# CHARACTERISTICS OF OREGON COAST WINTER STORM EVENTS FROM 1981-1990

by

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# DEFINITIONS OF ABBREVIATIONS AND ACRONYMS

## in Appendices, Graphs and Tables

Factors:

W/D.....Wind direction from 0 to 360 degrees.

W/S.....Wind speed in miles per hour.

W/S(M).....Maximum wind speed in miles per hour.

W/S(A).....Average wind speed in miles per hour.

PPT.....Precipitation in inches.

PPT(M).....Maximum precipitation in inches.

PPT(T).....Total precipitation in inches.

Stations:

A.....Astoria

N.....Newport

C.....Cape Blanco

Months:

1.....January

2.....February

3.....March

12.....December

# ABSTRACT

The purpose of this paper is to identify significant storm events occurring over a ten year period along the Oregon coast. The findings will be used in a larger research framework to build an information base that looks into the role of climatic forcing on coastal erosion and sediment transport processes. The work involved analysis of climatic data for a ten year period (1981-1990) during the months of December, January, February and March. The climatic factors considered most relevant to characterizing storm activity on the Oregon coast were: wind direction, wind speed and precipitation. The data was collected from documents and computer records at weather stations in Astoria, Newport and Cape Blanco. Tables and graphs were produced following arithmetic calculations. The data was manipulated to show daily, monthly and yearly storm distribution. Storm occurrence was plotted by time and location. A relationship of greater storm frequency was observed with 1982-1983 ENSO climatic events. Results showed that the greatest storm magnitude was found during the winter of 1982-1983. The prevailing wind direction during most winter storms was southerly. In addition to the winter 1982-1983 storm period, two other major storm periods were identified over the ten year study period. January 1990 appeared to be a major storm period at all three stations. When the three stations were compared, Cape Blanco had the most intensive storm activity over the ten year period.

# INTRODUCTION

The Oregon coast is a region approximately 429 miles in length, located from 42 to 46 degrees north latitude and is typified by a climate characterized by mild winters and cool summers. Unstable winter air masses bring considerable rain to the narrow littoral zones, and increases with elevation inland from the coast. The difference in precipitation found within a few kilometers of the coast is much greater than that found along the entire length of the Oregon coast (Loy et al., 1976). Differences in precipitation along the length of the coast have been ascribed to storm tracks rather than latitude. Winter storms on the coast are typified by high wind speed and heavy precipitation.

Sediment movement and erosional changes resulting from climatic forcing events have been researched by Jackson and Rosenfeld (1987) and Peterson, Jackson et al. (1990). Peterson, Jackson et al. (1990) found that beach sand displacement was due to latitudinal shifts in winter storm patterns. Furthermore, the northward displacement of sand observed in 1983 along portions of the Oregon coast, may have been related to particular wind patterns and wind directions. The 1982-1983 northward displacement of beach sand appeared not to be linked to a single climatic event, but rather to a general anomalous climatic condition prevailing over the entire winter season. The climatic factors associated with this condition, wind direction and wind speed, have greatest effect

on wave energy, angle of wave attack and change in sea level (Peterson, Jackson et al. 1990). Maximum interannual longshore transport between 1982 and 1987 was primarily forced by maximum winter storm events. A coincidence of large storms with spring tides can contribute to elevated sea levels, possibly resulting in increased offshore transport.

Research has been done to explore the relationship between the occurrence of El Nino and climate forcing. The El Nino Southern Oscillation (ENSO), which occurred from April 1982 to July 1983, had three major effects: 1) a rise in sea level, 2) a bulge of warm water along the coastline, and 3) higher energy storm wave conditions and increased winter storm frequency (Komar,1986).

This study is an extension of the work conducted by Jackson and Rosenfeld (1987) and Peterson, Jackson et al. (1990), related to climatic forcing along the Oregon coast. Previous research suggested that interannual climatic forcing was responsible for patterns of coastal erosion and deposition. However, a detailed analysis of specific storm patterns along the Oregon coast in relation to erosion and deposition has not been conducted.

## OBJECTIVES

My research project analyzes the nature of winter storms over a ten year period (1981-1990) using wind direction, wind speed and precipitation as storm criteria. The project describes the nature, pattern, and sequence of winter storm

occurrence on coastal Oregon, using available selected climatic data. Specifically, the project's goals were: 1) to define the frequency, characteristics and location of winter storms, from 1981 to 1990, based on data from three weather stations, 2) to examine major storm event frequency per year using pre-selected threshold levels for wind speed, wind direction and precipitation, and 3) to determine the relationship of these storm events to the occurrence of the 1982-83 El Nino events.

## RESEARCH AREA

Peterson, Jackson et al. (1990) selected an area of the central Oregon coast extending south from Yaquina Head to Cape Perpetua. The study area for this project involves three stations: Astoria, Newport and Cape Blanco. These stations were chosen for two specific reasons. First, they represent equally distributed points along the coastline, and secondly, the stations had data available for the ten year period of interest. Astoria, the most northerly station is located at latitude 46°9'N, longitude 123°53'W and is at an elevation of 8 feet. Newport, the centrally located station, is at latitude 44°35'N, longitude 124°3'W and an elevation of 140 feet. Precipitation data for Cape Blanco, the third station, was provided by the nearest weather station, at Port Orford, five miles to the north. The location of Port Orford is 42°45'N and 124°30'W and the elevation at this location is 30 feet.

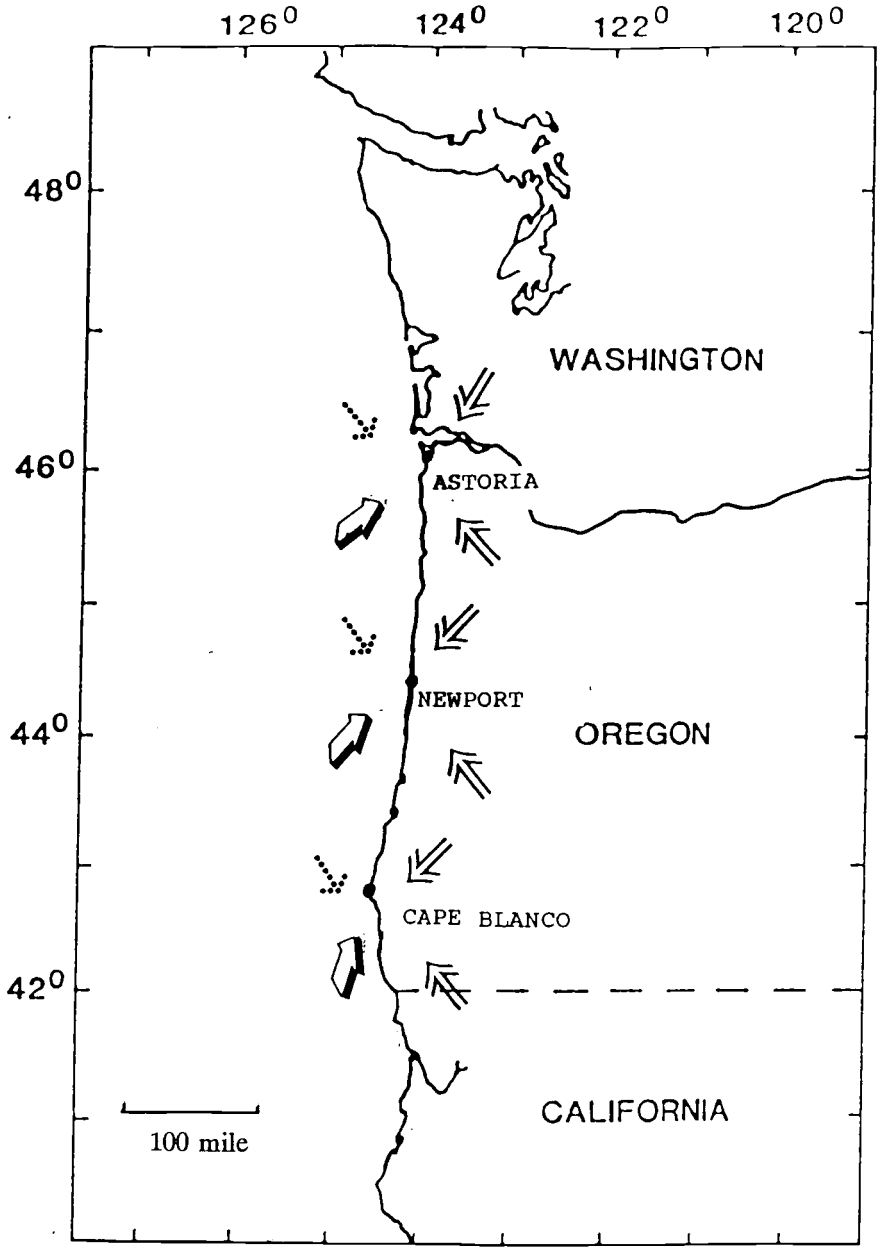



Figure 1. Location of study stations related to winter prevailing wind pattern during winter months on the Oregon coast.

Legend

3-dimensional Arrow: Prevailing wind direction during storm period

Single Dimensional Arrow: Prevailing wind direction before and after storm period

Dotted Arrow: Secondary wind direction after storm period

# METHODS

The methods used in this project can be classified into the acquisition, compilation and graphic display of climatic data from the selected weather stations. Another aspect of the research involved the selection of criteria for defining winter storm events. Finally, certain analytical arithmetic steps were necessary to convert data to a form useful to meet the objectives of the project.

## Data Acquisition

Climate data for the Astoria station was compiled from National Weather Service (NOAA) Local Climatological Data summaries. Newport climate data came from two sources. The Newport airport supplied Federal Aviation Administration wind speed and wind direction information. Precipitation data came from the National Weather Service (NOAA) Local Climatological Data summaries. Data for Cape Blanco came from two sources: Bonneville Power Administration supplied wind direction and wind speed information from its Cape Blanco Anemometer arrays, and precipitation data came from the nearby Port Orford weather station.

## Selection Criteria

Pertinent data on storm occurrence was taken from the available climate records. Storms were defined according to three factors: wind direction, wind

speed and precipitation. These factors were first expressed as daily averages. Specific storm characteristics were defined as daily average wind speed over 15 mph during a 48 hour period, and daily precipitation over one inch. Statistical analyses was used to select major storm events according to these criteria. "Significant storms" were identified as those events with a statistical ranking greater than one standard deviation above the "average" events for the study period.

Compilation of Data

Data tables were constructed for daily average wind speed and total daily precipitation as well as daily prevailing wind direction. Further tables were compiled for major storm events. For the tables of storm events, for each winter season, all storms were treated with equal weight regardless of storm duration. These tables portray maximum wind speed and maximum precipitation records for significant storm events. From the tables, a series of graphic representations were made. In order to produce both the tables and figures, the computer programs Quattro-Pro and Lotus 123 were used. Graphs were produced based on three sets of data: 1) daily distribution of average wind direction, average wind speed and total daily precipitation, 2) distribution of storm events for the winter season of each year from 1981 to 1990, and 3) Comparison of storm events among the three selected stations over time.

Comparisons were observed between storm occurrence frequency and station location. The frequency of winter storms per year was calculated from 1981 to 1990.

**Table Construction:** Appendix 1 contains basic climatic data, while subsequent appendices and tables are derived from information presented in previous tables or appendices. The tables provide general information about storm factors related to time and geographic location, as well as data covering storm sequences in relation to occurrence and location. The period of study consists only of the winter months, December, January, February and March. Appendix 1 consists of average daily distribution of wind direction, wind speed and precipitation for the three stations during the winter period 1981 to 1990. This table was used to plot the monthly frequency of individual storms during the study period.

Appendix 2 depicts storm wind direction, wind speed and precipitation daily averages. Appendix 2 is based on the data contained in Appendix 1, and gives the duration of individual storms for the three stations during the study period.

Appendix 3 depicts storm events for the three stations. The factors involved were maximum wind speed and maximum precipitation for the storm period. In addition, the appendix contains the wind direction that was most prevalent during maximum wind speed. For the study period, the number of storm events and the character of individual events can be found.

Appendix 4 is a summary of previous appendices. The data involves maximum wind speed and wind direction during maximum wind speed, as well as maximum precipitation. It contains monthly and yearly distribution of storm events for individual stations. The duration of storms, maximum wind speed and maximum precipitation for individual months and individual years are also included.

Table 1 summarizes the distribution of storm events by month and year, based on Appendices 1 through 4. It is concerned with monthly and yearly storm duration and extreme ranges in data. The data involves the total storm duration by month and year, maximum wind speed and precipitation amount by month, year and date of occurrence. In addition, the table gives the station location where maximum wind speed and maximum precipitation occurred by month and year. The wind direction for the maximum wind speed is also recorded.

Table 2 gives monthly total storm-days and monthly total precipitation for the storm days. The table also contains average wind speed for the monthly total storm days. The table compares the magnitude of the storm by month. The criteria for monthly storm magnitude was defined by the storm duration, average wind speed and total amount of precipitation. According to the table, average wind speed is not always an appropriate indicator of the size of storms. Maximum wind speed is a more suitable indicator and can be examined in the previous appendix and table. Wind direction is another very important indicator of major

storm events. The analysis of wind direction is shown in Appendix 5 and Tables 4 through 8.

Table 3 has been constructed in the same style as Table 2, but is a yearly data summary, rather than monthly. The table describes the yearly variation in storms by comparing total number of storm days, total precipitation and average wind speed during the storm events. The limitations of the criteria chosen to describe the yearly summary are the same as those outlined in Table 2. Graphic displays were also made for both Table 2 and Table 3.

Appendix 5 describes change in wind direction for individual storms. This was done by listing all storm events and determining the wind direction at the beginning and end of each storm, in order to discern if a recurring pattern characterized a series of storms. The appendix contains wind direction and maximum wind speed, the maximum wind speed during the storm period, and the date and station location of maximum wind speed occurrence.

Table 4 is the summary of Appendix 5. It can be used to determine wind direction patterns for the three stations. It summarizes prevailing wind direction prior to, during and after storm events. Wind direction at maximum wind speed during storm events has also been supplied. The data is based on the total ten year interval over the four month winter season.

Tables 5 through 8 contain data on prevailing wind directions at various times as related to storm events .

**Graphics Construction:** The graphics represent three major types of information: wind direction, wind speed and precipitation for the four winter months over the 1981 to 1990 period, and by station location. Two graphic series were plotted, based on data in the appendices and tables, and are included in their respective appendix. The first graphic series, based on Appendix 1, shows the daily distribution of wind direction, average wind speed and average precipitation over 10 years for the three stations. These graphs were used as the foundation for defining storms. The second graphic series is a representation of Appendix 3 and Appendix 4. These graphs describe the climatic factors of wind direction, wind speed and precipitation for each individual storm. Maximum wind speed and maximum precipitation during the storm period and wind direction at maximum wind speed were chosen to represent the storm events for each winter season. Figure 2 is a representation of Table 2, containing monthly storm days, total precipitation and average wind speed. This figure shows the difference in magnitude of monthly storms. Figure 3 is based on Table 3 and has the same structure as Figure 2. Figure 3 is a yearly data comparison from winter 1981 to 1990 for the three selected stations. The yearly difference in storm magnitude can be seen clearly here.

## RESULTS AND DISCUSSION

This project describes the basic character of winter storm events at the three selected stations. Since the project involved the analysis of a large data

base, the results can only be described here in summary. Detailed results are contained in Appendices 1 through 4, Tables 1 through 8 and Figures 2 and 3.

Appendix 1 describes daily storm data, including daily average wind speed, prevailing wind direction and daily average precipitation. Storm events were defined based on Appendix 1.

Appendix 2 gives the daily storm data and provides the foundation for Appendix 3. Appendix 3 describes individual storm events, the storm duration, prevailing wind direction, maximum wind speed, the date of occurrence, and maximum precipitation during the study period.

Results based on Appendix 3 show that from January 1981 to December 1990 there were 66 storm events for the station at Cape Blanco. However, there was incomplete wind data for 10 months at Cape Blanco. As a result, storm occurrence may have been more frequent than the number of storm events suggested by the data. Cape Blanco had 268 storm days during this period. For the station at Astoria, there were 64 storm events for the period January 1981 to December 1990. Astoria had 245 storm days during this period. The Newport station recorded 73 storm events for the period of study. Only precipitation for 1987 is missing for this station. Newport had 293 storm days over the ten year period. In general, the number of storm events and the number of storm days are similar for the three stations. It appears therefore, that there was an equal chance for storm occurrence within the study period. Most storm events probably cover the coast in its entirety. The date of storm occurrence and location of

monthly greatest wind speed, wind direction and precipitation are summarized in Table 1. For example, on January 25, 1982, the greatest wind speed, 53.3 mph, occurred at Cape Blanco. The greatest precipitation in January 1982 was 2.16 inches. This occurred on January 5th at Newport. During 1982-1983 winter, the greatest wind speed, 56.4 mph, occurred on February 11th at Cape Blanco. The greatest precipitation, 2.58 inches, occurred on December 3rd at Astoria. It is possible from Table 5 to determine the duration of the storm period by month and year for all stations, as well as the storm duration in relation to month, year and station location. The longest cumulative storm duration, by month, for all three stations was 44 days. This period occurred in January 1987. The table also provides the individual month and year for the most significant storm determined by the criteria of storm duration, wind speed and precipitation. Those years with reduced numbers or no storms are also given. In January 1985, there were no storms according to the chosen criteria and the available data for the selected stations. During the decade, the highest wind speed was 72 mph, with a 170° wind direction. This phenomenon occurred on January 31, 1987 at Cape Blanco. The greatest precipitation was 7.53 inches on December 23, 1987 at the same station.

From previous climatic forcing research on the Oregon coast, it was found that storms are related to other natural events such as sand displacement and El Nino. The coincidence of severe storms, the 1982-1983 northward sand

# Table 1. Distribution of Storm Days by Month and Year

| Year | Month | Days | W/D | W/S(M) | Date | Statio | PPT(M) | Date | Station | Yearly days |
|---|---|---|---|---|---|---|---|---|---|---|
| 81 | 1 | 4 | 10 | 13.5 | 6 | C | 1.71 | 6 | C | |
| | 2 | 22 | 22 | 42.8 | 18 | C | 1.93 | 15 | A | |
| | 3 | 12 | 19 | 22.8 | 14 | C | 1.4 | 14 | C | 38 |
| 81-82 | 12 | 14 | 21 | 18.5 | 15 | A | 3.94 | 5 | N | |
| | 1 | 18 | 19 | 24.3 | 23 | A | 3.05 | 22 | A | |
| | 2 | 22 | 20 | 23 | 16 | A | 1.74 | 13 | A | |
| | 3 | 24 | 20 | 45.6 | 1 | C | 1.74 | 13 | C | 78 |
| 82-83 | 12 | no | 19 | 25 | 3 | N | 2.58 | 3 | A | |
| | 1 | 40 | 17 | 53.3 | 25 | C | 2.16 | 5 | N | |
| | 2 | 40 | 19 | 56.4 | 11 | C | 2.5 | 21 | C | |
| | 3 | 36 | 17 | 47.4 | 13 | C | 1.74 | 14 | C | 116 |
| 83-84 | 12 | 26 | 18 | 53.2 | 12 | C | 2.91 | 14 | C | |
| | 1 | 14 | 20 | 22 | 23 | N | 0.82 | 3 | A | |
| | 2 | 31 | 19 | 54.8 | 12 | C | 2.5 | 13 | C | |
| | 3 | 14 | 17 | 47.4 | 13 | C | 1.74 | 14 | C | 85 |
| 84-85 | 12 | 14 | 17 | 39.5 | 29 | C | 1.61 | 30 | C | |
| | 1 | no | | | | | | | | |
| | 2 | 12 | 18 | 31.4 | 7 | C | 1.73 | 7 | C | |
| | 3 | 35 | 17 | 45.2 | 25 | C | 1.85 | 9 | N | 61 |
| 85-86 | 12 | 17 | 4 | 52.9 | 6 | C | 1.3 | 6 | N | |
| | 1 | 35 | 19 | 53.8 | 18 | C | 1.73 | 18 | A | |
| | 2 | 30 | 19 | 47.4 | 15 | C | 3.42 | 22 | C | |
| | 3 | 17 | 18 | 46.8 | 9 | C | 3.65 | 13 | C | 99 |
| 86-87 | 12 | 5 | 21 | 14.3 | 29 | A | 1.29 | 28 | A | |
| | 1 | 44 | 17 | 72.2 | 31 | C | 2.7 | 31 | A | |
| | 2 | 10 | 18 | 69.7 | 1 | C | 3.07 | 3 | A | |
| | 3 | 20 | 17 | 56.6 | 11 | C | 2 | 12 | N | 79 |
| 87-88 | 12 | 26 | 17 | 63.1 | 4 | C | 7.53 | 3 | C | |
| | 1 | 15 | 20 | 26.3 | 14 | A | 2.6 | 14 | C | |
| | 2 | 5 | 19 | 15 | 9 | N | 1.11 | 9 | A | |
| | 3 | 16 | 17 | 18.9 | 4 | C | 1.73 | 24 | A | 62 |
| 88-89 | 12 | 12 | 18 | 21 | 29 | N | 2.7 | 29 | A | |
| | 1 | 18 | 18 | 34.7 | 14 | C | 1.4 | 7 | N | |
| | 2 | 21 | 19 | 39.3 | 22 | C | 2.72 | 9 | A | |
| | 3 | 21 | 20 | 26 | 27 | C | 1.5 | 12 | C | 72 |
| 89-90 | 12 | 6 | 18 | 18 | 3 | N | 2.65 | 3 | N | |
| | 1 | 37 | 17 | 67.1 | 6 | C | 4.53 | 9 | A | |
| | 2 | 33 | 19 | 26 | 2 | N | 2.72 | 9 | N | |
| | 3 | 9 | 18 | 19 | 8 | A | 1.39 | 6 | A | 85 |
| 90 | 12 | 3 | 22 | 19 | 4 | A | 1.03 | 4 | A | |

Example: For 1981-1982, in December there were 14 total storm-days for 3 stations. The prevailing wind direction was 210°. The maximum wind speed in this month was 18.5 mph which occurred on the 15th at Astoria. Maximum precipitation was 3.94 inches. This occurred on the 5th at Newport. There were 78 total storm-days for 1981-1982.

displacement and the 1982-1983 El Nino phenomenon can be seen in Table 2, Table 3 and Figures 2 and 3. Despite the fact that the criteria of wind speed used in these tables is not a highly sophisticated technique, the magnitude of the storms shown by month and year is still clearly defined. For example, at Newport, during the ten year period, the greatest monthly precipitation was found in the winter months of 1982 to 1983. The longest storm period also occurred during this period (Table 2, Figure 2). The same pattern can be found in both Astoria and Cape Blanco. In Table 3, it can be clearly seen that the yearly total storm-days for winter 1982-83 are much greater than any other year in the ten year study period. Astoria had 33 storm days, Newport had 47 storm days and Cape Blanco had 66 storm days from December 1982 to March 1983. At Newport and Cape Blanco the total precipitation for the winter of 1982-1983 was much higher than other winters; 54.2 inches for Newport and 55.88 inches for Cape Blanco respectively. For Astoria, the total winter precipitation was much greater than other years except 1989-1990 (Tables 2, 3 and Figures 2, 3). The 1989-1990 winter storm will be discussed briefly later in this paper.

