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**A Compendium of Time Series  
Measurements From Moored  
Instrumentation during the MAM '77  
Phase of JOINT-II**

by

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Office for the International Decade  
of Ocean Exploration  
National Science Foundation  
OCE 78-03380, OCE 78-03382, and  
OCE 78-04823

Reference 78-17  
CUEA Technical Report 45

October 1978

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A COMPENDIUM OF TIME SERIES MEASUREMENTS FROM  
MOORED INSTRUMENTATION DURING THE MAM '77 PHASE OF JOINT-II

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## INTRODUCTION

An extensive array of instruments, including current meters, temperature recorders, anemometers and tide gauges, was moored off the Peru coast during the culminating phase of JOINT-II from early March to late May 1977. The basic description and analysis of the time series data from these instruments is given in reports of Oregon State University (Enfield, Huyer and Smith, 1978)<sup>1</sup> and of the NOAA Pacific Marine Environmental Laboratory (Halpern and Freitag, 1978, in preparation). The OSU moorings had Aanderaa instruments; the NOAA/PMEL moorings had vector-averaging current meters (VACM) and wind recorders.

The time series data used in this compendium are low pass filtered versions of the original data series. The low pass filter removed the diurnal tide and higher frequency fluctuations. For periods shorter than 26 hours less than 1% of the amplitude remains, half the amplitude is passed at 40 hours and more than 90% of the amplitude is passed at 60 hours. The half power point of the filter is at 46.6 hours. We present visual and statistical representations of the data in forms that will be generally useful to the interdisciplinary research of CUEA.

Comparable information for measurements during 1976 (March through September) can be found in Brink, Allen and Smith (1978).<sup>2</sup>

- 
1. Enfield, D. B., R. L. Smith and A. Huyer, 1978: A compilation of observations from moored current meters, Volume XII: Wind, currents and temperature over the continental shelf and slope off Peru during JOINT-II. March 1976 - May 1977. Data Rep. 70, Ref. 78-4, 347 pp., School of Oceanography, Oregon State University, Corvallis.
  2. Brink, K. H., J. S. Allen and R. L. Smith, 1978: A study of low-frequency fluctuations near the Peru coast. J. Phys. Oceanogr., 8, in press.

## EXPLANATIONS OF TABLES AND FIGURES

The positions of the instruments are given in Table 1 (page 5) and Figure 1 (page 11). Depth contours on the map are given in meters. The NOAA/PMEL moorings are PSS, PS and PD. The OSU moorings were named for indigenous cacti and succulents, except for Lagarta; these names are abbreviated to the first letter, except where two letters are needed to avoid ambiguity.

Simple statistics of the low passed data are given in Table 2 (pages 6 - 9). Standard deviations were computed after the data had the linear trend removed. The onshore,  $u$ , and alongshore,  $v$ , velocity components are positive towards the coast and towards the northwest, respectively. The current meter data are presented in a local coordinate system, determined by the depth averaged principal axes, except for the surface layer data (PS and PSS) which are rotated  $45^\circ$  counterclockwise from north. The principal axis (the direction of maximum variance) provides a more objective means of determining the alongshore direction than our uncertain knowledge of bottom topography from navigation charts. The principal axis direction,  $\theta$ , is given in degrees counterclockwise from the north. Wind data is rotated  $45^\circ$ , counterclockwise from north, the approximate general direction of the coastline. All statistics are computed over the 49.5 day common current meter period (0000 UT March 22 to 0600 UT May 10, 1977).

Stick diagrams are shown in Figures 2-14 (pages 12-24). They are plotted on a common scale, and show the entire record length from each instrument. Temperatures are shown at the top of each diagram (individual lines are not labeled since the shallowest instrument always has the highest temperature, and there are no persistent temperature inversions).

The arrow drawn on each figure points toward the north, and its length represents 50 cm/sec for currents and 10 m/sec for winds.

Line plots of alongshore wind velocity, adjusted sea level and current velocity components are shown in Figures 15-26 (pages 26-49 ). Current meter velocities are in the local coordinate system, and have units of cm/sec. Alongshore wind velocity and adjusted sea level have units of m/sec and cm, respectively. By adjusted sea level we indicate the sea level equivalent to the "subsurface" pressure (atmospheric plus sea level), i.e., we have adjusted for the static inverted barometer effect.

Line plots, arranged for easy intercomparison, are presented for wind velocity components (Figure 27, pages 50 and 51 ) and for adjusted sea level (Figure 28, page 52). Winds are given in m/sec, and sea level (referenced to an arbitrary datum) is given in cm.

Vertical profiles of the onshore-offshore and alongshore current components are presented for Agave/PSS (Figure 29, pages 54 - 62 ) and for Mila-5 (Figure 30, pages 64 - 72 ). The onshore and alongshore directions are taken as 45° counterclockwise from the east and north, respectively; these directions differ slightly from the principal axis orientation used in other plots (cf. Table 2). The profiles are presented at two day intervals. Since the characteristic time scale for  $u$  is less than two days (cf. Figure 17b), the reader should consult the line plots for velocities at times other than those given here.

## TABLES

Table 1. Summary of positions, water depths and current meter depths for instrument arrays in the MAM '77 phase of JOINT-II. Only instruments from which data were obtained are listed. M: Meteorological buoy  
T: Tide gauge

| Station   | Position  |           | Water Depth (m) | Current Meter Depths (m)  |
|-----------|-----------|-----------|-----------------|---------------------------|
| PSS       | 15°03.4'S | 75°27.0'W | 75              | M,4.5,8,12,16             |
| Agave     | 15°04.0'S | 75°27.8'W | 86              | 26,46,67,77,T             |
| PS        | 15°06.8'S | 75°30.2'W | 121             | M,2.5,4.6,8.1,12,16,20,24 |
| Mila-5    | 15°06.0'S | 75°30.8'W | 121             | M,19,39,59,80,100,115     |
| Ironwood  | 15°09.9'S | 75°32.9'W | 205             | 24,44,63,105,155,180,T    |
| Lobivia   | 15°11.5'S | 75°34.3'W | 580             | 58,83,183,283             |
| Lagarta   | 15°10.0'S | 75°36.0'W | 620             | 92,115,214,512            |
| PD        | 15°51.5'S | 76°25.0'W | 3220            | M                         |
| Euphorbia | 15°31.2'S | 75°00.8'W | 123             | M,25,63                   |
| Parodia   | 14°55.7'S | 75°39.8'W | 124             | M,24,64,104               |
| Opuntia   | 12°14.2'S | 77°35.9'W | 620             | 129,224,324,524           |
| Yucca-Too | 12°04.6'S | 77°19.5'W | 117             | 37,57,97                  |
| Peyote    | 9°57.8'S  | 78°24.3'W | 117             | 37,56,96,T                |



Table 2a. Current meter statistics from the 49.5 day common period (0000 UT 22 March 1977 to 0600 UT 10 May 1977). Velocities are in cm/sec and temperatures in °C. Principal axis direction,  $\theta$ , is given in degrees counterclockwise from North. Numbers in parentheses below the mooring name give the total water depth in m, and the assumed alongshore direction in degrees counterclockwise from North.

| Mooring                | Instrument Depth | Means |      |       | Standard Deviations |      |      | Principal Axis Direction |
|------------------------|------------------|-------|------|-------|---------------------|------|------|--------------------------|
|                        |                  | u     | v    | T     | u                   | v    | T    | $\theta$                 |
| PSS<br>(75, 45.0°)     | 4.5              | -1.6  | 13.2 | 16.02 | 3.3                 | 9.3  | 0.51 | 44.6°                    |
|                        | 8                | -1.1  | 10.2 | 15.89 | 3.6                 | 9.2  | 0.35 | 38.2°                    |
|                        | 12               | A     | A    | 15.77 | A                   | A    | 0.24 | A                        |
|                        | 16               | -1.0  | 3.7  | 15.67 | 3.1                 | 7.0  | 0.19 | 41.4°                    |
| Agave<br>(86, 45.3°)   | 26               | 4.2   | -0.2 | 15.53 | 3.9                 | 10.6 | 0.12 | 44.3°                    |
|                        | 46               | 6.1   | -6.2 | 15.32 | 4.2                 | 10.6 | 0.10 | 43.7°                    |
|                        | 67               | 1.8   | -4.8 | 15.13 | 3.0                 | 6.8  | 0.11 | 51.2°                    |
|                        | 77               | 0.1   | -3.7 | 15.05 | 2.0                 | 4.6  | 0.13 | 42.1°                    |
| PS<br>(121, 45.0°)     | 2.5              | -5.8  | 17.9 | 16.46 | 4.5                 | 11.2 | 0.39 | 58.5°                    |
|                        | 4.6              | -6.5  | 14.1 | 16.37 | 4.9                 | 10.6 | 0.33 | 62.7°                    |
|                        | 8.1              | -6.5  | 10.0 | 16.26 | 5.7                 | 9.7  | 0.27 | 68.2°                    |
|                        | 12               | -3.2  | 6.1  | 16.10 | 5.0                 | 8.6  | 0.22 | 62.1°                    |
|                        | 16               | -1.7  | 4.3  | 15.95 | 5.7                 | 8.6  | 0.18 | 64.2°                    |
|                        | 20               | -0.2  | 3.2  | 15.83 | 5.7                 | 8.0  | 0.16 | 64.6°                    |
|                        | 24               | 0.0   | 1.9  | 15.69 | 5.0                 | 8.0  | 0.15 | 51.2°                    |
| Mila V<br>(121, 47.5°) | 19               | B     | B    | 15.93 | B                   | B    | 0.18 | B                        |
|                        | 39               | 4.8   | -4.9 | 15.49 | 6.0                 | 8.5  | 0.10 | 33.8°                    |
|                        | 59               | 5.5   | -6.0 | 15.20 | 4.7                 | 8.9  | 0.08 | 42.2°                    |
|                        | 80               | 3.4   | -5.7 | 15.05 | 4.6                 | 8.5  | 0.13 | 60.1°                    |
|                        | 100              | 0.7   | -3.6 | 14.87 | 3.3                 | 6.8  | 0.16 | 58.4°                    |
|                        | 115              | -1.6  | -1.5 | 14.63 | 2.2                 | 4.7  | 0.22 | 43.1°                    |

Table 2a. (Continued)

| Mooring                   | Instrument<br>Depth | Means |      |        | Standard<br>Deviations |      |      | Principal<br>Axis<br>Direction |
|---------------------------|---------------------|-------|------|--------|------------------------|------|------|--------------------------------|
|                           |                     | u     | v    | T      | u                      | v    | T    | $\theta$                       |
| Ironwood<br>(205, 43.1°)  | 24                  | -5.7  | -0.8 | 16.14  | 6.7                    | 7.7  | 0.28 | 52.2°                          |
|                           | 44                  | -0.7  | -3.7 | 15.60  | 5.8                    | 8.9  | 0.17 | 48.0°                          |
|                           | 63                  | 0.3   | -6.3 | 15.21  | 7.0                    | 10.0 | 0.10 | 42.6°                          |
|                           | 105                 | -0.3  | -6.1 | 14.76  | 4.9                    | 9.4  | 0.16 | 44.7°                          |
|                           | 155                 | -0.8  | -4.5 | 13.87  | 2.4                    | 9.5  | 0.28 | 35.9°                          |
|                           | 180                 | -0.7  | -4.9 | 13.36  | 2.0                    | 8.2  | 0.41 | 35.9°                          |
| Lobivia<br>(580, 48.9°)   | 58                  | -1.6  | -6.9 | 15.37  | 5.3                    | 7.5  | 0.14 | 47.4°                          |
|                           | 83                  | C     | C    | C      | C                      | C    | C    | C                              |
|                           | 183                 | -0.4  | -1.3 | 13.31  | 3.4                    | 10.5 | 0.35 | 43.0°                          |
|                           | 283                 | -0.4  | +1.3 | 11.32  | 1.7                    | 7.5  | 0.33 | 56.1°                          |
| Lagarta<br>(620, 55.5°)   | 92                  | -2.8  | -8.6 | 14.85  | 4.4                    | 8.8  | 0.16 | 53.0°                          |
|                           | 115                 | -2.4  | -6.9 | 14.52  | 3.9                    | 8.9  | 0.21 | 51.1°                          |
|                           | 214                 | -0.0  | 3.1  | 12.57  | 2.7                    | 8.6  | 0.30 | 52.5°                          |
|                           | 512                 | 0.4   | -0.8 | 7.25   | 1.0                    | 4.9  | 0.18 | 65.5°                          |
| Euphorbia<br>(123, 62.3°) | 3                   | M     | M    | 17.13  | M                      | M    | 0.50 | -                              |
|                           | 25                  | 0.7   | -0.4 | 15.63  | 3.2                    | 14.5 | 0.22 | 60.1°                          |
|                           | 63                  | 0.3   | -5.7 | 14.98  | 2.9                    | 13.5 | 0.10 | 64.5°                          |
| Parodia<br>(124, 43.0°)   | 3                   | M     | M    | 16.99  | M                      | M    | 0.55 | -                              |
|                           | 24                  | D     | D    | 15.90  | D                      | D    | 0.22 | D                              |
|                           | 64                  | 1.6   | -8.2 | 15.15* | 4.9                    | 9.0  | 0.13 | 45.4°                          |
|                           | 104                 | -0.1  | -3.4 | 14.83  | 2.3                    | 7.7  | 0.18 | 42.2°                          |
| Yucca Too<br>(117, 4.9°)  | 37                  | 0.6   | -9.2 | 16.38  | 7.5                    | 8.4  | 0.13 | -13.1°                         |
|                           | 57                  | E     | E    | E      | E                      | E    | E    | E                              |
|                           | 97                  | 0.4   | -5.2 | 15.42  | 4.0                    | 7.6  | 0.26 | 23.0°                          |

Table 2a. (Continued)

| Mooring                 | Instrument<br>Depth | Means |       |       | Standard<br>Deviations |     |      | Principal<br>Axis<br>Direction |
|-------------------------|---------------------|-------|-------|-------|------------------------|-----|------|--------------------------------|
|                         |                     | u     | v     | T     | u                      | v   | T    |                                |
| Opuntia<br>(620, 39.8°) | 129                 | F     | F     | 14.25 | F                      | F   | 0.31 | F                              |
|                         | 224                 | -0.1  | -2.6  | 12.53 | 2.4                    | 7.0 | 0.26 | 43.2°                          |
|                         | 324                 | G     | G     | G     | G                      | G   | G    | G                              |
|                         | 524                 | +0.1  | -0.2  | 7.29  | 0.6                    | 2.0 | 0.21 | 36.5°                          |
| Peyote<br>(117, 8.2°)   | 37                  | 9.1   | -20.4 | 16.75 | 2.9                    | 5.7 | 0.31 | 6.5°                           |
|                         | 56                  | 8.9   | -22.2 | 15.78 | 3.4                    | 5.9 | 0.21 | 13.1°                          |
|                         | 96                  | 4.2   | -15.5 | 15.17 | 2.6                    | 5.7 | 0.20 | 5.0°                           |

A: LLP current data exists from 0000 UT 6 March 1977 to 1800 UT 20 April 1977.

B: LLP current data exists from 0600 UT 7 March 1977 to 0000 UT 27 April 1977.

C: Intermittent hourly data exists.

D: LLP current data exists from 0000 UT 19 March 1977 to 0600 UT 15 April 1977.

E: LLP data exists from 0000 UT 11 March 1977 to 0600 UT 6 April 1977.

F: No current velocity data was obtained.

G: LLP data exists from 0600 UT 14 March 1977 to 1200 UT 29 April 1977.

M: Data from meteorological buoy, which measured temperature but not currents at 3 m depth. Wind data from buoy is given in Table 2b.

\*: Temperature calibration is uncertain; the mean is probably low by 0.09°C.

Table 2b. Wind velocity statistics from the 49.5 day common period (0000 UT 22 March 1977 to 0600 UT 10 May 1977). Velocities are in m/sec. All records are rotated 45° from the North. Principal axis directions are given in degrees counterclockwise from the North.

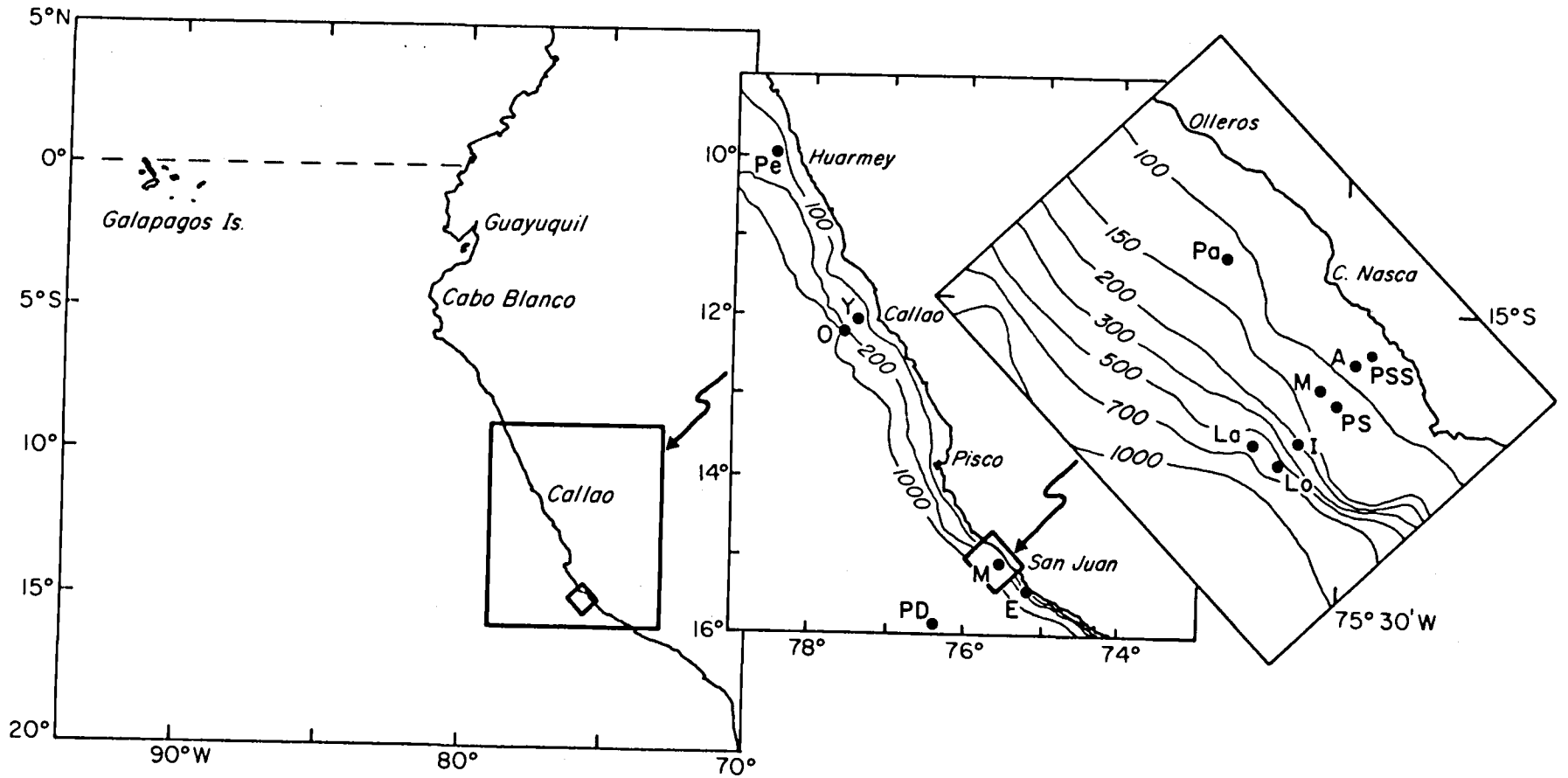
| Location  | Means |      | Standard Deviations |      | Principal Axis Direction |
|-----------|-------|------|---------------------|------|--------------------------|
|           | u     | v    | u                   | v    | $\theta$                 |
| PSS       | 2.35  | 5.26 | 0.57                | 1.97 | 30.5°                    |
| PS        | H     | H    | H                   | H    | H                        |
| PD        | 0.65  | 5.61 | 1.02                | 1.37 | 51.0°                    |
| Euphorbia | 0.57  | 2.14 | 0.51                | 1.08 | 54.1°                    |
| Parodia   | 0.68  | 2.72 | 0.35                | 1.88 | 47.5°                    |
| San Juan  | 2.52  | 5.91 | 0.50                | 1.65 | 37.6°                    |
| Callao*   | 1.03  | 2.94 | 0.38                | 2.03 | 36.8°                    |

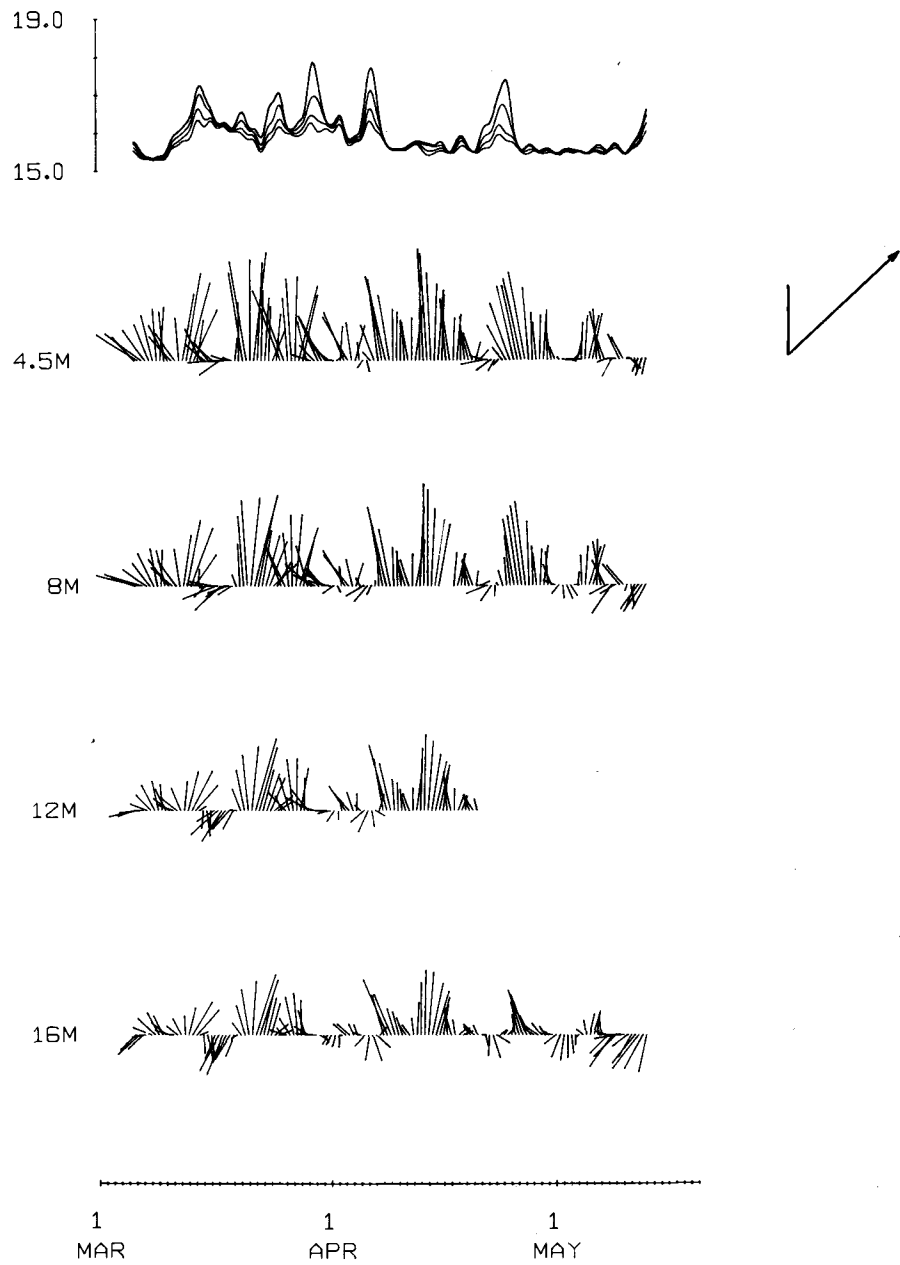
H: LLP data exists from 0000 UT 7 March 1977 to 1800 UT 14 April 1977.

\* Anemometer on top of IMARPE building

FIGURES

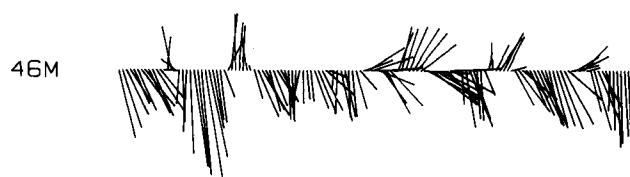
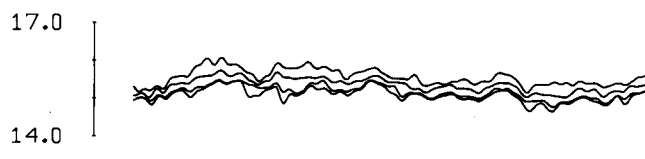
Figure 1.





PSS 1977

Figure 2.



