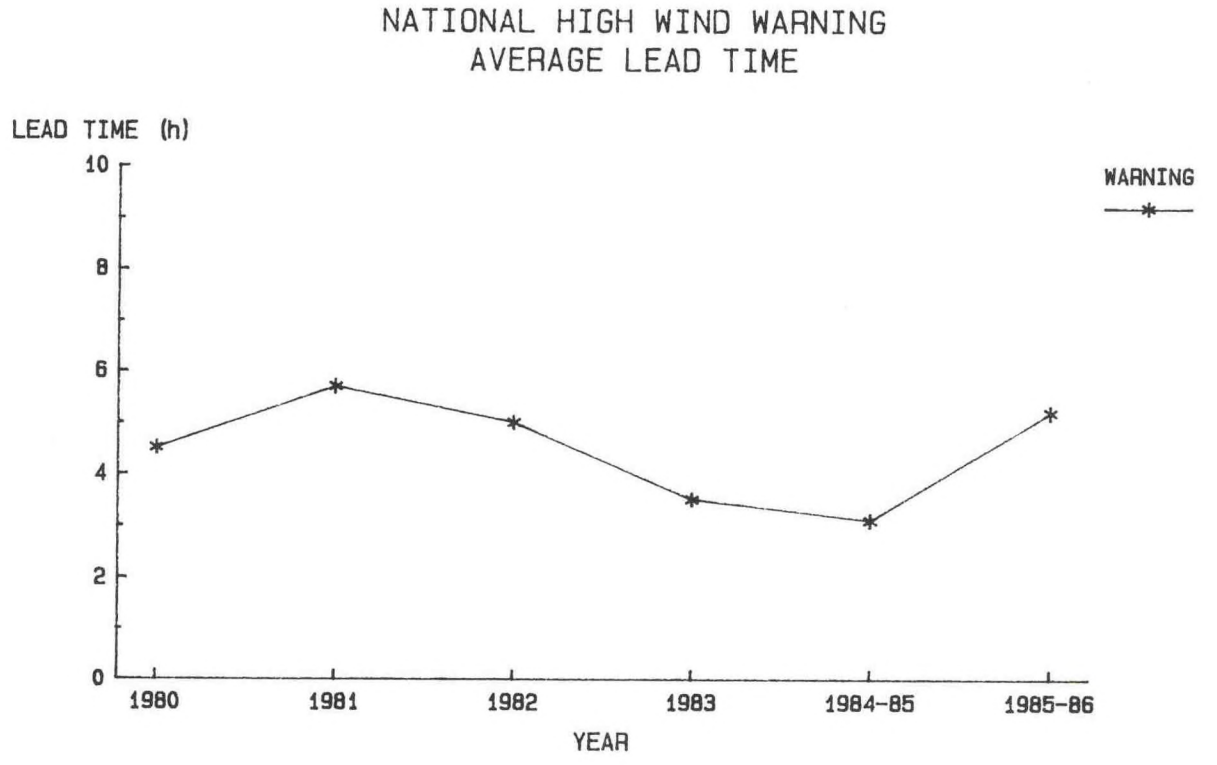

Figure 23.

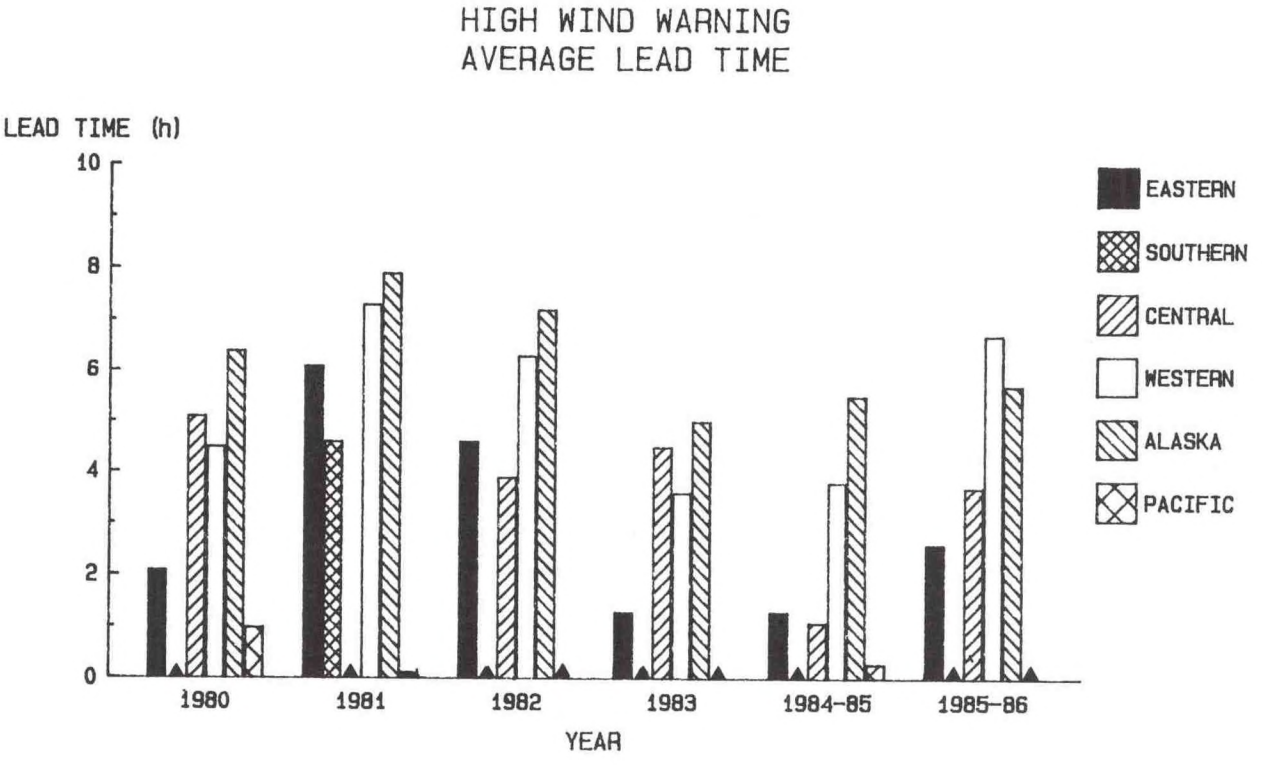

Figure 24. Regional breakdown of average lead time. Regions not plotted had insufficient data and are denoted by a "▲".

