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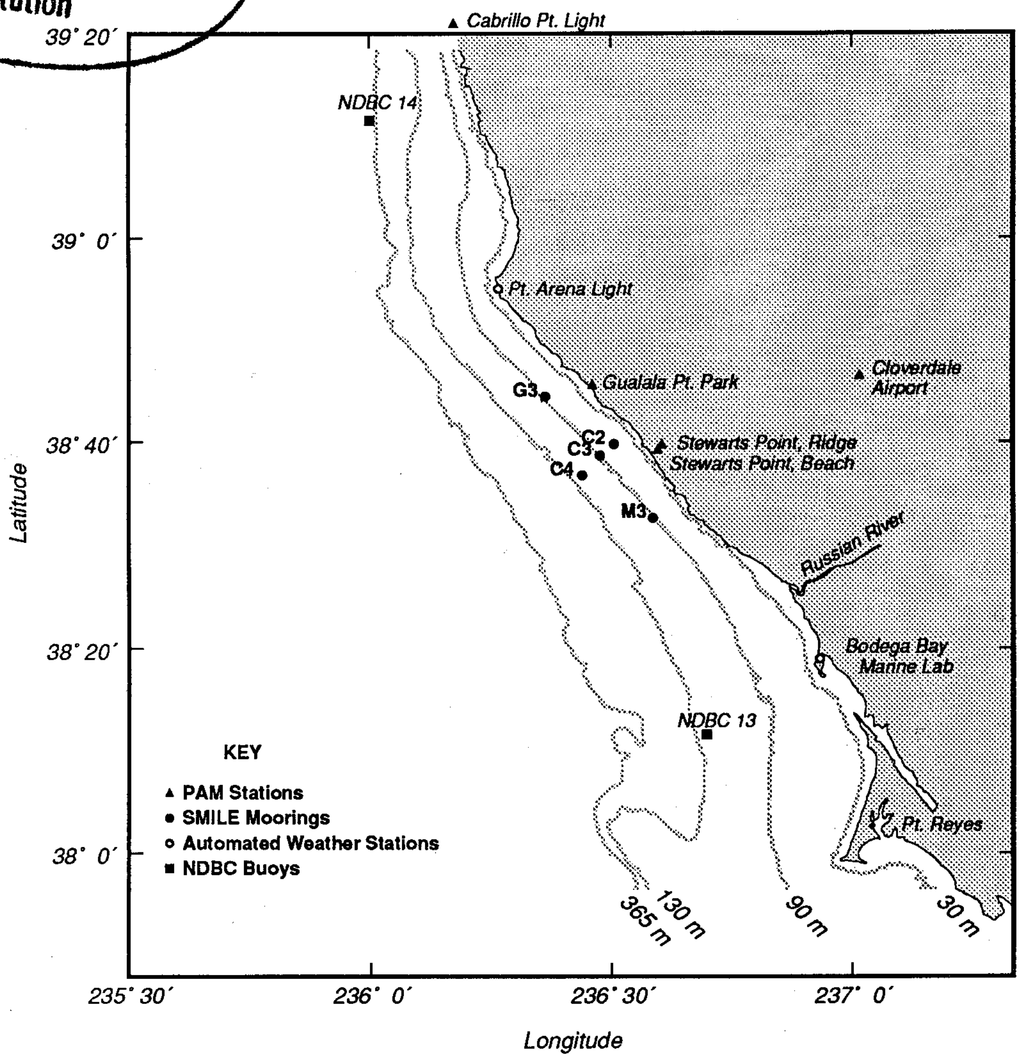
Shelf MIxed Layer Experiment (SMILE) Program Description and Coastal and Moored Array Data Report

by

Carol A. Alessi, Steven J. Lentz and Robert C. Beardsley

December 1991

Technical Report



Funding was provided by the National Science Foundation through Grant No. OCE-87-16937.

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Approved for publication; distribution unlimited.

Approved for Distribution:

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Department of Physical Oceanography

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Abstract

The Shelf MIxed Layer Experiment (SMILE) was designed to study the response of the oceanic surface boundary layer over the continental shelf to atmospheric forcing. The SMILE field program was conducted over the northern California shelf between Pt. Arena and Pt. Reyes from mid-November 1988 to mid-May 1989. The field program consisted of five main components: (a) a long-term moored array to obtain current, temperature, and conductivity time series observations in the upper ocean over the shelf; (b) a short-term moored instrument deployment to measure the vertical current shear and stratification in the top 6 m of the water column; (c) shipboard CTD and acoustic Doppler current profiler (ADCP) surveys over the shelf and adjacent slope to map regional water property and current distributions; (d) a long-term moored and coastal meteorological array including one sounding station to obtain time series observations of the atmospheric surface forcing and monitor the structure of the marine boundary layer; and (e) overflights with an instrumented aircraft to measure the spatial structure of the surface wind, wind stress, and heat flux fields under different atmospheric conditions.

This report has two objectives: (a) to describe the SMILE field program, including overviews of the five components, and (b) to present a statistical and graphical summary of the atmospheric (wind, air temperature, pressure, relative humidity, short- and long-wave radiation) and oceanic (current, water temperature, and conductivity) long-term array measurements made as part of SMILE. A more detailed description of the instrumentation used in SMILE and an assessment of instrument performance and accuracy are presented separately by Dean *et al.* (1991).

1. Introduction

The Shelf MIxed Layer Experiment (SMILE) was a cooperative research program designed to study how the ocean surface boundary layer over the continental shelf responds to atmospheric forcing. The SMILE field program was conducted over the northern California shelf primarily between Pt. Arena and Pt. Reyes from mid-November 1988 to mid-May 1989 (Figure 1). The site and timing were chosen because (a) historical data suggested that there would be a wide range of wind stress, surface heating and stratification conditions (Nelson, 1977; Nelson and Husby, 1983; Huyer, 1984), (b) previous CTD and moored observations made during the 1981–82 Coastal Ocean Dynamics Experiment (CODE) (Lentz, 1990) offer a good characterization of the interior current and density fields and some information on the local surface boundary layer behavior, and (c) two complementary field programs, the MMS-funded Northern California Coastal Circulation Study (NCCCS) (EG&G, 1989) and the ONR-funded Sediment Transport Events over the Shelf and Slope (Nowell *et al.*, (STRESS), 1987) were conducted in the same region at this time. The earlier CODE measurements showed that the surface and bottom boundary layer thicknesses can vary in time and space from less than a meter to more than 60 m depending on the boundary forcing and ambient stratification. Both layers often comprise a substantial fraction of the total water column, even over the outer shelf. The surface boundary layer is difficult to observe because of the problems associated with making reliable measurements near an energetic moving free surface and because of the dynamic character of the surface boundary layer itself which varies in time and space. Moored observations made in recent continental shelf field studies have typically been concentrated in the interior away from both boundary layers, so that the surface and bottom boundary layers are either poorly resolved or not sampled at all. As a consequence, very few data sets exist which can be used to describe the surface and bottom boundary layers over the shelf and investigate their dynamics.

SMILE was undertaken to obtain a comprehensive set of high-quality atmospheric and oceanographic measurements to determine the spatial and temporal characteristics of the continental shelf surface boundary layer and its response to atmospheric forcing and thus to provide a basis for developing and evaluating models of the shelf surface boundary layer. The proposed SMILE field program had six scientific objectives:

1. to determine by direct measurement at the central mid-shelf site the vertical structure of horizontal velocity and density through the surface layer and under what conditions the surface layer is well-mixed (*i.e.*, slablike),

2. to measure directly the very near-surface shear and determine its dependence on atmospheric forcing, the surface wave field, and current conditions,

3. to make crude estimates of the cross- and along-shelf scales over which the surface boundary layer structure varies,

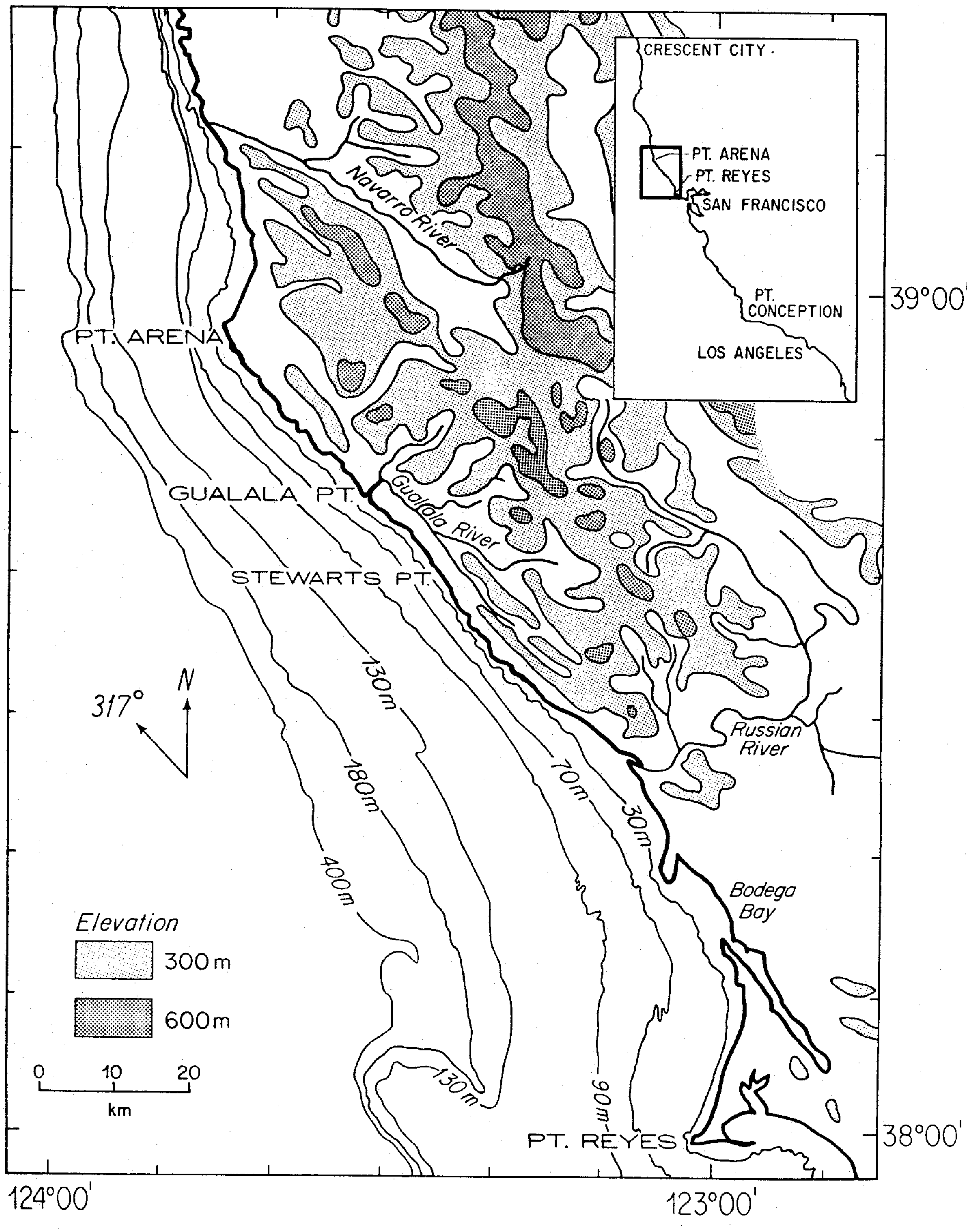


Figure 1: Bathymetric chart of northern California shelf and upper slope region from Pt. Reyes to north of Pt. Arena. The SMILE field program was focused near Stewarts Point. Depth in meters.

4. to construct volume and layered mass and heat budgets which allow estimation of the vertical velocity profile over the mid-shelf,

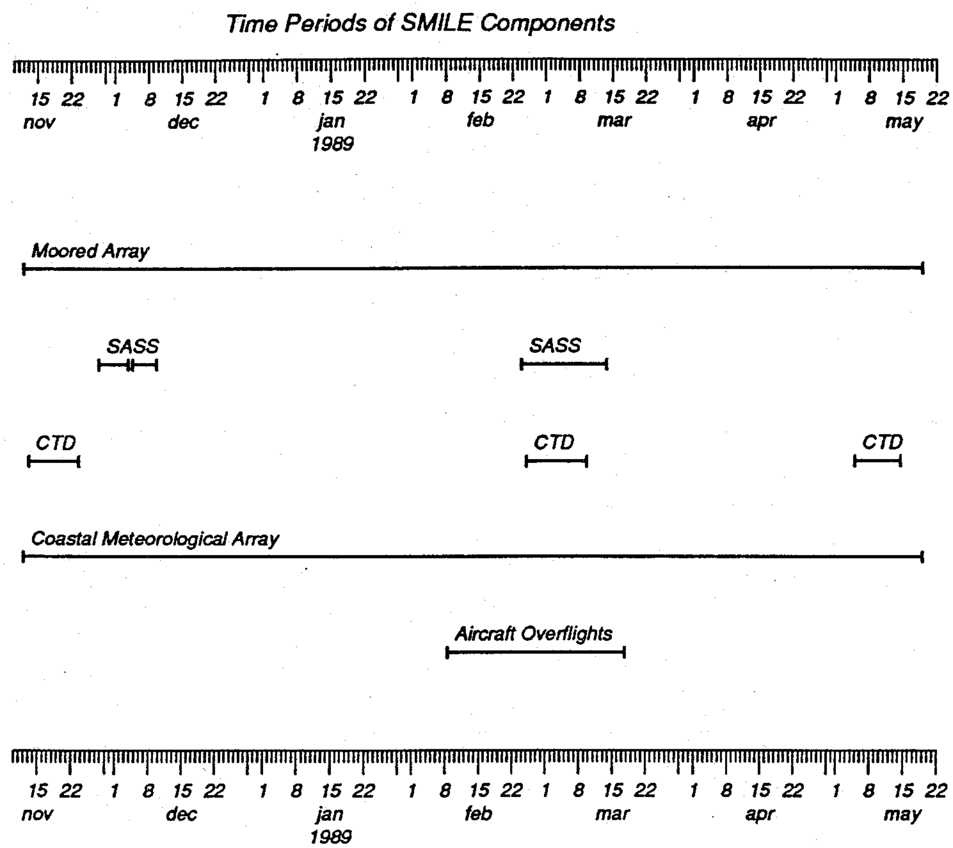
5. to determine the vertical resolution necessary to resolve the vertical structure of the mixed layer over the continental shelf,

6. to investigate the near-surface wind field and wind stress field during winter storms and document the re-establishment of the coastal stable marine layer between storms.

To address these objectives, a group of eight principal investigators at four different institutions (see Table 1) developed the SMILE field program which included the following five main components: (a) a long-term moored array to obtain current, temperature, and conductivity time series observations in the upper ocean over the shelf; (b) a short-term moored instrument deployment to measure the vertical current shear and stratification in the top 6 m of the water column; (c) shipboard CTD and acoustic Doppler current profiler (ADCP) surveys over the shelf and adjacent slope to map regional water property and current distributions; (d) a long-term moored and coastal meteorological array, including one sounding station, to obtain time series observations of the atmospheric surface forcing and monitor the structure of the marine boundary layer; and (e) overflights with an instrumented aircraft to measure the spatial structure of the surface wind, wind stress, and heat flux fields under different atmospheric conditions. The timing of these various components is shown in Figure 2.

This report has two objectives: a) to provide a brief description of the SMILE field program, including overviews of the five SMILE components and the complementary STRESS and NCCCS studies; and (b) to present statistical and graphical summaries of the long-term atmospheric and oceanographic measurements made as part of SMILE. In particular, standard statistics and time series plots of the following variables are presented: wind, air temperature, atmospheric pressure, relative humidity, insolation, long-wave solar radiation, rainfall, current, water temperature, and salinity (derived from temperature and conductivity measurements). To make the presentation of the moored current, temperature, and salinity data complete, observations made as part of STRESS by B. Butman of the United States Geological Survey (USGS) are also presented. A more detailed description of the instrumentation used in SMILE and an assessment of instrument performance and accuracy are presented separately by Dean *et al.* (1991).

This report is organized in the following way. A description of the SMILE field program is presented in Section 2. This includes a description of the five components of the field program and the associated data return. A brief overview of the complimentary STRESS and NCCCS programs is given in Section 3. A description of the long-term meteorological and oceanic data analysis procedures and data presentations is given in Section 4. Compilations are presented in Section 7 of the coastal and moored meteorological measurements



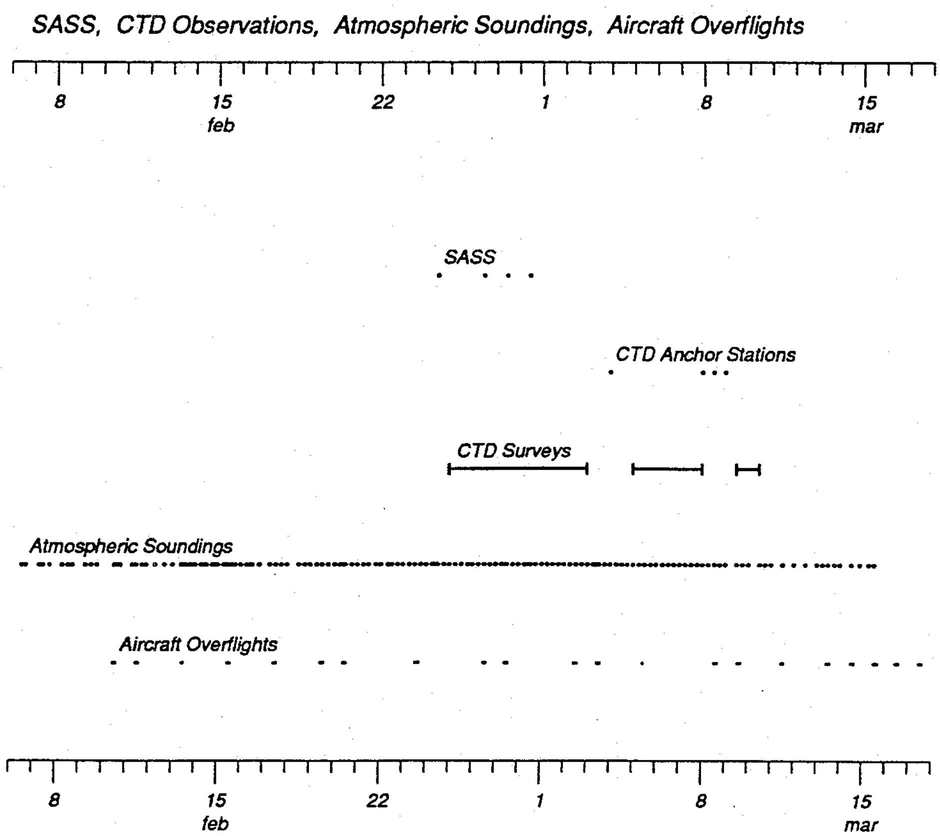


Figure 2: Timeline of the five main components of the SMILE field program from mid-November 1988 to mid-May 1989 (upper). Timeline for the intensive period (February 6 to March 18) showing aircraft overflights, atmospheric soundings at Stewarts Point, CTD observations, and SASS deployment (lower).

(7.1), moored velocity measurements (7.2), and the temperature and conductivity measurements (7.3). These compilations consist of basic statistics and time-series plots of unfiltered (hourly averages) and low-pass filtered data for each instrument.

Table 1: Principal Investigators and Primary Areas of Responsibility

Investigator	(Affiliation)	Areas of Responsibility
S. Lentz R. Beardsley R. Limeburner	(WHOI) (WHOI) (WHOI)	Long-term meteorological, current, temperature, and conductivity measurements at central site, hydrography, shipboard current measurements, overall program coordination.
R. Davis	(SIO)	Long-term current and temperature measurements at four perimeter sites.
A. J. Williams III E. Terray	(WHOI) (WHOI)	Short-term near-surface current, temperature, and conductivity measurements, long-term swell and wind-wave observations.
C. Friehe	(UCI)	Aircraft measurements of wind, wind stress, heat flux and sea surface temperature spatial variability and three-dimensional structure of marine layer.
C. Dorman	(SDSU)	Long-term coastal measurements of wind, rainfall, and other meteorological variables. Coastal soundings to monitor the vertical structure of marine layer.

Institutional affiliations are Scripps Institution of Oceanography (SIO), San Diego State University (SDSU), University of California, Irvine (UCI), and Woods Hole Oceanographic Institution (WHOI).

2. Overview of the SMILE Field Program

2.1 The Moored Oceanographic Array Component

The focal point of the SMILE field program was a five element moored array of oceanographic instrumentation deployed for a six-month period from mid-November 1988 to mid-May 1989. The locations of the SMILE moorings are listed in Table 2 and shown in Figure 3 along with the coastal meteorological stations discussed in Section 2.4 and the NCCCS moorings discussed in Section 3.2. The central mid-shelf mooring (C3) was set within a cross-configuration with moorings C2, C4, and M3, G3 yielding cross-shelf and along-shelf spatial information respectively. The along-shelf sub-array (G3, C3, and M3) was deployed approximately along the 93-m isobath, with horizontal spacings of 14.5 km between G3 and C3 and 14.7 km between C3 and M3. The cross-shelf sub-array (C2, C3, and C4) was deployed along a cross-shelf transect spanning the 80 m to the 120-m isobaths, with horizontal spacings of 3.2 km between C2 and C3 and 4.9 km between C3 and C4. These spatial separations were chosen to make this a coherent array for subtidal flow based on the previous CODE observations in this region. The C2 mooring was originally deployed closer to shore on the 60-m isobath, however, the mooring was found adrift six days after deployment. The mooring was then recovered with all instrumentation intact and redeployed during the February 1989 hydrographic cruise in slightly deeper water at the 80-m site shown in Figure 3. This new site was located outside the nearshore zone of intense crab fishing since it was believed that crabbers may have set the mooring adrift while retrieving their trap lines.

The central mid-shelf C3 mooring utilized a WHOI-designed 3 m diameter discus buoy to support both meteorological and oceanographic instrumentation (Figure 4). The C3 meteorological instrumentation included two Vector-Averaging Wind Recorders (VAWRs) equipped to measure wind and other atmospheric variables, water temperature at depths of 1 and 1.8 m, and conductivity at 1 m depth (see Section 2.4.1 for a description of the meteorological buoy and the VAWR instrumentation). Beneath the discus buoy was a string of 12 VMCMs with the rotor pairs centered at depths of 4, 7, 10, 13, 16, 19, 22, 27, 32, 37, 42, and 47 m. The VMCM was developed at SIO in the late 1970s by Weller and Davis (1980) to obtain accurate velocity measurements in the upper ocean when deployed on surface moorings. The field comparisons in CODE by Beardsley (1987) and Pettigrew *et al.* (1986) suggest that the VMCM mechanically filters out much of the high-frequency surface gravity wave and mooring motion noise and yields horizontal velocity measurements accurate to within a few percent. To complement the standard VMCM temperature measurements and obtain direct measurements of conductivity to allow estimation of salinity, self-contained temperature-conductivity units built by SeaBird Electronics called SeaCats were mounted on every other VMCM starting at 7 m. The VMCM at 47 m also had an EG&G conductivity

Table 2: SMILE Station Information

Station	Abbrev-iation	Station Elevation(+)/ Water Depth (-) m	Location (°N/°W)	
Cabrillo Pt. Light*	CL	15	39°20.95′	123°49.55′
NDBC 14	14	−306	39°11.98′	124°00.00′
Pt. Arena Light	PT	19	38°57.30′	123°44.40′
Gualala Pt. Park*	GP	14	38°45.56′	123°32.23′
SMILE Mooring G3	G3	−93	38°44.40′	123°36.40′
SMILE Mooring C2	C2	−80	38°39.80′	123°27.82′
SMILE Mooring C3	C3	−93	38°38.71′	123°29.56′
USGS Mooring C3b	C3b	−97	38°38.44′	123°29.64′
	C3b	−95	38°38.14′	123°29.97′
SMILE Mooring C4	C4	−117	38°36.78′	123°31.87′
Cloverdale Airport*	CA	83	38°46.45′	122°59.00′
Stewarts Point, Ridge*	SR	238	38°39.80′	123°23.63′
Stewarts Point, Beach*	SB	28	38°39.38′	123°24.15′
SMILE Mooring M3	M3	−93	38°32.67′	123°22.97′
Bodega Bay Marine Lab	BB	9	38°19.00′	123°04.00′
NDBC 13	13	−125	38°11.98′	123°18.00′

* Portable Atmospheric Monitor (PAM) station.

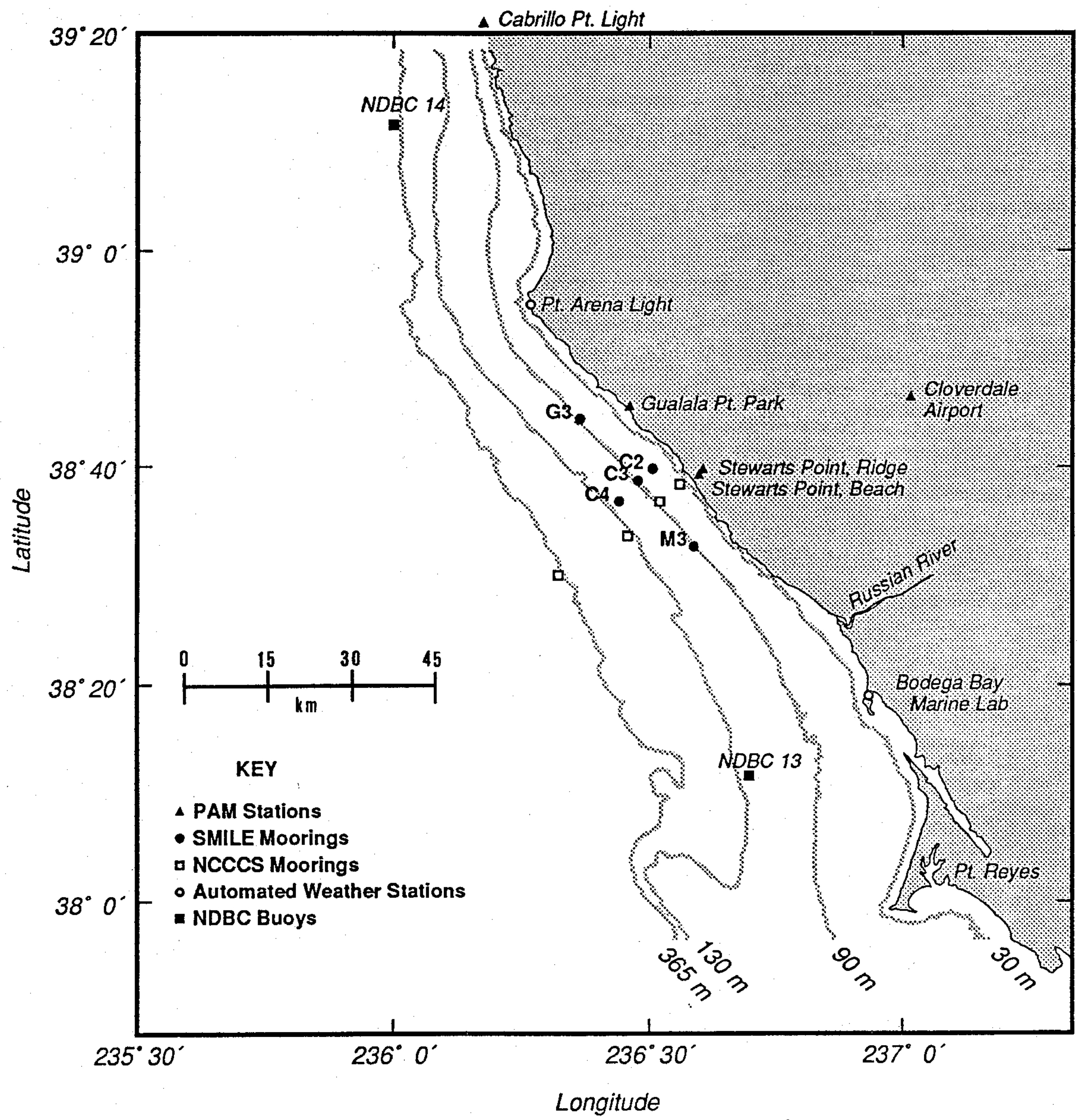


Figure 3: Map of the northern California shelf, showing locations of the SMILE long-term moored and coastal array. Also shown are locations of the two NDBC environmental buoys (NDBC 13 and NDBC 14) and the four NCCCS moorings deployed across the shelf just south of the SMILE central line.

cell. A 1700-pound depressor weight was attached to the mooring line about 20 m below the lowest VMCM to help keep the VMCM string as vertical as possible (tilts less than 12°) during strong currents.

A subsurface mooring supporting five VACMS at depths of 67, 73, 79, 85, and 91 m was deployed and maintained near the C3 discus mooring by B. Butman (USGS) as part of STRESS (Figure 4). This mooring was set in early December 1988, recovered and redeployed in late February 1989, and finally recovered in early May 1989. Three of the VACMs (at 67, 79, and 91 m) were fitted with SeaBird Electronics conductivity cells and SeaTech 25 cm beam transmissometers wired into the VACM electronics and data logger. The horizontal separation of the USGS mooring from the C3 discus mooring was 0.5 km during the first subsurface mooring deployment and 1.2 km during the second deployment. For completeness the USGS moored VACM data is included in the data summaries and displays. A brief description of the STRESS program is given in Section 3.

The four SMILE moorings (Figure 4) surrounding the central C3 mooring used SIO-designed 3 m toroids as their surface floatation. Three of these moorings were nearly identical in design (C4, M3, and G3). Each supported a basic VAWR with wind speed and direction sensor set at 3.5 m and a water temperature sensor at 1 m below the surface, and a separate temperature pod (T-pod) at 2 m below surface. The T-pods were self-contained temperature loggers built by Brancker Instruments and modified for oceanographic use by L. Regier (SIO). Both temperature sensors were installed on the bridle of the surface toroid. Attached to the mooring line below the bridle was a VMCM at 10 m, a self-contained SIO temperature chain with 14 temperature sensors per T-chain spanning the upper 50 m, and an upward-looking 300 kHz ADCP (manufactured by RD Instruments) with the acoustic transponders located at 54 m. The C2 toroid also supported a basic VAWR with wind speed and direction sensor set at 3.5 m and a water temperature sensor at 1 m below surface but because of the shallow deployment depth, a downward-looking 300 kHz ADCP was mounted within the toroid bridle with the acoustic transponders at 2 m depth. Attached to the mooring line beneath the C2 bridle was a VMCM at 10 m and 14 T-pods concentrated in the upper 50 m. The four ADCPs were configured to record data in 32 depth bins with a ping length of 6 m and a bin size of 2 m. Each profile was the average of 100 pings and a new profile was written every 7.5 minutes. The four toroid moorings were also set with depressor weights to help keep the mooring line vertical during strong flows. A cross-section of the shelf bottom bathymetry showing the instrument locations for the cross-shelf sub-array (C2–C4) is shown in Figure 5.

The overall data return was good but not outstanding, roughly 90% for temperature and conductivity and 70% for currents. The C2 mooring was found to be drifting six days after deployment. The mooring was recovered with all instrumentation and redeployed during the February 1989 hydrographic cruise in slightly deeper water (80 m versus 60 m), outside the nearshore zone of intense crab fishing. Of the 14 temperature pods deployed on the C2 mooring, the 37 m sensor was lost during mooring recovery operations. The central C3 mooring suffered several instrument problems which limited its data return. A leak in one of the C3 VAWRs caused the complete loss of water temperature data at 1 and 1.8 m depth. Additionally, the conductivity sensor on the C3 VAWR returned no data because it was improperly wired. The WHOI VMCM current time series are typically only 4 to 5 months long, rather than the complete six-month deployment period, due to bearing corrosion problems. The 4 m VMCM record has a large data gap and the 7 m VMCM record has two smaller gaps which we believe are due to fouling by drifting kelp. The C4 VAWR was lost resulting in no atmospheric and 1 m water temperature at C4. A gouge in the aluminum stand for the VAWR suggests the VAWR was sheared off its base when the buoy was hit by a passing ship. No data were recovered from the 2 m temperature pod installed in the bridle of M3 and from the T-chain temperature sensor at 13 m depth. The M3 and G3 ADCPs ran for only 2–3 weeks. The cause for the short records is not known. The G3 VAWR had a clock problem which resulted in an increased sampling rate and a short record. A summary of the moored oceanographic instrumentation deployed during SMILE and the data return is given in Table 3.

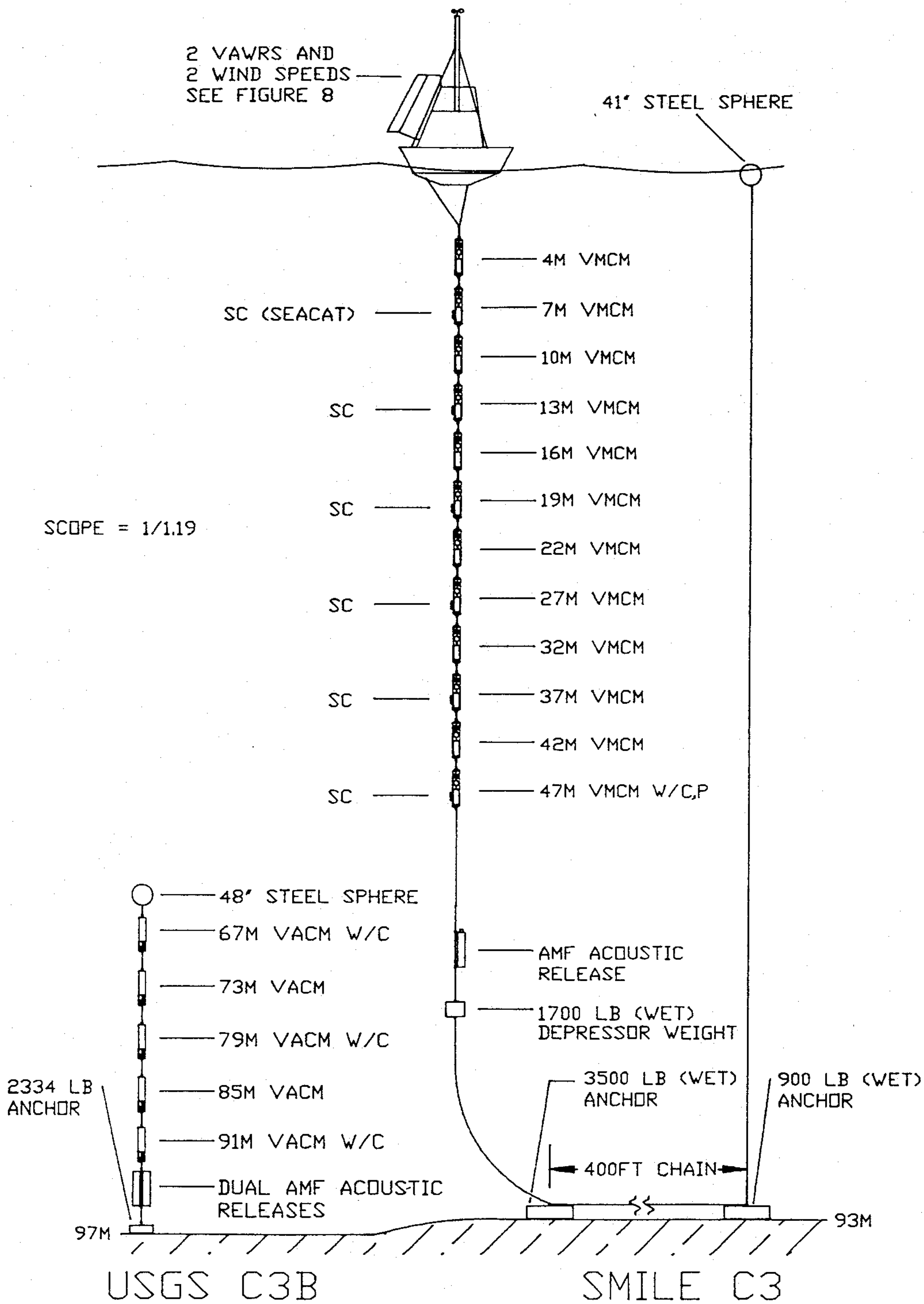


Figure 4: Schematics of the USGS and SMILE moorings.

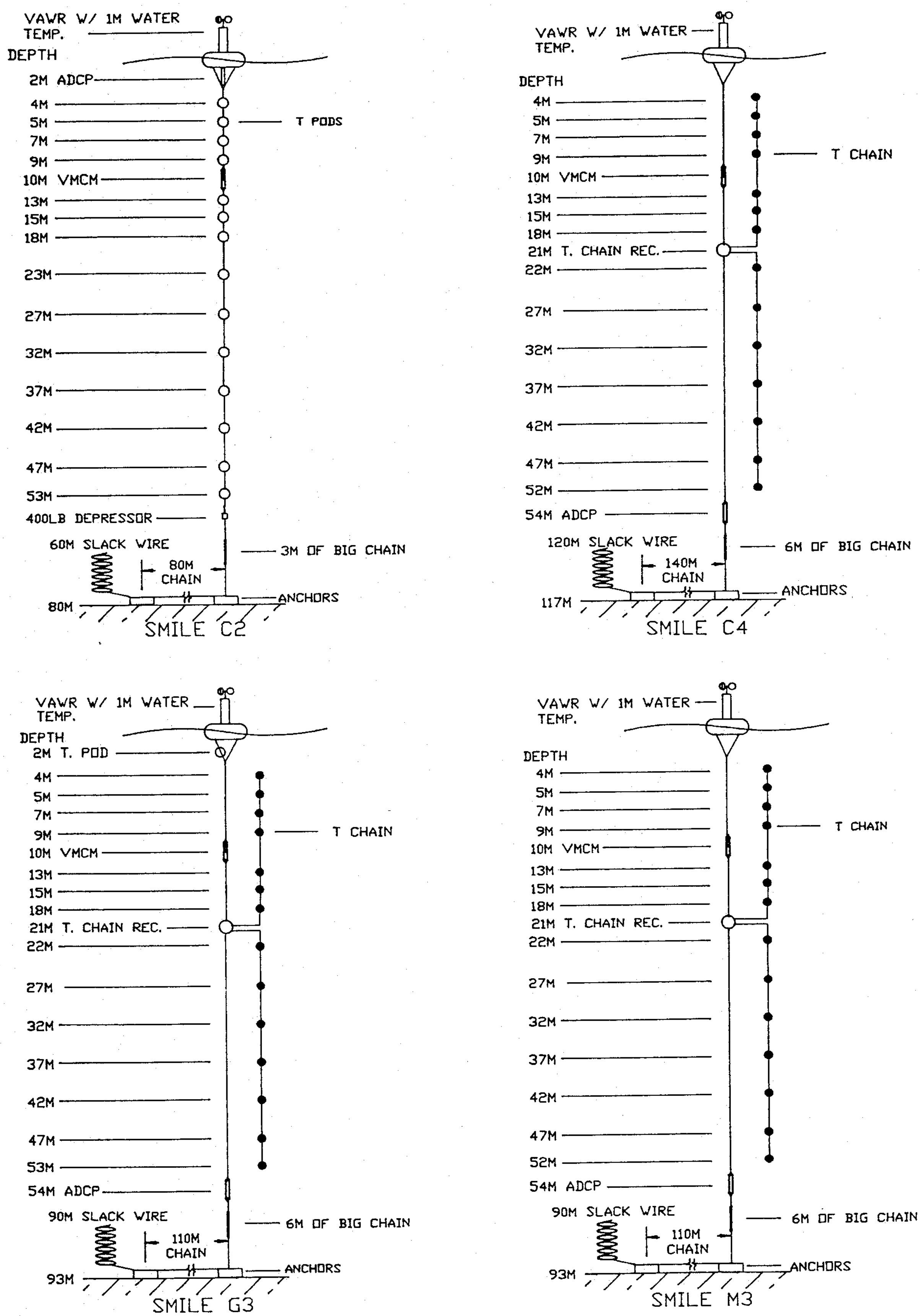


Figure 4: (Continued).

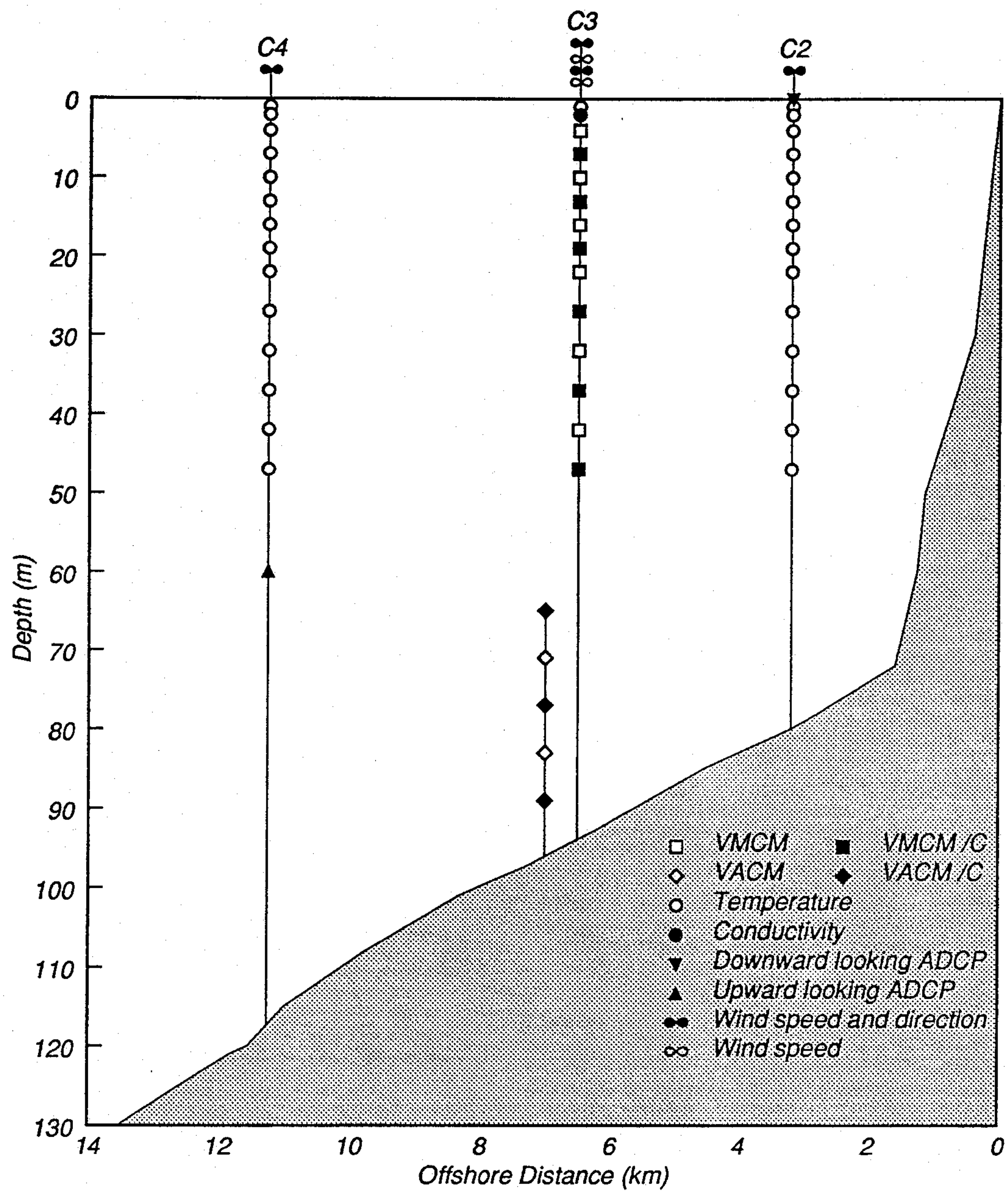


Figure 5: Cross-section of the shelf with bottom profile and instrument locations for the SMILE cross-shelf moored subarray formed by C2, C3, and C4. The USGS subsurface mooring at C3 is also shown.

Table 3: Summary of Moored Oceanographic Sensors Deployed During SMILE

Station	Sensor Type	Sensor Depth (m)	Record Rate (min)	Data Source	Record Length (days)	Comments
C2	T	1.0	15.0	WHOI	80	
C2	ADCP/T	2.0	7.5	SIO	80/80	
C2	T.POD	4.0	20.0	SIO	80	
C2	T.POD	5.0	20.0	SIO	80	
C2	T.POD	7.0	20.0	SIO	80	
C2	T.POD	8.0	20.0	SIO	80	
C2	VMCM/T	10.0	7.5	SIO	80/80	
C2	T.POD	13.0	20.0	SIO	80	
C2	T.POD	15.0	20.0	SIO	80	
C2	T.POD	18.0	20.0	SIO	80	
C2	T.POD	23.0	20.0	SIO	80	
C2	T.POD	27.0	20.0	SIO	80	
C2	T.POD	32.0	20.0	SIO	80	
C2	T.POD	37.0	20.0	SIO	—	lost
C2	T.POD	42.0	20.0	SIO	80	
C2	T.POD	47.0	20.0	SIO	80	
C2	T.POD	53.0	20.0	SIO	80	
C3	T	1.0	7.5	WHOI	—	no data
C3	T	1.8	7.5	WHOI	—	no data
C3	CD	1.0	7.5	WHOI	—	no data
C3	VMCM/T	4.0	7.5	WHOI	80/188	2 gaps
C3	VMCM/T	7.0	7.5	WHOI	178/188	2 gaps
C3	CD,T	7.0	5.0	WHOI	188/188	
C3	VMCM/T	10.0	7.5	WHOI	164/164	short
C3	VMCM/T	13.0	7.5	WHOI	75/188	short
C3	CD,T	13.0	5.0	WHOI	188/188	
C3	VMCM/T	16.0	7.5	WHOI	151/188	short
C3	VMCM/T	19.0	7.5	WHOI	188/188	
C3	CD,T	19.0	5.0	WHOI	188/188	
C3	VMCM/T	22.0	7.5	WHOI	137/188	short
C3	VMCM/T	27.0	7.5	WHOI	130/188	short
C3	CD,T	27.0	5.0	WHOI	188/188	
C3	VMCM/T	32.0	7.5	SIO	188/188	
C3	VMCM/T	37.0	7.5	WHOI	132/188	short
C3	CD,T	37.0	5.0	WHOI	188/188	
C3	VMCM/T	42.0	7.5	SIO	188/188	
C3	VMCM/T,CD,P	47.0	7.5	WHOI	129/188/188/188	short
C3	CD,T	47.0	5.0	WHOI	188/188	
C3b	VACM/CD,T	67.0	3.75	USGS	84/84/84	
C3b	VACM/T	73.0	3.75	USGS	84/84	
C3b	VACM/CD,T	79.0	3.75	USGS	84/84/84	
C3b	VACM/T	85.0	3.75	USGS	84/84	
C3b	VACM/CD,T	91.0	3.75	USGS	84/84/84	
C3b	VACM/CD,T	65.0	3.75	USGS	63/63/63	
C3b	VACM/T	71.0	3.75	USGS	63/63	
C3b	VACM/CD,T	77.0	3.75	USGS	63/63/63	
C3b	VACM/T	83.0	3.75	USGS	63/63	
C3b	VACM/CD,T	89.0	3.75	USGS	63/63/63	
C4	T	1.0	7.5	WHOI	—	lost
C4	T.POD	2.0	20.0	SIO	184	
C4	TC	4.0	2.0	SIO	184	
C4	TC	5.0	2.0	SIO	184	

Table 3: Moored Oceanographic Sensors Deployed during SMILE (Continued)

Station	Sensor Type	Sensor Depth (m)	Record Rate (min)	Data Source	Record Length (days)	Comments
C4	TC	7.0	2.0	SIO	184	
C4	TC	9.0	2.0	SIO	184	
C4	VMCM/T	10.0	7.5	SIO	184/184	
C4	TC	13.0	2.0	SIO	184	
C4	TC	15.0	2.0	SIO	184	
C4	TC	18.0	2.0	SIO	184	
C4	TC	22.0	2.0	SIO	184	
C4	TC	27.0	2.0	SIO	184	
C4	TC	32.0	2.0	SIO	184	
C4	TC	37.0	2.0	SIO	184	
C4	TC	42.0	2.0	SIO	184	
C4	TC	47.0	2.0	SIO	184	
C4	TC	53.0	2.0	SIO	184	
C4	ADCP/T	54.0	7.5	SIO	184/184	
G3	T	1.0	3.75	WHOI	147	short
G3	T.POD	2.0	20.0	SIO	184	
G3	TC	4.0	2.0	SIO	184	
G3	TC	5.0	2.0	SIO	184	
G3	TC	7.0	2.0	SIO	184	
G3	TC	9.0	2.0	SIO	184	
G3	VMCM/T	10.0	7.5	SIO	183/183	
G3	TC	13.0	2.0	SIO	184	
G3	TC	16.0	2.0	SIO	184	
G3	TC	19.0	2.0	SIO	184	
G3	TC	22.0	2.0	SIO	184	
G3	TC	27.0	2.0	SIO	184	
G3	TC	32.0	2.0	SIO	184	
G3	TC	37.0	2.0	SIO	184	
G3	TC	42.0	2.0	SIO	184	
G3	TC	47.0	2.0	SIO	184	
G3	TC	53.0	2.0	SIO	184	
G3	ADCP/T	54.0	7.5	SIO	15/15	short
M3	T	1.0	7.5	WHOI	185	
M3	T.POD	2.0	20.0	SIO	—	no data
M3	TC	4.0	2.0	SIO	184	
M3	TC	5.0	2.0	SIO	184	
M3	TC	7.0	2.0	SIO	184	
M3	TC	9.0	2.0	SIO	184	
M3	VMCM/T	10.0	7.5	SIO	185/185	
M3	TC	13.0	2.0	SIO	—	no data
M3	TC	15.0	2.0	SIO	184	
M3	TC	18.0	2.0	SIO	184	
M3	TC	22.0	2.0	SIO	184	
M3	TC	27.0	2.0	SIO	184	
M3	TC	32.0	2.0	SIO	184	
M3	TC	37.0	2.0	SIO	184	
M3	TC	42.0	2.0	SIO	184	
M3	TC	47.0	2.0	SIO	184	
M3	TC	52.0	2.0	SIO	184	
M3	ADCP/T	54.0	7.5	SIO	22/22	short
13	T	1.0	60.0	SDSU	188	
14	T	1.0	60.0	SDSU	188	

Abbreviations:

VACM:	Vector Averaging Current Meter	CD:	Conductivity
VMCM:	Vector Measuring Current Meter	P:	Pressure
ADCP:	Acoustic Doppler Current Profiler	T:	Water Temperature
T.POD:	Temperature Logging Pod	TC:	Thermistor Chain

Note: The VMCM/T is the standard current meter and multiple entries in the record length indicates the individual sensors.

2.2 Surface Shear Measurement (SASS) Component

The Surface Acoustic Shear Sensor (SASS) shown in Figure 6 was designed and deployed by A. J. Williams (WHOI) and co-workers to obtain high-quality, high-frequency measurements of the three dimensional velocity vector at six levels within the top 6 m of the water column (see Montgomery and Santala, 1989, for a description of SASS as used in SMILE). The SASS platform was a triangular frame with large surface floats at each apex so that the platform would follow the sea surface even in wind waves and maintain the velocity sensors at fixed depths perpendicular to the sea surface. The water velocity measurements relative to the platform were made with small acoustic travel-time velocimeters (Williams *et al.*, 1987). The motion of the platform was measured with a two-axis gyro motion sensing package and a VACM compass. The combination of the water velocity relative to the platform with the motion of the platform then gave absolute water velocity. The SASS platform was also equipped with two temperature/conductivity sensor sets and a wavestaff. SASS sampled at a rate of 4 Hz, and both sampling instructions and data were transmitted to ship or a shore station at Sea Ranch near Stewarts Point by a FM transceiver. The SASS mooring was placed as close as possible (about 500 m) to the C3 mooring (38°38.71′N, 123°29.56′W) so that the data from the two sets of instruments would nominally describe the same parcel of water and meaningful comparisons between the SASS and VMCM velocity measurements could be made. SASS was deployed for 12 days in the fall and 18 days in the winter. Data was selectively acquired for periods of 1–7 hours to sample a variety of conditions. Summary information for the SASS deployments and data return is given in Table 4.

Table 4: Summary of Available SASS Data

FALL DEPLOYMENT			
Position	Date Set/Recovered (GMT)	Available Data	Velocity Sensor Depths (cm)
38°38.88′N 123°29.32′W	27 Nov 1988@1600 03 Dec 1988 @1530	28 Nov 1988 182 minutes	110.8, 165.8, 251.1, 311.1, 391.4, 584.6

FALL DEPLOYMENT (Batteries Recharged)			
Position	Date Set/Recovered (GMT)	Available Data	Velocity Sensor Depths (cm)
38°38.93′N 123°29.38′W	04 Dec 1988 @1530 09 Dec 1988 @1600	05 Dec 1988 59 minutes	110.8, 165.8, 251.1, 311.1, 391.4, 584.6
		06 Dec 1988 101 minutes	

SPRING DEPLOYMENT			
Position	Date Set/Recovered (GMT)	Available Data	Velocity Sensor Depths (cm)
38°38.83′N 123°29.27′W	23 Feb 1989 @2140 13 Mar 1989 @1530	24 Feb 1989 260 minutes	110.8, 251.1, 311.1, 584.6
		26 Feb 1989 79 minutes	
		27 Feb 1989 365 minutes	
		28 Feb 1989 404 minutes	

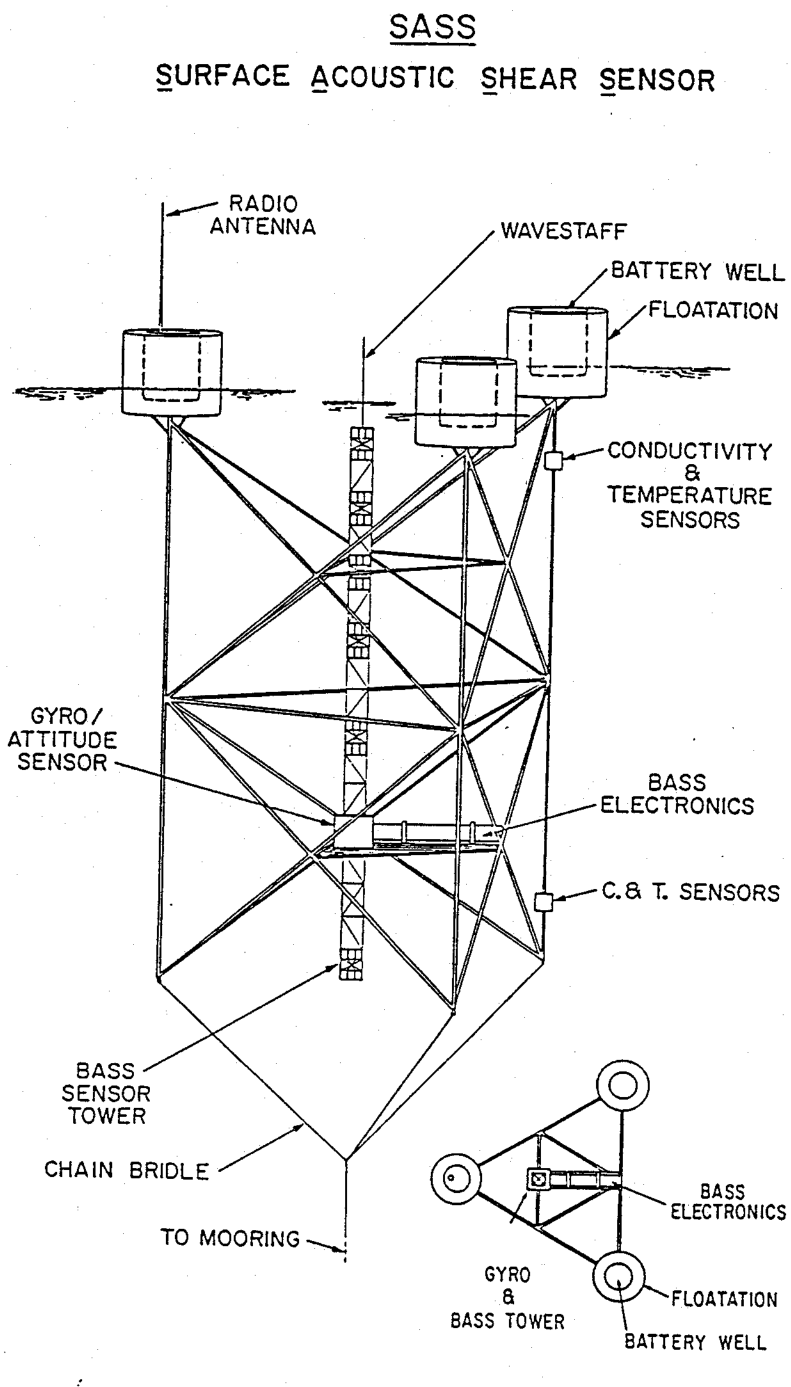


Figure 6: Schematic of Surface Acoustic Shear Sensor (SASS) showing the structure, floatation, sensor positions and radio location.

2.3 Hydrographic Component

Three hydrographic cruises were completed aboard the **R/V Wecoma** during SMILE: November 1988 following the mooring deployment; February/ March 1989 midway through the mooring deployment; and May 1989 during the spring transition and just before the mooring recovery operations. The three hydrographic cruises collected current profile data with a RD Instruments 150 kHz ADCP along most of the trackline and made a total of 860 CTD profiles using the ship's Neil Brown Instrument Systems Mark 3 CTD equipped with a SeaTech 25 cm beam transmissometer. CTD profiles were usually made to within 5 m of the bottom or to a maximum depth of 1500 m in deeper water. The hydrographic data base includes three large-scale surveys (consisting of four lines perpendicular to the coast extending from north of Pt. Arena to south of Pt. Reyes), seven small-scale surveys (consisting of five or more lines perpendicular to the coast concentrated in the region of the moored array), six additional sections along the central mooring line, and three sections along the 90-m isobath. Approximate CTD station locations for the large- and small-scale surveys are shown in Figure 7 and a listing of the different hydrographic sections is presented in Table 5. The large- and small-scale CTD survey data are summarized in three WHOI technical reports by Limeburner and Beardsley (1989a, b, and c).

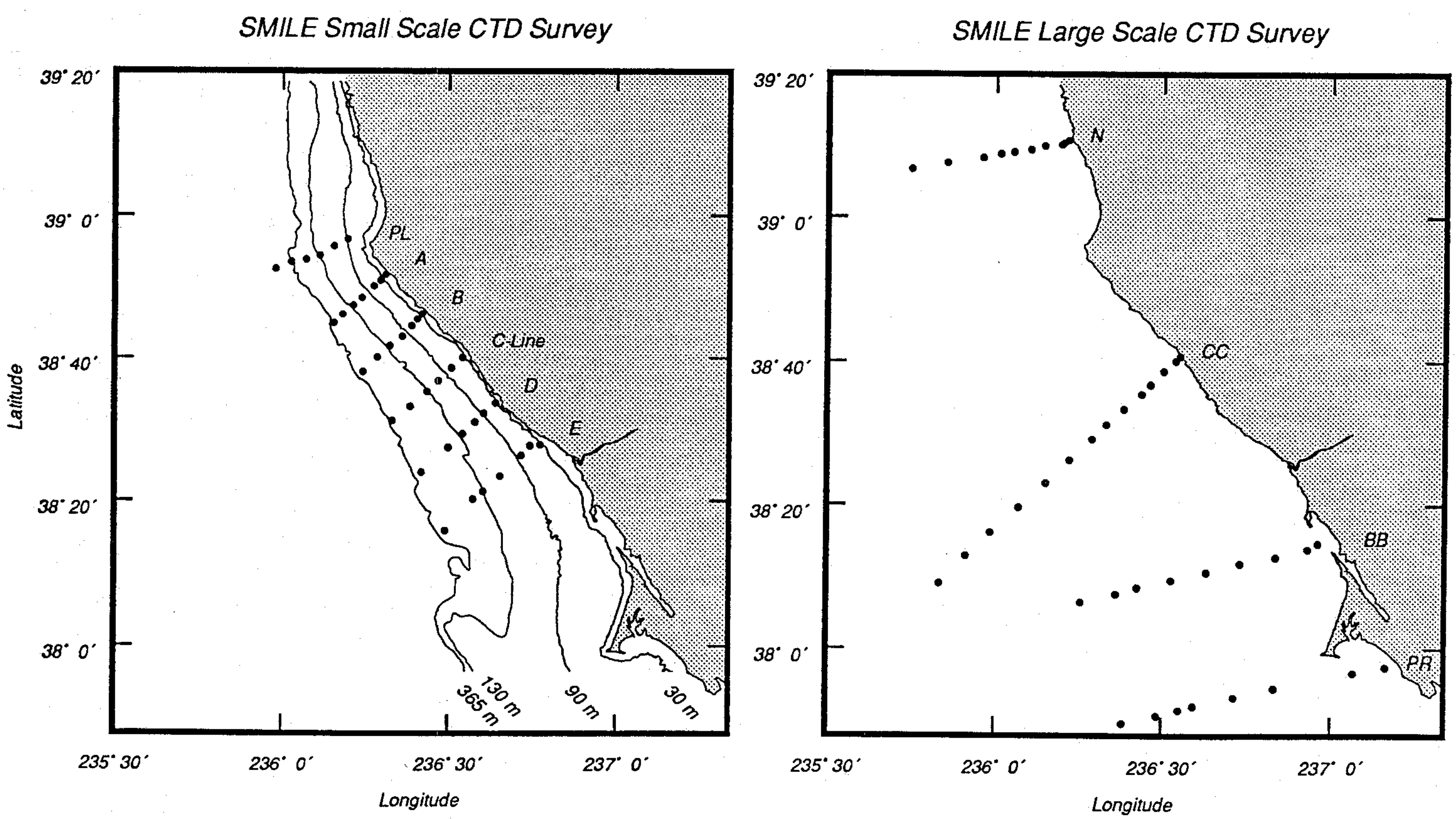


Figure 7: Examples of the repeated CTD small-scale (left) and large-scale (right) surveys conducted during SMILE. Actual station locations varied slightly during each surveys.

Table 5: Summary of CTD Observations Acquired During SMILE

Section	Date	Station Numbers
R/V Wecoma Cruise W8811:		
C-Line	13 Nov 1988	A1 – A6
Small-Scale No. 1 (Lines A–E)	15–16 Nov 1988	1 – 36
C-Line	16 Nov 1988	37 – 43
Yo-yo cast at mooring C3	18 Nov 1988	44 – 53
Along 93-m isobath	18 Nov 1988	54 – 57
Small-Scale No. 2 (Lines A–E)	19–20 Nov 1988	58 – 90
Along 93-m isobath	20 Nov 1988	91 – 92
Large-Scale (N, CC, BB, PR)	20–22 Nov 1988	93 – 133
Along 93-m isobath	22 Nov 1988	134 – 136
Small-Scale No. 3 (Lines A–E)	22–23 Nov 1988	137 – 167
C-Line	23 Nov 1988	168 – 173
Mooring C3 cast	24 Nov 1988	174
Yo-yo cast at mooring C4	24 Nov 1988	175 – 178
R/V Wecoma Cruise W8902:		
Large-Scale (N, CC, BB, PR)	25–27 Feb 1989	1 – 44
Small-Scale (Lines A–E)	27–28 Feb 1989	45 – 81
C-Line (CTD stations C4–C8)	28 Feb – 01 Mar 1989	82 – 86
Along 93-m isobath	03 Mar 1989	87 – 98
Yo-yo cast at mooring C3	04–05 Mar 1989	99 – 201
Along 93-m isobath	05 Mar 1989	202 – 206
Expanded Small-Scale (N, PL, A–E, BB, PR)	05–07 Mar 1989	207 – 271
Along 93-m isobath	07–08 Mar 1989	272 – 278
Yo-yo cast at mooring C2	08 Mar 1989	279 – 327
Yo-yo cast at mooring C4	08–09 Mar 1989	328 – 369
Yo-yo cast between CTD stations C6 and C7	09 Mar 1989	370 – 398
C-Line	09 Mar 1989	399 – 405
Along 93-m isobath	09–10 Mar 1989	406 – 419
R/V Wecoma Cruise W8905:		
Large-Scale (N, CC, BB, PR)	05–08 May 1989	1 – 44
Small-Scale (Lines A – E, BB)	08–09 May 1989	47 – 93
C-Line	10 May 1989	94 – 100
Yo-yo cast at CTD station C1	10–11 May 1989	102 – 121
PL-Line	11 May 1989	123 – 128
Small-Scale (Lines A – E, BB)	11–13 May 1989	129 – 170
Yo-yo cast at mooring C3	13–14 May 1989	171 – 255
C-Line	14 May 1989	256 – 263

2.4 Moored and Coastal Meteorological Component

2.4.1 Moored Meteorological Array

Meteorological instruments were deployed on the five SMILE surface buoys (Figure 3; Table 2) to obtain time series observations of the surface wind field and other atmospheric variables over the shelf during the long-term moored oceanographic measurements. The C3 meteorological instrumentation included two VAWRs equipped to measure wind speed at four levels (2, 3.5, 5, and 7 m), wind direction at two levels (3.5 and 7 m), air temperature at 2 m, relative humidity at 3 m, insolation (short-wave radiation) and downward long-wave radiation at 3 m, barometric pressure at 2.7 m, and water temperature at depths of 1 and 1.8 m (see Figure 8 for a schematic view of the C3 buoy). The top two wind sensors were mounted on a thin cylindrical mast and a large rigid steering vane was used to keep the buoy oriented into the wind so that the various sensors would have good exposure to clear air. The four surrounding buoys each supported a basic VAWR equipped with a wind speed and direction sensor set at 3.5 m and a water temperature sensor at 1 m below the surface.

Data return from the moored meteorological array was mixed. As noted in Section 2.1, the C2 mooring went adrift and was redeployed in February 1989. The C4 VAWR was missing in May 1989, and a gouge in the aluminum stand for the VAWR suggests that the surface buoy was hit by a passing ship. One of the C3 VAWRs leaked which resulted in the total loss of the sea surface and air temperature data. Data from the other sensors attached to that VAWR were recorded but with many small timing gaps in the records probably due to the water in the instrument case. Drift in the C3 relative humidity sensor caused the maximum relative humidity to exceed 100%. The G3 VAWR had a clock problem which resulted in an increased sampling rate and a short record. The other VAWRs worked well and gave complete records.

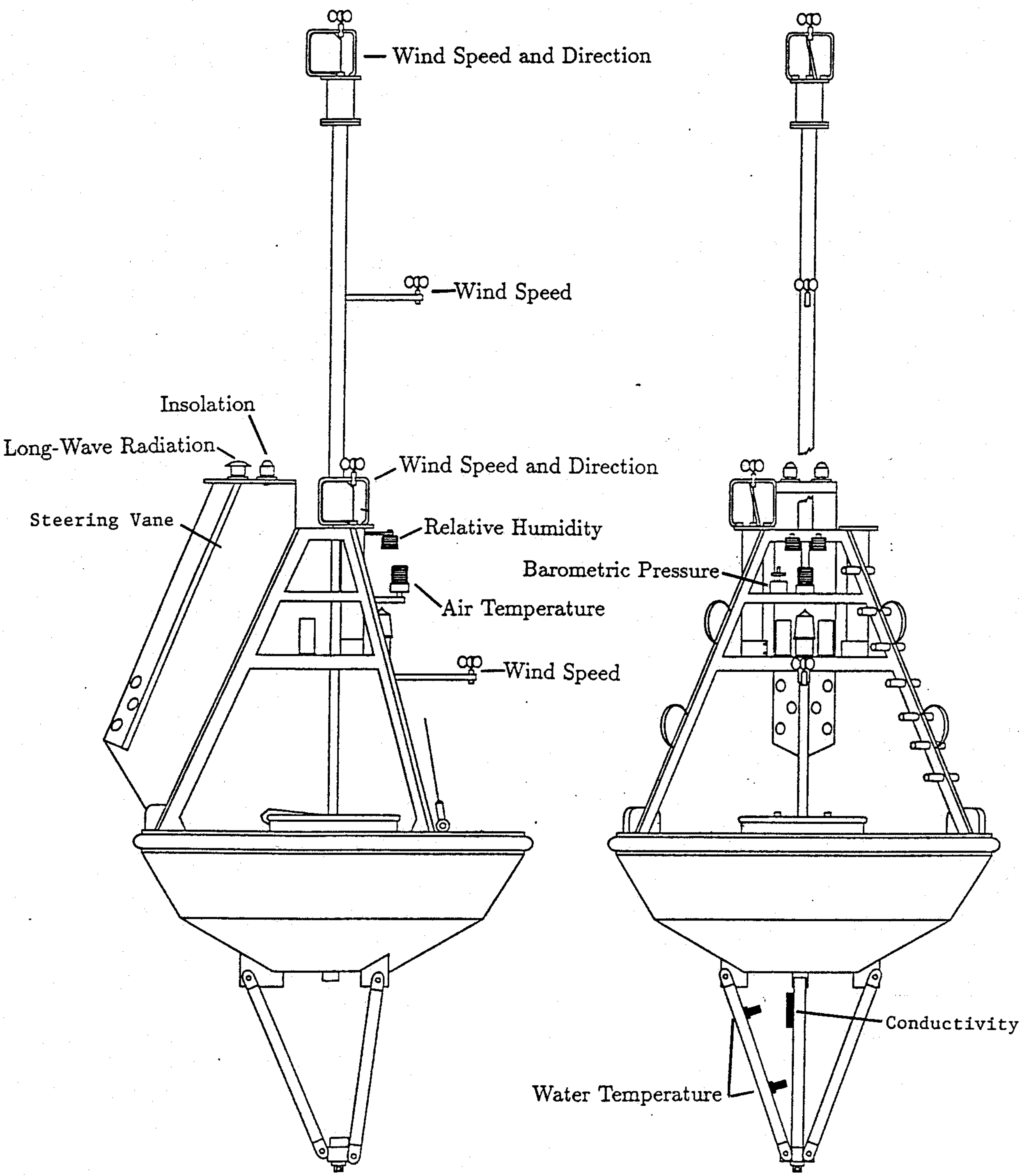


Figure 8: Schematic of the C3 surface discus buoy showing locations of various meteorological and oceanographic sensors.

2.4.2 Land-Based Meteorological Array

An array of meteorological stations was deployed along the coast of northern California from mid-November 1988 to mid-May 1989 to obtain better spatial information on the coastal wind field and other atmospheric variables during the moored array deployment (Figure 3; Table 2). This array consisted of five Portable Atmospheric Monitors (PAMs) designed to measure wind speed and direction at 10 m above ground, barometric pressure, air temperature, and dewpoint temperature at 2 m, and liquid precipitation (rainfall) at 1 m (see Figure 9 for a schematic view of a PAM and Militzer, 1987, for a detailed description). Data was collected from each sensor set every minute and transmitted directly to the National Center for Atmospheric Research (NCAR) for storage on 9-track tape via GEOS (Geostationary Operational Environmental Satellite). These units were developed at NCAR to support field experiments like SMILE, and the five PAMs used in SMILE were set up and maintained by NCAR technicians. The Stewarts Point PAM was modified to include insolation and downward long-wave radiation sensors (similar to those deployed on C3) to allow comparison of short- and long-wave radiation received at the coast and at mid-shelf (5 km offshore).

To augment the moored VAWR and coastal PAM coverage, atmospheric data were also obtained from existing coastal stations at Pt. Arena Light and the Bodega Bay Marine Laboratory and from NOAA Data Buoy Center (NDBC) environmental buoys NDBC 13 and NDBC 14 which bracket the SMILE moored array. The variables measured at these stations and buoys are listed in Table 6.

The PAM, coastal station and NDBC buoy data were obtained by C. Dorman (SDSU) and edited into basic hourly averaged time series before being sent to WHOI for final editing and inclusion in this report. The PAMs produced records with gaps of up to a few days for several reasons. Some sensor failures occurred, primarily due to air moisture. Small drifts in the wet and dry bulb sensors caused the computed relative humidity to exceed 100% at times. On a few occasions, there was a power or system failure of an individual PAM station which blocked all transmission from that station. On a few other occasions, the satellite signal was blocked or a system failure at NCAR resulted in the loss of all data from all PAMs. The coastal station data records also contain short gaps due mostly to individual sensor problems. The data return from the coastal and moored meteorological sensors is summarized in Table 6.

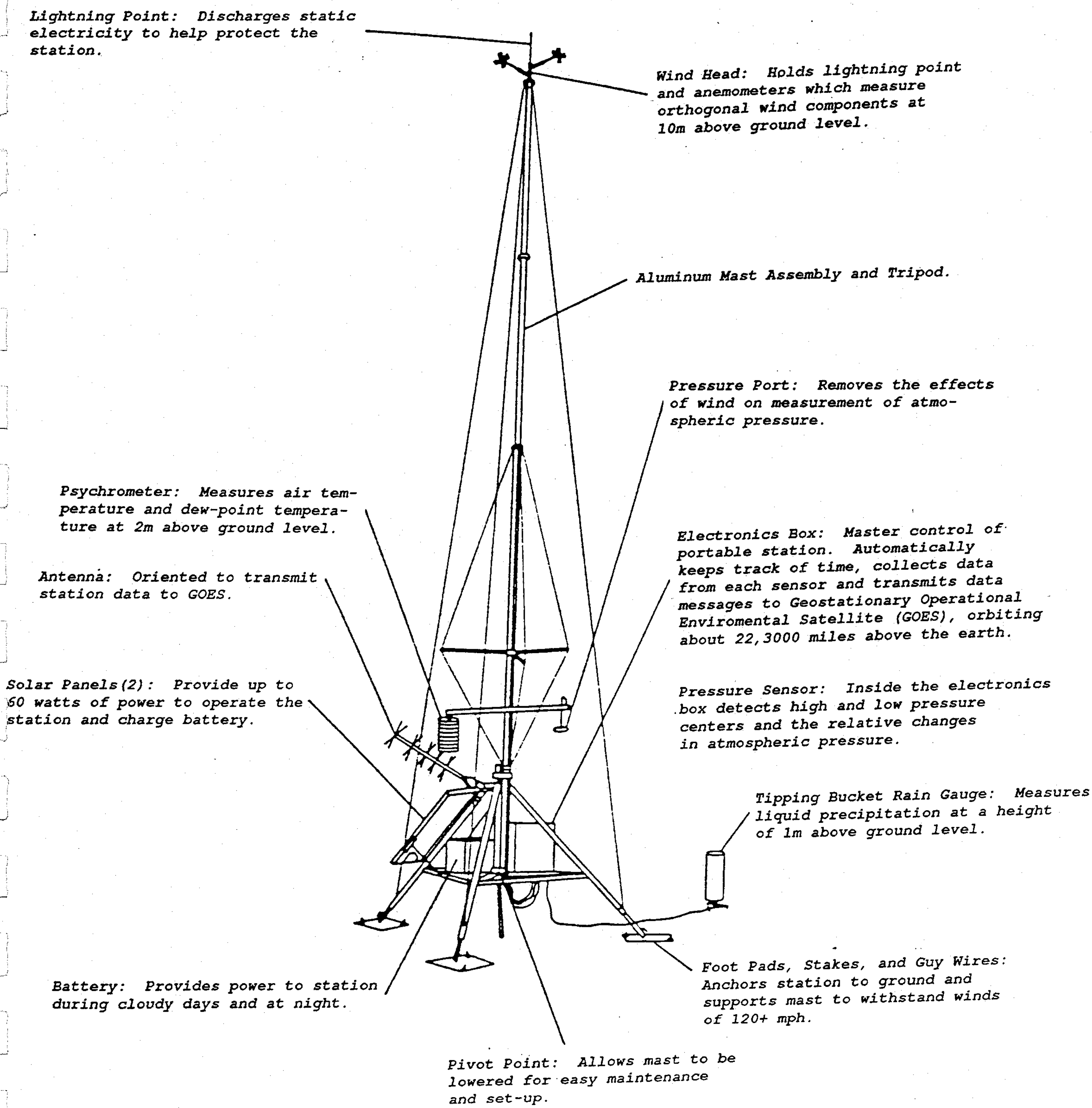


Figure 9: Schematic of the NCAR PAM II remote meteorological station showing locations of various meteorological sensors.

Table 6: Summary of Coastal and Moored Meteorological Sensors Deployed in SMILE

Station	Variable Type	Sensor Height (m)	Record Rate (min)	Data Source	Record Length (days)	Comments
CL	WS	10.0	1.0	SDSU	188	
CL	WD	10.0	1.0	SDSU	188	
CL	AT	2.0	1.0	SDSU	150	gaps
CL	BP	2.0	1.0	SDSU	183	gaps
CL	RF	2.0	1.0	SDSU	185	gaps
CL	RH	2.0	1.0	SDSU	185	gaps
14	WS	10.0	60.0	SDSU	114	
14	WD	10.0	60.0	SDSU	114	
14	AT	2.0	60.0	SDSU	114	
14	BP	10.0	60.0	SDSU	114	
14	DP	—	60.0	SDSU	114	
PT	WS	35.0	180.0	SDSU	192	
PT	WD	35.0	180.0	SDSU	192	
PT	AT	10.0	180.0	SDSU	192	
PT	BP	35.0	180.0	SDSU	192	
GP	WS	10.0	1.0	SDSU	189	
GP	WD	10.0	1.0	SDSU	189	
GP	AT	2.0	1.0	SDSU	180	gaps
GP	BP	2.0	1.0	SDSU	188	gaps
GP	RF	1.0	1.0	SDSU	189	gaps
GP	RH	2.0	1.0	SDSU	179	gaps
G3	WS	3.5	3.75	WHOI	188	
G3	WD	3.5	3.75	WHOI	188	
C2	WS	3.5	7.5	WHOI	80	
C2	WD	3.5	7.5	WHOI	80	
C3(s1)	WS	3.5	15.0	WHOI	188	
C3(s1)	WD	3.5	15.0	WHOI	188	
C3(s1)	WS	2.0	15.0	WHOI	188	
C3(s1)	SW	3.5	15.0	WHOI	87	
C3(s1)	LW	3.5	15.0	WHOI	149	
C3(s1)	BP	2.7	15.0	WHOI	188	
C3(s1)	RH	3.0	15.0	WHOI	—	no data
C3(s2)	WS	7.0	15.0	WHOI	188	
C3(s2)	WD	7.0	15.0	WHOI	188	
C3(s2)	WS	5.0	15.0	WHOI	188	
C3(s2)	SW	3.5	15.0	WHOI	188	
C3(s2)	LW	3.5	15.0	WHOI	174	
C3(s2)	RH	3.5	15.0	WHOI	184	
C3(s2)	AT	2.7	15.0	WHOI	—	no data

Table 6: Summary of Coastal and Moored Meteorological Sensors Deployed in SMILE (Continued)

Station	Variable Type	Sensor Height (m)	Record Rate (min)	Data Source	Record Length (days)	Comments
CA	WS	10.0	1.0	SDSU	188	
CA	WD	10.0	1.0	SDSU	188	
CA	AT	2.0	1.0	SDSU	187	gaps
CA	BP	2.0	1.0	SDSU	186	gaps
CA	RF	1.0	1.0	SDSU	187	gaps
CA	RH	2.0	1.0	SDSU	188	gaps
SR	WS	10.0	1.0	SDSU	188	
SR	WD	10.0	1.0	SDSU	188	
SR	AT	2.0	1.0	SDSU	176	gaps
SR	BP	2.0	1.0	SDSU	166	gaps
SR	RF	1.0	1.0	SDSU	177	gaps
SR	RH	2.0	1.0	SDSU	188	gaps
SB	WS	10.0	1.0	SDSU	188	
SB	WD	10.0	1.0	SDSU	188	
SB	AT	2.0	1.0	SDSU	188	gaps
SB	BP	2.0	1.0	SDSU	188	gaps
SB	RF	1.0	1.0	SDSU	188	gaps
SB	RH	2.0	1.0	SDSU	188	gaps
SB	LW	1.2	1.0	SDSU	188	gaps
SB	SW	1.2	1.0	SDSU	188	gaps
M3	WS	3.5	7.5	WHOI	188	
M3	WD	3.5	7.5	WHOI	188	
BB	WS	15.0	60.0	SDSU	176	
BB	WD	15.0	60.0	SDSU	176	
BB	AT	9.1	60.0	SDSU	176	gaps
BB	BP	2.1	60.0	SDSU	176	gaps
BB	RH	9.1	60.0	SDSU	176	gaps
13	WS	10.0	60.0	SDSU	192	
13	WD	10.0	60.0	SDSU	192	
13	AT	10.0	60.0	SDSU	192	
13	BP	10.0	60.0	SDSU	192	
13	DP	—	60.0	SDSU	192	

Abbreviations:

WS: Wind Speed
AT: Air Temperature
SW: Short-Wave Radiation
RH: Relative Humidity
DP: Dew Point
WD: Wind Direction
BP: Barometric Pressure
LW: Long-Wave Radiation
RF: Rainfall

2.4.3 Atmospheric Sounding Program

In order to characterize the lower atmosphere during the intensive SMILE measurement period, atmospheric soundings were made at Stewarts Point by C. Dorman (SDSU) from February 6 to March 15, 1989. Four soundings a day were attempted (see Figure 2 and Table 7). At 0100 and 1300 PST (1700 and 0500 GMT), a National Center for Atmospheric Research (NCAR) Cross-chain Loran Atmospheric Sounding System (CLASS) was used to track a VIZ sonde carried aloft by a 100 gram balloon (see Lauristen *et al.*, 1986). This sonde measures air temperature, humidity and pressure while receiving LORAN-C radio signals. This information is transmitted to the ground receiving station every 10 seconds where the LORAN-C signal is used to derive horizontal wind velocity. This sounding system obtained atmospheric profile data at 30 m intervals from the surface to 3 km in about 30 minutes.

At 0700 and 1900 PST, one of two other types of soundings was taken. If winds were less than 8 m/s, a 5.5 m long tethered balloon was used to lift a tethersonde designed to measure air temperature, wet bulb temperature, air pressure, wind speed and direction. This system obtained data every 30 m from the surface to 1 km in about eight minutes. If winds were above 8 m/s, a PIBAL sounding was made. The PIBAL is a free ascent balloon which is tracked with an optical theodolite. Wind velocity is computed from the angular orientation data and the assumption of a constant known ascent rate. Data were obtained with this system from the surface to 3 km at 30 m intervals in about 15 minutes. A description of the three sounding systems and a graphical presentation of the sounding data are presented in an SDSU technical report by Dorman (1990).

Table 7: Summary of Stewarts Point Atmospheric Soundings

Date/Time (PST)	Type	Max (m) Height	Comments
6 Feb 1304	P	2720	
6 Feb 1715	P	2210	
7 Feb 0710	P	2900	
7 Feb 1115	T	855	
7 Feb 1805	P	1710	
8 Feb 0705	P	3007	
8 Feb 1302	T	831	
8 Feb 1745	P	977	Lost balloon in cloud
9 Feb 0700	P	800	Lost balloon in cloud
9 Feb 1302	P	577	Lost balloon in cloud
9 Feb 1900	P	387	Lost balloon in cloud
10 Feb 1300	P	2320	
10 Feb 1600	T	885	
10 Feb 1900	T	856	
11 Feb 0720	T	849	
11 Feb 1100	T	884	
11 Feb 1730	T	272	
11 Feb 2200	T	602	
12 Feb 0700	T	613	
12 Feb 1650	C	6005	First test, winds gappy
13 Feb 0109	C	—	Test bad, no data
13 Feb 1000	P	3008	
13 Feb 1205	C	—	Test bad, no data
13 Feb 1310	P	3008	
13 Feb 1502	C	—	Test bad, no data
13 Feb 1920	T	844	
13 Feb 2200	P	672	Light separated from balloon
14 Feb 0100	P	1217	Lost view of light
14 Feb 0700	P	3010	
14 Feb 1000	T	1020	
14 Feb 1300	T	905	
14 Feb 1900	T	982	
14 Feb 2200	P	2127	Lost balloon in cloud bank
15 Feb 0100	P	640	Balloon burst
15 Feb 0700	P	3007	
15 Feb 1010	T	817	
15 Feb 1300	P	2817	
15 Feb 1600	T	844	Cloud base about 250 m
15 Feb 1832	C	2950	Winds poor
15 Feb 1905	T	983	
16 Feb 0100	P	1201	Lost balloon in cloud
16 Feb 0700	T	1069	
16 Feb 1100	T	942	
16 Feb 1300	T	914	
16 Feb 1950	C	5223	No winds 1400–1900 m, temp and humidity suspect
16 Feb 2030	T	943	
17 Feb 0700	P	3010	
17 Feb 1300	C	7182	No winds below 800 m
17 Feb 1310	P	3008	
17 Feb 1900	T	856	

Table 7: Summary of Stewarts Point Atmospheric Soundings
(Continued)

Date/Time (PST)	Type	Max (m) Height	Comments
18 Feb 0051	C	4583	
18 Feb 1251	C	5740	
18 Feb 1900	T	865	
19 Feb 0033	C	5740	
19 Feb 0700	T	817	
19 Feb 1254	C	4537	
19 Feb 1900	T	859	
20 Feb 0142	C	5830	
20 Feb 0700	T	1010	
20 Feb 1045	T	965	
20 Feb 1254	C	5713	No winds 300–1700 m
20 Feb 1930	T	900	
21 Feb 0108	C	5754	No winds below 500 m
21 Feb 0715	T	501	Balloon suspension problem
21 Feb 0803	C	5837	
21 Feb 1257	C	5843	
21 Feb 2030	P	1230	Lost balloon in cloud
22 Feb 0119	C	2977	
22 Feb 0200	P	383	Lost balloon in cloud
22 Feb 0858	C	—	System problem, no data
22 Feb 1257	C	4233	
22 Feb 1900	T	859	
23 Feb 0038	C	5681	No winds 500–1500 m
23 Feb 0715	P	1760	Lost balloon in cloud edge
23 Feb 1301	C	5646	
23 Feb 1900	T	865	
24 Feb 0047	C	5756	
24 Feb 0700	T	539	Lost balloon in cloud
24 Feb 0740	P	2144	
24 Feb 1005	T	628	
24 Feb 1352	C	5979	
24 Feb 1900	T	716	
25 Feb 0700	T	911	
25 Feb 1322	C	5979	
25 Feb 1945	T	869	
26 Feb 0048	C	5769	
26 Feb 0700	T	975	
26 Feb 1312	C	3572	
26 Feb 1900	T	733	
27 Feb 0056	C	4701	
27 Feb 0700	T	364	
27 Feb 0741	C	5865	
27 Feb 1052	C	—	Bad sonde, no data
27 Feb 1110	P	527	Lost balloon in sun
27 Feb 1231	C	5748	
27 Feb 1850	C	6116	
28 Feb 0046	C	5618	
28 Feb 0656	C	6303	
28 Feb 1000	P	2657	Lost balloon in cloud
28 Feb 1306	C	6234	No winds
28 Feb 1330	P	—	No data
28 Feb 1859	C	6394	

Table 7: Summary of Stewarts Point Atmospheric Soundings
(Continued)

Date/Time (PST)	Type	Max (m) Height	Comments
1 Mar 0113	C	6013	
1 Mar 0700	T	974	
1 Mar 1250	C	5858	
1 Mar 1855	C	5823	
2 Mar 0032	C	2764	
2 Mar 0658	C	5144	
2 Mar 1304	C	6031	
2 Mar 1856	C	6594	
3 Mar 0104	C	4967	
3 Mar 0659	C	5771	
3 Mar 1000	P	—	No data
3 Mar 1258	C	5788	
3 Mar 1857	C	5830	
4 Mar 0041	C	5698	
4 Mar 0700	T	188	Winds too fast, redo with PIBAL
4 Mar 0715	P	2627	
4 Mar 1249	C	—	No data
4 Mar 1837	C	5742	
5 Mar 0043	C	6812	
5 Mar 0704	C	6565	
5 Mar 1247	C	3547	
5 Mar 1904	C	5871	
6 Mar 0040	C	5669	
6 Mar 0711	C	5821	
6 Mar 1309	C	5890	
6 Mar 1900	T	873	
7 Mar 0101	C	5470	
7 Mar 0700	T	849	
7 Mar 1257	C	5643	
7 Mar 1908	C	6651	
8 Mar 0055	C	4520	
8 Mar 0700	C	4642	
8 Mar 1325	C	3011	No temp and humidity below 700 m
8 Mar 1848	C	2995	No winds 2600–2980 m
9 Mar 0053	C	4279	Most winds missing
9 Mar 1253	C	3387	
9 Mar 1857	C	3536	
10 Mar 0106	C	5375	
10 Mar 1300	C	6493	
10 Mar 1844	C	—	No data, very heavy rain
11 Mar 0046	C	5647	
11 Mar 1257	C	5364	
12 Mar 0036	C	5844	
12 Mar 1235	C	6535	
13 Mar 0043	C	6676	
13 Mar 0655	C	6717	
13 Mar 1240	C	6697	
13 Mar 1912	C	5976	
14 Mar 0102	C	5969	No winds 900–1400 m
14 Mar 1310	C	5722	
14 Mar 2157	C	6916	
15 Mar 0714	C	5707	
15 Mar 1251	C	6399	

C = CLASS sounding measuring wind, air temperature, humidity, and pressure every 30 m.
P = PIBAL sounding measuring wind every 30 m.
T = Tethered sounding measuring wind, air temperature, wet bulb temperature and pressure every 30 m.

2.5 Aircraft Overflight Component

During the intensive SMILE meteorological observation period (Feb 6 to Mar 18, 1989), C. Friehe (UC Irvine) used the NCAR King Air aircraft to obtain measurements of the atmospheric structure, surface forcing by turbulent fluxes, and sea surface temperature over the coastal ocean between approximately Pt. Arena and Bodega Bay and offshore about 40 km. The King Air is a twin-engine research aircraft equipped to measure the three-dimensional vector wind, air temperature and pressure, relative and absolute humidity, both up- and downward short- and long-wave radiation, rain and aerosol concentrations, and sea surface temperature. The King Air carries a very accurate inertial navigation system (INS) which allows the relative wind measurements made with a differential pressure system aboard the aircraft to be converted into absolute wind speed and direction. After the first two SMILE flights, the INS worked well and the total uncertainty in the wind data is about 1 m/s. Complete documentation of the aircraft instrumentation pertinent to the SMILE measurements is available from the Research Aircraft Facility of NCAR (Boulder, CO 80307).

The King Air was based at the Sonoma County airport and made a total of 23 flights between February 8 and March 8, 1989. The dates and times of each flight are listed in Table 8. A timeline showing the intensive SMILE observation period is shown in Figure 2. The basic flight pattern included a) a horizontal ladder pattern flown at about 30 m height between NDBC 13 and NDBC 14 to measure surface conditions and b) either an ascending or descending sounding to examine the vertical structure of the marine layer. In some flights, additional tracks were flown near the WHOI meteorological buoys at M3, C3 and G3. Also on some flights, vertical profiles were made off Stewarts Point to help resolve the vertical structure of the boundary layer. The flight pattern for Flight 8 is shown in Figure 10 for illustration. The aircraft data are presented in a UC Irvine technical report by Friehe *et al.* (1990).

Table 8: Summary of NCAR King Air SMILE Flights

Flt. No.	Date (1989)	Start–End Time (PST)	Comments
1	Feb 8	11:34 — 15:24	No INS data
2	Feb 10	10:55 — 15:03	INS drift
3	Feb 11	10:11 — 14:18	
4	Feb 13	10:13 — 14:10	
5	Feb 15	10:30 — 14:30	
6	Feb 17	10:03 — 14:20	
7	Feb 19	10:28 — 14:49	
8	Feb 20	09:54 — 14:13	
9	Feb 23	13:14 — 17:25	
10	Feb 26	11:16 — 15:25	
11	Feb 27	10:28 — 14:24	
12	Mar 2	10:17 — 14:37	Tape out
13	Mar 3	10:18 — 14:59	
14	Mar 5	10:06 — 11:28	
15	Mar 7	13:04 — 15:00	No data
16	Mar 8	12:00 — 16:42	
17	Mar 9	13:07 — 17:38	
18	Mar 11	11:06 — 14:03	
19	Mar 13	10:15 — 14:52	
20	Mar 14	11:44 — 15:56	
21	Mar 15	11:55 — 16:40	
22	Mar 16	10:24 — 15:05	
23	Mar 17	10:42 — 15:04	

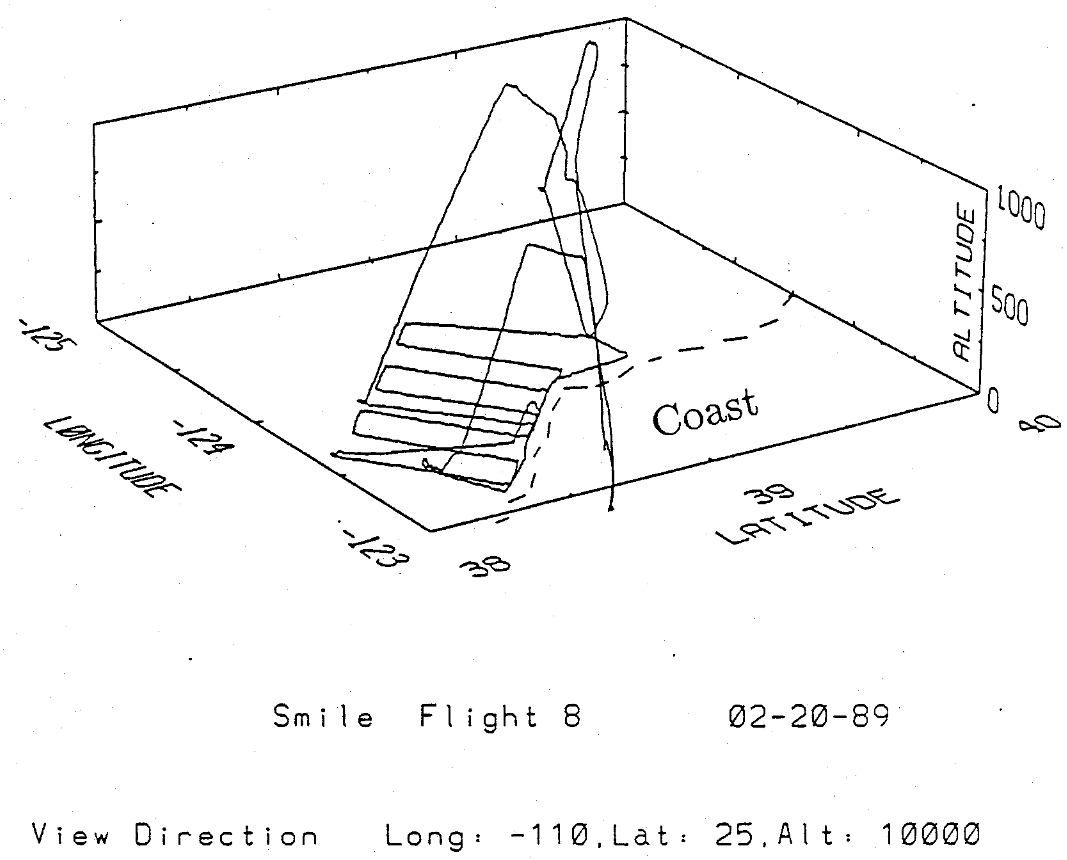


Figure 10: Perspective view of King Air flight track for SMILE flight 8. This flight was conducted on February 20, 1989 between 0954 and 1413 PST.

3. Complementary Field Programs: STRESS and NCCCS

In addition to SMILE, two other oceanographic field programs were conducted over this shelf region during the SMILE deployment period. The ONR-funded Sediment Transport Events on Shelves and Slopes (STRESS) was designed to make detailed bottom stress, velocity, and density measurements throughout the bottom boundary layer within the SMILE region to study sediment transport processes in this relatively simple sedimentary regime (see Nowell *et al.*, 1987, for a more complete description of STRESS and program objectives). In particular, two bottom tripods were deployed near C3 which supported either electromagnetic current sensors (Geoprobe) or acoustic travel-time velocimeters (similar to those on SASS) to obtain two and three dimensional velocity measurements respectively within the lowest 2–5 m of the water column above the bottom, and a subsurface string of five VACMs (three equipped with conductivity sensors) was deployed at C3 to observe the velocity, temperature and salinity structure over the lowest 25 m above the bottom (Figure 4). The combined STRESS and SMILE field program thus obtained high-quality, simultaneous, top-to-bottom ocean current measurements with the highest vertical resolution to date within the top and bottom boundary layers.

The MMS-funded Northern California Coastal Circulation Study (NCCCS) was a long-term physical oceanography program designed to describe the circulation over the shelf and upper slope between San Francisco and the California–Oregon border. As part of the main NCCCS field experiment conducted between March 1988 and October 1989, a moored array of near-surface current meters and bottom-pressure recorders was maintained along five cross-shelf transects, five regional hydrographic surveys were conducted, and four Lagrangian circulation experiments made using aircraft-tracked surface drifters. One mooring transect (the NCCCS C-line) was located about 5 km southeast of the SMILE cross-shelf subarray formed by C2, C3, and C4 (see Figure 3). While the NCCCS C-line was sparsely instrumented, each mooring did support a VMCM at 10 m, which returned current and temperature data. This data should be useful to compare with SMILE data to examine the horizontal structure of the circulation at 10 m depth on scales of 5–10 km. See EG&G (1989) for a detailed description of the NCCCS field program.

4. Description of Data Presentation

The remainder of this report provides a statistical and graphical summary of the long-term array measurements described in sections 2.1, 2.4.1, and 2.4.2.

The data presented covers the time period between November 10, 1988 and May 20, 1989. All vector plots (hourly averaged and PL64 low-pass filtered) are subsampled every six hours. For display purposes, the vector and composite plots are shown on two pages, side by side. The time axis on each page spans approximately three months. The individual time series of the hourly averaged data for each instrument is shown on one page, the top half and lower half each cover approximately three months of data.

4.1 Data Processing Methods

The data processing methods used to produce the final data sets (both atmospheric and oceanographic) presented in this report are described next. Greenwich Mean Time (GMT) is used throughout this report unless otherwise stated.

The moored array data collected with WHOI and USGS instruments (VAWRs, VMCMs, VACMs, and SeaCats) were recorded internally on standard magnetic cassette tapes and transcribed onto 9-track tapes at WHOI. The data were then converted to scientific units, and edited using the standard current meter processing system developed at WHOI (Tarbell *et al.*, 1988). This included a careful check of the time base, truncation to remove launch and retrieval transients, the removal of erroneous data cycles, and interpolation to fill any resulting short gaps in the data.

Preliminary processing of data collected with the SIO instruments (thermistor chains, Brancker temperature pods, VMCMs and ADCPs) was performed by L. Regier. The instruments were calibrated and the raw data converted into scientific units. The unedited data were then sent to WHOI on 9-track magnetic tape for further processing. The data were read from tape and the variables (east and north current, and temperature) were converted to common units. The data for each instrument were truncated to remove launch and retrieval transients, then plotted and checked for unrealistic data values. If a point was determined to be bad, it was filled using linear interpolation. The data for each ADCP profile were received from SIO in binary format output by the ADCP. These data were unpacked and scaled using a C program written by A. Plueddemann and M. Samelson at WHOI.

The PAM meteorological data were obtained from NCAR by C. Dorman and edited (removed bad points, flagged data gaps) at SDSU, forming basic hourly averaged time series before sending the data to WHOI. The data were put into a standard format at WHOI and checked against other observations for consistency.

For all vector and scalar variables that were sampled at intervals less than one hour, hourly values were formed by vector or scalar averaging (computed using a running mean), centering time on the hour (*e.g.*, the value assigned to 1200 is an average of data collected between 1130 and 1230). The resultant vector current and wind data collected in the SMILE region have been rotated into a standard coordinate system, with the north component aligned parallel with the coastline and local shelf topography near the central mooring line. This coordinate system is oriented 43° counter clockwise with respect to true north so that the alongshelf component is positive towards 317°T and the cross-shelf component is positive towards 47°T. For some purposes the hourly data were then filtered using the PL64 filter. The filter is symmetric with a total of 129 weights applied to the hourly time-series. The PL64 filter has a half-power period of 38 hours. A summary of the PL64 filter, including the generating function, can be found in the report by Beardsley *et al.* (1985).

4.2 The Coastal and Moored Meteorological Observations

Presented in Section 7.1 of this report are the coastal and moored meteorological time series observations collected off northern California during SMILE from mid-November 1988 to mid-May 1989. The combined meteorological array consisted of five PAM stations, four VAWR moorings (C2, C3, G3, and M3), two NDBC meteorological moorings (NDBC 13 and 14), and two coastal stations (Pt. Arena Light, Bodega Bay Marine Lab). Information about these stations is summarized in Tables 2 and 6.

Basic statistics for the hourly averaged data are shown in Table 9. Composite vector plots of the PL64 low-pass filtered winds are presented in Figures 11–13. The time-series for each instrument have been stacked vertically on the same time base for easy comparison. The stations are plotted from north to south, onshore to offshore. The individual time series of the basic hourly averaged wind components, in the form of vector and line plots, are shown in Figures 14–27. Time series of the hourly averaged air temperature, long-wave and short-wave radiation, atmospheric pressure, relative humidity, scalar speeds and rainfall are shown as composite plots in Figures 28–32, respectively. All wind time series have been rotated into the standard coordinate system (along-shelf is positive towards 317°T, cross-shelf is positive towards 47°T).

4.3 Moored Current Observations

Presented in Section 7.2 of this report are the moored current measurements made off northern California during SMILE from mid-November 1988 to mid-May 1989. The SMILE moored current observations consist of measurements made by VMCM and ADCP data collected from the five SMILE moorings and VACM data collected from the USGS STRESS mooring at C3. The mooring locations (C2, C3, C4, G3, and M3) are shown in Figure 3 and schematics of the moorings are shown in Figure 4. A cross-section of the shelf with the bottom bathymetry showing the instrument locations for the SMILE central mooring line (C2, C3, C4) is shown in Figure 5. The instrumentation for moorings G3 and M3 was similar to mooring C4. Additional information about the sensors and the basic recording rates for each type of oceanographic instrument are given in Table 3.

Basic statistics for the hourly averaged current components are given in Table 10. The ADCP sampled 2 m vertical bins and for completeness the statistics for each bin are presented in Table 10. However, the pulse length of the ADCP was 6 m, so individual 2 m bins are not independent; consequently, current time series plots are presented at depth intervals of 6 m rather than 2 m. Composite vector plots of the PL64 low-pass filtered currents are presented in Figures 33–47. The time series for each measurement depth have been stacked vertically on the same time base for easy comparison. The individual time series, in the form of vector and line plots, of the hourly averaged components are shown in Figures 48–101. All time series have been rotated into the standard coordinate system (along-shelf is positive towards 317°T, cross-shelf is positive towards 47°T).

4.4 Moored Temperature and Conductivity Observations

Presented in Section 7.3 of this report are the moored temperature and conductivity data collected off northern California from mid-November 1988 to mid-May 1989. The SMILE moored temperature array consisted of temperatures measured on current meters (VMCMs, VAWRs, ADCPs, and VACMs) deployed by WHOI, SIO and USGS, SeaBird temperature/conductivity sensor pairs deployed by WHOI and USGS, and thermistor chains (T-Chains) and temperature logging pods (T-Pods) deployed by SIO. Additional information about the instrumentation and the basic recording rates for each type of oceanographic instrument are given in Table 3.

