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

by

K. H. Brink, R. L. Smith and D. Halpern

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

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

K. H. BRINK & R. L. SMITH

School of Oceanography
Oregon State University
Corvallis, Oregon 97331

DAVID HALPERN

NOAA Pacific Marine Environmental Laboratory
3711 15th Avenue, N.E.
Seattle, Washington 98105

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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)[1] 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).[2]

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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° 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, θ, is given in degrees counterclockwise from the north. Wind data is rotated 45°, 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, θ, 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	θ
PSS	4.5	-1.6	13.2	16.02	3.3	9.3	0.51	44.6°
(75, 45.0°)	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	26	4.2	-0.2	15.53	3.9	10.6	0.12	44.3°
(86, 45.3°)	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	2.5	-5.8	17.9	16.46	4.5	11.2	0.39	58.5°
(121, 45.0°)	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	19	B	B	15.93	B	B	0.18	B
(121, 47.5°)	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 Depth	Means u	Means v	Means T	Standard Deviations u	Standard Deviations v	Standard Deviations T	Principal Axis Direction θ
Ironwood	24	-5.7	-0.8	16.14	6.7	7.7	0.28	52.2°
(205, 43.1°)	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	58	-1.6	-6.9	15.37	5.3	7.5	0.14	47.4°
(580, 48.9°)	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	92	-2.8	-8.6	14.85	4.4	8.8	0.16	53.0°
(620, 55.5°)	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	3	M	M	17.13	M	M	0.50	-
(123, 62.3°)	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	3	M	M	16.99	M	M	0.55	-
(124, 43.0°)	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	37	0.6	-9.2	16.38	7.5	8.4	0.13	-13.1°
(117, 4.9°)	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 Depth	Means			Standard Deviations			Principal Axis Direction
		u	v	T	u	v	T	θ
Opuntia	129	F	F	14.25	F	F	0.31	F
(620, 39.8°)	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	37	9.1	-20.4	16.75	2.9	5.7	0.31	6.5°
(117, 8.2°)	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.

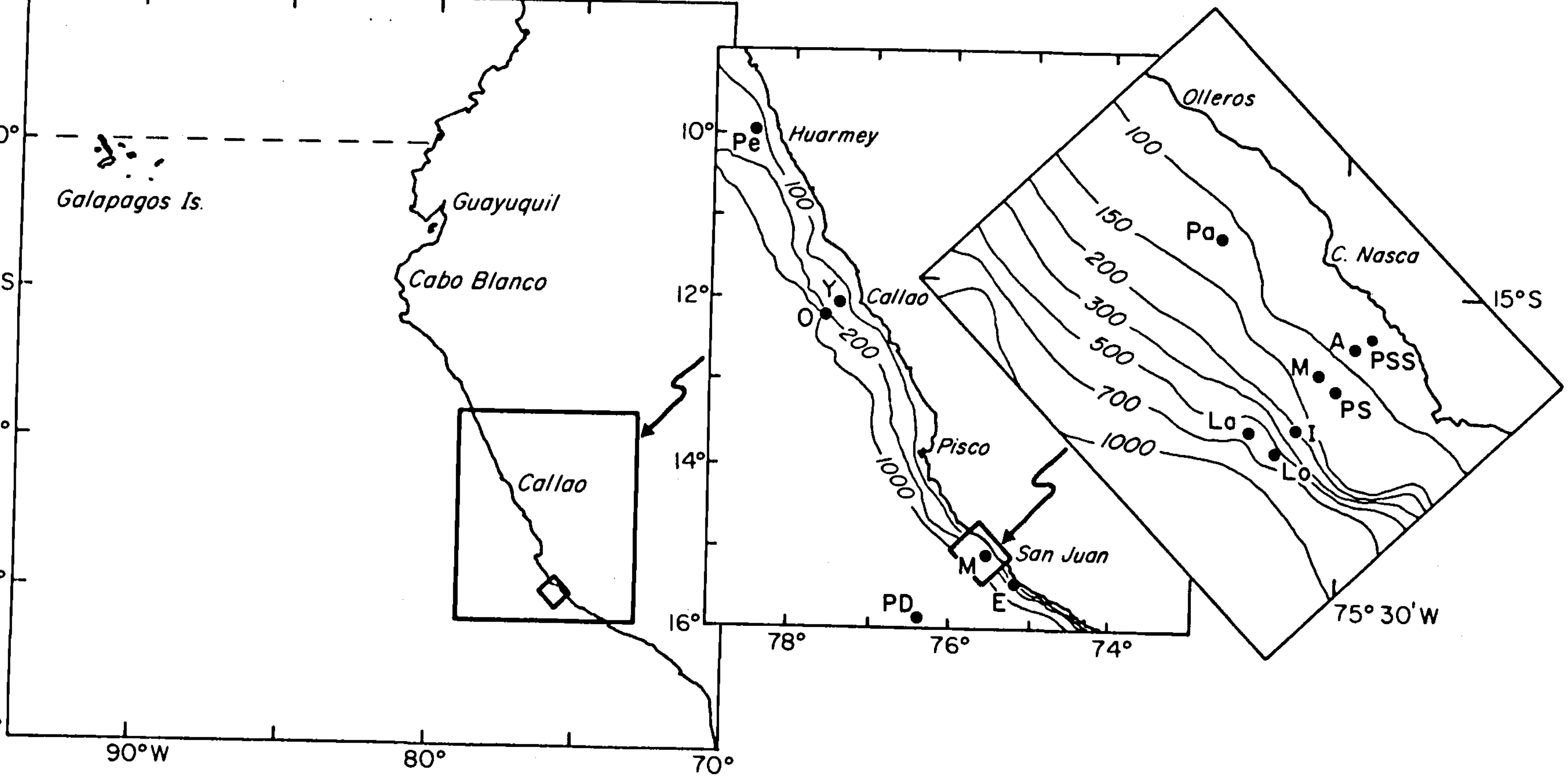
Table 2b. Wind velocity statistics from the 49.5 day common period (0000 UT 22 March 1977 to 0600 UT 10 May 1977). Velocities are in m/sec. All records are rotated 45° from the North. Principal axis directions are given in degrees counterclockwise from the North.

Location	Means		Standard Deviations		Principal Axis Direction
	u	v	u	v	θ
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



5°N
0°
5°S
10°
15°
20°
90°W
80°
70°
Galapagos Is.
Guayuquil
Cabo Blanco
Callao
10°
12°
14°
16°
78°
76°
74°
Pe
Huarmey
100
Y
O
Callao
200
Pisco
1000
San Juan
M
E
PD
Olleros
100
150
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15°S
A
PSS
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PS
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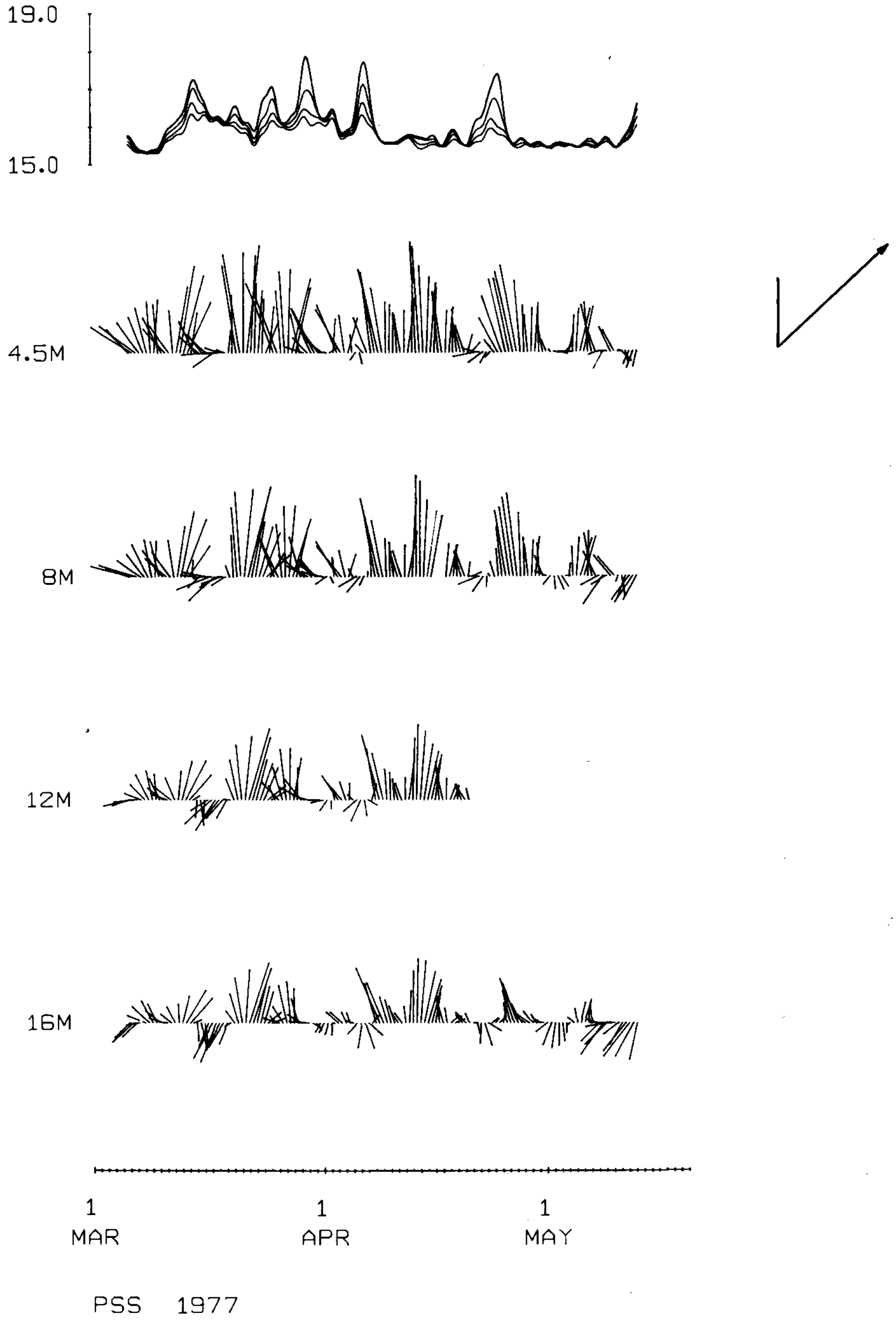
75° 30'W

Figure 1.



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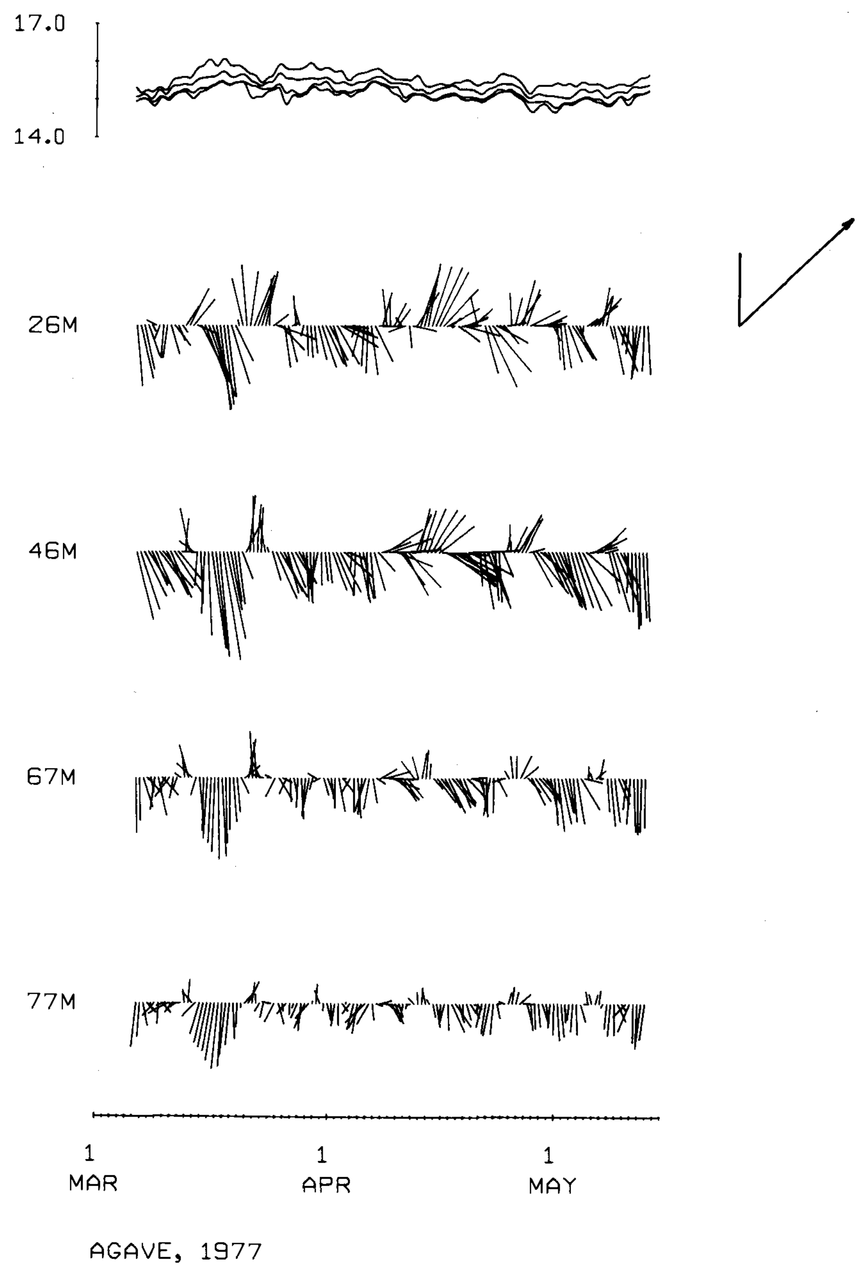

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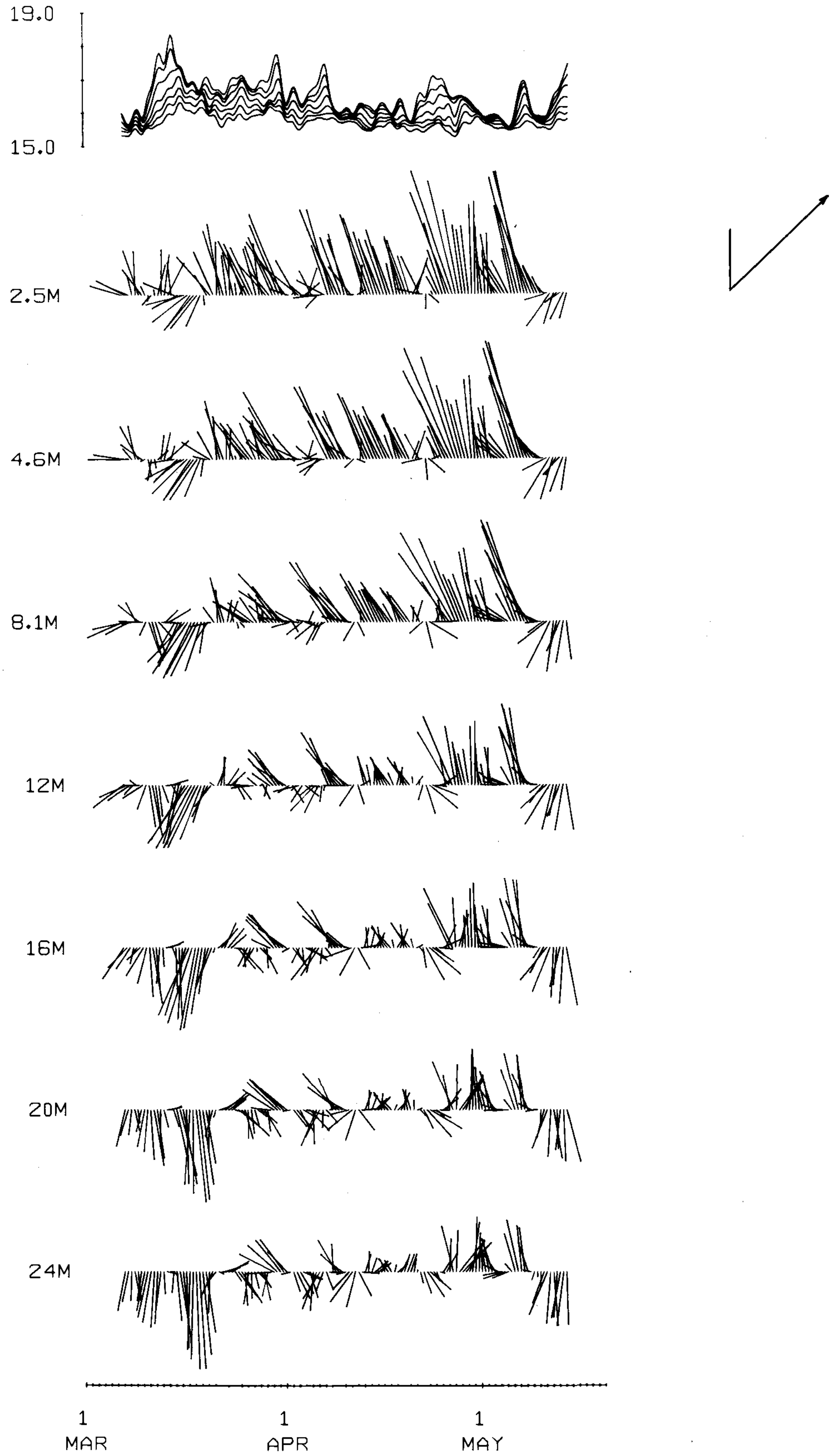

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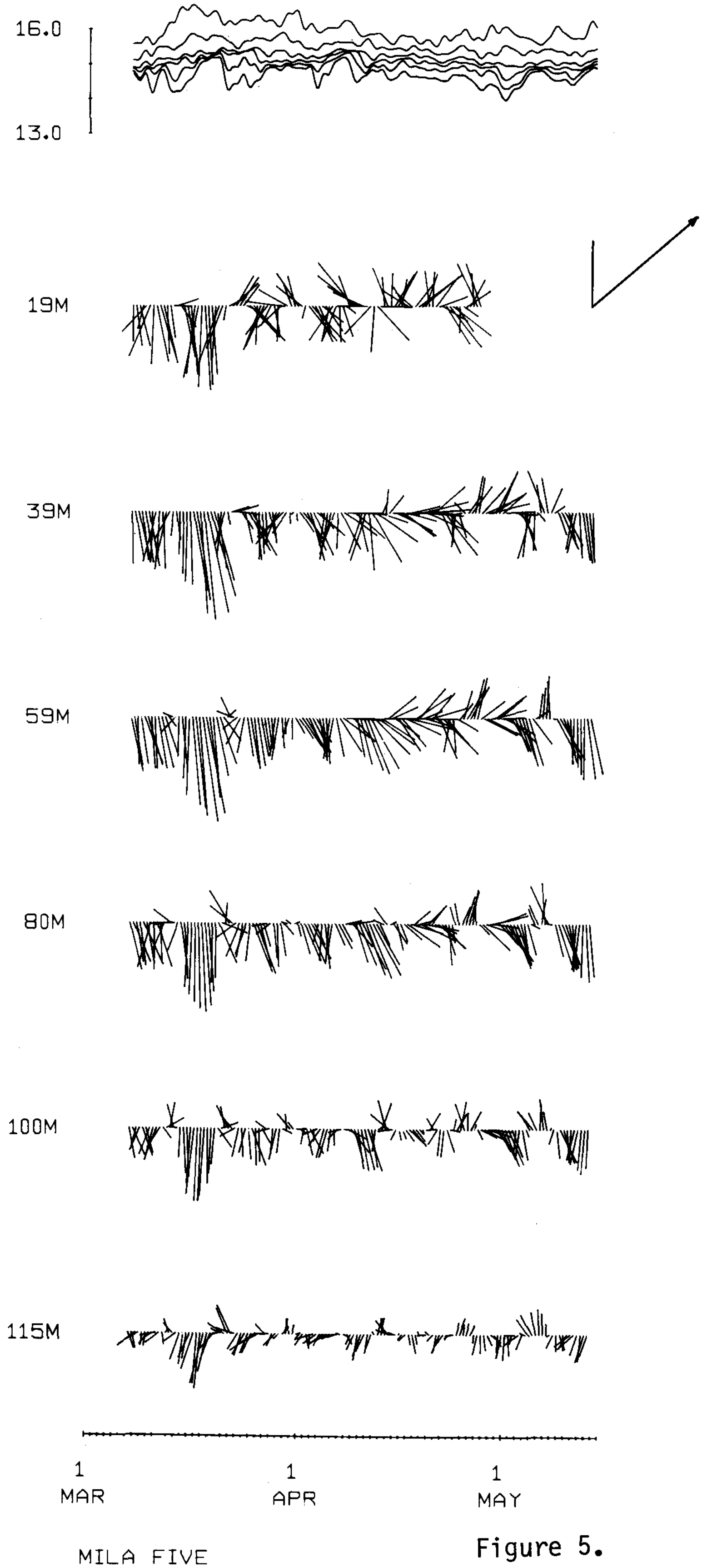

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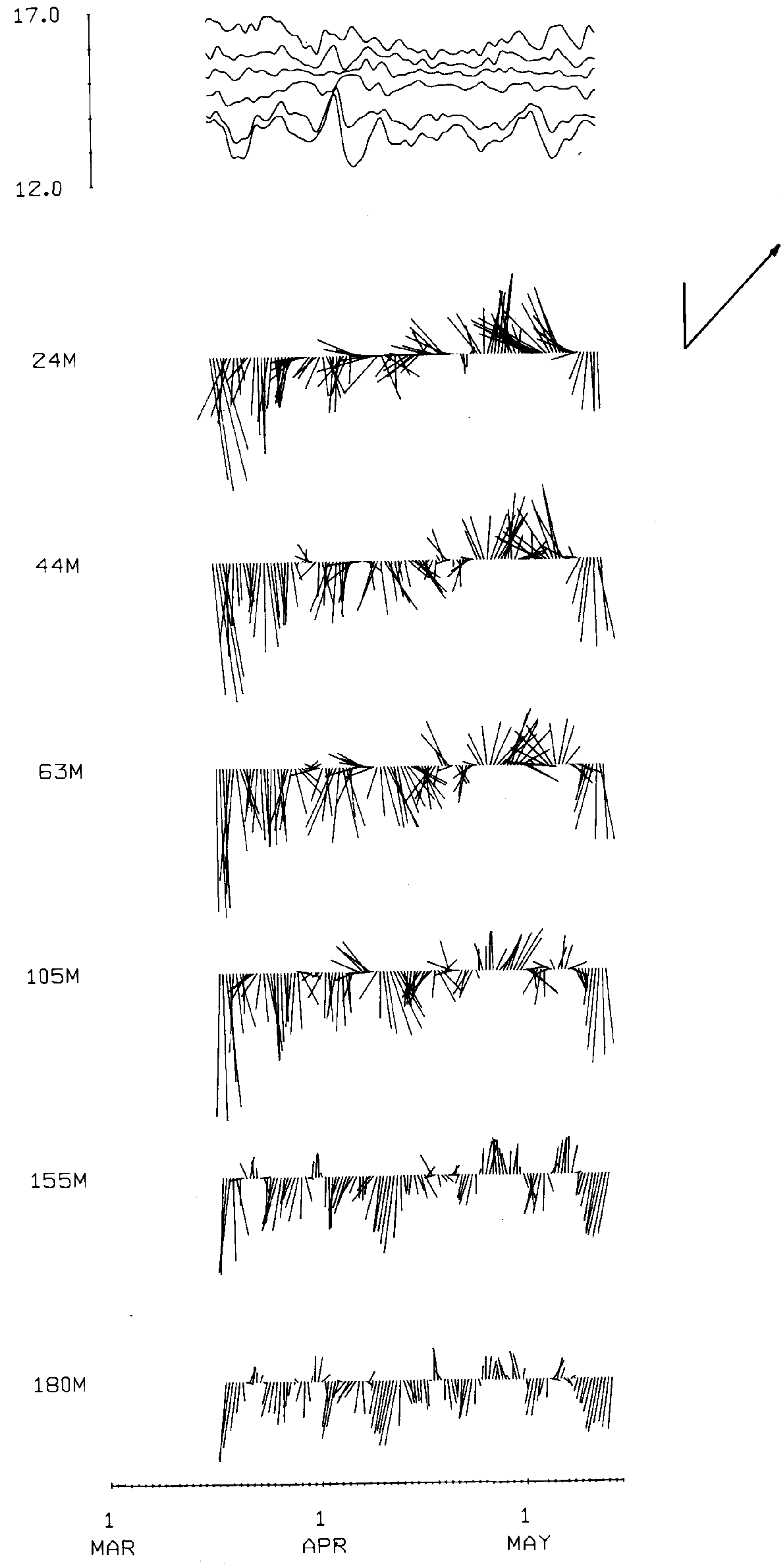

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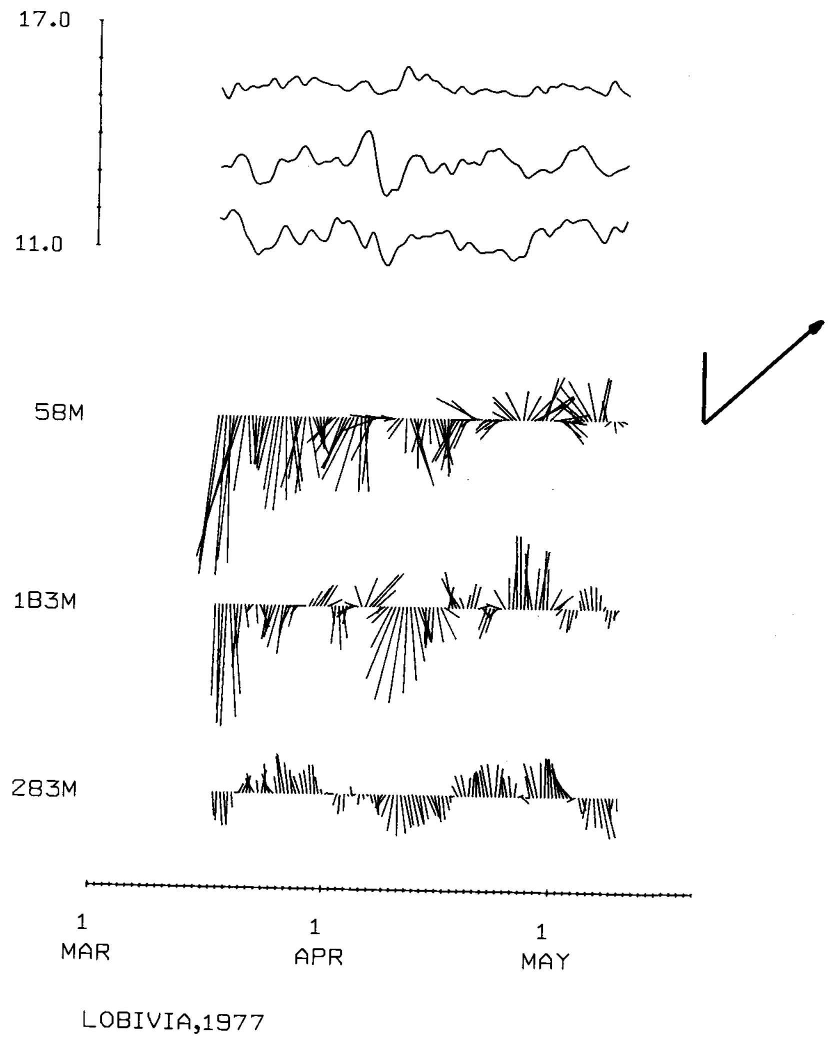
IRONWOOD