An examination of Figure 3 shows that, during the ten year period, there were three storm peaks at each of the three stations. One peak occurred in winter 1982-1983, while a second occurred in winter 1986-87 in Astoria and Newport, but shifted to 1985-1986 at Cape Blanco. This difference may be due to the missing data for Cape Blanco. A third storm peak was found in January 1990,

# Table 2-A. Total Storm Days, Precipitation and Wind Speed Summaries by Month, Astoria

| Year | Month | Days | W/S(A) | PPT(T) |
|---|---|---|---|---|
| 81 | 1 | 0 | | |
| | 2 | 9 | 15 | 7.25 |
| | 3 | 0 | | |
| | Total | 9 | 15 | 7.25 |
| | 12 | 7 | 12 | 6.53 |
| 81-82 | 1 | 5 | 17 | 10.07 |
| | 2 | 12 | 14 | 9.82 |
| | 3 | 0 | | |
| | Total | 33 | 14 | 26.35 |
| | 12 | 8 | 14 | 8.83 |
| 82-83 | 1 | 11 | 10 | 11.5 |
| | 2 | 6 | 9 | 3.59 |
| | 3 | 8 | 8 | 6.24 |
| | Total | 33 | 10 | 30.16 |
| | 12 | 2 | 15 | 2.72 |
| 83-84 | 1 | 7 | 14 | 5.53 |
| | 2 | 11 | 10 | 6.75 |
| | 3 | 0 | | |
| | Total | 20 | 13 | 15 |
| | 12 | 3 | 11 | 1.4 |
| 84-85 | 1 | 0 | | |
| | 2 | 2 | 16 | 1.09 |
| | 3 | 8 | 11 | 4.96 |
| | Total | 13 | 13 | 7.45 |
| | 12 | 3 | 14 | 1.17 |
| 85-86 | 1 | 13 | 13 | 8.27 |
| | 2 | 8 | 15 | 7.64 |
| | 3 | 4 | 11 | 2.57 |
| | Total | 28 | 13 | 19.65 |
| | 12 | 5 | 9 | 4.2 |
| 86-87 | 1 | 12 | 13 | 8.96 |
| | 2 | 4 | 13 | 2.2 |
| | 3 | 9 | 12 | 6.73 |
| | Total | 30 | 12 | 22.1 |
| | 12 | 10 | 15 | 6.75 |
| 87-88 | 1 | 5 | 14 | 3.11 |
| | 2 | 3 | 12 | 1.48 |
| | 3 | 8 | 15 | 5.57 |
| | Total | 26 | 14 | 16.91 |
| | 12 | 4 | 13 | 4.65 |
| 88-89 | 1 | 9 | 14 | 4.8 |
| | 2 | 6 | 13 | 5.49 |
| | 3 | 6 | 9 | 2.45 |
| | Total | 25 | 12 | 17.39 |
| | 12 | 3 | 15 | 5.53 |
| 89-90 | 1 | 14 | 14 | 14.56 |
| | 2 | 12 | 13 | 10.36 |
| | 3 | 8 | 10 | 3.71 |
| | Total | 37 | 13 | 34.16 |
| 90 | 12 | 3 | 12 | 2.08 |

Table 2-B. Total Storm Days, Precipitation and Wind Speed Summaries by Month, Newport

| Year | Month | Days | W/S(A) | PPT(T) |
|---|---|---|---|---|
| 81 | 1 | 5 | 13 | 3.64 |
| | 2 | 0 | | |
| | 3 | 5 | 16 | 4.19 |
| | Total | 10 | 15 | 7.83 |
| | 12 | 7 | 9 | 8.78 |
| 81-82 | 1 | 13 | 12 | 12.12 |
| | 2 | 10 | 16 | 9.21 |
| | 3 | 5 | 14 | 3.49 |
| | Total | 35 | 13 | 33.6 |
| | 12 | 15 | 16 | 13.86 |
| 82-83 | 1 | 16 | 16 | 14.98 |
| | 2 | 15 | 12 | 13 |
| | 3 | 16 | 15 | 12.45 |
| | Total | 47 | 15 | 54.3 |
| | 12 | 10 | 15 | 8.52 |
| 83-84 | 1 | 7 | 14 | 3.83 |
| | 2 | 9 | 14 | 7.23 |
| | 3 | 2 | 14 | 1.08 |
| | Total | 28 | 14 | 20.7 |
| | 12 | 6 | 10 | 4.4 |
| 84-85 | 1 | 0 | | |
| | 2 | 6 | 12 | 3.17 |
| | 3 | 7 | 14 | 5.05 |
| | Total | 19 | 12 | 12.6 |
| | 12 | 8 | 12 | 3.83 |
| 85-86 | 1 | 6 | 16 | 3.89 |
| | 2 | 8 | 12 | 6.75 |
| | 3 | 8 | 12 | 3.53 |
| | Total | 30 | 13 | 18 |
| | 12 | 0 | | |
| 86-87 | 1 | 14 | 12 | 9.61 |
| | 2 | 4 | 13 | 3.87 |
| | 3 | 6 | 15 | 7.69 |
| | Total | 24 | 13 | 21.17 |
| | 12 | missing PPT data | | |
| 87-88 | 1 | 10 | 16 | 10.58 |
| | 2 | 2 | 15 | 1.34 |
| | 3 | 4 | 14 | 3.7 |
| | Total | 16 | 14 | 5 |
| | 12 | 8 | 13 | 5.42 |
| 88-89 | 1 | 7 | 16 | 4.93 |
| | 2 | 7 | 14 | 5.51 |
| | 3 | 17 | 15 | 11.17 |
| | Total | 39 | 15 | 27 |
| | 12 | 3 | 16 | 3.29 |
| 89-90 | 1 | 13 | 19 | 12.1 |
| | 2 | 11 | 16 | 7.52 |
| | 3 | 3 | 15 | 1.8 |
| | Total | 30 | 17 | 24.7 |

Table 2-C. Total Storm Days, Precipitation and Wind Speed Summaries by Month, Cape Blanco

| Year | Month | Duration | W/S(A) | PPT(A) |
|---|---|---|---|---|
| 81 | 1 | 4 | 9 | 3.46 |
| | 2 | 8 | 16 | 5.9 |
| | 3 | 7 | 16 | 3.99 |
| | Total | 19 | 14 | 13.35 |
| | 12 | missing | | |
| 81-82 | 1 | 2 | 26 | 2.78 |
| | 2 | 8 | 44 | 12.05 |
| | 3 | 11 | 27 | 7.17 |
| | Total | 21 | 32 | 22 |
| | 12 | 12 | 41 | 15.32 |
| 82-83 | 1 | 13 | 35 | 9.78 |
| | 2 | 19 | 37 | 17.73 |
| | 3 | 16 | 30 | 13.05 |
| | Total | 60 | 36 | 55.88 |
| | 12 | 14 | 29 | 12.29 |
| 83-84 | 1 | 4 | 23 | 2.17 |
| | 2 | 11 | 20 | 8.65 |
| | 3 | 12 | 28 | 8.6 |
| | Total | 41 | 25 | 34.71 |
| | 12 | 5 | 18 | 3.34 |
| 84-85 | 1 | missing | | |
| | 2 | 6 | 29 | 4.43 |
| | 3 | 11 | 24 | 7.48 |
| | Total | 22 | 23 | 15.25 |

| Year | Month | Days | W/S(A) | PPT(T) |
|---|---|---|---|---|
| | 12 | 6 | 34 | 4.07 |
| 85-86 | 1 | 16 | 31 | 11.84 |
| | 2 | 14 | 31 | 18.49 |
| | 3 | 11 | 31 | 10.74 |
| | Total | 47 | 33 | 45.14 |
| | 12 | 0 | | |
| 86-87 | 1 | 18 | 33 | 15.45 |
| | 2 | 2 | 20 | 4.54 |
| | 3 | 5 | 34 | 4.31 |
| | Total | 25 | 29 | 24.3 |
| | 12 | 16 | 35 | 21.6 |
| 87-88 | 1 | missing | | |
| | 2 | 0 | | |
| | 3 | 4 | 16 | 2.22 |
| | Total | | | |
| | 12 | missing | | |
| 88-89 | 1 | 2 | 29 | 1.44 |
| | 2 | 2 | 37 | 1.87 |
| | 3 | 0 | | |
| | Total | 4 | 33 | 3.31 |
| | 12 | missing | | |
| 89-90 | 1 | 10 | 32 | 8.24 |
| | 2 | missing | | |
| | 3 | missing | | |
| | Total | | | |

Figure 2-A.

# Total Storm Days, Precipitation and Wind Speed Summaries by Month, Astoria

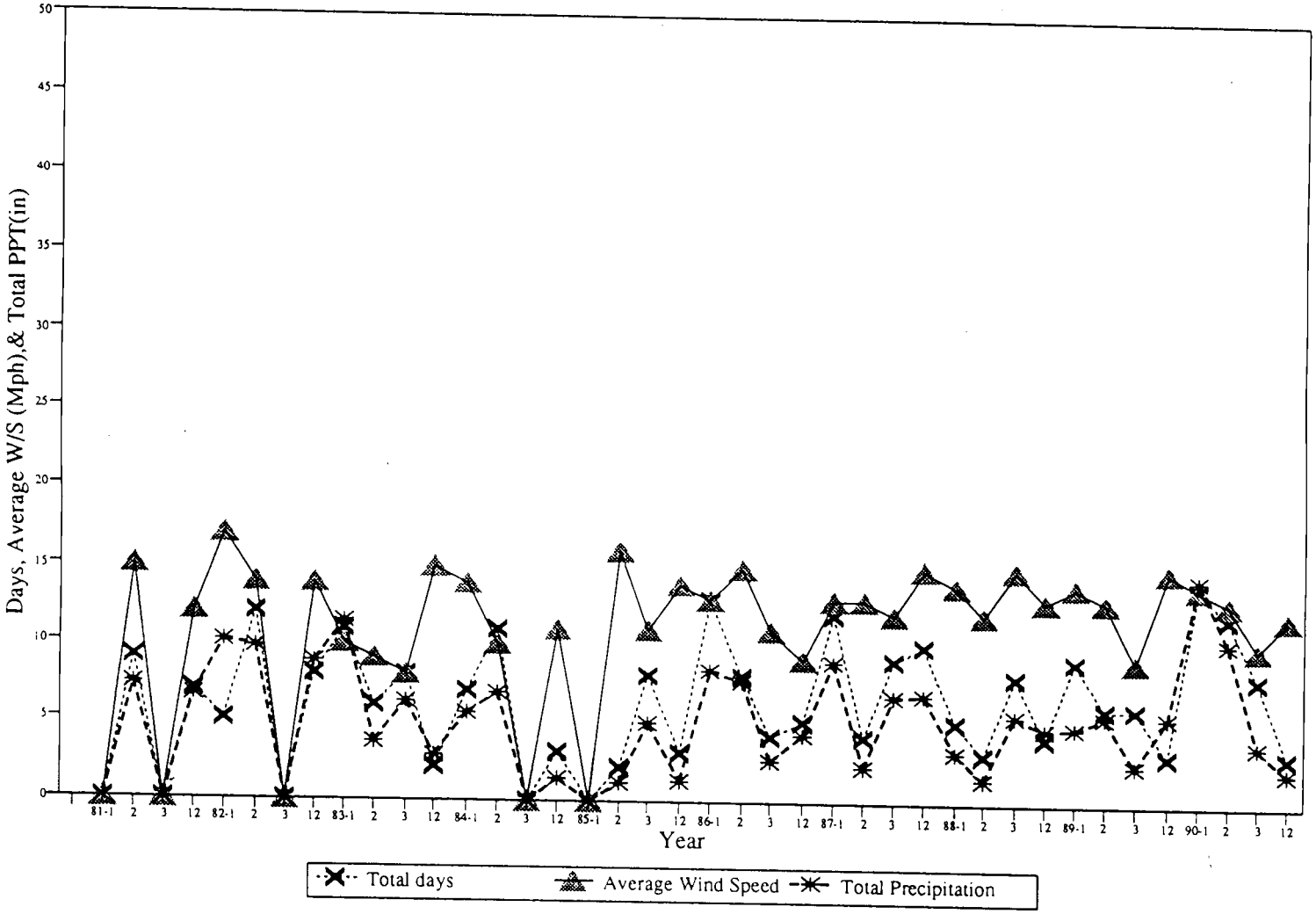


Figure 2-B

# Total Storm Days, Precipitation and Wind Speed Summaries by Month, Newport

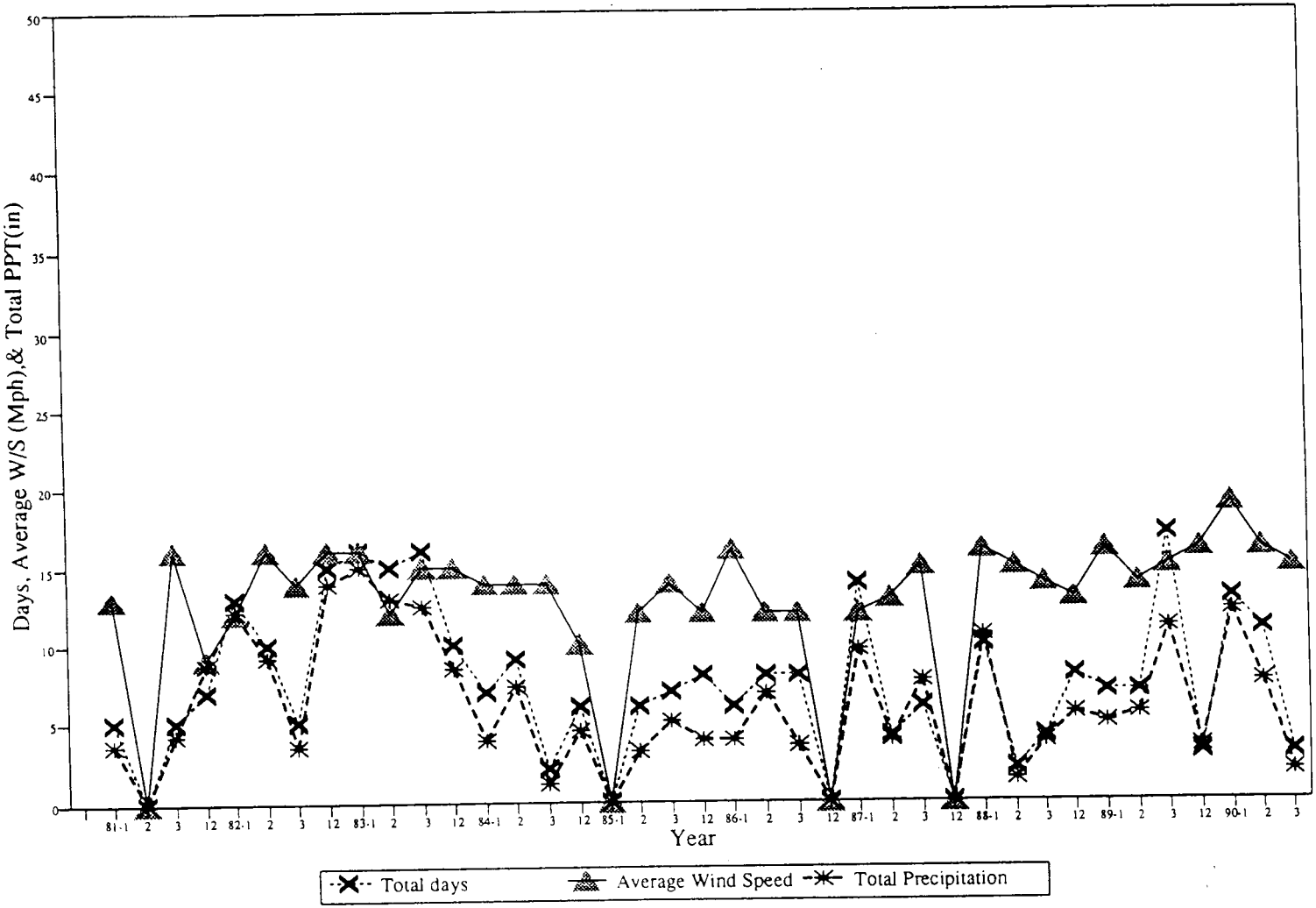


Figure 2-C

# Total Storm Days,Precipitation and Wind Speed Summaries by Month, Cape Blanco

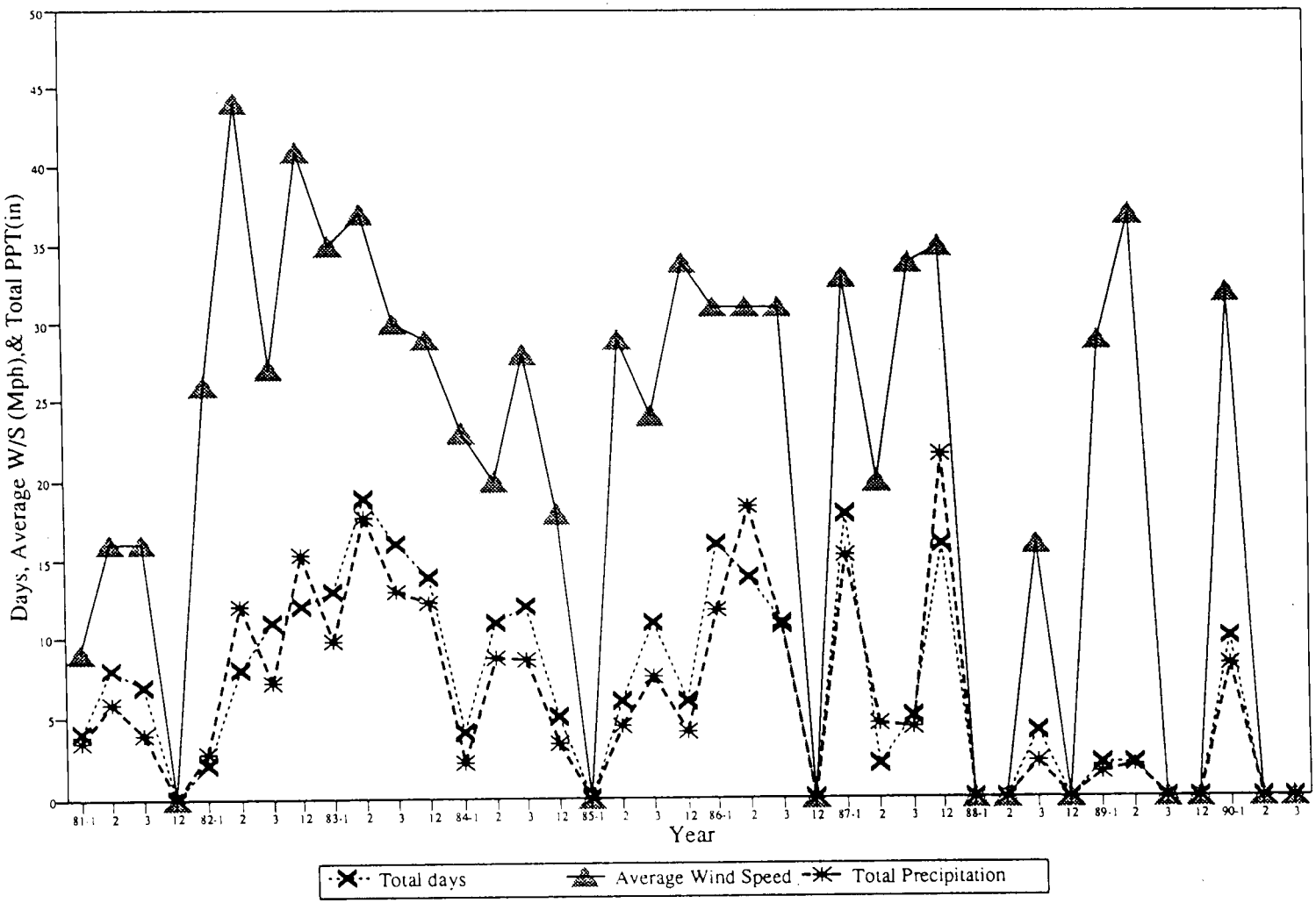


Table 3. Winter Storm Days, Precipitation and Wind Speed Summaries by Year

Astoria

| year | days | W/S(A) | PPT(T) |
|---|---|---|---|
| 81 | 9 | 15 | 7.25 |
| 81-82 | 33 | 14 | 26.35 |
| 82-83 | 33 | 10 | 30.16 |
| 83-84 | 20 | 13 | 15 |
| 84-85 | 13 | 13 | 7.45 |
| 85-86 | 28 | 13 | 19.65 |
| 86-87 | 30 | 12 | 22.1 |
| 87-88 | 26 | 14 | 16.91 |
| 88-89 | 25 | 12 | 17.39 |
| 89-90 | 37 | 13 | 34.16 |

Newport

| Year | Days | W/S(A) | PPT(T) |
|---|---|---|---|
| 81 | 10 | 15 | 7.83 |
| 81-82 | 35 | 13 | 33.6 |
| 82-83 | 47 | 15 | 54.3 |
| 83-84 | 28 | 14 | 20.7 |
| 84-85 | 19 | 12 | 12.6 |
| 85-86 | 30 | 13 | 18 |
| 86-87 | 24 | 13 | 21.17 |
| 87-88 | 16 | 14 | 5 |
| 88-89 | 39 | 15 | 27 |
| 89-90 | 30 | 17 | 24.7 |

Cape Blanco

| Year | Days | W/S(A) | PPT(T) |
|---|---|---|---|
| 81 | 19 | 14 | 13.35 |
| 81-82 | 21 | 32 | 22 |
| 82-83 | 60 | 36 | 55.88 |
| 83-84 | 41 | 25 | 34.71 |
| 84-85 | 22 | 23 | 15.25 |
| 85-86 | 47 | 33 | 45.14 |
| 86-87 | 25 | 29 | 24.3 |

Figure 3-A

# Winter Storm Days, Precipitation and Wind Speed Summaries by Year, Astoria

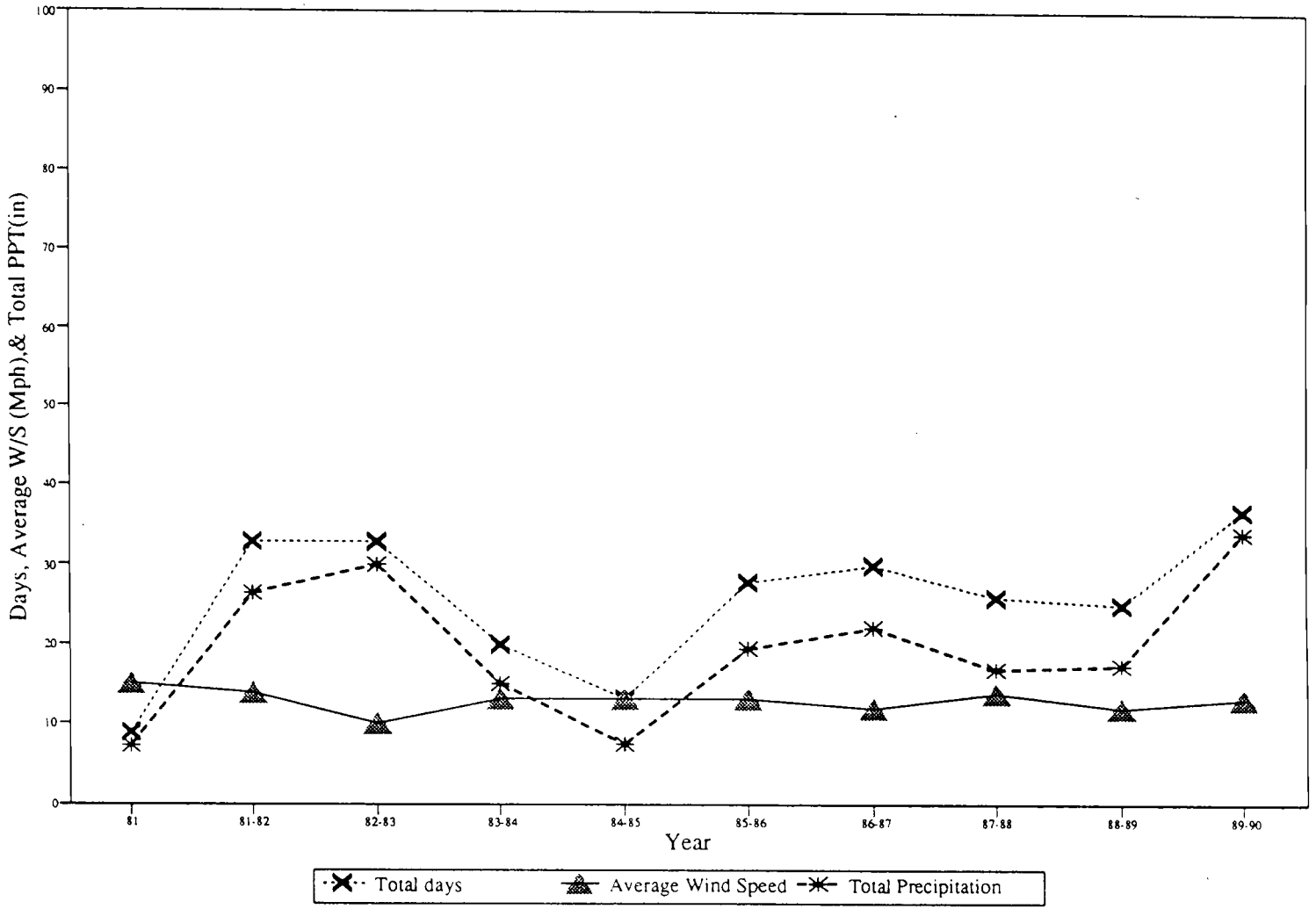


Figure 3-B

# Winter Storm Days, Precipitation and Wind Speed Summaries by Year, Newport

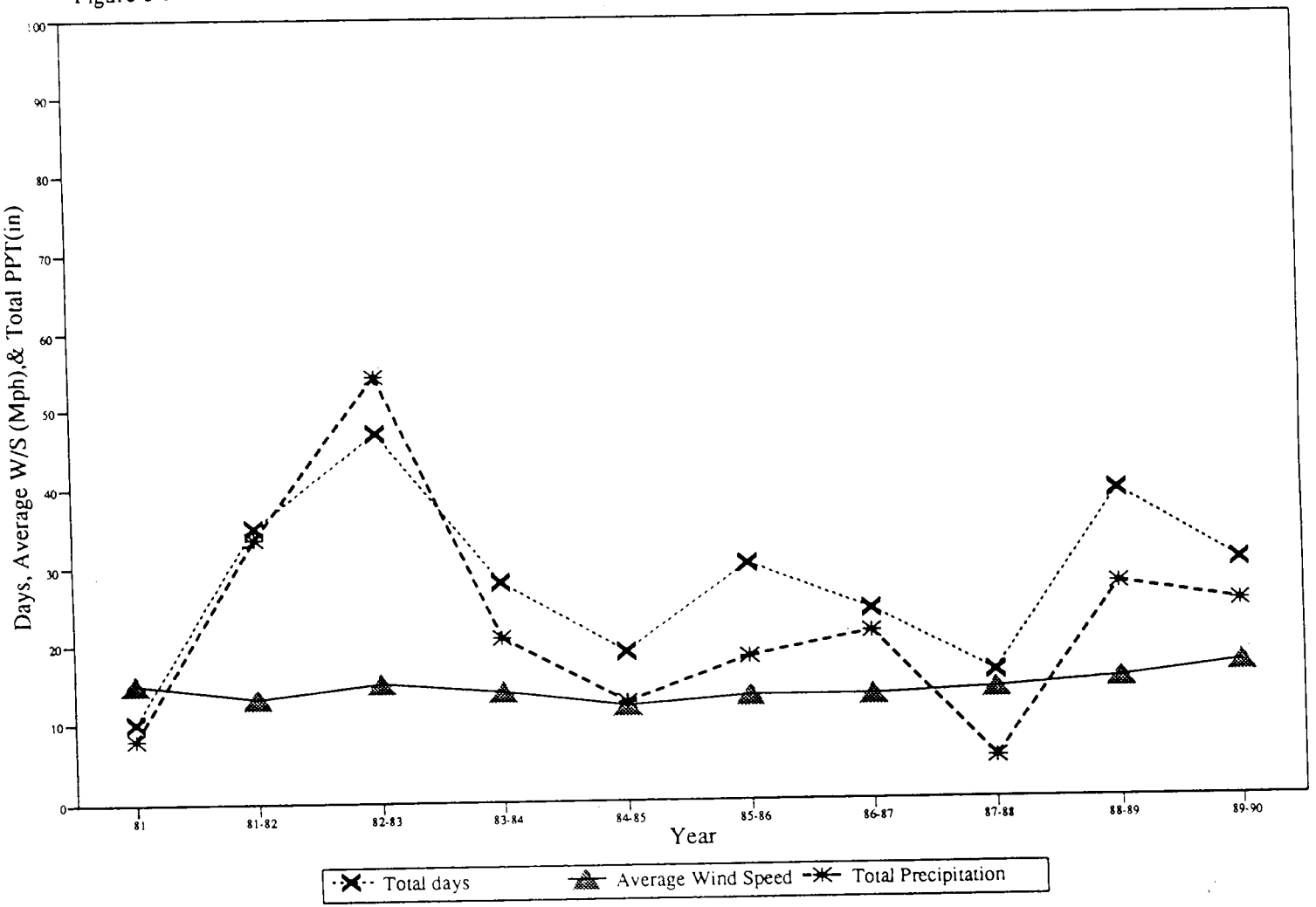
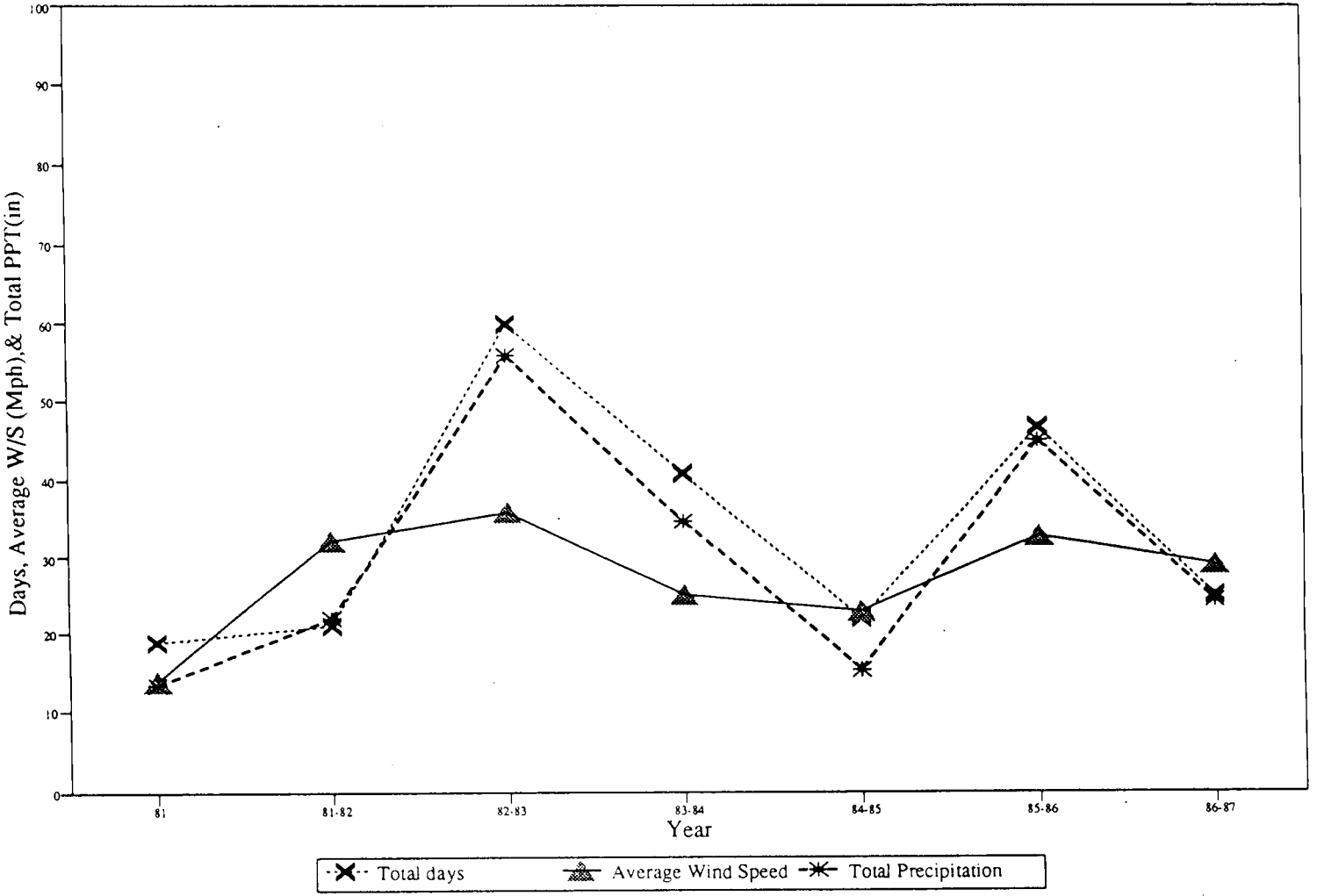


Figure 3-C

# Winter Storm Days,Precipitation&Wind Speed Summaries by Year, Cape Blanco



for all three stations (Figure 2). The cause of this peak requires further investigation.