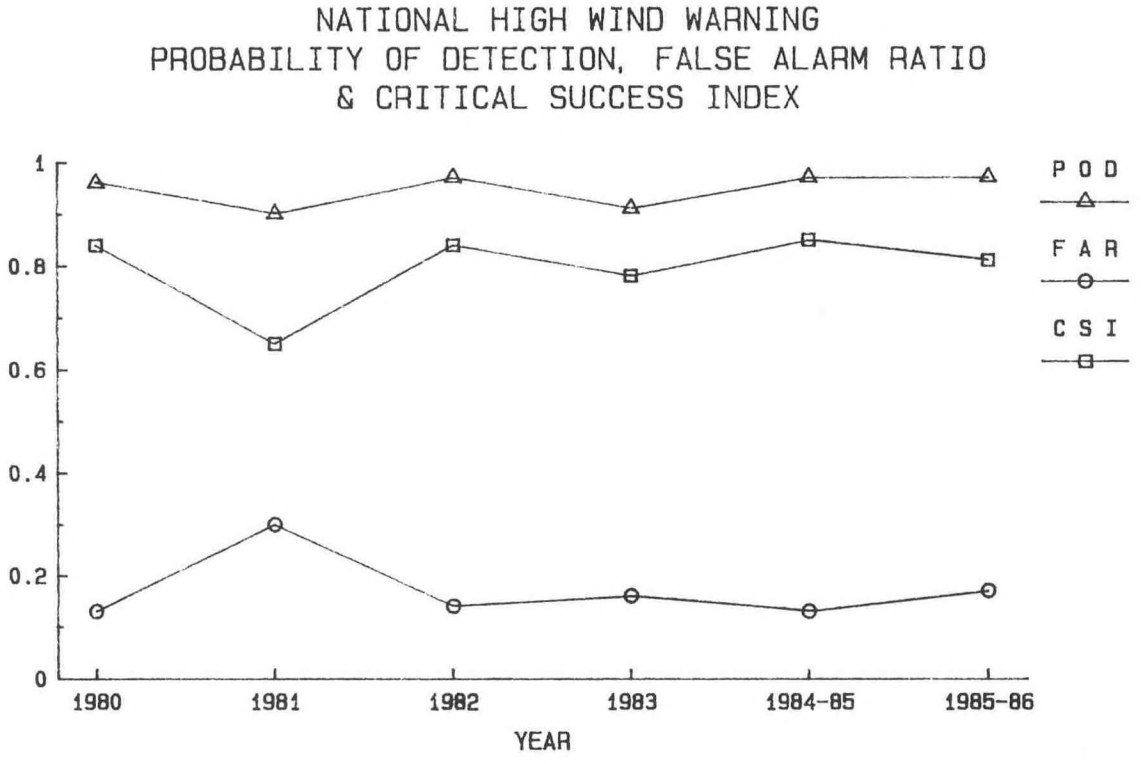

Figure 25.

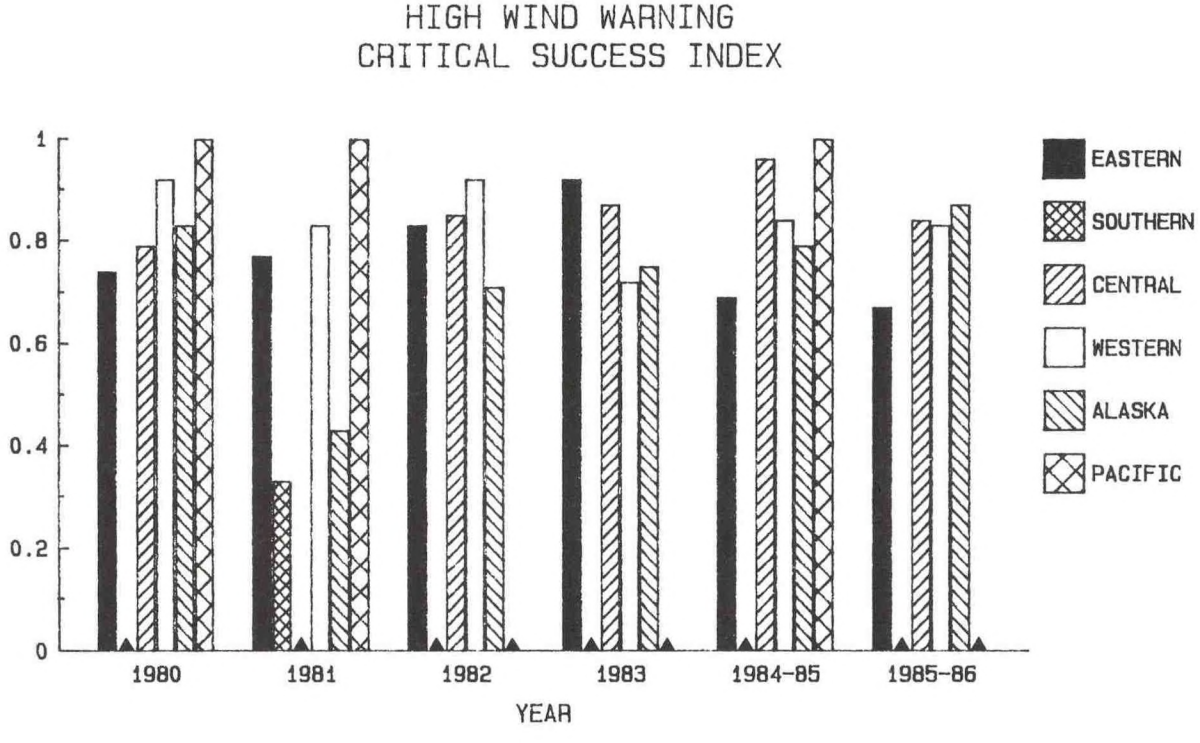

Figure 26. Same as Fig. 24, except for critical success index.

