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SCHOOL OF SCIENCE

OREGON STATE UNIVERSITY

A COMPILATION OF OBSERVATIONS FROM MOORED CURRENT METERS AND THERMOGRAPHS

Volume V: Oregon Continental Shelf
31 July-21 Sept. 1969

by

A. Huyer, J. Bottero
J. G. Pattullo, R. L. Smith

National Science Foundation
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Project NR 083-102

Data Report 46 **Reference 71-1**
June 1971

DEPARTMENT OF OCEANOGRAPHY
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John V. Byrne
Chairman

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ABSTRACT

Observations from an instrument array moored over the continental shelf off Oregon from 31 July to 21 September 1969 are presented. Temperature, current and wind observations were obtained every 20 minutes. First order statistics, histograms, progressive vector diagrams and time series plots are presented. Supplementary wind observations at Newport are also described. It is recommended that wind observations be part of a future coastal current observational program and that thermographs be placed in positions with a large temperature gradient.

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INTRODUCTION

This data report is one of a series describing observations from instrument arrays moored over the continental shelf of Oregon. This report describes current, temperature and wind data obtained in August and September, 1969. In addition, wind observations from near Newport, Oregon are included.

One purpose of this report is to provide a summary of the data; much of it will be studied later in more detail. Another purpose is to provide preliminary description and analysis of the data to aid in planning future observations.

The observational program and data processing are described. The three types of data - temperature, current and wind are presented separately. First order statistics, such as means, modes and standard deviations are given for each. Histograms and time series plots are also shown. Progressive vector diagrams are shown for the current and wind observations. A brief discussion of the observations is presented, and recommendations for future observations are made.

OBSERVATIONAL PROGRAM

The instrument array was designed to measure coastal currents off Oregon during the upwelling season. Temperatures were measured to monitor the hydrographic regime and the wind was measured in an attempt to determine its influence.

The Instrument Array

Instruments were moored at locations 3 and 15 miles west of Newport (NH-3 and NH-15) and 7 miles off Depoe Bay (DB-7); positions are shown in Figure 1. The array was installed on 30 July 1969. Thermographs were used at 20 m at each of the three locations and to 40 m at DB-7 and NH-15. Current meters were installed at 20 m at all locations and at 40 and 80 m at DB-7 and NH-15. A wind meter was used on the surface float at NH-15. The mooring technique was the same as described earlier by Pillsbury, Smith and Tipper (1969). A timed anchor release was used at NH-3; that string was recovered on August 12. The installation at NH-15 was recovered on 21 September. The instrument string at DB-7 broke loose before the scheduled recovery date. The 40 m instruments were found on the beach on 9 October; the others were lost. The current

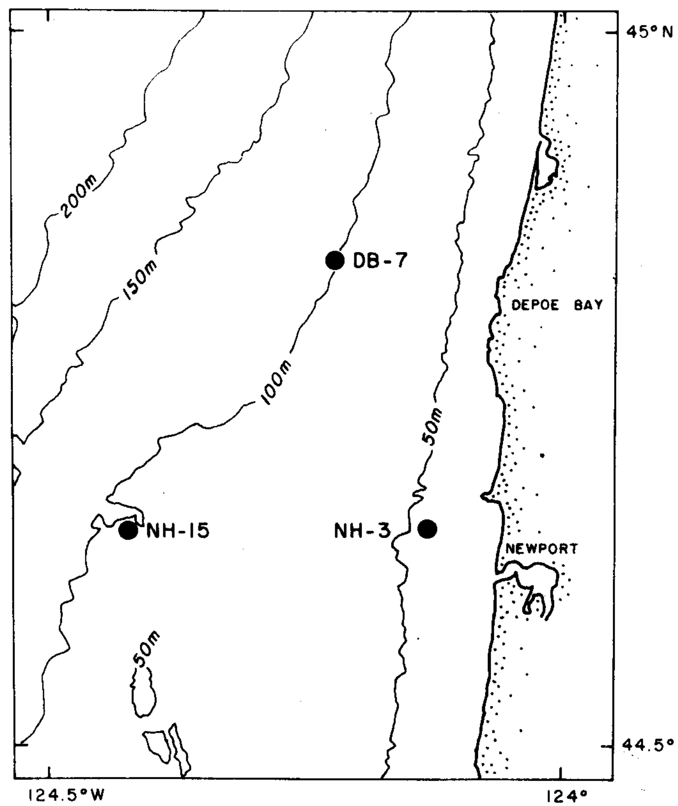


Fig. 1 Location of the moored instrument installations, August and September, 1969.

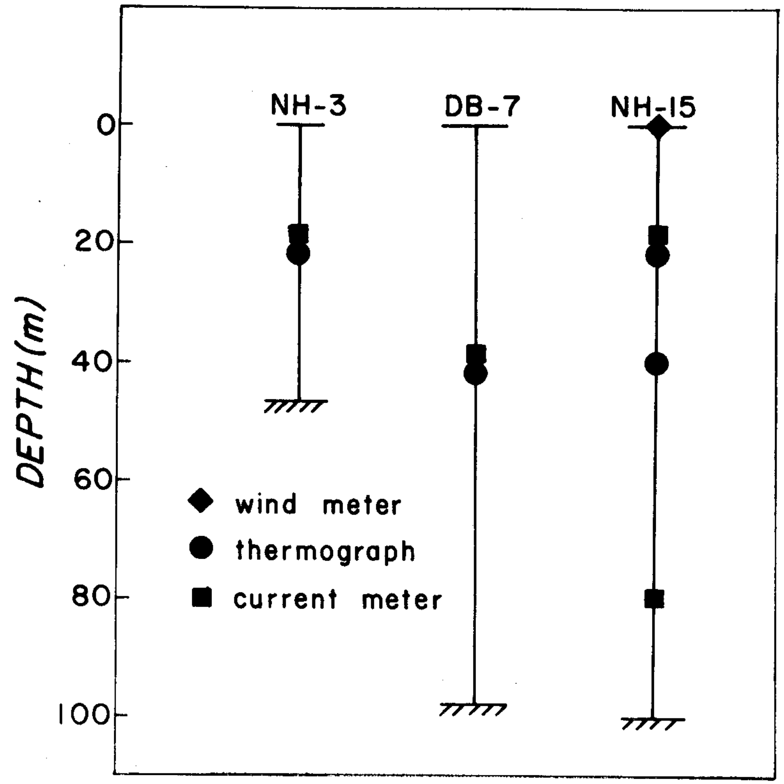


Fig. 2 Depths of instruments from which data were recovered.

meter at 40 m at NH 15 did not record speed. All of the other instruments yielded usable data; their positions are shown in Figure 2. Figure 3 shows periods when usable data were obtained from the moored instruments. It also shows the times of cruises on which hydrographic data was obtained (Wyatt et al., 1970).

The Instruments

The currents were measured with Braincon Histogram Current Meters (types 381 and 316). Mooers et al. (1968) described the type 316 meters. The 381 meters have similar specifications except that there is no room for a watch to be used as a time check. The meters record the number of rotations of a Savonius rotor and the positions of the direction vane during a 20-minute interval. The current velocity for the interval is taken to be the average speed and the most frequently observed direction.

The temperature was measured with Braincon Recording Thermographs (types 146 and 531). The type 146 thermograph was described by Brainard (1965); the 531 is similar. The type 146 meters (used at NH-3 and at 20 m at NH-15 achieve 95% of final value in 10 minutes; the 531 meters have a time constant of 14 minutes. The temperature ranges, reading errors and the sampling intervals for each meter were as follows:

Location Depth	Temperature Range	Reading Error	Sampling Interval
NH-3, 20 m	5 to 15 C	0.1 C	20 min.
NH-15, 20 m	-2 to 25 C	0.1 C	10 min.
NH-15, 80 m	-2 to 15 C	0.1 C	20 min.
DB-7, 40 m	-2 to 15 C	0.2 C	20 min.

The reading error is larger for the DB-7 data because the temperature grid did not appear on the film. A grid was superimposed on the film during the reading.

Wind measurements were made with a Braincon Histogram Wind Recorder 2 m above the sea surface NH-15. The instrument was described by Ewing (1965) and in an earlier data report in this series (Enfield et al., 1970). Wind speed and mean direction were obtained at 20 minute intervals. The wind was also measured hourly with an anemometer on the south jetty at Newport (Detweiler, 1971). The wind observations there are obtained on a continuing basis. They are not a part of the moored instrument observation program.

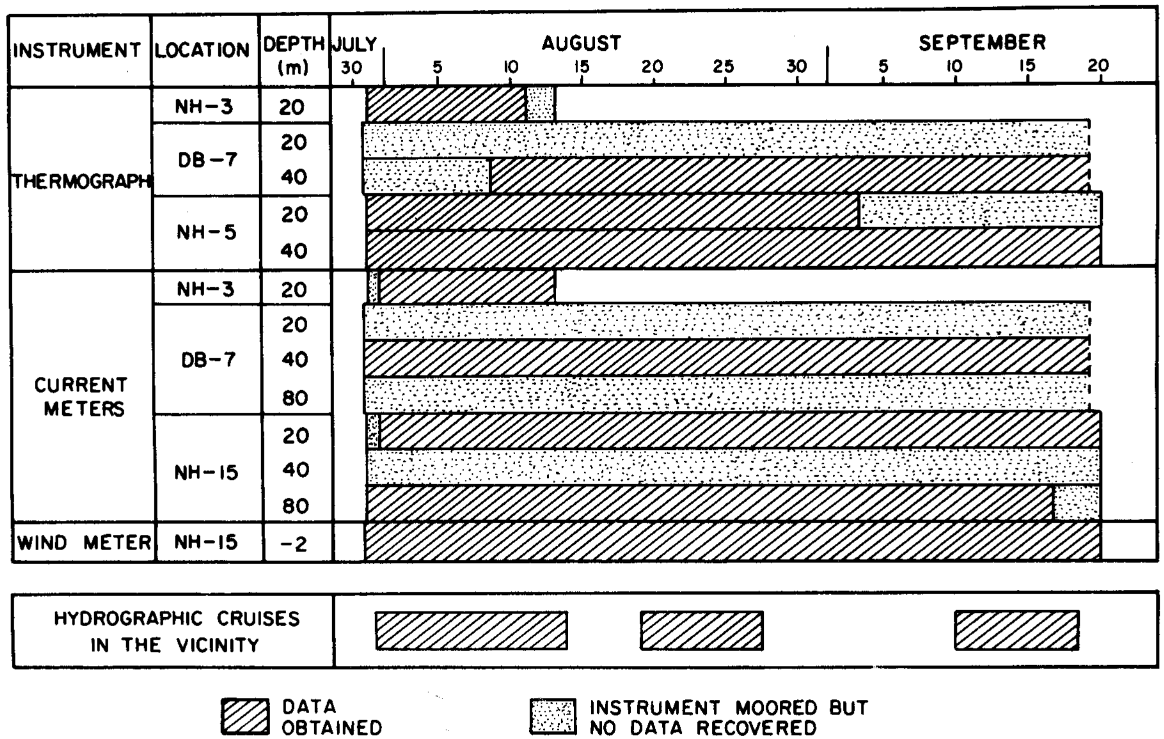


Fig. 3 Periods of moored instrument operation and of hydrographic cruises in the area. Lines at the beginning and end of the bars indicate installation and recovery times.

Summary of Observations

Some of the data records begin at the mooring time and continue until recovery. Others, for one reason or another, start some time after mooring or stop before recovery. Start and stop times were determined by comparing the data films to the installation and recovery log; they are given in Table 1.

The beginning of the current meter film from DB-7 is not clear; the correct start time is between 1720 and 1920 GMT (Greenwich Mean Time) 30 July. A definite discontinuity in the data occurs after 3640 frames; it seems that the mooring broke then. The stop time is then between 0630 and 0820 GMT, 19 September. The thermograph at DB-7 did not advance the film at first. After 2999 frames, the temperature increased to more than 15 C. We assumed that this occurred when the mooring broke. A stop time between 0620 and 0820 GMT, 19 September was assigned and the start time was computed to be between 1100 and 1300 GMT, 8 August.