It was found that for the three stations, Cape Blanco had the greatest storm magnitude according to the selected criteria. The wind speed is much greater at Cape Blanco than at the other two stations. The difference between stations has been observed but not thoroughly researched.

Prevailing wind direction is an important factor used in describing storms. Appendix 5 and Tables 4 through 8 are specific descriptions of wind direction, from which wind direction patterns may be determined. The most prevalent winddirection is expressed as the percentage of the number of wind direction data records. For example, the prevalent direction is described as the frequency that 190-270° wind directions occurred. Cape Blanco most frequently had both the highest wind speed and greatest precipitation. For four out of ten years, maximum precipitation occurred at Cape Blanco (Table 4). However, there was a considerable amount of missing data. Therefore, this number could change with an increase in available data. More details of this nature may be derived directly from the Appendices.

Wind direction changes with various storm situations. The most frequent wind direction during storm events was found to be 180°-270° (SW) which represents 50% of all directions measured during storm periods (Table 4). The second most frequent wind direction was 90°-180° (SE). Directions of 90°-270°(SW and SE) took place with an 84% frequency during storms (Table 5).

Table 4. Summary of Change in Wind Direction for 10 year Period

| Storm | Wind | WD before | | WD at Storm | | WD after | | WD at WS(M) | | Station | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| in month | Direction | Frequency | % | Frequency | % | Fequency | % | Frequency | % | A | N | C |
| *Dec | 0-90° | 20 | 50 | 1 | 2 | 25 | 62 | 0 | 0 | 0 | 0 | 0 |
| 40 | 91-180° | 6 | 16 | 17 | 42 | 12 | 31 | 21 | 52 | 4 | 4 | 7 |
| | 181-270° | 9 | 24 | 19 | 48 | 1 | 2 | 19 | 48 | 8 | 7 | 0 |
| | 271-360° | 3 | 9 | 3 | 8 | 2 | 5 | 0 | 0 | 0 | 0 | 0 |
| Jan | 0-90° | 18 | 32 | 1 | 2 | 20 | 38 | 0 | 0 | 0 | 0 | 0 |
| 56 | 91-180° | 22 | 39 | 30 | 54 | 17 | 29 | 16 | 29 | 4 | 0 | 1 |
| | 181-270° | 7 | 13 | 22 | 39 | 10 | 18 | 36 | 64 | 11 | 14 | 4 |
| | 271-360° | 9 | 16 | 3 | 5 | 9 | 16 | 4 | 7 | 0 | 3 | 1 |
| Feb | 0-90° | 25 | 45 | 1 | 2 | 20 | 36 | 1 | 2 | 0 | 0 | 0 |
| 55 | 91-180° | 20 | 36 | 20 | 36 | 15 | 27 | 19 | 40 | 6 | 5 | 6 |
| | 181-270° | 9 | 17 | 27 | 49 | 7 | 13 | 33 | 60 | 10 | 13 | 8 |
| | 271-360° | 1 | 2 | 7 | 13 | 13 | 24 | 0 | 0 | 0 | 0 | 0 |
| March | 0-90° | 19 | 39 | 0 | 0 | 11 | 22 | 0 | 0 | 1 | 0 | 0 |
| 49 | 91-180° | 17 | 35 | 19 | 39 | 19 | 39 | 26 | 53 | 4 | 2 | 1 |
| | 181-270° | 8 | 16 | 27 | 55 | 14 | 29 | 23 | 47 | 6 | 9 | 6 |
| | 271-360° | 5 | 10 | 3 | 6 | 5 | 10 | 0 | 0 | 0 | 0 | 0 |

Example: In December, the wind direction averaged over 10 years before storms at 0-90° was 20. This was 50% of the total wind directions. During storms there were no 0-90° wind directions. After storms the 0-90° wind direction frequency was 25. This represented 62% of this month's total wind directions. The station refers only to wind direction at maximum speed.

Table 5. Prevailing Wind Direction During Storm Events

| | 0°-90° | 90°-180° | 180°-270° | 270°-360° |
|---|---|---|---|---|
| DEC | 2 | 42% | 48% | 7.9% |
| JAN | 2 | 54% | 39% | 7% |
| FEB | 2 | 36% | 49% | 13% |
| MARCH | 0 | 39% | 55% | 6% |

Before storm events, the wind direction changed most frequently from 0°-90° (NE) or 90°-180° (SE), however, this pattern was not very clear (Table 6).

Table 6. Prevailing Wind Direction Before Storm Events.

| | 0°-90° | 90°-180° | 180°-270° | 270°-360° |
|---|---|---|---|---|
| DEC | 50% | 16% | 24 | 9% |
| JAN | 32% | 39% | 13% | 16% |
| FEB | 45% | 36% | 17% | 2% |
| MARCH | 39% | 35% | 16% | 10% |

Wind direction after a storm event often reverted back to 0°-90° and 90°-180° (NE) (Table 7).

Table 7. Prevailing Wind Direction After Storm Events

| | 0°-90° | 90°-180° | 180°-270° | 270°-360° |
|---|---|---|---|---|
| DEC | 62% | 31% | 2% | 5% |
| JAN | 38% | 29% | 18% | 16% |
| FEB | 36% | 27% | 13% | 24% |
| MARCH | 22% | 39% | 29% | 10% |

Change in wind direction varied with the month of storm events. For example, in March, the wind direction switched to a more southerly direction compared to the cooler months (Tables 6 and 7).

Wind direction at maximum wind speed was predominantly in the range of 90°-270° (SW, SE), with the greatest frequency at 180°-270° (SW). Almost 99% of wind directions recorded at maximum wind speed was 90°-270° (Table 8).

Table 8. Prevailing Wind Direction at Maximum Wind Speed

| | 0°-90° | 90°-180° | 180°-270° | 270°-360° |
|---|---|---|---|---|
| DEC | 0 | 52% | 48% | 0 |
| JAN | 0 | 29% | 64% | 7% |
| FEB | 2 | 40% | 60% | 0 |
| MARCH | 0 | 53% | 47% | 0 |

Maximum wind speed rarely occurred in a northerly direction. The prevailing wind direction at maximum wind speed for Astoria and Newport was 180°-270° (SW), and 90°-180° (SE) for Cape Blanco. The second most frequent direction for Astoria and Newport was 90°-180° (SE), and 180°-270° (SW) for Cape Blanco.

# CONCLUSIONS

The following major results have been found in this project:

1) The greatest storm magnitude was found in the winter 1982-83. This finding coincides with the work of Dr. Jackson and others who have studied winter storm characteristics and sand displacement on the Oregon coast.

2) There were three storm intensity peaks during the ten year period. These peaks occurred at all three stations. Moreover, significant storm events occurred at all three stations in January 1990.

3) Although most storms occurred at all three stations, storm strength decreased from south to north. That is, Cape Blanco had the most intense storm activity, typified by high wind speed.

4) The prevailing wind direction during storms was between 90° to 270° (SW and SE). Direction concentrated in the SW when wind speed reached its maximum during storm events.

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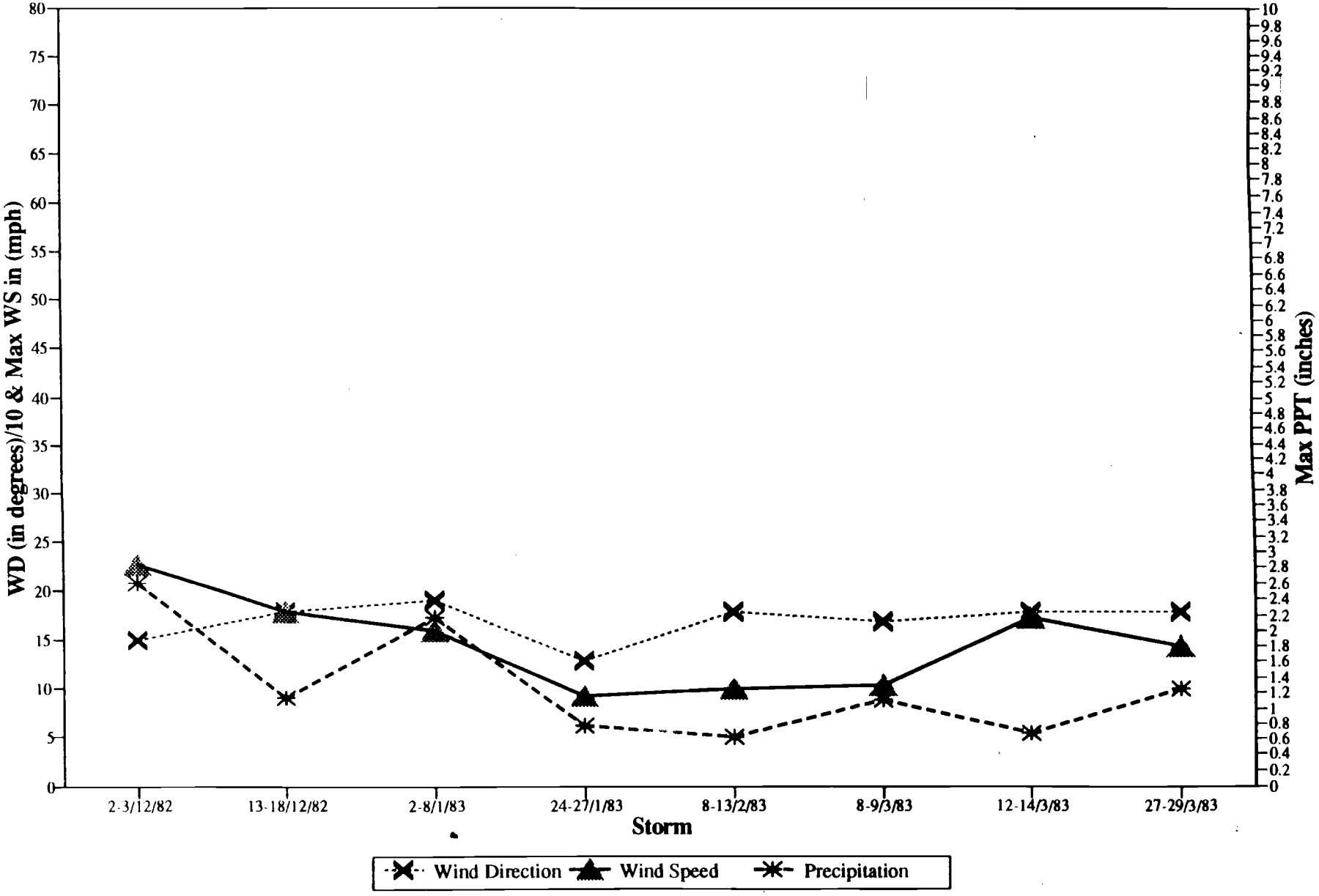
# APPENDICES

Appendix 3-A. W/D, W/S, and PPT for Storm Events, Astoria

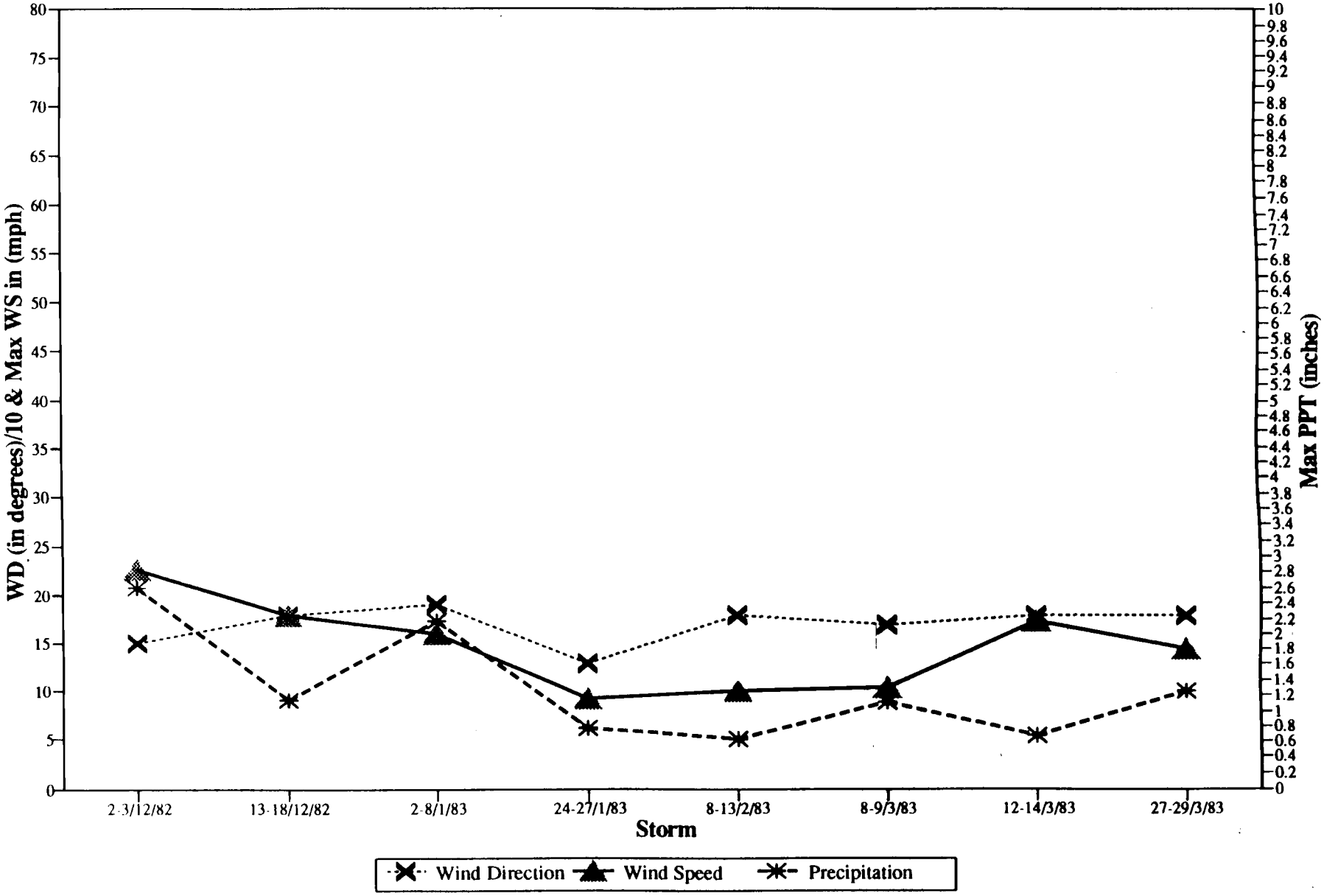
| Storm | Days | W/D | W/S(M) | Date | PPT(M) | Date |
|---|---|---|---|---|---|---|
| 11-19/2/81 | 9 | 19 | 22.6 | 16 | 1.93 | 15 |
| 4-5/12/81 | 2 | 20 | 13.5 | 5 | 2.14 | 5 |
| 9-10/12/81 | 2 | 20 | 13.8 | 10 | 1.53 | 9 |
| 13-15/12/81 | 3 | 21 | 18.5 | 15 | 0.89 | 14 |
| 15-17/1/82 | 3 | 20 | 19 | 16 | 2.39 | 16 |
| 22-23/1/82 | 2 | 19 | 24.3 | 23 | 3.84 | 23 |
| 11-22/2/82 | 12 | 18 | 22.9 | 13 | 1.74 | 13 |
| 2-3/12/82 | 2 | 15 | 22.7 | 3 | 2.58 | 3 |
| 13-18/12/82 | 6 | 18 | 17.8 | 16 | 1.14 | 15 |
| 2-8/1/83 | 7 | 19 | 16 | 7 | 2.15 | 7 |
| 24-27/1/83 | 4 | 13 | 9.2 | 26 | 0.77 | 27 |
| 8-13/2/83 | 6 | 18 | 10.1 | 9 | 0.63 | 9 |
| 8-9/3/83 | 2 | 17 | 10.4 | 9 | 1.12 | 8 |
| 12-14/3/83 | 3 | 18 | 17.4 | 13 | 0.67 | 12 |
| 27-29/3/83 | 3 | 18 | 14.4 | 29 | 1.26 | 29 |
| 29-30/12/83 | 2 | 11 | 16.5 | 29 | 2.19 | 29 |
| 2-4/1/84 | 3 | 18 | 16.7 | 3 | 1.02 | 2 |
| 22-25/1/84 | 4 | 20 | 18 | 24 | 1.65 | 23 |
| 9-13/2/84 | 5 | 17 | 16.3 | 9 | 0.59 | 9 |
| 19-24/2/84 | 6 | 8 | 13.4 | 24 | 0.96 | 23 |
| 28-30/12/84 | 3 | 22 | 15.4 | 29 | 1.18 | 29 |
| 10-11/2/85 | 2 | 20 | 16.7 | 11 | 0.64 | 11 |
| 3-4/3/85 | 2 | 17 | 9.7 | 4 | 0.73 | 4 |
| 22-24/3/85 | 3 | 20 | 16.7 | 23 | 0.98 | 23 |
| 29-31/3/85 | 3 | 21 | 15.7 | 30 | 1.21 | 30 |
| 1-3/12/85 | 3 | 13 | 15.4 | 2 | 1.03 | 2 |
| 1-2/1/86 | 2 | 18 | 11.6 | 2 | 0.74 | 2 |
| 15-19/1/86 | 5 | 20 | 31.2 | 18 | 1.73 | 18 |
| 21-23/1/96 | 3 | 14 | 10.4 | 22 | 1.31 | 22 |
| 29-31/1/86 | 3 | 16 | 9.6 | 30 | 0.83 | 30 |
| 13-16/2/86 | 4 | 20 | 19.3 | 15 | 0.76 | 16 |
| 21-24/2/86 | 4 | 20 | 20.2 | 24 | 1.33 | 22 |
| 6-9/3/86 | 4 | 21 | 17 | 7 | 1.12 | 8 |
| 24-25/12/86 | 2 | 10 | 9.3 | 25 | 1.72 | 25 |
| 27-29/12/86 | 3 | 21 | 14.3 | 29 | 1.29 | 28 |
| 1-4/1/87 | 4 | 16 | 16.5 | 2 | 1.23 | 3 |
| 11-13/1/87 | 3 | 23 | 14.2 | 12 | 0.83 | 12 |
| 25-27/1/87 | 3 | 17 | 15.1 | 26 | 1.01 | 26 |
| 30-31/1/87 | 2 | 19 | 16.9 | 31 | 2.7 | 31 |
| 1-2/2/87 | 2 | 21 | 16.6 | 1 | 0.76 | 1 |
| 27-28/2/87 | 2 | 21 | 11.2 | 28 | 1.08 | 28 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 1-3/3/87 | 3 | 19 | 22 | 3 | 1.68 | 3 |
| 8-10/3/87 | 3 | 14 | 10.2 | 9 | 1.05 | 9 |
| 12-14/3/87 | 3 | 21 | 12.9 | 13 | 0.74 | 13 |
| 1-10/12/87 | 10 | 21 | 26.1 | 9 | 1.04 | 9 |
| 12-16/1/88 | 5 | 20 | 26.3 | 14 | 1.19 | 14 |
| 8-10/2/88 | 3 | 23 | 14.4 | 9 | 1.11 | 9 |
| 4-5/3/88 | 2 | 19 | 13.2 | 5 | 0.58 | 5 |
| 22-23/3/88 | 6 | 26 | 18.3 | 22 | 1.73 | 24 |
| 20-21/12/88 | 2 | 15 | 9.2 | 20 | 0.92 | 20 |
| 29-30/12/88 | 2 | 21 | 20.4 | 29 | 2.7 | 29 |
| 8-10/1/89 | 3 | 21 | 13.9 | 8 | 1.01 | 9 |
| 12-17/1/89 | 6 | 21 | 21.2 | 16 | 1.22 | 16 |
| 16-18/2/89 | 3 | 18 | 19.1 | 17 | 2.32 | 16 |
| 21-23/2/89 | 3 | 19 | 19.5 | 22 | 0.89 | 22 |
| 14-17/3/89 | 4 | 20 | 11.5 | 14 | 1.24 | 15 |
| 2-4/12/89 | 3 | 20 | 16.7 | 4 | 2.3 | 4 |
| 3-9/1/90 | 7 | 21 | 17.6 | 9 | 4.53 | 9 |
| 21-22/1/90 | 2 | 24 | 15.3 | 22 | 0.83 | 22 |
| 25-29/1/90 | 5 | 23 | 22.1 | 28 | 1.41 | 28 |
| 2-11/2/90 | 10 | 22 | 18.3 | 9 | 2.72 | 9 |
| 14-15/2/90 | 2 | 23 | 10.8 | 15 | 0.76 | 15 |
| 5-10/3/90 | 6 | 22 | 13.4 | 8 | 1.39 | 6 |
| 3-5/12/90 | 3 | 22 | 19.4 | 4 | 1.03 | 4 |

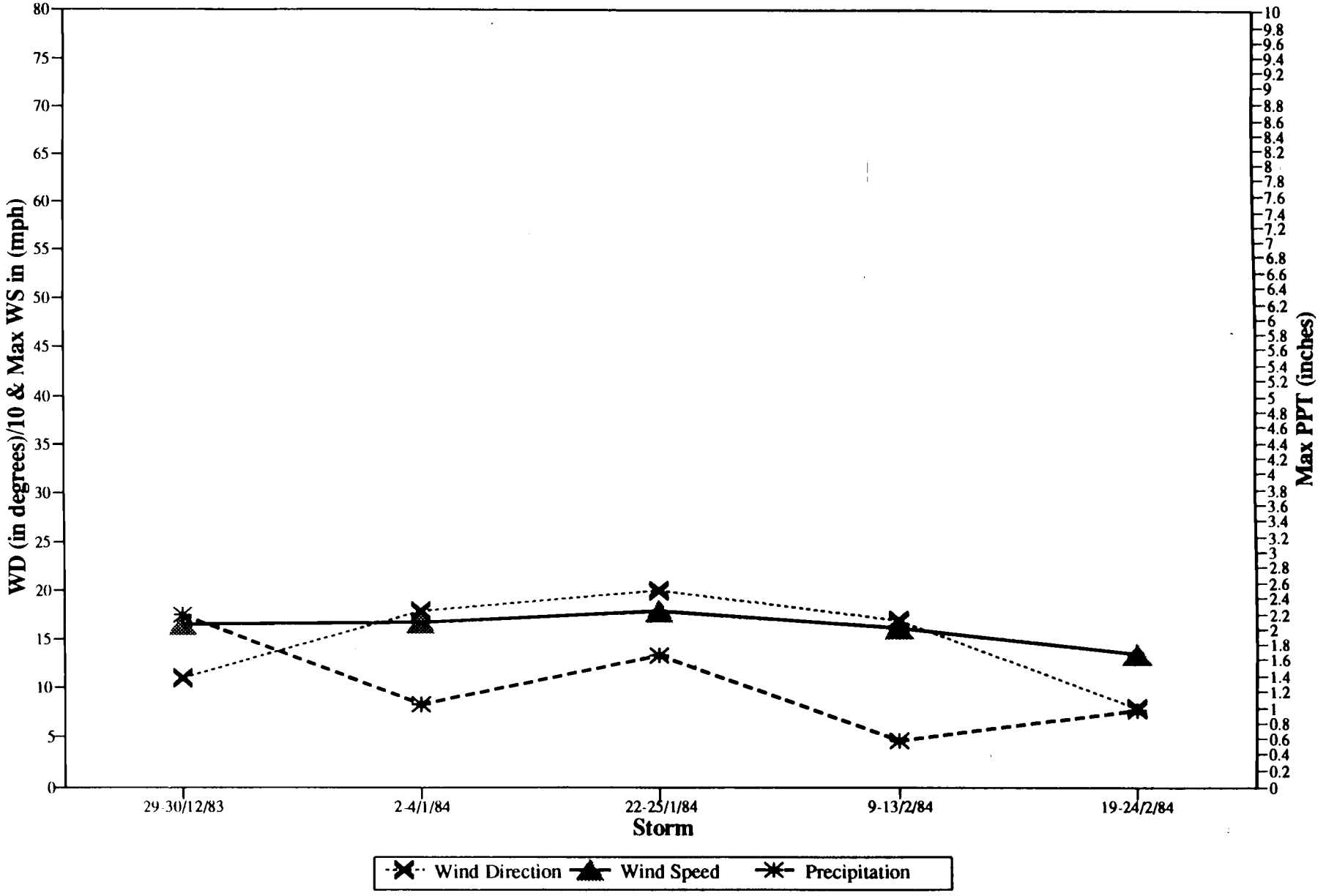
# Wind Direction, Wind Speed and PPT for Storm Events,Winter 81-82, Astoria