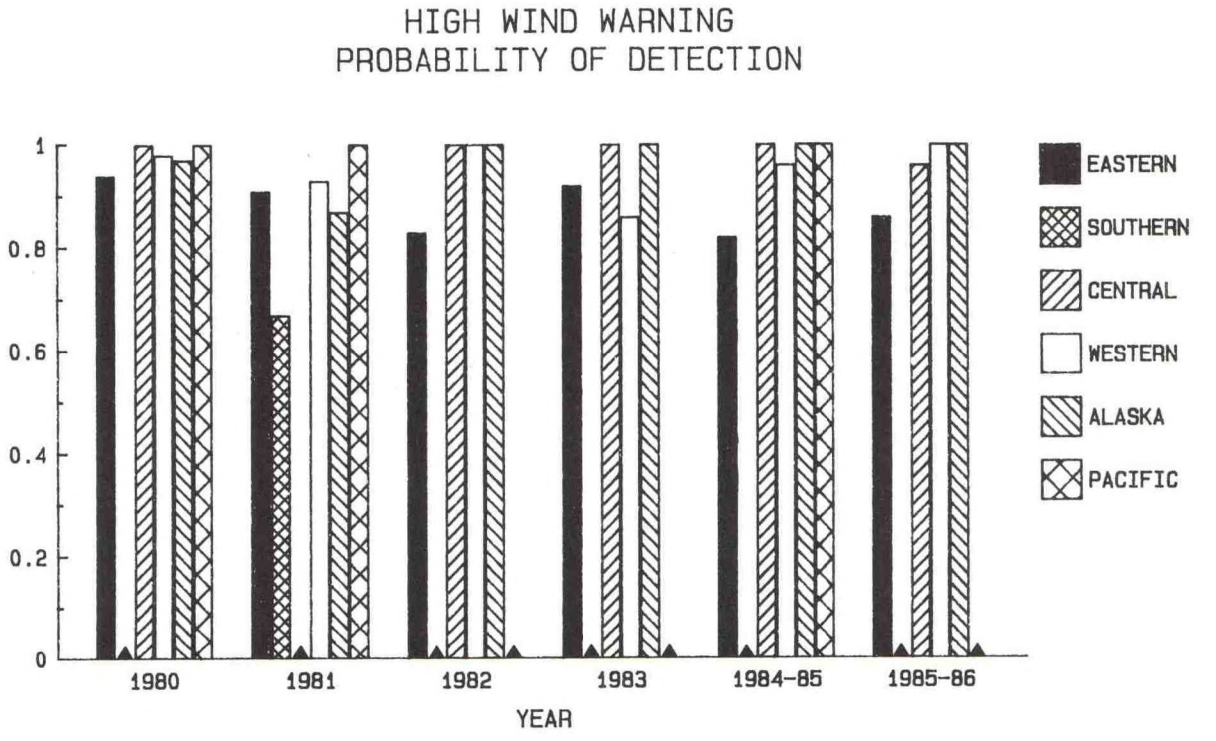

Figure 27. Same as Fig. 24, except for probability of detection.

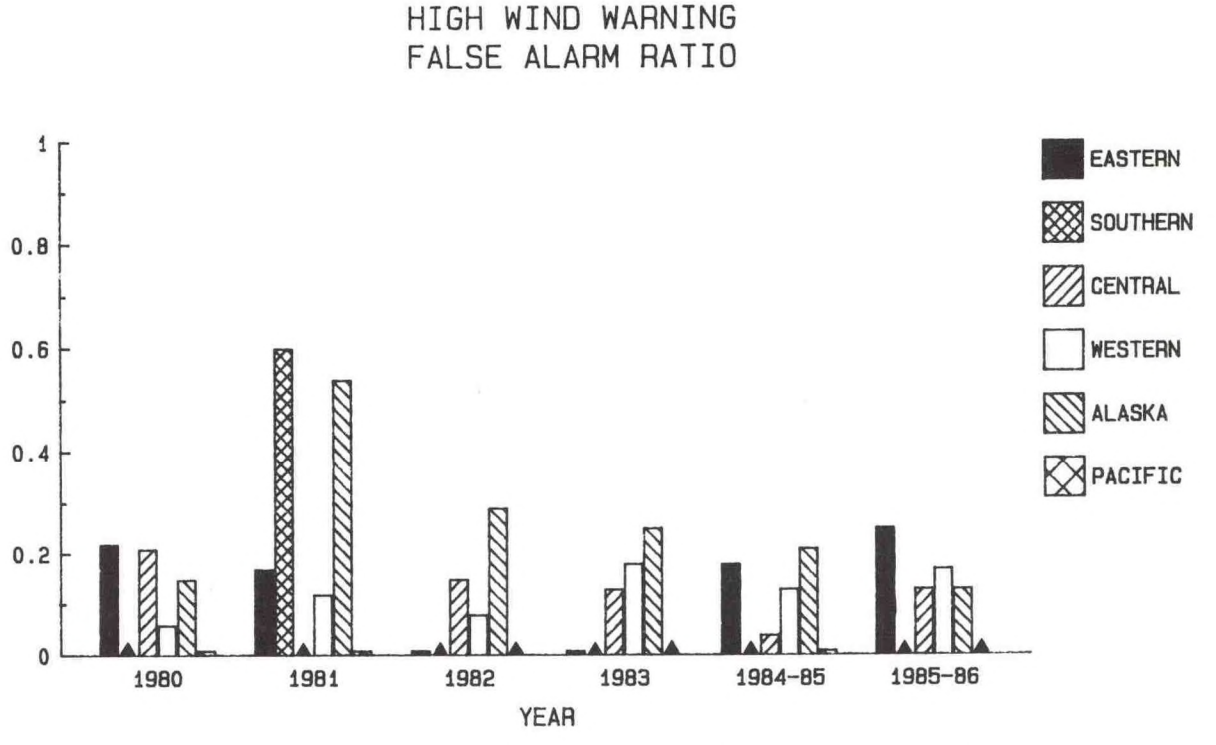

Figure 28. Same as Fig. 24, except for false alarm ratio.