The thermograph film from 20 m at NH-15 shows that the film did not advance immediately. However, it is clear that it was not stopped for more than a few exposure times. The start time error is less than an hour. Because of the 10-minute sampling interval, all the film was used before recovery and the stop time was not determined independently.

Table 1. Start and stop times for the data series obtained from the moored instrument array. *These times are uncertain. See text for details.

Type of data	Location	depth (m)	start time (GMT)	stop time (GMT)	no. of observations
Temperature	NH-3	20	0140, 31 July	0320, 11 Aug	798
	NH-15	20	2020, 30 July*	0440, 3 Sept*	4950
	NH-15	40	2000, 30 July	0120, 20 Sept	3689
	DB- 7	40	1300, 8 Aug*	0820, 19 Sept*	2999
Current	NH-3	20	1720, 31 July	0100, 13 Aug	888
	NH-15	20	2100, 31 July	0140, 20 Sept	3615
	NH-15	80	2000, 30 July	0900, 16 Sept	3424
	DB-7	40	1920, 30 July*	0820, 19 Sept*	3640
Wind	NH-15	-2	2020, 30 July	0020, 20 Sept	3685

DATA PROCESSING

All of the data from the array were recorded on photographic film; the films were developed commercially. The current records were read on a digitizer, while wind and temperature data were read manually. Error detection and data processing techniques were essentially the same as described in an earlier data report (Pillsbury, Smith and Pattullo, 1970, Appendix). The wind direction data had to be corrected because an iron bar, used to balance the instrument, distorted the magnetic field. The correction was determined ashore; after it was applied, the wind data were processed in the same way as the current data.

First order statistics were calculated for temperature, wind and current. Histograms of speed, direction and temperature are shown. Progressive vector diagrams are also presented for the current and wind data. The variation with time is shown as plots of the smoothed data (speed, eastward and northward vector components, and temperature) vs. time.

Two types of smoothed data series were obtained: "low pass" and "low low pass." In the low pass series, high frequencies are suppressed but tidal, inertial and oscillations of larger periods are retained without attenuation. In the low low pass series, tidal and inertial frequencies are also suppressed. To obtain the same pass band with different sampling intervals, it is necessary to use different filters. The filters used are described in an appendix; they are numbered there for easier cross-reference.

The temperature data were smoothed with filters with a half-amplitude point of 5.7 hours. Signals with a period less than 4 hours are thus suppressed completely. Two filters (1 and 2) were required because one temperature series had a 10 minute sampling interval while the others had a 20 minute sampling interval. The resulting smoothed series are comparable.

All current records have a sampling interval of 20 minutes. Filter 2 was used to obtain low pass time series of speed and eastward and northward components. The half-amplitude point of the Filter 2 is 5.7 hours. Low low pass series of speed and components were obtained with Filter 3. Its half-amplitude point is 35 hours; therefore, diurnal variations are completely suppressed.

The wind observations from NH-15 have a 20 minute sampling interval. Filter 2 was used to obtain the low pass speed and component series. Low pass series were obtained from the hourly observations from the south jetty at Newport with Filter 4. Its half-amplitude point is 5.8 hours. Low low pass series were obtained for the NH-15 data with Filter 3. No low low pass series were calculated for the Newport wind observations.

Mr. Joseph Bottero supervised all computer processing and analysis of the data.

DATA PRESENTATION AND DESCRIPTION

Temperature Data

First order statistics of temperature data are shown in Table 2. Since the reading error is higher for the thermograph at DB-7, the low standard deviation reflects very uniform temperatures. The temperature histograms (Fig. 4) show similar distributions at three of the positions; the distribution at 20 m, NH-15 has a much higher mean and range than the others. The histograms seem to be distorted by reading bias. For example, the histogram for 20 m, NH-15 shows that the reader preferred integral and half-integral values. The low pass time series are shown in Figure 5. The tick marks on the horizontal axis occur at 0000 GMT. At NH-3 the temperature is fairly uniform with small amplitude oscillations. The diurnal period appears to be dominant. The asymmetry of the periodic component indicates that the local temperature gradient decreased with depth. At 40 m DB-7, periodic temperature variations have very small amplitudes; the temperature increased slightly during the observation period. At 40 m, NH-15, the temperature is most uniform during the last two weeks of August. Semi-diurnal temperature oscillations dominate the data at 20 m NH-15. The amplitude of the oscillations was variable. It increased from a minimum at the beginning of August until about 8 August. It was again minimum from 17-19 August and reached another maximum 28 August. The mean temperature increased slowly until 7 August, then decreased until 12 August. It increased again 31 August. Then it dropped rapidly.

Table 2. Statistics of temperature data

		TEMPERATURES (C)				
Location	Depth (m)	Min.	Max.	Mean	Std. Dev.	Mode
NH-3	20	7.3	8.5	7.8	0.8	7.4
NH-15	20	7.5	15.2	10.1	1.8	9.0
NH-15	40	6.7	9.0	7.3	0.3	7.2
DB-7	40	6.9	8.7	7.3	0.2	7.2

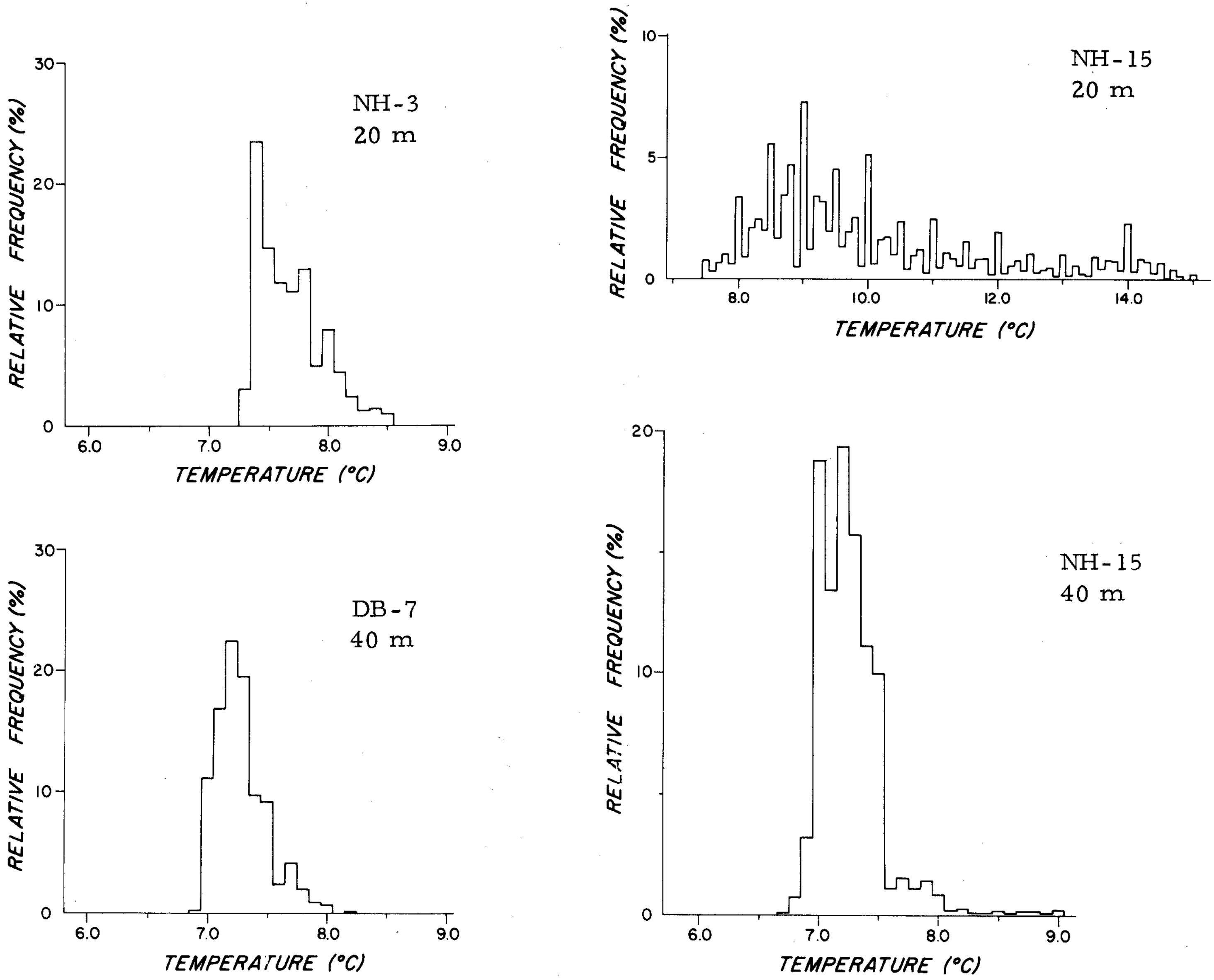


Fig. 4 Histograms of temperature observations.

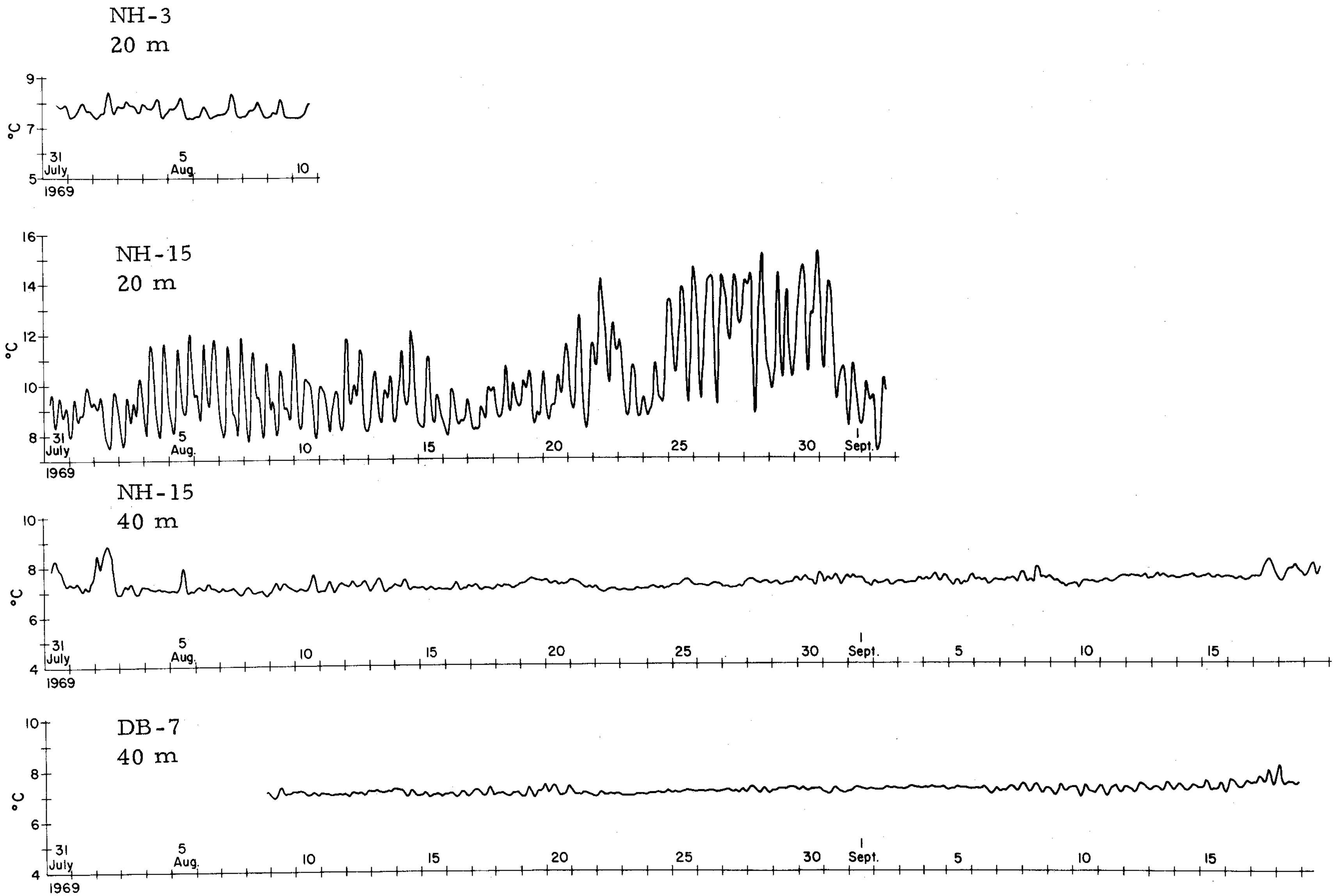


Fig. 5 Low pass temperature time series.