1 MAR                      1 APR                      1 MAY

AGAVE, 1977

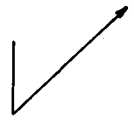
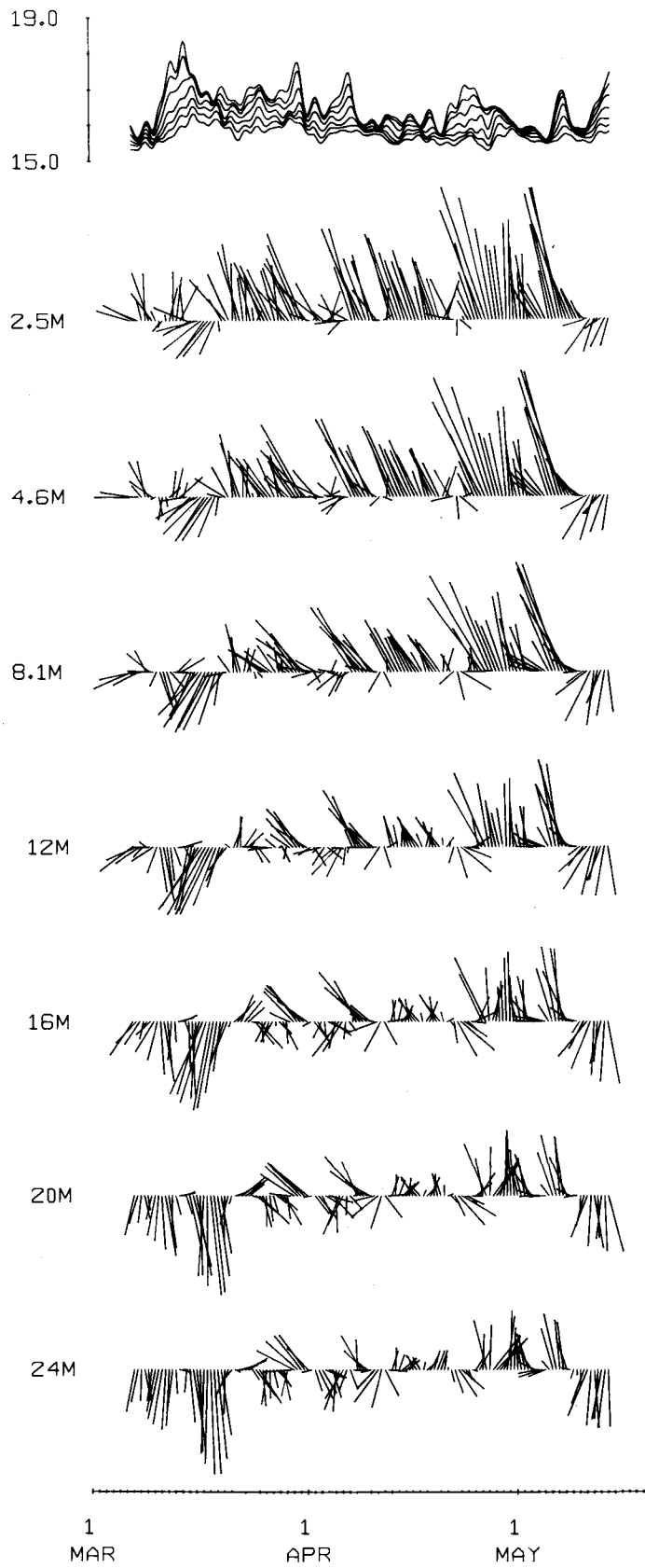


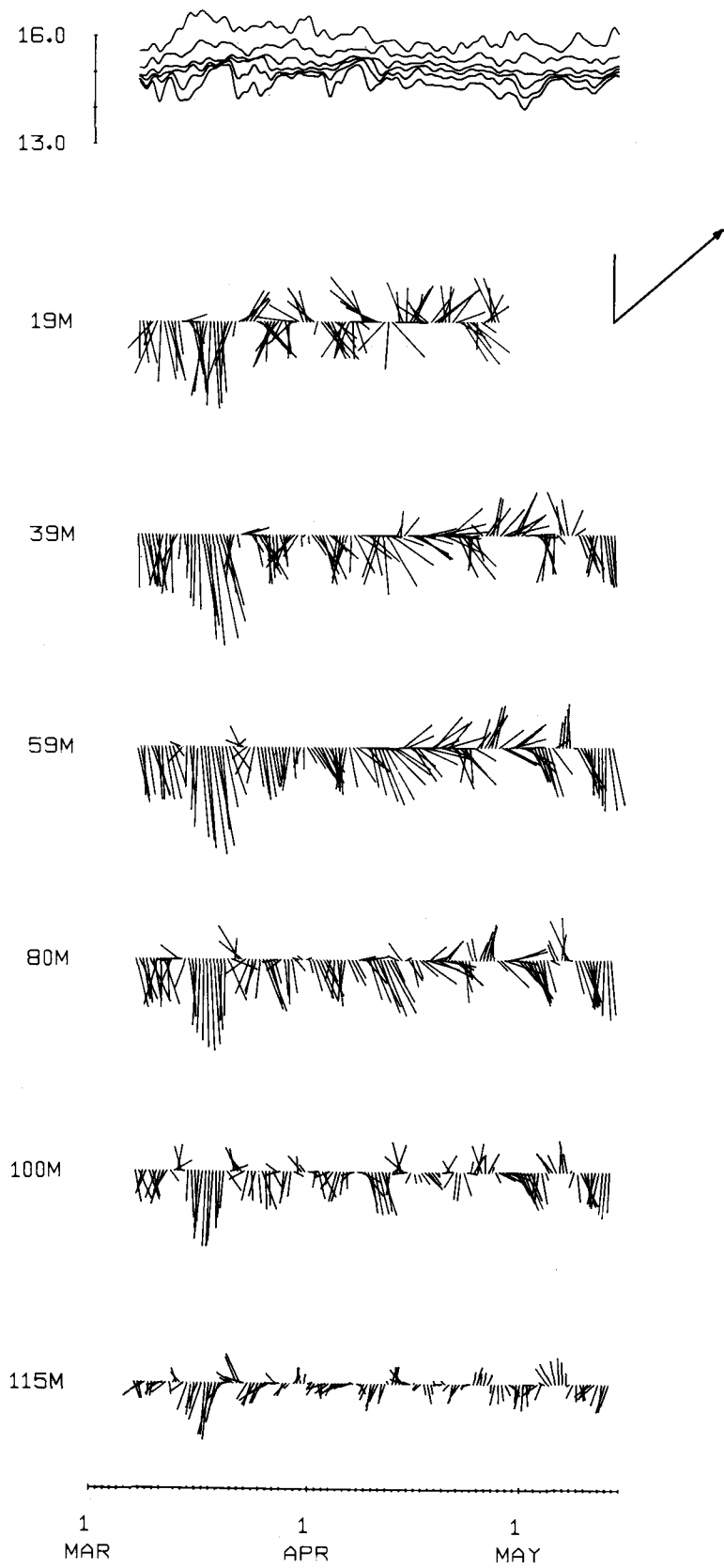
Figure 3.





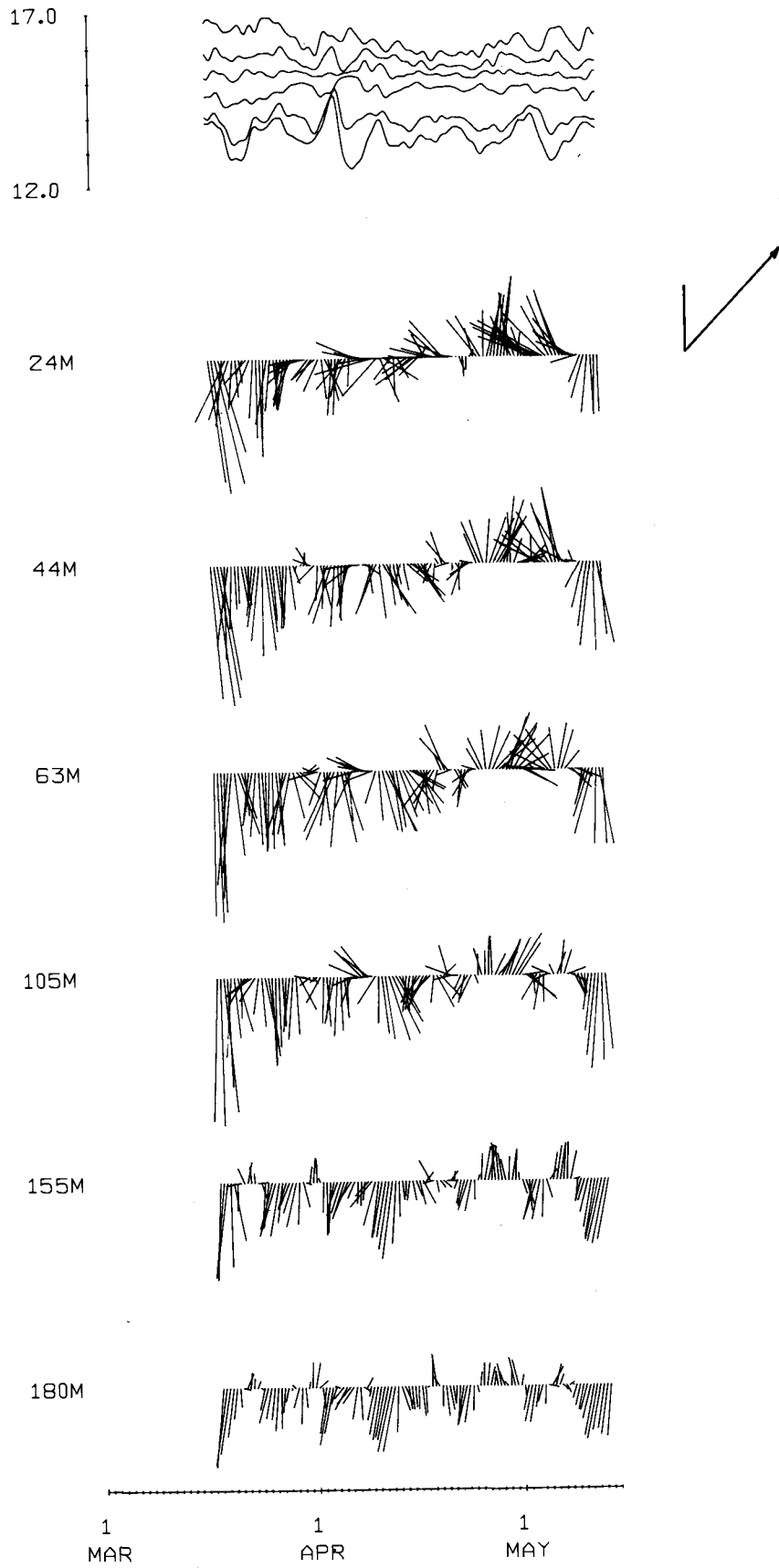
PS 1977

Figure 4.



MILA FIVE

Figure 5.



IRONWOOD

Figure 6.

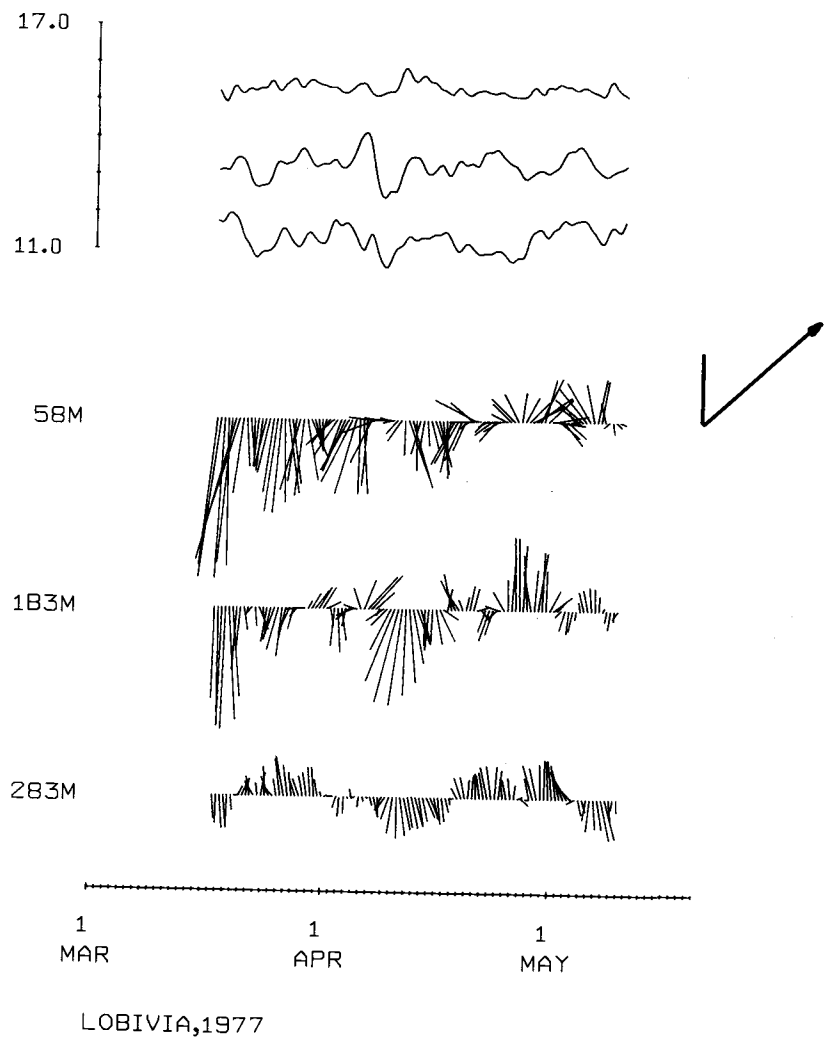
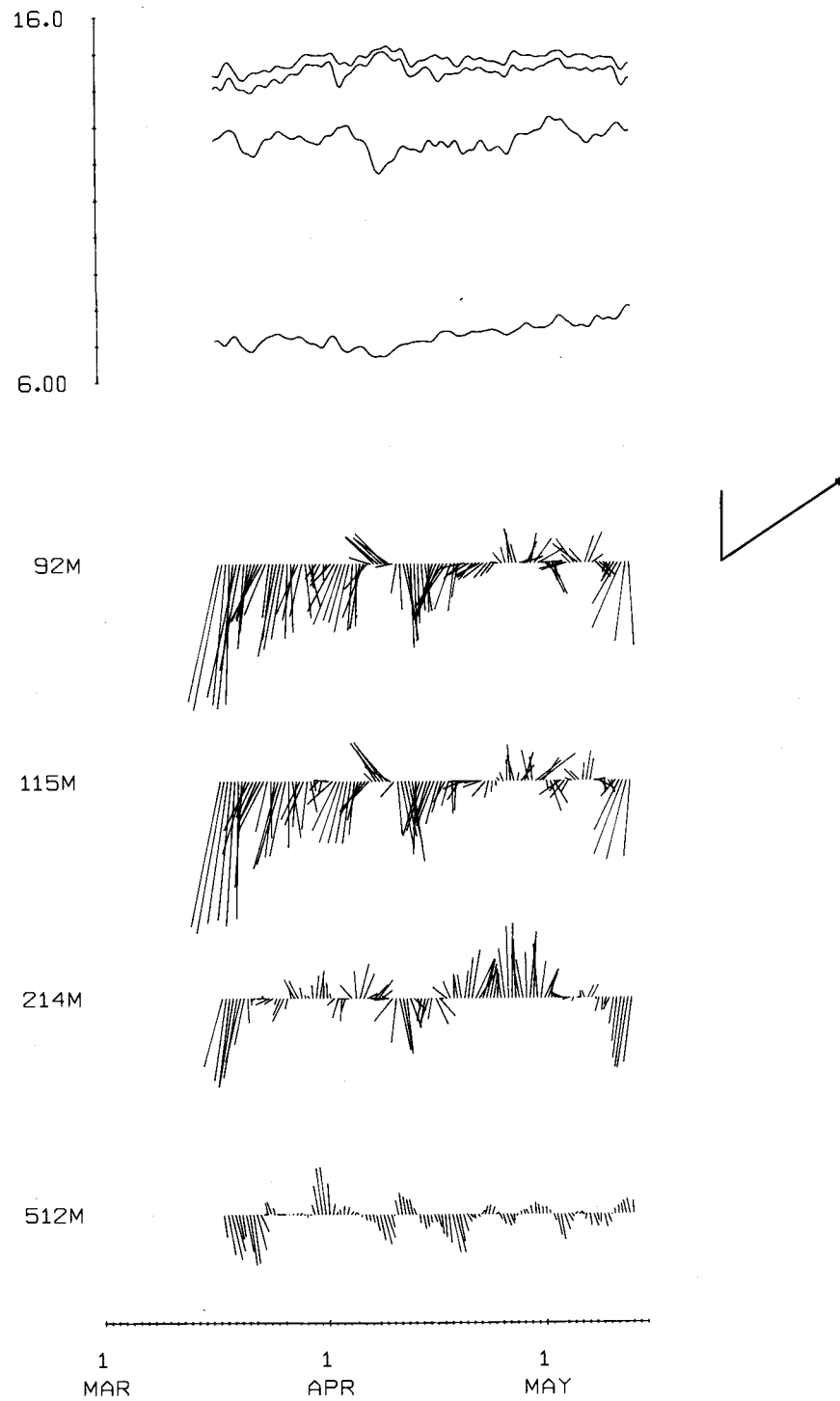


Figure 7.



LAGARTA, 1977

Figure 8.

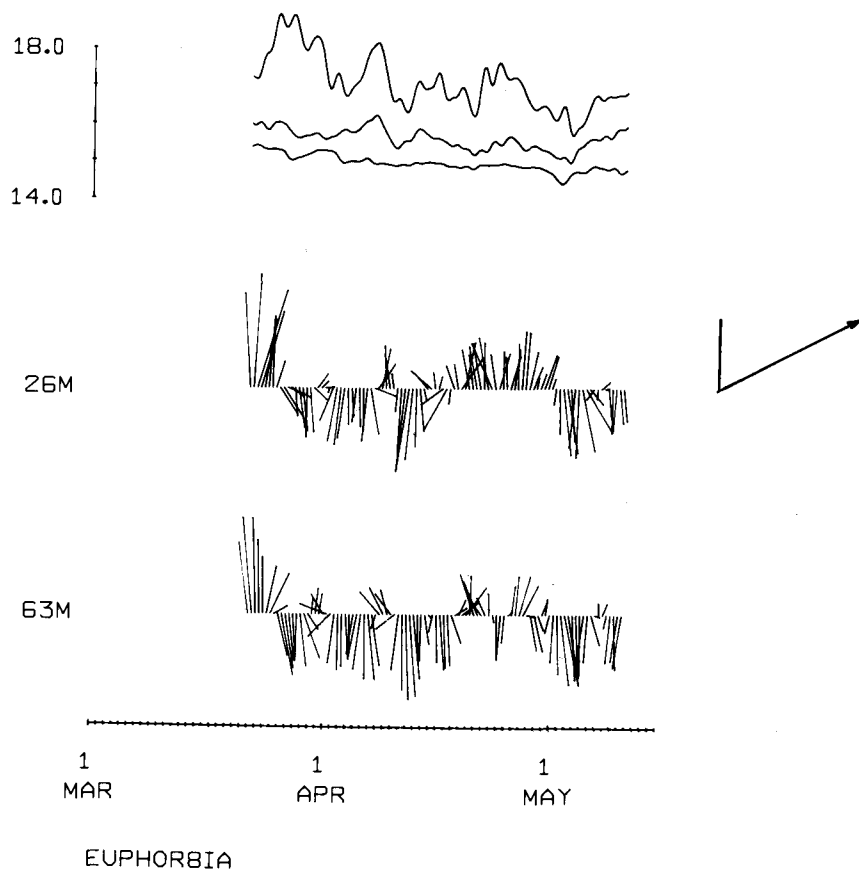


Figure 9.

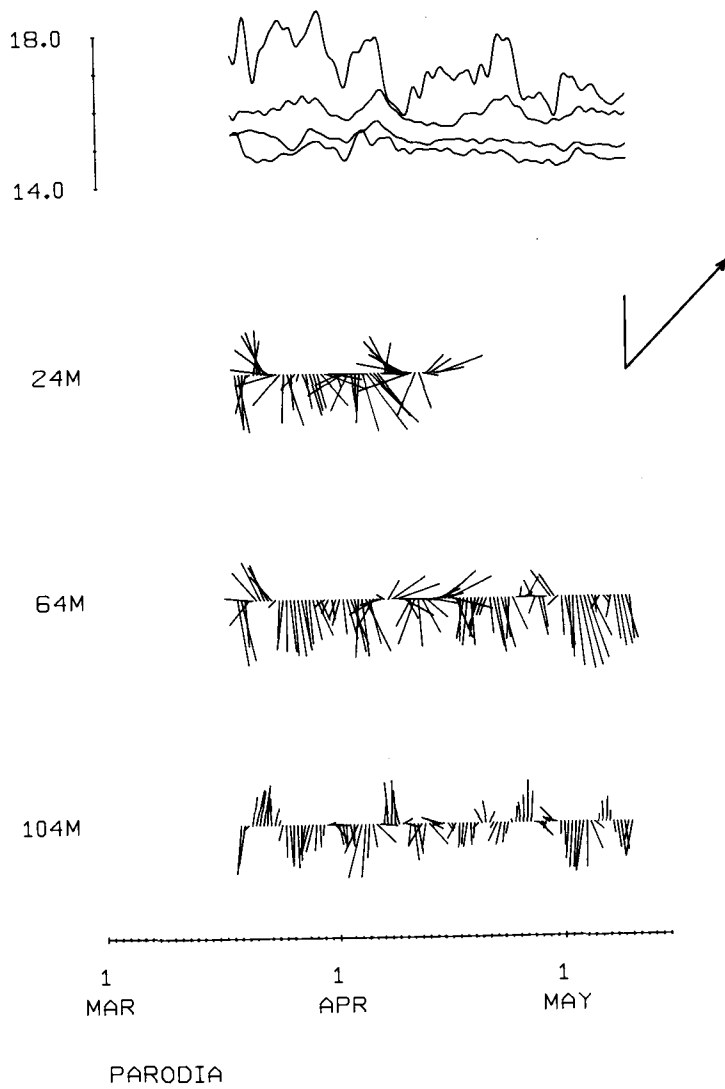


Figure 10.

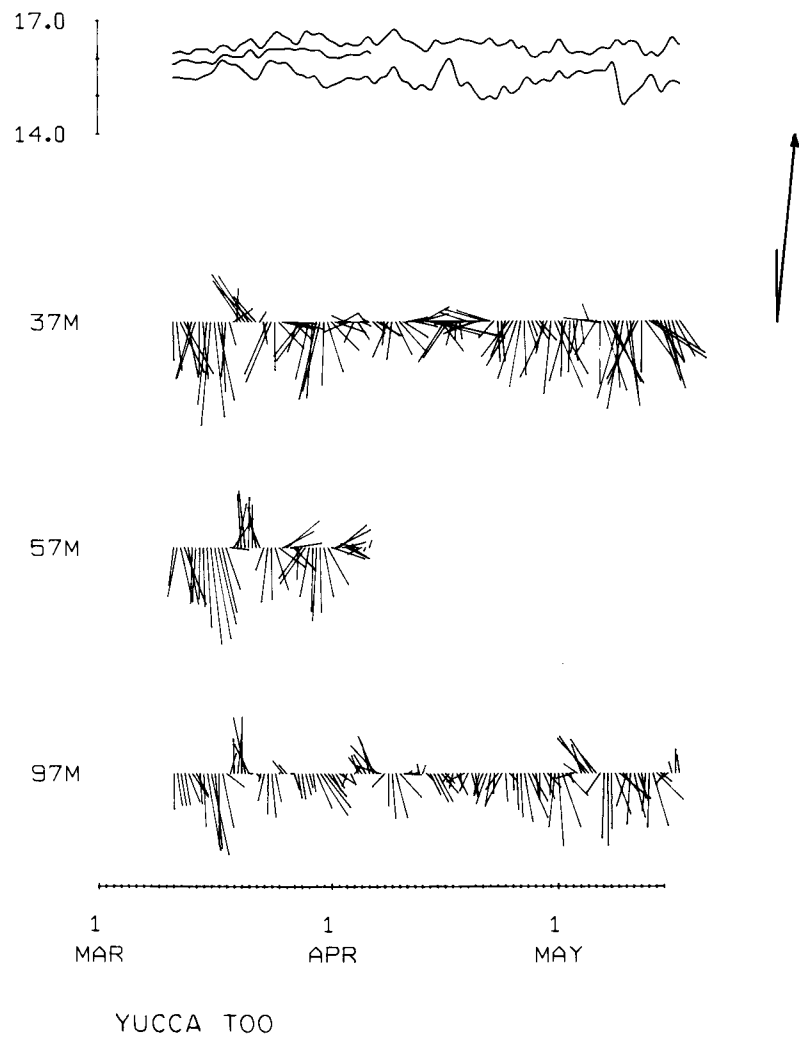
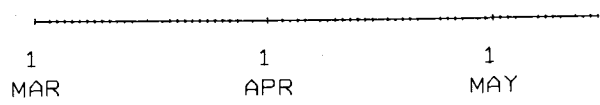
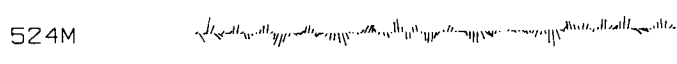
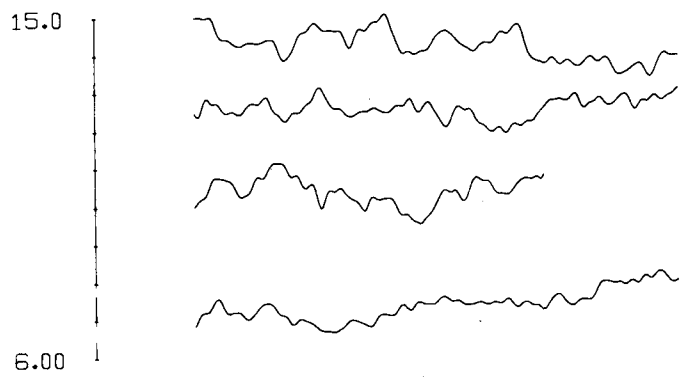


Figure 11.





OPUNTIA

Figure 12.

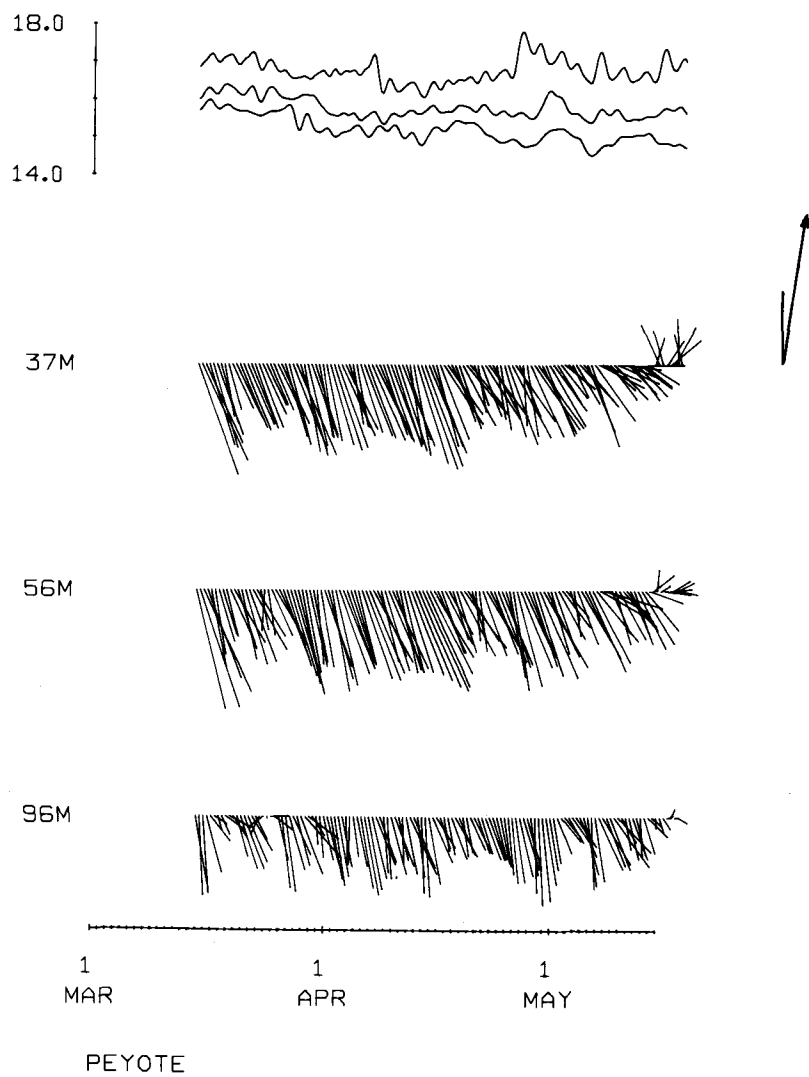
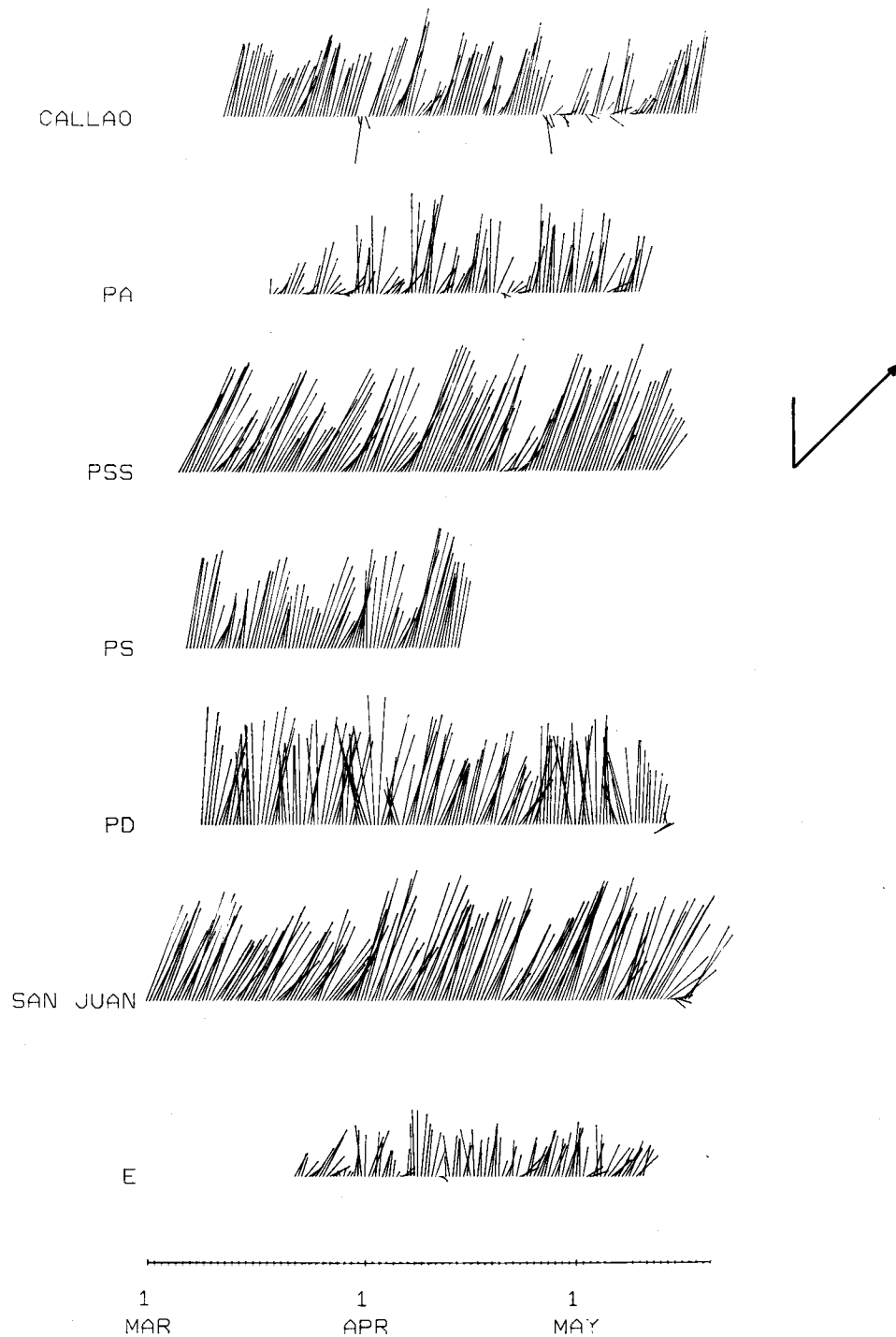


Figure 13.