Basic statistics for the hourly conductivity and salinity are shown in Table 11. The basic statistics for hourly averaged water temperature are shown in Table 12. Composite (overlay) plots of PL64 low-pass filtered salinity and temperature records by mooring are presented in Figures 102–104. Composite stacked plots of the hourly averaged individual salinity, temperature, and conductivity records are shown in Figures 105–112. Salinities were estimated from the SeaCat temperature and conductivity observations using the Sea Bird software. Salinity was estimated from the EG&G temperature and conductivity cell following Fofonoff and Millard (1983).

5. Acknowledgments

The efforts of a great many people contributed to the success of the SMILE program. The authors would like to take this opportunity to express their appreciation to the WHOI buoy group and engineers for their part in the design and execution of the moored array component of SMILE. The officers and crew of the **R/V Wecoma** (Oregon State University) did a fine job of handling the ship for deployments and recoveries which contributed significantly to the success of the seagoing operations. The authors would like to express their appreciation to Anne-Marie Michael for her assistance in the final preparation of this report. The Shelf MIxed Layer Experiment was supported by the Ocean Sciences Division of the National Science Foundation under NSF Grant OCE 87-16937, and this support is gratefully acknowledged.

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7. Data Presentation

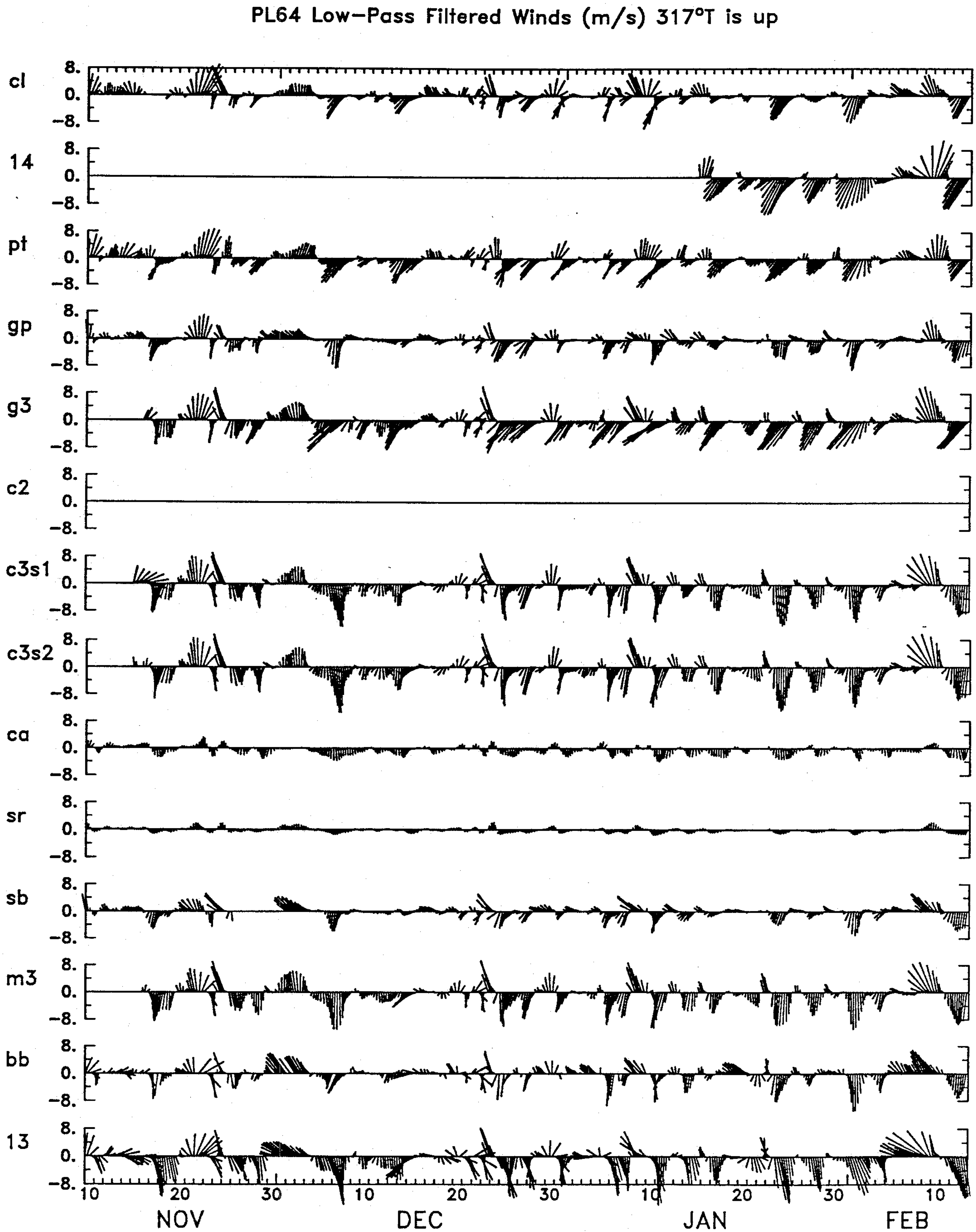
7.1 Coastal and Moored Meteorological Observations

Table 9: Statistics of Hourly-Averaged Meteorological Data

Sta	Elevation (m)	GMT Start Time (y m d/hm)	GMT Stop Time (y m d/hm)	Duration (Days)	Sensor Height (m)	Mean	Std Dev	Max	Min
			Air Temperature (°C)						
CL	15	881110/0000	890409/1000	150	2.0	9.24	2.86	17.86	−3.89
14	−306	890112/2100	890506/1600	114	10.0	10.09	1.97	15.80	1.30
PT	19	881110/0000	890519/2300	191	10.0	9.34	2.48	15.70	−1.50
GP	14	881110/0000	890508/2300	180	2.0	8.96	3.02	18.95	−1.95
CA	83	881110/0000	890516/0700	187	2.0	10.45	6.36	35.55	−5.51
SU	238	881110/0000	890505/1800	177	2.0	8.99	4.76	28.18	−3.19
SR	28	881110/0000	890414/0400	155	2.0	9.26	2.85	19.44	−0.55
BB	9	881110/0000	890504/1200	176	10.0	9.97	2.72	20.27	0.20
13	−125	881110/0000	890520/2300	192	10.0	10.50	1.91	17.30	2.30
			Barometric Pressure (mb)						
CL	15	881110/0000	890512/0500	183	2.0	1017.88	5.55	1031.82	1002.92
14	−306	890112/2100	890506/1600	114	10.0	1019.26	5.47	1031.90	998.30
PT	19	881110/0000	890520/2300	192	35.0	1019.92	5.44	1034.10	999.60
GP	14	881110/0000	890516/2300	188	2.0	1017.71	5.36	1029.99	998.25
C3	−93	881112/1300	890519/1200	188	2.7	1019.51	5.46	1033.10	999.55
CA	83	881110/0000	890515/0900	186	2.0	1009.72	5.53	1024.27	990.65
SU	238	881110/0000	890511/1300	183	2.0	990.05	5.20	1002.84	970.92
SR	28	881110/0000	890424/2200	166	2.0	1016.77	5.24	1029.77	996.76
BB	9	881110/0000	890504/1200	176	10.0	1021.31	4.80	1033.47	1003.38
13	−125	881110/0000	890520/2300	192	10.0	1020.19	5.41	1033.60	1000.70
			Relative Humidity (%)						
CL	15	881110/0000	890407/1000	148	2.0	88.99	11.85	119.96	26.39
14	−306	890201/0100	890309/1600	37	10.0	60.79	13.97	97.97	25.03
GP	14	881110/0000	890508/0200	179	2.0	86.00	12.17	117.79	23.62
C3	−93	881112/1300	890515/0100	184	3.5	82.31	12.38	104.12	17.99
CA	83	881110/0000	890513/1800	185	2.0	77.45	21.37	104.21	13.85
SU	238	881110/0000	890501/1700	173	2.0	82.53	18.10	114.24	18.31
SR	28	881110/0000	890413/1200	155	2.0	81.78	13.90	103.57	20.14
BB	9	881110/0000	890504/1200	176	9.1	81.50	16.68	99.00	4.00
13	−125	890315/1600	890520/2300	66	10.0	83.89	12.83	100.00	43.62
			Long-Wave Radiation (watts/m^2)						
C3	−93	881112/1300	890410/0500	149	3.5	323.88	35.77	403.28	228.22
C3	−93	881112/1300	890505/1400	174	3.5	308.49	40.28	388.03	160.75
SR	28	881110/0000	890426/2200	168	1.2	312.65	35.79	380.94	235.85
			Short-Wave Radiation (watts/m^2)						
C3	−93	881112/1300	890207/0500	87	3.5	117.47	166.13	767.07	3.22
C3	−93	881112/1300	890519/1600	188	3.5	143.74	209.76	1290.80	4.00
SR	28	881110/0000	890504/1700	176	1.2	154.19	239.99	1071.08	0.00
BB	9	881110/0000	890504/1200	176	10.0	193.09	246.17	1071.33	0.00
			Wind Speed (m/s)						
C3	−93	881112/1300	890519/1200	188	2.0	4.36	2.46	12.22	0.61
C3	−93	881112/1300	890519/1200	188	3.5	5.56	3.27	15.78	0.68
C3	−93	881112/1300	890519/1600	188	5.0	5.36	3.21	15.58	0.52
C3	−93	881112/1300	890519/1600	188	7.0	5.87	3.53	17.10	0.62

Table 9: Statistics of Hourly-Averaged Meteorological Data (Continued)

Sta	Elevation (m)	GMT Start Time (y m d/hm)	GMT Stop Time (y m d/hm)	Duration (Days)	Sensor Height (m)	Mean	Std Dev	Max	Min
				Rainfall (mm)					
CL	15	881110/0000	890513/1100	185	1.0	0.13	0.57	11.59	0.00
GP	14	881110/0000	890517/1100	189	1.0	0.14	0.60	8.51	0.00
CA	83	881110/0000	890516/0700	187	1.0	0.12	0.53	9.54	0.00
SR	245	881110/0000	890511/1300	183	1.0	0.16	0.63	8.75	0.00
SB	28	881110/0000	890505/1600	177	1.0	0.12	0.59	10.29	0.00
				Cross-Shelf Wind (m/s)					
Cl	15	881110/0000	890511/2300	183	10.0	−0.78	2.22	8.69	−7.09
14	−306	890112/2100	890506/1600	114	10.0	−0.48	3.19	8.39	−11.87
PT	19	881110/0000	890520/2300	192	35.0	−1.04	2.64	9.25	−11.25
GP	14	881110/0000	890517/1100	189	10.0	−0.92	1.75	6.56	−7.31
G3	−93	881113/1300	890409/0200	147	3.5	−1.99	2.90	7.99	−12.11
C2	−80	890225/1300	890516/1200	80	3.5	0.22	1.60	7.10	−5.96
C3	−93	881112/1300	890519/1200	188	3.5	0.01	2.03	8.71	−14.96
C3	−93	881112/1300	890519/1600	188	3.5	−0.13	1.99	9.20	−15.94
CA	83	881110/0000	890516/0700	187	10.0	0.18	1.03	4.15	−7.92
SR	245	881110/0000	890511/1300	183	10.0	−0.13	0.43	1.08	−2.36
SB	28	881110/0000	890429/0800	170	10.0	−0.99	1.80	15.05	−10.69
M3	−93	881113/1300	890517/1200	185	3.5	−0.23	1.67	8.46	−16.71
BB	9	881110/0000	890504/1200	176	10.0	−0.16	2.21	10.69	−10.61
13	−125	881110/0000	890520/2300	192	10.0	0.85	2.86	10.28	−15.05
				Along-Shelf Wind (m/s)					
CL	15	881110/0000	890511/2300	183	10.0	−0.15	4.01	12.23	−13.53
14	−306	890112/2100	890506/1600	114	10.0	−0.77	5.54	16.27	−14.78
PT	19	881110/0000	890520/2300	192	35.0	−0.45	4.43	15.05	−13.38
GP	14	881110/0000	890517/1100	189	10.0	−1.17	4.70	11.95	−15.98
G3	−93	881113/1300	890409/0200	147	3.5	−1.25	5.28	13.65	−11.87
C2	−80	890225/1300	890516/1200	80	3.5	−2.03	6.02	13.57	−15.03
C3	−93	881112/1300	890519/1200	188	3.5	−2.12	5.58	12.81	−15.17
C3	−93	881112/1300	890519/1600	188	3.5	−2.31	5.97	13.76	−16.59
CA	83	881110/0000	890516/0700	187	10.0	−0.59	2.04	6.31	−6.58
SR	245	881110/0000	890511/1300	183	10.0	−0.10	0.92	4.34	−2.63
SB	28	881110/0000	890429/0800	170	10.0	−0.48	3.24	9.13	−15.50
M3	−93	881113/1300	890517/1200	185	3.5	−1.86	5.32	14.81	−15.01
BB	9	881110/0000	890504/1200	176	10.0	−0.80	4.50	11.15	−15.11
13	−125	881110/0000	890520/2300	192	10.0	−2.93	5.72	12.85	−17.07


PL64 Low-Pass Filtered Winds (m/s) 317°T is up
cl
14
pt
gp
g3
c2
c3s1
c3s2
ca
sr
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8.
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Figure 11

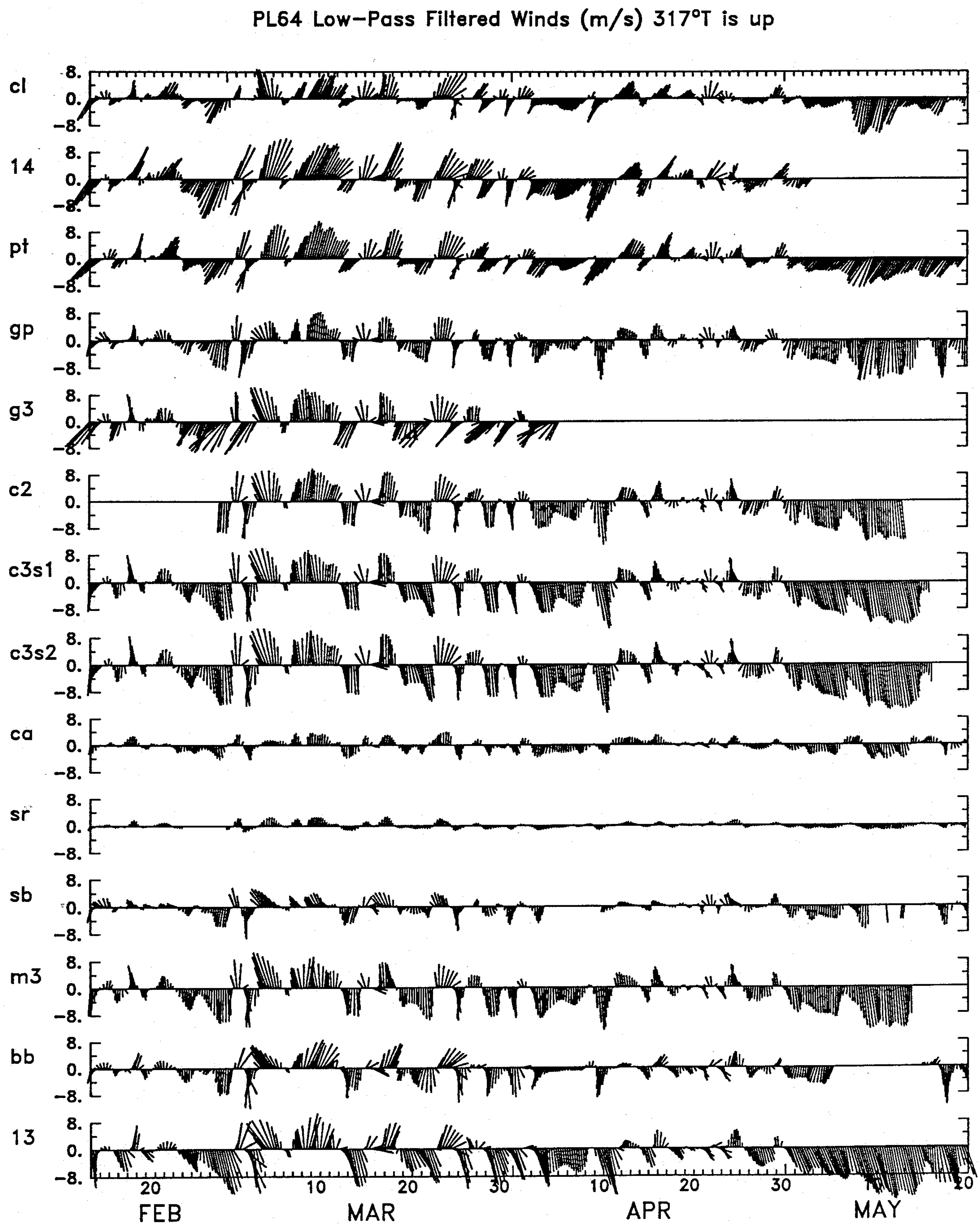
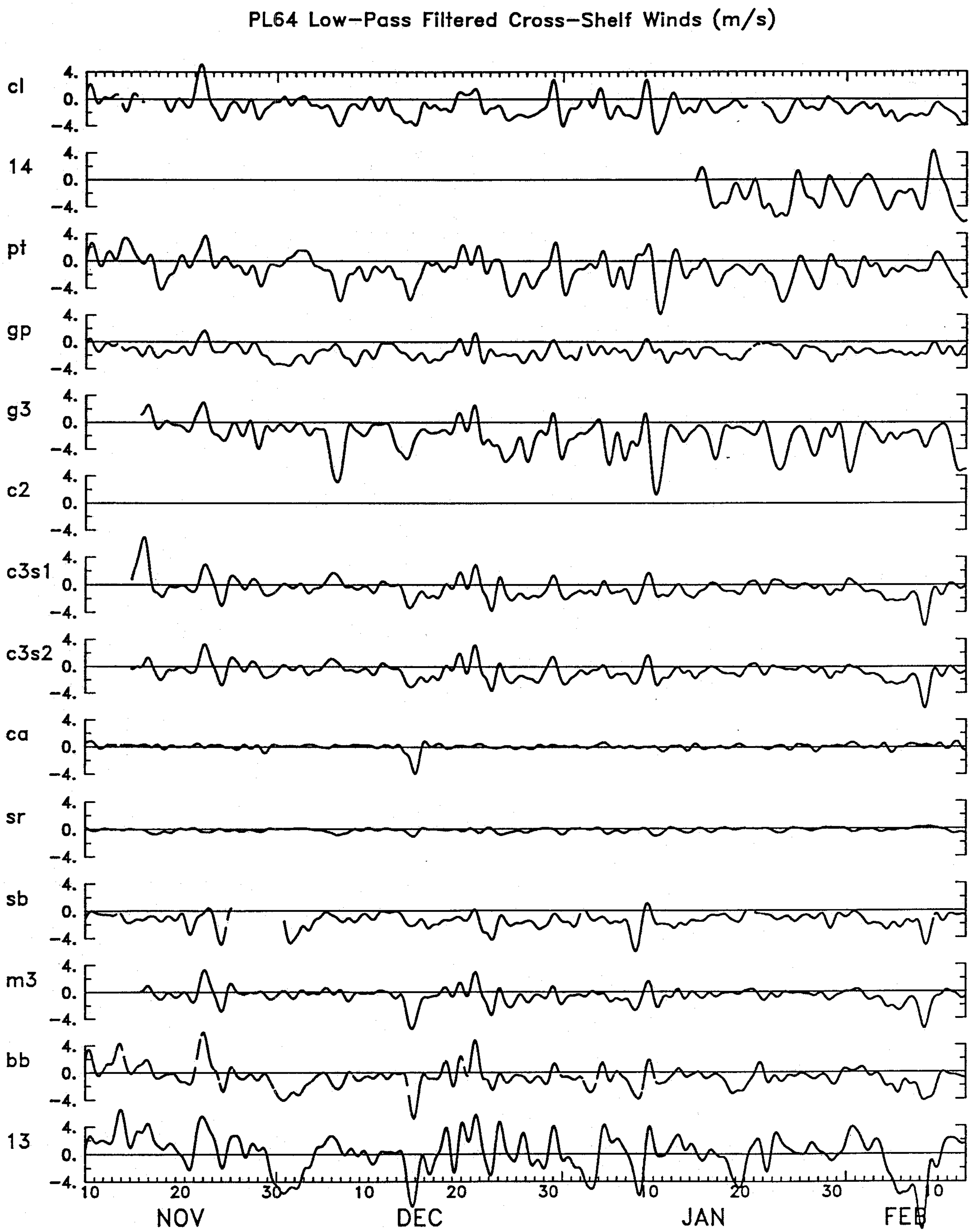


Figure 11 (cont.)


PL64 Low-Pass Filtered Cross-Shelf Winds (m/s)
cl
14
pt
gp
g3
c2
c3s1
c3s2
ca
sr
sb
m3
bb
13
4.
0.
-4.
10
20
30
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DEC
JAN
FEB

Figure 12

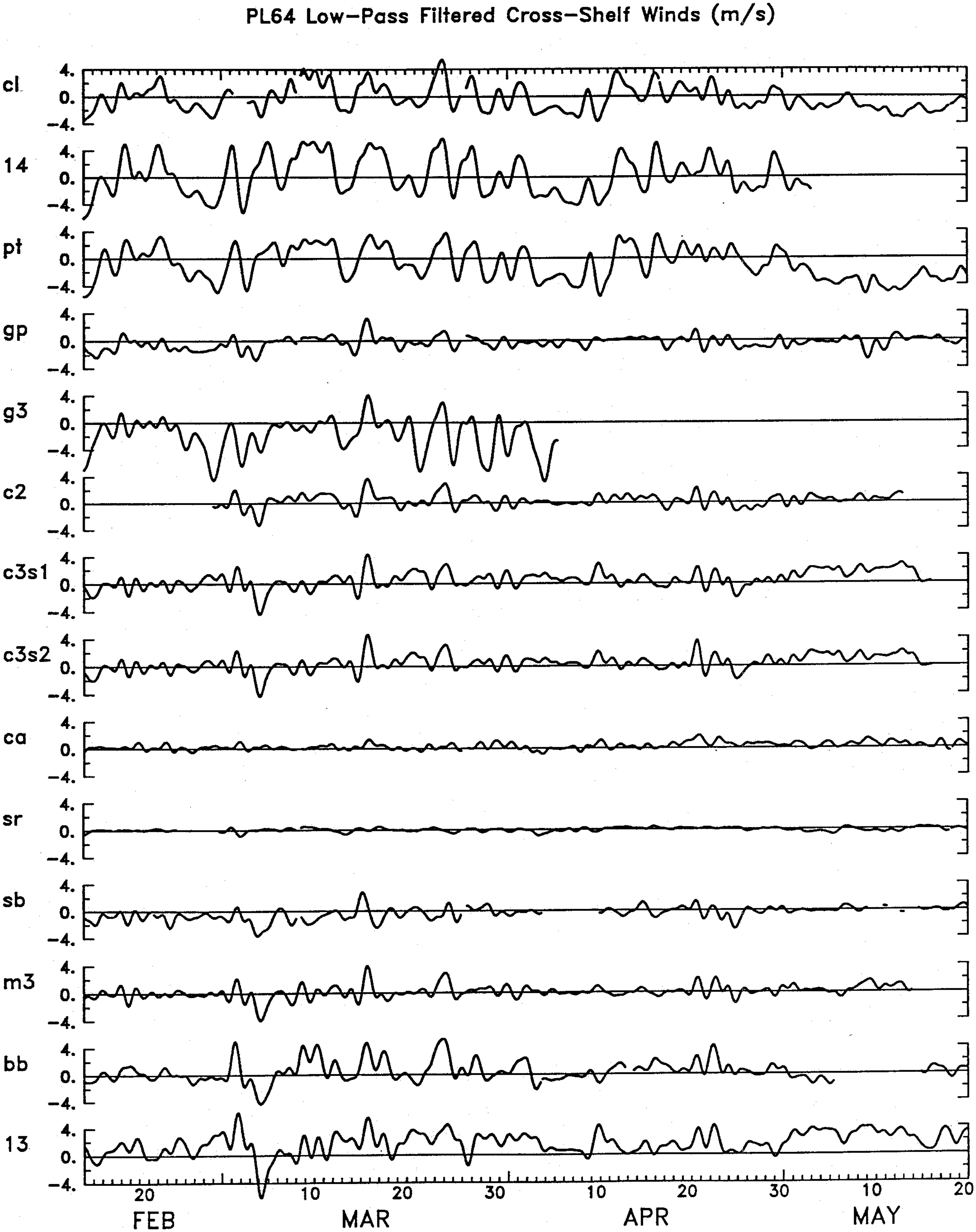


Figure 12 (cont.)

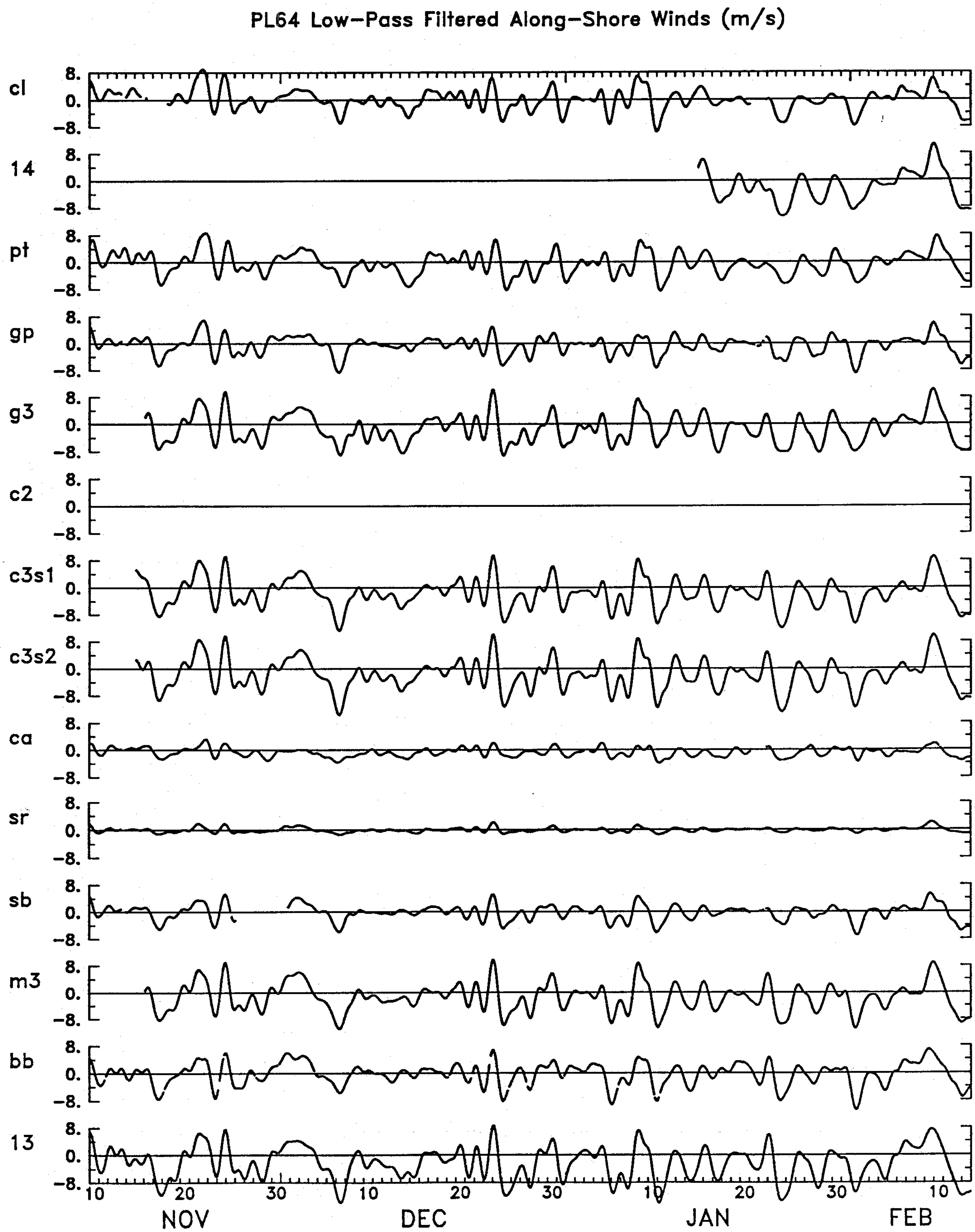

PL64 Low-Pass Filtered Along-Shore Winds (m/s)
cl
14
pt
gp
g3
c2
c3s1
c3s2
ca
sr
sb
m3
bb
13
8.
0.
-8.
10
20
30
10
20
30
10
20
30
10
NOV
DEC
JAN
FEB

Figure 13

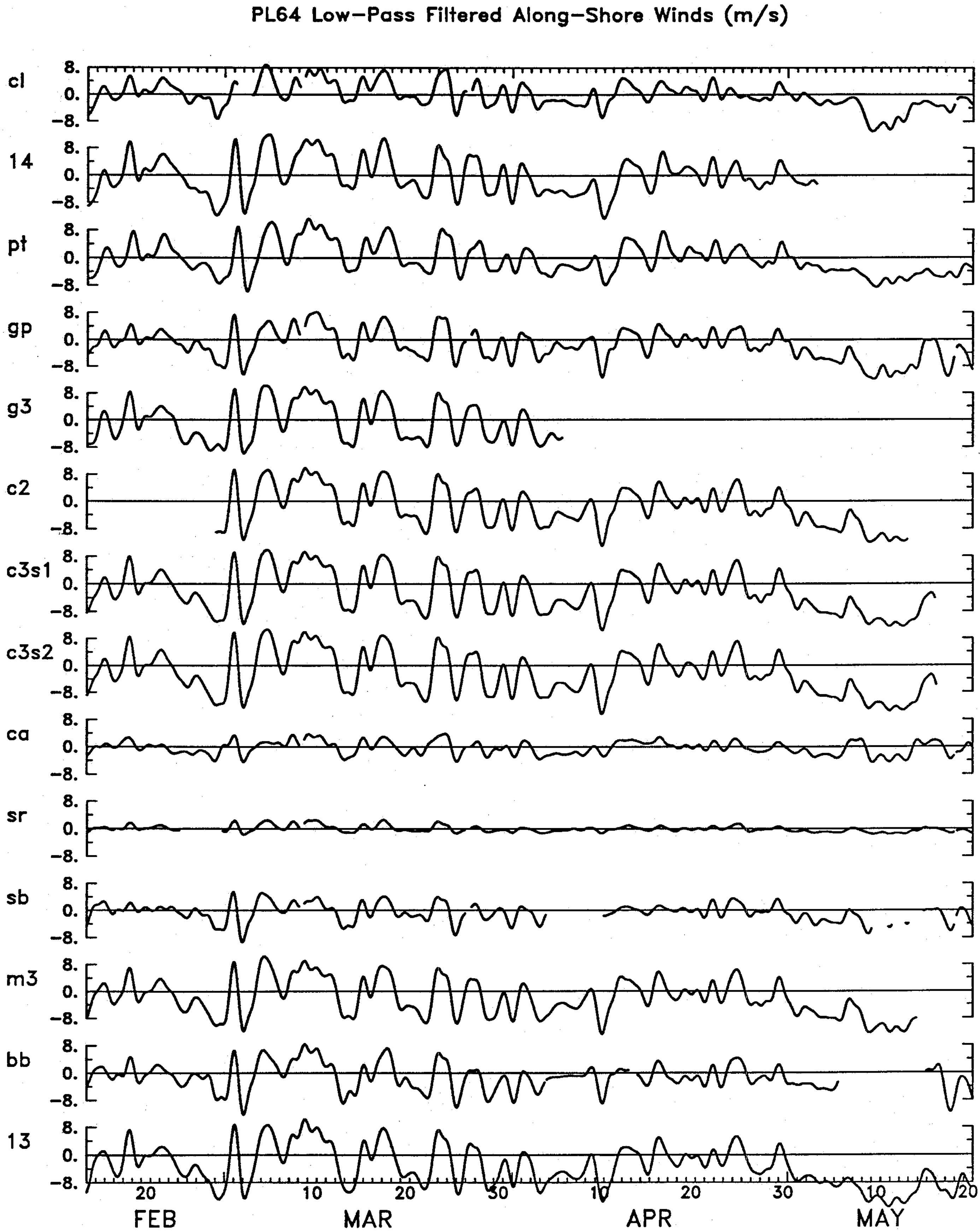


Figure 13 (cont.)

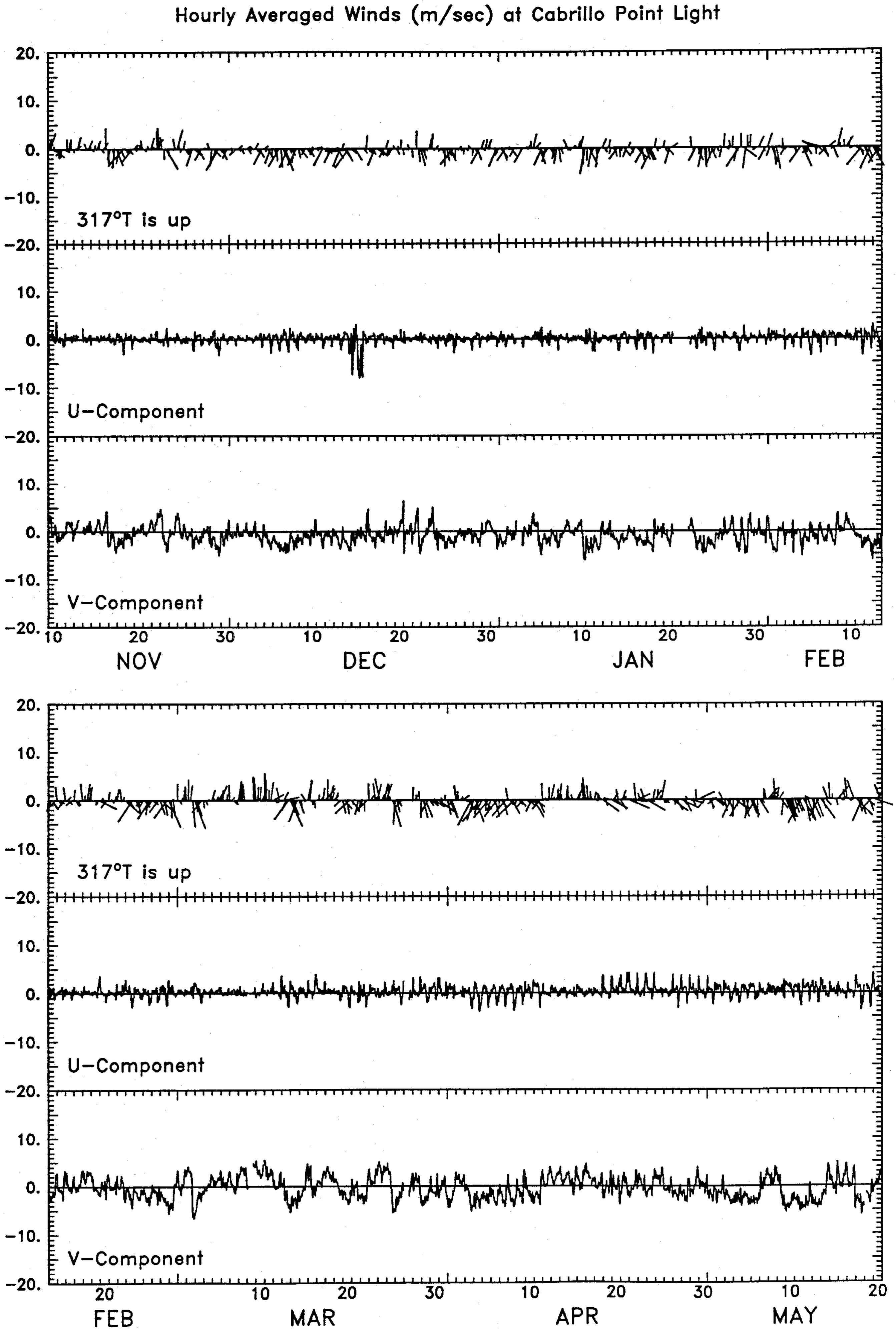
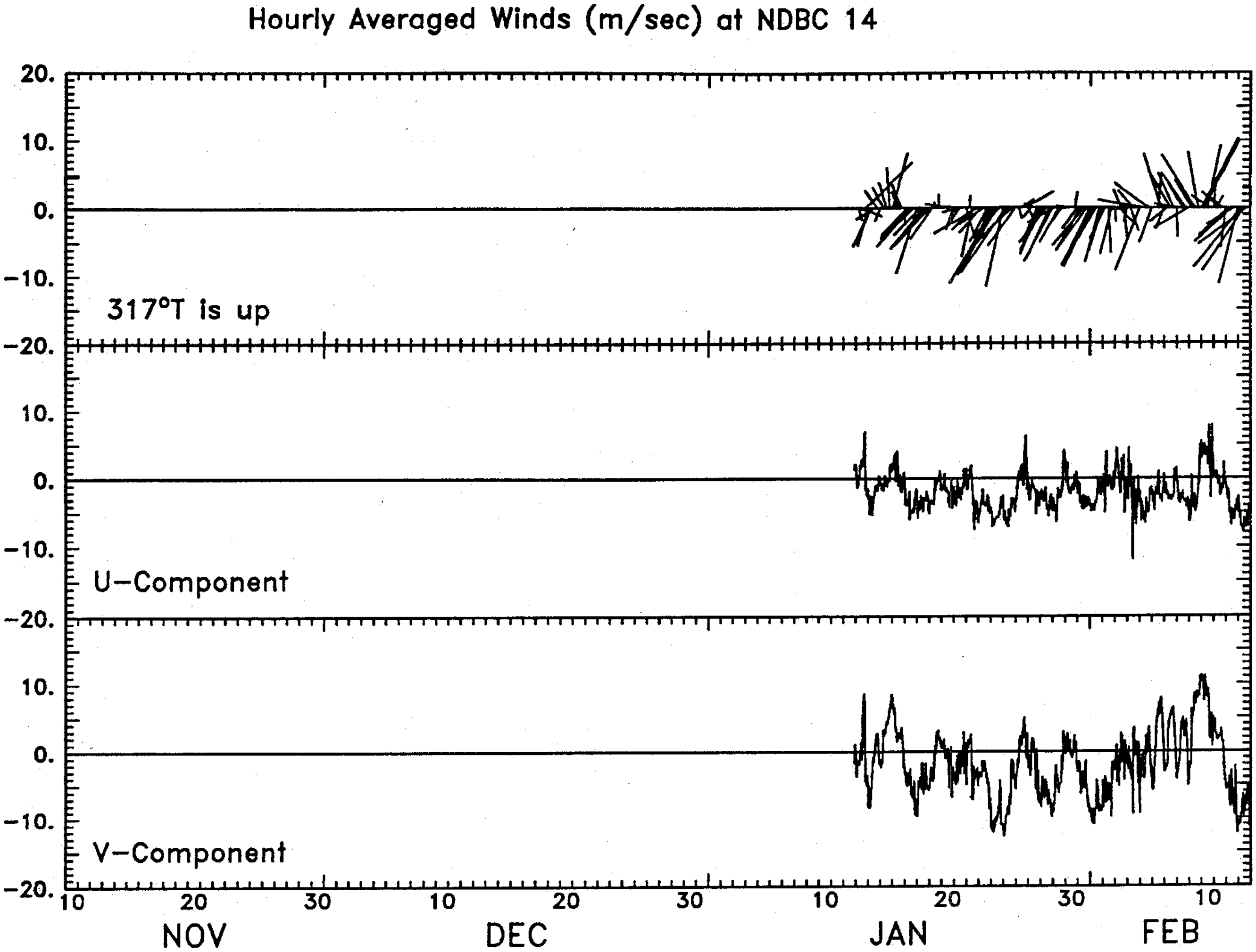
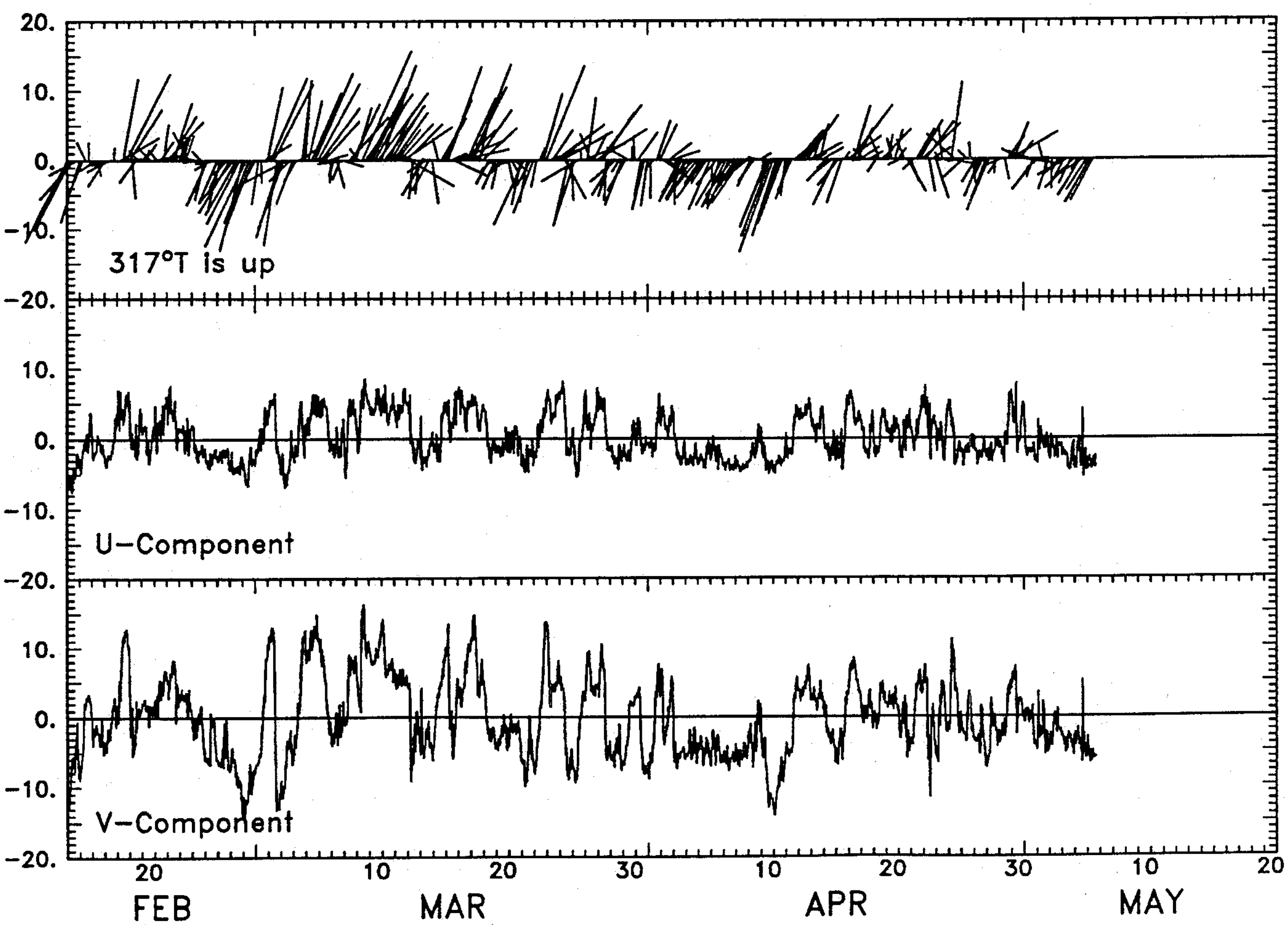

Hourly Averaged Winds (m/sec) at Cabrillo Point Light
20.
10.
0.
-10.
-20.
317°T is up
U-Component
V-Component
10
20
30
NOV
DEC
JAN
FEB
FEB
MAR
APR
MAY

Figure 14



Hourly Averaged Winds (m/sec) at NDBC 14
317°T is up
U-Component
V-Component
20.
10.
0.
-10.
-20.
10
20
30
10
20
30
10
20
30
10
NOV
DEC
JAN
FEB



317°T is up
U-Component
V-Component
20
10
20
30
10
20
30
10
20
FEB
MAR
APR
MAY

Figure 15

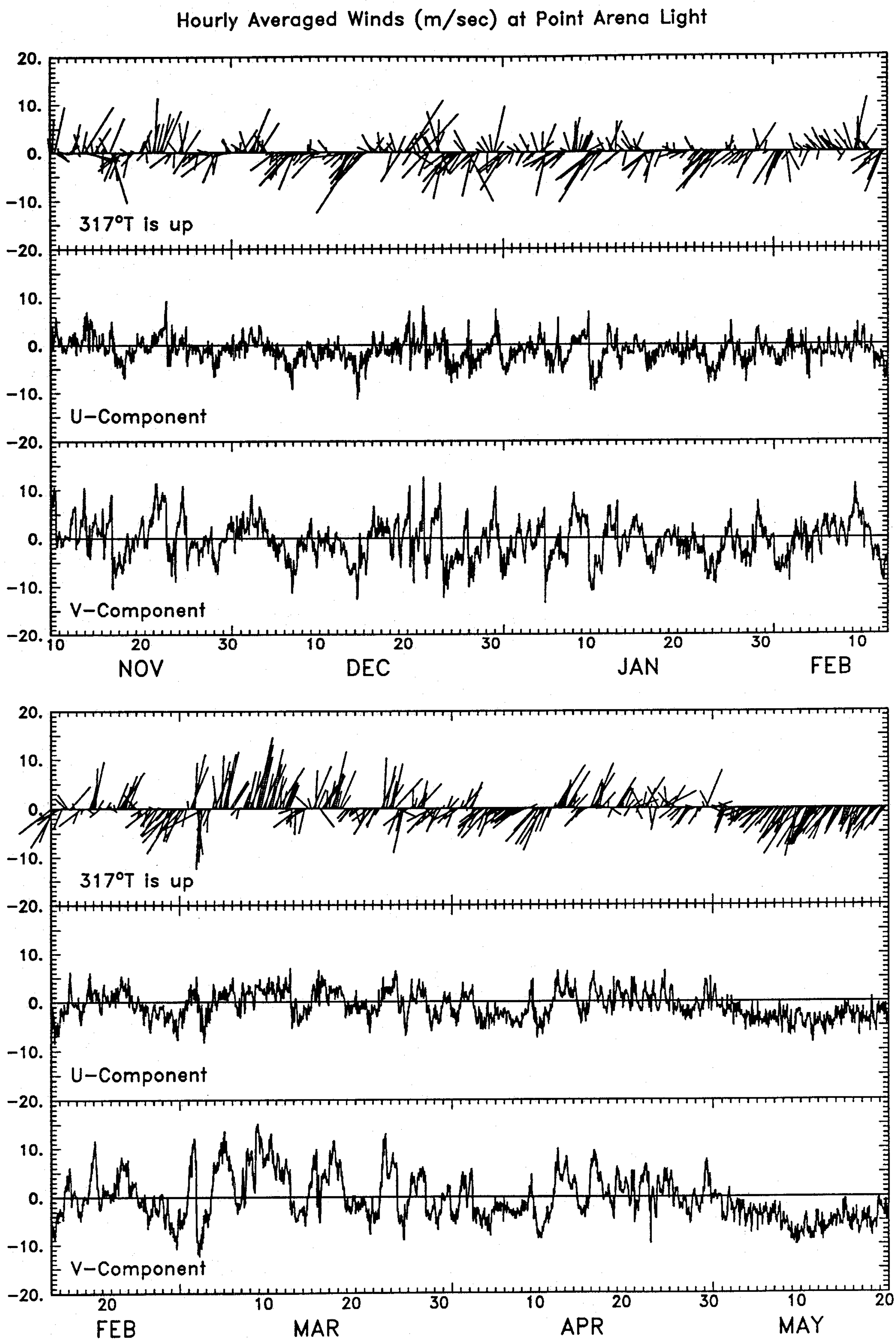

Hourly Averaged Winds (m/sec) at Point Arena Light
317°T is up
U–Component
V–Component
20. 10. 0. -10. -20.
10 20 30 10 20 30 10 20 30 10
NOV DEC JAN FEB
317°T is up
U–Component
V–Component
20 10 20 30 10 20 30 10 20
FEB MAR APR MAY

Figure 16

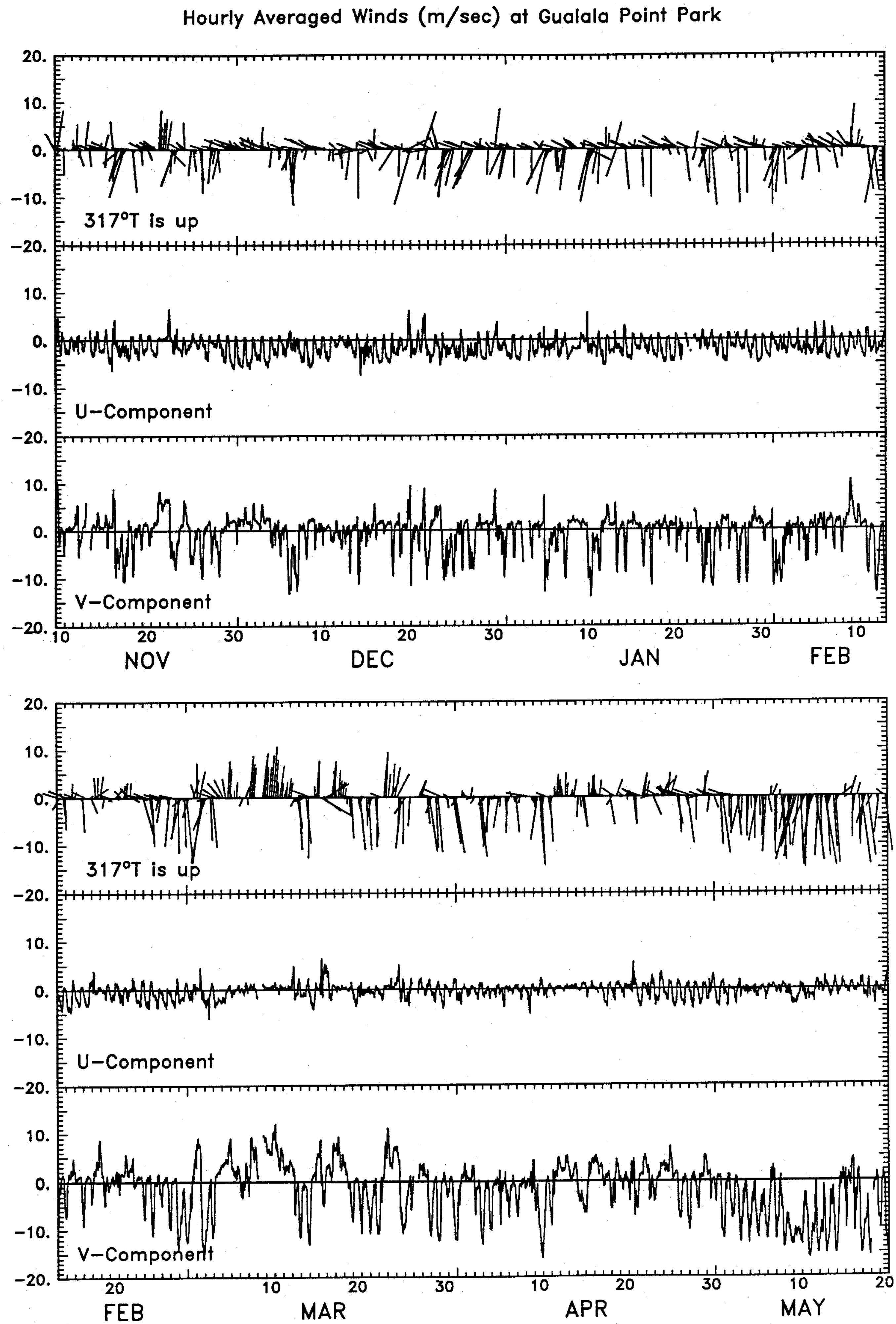

Hourly Averaged Winds (m/sec) at Gualala Point Park
20.
10.
0.
-10.
317°T is up
-20.
U-Component
V-Component
10
20
30
NOV
DEC
JAN
FEB
MAR
APR
MAY

Figure 17

Hourly Averaged Winds (m/sec) at Mooring G3

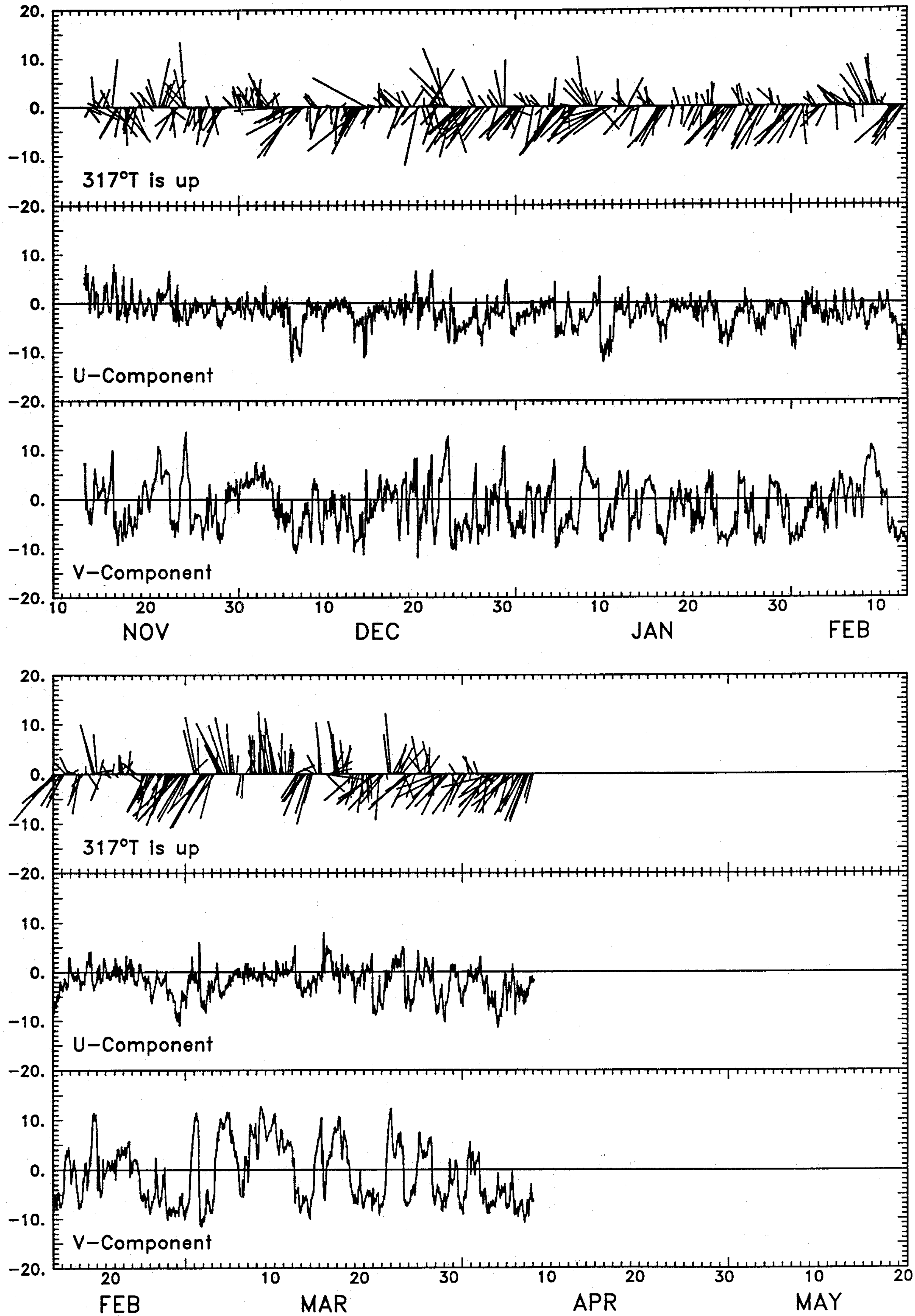


Figure 18

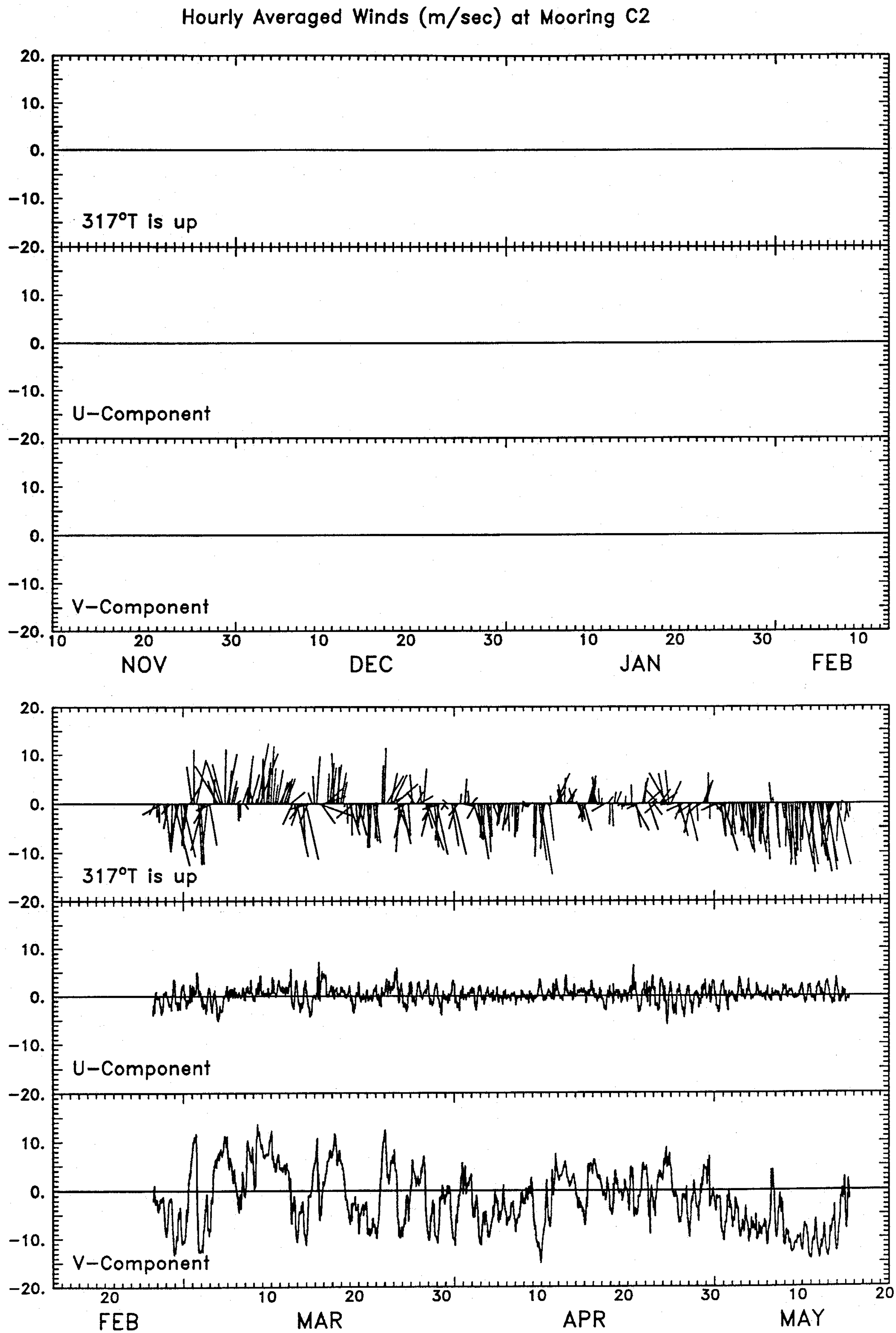

Hourly Averaged Winds (m/sec) at Mooring C2
20.
10.
0.
-10.
-20.
317°T is up
U-Component
V-Component
10 20 30 10 20 30 10 20 30 10
NOV DEC JAN FEB
20 10 20 30 10 20 30 10 20
FEB MAR APR MAY

Figure 19

Hourly Averaged Winds (m/sec) at Mooring C3(S1)

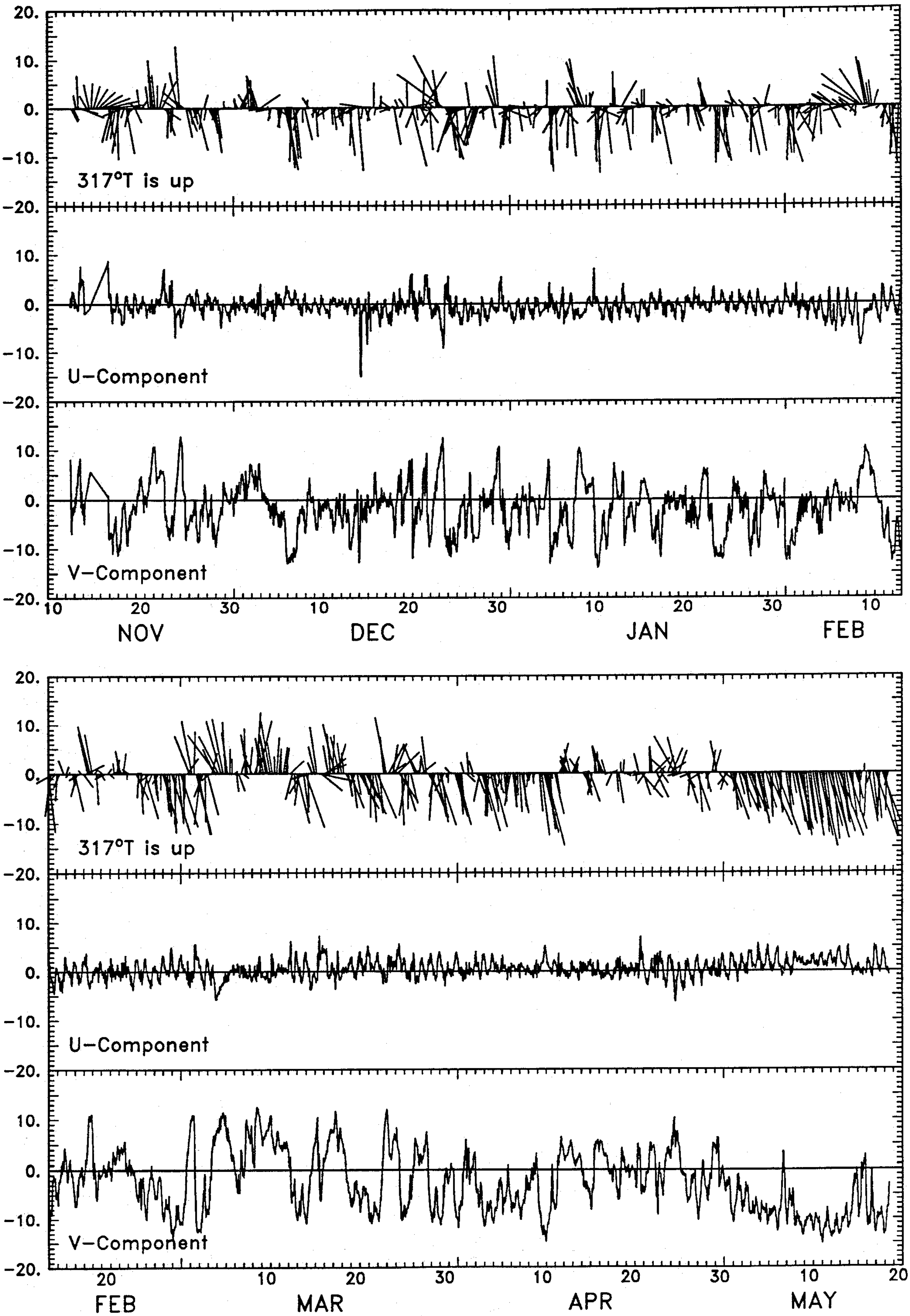
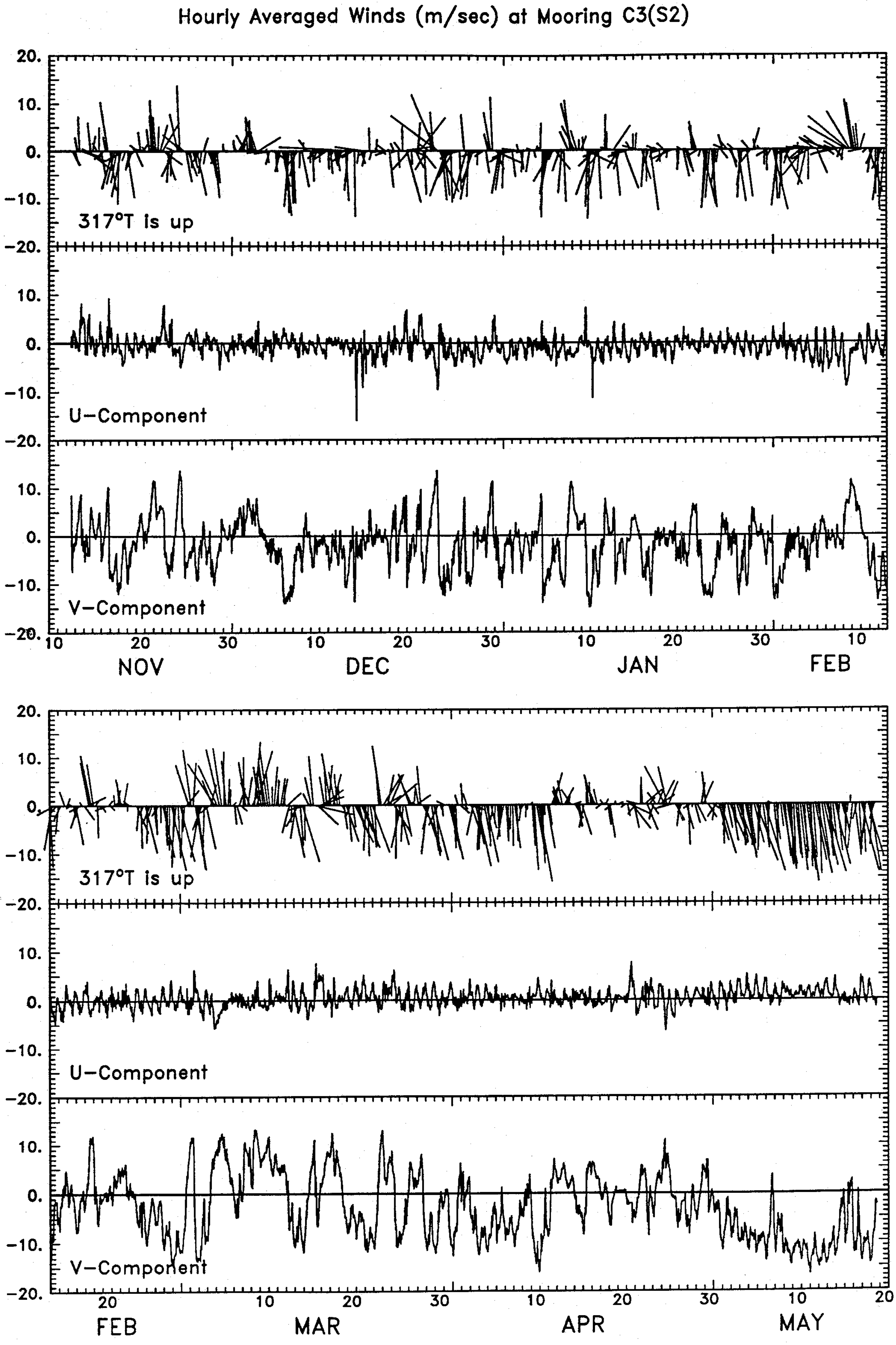


Figure 20



Hourly Averaged Winds (m/sec) at Mooring C3(S2)
317°T is up
U-Component
V-Component
NOV
DEC
JAN
FEB
317°T is up
U-Component
V-Component
FEB
MAR
APR
MAY

Figure 21

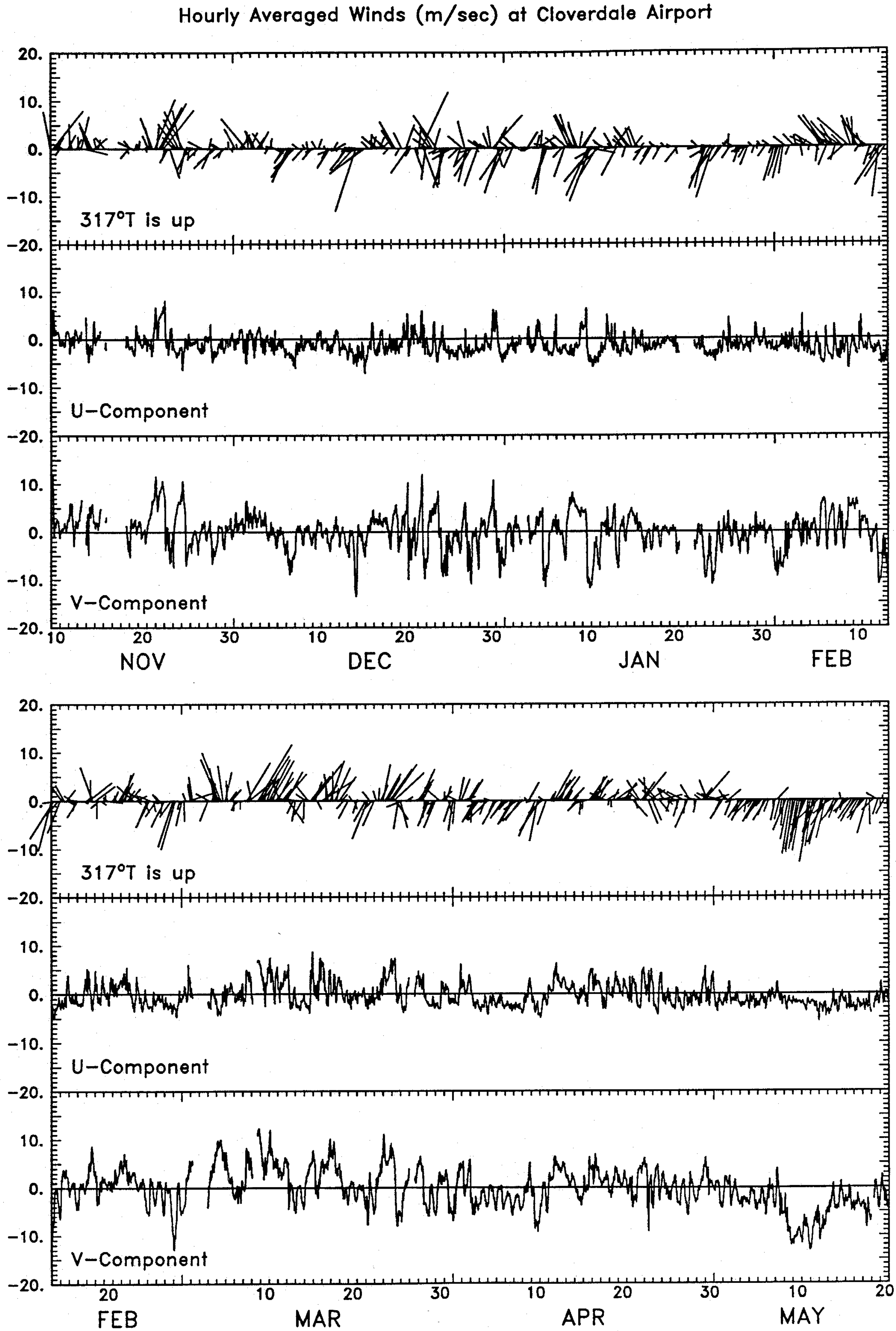

Hourly Averaged Winds (m/sec) at Cloverdale Airport
20.
10.
0.
-10.
317°T is up
-20.
U-Component
V-Component
10
20
30
NOV
DEC
JAN
FEB
MAR
APR
MAY

Figure 22

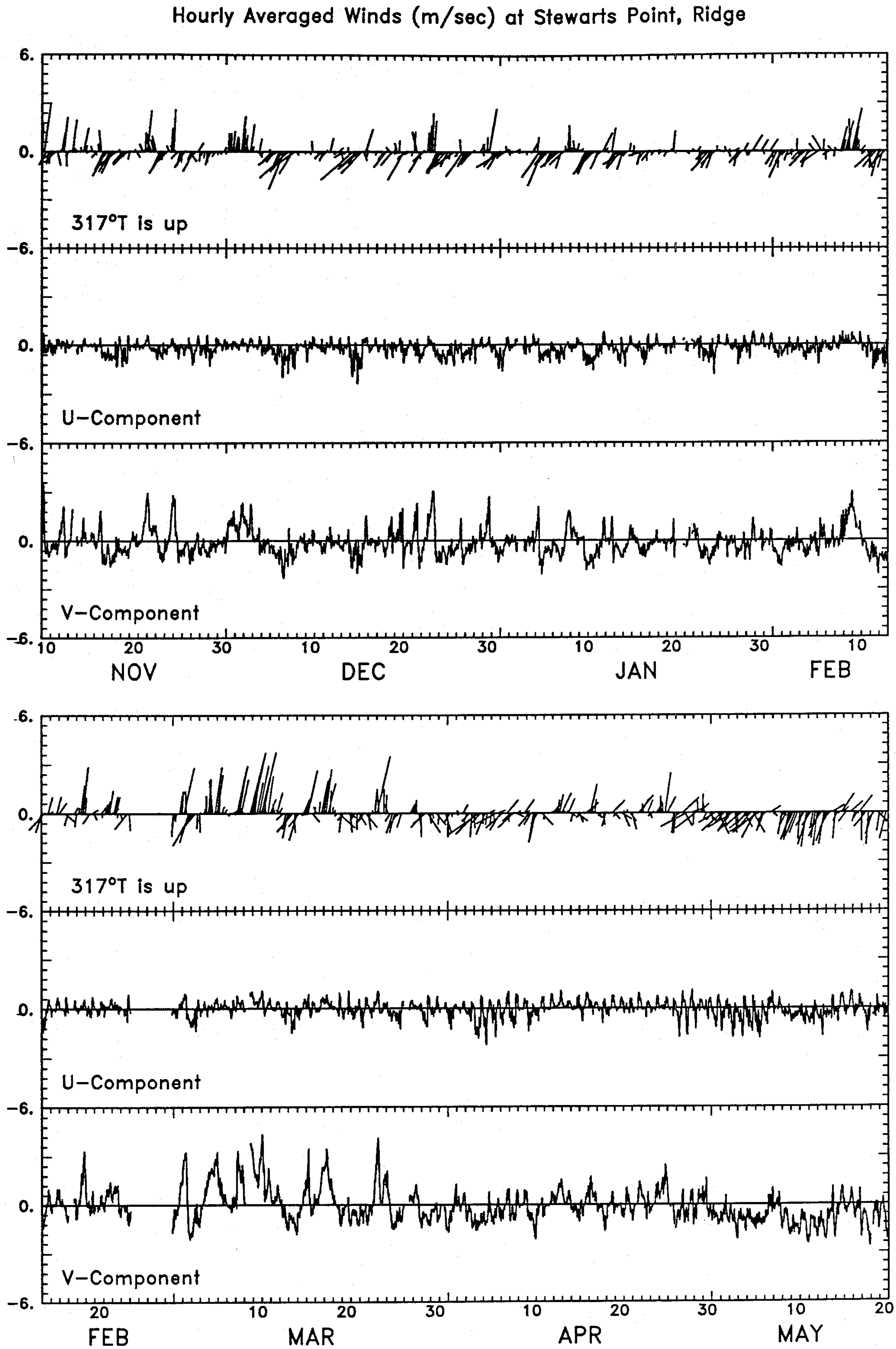
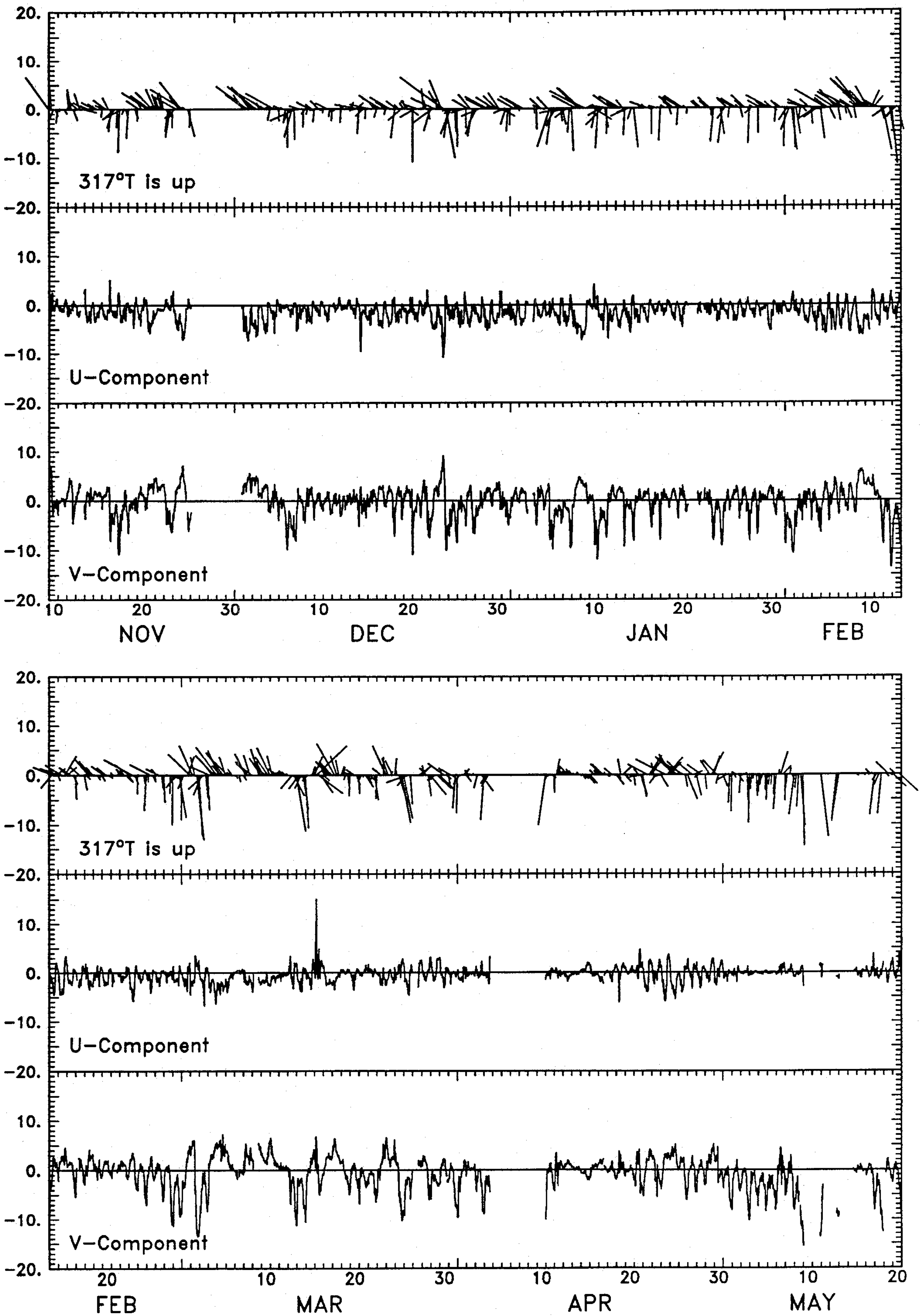

Hourly Averaged Winds (m/sec) at Stewarts Point, Ridge
6.
0.
-6.
317°T is up
U-Component
V-Component
10
20
30
NOV
DEC
JAN
FEB
MAR
APR
MAY

Figure 23

Hourly Averaged Winds (m/sec) at Stewarts Point, Beach



Hourly Averaged Winds (m/sec) at Mooring M3

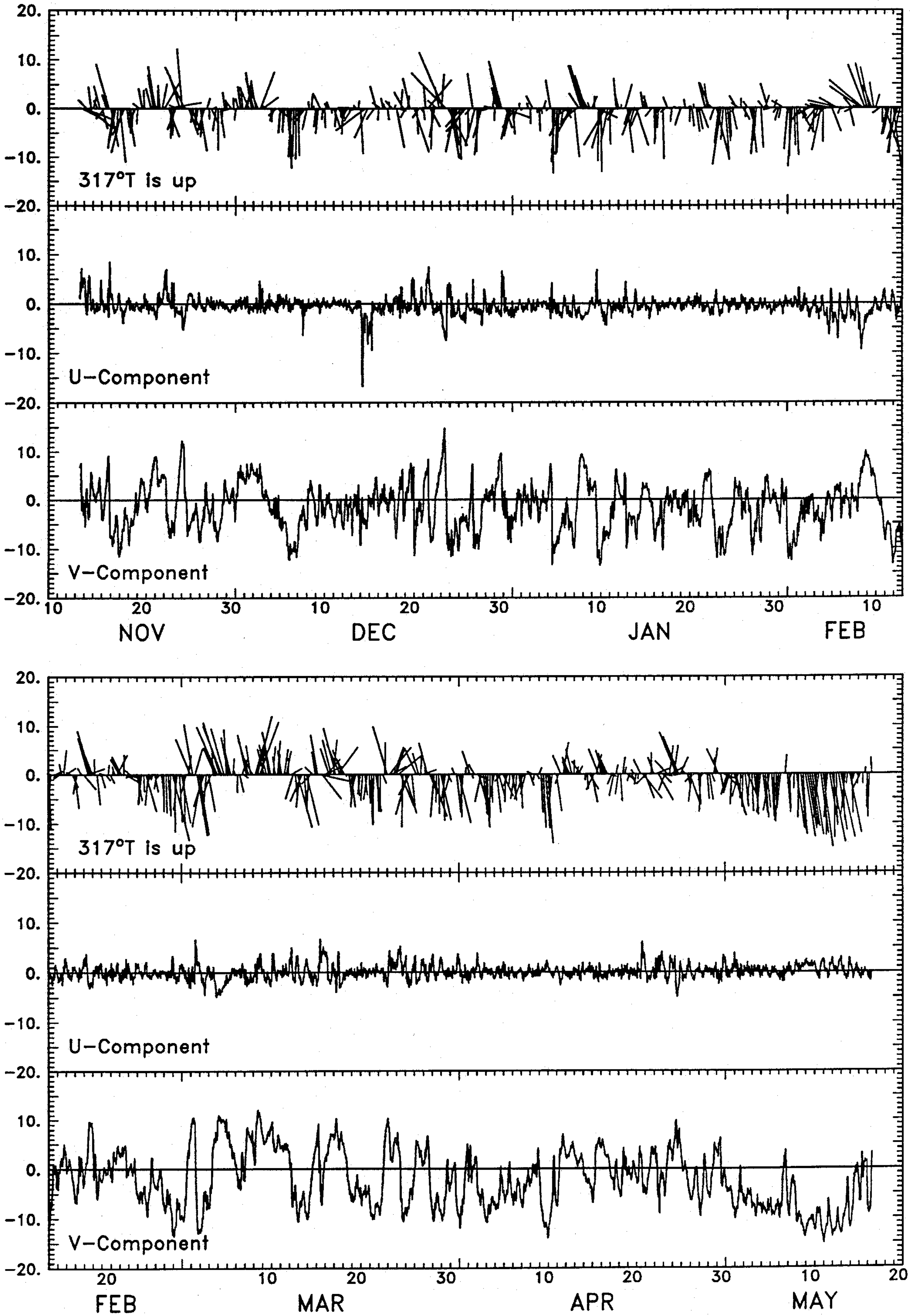


Figure 25

Hourly Averaged Winds (m/sec) at Bodega Bay

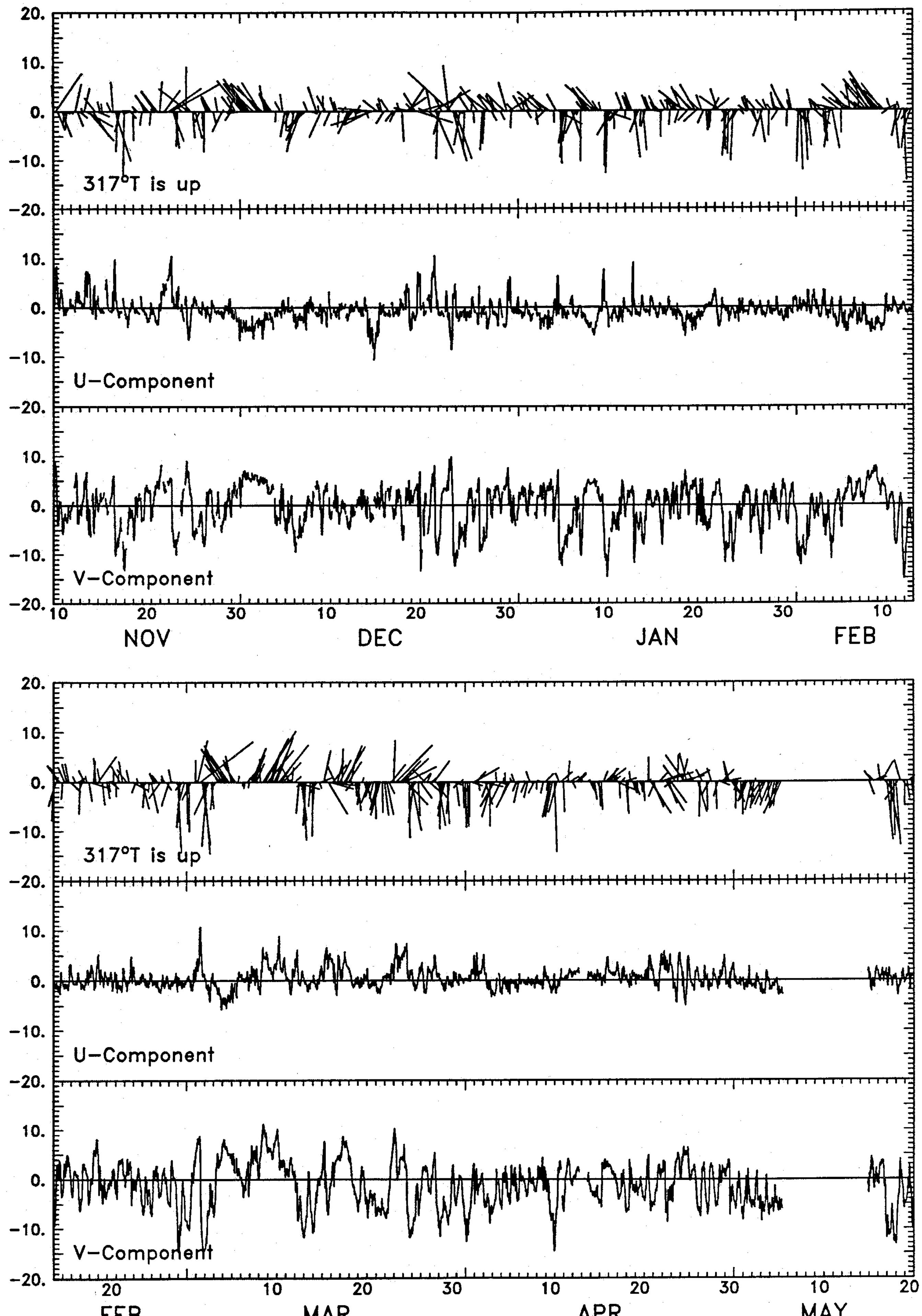
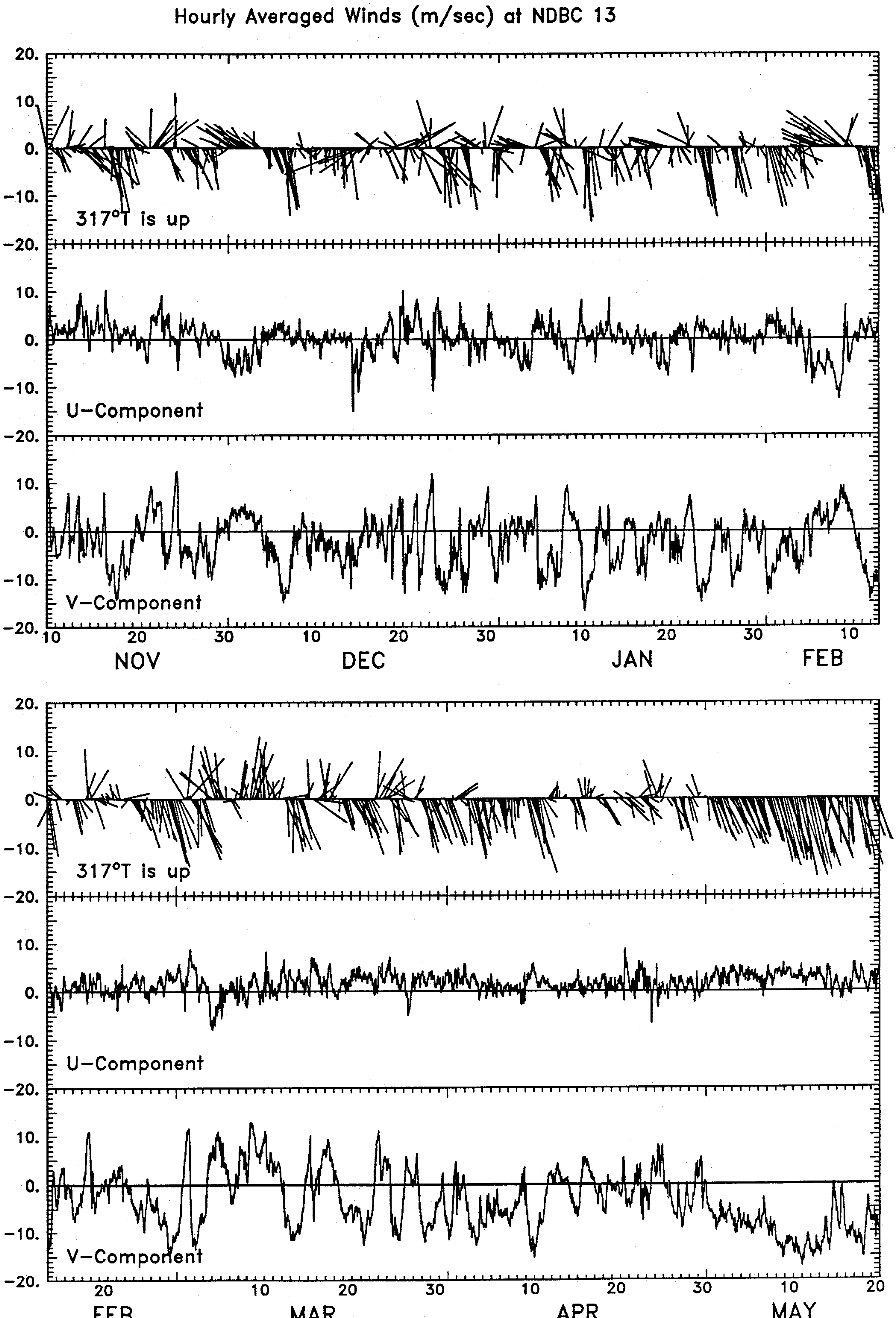


Figure 26



Hourly Averaged Winds (m/sec) at NDBC 13
20.
10.
0.
-10.
-20.
317°T is up
U-Component
V-Component
10
20
30
NOV
DEC
JAN
FEB
MAR
APR
MAY

Figure 27

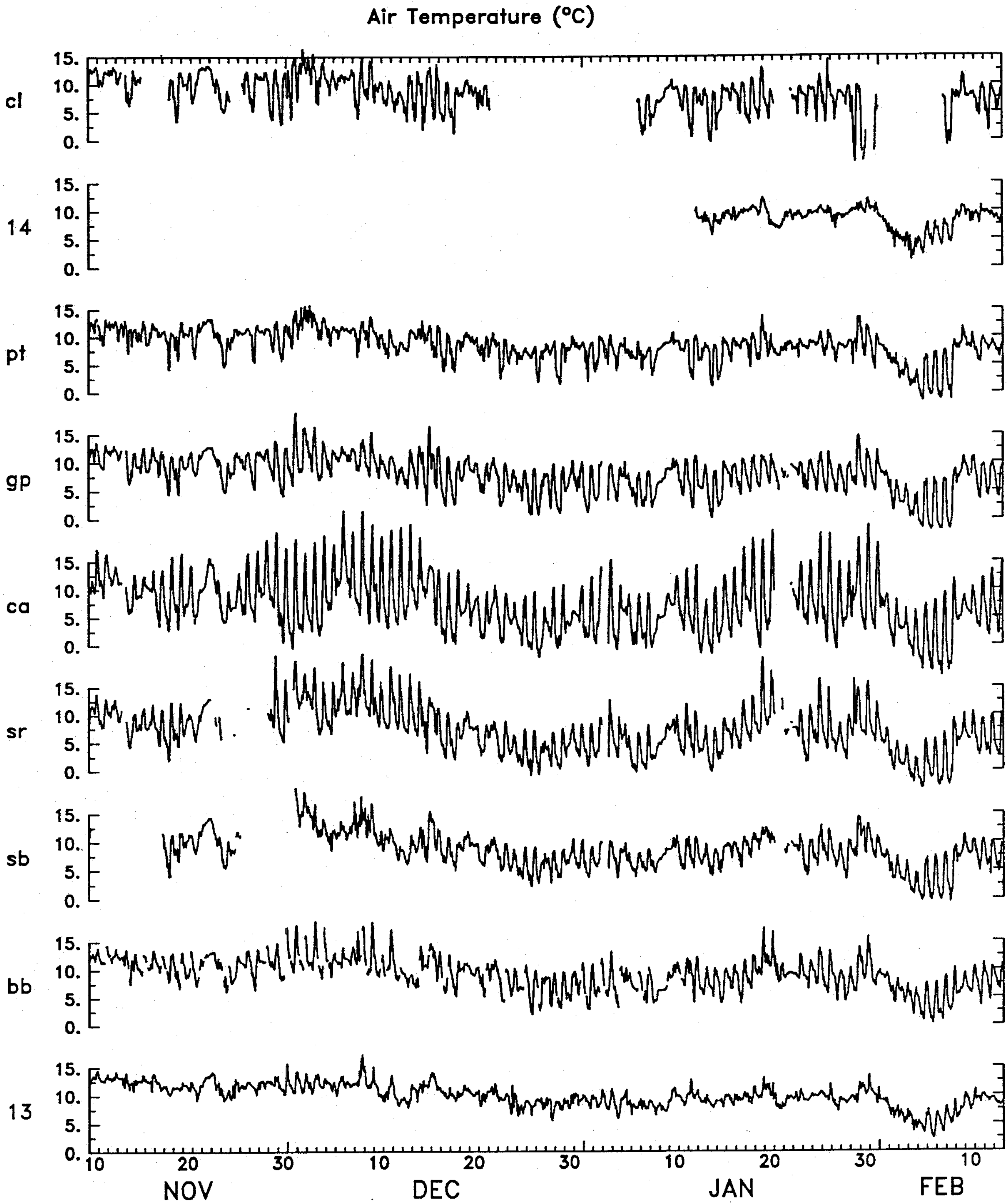

Air Temperature (°C)
cl
14
pt
gp
ca
sr
sb
bb
13
0.
5.
10.
15.
10
20
30
10
20
30
10
20
30
10
NOV
DEC
JAN
FEB

Figure 28

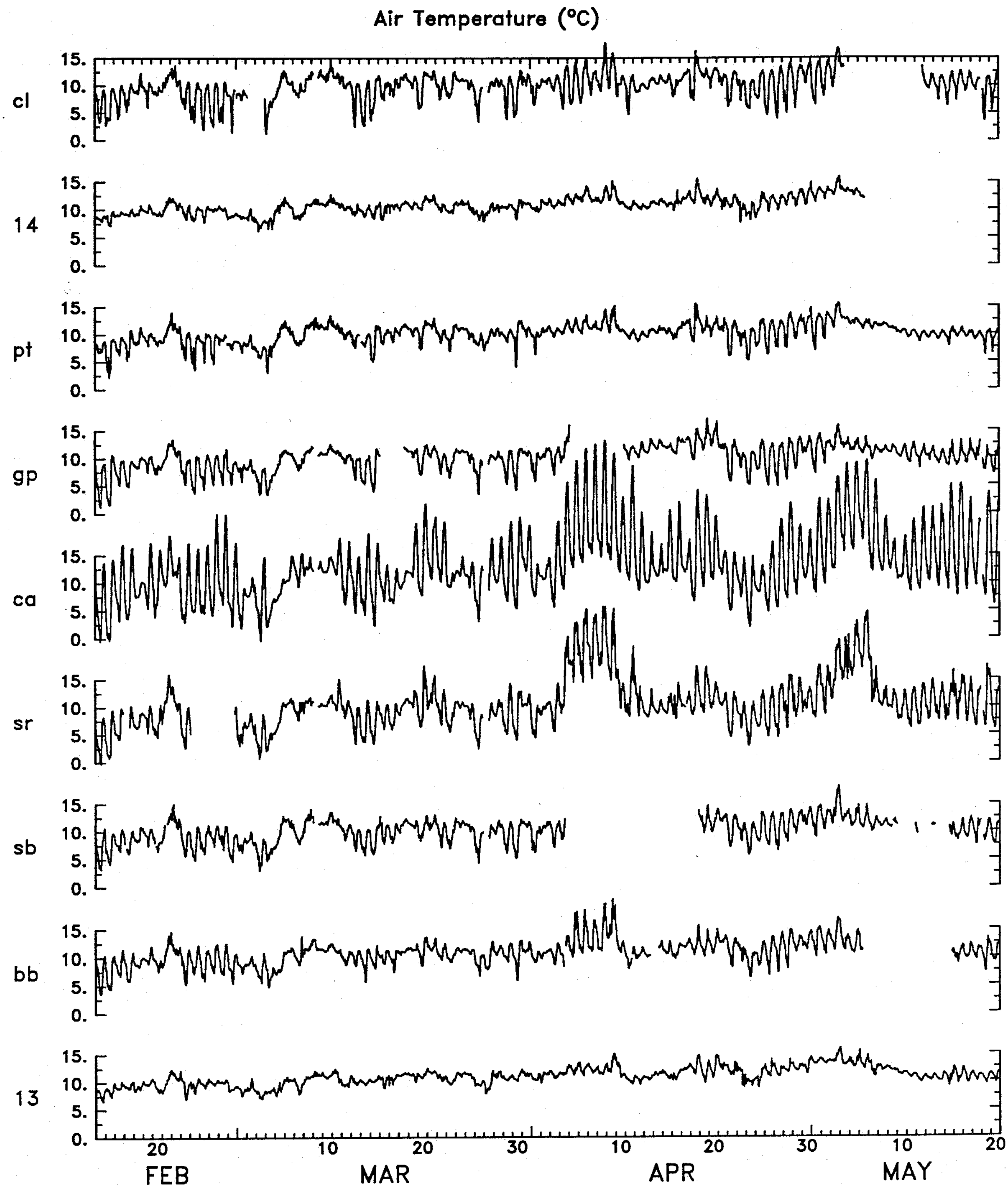


Figure 28 (cont.)

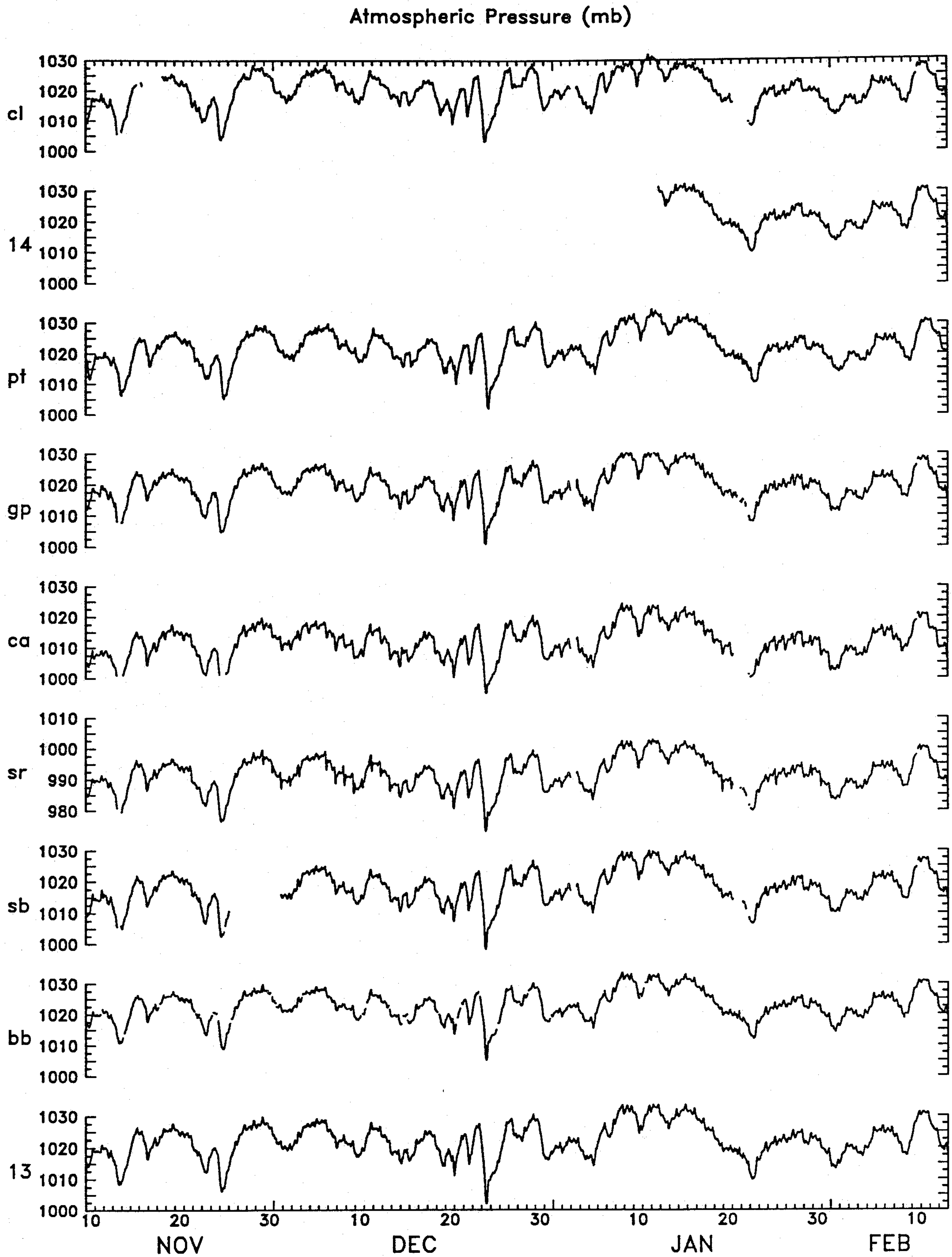

Atmospheric Pressure (mb)
cl
14
pt
gp
ca
sr
sb
bb
13
1030
1020
1010
1000
990
980
10
20
30
NOV
DEC
JAN
FEB

Figure 29

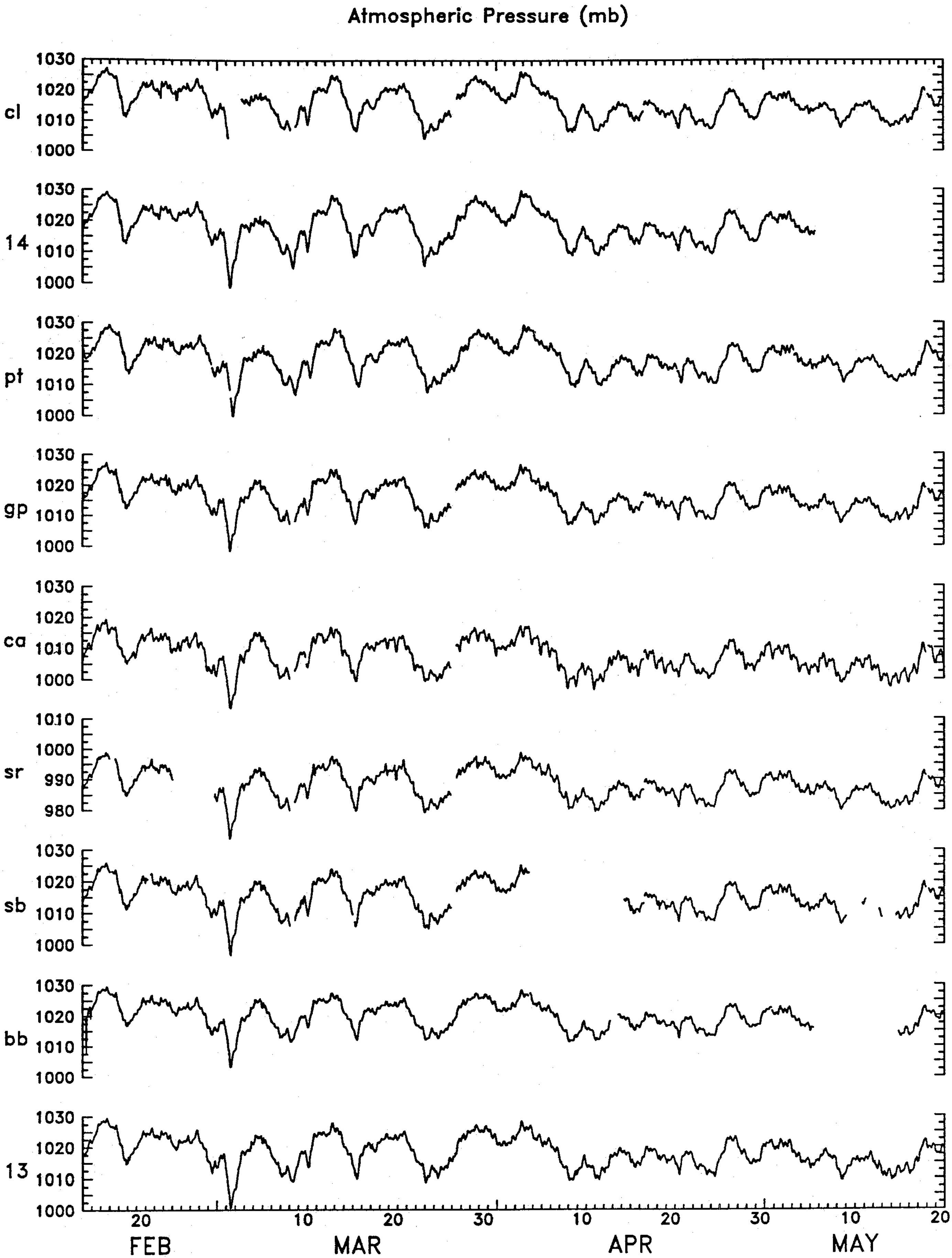


Figure 29 (cont.)