Current Data

There is an error in the direction data from 20 m, NH-15: the vane of the current meter became warped at some time during the observation period. It is likely that the direction error increased gradually and was always less than 10°. No correction has been applied to the data; all of the results for 20 m, NH-15 shown below are subject to this uncertainty.

First order statistics of the observed currents are shown in Table 3. The speed and direction histograms are shown in Figures 6 and 7. Speeds were highest and most variable at 20 m, NH-15 and 40 m, DB-7. The currents were generally southward; northward currents were observed frequently at NH-3 and NH-15.

The current is shown as a function of time in progressive vector diagrams (Figs. 8a, b) low pass time series (Figs. 9 a, b, c, d) and low low pass time series (Figs. 10 a, b). In each of these, 24 hour intervals are marked by dots or ticks; these marks occur at a different time of day for each record:

20 m NH-3	1100 GMT
20 m NH-15	0040 GMT
80 m NH-15	1830 GMT
40 m DB-7	0000 GMT

The progressive vector diagrams (Fig. 8) show that the currents were generally southward and roughly parallel to the local bottom contours. The current at 40 m, DB-7 and 20 m, NH-15 were very similar: velocities were low from 22-28 August, and the current reversed about 14-16 September. Current reversals occurred more frequently at the two other positions. All changes in direction were nearly 180°, i. e., currents apparently tend to be parallel to the bottom contours.

Plots of the low pass time series of the four current records are shown in Figure 9.

Currents observed at NH-3 were not very similar to those observed elsewhere. Tidal oscillations were superimposed on a variable current which was southward during 1-4 August and 6-7 August and nearly zero the rest of the time. The semidiurnal tide seemed to rotate: during 1-3 August it was largest in the u component. The diurnal tide was largest in the u component during 5-7 August; it was very large in the v component from 7-11 August.

Comparison of the low pass plots of the other three records (Fig. 9) shows the following:

1. Tidal oscillations are smallest at 40 m DB-7 and largest at 20 m NH-15.
2. Semidiurnal tides dominate in the u component.

Table 3. Statistics of current data

Location	NH-3	NH-15	NH-15	DB-7
Depth	20	20	80	40
Speed (cm/sec)				
minimum	10.3	9.6	4.7	8.2
maximum	41.5	67.5	61.6	65.8
mean	17.4	28.8	19.7	29.5
std. dev.	5.1	10.0	7.1	10.8
mode	15.1	21.2	15.1	21.4, 24.2
Direction (° T)				
principal mode	170	200	210	180
secondary mode	360	20	30	360
Vector mean				
speed (cm/sec)	4.5	20.6	4.3	22.1
direction (° T)	171	208	232	196
Components				
u				
mean	0.7	-9.9	-3.5	-6.1
std. dev.	7.0	16.2	14.4	11.3
v				
mean	-4.4	-18.1	-2.8	-21.1
std. dev.	16.1	15.5	12.1	19.4

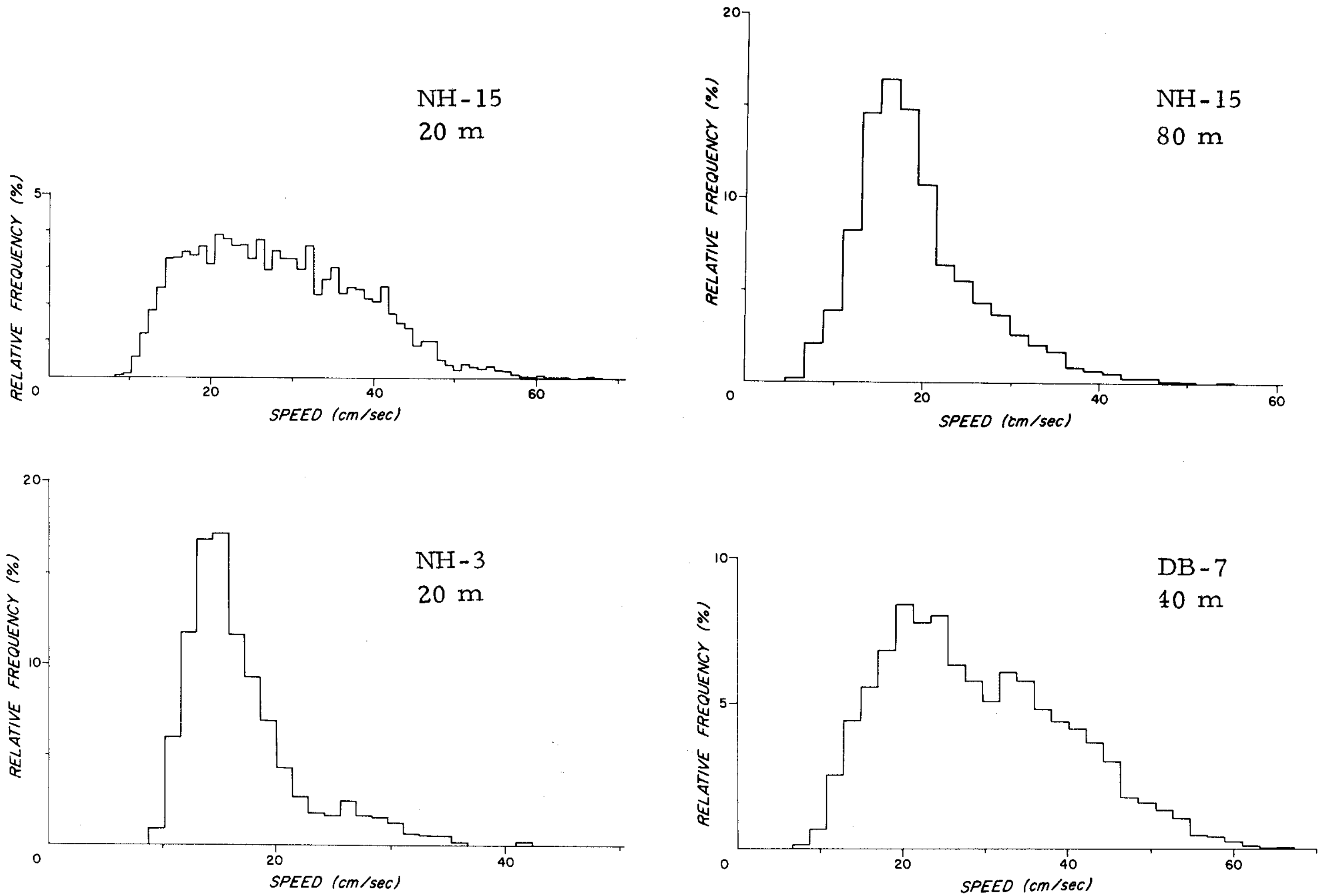


Fig. 6 Histograms of current speed.

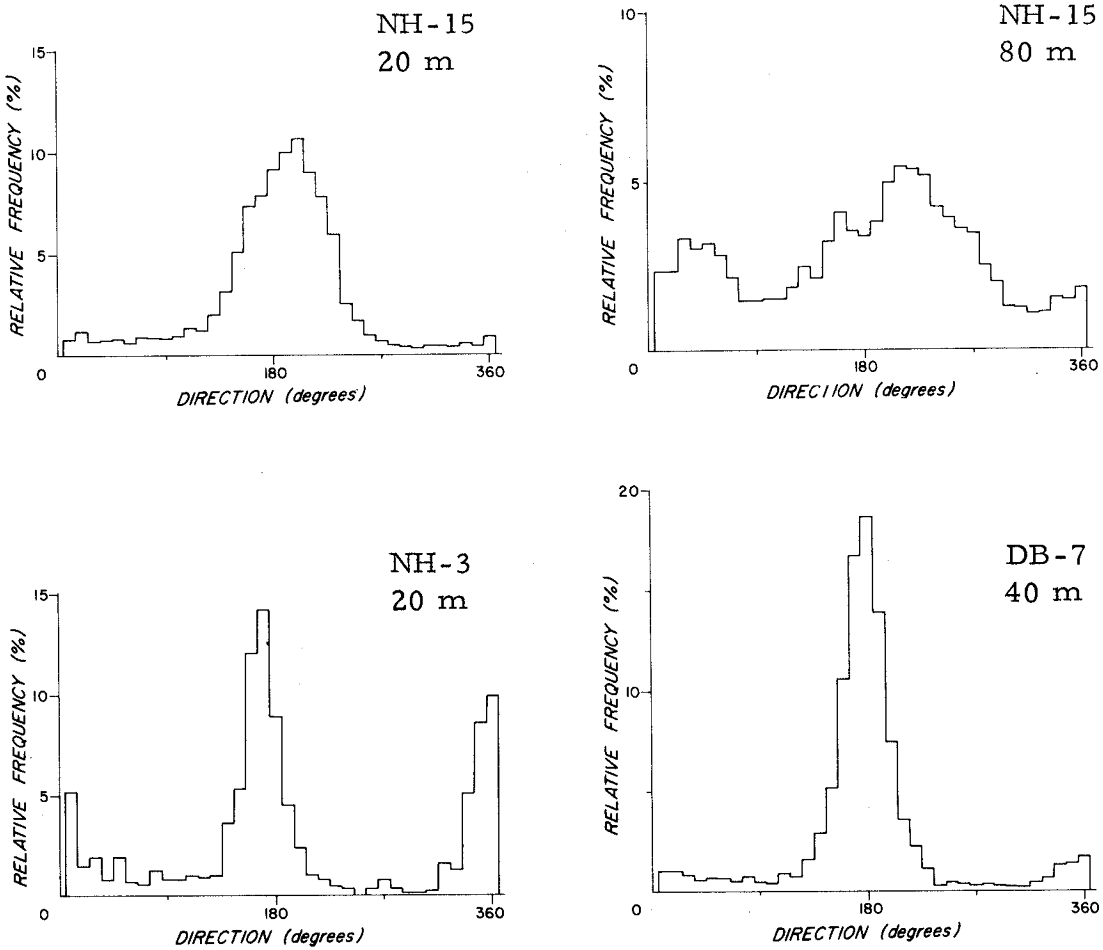


Fig. 7 Histograms of current direction.