PHASE FIVE WINDS

Figure 14.

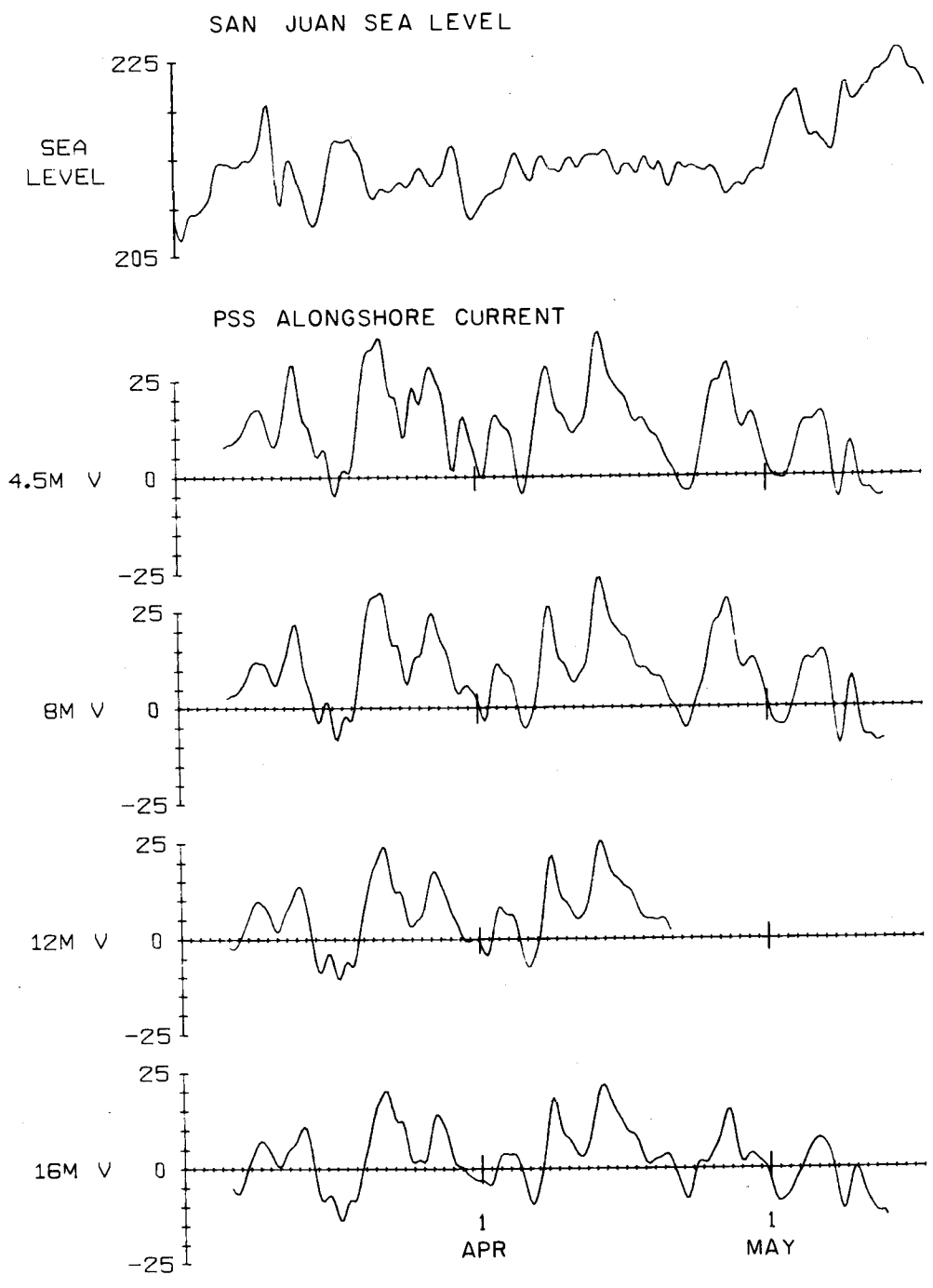


Figure 15a.

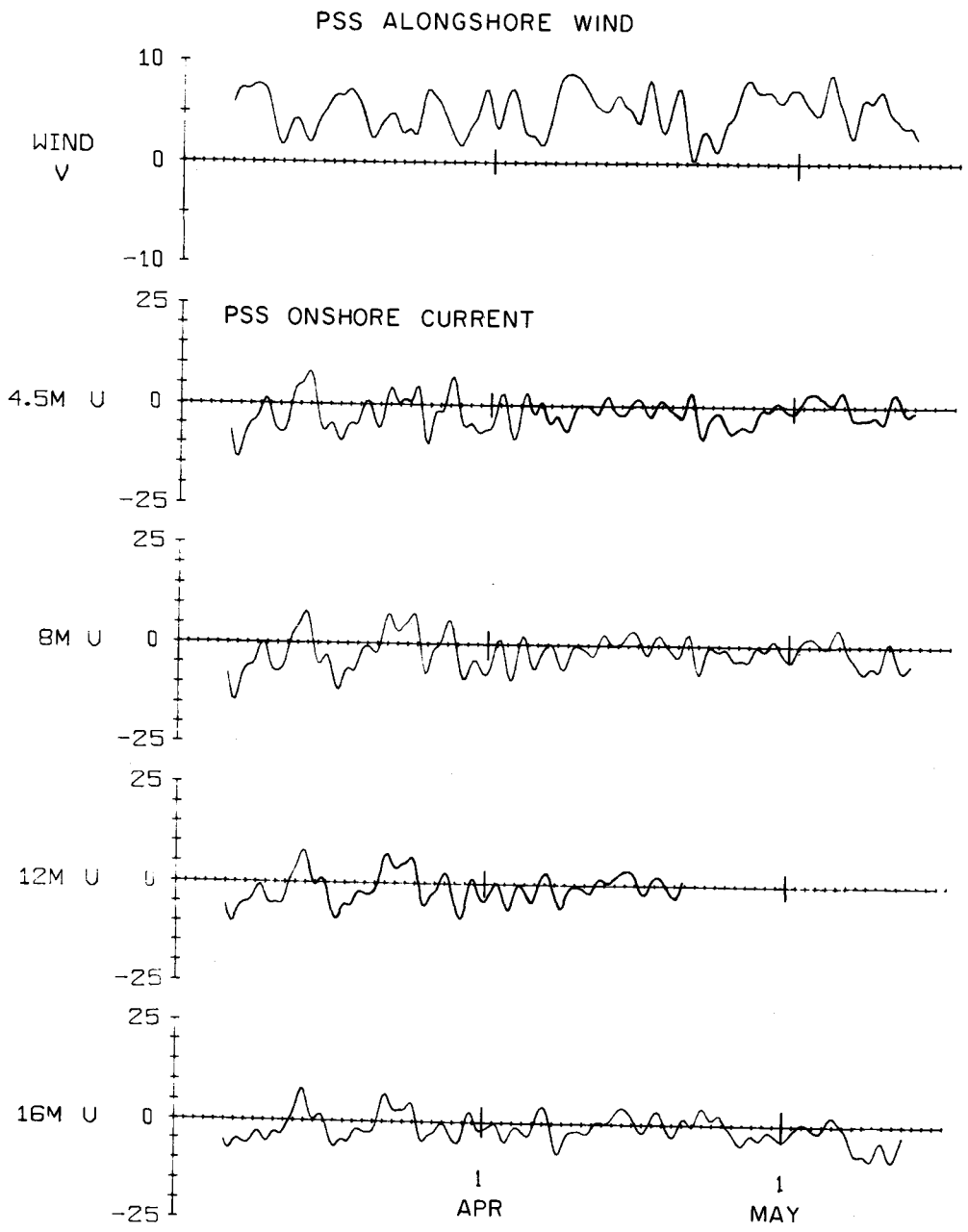


Figure 15b.

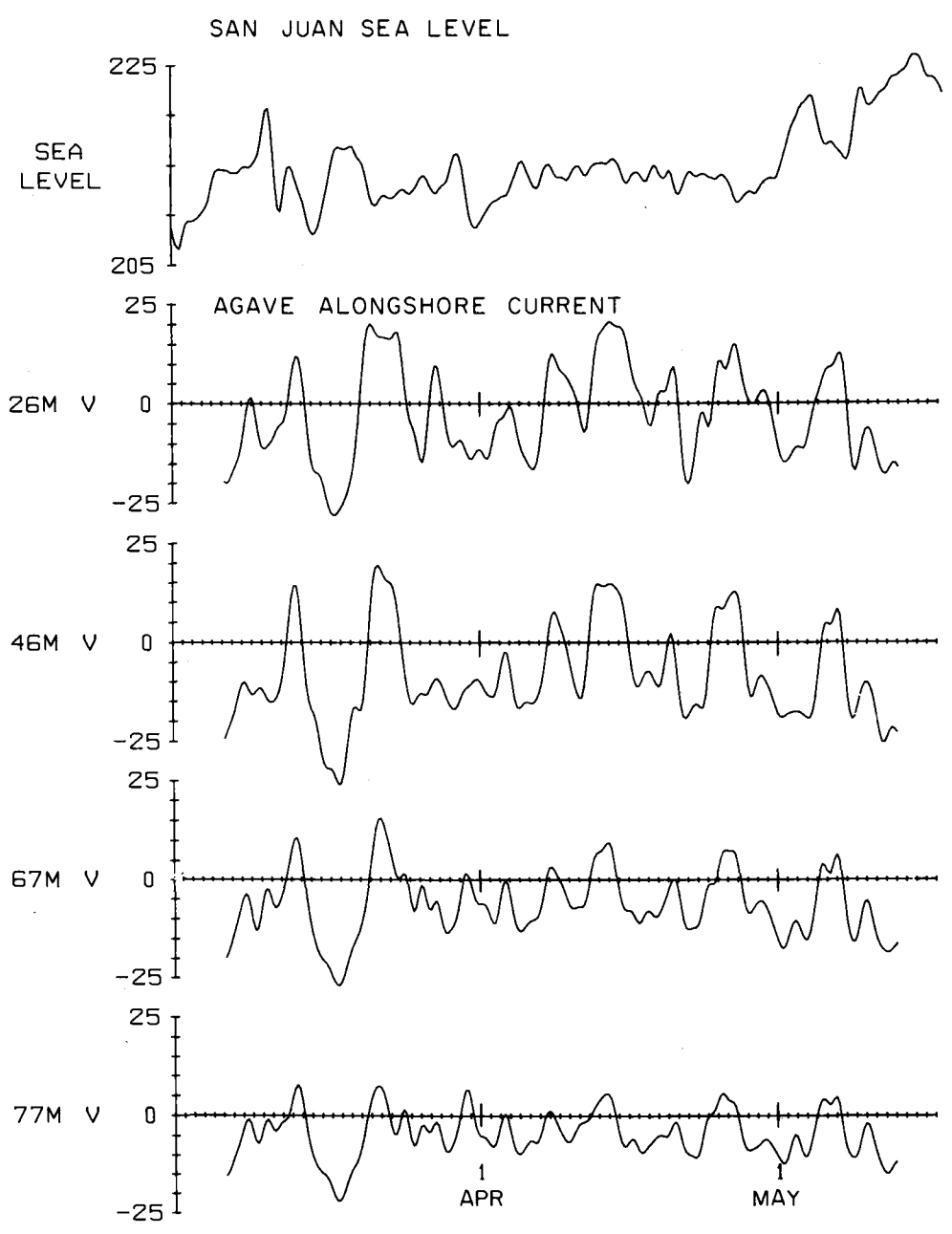


Figure 16a.

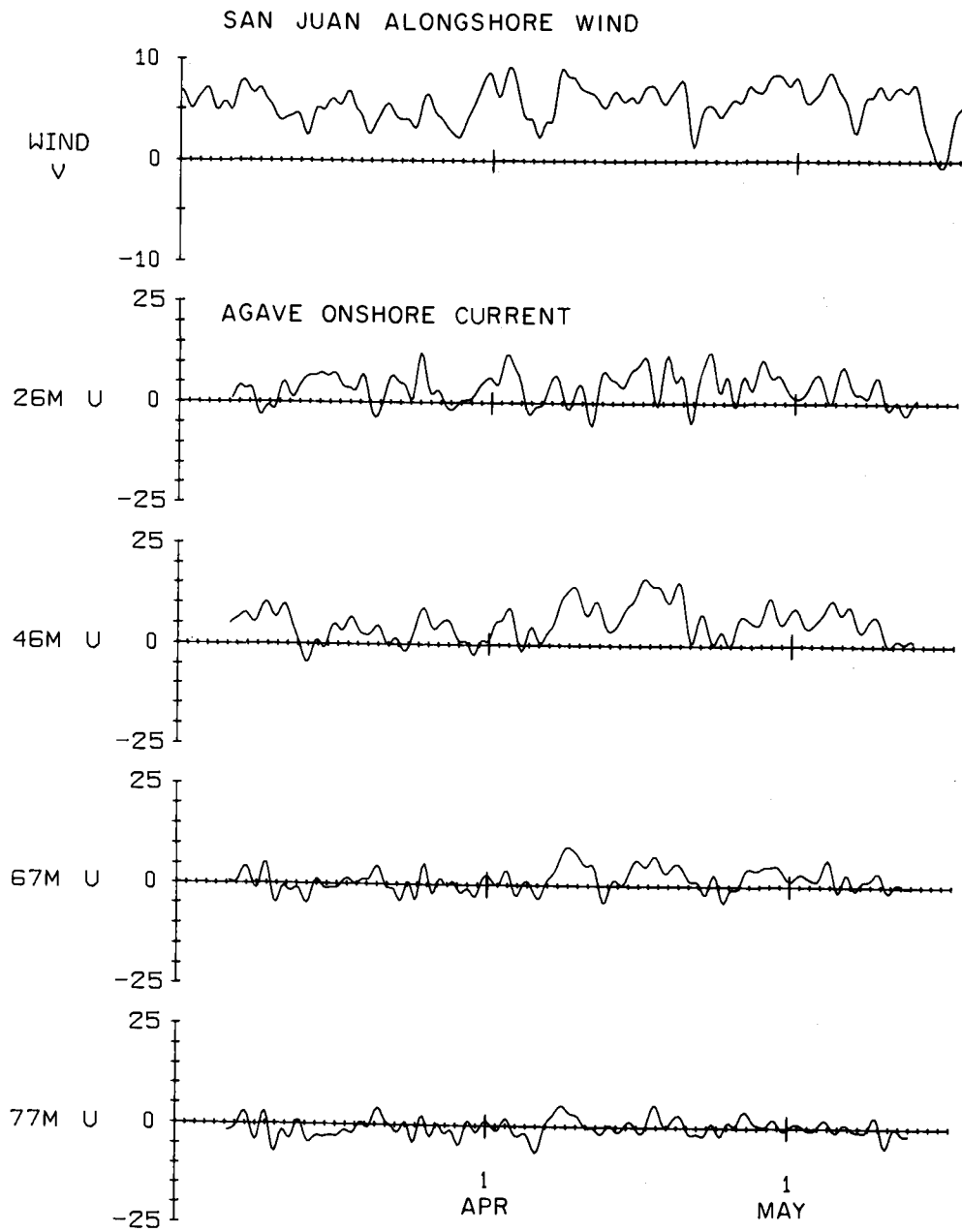


Figure 16b.

PS ALONGSHORE CURRENT

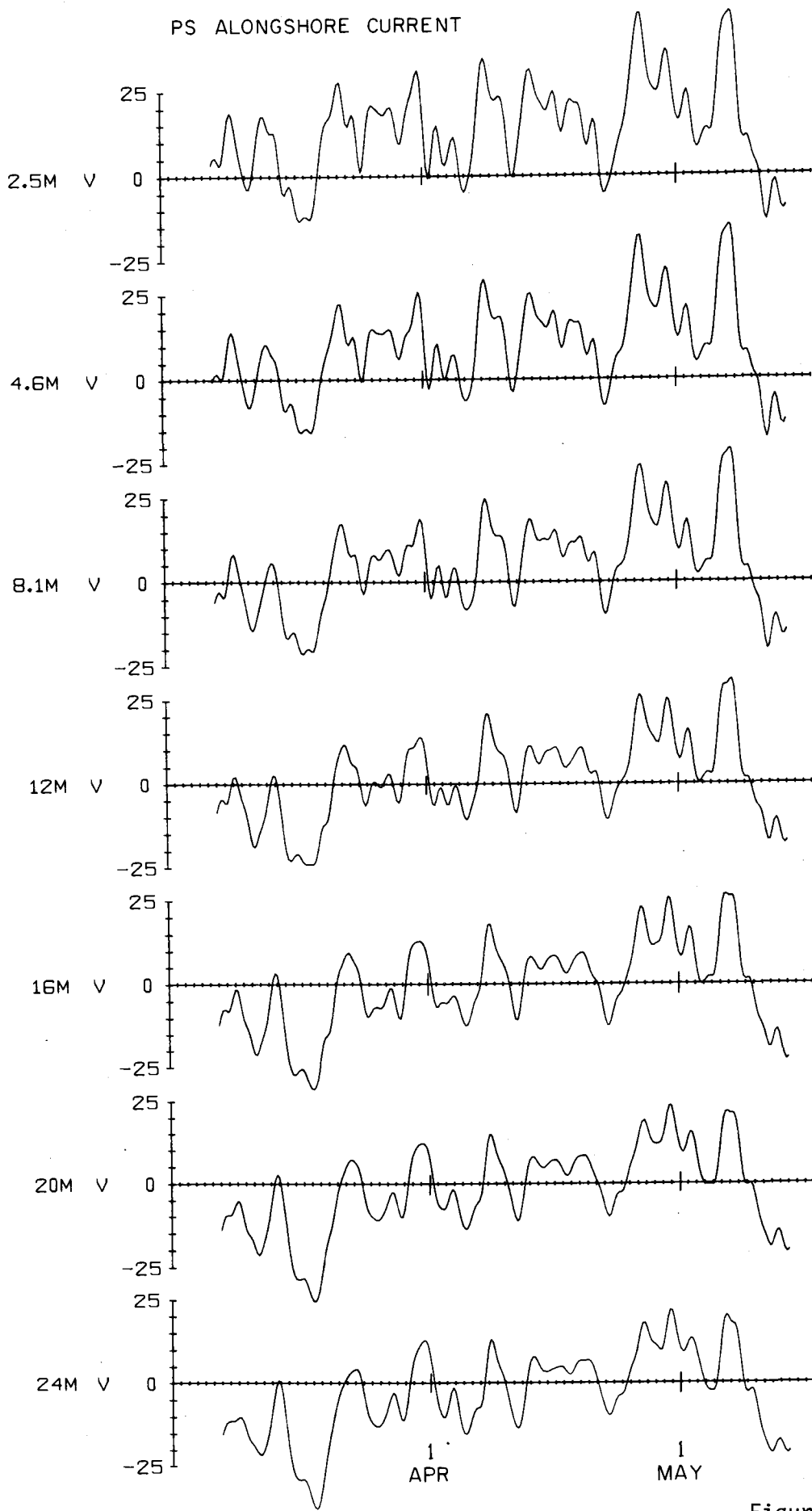


Figure 17a.



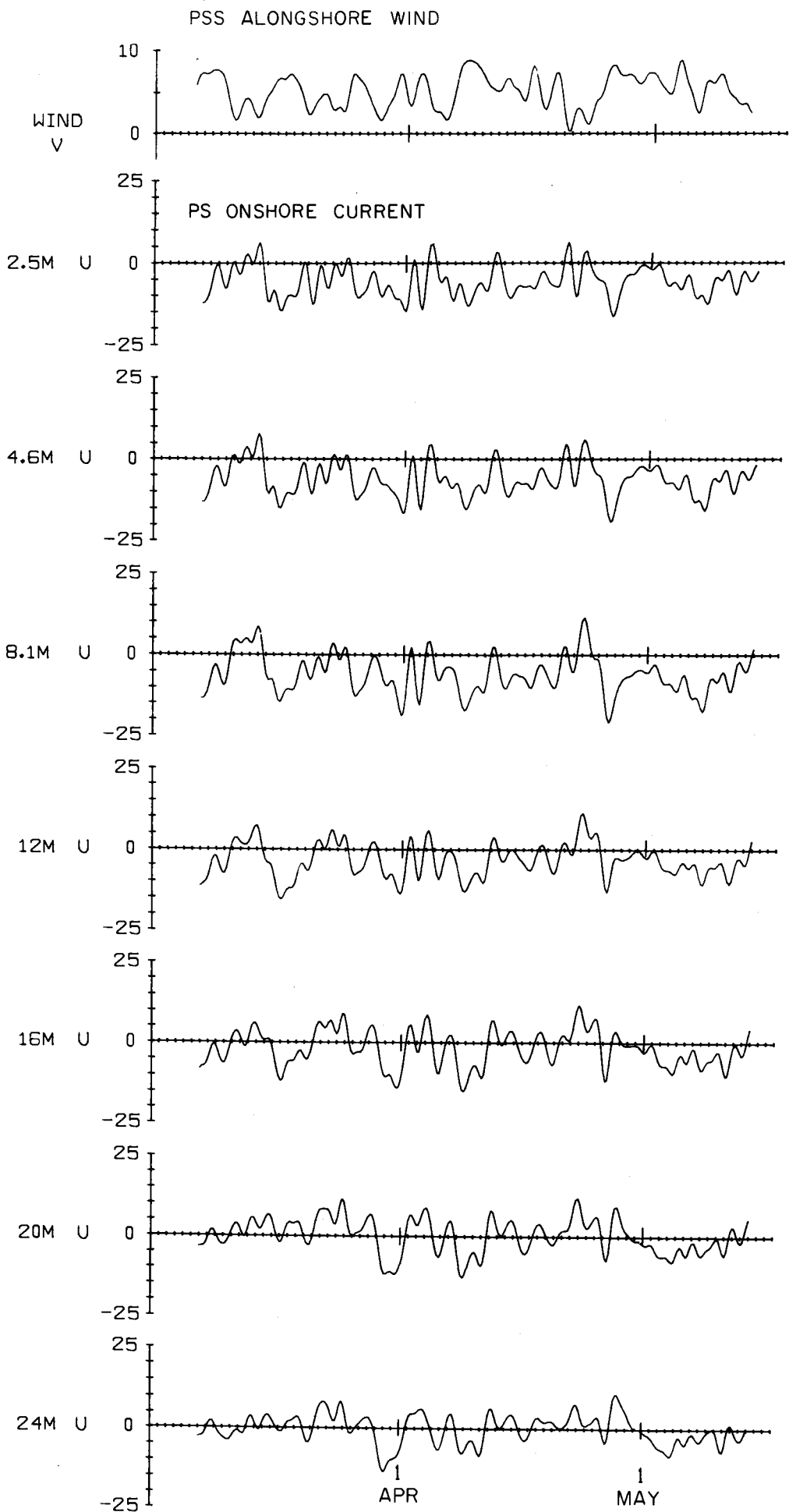


Figure 17b.

