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The Monterey Submarine Canyon, California Moored Array Data Report

by

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ABSTRACT

In August, 1993, a program was begun to study the mechanisms that govern the circulation within and the transport of sediment and water through Monterey Submarine Canyon. This is a very large, deep submarine canyon off central California that incises the continental margin from the outer slope to close to the coastline. The research plan was also designed to study the interactions among circulation patterns above, within, and past the mouth of the canyon. As part of the program, six moorings that measured current, temperature, salinity and water clarity were deployed simultaneously for one year at individual sites in Monterey Canyon. Sediment traps were attached to 5 of the 6 moorings. On recovery, the mooring at the deepest site only was replaced. The additional mooring collected information from August 1994 to May 1995. This report describes and depicts the data that were collected from the larger moored array and the single, redeployed mooring. The main section focuses on the moored array data, plus wind and sea level records, collected between August 1993 and August 1994. The subsequent data collected at the deepest site is included in a separate appendix.

INTRODUCTION

The mechanisms that govern the circulation within and the transport of sediment and bottom water through submarine canyons have long been among the more complex and enigmatic issues in marine ecosystems because monitoring these processes is difficult. In August, 1993, a year-long program involving the U.S. Geological Survey (USGS), Monterey Bay Aquarium Research Institute (MBARI), National Oceanic and Atmospheric Administration (NOAA) and University of Maine was begun to study these mechanisms in Monterey Canyon. As part of this program, an array of moorings was deployed in Monterey Canyon, California (Figure 1). Monterey is an interesting canyon in that it is large enough to have a great variety of physical dimensions along its entire length. In places, the size of the internal radius of deformation suggests that the canyon is dynamically narrow; at others it is dynamically wide. Analytical models of flows in canyons by Klinck (1989) and Hughes et al. (1990) suggest the dynamic width is a critical parameter in determining the nature of the circulation within a canyon and the effect of the canyon on overlying currents. In addition, it is known that sediment-transport events occur in the canyon and that the canyon supports a highly productive biological community

It was necessary to undertake a study to gather new information because the historical data sets that describe circulation and sediment transport in Monterey Canyon are scarce. Previous measurements of currents within the canyon consist of a few records from moorings deployed for a short period of time (Shepard et al., 1979), some microstructure observations (Itsweire and Osborn, 1988) and turbulence measurements (Lueck and Osborn, 1985). The current observations were too limited to provide a basis for a clear understanding of circulation within and near the canyon. Koehler (1990) has applied a simple 2-layer numerical model to the region. When he forces the outer boundary of his model with geostrophic flow measured during May, 1988, a cyclonic flow develops in the lower layer that is confined to the outer reaches of the canyon. A variety of investigations have shown that sediment transport in Monterey Canyon is a very active process. Shepard et al. (1979) and others suggested that internal tides are strong enough to transport sediment in the canyon. During the recent Loma Prieta earthquake, transponders deployed in the canyon moved 2 km down canyon (Garfield et al., 1994).

In order to gather the necessary information to describe circulation and sediment transport patterns in Monterey Canyon, 6 moorings were deployed at 3 cross-canyon sections (Figure 1). One cross-section is thought to be dynamically "narrow" (sites NN and NA), one dynamically "wide" (WN, WA, and WS) and one is near the "fan" (F) section of the canyon. Seven sediment traps were mounted on 5 of these moorings. In November, 1994 a conductivity, temperature and

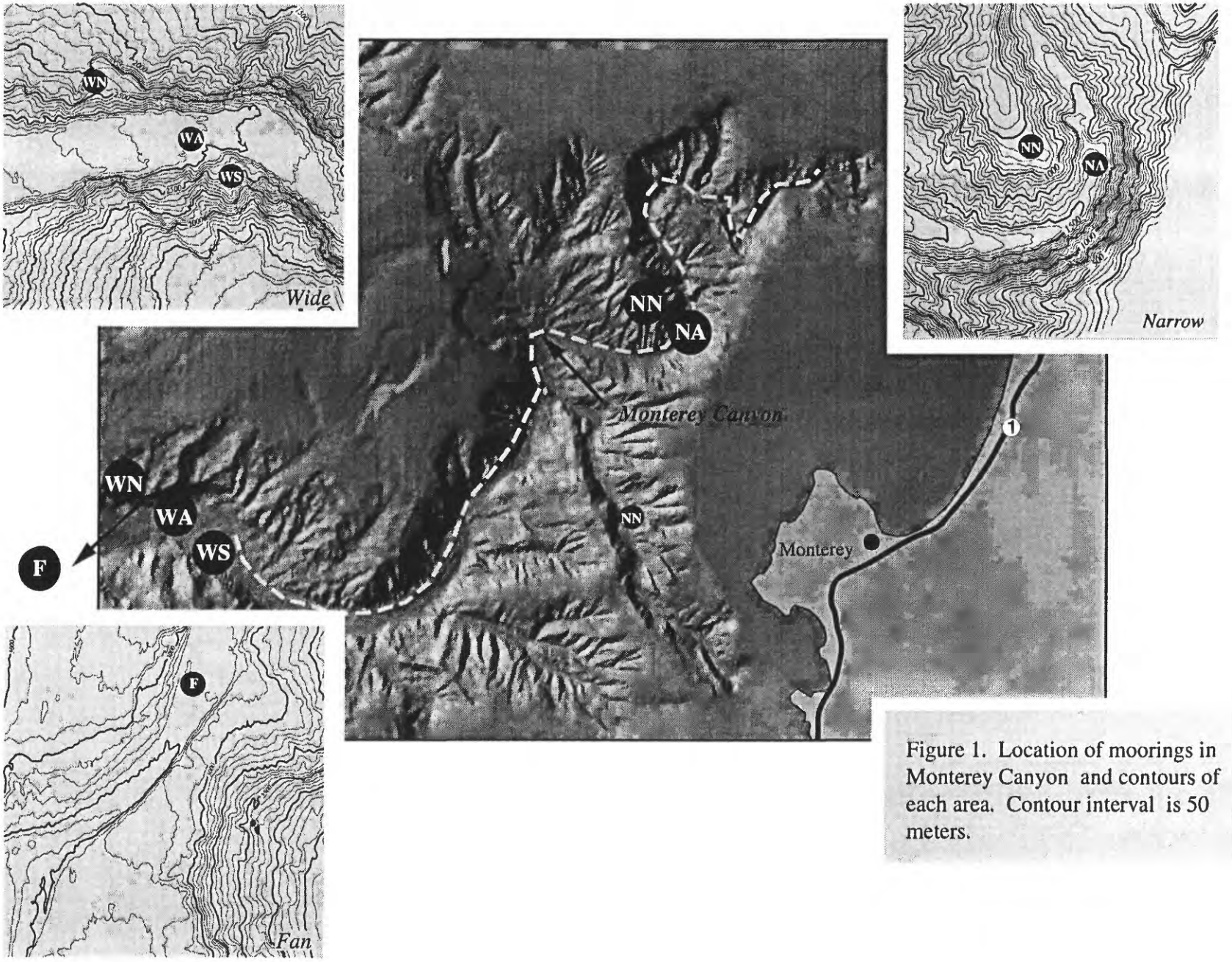

Figure 1. Location of moorings in Monterey Canyon and contours of each area. Contour interval is 50 meters.

depth (CTD) survey was conducted and 5 box cores were taken at different sites within the canyon Several other CTD surveys were conducted in the vicinity throughout the time period that the moorings were in place.

This report describes and depicts the data collected by the moored array. A detailed description of the moored array and the instruments on each mooring is given in the next section. The principal data collected in this field program include records of current direction and velocity, temperature, salinity and water clarity measured at several different sites in the canyon. The subsequent sections of the report list the statistical quantities of the entire data set and depict the characteristics of the hour-averaged and subtidal records. Because tidal currents are a major feature in submarine canyons,. the amplitudes of the diurnal and semidiurnal tides are listed in detail at each measurement site

Instrumentation

The exact design of each mooring was specific to each measurement site (Table 1), although there were many features common to each one (Figure 2a, b, c). All instruments at a site were attached to a single mooring. Either a single or dual acoustic release package was used to connect the mooring to the anchor.

The type of current meter used (Table 1) was a EG&G vector-averaging current meters (VACM). A VTCT is also referred to in this report. The VTCT is a vector averaging current meter with a transmissometer attached to it to record transmission data. The VACM is specifically designed to measure currents even when oscillatory currents from large surface waves are present. A detailed description of the design and measurement characteristics is provided by McCullough, 1975, Mero, 1982 and Beardsley et al., 1987. The meter measured the average current direction and speed every 15 minutes.

To measure water clarity (transmission), Sea Tech transmissometers with a 25 cm path length were used. The data were recorded on a Sea Cat data logger or a modified VACM data logger. The clear water reading for each transmissometer was recorded before each deployment. The relation between the transmissometer reading and the amount of material resuspended in the water column was derived using the natural sediment at the

Site	Mooring	Water Depth (m)	Start Time (M/D/Y)	Stop Time (M/D/Y)	Instrument	Position		Sensor Depth (m)	Data Type	Sample Interval (minutes)
						Latitude	Longitude			
NN	422-1	806	08/03/93	08/17/94	VACM	36 43.40 N	122 02.10 W	746	T,C*	15
NA	423-1	1450	08/03/93	08/17/94	VTCT	36 43.17 N	122 00.75 W	770	C,T,S,TR	15
NA	423-2	1450	08/03/93	08/17/94	VACM	36 43.17 N	122 00.75 W	1250	C, T	15
NA	423-3	1450	08/03/93	08/17/94	VTCT	36 43.17 N	122 00.75 W	1350	C,T,A,S,TR	15
WN	424-1	2420	08/03/93	08/17/94	VTCT	36 38.00 N	122 24.77 W	1960	C,T,A,S,TR	15
WN	424-2	2420	08/03/93	08/17/94	VTCT	36 38.00 N	122 24.77 W	2320	C,T,A,S,TR	15
WS	425-1	2560	08/03/93	08/18/94	VTCT	36 35.70 N	122 20.90 W	1990	C,T,A,S	15
WS	425-2	2560	08/03/93	08/18/94	VACM	36 35.70 N	122 20.90 W	2350	C,T	15
WA	426-1	2837	08/03/93	08/18/94	VACM	36 36.47 N	122 22.13 W	1612	C,T	15
WA	426-2	2837	08/03/93	08/18/94	VTCT	36 36.47 N	122 22.13 W	1982	C,T,A,S,TR	15
WA	426-3	2837	08/03/93	08/18/94	VACM	36 36.47 N	122 22.13 W	2342	C,T	15
WA	426-4	2837	08/03/93	08/18/94	VACM	36 36.47 N	122 22.13 W	2737	C,T	15
F	427-1	3223	08/05/93	08/20/94	VACM	36 27.47 N	122 37.53 W	3213	C,T	15 15

Table 1.- Data availability for all moorings for 1993-1994.

VACM = Vector averaging current meter (measures current and temperature)
VTCT = Vector averaging current meter (measures current, temperature and transmission)

A = attenuation
S = salinity
TR = transmission

C = current data
T = sea temperature
C* = rotor speed only

site and the calibration procedures described in Moody, et al., 1987. The sample rate was 15 minutes (Table 1).

Sea Bird conductivity cells were used to obtain the conductivity measurements. The data were recorded on either a Sea Cat data logger or a modified VACM data logger. Each conductivity cell was calibrated by the manufacturer's specifications before each deployment. The sample rate was the same as for the current meter (Table 1).

Water temperature was measured with temperature sensors installed in the VACM's and VTCT's or Sea Bird data logger. All temperature sensors were calibrated by the manufacturer's specifications before deployment. The sample rate was the same as for the current meter (Table 1).

A 0.5 m diameter Anderson sediment trap was used to collect a record of resuspended sediment at each site. An intervalometer that dispenses discrete layers of Teflon at a specified time interval were used in many of the sediment traps to generate a time base for the resuspended sediment.

Description of the moored array

The comprehensive field program consisted of several elements. An array of 6 moorings was deployed at 3 cross-sections in Monterey Canyon (Figure 1) in August 1993. The moorings at each site measured current, temperature, salinity and water clarity at several locations in the water column (Figures 1, 3a and 3b). The moorings also

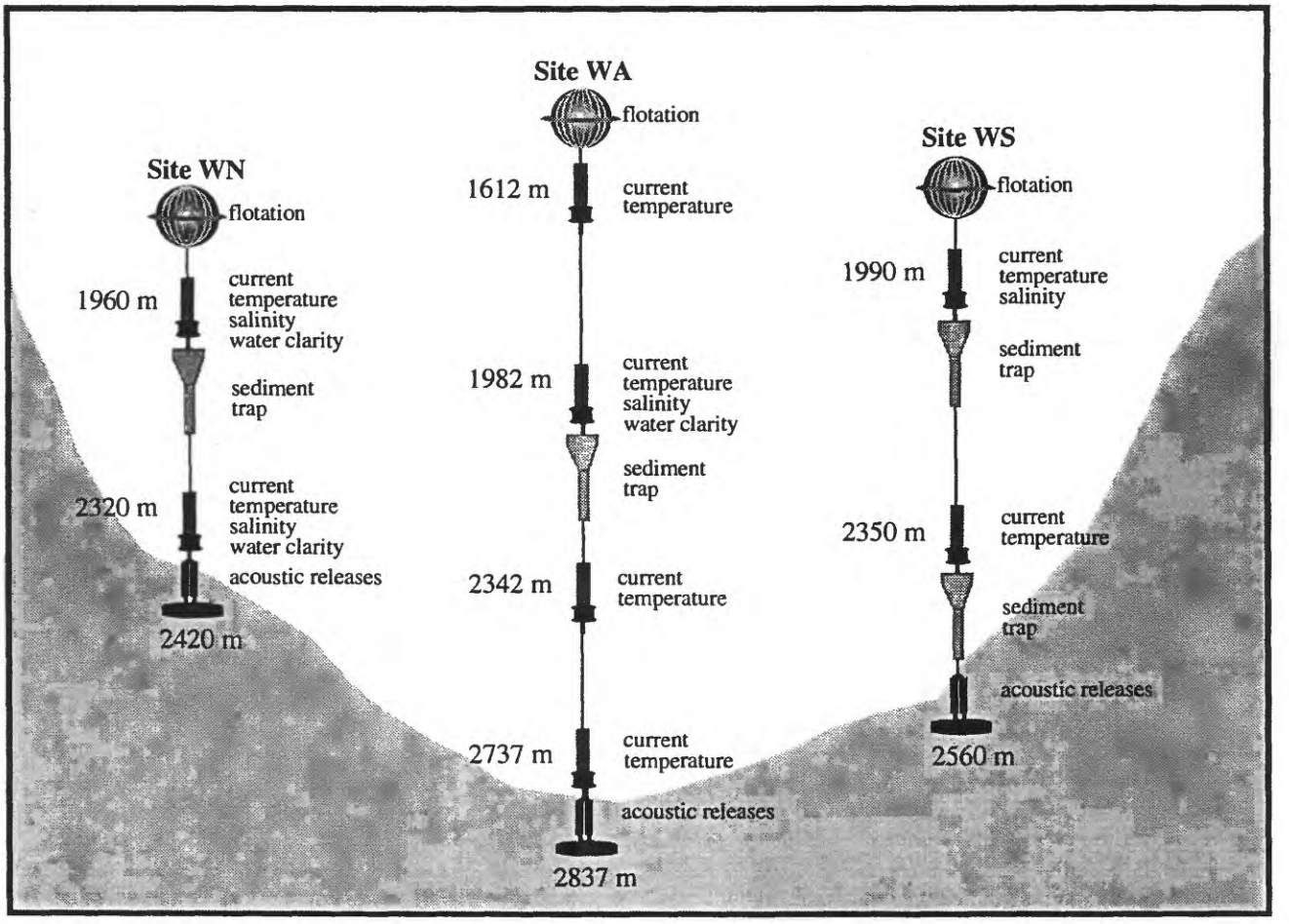

Figure 2a. Cross section view of mooring set-up at "wide" section of Monterey Canyon.

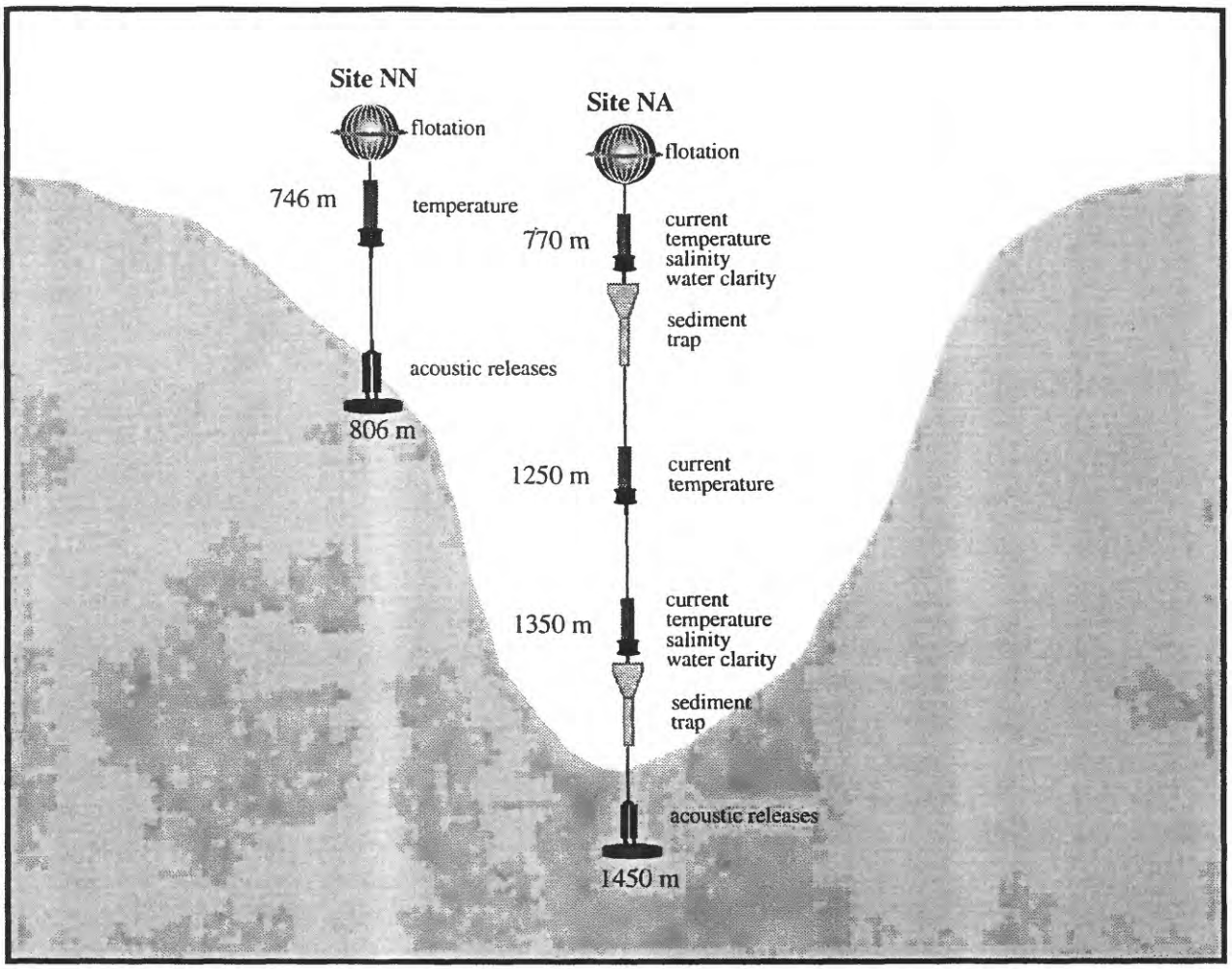

Figure 2b. Cross section view of mooring set-up at "narrow" section of Monterey Canyon.

collected suspended sediment in a trap at 4 of the sites. The moored array was designed to monitor conditions of the water so that reasonably stable estimates of the processes controlling circulation and sediment transport could be made.

Three of the moorings were located in a cross-canyon array, one on each slope and one in the axis, in a dynamically "wide" section of the canyon seaward of the intersection with Carmel Canyon in order to examine the 3-dimensional structure of the flow at depths just below the rim and deep within the canyon. In particular, it is hypothesized that a measurable current shear can develop across this wide portion of the canyon. The size of the shear may change with depth below the rim. One current meter was located in the middle of the canyon axis, but above the canyon rim in order to monitor flow over Monterey Canyon. This measurement will allow us to relate the circulation in the canyon to the parameters of the flow over the canyon.

Two other moorings were deployed closer to shore in a dynamically "narrow" section of the canyon. These moorings allow us to determine how spatial structures in flow patterns change between dynamically narrow and wide sections of the canyon. They also allow a determination of phase propagation of tidal currents along the canyon axis.

A sixth mooring was deployed farther down canyon on Monterey Fan. This mooring not only extends the moored array significantly, but the down canyon site allows us to monitor any significant turbidity currents that can reach Monterey Fan.

Hence it extends our understanding of nutrient transport pathways to the abyss and the processes that deposit materials in Monterey Fan.

Each mooring in the array had between 1 and 3 instrument packages that measured current, temperature and optionally salinity, water clarity and suspended sediments (Figures 2 a,b,c). An attempt was made to locate instrument packages at common depths at each cross-section.

Data sets and statistical methods

This report is a statistical and pictorial description of the data collected. The data sets from each instrument package have been decoded, transcribed into scientific units and passed through several processing steps. The data were checked for quality and errors, caused by instrument noise or failures, using programs developed at Woods Hole Oceanographic Institute (Tarbell, et al, 1988). The data were then analyzed using standard time series and statistical procedures. These procedures included temporal plots, means, standard deviations, maximum values, minimum values and spectra of each data variable (Appendix A, B, D). In addition, correlation, coherence and frequency-response statistics provided information on the relation of the various data sets. All times are in Greenwich mean time (GMT). The units for the currents are centimeters per second (cm/s), temperature degrees Celsius (^{o}C) and salinity parts per thousand (ppt).

The basic sample interval for all variables was 15 minutes (Table 1). All data in this report have been averaged into records that have an hour sample interval (denoted hour-averaged records). The data have also been lowpass filtered to remove oscillations with periods shorter than 33 hours. Since the majority of the variability at the shorter periods is due to tidal forcing, these lowpass-filtered records are referred to as subtidal records.

Moored current observations

Current observations were collected at all sites during the deployment period. At the "narrow" and "wide" sections of the canyon, current meters were located at common depths just below the lip of the canyon and near bottom (Figure 2a, 2b). In order to ensure the insturments on the moorings would not be damaged or buried by a possibly large turbidity flow, the deepest instruments were located 100 m above the sea bed. It was thought that turbidity currents at the "fan" site

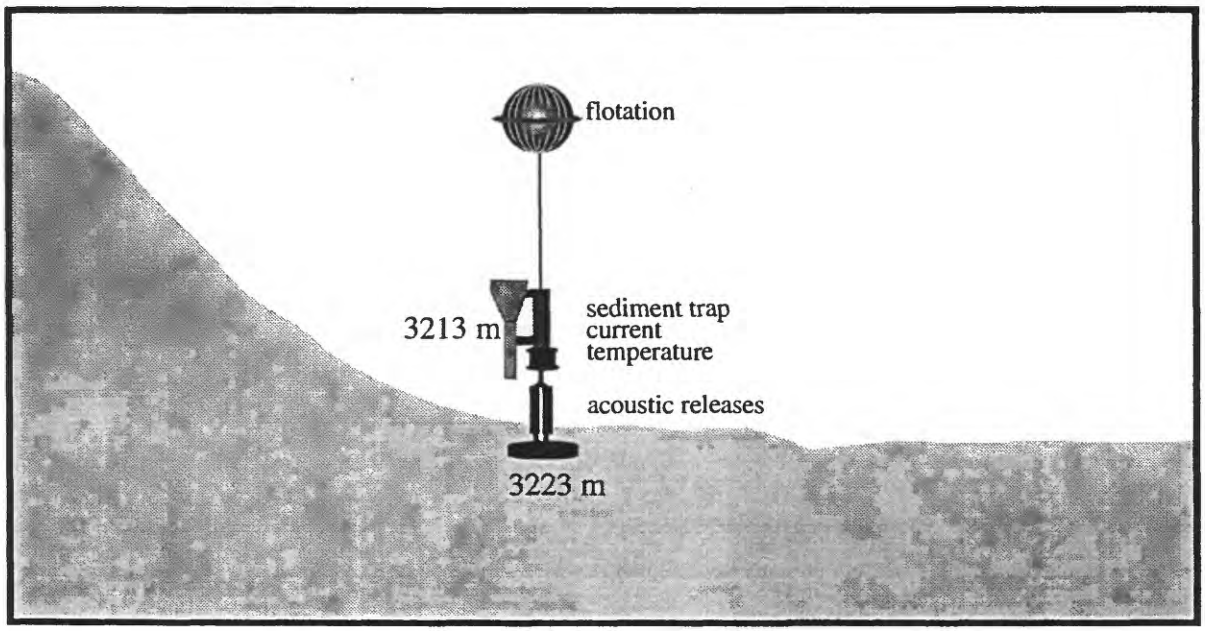

Figure 2c. Cross section view of mooring set-up on Monterey Fan.

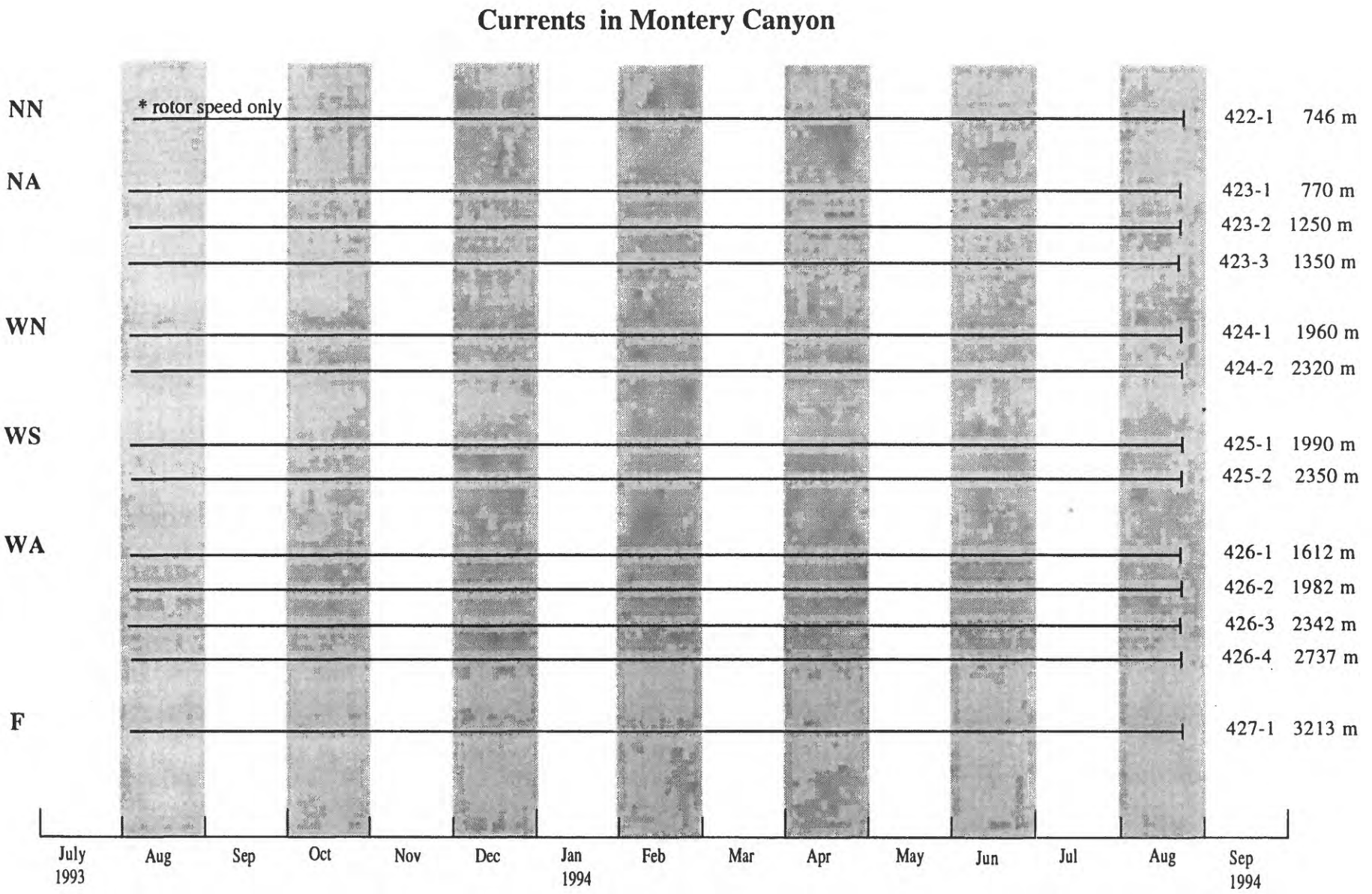

Figure 3a. Timelines showing dates when valid current data exist for Monterey Canyon and Fan.

Temperature, transmission, attenuation and salinity in Montery Canyon

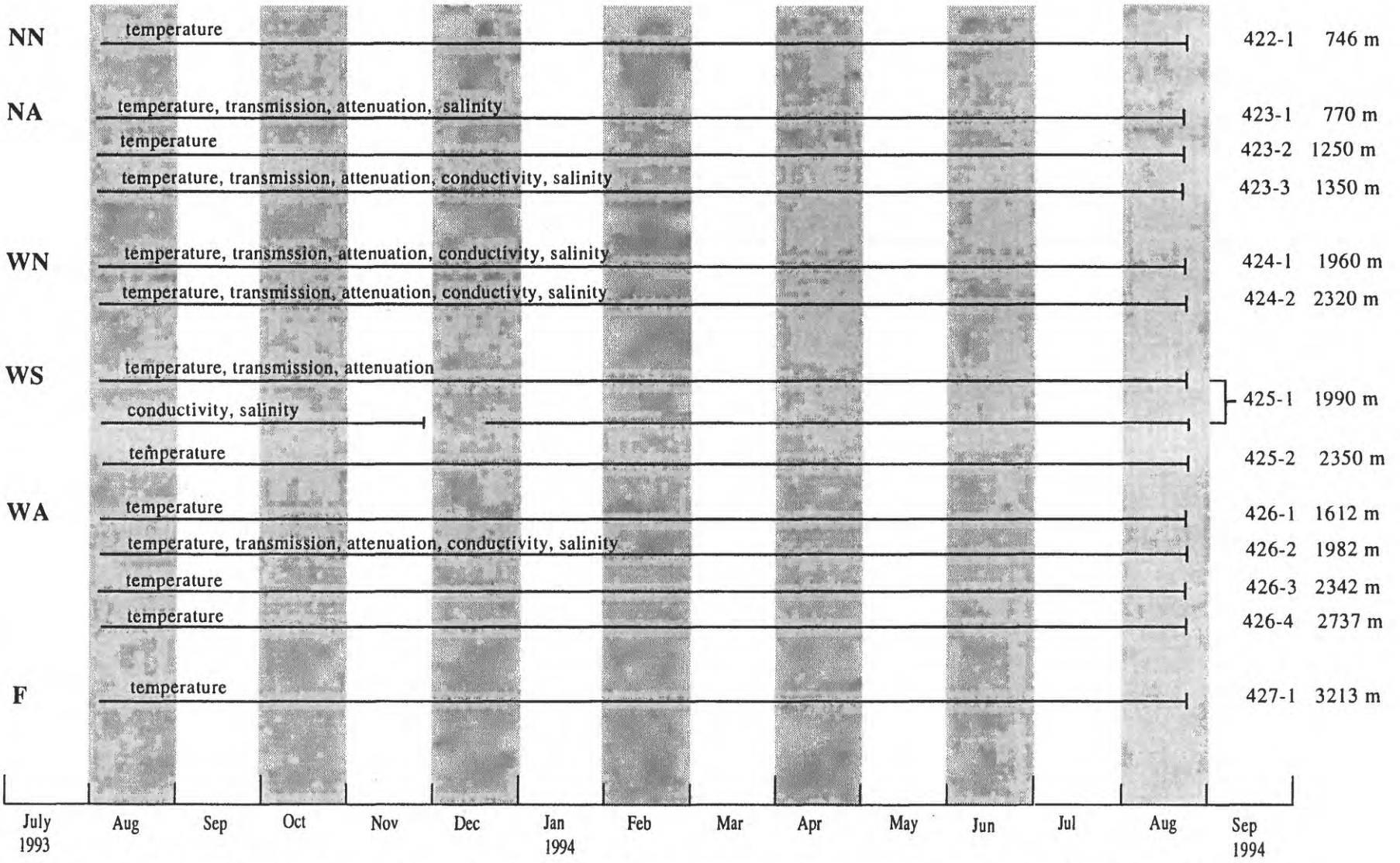

Figure 3b. Timelines showing dates when valid temperature, transmission, attenuation conductivity and salinity data exist for Monterey Canyon and Fan.

would not be as energetic as found in the upper reaches of the canyon. Hence the single current meter was located 10 m off the sea bed (Figure 2c).

The currents at all the moorings sites were rotated into a coordinate system that is aligned with, or perpendicular to, the alongshelf isobaths. At site NA the positive along canyon direction is 4°; positive cross canyon is 094°. At sites WA, WS and WN the positive along canyon direction is 85°; positive cross canyon is 175°. At site F the positive along canyon direction is 17°; positive cross canyon is 107°. These orientations are chosen so that at all sites, positive along-canyon currents flow toward the head of the canyon. Positive, cross-canyon currents flow to the right of positive along-canyon currents.

Several statistical quantities have been included in this data report. The mean, standard deviation, minimum and maximum of the hour-averaged current records are listed in the tables in Appendix A.

Error bars at the 95% confidence level have been calculated for the mean along and cross-canyon currents. The error bars around the mean value indicate how stable the calculated mean is. In order for a reliable mean direction to be estimated, the error bars can not span an interval that includes zero. Significant mean directions have been highlighted in the tables.

The formula for the error bar around the mean is

$$\frac{\Phi t_{m;\alpha/2}}{\sqrt{m+1}} \qquad (1)$$

where $t_{m;\alpha/2}$ is the student t statistic with m degrees of freedom at the $100(1-\alpha)\%$ confidence level. Φ is the standard deviation of the subtidal data set. The degrees of freedom of a record is the record length divided by the autocorrelation scale. The autocorrelation scale for along and cross-canyon currents was 4 days at most current sites, but lengthen to 17 days for cross-canyon currents above the wide portion of the canyon axis.

Tidal currents are the major current components in the canyon. It is to be expected that the narrowing of the canyon will cause barotropic tidal currents to be enhanced along the canyon axis. Baroclinic tidal currents can be generated along the canyon floor and propagate along the canyon axis. These strengthened tidal currents increase the potential for material to be eroded from the canyon walls or resuspended from the canyon floor. Hence, the characteristics of the major diurnal (O_1 and K_1) and semidiurnal (M_2 and S_2) tidal constituents are calculated for each measurement site (Tables A5 and A6). The tidal amplitudes are calculated for the existing record length of each data set (Table D1).

Several sections of this data report contain a series of figures that display characteristics of the measured currents. The time series of the hour-averaged and subtidal along and cross-canyon currents are in Appendix B. The time axes are the same for all current sites so that comparisons can easily be made between the instruments. The hour-averaged currents are shown first (Appendix B, pgs. B1-B11), the subtidal currents follow (pgs. B12-B21). An additional plot type, vector plots of the subtidal currents, are shown in Appendix C. These figures display the direction and amplitude of the current vectors simultaneously.

The energy in the currents at each measurement site is depicted as a function of the frequency of the process in Appendix D. A variance-conserving autospectra is calculated for the along and cross-canyon currents. We chose a variance-conserving spectra in order to highlight those frequencies that had the largest energies; the dominant processes occupy the biggest areas on the plots. The tidal frequencies generally have a large fraction of the energy; these large spectral peaks are found at frequencies above 10^{-5} hertz (1.2 days).

All spectra for the moored array are calculated with similar Fourier transform parameters. Each record was divided into pieces 2112 hours long that overlapped each other by 50% (Table D1). Each piece was windowed with a Hanning window shape in order to reduce leakage of energy from the dominant frequencies into the less energetic frequency bands. The spectra for all pieces at one location were averaged together.

Moored temperature, salinity, attenuation and transmission observations

Measurements of temperature were obtained at each sites in the moored array (Table 1, Figure 3b). Salinity and attenuation were monitored for at least one depth at 4 of the sites in the array and water clarity was monitored at 3 of the sites.

The mean, standard deviation, minimum and maximum values for both the hour-averaged and subtidal data are listed in Tables A3 and A4. Plots of all the data are located in Appendix F. Both the hour-averaged and subtidal data are depicted for temperature and salinity.

The attenuation data has been edited for obvious spikes and other bad data. Attenuation is an optical measurement. Hence, the instrument that make the measurement are subject to fouling from growth of organisms on the lenses. The fouling happens over periods of weeks. Surface instruments foul faster because more light is available. This fouling has not been removed from the attenuation records. Hence, the gradual decrease in water clarity that may be observed during the deployment periods is artificial and should be discounted.

Records from the mooring deployed at NA show that an unusually strong turbidity event occurred 100 m above the bed (mab) from February 8 through February 15, 1994 (Figure 4). Suspended material dense enough to initially block the transmissometer passed the site; the water column slowly cleared over the next week. At the beginning of the event, temperature increased by 1 degree, the pressure sensor failed and currents flowed down canyon. Unfortunately, no measurements were collected below 100 mab. It is probable that the main structure of the turbidity event passed below our deepest sensors.

Sediment traps

Extremely large particulate sediment fluxes of 22-60 g/m^2/day (Figure 5) were recorded at the 1360 m sediment trap at NA prior to it overflowing in November, 1993, although no major signal indicating a large resuspension event was recorded by the transmissometer that was located 10 meters above the trap. These sediment mass fluxes were approximately an order of magnitude greater than those measured at a trap located at 780 m on the same mooring. The shallower trap fluxes ranged from 2-4 g/m^2/day (Figure 5). The intervalometer

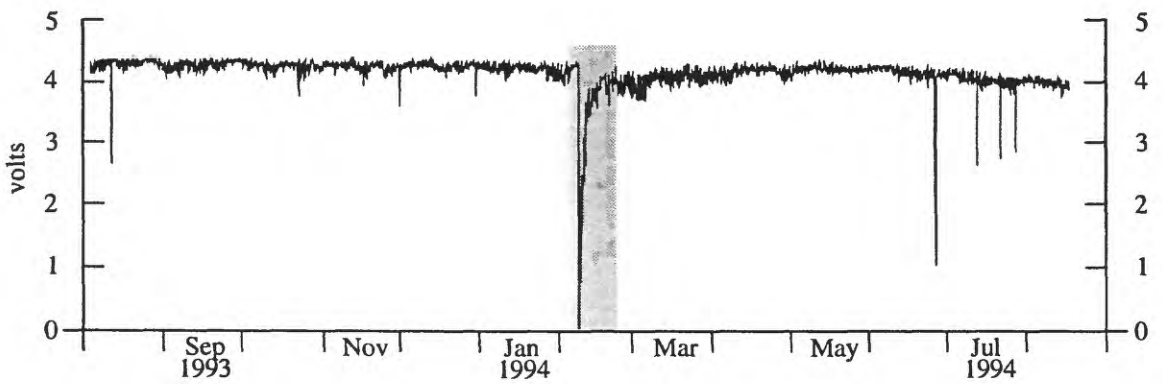

Figure 4. Hour-averaged transmission record from 1360 m at site NA. The gray box shows an unusually strong turbidity event that occurred from February 8 through February 15, 1994.