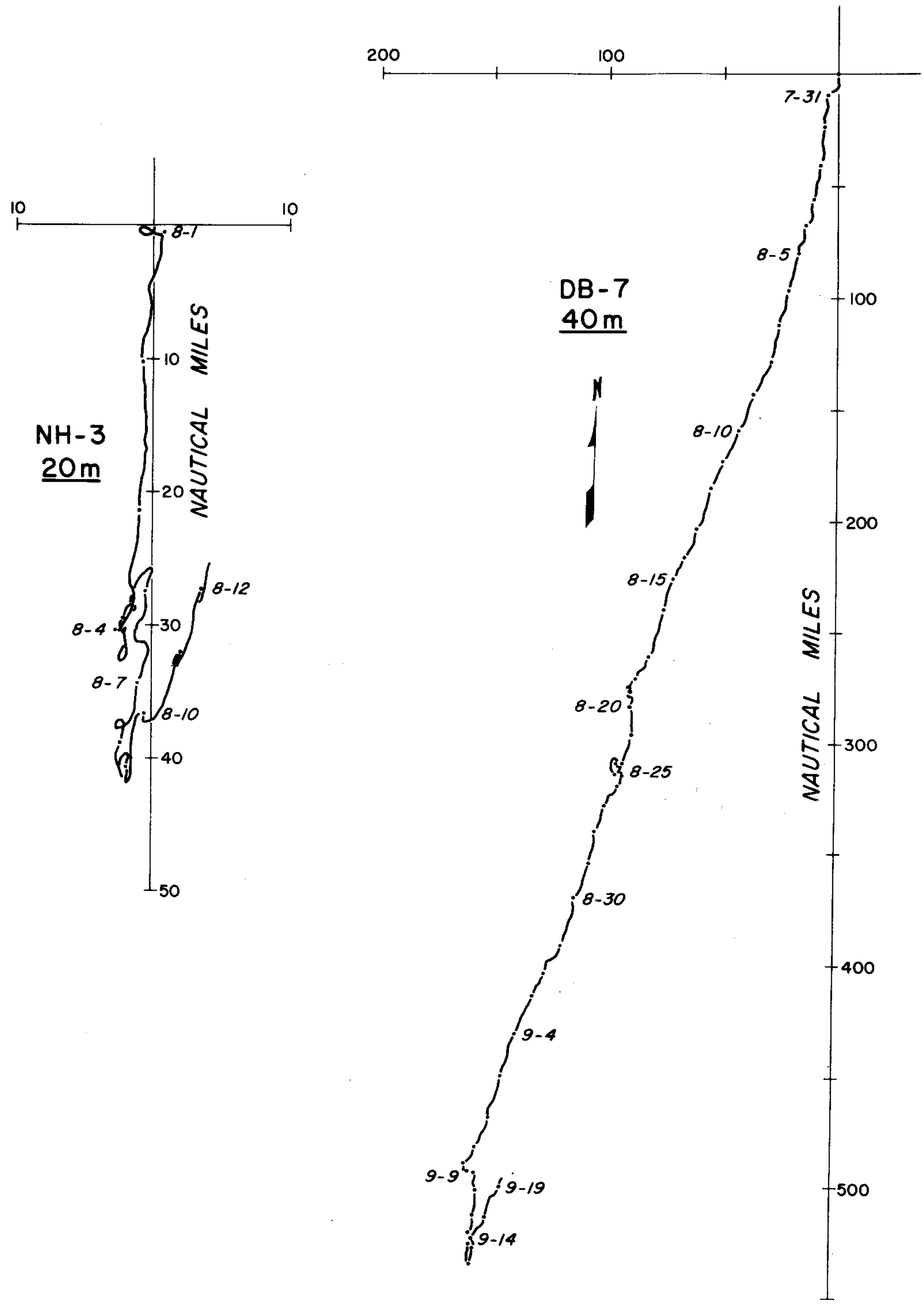
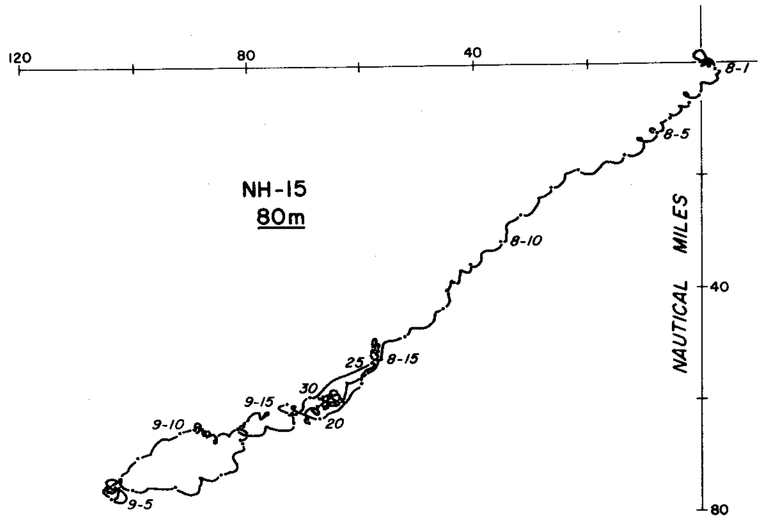


Fig. 8 (a) Progressive vector diagrams of current observations. NH-3, DB-7.



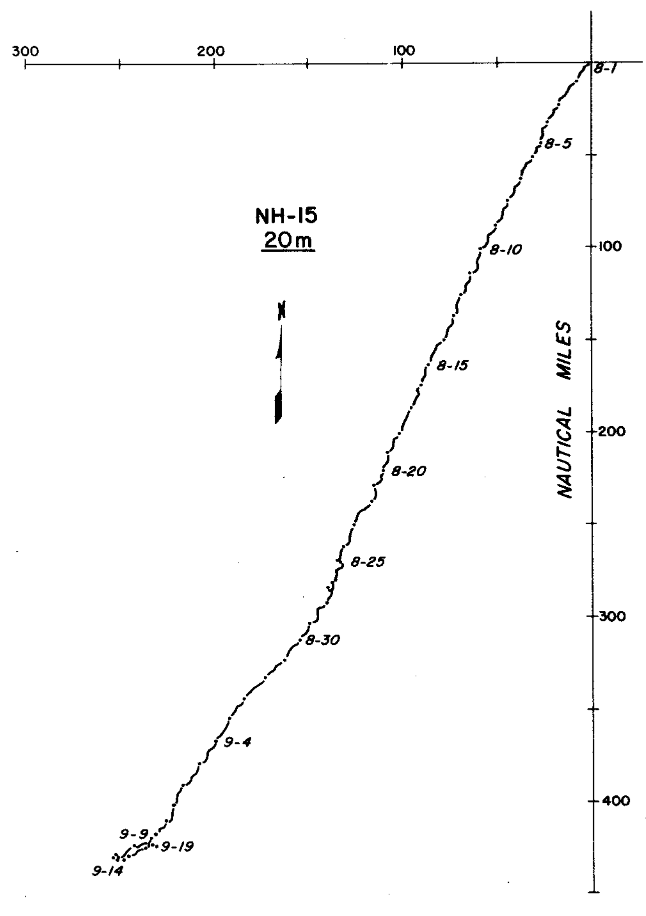


Fig. 8 (b). Progressive vector diagrams of current observations, NH-15

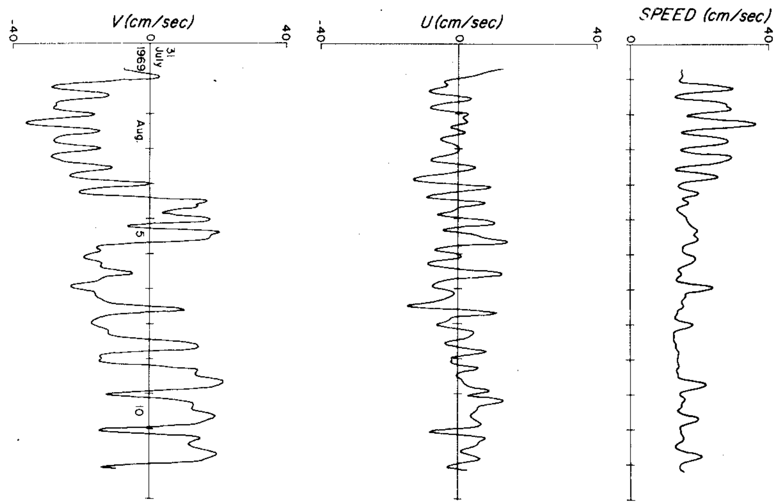


Fig. 9 (a) Low pass current time series showing speed, and eastward (u) and northward (v) components. 20 m NH-3.

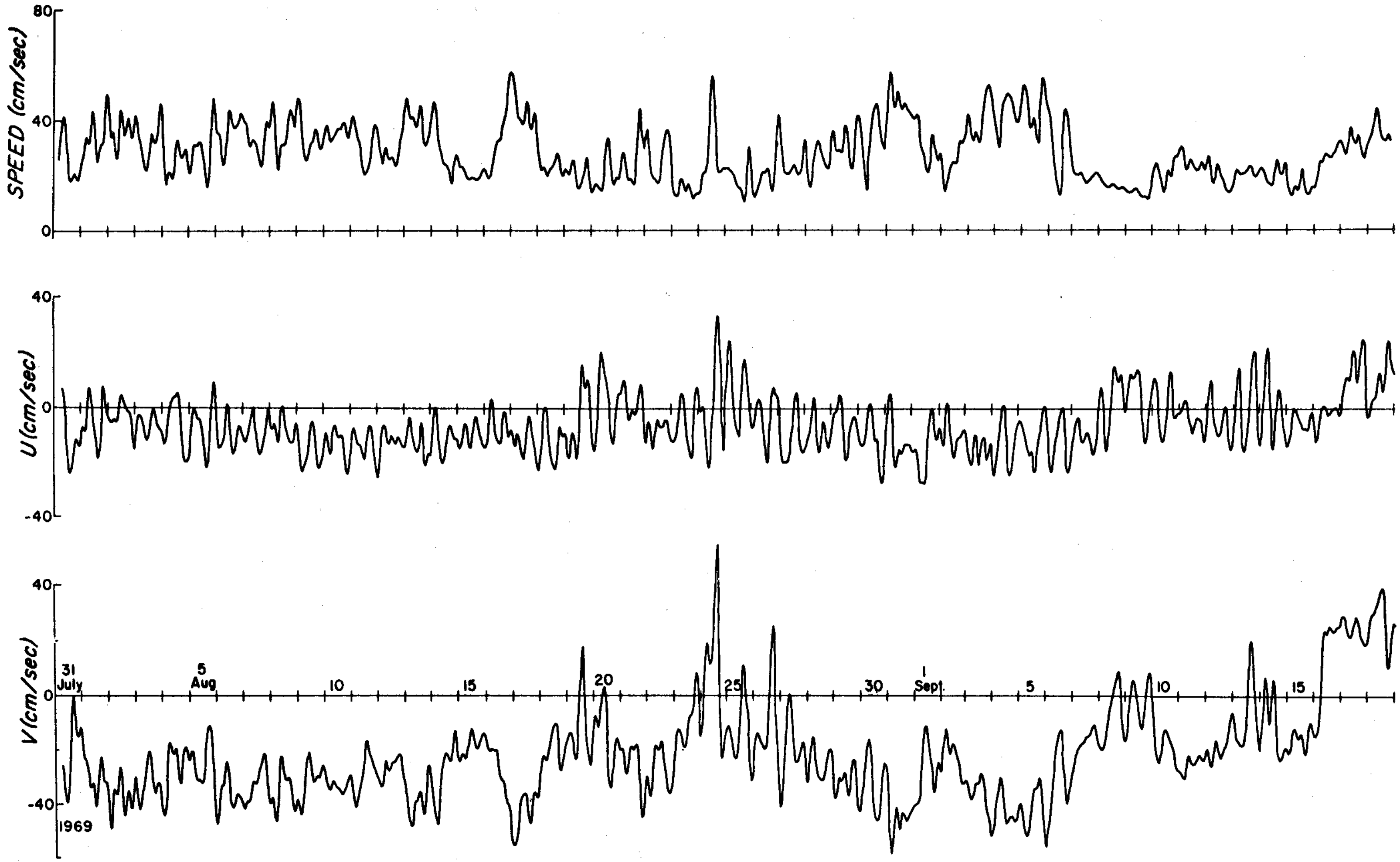


Fig. 9 (b) Low pass current time series showing speed, and eastward (u) and northward (v) components. 40 m DB-7.

