QC
879.5
.U47
no.2
c.2

NOAA Technical Report NESDIS 2 NODC 1

An Environmental Guide to Ocean Thermal Energy Conversion (OTEC) Operations in the Gulf of Mexico

Washington, D.C.
June 1983

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Environmental Satellite, Data, and Information Service

NOAA TECHNICAL REPORTS

National Environmental Satellite, Data, and Information Service

ronmental Satellite, Data, and Information Service (NESDIS) manages the Nation's rth-observing satellite systems, as well as global national data bases for meteorology, sics, and solar-terrestrial sciences. From these sources, it develops and disseminates nd information products critical to the protection of life and property, national l economy, energy development and distribution, global food supplies, and the development of natural resources.

Publication in the NOAA Technical Report series does not preclude later publication in scientific journals in expanded or modified form. The NESDIS series of NOAA Technical Reports is a continuation of the former NESS and EDIS series of NOAA Technical Reports and the NESC and EDS series of Environmental Science Services Administration (ESSA) Technical Reports.

These reports are available from the National Technical Information Service (NTIS), U.S. Department of Commerce, Sills Bldg., 5285 Port Royal Road, Springfield, VA 22161. Prices on request for paper copies or microfiche.

A more complete listing of these reports, by title and NTIS accession number, is available from the Assessment and Information Services Center, National Oceanic and Atmospheric Administration, Code E/AI13, Page Bldg. 2, 3300 Whitehaven Street, N.W., Washington, DC 20235. A partial listing of more recent reports appears below:

NESS Series

NESS 89 A Statistical Approach to Rainfall Estimation Using Satellite and Conventional Data. Linwood F. Whitney, Jr. April 1982. (PB82 215435)

NESS 90 Total Precipitable Water and Rainfall Determinations From the SEASAT Scanning Multichannel Microwave Radiometer (SMMR). John C. Alishouse, May 1982. (PB83 138263)

NESS 91 Numerical Smoothing and Differentiation by Finite Differences. Henry E. Fleming and Lawrence J. Crone, May 1982. (PB82-258385)

NESS 92 Satellite Infrared Observations of Oceanic Long Waves in the Eastern Equatorial Pacific 1975 to 1981. Richard Legeckis, November 1982. (PB83 161133)

NESS 93 A Method for Improving the Estimation of Conditional Instability from Satellite Retrievals. W.E. Togstad, J.M. Lewis, and H.M. Woolf, November 1982. (PB83 169938)

EDIS Series

EDS 29 GATE Convection Subprogram Data Center: Final Report on Rawinsonde Data Validation. Robert W. Reeves, March 1978. (PB-281-861)

EDS 30 Gamma Distribution Bias and Confidence Limits. Harold L. Crutcher and Raymond L. Joiner, September 1978. (PB-289-721)

EDIS 31 Calibration and Intercomparison of the GATE C-Band Radars. M. Hudlow, R. Arkell, V. Patterson, P. Pytlowany, F. Richards, and S. Geotis (MIT), November 1979. (PB81 120305)

EDIS 32 Distribution of Radiosonde Errors. Harold L. Crutcher, May 1979. (PB-297-383)

EDIS 33 Accurate Least-Squares Techniques Using the Orthogonal Function Approach. Jerry Sullivan, March 1980. (PB80 223241)

EDIS 34 An Application of Stochastic Forecasting to Monthly Averaged 700 mb Heights. Albert Koscielny, June 1982. (PB82 244625)

NESDIS Series

NESDIS 1 Satellite Observations on Variations in Southern Hemisphere Snow Cover. Kenneth F. Dewey and Richard Heim, Jr.

QC
879.5
.U47
no.2
c.2

NOAA Technical Report NESDIS 2 NODC 1

An Environmental Guide to Ocean Thermal Energy Conversion (OTEC) Operations in the Gulf of Mexico

A Report Submitted to the Department of Energy
DOE/NOAA Interagency Agreement Number EX-76-A-29-1041
Task Order #T037

National Oceanographic Data Center
Information Services Division
Washington, D.C.
June 1983

LIBRARY
MAR 1 2 199
N.O.A.A.
U.S. Dept. of Comm

LIBRARY
MAR 1 2 1990
N.O.A.A.
U.S. Dept. of Commerce

U.S. DEPARTMENT OF COMMERCE
Malcolm Baldrige, Secretary

National Oceanic and Atmospheric Administration
John V. Byrne, Administrator

National Environmental Satellite, Data, and Information Service
John H. McElroy, Acting Assistant Administrator

EXECUTIVE SUMMARY

The Gulf of Mexico is a semi-enclosed ocean basin lying in semitropical latitudes near highly populated regions. This body of water, with its warm surface temperatures, is a prime candidate as a site for Ocean Thermal Energy Conversion (OTEC) plants. OTEC plants exploit the temperature differential between warm surface water and cold water pumped from depth to generate electricity. The waters of the Gulf of Mexico provide one of the largest such temperature differentials adjacent to the continental United States and, therefore, have been of major interest to OTEC researchers and planners.

This publication is a compilation and summary of available environmental data for the Gulf of Mexico. These data define the climatology of wind, waves, currents, water temperature, and other phenomena that determine the environmental operating conditions of OTEC plants in the Gulf.

Although the same environmental parameters are of interest at all potential OTEC sites, each site has unique features that require special attention. Among the major controlling influences in the Gulf of Mexico on potential OTEC operations are the following:

- The flow regime and water mass distribution of the Gulf is largely controlled by an intense current system, the Loop Current. This current, which enters the Gulf through the Yucatan Channel and exits through the Straits of Florida, alternately penetrates northward toward the U.S. Gulf coast and then returns again to the south entraining water masses associated with it.

- The Gulf of Mexico is bordered by a major land mass, the North American continent, and is subject to greater climatic variability than more tropical, open ocean sites. Extratropical cyclones and their associated cold, continental air masses can plunge into the Gulf and affect winds, waves, currents, and water temperature.

- The Gulf is within the North Atlantic tropical cyclone basin and has been traversed by some of the most intense hurricanes ever recorded, for example, Hurricane Camille of 1969. Such storms will subject OTEC plants to the most severe environmental conditions they will encounter.

Through charts and tables gleaned from a variety of sources or prepared from the digital data bases of the Environmental Data and Information Service (EDIS) of the National Oceanic and Atmospheric Administration (NOAA), this guide presents a concise summary of present knowledge of basic environmental conditions in the Gulf of Mexico that are relevant to OTEC operations.

TABLE OF CONTENTS

Executive Summary iii

Table of Contents v

List of Figures vi

List of Tables vii

1. Introduction 1

1.1 The OTEC Concept 1

1.2 The OTEC Legal Regime 2

2. Environmental Data 3

2.1 Bathymetry 3

2.2 Water Masses 6

2.3 Water Temperature 9

2.4 General Circulation 30

2.5 The Loop Current 40

2.6 Winds 46

2.7 Cold Fronts (Extratropical Cyclones) 102

2.8 Tropical Storms and Hurricanes 105

2.9 Waves 111

Acknowledgement 208

References 209

Appendix. Data Sources 213

List of Figures

	Page
Figure 1. Bathymetry of the Gulf of Mexico (from Nowlin, 1972).	5
Figure 2. Mean monthly isotherms (°C) for the surface, 300 ft. (91.5 m), and 492 ft (150.0 m), and mean depth (in feet) of the 20°C isotherm (from Robinson, 1973).	11
Figure 3. Mean monthly temperature difference (°C) between 0 and 1000 m (from Molinari and Festa, 1978).	23
Figure 4. Location of 1° squares in the Gulf of Mexico for which temperature-depth data are presented in Table 2.	26
Figure 5. Estimated average speed (knots) of surface currents in the Gulf of Mexico for winter (February) and summer (August) (based on U.S. Naval Oceanographic Office Pilot Charts; from Nowlin, 1971).	31
Figure 6. Surface current roses by region within the Gulf of Mexico for winter and summer (from U.S. Department of Commerce, 1973).	32
Figure 7. Mean current speed (knots) and direction by 1° squares for winter (November - March) (from NODC Surface Current Data System, 1850-1974).	36
Figure 8. Mean current speed (knots) and direction by 1° squares for summer (April - October) (from NODC Surface Current Data System, 1850-1974).	38
Figure 9. Penetration of the Loop Current into the Gulf of Mexico versus time of year (derived from synoptic temperature data; penetration measured by the northern limit of the 150 m isobath of the 20°C isothermal surface; the category "others" includes the Leipper, Cochrane, Maul, and AOML cycles where they repeat themselves; from Behringer, Molinari, and Festa, 1977).	41
Figure 10. Sample observed positions of the Loop Current (from Ocean Data Systems, Inc., 1977a).	42
Figure 11. Percent frequency by month of the location of Loop Current water based on NOAA VHRR data for 1973-1977 (insufficient thermal contrast for June-October; from Vukovich et. al., 1978).	43
Figure 12. Mean monthly wind roses for the Gulf of Mexico (from U.S. Naval Oceanographic Office Pilot Charts, 1980).	48

Page

Figure 13. Location of 16 selected 1° squares in the Gulf of Mexico for which wind and wave data are presented in Tables 5, 7 and 8. 53

Figure 14. Tropical storms and hurricanes by month in the Gulf of Mexico, 1886-1957 (no occurrences, January - May; from Brower, Meserve, and Quayle, 1972). 106

List of Tables

Table 1. Water masses of the Gulf of Mexico and adjacent regions as related to particular features in the distributions of density and other properties (from Morrison and Nowlin, 1977). 8

Table 2. Most probable monthly values of temperature versus depth for selected 1° squares in the Gulf of Mexico based on historical data (from Ocean Data Systems, Inc., 1977a, 1977b, 1977c). 27

Table 3. Characteristics of the Loop Current (U.S. Department of Commerce, 1973). 41

Table 4. Mean monthly wind speed (m/s) and direction for west Florida coastal and northern Gulf areas (from Molinari and Festa, 1978; based on Hastenrath and Lamb, 1977). 52

Table 5. Percent frequency of wind direction and speed by month for selected 1° squares in the Gulf of Mexico (from NCC Surface Marine Observations Data Base, 1800-1975). 54

Table 6. Average properties of cold fronts observed in the eastern Gulf of Mexico from 1954 through 1963 (from Molinari and Mayer, 1980; based on Fernandez-Partegas and Mooers, 1975). 104

Table 7. Percent frequency of wave direction and height by month for selected 1° squares in the Gulf of Mexico (from NCC Surface Marine Observations Data Base, 1800-1975). 112

Table 8. Percent frequency of wave period and height by month for selected 1° squares in the Gulf of Mexico (from NCC Surface Marine Observations Data Base, 1800-1975). 160

1. INTRODUCTION

Ocean Thermal Energy Conversion (OTEC) is a technology under active development in the United States and other countries as a potential new energy source. OTEC powerplants exploit the temperature differential between near-surface and deep waters to generate electricity. Because the efficiency of this operation depends on the magnitude of this temperature difference --the so-called "OTEC thermal resource"--commercial OTEC operations are feasible only in tropical and subtropical waters (roughly 30°N to 30°S) where cold deep waters are overlain by a very warm surface layer. U.S. investigators have thus far concentrated their attention on potential OTEC sites off the Hawaiian Islands, the Virgin Islands, and Puerto Rico and in the Gulf of Mexico.

This guide was developed to bring together existing data and information that characterize the OTEC physical operating environment in the Gulf of Mexico. It establishes a climatology for the Gulf that defines the typical conditions under which an OTEC powerplant can expect to be operated and maintained. Extreme events are also considered as a guide to engineers and designers who must plan for safety and long-term OTEC plant survival. The scope of this document is limited to describing the physical environment and biological information has accordingly not been included.

1.1 The OTEC Concept

OTEC powerplants rely on the energy of the sun--not directly on solar radiation, but on solar energy stored as heat in the vast reservoir of the oceans. Like solar radiation, the OTEC thermal resource is renewable. It has the important advantage, however, of being equally available on sunny and cloudy days.

The closed-cycle OTEC process, the OTEC powerplant configuration that has received the most attention and study, illustrates how OTEC works. Warm surface water is pumped over heat exchanger coils containing a working fluid such as Freon or ammonia. The working fluid vaporizes and turns a turbine that drives an electric generator. The vapor is then condensed in coils cooled by water pumped up from depth (2000 to 3000 feet) and recirculated to continue the process. This process is the Rankine cycle of classical thermodynamics.

Whether constructed as a land-based facility, an anchored offshore platform, or a moored or free-floating hull, an OTEC plant requires a large-diameter cold water pipe extending offshore or vertically down to withdraw a sufficient quantity of cold water from the deeper layers of the ocean.

A good introduction to OTEC concepts and issues, along with a basic background bibliography, is available in the brief summary report published by the Environmental Data and Information Service (EDIS) of the National Oceanic and Atmospheric Administration (NOAA) (U.S. Department of Commerce, 1979).

1.2 The OTEC Legal Regime

The Ocean Thermal Energy Conversion Act of 1980 (P.L. 96-320), which became law on August 3, 1980, defines the legal framework under which the construction, location, ownership, and operation of OTEC plants will be authorized, licensed, and regulated by the United States. Licensing and regulatory authority for OTEC operations is vested in the National Oceanic and Atmospheric Administration (NOAA) of the U.S. Department of Commerce. Within NOAA, this responsibility has been delegated to the Office of Ocean Minerals and Energy (OME).

NOAA's Office of Ocean Minerals and Energy has issued the OTEC Final Environmental Impact Statement (U.S. Department of Commerce, 1981a) required by the National Environmental Policy Act of 1969, as amended. In compliance with the provisions of Executive Order 12291 and the Regulatory Flexibility Act (P.L. 96-354), it has also prepared the OTEC Final Regulatory Impact Analysis and Final Regulatory Flexibility Analysis (U.S. Department of Commerce, 1981b). Finally, it has prepared and published in the Federal Register the Final Rule for Licensing of Ocean Thermal Energy Conversion Facilities and Plantships (U.S. Department of Commerce, 1981c). These documents address the environmental issues, rulemaking procedures, and details of the licensing system for ownership, construction, location, and operation of OTEC plants that are associated with the United States or U.S. citizens.

2. ENVIRONMENTAL DATA

This section presents data on Gulf of Mexico climatology and extreme conditions. Separate subsections are devoted to phenomena and conditions that define the OTEC operating environment. The text is intentionally brief and intended to amplify and provide sufficient background information for proper interpretation of the figures and tables, which provide a summary of available environmental data about the Gulf.

2.1 Bathymetry

The bathymetry (water depth) of the Gulf of Mexico will influence OTEC operations in two ways. First, Gulf bathymetry defines the areas of sufficient depth for the water column to provide an adequate temperature difference between the surface and deeper layers. Given the temperature structure of Gulf waters, a depth of at least 1000 m is generally assumed necessary to provide the temperature difference required for successful OTEC plant operation. Second, bathymetry affects OTEC plant operations indirectly through influences on the hydrographic and dynamic characteristics of Gulf waters. Bathymetry strongly affects water mass distribution, currents, eddies, waves, and other phenomena.

Information on the bathymetry and submarine geology of the Gulf of Mexico has been summarized by a number of authors including Shepard (1973). Figure 1 (after Nowlin, 1972) presents the generalized bathymetry of the Gulf of Mexico with depth contours defining the shelf, slope, and basin regions.

The Gulf of Mexico has broad continental shelves along the west Florida and Texas-Louisiana coasts and flanking the north and west portions of the Yucatan Peninsula. Along the west Florida coast, the shelf is about 185 km wide. Although the shelf break (the sharp change in slope angle that often marks the outer edge of the continental shelf) is indefinite in this region, water depth over the shelf is generally less than 200 m.

The westernmost extreme of the west Florida continental shelf has one of the steepest continental slopes known. This is termed the Florida escarpment and is located roughly between 84°W and 87°W and 25°N and 29°N. Water depths vary from 1200 m to more than 3000 m in very short east-west distances across this feature.

At the northern end of the Florida escarpment the De Soto Canyon transects the continental shelf northeasterly in the general direction of Cape San Blas. This is a region of gentler slope than the Florida escarpment where the trend of the continental shelf changes from north-south to east-west. Immediately west of the De Soto canyon is the depositional feature termed the Mississippi cone which results from Mississippi river sediments deposited onto the continental shelf and slope regions.

The shelf narrows along the Mississippi-Alabama coast and, at the Mississippi Delta, is overlain by recent sediments. West of the present delta, the shelf is divided by a wide submarine trough that can be traced seaward for more than 100 km. Along the Texas-Louisiana border the shelf extends to a width of more than 200 km before narrowing toward the Mexican border.

In the southern part of the Gulf, the Yucatan (Campeche) shelf extends up to 200 km out from the north and west sides of the Yucatan Peninsula. In the Bay of Campeche the shelf narrows and is only about 35 km wide along the east coast of Mexico.

The basin floor of the Central Gulf is generally of low relief and lies at depths greater than 3000 m. A submarine cone of Mississippi River sediments descends from the Mississippi trough to abyssal depths. The Sigsbee Abyssal Plain, which lies in the west central part of the Gulf, is one of the flattest sea floor regions known. Extending northward from the Bay of Campeche is a series of diapiric structures that terminate in the Sigsbee Knolls, which trend toward the northeast across the middle of the Sigsbee Abyssal Plain and rise as much as 330 m above the ocean floor.

The Gulf connects to the Caribbean Sea through the Yucatan Channel and to the Atlantic Ocean though the Straits of Florida. Greatest depths in the Yucatan Channel are nearly 2000 m, while in the Straits of Florida they range from 800 to 1,000 m.

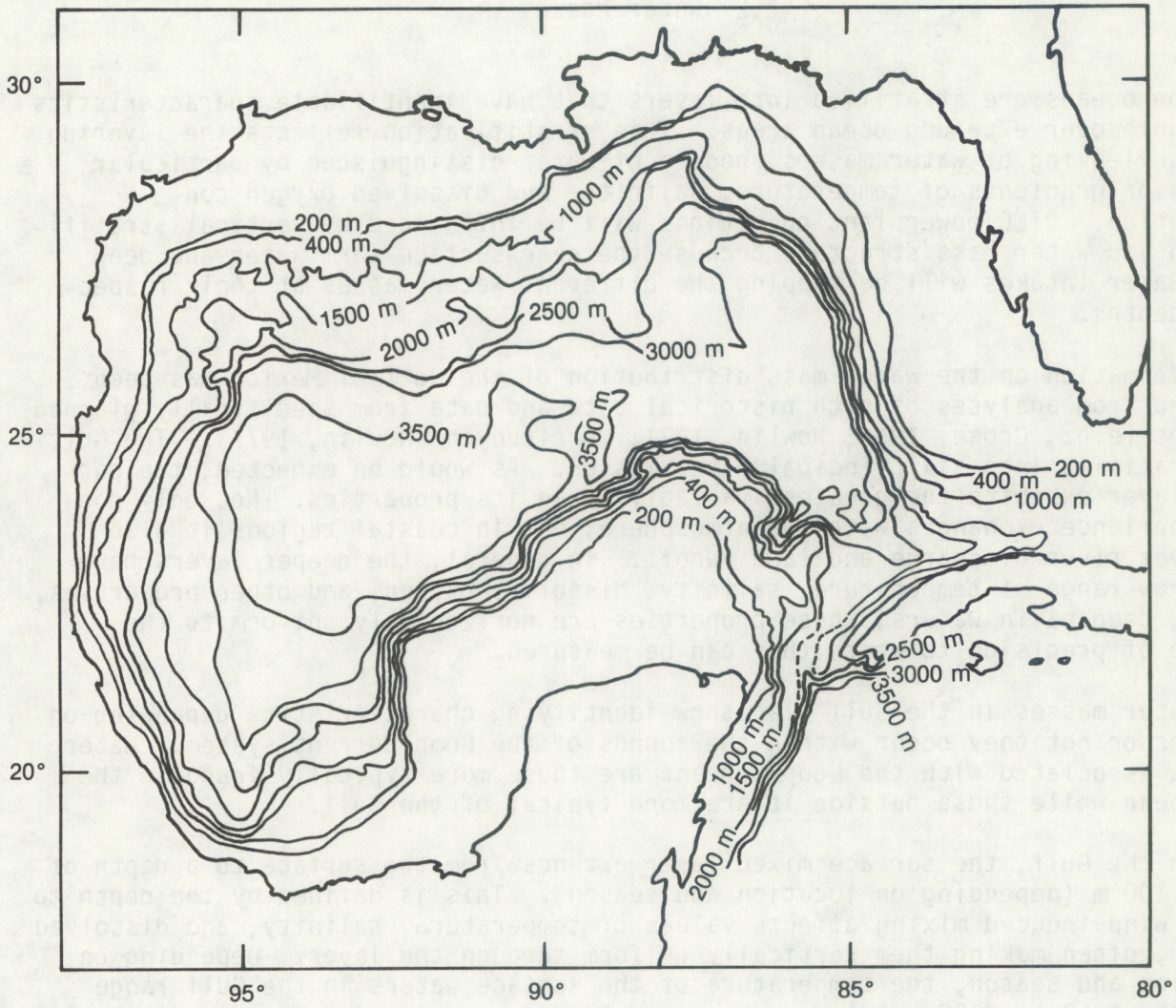


Figure 1. Bathymetry of the Gulf of Mexico (from Nowlin, 1972).

2.2 Water Masses

The oceans are stratified into layers that have identifiable characteristics traceable over extended ocean areas. This stratification reflects the layering or interleaving of water masses, bodies of water distinguished by particular values or gradients of temperature, salinity, and dissolved oxygen concentration. OTEC powerplant operations will be influenced by vertical stratification and water mass structure because the near-surface warm water and deep cold water intakes will be tapping the different water masses at their respective depths.

Information on the water mass distribution of the Gulf of Mexico has been derived from analyses of both historical data and data from specifically planned cruises (e.g., Grose, 1966; Nowlin, 1971; Morrison and Nowlin, 1977). The Gulf is stratified into six principal water masses. As would be expected, the surface layer exhibits the greatest variability in its properties. Not only does it experience exchanges with the atmosphere, but in coastal regions it also receives river discharge and land runoff. In general, the deeper layers have a narrow range of temperature, salinity, dissolved oxygen, and other properties. In the deep basin waters, these properties are horizontally uniform to the degree of precision to which they can be measured.

Water masses in the Gulf also show identifying characteristics depending on whether or not they occur within the bounds of the Loop Current system. Water masses associated with the Loop Current are those more typically found in the Caribbean while those outside it are more typical of the Gulf.

In the Gulf, the surface mixed layer extends from the surface to a depth of 50 to 100 m (depending on location and season). This is defined by the depth to which wind induced mixing affects values of temperature, salinity, and dissolved oxygen, often making them vertically uniform through the layer. Depending on location and season, the temperature of the surface waters in the Gulf range from about 17 to 29°C. Salinity has an extreme range varying from less than 30‰ (‰ reads "parts per thousand") along the northern coast to more than 37‰ in the central-western portion during summer. In open Gulf waters, however, values of surface salinity are typically 36.0 to 36.5‰.

Beneath the surface waters, at a depth of about 150 to 250 m, is the water mass designated by Wust (1964) as the Subtropical Underwater (SUW). This water mass is characterized by a salinity maximum in the Gulf. In Caribbean-type waters, this maximum reaches extreme values of 36.70 to 36.80‰, while in Gulf-type waters, it reaches only 36.45‰. In this layer, temperature ranges from about 24°C down to 18°C.

From about 400 to 700 m is the layer of oxygen minimum. The temperature at the core of the oxygen minimum is characteristically near 10°C.

Originating as a cold, relatively fresh water mass at the Antarctic Convergence, the remnant of Antarctic Intermediate Water (AAIW) can be identified in the Gulf as the layer of salinity minimum that occurs between about 700 to 1200 m. Properties of this water mass are nearly uniform throughout the Gulf with temperature in the range of 5.5 to 7.5°C and salinity near 34.89‰.

From the bottom of the Antarctic Intermediate Water to the depth at which the Gulf and Caribbean still communicate over the sill in the Yucatan Channel (about 2000 m), there is a water mass called the North Atlantic Deep Water (NADW). In this water mass temperature is near 4.0 to 4.5°C and salinity is very near 34.97‰.

Finally, in the deepest part of the Gulf, bathymetrically isolated from the Caribbean and Atlantic, there is Gulf Basin Water, a water mass with essentially uniform temperature, salinity, and oxygen content. The temperature of this layer is near 4°C.

From an analysis of variation of oxygen concentration, Morrison and Nowlin (1977) have shown that Caribbean-type waters (within the Loop Current) display a relative oxygen maximum within the oxygen minimum layer. They identify this water mass (with temperatures near 17.3°C and salinities near 36.3‰) as one previously denoted as 18°C Sargasso Sea Water.

Table 1 summarizes some of the characteristic identifying features of water masses in the Gulf of Mexico.

Table 1. Water masses of the Gulf of Mexico and adjacent regions as related to particular features in the distributions of density and other properties (from Morrison and Nowlin, 1977).

σ_0 mg cm^{-3}	σ_1 mg cm^{-3}	Depth Range (meters)	Feature	Values	Water Mass
25.40	30.70	150-250	Salinity Maximum	36.70-36.80 ‰	*SUW
26.50	30.80	200-400	Oxygen Maximum	3.60-3.80 ml l^{-1}	18°C Sargasso Sea Water
27.15	31.65	400-700	Oxygen Minimum	2.85-3.25 ml l^{-1}	
27.40	31.95	700-900	Phosphate Maximum	1.8-2.5 μg-at l^{-1}	**AAIW
27.50	32.10	800-1000	Salinity Minimum	34.88-34.89 ‰	**AAIW
27.70	32.30	900-1200	Silicate Maximum	23-25 μg-at l^{-1}	**AAIW
27.80	32.40		Silicate Minimum	15-20 μg-at l^{-1}	†NADW
27.85	33.00		Phosphate Minimum	1.2-1.3 μg-at l^{-1}	†NADW

(Note: In this table, water density is specified by values of σ_t (sigma-t), which is related to density by the equation $\sigma = (\rho-1) \times 10^3$. Parameters σ_0 and σ_1 are defined by this relation where ρ is the potential density relative to the surface and to a depth at which the pressure is 1000 decibars, i.e., the density that a water parcel would have if moved adiabatically from its in situ position to the sea surface or 1000 decibars, respectively.)

(* Subtropical Underwater)
(** Antarctic Intermediate Water)
(† North Atlantic Deep Water)

2.3 Water Temperature

Water temperature is the critical environmental parameter of concern to OTEC operations. As noted earlier, the OTEC concept depends fundamentally on the fact that the oceans maintain, through complex physical and dynamical processes, a strong vertical temperature gradient. It is accepted that a temperature difference (ΔT) of about 20°C - 23°C is required for efficient, economical OTEC operations. Through influence on rates of corrosion and biofouling, water temperature also has potential indirect effects on various aspects of plant operational efficiency and maintenance.

From tropical to temperate latitudes in the open oceans the vertical temperature gradient shows a characteristic pattern that defines three horizontal layers. From the ocean surface to a depth of perhaps 30 to 100 m, the mixed layer, the water is nearly isothermal. This layer is subject to direct atmospheric influences and is kept well-stirred by turbulence induced by the combined action of wind and waves.

In studies of potential OTEC sites 150 km south of Mobile, Alabama and 300 km west of Tampa, Florida, Molinari, Mayer, and Chew (1979) and Molinari and Mayer (1980) defined an "OTEC mixed layer" as the depth at which the temperature is 0.2°C lower than the sea surface temperature. Using this criterion, they found that during the period of their studies (July 1977 to November 1978 for the Mobile site and March 1978 to June 1979 for the Tampa site) the OTEC mixed layer depth ranged from 5 to 60 m at Tampa and from 18 to 200 m at Mobile.

Below the mixed layer, which receives direct solar heating, water temperature drops sharply and then decreases in a strong negative gradient. This is the layer of the main thermocline. From temperature profile data, Molinari, Mayer, and Chew (1979) and Molinari and Mayer (1980) show that the depth of the 12°C isotherm closely approximates the depth of the bottom of the thermocline at the Mobile and Tampa sites. During the respective study periods, the average depth of the thermocline at the Mobile site ranged from 282 to 343 m and at the Tampa site from 258 to 347 m. Below the bottom of the thermocline, at a depth of about 1000 m, the temperature again approaches isothermal conditions, decreasing only slightly with further depth. It is this water layer, where the temperature is about 5°C, that will be tapped as the OTEC cold water source. Since this temperature is nearly constant, it is the temperature of the surface mixed layer, reaching 25° to 30°C in the tropics, that essentially defines the magnitude of the OTEC thermal resource.

Figure 2 depicts the mean monthly isotherms (°C) for the Gulf of Mexico at selected water depths, and the mean depth of the (top of the) thermocline. The general atmospheric climate within the study area is subtropical. Sea surface temperatures range between 17°C (minimum) and 29°C (maximum).

The Gulf exhibits a strong change in thermal structure between winter and summer. In the northernmost regions surface isotherms generally trend east-west with observed temperature decreasing northward. Loop Current influence is apparent in southeastern Gulf surface temperatures and western gyre influence is also apparent in western and southwestern surface temperatures. Subsurface isotherms clearly show the influence of both of these features as well. The depth of the mixed layer (top of the thermocline) averages about 200 feet (61 m) in most areas. This depth is roughly twice that of the summer months of April through October as a result of stronger winds and wave-induced mixing in winter.

April marks the beginning of the establishment of the nearly isothermal sea surface temperature regime of summer. Increased solar heating results in the uniform sea surface temperature pattern that is especially noteworthy from July through September. Summer subsurface temperatures, which are not as strongly influenced by solar heating, never depart as much from the winter pattern. In October the tropical winter pattern of east-west trending horizontal isotherms begins to re-form.

Observations from satellite infrared and visible range sensors have shown that the seasonal development of sea surface temperature patterns in the Gulf follow a characteristic cycle (Huh et. al., 1978). Outbreaks of cold polar continental air first affect shallow coastal waters, which form a cold water band that expands seaward as winter progresses. At the extreme of winter cooling, thermal fronts mark the boundary between shelf and deeper waters and the warmer waters advected through the Yucatan Channel.

Temperature patterns in the Gulf of Mexico generally reflect the water circulation and currents. In the vicinity of the Yucatan Channel northward displacement of isotherms indicates the influence of the northward flowing Loop Current. Because the water being advected into the Gulf is more saline, as well as warmer, this current can be observed through the winter surface salinity distribution also. In the central and western Gulf, the circular pattern of isotherms (particularly evident at the surface from September through November) is evidence of a permanent gyre in this region. Data on the general circulation and the Loop Current are presented in Sections 2.4 and 2.5.

Figure 3 depicts the OTEC resource in the Gulf and its seasonal variability by presenting the mean monthly temperature difference between 0 and 1000 m. From December through April the temperature difference ranges from 15°C to 20-21°C in fairly uniform east-west trending isopleths that, like observed isotherms, show northward displacement in the Loop Current area. From May through November values of ΔT are larger, ranging from 19°C to greater than 24°C.

Figure 4 shows the location in the Gulf of three 1° squares for which data on the annual variation of temperature-depth profiles are presented in Table 2. This table gives the most probable monthly values of water temperature (°C) versus depth from the surface to 1500 m. The data show that water temperature below the main thermocline varies only slightly and that the annual variation in the magnitude of the OTEC thermal resource is almost solely determined by variation in temperature of water near the surface.

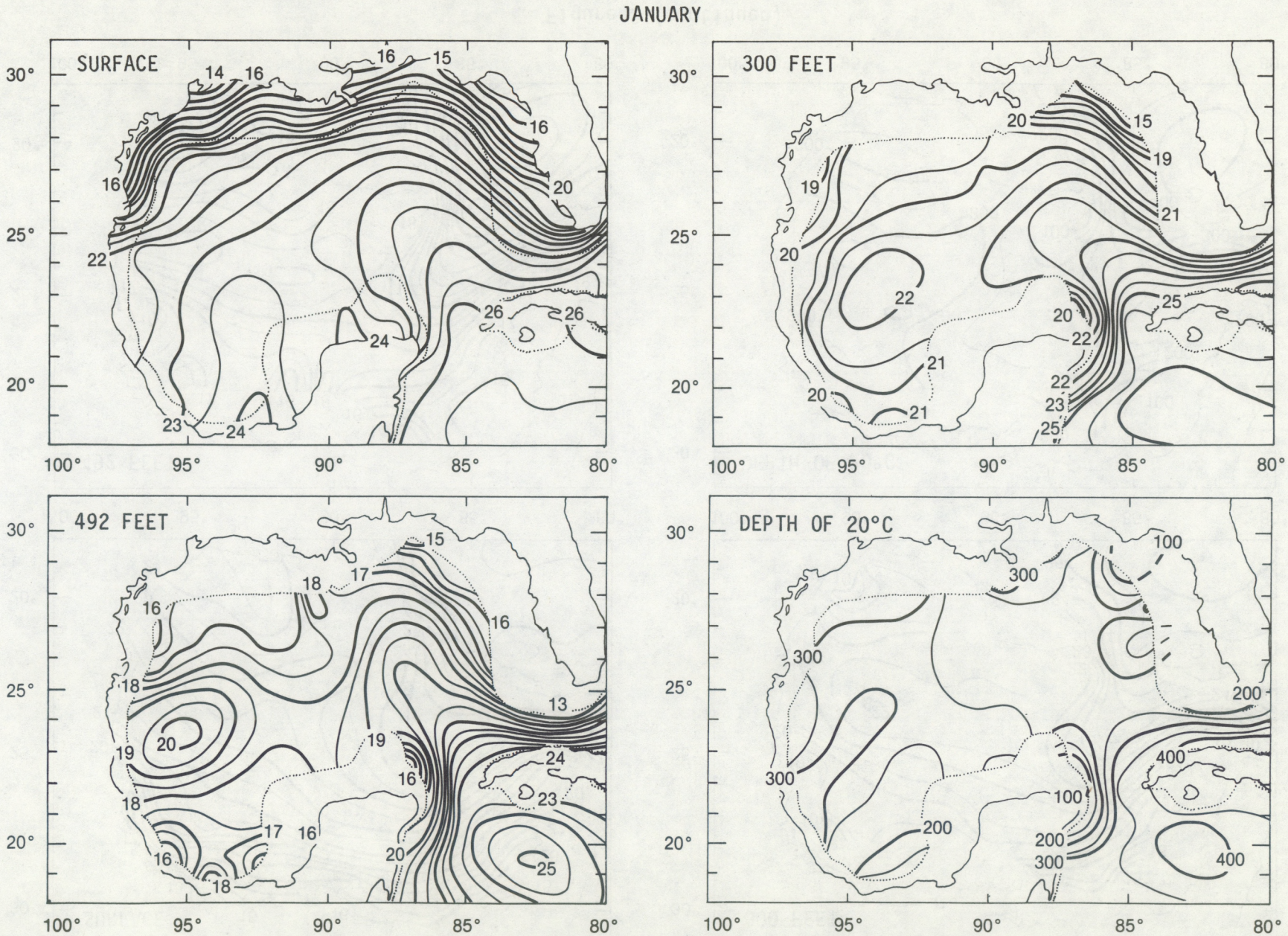


Figure 2. Mean monthly isotherms (°C) for the surface, 300 ft (91.5 m), and 492 ft (150.0 m), and mean depth (in feet) of the 20°C isotherm (from Robinson, 1973).

FEBRUARY

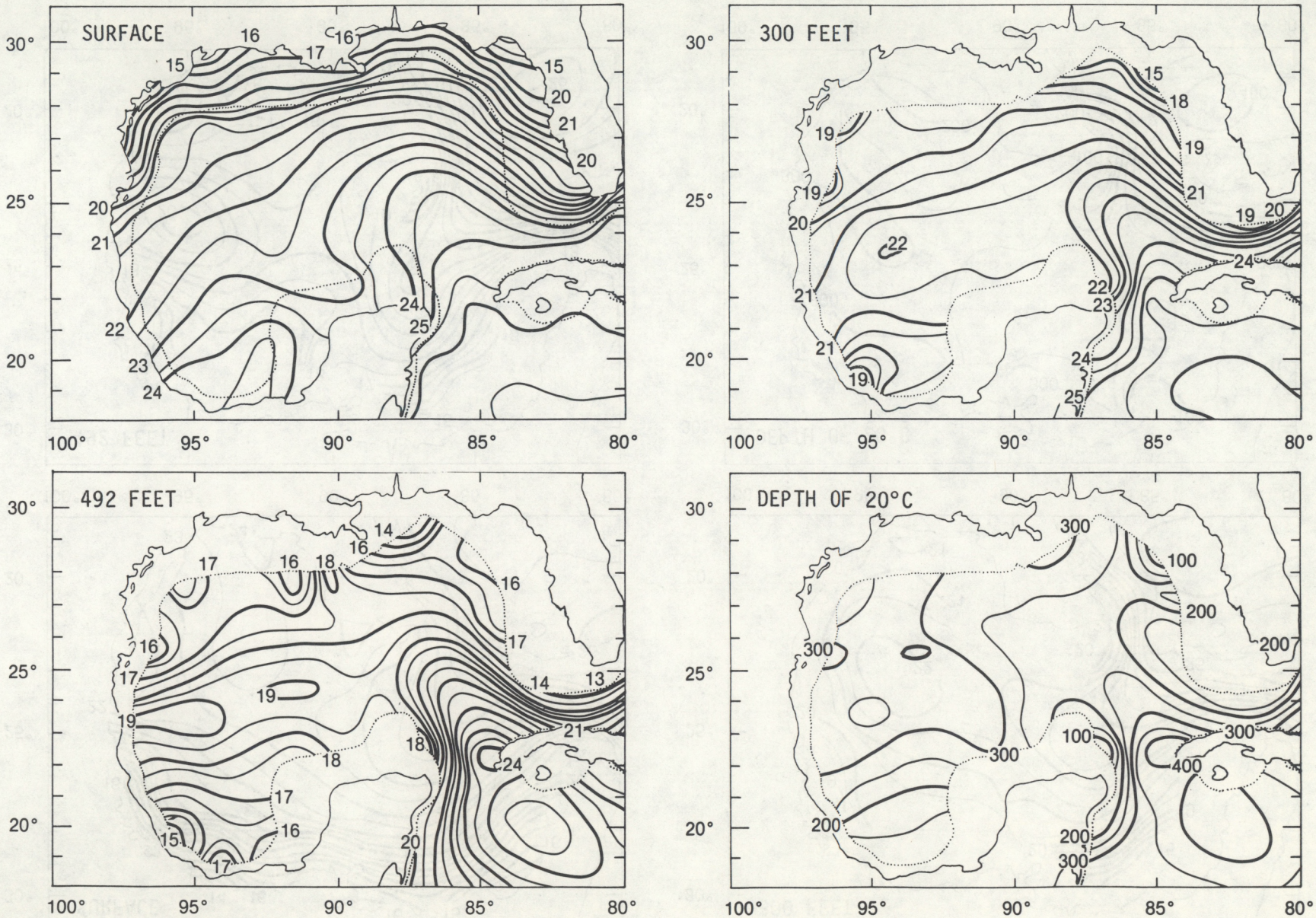


Figure 2 (continued)

MARCH

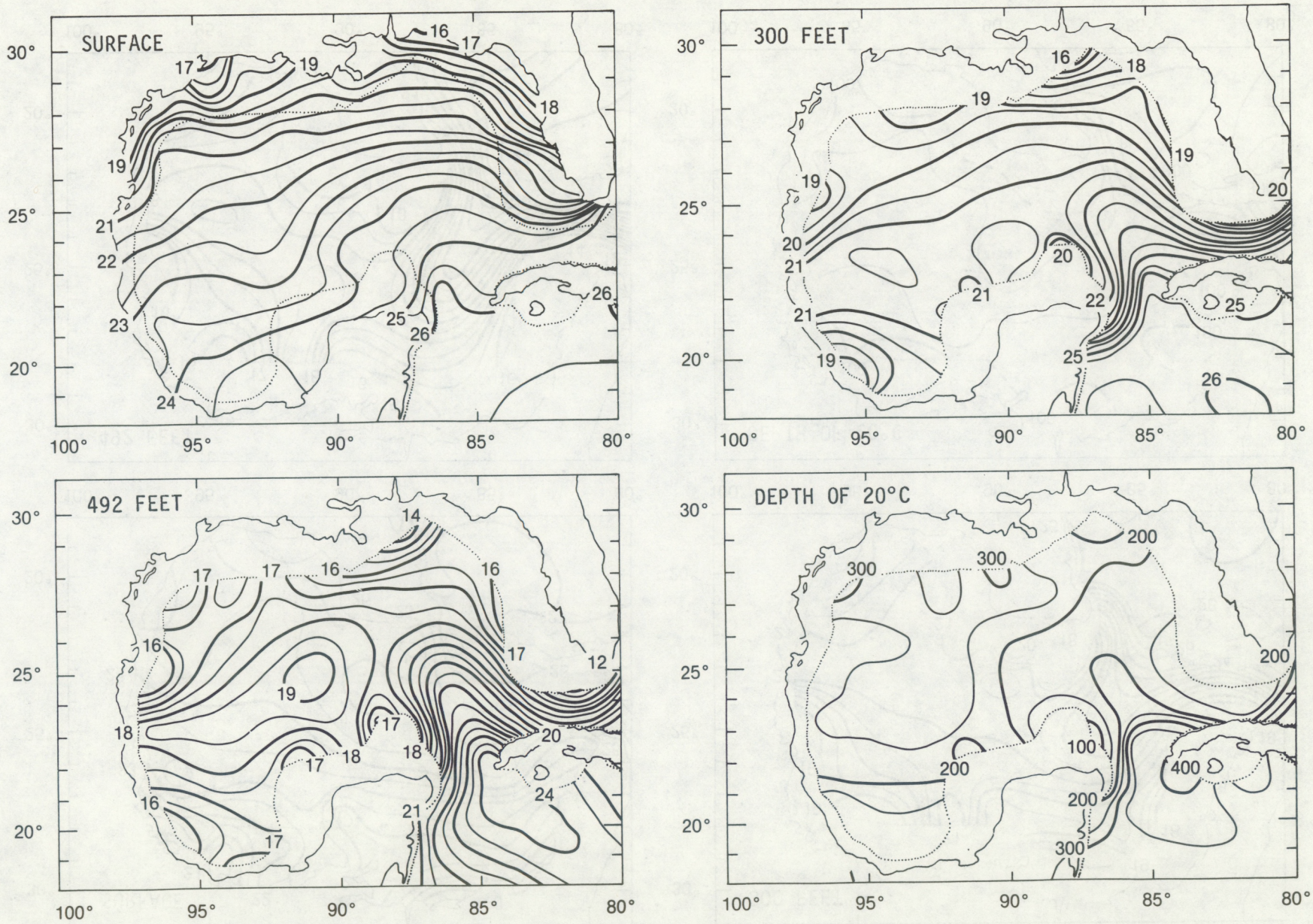


Figure 2 (continued)

APRIL

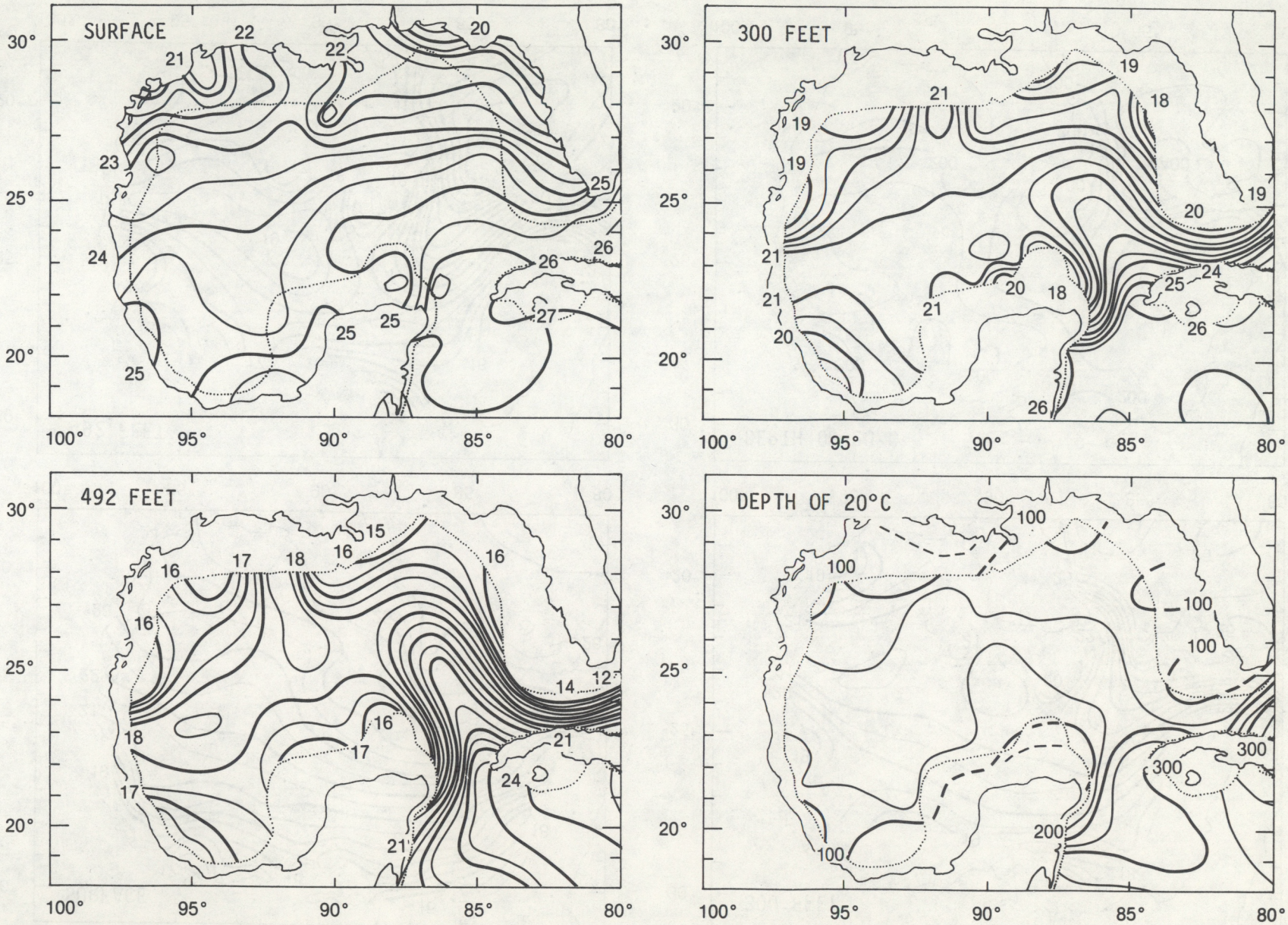


Figure 2 (continued)

MAY

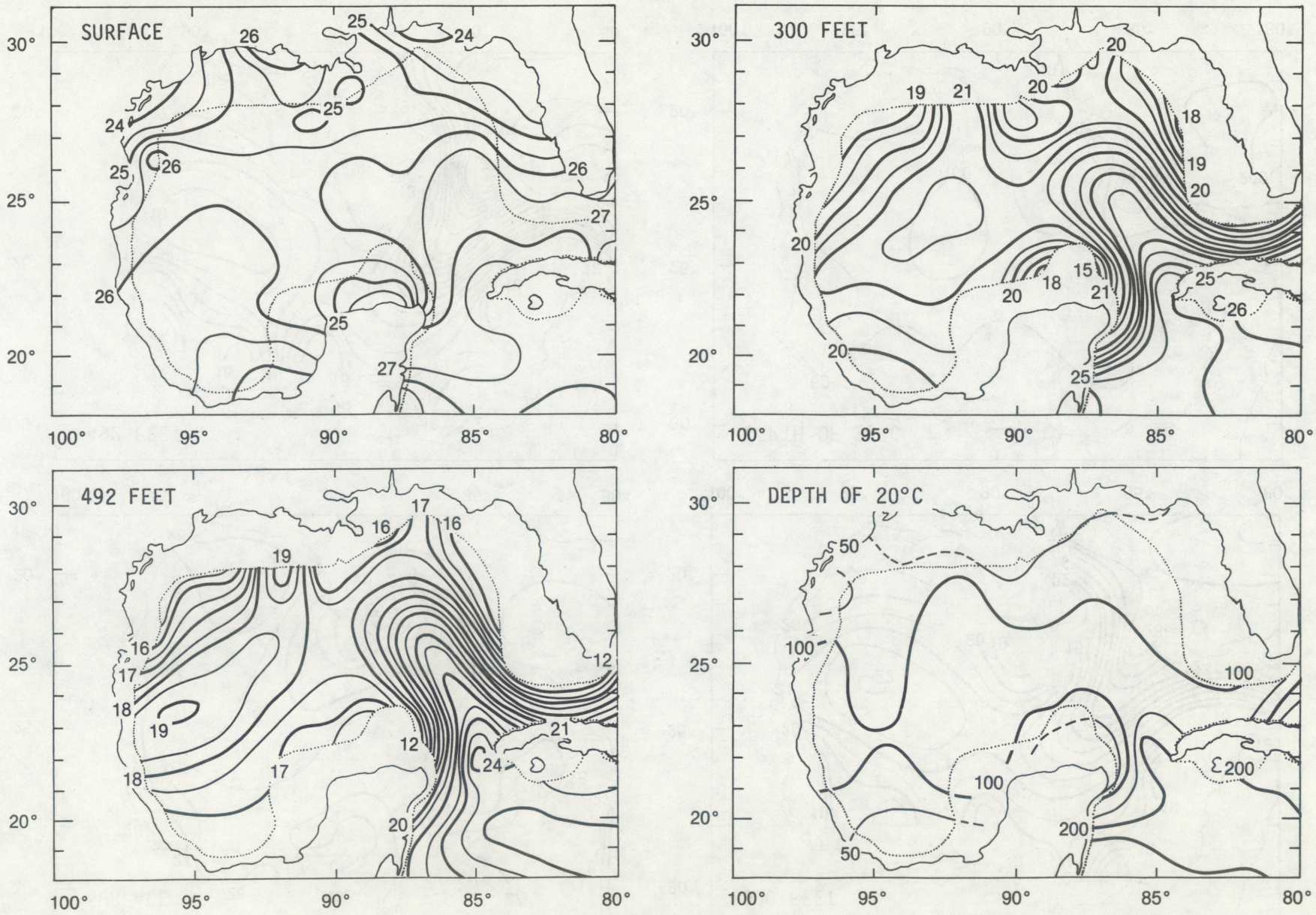


Figure 2 (continued)

JUNE

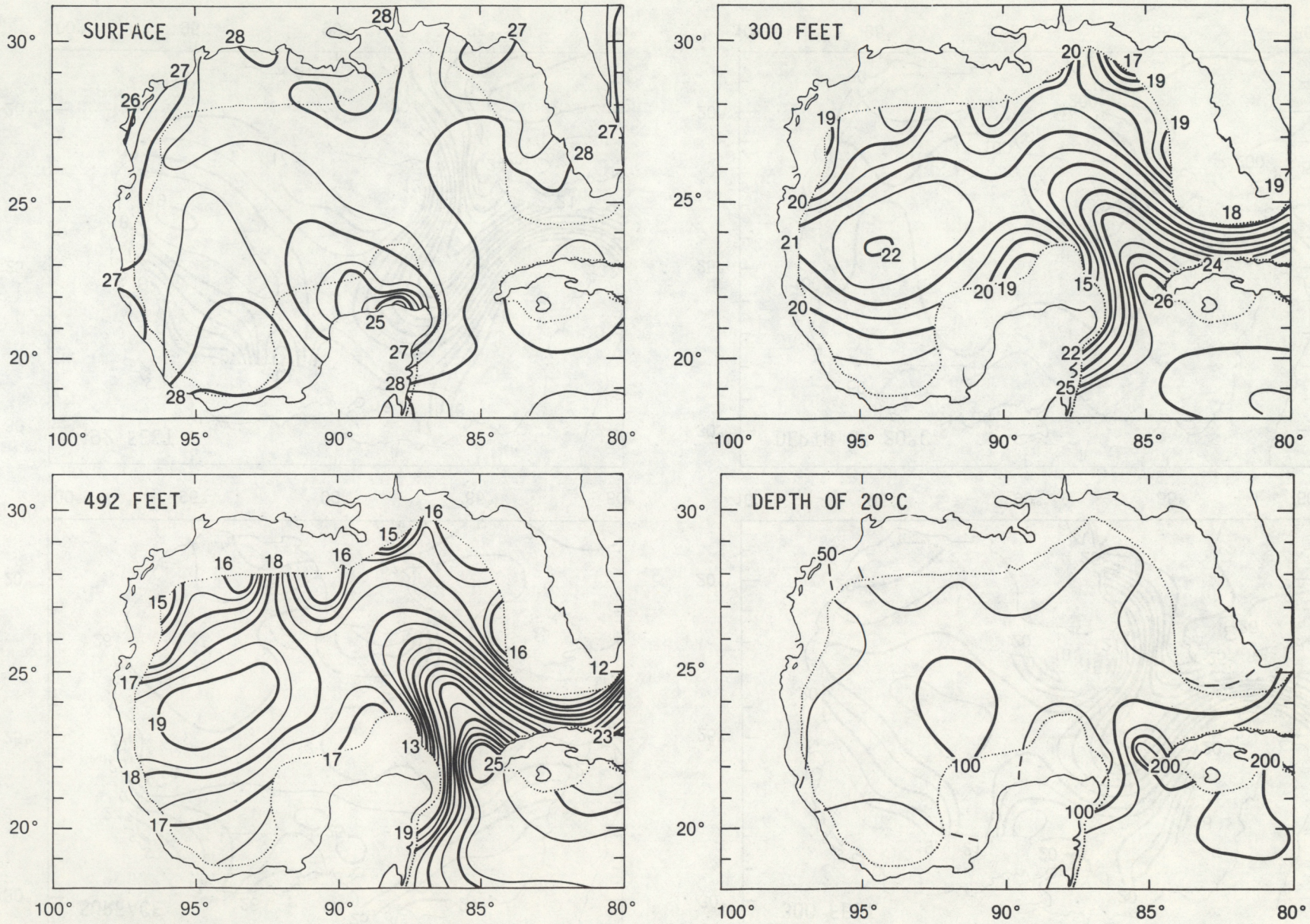


Figure 2 (continued)

JULY

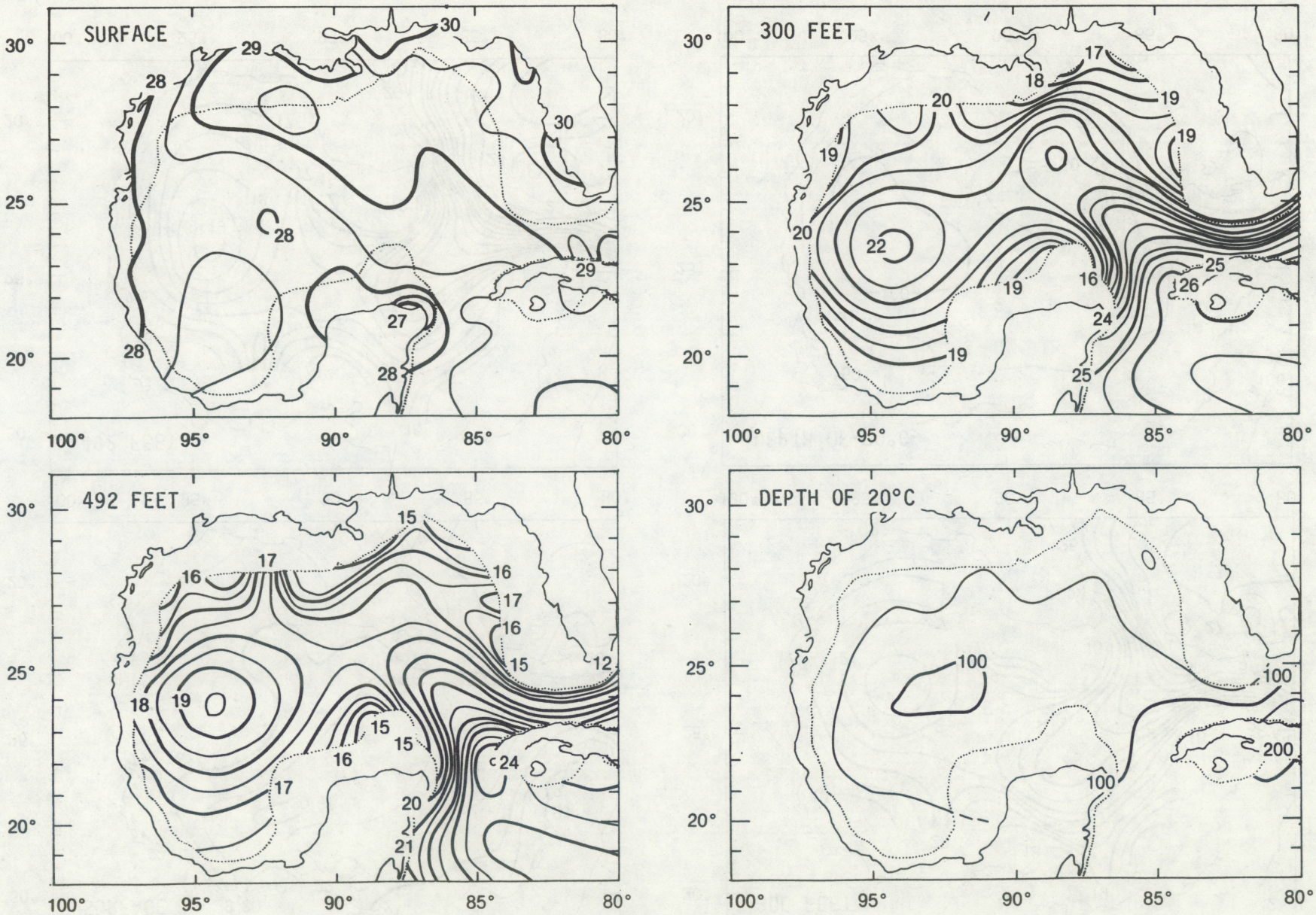


Figure 2 (continued)

AUGUST

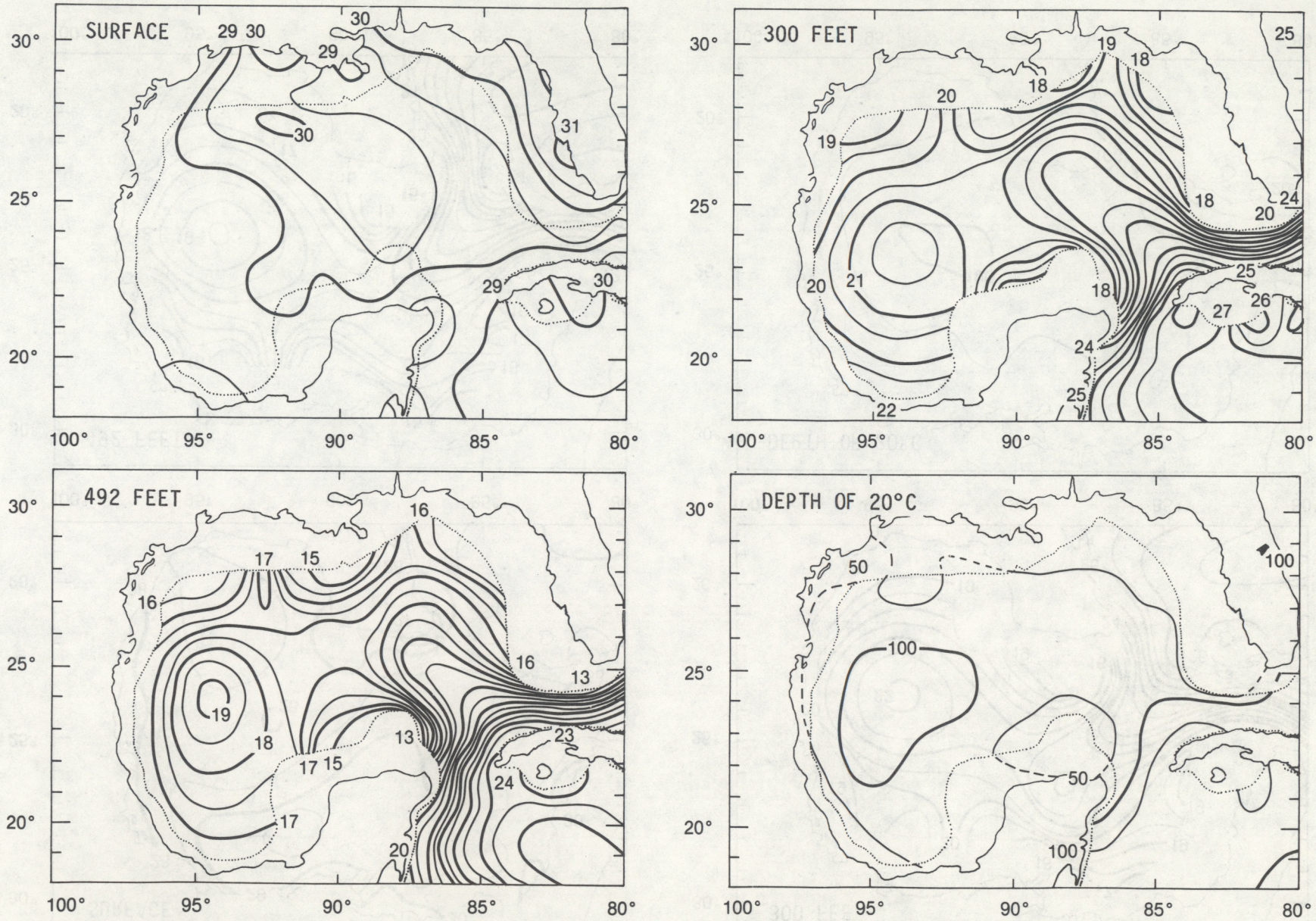


Figure 2 (continued)

SEPTEMBER

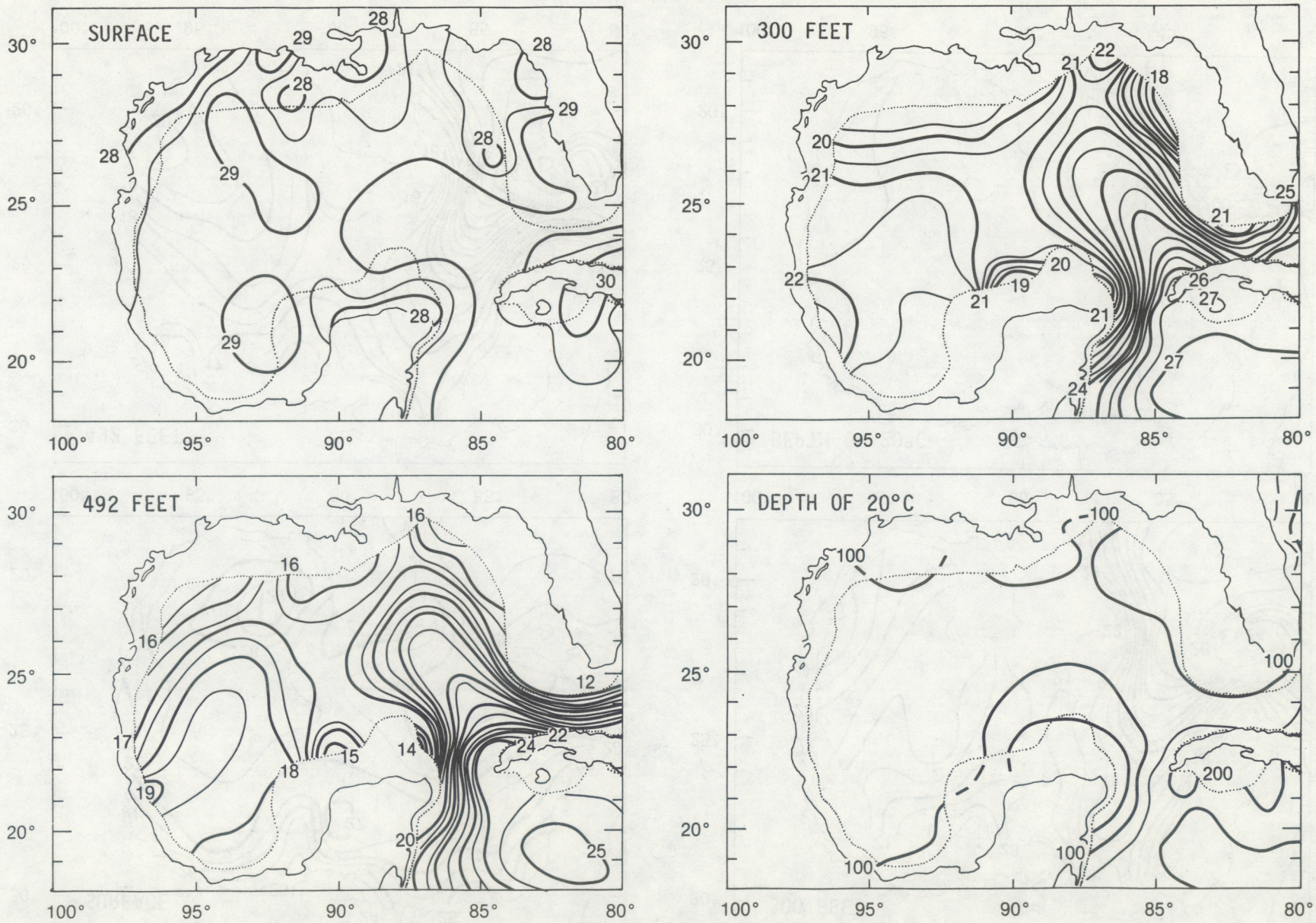


Figure 2 (continued)

OCTOBER

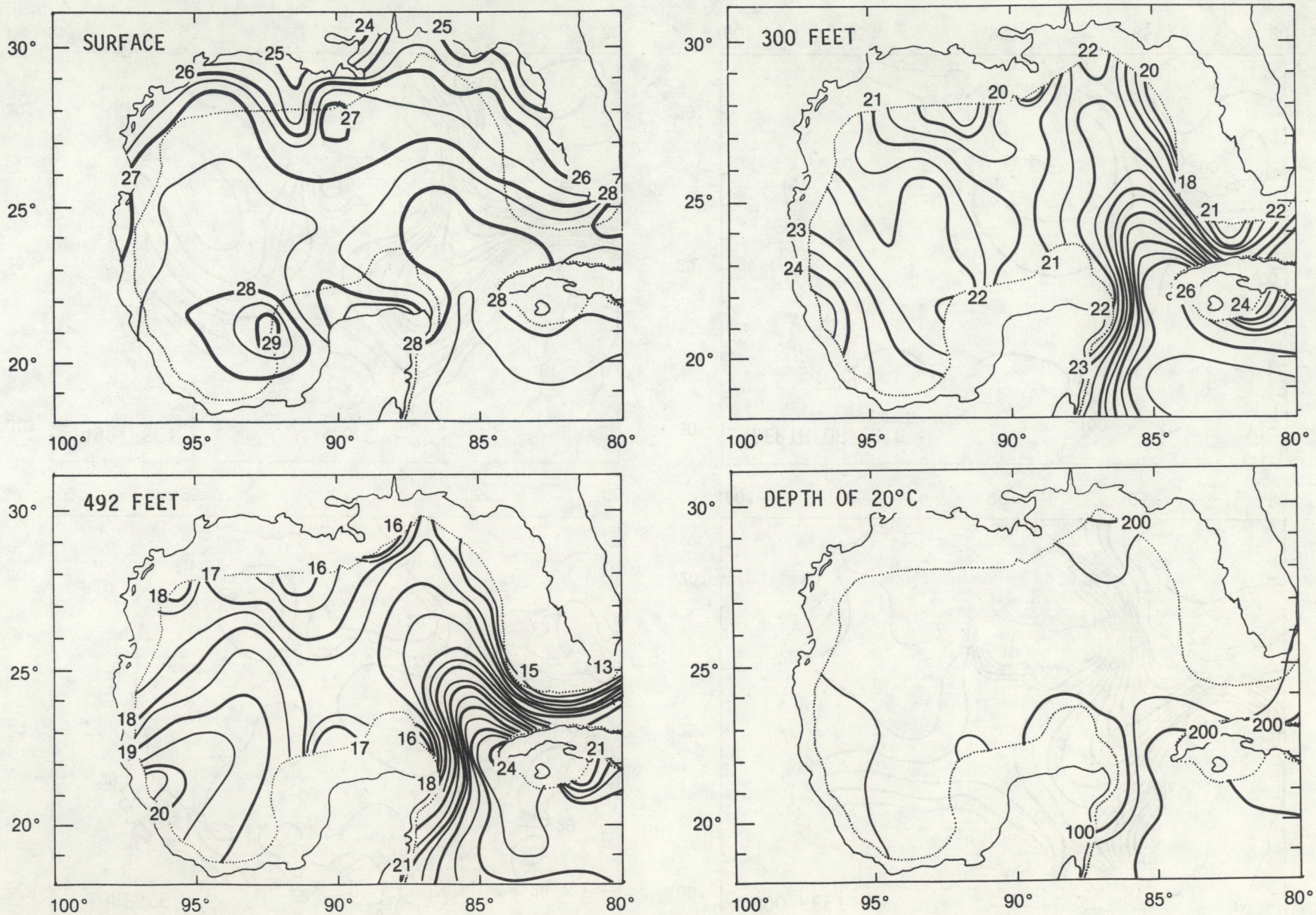


Figure 2 (continued)

NOVEMBER

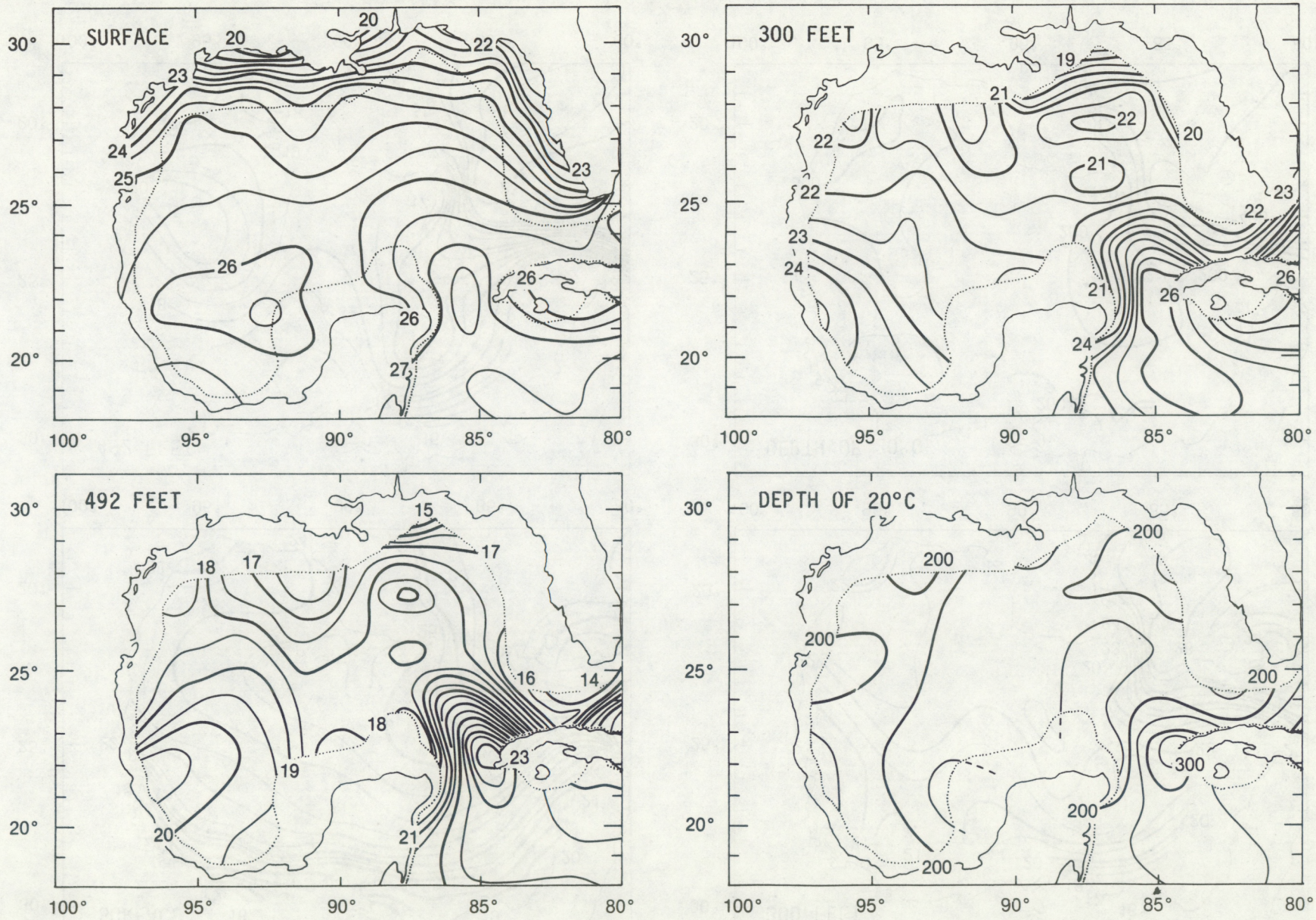


Figure 2 (continued)

DECEMBER

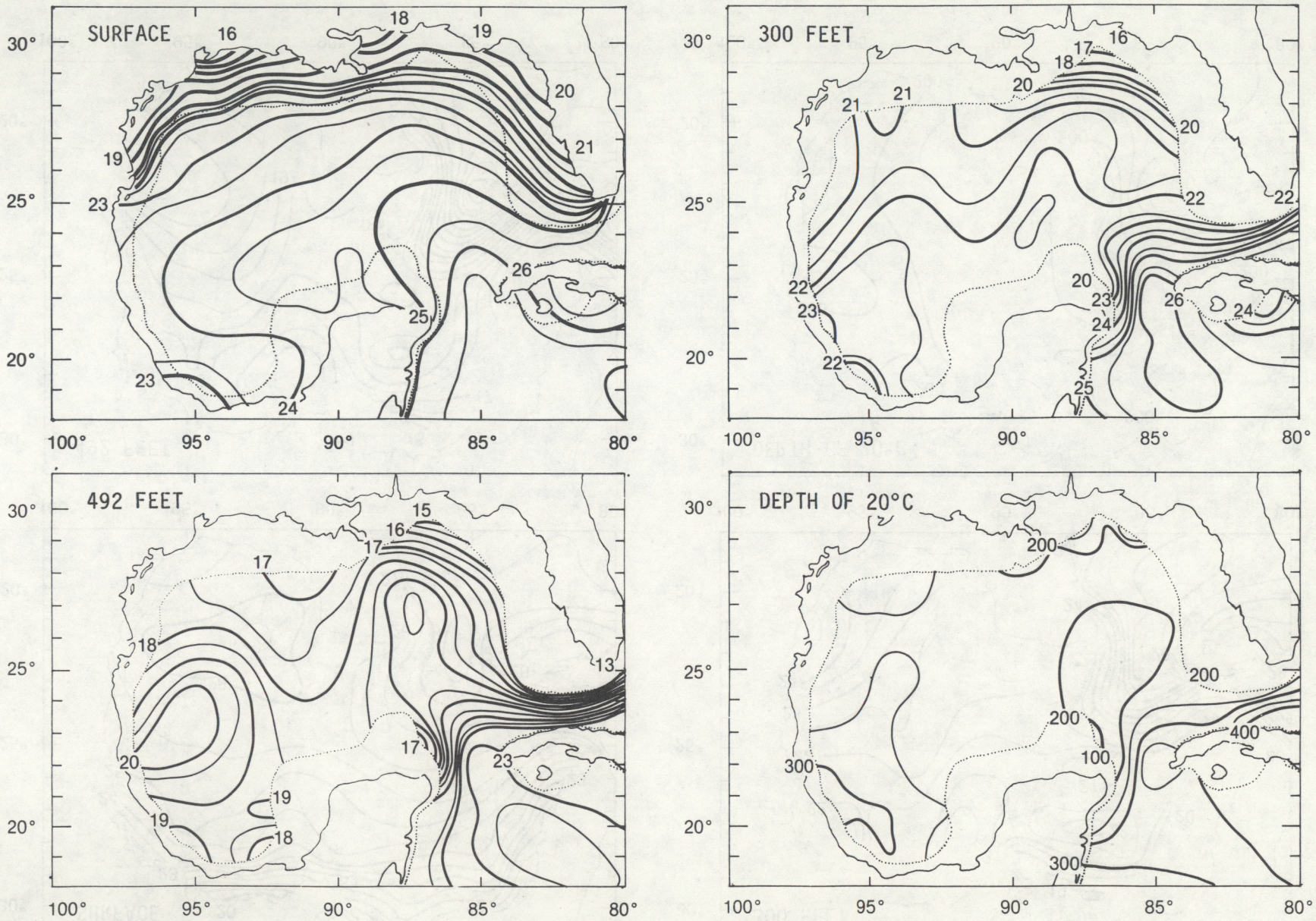


Figure 2 (continued)

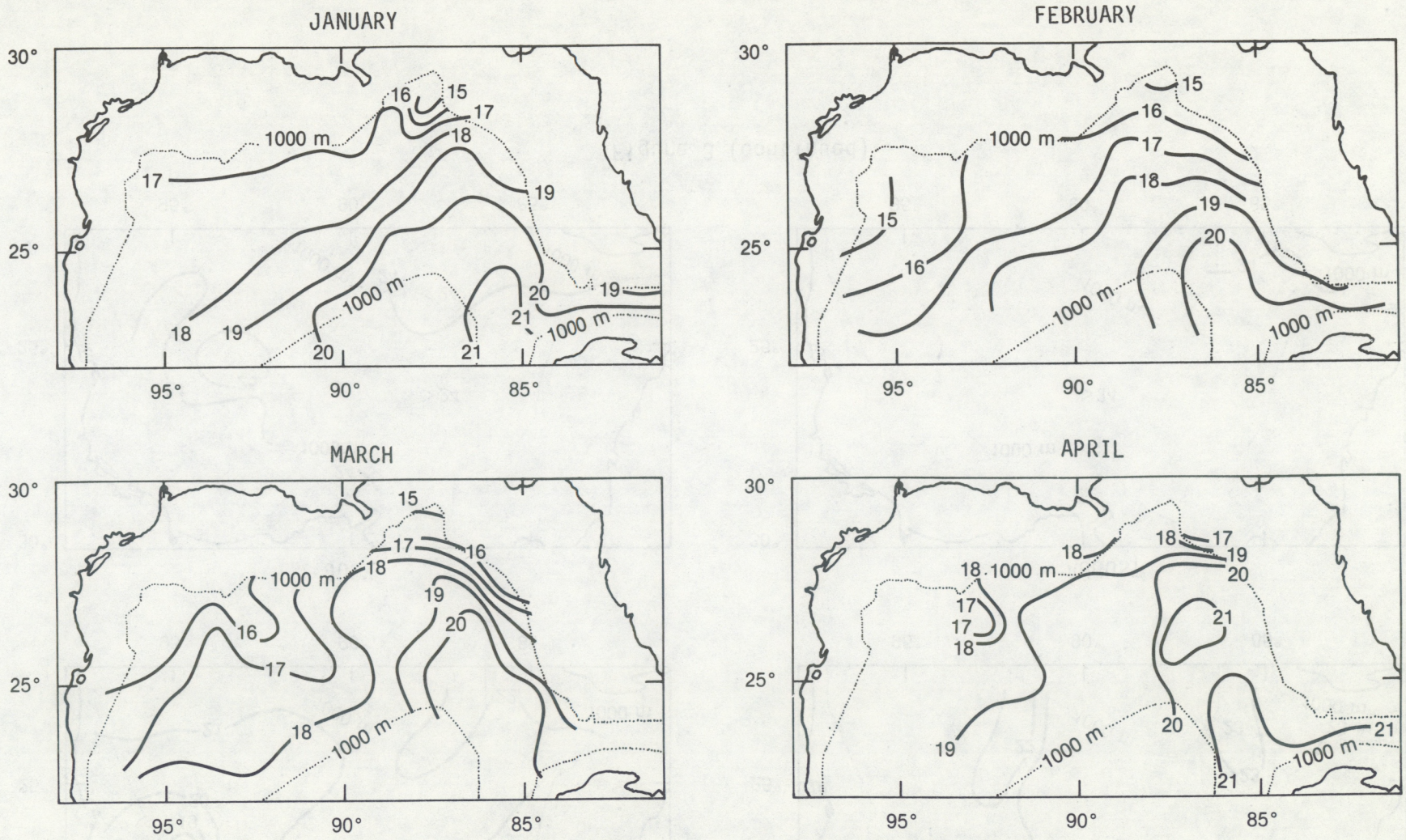


Figure 3. Mean monthly temperature difference (°C) between 0 and 1000 m (from Molinari and Festa, 1978).

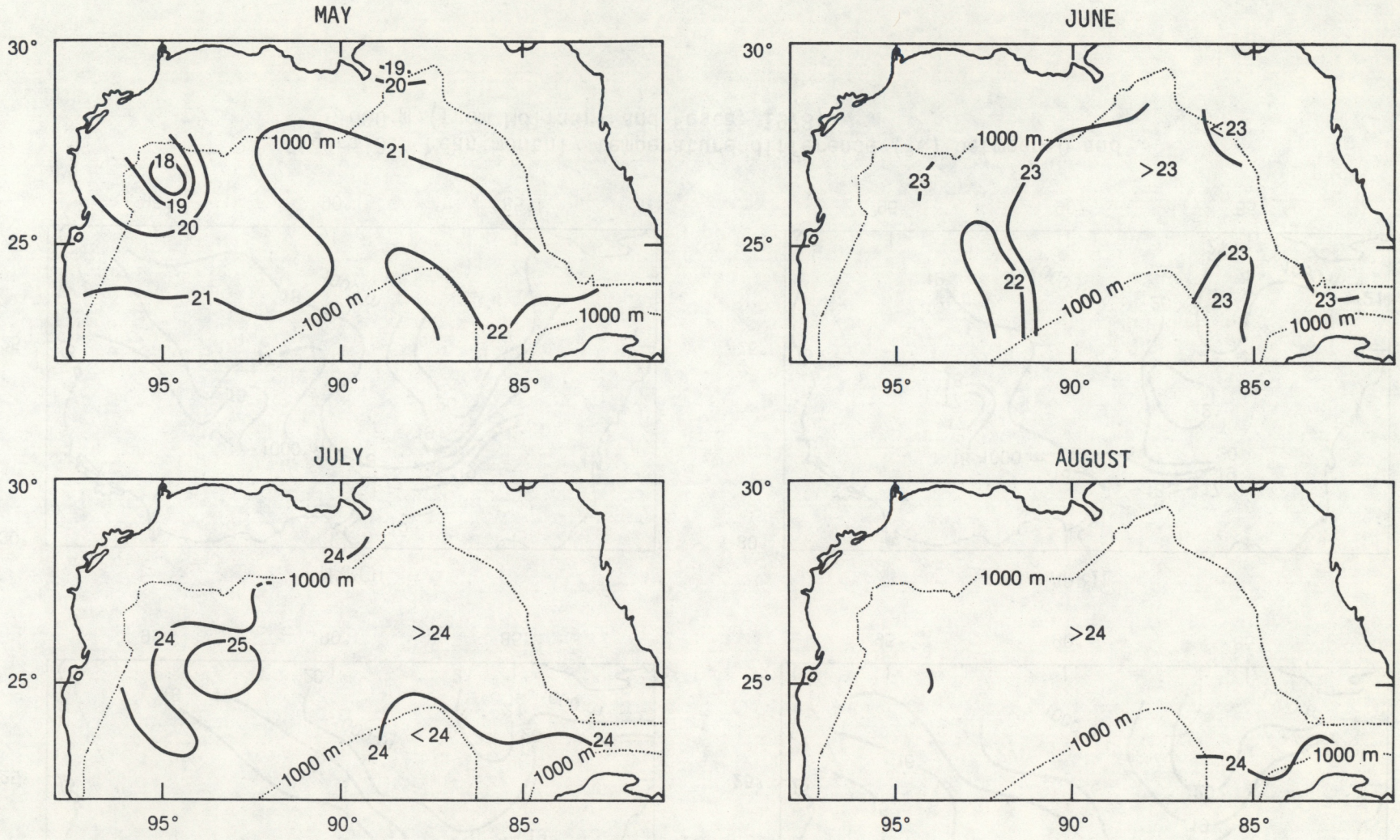


Figure 3 (continued)

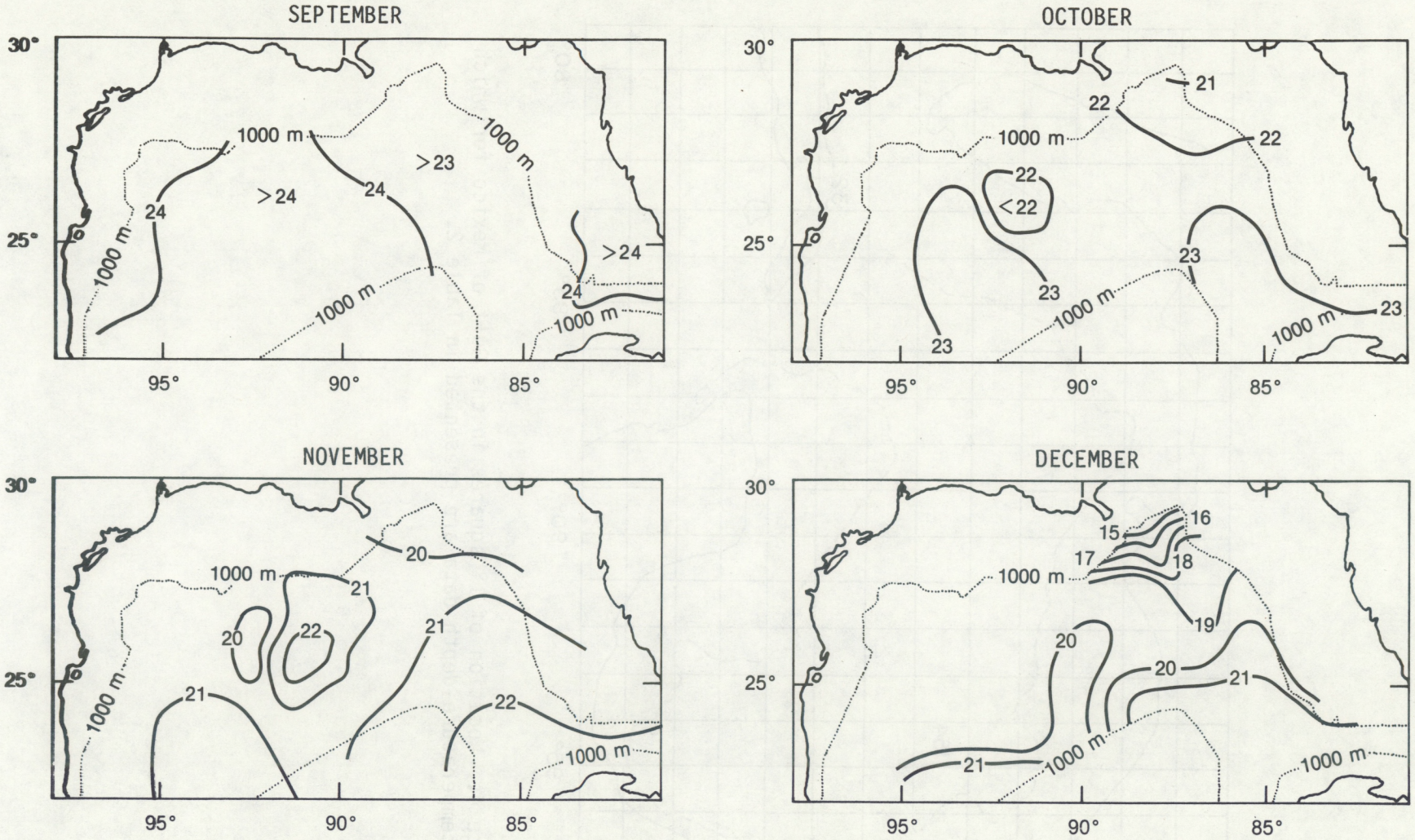


Figure 3 (continued)

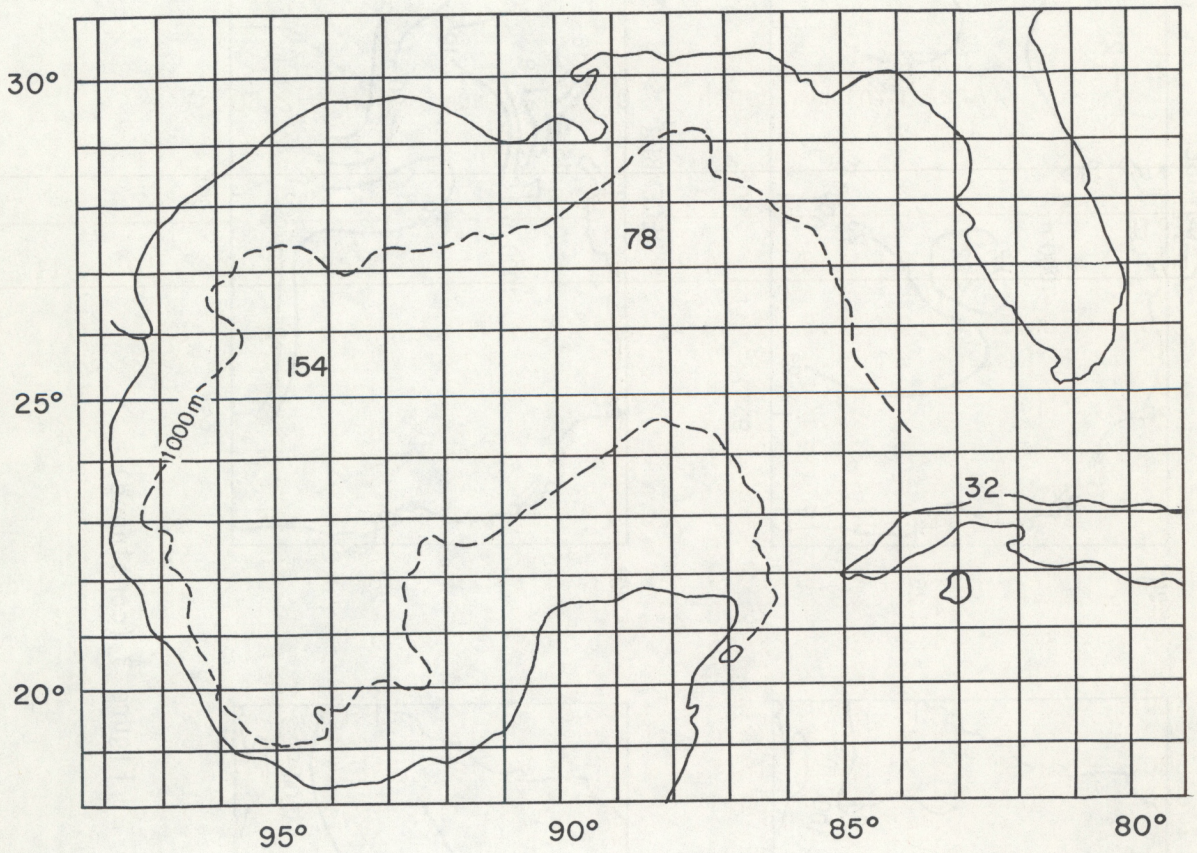


Figure 4. Location of 1° squares in the Gulf of Mexico for which temperature-depth data are presented in Table 2.

Table 2. Most probable* monthly values of temperature (°C) versus depth for selected 1° squares in the Gulf of Mexico based on historical data (from Ocean Data Systems Inc., 1977a, 1977b, 1977c).

Square 32
(Area minimum depth = 0 m; maximum depth = 2160 m)

DEPTH (m)	MONTH 1	2	3	4	5	6	7	8	9	10	11	12
0	26.2	24.9	24.9	25.7	26.8	28.8	29.5	29.5	28.6	28.3	27.3	27.0
10	26.2	24.9	24.9	25.7	26.8	28.8	29.5	29.5	28.6	28.3	27.3	27.0
20	26.1	24.8	24.9	25.7	26.8	28.8	29.5	29.5	28.6	28.3	27.3	27.0
30	26.1	24.7	24.9	25.7	26.8	28.5	29.5	29.5	28.6	28.3	27.3	27.0
40	26.0	24.6	24.9	25.7	26.8	27.6	28.5	29.5	28.0	28.0	27.2	26.9
50	25.1	24.5	24.3	25.0	26.6	27.0	28.0	28.7	27.0	27.0	26.3	26.9
60	25.7	24.5	23.9	24.7	26.3	26.8	27.5	28.0	26.0	26.3	25.8	26.8
70	24.3	24.5	23.3	24.5	26.0	26.5	27.0	27.3	25.0	25.0	25.4	26.8
80	24.0	24.5	22.8	24.4	25.8	26.3	26.5	26.3	24.0	24.0	25.1	26.7
90	24.5	24.5	22.4	24.2	25.7	25.9	26.1	25.9	23.0	23.0	24.8	26.6
100	23.1	24.3	22.0	24.0	25.5	25.5	25.8	25.2	22.0	21.3	24.5	26.4
150	21.5	21.4	21.4	21.6	22.0	22.1	21.6	20.7	20.1	20.0	20.6	21.2
200	19.1	19.1	19.1	19.3	19.6	19.6	19.2	18.5	18.0	17.8	18.3	18.8
250	17.0	16.8	16.8	17.0	17.4	17.5	17.3	16.7	16.3	16.1	16.4	16.8
300	15.4	15.2	15.3	15.6	16.0	16.1	15.7	15.1	14.5	14.5	14.9	15.3
350	13.7	13.5	13.5	13.9	14.4	14.6	14.2	13.5	13.1	13.0	13.4	13.7
400	12.4	12.1	12.1	12.5	13.0	13.0	12.7	12.2	11.9	11.9	12.3	12.5
450	11.5	11.1	11.0	11.3	11.7	11.7	11.4	11.0	10.8	11.0	11.5	11.7
500	10.1	9.8	9.8	10.1	10.6	10.8	10.6	10.3	10.1	10.1	10.3	10.3
600	8.6	8.4	8.4	8.6	8.8	8.9	8.8	8.6	8.5	8.5	8.7	8.7
700	7.5	7.3	7.2	7.3	7.4	7.4	7.3	7.3	7.3	7.4	7.6	7.6
800	6.4	6.3	6.3	6.4	6.4	6.4	6.4	6.4	6.4	6.5	6.5	6.5
900	5.8	5.7	5.7	5.7	5.7	5.8	5.7	5.8	5.8	5.9	6.0	5.9
1000	5.3	5.3	5.2	5.3	5.3	5.3	5.3	5.4	5.4	5.5	5.5	5.4
1100	5.0	4.9	4.9	4.9	4.9	4.9	4.9	4.9	5.0	5.1	5.1	5.0
1200	4.7	4.6	4.6	4.6	4.6	4.6	4.6	4.7	4.7	4.6	4.8	4.7
1300	4.5	4.5	4.5	4.4	4.4	4.5	4.5	4.5	4.5	4.6	4.6	4.6
1400	4.4	4.3	4.3	4.3	4.3	4.4	4.4	4.4	4.4	4.4	4.4	4.4
1500	4.3	4.2	4.2	4.2	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3

(*Because an insufficient number of observations are available to compute standard statistics, "most probable" soundings were determined by examination of data overplotted by month and area. No averaging was done; instead, the most probable value was determined from the clustering of soundings. For details of method, please see reference.)