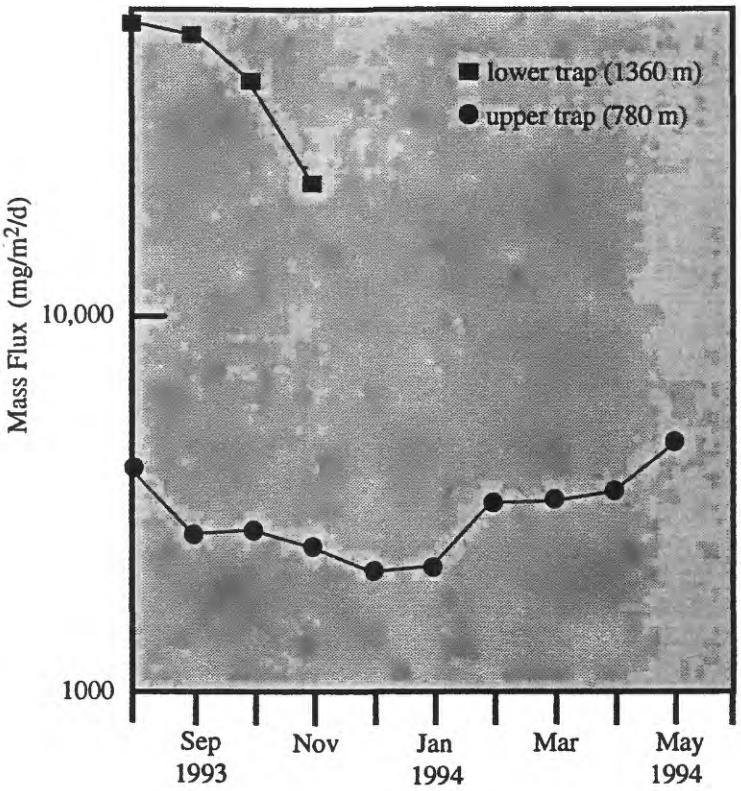

Figure 5. Sediment trap mass flux at site NA.

battery pack on the upper trap apparently failed after 10 events (months) as no more events after 10 were preserved and there was some wash-out of the final events from the tube as no particulate flux events were recovered after the tenth event (May 28, 1994).

Much of the material in the 1360 m trap was black and emitted an obvious hydrogen sulfide smell when first examined. The black sediment was overlain by more gray/green material collected just prior to the overflow of the trap in November. It is possible that the black sediment was originally part of an organic-rich, fine-grained sediment blanket that tends to drape extensive regions of the steep axis walls in upper Monterey Canyon. It was carried to the trap by the failure and subsequent down canyon movement of this material.

Dramatic differences in the mass fluxes are a function of trap location relative to canyon depth and proximity to canyon walls, the deeper trap experienced much larger fluxes due to particulate remobilization/slumping events (down slope/down canyon wall movement). It is unknown how often these transport events occur, whether they are predominantely triggered by major storm events, by the enhanced tidal currents typically found in canyons, by internal waves, by the frequent seismic activity in the Monterey Canyon region or by other processes. The relative instability of thick, muddy sediment accumulated along the steep-sided canyon walls and the recent history of sediment movement suggest that episodic, if not frequent, turbid sediment pulses move down Monterey Canyon.

Wind and sea level observations

For the same time period of this study, records of wind velocity and atmospheric pressure and sea level heights were obtained from the National Data Buoy Office and the National Ocean Service (Table 2, Figure 6). Winds along the coast were measured by offshore meteorological buoys

Buoy wind and Sea level

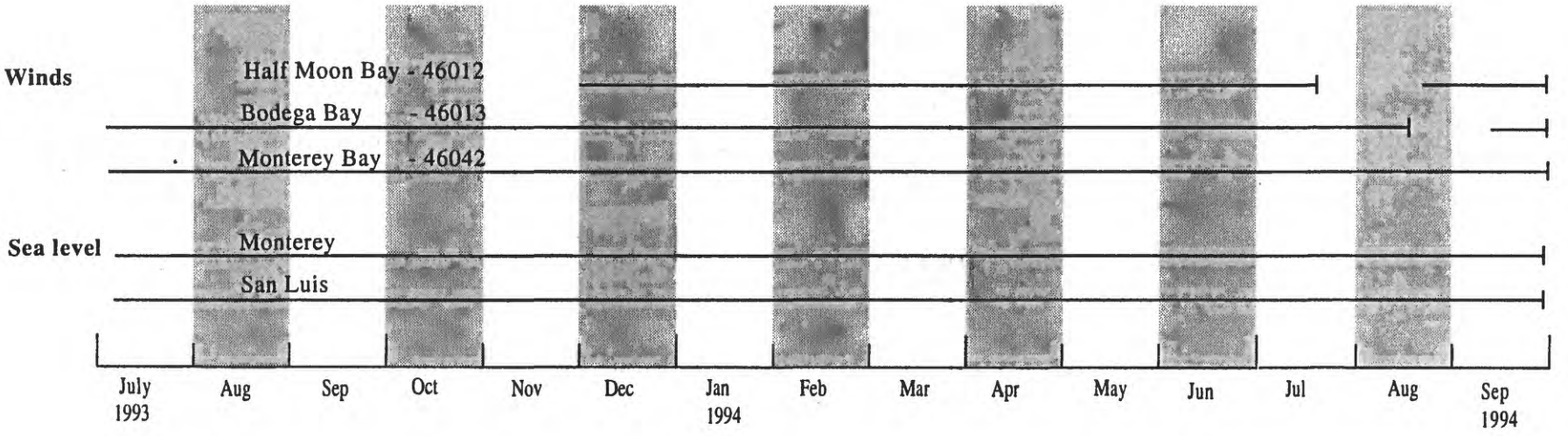

Figure 6. Timelines showing dates when valid sea level and wind data exist for Monterey Canyon and Fan.

at 3 locations between Bodega Bay and Monterey, California (Figure 7). The 2 sea level stations were located on the coast at Monterey Harbor and Port San Luis (Figure 7).

The hourly observations of wind velocity were converted into estimates of wind stress because wind stress represents the actual force that causes water to move over the shelf and slope. Wind stress was calculated from the formula by Wu (1980).

$$\tau = \rho c_D \mathbf{W}|\mathbf{W}| \qquad (2)$$

where ρ is the air density (0.0012 g cm^{-3}), c_D the drag coefficient and **W** the wind velocity. The drag coefficient increases with wind strength

$$c_D = \left(0.8 + 0.065|W_{10}|\right) \times 10^{-3} \quad (3)$$

where W_{10} is the wind speed 10 m above the surface in meters per second. The wind stress was lowpass filtered and rotated into an alongshelf/cross-shelf coordinate system. The positive alongshelf wind stress direction is 330° for the bouys off Monterey and Half Moon Bay (Buoys 46012 and46042), 320° for the northern most buoy (46013). These orientations are roughly parallel to the local alongshelf topography. The positive cross-shelf directions are 60° and 50°, respectively.

The coastal sea level records were converted into records of synthetic subsurface pressure (SSP) by adding atmospheric pressure to the sea level records. SSP is a better representation of the pressure forces that cause currents to move along the coast because changes in sea level caused by high and low pressure systems are removed from the record. The mean was removed from each SSP record. The record was lowpass filtered to remove the tidal signal.

The wind stress and sea level information is presented in appendix G. The tidal amplitudes computed from the unfiltered SSP records are given in Table G2. The basic statistics for the subtidal wind stress records are given in Table G3. The subsequent section displays the temporal and spectral plots of winds stress and SSP data.

Other data collected

A mooring supporting 2 current meters was deployed at site F in August, 1994. and recovered in May, 1995. The data set from this mooring is depicted in Appendix G.

Data Type/Station	Water Depth (m)	Start Time (M/D/Y)	Stop Time (M/D/Y)	Position		Data Type	Sample Interval (minutes)
				Latitude	Longitude		
Sea level							
Monterey	n/a	08/01/93	09/01/94	36 36.00 N	121 53.30	SL	60
Port San Luis	n/a	08/01/93	09/01/94	35 10.20	120 45.10	SL	60
Buoy winds							
Half Moon Bay (46012)	89	12/01/93	09/01/94	37 23.12 N	122 43.17 W	ST,P,AT,W	60
Bodega Bay (46013)	125	08/01/93	09/01/94	38 13.39 N	123 17.56 W	ST,P,AT,W	60
Monterey Bay (46042)	89	08/01/93	09/01/94	36 45.01	122 24.227	ST,P,AT,W	60

Table 2. Sea level, surface wind and buoy wind data available.

ST = sea temperature
P = atmospheric pressure
SL = sea level
AT = air temperature
W = wind (speed and direction)

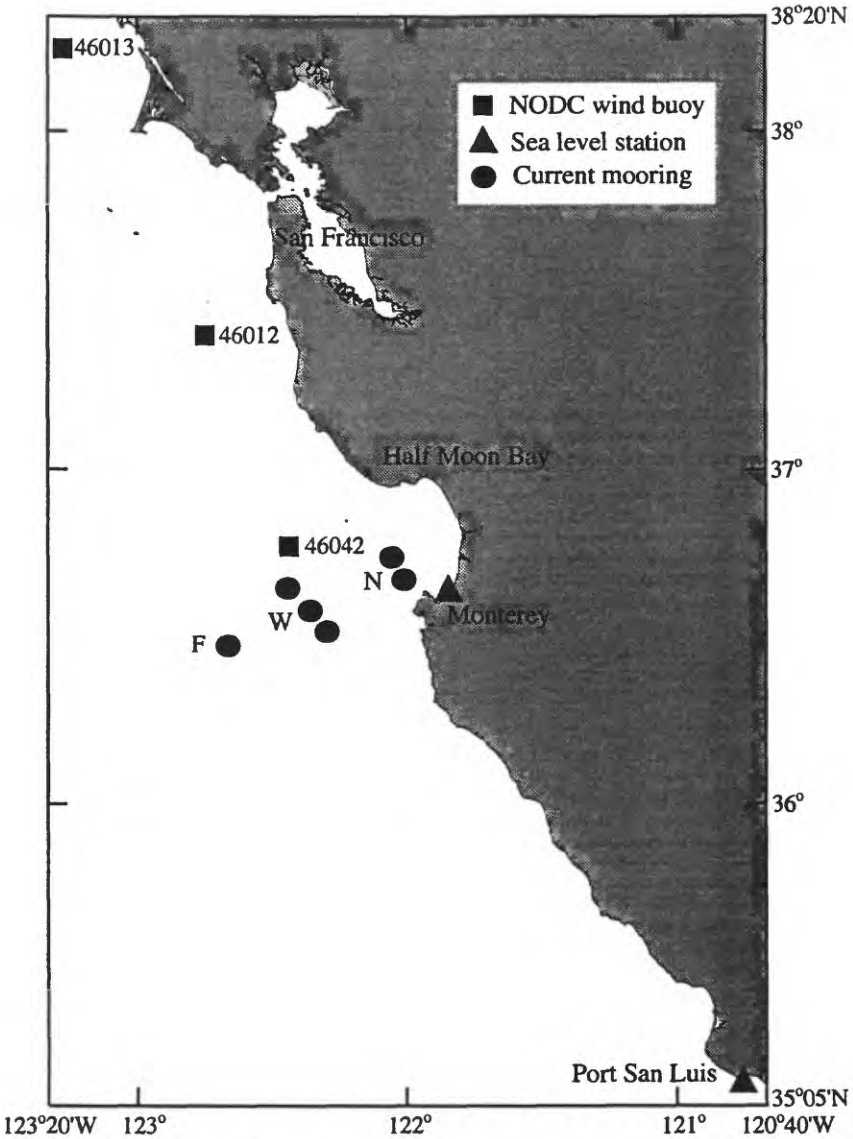

Figure 7. Location of wind buoys and sea level stations.

ACKNOWLEDGMENTS

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Appendix A - Tables

Table A1. - Hour-averaged horizontal current components A1

Table A2. - Lowpassed horizontal current components A2

Table A3. - Hour-averaged temperature and salinity A3

Table A4. - Lowpassed temperature and salinity A4

Table A5. - Diurnal tidal currents A5

Table A6. - Semi-diurnal tidal currents A6

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Site	Mooring	Water Depth (m)	Start Time GMT (M/D/Y)	Stop Time GMT (M/D/Y)	Instrument	Sensor Depth (m)	Cross canyon					Along canyon					Max Speed
							Mean		SD	Max	Min	Mean		SD	Max	Min	
NN	422-1	806	08/03/93	08/17/94	VACM	746	-	-	-	-	-	-	-	-	-	-	-
NA	423-1	1450	08/03/93	08/17/94	VTCT	770	-0.0	±0.1	2.8	11.13	-10.7	**1.2**	**±0.2**	4.7	18.6	-15.7	18.6
NA	423-2	1450	08/03/93	08/17/94	VACM	1250	**0.8**	**±0.1**	4.0	18.5	-15.7	**-3.4**	**±0.2**	12.0	40.1	-41.9	42.8
NA	423-3	1450	08/03/93	08/17/94	VTCT	1350	**1.2**	**±0.1**	4.8	28.0	-15.6	**-1.4**	**±0.2**	13.8	47.2	-47.9	51.3
WN	424-1	2420	08/03/93	08/17/94	VTCT	1960	**-1.8**	**±0.1**	4.8	13.1	-17.5	**-0.1**	**±0.1**	3.7	13.9	-13.5	17.5
WN	424-2	2420	08/03/93	08/17/94	VTCT	2320	**-1.0**	**±0.1**	6.0	66.9	-85.3	**0.3**	**±0.1**	3.5	35.5	-57.3	85.4
WS	425-1	2560	08/03/93	08/18/94	VTCT	1990	**0.4**	**±0.1**	3.3	13.1	-12.6	**-0.3**	**±0.2**	4.2	14.2	-17.9	18.1
WS	425-2	2560	08/03/93	08/18/94	VACM	2350	**0.6**	**±0.1**	3.1	12.7	-10.4	**0.3**	**±0.2**	4.7	19.1	-15.2	19.5
WA	426-1	2837	08/03/93	08/18/94	VACM	1612	0.4	±0.6	3.9	17.6	-12.0	**0.1**	**±0.1**	3.4	11.9	-13.7	17.6
WA	426-2	2837	08/03/93	08/18/94	VTCT	1982	-0.1	±0.2	3.5	12.1	-13.6	**0.2**	**±0.1**	3.6	13.1	-14.4	14.7
WA	426-3	2837	08/03/93	08/18/94	VACM	2342	0.1	±0.2	4.7	15.8	-17.2	**-0.3**	**±0.2**	3.9	15.3	-14.5	19.0
WA	426-4	2837	08/03/93	08/18/94	VACM	2737	**-0.5**	**±0.1**	6.1	23.0	-21.2	**-0.1**	**±0.1**	3.6	14.8	-13.1	23.4
F	427-1	3223	08/05/93	08/20/94	VACM	3213	**-0.4**	**±0.1**	3.6	11.0	-11.7	**0.5**	**±0.2**	4.9	16.0	-14.0	16.3

Table A1. - Hour-averaged horizontal current components (cm/s). Means in bold type are significantly different from zero at the 95% confidence level.

VACM = Vector averaging current meter (measures current and temperature)
VTCT = Vector averaging current meter (measures current, temperature and transmission)

Site	Mooring	Water Depth (m)	Start Time GMT (M/D/Y)	Stop Time GMT (M/D/Y)	Instrument	Sensor Depth (m)	Cross canyon					Along canyon				
							Mean		SD	Max	Min	Mean		SD	Max	Min
NN	422-1	806	08/03/93	08/17/94	VACM	746	-	-	-	-	-	-	-	-	-	-
NA	423-1	1450	08/03/93	08/17/94	VTCT	770	-0.0	±0.1	0.8	2.6	-2.8	**1.2**	**±0.2**	1.7	6.1	-6.7
NA	423-2	1450	08/03/93	08/17/94	VACM	1250	**0.8**	**±0.1**	1.0	4.0	-2.8	**-3.4**	**±0.2**	2.0	2.9	-10.2
NA	423-3	1450	08/03/93	08/17/94	VTCT	1350	**1.2**	**±0.1**	1.2	6.9	-3.4	**-1.4**	**±0.2**	1.6	3.2	-8.0
WN	424-1	2420	08/03/93	08/17/94	VTCT	1960	**-1.8**	**±0.1**	1.5	2.1	-7.0	**-0.1**	**±0.1**	1.3	4.1	-4.9
WN	424-2	2420	08/03/93	08/17/94	VTCT	2320	**-1.0**	**±0.1**	1.0	2.5	-11.3	**0.3**	**±0.1**	1.2	2.7	-15.4
WS	425-1	2560	08/03/93	08/18/94	VTCT	1990	**0.5**	**±0.1**	0.9	3.7	-2.4	**-0.3**	**±0.2**	1.6	5.3	-5.7
WS	425-2	2560	08/03/93	08/18/94	VACM	2350	**0.6**	**±0.1**	0.7	2.7	-2.2	**0.3**	**±0.2**	1.6	8.0	-4.7
WA	426-1	2837	08/03/93	08/18/94	VACM	1612	0.4	±0.6	2.6	13.6	-6.0	**0.1**	**±0.1**	1.4	5.1	-7.7
WA	426-2	2837	08/03/93	08/18/94	VTCT	1982	-0.1	±0.2	1.1	3.2	-2.9	**0.2**	**±0.1**	2.2	4.1	-4.0
WA	426-3	2837	08/03/93	08/18/94	VACM	2342	0.1	±0.2	1.2	3.7	-3.8	**-0.3**	**±0.2**	0.8	2.0	-2.4
WA	426-4	2837	08/03/93	08/18/94	VACM	2737	**-0.5**	**±0.1**	1.5	4.2	-4.7	**-0.1**	**±0.1**	0.7	2.4	-2.3
F	427-1	3223	08/05/93	08/20/94	VACM	3213	**-0.4**	**±0.1**	0.8	2.3	-3.8	**0.5**	**±0.2**	1.9	8.2	-5.8

Table A2. - Lowpassed horizontal current components (cm/s). Means in bold type are significantly different from zero at the 95% confidence level.

VACM = Vector averaging current meter (measures current and temperature)
VTCT = Vector averaging current meter (measures current, temperature and transmission)

Site	Mooring	Water Depth (m)	Start Time GMT (M/D/Y)	Stop Time GMT (M/D/Y)	Instrument	Sensor Depth (m)	Temperature (C)				Salinity (ppt)			
							Mean	SD	Max	Min	Mean	SD	Max	Min
NN	422-1	806	08/03/93	08/17/94	VACM	746	**4.8 ±0.0**	0.1	5.2	4.4	– –	–	–	–
NA	423-1	1450	08/03/93	08/17/94	VTCT	770	**4.7 ±0.0**	0.1	5.2	4.3	**34.3 ±0.0**	0.0	34.4	34.2
NA	423-2	1450	08/03/93	08/17/94	VACM	1250	**3.3 ±0.0**	0.1	3.8	2.9	– –	–	–	–
NA	423-3	1450	08/03/93	08/17/94	VTCT	1350	**4.2 ±0.0**	0.3	4.1	0.1	**34.5 ±0.0**	0.0	34.6	34.3
WN	424-1	2420	08/03/93	08/17/94	VTCT	1960	**2.1 ±0.0**	0.1	2.2	1.9	**34.6 ±0.0**	0.0	34.7	34.6
WN	424-2	2420	08/03/93	08/17/94	VTCT	2320	**1.4 ±0.0**	0.0	1.6	1.2	**35.2 ±0.0**	0.0	35.2	35.1
WS	425-1	2560	08/03/93	08/18/94	VTCT	1990	**2.0 ±0.0**	0.1	2.3	1.9	**34.6 ±0.0**	0.0	34.7	34.6
WS	425-2	2560	08/03/93	08/18/94	VACM	2350	**1.8 ±0.0**	0.0	1.9	1.7	– –	–	–	–
WA	426-1	2837	08/03/93	08/18/94	VACM	1612	**2.6 ±0.0**	0.1	2.9	2.4	– –	–	–	–
WA	426-2	2837	08/03/93	08/18/94	VTCT	1982	**2.1 ±0.0**	0.1	2.3	1.9	**34.6 ±0.0**	0.0	34.7	34.6
WA	426-3	2837	08/03/93	08/18/94	VACM	2342	**1.8 ±0.0**	0.0	2.0	1.7	– –	–	–	–
WA	426-4	2837	08/03/93	08/18/94	VACM	2737	**1.7 ±0.0**	0.0	1.8	1.6	– –	–	–	–
F	427-1	3223	08/05/93	08/20/94	VACM	3213	**1.6 ±0.0**	0.0	1.6	1.6	– –	–	–	–

Table A3. - Hour-averaged temperature and salinity. Means in bold type are significantly different from zero at the 95% confidence level.

VACM = Vector averaging current meter (measures current and temperature)
VTCT = Vector averaging current meter (measures current, temperature and transmission)

Site	Mooring	Water Depth (m)	Start Time GMT (M/D/Y)	Stop Time GMT (M/D/Y)	Instrument	Sensor Depth (m)	Temperature (C) Mean		SD	Max	Min	Salinity (ppt) Mean		SD	Max	Min
NN	422-1	806	08/03/93	08/17/94	VACM	746	**4.8**	**±0.0**	0.1	5.0	4.6	-	-	-	-	-
NA	423-1	1450	08/03/93	08/17/94	VTCT	770	**4.7**	**±0.0**	0.1	5.0	4.5	**34.3**	**±0.0**	0.0	34.4	34.2
NA	423-2	1450	08/03/93	08/17/94	VACM	1250	**3.3**	**±0.0**	0.2	3.5	3.1	-	-	-	-	-
NA	423-3	1450	08/03/93	08/17/94	VTCT	1350	**3.1**	**±0.0**	0.1	3.3	2.9	**34.5**	**±0.0**		34.5	34.3
WN	424-1	2420	08/03/93	08/17/94	VTCT	1960	**2.1**	**±0.0**	0.1	2.2	1.9	**34.6**	**±0.0**	0.0	34.7	34.6
WN	424-2	2420	08/03/93	08/17/94	VTCT	2320	**1.4**	**±0.0**	0.0	1.5	1.3	**35.2**	**±0.0**	0.0	35.2	35.2
WS	425-1	2560	08/03/93	08/18/94	VTCT	1990	**2.1**	**±0.0**	0.1	2.2	1.9	**34.6**	**±0.0**		34.6	34.6
WS	425-2	2560	08/03/93	08/18/94	VACM	2350	**1.8**	**±0.0**	0.0	1.9	1.7	-	-	-	-	-
WA	426-1	2837	08/03/93	08/18/94	VACM	1612	**2.6**	**±0.0**	0.1	2.8	2.5	-	-	-	-	-
WA	426-2	2837	08/03/93	08/18/94	VTCT	1982	**2.1**	**±0.0**	0.1	2.3	1.9	**34.6**	**±0.0**	0.0	34.7	34.6
WA	426-3	2837	08/03/93	08/18/94	VACM	2342	**1.8**	**±0.0**	0.0	1.9	1.8	-	-	-	-	-
WA	426-4	2837	08/03/93	08/18/94	VACM	2737	**1.7**	**±0.0**	0.0	1.7	1.6	-	-	-	-	-
F	427-1	3223	08/05/93	08/20/94	VACM	3213	**1.6**	**±0.0**	0.0	1.6	1.6	-	-	-	-	-

Table A4. - Lowpassed temperature and salinity. Means in bold type are significantly different from zero at the 95% confidence level.

VACM = Vector averaging current meter (measures current and temperature)
VTCT = Vector averaging current meter (measures current, temperature and transmission)

Site	Instrument depth	Mooring	Start time GMT (M/D/Y)	Stop time GMT (M/D/Y)	O_1			K_1		
					Major axis (cm/s)	Minor axis (cm/s)	Inclination (degrees)	Major Axis (cm/s)	Minor axis (cm/s)	Inclination (degrees)
NN	746	422-1	08/03/93	08/17/94	--	--	--	--	--	--
NA	770	423-1	08/03/93	08/17/94	0.9	-0.0	080.1	2.1	0.1	069.4
NA	1250	423-2	08/03/93	08/17/94	1.4	0.4	082.2	0.7	0.3	109.4
NA	1350	423-3	08/03/93	08/17/94	1.2	-0.1	115.3	1.8	0.0	105.0
WN	1960	424-1	08/03/93	08/17/94	0.7	0.1	007.3	1.3	0.4	007.2
WN	2320	424-2	08/03/93	08/17/94	0.9	0.3	034.7	1.4	0.4	037.1
WS	1990	425-1	08/03/93	08/18/94	1.4	0.1	000.9	2.4	0.2	001.0
WS	2350	425-2	08/03/93	08/18/94	1.6	0.1	179.1	3.0	0.2	001.9
WA	1612	426-1	08/03/93	08/18/94	0.7	0.0	158.4	1.3	0.1	167.0
WA	1982	426-2	08/03/93	08/18/94	1.2	0.1	006.5	2.0	0.2	010.0
WA	2342	426-3	08/03/93	08/18/94	1.4	0.0	004.4	0.7	0.3	002.0
WA	2737	426-4	08/03/93	08/18/94	1.8	-0.1	008.6	3.6	-0.1	010.1
F	3213	427-1	08/03/93	08/20/94	0.1	0.2	104.5	1.0	0.4	083.3

TableA5. - Diurnal tidal currents. A negative minor axis indicates a clockwise rotation for the tidal currents. The inclination angle is counterclockwise from east.

Site	Instrument depth	Mooring	Start time GMT (M/D/Y)	Stop time GMT (M/D/Y)	M_2 Major axis (cm/s)	M_2 Minor axis (cm/s)	M_2 Inclination (degrees)	S_2 Major Axis (cm/s)	S_2 Minor axis (cm/s)	S_2 Inclination (degrees)
NN	746	422-1	08/03/93	08/17/94	--	--	--	--	--	--
NA	770	423-1	08/03/93	08/17/94	3.37	0.6	065.5	1.7	0.1	072.8
NA	1250	423-2	08/03/93	08/17/94	10.0	0.5	081.4	3.5	0.2	076.6
NA	1350	423-3	08/03/93	08/17/94	10.6	1.9	094.1	2.9	0.6	088.1
WN	1960	424-1	08/03/93	08/17/94	3.1	-0.8	108.4	2.6	-1.2	116.8
WN	2320	424-2	08/03/93	08/17/94	3.9	1.8	095.7	2.7	1.3	094.4
WS	1990	425-1	08/03/93	08/18/94	1.7	0.4	009.1	1.1	0.4	128.3
WS	2350	425-2	08/03/93	08/18/94	2.6	-0.3	001.5	1.8	0.6	024.1
WA	1612	426-1	08/03/93	08/18/94	1.6	0.9	018.3	1.3	-0.2	133.8
WA	1982	426-2	08/03/93	08/18/94	1.3	1.1	061.3	1.5	-0.3	126.7
WA	2342	426-3	08/03/93	08/18/94	3.5	-0.9	006.2	2.6	0.0	049.5
WA	2737	426-4	08/03/93	08/18/94	3.0	0.7	008.6	3.5	-1.0	173.9
F	3213	427-1	08/03/93	08/20/94	5.1	-2.3	091.1	2.2	-1.3	107.2

Table A6. - Semidiurnal tidal currents. A negative minor axis indicates a clockwise rotation for the tidal currents. The inclination angle is counterclockwise from east.

Appendix B - Time series plots

Plots of hour-averaged currents ..... B1 - B11

Plots of subtidal currents ..... B12 - B21

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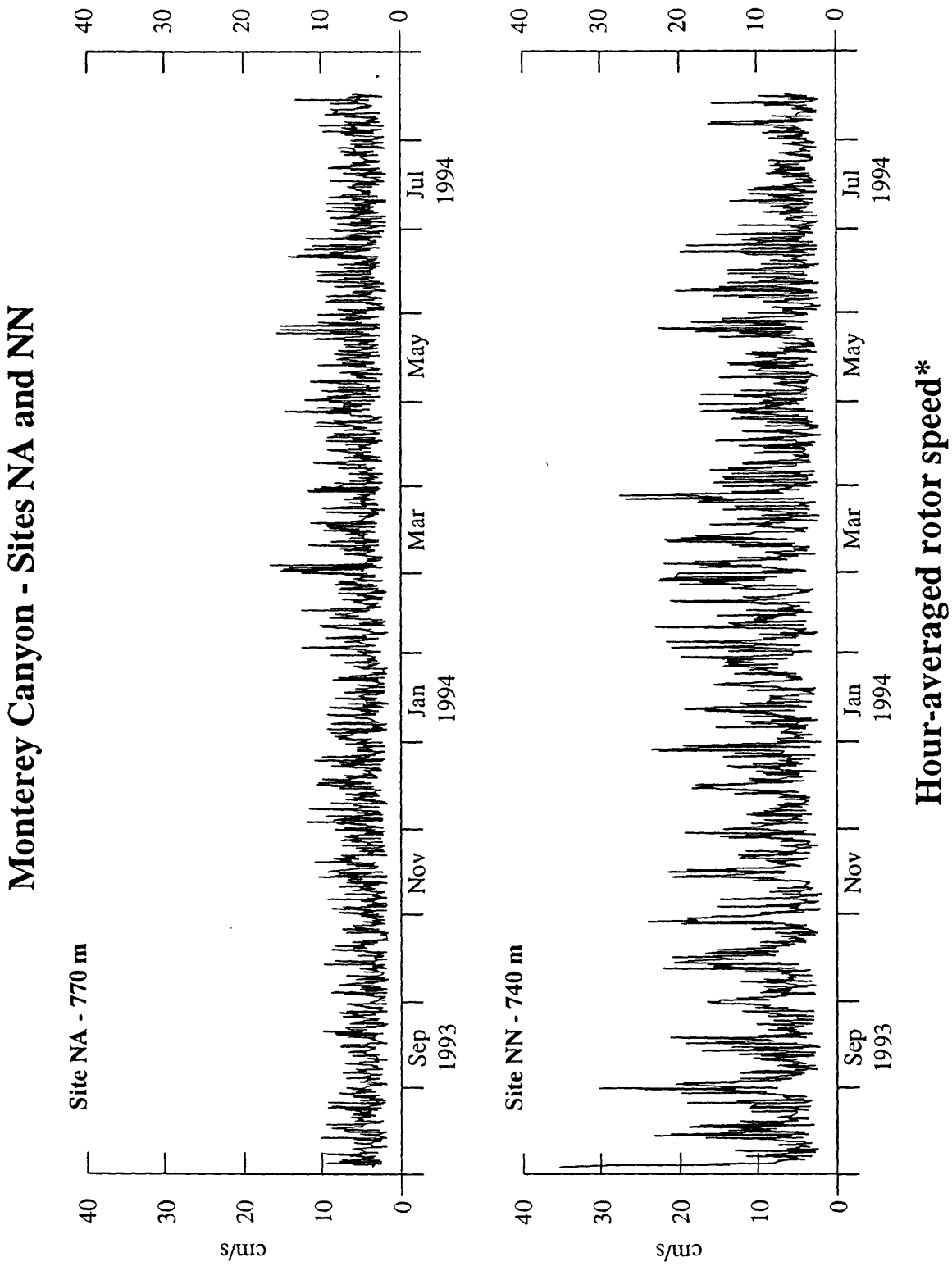
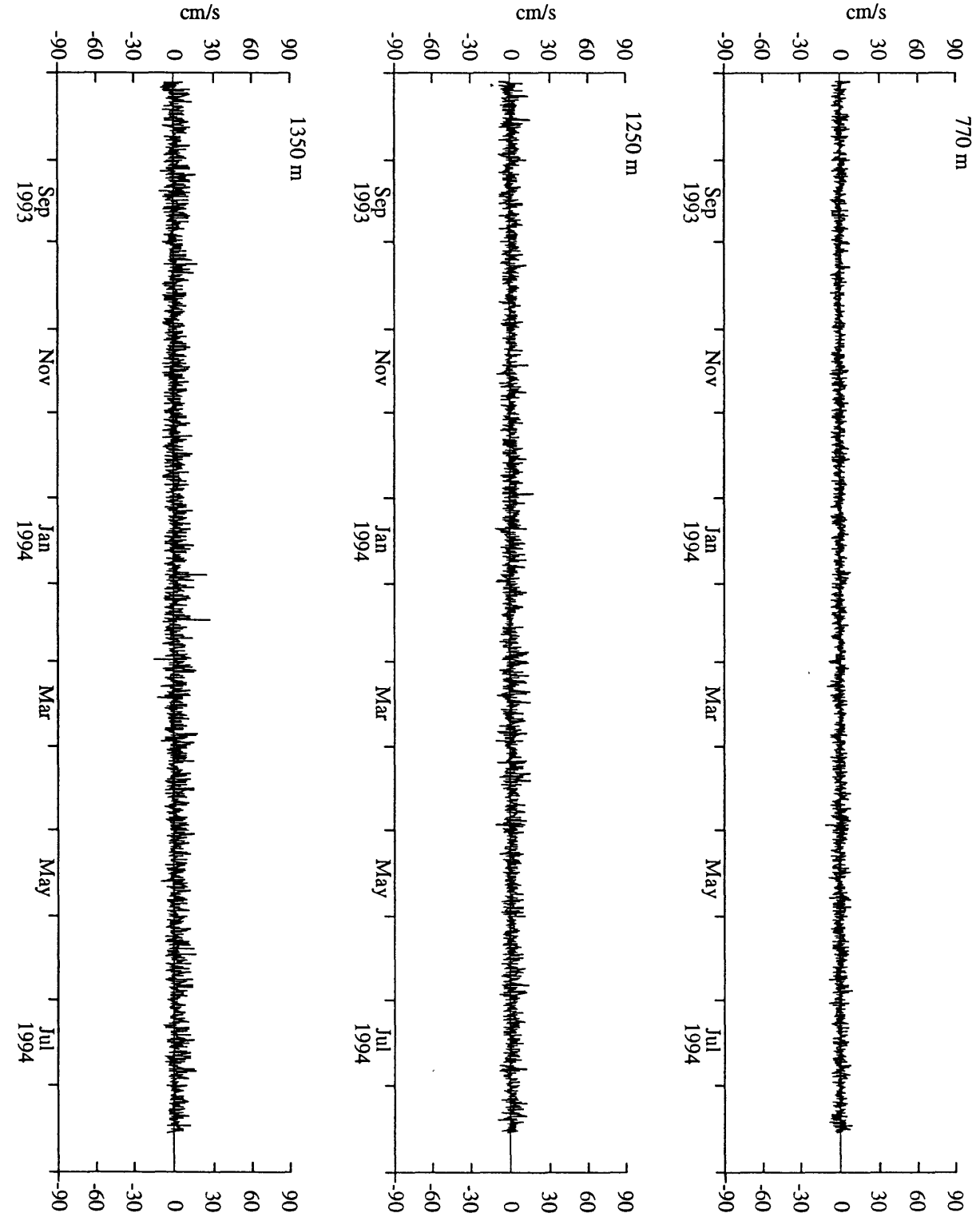
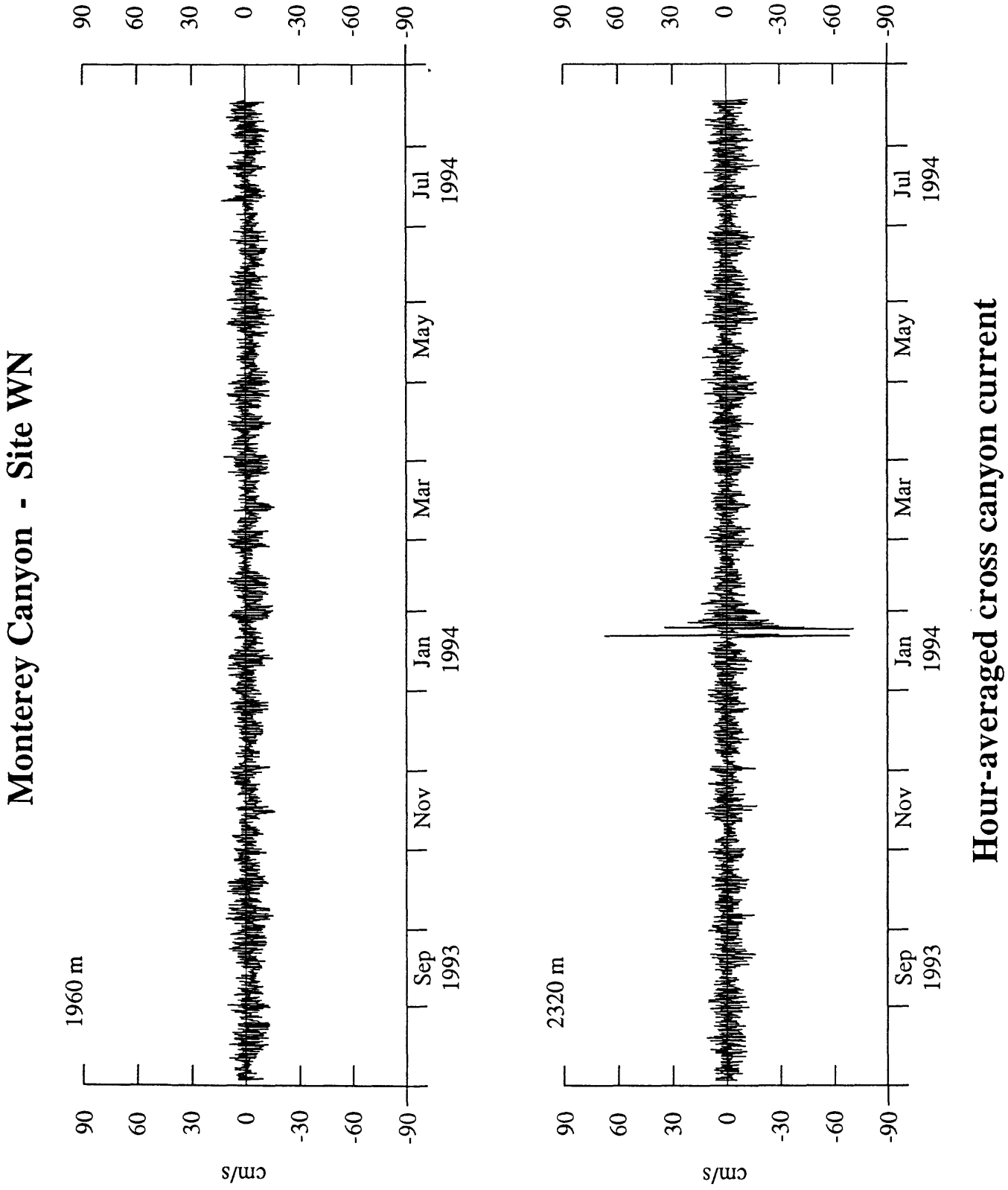
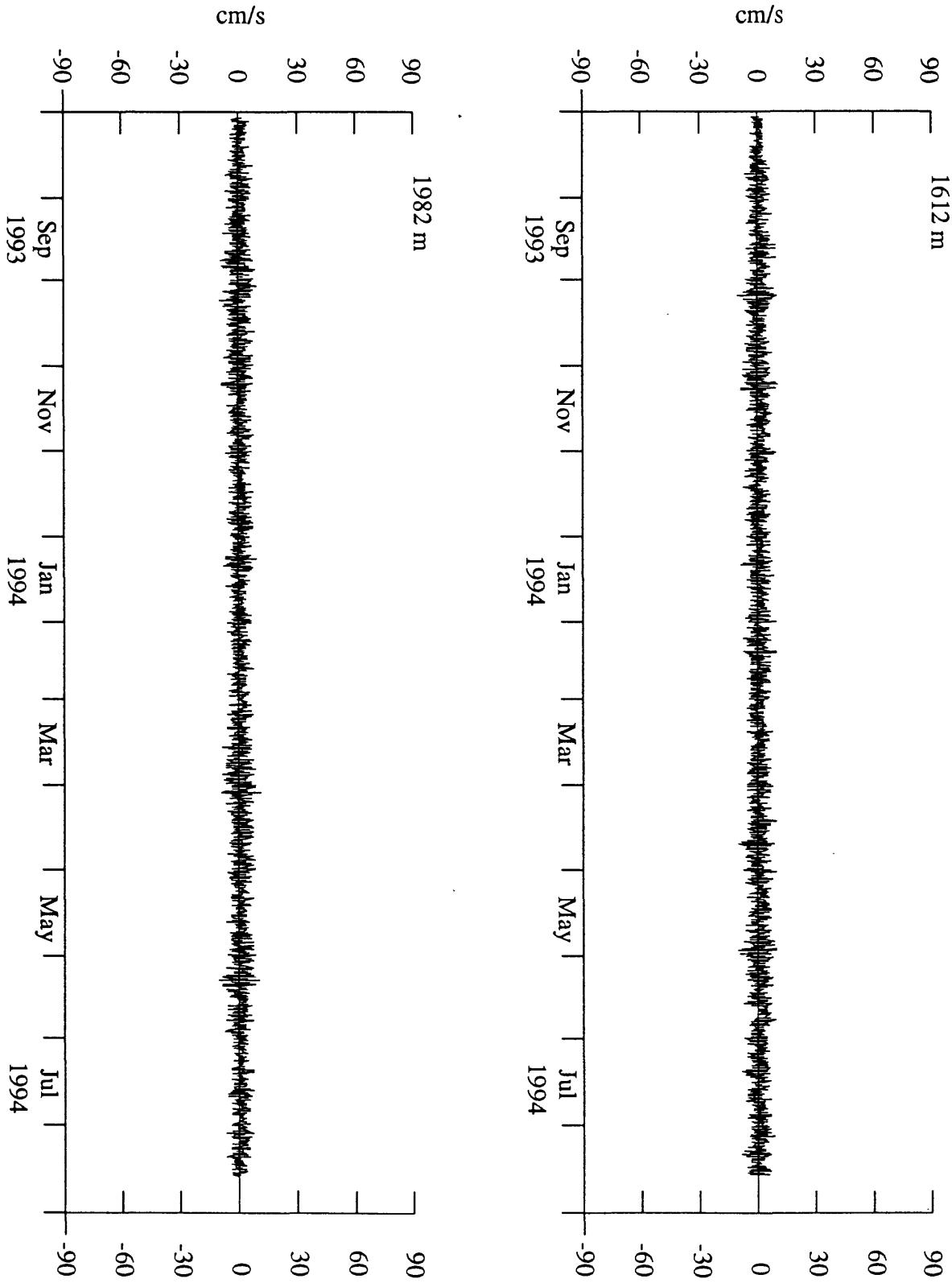