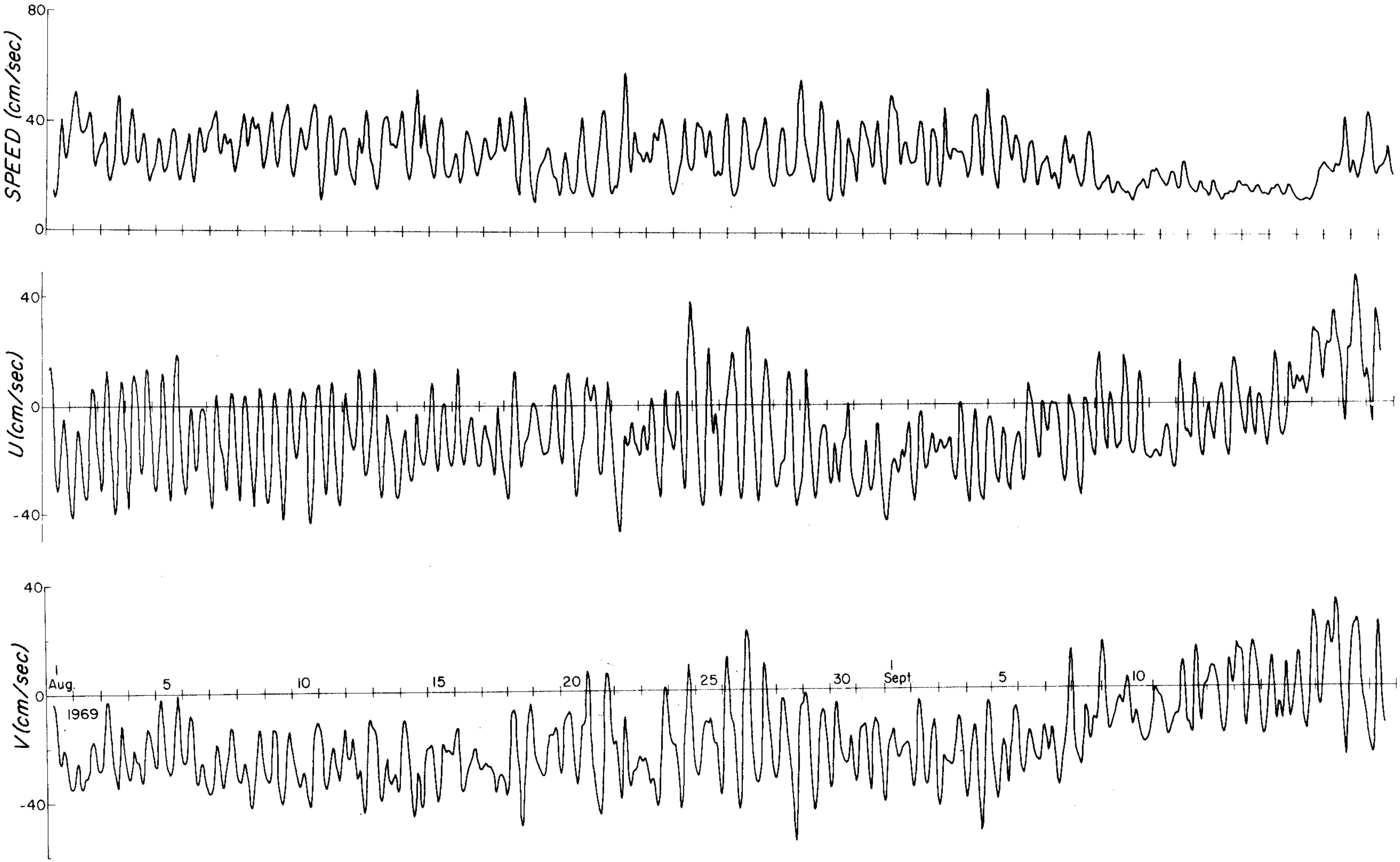


Fig. 9 (c) Low pass current time series showing speed, and eastward (u) and northward (v) components. 20 m NH-15.

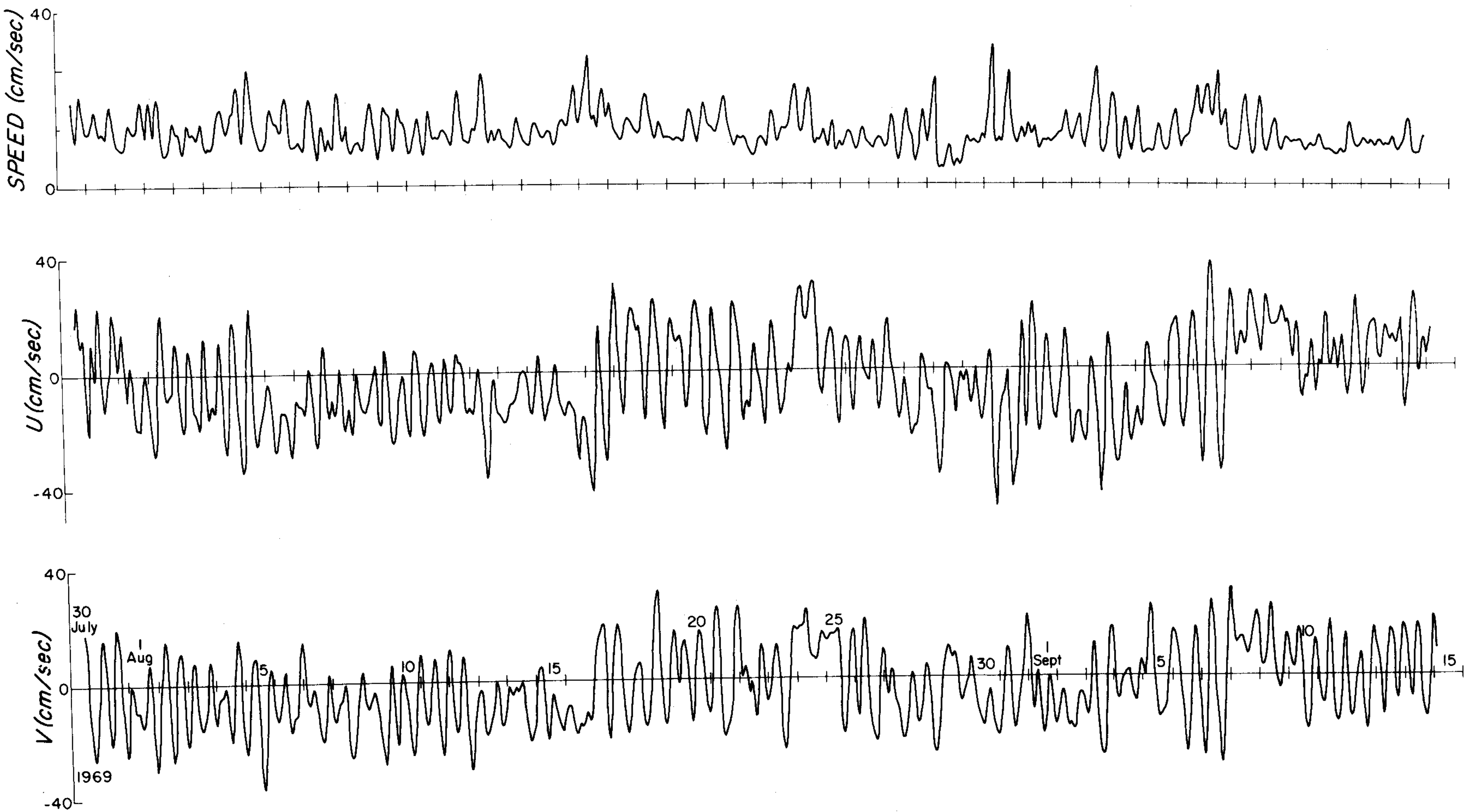


Fig. 9 (d) Low pass current time series showing speed, and eastward (u) and northward (v) components. 80 m NH-15.

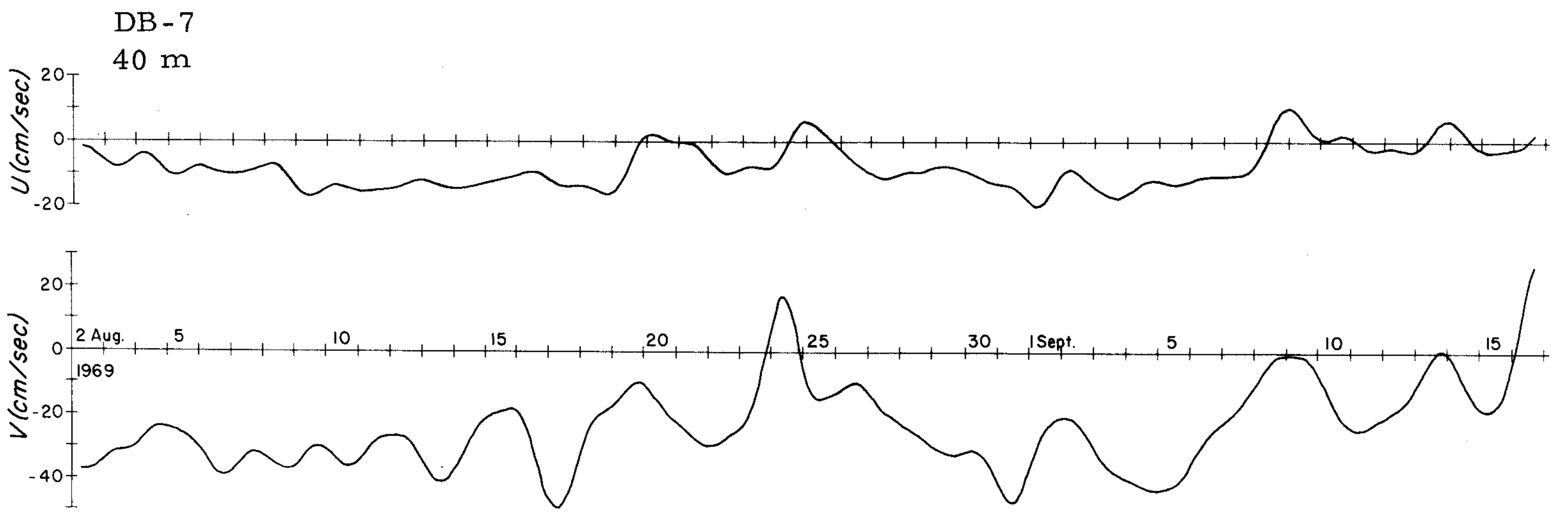


Fig. 10 (a) Low low pass current time series, showing eastward (u) and northward (v) components. 40 m DB-7.

