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DEPARTMENT OF ENERGY AND ENVIRONMENT

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ENVIRONMENTAL SCIENCES
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ABSTRACT

Air-sea interaction experiments conducted at an offshore platform near Atlantic City, New Jersey, during September 14 to 23, 1976, are described in this report. Momentum flux was measured by the eddy correlation method. Wave height, slope, and direction spectra were estimated from wave height variations measured by an array of wave staffs positioned in the corners of an equilateral triangle. Some preliminary results of the analysis are also presented.

LIST OF FIGURES

Figure No. Page No.

INTRODUCTION

Air-sea interaction experiments were conducted by the Atmospheric Sciences Division of Brookhaven National Laboratory (BNL) at an offshore platform in the vicinity of Atlantic City, New Jersey. The platform was located at 39° 50'N and 75° 10'W, about 4.8 km off Little Egg inlet and about 20 km northeast of Atlantic City (Figure 1). The objectives of the experiment were (1) to determine the slopes and propagation directions of surfaces waves with the use of an array of wave staffs, and (2) to supplement turbulent flux observations made from a stable air-sea interaction buoy.[1-3] The experiments were conducted for a 10-day period, September 14-23, 1976. The purpose of this report is to describe the experiment and present some typical results. Detailed analysis of the data is being carried out and the results will be published in a future report.

MEASUREMENTS

The Atlantic Ocean is about 14 m deep at the site and the platform was about 6 m above mean sea level. The meteorological tower above the platform was about 4 m high so that the instruments were located at a height of about 10 m above mean sea level (Figure 2). A single-sensor vertical hotwire probe (manufactured by Thermo Systems, Inc.) with a frequency response of about 5 Hz (or a response distance of 0.5 m) was used to measure longitudinal velocity fluctuations. Lateral and vertical velocity fluctuations were measured by a BNL bivane which has a response distance of about 1 m. Characteristics of this bivane have been described elsewhere by SethuRaman and Tuthill.[4] A cup anemometer was also installed in the same level as the hotwire for a continuous field calibration check on the hotwire sensor. The arrangement of meteorological sensors on the tower is shown in Figure 3 and a close-up view of the instruments in Figure 4. A weather station (manufactured by Climatronics, Inc.) was used to make continuous measurements of mean wind speed, direction, air temperature, sea surface temperature, and relative humidity for the experimental period (Figure 5). Sea surface temperature was obtained with a thermistor on a float. An array of wave staffs with three capacitance-type wave height sensors was used to estimate the wave height, wave slope, and direction spectra (Figure 6). The sensors were arranged in an equilateral triangular geometry with known orientation. Wave slope, and direction spectra were obtained by correlating the simultaneous wave height variations measured by the three wave height sensors. Surface drift current measurements were made in the vicinity of the platform from a boat using a drogue. The drogue consisted of two metal fins at right angles to each other, positioned 50 cm from a surface float, and a rope 10 m long. Drift currents were estimated by recording the time it took for the 10 m length of rope to be stretched on the surface of the ocean from the anchored boat. Several observations were made to obtain a reasonable average. Sea surface temperatures were measured periodically from the boat with a mercury thermometer fitted in a float. Dry and wet bulb temperatures were obtained over the boat with a sling psychrometer.

The data acquisition system consisted of a Metrodata 620B digital magnetic cartridge recorder, two TEAC analog magnetic cassette recorders, and a strip chart recorder. The digital recorder was operated in continuous mode whenever the crew could stay near the platform and was put in remote mode for overnight observations. In remote mode, a timer activated the recorder at preset times which usually consisted of 10-minute recordings every hour. Power supply for this recorder consisted of a 12 V - 96 A hr wet-cell battery.

To avoid aliasing problems in spectral analysis, outputs from the bivane, hotwire, and wave staff array were prefiltered before digital recording. Krohn-hite filters requiring two 12 V - 40 A hr batteries were used for this purpose. All the instruments were operated by a 12 V - 96 A hr battery through a junction box. The Climatronics weather station had its own 12-V battery that could last for a period of about 21 days. A view of the data acquisition system is shown in Figure 7. High frequency data were obtained from September 14 to 18 and recorded on magnetic tapes. Mean data from the weather station were recorded continuously from September 14 to 23.

ANALYSES OF DATA

Synoptic conditions varied significantly during the experiment. A high pressure system was centered over the area on the first and second days (September 14 and 15). A coastal low affected the winds near the platform on September 16 and a cold front passage occurred on September 17. Surface weather maps for September 14, 16 and 18 are given in Figures 8, 9, and 10, respectively.