Table 2 (continued)

Square 154
(Area minimum depth = 1350 m; maximum depth = 3460 m)

DEPTH (m)	MONTH 1	2	3	4	5	6	7	8	9	10	11	12
0	22.0	20.7	21.7	23.5	24.2	27.6	28.3	29.7	29.6	27.7	25.0	22.6
10	21.9	20.7	21.7	23.3	24.1	27.7	28.2	29.4	29.6	27.7	25.0	22.6
20	21.7	20.6	21.6	22.5	24.0	27.6	28.0	29.2	29.6	27.8	25.0	22.6
30	21.7	20.6	21.6	21.4	23.2	27.7	27.5	28.3	29.5	27.8	25.0	22.6
40	21.6	20.6	21.5	20.9	22.2	25.1	25.4	26.6	28.7	27.8	24.9	22.6
50	21.6	20.5	21.3	20.6	21.3	24.6	23.9	24.9	25.8	27.1	24.8	22.6
60	21.5	20.8	21.0	20.4	20.8	23.3	23.0	23.2	23.9	24.9	24.7	22.2
70	21.3	20.7	20.9	20.2	20.3	22.8	22.4	22.0	22.2	23.8	23.5	20.7
80	21.2	20.5	20.7	20.1	19.8	22.5	21.8	21.0	21.1	22.5	21.0	18.9
90	21.0	20.2	20.6	19.8	19.4	22.2	21.5	20.3	20.3	21.4	20.4	18.0
100	20.7	19.7	20.4	19.4	19.0	21.9	21.1	19.6	19.6	20.3	19.8	17.3
150	16.8	17.3	17.6	17.6	17.7	17.8	17.7	17.5	17.0	16.5	16.1	16.3
200	14.8	15.1	15.0	14.8	14.7	14.9	15.1	15.1	14.8	14.5	14.3	14.5
250	13.1	13.2	13.0	12.6	12.4	12.5	12.8	12.9	12.8	12.6	12.6	12.7
300	11.8	11.9	11.7	11.3	11.1	11.2	11.5	11.7	11.6	11.5	11.5	11.6
350	10.8	10.7	10.3	9.8	9.7	9.9	10.3	10.5	10.6	10.6	10.6	10.6
400	9.8	9.7	9.4	9.0	8.9	9.1	9.3	9.5	9.6	9.6	9.6	9.7
450	8.8	8.8	8.5	8.2	8.0	8.1	8.3	8.5	8.6	8.6	8.6	8.7
500	8.2	8.2	7.9	7.6	7.4	7.5	7.6	7.7	7.8	7.9	7.9	8.1
600	7.4	7.3	6.9	6.5	6.3	6.3	6.4	6.5	6.6	6.8	7.0	7.2
700	6.2	6.2	6.1	5.8	5.6	5.6	5.6	5.7	5.8	5.9	6.0	6.1
800	5.7	5.7	5.5	5.3	5.2	5.1	5.2	5.3	5.4	5.5	5.6	5.7
900	5.3	5.2	5.1	5.0	4.9	4.8	4.9	5.0	5.1	5.2	5.2	5.3
1000	4.9	4.8	4.8	4.7	4.6	4.6	4.6	4.7	4.8	4.8	4.9	4.9
1100	4.7	4.6	4.6	4.5	4.5	4.5	4.5	4.6	4.6	4.6	4.7	4.7
1200	4.5	4.5	4.4	4.4	4.4	4.4	4.4	4.5	4.5	4.5	4.5	4.5
1300	4.4	4.4	4.4	4.3	4.3	4.3	4.3	4.4	4.4	4.4	4.4	4.4
1400	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3
1500	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2

Table 2 (continued)

Square 78

(Area minimum depth = 180 m; maximum depth = 2160 m)

DEPTH (m)	MONTH 1	2	3	4	5	6	7	8	9	10	11	12
0	22.1	21.8	21.4	24.0	25.8	28.8	29.8	30.0	29.4	27.0	25.5	23.3
10	22.1	21.8	21.4	24.0	25.8	28.7	29.7	29.5	29.4	27.0	25.5	23.3
20	22.1	21.8	21.4	23.8	25.8	27.8	28.8	29.0	29.4	27.0	25.5	23.3
30	22.1	21.8	21.4	23.0	24.8	25.0	28.0	28.3	29.4	27.0	25.5	23.3
40	22.1	21.8	21.2	22.0	23.5	23.8	27.0	26.0	28.4	27.0	25.5	23.3
50	22.1	21.8	21.0	20.9	21.8	22.0	26.0	25.0	26.8	27.0	25.5	23.3
60	22.1	21.8	20.8	20.4	21.0	21.3	25.0	24.5	25.8	26.0	25.5	23.3
70	22.1	21.8	20.4	20.0	20.5	20.8	24.0	24.0	25.0	25.2	25.5	23.3
80	22.1	21.8	20.1	19.6	20.0	20.2	23.0	23.5	23.8	24.0	25.5	23.3
90	22.1	20.8	19.7	19.2	19.5	19.7	22.0	23.0	22.0	22.2	24.5	23.3
100	21.1	20.1	19.2	18.8	18.9	19.2	21.0	21.9	20.9	21.2	24.0	22.3
150	19.0	18.2	17.4	17.1	17.2	17.6	18.0	18.2	18.4	18.9	19.4	19.5
200	16.8	16.1	15.6	15.3	15.3	15.4	15.6	15.9	16.2	16.7	17.2	17.2
250	14.2	13.8	13.6	13.5	13.6	13.8	13.9	14.1	14.2	14.4	14.6	14.5
300	12.6	12.3	12.1	12.1	12.1	12.3	12.4	12.6	12.8	12.9	13.0	12.8
350	11.2	11.0	10.8	10.8	10.9	10.9	11.0	11.2	11.4	11.6	11.6	11.4
400	10.2	10.0	9.8	9.8	9.9	10.0	10.1	10.3	10.5	10.6	10.7	10.5
450	9.3	9.1	9.0	9.0	9.1	9.1	9.2	9.4	9.6	9.7	9.7	9.5
500	8.6	8.5	8.3	8.3	8.3	8.4	8.5	8.6	8.8	8.9	8.9	8.8
600	7.6	7.4	7.3	7.3	7.3	7.4	7.5	7.7	7.8	7.9	7.9	7.8
700	6.7	6.6	6.5	6.4	6.4	6.4	6.5	6.7	6.8	6.9	7.0	6.9
800	5.9	5.8	5.7	5.7	5.8	5.8	5.8	5.9	6.0	6.1	6.1	6.0
900	5.5	5.4	5.3	5.2	5.2	5.3	5.3	5.4	5.5	5.6	5.6	5.6
1000	4.9	4.9	4.8	4.9	4.9	4.9	4.9	5.0	5.0	5.1	5.1	5.0
1100	4.7	4.6	4.5	4.5	4.6	4.6	4.7	4.7	4.8	4.8	4.8	4.7
1200	4.5	4.5	4.4	4.4	4.4	4.5	4.5	4.6	4.6	4.6	4.6	4.6
1300	4.4	4.4	4.3	4.3	4.3	4.4	4.4	4.4	4.4	4.5	4.5	4.4
1400	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3
1500	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2

2.4 General Circulation

Ocean currents can affect both the structural integrity and the station keeping abilities of OTEC plants. Drag forces, which are proportional to the square of current velocity, will exert dynamic loads on the OTEC hull, cold water pipe, and mooring cables. Unless moored or equipped with thrusters, floating OTEC plants will drift with steady currents. And potentially this drift would carry the plant away from areas of maximum thermal resource or into coastal shallows. Oscillatory currents associated with wave particle orbits exert periodic forcing on OTEC plant structural components possibly contributing to weakening and failure through fatigue. Streaming flow around the cold water pipe will also induce vortex shedding that can lead to undesirable resonance effects. Although design and construction of offshore OTEC plants to withstand these dynamical effects present novel engineering problems and stretch the limits of existing technology, components of OTEC structures are not without recent precedents. These engineering precedents and their implications for OTEC design have been reviewed by Mavor et. al. (1977).

Circulation in the Gulf of Mexico is dominated by two prominent flow features. In the eastern Gulf a narrow current enters through the Yucatan Channel, turns anticyclonically (clockwise), and continues out the Straits of Florida eventually feeding into the northward-flowing Gulf Stream. Because of its well-defined looped shape, this current is called the Gulf Loop Current, or simply the Loop Current. Details about the Loop Current and its variability are presented in Section 2.5.

In the western and central Gulf it has now been well established that there is a permanent anticyclonic gyre, a closed circulation cell, centered about a persistent warm water area at about 24°N (Behringer, Molinari, and Festa, 1977). This gyre is composed of a narrow western boundary current flowing northward along the Mexican Coast and a broad return flow in the central Gulf that closes this circulation. Sturges and Blaha (1976) suggested that since the curl of the wind stress over the Gulf in winter and summer is similar to that of the Central North Atlantic this circulation feature in the Gulf is analogous to the anticyclonic gyre in the Central North Atlantic (in which the western boundary current is the Gulf Stream). In a later analysis (Blaha and Sturges, 1981), they examine correlations among winds, coastal sea level, and dynamic heights and present further evidence for wind forcing of circulation in the western Gulf. Cochrane (1972), on the other hand, has suggested that the western gyre in the Gulf is maintained by eddies that separate from the Loop Current flow and drift to the west.

Figure 5 shows estimated average speed (in knots) of surface currents in the Gulf of Mexico for winter (February) and summer (August). These schematic syntheses, derived from ship drift data, clearly show the Loop Current flow and also give indications of the anticyclonic gyre in the western Gulf. Figure 6 depicts the general surface circulation for winter and summer by means of current roses for specified subregions within the Gulf.

Mean current speed (in knots) and direction by 1° squares in the Gulf for winter and summer are presented in Figures 7 and 8. These figures clearly show the Loop Current flow and also give indications of the western gyre.

It should be noted that mean current values cited in this document may represent gross underestimates of actual currents observed at any given time. Current velocities may be at least double the indicated mean value over short durations at any observation location, a fact with important engineering implications.

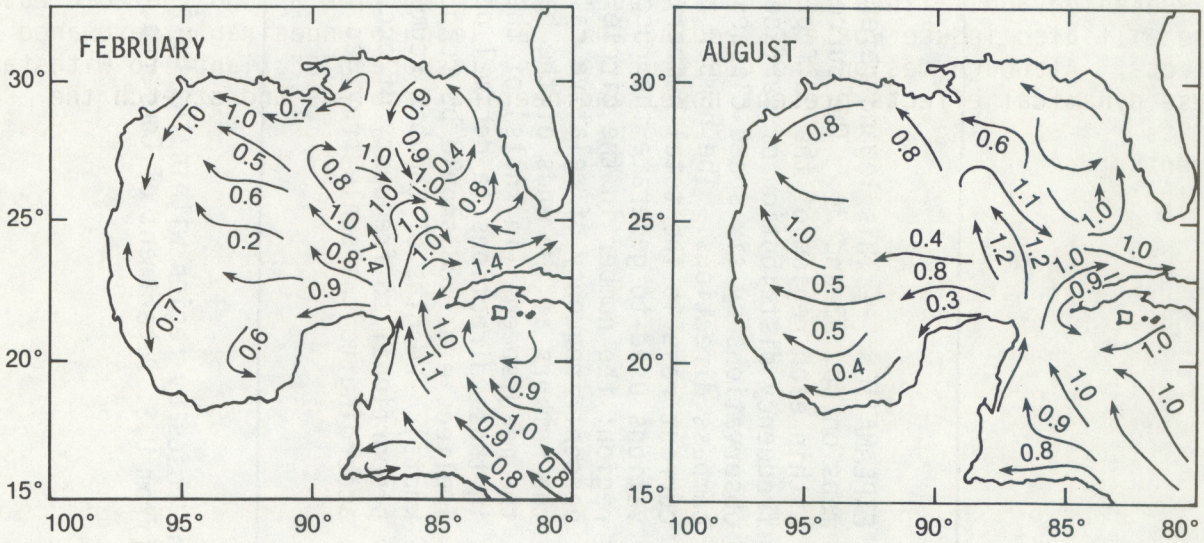
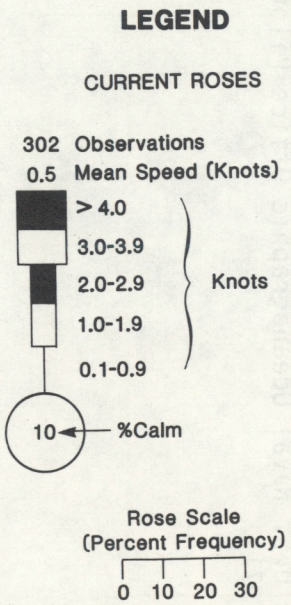


Figure 5. Estimated average speed (knots) of surface currents in the Gulf of Mexico for winter (February) and summer (August) (based on U.S. Naval Oceanographic Office Pilot Charts; from Nowlin, 1971).



EXPLANATION. -- This legend refers to the maps on pp. 33 and 34. The current roses within each region of the Gulf present a frequency distribution of surface current observations by six speed classes in eight compass directions. The number above each current rose is the total number of observations used to generate the rose in that region; the number in the circle is the percent frequency of relative calm; and the numbers at the ends of the bars are the mean speeds (in knots) of the current in those directions (a decimal point is implied, e.g., 08 should be read as 0.8 knots). Lengths of the bar segments are proportional to frequency of occurrence according to the scale provided.

Figure 6. Surface current roses by region within the Gulf of Mexico for winter and summer (from U.S. Department of Commerce, 1973).

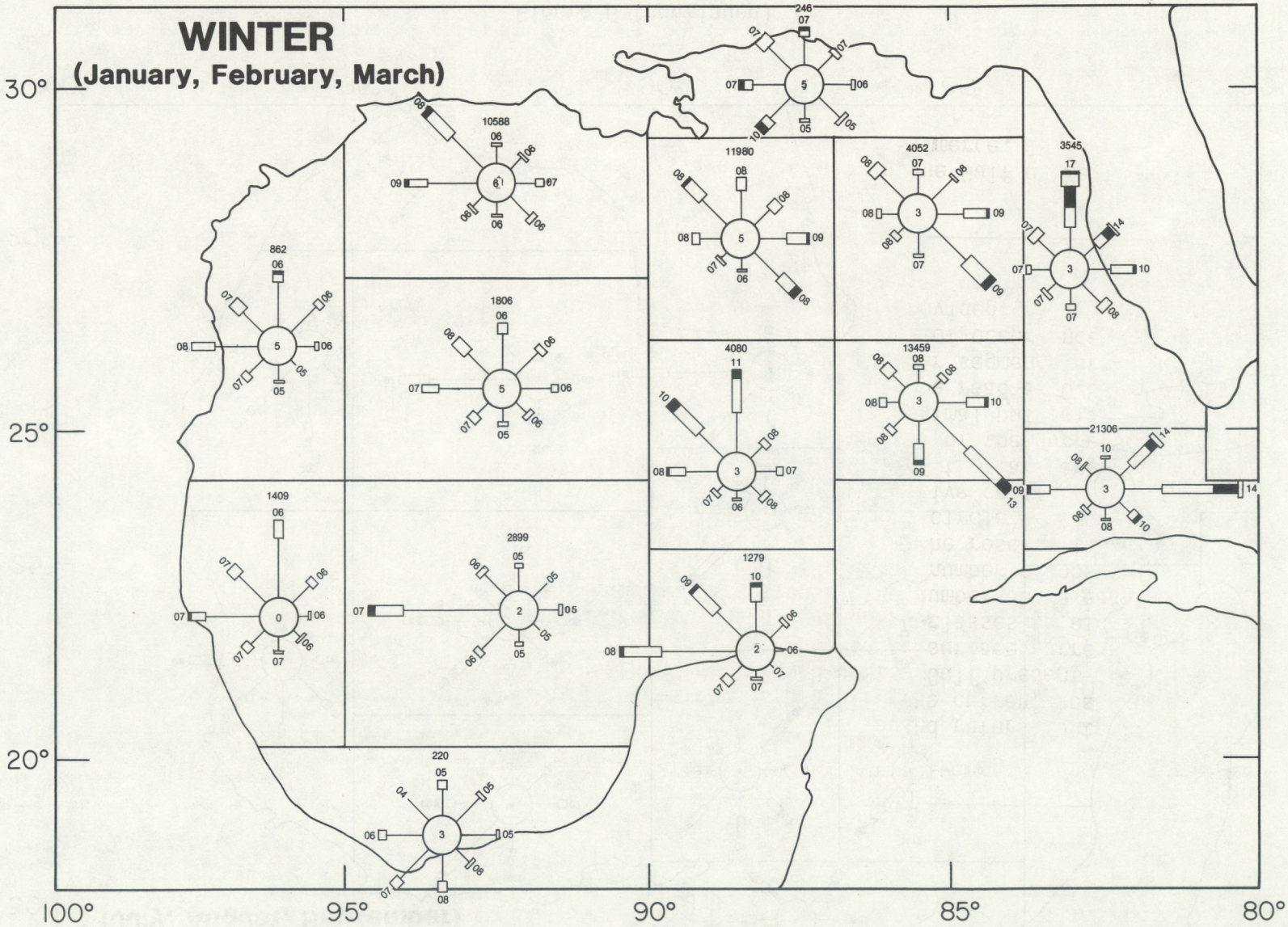


Figure 6 (continued)

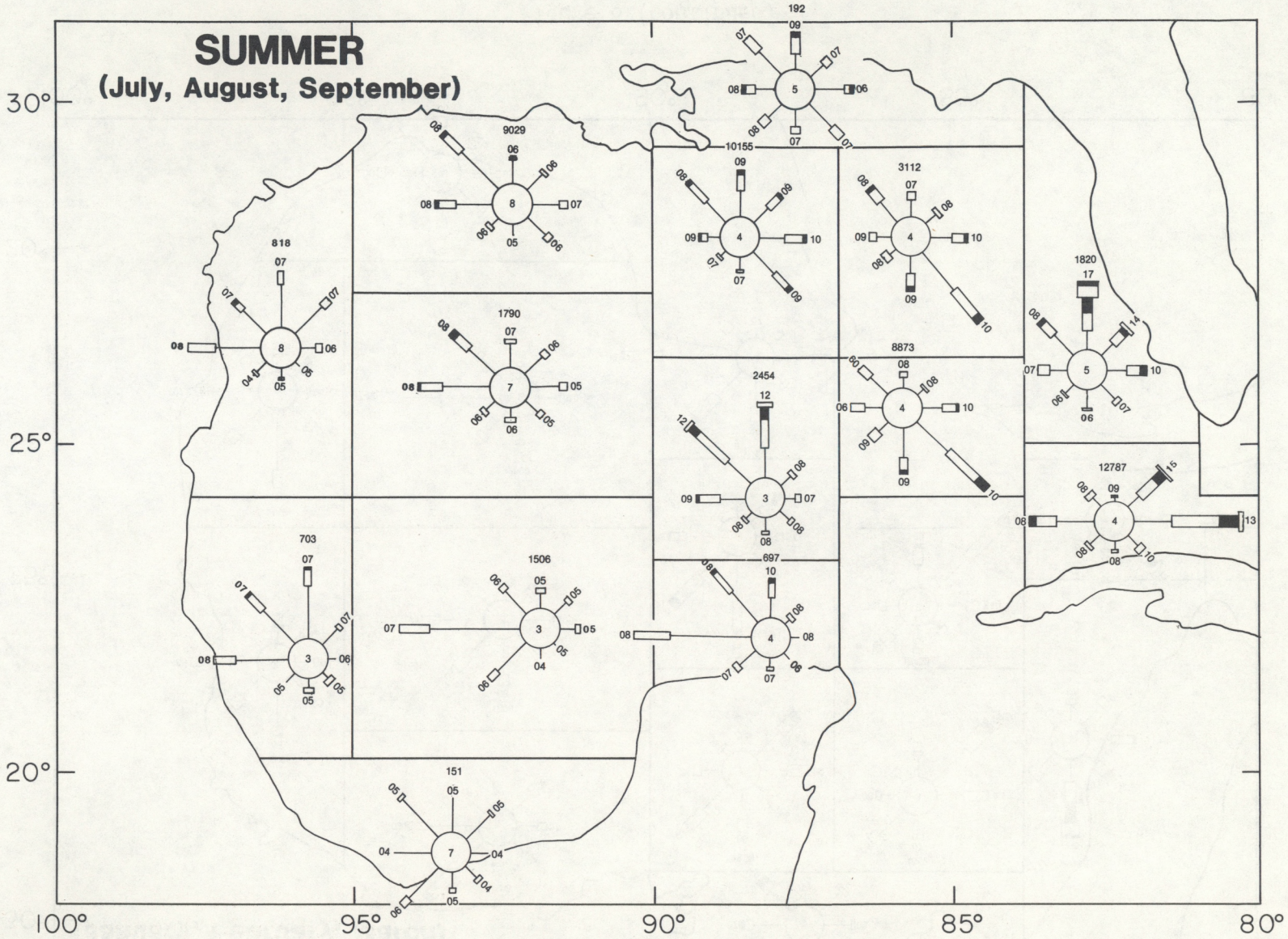


Figure 6 (continued)

(BLANK)

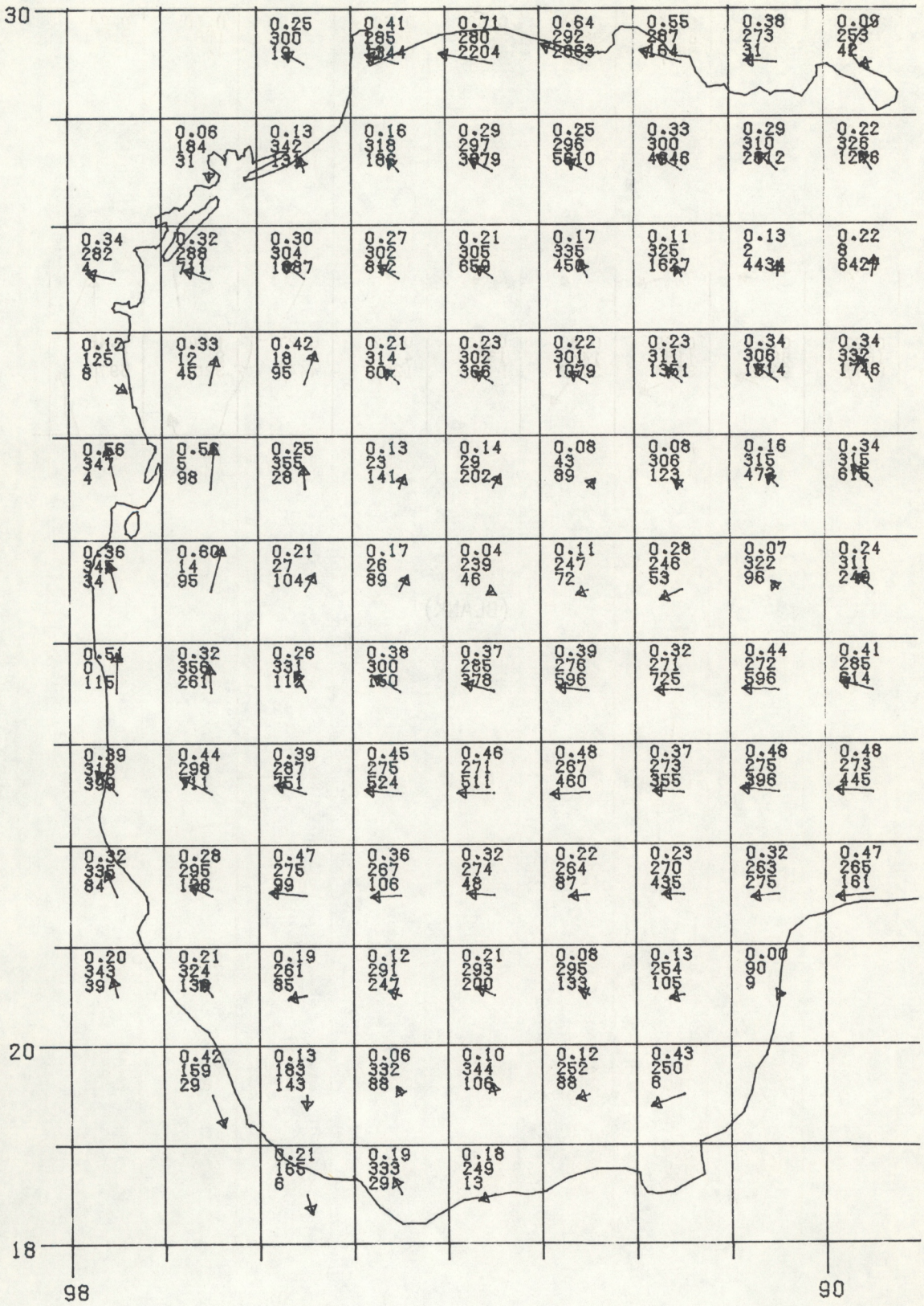


Figure 7. Mean current speed (knots) and direction by 1° squares for winter (November - March) (from NODC Surface Current Data System, 1850-1974).

LEGEND
Current Speed (knots)
Current Direction (Degrees from N)
Number of Observations
← = Vector Length of 1 knot

Figure 7. (continued)

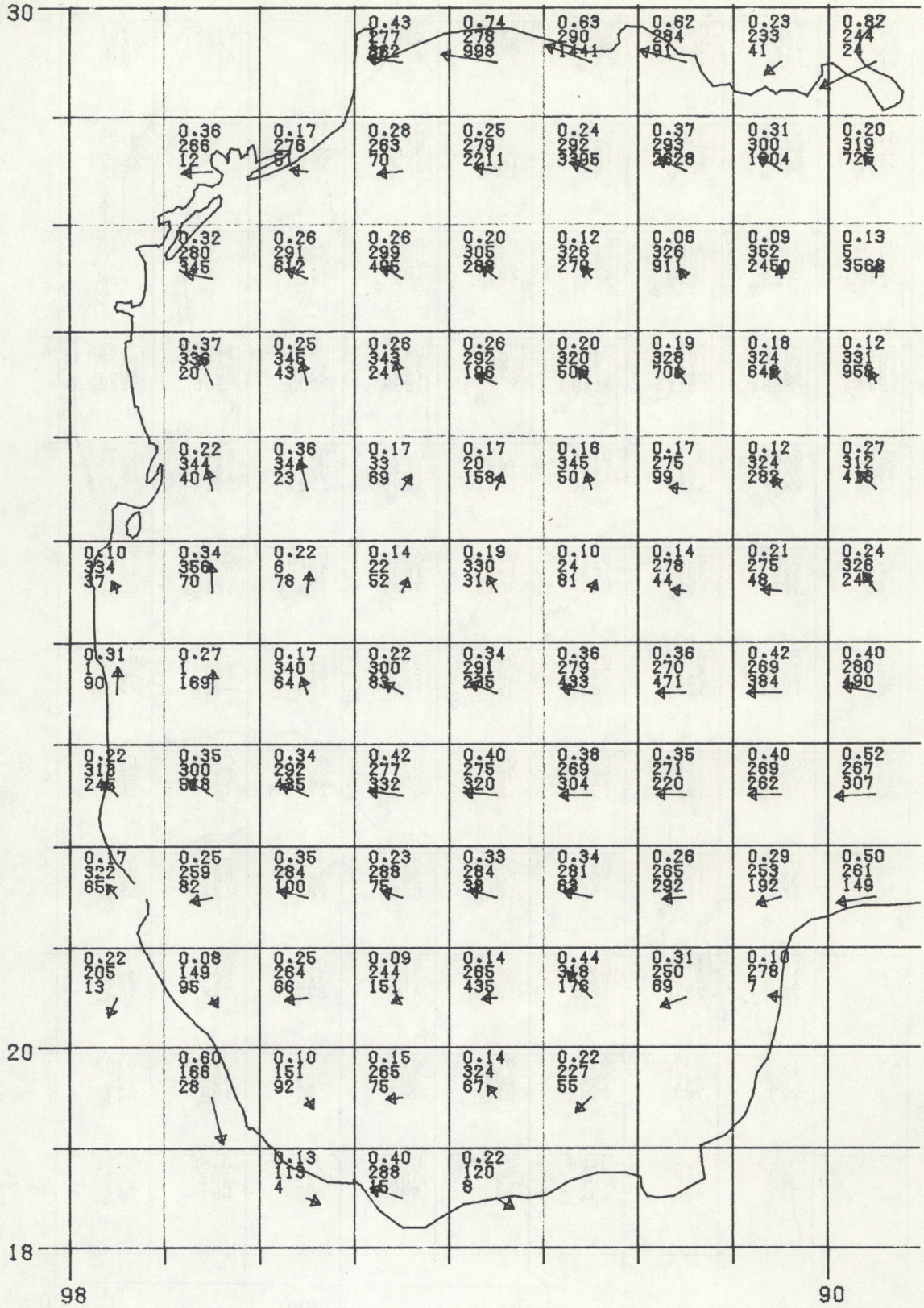
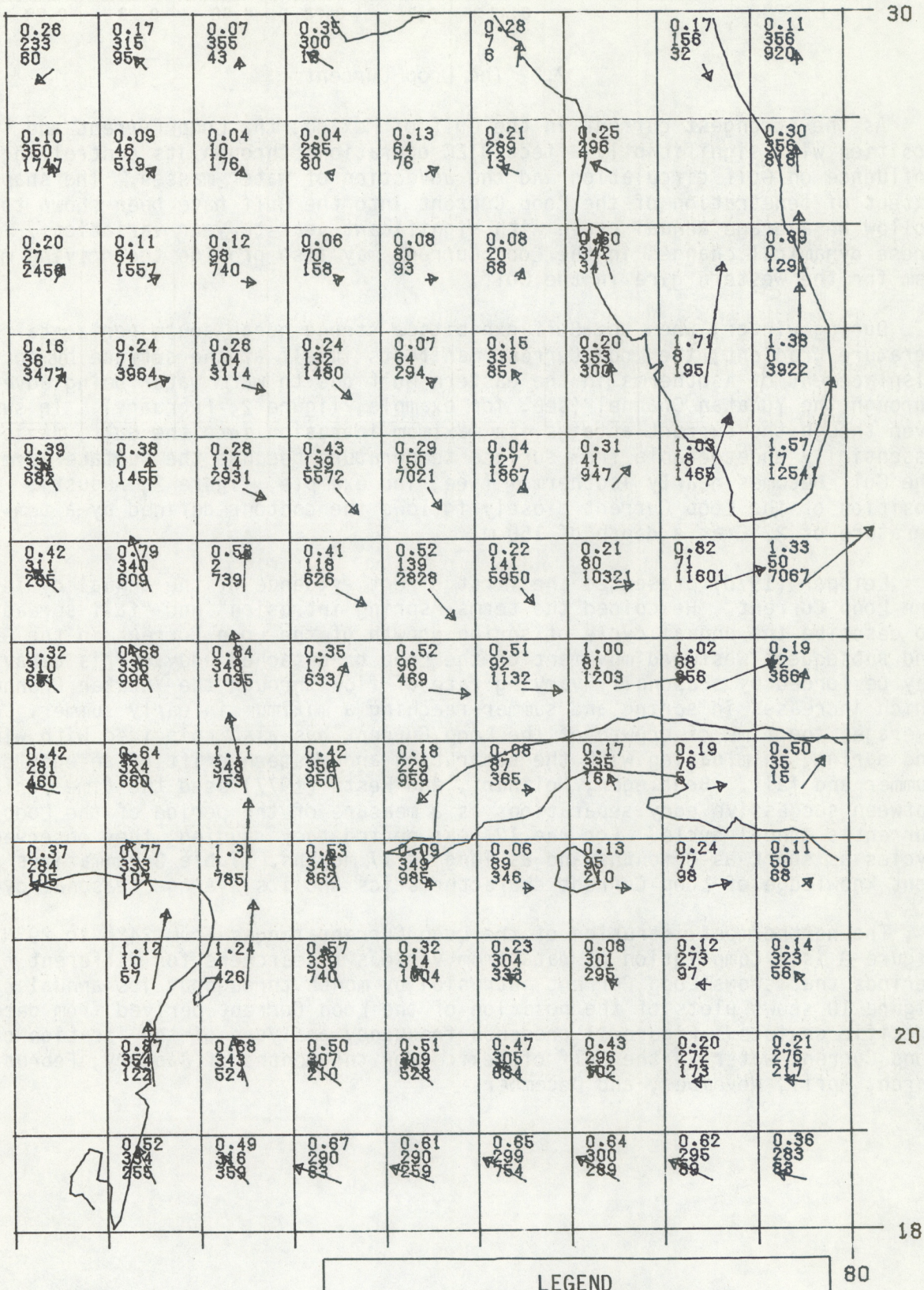


Figure 8. Mean current speed (knots) and direction by 1° squares for summer (April - October) (from NODC Surface Current Data System, 1850-1974).



LEGEND
Current Speed (knots)
Current Direction (Degrees from N)
Number of Observations
← = Vector Length of 1 knot

Figure 8. (continued)

2.5 The Loop Current

As the strongest current in the Gulf of Mexico, the Loop Current and its position will significantly affect OTEC operations through its controlling influence on Gulf circulation and the advection of water masses. The shape and extent of penetration of the Loop Current into the Gulf have been shown to follow an average annual cycle with significant year-to-year variations. These dynamical changes in the Loop Current may also provide the driving mechanism for the western gyre in the Gulf.

During winter, when the Gulf exhibits a strong north-south horizontal temperature gradient, the Loop Current manifests itself at the surface by northward displacement of isotherms in the eastern Gulf due to warm water being advected through the Yucatan Channel (see, for example, figure 2, February). In summer, even though the current attains its maximum intrusion into the Gulf, it is essentially undetectable from surface temperature because the surface layer in the Gulf becomes nearly isothermal (see, for example, figure 2, August). The position of the Loop Current closely follows the contour defined by a temperature of 22°C at a depth of 150 m.

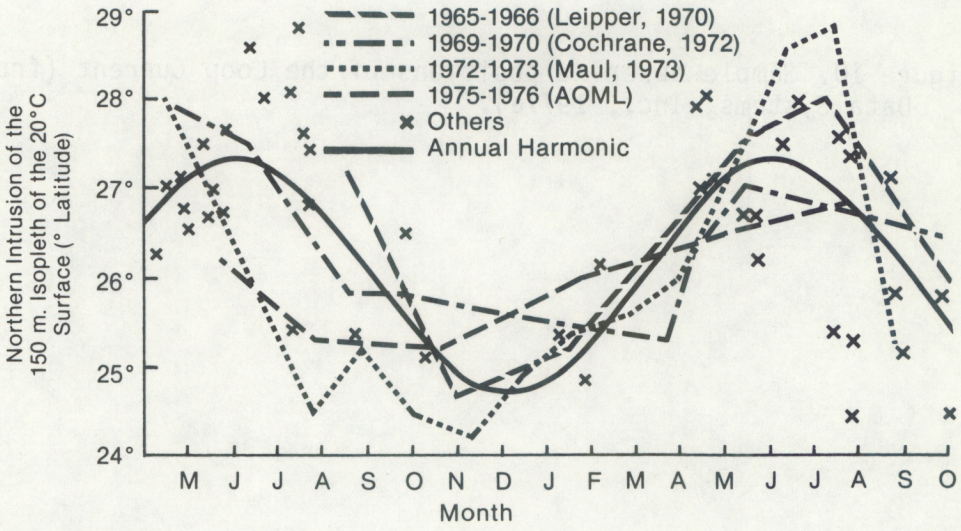
Leipper (1970) presented the first direct evidence of the annual cycle of the Loop Current. He coined the terms "spring intrusion" and "fall spreading" to describe the annual cycle of spring growth of the Loop Current in the Gulf and subsequent westward movement of the Loop or detached eddy. This behavior may be forced by seasonally-varying rate of flow through the Yucatan Channel, which increases in spring and summer reaching a maximum in early summer. On the average, the time of growth of the Loop Current has also coincided with winter and spring, culminating with the separation and western drift of an eddy during summer and fall. Behringer, Molinari, and Festa (1977) used the time period between successive eddy separations as a measure of the period of the Loop Current's annual cycle. For the 12-year period they studied, they observed cycles as short as 8 months and as long as 17 months. Table 3 summarizes present knowledge of Loop Current characteristics and its average seasonal cycle.

The northermost intrusion of the Loop Current ranges from 24°N to 29°N. Figure 9 is a compilation of data from various researchers for different time periods that shows Loop Current intrusion by month throughout its annual cycle. Figure 10 shows plots of the position of the Loop Current derived from data from specific cruises. Figure 11 presents frequency analyses of the location of the Loop Current water in the Gulf of Mexico for the months of January, February, March, April, November, and December.

Table 3. Characteristics of the Loop Current (U.S. Department of Commerce, 1973)

Width	60 - 80 km
Thickness (velocity 1 kt)	500 m
Velocity	0.5 - 2.0 m/s
Early Summer	0.8 m/s
October-November	0.5 m/s
Maximum	2.0 - 2.5 m/s
Volume Transport	25 - 30 x 10^6 m^3/s

Figure 9. Penetration of the Loop Current into the Gulf of Mexico versus time of year (derived from synoptic temperature data; penetration measured by the northern limit of the 150 m isobath of the 20°C isothermal surface; the category "others" includes the Leipper, Cochrane, Maul, and AOML cycles where they repeat themselves; from Behringer, Molinari, and Festa, 1977).



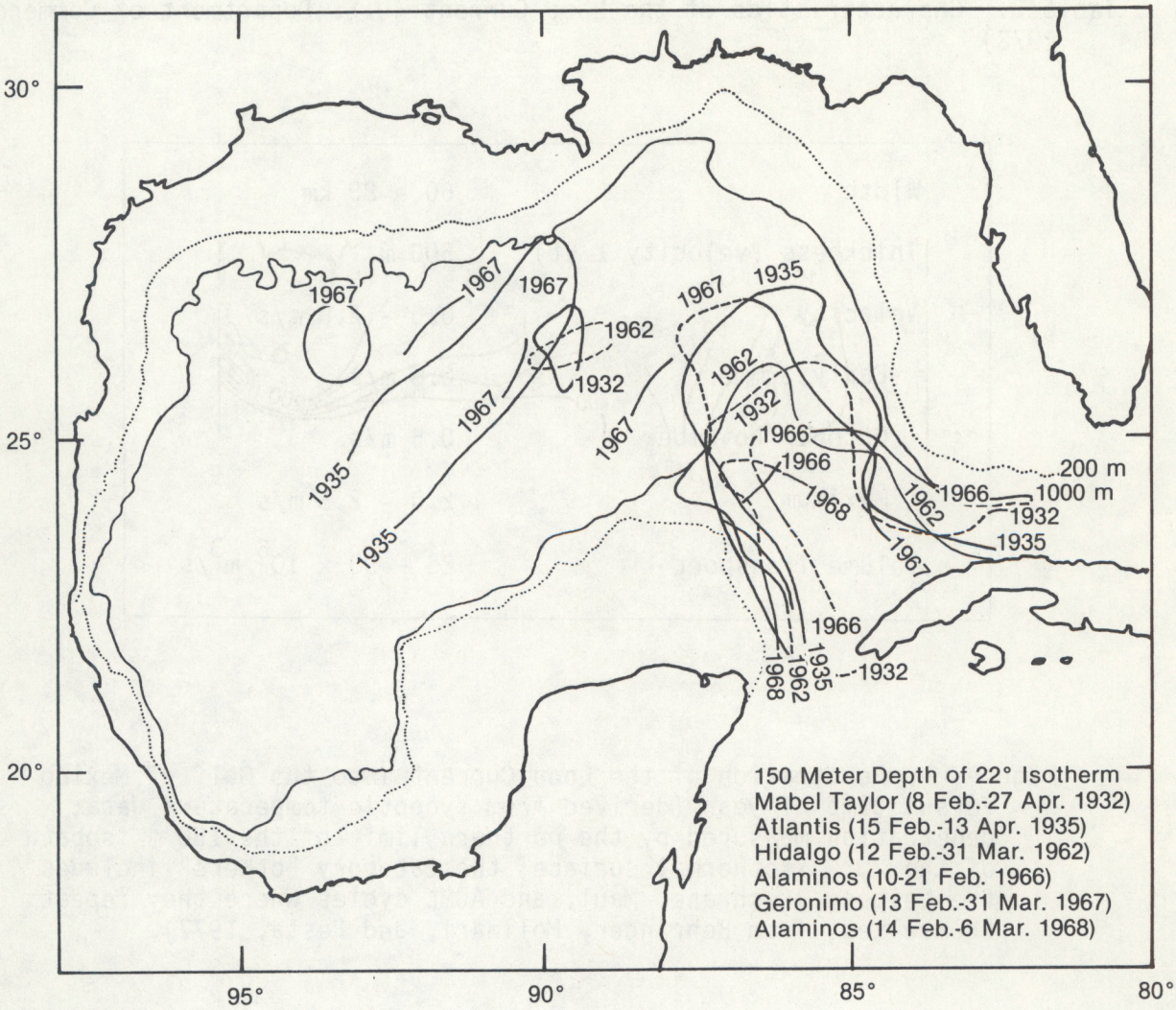


Figure 10. Sample observed positions of the Loop Current (from Ocean Data Systems, Inc., 1977a).

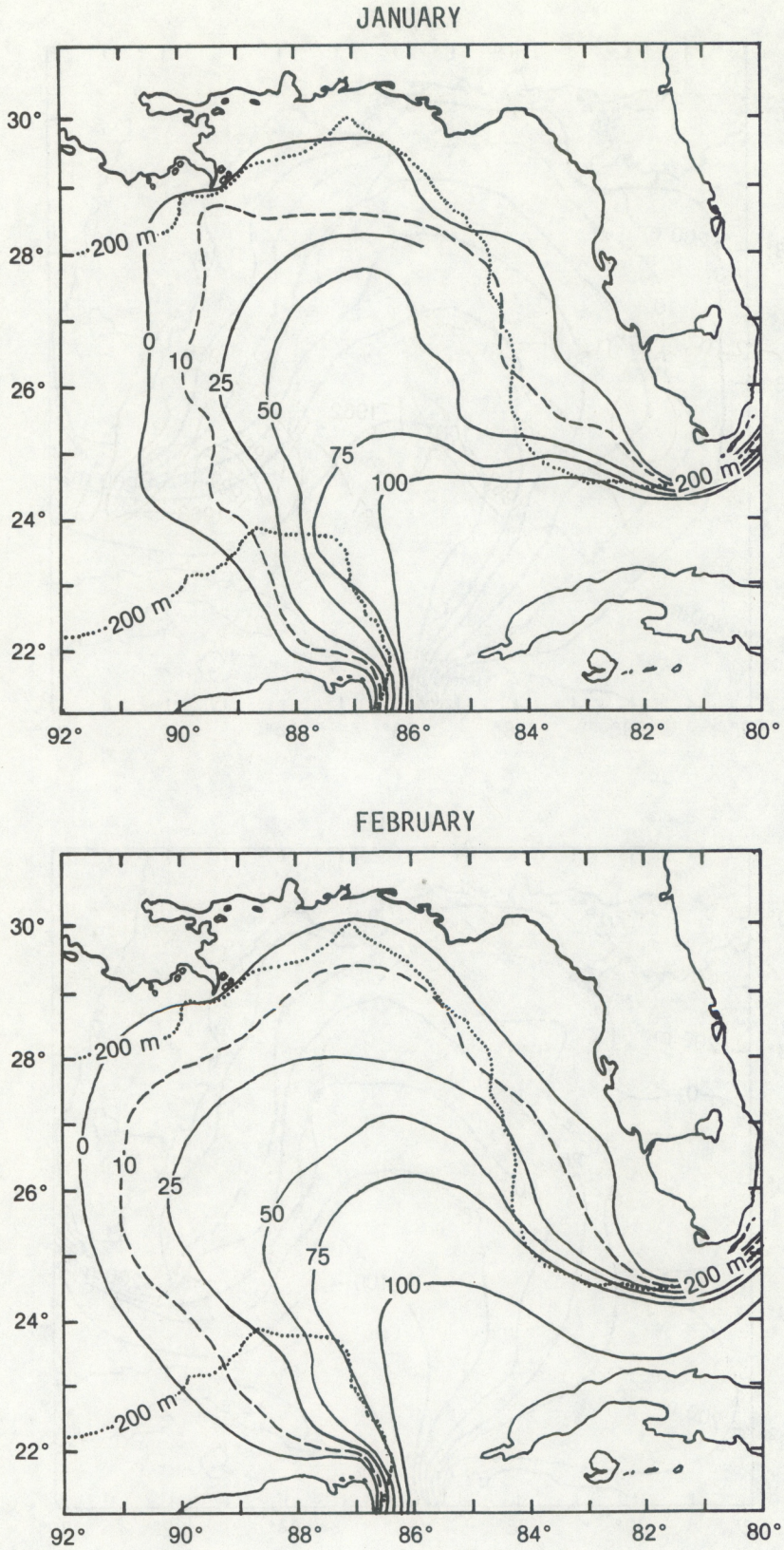
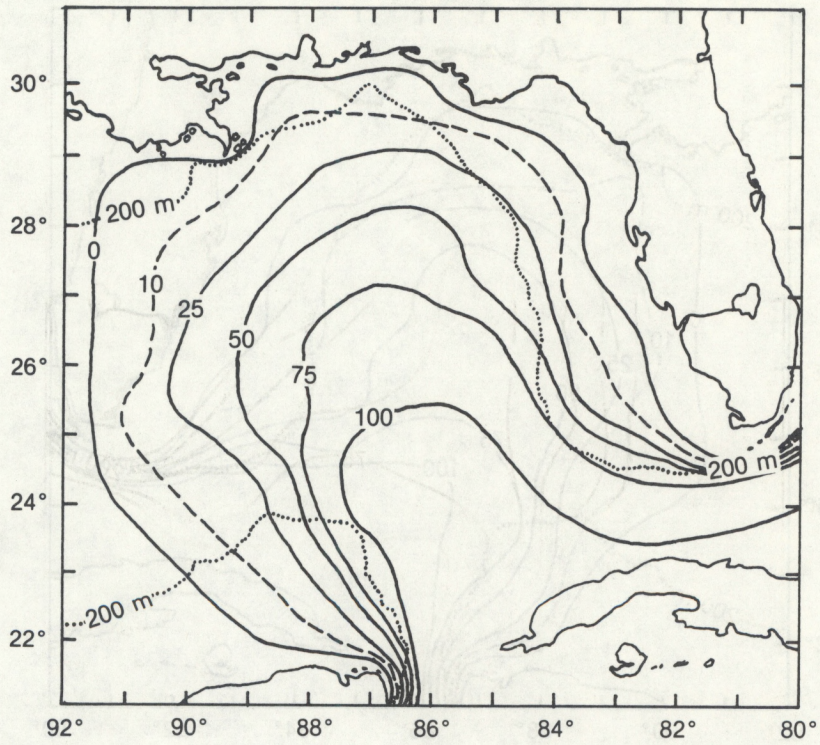


Figure 11. Percent frequency by month of the location of Loop Current water based on NOAA VHRR data for 1973-1977 (insufficient thermal contrast for June-October; from Vukovich et. al., 1978).

MARCH



APRIL

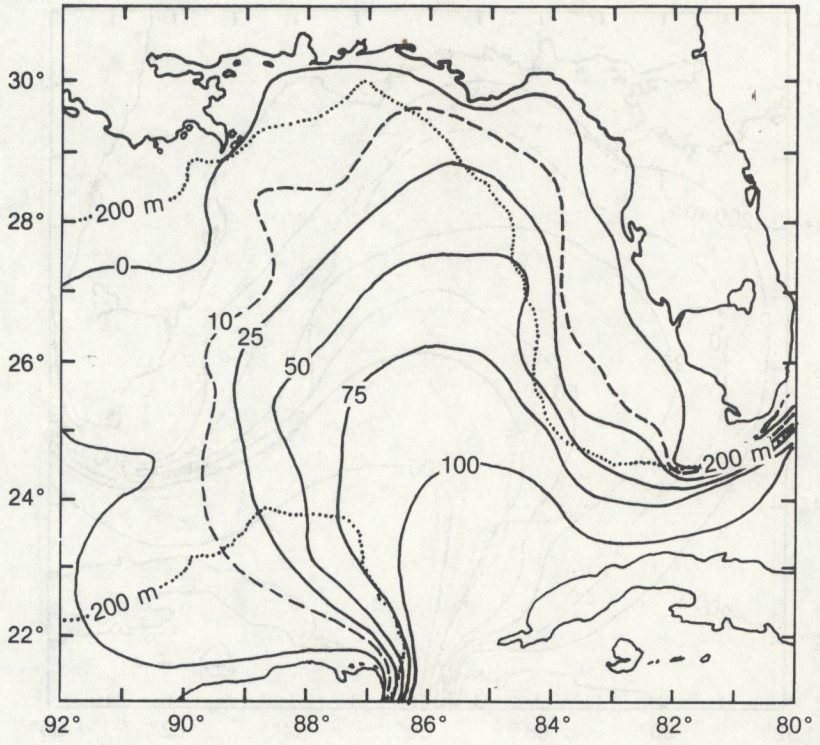
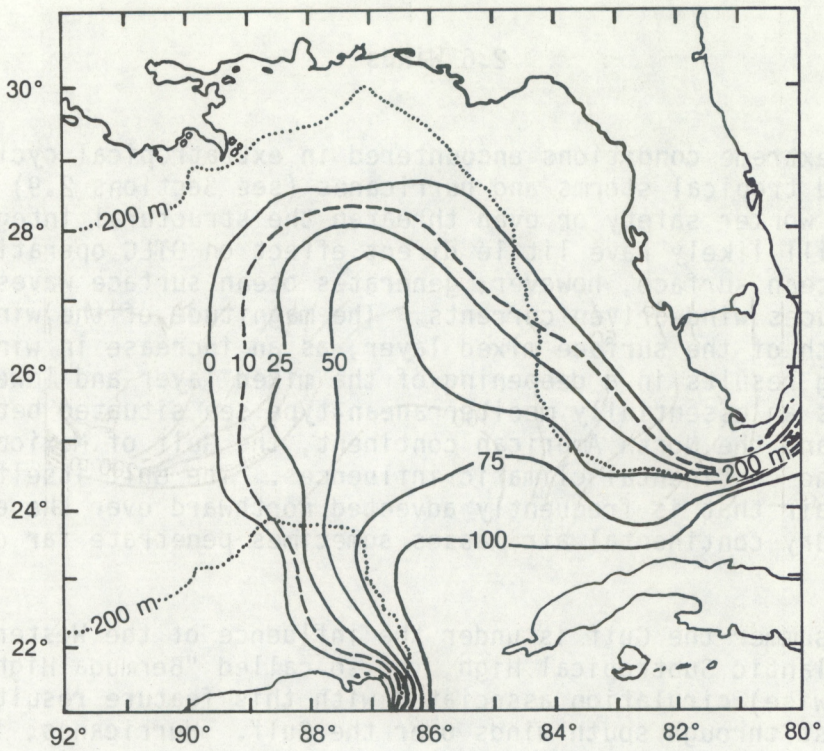


Figure 11 (continued)

NOVEMBER



DECEMBER

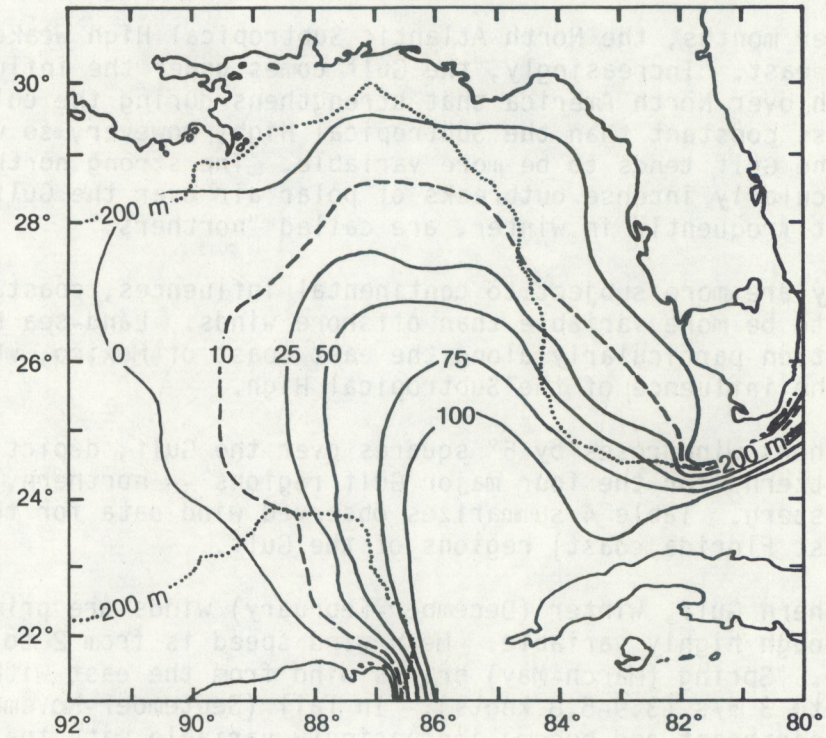


Figure 11 (continued)

2.6 Winds

Except for extreme conditions encountered in extratropical cyclones (see Section 2.7) and tropical storms and hurricanes (see Sections 2.9) that may present hazards to worker safety or even threaten the structural integrity of OTEC plants, winds will likely have little direct effect on OTEC operations. Wind stress at the ocean surface, however, generates ocean surface waves (winds waves) and produces wind-driven currents. The magnitude of the wind stress also affects the depth of the surface mixed layer, as an increase in wind-induced turbulent mixing results in a deepening of the mixed layer and lowering of the thermocline. As an essentially mediterranean-type sea situated between the Atlantic Ocean and the North American continent, the Gulf of Mexico experiences both maritime and continental climatic influences. The Gulf itself is a source of warm, moist air that is frequently advected northward over the eastern United States. Cold, dry continental air masses sometimes penetrate far over the Gulf, however.

During the summer the Gulf is under the influence of the Western extension of the North Atlantic Subtropical High, the so-called "Bermuda High." The anticyclonic (clockwise) cirulation associated with this feature results in prevailing southeast through south winds over the Gulf. Hurricanes, intense cyclonic storms spawned by disturbances in the tropical Atlantic, Caribbean, and Gulf of Mexico, occur mostly from June through October, as shown by historical data.

In the winter months, the North Atlantic Subtropical High weakens and retreats to the east. Increasingly, the Gulf comes under the influence of the continental high over North America that strengthens during the cold season. This high is less constant than the Subtropical High, however, so winter circulation over the Gulf tends to be more variable. The strong north winds that accompany particularly intense outbreaks of polar air over the Gulf, a condition that occurs most frequently in winter, are called "northers."

Because they are more subject to continental influences, coastal winds generally tend to be more variable than offshore winds. Land-sea breezes modify coastal circulation particularly along the east coast of Mexico, which lies farthest from the influence of the Subtropical High.

Figure 13 shows wind roses by 5° squares over the Gulf, depicting the monthly wind patterns for the four major Gulf regions -- northern, eastern, southern and western. Table 4 summarizes observed wind data for the northern and eastern (west Florida coast) regions of the Gulf.

In the northern Gulf, winter (December-February) winds are primarily from the north, although highly variable. Mean wind speed is from 2 to 3 m/s (3.9-5.8 knots). Spring (March-May) brings wind from the east with mean speeds ranging from 2 to 3 m/s (3.9-5.8 knots). In fall (September-November) winds return to east-northeast and become increasingly variable with the approach of winter. Mean winds average 2 to 4 m/s (3.9-7.8 knots) during this season. In the eastern Gulf of Mexico, wind direction shows the same basic seasonal pattern

as in the north, but with less pronounced variation. Winter winds in the eastern Gulf are from the east-northeast, with mean speeds of 2 to 3 m/s (3.9-5.8 knots). Spring winds are easterly with mean speeds of 2 to 4 m/s (3.9-7.8 knots). Summer winds shift to east-southeast at a mean speed of 2 to 3 m/s (3.9-5.8 knots). In autumn mean wind speed increases to 3 to 4 m/s (5.8-7.8 knots) and direction moves to east-northeast indicating the move into winter.

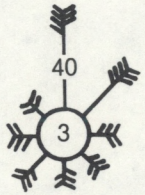
The southern Gulf, farther removed from continental influences, shows fairly constant east wind direction for the months December-September. In October and November, mean winds are more northeast-east. Mean speeds are 2 to 3 m/s (3.9-5.8 knots).

In the western Gulf, winter winds are from the north at speeds of 2 to 3 m/s (3.9-5.8 knots). Spring winds are east-southeast at 2 to 3 m/s (3.9-5.8 knots). Summer winds are southeast-east at 2 to 3 m/s (3.9-5.8 knots). Autumn winds are easterly, with a southeast component early in the season changing to a north components as winter approaches. During autumn mean speeds are 2 to 4 m/s (3.9-7.8 knots).

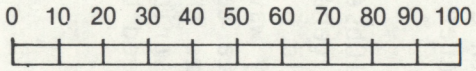
The Surface Marine Observations Data Base of the National Climatic Center (NCC) has been used to generate summaries of mean monthly wind direction and speed presented in Table 5 (and summaries of mean monthly wave direction and height and mean monthly wave period and height shown in Section 2.9). In this table (and the wave data tables) data are presented for 16 one-degree squares selected to characterize the Gulf environment (Figure 13). Wind data are presented as frequency distributions for wind direction by the eight compass points (and calm) and wind speed by 10 speed classes.

EXPLANATION OF WIND ROSES

PREVAILING WINDS AND CALMS.——————— The wind rose is located in the center of each 5° square where there was sufficient data. The rose shows the distribution of the winds that have prevailed in the area over a considerable period. The wind percentages are summarized for the eight points and calm. The arrows fly with the wind indicating the direction from which the wind blew. The length of the shaft, measured from the outside of the circle using the scale below, gives the percent of the total number of observations in which the wind has blown from that direction. The number of feathers shows the average force of the wind on the Beaufort scale. The figure in the center of the circle gives the percentage of calms. When the arrow is too long to fit conveniently in the 5° square, anything over 29 percent, the shaft is broken and the percentage is indicated by numerals.



FOR EXAMPLE.—The sample wind rose should read thus: In the reported observations the wind has averaged as follows: From N. 40 percent, force 7; from N.E. 19 percent, force 7; from E. 6 percent, force 5; from S.E. 5 percent, force 5; from S. 5 percent, force 5; from S.W. 9 percent, force 5; from W. 8 percent, force 5; from N.W. 5 percent, force 4; calms 3 percent.



Scale of Wind Percentages

Figure 12. Mean monthly wind roses for the Gulf of Mexico (from U.S. Naval Oceanographic Office Pilot Charts, 1980).

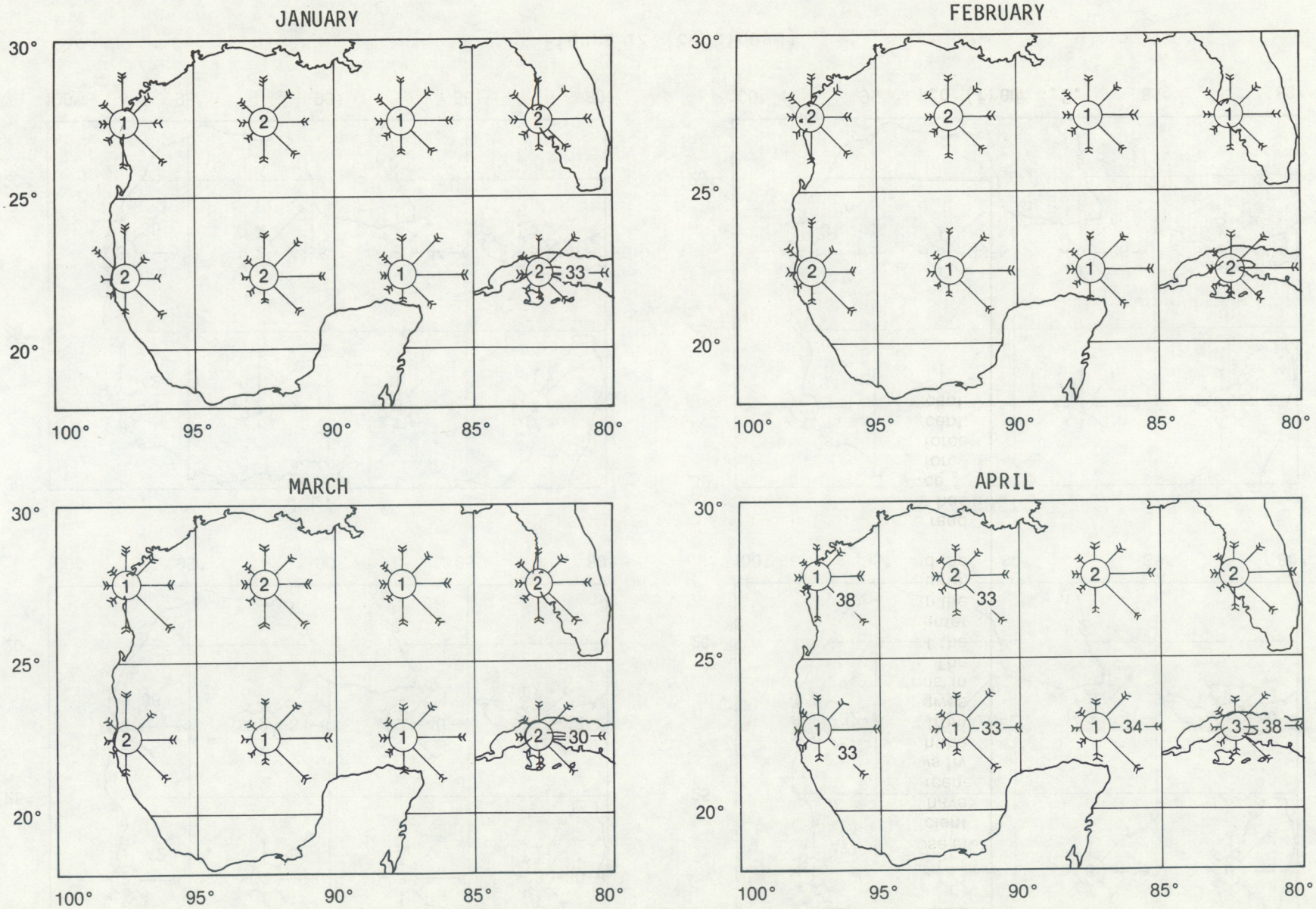


Figure 12 (continued)

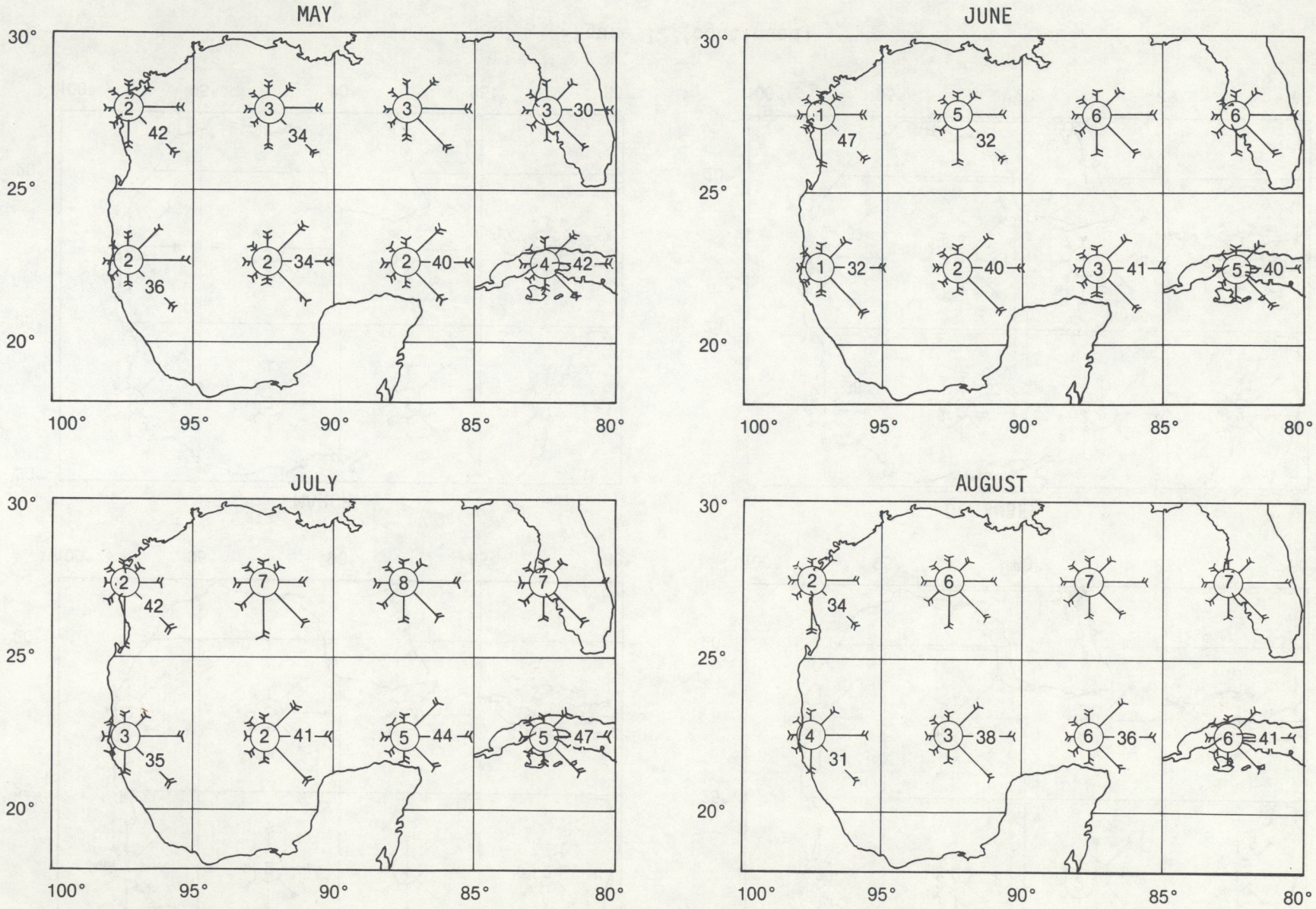


Figure 12 (continued)

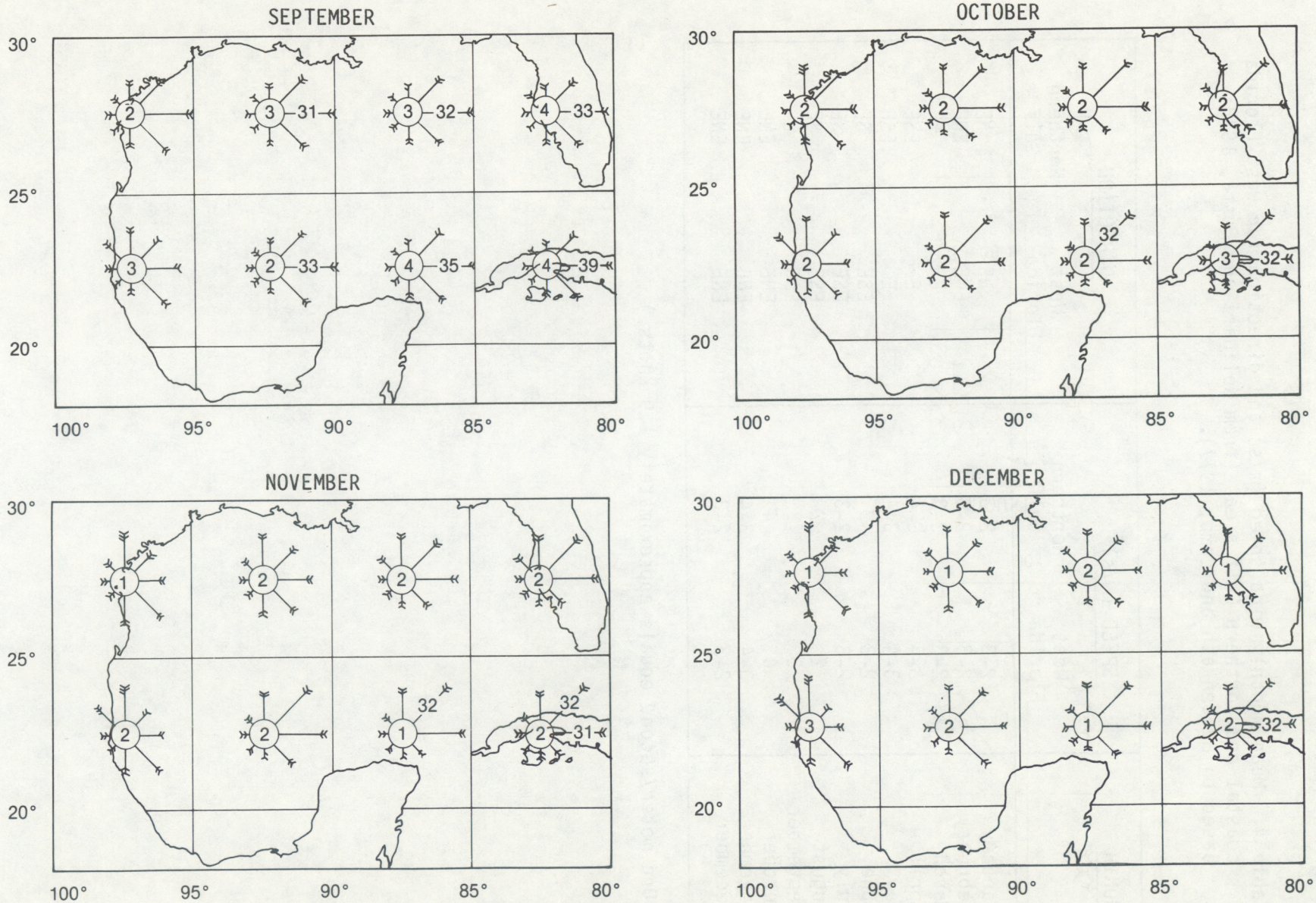


Figure 12 (continued)

Table 4. Mean monthly wind speed (m/s) and direction for west Florida coastal and northern Gulf areas (from Molinari and Festa, 1978; based on Hastenrath and Lamb, 1977).

MONTH	SPEED (m/s)*		DIRECTION	
	West Florida	Northern Gulf	West Florida	Northern Gulf
January	2-3	2-3	NE	NE
February	2-3	2-3	ENE	ENE
March	2-3	2-3	E	E
April	3-4	3-4	E	ESE
May	3-4	3-4	E	ESE
June	2-3	3	ESE	SE
July	2-3	2-3	ESE	SE
August	2	2	ESE	SE
September	3	3	ESE	E
October	4	4	ENE	ENE
November	3-4	3-4	ENE	ENE
December	2-3	2-3	ENE	ENE

(* One meter/second equals approximately 1.9 knots.)

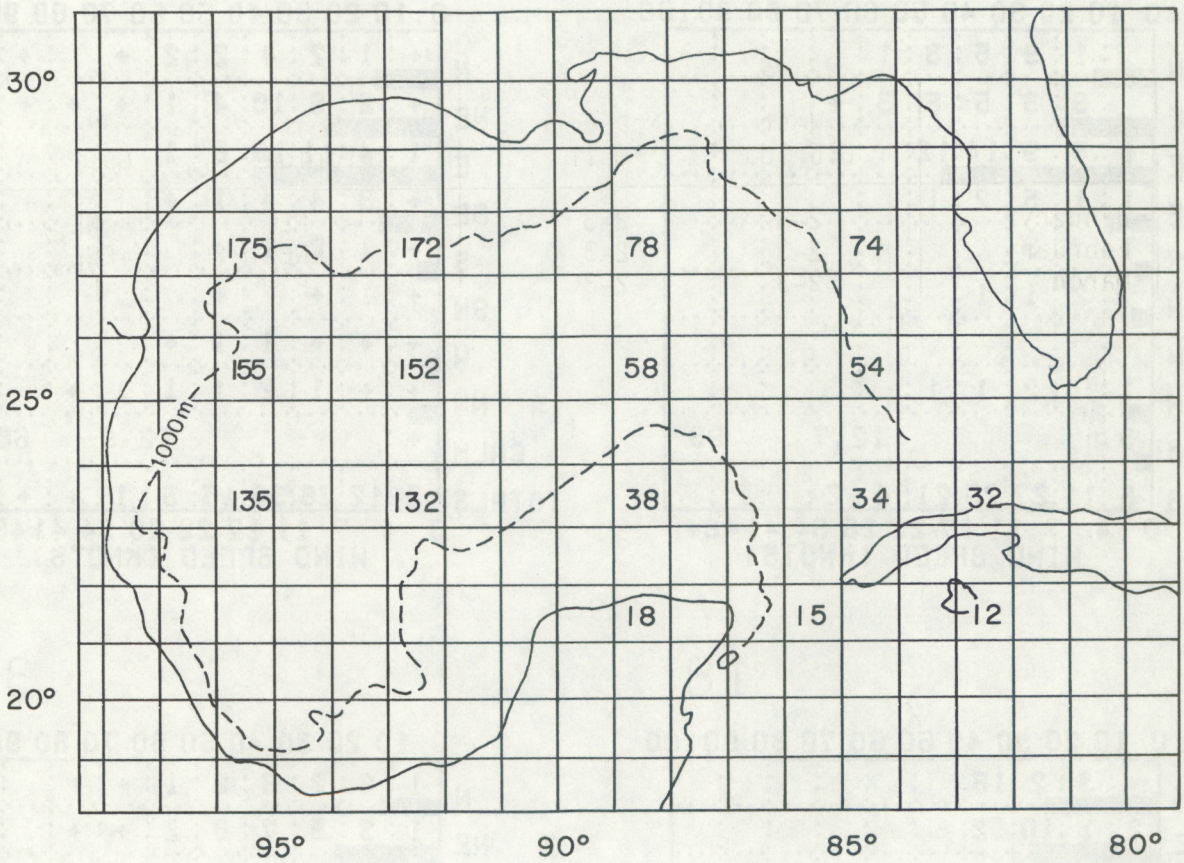


Figure 13. Location of 16 selected 1° squares in the Gulf of Mexico for which wind and wave data are presented in Tables 5, 7 and 8.

WIND DIRECTION AND SPEED

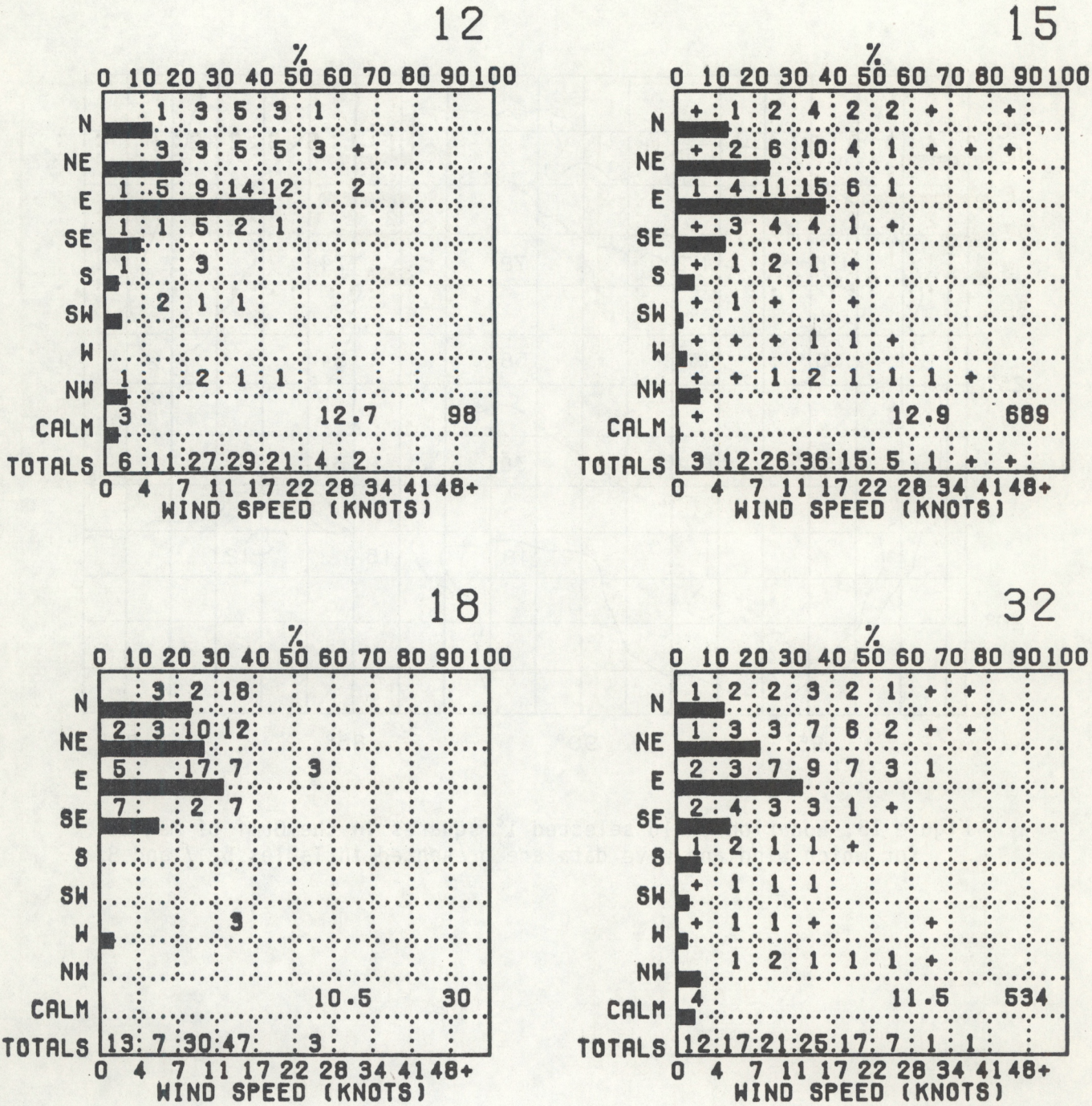


Table 5. Percent frequency of wind direction and speed by month for selected 1° squares in the Gulf of Mexico (from NCC Surface Marine Observations Data Base, 1800-1975).

Month: January Squares: 12, 15, 18, 32

WIND DIRECTION AND SPEED

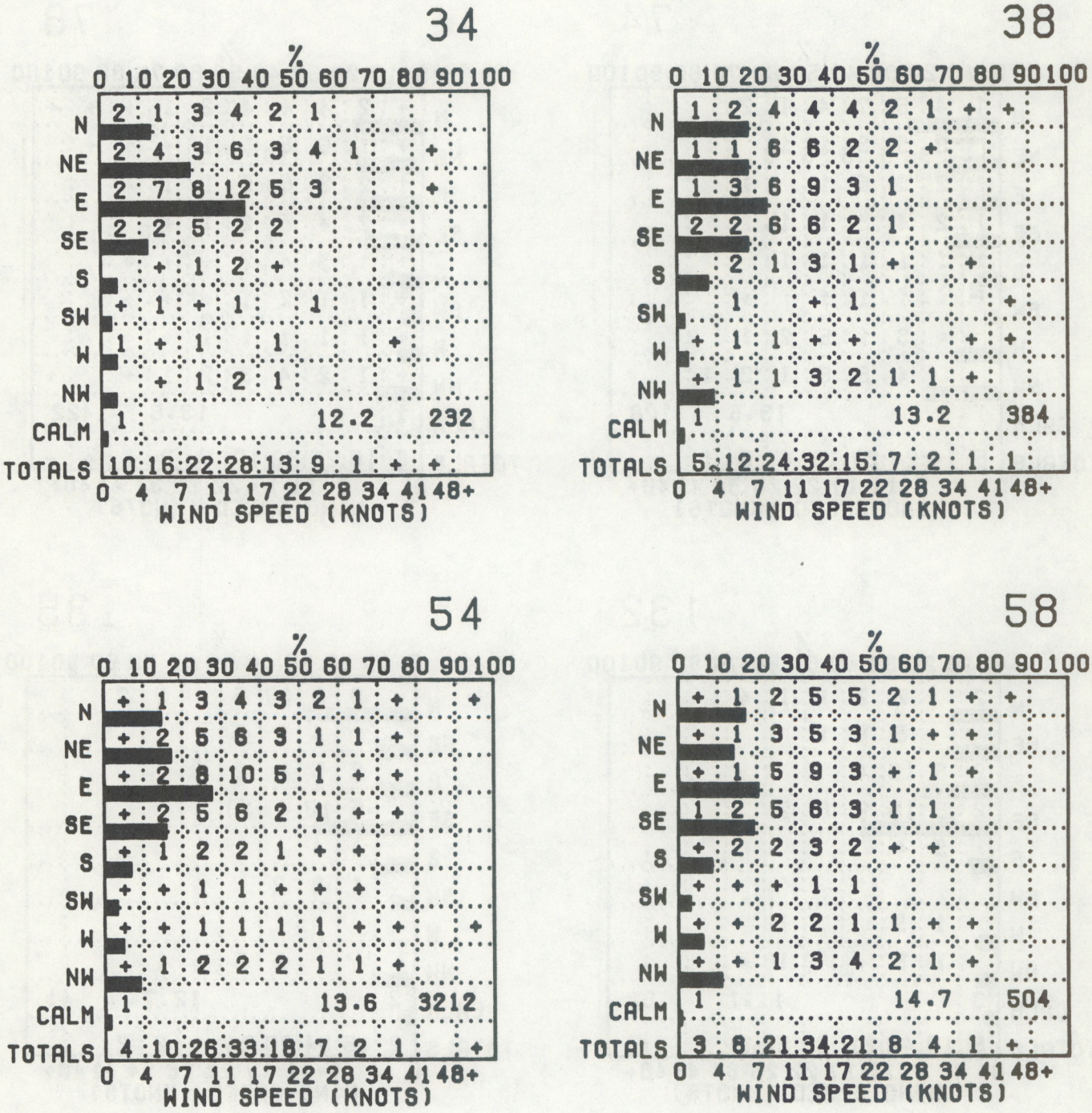
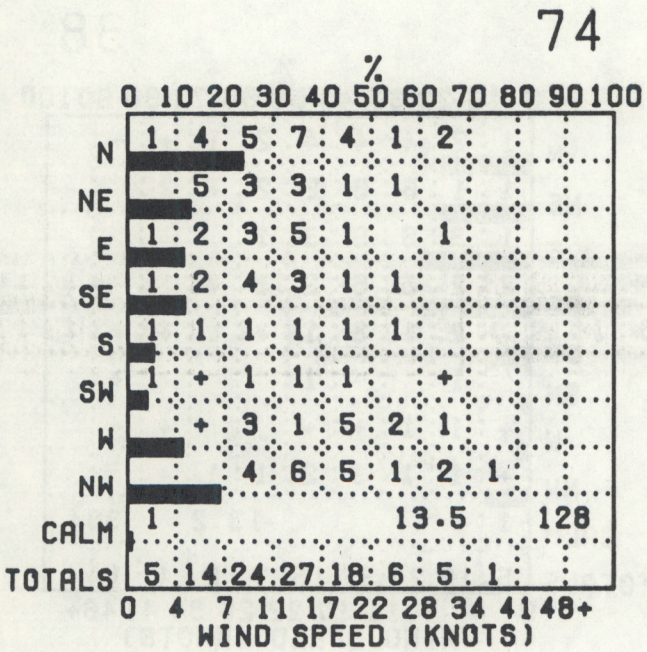
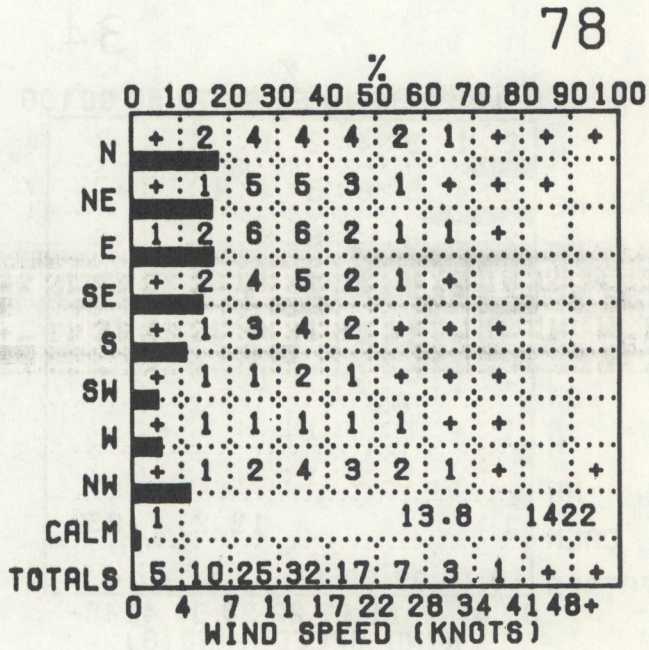
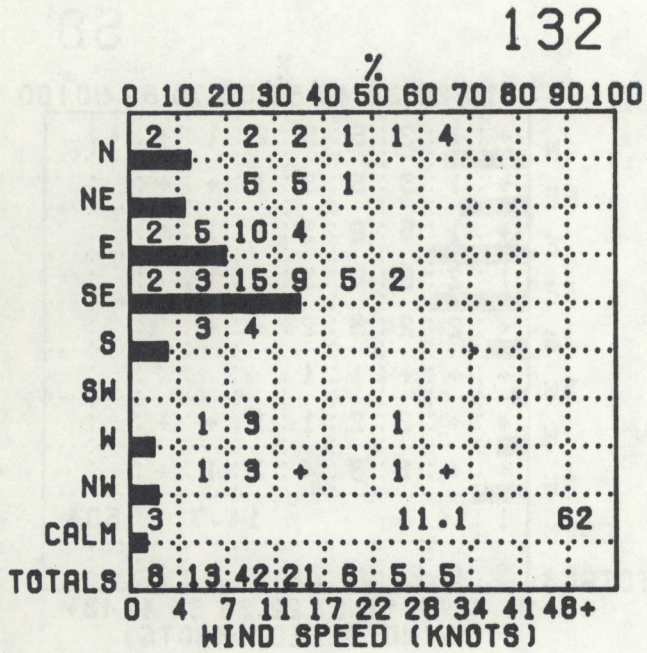


Table 5 (continued)
Month: January Squares: 34, 38, 54, 58

WIND DIRECTION AND SPEED







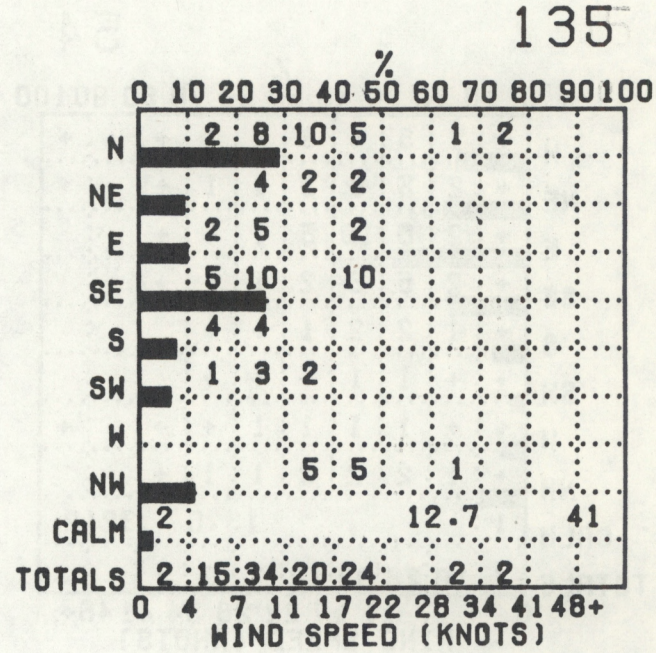
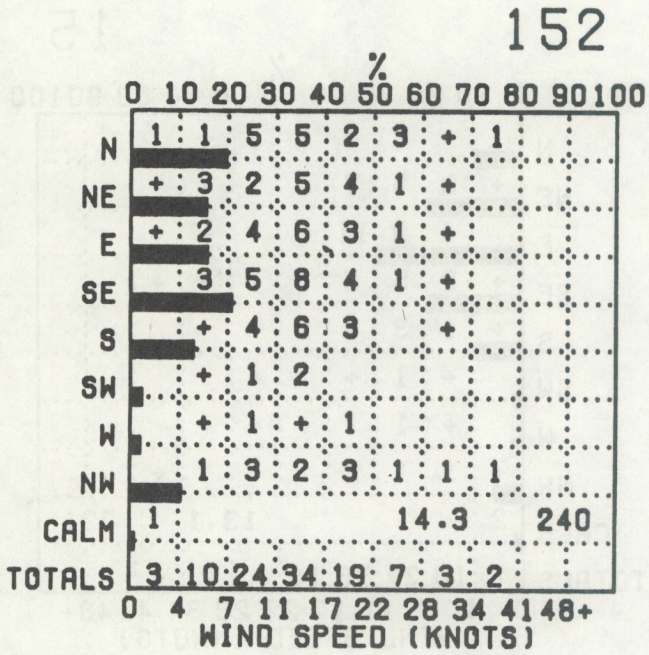
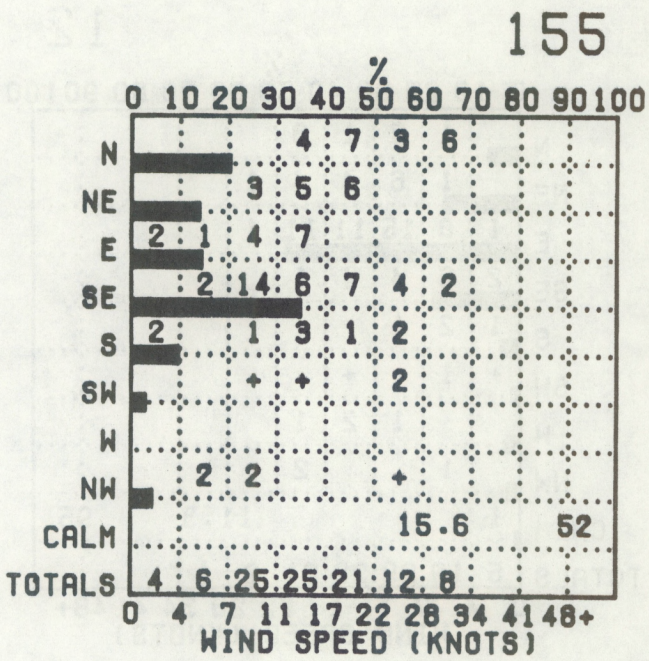
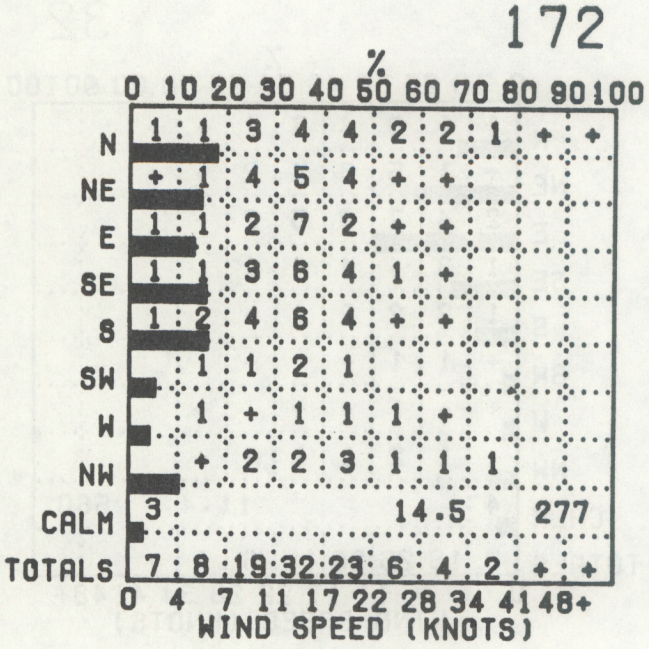


Table 5 (continued)
Month: January Squares: 74, 78, 132, 135

WIND DIRECTION AND SPEED







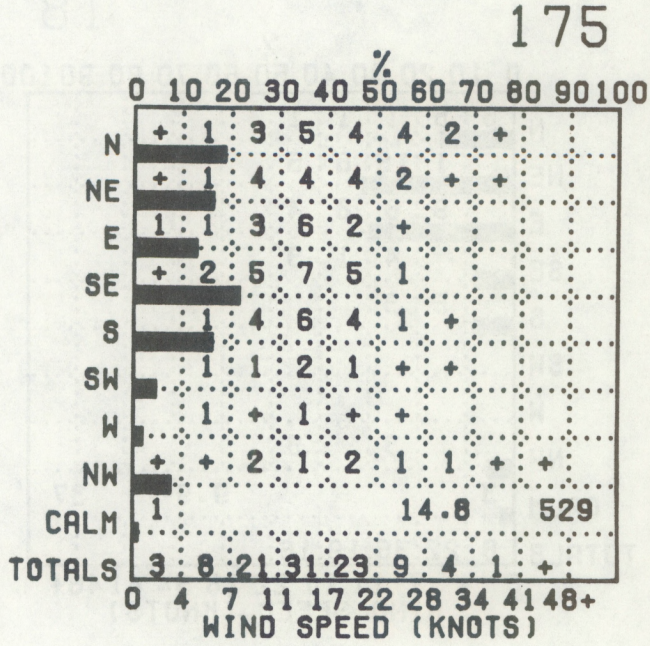
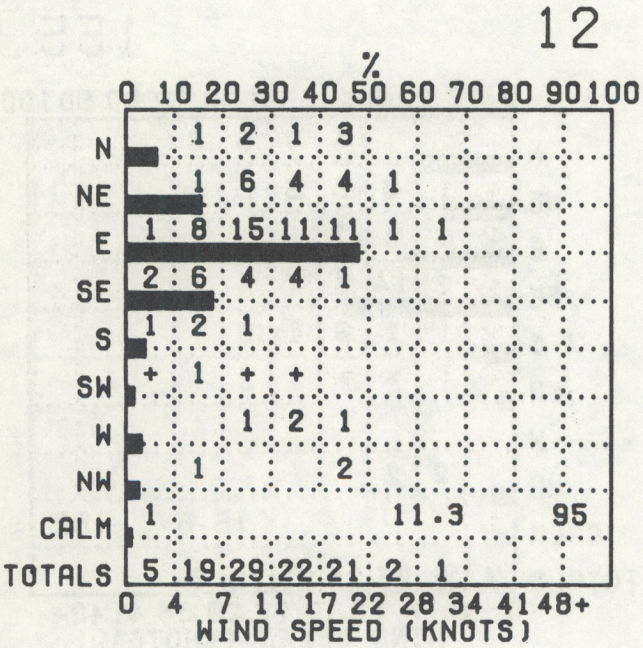
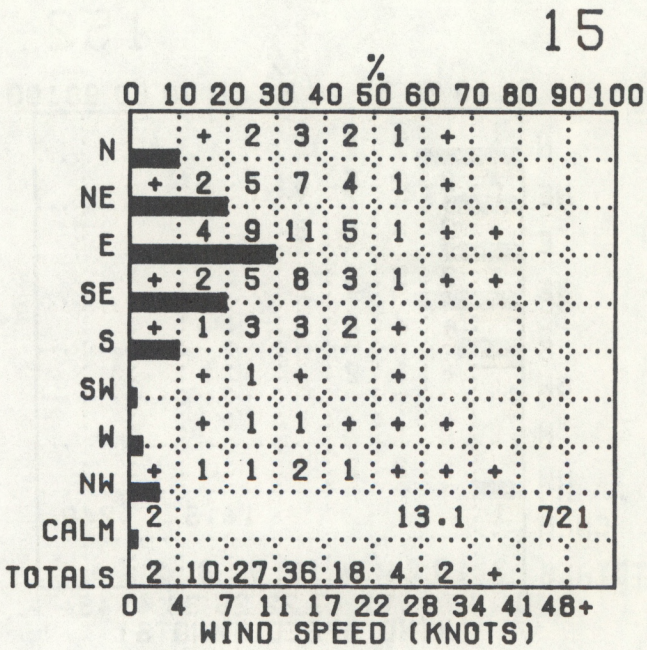
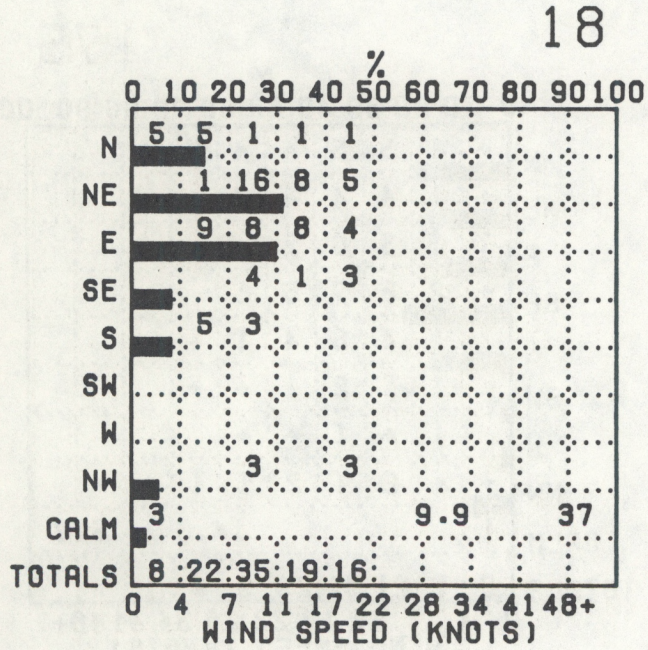


Table 5 (continued)
Month: January Squares: 152, 155, 172, 175

WIND DIRECTION AND SPEED







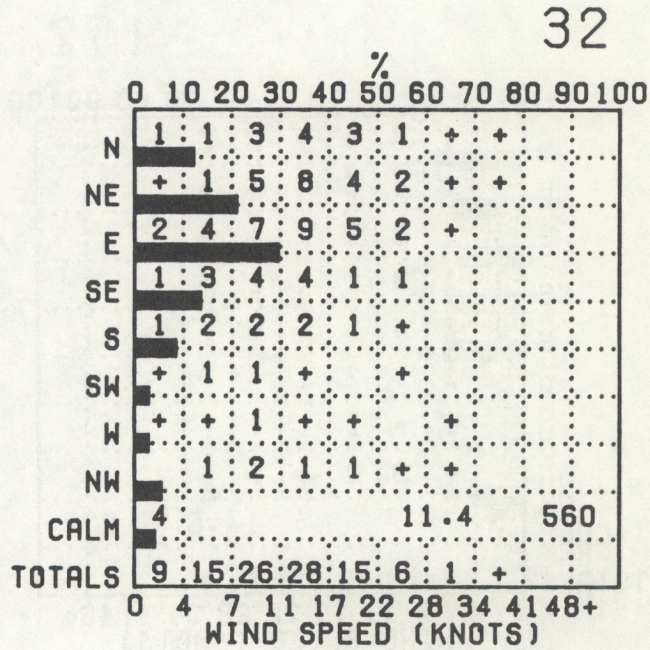
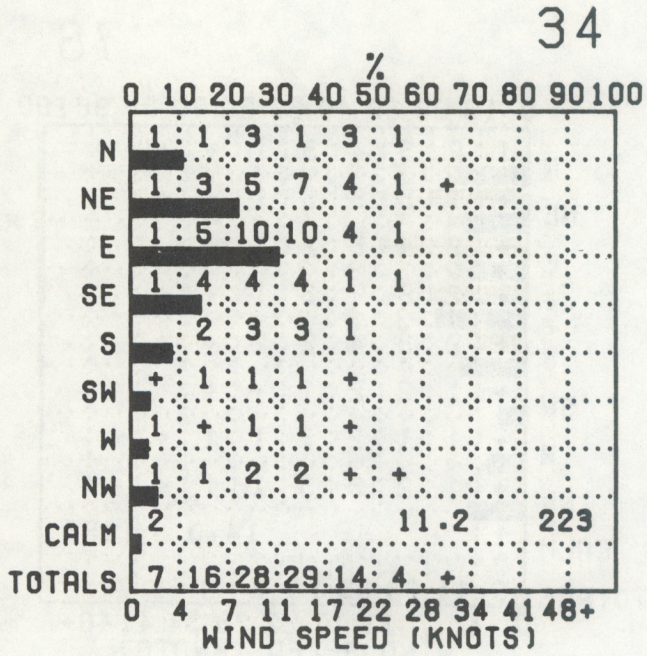
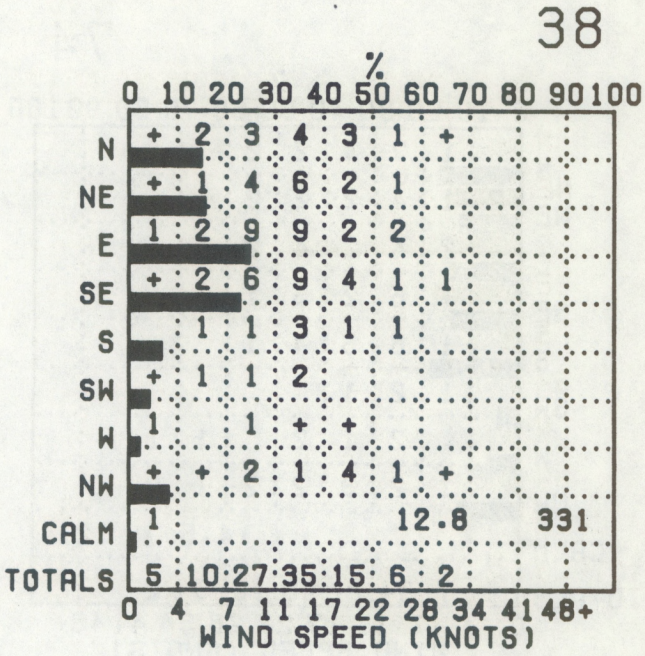
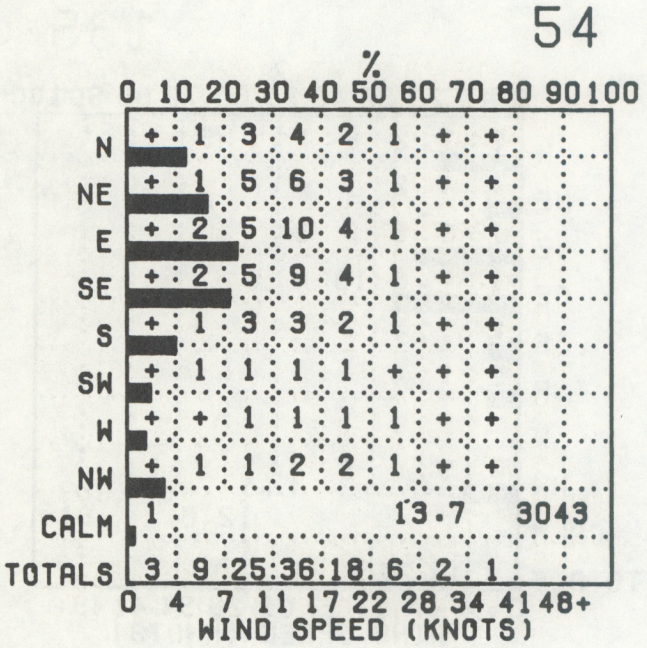