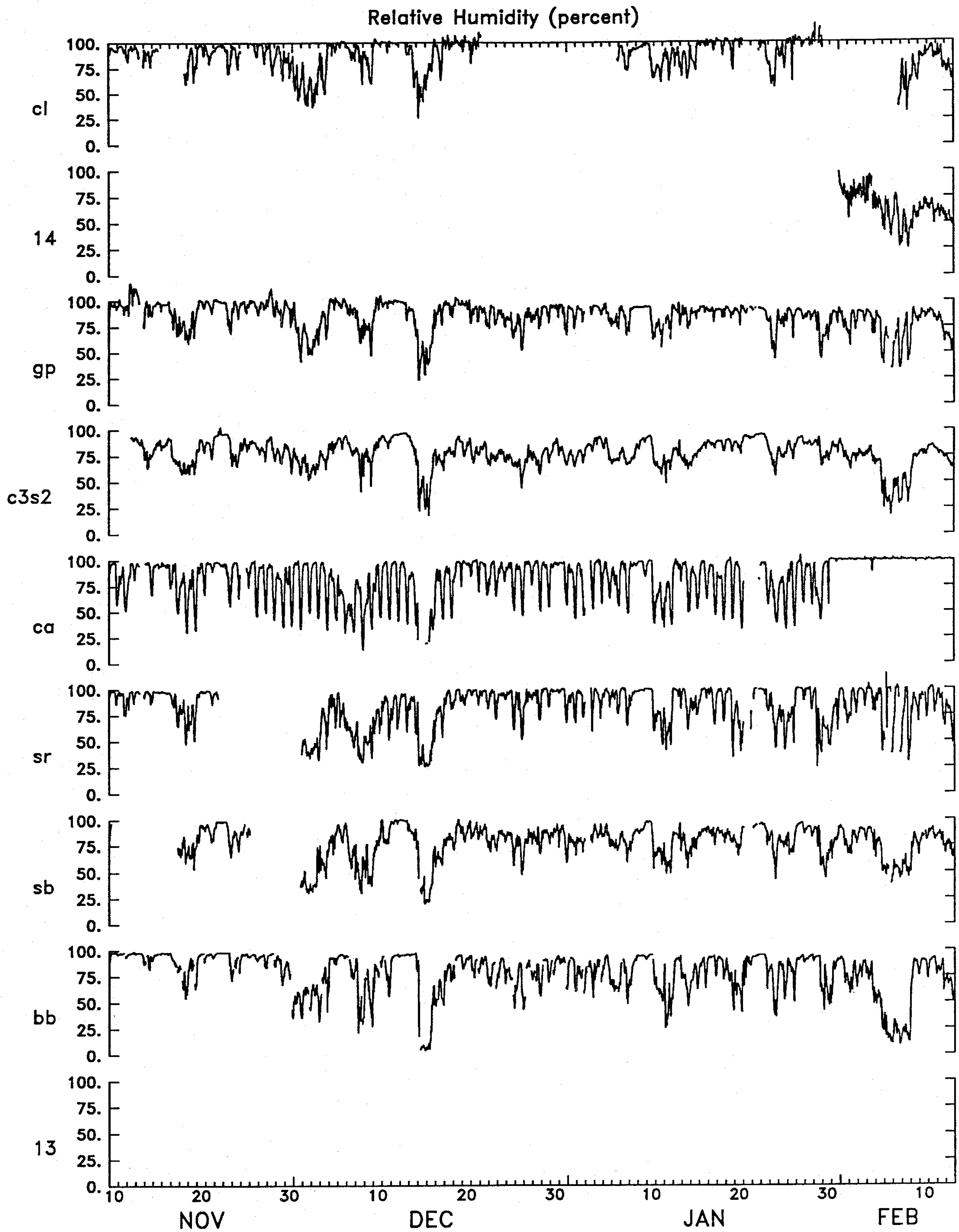

Relative Humidity (percent)
cl
14
gp
c3s2
ca
sr
sb
bb
13
100.
75.
50.
25.
0.
10
20
30
NOV
DEC
JAN
FEB

Figure 30

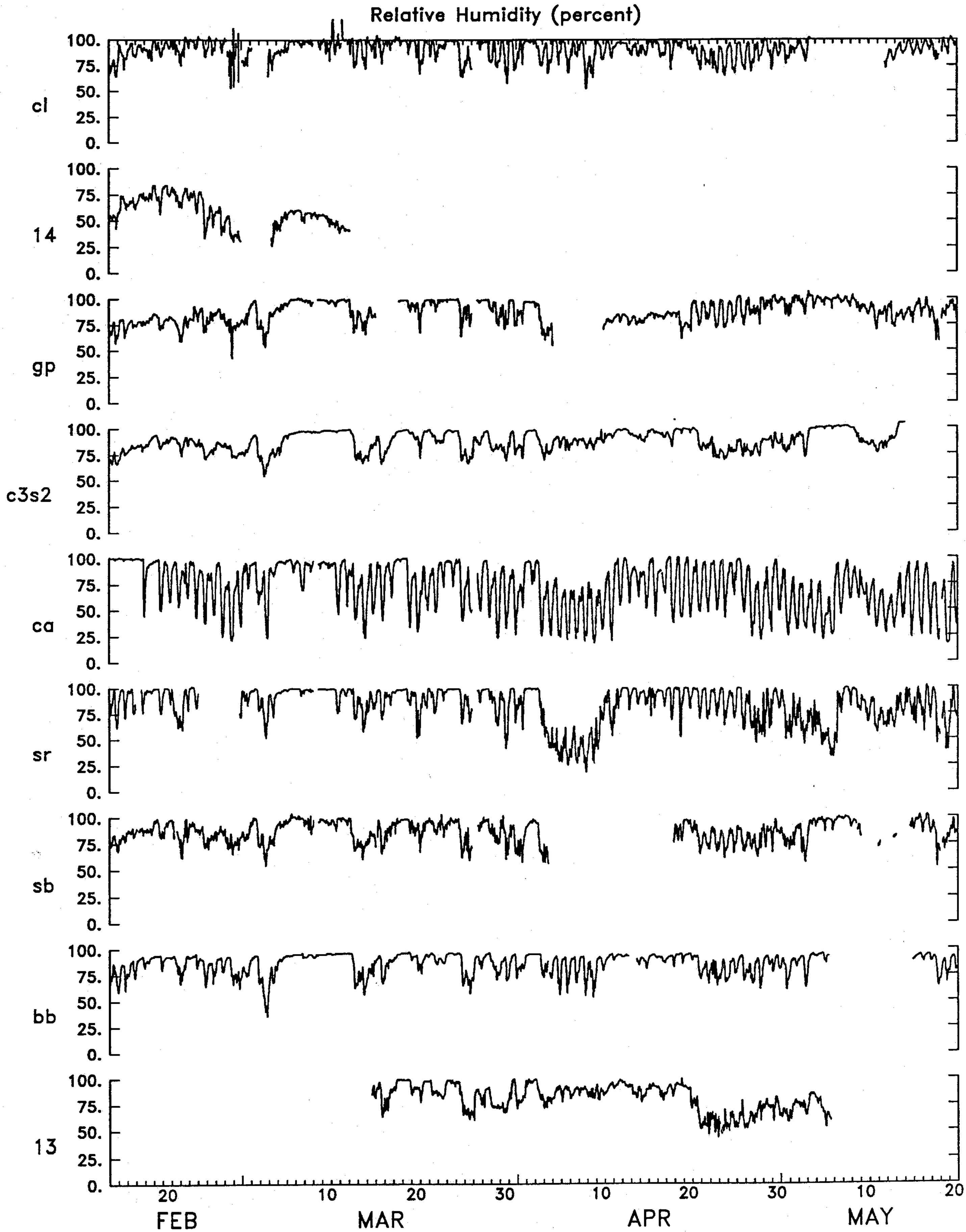
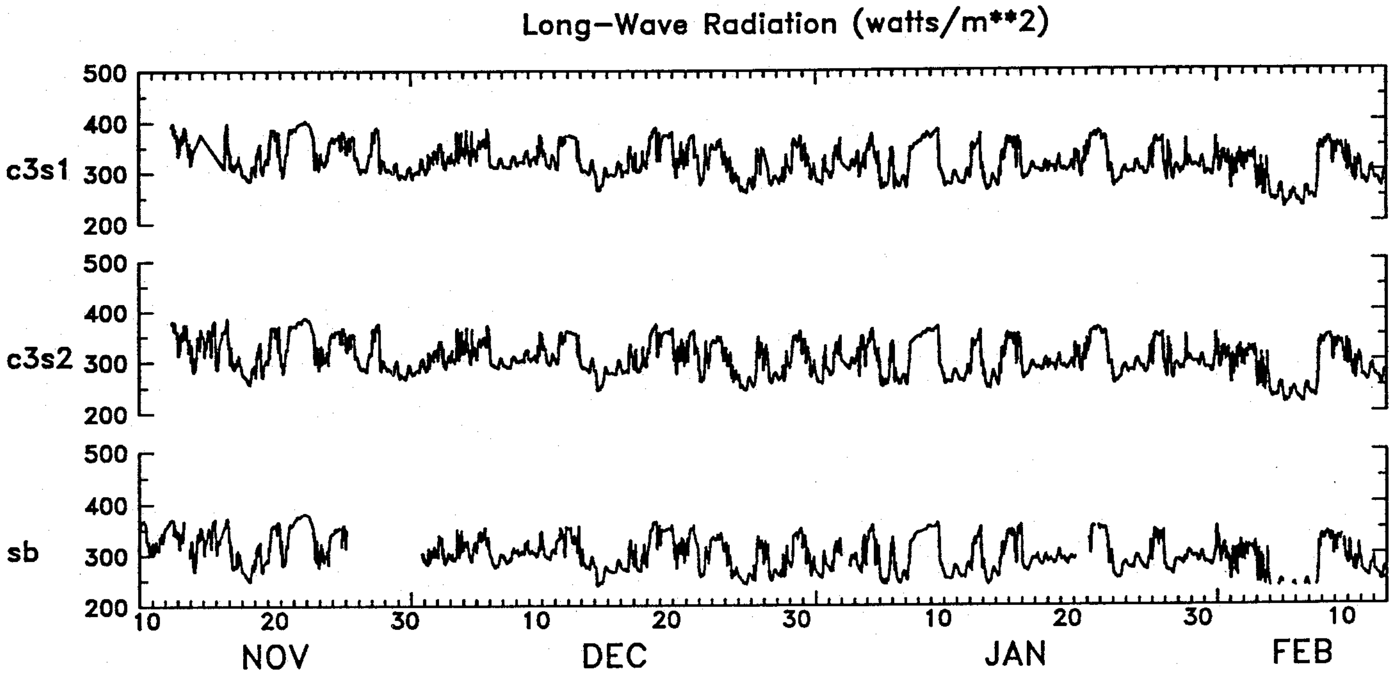


Figure 30 (cont.)


Long-Wave Radiation (watts/m**2)
c3s1
c3s2
sb
500
400
300
200
10
20
30
NOV
DEC
JAN
FEB

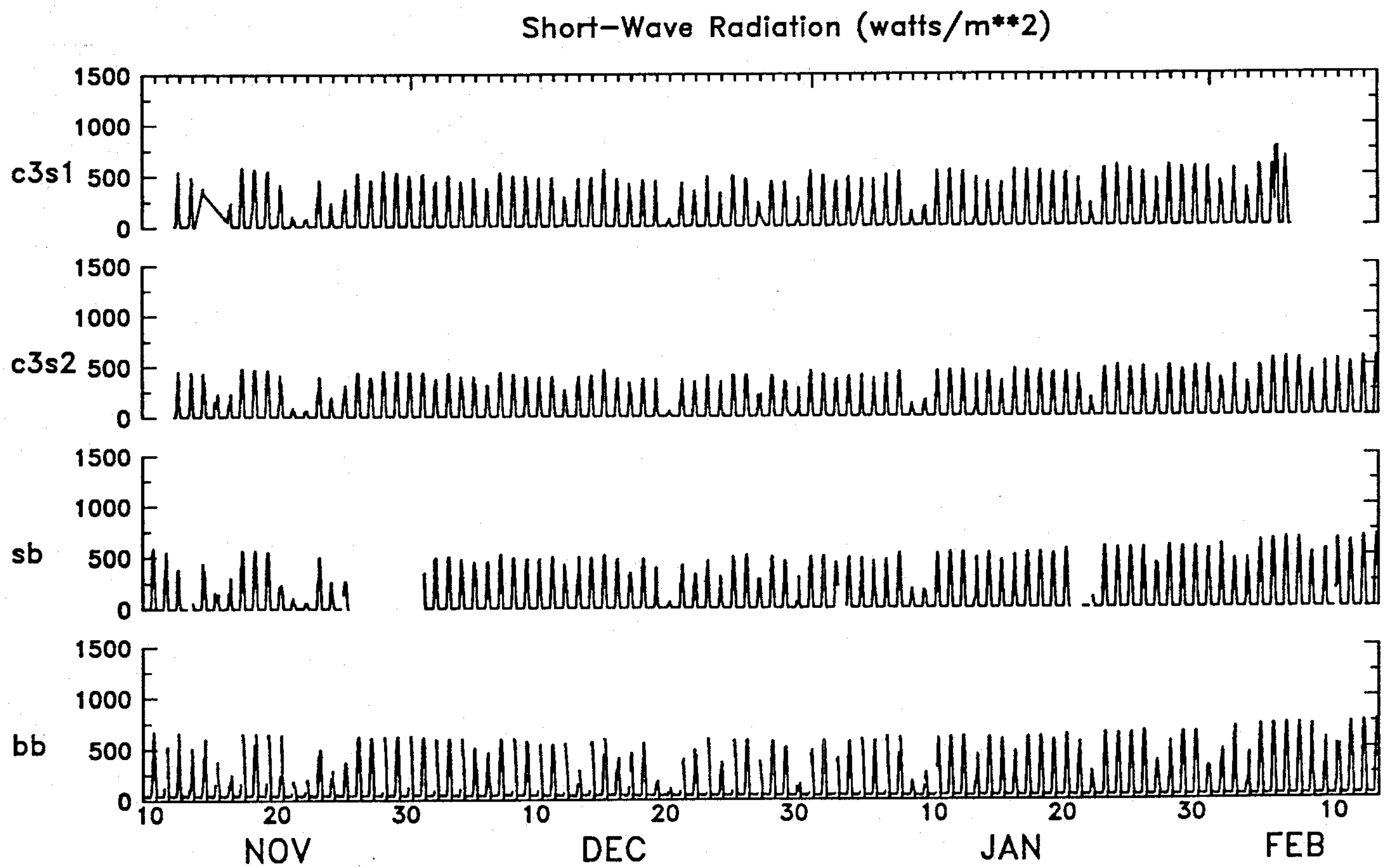
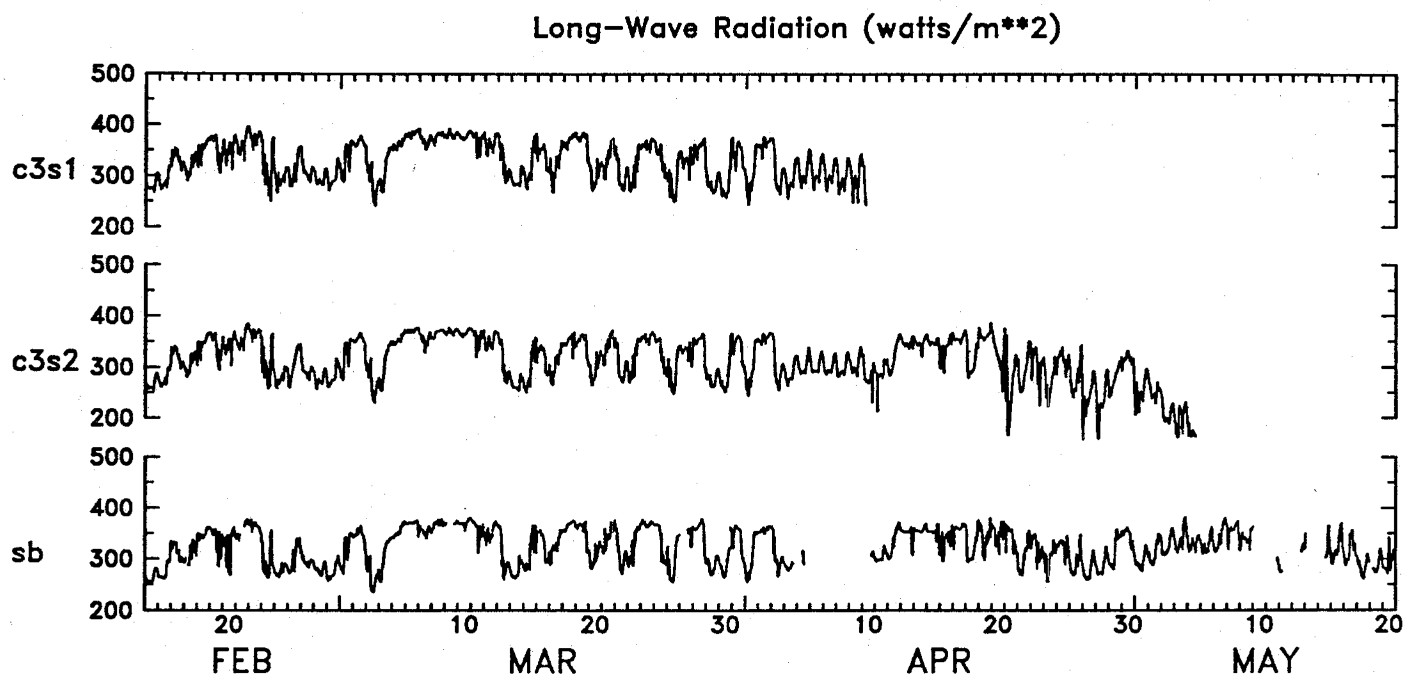

Short-Wave Radiation (watts/m**2)
c3s1
c3s2
sb
bb
1500
1000
500
0
10
20
30
NOV
DEC
JAN
FEB

Figure 31



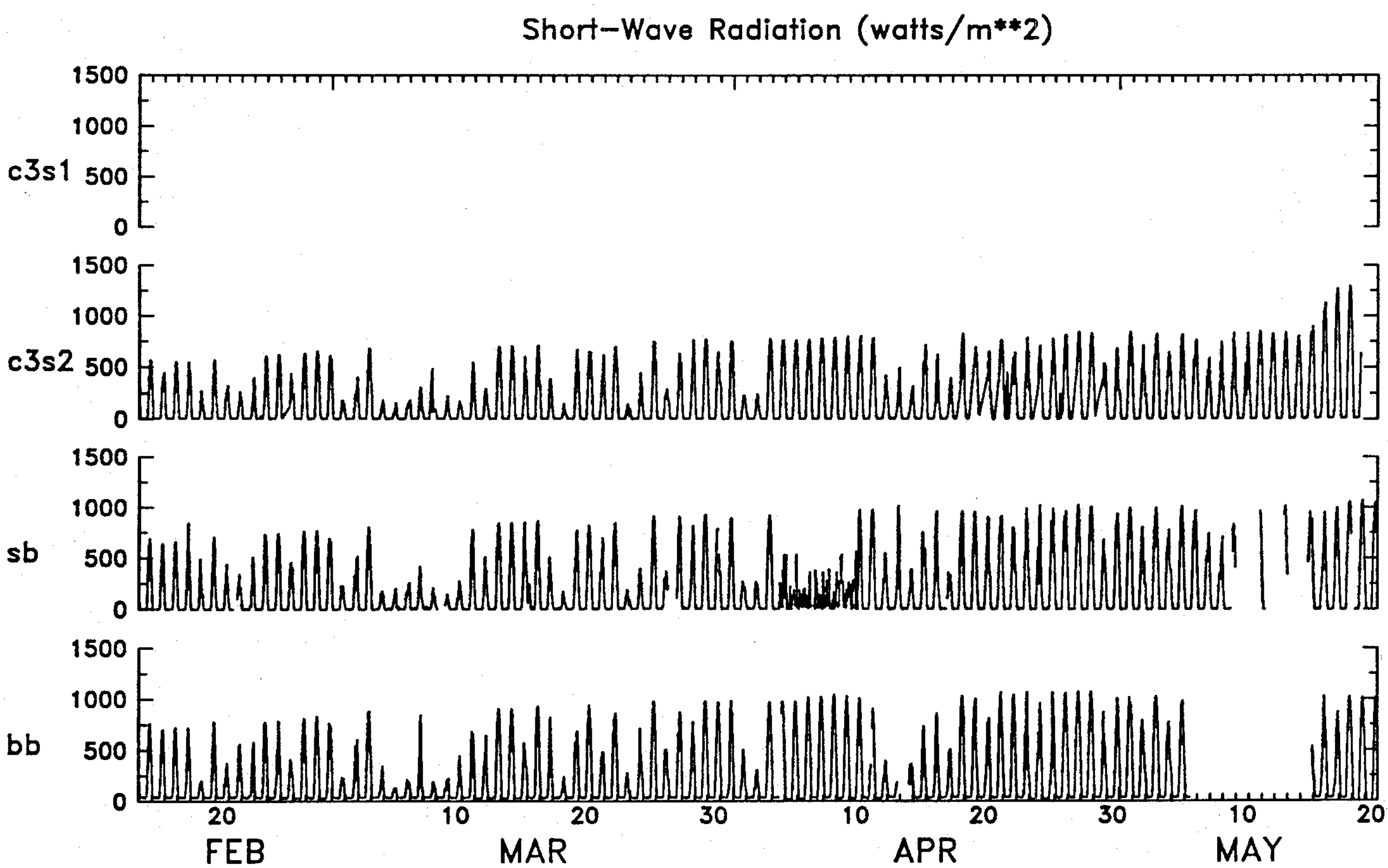


Figure 31 (cont.)

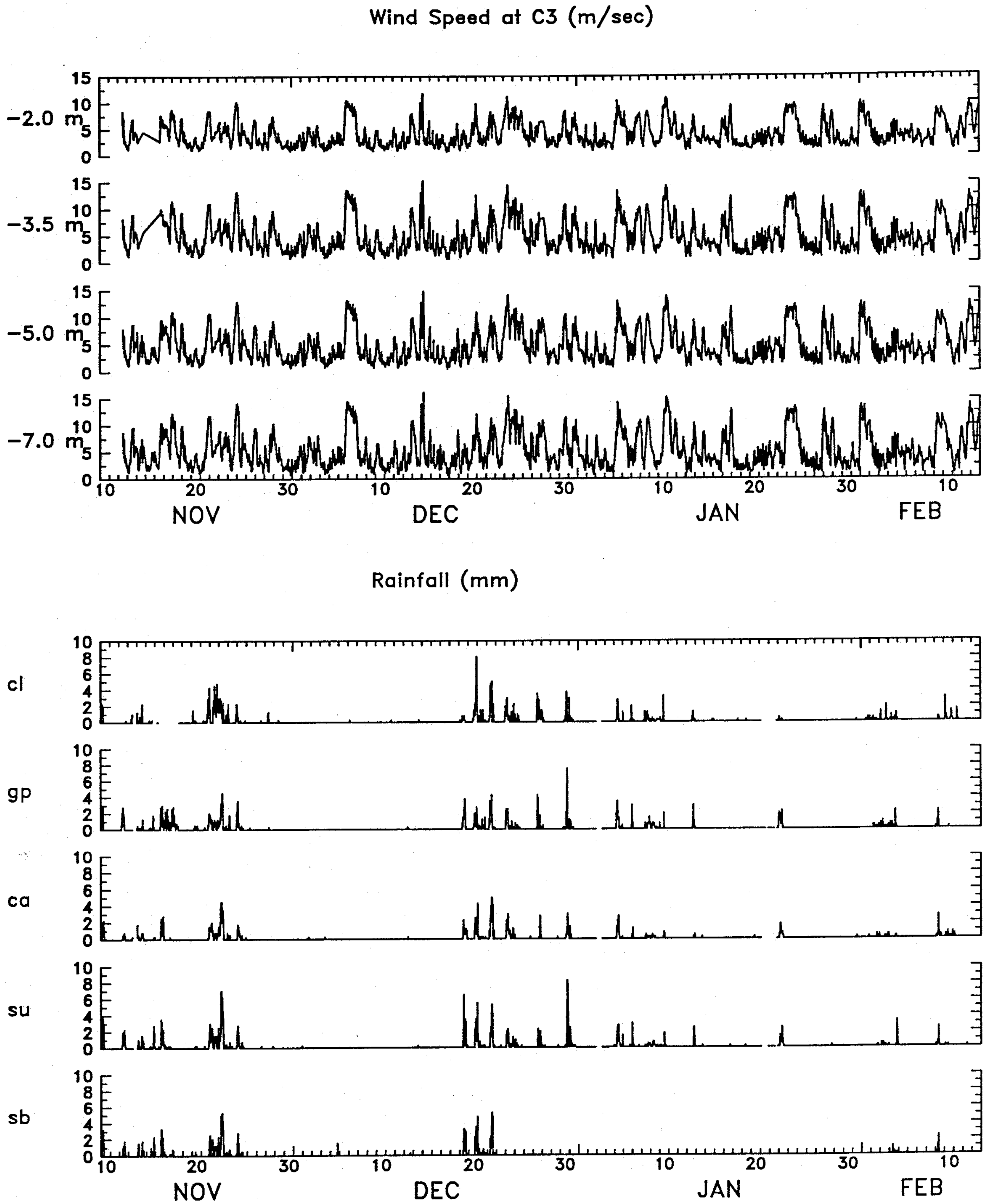
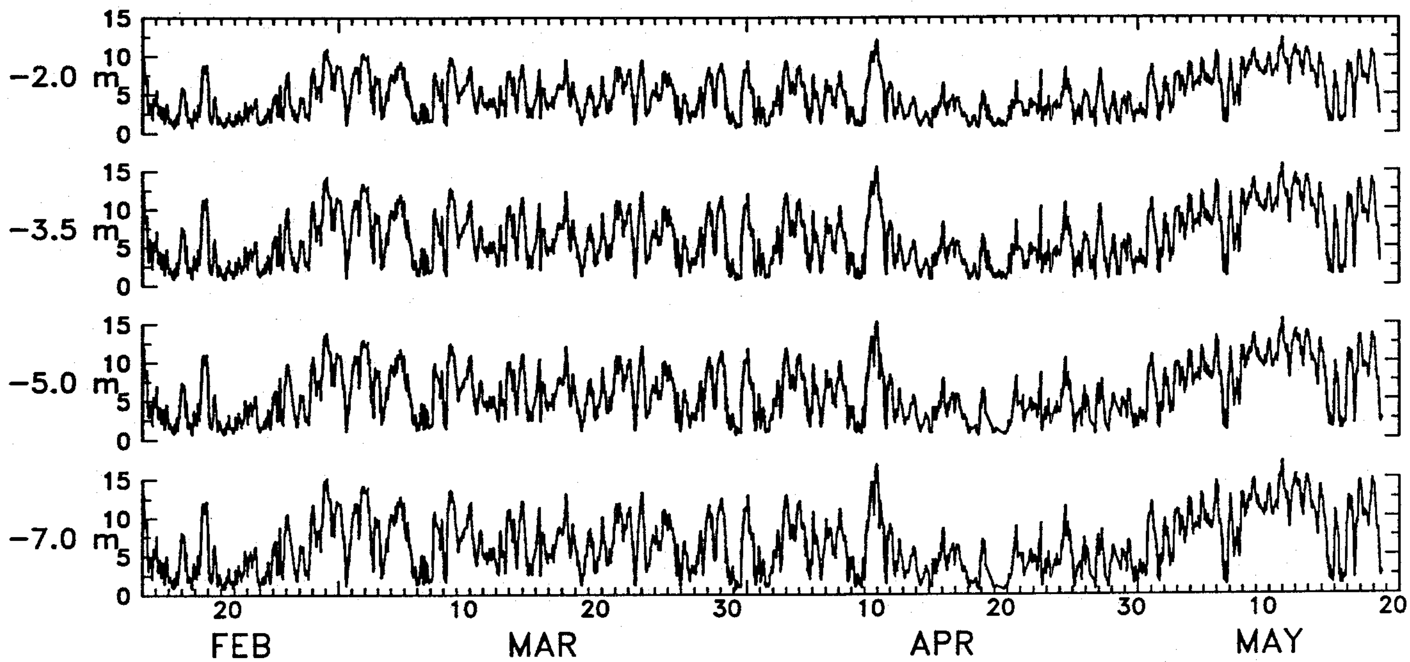

Wind Speed at C3 (m/sec)
−2.0 m
−3.5 m
−5.0 m
−7.0 m
0
5
10
15
10
20
30
NOV
DEC
JAN
FEB
Rainfall (mm)
cl
gp
ca
su
sb
0
2
4
6
8
10

Figure 32

Wind Speed at C3 (m/sec)



Rainfall (mm)

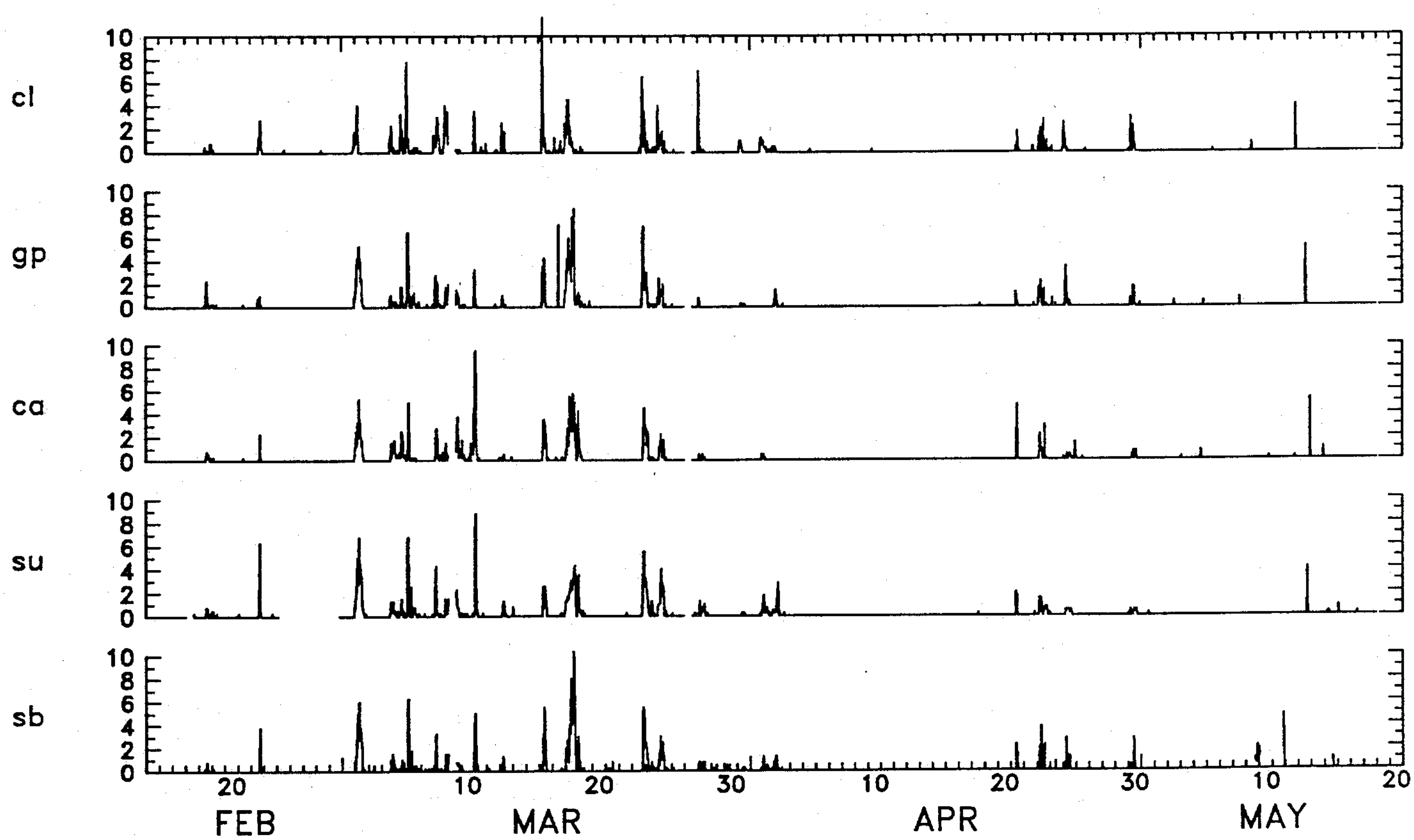


Figure 32 (cont.)

7.2 Moored Current Observations

Table 10: Statistics of Hourly-Averaged Moored Current Observations

Sta	Water Depth (m)	GMT Start Time (y m d/hm)	GMT Stop Time (y m d/hm)	Duration (Days)	Sensor Depth (m)	Mean	Std Dev	Max	Min
				Cross-Shelf Velocity (cm/s)					
C2	80	890225/1300	890516/1400	80	4.0	0.15	8.03	26.85	−18.57
C2	80	890225/1300	890516/1400	80	6.0	0.70	8.76	28.93	−21.28
C2	80	890225/1300	890516/1400	80	8.0	1.04	8.82	29.36	−24.95
C2 vm	80	890225/1300	890516/1400	80	10.0	−4.04	10.87	30.89	−36.94
C2	80	890225/1300	890516/1400	80	10.0	1.44	8.54	29.46	−24.84
C2	80	890225/1300	890516/1400	80	12.0	1.63	8.19	29.29	−24.51
C2	80	890225/1300	890516/1400	80	14.0	1.96	7.96	26.95	−23.13
C2	80	890225/1300	890516/1400	80	16.0	2.16	7.65	26.75	−19.95
C2	80	890225/1300	890516/1400	80	18.0	2.35	7.38	25.13	−18.15
C2	80	890225/1300	890516/1400	80	20.0	2.40	6.98	24.54	−16.61
C2	80	890225/1300	890516/1400	80	22.0	2.55	6.69	26.66	−16.83
C2	80	890225/1300	890516/1400	80	24.0	2.51	6.37	26.75	−18.04
C2	80	890225/1300	890516/1400	80	26.0	2.57	6.03	27.21	−19.01
C2	80	890225/1300	890516/1400	80	28.0	2.58	5.68	25.57	−19.94
C2	80	890225/1300	890516/1400	80	30.0	2.68	5.34	23.99	−21.82
C2	80	890225/1300	890516/1400	80	32.0	2.65	5.06	23.23	−19.67
C2	80	890225/1300	890516/1400	80	34.0	2.68	4.76	18.16	−14.85
C2	80	890225/1300	890516/1400	80	36.0	2.59	4.60	15.98	−12.57
C2	80	890225/1300	890516/1400	80	38.0	2.51	4.55	15.88	−11.65
C2	80	890225/1300	890516/1400	80	40.0	2.33	4.59	18.16	−12.64
C2	80	890225/1300	890516/1400	80	42.0	2.20	4.72	18.45	−13.24
C2	80	890225/1300	890516/1400	80	44.0	2.01	4.90	20.26	−15.34
C2	80	890225/1300	890516/1400	80	46.0	1.80	5.15	20.53	−16.84
C2	80	890225/1300	890516/1400	80	48.0	1.58	5.40	18.75	−17.44
C2	80	890225/1300	890516/1400	80	50.0	1.45	5.68	18.06	−16.98
C2	80	890225/1300	890516/1400	80	52.0	1.23	5.96	17.82	−16.90
C2	80	890225/1300	890516/1400	80	54.0	1.07	6.21	18.17	−18.47
C2	80	890225/1300	890516/1400	80	56.0	0.91	6.50	19.80	−20.69
C2	80	890225/1300	890516/1400	80	58.0	0.71	6.76	20.21	−20.65
C2	80	890225/1300	890516/1400	80	60.0	0.50	7.02	22.90	−23.48
C2	80	890225/1300	890516/1400	80	62.0	0.34	7.26	23.16	−24.65
C2	80	890225/1300	890516/1400	80	64.0	−0.09	7.19	23.25	−24.73
C2	80	890225/1300	890516/1400	80	66.0	−0.21	6.80	21.70	−25.12
C3 vm	93	881112/1300	881225/0500	43	4.0				
C3 vm	93	890127/0100	890210/1700	15	4.0	−2.28	10.62	30.04	−36.19
C3 vm	93	890227/0000	890320/1700	22	4.0				
C3 vm	93	881112/1300	890220/2300	100	7.0				
C3 vm	93	890302/0400	890502/0400	61	7.0	−2.04	8.53	29.90	−34.42
C3 vm	93	890503/0100	890519/1500	17	7.0				
C3 vm	93	881112/1300	890424/0500	163	10.0	−2.00	8.28	31.86	−31.46
C3 vm	93	881112/1300	890126/1700	75	13.0	−0.26	7.35	31.02	−29.32
C3 vm	93	881112/1300	890412/2300	151	16.0	−0.86	7.24	29.24	−25.47
C3 vm	93	881112/1300	890519/1500	188	19.0	−0.09	6.94	27.26	−25.42
C3 vm	93	881112/1300	890329/1100	137	22.0	−0.22	5.98	25.38	−22.83
C3 vm	93	881112/1300	890322/2300	130	27.0	0.72	5.49	21.52	−19.77
C3 vm	93	881112/1300	890519/1500	188	32.0	1.11	5.67	19.55	−17.50
C3 vm	93	881112/1300	890324/2300	132	37.0	1.85	4.73	18.06	−16.74
C3 vm	93	881112/1300	890519/1500	188	42.0	1.69	4.89	19.90	−16.16
C3 vm	93	881112/1300	890321/2300	129	47.0	1.96	4.60	17.86	−14.78

Table 10: Statistics of Hourly-Averaged Moored Current Observations

Sta	Water Depth (m)	GMT Start Time (y m d/hm)	GMT Stop Time (y m d/hm)	Duration (Days)	Sensor Depth (m)	Mean	Std Dev	Max	Min
				Alongshore Velocity (cm/s)					
C2	80	890225/1300	890516/1400	80	4.0	−6.33	18.91	50.79	−56.75
C2	80	890225/1300	890516/1400	80	6.0	−6.85	19.72	52.47	−60.11
C2	80	890225/1300	890516/1400	80	8.0	−6.67	19.83	52.02	−62.07
C2 vm	80	890225/1300	890516/1400	80	10.0	−8.60	20.36	52.37	−63.12
C2	80	890225/1300	890516/1400	80	10.0	−6.43	19.59	51.57	−62.51
C2	80	890225/1300	890516/1400	80	12.0	−6.10	19.26	48.92	−61.94
C2	80	890225/1300	890516/1400	80	14.0	−5.68	18.92	47.93	−58.80
C2	80	890225/1300	890516/1400	80	16.0	−5.24	18.57	48.67	−58.61
C2	80	890225/1300	890516/1400	80	18.0	−4.85	18.22	45.95	−55.53
C2	80	890225/1300	890516/1400	80	20.0	−4.33	17.82	45.68	−55.27
C2	80	890225/1300	890516/1400	80	22.0	−3.89	17.50	45.86	−52.95
C2	80	890225/1300	890516/1400	80	24.0	−3.38	17.16	45.86	−52.00
C2	80	890225/1300	890516/1400	80	26.0	−2.98	16.82	45.66	−51.13
C2	80	890225/1300	890516/1400	80	28.0	−2.53	16.45	44.65	−49.83
C2	80	890225/1300	890516/1400	80	30.0	−2.21	16.16	43.90	−48.81
C2	80	890225/1300	890516/1400	80	32.0	−1.85	15.81	43.89	−46.86
C2	80	890225/1300	890516/1400	80	34.0	−1.56	15.52	44.08	−46.29
C2	80	890225/1300	890516/1400	80	36.0	−1.24	15.16	42.35	−46.43
C2	80	890225/1300	890516/1400	80	38.0	−0.94	14.91	43.97	−43.99
C2	80	890225/1300	890516/1400	80	40.0	−0.69	14.62	44.28	−43.83
C2	80	890225/1300	890516/1400	80	42.0	−0.48	14.36	44.89	−42.38
C2	80	890225/1300	890516/1400	80	44.0	−0.27	14.11	44.40	−43.13
C2	80	890225/1300	890516/1400	80	46.0	−0.10	13.87	44.57	−44.17
C2	80	890225/1300	890516/1400	80	48.0	0.05	13.68	42.49	−44.58
C2	80	890225/1300	890516/1400	80	50.0	0.15	13.45	41.86	−47.29
C2	80	890225/1300	890516/1400	80	52.0	0.26	13.17	41.00	−46.11
C2	80	890225/1300	890516/1400	80	54.0	0.35	12.94	40.48	−47.41
C2	80	890225/1300	890516/1400	80	56.0	0.46	12.70	37.70	−47.12
C2	80	890225/1300	890516/1400	80	58.0	0.43	12.43	37.58	−47.17
C2	80	890225/1300	890516/1400	80	60.0	0.39	12.09	35.85	−47.64
C2	80	890225/1300	890516/1400	80	62.0	0.34	11.74	34.49	−45.98
C2	80	890225/1300	890516/1400	80	64.0	0.34	11.07	34.72	−43.03
C2	80	890225/1300	890516/1400	80	66.0	0.14	10.05	33.81	−41.04
C3 vm	93	881112/1300	881225/0500	43	4.0				
C3 vm	93	890127/0100	890210/1700	15	4.0	−1.35	17.22	53.74	−55.12
C3 vm	93	890227/0000	890320/1700	22	4.0				
C3 vm	93	881112/1300	890220/2300	100	7.0				
C3 vm	93	890302/0400	890502/0400	61	7.0	−4.84	15.65	47.37	−56.03
C3 vm	93	890503/0100	890519/1500	17	7.0				
C3 vm	93	881112/1300	890424/0500	163	10.0	−3.63	15.89	48.08	−53.88
C3 vm	93	881112/1300	890126/1700	75	13.0	3.52	11.93	38.16	−40.88
C3 vm	93	881112/1300	890412/2300	151	16.0	−1.10	14.55	41.72	−53.40
C3 vm	93	881112/1300	890519/1500	188	19.0	−2.63	14.74	41.43	−55.28
C3 vm	93	881112/1300	890329/1100	137	22.0	1.13	12.86	37.51	−46.01
C3 vm	93	881112/1300	890322/2300	130	27.0	2.64	11.85	40.50	−47.31
C3 vm	93	881112/1300	890519/1500	188	32.0	−0.31	13.32	42.99	−47.20
C3 vm	93	881112/1300	890324/2300	132	37.0	3.63	11.36	40.92	−40.81
C3 vm	93	881112/1300	890519/1500	188	42.0	1.79	12.02	43.75	−42.37
C3 vm	93	881112/1300	890321/2300	129	47.0	5.47	10.47	42.60	−31.49

Table 10: Statistics of Hourly-Averaged Moored Current Observations (Continued)

Sta	Water Depth (m)	GMT Start Time (y m d/hm)	GMT Stop Time (y m d/hm)	Duration (Days)	Sensor Depth (m)	Mean	Std Dev	Max	Min
				Cross-Shelf Velocity (cm/s)					
C3b va	97	881206/0300	890227/2200	84	67.0				
C3b va	95	890303/2100	890505/1600	63	65.0	1.47	5.88	20.98	−19.74
C3b va	97	881206/0300	890227/2200	84	73.0				
C3b va	95	890303/2100	890505/1600	63	71.0	0.79	6.21	21.40	−20.12
C3b va	97	881206/0300	890227/2200	84	79.0				
C3b va	95	890303/2100	890505/1600	63	77.0	−0.08	6.55	20.62	−21.12
C3b va	97	881206/0300	890227/2200	84	85.0				
C3b va	95	890303/2100	890505/1600	63	83.0	−0.76	5.72	19.38	−23.14
C3b va	97	881206/0300	890227/2200	84	91.0				
C3b va	95	890303/2100	890505/1600	63	89.0	−0.97	6.60	19.12	−30.47
C4 vm	117	881113/1300	890516/1300	184	10.0	−5.79	12.88	38.52	−42.33
C4	117	881113/1600	890516/1000	184	10.0	−2.94	10.11	37.91	−41.37
C4	117	881113/1600	890516/1000	184	12.0	−3.01	10.38	39.66	−38.22
C4	117	881113/1600	890516/1000	184	14.0	−3.19	11.11	36.67	−41.50
C4	117	881113/1600	890516/1000	184	16.0	−3.13	11.15	37.47	−43.09
C4	117	881113/1600	890516/1000	184	18.0	−2.92	10.97	35.10	−44.10
C4	117	881113/1600	890516/1000	184	20.0	−2.67	10.70	35.05	−43.01
C4	117	881113/1600	890516/1000	184	22.0	−2.39	10.43	35.28	−42.83
C4	117	881113/1600	890516/1000	184	24.0	−2.09	10.09	33.17	−39.50
C4	117	881113/1600	890516/1000	184	26.0	−1.83	9.78	32.33	−38.19
C4	117	881113/1600	890516/1000	184	28.0	−1.55	9.45	33.56	−35.87
C4	117	881113/1600	890516/1000	184	30.0	−1.27	9.13	31.72	−31.35
C4	117	881113/1600	890516/1000	184	32.0	−1.00	8.79	30.89	−30.01
C4	117	881113/1600	890516/1000	184	34.0	−0.76	8.52	28.76	−27.81
C4	117	881113/1600	890516/1000	184	36.0	−0.56	8.25	29.47	−27.00
C4	117	881113/1600	890516/1000	184	38.0	−0.39	8.05	29.44	−29.01
C4	117	881113/1600	890516/1000	184	40.0	−0.24	7.83	29.58	−27.50
C4	117	881113/1600	890516/1000	184	42.0	−0.10	7.66	29.06	−27.26
C4	117	881113/1600	890516/1000	184	44.0	0.10	7.50	27.92	−26.40
C4	117	881113/1600	890516/1000	184	46.0	0.27	7.29	28.77	−24.98
C4	117	881113/1600	890516/1000	184	48.0	0.13	7.12	25.82	−24.44
C4	117	881113/1600	890516/1000	184	50.0	−0.18	7.10	23.92	−24.27
C4	117	881113/1600	890516/1000	184	52.0	0.35	6.60	25.41	−20.76
G3 vm	93	881113/1300	890516/1300	184	10.0	−3.54	9.70	33.89	−32.18
G3	93	881113/0100	881201/0300	15	10.0	1.06	6.84	20.58	−18.52
G3	93	881113/0100	881201/0300	15	12.0	0.63	7.25	22.56	−18.17
G3	93	881113/0100	881201/0300	15	14.0	0.41	7.92	22.11	−20.32
G3	93	881113/0100	881201/0300	15	16.0	0.57	7.70	22.71	−20.40
G3	93	881113/0100	881201/0300	15	18.0	0.75	7.18	20.70	−15.97
G3	93	881113/0100	881201/0300	15	20.0	0.88	6.80	21.83	−15.76
G3	93	881113/0100	881201/0300	15	22.0	1.01	6.51	21.87	−16.16
G3	93	881113/0100	881201/0300	15	24.0	1.32	6.33	22.05	−15.36
G3	93	881113/0100	881201/0300	15	26.0	1.74	6.22	22.67	−14.40
G3	93	881113/0100	881201/0300	15	28.0	2.05	6.18	22.09	−13.10
G3	93	881113/0100	881201/0300	15	30.0	2.42	6.23	22.37	−12.31
G3	93	881113/0100	881201/0300	15	32.0	2.63	6.14	21.29	−11.47
G3	93	881113/0100	881201/0300	15	34.0	2.89	6.24	20.14	−10.00
G3	93	881113/0100	881201/0300	15	36.0	2.93	6.24	19.71	−10.30
G3	93	881113/0100	881201/0300	15	38.0	2.95	6.19	19.71	−10.74
G3	93	881113/0100	881201/0300	15	40.0	2.74	6.17	21.57	−12.95
G3	93	881113/0100	881201/0300	15	42.0	2.69	6.08	19.88	−13.07
G3	93	881113/0100	881201/0300	15	44.0	2.45	5.94	19.14	−14.16

Table 10: Statistics of Hourly-Averaged Moored Current Observations (Continued)

Sta	Water Depth (m)	GMT Start Time (y m d/hm)	GMT Stop Time (y m d/hm)	Duration (Days)	Sensor Depth (m)	Mean	Std Dev	Max	Min
					Alongshore Velocity (cm/s)				
C3b va	97	881206/0300	890227/2200	84	67.0				
C3b va	95	890303/2100	890505/1600	63	65.0	3.13	11.94	43.29	−33.96
C3b va	97	881206/0300	890227/2200	84	73.0				
C3b va	95	890303/2100	890505/1600	63	71.0	3.58	11.23	43.69	−32.90
C3b va	97	881206/0300	890227/2200	84	79.0				
C3b va	95	890303/2100	890505/1600	63	77.0	3.67	10.81	44.02	−33.00
C3b va	97	881206/0300	890227/2200	84	85.0				
C3b va	95	890303/2100	890505/1600	63	83.0	2.44	8.68	34.09	−31.05
C3b va	97	881206/0300	890227/2200	84	91.0				
C3b va	95	890303/2100	890505/1600	63	89.0	2.43	8.75	35.73	−27.29
C4 vm	117	881113/1300	890516/1300	184	10.0	−11.72	18.26	51.42	−70.25
C4	117	881113/1600	890516/1000	184	10.0	−10.42	15.79	45.39	−59.61
C4	117	881113/1600	890516/1000	184	12.0	−10.43	16.23	48.21	−62.36
C4	117	881113/1600	890516/1000	184	14.0	−10.74	17.31	51.51	−65.54
C4	117	881113/1600	890516/1000	184	16.0	−10.74	17.70	52.00	−67.29
C4	117	881113/1600	890516/1000	184	18.0	−10.42	17.70	52.26	−68.06
C4	117	881113/1600	890516/1000	184	20.0	−9.96	17.50	52.05	−67.66
C4	117	881113/1600	890516/1000	184	22.0	−9.48	17.27	52.65	−66.63
C4	117	881113/1600	890516/1000	184	24.0	−8.99	17.03	51.96	−65.18
C4	117	881113/1600	890516/1000	184	26.0	−8.59	16.79	51.31	−61.38
C4	117	881113/1600	890516/1000	184	28.0	−8.18	16.56	51.42	−58.99
C4	117	881113/1600	890516/1000	184	30.0	−7.81	16.31	50.70	−60.12
C4	117	881113/1600	890516/1000	184	32.0	−7.43	16.08	50.07	−60.43
C4	117	881113/1600	890516/1000	184	34.0	−7.05	15.85	49.36	−62.50
C4	117	881113/1600	890516/1000	184	36.0	−6.64	15.60	47.87	−64.27
C4	117	881113/1600	890516/1000	184	38.0	−6.24	15.38	47.07	−64.63
C4	117	881113/1600	890516/1000	184	40.0	−5.77	15.15	46.31	−65.34
C4	117	881113/1600	890516/1000	184	42.0	−5.40	14.97	48.32	−66.33
C4	117	881113/1600	890516/1000	184	44.0	−4.97	14.82	49.55	−64.67
C4	117	881113/1600	890516/1000	184	46.0	−4.69	14.70	48.23	−63.94
C4	117	881113/1600	890516/1000	184	48.0	−4.16	14.34	48.99	−63.19
C4	117	881113/1600	890516/1000	184	50.0	−3.45	13.81	47.92	−57.34
C4	117	881113/1600	890516/1000	184	52.0	−4.19	14.22	50.96	−58.81
G3 vm	93	881113/1300	890516/1300	184	10.0	−5.91	17.55	58.60	−66.93
G3	93	881113/0100	881201/0300	15	10.0	2.86	10.38	26.21	−30.27
G3	93	881113/0100	881201/0300	15	12.0	3.78	10.75	26.55	−28.69
G3	93	881113/0100	881201/0300	15	14.0	4.21	11.67	31.83	−30.76
G3	93	881113/0100	881201/0300	15	16.0	4.14	11.46	31.36	−30.08
G3	93	881113/0100	881201/0300	15	18.0	4.24	11.33	30.66	−30.32
G3	93	881113/0100	881201/0300	15	20.0	4.43	11.12	31.23	−27.96
G3	93	881113/0100	881201/0300	15	22.0	4.65	11.11	30.68	−27.05
G3	93	881113/0100	881201/0300	15	24.0	4.91	11.14	31.05	−27.40
G3	93	881113/0100	881201/0300	15	26.0	5.16	11.24	31.71	−24.41
G3	93	881113/0100	881201/0300	15	28.0	5.43	11.33	32.44	−23.67
G3	93	881113/0100	881201/0300	15	30.0	5.72	11.52	31.66	−24.43
G3	93	881113/0100	881201/0300	15	32.0	6.01	11.60	32.60	−23.90
G3	93	881113/0100	881201/0300	15	34.0	6.26	11.66	32.45	−22.74
G3	93	881113/0100	881201/0300	15	36.0	6.45	11.62	33.20	−20.77
G3	93	881113/0100	881201/0300	15	38.0	6.69	11.64	34.18	−19.95
G3	93	881113/0100	881201/0300	15	40.0	6.88	11.54	34.37	−20.00
G3	93	881113/0100	881201/0300	15	42.0	7.07	11.45	34.94	−20.90
G3	93	881113/0100	881201/0300	15	44.0	7.08	11.24	34.26	−20.01

Table 10: Statistics of Hourly-Averaged Moored Current Observations (Continued)

Sta	Water Depth (m)	GMT Start Time (y m d/hm)	GMT Stop Time (y m d/hm)	Duration (Days)	Sensor Depth (m)	Mean	Std Dev	Max	Min
				Cross-Shelf Velocity (cm/s)					
G3	93	881113/0100	881201/0300	15	46.0	2.37	5.81	17.77	−13.40
G3	93	881113/0100	881201/0300	15	48.0	2.00	5.59	17.44	−13.89
G3	93	881113/0100	881201/0300	15	50.0	2.22	5.43	18.27	−13.17
G3	93	881113/0100	881201/0300	15	52.0	2.43	5.18	18.53	−11.75
m3 vm	93	881113/1300	890517/1300	185	10.0	−4.16	9.48	29.69	−43.51
m3	93	881113/2100	881205/1800	22	10.0	1.50	7.45	23.49	−22.45
m3	93	881113/2100	881205/1800	22	12.0	1.08	7.74	24.24	−23.65
m3	93	881113/2100	881205/1800	22	14.0	1.05	7.94	23.97	−24.54
m3	93	881113/2100	881205/1800	22	16.0	1.34	7.67	22.88	−22.87
m3	93	881113/2100	881205/1800	22	18.0	1.62	7.37	24.32	−21.29
m3	93	881113/2100	881205/1800	22	20.0	1.97	6.89	22.47	−19.17
m3	93	881113/2100	881205/1800	22	22.0	2.40	6.61	23.54	−16.07
m3	93	881113/2100	881205/1800	22	24.0	2.76	6.30	23.75	−12.60
m3	93	881113/2100	881205/1800	22	26.0	3.13	6.23	22.37	−11.17
m3	93	881113/2100	881205/1800	22	28.0	3.41	6.29	22.89	−10.04
m3	93	881113/2100	881205/1800	22	30.0	3.55	6.40	21.62	−10.93
m3	93	881113/2100	881205/1800	22	32.0	3.68	6.52	23.39	−10.87
m3	93	881113/2100	881205/1800	22	34.0	3.62	6.58	23.95	−11.47
m3	93	881113/2100	881205/1800	22	36.0	3.65	6.33	23.84	−11.32
m3	93	881113/2100	881205/1800	22	38.0	3.67	6.24	25.21	−10.99
m3	93	881113/2100	881205/1800	22	40.0	3.55	6.01	24.64	−9.54
m3	93	881113/2100	881205/1800	22	42.0	3.57	5.89	26.70	−10.25
m3	93	881113/2100	881205/1800	22	44.0	3.49	5.56	23.97	−9.42
m3	93	881113/2100	881205/1800	22	46.0	3.60	5.42	24.92	−9.30
m3	93	881113/2100	881205/1800	22	48.0	3.71	5.15	25.08	−9.24
m3	93	881113/2100	881205/1800	22	50.0	3.63	4.87	22.87	−9.43
m3	93	881113/2100	881205/1800	22	52.0	3.46	4.69	19.78	−9.41

Abbreviations:

vm: Vector Measuring Current Meter (VMCM)
va: Vector Averaging Current Meter (VACM)

Table 10: Statistics of Hourly-Averaged Moored Current Observations (Continued)

Sta	Water Depth (m)	GMT Start Time (y m d/hm)	GMT Stop Time (y m d/hm)	Duration (Days)	Sensor Depth (m)	Mean	Std Dev	Max	Min
				Alongshore Velocity (cm/s)					
G3	93	881113/0100	881201/0300	15	46.0	7.26	11.00	33.29	−19.20
G3	93	881113/0100	881201/0300	15	48.0	7.15	10.52	33.45	−18.34
G3	93	881113/0100	881201/0300	15	50.0	7.28	10.41	32.00	−17.57
G3	93	881113/0100	881201/0300	15	52.0	7.00	10.21	31.04	−16.43
m3 vm	93	881113/1300	890517/1300	185	10.0	−4.14	18.79	49.69	−67.30
M3	93	881113/2100	881205/1800	22	10.0	1.87	9.82	33.63	−31.61
M3	93	881113/2100	881205/1800	22	12.0	2.52	9.80	33.43	−29.51
M3	93	881113/2100	881205/1800	22	14.0	2.93	10.05	36.02	−31.21
M3	93	881113/2100	881205/1800	22	16.0	3.21	9.90	34.33	−30.87
M3	93	881113/2100	881205/1800	22	18.0	3.72	9.70	34.42	−32.22
M3	93	881113/2100	881205/1800	22	20.0	4.02	9.49	32.57	−29.81
M3	93	881113/2100	881205/1800	22	22.0	4.39	9.35	32.47	−29.46
M3	93	881113/2100	881205/1800	22	24.0	4.70	9.34	30.99	−28.35
M3	93	881113/2100	881205/1800	22	26.0	5.09	9.46	32.28	−28.06
M3	93	881113/2100	881205/1800	22	28.0	5.42	9.64	32.91	−26.38
M3	93	881113/2100	881205/1800	22	30.0	5.68	9.79	32.34	−24.79
M3	93	881113/2100	881205/1800	22	32.0	6.03	9.81	33.98	−22.28
M3	93	881113/2100	881205/1800	22	34.0	6.29	9.77	33.20	−20.42
M3	93	881113/2100	881205/1800	22	36.0	6.63	9.59	31.60	−19.01
M3	93	881113/2100	881205/1800	22	38.0	6.79	9.43	29.66	−18.96
M3	93	881113/2100	881205/1800	22	40.0	6.92	9.16	31.01	−16.81
M3	93	881113/2100	881205/1800	22	42.0	7.04	9.00	29.68	−15.48
M3	93	881113/2100	881205/1800	22	44.0	7.12	8.78	31.13	−15.15
M3	93	881113/2100	881205/1800	22	46.0	7.07	8.62	30.64	−16.14
M3	93	881113/2100	881205/1800	22	48.0	6.97	8.34	30.07	−13.53
M3	93	881113/2100	881205/1800	22	50.0	6.92	8.12	30.17	−15.10
M3	93	881113/2100	881205/1800	22	52.0	6.96	8.02	29.72	−13.90

Abbreviations:

vm: Vector Measuring Current Meter (VMCM)
va: Vector Averaging Current Meter (VACM)

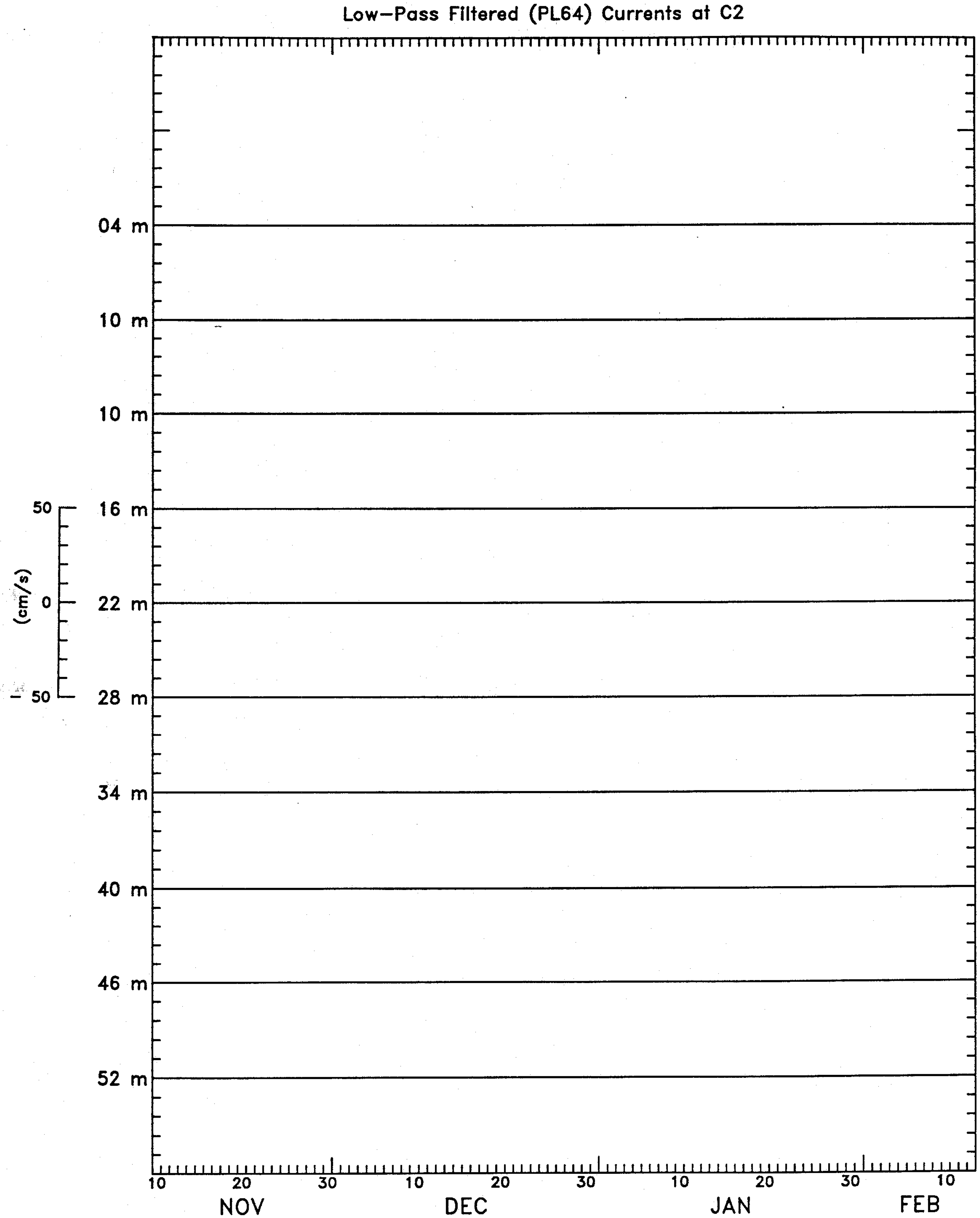

Low–Pass Filtered (PL64) Currents at C2
04 m
10 m
10 m
16 m
22 m
28 m
34 m
40 m
46 m
52 m
50
0
-50
(cm/s)
10
20
30
10
20
30
10
20
30
10
NOV
DEC
JAN
FEB

Figure 33

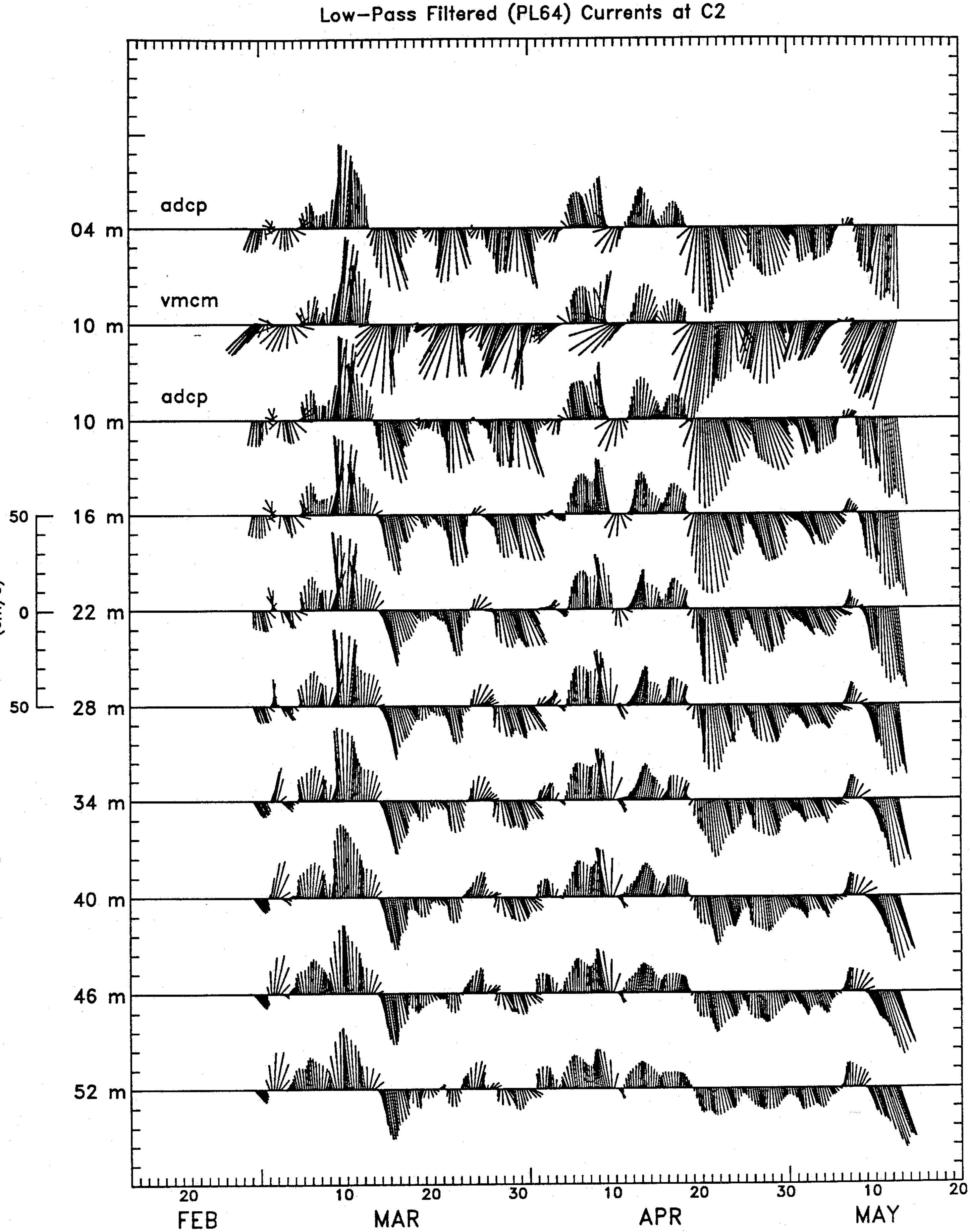


Figure 33 (cont.)

C2 Cross-Shelf Low-Pass Filtered (PL64) Currents

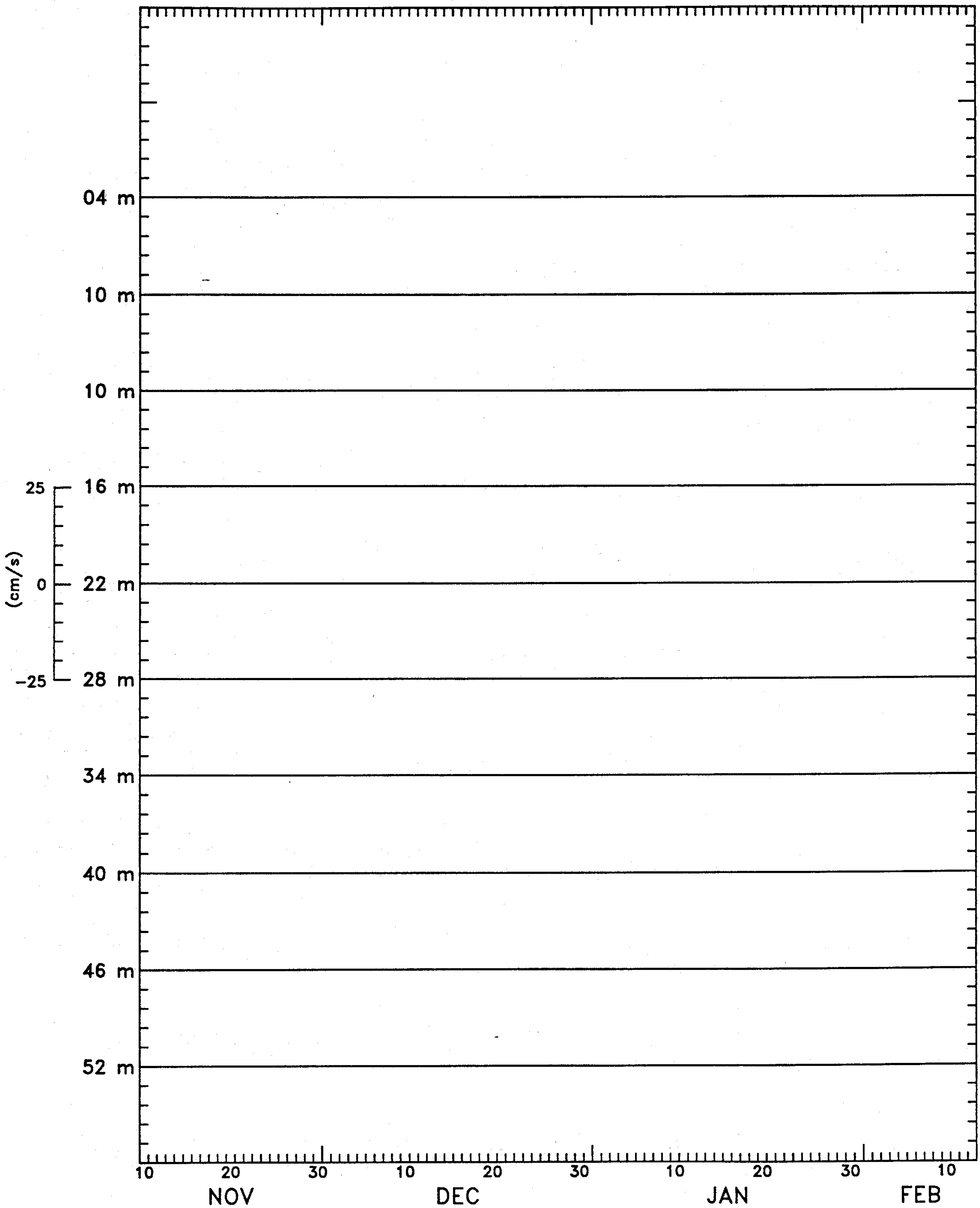


Figure 34

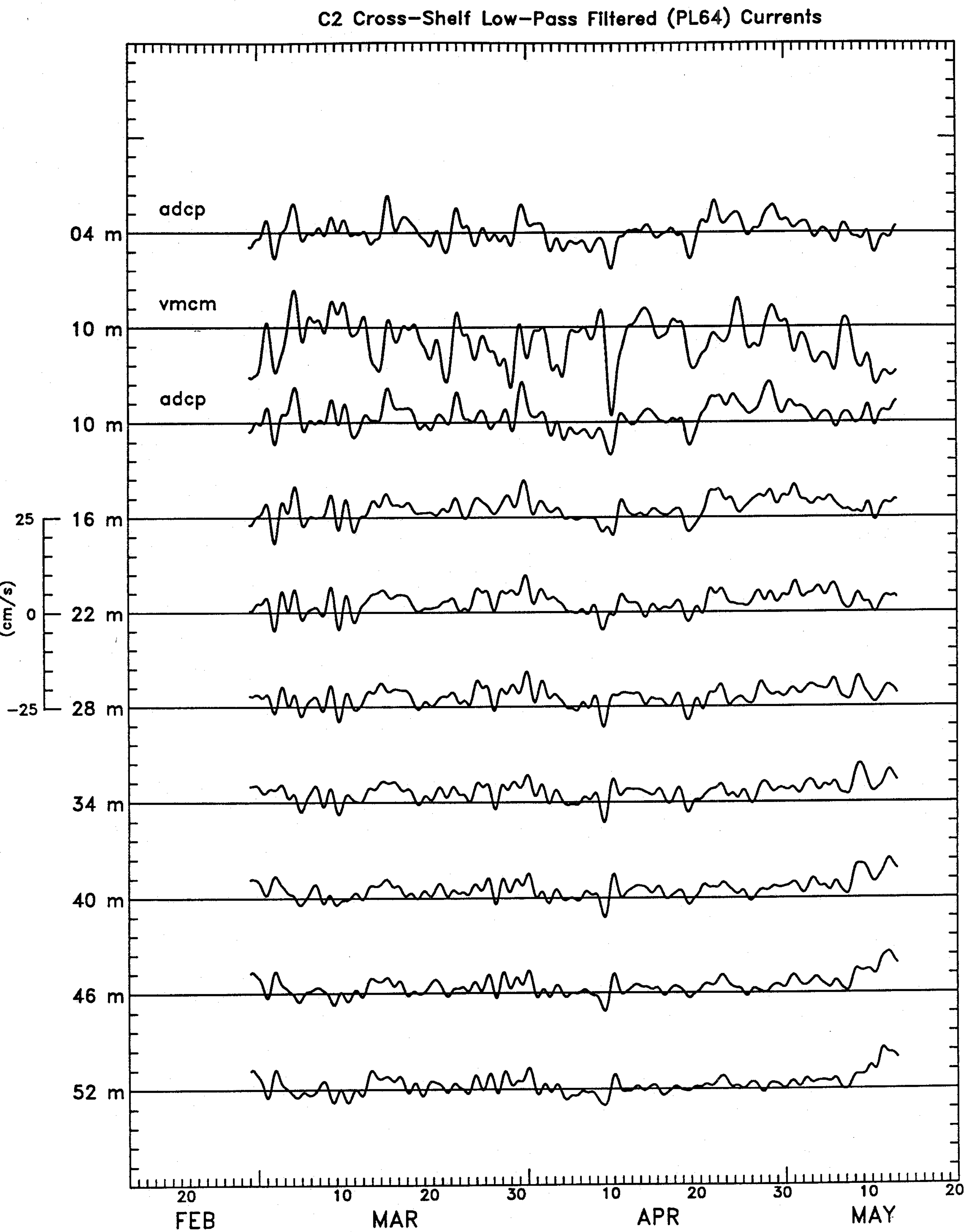


Figure 34 (cont.)

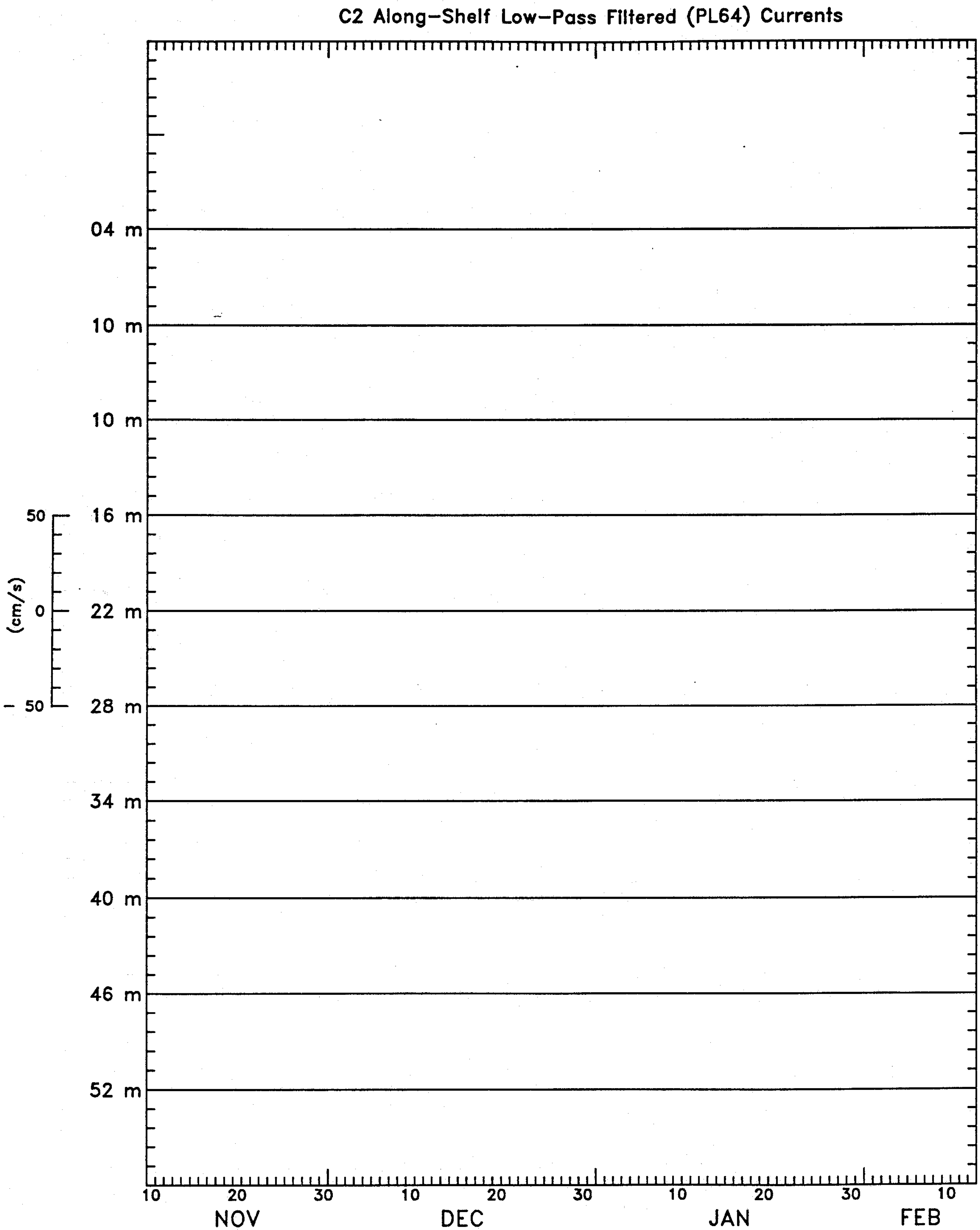

C2 Along-Shelf Low-Pass Filtered (PL64) Currents
04 m
10 m
10 m
16 m
22 m
28 m
34 m
40 m
46 m
52 m
50
0
- 50
(cm/s)
10
20
30
10
20
30
10
20
30
10
NOV
DEC
JAN
FEB

Figure 35

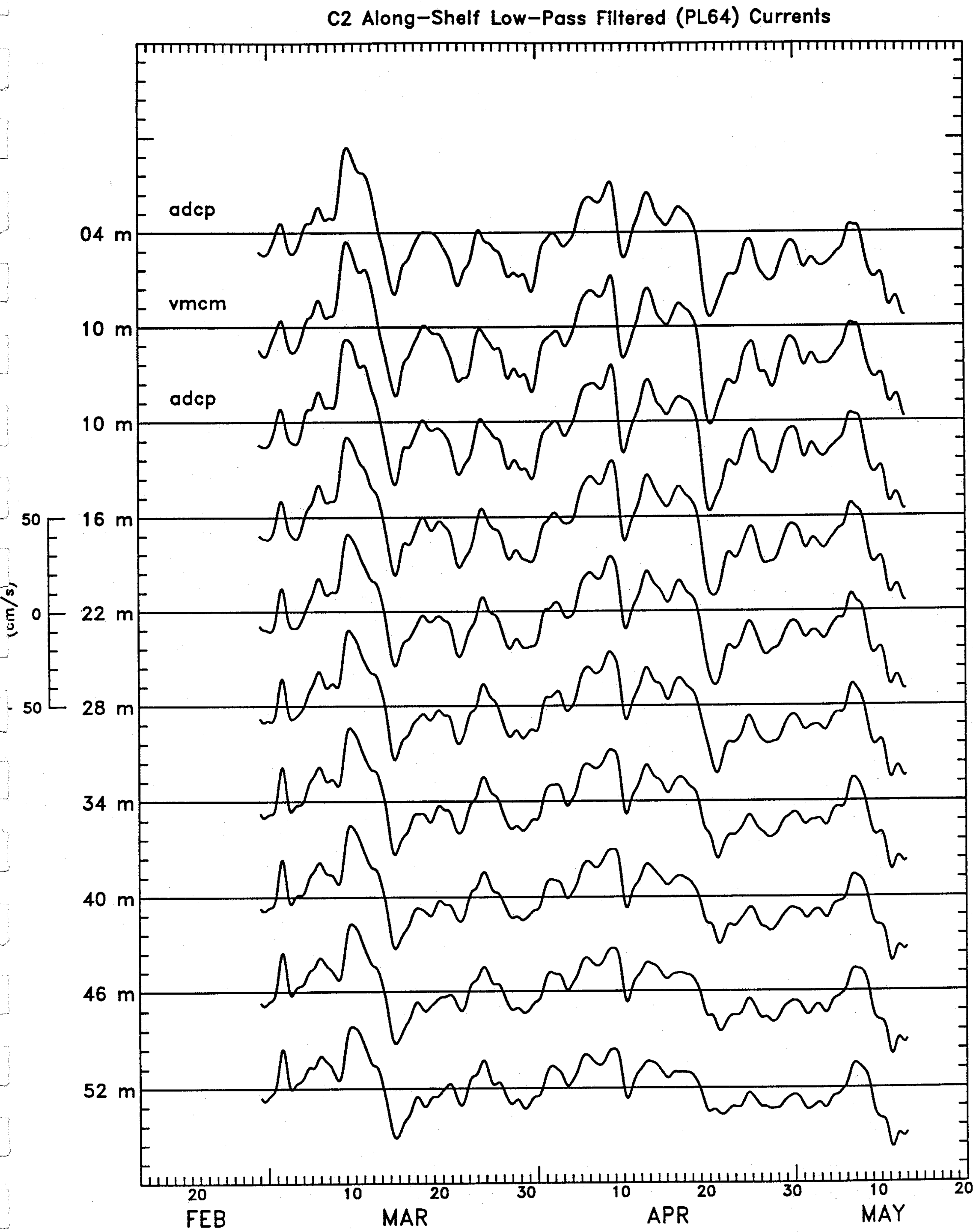
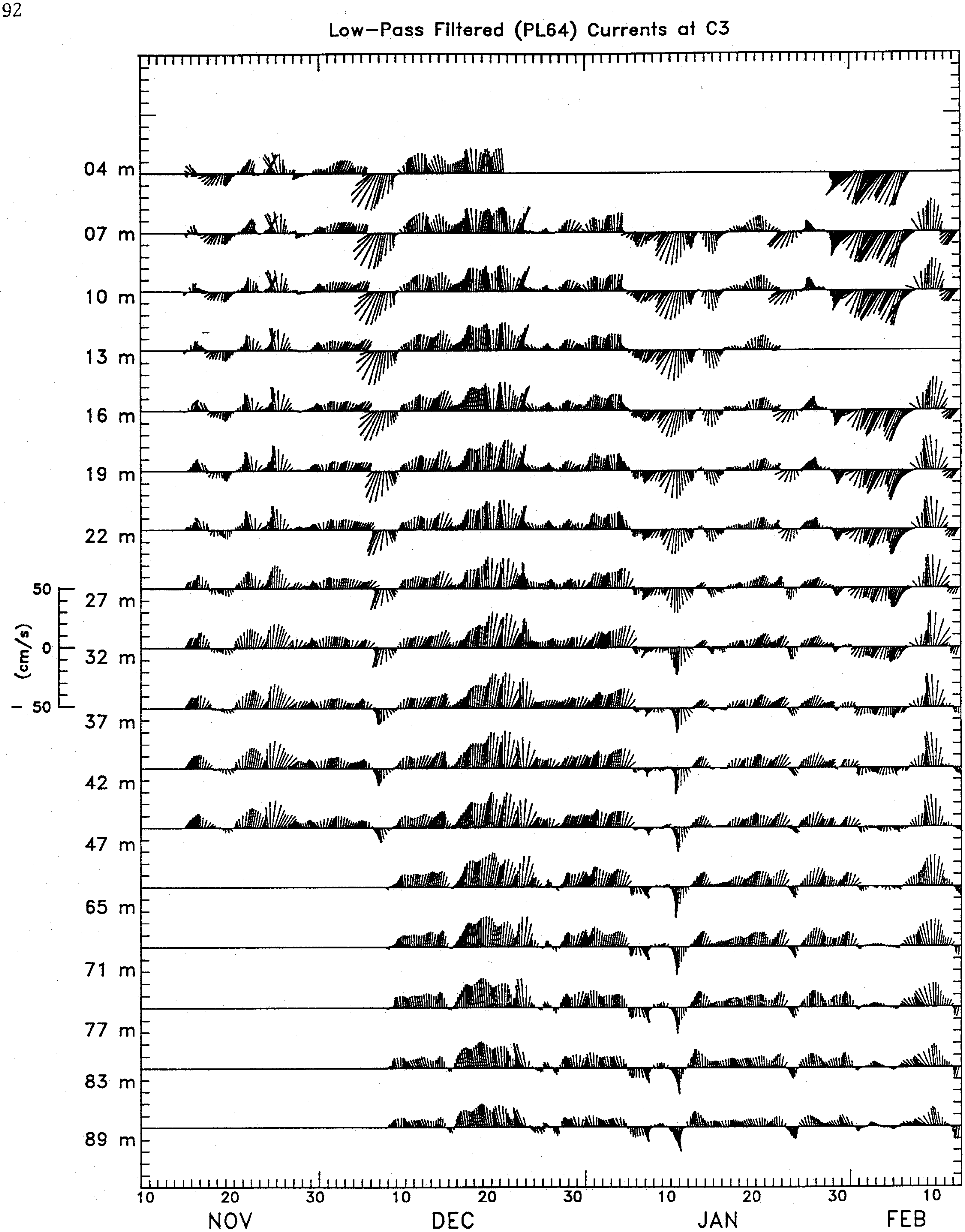


Figure 35 (cont.)



Low-Pass Filtered (PL64) Currents at C3
04 m
07 m
10 m
13 m
16 m
19 m
22 m
27 m
32 m
37 m
42 m
47 m
65 m
71 m
77 m
83 m
89 m
50
0
- 50
(cm/s)
10
20
30
10
20
30
10
20
30
10
NOV
DEC
JAN
FEB

Figure 36

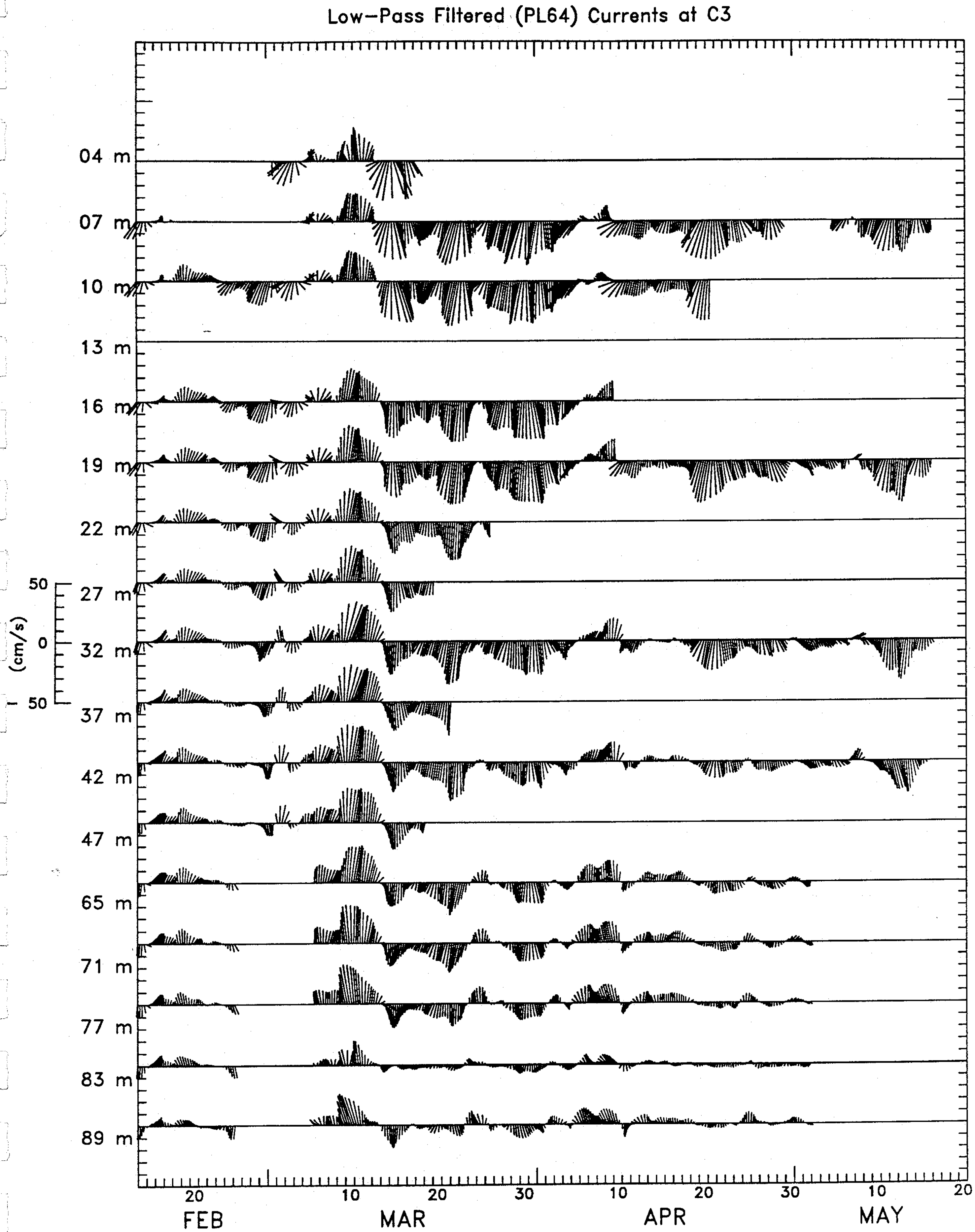


Figure 36 (cont.)

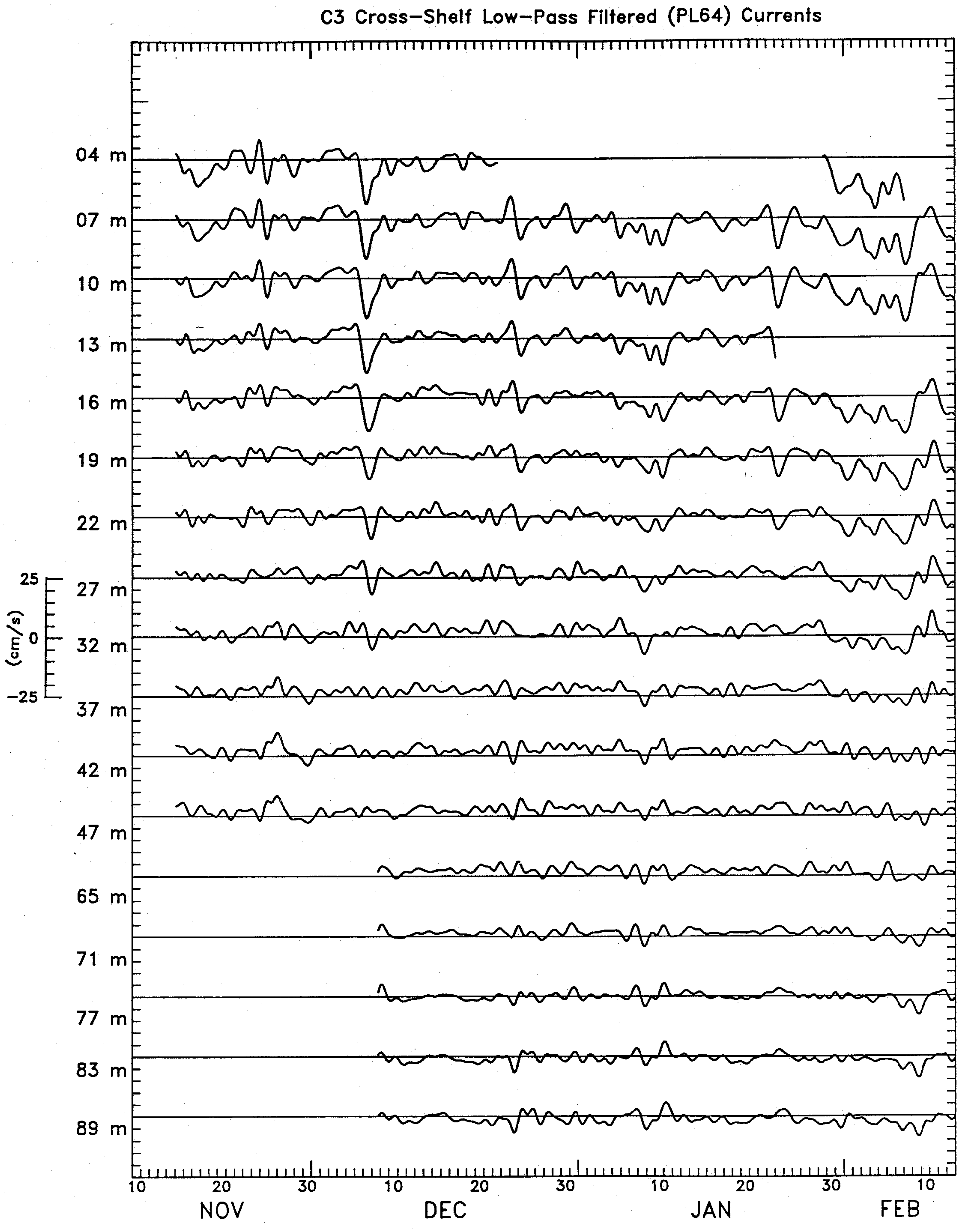

C3 Cross-Shelf Low-Pass Filtered (PL64) Currents
04 m
07 m
10 m
13 m
16 m
19 m
22 m
27 m
32 m
37 m
42 m
47 m
65 m
71 m
77 m
83 m
89 m
25
0
-25
(cm/s)
10
20
30
10
20
30
10
20
30
10
NOV
DEC
JAN
FEB

Figure 37

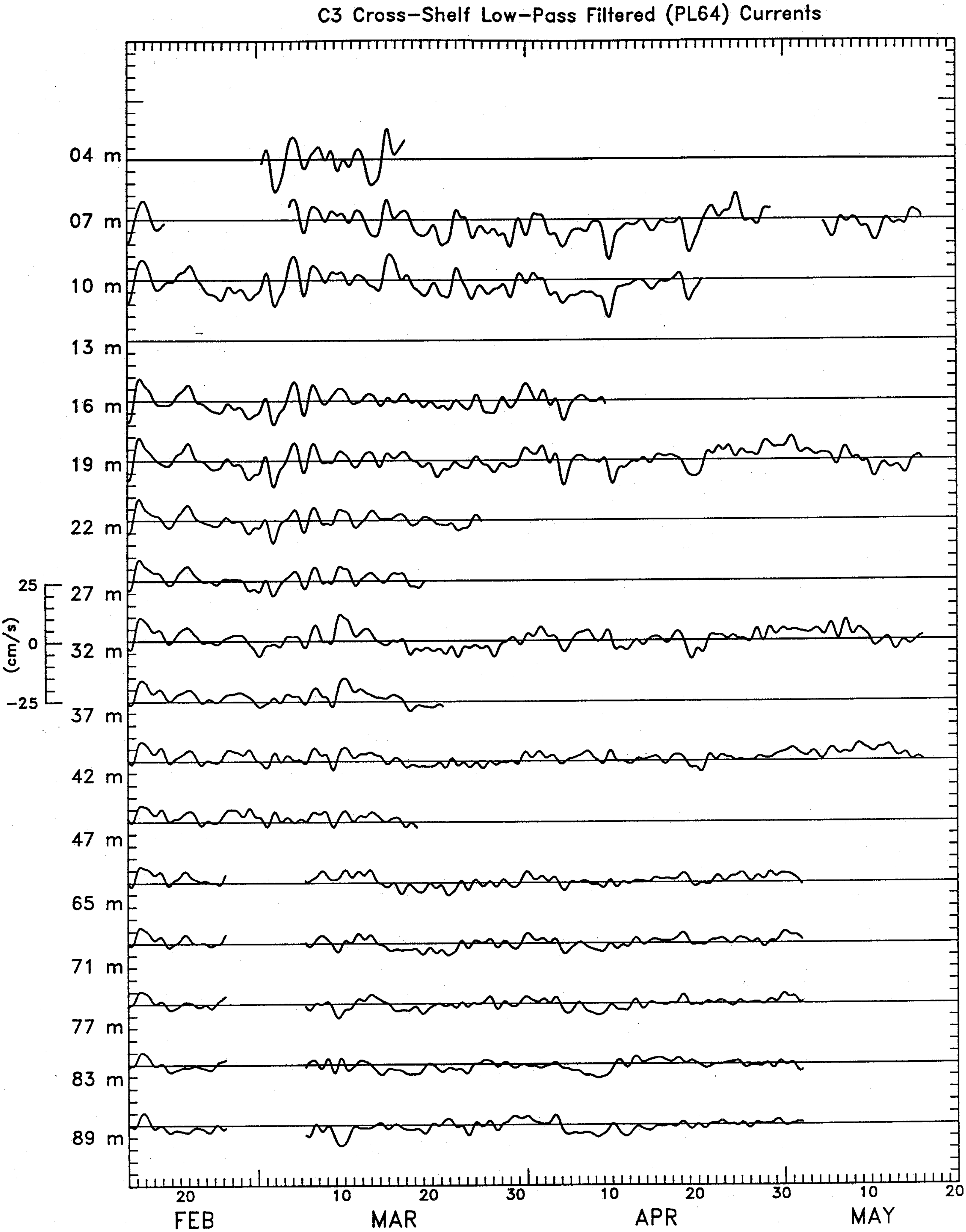
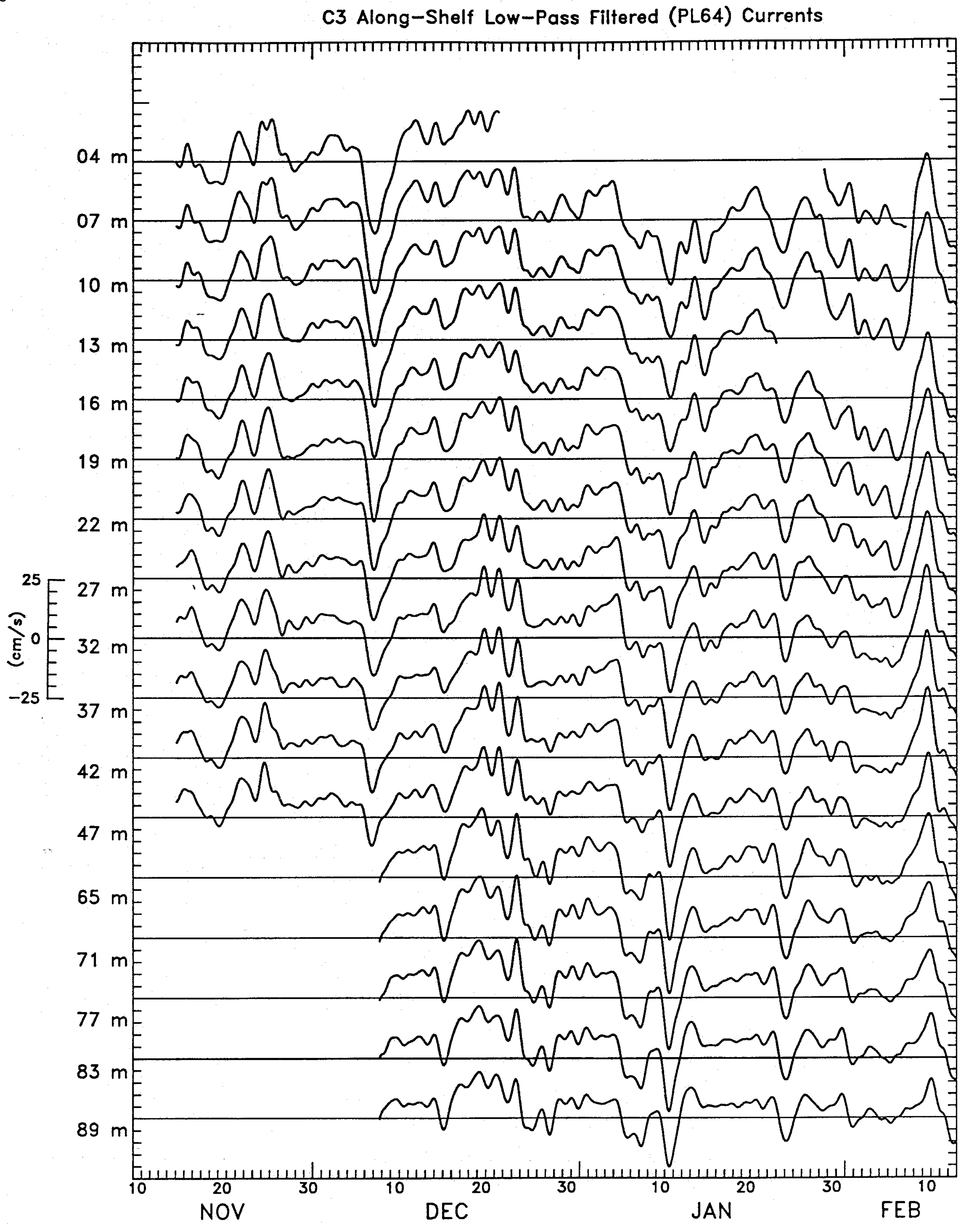


Figure 37 (cont.)