7. SUMMARY

This report has presented flash flood, winter storm, and high wind watch and warning statistics of lead time, POD, FAR, and CSI. The period of record is 1980 through 1985 for flash floods and 1980 through the 1985-86 season for winter storms and high winds.

Nationally, the average lead time for flash flood warnings was nearly constant at 40 minutes; for watches, the average lead time increased slightly to average near 5.3 hours. The POD for warnings held steady near .80 and the FAR increased very slightly and averaged .15. The CSI for warnings remained steady near .70. The FAR for watches increased in the early 1980's, then settled near .55. The Southern Region had 57% of the flash flood events followed by the Central, Western, Eastern, Pacific, and Alaskan Regions with 17%, 12%, 11%, 2%, and 1%, respectively.

Nationally, the average lead time for winter storm warnings increased from 5.1 hours to 7.6 hours. The average lead time for watches gradually increased from 18.2 hours to 23.9 hours. The POD for watches and warnings increased very little and averaged .50 and .80, respectively. The FAR for watches has remained nearly constant at .47; the FAR for warnings has decreased slightly to near .24 in the 1985-86 season. The CSI for watches remained constant near .30; the CSI for warnings increased slightly to .70, except in the 1985-86 season. The Central Region experienced the largest percentage, 32%, of winter storm events followed by the Western, Eastern, Southern, and Alaskan Regions with 27%, 21%, 12%, and 8%, respectively.

The national average lead time for high wind warnings exhibited a large annual variability from 1980 through the 1985-86 season. The POD for high wind warnings has been consistently very high and averaged .95; with the exception of 1981, the FAR and CSI have remained stable near .15 and .80, respectively. The Western Region reported the largest percentage of high wind events, 37%, followed by the Central, Alaskan, Eastern, Pacific, and Southern Regions with 22%, 19%, 14%, 5%, and 3%, respectively.

Figure 29 summarizes the average lead time for watches and warnings for flash floods, winter storms, and high winds over the 6-year period specified earlier. Figure 30 summarizes the 6-year average of POD, FAR, and CSI scores for flash flood, winter storm, and high wind watches and warnings. As previously discussed, high wind watches are not verified, and flash flood watch POD and CSI scores are not calculated.