*rotor speed is the only current data available for site NN

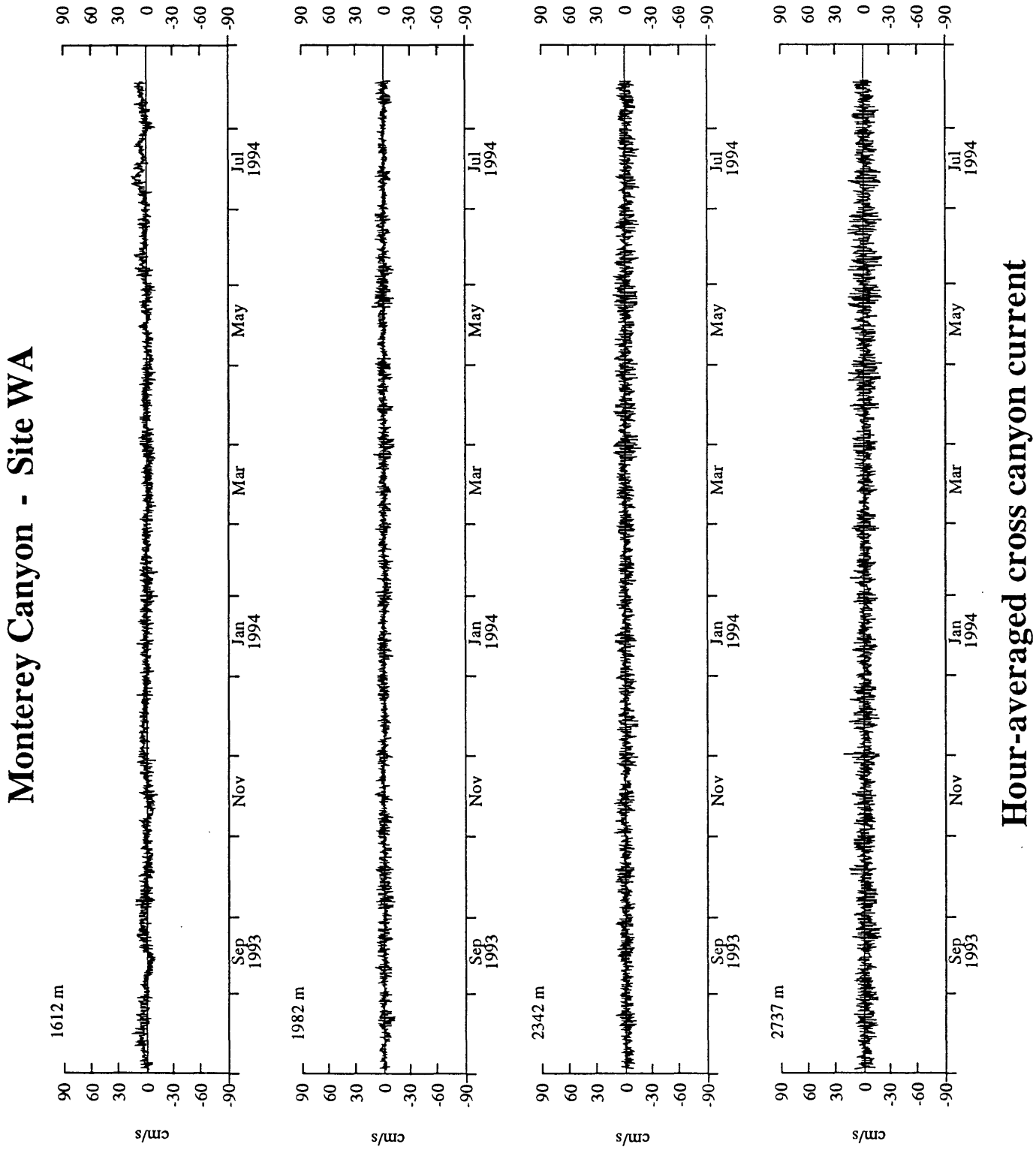


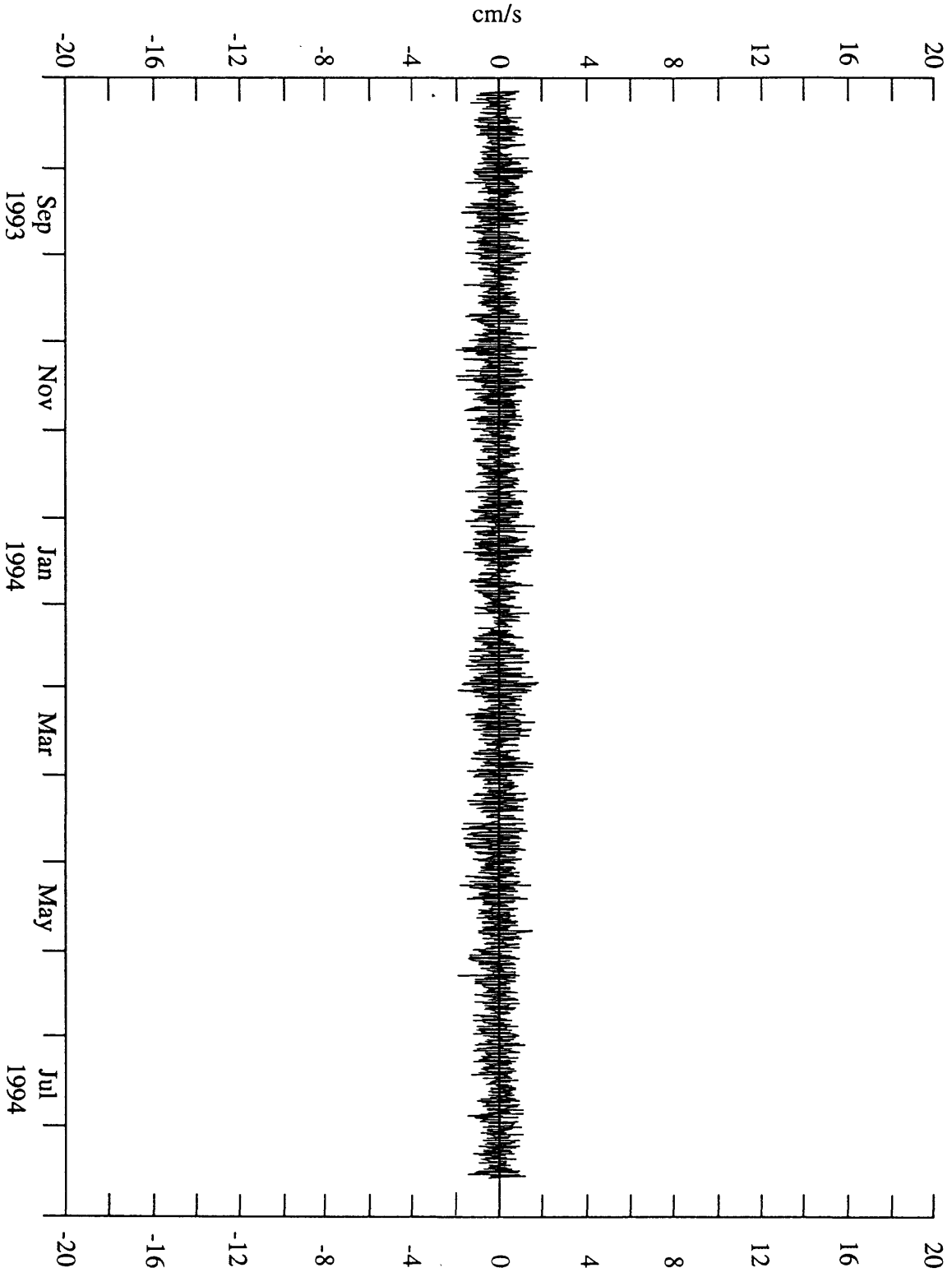
Hour-averaged cross canyon current


Monterey Canyon - Site WN
1960 m
2320 m
cm/s
90
60
30
0
-30
-60
-90
Sep 1993
Nov
Jan 1994
Mar
May
Jul 1994
Hour-averaged cross canyon current

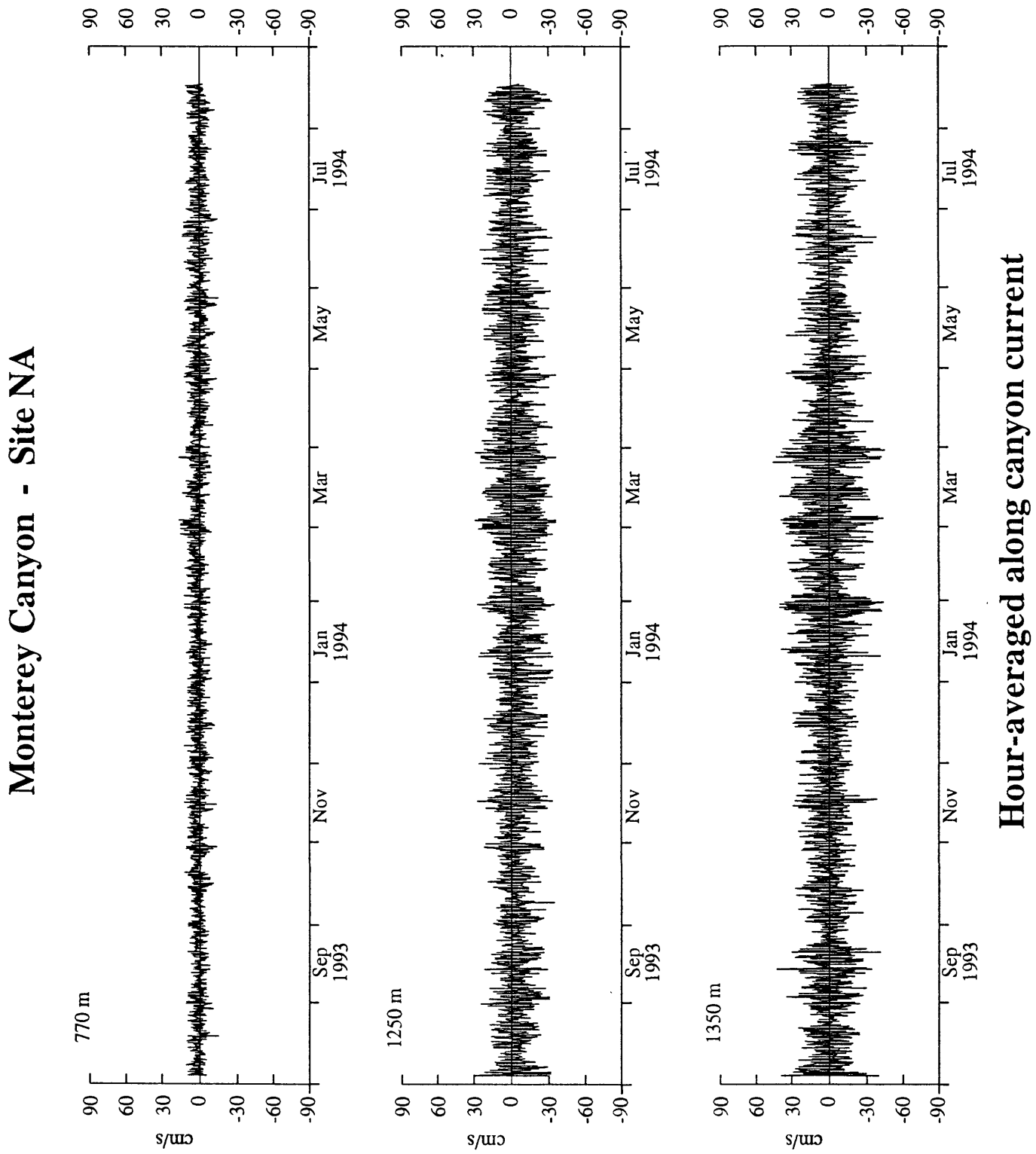


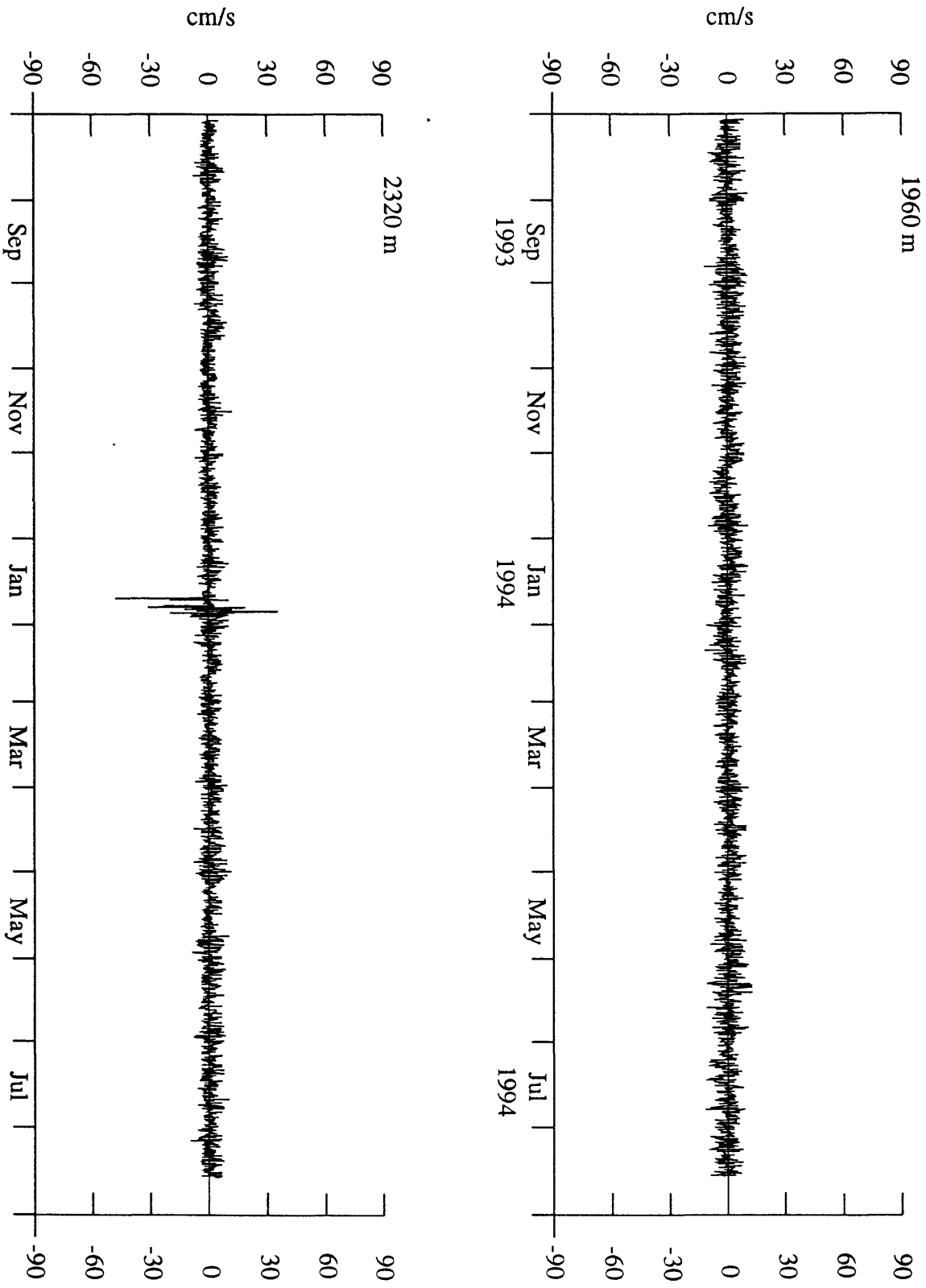
Hour-averaged cross canyon current


Monterey Canyon - Site WA
1612 m
1982 m
2342 m
2737 m
cm/s
90
60
30
0
-30
-60
-90
Sep 1993
Nov
Jan 1994
Mar
May
Jul 1994
Hour-averaged cross canyon current

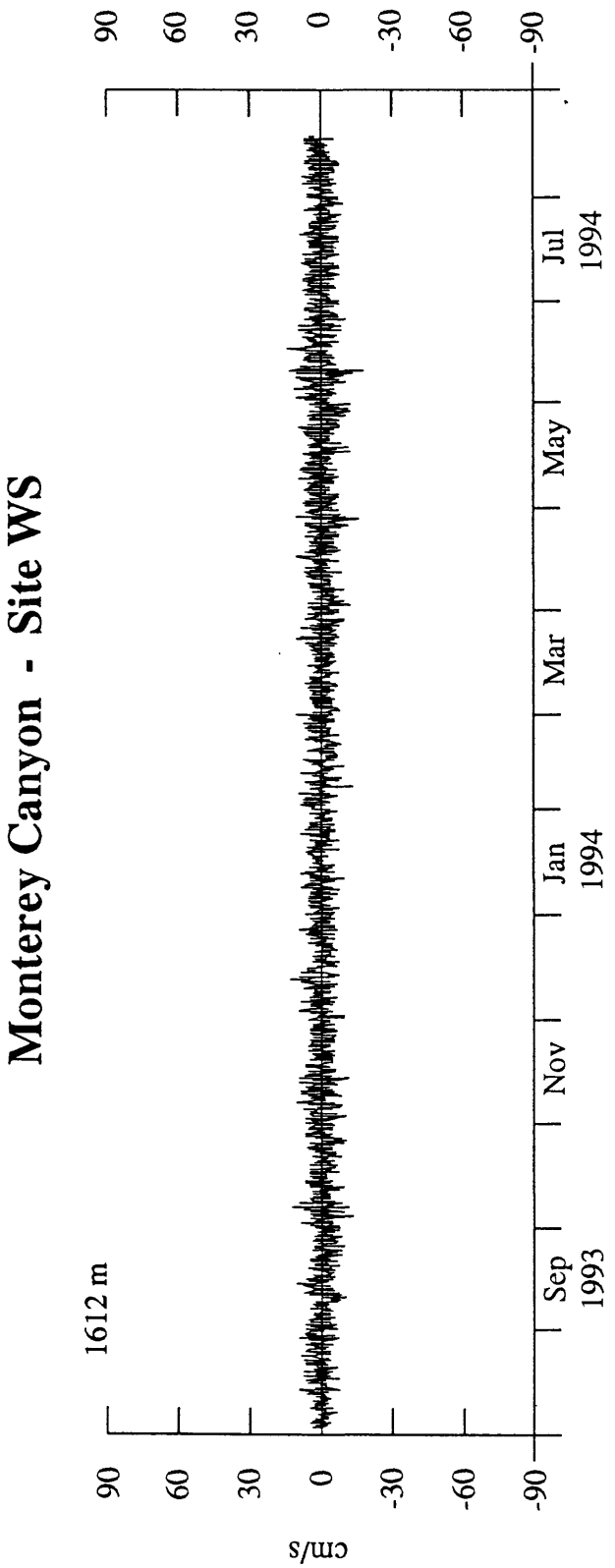


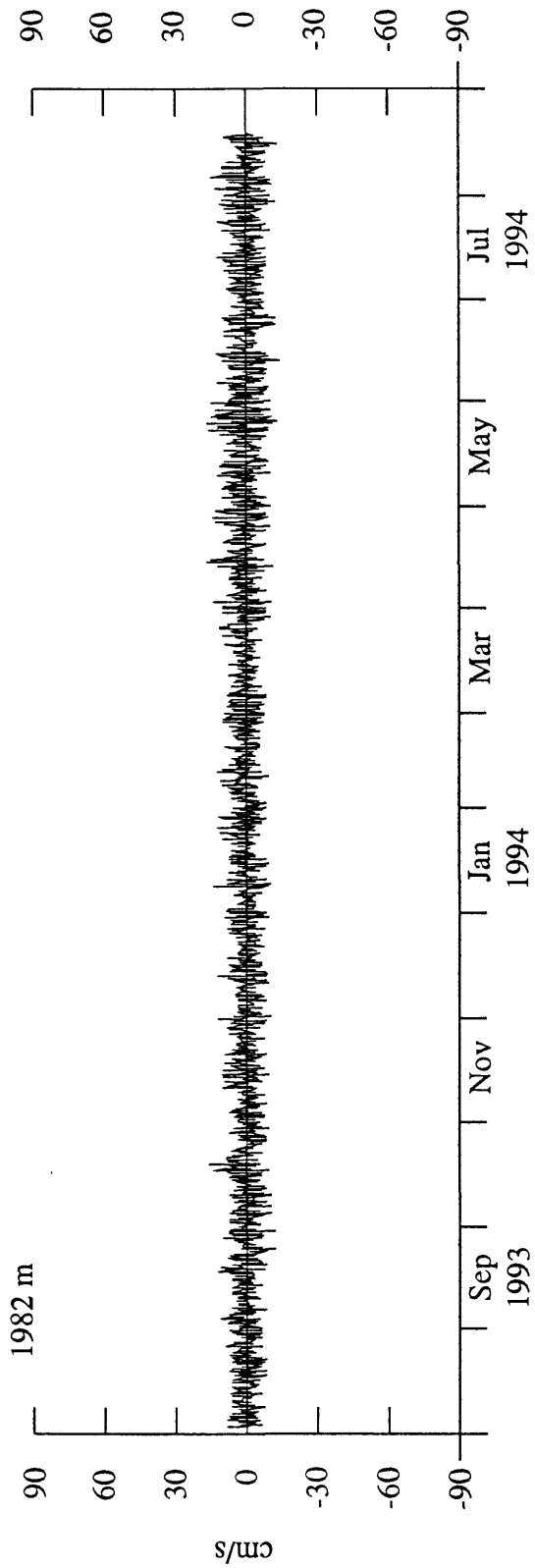
Hour-averaged cross canyon current


Monterey Canyon - Site NA
770 m
1250 m
1350 m
cm/s
90
60
30
0
-30
-60
-90
Sep 1993
Nov
Jan 1994
Mar
May
Jul 1994
Hour-averaged along canyon current

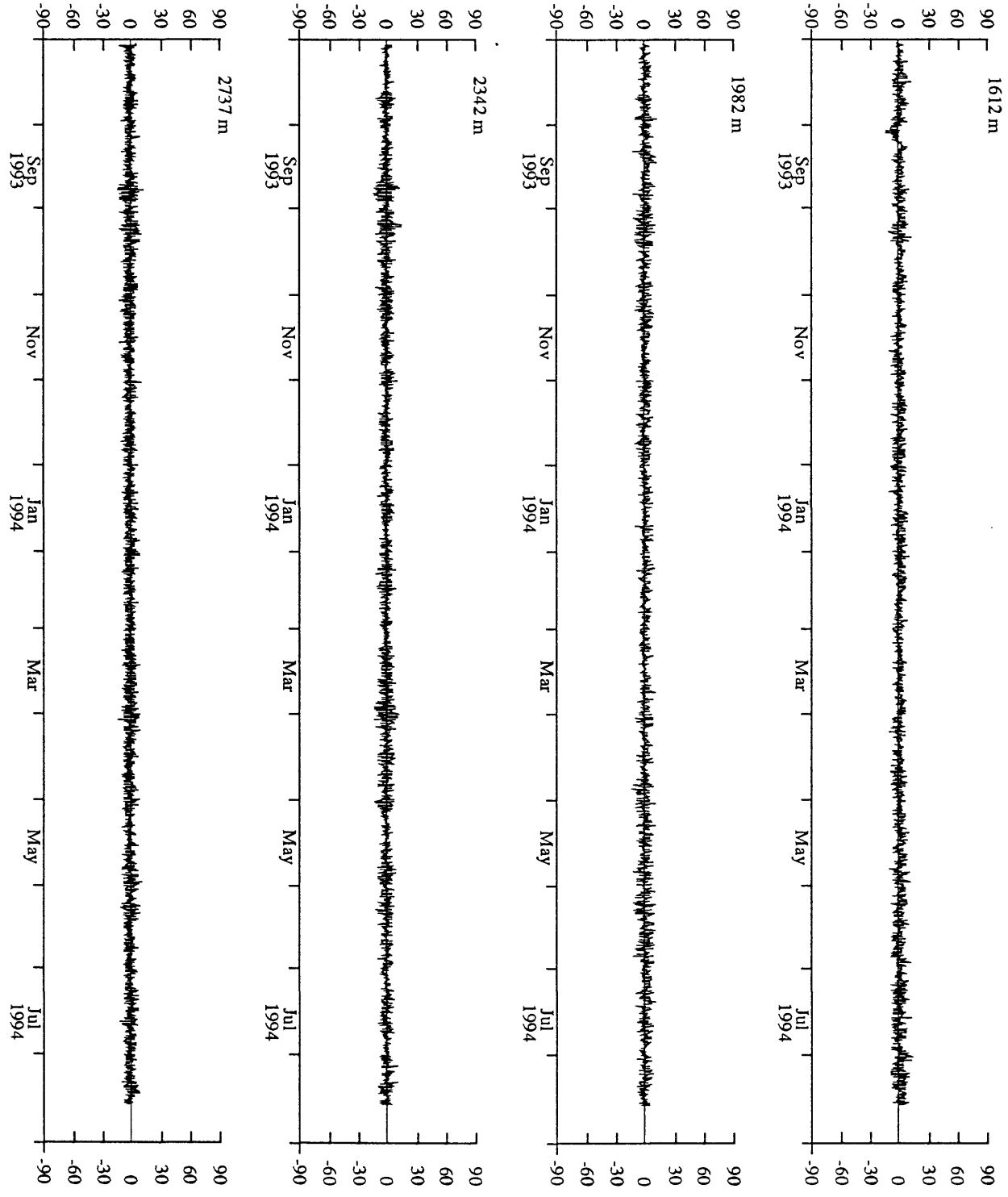


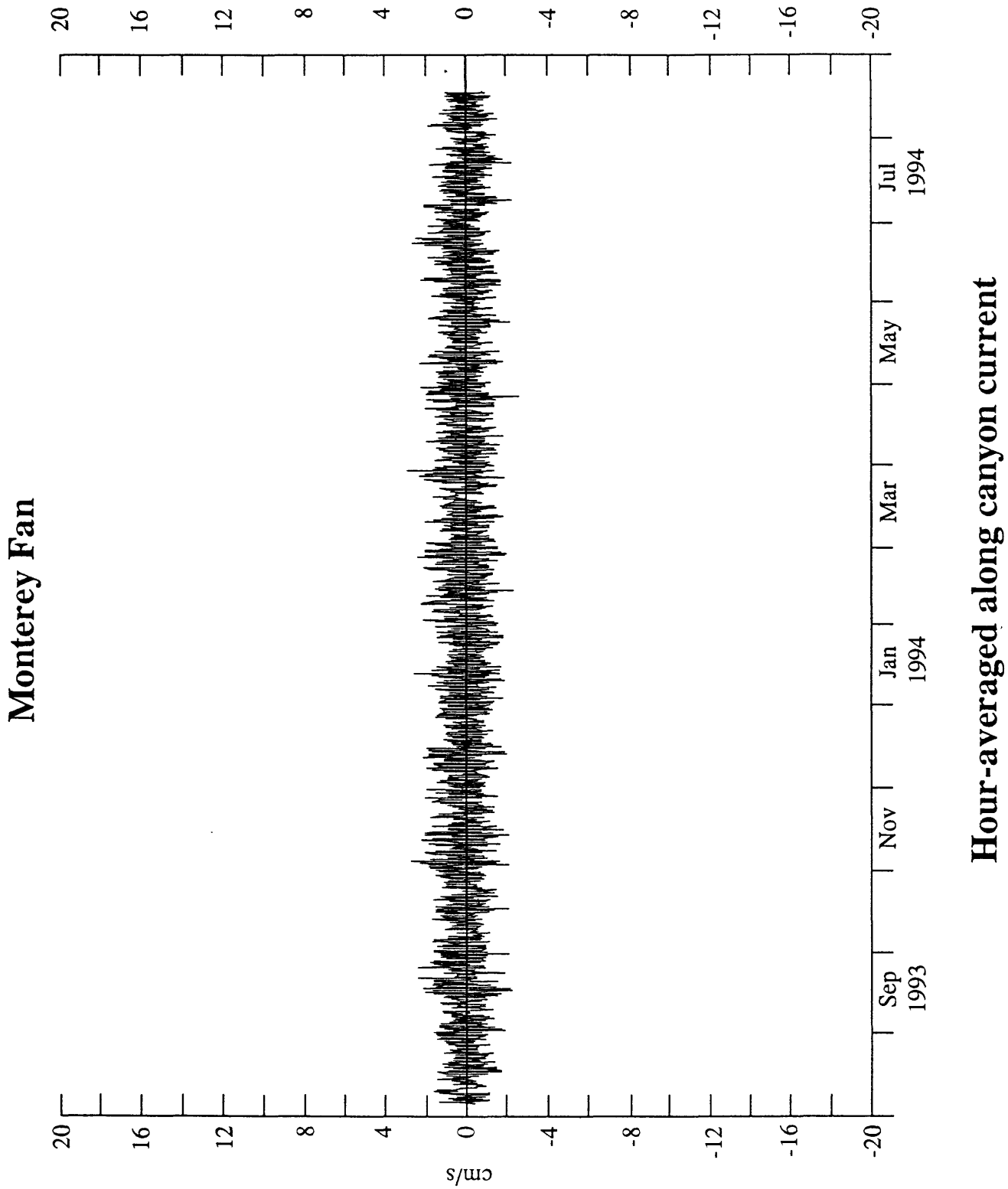
Hour-averaged along canyon current

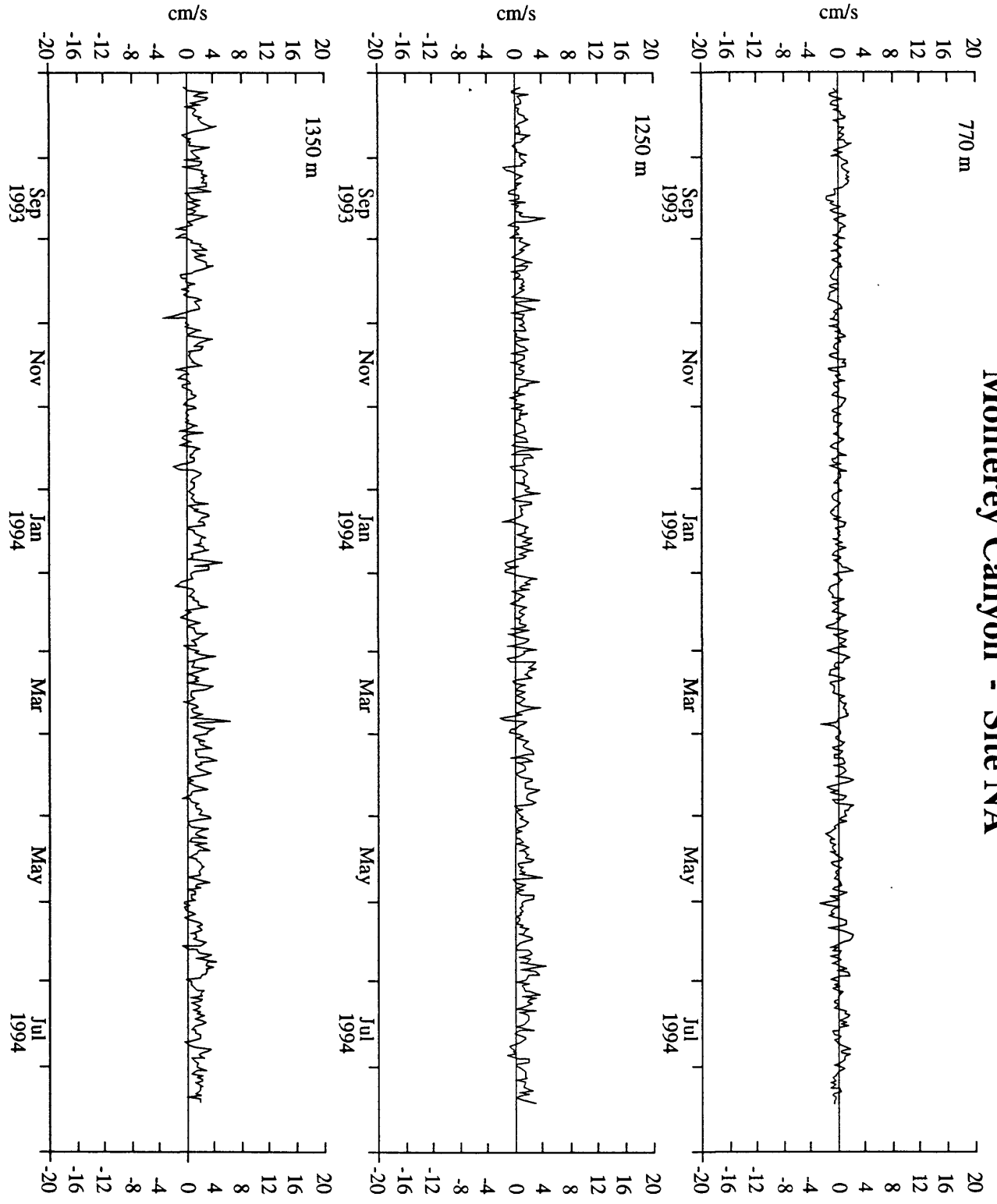




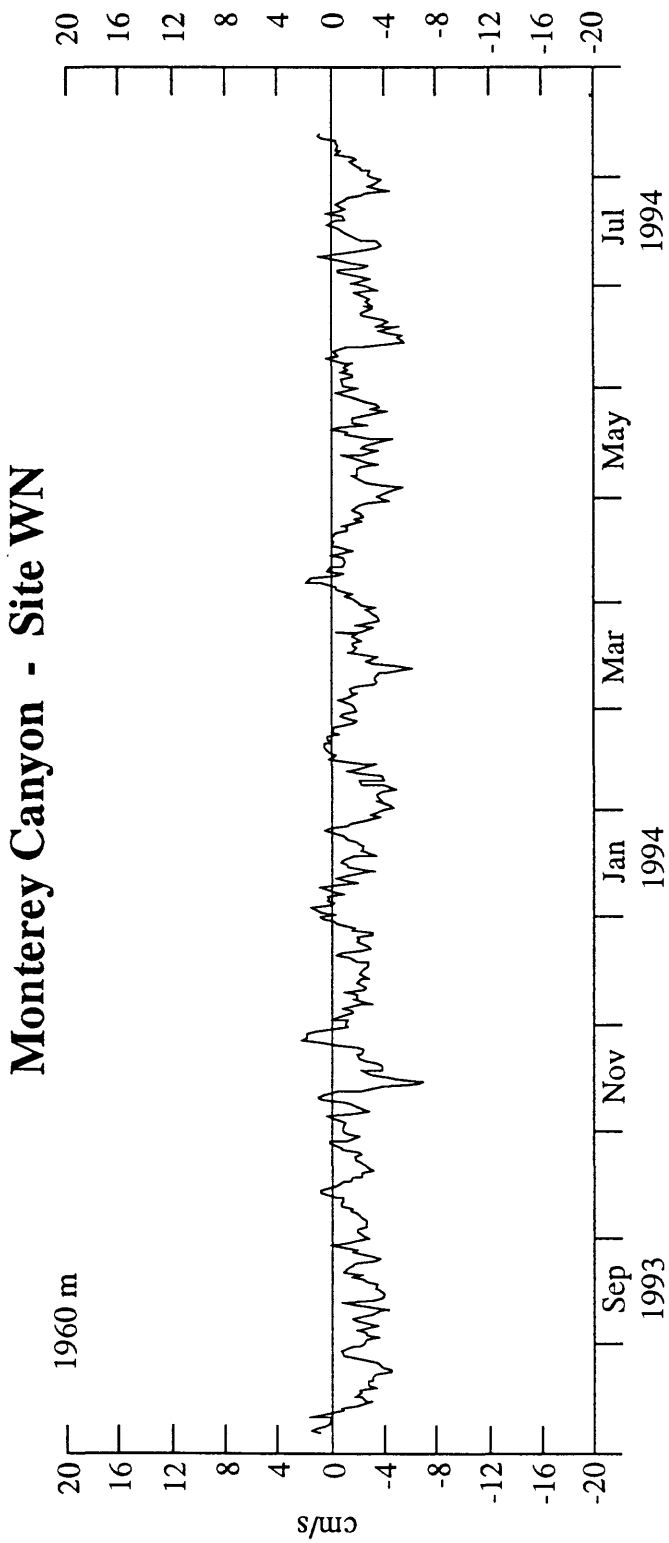
Hour-averaged along canyon current

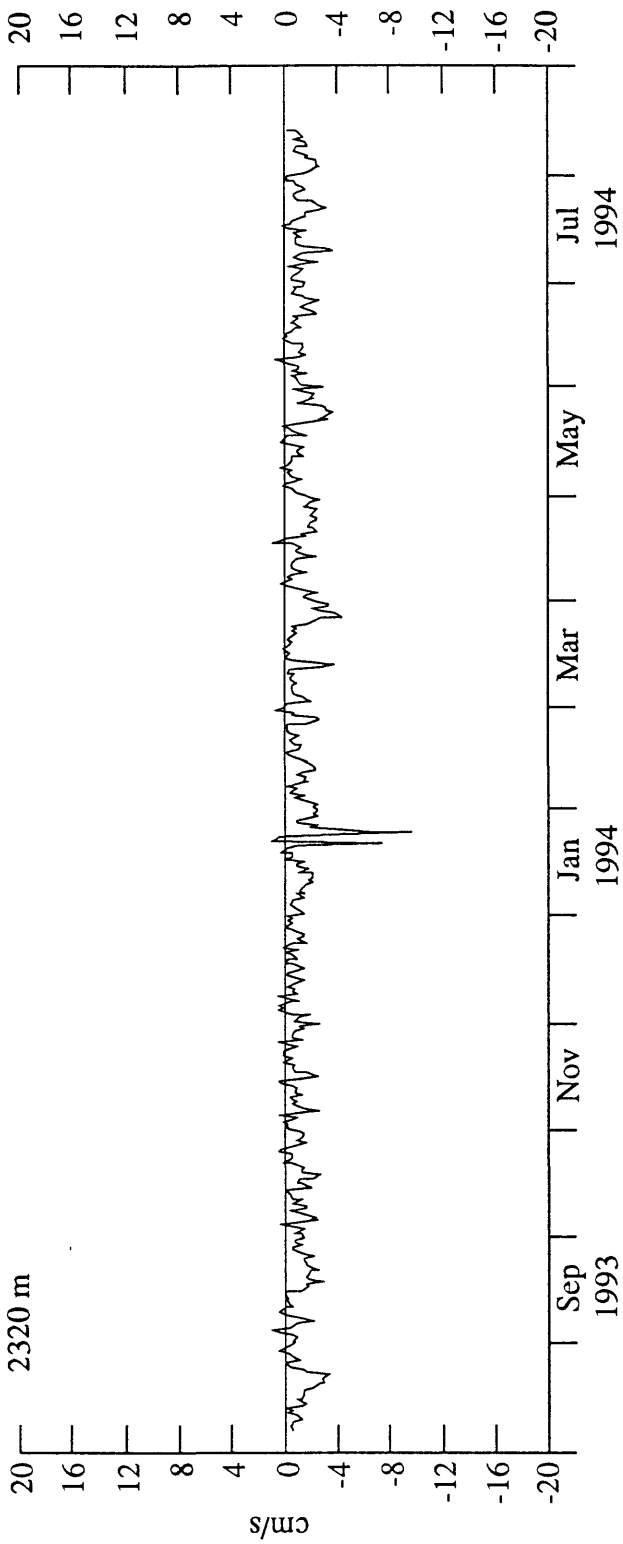

Monterey Canyon - Site WA
1612 m
1982 m
2342 m
2737 m
90
60
30
0
-30
-60
-90
Sep 1993
Nov
Jan 1994
Mar
May
Jul 1994
Hour-averaged along-canyon current