C3 Along-Shelf Low-Pass Filtered (PL64) Currents
04 m
07 m
10 m
13 m
16 m
19 m
22 m
27 m
32 m
37 m
42 m
47 m
65 m
71 m
77 m
83 m
89 m
25
0
-25
(cm/s)
10
20
30
10
20
30
10
20
30
10
NOV
DEC
JAN
FEB

Figure 38

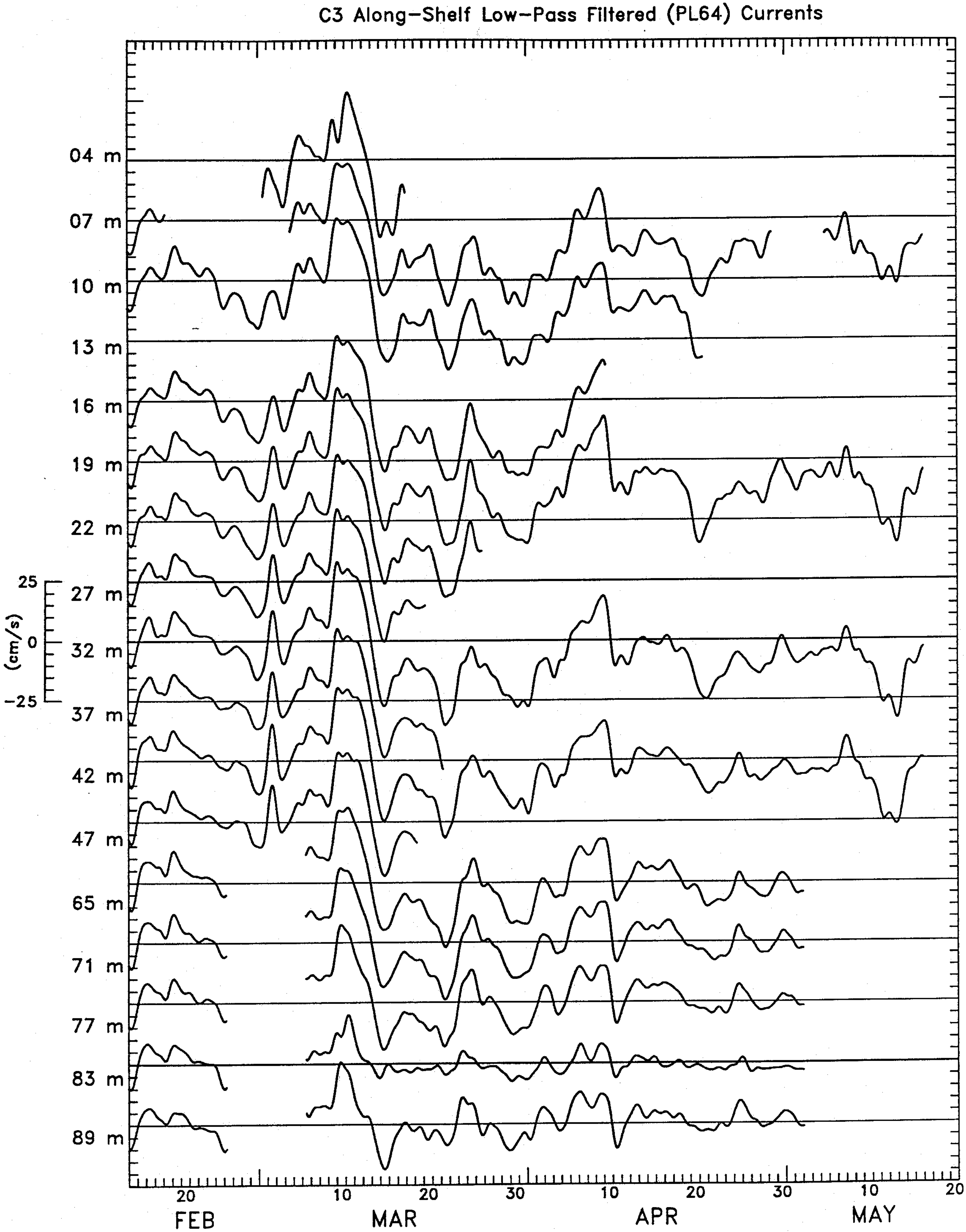


Figure 38 (cont.)

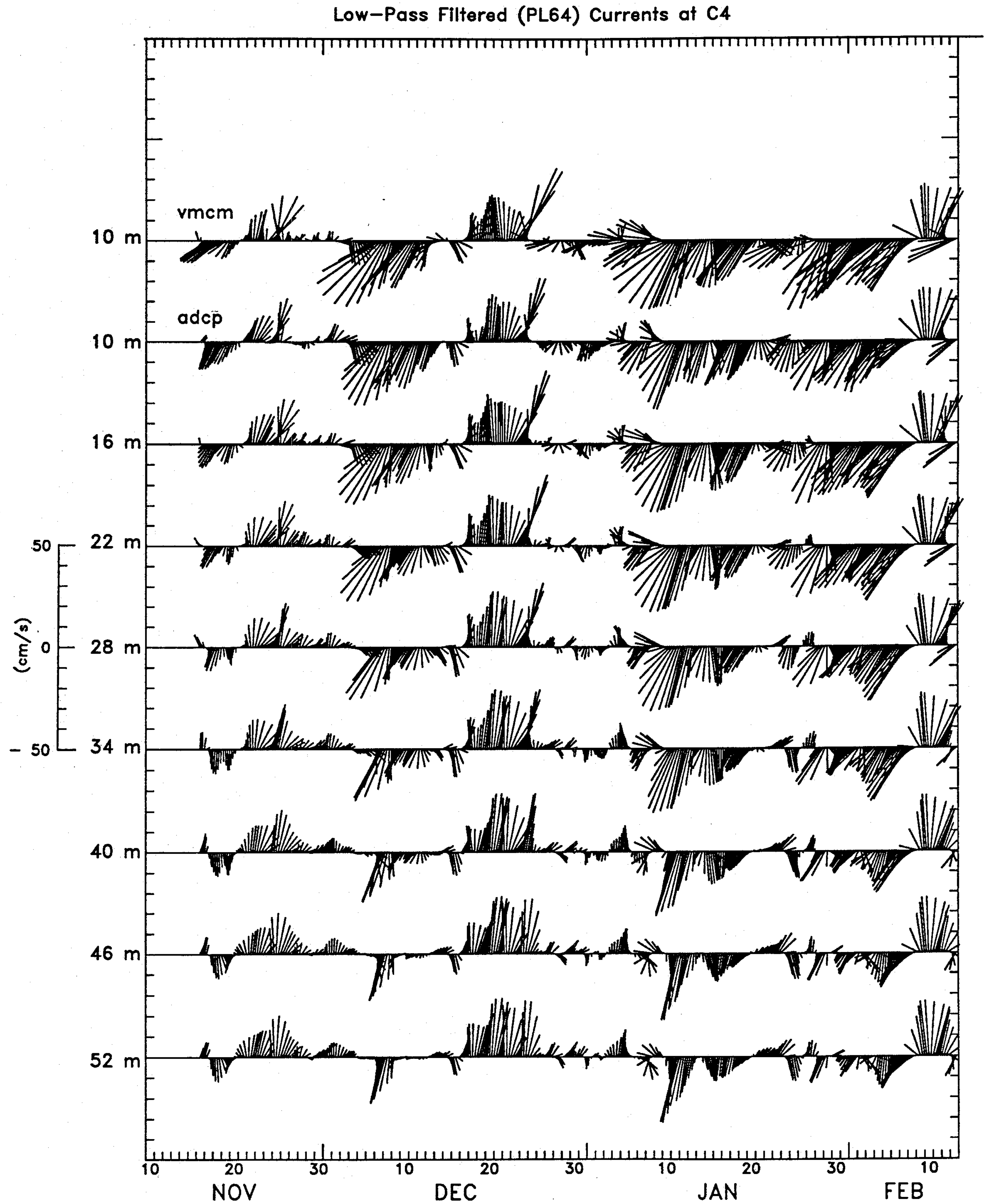

Low-Pass Filtered (PL64) Currents at C4
vmcm
adcp
10 m
10 m
16 m
22 m
28 m
34 m
40 m
46 m
52 m
50
0
- 50
(cm/s)
10
20
30
10
20
30
10
20
30
10
NOV
DEC
JAN
FEB

Figure 39

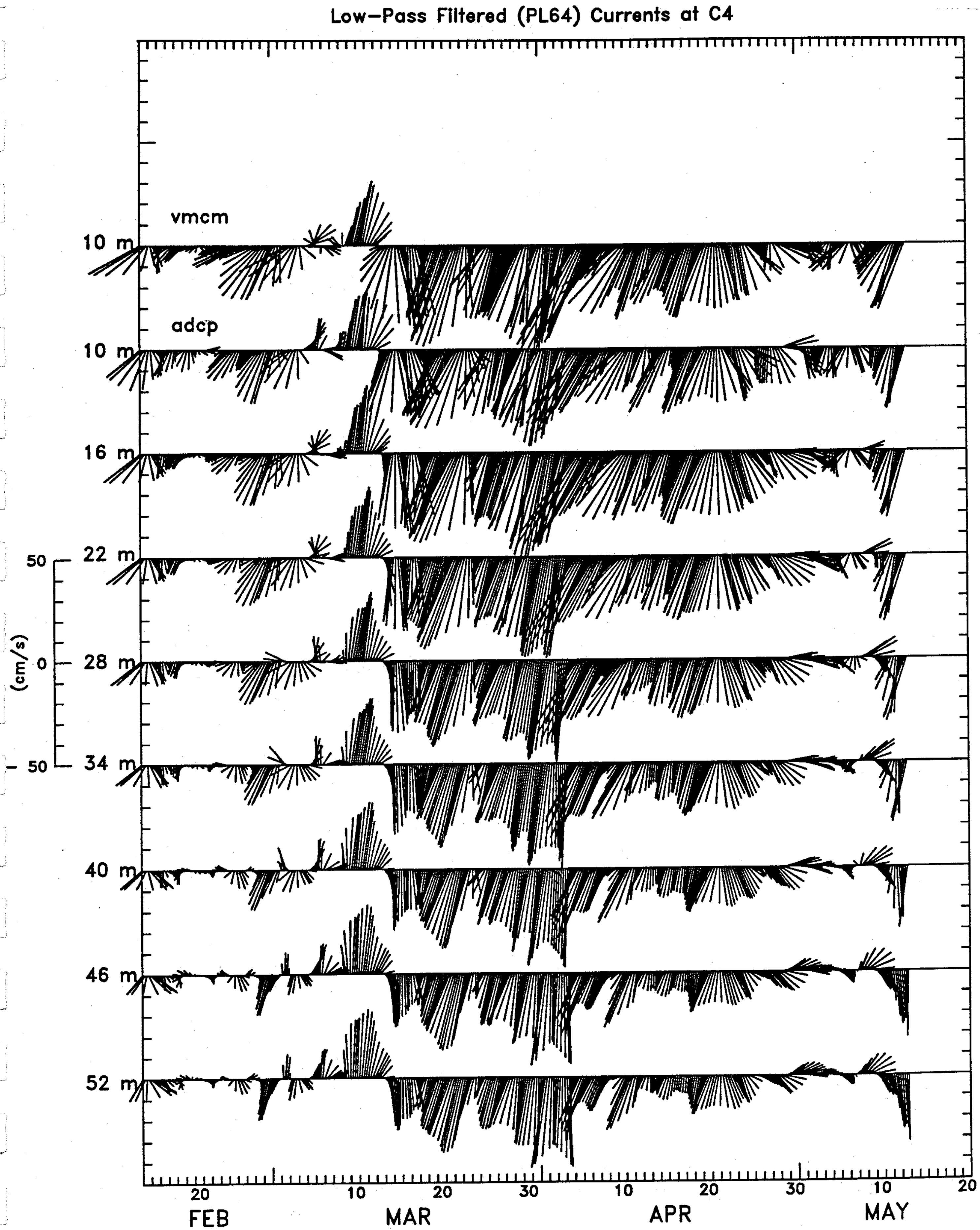


Figure 39 (cont.)

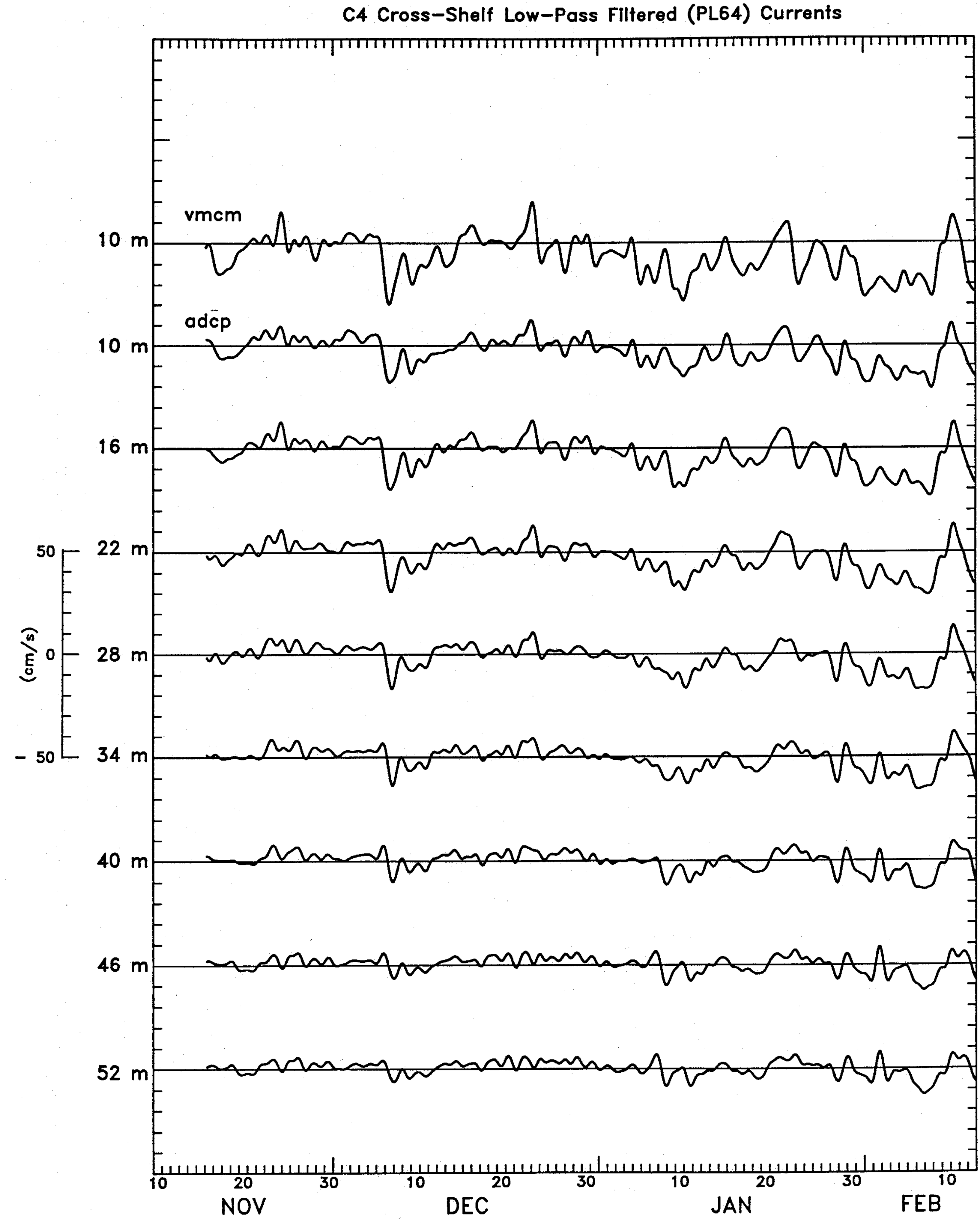

C4 Cross-Shelf Low-Pass Filtered (PL64) Currents
vmcm
10 m
adcp
10 m
16 m
22 m
28 m
34 m
40 m
46 m
52 m
50
0
- 50
(cm/s)
10
20
30
10
20
30
10
20
30
10
NOV
DEC
JAN
FEB

Figure 40

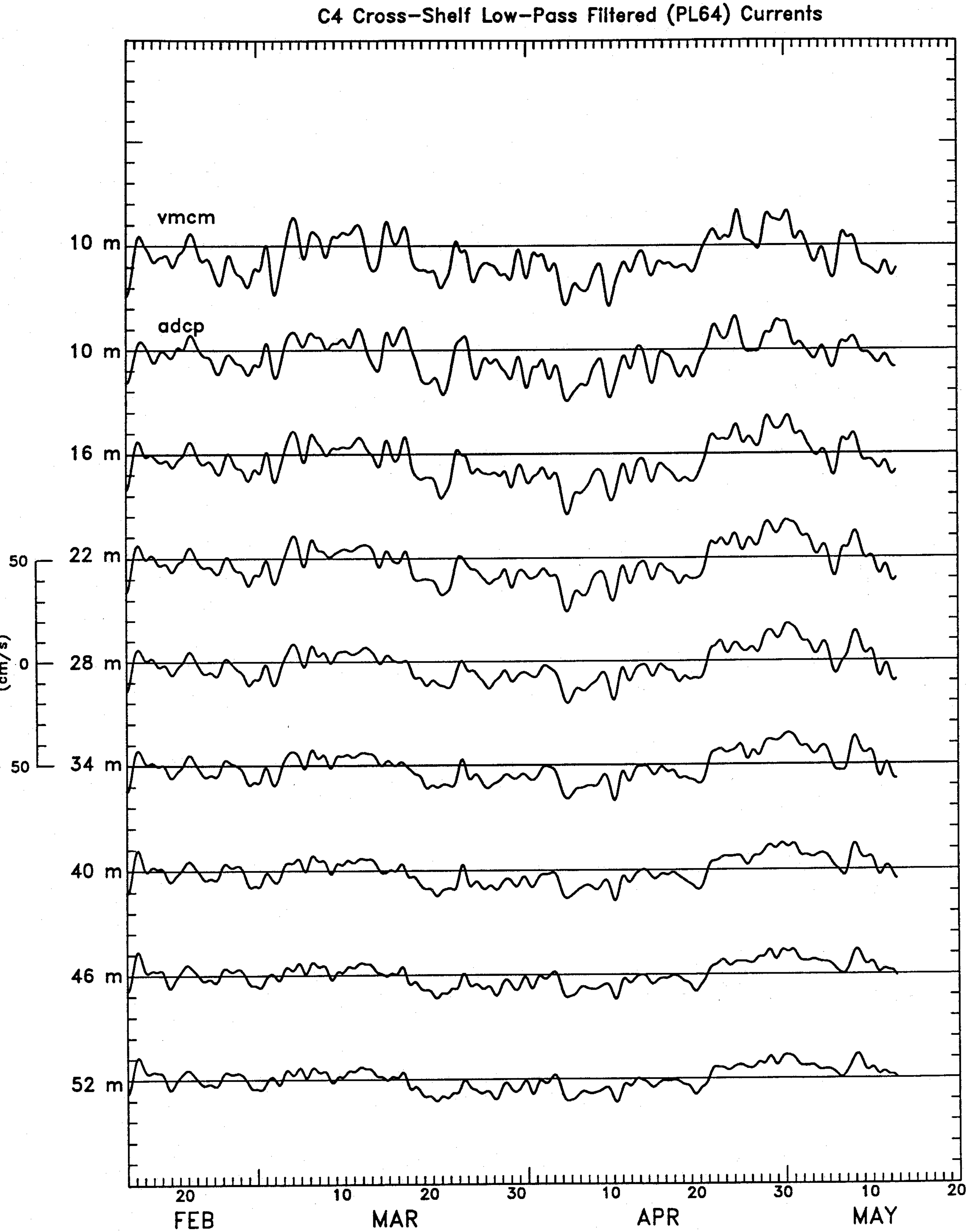


Figure 40 (cont.)

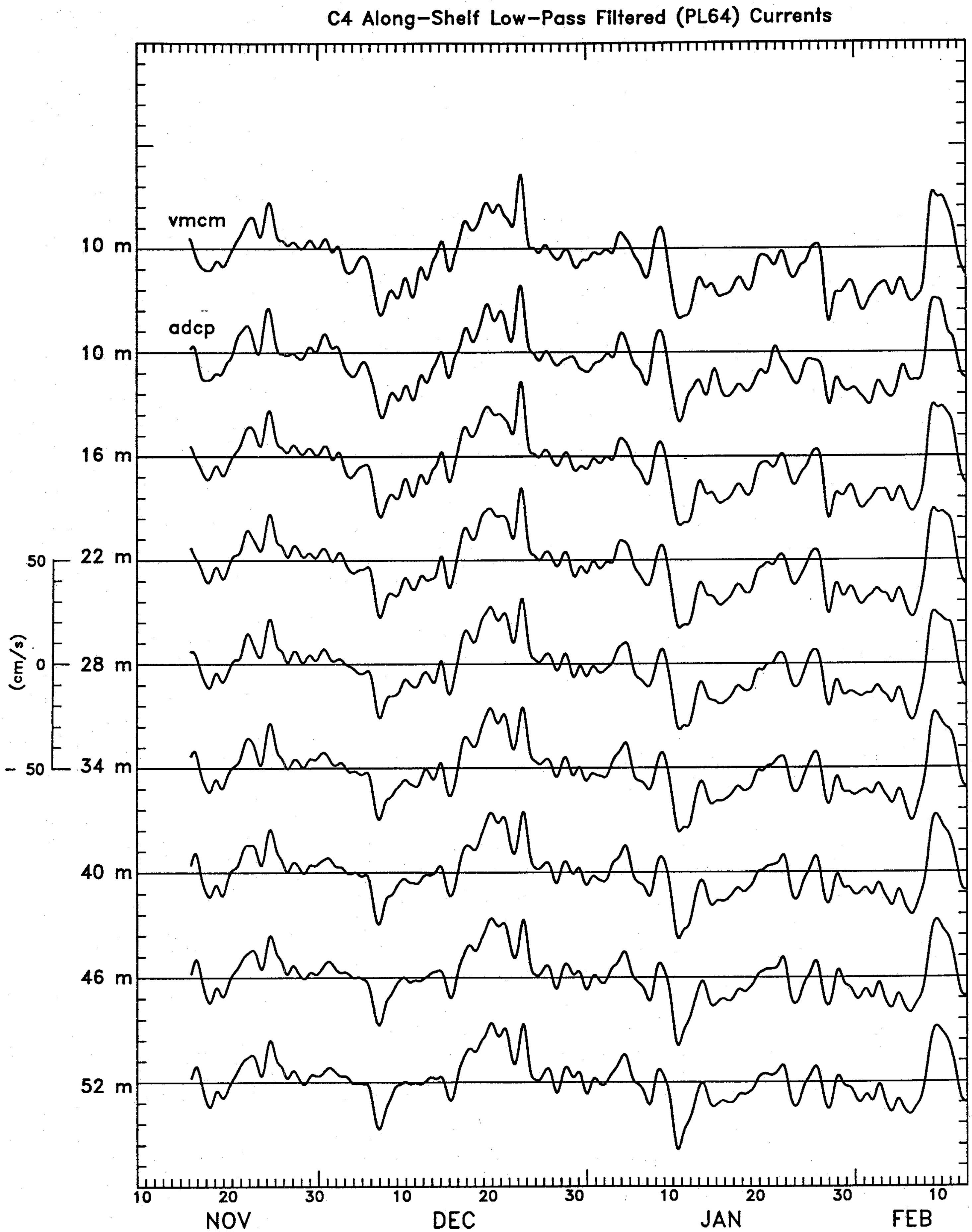

C4 Along-Shelf Low-Pass Filtered (PL64) Currents
vmcm
10 m
adcp
10 m
16 m
22 m
28 m
34 m
40 m
46 m
52 m
50
0
- 50
(cm/s)
10
20
30
10
20
30
10
20
30
10
NOV
DEC
JAN
FEB

Figure 41

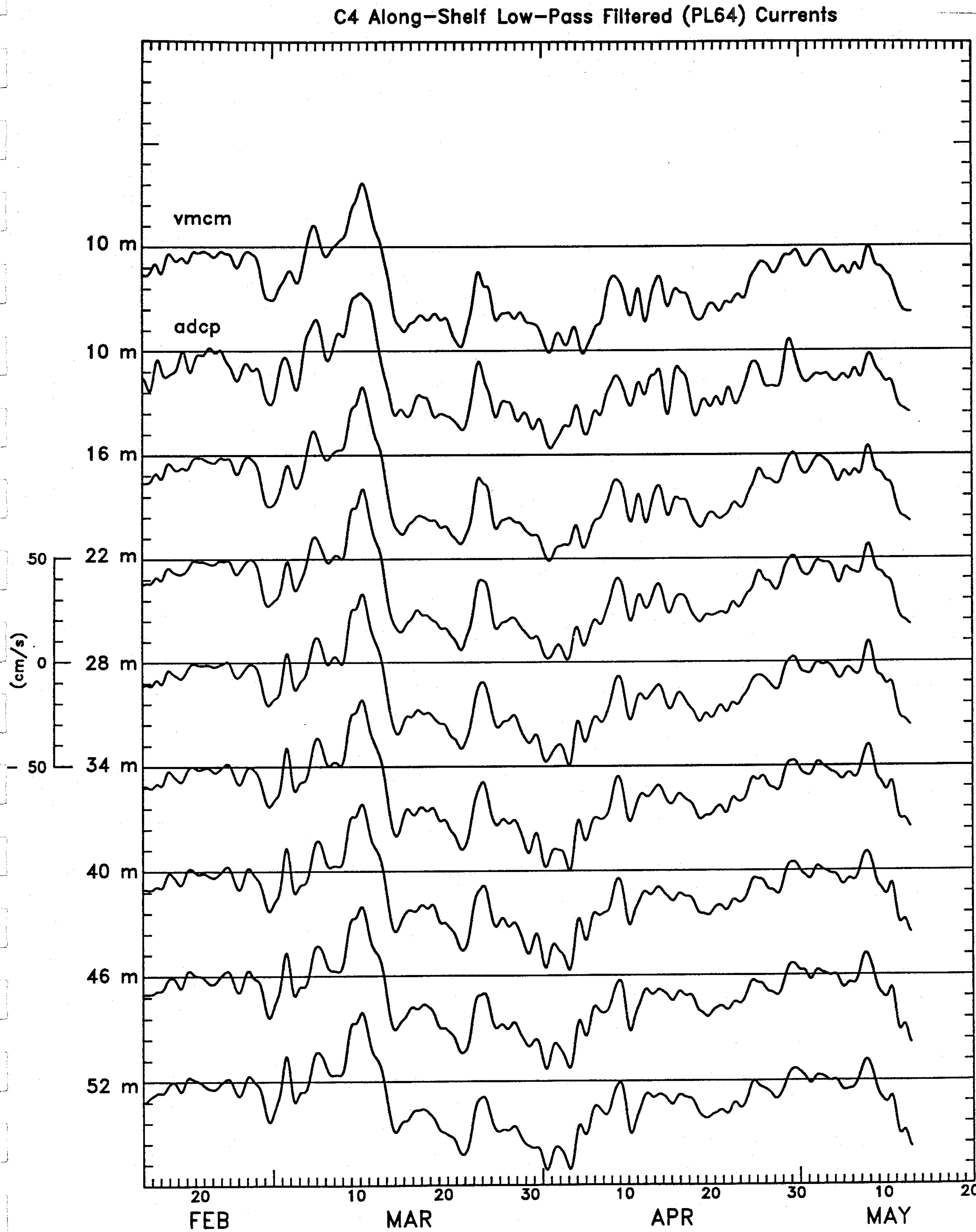


Figure 41 (cont.)

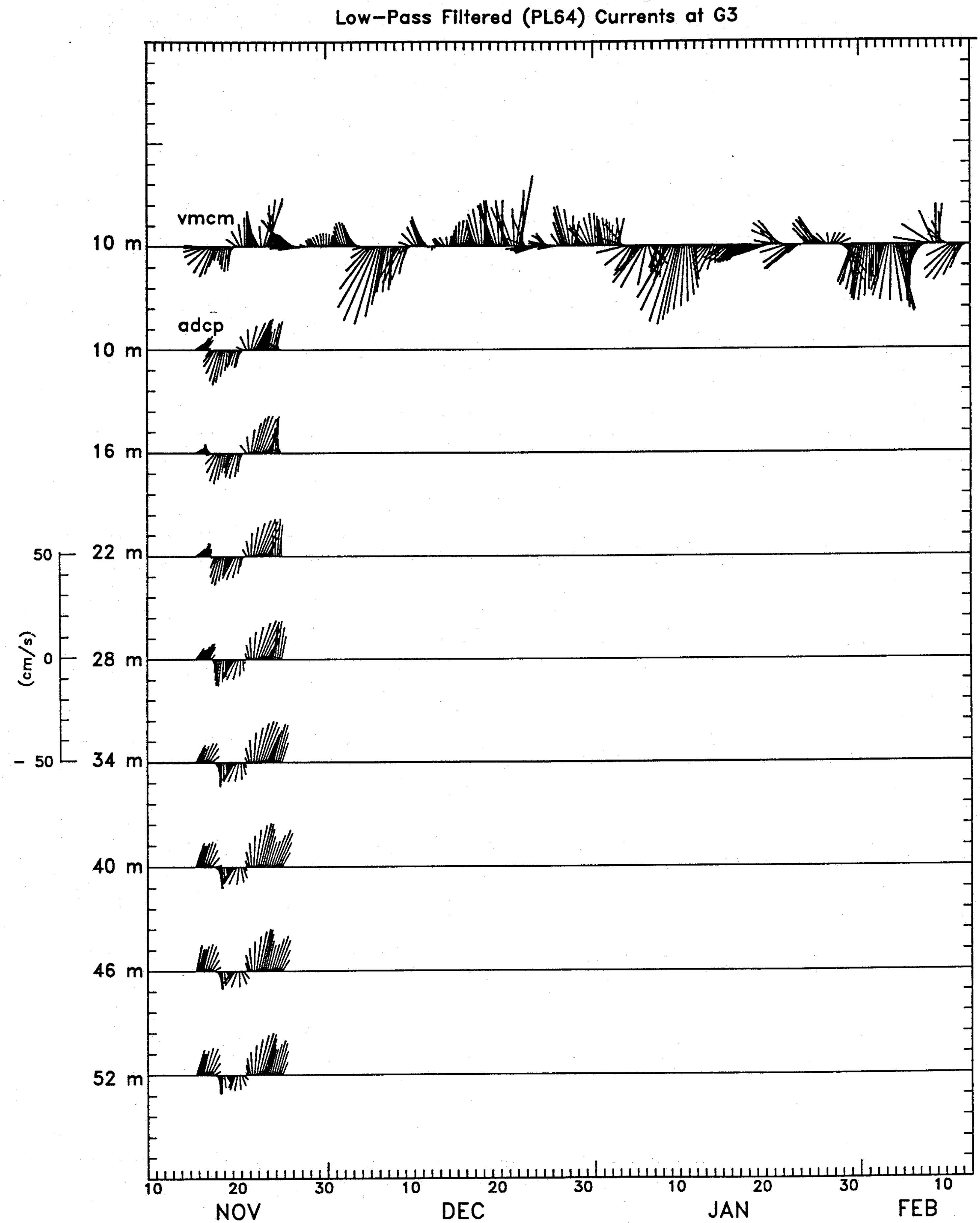

Low-Pass Filtered (PL64) Currents at G3
vmcm
10 m
adcp
10 m
16 m
22 m
28 m
34 m
40 m
46 m
52 m
50
0
- 50
(cm/s)
10
20
30
10
20
30
10
20
30
10
NOV
DEC
JAN
FEB

Figure 42

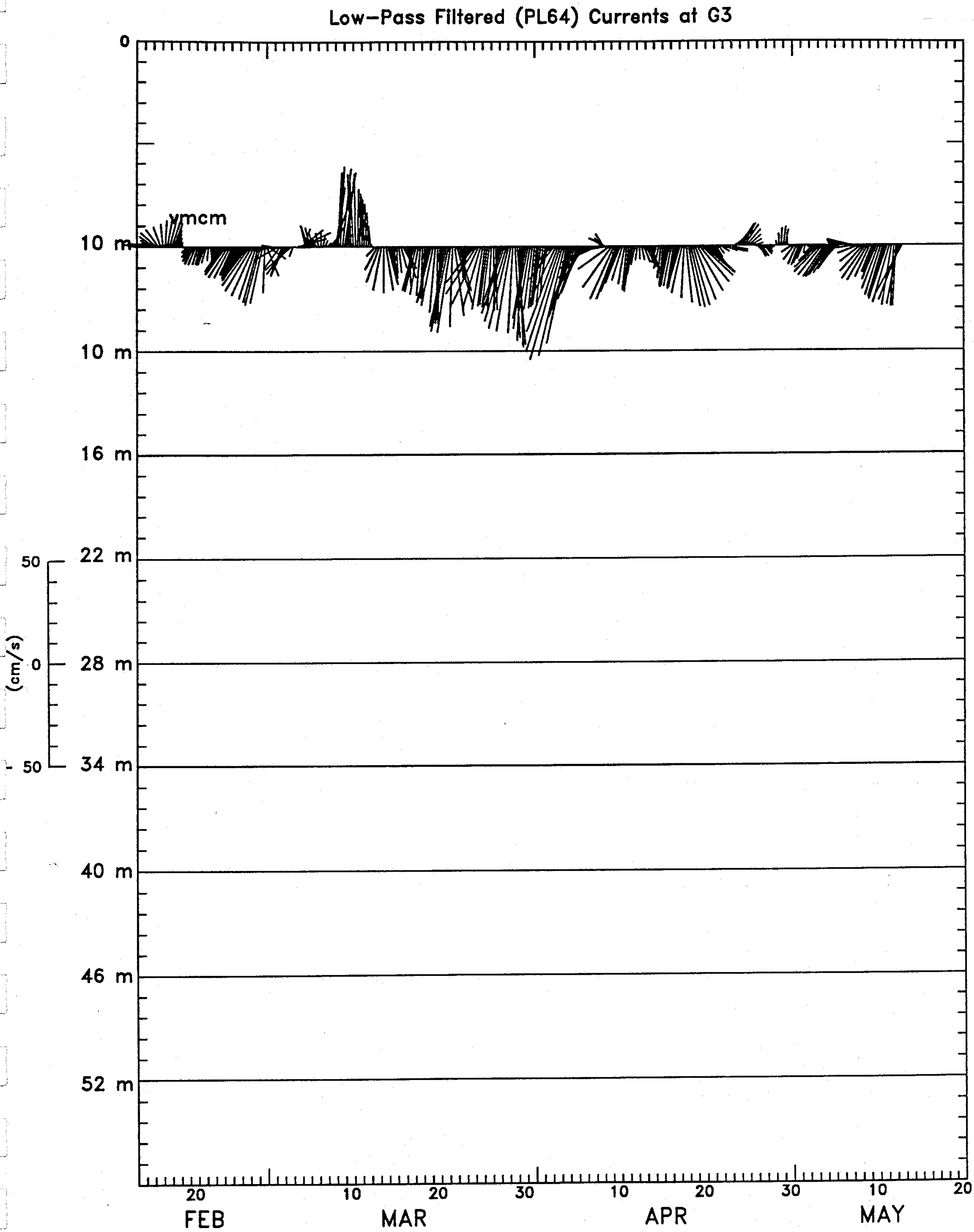


Figure 42 (cont.)

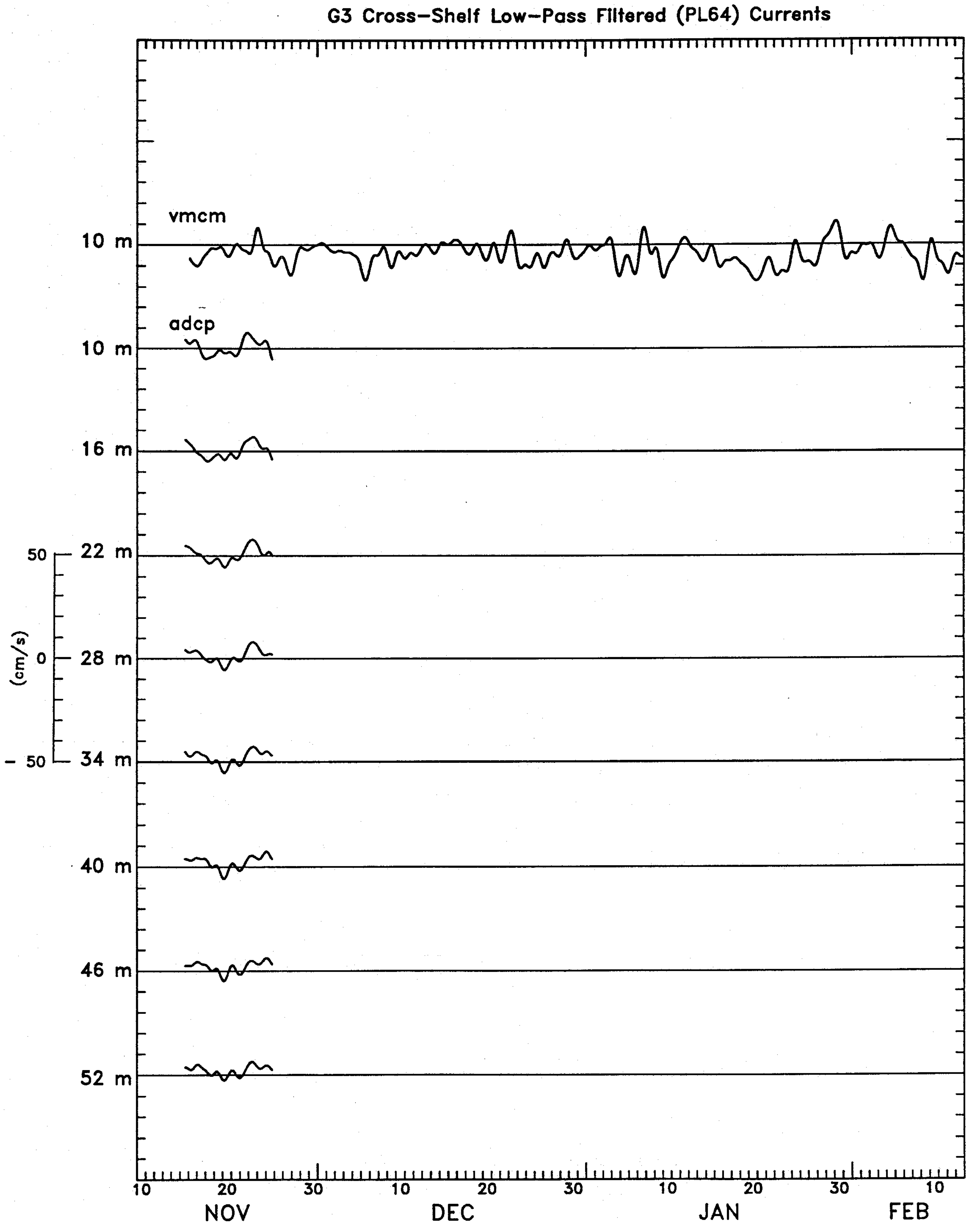

G3 Cross-Shelf Low-Pass Filtered (PL64) Currents
vmcm
10 m
adcp
10 m
16 m
22 m
28 m
34 m
40 m
46 m
52 m
50
0
- 50
(cm/s)
10
20
30
10
20
30
10
20
30
10
NOV
DEC
JAN
FEB

Figure 43

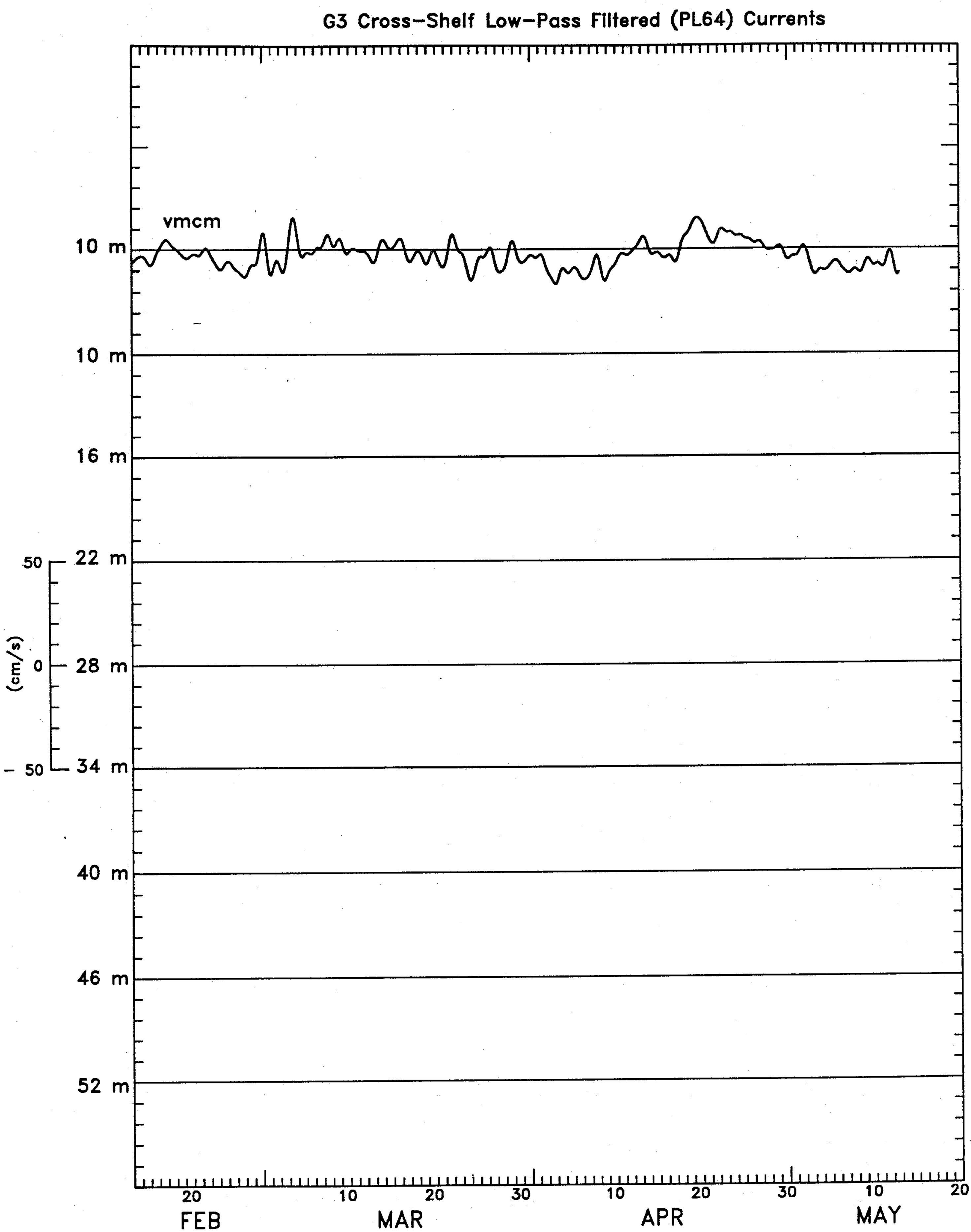
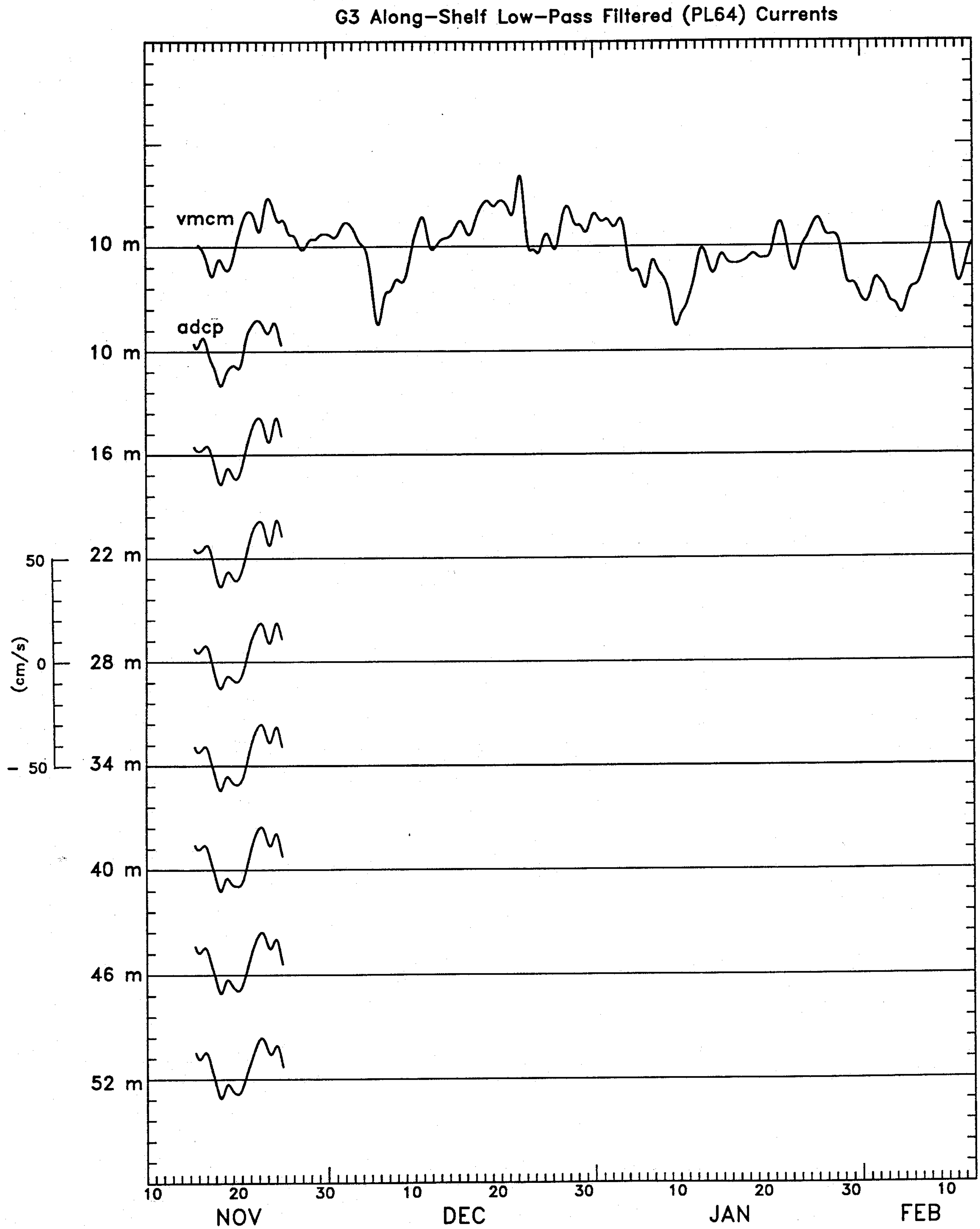


Figure 43 (cont.)



G3 Along-Shelf Low-Pass Filtered (PL64) Currents
vmcm
10 m
adcp
10 m
16 m
22 m
28 m
34 m
40 m
46 m
52 m
50
0
- 50
(cm/s)
10
20
30
10
20
30
10
20
30
10
NOV
DEC
JAN
FEB

Figure 44

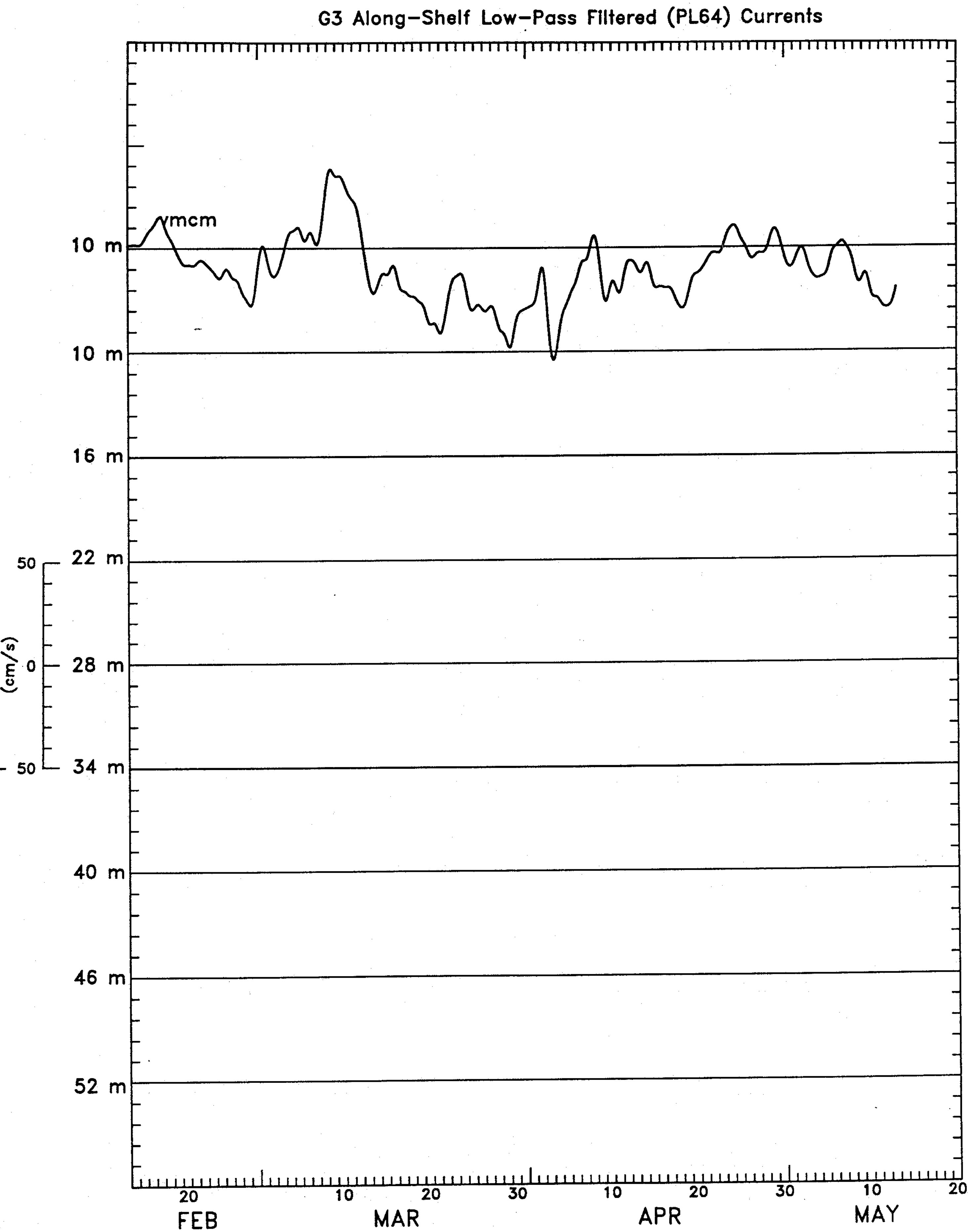


Figure 44 (cont.)

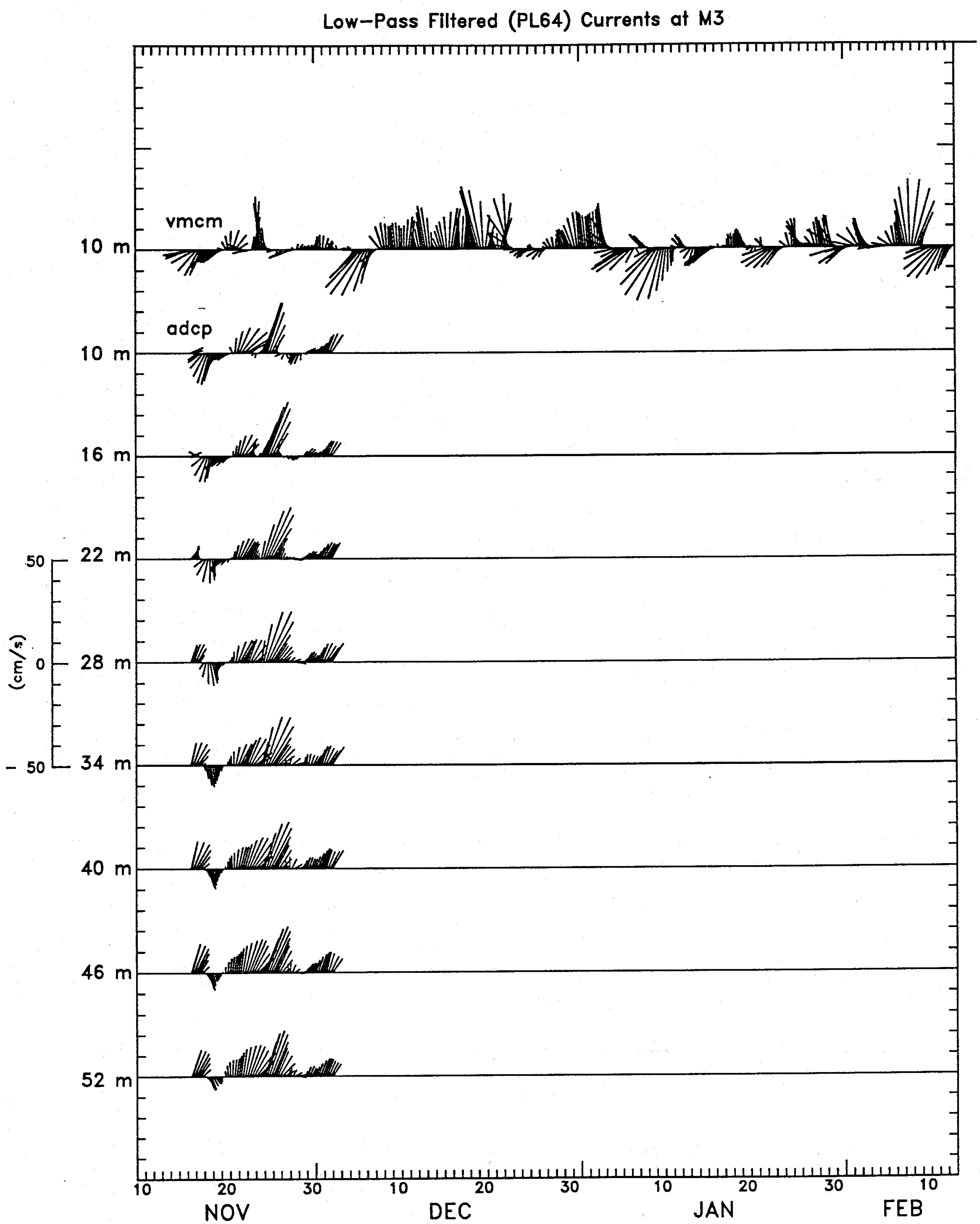

Low-Pass Filtered (PL64) Currents at M3
vmcm
10 m
adcp
10 m
16 m
22 m
28 m
34 m
40 m
46 m
52 m
50
0
- 50
(cm/s)
10
20
30
10
20
30
10
20
30
10
NOV
DEC
JAN
FEB

Figure 45

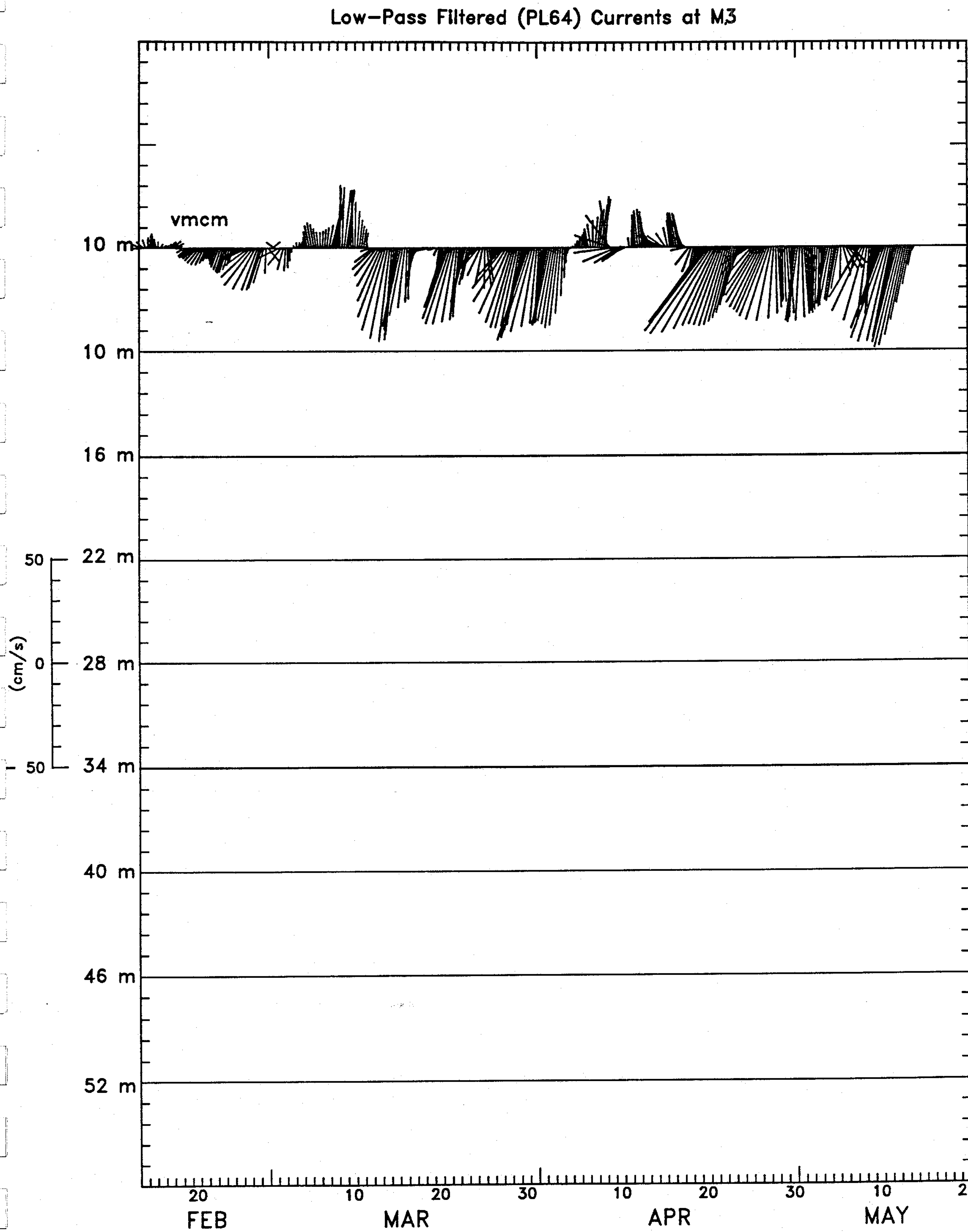
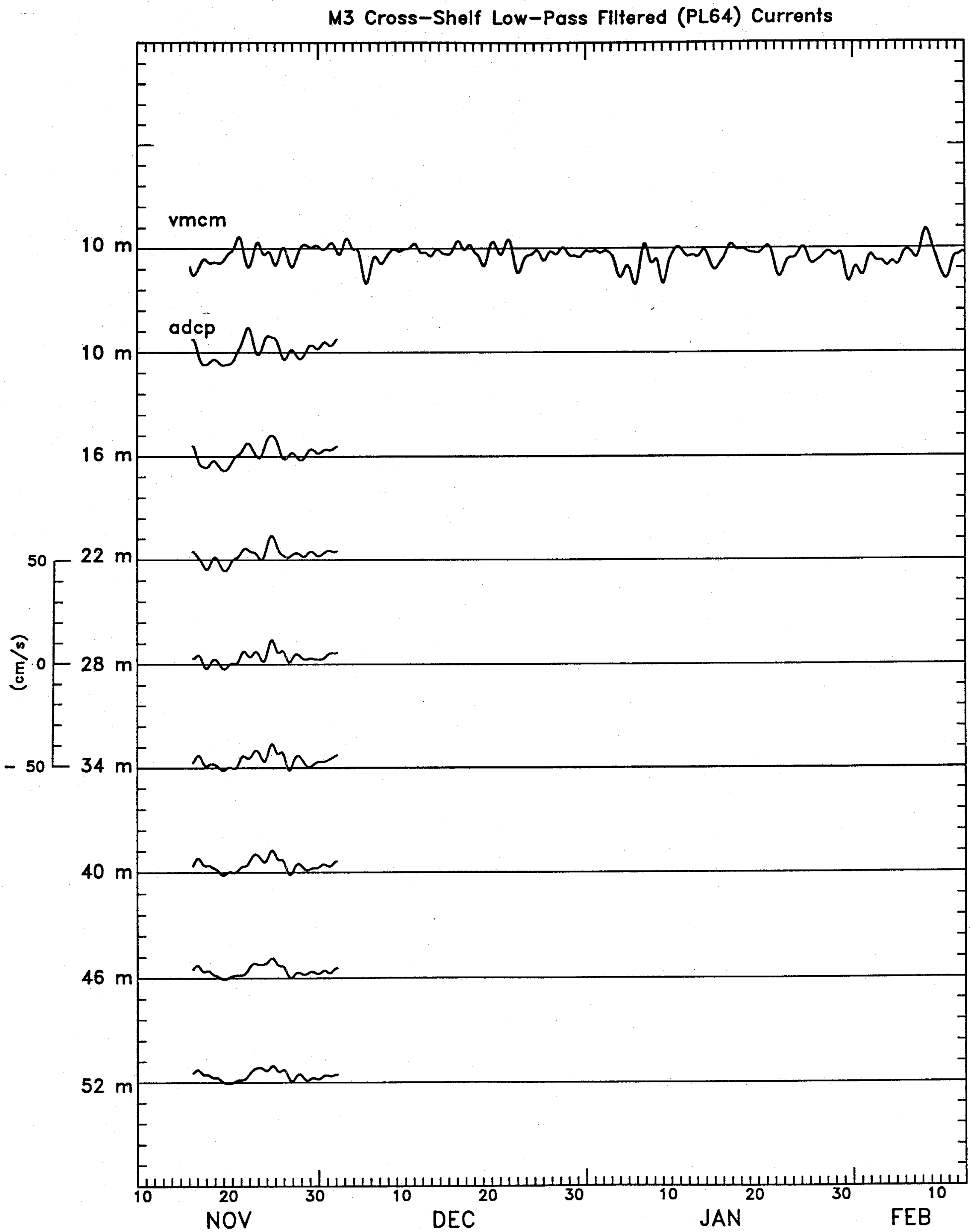


Figure 45 (cont.)



M3 Cross-Shelf Low-Pass Filtered (PL64) Currents
vmcm
10 m
adcp
10 m
16 m
22 m
28 m
34 m
40 m
46 m
52 m
50
0
- 50
(cm/s)
10
20
30
10
20
30
10
20
30
10
NOV
DEC
JAN
FEB

Figure 46

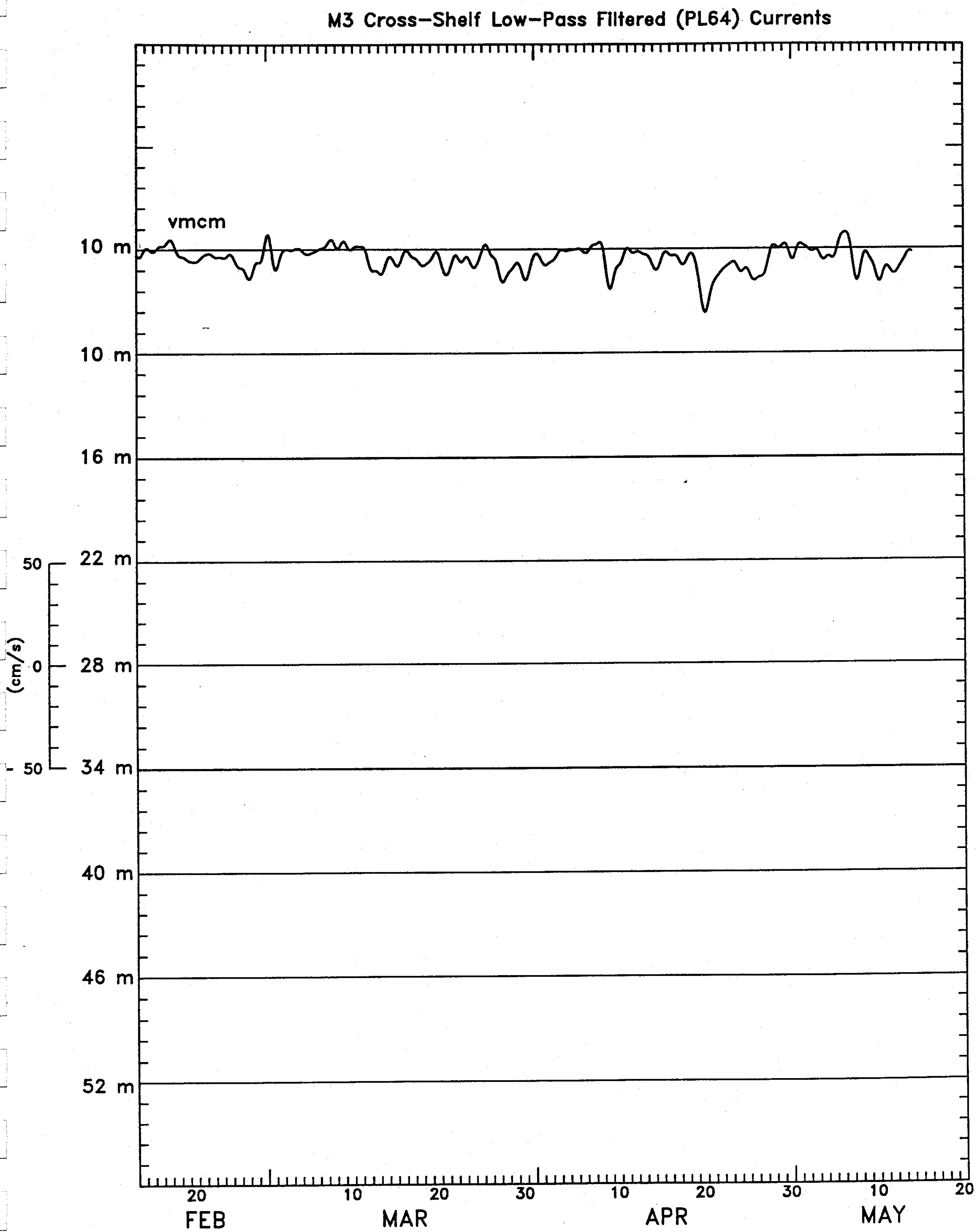


Figure 46 (cont.)

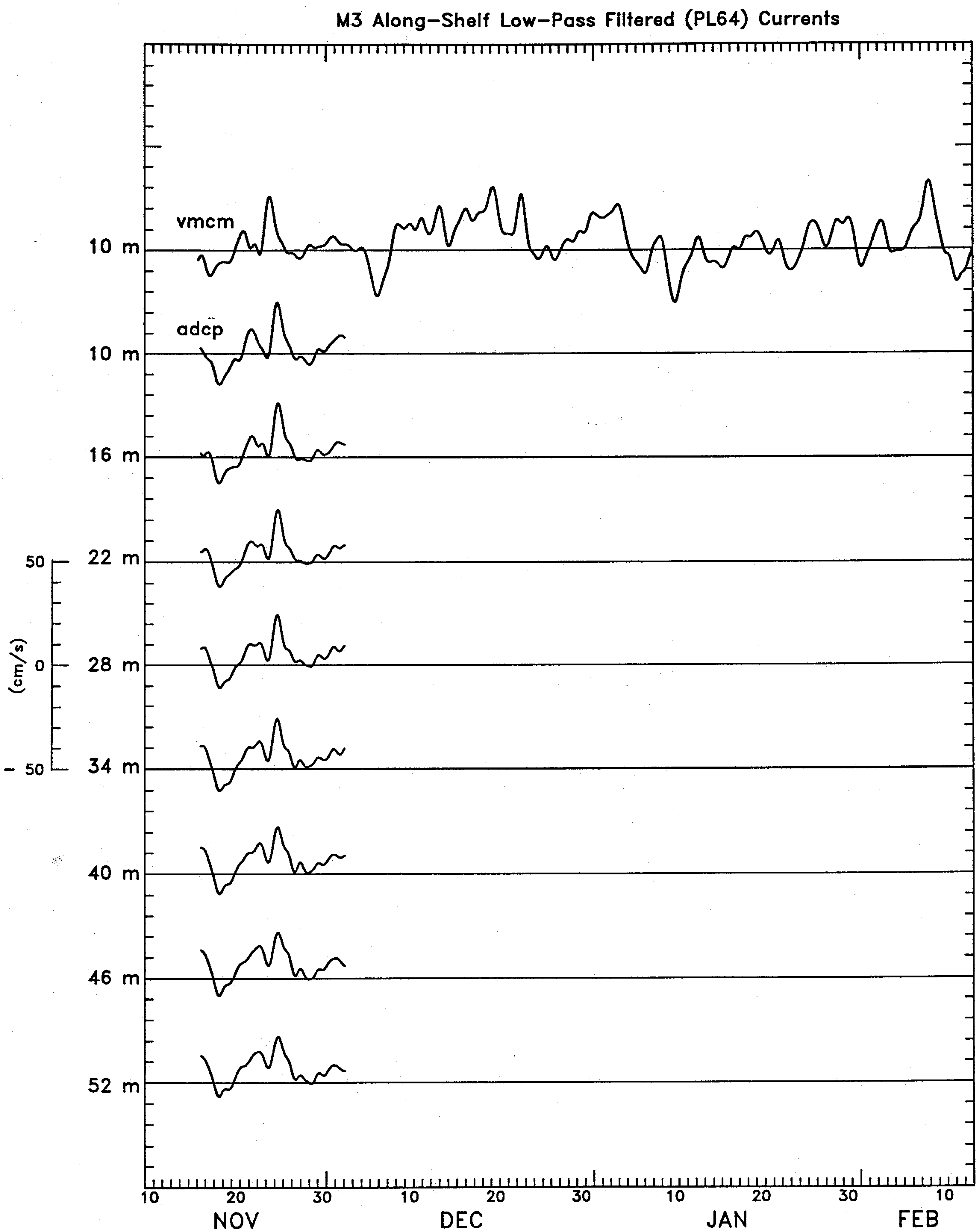

M3 Along-Shelf Low-Pass Filtered (PL64) Currents
vmcm
10 m
adcp
10 m
16 m
22 m
28 m
34 m
40 m
46 m
52 m
50
0
- 50
(cm/s)
10
20
30
10
20
30
10
20
30
10
NOV
DEC
JAN
FEB

Figure 47

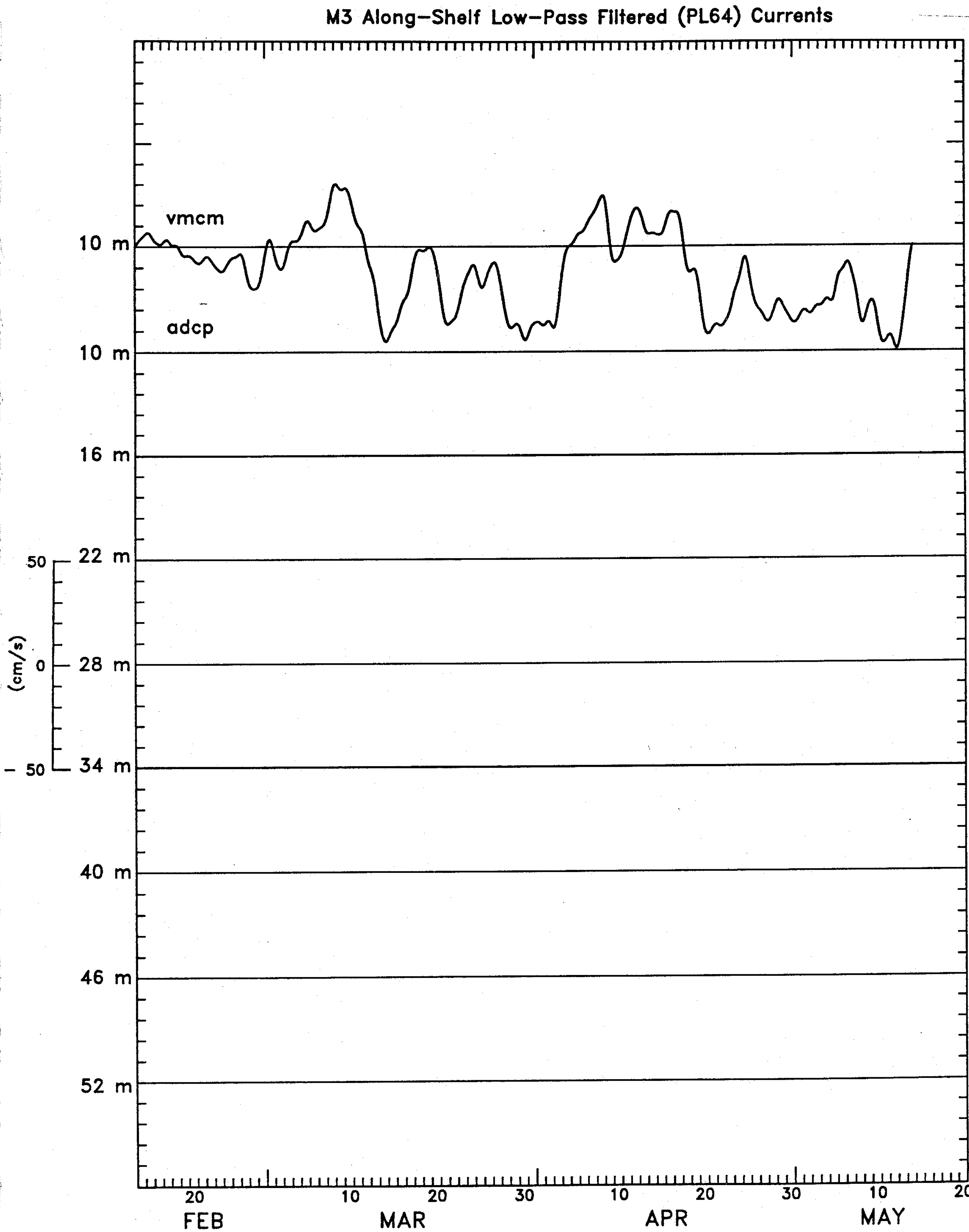


Figure 47 (cont.)

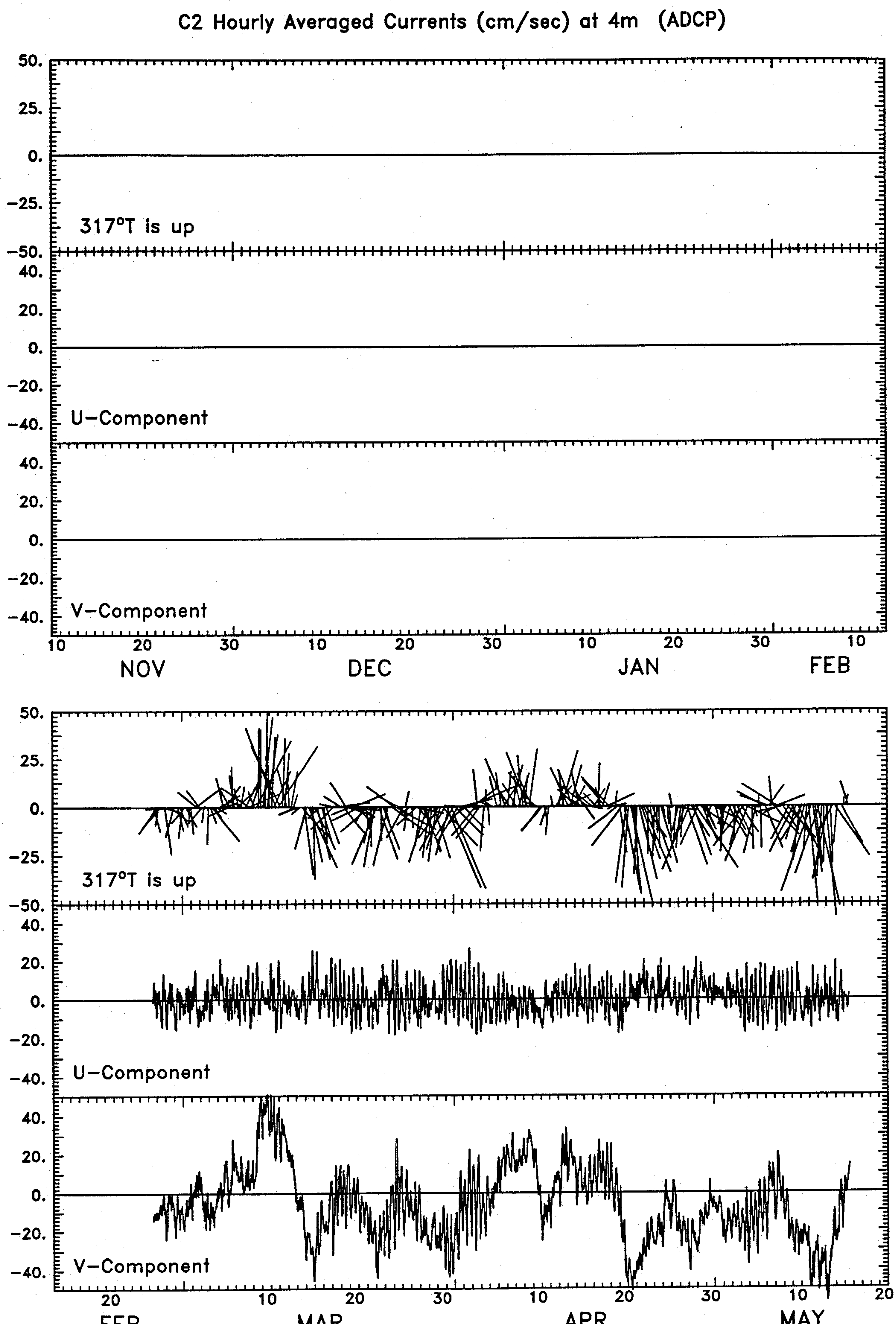
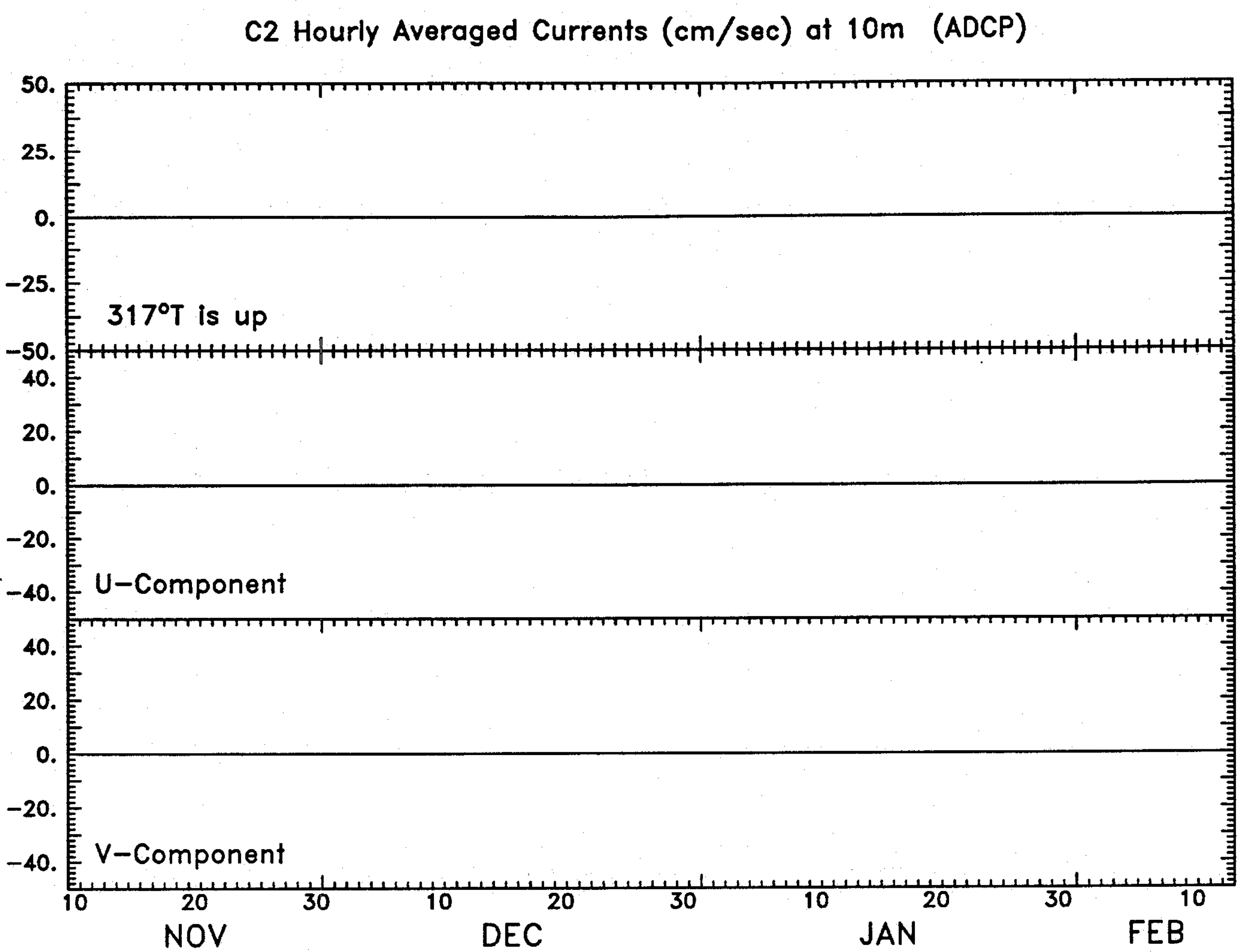

C2 Hourly Averaged Currents (cm/sec) at 4m (ADCP)
317°T is up
U-Component
V-Component
NOV
DEC
JAN
FEB
MAR
APR
MAY

Figure 48


C2 Hourly Averaged Currents (cm/sec) at 10m (ADCP)
50.
25.
0.
−25.
317°T is up
−50.
40.
20.
0.
−20.
U−Component
−40.
40.
20.
0.
−20.
V−Component
−40.
10
20
30
10
20
30
10
20
30
10
NOV
DEC
JAN
FEB

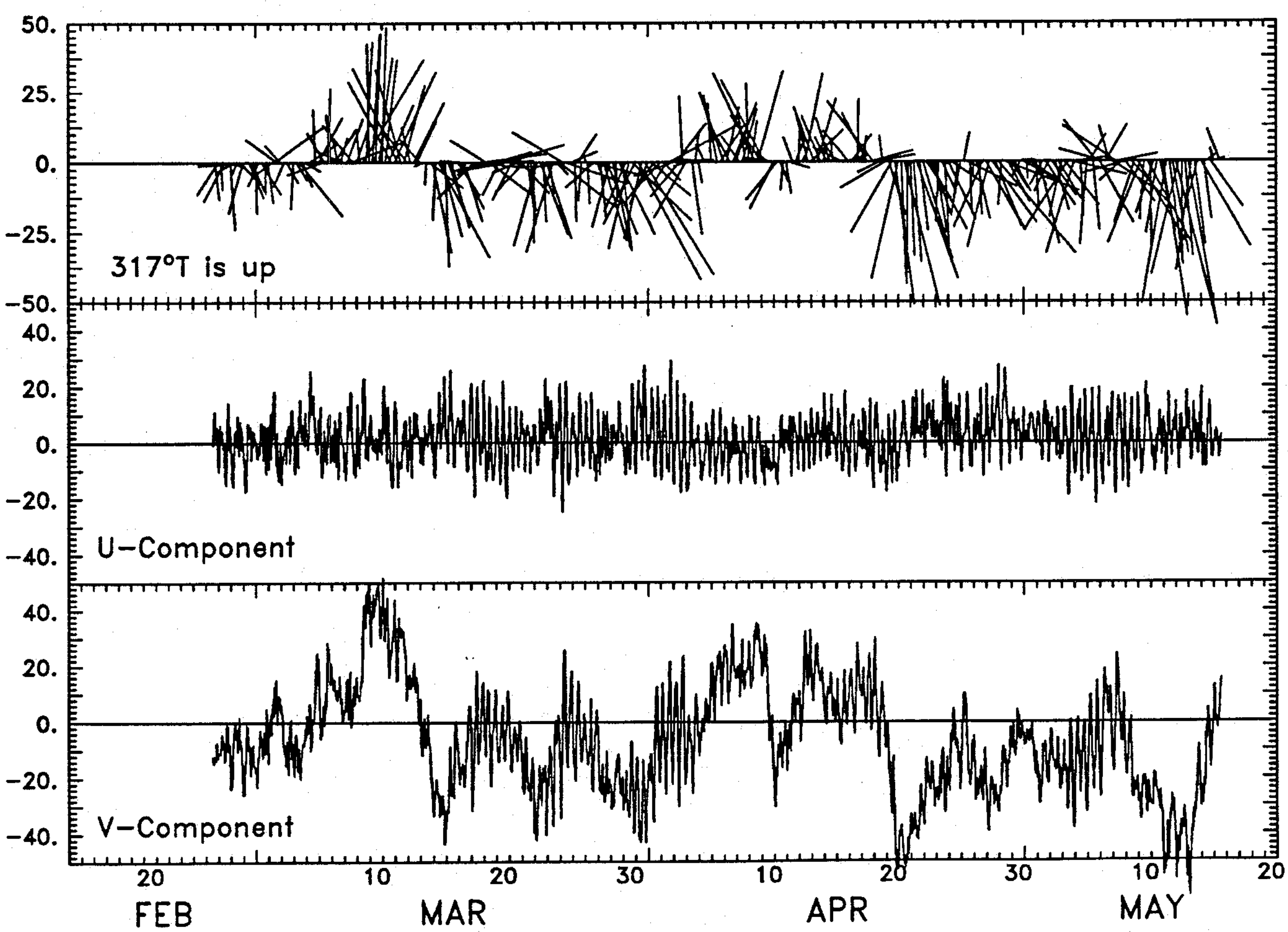
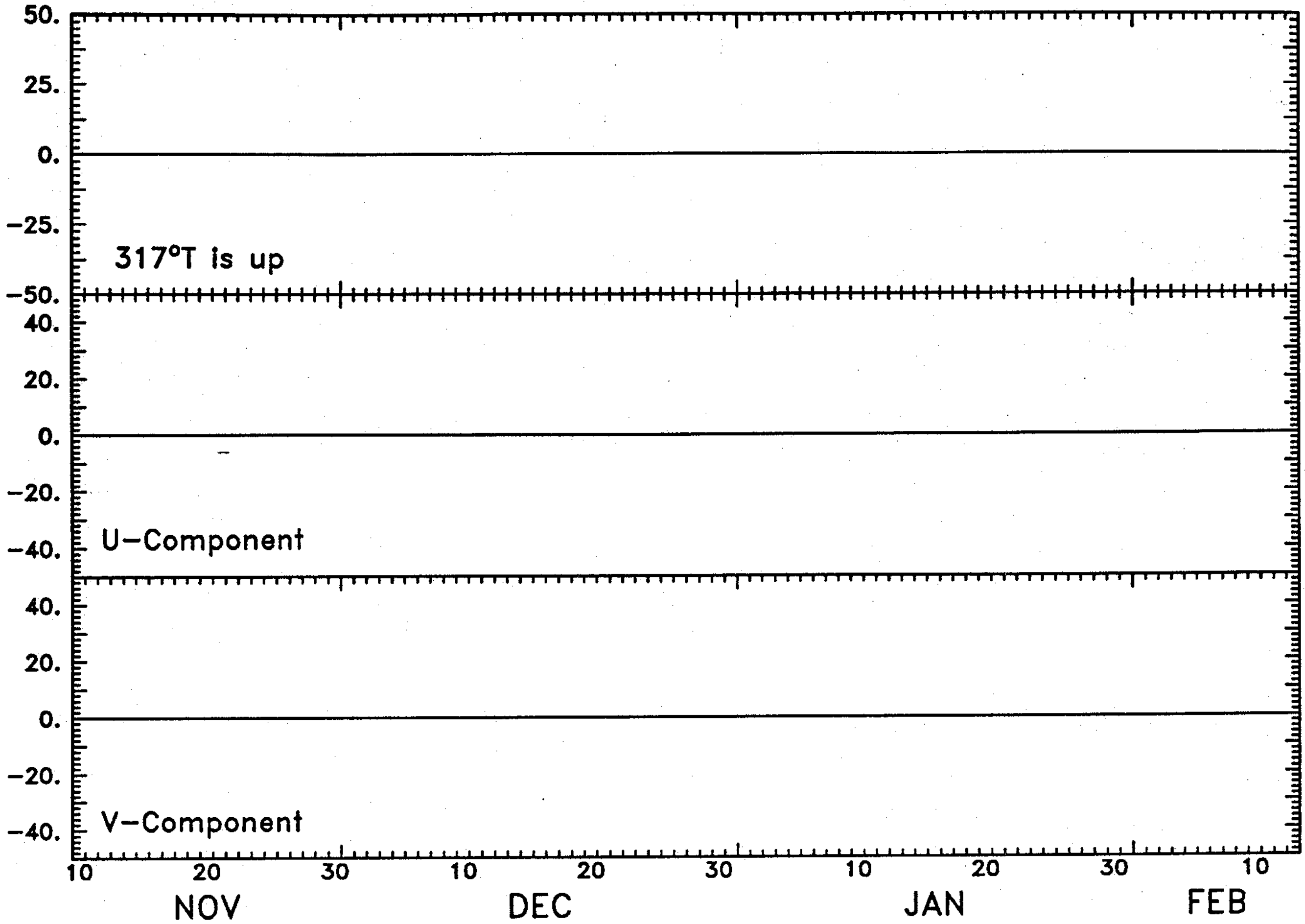

50.
25.
0.
−25.
317°T is up
−50.
40.
20.
0.
−20.
U−Component
−40.
40.
20.
0.
−20.
V−Component
−40.
20
10
20
30
10
20
30
10
20
FEB
MAR
APR
MAY

Figure 49

C2 Hourly Averaged Currents (cm/sec) at 10m (VMCM)



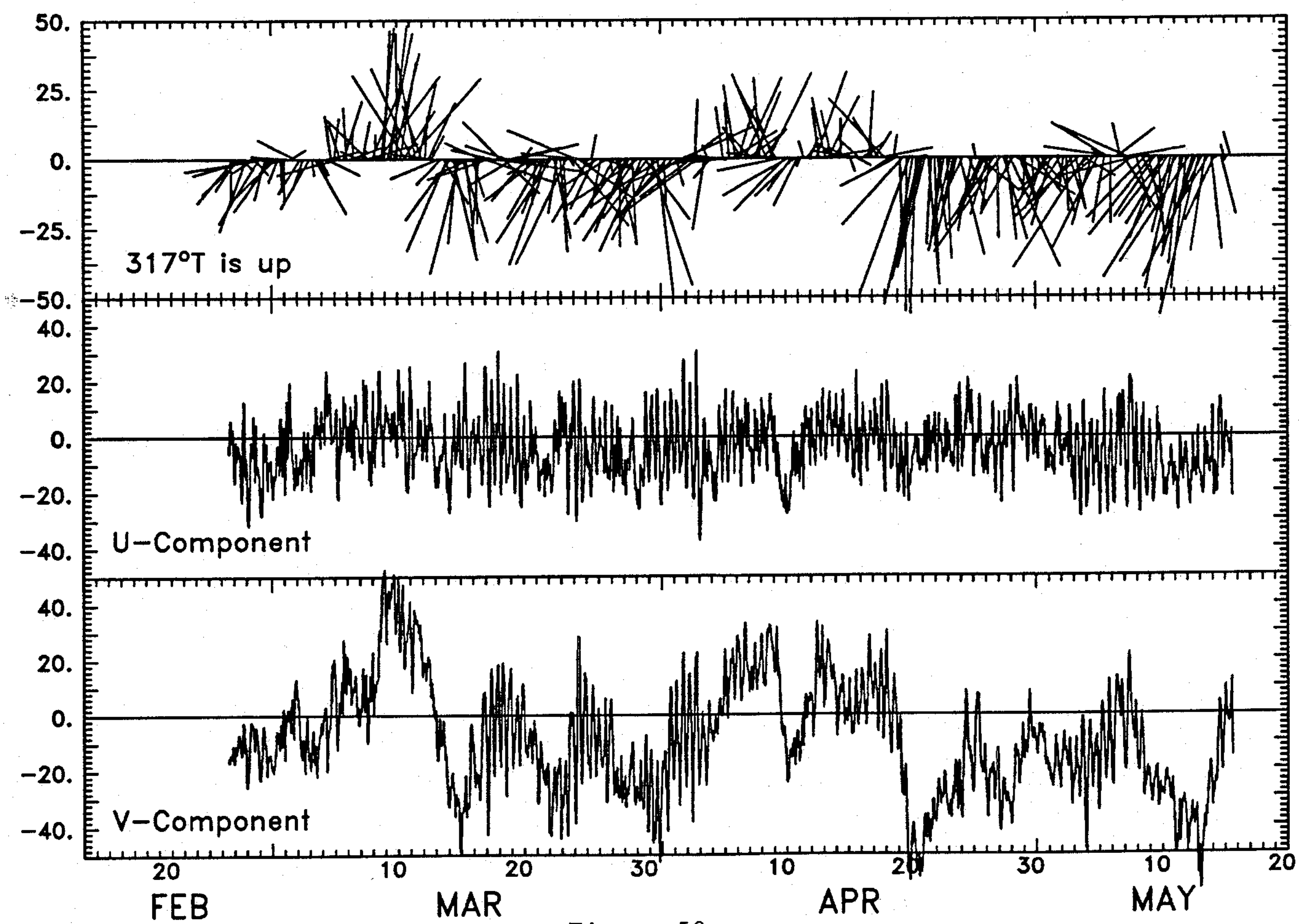


Figure 50

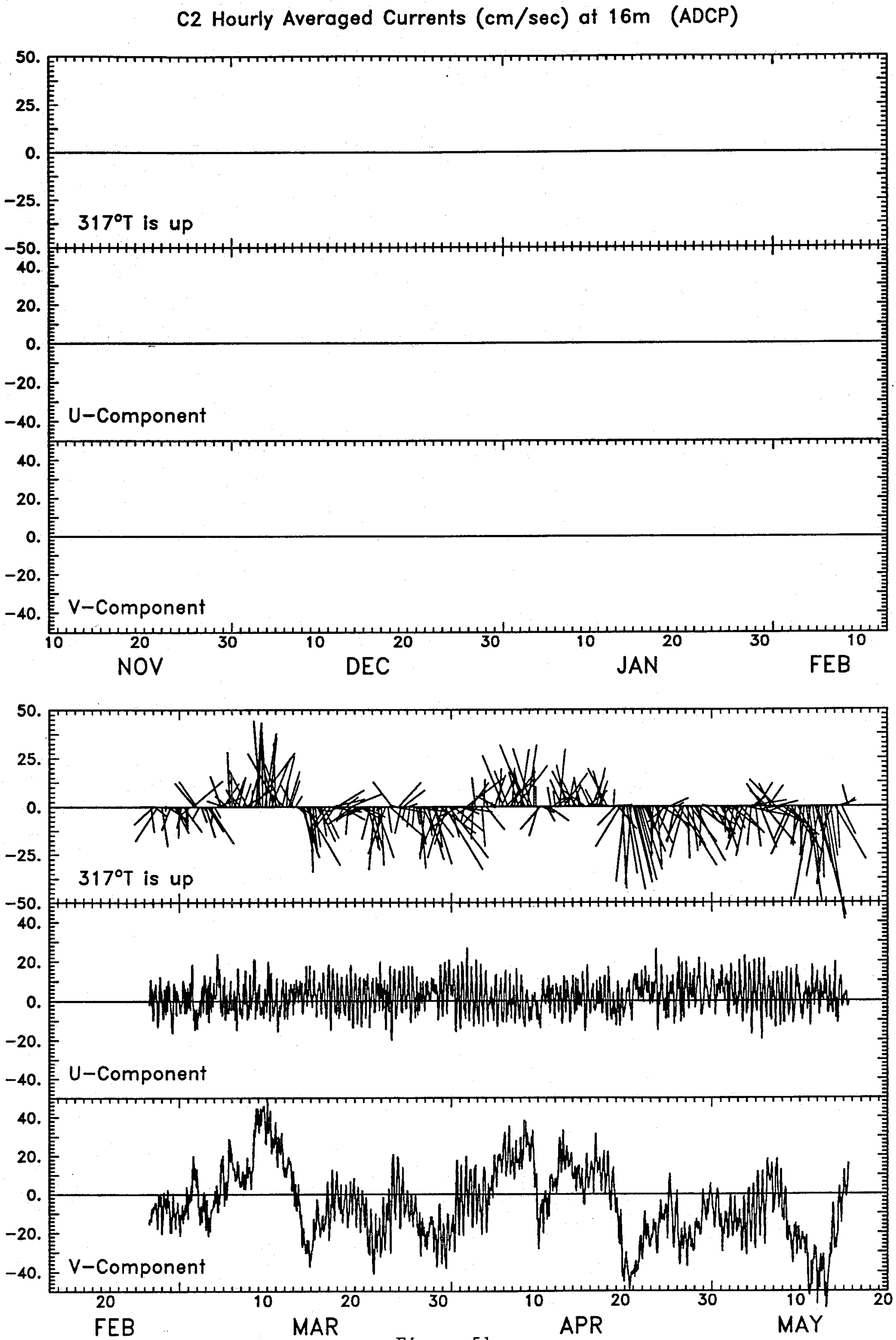

C2 Hourly Averaged Currents (cm/sec) at 16m (ADCP)
50.
25.
0.
-25.
-50.
317°T is up
40.
20.
0.
-20.
-40.
U-Component
V-Component
10
20
30
NOV
DEC
JAN
FEB
MAR
APR
MAY

Figure 51

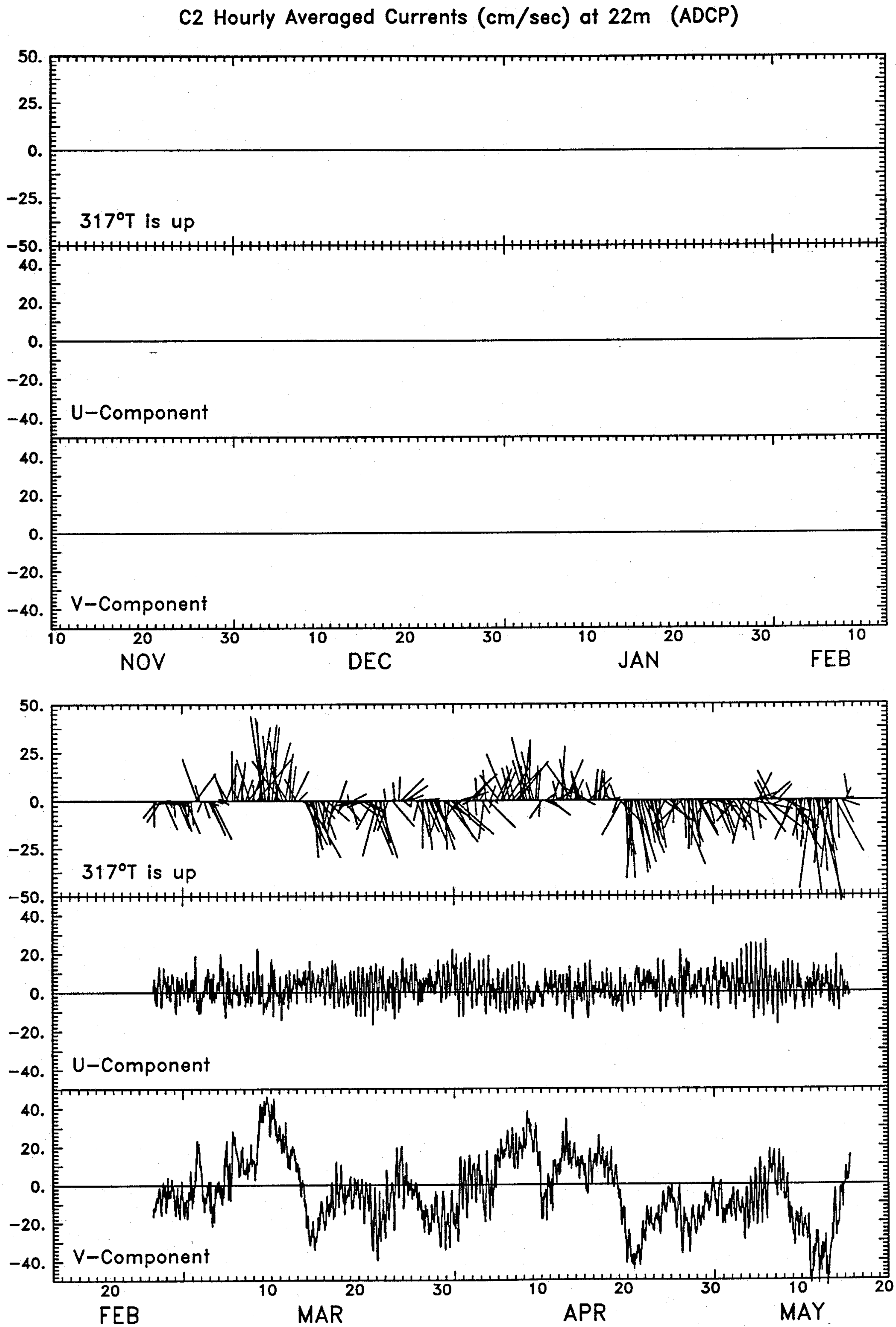
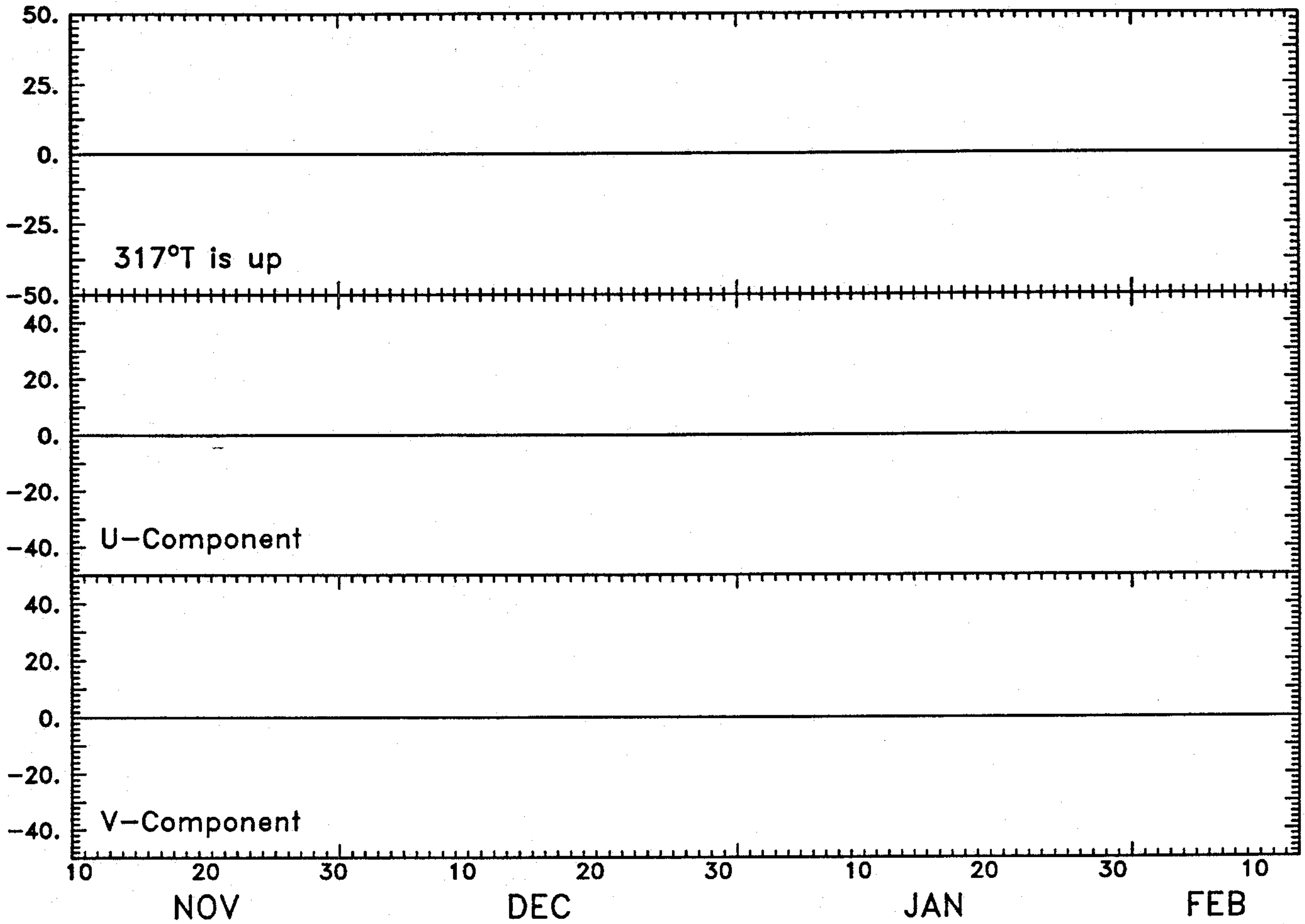