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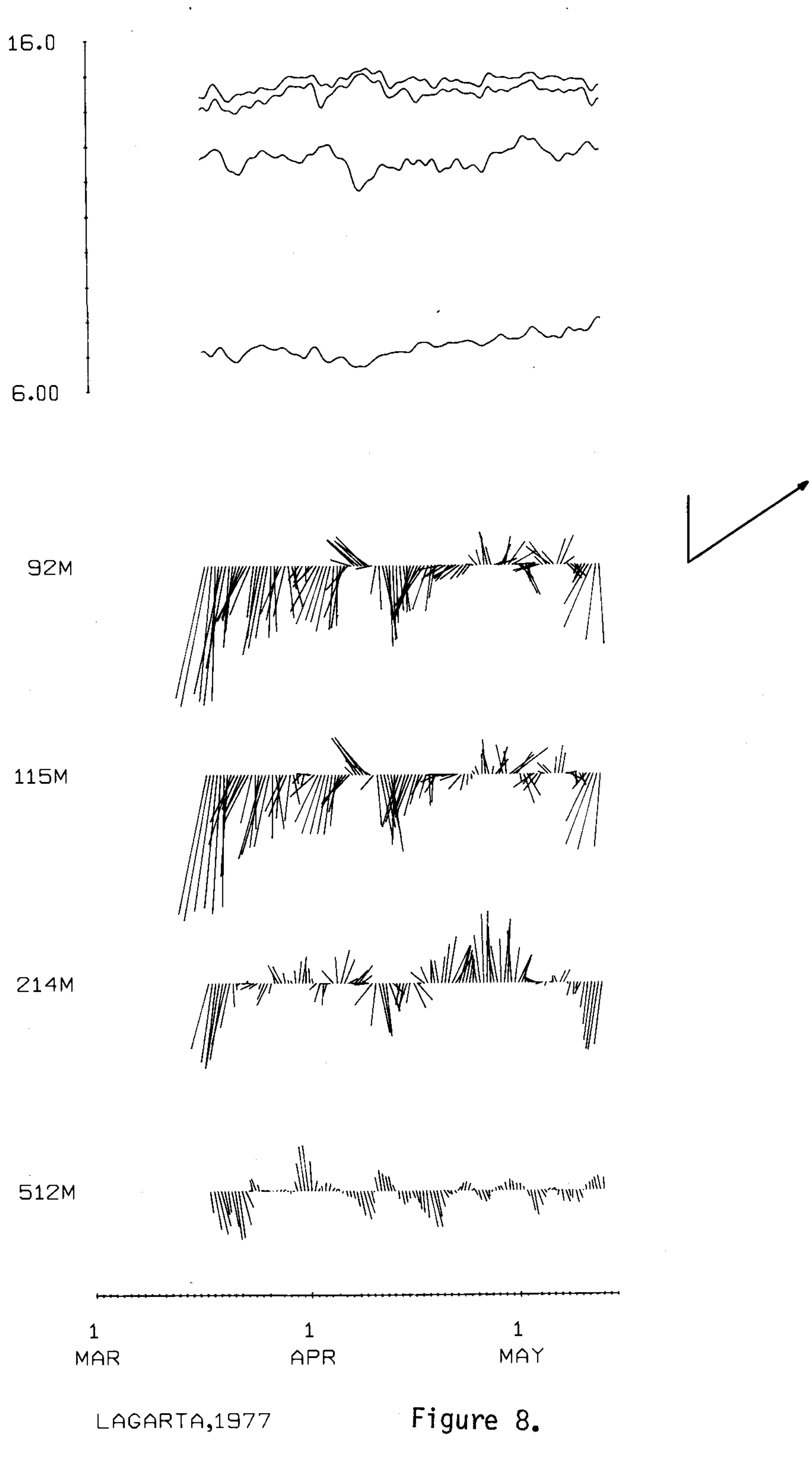

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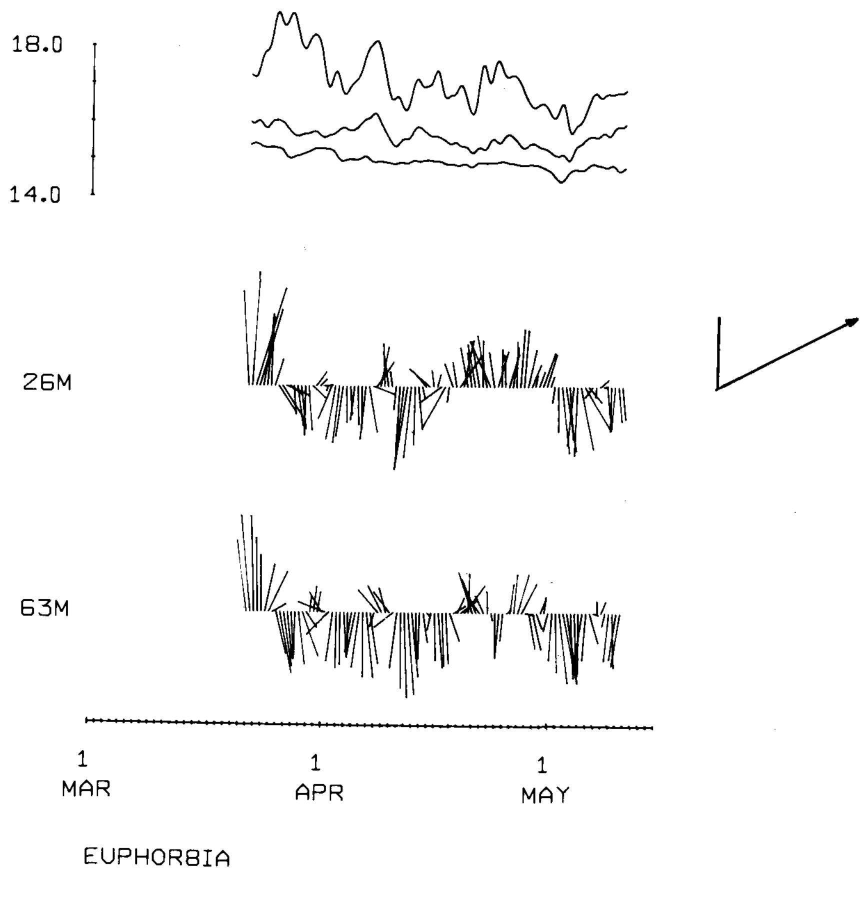

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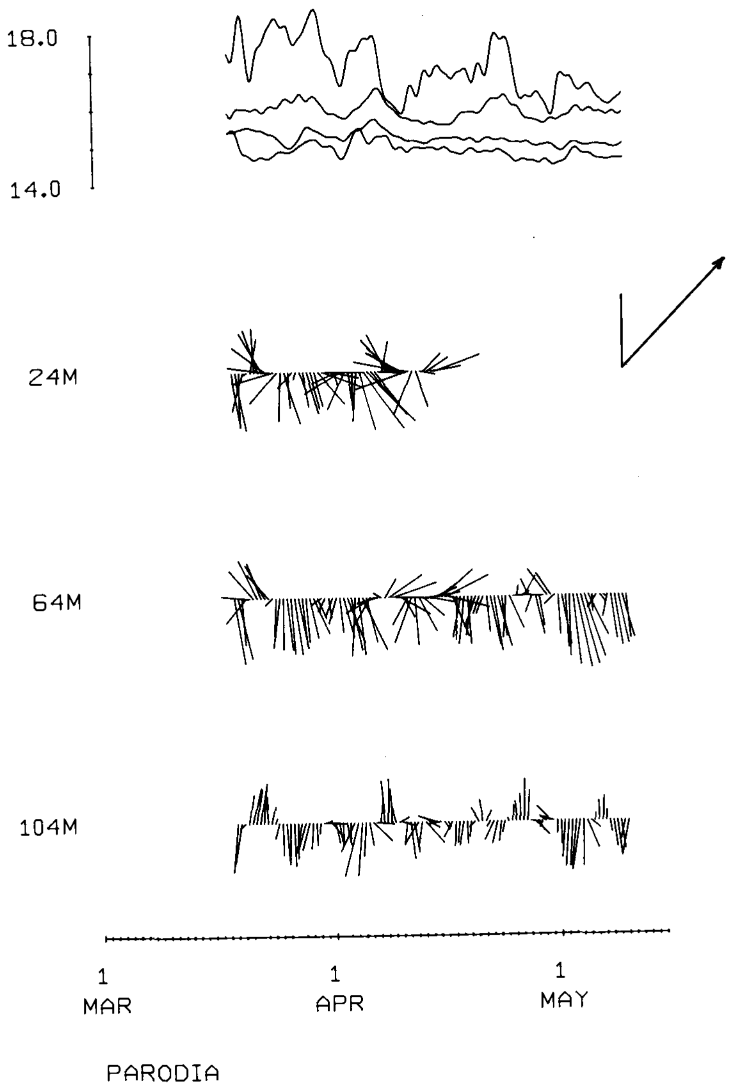

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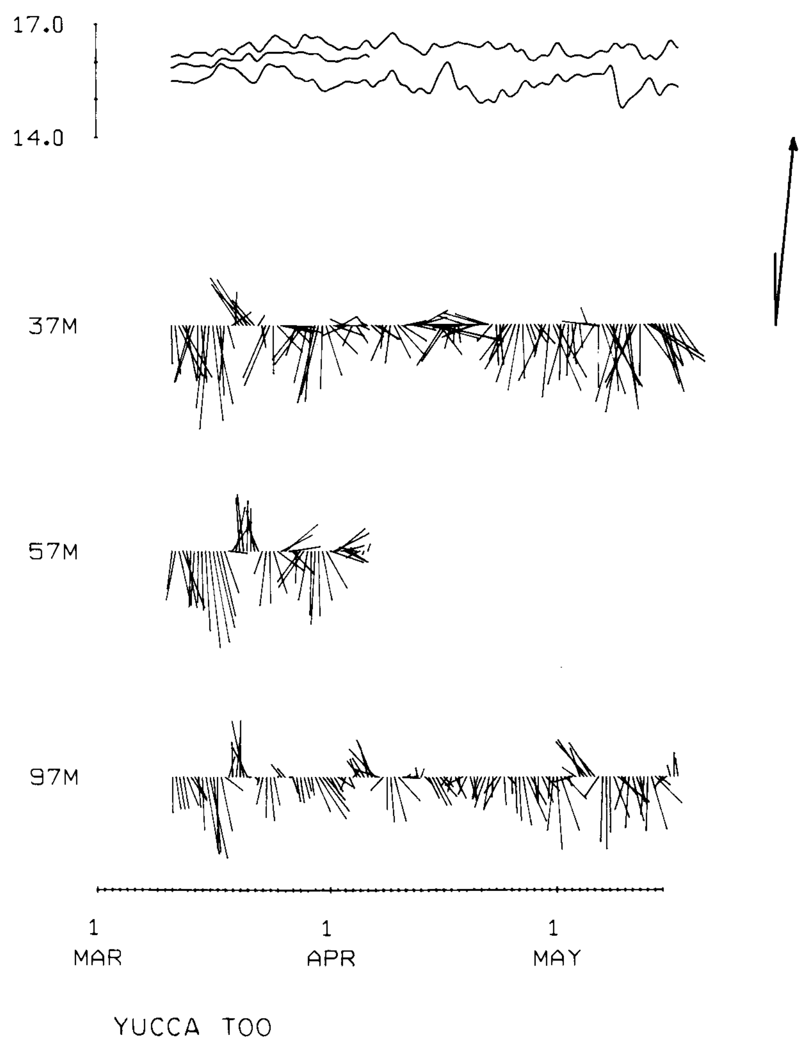

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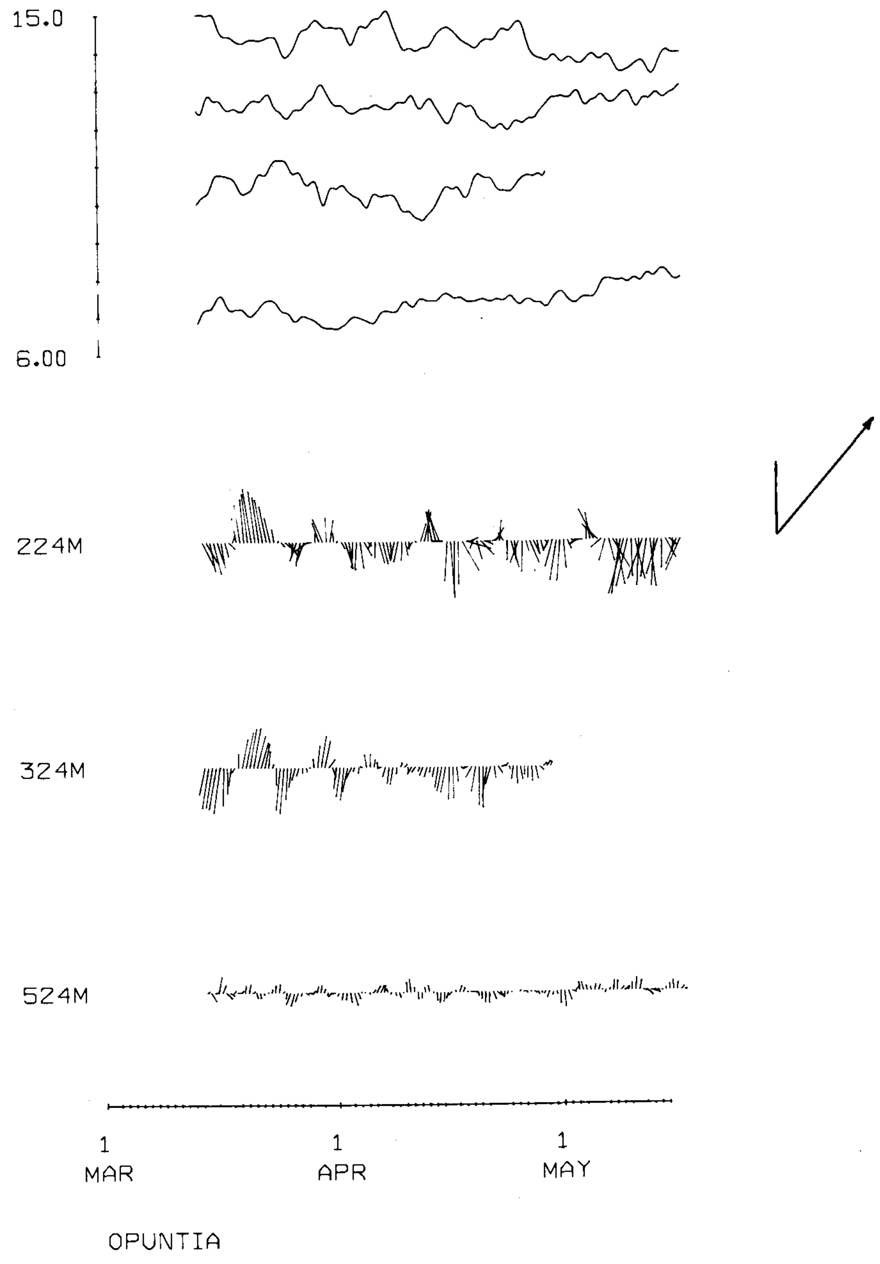

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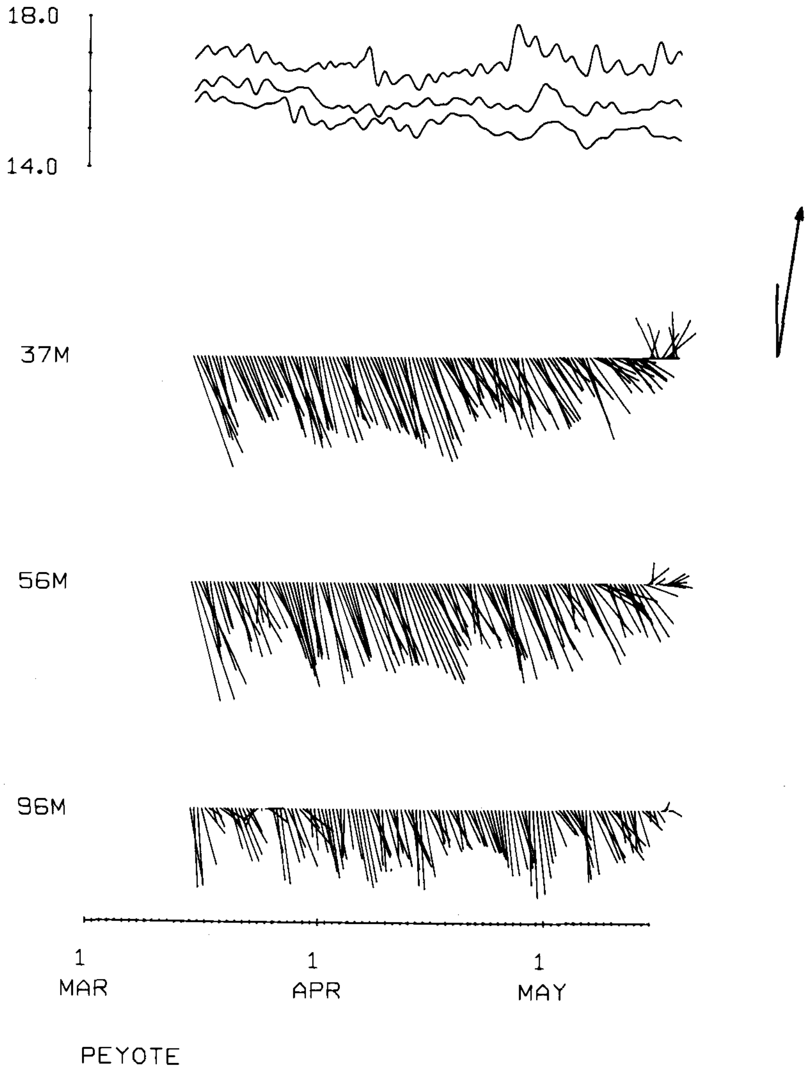

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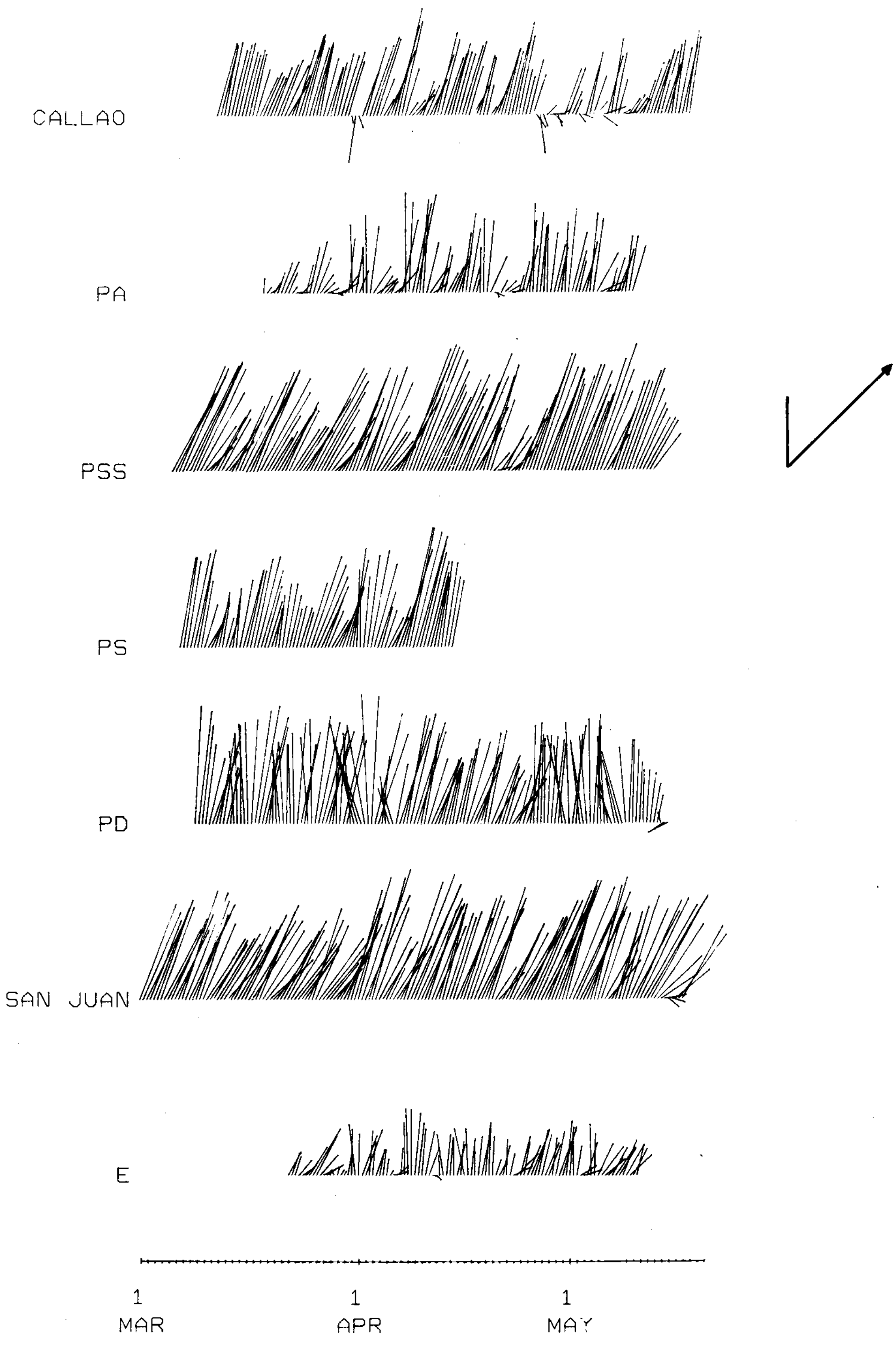

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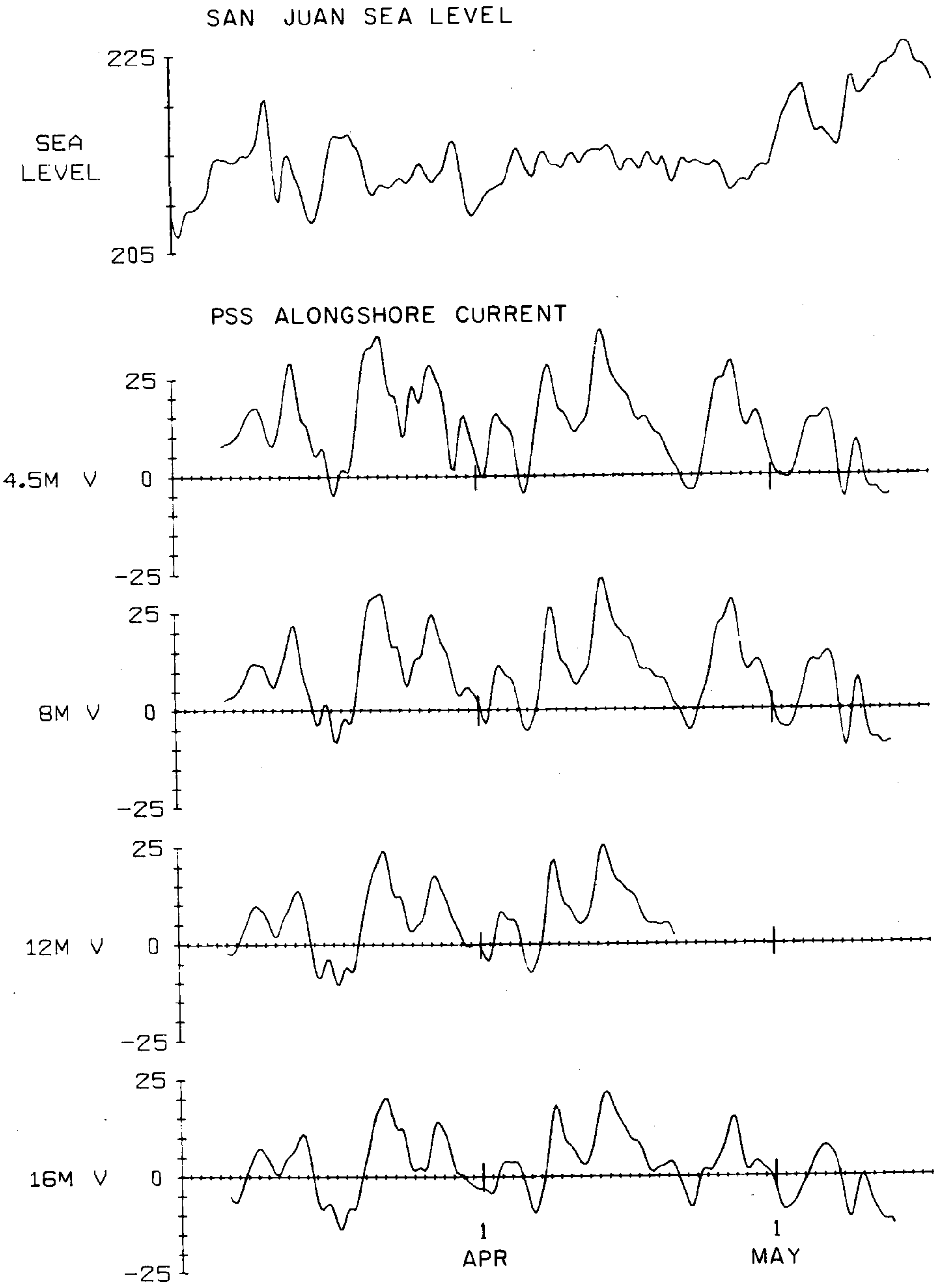