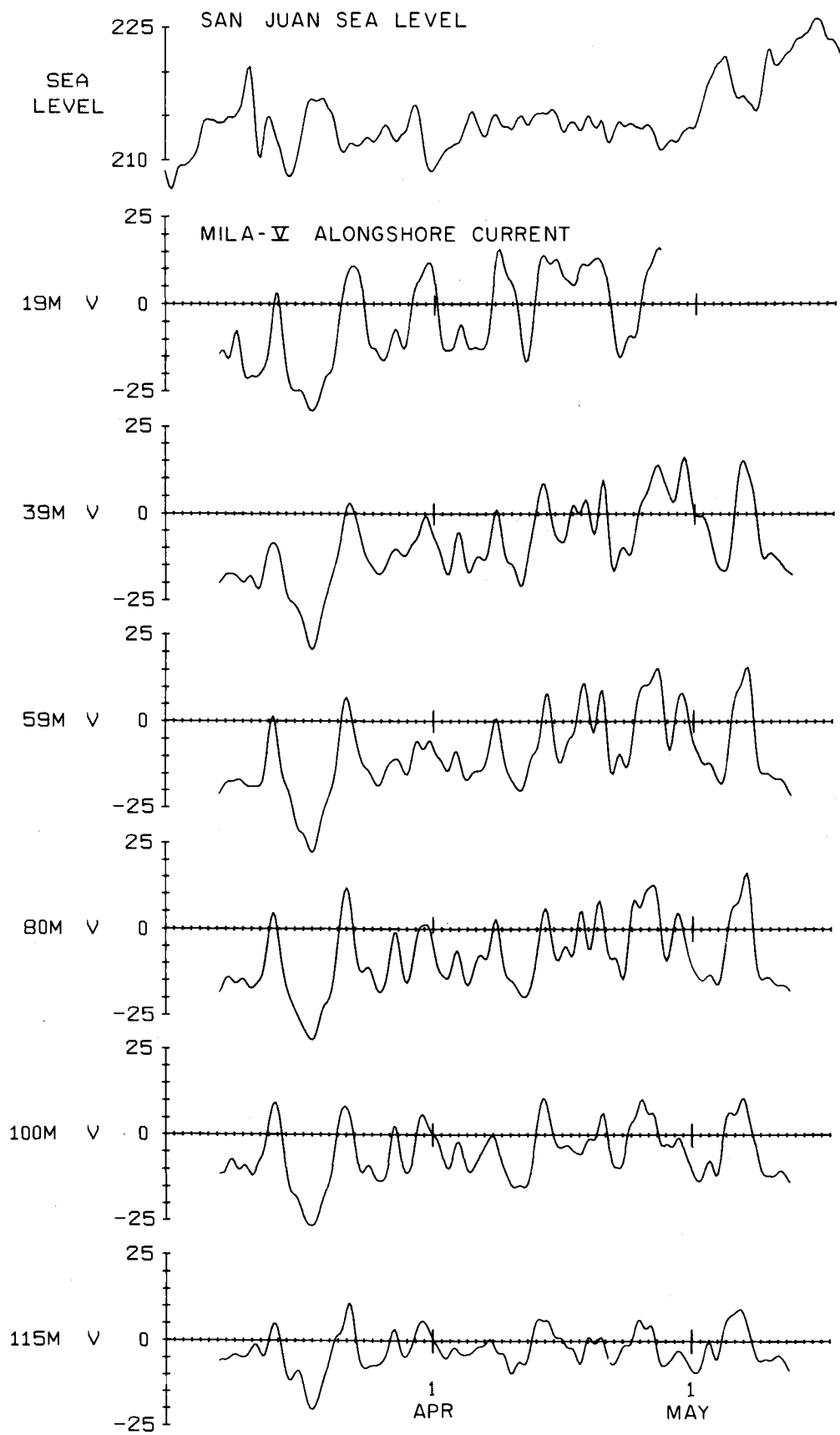


Figure 18a.

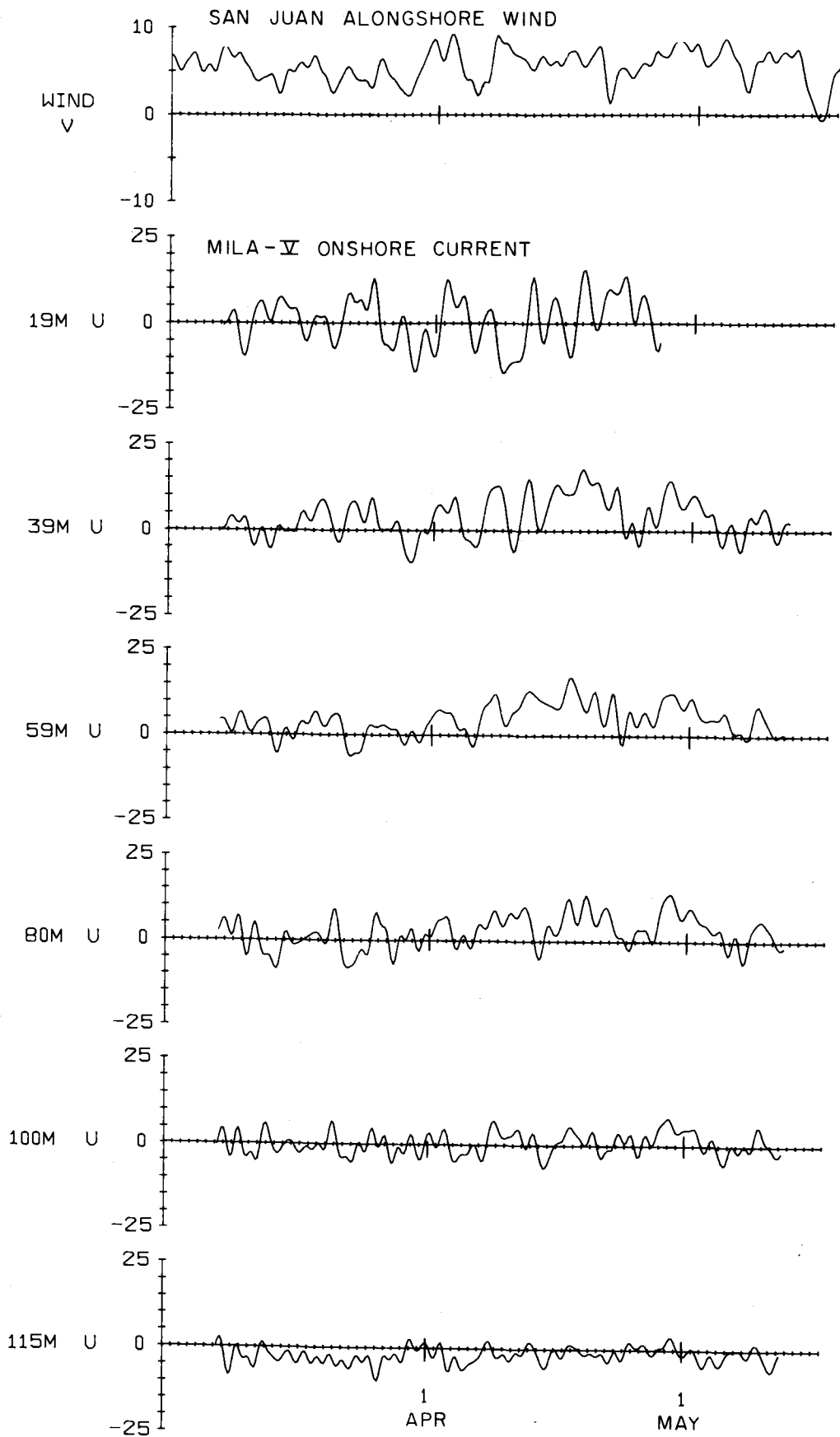


Figure 18b.

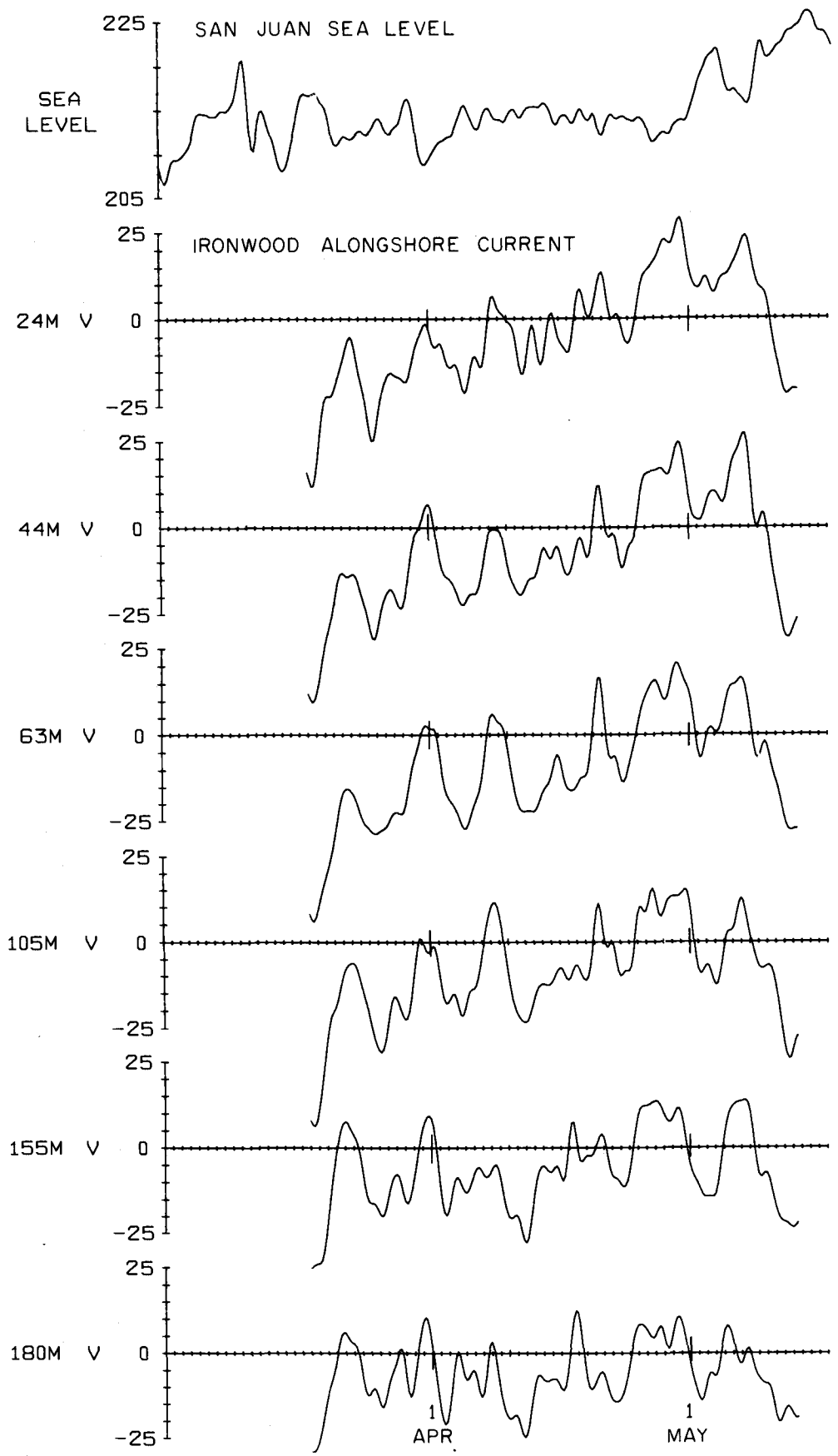


Figure 19a.

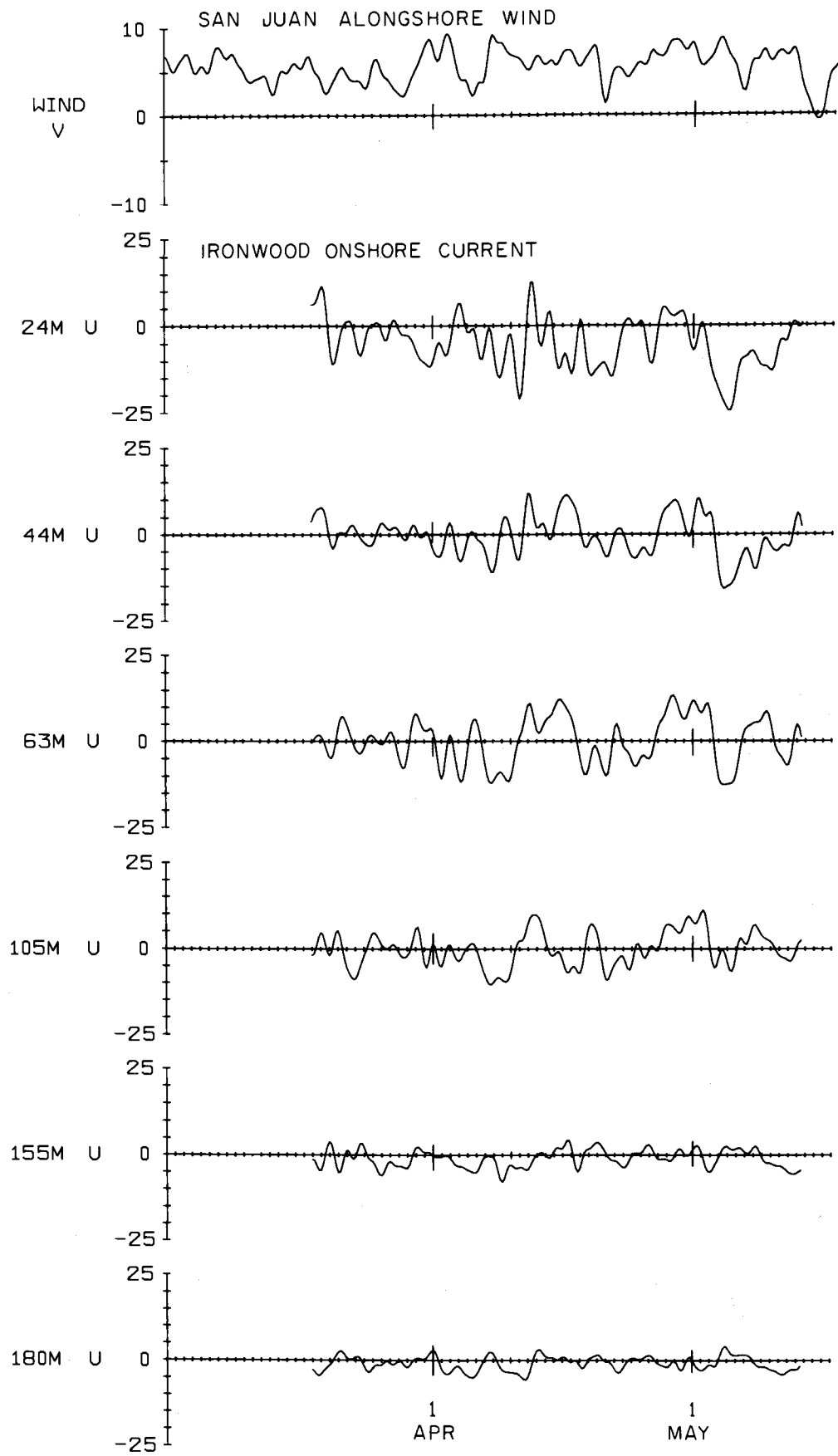


Figure 19b.

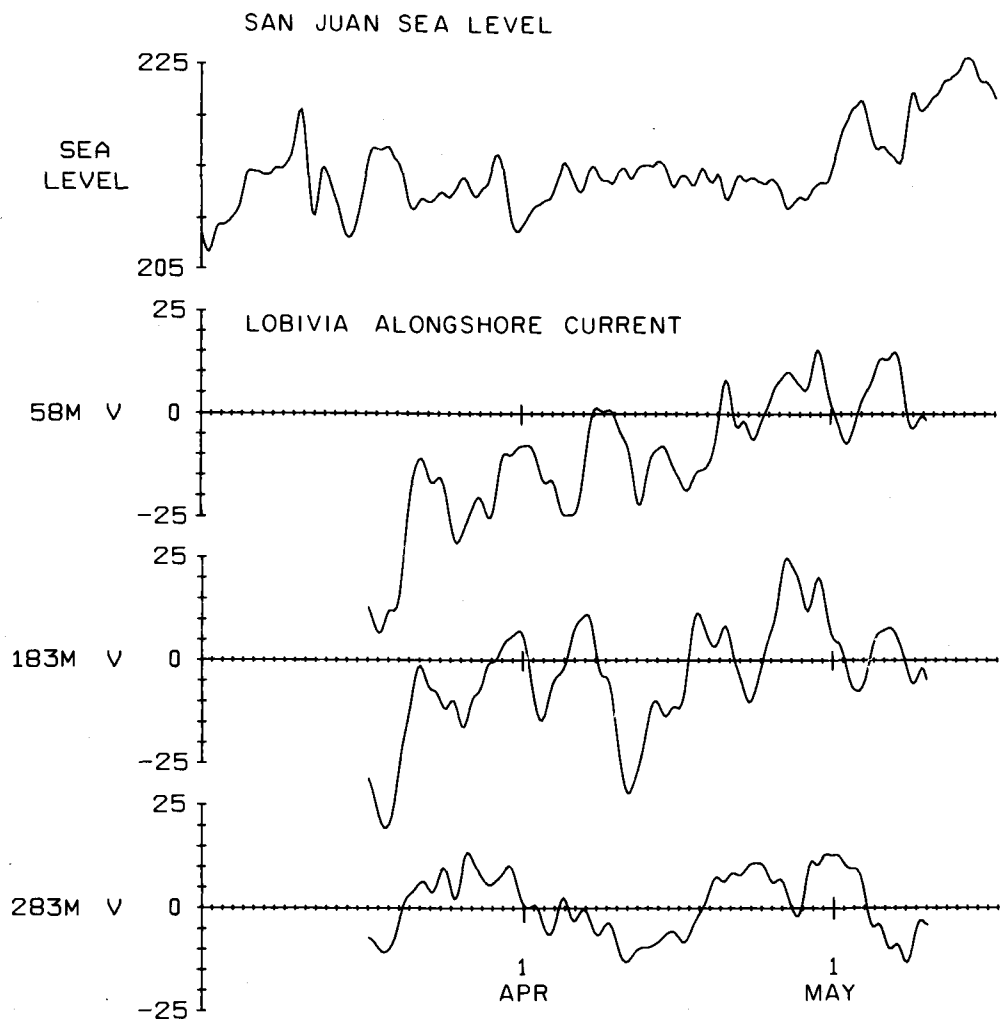


Figure 20a.

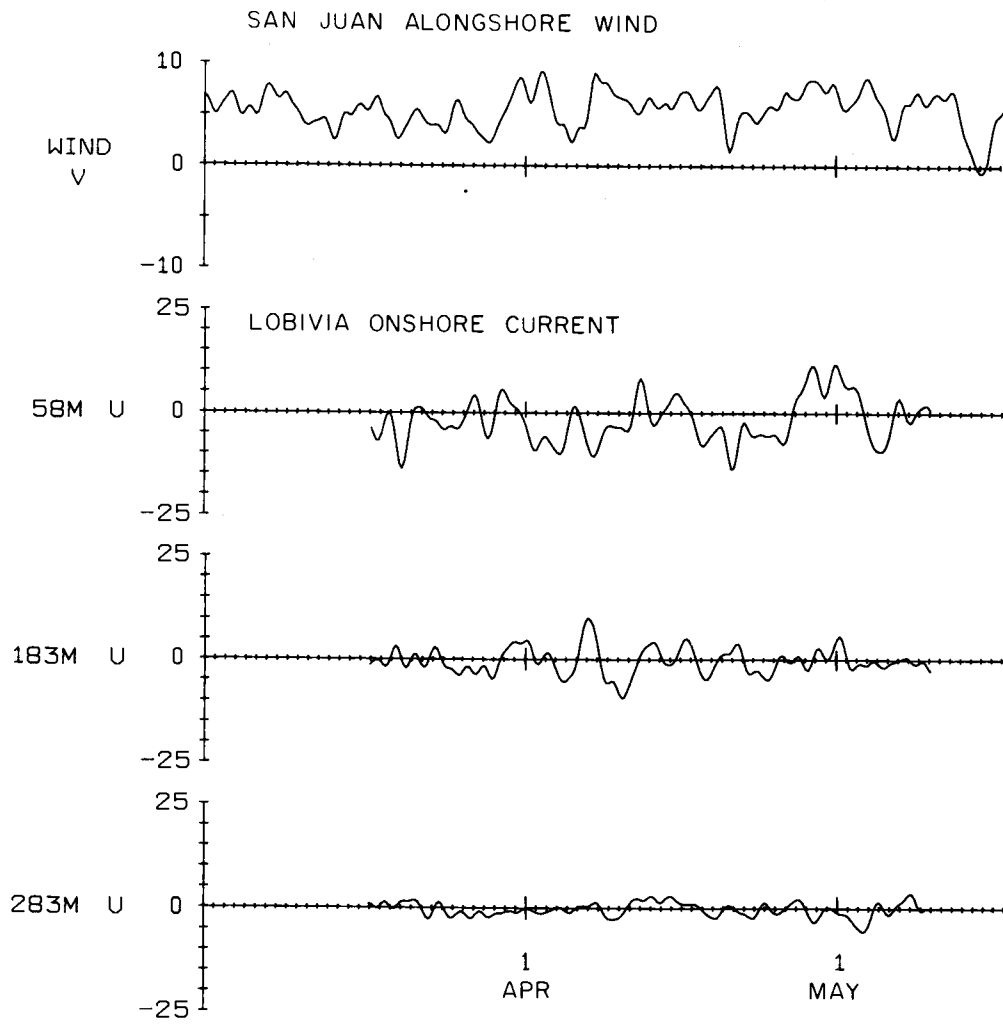


Figure 20b.

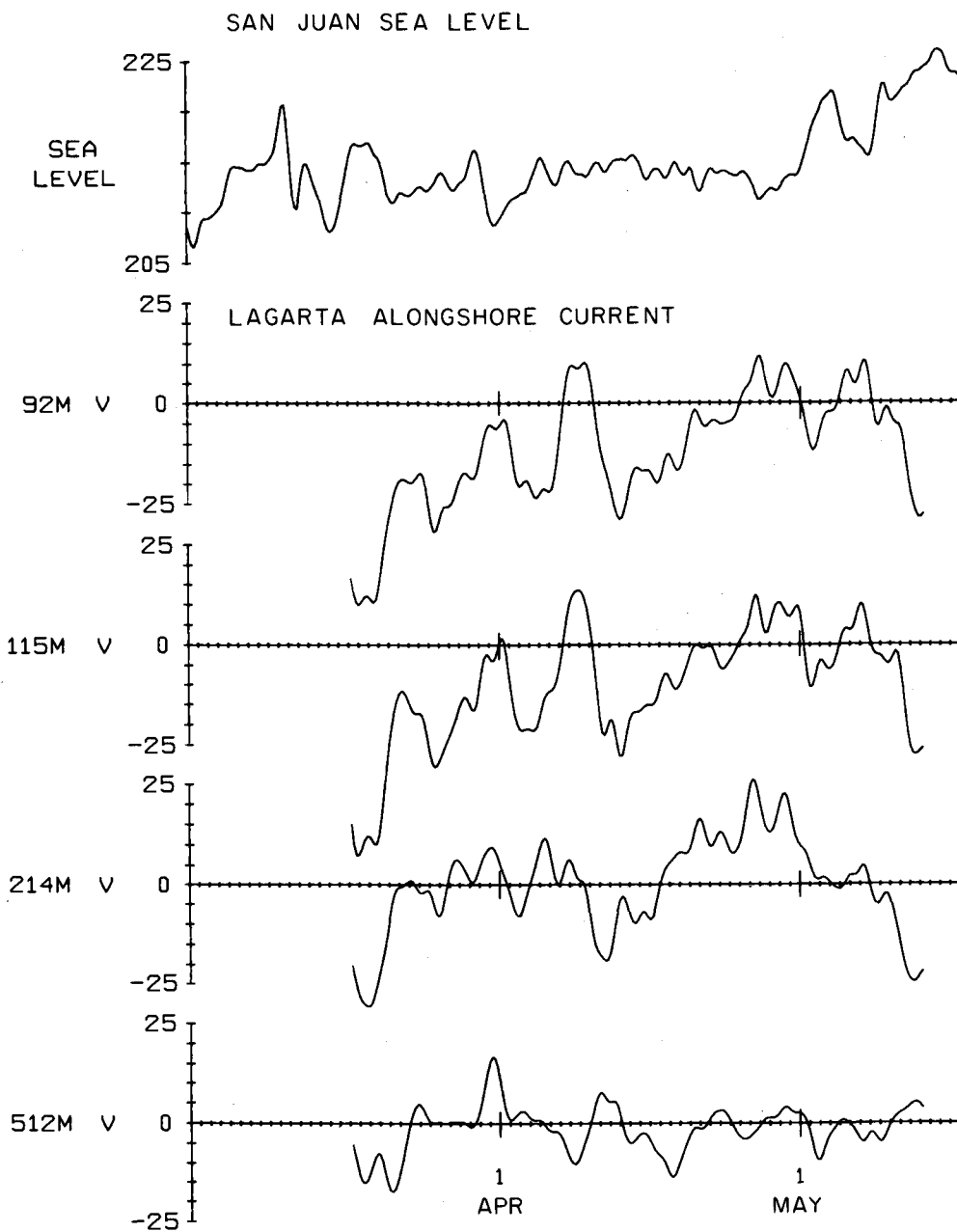


Figure 21a.



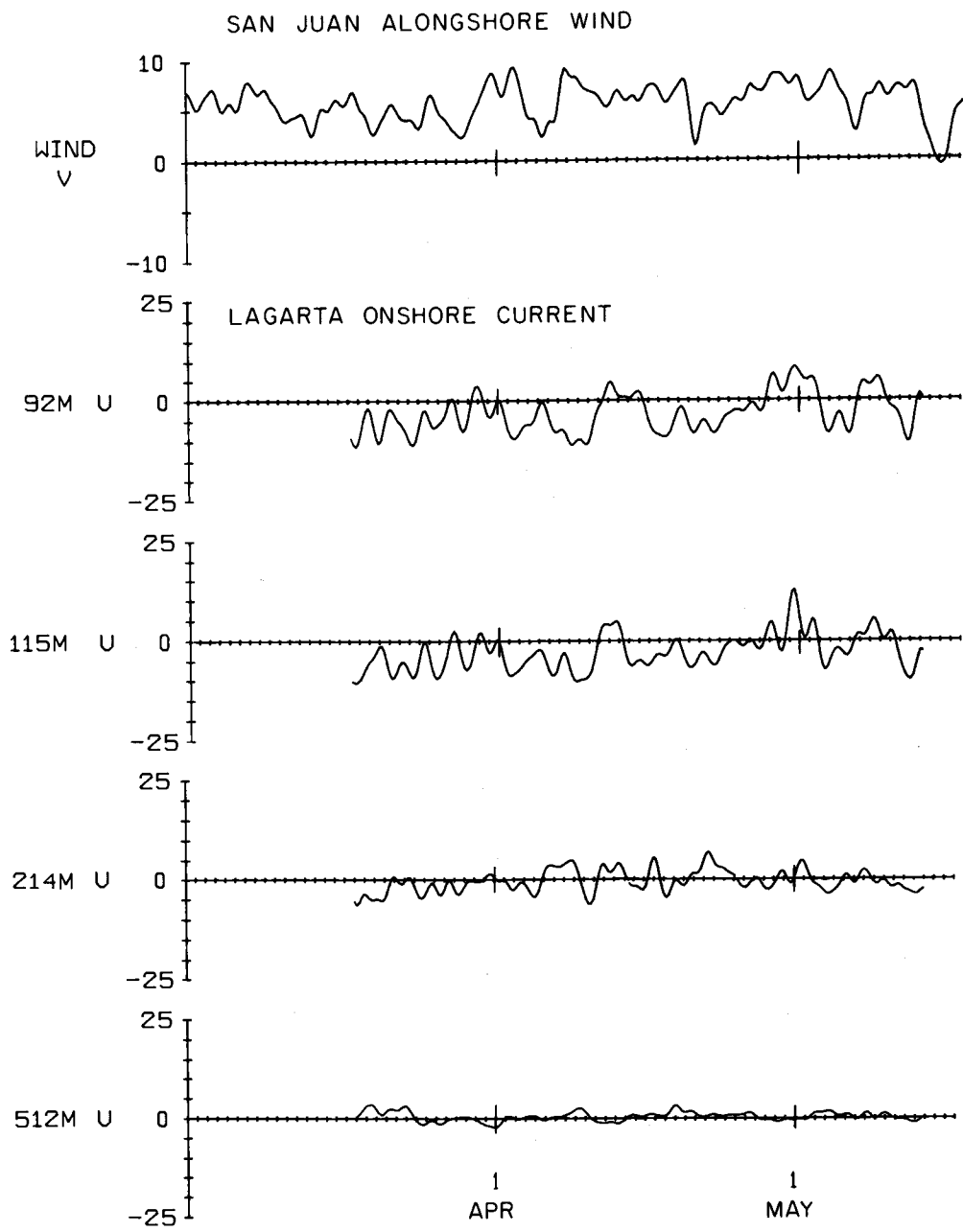


Figure 21b.