Monterey Fan
Hour-averaged along canyon current
cm/s
20
16
12
8
4
0
-4
-8
-12
-16
-20
Sep 1993
Nov
Jan 1994
Mar
May
Jul 1994

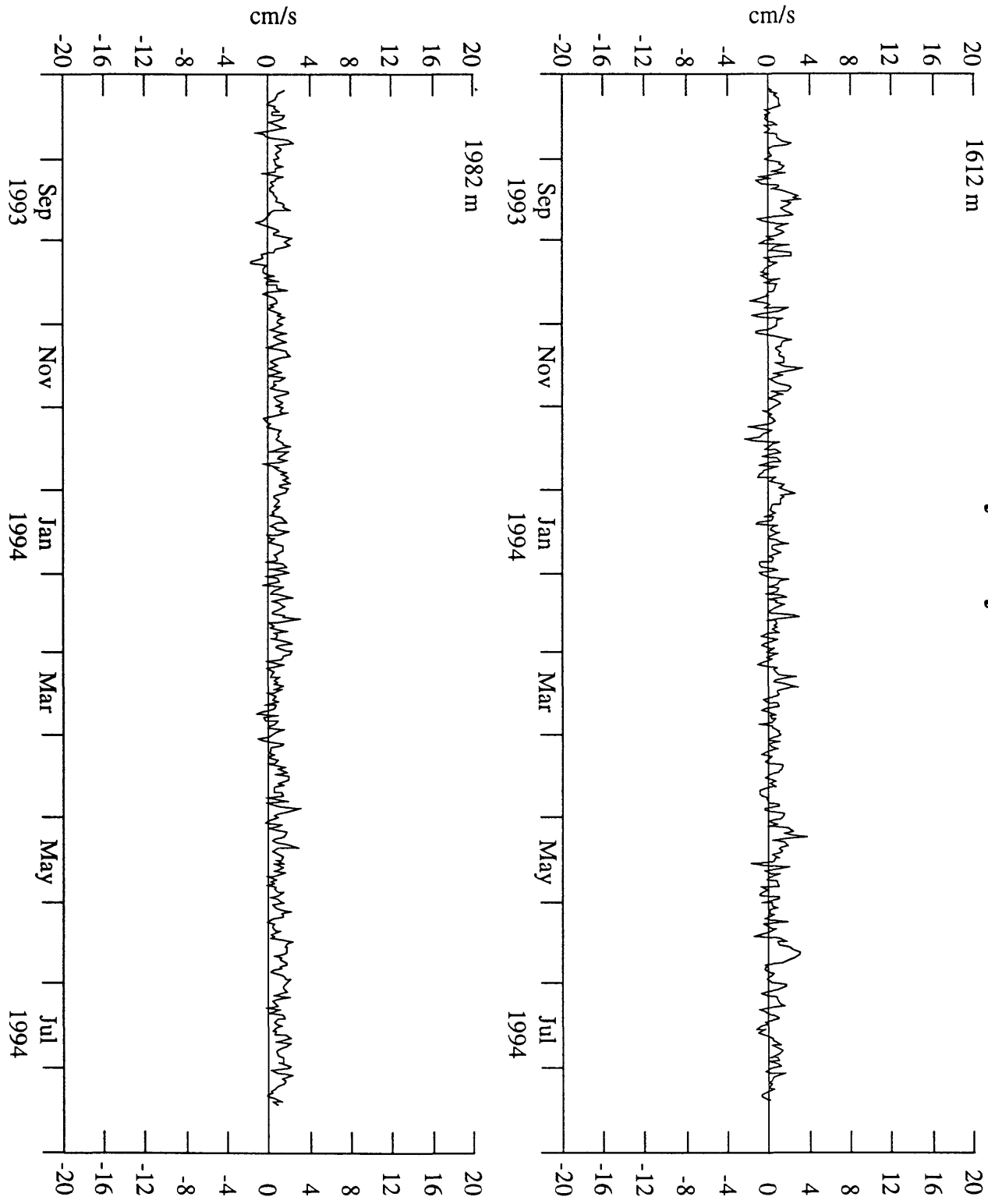


Subtidal cross canyon current

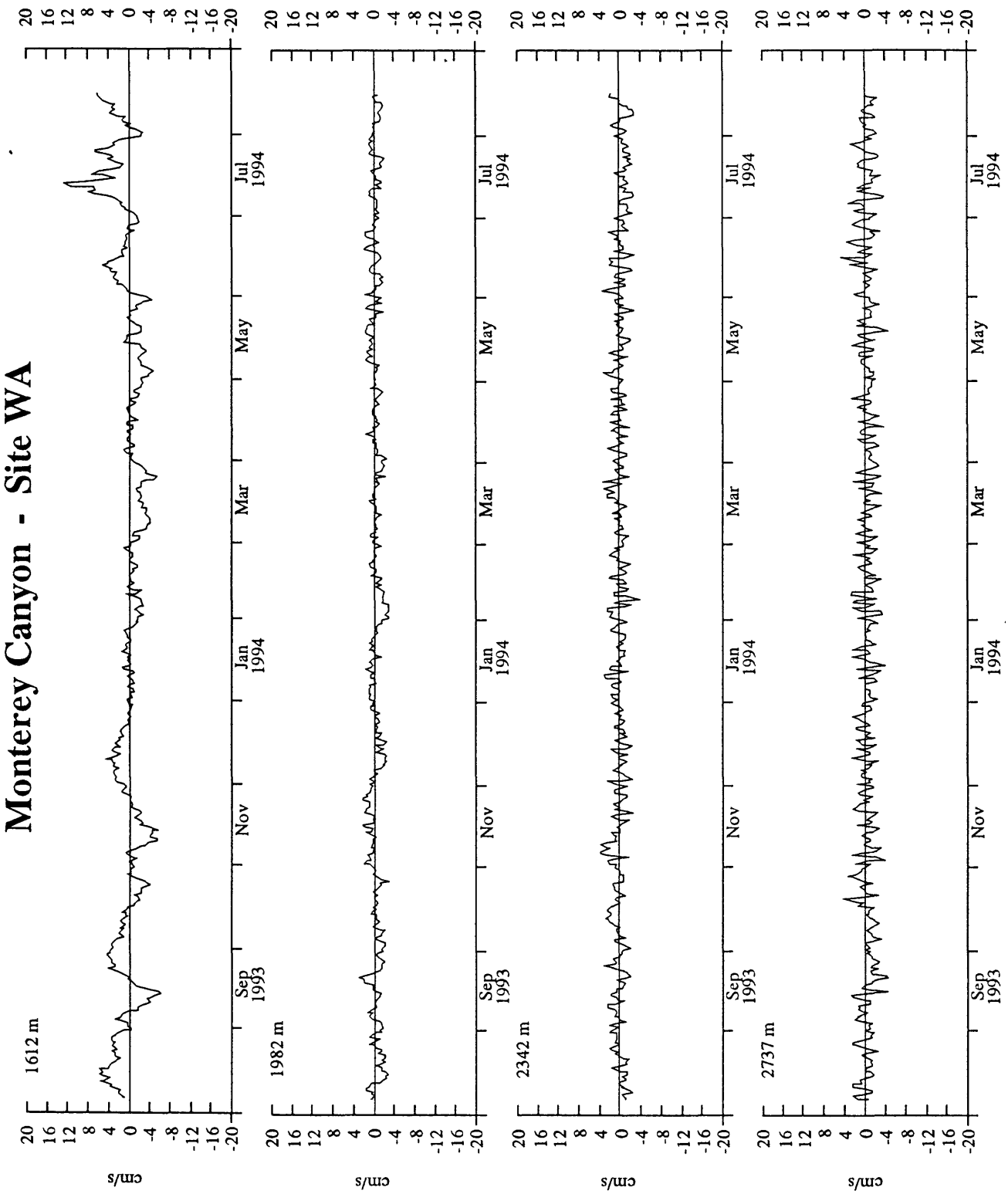




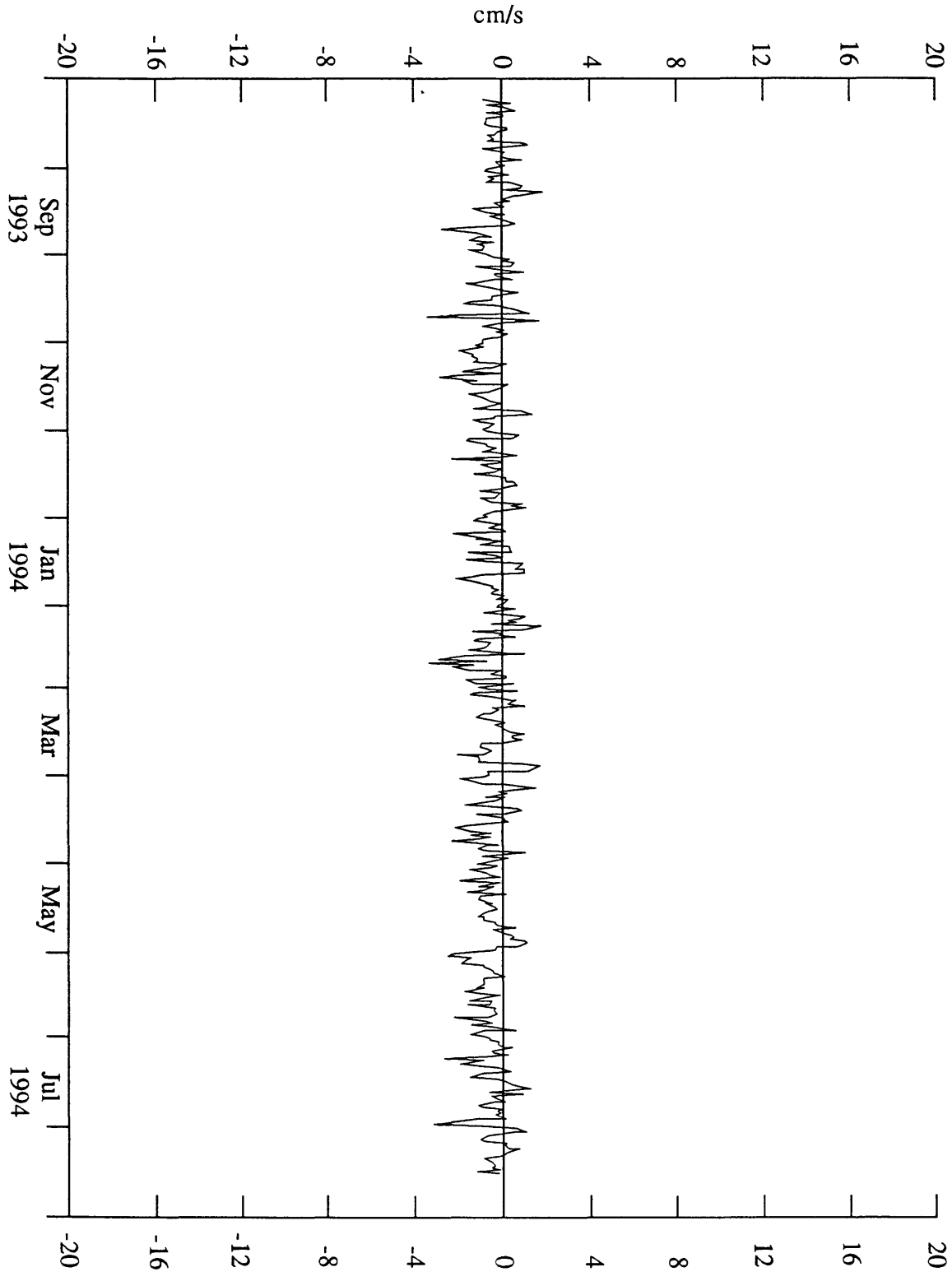
Subtidal cross canyon current



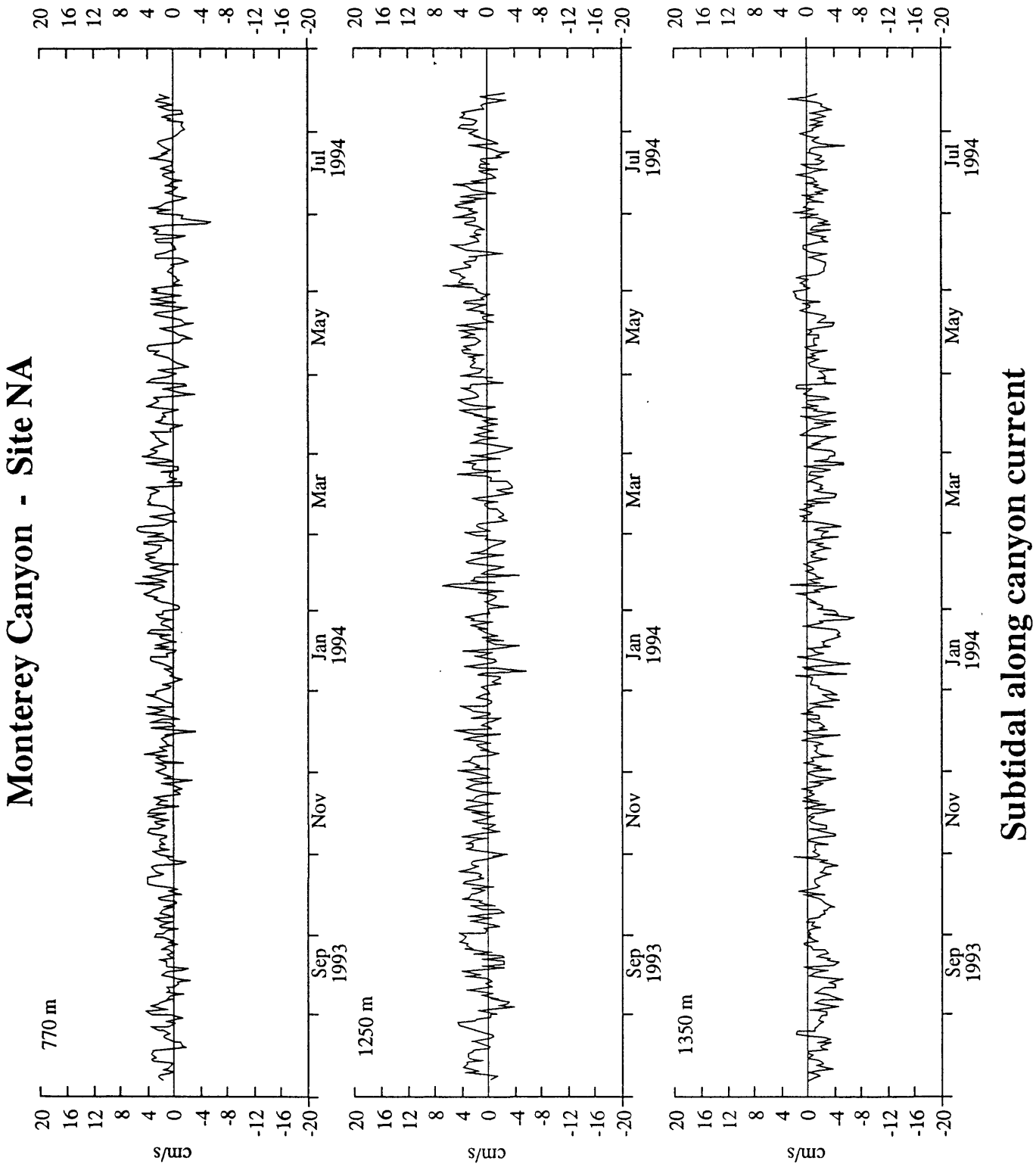
Subtidal cross canyon current

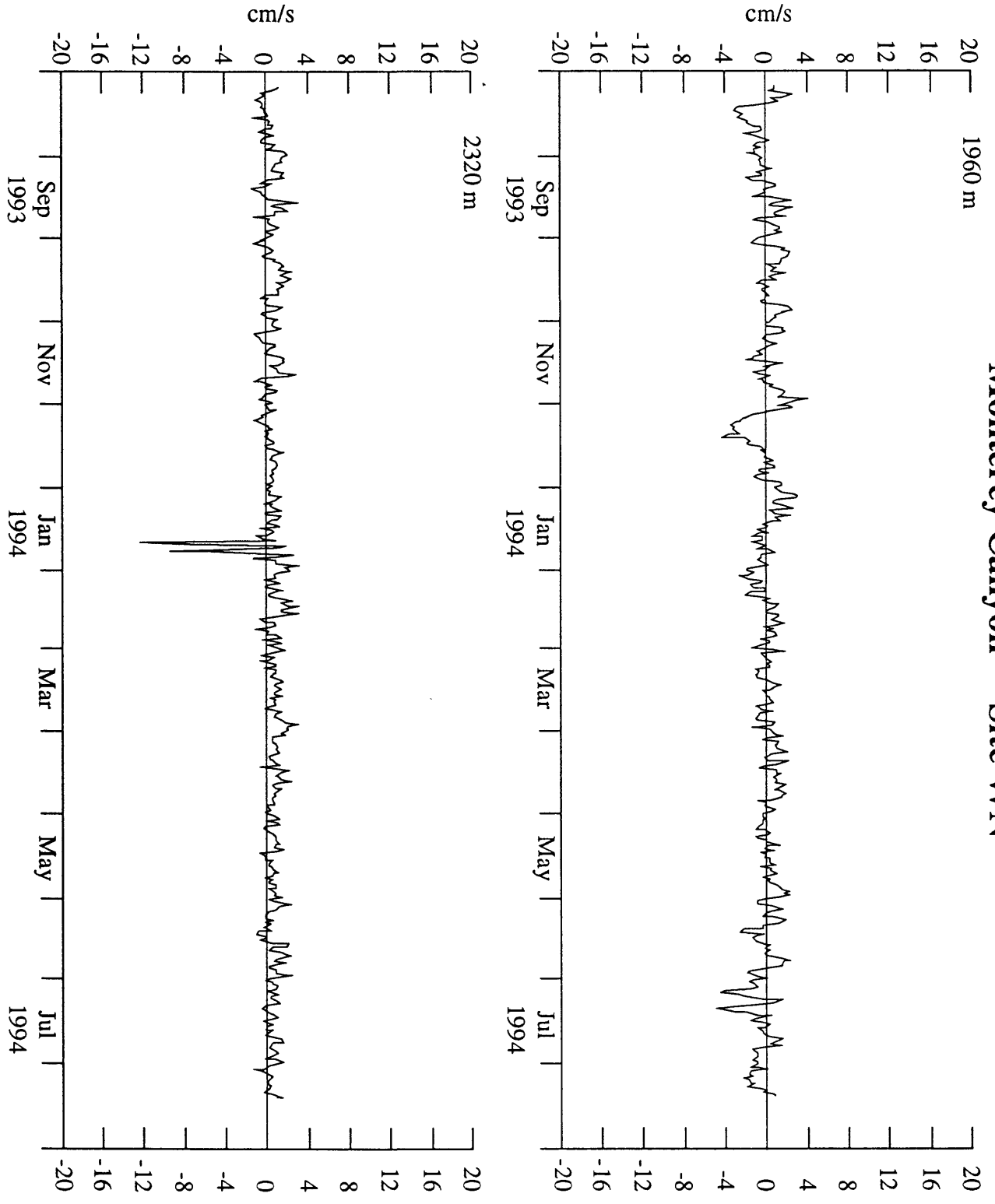


Subtidal cross canyon current

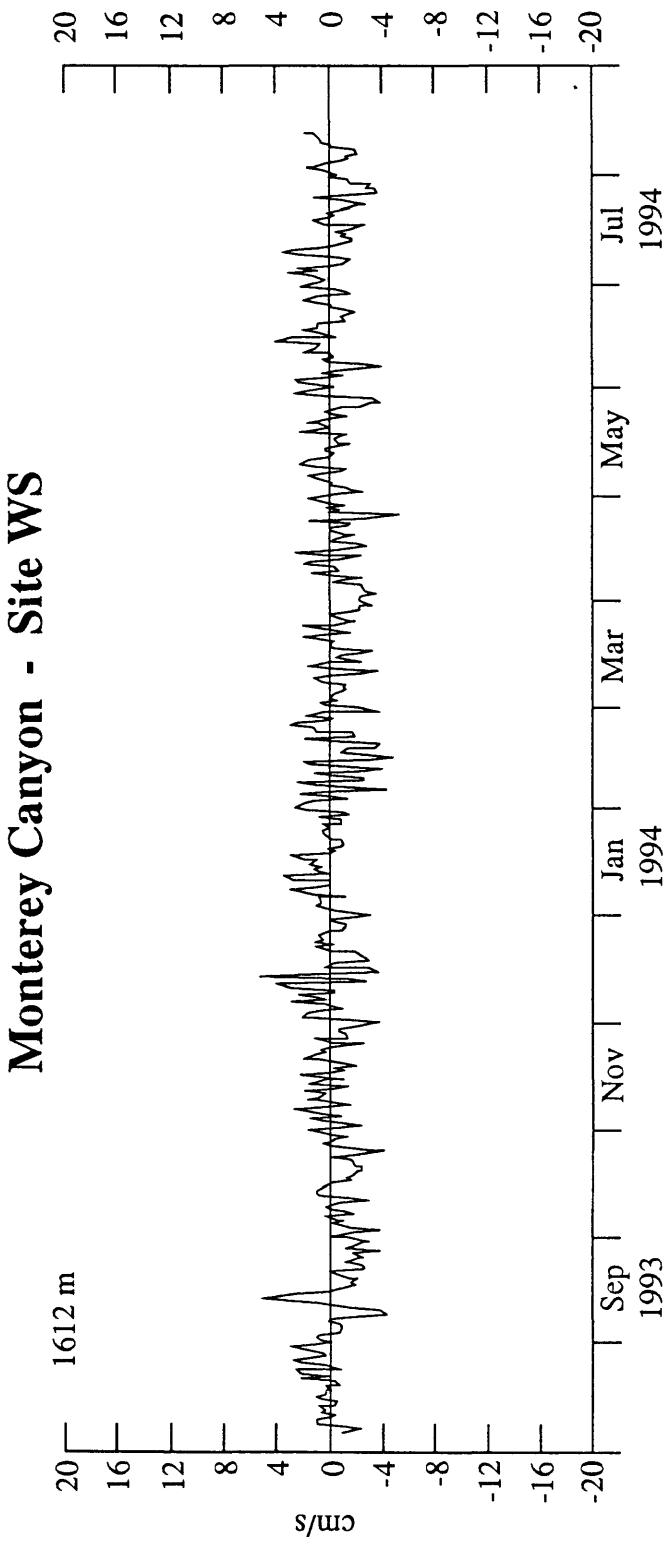


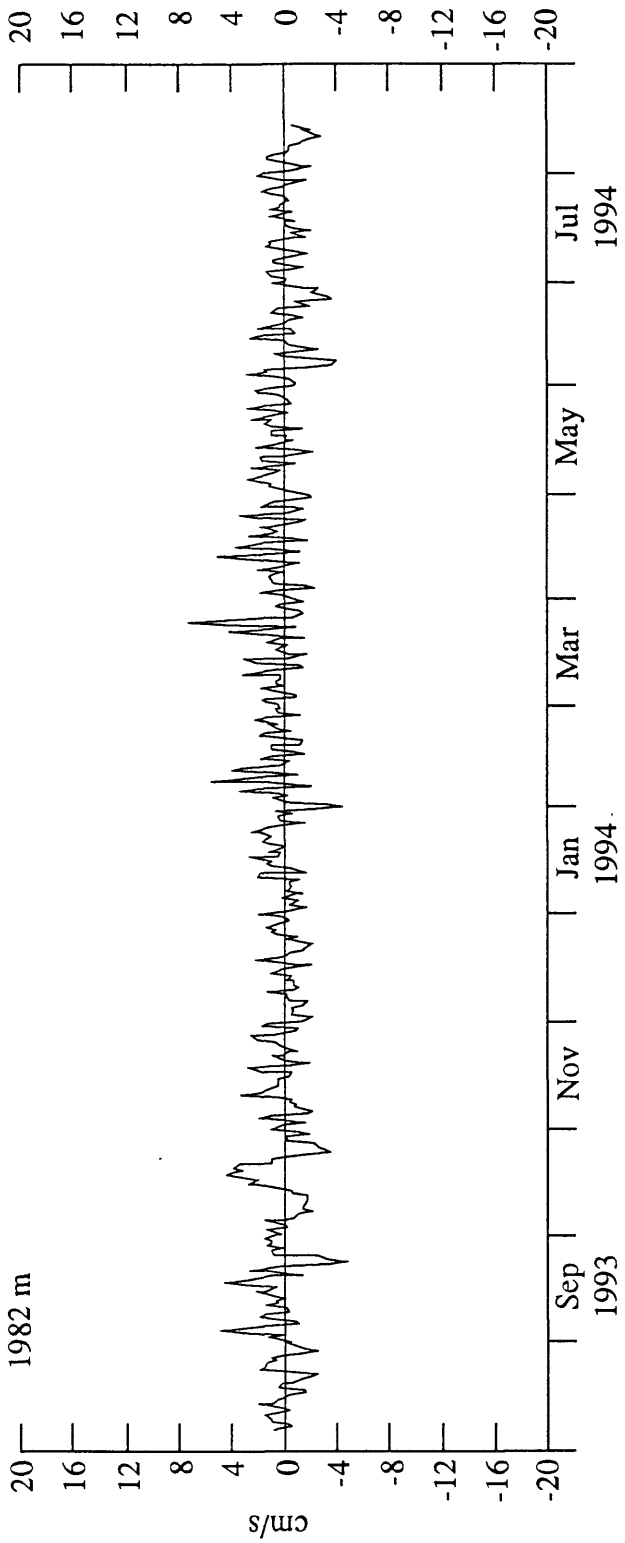
Subtidal cross canyon current


Monterey Canyon - Site NA
770 m
1250 m
1350 m
cm/s
20
16
12
8
4
0
-4
-8
-12
-16
-20
Sep 1993
Nov
Jan 1994
Mar
May
Jul 1994
Subtidal along canyon current

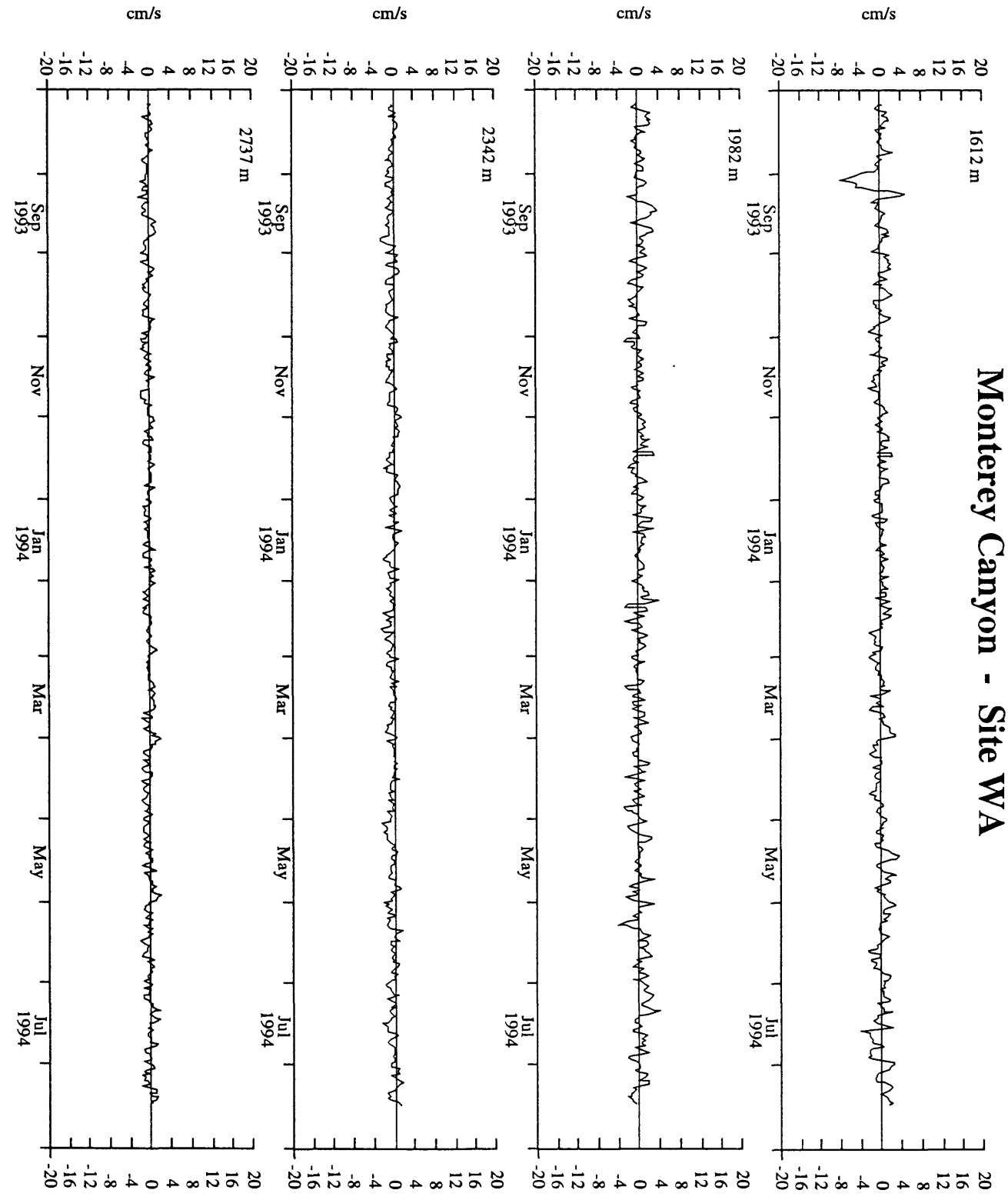


Subtidal along canyon current

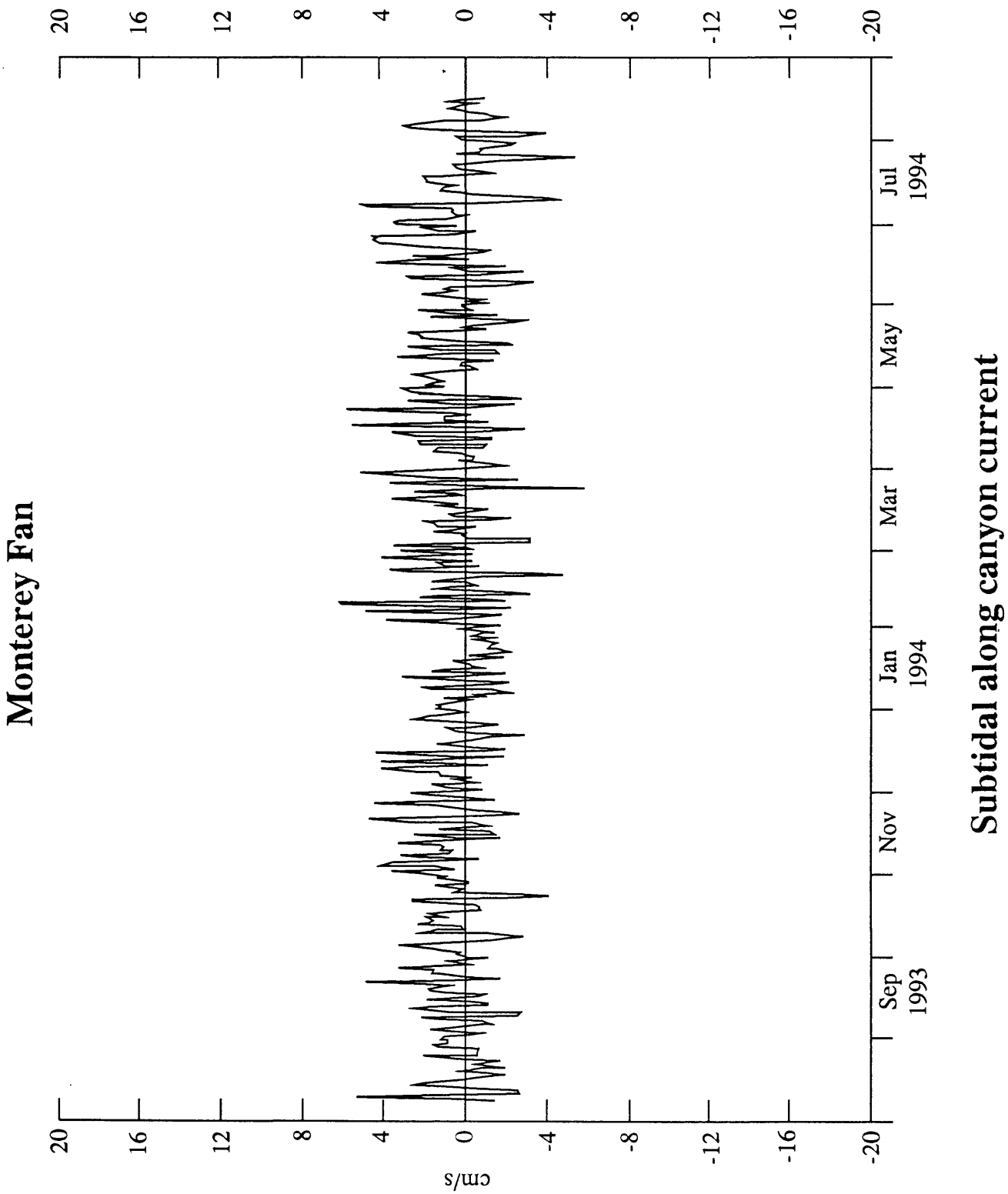




Subtidal along canyon current



Subtidal along canyon current


Monterey Fan
Subtidal along canyon current
cm/s
20
16
12
8
4
0
-4
-8
-12
-16
-20
Sep 1993
Nov
Jan 1994
Mar
May
Jul 1994

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Appendix C - Subtidal current vectors

