# AN ANALYSIS OF THE WINDS (1974-1984) AND SEA LEVEL ELEVATIONS (1973-1983) IN COASTAL ALABAMA



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## LIST OF ABBREVIATIONS AND SYMBOLS

| | |
|---|---|
| cfs | cubic feet per second |
| DISL | Dauphin Island Sea Lab |
| E | East |
| ft | feet |
| k or K | knot(s) |
| max | maximum |
| N | North |
| n | number of observations |
| NCDC | National Climatic Data Center |
| NE | Northeast |
| NGVD | National Geodetic Vertical Datium of 1929 |
| NOAA | National Oceanic and Atmosphere Administration |
| NOS | National Ocean Survey |
| NW | Northwest |
| NWS | National Weather Service |
| S | South |
| SE | Southeast |
| SW | Southwest |
| W | West |
| $^{o}$Mag | degrees magnetic |

ABSTRACT

Monthly and annual wind roses, constructed from 10.5 years of data collected on Dauphin Island, Alabama, exhibit a high degree of variability. However, monthly composite roses present a recognizable seasonal pattern: northerly winter winds; easterly to southerly spring winds; southerly to westerly and back to easterly winds in the summer; and in the fall a return to northeasterly and northerly winds. Mean monthly wind speeds ranged from a high of 8.1 k in January to a low of 5.2 k in July. On a directional interval basis the highest mean speed, 9.5 k, occurred during northerly winds while the lowest mean speed, 4.9 k, occurred during westerly winds. Sustained wind speeds of 30 k or greater were recorded during tropical cyclones, a winter "cold front" storm and a thunderstorm.

Eleven years of NOAA-NOS tide data from the east end of Dauphin Island document both long term (seasonal) variability in mean sea level and short term (aperiodic) non-tidal perturbations in sea level along the Alabama coast. The seasonal cycle of mean sea level is: low in winter and early summer; and high in spring and late summer thru the fall. These fluctuations result from a combination of: local-regional winds; river run-off; and thermal expansion - contraction of the water column. The short term non-tidal response along the coast to winter "cold front" storms is a rapid sea level set up - set down sequence, while strong easterly winds and flooding events result in periods of sea level set up. The impact of tropical cyclones is dependent on the path, speed of propagation, size, and intensity of the individual storms. Annually, the total number of hourly observations of water levels greater than 1.5 ft. above NGVD ranged between 50 and 196 or 0.6 to 2.3% of the observations. For water levels lower than 1.0 ft below NGVD the total number of observations annually ranged between 60 and 230 or 0.7 to 2.5% of the observations.

# INTRODUCTION

In the early 1970's the broad problems associated with studying and managing the coastal zone were brought to light by Ketchum (1972). Wind and water movements are among the active physical processes directly controlling the characteristics of coastal environments. Inman and Brusch (1973) state:

> "Waves, winds and currents mold the shorelines of the world, and their interaction with land and its runoff determines the configuration of coast lines and the adjacent bathymetry."

At the Second Conference on Coastal Meteorology (Authors, 1980) sponsored by the American Meteorological Society, K.H. Jehn, chairman of the AMS Committee on Meteorology of the Coastal Zone emphasized:

> "A continental coastal zone is often seen as a "triple-point" intersection of land, water, and air, where the restless energies of sea and air dissipate against the land and each other. It is more. In addition to the lithosphere, hydrosphere, and atmosphere, which interact on scales from large to small (from jet streams to beach microclimates), the biosphereadds a fourthdimension to a region which continues to be attractive to mankind in numerous ways. Were it not for man'simpact, there would be only the problem of studying the naturalstate of the coastal zone, whether as geologist, oceanographer, meteorologist, or biologist, or the ever more common combinations of these disciplines. Instead, pressures on coastal zones have created a condition in which undisturbed coasts are rare, and basic knowledge of coastal processes in the larger interactive sense is only rudimentary."

It has only been over the past 10 to 20 years that serious attention has been paid to the unique atmospheric properties of the coastal zone. Of significant importance are the differences that can exist within the coastal zone as compared to the adjacent inland and offshore areas (see e.g., Jehn, 1974; Hsu, 1977,). Particularly of interest is the documentation of the behavior of the winds (Smith and Kindle, 1976; SethuRaman and Raynor, 1980; Hsu, 1980, 1981).

Similarily, the extensive role played in the coastal zone by sea level elevation changes, other than the regular daily and long period (fortnigthly, monthly and semi-annual) tidal cycle flucuations (Marmer, 1954), have only in the past two decades been examined in any detail. These non-tidal sea level elevation changes are actually disturbances arising primarily from both local and non-local meteorological conditions.

Wind, barometric pressure and storm events individually and in combination can result in irregular influences on sea level affecting the times of occurrence, the duration, and the heights of high and low water elevations.

Examples of coastal zone environment research concerned with non-tidal sea level elevation changes and the associated hydrodynamic ramifications are:

Geological - Gorsline, 1966; Fox and Davis, 1976; Aubrey, 1979; Lins, 1985.

Physical - Elliott and Wang, 1978; Smith, 1978; Wang and Elliott, 1978; Wong and Garvine, 1984.

Biological - Chabreck and Palmisano, 1973; Hackney and Bishop, 1979; Turner et.al., 1979; Norcross and Shaw, 1984.

This report presents an analysis of wind speed and direction data collected over the period February, 1974 to July, 1984 by the Marine Environmental Sciences Consortium at the DISL and sea level elevation data collected from January, 1973 to November, 1983 by the NOAA-NOS on the east end of Dauphin Island. A map of coastal Alabama showing the locations of the data collection sites is presented in Plate 1. Bar graphs showing the completeness of the two data sets are presented in Plate 2.

## METHODOLOGY

Wind Data The DISL meteorological station is located on the east end of Dauphin Island (Plate. 1) at 30° 14' 57" N Lat. and 88° 04' 38" W Long. Wind speed and direction data are continously measured by a Bendix-Friez Aerovane Model 141-8 strip chart recording anemometer. The anemometer sensor unit is mounted at an elevation of 35 ft above the NGVD . The digitized data set is constructed by reading instantaneous speed and direction values every hour on the hour from the analog record produced on the strip chart. The speed values are read to the nearest whole knot and are the estimated sustained wind speeds. No attempt has been made to document the wind gust speeds. Wind direction is recorded using the meteorological convention of reporting the direction the wind is from (e.g. a north wind is a wind blowing from the north).

Wind roses are constructed from matrices produced by sorting the total data set into individual monthly, composite monthly and annual subsets. An all data matrix and wind rose has also been produced. An example matrix and wind rose, including an explanation of the directional intervals is presented in Plate 3.

Additional information on the DISL meteorogical station is provided in Schroeder (1976a). For daily observation records and monthly summaries of the entire suite of meteorological data collected at the Dauphin Island Sea Lab see Schroeder (1976b) for the period 1974 through 1976, Schroeder (1978) for year 1977, Schroeder et al. (1979) for year 1978 and Schroeder et al. (1980) for year 1979. Data collected for the period 1980 through 1984 is available through the Data Processing Center at the DISL.

Sea Level Elevation Data The NOAA-NOS operates a tide station on the east end of Dauphin Island (Plate 1) at 30° 15' 00" N. Lat. and 88° 04' 30" W. Long. Hourly heights data were obtained from the NOAA-NOS Tidal Datum Section for the period 1973 through 1983. These data were digitized and uniformly adjusted, utilizing the correction factors designated by NOAA-NOS for specific segments of the record, to the NGVD.

A plotting interval of 0.1 ft is used in the annual plots of the frequency of observed occurrences within given water elevation ranges and the cumulative frequency of observed occurrences to given water elevations. All of the plots are constructed utilizing a sorting or bin interval of "less than or equal to".

## RESULTS AND DISCUSSION

Wind Data Monthly wind roses are presented in Plates 4 through 44 for the period April, 1974 to June, 1984. Two exceptions are the months of September and October, 1979 when a large data gap was created (see Plate 2) due to damage to the anemometer and an extended power outage caused by Hurricane Frederic on September 12, 1979. Also monthly wind roses are not presented for: 1) February and March, 1974 because of data gaps resulting from system start up problems; and 2) July, 1984 because data was obtained for only the first eleven days of the month. However, the available data from each of these five "partial" months is utilized in the generation of the appropriate monthly composite, annual and all data matrices and roses.

Monthly composite wind roses and matrices are presented in Plates 45 through 48. As a result of the staggered first and last months of the data collection period (Plate 2) the number of months contributing data to these monthly composites is ten for the months of January, August, September, October, November and December and eleven for the months of February, March, April, May, June and July.

Annual wind roses and matrices for the years of 1975 to 1983 are presented in Plates 49 through 51. All of these years have data sets that are at least 95% complete except 1979 which is 87% complete. Annual wind roses are not presented for years 1974 and 1984 due to insufficent data (see Plate 2). An All-data wind rose and matrix for the period February, 1974 to July, 1984 is presented in Plate 52.

The frequency of observed occurrences of wind speed by directional interval have been calculated for the monthly composite and the all-data data sets and are presented in Plates 53 through 64 and Plate 65 respectively. These plates permit a detailed examination of the long term (10 to 11 years) trends in wind speed distribution by directional interval. Finally, Plate 66 presents a monthly composite summary of the percent occurrences and mean speeds by directional intervals for the period February, 1974 to July, 1984.

Wind Direction The individual monthly wind roses (Plates 4 through 44) show a high degree of variability between months within individual years (e.g. comparing the individual months of January through December to each other for the year 1977, see Plates 15 to 18). Likewise, high variability is seen when individual months in a particular year are compared to that year's annual wind rose (e.g. comparing the individual months of 1977, see Plates 15 to 18, to the 1977 annual wind rose, see Plate 49). Similarly, a high degree of variability is apparent when the same months from different years are compared with each other (e.g. comparing all Aprils for the years 1974 to 1984, see Plates 4, 8, 12, 16, 20, 24, 28, 32, 36, 40, and 44) or when these same individual months are compared to the composite for that month (e.g. comparing all Aprils for the years 1974 to 1984, see above for Plate numbers, to the monthly composite for April, see Plate 46).

There is also a high degree of variability when the annual wind roses for 1975 to 1983 (Plates 49 to 51) are compared to each other or to the All-data wind rose (Plate 52). The following mean and standard deviation calculations are based on the percent occurrences of the nine directional intervals and the calm category from the 1975 to 1983 annual wind matrices (Plates 49 to 51):

| Directional Interval | Mean Percent Occurrence | Standard Deviation |
|---|---|---|
| N | 19.9 | 1.63 |
| NE | 10.7 | 0.92 |
| E | 13.9 | 2.62 |
| SE | 13.5 | 2.24 |
| S | 13.5 | 2.40 |
| SW | 9.3 | 1.71 |
| W | 8.7 | 1.24 |
| NW | 8.0 | 1.15 |
| Calm | 2.5 | 0.48 |

As indicated above the highest degree of variability between the 1975 to 1983 data sets occurs within the east, south and southeast directional intervals while the lowest degree of variability occurs within the northeast, northwest and west directional intervals and the calm category.

The directional variability observed in the monthly composite wind roses (Plates 45 to 48) presents a recognizable seasonal pattern for the winds. In the following discussion a single directional interval is considered to be dominant if its percent occurrence is greater than the sum of the second and third largest percent occurrences.

Northerly winds dominate the winter months of December (Plate 48), January and February (Plates 45). The spring season begins with the month of March (Plate 45) with southeasterly, northerly, southerly, and easterly winds all closely occurring an equal percentage of the time. During the spring southeasterly winds nearly dominate the month of April (Plate 46) while southeasterly and southerly winds combine to dominate the month of May (Plate 46).

The winds rotate clockwise during the summer months of June (Plate 46) and July (Plate 47) to a dominant combination of southerly and southwesterly winds and nearly equally occurring southerly, southwesterly and westerly winds respectively. During the late summer month of August (Plate 47) there is a shift back to nearly equally occurring easterly, southerly and southeasterly winds.

As the fall season approaches the month of September (Plate (47) shows that there is a return to predominantly northerly and northeasterly winds. The fall months of October and November (Plate 48) are nearly dominated by northerly winds. These two months principally differ from the northerly dominated winter months of December (Plate 48), January and February (Plate 45) by having higher combined percent occurrences for northeasterly and easterly winds and slightly lower combined percent occurrences for northwesterly and westerly winds.

Wind Speed When utilizing the information presented in this section it is important to keep in mind the methodology used in reading the wind speeds from the strip chart records (see the Wind Data section under Methodology).

On a monthly basis the highest mean wind speeds occur in January (8.1 k), December (8.0 k) and October (7.9 k) followed closely by March (7.7 k) November (7.6 k), February (7.5 k) and April (7.4 k). The lowest mean speeds occur during the months of July (5.2 k) and August (5.3 k). Inbetween these extremes are the months of September, May and June with mean speeds of 6.8 k, 6.7 k and 6.0 k respectively (Plate 66). From an annual-seasonal perspective these monthly means indicate that on the average: 1) the seven month period from October or mid fall until April or mid spring, which includes all of the winter season, is the "high-wind speed" time of the year; and 2) the five month period from May or late spring until September or early fall, which includes all of the summer season, is the "low-wind speed" time of the year.

On a directional interval basis the highest mean speeds occur during northerly (9.5 k) winds followed by northeasterly (8.5 k), northwesterly (8.3k) and easterly (7.6k) winds (Plate 66). The lowest mean speeds occur during westerly (4.9 k), southwesterly (5.1 k), southerly (5.9 k) and southeasterly (6.1 k) winds (Plate 66).

Overall the five highest monthly mean wind speeds by directional interval are:

| Mean Speed (k) | Month | Directional Interval (°mag) |
|---|---|---|
| 11.0 | March | N |
| 10.6 | January | N |
| 10.6 | March | NW |
| 10.5 | December | N |
| 10.1 | February | N |

While the five lowest monthly mean wind speeds by directional interval are:

| Mean Speed (k) | Month | Directional Interval (°mag) |
|---|---|---|
| 3.2 | September | W |
| 3.4 | August | W |
| 4.1 | July | W |
| 4.1 | September | SW |
| 4.3 | October | W |

When the directional intervals are ordered from the highest to the lowest monthly mean speeds for each individual month seasonal patterns can be seen for the two highest mean speed values (1 and 2), and for the two lowest mean speed values (7 and 8):

| Month | Directional Interval (°mag) | | | |
|---|---|---|---|---|
| | Highest Mean Speeds | | Lowest Mean Speeds | |
| | 1 | 2 | 7 | 8 |
| January | N | NW | SW | S |
| February | N | NW | SW | S |
| March | N | NW | S | SW |
| April | N | NW | W | SW |
| May | N | NE | SW | W |
| June | N | NE | SW | W |
| July | NE | E | SW | W |
| August | NE | E | SW | W |
| September | NE | N | SW | W |
| October | N | NE | SW | W |
| November | N | NW | W | SW |
| December | N | NW | W | SW |

From late fall (November) through until mid spring (April) the winds with the highest monthly mean speeds occur from the north and northwest. In late spring (May) and early summer (June) the highest monthly mean speeds shift to the north and northeast while during the mid to late summer (July and August) they are from the northeast and east. In early and mid fall (September and October) the high winds rotate back to northeast and north and north and northeast respectively. The winds with the lowest monthly mean speeds undergo a seasonal change but it is much less of a change compared to the winds with the highest monthly mean speeds. During the period of mid winter (January) until early spring (March) the lowest monthly mean speeds occur from either the south or southwest. During the remainder of the year, mid spring (April) until early winter (December), all of the lowest monthly mean wind speeds occur from either the west or southwest.

The percent occurrence of wind speeds greater than 21 k is highest during the months of January (1.84%) (Plate 45b) and December (1.44%) (Plate 48b) and lowest during the months of June (0.13%) (Plate 46b) and July (0.15%) and August (0.15%) (Plate 47b). For the speed interval of 16 to 20 k the highest percent occurrence also occurs during the months of January (8.78%) (Plate 45b) and December (7.34%) (Plate 48b) however the

lowest percent occurs during the months of July (0.54%) and August (0.69%) (Plate 47b). The highest percent occurrence of wind speeds greater than 21k by direction interval are: 1) 1.01% from the north in December (Plate 48b); 2) 0.74% from the northwest in January (Plate 45b); and 3) 0.70% from the north in January (Plate 45b). The highest percent occurrence of wind speeds in the speed interval of 16 to 20 k are: 1) 5.35% from the north in January (Plate 45b); 2) 4.35% from the north in December (Plate 48b) and 3) 3.41% from the north in October (Plate 48b).

Sustained wind speeds of 30 k or greater occurred on four occasions:

| Date | Type of Weather | Hourly Observations 30 k or greater | Max. Speed/ direction |
|---|---|---|---|
| Sept. 23, 1975 | Hurricane Eloise | 3 | 31 k/N |
| Sept. 12, 1979 | Hurricane Frederic* | 6* | 39 k/NE* |
| Jan. 20, 1983 | Winter "cold front" storm | 4 | 33 k/NE |
| Apr. 7, 1983 | Thunderstorm | 1 | 32 k/N |

*During Hurricane Frederic a power outage prevented a continuous recording of the winds. A maximum wind measurement of 119 k was recorded prior to the sensor being destroyed but the wind direction and the time of occurrence were not recorded.

"CHURN" Station Winds During Hurricane Frederic Because the DISL wind records are incomplete for the passage of Hurricane Frederic this section will report on wind data collected at an unofficial weather station that was located on the old Dauphin Island lift-span bridge. The station was a "CHURN" (Cooperative Hurricane Reporting Network) station and provided supplemental weather data to the NWS. The sensor was located between 70 to 100 ft above mean sea level.

Plate 67 presents a stick diagram of half-hourly winds for the period 10:30 AM CDT, September 12, 1979 to 5:30 AM CDT, September 13, 1979. From 10:30 AM to 1:30 PM CDT on September 12 the pre-hurricane winds from the northeast ranged in speed from 24 to 33 k. For the next four hours (2:00 to 6:00 PM CDT) the winds shifted back and forth between north and northeast at speeds increasing from 40 to 60 k. Wind speeds steadly increased from 6:30 PM CDT, when the sustained wind speed was 65 k out of the northeast until 8:30 PM CDT when the full force of the hurricane was felt with 120 k east-northeast winds (peak recorded wind gust was 126 k from the east-northeast). During that 2 hour period the wind speed increased at an average of nearly one knot every two minutes. One half hour after the highest winds were recorded wind speeds had decreased by over 20 k to 98 k out of the east. For the next hour and a half the wind rotated rapidly to the south-southeast and decreased in speed at an average rate of approximately one knot every two minutes. For the next two hours the wind increased back up to speeds of 70 to 80 k and continued to rotate clockwise. At 1:30 AM CDT on September 13, when the wind speed was 62 k from the south-southwest, Hurricane Frederic had moved sufficiently that hurricane force winds did not occur again along the coast. From then on the wind speeds steadly decreased and continued to shift towards the west.

Hurricane force winds of 64 k or greater were recorded for nearly seven hours. These winds first occurred out of the northeast and then rotated clockwise until they were out of the south-southwest. Wind speeds of 100 k or greater were recorded for slightly over one hour and were mostly from the east-northeast.

Comparison of DISL and NWS Wind Data This section presents a comparison of the monthly mean wind speeds from the DISL to those reported from the NWS stations at Mobile, AL., Pensacola, FL., and New Orleans, LA. The wind data for the NWS stations was obtained from the Local Climatological Data Summaries published by the NOAA-NCDC.

Overall the differences between the individual monthly mean wind speeds recorded at the DISL and those reported by the three NWS stations are less that $\pm$ 2.0 k. For all twelve months combined the mean differences are less than $\pm$ 0.5 k amoung all of the stations.

It was anticipated by the authors that the wind speeds at the DISL would be higher than those reported at the NWS stations which are located inland from the coast. However, since the mean wind speeds at the DISL are virtually the same as the mean wind speeds reported by the three NWS stations we feel that perhaps the method used to estimate the sustained wind speeds in our study may have inadvertently biased the DISL wind speeds downward. Although, when the DISL data are compared to offshore Mississippi-Alabama wind data (Brower et al, 1972) the offshore monthly mean wind speeds are, as excepted, higher (3 to 6 k) than the DISL monthly mean wind speeds.

Sea Level Elevation Data All of the sea level elevation data in this section are referenced to the NGVD. The relationship of NGVD to other tidal datum references for NOAA-NOS tide station 873-5180 at Dauphin Island (Fort Gaines) Alabama are depicted in Plate 68. The range between the mean higher hige water and the mean lower low water is approximately 1.2 ft. These tidal datum relationships are calculated for the National Tidal Datum Epoch of 1960-1978. This information is provided by the Tidal Datums Section, Tides and Water Levels Branch, NOAA-NOS, and is labeled "Preliminary Data". For definitions of the terminology used in this section consult the "Glossary of Terms" provided in the NOAA-NOS publication "Tide Tables-high and low water predictions (East Coast of North and South America)" which is published annually.

Plots of hourly observations of sea level elevation are presented in Plate 69 for 1977 and 1979 and in Plate 70 for 1982 and 1983. These four years were selected because their records illustrated the seasonal cycle of mean sea level and/or contained examples of the impact of various meteorological and river flooding events on sea level along the Alabama coast.

Annual plots of the frequency of observed occurrences within given water elevation ranges and the cumulative frequency of observed occurrences to given water elevations are presented for the years 1977 (Plate 72), 1978 (Plate 73), 1980 (Plate 74), 1981 (Plate 75) and 1982 (Plate 76). These are the only years during the study with data sets that are at least 98% complete (Table 2).

Sea Level Variability Long term (weeks to months) seasonal variability in mean sea level can be seen to some degree in all four of the plots of hourly observations of sea level elevation (Plates 69 and 70). However, the clearest illustration is depicted in the record of 1977 (Plate 69a). The annual cyclic nature of the mean sea level variability follows a pattern of low-high-low-high-low. In 1977 (Plate 69a) mean sea level is falling and low during January, low in February, rising to high in March and high during April and May. In June mean sea level falls and remains low until mid July when it rises again and remains high until October-November when it falls to a low in December. Seasonally then for 1977 the winter months of January, February and December and the summer months of June and July have low mean sea levels. The winter period having the lowest elevations. High mean sea levels occurred in the spring months of March, April and May and the late summer and fall months of August through November. This pattern is similar to the other years by generally plus or minus one month (Plates 69a and 70a and b).

In the Gulf of Mexico there are four processes that can potentially play a role in the annual "low-high" mean sea level cycle: 1) local-regional winds; 2) river run-off; 3) thermal expansion-contraction of the water column; and 4) large scale "Gulf wide wind stress curl". Generally, during the winter months (January, February and December) a combination of northerly dominant winds (Plates 45 and 48) and cold water are responsible for the low mean sea level. In the spring (March, April and May) the annual flooding of the adjacent river systems and solar heating leading to thermal expansion of the water column coupled with winds that have shifted to southeasterly and southerly (Plates 46 and 47) result in high mean sea levels. The low mean sea level during June, July and August is, according to Blaha and Sturges (1981), a result of a broad-scale, wind stress-driven circulation in the Gulf in combination with local forcing of nearshore flow by longshore winds. For offshore Alabama, and the eastern Gulf of Mexico in general, the evidence for a coastal sea level response to wind stress curl forcing is weak because of the strong noise to signal ratio caused by the presence of the Loop current. However, westerly "longshore" winds (Plates 46 and 47) produce an Ekman transport which carries water offshore and causes sea level set-down at the coast. The fall (September, October and November) high sea level occurs when the local winds shift back to easterly (Plates 47 and 48) which causes an on-shore Ekman transport that results in a sea level set-up at the coast. Also during this time of year there remains some influence from solar heating induced thermal expansion of the water column.

Examples of short term (hours to days) non-tidal variability in sea level are depicted in the plots of hourly observations of sea level elevation for 1977 and 1979 (Plate 69) and 1982 and 1983 (Plate 70). Although the sea level record for 1982 (Plate 70a) contains non-tidal variability it is presented in order to illustrate what is considered to be a rather "uneventful year" relative to the records of the other three years.

The processes principally responsible for causing non-tidal perturbations in sea level at Dauphin Island are:

1) winter "cold front" storms;
2) tropical cyclones;
3) strong easterly winds; and
4) river flooding.

The winter cold fronts (also referred to as "northers" or "cold-air outbreaks) can occur from October through March. Over the northern Gulf of Mexico these storms have a distinctive and repetitive pattern of wind, barometric pressure, humidity and cloud cover (Ferrandez-Partegas and Moores, 1975; Huh et al., 1984). Huh et al. (1984) noted a three phase cycle in winter "cold front" storms: the prefrontal, frontal passage and cold-air outbreak/high pressure phases. The prefrontal phase is characterized by falling barometric pressure, strengthening of southerly winds (developing high, long-fetched seas), and warm, moist air conditions. The frontal passage phase involves an abrupt reversal of these conditions, accompanied by a squall line passage, strong wind shear, precipitation and a rapid drop in air temperature. During the cold-air outbreak/high-pressure phase, pressure rises rapidly, strong winds rotate from northwest to northeast. Seas and sea level, set up by the prefrontal southerly winds and falling atmosphere pressure, are set down by the strong northerly winds and rising pressure.

The impacts of numerous winter storms are depicted during January and February of 1979 (Plate 69b). Differences in sea level elevation between prefrontal set up and post-frontal set down are commonly 2.5 to 3.0 feet. These differences occur over periods of 12 to 24 hour. A very low sea level elevation is recorded in January, 1977 (Plate 69a) when a strong winter storm occurred during a period of predicted very low tides.