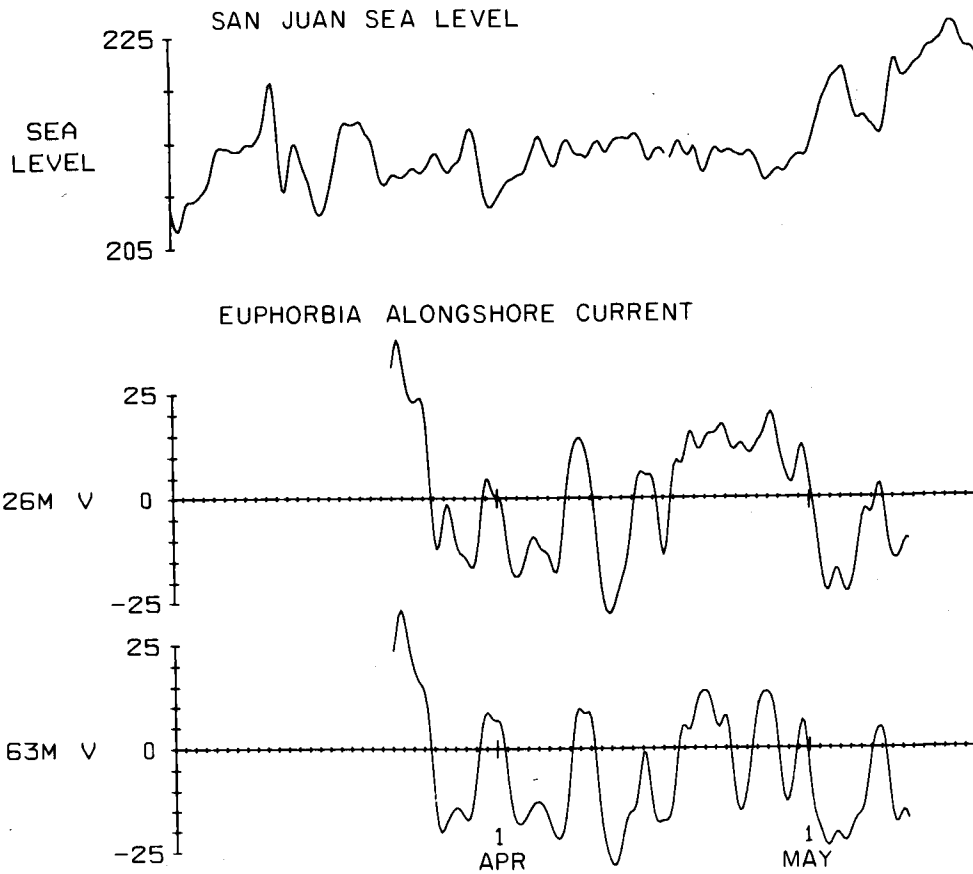


Figure 22a.

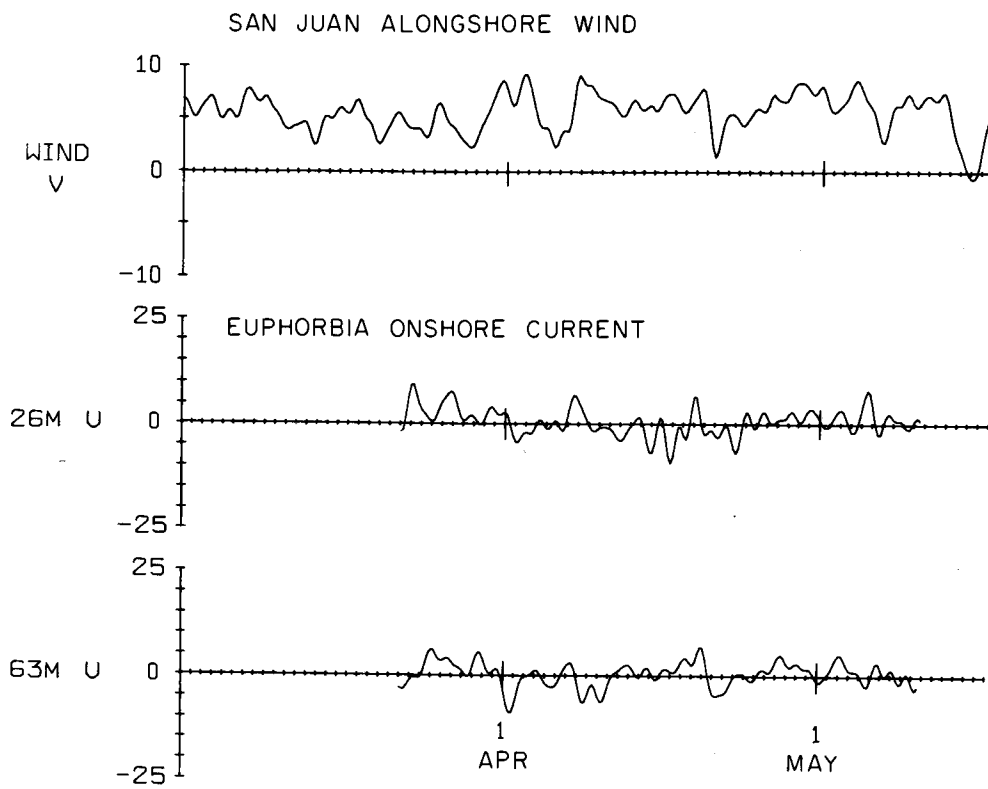


Figure 22b.

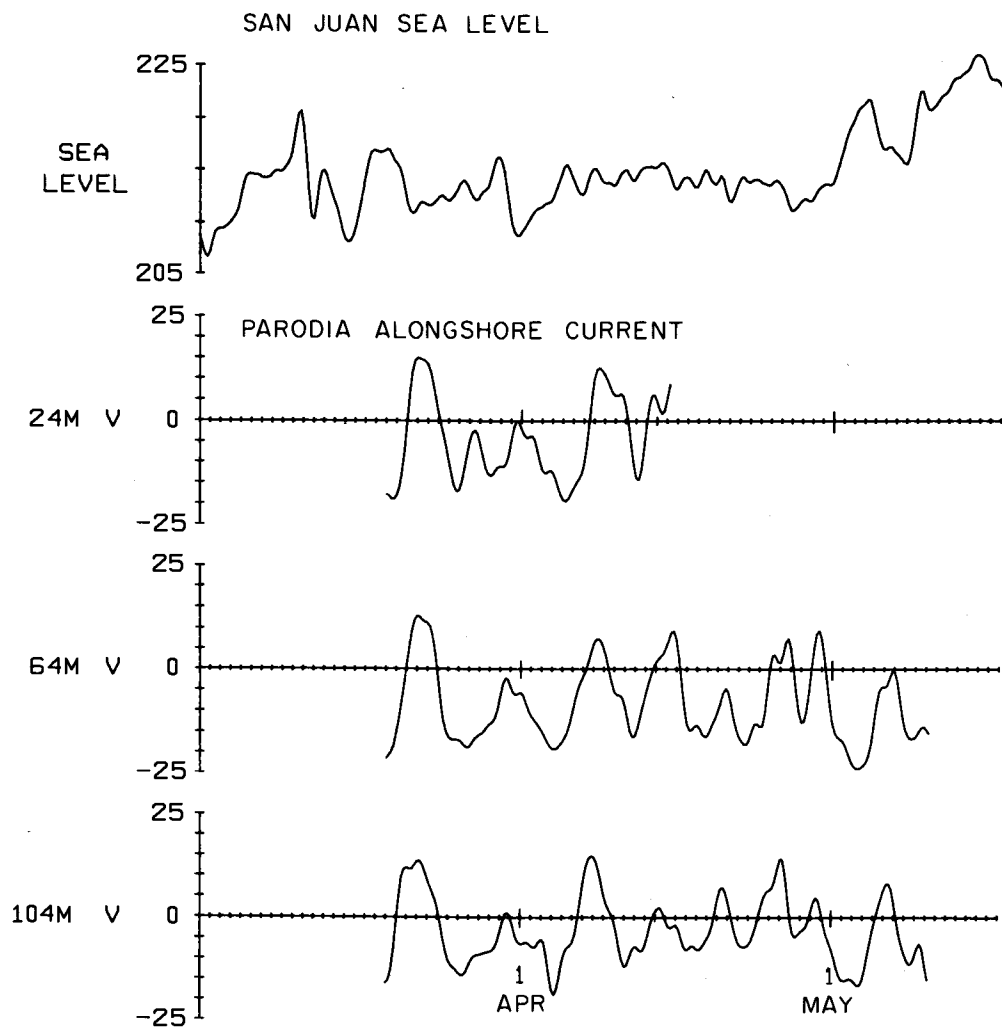


Figure 23a.

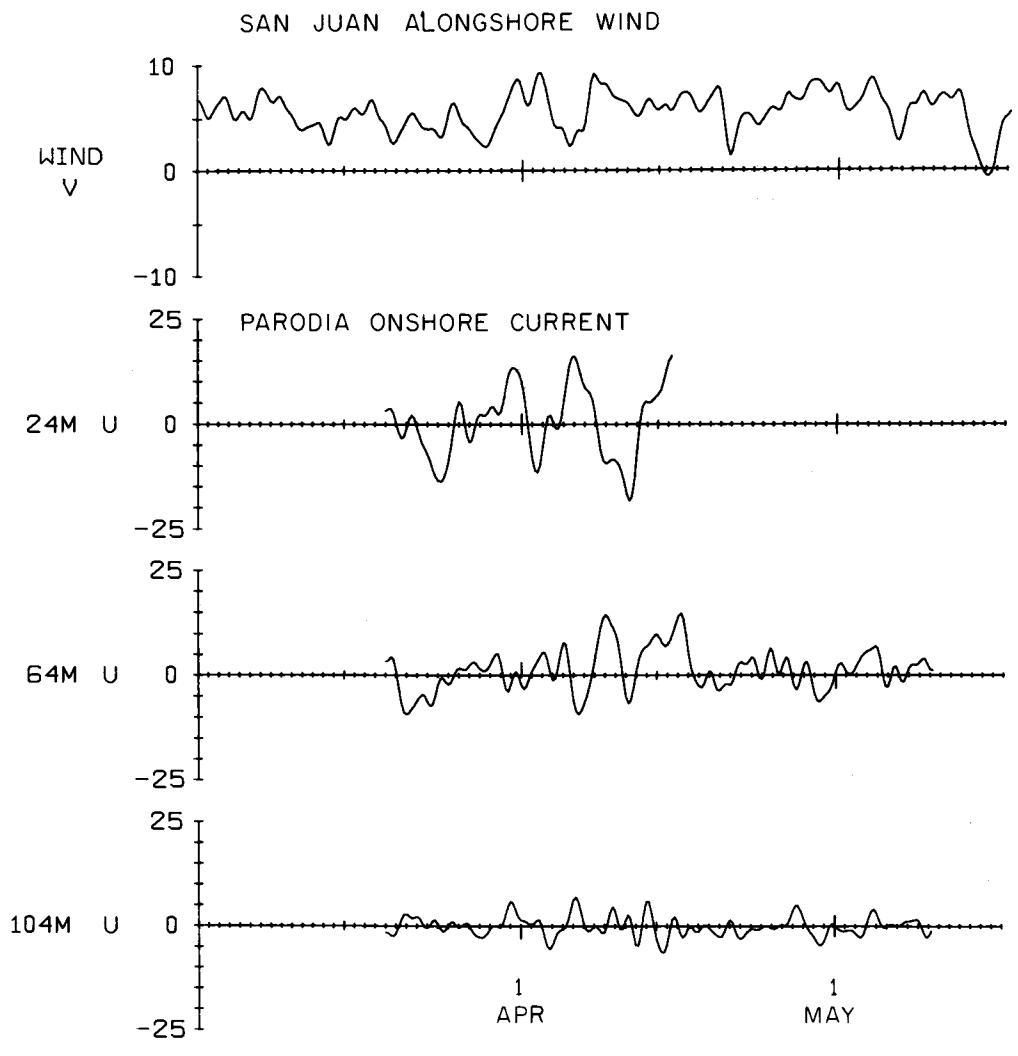


Figure 23b.

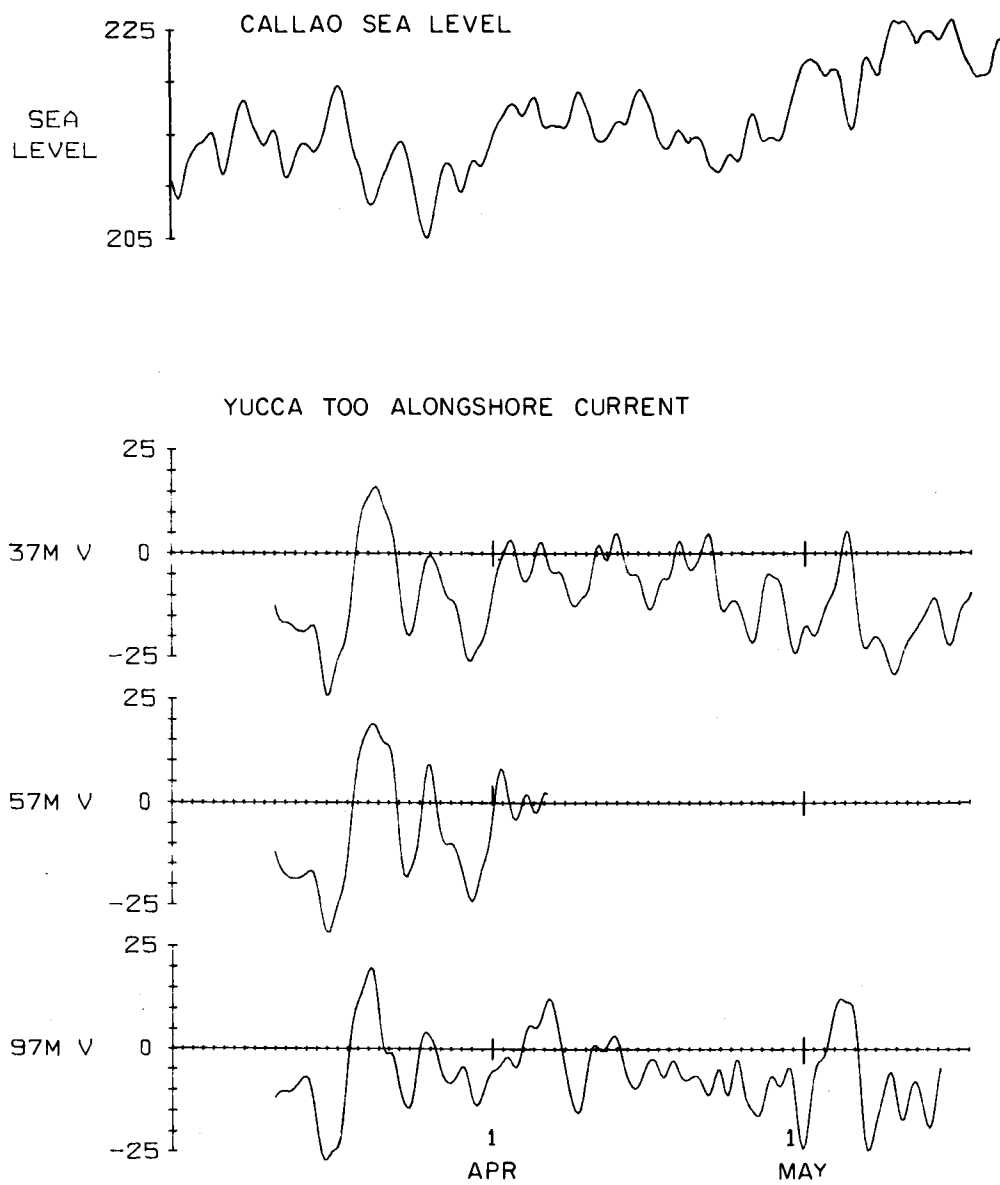


Figure 24a.

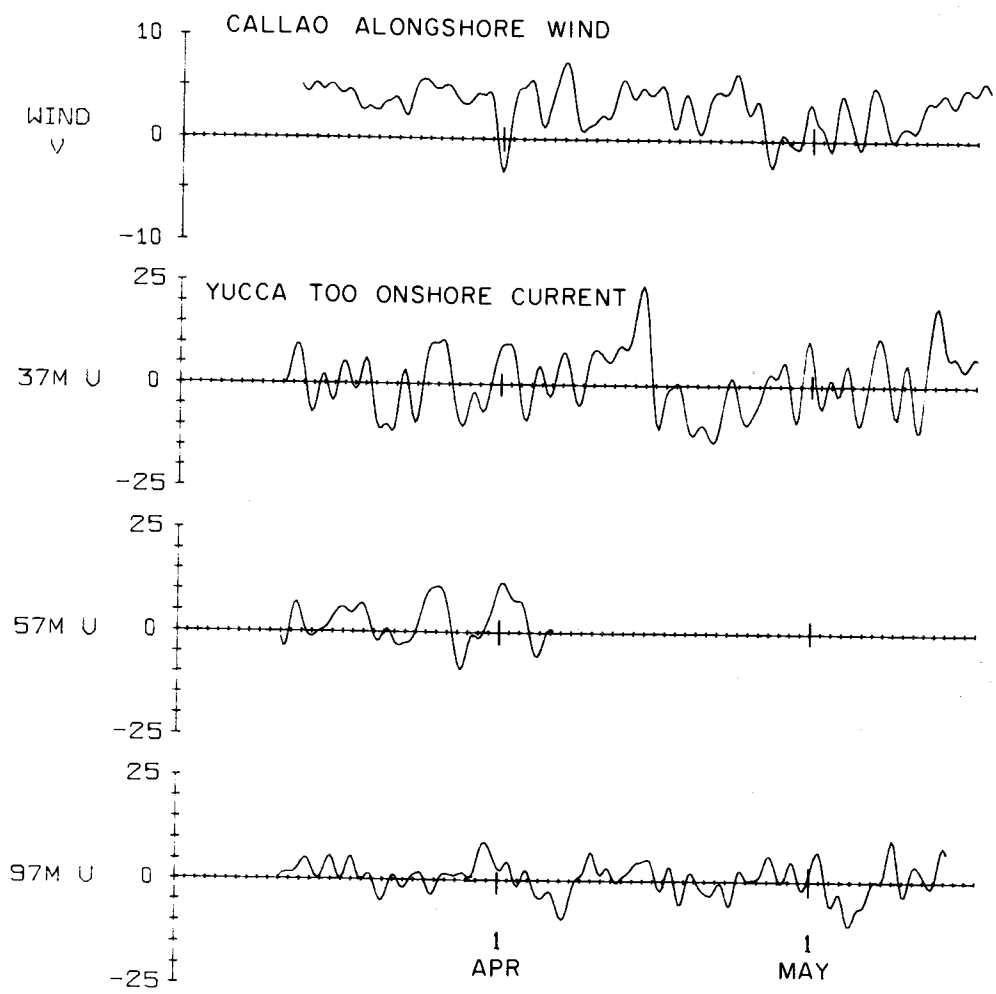


Figure 24b.

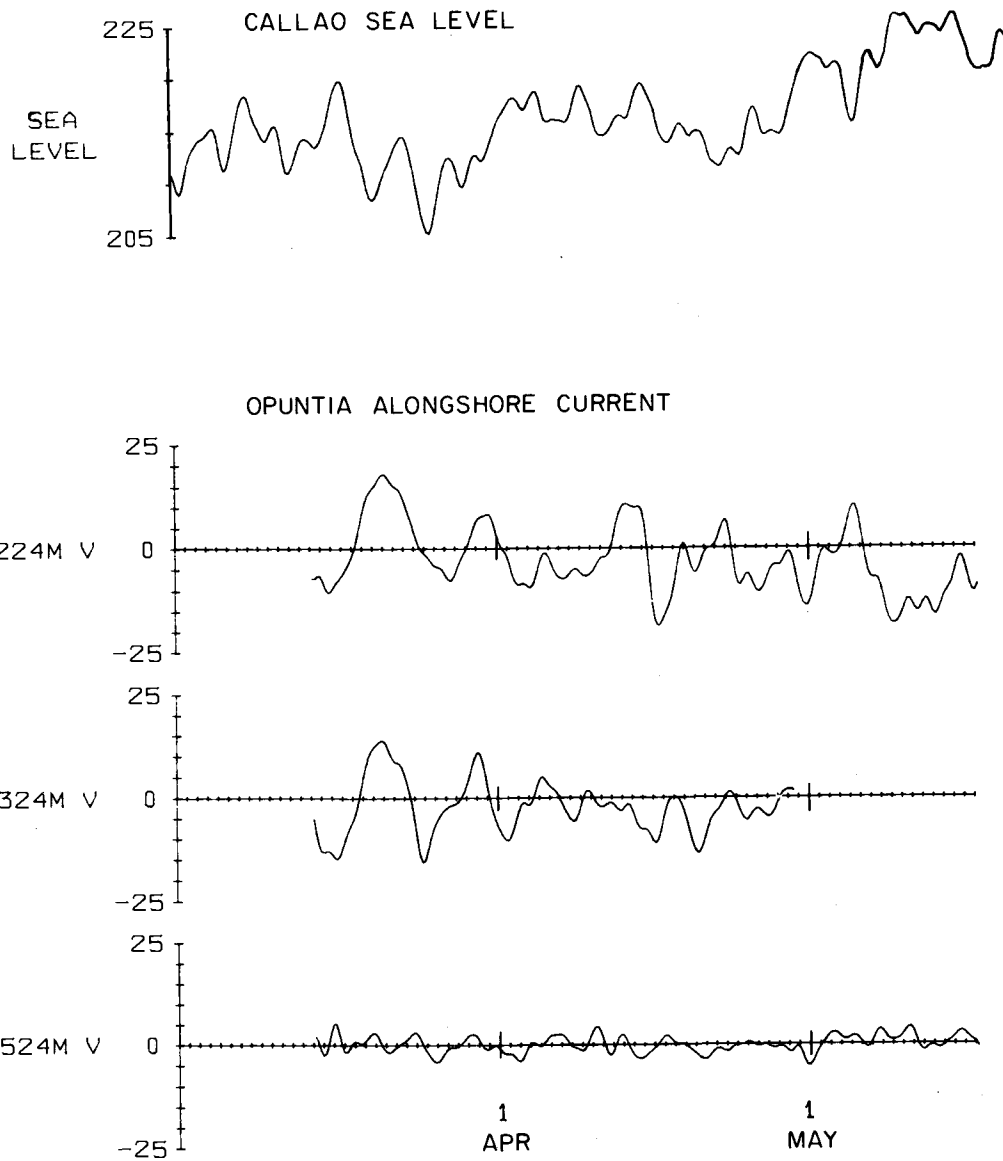


Figure 25a.



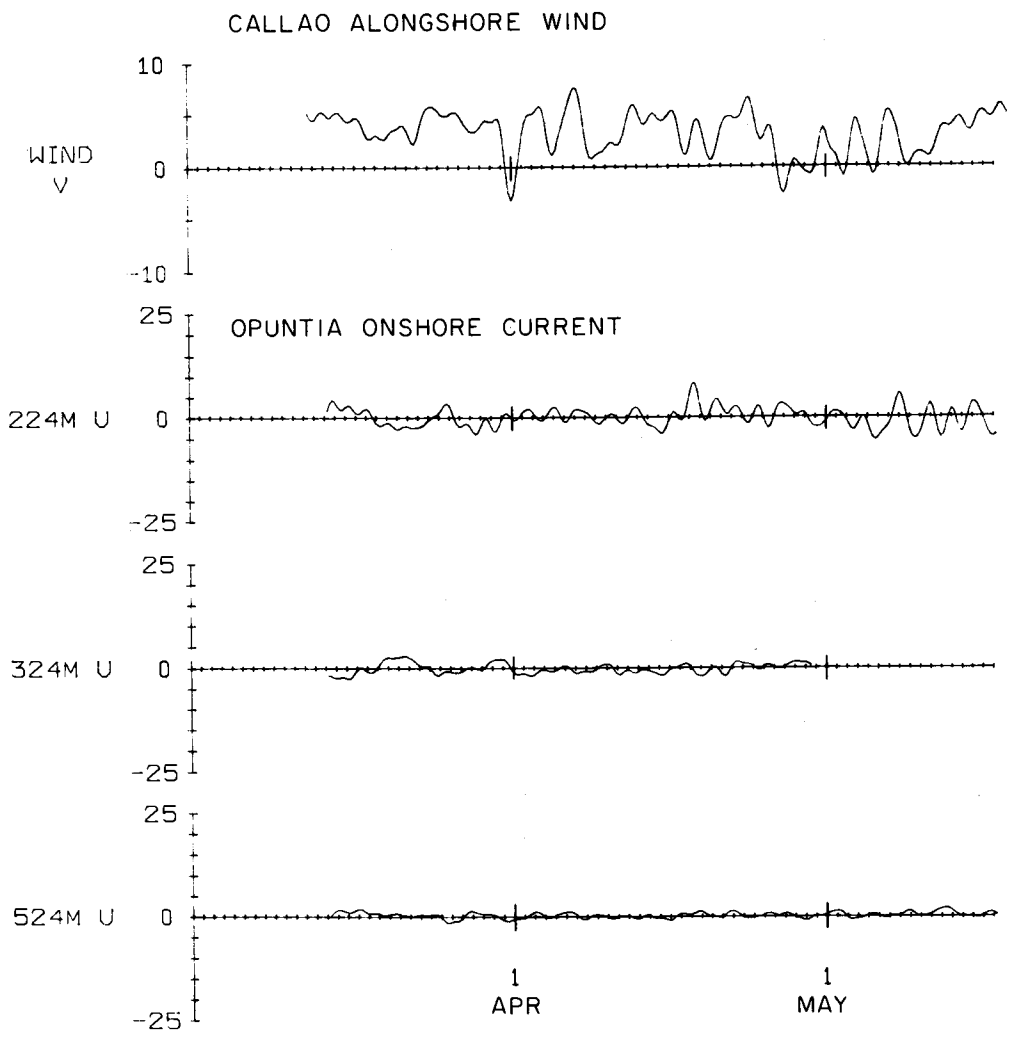


Figure 25b.