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SEA LEVEL
205
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25
4.5M V 0
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12M V 0
-25
25
16M V 0
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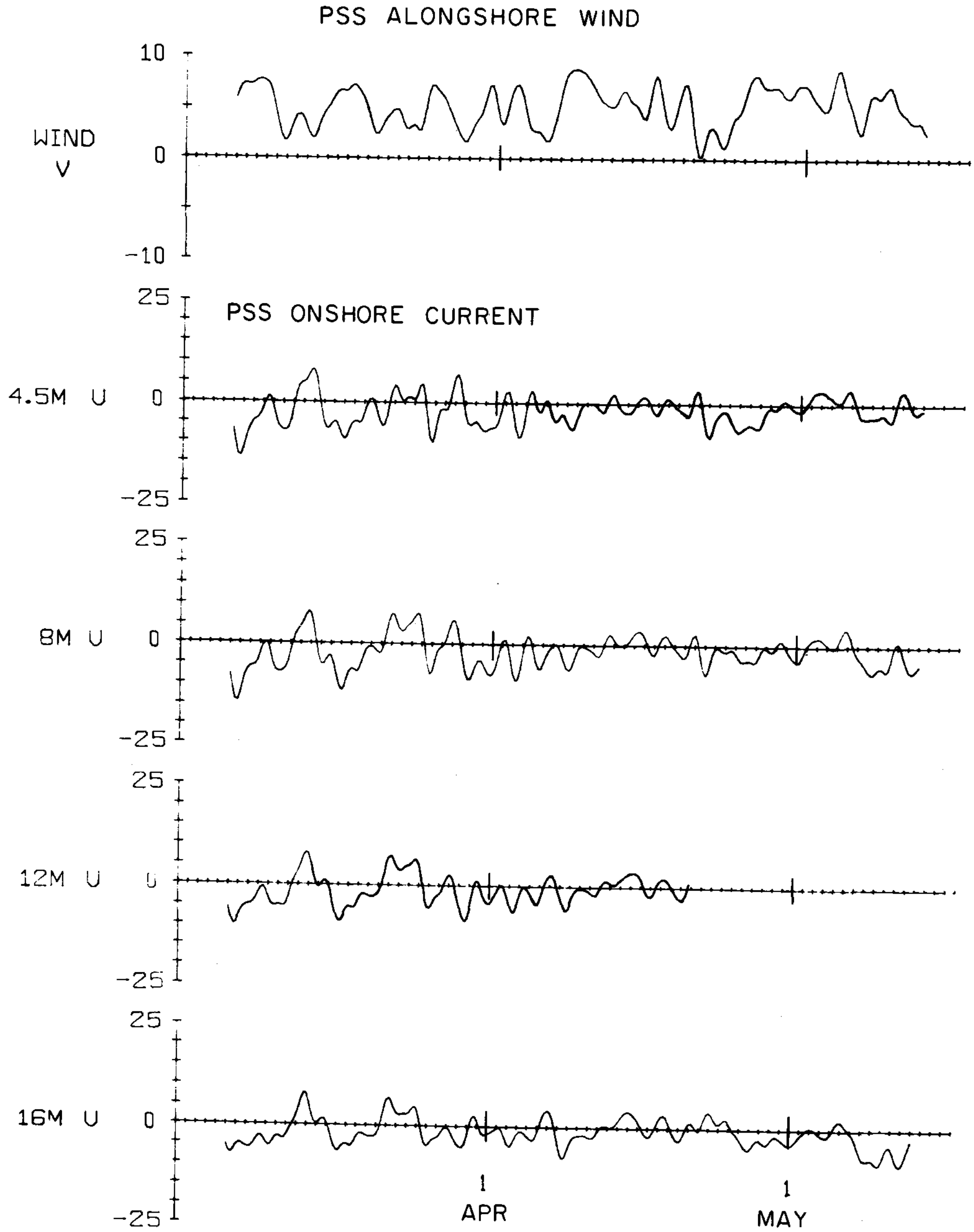
1 APR
1 MAY

Figure 15a.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PSS ONSHORE CURRENT
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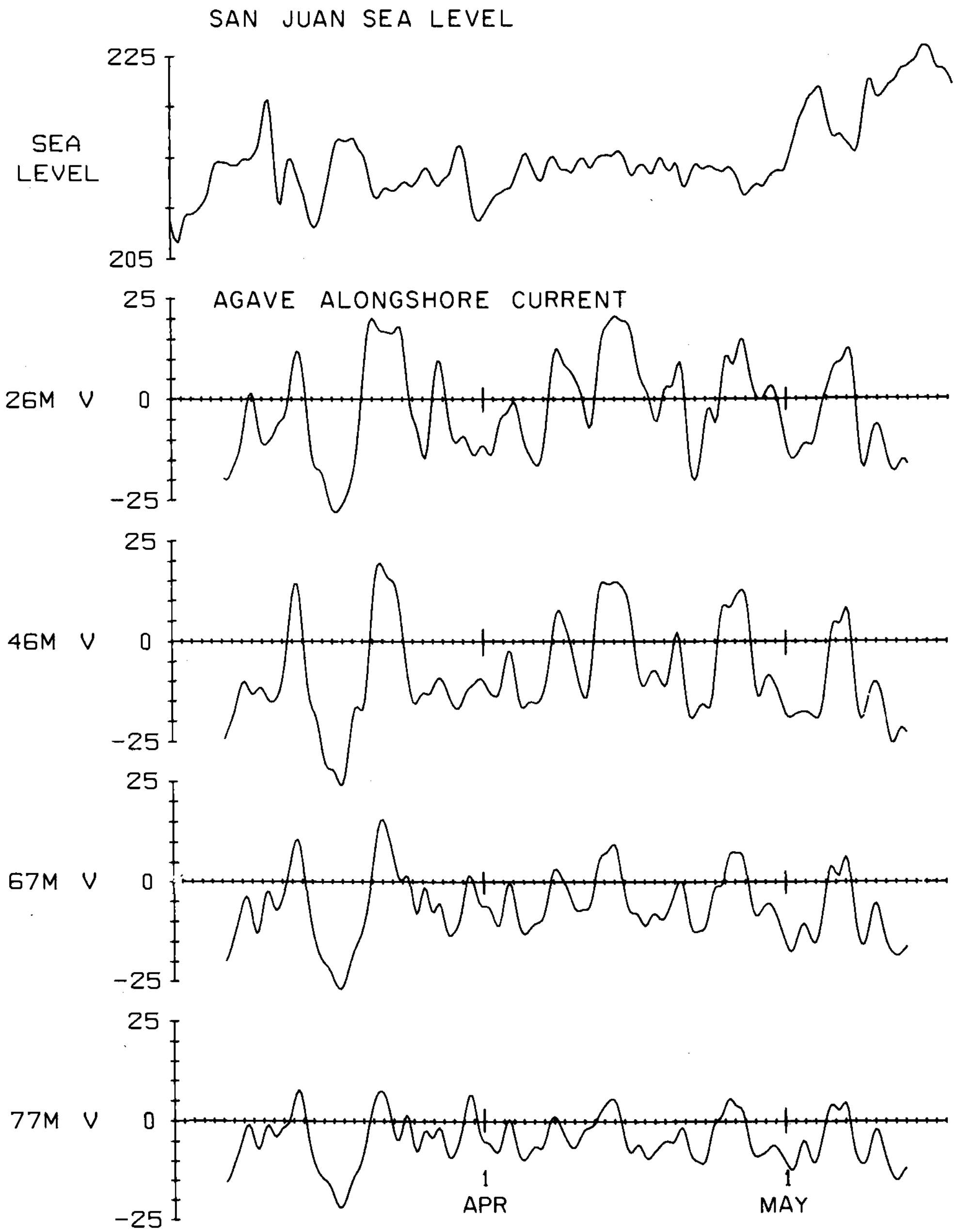
APR
1
MAY

Figure 15b.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67M V
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-25
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APR
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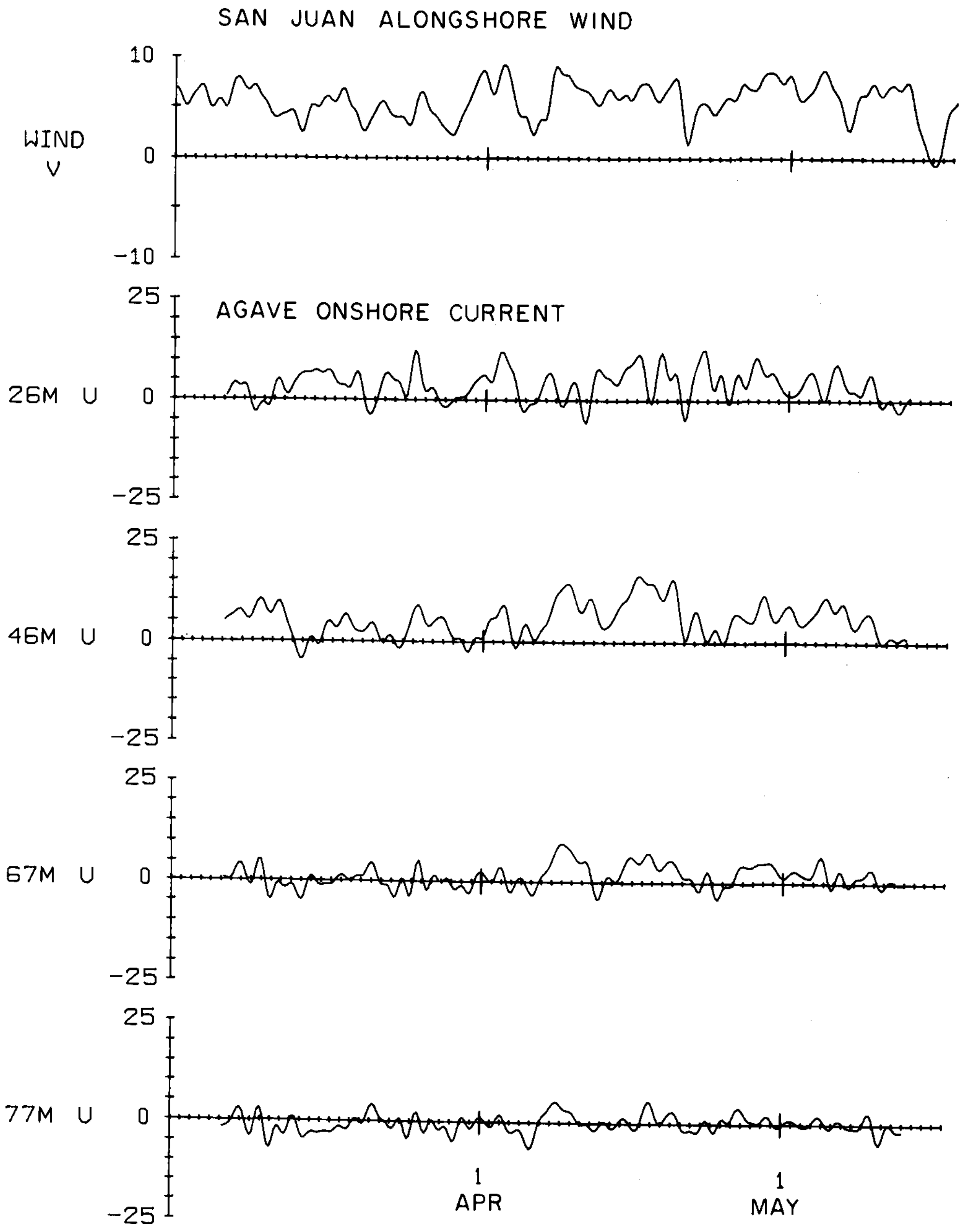
MAY

Figure 16a.



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WIND
V
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AGAVE ONSHORE CURRENT
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APR
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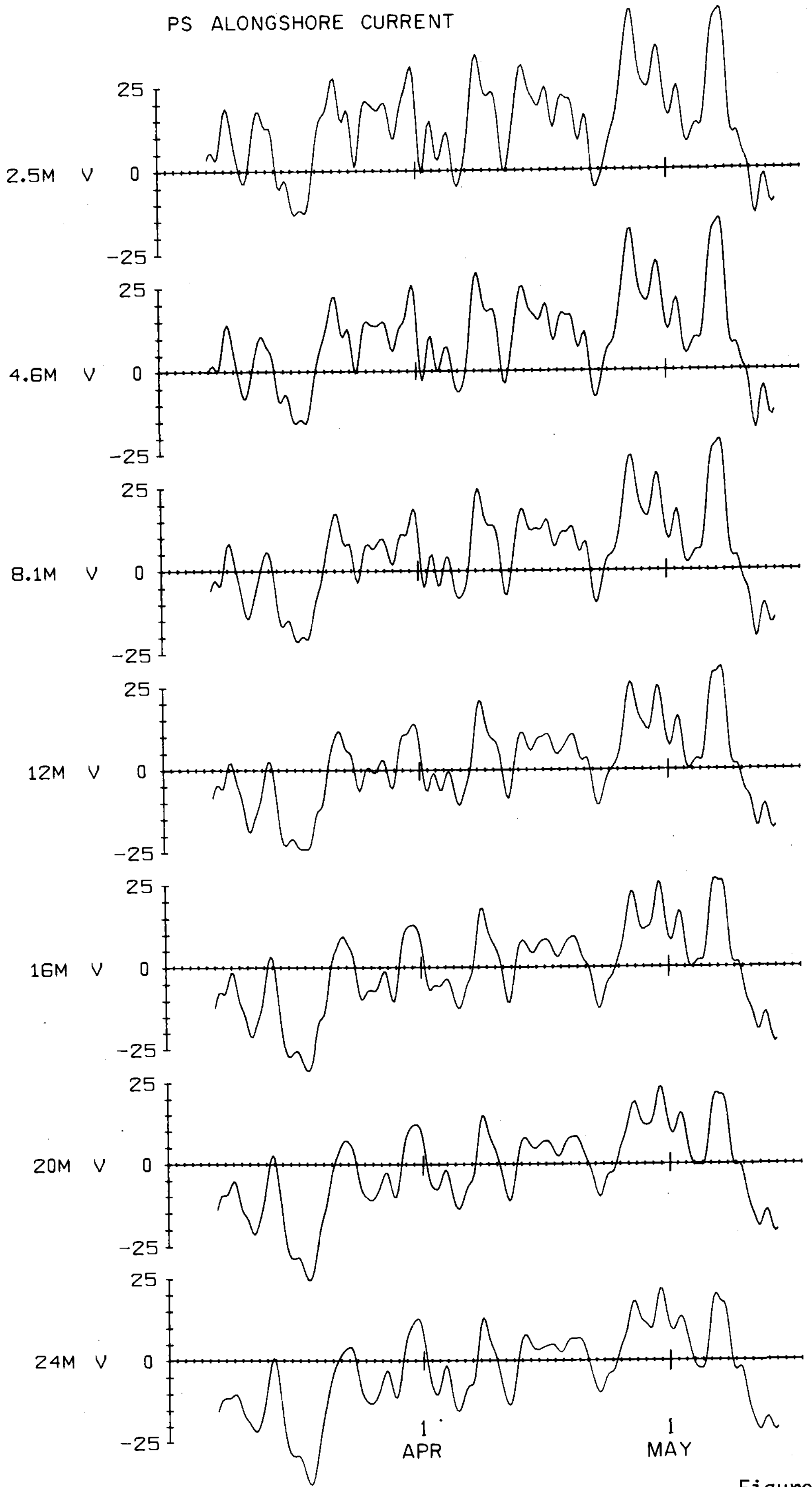
MAY

Figure 16b.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20M V 0
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24M V 0
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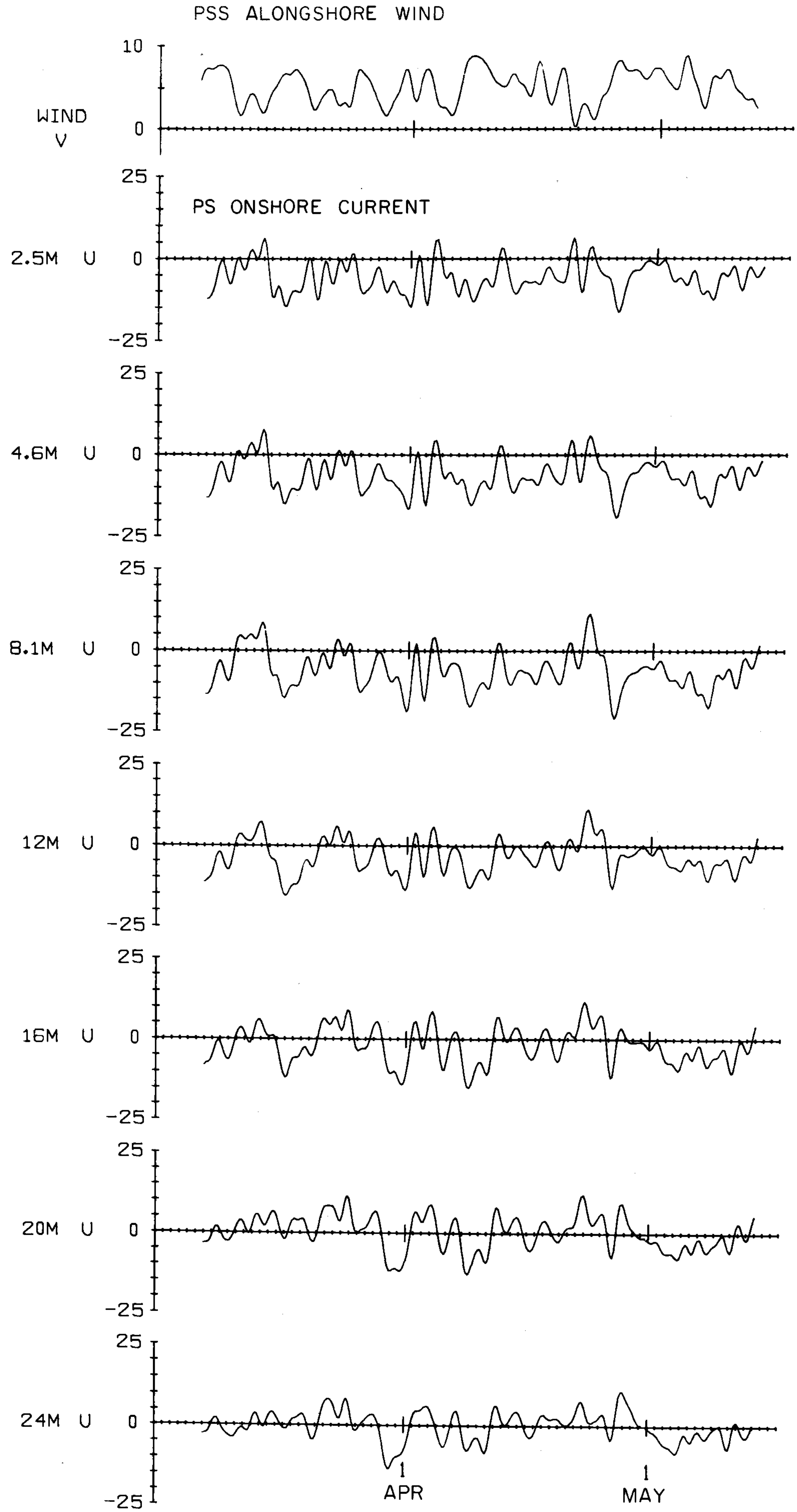
1
APR
1
MAY

Figure 17a.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WIND
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PS ONSHORE CURRENT
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24M U
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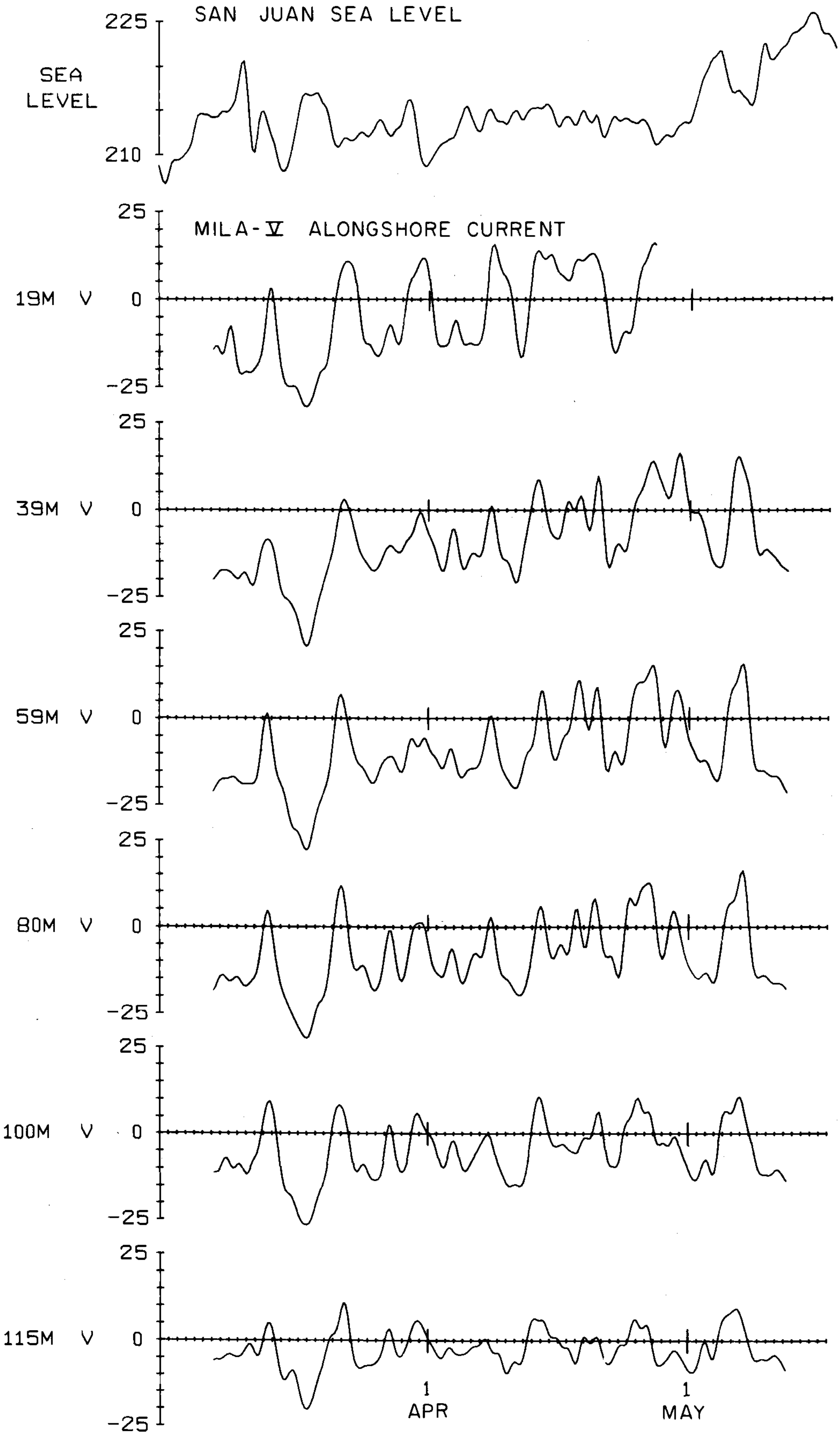
APR
1
MAY

Figure 17b.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SEA LEVEL
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MILA-V ALONGSHORE CURRENT
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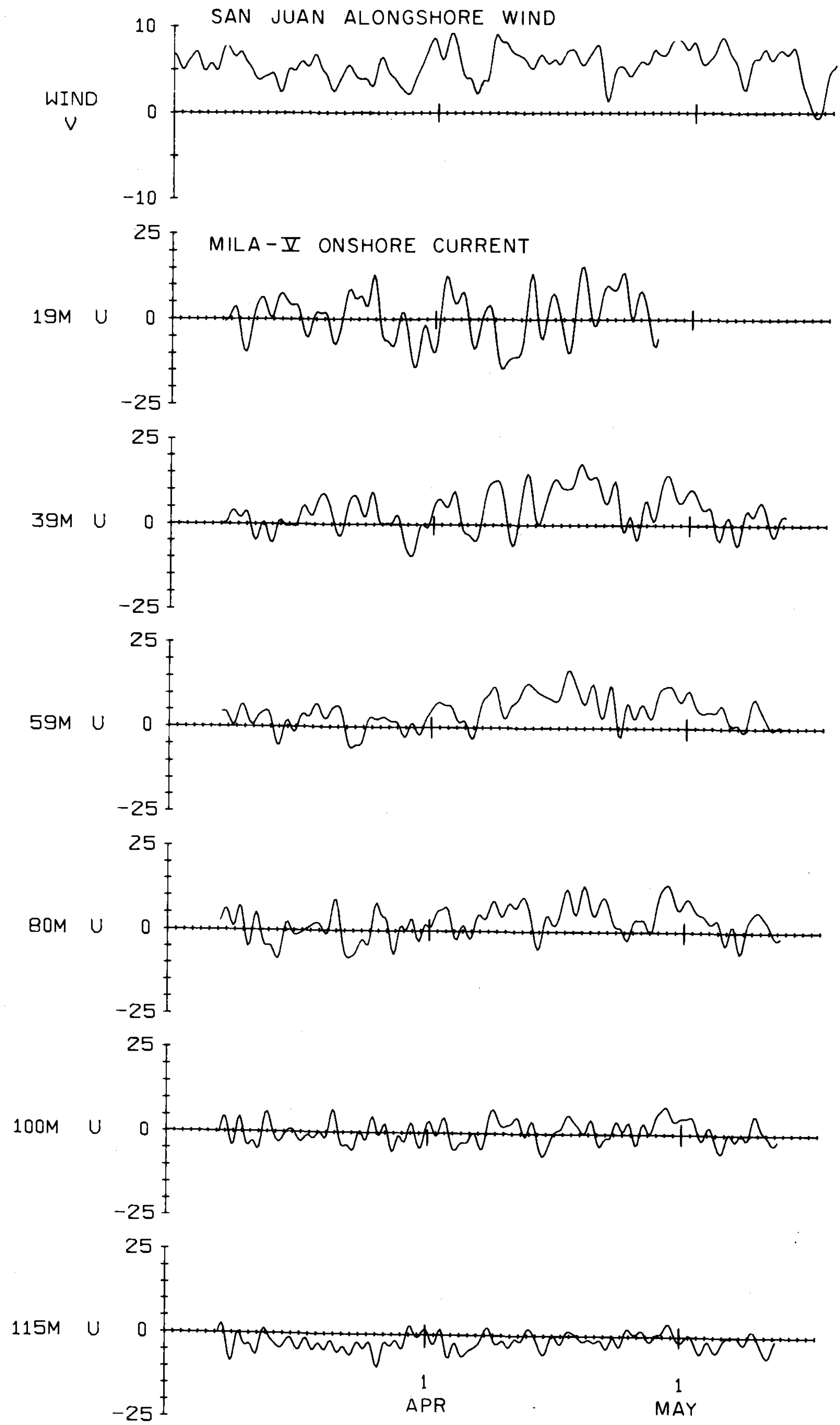
59M V
80M V
100M V
115M V
1 APR
1 MAY

Figure 18a.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MILA-V ONSHORE CURRENT
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100M U
115M U
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0
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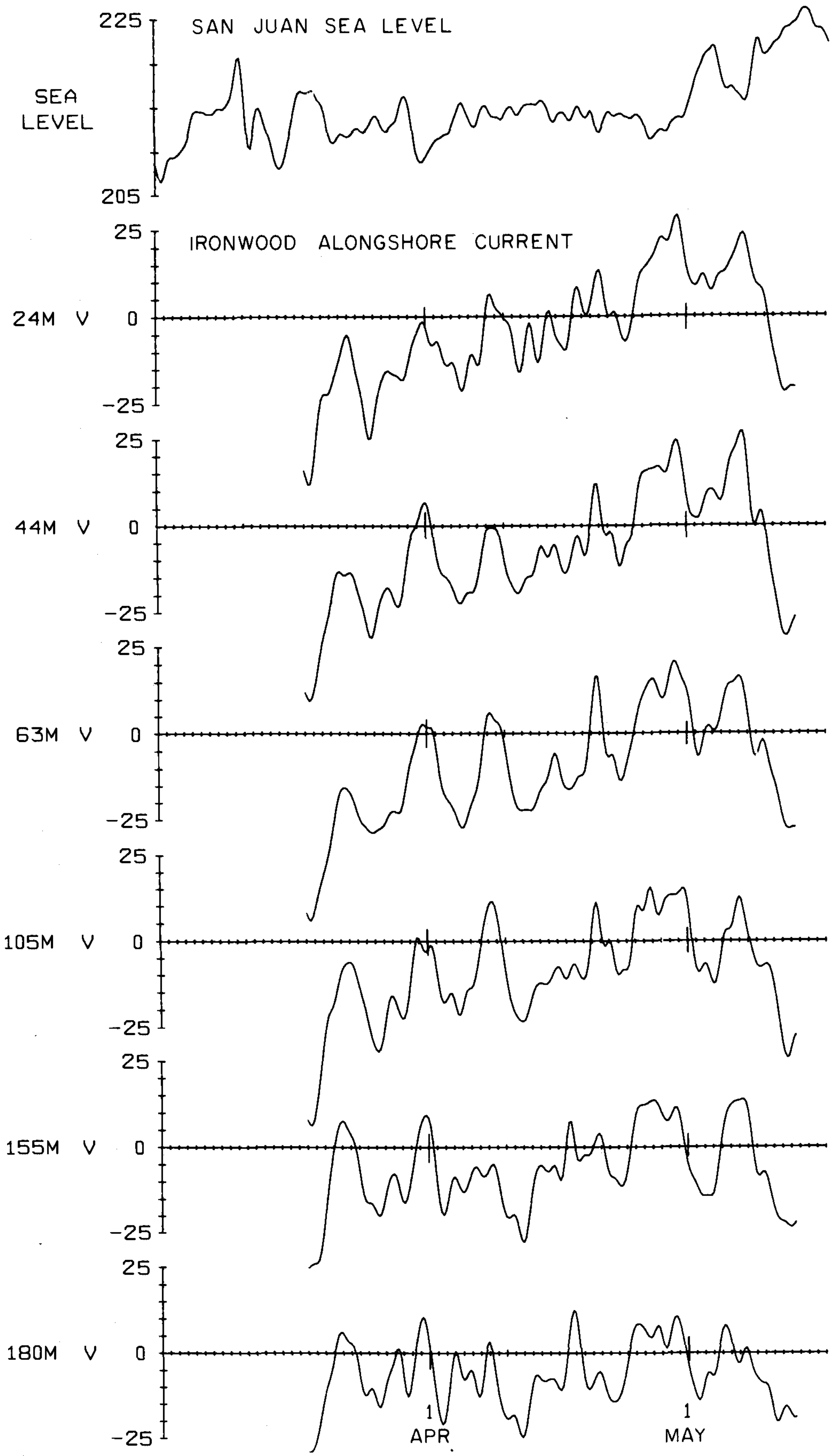
1 APR
1 MAY

Figure 18b.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SEA LEVEL
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63M V 0
-25
25
105M V 0
-25
25
155M V 0
-25
25
180M V 0
-25
1 APR
1 MAY

Figure 19a.