The response of coastal waters to the passage of a tropical cyclone is determined by the geometry of the coast and adjacent continental shelf and the path, speed of propagation, size and intersity of the storm (Anthes, 1982). Plate 69b illustrates the effects of three tropical cyclones that formed in or propogated through the Gulf of Mexico (Hurricanes Bob and Frederic and Tropical Storm Claudette) and a forth (Hurricane David) which was large enough to influence the eastern Gulf of Mexico even through the eye moved up the Atlantic coast of Florida.

During all four storms offshore waters were pushed towards the coast resulting in a set up of sea level. The degree of increase in sea level and the duration of the increases varied for each storm. Hurricane Bob moved rather fast through the western Gulf of Mexico making land fall around Grand Isle, Louisiana (Hebert, 1980a; b). At Dauphin Island sea level increased quickly to a single peak of high water (maximum height 2.2 to 2.3 feet above NGVD) which lasted for less than 12 hours (Plate 69b). On the other hand Tropical Storm Claudette moved slowly through the western Gulf of Mexico at times making little or no forward progress. When the center of Claudette finally crossed the coast near the Texas-Louisiana border it stalled completely and then slowly moved to the west (Hebert,

1980a; b). This resulted in a slower increase in sea level along the Alabama coast and an even slower recovery. Although Claudette was only a tropical storm, compared to Hurricane Bob it produced slightly higher increases in sea level (maximum height 2.3 to 2.4 ft above NGVD) that lasted two to three times longer (Plate 69b).

Hurricane David moved rapidly up the east coast of Florida (Hebert 1980a; b) and did not have a major impact on sea level at Dauphin Island (Plate 69b). Hurricane Frederic moved steadly across the eastern Gulf of Mexico and made land fall near the Alabama-Mississippi state line (Hebert, 1980a; b). Maximum winds gusts of 126 k out of the east-northeast were recorded along the Alabama coast. These winds produced such high waves on the east end of Dauphin Island that the NOAA-NOS tide gage was destroyed. The short record that does exist during the early part of Frederic shows a rapid increase in sea level up to approximately 6 hours before it came ashore. The impact of the storm surge accompaning Frederic, as determined by post-storm surge high water marks, is discussed in the next section of this report.

During periods of strong easterly and southeasterly winds on-shore cross-shelf Ekman transport produces a set up of sea level along the Alabama coast. The effect of strong easterly and easterly and southeasterly winds blowing for 24 to 48 hours can be seen as sharp upward spikes in the sea level elevation records of 1979 (Plate 69b) and 1983 (Plate 70b). These high sea level events last for 16 to 36 hours and have maximum heights that range between 2.0 to 2.6 ft above NGVD. Strong sustained easterly winds can produce a sea level set up that is maintained for weeks at a time. During two weeks in August and September, 1977 (Plate 69a) a set up along the coast shifted mean sea level upward approximately one foot above the pre and post wind event mean sea levels. Maximum heights of individual high tides reach levels of 2.3 to 2.4 ft above NGVD.

Flooding of the Mobile River Systems can result in changes in the hydrography of Mobile Bay and East Mississippi Sound (Schroeder, 1977; 1979) as well as changes in sea level elevation at the coast (see Plates 69a and b and 70b). During two four year recurrence floods (3.1 X $10^6$cfs and 3.3 X $10^6$ cfs) in March and April, 1977 mean sea level shifted upward approximately one foot above pre and post flood mean sea levels (Plate 69a). This condition persisted for 9 to 10 days during which the maximum water level heights reached 1.7 ft above NGVD.

In April and May, 1979 a flood with a recurrence interval of over 50 years (5.8 X $10^6$ cfs) occurred. During this flood mean sea level shifted upward approximately 1.5 ft above pre and post flood levels for 4 to 5 days (Plate 69b). Maximum water level heights reached 2.0 ft above NGVD. A 3 year recurrence flood (2.9 X $10^6$ cfs) in March, 1983 shifted mean sea level upward between 1.0 to 1.5 ft above pre and post flood levels for 2 days (Plate 70b). The maximum water level heights recorded were 1.8 ft above NGVD.

Hurricane High Water Profiles During the eleven year period of 1973 through 1983 coastal Alabama was exposed to the direct impact of one tropical cyclone, Hurricane Frederic (September 12, 1979). The NOAA-NOS tide station on Dauphin Island was destroyed by high wind and waves six hours before Frederic crossed the coast at the Alabama-Mississippi border.

Therefore, there is not a complete record of sea level changes associated with Frederic. A post-storm high water profile for the coastline from Gulfport, Mississippi to Destin, Florida was prepared by the U.S. Geological Survey and Corps of Engineers. The profile was constructed by surveying post-storm surge height marks at selected field locations. Plate 71 illustrates the high water profile for the Alabama coastline.

The storm surge was greatest in the northeast quadrant of Hurricane Frederic, which came ashore west of the Alabama-Florida border. High water elevations of 15 ft above NGVD were surveyed just west of Perdido Pass (Plate 71). Along the remainder of the Baldwin County coast storm surge heights ranged from 10 to 13 ft above NGVD. On Dauphin Island high water elevations ranged from 9 ft above NGVD on the eastern end near Fort Gaines to over 13 ft above NGVD on the Gulf (south) side, two to three miles to the west of Fort Gaines. Further to the west on Dauphin Island the high water elevations steadily fell to a height of just over 8 ft above NGVD at the Alabama-Mississippi border.

For comparison purposes the high water profile associated with the storm surge generated by Hurricane Camille which made landfall west of the Alabama coast near Bay St. Louis, Mississippi in August, 1969 is also shown on Plate 71. Along the Alabama coast the storm surge heights during Hurricane Camille ranged from 9 ft above NGVD on the west end of Dauphin Island to 4 ft above NGVD at Perdido Pass.

Annual Water Level Elevation Distributions Annual plots of the frequency of observed occurrences within given water level elevation ranges and the cummulative frequency of observed occurrences to given water elevations are presented for the years 1977 ( Plate 72), 1978 (Plate 73), 1980 (Plate 74), 1981 (Plate 75) and 1982 (Plate 76). The general shape of these two plots is basically similar for each of the five years. Annual mean sea level (the arithmetic mean of hourly water elevations) for each of these years is:

| Year | Percent Completeness of the Data Set | Annual Mean Sea Level (Feet above NGVD) |
|---|---|---|
| 1977 | 97.8 | 0.33 |
| 1978 | 100 | 0.26 |
| 1980 | 100 | 0.29 |
| 1981 | 100 | 0.21 |
| 1982 | 100 | 0.36 |

All but one of these annual mean sea levels is slightly higher than the 0.23 feet above NGVD mean sea level for the tidal datum epoch of 1960-1978 (Plate 68).

At the extreme high and low water levels each of the five years has a different distributional pattern. The total number of hourly observations at observed water levels either above or below fixed elevations relative to NGVD are:

| Heights Relative to NGVD | Year 1977 | 1978 | 1980 | 1981 | 1982 |
|---|---|---|---|---|---|
| greater than 2.0 ft | 15 | 0 | 2 | 2 | 13 |
| greater than 1.5 ft | 181 | 50 | 98 | 77 | 182 |
| less than or equal to 1.0 ft | 181 | 219 | 59 | 158 | 61 |
| less than or equal to 1.5 ft | 23 | 12 | 1 | 15 | 8 |
| less than or equal to 2.5 ft | 6 | 0 | 0 | 0 | 0 |

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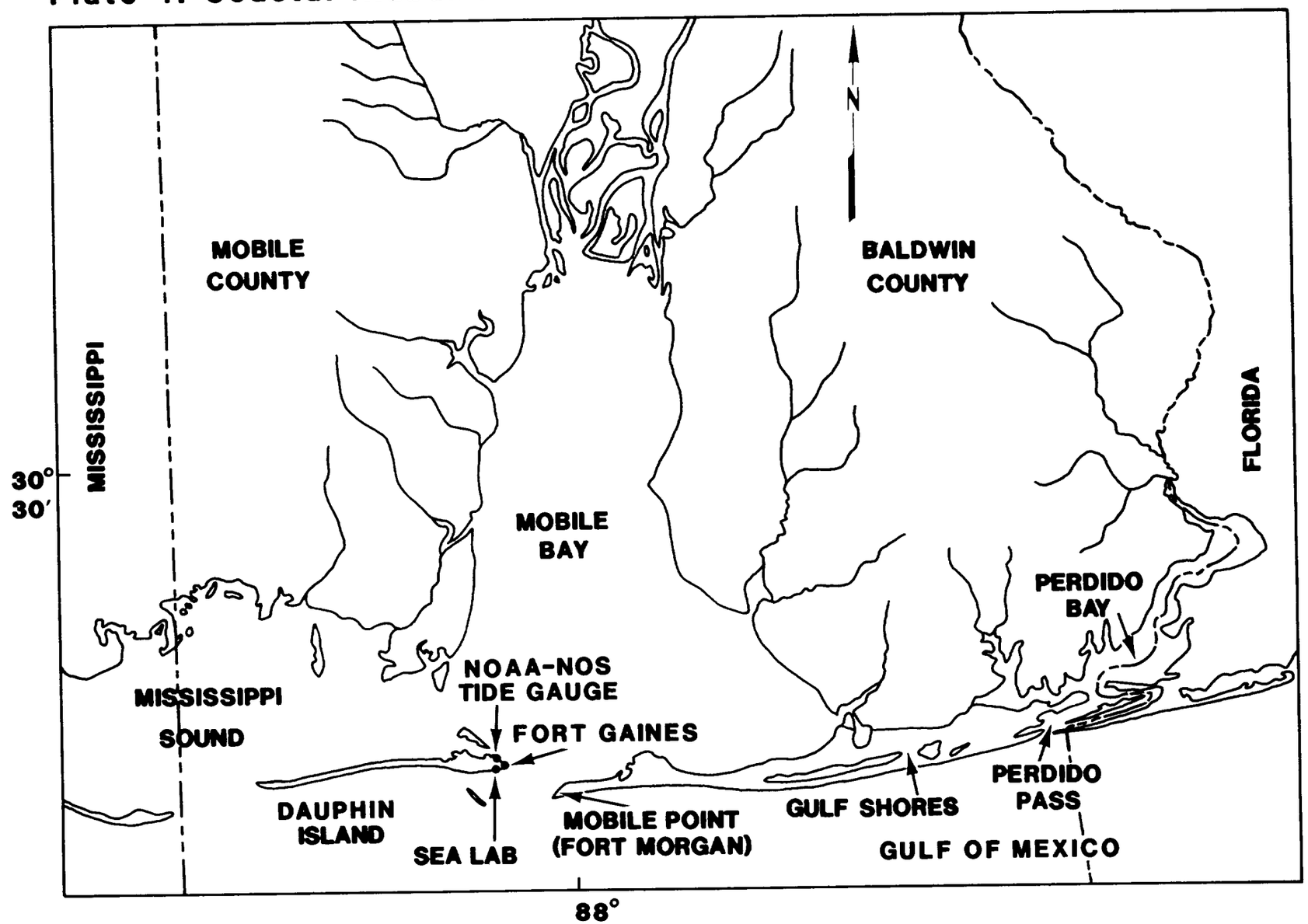
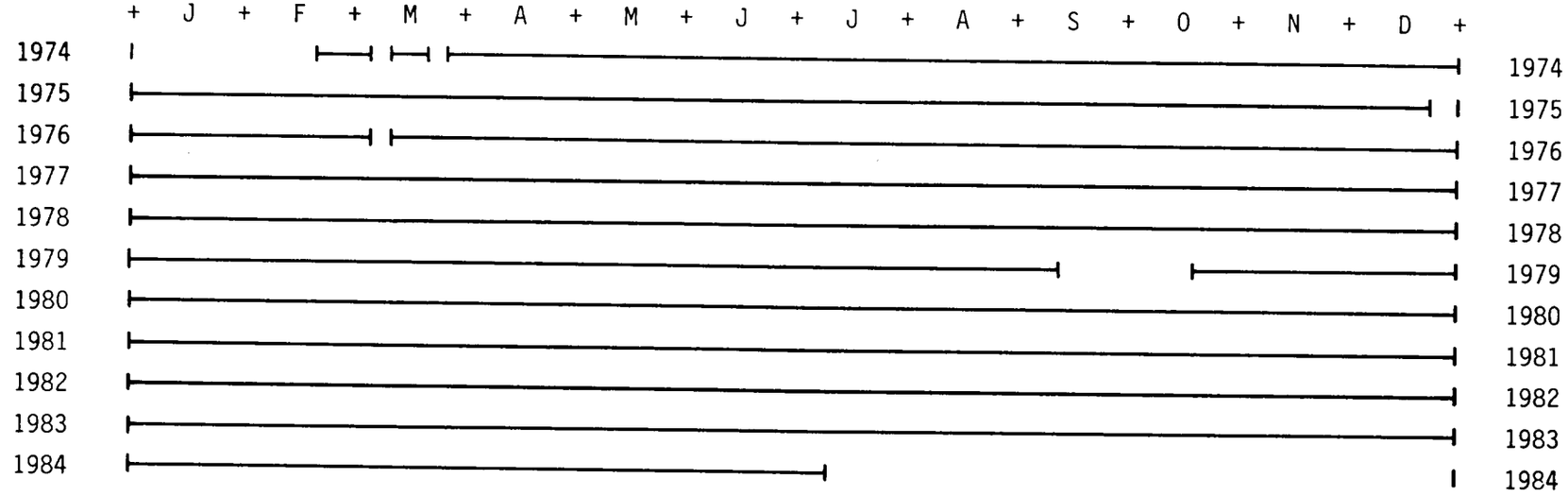
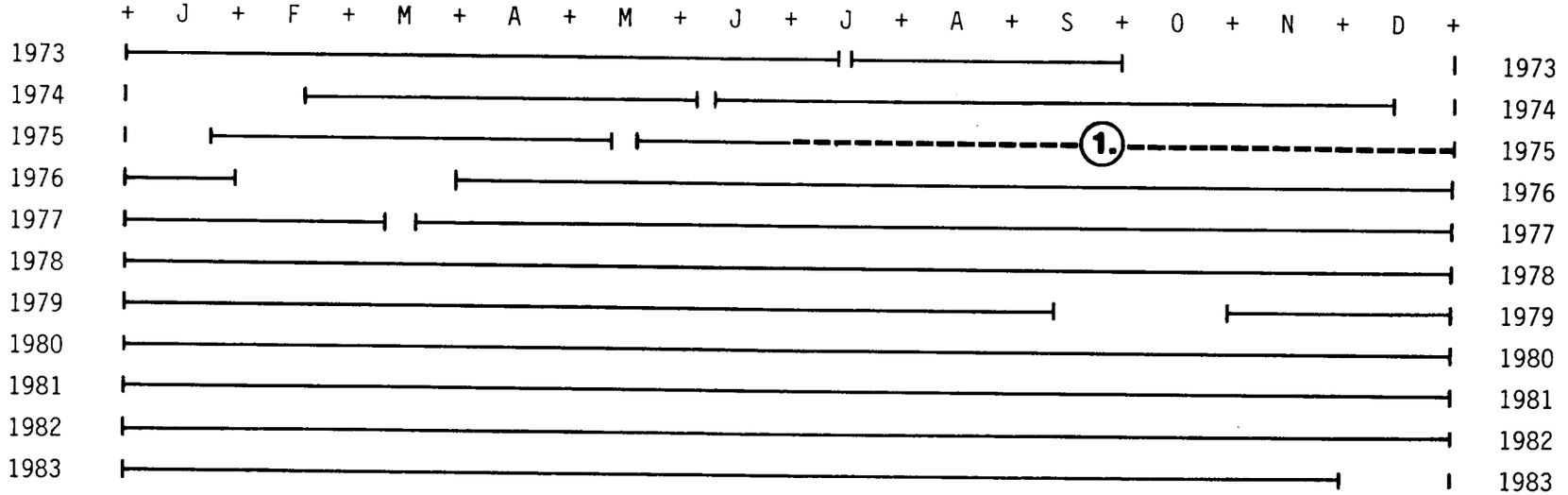
Plate 1. Coastal Alabama.



WIND SPEED AND DIRECTION DATA FROM THE DAUPHIN ISLAND SEA LAB METEOROLOGICAL STATION

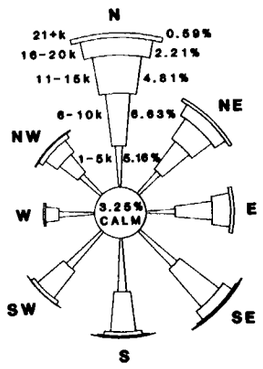



SEA LEVEL ELEVATION DATA FOR DAUPHIN ISLAND ALABAMA (OBTAINED FROM NOAA-NOS)




1. Gauge float periodically malfunctioned. Approximately 12% of the data is unusable.

**Plate 3. Example of a wind rose and matrix.**



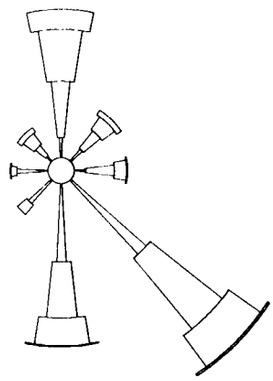

SPEED AND DIRECTION MATRICES (PERCENT OCCURANCE)

| DIRECTION | SPEED INTERVALS (kn) Calm 3.25 | 1-5 | 6-10 | 11-15 | 16-20 | 21+ | ROW TOTAL |
|---|---|---|---|---|---|---|---|
| N | | 5.16 | 6.63 | 4.81 | 2.21 | 0.59 | 19.40 |
| NE | | 3.71 | 4.36 | 3.06 | 1.59 | 0.42 | 13.14 |
| E | | 3.64 | 4.68 | 2.27 | 0.45 | 0.00 | 11.04 |
| SE | | 6.20 | 6.27 | 1.36 | 0.22 | 0.11 | 14.16 |
| S | | 6.82 | 5.06 | 0.51 | 0.20 | 0.05 | 12.64 |
| SW | | 6.12 | 4.29 | 0.50 | 0.03 | 0.00 | 10.94 |
| W | | 4.50 | 1.71 | 0.24 | 0.00 | 0.00 | 6.45 |
| NW | | 3.52 | 2.86 | 1.85 | 0.63 | 0.12 | 8.98 |
| COLUMN TOTAL | | 39.67 | 35.86 | 14.60 | 5.33 | 1.29 | 100 |

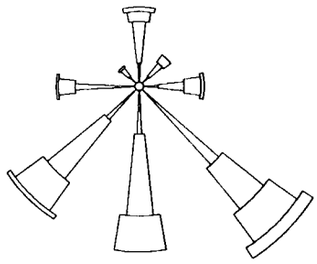
| DIRECTION INTERVAL | DIRECTION HEADING | DIRECTION INTERVAL RANGE (°mag) |
|---|---|---|
| N | 0° | 337.6 - 22.5 |
| NE | 45° | 22.6 - 67.5 |
| E | 90° | 67.6 - 112.5 |
| SE | 135° | 112.6 - 157.5 |
| S | 180° | 157.6 - 202.5 |
| SW | 225° | 202.6 - 247.5 |
| W | 270° | 247.6 - 292.5 |
| NW | 315° | 292.6 - 337.5 |

**Plate 4. Monthly wind roses.**

APR 1974



MAY 1974



JUN 1974

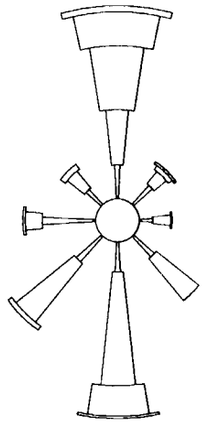
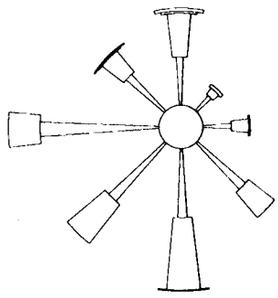
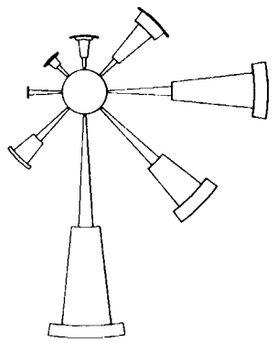


**Plate 5. Monthly wind roses.**

JUL 1974



AUG 1974



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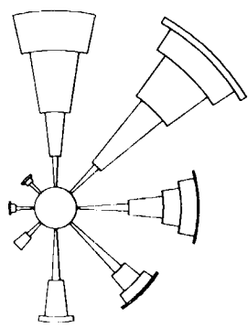
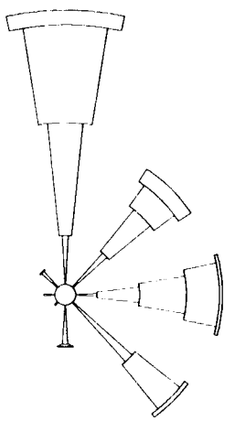


**Plate 6.Monthly wind roses.**

OCT 1974



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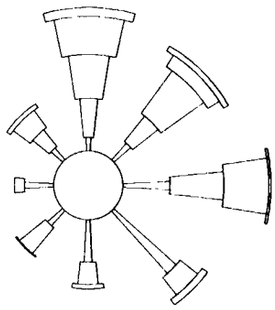


DEC 1974

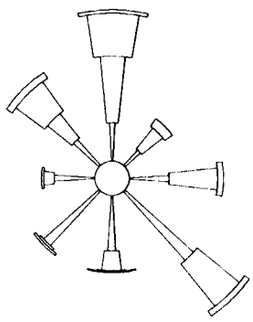
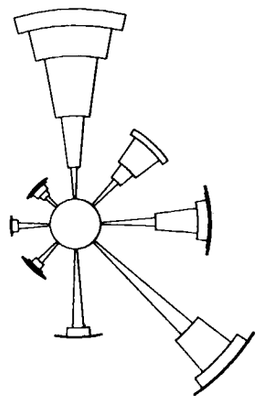
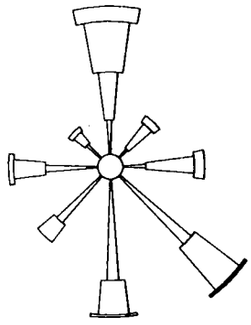


**Plate 7. Monthly wind roses.**

JAN 1975



FEB 1975



MAR 1975

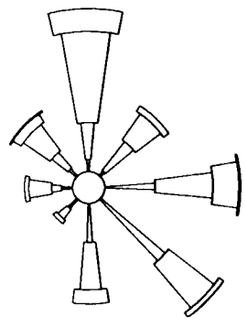
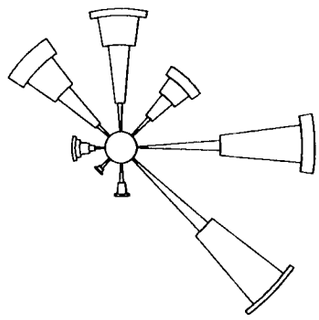
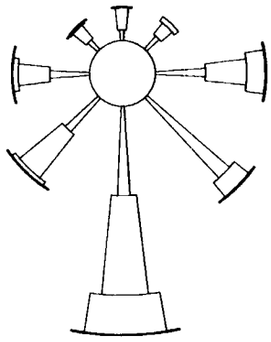


**Plate 8. Monthly wind roses.**

APR 1975



MAY 1975



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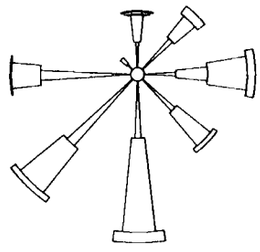
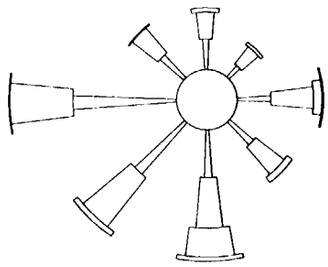
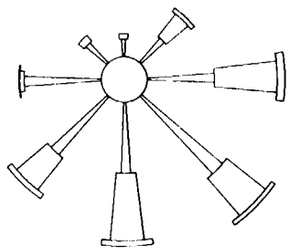


**Plate 9. Monthly wind roses.**

JUL 1975



AUG 1975



SEP 1975

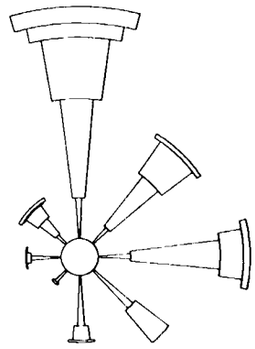
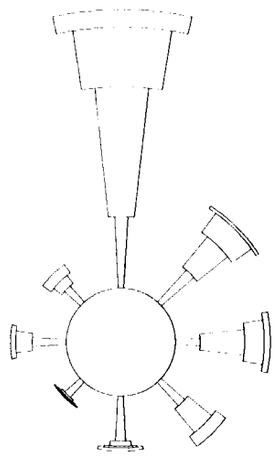
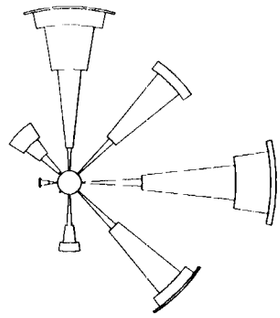