Table 5 (continued)
Month: February Squares: 12, 15, 18, 32

WIND DIRECTION AND SPEED







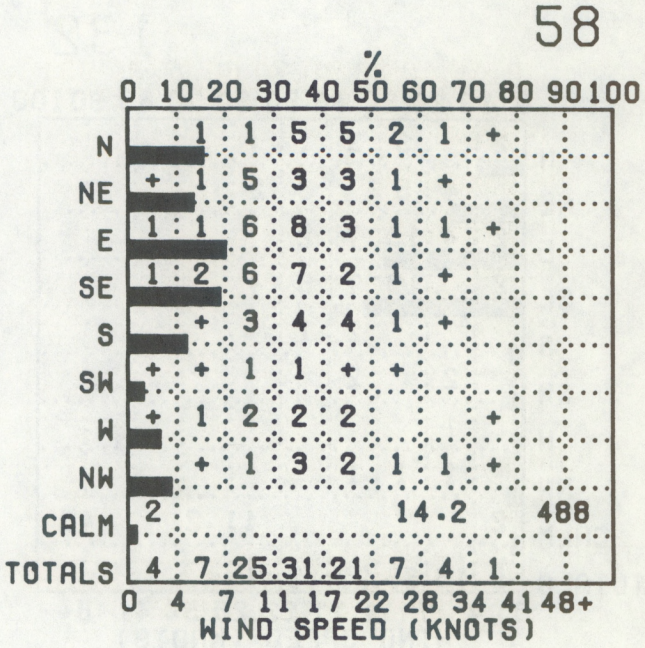
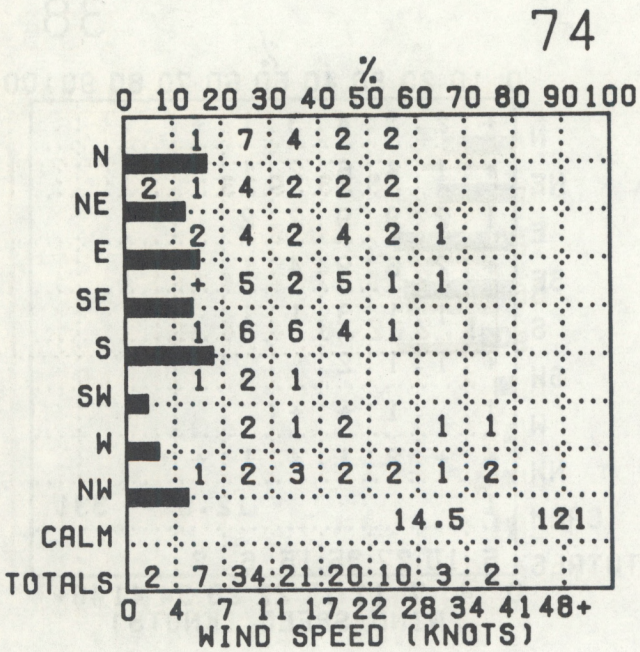
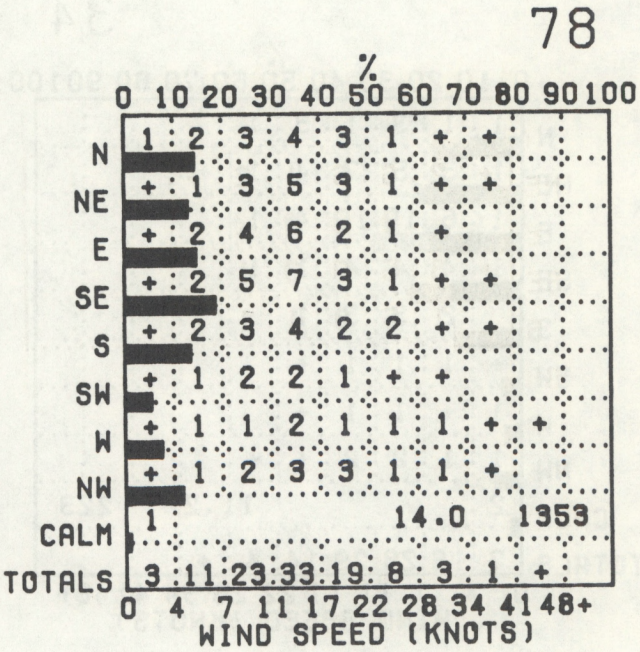
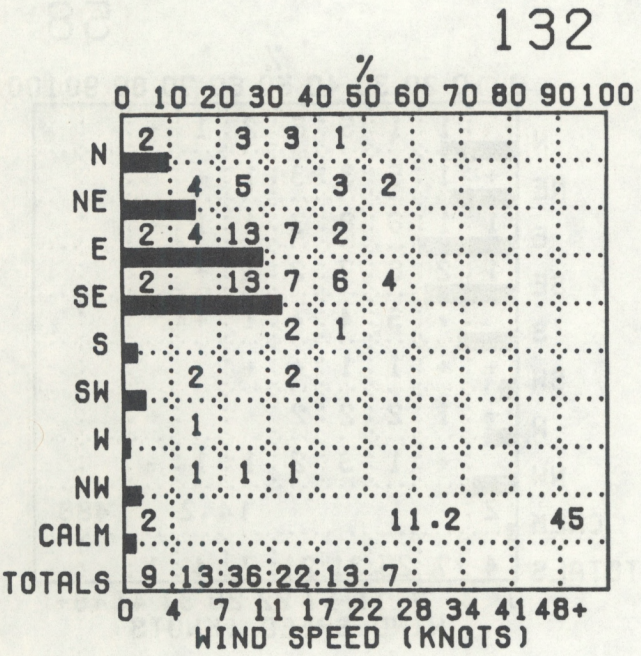


Table 5 (continued)
Month: February Squares: 34, 38, 54, 58

WIND DIRECTION AND SPEED







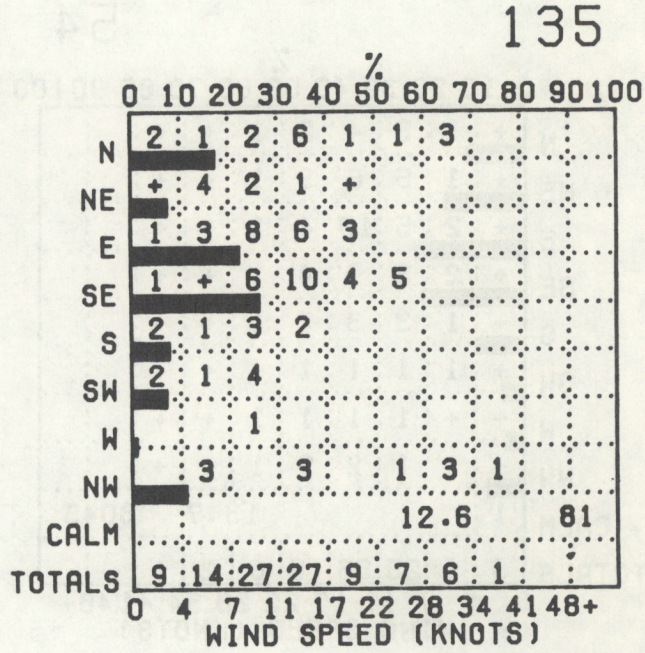
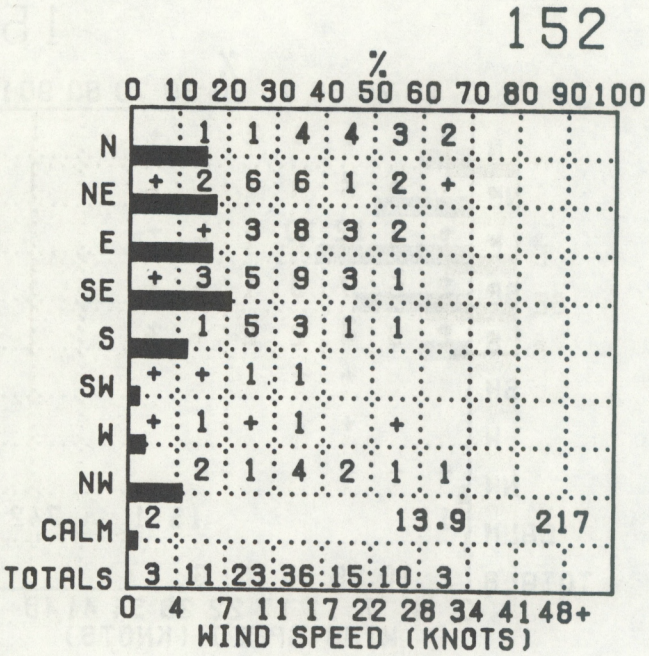
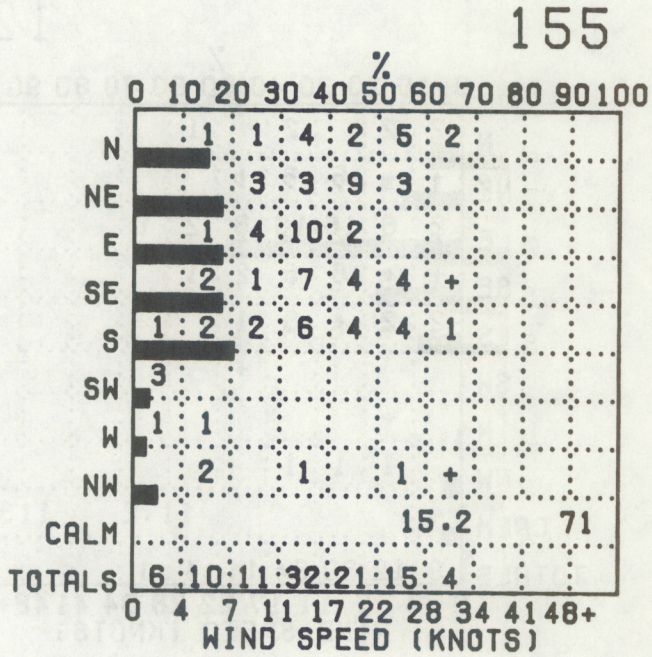
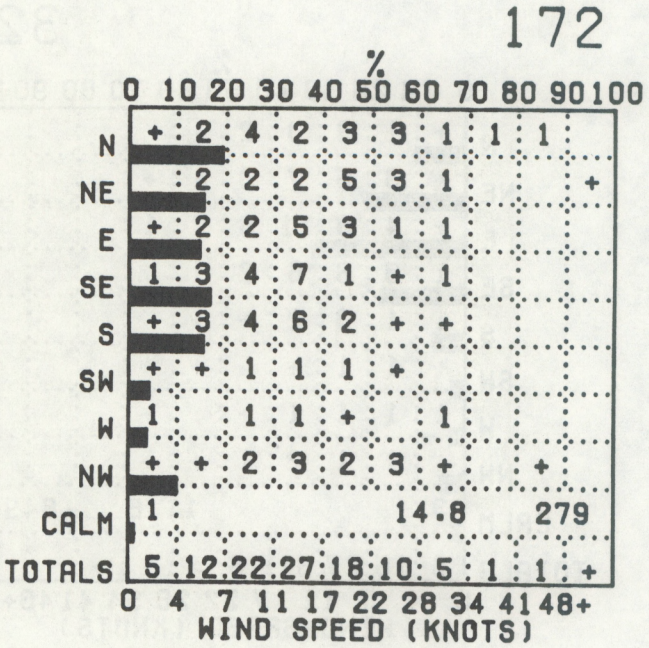


Table 5 (continued)
Month: February Squares: 74, 78, 132, 135

WIND DIRECTION AND SPEED







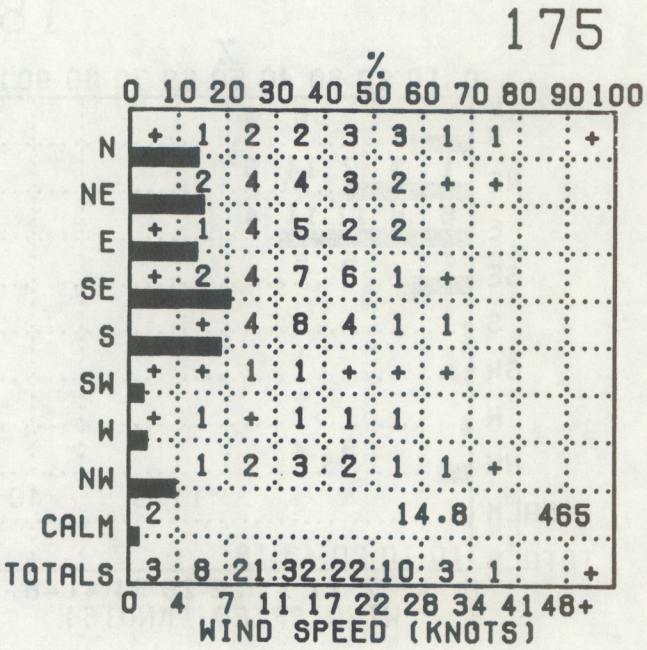
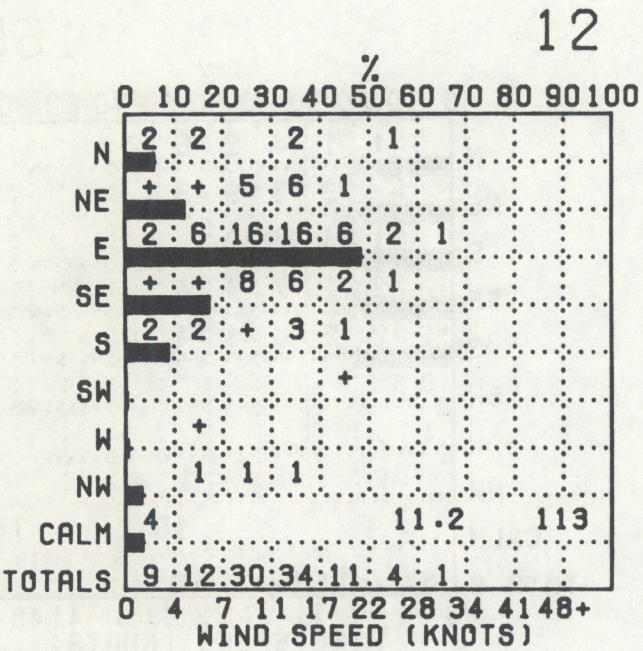
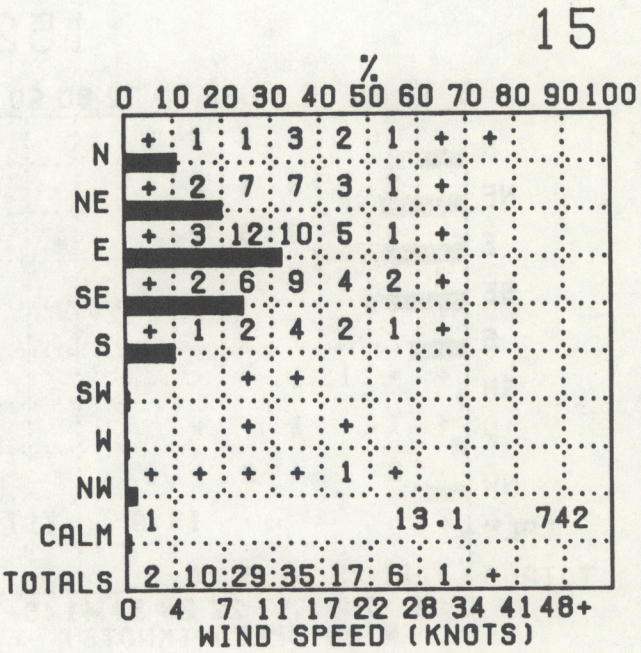
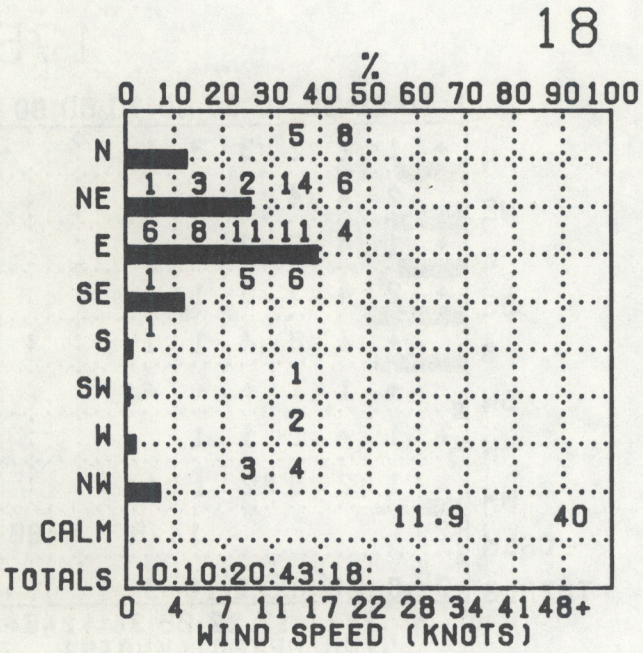


Table 5 (continued)
Month: February Squares: 152, 155, 172, 175

WIND DIRECTION AND SPEED







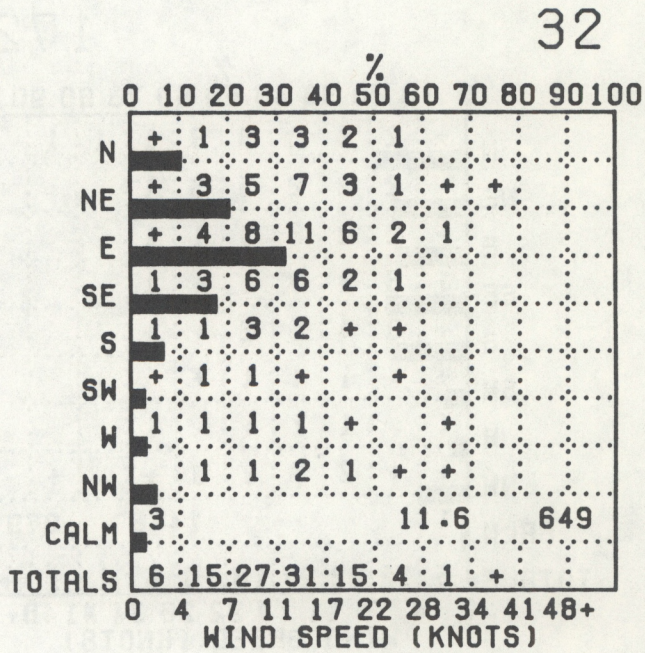
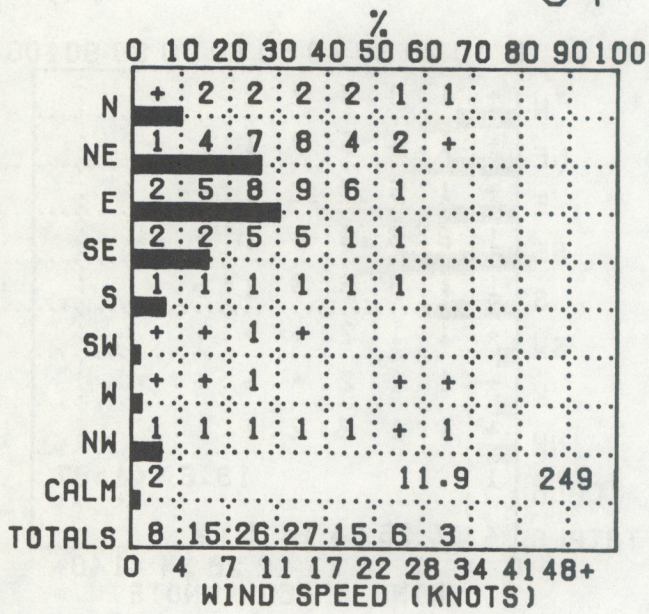


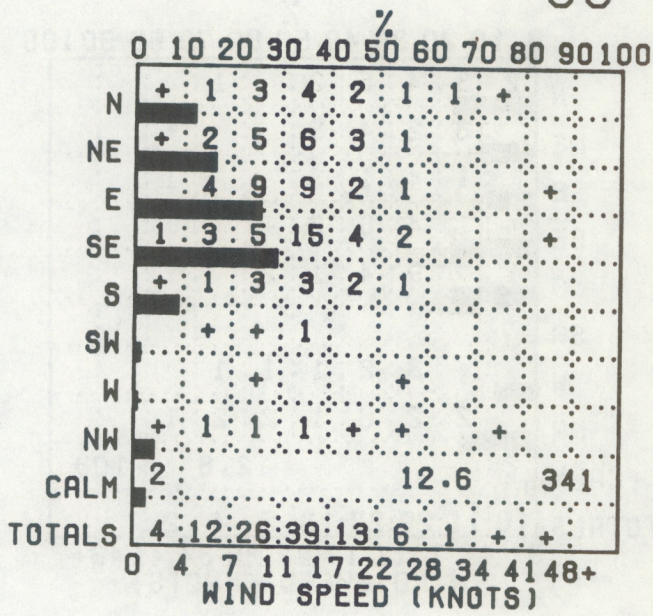
Table 5 (continued)
Month: March Squares: 12, 15, 18, 32

WIND DIRECTION AND SPEED

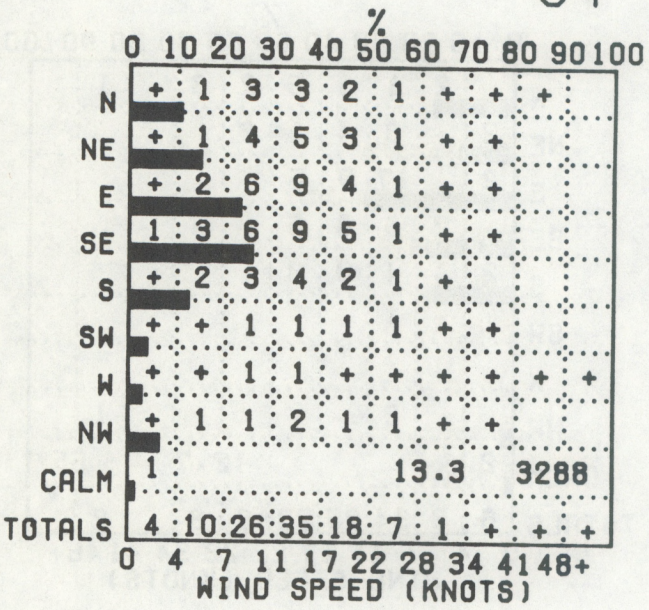
34



38



54



58

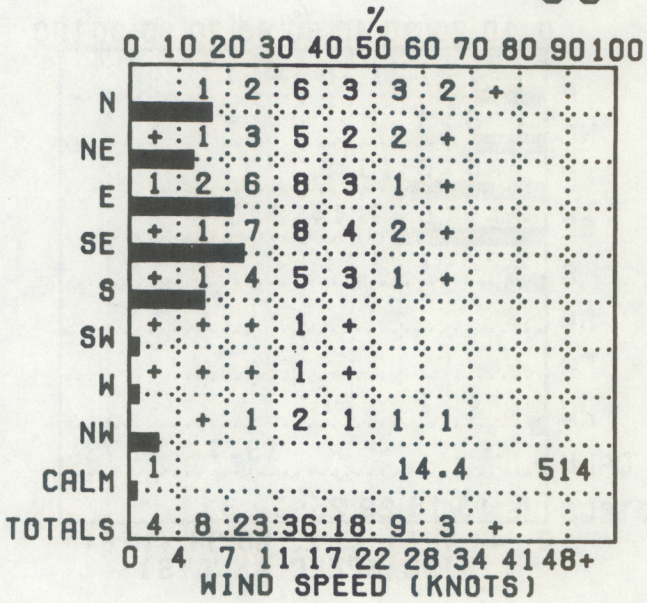
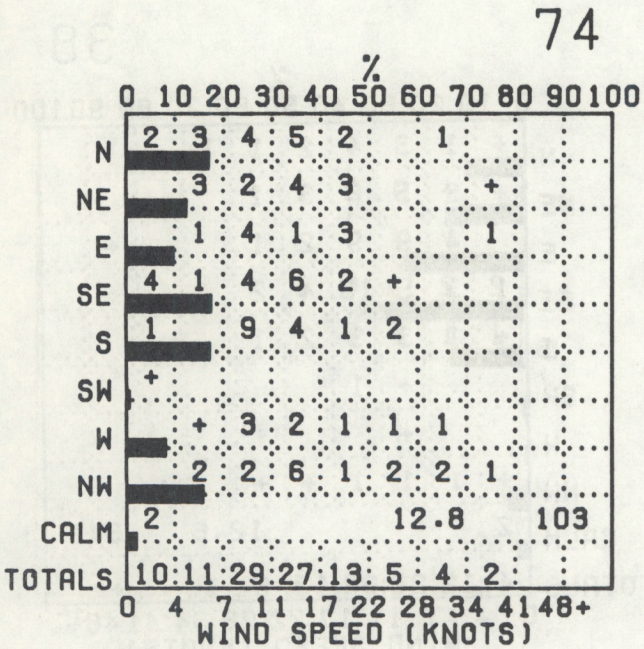
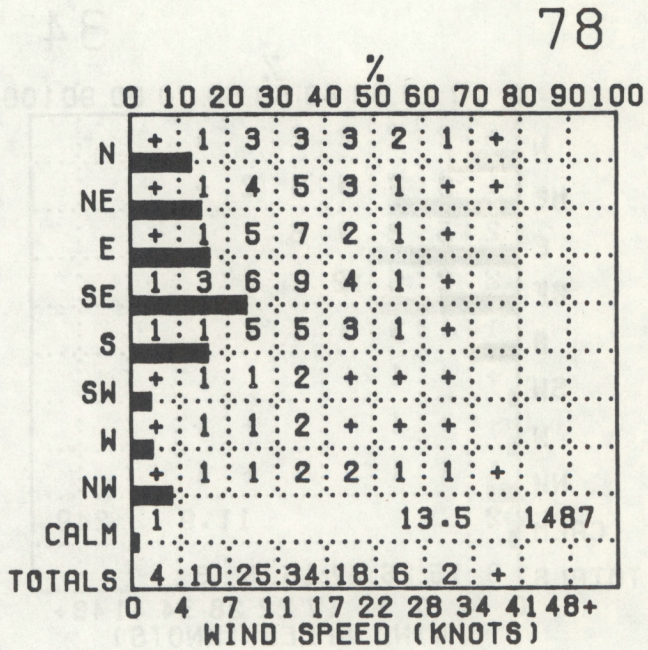
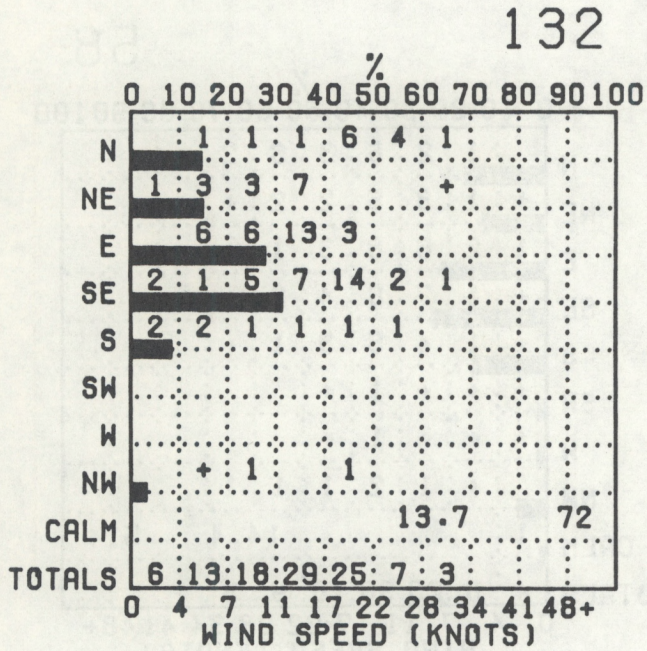


Table 5 (continued)
Month: March Squares: 34, 38, 54, 58

WIND DIRECTION AND SPEED







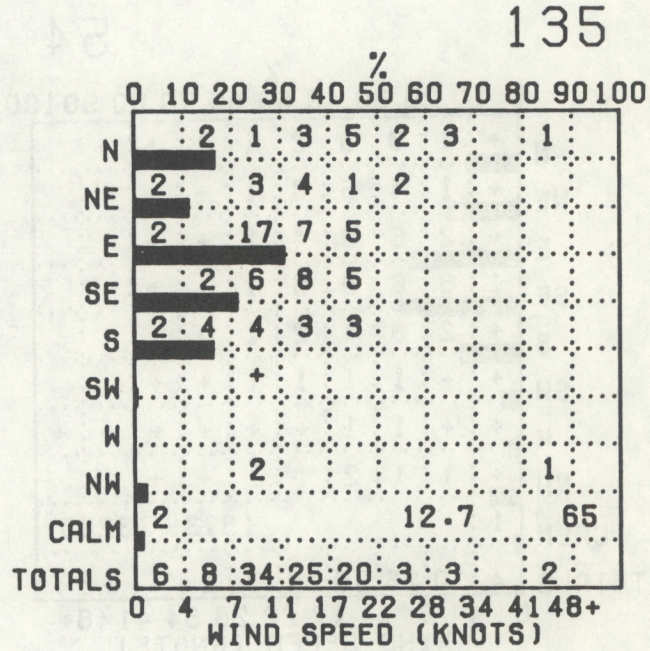


Table 5 (continued)
Month: March Squares: 74, 78, 132, 135

WIND DIRECTION AND SPEED

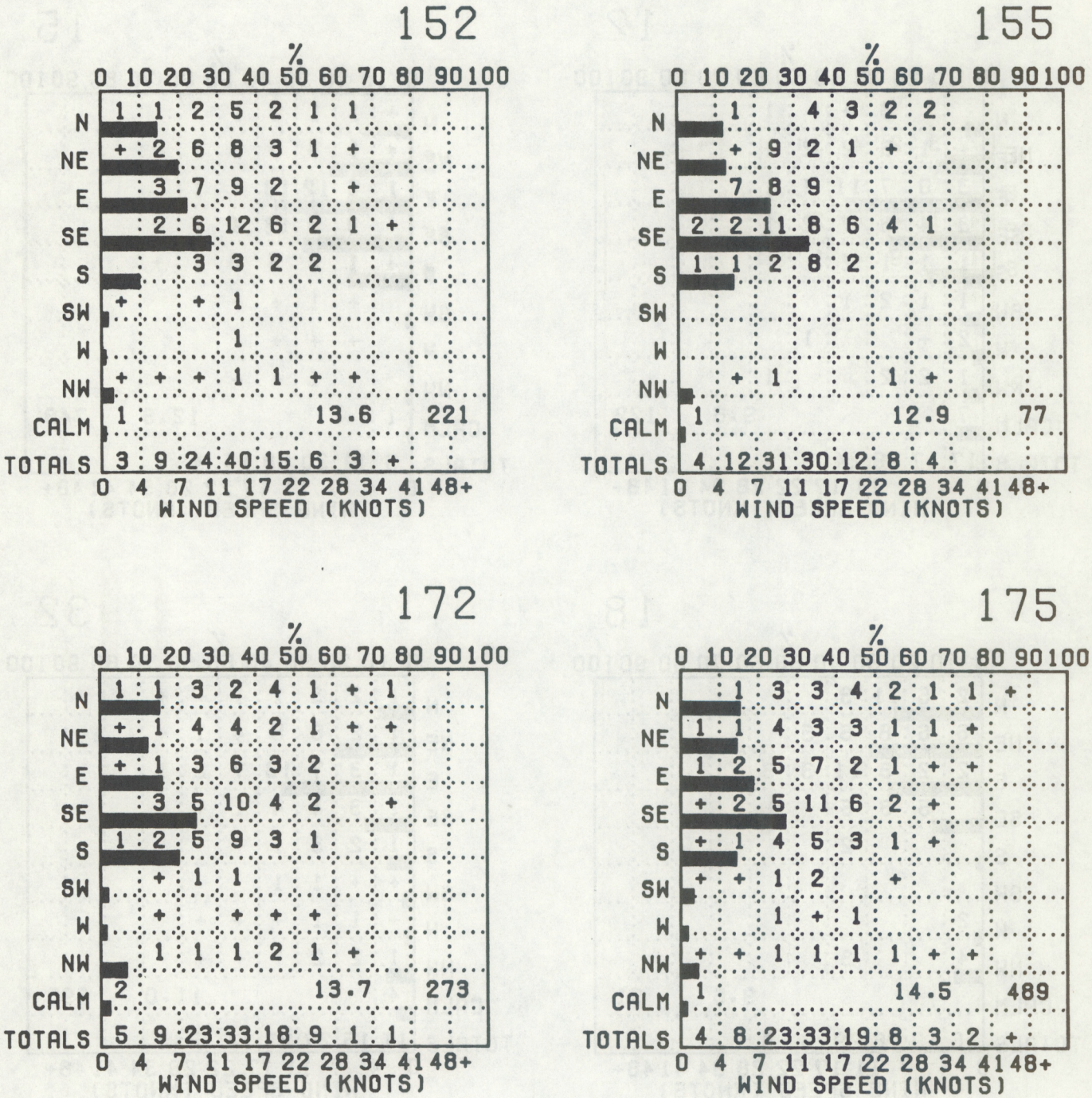
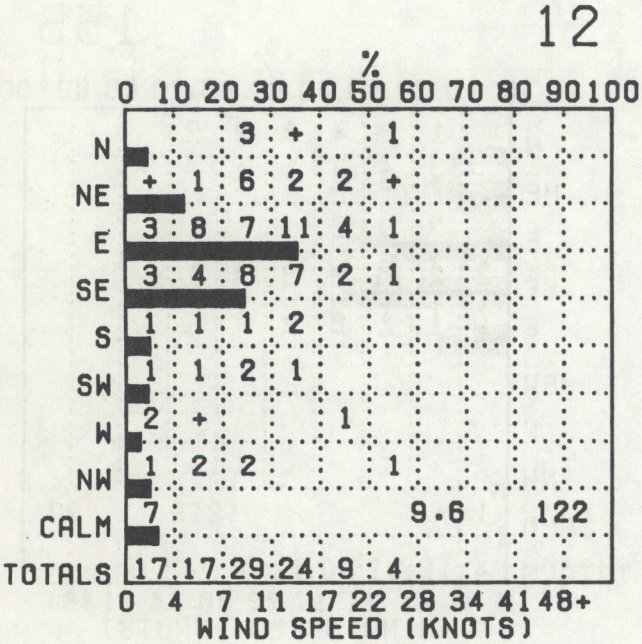
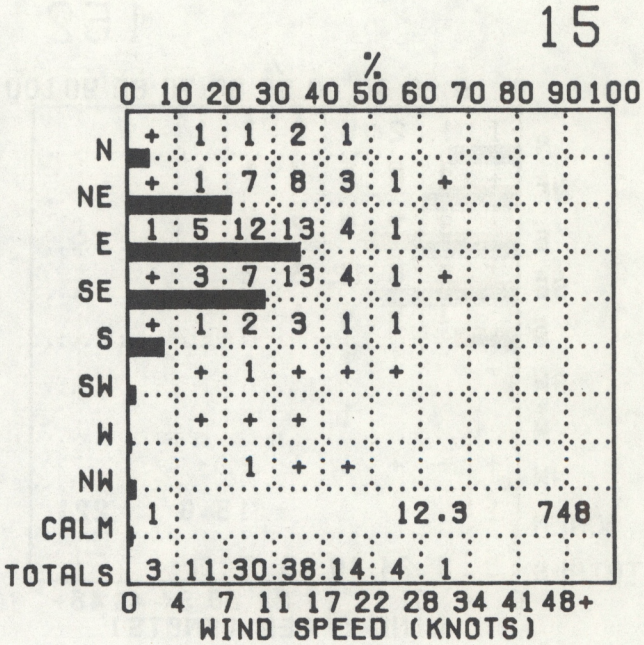
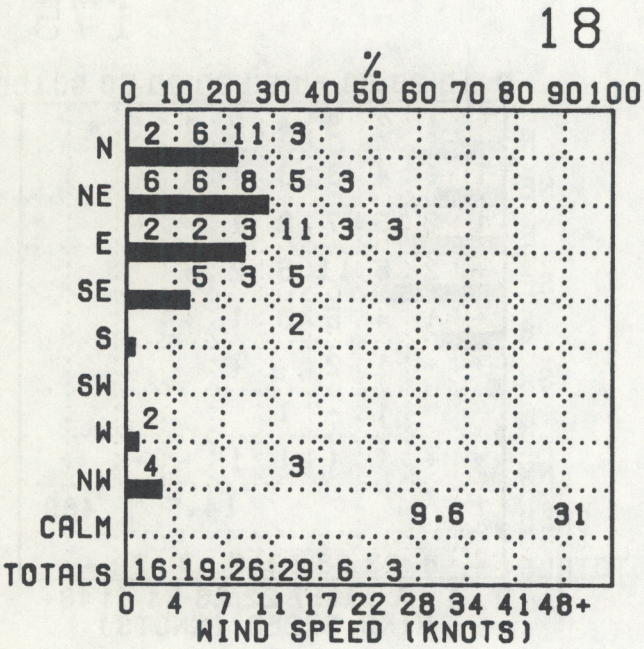


Table 5 (continued)
Month: March Squares: 152, 155, 172, 175

WIND DIRECTION AND SPEED







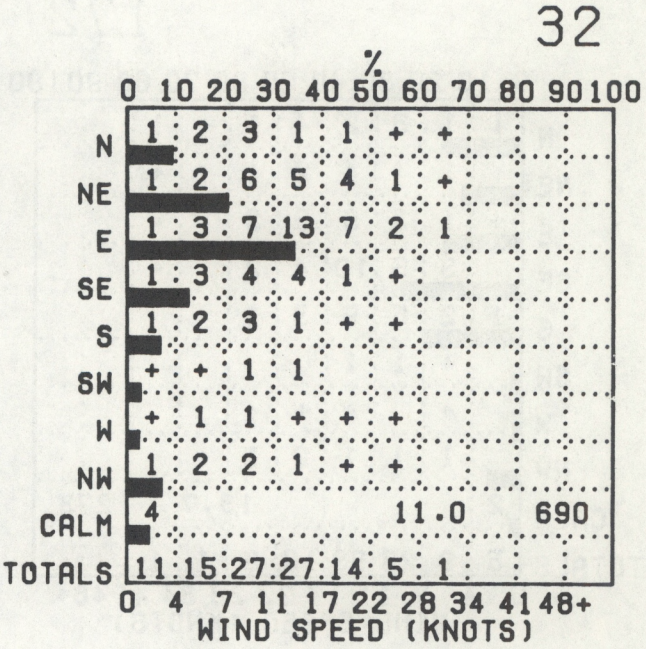
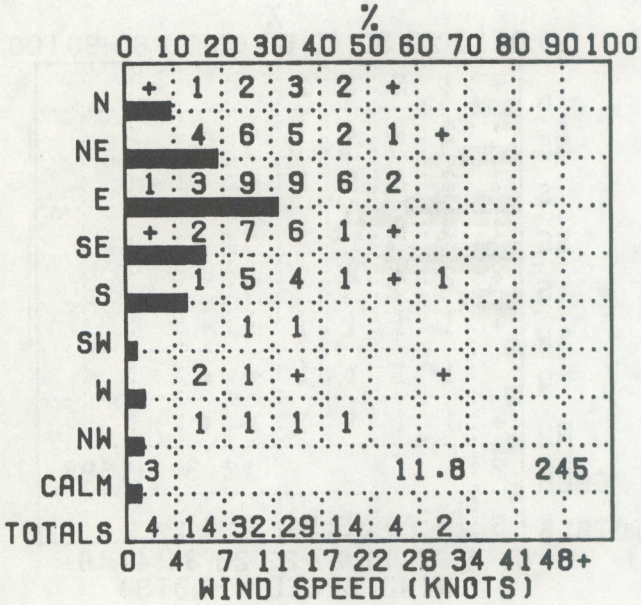


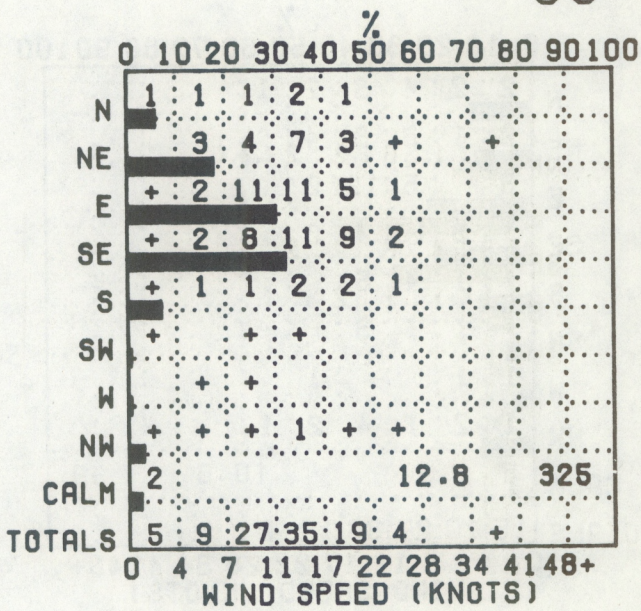
Table 5 (continued)
Month: April Squares: 12, 15, 18, 32

WIND DIRECTION AND SPEED

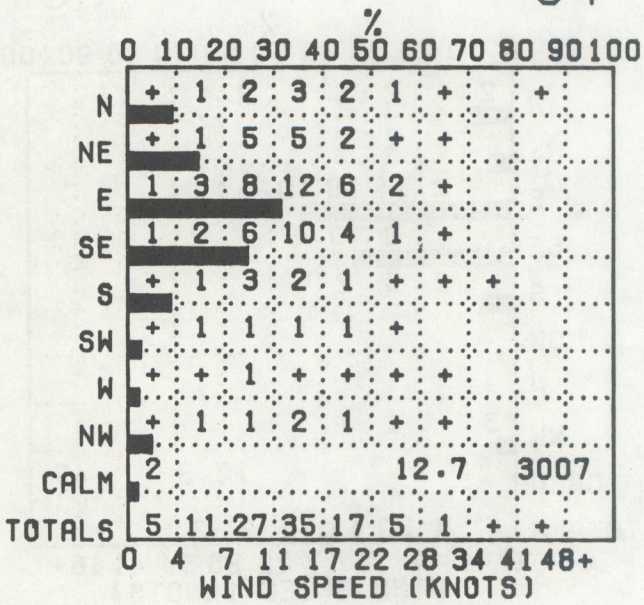
34



38



54



58

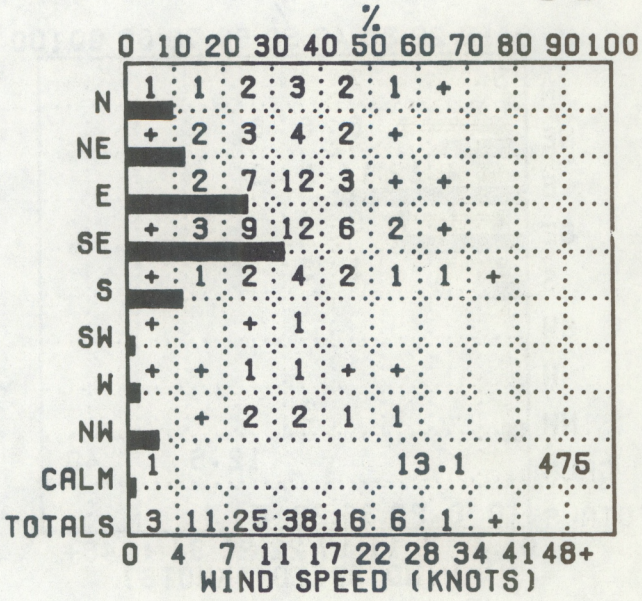
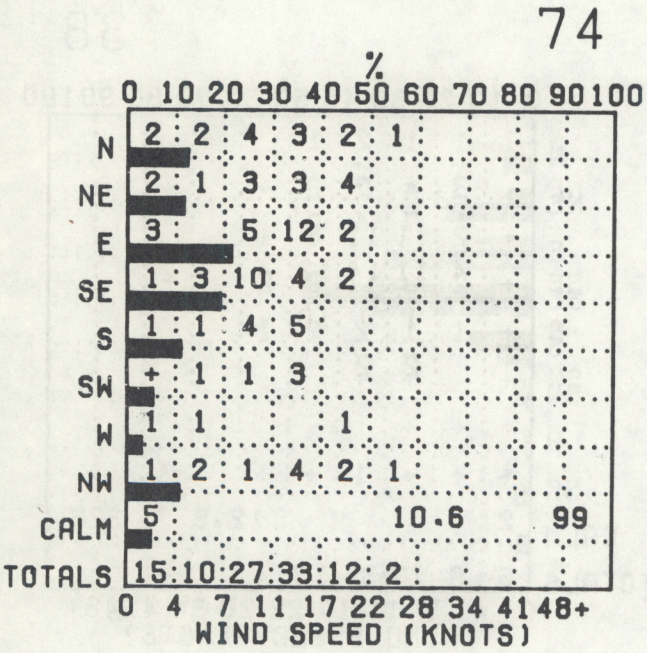
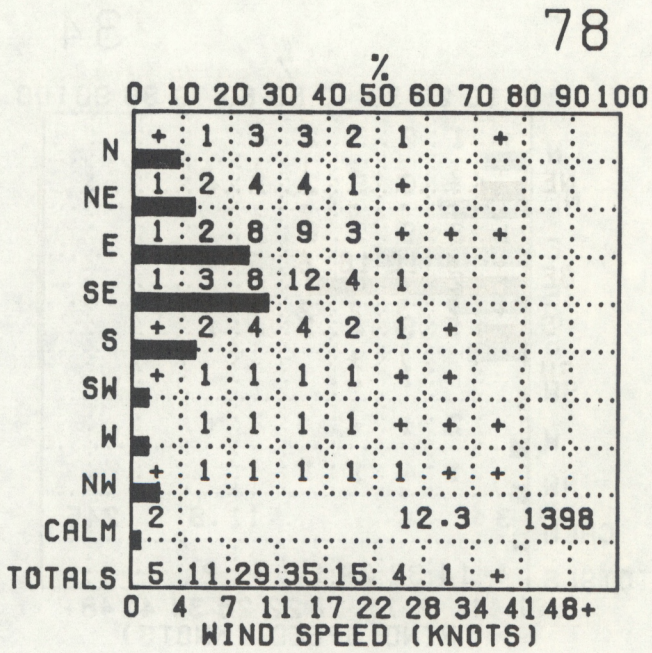
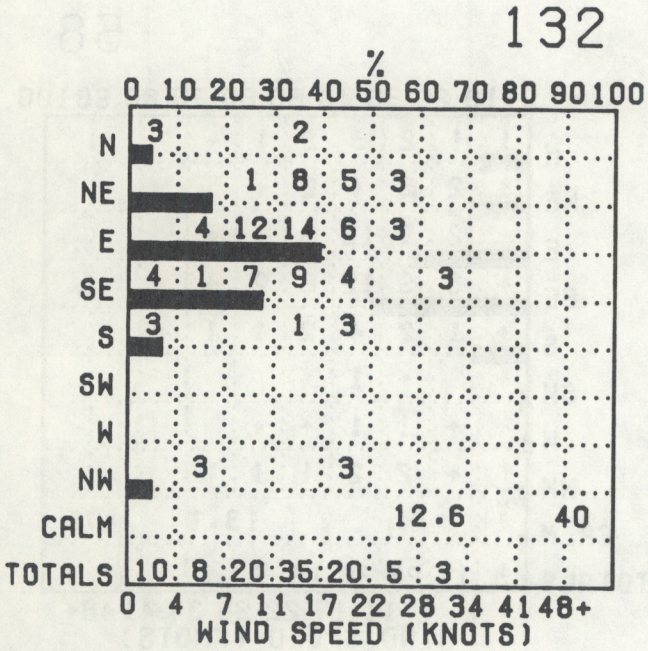


Table 5 (continued)
Month: April Squares: 34, 38, 54, 58

WIND DIRECTION AND SPEED







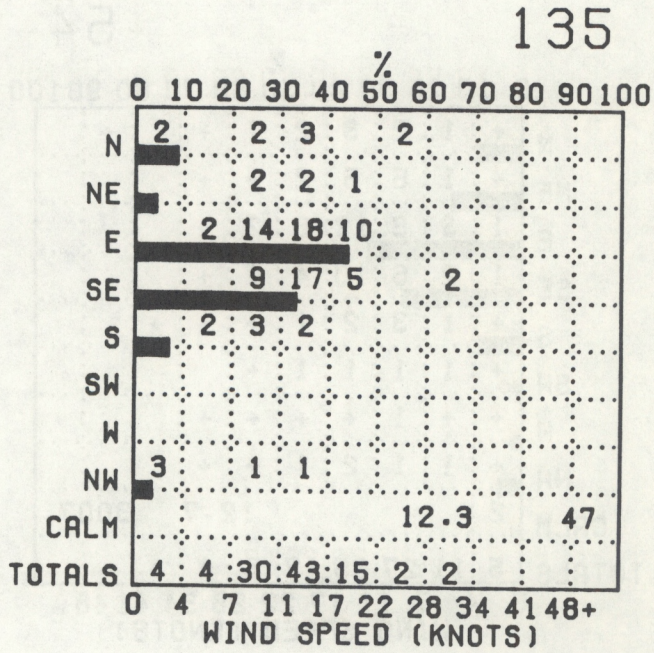
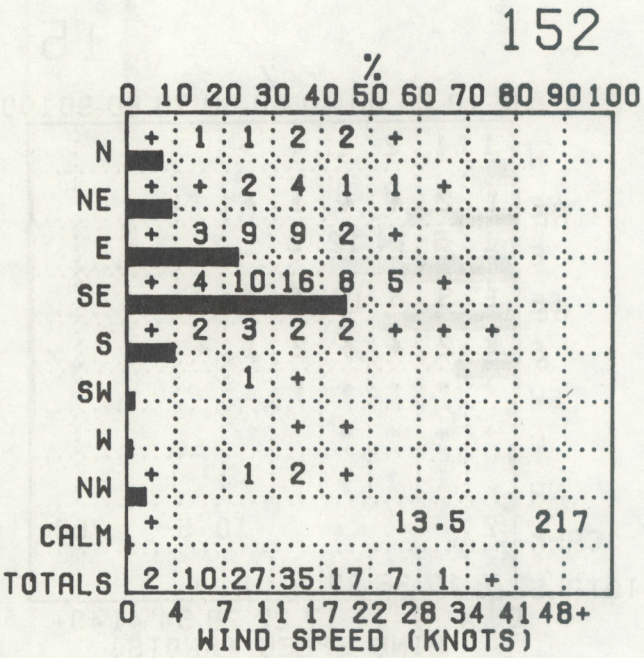
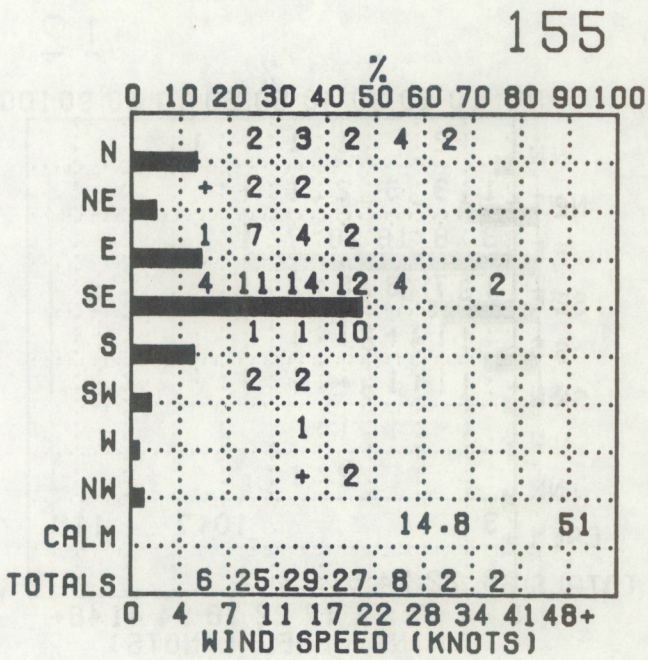
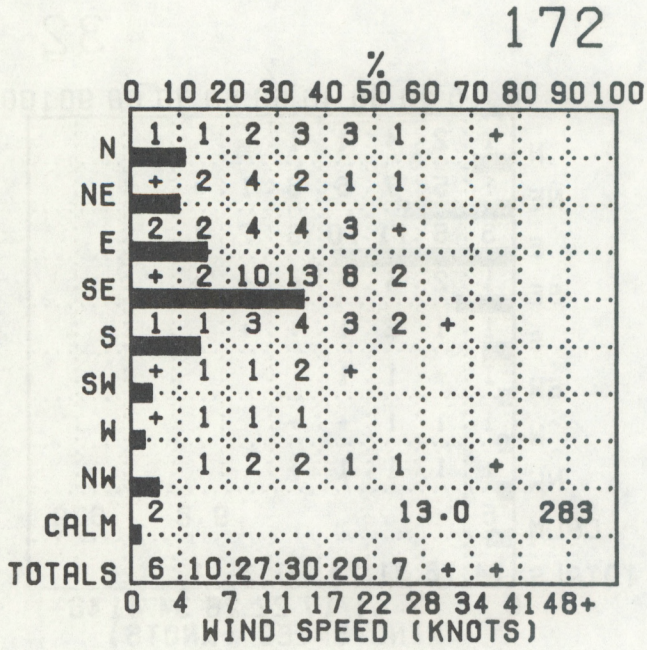


Table 5 (continued)
Month: April Squares: 74, 78, 132, 135

WIND DIRECTION AND SPEED







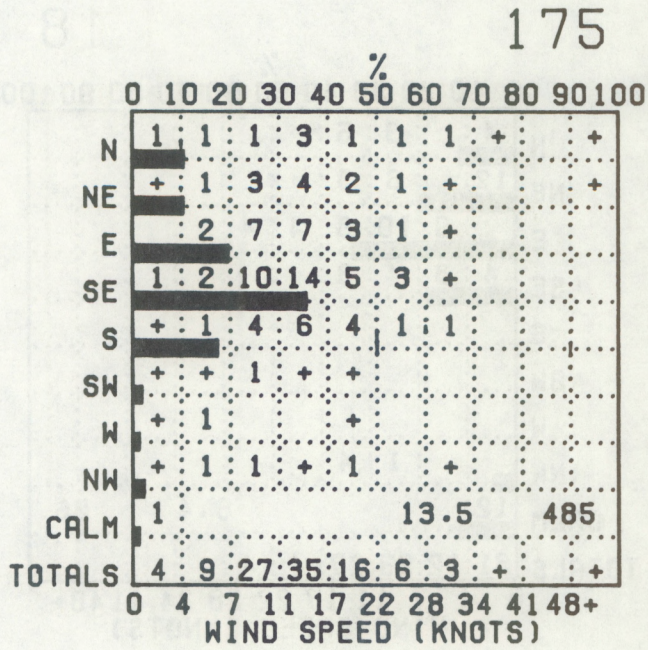
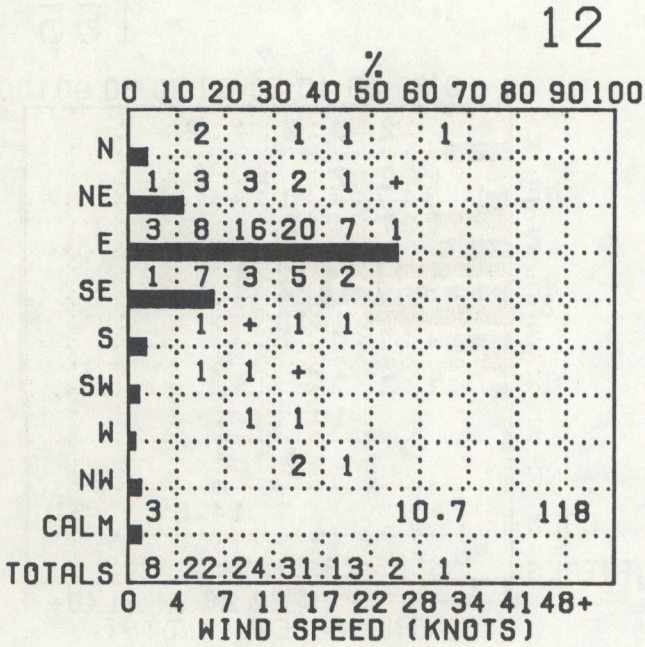
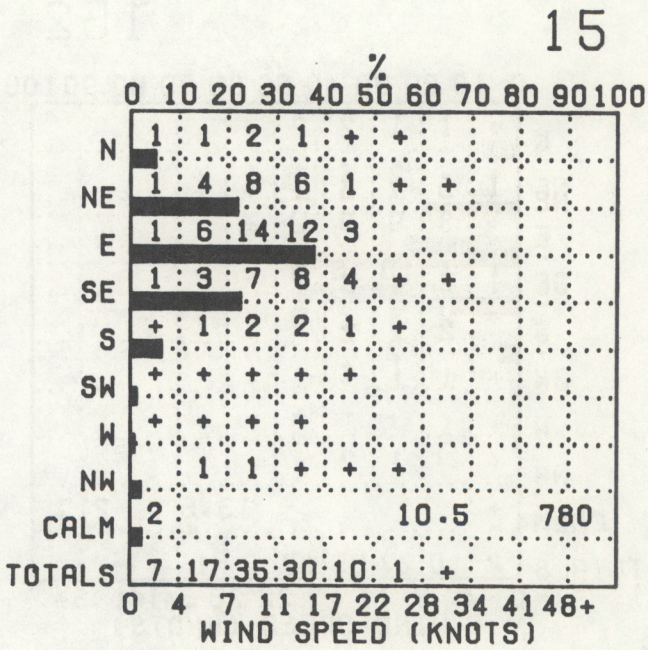
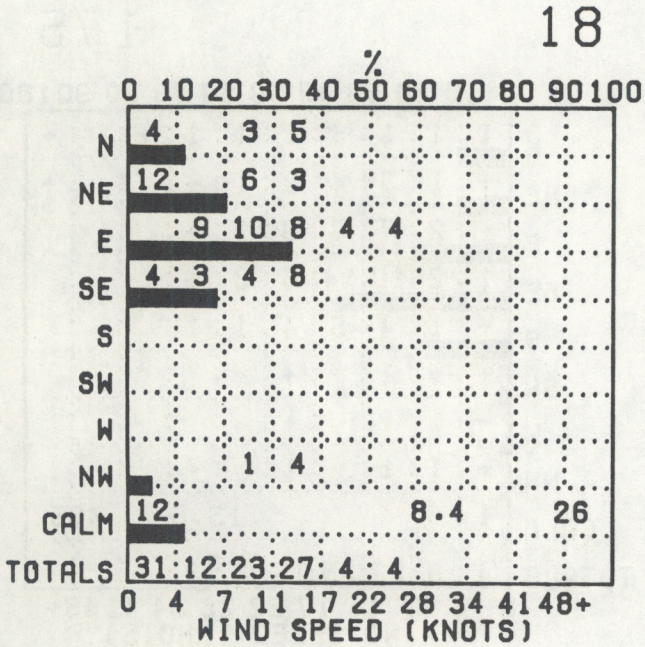


Table 5 (continued)
Month: April Squares: 152, 155, 172, 175

WIND DIRECTION AND SPEED







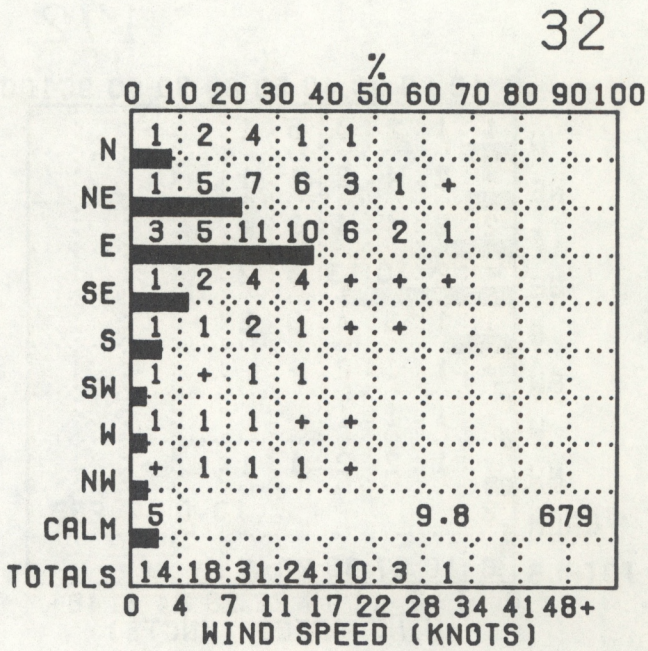
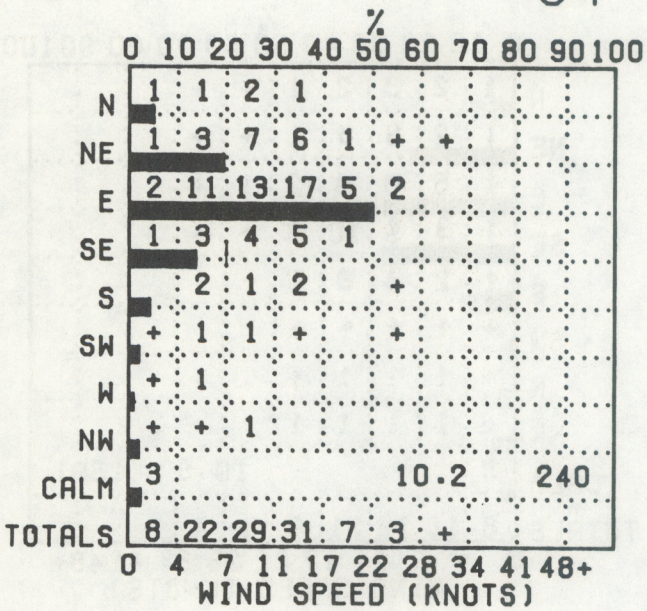


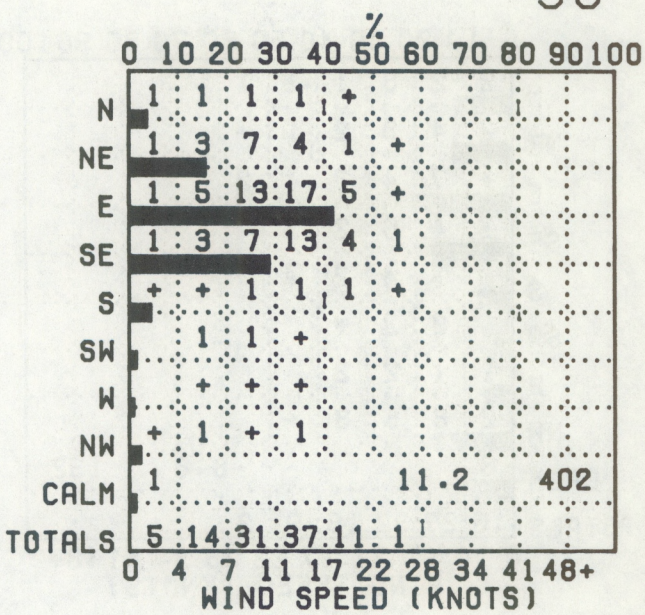
Table 5 (continued)
Month: May Squares: 12, 15, 18, 32

WIND DIRECTION AND SPEED

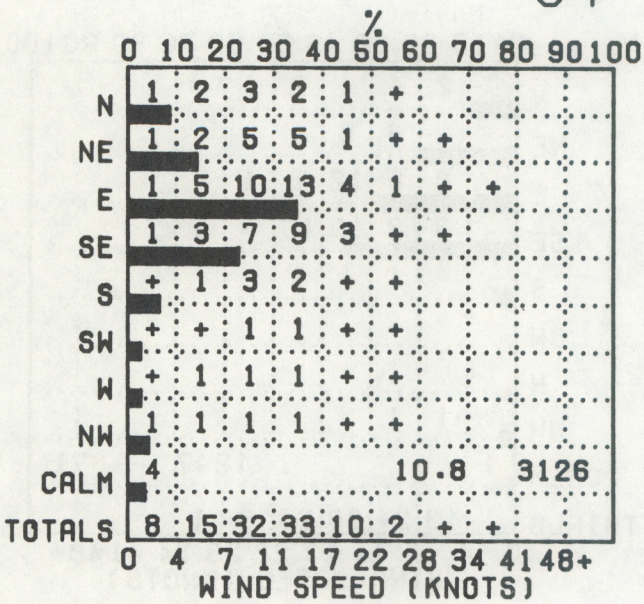
34



38



54



58

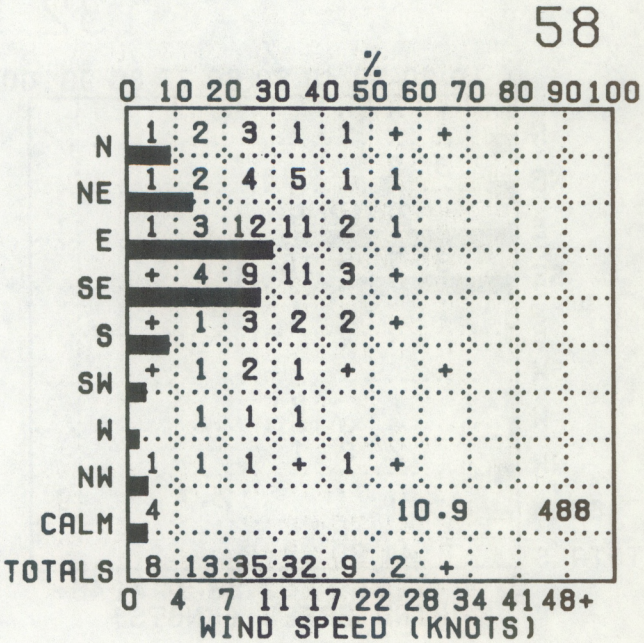
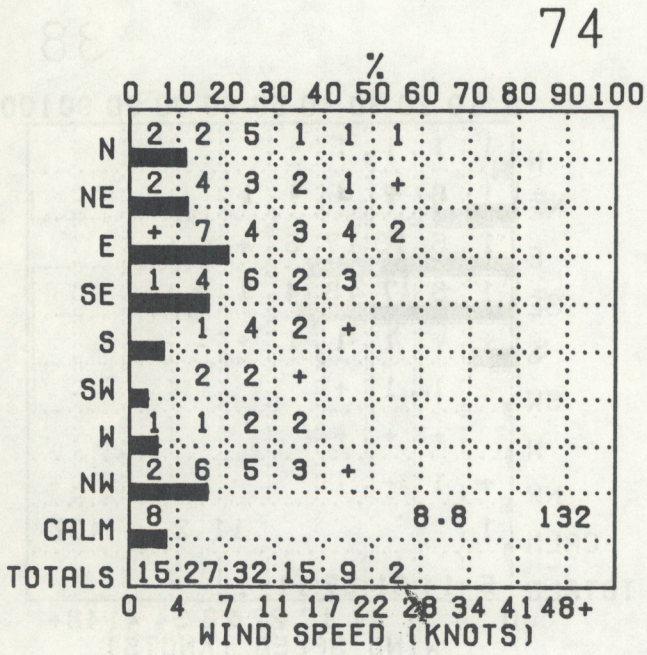
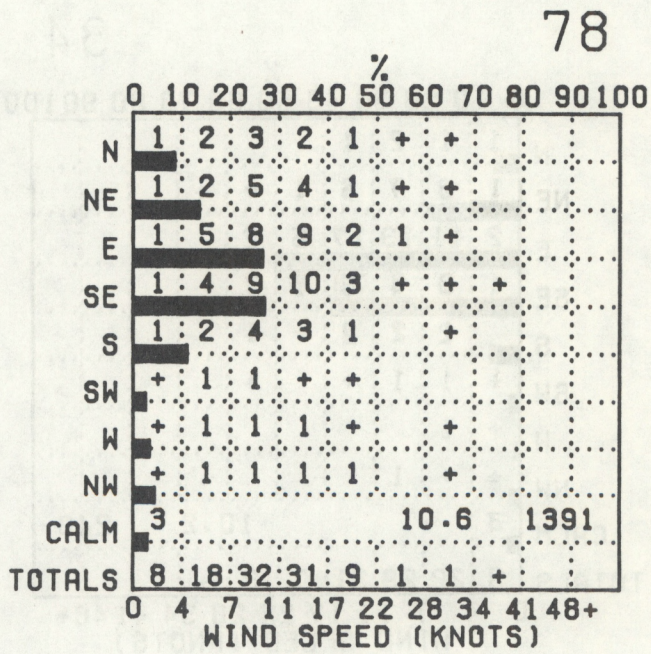
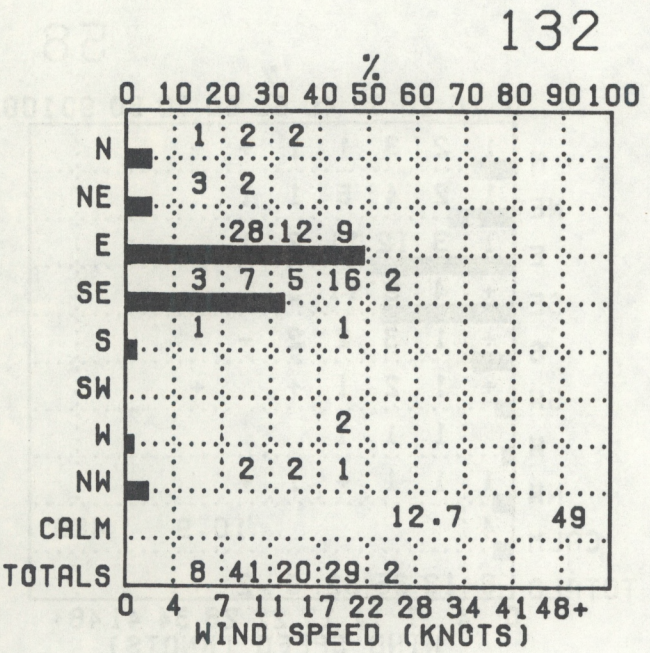


Table 5 (continued)
Month: May Squares: 34, 38, 54, 58

WIND DIRECTION AND SPEED







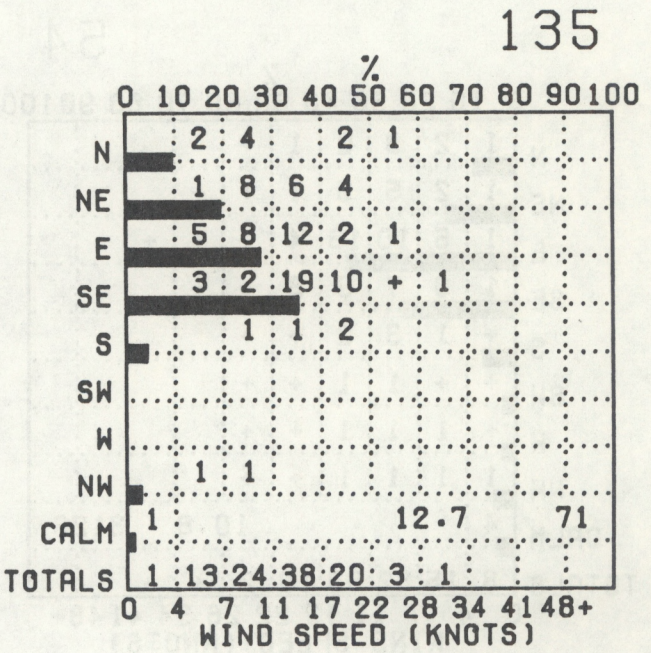
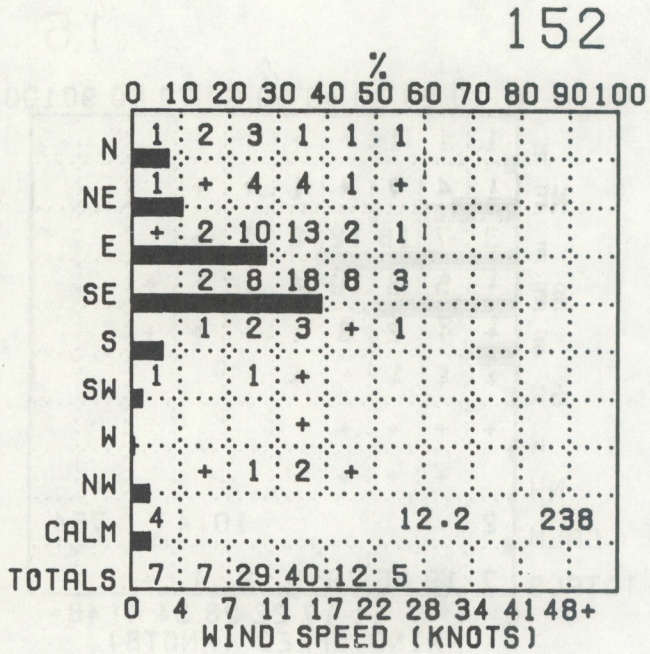
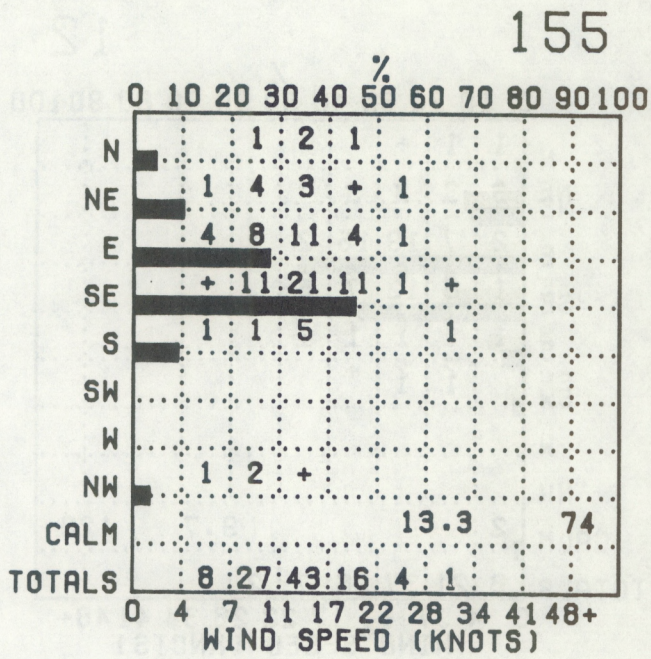
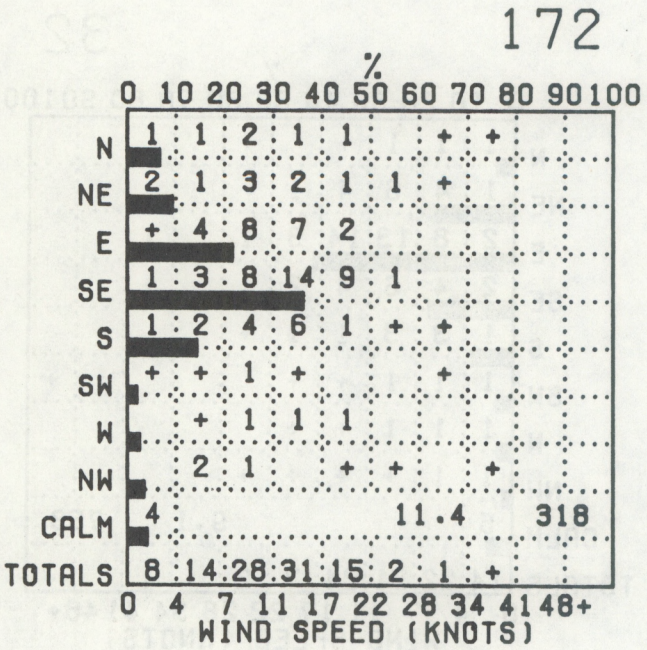


Table 5 (continued)
Month: May Squares: 74, 78, 132, 135

WIND DIRECTION AND SPEED







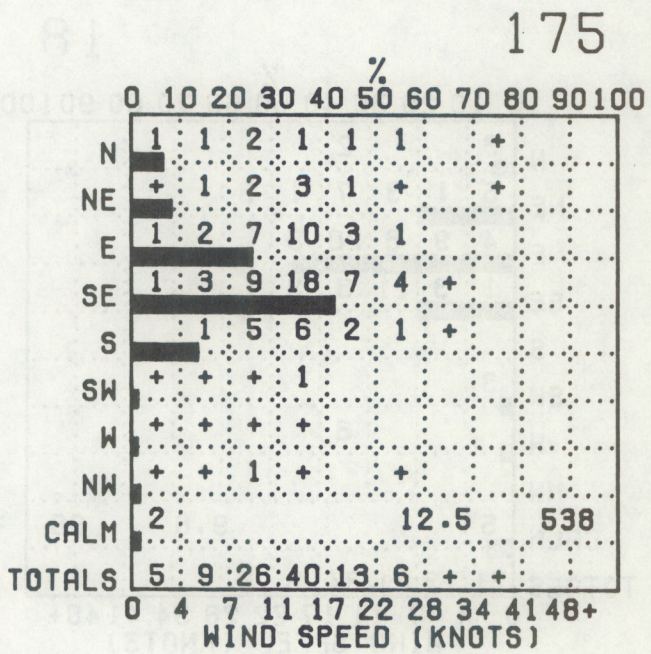
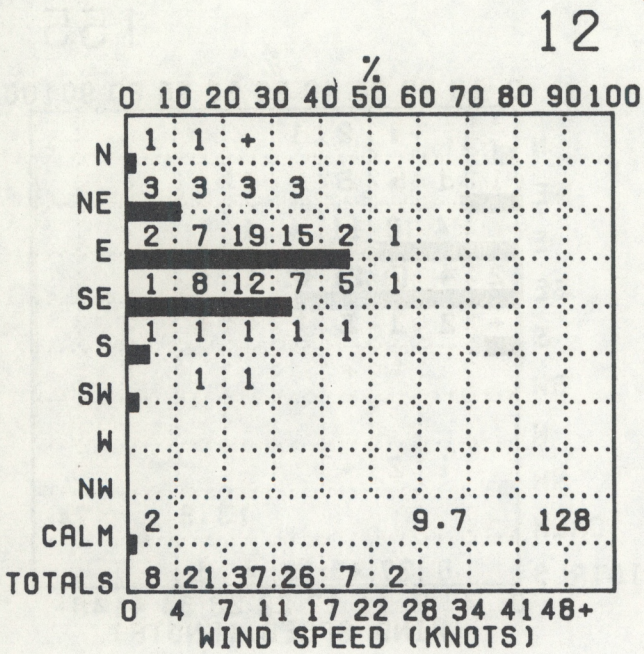
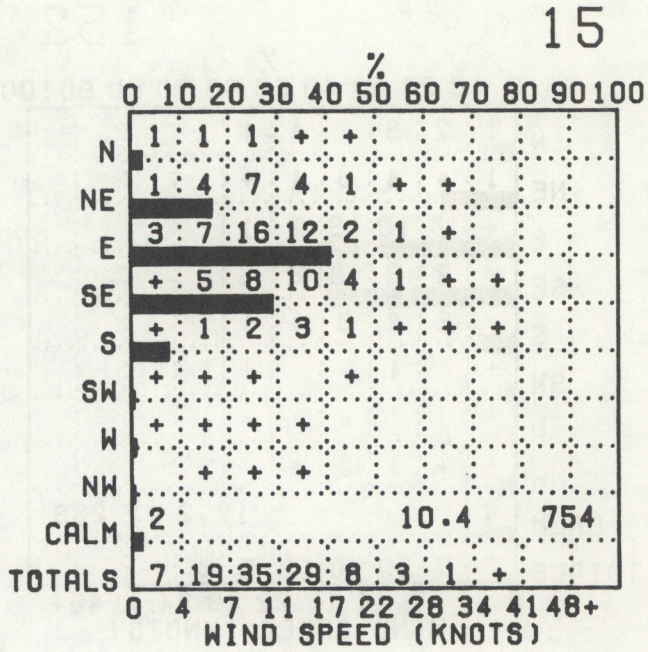
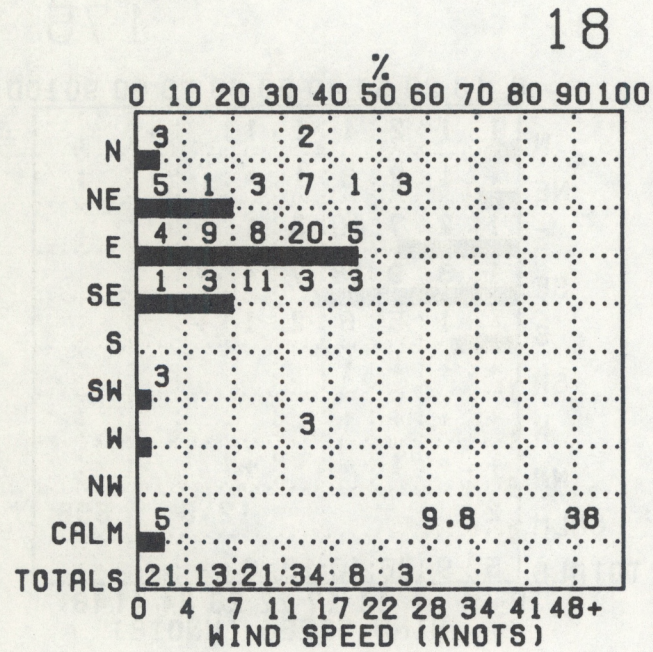


Table 5 (continued)
Month: May Squares: 152, 155, 172, 175

WIND DIRECTION AND SPEED







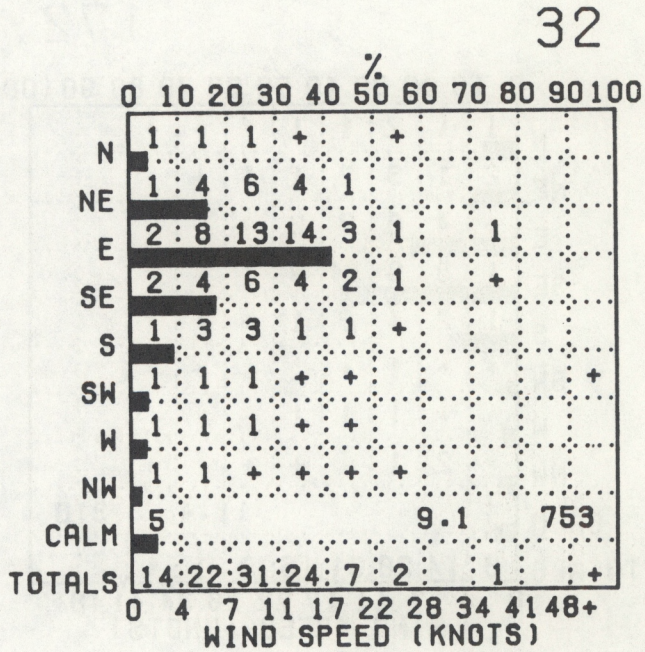
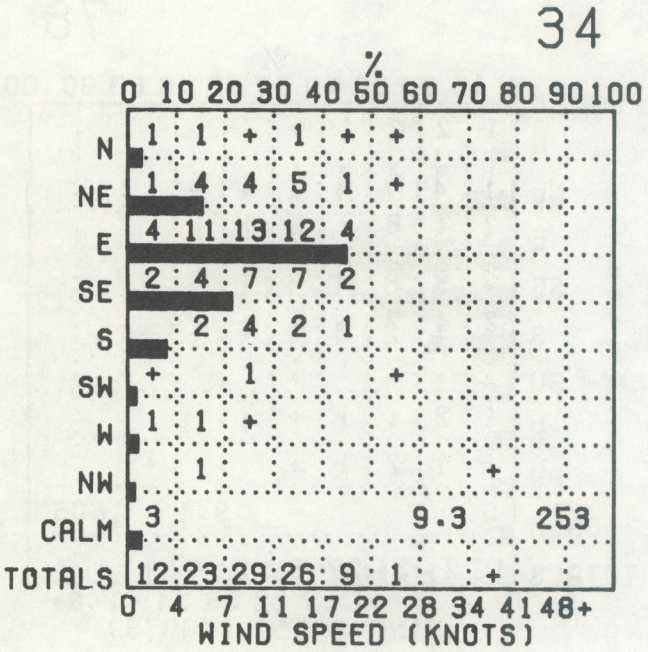
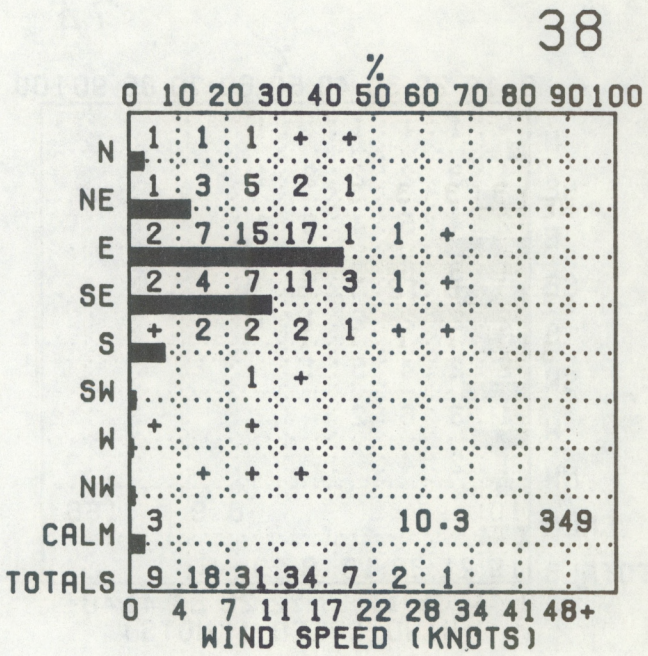
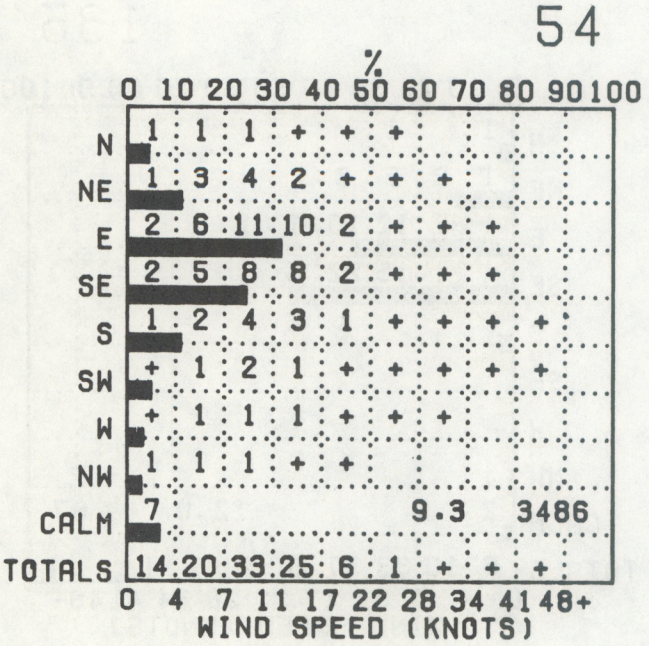


Table 5 (continued)
Month: June Squares: 12, 15, 18, 32







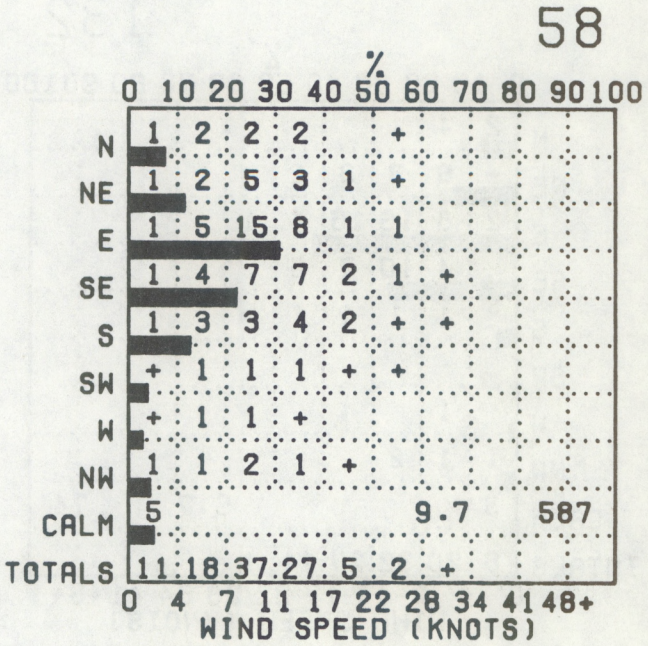
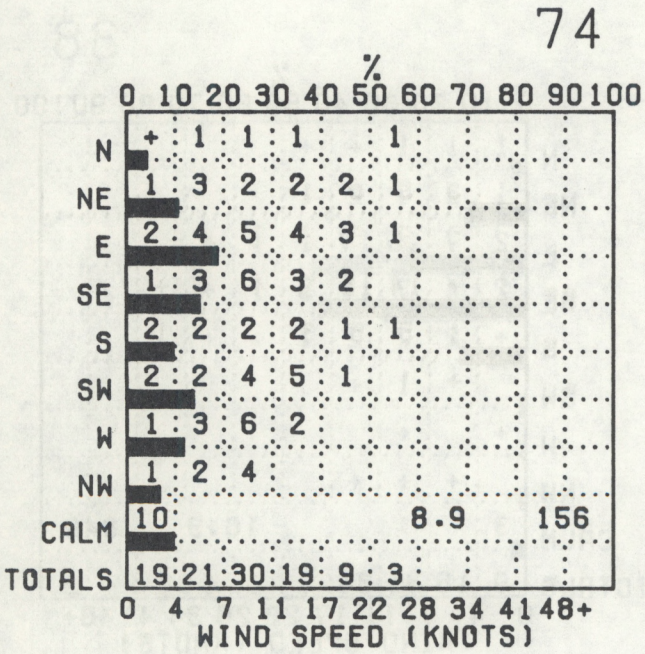
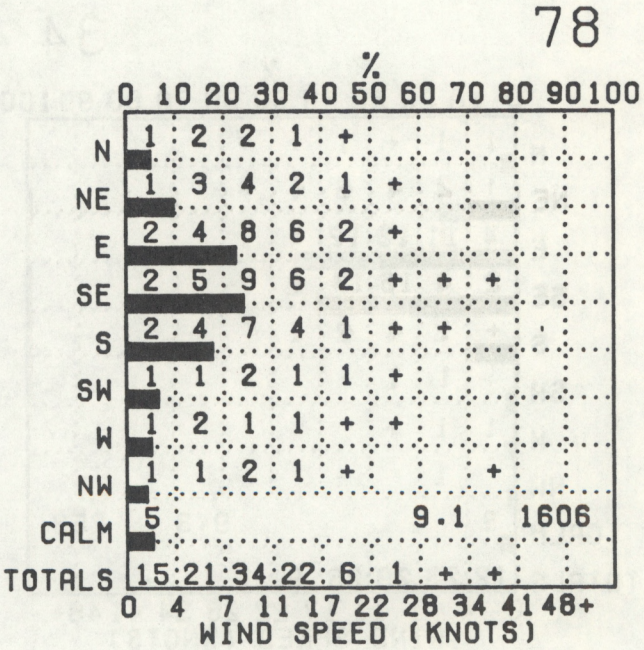
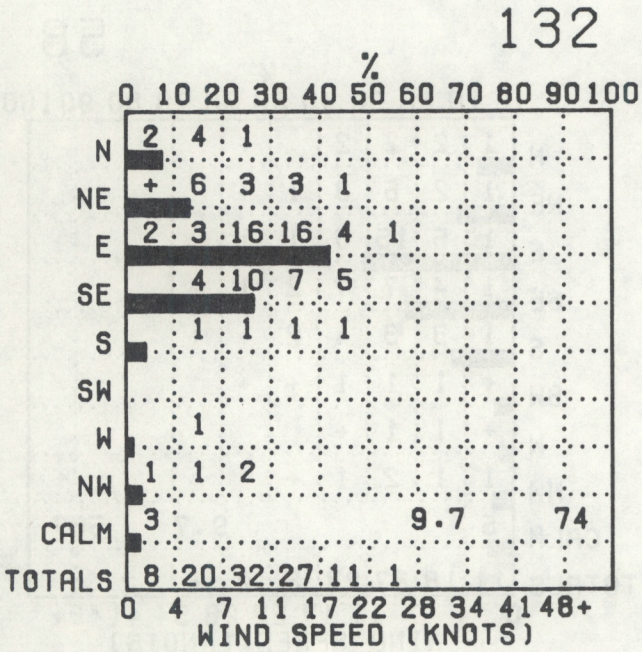


Table 5 (continued)
Month: June Squares: 34, 38, 54, 58

WIND DIRECTION AND SPEED







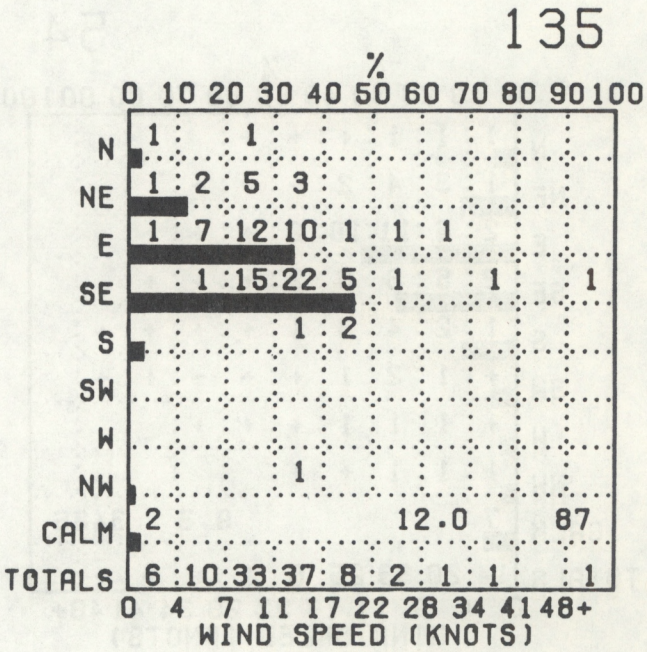
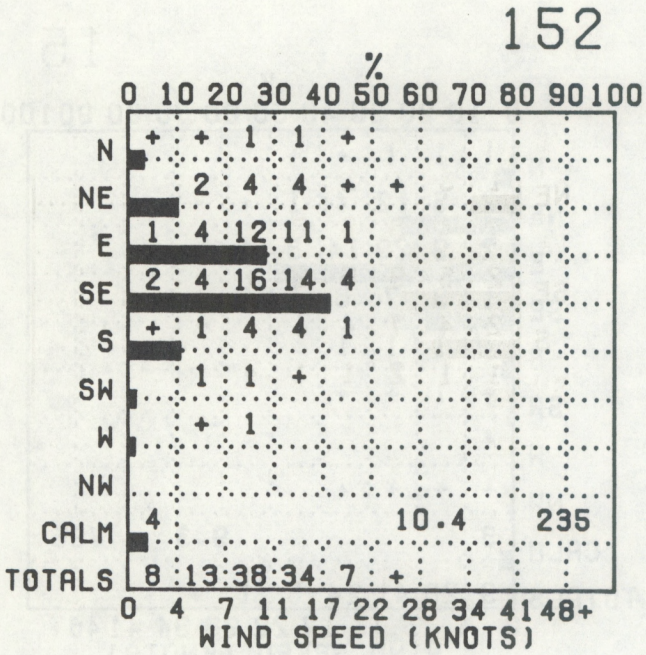
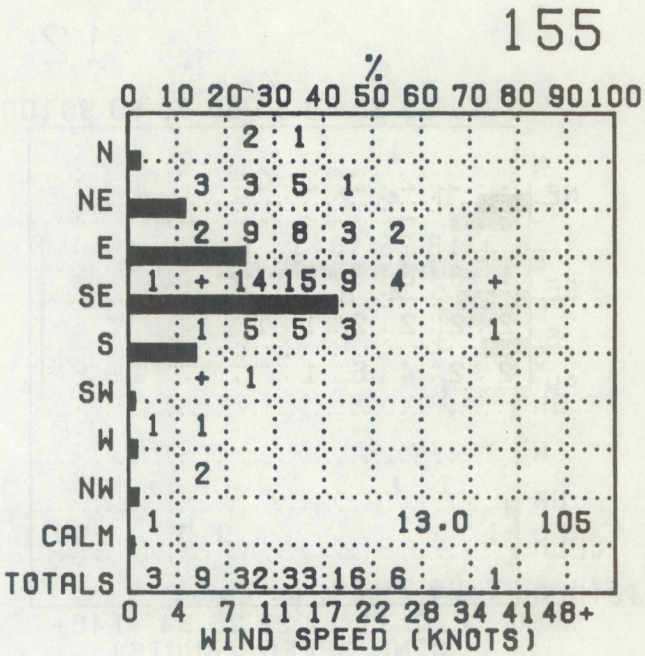
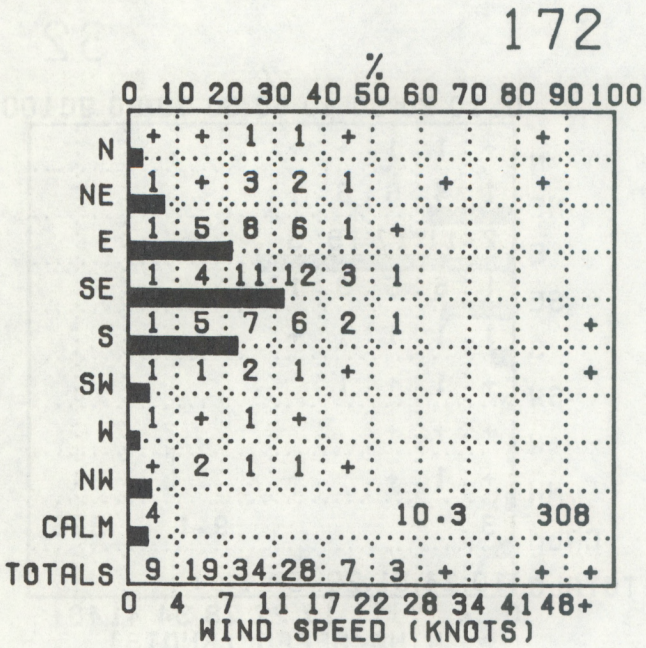