Plots of subtidal current vectors ..... C1 - C5

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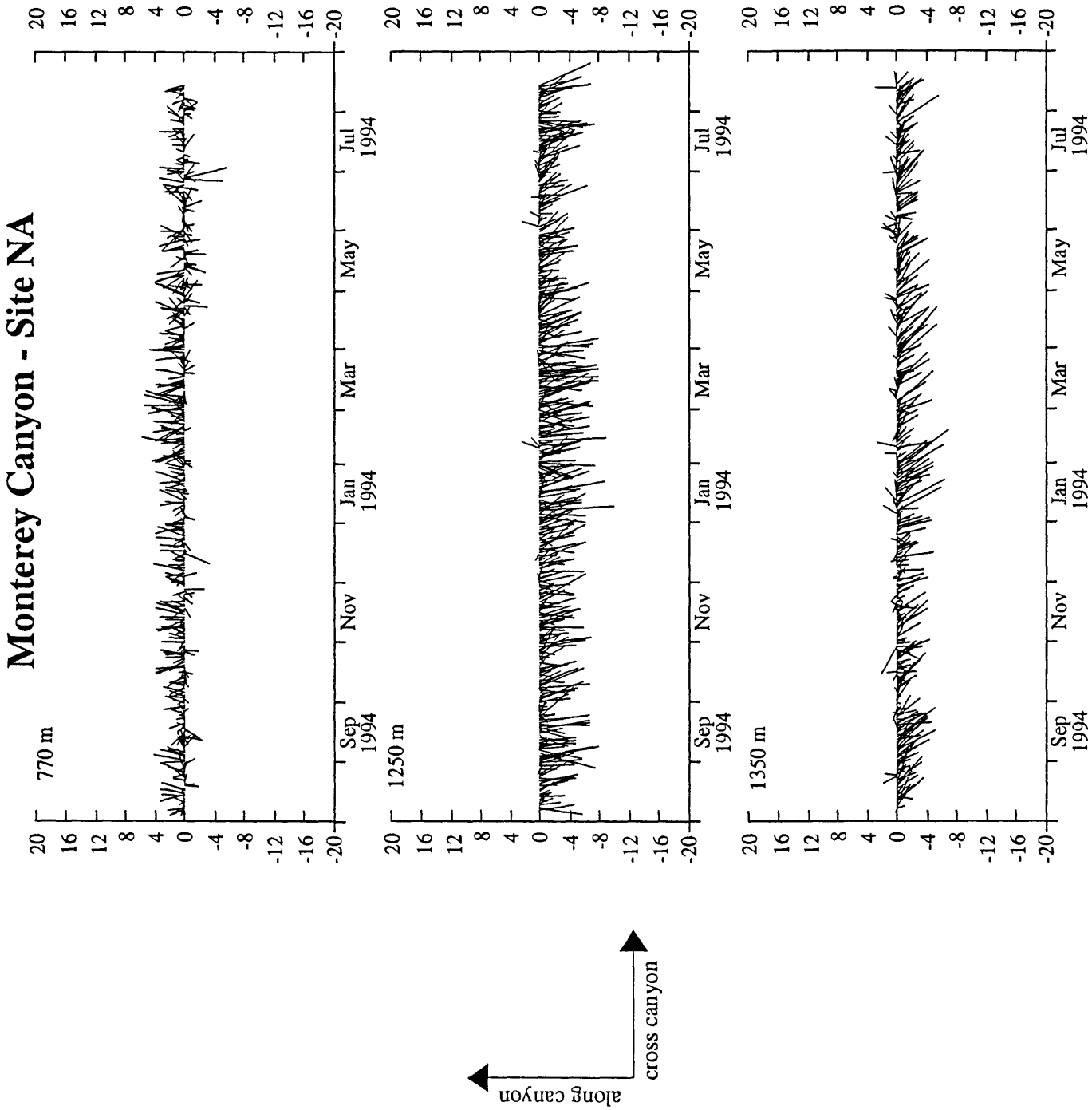
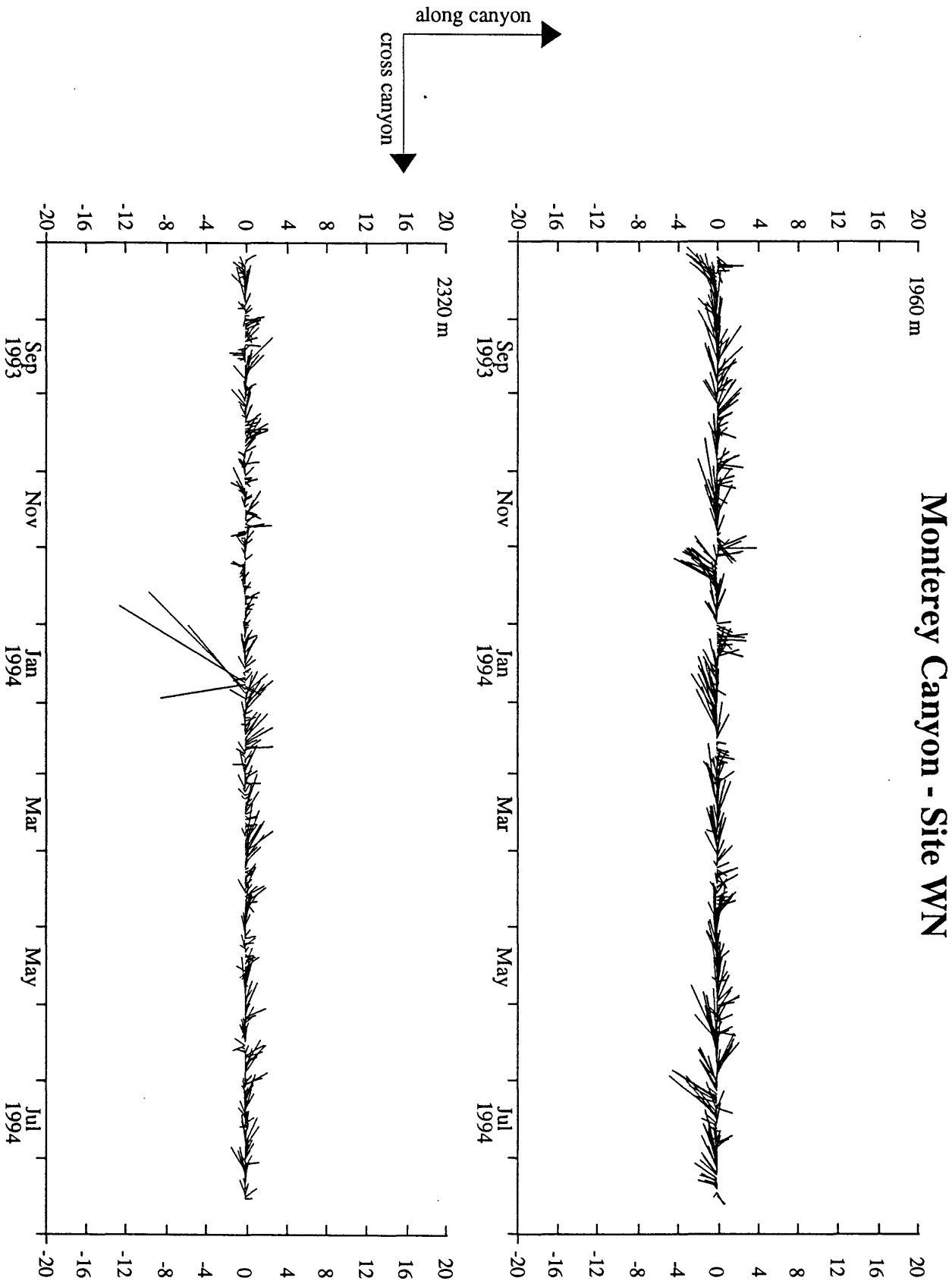
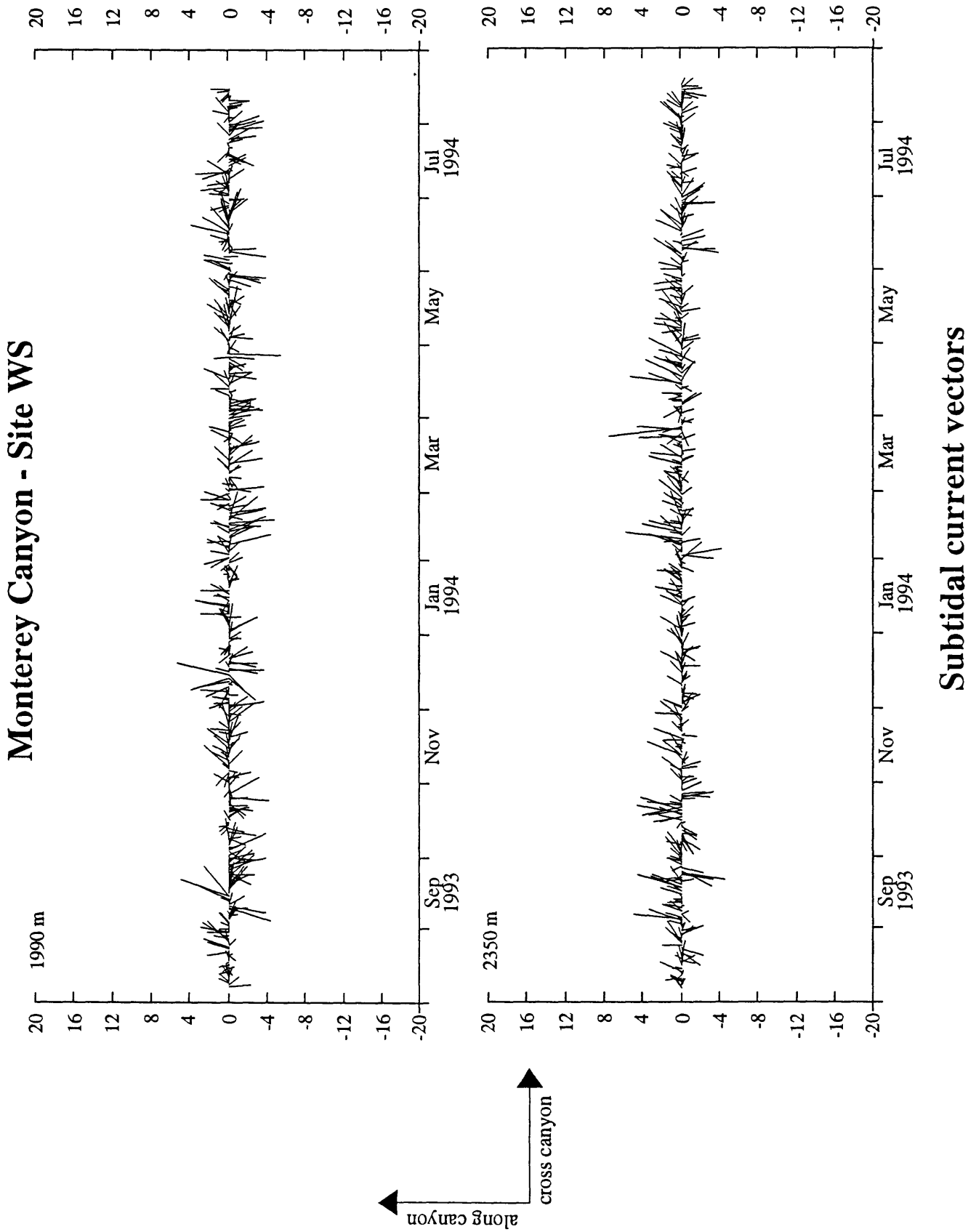
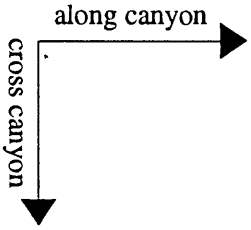


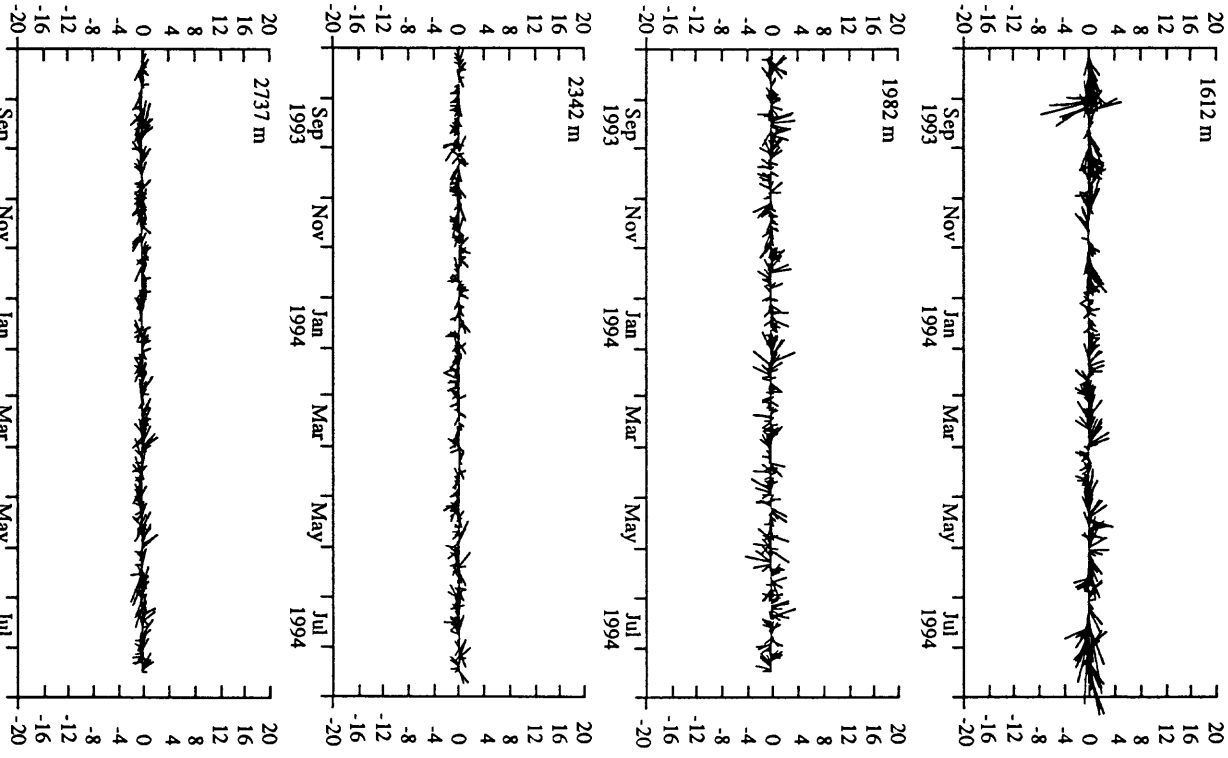
Subtidal current vectors



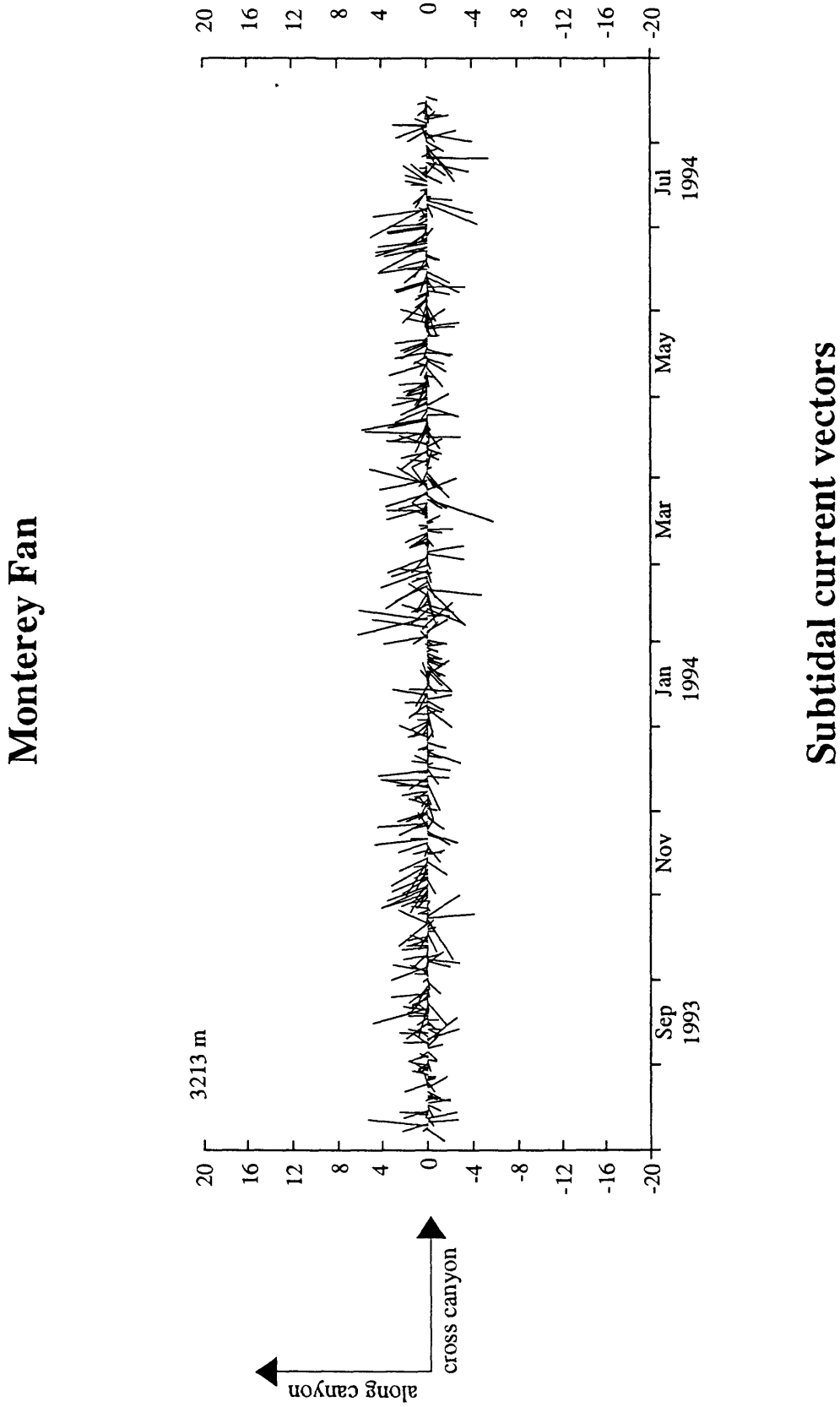
Subtidal current vectors


Monterey Canyon - Site WS
1990 m
2350 m
20
16
12
8
4
0
-4
-8
-12
-16
-20
Sep 1993
Nov
Jan 1994
Mar
May
Jul 1994
Subtidal current vectors
cross canyon
along canyon





Subtidal current vectors


Monterey Fan
3213 m
20
16
12
8
4
0
-4
-8
-12
-16
-20
Sep 1993
Nov
Jan 1994
Mar
May
Jul 1994
cross canyon
along canyon
Subtidal current vectors

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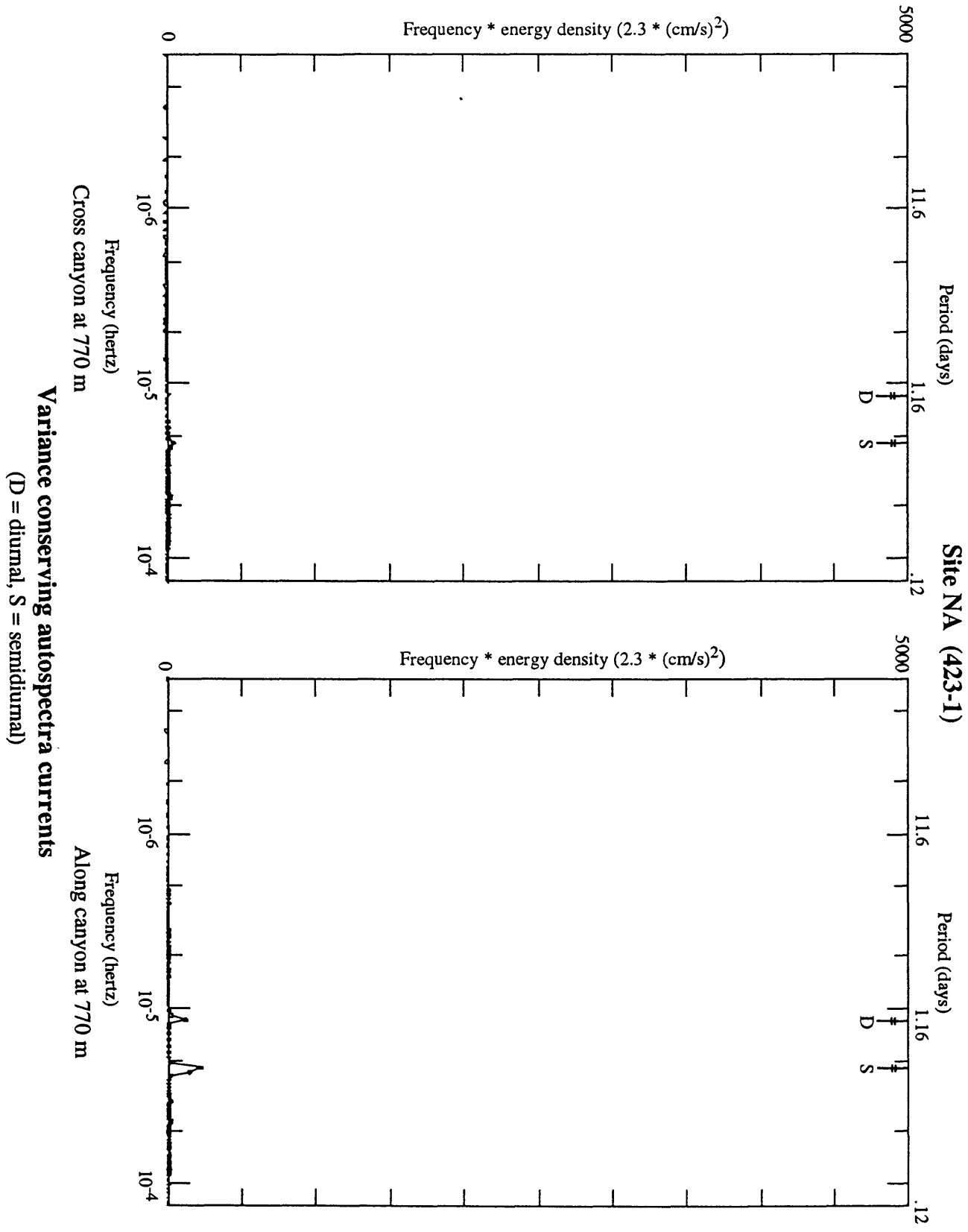
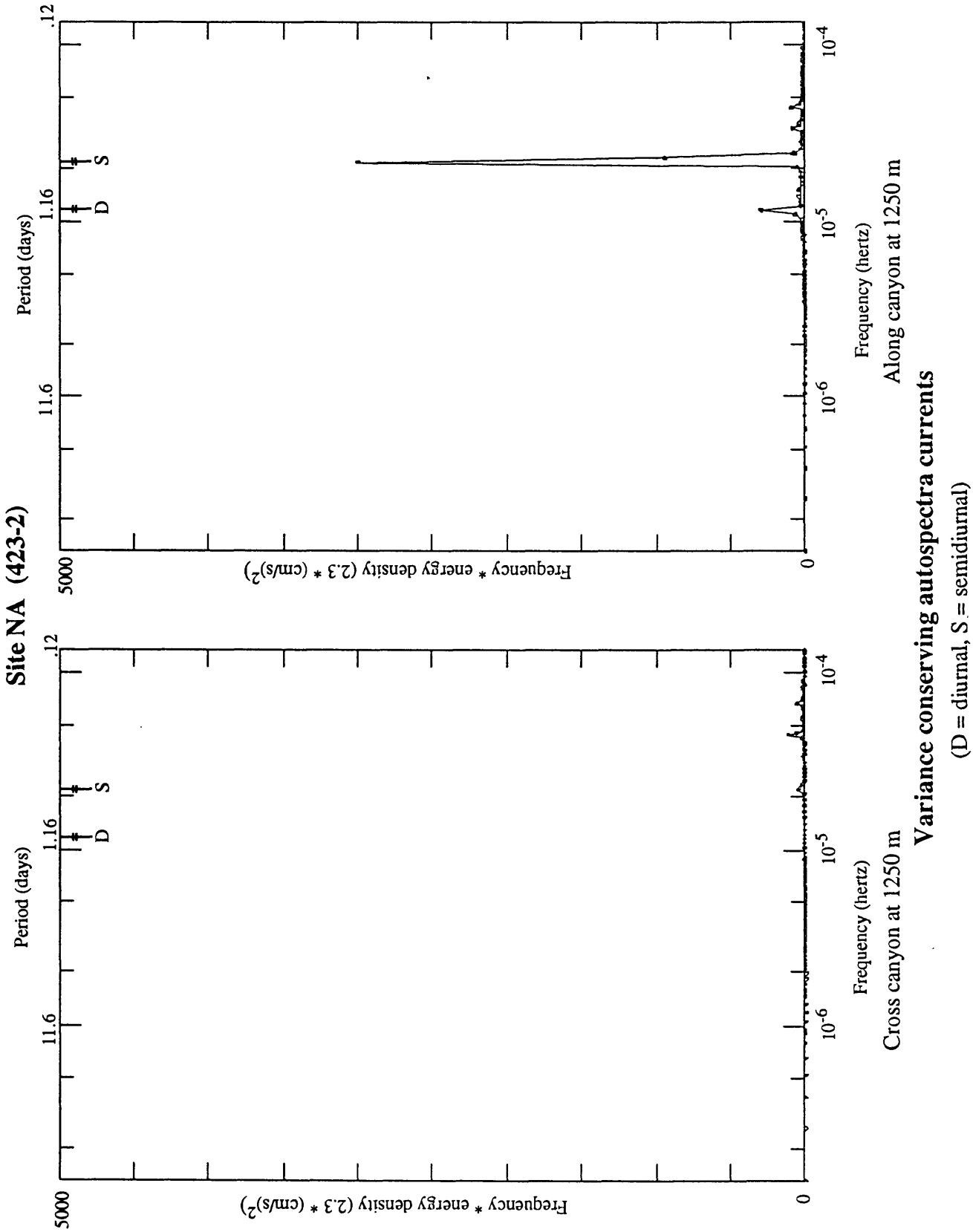
Site	Mooring	Sensor Depth (m)	Start time GMT (M/D/Y)	Stop time GMT (M/D/Y)	Piece length hours
NN	422-1	806	08/03/93	08/17/94	2112
NA	423-1	1450	08/03/93	08/17/94	2112
NA	423-2	1450	08/03/93	08/17/94	2112
NA	423-3	1450	08/03/93	08/17/94	2112
WN	424-1	2420	08/03/93	08/17/94	2112
WN	424-2	2420	08/03/93	08/17/94	2112
WS	425-1	2560	08/03/93	08/18/94	2112
WS	425-2	2560	08/03/93	08/18/94	2112
					2112
WA	426-1	2837	08/03/93	08/18/94	
WA	426-2	2837	08/03/93	08/18/94	2112
WA	426-3	2837	08/03/93	08/18/94	2112
WA	426-4	2837	08/03/93	08/18/94	2112
F	427-1	3223	08/05/93	08/20/94	2112

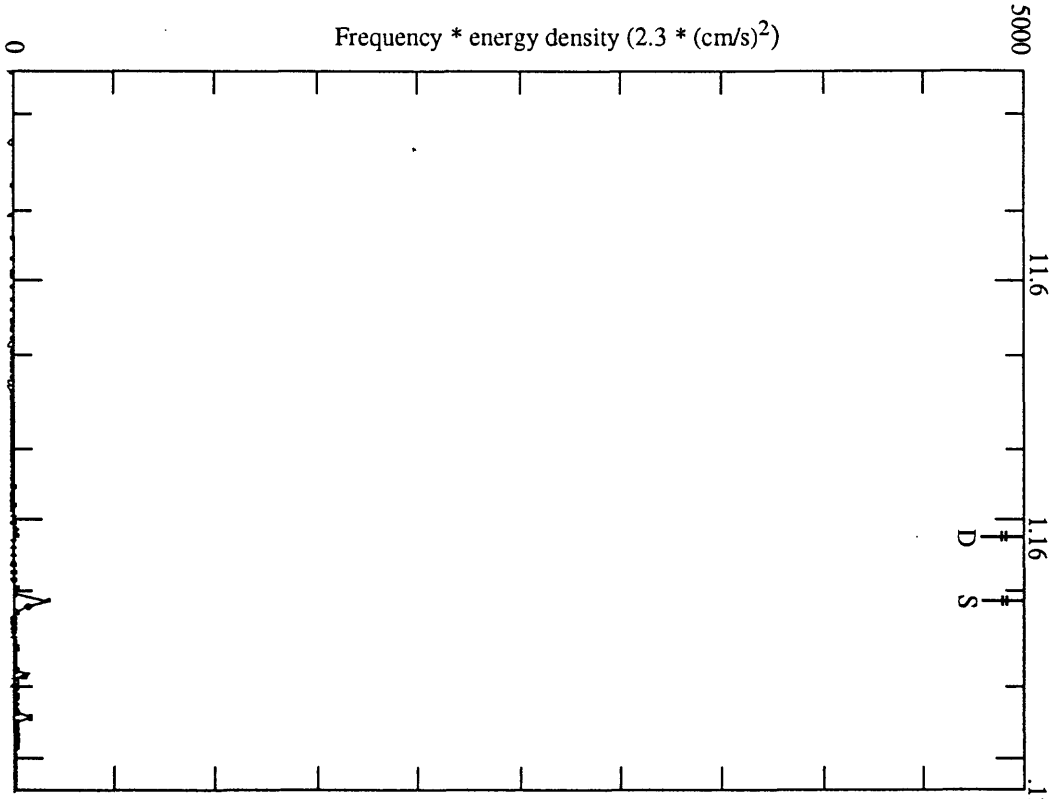
Table D1. Dates and piece lengths used for the spectral plots.



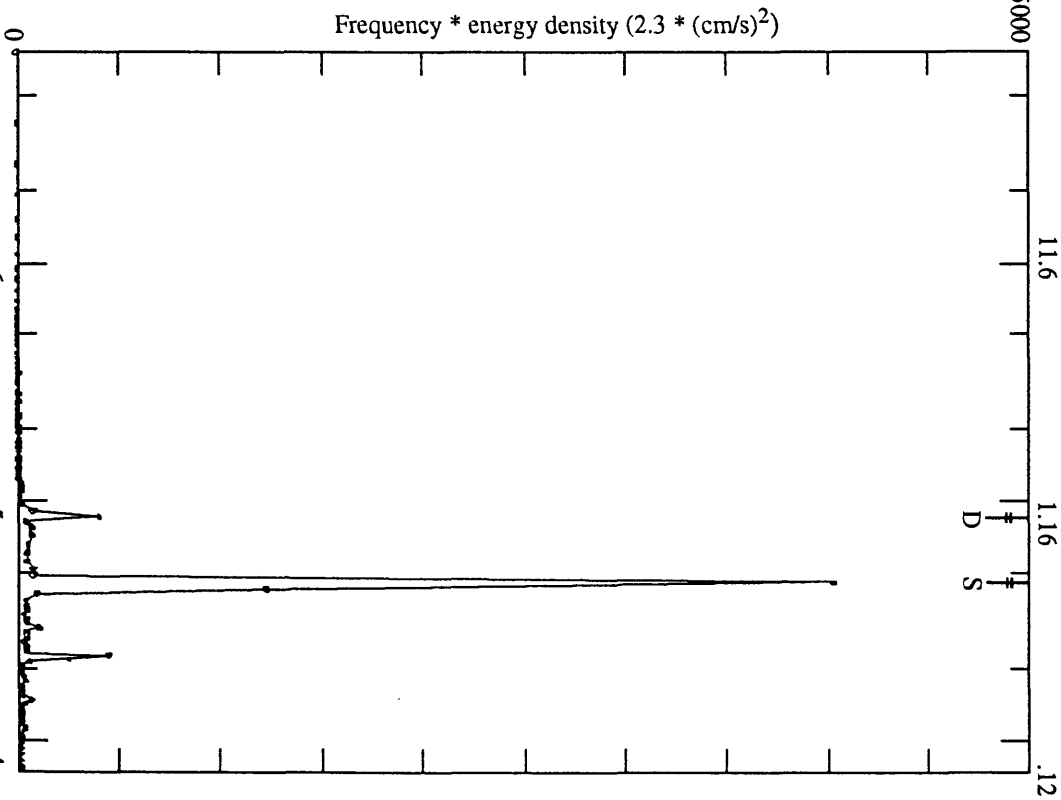
Variance conserving autospectra currents

(D = diurnal, S = semidiurnal)


Site NA (423-2)
Period (days)
11.6
1.16
.12
D
S
5000
0
Frequency * energy density (2.3 * (cm/s)^2)
10^{-6}
10^{-5}
10^{-4}
Frequency (hertz)
Cross canyon at 1250 m
Along canyon at 1250 m
Variance conserving autospectra currents
(D = diurnal, S = semidiurnal)



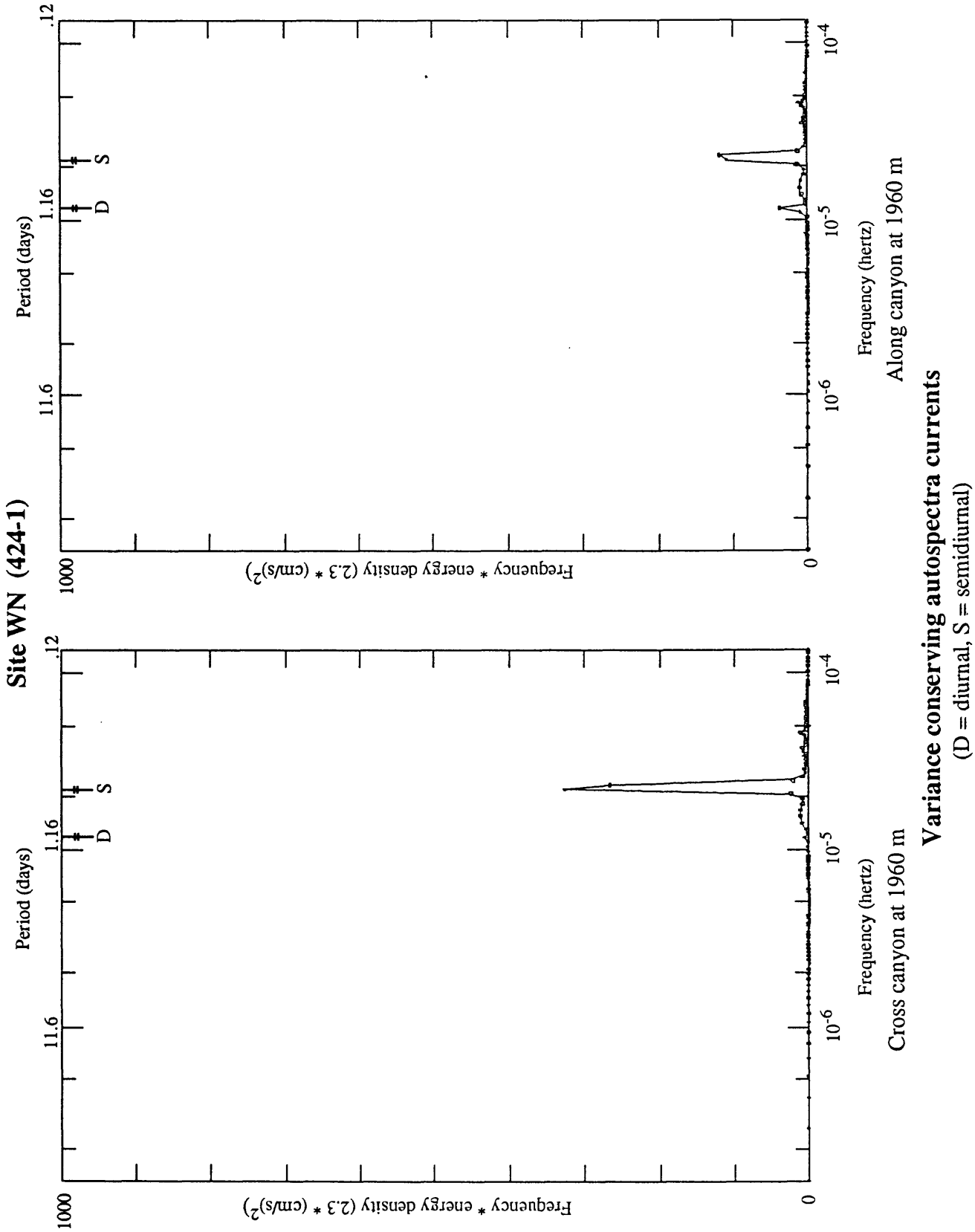
Cross canyon at 1350 m



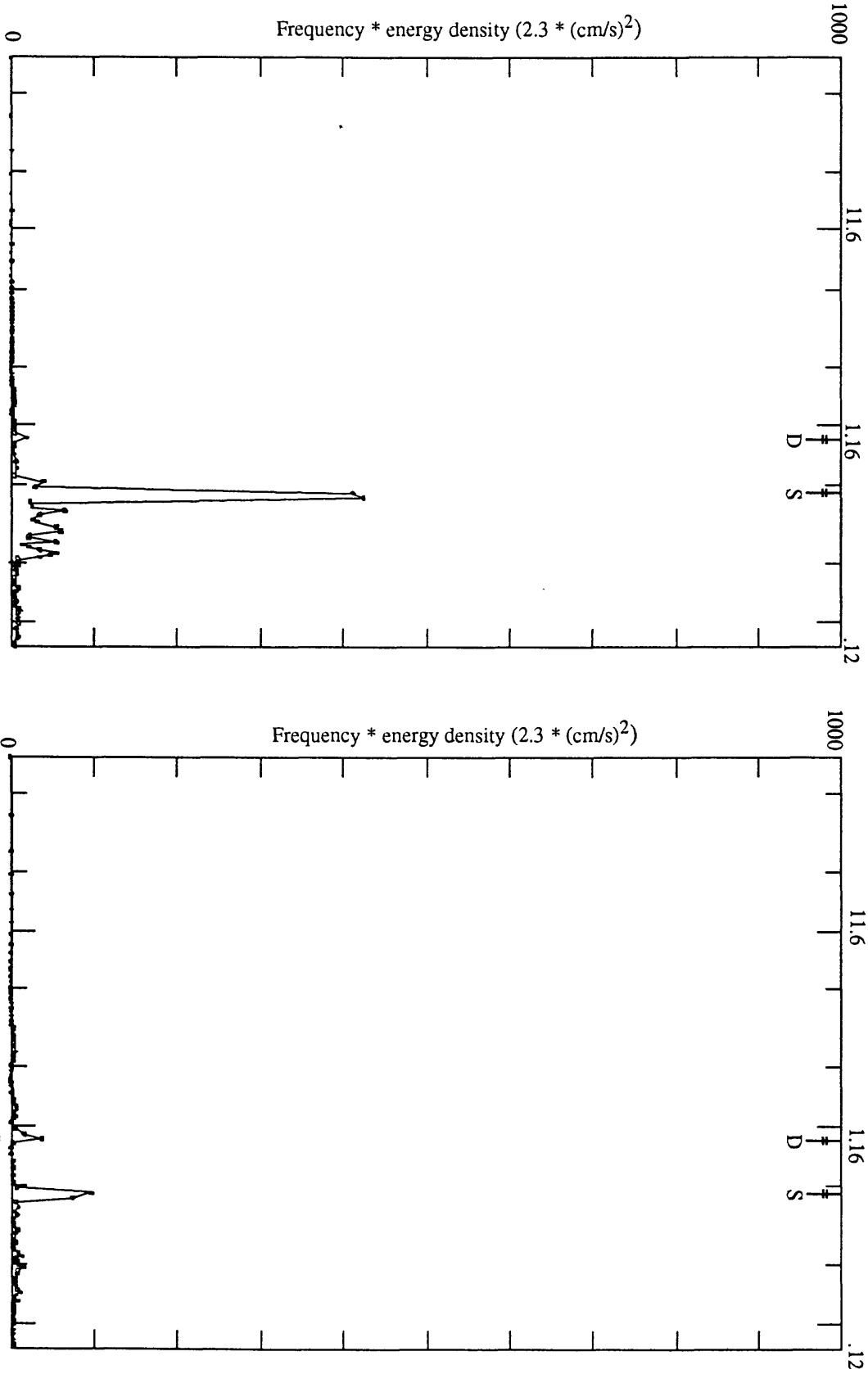
Along canyon at 1350 m

Variance conserving autospectra currents

(D = diurnal, S = semidiurnal)