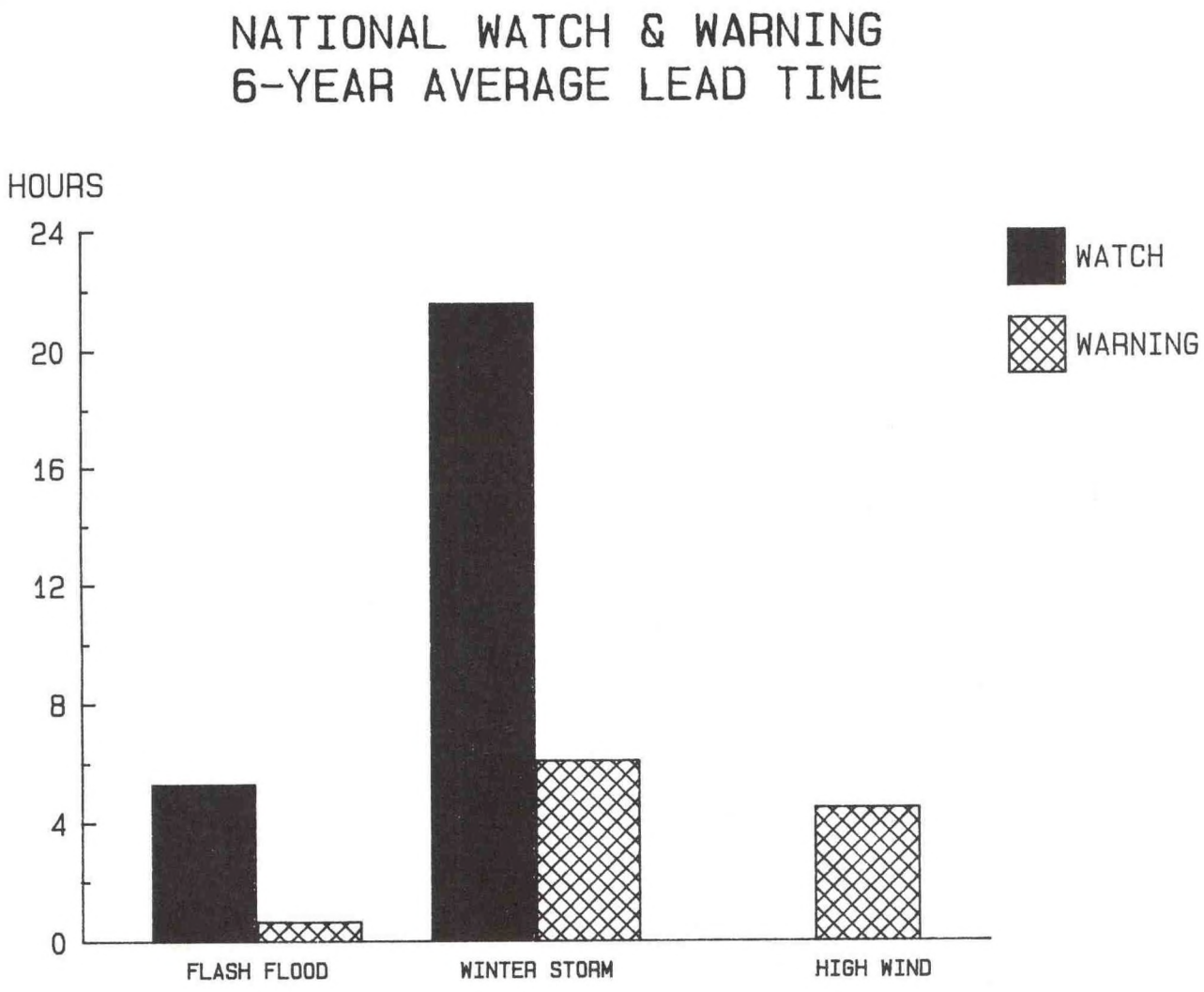

Figure 29. For flash floods, the calendar years 1980-85. For winter storms and high winds, the calendar years 1980-83 and the seasons 1984-85 and 1985-86.

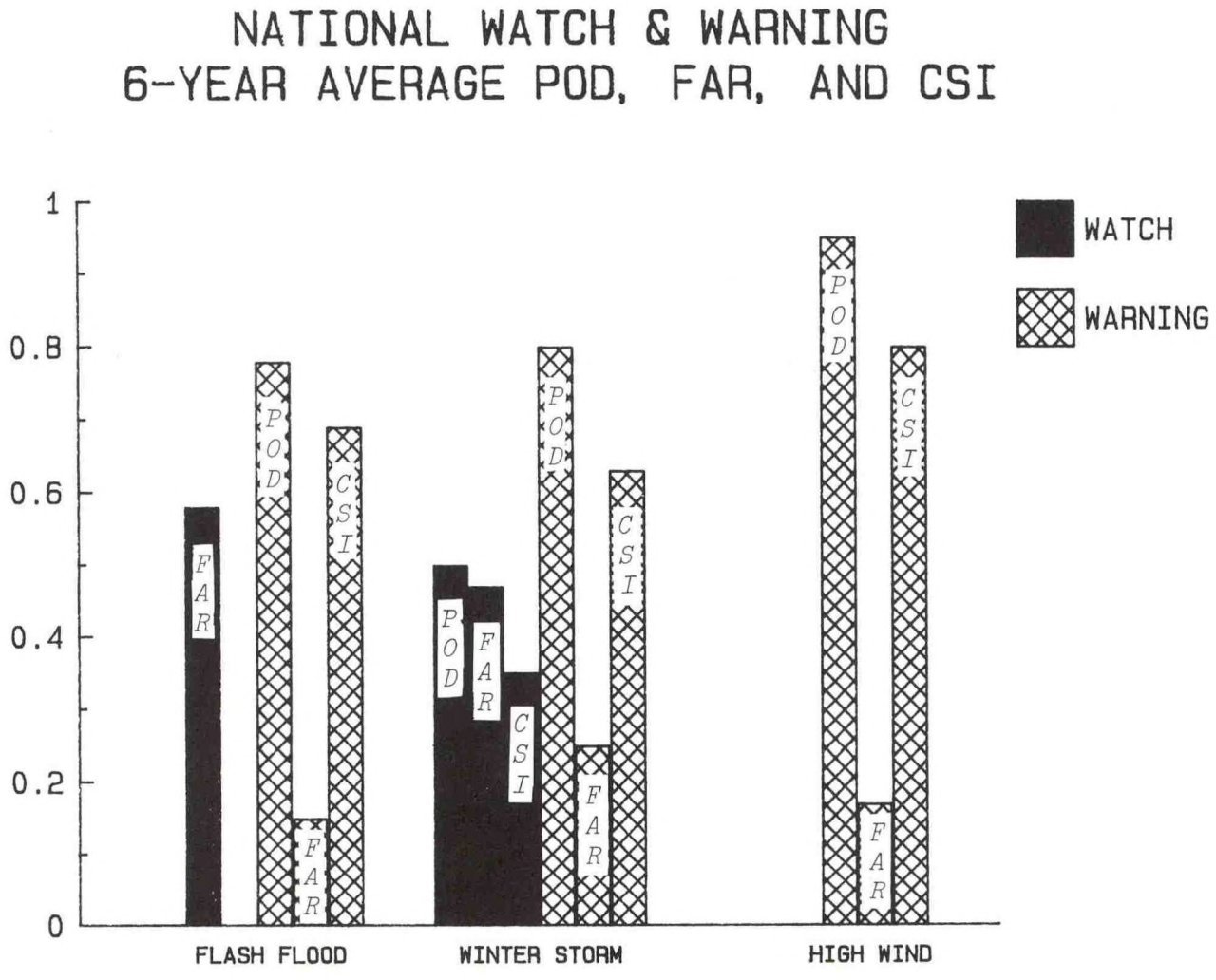

Figure 30. For flash floods, the calendar years 1980-85. For winter storms and high winds, the calendar years 1980-83 and the seasons 1984-85 and 1985-86.

Users of this information should be aware that the results presented here are influenced by the limitations mentioned in the Problems section. Some events undoubtedly go undetected (especially in sparsely populated areas), and an occasional inconsistent or incomplete watch/warning log introduces a certain degree of subjectivity. Therefore, caution should be exercised in comparing the results presented here to subsequent results from the new watch/warning verification program implemented at the NSSFC.

8. ACKNOWLEDGMENTS

The author expresses thanks to Paul D. Polger for his guidance in helping the author write this report and Robert P. Krebs for reviewing it. Thanks also to Dr. John C. Schaake, Jr. from the Office of Hydrology for developing the software for the geographical figures.