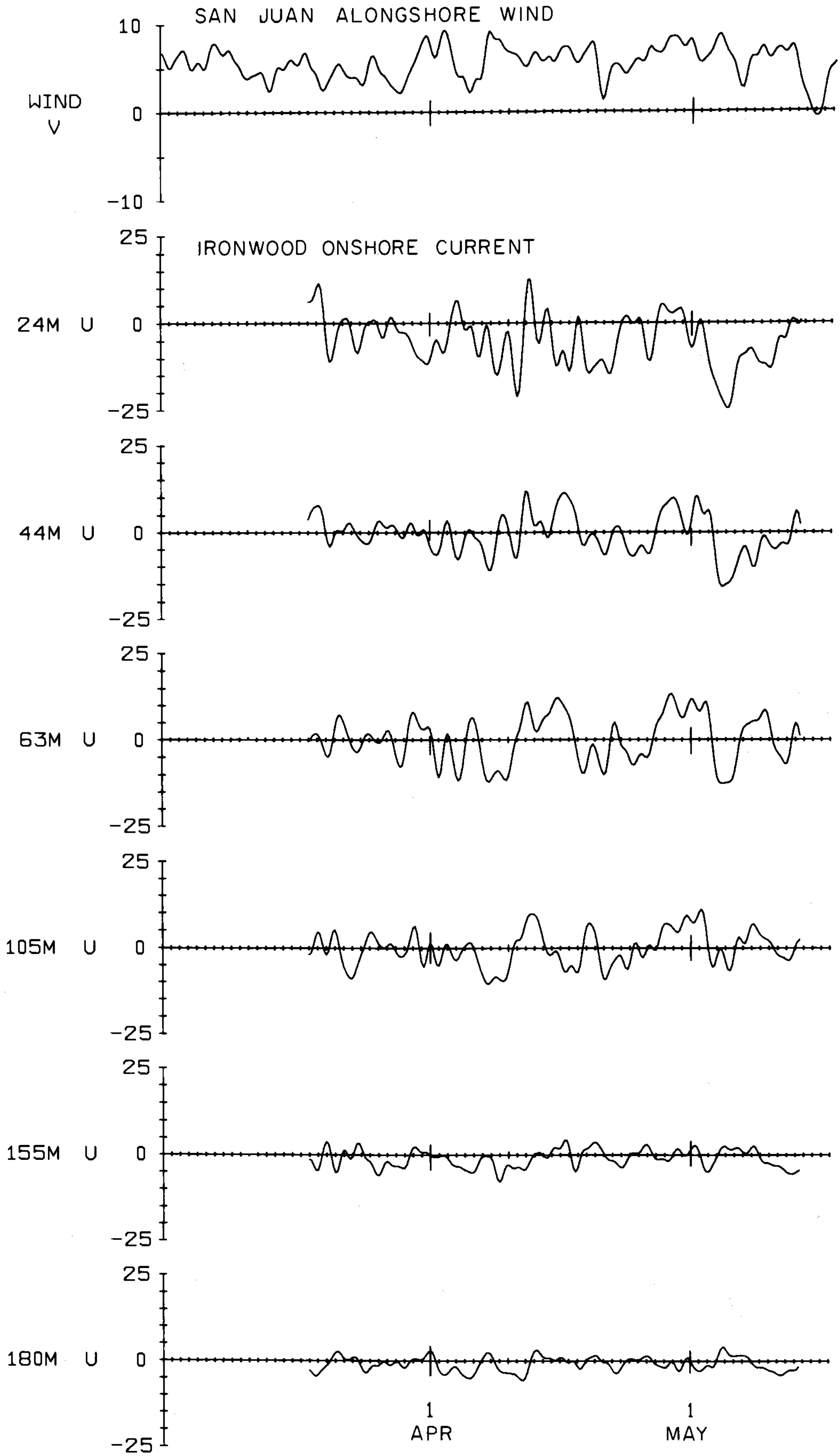

SAN JUAN ALONGSHORE WIND
WIND
V
10
0
-10
IRONWOOD ONSHORE CURRENT
24M U
44M U
63M U
105M U
155M U
180M U
25
0
-25
1
APR
1
MAY

Figure 19b.

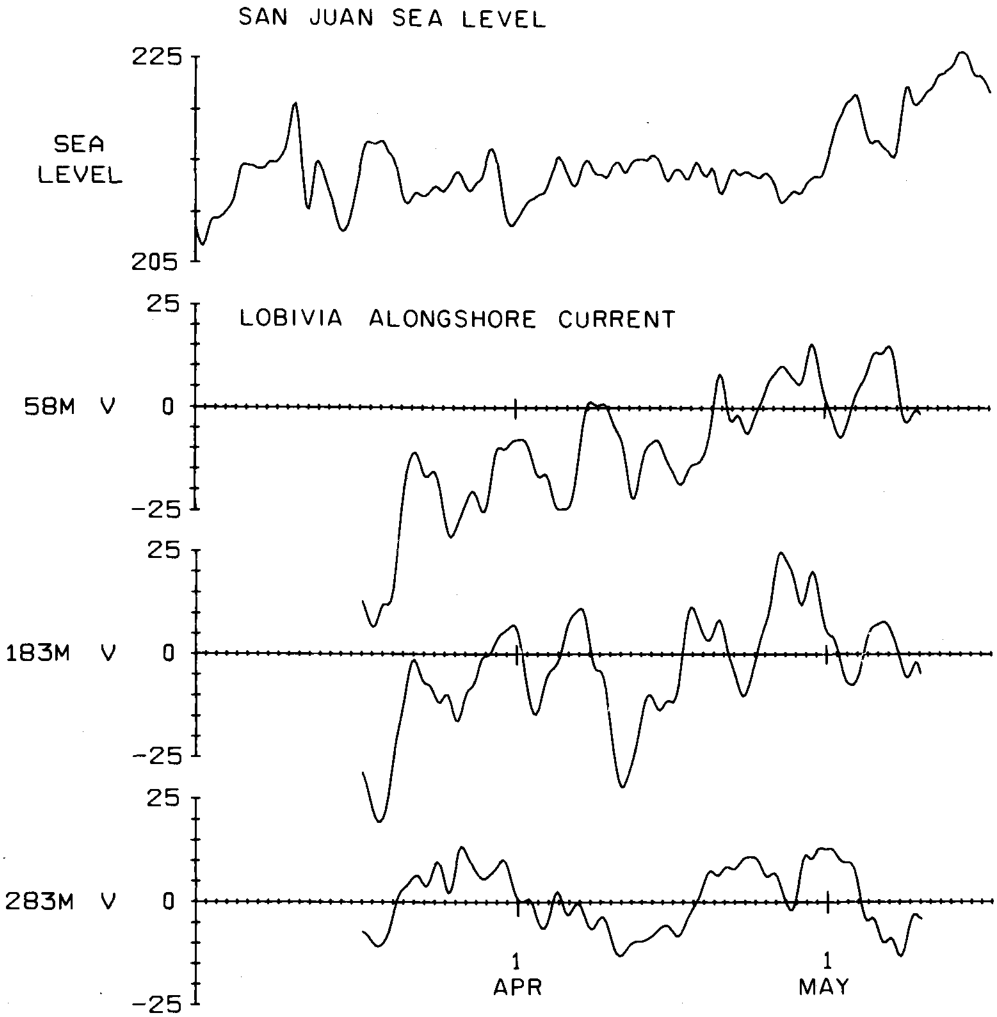
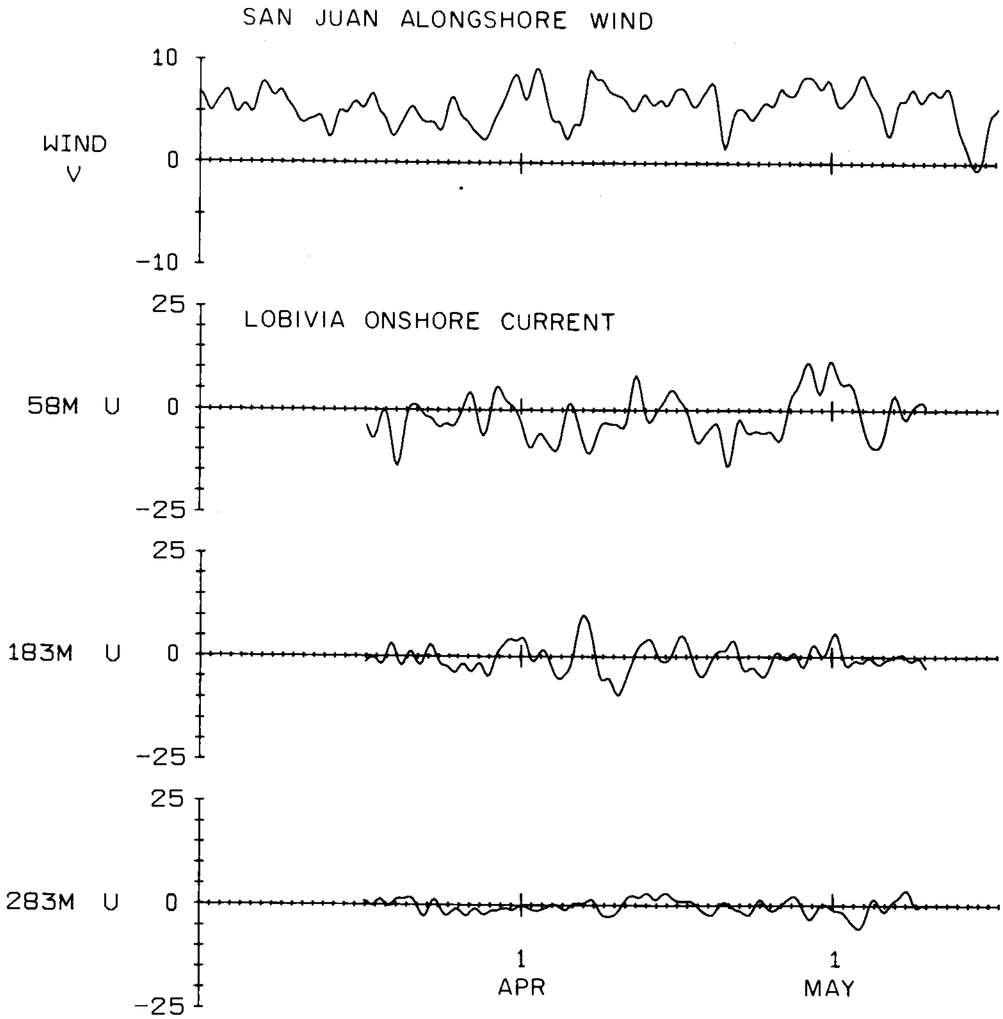

SAN JUAN SEA LEVEL
225
SEA
LEVEL
205
25
LOBIVIA ALONGSHORE CURRENT
58M V 0
-25
25
183M V 0
-25
25
283M V 0
-25
1
APR
1
MAY

Figure 20a.



SAN JUAN ALONGSHORE WIND
10
WIND
V
0
-10
25
LOBIVIA ONSHORE CURRENT
58M U
0
-25
25
183M U
0
-25
25
283M U
0
1
APR
1
MAY
-25

Figure 20b.

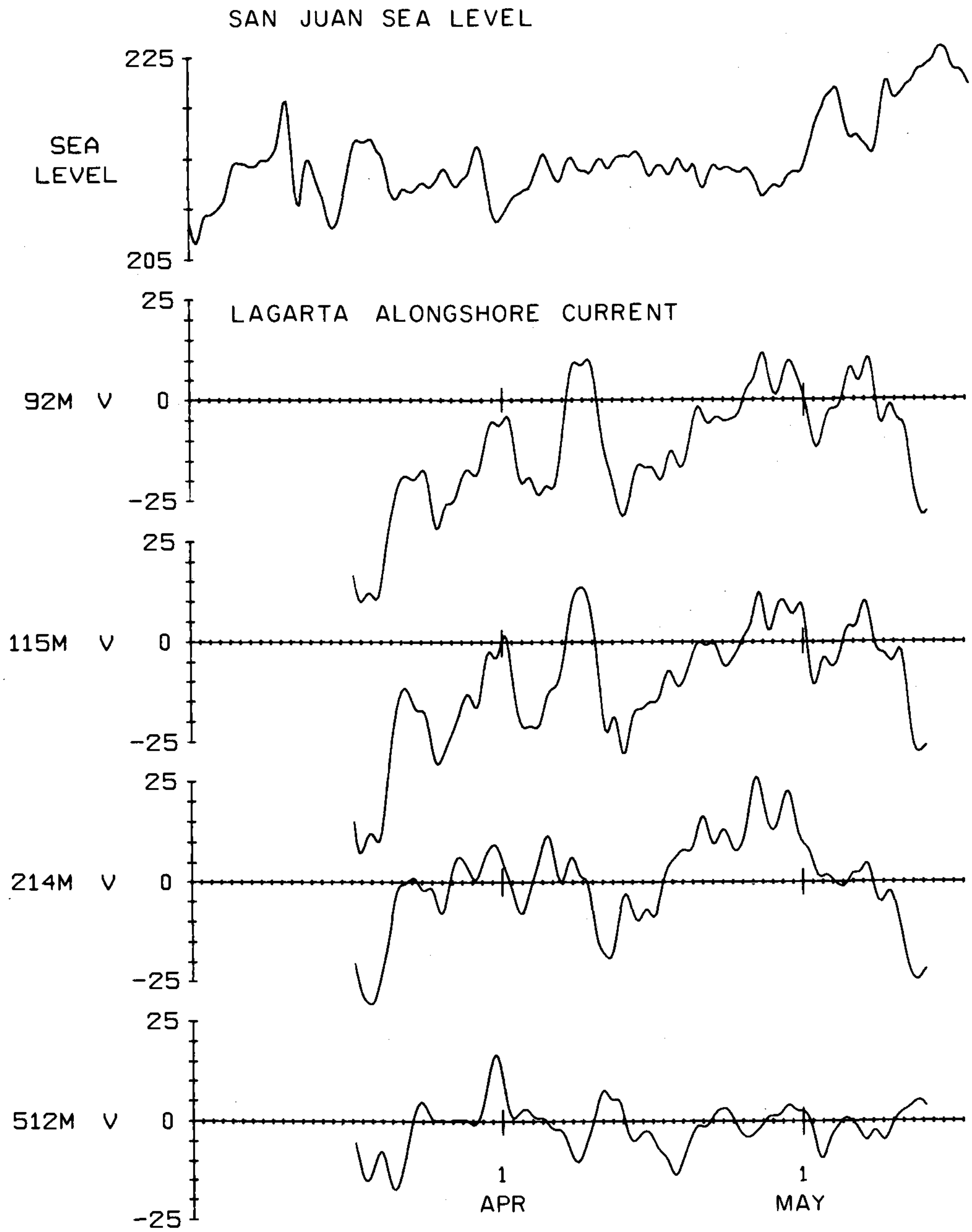
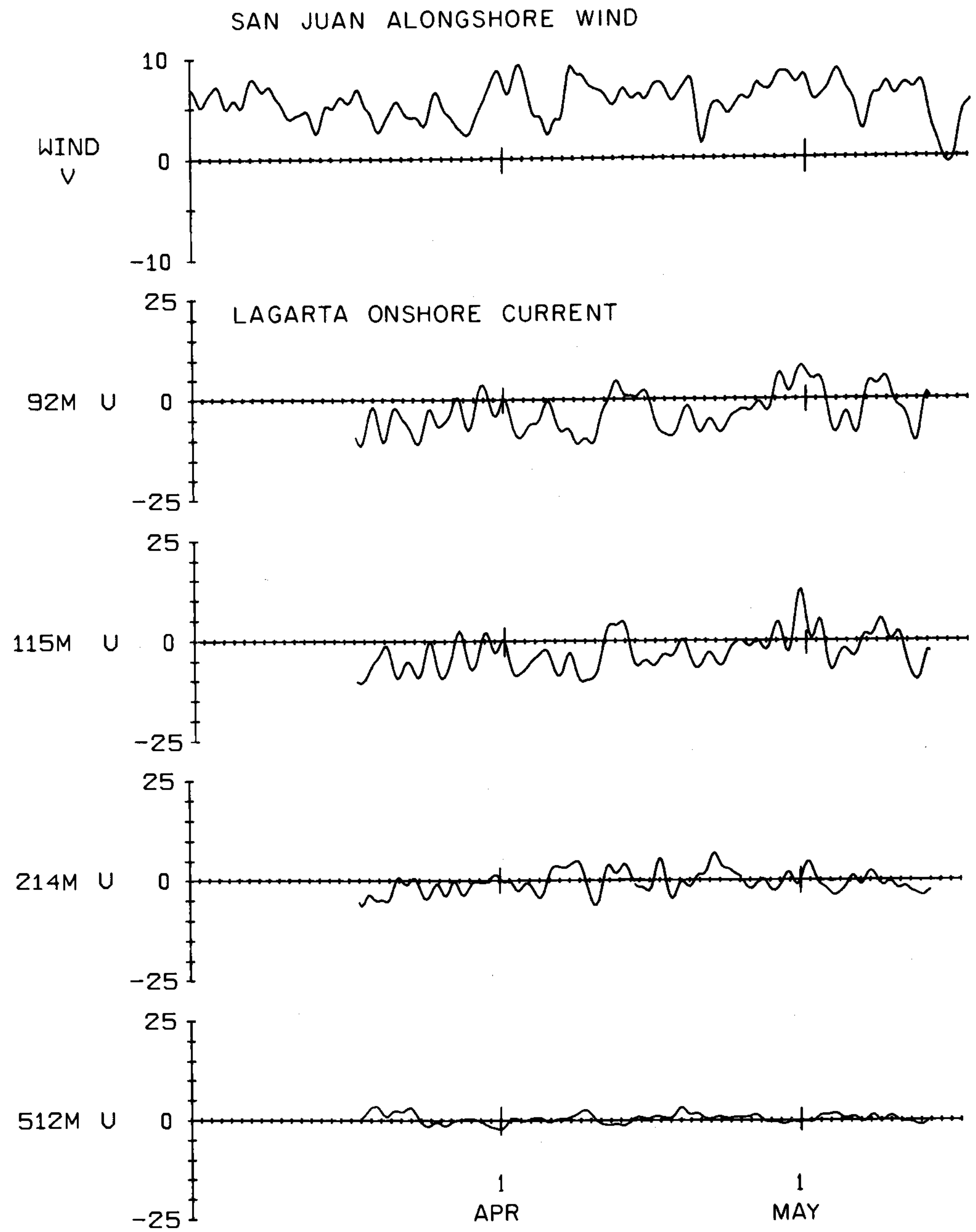

SAN JUAN SEA LEVEL
225
SEA
LEVEL
205
25
LAGARTA ALONGSHORE CURRENT
92M V 0
-25
25
115M V 0
-25
25
214M V 0
-25
25
512M V 0
-25
1
APR
1
MAY

Figure 21a.



SAN JUAN ALONGSHORE WIND
WIND
V
10
0
-10
LAGARTA ONSHORE CURRENT
25
92M U
0
-25
25
115M U
0
-25
25
214M U
0
-25
25
512M U
0
-25
1
APR
1
MAY

Figure 21b.

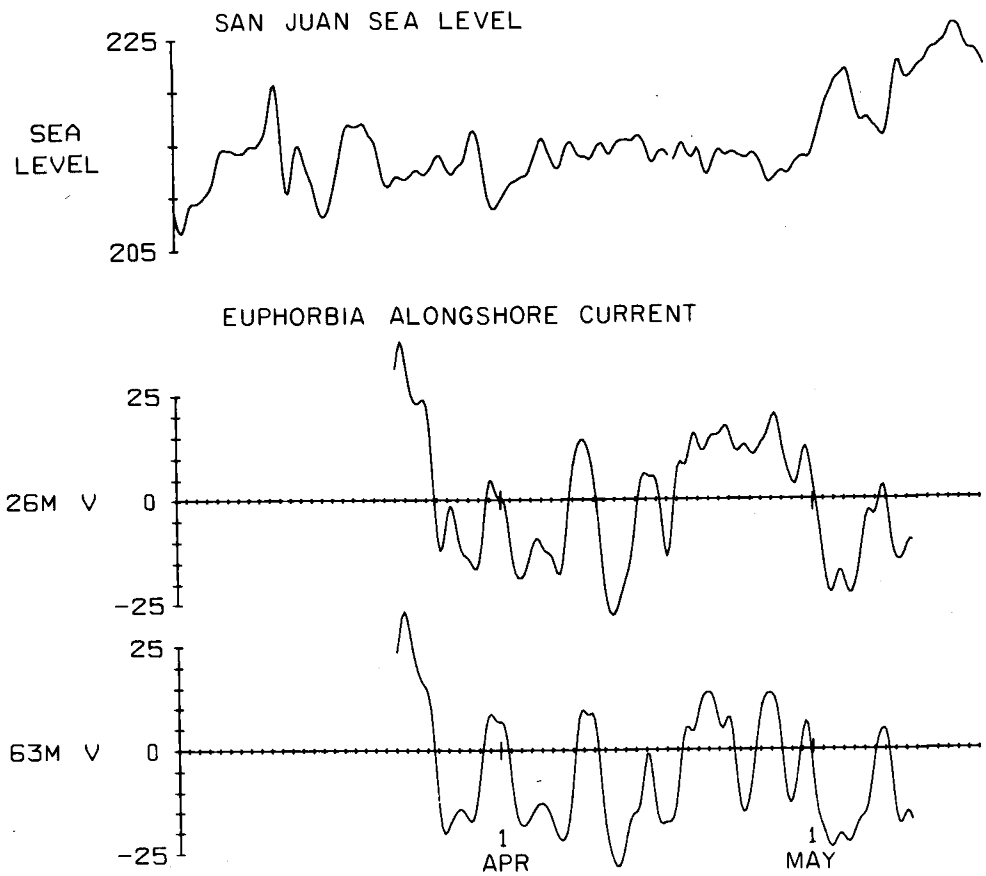

SAN JUAN SEA LEVEL
225
SEA
LEVEL
205
EUPHORBIA ALONGSHORE CURRENT
25
26M V 0
-25
25
63M V 0
-25
1
APR
1
MAY

Figure 22a.

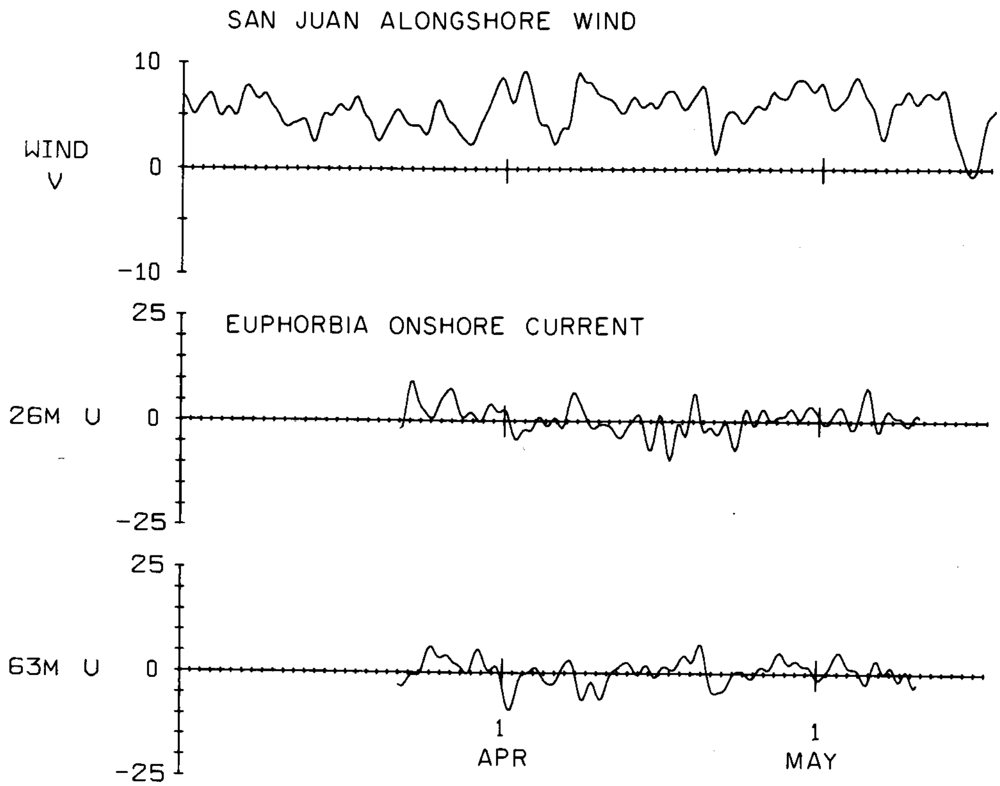

SAN JUAN ALONGSHORE WIND
10
WIND
V
0
-10
25
EUPHORBIA ONSHORE CURRENT
26M U
0
-25
25
63M U
0
-25
1
APR
1
MAY

Figure 22b.