C2 Hourly Averaged Currents (cm/sec) at 22m (ADCP)
50.
25.
0.
-25.
-50.
317°T is up
40.
20.
0.
-20.
-40.
U-Component
40.
20.
0.
-20.
-40.
V-Component
10
20
30
10
20
30
10
20
30
10
NOV
DEC
JAN
FEB
50.
25.
0.
-25.
-50.
317°T is up
40.
20.
0.
-20.
-40.
U-Component
40.
20.
0.
-20.
-40.
V-Component
20
10
20
30
10
20
30
10
20
FEB
MAR
APR
MAY

Figure 52

C2 Hourly Averaged Currents (cm/sec) at 28m (ADCP)



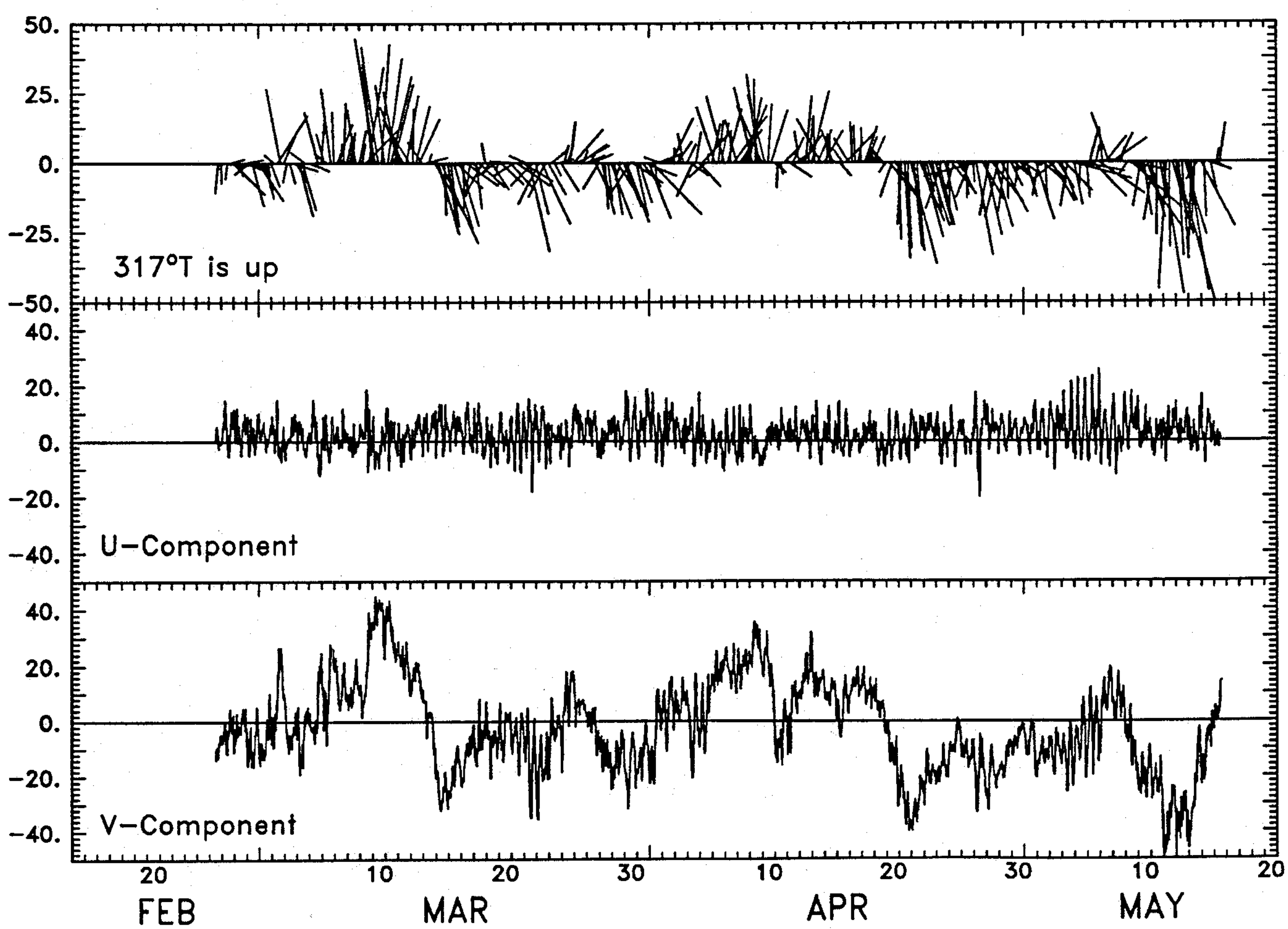


Figure 53

C2 Hourly Averaged Currents (cm/sec) at 34m (ADCP)

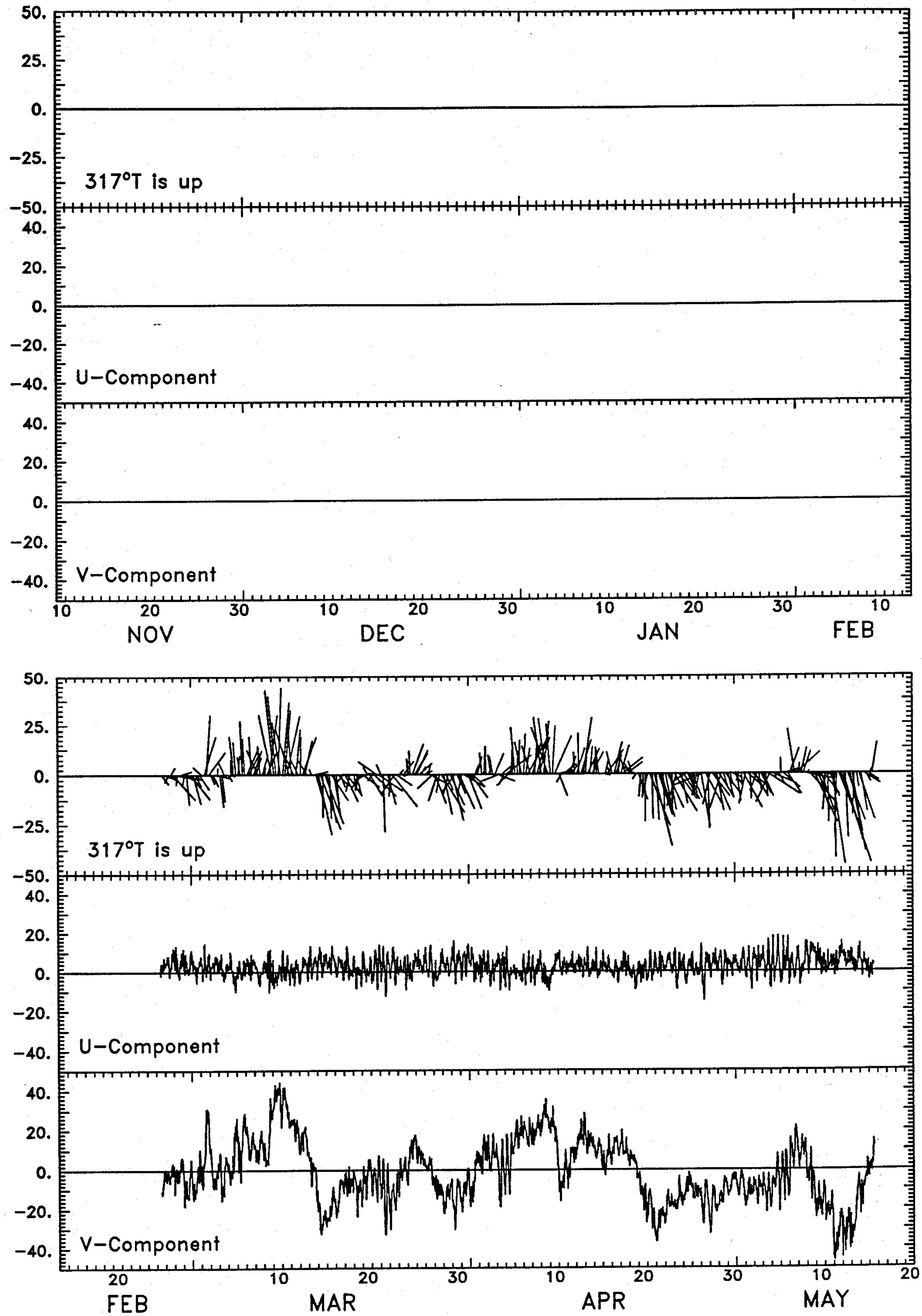


Figure 54

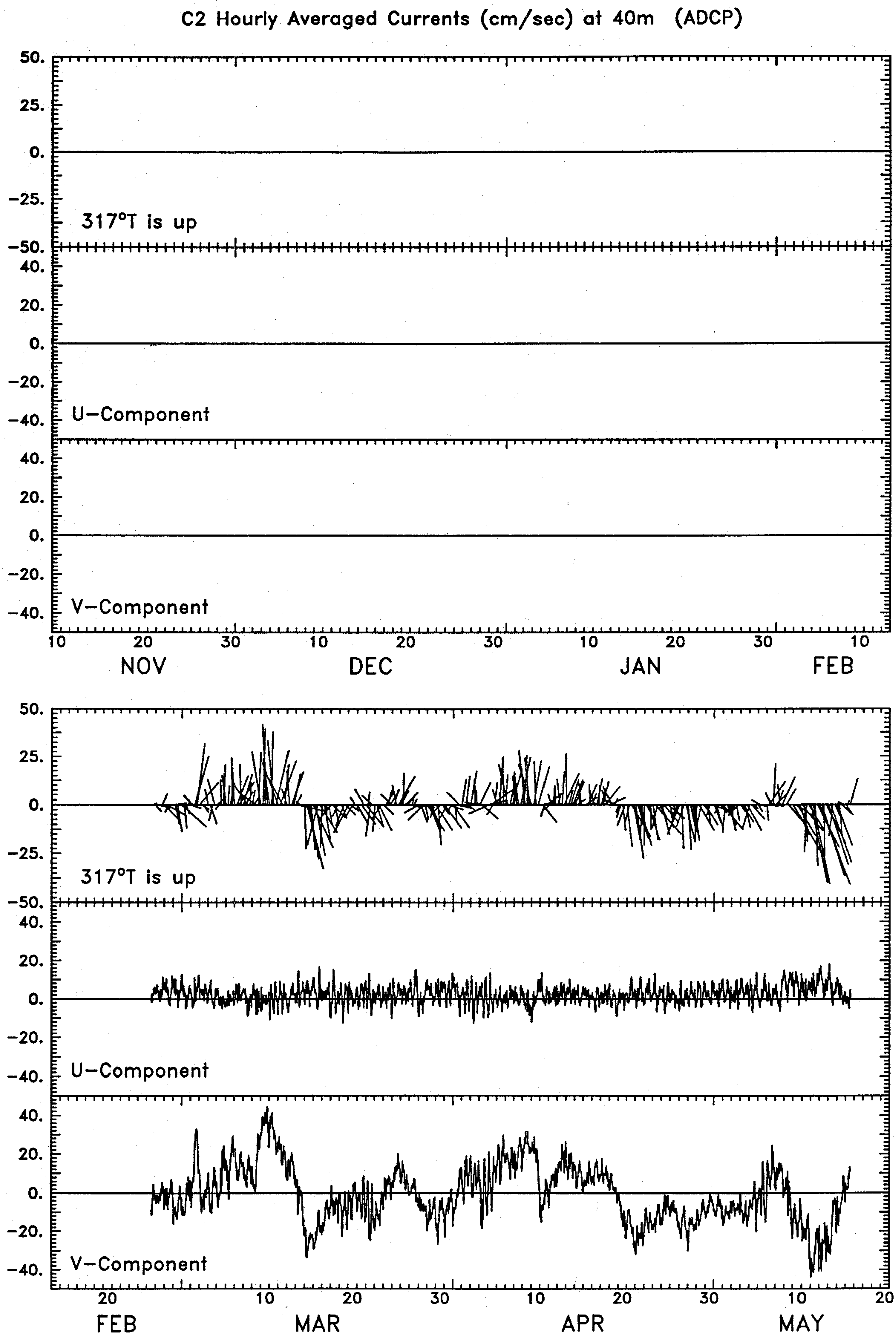

C2 Hourly Averaged Currents (cm/sec) at 40m (ADCP)
317°T is up
U–Component
V–Component
NOV
DEC
JAN
FEB
FEB
MAR
APR
MAY

Figure 55

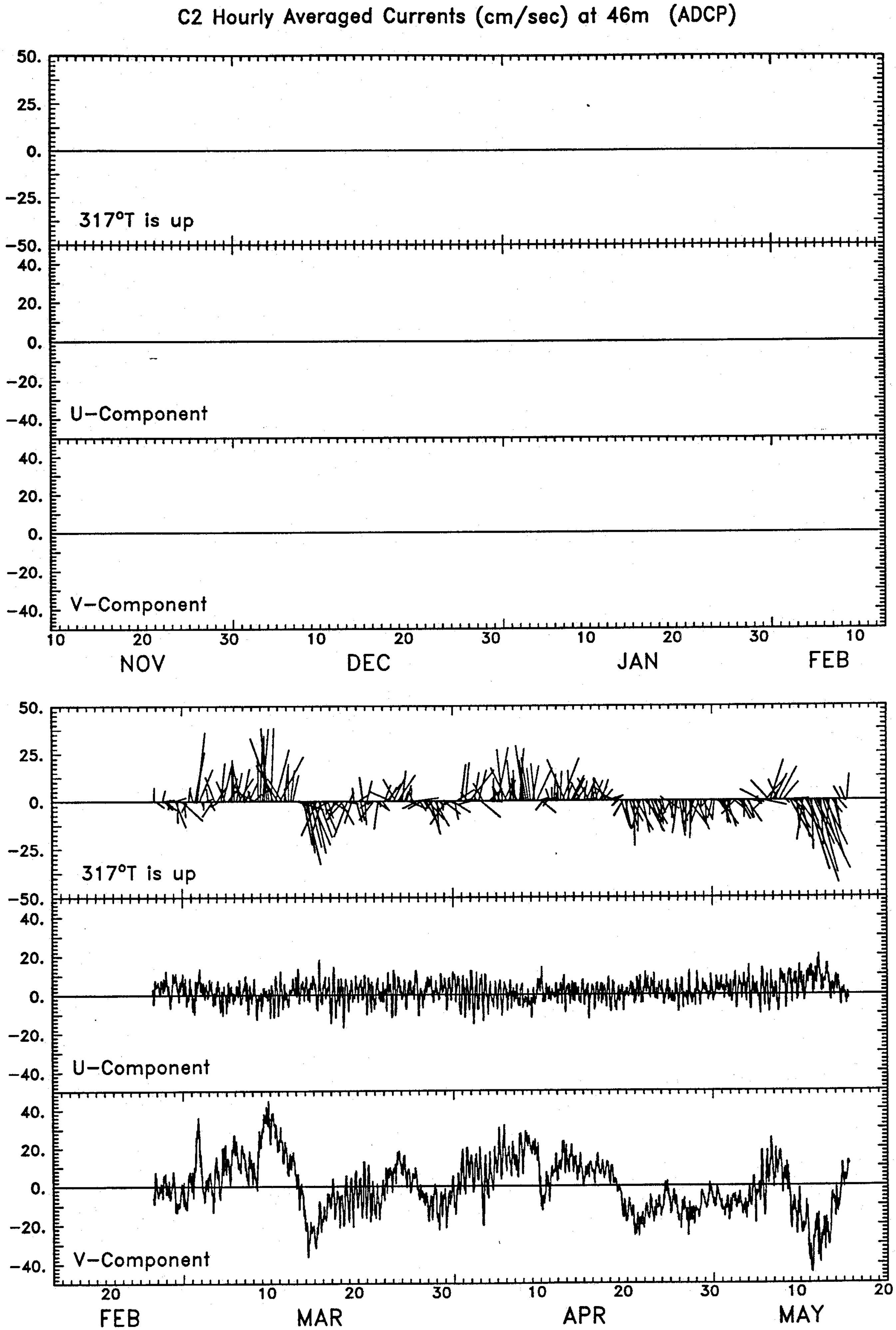

C2 Hourly Averaged Currents (cm/sec) at 46m (ADCP)
317°T is up
U-Component
V-Component
NOV
DEC
JAN
FEB
317°T is up
U-Component
V-Component
FEB
MAR
APR
MAY

Figure 56

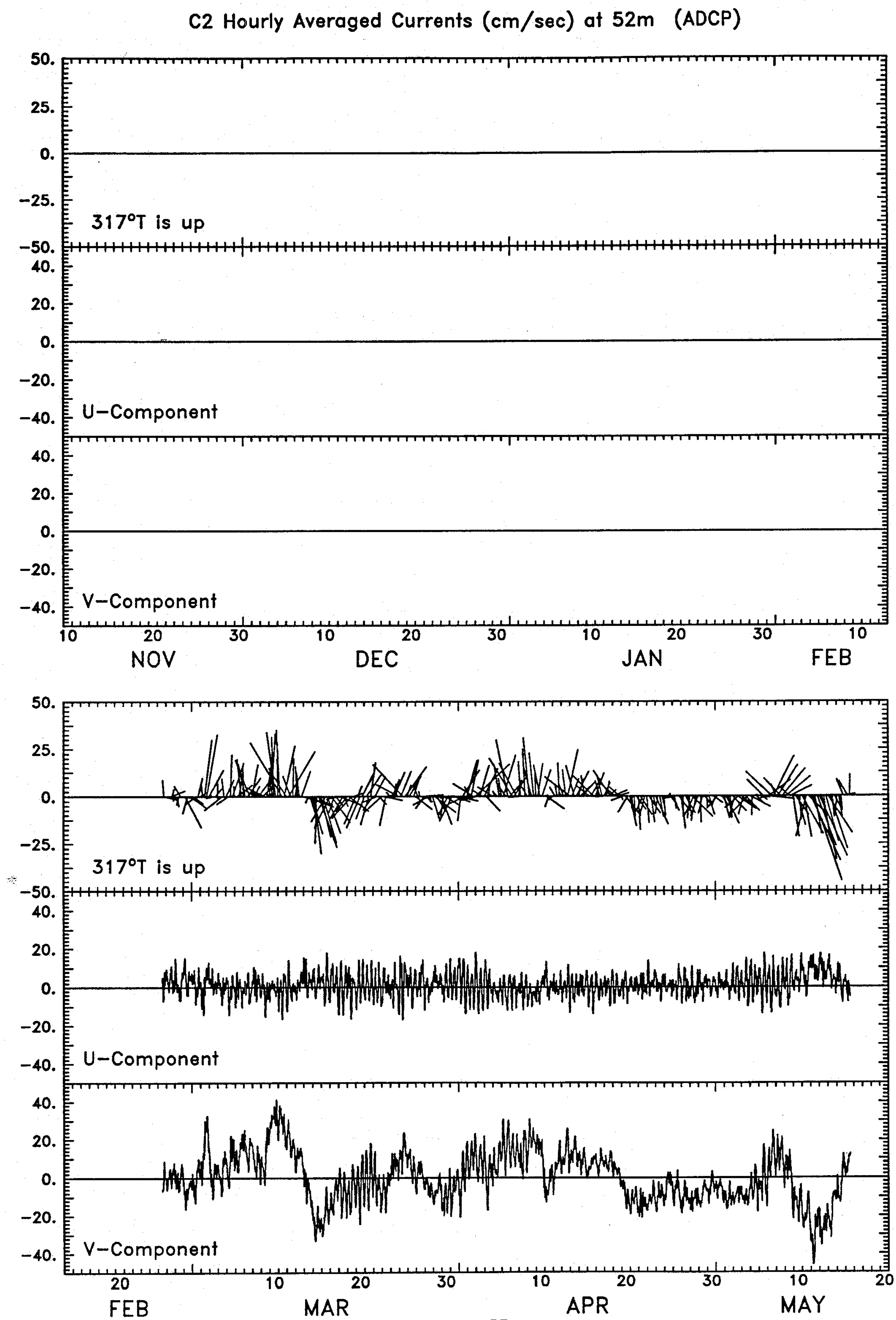
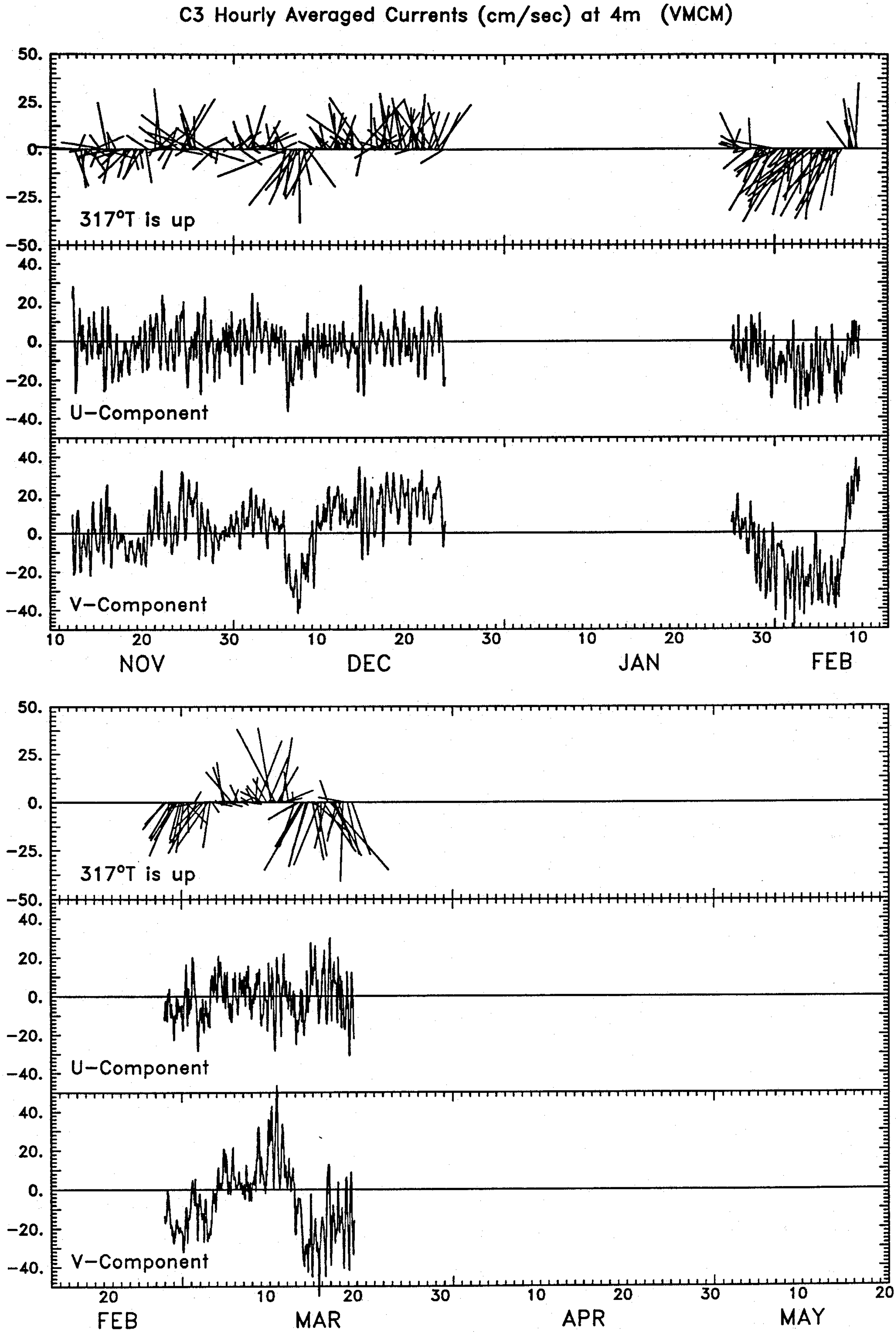

C2 Hourly Averaged Currents (cm/sec) at 52m (ADCP)
317°T is up
U–Component
V–Component
NOV
DEC
JAN
FEB
317°T is up
U–Component
V–Component
FEB
MAR
APR
MAY

Figure 57



C3 Hourly Averaged Currents (cm/sec) at 4m (VMCM)
317°T is up
U−Component
V−Component
NOV
DEC
JAN
FEB
MAR
APR
MAY

Figure 58

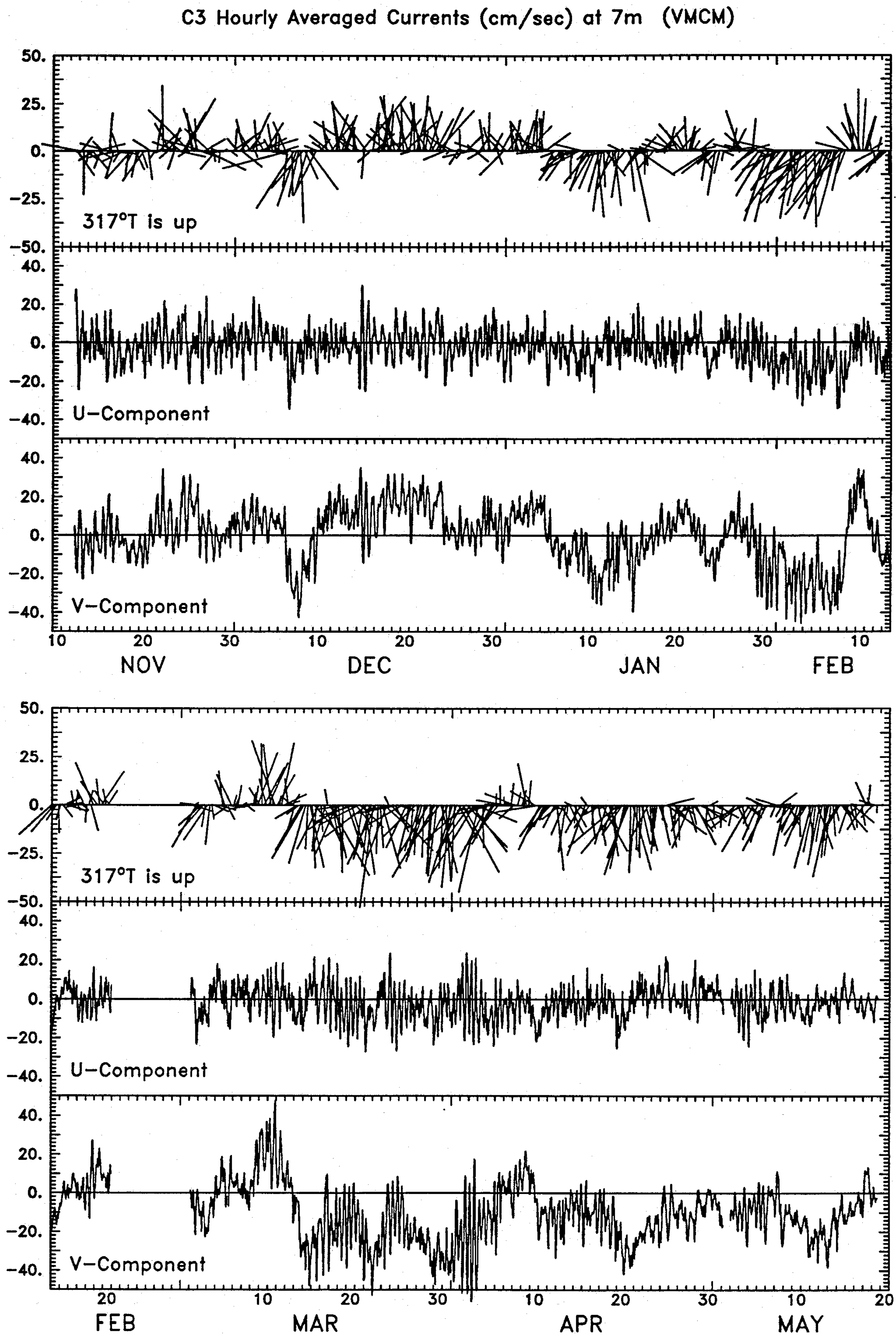

C3 Hourly Averaged Currents (cm/sec) at 7m (VMCM)
50.
25.
0.
-25.
-50.
317°T is up
40.
20.
0.
-20.
-40.
U-Component
V-Component
10 20 30 10 20 30 10 20 30 10
NOV
DEC
JAN
FEB
317°T is up
U-Component
V-Component
20 10 20 30 10 20 30 10 20
FEB
MAR
APR
MAY

Figure 59

C3 Hourly Averaged Currents (cm/sec) at 10m (VMCM)

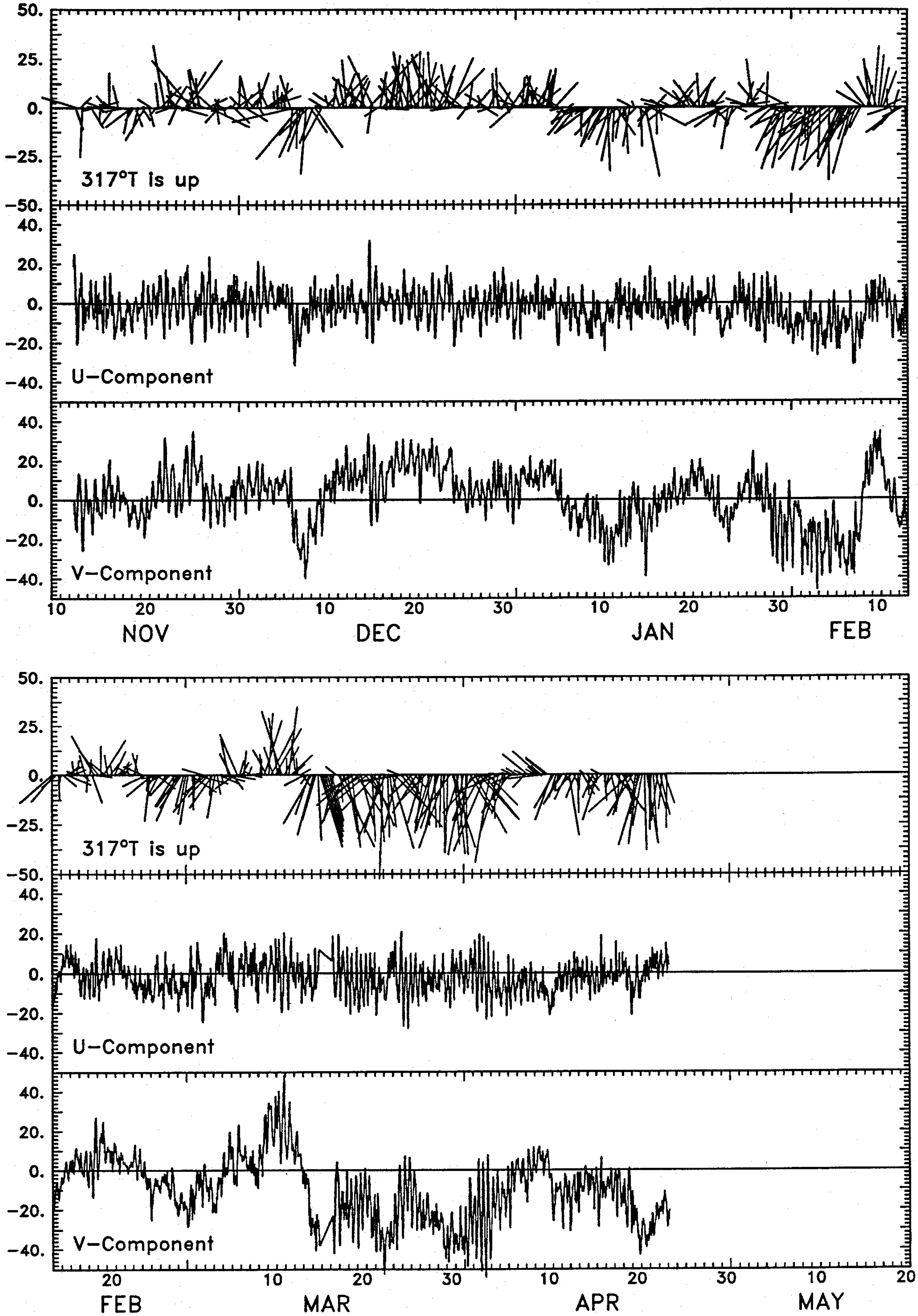


Figure 60

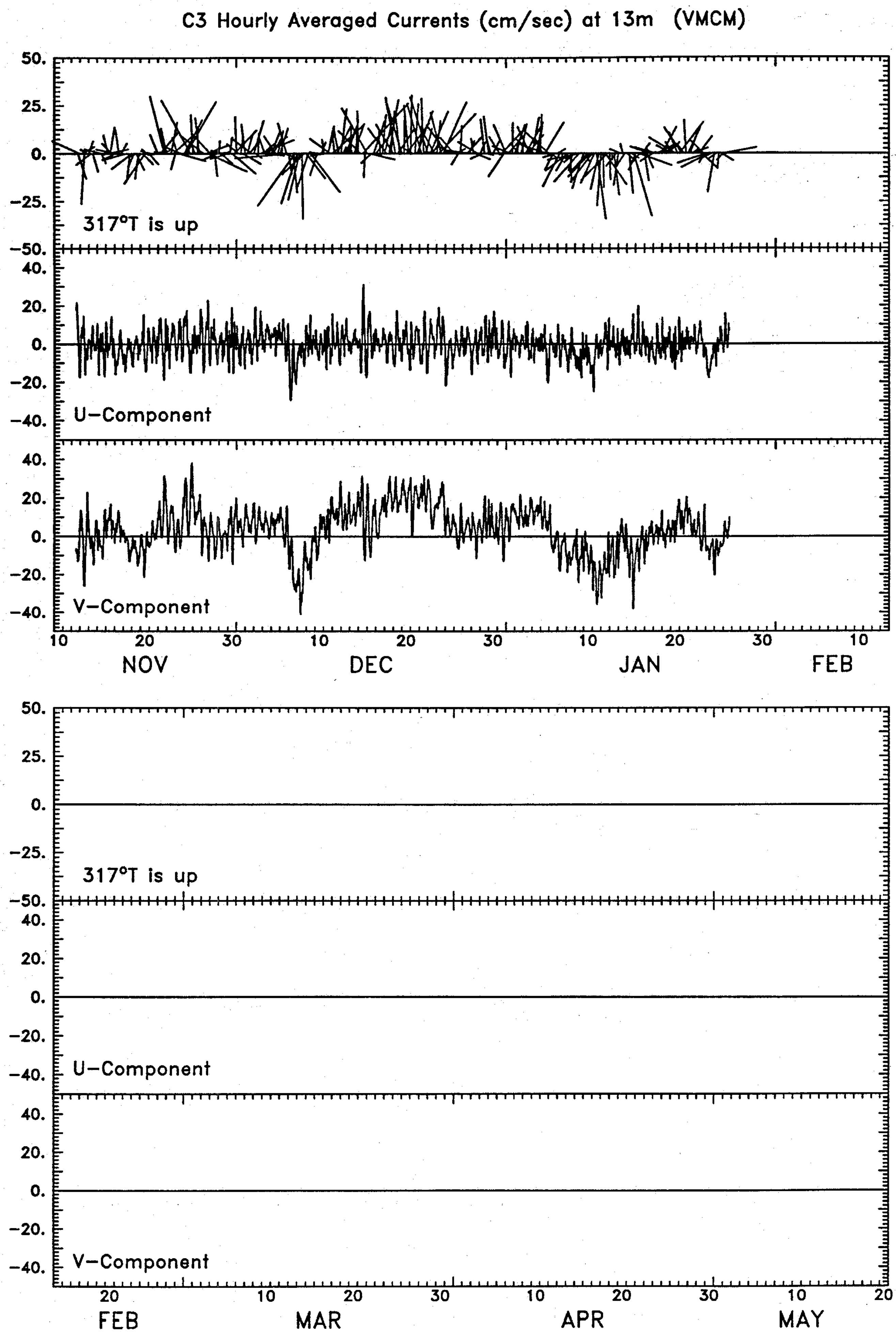

C3 Hourly Averaged Currents (cm/sec) at 13m (VMCM)
317°T is up
U–Component
V–Component
NOV
DEC
JAN
FEB
317°T is up
U–Component
V–Component
FEB
MAR
APR
MAY

Figure 61

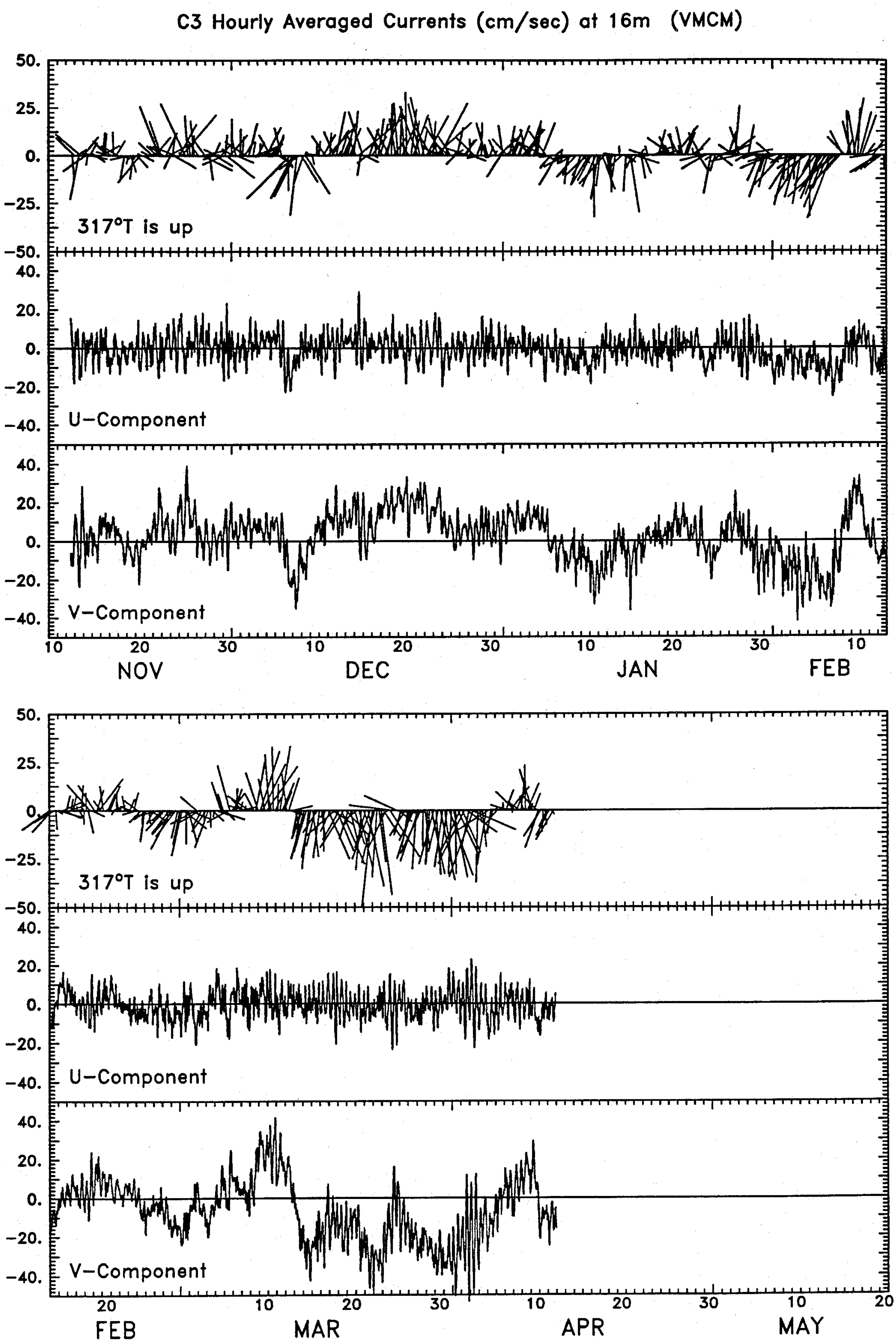

C3 Hourly Averaged Currents (cm/sec) at 16m (VMCM)
317°T is up
U-Component
V-Component
NOV
DEC
JAN
FEB
MAR
APR
MAY

Figure 62

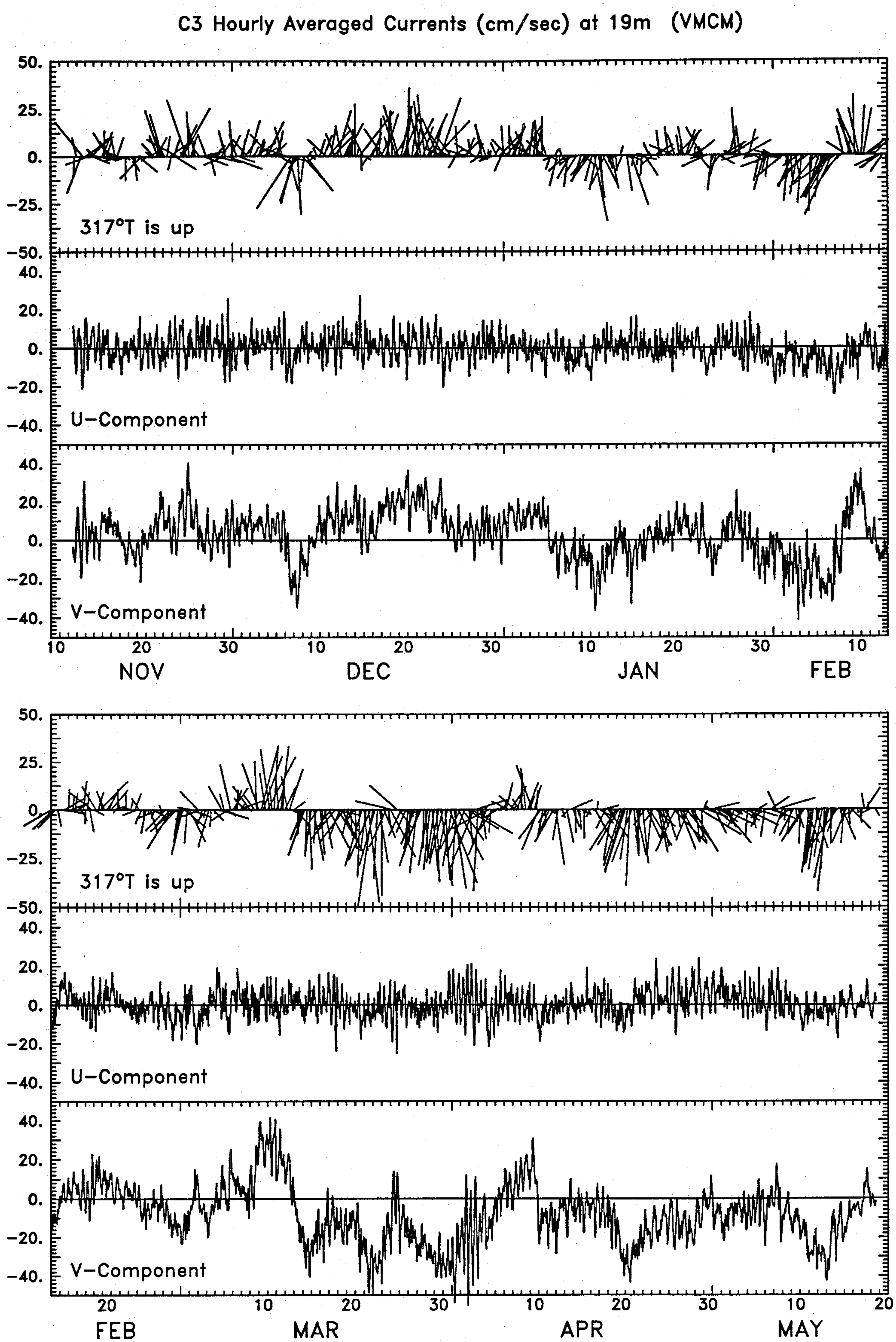

C3 Hourly Averaged Currents (cm/sec) at 19m (VMCM)
317°T is up
U-Component
V-Component
NOV
DEC
JAN
FEB
317°T is up
U-Component
V-Component
FEB
MAR
APR
MAY

Figure 63

C3 Hourly Averaged Currents (cm/sec) at 22m (VMCM)

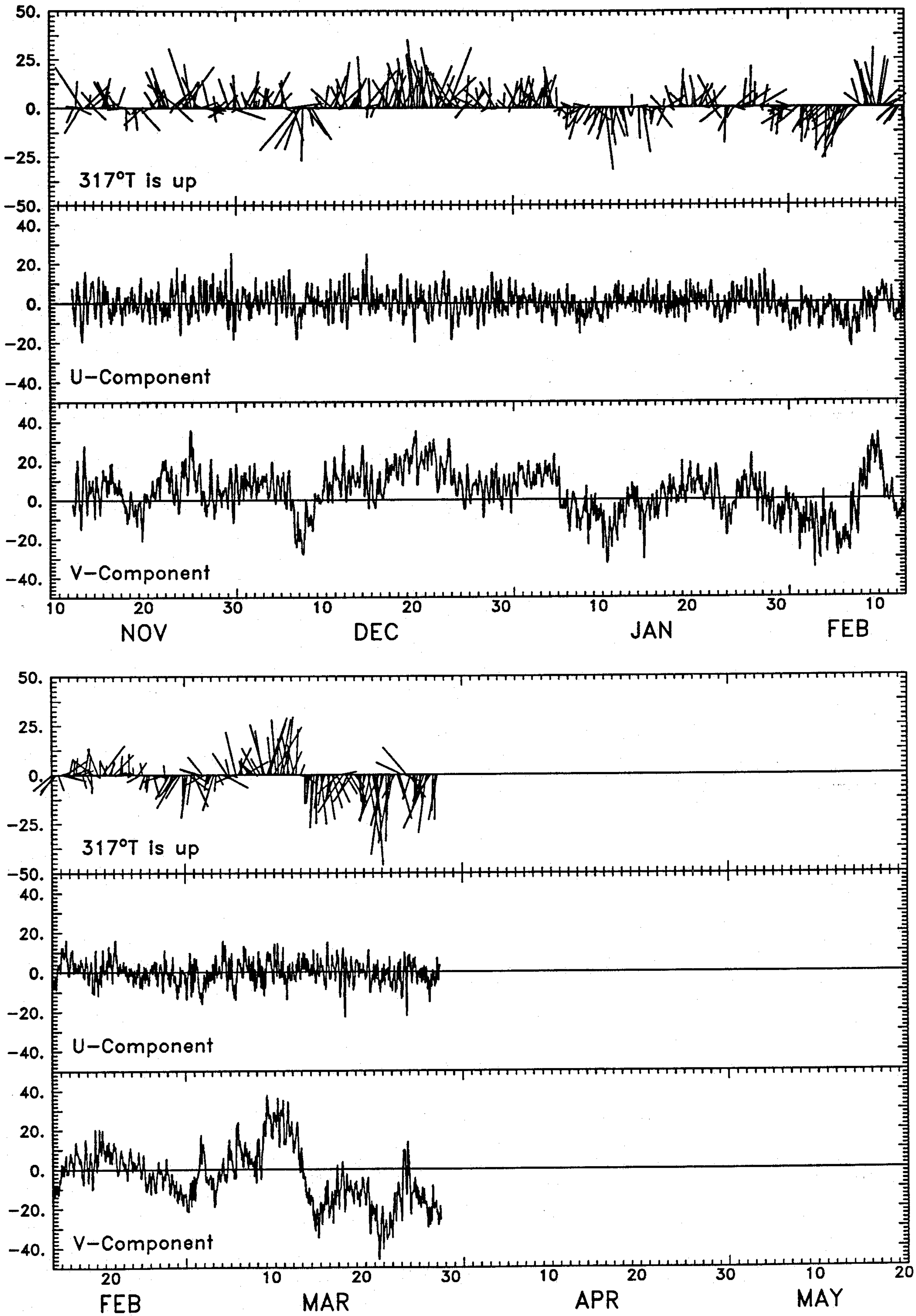
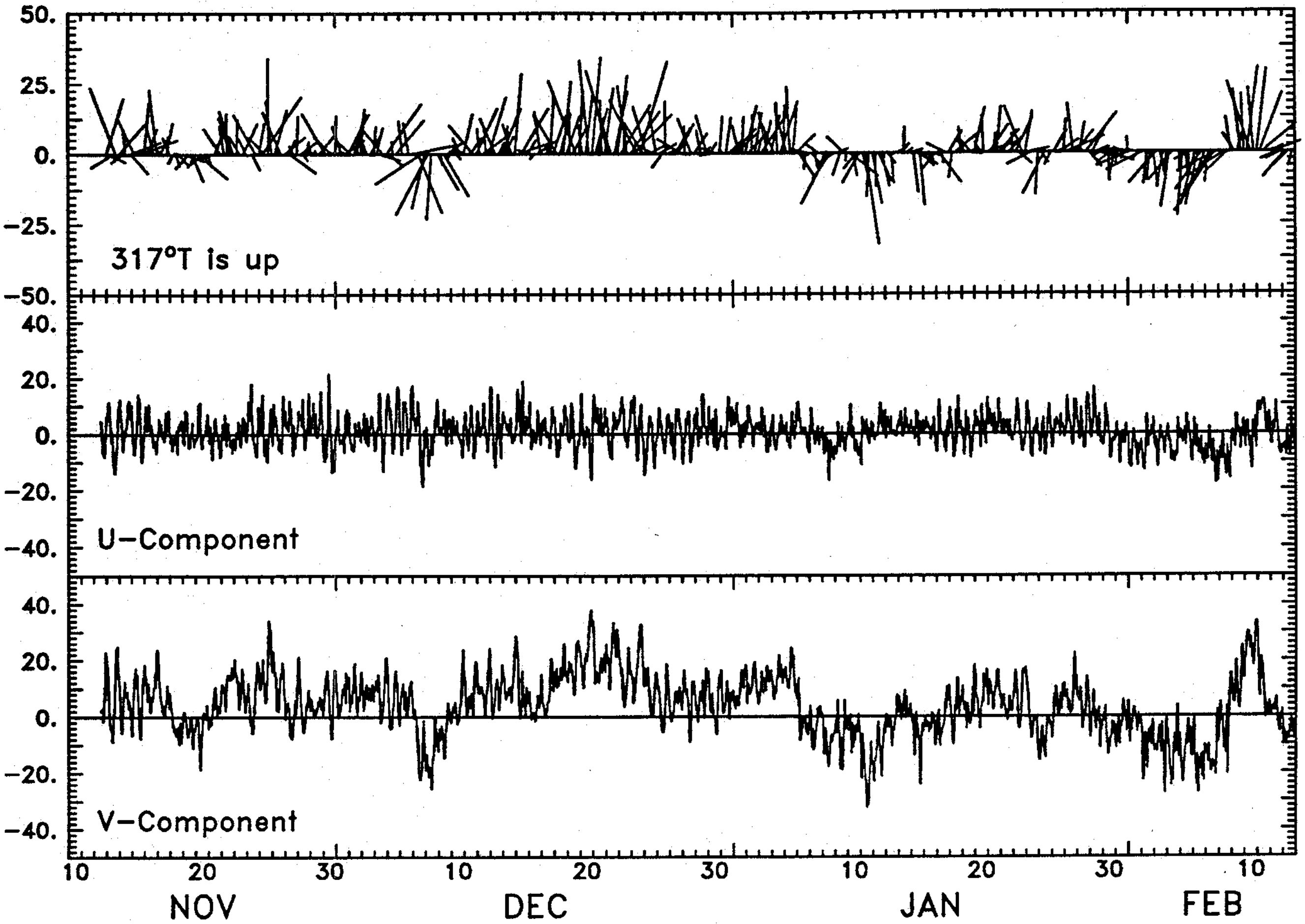


Figure 64

C3 Hourly Averaged Currents (cm/sec) at 27m (VMCM)



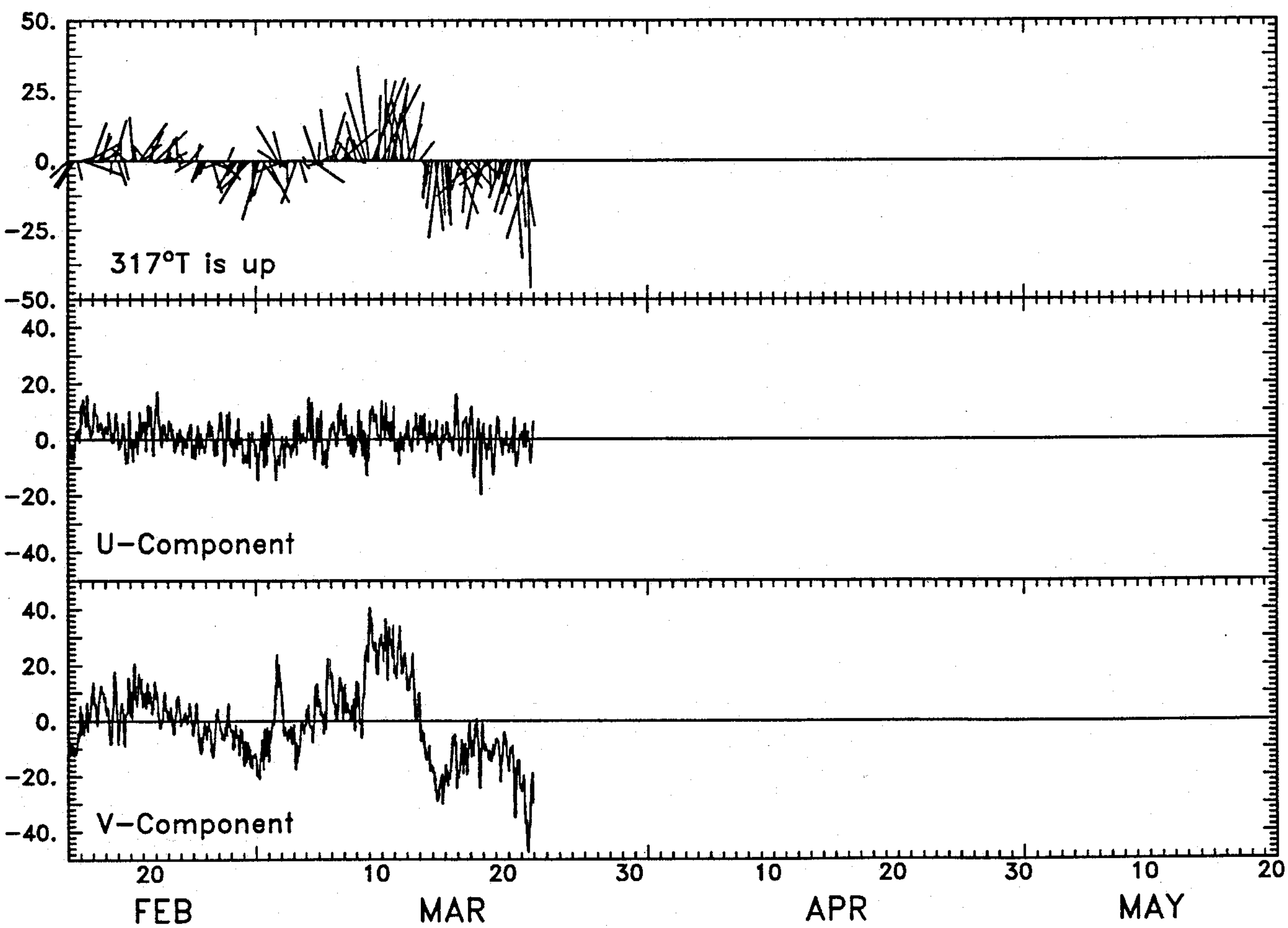


Figure 65

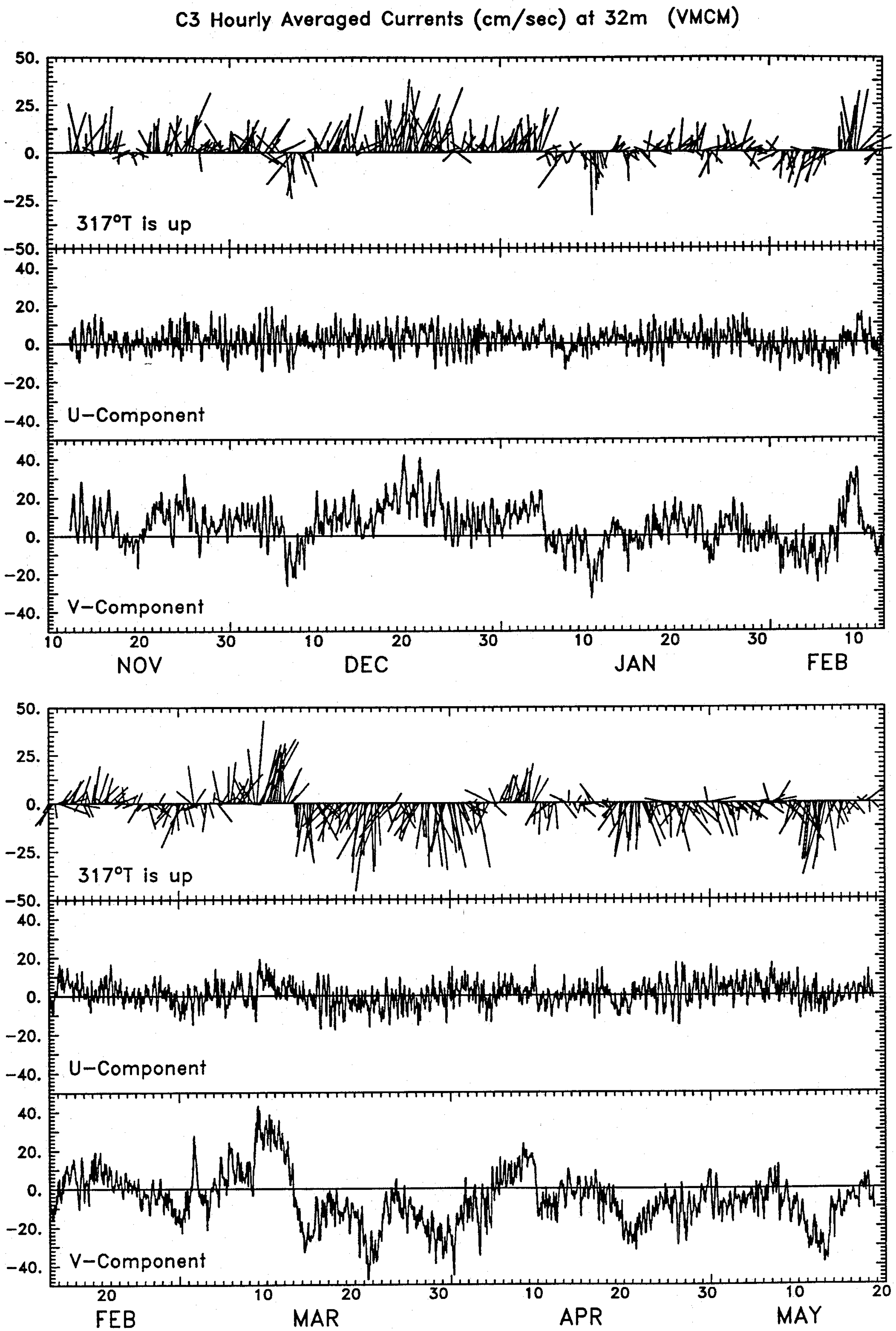

C3 Hourly Averaged Currents (cm/sec) at 32m (VMCM)
50.
25.
0.
-25.
-50.
317°T is up
40.
20.
0.
-20.
-40.
U-Component
40.
20.
0.
-20.
-40.
V-Component
10 20 30 10 20 30 10 20 30 10
NOV DEC JAN FEB
50.
25.
0.
-25.
-50.
317°T is up
40.
20.
0.
-20.
-40.
U-Component
40.
20.
0.
-20.
-40.
V-Component
20 10 20 30 10 20 30 10 20
FEB MAR APR MAY

Figure 66

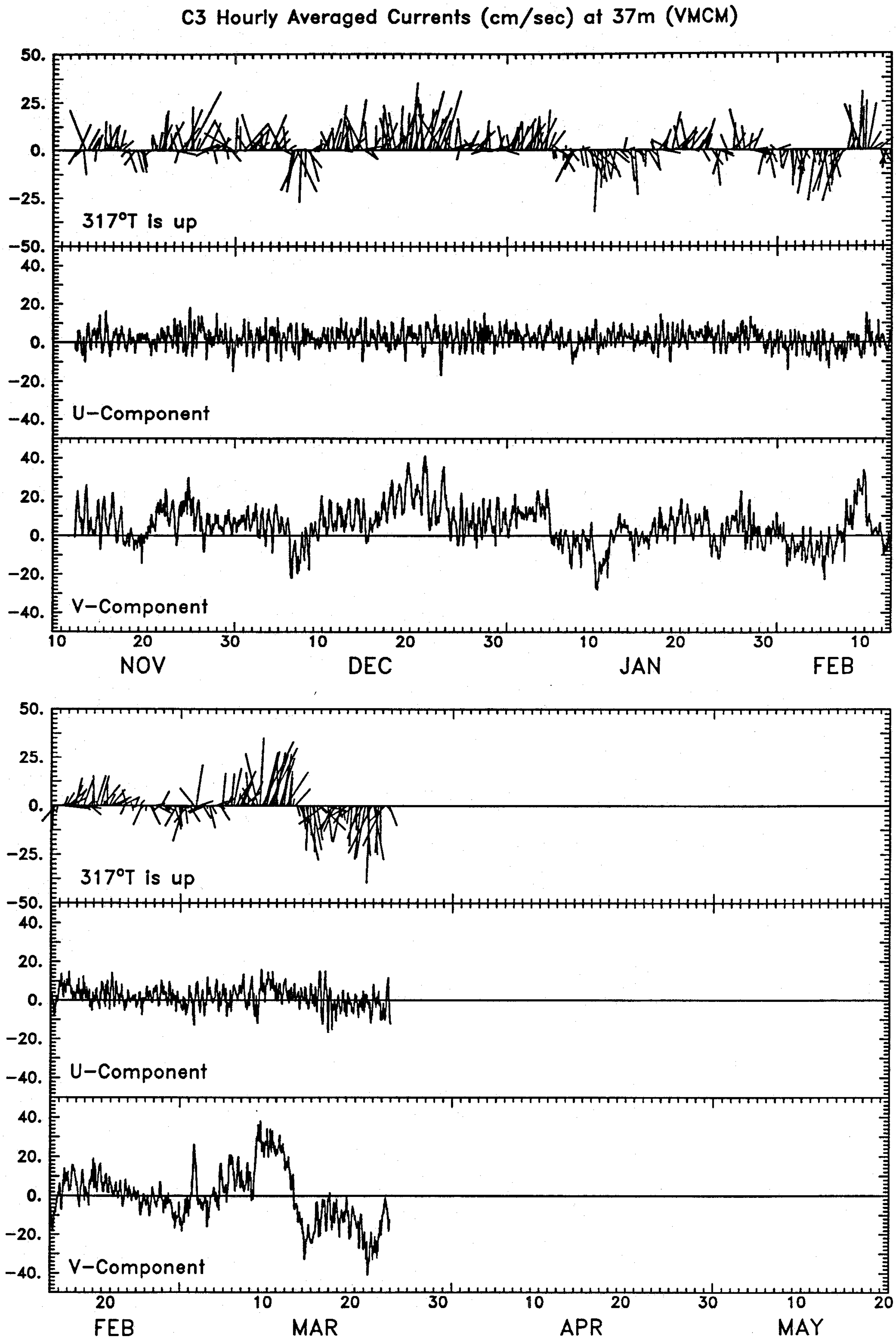

C3 Hourly Averaged Currents (cm/sec) at 37m (VMCM)
50.
25.
0.
-25.
-50.
317°T is up
40.
20.
0.
-20.
-40.
U-Component
40.
20.
0.
-20.
-40.
V-Component
10
20
30
10
20
30
10
20
30
10
NOV
DEC
JAN
FEB
50.
25.
0.
-25.
-50.
317°T is up
40.
20.
0.
-20.
-40.
U-Component
40.
20.
0.
-20.
-40.
V-Component
20
10
20
30
10
20
30
10
20
FEB
MAR
APR
MAY

Figure 67

C3 Hourly Averaged Currents (cm/sec) at 42m (VMCM)

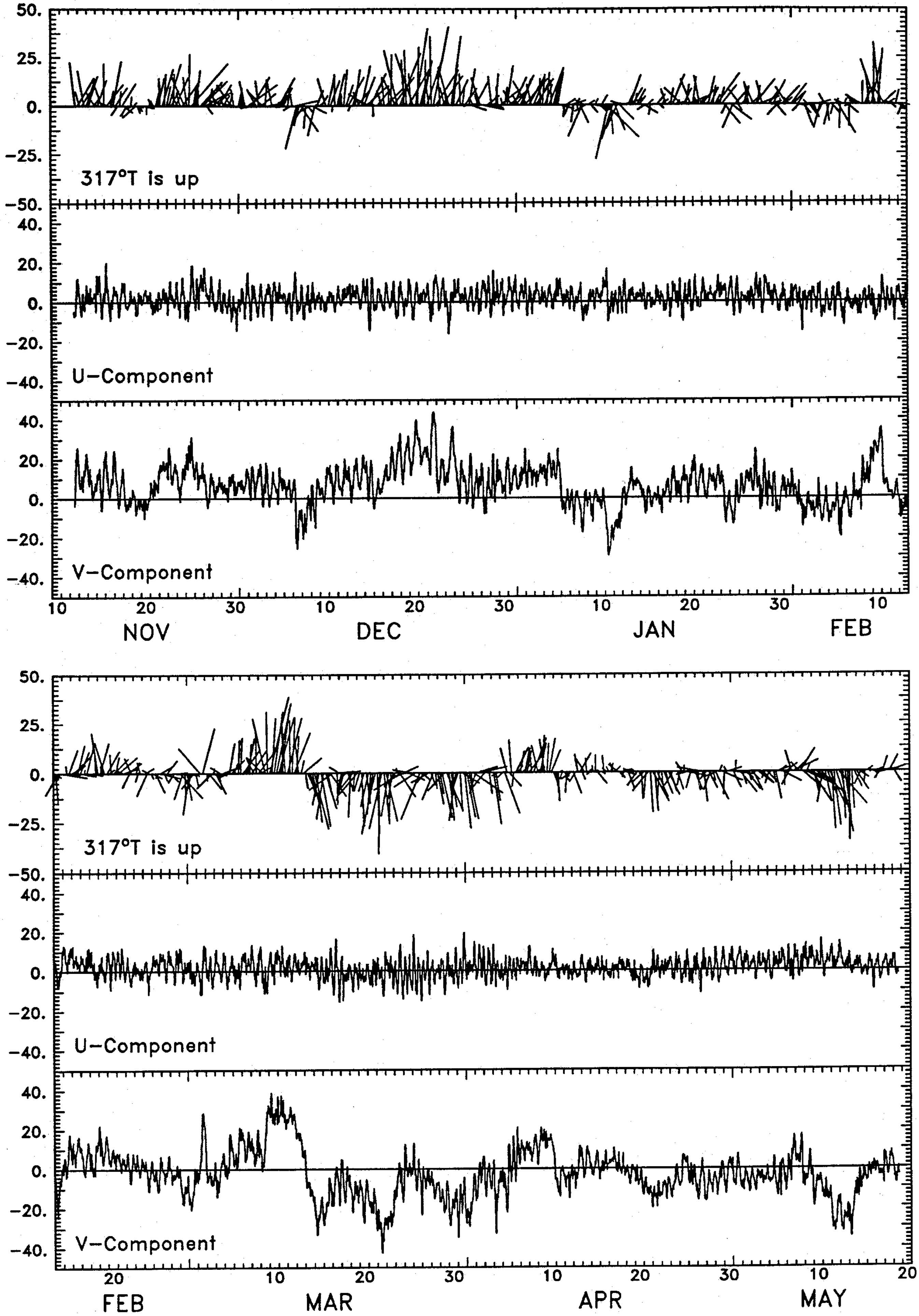


Figure 68

C3 Hourly Averaged Currents (cm/sec) at 47m (VMCM)

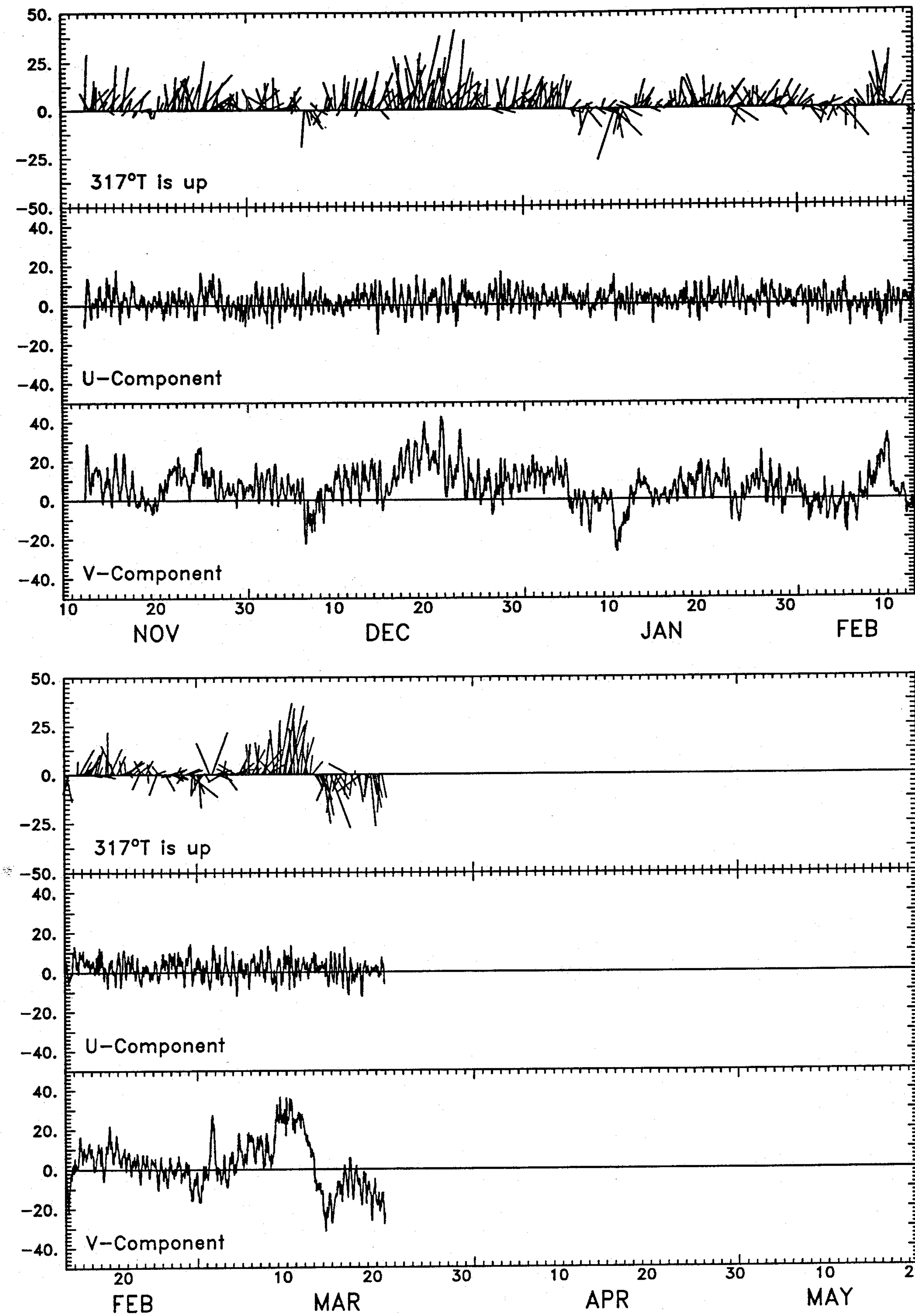


Figure 69

C3 Hourly Averaged Currents (cm/sec) at 65m (VACM)

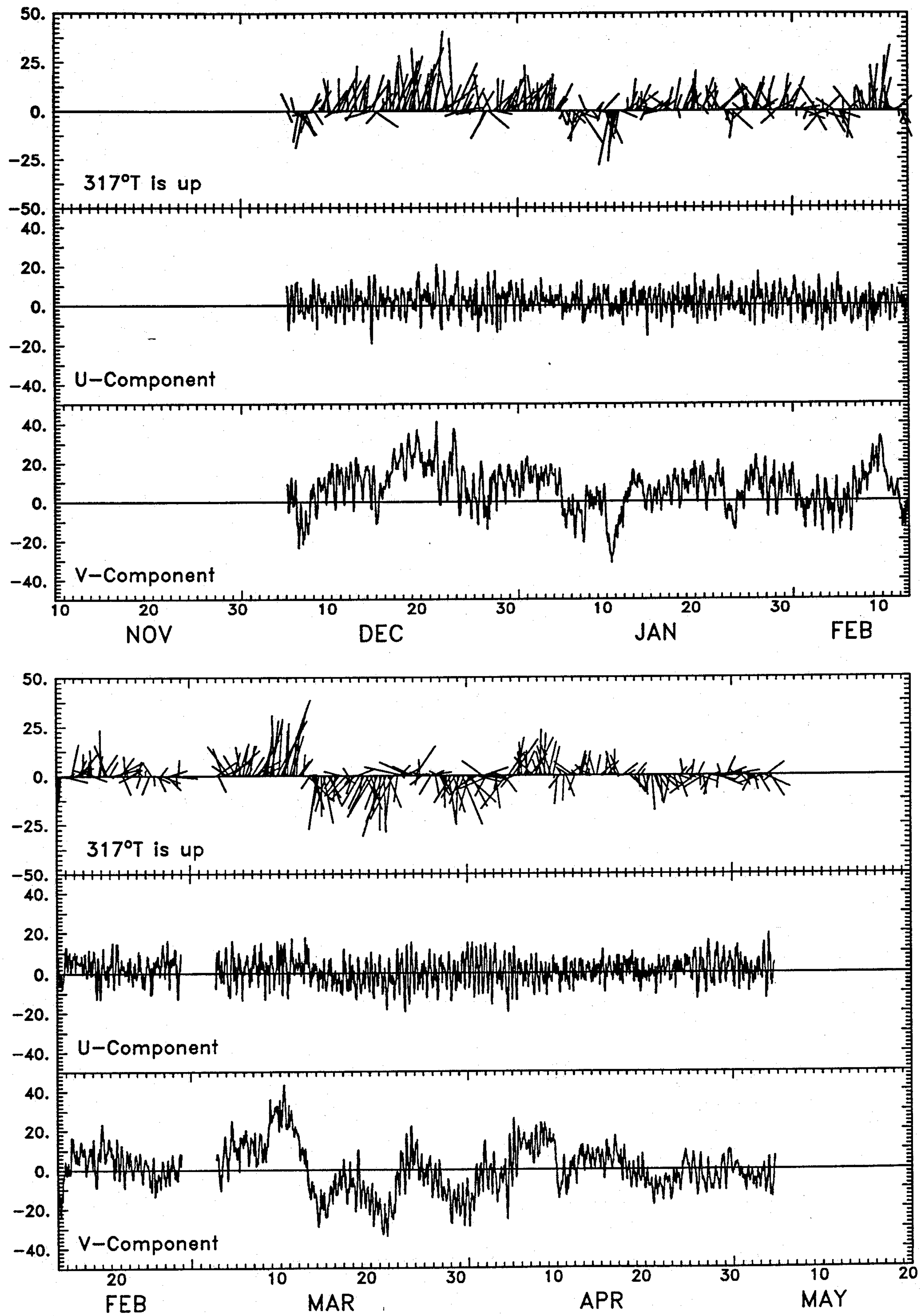


Figure 70

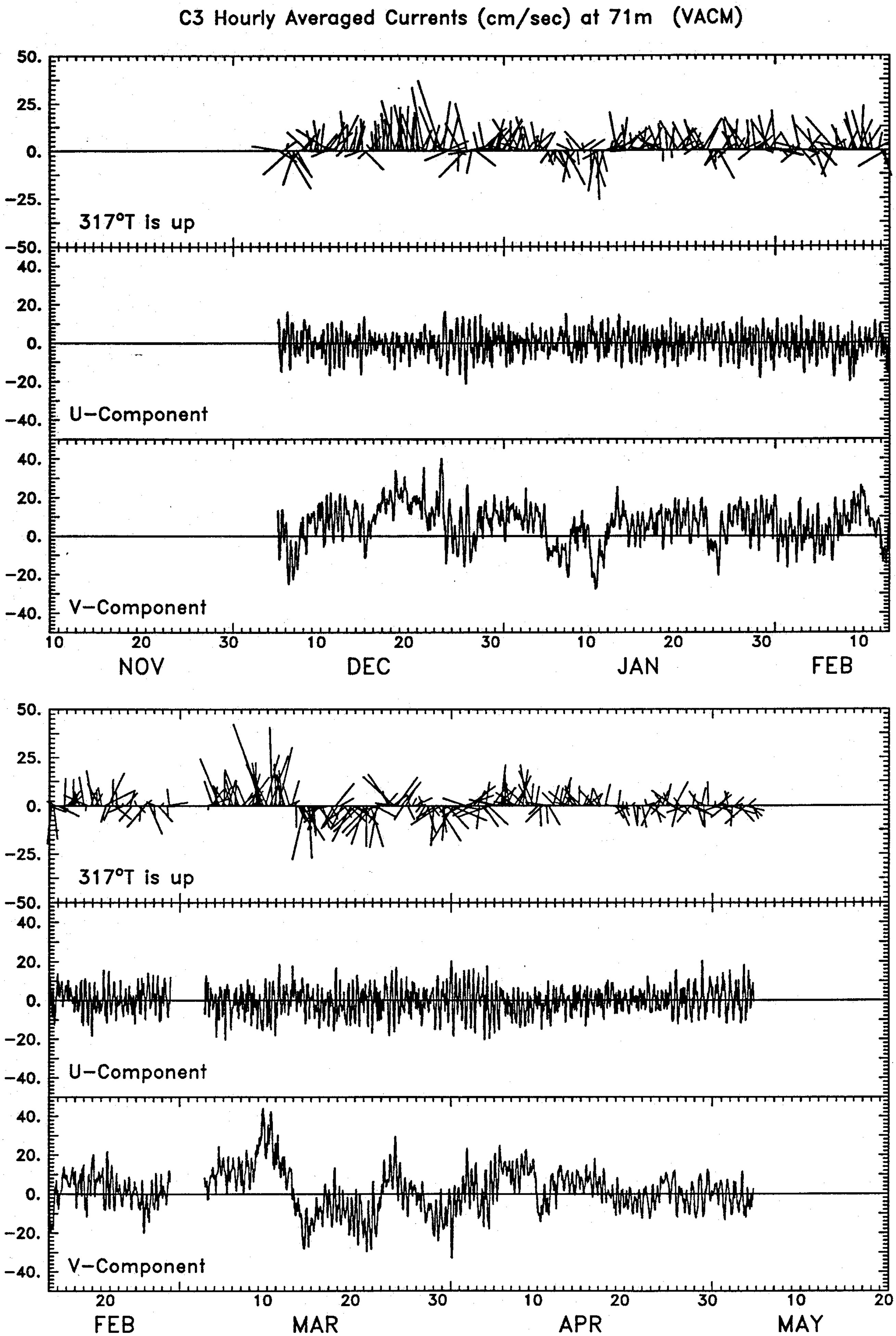
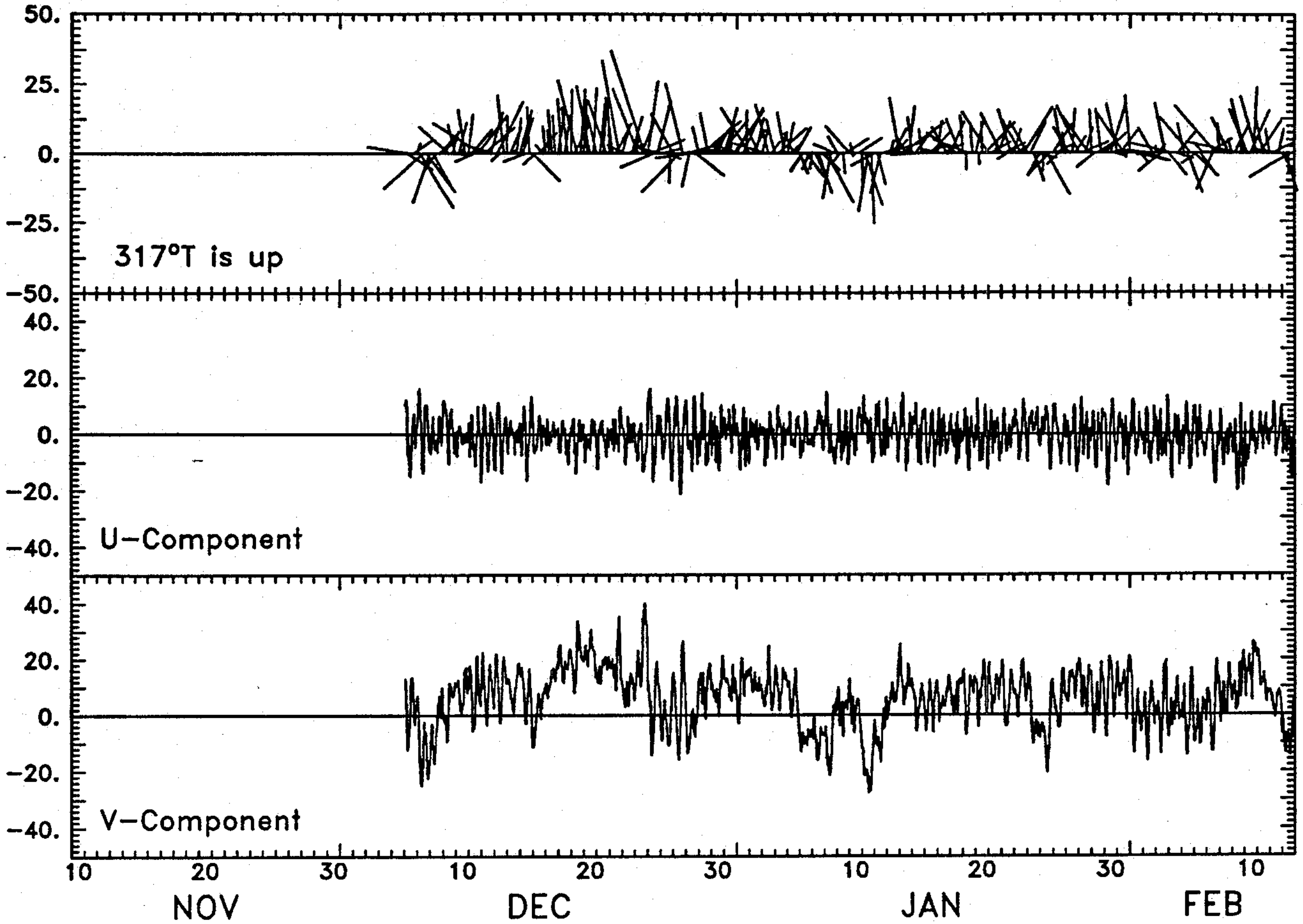

C3 Hourly Averaged Currents (cm/sec) at 71m (VACM)
317°T is up
U-Component
V-Component
NOV
DEC
JAN
FEB
317°T is up
U-Component
V-Component
FEB
MAR
APR
MAY

Figure 71

C3 Hourly Averaged Currents (cm/sec) at 77m (VACM)



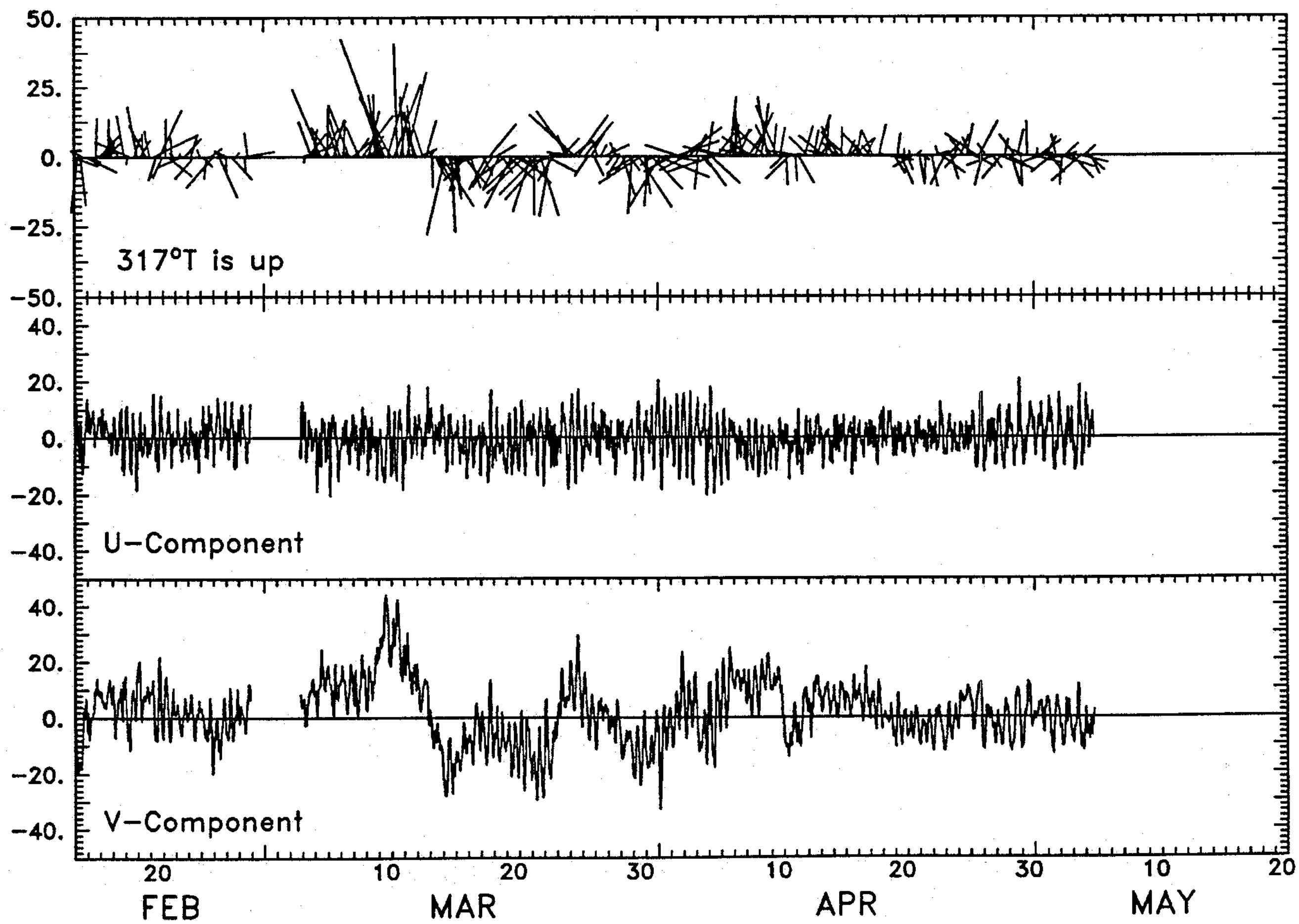
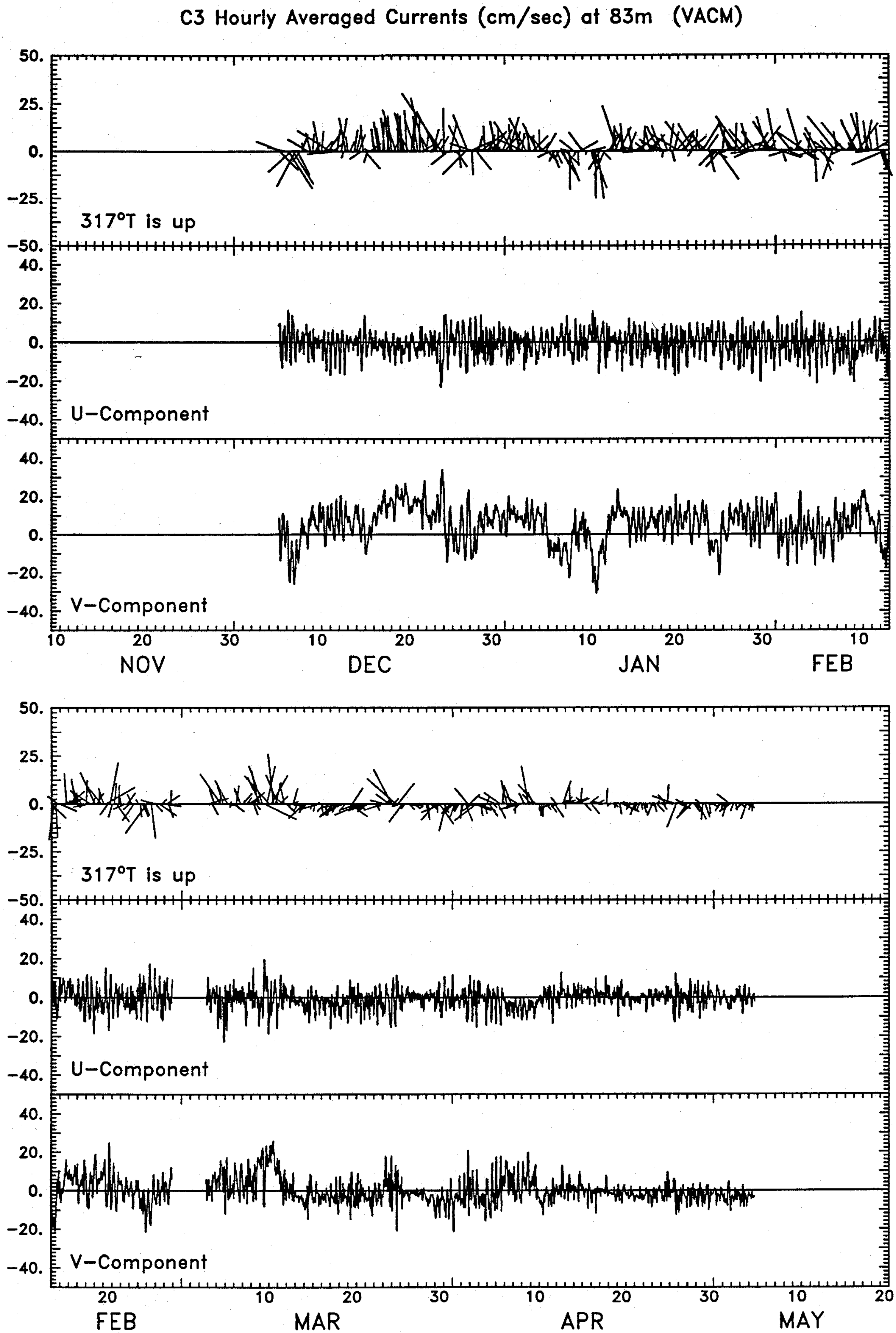


Figure 72



C3 Hourly Averaged Currents (cm/sec) at 83m (VACM)
50.
25.
0.
-25.
-50.
317°T is up
40.
20.
0.
-20.
-40.
U-Component
V-Component
10
20
30
NOV
DEC
JAN
FEB
MAR
APR
MAY

Figure 73

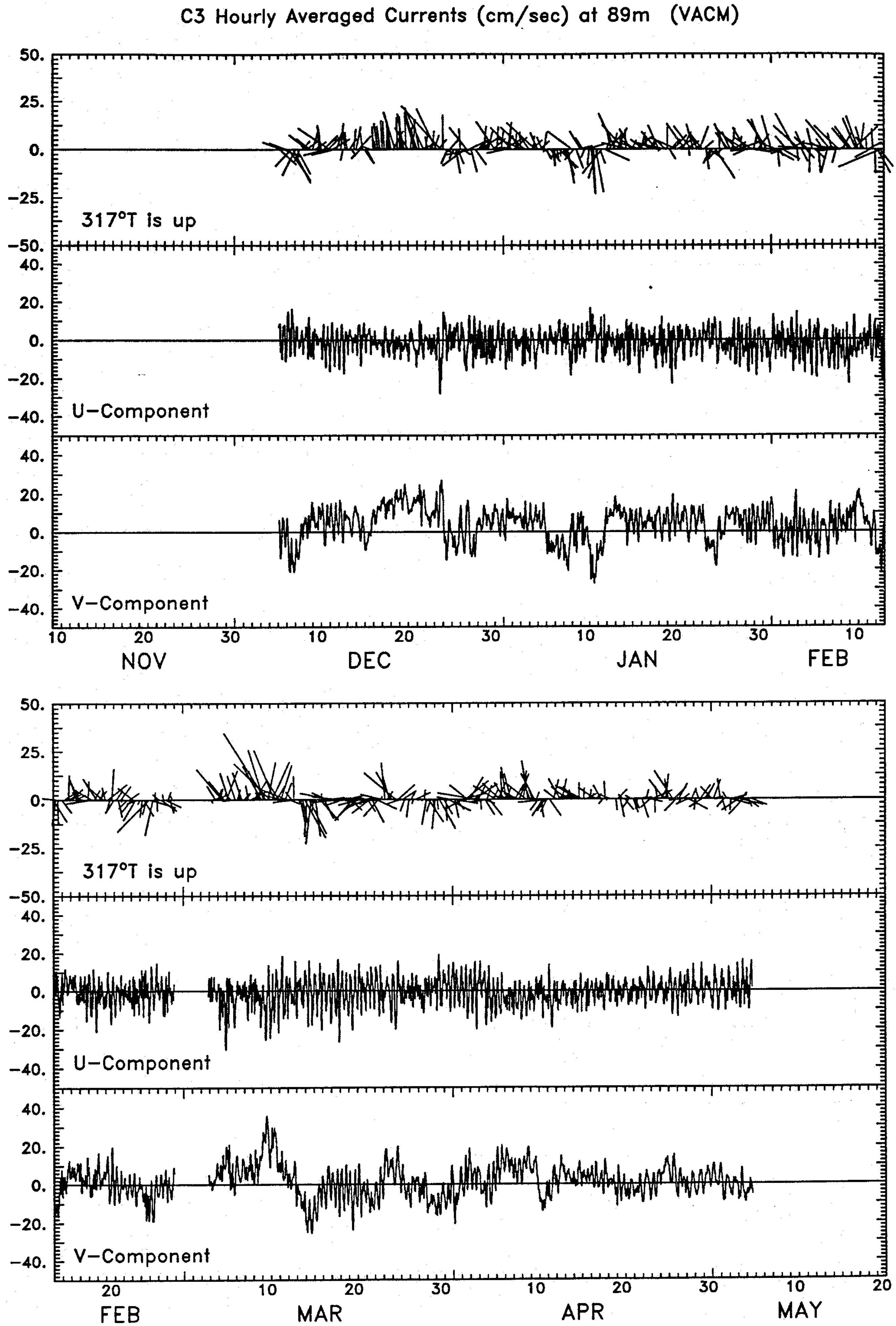

C3 Hourly Averaged Currents (cm/sec) at 89m (VACM)
50.
25.
0.
-25.
-50.
317°T is up
40.
20.
0.
-20.
-40.
U-Component
40.
20.
0.
-20.
-40.
V-Component
10
20
30
10
20
30
10
20
30
10
NOV
DEC
JAN
FEB
50.
25.
0.
-25.
-50.
317°T is up
40.
20.
0.
-20.
-40.
U-Component
40.
20.
0.
-20.
-40.
V-Component
20
10
20
30
10
20
30
10
20
FEB
MAR
APR
MAY

Figure 74

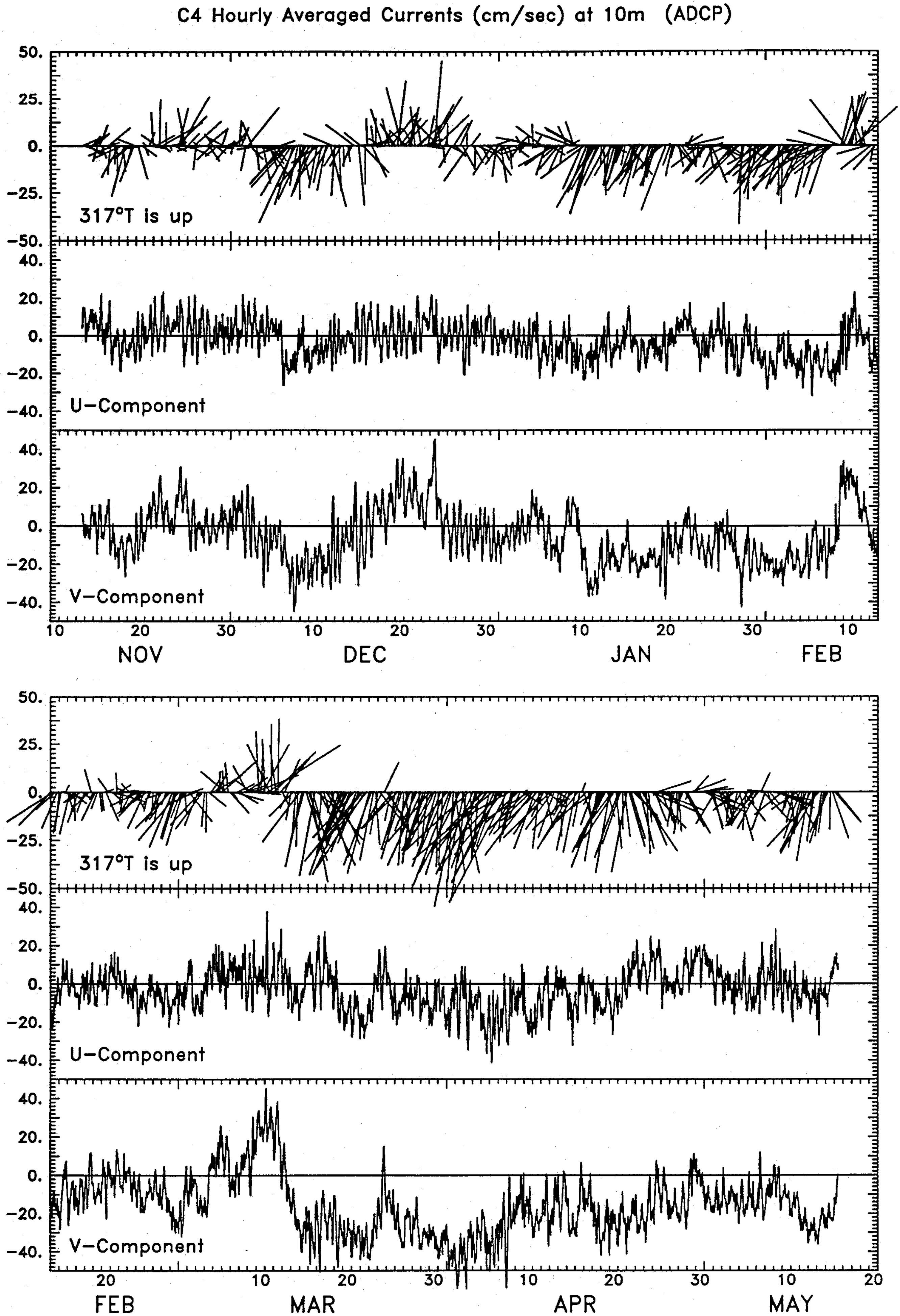

C4 Hourly Averaged Currents (cm/sec) at 10m (ADCP)
317°T is up
U−Component
V−Component
NOV
DEC
JAN
FEB
MAR
APR
MAY