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Campbell, A. K., 1982: National Weather Service 1981 Watch/Warning Verification: Flash Flood, Winter Storm and High Wind. NOAA Tech. Memo., NWS FCST-27, 36 pp.

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Thompson, R. M., 1985a: 1984 Flash Flood Watch/Warning Verification, A Preliminary Look. NWS, Office of Meteorology, NOAA, Unpublished Manuscript, July 1985.

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APPENDIX I

National Weather Service Forecast Offices

EASTERN REGION

Portland, Maine
Boston, Massachusetts
New York City, New York
Albany, New York
Buffalo, New York
Cleveland, Ohio
Charleston, West Virginia
Pittsburgh, Pennsylvania
Philadelphia, Pennsylvania
Washington, D.C.
Raleigh, North Carolina
Columbia, South Carolina

CENTRAL REGION

Louisville, Kentucky
Ann Arbor, Michigan
Indianapolis, Indiana
Chicago, Illinois
Milwaukee, Wisconsin
Des Moines, Iowa
Minneapolis, Minnesota
Sioux Falls, South Dakota
Bismarck, North Dakota
Cheyenne, Wyoming
Denver, Colorado
Omaha, Nebraska
Topeka, Kansas
St. Louis, Missouri

SOUTHERN REGION

San Juan, Puerto Rico
Miami, Florida
Atlanta, Georgia
Birmingham, Alabama
New Orleans, Louisiana
Jackson, Mississippi
Memphis, Tennessee
Little Rock, Arkansas
Oklahoma City, Oklahoma
Fort Worth, Texas
San Antonio, Texas
Lubbock, Texas
Albuquerque, New Mexico

WESTERN REGION

Phoenix, Arizona
Salt Lake City, Utah
Great Falls, Montana
Boise, Idaho
Reno, Nevada
Los Angeles, California
San Francisco, California
Portland, Oregon
Seattle, Washington

PACIFIC REGION

Honolulu, Hawaii

ALASKA REGION

Juneau, Alaska
Anchorage, Alaska
Fairbanks, Alaska

APPENDIX II

1984 FLASH FLOOD VERIFICATION

FLASH FLOOD WATCH
(PRESELECTED ZONE STATISTICS ONLY)

REGION	#WATCHES	#UNKNOWN* CASES	PV	FAR	AVERAGE LEAD TIME (h)
EASTERN	17	3	64	.36	6.8
SOUTHERN	92	4	38	.62	2.5
CENTRAL	44	0	34	.66	5.8
WESTERN	63	40	57	.43	1.9
ALASKA	8	0	88	.12	3.4
PACIFIC	4	0	0	1.00	-
NATION	228	47	43	.57	3.8

FLASH FLOOD WARNING

REGION	#WARNINGS	#UNKNOWN* CASES	PV	FAR	#EVENTS	POD	CSI
EASTERN	53	0	94	.06	54	.85	.81
SOUTHERN	259	14	80	.20	216	.73	.62
CENTRAL	115	0	88	.12	100	.89	.79
WESTERN	62	6	89	.11	63	.79	.72
ALASKA	3	0	100	.00	12	.25	.25
PACIFIC	3	0	67	.33	2	1.00	.67
NATION	495	20	85	.15	447	.78	.69

REGION	#COUNTIES WARNED	AVG. #COUNTIES PER WARNING	% COUNTIES VERIFIED	AVERAGE LEAD TIME (h)
EASTERN	83	1.6	92	.7
SOUTHERN	577	2.2	73	.7
CENTRAL	283	2.5	81	.3
WESTERN	118	1.9	72	.4
ALASKA	3	1.0	100	4.7
PACIFIC	3	1.0	67	1.0
NATION	1067	2.2	73	.6

* An unknown case is a situation where it was not possible to verify that an event occurred while a watch or warning was valid.

1985 FLASH FLOOD VERIFICATION

FLASH FLOOD WATCH
(PRESELECTED ZONE STATISTICS ONLY)

REGION	#WATCHES	#UNKNOWN* CASES	PV	FAR	AVERAGE LEAD TIME (h)
EASTERN	20	0	60	.40	10.8
SOUTHERN	68	0	40	.60	5.8
CENTRAL	11	0	36	.64	13.6
WESTERN	15	10	80	.20	1.5
ALASKA	4	0	50	.50	3.8
PACIFIC	9	3	33	.67	3.5
NATION	127	13	45	.55	6.8

FLASH FLOOD WARNING

REGION	#WARNINGS	#UNKNOWN* CASES	PV	FAR	#EVENTS	POD	CSI
EASTERN	35	1	97	.03	50	.66	.65
SOUTHERN	288	5	76	.24	256	.84	.66
CENTRAL	41	0	93	.07	48	.79	.75
WESTERN	42	10	100	.00	37	.86	.86
ALASKA	0	0	-	-	3	.00	.00
PACIFIC	14	1	62	.38	8	1.00	.62
NATION	420	17	81	.19	402	.81	.68

REGION	#COUNTIES WARNED	AVG. #COUNTIES PER WARNING	% COUNTIES VERIFIED	AVERAGE LEAD TIME (h)
EASTERN	85	2.5	81	1.3
SOUTHERN	503	1.8	62	.5
CENTRAL	107	2.6	77	.2
WESTERN	67	2.1	67	1.2
ALASKA	0	-	-	-
PACIFIC	13	1.0	62	.7
NATION	775	1.9	67	.6

* An unknown case is a situation where it was not possible to verify that an event occurred while a watch or warning was valid.