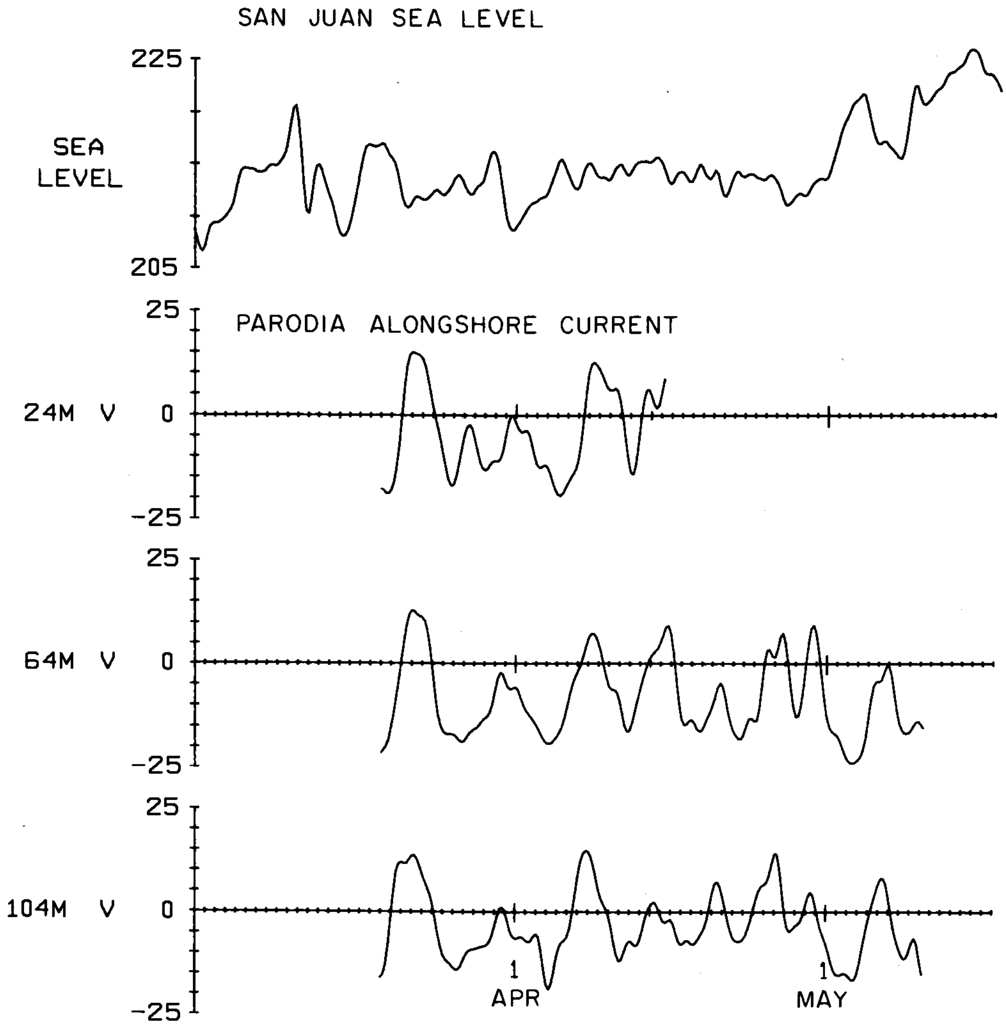

SAN JUAN SEA LEVEL
225
SEA
LEVEL
205
25
PARODIA ALONGSHORE CURRENT
24M V
0
-25
25
64M V
0
-25
25
104M V
0
1
APR
1
MAY
-25

Figure 23a.

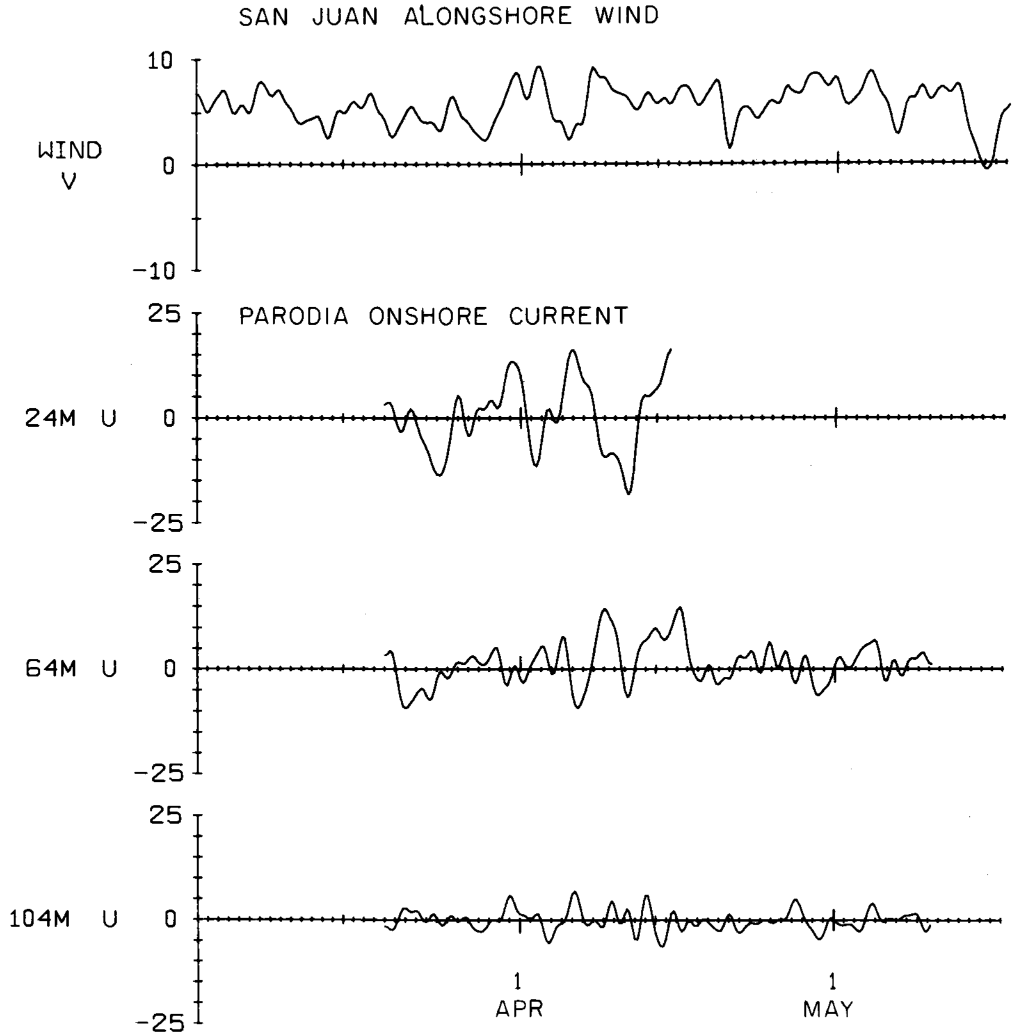

SAN JUAN ALONGSHORE WIND
10
WIND
V
0
-10
25
PARODIA ONSHORE CURRENT
24M U
0
-25
25
64M U
0
-25
25
104M U
0
-25
1
APR
1
MAY

Figure 23b.

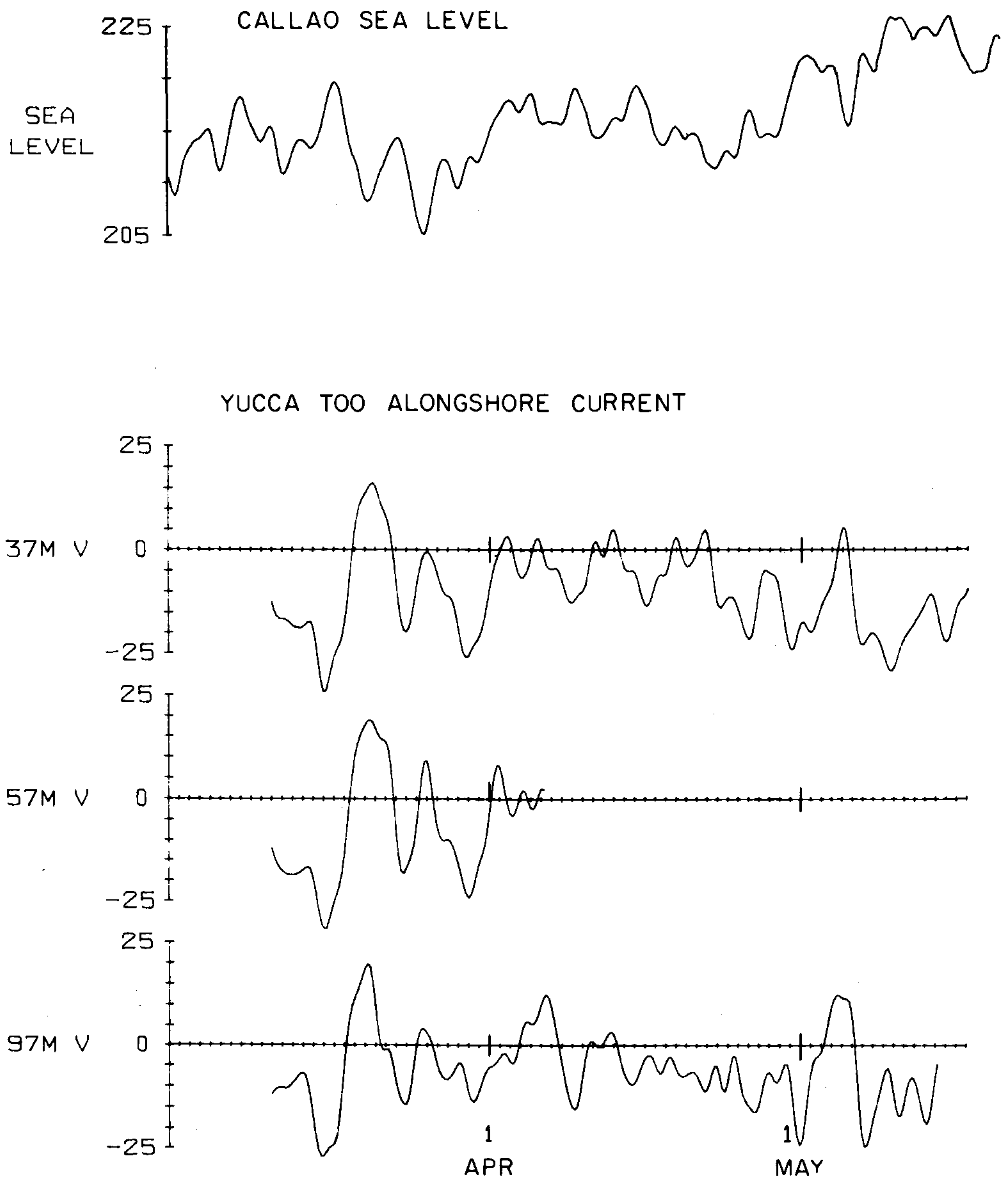
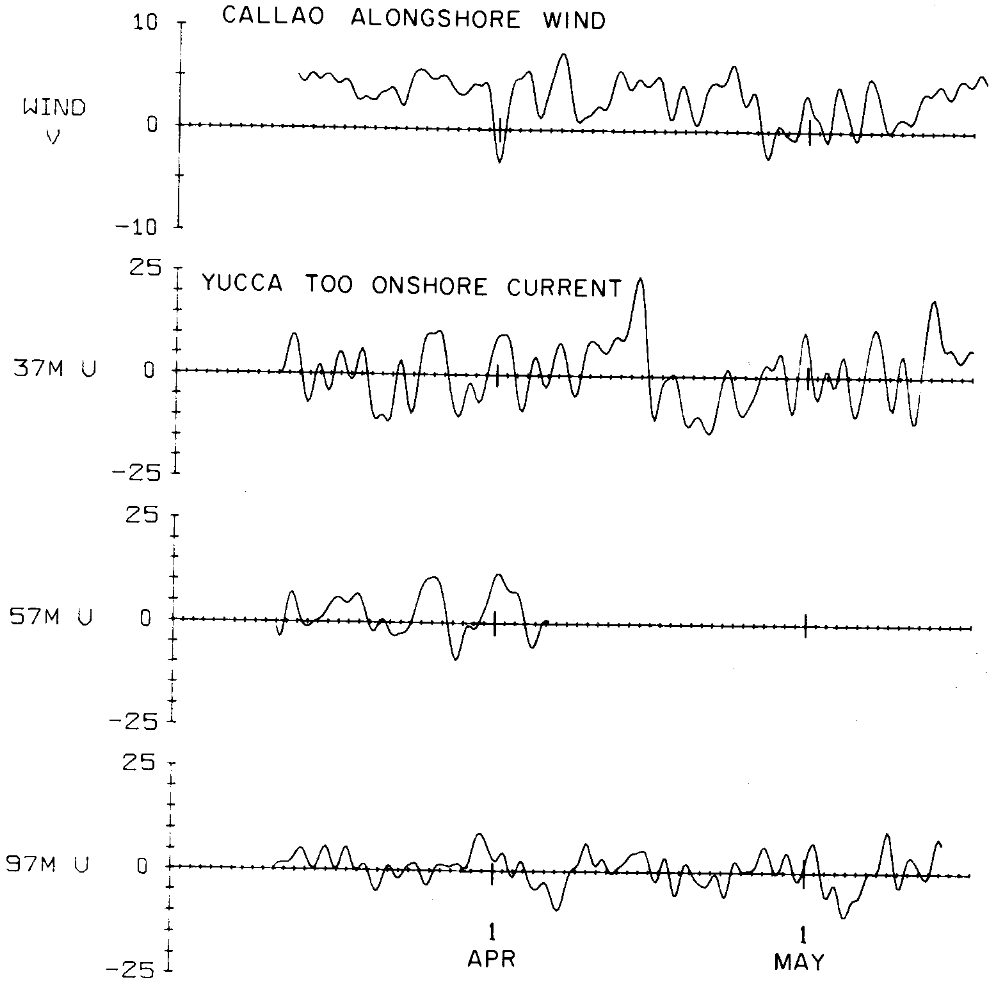

CALLAO SEA LEVEL
225
SEA
LEVEL
205
YUCCA TOO ALONGSHORE CURRENT
25
37M V
0
-25
25
57M V
0
-25
25
97M V
0
-25
1
APR
1
MAY

Figure 24a.



CALLAO ALONGSHORE WIND
WIND
V
10
0
-10
YUCCA TOO ONSHORE CURRENT
37M U
25
0
-25
57M U
25
0
-25
97M U
25
0
-25
1
APR
1
MAY

Figure 24b.

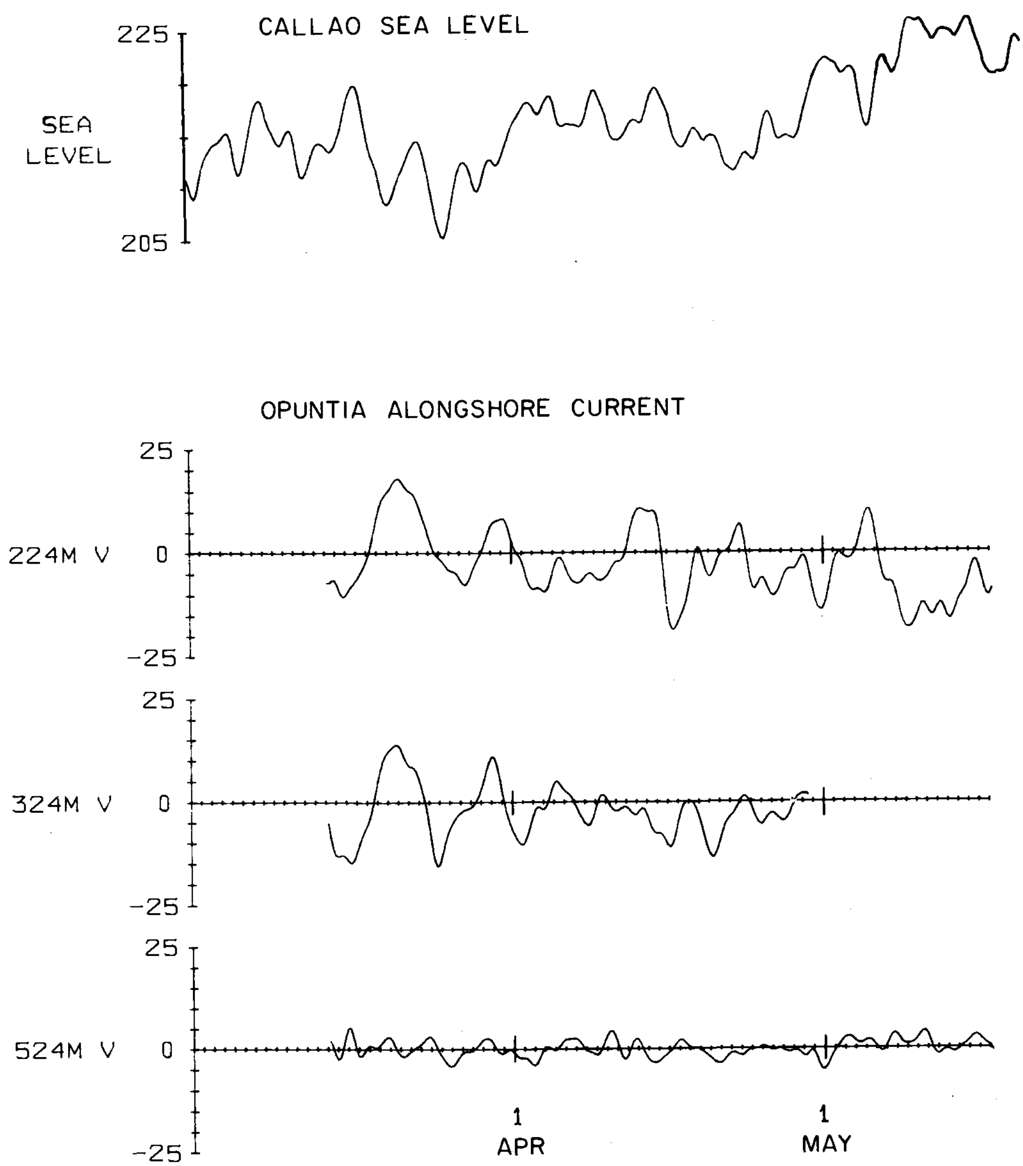
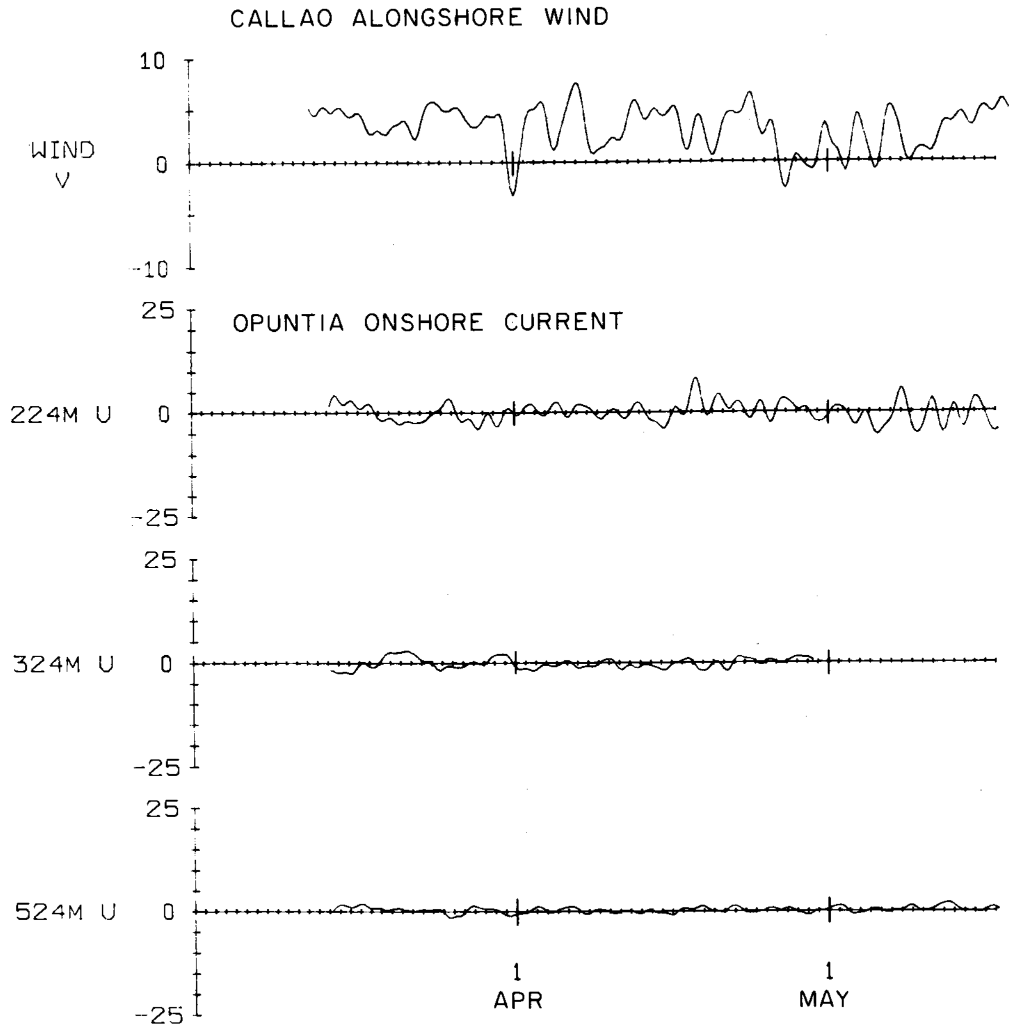

CALLAO SEA LEVEL
225
SEA
LEVEL
205
OPUNTIA ALONGSHORE CURRENT
25
224M V
0
-25
25
324M V
0
-25
25
524M V
0
-25
1
APR
1
MAY

Figure 25a.



CALLAO ALONGSHORE WIND
10
WIND
V
0
-10
25
OPUNTIA ONSHORE CURRENT
224M U
0
-25
25
324M U
0
-25
25
524M U
0
1
APR
1
MAY
-25

Figure 25b.

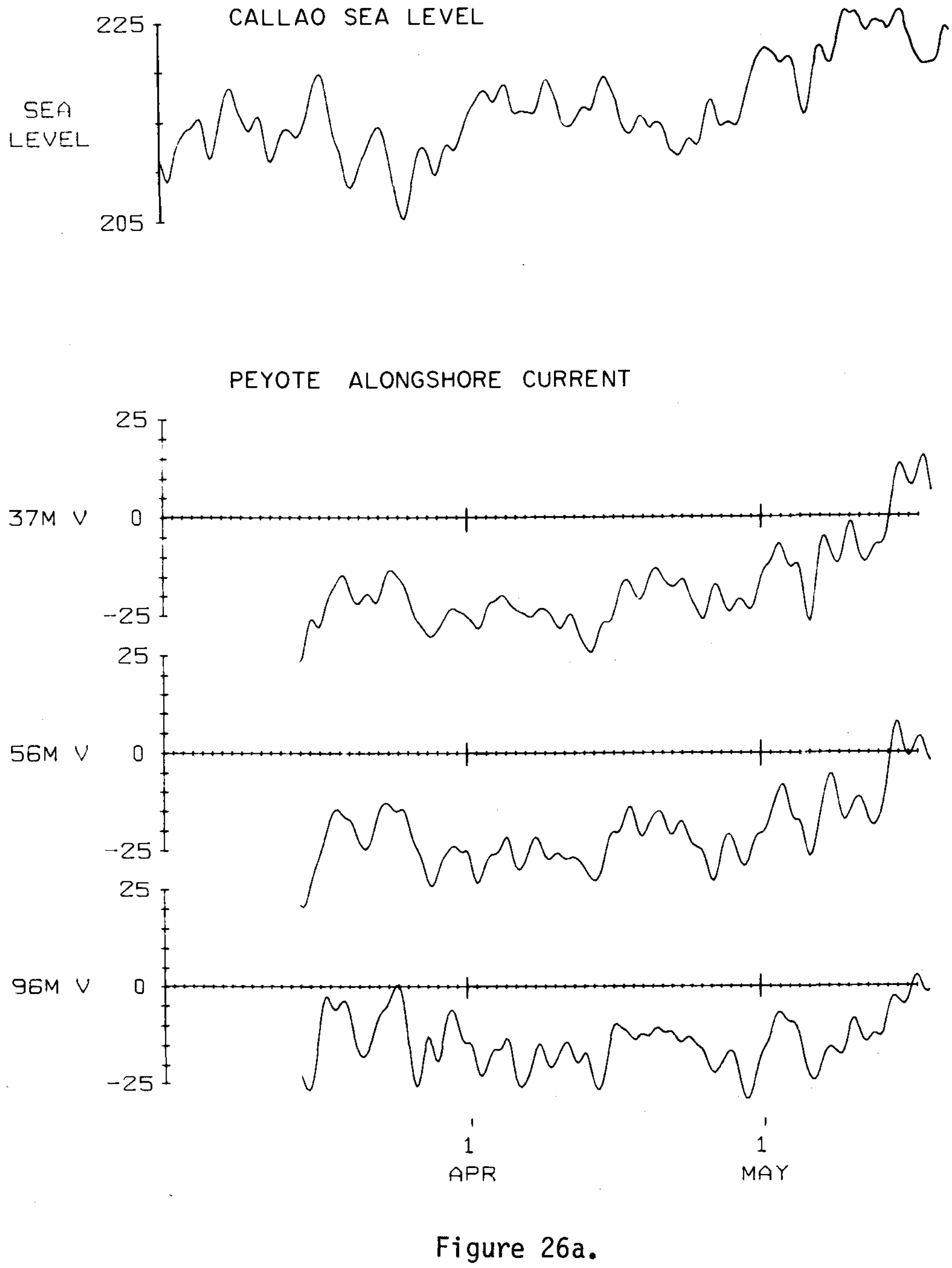

CALLAO SEA LEVEL
225
SEA
LEVEL
205
PEYOTE ALONGSHORE CURRENT
25
37M V 0
-25
25
56M V 0
-25
25
96M V 0
-25
1
APR
1
MAY

Figure 26a.