**Plate 10. Monthly wind roses.**

OCT 1975



NOV 1975



DEC 1975

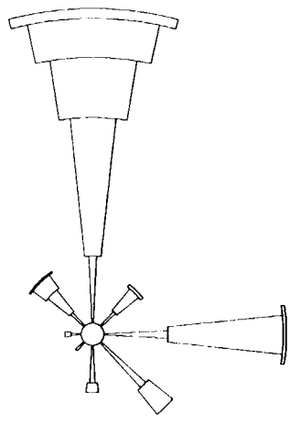
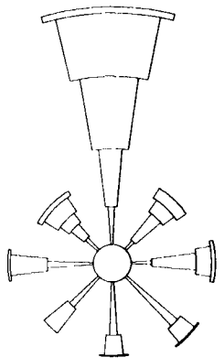
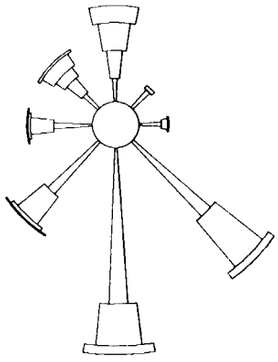


**Plate 11. Monthly wind roses.**

JAN 1976



FEB 1976



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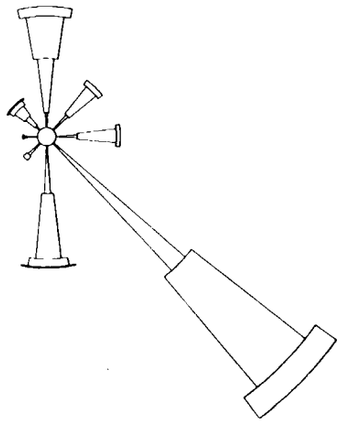
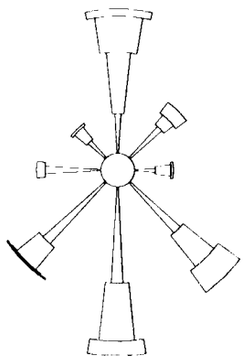


**Plate 12. Monthly wind roses.**

APR 1976



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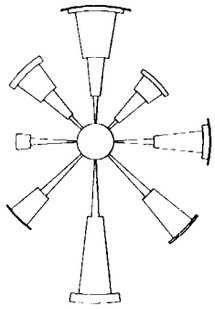

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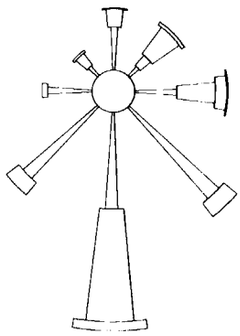
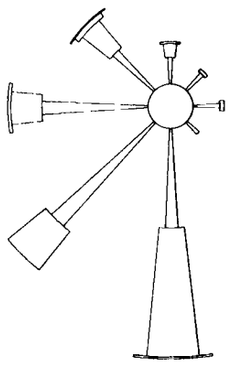
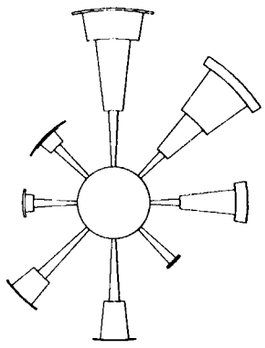


**Plate 13. Monthly wind roses.**

JUL 1976



AUG 1976



SEP 1976

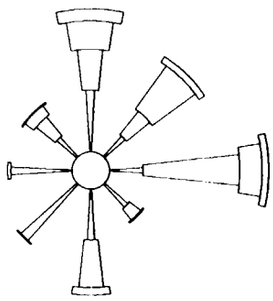
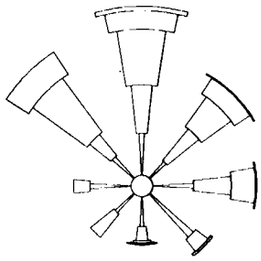
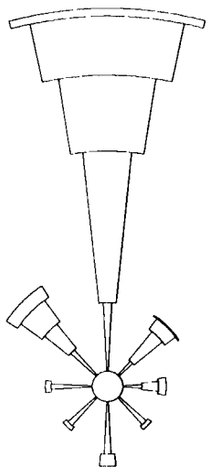


**Plate 14. Monthly wind roses.**

OCT 1976



NOV 1976



DEC 1976

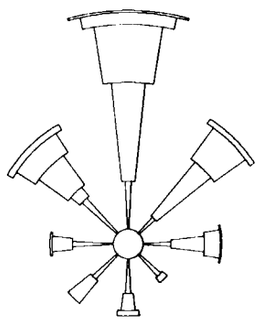
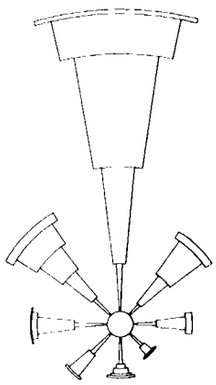
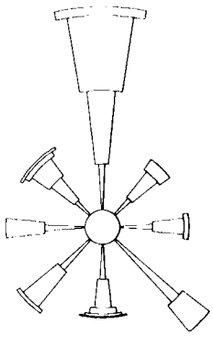


**Plate 15. Monthly wind roses.**

JAN 1977



FEB 1977



MAR 1977

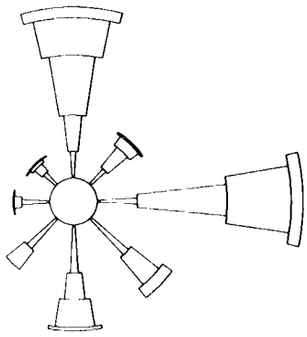
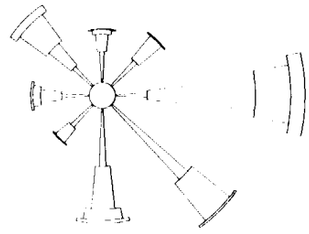
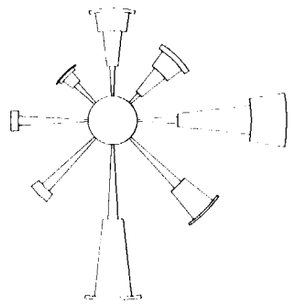


**Plate 16. Monthly wind roses.**

APR 197?



MAY 197?



JUN 197?

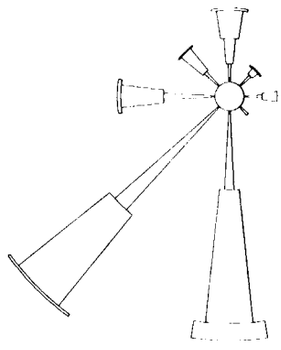
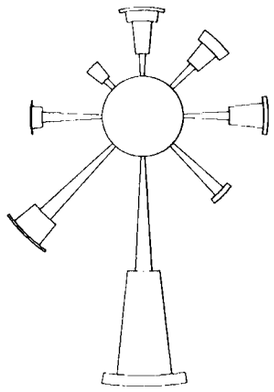
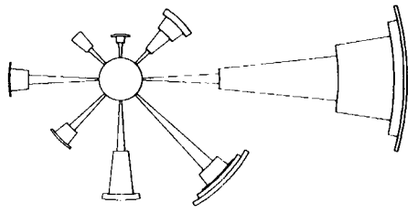


**Plate 17. Monthly wind roses.**

JUL 1977



AUG 1977



SEP 1977

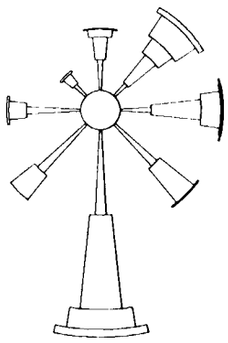
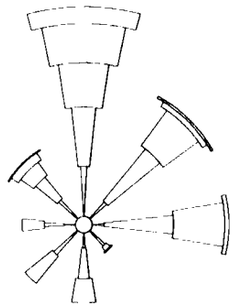
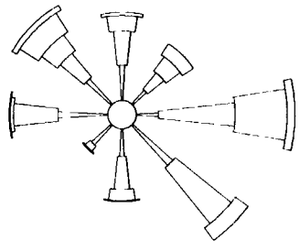


**Plate 18. Monthly wind roses.**

OCT 1977



NOV 1977



DEC 1977

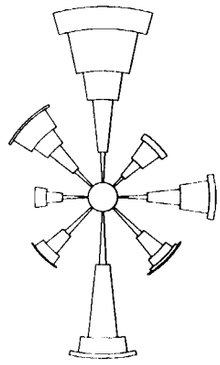
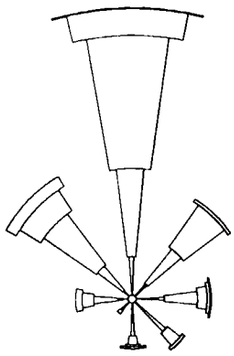
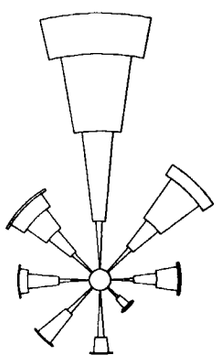


**Plate 19. Monthly wind roses.**

JAN 1978



FEB 1978



MAR 1978

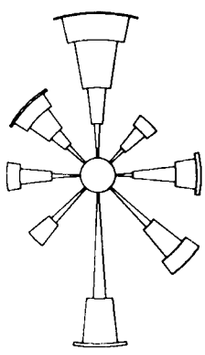
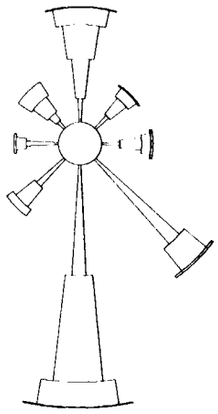
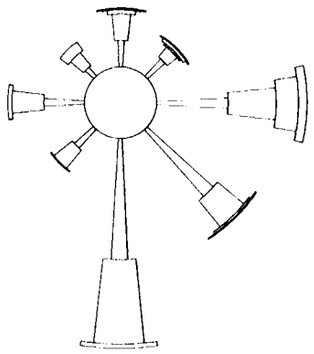


**Plate 20. Monthly wind roses.**

APR 1978



MAY 1978



JUN 1978

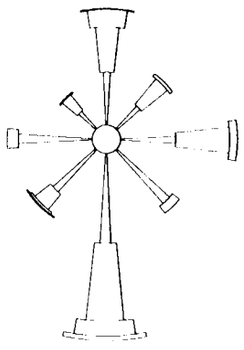
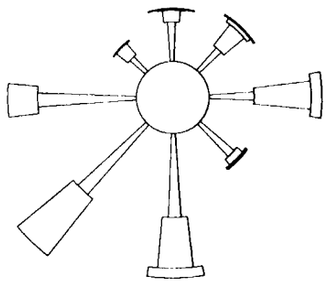
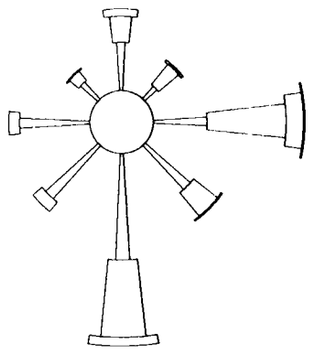


**Plate 21. Monthly wind roses.**

JUL 1978



AUG 1978



SEP 1978

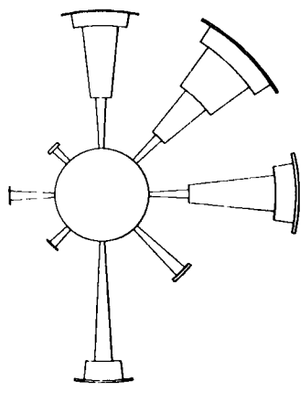
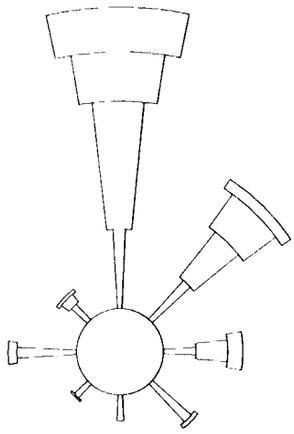
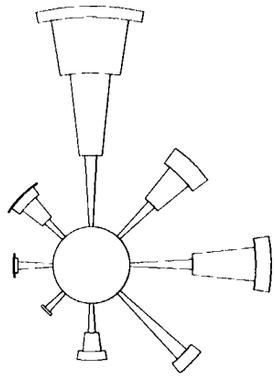


**Plate 22. Monthly wind roses.**

OCT 1978



NOV 1978



DEC 1978

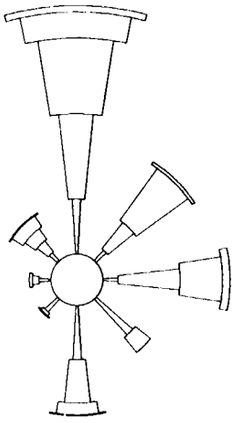
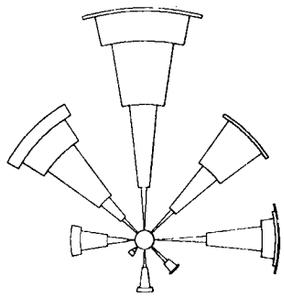
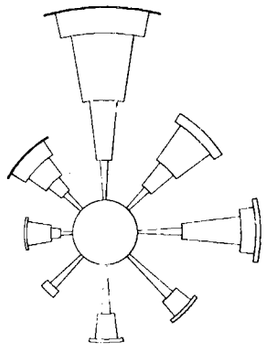


**Plate 23. Monthly wind roses.**

JAN 1979



FEB 1979



MAR 1979

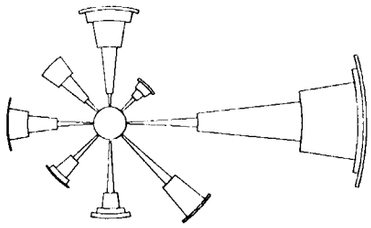
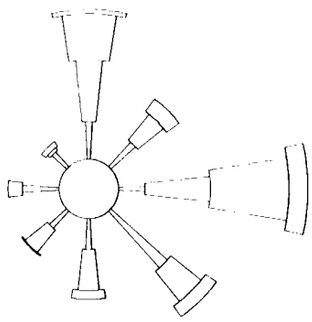
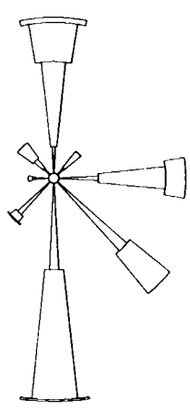


**Plate 24. Monthly wind roses.**

APR 1979



MAY 1979



JUN 1979

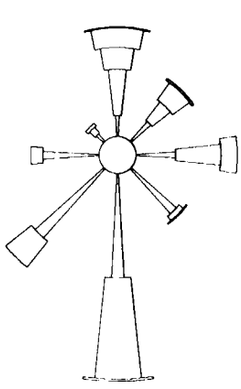
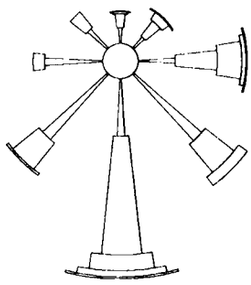


**Plate 25. Monthly wind roses.**

JUL 1979



AUG 1979

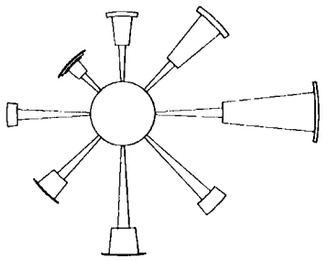
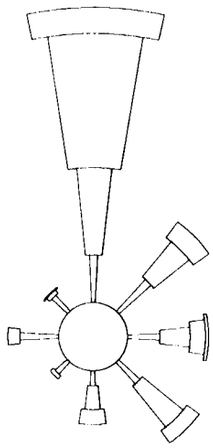


**Plate 26. Monthly wind roses.**

NOV 1979



DEC 1979

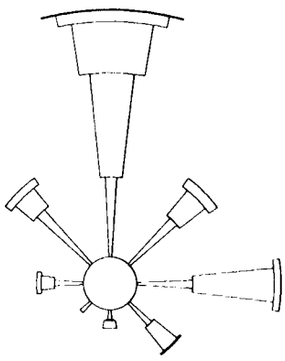
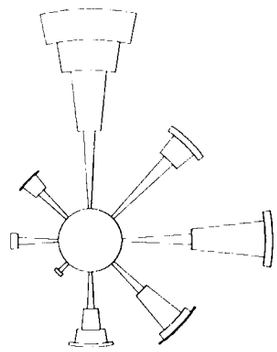
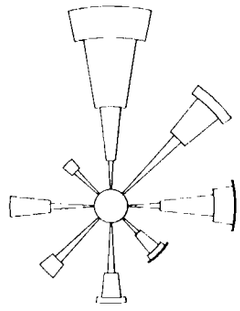


**Plate 2Z Monthly wind roses.**

JAN 1980



FEB 1980



MAR 1980

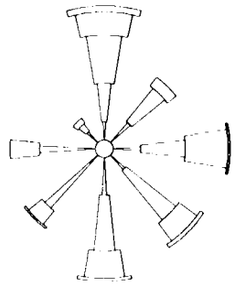
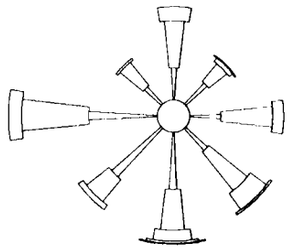
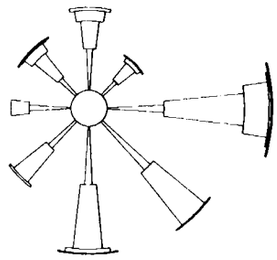


**Plate 28. Monthly wind roses.**

APR 1980



MAY 1980



JUN 1980

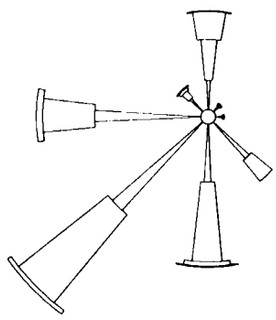
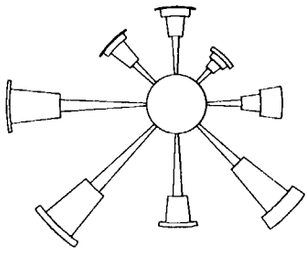
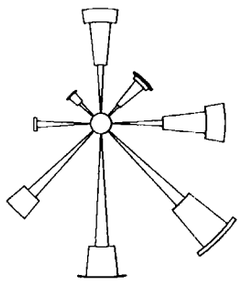


**Plate 29. Monthly wind roses.**

JUL 1980



AUG 1980



SEP 1980

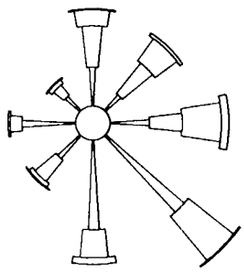
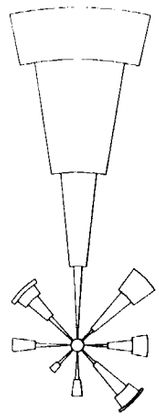
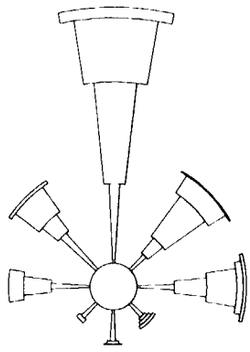


**Plate 30. Monthly wind roses.**

OCT 1980



NOV 1980



DEC 1980

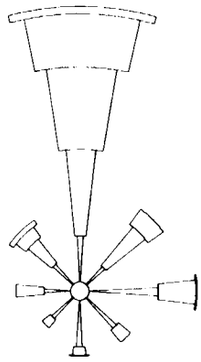
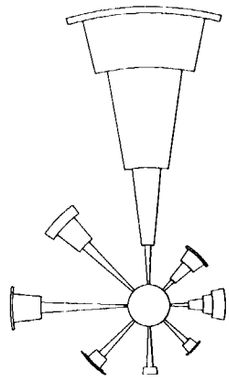
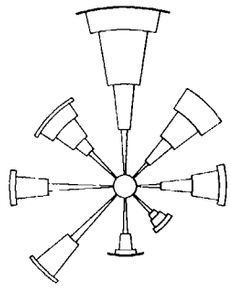


**Plate 31 Monthly wind roses.**

JAN 1981



FEB 1981



MAR 1981

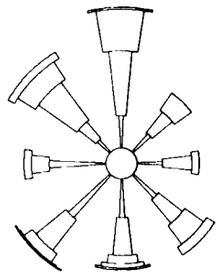
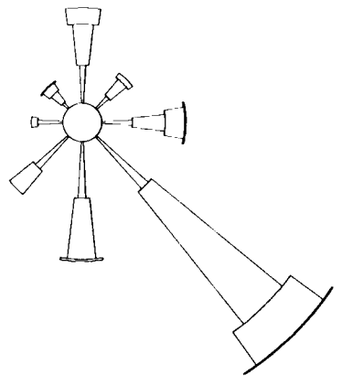
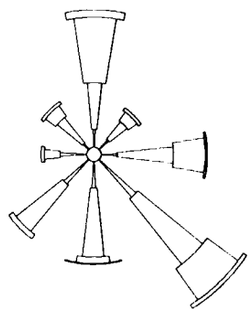


**Plate 32. Monthly wind roses.**

APR 1981



MAY 1981



JUN 1981

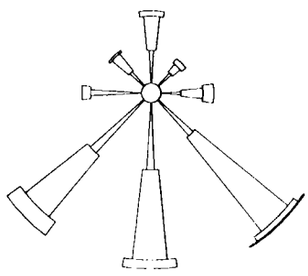
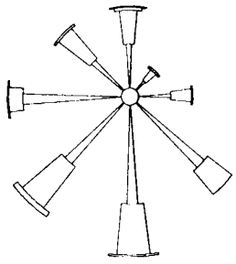
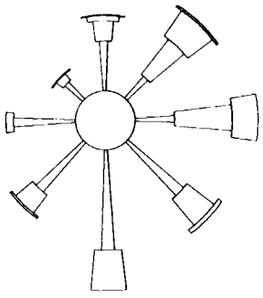


**Plate 33. Monthly wind roses.**

JUL 1981



AUG 1981



SEP 1981

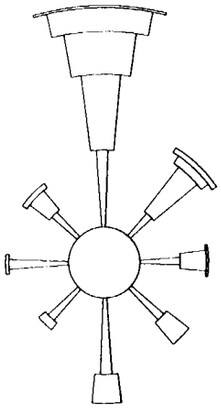
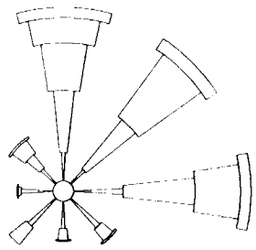
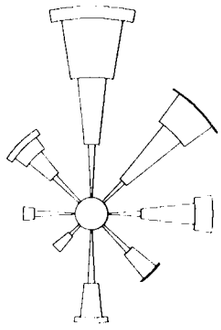


**Plate 34. Monthly wind roses.**

OCT 1981



NOV 1981



DEC 1981

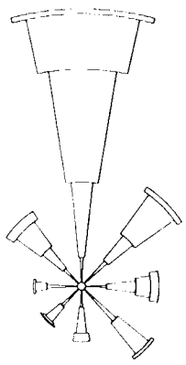
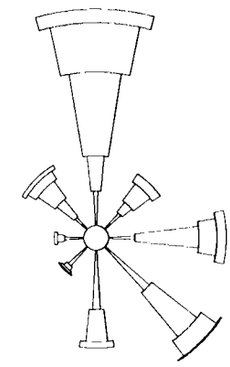
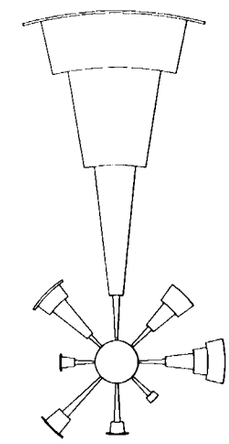


**Plate 35. Monthly wind roses.**

JAN 1982



FEB 1982



MAR 1982

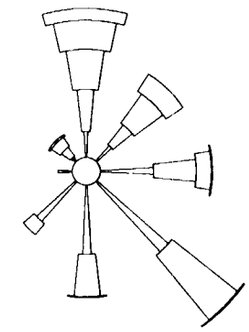
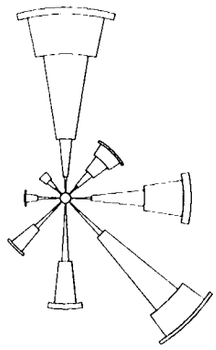
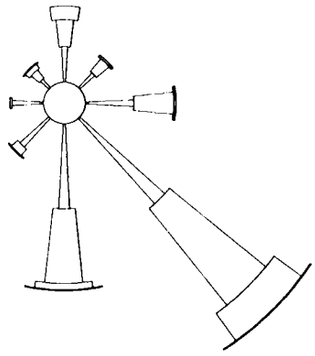


**Plate 36. Monthly wind roses.**

APR 1982



MAY 1982



JUN 1982

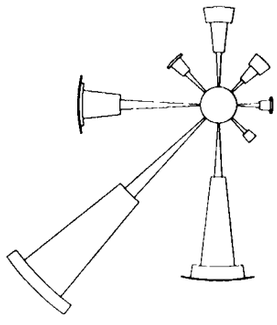
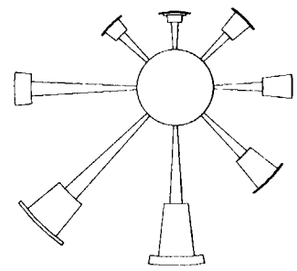
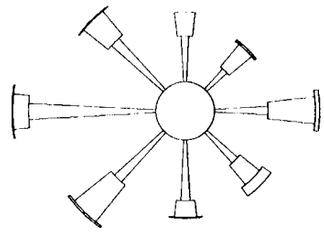