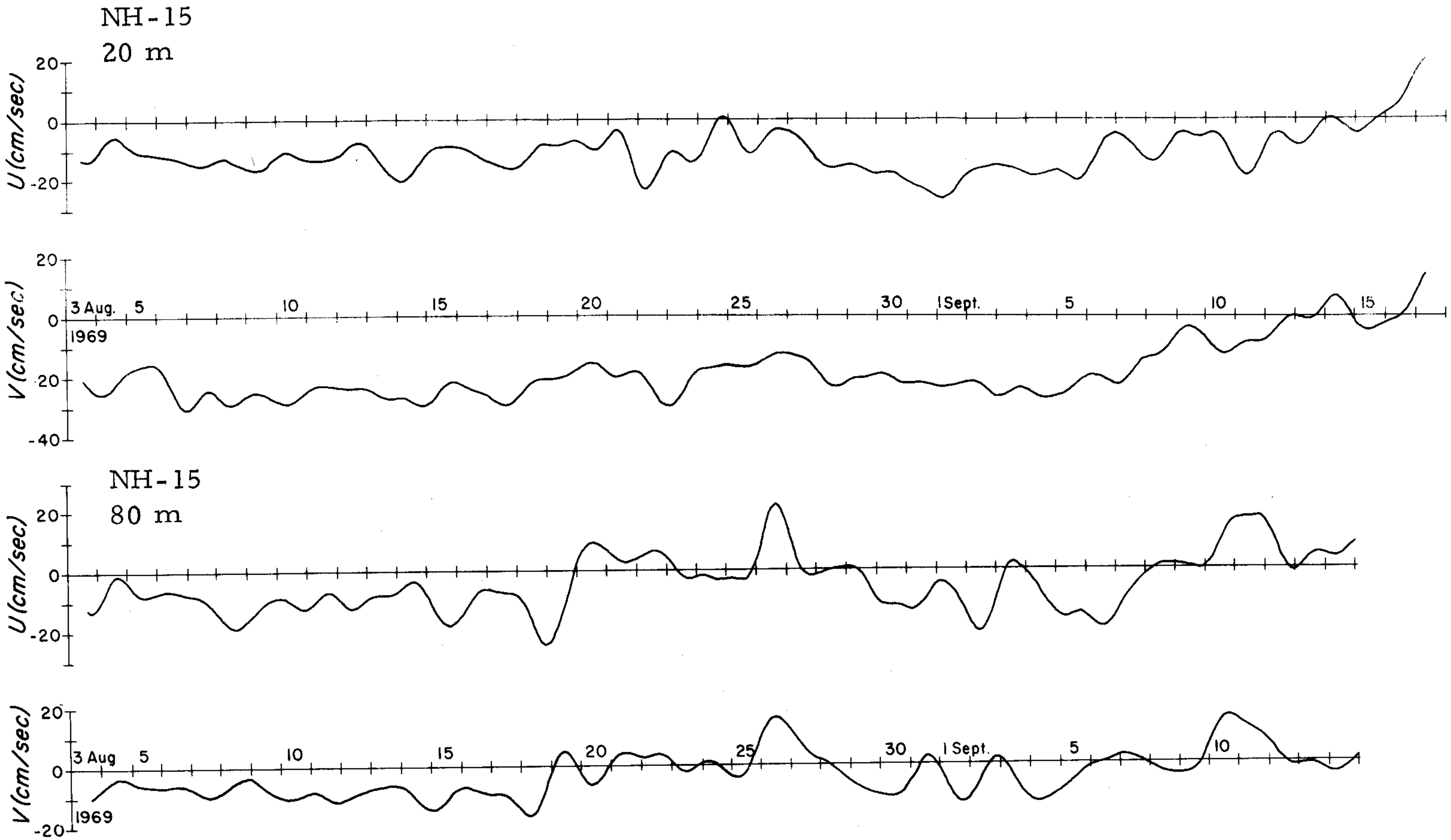


Fig. 10 (b) Low low pass current time series, showing eastward (u) and northward (v) components. NH-15.

3. Diurnal tides are more important in the v component.
4. The amplitudes of the tidal oscillations are variable.

They are large until 6 August. The amplitudes increase on 19 August, especially at 80 m, NH-15. On 24 August larger increases are observed at 20 m NH-15 and 40 m DB-7.

5. The net current at 20 m NH-15 is similar to that at 40m DB-7.

Plots of the low low pass series are shown for the eastward and northward components in Figure 10. No low low pass series were obtained for NH-3 as the record was too short. At each position, variations in the u component are associated with variations in v. This similarity between u and v was strongest at 80 m NH-15. This suggests that u and v are not components in the natural coordinate systems. More natural coordinates may be parallel to the bottom contours or the vector mean of the observed currents.

Variations in the current at 80 m NH-15 are very similar to those at 40 m DB-7. At DB-7 these variations seem to be superimposed on a net southward current. The amplitude of the variations is smaller at 20 m NH-15; there the net current seems to be similar to that at DB-7.

Wind Data

Winds were observed offshore at NH-15 from 31 July to 20 September. Of the data available from the Newport south jetty, only the observations from 1 August through 19 September are presented in this report. First order statistics of the wind observations are shown in Table 4. Both the maximum speed and the standard deviation are higher at Newport than at NH-15. Histograms of speed and direction are shown in Figure 11.

The progressive vector diagrams are shown in Figure 12. The PVD is about 40% longer for NH-15 than for Newport, i.e. the vector mean speed is larger offshore than at Newport. At Newport, short periods of eastward winds are frequently observed at the beginning of the day; Detweiler (1971) attributes this to channeling of the wind by the topography around the observation site.

Table 4. First order statistics of the wind observations.

	NH-15	South Jetty Newport
Speed (knots)		
minimum	2	0
maximum	20	28
mean	8.3	7.5
std. dev.	3.8	5.3
mode	6	3
Direction (° T)		
principal mode	180	180
secondary mode	360	360
Vector mean		
speed (knots)	2.7	1.8
direction (° T)	182	184
Components		
u		
mean	-0.1	-0.1
std. dev.	2.4	2.4
v		
mean	-3.2	-2.0
std. dev.	8.3	8.8

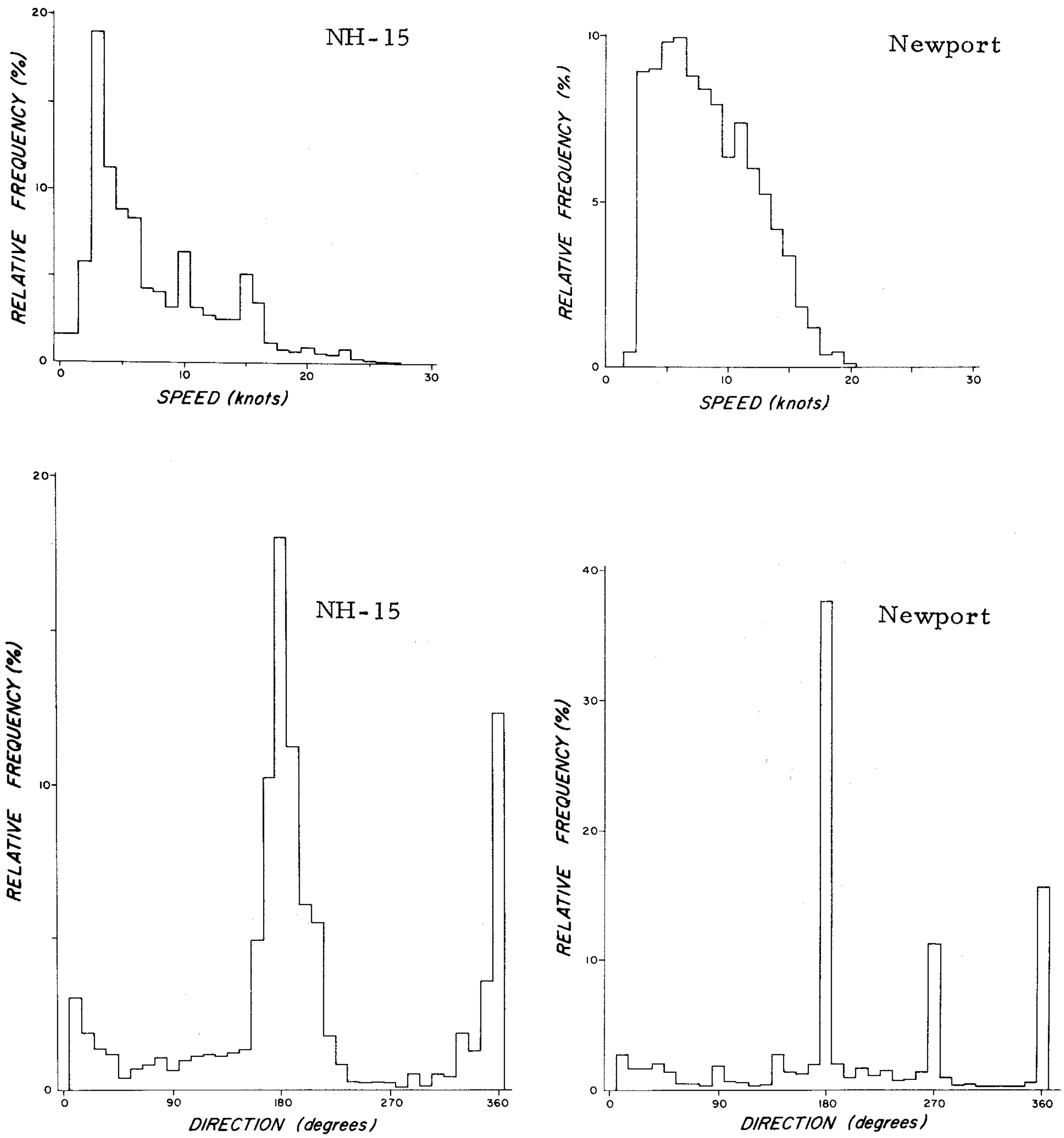


Fig. 11 Histograms of wind speed and direction at NH-15 and the Newport south jetty.

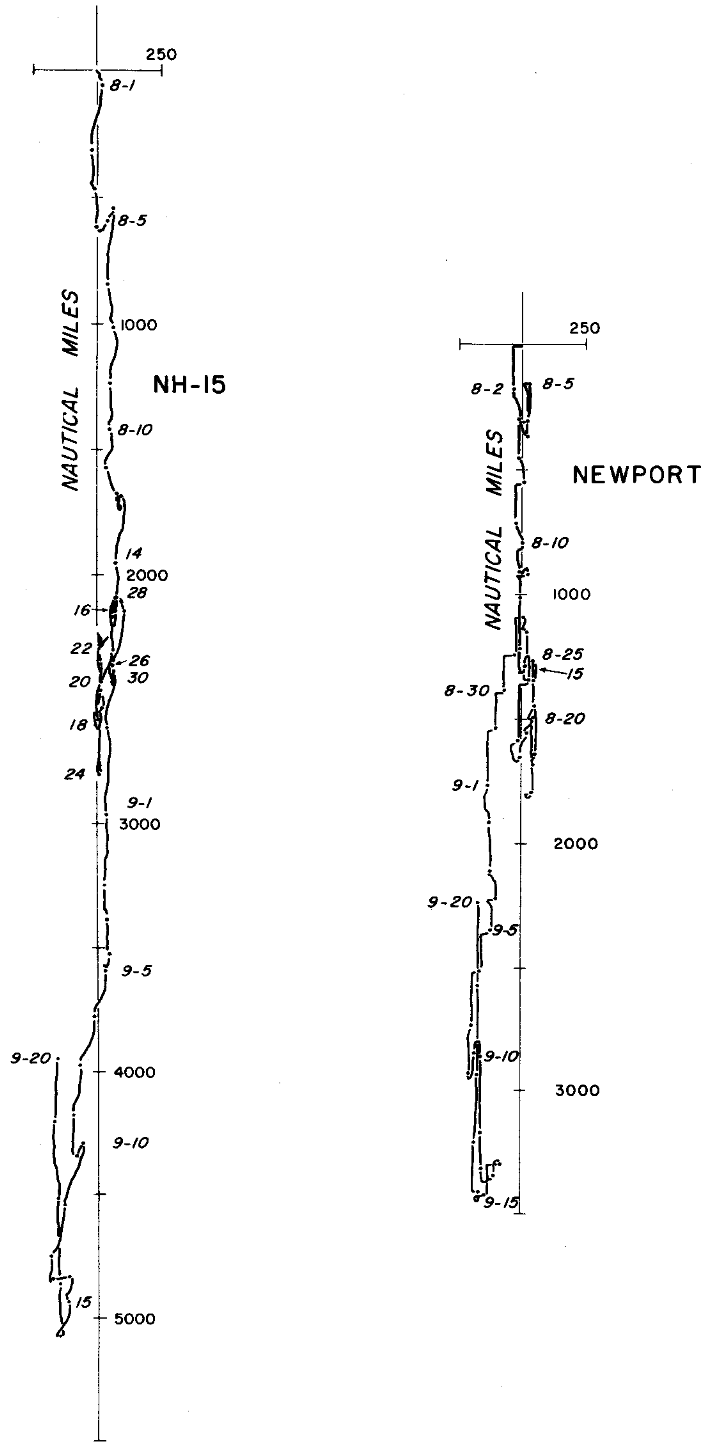


Fig. 12 Progressive vector diagrams of wind observations.