1984-85 WINTER STORM VERIFICATION

PRESELECTED ZONE STATISTICS

WINTER STORM WATCH

REGION	#WATCHES	POD	CSI	PV	FAR	AVERAGE LEAD TIME (h)
EASTERN	28	.70	.46	57	.43	23.0
SOUTHERN	24	.63	.46	63	.37	18.4
CENTRAL	34	.50	.24	32	.68	22.7
WESTERN	19	.52	.42	68	.32	25.8
ALASKA	2	.14	.12	50	.50	27.5
NATION	107	.55	.36	52	.48	22.5

WINTER STORM WARNING

REGION	#WARNING	POD	CSI	PV	FAR	AVERAGE LEAD TIME (h)
EASTERN	23	.83	.71	83	.17	7.7
SOUTHERN	21	.79	.73	90	.10	5.0
CENTRAL	33	.95	.62	64	.36	3.8
WESTERN	22	.84	.80	95	.05	8.9
ALASKA	8	1.00	.88	88	.12	4.8
NATION	107	.86	.72	81	.19	6.2

REGION	#EVENTS	PERCENT OF EVENTS COVERED BY WATCH AND WARNING	WATCH ONLY	WARNING ONLY	NO WATCH OR WARNING
EASTERN	23	61	9	21	9
SOUTHERN	24	42	21	37	0
CENTRAL	22	45	5	50	0
WESTERN	25	44	8	40	8
ALASKA	7	14	0	86	0
NATION	101	45	10	41	4

1985-86 WINTER STORM VERIFICATION

PRESELECTED ZONE STATISTICS

WINTER STORM WATCH

REGION	#WATCHES	POD	CSI	PV	FAR	AVERAGE LEAD TIME (h)
EASTERN	20	.41	.23	35	.65	23.9
SOUTHERN	7	.60	.33	43	.57	27.8
CENTRAL	28	.60	.33	43	.57	19.3
WESTERN	40	.51	.42	70	.30	25.4
ALASKA	2	.33	.33	100	.00	23.9
NATION	97	.50	.35	54	.46	23.9

WINTER STORM WARNING

REGION	#WARNING	POD	CSI	PV	FAR	AVERAGE LEAD TIME (h)
EASTERN	22	.88	.62	68	.32	4.4
SOUTHERN	7	1.00	.71	71	.29	7.9
CENTRAL	26	.80	.54	62	.38	4.6
WESTERN	49	.76	.68	86	.14	10.2
ALASKA	3	.50	.50	100	.00	3.4
NATION	107	.79	.63	76	.24	7.6

REGION	#EVENTS	PERCENT OF EVENTS COVERED BY WATCH AND WARNING	WATCH ONLY	WARNING ONLY	NO WATCH OR WARNING
EASTERN	17	35	6	53	6
SOUTHERN	5	60	0	40	0
CENTRAL	20	40	20	40	0
WESTERN	55	40	11	36	13
ALASKA	6	0	33	50	17
NATION	103	38	12	41	9

1984-85 HIGH WIND VERIFICATION

PRESELECTED ZONE STATISTICS

HIGH WIND WARNING

REGION	#WARNING	#UNKNOWN* CASES	POD	CSI	PV	FAR	#EVENTS	AVERAGE LEAD TIME(h)
EASTERN	11	0	.82	.69	82	.18	11	1.3
SOUTHERN	2	1	1.00	1.00	100	.00	1	0.1
CENTRAL	24	0	1.00	.96	96	.04	23	1.1
WESTERN	36	5	.96	.84	87	.13	28	3.8
ALASKA	37	3	1.00	.79	79	.21	27	5.5
PACIFIC	6	0	1.00	1.00	100	.00	6	0.3
NATION	116	9	.97	.85	87	.13	96	3.1

* An unknown case is a situation where it was not possible to verify that an event occurred while a warning was valid.

1985-86 HIGH WIND VERIFICATION

PRESELECTED ZONE STATISTICS

HIGH WIND WARNING

REGION	#WARNING	#UNKNOWN* CASES	POD	CSI	PV	FAR	#EVENTS	AVERAGE LEAD TIME(h)
EASTERN	8	0	.86	.67	75	.25	7	2.6
SOUTHERN	4	0	.75	.60	75	.25	4	5.8
CENTRAL	31	0	.96	.84	87	.13	28	3.7
WESTERN	41	0	1.00	.83	83	.17	34	6.7
ALASKA	18	3	1.00	.87	87	.13	13	5.7
PACIFIC	3	0	1.00	.67	67	.33	2	0.0
NATION	105	3	.97	.81	83	.17	88	5.2

* An unknown case is a situation where it was not possible to verify that an event occurred while a warning was valid.

APPENDIX III

Definitions: WSOM Chapter C-42, Winter Weather Warnings

Winter Storm Watch A winter storm watch is highlighted in forecasts and in special weather statements to cover the possible occurrence of the following weather elements, either separately or in combination: blizzard conditions, heavy snow, snow in areas where it is relatively rare, accumulations of freezing rain or freezing drizzle, and/or heavy sleet. A watch gives longer advance notice of the potential for the occurrence of a winter storm event than a warning provides. Therefore, it is issued with a lower probability of occurrence than a warning and has somewhat less chance of verification. Ideally, a winter storm watch will precede the issuance of a winter storm warning. Weather Service Forecast Offices (WSFO) issue winter storm watches for their areas of forecast responsibility.

Winter Storm Warning A winter storm warning is highlighted in forecasts and in special weather statements to inform the public of a high probability for the occurrence of severe winter weather. The warning is issued for the same events (except for blizzard conditions) that serve as a basis for the issuance of a winter storm watch. An exception may be made in two special situations. One is the heavy snowfall often occurring along the lee of the Great Lakes. The other is locally heavy orographic snowfall in mountainous terrain. When these conditions cannot be directly connected to a synoptic scale winter storm, the term "Heavy Snow Warning" may be used in forecasts. The term "Winter Storm Warning" will still be used in these areas for heavy snows produced by synoptic scale storms. Normally, only WSFO's will issue winter storm warnings, but Weather Service Offices (WSO) should issue warnings in certain situations.

Hazardous Winter Weather Events The following hazardous winter weather events form the basis for the issuance of a winter storm watch and expected blizzard conditions. The criteria used in defining blizzard and heavy snow are not intended to be absolutely rigid. Although they provide standardization across regional lines, you should recognize these precise limits may not fit every situation, and you will need to use individual initiative and good judgment to make minor adjustments to these criteria in specific situations.