Time histories of wind speed and air temperature are shown in Figures 11 and 12, respectively. Related wind direction and synoptic and mesoscale features are also indicated in Figure 12. The 10-m air temperature was roughly the same as the sea surface temperature when the wind direction was E-SE with significant overwater fetch. Variations in air temperatures occurred with winds of limited fetch over water. Drift current and sea surface temperatures measured from the boat are given in Table 1.

Table 1
Surface Current and Temperatures From Boat

Date	Time (EST)	Mean surface current (cm/sec)	Direction (towards)	T_{dry}* (°C)	T_{wet}* (°C)	T_{sea} (°C)
9-14-76	1700	28	North	22.2	21.6	22.2
9-15-76	0900	16	N-NW	21.7	21.6	20.8
	1200	18	N-NW	22.8	22.1	21.7
	1300	12	N-NW	22.8	21.7	21.8
	1400	9	N-NW	22.2	21.4	21.4
9-17-76	1300	66	North	23.6	22.8	22.0
	1500	19	North	23.3	22.2	21.9

*Wet and dry bulb temperatures were measured from the boat and the height of measurement is estimated to be about 2 m.

Wave direction spectra can be computed by correlating the simultaneous wave height variations measured by the three wave staffs.[5] Typical wave direction spectra are shown in Figure 13. Low frequency waves seem to be approximately parallel to the wind and the high frequency waves more random in direction. Previous studies[1] indicated that the surface shear stress is influenced by the wave age and consequent variations in the relative motion between the waves and near-surface wind. Further analysis of wave staff data is being carried out to relate wave direction to surface drag.

ACKNOWLEDGMENTS

The authors would like to thank M. Butler of M.E.S., Inc., for his help in conducting the experiments and E.G. & G., New Jersey, for permission to use the platform.

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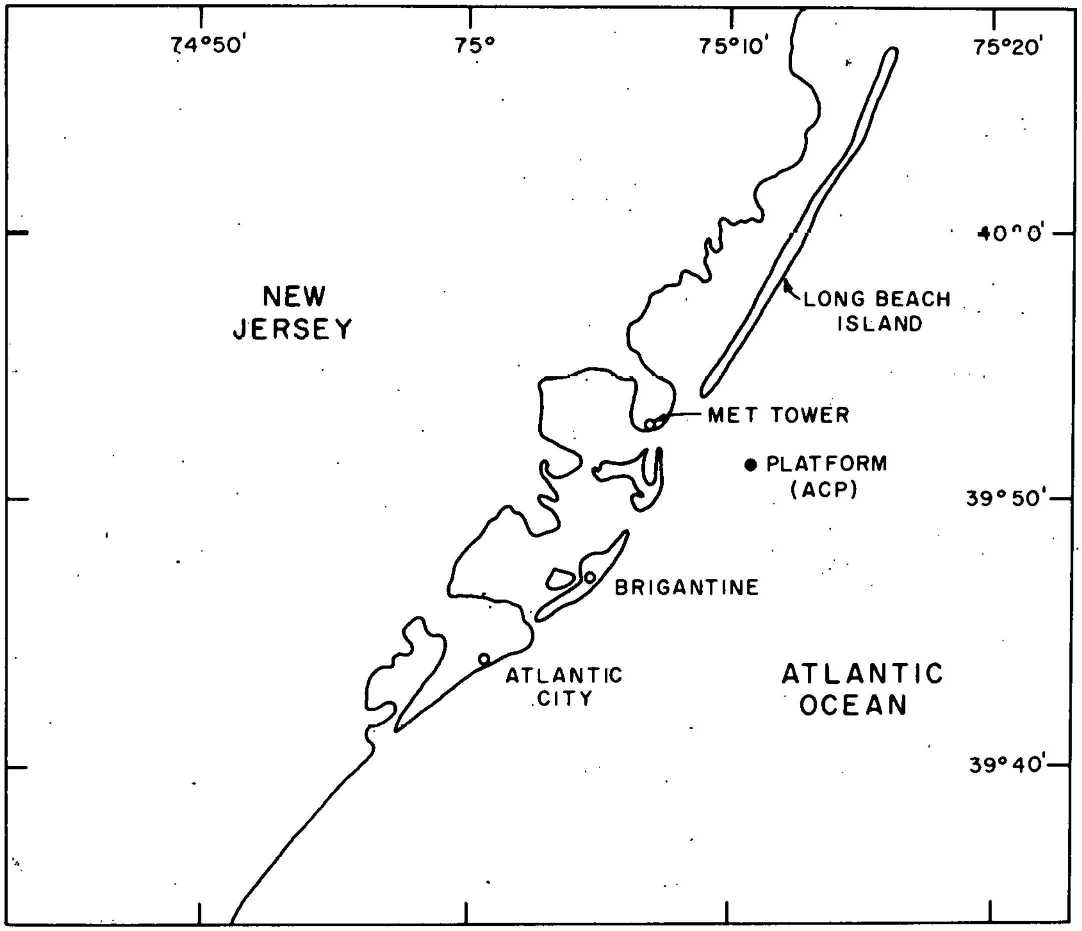