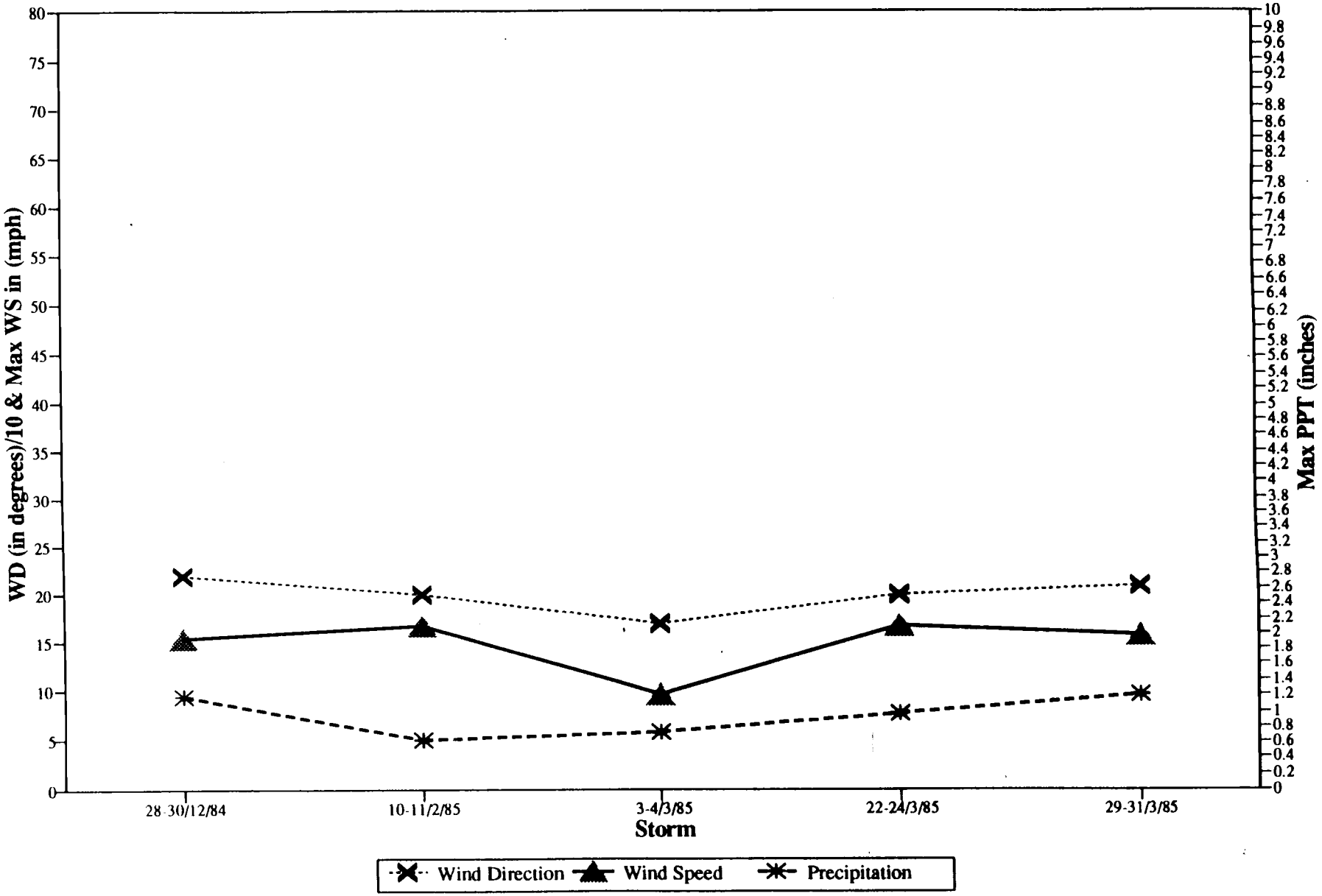
# Wind Direction, Wind Speed and PPT for Storm Events,Winter 82-83, Astoria



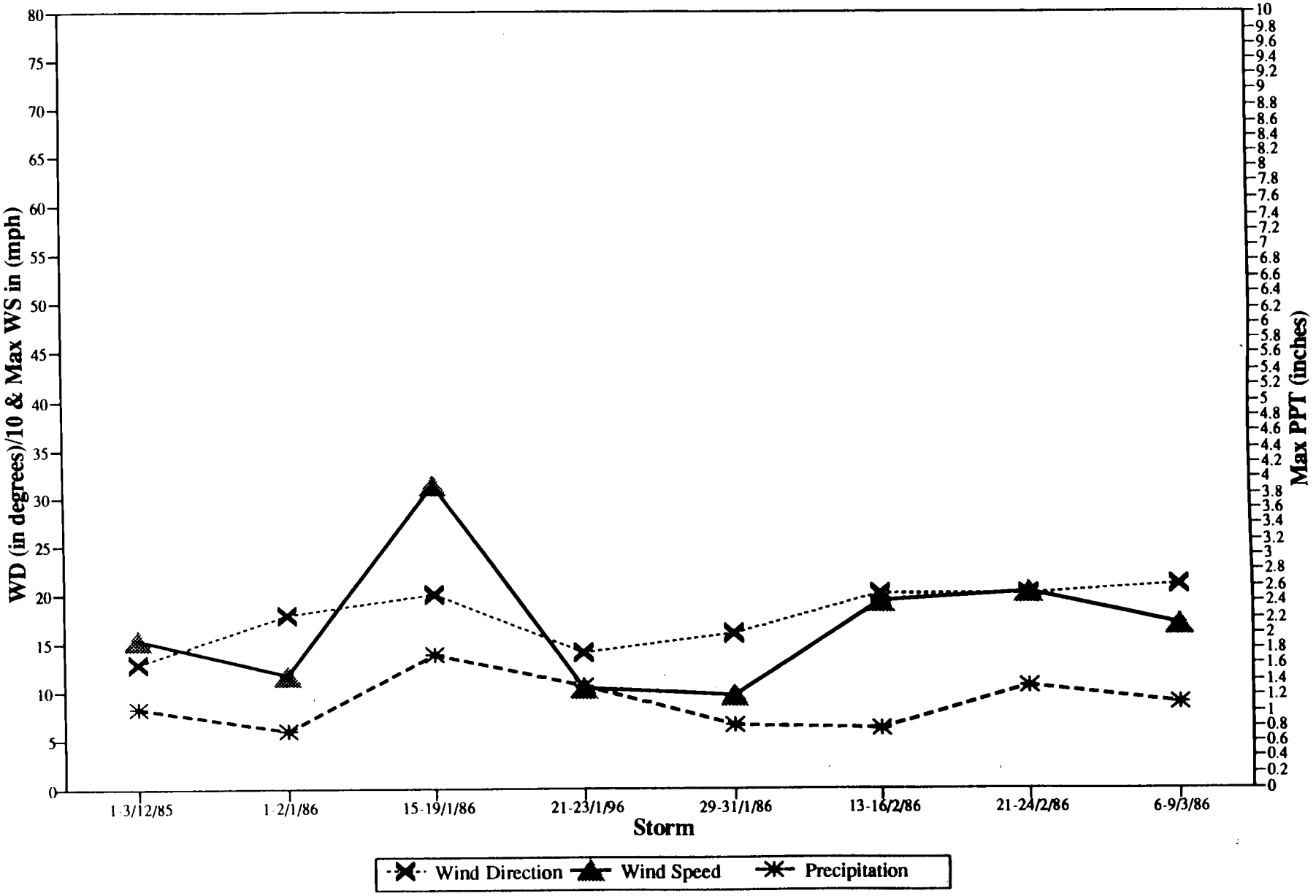
# Wind Direction, Wind Speed and PPT for Storm Events,Winter 83-84, Astoria



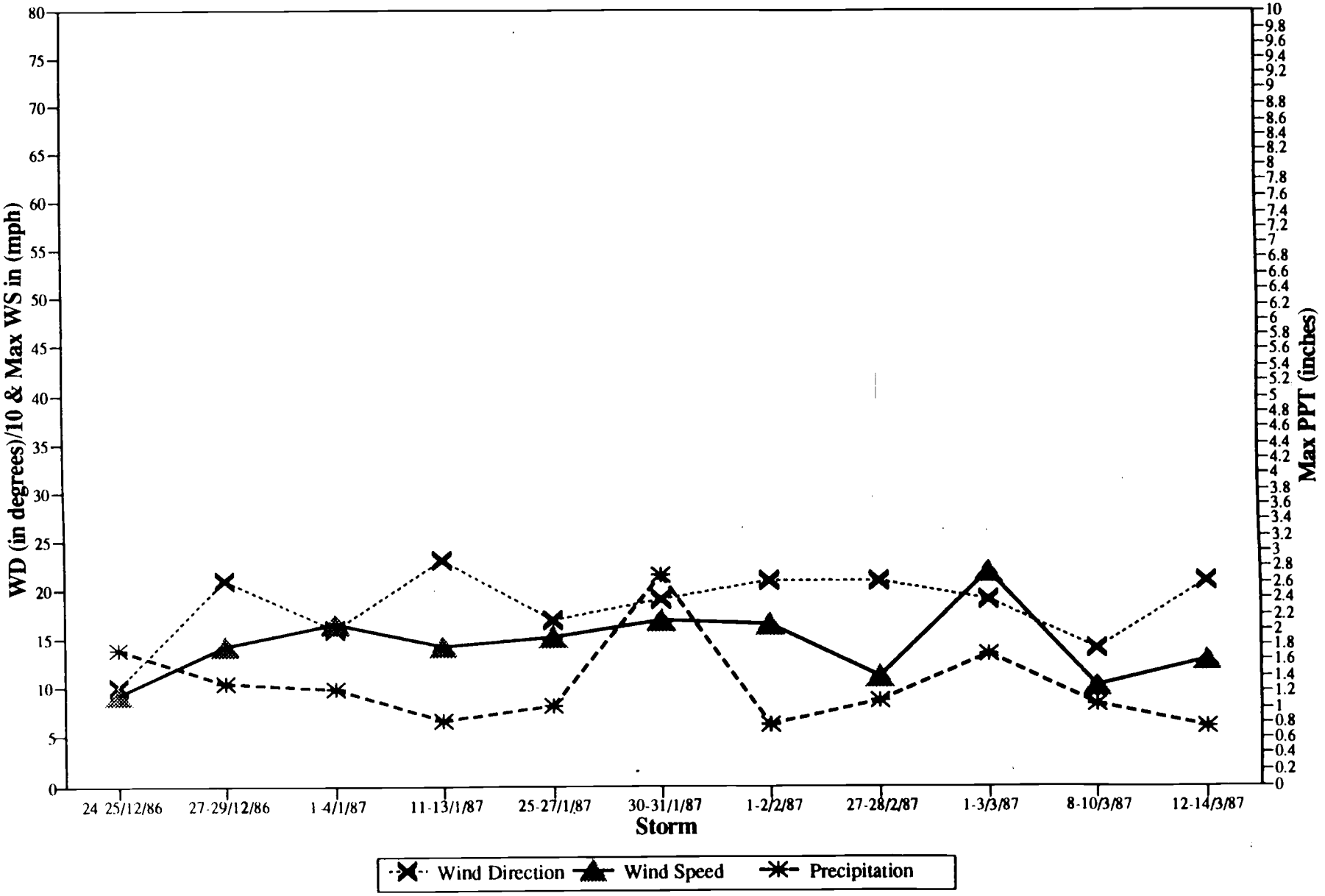
# Wind Direction, Wind Speed and PPT for Storm Events,Winter 84-85, Astoria



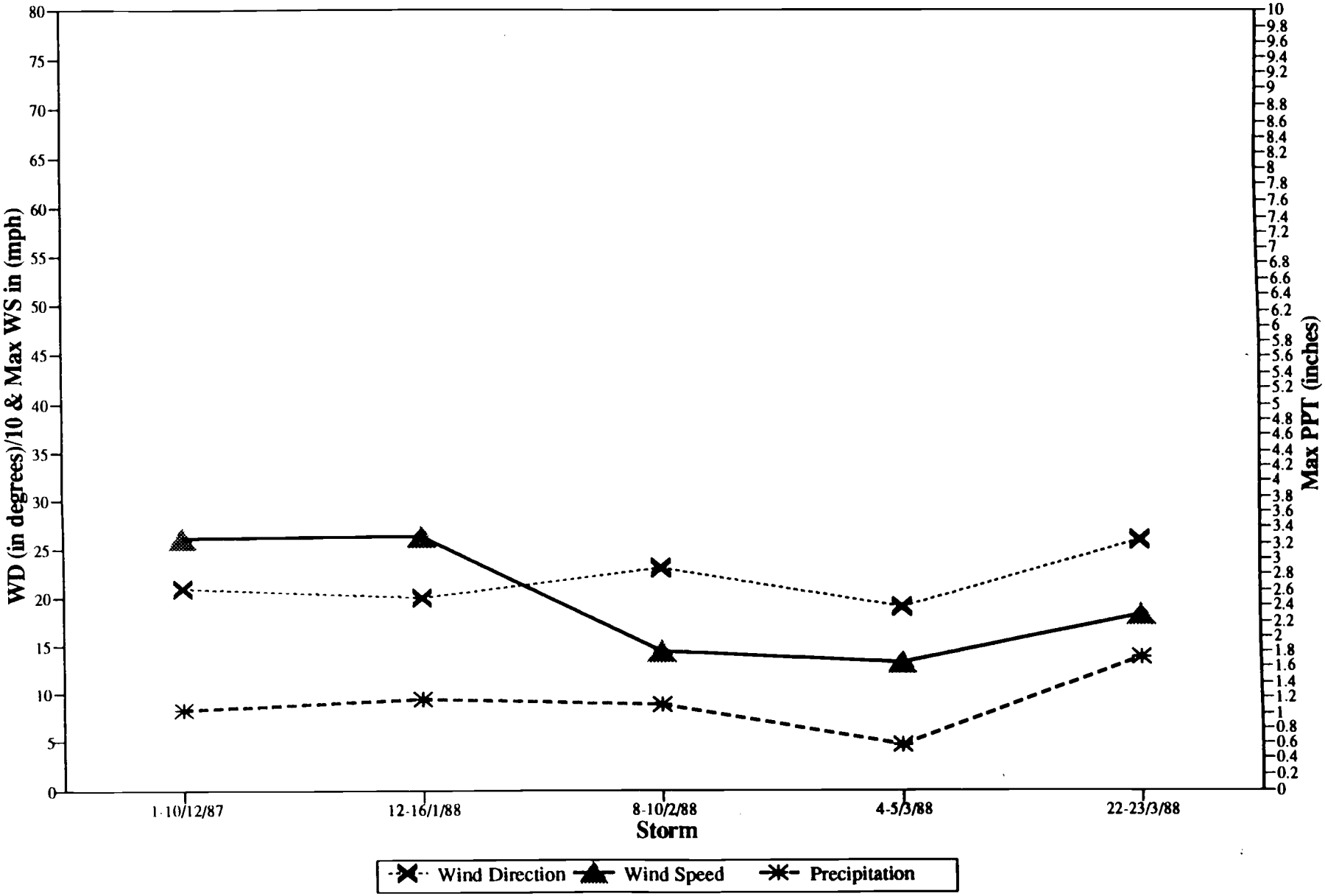
# Wind Direction, Wind Speed and PPT for Storm Events,Winter 85-86, Astoria



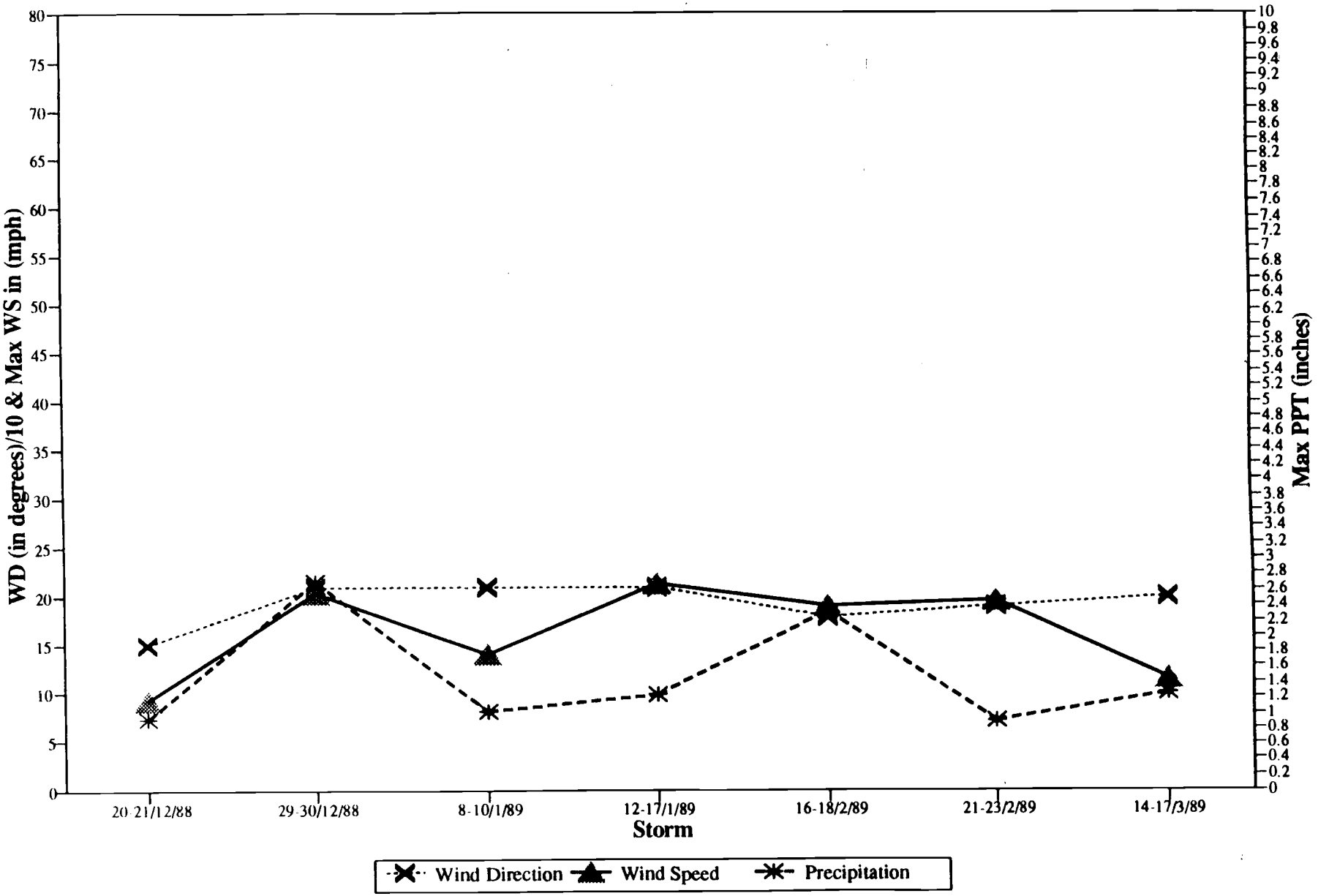
# Wind Direction, Wind Speed and PPT for Storm Events,Winter 86-87, Astoria



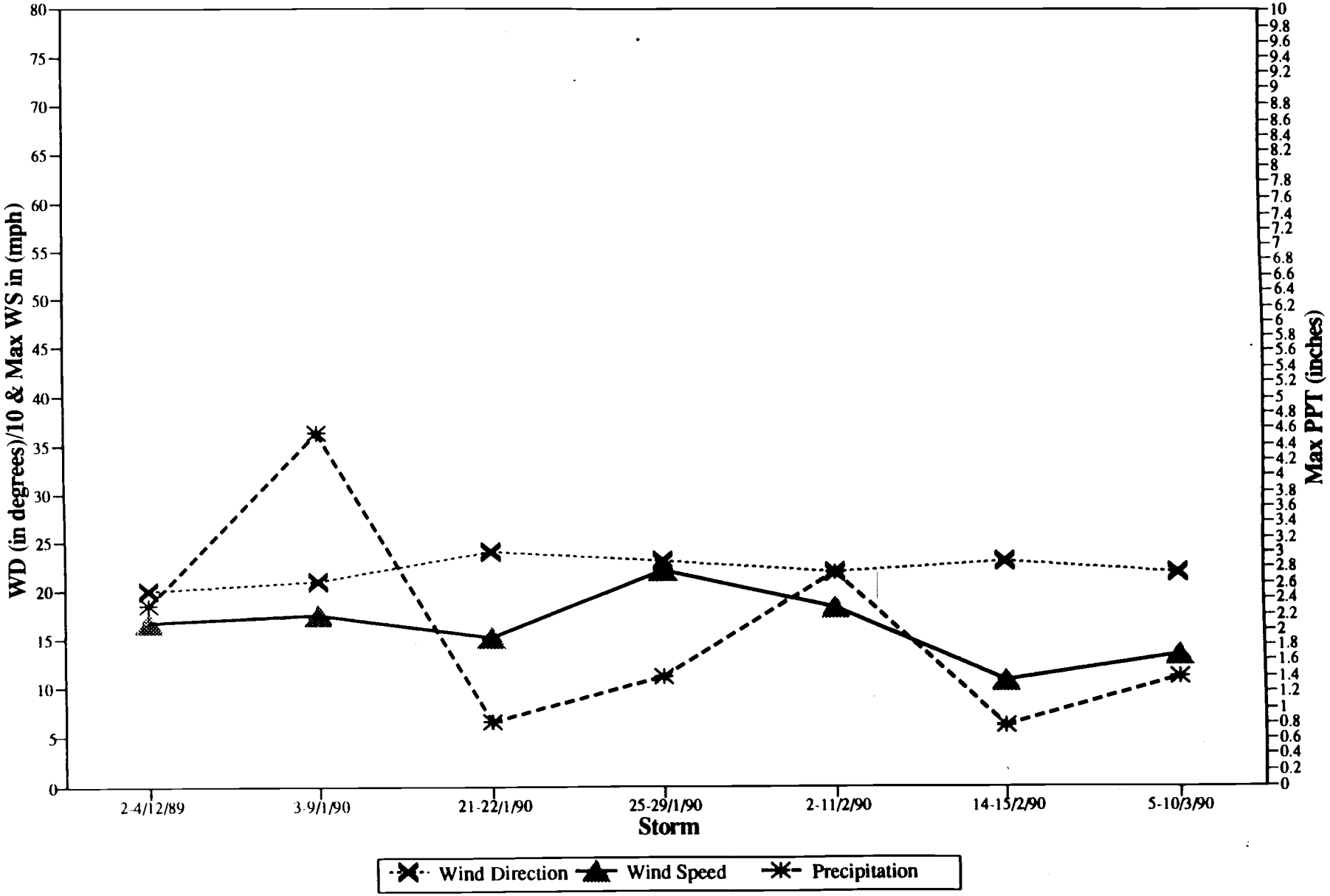
# Wind Direction, Wind Speed and PPT for Storm Events,Winter 87-88, Astoria