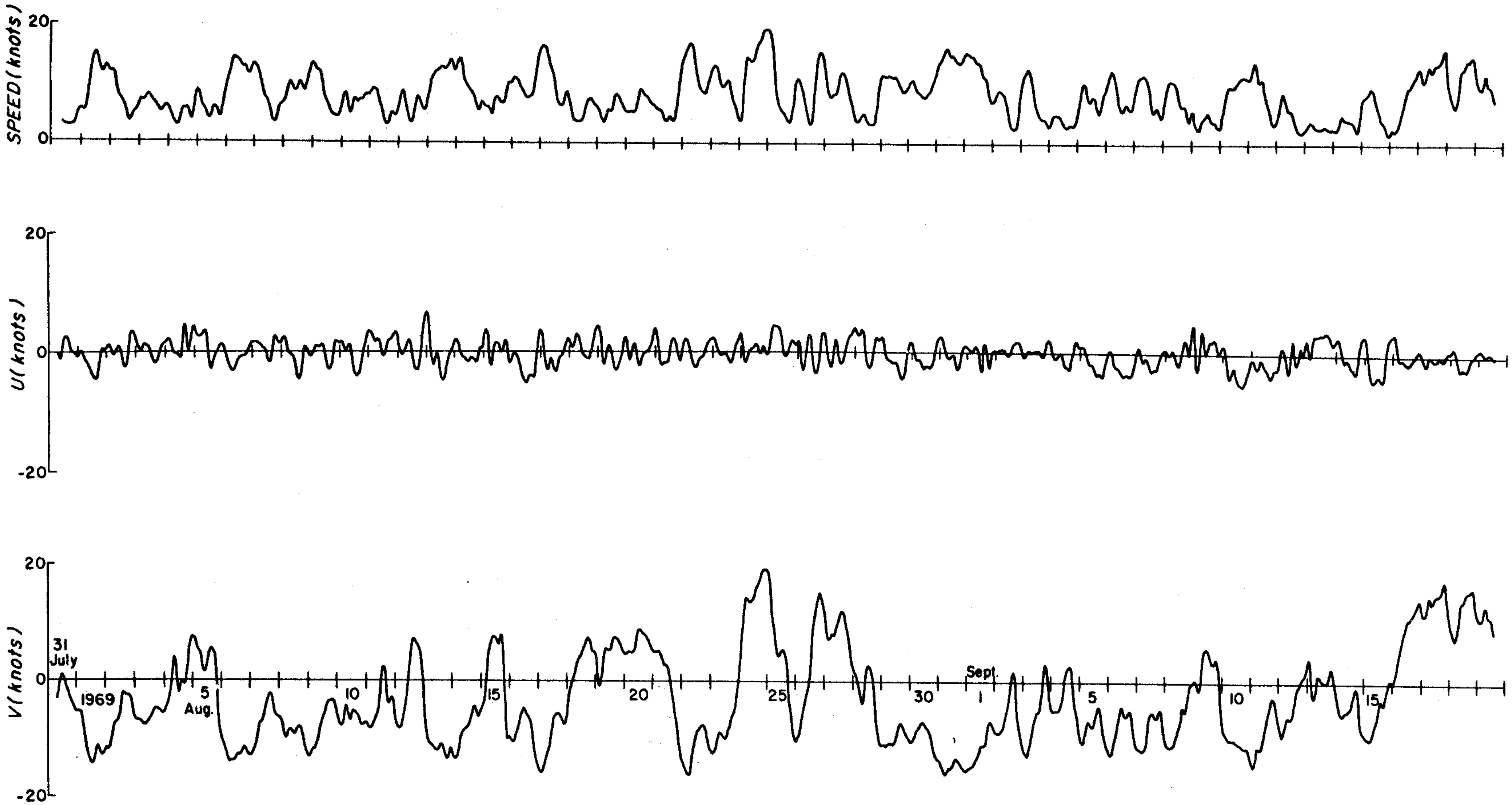


Fig. 13 (a) Low pass time series of wind, showing speed and eastward (u) and northward (v) components. NH-15.

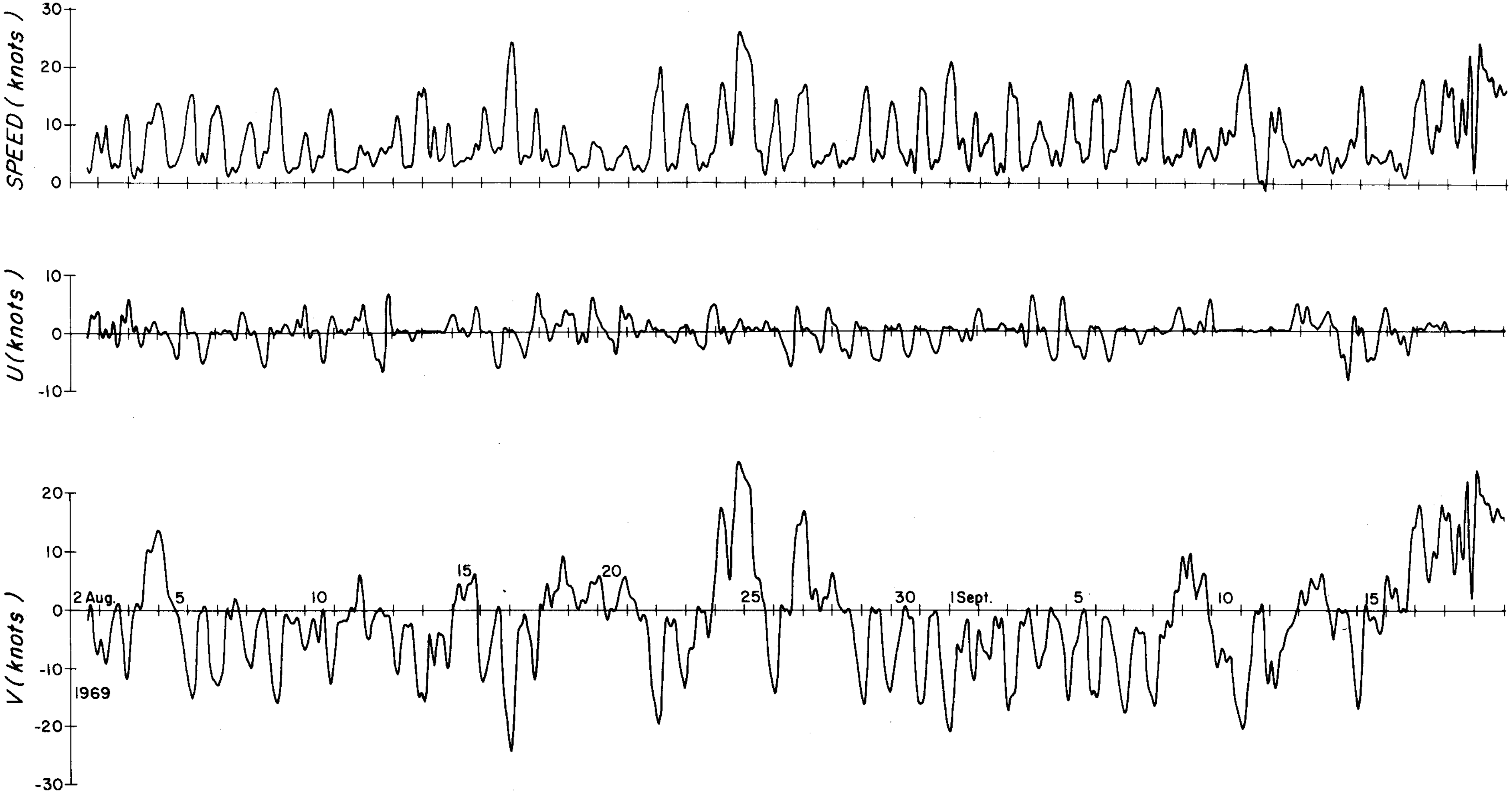


Fig. 13 (b) Low pass time series of wind, showing speed and eastward (u) and northward (v) components. Newport south jetty.

The low pass time series are presented in Figure 13. Velocities have larger extremes at Newport than offshore. The diurnal oscillation is very strong at Newport; it is also observed at NH-15. Variations of periods longer than one day occur mainly in the v component. They are very similar in the two records.

The low low pass time series of the wind at NH-15 is shown in Figure 14. It shows the longer term variations in the wind more clearly.

DISCUSSION

Temperature

Temperature observations can only be used to study time variations in the dynamical regime only if temperature gradients are present. Two thermographs (40 m DB-7 and 40 m NH-15) were located in water of nearly uniform temperature. At NH-3, the temperature gradient is sufficient to show the existence of a diurnal motion. The thermograph at 20 m NH-15 was located in the thermocline; there the temperature seems to have been a good indicator of vertical water movement.

Current

Comparison of the low pass current series shows that tidal oscillations are largest at NH-15 and smallest at NH-3 and DB-7. This must be partly due to the hydrographic regime; density stratification is stronger at NH-15 because of upwelling.

Comparison of the low pass current series shows there is some similarity between longer term variations at three of the locations. If the currents were resolved into components parallel to and perpendicular to the mean flow, similarities would be more apparent. Current variations at 80 m NH-15 are more closely related to the current at DB-7 than at 20 m NH-15.

The mean flow tends to be roughly parallel to the bottom contours at each of the three locations.

Wind

Diurnal variations in the wind are larger at Newport than 15 miles offshore. The mean wind is larger offshore than onshore. Long period variations in the wind seem to be similar at both locations.

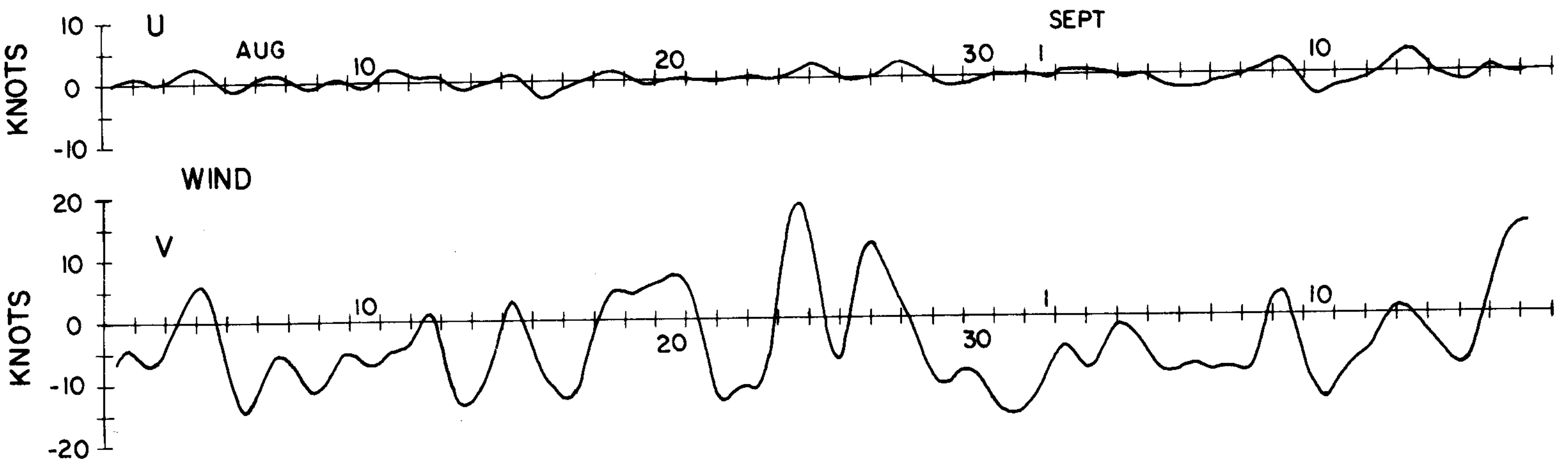


Fig. 14 Low low pass time series of the wind at NH-15.

Wind and Current

Comparison of the low pass time series of wind and current (Figs. 9 and 13) suggests that they are related. Huyer (1971) has compared the wind at NH-15 to the current at 40 m DB-7; apparently they are closely related. The current at 80 m NH-15 also seems to be related to the wind.

Temperature and Wind

The temperature record from 20 m NH-15 seems to be related to the wind.

Temperatures are low when the southward wind is strongest and high when the northward wind is strongest. This implies the thermocline moves upward during southward winds and downward during northward winds.