Figure 1. Map showing the location of the offshore platform.

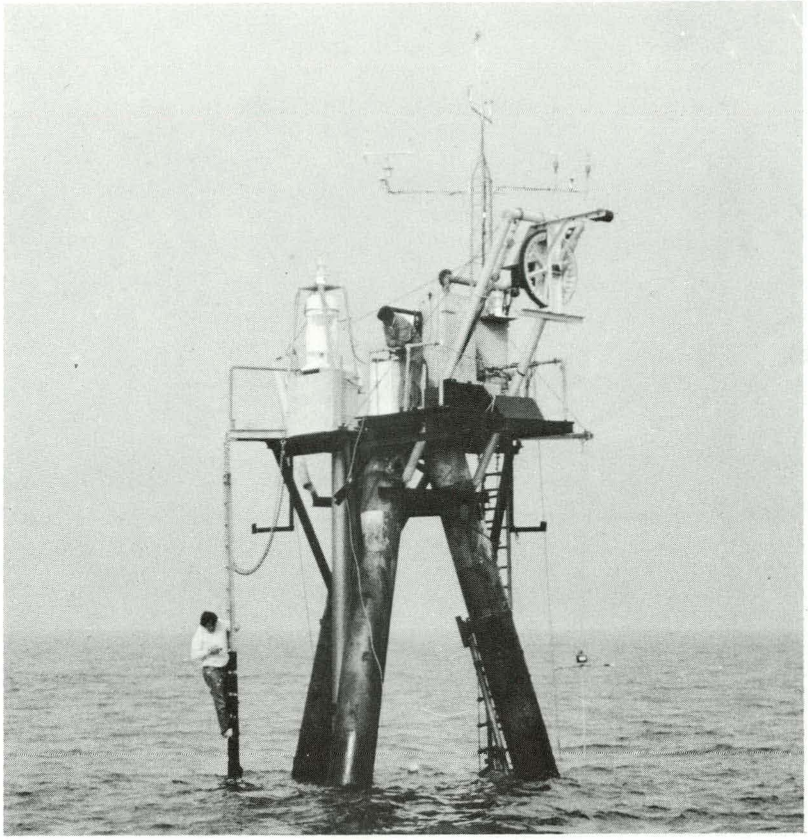

Figure 2. Photograph of the platform.

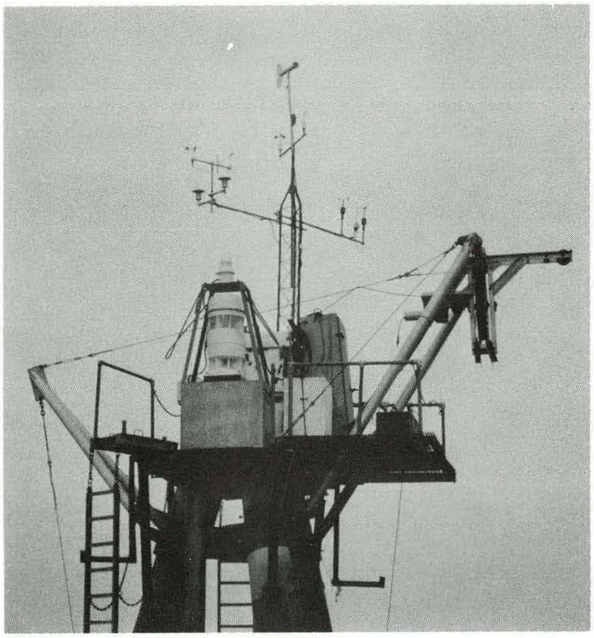

Figure 3. Meteorological instruments on the tower above the platform.