# Wind Direction, Wind Speed and PPT for Storm Events,Winter 88-89, Astoria



# Wind Direction, Wind Speed and PPT for Storm Events,Winter 89-90, Astoria

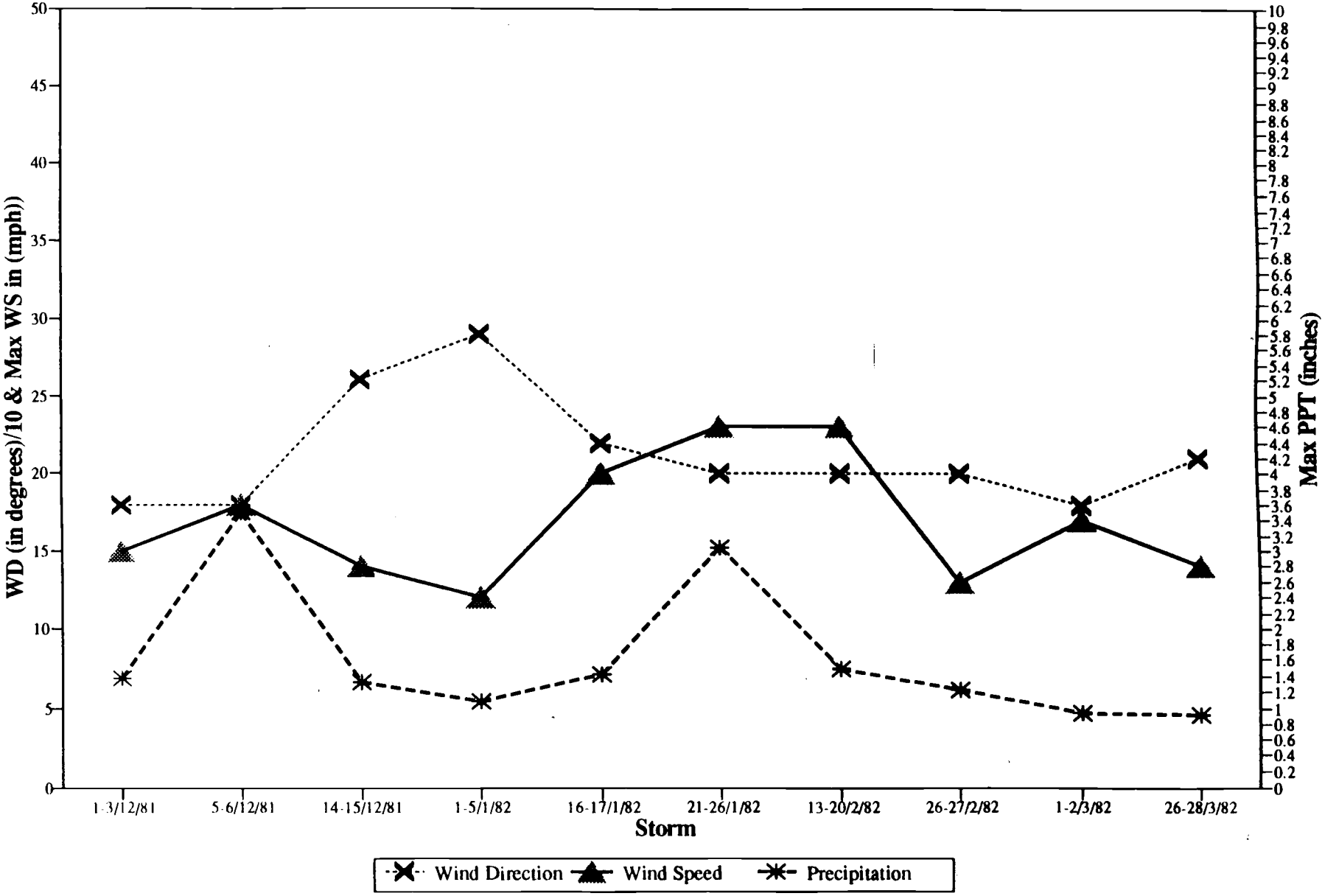


Appendix 3-B. W/D, W/S and PPT for Storm Events, Newport

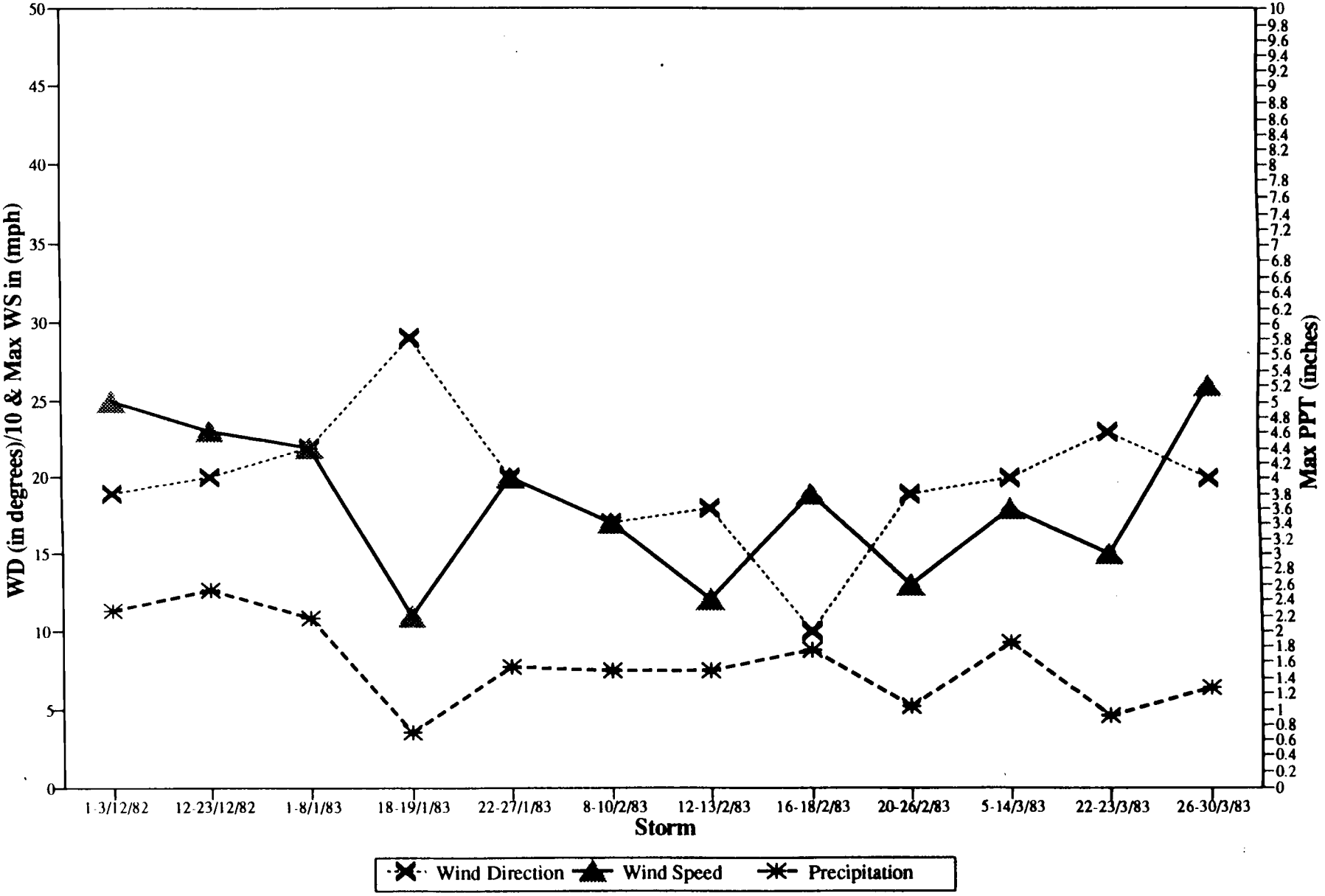
| Storm | Days | W/D | W/S(M) | Date | PPT(M) | Date |
|---|---|---|---|---|---|---|
| 17-19/1/81 | 3 | 18 | 20 | 18 | 1.74 | 18 |
| 23-24/1/81 | 2 | 18 | 11 | 23 | 1.01 | 23 |
| 23-24/3/81 | 2 | 18 | 14 | 24 | 1.21 | 23 |
| 29-31/3/81 | 3 | 21 | 14 | 31 | 1.22 | 30 |
| 1-3/12/81 | 3 | 18 | 15 | 1 | 1.36 | 1 |
| 5-6/12/81 | 2 | 18 | 18 | 5 | 3.49 | 5 |
| 14-15/12/81 | 2 | 26 | 14 | 15 | 1.34 | 15 |
| 1-5/1/82 | 5 | 29 | 12 | 3 | 1.08 | 4 |
| 16-17/1/82 | 2 | 22 | 20 | 16 | 1.43 | 16 |
| 21-26/1/82 | 6 | 20 | 23 | 23 | 3.05 | 22 |
| 13-20/2/82 | 8 | 20 | 23 | 16 | 1.5 | 18 |
| 26-27/2/82 | 2 | 20 | 13 | 26 | 1.23 | |
| 1-2/3/82 | 2 | 18 | 17 | 1 | 0.94 | 1 |
| 26-28/3/82 | 3 | 21 | 14 | 27 | 0.92 | 26 |
| 1-3/12/82 | 3 | 19 | 25 | 3 | 2.26 | 3 |
| 12-23/12/82 | 12 | 20 | 23 | 15 | 2.53 | 15 |
| 1-8/1/83 | 8 | 22 | 22 | 6 | 2.16 | 5 |
| 18-19/1/83 | 2 | 29 | 11 | 19 | 0.69 | 19 |
| 22-27/1/83 | 6 | 20 | 20 | 24 | 1.54 | 26 |
| 8-10/2/83 | 3 | 17 | 17 | 8 | 1.49 | 9 |
| 12-13/2/83 | 2 | 18 | 12 | 12 | 1.5 | 12 |
| 16-18/2/83 | 3 | 10 | 19 | 17 | 1.74 | 17 |
| 20-26/2/83 | 7 | 19 | 13 | 21 | 1.02 | 21 |
| 5-14/3/83 | 9 | 20 | 18 | 13 | 1.85 | 9 |
| 22-23/3/83 | 2 | 23 | 15 | 22 | 0.92 | 22 |
| 26-30/3/83 | 5 | 20 | 26 | 29 | 1.28 | 29 |
| 4-10/12/83 | 6 | 21 | 16 | 7 | 1.25 | 7 |
| 25-26/12/83 | 2 | 25 | 20 | 25 | 0.78 | 25 |
| 29-30/12/83 | 2 | 18 | 18 | 29 | 1.54 | 29 |
| 2-4/1/84 | 3 | 20 | 15 | 3 | 0.82 | 3 |
| 22-25/1/84 | 4 | 20 | 22 | 23 | 0.69 | 23 |
| 9-13/2/84 | 5 | 19 | 17 | 12 | 1.85 | 12 |
| 19-20/2/84 | 2 | 21 | 12 | 20 | 1.34 | 20 |
| 23-24/2/84 | 2 | 20 | 25 | 24 | 0.78 | 23 |
| 25-26/3/84 | 2 | 19 | 14 | 25 | 0.64 | 25 |
| 9-11/12/84 | 3 | 21 | 9 | 9 | 1.28 | 10 |
| 28-30/12/84 | 3 | 20 | 17 | 29 | 1.57 | 29 |
| 6-11/2/85 | 6 | 18 | 17 | 11 | 0.82 | 11 |
| 23-27/3/85 | 5 | 19 | 15 | 23 | 1.42 | 23 |
| 30-31/3/85 | 2 | 20 | 18 | 30 | 0.72 | 30 |
| 1-8/12/85 | 8 | 21 | 22 | 2 | 1.03 | 6 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 15-18/1/86 | 4 | **20** | 20 | 16 | 0.83 | 17 |
| 22-23/1/86 | 2 | **19** | 13 | 22 | 1.08 | 22 |
| 12-16/2/86 | 5 | **21** | 17 | 15 | 0.68 | 12 |
| 20-22/2/86 | 3 | **21** | 13 | 22 | 1.46 | 22 |
| 6-13/3/86 | 8 | **20** | 23 | 7 | 0.94 | 7 |
| 3-4/1/87 | 2 | **23** | 13 | 3 | 1.13 | 3 |
| 11-14/1/87 | 4 | **25** | 16 | 12 | 1.13 | 12 |
| 24-31/1/87 | 8 | **20** | 26 | 31 | 1.65 | 25 |
| 1-2/2/87 | 2 | **22** | 11 | 2 | 1.63 | 1 |
| 12-13/2/87 | 2 | **22** | 17 | 13 | 1.18 | 13 |
| 2-3/3/87 | 2 | **20** | 15 | 3 | 3.07 | 3 |
| 10-13/3/87 | 4 | **20** | 14 | 11 | 1.7 | 12 |
| 8-11/1/88 | 4 | **20** | 25 | 10 | 2.34 | 10 |
| 13-16/1/88 | 4 | **19** | 26 | 14 | 2.6 | 14 |
| 28-29/1/88 | 2 | **36** | 15 | 29 | 0.68 | 29 |
| 8-9/2/88 | 2 | **19** | 15 | 9 | 0.79 | 8 |
| 23-26/3/88 | 4 | **18** | 15 | 24 | 1.18 | 24 |
| 20-24/12/88 | 5 | **18** | 15 | 21 | 0.72 | 23 |
| 29-31/12/88 | 3 | **18** | 21 | 29 | 1.28 | 29 |
| 6-9/1/89 | 4 | **19** | 18 | 8 | 1.4 | 7 |
| 14-16/1/89 | 3 | **19** | 21 | 15 | 0.99 | 15 |
| 16-18/2/89 | 3 | **18** | 22 | 16 | 2.29 | 16 |
| 21-24/2/89 | 4 | 17 | 16 | 22 | 0.66 | 22 |
| 4-6/3/89 | 3 | 18 | 22 | 5 | 0.89 | 5 |
| 9-17/3/89 | 9 | 18 | 17 | 11 | 1.5 | 12 |
| 24-28/3/89 | 5 | 20 | 26 | 27 | 0.91 | 24 |
| 2-4/12/89 | 3 | 18 | 18 | 3 | 2.65 | 3 |
| 4-9/1/90 | 6 | 20 | 25 | 7 | 1.32 | 6 |
| 25-31/1/90 | 7 | 20 | 26 | 28 | 1.32 | 28 |
| 2-10/2/90 | 9 | 19 | 26 | 2 | 1.16 | 8 |
| 15-16/2/90 | 2 | 18 | 18 | 15 | 1.05 | 15 |
| 7-9/31/90 | 3 | 18 | 19 | 9 | 0.79 | 7 |

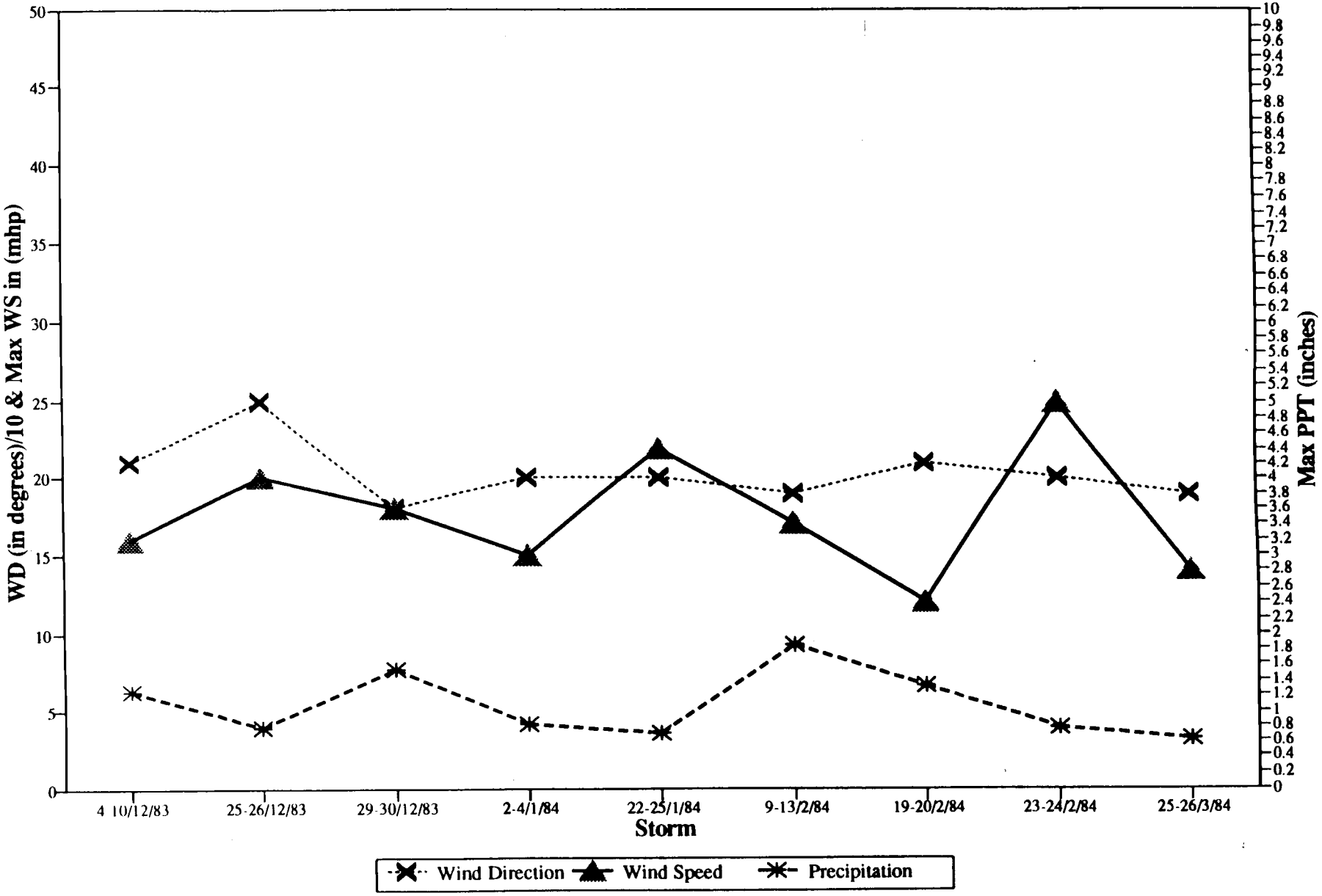
# Wind Direction, Wind Speed and PPT for Storm Events, Winter 81-82, Newport



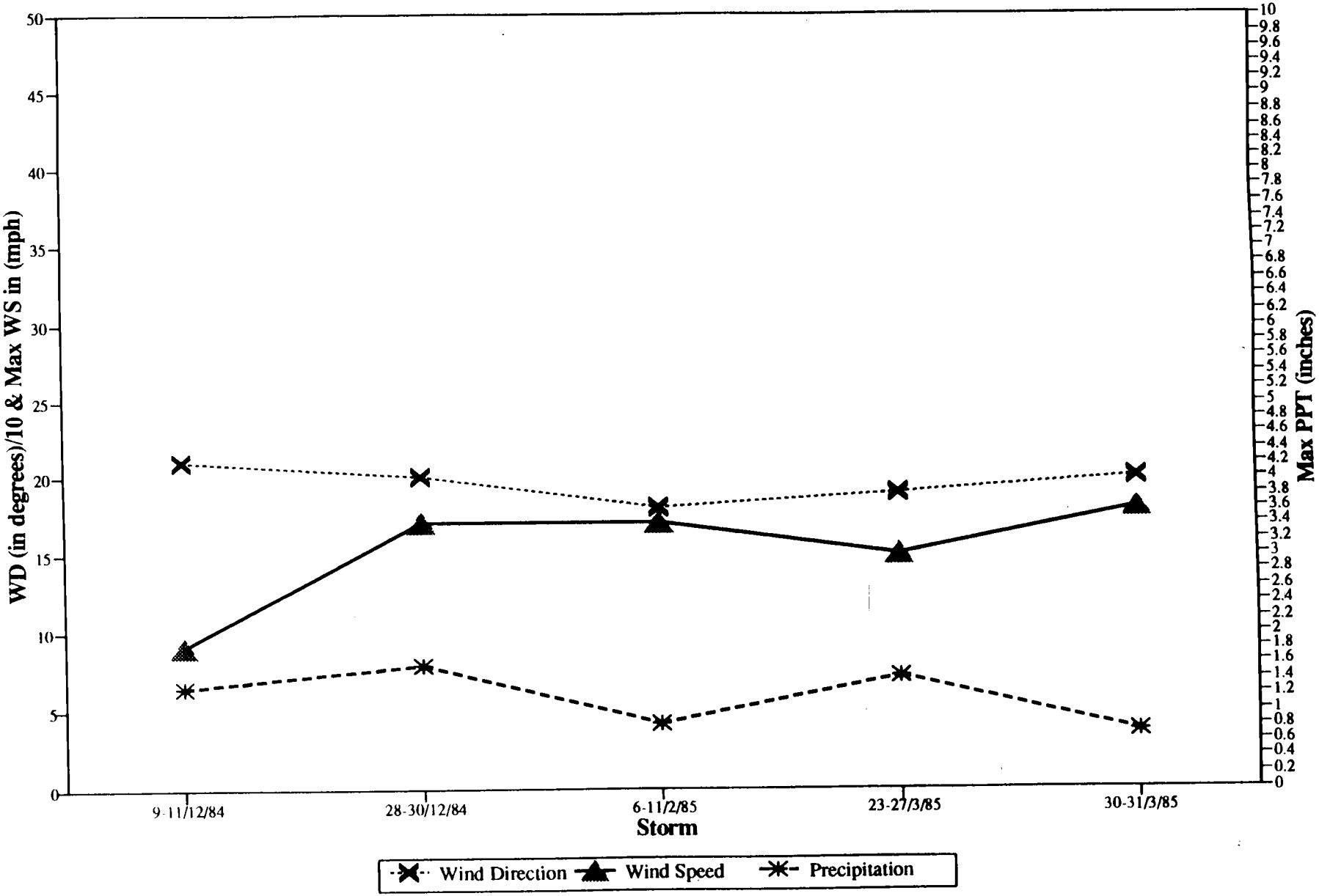
# Wind Direction, Wind Speed and PPT for Storm Events, Winter 82-83, Newport



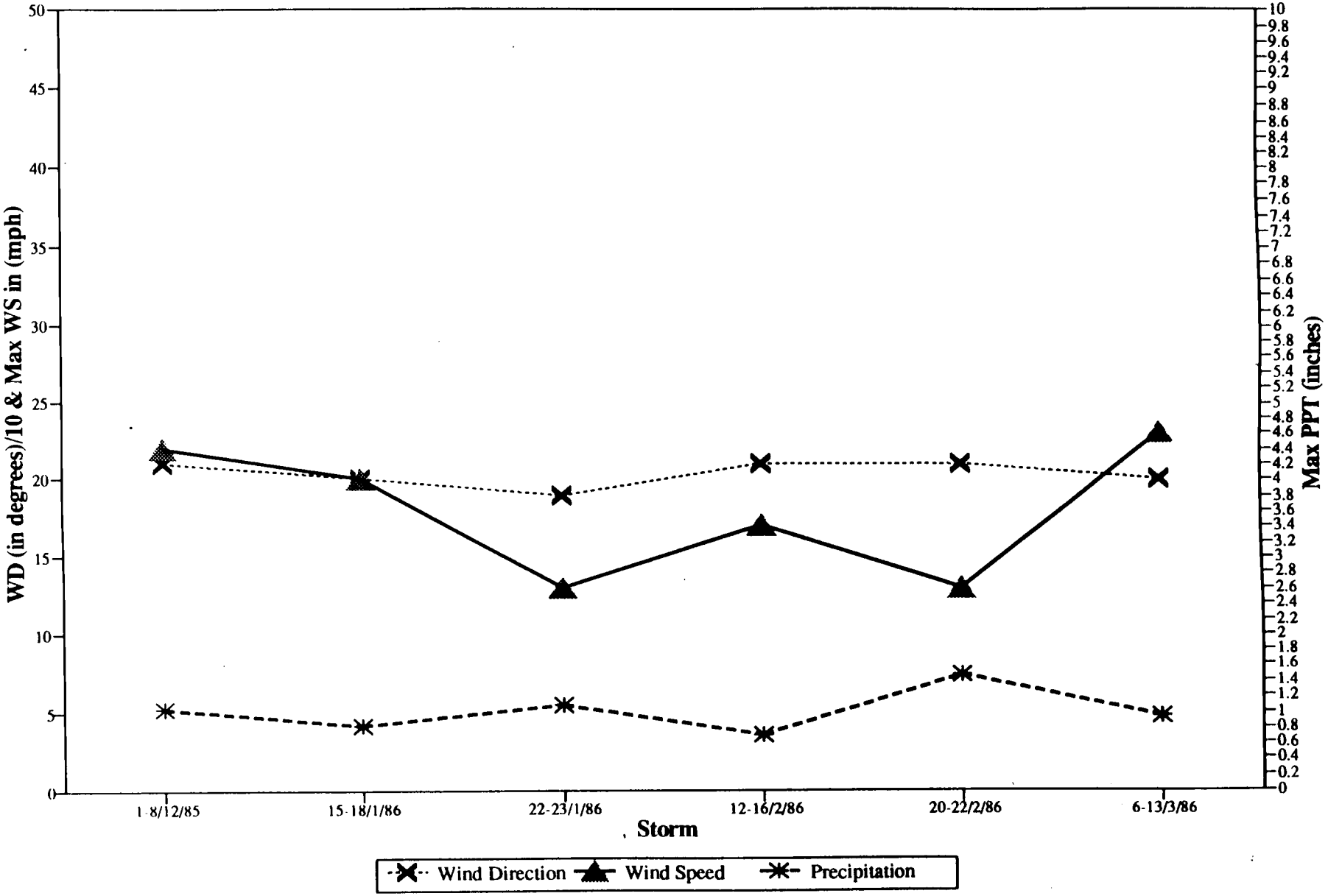
# Wind Direction, Wind Speed and PPT at Storm Time for Winter 83-84, Newport



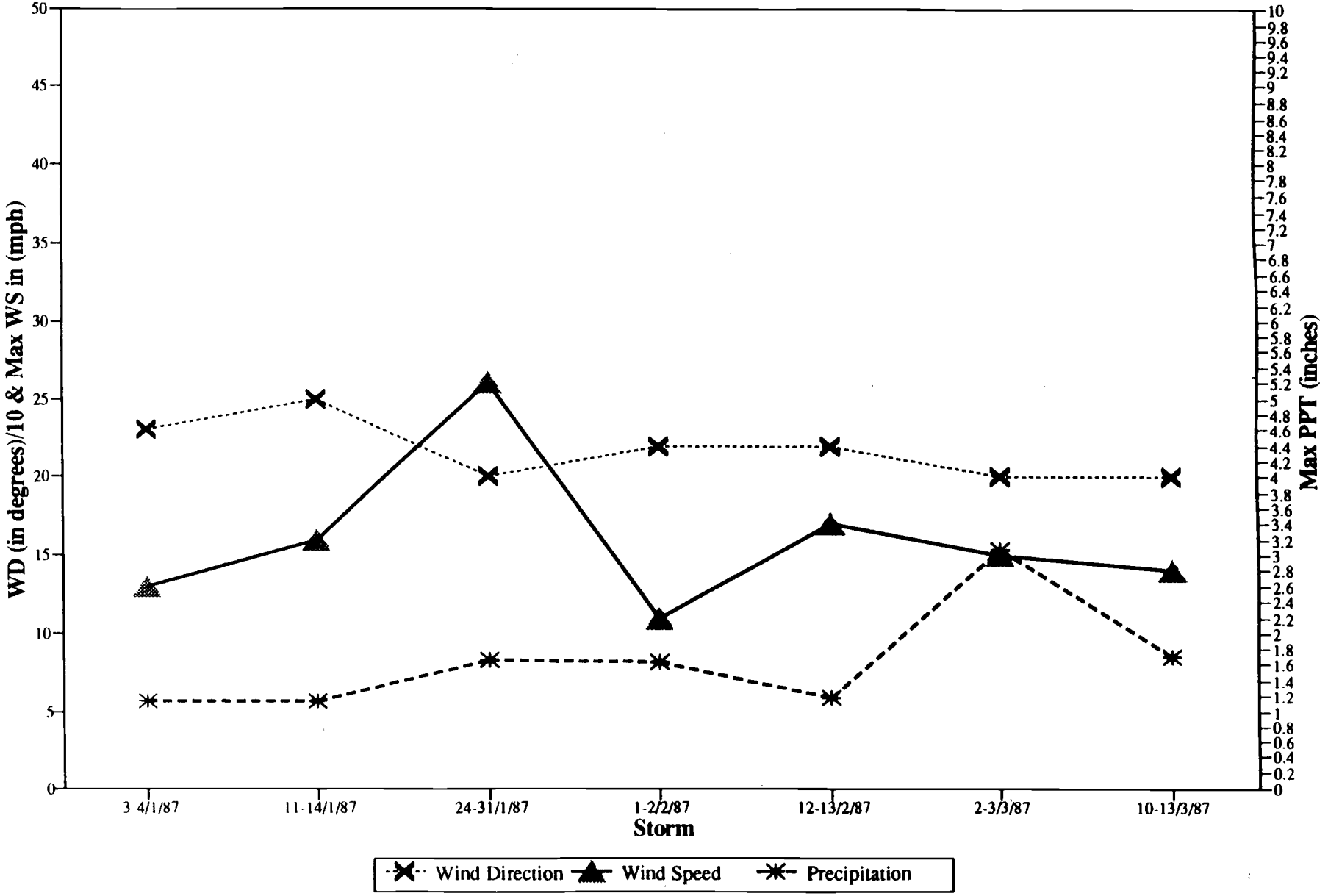
# Wind Direction, Wind Speed and PPT for Storm Events, Winter 84-85, Newport