RECOMMENDATIONS

Temperature Data

If temperature data are to be used to study the dynamics of the region, thermographs should be placed in water with a high temperature gradient. Measuring the gradient would be useful: the temperature data could then be used to estimate vertical velocities.

Current Data

Further study of the current data should prove interesting. The data can be used to study the tidal and inertial oscillations. Coherence between the currents at the various locations should also be examined. Resolving the current data into components in other coordinate systems and then comparing the records may clarify the influence of the hydrographic regime on long period variations.

Wind Data

The Braincon wind meter should be installed near the anemometer on the Newport south jetty for a few weeks to see if there is a systematic difference between the two instruments. When this has been done, the two 1969 wind records can be used to study the differences in the offshore and onshore winds. The data could be used to learn more about the diurnal oscillation (sea-breeze). As well, it may be possible to learn about the interaction of the sea-breeze with the mean wind.

Since Huyer (1971) has shown that local currents are closely related to the local wind, we recommend that wind observations be part of any nearshore current observation program.

An Integrated Study

Study of the relationship between the various currents records, the wind and the temperature at 20 m NH-15 should yield a greater understanding of the dynamics of the coastal water. When possible the observed currents and temperature should also be related to independent temperature and salinity observations.

PERSONNEL

Drs. June G. Pattullo and Robert L. Smith were principal investigators of the project. Mr. R. Dale Pillsbury was responsible for the instrument preparation and installation. Mr. Joseph Bottero was responsible for most of the data processing; some of it was done by Miss Suzann Calkins, Miss Lillie Muller and Mr. William E. Gilbert. Miss Marilynne Hakanson aided in the preparation of the report. Mr. Gilbert and Mr. Ronald Hill drafted the figures.

Dale Pillsbury provided many of the details that made this report possible.

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A. Huyer was on educational leave from the Marine Sciences

Branch, Department of Energy, Mines and Resources, Canada, while working on this project.

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APPENDIX

The Numerical Filters

Four numerical filters were used to smooth the observed data series. They are similar in design: they are symmetrical and differ only in the number and values of weighting factors used. Details for each filter are given below.

The general form of the filters is as follows:

x(i) = observed value
y(i) = smoothed value

$$y(i) = \frac{1}{G} \sum_{m=-N}^{N} f(m) \; x(1-m)$$

where (2N+1) is the number of weighting factors, f (m), and G is a normalization factor such that

$$G = \sum_{m=-N}^{N} f(m)$$

and $f(-m) = f(m)$

In each of the filters below, except Filter 4, $f(0) = 1$.

The different filters were used with series with different data intervals. Table A-1 shows which filter was used for each data interval and the periods at which the amplitudes of the response functions are 0.1, 0.5, and 0.9.

Filter 1. The Cosine-Lanczos Filter

This filter was described in detail by Mooers *et al.* (1968). Its half-amplitude point is 0.029 cycles per data interval.

Filter 2.

This is a simple modification of the Cosine-Lanczos filter. Alternate weighting factors of Filter 1 were used, so N = 29. The weighting factors are listed in Table A-2. The frequency response function is shown in Table A-3.

Filter 3.

This filter was designed by a computer program GENER 1 (Ochs, Baughman and Ballance, 1970, pp. 62-66). The Cosine taper function was used. The weighting factors and the frequency response function are shown (Tables A-4 and A-5).

Filter 4.

This filter was also designed by GENER 1 using the Cosine taper. Table A-6 shows the weighting factors. These factors have been normalized, i. e. G = 1, so $f(0) \neq 1$ as for the other filters. The frequency response function is given in Table A-7.

Table A-1

The filters used for different data intervals, and the periods at which the amplitude of the response function was 0.1, 0.5, and 0.9.

filter	sampling interval (min)	response 0.1	0.5	0.9
		period (hours)		
1	10	4.5	5.7	8.0
2	20	4.5	5.7	8.0
4	60	5.2	5.8	6.4
3	20	26	34	48

Table A-2

Weighting factors for Filter 2.

m	f(m)	m	f(m)
1	.970000	16	-0.030900
2	.900000	17	-0.003290
3	.787000	18	.016200
4	.648000	19	.026600
5	.490000	20	.029500
6	.331000	21	.026300
7	.184000	22	.020000
8	.058900	23	.012800
9	-0.037400	24	.006340
10	-0.102000	25	.001890
11	-0.135000	26	-0.000468
12	-0.141000	27	-0.001120
13	-0.126000	28	-0.000793
14	-0.098100	29	-0.000219
15	-0.064300		

Table A-3. The frequency response function of Filter 2.

Frequency (cycles per data interval)	Response Function
0	1.000E 00
.0040000	9.998E-01
.0080000	9.996E-01
.0120000	1.000E-00
.0160000	1.002E 00
.0200000	1.004E 00
.0240000	1.007E 00
.0280000	1.005E 00
.0320000	9.955E-01
.0360000	9.726E-01
.0400000	9.317E-01
.0440000	8.698E-01
.0480000	7.866E-01
.0520000	6.848E-01
.0560000	5.701E-01
.0600000	4.504E-01
.0640000	3.345E-01
.0680000	2.303E-01
.0720000	1.439E-01
.0760000	7.844E-02
.0800000	3.407E-02
.0840000	8.170E-03
.0880000	-3.592E-03
.0920000	-6.197E-03
.0960000	-4.217E-03
.1000000	-1.087E-03
.1040000	1.200E-03
.1080000	1.976E-03
.1120000	1.501E-03
.1160000	4.607E-04
.1200000	-4.791E-04
.1240000	-9.336E-04
.1280000	-8.624E-04
.1320000	-4.730E-04
.1360000	-5.193E-05
.1400000	1.866E-04
.1440000	1.780E-04
.1480000	-1.568E-06
.1520000	-2.065E-04
.1560000	-3.070E-04

Table A-4. The weighting factors of Filter 3.

m	f(m)	m	f(m)	m	f(m)
1	.9992808	61	-0.1107401	121	.0300478
2	.9972262	62	-0.1175201	122	.0296882
3	.9937335	63	-0.1234783	123	.0292259
4	.9888540	64	-0.1286147	124	.0286096
5	.9826389	65	-0.1328779	125	.0278905
6	.9750885	66	-0.1363706	126	.0270687
7	.9662026	67	-0.1391443	127	.0261441
8	.9559812	68	-0.1410961	128	.0251682
9	.9445271	69	-0.1423802	129	.0240896
10	.9317889	70	-0.1429965	130	.0229596
11	.9178693	71	-0.1429452	131	.0218296
12	.9028198	72	-0.1422774	132	.0205968
13	.8866402	73	-0.1410447	133	.0193641
14	.8693306	74	-0.1392470	134	.0181314
15	.8510451	75	-0.1369356	135	.0168473
16	.8317324	76	-0.1341106	136	.0156146
17	.8115465	77	-0.1308747	137	.0143818
18	.7904360	78	-0.1272279	138	.0131491
19	.7685550	79	-0.1232215	139	.0119677
20	.7458523	80	-0.1188556	140	.0107864
21	.7225332	81	-0.1141815	141	.0096564
22	.6985463	82	-0.1092506	142	.0085777
23	.6739945	83	-0.1041142	143	.0075505
24	.6489290	84	-0.0987724	144	.0065746
25	.6234012	85	-0.0932765	145	.0056500
26	.5975139	86	-0.0876778	146	.0047768
27	.5713184	87	-0.0819251	147	.0040064
28	.5449175	88	-0.0761724	148	.0032359
29	.5183111	89	-0.0703683	149	.0025682
30	.4915506	90	-0.0645128	150	.0019518
31	.4647901	91	-0.0587601	151	.0013868
32	.4380296	92	-0.0530073	152	.0008732
33	.4113719	93	-0.0473573	153	.0004623
34	.3848168	94	-0.0417587	154	.0000514
35	.3585186	95	-0.0363141	155	-0.0002568
36	.3324259	96	-0.0310237	156	-0.0005650
37	.3066927	97	-0.0258873	157	-0.0007705
38	.2813190	98	-0.0209050	158	-0.0009245
39	.2563562	99	-0.0161282	159	-0.0010786
40	.2319071	100	-0.0115568	160	-0.0011814
41	.2079203	101	-0.0071909	161	-0.0012327
42	.1845498	102	-0.0030305	162	-0.0012327
43	.1617957	103	.0008732	163	-0.0012327
44	.1397093	104	.0045200	164	-0.0012327
45	.1182906	105	.0079100	165	-0.0011814
46	.0976424	106	.0110946	166	-0.0010786
47	.0777133	107	.0140223	167	-0.0010273
48	.0586060	108	.0166932	168	-0.0009245
49	.0402691	109	.0190559	169	-0.0008218
50	.0228055	110	.0212132	170	-0.0007191
51	.0062150	111	.0231137	171	-0.0006164
52	-0.0095536	112	.0248087	172	-0.0005136
53	-0.0243978	113	.0262469	173	-0.0004109
54	-0.0383687	114	.0274282	174	-0.0003082
55	-0.0514151	115	.0284041	175	-0.0002568
56	-0.0635369	116	.0291746	176	-0.0001541
57	-0.0747855	117	.0296882	177	-0.0001027
58	-0.0851097	118	.0300478	178	-0.0000514
59	-0.0945606	119	.0302019	179	-0.0000514
60	-0.1030869	120	.0302019		

Table A-5. The frequency response function of Filter 3.

frequency (cycles per data interval)	response	frequency (cycles per data interval)	response
0	1.	.0100	.4513
.0005	.9999	.0105	.3630
.0010	.9996	.0110	.2804
.0015	.9994	.0115	.2063
.0020	.9997	.0120	.1431
.0025	1.001	.0125	.09187
.0030	1.002	.0130	.05281
.0035	1.005	.0135	.02518
.0040	1.006	.0140	.007504
.0045	1.006	.0145	-0.002181
.0050	1.002	.0150	-0.006029
.0055	.9918	.0155	-0.006126
.0060	.9736	.0160	-0.004276
.0065	.9453	.0165	-0.001860
.0070	.9053	.0170	.0002157
.0075	.8530	.0175	.001500
.0080	.7887	.0180	.001913
.0085	.7137	.0185	.001627
.0090	.6304	.0190	.000940
.0095	.5417	.0195	.000164
		.0200	-0.000456

Table A-6. The weighting factors of Filter 4.

m	f(m)	m	f(m)
0	.34799	15	-0.0067631
1	.28192	16	-0.0087047
2	.12850	17	-0.0019342
3	-0.014262	18	.0045058
4	-0.071795	19	.0046649
5	-0.043298	20	.0004987
6	.013097	21	-0.0025727
7	.038834	22	-0.0021118
8	.020843	23	.0000223
9	-0.011313	24	.0011320
10	-0.023826	25	.0006900
11	-0.010470	26	-0.0000795
12	.0091175	27	-0.0002732
13	.014746	28	-0.0000895
14	.0049142	29	.00000857

Table A-7. The frequency response function of Filter 4.

frequency (cycles per data interval)	response	frequency (cycles per data interval)	response
0.0	1.0000	.160	.8628
.050	.9999	.165	.7538
.100	1.000	.170	.6185
.105	1.001	.175	.4700
.110	1.001	.180	.3249
.115	.9998	.185	.1989
.120	.9986	.190	.1027
.125	.9982	.195	.0398
.130	.9997	.200	.0065
.135	1.003	.205	-0.0054
.140	1.006	.210	-0.0055
.145	1.003	.215	-0.0017
.150	.9833	.220	.0012
.155	.9389	.225	.0018

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13. ABSTRACT

Observations from an instrument array moored over the continental shelf off Oregon from 31 July to 21 September 1969 are presented. Temperature, current and wind observations were obtained every 20 minutes. First order statistics, histograms, progressive vector diagrams and time series plots are presented. Supplementary wind observations at Newport are also described. It is recommended that wind observations be part of future coastal current observational programs and that thermographs be placed in positions with a large temperature gradient.

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