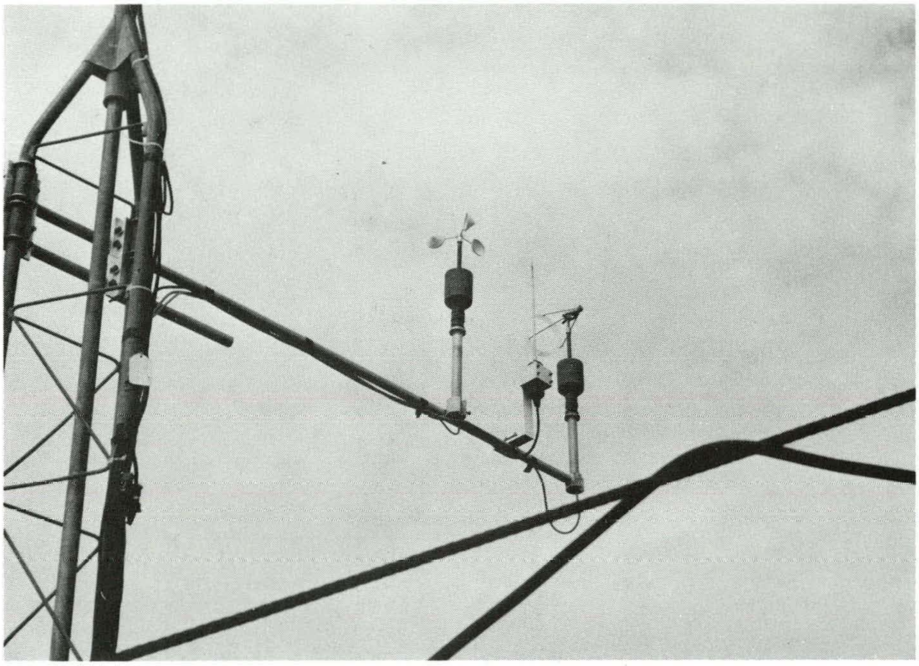

Figure 4. A close-up view of the turbulence instruments comprising a single-sensor hotwire, a bi-directional vane, and a cup anemometer.

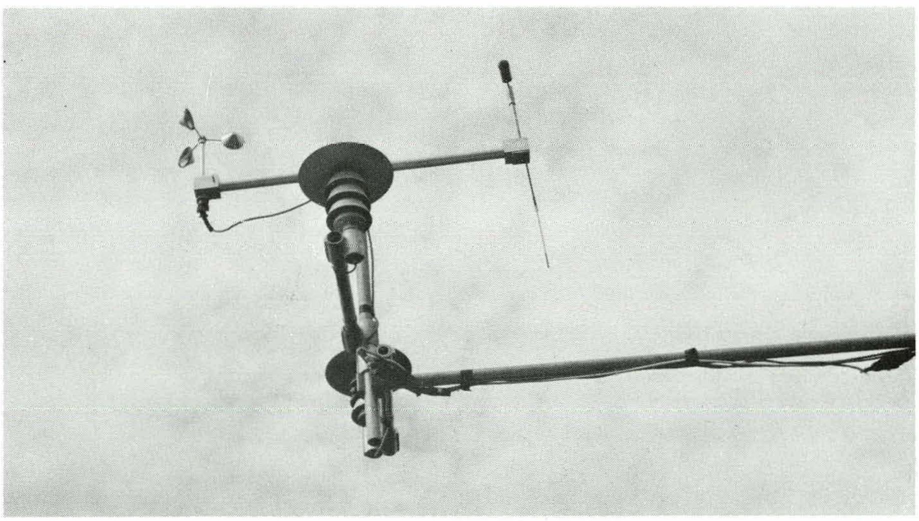

Figure 5. A close-up view of the weather station with instruments to measure mean wind speed, direction, air and sea temperatures, and relative humidity.