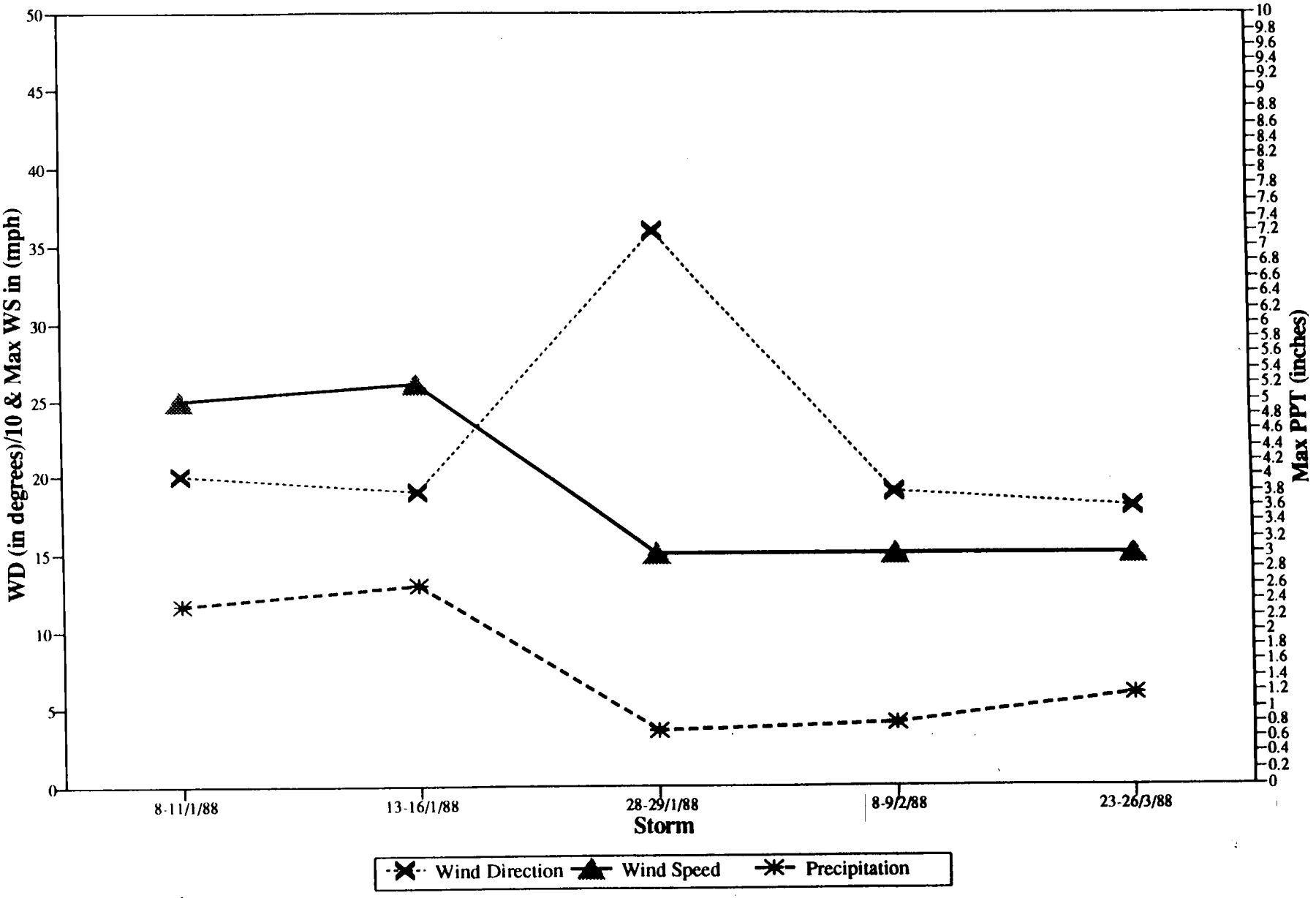
# Wind Direction, Wind Speed and PPT for Storm Events, Winter 85-86, Newport



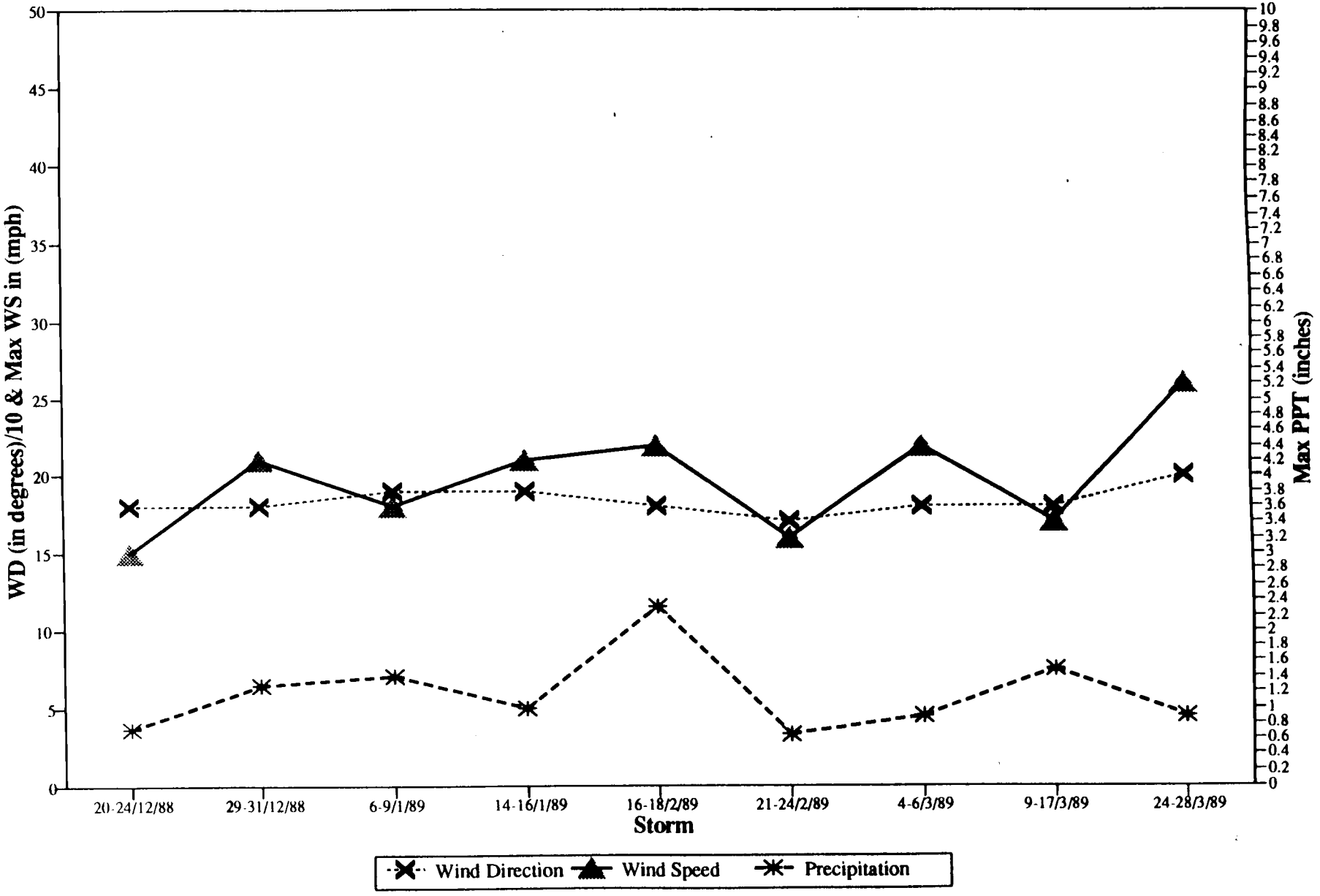
# Wind Direction, Wind Speed and PPT for Storm Events,Winter 86-87, Newport



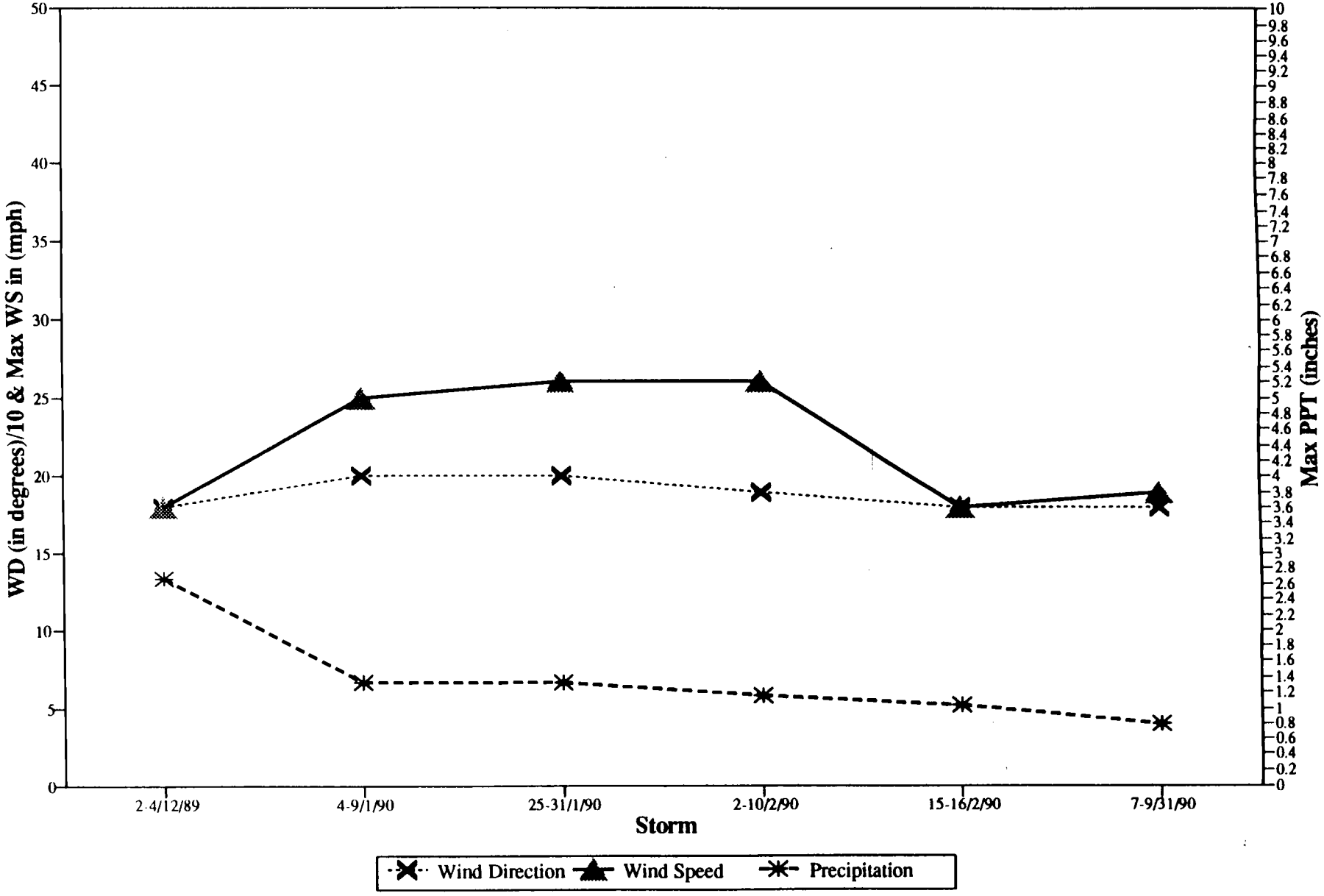
# Wind Direction, Wind Speed and PPT for Storm Events,Winter 87-88, Newport



# Wind Direction, Wind Speed and PPT for Storm Events,Winter 88-89, Newport



# Wind Direction, Wind Speed and PPT for Storm Events,Winter 89-90, Newport

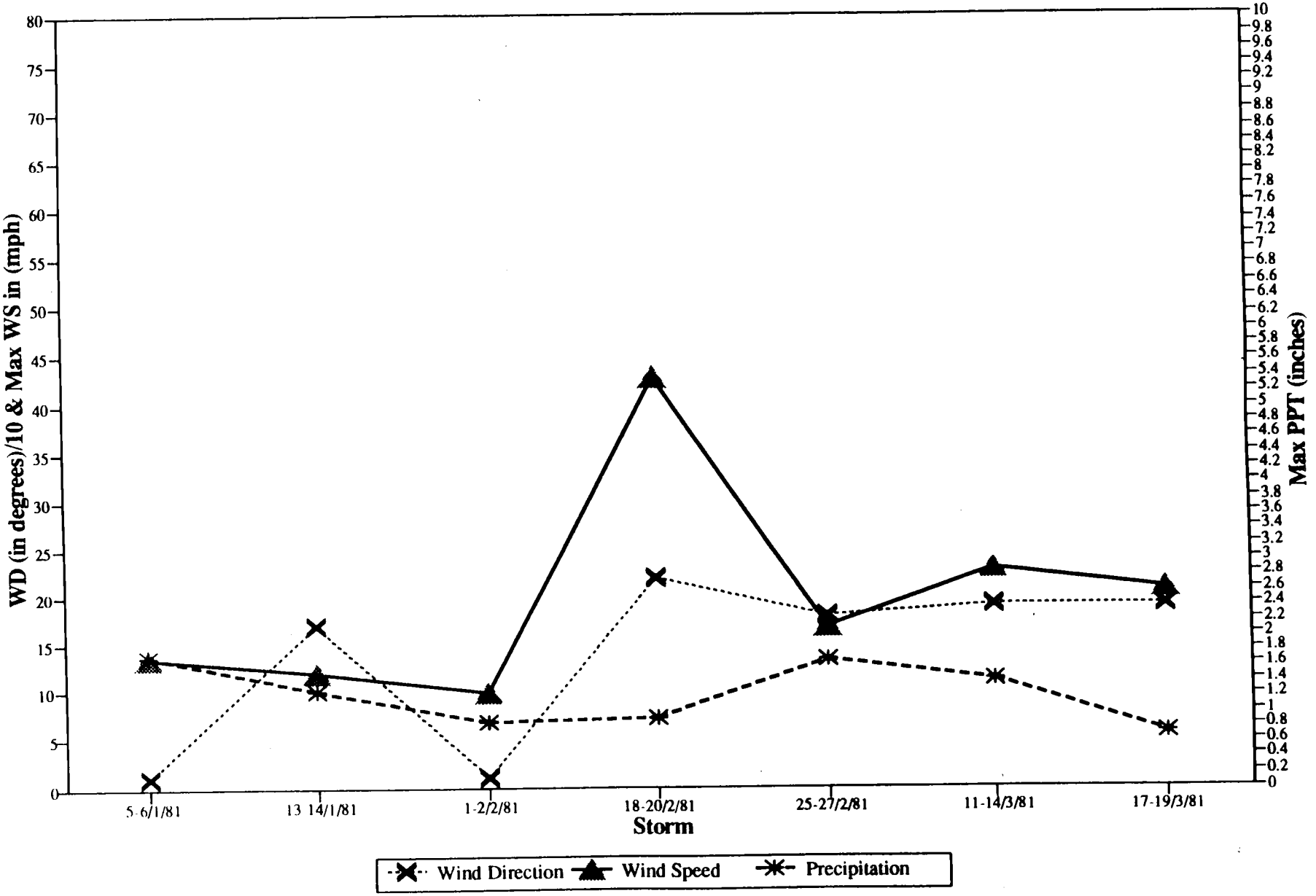


Appendix 3-C. W/D, W/S and PPT for Storm Events, Cape Blanco

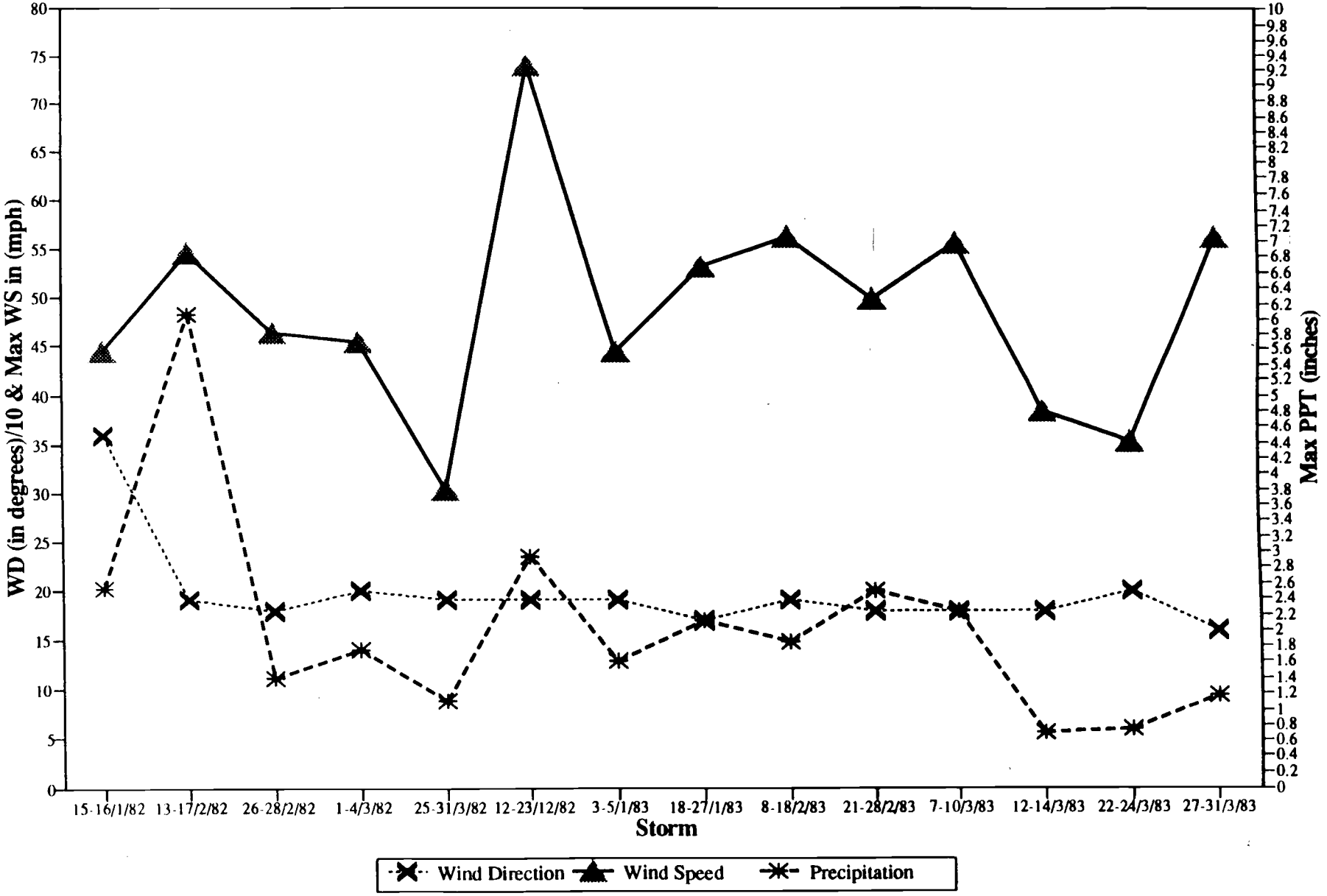
| Storm | Days | W/D | W/S(M) | Date | PPT(M) | Date |
|---|---|---|---|---|---|---|
| 5-6/1/81 | 2 | 1 | 13.5 | 6 | 1.71 | 6 |
| 13-14/1/81 | 2 | 17 | 12 | 14 | 1.25 | 14 |
| 1-2/2/81 | 2 | 1 | 9.8 | 2 | 0.85 | 2 |
| 18-20/2/81 | 3 | 22 | 42.8 | 18 | 0.9 | 19 |
| 25-27/2/81 | 3 | 18 | 16.7 | 26 | 1.65 | 27 |
| 11-14/3/81 | 4 | 19 | 22.8 | 14 | 1.4 | 14 |
| 17-19/3/81 | 3 | 19 | 20.8 | 18 | 0.68 | 17 |
| 15-16/1/82 | 2 | 36 | 44.5 | 16 | 2.53 | 16 |
| 13-17/2/82 | 5 | 19 | 54.8 | 14 | 6.03 | 14 |
| 26-28/2/82 | 3 | 18 | 46.4 | 26 | 1.38 | 26 |
| 1-4/3/82 | 4 | 20 | 45.6 | 1 | 1.74 | 1 |
| 25-31/3/82 | 7 | 19 | 30.2 | 27 | 1.11 | 27 |
| 12-23/12/82 | 12 | 19 | 74 | 15 | 2.93 | 15 |
| 3-5/1/83 | 3 | 19 | 44.5 | 4 | 1.6 | 4 |
| 18-27/1/83 | 10 | 17 | 53.3 | 25 | 2.12 | 26 |
| 8-18/2/83 | 11 | 19 | 56.4 | 11 | 1.85 | 17 |
| 21-28/2/83 | 8 | 18 | 50 | 21 | 2.5 | 21 |
| 7-10/3/83 | 4 | 18 | 55.9 | 8 | 2.22 | 7 |
| 12-14/3/83 | 4 | 18 | 38.4 | 12 | 0.71 | 13 |
| 22-24/3/83 | 3 | 20 | 35.3 | 22 | 0.74 | 22 |
| 27-31/3/83 | 5 | 16 | 56.4 | 29 | 1.18 | 30 |
| 4-7/12/83 | 4 | 18 | 46.9 | 7 | 2.57 | 6 |
| 9-10/12/83 | 2 | 17 | 36.5 | 9 | 0.97 | 9 |
| 12-15/12/83 | 4 | 18 | 53.2 | 12 | 2.91 | 14 |
| 24-25/12/83 | 2 | 23 | 25.8 | 25 | 0.96 | 25 |
| 29-30/12/83 | 2 | 18 | 52.5 | 29 | 1.39 | 30 |
| 11-12/1/84 | 2 | 1 | 28.6 | 12 | 0.92 | 11 |
| 21-22/1/84 | 2 | 18 | 31.4 | 21 | 0.54 | 22 |
| 8-13/2/84 | 6 | 19 | 54.8 | 12 | 2.5 | 13 |
| 15-16/2/84 | 2 | 23 | 29.4 | 15 | 0.68 | 15 |
| 20-22/2/84 | 3 | 17 | 31.5 | 20 | 1.1 | 20 |
| 9-10/3/84 | 2 | 17 | 24.7 | 9 | 0.61 | 10 |
| 12-21/3/84 | 10 | 17 | 47.4 | 13 | 1.74 | 14 |
| 15-16/12/84 | 2 | 14 | 17 | 16 | 0.85 | 15 |
| 29-31/12/84 | 3 | 17 | 39.5 | 29 | 1.61 | 30 |
| 1-2/2/85 | 2 | 16 | 21.6 | 1 | 0.68 | 1 |
| 7-8/2/85 | 2 | 18 | 31.4 | 7 | 1.73 | 7 |
| 11-12/12/85 | 2 | 17 | 55.9 | 11 | 0.6 | 11 |
| 4-7/3/85 | 4 | 15 | 26.9 | 5 | 0.95 | 5 |
| 22-28/3/85 | 7 | 17 | 45.2 | 25 | 1.27 | 26 |
| 1-2/12/85 | 2 | 21 | 45.7 | 2 | 0.56 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 5-8/12/85 | 4 | 18 | 52.9 | 6 | 0.91 | 5 |
| 1-2/1/86 | 2 | 19 | 35.5 | 2 | 0.67 | 1 |
| 8-10/1/86 | 3 | 19 | 41 | 10 | 1 | 9 |
| 13-18/1/86 | 6 | 19 | 53.8 | 18 | 1.7 | 18 |
| 21-22/1/86 | 2 | 18 | 49.9 | 22 | 1.35 | 21 |
| 28-29/1/86 | 3 | 18 | 31.1 | 30 | 1.72 | 29 |
| 1-3/2/86 | 3 | 19 | 43.1 | 2 | 1.23 | 2 |
| 12-18/2/86 | 7 | 19 | 47.4 | 15 | 1.83 | 15 |
| 20-23/2/86 | 4 | 18 | 44.8 | 21 | 3.42 | 22 |
| 7-13/3/86 | 7 | 18 | 46.8 | 9 | 3.65 | 13 |
| 23-24/3/86 | 2 | 18 | 36.2 | 23 | 1.8 | 23 |
| 1-5/1/87 | 5 | 17 | 47 | 2 | 2.33 | 1 |
| 12-14/1/87 | 3 | 3 | 22.3 | 14 | 1.56 | 12 |
| 22-31/1/87 | 10 | 17 | 72 | 31 | 1.65 | 25 |
| 1-2/2/87 | 2 | 18 | 39.7 | 1 | 2.52 | 1 |
| 4-6/3/87 | 3 | 17 | 32.6 | 5 | 1.41 | 5 |
| 11-12/3/87 | 2 | 17 | 56.6 | 11 | 2 | 12 |
| 1-10/12/87 | 10 | 17 | 63.1 | 5 | 7.53 | 3 |
| 14-16/12/87 | 3 | 17 | 27.9 | 14 | 1.27 | 15 |
| 29-31/12/87 | 3 | 17 | 34.1 | 29 | 1.24 | 30 |
| 1-4/3/88 | 4 | 17 | 18.9 | 4 | 1.09 | 1 |
| 13-14/1/89 | 2 | 18 | 34.7 | 14 | 0.72 | 14 |
| 21-22/2/89 | 2 | 19 | 39.3 | 22 | 1.3 | 21 |
| 4-8/1/90 | 5 | 17 | 67.1 | 6 | 3.1 | 7 |
| 12-16/1/90 | 5 | 36 | 20 | 14 | 1.11 | 14 |

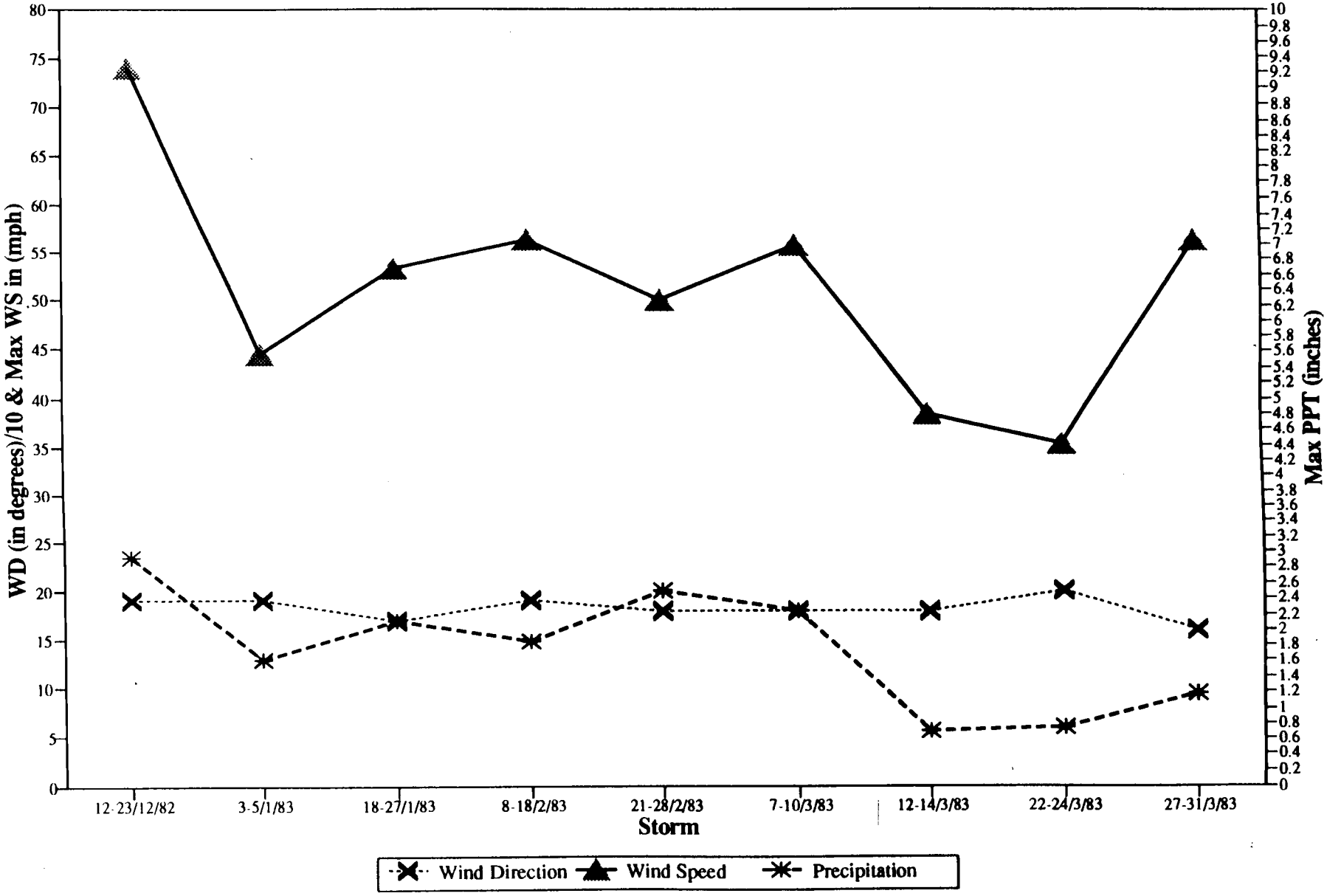
# Wind Direction, Wind Speed and PPT for Storm Events,Winter 81,Cape Blanco