**Plate 37. Monthly wind roses.**

JUL 1982



AUG 1982



SEP 1982

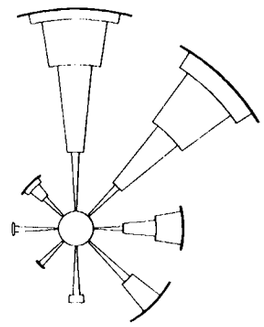
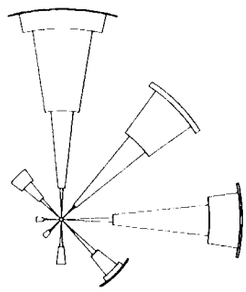
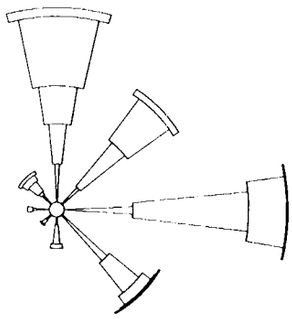


**Plate 38. Monthly wind roses.**

OCT 1982



NOV 1982



DEC 1982

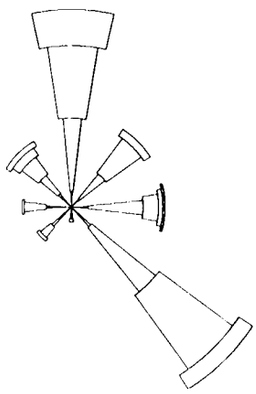
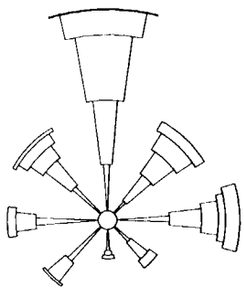
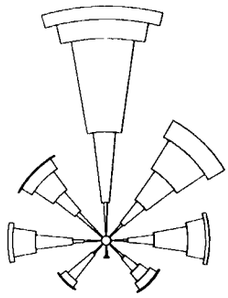


**Plate 39 Monthly wind roses.**

JAN 1983



FEB 1983



MAR 1983

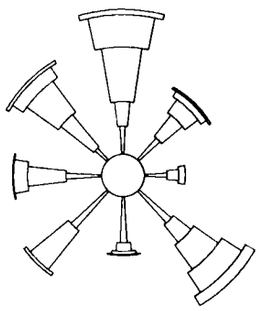
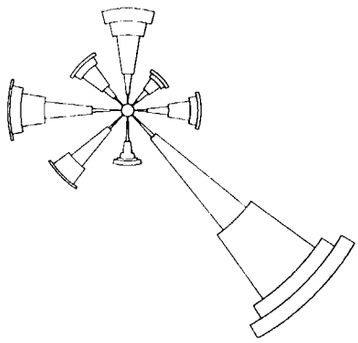
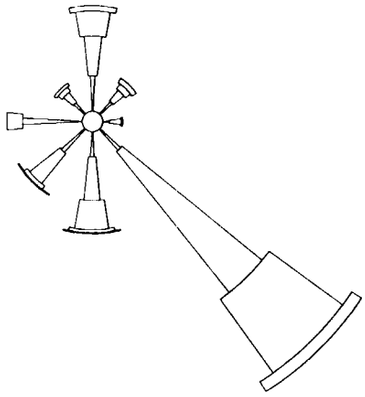


**Plate 40 Monthly wind roses.**

APR 1983



MAY 1983



JUN 1983

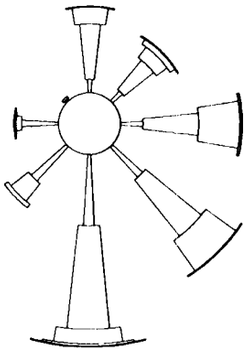
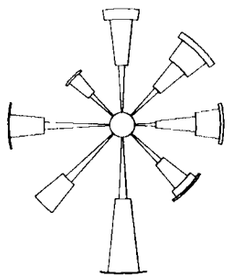
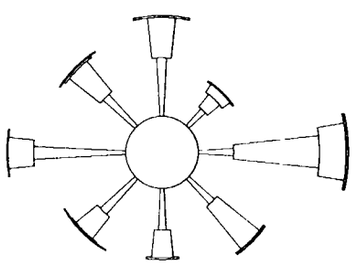


**Plate 41. Monthly wind roses.**

JUL 1983



AUG 1983



SEP 1983

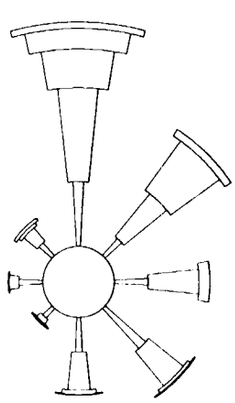
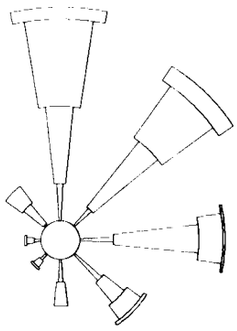
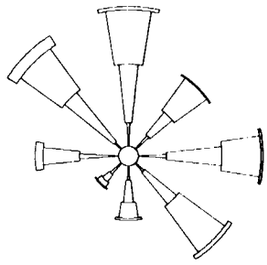


**Plate 42. Monthly wind roses.**

OCT 1983



NOV 1983



DEC 1983

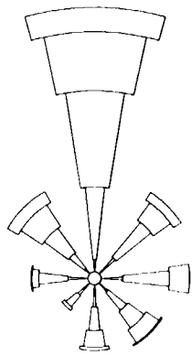
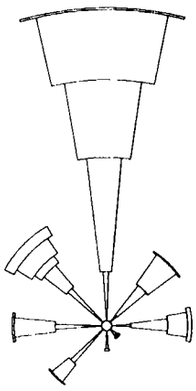
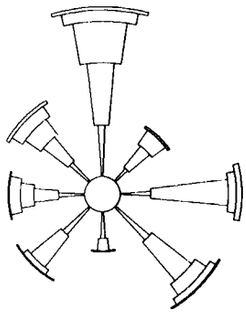


**Plate 43. Monthly wind roses.**

JAN 1984



FEB 1984



MAR 1984

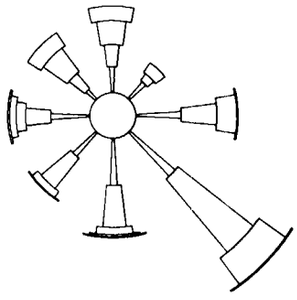
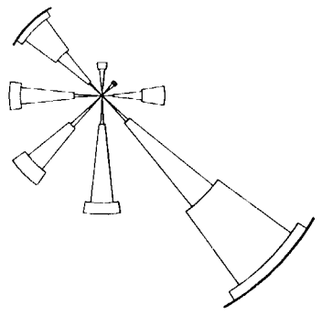
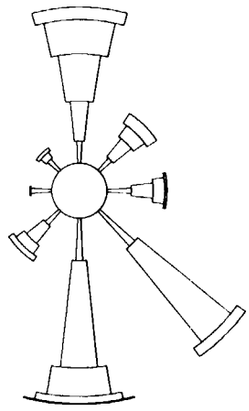


**Plate 44. Monthly wind roses.**

APR 1984



MAY 1984



JUN 1984

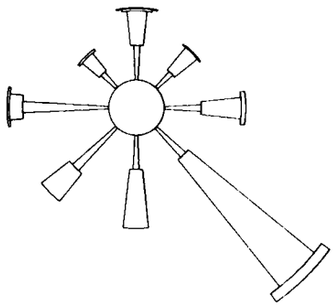
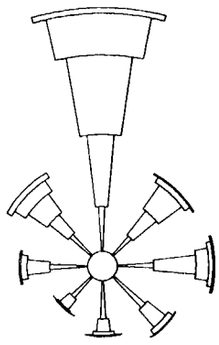


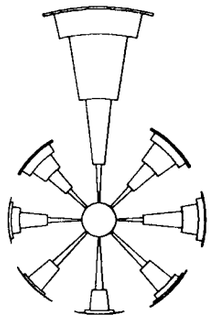
**Plate 45. Monthly composite wind roses (a) and matrices (b).**

(a)

JAN.



FEB.



MAR.

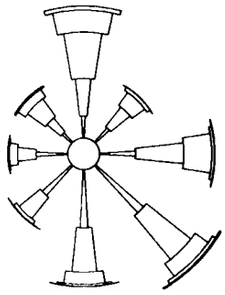


PLATE 45b.
MONTHLY COMPOSITE WIND SPEED AND DIRECTION MATRICES
(VALUES REPRESENT THE PERCENT OCCURRENCE)

JANUARY
(1975-1984)

| DIRECTION / MAG INTERVALS | SPEED INTERVALS (kn) CALM 1.92 | 1-5 | 6-10 | 11-15 | 16-20 | 21+ | ROW TOTAL |
|---|---|---|---|---|---|---|---|
| N | | 5.71 | 9.33 | 10.22 | 5.35 | 0.70 | 31.31 |
| NE | | 3.16 | 3.90 | 3.71 | 0.78 | 0.13 | 11.67 |
| E | | 4.64 | 5.42 | 1.60 | 0.57 | 0.21 | 12.44 |
| SE | | 5.40 | 2.98 | 0.74 | 0.07 | 0.00 | 9.19 |
| S | | 4.92 | 1.66 | 0.47 | 0.08 | 0.06 | 7.19 |
| SW | | 3.52 | 1.67 | 0.20 | 0.04 | 0.01 | 5.45 |
| W | | 4.82 | 2.90 | 0.81 | 0.22 | 0.00 | 8.75 |
| NW | | 3.65 | 3.08 | 2.95 | 1.66 | 0.74 | 12.08 |
| COLUMN TOTAL | | 35.83 | 30.94 | 20.70 | 8.78 | 1.84 | 100 |

FEBRUARY
(1974-1984)

| DIRECTION / MAG INTERVALS | SPEED INTERVALS (kn) CALM 2.20 | 1-5 | 6-10 | 11-15 | 16-20 | 21+ | ROW TOTAL |
|---|---|---|---|---|---|---|---|
| N | | 4.95 | 8.40 | 8.34 | 3.23 | 0.29 | 25.23 |
| NE | | 3.58 | 3.64 | 2.82 | 1.08 | 0.24 | 11.35 |
| E | | 3.49 | 5.01 | 2.03 | 0.84 | 0.06 | 11.44 |
| SE | | 6.16 | 3.63 | 0.68 | 0.29 | 0.03 | 10.79 |
| S | | 6.88 | 2.64 | 0.43 | 0.04 | 0.03 | 10.02 |
| SW | | 5.88 | 3.64 | 0.32 | 0.03 | 0.01 | 9.89 |
| W | | 4.41 | 3.54 | 1.06 | 0.37 | 0.03 | 9.40 |
| NW | | 3.20 | 2.99 | 2.08 | 1.21 | 0.22 | 9.71 |
| COLUMN TOTAL | | 38.56 | 33.49 | 17.76 | 7.09 | 0.91 | 100 |

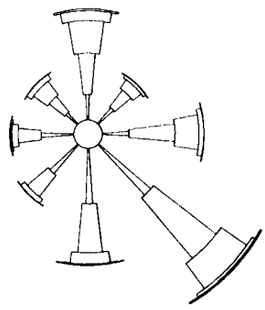
MARCH
(1974-1984)

| DIRECTION / MAG INTERVALS | SPEED INTERVALS (kn) CALM 2.06 | 1-5 | 6-10 | 11-15 | 16-20 | 21+ | ROW TOTAL |
|---|---|---|---|---|---|---|---|
| N | | 2.81 | 4.83 | 5.99 | 2.83 | 0.53 | 16.98 |
| NE | | 2.47 | 3.17 | 2.02 | 0.48 | 0.03 | 8.16 |
| E | | 4.58 | 6.18 | 3.53 | 0.37 | 0.04 | 14.70 |
| SE | | 8.22 | 7.27 | 2.02 | 0.46 | 0.13 | 18.11 |
| S | | 7.48 | 5.70 | 1.56 | 0.28 | 0.04 | 15.06 |
| SW | | 5.11 | 3.50 | 0.48 | 0.05 | 0.01 | 9.15 |
| W | | 4.02 | 2.39 | 1.04 | 0.17 | 0.04 | 7.66 |
| NW | | 1.65 | 2.29 | 2.82 | 1.15 | 0.22 | 8.12 |
| COLUMN TOTAL | | 36.34 | 35.33 | 19.45 | 5.79 | 1.03 | 100 |

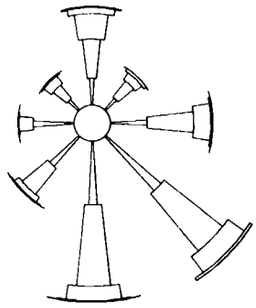
**Plate 46 . Monthly composite wind roses (a) and matrices (b).**

**(a)**

APR.



MAY



JUN.

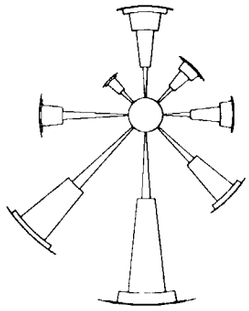


PLATE 46b.
MONTHLY COMPOSITE WIND SPEED AND DIRECTION MATRICES
(VALUES REPRESENT THE PERCENT OCCURRENCE)

APRIL
(1974-1984)

| DIRECTION / MAG | SPEED INTERVALS (kn) | | | | | | |
|---|---|---|---|---|---|---|---|
| | CALM 1.85 | 1-5 | 6-10 | 11-15 | 16-20 | 21+ | ROW TOTAL |
| N | | 3.27 | 5.32 | 4.24 | 1.29 | 0.25 | 14.36 |
| NE | | 2.65 | 2.72 | 1.34 | 0.41 | 0.06 | 7.19 |
| E | | 3.42 | 5.91 | 3.09 | 0.62 | 0.04 | 13.08 |
| SE | | 8.86 | 10.20 | 4.02 | 0.40 | 0.19 | 23.67 |
| S | | 7.13 | 6.34 | 1.43 | 0.12 | 0.06 | 15.10 |
| SW | | 4.86 | 3.50 | 0.65 | 0.04 | 0.00 | 9.04 |
| W | | 4.21 | 2.94 | 0.80 | 0.22 | 0.06 | 8.24 |
| NW | | 1.95 | 2.57 | 2.20 | 0.72 | 0.05 | 7.49 |
| COLUMN TOTAL | | 36.34 | 39.51 | 17.76 | 3.82 | 0.72 | 100 |

MAY
(1974-1984)

| DIRECTION / MAG | SPEED INTERVALS (kn) | | | | | | |
|---|---|---|---|---|---|---|---|
| | CALM 2.36 | 1-5 | 6-10 | 11-15 | 16-20 | 21+ | ROW TOTAL |
| N | | 3.44 | 5.04 | 3.32 | 0.79 | 0.16 | 12.84 |
| NE | | 1.94 | 2.64 | 1.03 | 0.39 | 0.01 | 6.02 |
| E | | 4.71 | 5.99 | 2.21 | 0.24 | 0.01 | 13.16 |
| SE | | 9.45 | 9.61 | 2.58 | 0.36 | 0.00 | 21.99 |
| S | | 8.21 | 10.49 | 1.88 | 0.15 | 0.04 | 20.77 |
| SW | | 5.08 | 4.28 | 0.74 | 0.13 | 0.01 | 10.23 |
| W | | 5.24 | 1.81 | 0.16 | 0.00 | 0.01 | 7.23 |
| NW | | 1.83 | 2.23 | 1.21 | 0.20 | 0.01 | 5.48 |
| COLUMN TOTAL | | 39.90 | 42.09 | 13.12 | 2.26 | 0.27 | 100 |

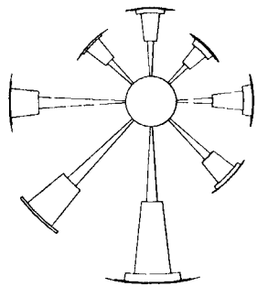
JUNE
(1974-1984)

| DIRECTION / MAG | SPEED INTERVALS (kn) | | | | | | |
|---|---|---|---|---|---|---|---|
| | CALM 2.23 | 1-5 | 6-10 | 11-15 | 16-20 | 21+ | ROW TOTAL |
| N | | 3.94 | 4.79 | 2.30 | 0.69 | 0.10 | 11.83 |
| NE | | 2.60 | 2.48 | 1.24 | 0.17 | 0.01 | 6.50 |
| E | | 3.58 | 3.85 | 1.58 | 0.13 | 0.00 | 9.14 |
| SE | | 6.21 | 6.06 | 0.68 | 0.03 | 0.00 | 12.98 |
| S | | 8.64 | 12.17 | 1.42 | 0.13 | 0.01 | 22.38 |
| SW | | 10.57 | 7.99 | 0.61 | 0.01 | 0.00 | 19.19 |
| W | | 8.46 | 2.72 | 0.23 | 0.03 | 0.00 | 11.44 |
| NW | | 2.06 | 1.97 | 0.27 | 0.01 | 0.00 | 4.32 |
| COLUMN TOTAL | | 46.07 | 42.02 | 8.34 | 1.20 | 0.13 | 100 |

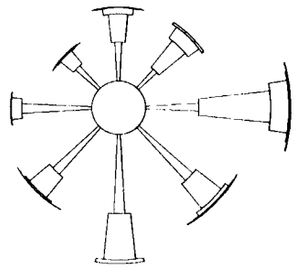
**Plate 47. Monthly composite wind roses (a) and matrices (b).**

(a)

JUL.



AUG.



SEP.

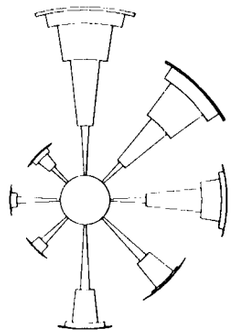


PLATE 47b.
MONTHLY COMPOSITE WIND SPEED AND DIRECTION MATRICES
(VALUES REPRESENT THE PERCENT OCCURRENCE)

JULY
(1974-1984)

| DIRECTION / MAG INTERVALS | SPEED INTERVALS (kn) | | | | | | |
|---|---|---|---|---|---|---|---|
| | CALM 3.26 | 1-5 | 6-10 | 11-15 | 16-20 | 21+ | ROW TOTAL |
| N | | 4.52 | 3.63 | 0.58 | 0.11 | 0.04 | 8.87 |
| NE | | 3.22 | 2.61 | 0.78 | 0.15 | 0.04 | 6.80 |
| E | | 4.62 | 3.95 | 1.19 | 0.09 | 0.03 | 9.88 |
| SE | | 6.96 | 3.39 | 0.53 | 0.03 | 0.00 | 10.91 |
| S | | 9.71 | 9.28 | 1.06 | 0.13 | 0.03 | 20.20 |
| SW | | 11.29 | 5.97 | 0.30 | 0.00 | 0.00 | 17.58 |
| W | | 11.16 | 3.62 | 0.12 | 0.01 | 0.00 | 14.91 |
| NW | | 4.17 | 3.14 | 0.25 | 0.03 | 0.01 | 7.61 |
| COLUMN TOTAL | | 55.65 | 35.60 | 4.81 | 0.54 | 0.15 | 100 |

AUGUST
(1974-1983)

| DIRECTION / MAG INTERVALS | SPEED INTERVALS (kn) | | | | | | |
|---|---|---|---|---|---|---|---|
| | CALM 3.46 | 1-5 | 6-10 | 11-15 | 16-20 | 21+ | ROW TOTAL |
| N | | 4.98 | 3.65 | 0.81 | 0.10 | 0.01 | 9.55 |
| NE | | 3.23 | 4.35 | 1.73 | 0.29 | 0.00 | 9.60 |
| E | | 6.84 | 9.14 | 2.35 | 0.16 | 0.04 | 18.53 |
| SE | | 9.24 | 4.10 | 0.52 | 0.07 | 0.05 | 13.99 |
| S | | 10.21 | 5.90 | 0.48 | 0.00 | 0.00 | 16.60 |
| SW | | 8.00 | 3.36 | 0.23 | 0.00 | 0.01 | 11.61 |
| W | | 8.95 | 1.35 | 0.08 | 0.00 | 0.00 | 10.38 |
| NW | | 3.94 | 2.14 | 0.11 | 0.07 | 0.03 | 6.29 |
| COLUMN TOTAL | | 55.39 | 34.00 | 6.31 | 0.69 | 0.15 | 100 |

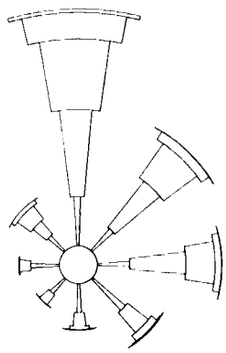
SEPTEMBER
(1974-1983)

| DIRECTION / MAG INTERVALS | SPEED INTERVALS (kn) | | | | | | |
|---|---|---|---|---|---|---|---|
| | CALM 3.19 | 1-5 | 6-10 | 11-15 | 16-20 | 21+ | ROW TOTAL |
| N | | 6.39 | 8.50 | 4.65 | 1.70 | 0.43 | 21.67 |
| NE | | 3.44 | 6.90 | 5.15 | 1.76 | 0.24 | 17.48 |
| E | | 4.62 | 7.12 | 2.50 | 0.69 | 0.03 | 14.95 |
| SE | | 7.42 | 3.96 | 0.25 | 0.04 | 0.01 | 11.69 |
| S | | 8.37 | 4.30 | 0.66 | 0.12 | 0.00 | 13.45 |
| SW | | 4.39 | 1.30 | 0.07 | 0.03 | 0.00 | 5.79 |
| W | | 5.55 | 0.80 | 0.09 | 0.01 | 0.00 | 6.46 |
| NW | | 2.68 | 1.83 | 0.66 | 0.10 | 0.04 | 5.32 |
| COLUMN TOTAL | | 42.86 | 34.71 | 14.03 | 4.45 | 0.76 | 100 |

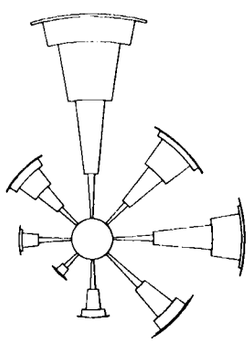
**Plate 48 . Monthly composite wind roses (a) and matrices (b).**

(a)

OCT.



NOV.



DEC.