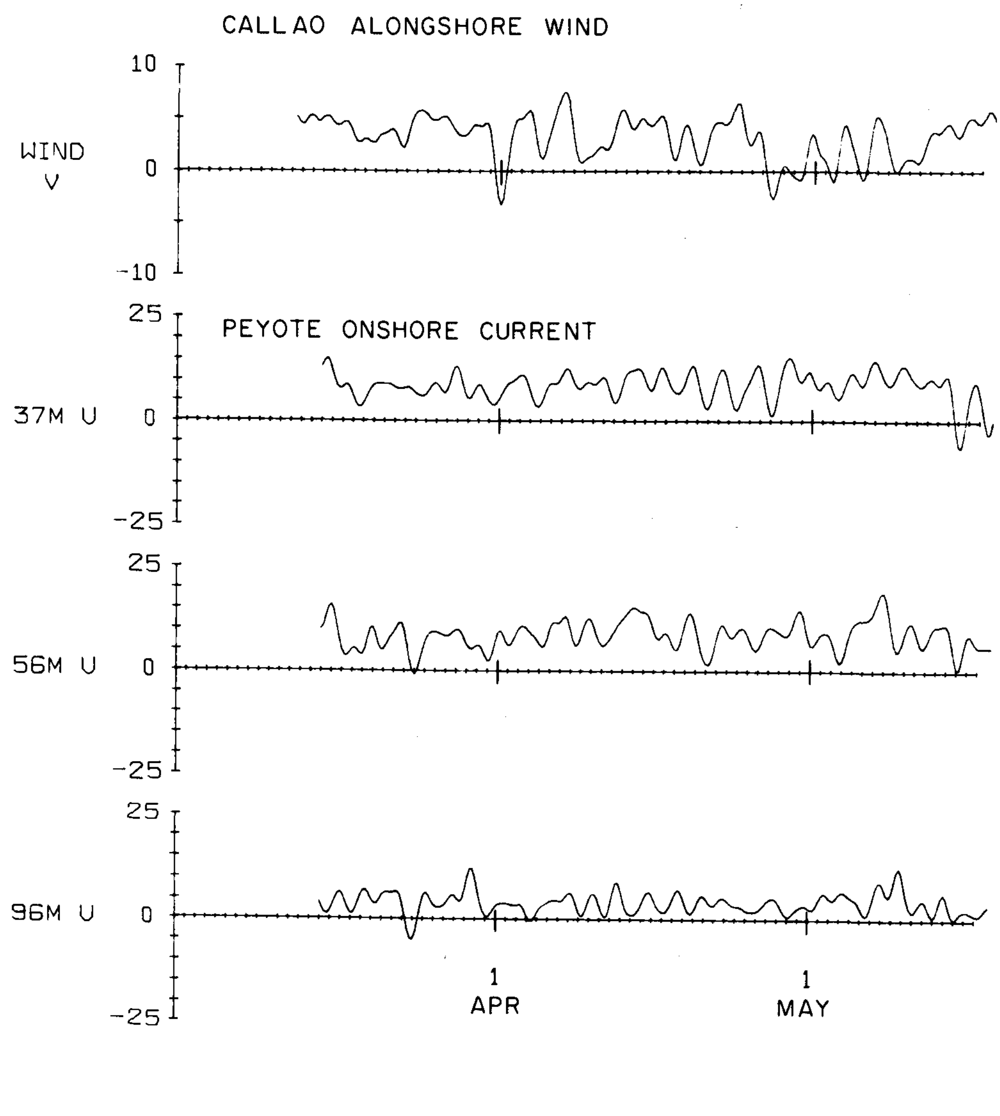

CALLAO ALONGSHORE WIND
10
WIND V
0
-10
25
PEYOTE ONSHORE CURRENT
37M U
0
-25
25
56M U
0
-25
25
96M U
0
-25
1 APR
1 MAY

Figure 26b.

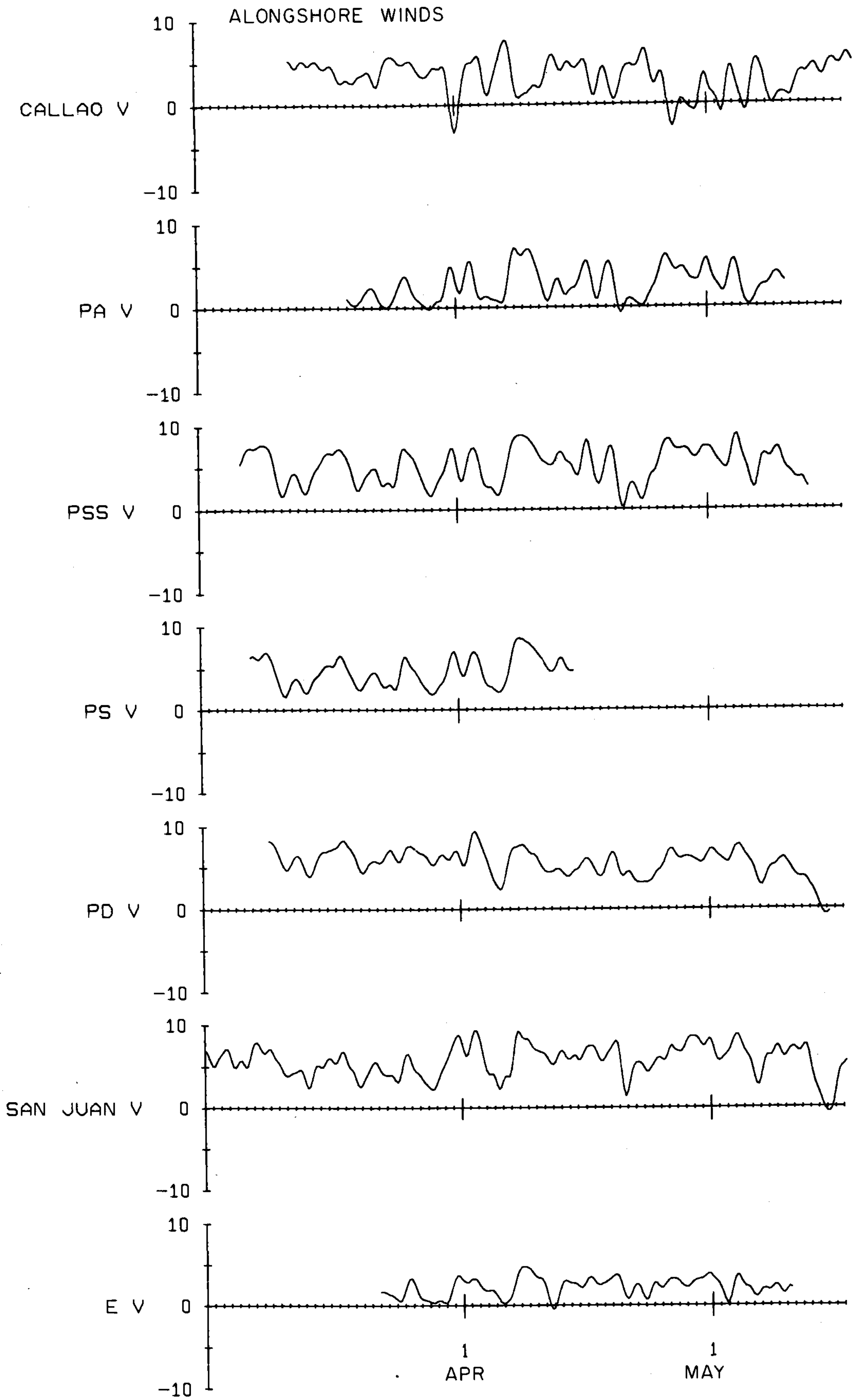
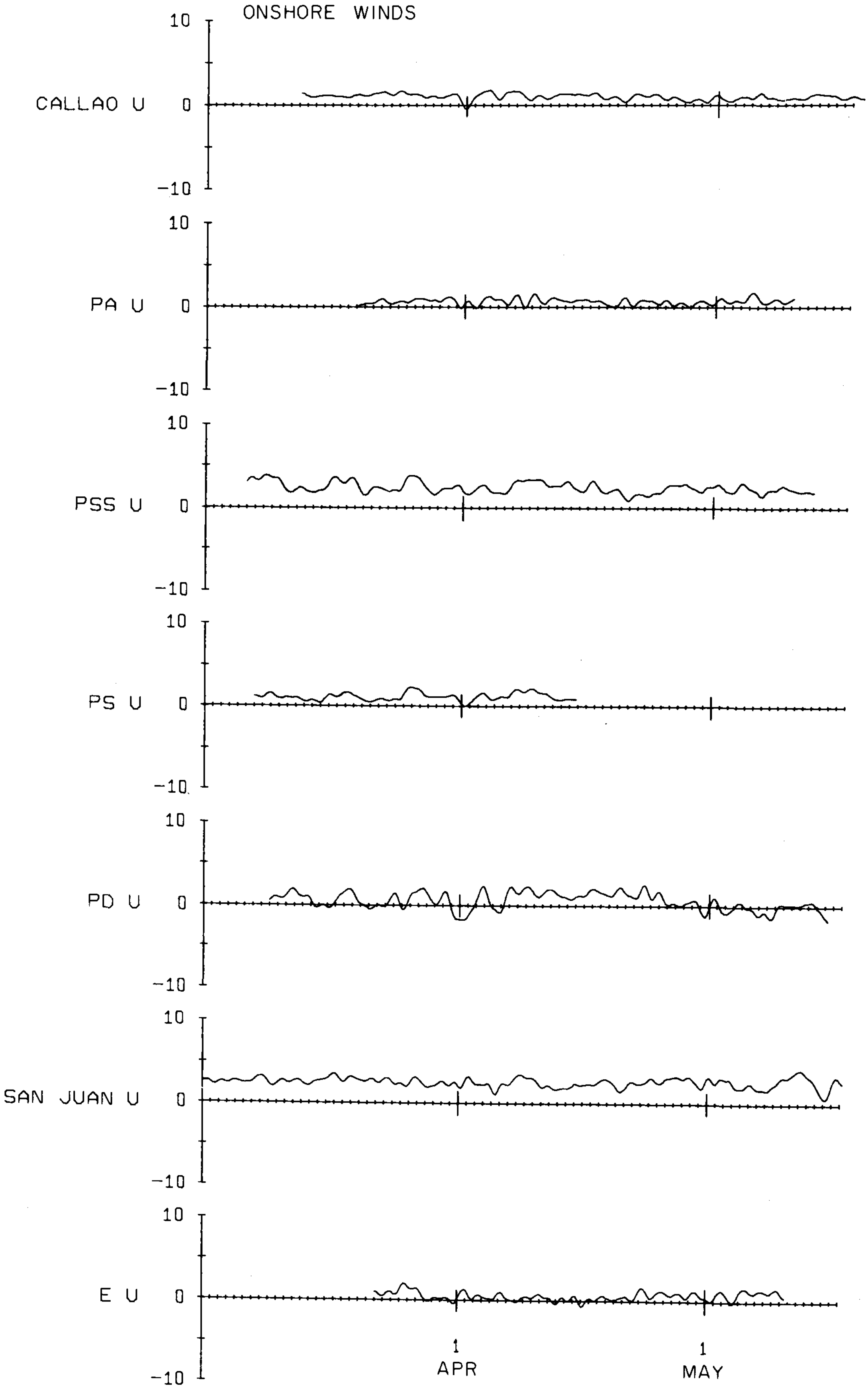
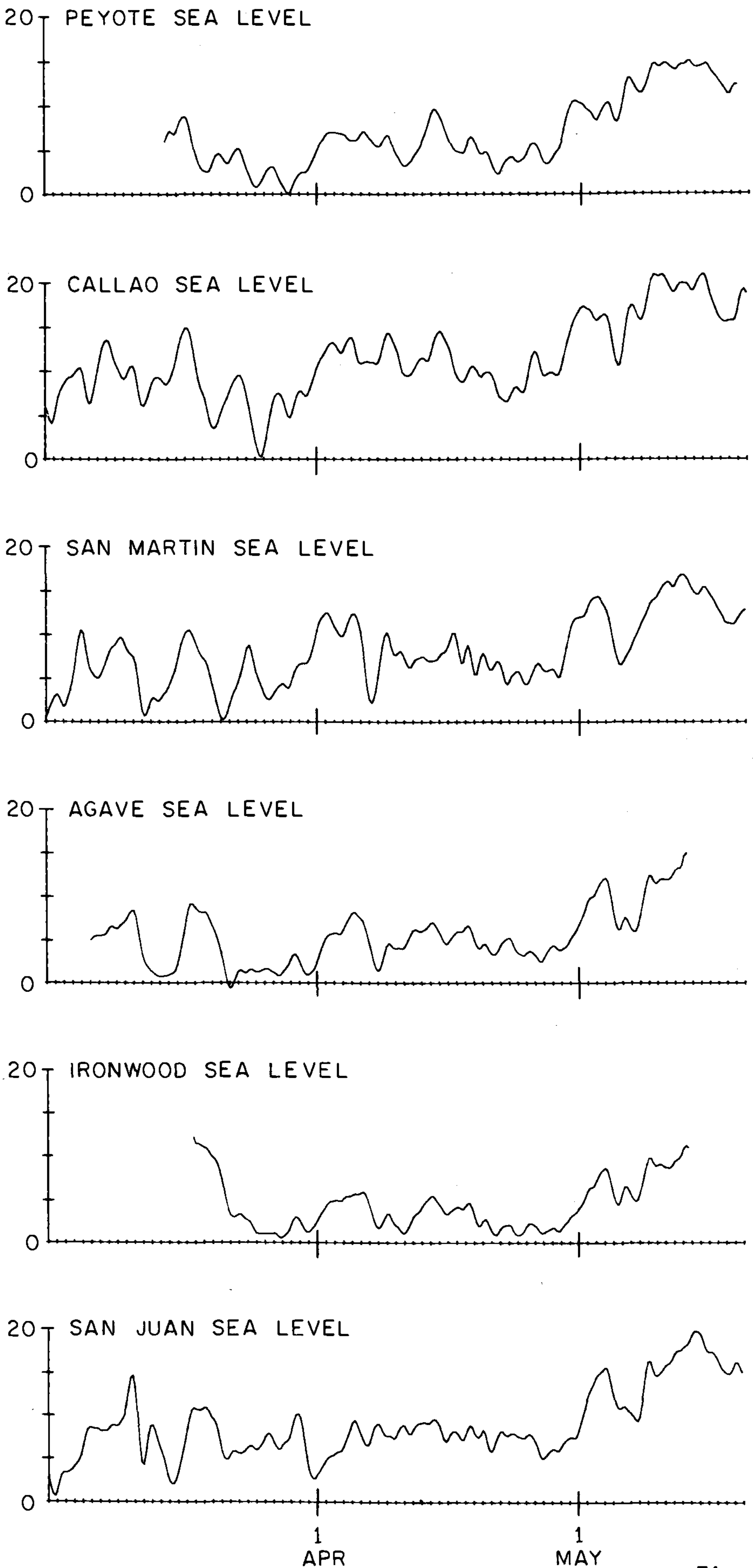

ALONGSHORE WINDS
10
CALLAO V
0
-10
10
PA V
0
-10
10
PSS V
0
-10
10
PS V
0
-10
10
PD V
0
-10
10
SAN JUAN V
0
-10
10
E V
0
-10
1
APR
1
MAY

Figure 27a.


ONSHORE WINDS
CALLAO U
PA U
PSS U
PS U
PD U
SAN JUAN U
E U
10
0
-10
1
APR
1
MAY
Figure 27b.



20
PEYOTE SEA LEVEL
0
20
CALLAO SEA LEVEL
0
20
SAN MARTIN SEA LEVEL
0
20
AGAVE SEA LEVEL
0
20
IRONWOOD SEA LEVEL
0
20
SAN JUAN SEA LEVEL
0
1
APR
1
MAY

Figure 28.

JOINT-2, PSS/AGAVE

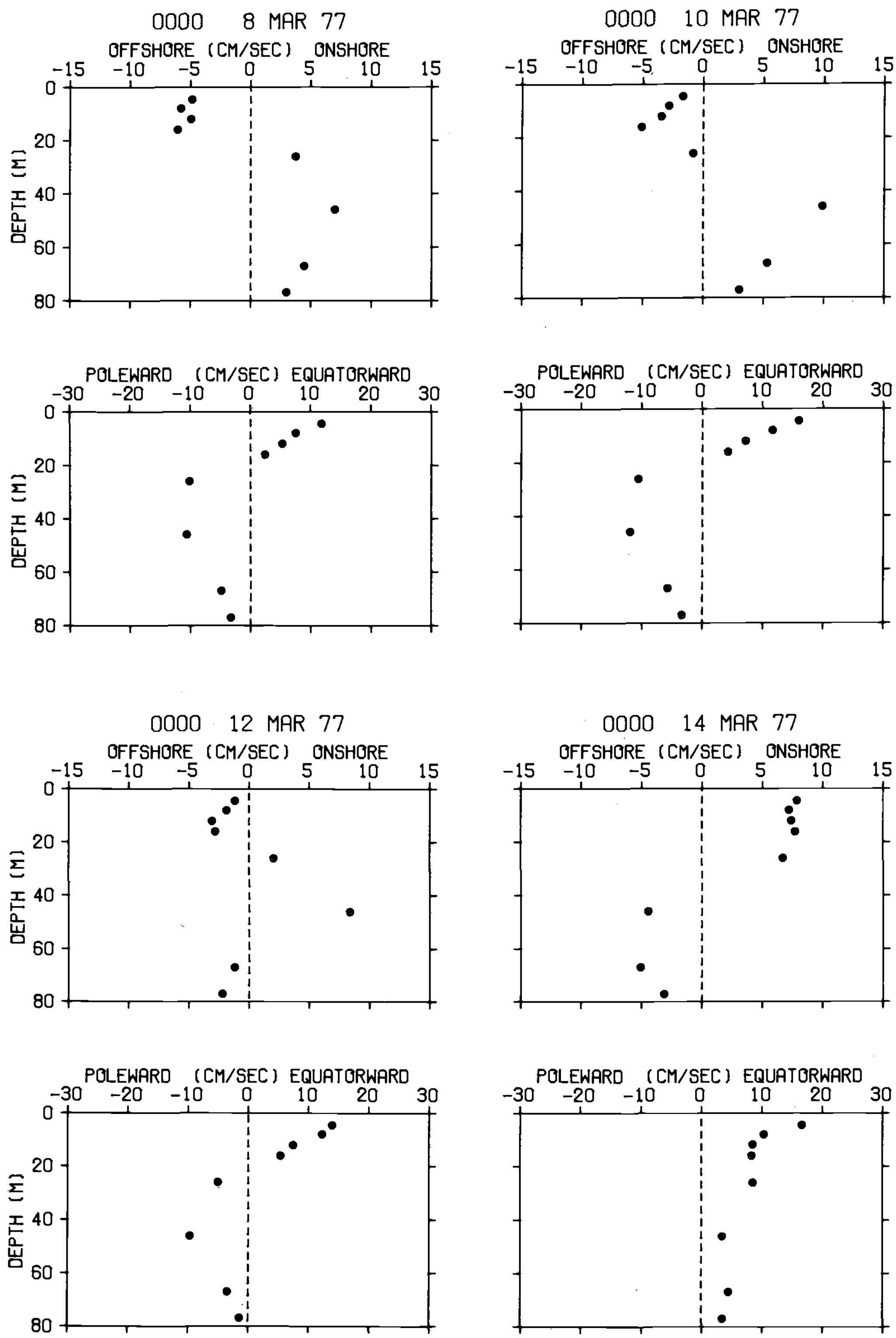


Figure 29(1).

JOINT-2, PSS/AGAVE

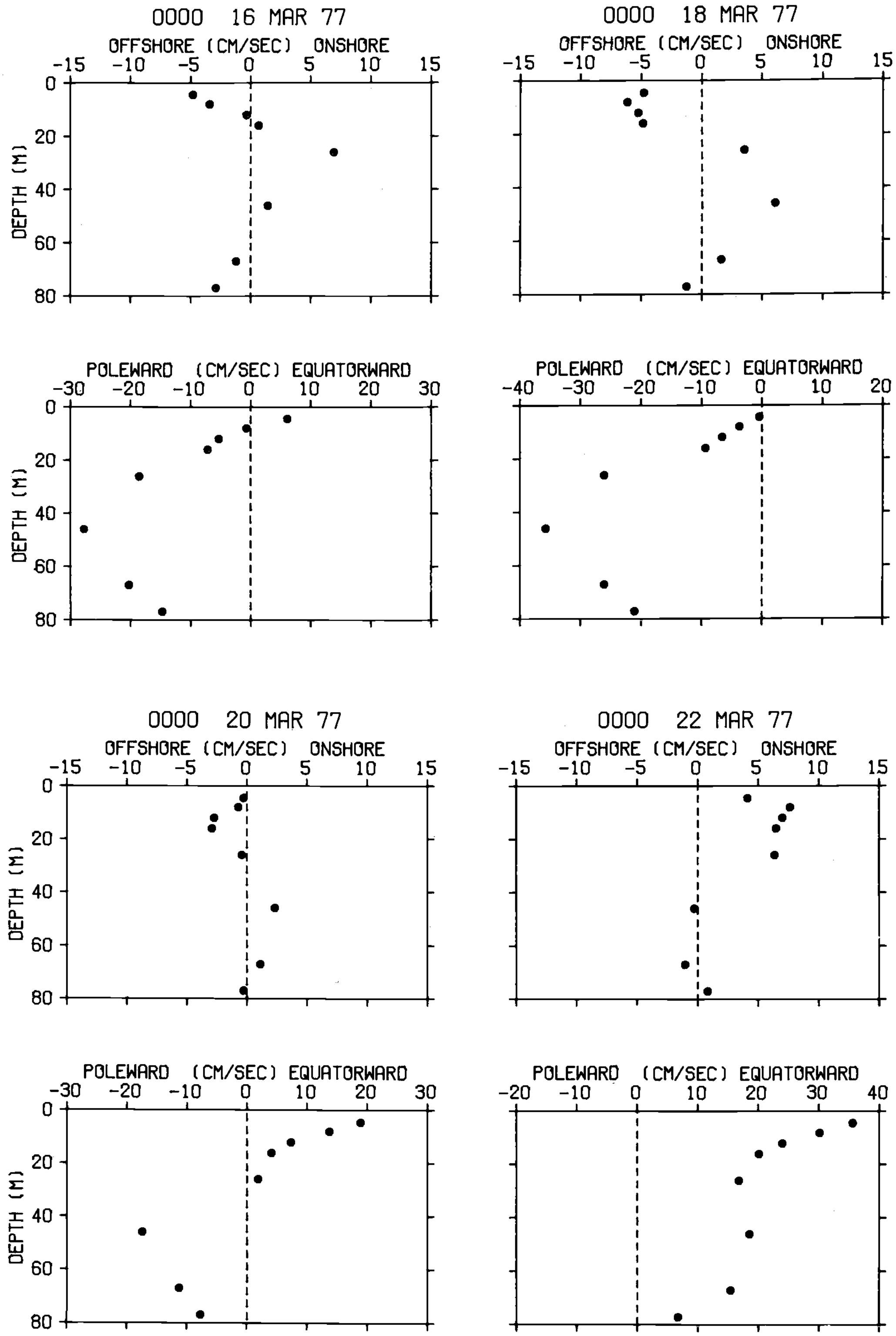


Figure 29(2).

JOINT-2, PSS/AGAVE

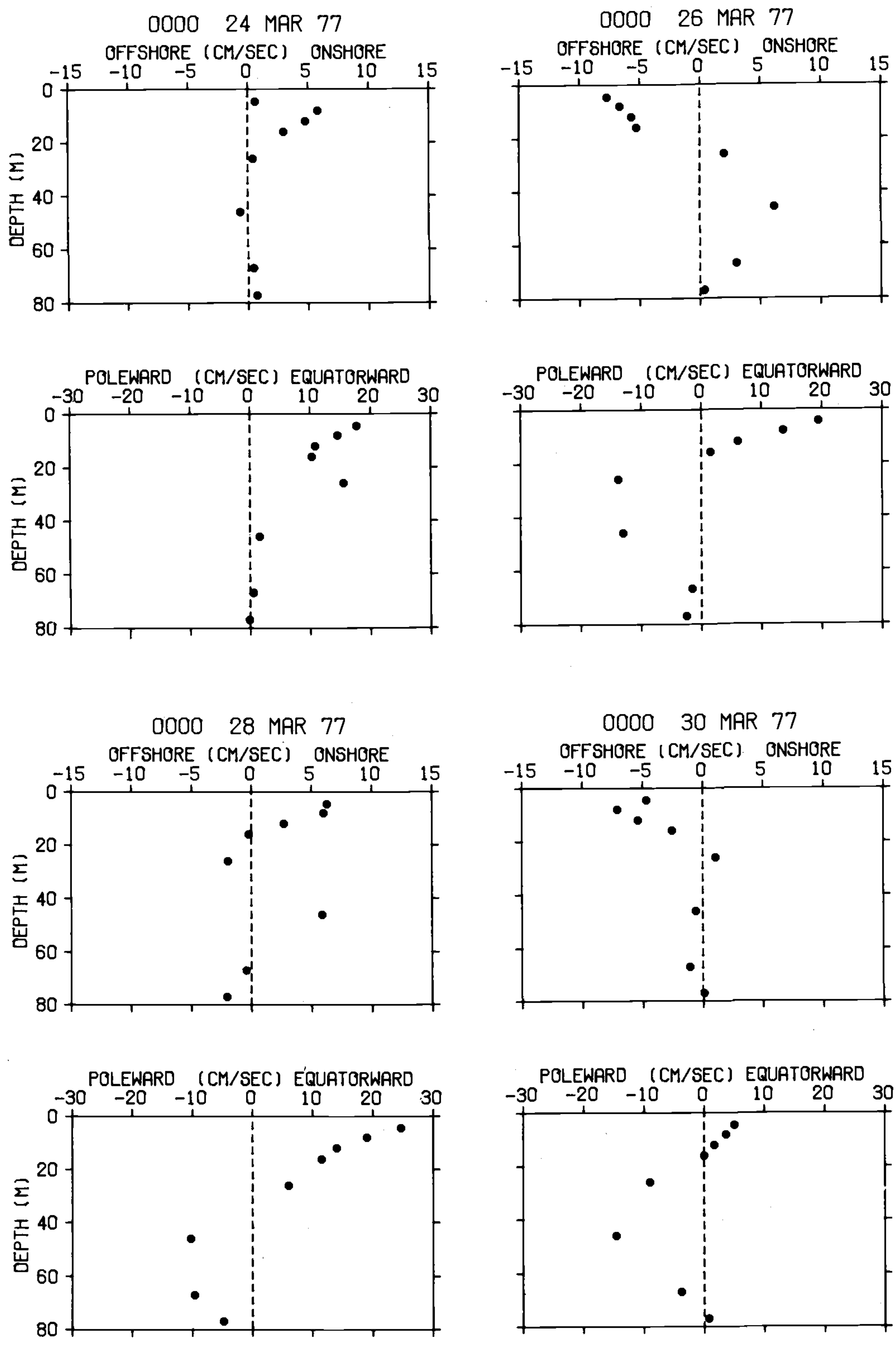


Figure 29(3).