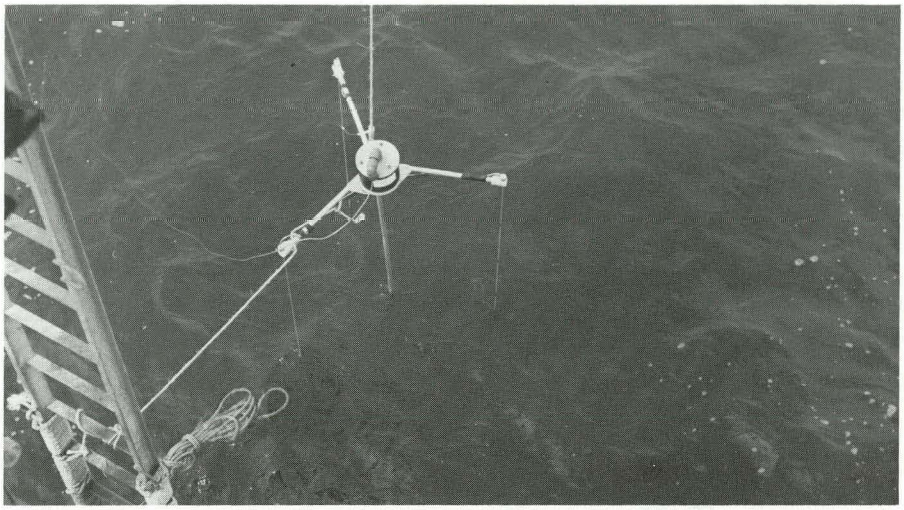

Figure 6. Plan view of the array of wave staffs arranged in an equilateral triangular pattern to measure wave height, slope, and direction spectra.

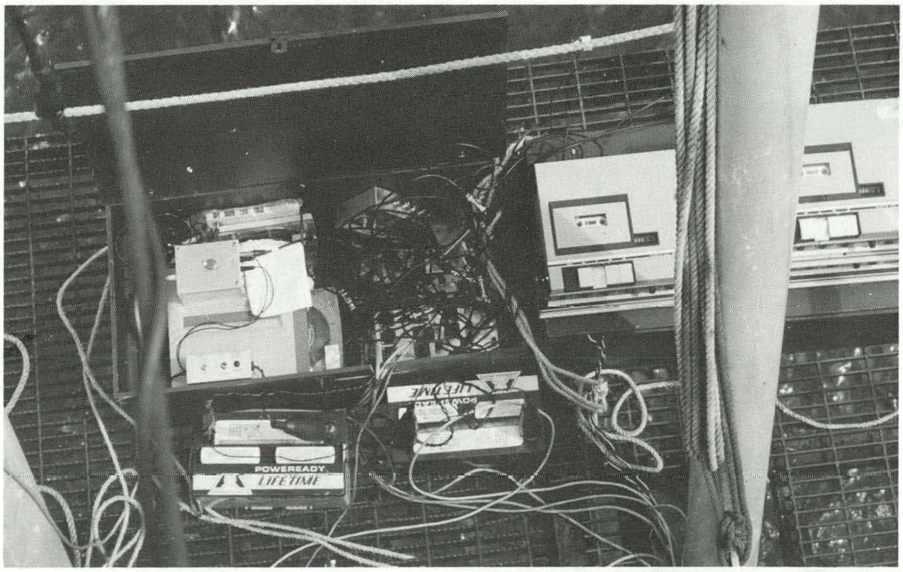

Figure 7. A view of the portable data acquisition system on the platform.