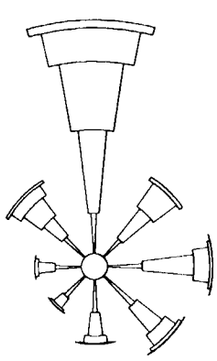


PLATE 48b.
MONTHLY COMPOSITE WIND SPEED AND DIRECTION MATRICES
(VALUES REPRESENT THE PERCENT OCCURRENCE)

OCTOBER
(1974-1983)

| DIRECTION / MAG | SPEED INTERVALS (kn) CALM 2.45 | 1-5 | 6-10 | 11-15 | 16-20 | 21+ | ROW TOTAL |
|---|---|---|---|---|---|---|---|
| N | | 6.37 | 11.25 | 9.07 | 3.41 | 0.47 | 30.57 |
| NE | | 3.71 | 7.56 | 5.35 | 1.20 | 0.04 | 17.85 |
| E | | 4.17 | 7.19 | 3.76 | 0.82 | 0.04 | 15.99 |
| SE | | 5.58 | 3.40 | 0.95 | 0.12 | 0.01 | 10.06 |
| S | | 3.72 | 1.80 | 0.42 | 0.06 | 0.01 | 6.02 |
| SW | | 2.50 | 1.58 | 0.04 | 0.01 | 0.00 | 4.14 |
| W | | 3.68 | 1.44 | 0.12 | 0.00 | 0.00 | 5.23 |
| NW | | 2.74 | 2.24 | 2.14 | 0.56 | 0.01 | 7.69 |
| COLUMN TOTAL | | 32.74 | 36.45 | 21.85 | 6.18 | 0.60 | 100 |

NOVEMBER
(1974-1983)

| DIRECTION / MAG | SPEED INTERVALS (kn) CALM 2.65 | 1-5 | 6-10 | 11-15 | 16-20 | 21+ | ROW TOTAL |
|---|---|---|---|---|---|---|---|
| N | | 5.80 | 9.50 | 7.52 | 3.19 | 0.35 | 26.37 |
| NE | | 3.68 | 5.51 | 3.91 | 0.73 | 0.08 | 13.91 |
| E | | 5.25 | 7.54 | 3.75 | 0.36 | 0.04 | 16.97 |
| SE | | 5.98 | 4.57 | 1.53 | 0.14 | 0.01 | 12.23 |
| S | | 3.91 | 2.63 | 0.95 | 0.04 | 0.00 | 7.54 |
| SW | | 2.30 | 1.13 | 0.11 | 0.01 | 0.00 | 3.56 |
| W | | 4.30 | 2.10 | 0.36 | 0.01 | 0.00 | 6.78 |
| NW | | 3.04 | 3.18 | 2.59 | 1.09 | 0.11 | 10.02 |
| COLUMN TOTAL | | 34.27 | 36.16 | 20.73 | 5.59 | 0.60 | 100 |

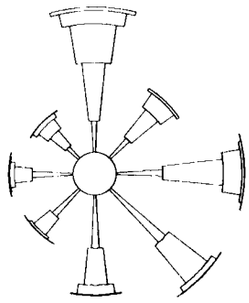
DECEMBER
(1974-1983)

| DIRECTION / MAG | SPEED INTERVALS (kn) CALM 1.70 | 1-5 | 6-10 | 11-15 | 16-20 | 21+ | ROW TOTAL |
|---|---|---|---|---|---|---|---|
| N | | 5.22 | 10.74 | 8.78 | 4.35 | 1.01 | 30.09 |
| NE | | 3.05 | 4.76 | 3.68 | 0.49 | 0.00 | 11.99 |
| E | | 4.46 | 6.62 | 2.03 | 0.37 | 0.03 | 13.51 |
| SE | | 5.25 | 4.16 | 1.70 | 0.46 | 0.03 | 13.51 |
| S | | 4.27 | 3.02 | 0.95 | 0.12 | 0.01 | 8.38 |
| SW | | 3.60 | 1.53 | 0.30 | 0.03 | 0.00 | 5.45 |
| W | | 3.37 | 2.14 | 0.46 | 0.01 | 0.00 | 5.99 |
| NW | | 3.57 | 3.01 | 2.86 | 1.51 | 0.36 | 11.28 |
| COLUMN TOTAL | | 32.80 | 35.98 | 20.74 | 7.34 | 1.44 | 100 |

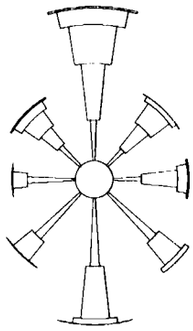
**Plate 49. Annual wind roses (a) and matrices (b).**

**(a)**

1975



1976



1977

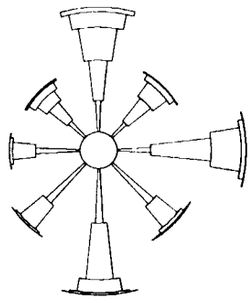


PLATE 49b.
ANNUAL WIND SPEED AND DIRECTION MATRICES
(VALUES REPRESENT THE PERCENT OCCURRENCE)

1975

| DIRECTION / MAG INTERVALS | SPEED INTERVALS (kn) | | | | | |
|---|---|---|---|---|---|---|
| | CALM 2.78 | 1-5 | 6-10 | 11-15 | 16-20 | 21+ | ROW TOTAL |
| N | | 4.04 | 7.45 | 4.99 | 1.70 | 0.47 | 18.65 |
| NE | | 3.31 | 4.44 | 2.11 | 0.35 | 0.00 | 10.20 |
| E | | 5.94 | 7.74 | 2.35 | 0.32 | 0.02 | 16.37 |
| SE | | 9.35 | 6.24 | 0.72 | 0.04 | 0.00 | 16.35 |
| S | | 6.90 | 4.75 | 1.25 | 0.11 | 0.00 | 13.01 |
| SW | | 4.60 | 2.73 | 0.31 | 0.04 | 0.01 | 7.69 |
| W | | 5.23 | 2.25 | 0.60 | 0.12 | 0.05 | 8.25 |
| NW | | 2.00 | 2.49 | 1.52 | 0.63 | 0.06 | 6.71 |
| COLUMN TOTAL | | 41.37 | 38.10 | 13.84 | 3.31 | 0.61 | 100 |

1976

| DIRECTION / MAG INTERVALS | SPEED INTERVALS (kn) | | | | | |
|---|---|---|---|---|---|---|
| | CALM 2.42 | 1-5 | 6-10 | 11-15 | 16-20 | 21+ | ROW TOTAL |
| N | | 5.23 | 7.27 | 4.99 | 2.11 | 0.23 | 19.83 |
| NE | | 2.81 | 3.81 | 2.97 | 0.65 | 0.01 | 10.25 |
| E | | 3.65 | 4.61 | 1.31 | 0.16 | 0.00 | 9.73 |
| SE | | 8.20 | 3.65 | 0.64 | 0.00 | 0.00 | 12.48 |
| S | | 8.78 | 6.72 | 0.71 | 0.02 | 0.01 | 16.25 |
| SW | | 7.86 | 3.10 | 0.07 | 0.02 | 0.00 | 11.06 |
| W | | 6.15 | 1.84 | 0.13 | 0.01 | 0.00 | 8.14 |
| NW | | 3.56 | 2.69 | 2.32 | 1.11 | 0.18 | 9.85 |
| COLUMN TOTAL | | 46.24 | 33.69 | 13.13 | 4.09 | 0.43 | 100 |

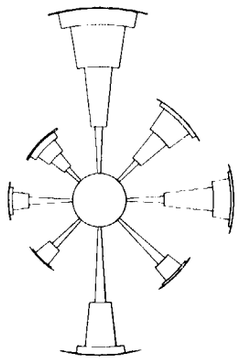
1977

| DIRECTION / MAG INTERVALS | SPEED INTERVALS (kn) | | | | | |
|---|---|---|---|---|---|---|
| | CALM 2.39 | 1-5 | 6-10 | 11-15 | 16-20 | 21+ | ROW TOTAL |
| N | | 4.05 | 5.20 | 4.24 | 1.99 | 0.59 | 16.07 |
| NE | | 2.51 | 3.72 | 2.23 | 0.77 | 0.08 | 9.31 |
| E | | 4.27 | 7.72 | 3.82 | 0.59 | 0.05 | 16.45 |
| SE | | 7.04 | 3.46 | 0.48 | 0.09 | 0.06 | 11.14 |
| S | | 7.07 | 7.27 | 1.67 | 0.26 | 0.03 | 16.30 |
| SW | | 6.79 | 3.84 | 0.27 | 0.01 | 0.00 | 10.90 |
| W | | 5.67 | 2.93 | 0.38 | 0.06 | 0.00 | 9.04 |
| NW | | 2.77 | 2.93 | 1.52 | 0.95 | 0.22 | 8.39 |
| COLUMN TOTAL | | 40.17 | 37.06 | 14.62 | 4.72 | 1.03 | 100 |

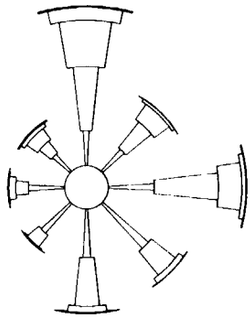
**Plate 50. Annual wind roses (a) and matrices (b).**

**(a)**

1978



1979



1980

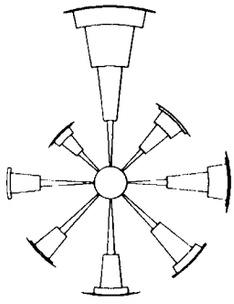


PLATE 50b.
ANNUAL WIND SPEED AND DIRECTION MATRICES
(VALUES REPRESENT THE PERCENT OCCURRENCE)

1978

| DIRECTION / MAG | SPEED INTERVALS (kn) CALM 3.46 | 1-5 | 6-10 | 11-15 | 16-20 | 21+ | ROW TOTAL |
|---|---|---|---|---|---|---|---|
| N | | 5.98 | 7.68 | 5.45 | 2.04 | 0.13 | 21.27 |
| NE | | 3.49 | 4.26 | 3.18 | 0.56 | 0.03 | 11.52 |
| E | | 4.88 | 6.33 | 2.23 | 0.35 | 0.01 | 13.80 |
| SE | | 7.81 | 2.24 | 0.30 | 0.02 | 0.00 | 10.38 |
| S | | 9.79 | 5.77 | 0.97 | 0.07 | 0.02 | 16.62 |
| SW | | 4.81 | 2.38 | 0.14 | 0.01 | 0.00 | 7.35 |
| W | | 5.63 | 2.12 | 0.46 | 0.08 | 0.00 | 8.29 |
| NW | | 2.31 | 2.13 | 1.79 | 0.89 | 0.19 | 7.31 |
| COLUMN TOTAL | | 44.71 | 32.91 | 14.53 | 4.01 | 0.38 | 100 |

1979

| DIRECTION / MAG | SPEED INTERVALS (kn) CALM 2.82 | 1-5 | 6-10 | 11-15 | 16-20 | 21+ | ROW TOTAL |
|---|---|---|---|---|---|---|---|
| N | | 4.52 | 8.28 | 6.00 | 1.68 | 0.20 | 20.66 |
| NE | | 3.77 | 4.24 | 2.37 | 0.38 | 0.04 | 10.80 |
| E | | 5.88 | 8.24 | 3.02 | 0.56 | 0.07 | 17.77 |
| SE | | 7.86 | 3.97 | 0.73 | 0.04 | 0.00 | 12.60 |
| S | | 6.30 | 6.23 | 0.80 | 0.13 | 0.03 | 13.49 |
| SW | | 5.08 | 1.94 | 0.18 | 0.01 | 0.00 | 7.21 |
| W | | 4.64 | 1.64 | 0.88 | 0.14 | 0.01 | 7.31 |
| NW | | 3.02 | 1.90 | 1.72 | 0.52 | 0.18 | 7.34 |
| COLUMN TOTAL | | 41.06 | 36.43 | 15.70 | 3.47 | 0.52 | 100 |

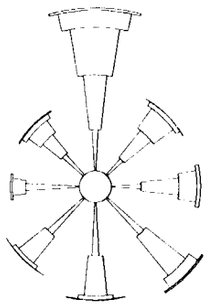
1980

| DIRECTION / MAG | SPEED INTERVALS (kn) CALM 2.11 | 1-5 | 6-10 | 11-15 | 16-20 | 21+ | ROW TOTAL |
|---|---|---|---|---|---|---|---|
| N | | 5.93 | 7.05 | 5.37 | 2.24 | 0.15 | 20.73 |
| NE | | 3.77 | 3.77 | 1.83 | 0.34 | 0.01 | 9.72 |
| E | | 5.17 | 5.31 | 2.51 | 0.21 | 0.05 | 13.24 |
| SE | | 6.05 | 5.34 | 1.00 | 0.15 | 0.00 | 12.54 |
| S | | 7.22 | 4.30 | 0.87 | 0.11 | 0.01 | 12.52 |
| SW | | 6.84 | 3.74 | 0.26 | 0.01 | 0.00 | 10.85 |
| W | | 6.96 | 3.83 | 0.43 | 0.00 | 0.00 | 11.22 |
| NW | | 3.45 | 2.48 | 0.94 | 0.18 | 0.01 | 7.07 |
| COLUMN TOTAL | | 45.39 | 35.81 | 13.21 | 3.25 | 0.23 | 100 |

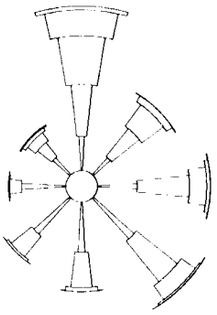
**Plate 51. Annual wind roses (a) and matrices (b).**

**(a)**

1981



1982



1983

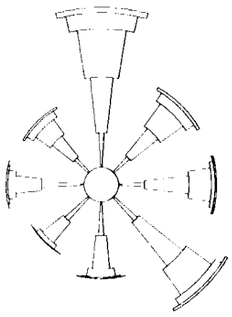


PLATE 51b.
ANNUAL WIND SPEED AND DIRECTION MATRICES
(VALUES REPRESENT THE PERCENT OCCURRENCE)

1981

| DIRECTION / MAG | SPEED INTERVALS (kn) CALM 2.04 | 1-5 | 6-10 | 11-15 | 16-20 | 21+ | ROW TOTAL |
|---|---|---|---|---|---|---|---|
| N | | 5.16 | 6.93 | 6.00 | 2.21 | 0.29 | 20.58 |
| NE | | 2.71 | 4.36 | 3.07 | 0.59 | 0.02 | 10.76 |
| E | | 3.74 | 4.78 | 2.27 | 0.45 | 0.00 | 11.24 |
| SE | | 6.20 | 6.37 | 1.36 | 0.22 | 0.00 | 14.15 |
| S | | 6.82 | 5.06 | 0.51 | 0.05 | 0.05 | 12.48 |
| SW | | 6.12 | 4.29 | 0.50 | 0.03 | 0.01 | 10.96 |
| W | | 6.75 | 1.71 | 0.24 | 0.00 | 0.00 | 8.70 |
| NW | | 3.52 | 2.96 | 1.85 | 0.63 | 0.12 | 9.07 |
| COLUMN TOTAL | | 41.03 | 36.46 | 15.80 | 4.18 | 0.48 | 100 |

1982

| DIRECTION / MAG | SPEED INTERVALS (kn) CALM 2.02 | 1-5 | 6-10 | 11-15 | 16-20 | 21+ | ROW TOTAL |
|---|---|---|---|---|---|---|---|
| N | | 4.35 | 6.51 | 6.15 | 3.27 | 0.50 | 20.78 |
| NE | | 2.88 | 4.48 | 3.38 | 0.87 | 0.03 | 11.64 |
| E | | 4.98 | 6.60 | 2.18 | 0.46 | 0.02 | 14.24 |
| SE | | 6.93 | 6.62 | 2.14 | 0.25 | 0.03 | 15.98 |
| S | | 6.34 | 4.47 | 0.54 | 0.02 | 0.00 | 11.38 |
| SW | | 6.08 | 3.34 | 0.30 | 0.01 | 0.00 | 9.73 |
| W | | 5.59 | 1.51 | 0.12 | 0.02 | 0.00 | 7.24 |
| NW | | 2.90 | 2.25 | 1.25 | 0.43 | 0.16 | 6.99 |
| COLUMN TOTAL | | 39.82 | 35.79 | 16.06 | 5.34 | 0.75 | 100 |

1983

| DIRECTION / MAG | SPEED INTERVALS (kn) CALM 2.21 | 1-5 | 6-10 | 11-15 | 16-20 | 21+ | ROW TOTAL |
|---|---|---|---|---|---|---|---|
| N | | 4.40 | 7.08 | 6.14 | 2.05 | 0.67 | 20.34 |
| NE | | 2.61 | 4.40 | 3.49 | 1.21 | 0.37 | 12.08 |
| E | | 3.25 | 5.62 | 2.81 | 0.46 | 0.21 | 12.35 |
| SE | | 3.98 | 7.09 | 3.94 | 0.93 | 0.31 | 16.25 |
| S | | 4.30 | 4.16 | 1.05 | 0.16 | 0.07 | 9.74 |
| SW | | 3.96 | 3.37 | 0.58 | 0.06 | 0.02 | 7.98 |
| W | | 5.36 | 3.30 | 0.93 | 0.21 | 0.02 | 9.82 |
| NW | | 2.39 | 3.37 | 2.30 | 0.92 | 0.25 | 9.22 |
| COLUMN TOTAL | | 30.25 | 38.38 | 21.23 | 6.01 | 1.92 | 100 |

**Plate 52 . All-data wind rose (a) and matrix (b) .**

**(a)**

ALL YEAR

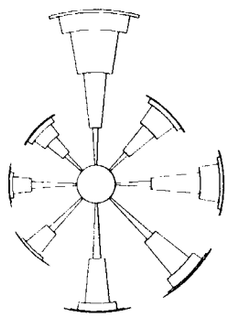


PLATE 52b.
ALL DATA WIND SPEED AND DIRECTION MATRIX
(VALUES REPRESENT THE PERCENT OCCURRENCE)

ALL DATA
(1974-1984)

| DIRECTION OF INTERVALS MAG | SPEED INTERVALS (kn) | | | | | | |
|---|---|---|---|---|---|---|---|
| | CALM 2.43 | 1-5 | 6-10 | 11-15 | 16-20 | 21+ | ROW TOTAL |
| N | | 4.72 | 6.96 | 5.39 | 2.21 | 0.35 | 19.63 |
| NE | | 3.03 | 4.12 | 2.66 | 0.64 | 0.07 | 10.52 |
| E | | 4.53 | 6.14 | 2.47 | 0.43 | 0.05 | 13.62 |
| SE | | 7.12 | 5.39 | 1.38 | 0.24 | 0.04 | 14.17 |
| S | | 7.00 | 5.63 | 1.00 | 0.11 | 0.03 | 13.77 |
| SW | | 5.66 | 3.35 | 0.35 | 0.03 | 0.01 | 9.40 |
| W | | 5.72 | 2.32 | 0.45 | 0.09 | 0.01 | 8.59 |
| NW | | 2.84 | 2.56 | 1.67 | 0.69 | 0.15 | 7.91 |
| COLUMN TOTAL | | 40.62 | 36.47 | 15.37 | 4.41 | 0.71 | 100 |

PLATE 53

MONTHLY COMPOSITE: FREQUENCY OF OBSERVED OCCURRENCES OF WIND SPEED BY DIRECTION INTERVAL (VALUES REPRESENT THE PERCENT OCCURRENCE)

JANUARY

1975-1984

DIRECTION INTERVALS (°MAG)

| SPEED IN KNOTS | CALM 1.92 | N | NE | E | SE | S | SW | W | NW |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | 0.84 | 0.72 | 0.57 | 0.92 | 0.88 | 0.50 | 0.65 | 0.46 |
| 2 | | 1.30 | 0.92 | 1.06 | 1.28 | 1.57 | 0.75 | 0.98 | 0.96 |
| 3 | | 0.79 | 0.36 | 0.75 | 0.79 | 0.64 | 0.65 | 0.71 | 0.63 |
| 4 | | 1.37 | 0.53 | 0.98 | 1.41 | 1.09 | 0.77 | 1.45 | 1.00 |
| 5 | | 1.42 | 0.63 | 1.28 | 1.00 | 0.74 | 0.85 | 1.03 | 0.60 |
| 6 | | 1.84 | 0.67 | 1.34 | 1.02 | 0.60 | 0.52 | 0.70 | 0.70 |
| 7 | | 2.17 | 0.72 | 1.25 | 0.78 | 0.42 | 0.52 | 0.81 | 0.60 |
| 8 | | 1.84 | 1.06 | 0.98 | 0.60 | 0.35 | 0.29 | 0.53 | 0.61 |
| 9 | | 1.37 | 0.60 | 0.95 | 0.25 | 0.15 | 0.14 | 0.42 | 0.42 |
| 10 | | 2.12 | 0.85 | 0.91 | 0.33 | 0.14 | 0.21 | 0.45 | 0.75 |
| 11 | | 1.89 | 0.92 | 0.47 | 0.33 | 0.14 | 0.04 | 0.13 | 0.54 |
| 12 | | 2.45 | 1.03 | 0.49 | 0.14 | 0.11 | 0.06 | 0.25 | 0.67 |
| 13 | | 2.24 | 0.86 | 0.28 | 0.15 | 0.08 | 0.04 | 0.14 | 0.68 |
| 14 | | 2.20 | 0.57 | 0.24 | 0.06 | 0.11 | 0.03 | 0.18 | 0.88 |
| 15 | | 1.43 | 0.32 | 0.13 | 0.06 | 0.03 | 0.03 | 0.11 | 0.18 |
| 16 | | 2.02 | 0.36 | 0.15 | 0.03 | 0.01 | 0.01 | 0.04 | 0.52 |
| 17 | | 1.25 | 0.25 | 0.17 | 0.03 | 0.06 | 0.01 | 0.07 | 0.40 |
| 18 | | 1.07 | 0.04 | 0.17 | 0.01 | 0.00 | 0.01 | 0.10 | 0.32 |
| 19 | | 0.47 | 0.07 | 0.03 | 0.00 | 0.01 | 0.00 | 0.00 | 0.21 |
| 20 | | 0.56 | 0.06 | 0.07 | 0.00 | 0.03 | 0.00 | 0.01 | 0.25 |
| 21 | | 0.18 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.18 |
| 22 | | 0.25 | 0.01 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.18 |
| 23 | | 0.14 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.18 |
| 24 | | 0.04 | 0.03 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.07 |
| 25 | | 0.06 | 0.03 | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 | 0.06 |
| 26 | | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 | 0.01 |
| 27 | | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 28 | | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 |
| 29 | | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 30 | | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 31 | | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 33 | | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| n | | 2248 | 838 | 893 | 660 | 516 | 391 | 628 | 867 |
| MEAN SPEED | | 10.62 | 8.85 | 7.48 | 5.28 | 4.82 | 5.00 | 5.97 | 9.88 |

PLATE 54

MONTHLY COMPOSITE: FREQUENCY OF OBSERVED OCCURRENCES OF WIND SPEED BY DIRECTION INTERVAL (VALUES REPRESENT THE PERCENT OCCURRENCE)

FEBRUARY

1974-1984

DIRECTION INTERVALS (°MAG)

| | CALM | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2.17 | N | NE | E | SE | S | SW | W | NW |
| | 1 | 0.53 | 0.46 | 0.47 | 0.72 | 0.80 | 0.68 | 0.65 | 0.35 |
| | 2 | 0.94 | 0.68 | 0.88 | 1.40 | 1.78 | 1.31 | 1.09 | 0.91 |
| | 3 | 0.74 | 0.46 | 0.55 | 1.43 | 1.08 | 1.14 | 0.65 | 0.52 |
| | 4 | 1.36 | 1.16 | 0.69 | 1.43 | 1.87 | 1.44 | 1.16 | 0.81 |
| | 5 | 1.39 | 0.83 | 0.90 | 1.18 | 1.36 | 1.31 | 0.86 | 0.60 |
| | 6 | 1.40 | 0.97 | 1.00 | 1.53 | 1.21 | 1.44 | 1.14 | 0.65 |
| | 7 | 1.72 | 0.63 | 1.25 | 0.90 | 0.60 | 1.12 | 0.74 | 0.52 |
| | 8 | 1.44 | 1.00 | 1.05 | 0.62 | 0.25 | 0.55 | 0.71 | 0.72 |
| | 9 | 1.36 | 0.35 | 0.83 | 0.28 | 0.31 | 0.35 | 0.31 | 0.46 |
| | 10 | 2.48 | 0.68 | 0.88 | 0.29 | 0.27 | 0.18 | 0.65 | 0.65 |
| S | 11 | 1.53 | 0.49 | 0.53 | 0.18 | 0.19 | 0.16 | 0.32 | 0.38 |
| P | 12 | 2.33 | 0.71 | 0.44 | 0.24 | 0.15 | 0.03 | 0.18 | 0.50 |
| E | 13 | 1.68 | 0.60 | 0.37 | 0.13 | 0.04 | 0.07 | 0.15 | 0.28 |
| E | 14 | 1.65 | 0.69 | 0.34 | 0.06 | 0.03 | 0.06 | 0.29 | 0.50 |
| D | 15 | 1.15 | 0.32 | 0.35 | 0.07 | 0.01 | 0.00 | 0.12 | 0.41 |
| | 16 | 1.46 | 0.29 | 0.34 | 0.09 | 0.01 | 0.01 | 0.18 | 0.43 |
| I | 17 | 0.91 | 0.24 | 0.21 | 0.03 | 0.01 | 0.01 | 0.10 | 0.25 |
| N | 18 | 0.47 | 0.25 | 0.06 | 0.06 | 0.00 | 0.00 | 0.07 | 0.28 |
| | 19 | 0.16 | 0.10 | 0.09 | 0.03 | 0.01 | 0.00 | 0.00 | 0.10 |
| K | 20 | 0.22 | 0.19 | 0.15 | 0.09 | 0.00 | 0.00 | 0.01 | 0.16 |
| N | 21 | 0.03 | 0.07 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.07 |
| O | 22 | 0.07 | 0.09 | 0.00 | 0.03 | 0.01 | 0.01 | 0.01 | 0.06 |
| T | 23 | 0.09 | 0.03 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.04 |
| S | 24 | 0.03 | 0.03 | 0.01 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 |
| | 25 | 0.03 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 |
| | 26 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 |
| | 27 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 28 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | n | 1711 | 770 | 776 | 732 | 680 | 671 | 638 | 658 |
| | MEAN SPEED | 10.10 | 8.88 | 8.09 | 5.54 | 4.72 | 5.01 | 6.49 | 8.96 |

PLATE 55

MONTHLY COMPOSITE: FREQUENCY OF OBSERVED OCCURRENCES OF WIND SPEED BY DIRECTION INTERVAL (VALUES REPRESENT THE PERCENT OCCURRENCE)

MARCH

1974-1984

DIRECTION INTERVALS (°MAG)

| SPEED IN KNOTS | CALM 2.05 | N | NE | E | SE | S | SW | W | NW |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | 0.33 | 0.25 | 0.51 | 0.88 | 0.68 | 0.64 | 0.40 | 0.08 |
| 2 | | 0.47 | 0.51 | 0.86 | 1.63 | 1.30 | 1.06 | 0.75 | 0.43 |
| 3 | | 0.37 | 0.43 | 0.68 | 1.25 | 0.85 | 0.91 | 0.66 | 0.27 |
| 4 | | 0.75 | 0.67 | 1.31 | 2.20 | 2.30 | 1.43 | 1.06 | 0.47 |
| 5 | | 0.87 | 0.58 | 1.19 | 2.32 | 2.25 | 1.02 | 1.10 | 0.39 |
| 6 | | 0.87 | 0.52 | 1.47 | 2.13 | 1.77 | 1.09 | 0.63 | 0.44 |
| 7 | | 0.93 | 0.64 | 1.26 | 1.67 | 1.31 | 0.78 | 0.58 | 0.44 |
| 8 | | 1.01 | 0.82 | 1.52 | 1.67 | 1.06 | 0.77 | 0.57 | 0.49 |
| 9 | | 0.77 | 0.45 | 0.67 | 0.75 | 0.90 | 0.44 | 0.27 | 0.34 |
| 10 | | 1.24 | 0.77 | 1.30 | 1.14 | 0.58 | 0.38 | 0.30 | 0.63 |
| 11 | | 1.24 | 0.57 | 0.99 | 0.66 | 0.48 | 0.11 | 0.34 | 0.48 |
| 12 | | 1.34 | 0.56 | 1.21 | 0.47 | 0.47 | 0.14 | 0.28 | 0.69 |
| 13 | | 1.39 | 0.27 | 0.77 | 0.42 | 0.27 | 0.09 | 0.20 | 0.66 |
| 14 | | 1.36 | 0.47 | 0.48 | 0.27 | 0.28 | 0.06 | 0.15 | 0.66 |
| 15 | | 0.72 | 0.25 | 0.09 | 0.19 | 0.09 | 0.06 | 0.09 | 0.35 |
| 16 | | 1.16 | 0.20 | 0.23 | 0.20 | 0.10 | 0.03 | 0.06 | 0.38 |
| 17 | | 0.64 | 0.10 | 0.11 | 0.14 | 0.06 | 0.00 | 0.03 | 0.32 |
| 18 | | 0.52 | 0.08 | 0.03 | 0.03 | 0.05 | 0.01 | 0.05 | 0.25 |
| 19 | | 0.25 | 0.08 | 0.00 | 0.09 | 0.05 | 0.01 | 0.01 | 0.04 |
| 20 | | 0.32 | 0.03 | 0.00 | 0.00 | 0.01 | 0.00 | 0.03 | 0.24 |
| 21 | | 0.09 | 0.01 | 0.00 | 0.04 | 0.01 | 0.00 | 0.03 | 0.05 |
| 22 | | 0.13 | 0.00 | 0.01 | 0.05 | 0.03 | 0.01 | 0.01 | 0.06 |
| 23 | | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 |
| 24 | | 0.09 | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 | 0.00 | 0.05 |
| 25 | | 0.03 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 26 | | 0.04 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 |
| 27 | | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 28 | | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| n | | 1346 | 654 | 1162 | 1442 | 1179 | 717 | 601 | 653 |
| MEAN SPEED | | 11.01 | 8.43 | 7.77 | 6.57 | 6.29 | 5.44 | 6.39 | 10.59 |