Table 5 (continued)
Month: June Squares: 74, 78, 132, 135

WIND DIRECTION AND SPEED







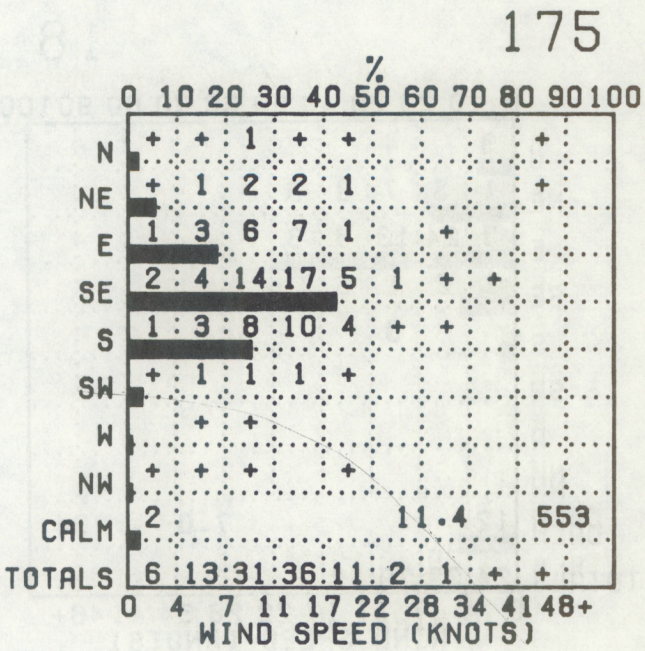
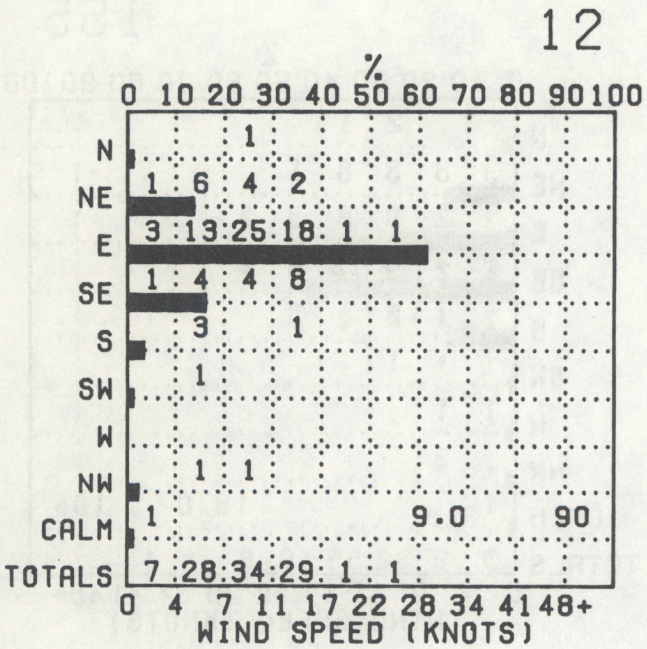
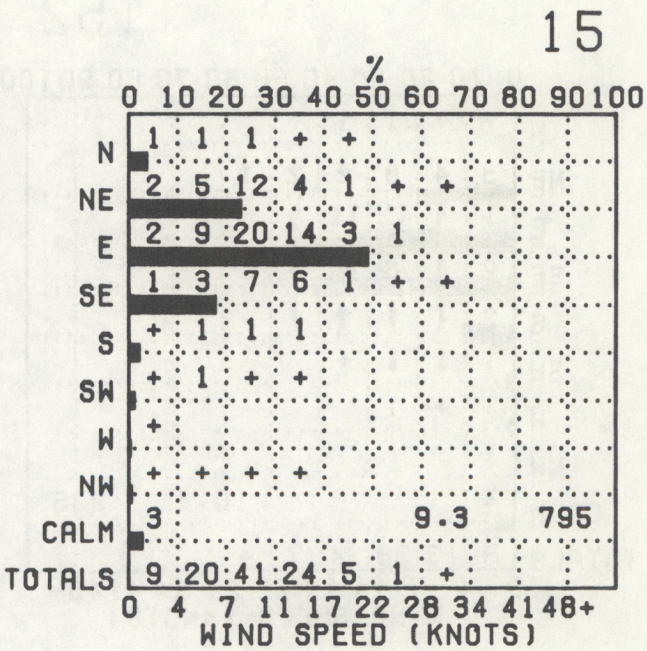
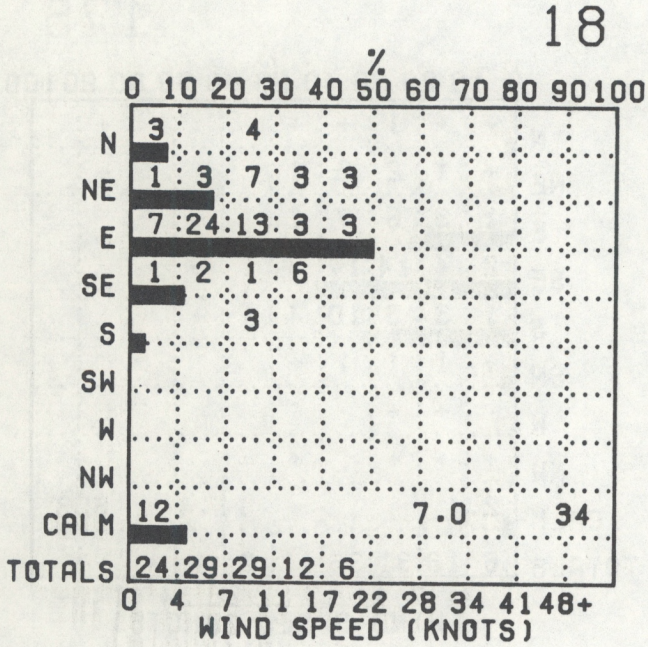


Table 5 (continued)
Month: June Squares: 152, 155, 172, 175

WIND DIRECTION AND SPEED







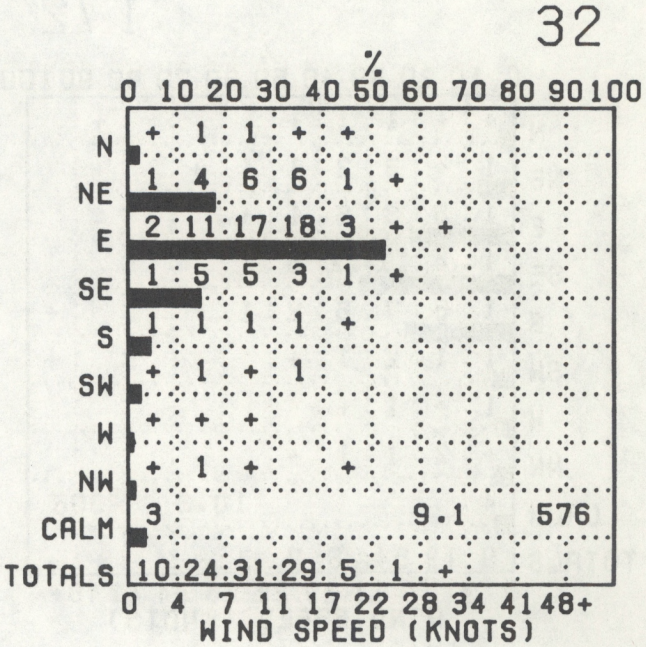


Table 5 (continued)
Month: July Squares: 12, 15, 18, 32

WIND DIRECTION AND SPEED

34

	0 4	4 7	7 11	11 17	17 22	22 28	28 34	34 41	41 48+	%
N	1	1	1							
NE	3	4	8	2	2	1				
E	4	12	17	10	2	1				
SE	2	4	6	4	+					
S	2	1	1	1		+				
SW	1	+	+	1						
W	1	+	1							
NW	1	1	1	+						
CALM	3									8.4 254
TOTALS	17	24	34	18	5	2				

WIND SPEED (KNOTS)

38

	0 4	4 7	7 11	11 17	17 22	22 28	28 34	34 41	41 48+	%
N	1	1	1							
NE	3	5	5	3						
E	4	11	18	12	1	+				
SE	2	2	9	7	+	+				
S	1	1	4	1						
SW	1	1	1	+						
W	1	+	1							
NW	1	1	1							
CALM	2									8.3 341
TOTALS	15	22	39	23	1	+				

WIND SPEED (KNOTS)

54

	0 4	4 7	7 11	11 17	17 22	22 28	28 34	34 41	41 48+	%
N	1	1	1	+						
NE	1	2	2	1	+	+				
E	2	6	13	10	2	+	+			
SE	2	6	9	6	1	+				
S	1	3	4	2	+	+				
SW	1	2	2	1	+	+	+			
W	+	2	1	1	+	+				
NW	+	1	1	1	+					
CALM	8									8.5 3508
TOTALS	16	22	35	22	4	1	+			

WIND SPEED (KNOTS)

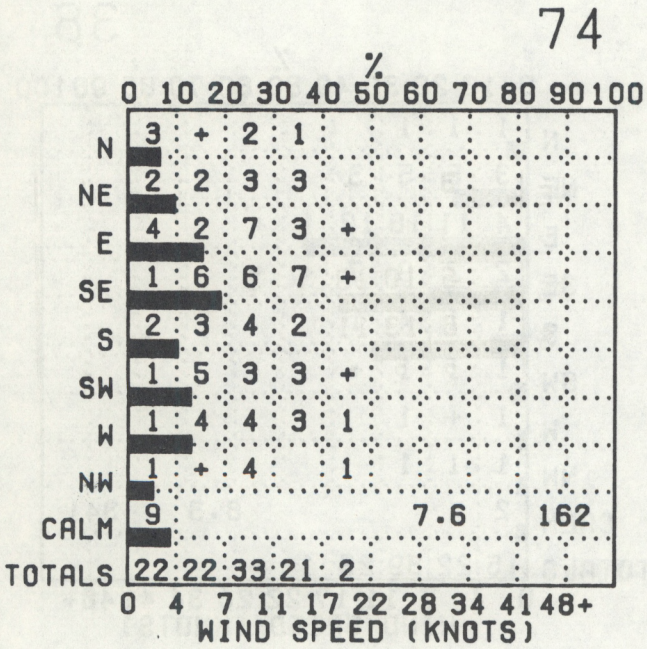
58

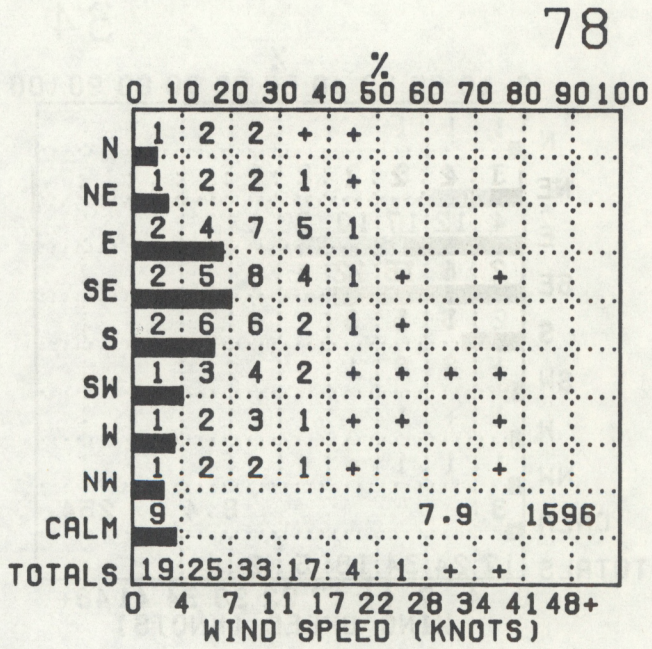
	0 4	4 7	7 11	11 17	17 22	22 28	28 34	34 41	41 48+	%
N	1	1	2	1	+					
NE	1	2	4	2	+	+				
E	1	5	11	8	1	+				
SE	2	5	9	4	1	+				
S	2	5	4	2	+	+				
SW	1	1	2	1	+					
W	1	2	2	1						
NW	1	1	2	+	+					
CALM	9									8.2 580
TOTALS	18	21	37	20	3	1				

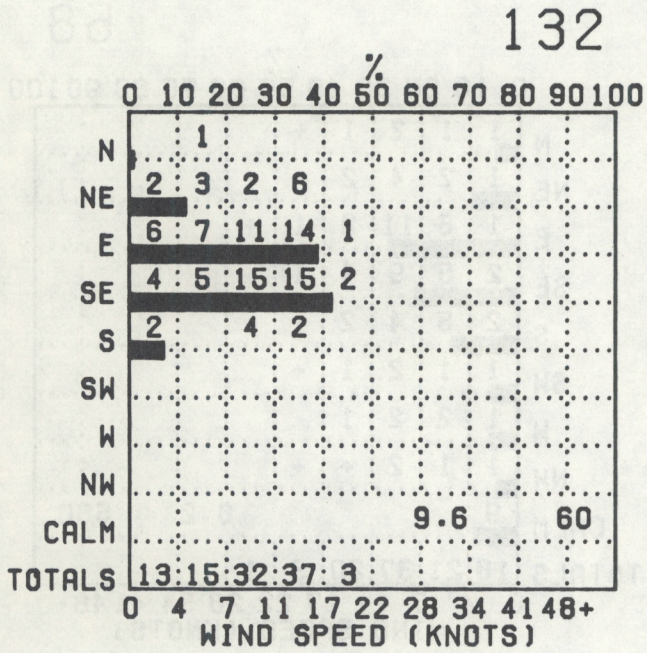
WIND SPEED (KNOTS)

Table 5 (continued)
Month: July Squares: 34, 38, 54, 58

WIND DIRECTION AND SPEED







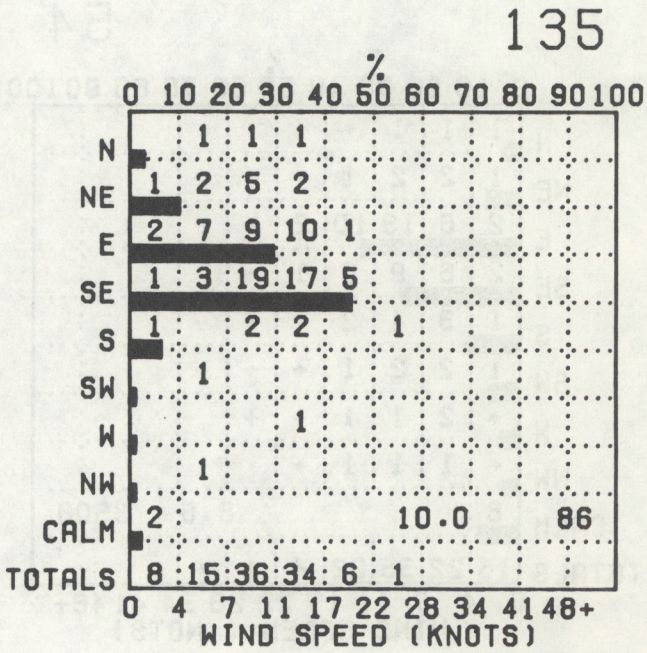
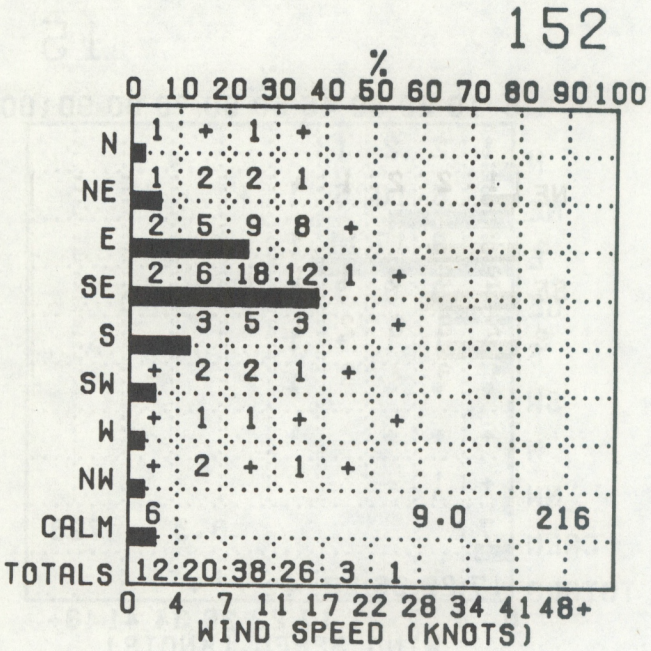
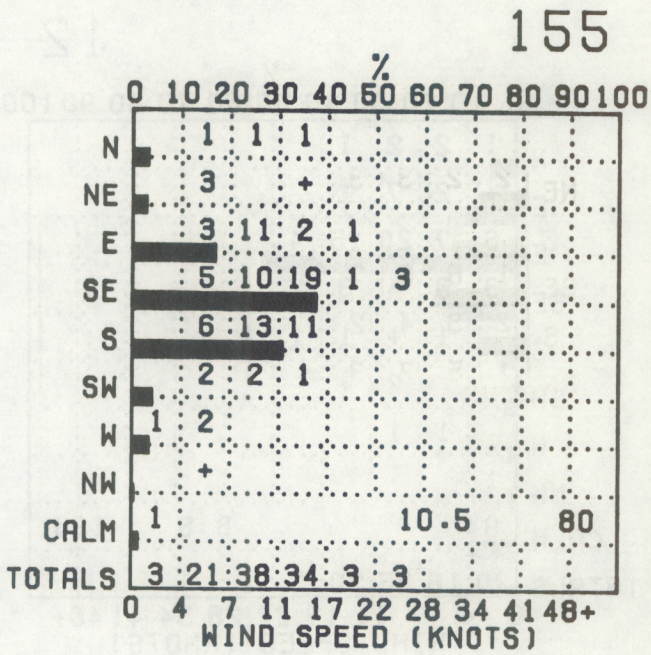
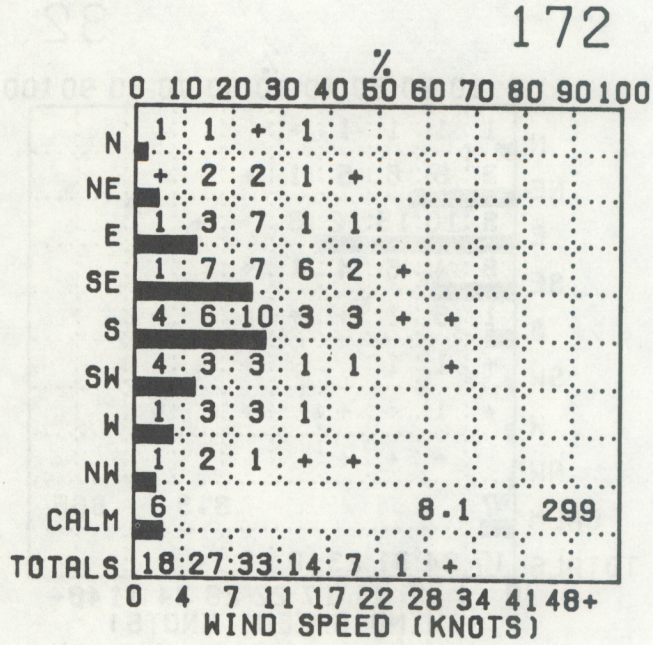


Table 5 (continued)
Month: July Squares: 74, 78, 132, 135

WIND DIRECTION AND SPEED







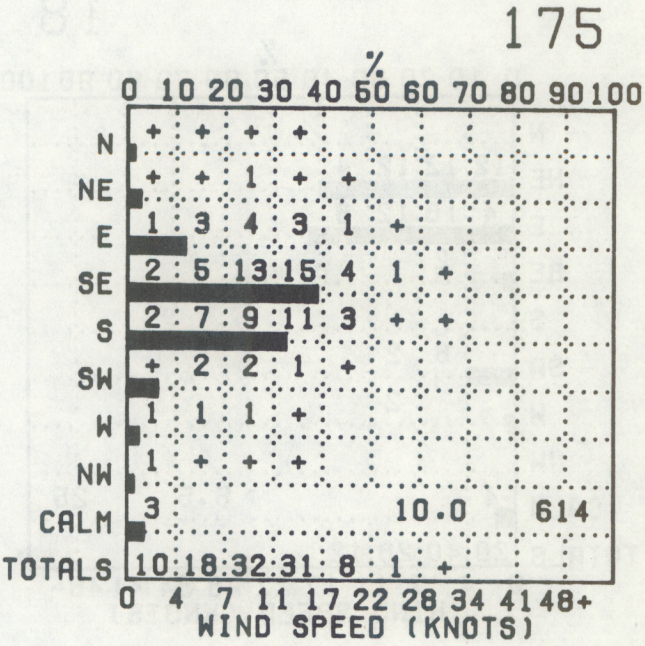
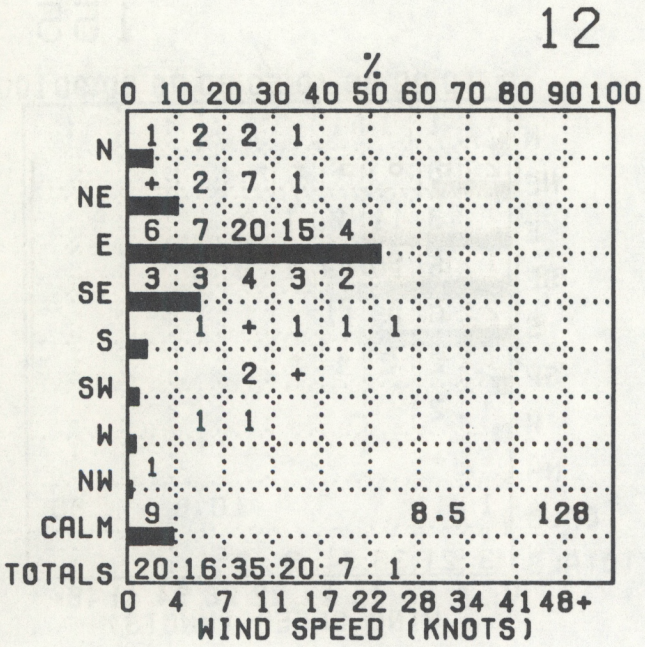
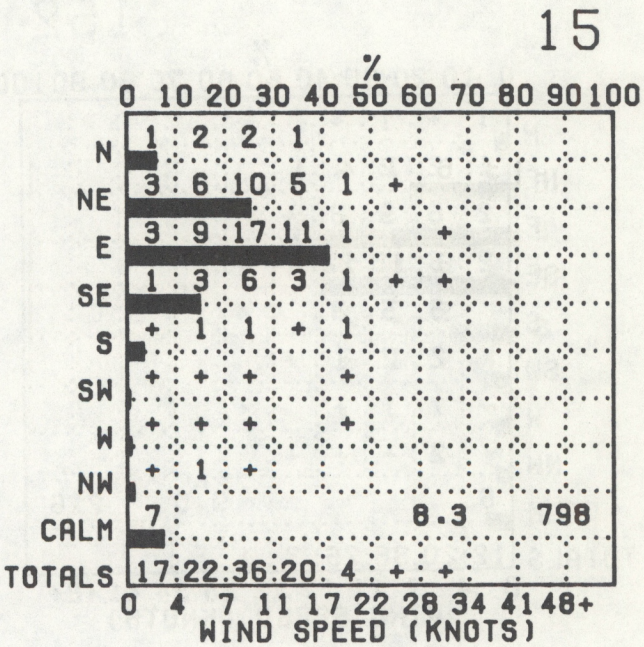
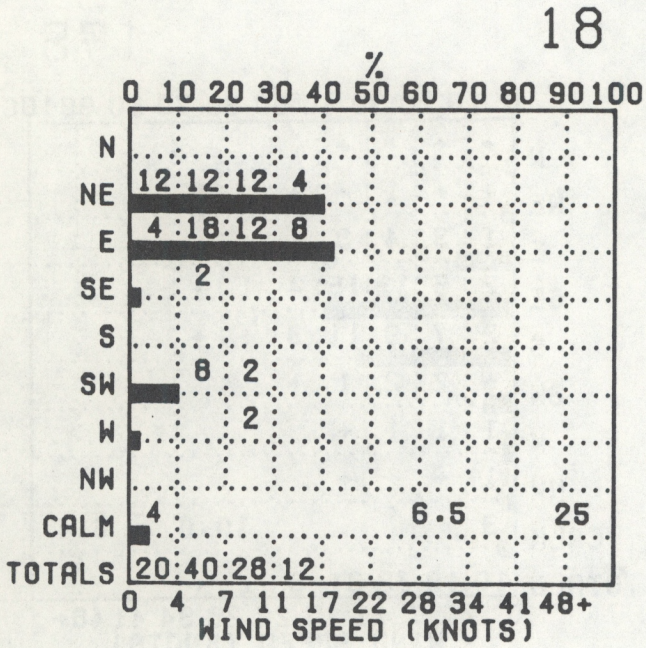


Table 5 (continued)
Month: July Squares: 152, 155, 172, 175

WIND DIRECTION AND SPEED







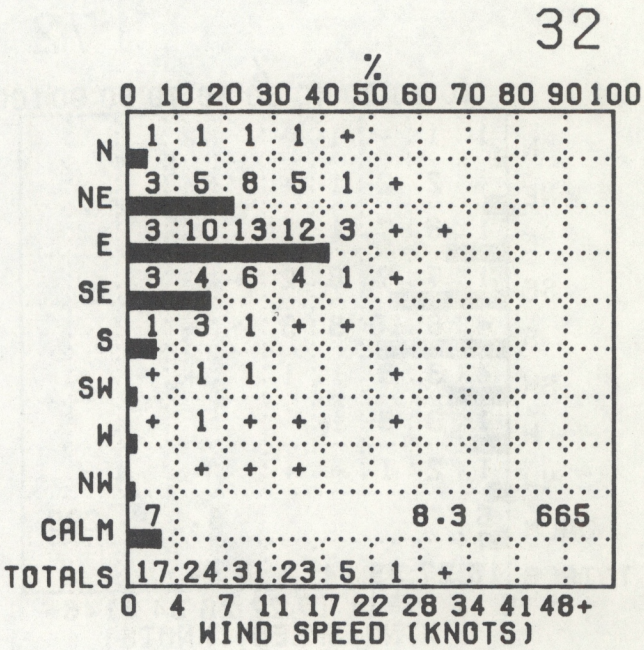
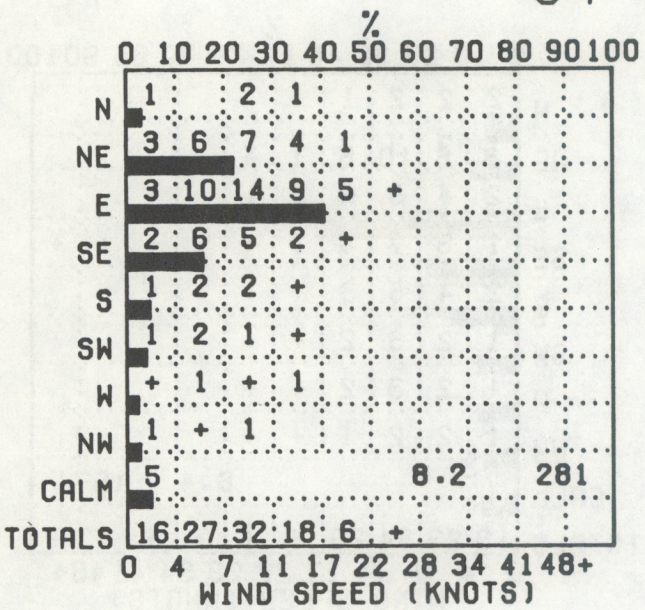


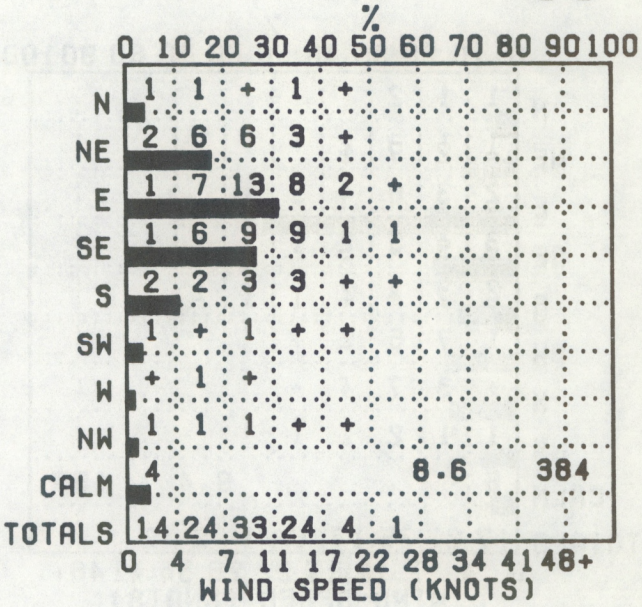
Table 5 (continued)
Month: August Squares: 12, 15, 18, 32

WIND DIRECTION AND SPEED

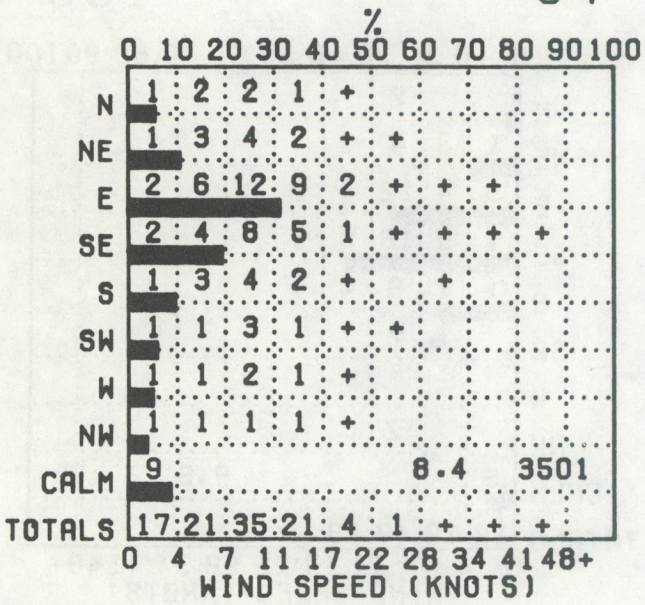
34



38



54



58

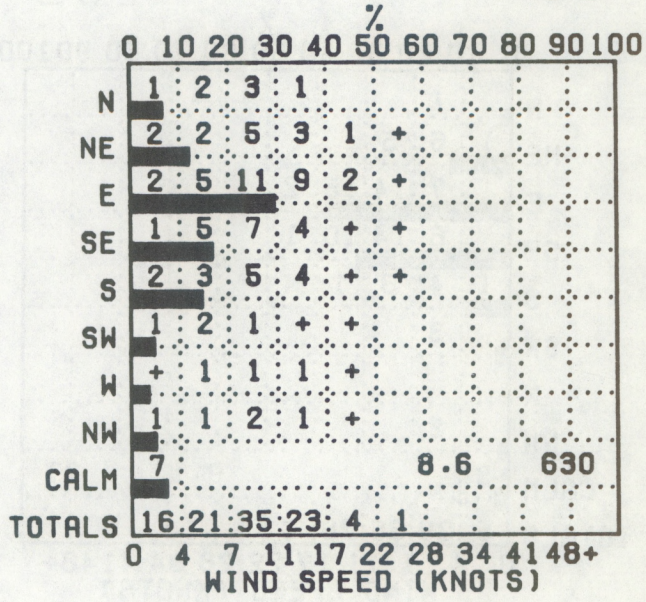
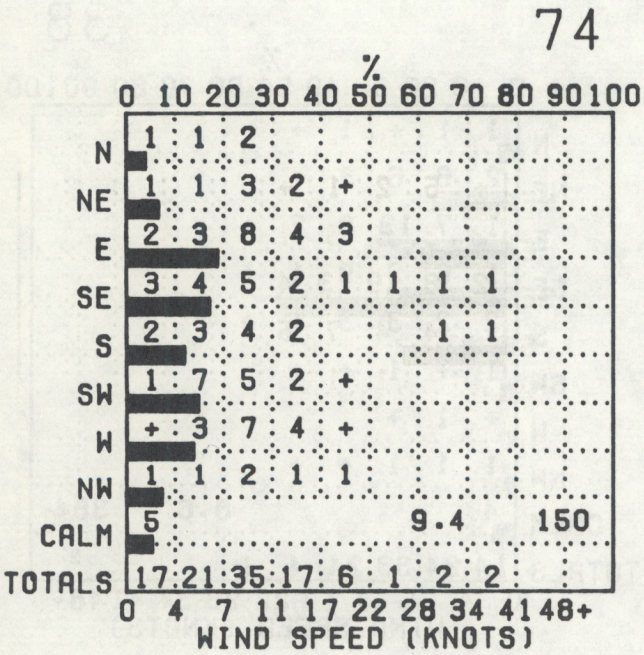
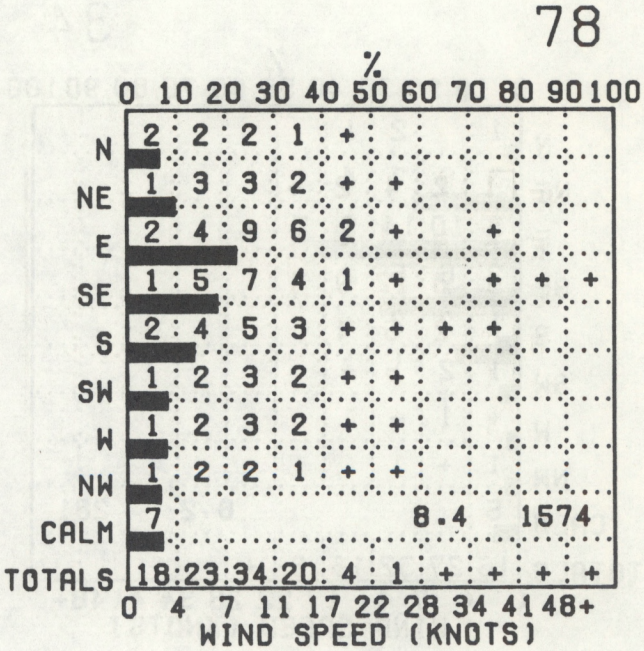
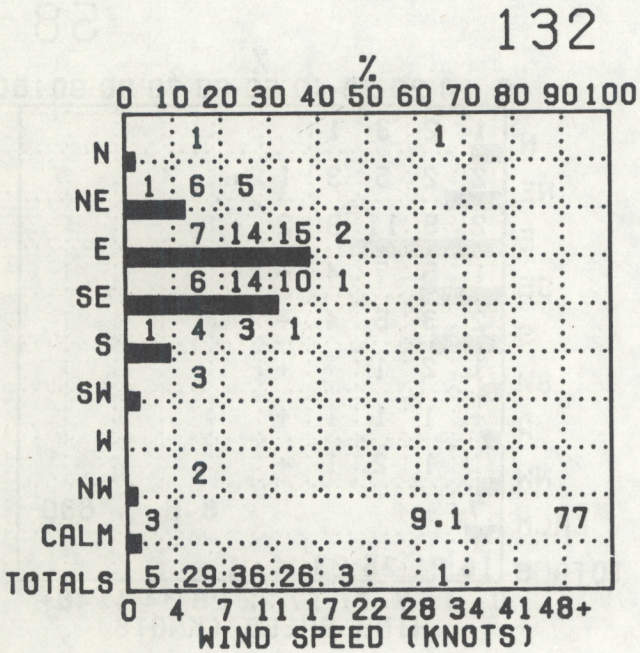


Table 5 (continued)
Month: August Squares: 34, 38, 54, 58

WIND DIRECTION AND SPEED







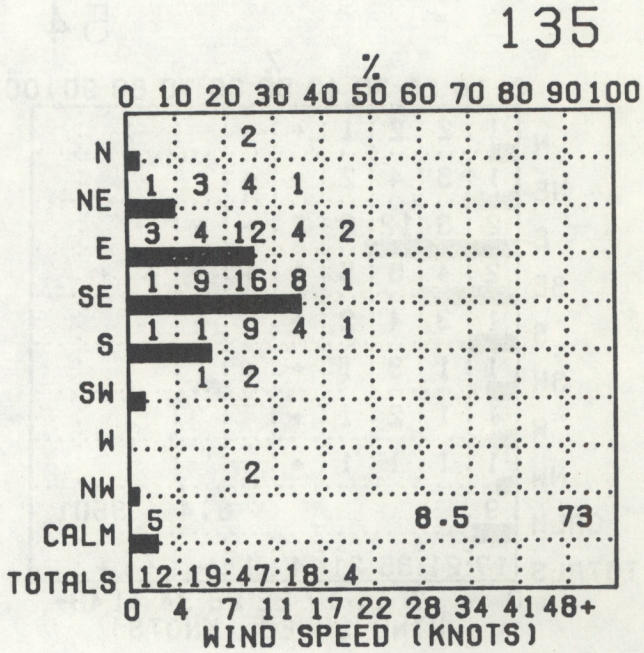
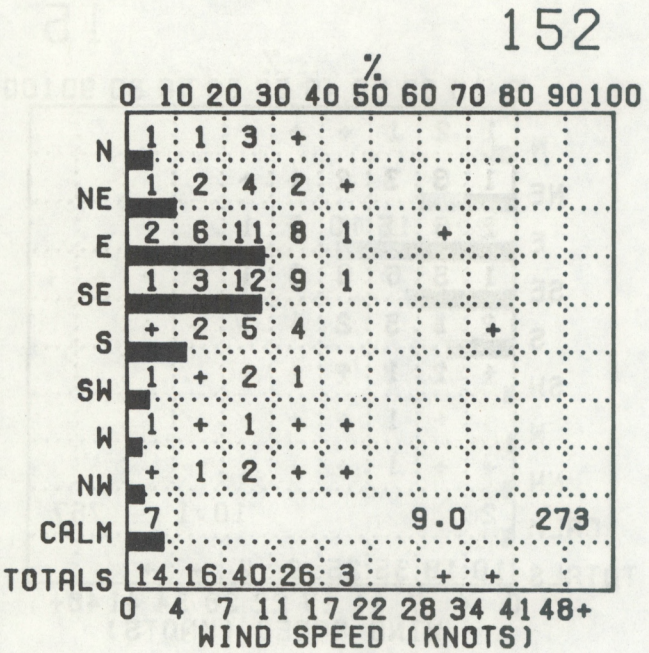
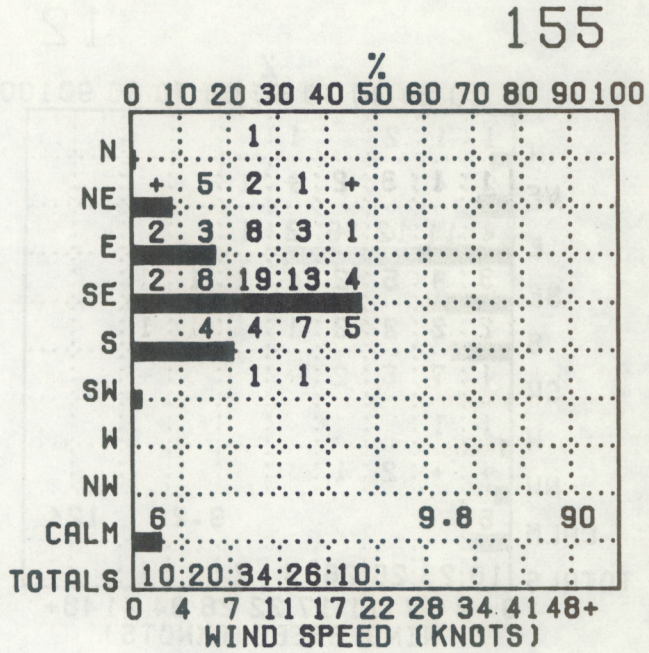
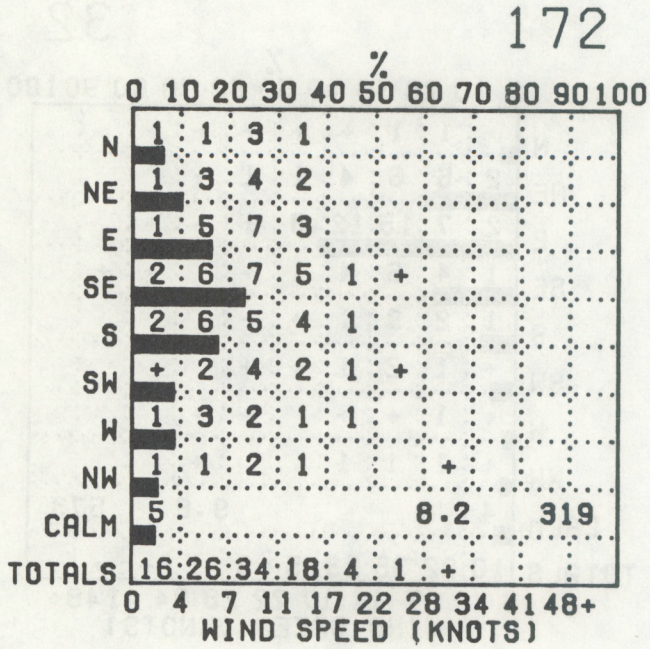


Table 5 (continued)
Month: August Squares: 74, 78, 132, 135

WIND DIRECTION AND SPEED







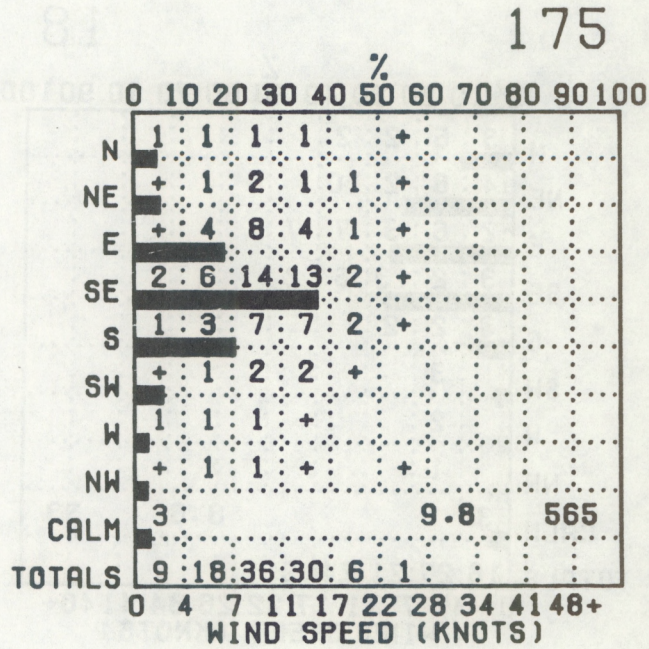
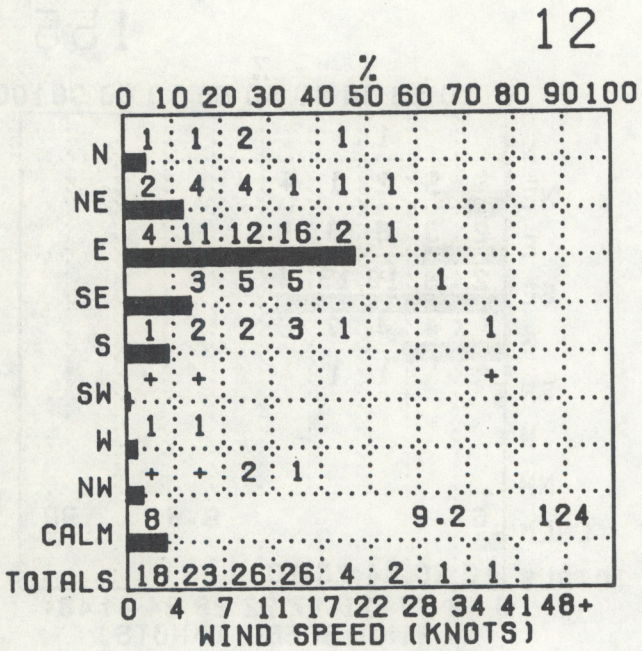
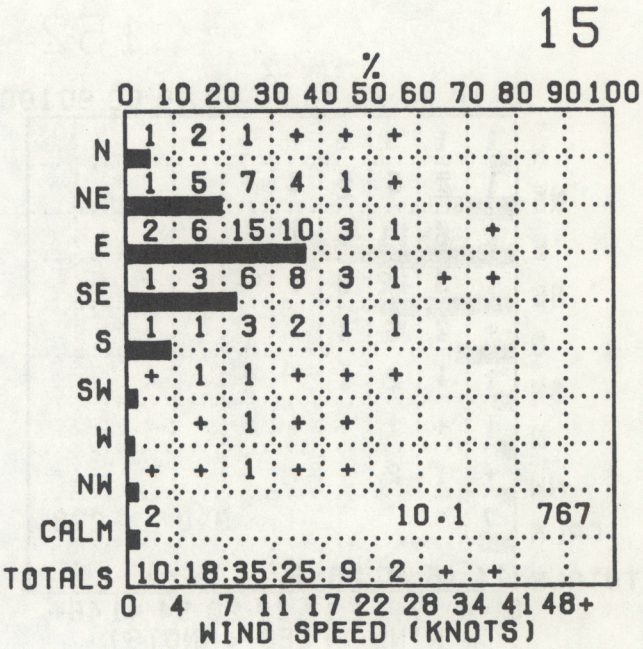
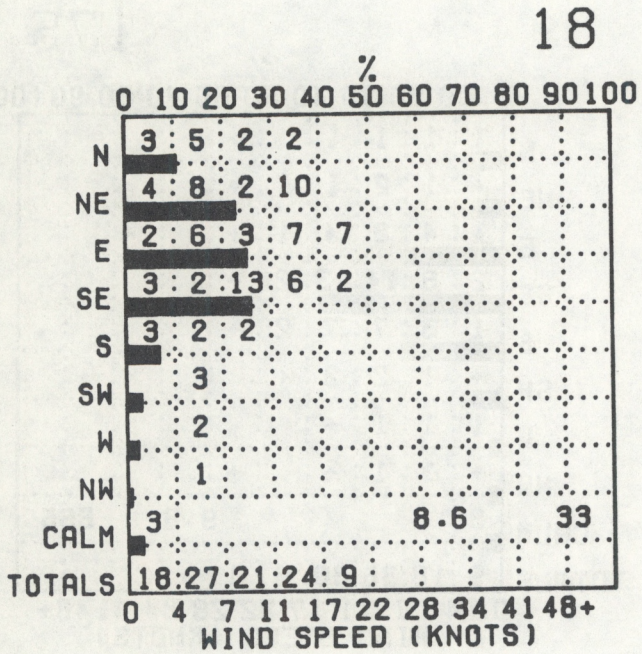


Table 5 (continued)
Month: August Squares: 152, 155, 172, 175

WIND DIRECTION AND SPEED







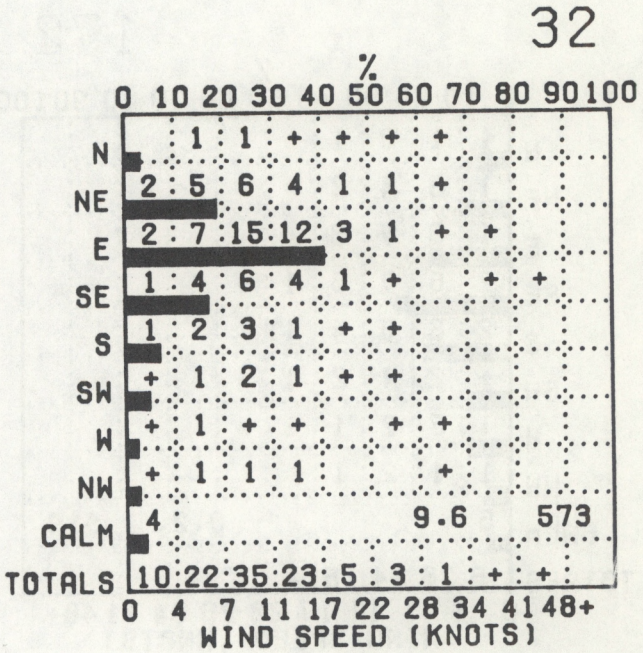
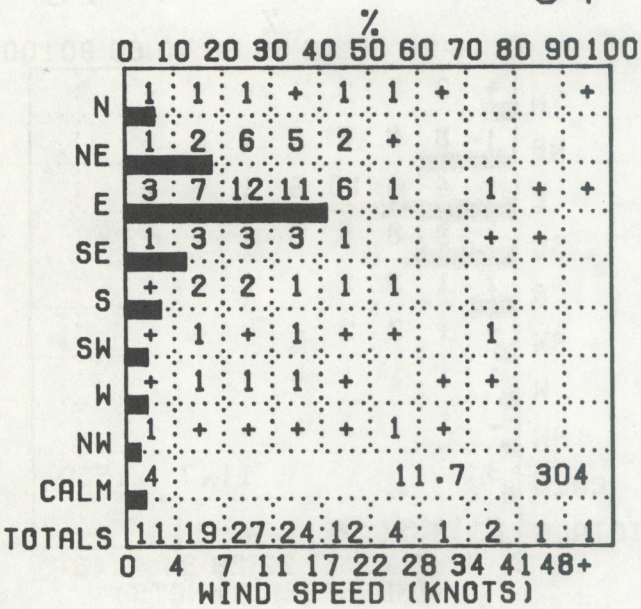


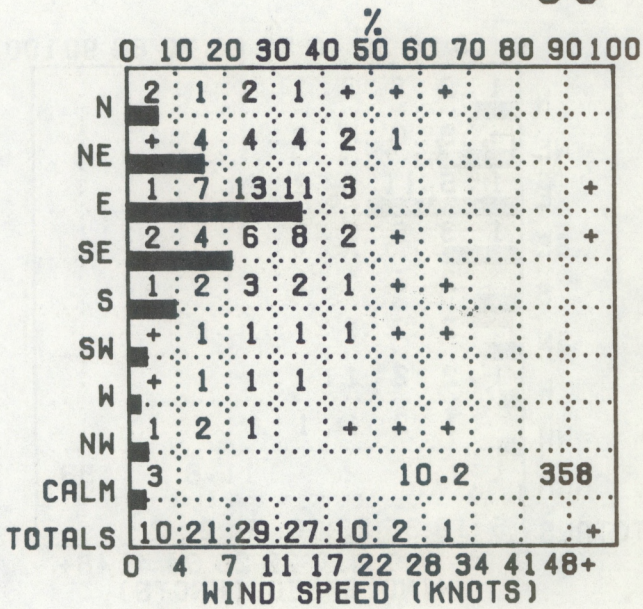
Table 5 (continued)
Month: September Squares: 12, 15, 18, 32

WIND DIRECTION AND SPEED

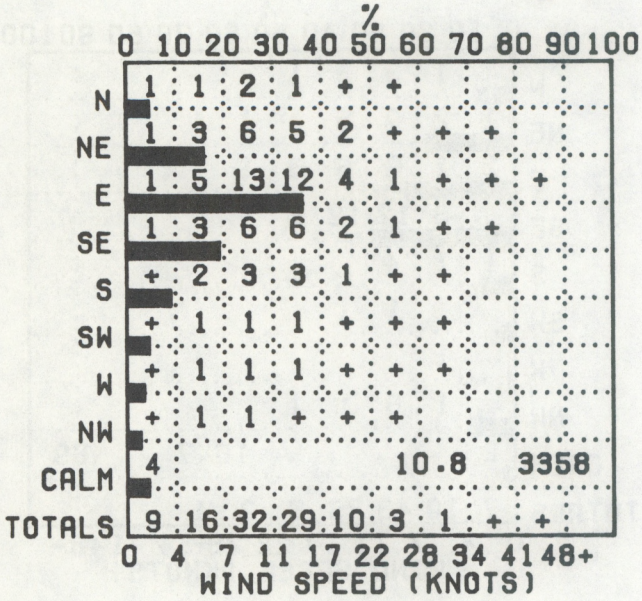
34



38



54



58

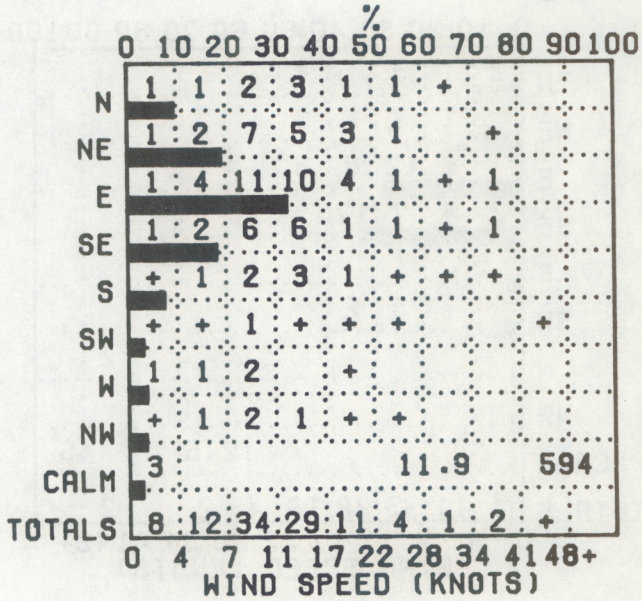
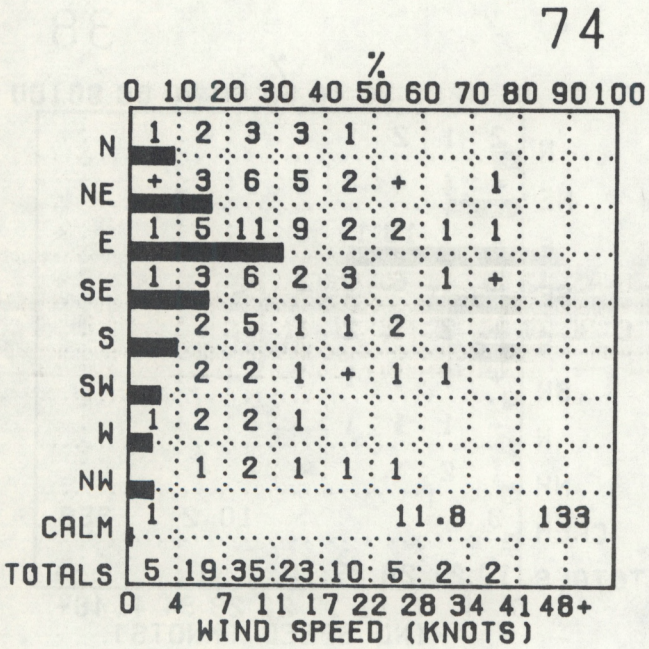
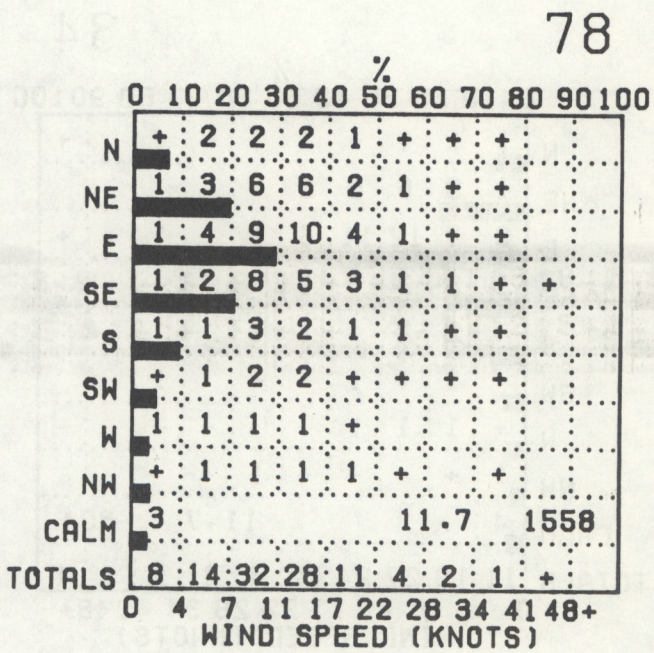
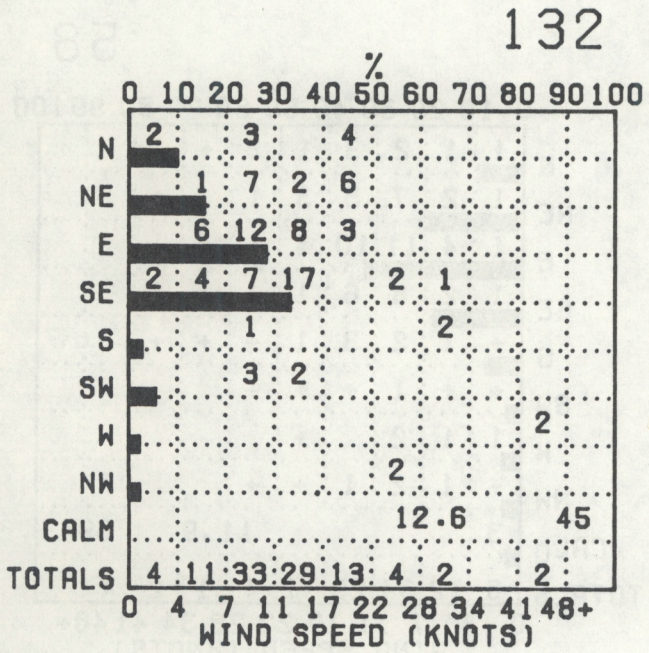


Table 5 (continued)
Month: September Squares: 34, 38, 54, 58

WIND DIRECTION AND SPEED







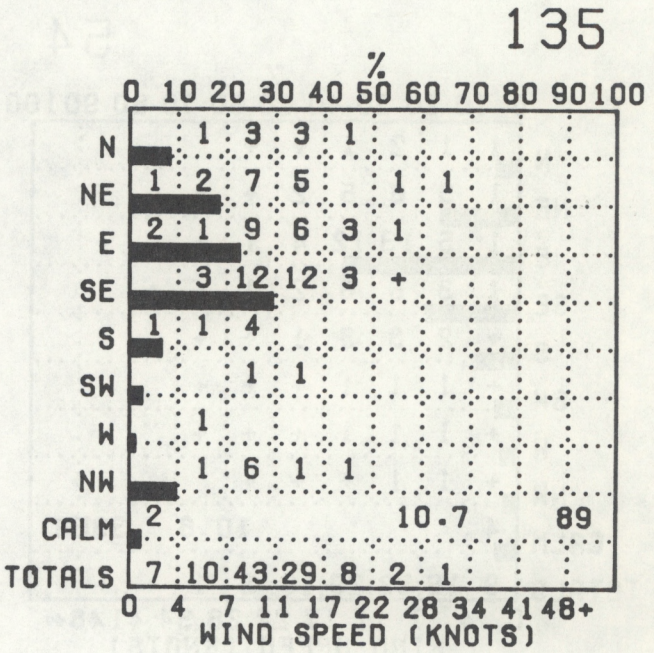
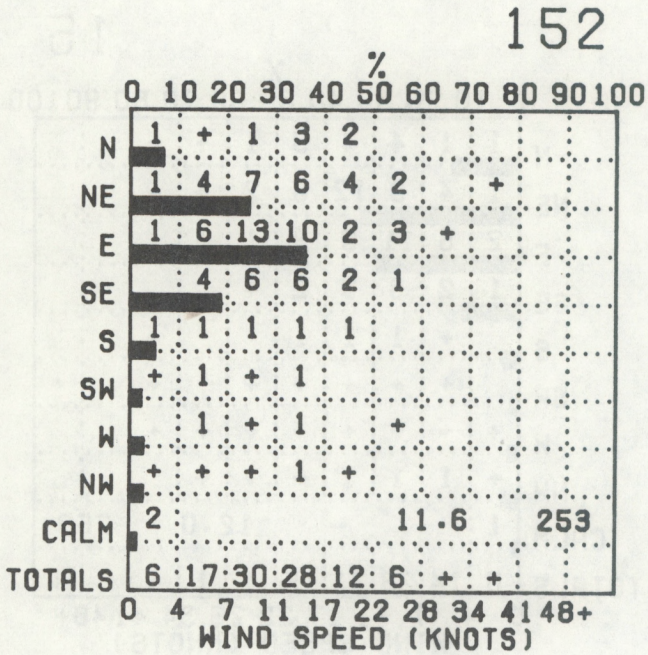
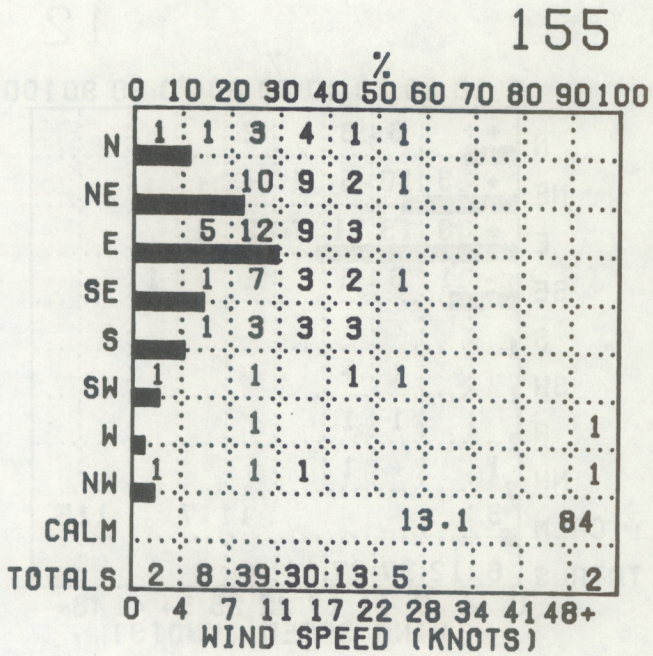
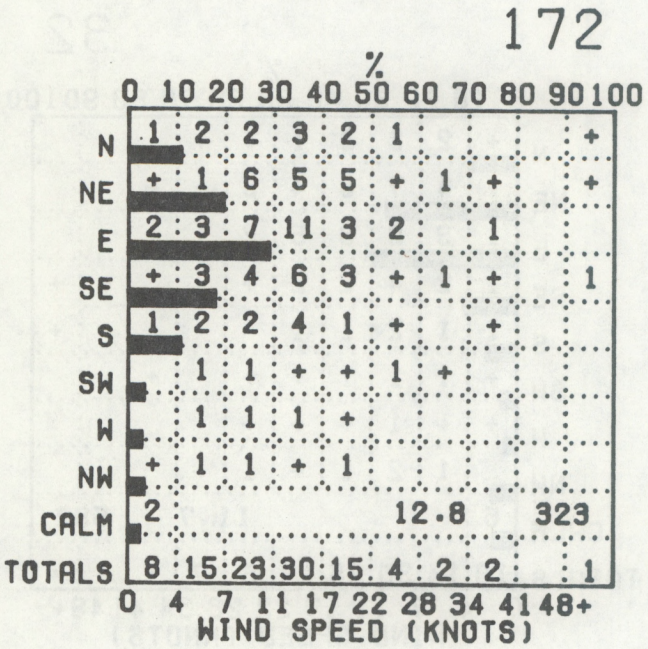


Table 5 (continued)
Month: September Squares: 74, 78, 132, 135

WIND DIRECTION AND SPEED







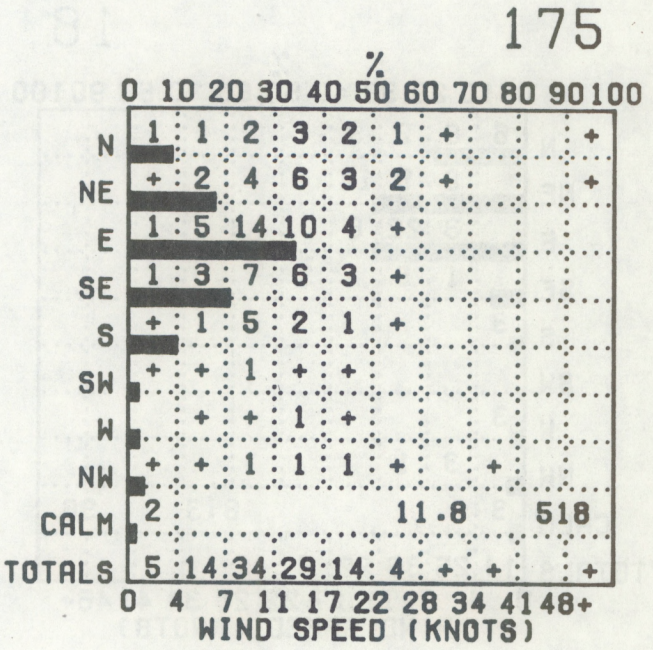
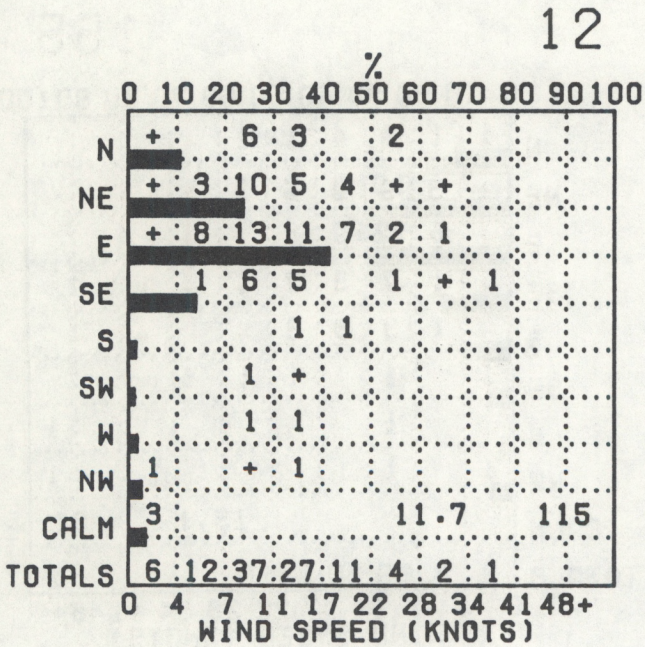
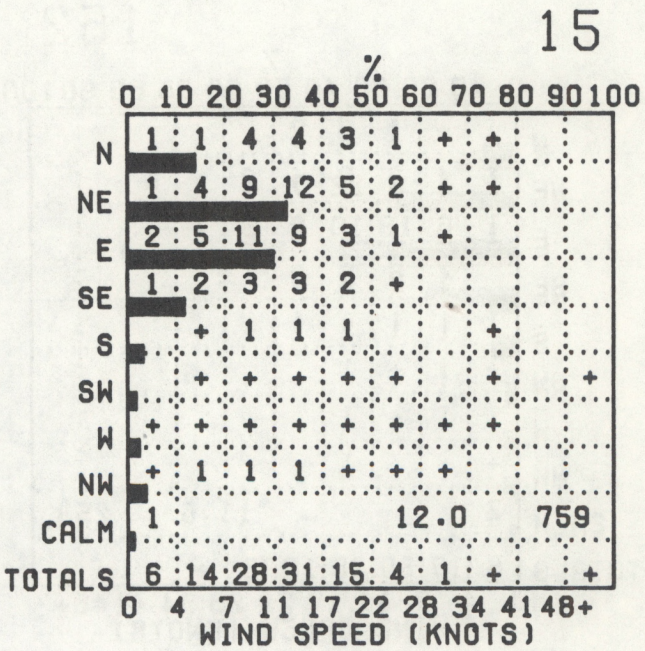
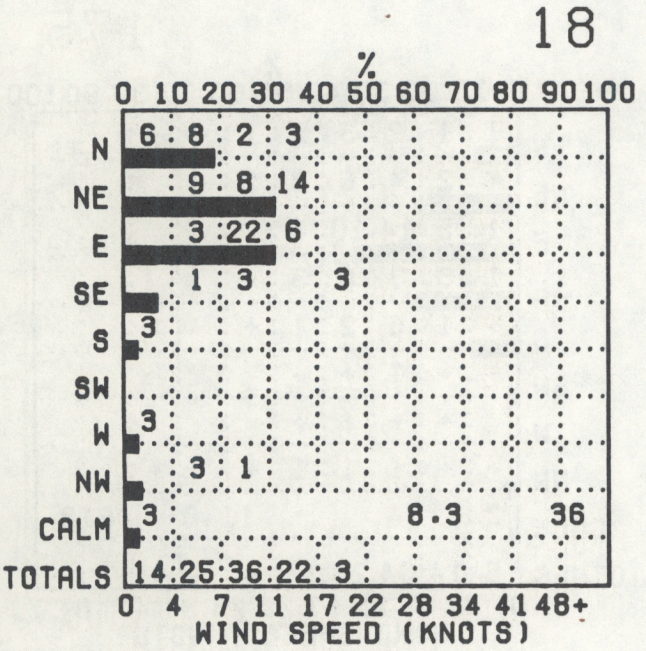


Table 5 (continued)
Month: September Squares: 152, 155, 172, 175

WIND DIRECTION AND SPEED







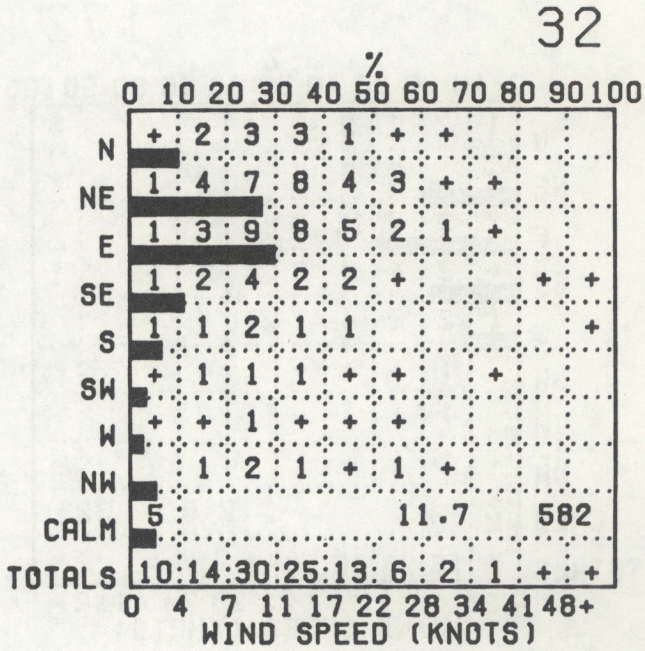
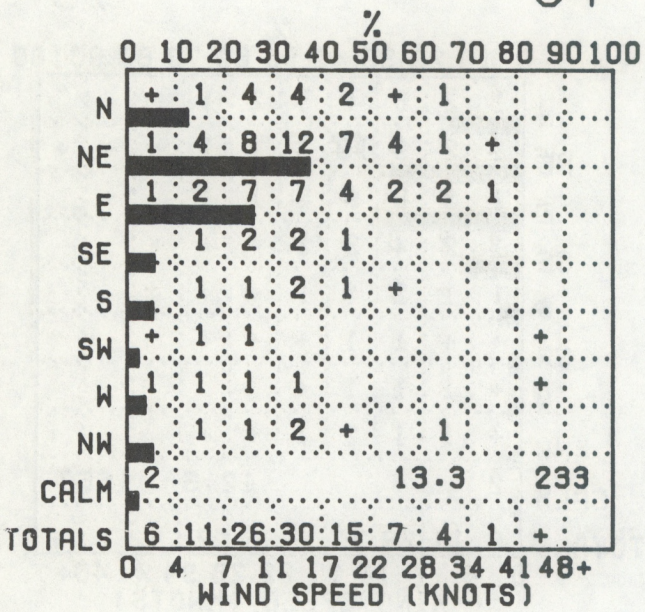


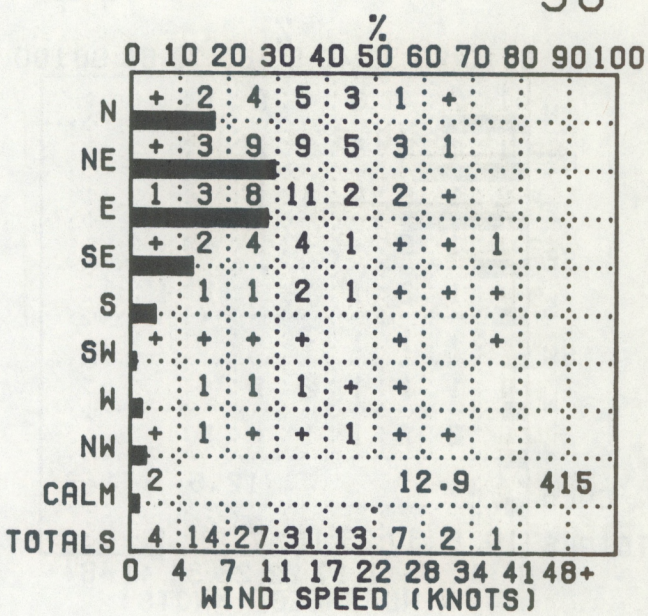
Table 5 (continued)
Month: October Squares: 12, 15, 18, 32

WIND DIRECTION AND SPEED

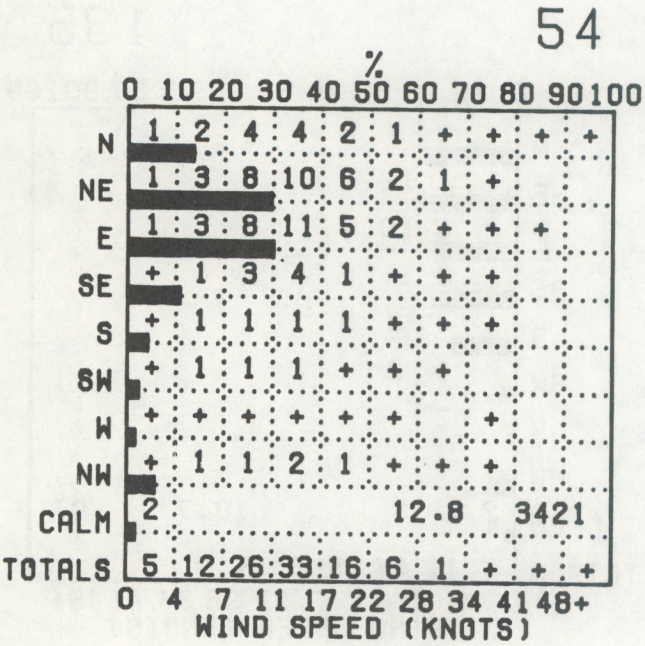
34



38



54



58

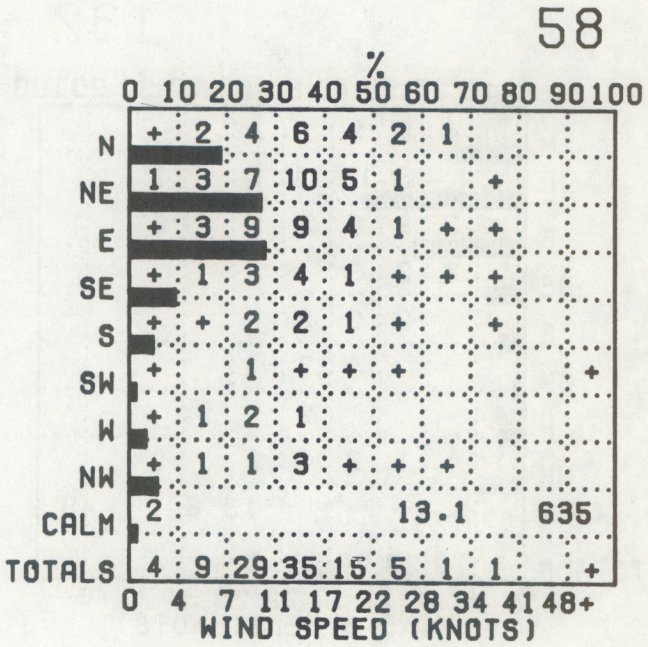
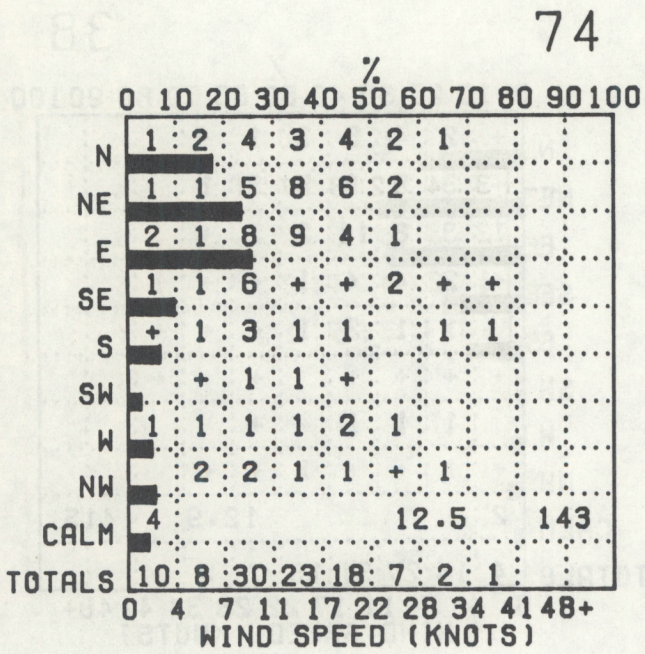
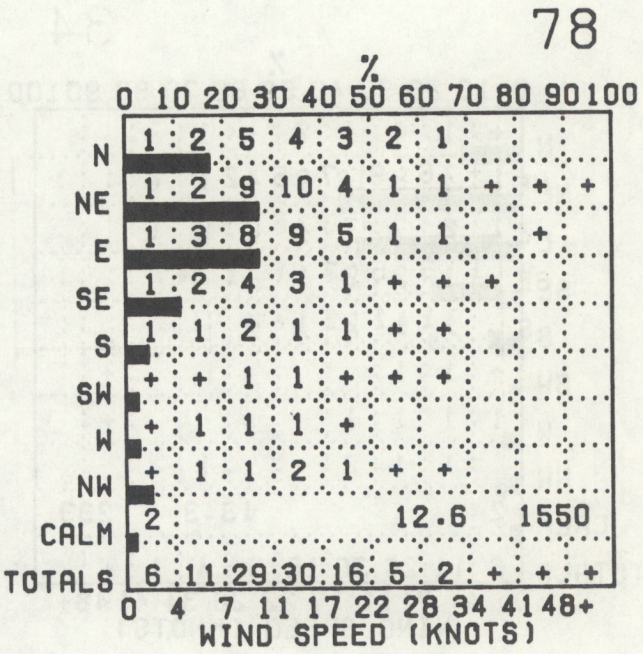
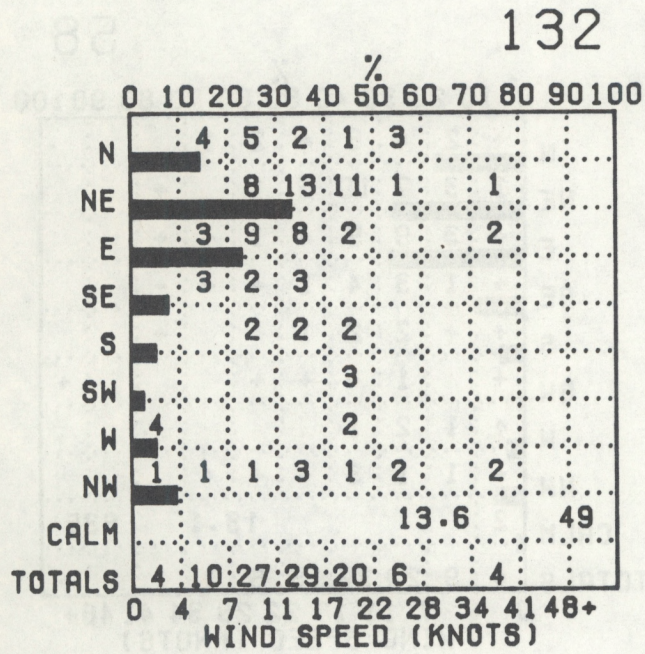


Table 5 (continued)
Month: October Squares: 34, 38, 54, 58

WIND DIRECTION AND SPEED







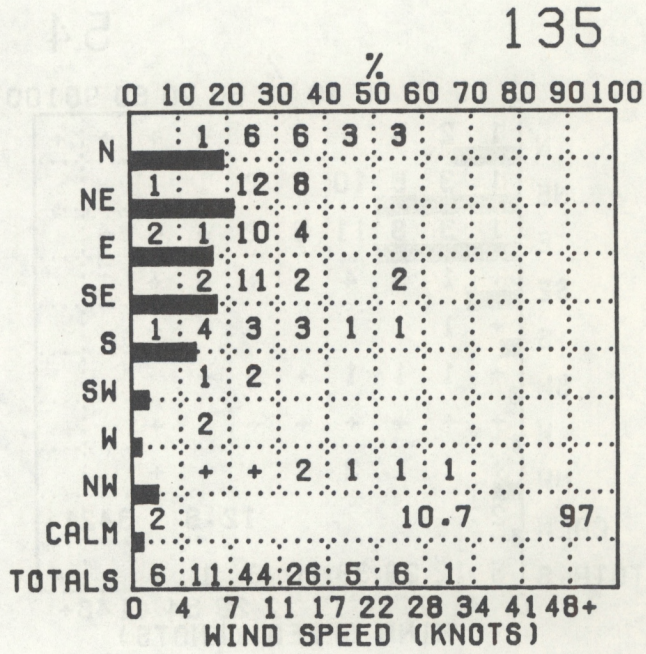
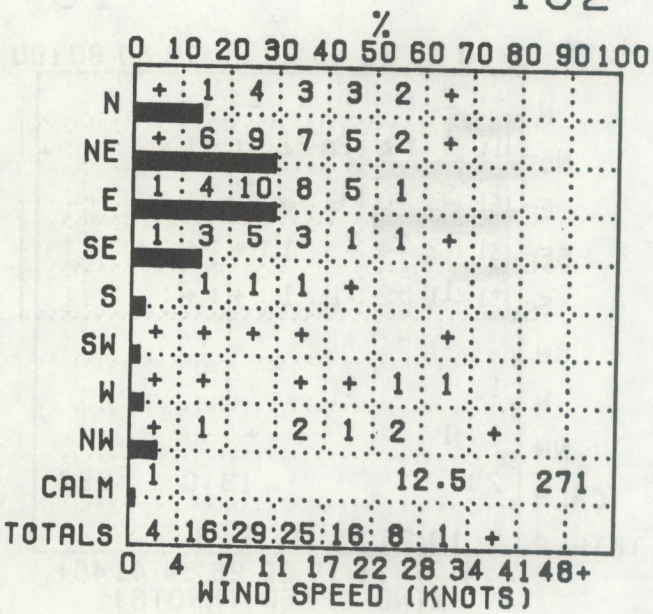


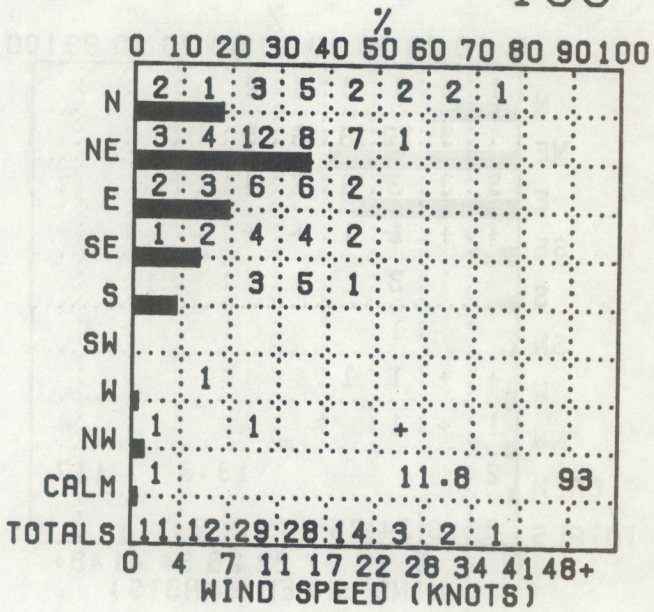
Table 5 (continued)
Month: October Squares: 74, 78, 132, 135

WIND DIRECTION AND SPEED

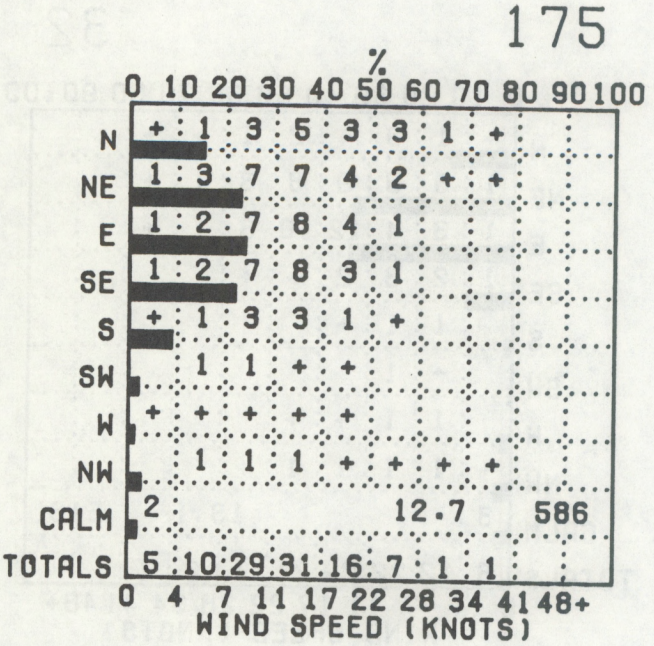
152



155



175



172

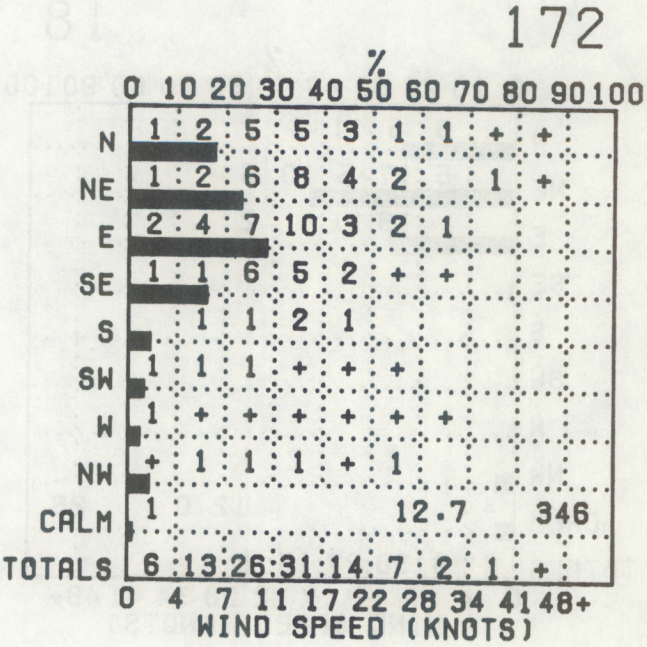
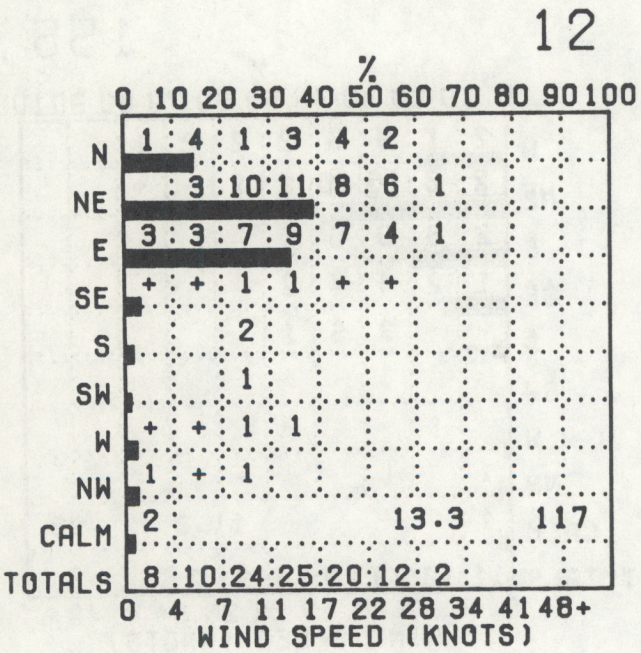
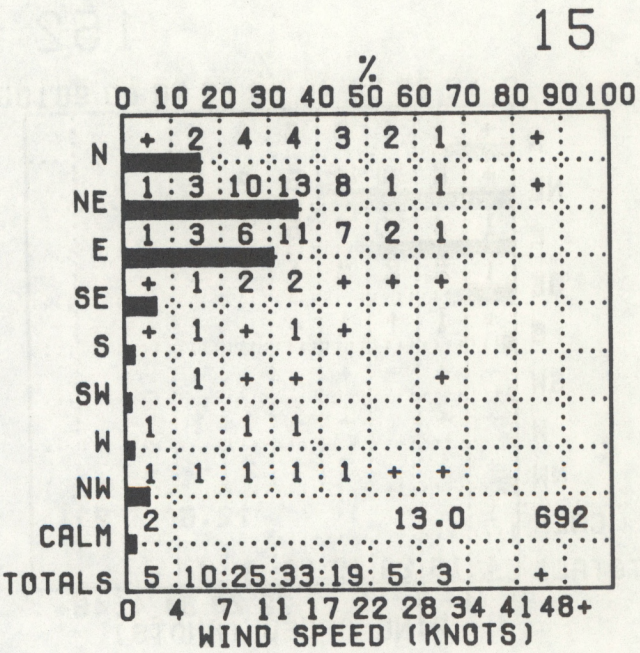
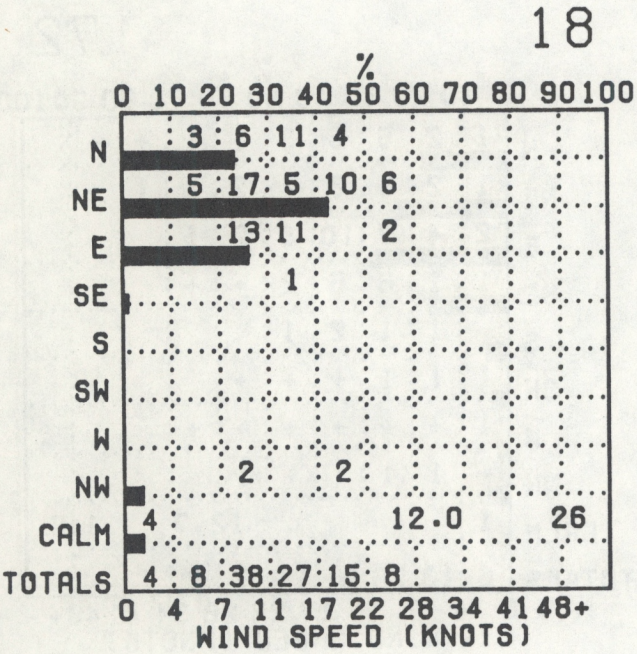


Table 5 (continued)
Month: October Squares: 152, 155, 172, 175

WIND DIRECTION AND SPEED







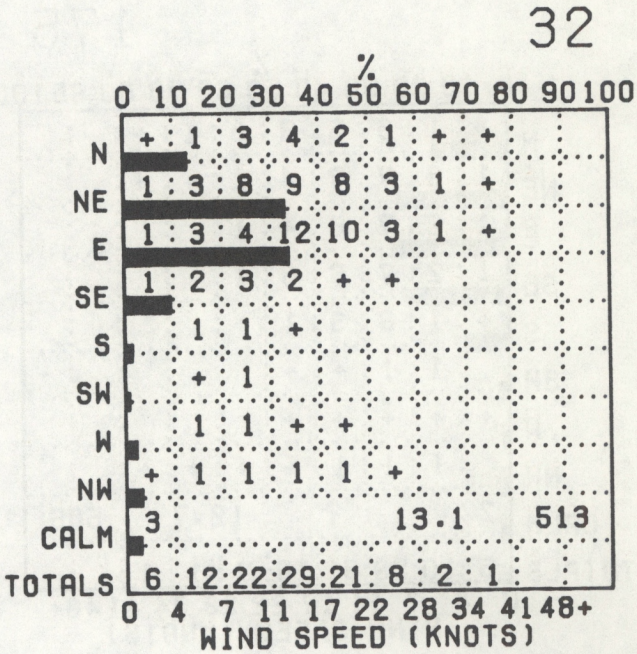
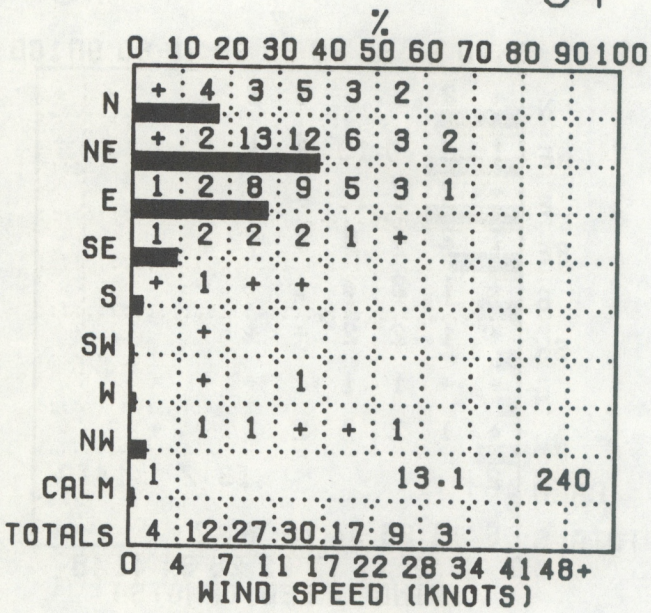


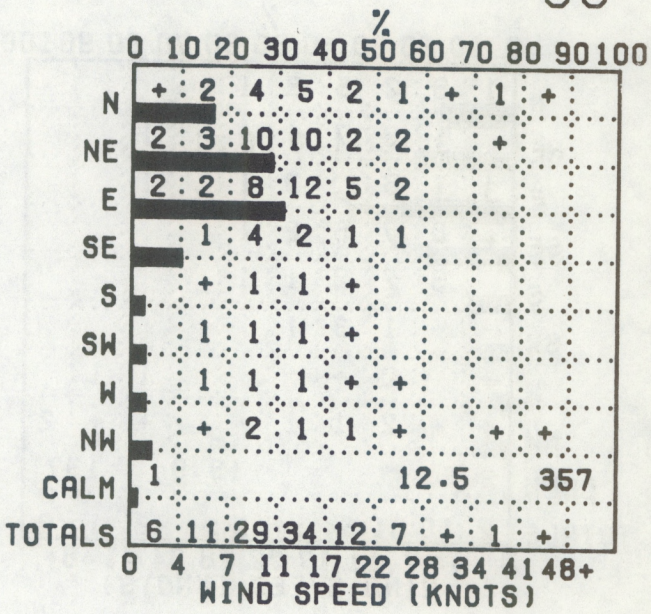
Table 5 (continued)
Month: November Squares: 12, 15, 18, 32