Figure 75

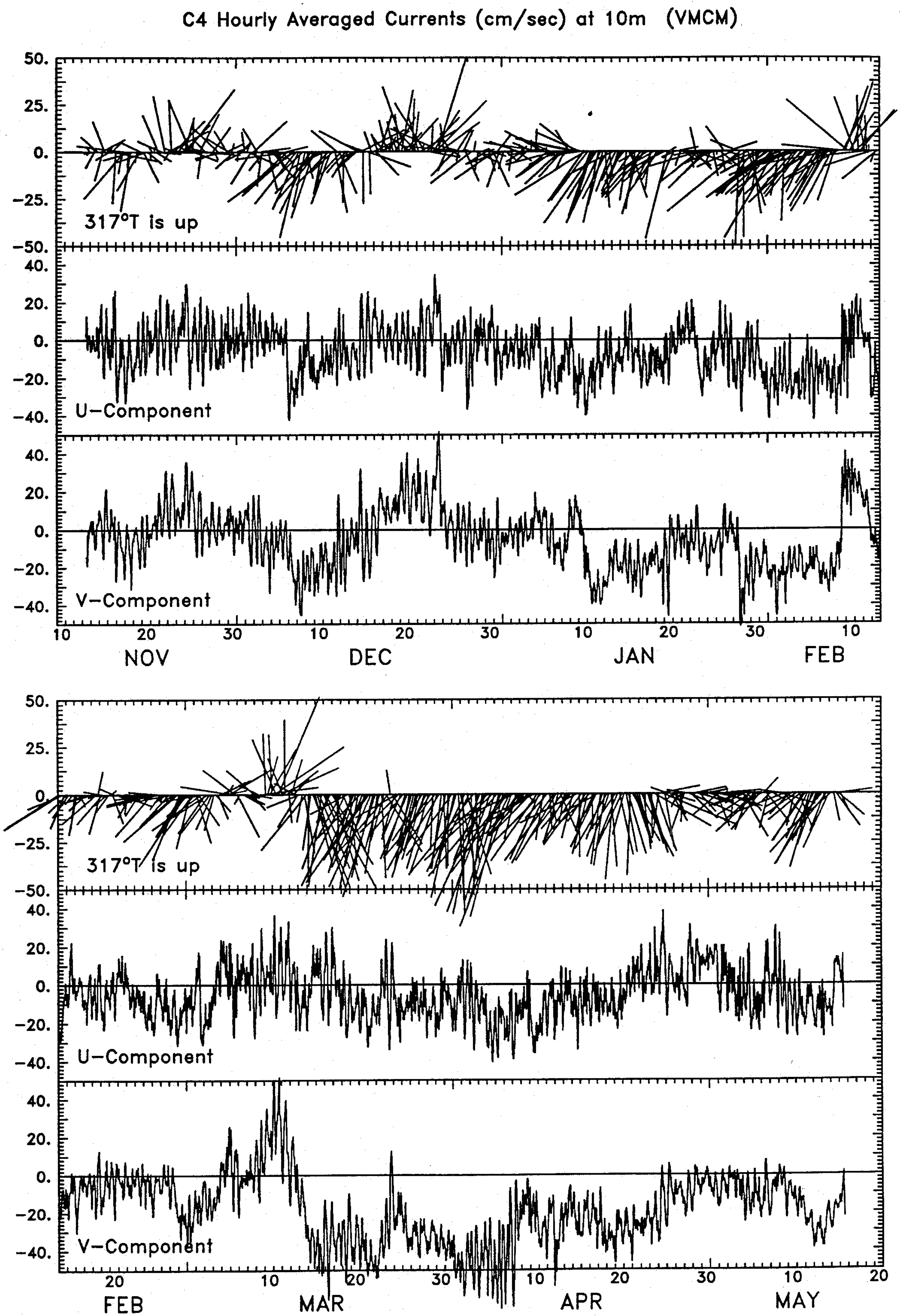
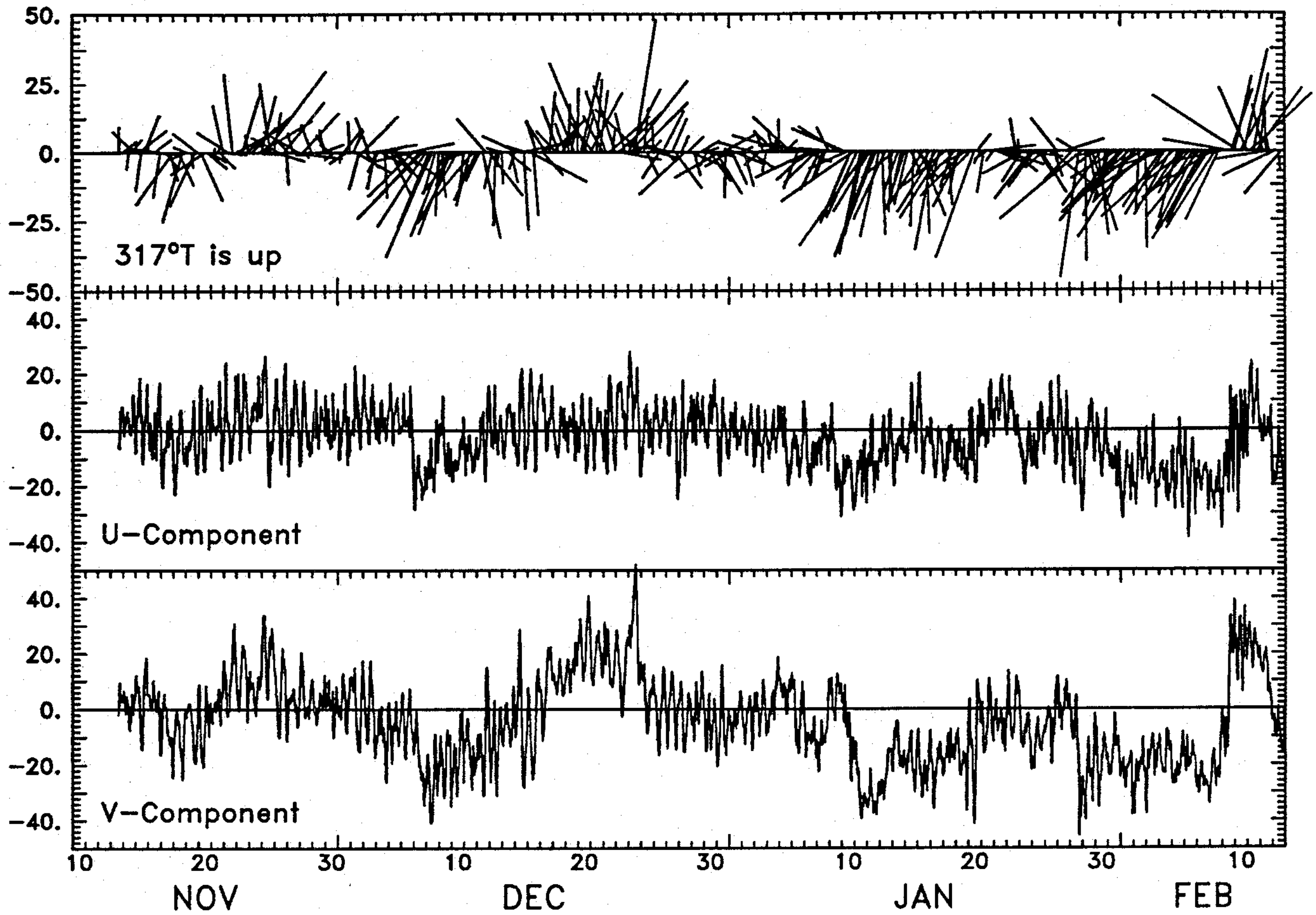

C4 Hourly Averaged Currents (cm/sec) at 10m (VMCM)
317°T is up
U-Component
V-Component
NOV
DEC
JAN
FEB
MAR
APR
MAY

Figure 76

C4 Hourly Averaged Currents (cm/sec) at 16m (ADCP)



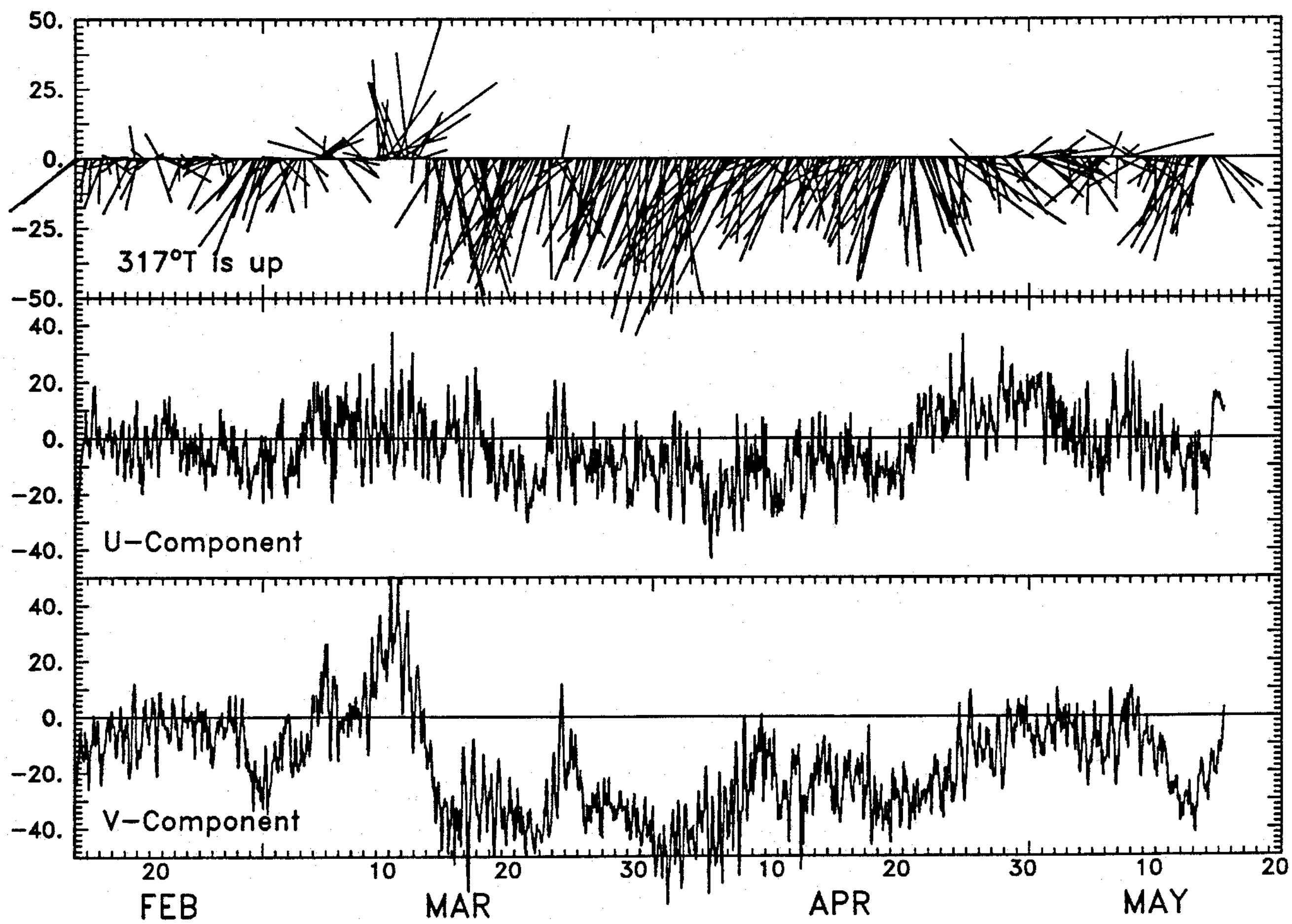
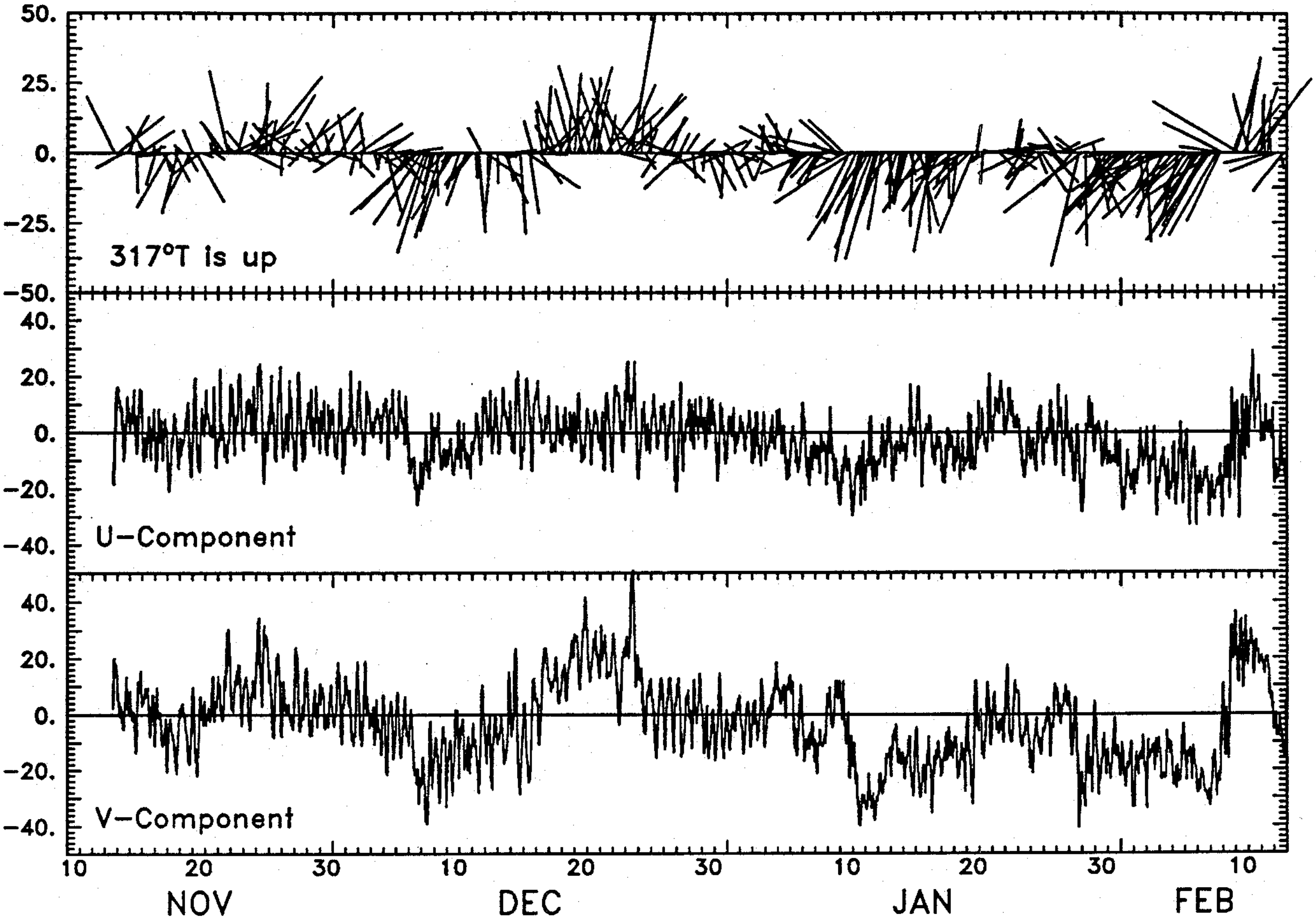


Figure 77

C4 Hourly Averaged Currents (cm/sec) at 22m (ADCP)



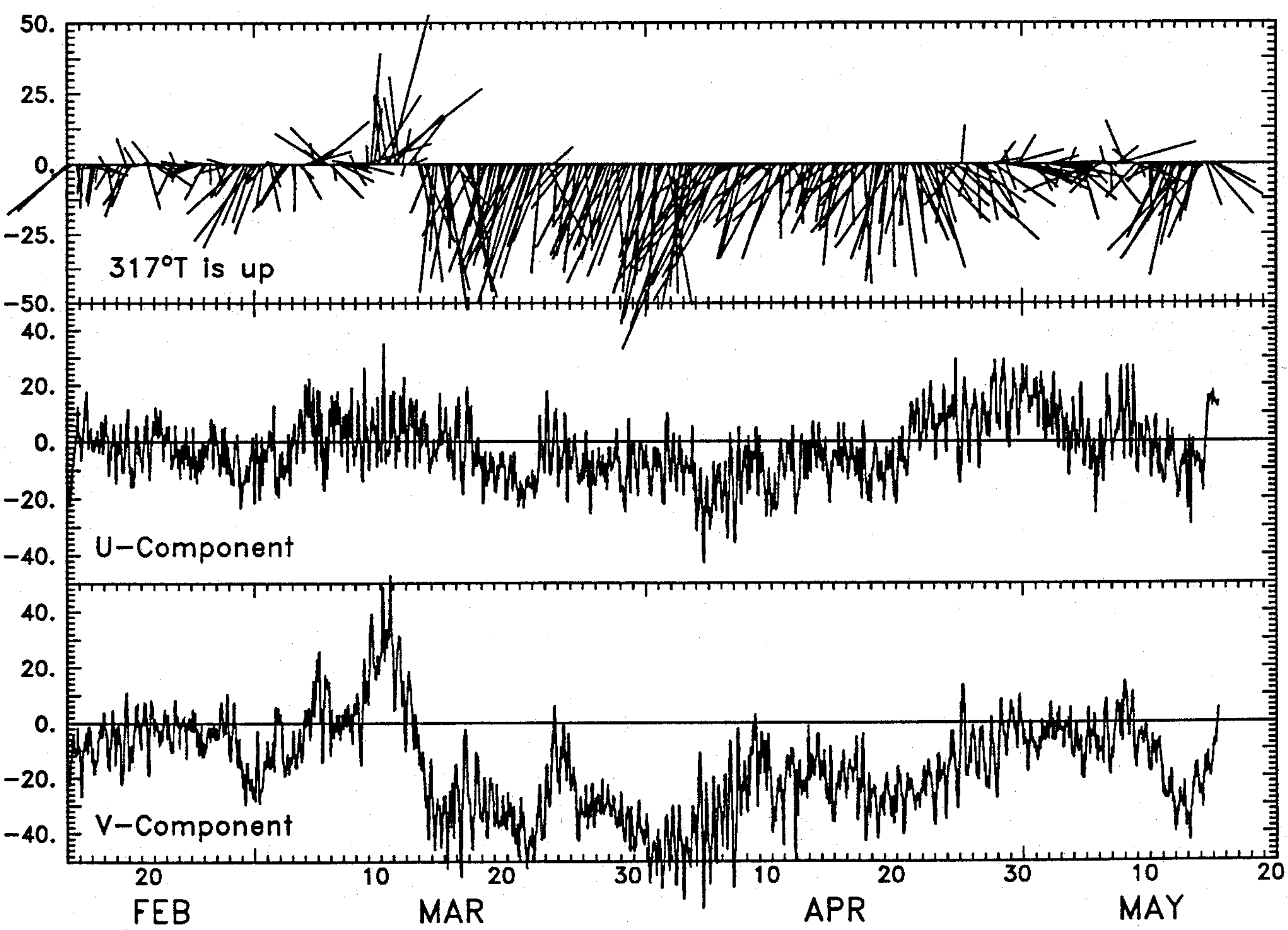


Figure 78

C4 Hourly Averaged Currents (cm/sec) at 28m (ADCP)

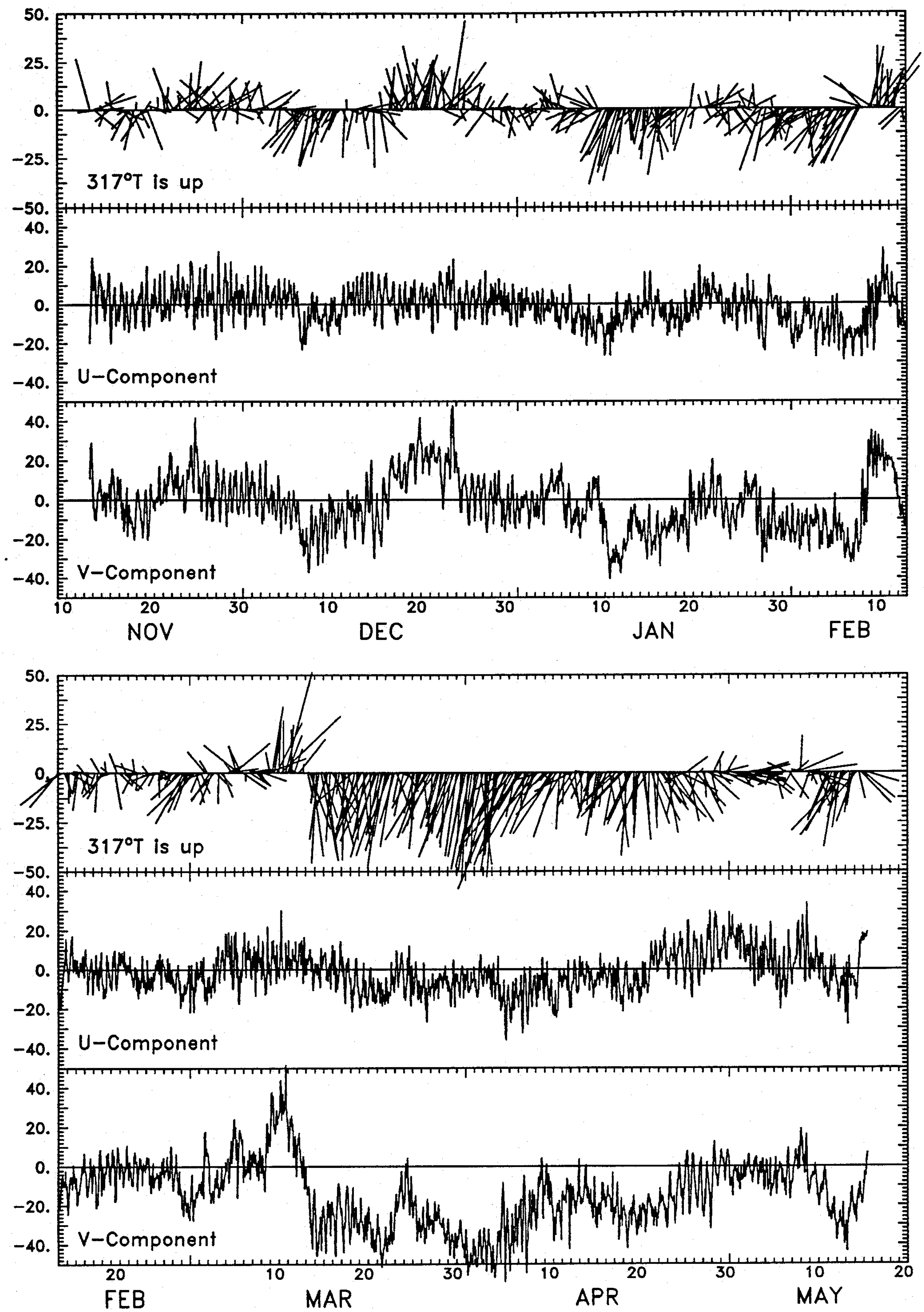


Figure 79

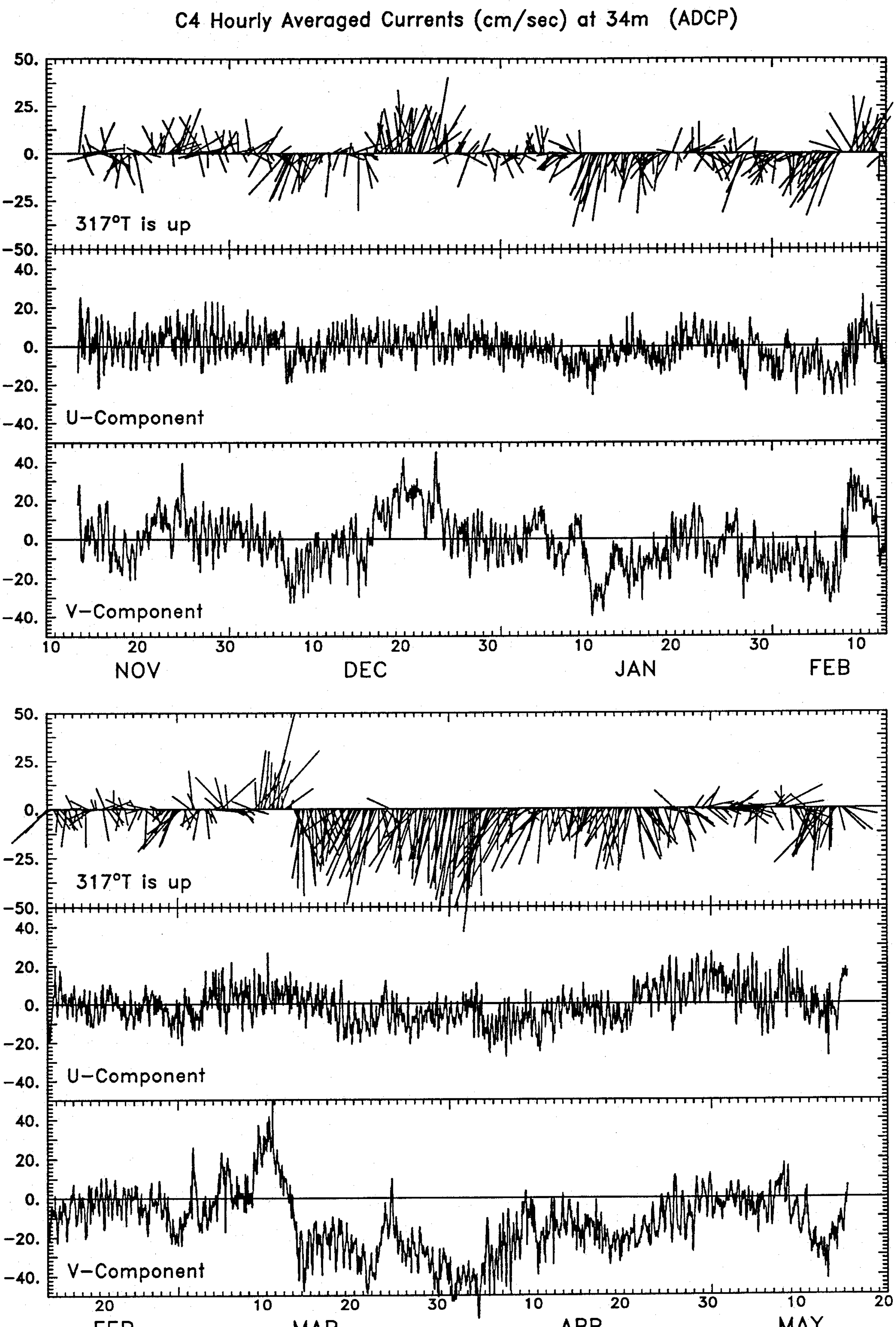
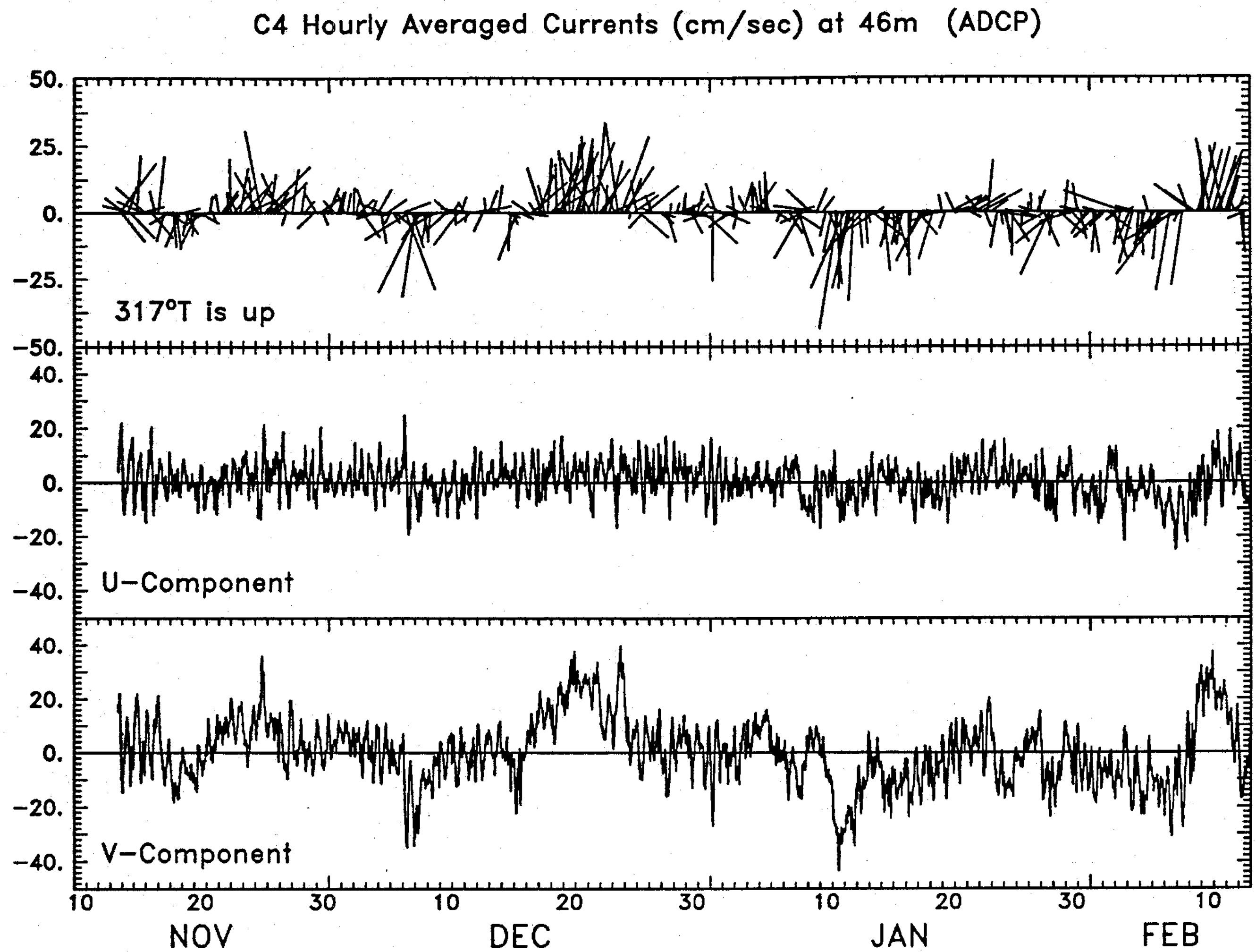

C4 Hourly Averaged Currents (cm/sec) at 34m (ADCP)
317°T is up
U-Component
V-Component
NOV
DEC
JAN
FEB
317°T is up
U-Component
V-Component
FEB
MAR
APR
MAY

Figure 80


C4 Hourly Averaged Currents (cm/sec) at 46m (ADCP)
317°T is up
U-Component
V-Component
NOV
DEC
JAN
FEB

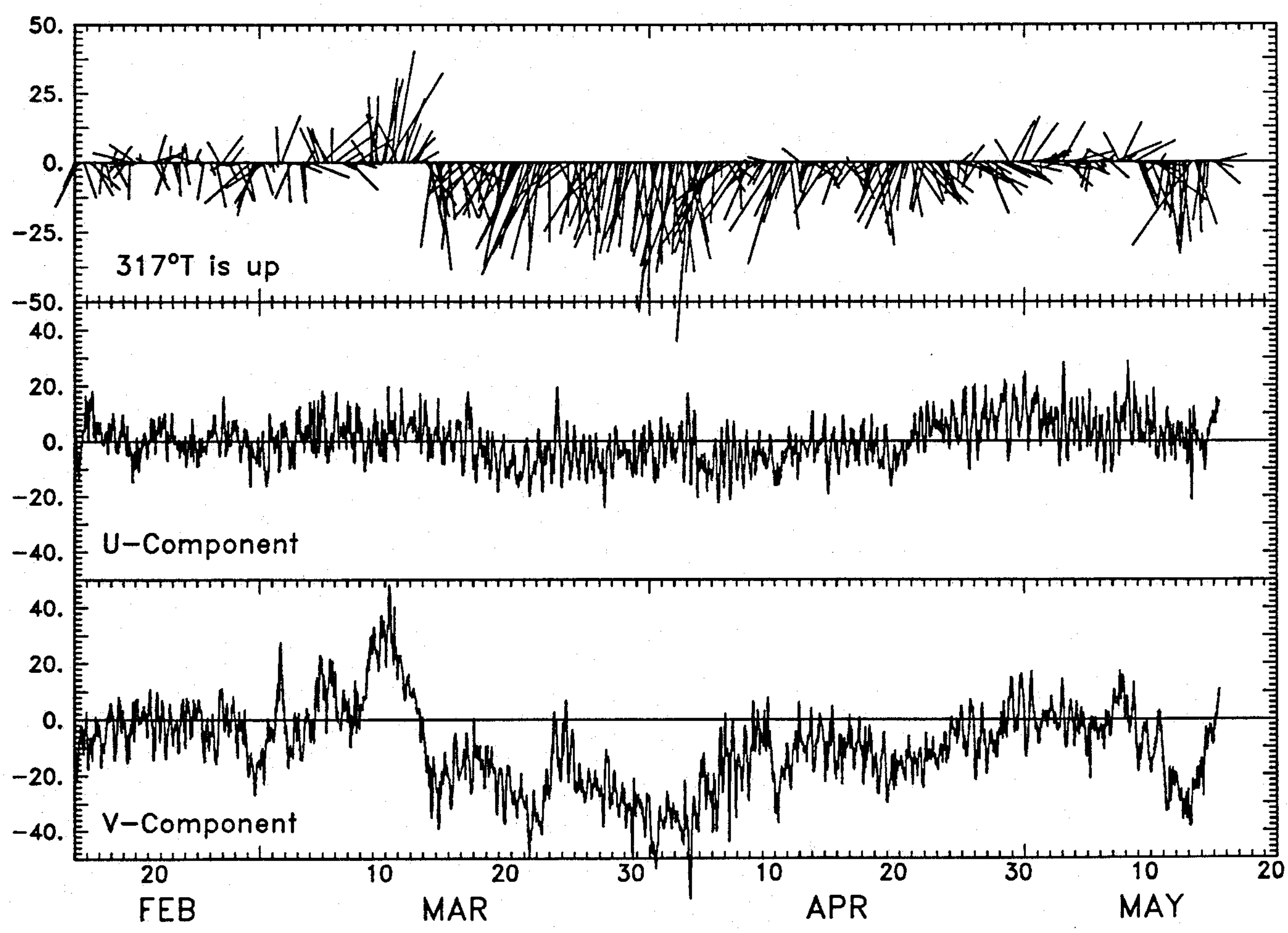

317°T is up
U-Component
V-Component
FEB
MAR
APR
MAY

Figure 81

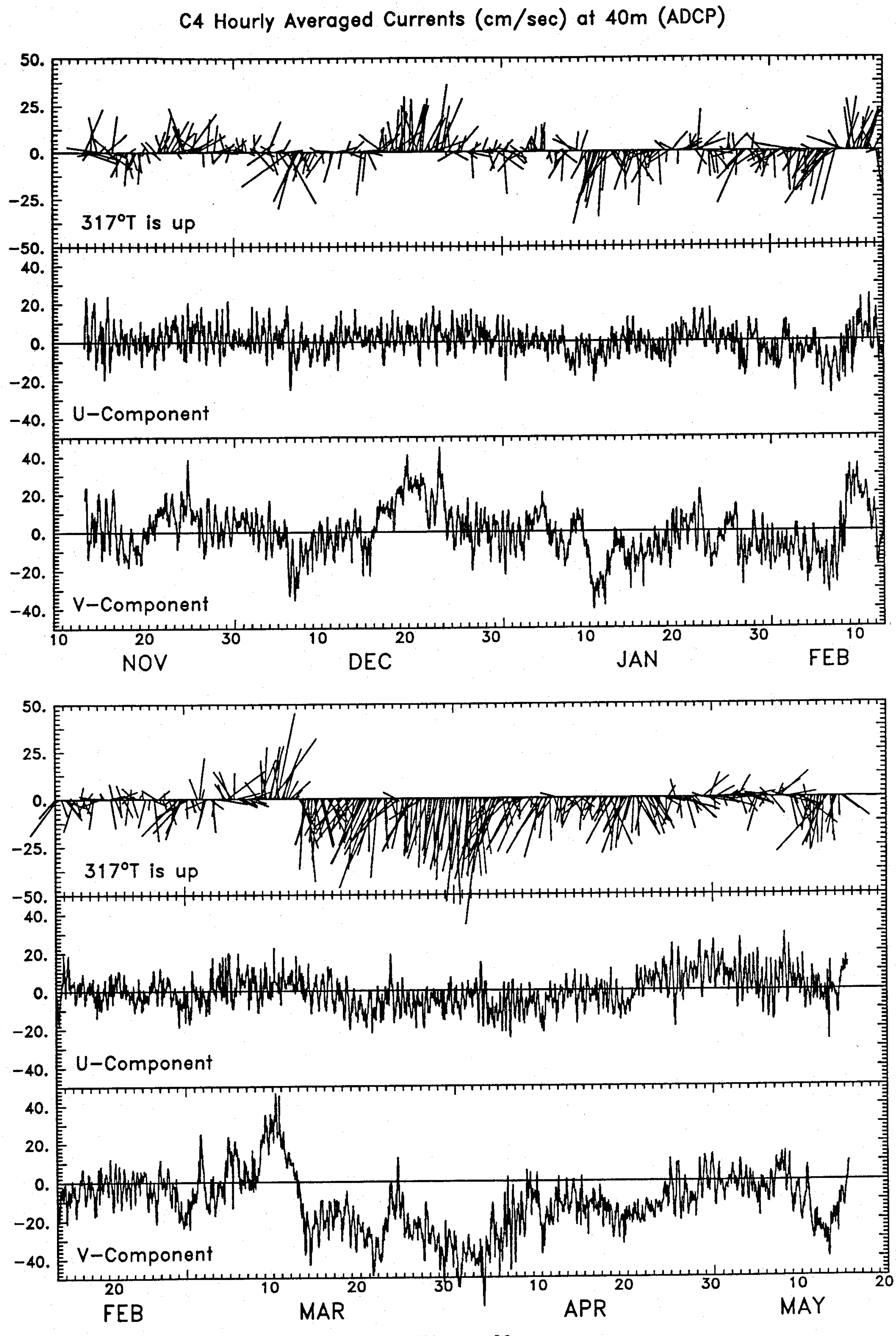

C4 Hourly Averaged Currents (cm/sec) at 40m (ADCP)
317°T is up
U–Component
V–Component
NOV
DEC
JAN
FEB
317°T is up
U–Component
V–Component
FEB
MAR
APR
MAY

Figure 82

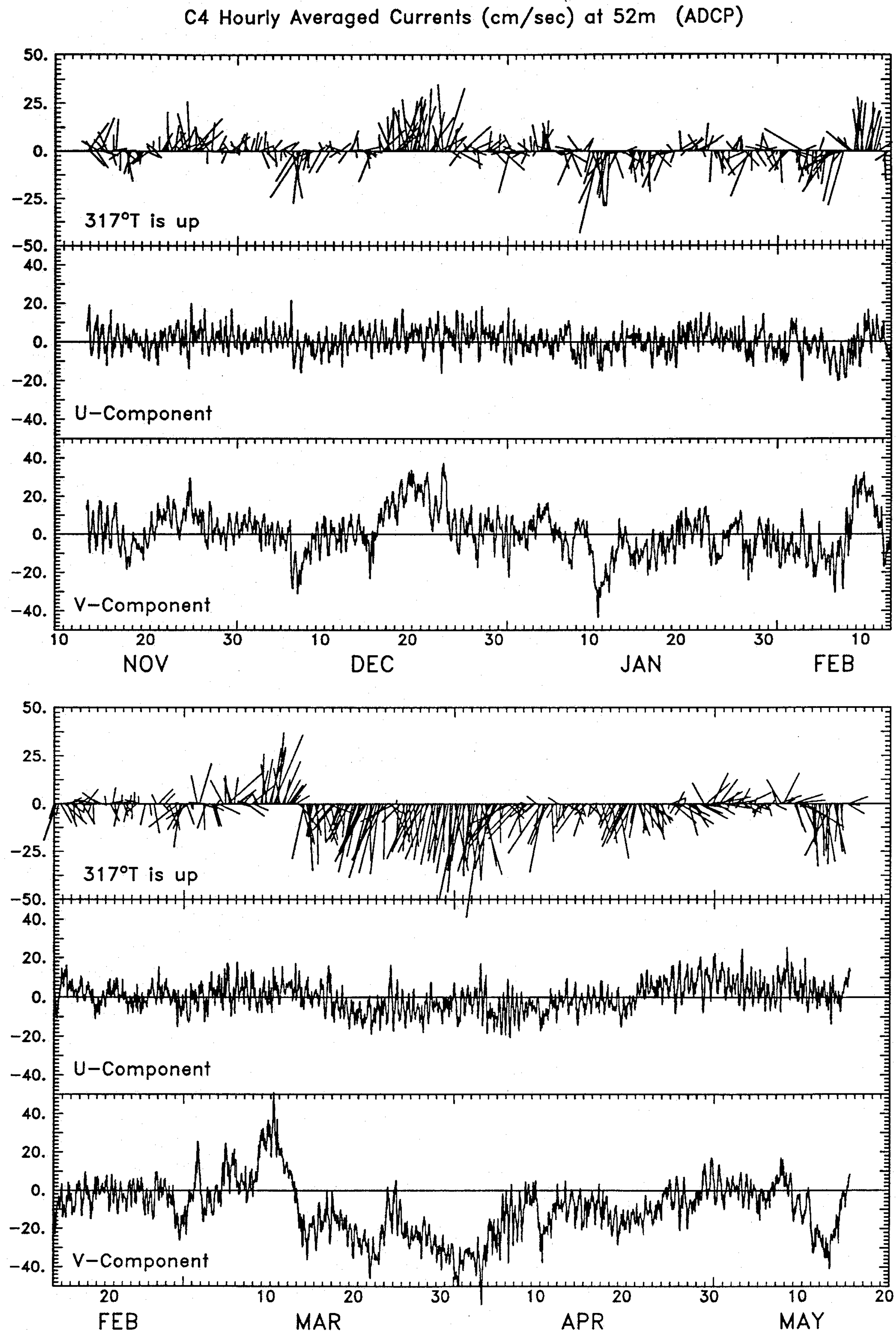

C4 Hourly Averaged Currents (cm/sec) at 52m (ADCP)
50.
25.
0.
-25.
-50.
317°T is up
40.
20.
0.
-20.
-40.
U-Component
40.
20.
0.
-20.
-40.
V-Component
10 20 30 10 20 30 10 20 30 10
NOV DEC JAN FEB
50.
25.
0.
-25.
-50.
317°T is up
40.
20.
0.
-20.
-40.
U-Component
40.
20.
0.
-20.
-40.
V-Component
20 10 20 30 10 20 30 10 20
FEB MAR APR MAY

Figure 83

G3 Hourly Averaged Currents (cm/sec) at 10m (ADCP)

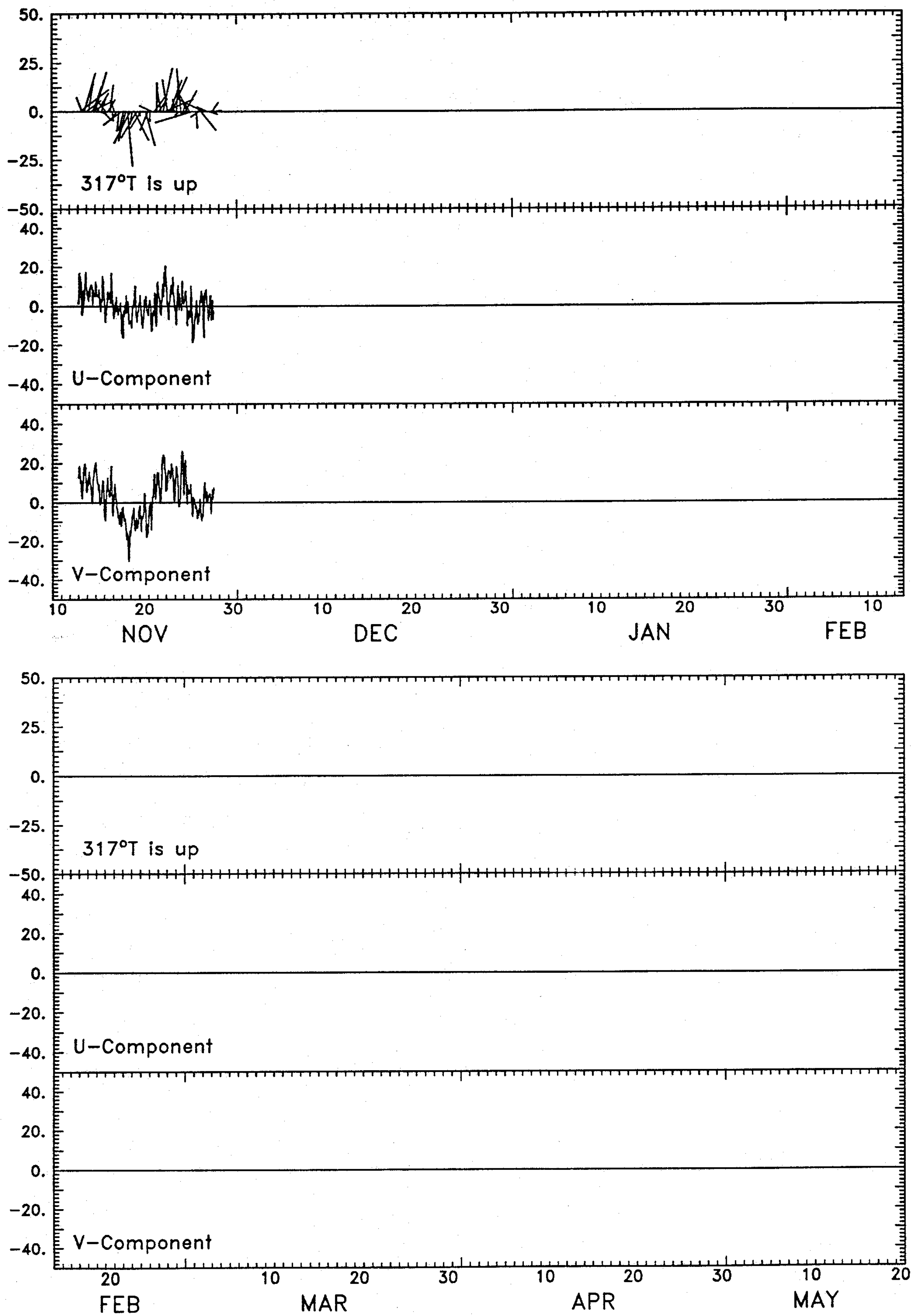


Figure 84

G3 Hourly Averaged Currents (cm/sec) at 10m (VMCM)

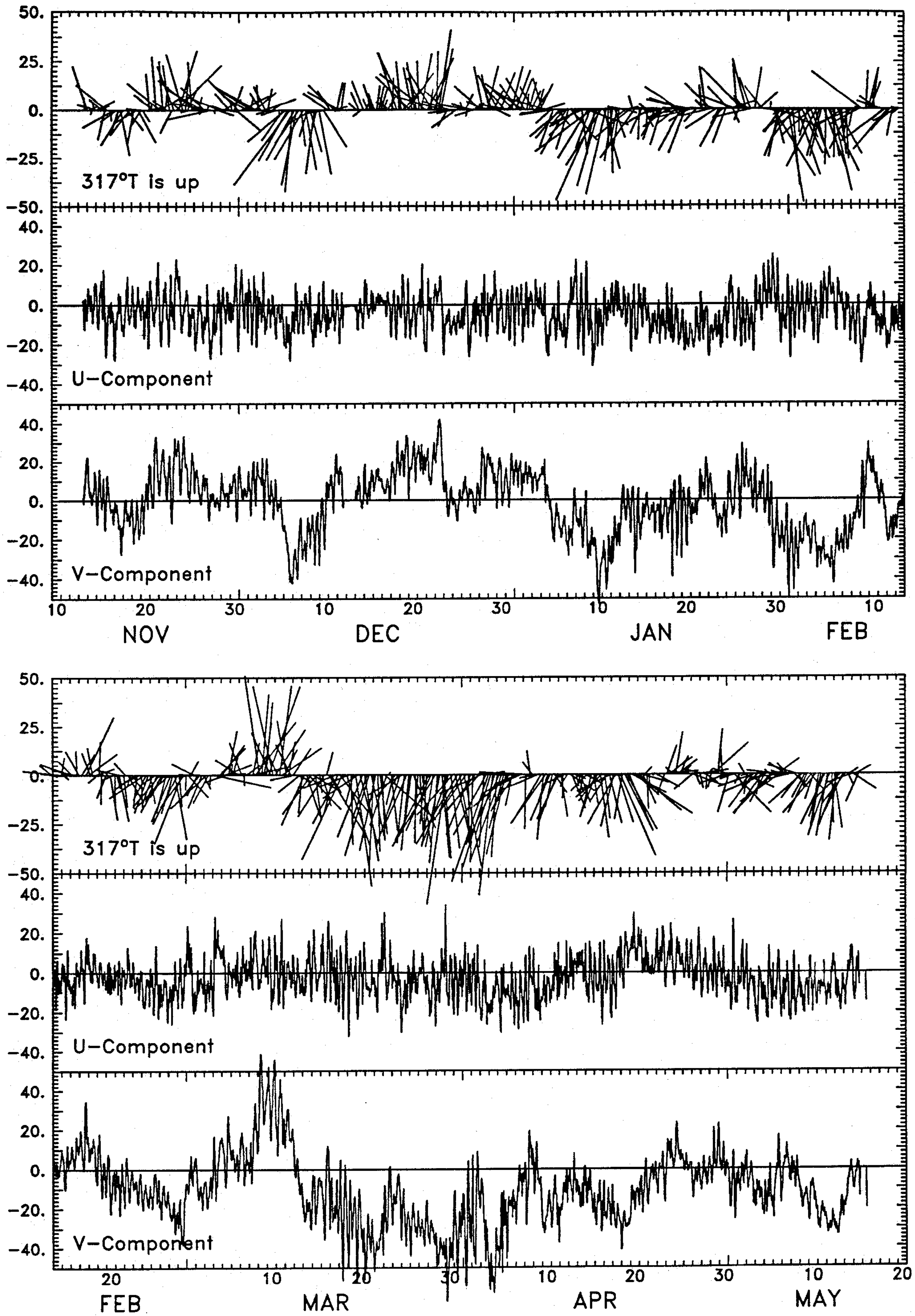


Figure 85

G3 Hourly Averaged Currents (cm/sec) at 16m (ADCP)

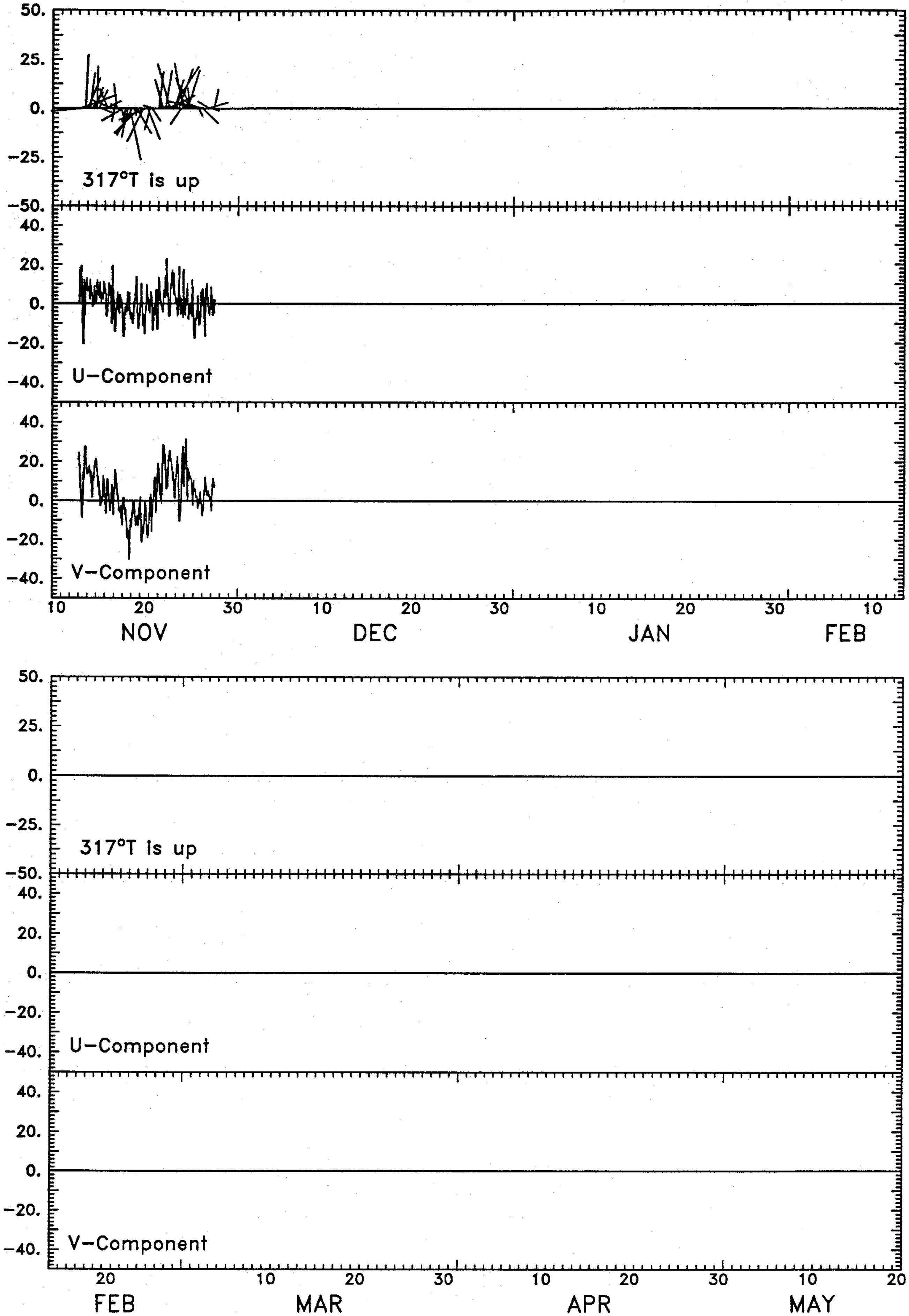


Figure 86

G3 Hourly Averaged Currents (cm/sec) at 22m (ADCP)

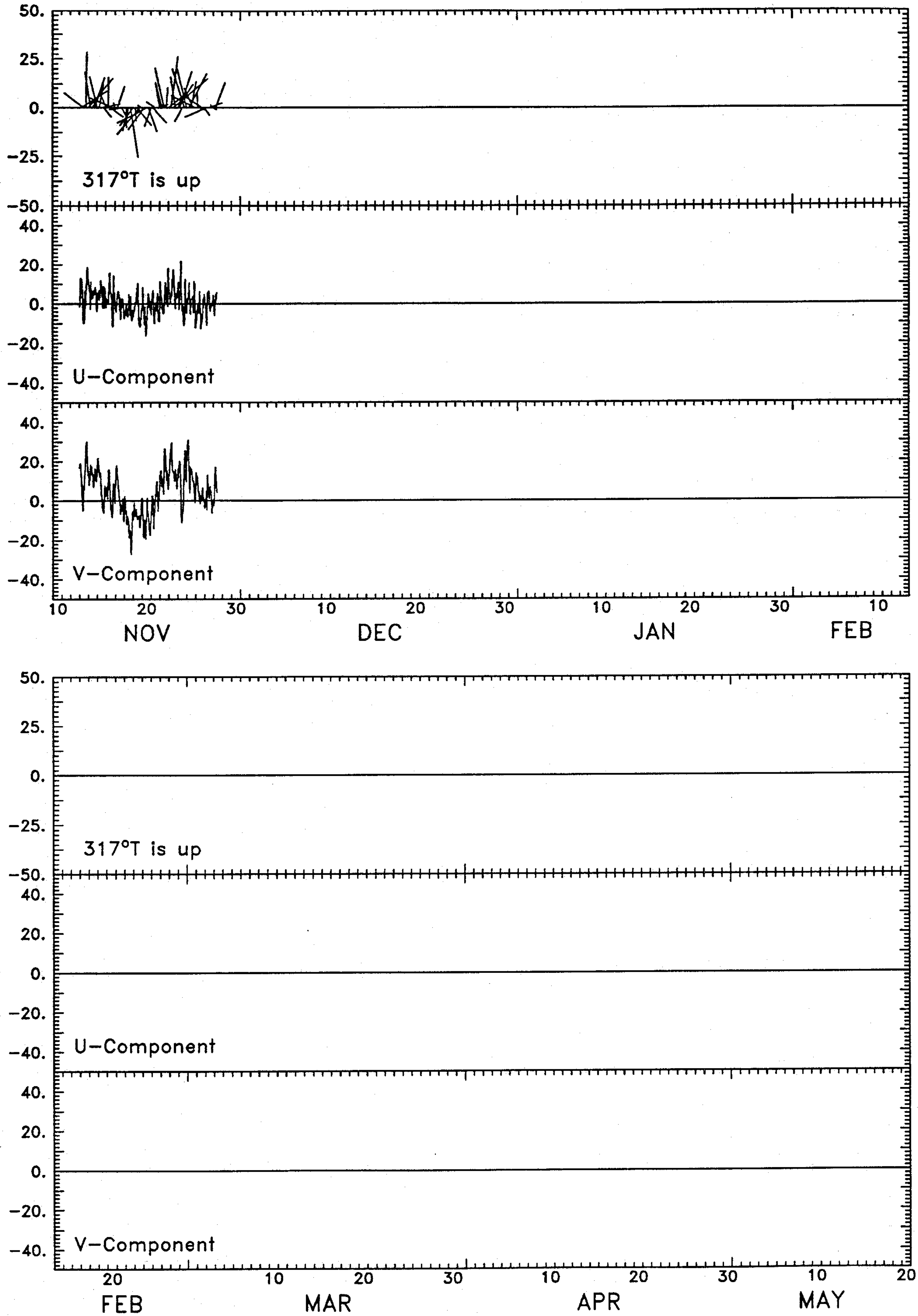
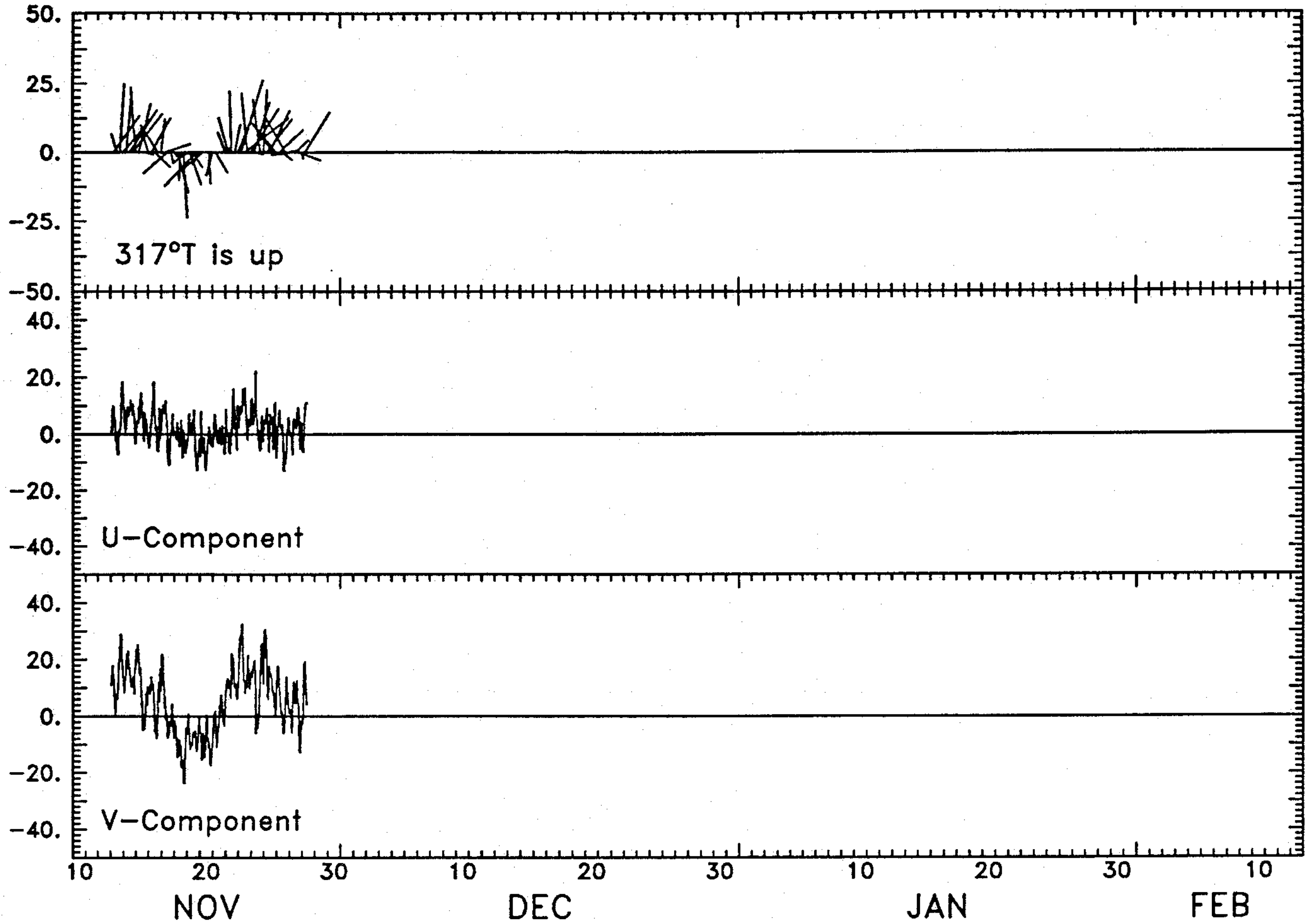


Figure 87

G3 Hourly Averaged Currents (cm/sec) at 28m (ADCP)



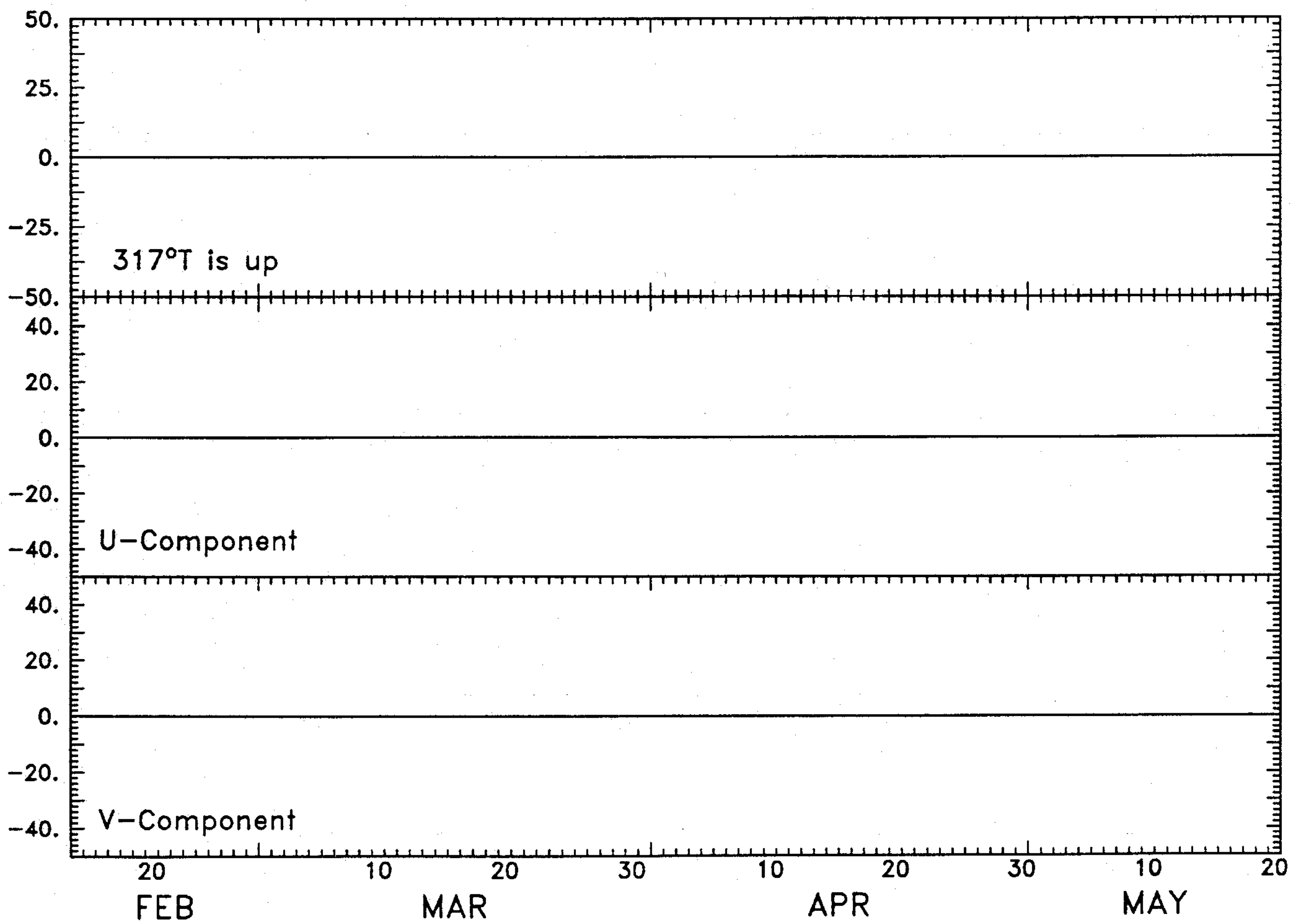


Figure 88

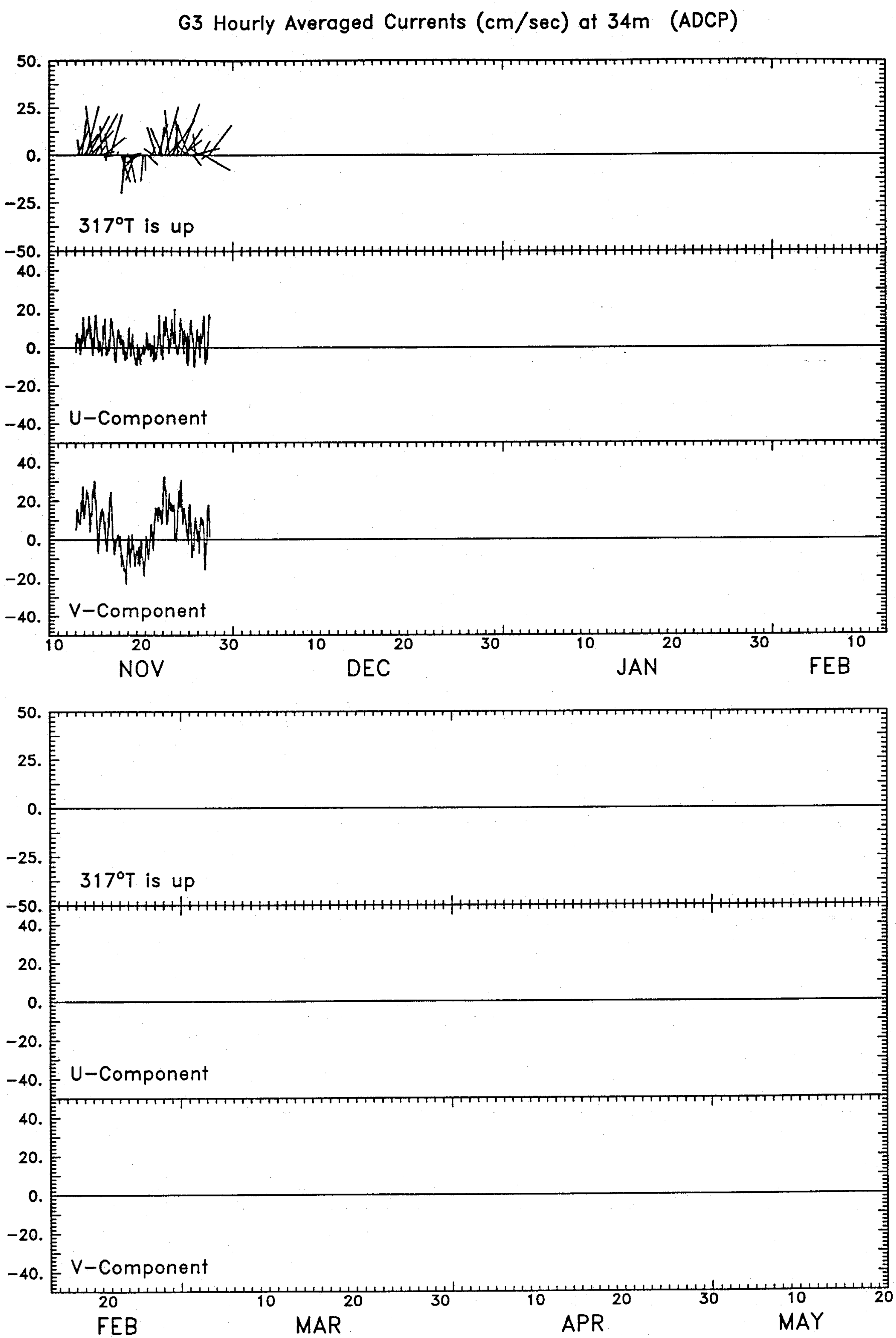
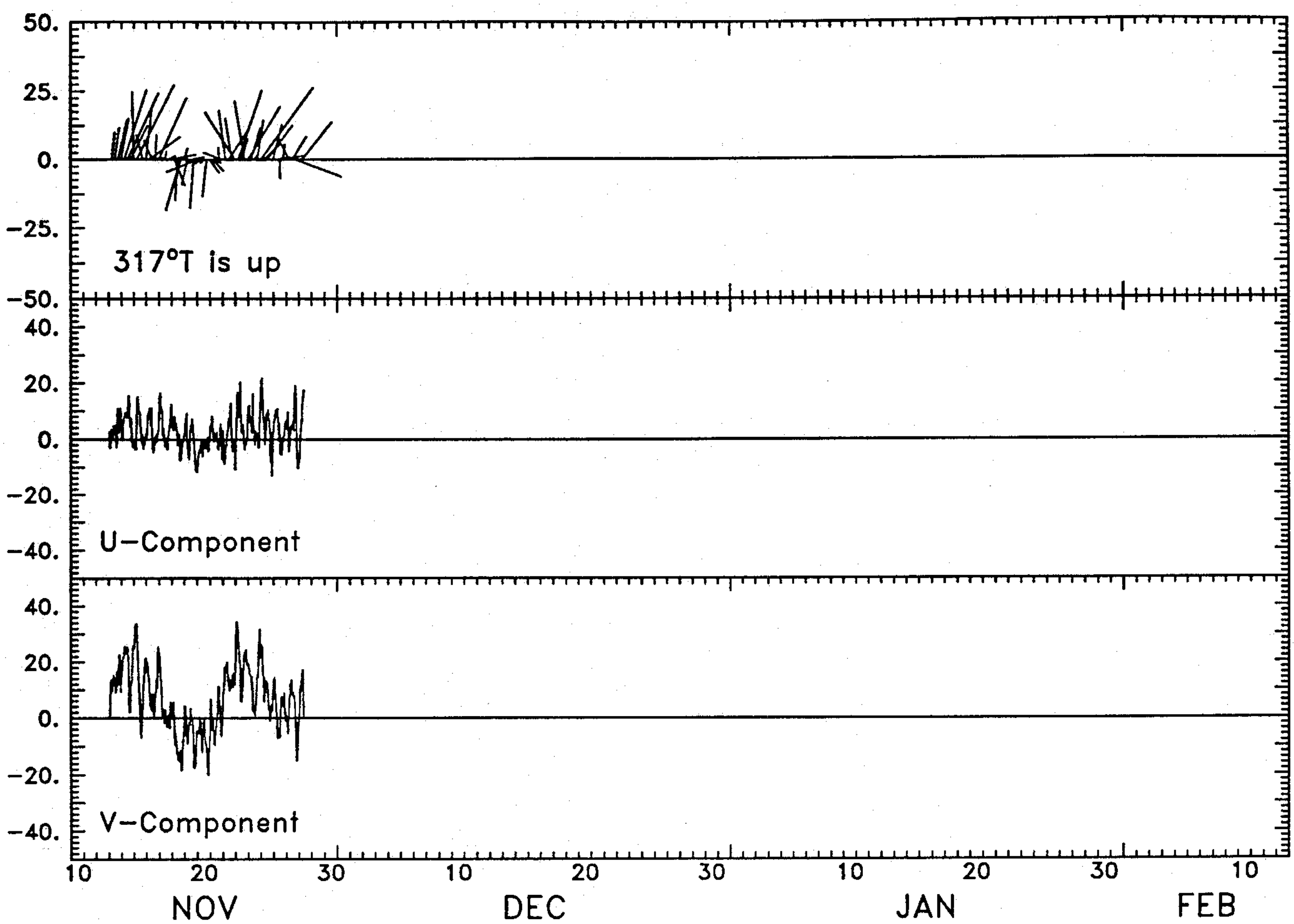

G3 Hourly Averaged Currents (cm/sec) at 34m (ADCP)
50.
25.
0.
-25.
-50.
317°T is up
40.
20.
0.
-20.
-40.
U-Component
V-Component
10
20
30
NOV
DEC
JAN
FEB
MAR
APR
MAY

Figure 89

G3 Hourly Averaged Currents (cm/sec) at 40m (ADCP)



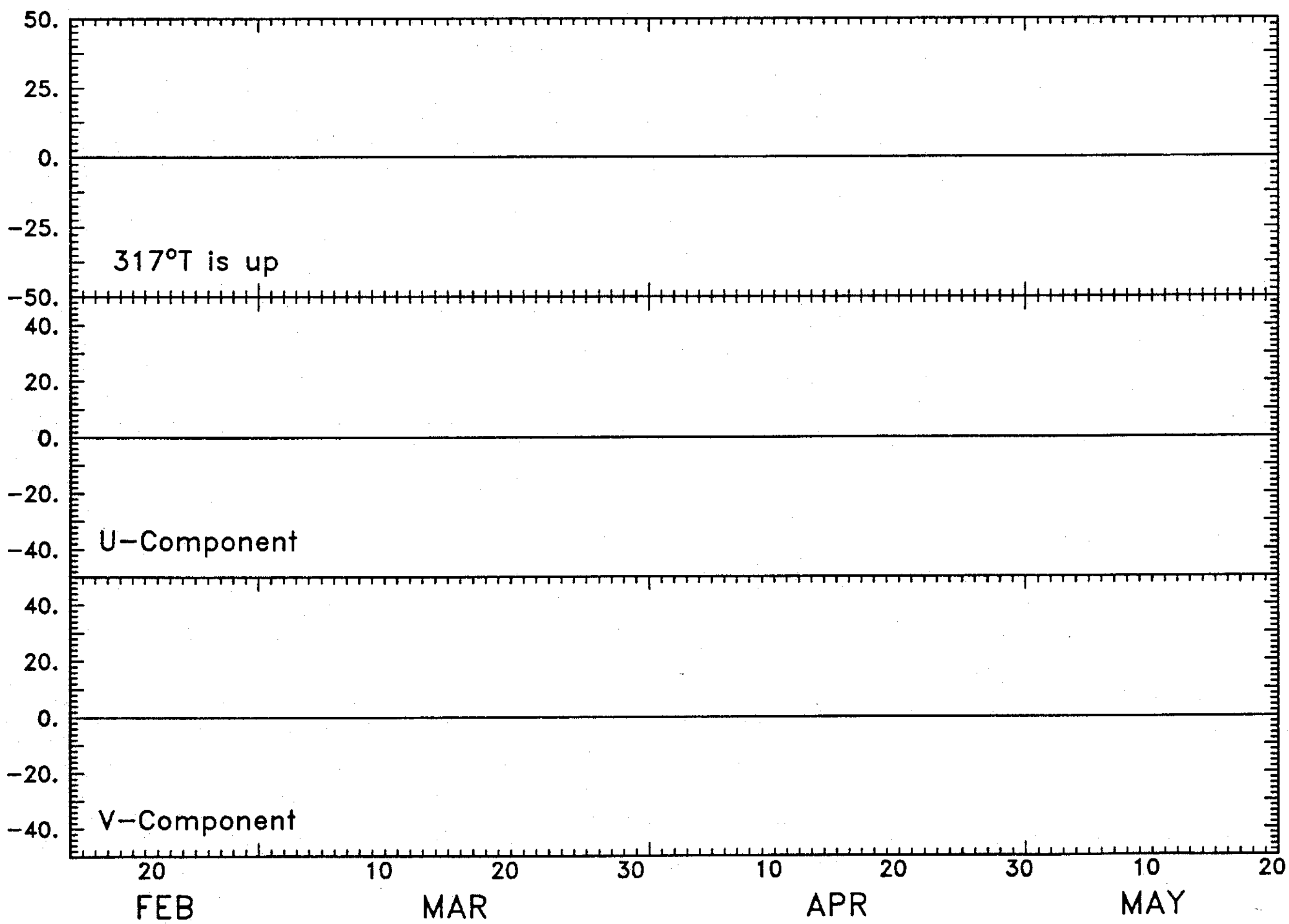


Figure 90

G3 Hourly Averaged Currents (cm/sec) at 46m (ADCP)

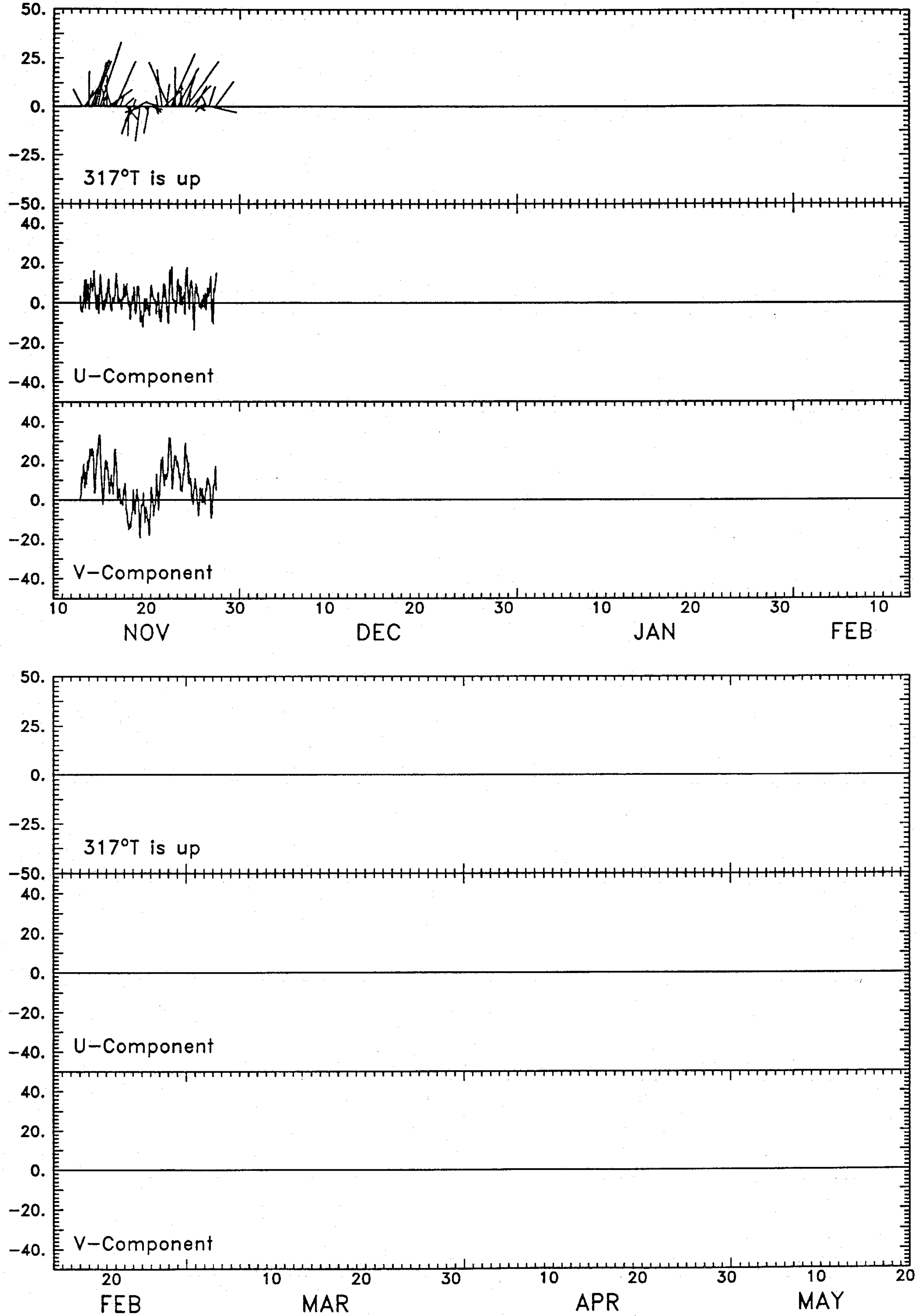
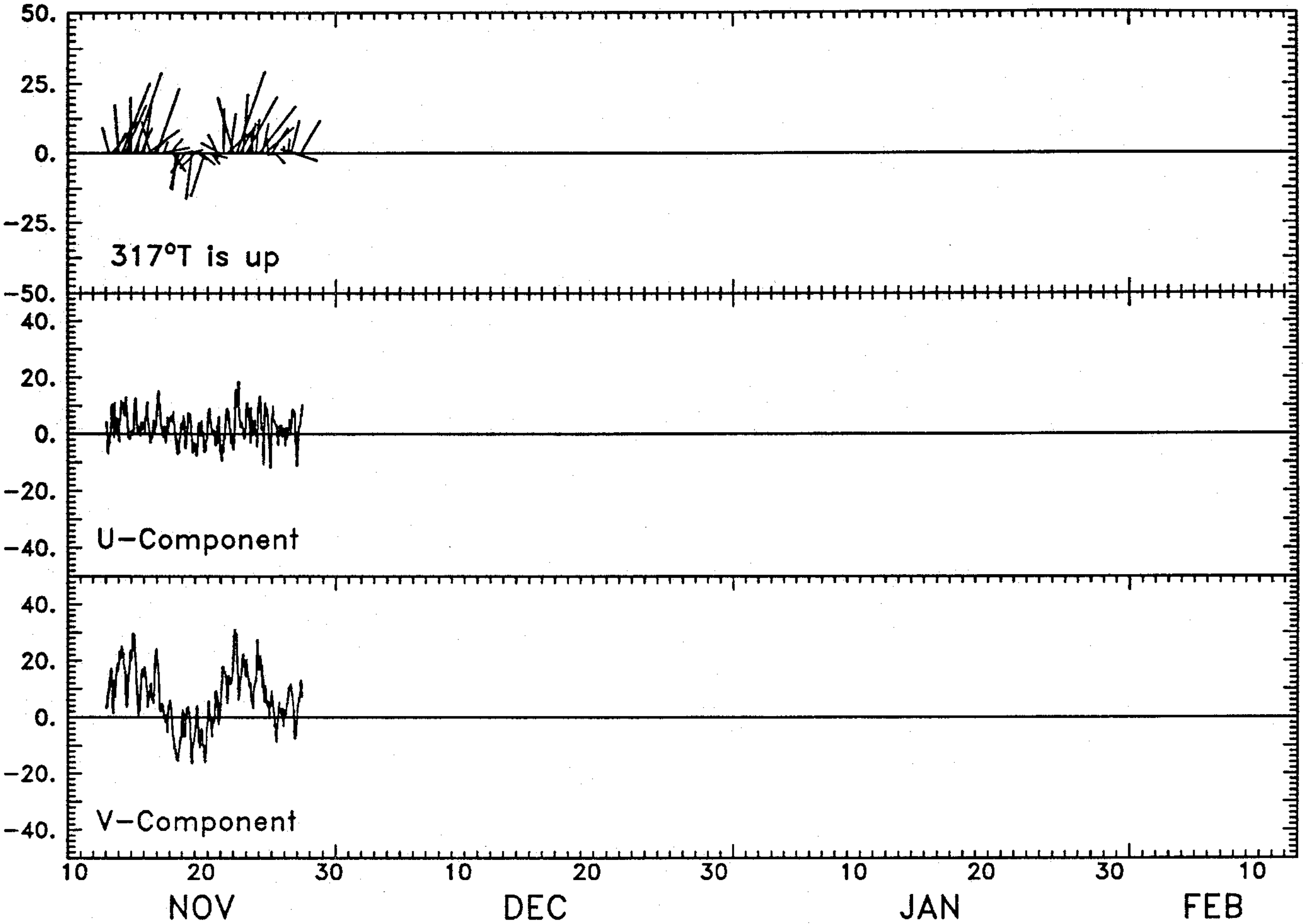


Figure 91

G3 Hourly Averaged Currents (cm/sec) at 52m (ADCP)



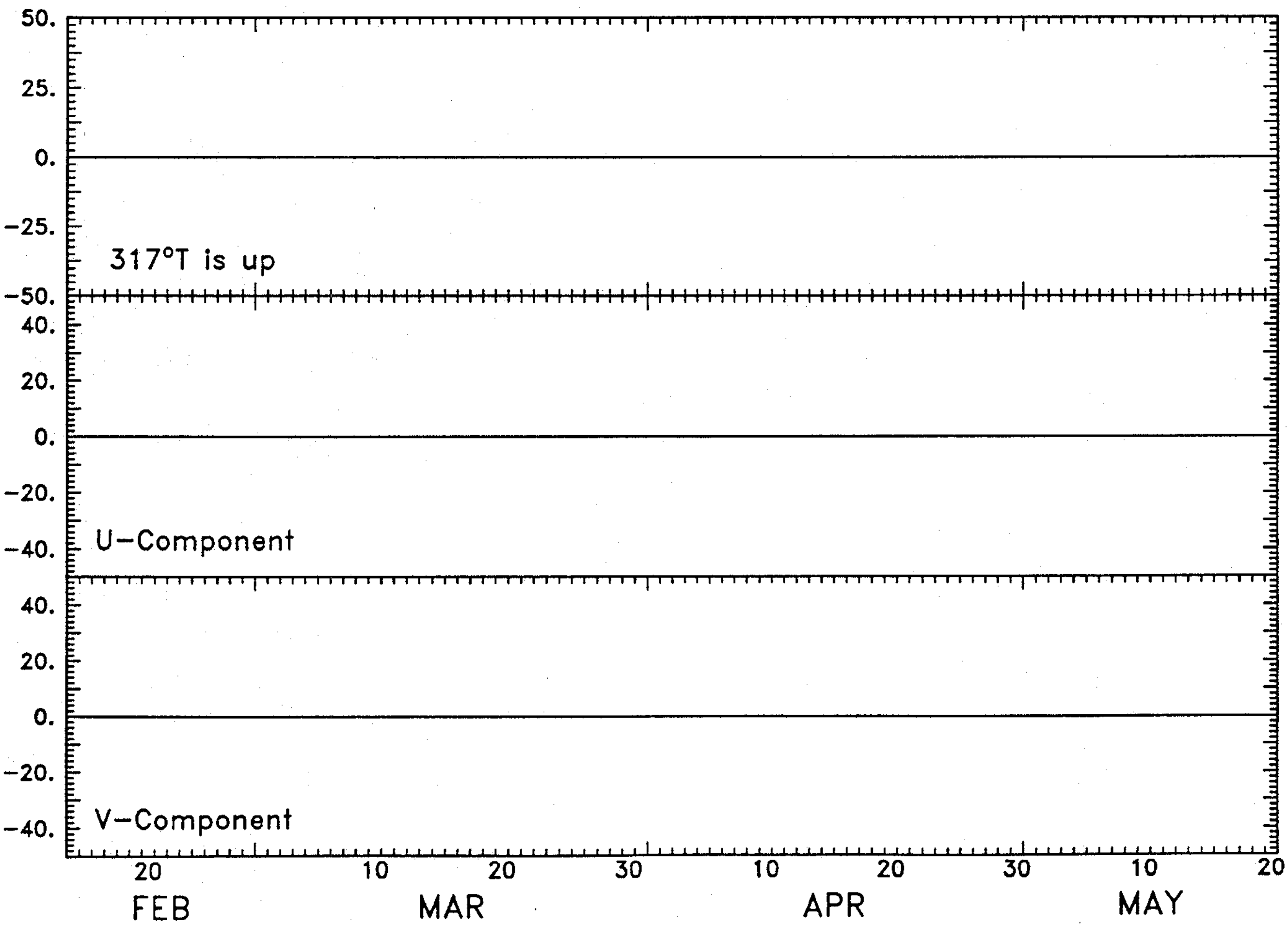


Figure 92

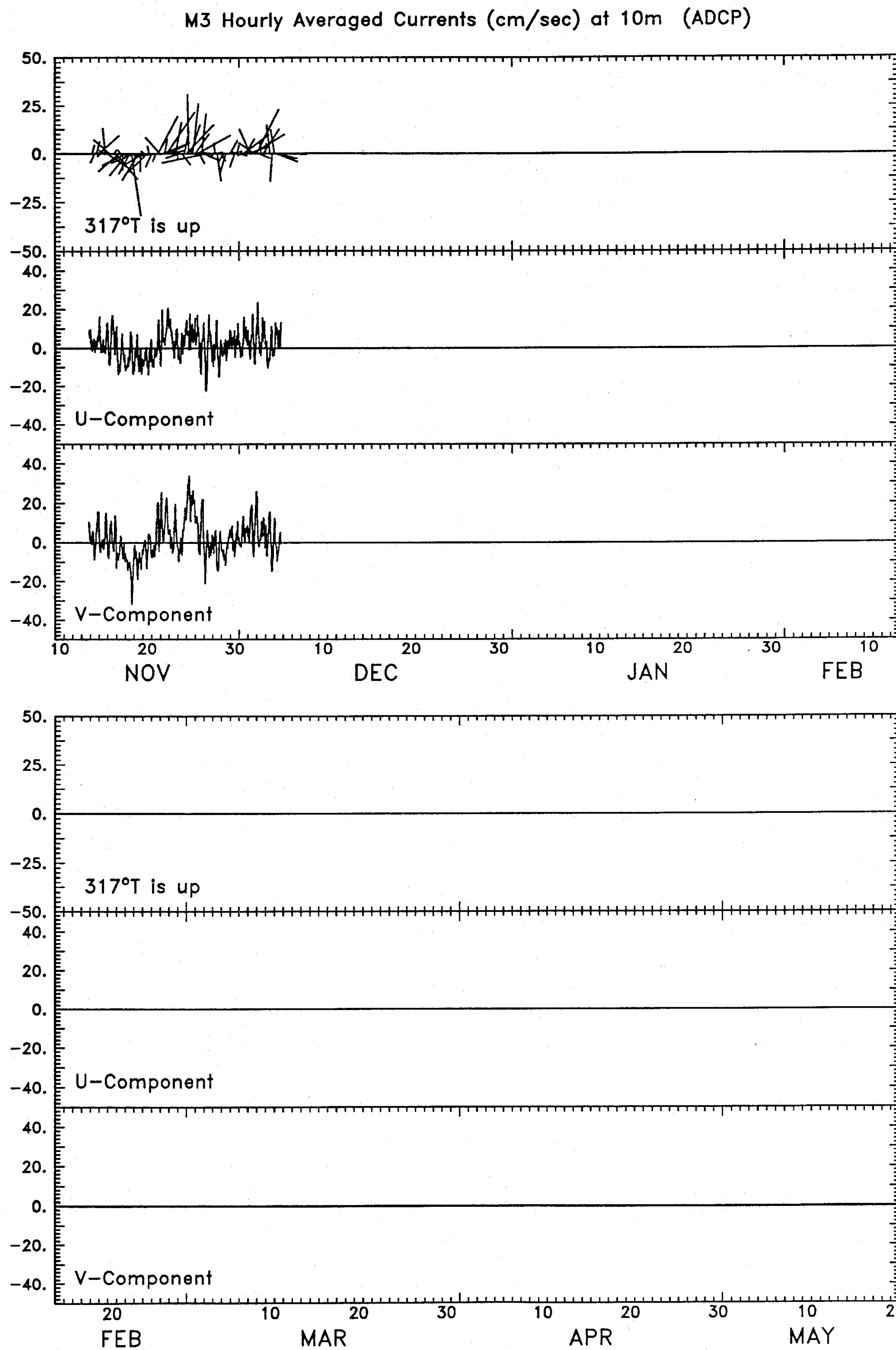

M3 Hourly Averaged Currents (cm/sec) at 10m (ADCP)
317°T is up
U–Component
V–Component
NOV
DEC
JAN
FEB
317°T is up
U–Component
V–Component
FEB
MAR
APR
MAY

Figure 93

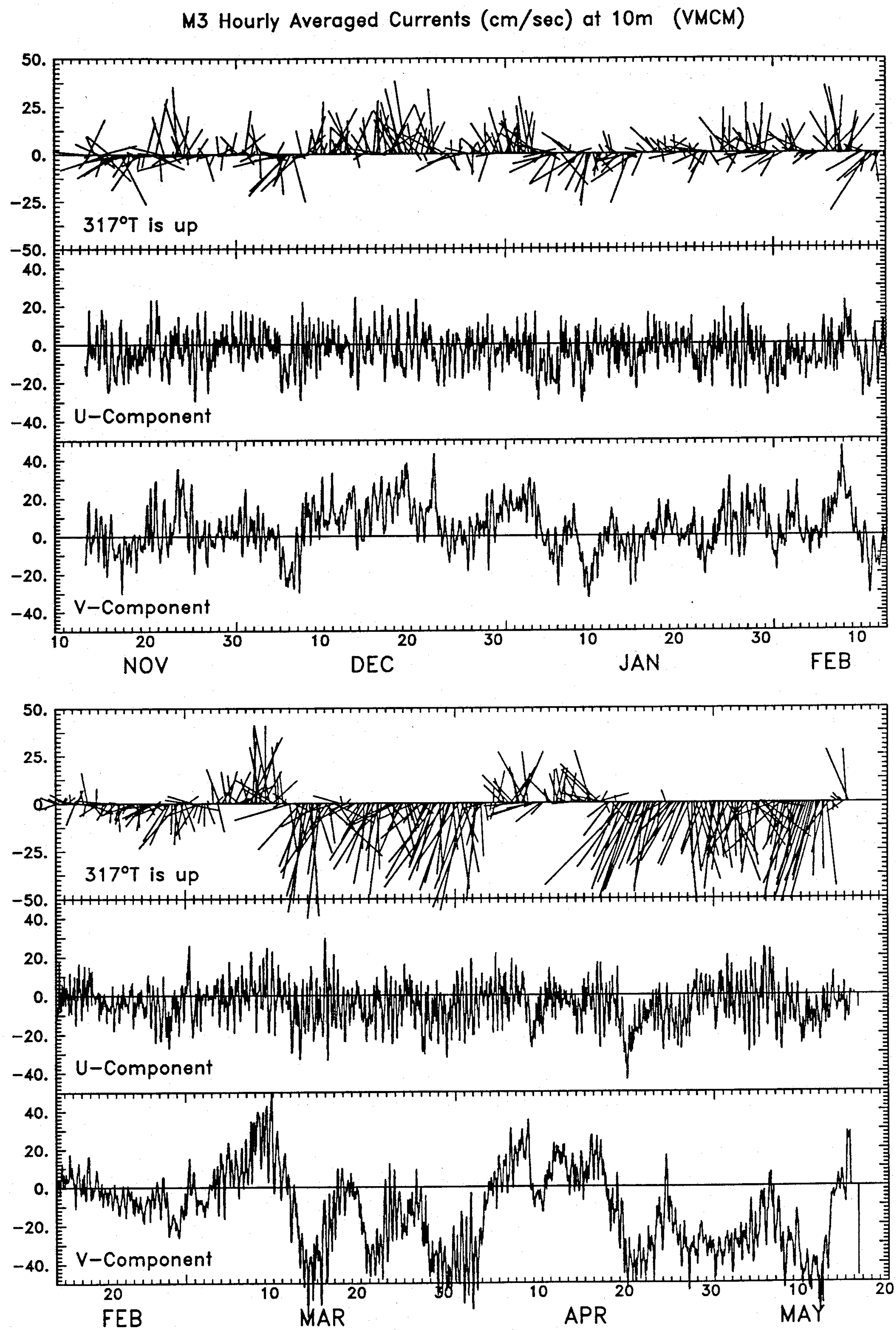

M3 Hourly Averaged Currents (cm/sec) at 10m (VMCM)
50.
25.
0.
-25.
-50.
317°T is up
40.
20.
0.
-20.
-40.
U-Component
40.
20.
0.
-20.
-40.
V-Component
10 20 30 10 20 30 10 20 30 10
NOV DEC JAN FEB
50.
25.
0.
-25.
-50.
317°T is up
40.
20.
0.
-20.
-40.
U-Component
40.
20.
0.
-20.
-40.
V-Component
20 10 20 30 10 20 30 10 20
FEB MAR APR MAY

Figure 94

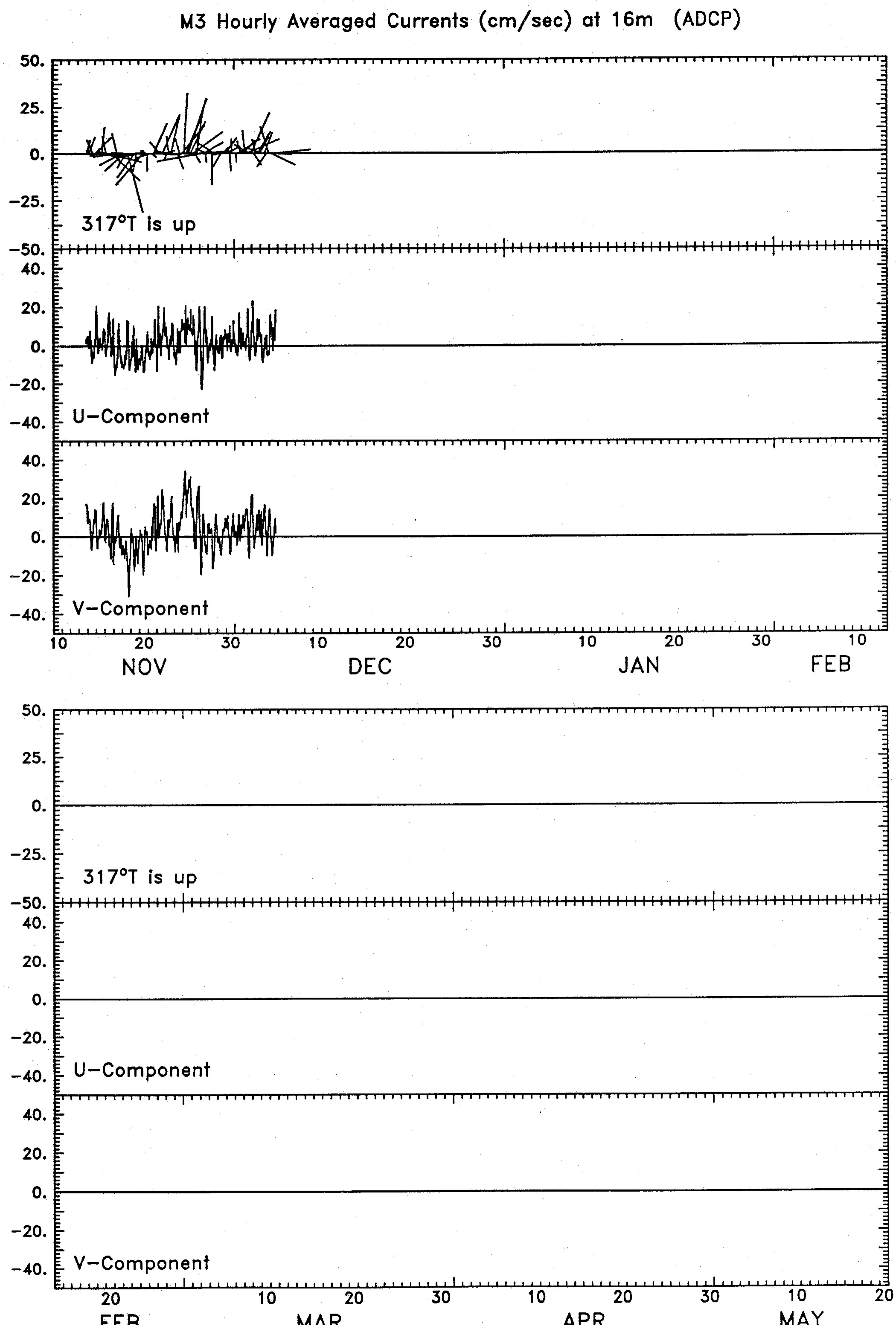
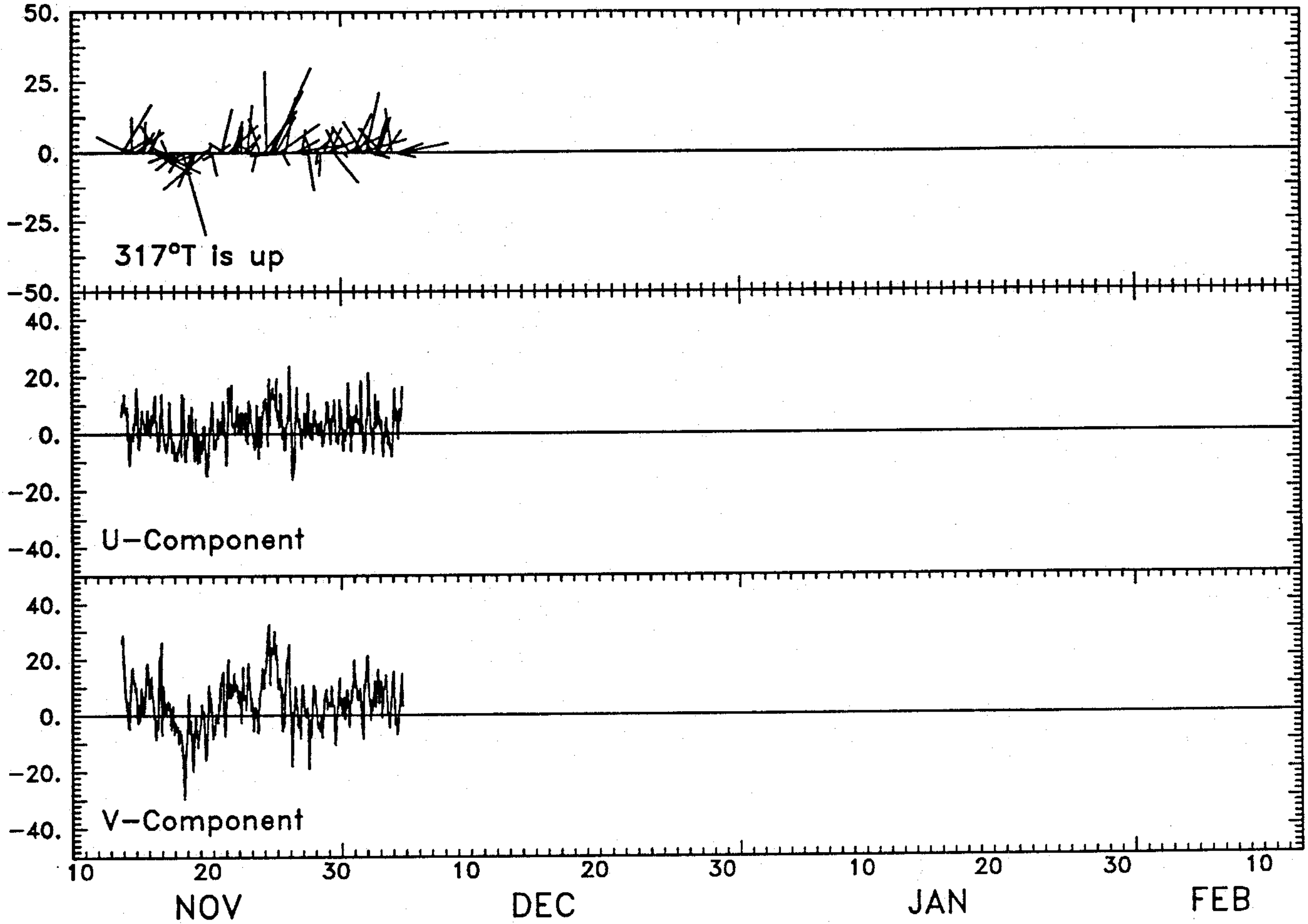