PLATE 56

MONTHLY COMPOSITE: FREQUENCY OF OBSERVED OCCURRENCES OF WIND SPEED BY DIRECTION INTERVAL (VALUES REPRESENT THE PERCENT OCCURRENCE)

APRIL

1974-1984

DIRECTION INTERVALS (°MAG)

| | CALM 1.83 | N | NE | E | SE | S | SW | W | NW |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 0.31 | 0.22 | 0.34 | 0.66 | 0.65 | 0.63 | 0.49 | 0.28 |
| | 2 | 0.56 | 0.40 | 0.68 | 1.42 | 1.12 | 1.03 | 1.14 | 0.37 |
| | 3 | 0.68 | 0.52 | 0.68 | 1.72 | 1.24 | 0.93 | 0.89 | 0.39 |
| | 4 | 1.02 | 0.72 | 0.92 | 2.54 | 1.96 | 1.20 | 0.79 | 0.59 |
| | 5 | 0.70 | 0.79 | 0.80 | 2.52 | 2.16 | 1.06 | 0.90 | 0.31 |
| | 6 | 1.15 | 0.77 | 1.10 | 2.51 | 1.90 | 0.89 | 0.85 | 0.50 |
| | 7 | 1.02 | 0.56 | 1.14 | 1.87 | 1.49 | 1.10 | 0.74 | 0.54 |
| | 8 | 1.12 | 0.54 | 1.30 | 2.56 | 1.50 | 0.71 | 0.63 | 0.65 |
| | 9 | 0.85 | 0.35 | 0.97 | 1.64 | 0.71 | 0.40 | 0.41 | 0.41 |
| | 10 | 1.18 | 0.50 | 1.41 | 1.63 | 0.75 | 0.40 | 0.31 | 0.46 |
| S | 11 | 0.93 | 0.36 | 0.70 | 1.28 | 0.32 | 0.31 | 0.26 | 0.67 |
| P | 12 | 0.96 | 0.26 | 0.97 | 1.20 | 0.45 | 0.15 | 0.26 | 0.57 |
| E | 13 | 0.93 | 0.31 | 0.63 | 0.79 | 0.34 | 0.13 | 0.12 | 0.36 |
| E | 14 | 0.83 | 0.23 | 0.54 | 0.46 | 0.23 | 0.03 | 0.13 | 0.41 |
| D | 15 | 0.59 | 0.18 | 0.25 | 0.28 | 0.09 | 0.03 | 0.04 | 0.18 |
| | 16 | 0.43 | 0.05 | 0.32 | 0.17 | 0.04 | 0.01 | 0.06 | 0.35 |
| I | 17 | 0.37 | 0.15 | 0.17 | 0.14 | 0.03 | 0.01 | 0.05 | 0.14 |
| N | 18 | 0.27 | 0.12 | 0.05 | 0.05 | 0.00 | 0.01 | 0.05 | 0.15 |
| | 19 | 0.04 | 0.06 | 0.05 | 0.01 | 0.04 | 0.00 | 0.01 | 0.04 |
| K | 20 | 0.18 | 0.03 | 0.03 | 0.03 | 0.01 | 0.00 | 0.04 | 0.04 |
| N | 21 | 0.10 | 0.00 | 0.01 | 0.03 | 0.00 | 0.00 | 0.04 | 0.03 |
| O | 22 | 0.04 | 0.05 | 0.01 | 0.04 | 0.03 | 0.00 | 0.03 | 0.00 |
| T | 23 | 0.01 | 0.00 | 0.00 | 0.04 | 0.01 | 0.00 | 0.00 | 0.01 |
| S | 24 | 0.04 | 0.00 | 0.01 | 0.05 | 0.01 | 0.00 | 0.00 | 0.01 |
| | 25 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 26 | 0.01 | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 28 | 0.01 | 0.01 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 |
| | n | 1112 | 557 | 1013 | 1833 | 1168 | 700 | 638 | 580 |
| | MEAN: SPEED: | 9.46 | 7.83 | 8.36 | 7.26 | 6.26 | 5.56 | 6.11 | 8.99 |

PLATE 57

MONTHLY COMPOSITE: FREQUENCY OF OBSERVED OCCURRENCES OF WIND SPEED BY DIRECTION INTERVAL (VALUES REPRESENT THE PERCENT OCCURRENCE)

MAY

1974-1984

DIRECTION INTERVALS (°MAG)

| SPEED IN KNOTS | CALM 2.27 | N | NE | E | SE | S | SW | W | NW |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | 0.28 | 0.05 | 0.29 | 0.61 | 0.42 | 0.61 | 0.58 | 0.15 |
| 2 | | 0.50 | 0.43 | 0.88 | 1.40 | 0.90 | 0.97 | 1.28 | 0.36 |
| 3 | | 0.61 | 0.28 | 0.70 | 2.07 | 1.27 | 0.77 | 0.95 | 0.28 |
| 4 | | 0.94 | 0.51 | 1.30 | 2.67 | 2.67 | 1.44 | 1.52 | 0.38 |
| 5 | | 1.12 | 0.67 | 1.55 | 2.72 | 2.96 | 1.30 | 0.90 | 0.66 |
| 6 | | 0.88 | 0.58 | 1.50 | 2.62 | 3.23 | 1.13 | 0.70 | 0.44 |
| 7 | | 1.02 | 0.58 | 1.22 | 2.15 | 2.97 | 1.27 | 0.41 | 0.46 |
| 8 | | 1.14 | 0.58 | 1.49 | 2.11 | 1.93 | 1.00 | 0.46 | 0.44 |
| 9 | | 0.93 | 0.44 | 0.86 | 1.41 | 1.24 | 0.44 | 0.09 | 0.50 |
| 10 | | 1.08 | 0.44 | 0.93 | 1.33 | 1.13 | 0.43 | 0.17 | 0.39 |
| 11 | | 0.65 | 0.23 | 0.58 | 0.70 | 0.62 | 0.19 | 0.05 | 0.25 |
| 12 | | 0.89 | 0.23 | 0.80 | 0.80 | 0.71 | 0.22 | 0.04 | 0.36 |
| 13 | | 0.76 | 0.23 | 0.39 | 0.66 | 0.30 | 0.18 | 0.04 | 0.25 |
| 14 | | 0.66 | 0.24 | 0.22 | 0.25 | 0.15 | 0.08 | 0.04 | 0.23 |
| 15 | | 0.37 | 0.10 | 0.22 | 0.17 | 0.09 | 0.08 | 0.00 | 0.11 |
| 16 | | 0.33 | 0.17 | 0.15 | 0.14 | 0.03 | 0.05 | 0.00 | 0.10 |
| 17 | | 0.18 | 0.14 | 0.05 | 0.14 | 0.04 | 0.04 | 0.00 | 0.04 |
| 18 | | 0.10 | 0.03 | 0.03 | 0.04 | 0.04 | 0.03 | 0.00 | 0.03 |
| 19 | | 0.08 | 0.03 | 0.00 | 0.03 | 0.01 | 0.00 | 0.00 | 0.03 |
| 20 | | 0.10 | 0.04 | 0.01 | 0.01 | 0.04 | 0.01 | 0.00 | 0.01 |
| 21 | | 0.08 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 22 | | 0.04 | 0.00 | 0.00 | 0.00 | 0.03 | 0.01 | 0.01 | 0.00 |
| 23 | | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 24 | | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| 25 | | 0.04 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 26 | | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 |
| n | | 1005 | 474 | 1037 | 1733 | 1637 | 806 | 570 | 432 |
| MEAN SPEED | | 8.84 | 7.98 | 7.23 | 6.61 | 6.54 | 5.94 | 4.43 | 7.91 |

PLATE 58

MONTHLY COMPOSITE: FREQUENCY OF OBSERVED OCCURRENCES OF WIND SPEED BY DIRECTION INTERVAL (VALUES REPRESENT THE PERCENT OCCURRENCE)

JUNE

1974-1984

DIRECTION INTERVALS (°MAG)

| SPEED IN KNOTS | CALM 2.23 | N | NE | E | SE | S | SW | W | NW |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 0.27 | 0.17 | 0.22 | 0.47 | 0.43 | 0.72 | 0.95 | 0.21 |
| | 2 | 0.55 | 0.54 | 0.70 | 1.06 | 1.04 | 2.14 | 2.21 | 0.46 |
| | 3 | 0.77 | 0.54 | 0.56 | 1.45 | 1.20 | 2.04 | 1.71 | 0.23 |
| | 4 | 1.11 | 0.72 | 1.04 | 1.72 | 2.74 | 2.66 | 2.30 | 0.56 |
| | 5 | 1.24 | 0.64 | 1.04 | 1.51 | 3.22 | 3.02 | 1.29 | 0.60 |
| | 6 | 1.23 | 0.73 | 1.10 | 1.63 | 3.98 | 2.68 | 1.04 | 0.67 |
| | 7 | 0.91 | 0.44 | 0.76 | 1.66 | 2.91 | 2.32 | 0.87 | 0.65 |
| | 8 | 1.03 | 0.59 | 0.90 | 1.51 | 2.81 | 1.66 | 0.40 | 0.35 |
| | 9 | 0.77 | 0.29 | 0.61 | 0.76 | 1.36 | 0.76 | 0.26 | 0.14 |
| | 10 | 0.85 | 0.43 | 0.48 | 0.50 | 1.11 | 0.57 | 0.13 | 0.16 |
| | 11 | 0.52 | 0.37 | 0.37 | 0.27 | 0.64 | 0.33 | 0.09 | 0.10 |
| | 12 | 0.74 | 0.31 | 0.46 | 0.25 | 0.35 | 0.18 | 0.07 | 0.07 |
| | 13 | 0.38 | 0.26 | 0.42 | 0.07 | 0.27 | 0.05 | 0.03 | 0.09 |
| | 14 | 0.38 | 0.22 | 0.25 | 0.05 | 0.08 | 0.03 | 0.01 | 0.00 |
| | 15 | 0.27 | 0.08 | 0.09 | 0.04 | 0.08 | 0.03 | 0.04 | 0.01 |
| | 16 | 0.30 | 0.10 | 0.08 | 0.01 | 0.04 | 0.01 | 0.00 | 0.00 |
| | 17 | 0.16 | 0.01 | 0.03 | 0.00 | 0.03 | 0.00 | 0.00 | 0.01 |
| | 18 | 0.16 | 0.03 | 0.01 | 0.01 | 0.04 | 0.00 | 0.03 | 0.00 |
| | 19 | 0.04 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 20 | 0.04 | 0.01 | 0.01 | 0.00 | 0.03 | 0.00 | 0.00 | 0.00 |
| | 21 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 22 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 23 | 0.04 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 24 | 0.05 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| | 25 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | n | 906 | 498 | 700 | 994 | 1714 | 1470 | 876 | 331 |
| | MEAN SPEED | 8.03 | 7.17 | 7.02 | 5.80 | 6.39 | 5.34 | 4.27 | 5.75 |

PLATE 59

MONTHLY COMPOSITE: FREQUENCY OF OBSERVED OCCURRENCES OF WIND SPEED BY DIRECTION INTERVAL (VALUES REPRESENT THE PERCENT OCCURRENCE)

JULY

1974-1984

DIRECTION INTERVALS (°MAG)

| | CALM 3.25 | N | NE | E | SE | S | SW | W | NW |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 0.53 | 0.45 | 0.50 | 0.91 | 0.37 | 1.45 | 1.39 | 0.54 |
| | 2 | 0.86 | 0.78 | 1.23 | 1.47 | 1.49 | 1.81 | 3.00 | 0.79 |
| | 3 | 0.81 | 0.55 | 0.81 | 1.23 | 1.36 | 2.19 | 2.34 | 0.74 |
| | 4 | 1.31 | 0.74 | 1.15 | 1.94 | 3.00 | 2.99 | 2.43 | 1.00 |
| | 5 | 1.02 | 0.70 | 0.94 | 1.41 | 3.49 | 2.85 | 2.01 | 1.10 |
| | 6 | 1.10 | 0.81 | 1.18 | 1.25 | 3.10 | 2.85 | 1.43 | 1.10 |
| | 7 | 0.86 | 0.41 | 0.73 | 0.57 | 2.52 | 1.62 | 1.15 | 0.77 |
| | 8 | 0.90 | 0.61 | 0.92 | 0.78 | 2.30 | 0.89 | 0.49 | 0.63 |
| | 9 | 0.49 | 0.38 | 0.54 | 0.44 | 0.79 | 0.38 | 0.28 | 0.41 |
| | 10 | 0.29 | 0.41 | 0.58 | 0.36 | 0.57 | 0.22 | 0.28 | 0.24 |
| S | 11 | 0.22 | 0.24 | 0.32 | 0.22 | 0.38 | 0.11 | 0.09 | 0.12 |
| P | 12 | 0.15 | 0.16 | 0.32 | 0.17 | 0.24 | 0.12 | 0.01 | 0.07 |
| E | 13 | 0.11 | 0.15 | 0.20 | 0.07 | 0.13 | 0.05 | 0.01 | 0.01 |
| E | 14 | 0.05 | 0.12 | 0.24 | 0.03 | 0.20 | 0.03 | 0.00 | 0.03 |
| D | 15 | 0.05 | 0.12 | 0.12 | 0.04 | 0.11 | 0.00 | 0.00 | 0.03 |
| | 16 | 0.03 | 0.09 | 0.07 | 0.03 | 0.03 | 0.00 | 0.00 | 0.00 |
| I | 17 | 0.04 | 0.04 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 |
| N | 18 | 0.01 | 0.01 | 0.00 | 0.00 | 0.04 | 0.00 | 0.00 | 0.01 |
| | 19 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 |
| K | 20 | 0.00 | 0.00 | 0.01 | 0.00 | 0.05 | 0.00 | 0.00 | 0.00 |
| N | 21 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 |
| O | 22 | 0.03 | 0.01 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| T | 23 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| S | 24 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 25 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | n | 672 | 515 | 747 | 826 | 1529 | 1330 | 1129 | 576 |
| | MEAN: SPEED: | 5.86 | 6.39 | 6.26 | 4.98 | 5.95 | 4.71 | 4.13 | 5.35 |

PLATE 60

MONTHLY COMPOSITE: FREQUENCY OF OBSERVED OCCURRENCES OF WIND SPEED BY DIRECTION INTERVAL (VALUES REPRESENT THE PERCENT OCCURRENCE)

AUGUST

1974-1983

DIRECTION INTERVALS (°MAG)

| | CALM 3.31 | N | NE | E | SE | S | SW | W | NW |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 0.56 | 0.27 | 0.48 | 1.01 | 0.75 | 1.13 | 1.48 | 0.36 |
| | 2 | 1.03 | 0.71 | 1.26 | 2.23 | 1.82 | 1.53 | 2.59 | 0.78 |
| | 3 | 0.87 | 0.38 | 1.01 | 1.90 | 1.82 | 1.74 | 1.82 | 0.75 |
| | 4 | 1.37 | 0.85 | 1.84 | 2.58 | 3.02 | 1.88 | 2.05 | 0.78 |
| | 5 | 1.03 | 0.87 | 2.04 | 1.68 | 2.72 | 1.78 | 1.00 | 1.07 |
| | 6 | 1.13 | 0.87 | 2.49 | 1.42 | 2.72 | 1.33 | 0.65 | 0.82 |
| | 7 | 1.00 | 0.98 | 1.98 | 0.82 | 1.35 | 1.10 | 0.38 | 0.67 |
| | 8 | 0.75 | 1.03 | 2.01 | 0.88 | 1.06 | 0.58 | 0.20 | 0.39 |
| | 9 | 0.42 | 0.75 | 1.45 | 0.58 | 0.48 | 0.22 | 0.06 | 0.17 |
| | 10 | 0.38 | 0.67 | 1.37 | 0.41 | 0.43 | 0.19 | 0.07 | 0.13 |
| S | 11 | 0.39 | 0.46 | 0.90 | 0.16 | 0.17 | 0.12 | 0.01 | 0.07 |
| P | 12 | 0.19 | 0.59 | 0.75 | 0.23 | 0.16 | 0.07 | 0.06 | 0.01 |
| E | 13 | 0.07 | 0.36 | 0.49 | 0.04 | 0.10 | 0.06 | 0.01 | 0.03 |
| E | 14 | 0.13 | 0.25 | 0.26 | 0.06 | 0.04 | 0.00 | 0.00 | 0.00 |
| D | 15 | 0.07 | 0.16 | 0.06 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| | 16 | 0.06 | 0.25 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 |
| I | 17 | 0.03 | 0.06 | 0.07 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 |
| N | 18 | 0.01 | 0.00 | 0.06 | 0.03 | 0.00 | 0.00 | 0.00 | 0.01 |
| | 19 | 0.00 | 0.00 | 0.01 | 0.03 | 0.00 | 0.00 | 0.00 | 0.01 |
| K | 20 | 0.00 | 0.00 | 0.01 | 0.03 | 0.00 | 0.00 | 0.00 | 0.01 |
| N | 21 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.03 |
| O | 22 | 0.01 | 0.00 | 0.01 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 |
| T | 23 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| S | 24 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 25 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | n | 657 | 657 | 1286 | 975 | 1152 | 811 | 718 | 425 |
| | MEAN SPEED | 5.85 | 7.57 | 6.94 | 4.87 | 5.06 | 4.53 | 3.44 | 5.12 |

PLATE 61

MONTHLY COMPOSITE: FREQUENCY OF OBSERVED OCCURRENCES OF WIND SPEED BY DIRECTION INTERVAL (VALUES REPRESENT THE PERCENT OCCURRENCE)

SEPTEMBER

1974-1983

DIRECTION INTERVALS (°MAG)

| SPEED IN KNOTS | CALM 3.19 | N | NE | E | SE | S | SW | W | NW |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 0.49 | 0.42 | 0.45 | 1.01 | 0.80 | 0.92 | 1.22 | 0.37 |
| | 2 | 1.25 | 0.64 | 0.98 | 1.59 | 1.61 | 1.18 | 2.14 | 0.61 |
| | 3 | 1.33 | 0.57 | 0.83 | 1.76 | 1.56 | 0.73 | 0.94 | 0.39 |
| | 4 | 1.46 | 0.73 | 1.12 | 1.59 | 2.53 | 0.79 | 0.89 | 0.80 |
| | 5 | 1.86 | 1.09 | 1.24 | 1.46 | 1.86 | 0.77 | 0.36 | 0.51 |
| | 6 | 2.06 | 1.24 | 1.74 | 1.27 | 1.44 | 0.43 | 0.37 | 0.52 |
| | 7 | 2.00 | 1.31 | 1.55 | 1.25 | 1.13 | 0.45 | 0.19 | 0.43 |
| | 8 | 1.71 | 1.53 | 1.56 | 0.74 | 0.86 | 0.19 | 0.12 | 0.33 |
| | 9 | 1.24 | 1.30 | 0.92 | 0.30 | 0.36 | 0.06 | 0.03 | 0.31 |
| | 10 | 1.50 | 1.52 | 1.34 | 0.40 | 0.51 | 0.16 | 0.09 | 0.24 |
| | 11 | 1.16 | 1.15 | 0.67 | 0.07 | 0.30 | 0.01 | 0.04 | 0.21 |
| | 12 | 1.03 | 1.12 | 0.66 | 0.06 | 0.16 | 0.03 | 0.01 | 0.22 |
| | 13 | 0.85 | 1.00 | 0.45 | 0.07 | 0.13 | 0.01 | 0.00 | 0.12 |
| | 14 | 0.95 | 1.04 | 0.43 | 0.04 | 0.06 | 0.00 | 0.03 | 0.07 |
| | 15 | 0.66 | 0.85 | 0.30 | 0.00 | 0.00 | 0.01 | 0.00 | 0.03 |
| | 16 | 0.71 | 0.77 | 0.22 | 0.01 | 0.01 | 0.00 | 0.00 | 0.06 |
| | 17 | 0.42 | 0.42 | 0.27 | 0.01 | 0.04 | 0.00 | 0.00 | 0.03 |
| | 18 | 0.25 | 0.24 | 0.10 | 0.01 | 0.03 | 0.00 | 0.00 | 0.01 |
| | 19 | 0.10 | 0.24 | 0.06 | 0.00 | 0.03 | 0.00 | 0.01 | 0.00 |
| | 20 | 0.21 | 0.12 | 0.04 | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 |
| | 21 | 0.03 | 0.04 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 22 | 0.06 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 23 | 0.03 | 0.07 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 |
| | 24 | 0.06 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 |
| | 25 | 0.03 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 26 | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 27 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 28 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 29 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 30 | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 31 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 33 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 35 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 39 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | n | 1455 | 1173 | 1004 | 785 | 903 | 389 | 434 | 357 |
| | MEAN SPEED | 8.68 | 9.68 | 7.70 | 4.83 | 5.19 | 4.05 | 3.21 | 6.26 |

PLATE 62

MONTHLY COMPOSITE: FREQUENCY OF OBSERVED OCCURRENCES OF WIND SPEED BY DIRECTION INTERVAL (VALUES REPRESENT THE PERCENT OCCURRENCE)

OCTOBER

1974-1983

DIRECTION INTERVALS (°MAG)

| SPEED IN KNOTS | CALM 2.45 | N | NE | E | SE | S | SW | W | NW |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | 0.50 | 0.34 | 0.37 | 0.94 | 0.53 | 0.35 | 0.51 | 0.15 |
| 2 | | 1.19 | 0.85 | 0.73 | 1.32 | 0.86 | 0.67 | 1.30 | 0.97 |
| 3 | | 0.88 | 0.59 | 0.63 | 0.95 | 0.60 | 0.29 | 0.63 | 0.42 |
| 4 | | 1.77 | 1.07 | 1.04 | 1.27 | 0.98 | 0.59 | 0.73 | 0.69 |
| 5 | | 2.04 | 0.86 | 1.41 | 1.10 | 0.75 | 0.60 | 0.50 | 0.51 |
| 6 | | 2.31 | 1.55 | 1.55 | 1.16 | 0.53 | 0.56 | 0.53 | 0.44 |
| 7 | | 2.12 | 1.32 | 1.60 | 0.81 | 0.47 | 0.40 | 0.44 | 0.34 |
| 8 | | 2.36 | 1.64 | 1.39 | 0.63 | 0.42 | 0.35 | 0.19 | 0.57 |
| 9 | | 1.55 | 1.22 | 1.00 | 0.35 | 0.13 | 0.13 | 0.12 | 0.40 |
| 10 | | 2.90 | 1.83 | 1.66 | 0.45 | 0.25 | 0.15 | 0.16 | 0.50 |
| 11 | | 1.73 | 1.16 | 0.82 | 0.23 | 0.15 | 0.01 | 0.04 | 0.38 |
| 12 | | 2.14 | 1.41 | 0.95 | 0.22 | 0.10 | 0.01 | 0.06 | 0.48 |
| 13 | | 2.01 | 1.17 | 0.95 | 0.25 | 0.10 | 0.00 | 0.01 | 0.44 |
| 14 | | 2.04 | 0.94 | 0.72 | 0.18 | 0.04 | 0.01 | 0.00 | 0.56 |
| 15 | | 1.16 | 0.67 | 0.32 | 0.07 | 0.03 | 0.00 | 0.00 | 0.28 |
| 16 | | 1.27 | 0.48 | 0.31 | 0.09 | 0.03 | 0.00 | 0.00 | 0.12 |
| 17 | | 0.82 | 0.29 | 0.23 | 0.03 | 0.01 | 0.00 | 0.00 | 0.23 |
| 18 | | 0.63 | 0.26 | 0.18 | 0.00 | 0.01 | 0.01 | 0.00 | 0.10 |
| 19 | | 0.41 | 0.15 | 0.07 | 0.00 | 0.00 | 0.00 | 0.00 | 0.06 |
| 20 | | 0.31 | 0.03 | 0.04 | 0.00 | 0.00 | 0.00 | 0.00 | 0.06 |
| 21 | | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 22 | | 0.22 | 0.00 | 0.03 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 23 | | 0.06 | 0.03 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| 24 | | 0.04 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 25 | | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 26 | | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 28 | | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| n | | 2086 | 1219 | 1092 | 686 | 411 | 283 | 357 | 525 |
| MEAN SPEED | | 9.80 | 9.12 | 8.42 | 5.60 | 5.28 | 4.90 | 4.25 | 8.38 |