WIND DIRECTION AND SPEED

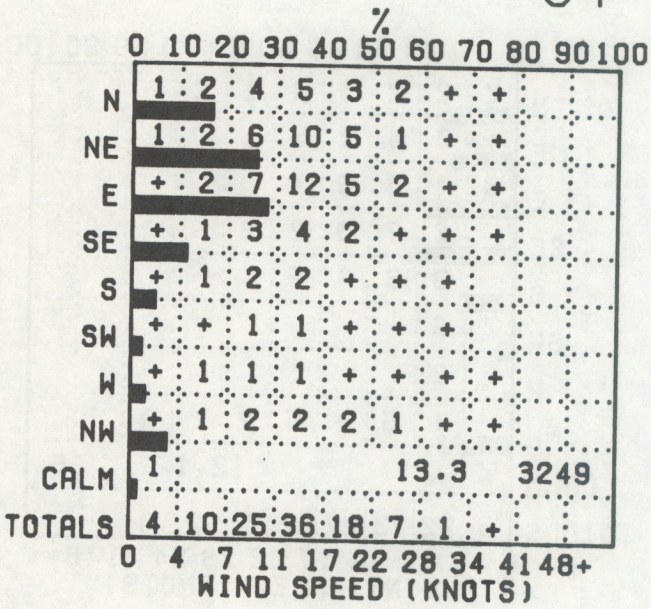
34



38



54



58

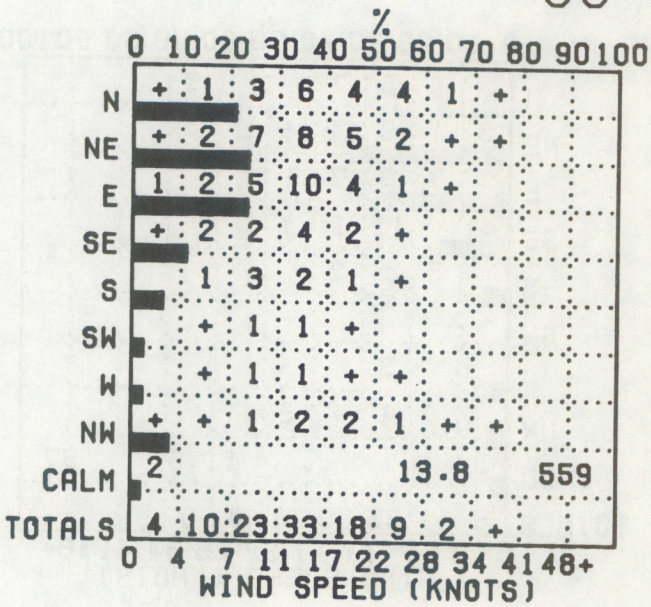
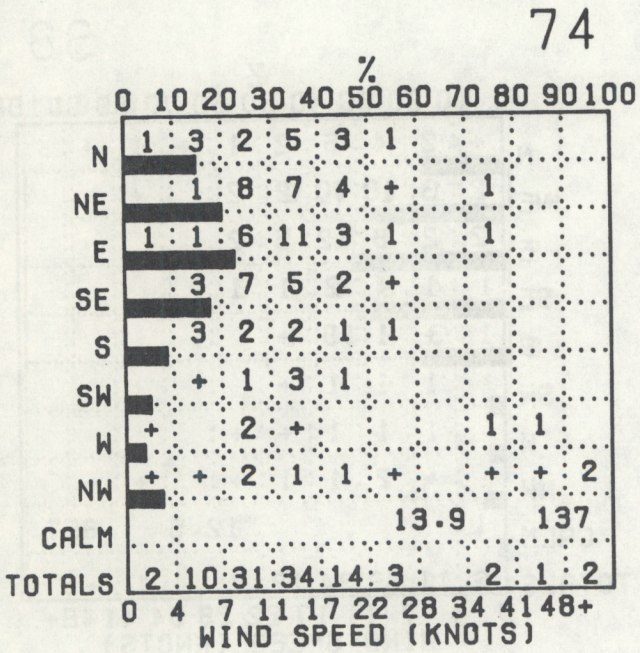
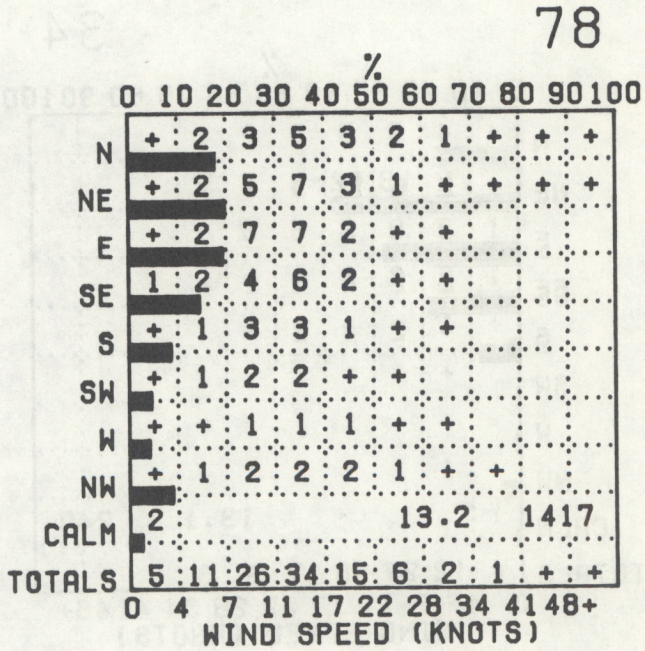
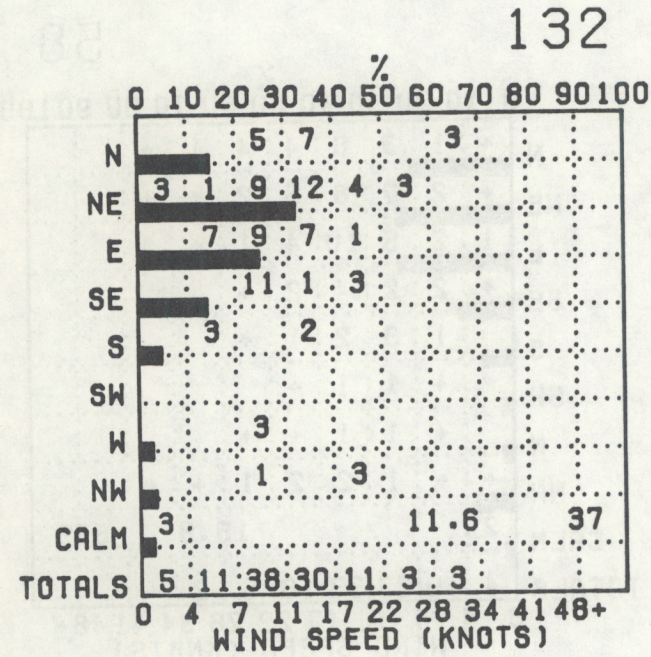


Table 5 (continued)
Month: November Squares: 34, 38, 54, 58

WIND DIRECTION AND SPEED







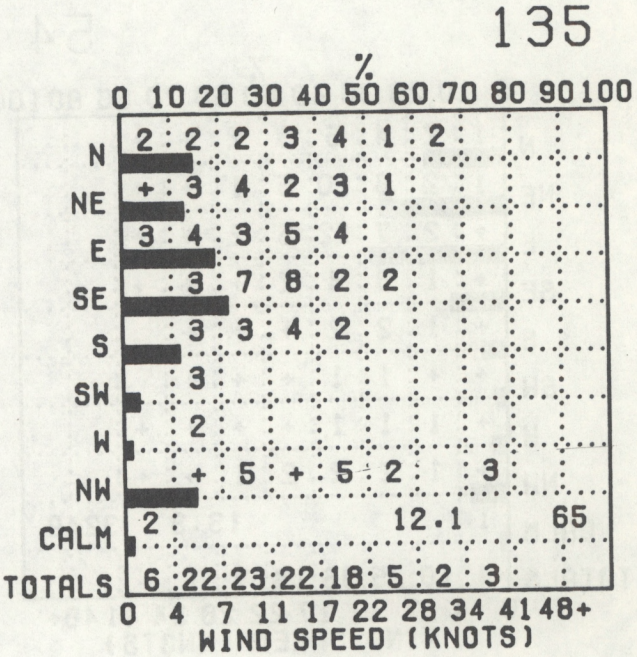
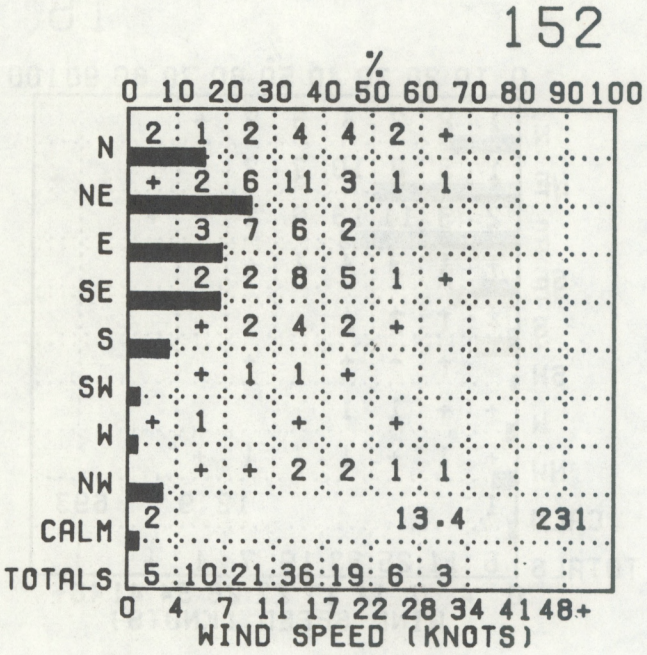
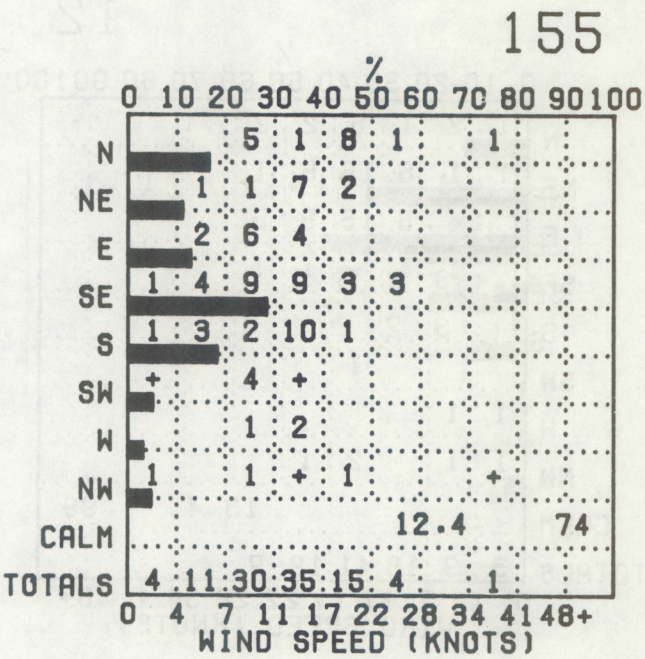
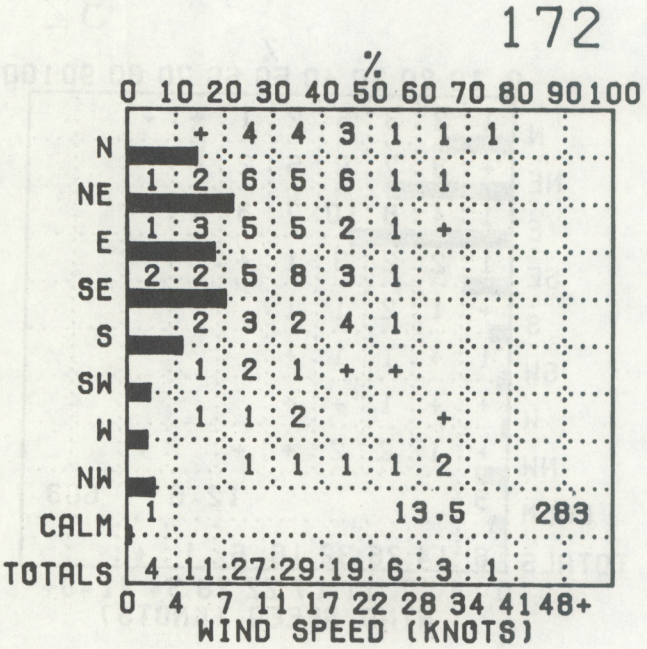


Table 5 (continued)
Month: November Squares: 74, 78, 132, 135

WIND DIRECTION AND SPEED







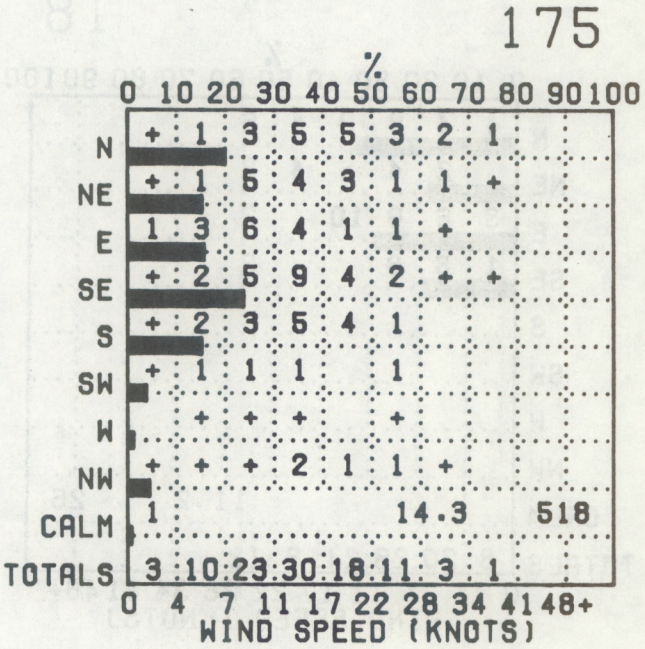
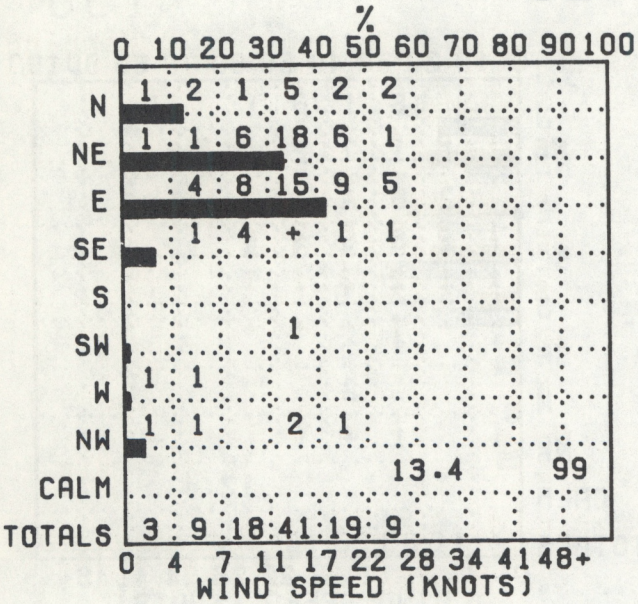


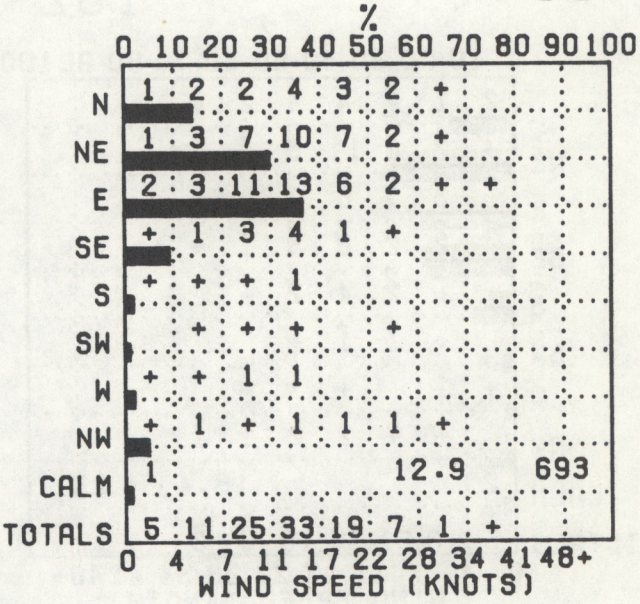
Table 5 (continued)
Month: November Squares: 152, 155, 172, 175

WIND DIRECTION AND SPEED

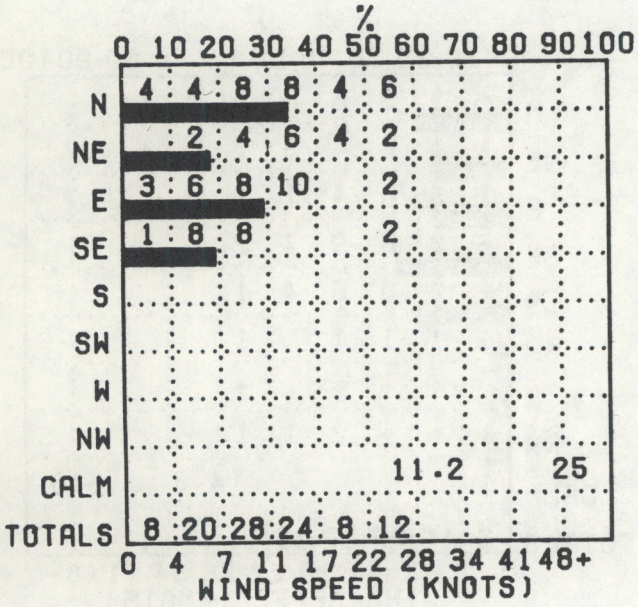
12



15



18



32

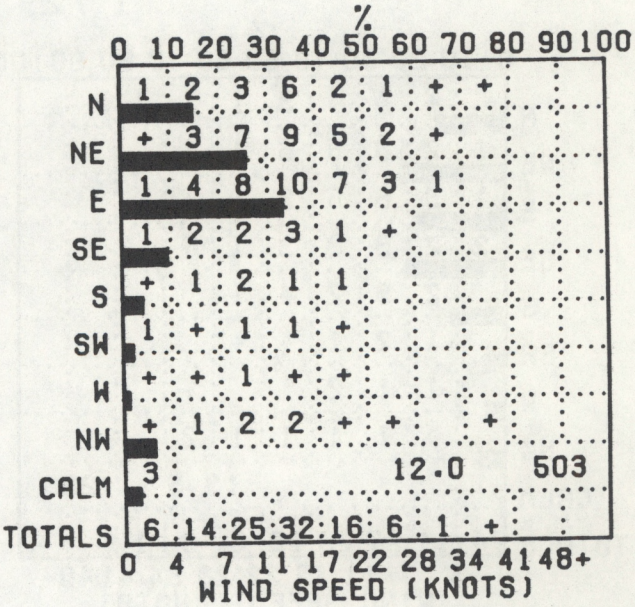
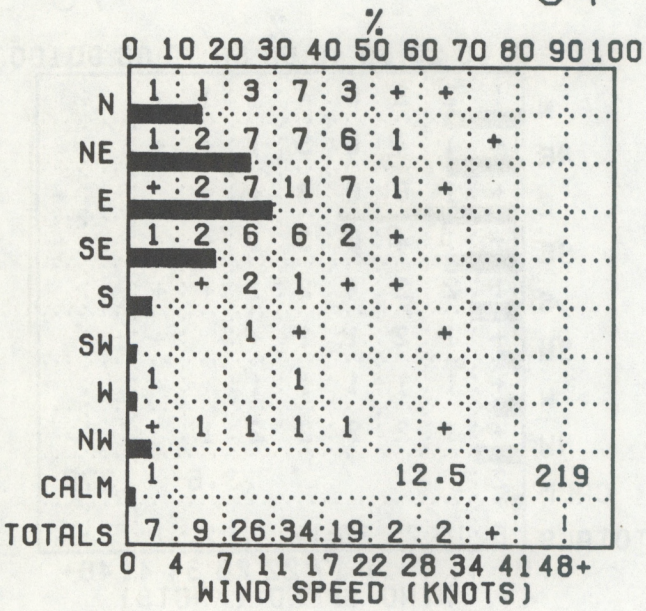


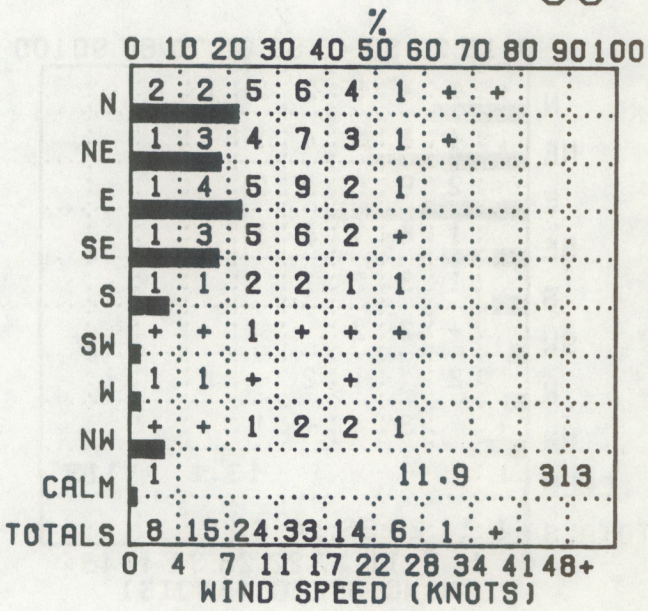
Table 5 (continued)
Month: December Squares: 12, 15, 18, 32

WIND DIRECTION AND SPEED

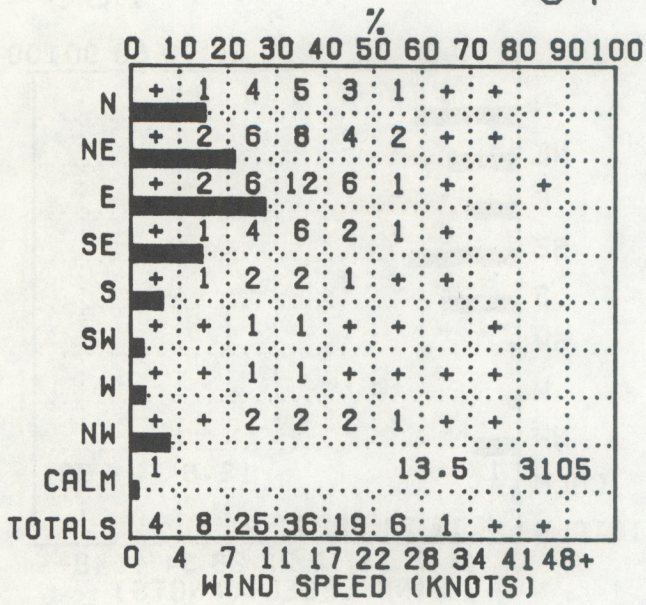
34



38



54



58

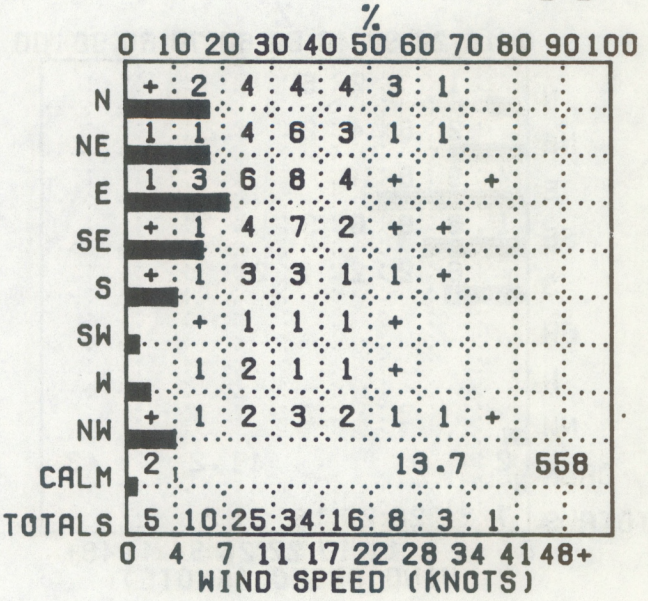
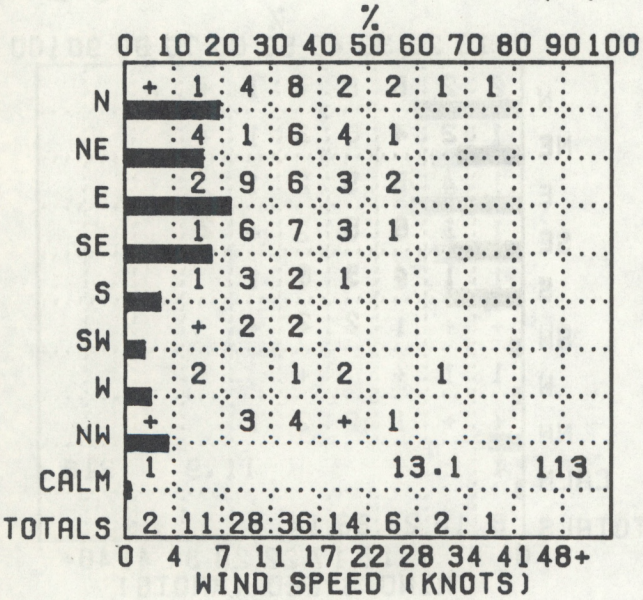


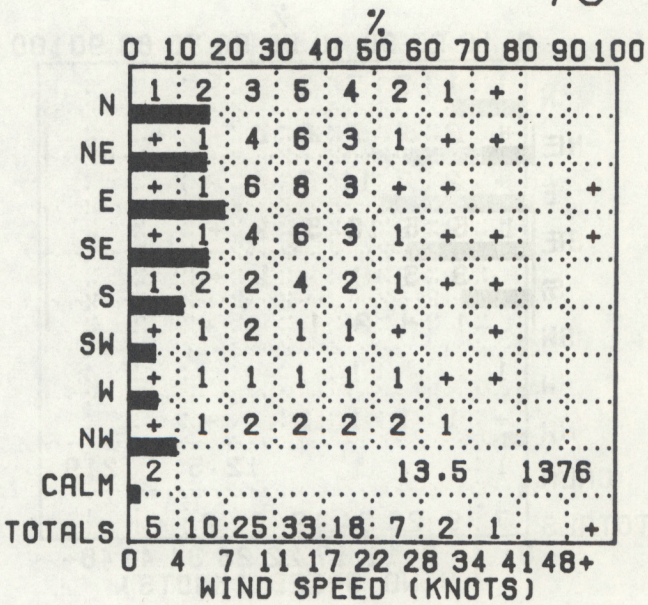
Table 5 (continued)
Month: December Squares: 34, 38, 54, 58

WIND DIRECTION AND SPEED

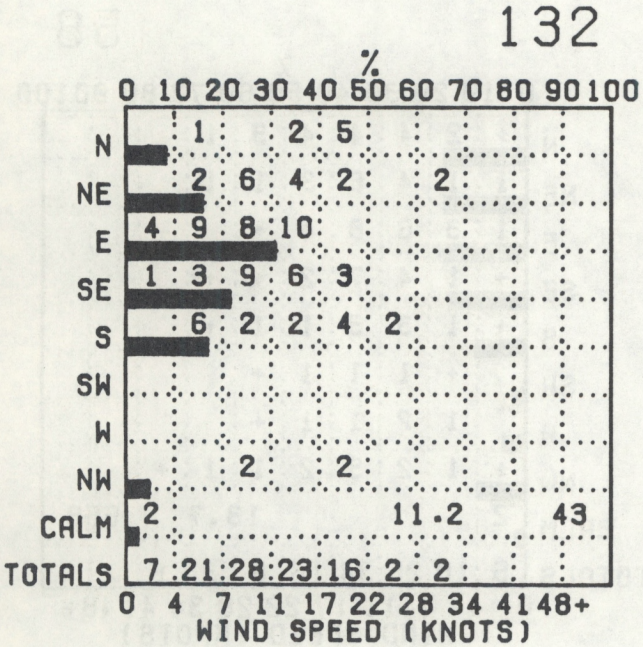
74



78



132



135

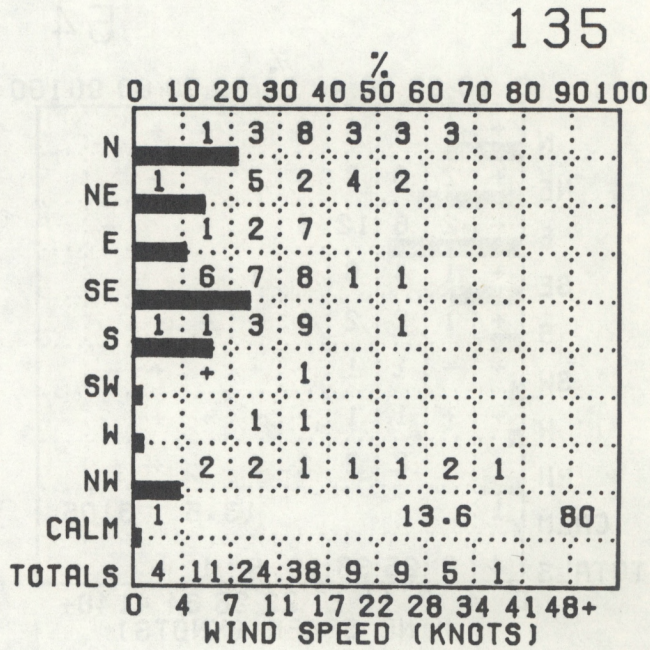


Table 5 (continued)
Month: December Squares: 74, 78, 132, 135

WIND DIRECTION AND SPEED

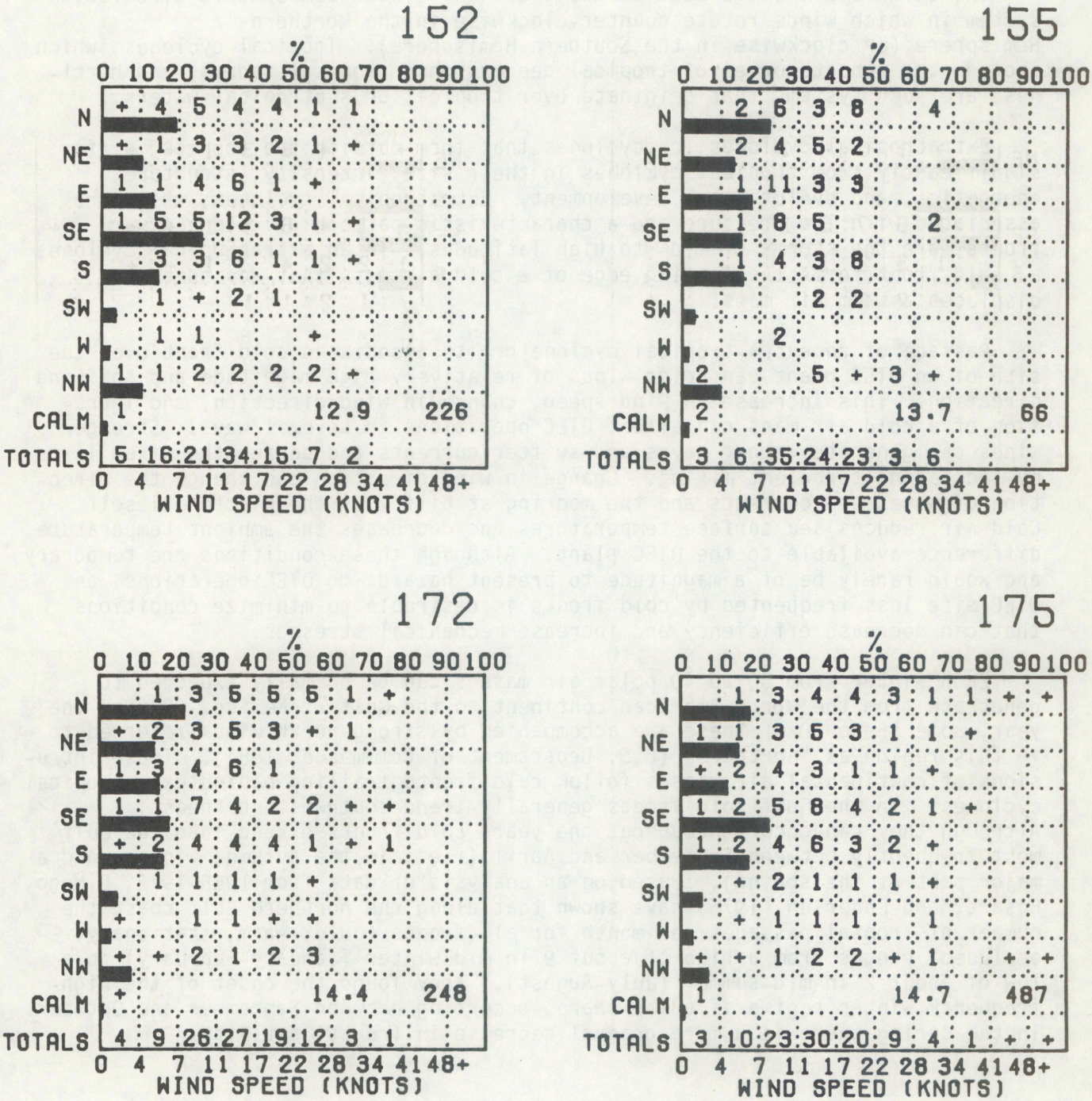


Table 5 (continued)
Month: December Squares: 152, 155, 172, 175

2.7 Cold Fronts (Extratropical Cyclones)

The term "cyclone" is used to designate any closed atmospheric circulation system in which winds rotate counter-clockwise in the Northern Hemisphere (or clockwise in the Southern Hemisphere). Tropical cyclones, which include the subcategories of tropical depressions, tropical storms, and hurrines, are such systems that originate over tropical or subtropical waters.

Extratropical cyclones, or cyclones that form outside the tropics, differ significantly from tropical cyclones in their size, intensity, structure, energetics, and evolutionary development. Extratropical cyclones, which are associated with low pressure and a characteristic pattern of cold and warm fronts, are the storms of mid- to high latitudes. In an extratropical cyclone, a cold front forms the leading edge of a cold air mass that advances and displaces a warm air mass.

Passage of an extra-tropical cyclone or its associated cold front over the site of an OTEC plant can bring winds of relatively high magnitude and shifting direction. This increase in wind speed, change in wind direction, and intrusion of a cold air mass can affect OTEC operations in several ways. Stronger winds can generate larger waves and swifter currents and deepen the mixed layer by increasing turbulent mixing. Change in wind direction can change the direction of waves and currents and the mooring stability of the platform itself. Cold air reduces sea surface temperatures and decreases the ambient temperature difference available to the OTEC plant. Although these conditions are temporary and would rarely be of a magnitude to present hazards to OTEC operations, an OTEC site less frequented by cold fronts is desirable to minimize conditions that can decrease efficiency and increase mechanical stresses.

Each winter from 30 to 40 polar air masses can be normally expected to penetrate from the North American continent to the Gulf of Mexico. During the year, some 15 to 20 of these are accompanied by strong north winds referred to in this region as "northers" (U.S. Department of Commmerce, 1981). These intrusions of continental air masses follow cold fronts trailing behind extratropical cyclones. In the Gulf cold fronts generally trend southwest-northeast. Although they can occur throughout the year, cold fronts extend into the Gulf most frequently between September and April (i.e., in the autumn, winter, and a major part of the spring). Based on an analysis of data from 1965-1972, DiMego, Bosart, and Endersen (1976) have shown that along the northern Gulf coast the number of frontal passages per month for all fronts (cold, warm, stationary, occluded) ranges from a high of about 9 in mid-winter (January-February) to a low of about 2 in mid-summer (July-August). They found the onset of the high-frequency winter regime is quite sharp, occurring between September and October. In the spring there is a more gradual decrease in frontal activity.

The mean duration of cold front conditions in the Gulf is about 2 days, with a 4 to 6 day interval between frontal events. Observed mean wind speeds of 7 to 9 m/s (13.6-17.5 knots) occur following cold front pasages with higher speeds typical of late autumn and winter months and lower speeds typical in the spring to mid-autumn.

Characteristics of cold fronts observed in the eastern Gulf from 1954 through 1963 are summarized in Table 6.

Table 6. Average properties of cold fronts observed in the eastern Gulf of Mexico from 1954 through 1963 (from Molinari and Mayer, 1980; based on Fernandez-Partegas and Mooers, 1975).

PROPERTY	SEPTEMBER-OCTOBER	NOVEMBER-DECEMBER	JANUARY-FEBRUARY	MARCH-APRIL
1) Average time interval between first days of fronts (days)	6	4	4	4
2) Average front speed (m/s (knots))	~ 6.6 (~13)	9.2 (18)	9.2 (18)	6.6 (13)
3) Average front direction	NW	NW	NW	NW
4) Average duration of cold fronts in the Gulf of Mexico (days)	2	2	<1	2

2.8 Tropical Storms and Hurricanes

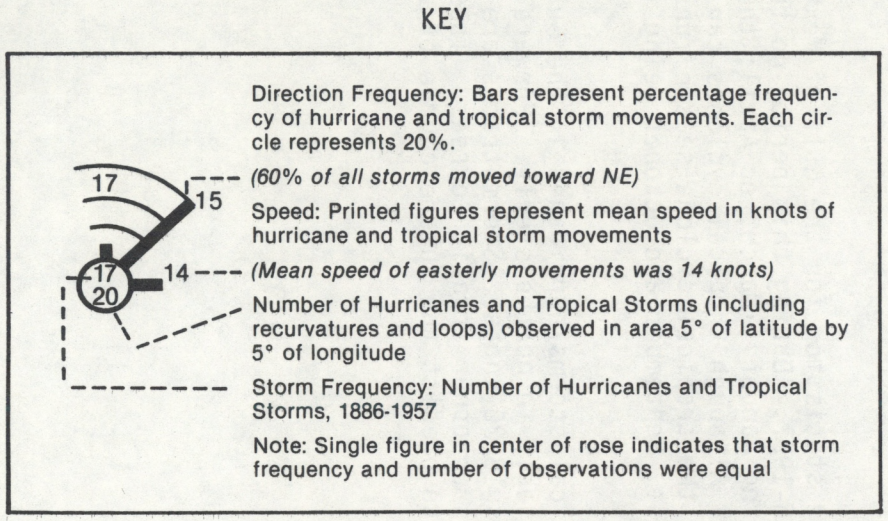
Tropical cyclones are further classified as tropical depressions, tropical storms, or hurricanes depending on whether sustained surface winds near the center of the system are, respectively, $\leq$ 33 knots, 34 to 63 knots, or $\geq$ 64 knots. With maximum winds speeds that may approach or exceed 175 knots, as for example, in hurricane Camille (1969), hurricanes present offshore structures with the most severe environmental conditions that they may encounter.

At sea OTEC plants would be threatened primarily by the high waves (up to 20 m) and strong currents produced by hurricanes. To survive a major hurricane, an OTEC cold water pipe would have to withstand both extreme steady currents and oscillatory forcing caused by wave orbital motions. In their review of direct data model calculations of extreme currents in hurricanes, Mavor et al. (1977), estimate that at the surface mean currents could attain 4 knots and wave orbital speeds 9 knots (compared to normal ambient current of 0-3 knots).

The Gulf of Mexico is part of the Atlantic tropical cyclone basin, one of six such areas around the globe where tropical cyclones occur. Besides the Gulf, the Atlantic tropical cyclone basin includes much of the North Atlantic Ocean, and the Caribbean Sea, as well as adjacent coastal areas. Tropical cyclones originate in the southern-most latitudes of this area and follow characteristic trajectories as they mature and dissipate. Neumann et. al. (1981) have summarized data on frequency of occurence and tracks of the 882 tropical cyclones recorded over the North Atlantic over the 110-year period 1871-1980.

Figure 14 presents tropical cyclone statistics for the Gulf of Mexico by five-degree squares for the period 1886-1957. During this period no tropical cyclones were recorded in the Gulf during January, March, or April; thus, these months are not included in the figure. Although tropical cyclones can form in any month in the North Atlantic basin, the tropical cyclone season runs from June through early November, with August, September and October being the months of highest observed frequency.

As can be seen in the figure, tropical storms/hurricanes in the Gulf usually travel in a direction ranging from westerly to northeasterly. Forward speeds of advance vary from 5 knots to as high as 18-20 knots. Storm tracks are unpredictable, however, and may trace out loops or other erratic courses. Thus, tropical cyclone statistics cannot be used to predict the future course of any specific storm.



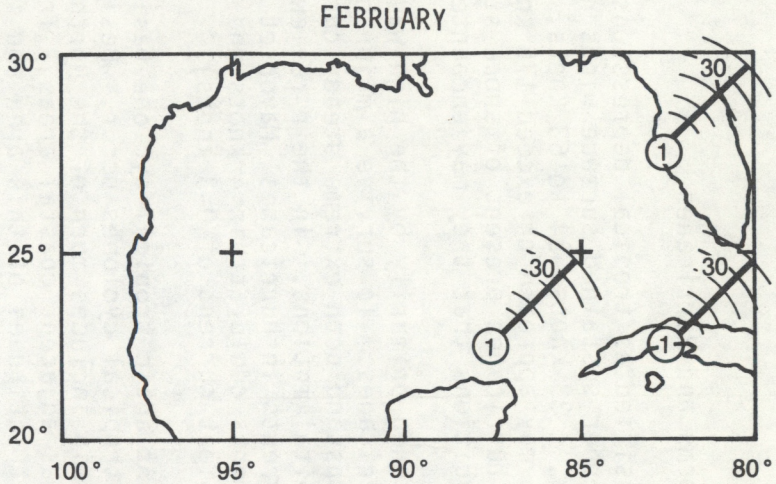


Figure 14. Tropical storms and hurricanes by month in the Gulf of Mexico, 1886-1957 (no occurrences, January - May; from Brower, Meserve, and Quayle, 1972).

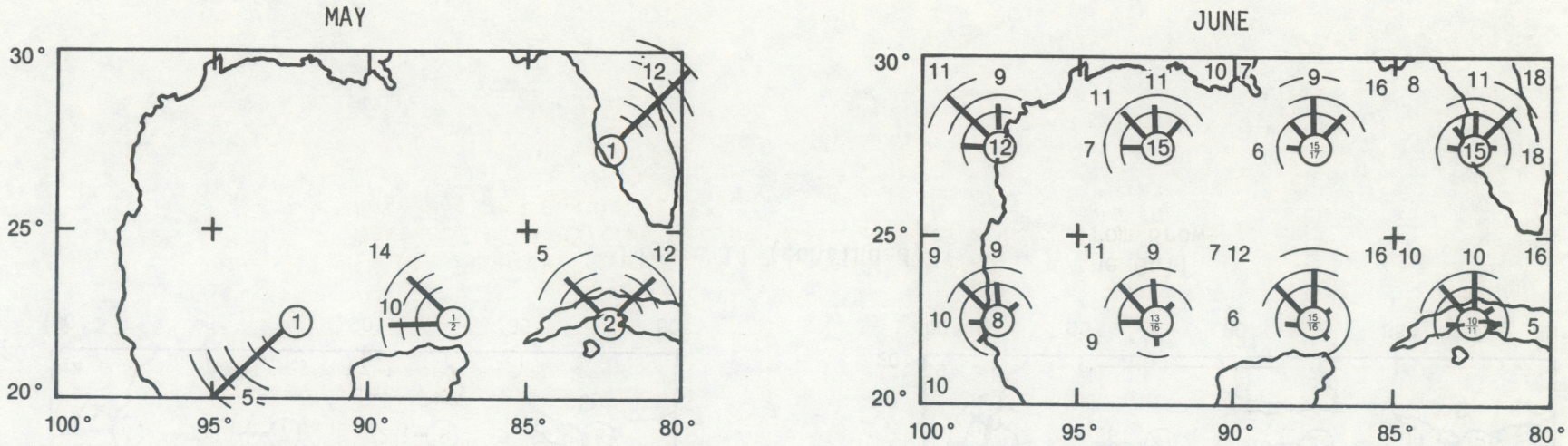


Figure 14 (continued)

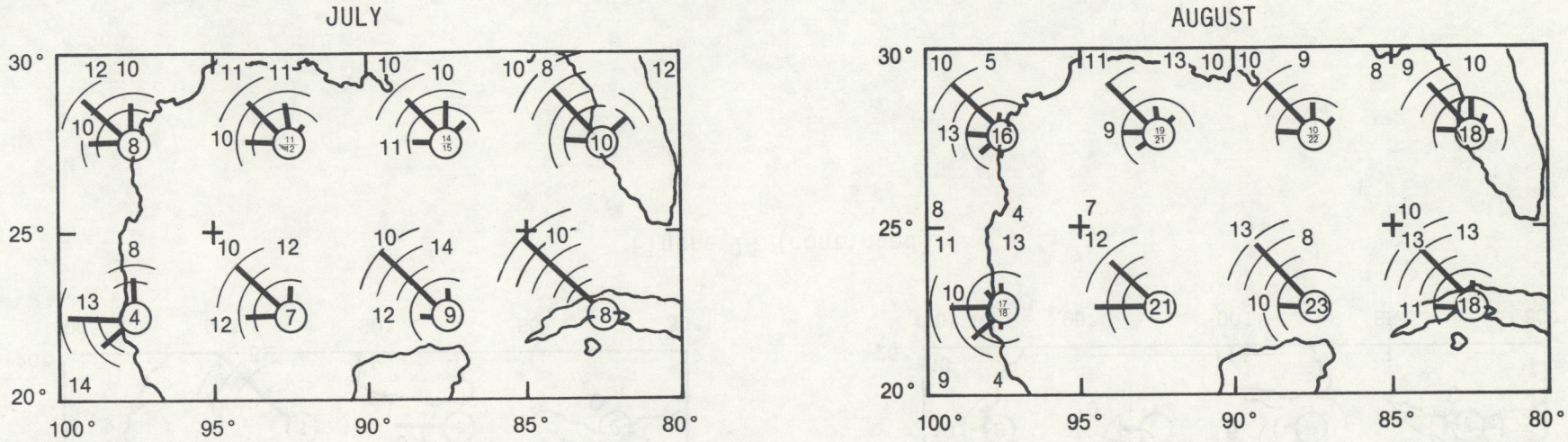


Figure 14 (continued)

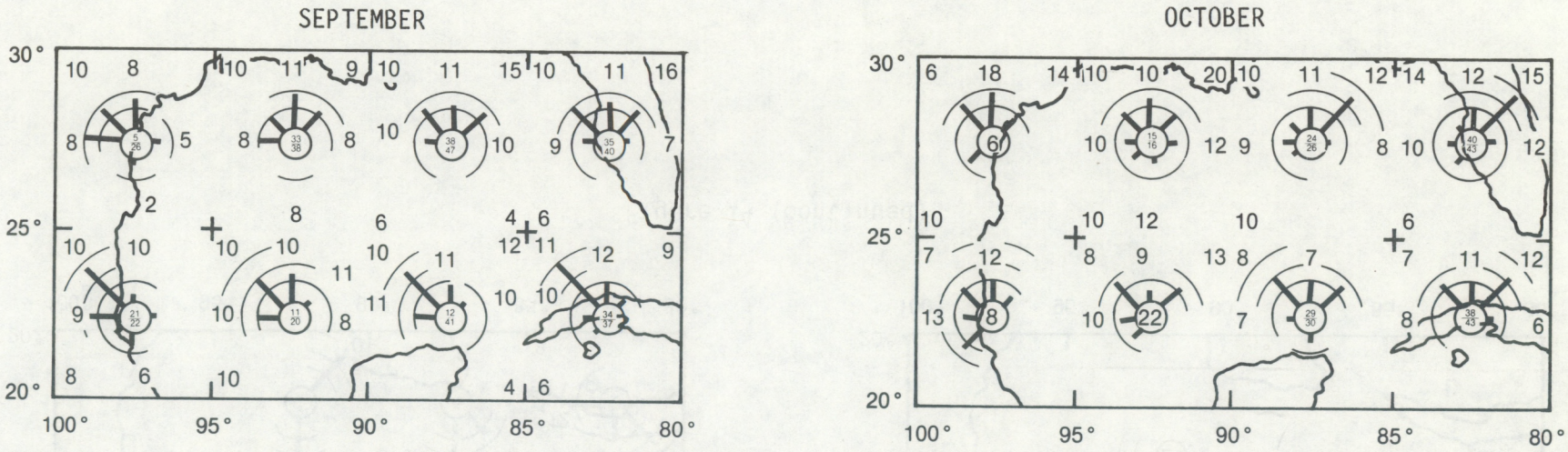


Figure 14 (continued)

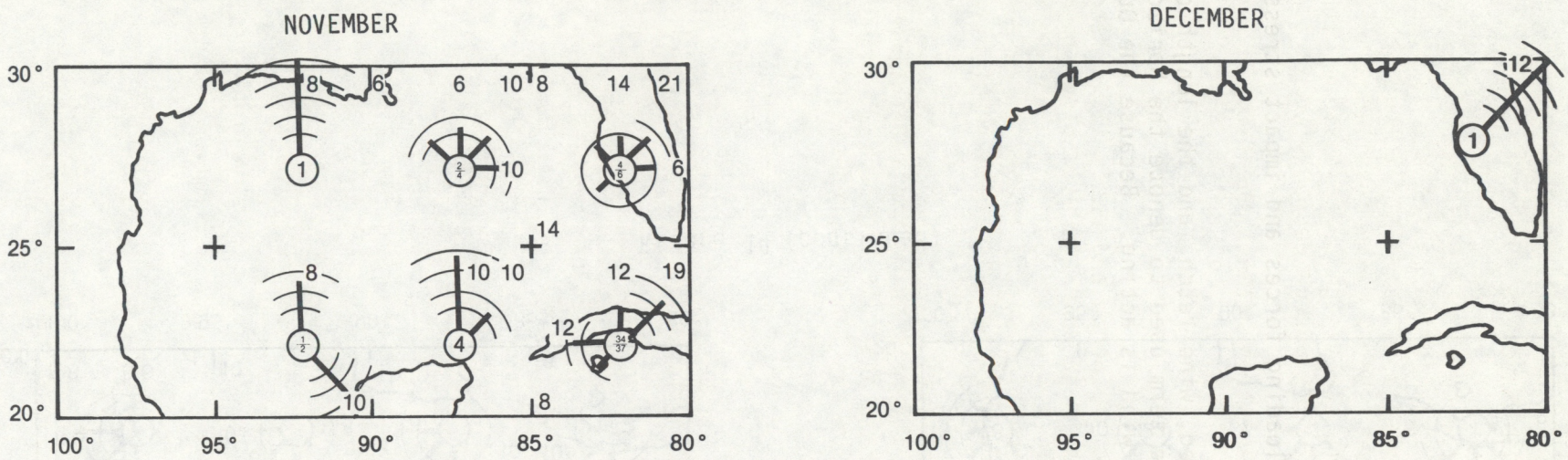


Figure 14 (continued)

2.9 Waves

Ocean surface waves generated by wind affect OTEC operations directly through oscillatory stresses imposed on mooring cables and structures, the cold water pipe, and other plant components, and indirectly through the action of turbulent mixing in the surface layer. Normal wave conditions in the Gulf appear to present no unusual or difficult design contraints on OTEC plants; however, waves of extreme height and long period encountered in tropical storms and hurricanes would impose severe loading forces and impact stresses on the hull and cold water pipe and the connection between the two.

Wave height depends on wind speed, wind fetch, and the length of time the wind has been blowing. Fetch is the term used to denote the horizontal distance over the sea that a wave-generating wind is acting. Because the Gulf is nearly land-locked--and is completely so to the north and west--it is fetch limited. Waves is coastal areas will not be as high when the wind blows from the land as when it blows inland from the open waters of the Gulf. In the Gulf limited fetch particularly will tend to suppress growth of higher waves during the autumn and winter when strong winds associated with cold front passages blow from the north and west.

Tables 7 and 8 present detailed information on the wave climatology of the Gulf for the 16 one-degree square areas shown in Figure 13. Table 7 presents mean monthly wave height and direction and Table 8 presents mean monthly wave period and height.

WAVE DIRECTION AND HEIGHT

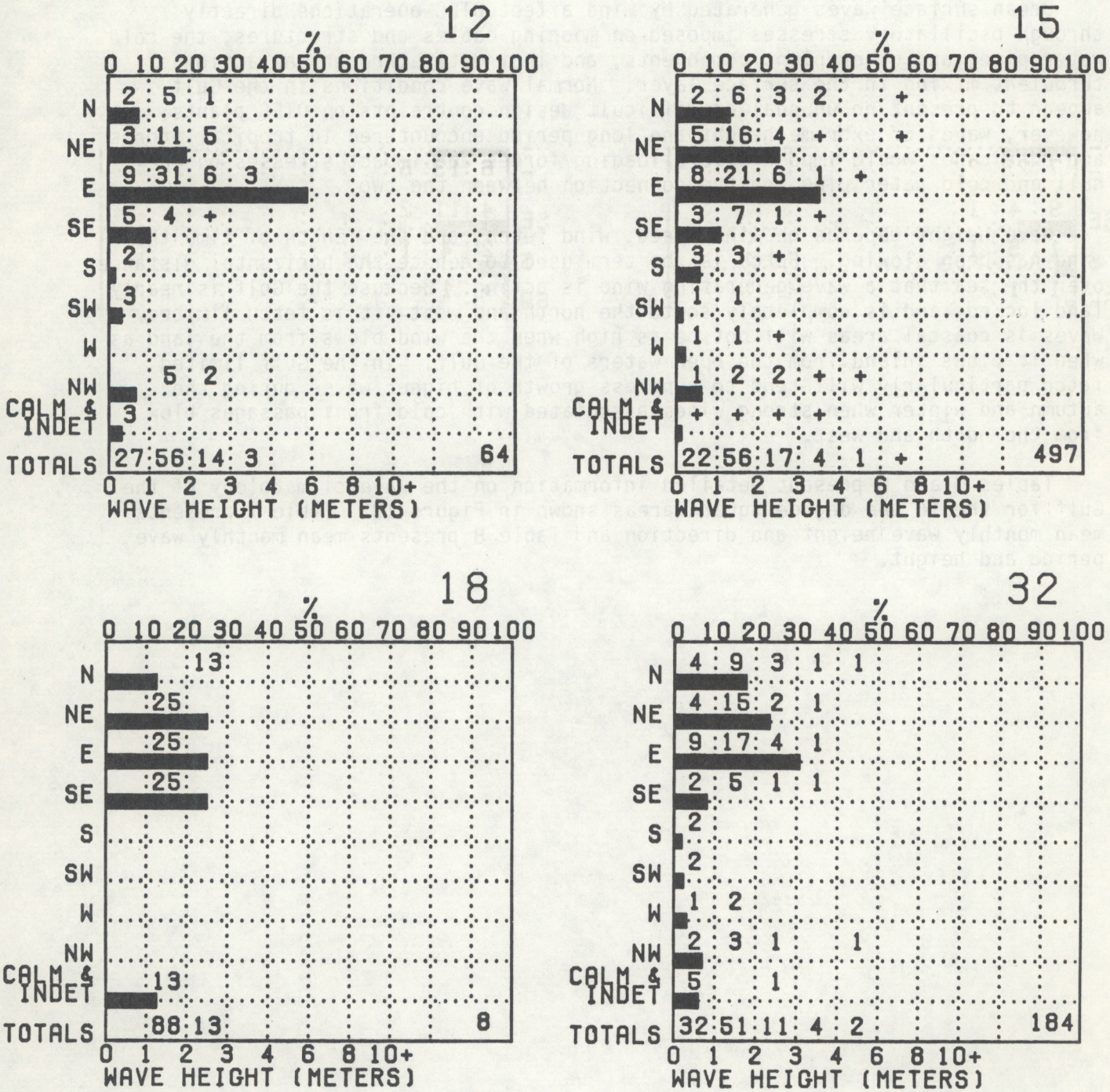


Table 7. Percent frequency of wave direction and height by month for selected 1° squares in the Gulf of Mexico (from NCC Surface Marine Observations Data Base, 1800-1975).

Month: January Squares: 12, 15, 18, 32

WAVE DIRECTION AND HEIGHT

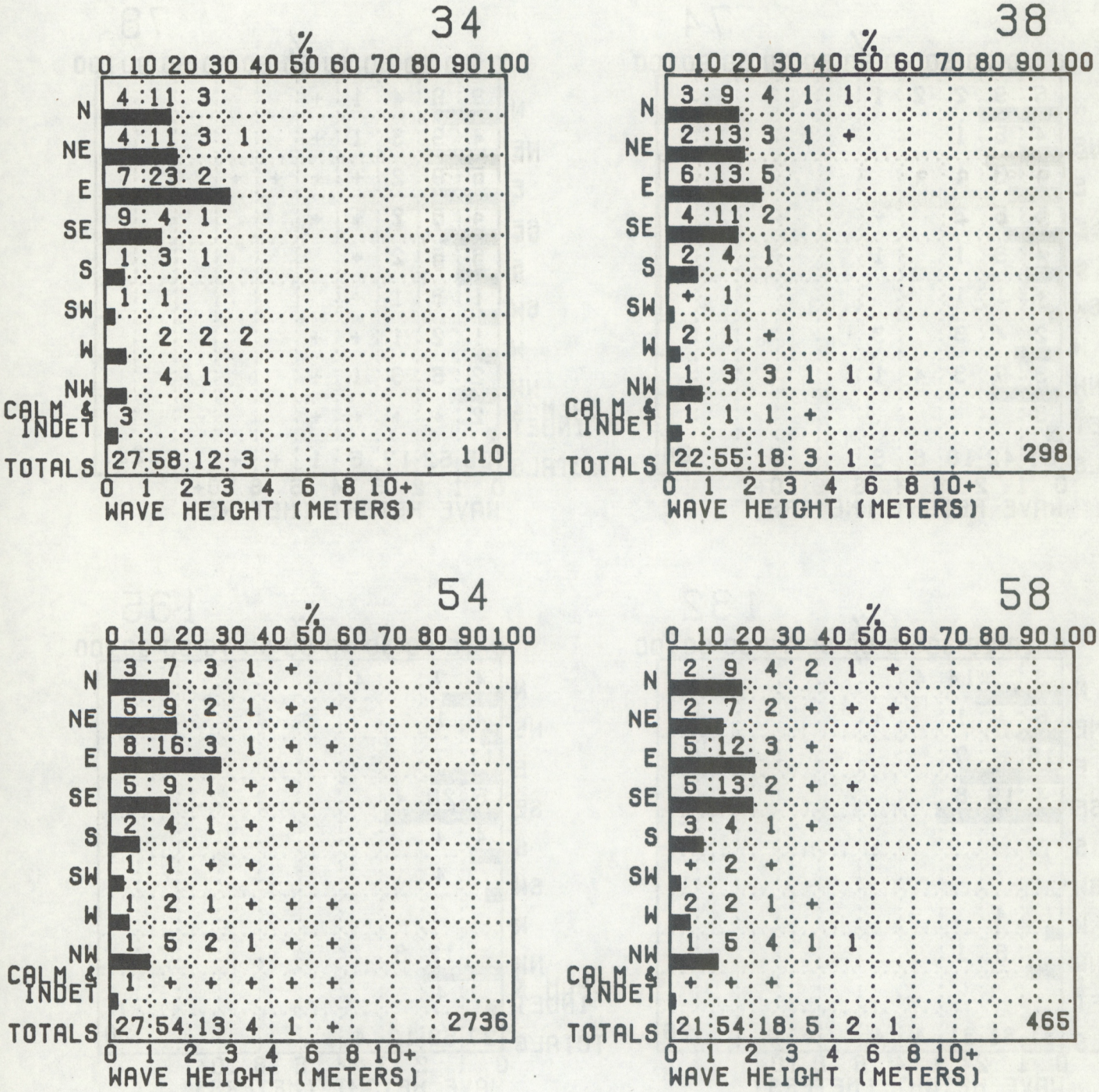
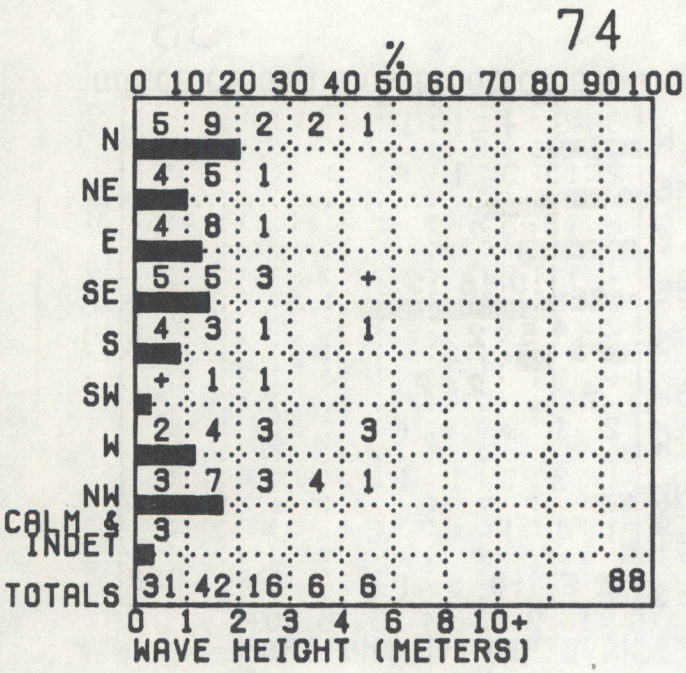
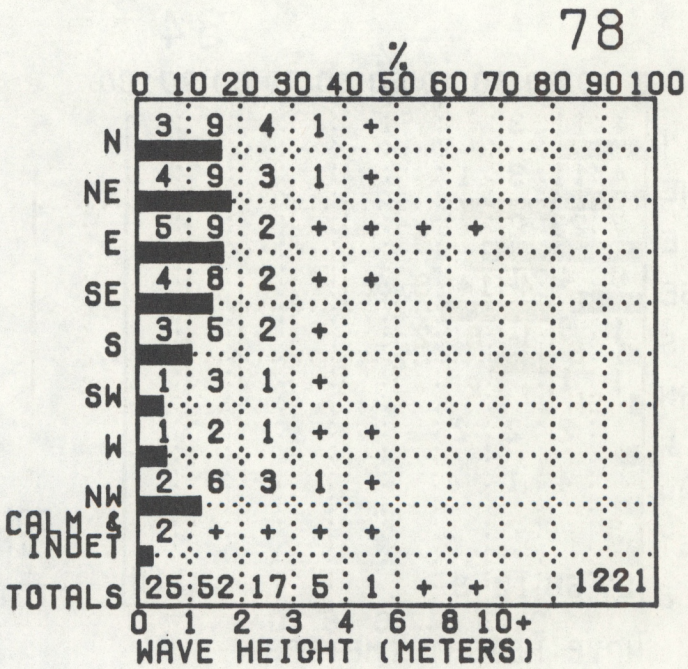
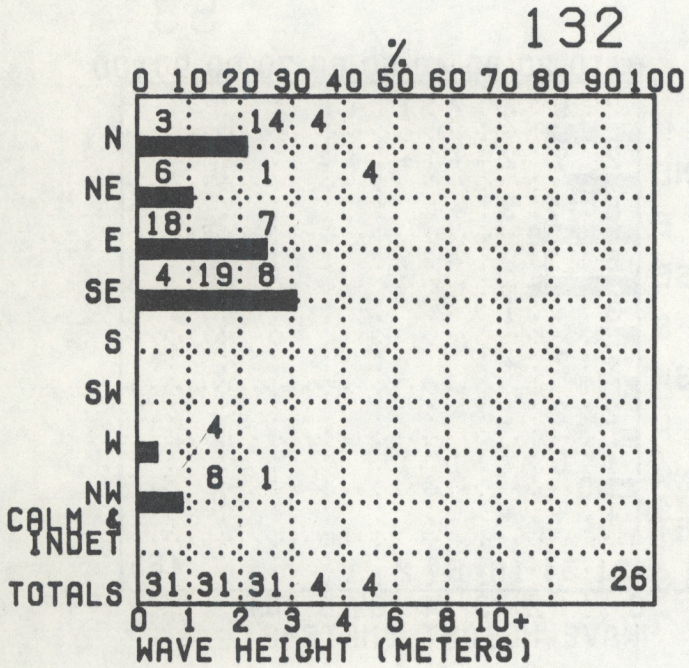


Table 7 (continued)
Month: January Squares: 34, 38, 54, 58

WAVE DIRECTION AND HEIGHT







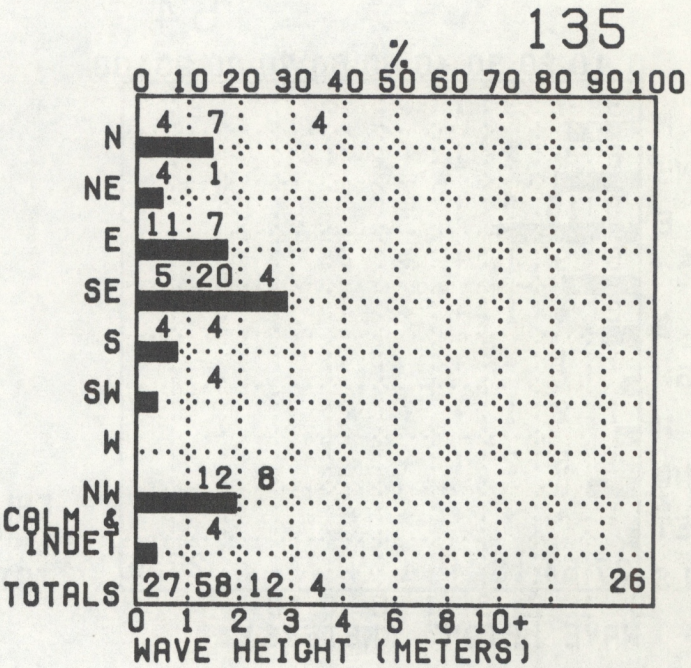


Table 7 (continued)
Month: January Squares: 74, 78, 132, 135

WAVE DIRECTION AND HEIGHT

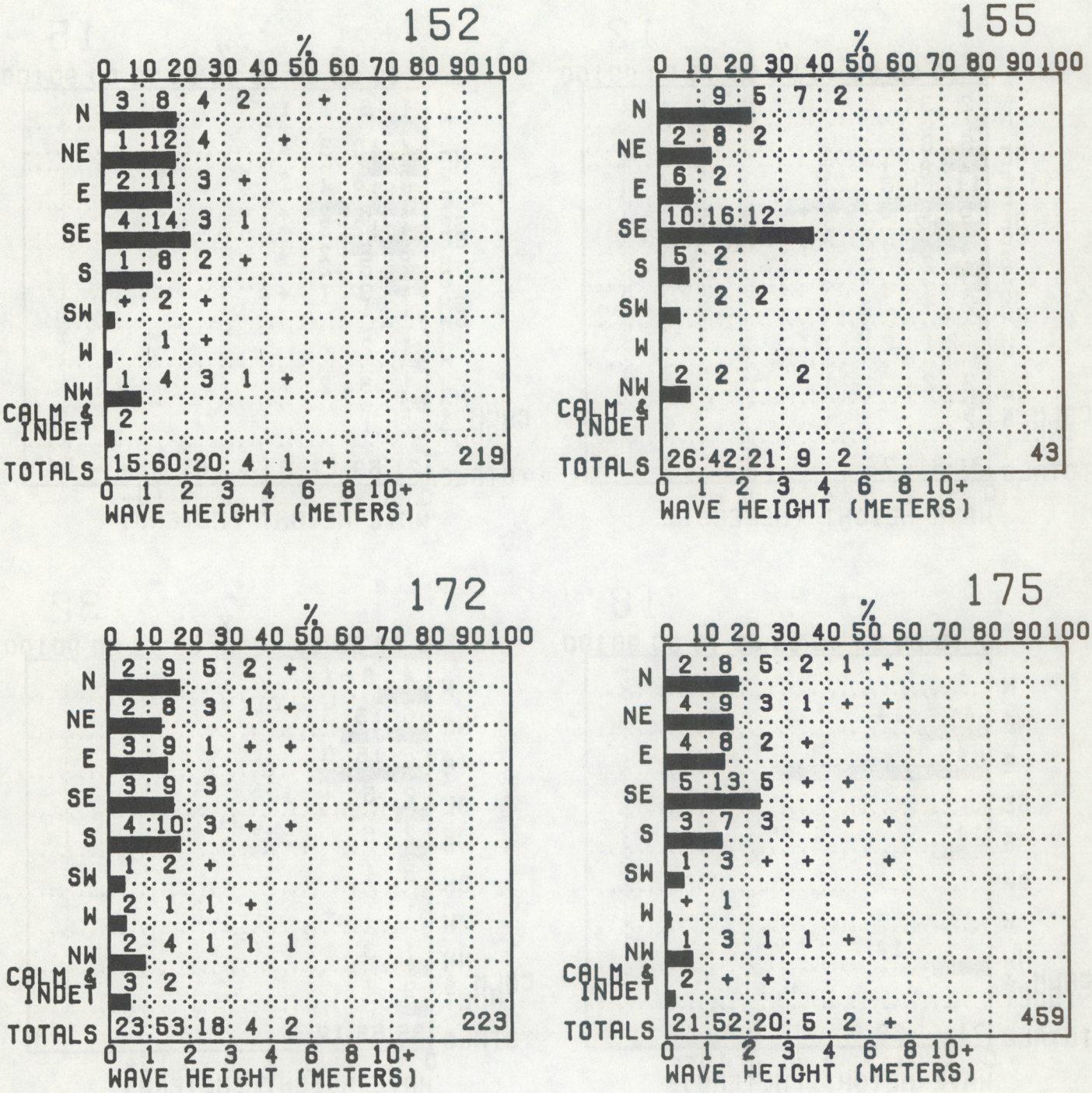
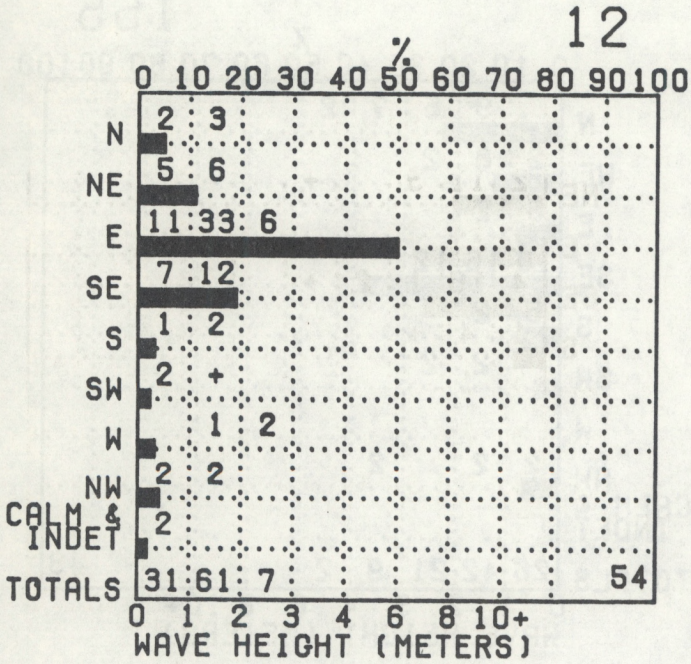
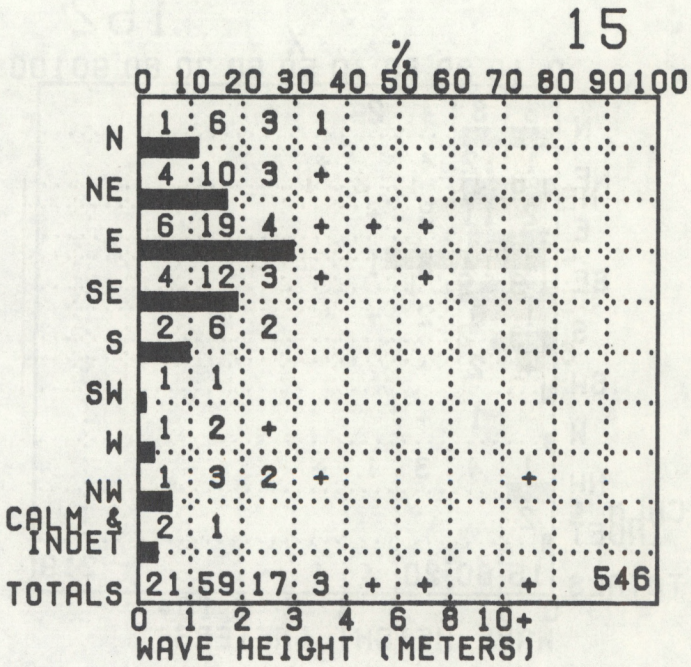
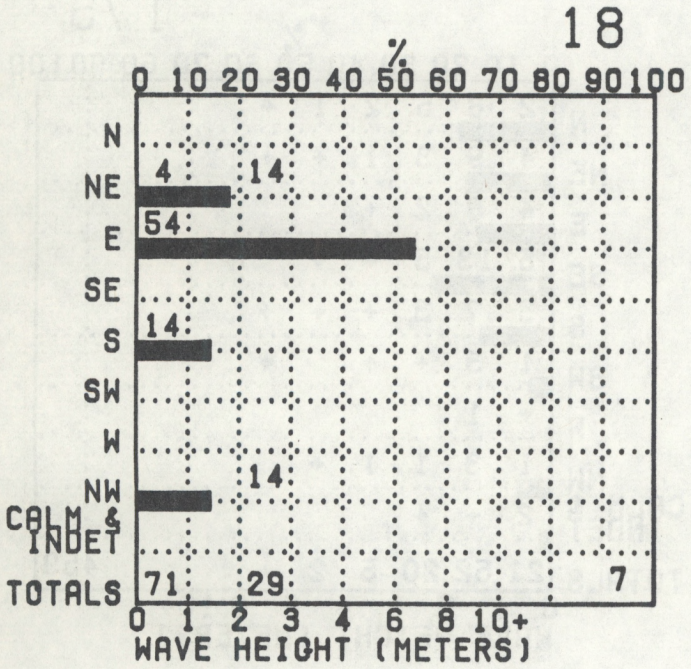


Table 7 (continued)
Month: January Squares: 152, 155, 172, 175

WAVE DIRECTION AND HEIGHT







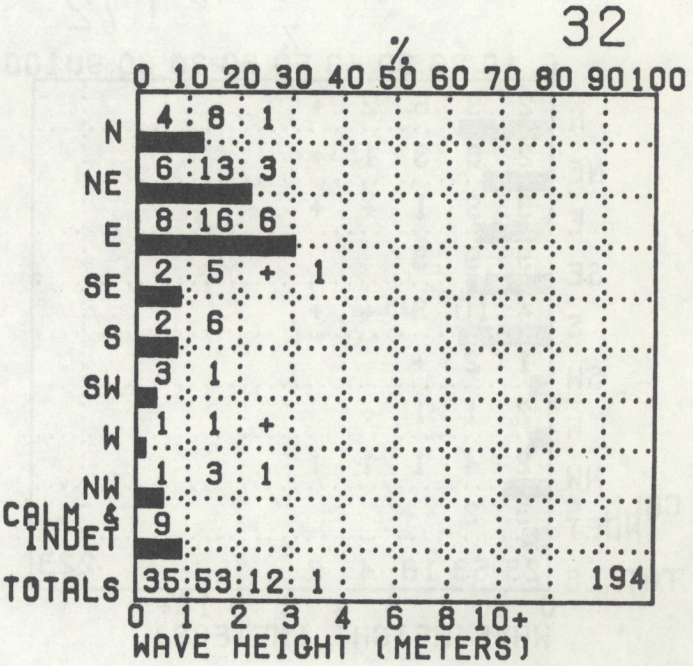
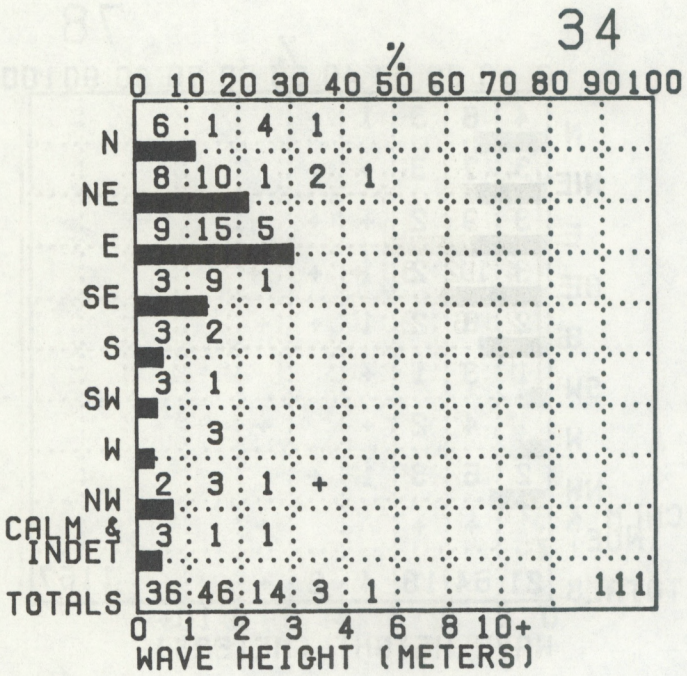
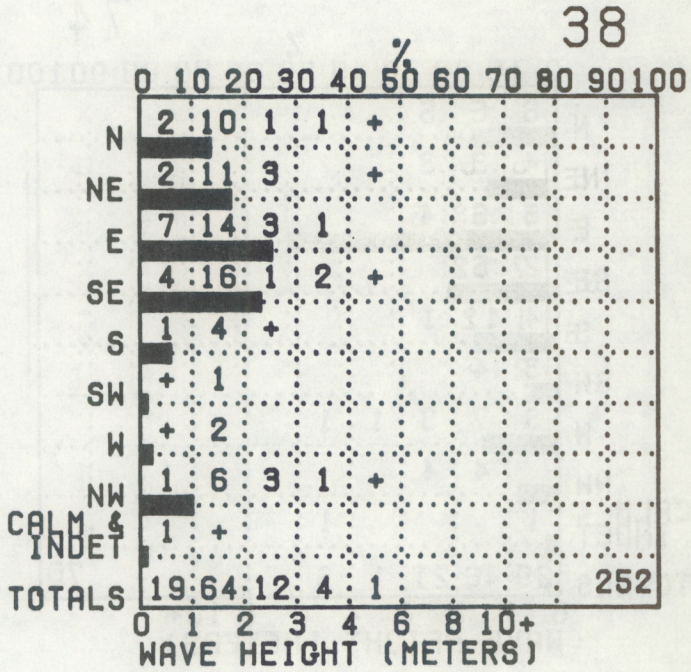
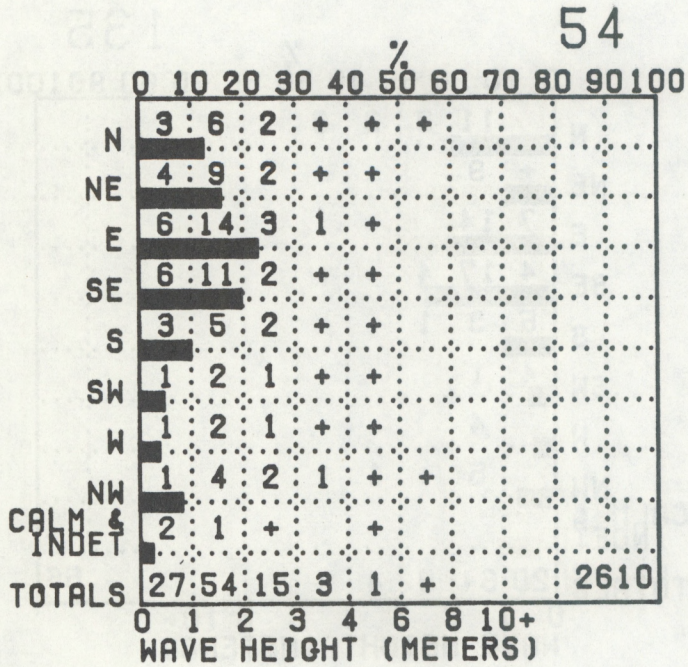


Table 7 (continued)
Month: February Squares: 12, 15, 18, 32

WAVE DIRECTION AND HEIGHT







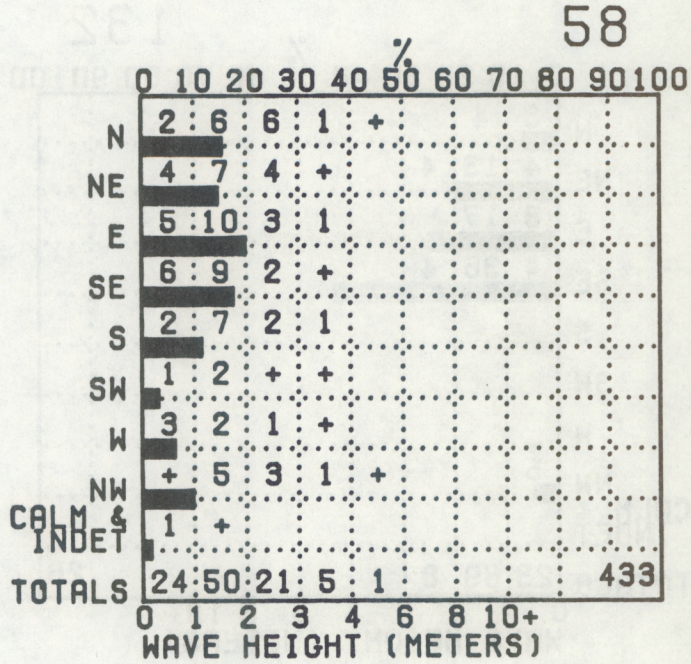
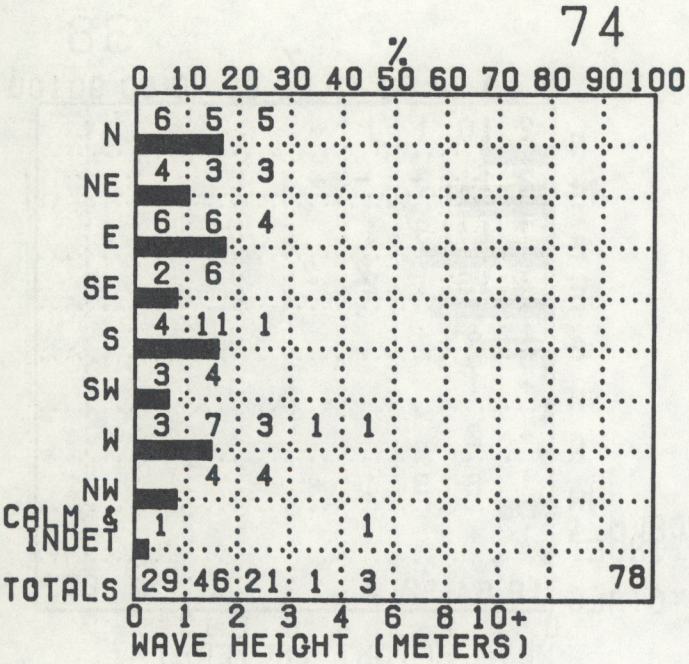
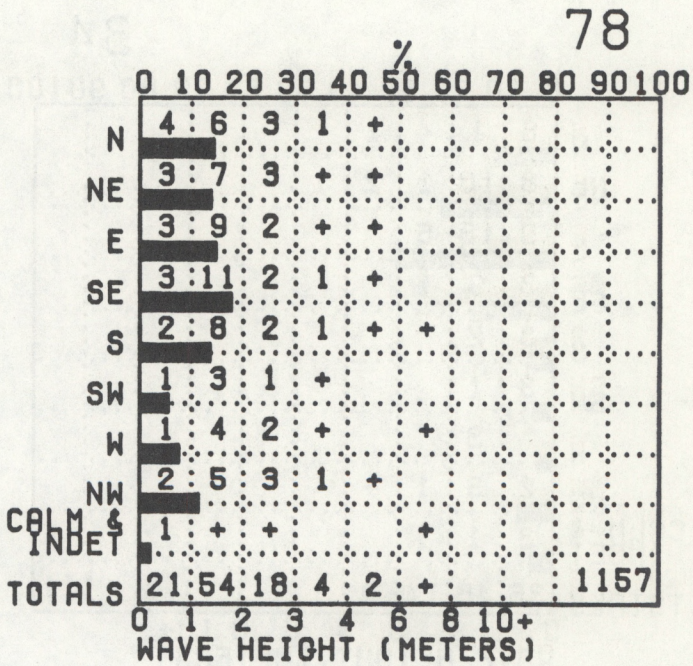
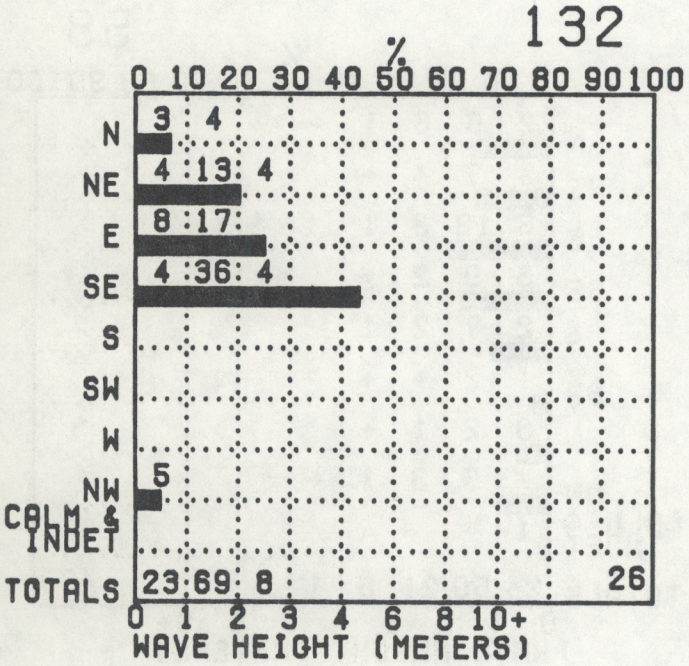


Table 7 (continued)
Month: February Squares: 34, 38, 54, 58

WAVE DIRECTION AND HEIGHT







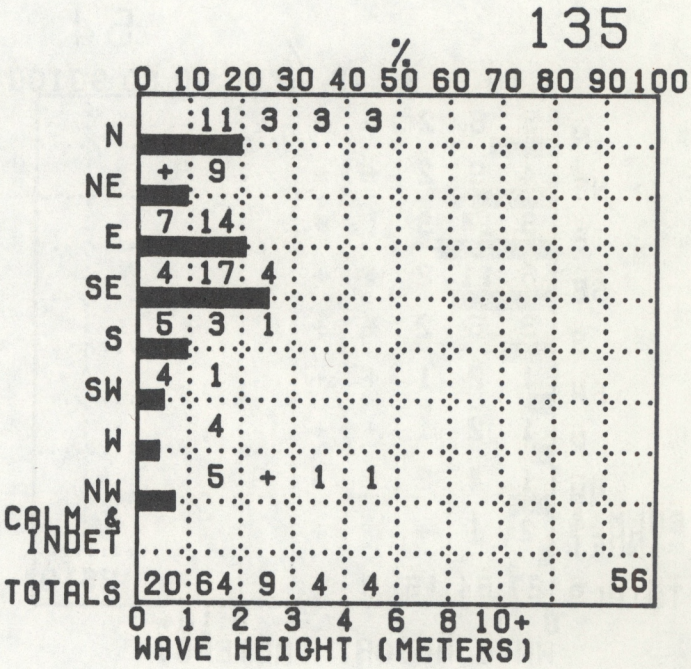
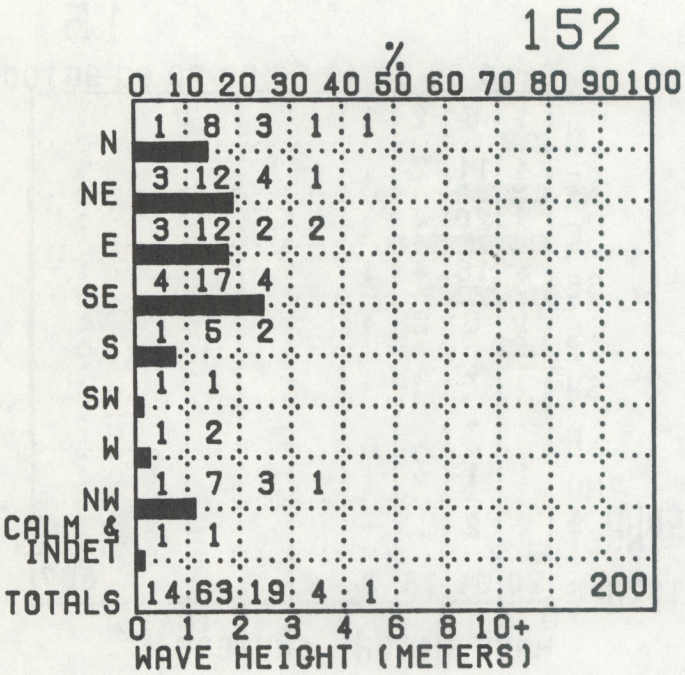
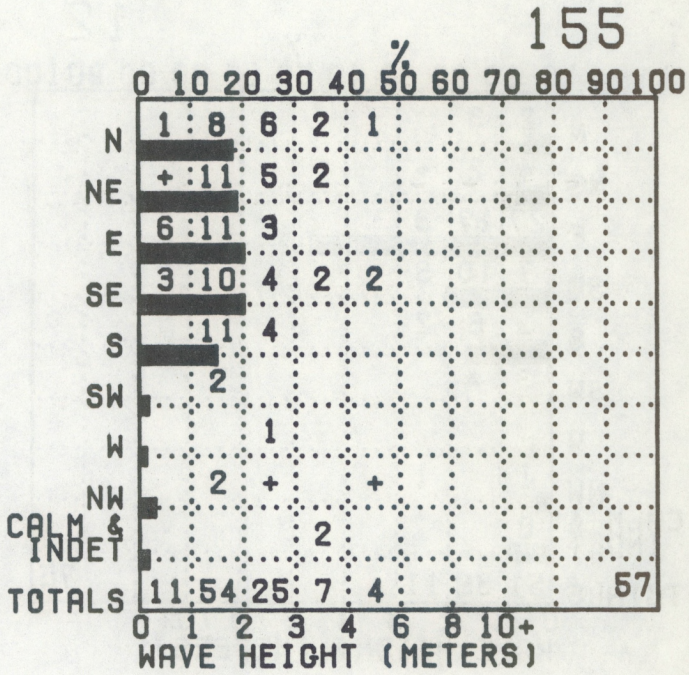
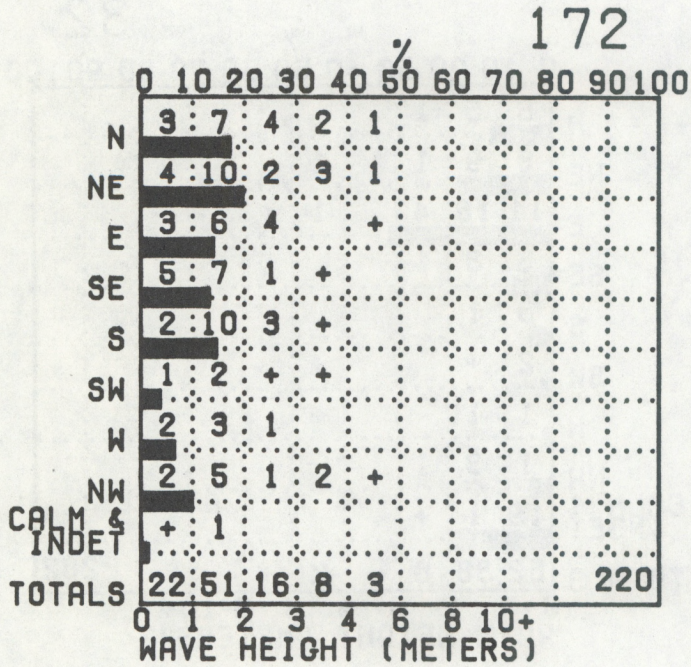


Table 7 (continued)
Month: February Squares: 74, 78, 132, 135

WAVE DIRECTION AND HEIGHT







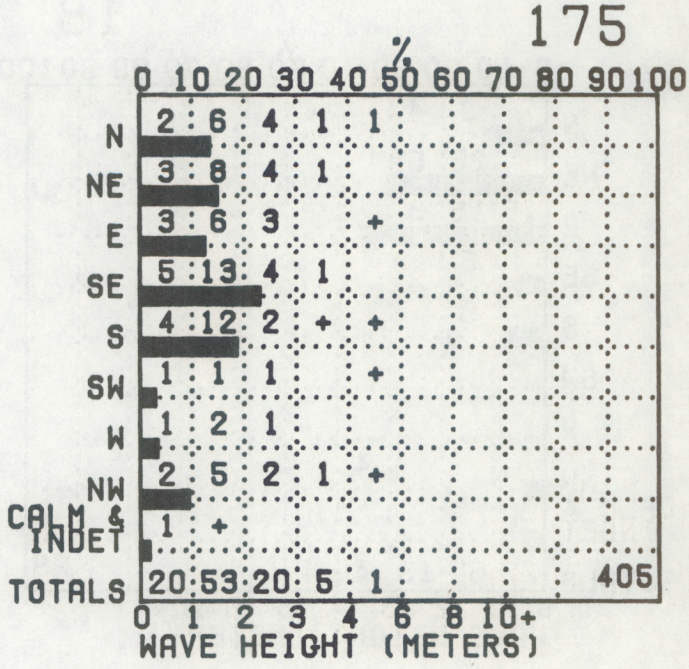
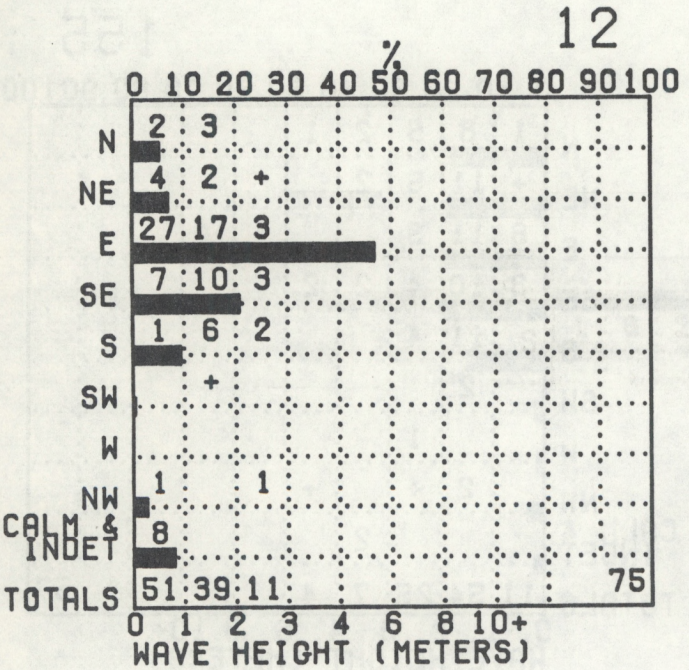
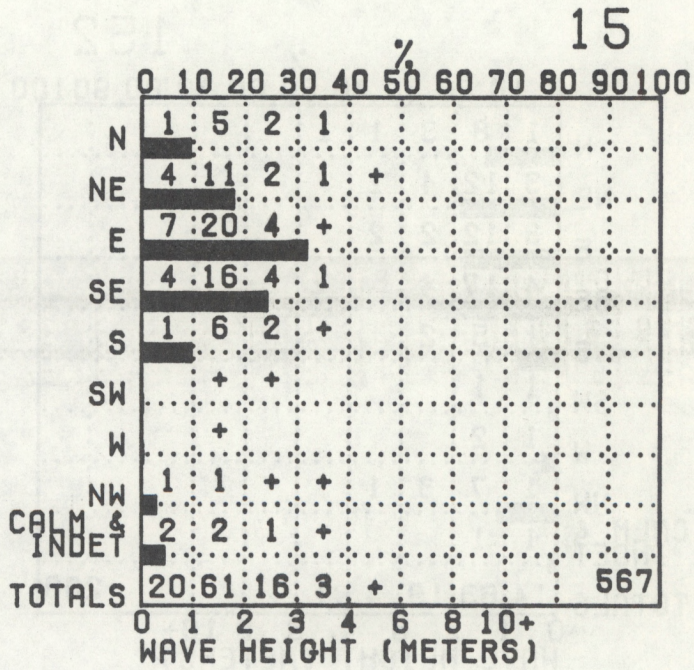
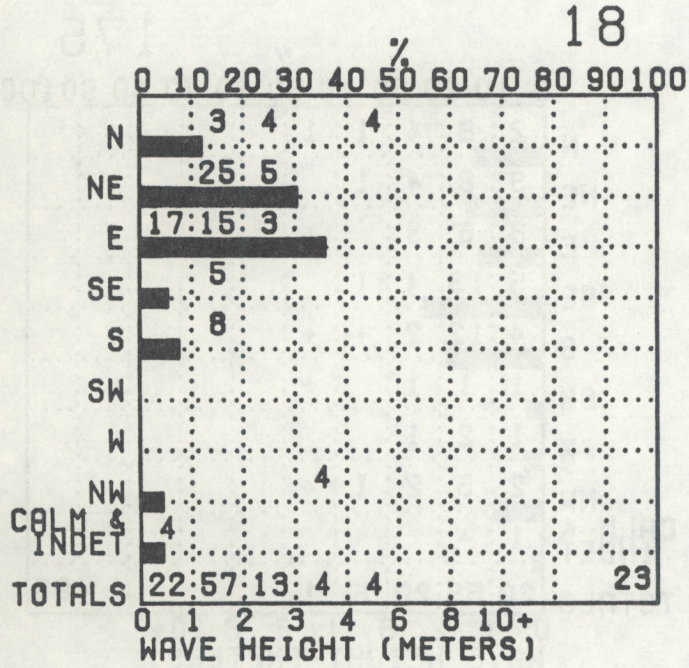