M3 Hourly Averaged Currents (cm/sec) at 16m (ADCP)
50.
25.
0.
-25.
-50.
317°T is up
40.
20.
0.
-20.
-40.
U-Component
40.
20.
0.
-20.
-40.
V-Component
10
20
30
10
20
30
10
20
30
10
NOV
DEC
JAN
FEB
50.
25.
0.
-25.
-50.
317°T is up
40.
20.
0.
-20.
-40.
U-Component
40.
20.
0.
-20.
-40.
V-Component
20
10
20
30
10
20
30
10
20
FEB
MAR
APR
MAY

Figure 95

M3 Hourly Averaged Currents (cm/sec) at 22m (ADCP)



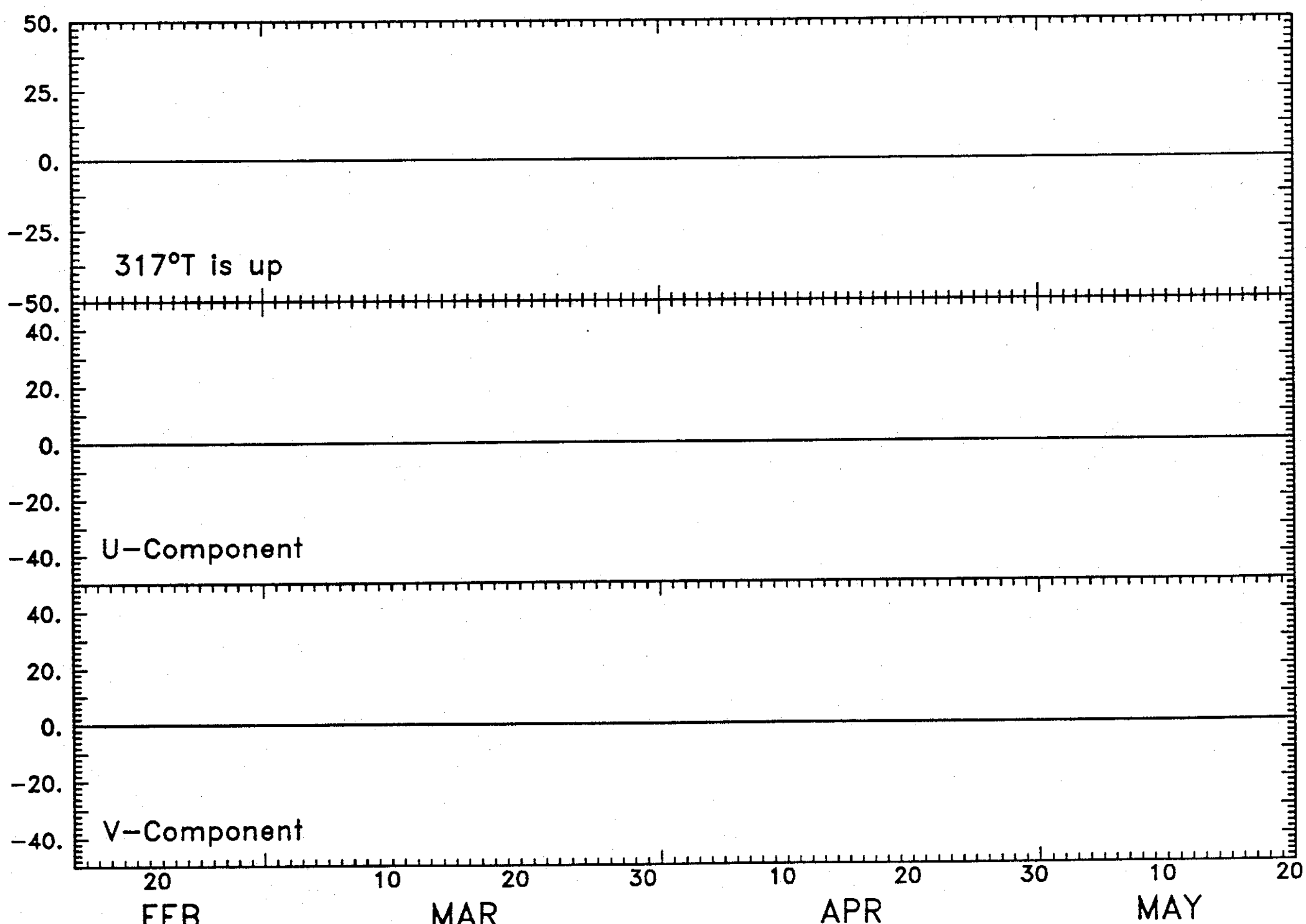
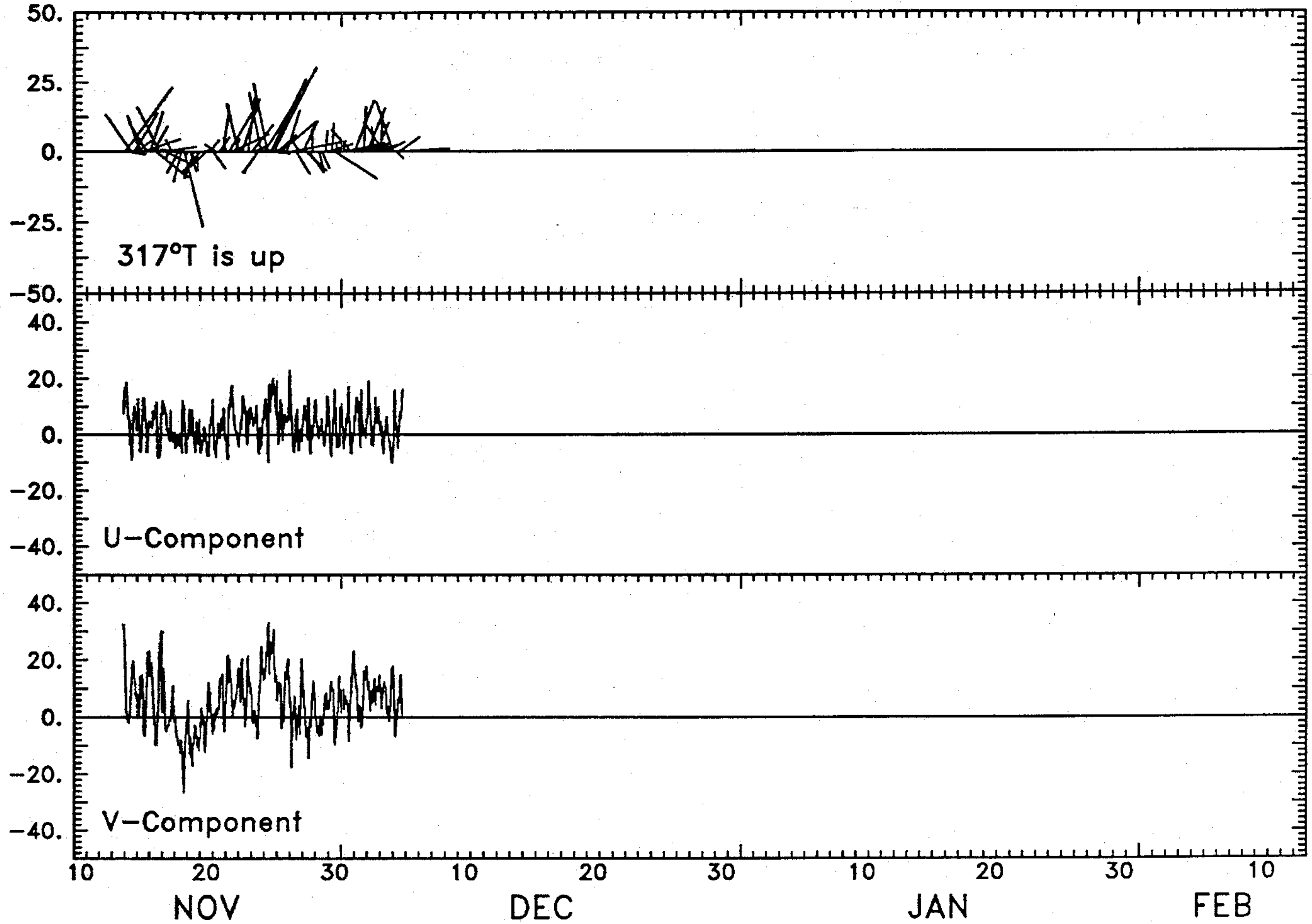


Figure 96

M3 Hourly Averaged Currents (cm/sec) at 28m (ADCP)



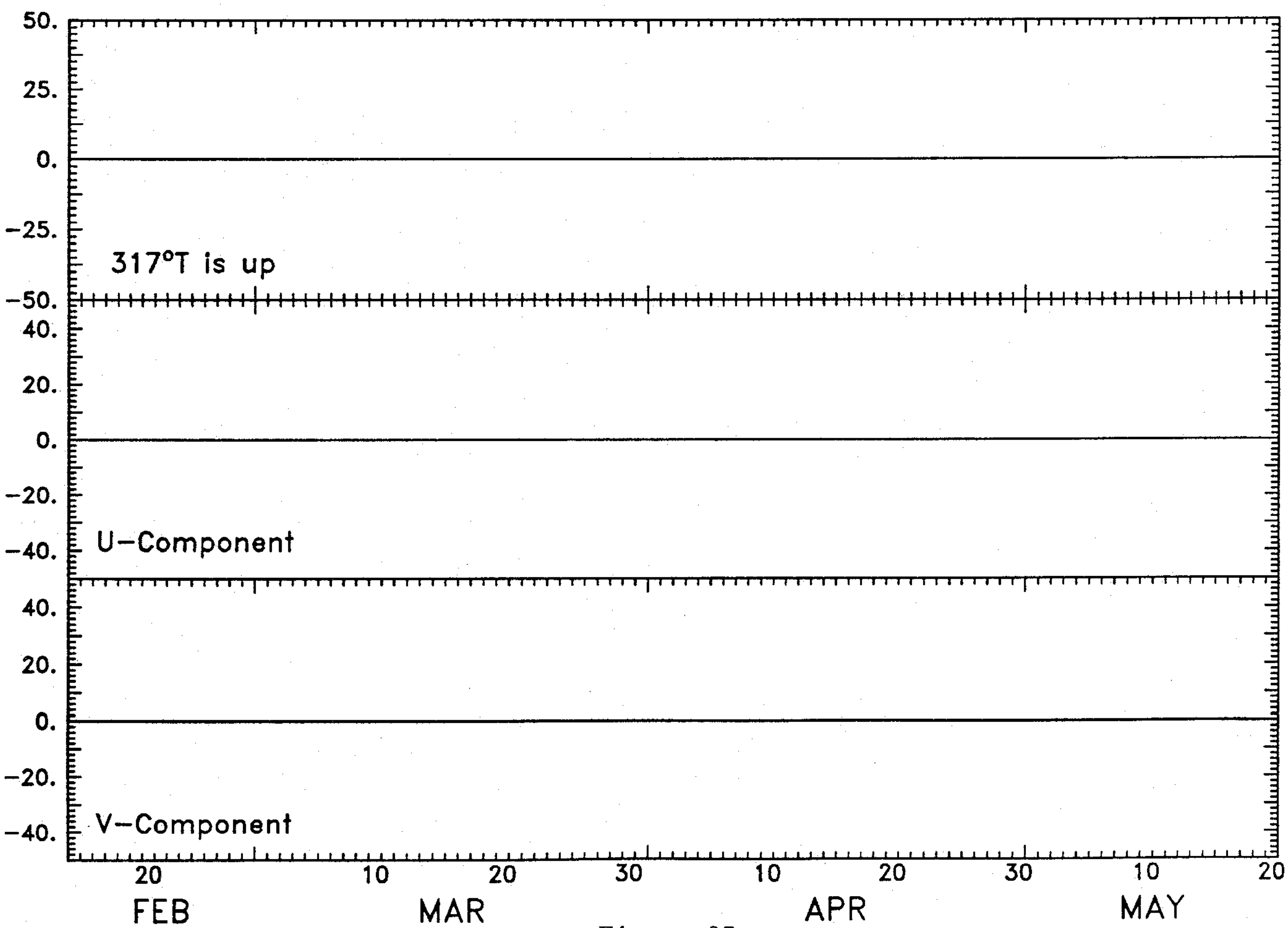
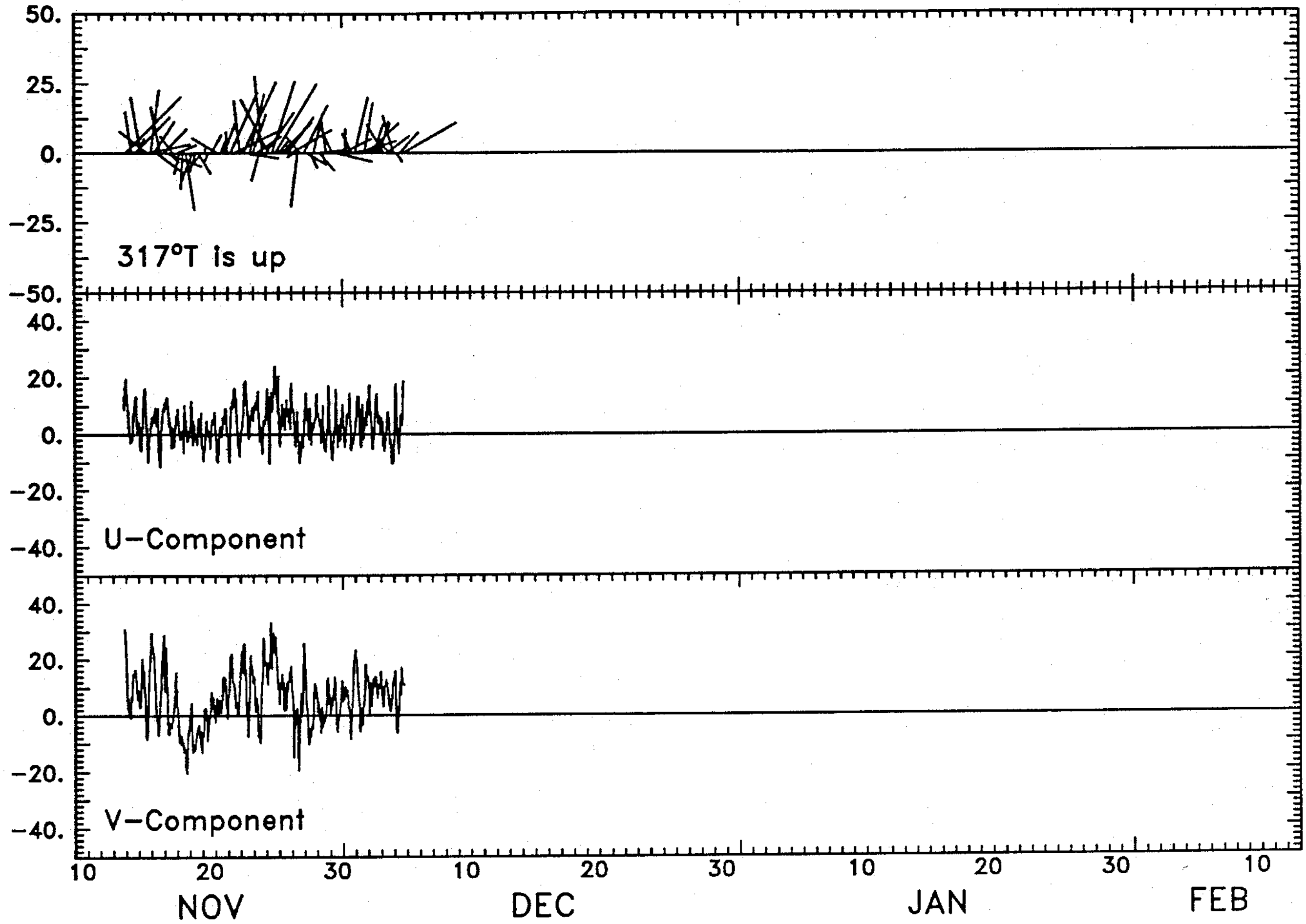


Figure 97

M3 Hourly Averaged Currents (cm/sec) at 34m (ADCP)



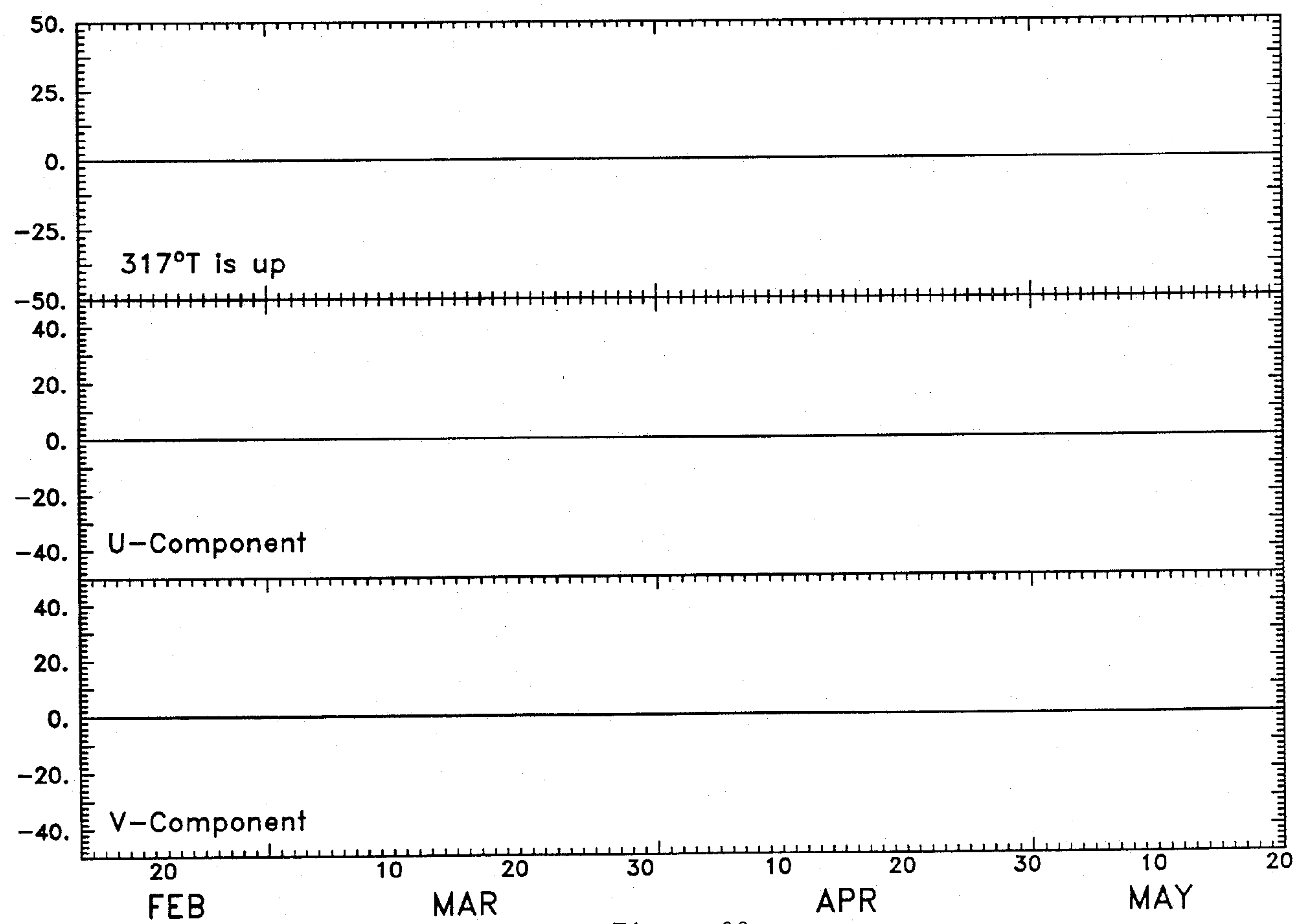
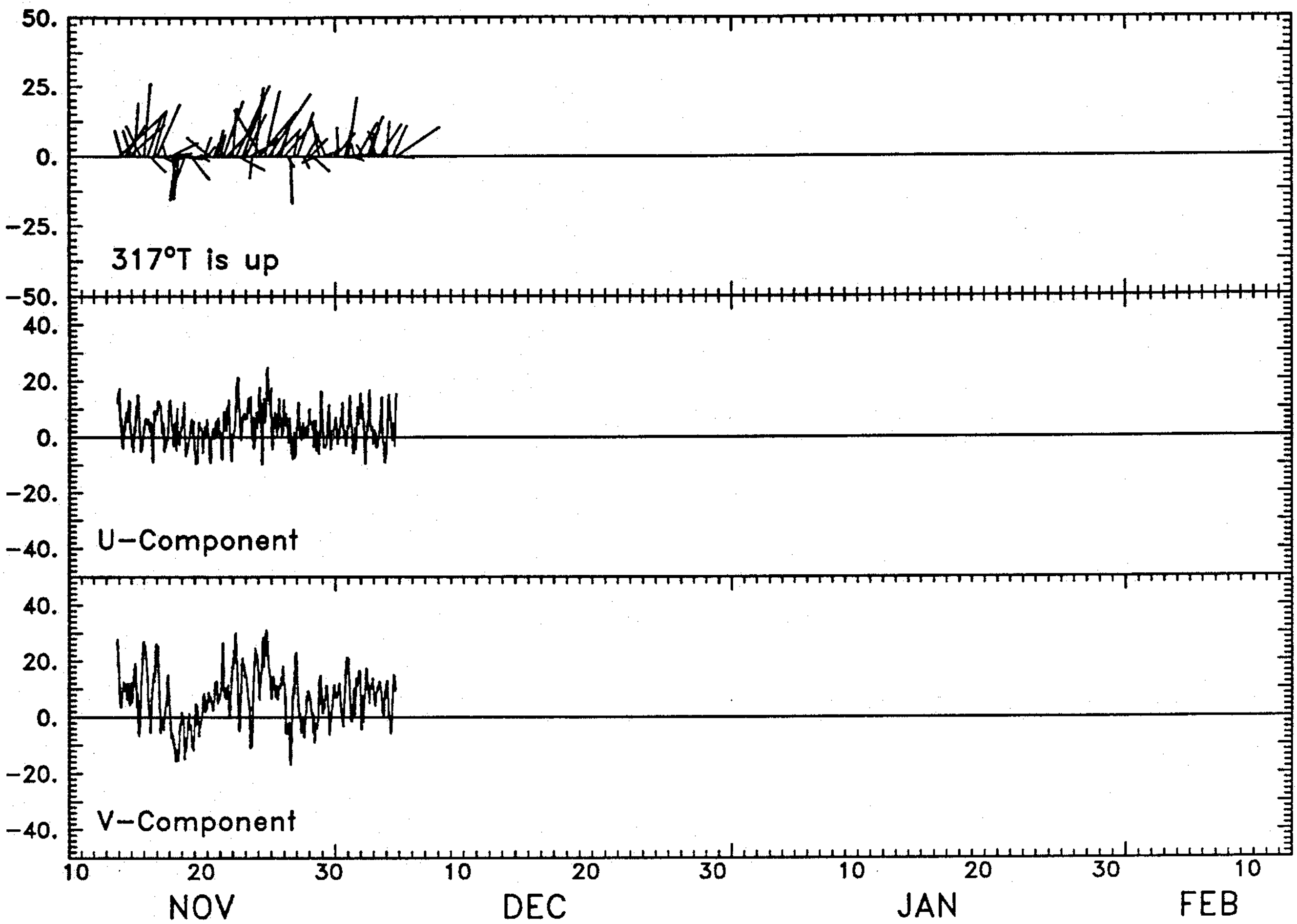


Figure 98

M3 Hourly Averaged Currents (cm/sec) at 40m (ADCP)



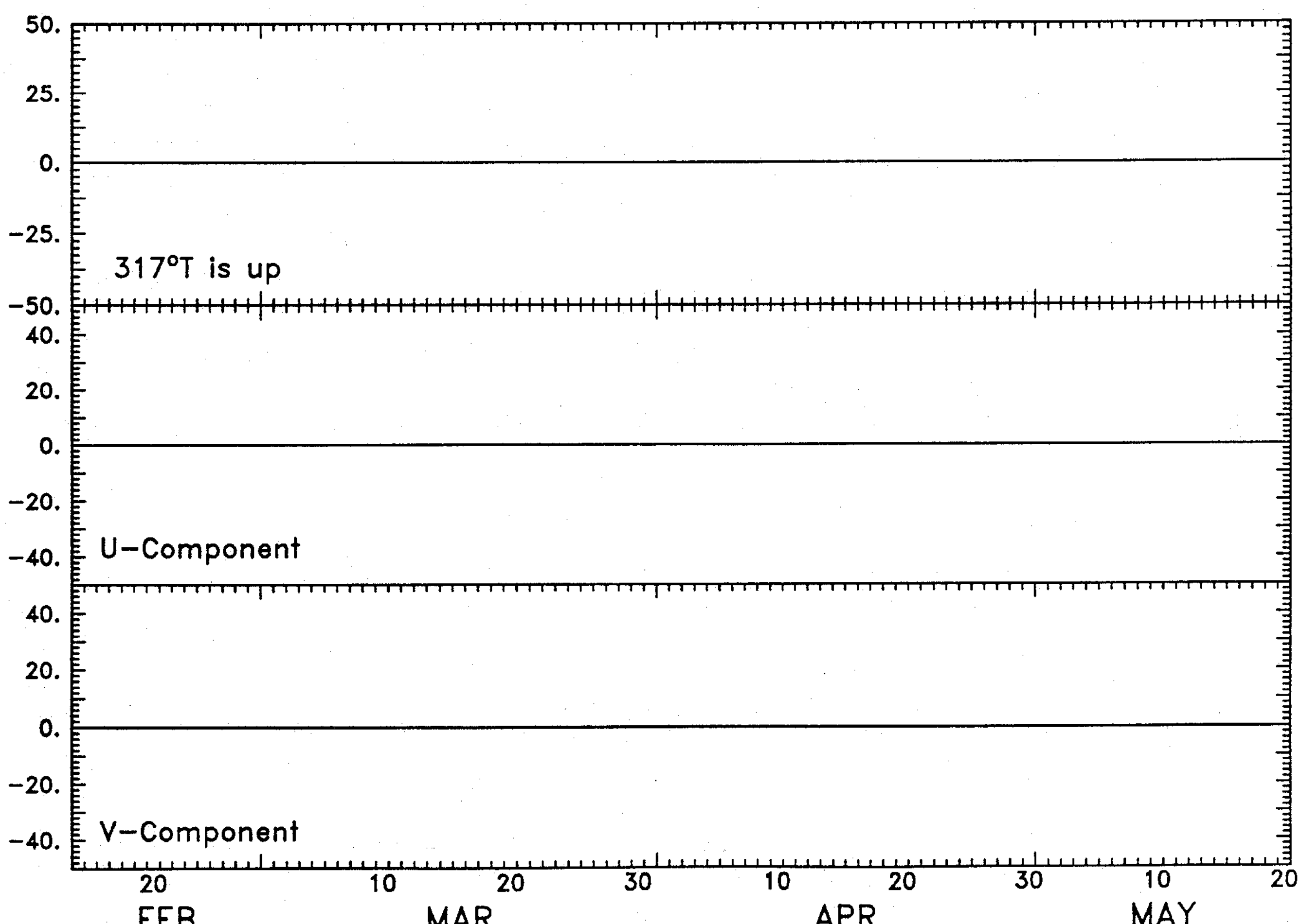
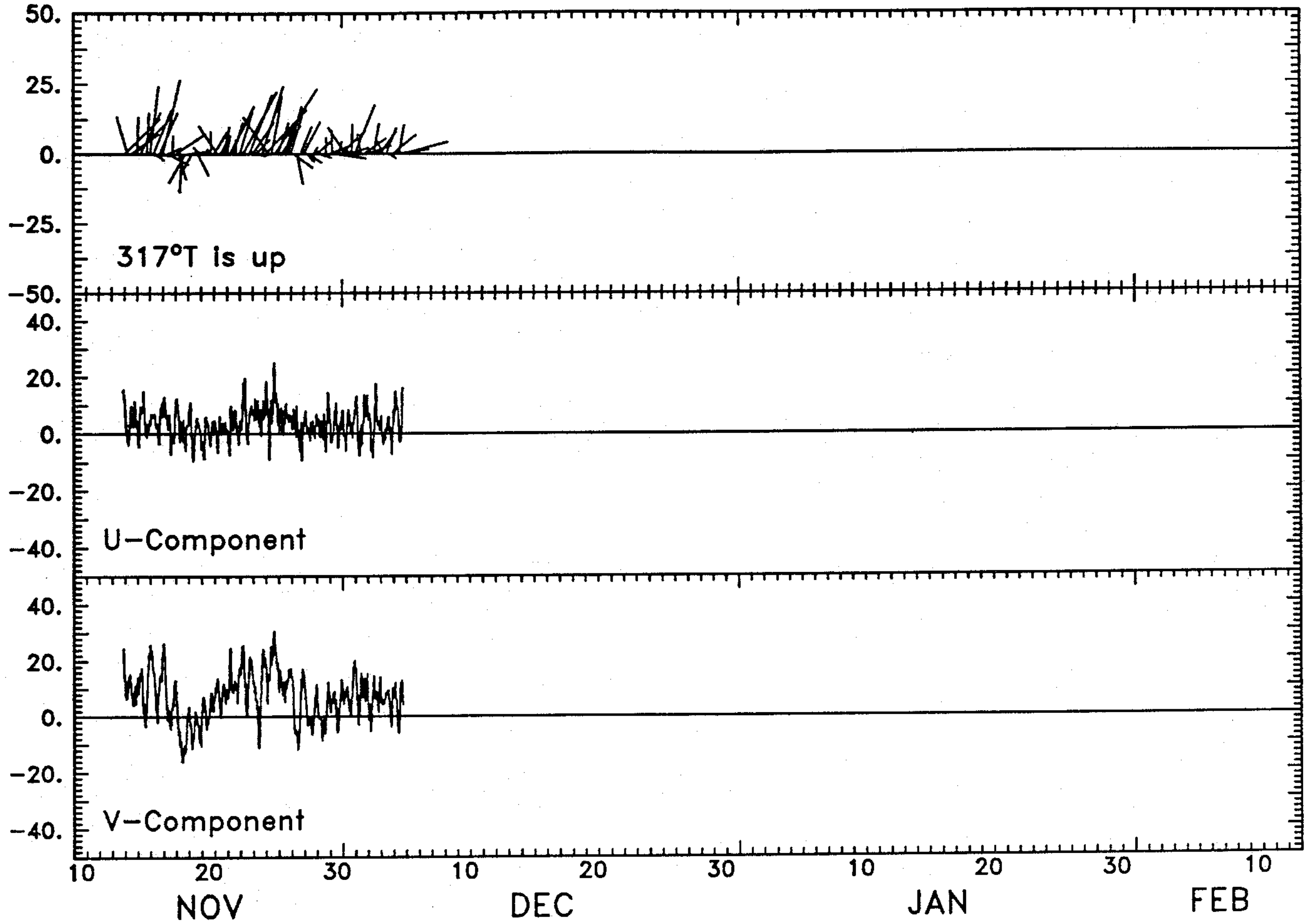


Figure 99

M3 Hourly Averaged Currents (cm/sec) at 46m (ADCP)



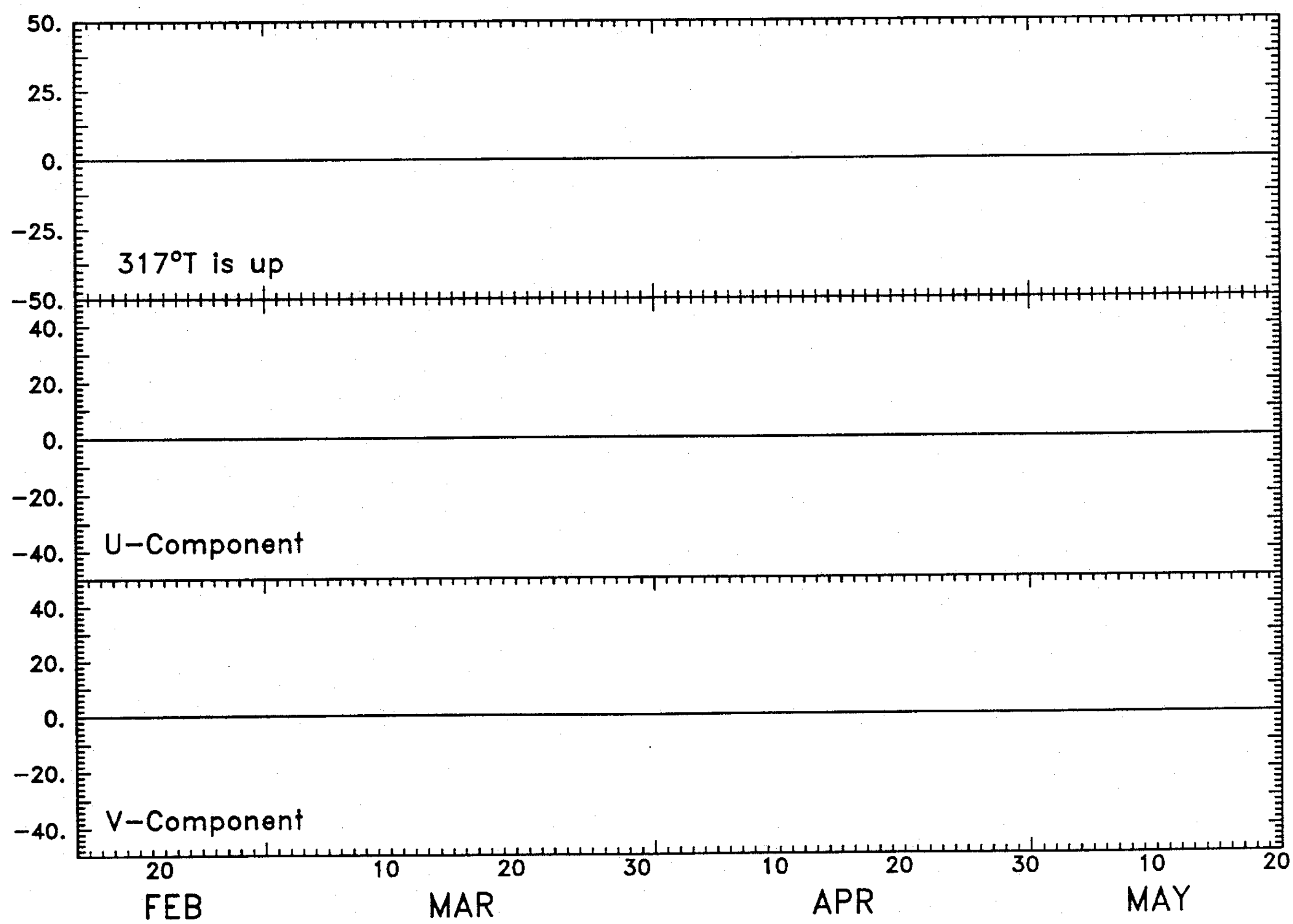


Figure 100

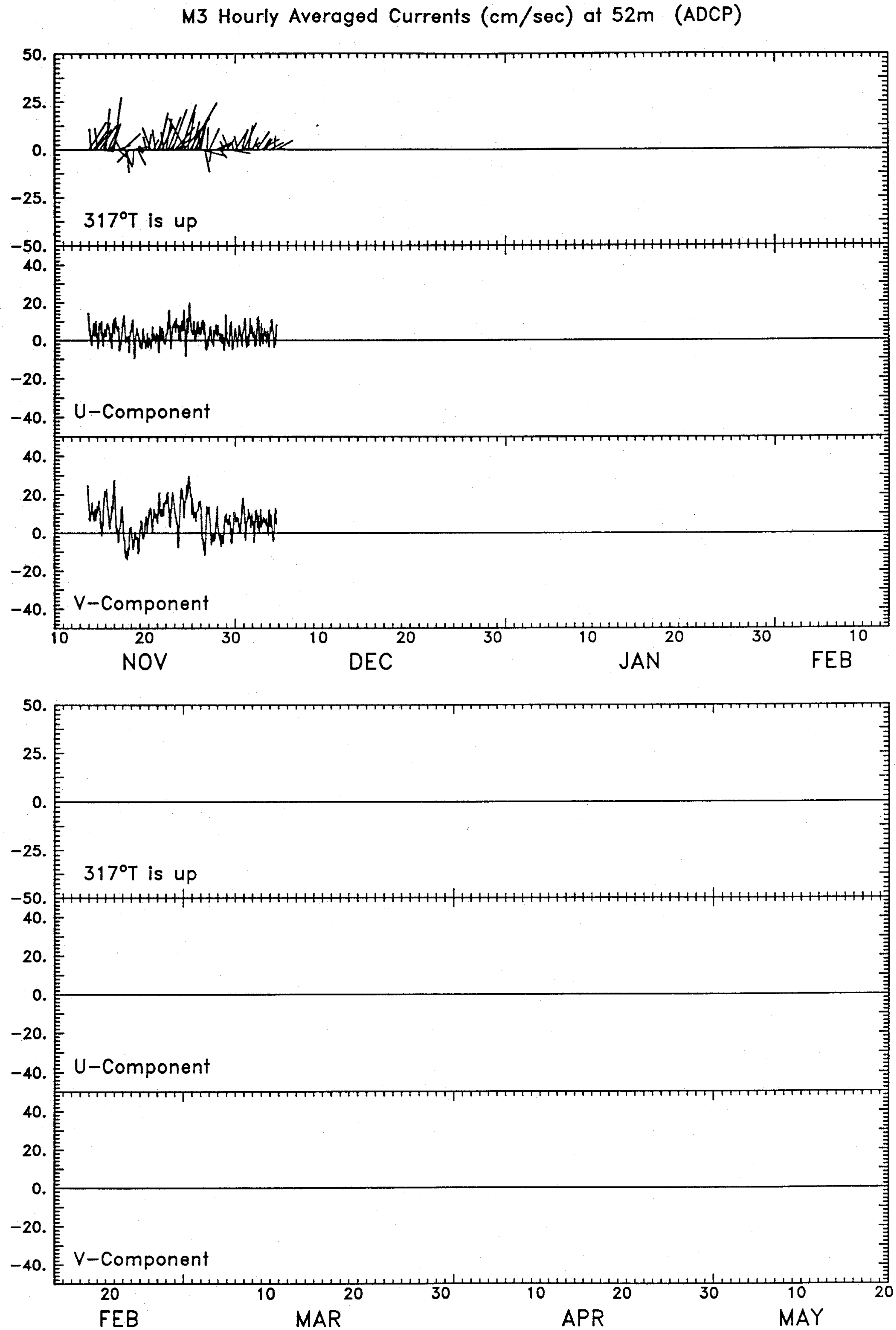

M3 Hourly Averaged Currents (cm/sec) at 52m (ADCP)
317°T is up
U-Component
V-Component
NOV
DEC
JAN
FEB
317°T is up
U-Component
V-Component
FEB
MAR
APR
MAY

Figure 101

7.3 Temperature and Conductivity Observations

Table 11: Statistics of Hourly-Averaged Conductivity and Salinity

Sta	Water Depth (m)	GMT Start Time (y m d/hm)	GMT Stop Time (y m d/hm)	Duration (Days)	Sensor Depth (m)	Mean	Std Dev	Max	Min
				Conductivity (s/m)					
C3 sc	93	881112/1300	890519/1500	188	7.0	3.68	0.07	3.89	3.52
C3 sc	93	881112/1300	890519/1500	188	13.0	3.67	0.06	3.87	3.52
C3 sc	93	881112/1300	890519/1500	188	19.0	3.66	0.06	3.86	3.51
C3 sc	93	881112/1300	890519/1500	188	27.0	3.65	0.05	3.82	3.49
C3 sc	93	881112/1300	890519/1500	188	37.0	3.64	0.04	3.80	3.46
C3	93	881114/0400	890519/1500	187	47.0	3.63	0.04	3.75	3.45
C3 sc	93	881112/1300	890519/1500	188	47.0	3.63	0.04	3.76	3.45
C3b	97	881206/0400	890227/2200	84	67.0				
C3b	95	890303/2200	890505/1600	63	65.0	3.62	0.03	3.70	3.60
C3b	97	881206/0400	890227/2200	84	79.0				
C3b	95	890303/1700	890505/1100	63	77.0	3.61	0.03	3.70	3.59
C3b	97	881206/0400	890227/2200	84	91.0				
C3b	95	890303/2200	890505/1600	63	89.0	3.60	0.04	3.68	3.56
				Salinity (ppt)					
C3 sc	93	881112/1300	890519/1500	188	7.0	33.27	0.26	33.95	32.50
C3 sc	93	881112/1300	890519/1500	188	13.0	33.30	0.24	33.94	32.65
C3 sc	93	881112/1300	890519/1500	188	19.0	33.36	0.22	33.96	32.72
C3 sc	93	881112/1300	890519/1500	188	27.0	33.42	0.20	33.96	32.78
C3 sc	93	881112/1300	890519/1500	188	37.0	33.54	0.17	34.03	32.96
C3	93	881114/0400	890519/1500	187	47.0	33.63	0.16	34.07	33.16
C3 sc	93	881112/1300	890519/1500	188	47.0	33.66	0.15	34.07	33.16
C3b	97	881206/0400	890227/2200	84	67.0				
C3b	95	890303/2200	890505/1600	63	65.0	33.69	0.12	34.01	33.33
C3b	97	881206/0400	890227/2200	84	79.0				
C3b	95	890303/1700	890505/1100	63	77.0	33.75	0.10	33.98	33.46
C3b	97	881206/0400	890227/2200	84	91.0				
C3b	95	890303/2200	890505/1600	63	89.0	33.77	0.09	33.99	33.49

Table 12: Statistics of Hourly-Averaged Water Temperature

Sta	Water Depth (m)	GMT Start Time (y m d/hm)	GMT Stop Time (y m d/hm)	Duration (Days)	Sensor Depth (m)	Mean	Std Dev	Max	Min
				Water Temperature (°C)					
C2	80	890225/1300	890516/1100	80	1.0	10.63	1.19	14.00	7.67
C2	80	890225/1300	890516/1400	80	2.0	10.54	1.16	13.69	7.61
C2	80	890225/1300	890516/1100	80	4.0	10.52	1.12	13.23	7.68
C2	80	890225/1300	890516/1100	80	5.0	10.50	1.11	13.23	7.66
C2	80	890225/1300	890516/1100	80	7.0	10.44	1.07	13.22	7.62
C2	80	890225/1300	890516/1100	80	8.0	10.37	1.04	13.19	7.59
C2	80	890225/1300	890516/1100	80	10.0	10.29	0.99	13.15	7.56
C2	80	890225/1300	890516/1100	80	13.0	10.19	0.92	12.90	7.56
C2	80	890225/1300	890516/1100	80	15.0	10.11	0.87	12.79	7.56
C2	80	890225/1300	890516/1100	80	18.0	9.98	0.80	12.51	7.40
C2	80	890225/1300	890516/1100	80	23.0	9.77	0.70	11.79	7.17
C2	80	890225/1300	890516/1100	80	27.0	9.64	0.65	11.76	7.12
C2	80	890225/1300	890516/1100	80	32.0	9.49	0.62	11.23	7.05
C2	80	890225/1300	890516/1100	80	42.0	9.27	0.61	10.72	7.01
C2	80	890225/1300	890516/1100	80	47.0	9.17	0.62	10.46	7.01
C2	80	890225/1300	890516/1100	80	53.0	9.05	0.62	10.27	6.97
C3	93	881112/1300	890519/1500	188	4.0	10.55	0.94	13.40	7.97
C3	93	881112/1300	890519/1500	188	7.0	10.49	0.91	13.07	7.94
C3 sc	93	881112/1300	890519/1500	188	7.0	10.49	0.90	13.03	7.94
C3	93	881112/1300	890425/0900	164	10.0	10.45	0.72	12.76	9.07
C3	93	881112/1300	890519/1500	188	13.0	10.34	0.81	12.84	7.91
C3 sc	93	881112/1300	890519/1500	188	13.0	10.34	0.81	12.81	7.91
C3	93	881112/1300	890519/1500	188	16.0	10.25	0.77	12.56	7.88
C3	93	881112/1300	890519/1500	188	19.0	10.17	0.73	12.51	7.87
C3 sc	93	881112/1300	890519/1500	188	19.0	10.16	0.73	12.51	7.86
C3	93	881112/1300	890519/1500	188	22.0	10.09	0.69	12.39	7.83
C3	93	881112/1300	890519/1500	188	27.0	9.95	0.65	11.97	7.66
C3 sc	93	881112/1300	890519/1500	188	27.0	9.94	0.65	11.92	7.66
C3	93	881112/1300	890519/1500	188	32.0	9.82	0.62	11.65	7.45
C3	93	881112/1300	890519/1500	188	37.0	9.68	0.59	11.51	7.22
C3 sc	93	881112/1300	890519/1500	188	37.0	9.68	0.59	11.56	7.26
C3	93	881112/1300	890519/1500	188	42.0	9.58	0.58	11.36	7.10
C3	93	881112/1300	890519/1500	188	47.0	9.46	0.57	11.17	7.04
C3 sc	93	881112/1300	890519/1500	188	47.0	9.46	0.57	11.17	7.04
C3b	97	881206/0300	890227/2200	84	67.0				
C3b	95	890303/2100	890505/1600	63	65.0	9.31	0.45	10.64	8.92
C3b	97	881206/0300	890227/2200	84	73.0				
C3b	95	890303/2100	890505/1600	63	71.0	9.25	0.45	10.57	8.86
C3b	97	881206/0300	890227/2200	84	79.0				
C3b	95	890303/2100	890505/1600	63	77.0	9.19	0.45	10.47	8.79
C3b	97	881206/0300	890227/2200	84	85.0				
C3b	95	890303/2100	890505/1600	63	83.0	9.11	0.47	10.18	8.61
C3b	97	881206/0300	890227/2200	84	91.0				
C3b	95	890303/2100	890505/1600	63	89.0	9.04	0.48	10.16	8.40
C4	117	881113/1300	890516/1200	184	2.0	10.77	0.95	13.88	8.51
C4	117	881113/1300	890516/1200	184	4.0	10.69	0.93	13.57	8.45
C4	117	881113/1300	890516/1200	184	5.0	10.68	0.92	13.46	8.45
C4	117	881113/1300	890516/1200	184	7.0	10.65	0.91	13.44	8.45
C4	117	881113/1300	890516/1200	184	9.0	10.63	0.89	13.44	8.45
C4	117	881113/1300	890516/1200	184	10.0	10.63	0.87	13.49	8.50
C4	117	881113/1300	890516/1200	184	13.0	10.55	0.84	13.39	8.45
C4	117	881113/1300	890516/1200	184	15.0	10.49	0.80	13.27	8.45
C4	117	881113/1300	890516/1200	184	18.0	10.41	0.75	12.96	8.44

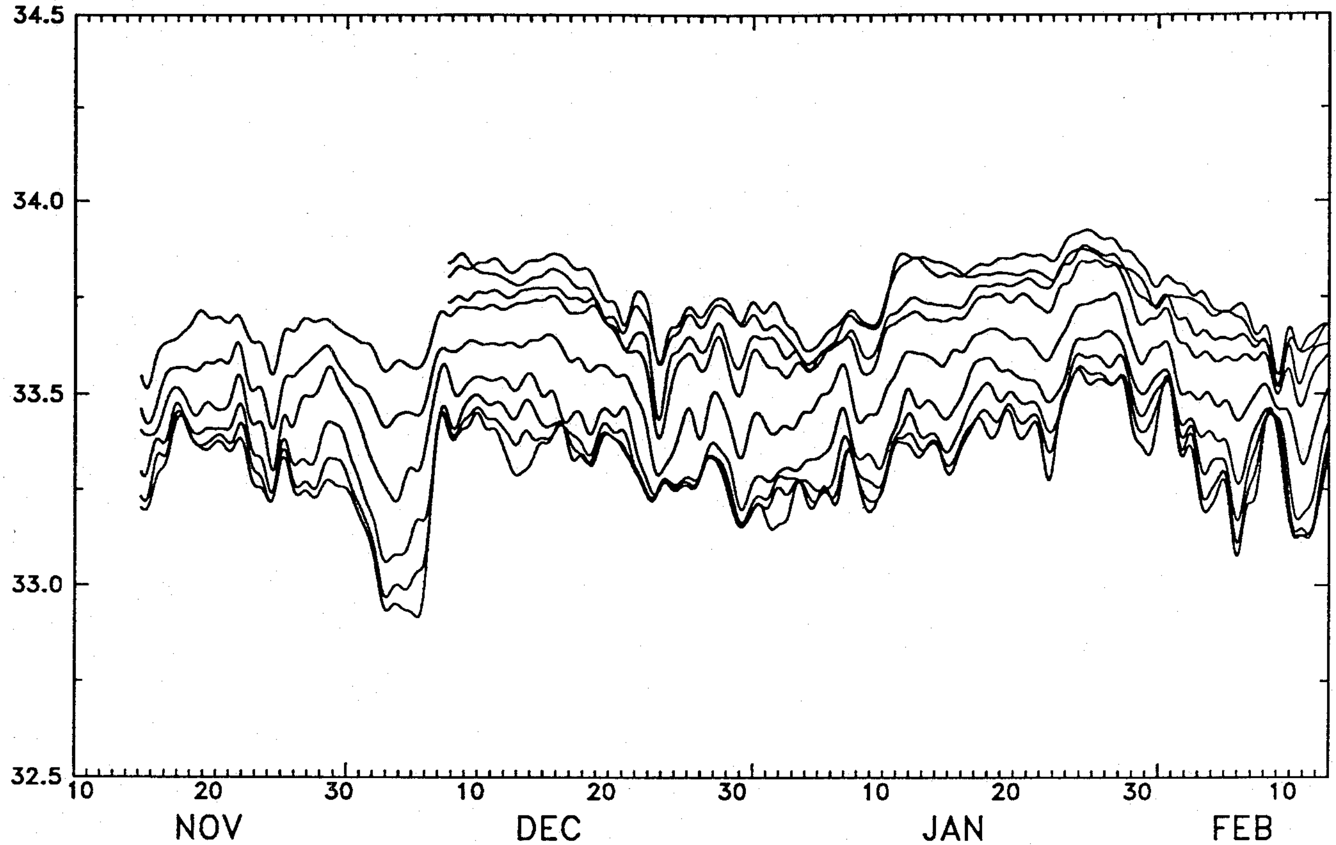
Table 12: Statistics of Hourly-Averaged Water Temperature (Continued)

Sta	Water Depth (m)	GMT Start Time (y m d/hm)	GMT Stop Time (y m d/hm)	Duration (Days)	Sensor Depth (m)	Mean	Std Dev	Max	Min
C4	117	881113/1300	890516/1200	184	22.0	10.31	0.69	12.60	8.43
C4	117	881113/1300	890516/1200	184	27.0	10.18	0.62	12.43	8.39
C4	117	881113/1300	890516/1200	184	32.0	10.03	0.56	12.04	8.36
C4	117	881113/1300	890516/1200	184	37.0	9.88	0.51	11.65	8.11
C4	117	881113/1300	890516/1200	184	42.0	9.77	0.47	11.46	7.97
C4	117	881113/1300	890516/1200	184	47.0	9.64	0.44	11.17	7.61
C4	117	881113/1300	890516/1200	184	53.0	9.50	0.43	11.03	7.43
C4	117	881113/1600	890516/1000	184	54.0	8.50	0.41	9.96	6.54
G3	93	881113/1300	890409/0200	147	1.0	10.49	0.69	12.53	9.13
G3	93	881113/1300	890516/1200	184	2.0	10.55	0.90	13.45	8.38
G3	93	881113/1300	890516/1200	184	4.0	10.53	0.88	13.19	8.39
G3	93	881113/1300	890516/1200	184	5.0	10.52	0.87	13.07	8.39
G3	93	881113/1300	890516/1200	184	7.0	10.48	0.84	12.91	8.38
G3	93	881113/1300	890516/1200	184	9.0	10.46	0.82	12.90	8.37
G3	93	881113/1300	890516/1200	184	10.0	10.38	0.80	12.79	8.31
G3	93	881113/1300	890516/1200	184	13.0	10.37	0.77	12.58	8.26
G3	93	881113/1300	890516/1200	184	16.0	10.32	0.74	12.43	8.13
G3	93	881113/1300	890516/1200	184	19.0	10.25	0.70	12.41	8.02
G3	93	881113/1300	890516/1200	184	22.0	10.16	0.67	12.19	7.95
G3	93	881113/1300	890516/1200	184	27.0	10.04	0.63	12.10	7.91
G3	93	881113/1300	890516/1200	184	32.0	9.93	0.60	11.86	7.83
G3	93	881113/1300	890516/1200	184	37.0	9.81	0.57	11.57	7.68
G3	93	881113/1300	890516/1200	184	42.0	9.70	0.56	11.38	7.35
G3	93	881113/1300	890516/1200	184	47.0	9.60	0.55	11.15	7.20
G3	93	881113/1300	890516/1200	184	53.0	9.49	0.55	11.02	7.09
G3	93	881113/0100	881128/0900	15	54.0	10.10	0.22	11.01	9.69
M3	93	881113/1300	890517/1200	185	1.0	10.66	0.96	13.95	8.14
M3	93	881113/1300	890516/1200	184	4.0	10.57	0.91	13.44	8.10
M3	93	881113/1300	890516/1200	184	5.0	10.57	0.90	13.43	8.13
M3	93	881113/1300	890516/1200	184	7.0	10.53	0.88	13.42	8.13
M3	93	881113/1300	890516/1200	184	9.0	10.40	0.85	13.32	8.04
M3	93	881113/1300	890517/1200	185	10.0	10.48	0.84	13.44	8.16
M3	93	881113/1300	890516/1200	184	15.0	10.34	0.77	13.29	8.10
M3	93	881113/1300	890516/1200	184	18.0	10.24	0.73	12.95	8.02
M3	93	881113/1300	890516/1200	184	22.0	10.15	0.69	12.22	7.92
M3	93	881113/1300	890516/1200	184	27.0	10.06	0.65	12.12	7.85
M3	93	881113/1300	890516/1200	184	32.0	9.92	0.62	12.06	7.63
M3	93	881113/1300	890516/1200	184	37.0	9.80	0.59	11.68	7.48
M3	93	881113/1300	890516/1200	184	42.0	9.71	0.57	11.52	7.31
M3	93	881113/1300	890516/1200	184	47.0	9.59	0.55	11.31	7.17
M3	93	881113/1300	890516/1200	184	52.0	9.48	0.54	11.12	7.13
M3	93	881113/2100	881128/0900	15	54.0	10.17	0.33	11.34	9.54
13	125	881110/0000	890520/2300	192	1.0	11.10	1.12	14.80	9.00
14	306	890112/2100	890506/1600	114	1.0	10.89	1.05	14.47	9.37

Abbreviations:

sc: Self-contained temperature-conductivity unit, SeaCat

PL64 Low-Pass Filtered Salinity (ppt) at C3



PL64 Low-Pass Filtered Temperature (°C) at C3

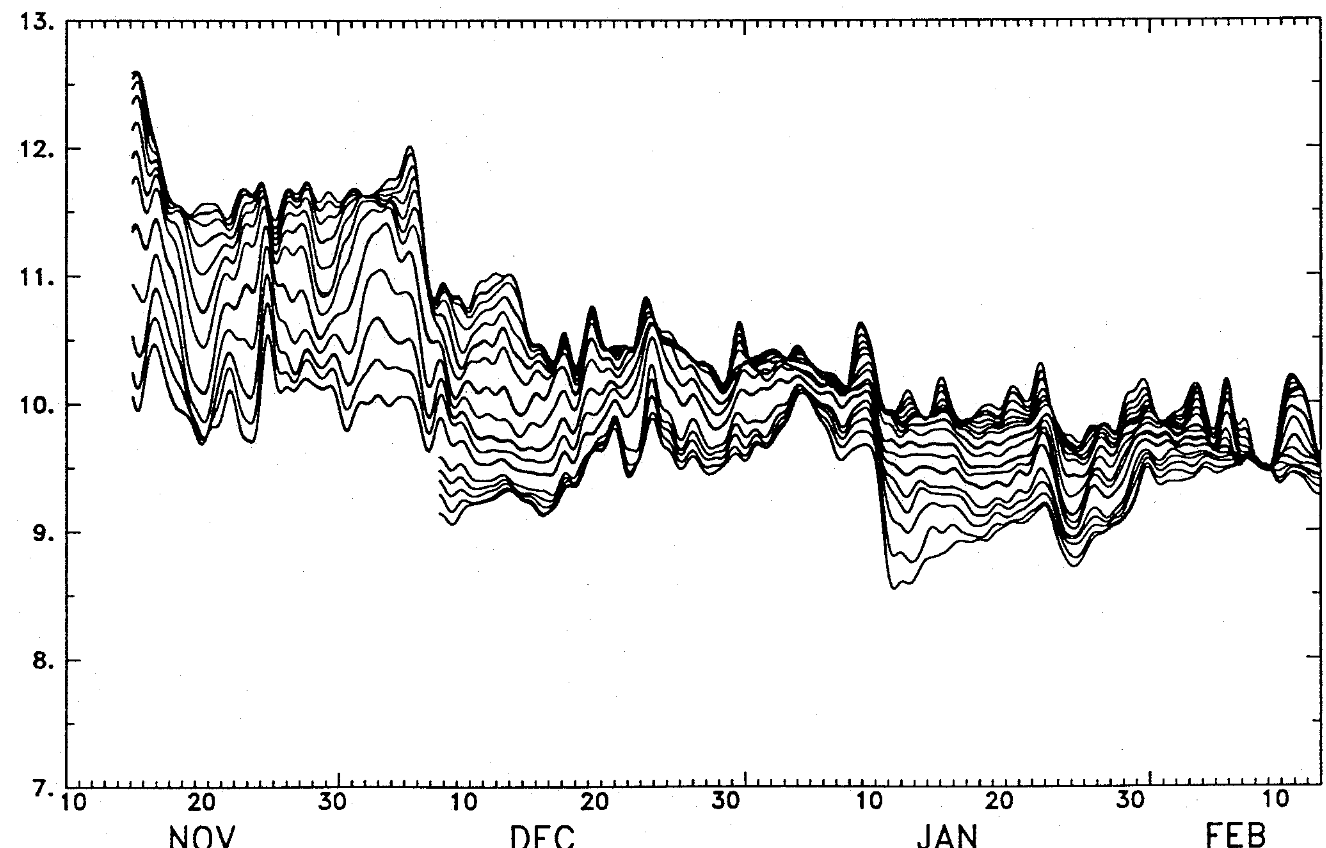
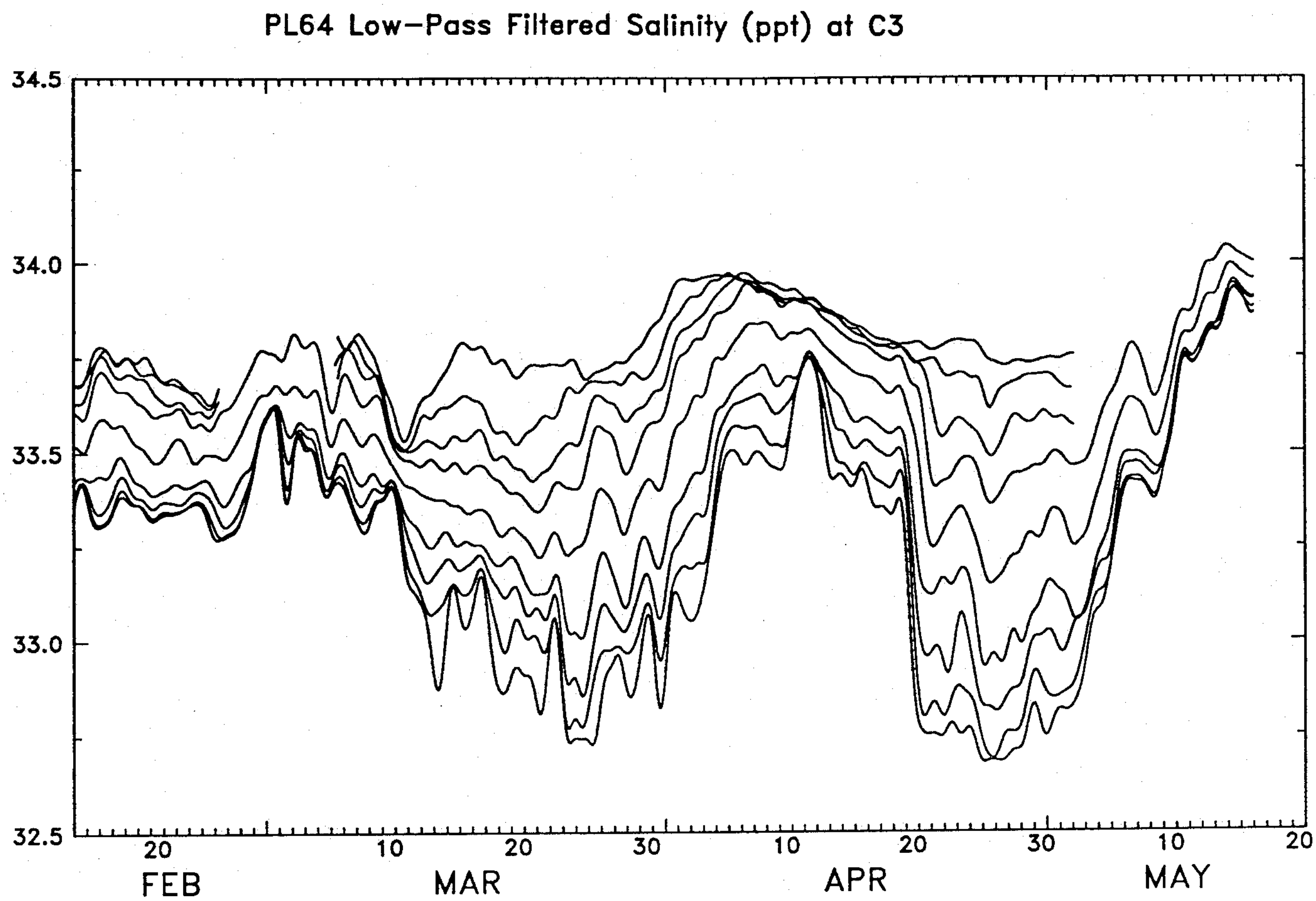


Figure 102



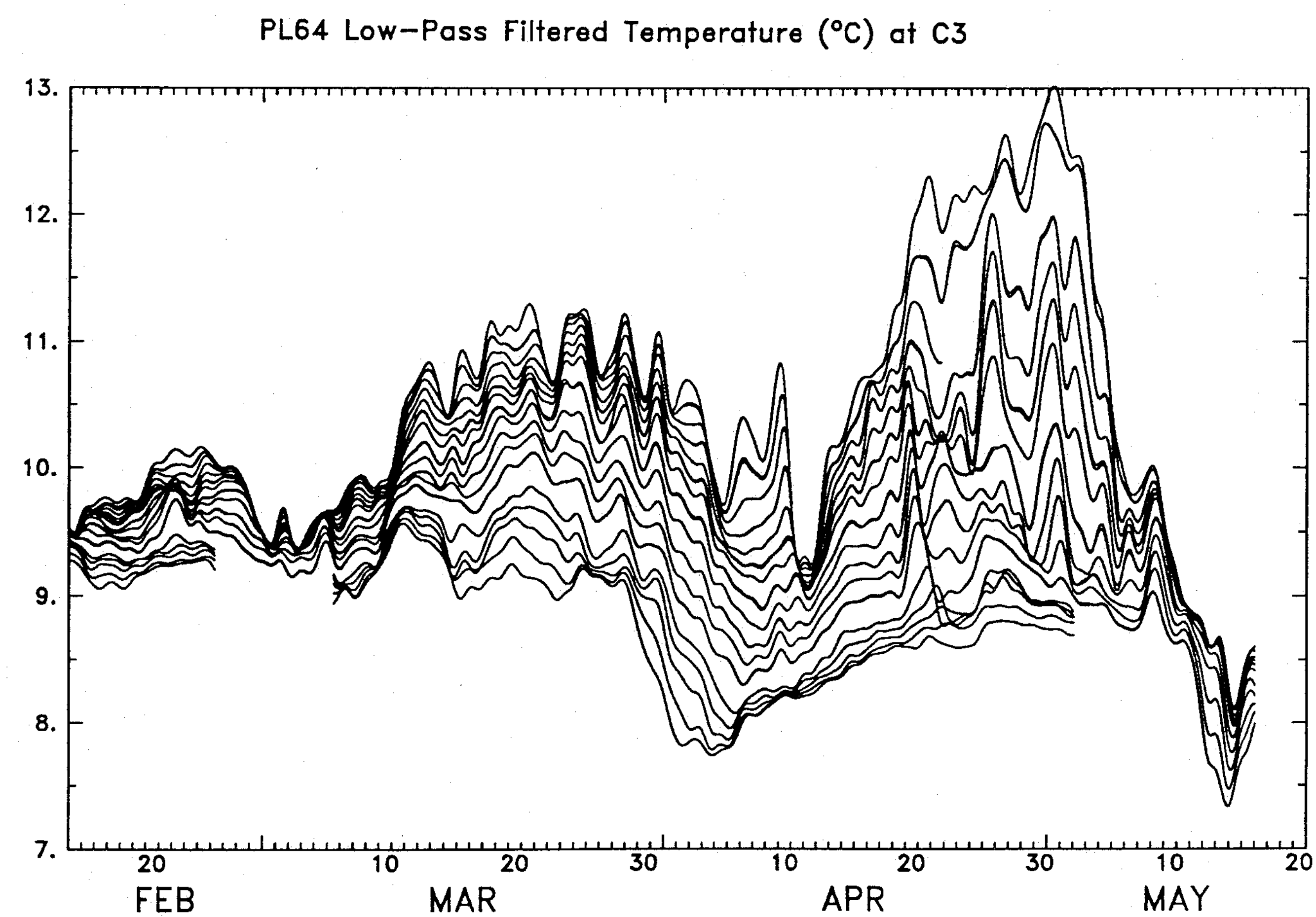
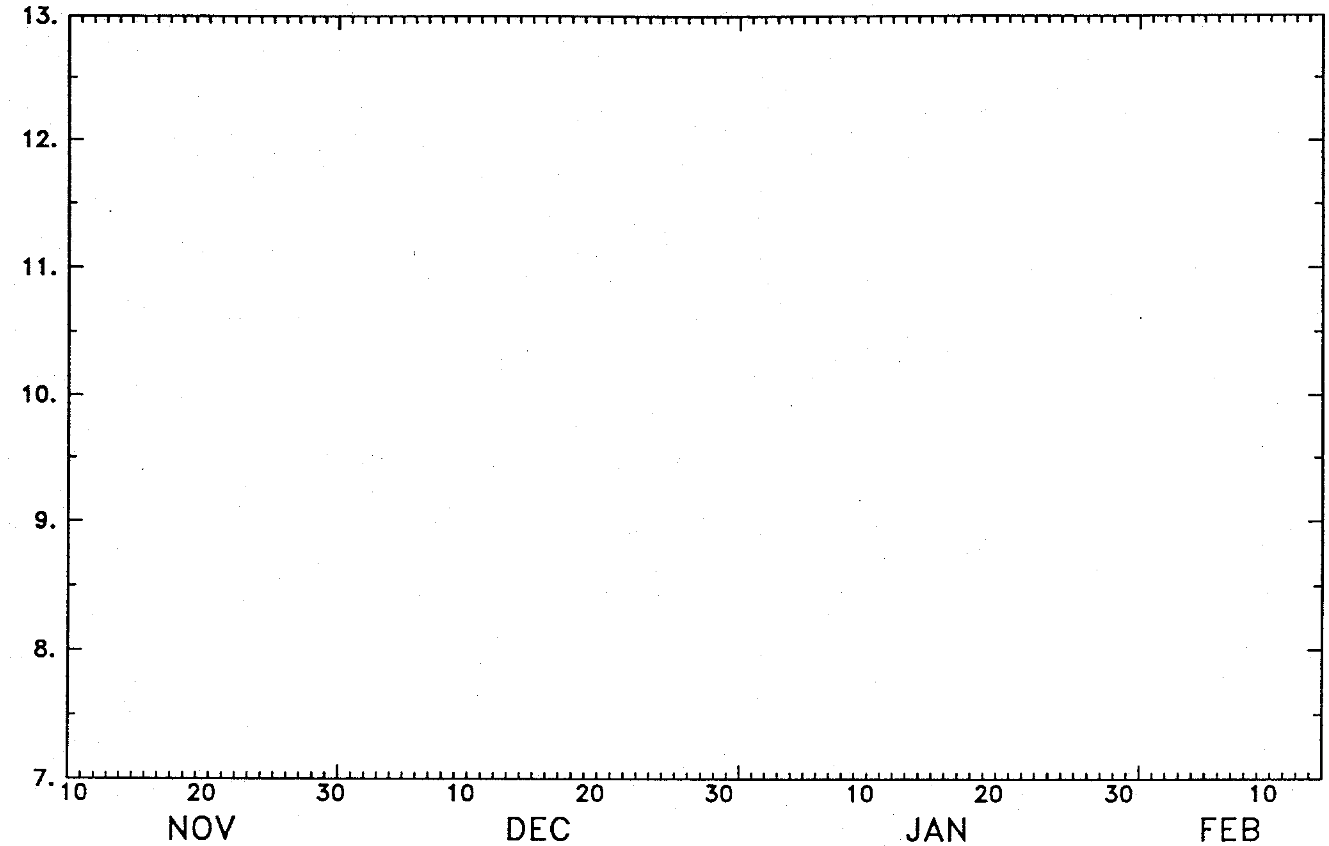


Figure 102 (cont.)

PL64 Low–Pass Filtered Temperature (°C) at C2



PL64 Low–Pass Filtered Temperature (°C) at C4

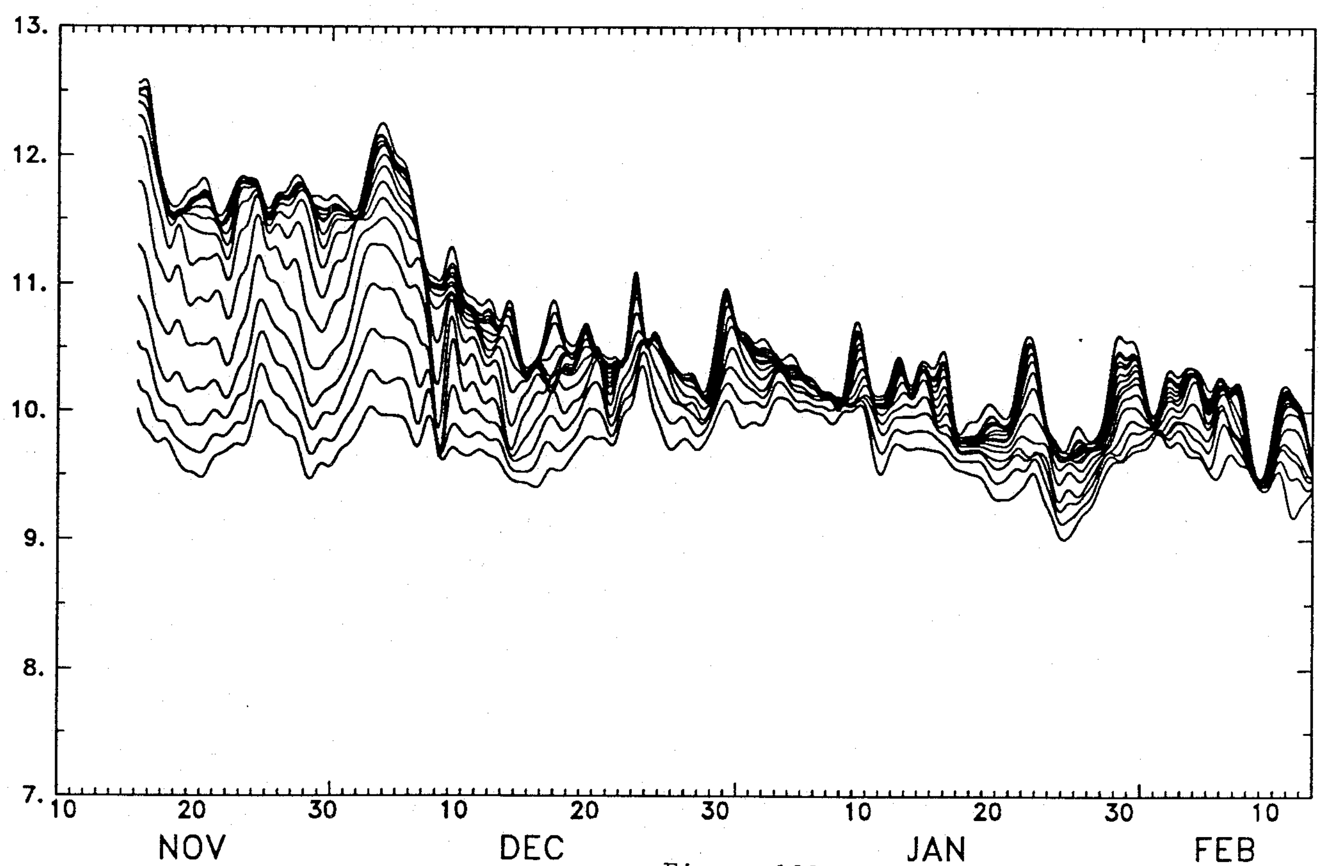
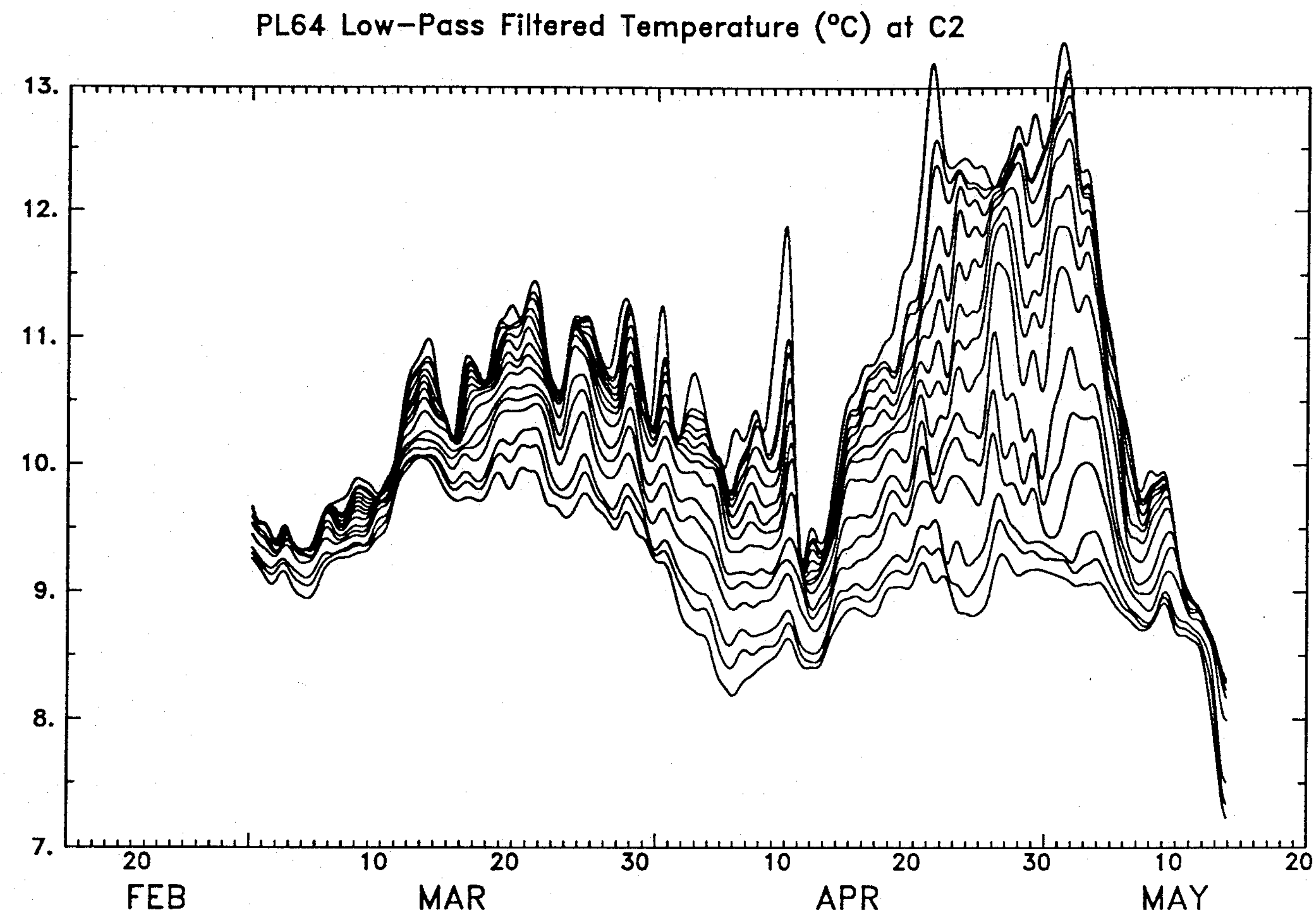


Figure 103



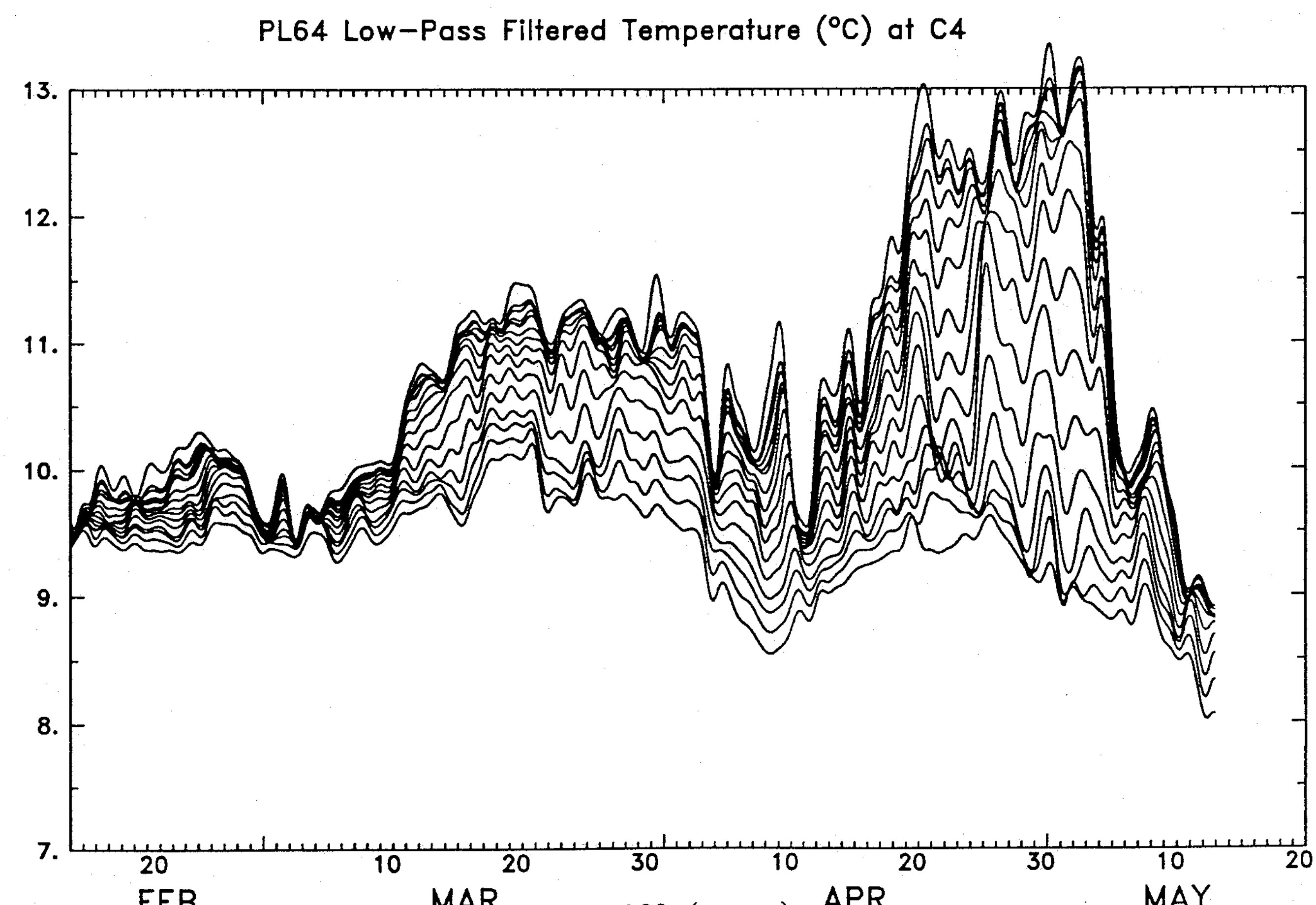
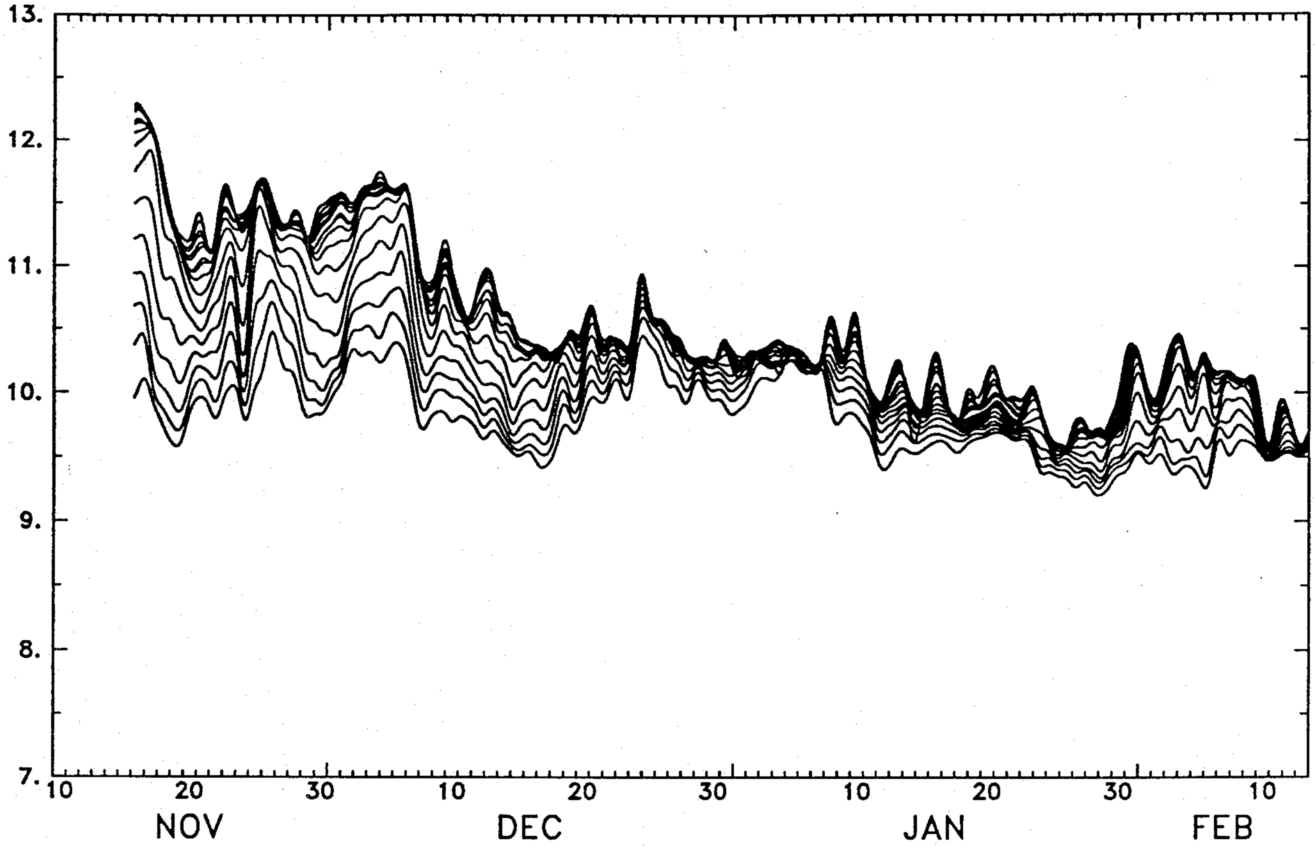


Figure 103 (cont.)

PL64 Low-Pass Filtered Temperature (°C) at G3



PL64 Low-Pass Filtered Temperature (°C) at M3

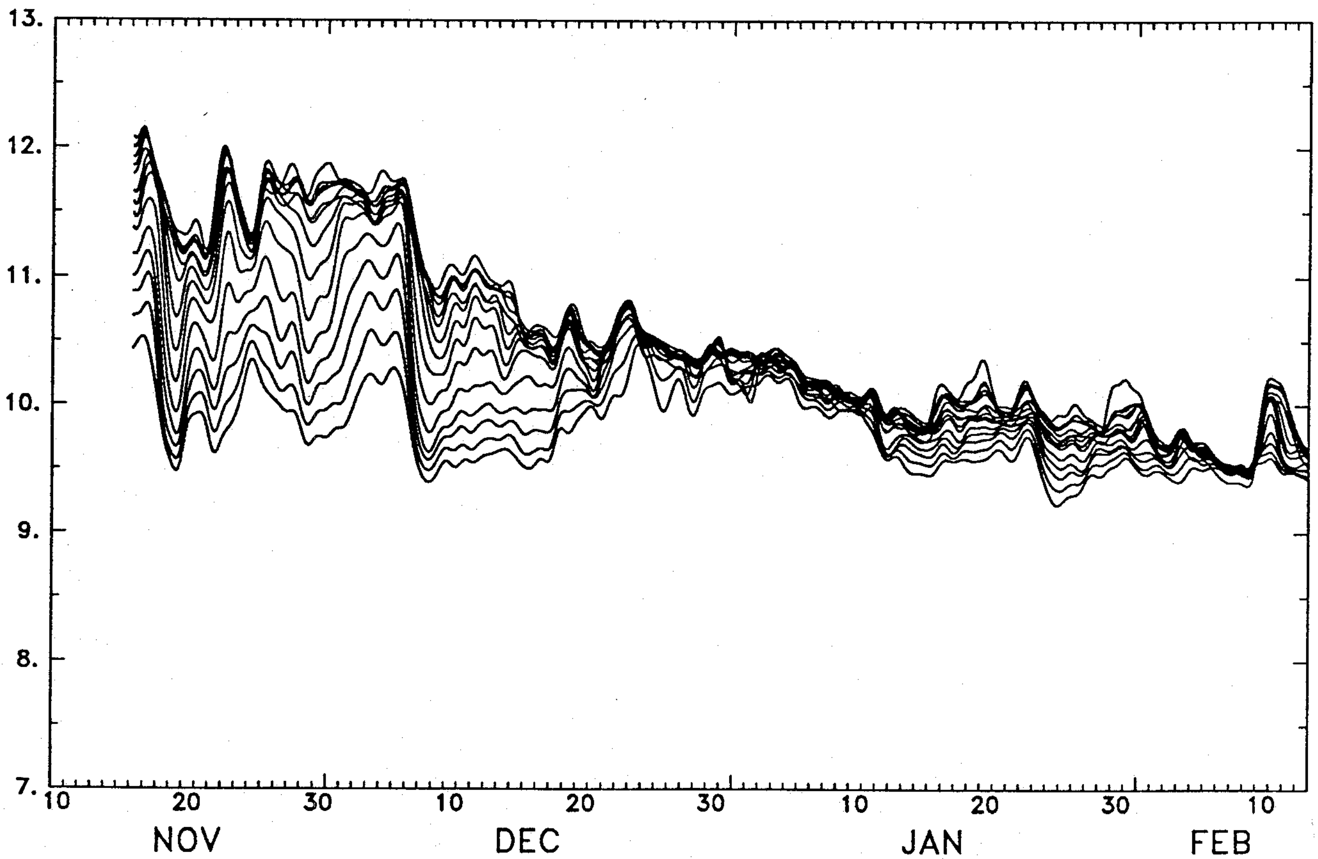
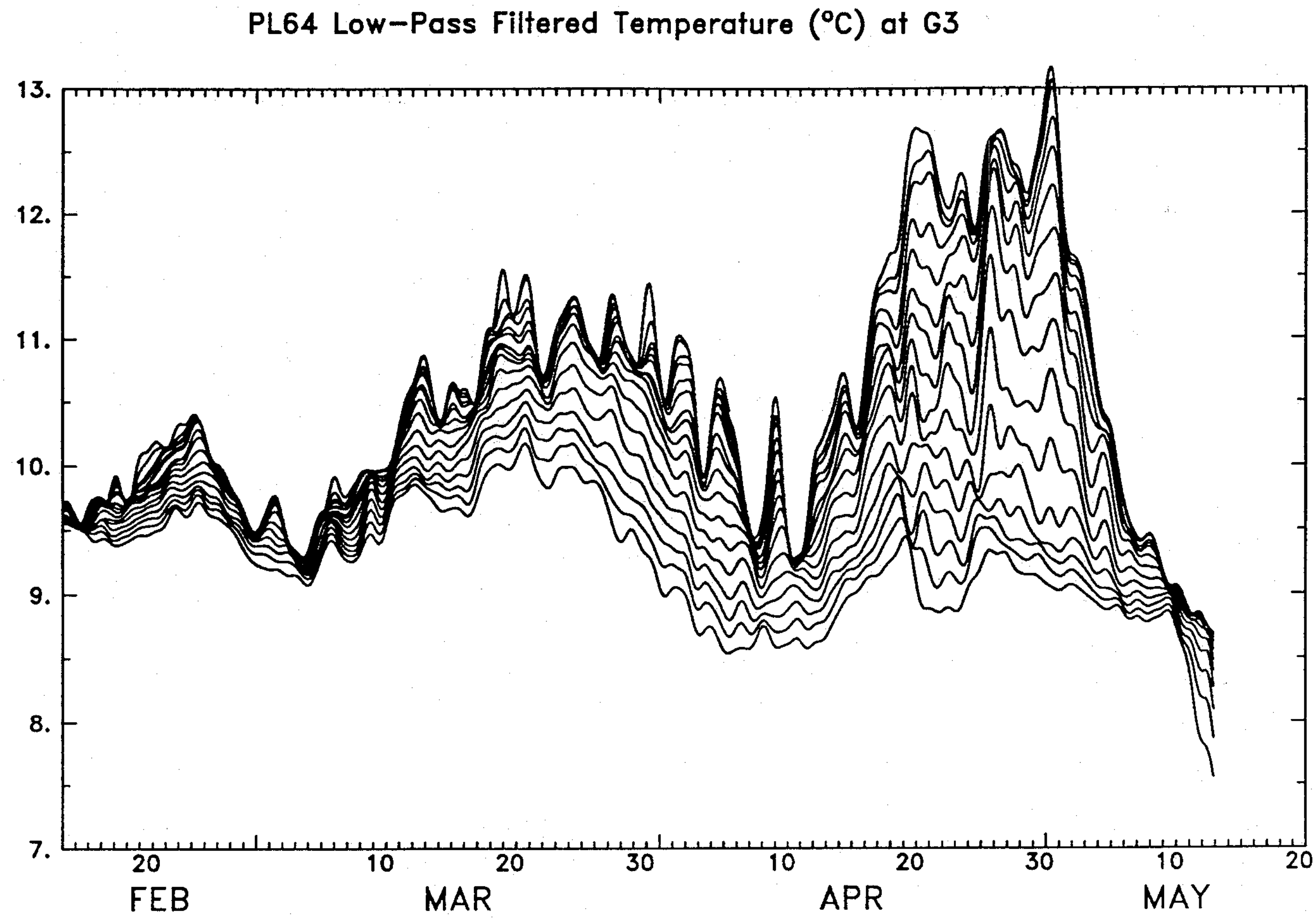


Figure 104



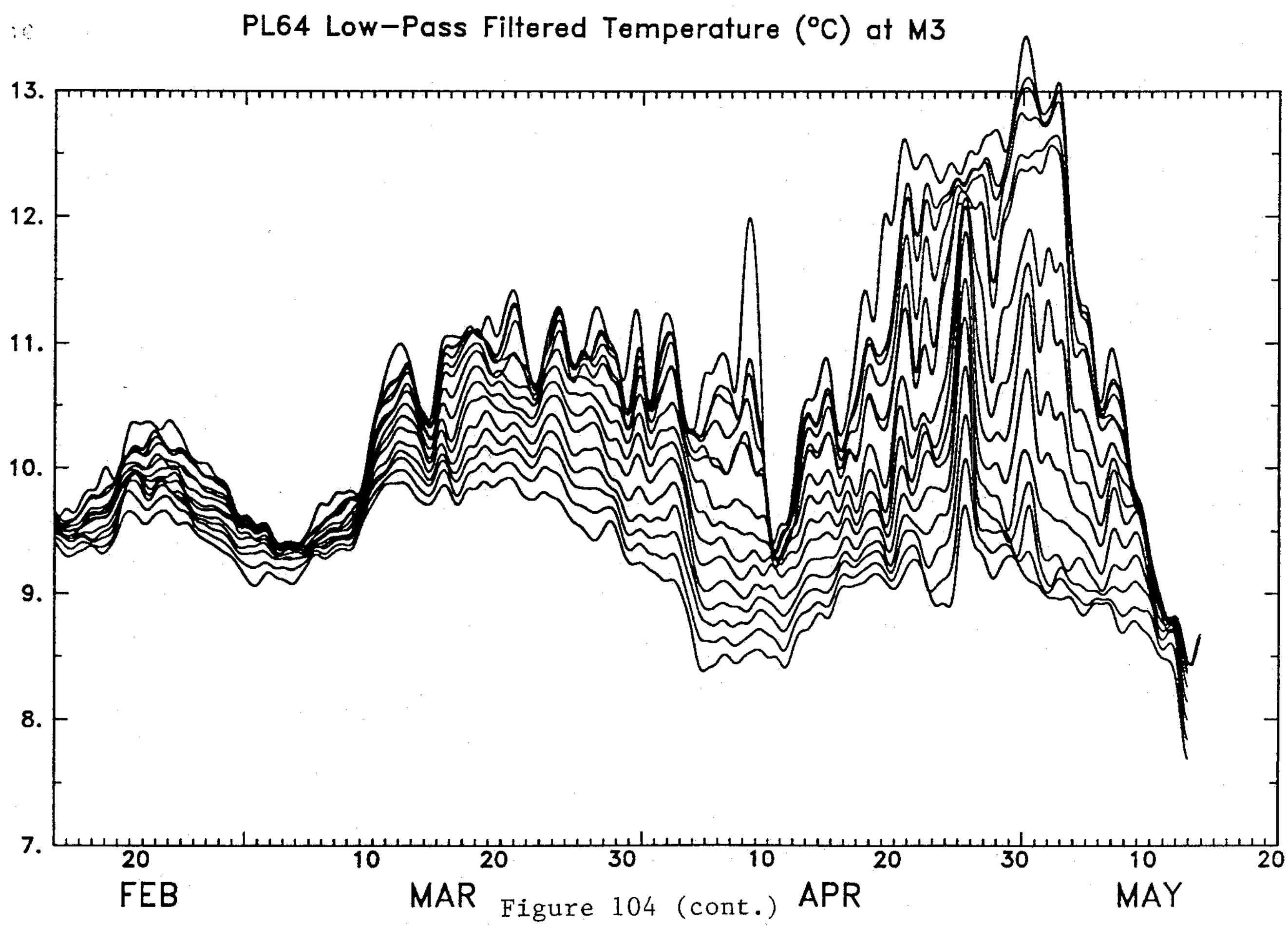


Figure 104 (cont.)

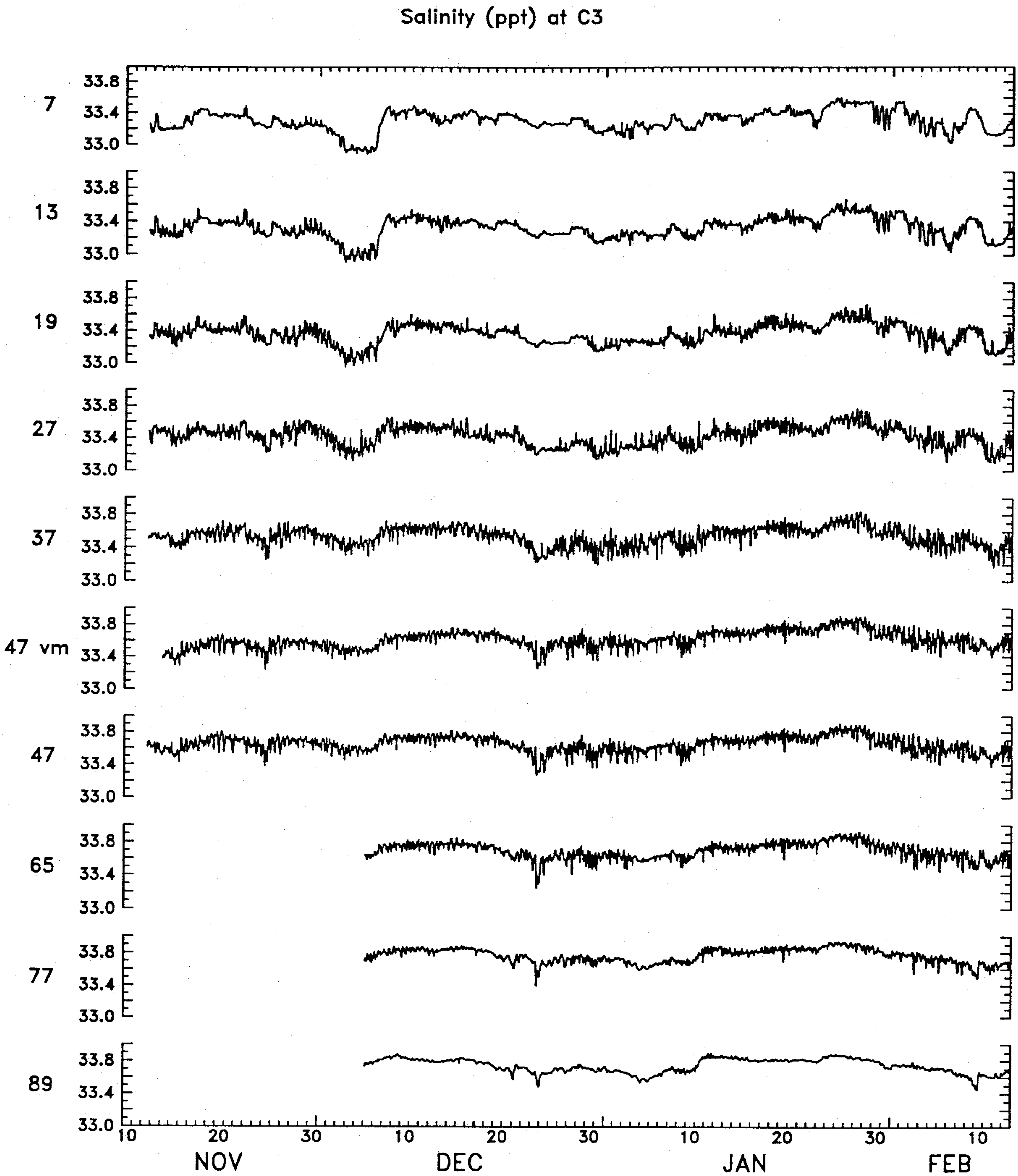

Salinity (ppt) at C3
7
13
19
27
37
47 vm
47
65
77
89
33.8
33.4
33.0
10
20
30
NOV
DEC
JAN
FEB

Figure 105

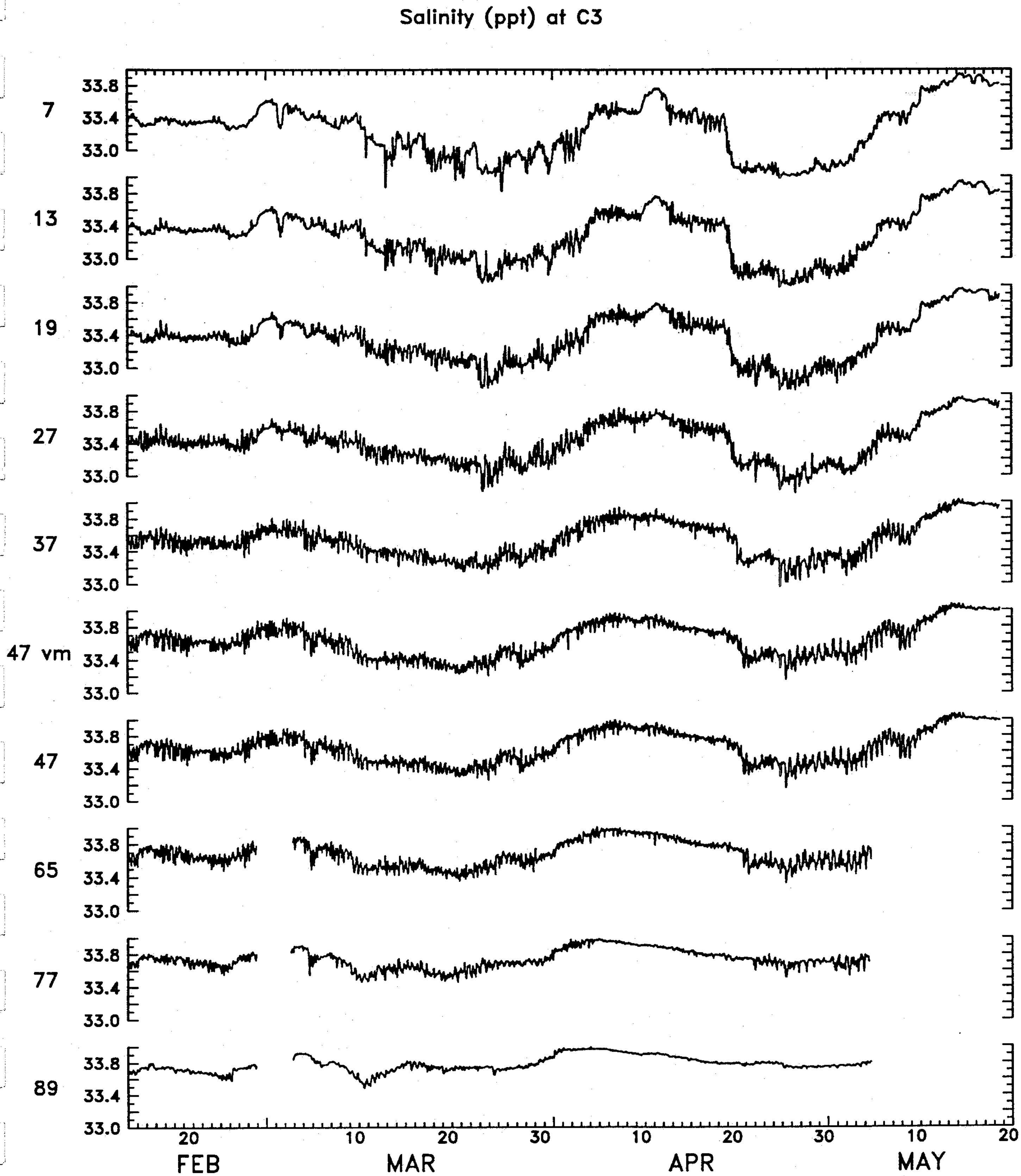


Figure 105 (cont.)