PLATE 63

MONTHLY COMPOSITE: FREQUENCY OF OBSERVED OCCURRENCES OF WIND SPEED BY DIRECTION INTERVAL (VALUES REPRESENT THE PERCENT OCCURRENCE)

NOVEMBER

1974-1983

DIRECTION INTERVALS (°MAG)

| | CALM | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2.63 | N | NE | E | SE | S | SW | W | NW |
| | 1 | 0.57 | 0.39 | 0.39 | 0.71 | 0.45 | 0.52 | 0.57 | 0.43 |
| | 2 | 1.22 | 0.83 | 1.09 | 1.33 | 1.02 | 0.56 | 1.23 | 0.78 |
| | 3 | 0.84 | 0.46 | 0.88 | 0.90 | 0.45 | 0.36 | 0.78 | 0.45 |
| | 4 | 1.44 | 1.11 | 1.40 | 1.74 | 1.16 | 0.48 | 0.99 | 0.66 |
| | 5 | 1.72 | 0.90 | 1.49 | 1.30 | 0.83 | 0.38 | 0.71 | 0.71 |
| | 6 | 1.72 | 1.32 | 1.68 | 1.57 | 0.88 | 0.46 | 0.73 | 0.59 |
| | 7 | 1.78 | 1.22 | 1.77 | 0.99 | 0.70 | 0.17 | 0.42 | 0.67 |
| | 8 | 2.14 | 1.29 | 1.51 | 0.90 | 0.35 | 0.25 | 0.46 | 0.56 |
| | 9 | 1.54 | 0.66 | 1.04 | 0.49 | 0.27 | 0.04 | 0.20 | 0.56 |
| | 10 | 2.31 | 1.02 | 1.54 | 0.62 | 0.43 | 0.21 | 0.29 | 0.80 |
| S | 11 | 1.81 | 1.04 | 1.05 | 0.59 | 0.31 | 0.07 | 0.07 | 0.64 |
| P | 12 | 1.84 | 1.02 | 1.36 | 0.52 | 0.25 | 0.01 | 0.11 | 0.57 |
| E | 13 | 1.49 | 0.74 | 0.78 | 0.17 | 0.21 | 0.00 | 0.10 | 0.62 |
| E | 14 | 1.58 | 0.88 | 0.39 | 0.18 | 0.13 | 0.03 | 0.08 | 0.56 |
| D | 15 | 0.81 | 0.22 | 0.17 | 0.07 | 0.06 | 0.00 | 0.00 | 0.20 |
| | 16 | 1.40 | 0.36 | 0.17 | 0.08 | 0.01 | 0.01 | 0.01 | 0.32 |
| I | 17 | 0.62 | 0.15 | 0.08 | 0.00 | 0.01 | 0.00 | 0.00 | 0.31 |
| N | 18 | 0.64 | 0.11 | 0.07 | 0.04 | 0.01 | 0.00 | 0.00 | 0.28 |
| | 19 | 0.24 | 0.04 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.07 |
| K | 20 | 0.32 | 0.10 | 0.03 | 0.01 | 0.00 | 0.00 | 0.00 | 0.15 |
| N | 21 | 0.14 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O | 22 | 0.04 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.07 |
| T | 23 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| S | 24 | 0.06 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 25 | 0.03 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 26 | 0.03 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 27 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 29 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | n | 1882 | 993 | 1210 | 872 | 538 | 254 | 484 | 715 |
| | MEAN SPEED | 9.68 | 8.52 | 7.72 | 6.10 | 5.95 | 4.65 | 4.93 | 8.98 |

PLATE 64

MONTHLY COMPOSITE: FREQUENCY OF OBSERVED OCCURRENCES OF WIND SPEED BY DIRECTION INTERVAL (VALUES REPRESENT THE PERCENT OCCURRENCE)

DECEMBER

1974-1983

DIRECTION INTERVALS (°MAG)

| | CALM | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1.70 | N | NE | E | SE | S | SW | W | NW |
| | 1 | 0.76 | 0.55 | 0.50 | 0.71 | 0.91 | 0.62 | 0.56 | 0.49 |
| | 2 | 0.92 | 0.52 | 0.83 | 1.01 | 1.04 | 1.19 | 0.95 | 1.02 |
| | 3 | 0.75 | 0.42 | 0.43 | 0.59 | 0.40 | 0.30 | 0.36 | 0.53 |
| | 4 | 1.53 | 0.76 | 1.38 | 1.60 | 1.11 | 0.83 | 0.81 | 0.76 |
| | 5 | 1.27 | 0.81 | 1.31 | 1.35 | 0.82 | 0.65 | 0.69 | 0.76 |
| | 6 | 1.94 | 0.89 | 1.61 | 1.35 | 1.11 | 0.69 | 0.81 | 0.83 |
| | 7 | 2.10 | 1.05 | 1.38 | 0.94 | 0.72 | 0.35 | 0.42 | 0.66 |
| | 8 | 2.39 | 0.85 | 1.68 | 0.81 | 0.62 | 0.32 | 0.42 | 0.53 |
| | 9 | 1.57 | 0.83 | 0.75 | 0.46 | 0.24 | 0.07 | 0.23 | 0.37 |
| | 10 | 2.73 | 1.14 | 1.19 | 0.60 | 0.33 | 0.10 | 0.27 | 0.60 |
| S | 11 | 1.80 | 0.96 | 0.75 | 0.47 | 0.26 | 0.12 | 0.14 | 0.73 |
| P | 12 | 2.12 | 1.02 | 0.60 | 0.43 | 0.30 | 0.09 | 0.13 | 0.56 |
| E | 13 | 1.58 | 0.63 | 0.35 | 0.36 | 0.17 | 0.04 | 0.06 | 0.58 |
| E | 14 | 1.97 | 0.75 | 0.19 | 0.29 | 0.10 | 0.06 | 0.12 | 0.85 |
| D | 15 | 1.31 | 0.32 | 0.14 | 0.14 | 0.12 | 0.00 | 0.01 | 0.12 |
| | 16 | 1.41 | 0.30 | 0.19 | 0.17 | 0.04 | 0.01 | 0.01 | 0.42 |
| I | 17 | 1.14 | 0.16 | 0.06 | 0.04 | 0.04 | 0.00 | 0.00 | 0.49 |
| N | 18 | 0.86 | 0.03 | 0.04 | 0.13 | 0.01 | 0.01 | 0.00 | 0.36 |
| | 19 | 0.37 | 0.00 | 0.06 | 0.06 | 0.01 | 0.00 | 0.00 | 0.12 |
| K | 20 | 0.76 | 0.00 | 0.03 | 0.06 | 0.01 | 0.00 | 0.00 | 0.14 |
| N | 21 | 0.10 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.09 |
| O | 22 | 0.29 | 0.00 | 0.01 | 0.03 | 0.00 | 0.00 | 0.00 | 0.13 |
| T | 23 | 0.14 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.04 |
| S | 24 | 0.12 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.04 |
| | 25 | 0.07 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 |
| | 26 | 0.07 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 |
| | 29 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | n | 2019 | 833 | 939 | 806 | 582 | 379 | 416 | 784 |
| | MEAN: | 10.49 | 8.56 | 7.51 | 6.80 | 5.85 | 4.66 | 5.36 | 9.27 |
| | SPEED: | | | | | | | | |

PLATE 65

ALL-DATA: FREQUENCY OF OBSERVED OCCURRENCES OF WIND SPEED
BY DIRECTION INTERVAL (VALUES REPRESENT THE PERCENT OCCURRENCE)

1974-1984

DIRECTION INTERVALS (°MAG)

| SPEED IN KNOTS | CALM 2.41 | N | NE | E | SE | S | SW | W | NW |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.49 | 0.35 | 0.42 | 0.79 | 0.63 | 0.73 | 0.78 | 0.32 |
| 2 | 0.88 | 0.64 | 0.93 | 1.43 | 1.29 | 1.19 | 1.55 | 0.69 |
| 3 | 0.78 | 0.46 | 0.71 | 1.34 | 1.04 | 1.02 | 1.05 | 0.46 |
| 4 | 1.27 | 0.79 | 1.18 | 1.91 | 2.05 | 1.39 | 1.36 | 0.70 |
| 5 | 1.29 | 0.77 | 1.26 | 1.65 | 1.96 | 1.32 | 0.96 | 0.65 |
| 6 | 1.45 | 0.90 | 1.47 | 1.64 | 1.91 | 1.19 | 0.80 | 0.64 |
| 7 | 1.45 | 0.81 | 1.31 | 1.22 | 1.42 | 0.95 | 0.60 | 0.56 |
| 8 | 1.47 | 0.95 | 1.35 | 1.18 | 1.16 | 0.65 | 0.44 | 0.52 |
| 9 | 1.06 | 0.62 | 0.88 | 0.66 | 0.60 | 0.30 | 0.22 | 0.37 |
| 10 | 1.56 | 0.84 | 1.13 | 0.69 | 0.55 | 0.27 | 0.26 | 0.46 |
| 11 | 1.14 | 0.65 | 0.68 | 0.44 | 0.34 | 0.14 | 0.14 | 0.38 |
| 12 | 1.33 | 0.68 | 0.75 | 0.40 | 0.30 | 0.10 | 0.12 | 0.40 |
| 13 | 1.11 | 0.53 | 0.51 | 0.27 | 0.18 | 0.06 | 0.07 | 0.34 |
| 14 | 1.13 | 0.52 | 0.36 | 0.16 | 0.12 | 0.03 | 0.09 | 0.39 |
| 15 | 0.70 | 0.29 | 0.18 | 0.10 | 0.06 | 0.02 | 0.03 | 0.16 |
| 16 | 0.87 | 0.28 | 0.19 | 0.09 | 0.03 | 0.01 | 0.03 | 0.22 |
| 17 | 0.54 | 0.16 | 0.12 | 0.05 | 0.03 | 0.01 | 0.02 | 0.19 |
| 18 | 0.41 | 0.10 | 0.06 | 0.03 | 0.02 | 0.01 | 0.03 | 0.15 |
| 19 | 0.18 | 0.06 | 0.03 | 0.02 | 0.01 | * | * | 0.06 |
| 20 | 0.25 | 0.05 | 0.04 | 0.02 | 0.02 | * | 0.01 | 0.09 |
| 21 | 0.06 | 0.01 | * | 0.01 | * | * | 0.01 | 0.04 |
| 22 | 0.10 | 0.02 | 0.01 | 0.01 | 0.01 | * | 0.01 | 0.04 |
| 23 | 0.05 | 0.01 | * | * | * | 0.00 | 0.00 | 0.03 |
| 24 | 0.04 | 0.01 | * | 0.01 | 0.01 | 0.00 | * | 0.02 |
| 25 | 0.03 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 |
| 26 | 0.02 | * | * | * | 0.00 | * | 0.00 | 0.01 |
| 27 | * | * | * | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 28 | 0.01 | * | * | * | * | 0.00 | 0.00 | * |
| 29 | * | 0.00 | * | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 30 | * | 0.00 | * | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 31 | * | * | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 32 | * | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 33 | * | 0.00 | * | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 35 | * | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 39 | 0.00 | * | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| n | 17171 | 9181 | 11859 | 12344 | 12009 | 8201 | 7489 | 6903 |
| MEAN SPEED | 9.53 | 8.48 | 7.55 | 6.06 | 5.87 | 5.07 | 4.88 | 8.32 |

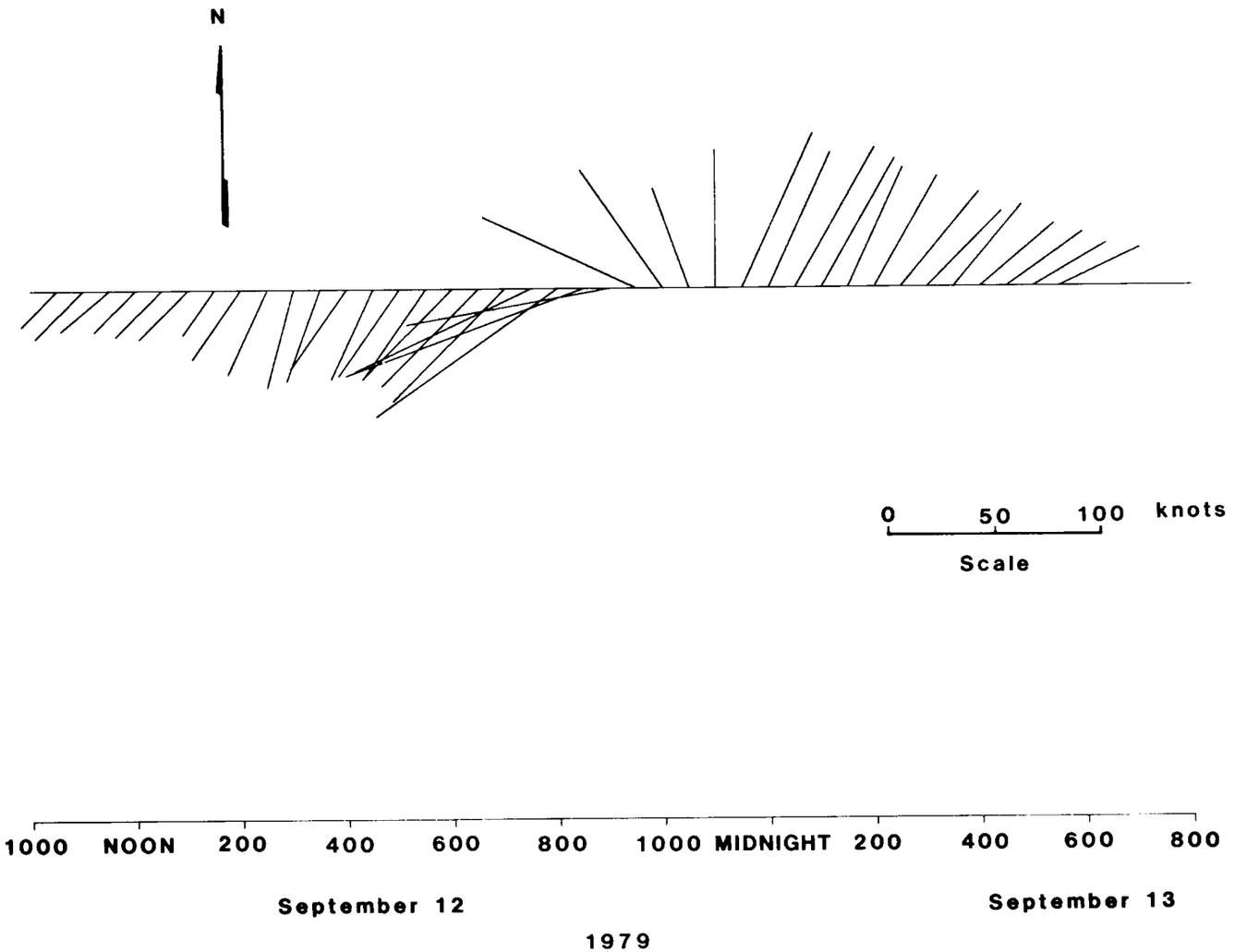
*Percent occurrence is less than 0.01.

PLATE 66. Summary of the monthly composite and all-data percent occurrences and mean speeds by directional intervals (February 1974 to July 1984).

| | N | NE | E | SE | S | SW | W | NW | CALM | MONTHLY |
|---|---|---|---|---|---|---|---|---|---|---|
| January | 31.3% | 11.7% | 12.4% | 9.2% | 7.2% | 5.5% | 8.8% | 12.1% | 1.9% | 100% |
| | 10.6k | 8.9k | 7.5k | 5.3k | 4.8k | 5.0k | 6.0k | 9.9k | - | 8.1k |
| February | 25.2% | 11.4% | 11.4% | 10.8% | 10.0% | 9.9% | 9.4% | 9.7% | 2.2% | 100% |
| | 10.1k | 8.9k | 8.1k | 5.5k | 4.7k | 5.0k | 6.5k | 9.0k | - | 7.5k |
| March | 17.0% | 8.3% | 14.7% | 18.2% | 14.9% | 9.1% | 7.6% | 8.3% | 2.1% | 100% |
| | 11.0k | 8.4k | 7.8k | 6.6k | 6.3k | 5.4k | 6.4k | 10.6k | - | 7.7k |
| April | 14.4% | 7.2% | 13.1% | 23.7% | 15.1% | 9.0% | 8.2% | 7.5% | 1.8% | 100% |
| | 9.5k | 7.4k | 8.4k | 7.3k | 6.3k | 5.6k | 6.1k | 9.0k | - | 7.4k |
| May | 12.8% | 6.0% | 13.2% | 22.0% | 20.8% | 10.2% | 7.2% | 5.5% | 2.3% | 100% |
| | 8.8k | 8.0k | 7.2k | 6.6k | 6.5k | 5.9k | 4.4k | 7.9k | - | 6.7k |
| June | 11.8% | 6.5% | 9.1% | 13.0% | 22.4% | 19.2% | 11.4% | 4.3% | 2.2% | 100% |
| | 8.0k | 7.2k | 7.0k | 5.8k | 6.4k | 5.3k | 4.3k | 5.8k | - | 6.0K |
| July | 8.9% | 6.8% | 9.9% | 10.9% | 20.2% | 17.6% | 14.9% | 7.6% | 3.3% | 100% |
| | 5.9k | 6.4k | 6.3k | 5.0k | 6.0k | 4.7k | 4.1k | 5.4k | - | 5.2k |
| August | 9.5% | 9.5% | 18.6% | 14.1% | 16.7% | 11.7% | 10.4% | 6.2% | 3.3% | 100% |
| | 5.9k | 7.6k | 6.9k | 4.9k | 5.1k | 4.5k | 3.4k | 5.1k | - | 5.3k |
| September | 21.7% | 17.5% | 15.0% | 11.7% | 13.5% | 5.8% | 6.5% | 5.3% | 3.2% | 100% |
| | 8.7k | 9.7k | 7.7k | 4.8k | 5.2k | 4.1k | 3.2k | 6.3k | - | 6.8k |
| October | 30.6% | 17.9% | 16.0% | 10.1% | 6.0% | 4.2% | 5.2% | 7.7% | 2.5% | 100% |
| | 9.8k | 9.1k | 8.4k | 5.6k | 5.3k | 4.9k | 4.3k | 8.4k | - | 7.9k |
| November | 26.4% | 13.9% | 17.0% | 12.2% | 7.5% | 3.6% | 6.8% | 10.0% | 2.6% | 100% |
| | 9.7k | 8.5k | 7.7k | 6.1k | 6.0k | 4.7k | 4.9k | 8.9k | - | 7.6k |
| December | 30.1% | 12.0% | 13.5% | 11.6% | 8.4% | 5.5% | 6.0% | 11.3% | 1.7% | 100% |
| | 10.5k | 8.6k | 7.5k | 6.8k | 5.9k | 4.7k | 5.4k | 9.3k | - | 8.0k |
| All Data | 19.7% | 10.5% | 13.6% | 14.2% | 13.8% | 9.4% | 8.6% | 7.9% | 2.4% | 100% |
| | 9.5k | 8.5k | 7.6k | 6.1k | 5.9k | 5.1k | 4.9k | 8.3k | - | 7.0k |

Plate 67. "CHURN" station winds during Hurricane Frederic.

(Vector points in the direction the wind is blowing).



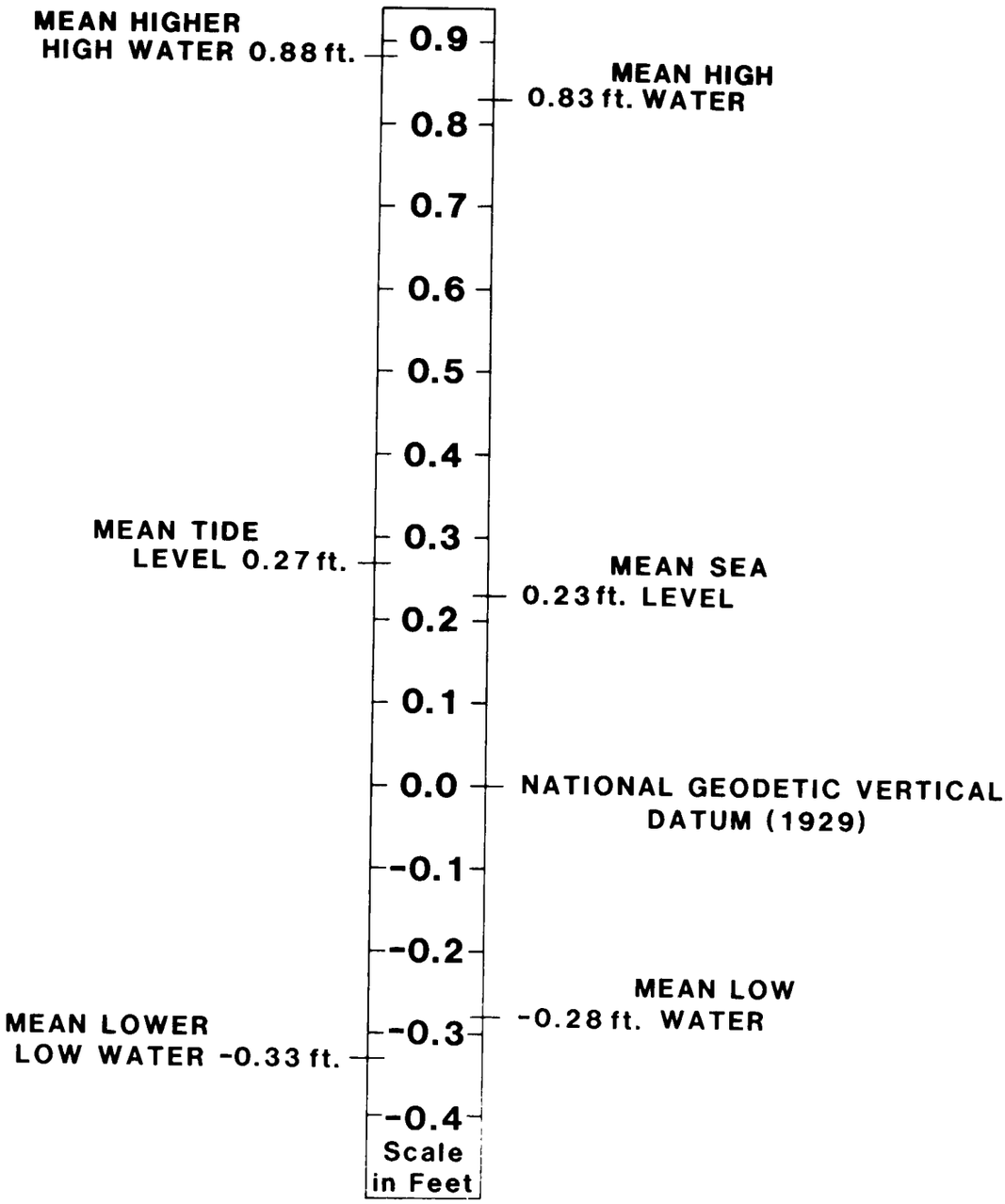



Plate 68. Tidal datum references for tide station 873-5180, Dauphin Island (Fort Gaines), Alabama, for the National Tidal Datum Epoch of 1960-1978. (This information has been provided by the Tidal Datums Section, Tides and Water Levels Branch, NOAA-NOS, and is labeled "Preliminary Data".)