Table 7 (continued)
Month: February Squares: 152, 155, 172, 175

WAVE DIRECTION AND HEIGHT







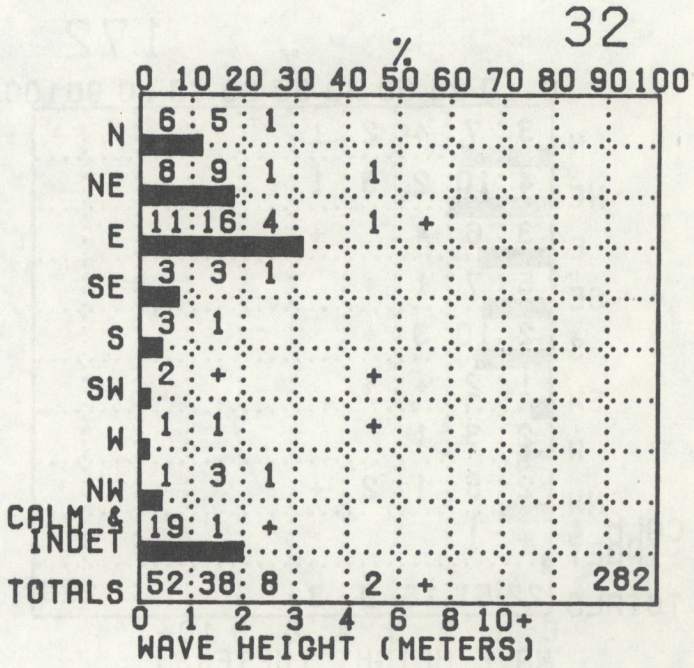
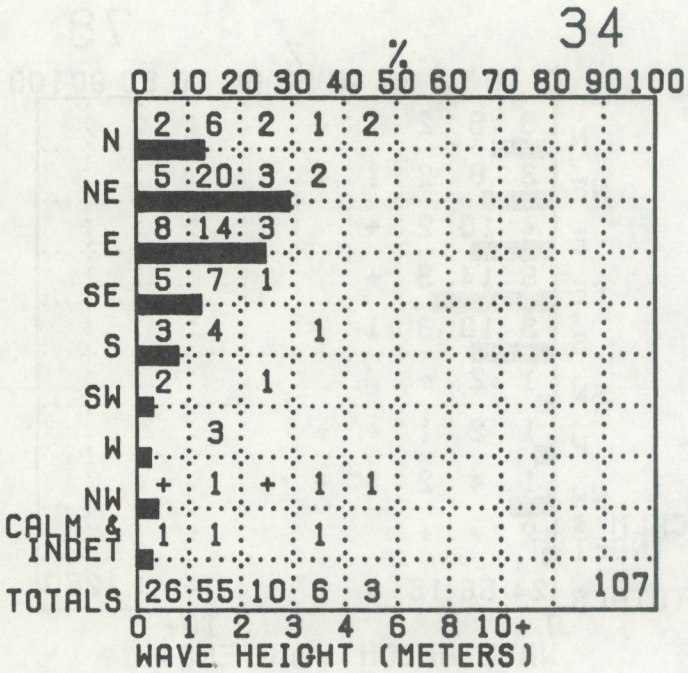
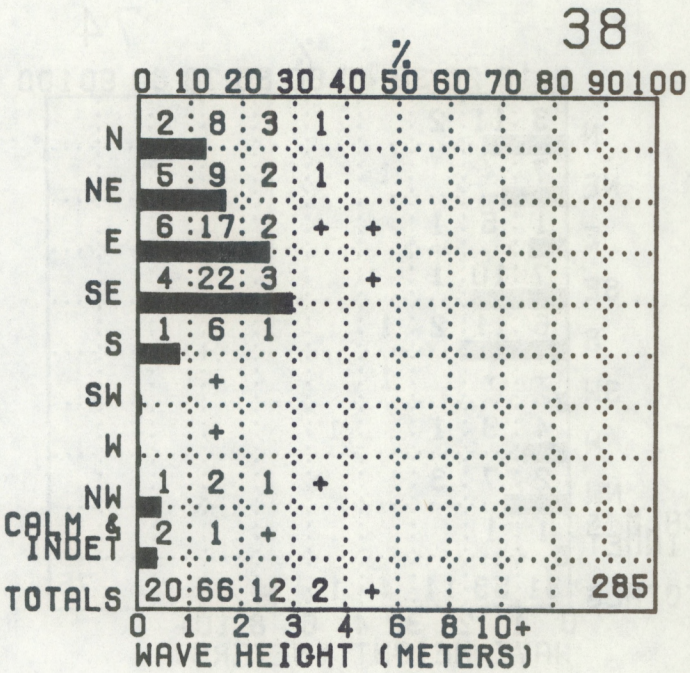
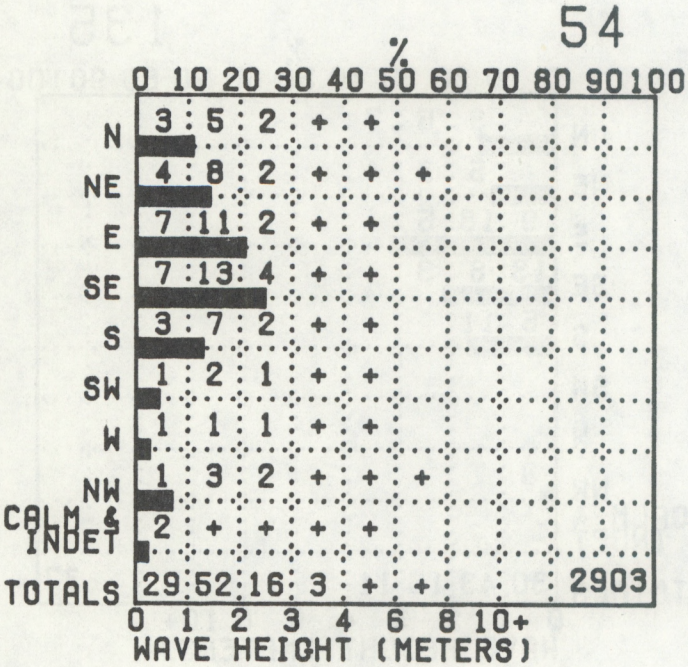


Table 7 (continued)
Month: March Squares: 12, 15, 18, 32

WAVE DIRECTION AND HEIGHT







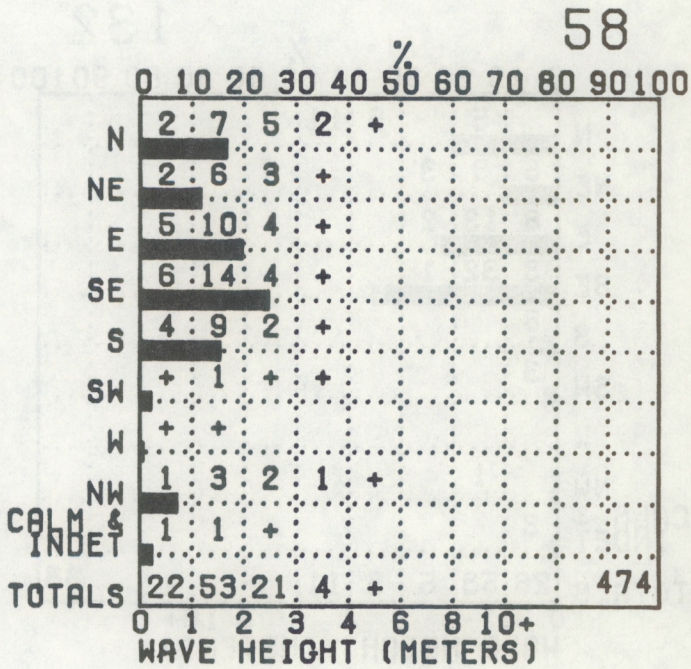


Table 7 (continued)
Month: March Squares: 34, 38, 54, 58

WAVE DIRECTION AND HEIGHT

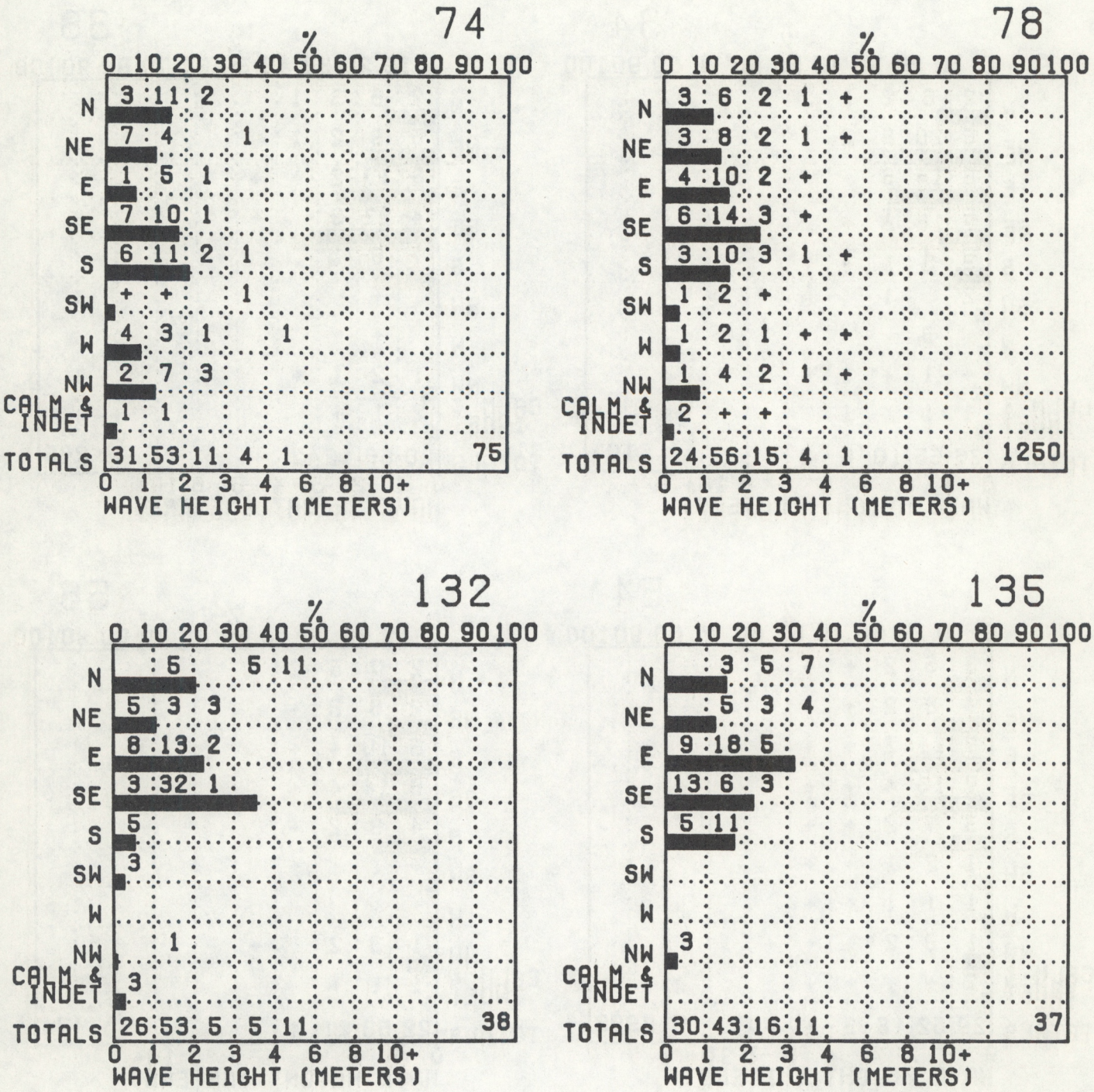
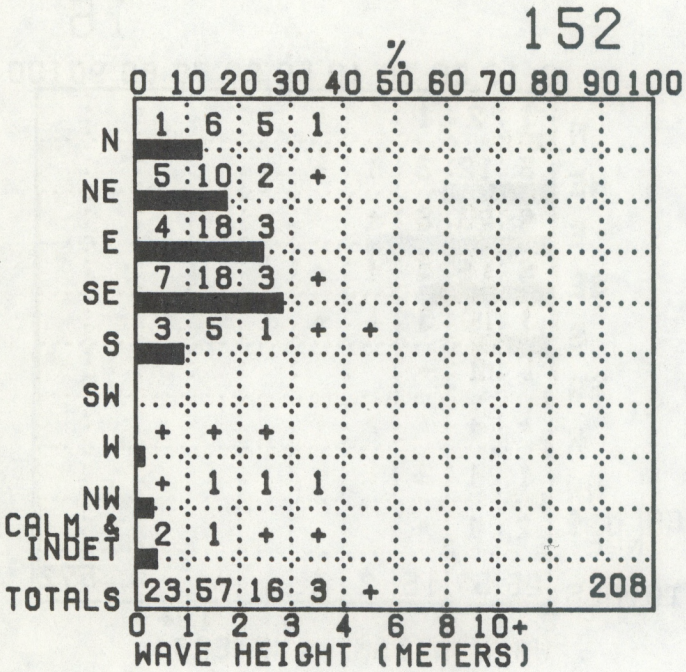
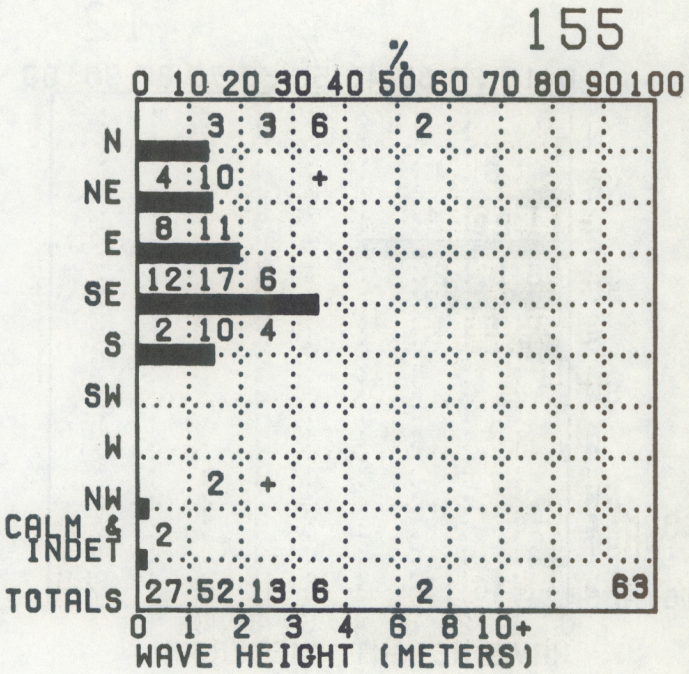
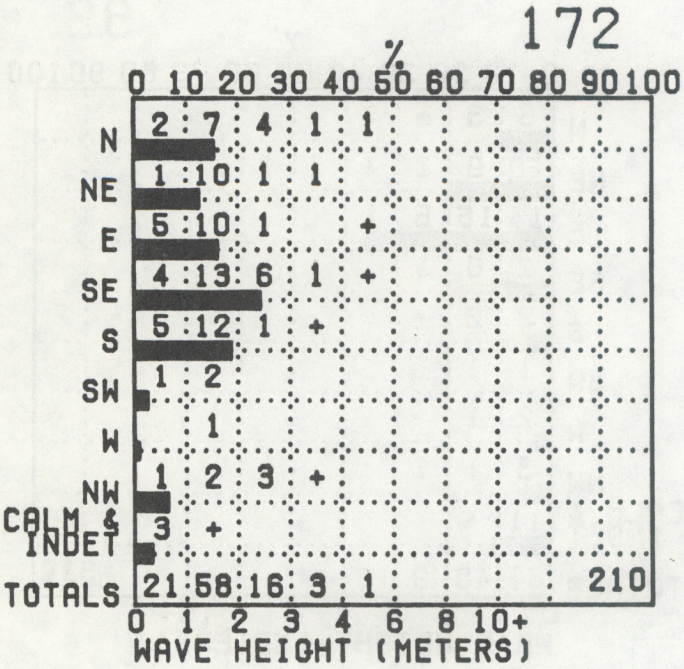


Table 7 (continued)
Month: March Squares: 74, 78, 132, 135

WAVE DIRECTION AND HEIGHT







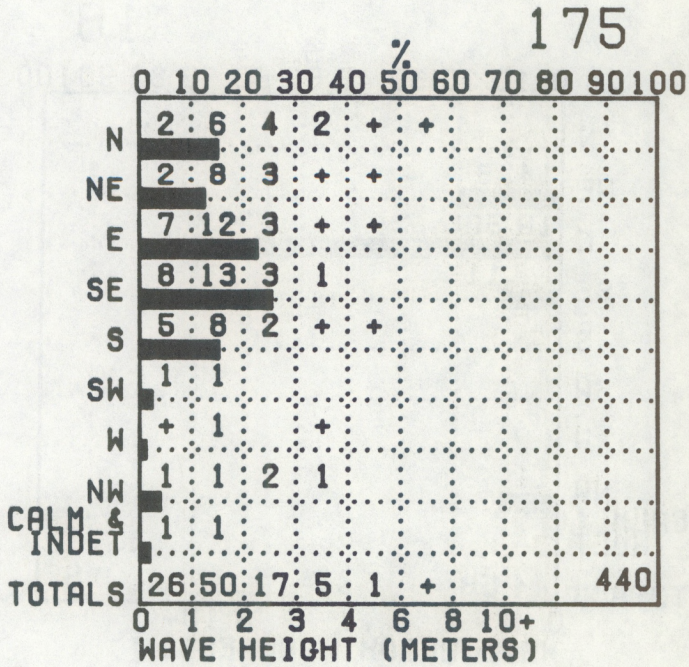
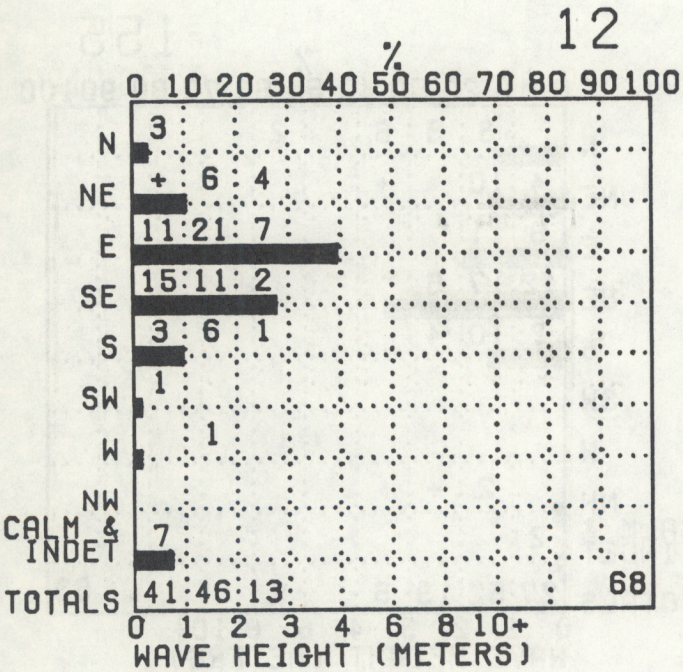
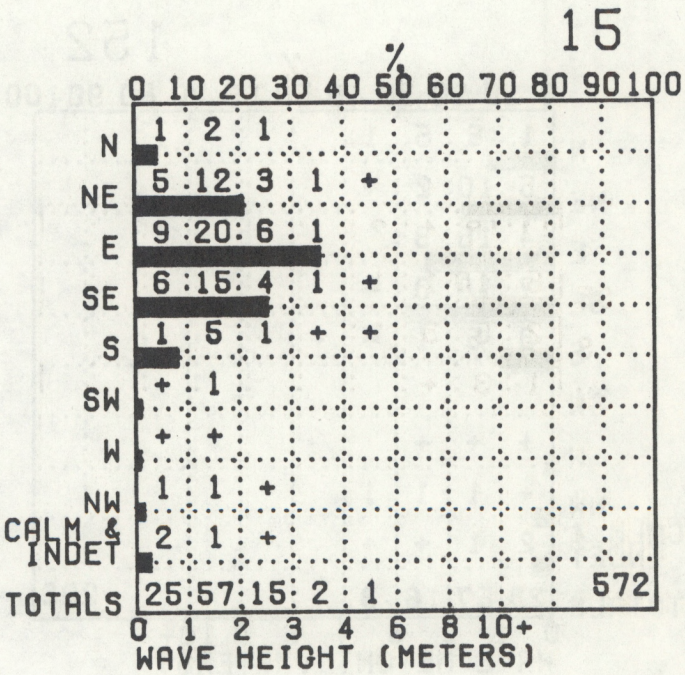
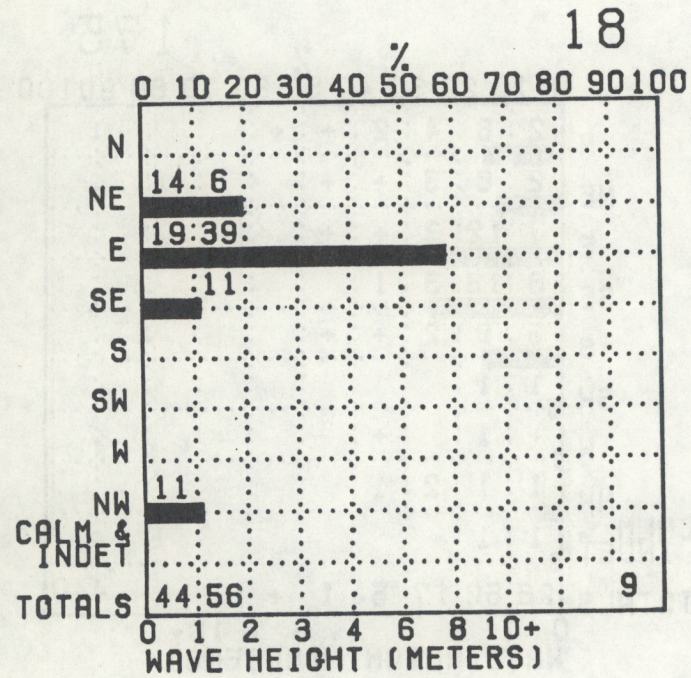


Table 7 (continued)
Month: March Squares: 152, 155, 172, 175

WAVE DIRECTION AND HEIGHT







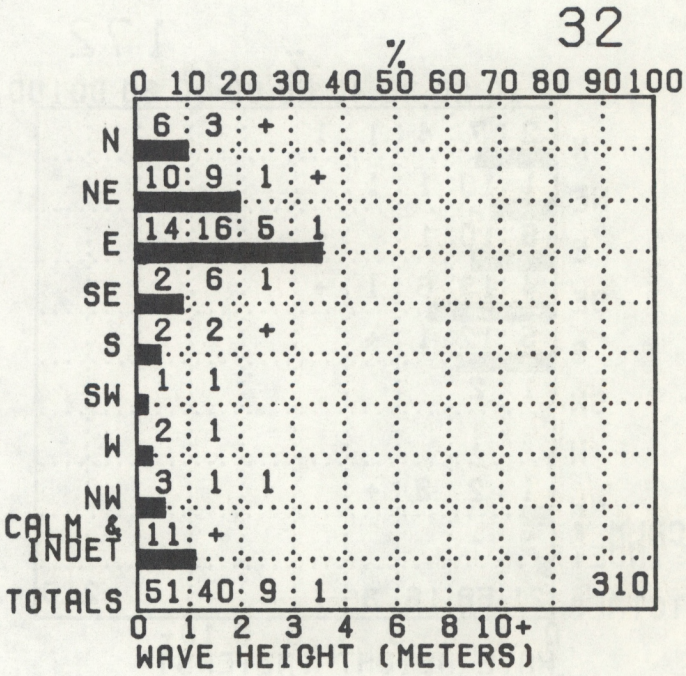
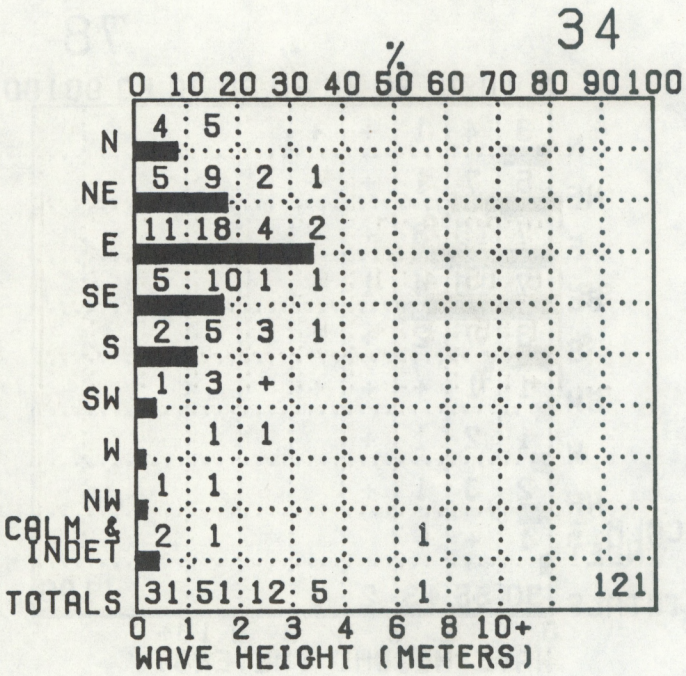
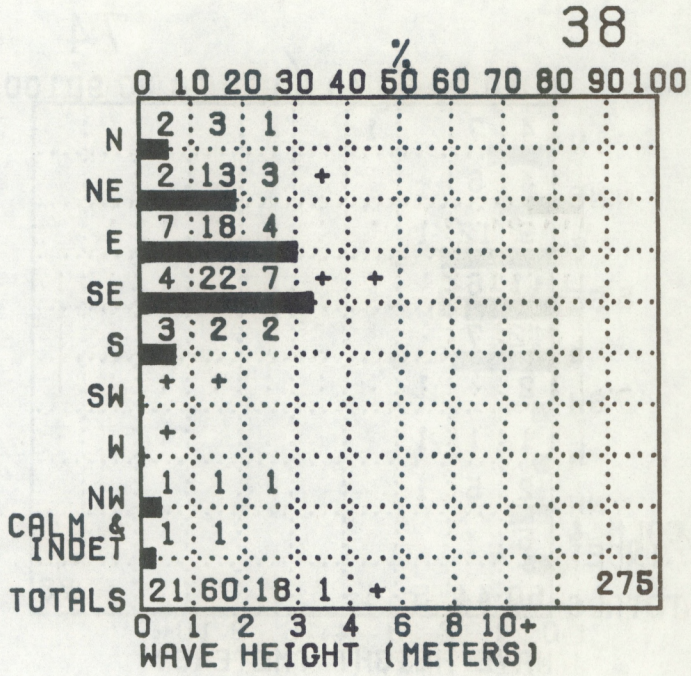
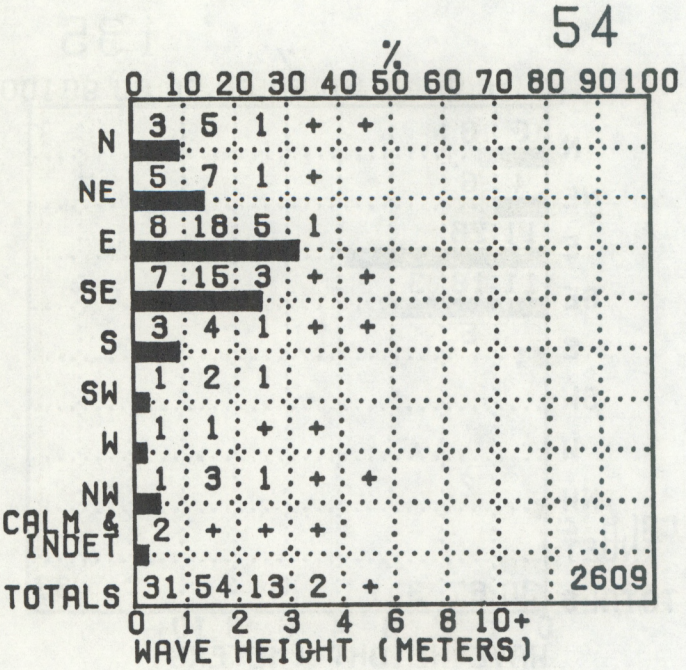


Table 7 (continued)
Month: April Squares: 12, 15, 18, 32

WAVE DIRECTION AND HEIGHT







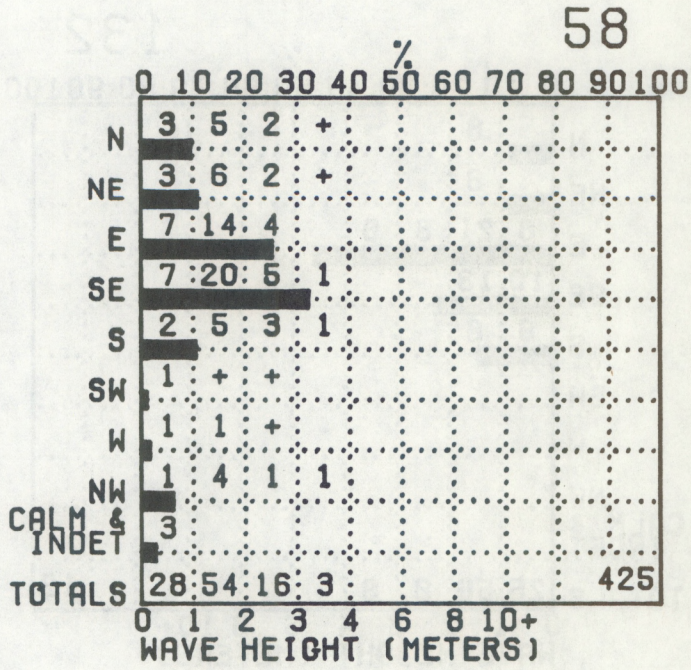
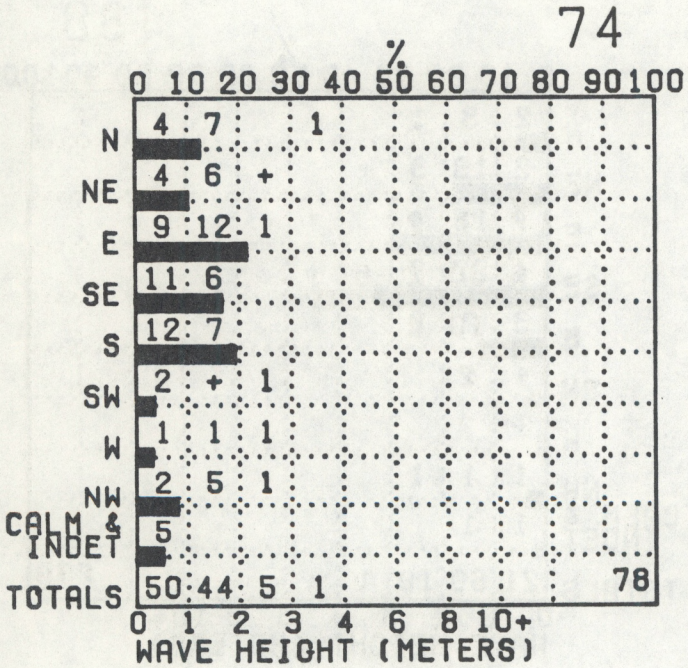
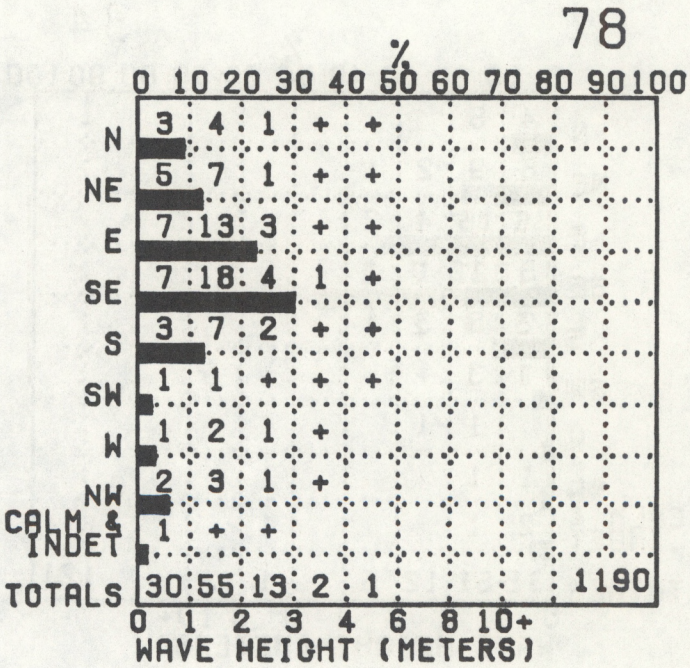
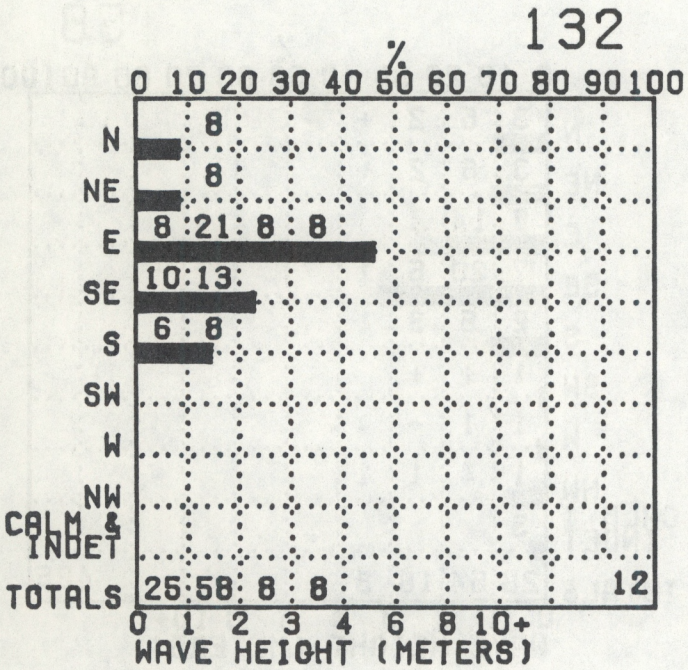


Table 7 (continued)
Month: April Squares: 34, 38, 54, 58

WAVE DIRECTION AND HEIGHT







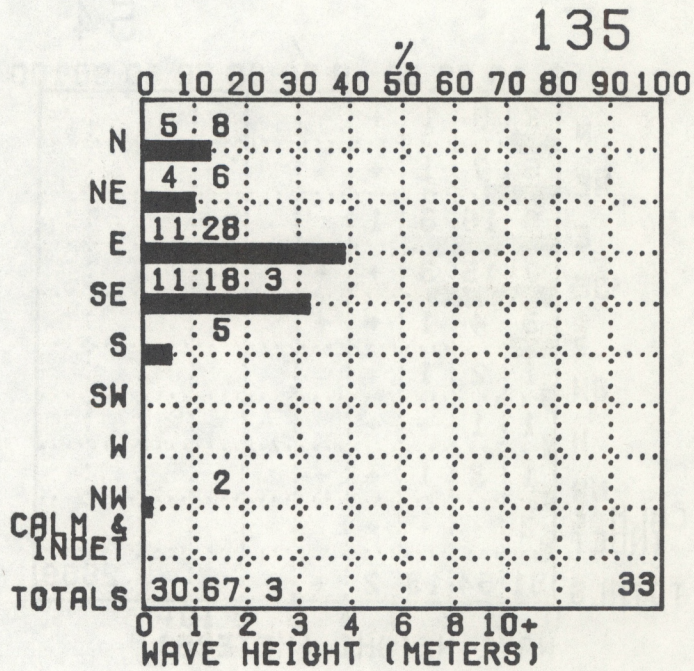
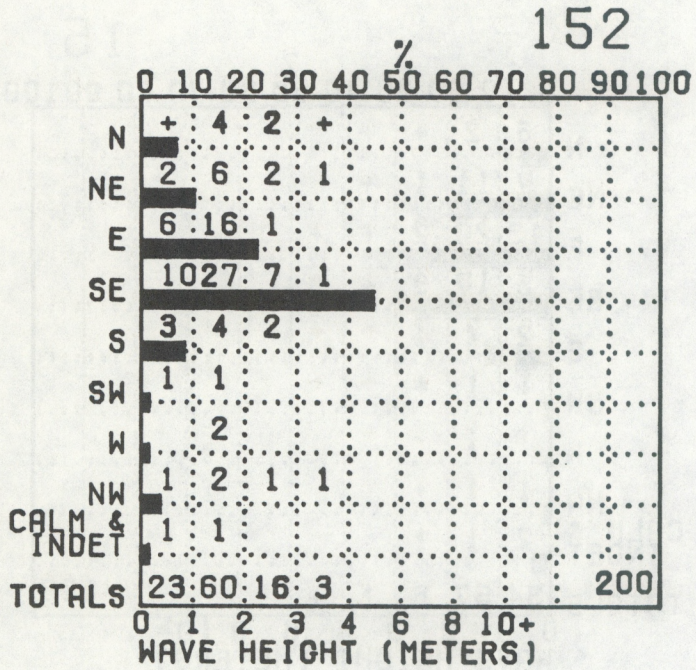
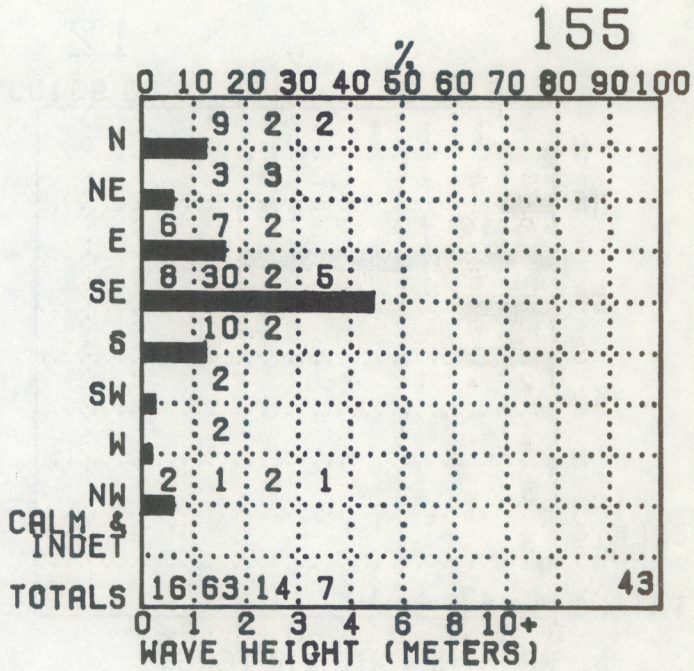
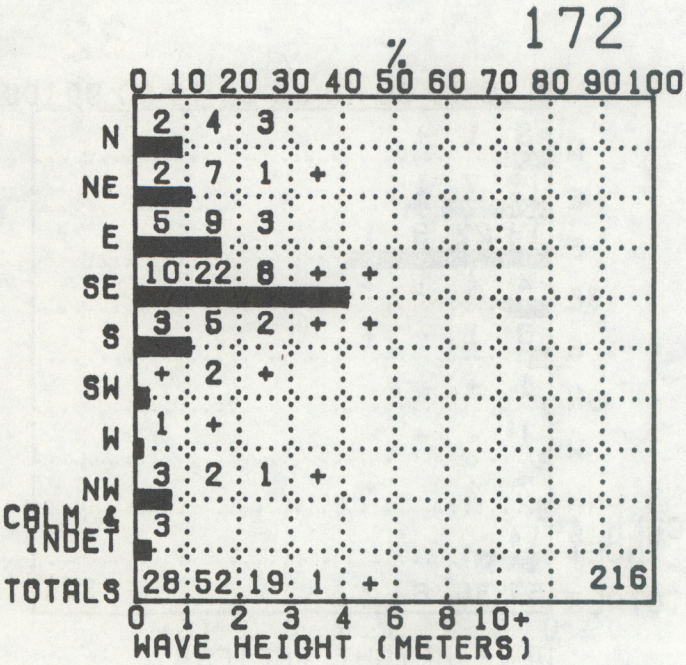


Table 7 (continued)
Month: April Squares: 74, 78, 132, 135

WAVE DIRECTION AND HEIGHT







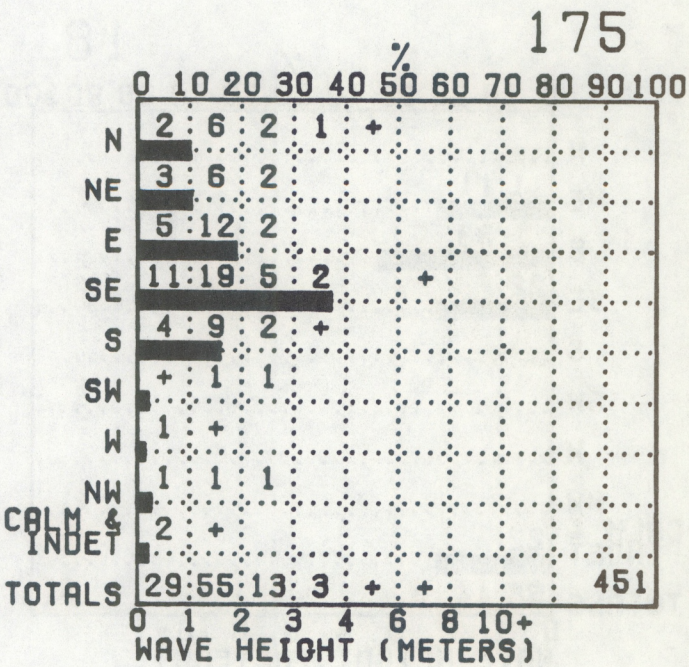
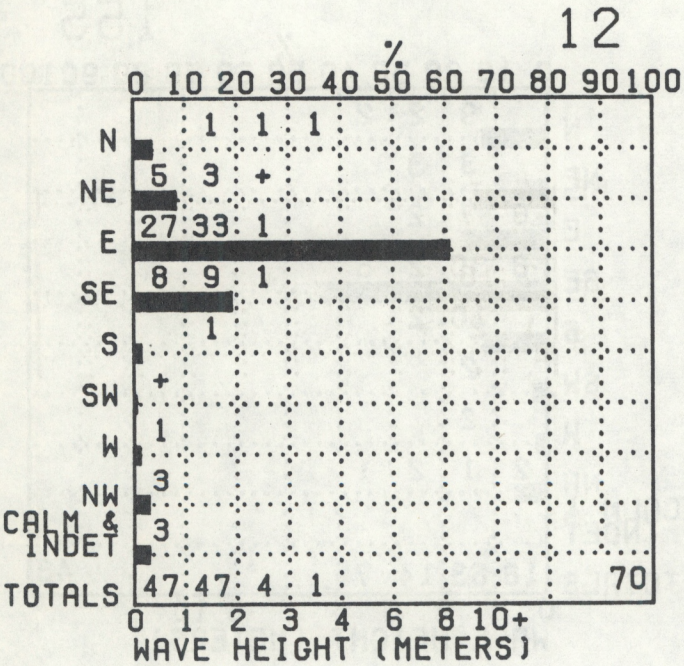
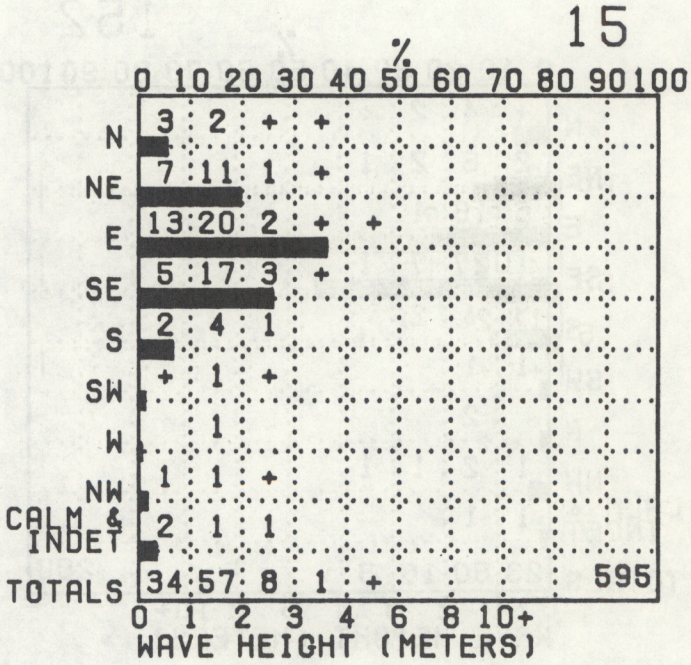
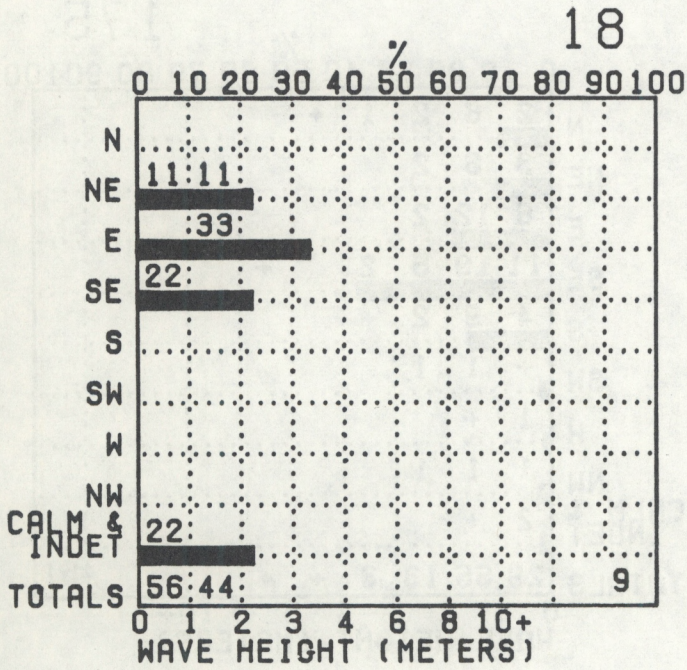


Table 7 (continued)
Month: April Squares: 152, 155, 172, 175

WAVE DIRECTION AND HEIGHT







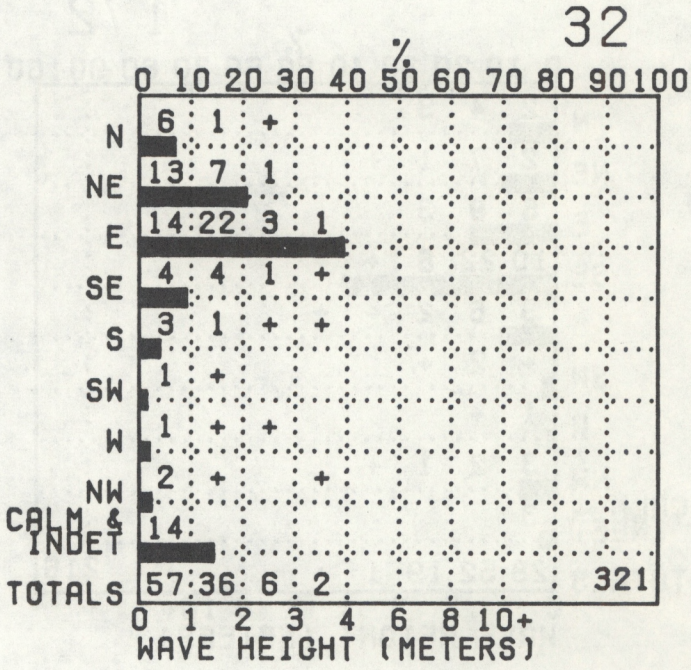
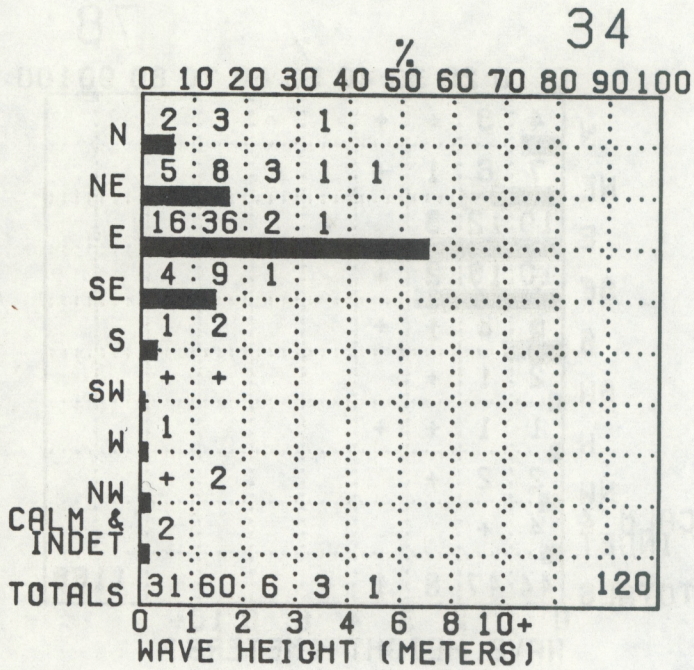
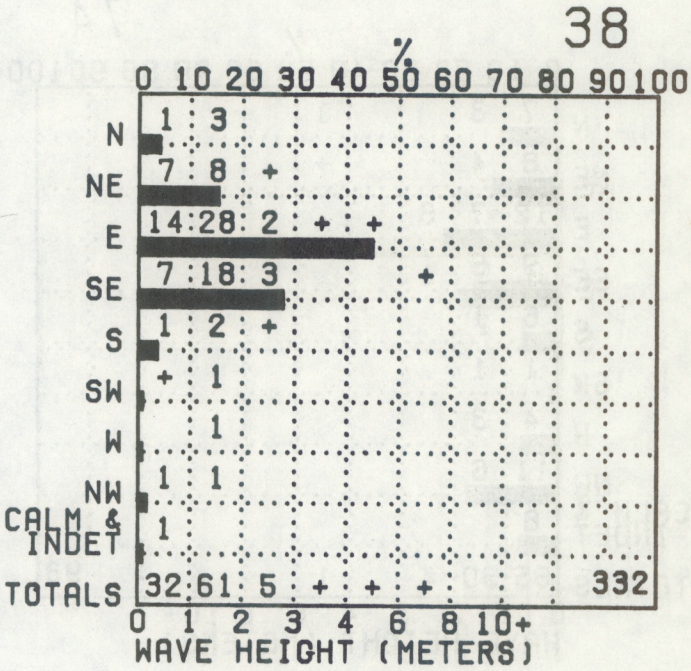
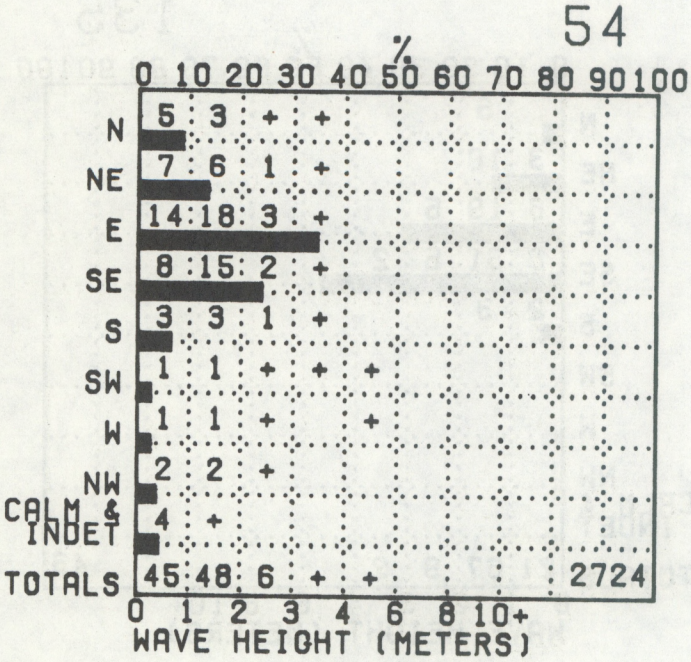


Table 7 (continued)
Month: May Squares: 12, 15, 18, 32

WAVE DIRECTION AND HEIGHT







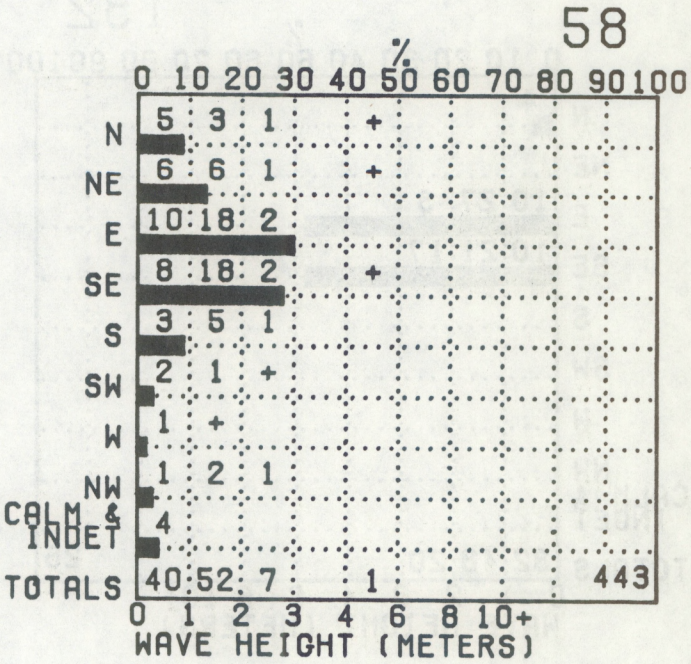
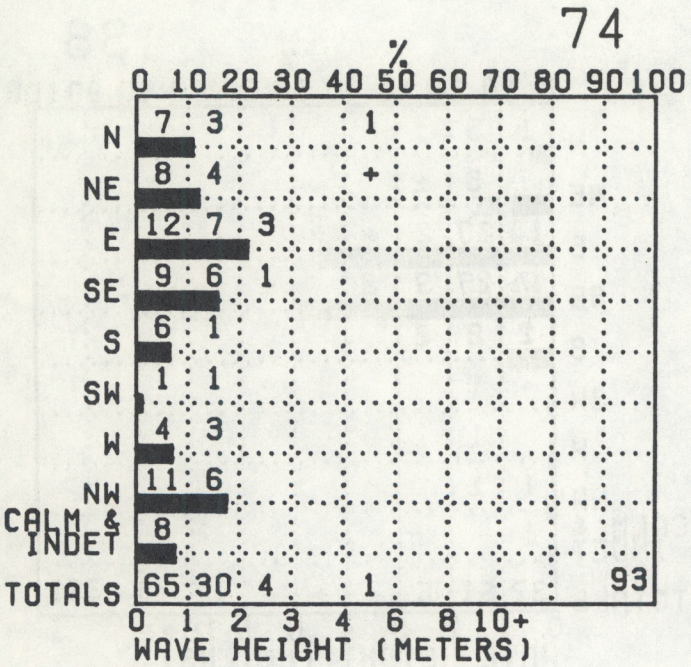
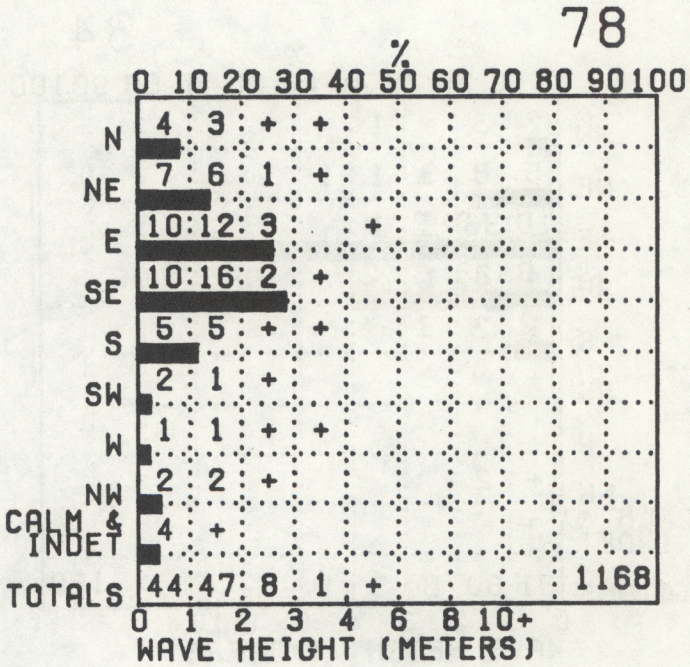
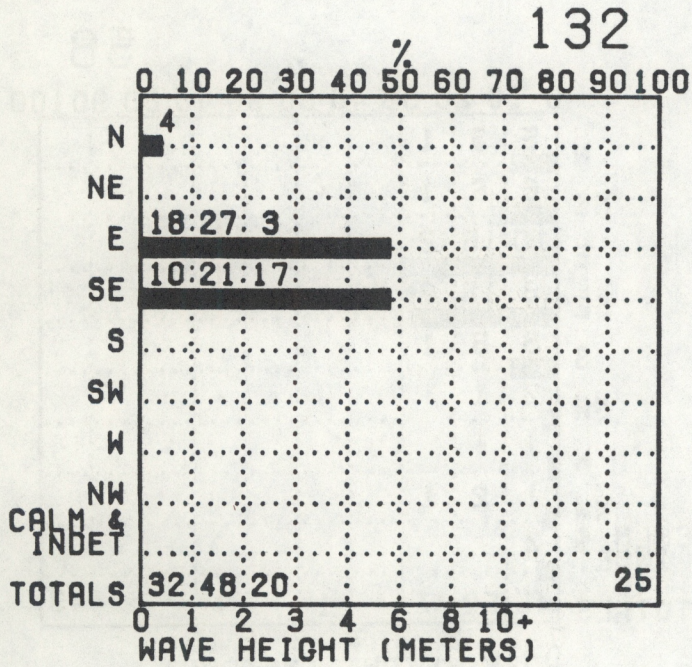


Table 7 (continued)
Month: May Squares: 34, 38, 54, 58

WAVE DIRECTION AND HEIGHT







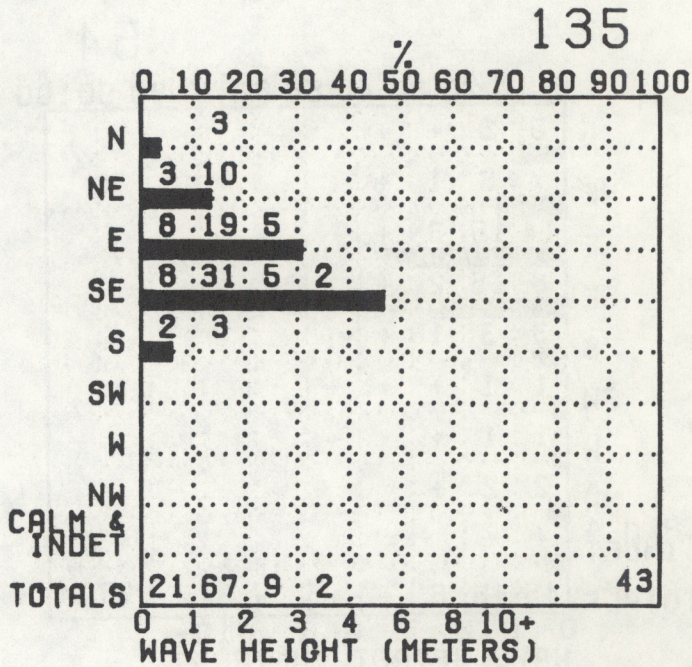
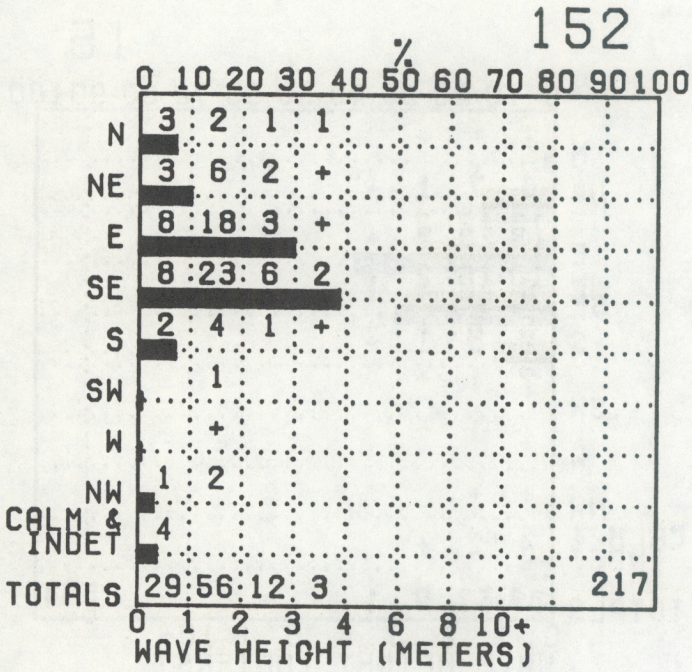
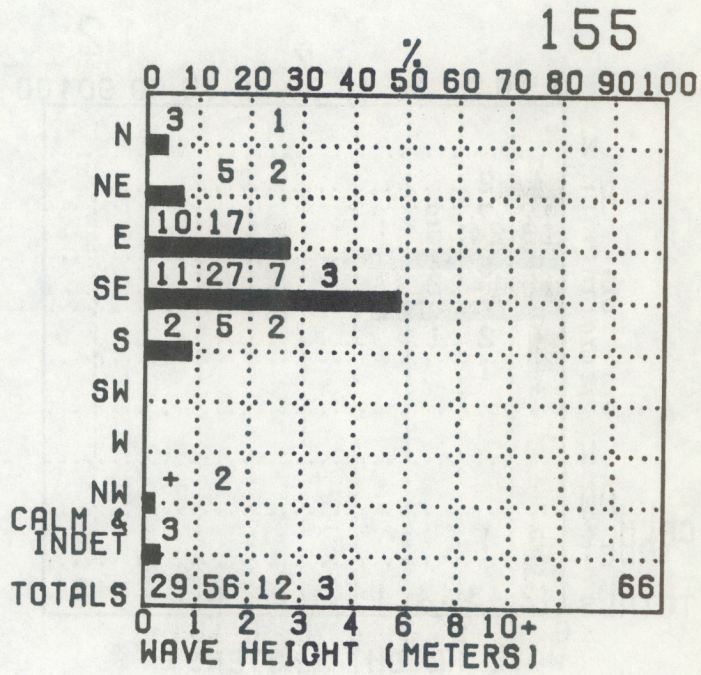
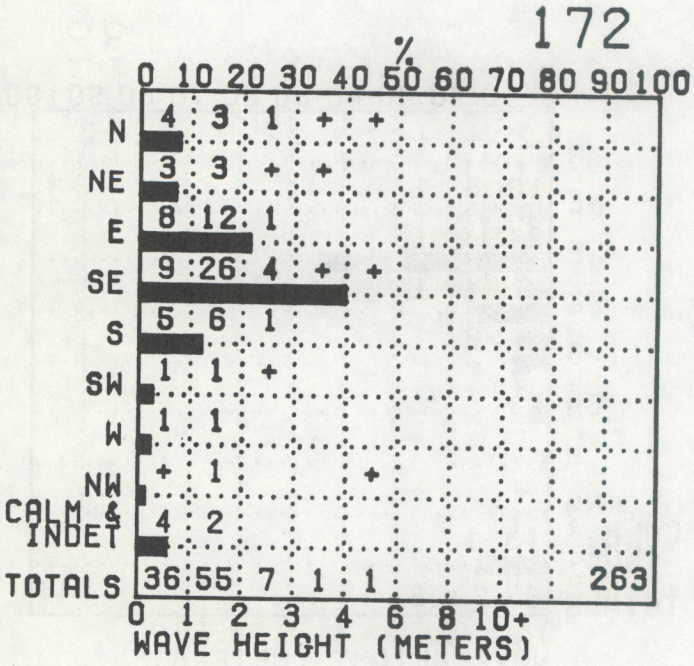


Table 7 (continued)
Month: May Squares: 74, 78, 132, 135

WAVE DIRECTION AND HEIGHT







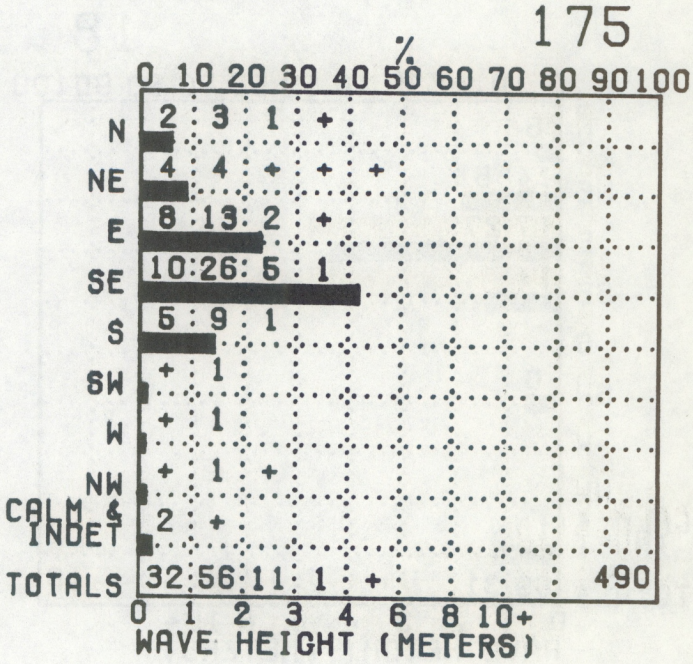
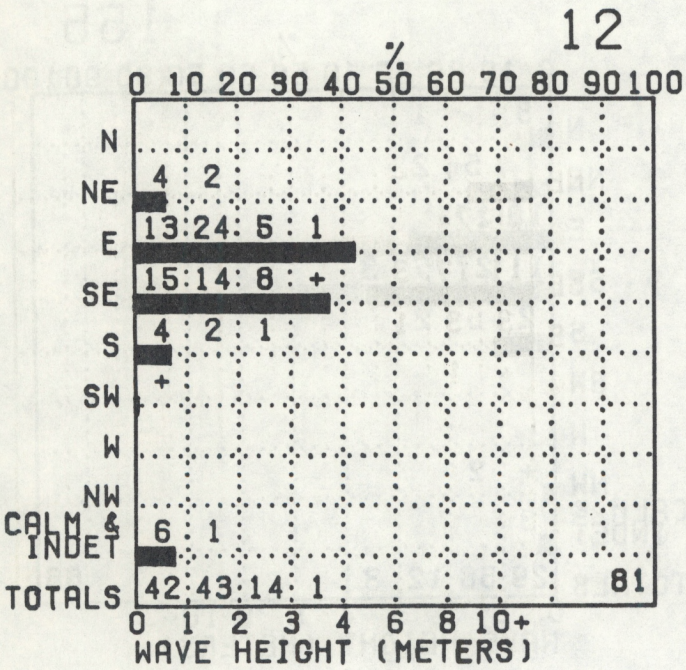
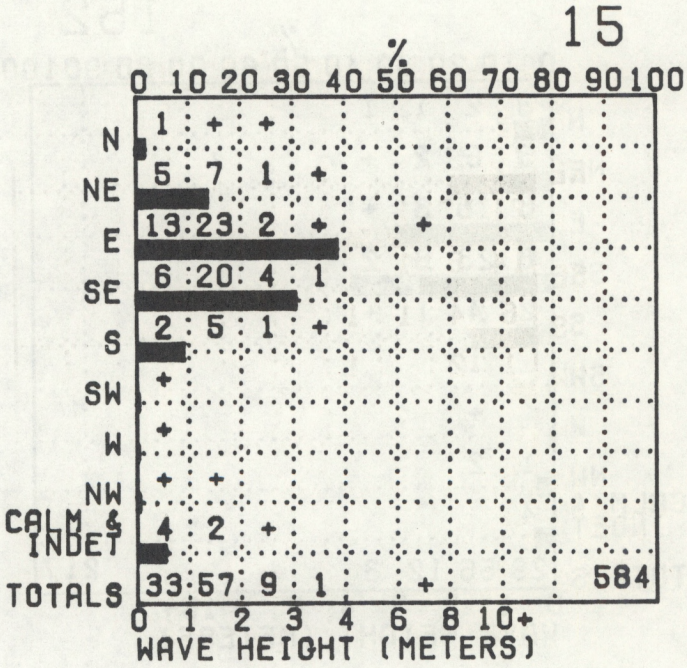
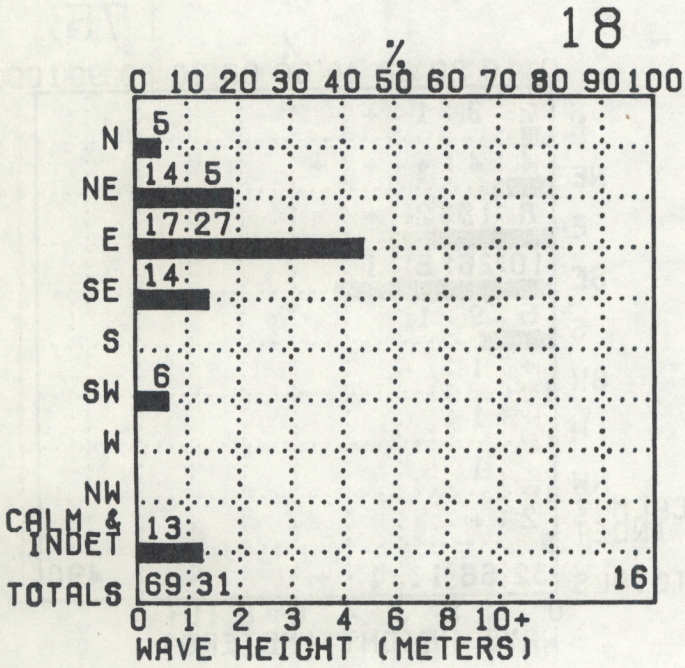


Table 7 (continued)
Month: May Squares: 152, 155, 172, 175

WAVE DIRECTION AND HEIGHT







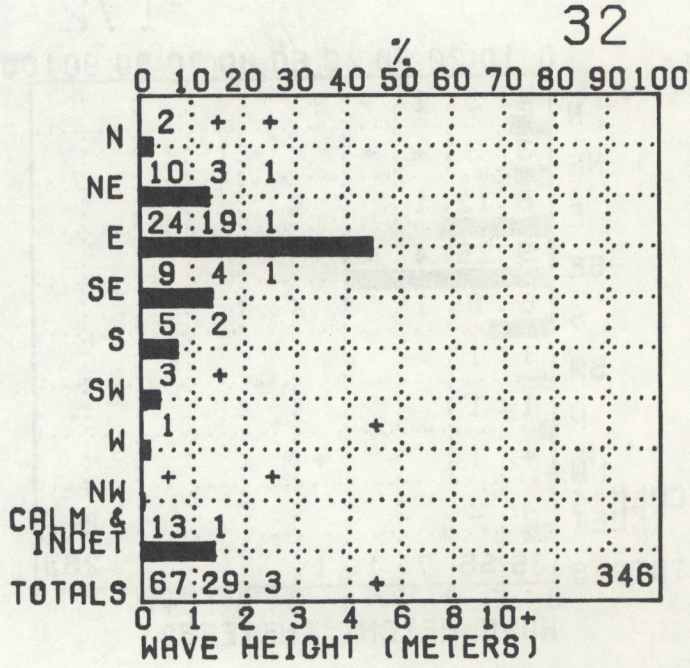
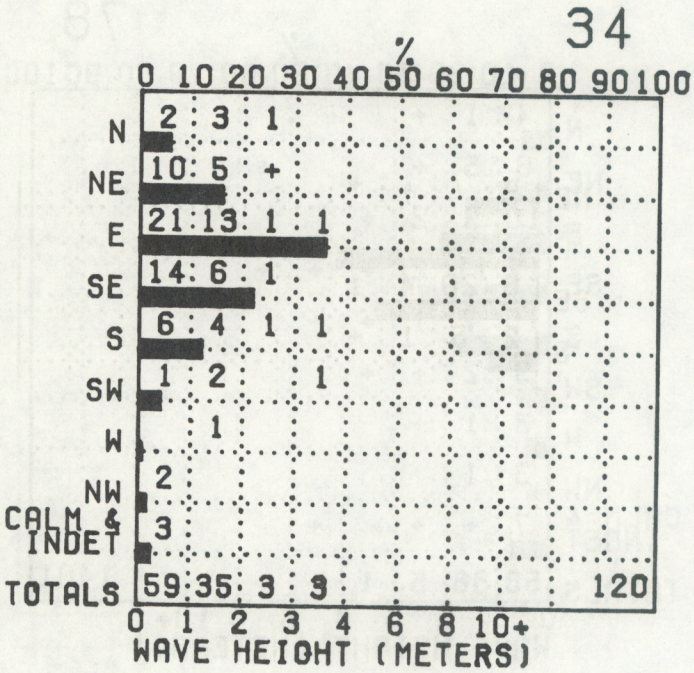
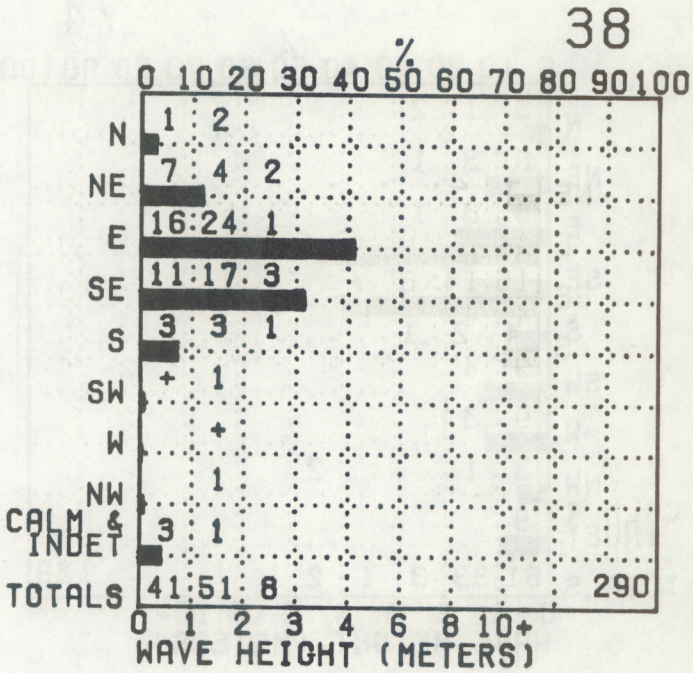
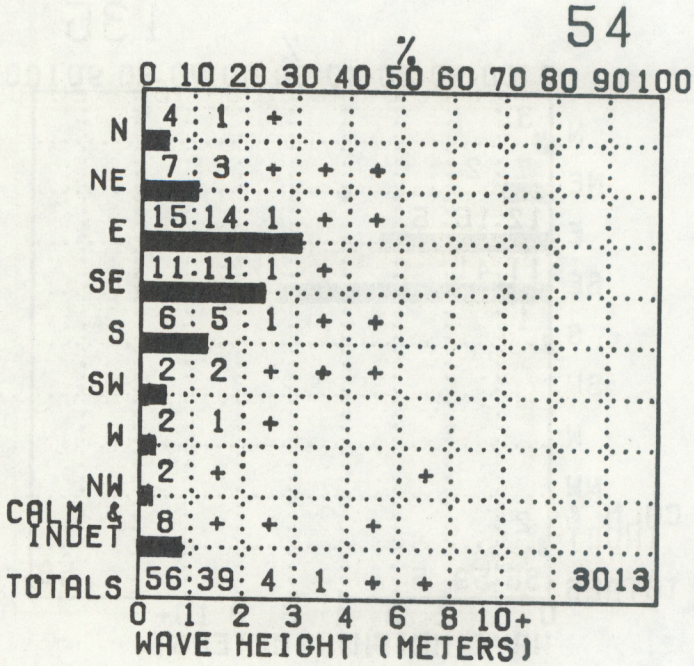


Table 7 (continued)
Month: June Squares: 12, 15, 18, 32

WAVE DIRECTION AND HEIGHT







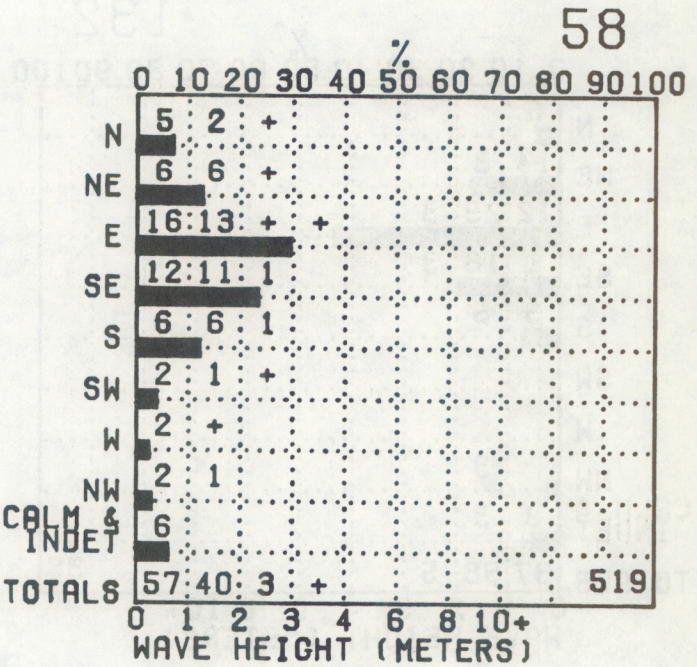
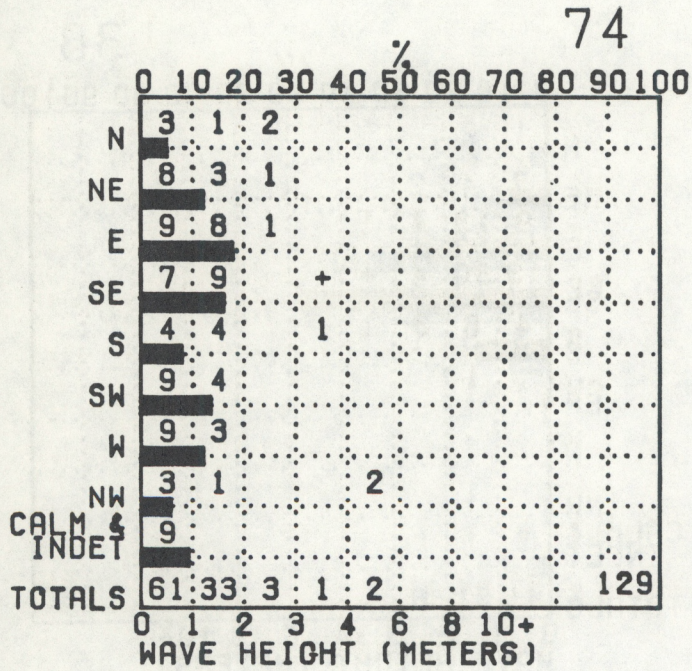
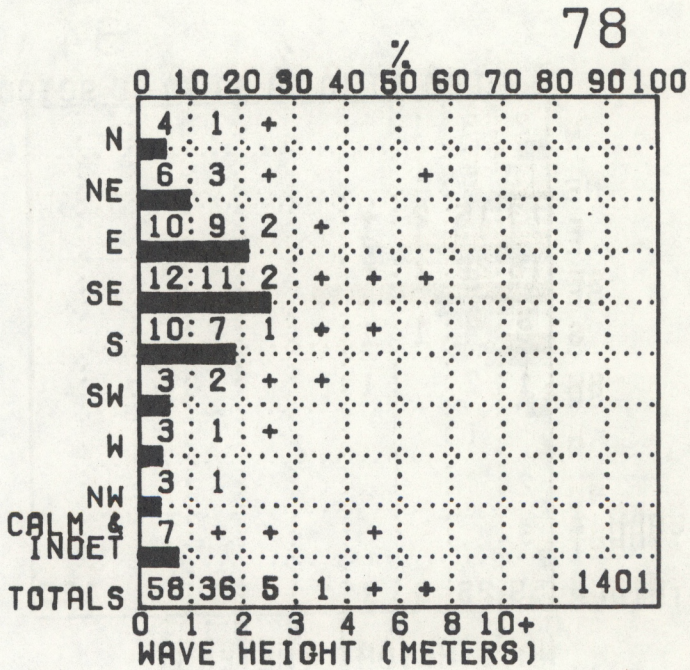
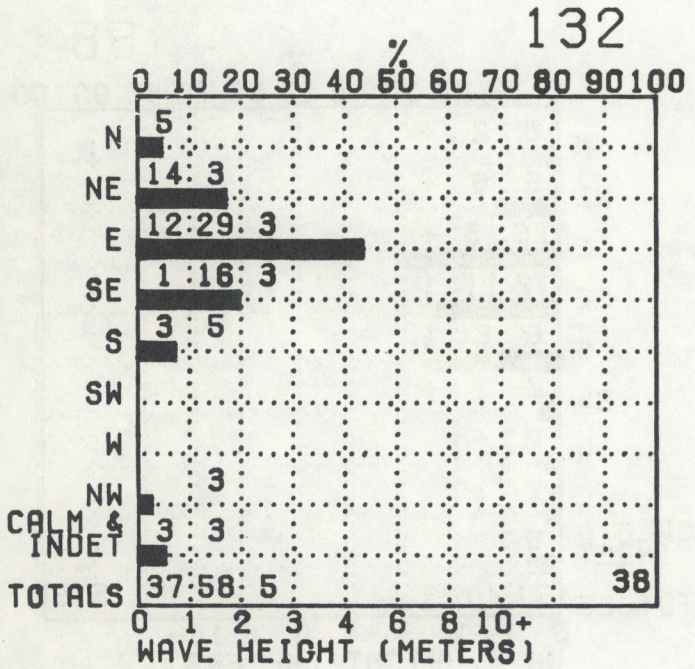


Table 7 (continued)
Month: June Squares: 34, 38, 54, 58

WAVE DIRECTION AND HEIGHT







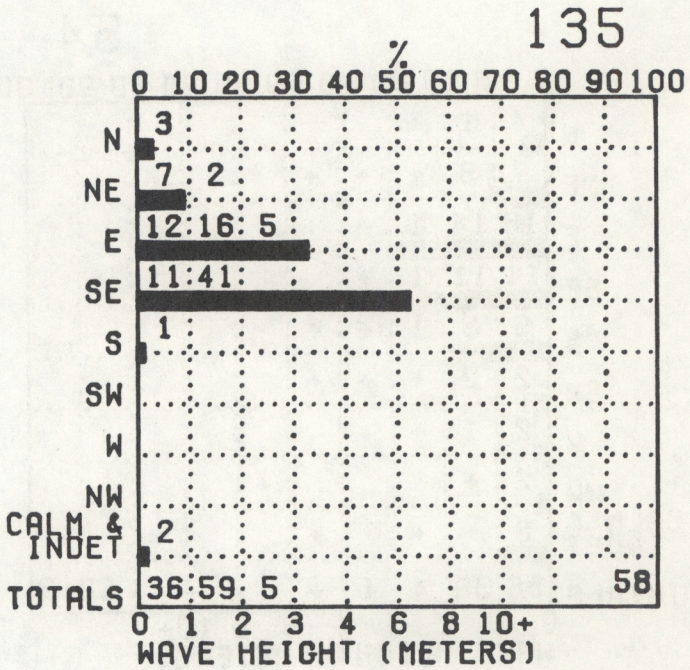
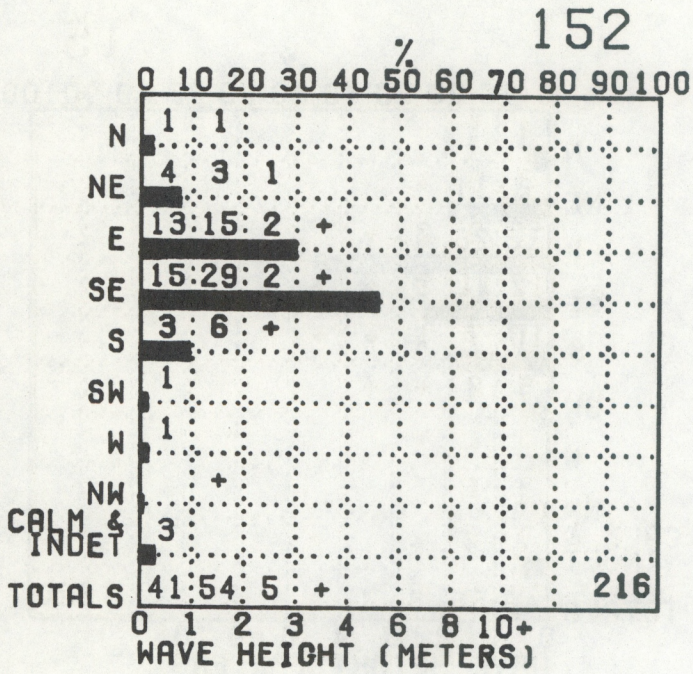
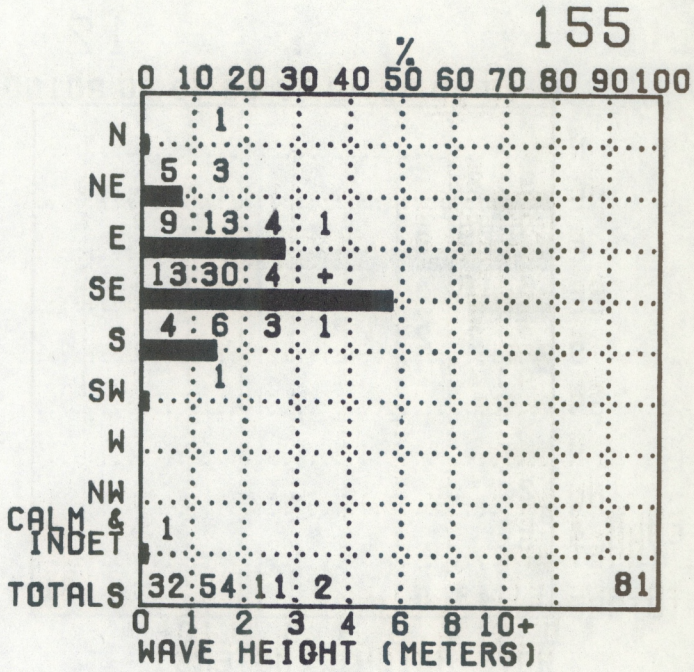
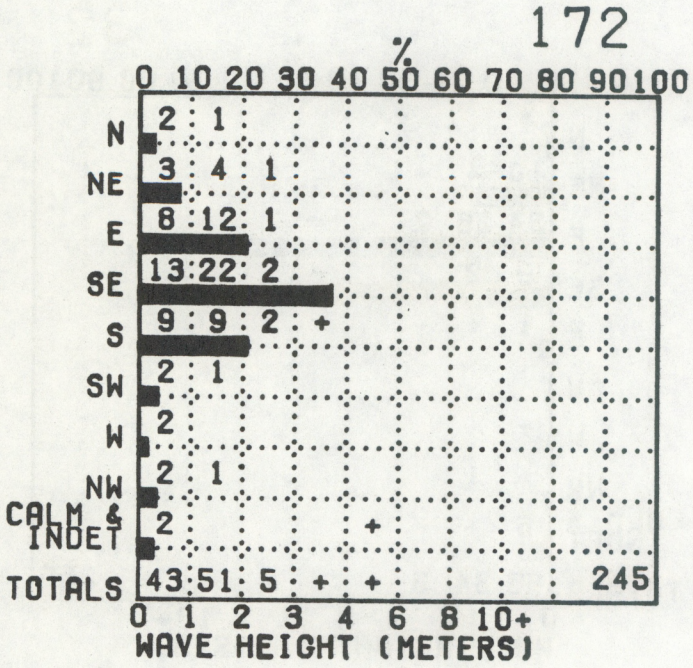


Table 7 (continued)
Month: June Squares: 74, 78, 132, 135

WAVE DIRECTION AND HEIGHT







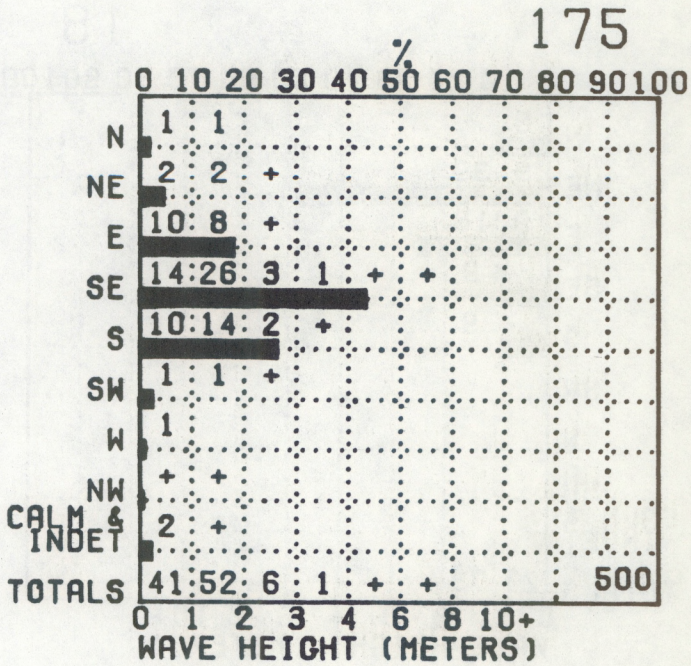
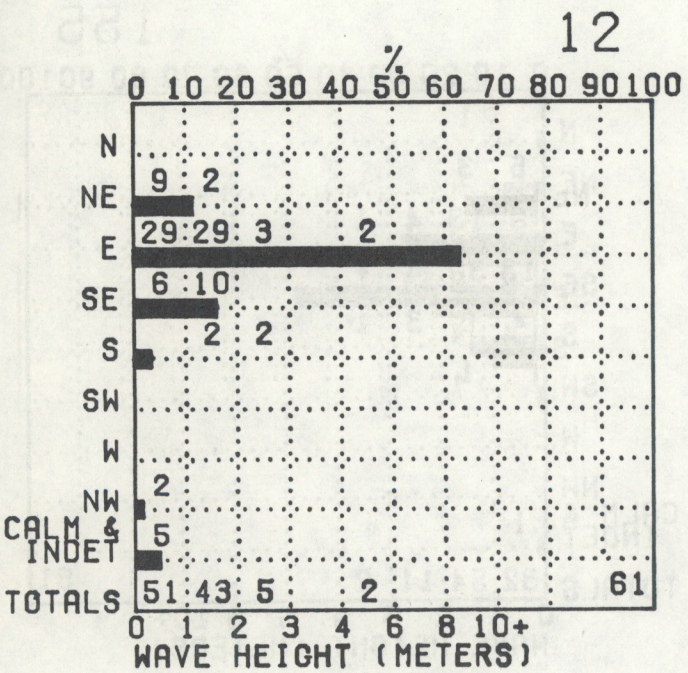
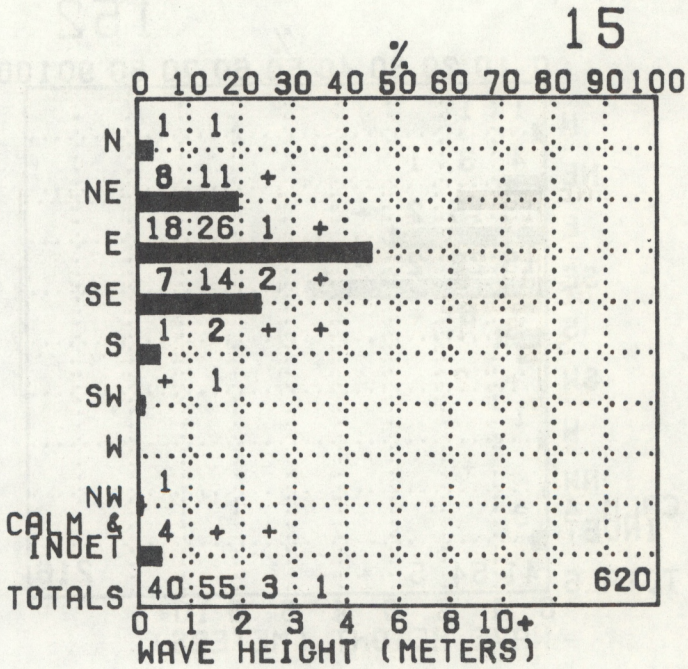
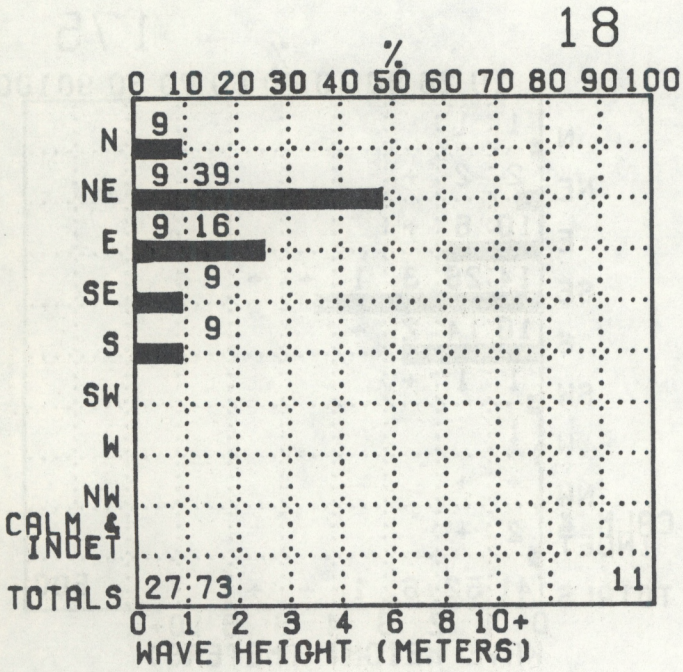


Table 7 (continued)
Month: June Squares: 152, 155, 172, 175

WAVE DIRECTION AND HEIGHT







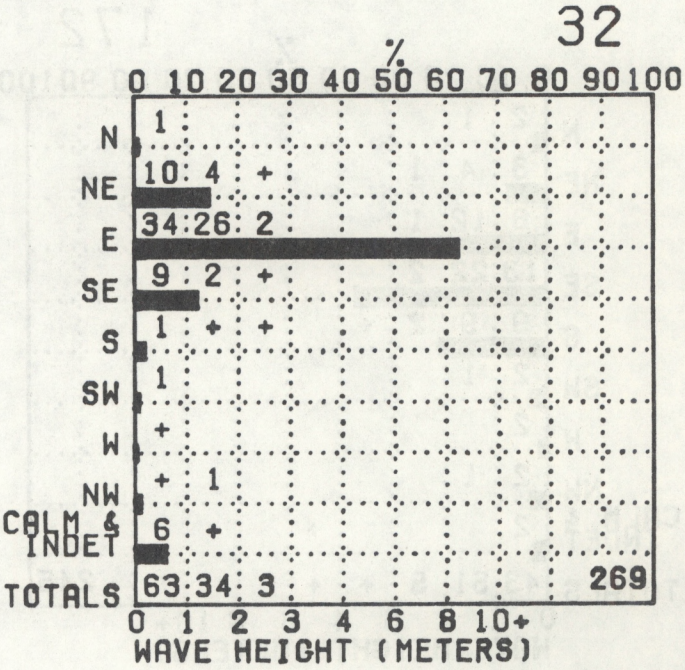
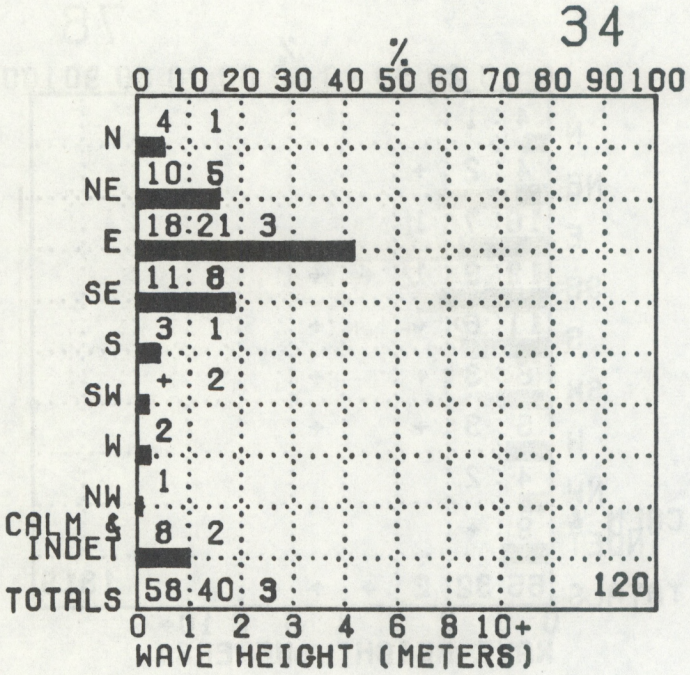
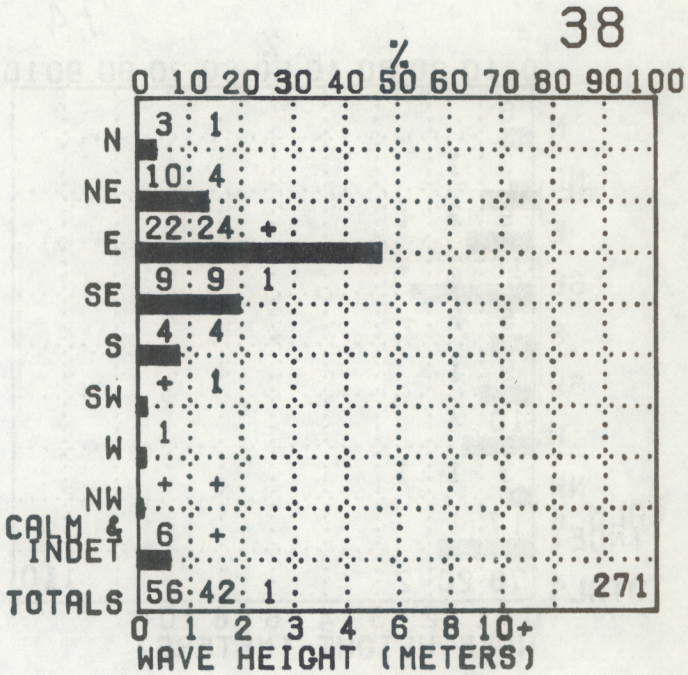
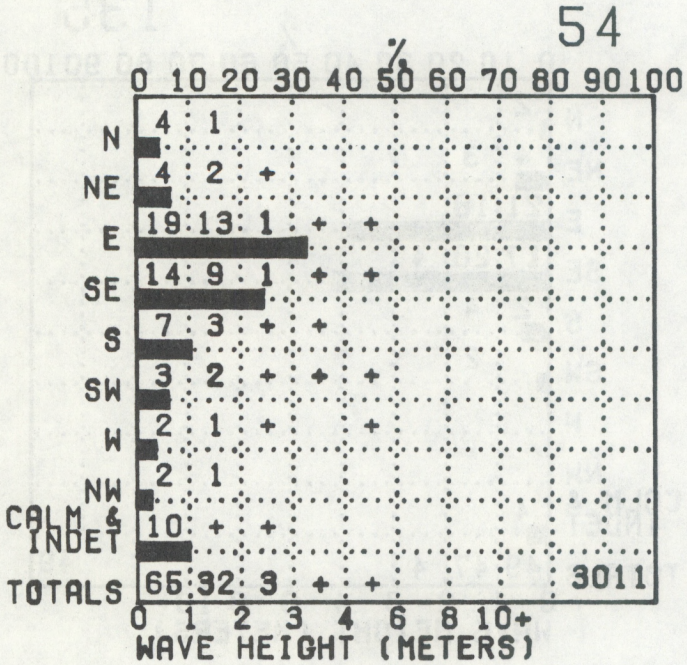