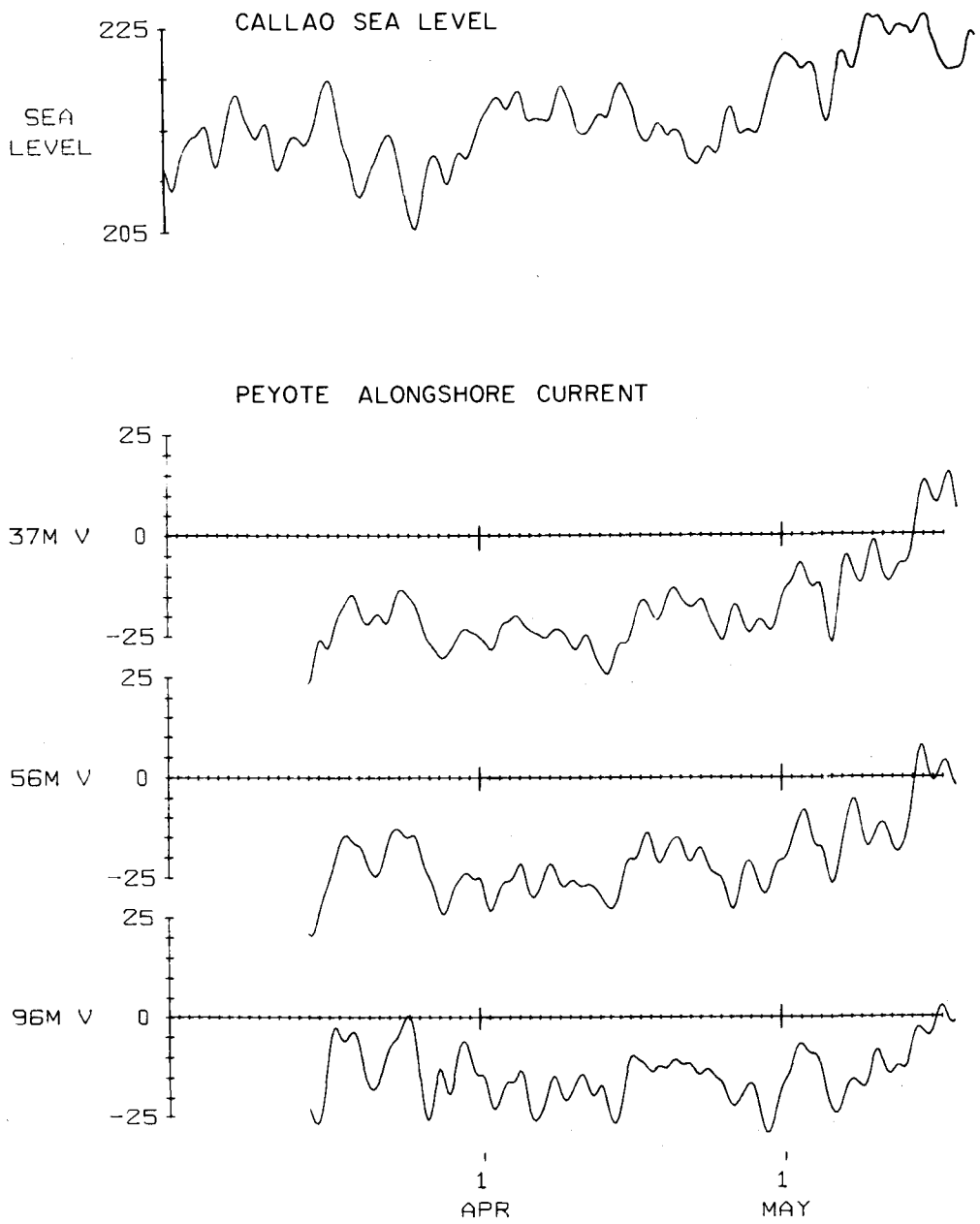


Figure 26a.

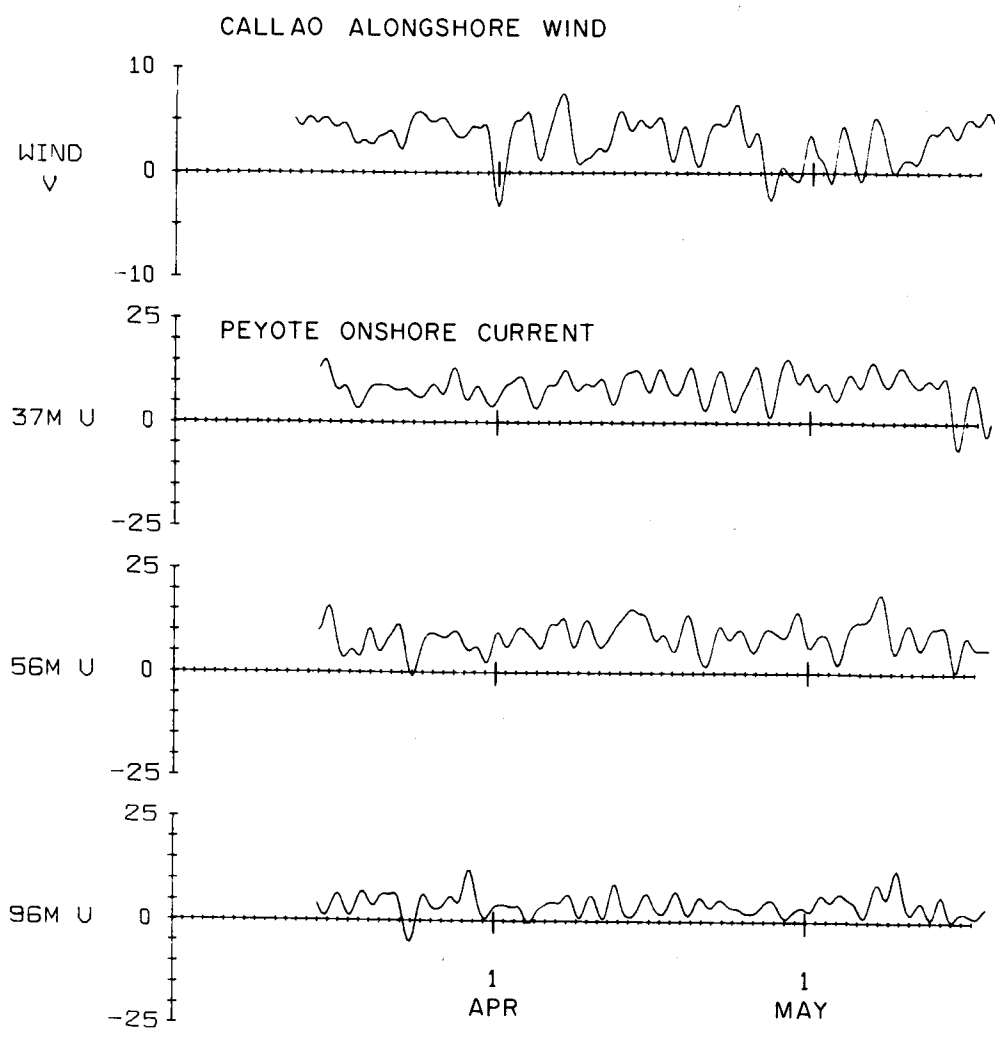


Figure 26b.

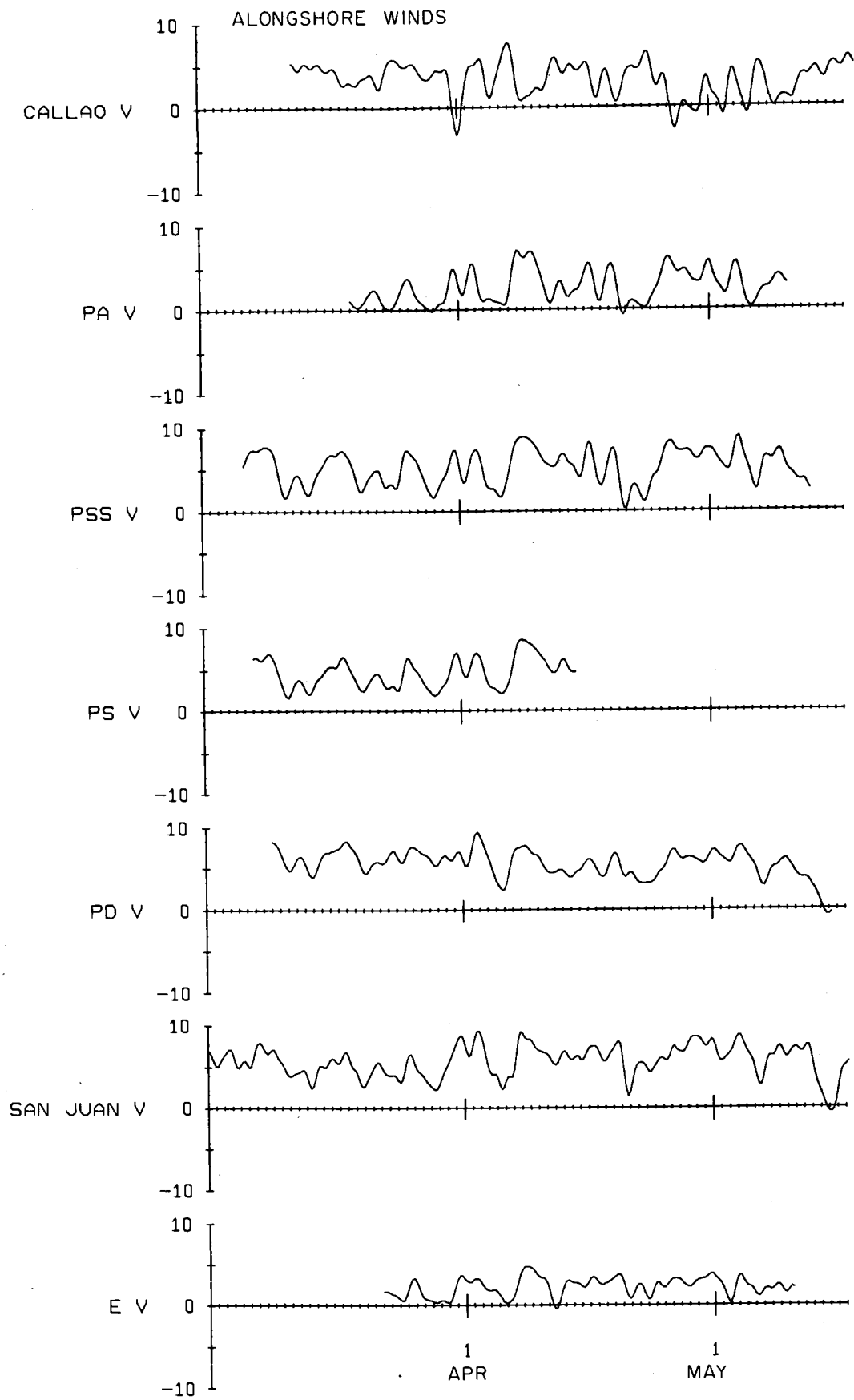


Figure 27a.

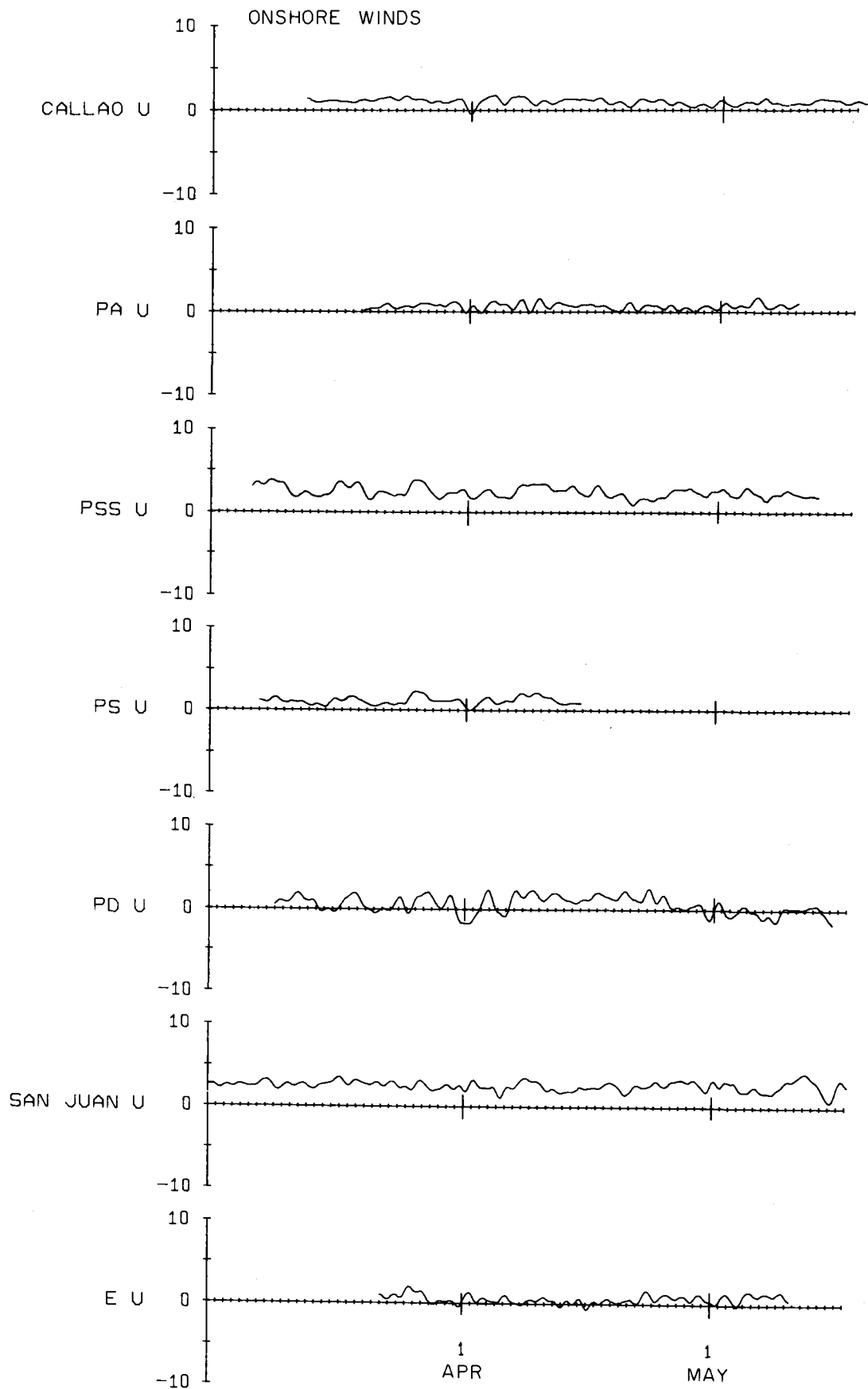
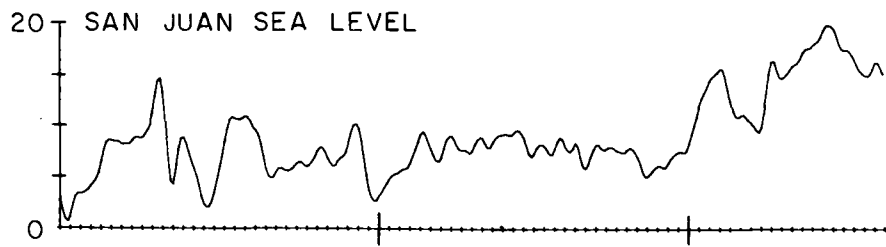
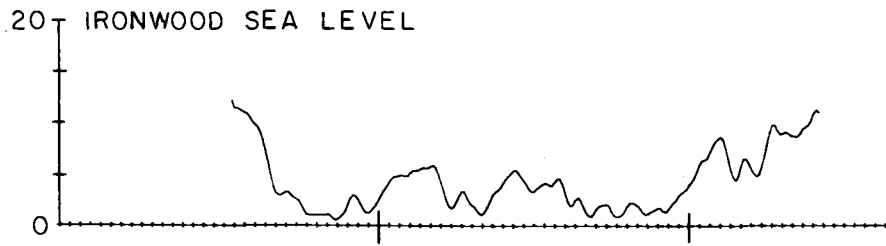
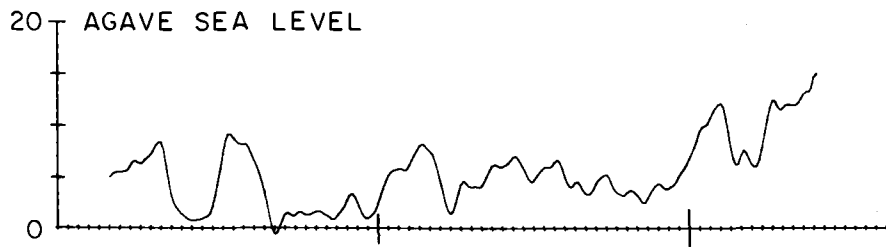
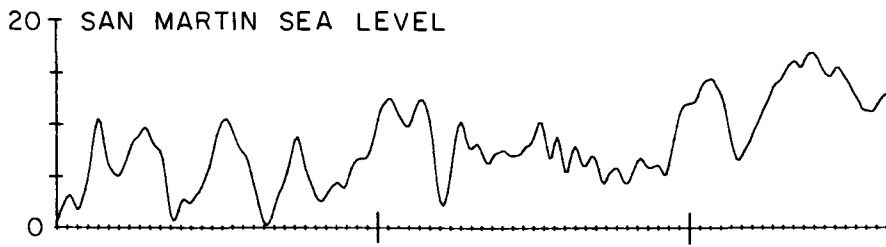
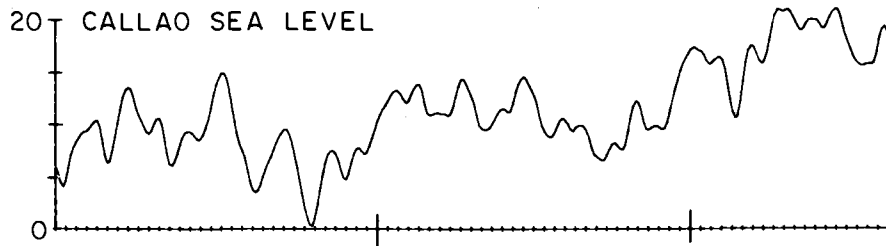
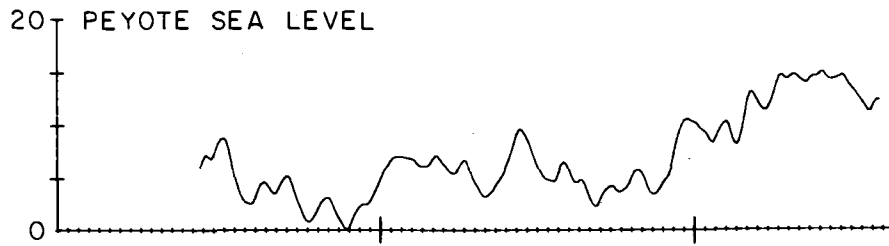


Figure 27b.



1 APR

1 MAY

Figure 28.

JOINT-2, PSS/AGAVE

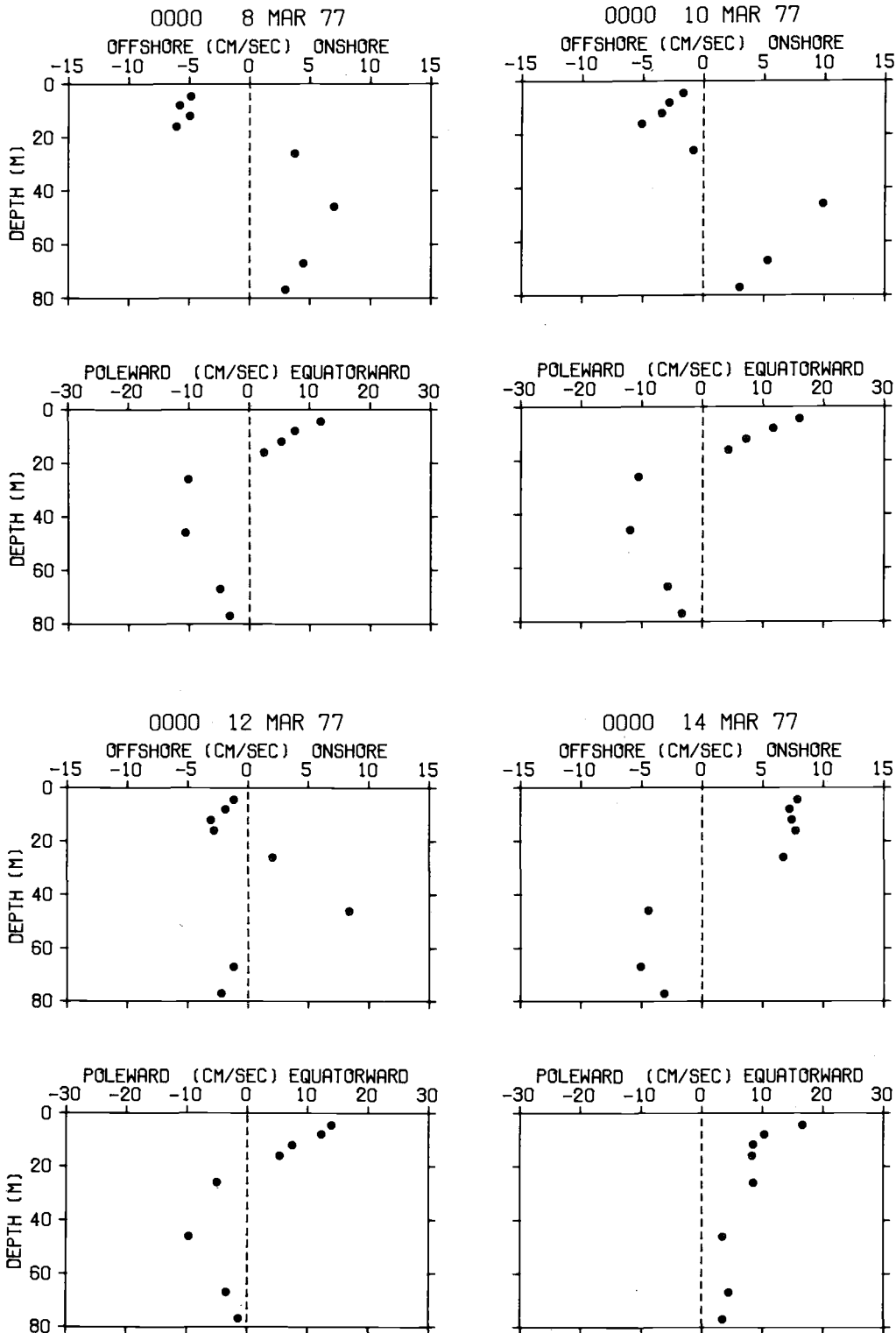


Figure 29(1).

JOINT-2, PSS/AGAVE

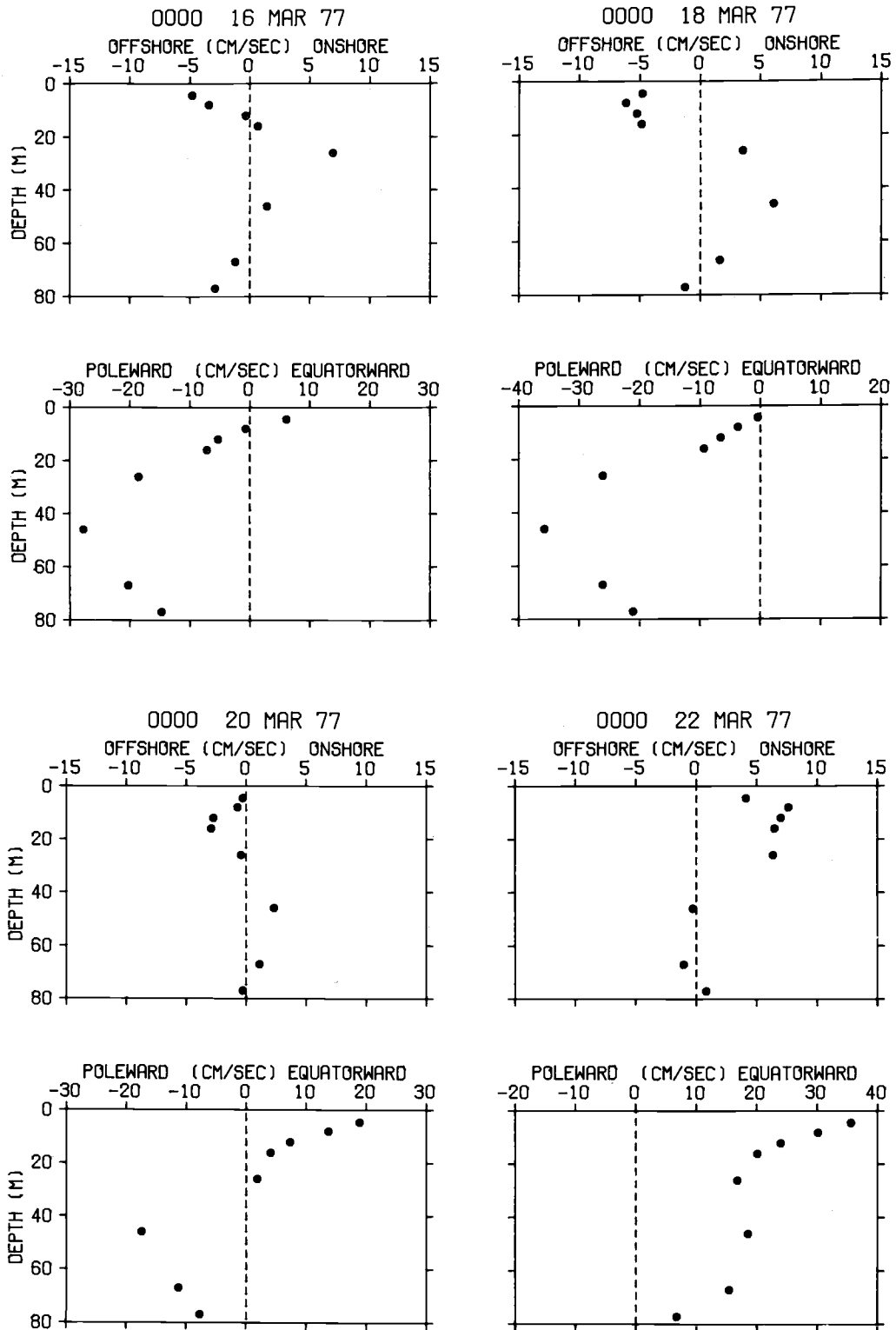


Figure 29(2).



JOINT-2, PSS/AGAVE

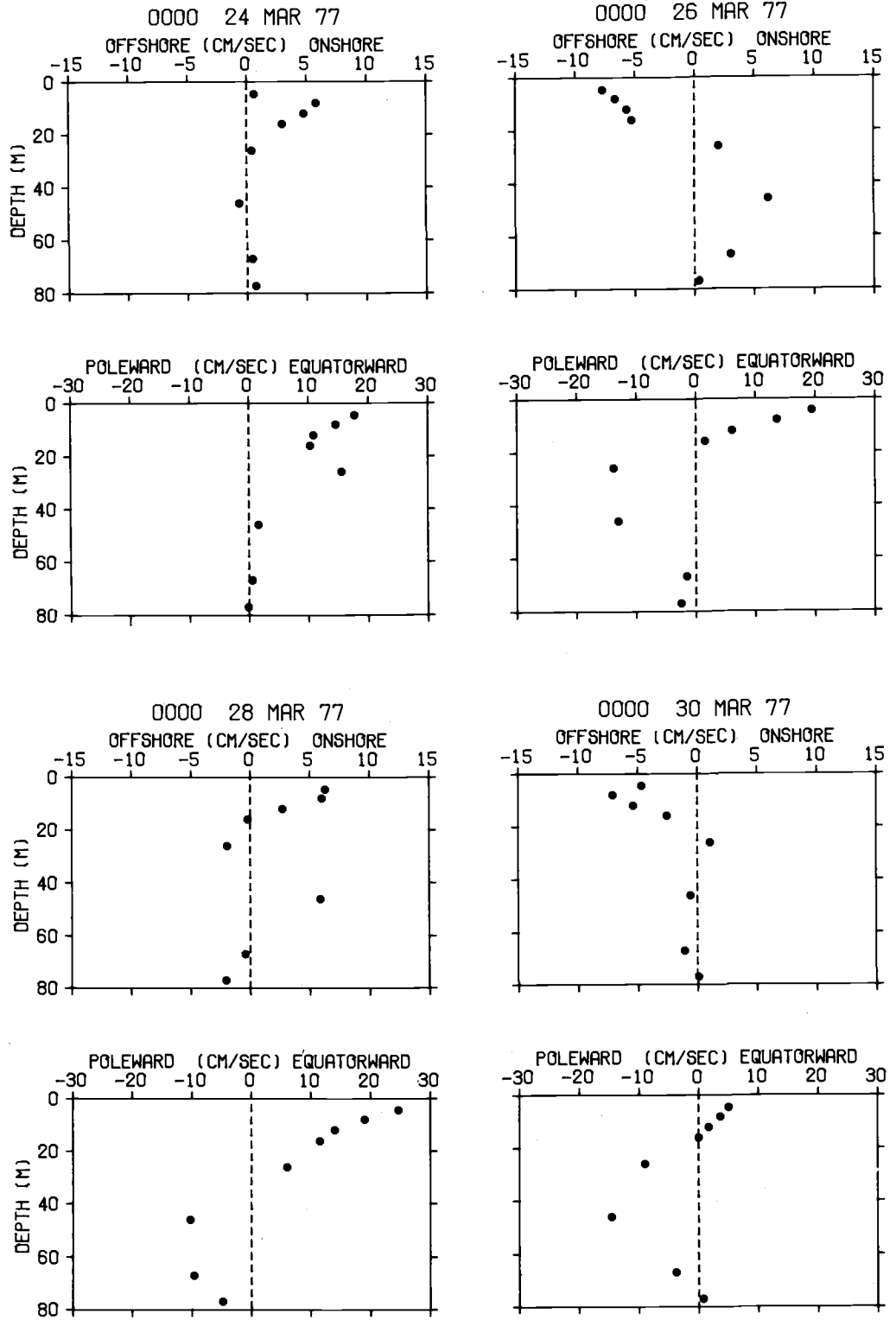


Figure 29(3).