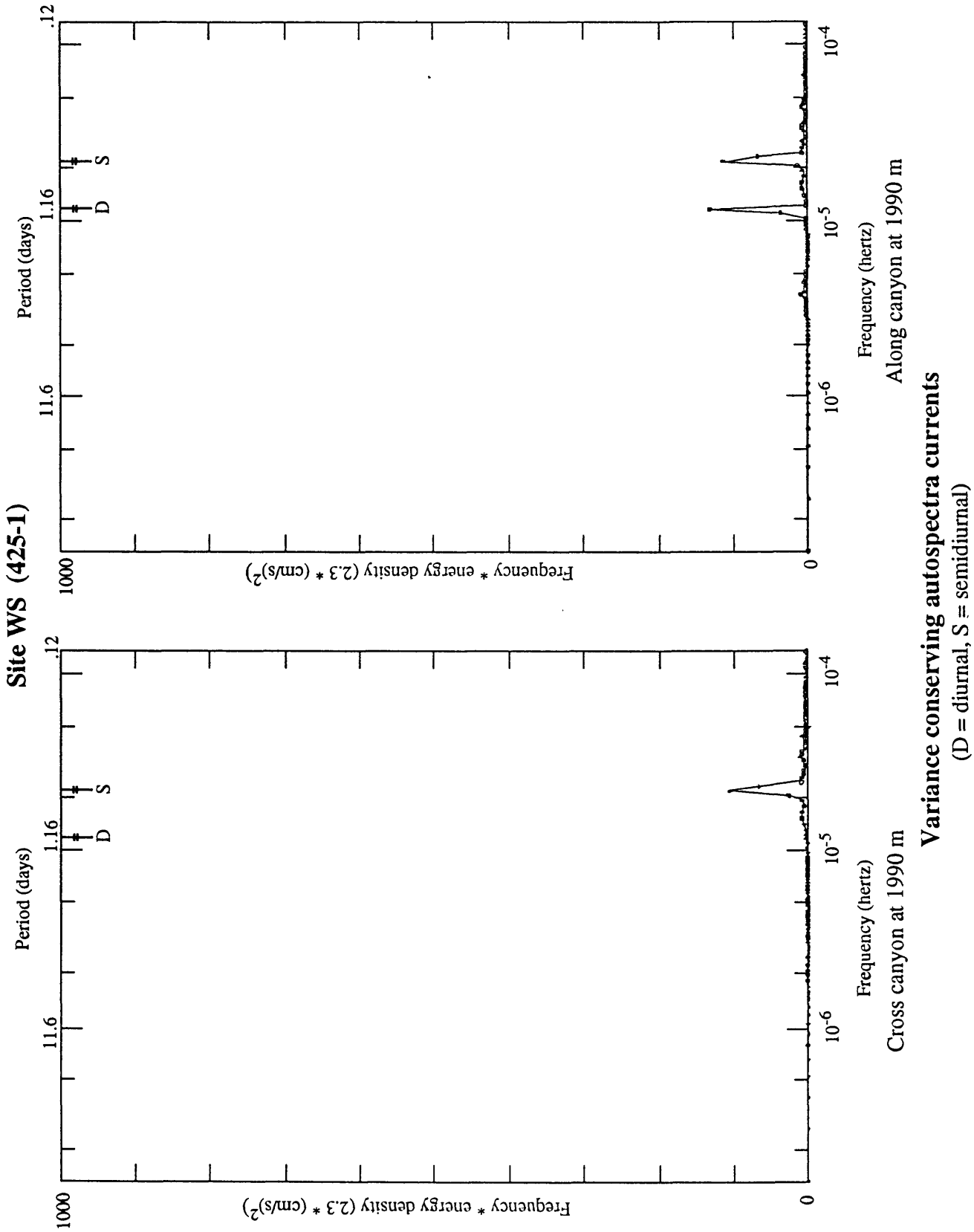


Variance conserving autospectra currents
(D = diurnal, S = semidiurnal)

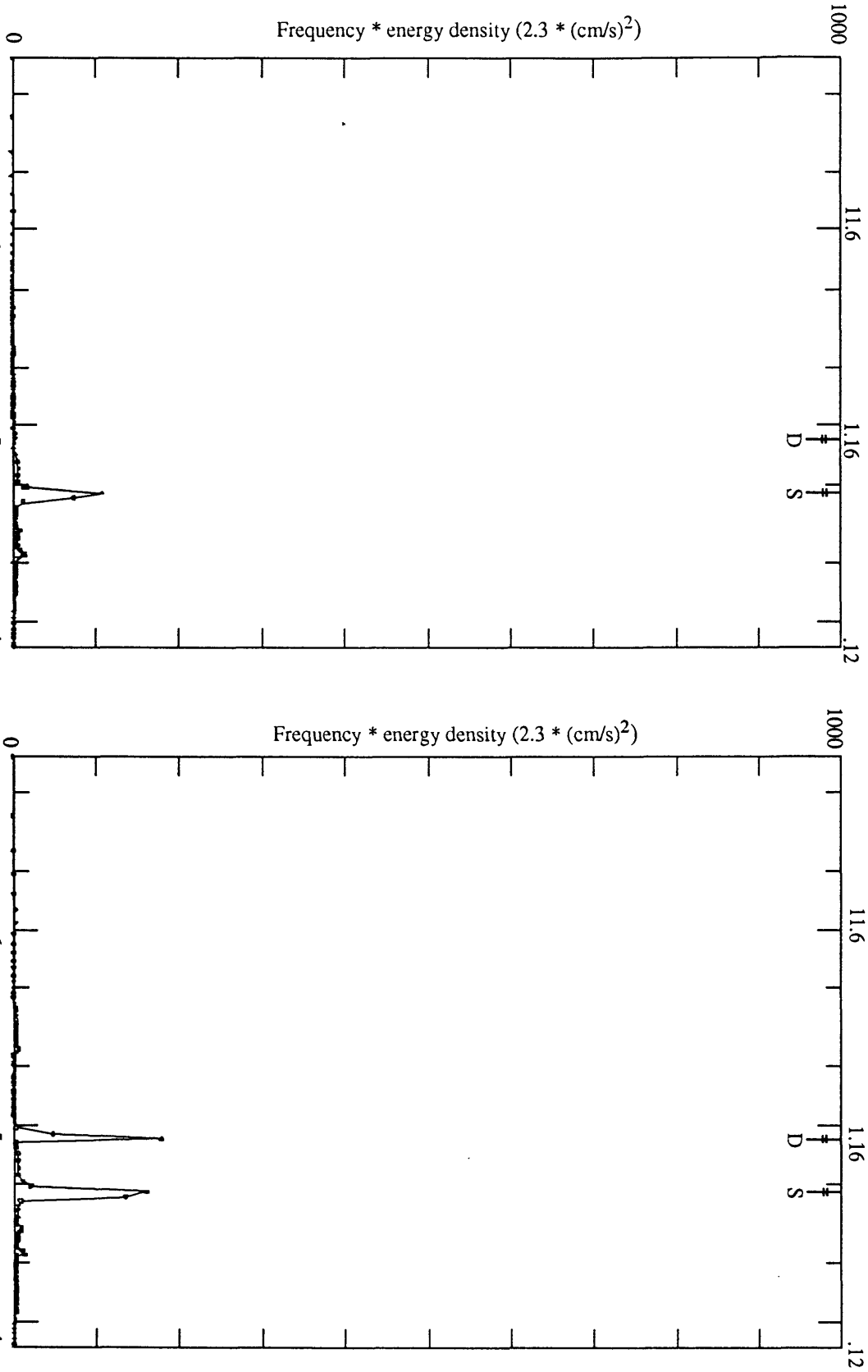


Variance conserving autospectra currents

(D = diurnal, S = semidiurnal)

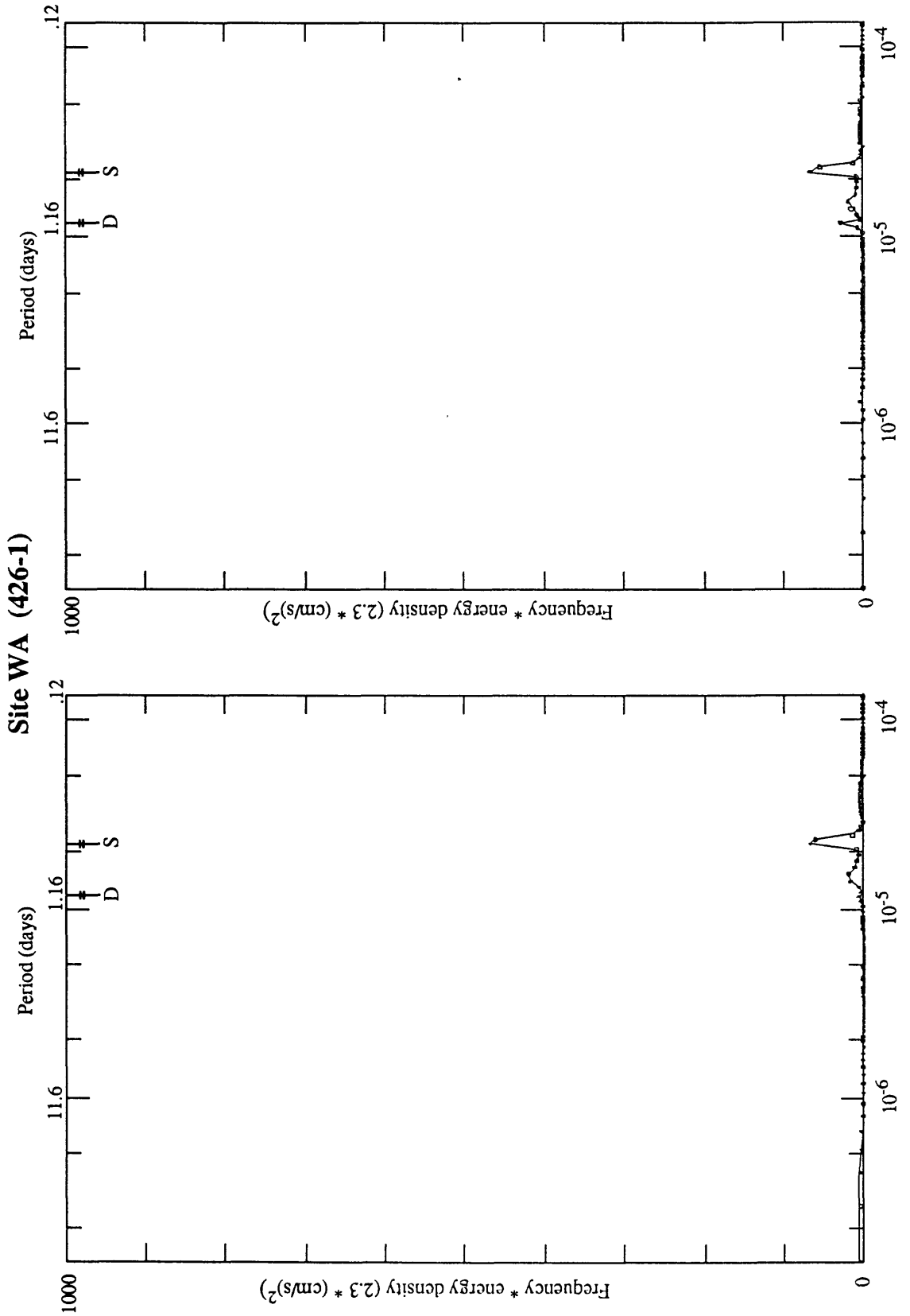


Variance conserving autospectra currents
(D = diurnal, S = semidiurnal)

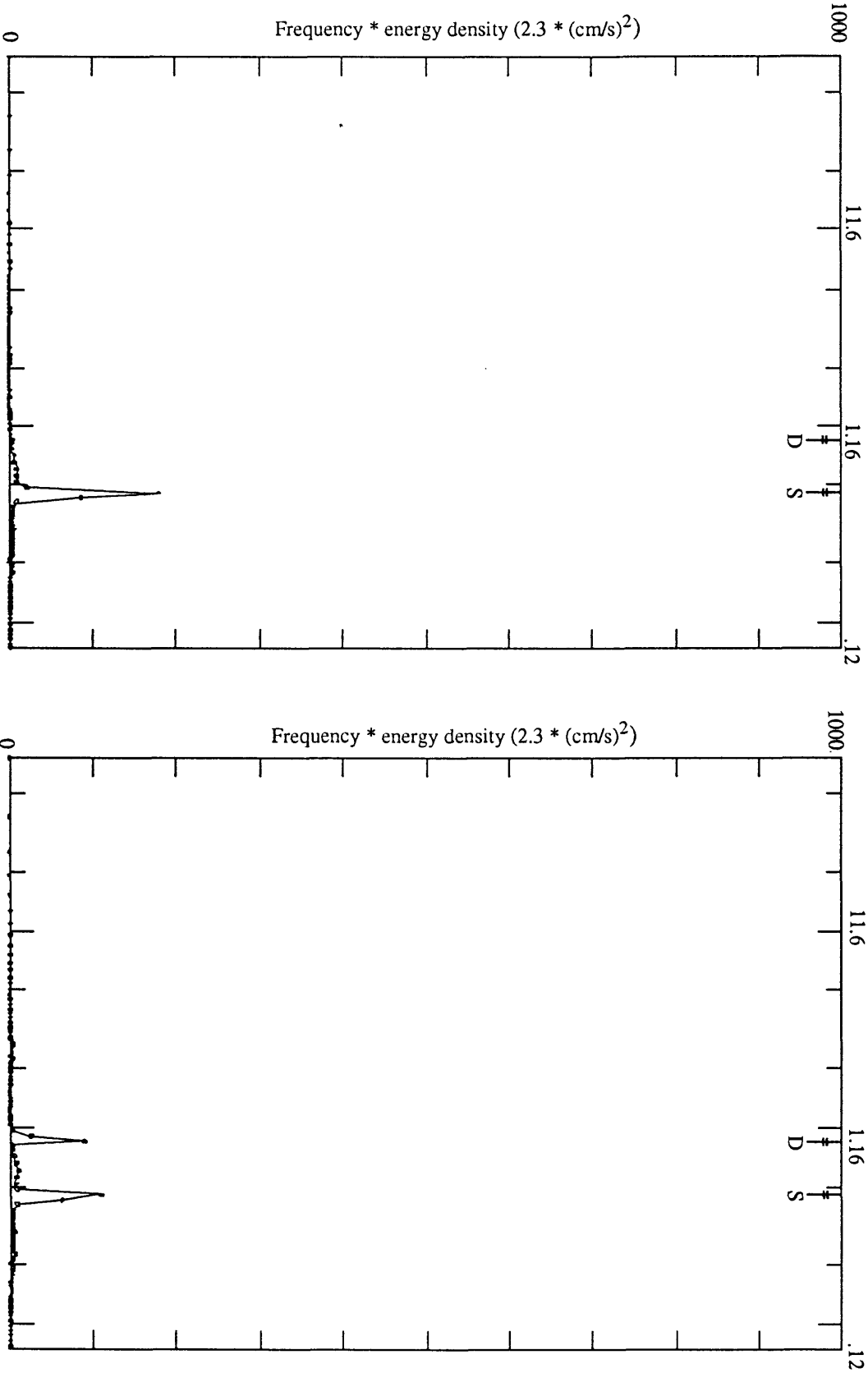


Variance conserving autospectra currents

(D = diurnal, S = semidiurnal)

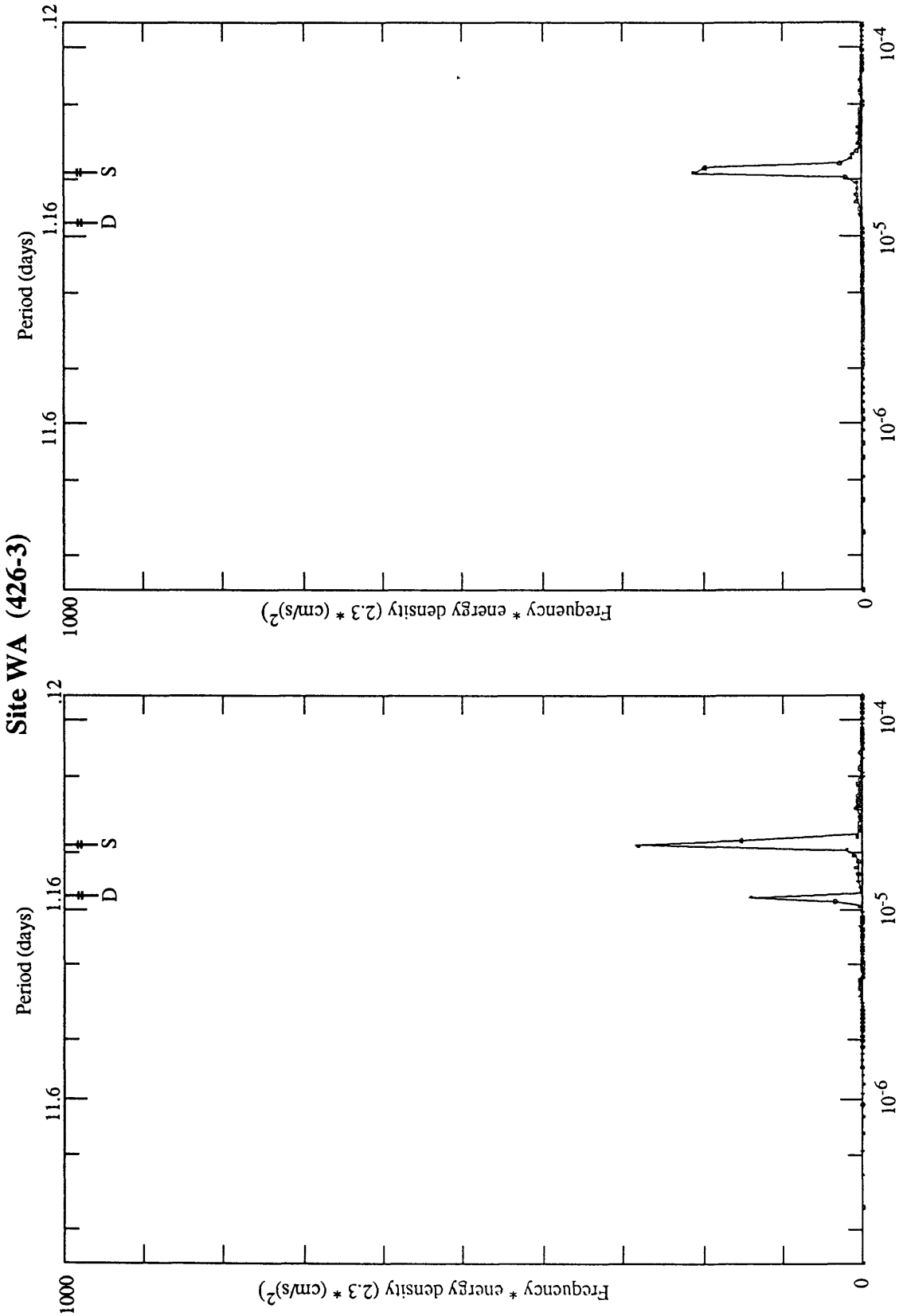


Variance conserving autospectra currents
(D = diurnal, S = semidiurnal)

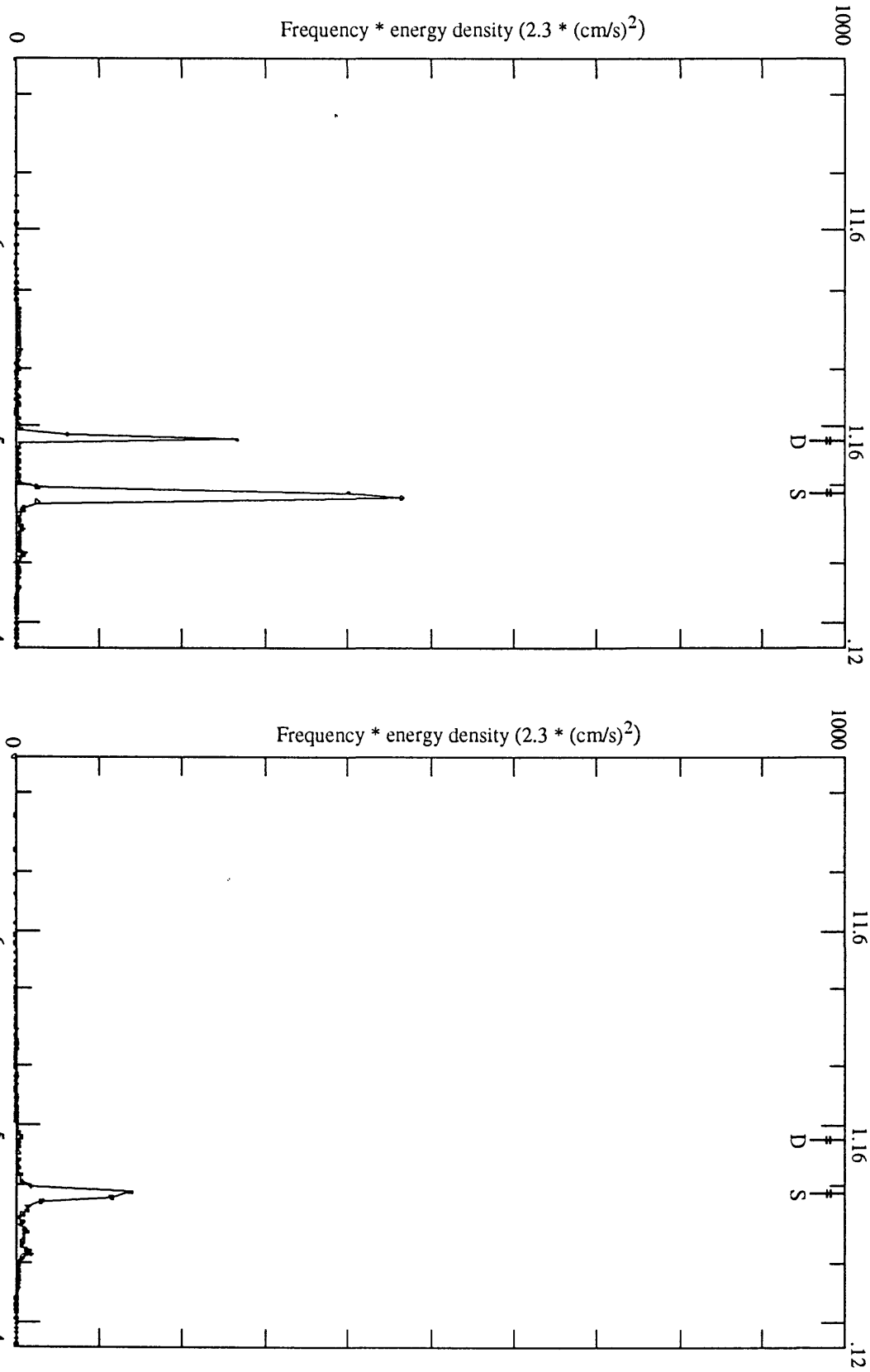


Variance conserving autospectra currents

(D = diurnal, S = semidiurnal)

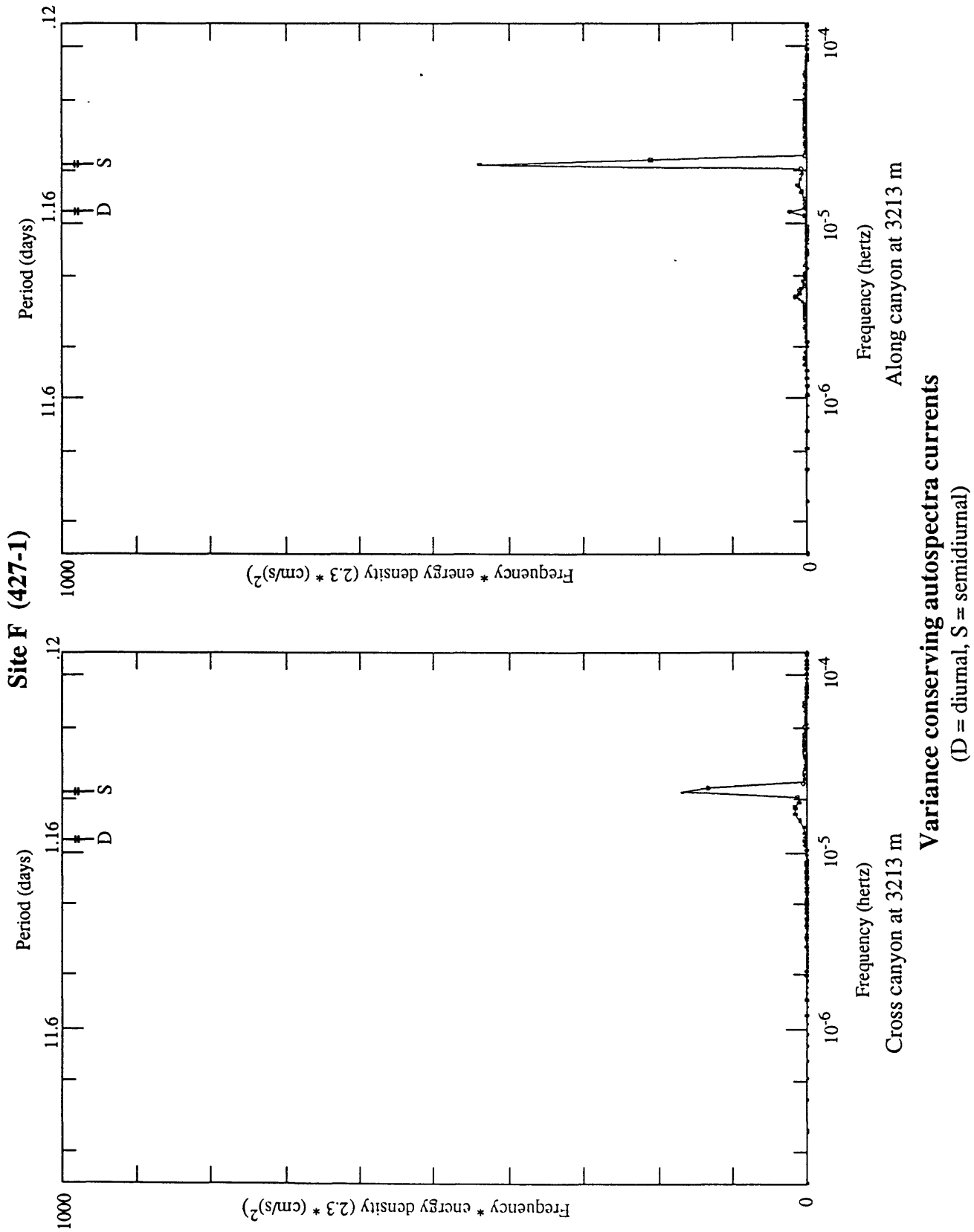


Variance conserving autospectra currents
(D = diurnal, S = semidiurnal)



Variance conserving autospectra currents

(D = diurnal, S = semidiurnal)



Variance conserving autospectra currents
(D = diurnal, S = semidiurnal)

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Appendix E - Temperature, salinity and transmission

Plots of hour-averaged temperature ..... E1 - E6

Plots of lowpassed temperature ..... E7 - E12

Plots of hour-averaged salinity ..... E13 - E16

Plots of lowpassed salinity ..... E17 - E20

Plots of hour-averaged transmission ..... E21 - E24

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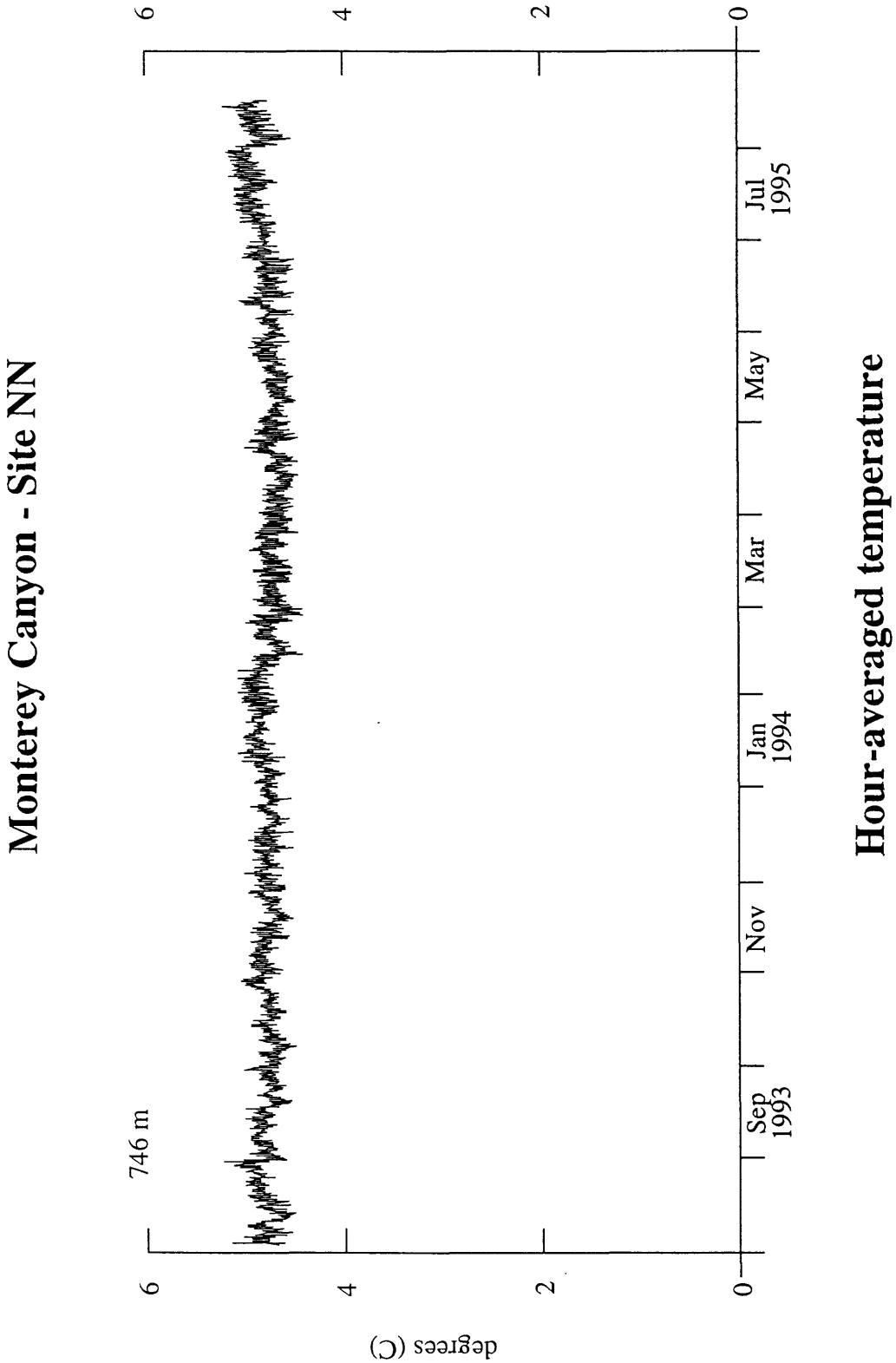
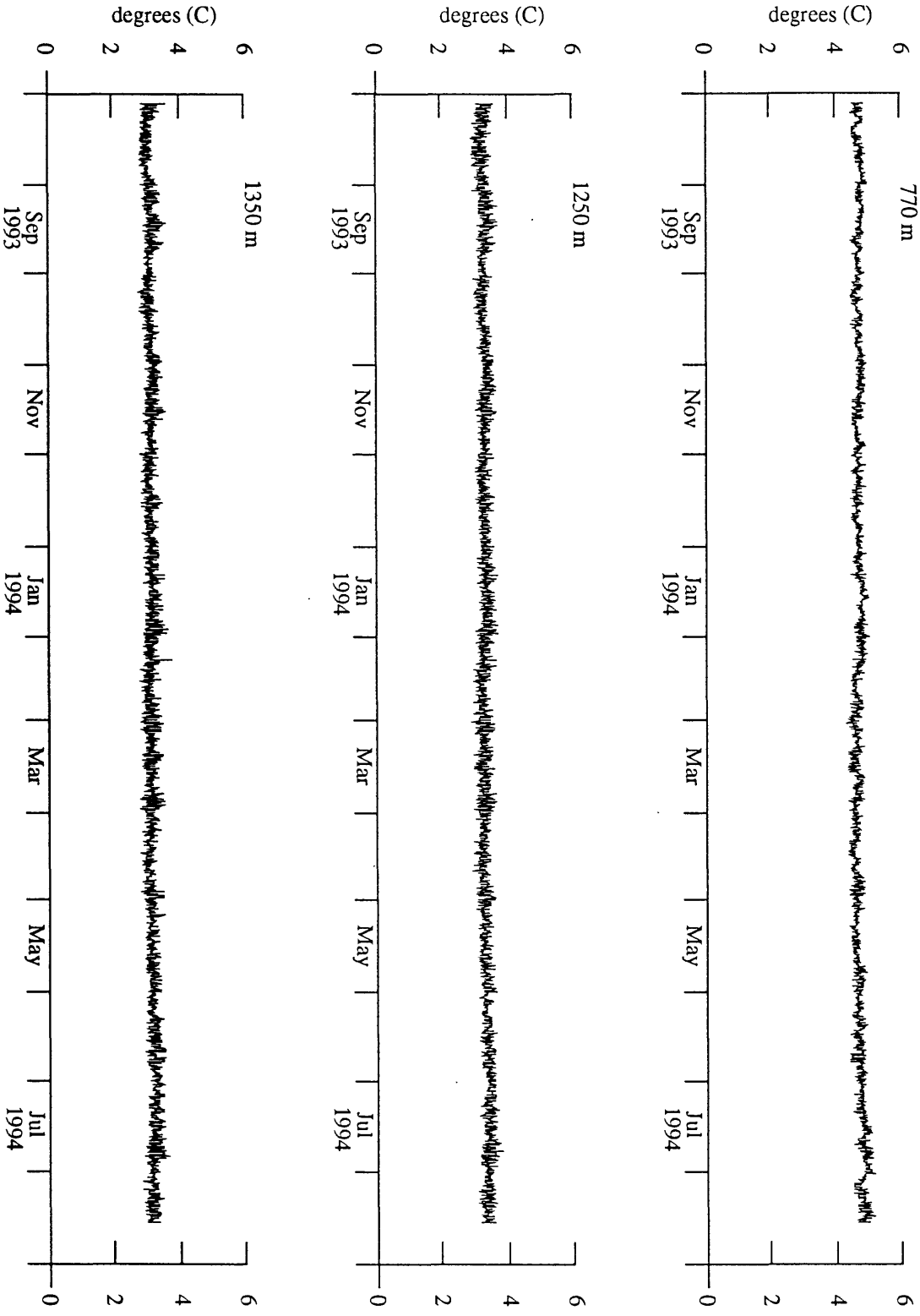
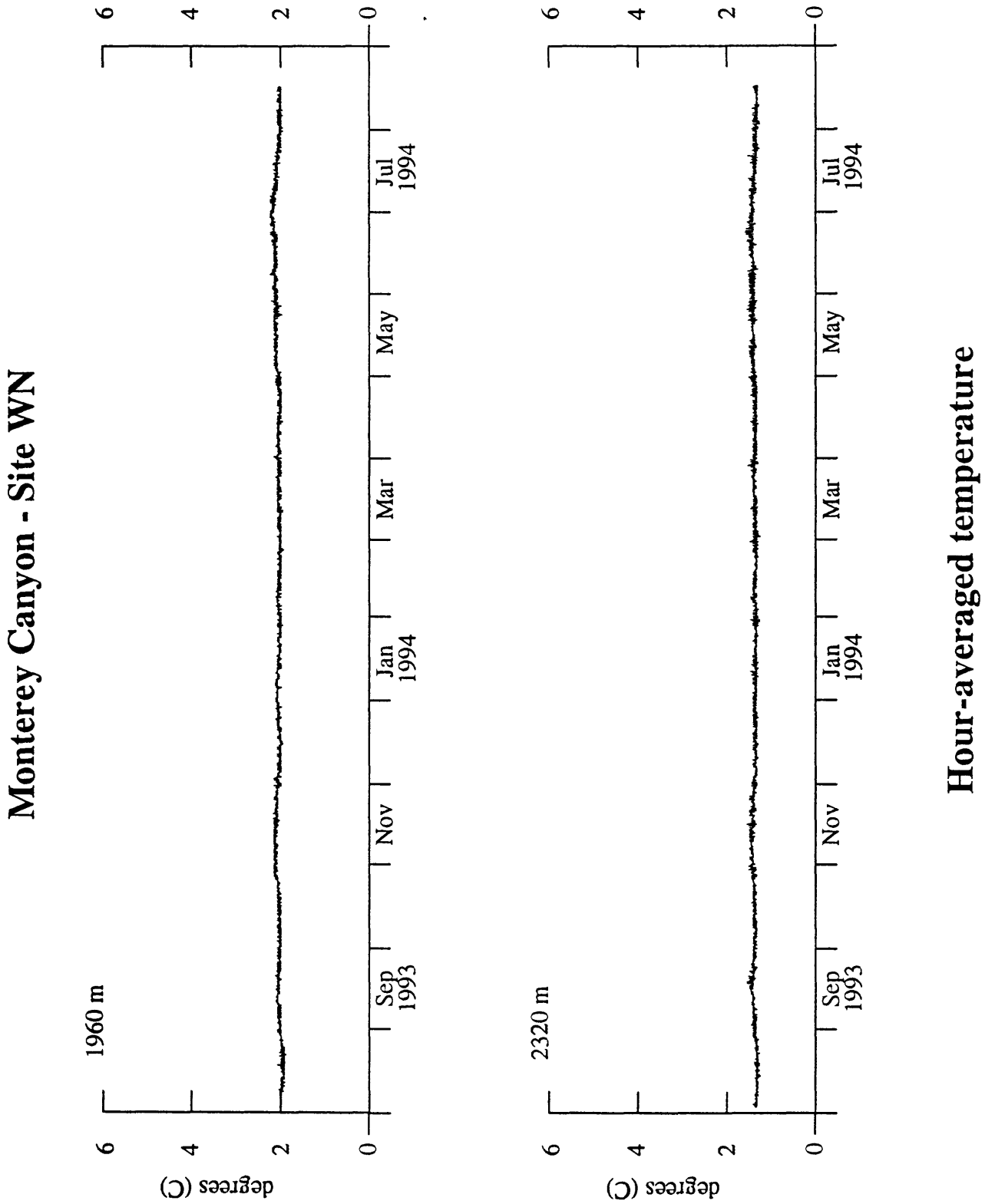
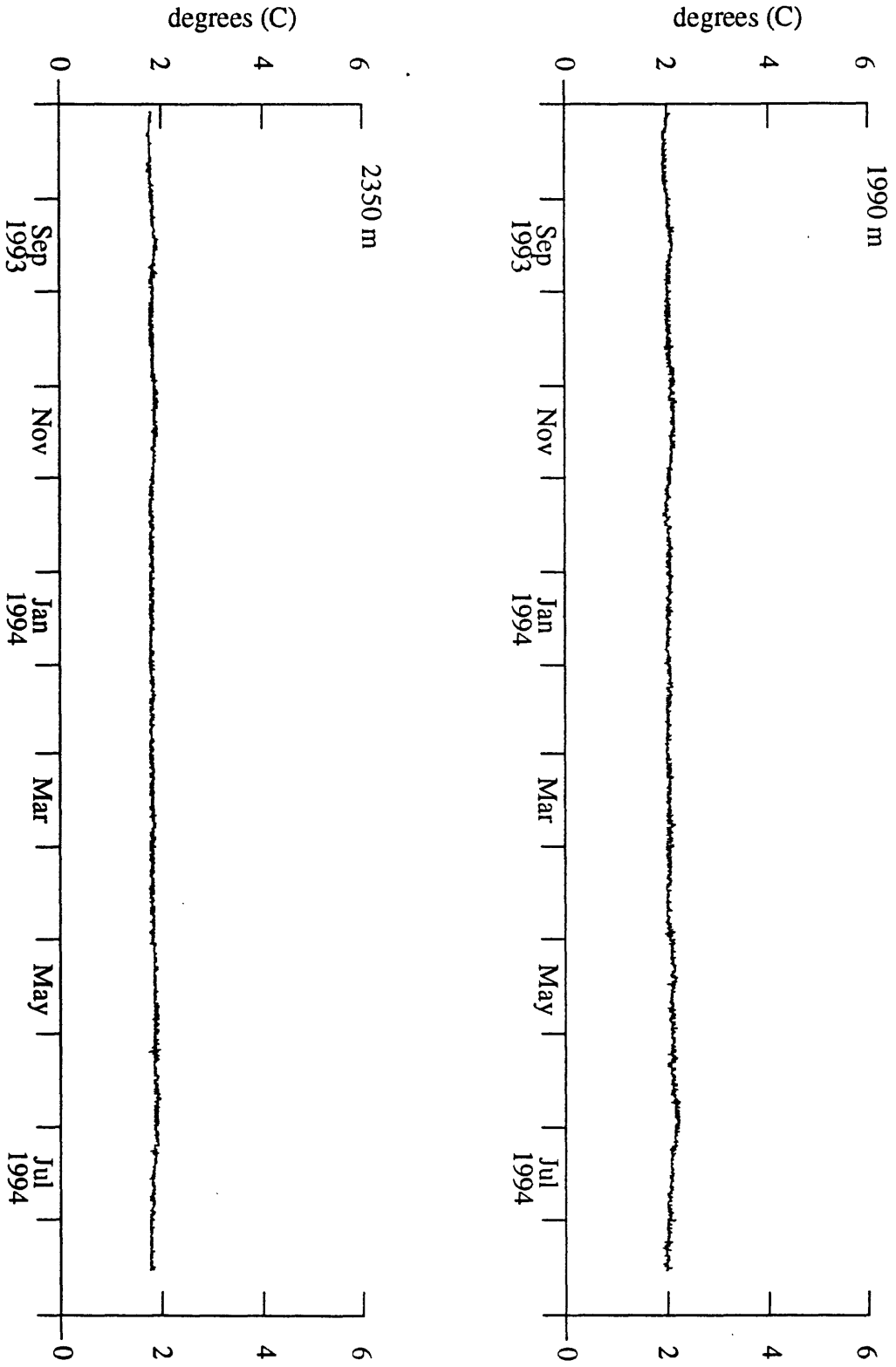