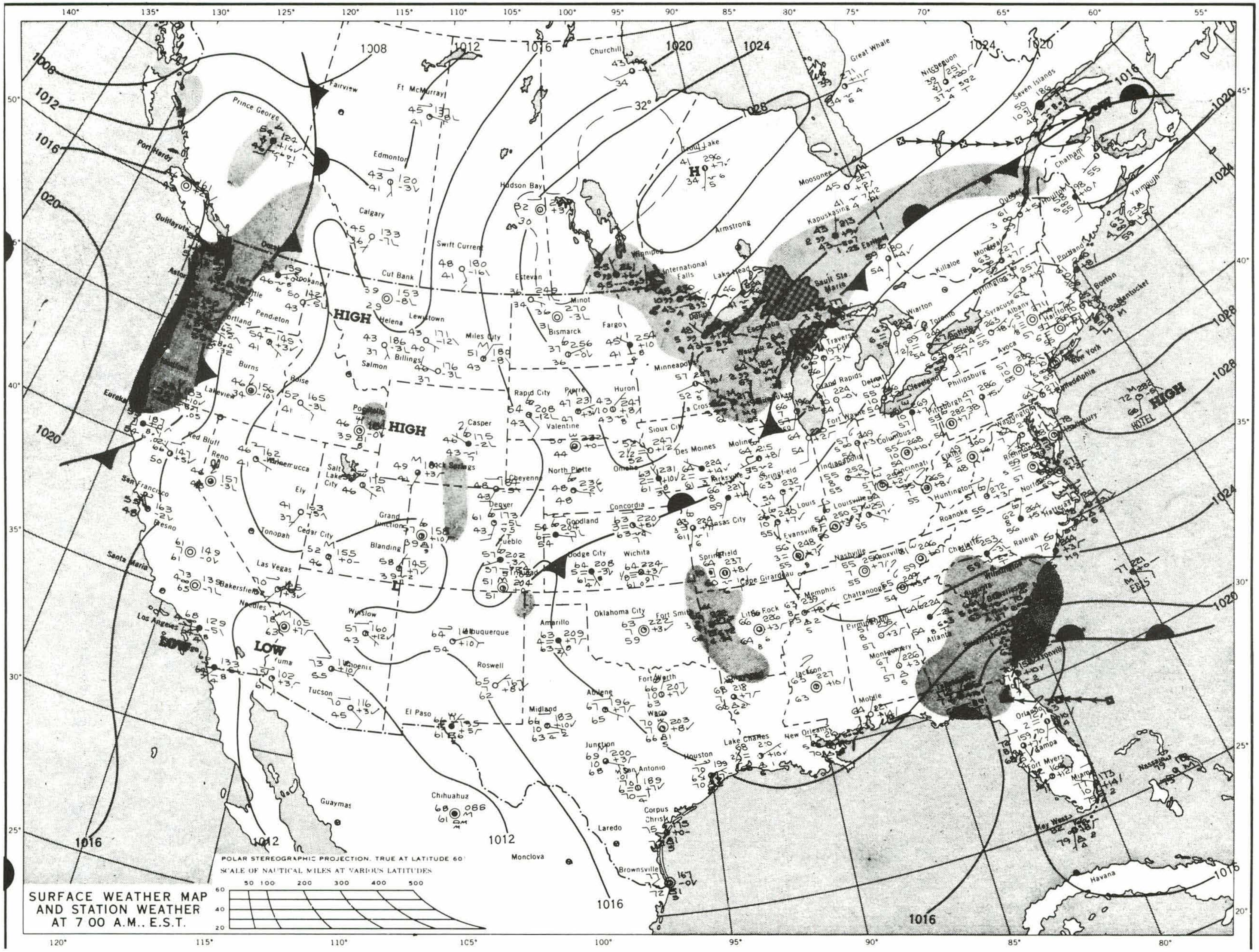

Figure 8. Surface weather map at 0700 EST on September 14, 1976.