JOINT-2. PSS/AGAVE

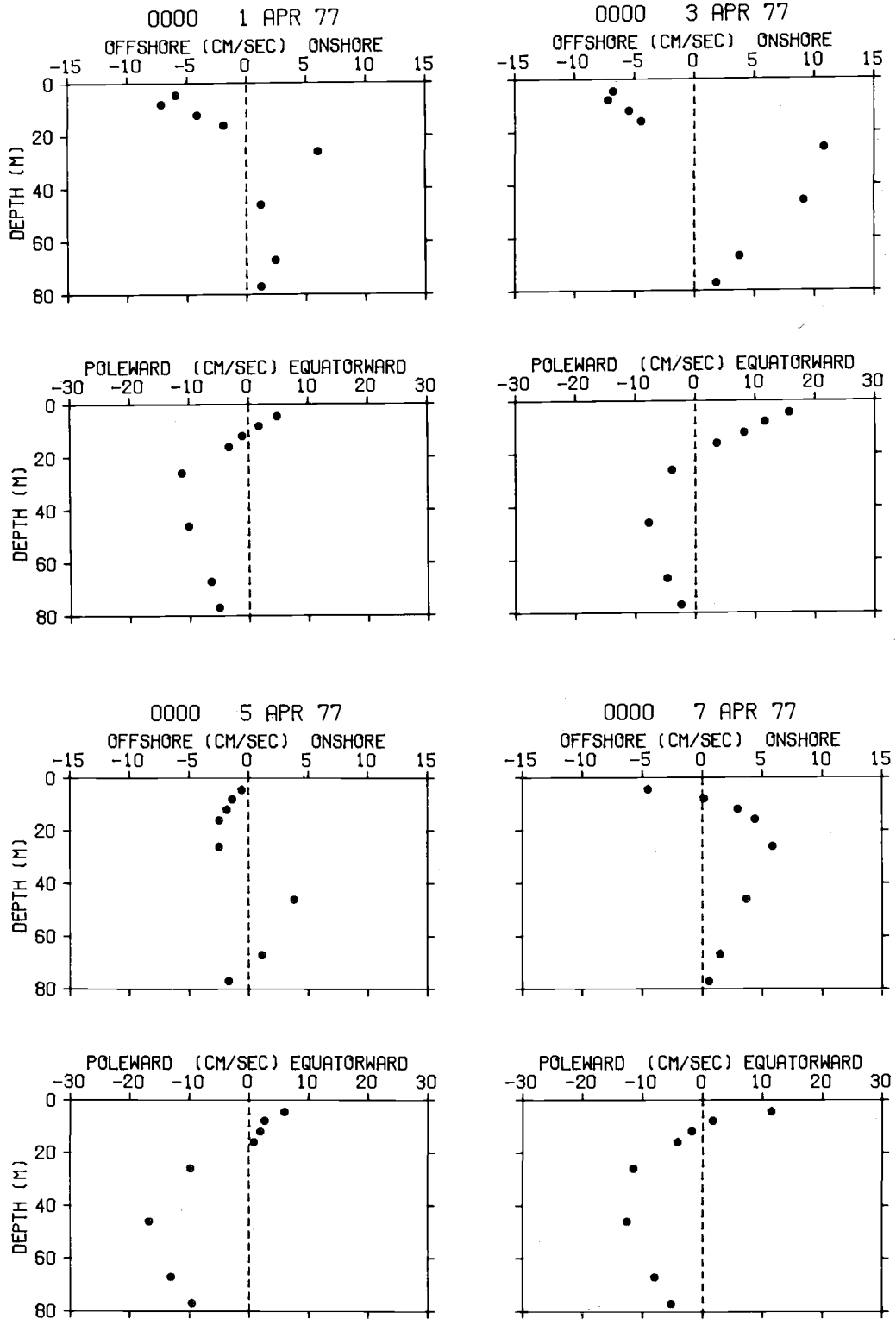


Figure 29(4).

JOINT-2, PSS/AGAVE

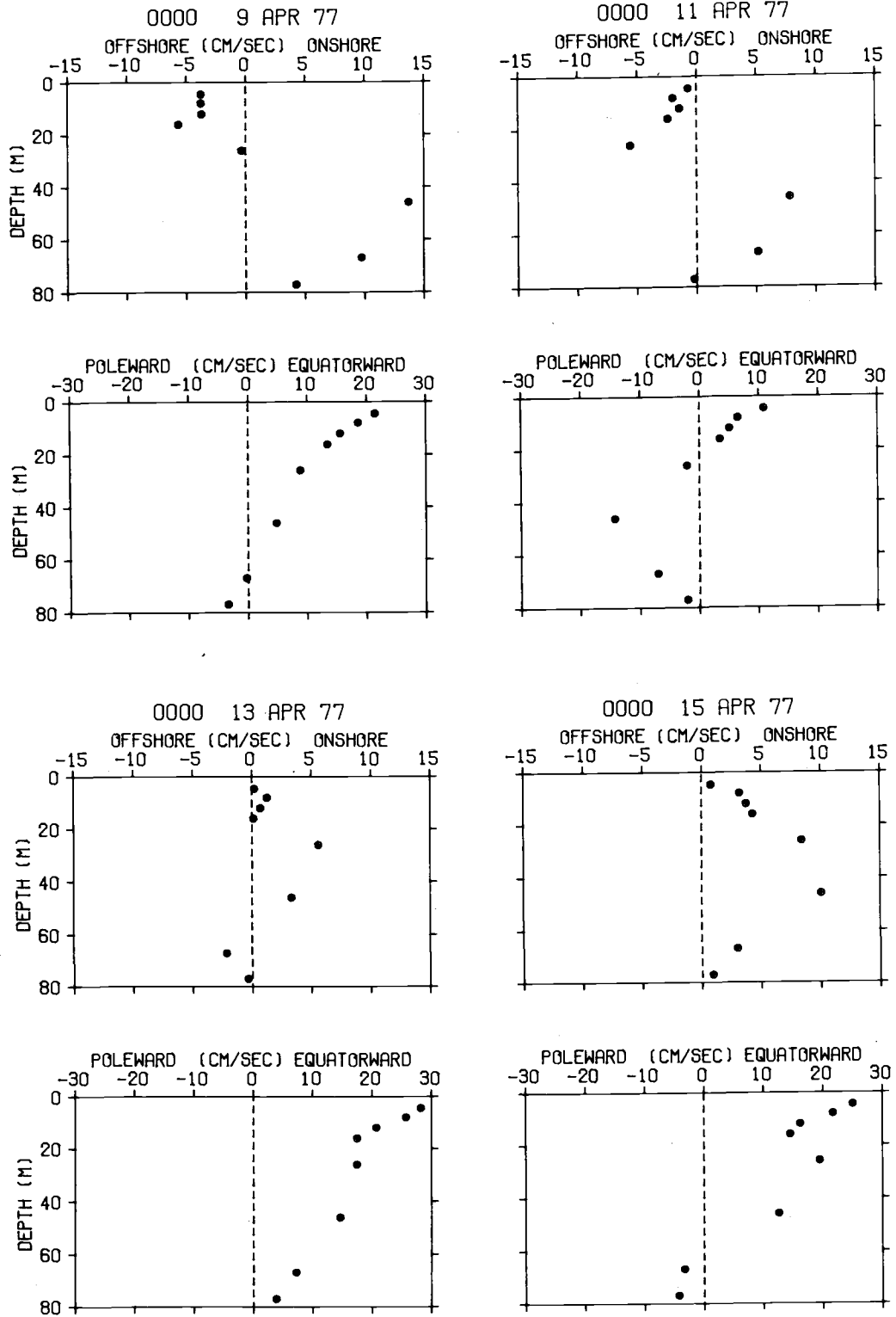


Figure 29(5).

JOINT-2, PSS/AGAVE

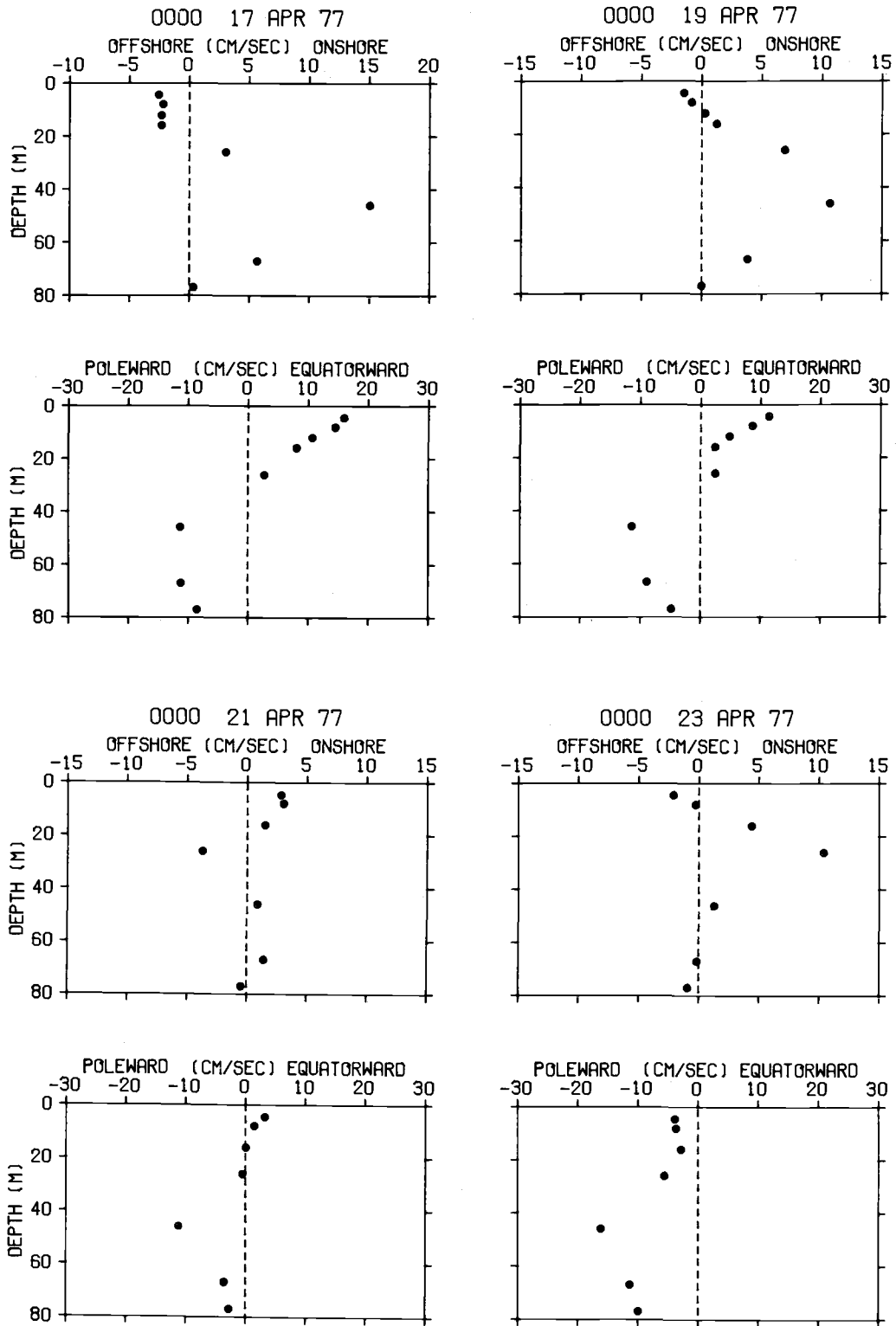


Figure 29(6).

JOINT-2. PSS/AGAVE

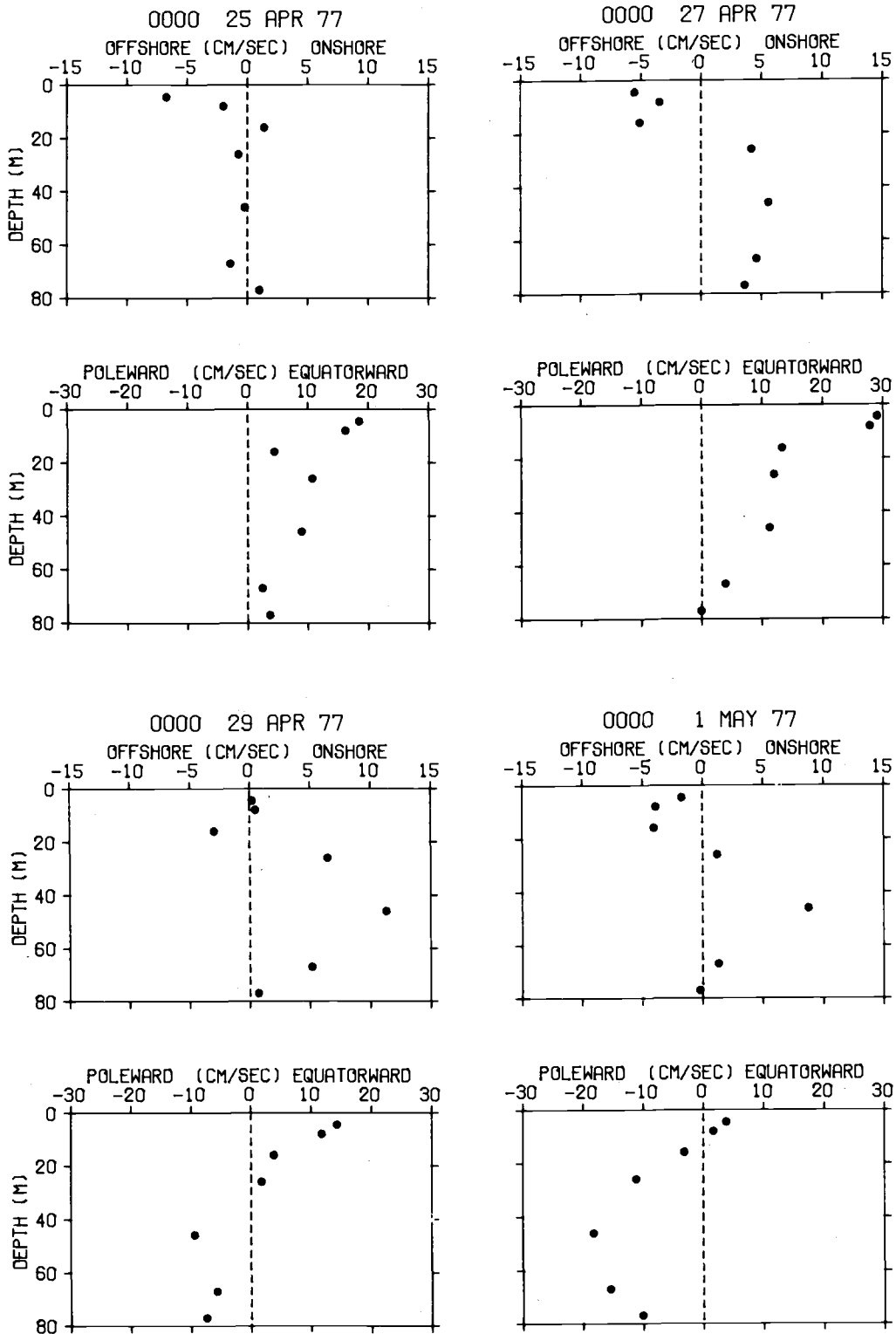


Figure 29(7).

JOINT-2, PSS/ACAVE

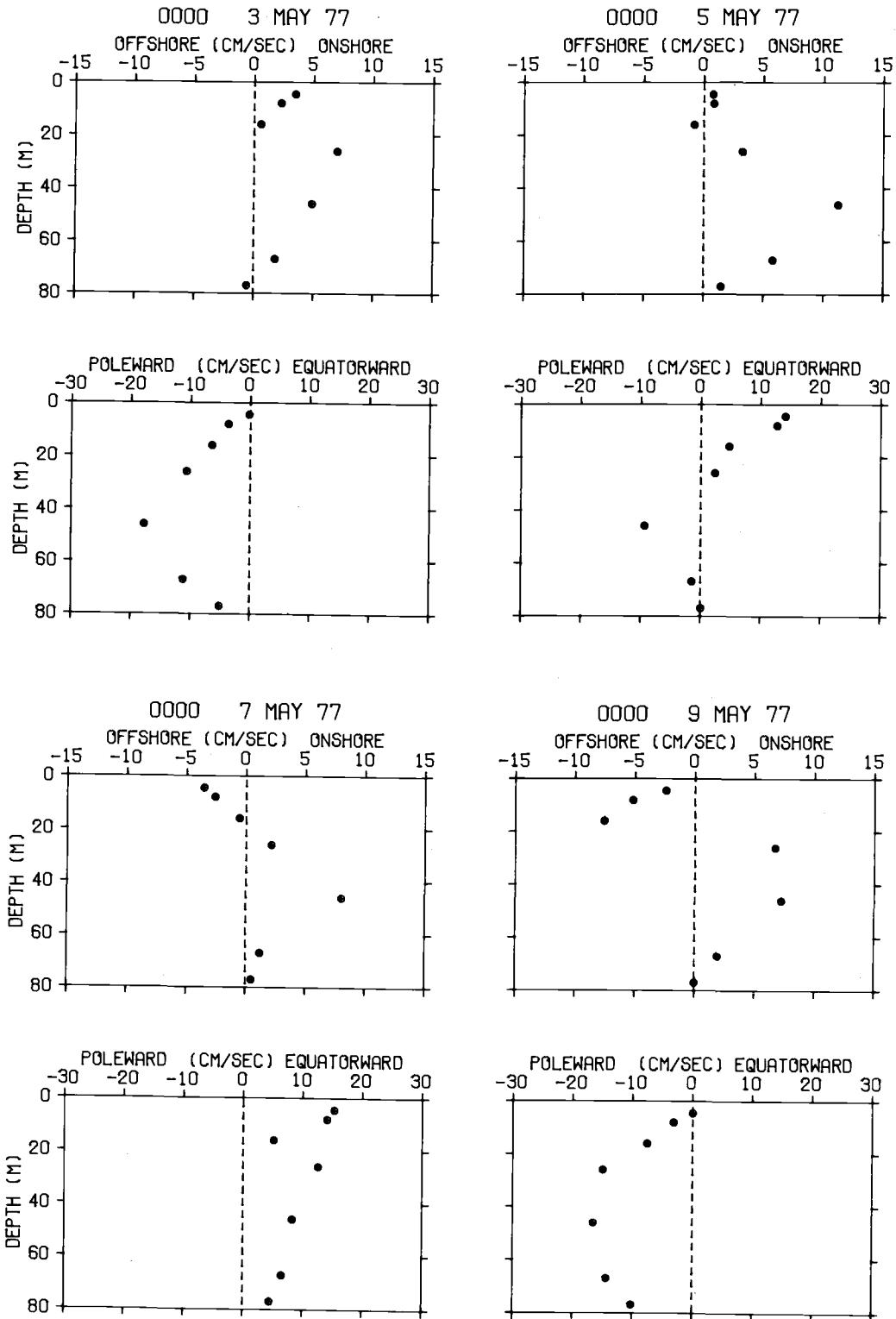


Figure 29(8).

JOINT-2, PSS/AGAVE

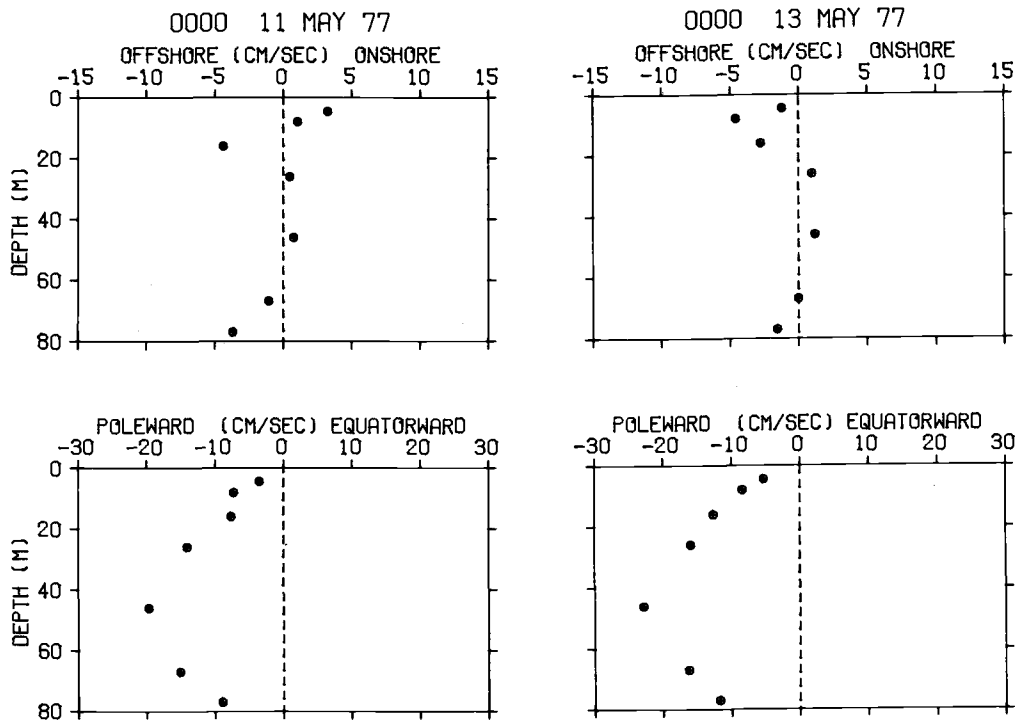


Figure 29(9).

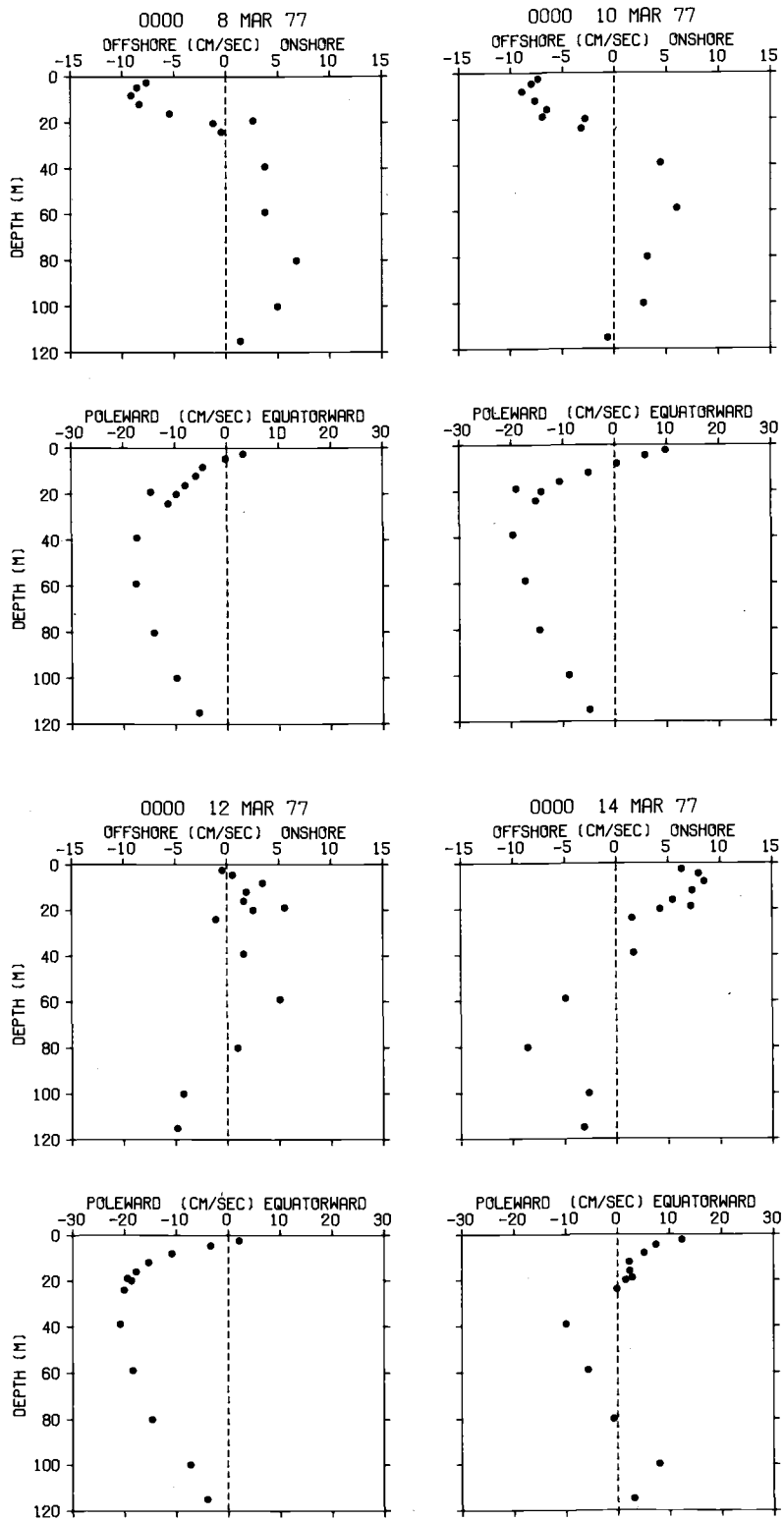


Figure 30(1).