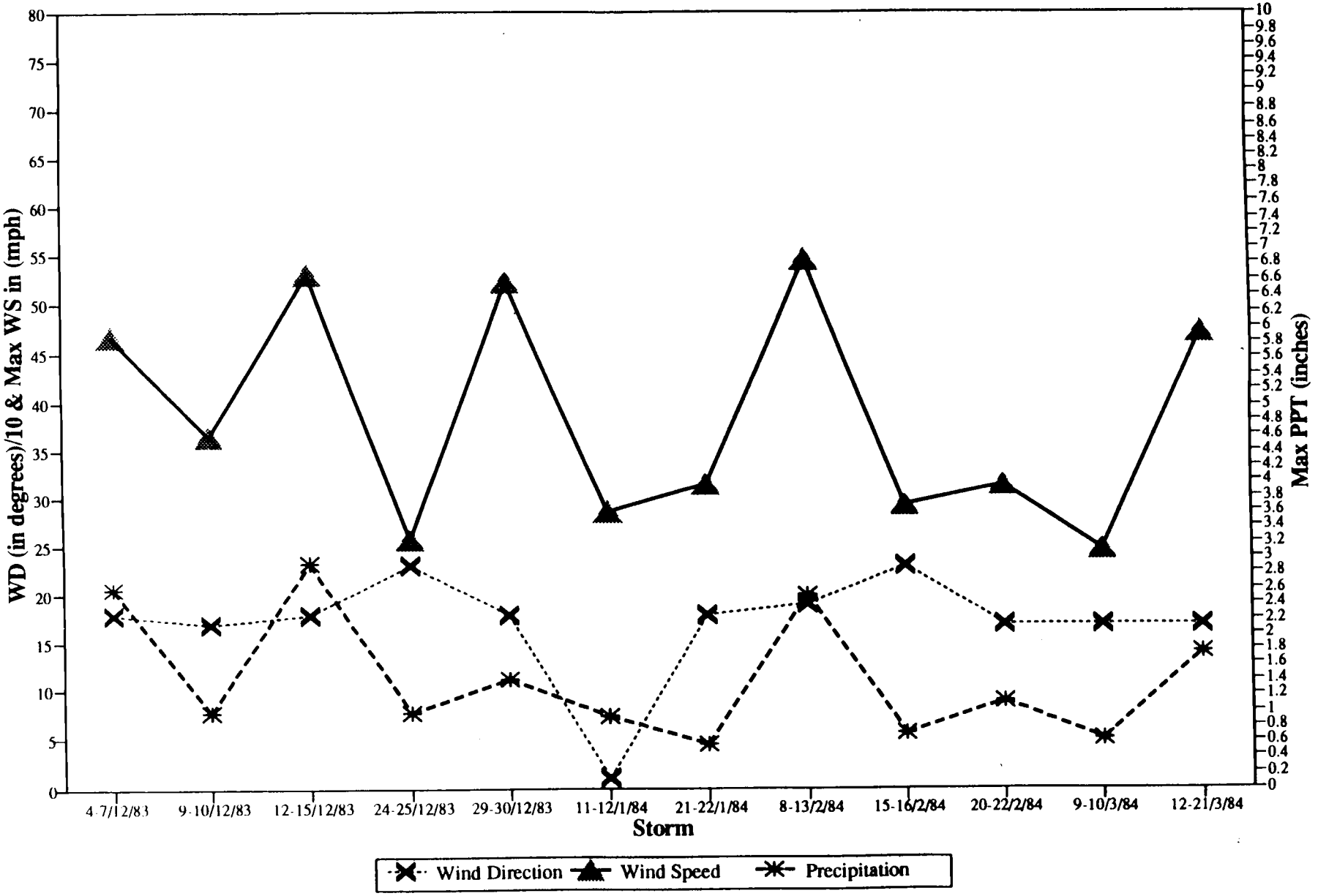
# Wind Direction, Wind Speed and PPT for Storm Events,Winter 81-82,Cape Blanco



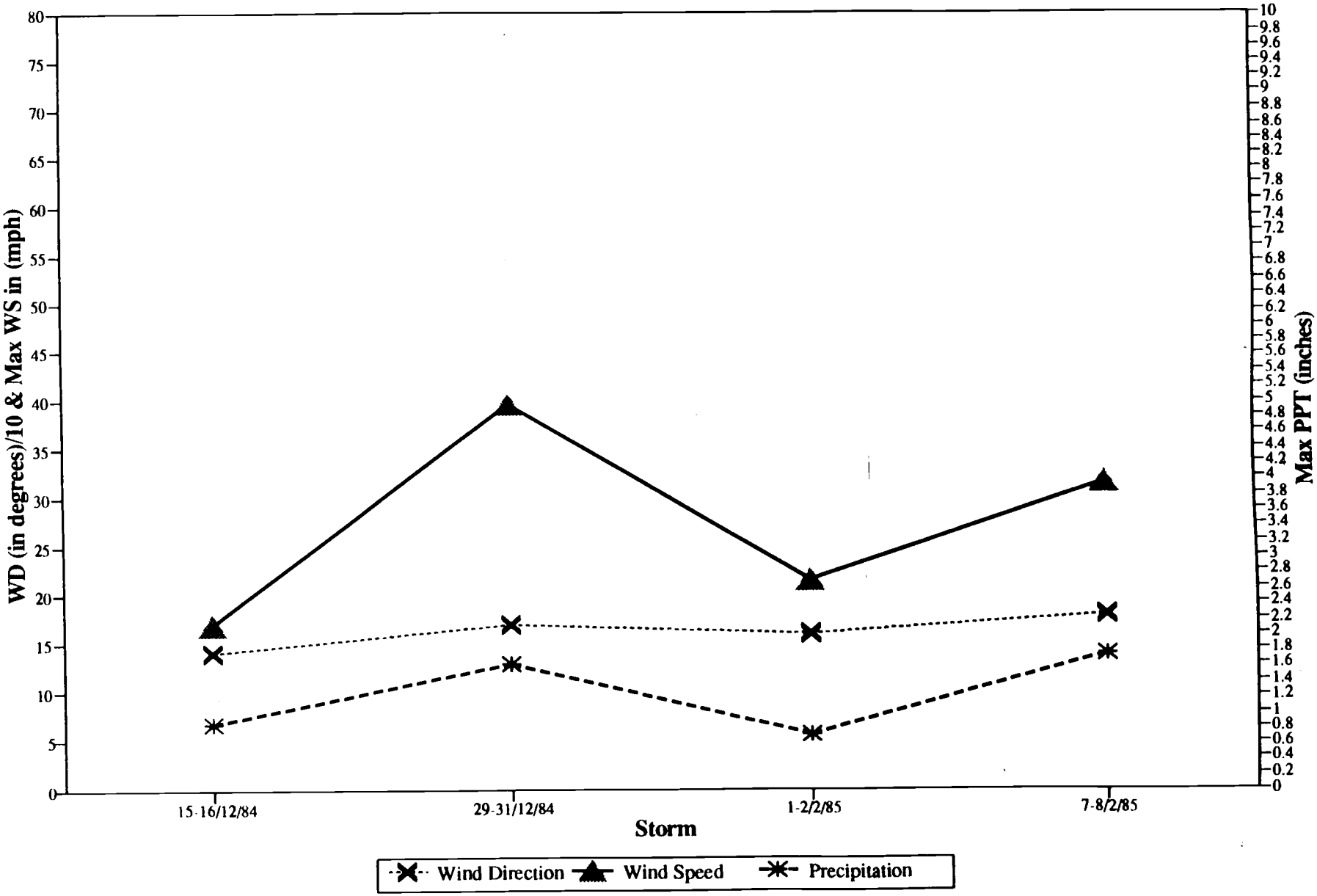
# Wind Direction, Wind Speed and PPT for Storm Events,Winter 82-83,Cape Blanco



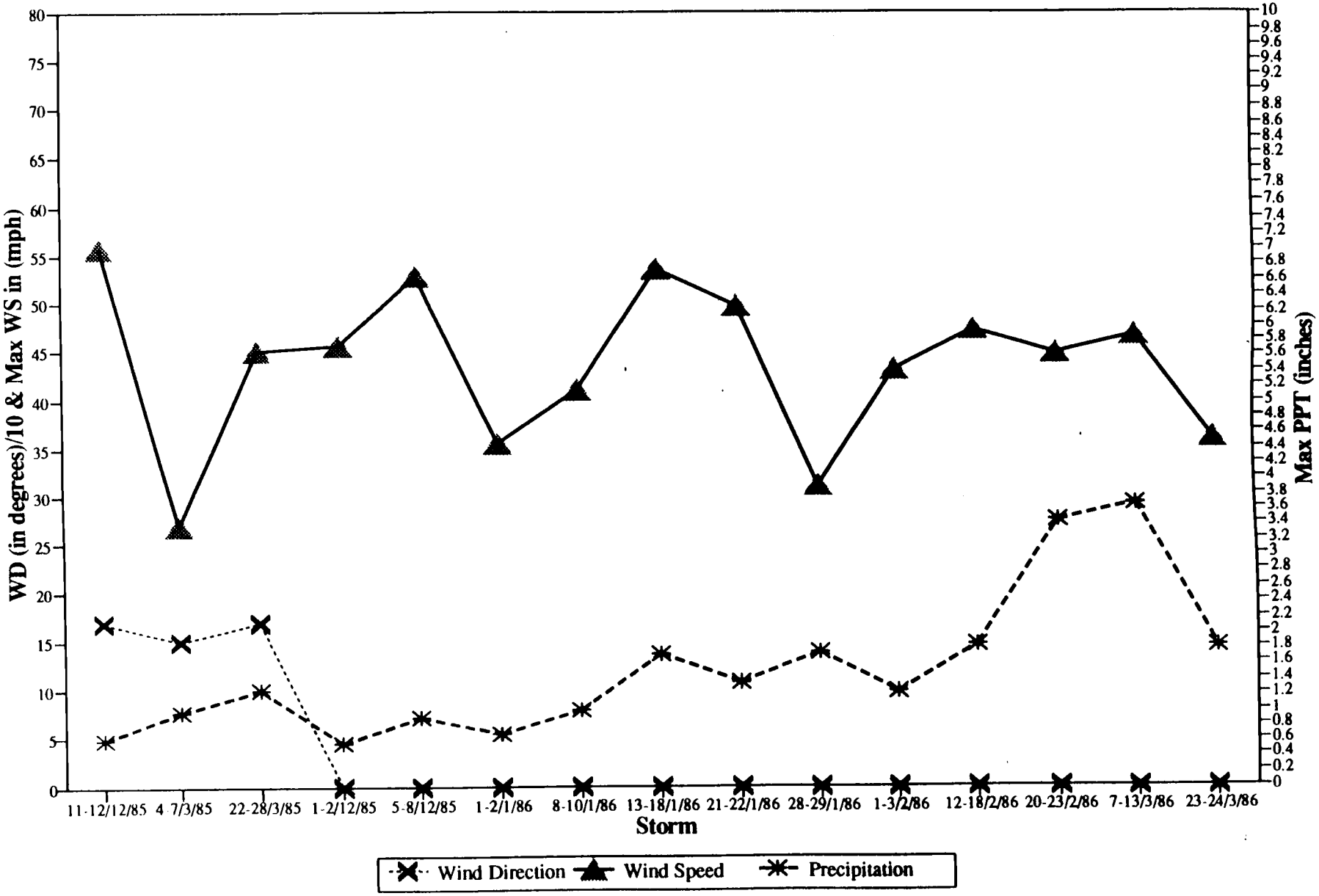
# Wind Direction, Wind Speed and PPT for Storm Events,Winter 83-84,Cape Blanco



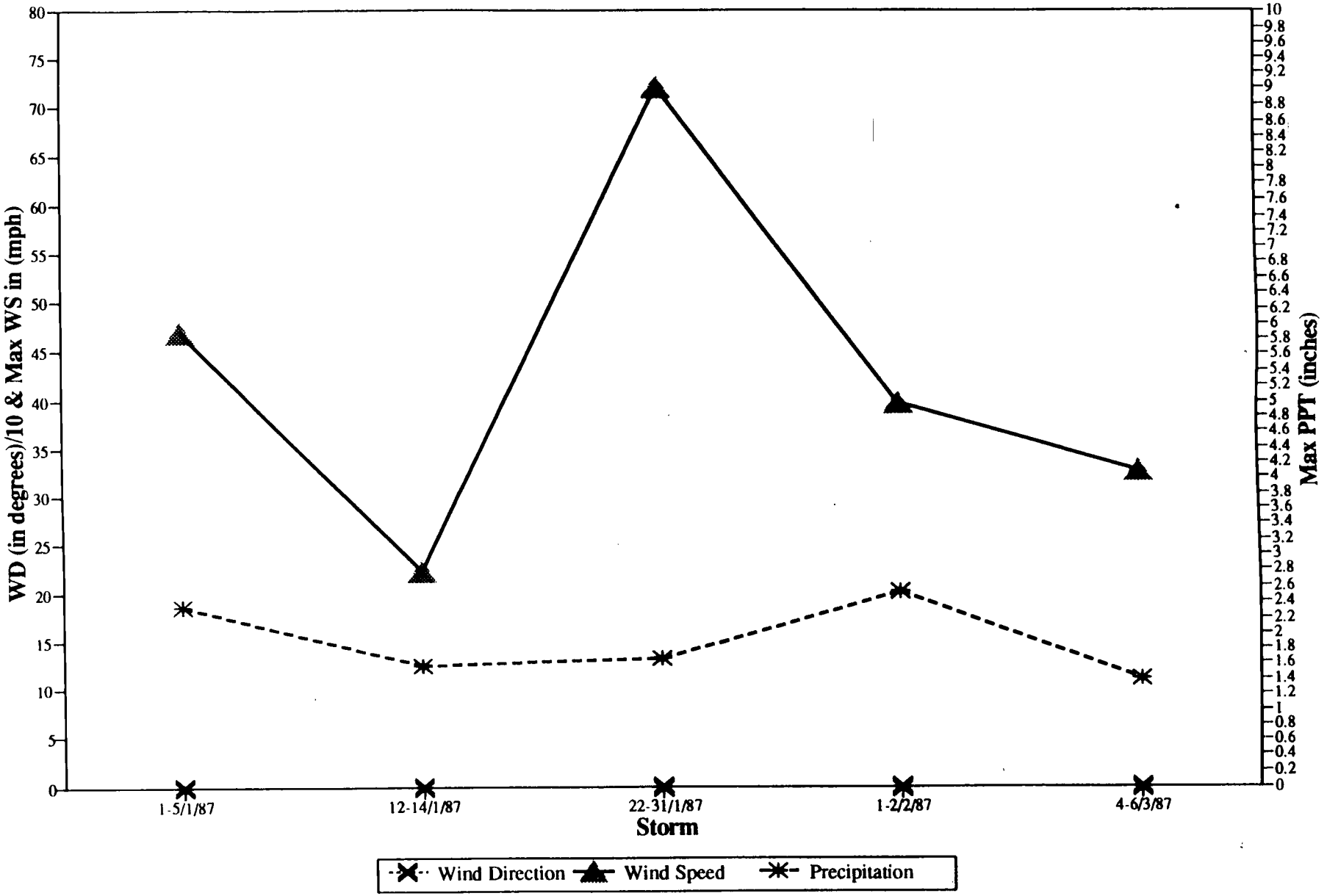
# Wind Direction, Wind Speed and PPT for Storm Events,Winter 84-85, Cape Blanco



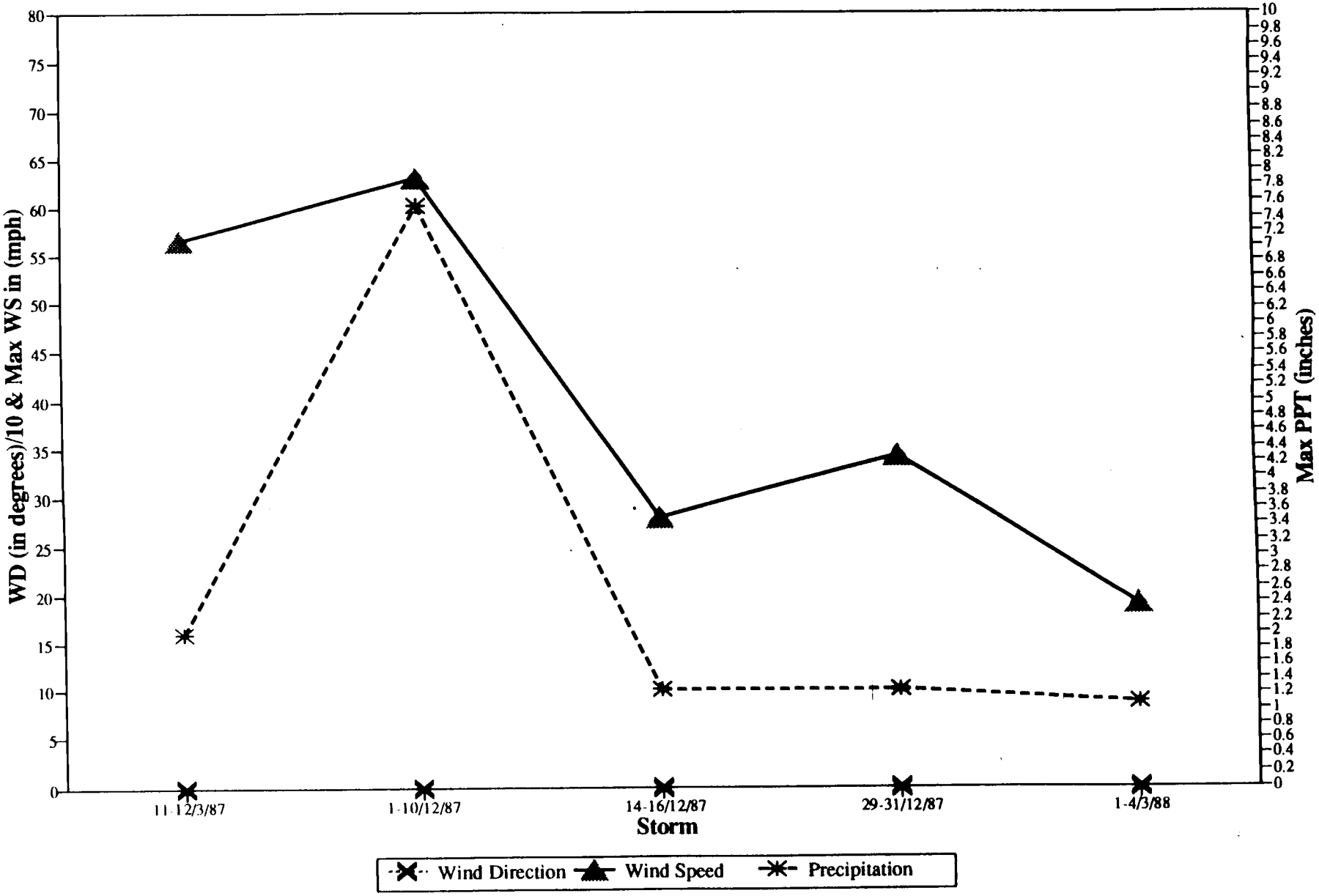
# Wind Direction, Wind Speed and PPT for Storm Events,Winter 85-86, Cape Blanco



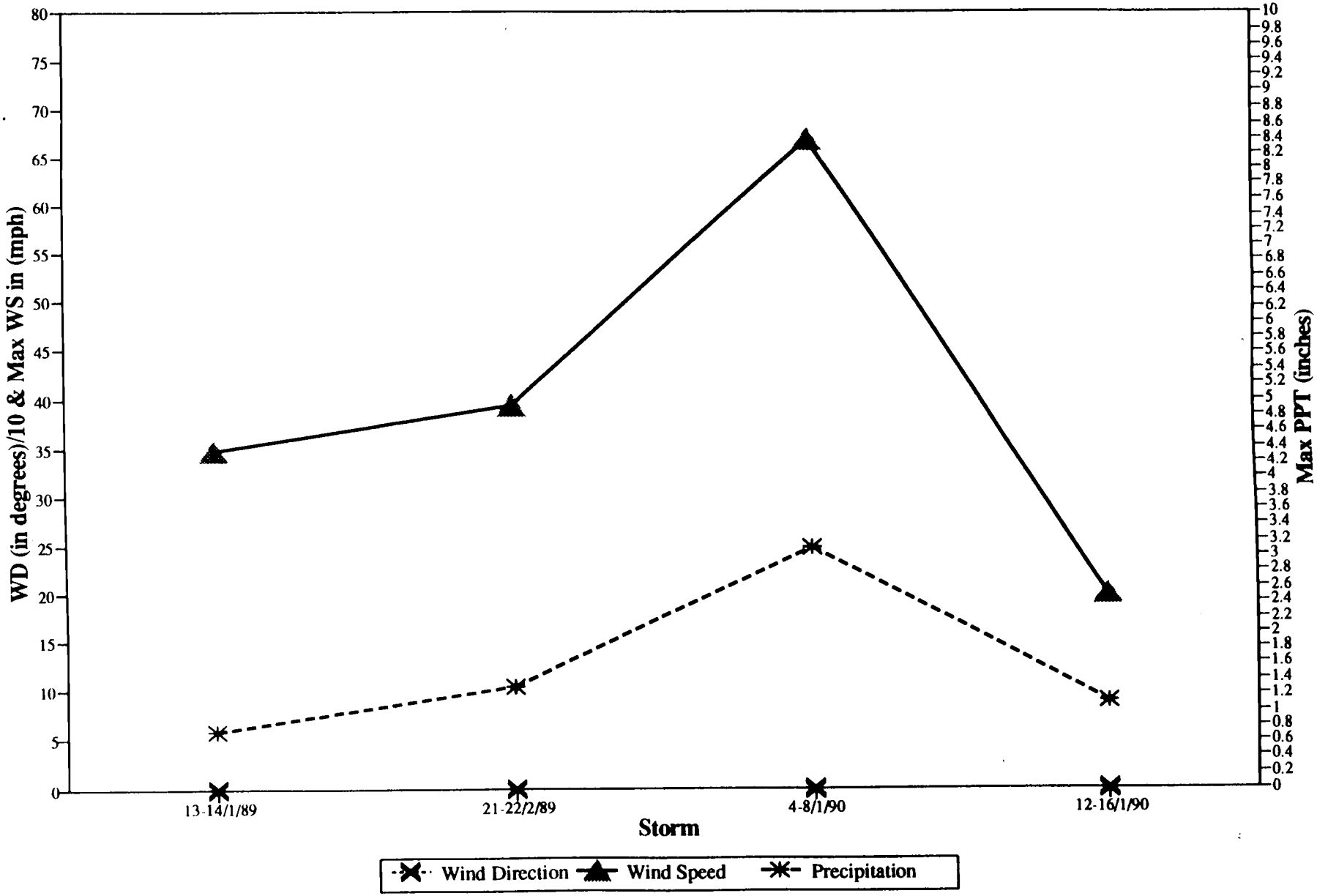
# Wind Direction, Wind Speed and PPT for Storm Events,Winter 86-87, Cape Blanco



# Wind Direction, Wind Speed and PPT for Storm Events,Winter 87-88, Cape Blanco



# Wind Direction, Wind Speed and PPT for Storm Events,Winter 89-90, Cape Blanco



Appendix 4. Discription of Monthly Storm Events by Station

Winter 81

| Month | Station | Storm | Days | W/D | W/S(M) | at date | PPT(M) | at date |
|---|---|---|---|---|---|---|---|---|
| 1 | A | | | | | | | |
| | N | | | | | | | |
| | C | 5-6,13-14 | 4 | 10 | 13.5 | 6 | 1.71 | 6 |
| 2 | A | 11-19 | 9 | 19 | 21.6 | 16 | 1.93 | 15 |
| | N | 17-19,23-24 | 5 | 18 | 20 | 18 | 1.74 | 18 |
| | C | 1-2,18-20,25-27 | 8 | 22 | 42.8 | 18 | 1.65 | 27 |
| 3 | A | | | | | | | |
| | N | 23-24,29-31 | 5 | 21 | 14 | 31 | 1.22 | 30 |
| | C | 11-14,17-19 | 7 | 19 | 22.8 | 14 | 1.4 | 14 |

Winter 81-82

| Month | Station | Storm | Days | W/D | W/S(M) | at date | PPT(M) | at date |
|---|---|---|---|---|---|---|---|---|
| 12 | A | 4-5,9-10,13-15 | 7 | 21 | 18 | 15 | 2.14 | 5 |
| | N | 1-3,4-6,14-15 | 7 | 18 | 18 | 5 | 3.94 | 5 |
| | C | Missing | | | | | | |
| 1 | A | 15-17,22-23 | 5 | 19 | 24.3 | 23 | 3.84 | 23 |
| | N | 1-5,15-17,21-26 | 13 | 20 | 23 | 23 | 3.04 | 22 |
| | C | missing | | | | | | |
| 2 | A | 11-22 | 12 | 18 | 22.9 | 13 | 1.74 | 13 |
| | N | 13-20,26-27 | 10 | 20 | 23 | 16 | 1.5 | 18 |
| | C | missing | | | | | | |
| 3 | A | 8-9,12-14,26-29 | 8 | 18 | 17.4 | 13 | 1.26 | 29 |
| | N | 1-2,26-28 | 5 | 18 | 17 | 1 | 1.94 | 1 |
| | C | 1-4,25-31 | 11 | 20 | 45.6 | 1 | 1.74 | 1 |