THURSDAY, SEPTEMBER 16, 1976

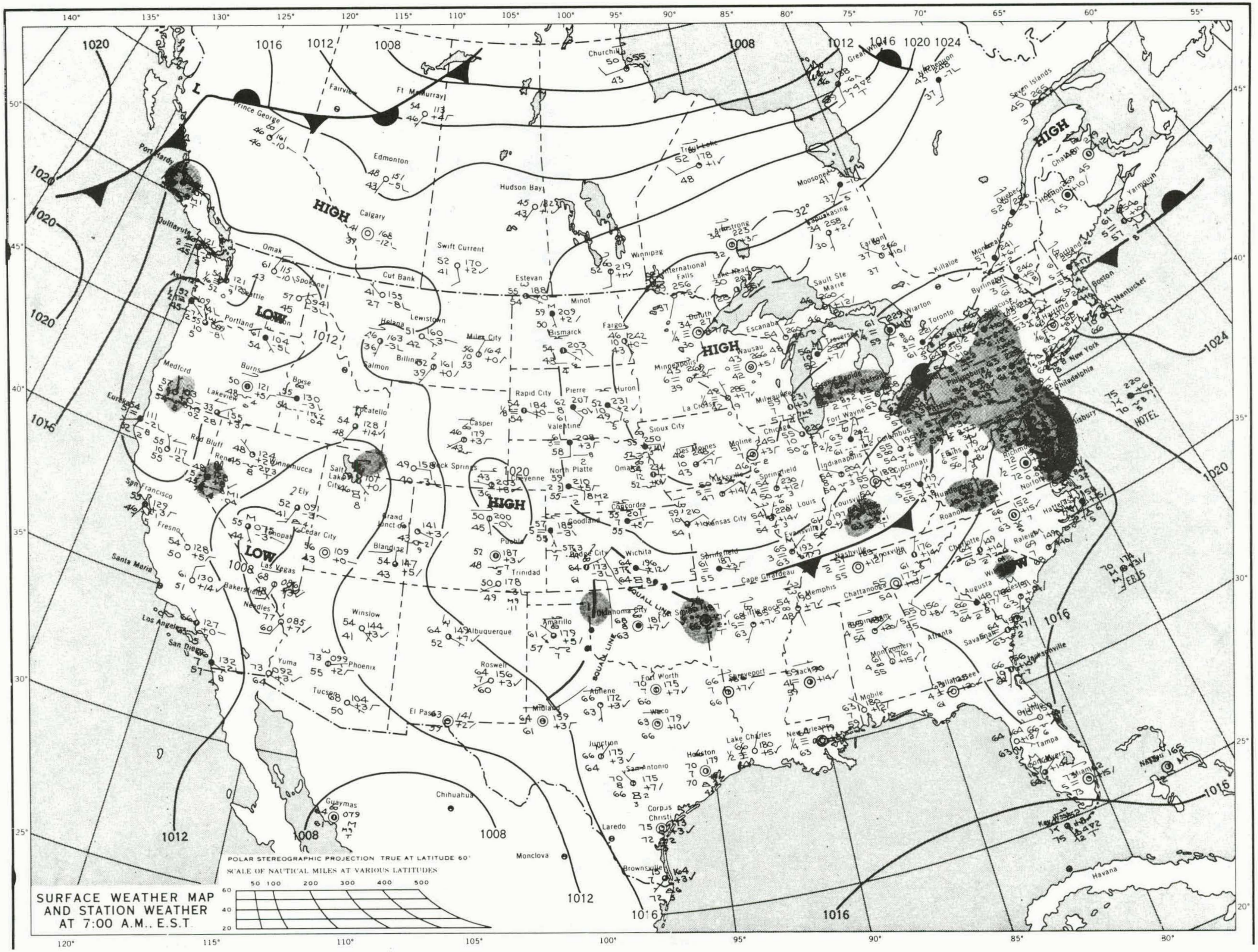

Figure 9. Surface weather map at 0700 EST on September 16, 1976.