Plate 69. Plots of hourly observations of sea level

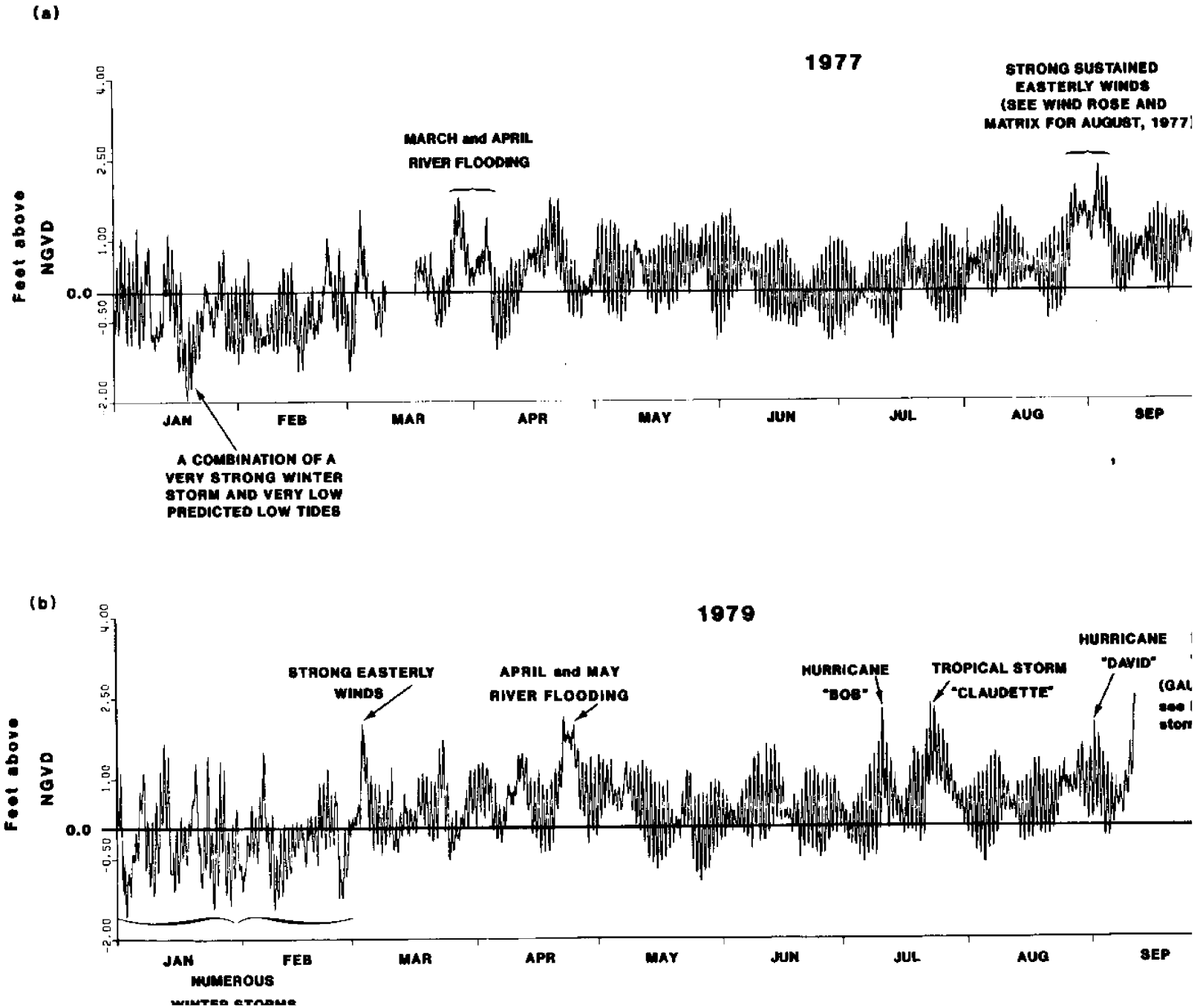
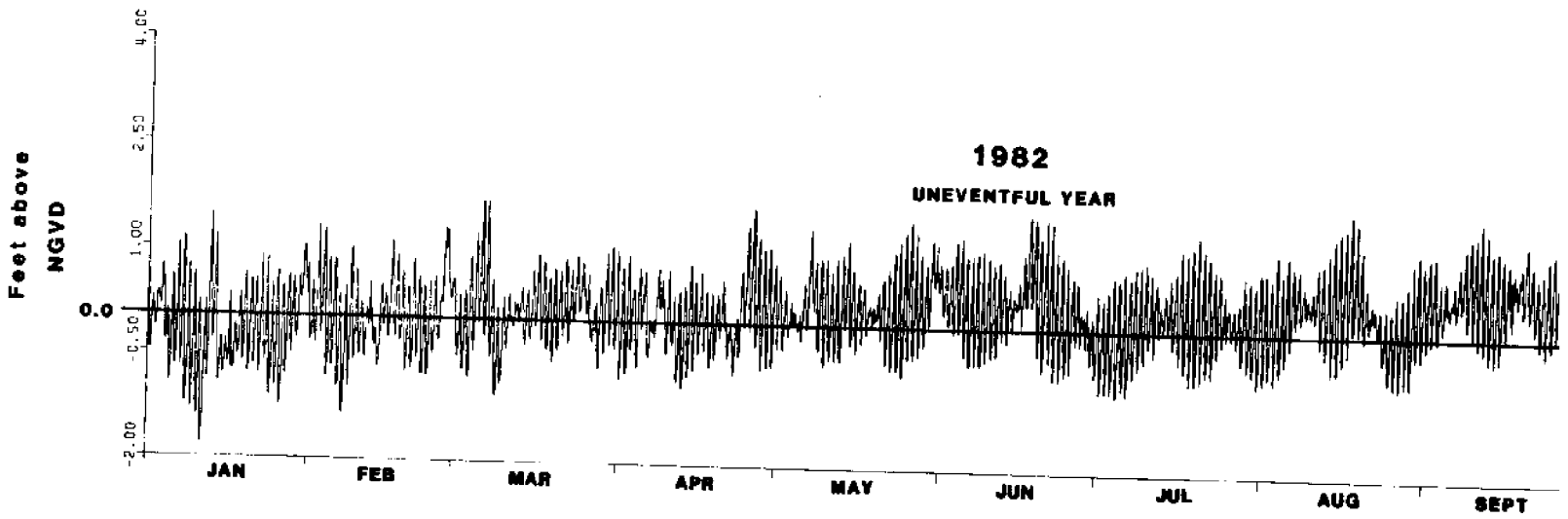
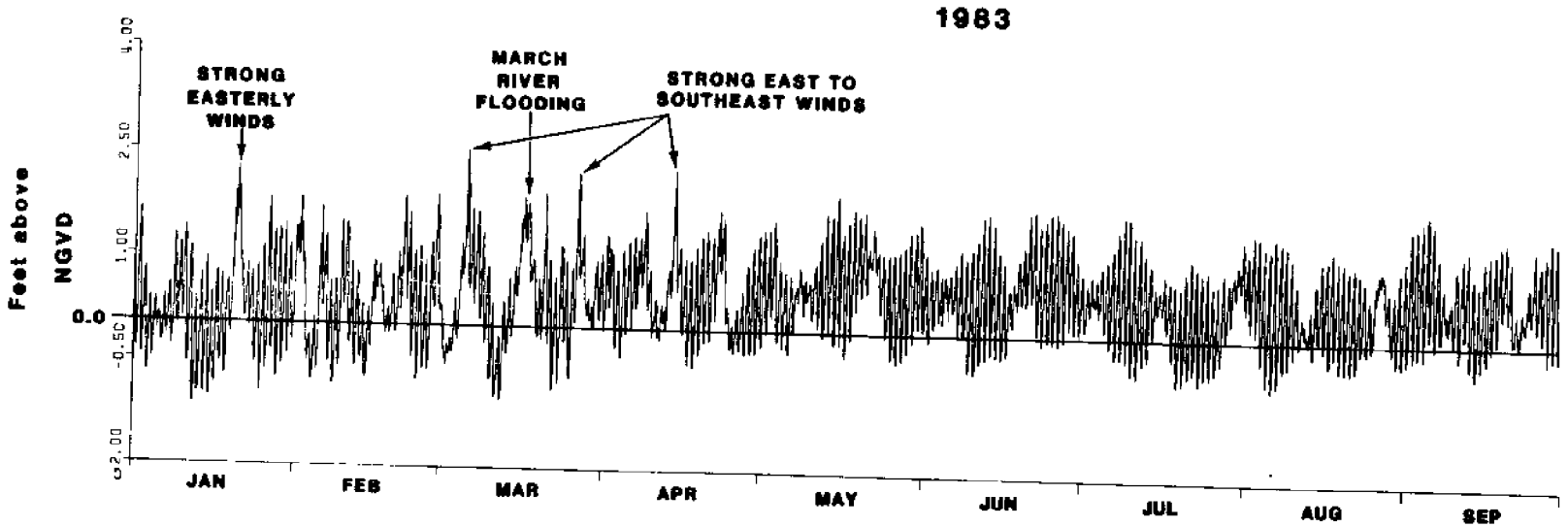


Plate 70. Plots of hourly observations of sea lev

(a)




(b)



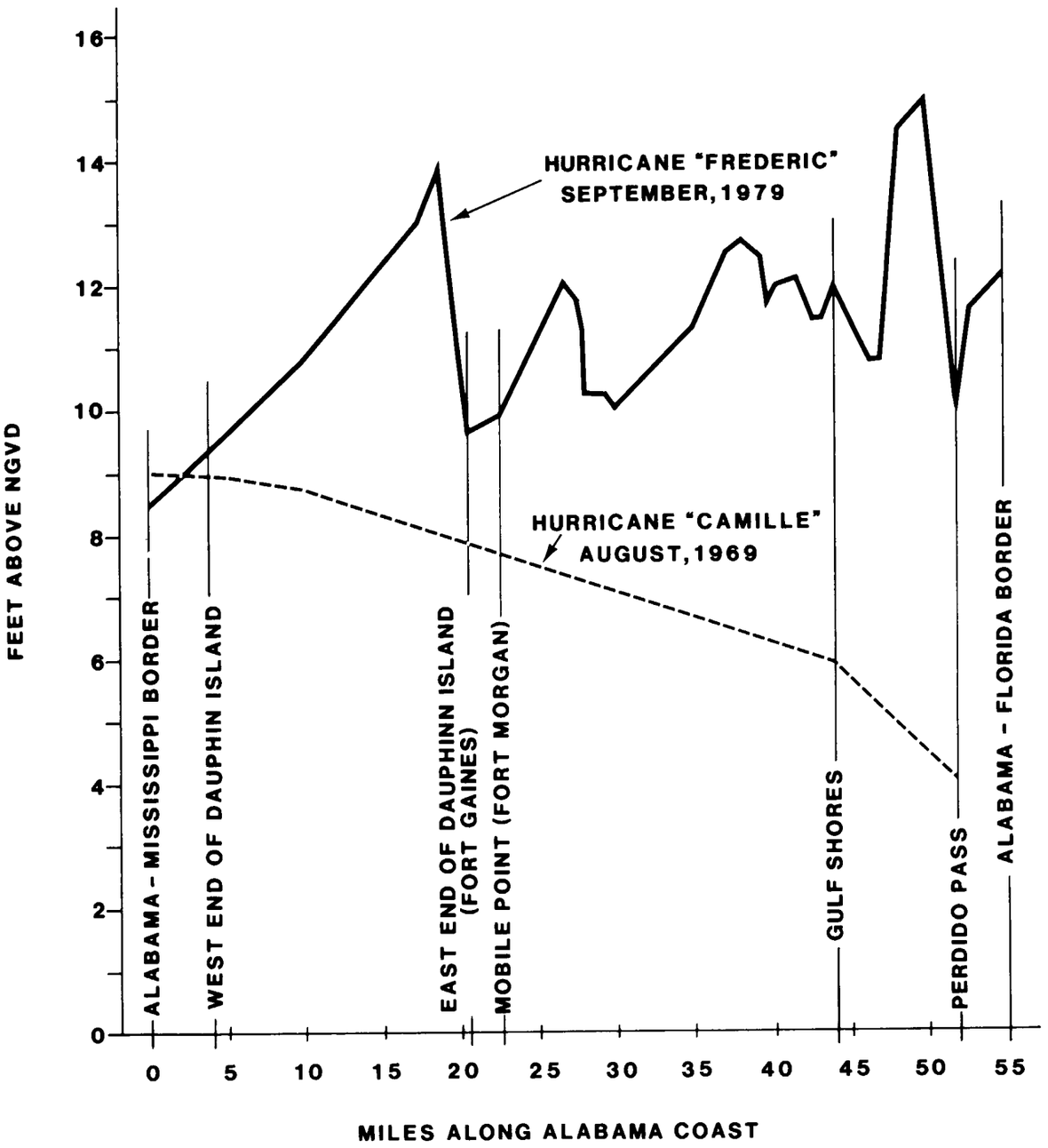
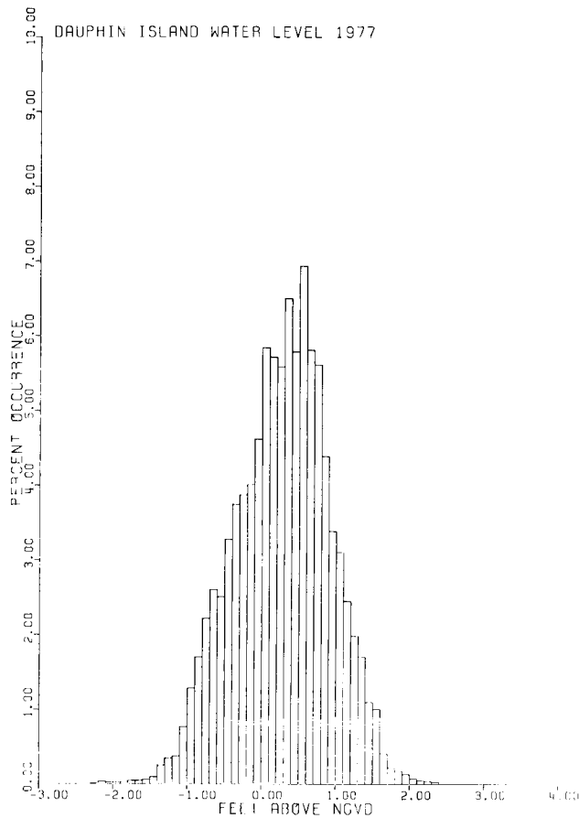



**Plate 71.** High water profiles. (Produced from data presented in: HURRICANE CAMILLE, U.S. Army Engineer District, Mobile Alabama, May, 1970 and HURRICANE FREDERIC POST DISASTER REPORT, U.S. Army Engineer District, Mobile Alabama, February, 1981.)

**Plate 72. Plots of (a) frequency of observed occurences within given water elevation ranges and (b) cumulative frequency of observed occurences to given water elevations for 1977.**

(a)




(b)

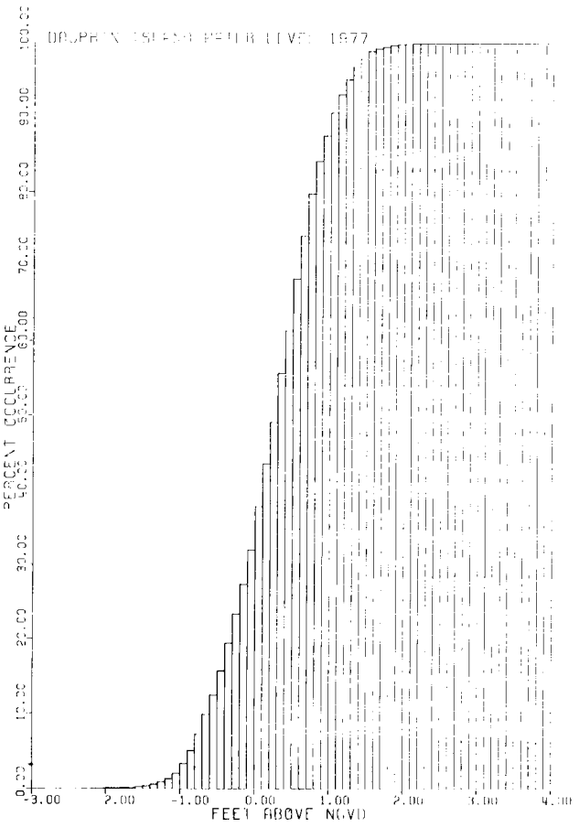
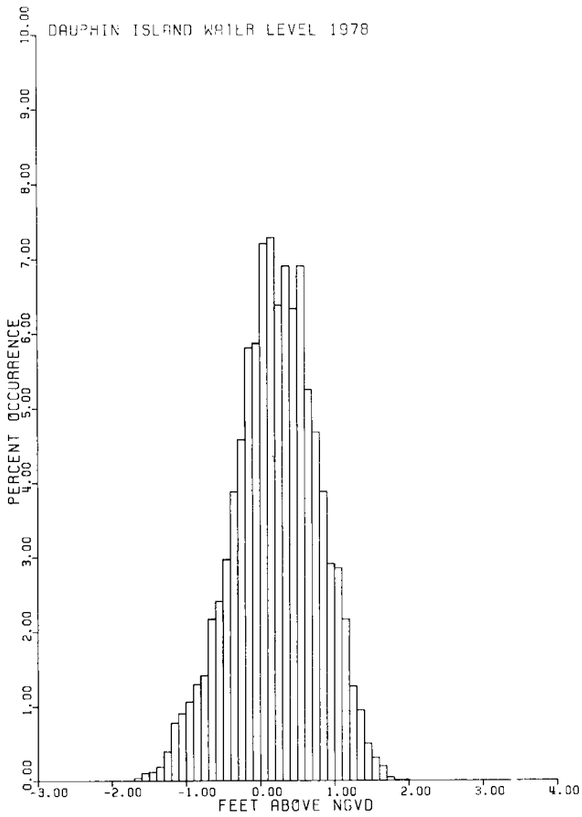


**Plate 73. Plots of (a) frequency of observed occurences within given water elevation ranges and (b) cumulative frequency of observed occurences to given water elevations for 1978.**

(a)




(b)

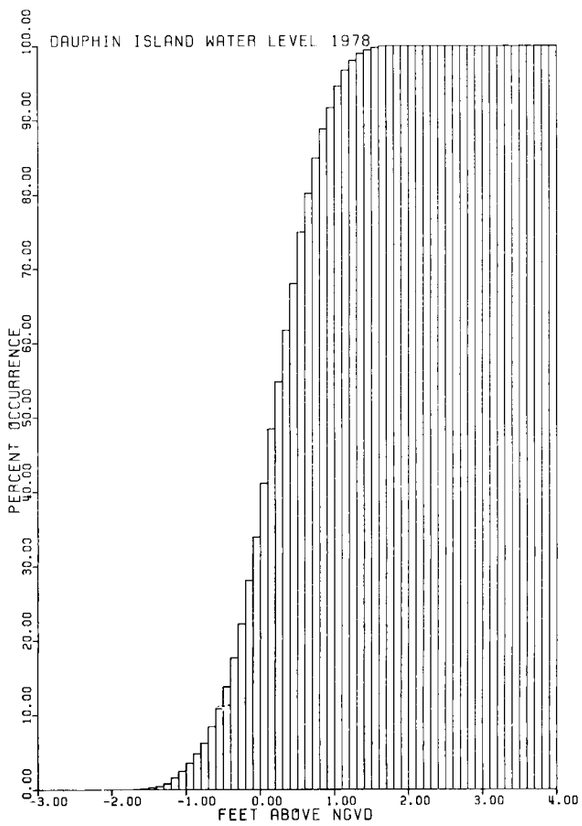
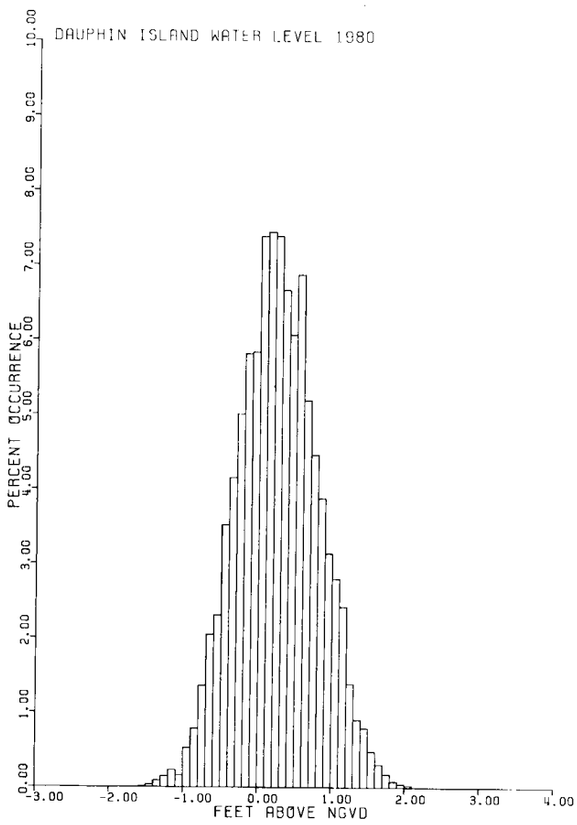


**Plate 74. Plots of (a) frequency of observed occurences within given water elevation ranges and (b) cumulative frequency of observed occurences to given water elevations for 1980.**

(a)




(b)

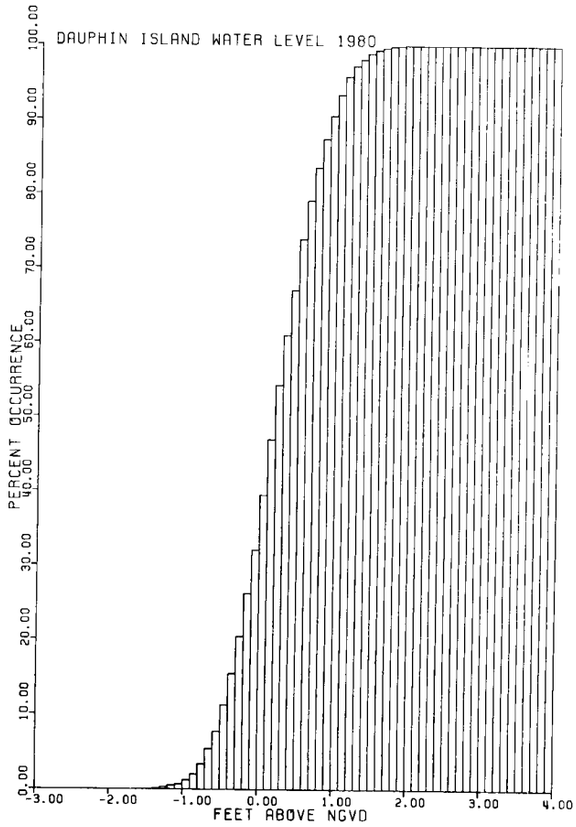
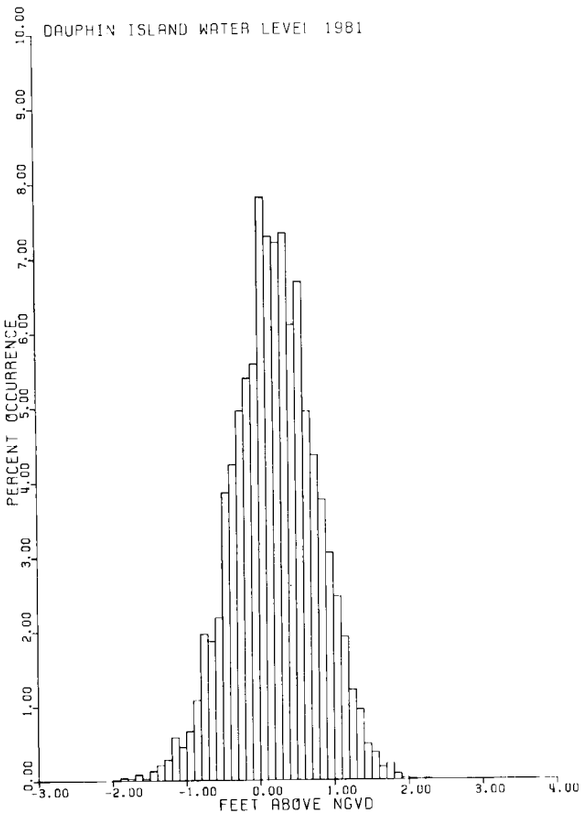


**Plate 75. Plots of (a) frequency of observed occurrences within given water elevation ranges and (b) cumulative frequency of observed occurences to given water elevations for 1981.**

(a)




(b)

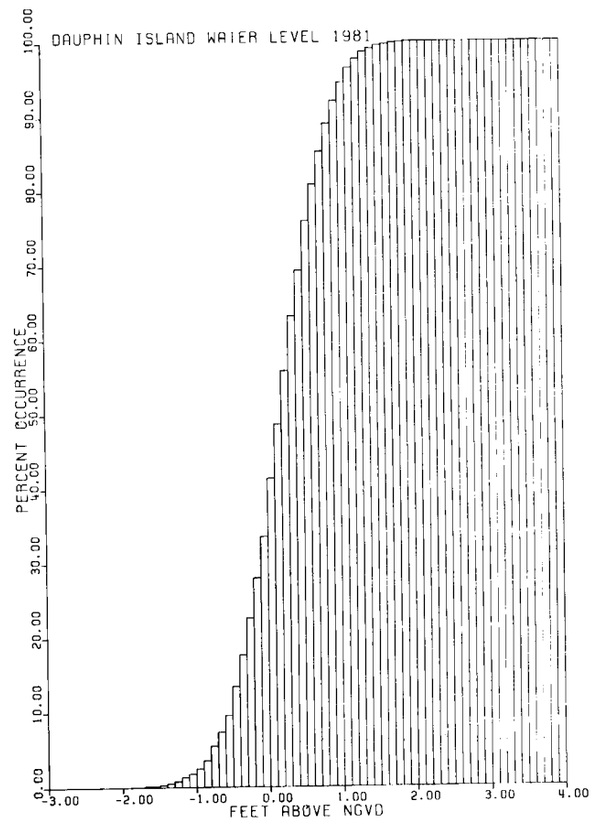
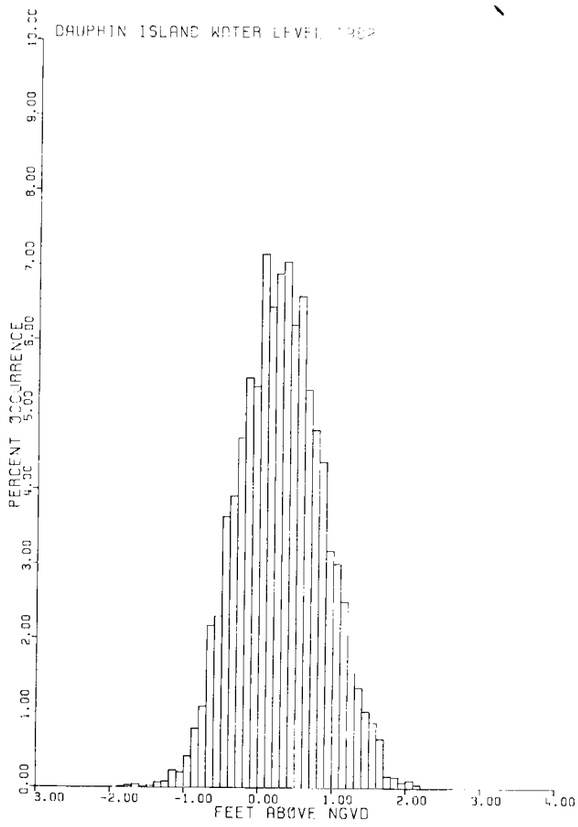


**Plate 76. Plots of (a) frequency of observed occurences within given water elevation ranges and (b) cumulative frequency of observed occurences to given water elevations for 1982.**

(a)




(b)