JOINT-2, PSS/AGAVE

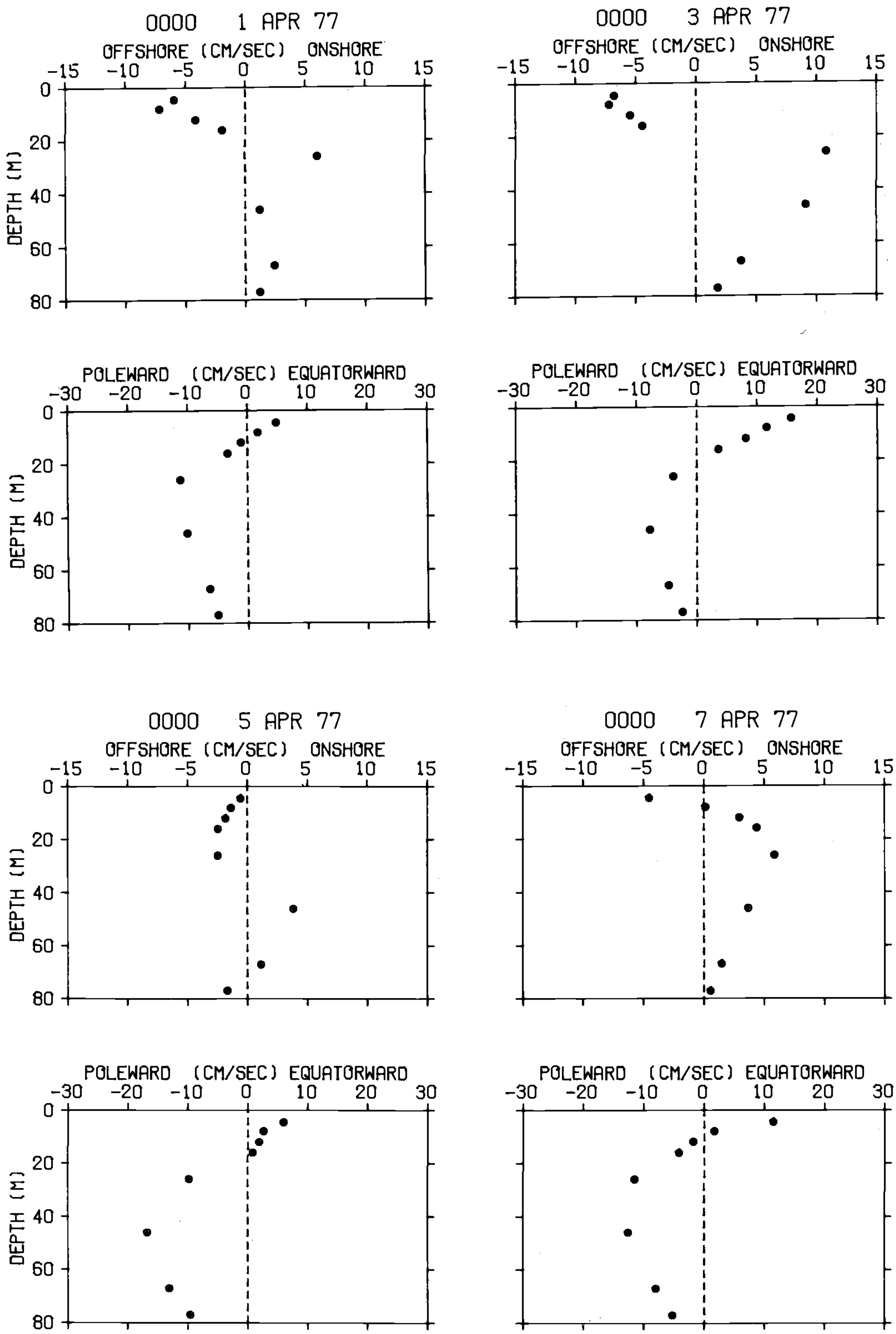


Figure 29(4).

JOINT-2, PSS/AGAVE

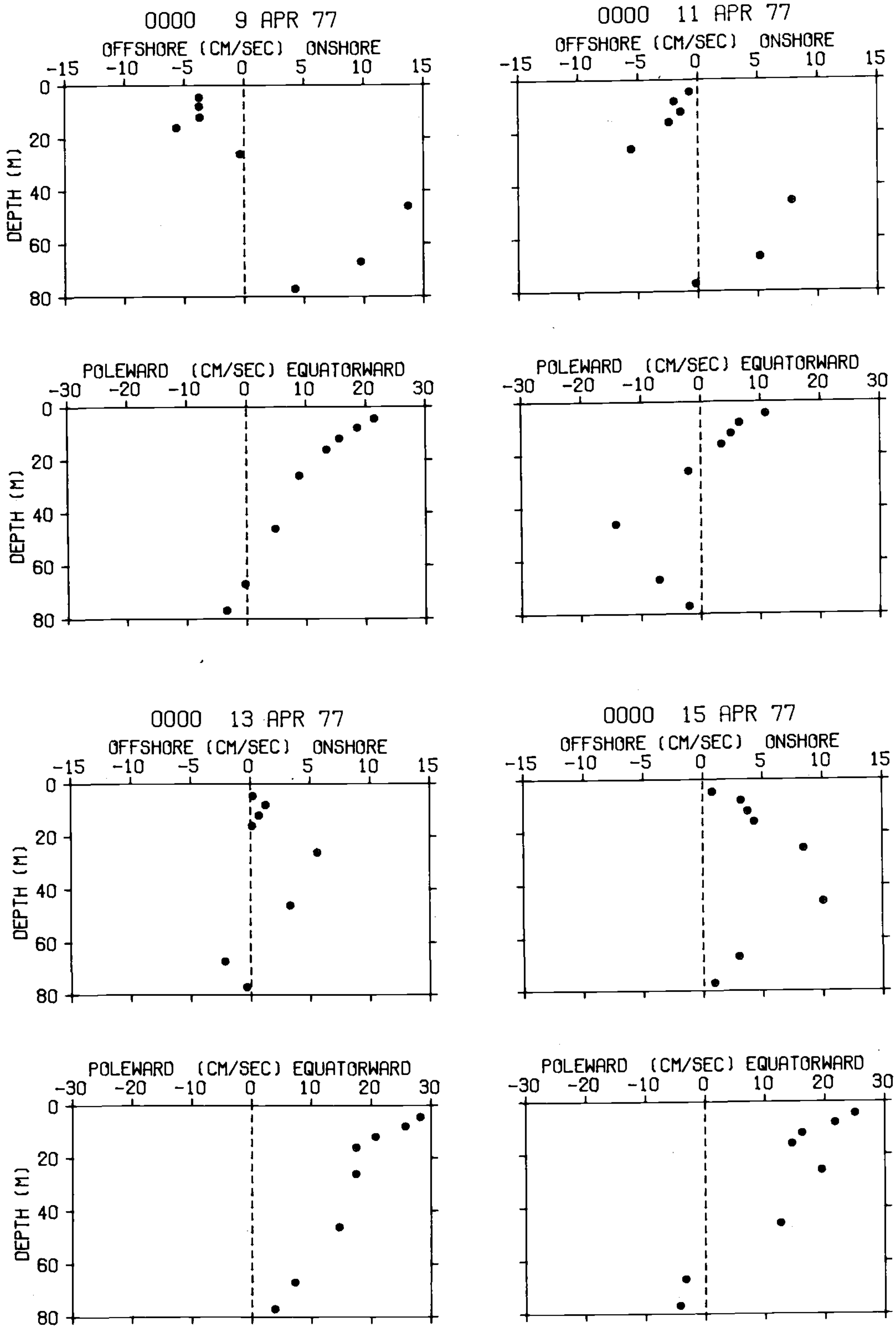


Figure 29(5).

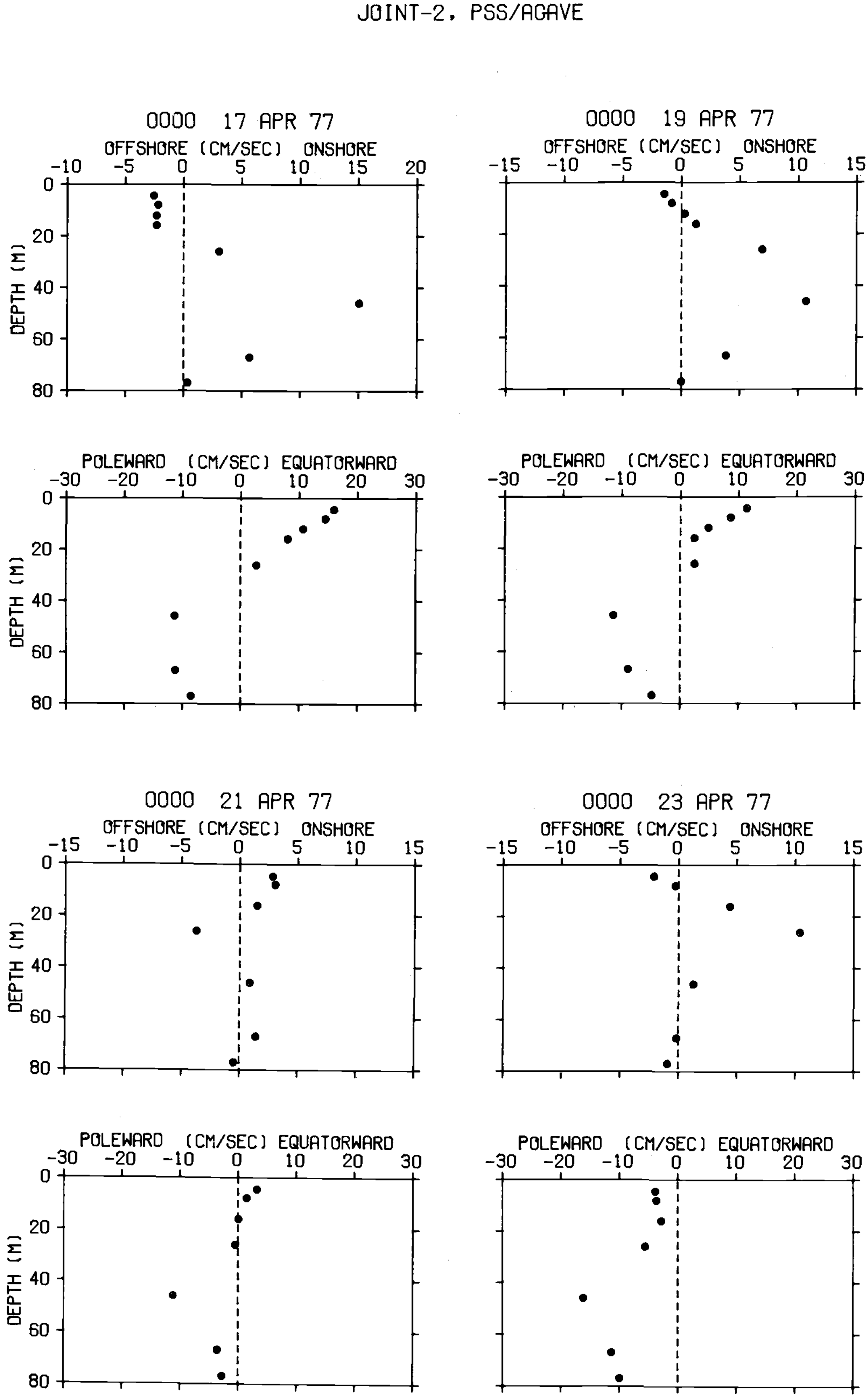

JOINT-2, PSS/AGAVE
0000 17 APR 77
OFFSHORE (CM/SEC) ONSHORE
DEPTH (M)
POLEWARD (CM/SEC) EQUATORWARD
0000 19 APR 77
0000 21 APR 77
0000 23 APR 77

Figure 29(6).

JOINT-2, PSS/AGAVE

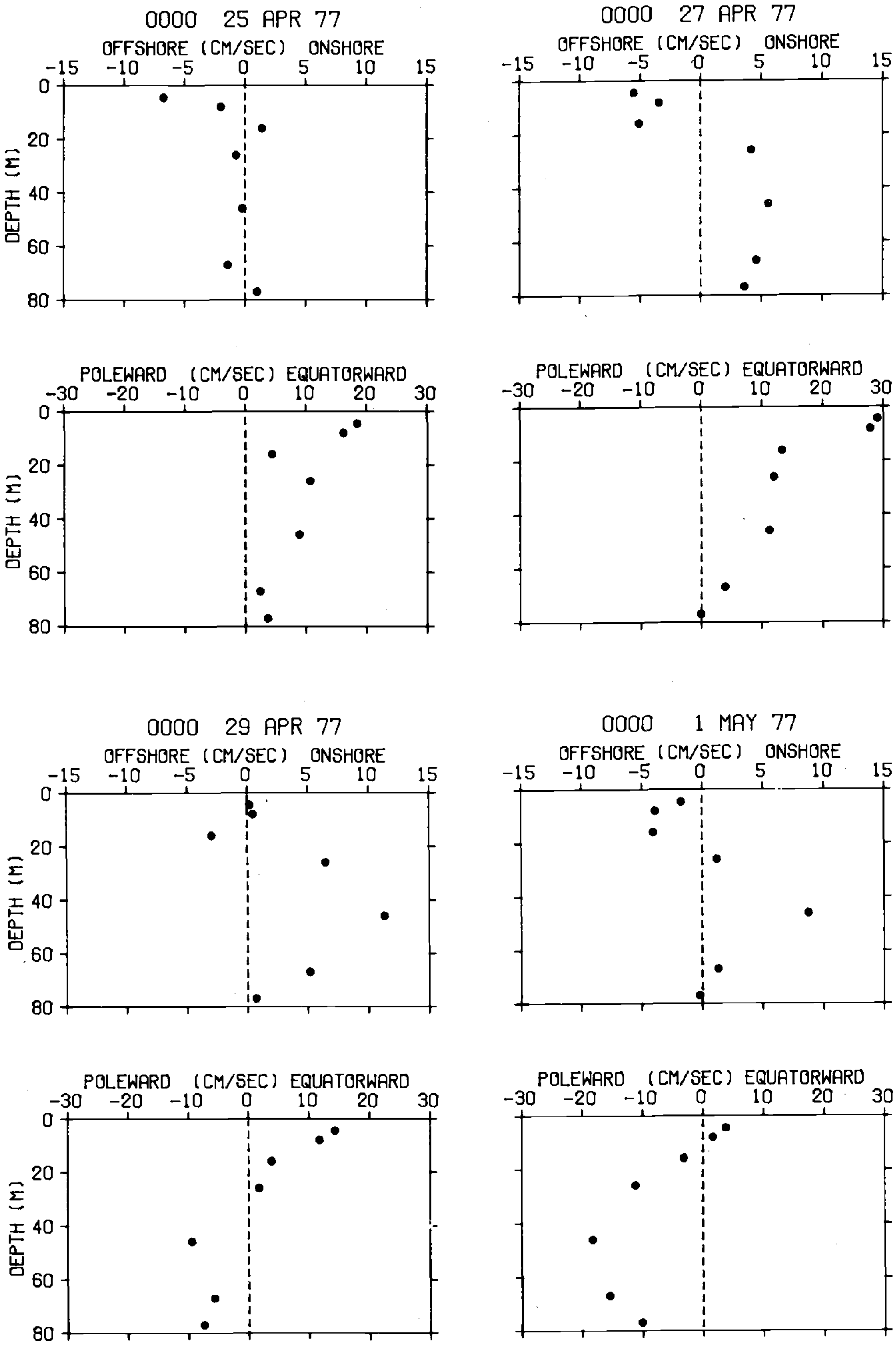


Figure 29(7).

JOINT-2, PSS/AGAVE

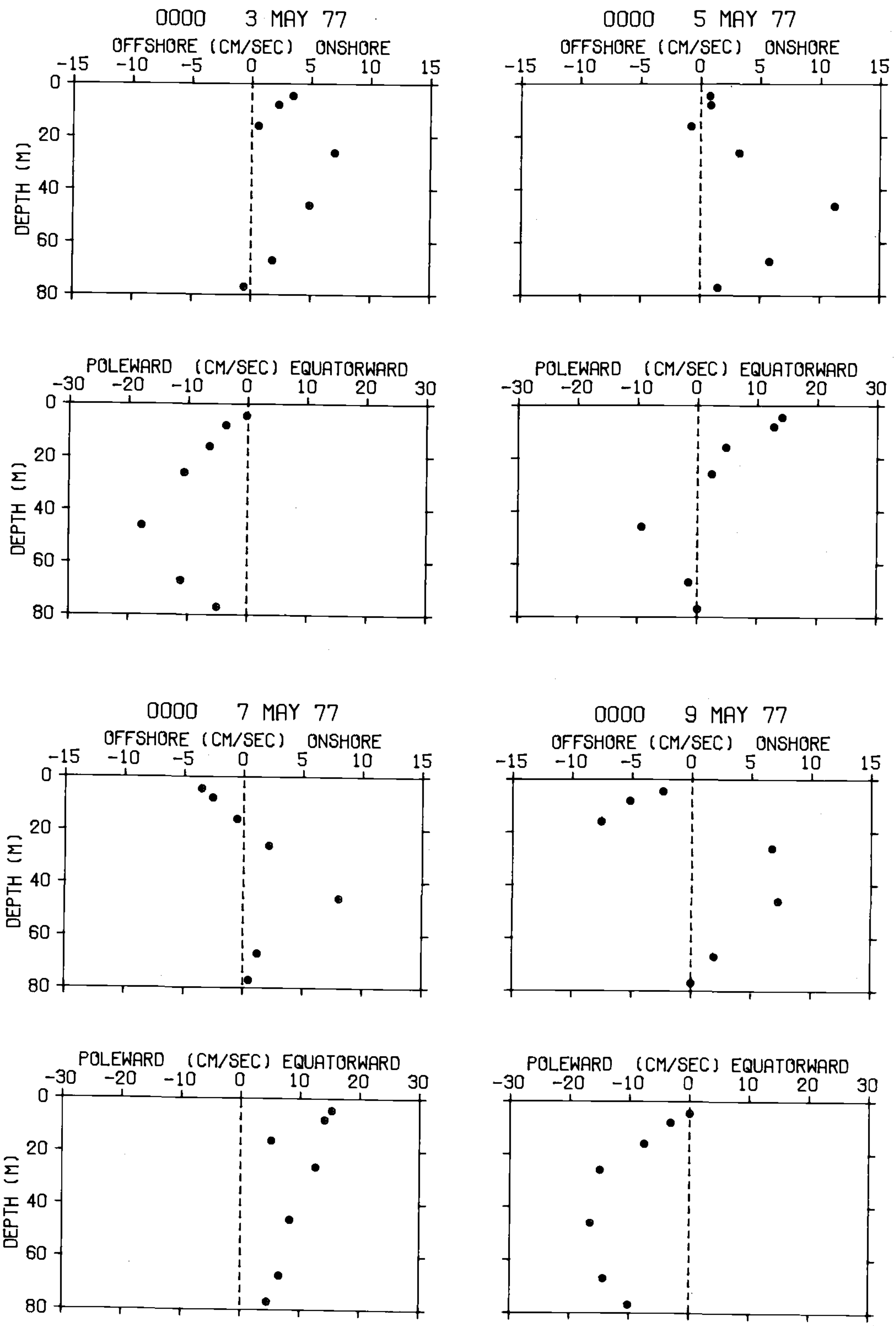


Figure 29(8).

JOINT-2, PSS/AGAVE

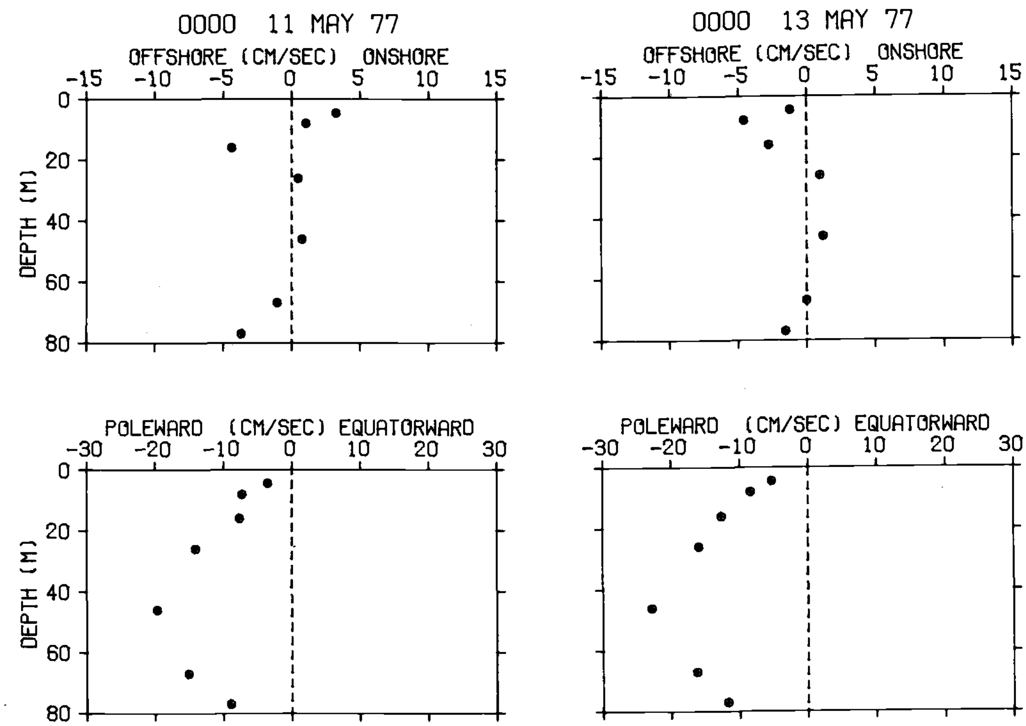


Figure 29(9).

JOINT-2, PS/MILA

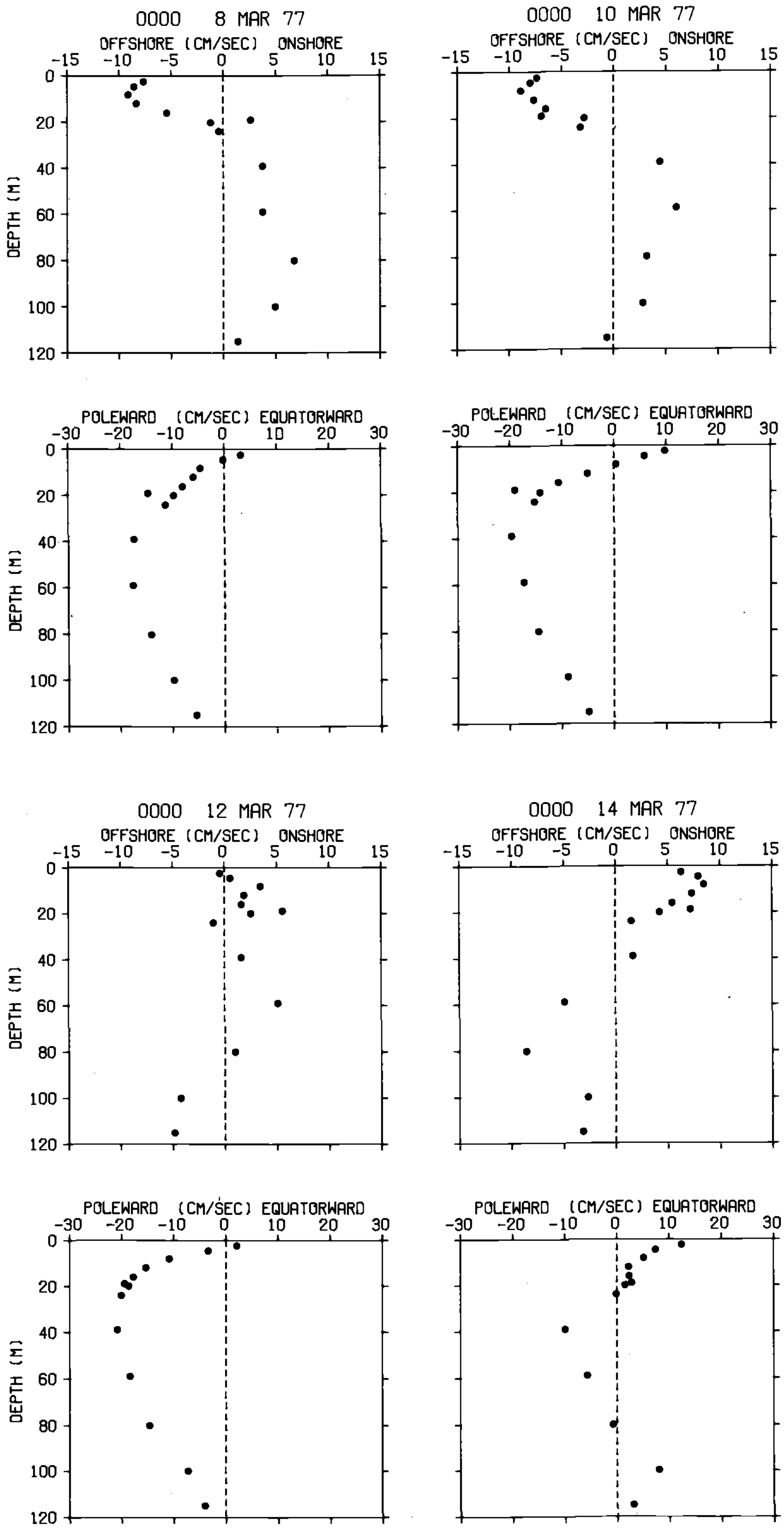


Figure 30(1).

JOINT-2, PS/MILA

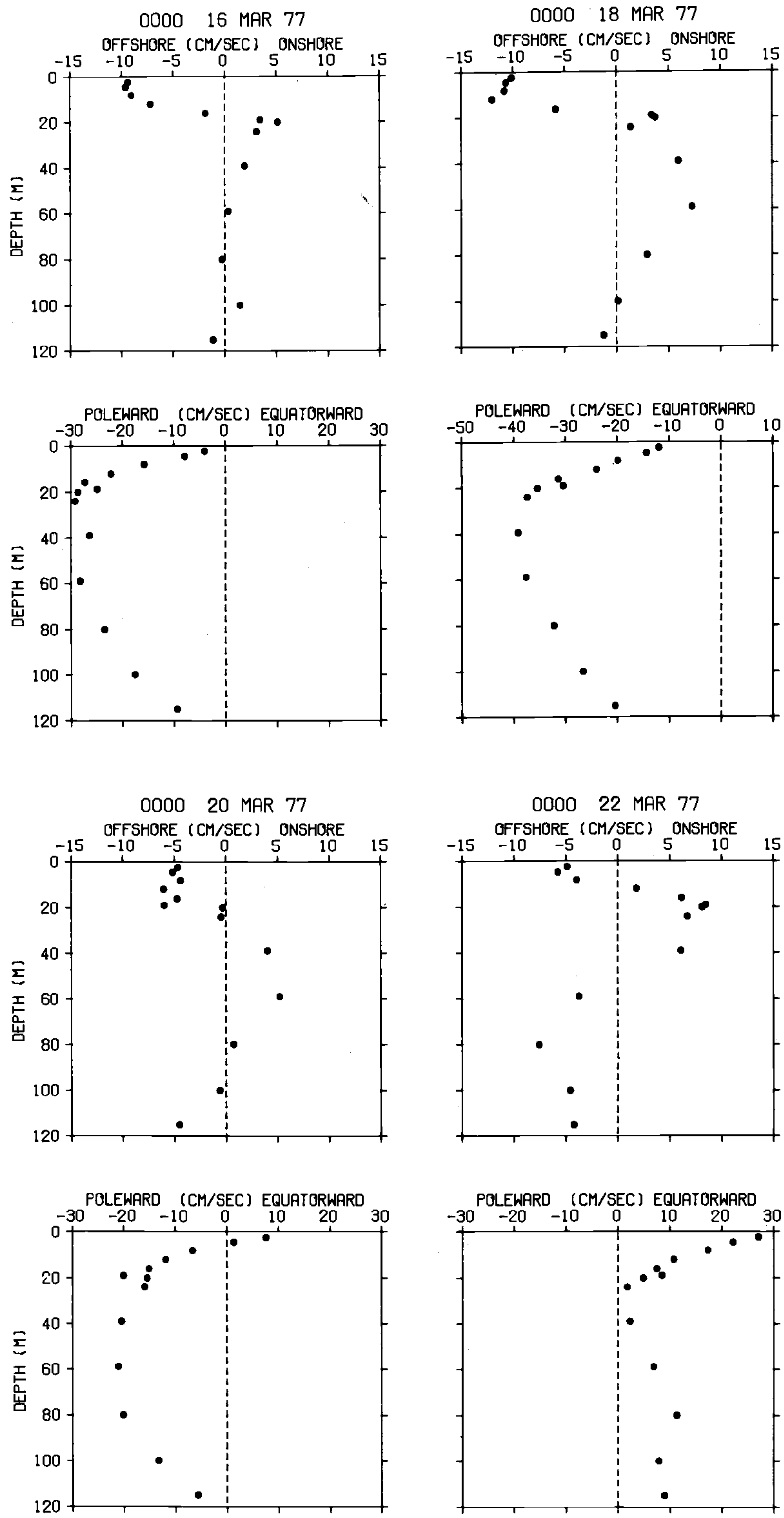


Figure 30(2).