Table 7 (continued)
Month: July Squares: 12, 15, 18, 32

WAVE DIRECTION AND HEIGHT







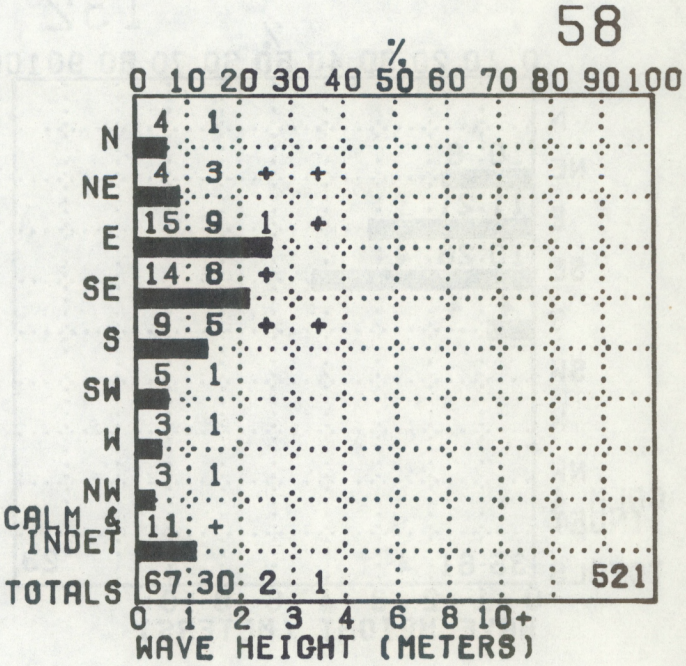
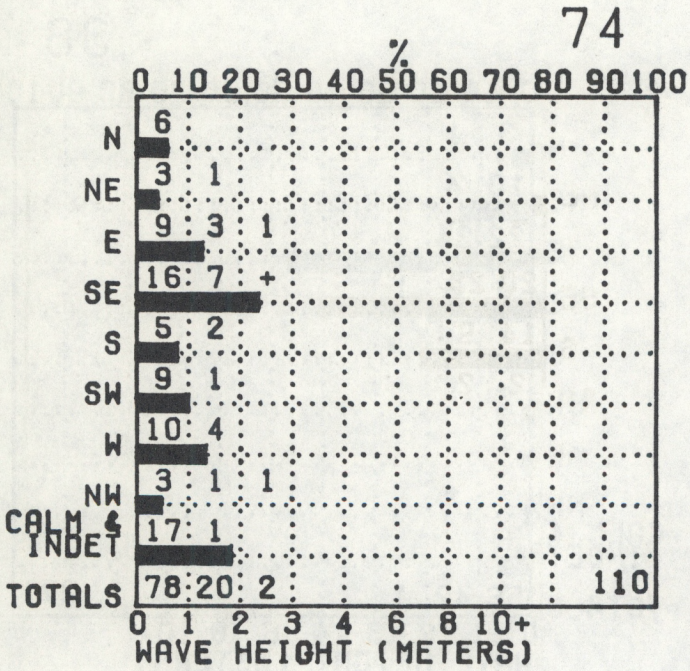
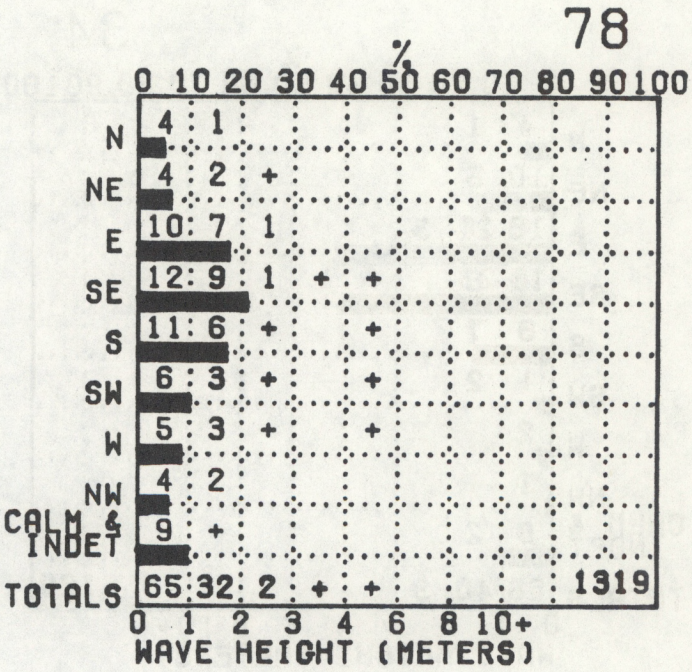
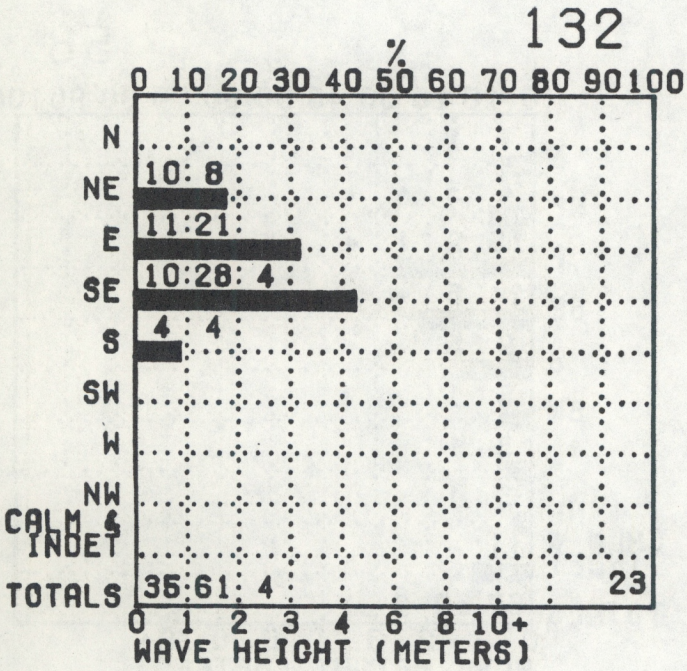


Table 7 (continued)
Month: July Squares: 34, 38, 54, 58

WAVE DIRECTION AND HEIGHT







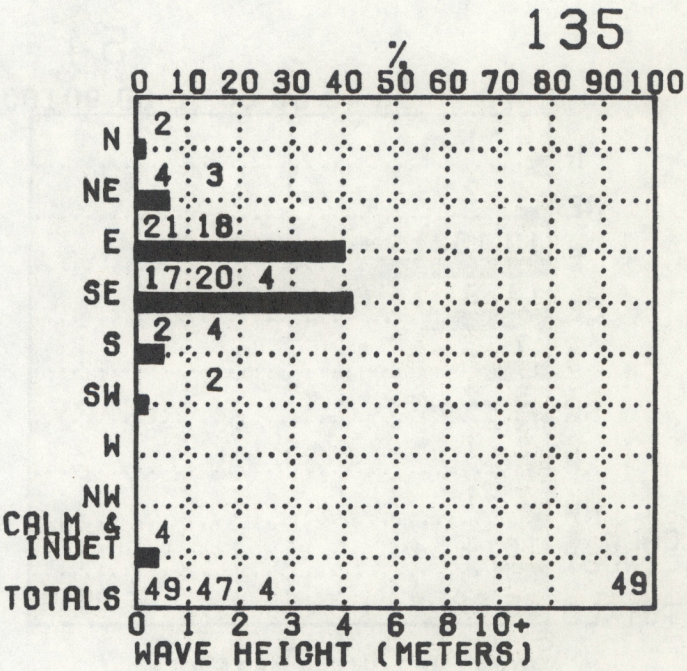
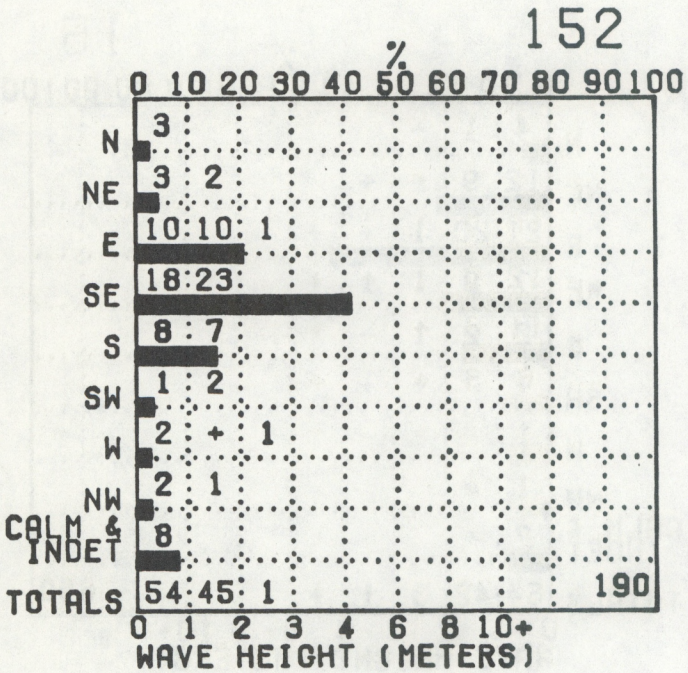
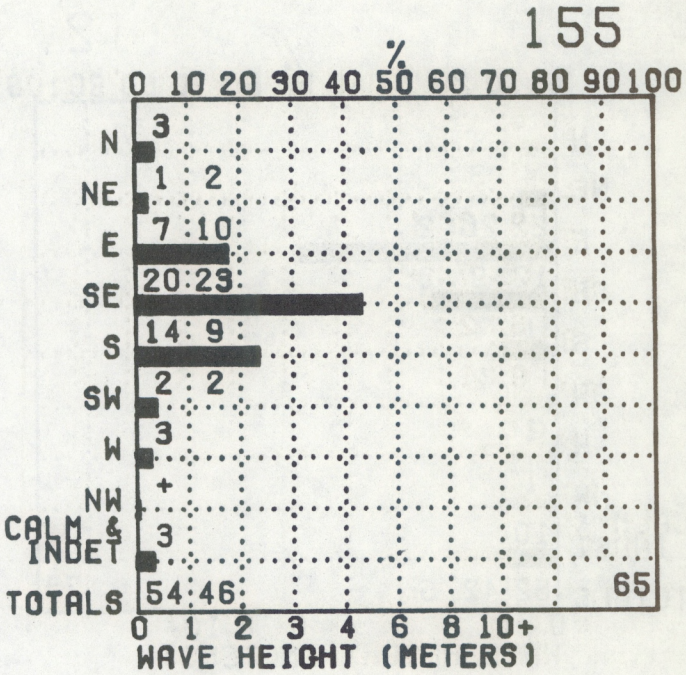
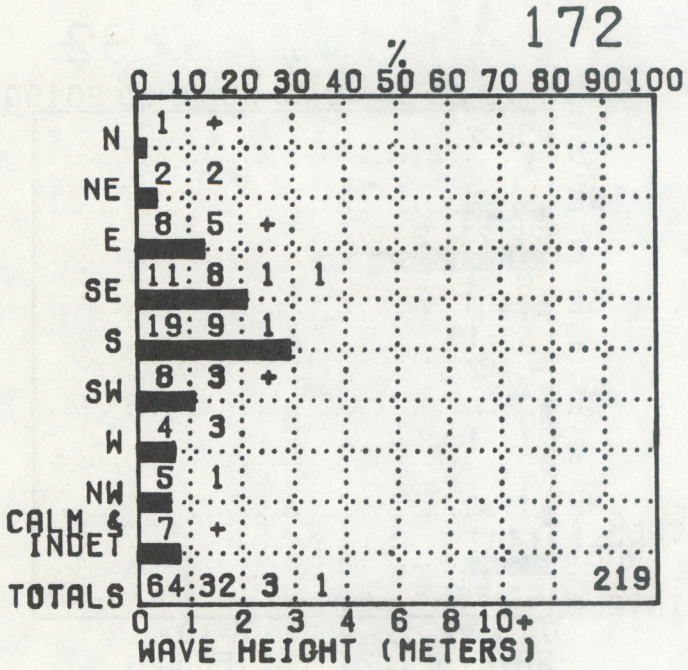


Table 7 (continued)
Month: July Squares: 74, 78, 132, 135

WAVE DIRECTION AND HEIGHT







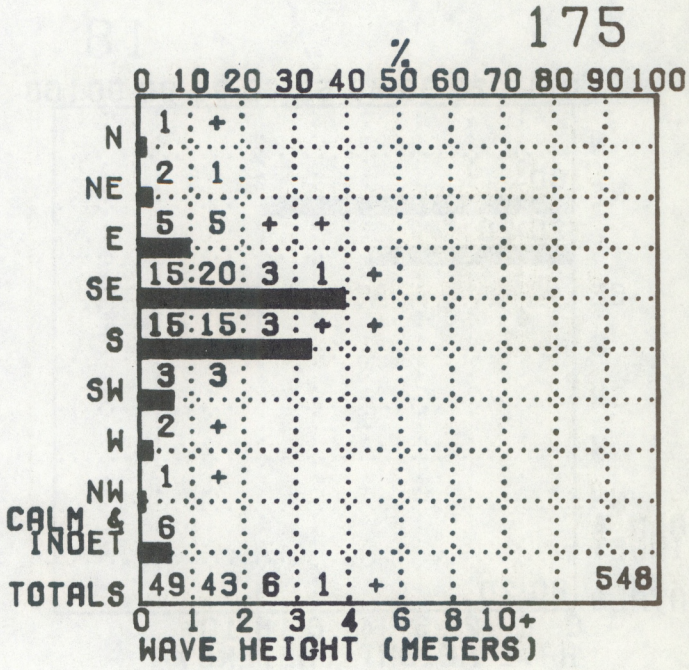
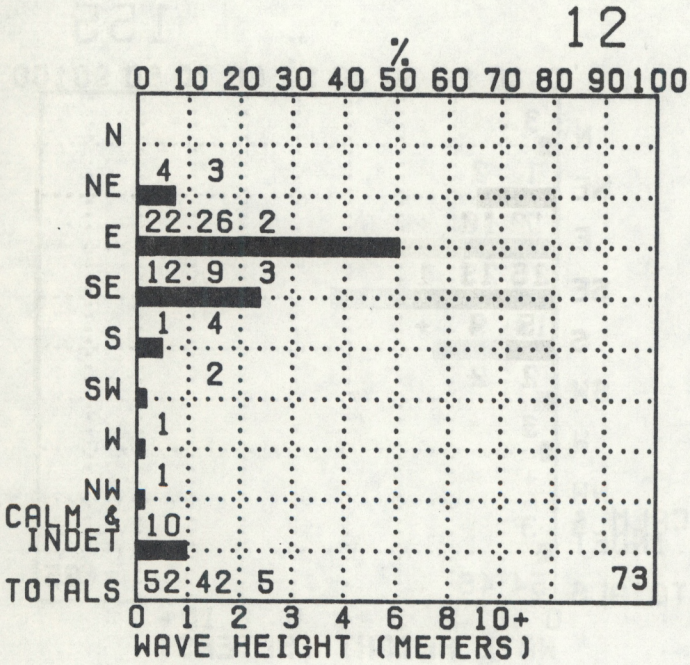
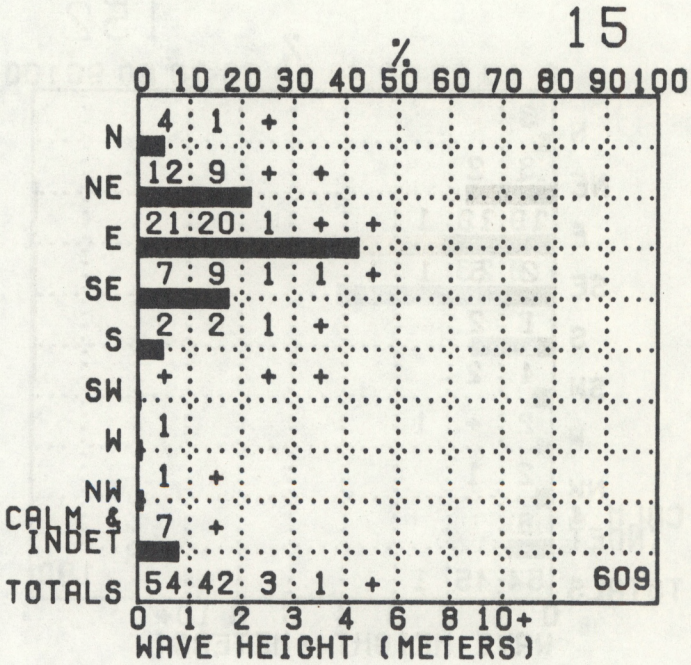
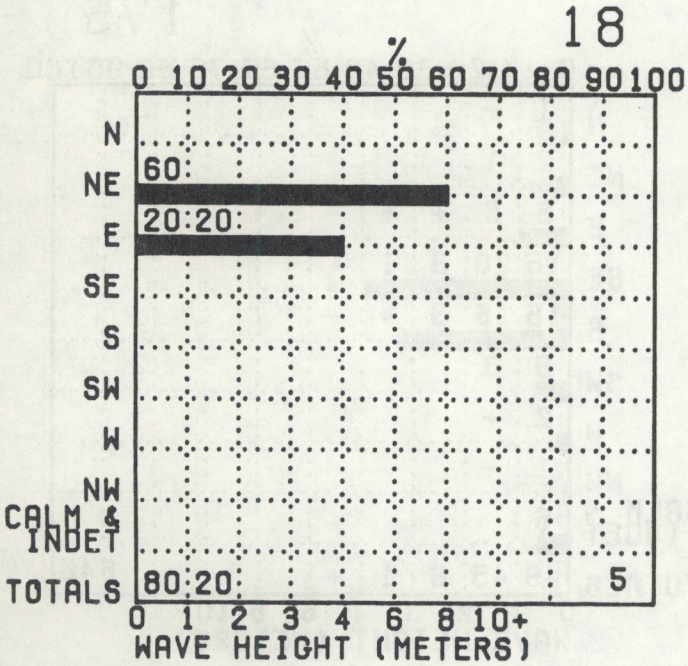


Table 7 (continued)
Month: July Squares: 152, 155, 172, 175

WAVE DIRECTION AND HEIGHT







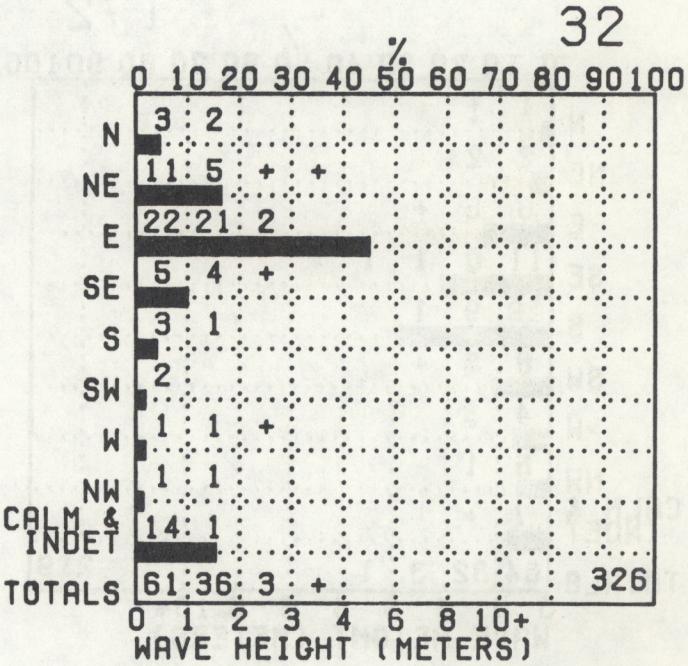
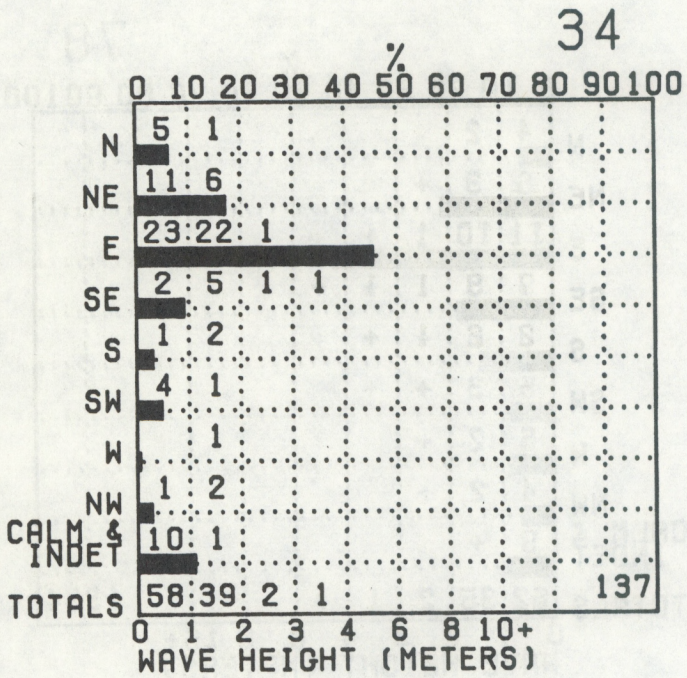
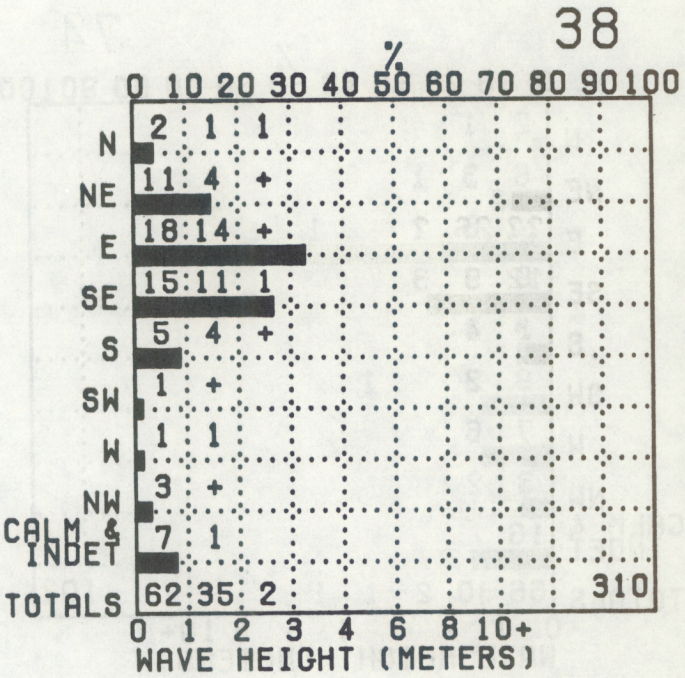
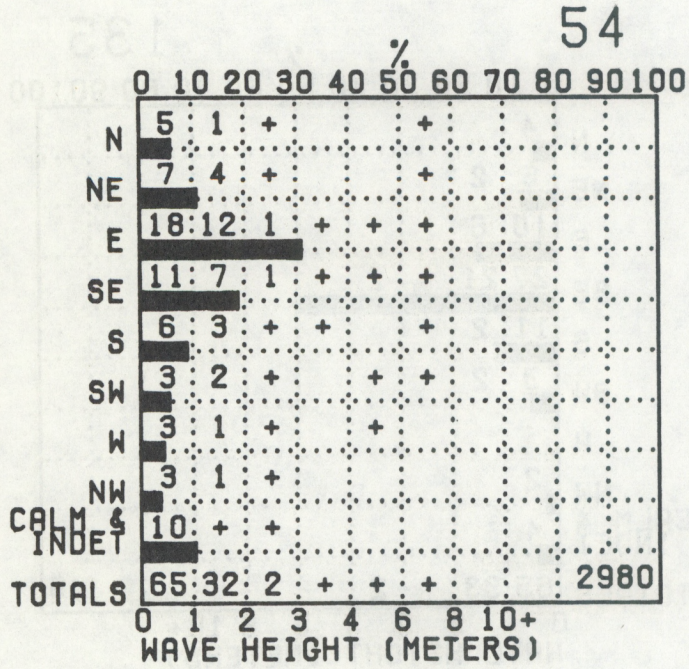


Table 7 (continued)
Month: August Squares: 12, 15, 18, 32

WAVE DIRECTION AND HEIGHT







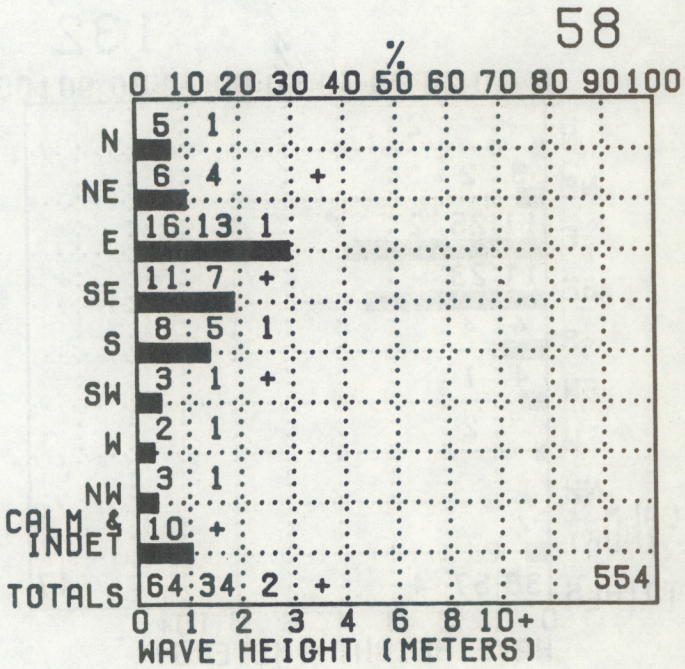
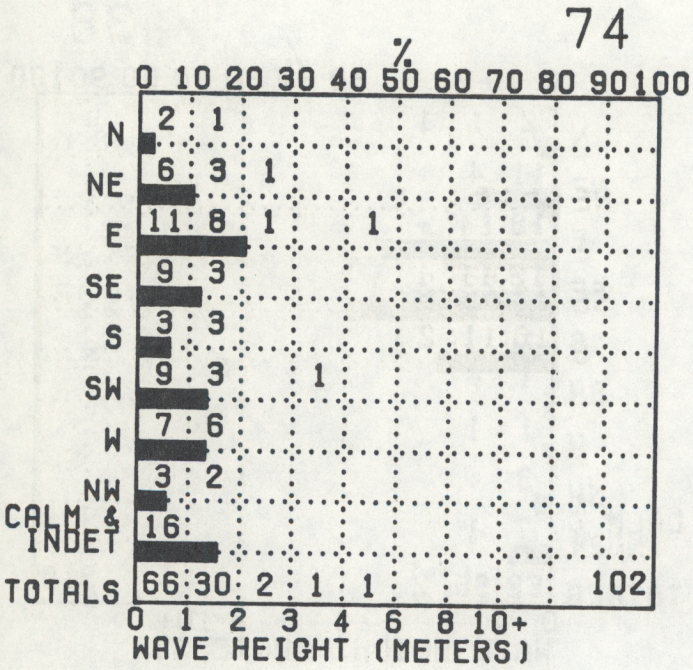
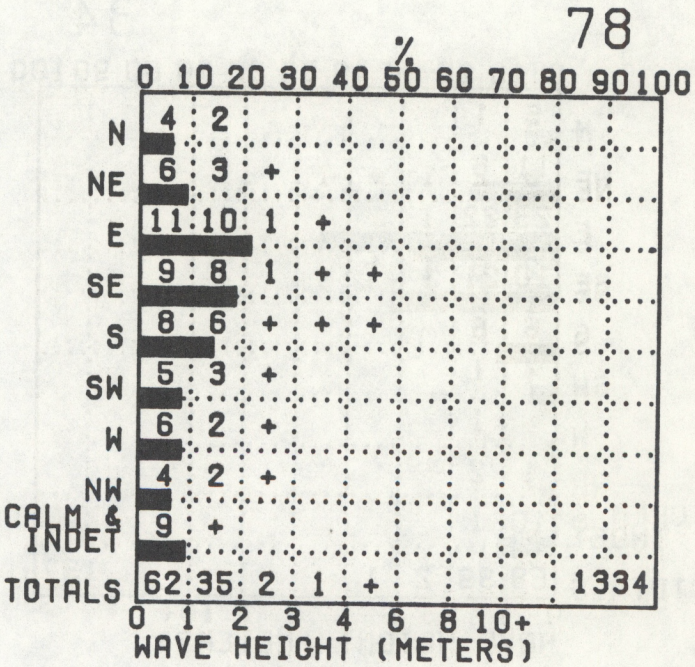
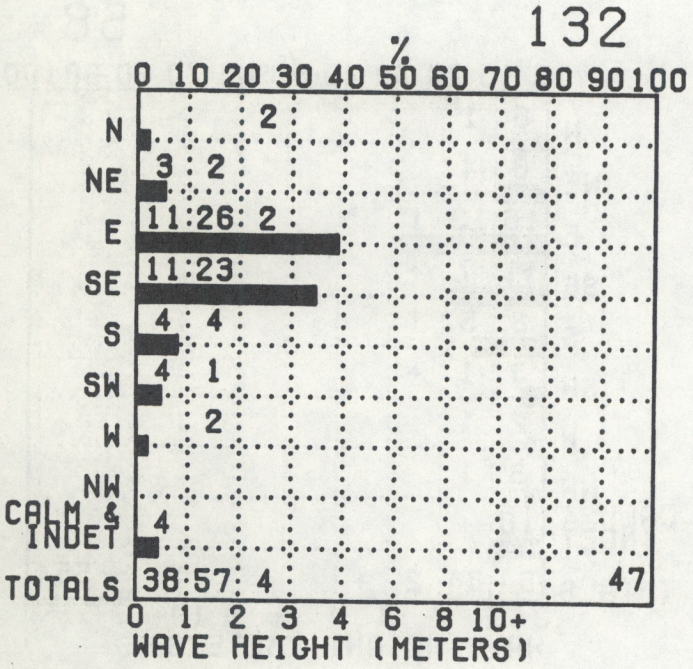


Table 7 (continued)
Month: August Squares: 34, 38, 54, 58

WAVE DIRECTION AND HEIGHT







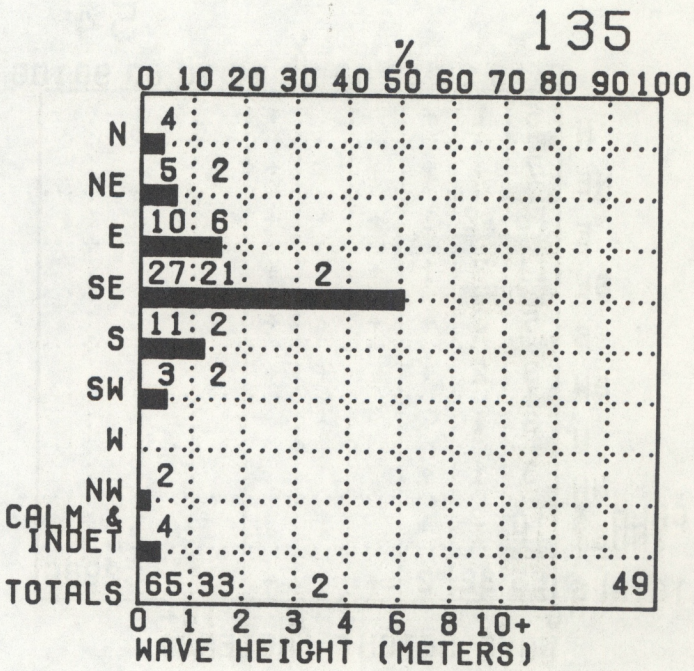
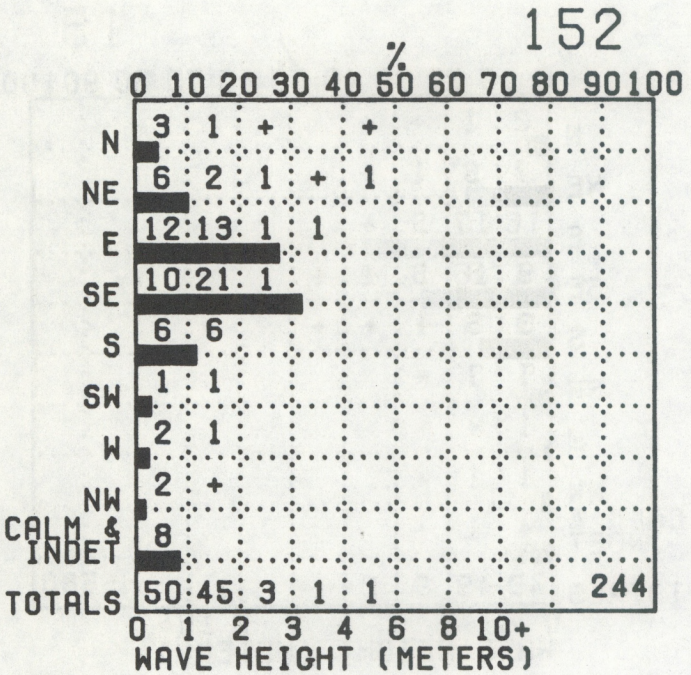
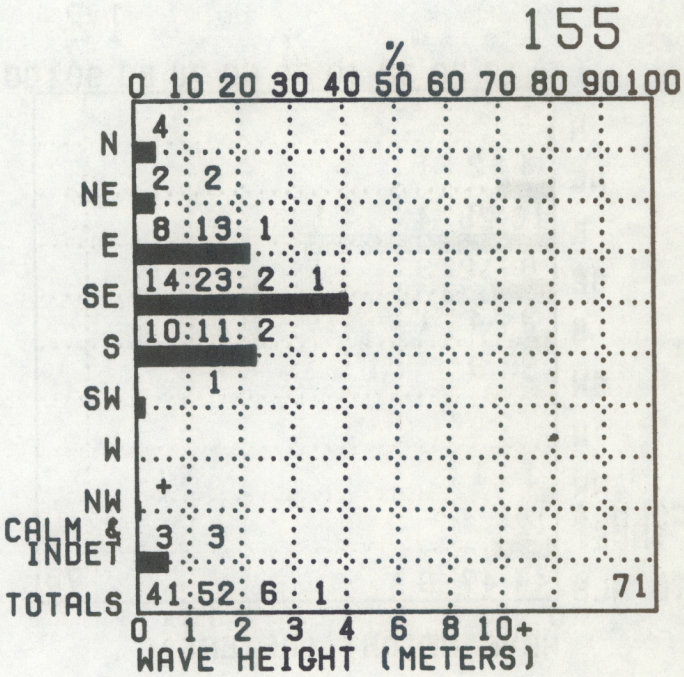
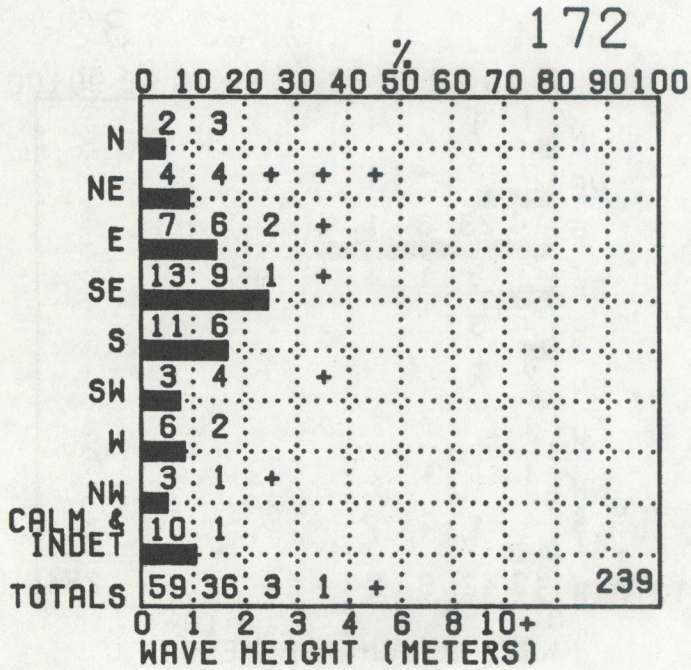


Table 7 (continued)
Month: August Squares: 74, 78, 132, 135

WAVE DIRECTION AND HEIGHT







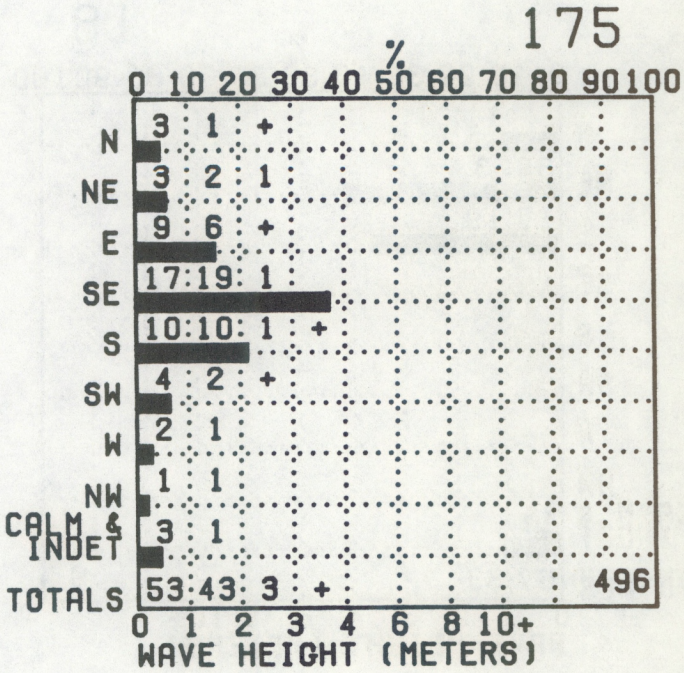
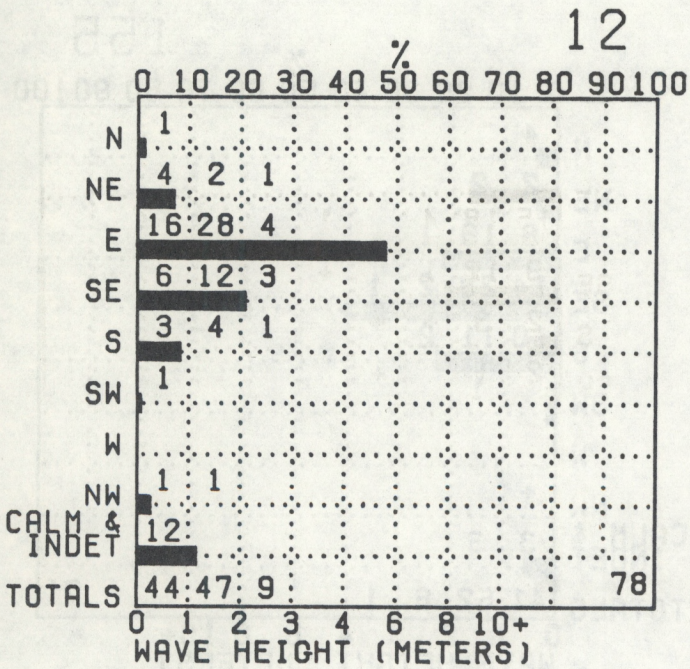
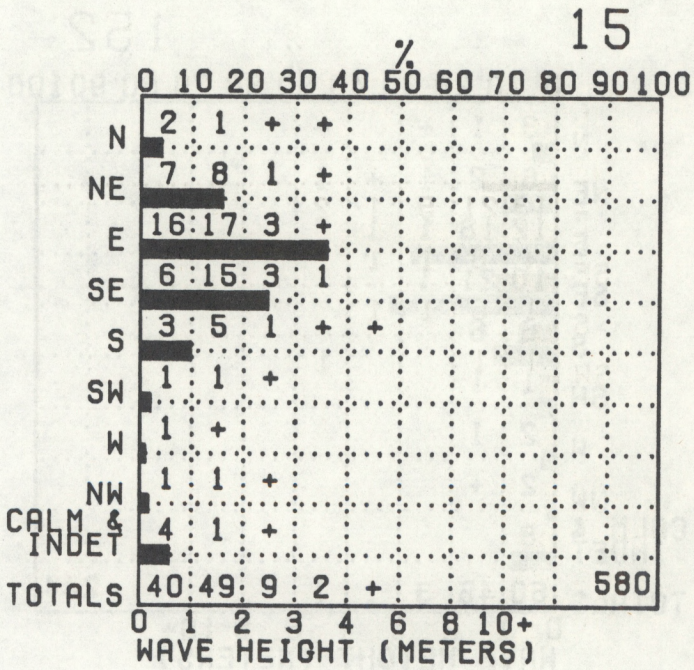
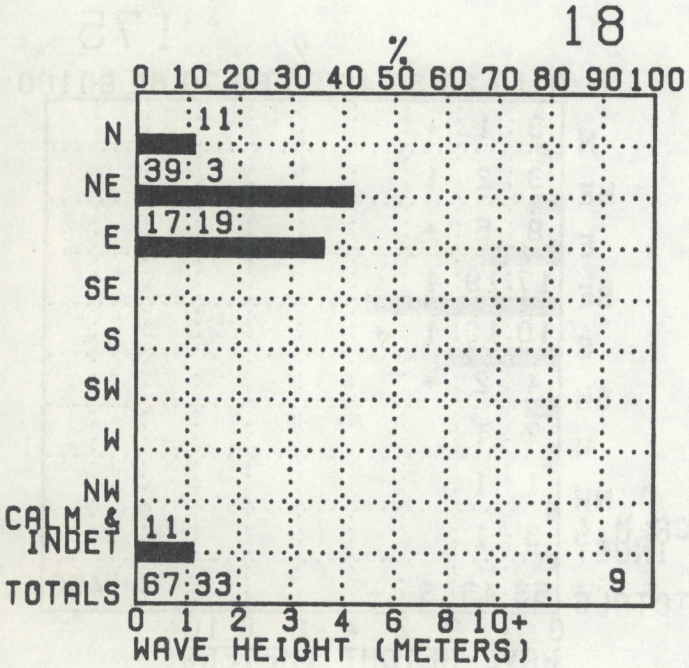


Table 7 (continued)
Month: August Squares: 152, 155, 172, 175

WAVE DIRECTION AND HEIGHT







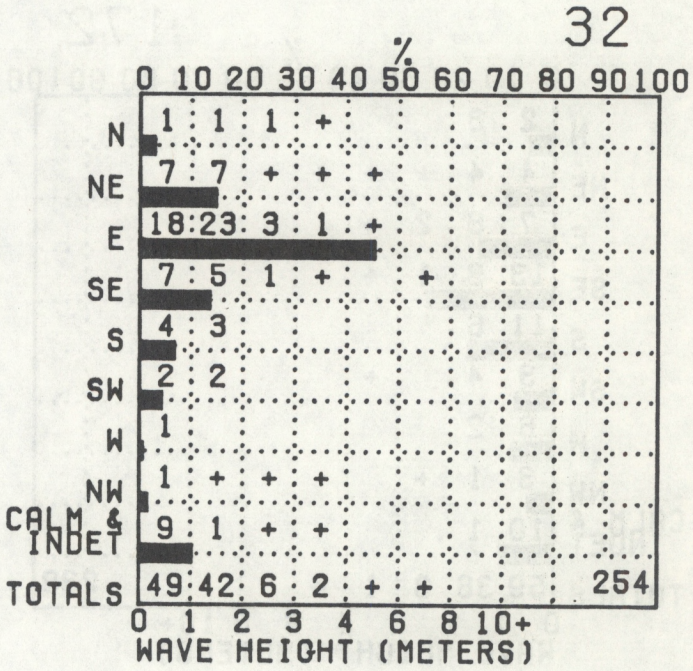
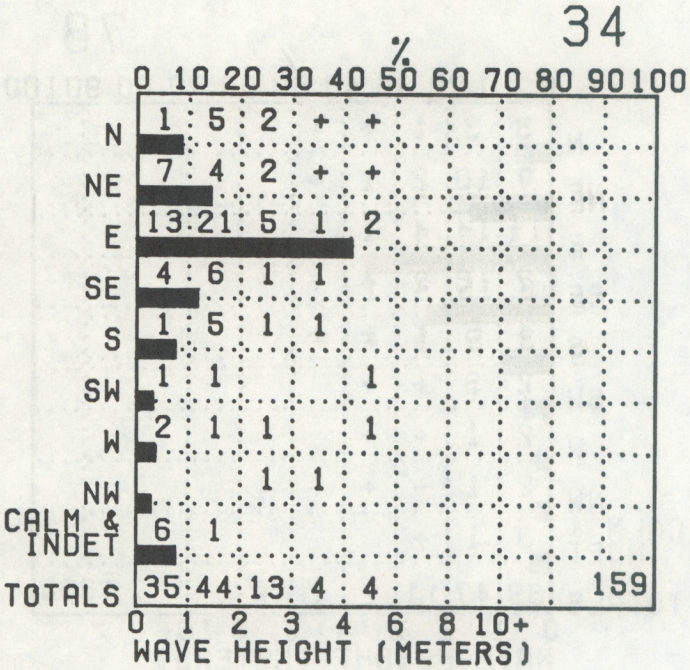
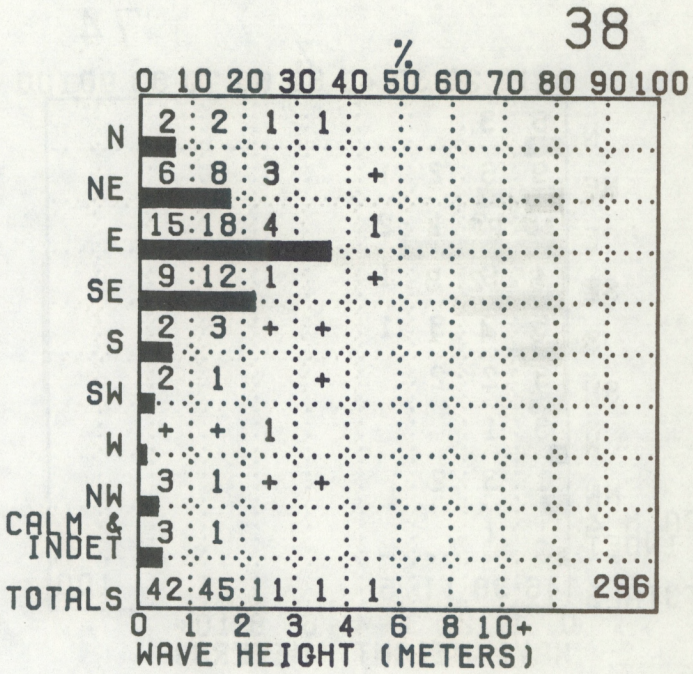
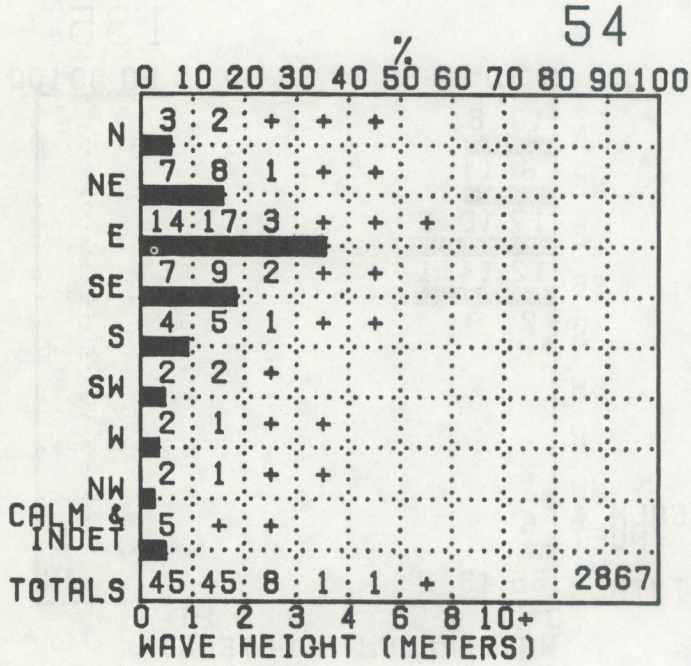


Table 7 (continued)
Month: September Squares: 12, 15, 18, 32

WAVE DIRECTION AND HEIGHT







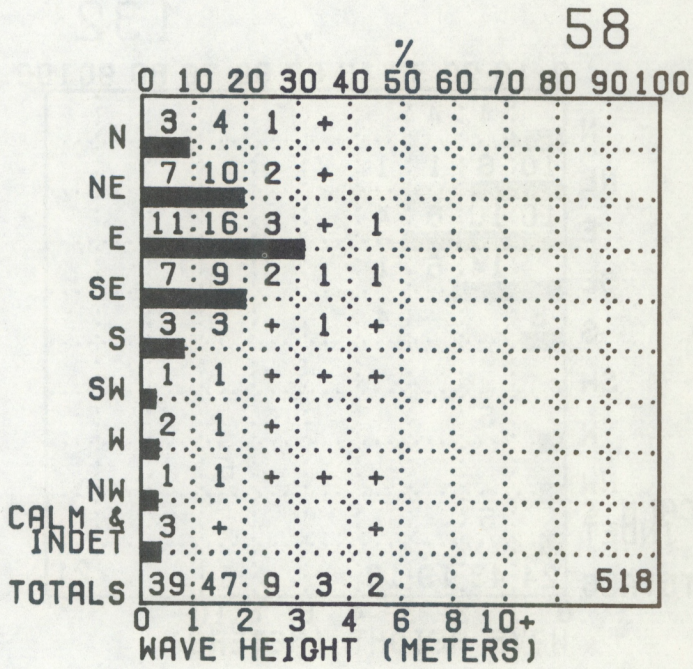
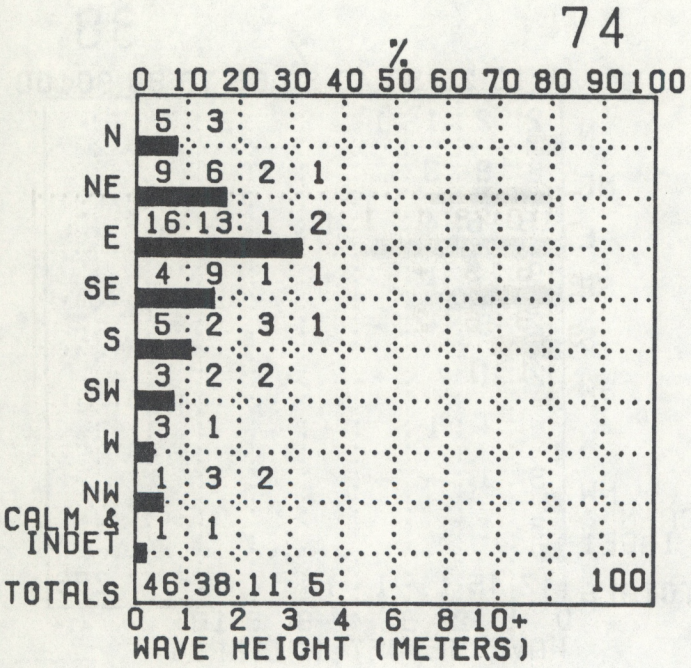
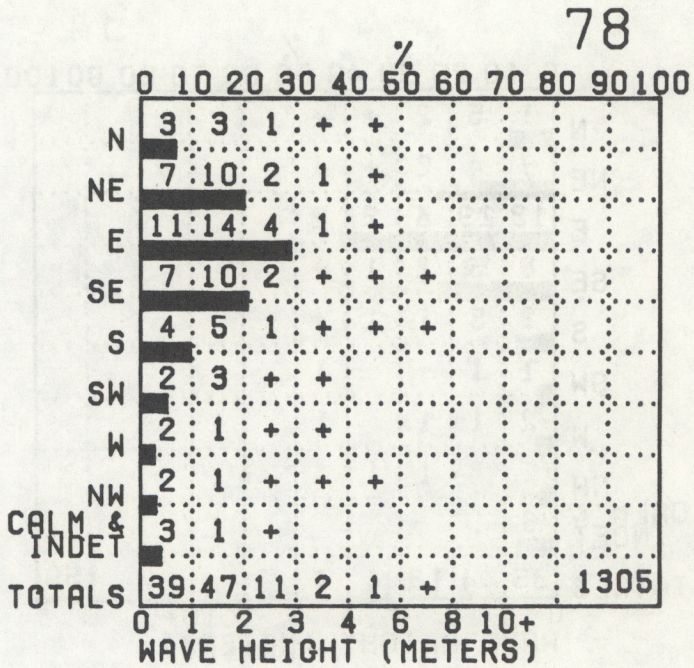
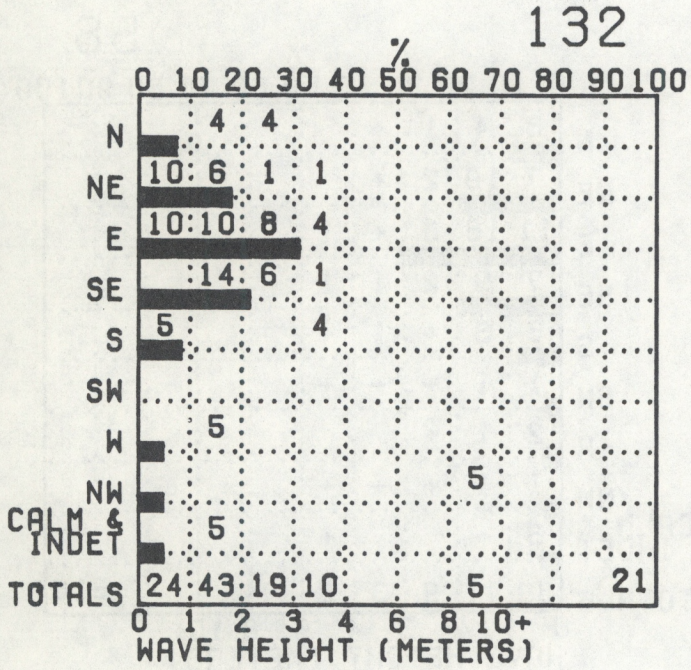


Table 7 (continued)
Month: September Squares: 34, 38, 54, 58

WAVE DIRECTION AND HEIGHT







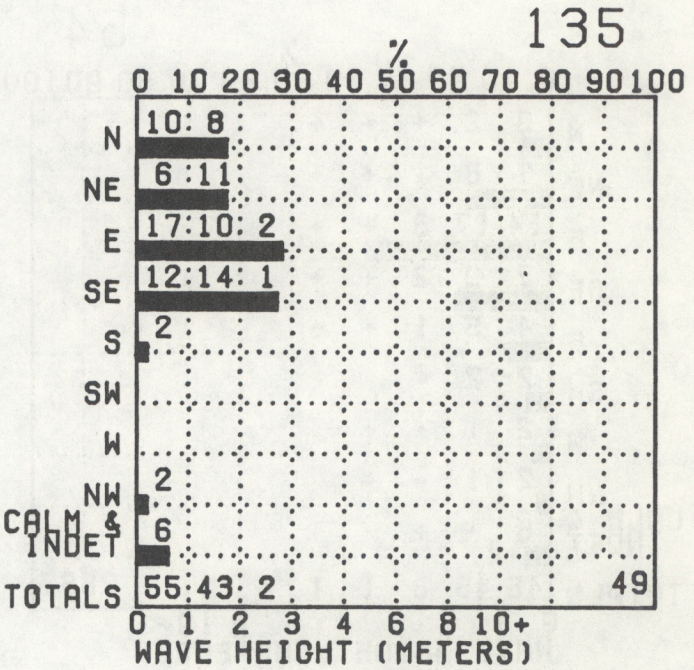
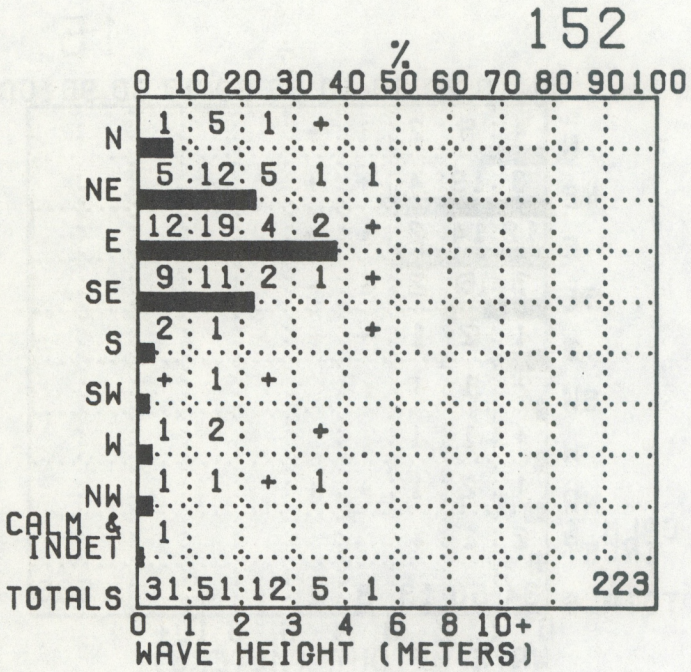
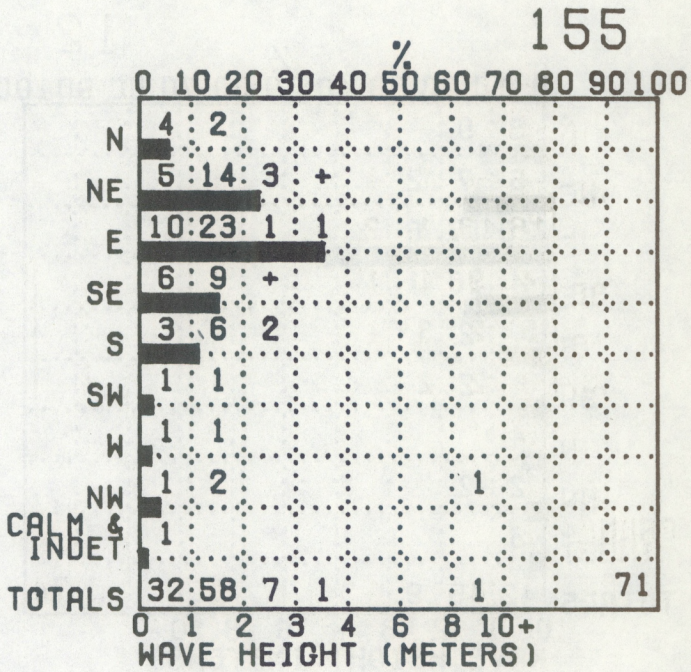
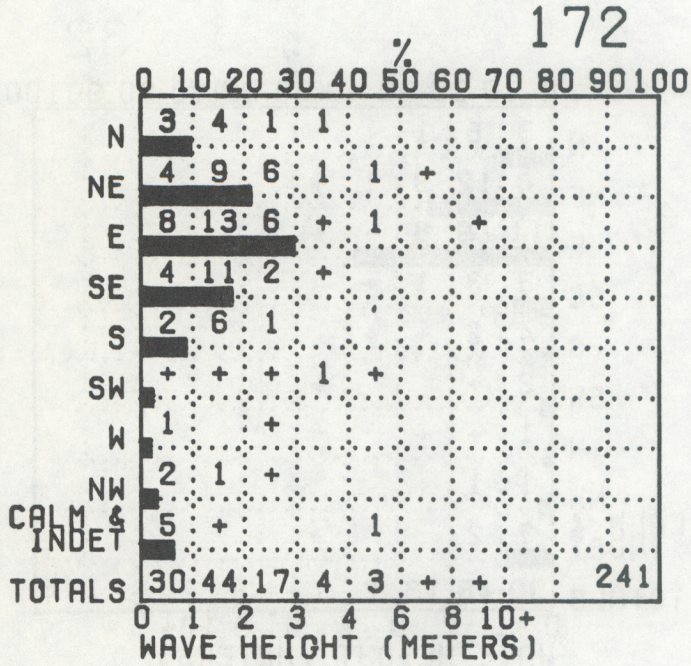


Table 7 (continued)
Month: September Squares: 74, 78, 132, 135

WAVE DIRECTION AND HEIGHT







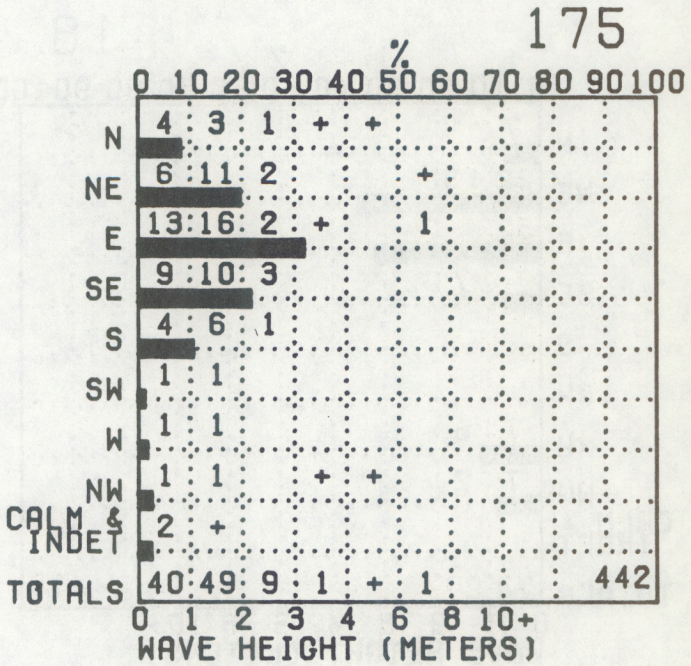
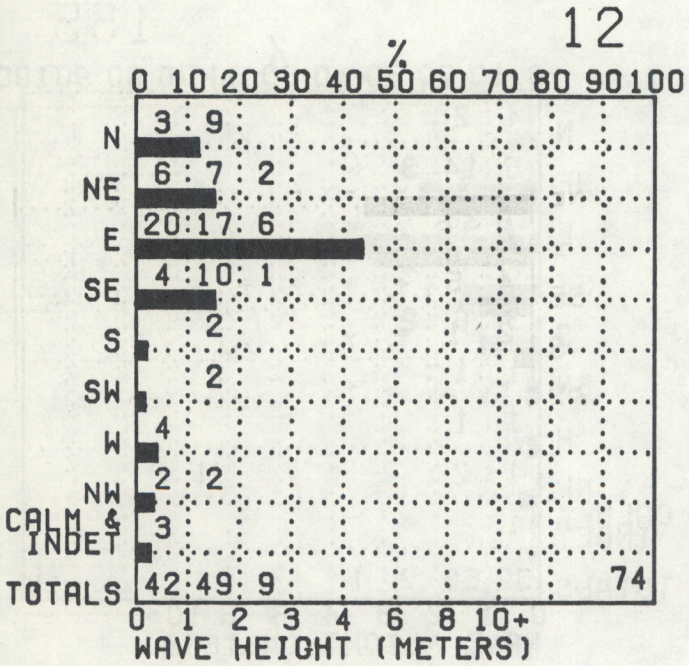
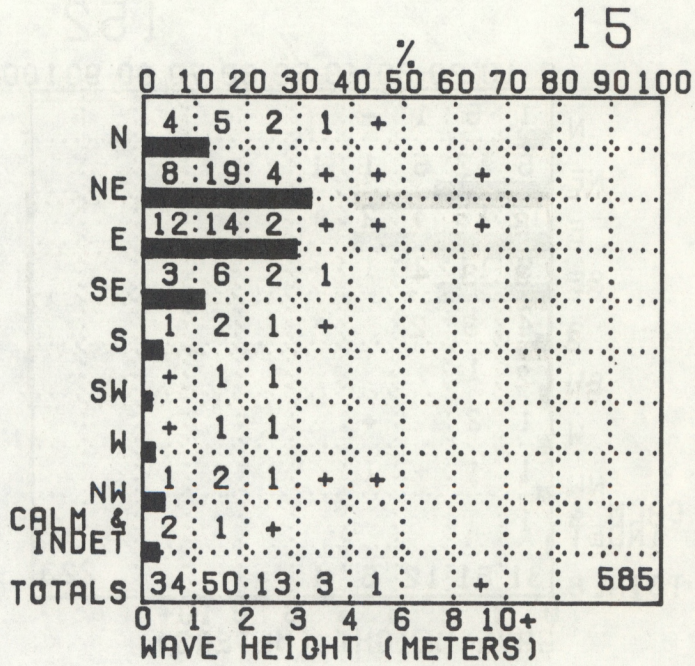
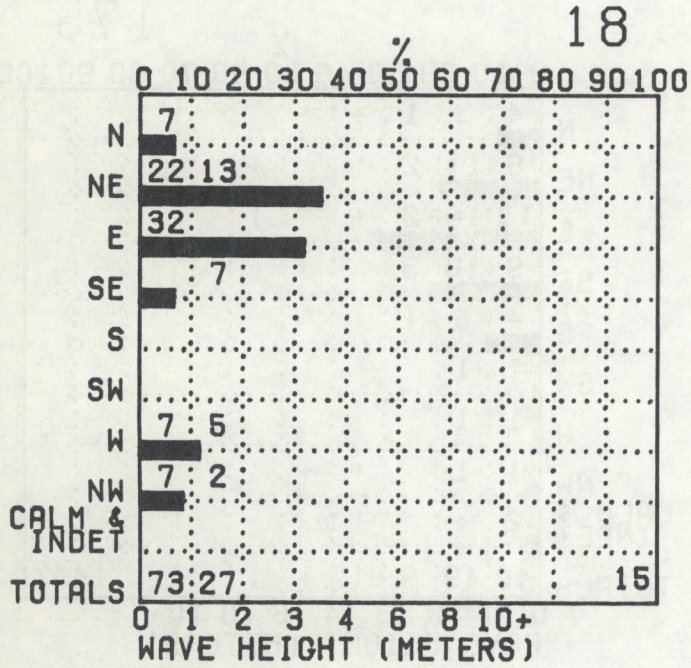


Table 7 (continued)
Month: September Squares: 152, 155, 172, 175

WAVE DIRECTION AND HEIGHT







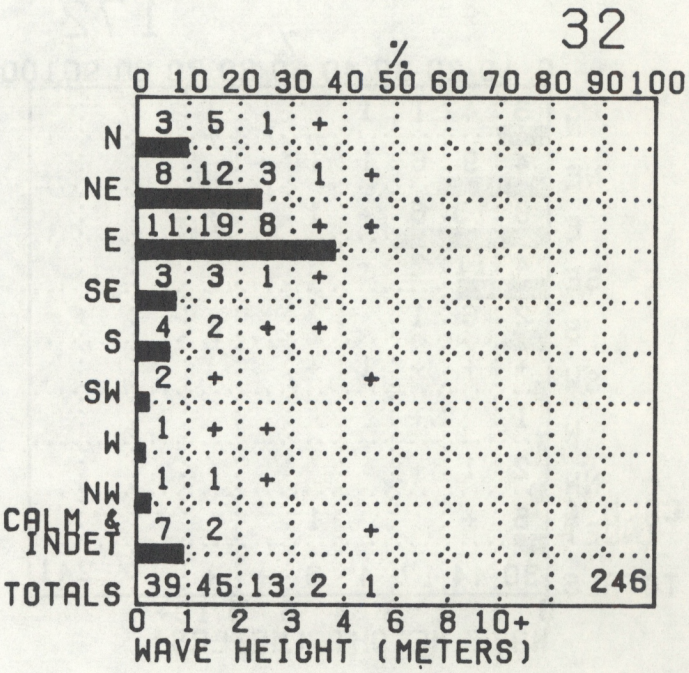
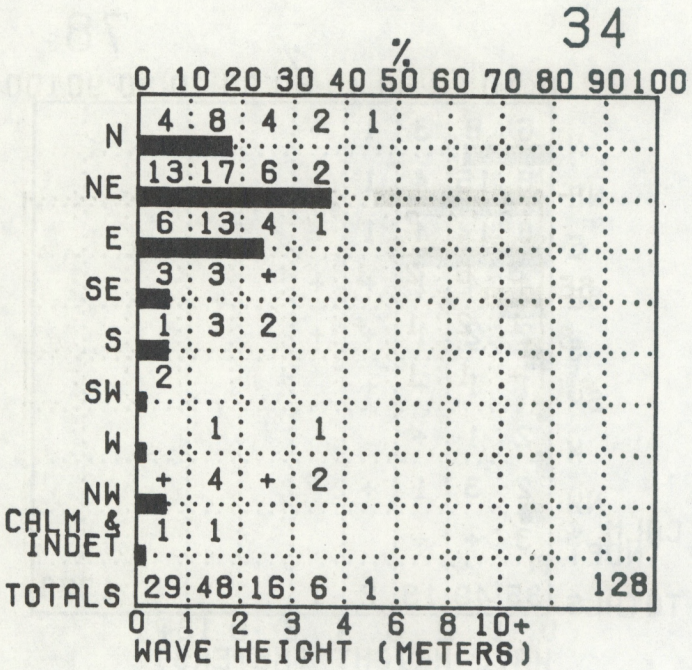
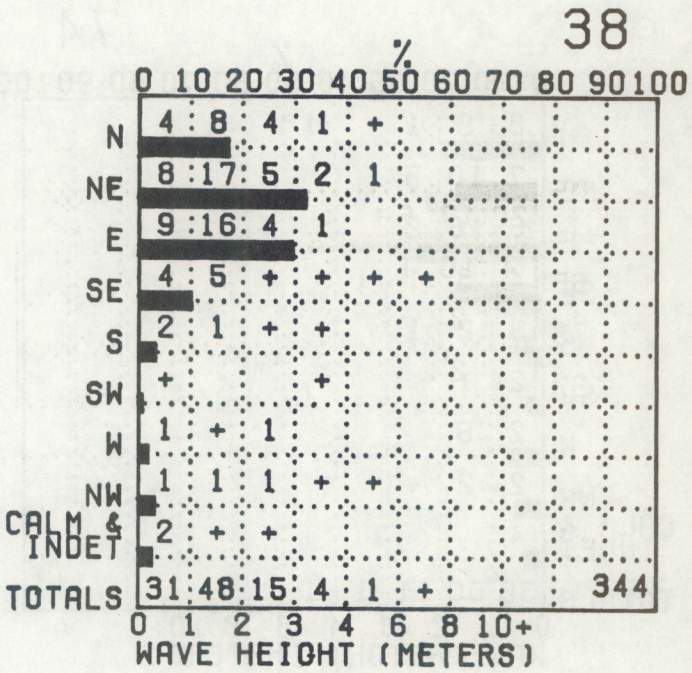
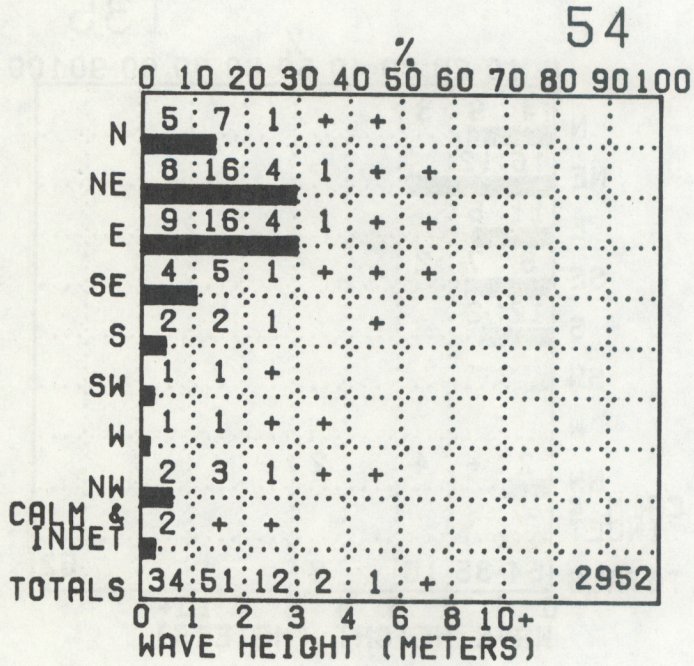


Table 7 (continued)
Month: October Squares: 12, 15, 18, 32

WAVE DIRECTION AND HEIGHT







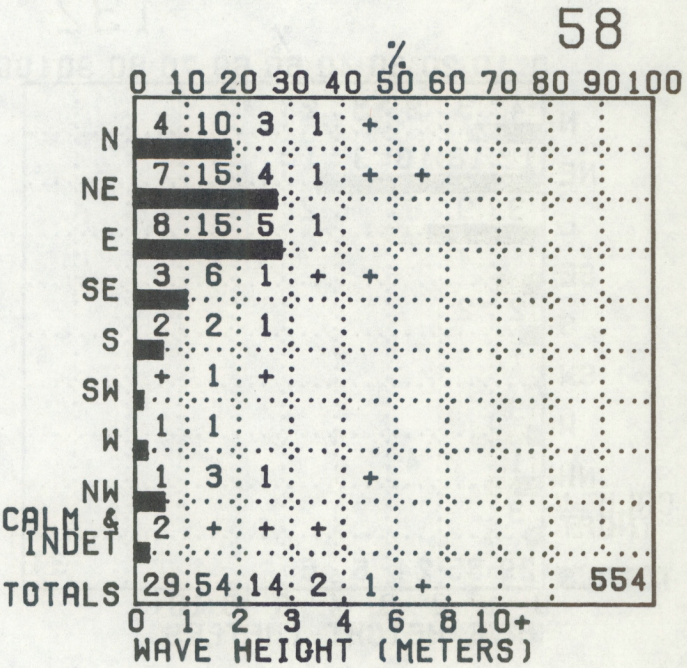
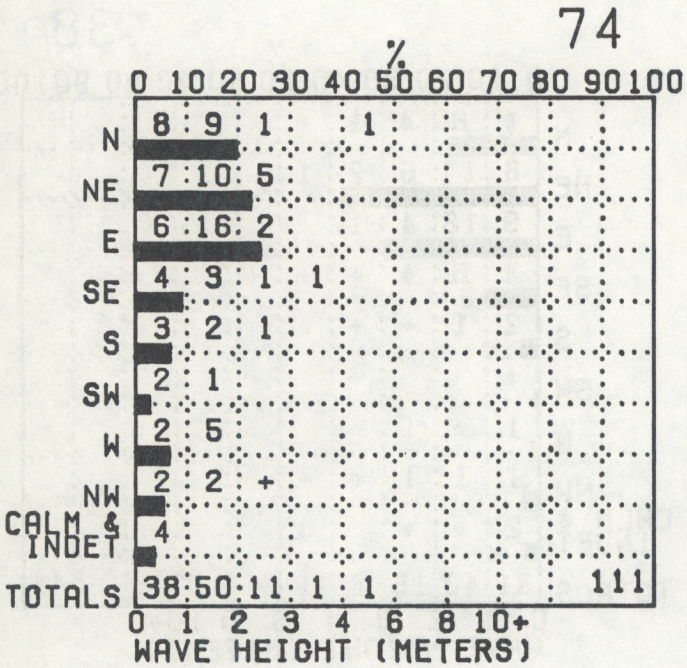
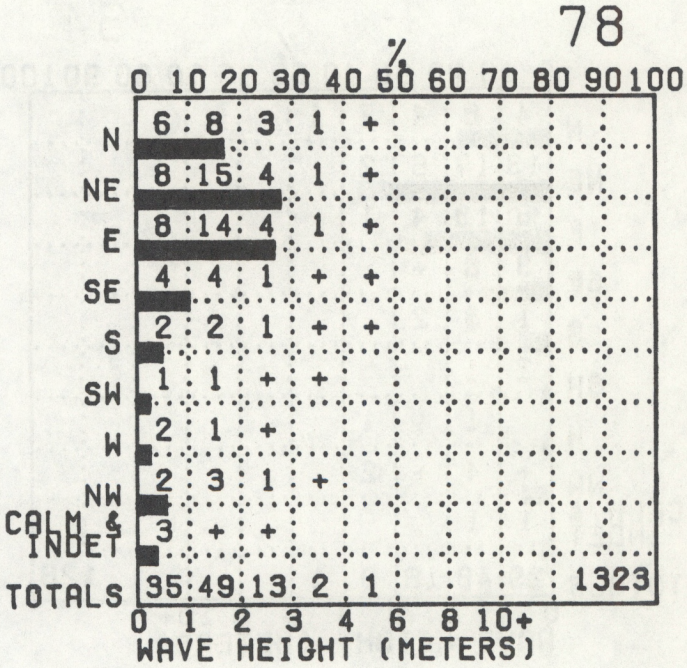
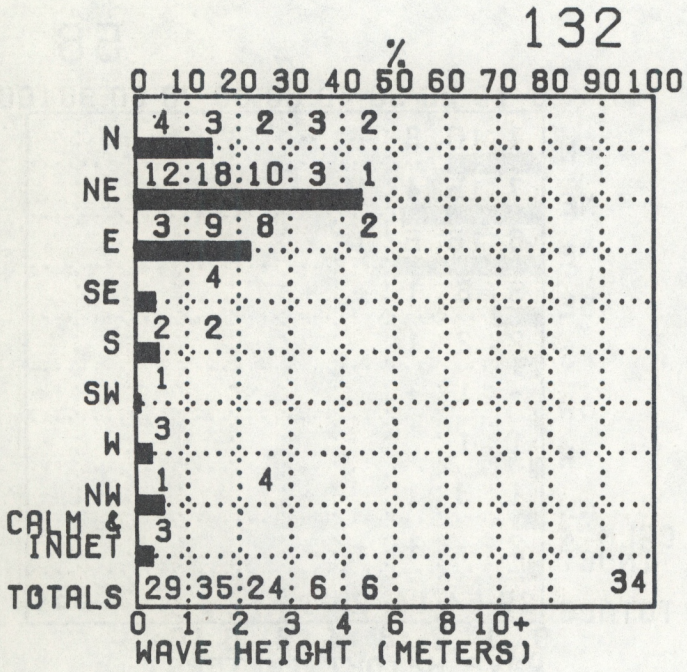


Table 7 (continued)
Month: October Squares: 34, 38, 54, 58

WAVE DIRECTION AND HEIGHT







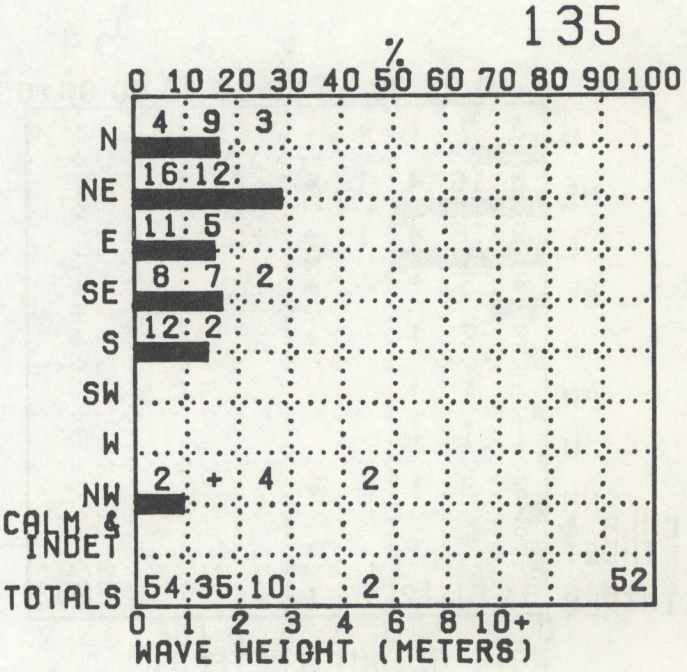
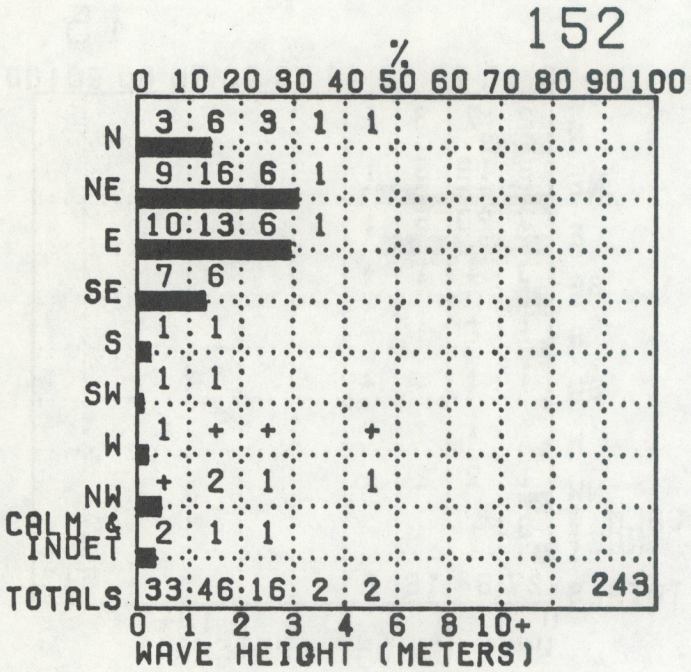
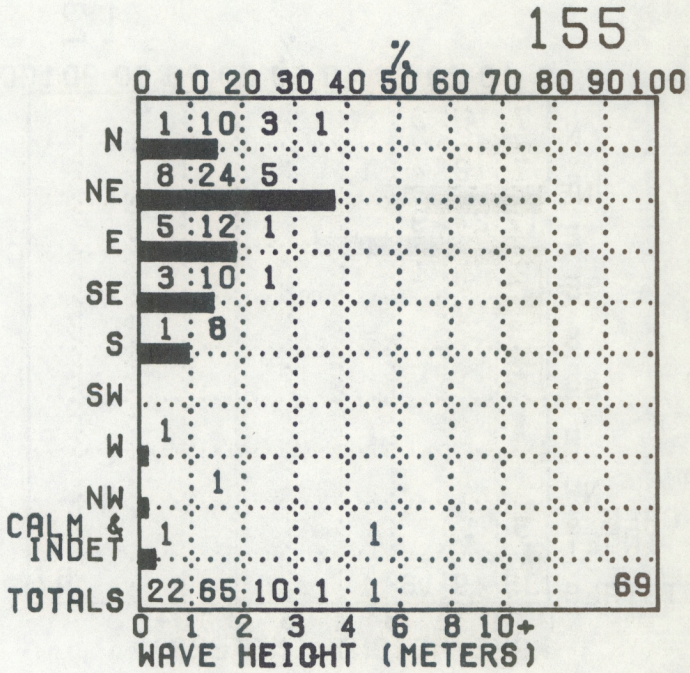
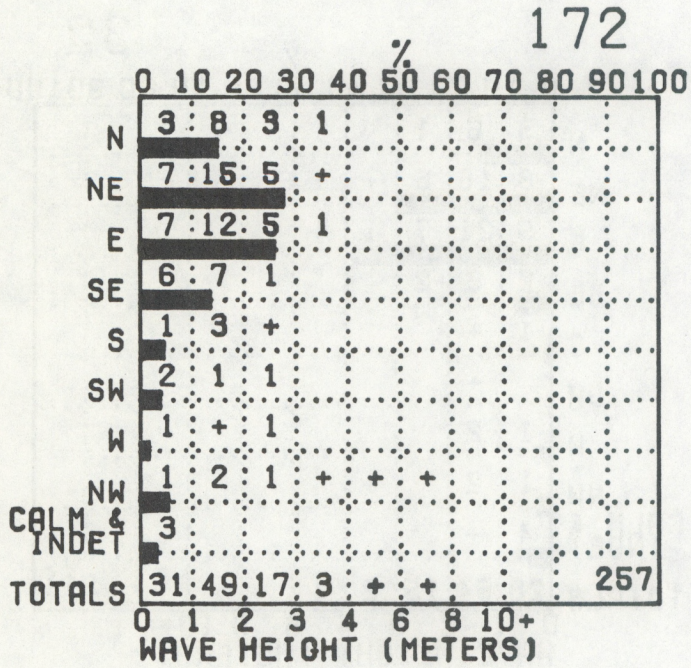


Table 7 (continued)
Month: October Squares: 74, 78, 132, 135

WAVE DIRECTION AND HEIGHT







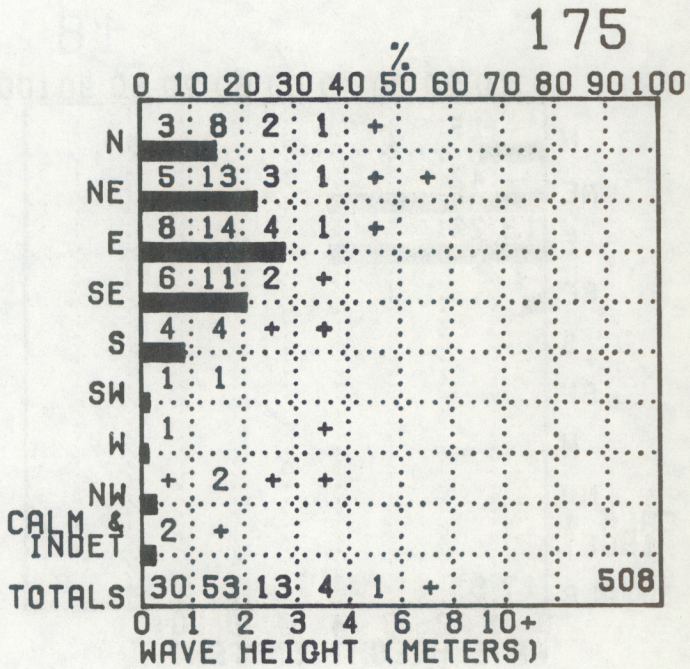
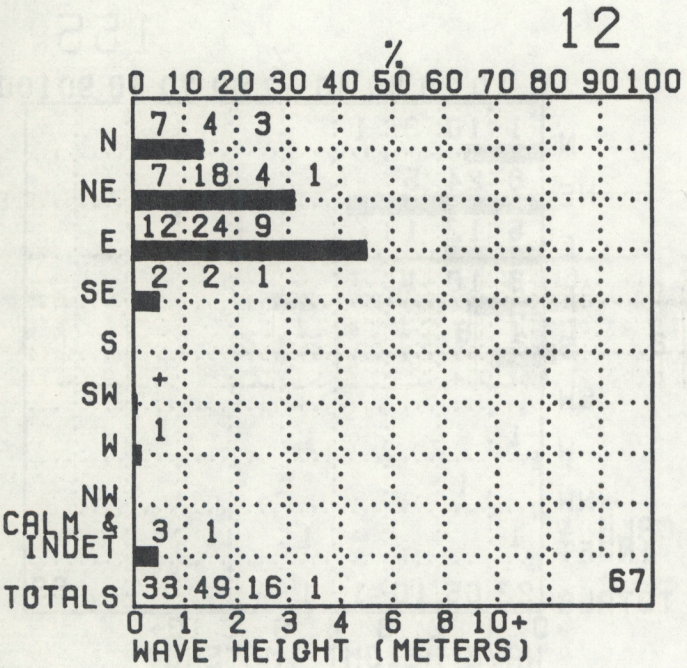
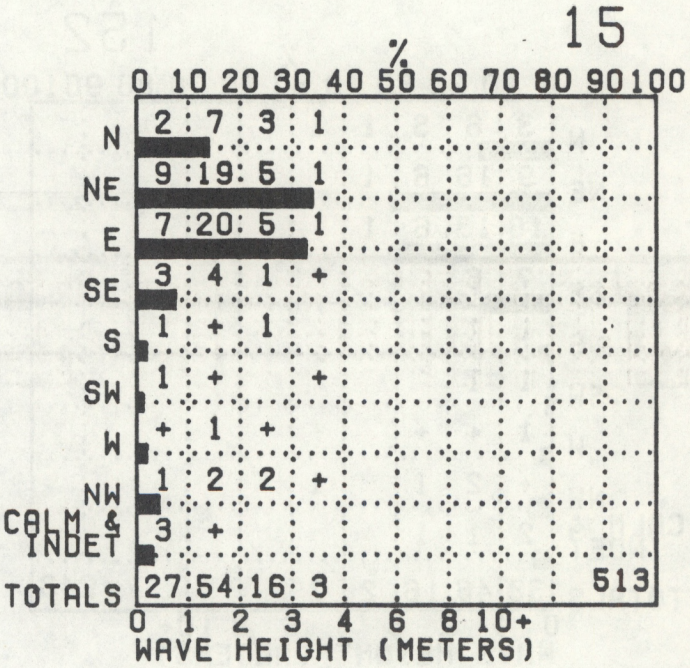
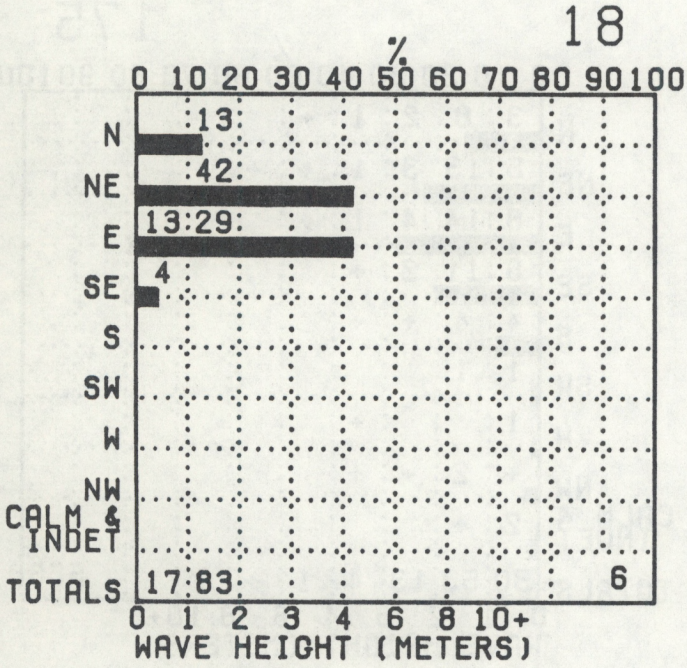


Table 7 (continued)
Month: October Squares: 152, 155, 172, 175

WAVE DIRECTION AND HEIGHT







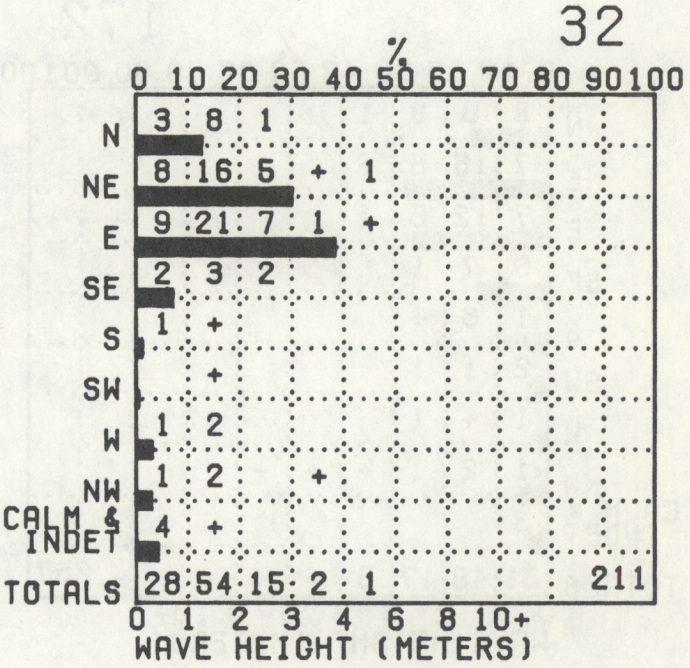
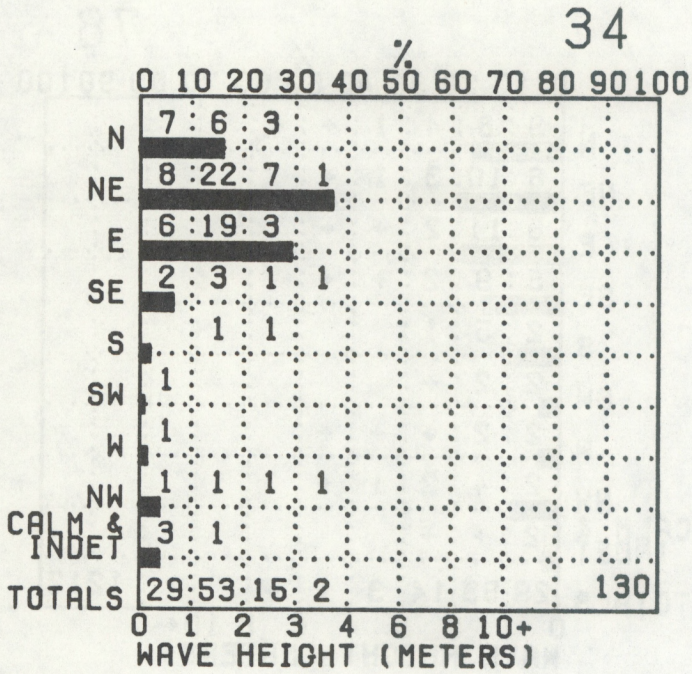
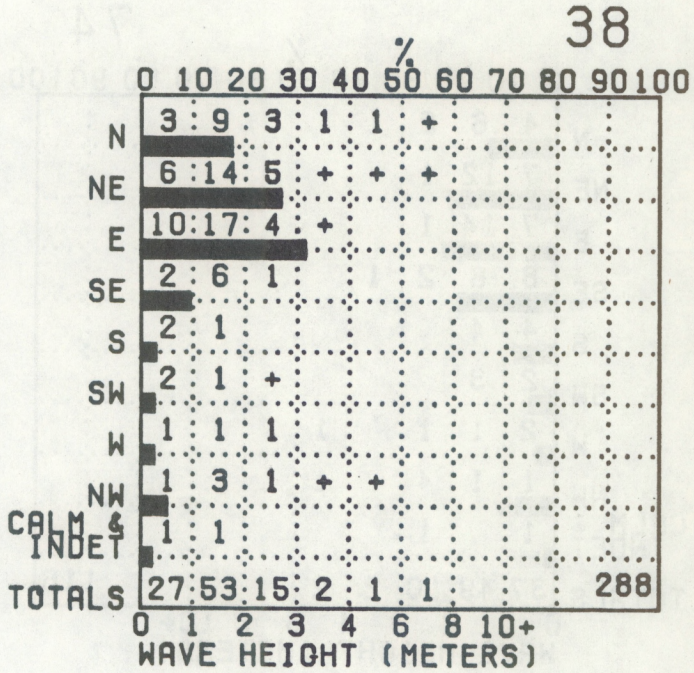
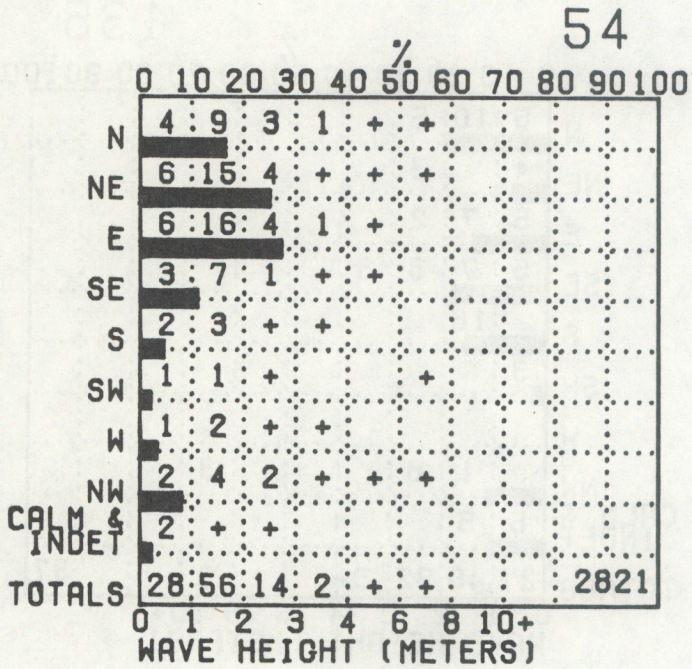