Winter 82-83

| Month | Station | Storm | Days | W/D | W/S(M) | at date | PPT(M) | at date |
|---|---|---|---|---|---|---|---|---|
| 12 | A | 2-3,13-18 | 8 | 15 | 22.7 | 3 | 2.58 | 3 |
| | N | 1-3,10-23 | 15 | 19 | 25 | 3 | 2.53 | 15 |
| | C | missing | | | | | | |
| 1 | A | 2-8,24-27 | 11 | 19 | 16 | 7 | 15 | 7 |
| | N | 1-8,18-19,22-27 | 16 | 22 | 22 | 6 | 2.16 | 5 |
| | C | 3-5,17-27 | 13 | 17 | 53.3 | 25 | 2.12 | 26 |
| 2 | A | 8-13, | 6 | 18 | 10.1 | 9 | 0.63 | 9 |
| | N | 8-10,12-13 16-18,20-26 | 15 | 10 | 19 | 17 | 1.74 | 17 |
| | C | 8-18,21-28 | 19 | 19 | 56.4 | 11 | 2.5 | 21 |
| 3 | A | 8-9,12-14 27-29 | 8 | 18 | 17.4 | 13 | 1.26 | 29 |
| | N | 5-14,22-23 26-30 | 16 | 20 | 26 | 29 | 1.28 | 29 |
| | C | 9-10,12-21 | 12 | 17 | 47.4 | 13 | 1.74 | 14 |

Winter Winter 83-84

| Month | Station | Storm | Days | W/D | W/S(M) | at date | PPT(M) | at date |
|---|---|---|---|---|---|---|---|---|
| 12 | A | 29-30 | 2 | 11 | 16.5 | 29 | 2.19 | 29 |
| | N | 14-10,25-26 29-30 | 10 | 25 | 20 | 25 | 1.54 | 29 |
| | C | 4-7,8-10,12-15 24-25,29-30 | 14 | 18 | 53.2 | 12 | 2.91 | 14 |
| 1 | A | 2-4,22-25 | 7 | 20 | 18 | 24 | 1.65 | 24 |
| | N | 2-4,22-25 | 7 | 20 | 22 | 23 | 0.82 | 3 |
| | C | missing | | | | | | |
| 2 | A | 9-13,19-24 | 11 | 17 | 16.3 | 9 | 0.96 | 23 |
| | N | 9-13,19-20 23-24 | 9 | 20 | 25 | 24 | 1.85 | 12 |
| | C | 8-13,15-16 20-22 | 11 | 19 | 54.8 | 12 | 2.5 | 13 |
| 3 | A | | | | | | | |
| | N | 25-26 | 2 | 19 | 14 | 25 | 0.64 | 25 |
| | C | 9-10,12-21 | 12 | 17 | 47.4 | 13 | 1.74 | 14 |

Winter 84-85

| Month | Station | Storm | Days | W/D | W/S(M) | at date | PPT(M) | at date |
|---|---|---|---|---|---|---|---|---|
| 12 | A | 28-30 | 3 | 22 | 15.4 | 29 | 1.18 | 29 |
| | N | 9-11,28-30 | 6 | 20 | 17 | 29 | 1.57 | 29 |
| | C | 15=16,29-31 | 5 | 17 | 31.5 | 29 | 1.61 | 30 |
| 1 | A | | | | | | | |
| | N | | | | | | | |
| | C | mising | | | | | | |
| 2 | A | 10-11 | 2 | 30 | 16.7 | 11 | 0.64 | 11 |
| | N | 6-11 | 6 | 18 | 17 | 11 | 0.82 | 11 |
| | C | 1-2,7-8 | 4 | 18 | 31.4 | 7 | 1.73 | 7 |
| 3 | A | 3-4,22-24 29-31 | 8 | 20 | 16.7 | 23 | 1.21 | 30 |
| | N | 5-14,22-23 26-30 | 16 | 20 | 26 | 29 | 1.85 | 9 |
| | C | 4-7,22-28 | 11 | 17 | 45.2 | 25 | 1.27 | 25 |

Winter 85-86

| Month | Station | Storm | Days | W/D | W/S(M) | at date | PPT(M) | at date |
|---|---|---|---|---|---|---|---|---|
| 12 | A | 1-3 | 3 | 13 | 15.4 | 2 | 1.03 | 2 |
| | N | 1-8 | 8 | 21 | 22 | 2 | 1.03 | 6 |
| | C | 1-2,5-8 | 6 | 4 | 52.9 | 6 | 0.91 | 6 |
| 1 | A | 1-2,15-19,21-23,29- | 13 | 20 | 31.2 | 18 | 1.73 | 18 |
| | N | 15-18,22-23, | 6 | 20 | 20 | 16 | 1.08 | 22 |
| | C | 1-2,8-10,13-18 21-22,28-29 | 16 | 19 | 53.8 | 18 | 1.72 | 29 |
| 2 | A | 13-16,21-24 | 8 | 20 | 20.2 | 24 | 1.33 | 22 |
| | N | 12-16,20-22 | 8 | 21 | 17 | 15 | 1.46 | 22 |
| | C | 1-3,12-18,20-23 | 14 | 19 | 47.4 | 15 | 3.42 | 22 |
| 3 | A | 6-9 | 4 | 21 | 17 | 7 | 1.12 | 8 |
| | N | 6-13 | 8 | 20 | 23 | 7 | 0.94 | 7 |
| | C | 7-13,23-24 | 9 | 18 | 46.8 | 9 | 3.65 | 13 |

Winter 86-87

| Month | Station | Storm | Days | W/D | W/S(M) | at date | PPT(M) | at date |
|---|---|---|---|---|---|---|---|---|
| 12 | A | 24-25,27-29 | 5 | 21 | 14.3 | 29 | 1.29 | 28 |
| | N | | | | | | | |
| | C | missing | | | | | | |
| 1 | A | 1-4,11-13,25-27 30-31 | 12 | 19 | 16.9 | 31 | 2.7 | 31 |
| | N | 3-4,11-14,24-31 | 14 | 20 | 26 | 31 | 1.65 | 25 |
| | C | 1-5,12-14,22-31 | 18 | 17 | 22 | 31 | 2.33 | 1 |
| 2 | A | 1-2,27-28 | 4 | 21 | 16.6 | 28 | 1.08 | 28 |
| | N | 1-2,12-13 | 4 | 20 | 15 | 3 | 3.07 | 3 |
| | C | 1-2 | 2 | 18 | 39.7 | 1 | 2.52 | 1 |
| 3 | A | 1-3,8-10,12-14 | 9 | 19 | 22 | 3 | 1.68 | 3 |
| | N | 2-3,10-13 | 6 | 20 | 15 | 3 | 3.07 | 3 |
| | C | 4-6,11-12 | 5 | 17 | 56.6 | 11 | 2 | 12 |

Winter 87-88

| Month | Station | Storm | Days | W/D | W/S(M) | at date | PPT(M) | at date |
|---|---|---|---|---|---|---|---|---|
| 12 | A | 1-10 | 10 | 21 | 26.1 | 9 | 1.04 | 9 |
| | N | missing | | | | | | |
| | C | 1-10,14-16,29-31 | 16 | 17 | 63.1 | 5 | 7.53 | 3 |
| 1 | A | 12-16 | 5 | 20 | 26.3 | 14 | 1.19 | 14 |
| | N | 8-11,13-16,28-29 | 10 | 19 | 26 | 14 | 2.6 | 14 |
| | C | | | | | | | |
| 2 | A | 8-10 | 3 | 23 | 14.4 | 9 | 1.11 | 9 |
| | N | 8-9 | 2 | 19 | 15 | 9 | 0.79 | 8 |
| | C | | | | | | | |
| 3 | A | 4-5,22-23 | 8 | 26 | 18.3 | 22 | 1.73 | 24 |
| | N | 23-26 | 4 | 18 | 15 | 14 | 1.18 | 24 |
| | C | 1-4 | 4 | 17 | 18.9 | 4 | 1.09 | 1 |

Winter 88-89

| Month | Station | Storm | Days | W/D | W/S(M) | at date | PPT(M) | at date |
|---|---|---|---|---|---|---|---|---|
| 12 | A | 20-21,29-30 | 4 | 21 | 20.4 | 29 | 2.7 | 29 |
| | N | 20-24,29-31 | 8 | 18 | 21 | 29 | 1.28 | 29 |
| | C | missing | | | | | | |
| 1 | A | 8-10,12-17 | 9 | 21 | 21.2 | 16 | 1.22 | 16 |
| | N | 6-9,14-16 | 7 | 19 | 21 | 15 | 1.4 | 7 |
| | C | 13-14 | 2 | 18 | 34.7 | 14 | 0.72 | 14 |
| 2 | A | 2-11,14-15 | 12 | 22 | 18.3 | 9 | 2.72 | 9 |
| | N | 16-18,21-24 | 7 | 18 | 22 | 16 | 2.29 | 16 |
| | C | 21-22 | 2 | 19 | 39.3 | 22 | 1.3 | 21 |
| 3 | A | 14-17 | 4 | 20 | 11.5 | 14 | 1.24 | 15 |
| | N | 4-6,9-17,24-28 | 17 | 20 | 26 | 27 | 1.5 | 12 |
| | C | | | | | | | |

Winter 89-90

| Month | Station | Storm | Days | W/D | W/S(M) | at date | PPT(M) | at date |
|---|---|---|---|---|---|---|---|---|
| 12 | A | 2-4 | 3 | 20 | 16.7 | 4 | 2.3 | 4 |
| | N | 2-4 | 3 | 18 | 18 | 3 | 2.65 | 3 |
| | C | missing | | | | | | |
| 1 | A | 3-9,21-22,25-29 | 14 | 23 | 22.1 | 28 | 4.53 | 9 |
| | N | 4-9,25-31 | 13 | 20 | 26 | 28 | 1.32 | 28 |
| | C | 4-8,12-16 | 10 | 17 | 67.1 | 6 | 3.1 | 7 |
| 2 | A | 2-11,14-15 | 12 | 22 | 18.3 | 9 | 2.72 | 9 |
| | N | 2-10,15-16 | 11 | 19 | 26 | 2 | 1.16 | 8 |
| | C | missing | | | | | | |
| 3 | A | 5-10 | 16 | 22 | 13.4 | 8 | 1.39 | 6 |
| | N | 7-9 | 3 | 18 | 19 | 9 | 0.79 | 7 |
| | C | missing | | | | | | |

90

| Month | Station | Storm | Days | W/D | W/S(M) | at date | PPT(M) | at date |
|---|---|---|---|---|---|---|---|---|
| 12 | A | 3-5 | 3 | 22 | 19.4 | 4 | 1.03 | 4 |

Appendix 5. Change of WD for Storm Events for 3 Stations

| Storm | WD befor | Beginin | End | WD after at | W/S(M) | W/D(M) |
|---|---|---|---|---|---|---|
| 4-5/12/81 | 270 | 150 | 200 | 160 | 200 | 13.7 |
| 9-10/12/81 | 70 | 170 | 200 | 60 | 200 | 13.8 |
| 13-15/12/81 | 70 | 110 | 210 | 70 | 210 | 18.4 |
| 1-3/12/81 | 240 | 280 | 200 | 190 | 180 | 15 |
| 5-6/12/81 | 190 | 180 | 180 | 300 | 180 | 18 |
| 14-15/12/81 | 90 | 180 | 260 | 10 | 230 | 14 |
| 2-3/12/82 | 180 | 190 | 150 | 80 | 150 | 22.7 |
| 13-18/12/82 | 60 | 160 | 170 | 100 | 180 | 17.8 |
| 1-3/12/82 | 210 | 300 | 190 | 80 | 190 | 25 |
| 12-23/12/82 | 70 | 190 | 320 | 80 | 200 | 23 |
| 4-10/12/83 | 340 | 190 | 250 | 80 | 210 | 16 |
| 25-26/12/83 | 90 | 250 | 100 | 90 | 250 | 20 |
| 29-30/12/83 | 60 | 110 | 190 | 70 | 110 | 16.5 |
| 4-7/12/83 | 30 | 110 | 180 | 70 | 180 | 46.9 |
| 9-10/12/83 | 30 | 190 | 180 | 30 | 180 | 46.9 |
| 12-15/12/83 | 30 | 180 | 230 | 10 | 180 | 53.2 |
| 24-25/12/83 | 30 | 180 | 230 | 180 | 180 | 25.8 |
| 29-30/12/83 | 180 | 180 | 210 | 120 | 230 | 52.5 |
| 28-30/12/84 | 250 | 230 | 260 | 70 | 180 | 15.4 |
| 9-11/12/84 | 80 | 210 | 270 | 340 | 220 | 9 |
| 28-30/12/83 | 90 | 350 | 220 | 60 | 210 | 17 |
| 15-16/12/84 | 30 | 140 | 140 | 20 | 200 | 17 |
| 29-31/12/84 | 200 | 170 | 10 | 20 | 140 | 39.5 |
| 1-3/12/85 | 310 | 170 | 190 | 110 | 170 | 15.7 |
| 1-8/12/85 | 210 | 200 | 360 | 90 | 210 | 22 |
| 1-2/12/85 | 160 | 110 | 190 | 40 | 180 | 52.6 |
| 5-8/12/85 | 160 | 110 | 190 | 40 | 180 | 52.6 |
| 24-25/12/86 | 190 | 180 | 100 | 90 | 100 | 9.3 |
| 27-29/12/86 | 90 | 100 | 210 | 100 | 210 | 14.3 |
| 1-10/12/87 | 60 | 190 | 260 | 40 | 210 | 26.1 |
| 1-10/12/87 | 60 | 170 | 210 | 190 | 170 | 32.6 |
| 14-16/12/87 | 170 | 170 | 170 | 190 | 170 | 56.6 |
| 29-31/12/87 | | 190 | 210 | 30 | 150 | 63.1 |
| 20-21/12/88 | 270 | 210 | 170 | 60 | 210 | 9.2 |
| 29-30/12/88 | 110 | 210 | 220 | 110 | 180 | 20.4 |
| 20-24/12/88 | 50 | 180 | 320 | 70 | 180 | 23 |
| 29-31/12/88 | 50 | 180 | 300 | 180 | 180 | 30 |
| 2-4/12/89 | 90 | 100 | 200 | 120 | 200 | 16.7 |
| 2-4/12/89 | 70 | 170 | 200 | 70 | 180 | 27 |
| 3-5/12/90 | 160 | 160 | 220 | 100 | 220 | 19.4 |
| 5-6/1/81 | 300 | 170 | 170 | 170 | 100 | 13.5 |
| 13-14/1/81 | 160 | 210 | 170 | 150 | 170 | 12 |
| 15-17/1/82 | 230 | 200 | 220 | 70 | 200 | 19 |
| 22-23/1/82 | 280 | 170 | 190 | 90 | 190 | 19 |
| 1-5/1/82 | 340 | 190 | 360 | 90 | 280 | 13 |
| 16-17/1/82 | 190 | 220 | 240 | 360 | 240 | 17 |
| 21-26/1/82 | 70 | 360 | 210 | 170 | 200 | 23 |
| 3-5/1/83 | 180 | 180 | 180 | 190 | 190 | 44.5 |
| 18-27/1/83 | 180 | 180 | 190 | 170 | 170 | 53.3 |
| 2-8/1/83 | 70 | 160 | 250 | 200 | 190 | 16 |
| 24-27/1/83 | 100 | 150 | 250 | 70 | 130 | 9.2 |
| 1-8/1/83 | 90 | 220 | 220 | 190 | 220 | 22 |
| 18-19/1/83 | 200 | 140 | 290 | 90 | 290 | 11 |
| 22-27/1/83 | 70 | 210 | 190 | 80 | 200 | 20 |
| 2-4/1/84 | 70 | 70 | 200 | 350 | 180 | 16.7 |
| 22-25/1/84 | 110 | 220 | 240 | 170 | 190 | 16.9 |
| 2-4/1/84 | 90 | 190 | 210 | 90 | 200 | 150 |
| 22-25/1/84 | 220 | 190 | 300 | 230 | 200 | 22 |
| 11-12/1/84 | 180 | 220 | 200 | 100 | 200 | 20.2 |
| 21-22/1/84 | 220 | 180 | 150 | 10 | 180 | 31.4 |
| 15-19/1/86 | 130 | 250 | 180 | 160 | 180 | 11.6 |
| 21-23/1/86 | 80 | 150 | 200 | 160 | 200 | 31.2 |
| 29-31/1/86 | 80 | 160 | 110 | 180 | 160 | 9.6 |
| 15-18/1/86 | 90 | 200 | 200 | 90 | 200 | 20 |
| 22-23/1/86 | 70 | 190 | 220 | 80 | 190 | 13 |
| 1-2/1/86 | 200 | 190 | 190 | 110 | 190 | 35.5 |
| 8-10/1/86 | 180 | 180 | 180 | 180 | 180 | 39.4 |
| 13-18/1/86 | 180 | 170 | 190 | 30 | 190 | 53.8 |
| 21-22/1/86 | 140 | 180 | 180 | 220 | 100 | 49.9 |
| 28-29/1/86 | 30 | 180 | 180 | 180 | 180 | 31.1 |
| 1-4/1/87 | 210 | 160 | 150 | 100 | 160 | 16.5 |
| 11-13/1/87 | 80 | 180 | 250 | 70 | 230 | 14.2 |
| 25-27/1/87 | 100 | 200 | 210 | 130 | 210 | 17.2 |
| 30-31/1/87 | 130 | 170 | 190 | 210 | 190 | 16.9 |
| 3-4/1/87 | 170 | 230 | 310 | 150 | 230 | 13 |
| 11-14/1/87 | 60 | 200 | 210 | 80 | 250 | 16 |
| 24-31/1/87 | 110 | 180 | 200 | 180 | 210 | 22 |
| 1-5/1/87 | 170 | 180 | 150 | 360 | 180 | 31.6 |
| 12-14/1/87 | 360 | 170 | 300 | 300 | 300 | 22.3 |
| 22-31/1/87 | 100 | 170 | | | | |
| 12-16/1/88 | 100 | 160 | 200 | 120 | 200 | 26.3 |
| 8-11/1/89 | 80 | 180 | 220 | 290 | 200 | 25 |
| 13-16/1/88 | 290 | 190 | 200 | 70 | 190 | 29 |
| 28-29/1/88 | 80 | 200 | 220 | 80 | 360 | 19 |
| 8-10/1/89 | 100 | 210 | 290 | 230 | 210 | 13.9 |
| 12-17/1/89 | 230 | 170 | 230 | 90 | 210 | 21.2 |
| 6-9/1/89 | 310 | 290 | 290 | 330 | 190 | 26 |
| 14-16/1/89 | 330 | 180 | 190 | 210 | 190 | 26 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 13-14/1/89 | 100 | 200 | 190 | 300 | 180 | 42.8 |
| 3-9/1/90 | 290 | 190 | 210 | 90 | 210 | 17.6 |
| 21-22/1/90 | 170 | 180 | 280 | 90 | 240 | 15.3 |
| 25-29/1/90 | 90 | 220 | 220 | 320 | 230 | 22.1 |
| 4-8/1/90 | 300 | 140 | 180 | 200 | 170 | 67.1 |
| 12-16/1/90 | 170 | 180 | 200 | 300 | 180 | 18.8 |
| 4-9/1/90 | 170 | 180 | 180 | 60 | 200 | 25 |
| 25-31/1/90 | 70 | 180 | 170 | 270 | 200 | 26 |
| 11-19/2/81 | 90 | 140 | 210 | 80 | 190 | 22.6 |
| 18-20/2/81 | 220 | 220 | 300 | 50 | 220 | 42.6 |
| 25-27/2/81 | 150 | 110 | 180 | 130 | 180 | 16.7 |
| 1-2/2/81 | 100 | 100 | 100 | 200 | 100 | 9.8 |
| 11-12/2/82 | 50 | 120 | 230 | 110 | 210 | 19.4 |
| 13-20/2/82 | 60 | 210 | 340 | 210 | 220 | 23 |
| 26-27/2/82 | 60 | 230 | 190 | 80 | 190 | 13 |
| 13-17/2/82 | 180 | 180 | 190 | | 190 | 54.8 |
| 26-28/2/82 | | 180 | 230 | 200 | 180 | 46.4 |
| 8-13/2/83 | 50 | 180 | 190 | 120 | 170 | 10.6 |
| 8-10/2/83 | 100 | 170 | 180 | 200 | 200 | 15 |
| 12-13/2/83 | 200 | 180 | 220 | 200 | 180 | 12 |
| 16-18/2/83 | 200 | 210 | 300 | 180 | 100 | 19 |
| 20-26/2/83 | 180 | 190 | 190 | 100 | 190 | 13 |
| 8-18/2/83 | 110 | 200 | 180 | 300 | 190 | 56.4 |
| 21-28/2/83 | 110 | 200 | 180 | 300 | 190 | 56.4 |
| 9-13/2/84 | 70 | 150 | 120 | 90 | 170 | 16.3 |
| 19-24/2/84 | 70 | 180 | 270 | 90 | 80 | 13.4 |
| 9-13/2/84 | 80 | 190 | 270 | 160 | 190 | 17 |
| 19-20/2/84 | 130 | 170 | 210 | 340 | 210 | 12 |
| 23-24/2/84 | 180 | 180 | 200 | 330 | 200 | 25 |
| 8-13/2/84 | 180 | 190 | 210 | | 190 | 54.8 |
| 15-16/2/84 | | 230 | 160 | 150 | 230 | 29.4 |
| 20-22/2/84 | 170 | 170 | 190 | 170 | 170 | 31.7 |
| 10-11/2/85 | 160 | 220 | 200 | 50 | 200 | 16.7 |
| 6-11/2/85 | 80 | 210 | 340 | 70 | 180 | 17 |
| 1-2/2/85 | 190 | 160 | | 170 | 160 | 21.6 |
| 7-8/2/85 | 170 | 180 | 200 | 100 | 170 | 55.9 |
| 13-16/2/86 | 80 | 80 | 250 | 70 | 200 | 19.3 |
| 21-24/2/86 | 90 | 200 | 160 | 80 | 210 | 17.2 |
| 12-16/2/86 | 60 | 210 | 350 | 90 | 210 | 17 |
| 20-22/2/86 | 70 | 110 | 200 | 90 | 190 | 13 |
| 1-3/2/86 | 180 | 180 | 180 | 40 | 180 | 37.2 |
| 12-18/2/86 | 40 | 210 | 300 | 300 | 190 | 47.4 |
| 20-23/2/86 | 300 | 190 | 180 | 30 | 180 | 44.8 |
| 1-2/2/87 | 200 | 160 | 120 | 110 | 210 | 17.2 |
| 27-28/2/87 | 170 | 250 | 190 | 210 | 180 | 17.1 |
| 1-2/2/87 | 200 | 180 | 220 | 180 | 220 | 11 |
| 12-13/2/87 | 60 | 200 | 220 | 90 | 220 | 17 |
| 1-2/2/87 | 170 | 180 | 190 | 170 | 170 | 53.4 |
| 8-10/2/88 | 140 | 200 | 210 | 110 | 230 | 14.4 |
| 8-9/2/88 | 60 | 190 | 190 | 200 | 190 | 21 |
| 16-18/2/89 | 50 | 160 | 180 | 90 | 180 | 19.1 |
| 21-23/2/89 | 90 | 150 | 150 | 130 | 190 | 19.5 |
| 16-18/2/89 | 190 | 180 | 180 | 70 | 180 | 25 |
| 21-24/2/89 | 70 | 180 | 180 | 20 | 180 | 19 |
| 21-22/2/89 | 180 | 180 | 190 | 190 | 190 | 39.3 |
| 2-11/2/90 | 240 | 200 | 290 | 70 | 200 | 19.7 |
| 14-15/2/90 | 70 | 160 | 230 | 170 | 230 | 10.8 |
| 2-10/2/90 | 270 | 190 | 190 | 310 | 190 | 26 |
| 15-16/2/90 | 160 | 180 | 190 | 340 | 180 | 18 |
| 23-24/3/81 | 190 | 180 | 180 | 360 | 180 | 14 |
| 29-31/3/81 | 320 | 240 | 200 | 190 | 190 | 15 |
| 11-14/3/81 | 330 | 190 | 190 | 50 | 190 | 23.4 |
| 17-19/3/81 | 50 | 180 | 220 | 130 | 180 | 20.8 |
| 1-2/3/82 | 80 | 180 | 190 | 310 | 180 | 17 |
| 26-28/3/82 | 190 | 210 | 190 | 230 | 210 | 14 |
| 1-4/3/82 | | | 200 | 50 | 200 | 45.6 |
| 25-31/3/82 | 200 | 200 | 250 | | 190 | 30.2 |
| 8-9/3/83 | 110 | 170 | 190 | 110 | 170 | 10.4 |
| 12-14/3/83 | 110 | 160 | 190 | 60 | 180 | 17.4 |
| 27-29/3/83 | 100 | 170 | 180 | 200 | 180 | 14.4 |
| 5-14/3/83 | 360 | 200 | 200 | 180 | 200 | 17 |
| 22-23/3/83 | 180 | 190 | 130 | 70 | 200 | 18 |
| 26-30/3/83 | 320 | 150 | 210 | 160 | 200 | 26 |
| 7-10/3/83 | 180 | 200 | 200 | 180 | 180 | 55.9 |
| 12-14/3/83 | 180 | 180 | 220 | 100 | 180 | 38.4 |
| 22-24/3/83 | 170 | 200 | 330 | 180 | 200 | 35.3 |
| 27-31/3/83 | 150 | 170 | 190 | 180 | 160 | 56.4 |
| 25-26/3/83 | 340 | 190 | 320 | 320 | 190 | 14 |
| 9-10/3/84 | 170 | 170 | 180 | 170 | 170 | 24.7 |
| 12-21/3/84 | 170 | 200 | 220 | 330 | 170 | 47.5 |
| 3-4/3/85 | 310 | 180 | 170 | 150 | 170 | 9.7 |
| 22-24/3/85 | 200 | 240 | 220 | 170 | 200 | 16.7 |
| 29-31/3/85 | 310 | 170 | 200 | 100 | 210 | 15.7 |
| 23-27/3/85 | 220 | 190 | 190 | 330 | 190 | 15 |
| 30-31/3/85 | 210 | 200 | 200 | 190 | 210 | 22 |
| 4-7/3/85 | 160 | 180 | 160 | 170 | 150 | 26.9 |
| 22-28/3/85 | 30 | 170 | 350 | 140 | 190 | 45.2 |
| 6-9/3/86 | 210 | 160 | 130 | 140 | 130 | 10.9 |
| 6-13/3/86 | 200 | 190 | 300 | 180 | 200 | 23 |
| 7-13/3/86 | 20 | 180 | 180 | 40 | 180 | 46.8 |
| 23-24/3/86 | 40 | 190 | 230 | 180 | 180 | 36.2 |
| 1-3/3/87 | 60 | 250 | 190 | 210 | 180 | 17.1 |