JOINT-2, PS/MILA

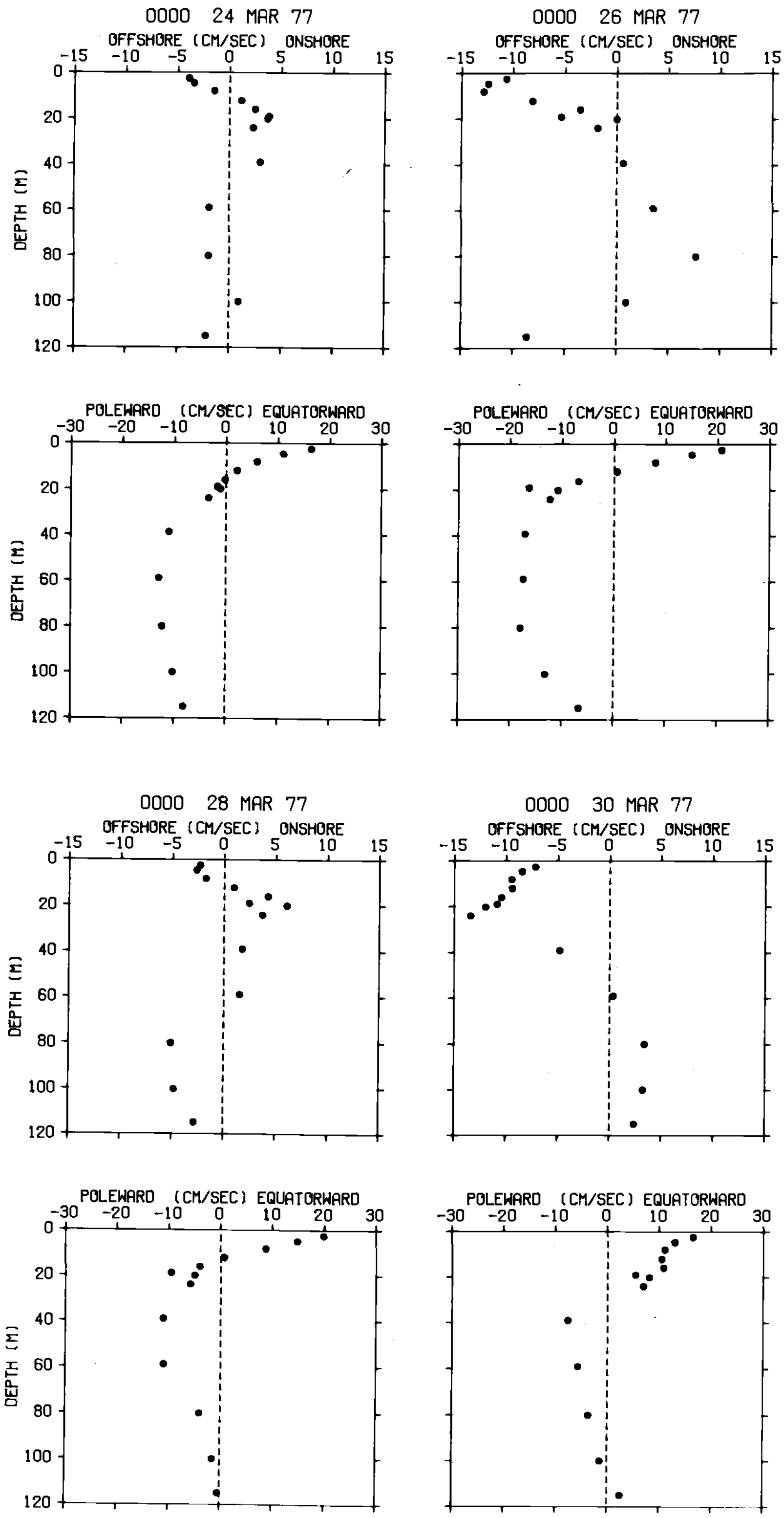


Figure 30(3).

JOINT-2, PS/MILA

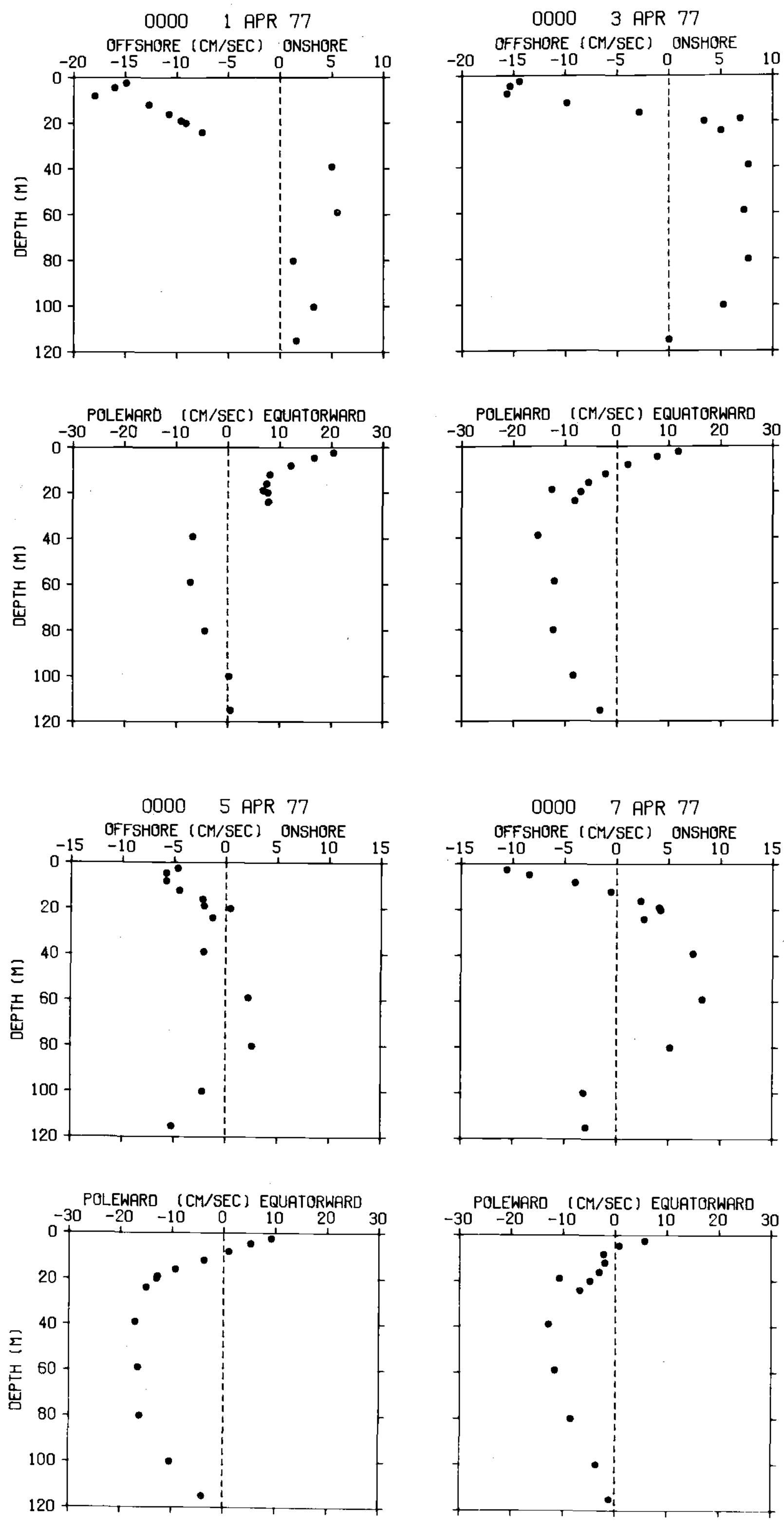


Figure 30(4).

JOINT-2, PS/MILA

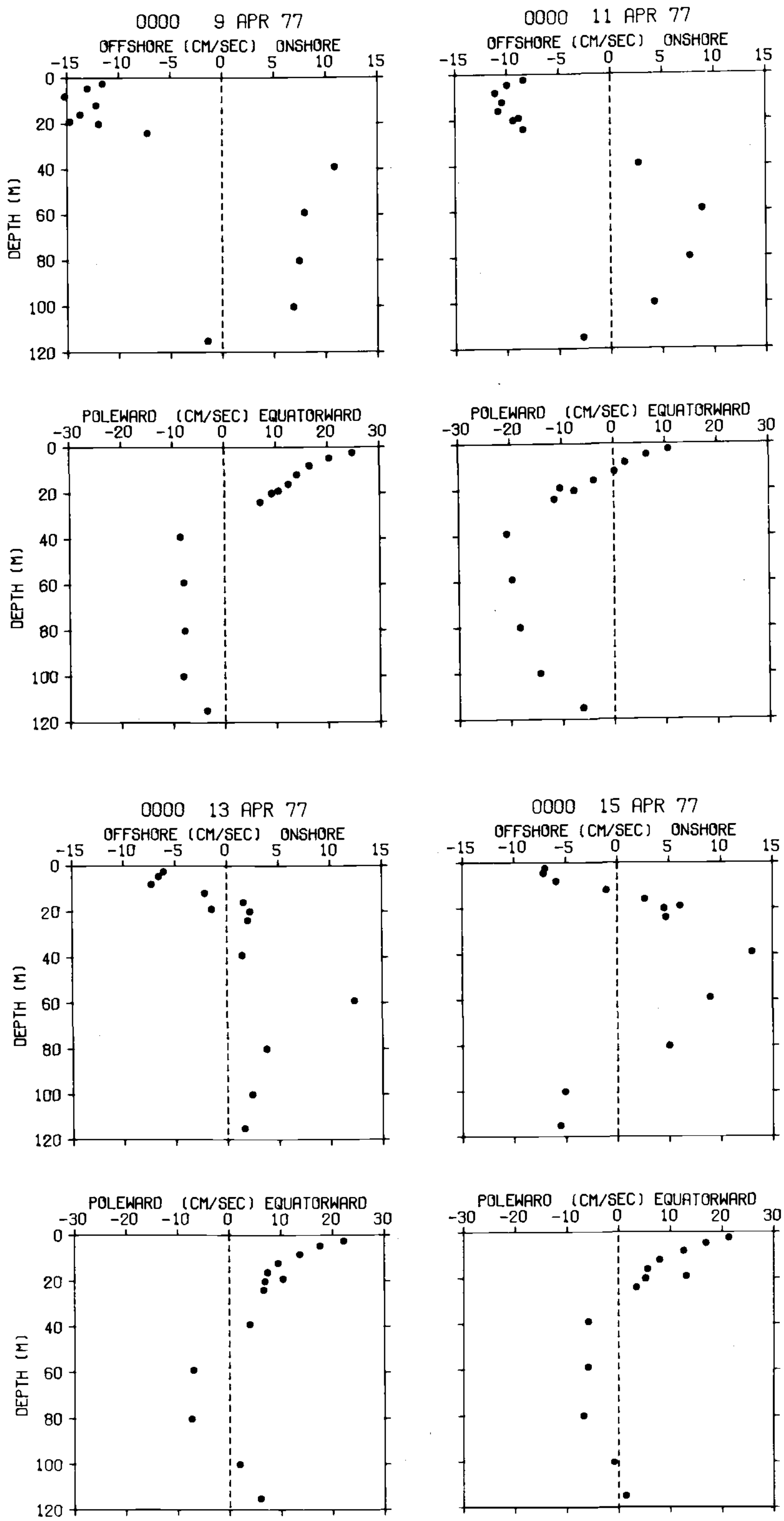


Figure 30(5).

JOINT-2, PS/MILA

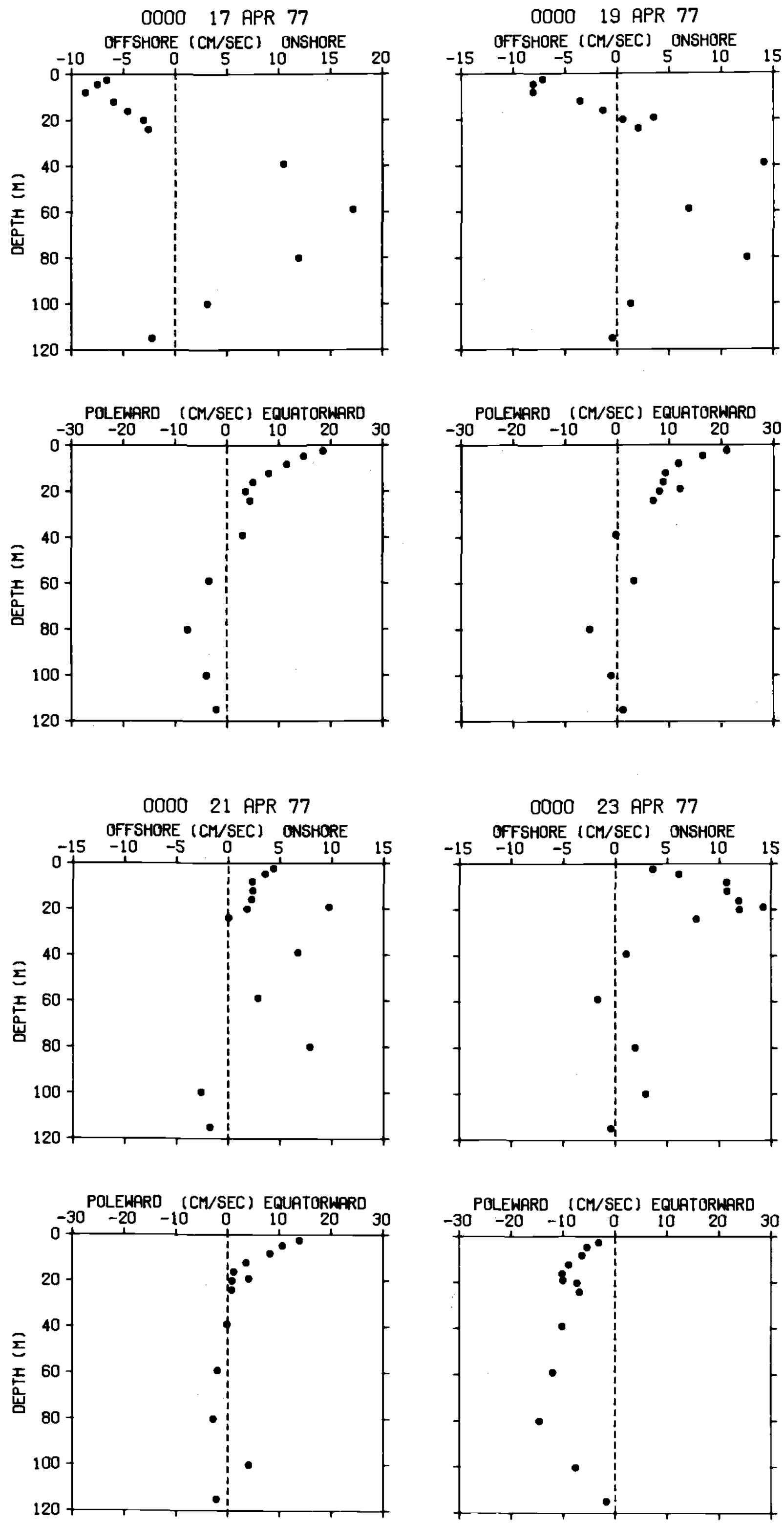


Figure 30(6).

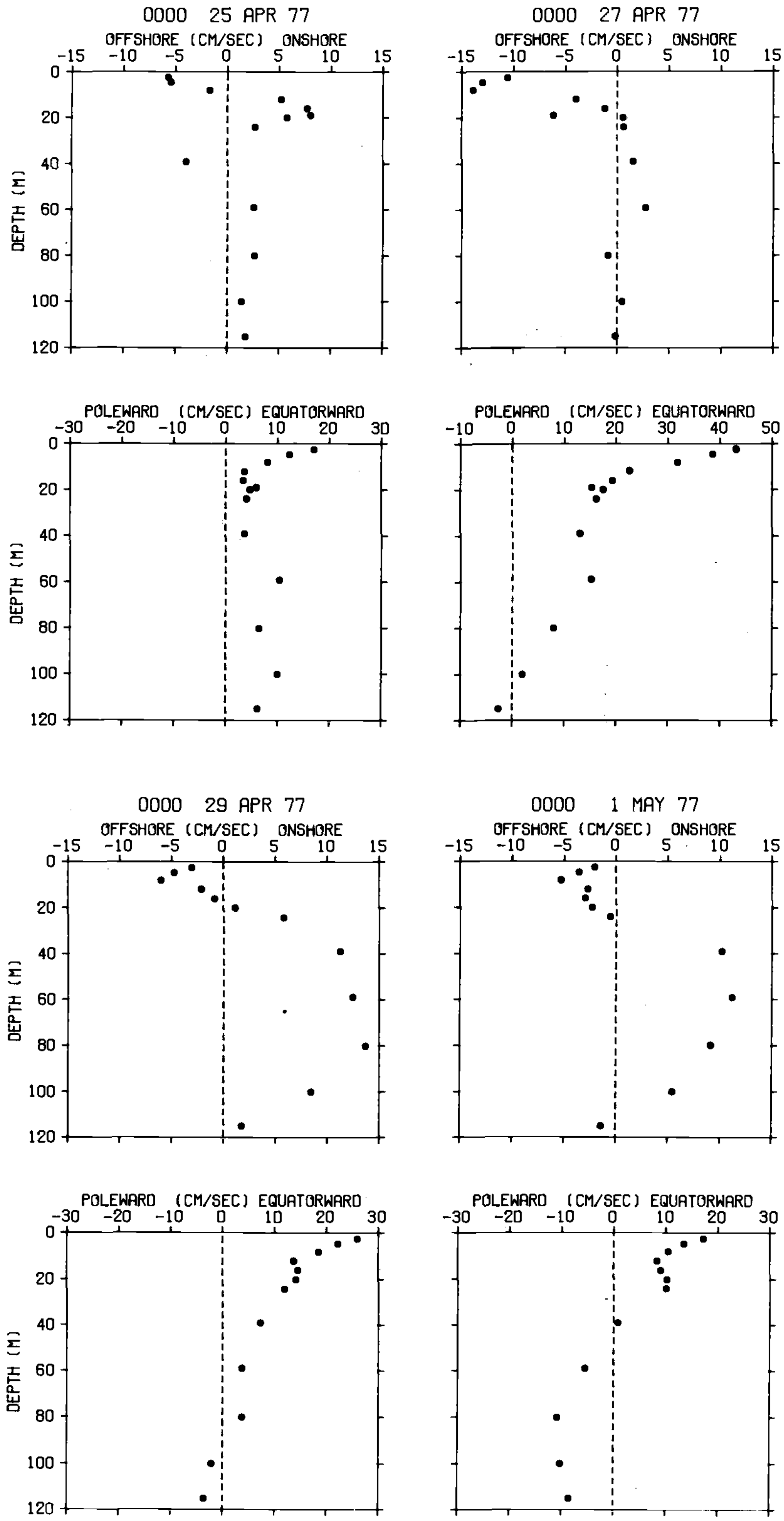

0000 25 APR 77
OFFSHORE (CM/SEC) ONSHORE
DEPTH (M)
0000 27 APR 77
OFFSHORE (CM/SEC) ONSHORE
POLEWARD (CM/SEC) EQUATORWARD
POLEWARD (CM/SEC) EQUATORWARD
0000 29 APR 77
OFFSHORE (CM/SEC) ONSHORE
0000 1 MAY 77
OFFSHORE (CM/SEC) ONSHORE
POLEWARD (CM/SEC) EQUATORWARD
POLEWARD (CM/SEC) EQUATORWARD

Figure 30(7).

JOINT-2, PS/MILA

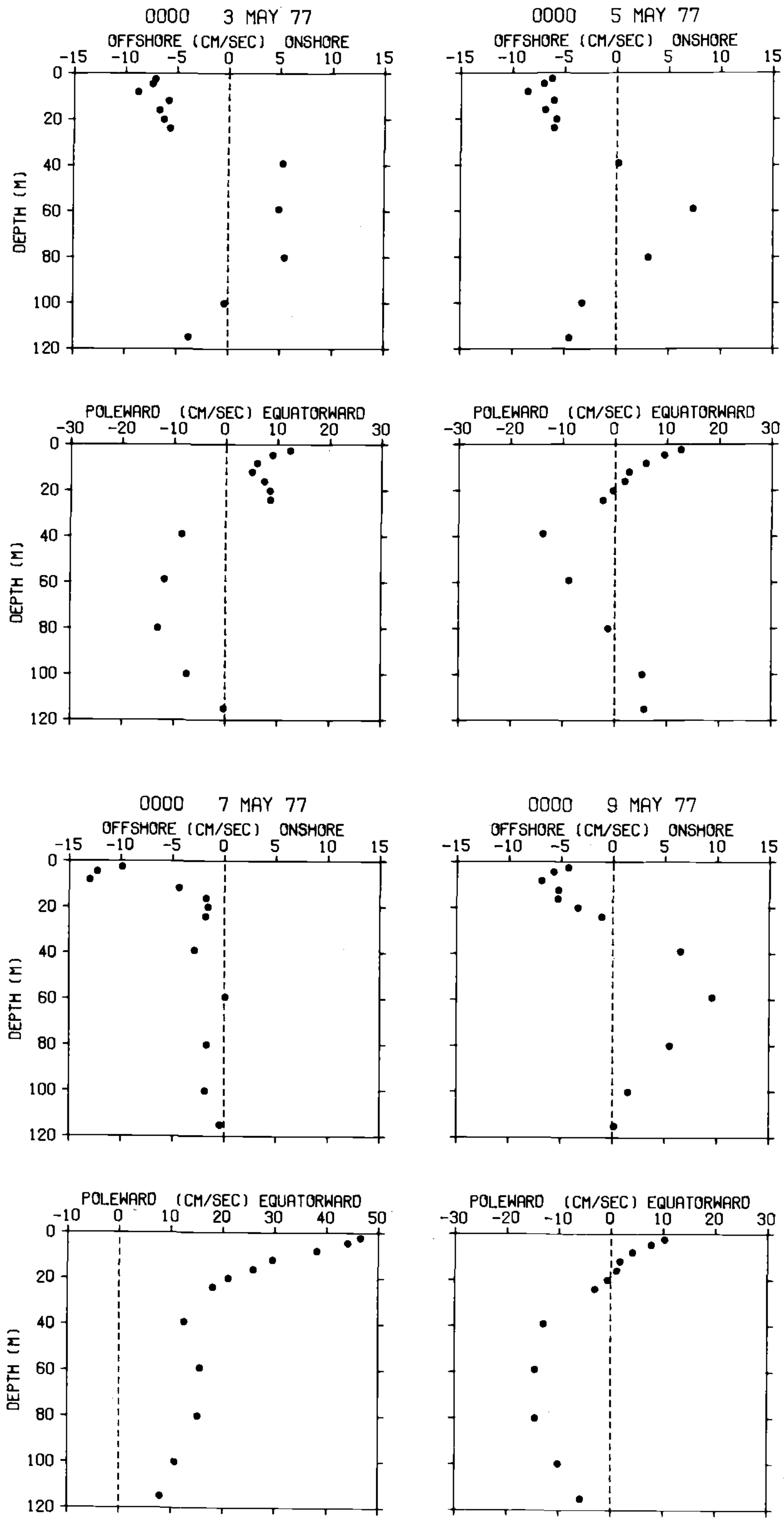


Figure 30(8).

JOINT-2, PS/MILA

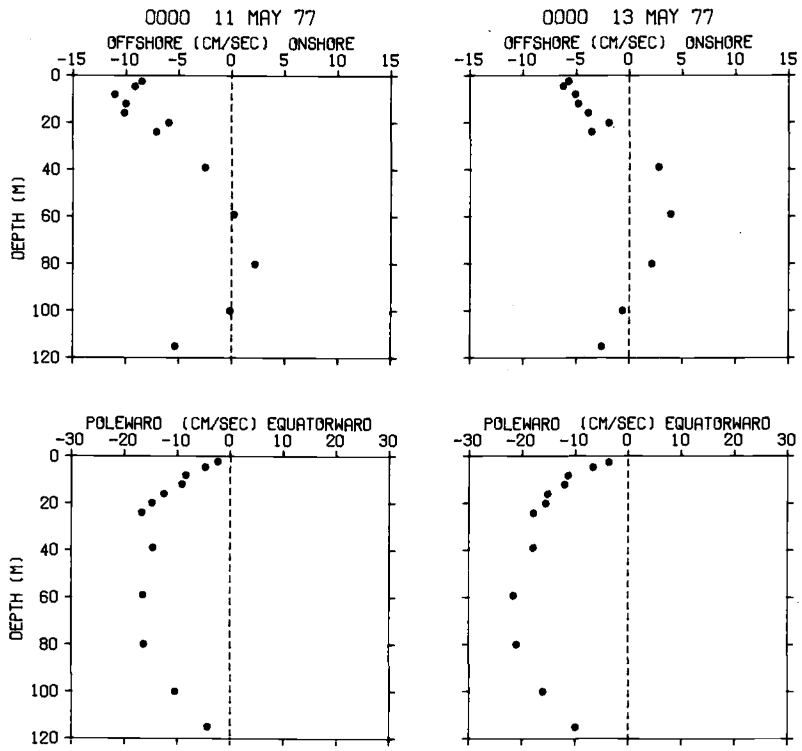


Figure 30(9).