Blizzard indicates that the following conditions are expected to prevail for an extended period (for 3 hours or longer):

(1) sustained wind speeds of 35 miles and hour or more, and
(2) considerable falling and/or blowing snow (i.e. visibility frequently less than 1/4 mile).

Heavy Snow generally means:
(1) a fall accumulating to 4 inches or more in depth in 12 hours, or
(2) a fall accumulating to 6 inches or more in depth in 24 hours.

Some variation in the criteria for heavy snowfall in certain sections of the country may be established at the option of the Regional Director.

Freezing Rain (or Drizzle) describes the freezing of rain or drizzle on objects as it strikes them. Winter storm warnings should be reserved for occasions when significant, and possibly damaging, accumulations of ice are expected. However, even small amounts are extremely dangerous to traffic when encountered unexpectedly, and these conditions frequently require the issuance a travelers' advisory.

High Wind normally indicates sustained winds of 40 mph or greater or winds gusting to 58 mph or greater. In this context, it is intended to be used for strong gradient wind conditions lasting for an extended period of time. However, at regional option, some variation in these criteria may be established to describe strong gusty winds occurring over a shorter time period.

Duststorm (or Sandstorm) indicates the following conditions will prevail over a widespread area:
(1) visibility of 1/2 mile or less due to dust or sand, and
(2) wind speeds of 30 miles an hour or more.

(Continued from inside front cover)

NOAA Technical Memorandums

NWS FCST 16	Weather Bureau April 1969 to March 1970 Verification Report With Special Emphasis on Performance Scores within Echelons. Robert G. Derouin and Geraldine F. Cobb, April 1971. (COM-71-00555)
NWS FCST 17	National Weather Service May 1970 to April 1971 Public Forecast Verification Summary. Robert G. Derouin and Geraldine F. Cobb, March 1972. (COM-72-10484)
NWS FCST 18	Long-Term Verification Trends of Forecasts by the National Weather Service. Duane S. Cooley and Robert G. Derouin, May 1972. (COM-72-11114)
NWS FCST 19	National Weather Service May 1971 to April 1972 Public Forecast Verification Summary. Alexander F. Sadowski and Geraldine F. Cobb, July 1973. (COM-73-11-55 7/AS)
NWS FCST 20	National Weather Service Heavy Snow Forecast Verification 1962 to 1972. Alexander F. Sadowski and Geraldine F. Cobb, January 1974. (COM-74-10518)
NWS FCST 21	National Weather Service April 1972 to March 1973 Public Forecast Verification Summary. Alexander F. Sadowski and Geraldine F. Cobb, June 1974. (COM-74-1 1467/AS)
NWS FCST 22	Photochemical (Oxidant) Air Pollution Summary Information. Stephen W. Harned and Thomas Laufer, December 1977. (PB-283868/AS)
NWS FCST 23	Low-Level Wind Shear: A Critical Review. Julius Badner, April 1979, 72 pp. (PB-300715)
NWS FCST 24	Probability Forecasting--Reasons, Procedures, Problems. Lawrence A. Hughes, January 1980, 89 pp. (PB80-164353)
NWS FCST 25	National Weather Service Public Forecast Verification Summary--April 1973 to March 1978. Duane S. Cooley, Frederick S. Zbar, Dean F. Dubofsky, and A. Kristine Campbell, March 1981, 136 pp. (PB81-231714)
NWS FCST 26	National Weather Service 1980 Watch/Warning Verification: Flash Flood, Winter Storm and High Wind. A. Kristine Campbell, August 1981, 36 pp. (PB82-148719)
NWS FCST 27	National Weather Service 1981 Watch/Warning Verification: Flash Flood, Winter Storm and High Wind. A. Kristine Campbell, July 1982. (PB83-118018)
NWS FCST 28	National Weather Service Public Forecast Verification Summary, April 1978 to March 1982. Paul D. Polger, April 1983. (PB83-232173)
NWS FCST 29	Public Response to Hurricane Probability Forecasts. Jay Baker, January 1984. (PB84-158658)
NWS FCST 30	1982 and 1983 Watch/Warning Verification: Flash Flood, Winter Storm and High Wind. A. Kristine Campbell, January 1985. (PB85-20-1899)
NWS FCST 31	A 20-Year Summary of National Weather Service Verification Results For Temperature and Precipitation. Gary M. Carter and Paul D. Polger, August 1986, 50pp.

NOAA SCIENTIFIC AND TECHNICAL PUBLICATIONS

The National Oceanic and Atmospheric Administration was established as part of the Department of Commerce on October 3, 1970. The mission responsibilities of NOAA are to assess the socioeconomic impact of natural and technological changes in the environment and to monitor and predict the state of the solid Earth, the oceans and their living resources, the atmosphere, and the space environment of the Earth.

The major components of NOAA regularly produce various types of scientific and technical information in the following kinds of publications:

PROFESSIONAL PAPERS-Important definitive research results, major techniques, and special investigations.

CONTRACT AND GRANT REPORTS-Reports prepared by contractors or grantees under NOAA sponsorship.

ATLAS-Presentation of analyzed data generally in the form of maps showing distribution of rainfall, chemical and physical conditions of oceans and atmosphere, distribution of fishes and marine mammals, ionospheric conditions, etc.

TECHNICAL SERVICE PUBLICATIONS-Reports containing data, observations, instructions, etc. A partial listing includes data serials; prediction and outlook periodicals; technical manuals, training papers, planning reports, and information serials; and miscellaneous technical publications.

TECHNICAL REPORTS-Journal quality with extensive details, mathematical developments, or data listings.

TECHNICAL MEMORANDUMS-Reports of preliminary, partial, or negative research or technology results, interim instructions, and the like.