Monterey Canyon - Site NN
746 m
6
4
2
0
degrees (C)
Sep 1993
Nov
Jan 1994
Mar
May
Jul 1995
Hour-averaged temperature

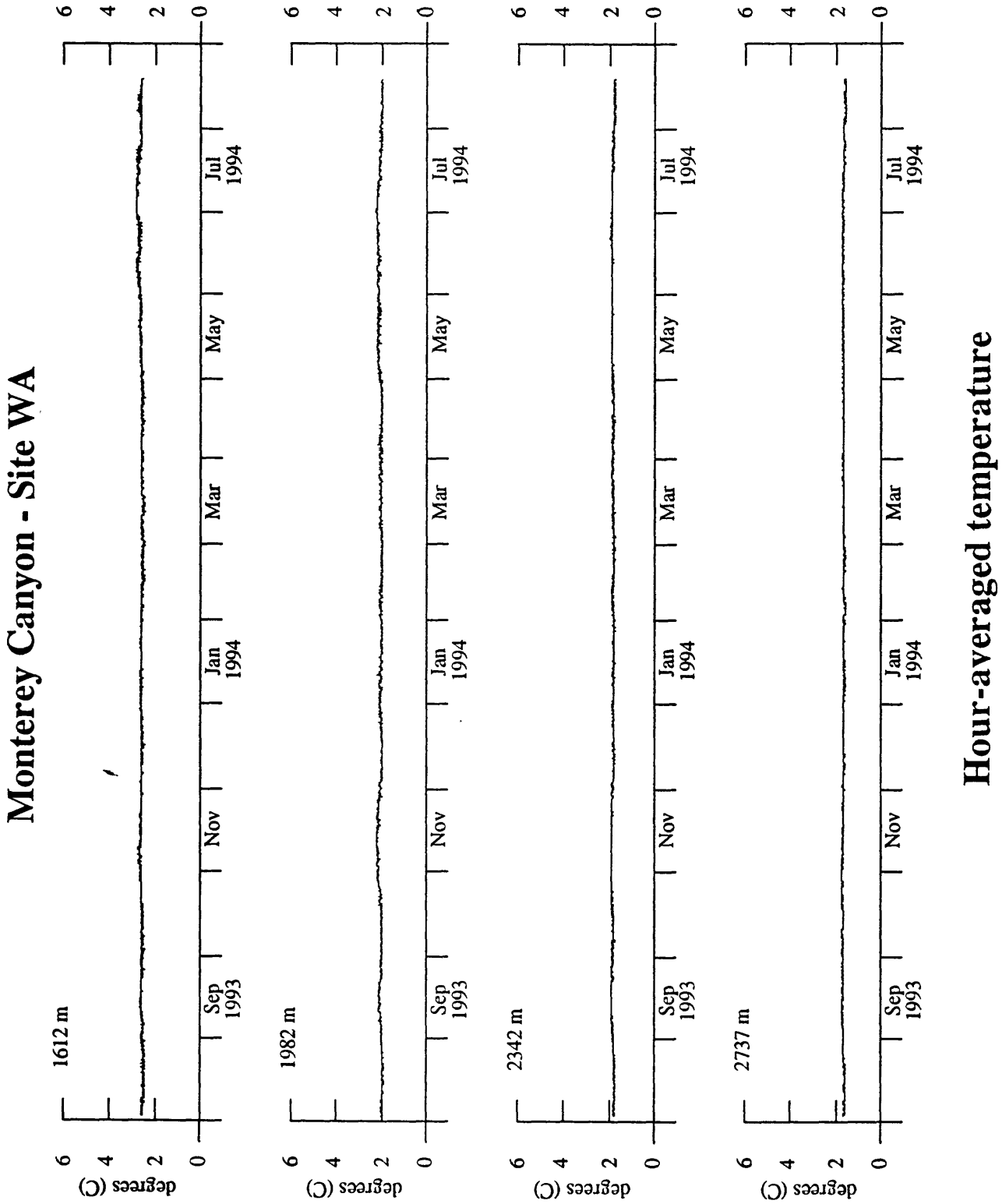


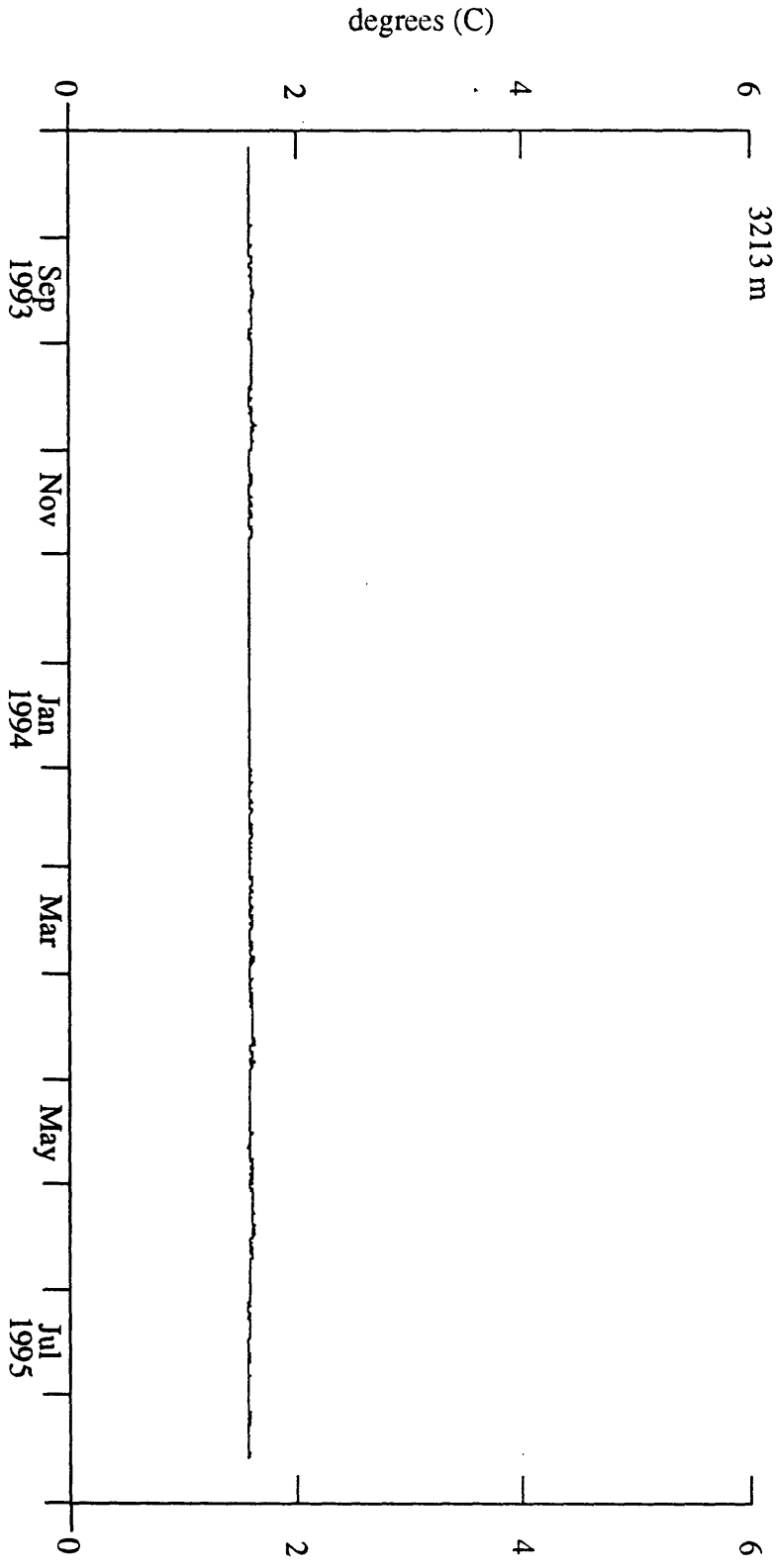
Hour-averaged temperature


Monterey Canyon - Site WN
1960 m
2320 m
degrees (C)
6
4
2
0
Sep 1993
Nov
Jan 1994
Mar
May
Jul 1994
Hour-averaged temperature

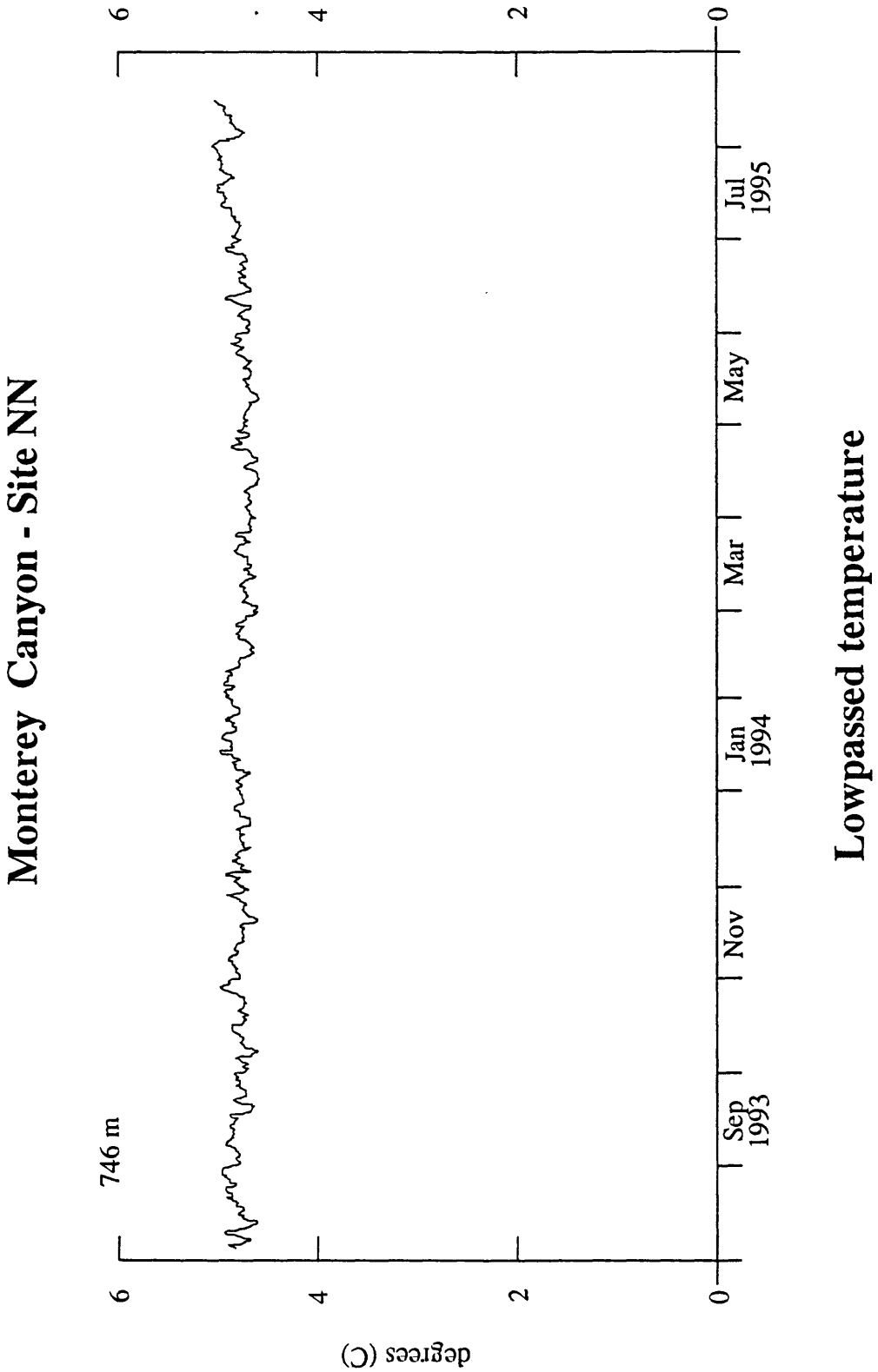


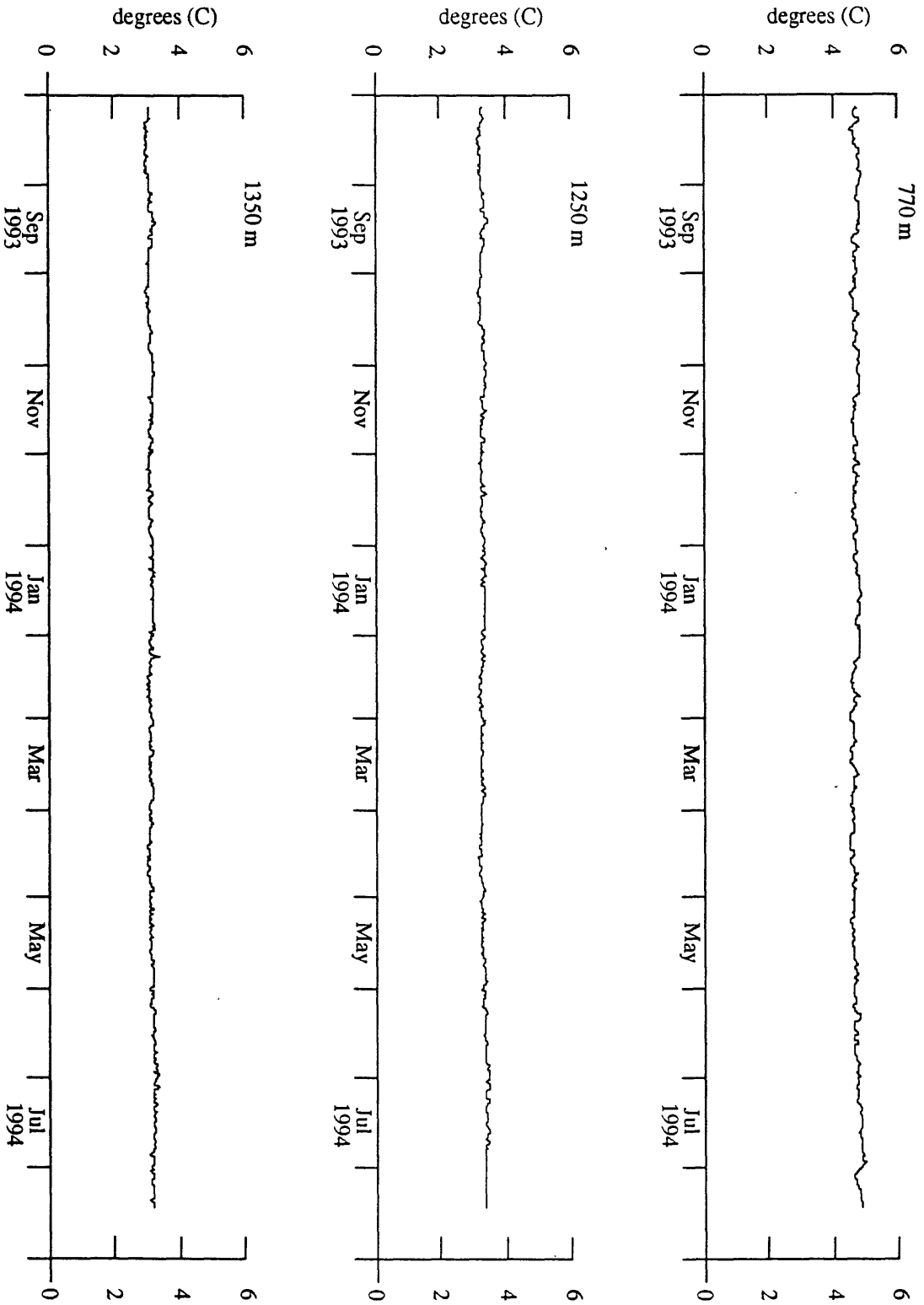
Hour-averaged temperature


Monterey Canyon - Site WA
1612 m
1982 m
2342 m
2737 m
degrees (C)
0
2
4
6
Sep 1993
Nov
Jan 1994
Mar
May
Jul 1994
Hour-averaged temperature

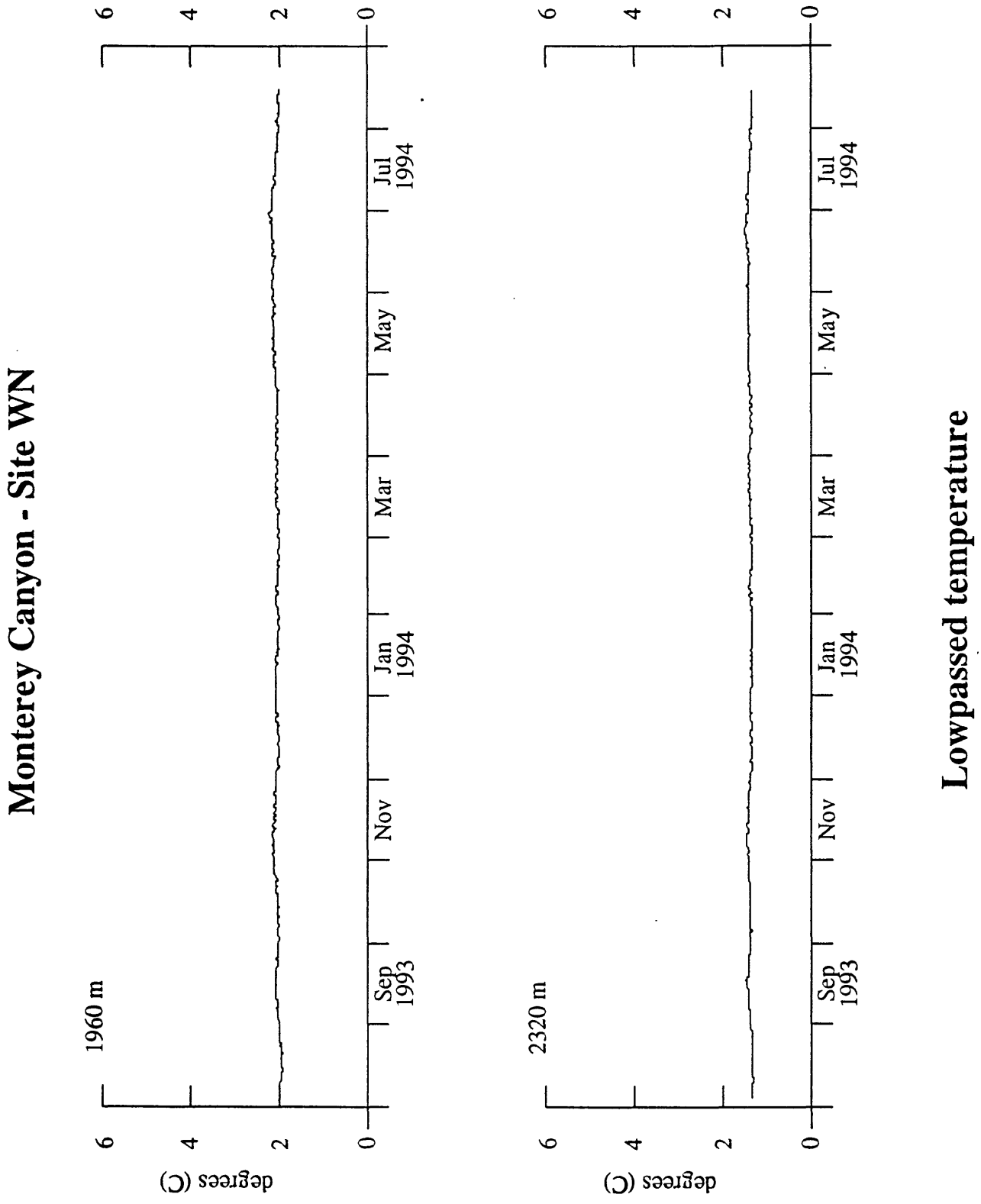


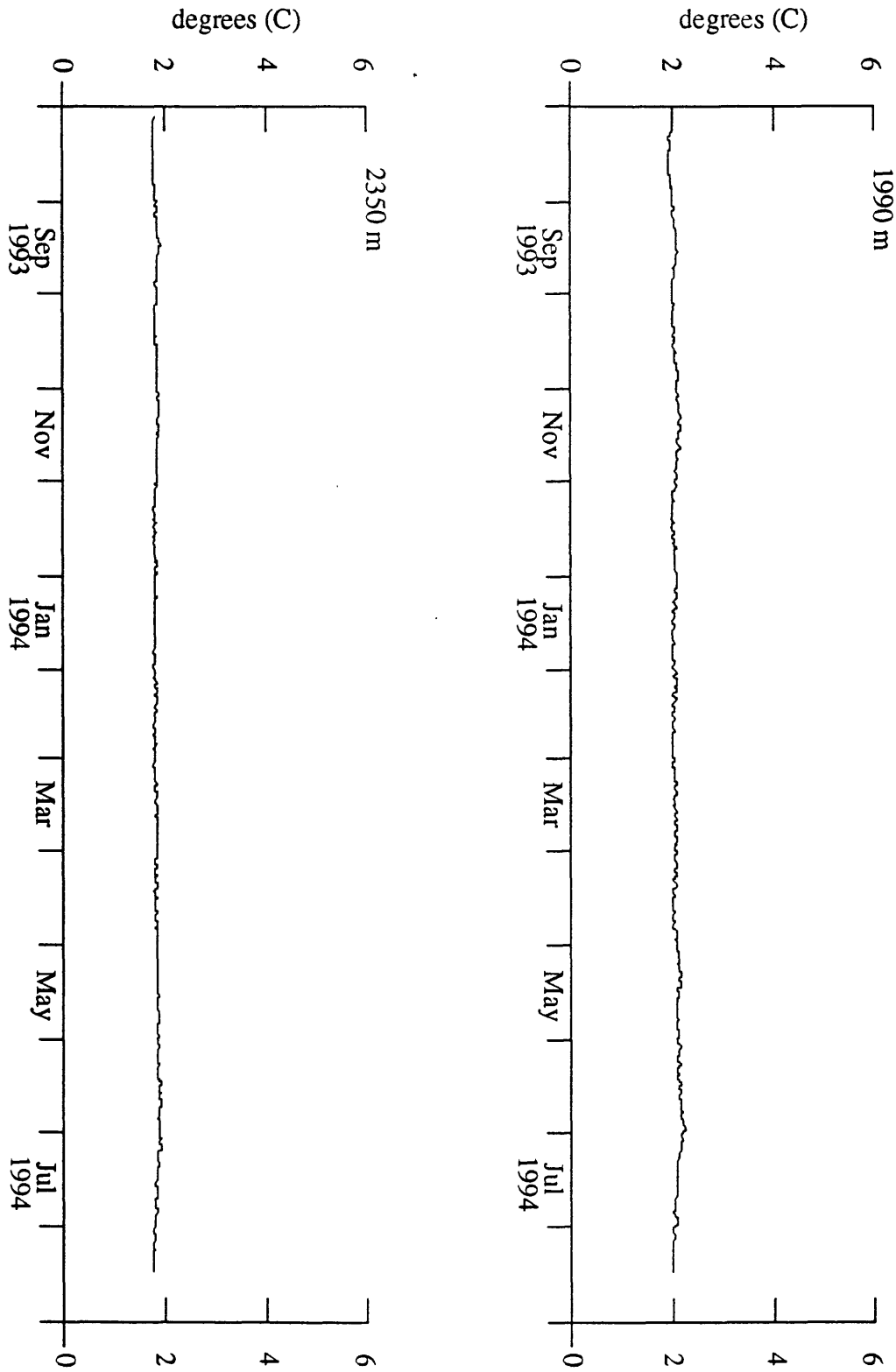
Hour-averaged temperature


Monterey Canyon - Site NN
746 m
6
4
2
0
degrees (C)
Sep 1993
Nov
Jan 1994
Mar
May
Jul 1995
Lowpassed temperature

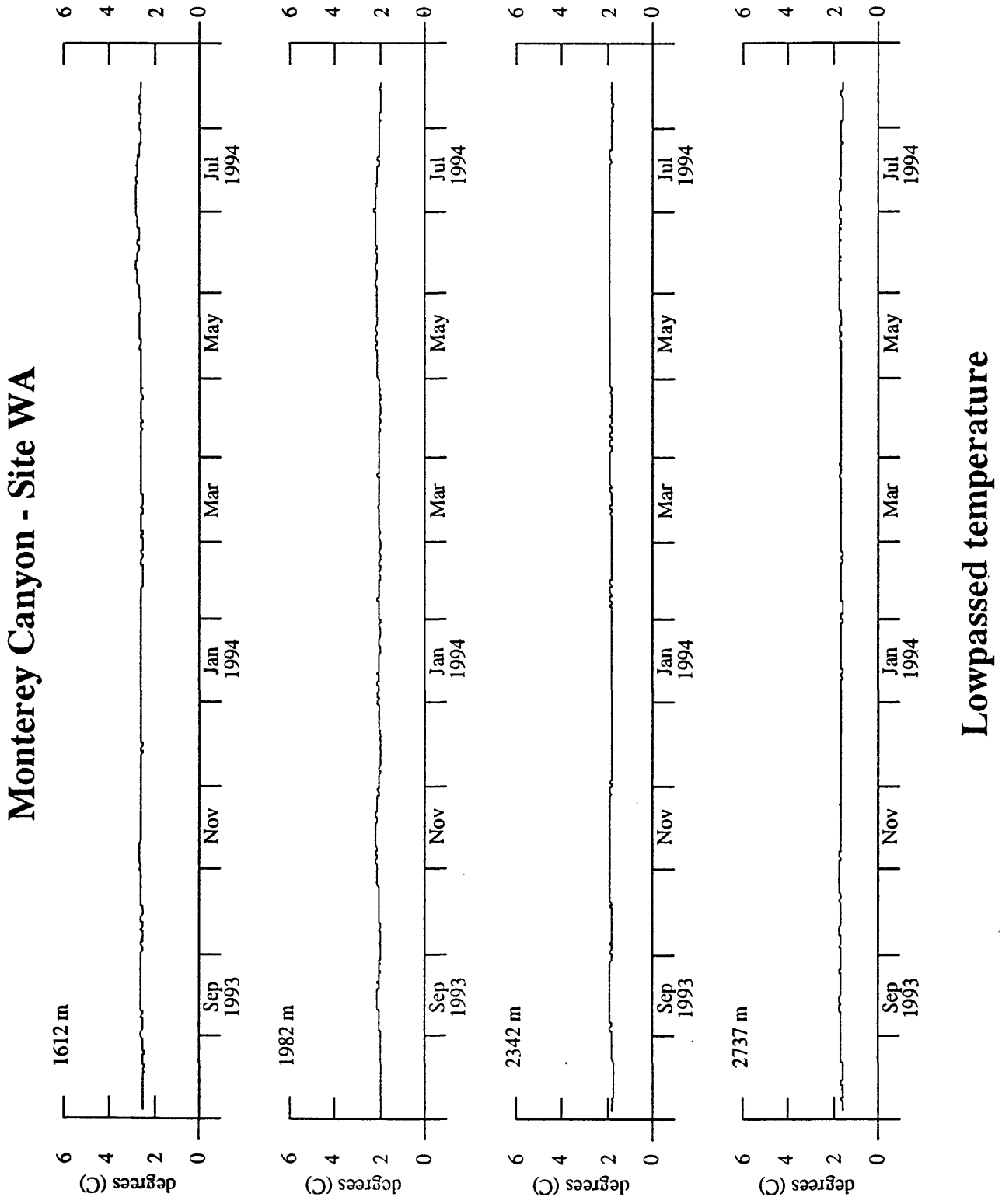


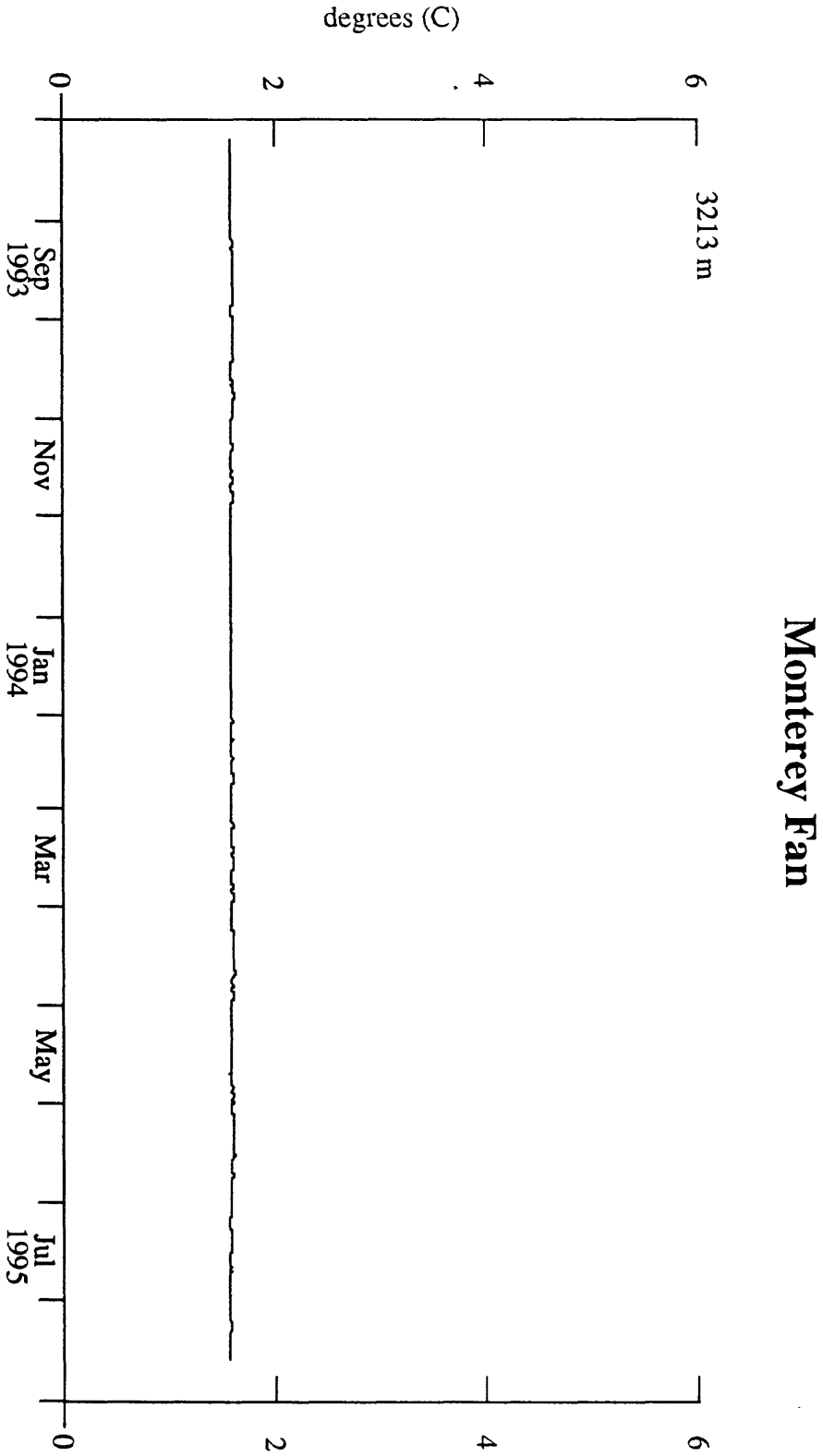
Lowpassed temperature


Monterey Canyon - Site WN
1960 m
2320 m
degrees (C)
0
2
4
6
Sep 1993
Nov
Jan 1994
Mar
May
Jul 1994
Lowpassed temperature