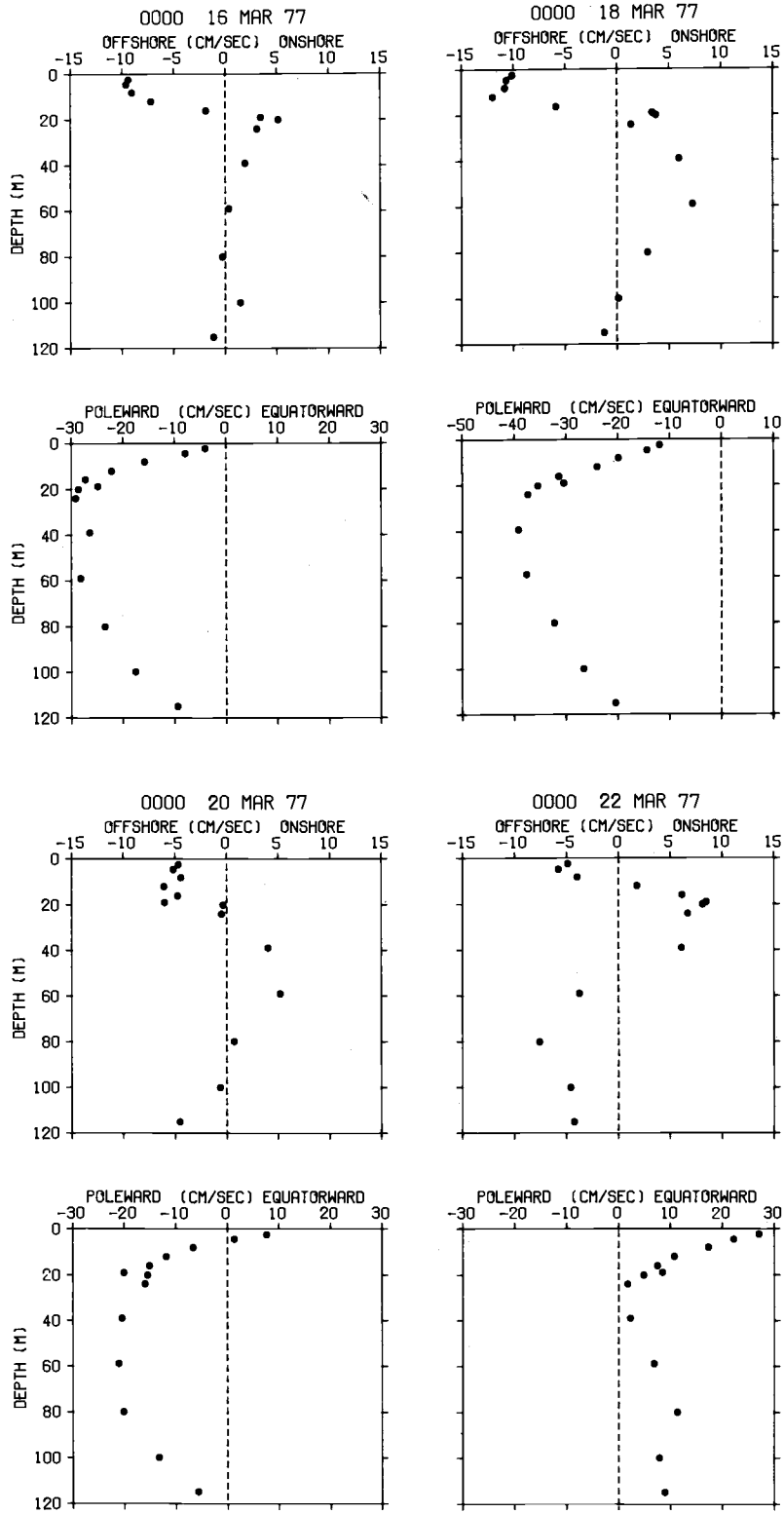


Figure 30(2).

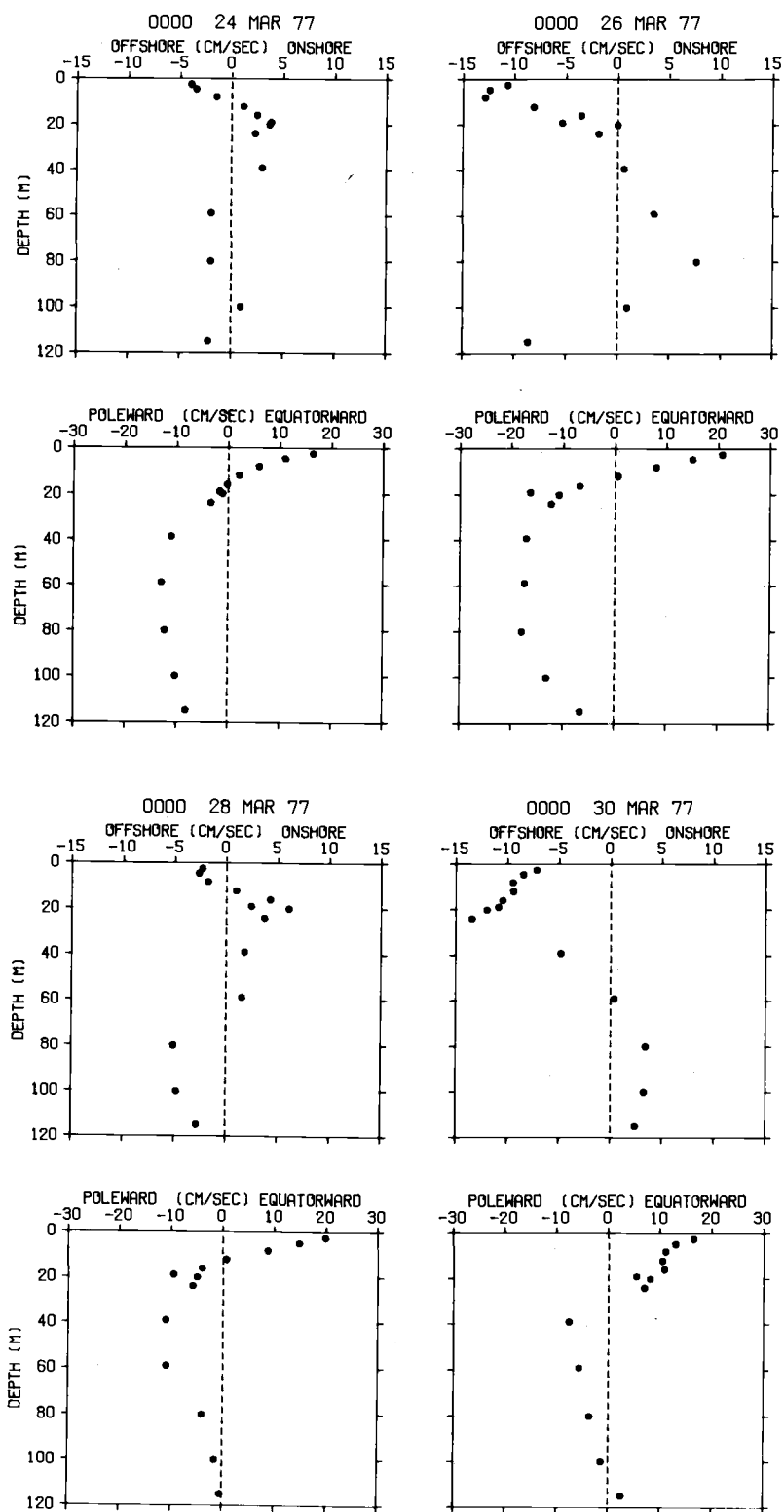


Figure 30(3).

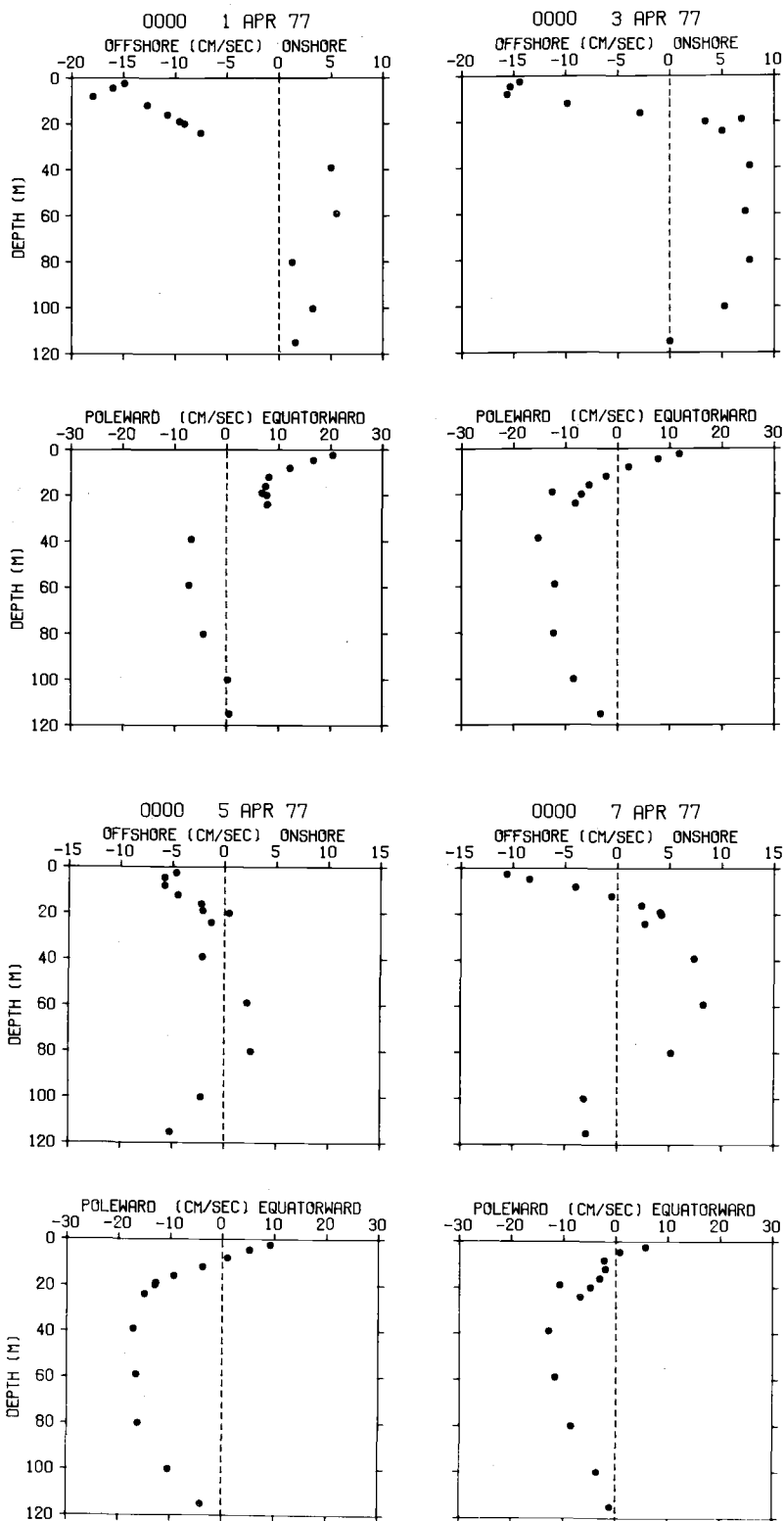


Figure 30(4).

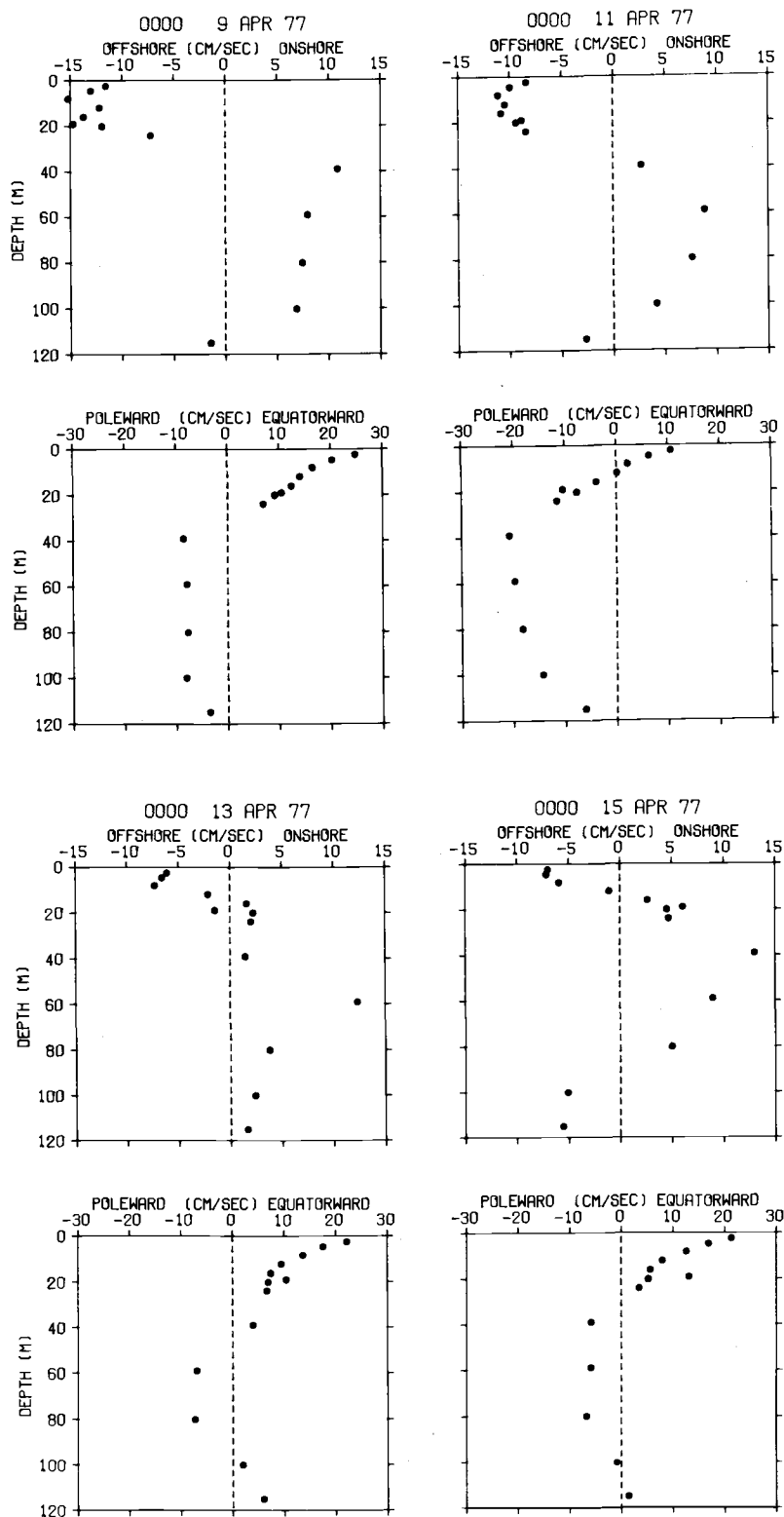


Figure 30(5).

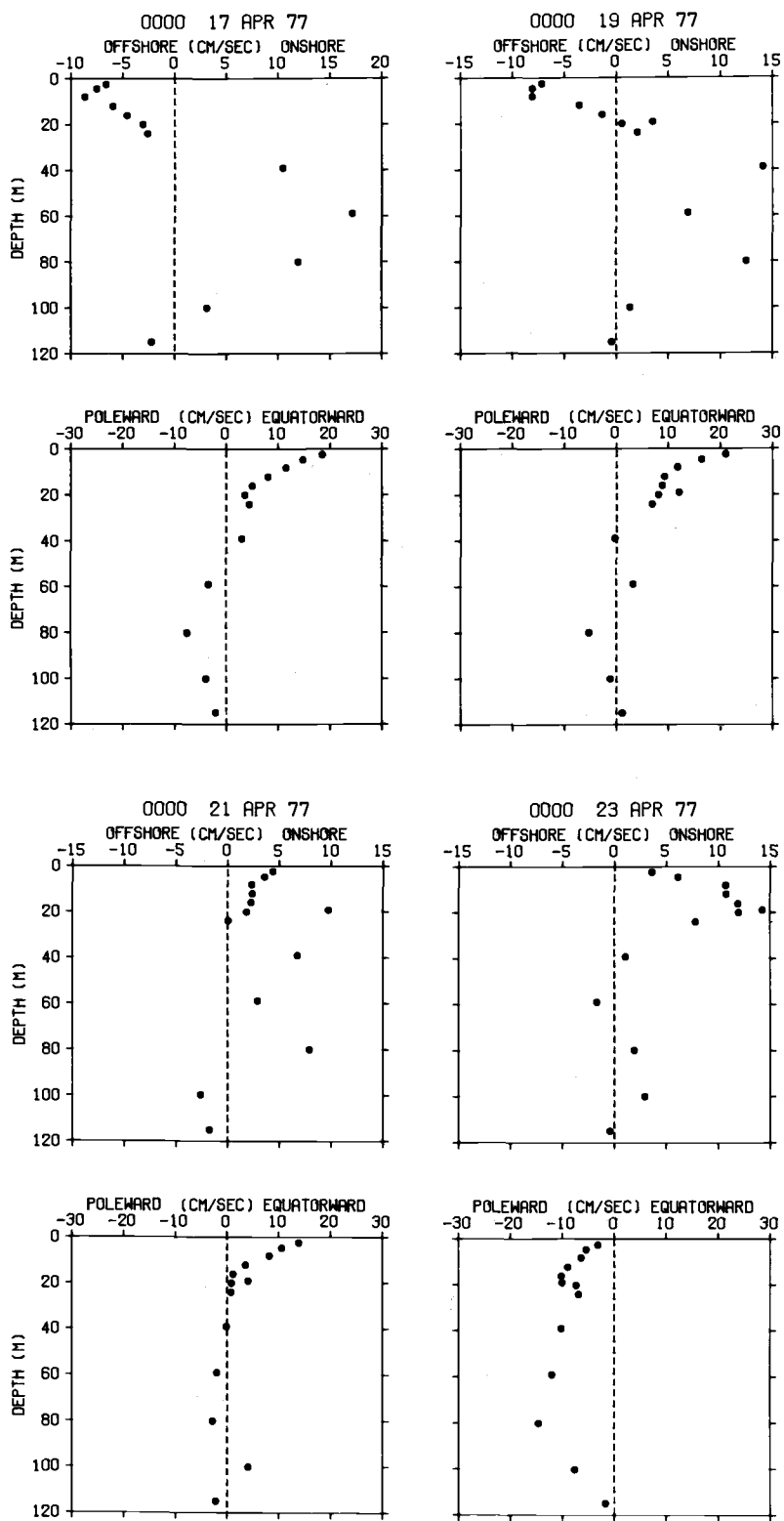


Figure 30(6).

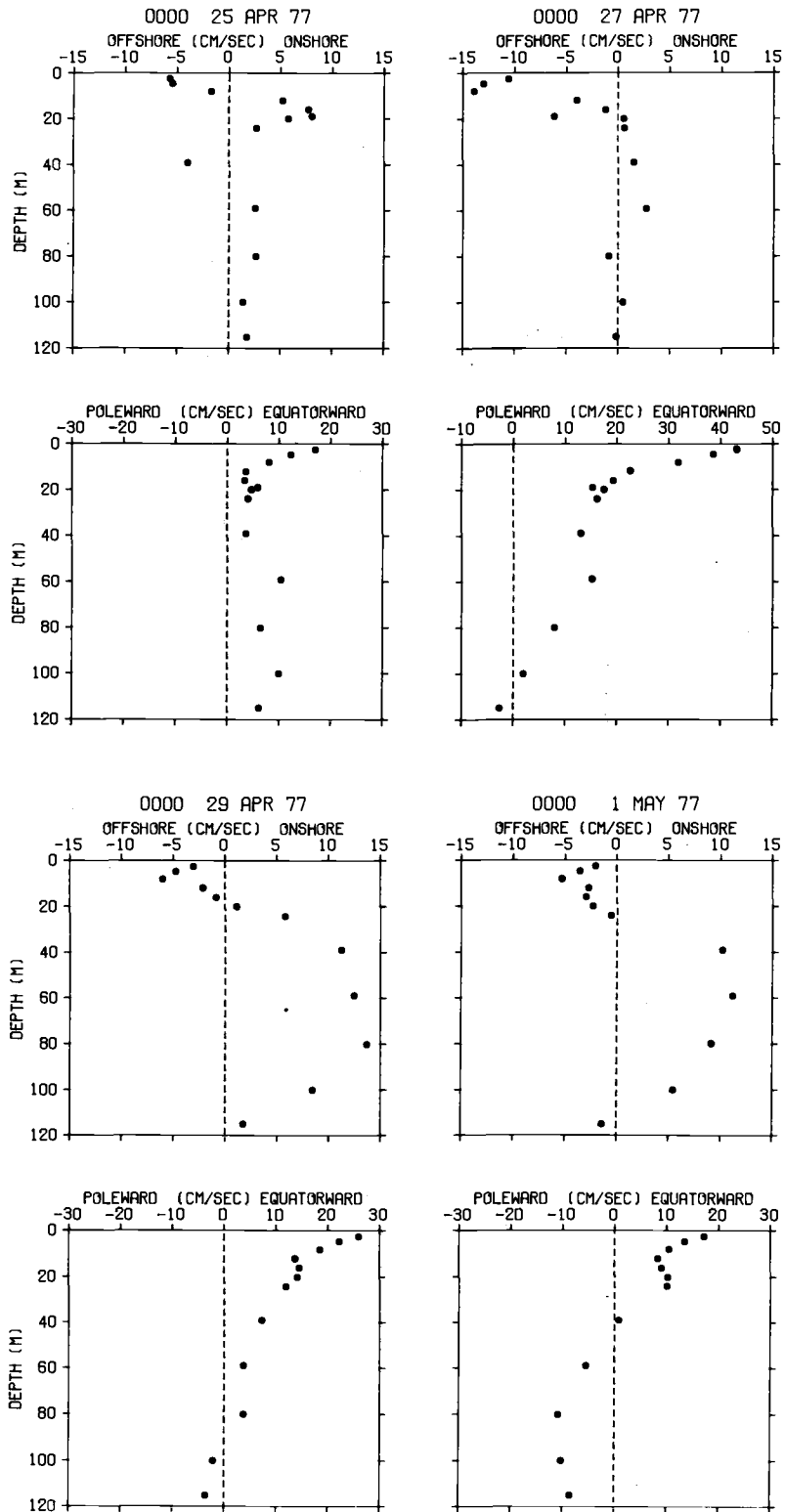


Figure 30(7).

JOINT-2, PS/MILA

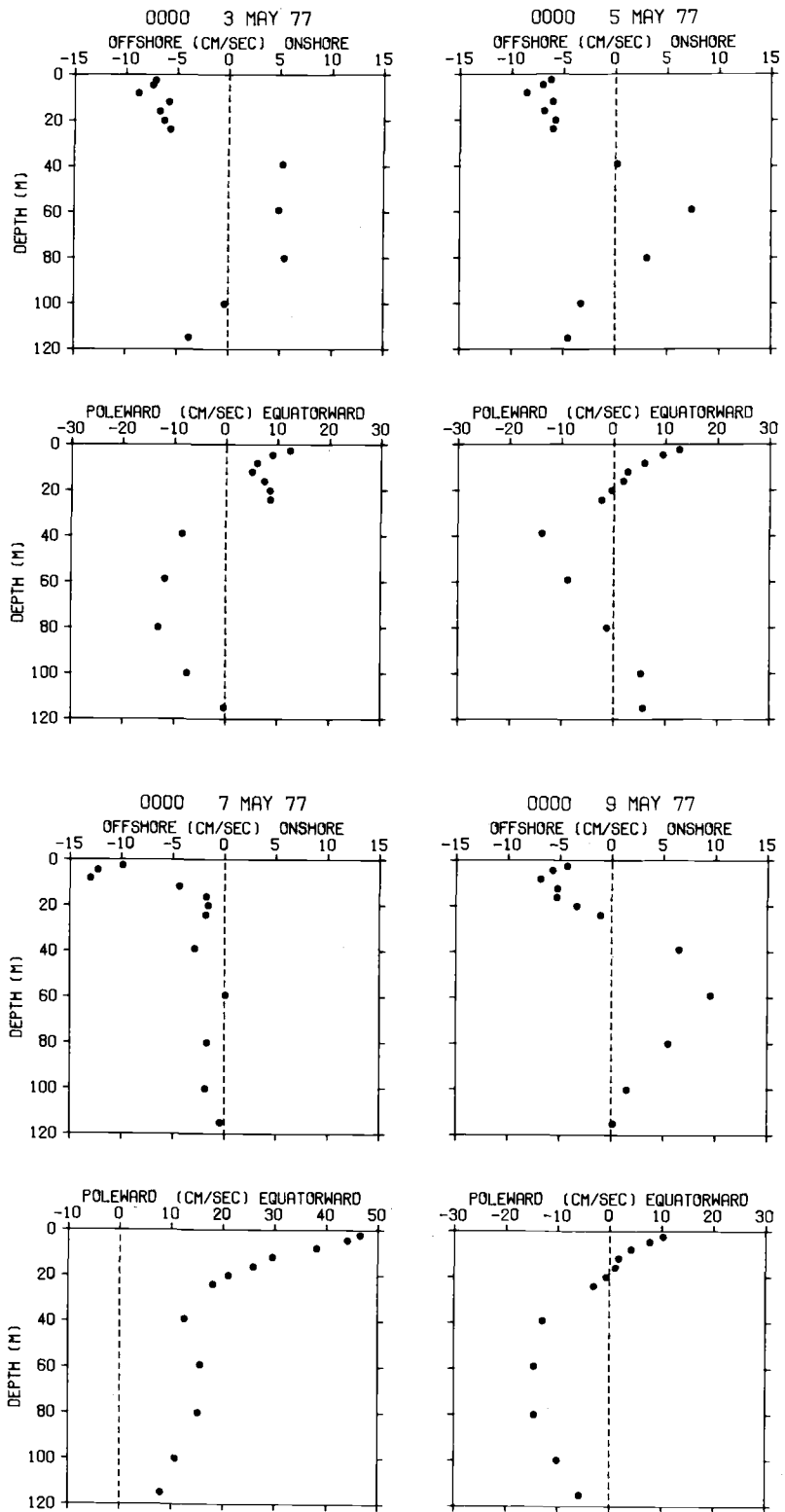


Figure 30(8).

JOINT-2. PS/MILA

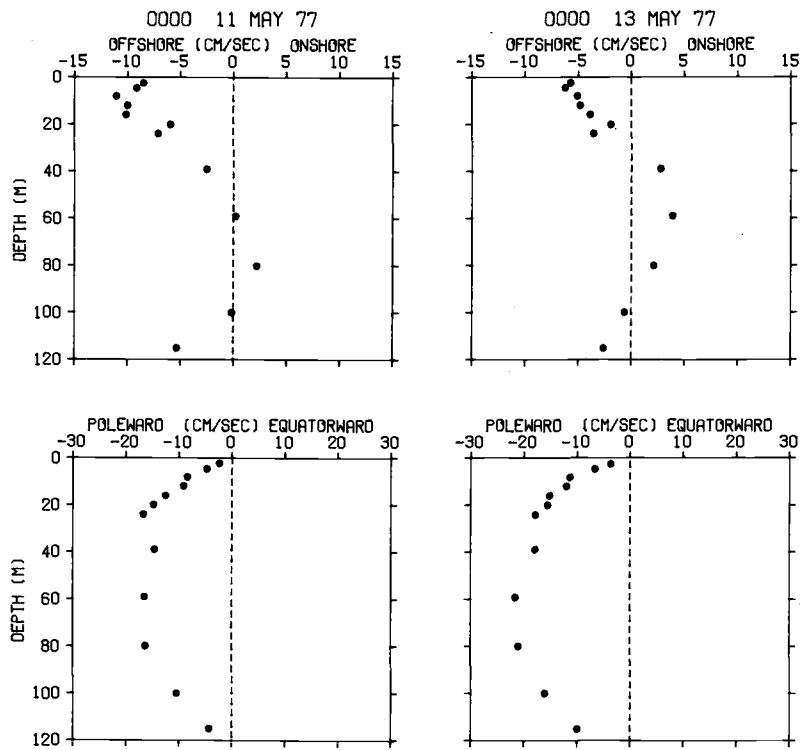


Figure 30(9).