Table 7 (continued)
Month: November Squares: 12, 15, 18, 32

WAVE DIRECTION AND HEIGHT







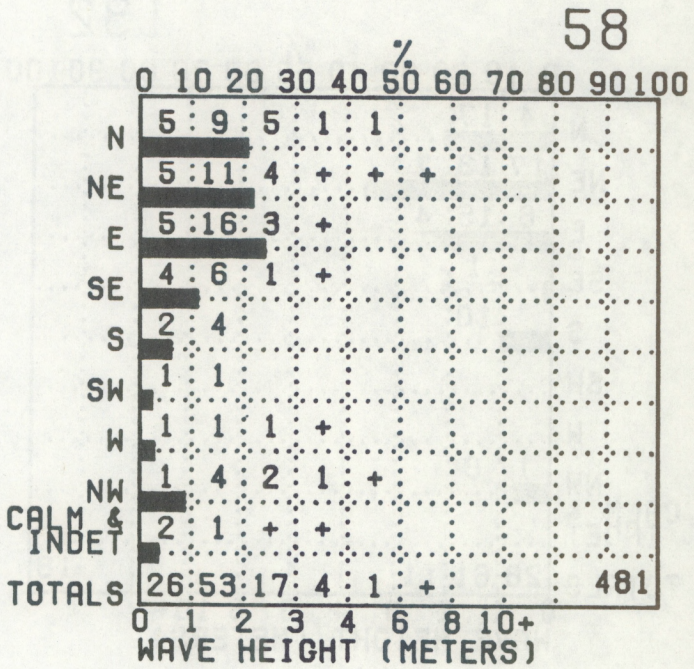
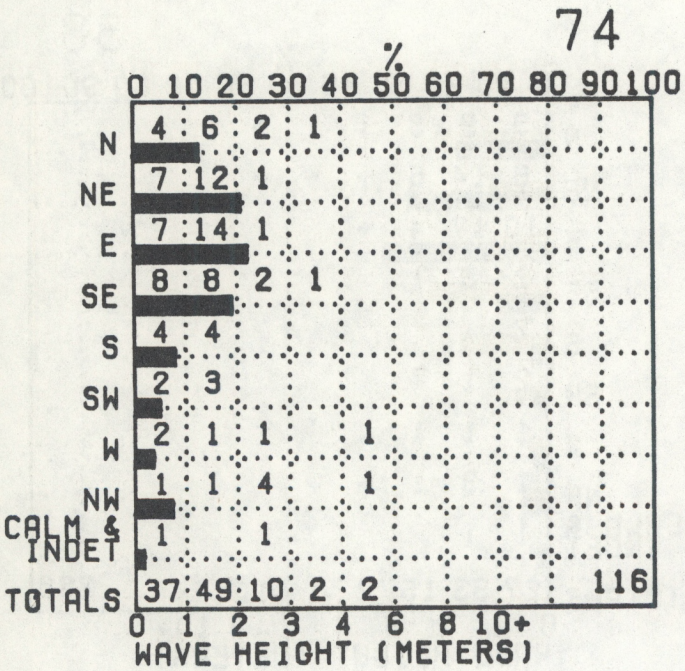
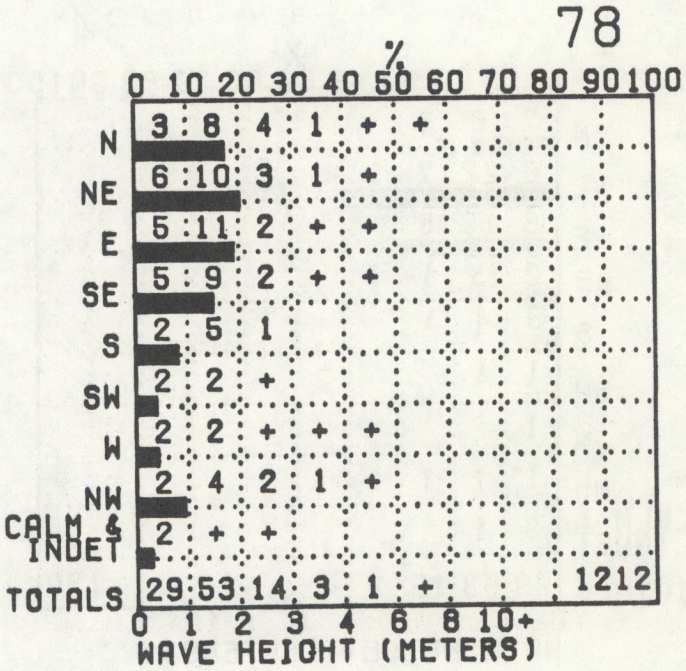
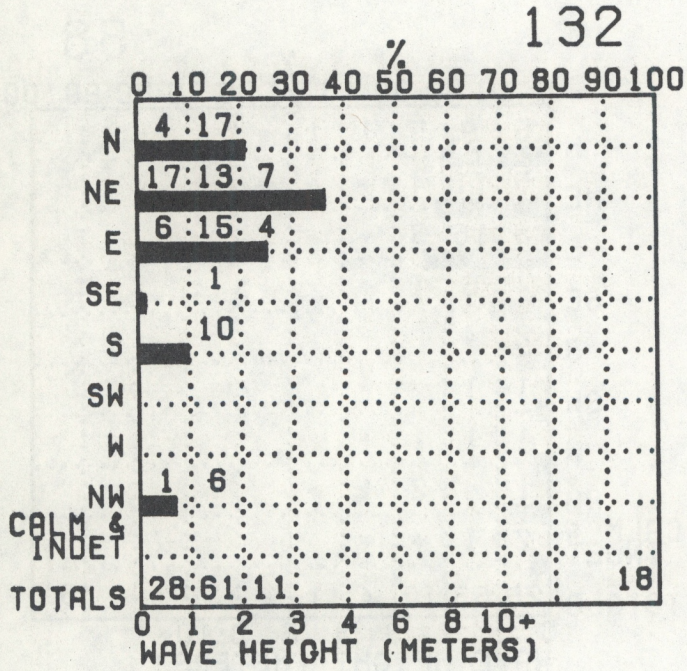


Table 7 (continued)
Month: November Squares: 34, 38, 54, 58

WAVE DIRECTION AND HEIGHT







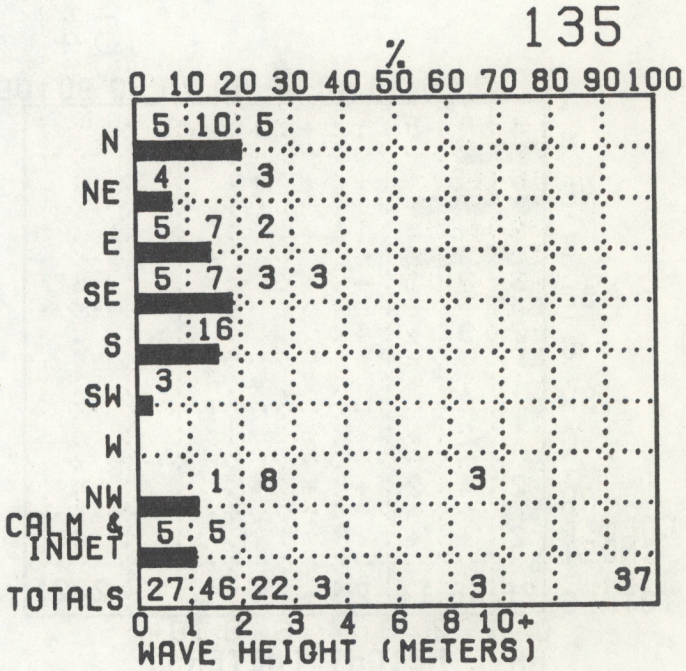
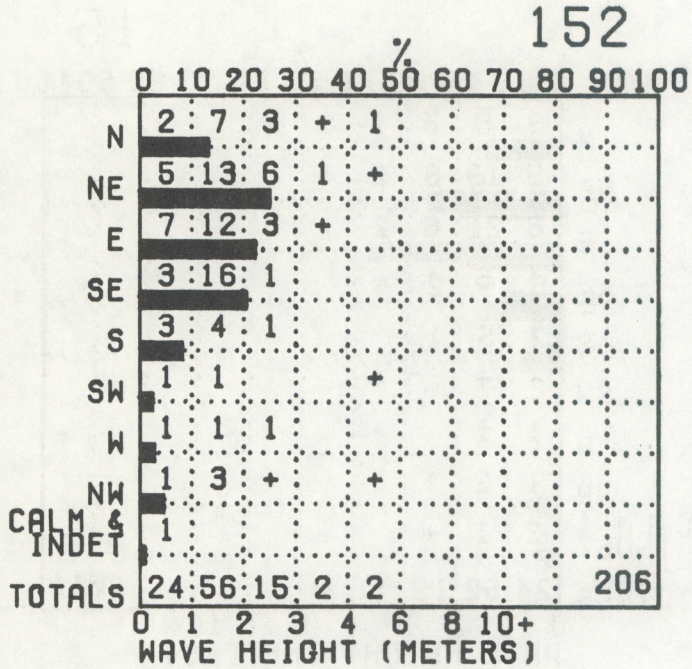
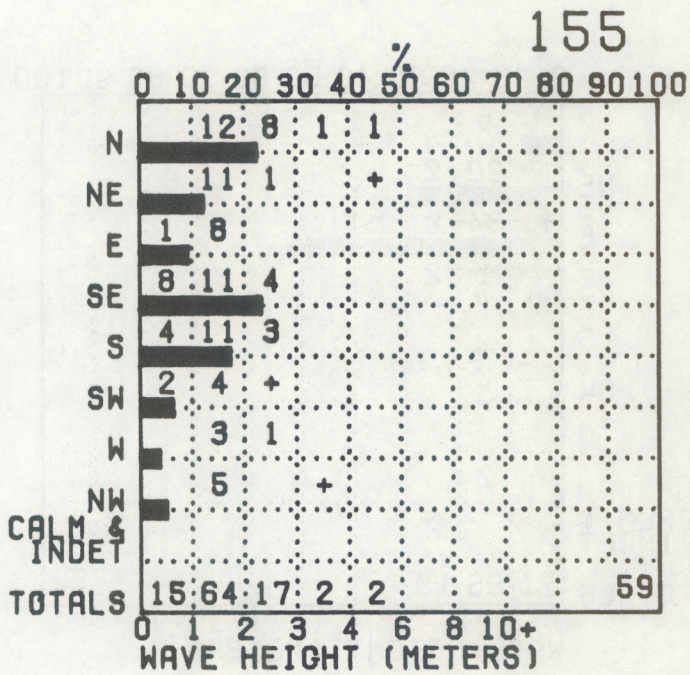
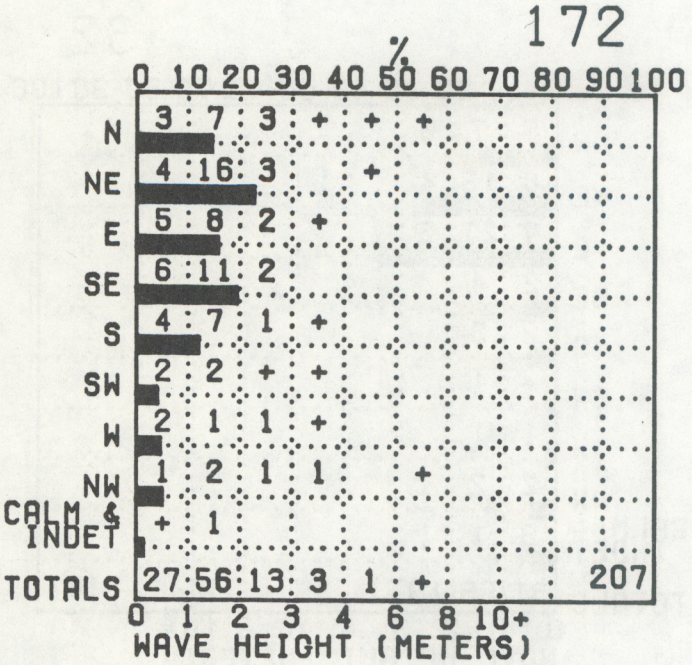


Table 7 (continued)
Month: November Squares: 74, 78, 132, 135

WAVE DIRECTION AND HEIGHT







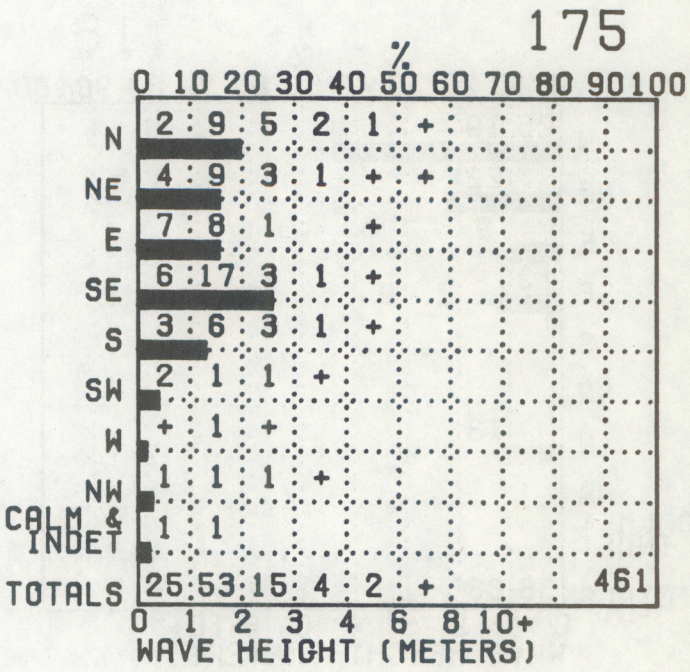
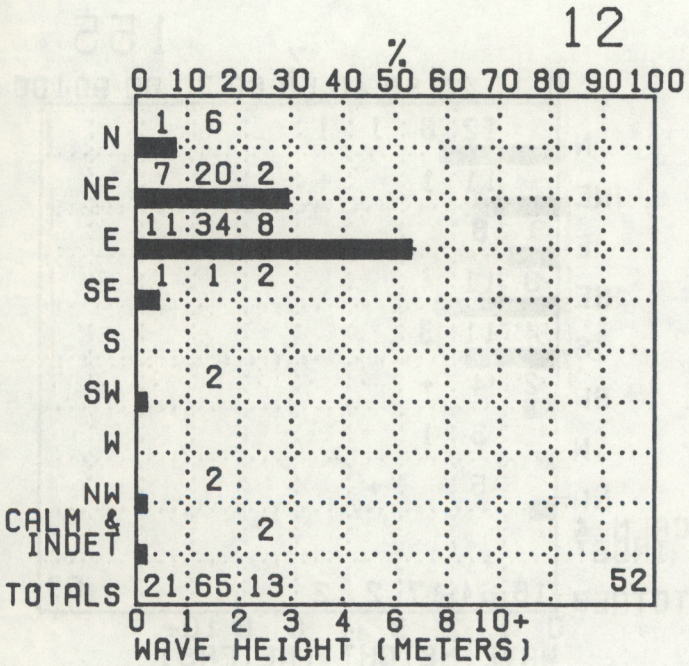
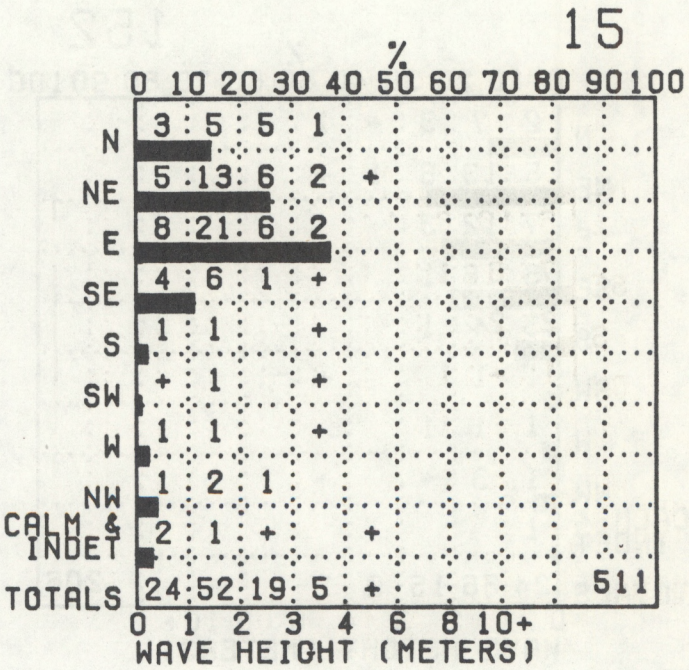
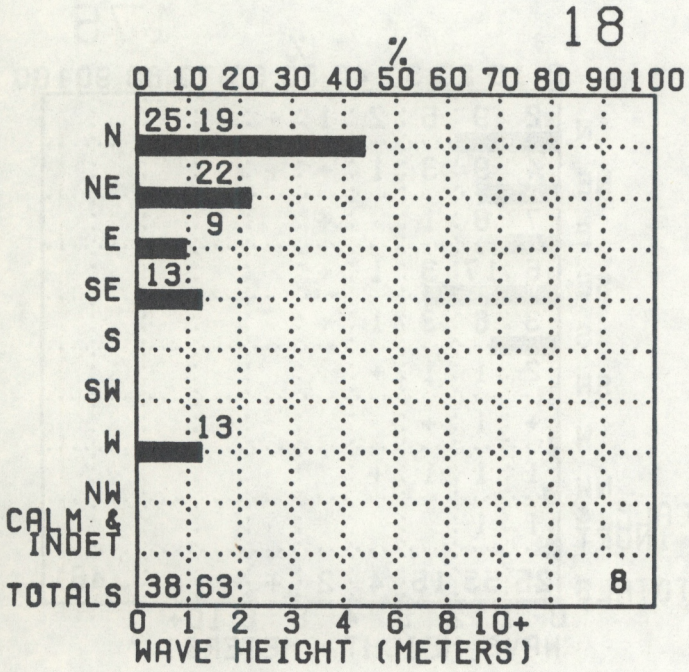


Table 7 (continued)
Month: November Squares: 152, 155, 172, 175

WAVE DIRECTION AND HEIGHT







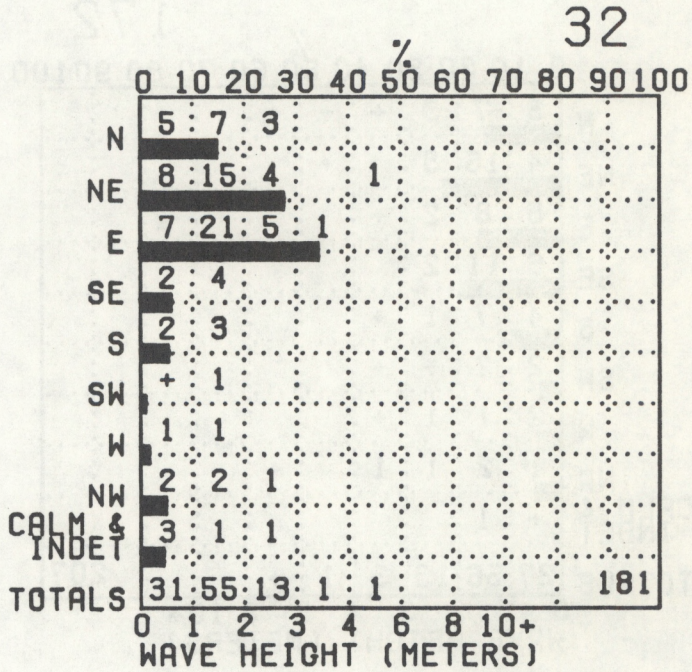
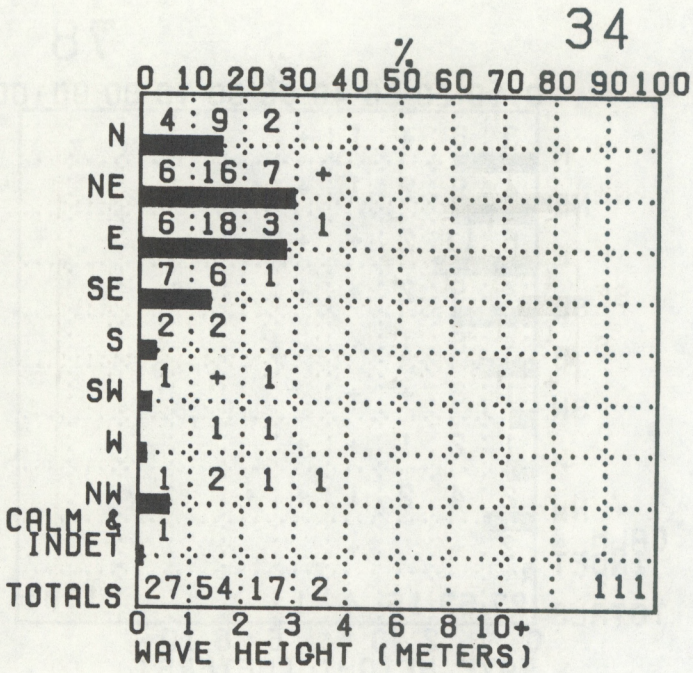
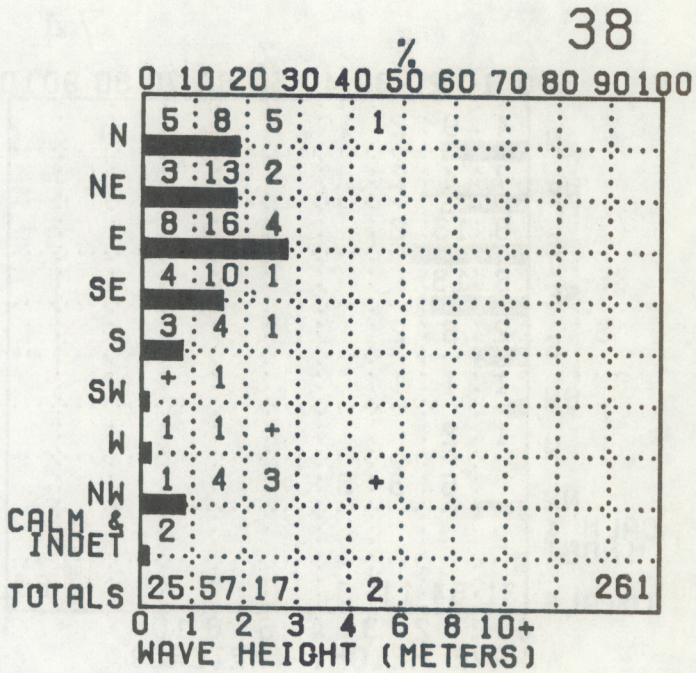
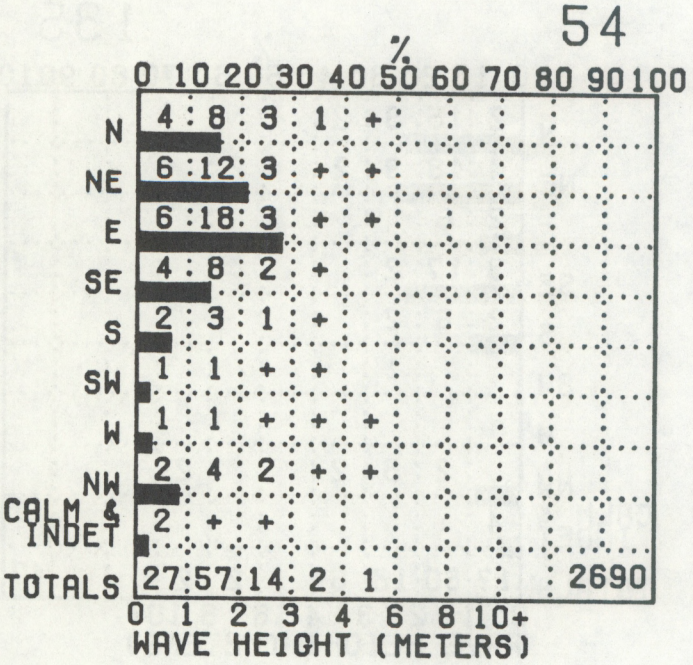


Table 7 (continued)
Month: December Squares: 12, 15, 18, 32

WAVE DIRECTION AND HEIGHT







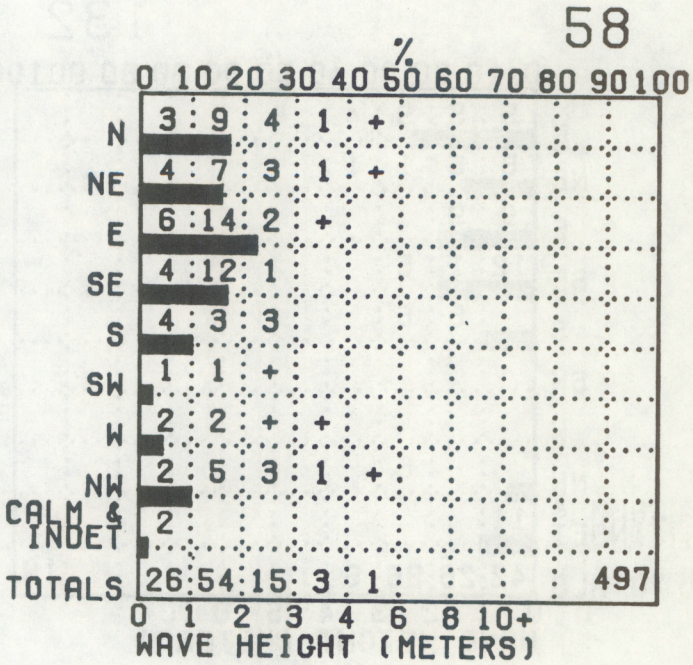
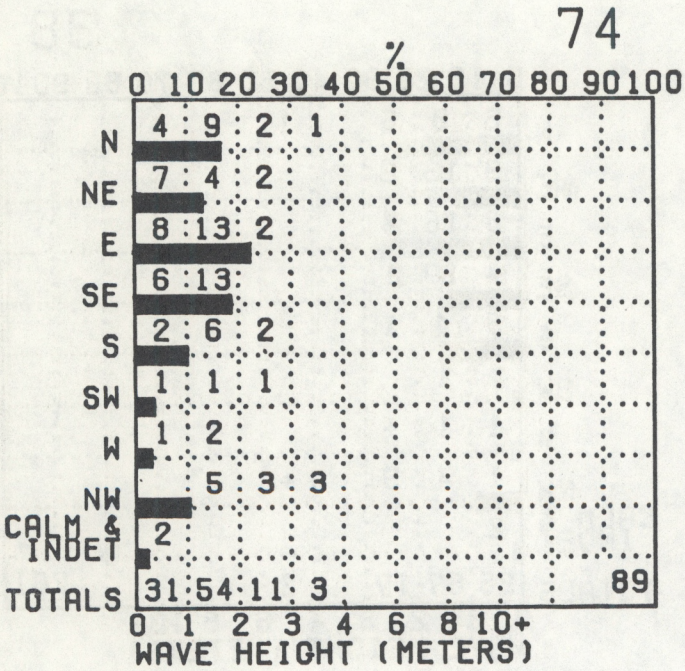
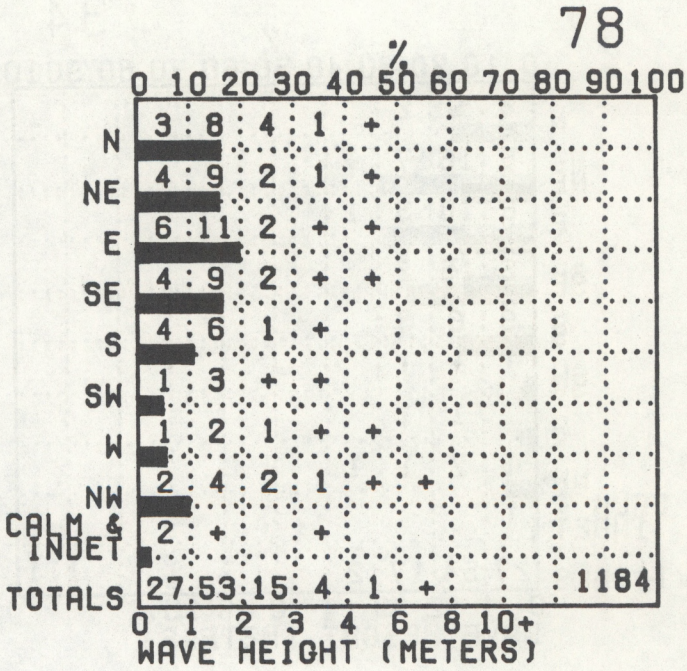
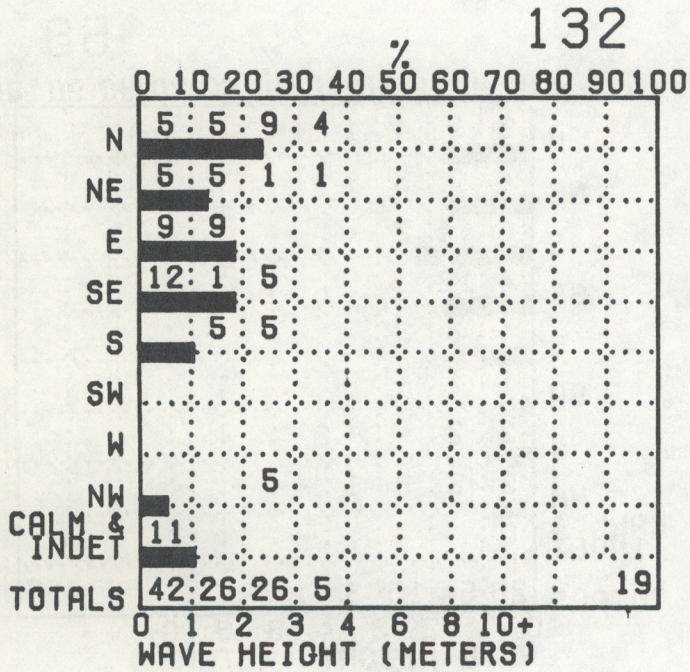


Table 7 (continued)
Month: December Squares: 34, 38, 54, 58

WAVE DIRECTION AND HEIGHT







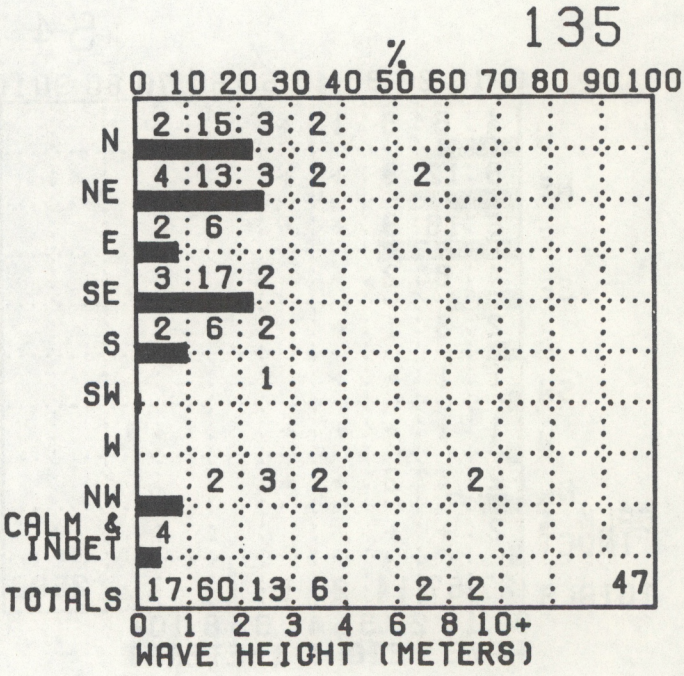
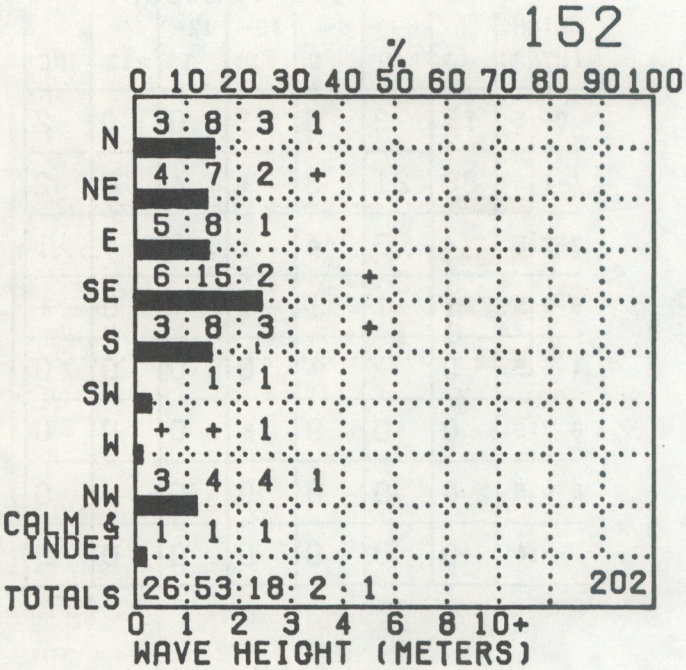
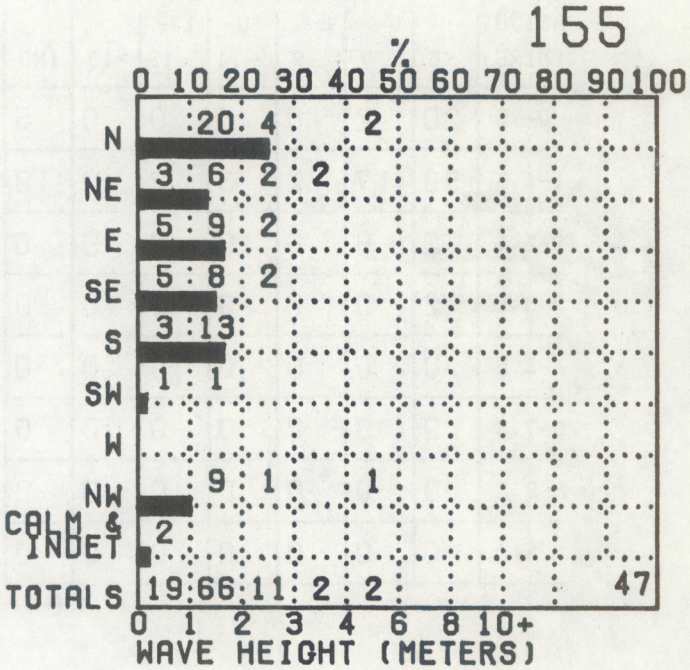
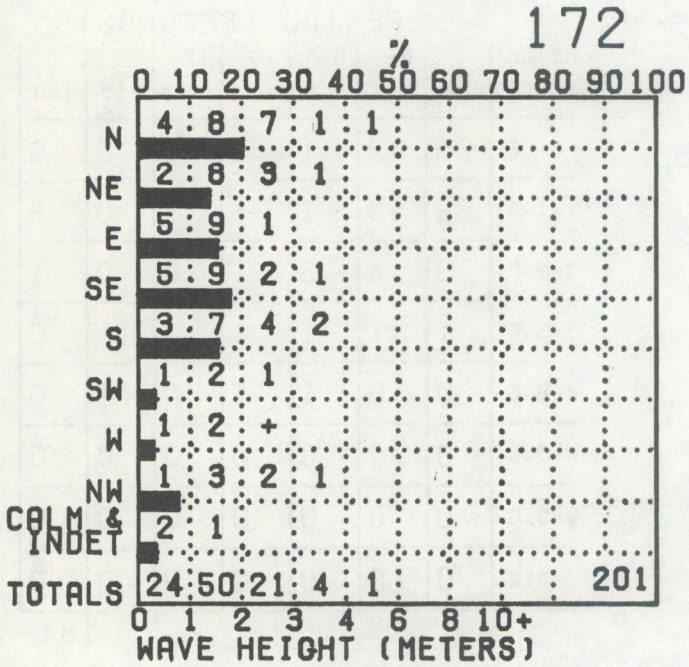


Table 7 (continued)
Month: December Squares: 74, 78, 132, 135

WAVE DIRECTION AND HEIGHT







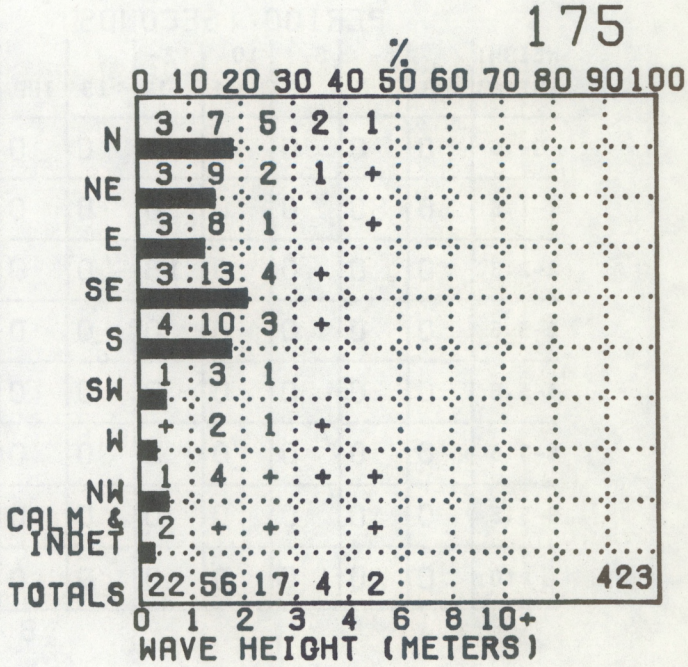


Table 7 (continued)
Month: December Squares: 152, 155, 172, 175

12

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	20	2	0	0	0	0	5
1-1.5	33	17	2	3	2	0	0
2-2.5	2	6	6	0	0	0	0
3-3.5	2	0	2	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

64

15

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	17	2	0	1	0	0	2
1-1.5	30	21	3	+	+	0	2
2-2.5	4	6	4	1	0	+	1
3-3.5	1	1	1	1	+	0	+
4-5.5	0	+	+	0	0	0	0
6-7.5	0	0	0	+	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

497

18

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	0	0	0	0	0	0	0
1-1.5	38	50	0	0	0	0	0
2-2.5	0	0	0	0	13	0	0
3-3.5	0	0	0	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

8

32

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	20	2	1	1	0	0	9
1-1.5	29	13	1	1	1	0	6
2-2.5	3	4	3	1	0	0	1
3-3.5	1	1	1	1	0	1	0
4-5.5	0	0	1	1	0	1	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

184

Table 8. Percent frequency of wave period and height by month for selected 1° squares in the Gulf of Mexico (from NCC Surface Marine Observations Data Base, 1800-1975).

Month: January Squares: 12, 15, 18, 32

WAVE PERIOD AND HEIGHT

34

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	21	0	0	1	0	0	5
1-1.5	26	17	10	2	1	0	2
2-2.5	3	4	5	0	0	0	0
3-3.5	0	2	0	0	0	0	1
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

110

38

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	18	1	1	+	0	0	3
1-1.5	33	16	1	1	+	0	3
2-2.5	2	8	5	2	0	+	+
3-3.5	0	1	1	+	0	1	+
4-5.5	0	1	+	0	0	+	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

298

54

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	23	1	+	+	0	+	3
1-1.5	33	16	3	1	1	+	1
2-2.5	3	6	3	1	+	+	+
3-3.5	+	1	1	1	+	+	+
4-5.5	+	+	+	+	+	+	+
6-7.5	0	0	+	0	+	0	+
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

2736

58

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	19	1	0	+	0	0	1
1-1.5	30	18	3	1	+	+	1
2-2.5	4	7	4	1	+	+	1
3-3.5	+	1	3	1	0	+	0
4-5.5	0	0	+	+	1	+	+
6-7.5	0	0	0	0	1	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

465

Table 8 (continued)
Month: January Squares: 34, 38, 54, 58

74

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	24	1	1	0	0	0	5
1-1.5	17	17	6	0	0	0	2
2-2.5	3	5	3	0	0	0	5
3-3.5	0	1	2	1	0	1	0
4-5.5	1	1	1	0	1	1	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

88

78

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	19	2	+	+	0	0	3
1-1.5	29	17	3	1	+	+	1
2-2.5	3	8	4	2	+	+	+
3-3.5	+	2	1	1	+	+	+
4-5.5	+	+	0	+	+	0	0
6-7.5	0	0	0	0	+	0	0
8-9.5	0	0	0	0	+	0	0
≥10	0	0	0	0	0	0	0

1221

132

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	12	12	4	0	0	0	4
1-1.5	19	12	0	0	0	0	0
2-2.5	12	15	4	0	0	0	0
3-3.5	0	0	0	4	0	0	0
4-5.5	0	4	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

26

135

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	27	0	0	0	0	0	0
1-1.5	38	4	8	0	0	0	8
2-2.5	4	0	4	4	0	0	0
3-3.5	0	0	4	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

26

Table 8 (continued)
Month: January Squares: 74, 78, 132, 135

WAVE PERIOD AND HEIGHT

152

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	11	1	0	0	0	0	3
1-1.5	37	19	2	1	+	0	+
2-2.5	4	9	5	1	1	0	0
3-3.5	0	2	1	+	0	0	0
4-5.5	0	0	+	+	0	0	0
6-7.5	0	0	0	0	+	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

219

155

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	26	0	0	0	0	0	0
1-1.5	19	21	2	0	0	0	0
2-2.5	5	5	12	0	0	0	0
3-3.5	0	5	5	0	0	0	0
4-5.5	0	0	0	2	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

43

172

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	15	2	+	1	0	0	4
1-1.5	29	16	2	1	1	+	3
2-2.5	5	4	5	1	1	0	1
3-3.5	1	2	1	+	0	0	0
4-5.5	0	+	1	1	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

223

175

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	17	1	0	1	0	0	2
1-1.5	28	18	4	+	+	0	+
2-2.5	5	7	5	2	+	+	1
3-3.5	1	2	1	1	+	0	0
4-5.5	+	+	1	+	+	+	0
6-7.5	0	0	0	+	0	+	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

459

Table 8 (continued)
Month: January Squares: 152, 155, 172, 175

12

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	20	4	0	0	0	0	7
1-1.5	35	22	2	2	0	0	0
2-2.5	4	4	0	0	0	0	0
3-3.5	0	0	0	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

54

15

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	17	1	0	+	0	0	2
1-1.5	33	20	2	+	1	0	2
2-2.5	6	8	3	+	1	0	+
3-3.5	1	1	+	1	0	0	+
4-5.5	0	0	0	0	0	0	+
6-7.5	0	0	0	0	0	+	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	+	0	0	0

546

18

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	71	0	0	0	0	0	0
1-1.5	0	0	0	0	0	0	0
2-2.5	0	29	0	0	0	0	0
3-3.5	0	0	0	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

7

32

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	20	1	0	0	0	0	14
1-1.5	33	13	2	1	1	1	3
2-2.5	1	5	3	2	1	0	1
3-3.5	0	0	1	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

194

Table 8 (continued)
Month: February Squares: 12, 15, 18, 32

34

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	26	3	0	0	0	0	7
1-1.5	27	13	4	0	0	0	3
2-2.5	4	5	3	2	0	0	1
3-3.5	2	1	0	0	0	0	0
4-5.5	0	1	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

111

38

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	14	1	0	1	0	0	3
1-1.5	38	19	2	3	+	0	2
2-2.5	3	4	4	0	+	+	0
3-3.5	1	+	1	1	0	0	0
4-5.5	0	+	1	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

252

54

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	22	2	+	+	0	0	3
1-1.5	34	15	3	1	+	+	1
2-2.5	3	6	3	1	+	0	+
3-3.5	1	1	1	+	+	+	+
4-5.5	+	+	+	+	+	+	+
6-7.5	0	+	+	0	0	+	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

2610

58

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	19	1	+	0	0	0	4
1-1.5	29	16	3	1	+	0	1
2-2.5	3	9	6	2	+	0	0
3-3.5	1	1	1	1	+	0	0
4-5.5	+	0	+	0	0	0	+
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

433

Table 8 (continued)
Month: February Squares: 34, 38, 54, 58

74

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	27	0	0	0	0	0	3
1-1.5	23	10	8	1	1	0	3
2-2.5	3	12	3	1	3	0	0
3-3.5	0	0	0	1	0	0	0
4-5.5	0	0	0	0	0	1	1
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

78

78

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	17	2	+	+	0	0	2
1-1.5	31	17	4	1	+	0	2
2-2.5	3	8	5	1	+	0	1
3-3.5	1	1	1	1	+	0	0
4-5.5	+	+	1	1	+	+	0
6-7.5	0	0	+	0	0	+	+
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

1157

132

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	12	8	0	4	0	0	0
1-1.5	42	23	4	0	0	0	0
2-2.5	4	0	4	0	0	0	0
3-3.5	0	0	0	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

26

135

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	11	2	2	0	0	0	5
1-1.5	29	27	5	2	0	0	2
2-2.5	4	5	0	0	0	0	0
3-3.5	0	2	2	0	0	0	0
4-5.5	0	2	2	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

56

Table 8 (continued)
Month: February Squares: 74, 78, 132, 135

152

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	9	3	0	1	0	0	3
1-1.5	34	24	3	1	1	0	1
2-2.5	4	7	6	2	1	0	0
3-3.5	2	1	1	0	0	0	0
4-5.5	0	1	1	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

200

155

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	5	5	0	0	0	0	0
1-1.5	28	25	2	0	0	0	0
2-2.5	7	9	5	4	0	0	0
3-3.5	0	4	0	2	0	0	2
4-5.5	0	2	2	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

57

172

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	18	0	0	1	0	0	3
1-1.5	32	15	2	+	0	0	1
2-2.5	4	5	4	2	+	+	0
3-3.5	3	4	+	+	0	+	0
4-5.5	1	1	0	0	+	0	+
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

220

175

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	15	2	+	+	0	0	2
1-1.5	29	18	4	1	0	0	1
2-2.5	4	9	5	1	+	0	0
3-3.5	0	1	2	1	+	0	0
4-5.5	+	+	+	0	0	+	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

405

Table 8 (continued)
Month: February Squares: 152, 155, 172, 175

12

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	43	0	0	0	0	0	8
1-1.5	23	7	5	0	0	1	3
2-2.5	1	3	7	0	0	0	0
3-3.5	0	0	0	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

75

15

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	15	1	0	+	0	0	3
1-1.5	33	17	4	1	1	0	4
2-2.5	5	5	4	1	+	0	1
3-3.5	+	1	1	1	0	0	+
4-5.5	0	+	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

568

18

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	4	0	0	0	0	0	17
1-1.5	30	26	0	0	0	0	0
2-2.5	9	4	0	0	0	0	0
3-3.5	0	0	4	0	0	0	0
4-5.5	0	0	4	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

23

32

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	23	6	4	1	0	0	19
1-1.5	18	10	2	2	1	0	4
2-2.5	1	4	1	+	0	0	1
3-3.5	0	0	0	0	0	0	0
4-5.5	0	1	+	0	0	0	0
6-7.5	0	0	0	0	0	+	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

282

Table 8 (continued)
Month: March Squares: 12, 15, 18, 32

34

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	21	3	0	0	0	0	3
1-1.5	31	15	5	2	0	0	3
2-2.5	3	6	2	0	0	0	0
3-3.5	0	1	2	0	0	1	2
4-5.5	1	0	1	1	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

107

38

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	15	1	+	0	0	0	3
1-1.5	36	24	5	+	0	+	1
2-2.5	4	4	3	+	0	0	+
3-3.5	0	+	+	+	1	0	0
4-5.5	0	0	+	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

285

54

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	23	2	+	+	0	0	3
1-1.5	33	15	2	1	+	+	1
2-2.5	5	6	4	1	+	+	+
3-3.5	+	1	1	+	+	+	+
4-5.5	+	+	+	+	0	0	+
6-7.5	0	0	0	+	0	+	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

2903

58

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	18	1	+	+	0	0	2
1-1.5	30	18	3	+	+	0	1
2-2.5	6	8	5	2	+	+	+
3-3.5	1	1	2	+	+	0	0
4-5.5	0	0	0	+	0	+	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

474

Table 8 (continued)
Month: March Squares: 34, 38, 54, 58

74

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	21	1	0	0	0	0	8
1-1.5	29	20	3	0	0	0	1
2-2.5	3	5	3	0	0	0	0
3-3.5	3	1	0	0	0	0	0
4-5.5	0	0	0	1	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

75

78

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	19	2	+	+	0	0	4
1-1.5	30	19	4	1	+	0	1
2-2.5	2	7	4	1	+	+	1
3-3.5	+	1	1	1	+	+	+
4-5.5	+	+	+	+	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

1250

132

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	18	3	0	0	0	0	5
1-1.5	47	5	0	0	0	0	0
2-2.5	5	0	0	0	0	0	0
3-3.5	5	0	0	0	0	0	0
4-5.5	0	11	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

38

135

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	24	3	0	0	0	0	3
1-1.5	19	8	5	0	0	0	11
2-2.5	5	8	0	0	0	0	3
3-3.5	0	11	0	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

37

Table 8 (continued)
Month: March Squares: 74, 78, 132, 135

152

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	19	0	+	0	0	0	3
1-1.5	37	15	3	1	0	0	1
2-2.5	4	8	2	2	0	0	0
3-3.5	0	1	+	+	0	0	+
4-5.5	0	0	0	0	+	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

208

155

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	22	0	0	0	0	0	5
1-1.5	32	19	2	0	0	0	0
2-2.5	3	8	0	2	0	0	0
3-3.5	0	5	0	2	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	2	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

63

172

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	16	1	0	+	0	0	4
1-1.5	33	20	4	1	0	0	+
2-2.5	4	9	3	+	+	0	0
3-3.5	0	+	+	2	+	0	0
4-5.5	0	1	+	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

210

175

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	21	3	+	+	0	0	3
1-1.5	27	18	3	1	+	0	1
2-2.5	3	7	5	2	0	0	+
3-3.5	1	1	1	1	+	0	0
4-5.5	+	+	0	0	0	+	0
6-7.5	0	+	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

440

Table 8 (continued)
Month: March Squares: 152, 155, 172, 175

12

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	25	4	0	1	0	0	10
1-1.5	29	12	3	1	0	0	0
2-2.5	7	3	3	0	0	0	0
3-3.5	0	0	0	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

68

15

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	19	2	+	+	0	0	4
1-1.5	36	15	2	1	+	0	3
2-2.5	4	7	3	1	1	+	+
3-3.5	0	2	+	+	0	0	0
4-5.5	0	+	0	0	+	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

572

18

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	11	33	0	0	0	0	0
1-1.5	11	22	11	0	11	0	0
2-2.5	0	0	0	0	0	0	0
3-3.5	0	0	0	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

9

32

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	25	5	5	4	0	0	12
1-1.5	23	7	2	3	4	0	1
2-2.5	2	2	3	+	1	+	1
3-3.5	+	+	+	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

310

Table 8 (continued)
Month: April Squares: 12, 15, 18, 32

74

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	36	8	0	0	0	0	6
1-1.5	27	10	4	1	0	0	1
2-2.5	3	3	0	0	0	0	0
3-3.5	1	0	0	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

78

78

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	24	2	1	+	0	0	3
1-1.5	31	18	3	1	+	0	2
2-2.5	3	5	3	1	+	+	+
3-3.5	+	1	1	+	0	0	+
4-5.5	+	+	+	+	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

1190

132

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	25	0	0	0	0	0	0
1-1.5	33	25	0	0	0	0	0
2-2.5	0	8	0	0	0	0	0
3-3.5	8	0	0	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

12

135

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	27	3	0	0	0	0	0
1-1.5	33	12	3	0	0	0	18
2-2.5	0	3	0	0	0	0	0
3-3.5	0	0	0	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

33

Table 8 (continued)
Month: April Squares: 34, 38, 54, 58

34

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	24	0	2	0	0	0	5
1-1.5	31	14	2	0	0	0	4
2-2.5	3	2	2	3	1	0	1
3-3.5	0	1	1	2	1	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	1
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

121

38

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	16	1	+	0	0	0	4
1-1.5	30	24	4	1	0	+	1
2-2.5	6	6	4	+	+	1	0
3-3.5	+	0	+	0	0	0	0
4-5.5	+	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

275

54

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	25	2	+	+	0	0	4
1-1.5	33	17	2	1	+	+	1
2-2.5	4	6	2	1	+	+	+
3-3.5	+	+	+	+	+	+	+
4-5.5	0	0	+	+	0	+	+
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

2609

58

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	22	1	1	+	0	0	3
1-1.5	33	16	2	1	+	0	1
2-2.5	3	7	4	1	+	0	+
3-3.5	+	1	+	+	+	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

425

Table 8 (continued)
Month: April Squares: 74, 78, 132, 135

WAVE PERIOD AND HEIGHT

152

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	17	3	0	0	0	0	3
1-1.5	38	18	2	1	1	0	1
2-2.5	3	7	6	0	0	1	0
3-3.5	1	1	0	1	1	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

200

155

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	16	0	0	0	0	0	0
1-1.5	37	21	2	0	0	2	0
2-2.5	5	0	7	0	2	0	0
3-3.5	0	2	0	2	0	2	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

43

175

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	22	3	1	+	0	+	3
1-1.5	33	16	4	+	1	+	+
2-2.5	4	5	3	1	0	+	+
3-3.5	0	1	1	1	0	0	+
4-5.5	0	0	0	+	0	0	0
6-7.5	0	+	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

451

172

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	21	2	1	+	0	0	3
1-1.5	33	15	3	0	0	0	1
2-2.5	6	10	1	+	1	0	+
3-3.5	0	1	0	+	0	0	0
4-5.5	0	+	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

216

Table 8 (continued)
Month: April Squares: 152, 155, 172, 175

12

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	37	7	0	0	0	0	3
1-1.5	30	17	0	0	0	0	0
2-2.5	0	3	0	0	0	0	1
3-3.5	0	0	1	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

70

15

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	27	2	+	+	0	0	5
1-1.5	36	16	2	1	1	0	2
2-2.5	3	3	2	+	1	0	1
3-3.5	+	+	+	+	0	0	0
4-5.5	0	0	0	0	0	+	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

595

18

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	22	11	0	0	0	0	22
1-1.5	33	11	0	0	0	0	0
2-2.5	0	0	0	0	0	0	0
3-3.5	0	0	0	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

9

32

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	37	2	1	+	0	0	17
1-1.5	22	11	1	0	0	0	1
2-2.5	1	2	2	0	0	0	1
3-3.5	1	+	+	+	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

321

Table 8 (continued)
Month: May Squares: 12, 15, 18, 32

34

PERIOD (SECONDS)

HEIGHT (MTRS)	<6	6-7	8-9	10-11	12-13	>13	IND
0-.5	22	2	0	1	0	0	7
1-1.5	36	14	3	1	1	0	6
2-2.5	1	3	3	0	0	0	0
3-3.5	1	0	2	0	0	0	0
4-5.5	0	1	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

120

38

PERIOD (SECONDS)

HEIGHT (MTRS)	<6	6-7	8-9	10-11	12-13	>13	IND
0-.5	27	2	+	0	0	0	3
1-1.5	38	19	2	1	+	0	2
2-2.5	2	2	1	+	0	1	0
3-3.5	0	0	+	0	0	0	0
4-5.5	0	+	0	0	0	0	0
6-7.5	0	0	0	0	0	0	+
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

332

54

PERIOD (SECONDS)

HEIGHT (MTRS)	<6	6-7	8-9	10-11	12-13	>13	IND
0-.5	35	2	+	+	0	0	7
1-1.5	33	12	2	1	+	+	1
2-2.5	2	3	1	+	+	+	+
3-3.5	+	+	+	0	+	0	0
4-5.5	0	0	+	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

2724

58

PERIOD (SECONDS)

HEIGHT (MTRS)	<6	6-7	8-9	10-11	12-13	>13	IND
0-.5	30	2	1	+	0	0	7
1-1.5	35	13	2	1	+	0	1
2-2.5	2	4	1	+	0	0	+
3-3.5	0	0	0	0	0	0	0
4-5.5	0	+	+	+	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

443

Table 8 (continued)
Month: May Squares: 34, 38, 54, 58

74

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	48	2	1	0	0	0	13
1-1.5	17	11	0	1	1	0	0
2-2.5	1	2	1	0	0	0	0
3-3.5	0	0	0	0	0	0	0
4-5.5	0	1	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

93

78

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	34	2	1	1	0	0	6
1-1.5	30	13	2	1	+	0	1
2-2.5	2	3	2	+	+	0	+
3-3.5	+	+	+	+	+	0	0
4-5.5	0	+	+	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

1168

132

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	32	0	0	0	0	0	0
1-1.5	28	16	4	0	0	0	0
2-2.5	4	16	0	0	0	0	0
3-3.5	0	0	0	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

25

135

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	16	0	0	0	0	0	5
1-1.5	30	21	5	0	0	0	12
2-2.5	2	2	5	0	0	0	0
3-3.5	0	2	0	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

43

Table 8 (continued)
Month: May Squares: 74, 78, 132, 135

152

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	21	2	1	0	0	0	5
1-1.5	34	17	3	1	0	0	+
2-2.5	4	4	3	+	+	+	0
3-3.5	+	2	0	0	+	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

217

155

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	23	0	3	0	0	0	3
1-1.5	24	27	3	0	0	0	2
2-2.5	2	8	3	0	0	0	0
3-3.5	0	3	0	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

66

172

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	27	2	1	+	0	0	5
1-1.5	35	15	2	+	+	0	2
2-2.5	4	2	+	+	+	0	0
3-3.5	0	+	+	0	0	0	0
4-5.5	0	+	0	0	+	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

263

175

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	24	3	1	+	0	0	4
1-1.5	33	17	4	1	+	0	1
2-2.5	4	4	2	+	0	+	0
3-3.5	0	+	1	0	+	0	0
4-5.5	0	0	0	+	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

490

Table 8 (continued)
Month: May Squares: 152, 155, 172, 175

12

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	33	2	0	0	0	0	6
1-1.5	23	19	1	0	0	0	0
2-2.5	1	4	4	1	2	0	1
3-3.5	1	0	0	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

81

15

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	25	1	1	+	0	0	5
1-1.5	33	16	4	1	1	0	2
2-2.5	2	4	2	0	+	+	+
3-3.5	0	1	+	+	+	+	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	+	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

584

18

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	38	13	0	0	0	0	19
1-1.5	31	0	0	0	0	0	0
2-2.5	0	0	0	0	0	0	0
3-3.5	0	0	0	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

16

32

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	49	1	0	+	0	0	17
1-1.5	21	6	1	+	0	0	1
2-2.5	+	2	1	0	0	0	0
3-3.5	0	0	0	0	0	0	0
4-5.5	0	0	0	+	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

346

Table 8 (continued)
Month: June Squares: 12, 15, 18, 32

WAVE PERIOD AND HEIGHT

34

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	42	3	0	0	0	0	14
1-1.5	24	7	2	1	0	0	2
2-2.5	1	1	1	0	0	0	1
3-3.5	0	1	2	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

120

38

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	32	1	1	0	0	0	6
1-1.5	31	16	1	1	1	0	2
2-2.5	1	3	3	1	0	0	0
3-3.5	0	0	0	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

290

54

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	42	3	+	+	0	0	11
1-1.5	26	10	1	+	+	+	1
2-2.5	1	2	1	+	+	+	+
3-3.5	+	+	+	+	+	+	0
4-5.5	+	+	+	+	+	+	+
6-7.5	0	+	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

3013

58

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	44	2	1	1	0	0	10
1-1.5	26	9	3	+	+	+	1
2-2.5	1	1	1	+	+	0	0
3-3.5	0	+	+	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

519

Table 8 (continued)
Month: June Squares: 34, 38, 54, 58

74

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	43	2	1	0	0	0	16
1-1.5	24	6	1	0	0	0	2
2-2.5	1	2	0	0	0	0	0
3-3.5	0	1	0	0	0	0	0
4-5.5	0	0	2	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

129

78

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	43	3	1	+	0	+	10
1-1.5	22	10	2	1	+	+	1
2-2.5	1	3	1	+	+	+	+
3-3.5	+	+	+	+	+	0	0
4-5.5	0	0	+	+	0	0	+
6-7.5	0	0	0	0	0	+	+
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

1401

132

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	11	11	5	0	0	0	11
1-1.5	21	29	5	0	0	0	3
2-2.5	3	0	0	3	0	0	0
3-3.5	0	0	0	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

38

135

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	22	5	0	0	0	0	9
1-1.5	22	17	3	0	2	0	14
2-2.5	2	3	0	0	0	0	0
3-3.5	0	0	0	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

58

Table 8 (continued)
Month: June Squares: 74, 78, 132, 135

152

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	31	4	0	+	0	0	6
1-1.5	37	15	2	0	+	0	0
2-2.5	1	3	+	0	0	0	0
3-3.5	0	0	+	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

216

155

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	25	4	1	0	0	0	2
1-1.5	36	16	1	1	0	0	0
2-2.5	6	4	1	0	0	0	0
3-3.5	1	1	0	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

81

172

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	34	2	2	0	0	0	5
1-1.5	32	15	2	+	0	+	1
2-2.5	1	2	1	+	0	0	0
3-3.5	+	0	0	0	0	0	0
4-5.5	0	0	0	0	0	+	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

245

175

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	32	4	1	+	0	0	4
1-1.5	32	15	3	+	+	0	1
2-2.5	2	3	1	+	+	0	+
3-3.5	0	+	1	+	0	0	0
4-5.5	0	0	0	+	0	0	0
6-7.5	0	0	0	0	0	0	+
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

500

Table 8 (continued)
Month: June Squares: 152, 155, 172, 175

12

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	34	7	0	0	0	0	10
1-1.5	16	18	5	2	0	0	2
2-2.5	0	2	2	0	2	0	0
3-3.5	0	0	0	0	0	0	0
4-5.5	0	0	0	2	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

61

15

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	31	3	+	+	0	0	6
1-1.5	35	15	2	1	1	0	2
2-2.5	1	2	+	+	0	0	0
3-3.5	0	1	0	+	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

620

18

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	27	0	0	0	0	0	0
1-1.5	36	18	18	0	0	0	0
2-2.5	0	0	0	0	0	0	0
3-3.5	0	0	0	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

11

32

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	52	2	0	0	0	0	9
1-1.5	21	9	1	0	1	0	2
2-2.5	0	1	1	+	0	0	+
3-3.5	0	0	0	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

269

Table 8 (continued)
Month: July Squares: 12, 15, 18, 32

34

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	44	3	0	0	0	0	11
1-1.5	23	9	1	0	2	0	5
2-2.5	1	1	0	0	0	0	1
3-3.5	0	0	0	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

120

38

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	42	1	2	+	0	0	10
1-1.5	29	11	1	0	1	0	1
2-2.5	0	1	1	0	0	0	0
3-3.5	0	0	0	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

271

54

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	49	3	+	+	0	0	13
1-1.5	22	8	1	+	0	+	1
2-2.5	1	1	1	+	+	0	+
3-3.5	0	+	+	+	0	0	0
4-5.5	+	+	0	+	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

3011

58

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	51	1	1	+	0	0	14
1-1.5	21	6	2	0	0	0	1
2-2.5	1	1	1	0	0	0	0
3-3.5	+	+	+	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

521

Table 8 (continued)
Month: July Squares: 34, 38, 54, 58

74

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	52	2	0	0	0	0	25
1-1.5	12	5	0	0	0	1	3
2-2.5	1	0	1	0	0	0	0
3-3.5	0	0	0	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

110

78

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	46	4	+	1	0	0	14
1-1.5	22	8	1	+	+	+	1
2-2.5	1	1	+	+	+	+	+
3-3.5	0	+	0	0	0	0	0
4-5.5	+	0	+	0	+	+	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

1319

132

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	26	0	0	0	0	0	9
1-1.5	39	13	9	0	0	0	0
2-2.5	0	4	0	0	0	0	0
3-3.5	0	0	0	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

23

135

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	37	6	0	0	0	0	6
1-1.5	31	8	0	0	2	0	6
2-2.5	2	2	0	0	0	0	0
3-3.5	0	0	0	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

49

Table 8 (continued)
Month: July Squares: 74, 78, 132, 135

152

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	41	2	1	1	0	0	11
1-1.5	27	14	2	0	0	0	2
2-2.5	1	1	0	0	0	0	0
3-3.5	0	0	0	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

190

155

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	42	5	0	3	0	0	5
1-1.5	28	15	2	2	0	0	0
2-2.5	0	0	0	0	0	0	0
3-3.5	0	0	0	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

65

172

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	48	4	2	+	0	0	10
1-1.5	24	6	1	+	0	0	+
2-2.5	+	1	+	+	0	0	0
3-3.5	+	0	+	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

219

175

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	36	4	+	0	0	0	9
1-1.5	29	10	3	1	0	0	+
2-2.5	2	2	1	+	+	0	0
3-3.5	1	0	0	+	0	0	0
4-5.5	0	0	+	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

548

Table 8 (continued)
Month: July Squares: 152, 155, 172, 175

12

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	37	3	0	0	0	0	12
1-1.5	27	14	1	0	0	0	0
2-2.5	1	1	3	0	0	0	0
3-3.5	0	0	0	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

73

15

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	37	3	1	+	0	+	13
1-1.5	28	11	2	+	1	0	1
2-2.5	2	+	+	+	+	0	0
3-3.5	0	+	1	0	+	0	0
4-5.5	0	0	+	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

609

18

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	80	0	0	0	0	0	0
1-1.5	0	0	20	0	0	0	0
2-2.5	0	0	0	0	0	0	0
3-3.5	0	0	0	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

5

32

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	40	1	0	0	0	0	19
1-1.5	25	7	1	+	+	0	2
2-2.5	2	1	+	+	0	0	0
3-3.5	0	0	0	+	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

326

Table 8 (continued)
Month: August Squares: 12, 15, 18, 32

34

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	37	3	1	1	0	0	16
1-1.5	19	11	0	1	2	0	7
2-2.5	1	1	0	0	0	0	1
3-3.5	0	1	0	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

137

38

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	47	3	1	1	0	0	11
1-1.5	25	6	1	1	0	0	2
2-2.5	1	1	0	0	0	0	0
3-3.5	0	0	0	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

310

54

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	49	2	+	+	0	0	14
1-1.5	22	8	1	+	+	0	+
2-2.5	1	1	+	+	0	+	0
3-3.5	+	+	+	+	0	+	0
4-5.5	+	+	+	0	0	+	0
6-7.5	0	+	0	0	+	+	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

2980

58

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	47	1	+	0	0	0	15
1-1.5	25	8	1	+	0	0	+
2-2.5	+	1	+	+	0	0	0
3-3.5	+	0	0	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

554

Table 8 (continued)
Month: August Squares: 34, 38, 54, 58

74

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	38	6	2	0	0	0	20
1-1.5	15	11	3	0	0	1	1
2-2.5	0	1	1	0	0	0	0
3-3.5	0	0	0	1	0	0	0
4-5.5	0	0	0	0	0	1	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

102

78

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	44	3	1	+	0	0	14
1-1.5	23	10	2	+	+	0	1
2-2.5	1	1	1	0	0	+	+
3-3.5	0	+	+	+	+	+	+
4-5.5	+	0	0	+	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

1335

132

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	26	2	0	0	0	0	11
1-1.5	40	15	2	0	0	0	0
2-2.5	0	4	0	0	0	0	0
3-3.5	0	0	0	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

47

135

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	45	2	0	0	0	0	18
1-1.5	16	10	0	2	0	0	4
2-2.5	0	0	0	0	0	0	0
3-3.5	0	2	0	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

49

Table 8 (continued)
Month: August Squares: 74, 78, 132, 135

152

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	35	1	1	0	0	0	13
1-1.5	34	9	1	0	+	0	1
2-2.5	1	1	1	+	0	0	0
3-3.5	0	+	0	1	0	0	0
4-5.5	0	0	0	+	0	+	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

244

155

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	32	4	0	0	0	0	4
1-1.5	37	10	1	0	0	1	3
2-2.5	1	3	1	0	0	0	0
3-3.5	0	0	1	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

71

172

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	42	5	0	0	0	0	13
1-1.5	26	6	1	1	0	0	1
2-2.5	2	1	+	+	0	0	0
3-3.5	0	1	0	+	0	0	0
4-5.5	0	+	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

239

175

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	42	4	0	+	0	0	8
1-1.5	28	11	1	+	+	+	2
2-2.5	1	1	+	+	+	0	+
3-3.5	0	0	+	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

496

Table 8 (continued)
Month: August Squares: 152, 155, 172, 175

12

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	31	0	1	0	0	0	12
1-1.5	22	21	5	0	0	0	0
2-2.5	4	1	4	0	0	0	0
3-3.5	0	0	0	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

78

15

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	29	2	1	+	0	0	8
1-1.5	31	13	2	1	+	+	2
2-2.5	2	4	2	1	0	0	1
3-3.5	+	1	1	0	+	+	0
4-5.5	0	0	0	0	+	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

580

18

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	44	0	11	0	0	0	11
1-1.5	0	11	22	0	0	0	0
2-2.5	0	0	0	0	0	0	0
3-3.5	0	0	0	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

9

32

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	32	3	2	0	0	0	13
1-1.5	27	9	1	0	+	0	4
2-2.5	1	3	1	0	0	0	1
3-3.5	0	1	1	0	+	0	0
4-5.5	0	0	0	+	0	0	0
6-7.5	0	0	0	+	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

254

Table 8 (continued)
Month: September Squares: 12, 15, 18, 32

WAVE PERIOD AND HEIGHT

34

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	22	0	1	0	0	0	12
1-1.5	25	11	3	1	0	1	4
2-2.5	1	3	6	1	0	0	1
3-3.5	1	1	1	1	1	0	1
4-5.5	1	0	0	0	3	1	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

159

38

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	33	3	0	+	0	0	6
1-1.5	28	13	2	1	+	0	2
2-2.5	2	6	2	1	0	0	0
3-3.5	0	+	1	0	0	0	0
4-5.5	0	1	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

296

54

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	35	3	+	+	0	0	7
1-1.5	28	13	2	1	+	+	1
2-2.5	2	3	2	1	+	0	+
3-3.5	+	+	+	+	0	+	+
4-5.5	0	+	+	+	0	+	+
6-7.5	0	0	0	0	0	+	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

2867

58

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	28	2	1	+	0	0	8
1-1.5	25	17	2	0	0	+	2
2-2.5	1	3	3	1	+	+	+
3-3.5	+	1	1	0	+	0	0
4-5.5	0	+	1	1	+	0	+
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

518

Table 8 (continued)
Month: September Squares: 34, 38, 54, 58

74

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	40	2	1	0	0	0	3
1-1.5	21	12	3	0	0	0	2
2-2.5	1	5	1	4	0	0	0
3-3.5	1	0	3	0	1	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

100

78

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	30	3	+	+	0	0	6
1-1.5	27	15	3	1	+	+	1
2-2.5	2	4	3	1	+	+	+
3-3.5	0	1	1	+	0	+	+
4-5.5	+	+	+	+	+	+	0
6-7.5	0	0	+	+	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

1305

132

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	14	10	0	0	0	0	0
1-1.5	24	10	5	0	0	0	5
2-2.5	5	5	5	0	5	0	0
3-3.5	0	5	5	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	5	0
≥10	0	0	0	0	0	0	0

21

135

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	37	0	0	0	0	0	18
1-1.5	16	8	8	0	2	0	8
2-2.5	2	0	0	0	0	0	0
3-3.5	0	0	0	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

49

Table 8 (continued)
Month: September Squares: 74, 78, 132, 135

WAVE PERIOD AND HEIGHT

152

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	26	1	+	0	0	0	3
1-1.5	33	14	3	0	+	0	0
2-2.5	2	5	4	+	+	0	0
3-3.5	1	1	0	1	+	1	0
4-5.5	0	+	0	0	1	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

223

155

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	25	6	0	0	0	0	1
1-1.5	30	20	4	4	0	0	0
2-2.5	1	6	0	0	0	0	0
3-3.5	0	0	0	0	1	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	1	0	0	0
≥10	0	0	0	0	0	0	0

71

172

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	22	2	+	0	0	0	6
1-1.5	24	15	2	1	1	0	2
2-2.5	7	7	2	2	0	0	+
3-3.5	0	2	1	0	1	0	0
4-5.5	1	+	1	0	0	0	1
6-7.5	0	0	0	0	0	+	0
8-9.5	0	0	0	0	0	+	0
≥10	0	0	0	0	0	0	0

241

175

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	30	3	+	+	0	0	6
1-1.5	25	18	3	1	0	+	2
2-2.5	2	4	2	+	+	0	0
3-3.5	+	0	+	0	0	0	0
4-5.5	0	0	+	+	0	0	0
6-7.5	0	+	0	+	0	+	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

442

Table 8 (continued)
Month: September Squares: 152, 155, 172, 175

WAVE PERIOD AND HEIGHT

12

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	35	0	1	0	0	0	5
1-1.5	26	12	8	0	1	0	1
2-2.5	3	5	1	0	0	0	0
3-3.5	0	0	0	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

74

15

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	26	2	+	1	0	0	5
1-1.5	29	15	3	1	+	0	2
2-2.5	3	6	2	1	+	0	+
3-3.5	+	1	1	+	+	0	+
4-5.5	0	+	+	+	0	0	+
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	+	0	0	0
≥10	0	0	0	0	0	0	0

585

18

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	73	0	0	0	0	0	0
1-1.5	13	13	0	0	0	0	0
2-2.5	0	0	0	0	0	0	0
3-3.5	0	0	0	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

15

32

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	27	3	0	0	0	0	9
1-1.5	24	14	2	+	+	0	4
2-2.5	4	4	3	+	+	+	+
3-3.5	0	+	+	+	0	+	+
4-5.5	+	+	0	+	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

246

Table 8 (continued)
Month: October Squares: 12, 15, 18, 32

34

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	25	2	0	0	0	0	2
1-1.5	25	13	4	0	0	0	6
2-2.5	2	8	3	2	0	0	1
3-3.5	0	1	2	1	2	1	0
4-5.5	0	0	0	1	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

128

38

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	25	1	1	0	0	0	4
1-1.5	29	14	3	1	0	0	1
2-2.5	4	5	4	1	0	0	1
3-3.5	2	1	1	1	0	0	0
4-5.5	0	+	+	0	1	+	0
6-7.5	0	0	+	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

344

58

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	23	2	+	0	0	0	3
1-1.5	29	19	4	1	1	0	1
2-2.5	2	6	3	2	+	0	1
3-3.5	+	1	1	1	+	0	0
4-5.5	0	+	+	+	0	0	+
6-7.5	0	0	0	0	+	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

554

54

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	27	2	+	+	0	0	5
1-1.5	30	17	3	+	+	+	1
2-2.5	2	5	3	1	+	+	+
3-3.5	+	1	1	+	+	+	+
4-5.5	+	+	+	+	+	+	0
6-7.5	0	+	+	+	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

2952

Table 8 (continued)
Month: October Squares: 34, 38, 54, 58

74

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	32	1	0	0	0	0	5
1-1.5	25	19	3	0	0	0	3
2-2.5	3	3	3	1	0	2	0
3-3.5	0	0	0	1	0	0	0
4-5.5	1	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

111

78

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	26	3	+	+	0	0	5
1-1.5	26	17	3	+	+	+	1
2-2.5	2	6	3	1	+	0	1
3-3.5	+	1	1	+	+	+	+
4-5.5	+	0	+	+	+	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

1323

132

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	24	0	0	0	0	0	6
1-1.5	21	15	0	0	0	0	0
2-2.5	6	18	0	0	0	0	0
3-3.5	0	3	0	3	0	0	0
4-5.5	0	0	0	6	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

34

135

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	38	8	0	0	0	0	8
1-1.5	10	13	2	0	0	0	10
2-2.5	0	6	2	0	0	0	2
3-3.5	0	0	0	0	0	0	0
4-5.5	0	0	2	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

52

Table 8 (continued)
Month: October Squares: 74, 78, 132, 135

152

PERIOD (SECONDS)

HEIGHT (MTRS)	<6	6-7	8-9	10-11	12-13	>13	IND
0-.5	26	3	+	0	0	0	4
1-1.5	33	8	3	1	0	0	+
2-2.5	2	9	3	1	0	0	1
3-3.5	+	+	1	+	0	0	0
4-5.5	0	+	+	+	1	+	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

243

155

PERIOD (SECONDS)

HEIGHT (MTRS)	<6	6-7	8-9	10-11	12-13	>13	IND
0-.5	14	1	0	1	0	0	4
1-1.5	43	19	3	0	0	0	0
2-2.5	1	6	1	1	0	0	0
3-3.5	0	1	0	0	0	0	0
4-5.5	0	0	0	0	0	0	1
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

69

172

PERIOD (SECONDS)

HEIGHT (MTRS)	<6	6-7	8-9	10-11	12-13	>13	IND
0-.5	23	1	+	+	0	0	6
1-1.5	30	14	3	+	1	+	+
2-2.5	6	5	4	1	1	0	+
3-3.5	+	+	1	0	+	+	+
4-5.5	0	0	0	0	+	0	0
6-7.5	0	0	+	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

257

175

PERIOD (SECONDS)

HEIGHT (MTRS)	<6	6-7	8-9	10-11	12-13	>13	IND
0-.5	24	2	1	+	0	0	3
1-1.5	31	17	4	1	1	0	1
2-2.5	4	4	3	2	+	+	0
3-3.5	1	1	1	1	+	0	0
4-5.5	+	0	+	0	0	0	0
6-7.5	0	0	+	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

508

Table 8 (continued)
Month: October Squares: 152, 155, 172, 175

12

PERIOD (SECONDS)

HEIGHT (MTRS)	<6	6-7	8-9	10-11	12-13	>13	IND
0-.5	22	1	1	0	0	0	7
1-1.5	27	19	3	0	0	0	0
2-2.5	4	6	4	0	1	0	0
3-3.5	1	0	0	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

67

15

PERIOD (SECONDS)

HEIGHT (MTRS)	<6	6-7	8-9	10-11	12-13	>13	IND
0-.5	22	1	+	+	0	0	4
1-1.5	31	18	3	1	0	0	3
2-2.5	3	8	4	1	+	0	0
3-3.5	1	1	1	+	+	0	+
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

513

18

PERIOD (SECONDS)

HEIGHT (MTRS)	<6	6-7	8-9	10-11	12-13	>13	IND
0-.5	17	0	0	0	0	0	0
1-1.5	33	33	17	0	0	0	0
2-2.5	0	0	0	0	0	0	0
3-3.5	0	0	0	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

6

32

PERIOD (SECONDS)

HEIGHT (MTRS)	<6	6-7	8-9	10-11	12-13	>13	IND
0-.5	18	3	1	0	0	0	6
1-1.5	32	13	3	1	1	0	3
2-2.5	3	7	2	+	0	0	3
3-3.5	0	+	1	0	0	0	0
4-5.5	0	+	+	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

211

Table 8 (continued)
Month: November Squares: 12, 15, 18, 32

WAVE PERIOD AND HEIGHT

34

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	20	3	0	0	0	0	6
1-1.5	28	17	2	0	0	0	6
2-2.5	2	7	6	0	1	0	0
3-3.5	0	1	2	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

130

38

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	23	1	0	0	0	0	4
1-1.5	30	18	2	1	0	0	3
2-2.5	4	7	2	2	+	+	0
3-3.5	0	1	1	1	0	0	0
4-5.5	0	1	+	+	0	0	0
6-7.5	0	1	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

288

54

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	23	2	1	+	0	0	2
1-1.5	34	17	3	+	+	+	1
2-2.5	3	6	4	1	+	+	+
3-3.5	+	1	1	+	+	+	+
4-5.5	+	+	+	+	+	0	0
6-7.5	0	+	0	0	0	+	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

2821

58

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	20	1	+	+	0	0	4
1-1.5	29	18	3	1	1	0	1
2-2.5	3	7	5	1	+	0	0
3-3.5	0	1	1	1	1	+	0
4-5.5	+	+	+	0	0	0	0
6-7.5	0	+	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

481

Table 8 (continued)
Month: November Squares: 34, 38, 54, 58

74

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	29	2	1	0	0	0	5
1-1.5	31	14	2	0	1	0	2
2-2.5	2	4	1	0	0	3	1
3-3.5	0	1	0	0	0	0	1
4-5.5	0	0	0	1	1	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

116

78

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	23	2	+	+	0	0	4
1-1.5	30	19	2	1	+	+	1
2-2.5	2	7	4	1	+	+	1
3-3.5	1	1	1	1	+	+	0
4-5.5	+	+	+	0	0	+	0
6-7.5	0	0	0	0	0	+	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

1212

132

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	28	0	0	0	0	0	0
1-1.5	39	22	0	0	0	0	0
2-2.5	0	6	6	0	0	0	0
3-3.5	0	0	0	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

18

135

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	16	0	0	3	0	0	8
1-1.5	16	14	3	0	0	0	14
2-2.5	5	5	5	0	3	0	3
3-3.5	0	3	0	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	3	0
≥10	0	0	0	0	0	0	0

37

Table 8 (continued)
Month: November Squares: 74, 78, 132, 135

WAVE PERIOD AND HEIGHT

152

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	21	1	0	+	0	0	1
1-1.5	34	17	3	+	+	0	1
2-2.5	3	4	6	1	0	+	0
3-3.5	0	1	0	1	0	+	0
4-5.5	+	+	1	0	0	+	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

206

155

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	14	0	0	0	0	0	2
1-1.5	37	19	5	0	3	0	0
2-2.5	5	7	3	2	0	0	0
3-3.5	2	0	0	0	0	0	0
4-5.5	0	0	2	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

59

172

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	23	2	0	+	0	0	2
1-1.5	32	16	3	1	1	0	2
2-2.5	4	5	3	+	0	0	0
3-3.5	1	0	1	0	+	0	0
4-5.5	+	0	0	0	+	0	0
6-7.5	0	0	+	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

207

175

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	19	3	1	+	0	0	2
1-1.5	29	17	4	1	1	0	1
2-2.5	5	5	3	2	+	0	0
3-3.5	+	2	1	1	+	0	0
4-5.5	0	+	1	+	+	+	0
6-7.5	0	0	+	0	+	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

461

Table 8 (continued)
Month: November Squares: 152, 155, 172, 175

12

PERIOD (SECONDS)

HEIGHT (MTRS)	<6	6-7	8-9	10-11	12-13	>13	IND
0-.5	17	2	0	2	0	0	0
1-1.5	35	21	8	0	0	0	2
2-2.5	0	4	6	2	0	0	2
3-3.5	0	0	0	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

52

15

PERIOD (SECONDS)

HEIGHT (MTRS)	<6	6-7	8-9	10-11	12-13	>13	IND
0-.5	18	2	1	0	0	0	3
1-1.5	30	16	3	1	+	0	2
2-2.5	3	9	5	1	1	0	+
3-3.5	1	2	2	0	+	0	+
4-5.5	0	+	0	0	0	0	+
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

511

18

PERIOD (SECONDS)

HEIGHT (MTRS)	<6	6-7	8-9	10-11	12-13	>13	IND
0-.5	25	13	0	0	0	0	0
1-1.5	38	0	13	13	0	0	0
2-2.5	0	0	0	0	0	0	0
3-3.5	0	0	0	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

8

32

PERIOD (SECONDS)

HEIGHT (MTRS)	<6	6-7	8-9	10-11	12-13	>13	IND
0-.5	20	1	2	2	0	0	7
1-1.5	32	18	4	1	0	0	1
2-2.5	3	6	3	1	0	0	1
3-3.5	0	1	0	0	0	0	0
4-5.5	0	0	1	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

181

Table 8 (continued)
Month: December Squares: 12, 15, 18, 32

34

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	22	1	0	0	0	0	5
1-1.5	36	10	4	1	0	0	4
2-2.5	1	7	6	1	0	0	2
3-3.5	1	1	0	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

111

38

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	18	3	0	+	0	0	3
1-1.5	27	20	5	0	1	1	2
2-2.5	3	8	4	2	+	0	0
3-3.5	0	0	0	0	0	0	0
4-5.5	0	+	0	0	1	0	+
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

261

54

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	22	2	+	+	0	0	3
1-1.5	34	18	2	1	+	+	1
2-2.5	2	6	4	1	+	+	+
3-3.5	+	+	1	+	0	+	+
4-5.5	+	+	+	+	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

2690

58

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	21	2	+	1	0	0	2
1-1.5	29	20	4	+	0	+	1
2-2.5	2	7	3	2	+	+	+
3-3.5	0	1	2	1	+	0	0
4-5.5	+	+	+	0	+	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

497

Table 8 (continued)
Month: December Squares: 34, 38, 54, 58

74

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	20	4	0	0	0	0	7
1-1.5	24	25	3	0	1	0	1
2-2.5	1	4	2	1	0	0	2
3-3.5	1	0	1	0	0	1	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

89

78

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	21	2	+	+	0	0	3
1-1.5	28	19	3	1	1	+	2
2-2.5	3	7	4	1	+	+	+
3-3.5	1	1	1	1	+	+	0
4-5.5	0	+	+	+	+	0	0
6-7.5	0	0	0	0	0	+	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

1184

132

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	26	0	5	0	0	0	11
1-1.5	16	11	0	0	0	0	0
2-2.5	11	11	0	5	0	0	0
3-3.5	0	0	5	0	0	0	0
4-5.5	0	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

19

135

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	11	0	0	2	0	0	4
1-1.5	26	21	2	2	0	0	9
2-2.5	2	4	0	0	4	0	2
3-3.5	2	0	2	0	0	0	2
4-5.5	0	0	0	0	0	0	0
6-7.5	0	2	0	0	0	0	0
8-9.5	0	0	0	0	2	0	0
≥10	0	0	0	0	0	0	0

47

Table 8 (continued)
Month: December Squares: 74, 78, 132, 135

WAVE PERIOD AND HEIGHT

152

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	22	1	0	1	0	0	1
1-1.5	33	16	3	1	1	0	1
2-2.5	6	7	3	1	1	0	1
3-3.5	0	1	1	0	0	0	0
4-5.5	0	1	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

202

155

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	17	0	0	0	0	0	2
1-1.5	43	17	4	2	0	0	0
2-2.5	0	2	6	0	2	0	0
3-3.5	0	2	0	0	0	0	0
4-5.5	0	0	2	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

47

172

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	17	2	1	0	0	0	4
1-1.5	32	11	4	1	0	0	2
2-2.5	3	7	5	3	2	0	1
3-3.5	1	1	1	1	0	0	1
4-5.5	1	0	0	0	0	0	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

201

175

HEIGHT (MTRS)	PERIOD (SECONDS) <6	6-7	8-9	10-11	12-13	>13	IND
0-.5	17	1	1	+	0	0	3
1-1.5	31	17	4	1	1	0	+
2-2.5	4	8	4	1	+	0	1
3-3.5	+	1	1	1	+	+	+
4-5.5	+	+	1	+	0	+	0
6-7.5	0	0	0	0	0	0	0
8-9.5	0	0	0	0	0	0	0
≥10	0	0	0	0	0	0	0

423

Table 8 (continued)
Month: December Squares: 152, 155, 172, 175

Acknowledgement

The National Oceanographic Data Center (NODC) gratefully acknowledges assistance provided by Mr. Richard Abram, Mr. E. Franklin Johnson, and Ms. Vanessa Mello in preparation of this document. In addition, Dr. Joseph M. Bishop, Federal Emergency Management Agency (FEMA), kindly provided an invaluable technical review of the draft manuscript.

References

Behringer, D.W., R.L. Molinari, and J.F. Festa. 1977. The variability of anticyclonic current patterns in the Gulf of Mexico. Journal of Geophysical Research, 82:5469-5476.

Blaha, J. and W. Sturges. 1981. Evidence for wind-forced circulation in the Gulf of Mexico. Journal of Marine Research, 39(4):711-734.

Brower, W.A., J.M. Meserve, and R.G. Quayle. 1972. Environmental guide for the U.S. Gulf Coast. NOAA National Climatic Center. 177 pp.

Cochrane, J.D. 1972. Separation of an anticyclone and subsequent developments in the Loop Current (1969). In: Contributions on the Physical Oceanography of the Gulf of Mexico. L.R.A. Capurro and J.L. Reid, eds. Texas A&M University Oceanographic Studies, Vol. 2. Gulf Publishing Co., Houston, TX 288 pp.

DiMego, G.J., L.F. Bosart, and G.W. Endersen. 1976. An examination of the frequency and mean conditions surrounding frontal incursions into the Gulf of Mexico and Caribbean Sea. Monthly Weather Review. 104: 709-718.

Duncan, C.P. and S.G. Schadlow. 1981. World surface currents from ship's drift observations. International Hydrographic Review, 58(2): 101-112.

Fernandez-Partegas, J. and C.N.K. Mooers. 1975. A subsynoptic study of winter cold fronts in Florida. Monthly Weather Review, 103: 742-744.

Grose, P.L. 1966. The stratification and circulation of the subsurface waters of the Gulf of Mexico. Unpublished Master's Thesis. Florida State University, Tallahassee, FL. 84 pp.

Hastenrath, S. and P.J. Lamb, 1977. Climatic atlas of the tropical Atlantic and eastern Pacific Oceans. The University of Wisconsin Press, Madison, Wisc.

Huh, O.K., W.J. Wiseman, Jr., and L.J. Rouse, Jr. 1978. Winter cycle of sea surface thermal patterns, Northeastern Gulf of Mexico. Journal of Geophysical Research, 83(C9):4523-4529.

Leipper, D.F. 1970. A sequence of current patterns in the Gulf of Mexico. Journal of Geophysical Research, 75: 637-657.

Maul, G.A. 1977. The annual cycle of the Gulf Loop Current, Part I: Observations during a one-year time series. Journal of Marine Research, 35 (1): 29-47.

Mavor, J.W., Jr. (ed.), H.O. Berteaux, J.R. McCullough, A.R. Miller and S.W. Smith, Jr. 1977. Interpretation of oceanographic data for OTEC design. Unpublished manuscript. Woods Hole Oceanographic Institution Technical Report WHOI-77-65 prepared for U.S. Department of Energy, Washington, D.C. Contract No. EG-77-S-02-4293.A000.

Molinari, R.L. and J.F. Festa. 1978. Ocean thermal and velocity characteristics of the Gulf of Mexico relative to the placement of a moored OTEC plant. NOAA Technical Memorandum ERL AOML-33. NOAA Atlantic Oceanographic and Meteorological Laboratories. Miami, FL.

Molinari, R.L. and D. Mayer. 1980. Physical oceanographic conditions at a potential OTEC site in the Gulf of Mexico; 27.5°N, 85.5°W. NOAA Technical Memorandum ERL AOML-42. NOAA Atlantic Oceanographic and Meteorological Laboratories. Miami, FL.

Molinari, R.L., D. Mayer, and F. Chew. 1979. Physical oceanographic conditions at a potential OTEC site in the Gulf of Mexico; 88°W, 29°N. NOAA Technical Memorandum ERL AOML-41. NOAA Atlantic Oceanographic and Meteorological Laboratories. Miami, FL.

Molinari, R.L., S. Baig, D.W. Behringer, G.A. Maul, and R. Legeckis. 1977. Winter intrusions of the Loop Current. Science, 198:505-507.

Morrison, J.M. and W.D. Nowlin, Jr. 1977. Repeated nutrient, oxygen and density sections through the Loop current. Journal of Marine Research, 35(1): 105-128.

Neumann, C.J., G.W. Cry, E.L. Caso, and B.R. Jarvinen. 1981. Tropical cyclones of the North Atlantic Ocean, 1871-1980. NOAA National Climatic Center and National Hurricane Center. Asheville, NC 174 pp.

Nowlin, W.D., Jr. 1972. Winter circulation patterns and property distributions. In: Contributions on the Physical Oceanography of the Gulf of Mexico. L.R.A. Capurro and J.L. Reid, eds. Texas A&M University Oceanographic Studies, Vol. 2. Gulf Publishing Co., Houston, TX. 288 pp.

Nowlin, W.D., Jr. 1971. Water masses and general circulation of the Gulf of Mexico. Oceanology International, 6(2):28-33.

Ocean Data Systems, Inc. 1977a. OTEC thermal resource report for central Gulf of Mexico. Prepared for U.S. Energy Research and Development Administration, Division of Solar Energy, Washington, DC Contract No. EC-77-C-01-4028.

Ocean Data Systems, Inc. 1977b. OTEC thermal resource report for Key West area. Prepared for U.S. Energy Research and Development Administration, Division of Solar Energy, Washington, DC. Contract No. EC-77-C-01-4028.

Ocean Data Systems, Inc. 1977c. OTEC thermal resource report for western Gulf of Mexico. Prepared for U.S. Energy Research and Development Administration, Division of Solar Energy, Washington, DC. Contract No. EC-77-C-01-4028.

Robinson, M.K. 1973. Atlas of monthly mean sea surface and subsurface temperature and depth of the top of the thermocline: Gulf of Mexico and Caribbean Sea. Scripps Inst. Oceanography. Reference 73-8, 105 pp.

Shepard, F.J. 1973. Submarine geology. Harper and Row, New York. 517 pp.

Sturges, W. and J.P. Blaha. 1976. A western boundary current in the Gulf of Mexico. Science, 192:367-369.

Texas A&M University. 1972. Environmental aspects of a supertanker port on the Texas Gulf Coast. Texas A&M University Sea Grant Program Report No. TAMU-SG-73-201 prepared for NOAA Office of Sea Grant, Rockville, MD. 445 pp.

U.S. Department of Commerce. 1981a. Final environmental impact statement for commercial ocean thermal energy conversion (OTEC) licensing. NOAA Office of Ocean Minerals and Energy, Washington, DC.

U.S. Department of Commerce. 1981b. Final regulatory impact analysis and final regulatory flexibility analysis for regulations to implement Public Law 96-320, the Ocean Thermal Energy Conversion Act of 1980. NOAA Office of Ocean Minerals and Energy, Washington, DC. 34 pp.

U.S. Department of Commerce. 1981c. Licensing of ocean thermal energy conversion facilities and plantships. (Reprint of Federal Register, Vol. 48, No. 147, Friday, July 31, 1981, pp. 39388-39420). NOAA Office of Ocean Minerals and Energy, Washington, DC.

U.S. Department of Commerce. 1981d. United States Coast Pilot 5, Atlantic Coast: Gulf of Mexico, Puerto Rico, and Virgin Islands. 14th ed. NOAA National Ocean Survey, Washington, DC.

U.S. Department of Commerce. 1979. Ocean thermal energy conversion (OTEC). Current Issue Outline 79-3. National Oceanic and Atmospheric Administration/Environmental Data and Information Service, Washington, DC. 9 pp.

U.S. Department of Commerce. 1974. User's guide to NODC's data services. NOAA National Oceanographic Data Center, Washington, D.C.

U.S. Department of Commerce. 1973. Environmental conditions within specified geographical regions: offshore east and west coasts of the United States and in the Gulf of Mexico. Prepared for NOAA National Data Buoy Center by Interagency Ad Hoc Task Force under coordination of NOAA National Oceanographic Data Center, Washington, DC. 735 pp.

U.S. Department of Commerce. 1972a. Environmental guide for seven U.S. ports and harbor approaches. Prepared for the President's Council on Environmental Quality by: NOAA National Climatic Center, Asheville, NC.

U.S. Department of Commerce. 1972b. Environmental guide for the U.S. Gulf Coast. NOAA National Climatic Center. Asheville, NC.

U.S. Department of Defense. 1976. Sailing directions (planning guide) for the North Atlantic Ocean. Publication 140. Defense Mapping Agency Hydrographic Center, Washington, DC.

U.S. Department of Commerce. 1968. TDF-11 Surface Marine Observations Reference Manual. NOAA National Climatic Center, Asheville, N.C.

Vukovich, F.M., B.W. Crissman, M.Bushnell, and W.J. King. 1979. Some aspects of the oceanography of the Gulf of Mexico using satellite and in situ data. Journal of Geophysical Research. 84(c12): 7749-7768.

Vukovich, F.M., B.W. Crissman, M. Bushnell, and W.J. King. 1978. Sea-surface temperature variability analysis of potential OTEC sites utilizing satellite data. Research Triangle Institute, Research Triangle Park, NC. Prepared for U.S. Department of Energy, Washington, DC. Contract No. EG-77-C-05-5444.

Wust, G. 1964. Stratification and circulation in the Antillean-Caribbean Basins. Part 1. Spreading and mixing of the water types with an oceanographic atlas. Vema Research Series No. 2, Columbia University Press, New York, 201 pp.

APPENDIX. Data Sources

Figures 7 and 8, which show resultant mean surface current speed and direction by 1° squares in the Gulf for winter and summer, were prepared from the National Oceanographic Data Center (NODC) Surface Current Data System (SCUDS). The SCUDS data base contains over 4 million ship's drift observations taken during the period from the 1850's through 1974. Most data are from ships of the United States and the Netherlands, with lesser amounts form Japan, Britain, and France.

These observations are not actual current measurements, but indirect determinations of surface currents by their effect on ship's course. Basically in this method, the difference between a vessel's dead reckoned position and course made true is ascribed solely to the effect of surface current. Wind effects also contribute to these deviations from dead reckoned course, but are ignored in this simplification.

Although individual observations are not highly accurate, useful statistical summaries of average current direction and speed can be produced from these data. Duncan and Shadlow (1981), for example, used this data base to examine gross features of the global surface circulation.

At NODC the SCUDS data base is maintained on magnetic tape with observations sorted by geographic area according to a latitude-longitude grid numbering system. The data base is available for generation of graphic plots or frequency analyses of surface current observations. Further details about this data base are contained in the SCUDS supplement to the User's Guide to NODC's Data Services (U.S. Department of Commerce, 1974).

The frequency analyses of wind speed and direction, wave direction and height, and wave period and height presented in Tables 5, 7, and 8 respectively, were derived from the National Climatic Center (NCC) Surface Marine Observations Data Base, also known as Tape Data Family 11 (TDF-11). The major parameters reported in this data base are wind, visibility, weather, temperature (air and sea), sky condition, sea and swell wave data, and atmospheric pressure. The data base was derived from a variety of ship logs, ship weather reporting forms, published ship observations, teletype reports, punch cards from several foreign meteorological services, and other sources. Processing of data in the data base consists essentially of reformatting data into a common file structure. The quality of observing instruments and observer qualifications ranges from poor to very good. Quality control mainly involves gross limit checking to remove values that fall outside physically reasonable ranges.

These types of observations are subject to various biases Because ships try to avoid bad weather, observations are biased toward more benign conditions. Wave data may also include some bias because only the highest waves of either sea or swell were keyed. A full description of the data base is available in the TDF-11 Surface Marine Observations Reference Manual (U.S. Department of Commerce, 1968).

NOAA CENTRAL LIBRARY
CIRC QC879.5 .U47 no.2
An environmental guide to
3 8398 0004 2424 6

NOAA SCIENTIFIC AND TECHNICAL PUBLICATIONS

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

The major components of NOAA regularly produce various types of scientific and techni a- tion in the following kinds of publications:

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

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

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

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

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

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

Information on availability of NOAA publications can be obtained from:

PUBLICATION SERVICES BRANCH (E/AI13)
NATIONAL ENVIRONMENTAL SATELLITE, DATA, AND INFORMATION SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

Washington, DC 20235

NOAA--S/T 83-112