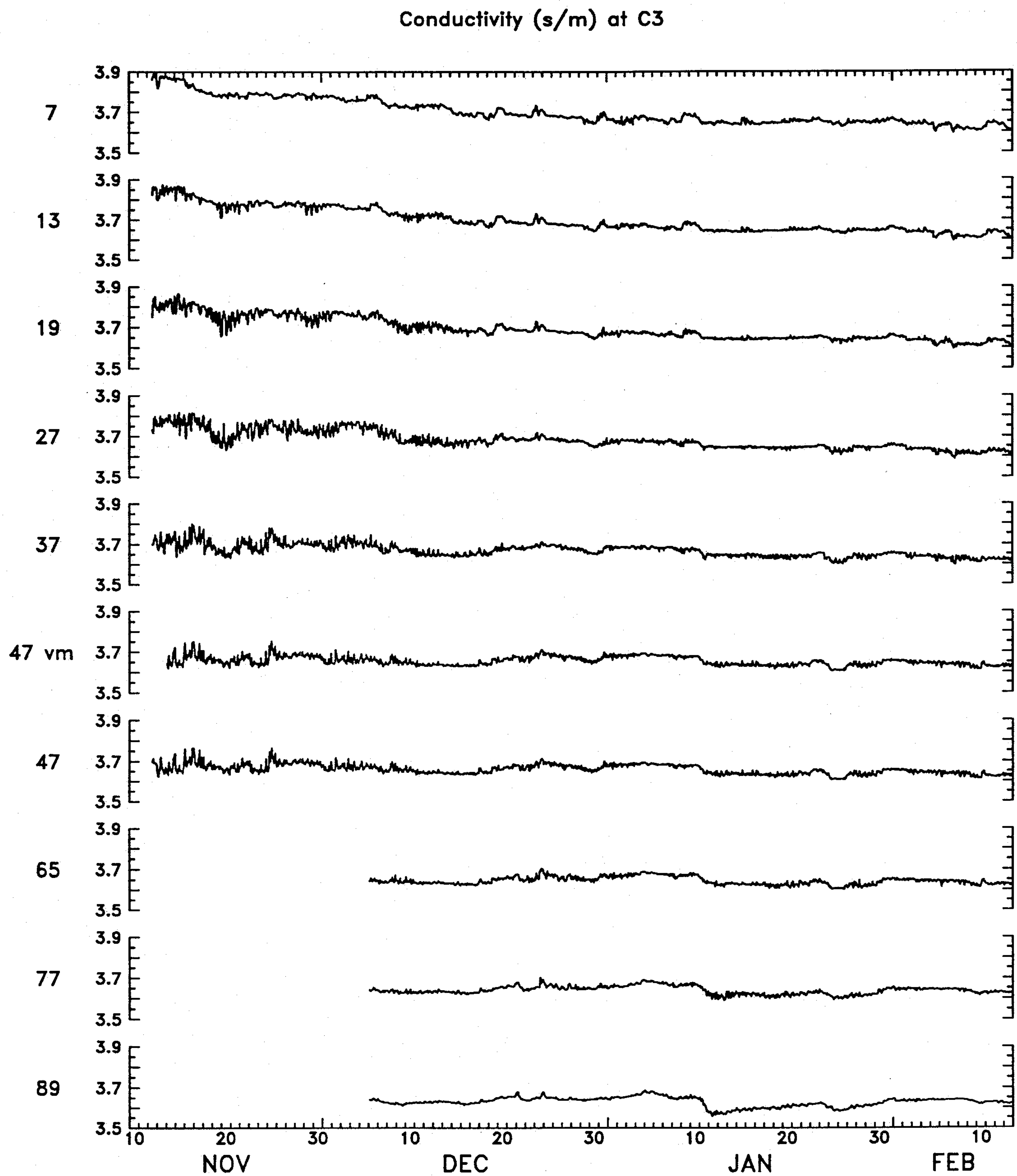

Conductivity (s/m) at C3
7
13
19
27
37
47 vm
47
65
77
89
3.9
3.7
3.5
10
20
30
NOV
DEC
JAN
FEB

Figure 106

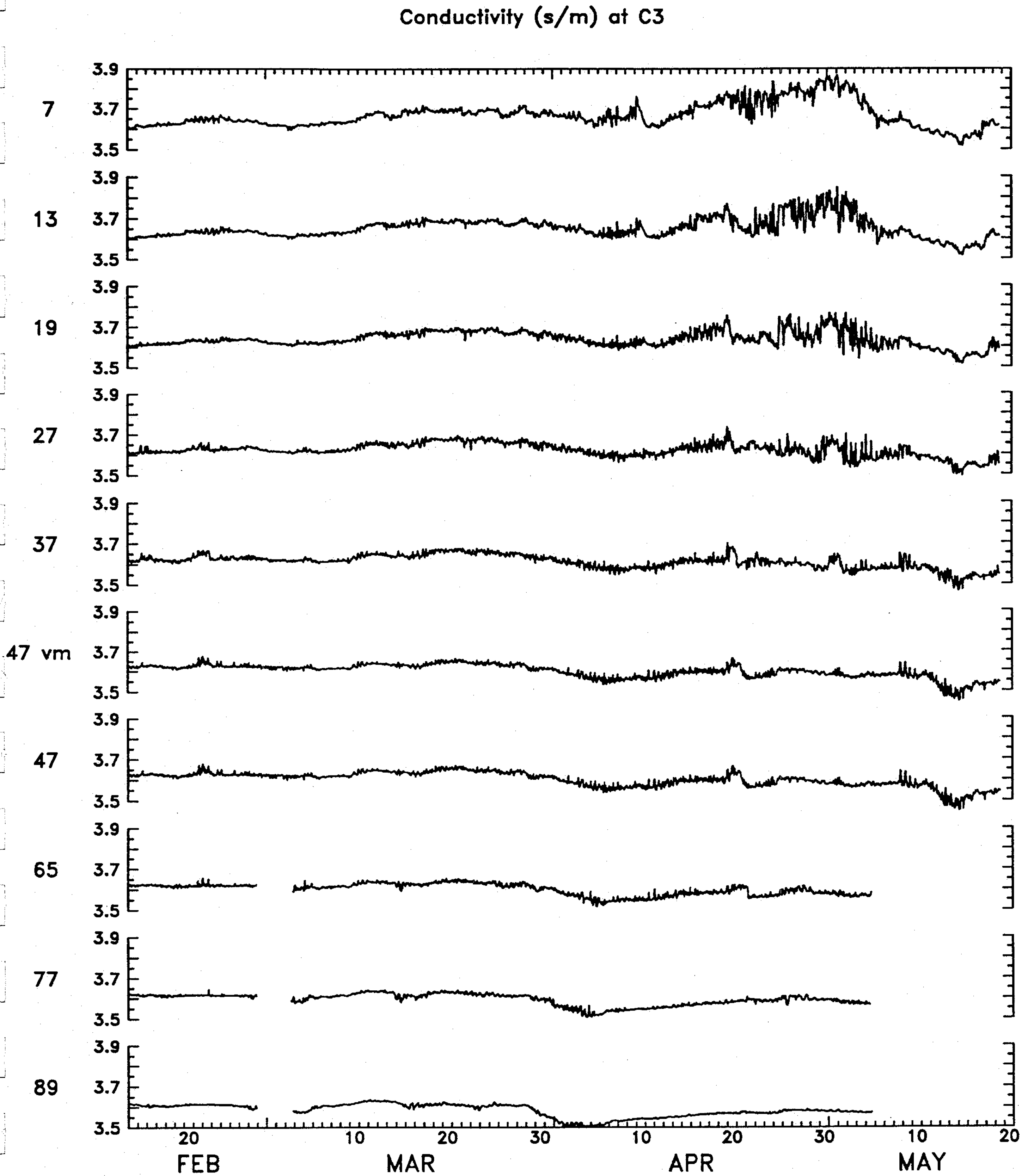
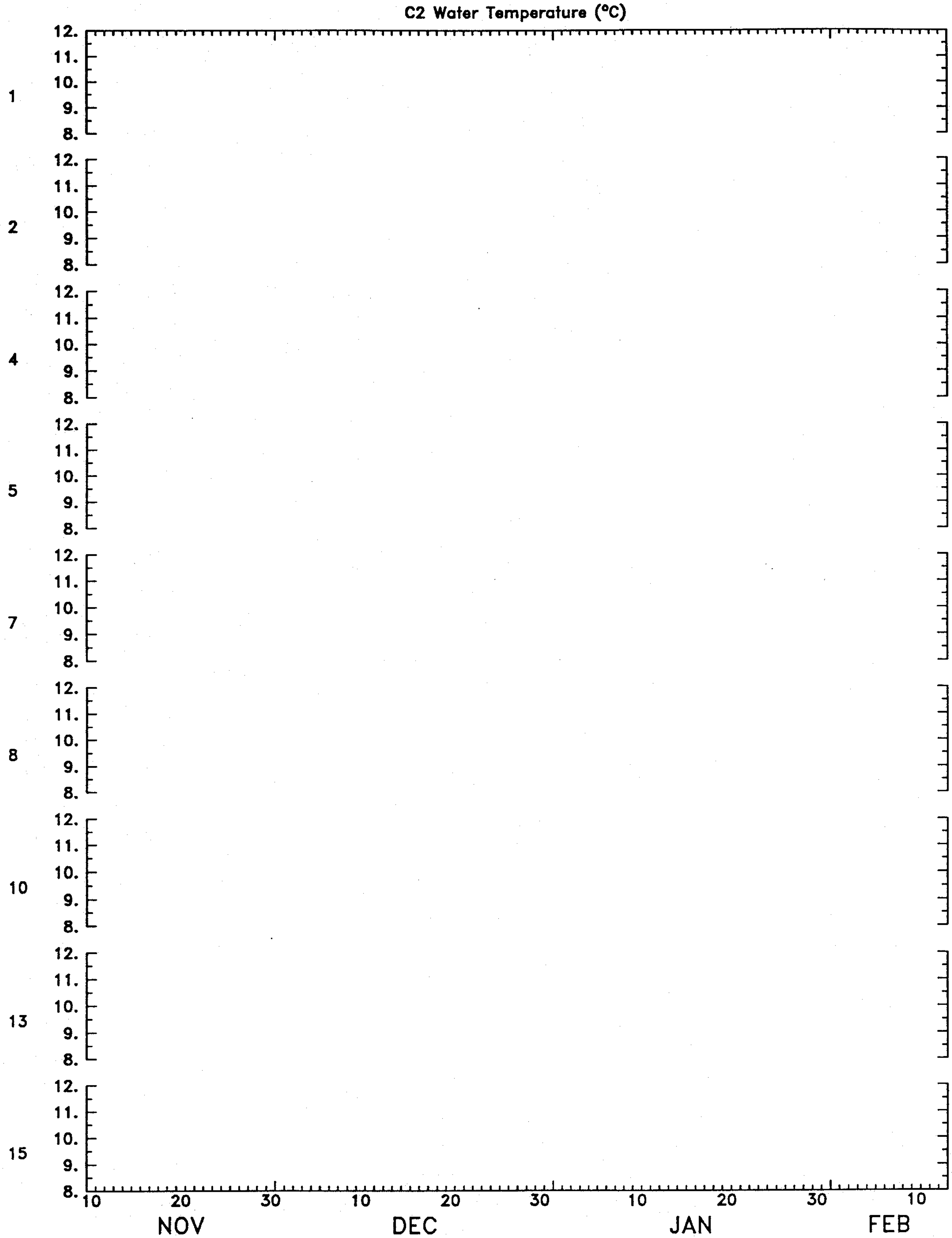
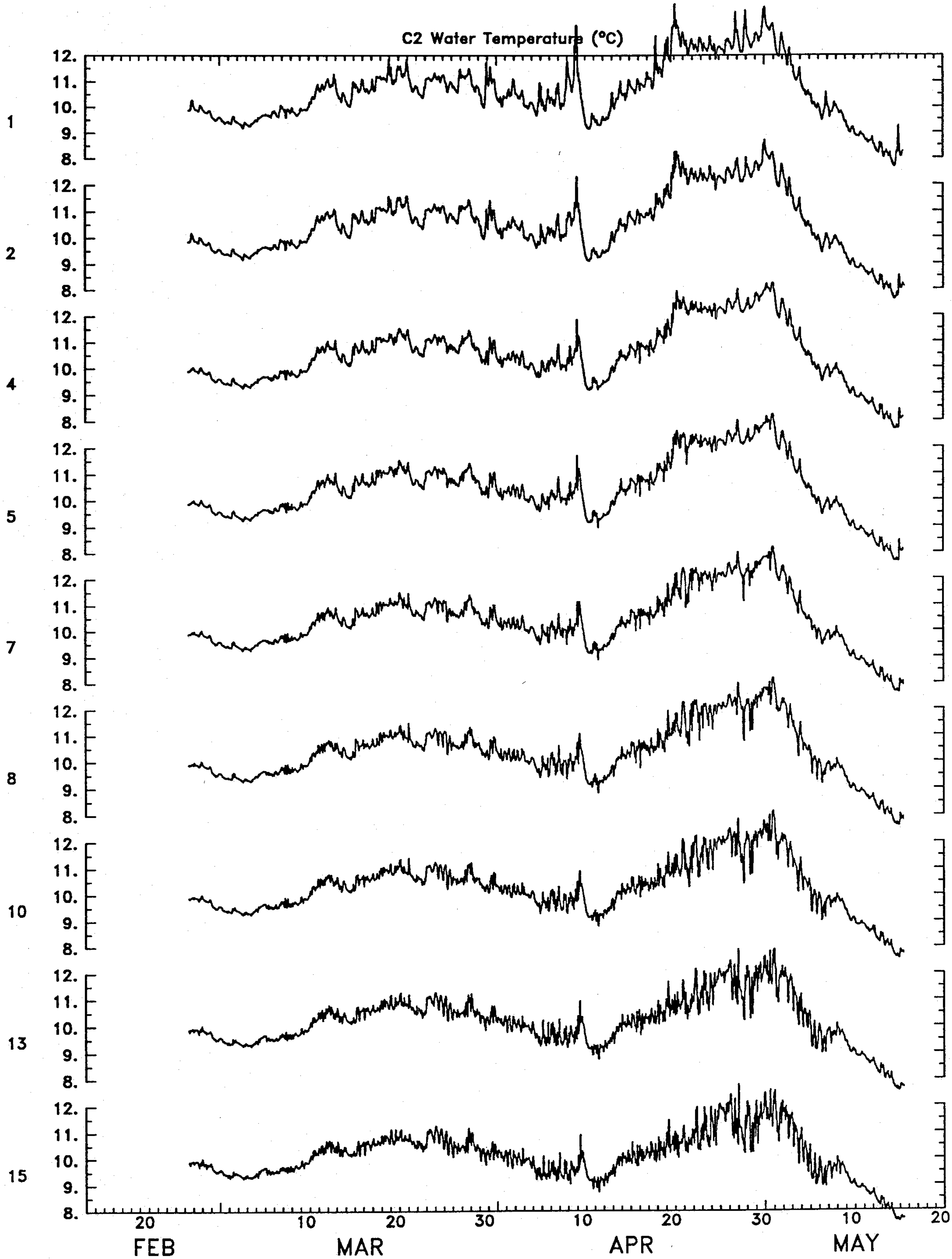


Figure 106 (cont.)



C2 Water Temperature (°C)
1
2
4
5
7
8
10
13
15
12.
11.
10.
9.
8.
10
20
30
NOV
DEC
JAN
FEB

Figure 107



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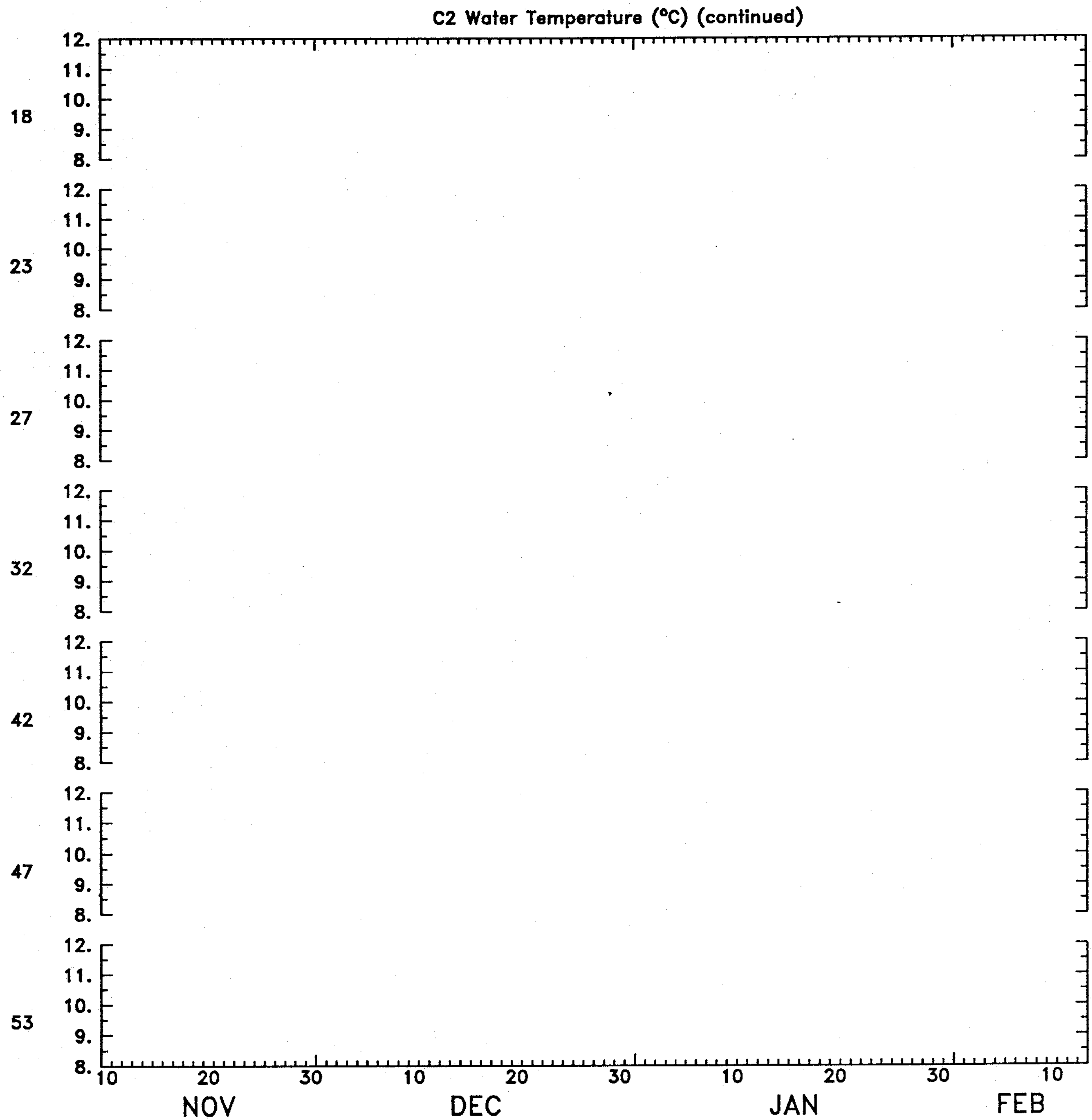

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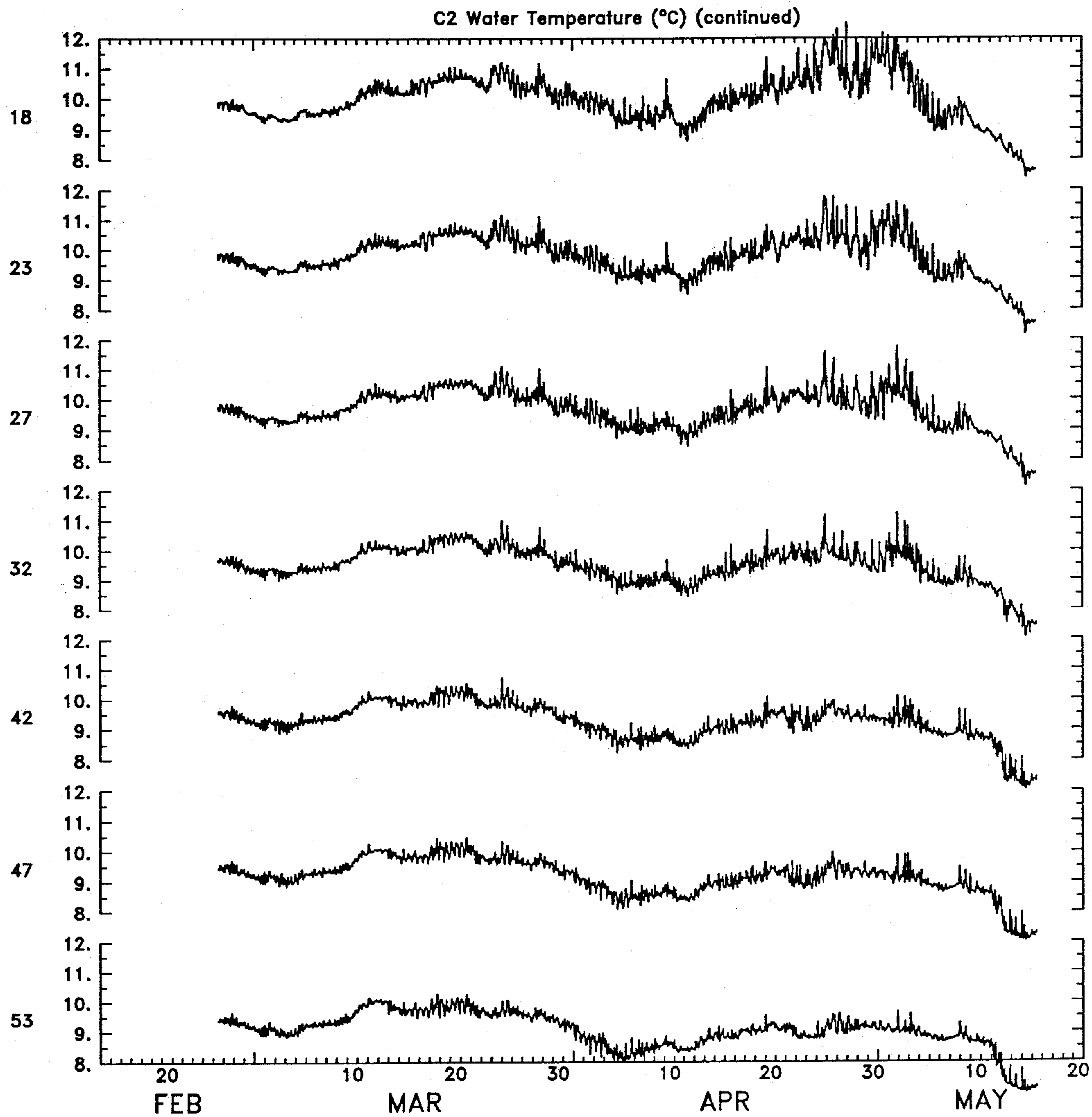

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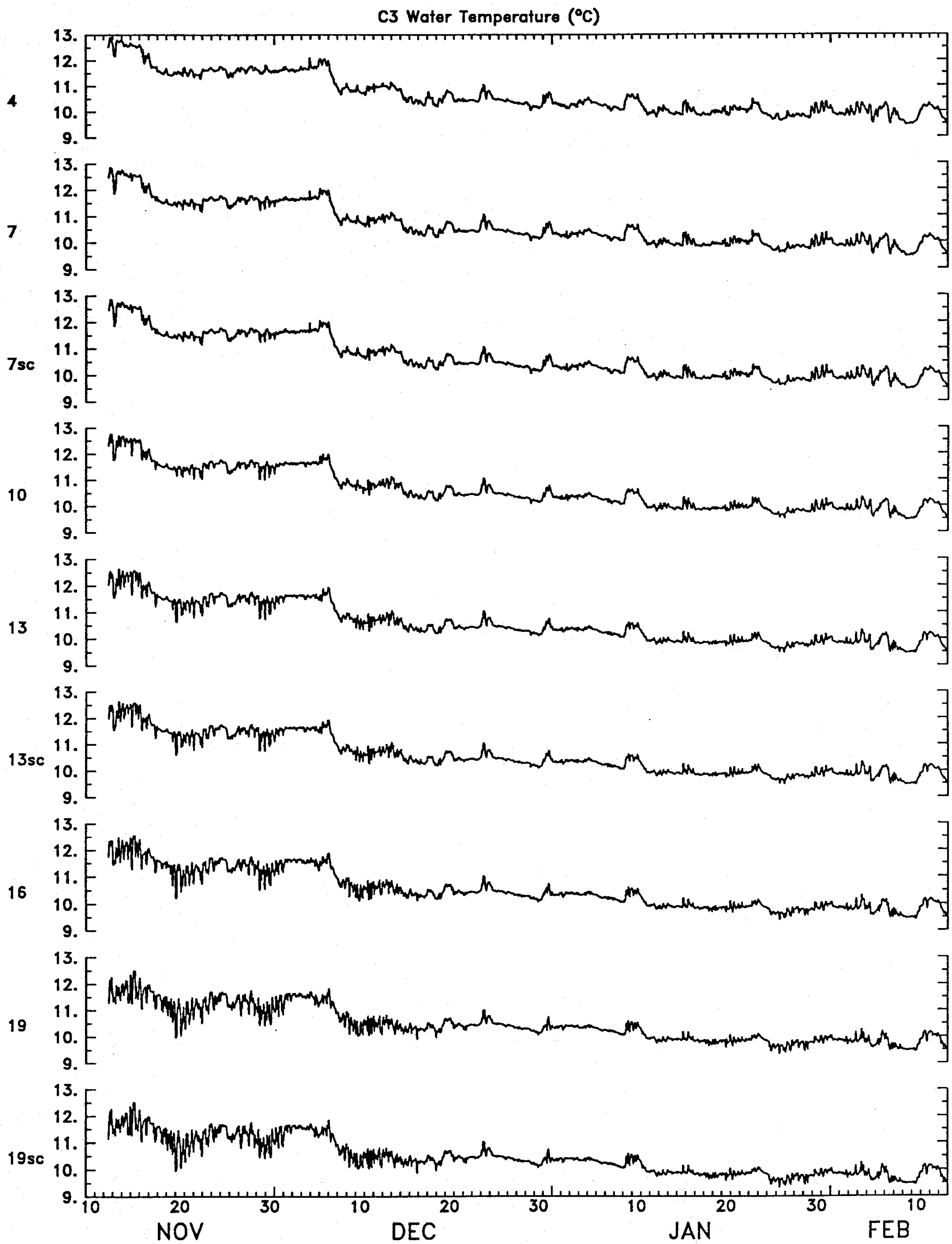
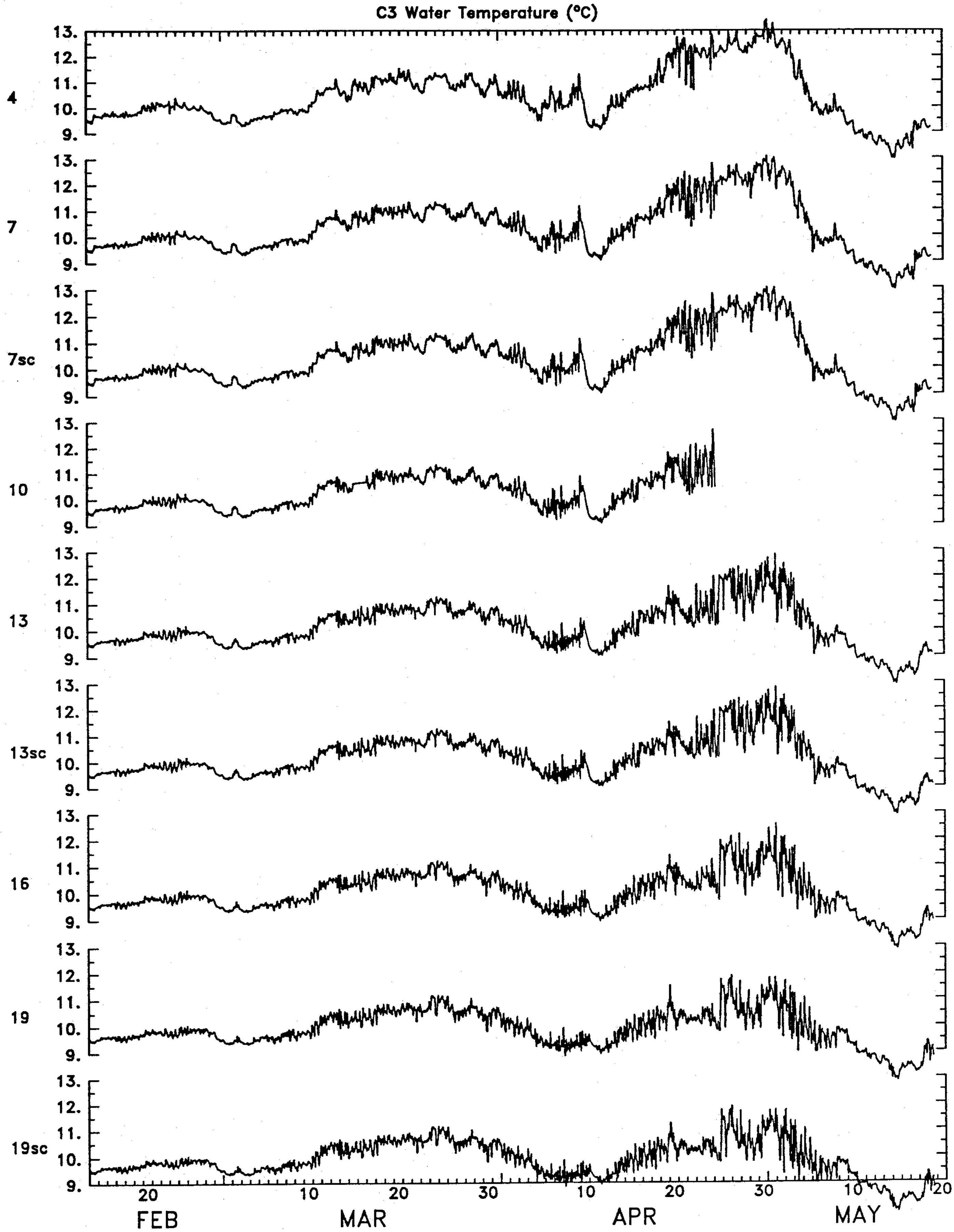


C3 Water Temperature (°C)
4
7
7sc
10
13
13sc
16
19
19sc
13.
12.
11.
10.
9.
10
20
30
10
20
30
10
20
30
10
NOV
DEC
JAN
FEB

Figure 108



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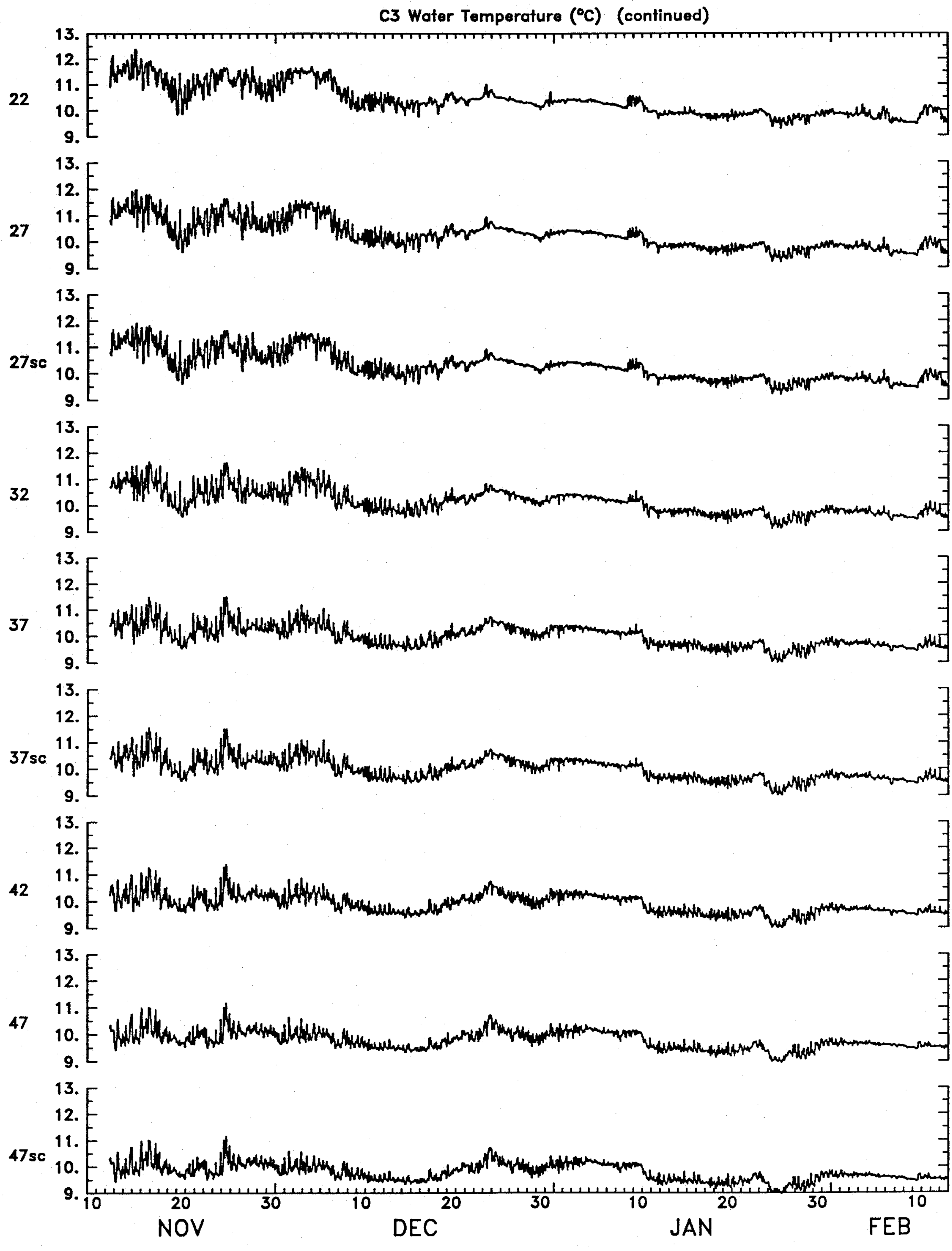

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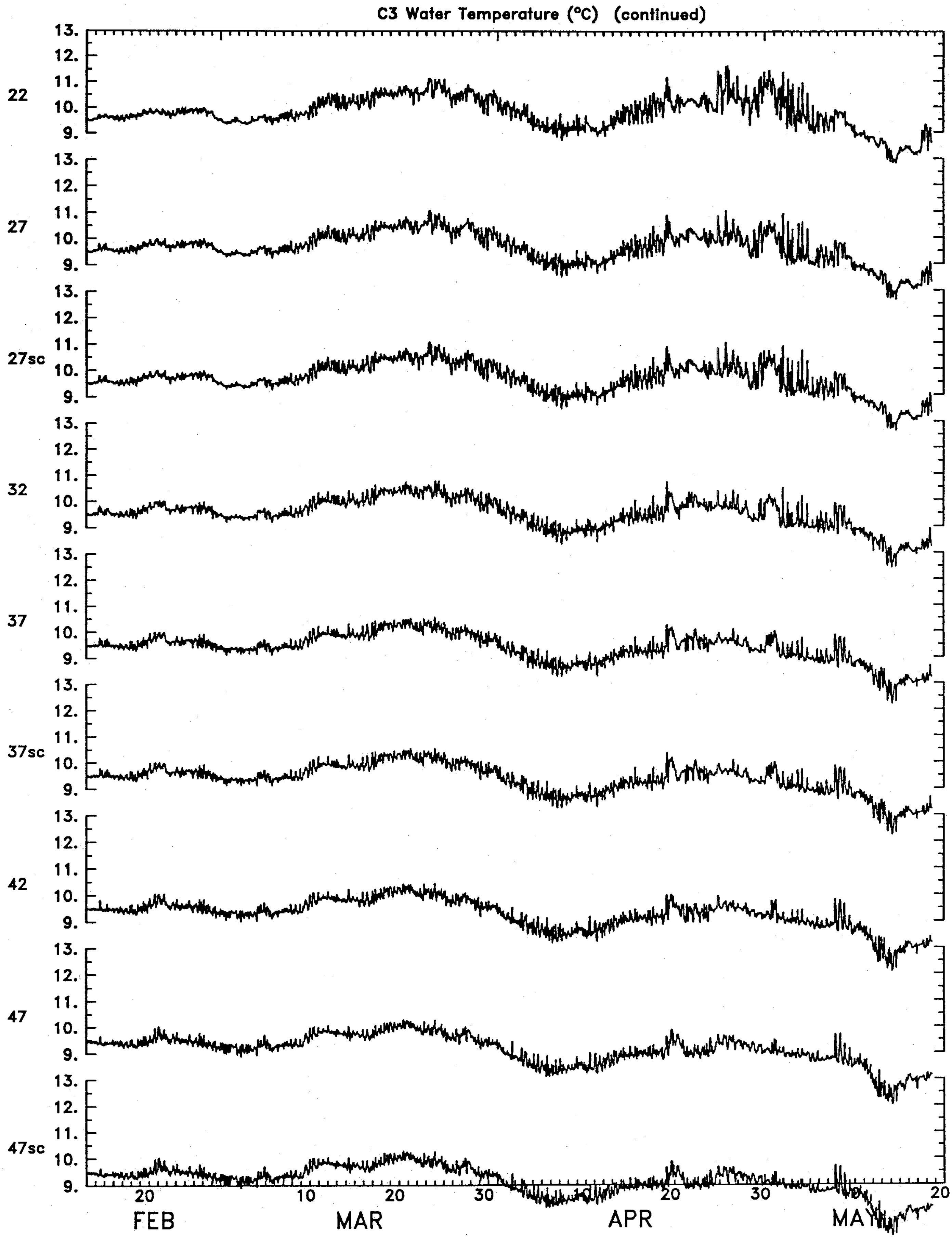

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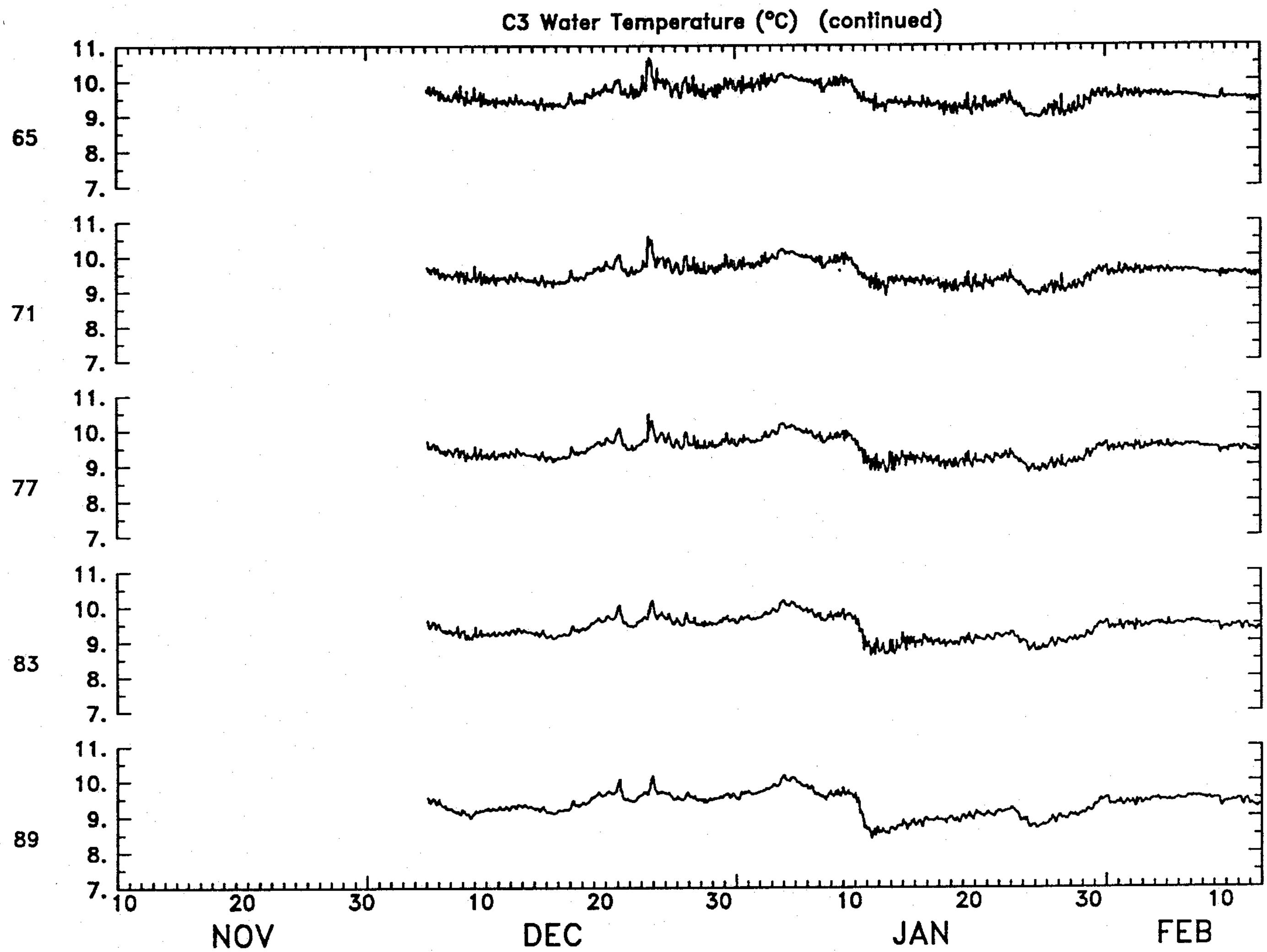

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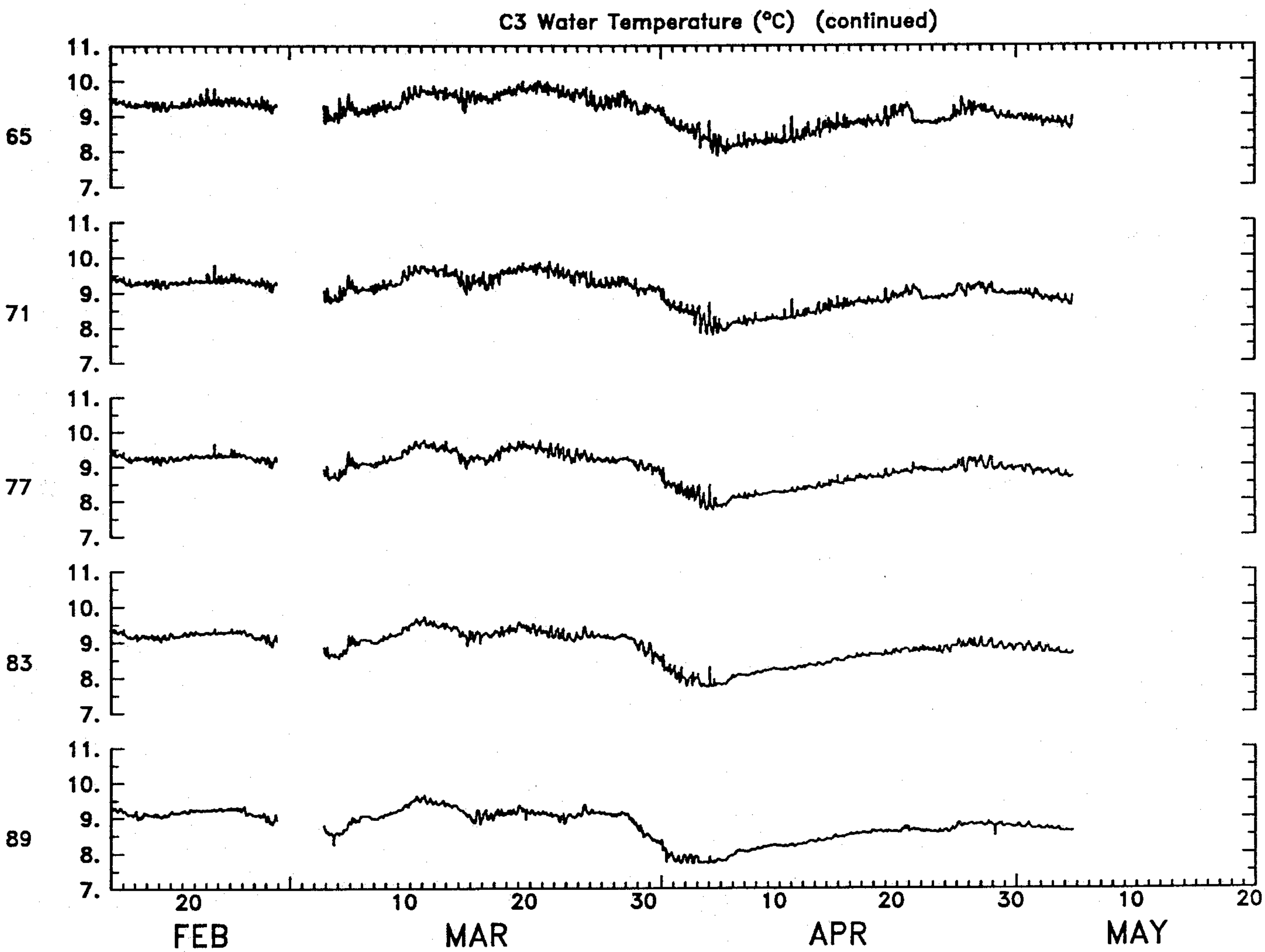

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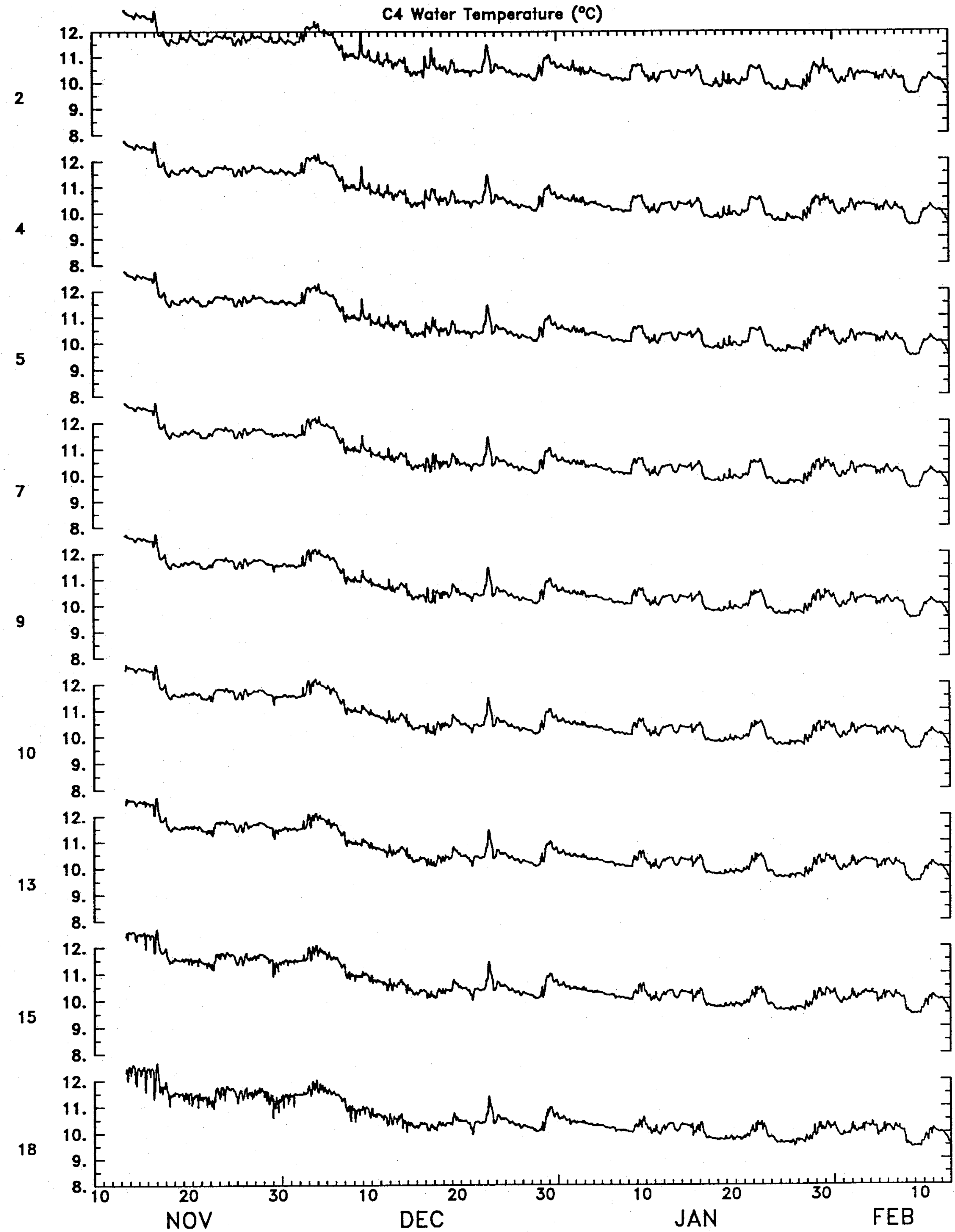

C4 Water Temperature (°C)
2
4
5
7
9
10
13
15
18
12.
11.
10.
9.
8.
10
20
30
10
20
30
10
20
30
10
NOV
DEC
JAN
FEB

Figure 109

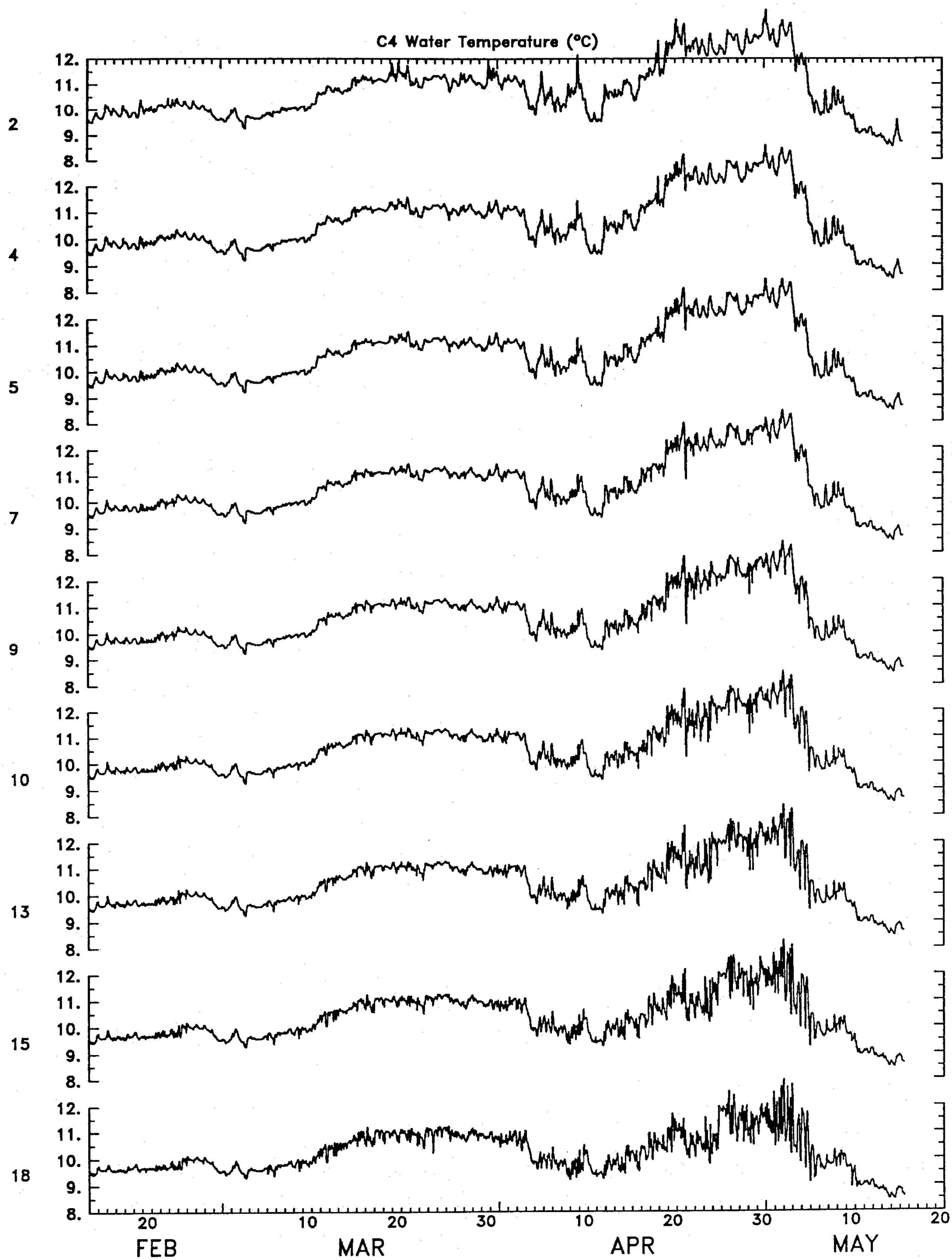


Figure 109 (cont.)

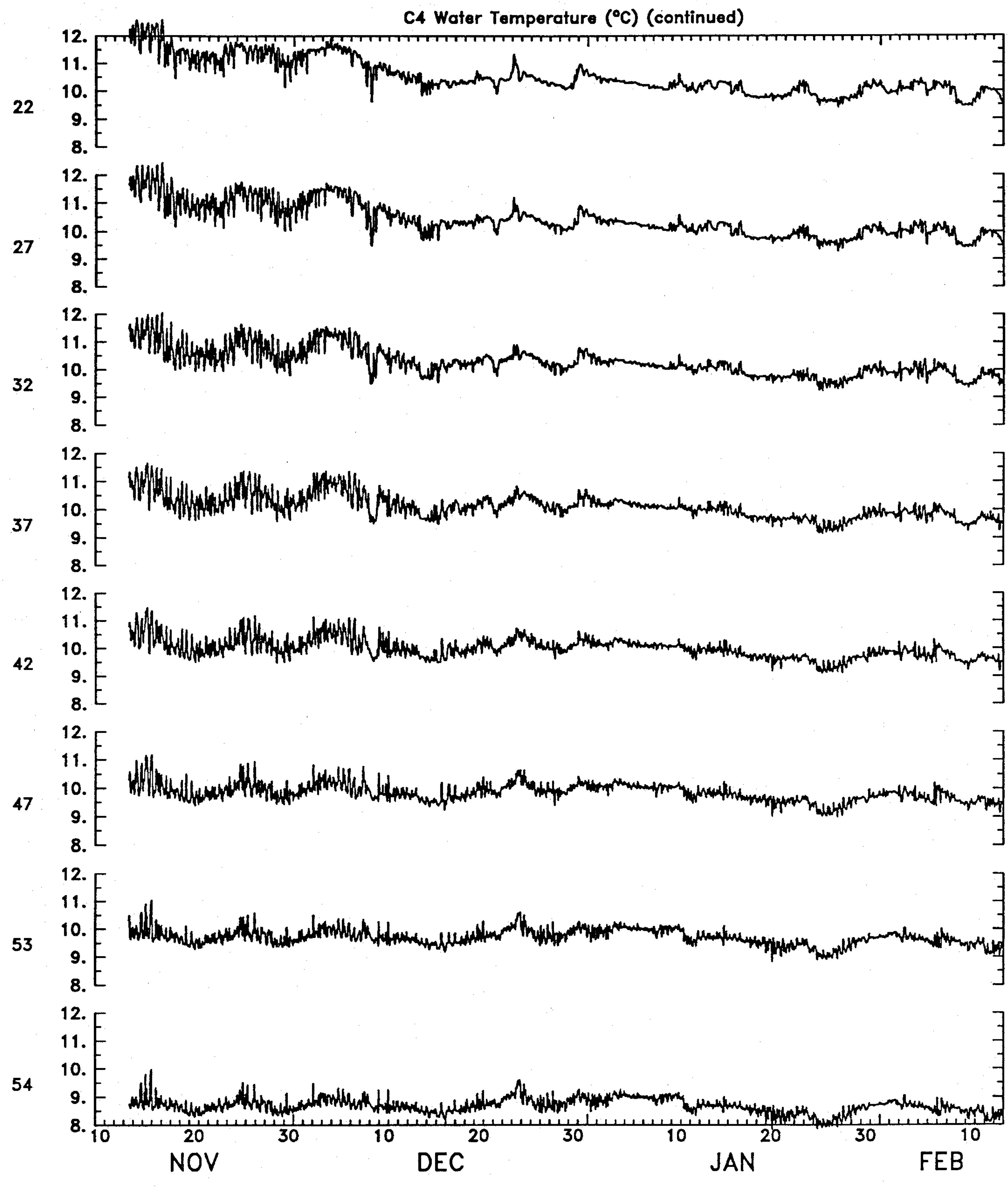


Figure 109 (cont.)

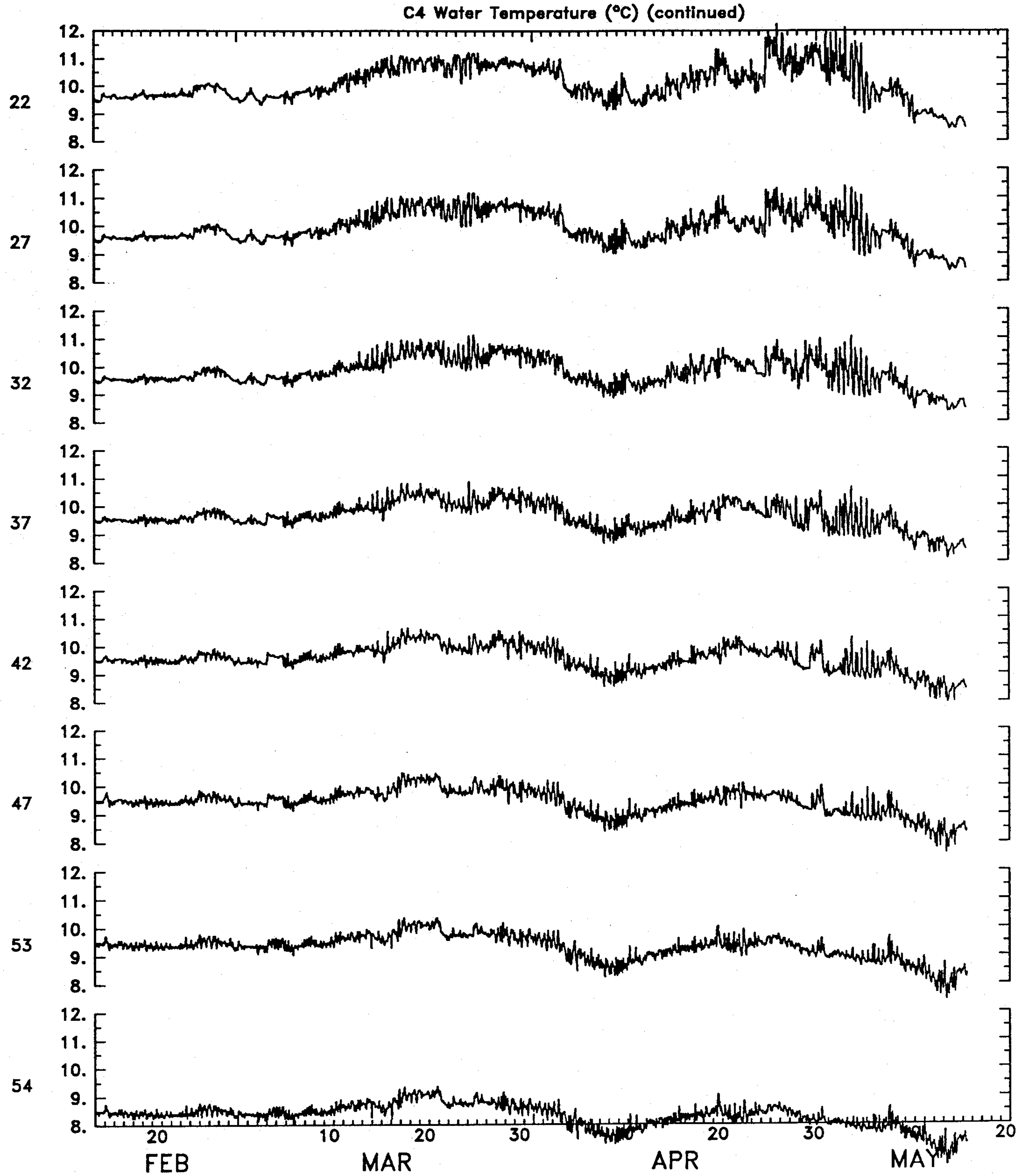


Figure 109 (cont.)

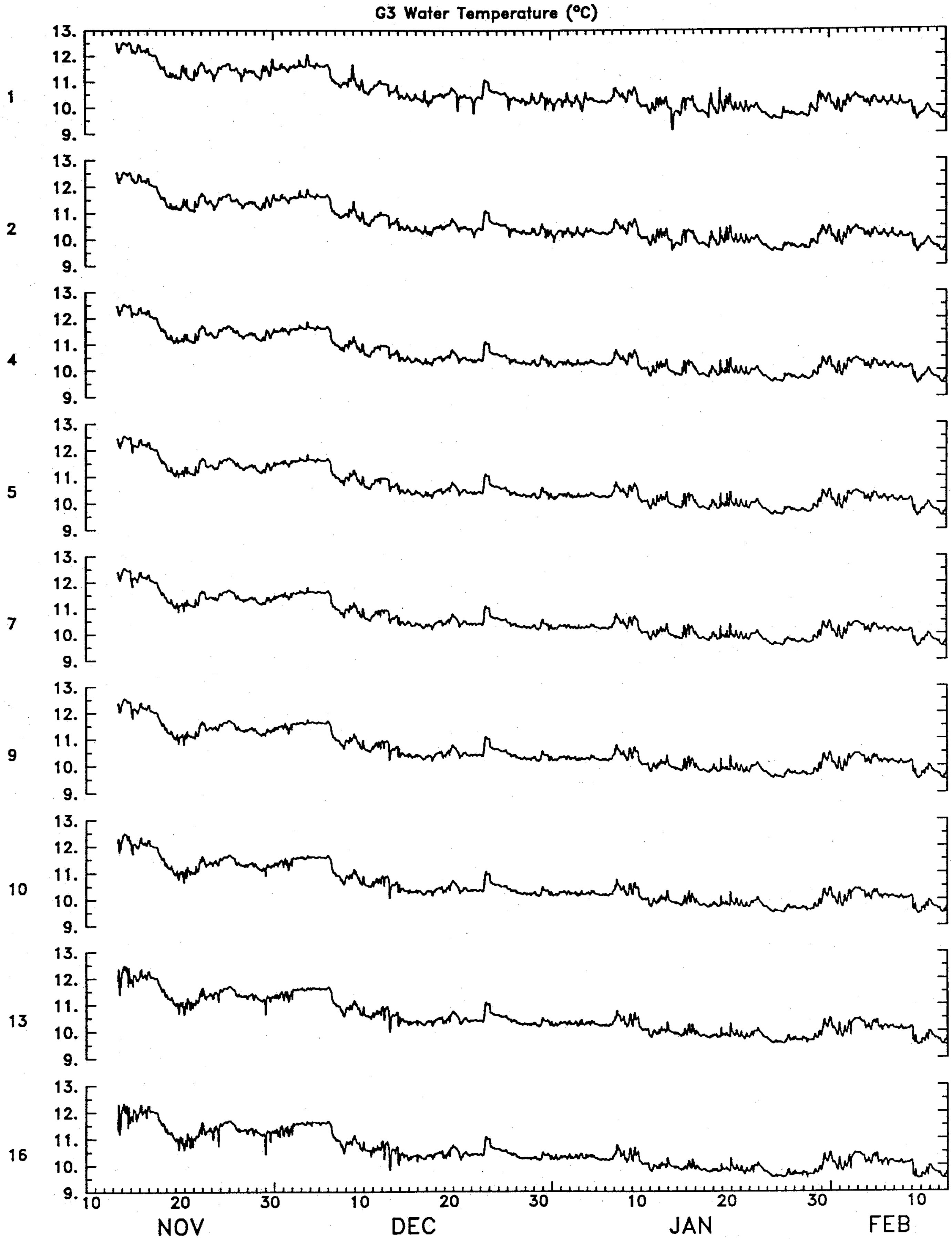
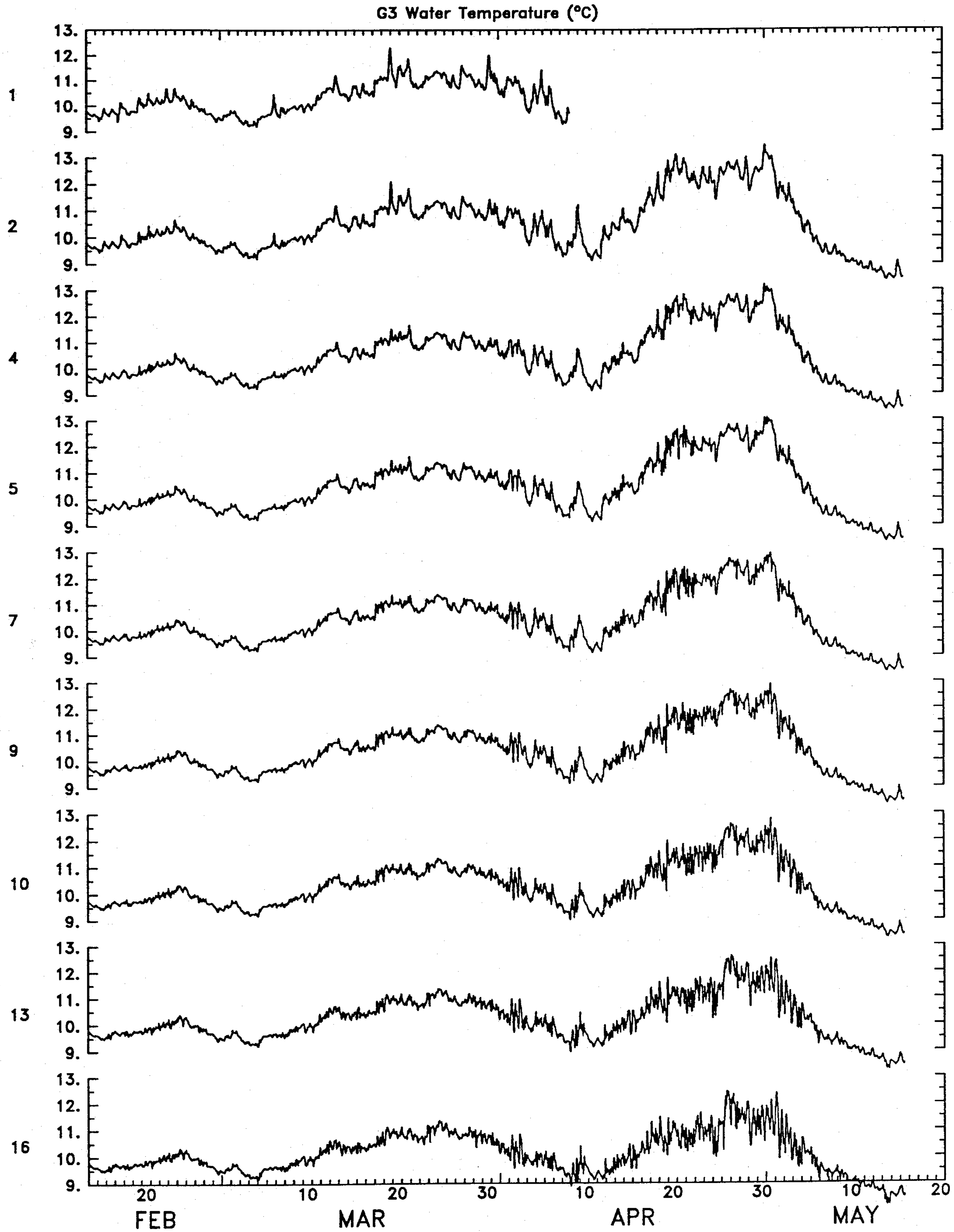

G3 Water Temperature (°C)
13.
12.
11.
10.
9.
1
2
4
5
7
9
10
13
16
10
20
30
10
20
30
10
20
30
10
NOV
DEC
JAN
FEB

Figure 110



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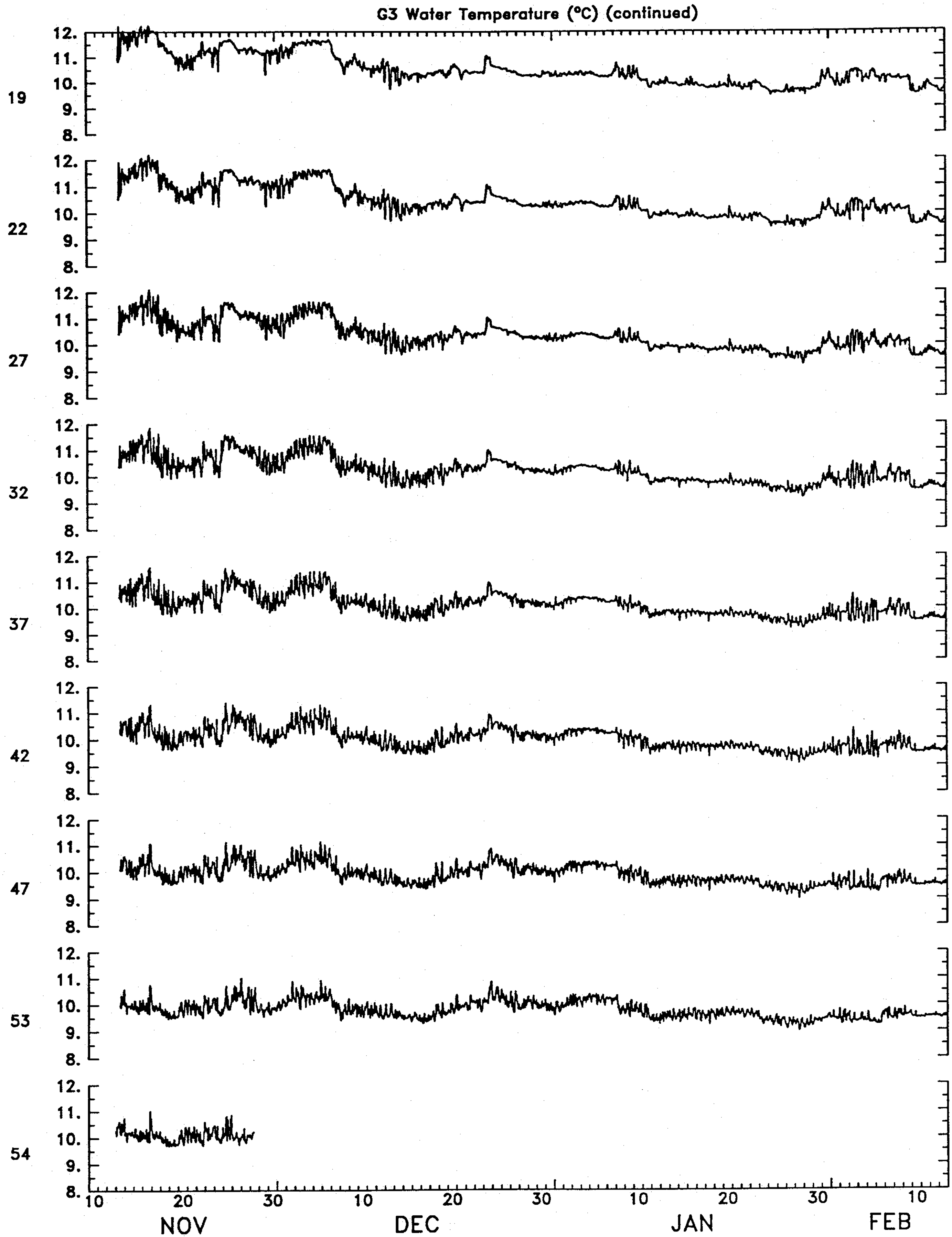


Figure 110 (cont.)

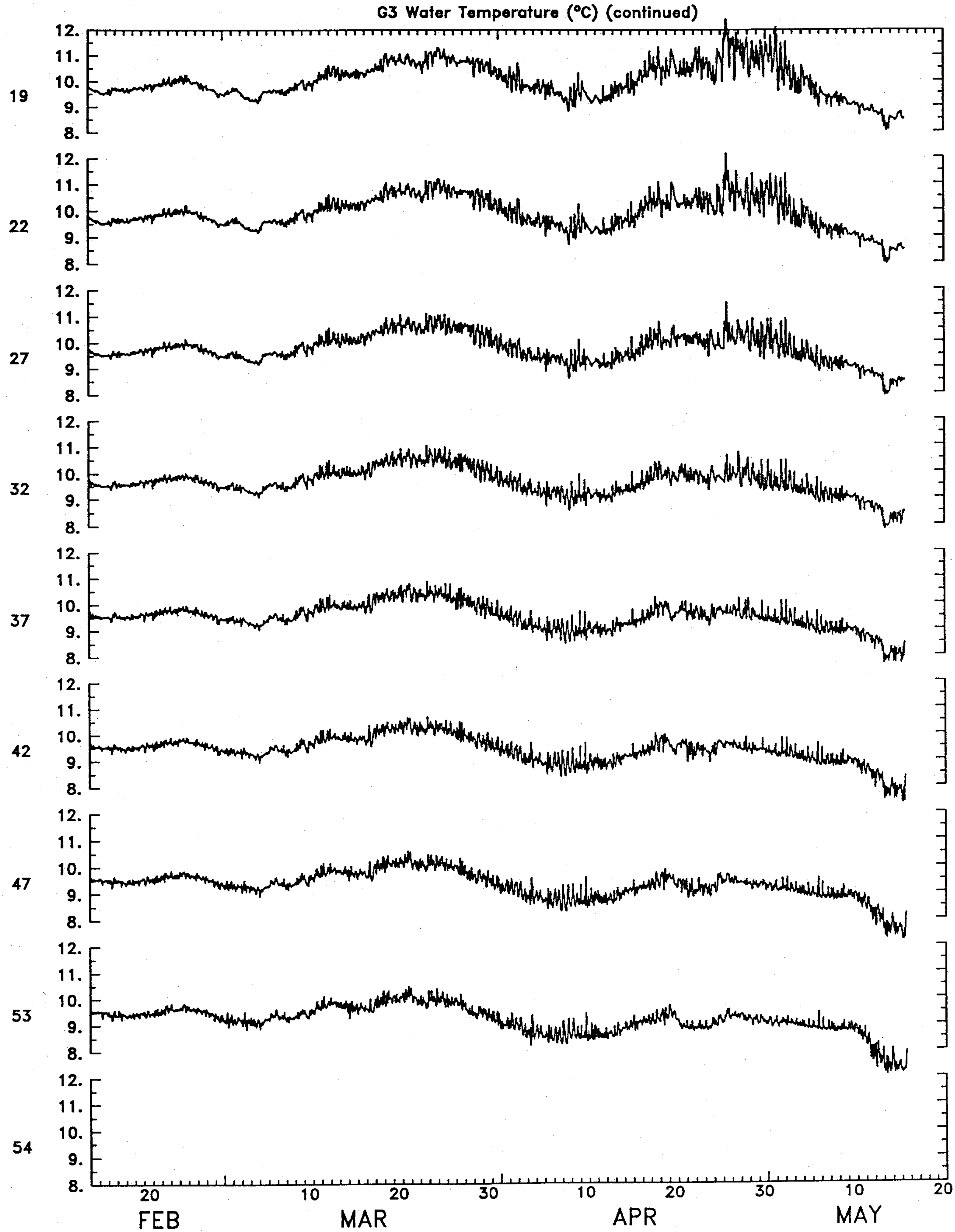


Figure 110 (cont.)

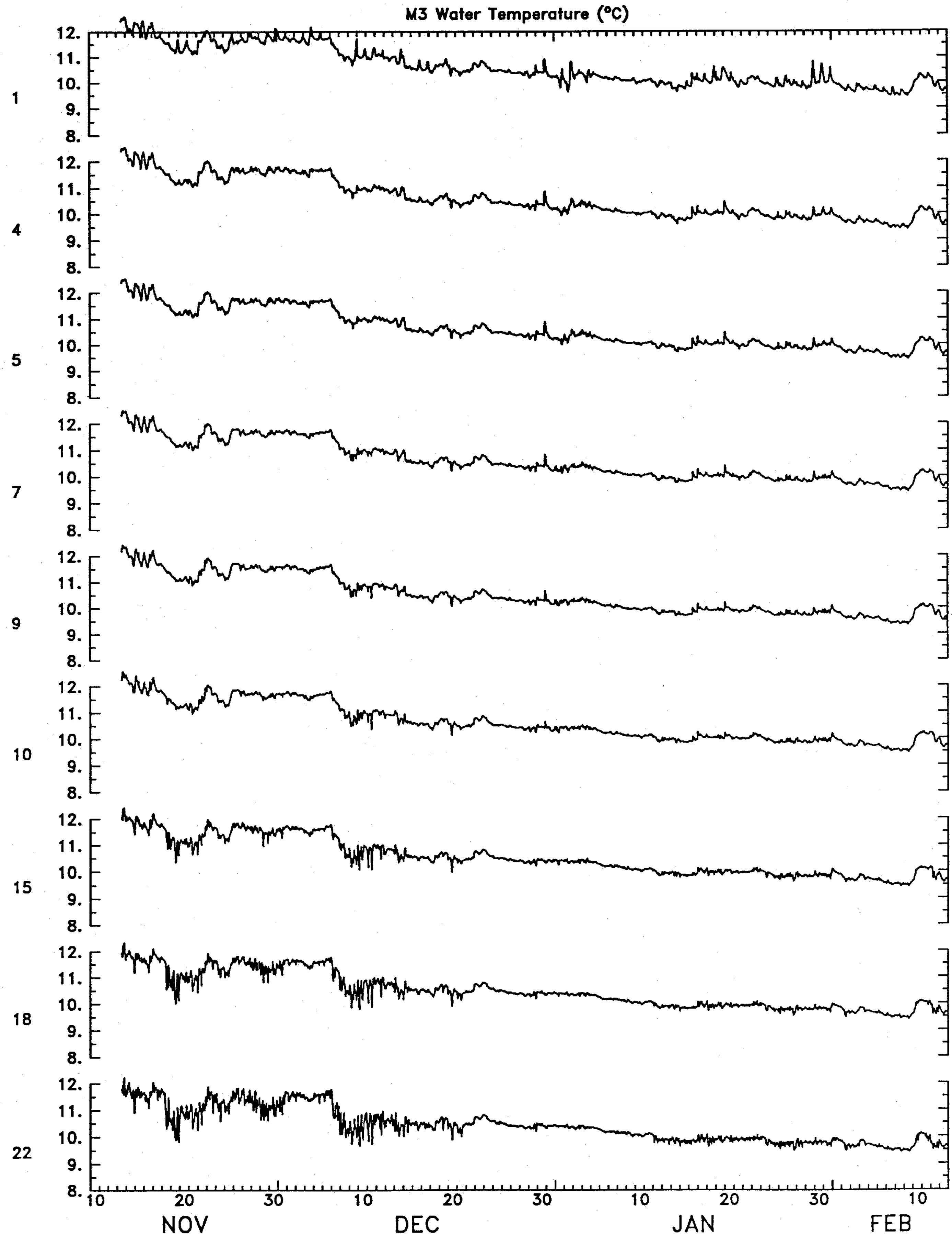

M3 Water Temperature (°C)
1
4
5
7
9
10
15
18
22
12.
11.
10.
9.
8.
10
20
30
10
20
30
10
20
30
10
NOV
DEC
JAN
FEB

Figure 111

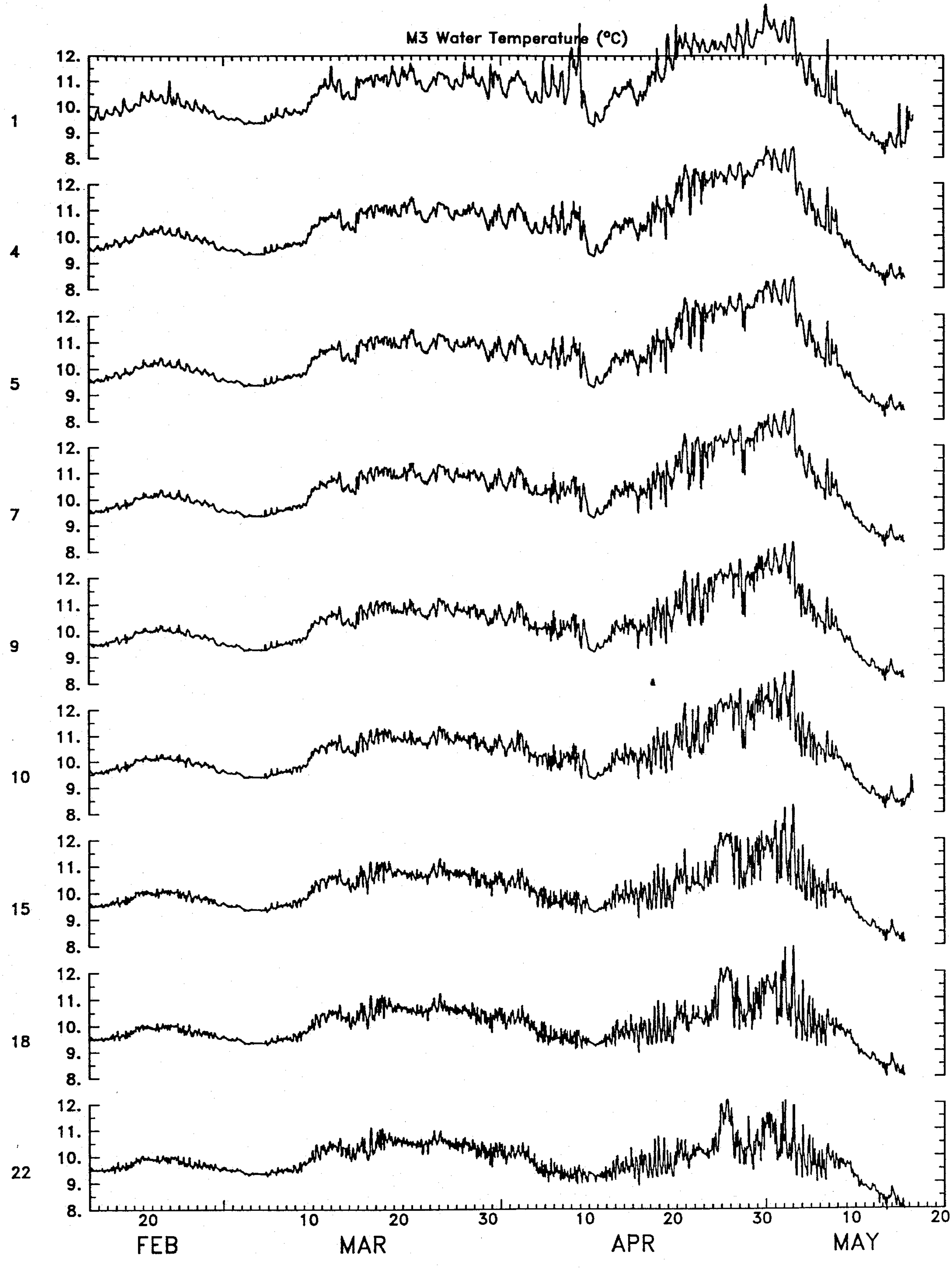
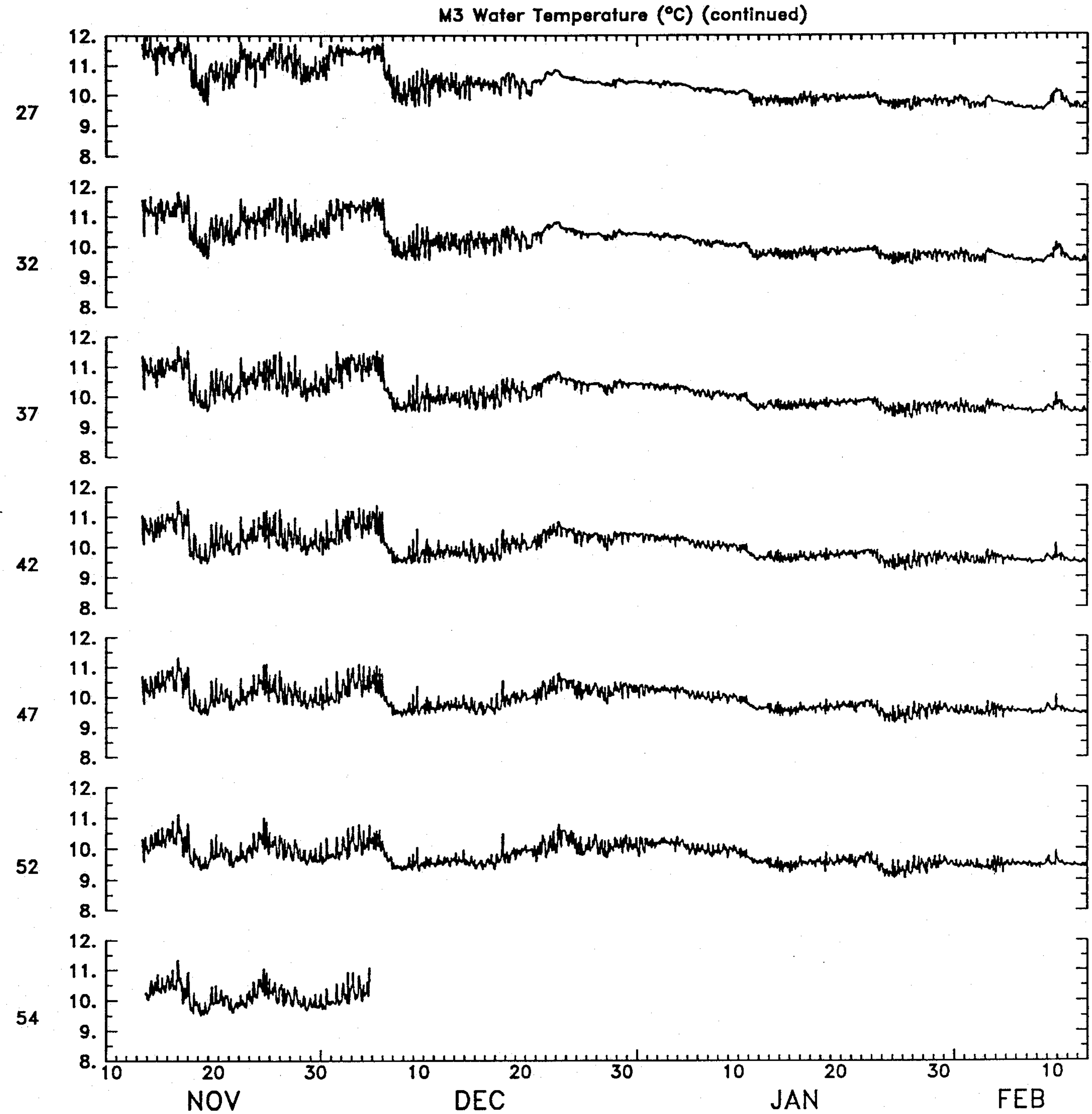


Figure 111 (cont.)



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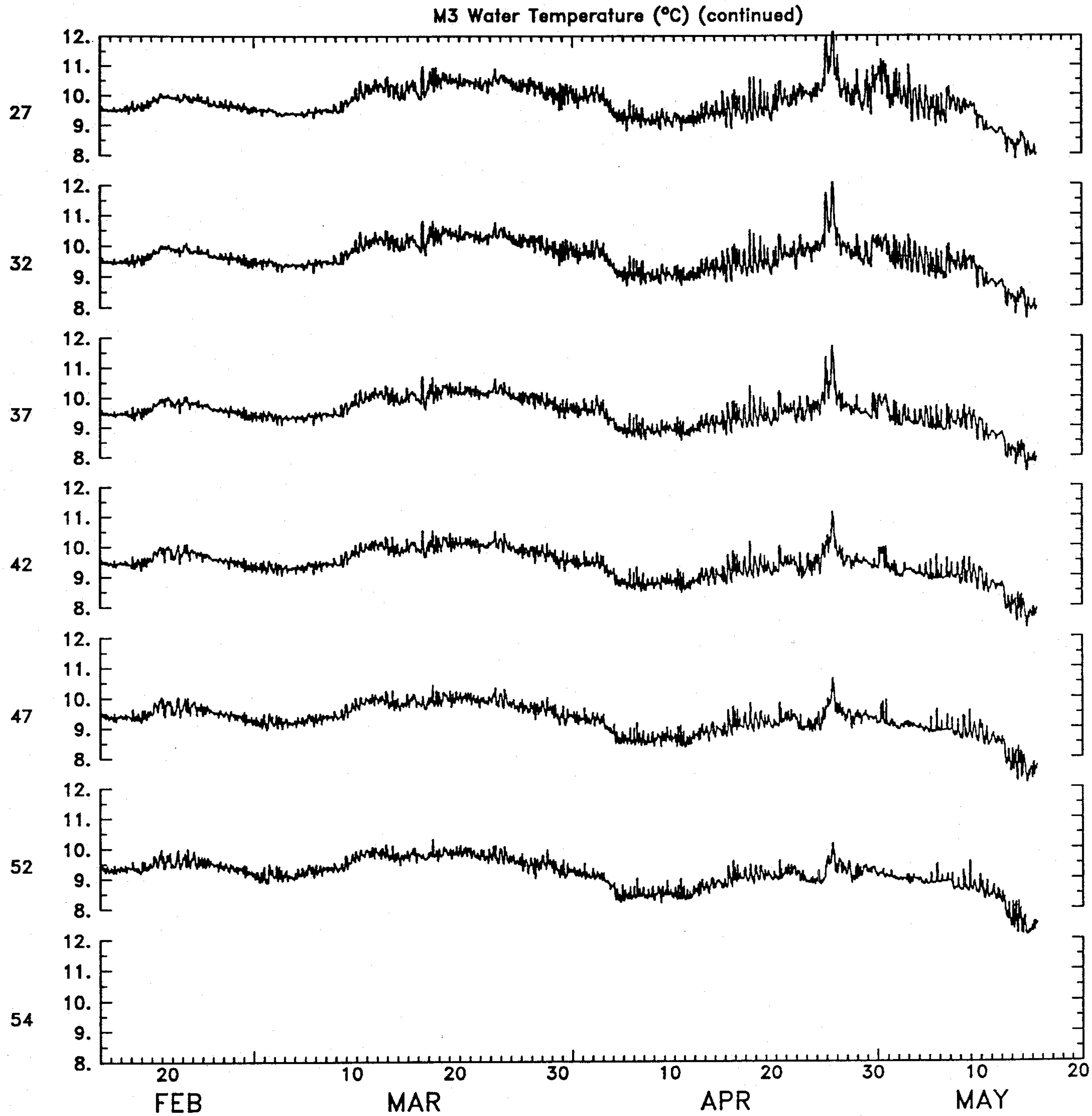

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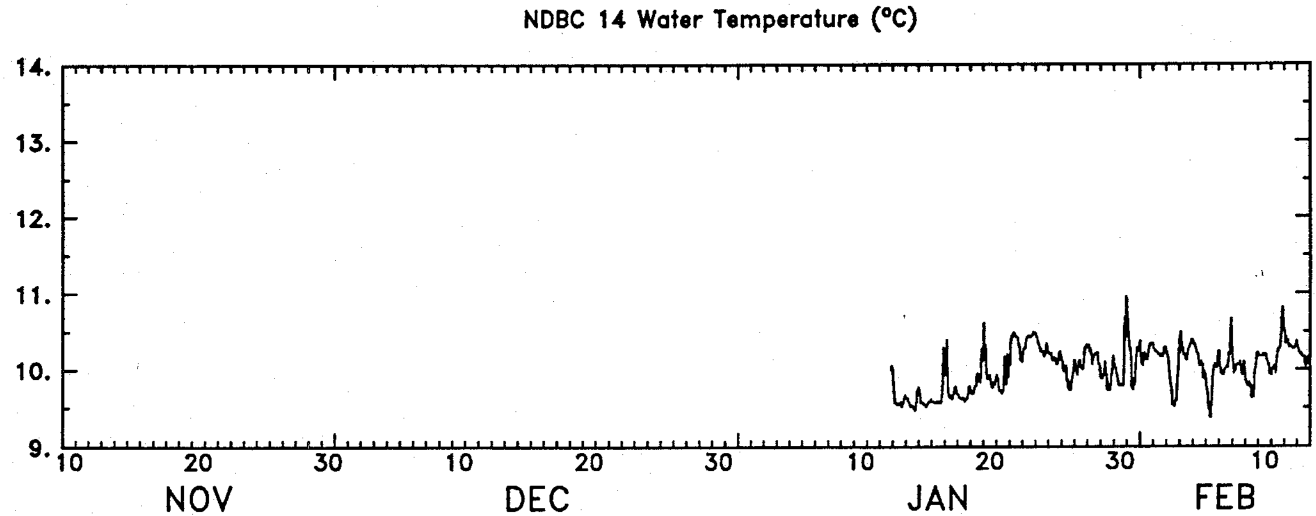

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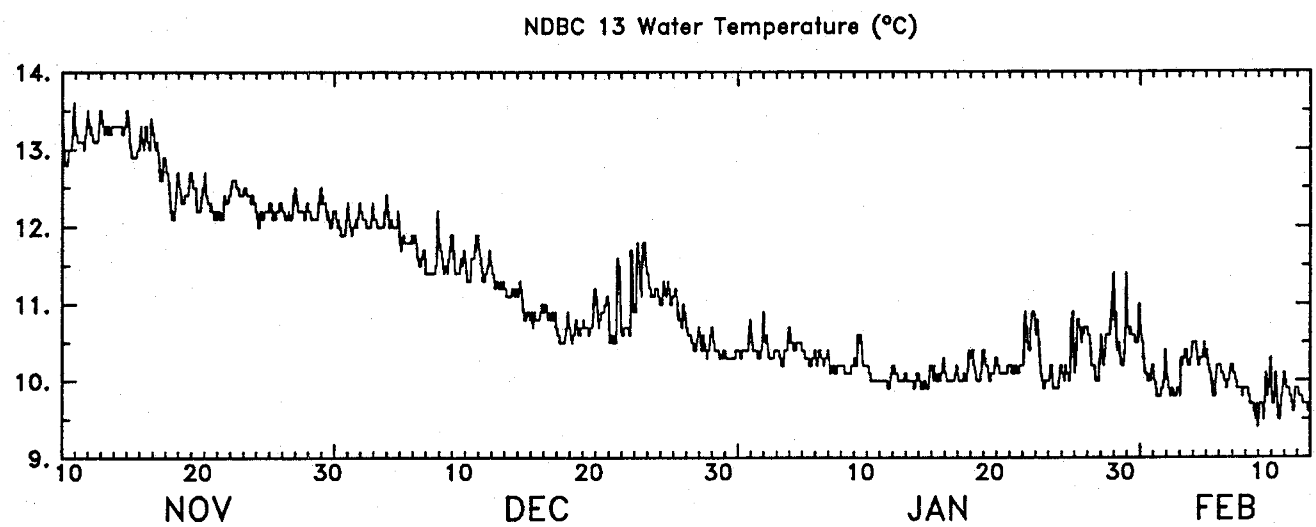
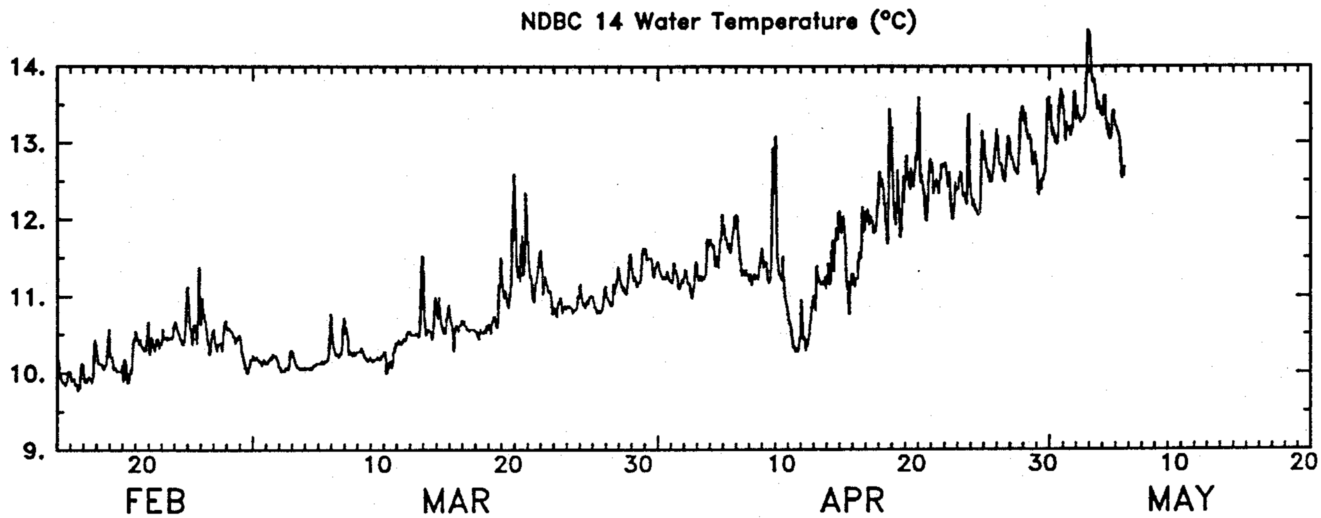


13

Figure 112

14


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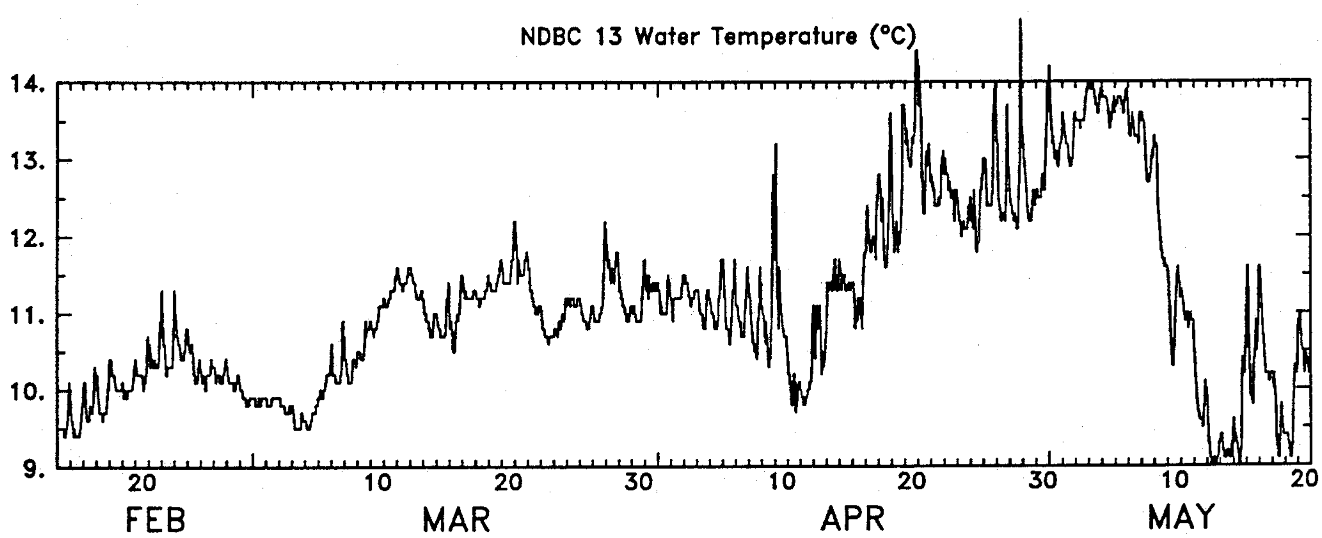

Figure 112 (cont.)

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REPORT DOCUMENTATION PAGE	1. REPORT NO. WHOI-91-39	2.	3. Recipient's Accession No.

4. Title and Subtitle Shelf MIxed Layer Experiment (SMILE) Program Description and Coastal and Moored Array Data Report	5. Report Date December 1991 6.
7. Author(s) Carol A. Alessi, Steven J. Lentz and Robert C. Beardsley	8. Performing Organization Rept. No. WHOI 91-39
9. Performing Organization Name and Address The Woods Hole Oceanographic Institution Woods Hole, Massachusetts 02543	10. Project/Task/Work Unit No. 11. Contract(C) or Grant(G) No. (C) (G) OCE-87-16937
12. Sponsoring Organization Name and Address The National Science Foundation	13. Type of Report & Period Covered Technical Report 14.

15. Supplementary Notes

This report should be cited as: Woods Hole Oceanog. Inst. Tech. Rept., WHOI-91-39.

16. Abstract (Limit: 200 words)

The Shelf MIxed Layer Experiment (SMILE) was designed to study the response of the oceanic surface boundary layer over the continental shelf to atmospheric forcing. The SMILE field program was conducted over the northern California shelf between Pt. Arena and Pt. Reyes from mid-November 1988 to mid-May 1989. The field program consisted of five main components: (a) a long-term moored array to obtain current, temperature, and conductivity time series observations in the upper ocean over the shelf; (b) a short-term moored instrument deployment to measure the vertical current shear and stratification in the top 6 m of the water column; (c) shipboard CTD and acoustic Doppler current profiler (ADCP) surveys over the shelf and adjacent slope to map regional water property and current distributions; (d) a long-term moored and coastal meteorological array including one sounding station to obtain time series observations of the atmospheric surface forcing and monitor the structure of the marine boundary layer; and (e) overflights with an instrumented aircraft to measure the spatial structure of the surface wind, wind stress, and heat flux fields under different atmospheric conditions.

This report has two objectives: (a) to describe the SMILE field program, including overviews of the five components, and (b) to present a statistical and graphical summary of the atmospheric (wind, air temperature, pressure, relative humidity, short- and long-wave radiation) and oceanic (current, water temperature, and conductivity) long-term array measurements made as part of SMILE. A more detailed description of the instrumentation used in SMILE and an assessment of instrument performance and accuracy are presented separately by Dean *et al.* (1991).

17. Document Analysis a. Descriptors

1. moored meteorological/oceanographic observations
2. N. California coastal region
3. SMILE (Shelf MIxed Layer Experiment)

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

18. Availability Statement Approved for publication; distribution unlimited.	19. Security Class (This Report) UNCLASSIFIED	21. No. of Pages 221
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