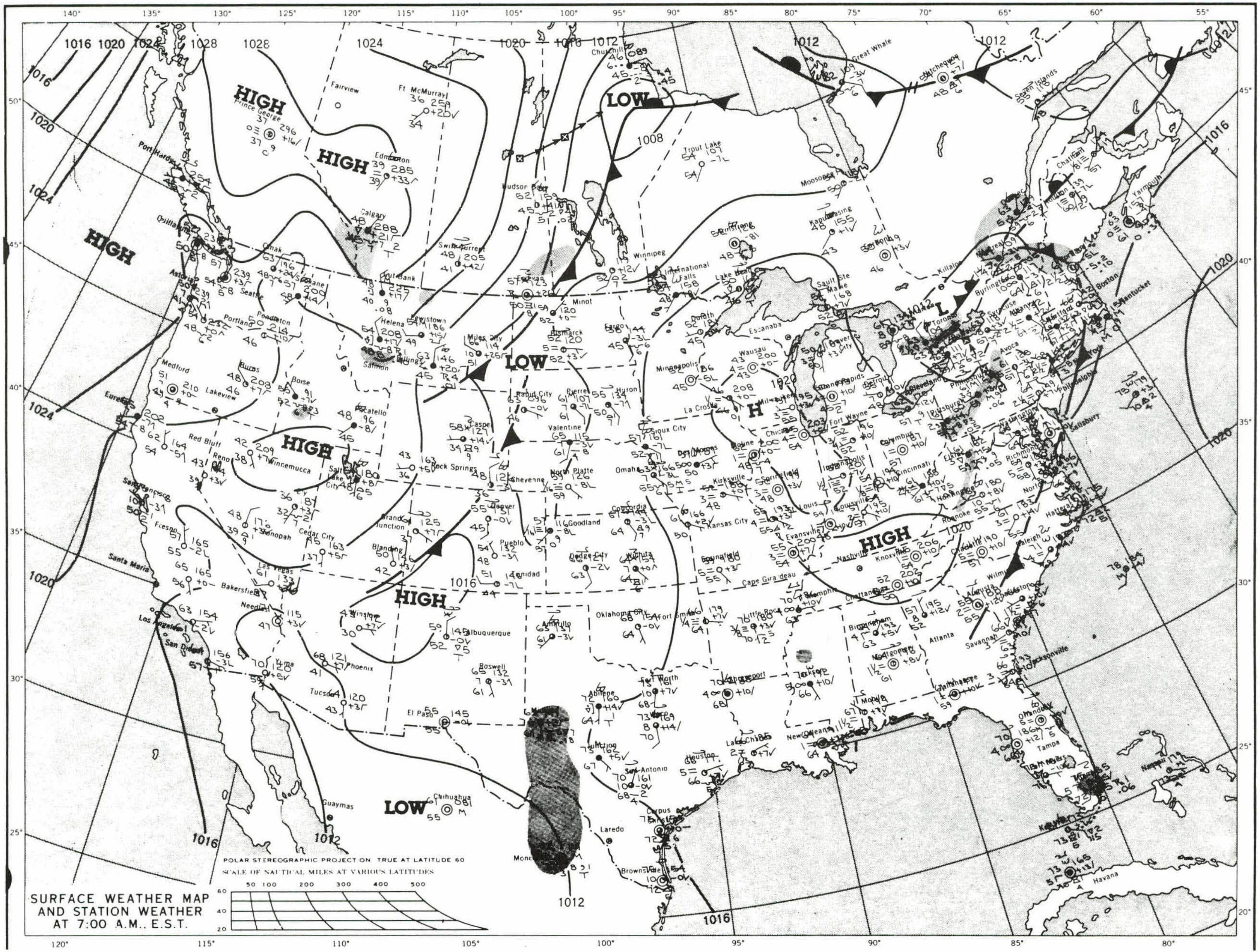

Figure 10. Surface weather map at 0700 EST on September 18, 1976.

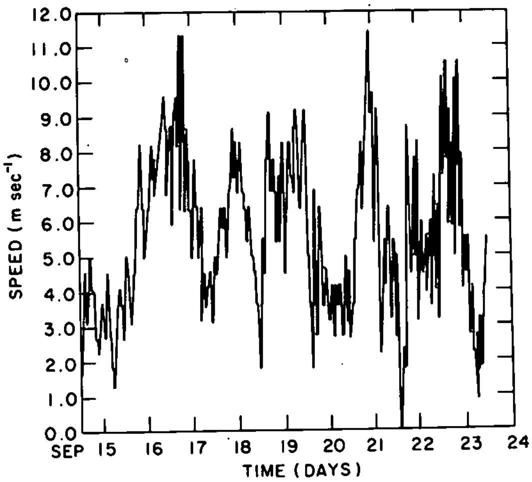

Figure 11. Time history of wind speed ($z = 10$ m) for the duration of the experiment.

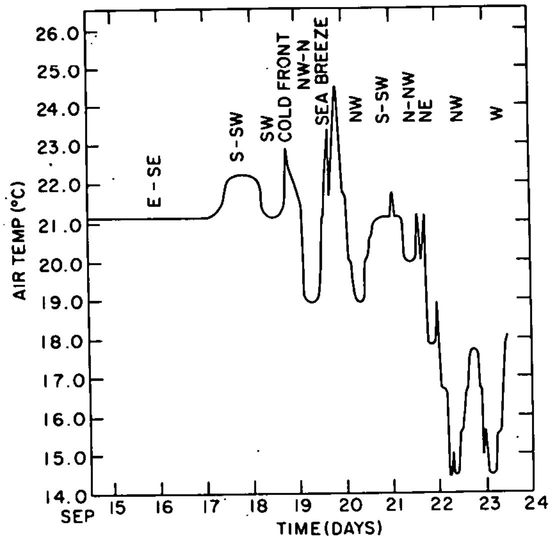

Figure 12. Time history of air temperature for the duration of the experiment. Wind directions and significant synoptic and mesoscale features are also indicated.

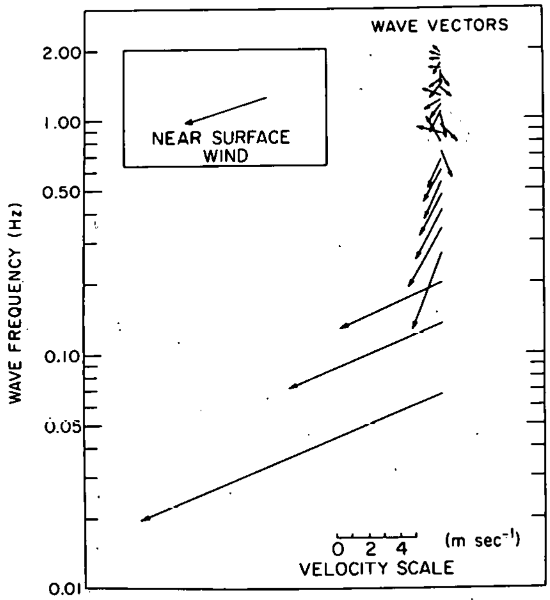

Figure 13. Typical wave direction spectra.