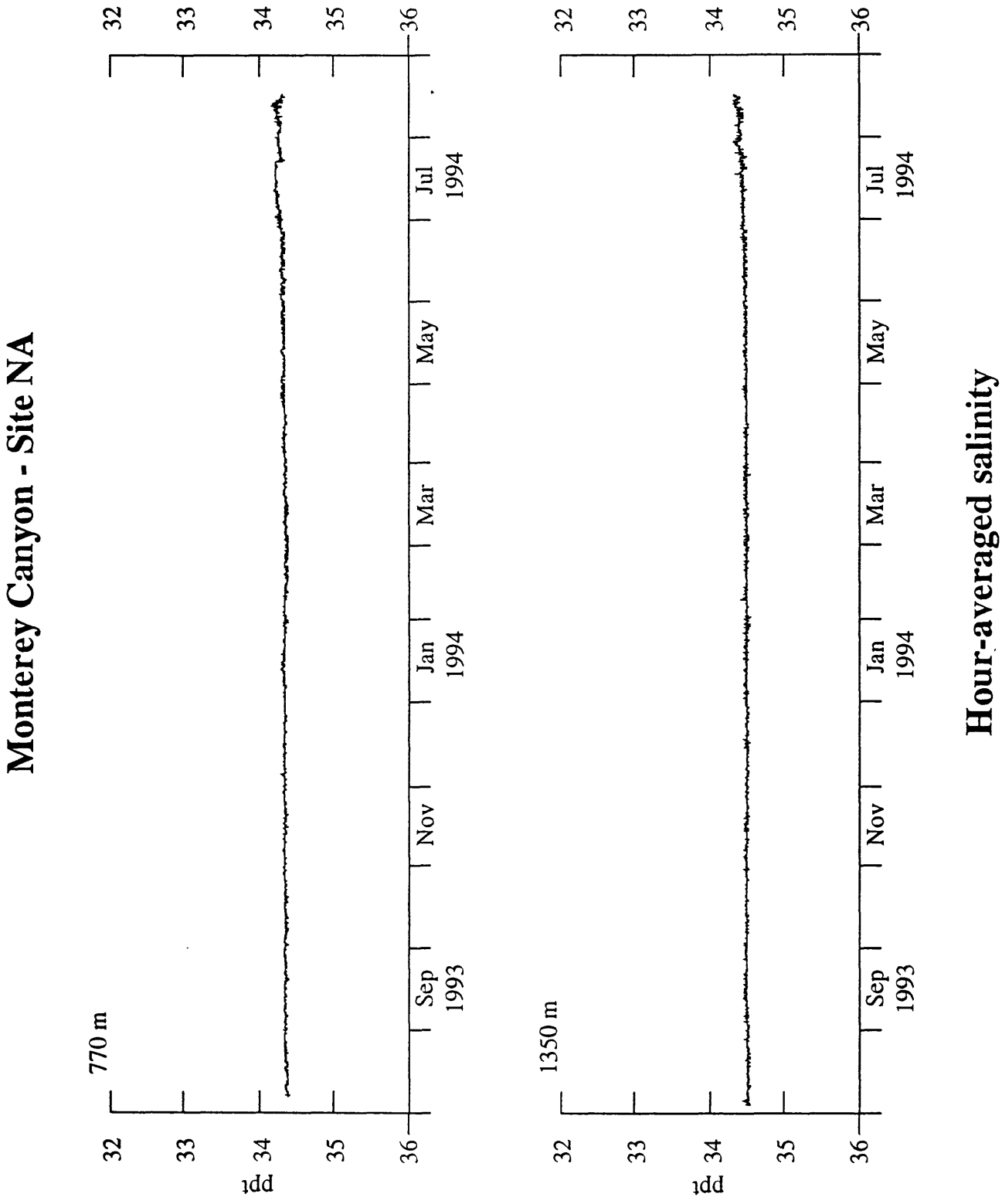


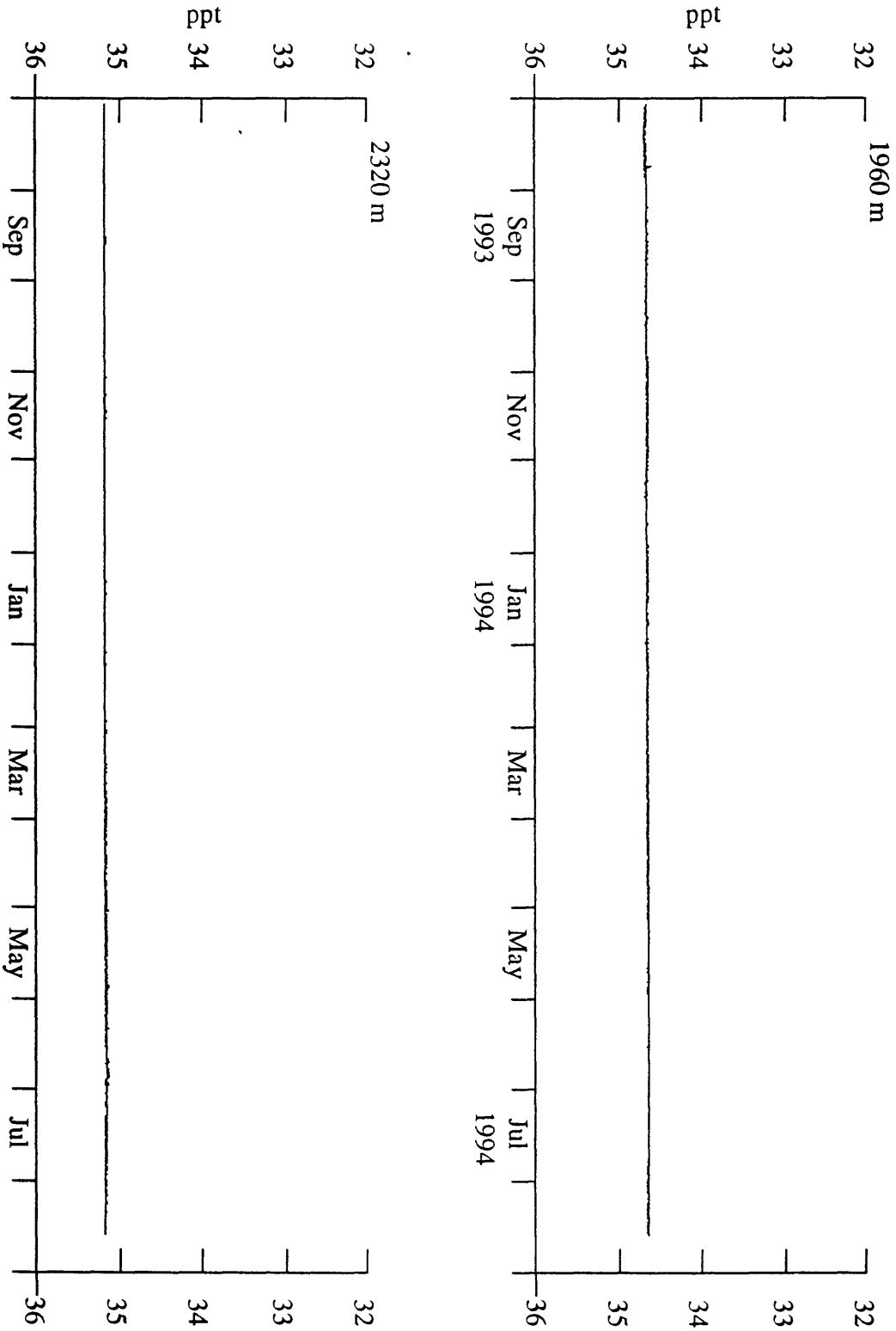
Lowpassed temperature


Monterey Canyon - Site WA
1612 m
1982 m
2342 m
2737 m
degrees (C)
0
2
4
6
Sep 1993
Nov
Jan 1994
Mar
May
Jul 1994
Lowpassed temperature

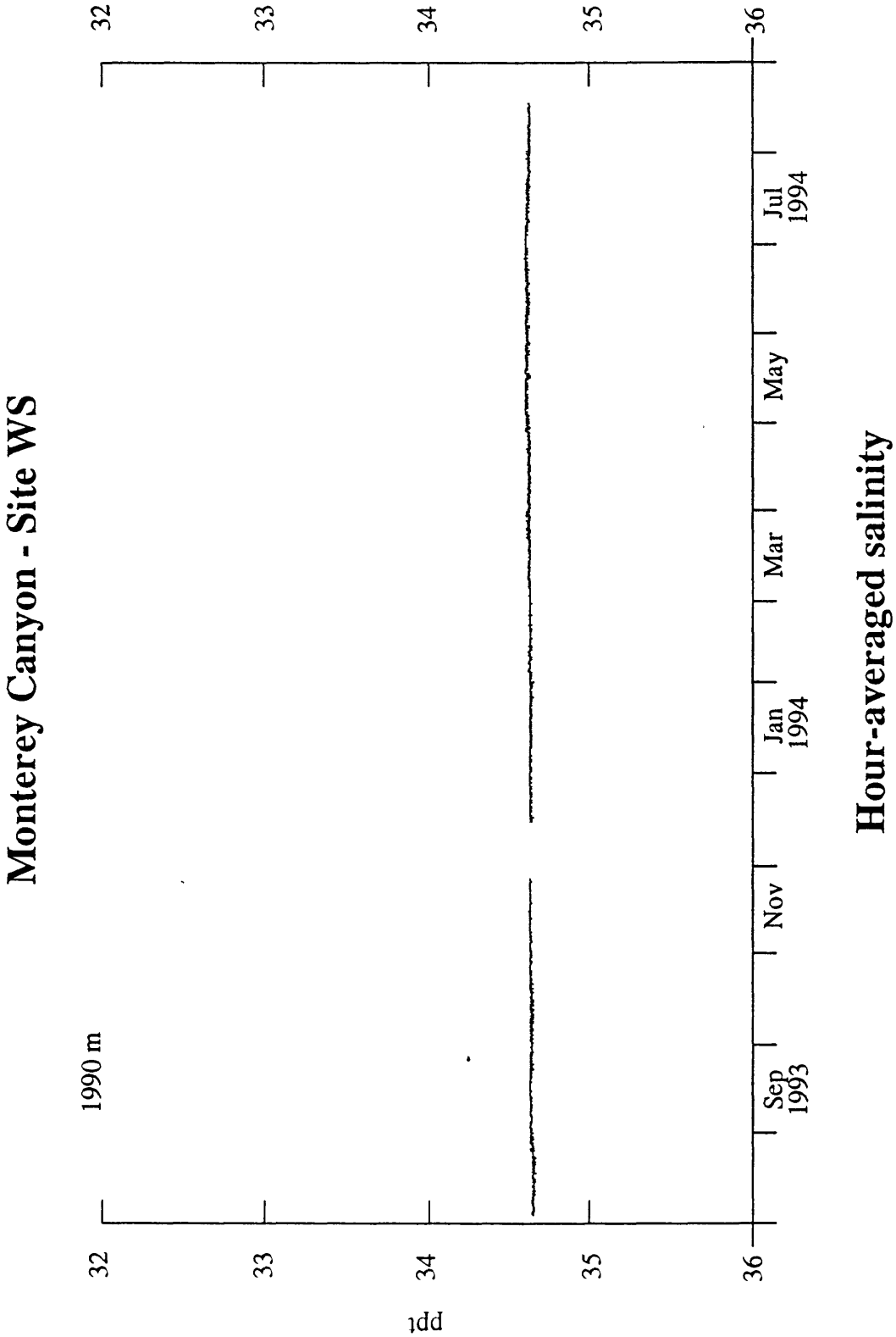


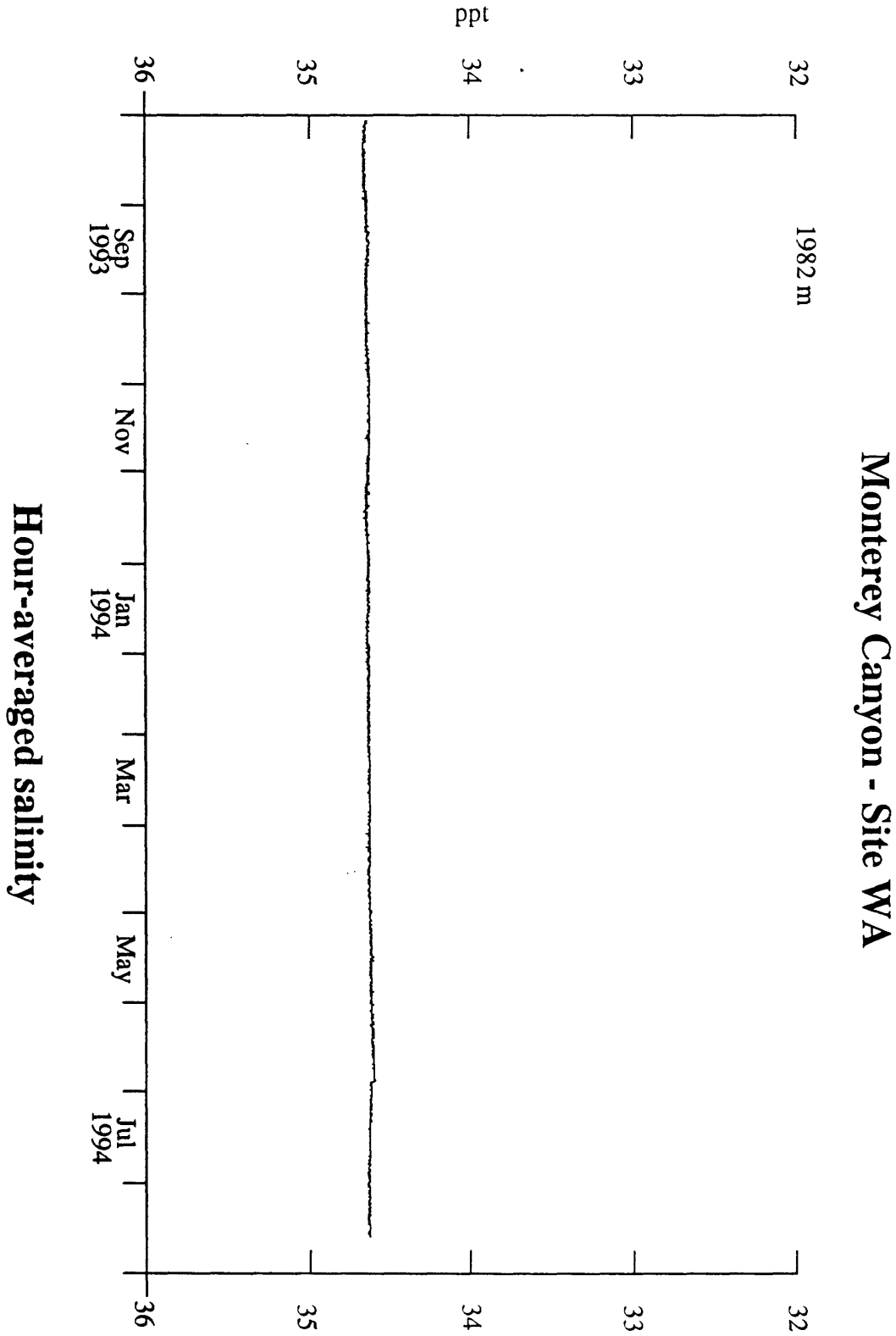
Lowpassed temperature

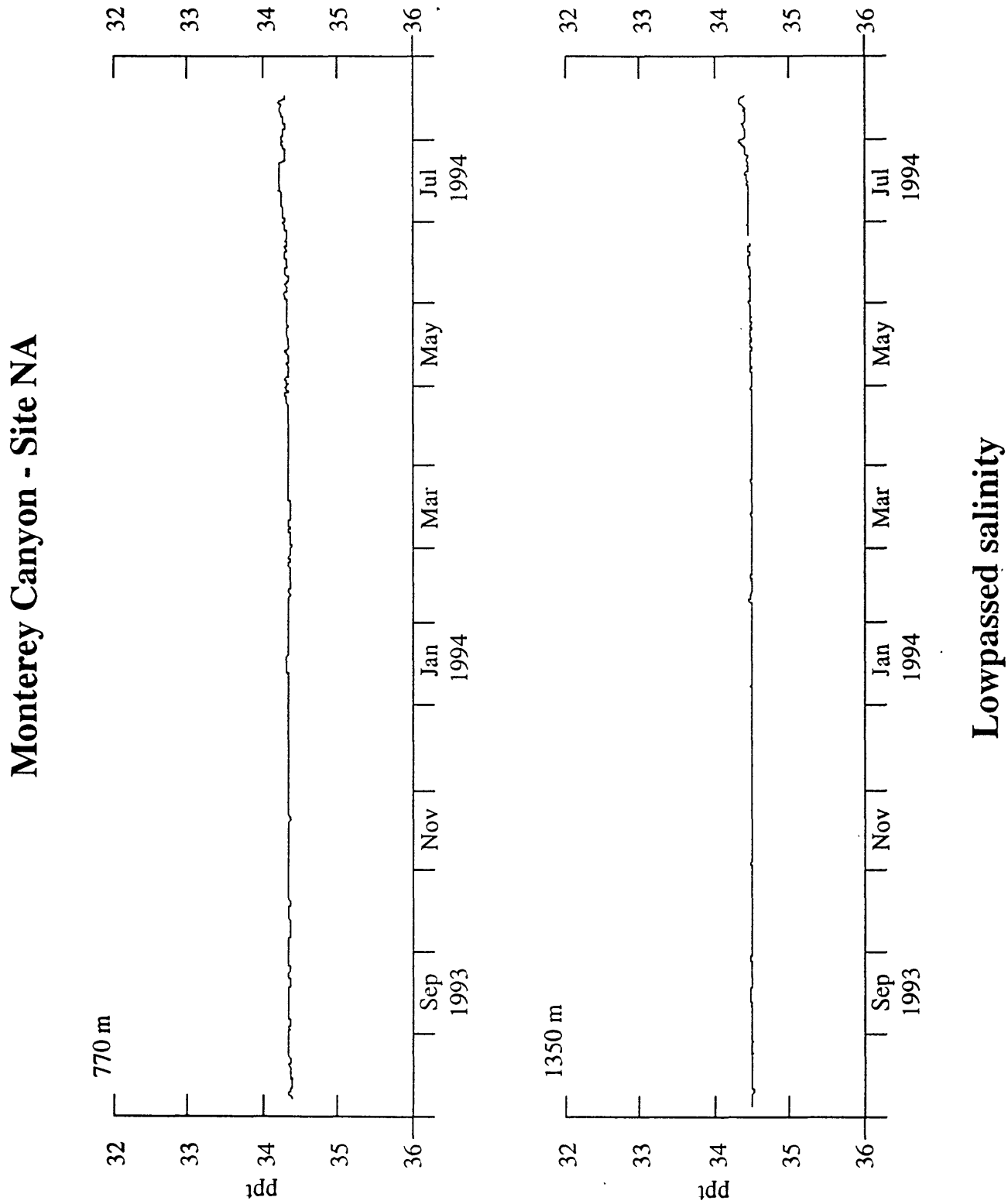

Monterey Canyon - Site NA
770 m
1350 m
ppt
32
33
34
35
36
Sep 1993
Nov
Jan 1994
Mar
May
Jul 1994
Hour-averaged salinity

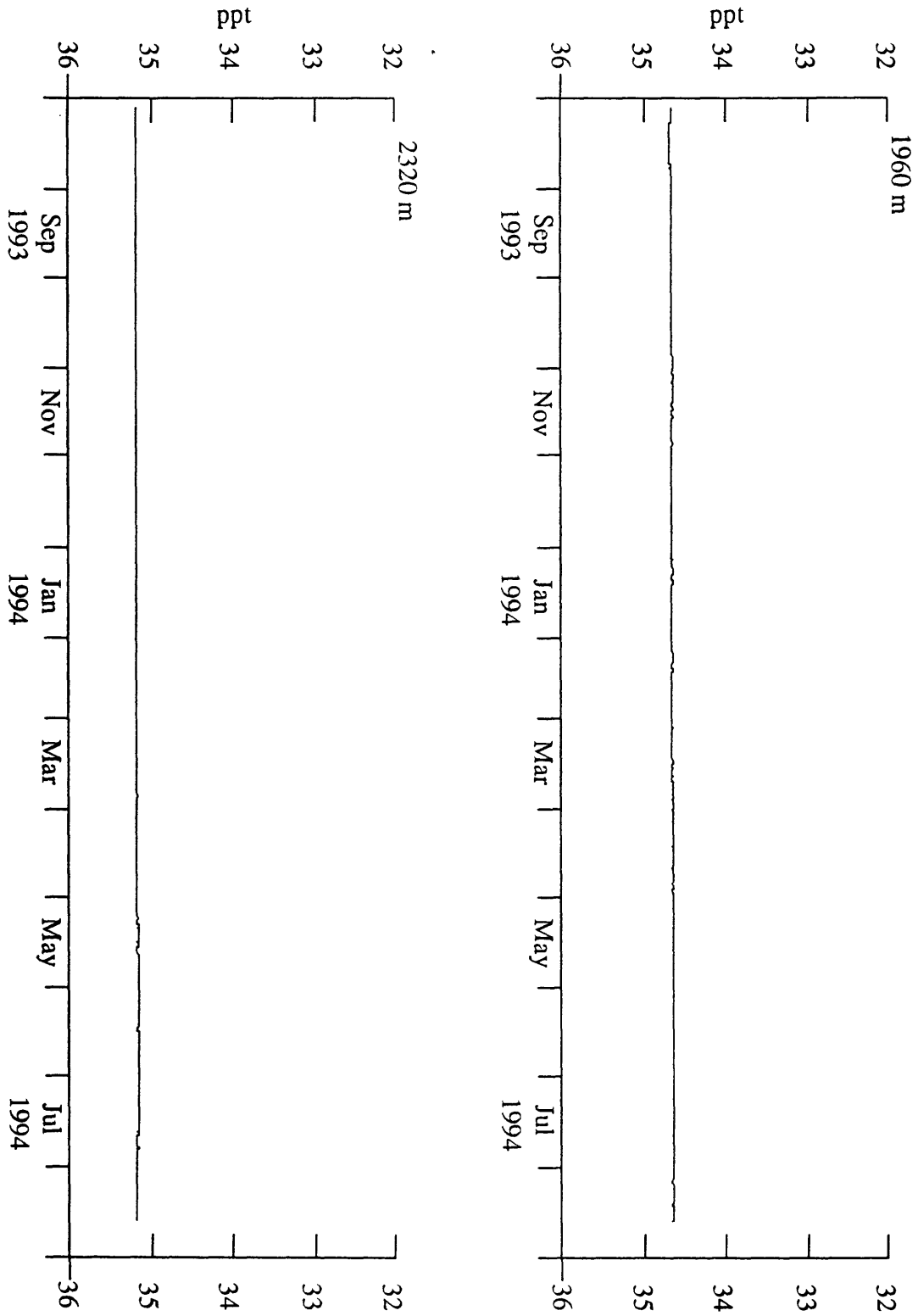


Hour-averaged salinity

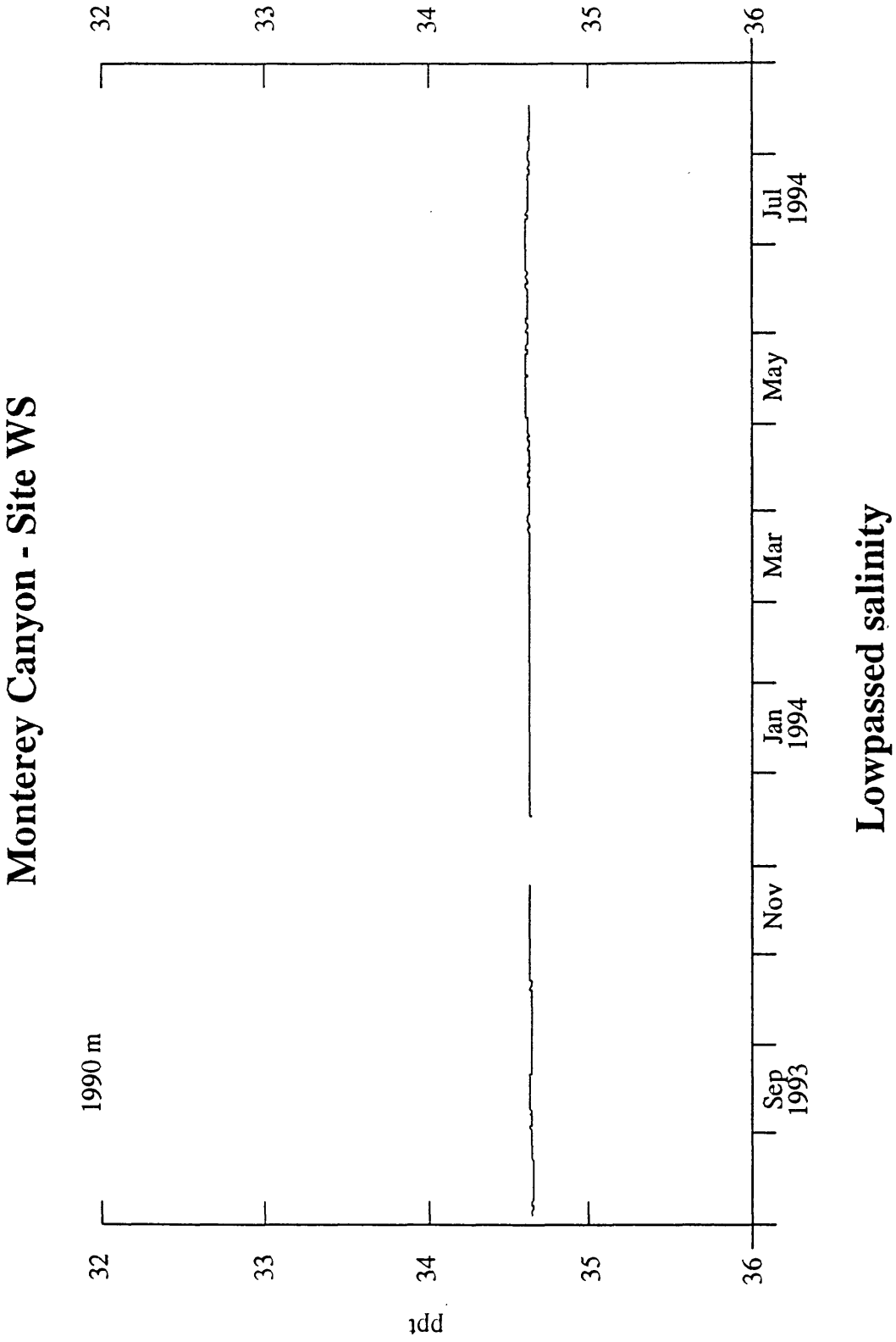

Monterey Canyon - Site WS
1990 m
32
33
34
35
36
ppt
Sep 1993
Nov
Jan 1994
Mar
May
Jul 1994
Hour-averaged salinity

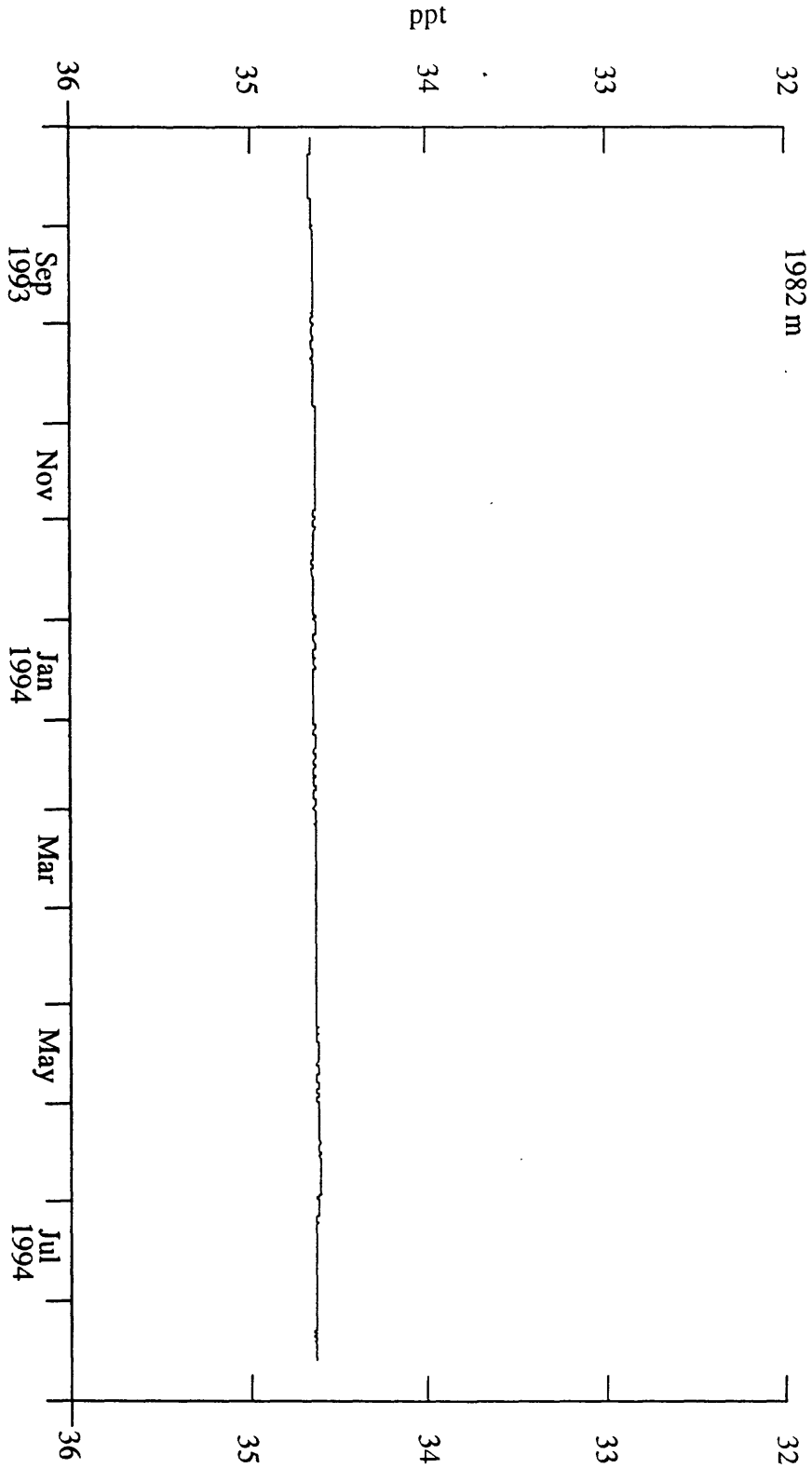

Monterey Canyon - Site WA
1982 m
ppt
32
33
34
35
36
Sep 1993
Nov
Jan 1994
Mar
May
Jul 1994
Hour-averaged salinity


Monterey Canyon - Site NA
770 m
1350 m
ppt
32
33
34
35
36
Sep 1993
Nov
Jan 1994
Mar
May
Jul 1994
Lowpassed salinity

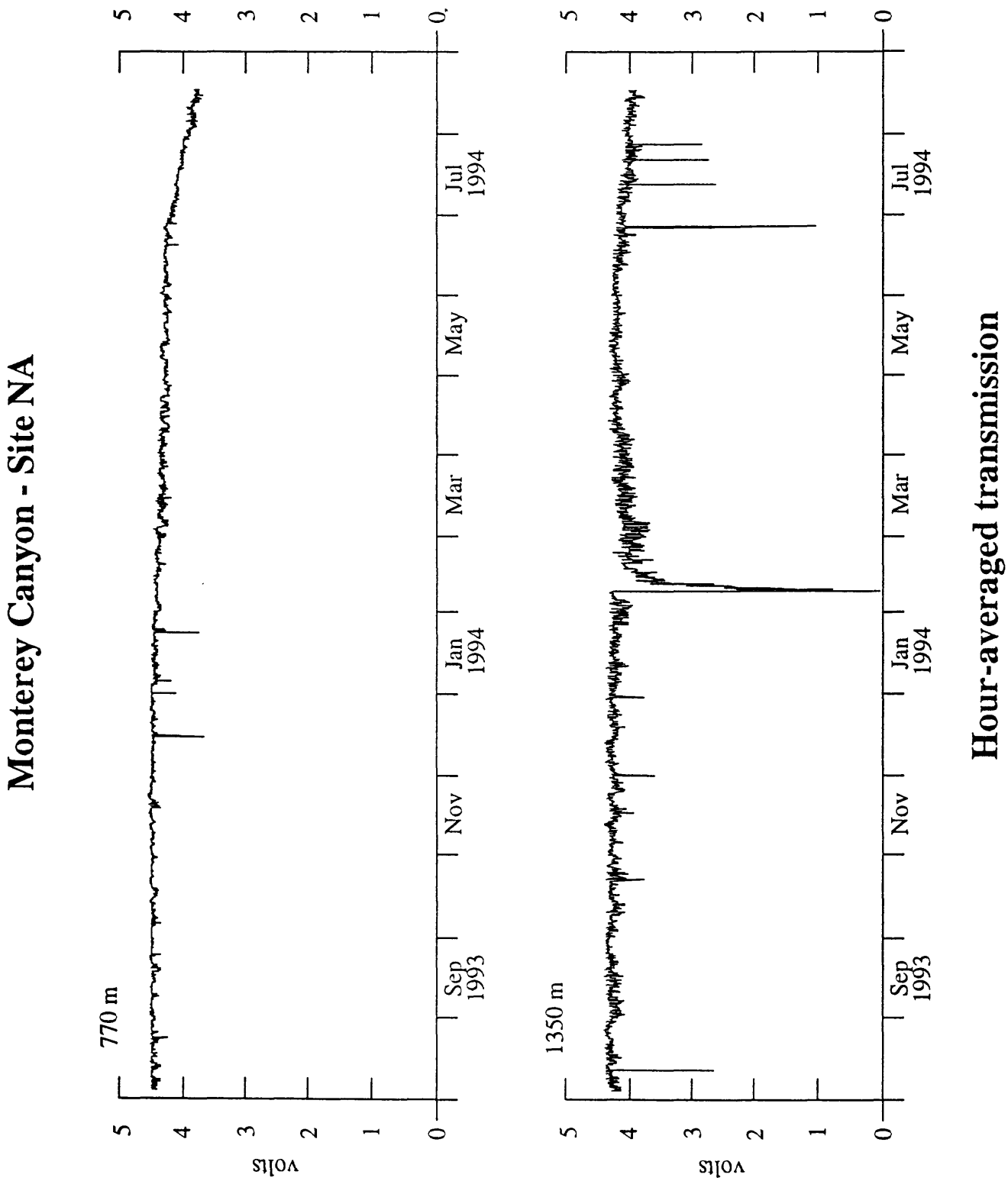


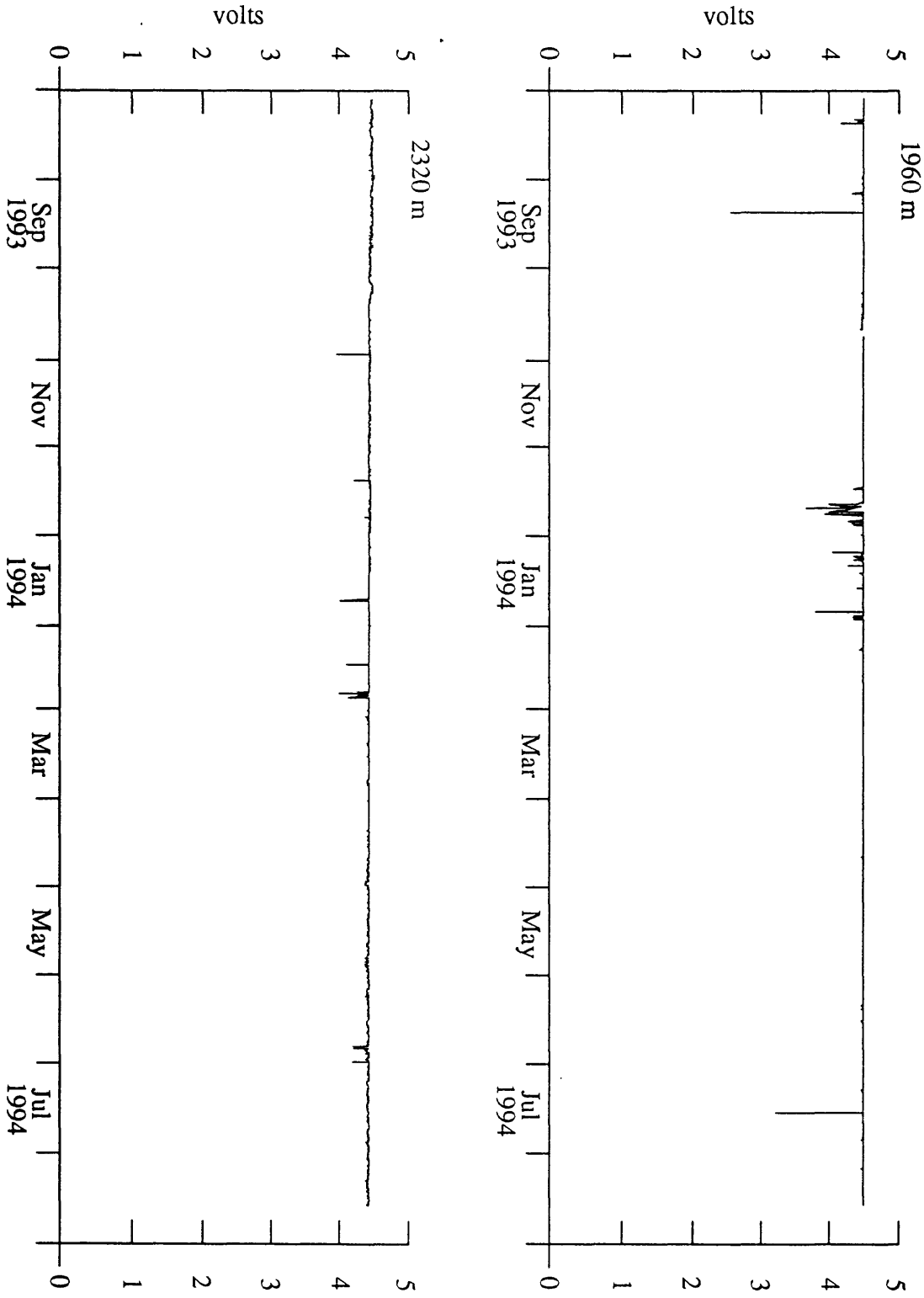
Lowpassed salinity


Monterey Canyon - Site WS
1990 m
32
33
34
35
36
ppt
Sep 1993
Nov
Jan 1994
Mar
May
Jul 1994
Lowpassed salinity

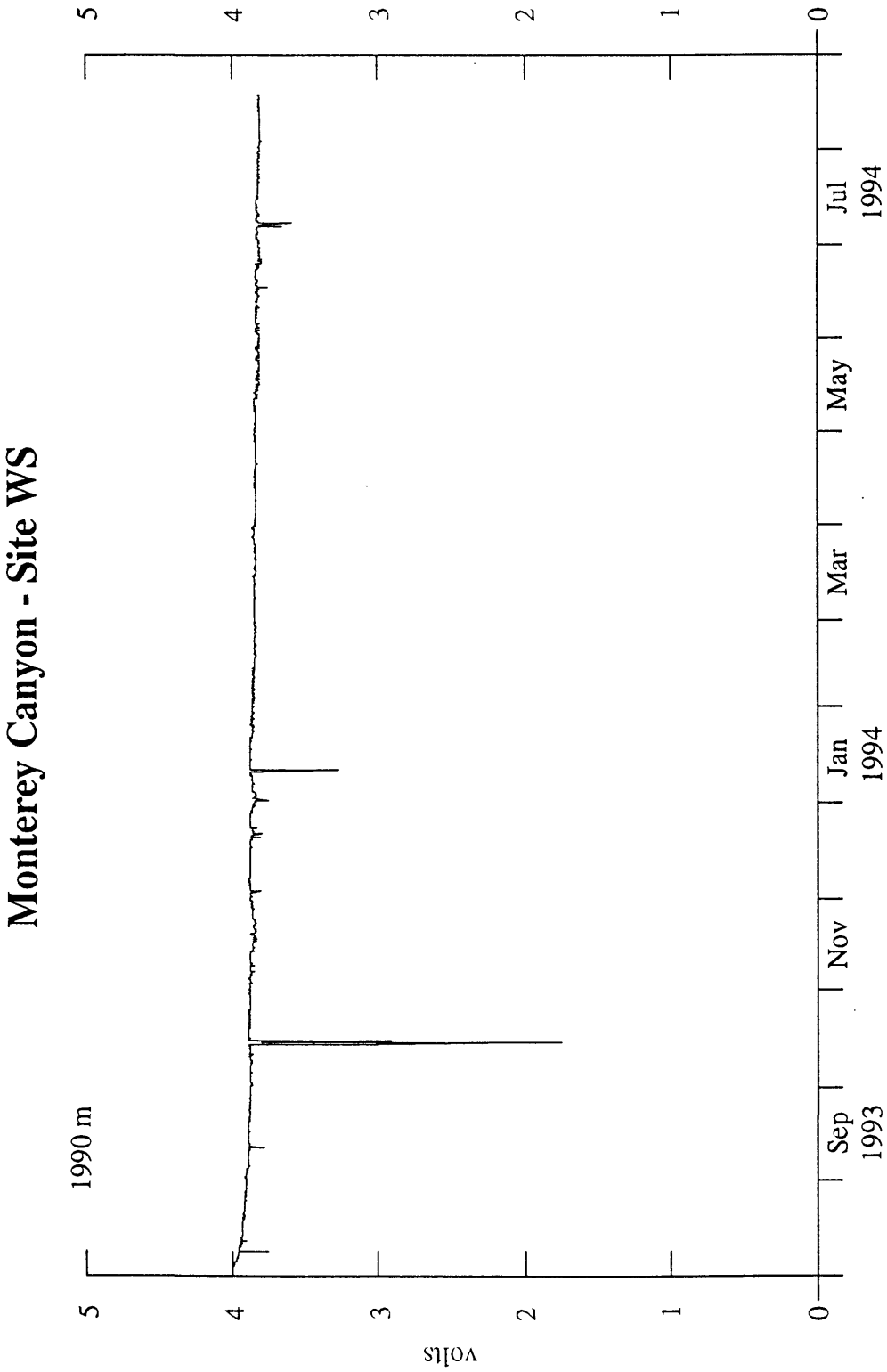


Lowpassed salinity

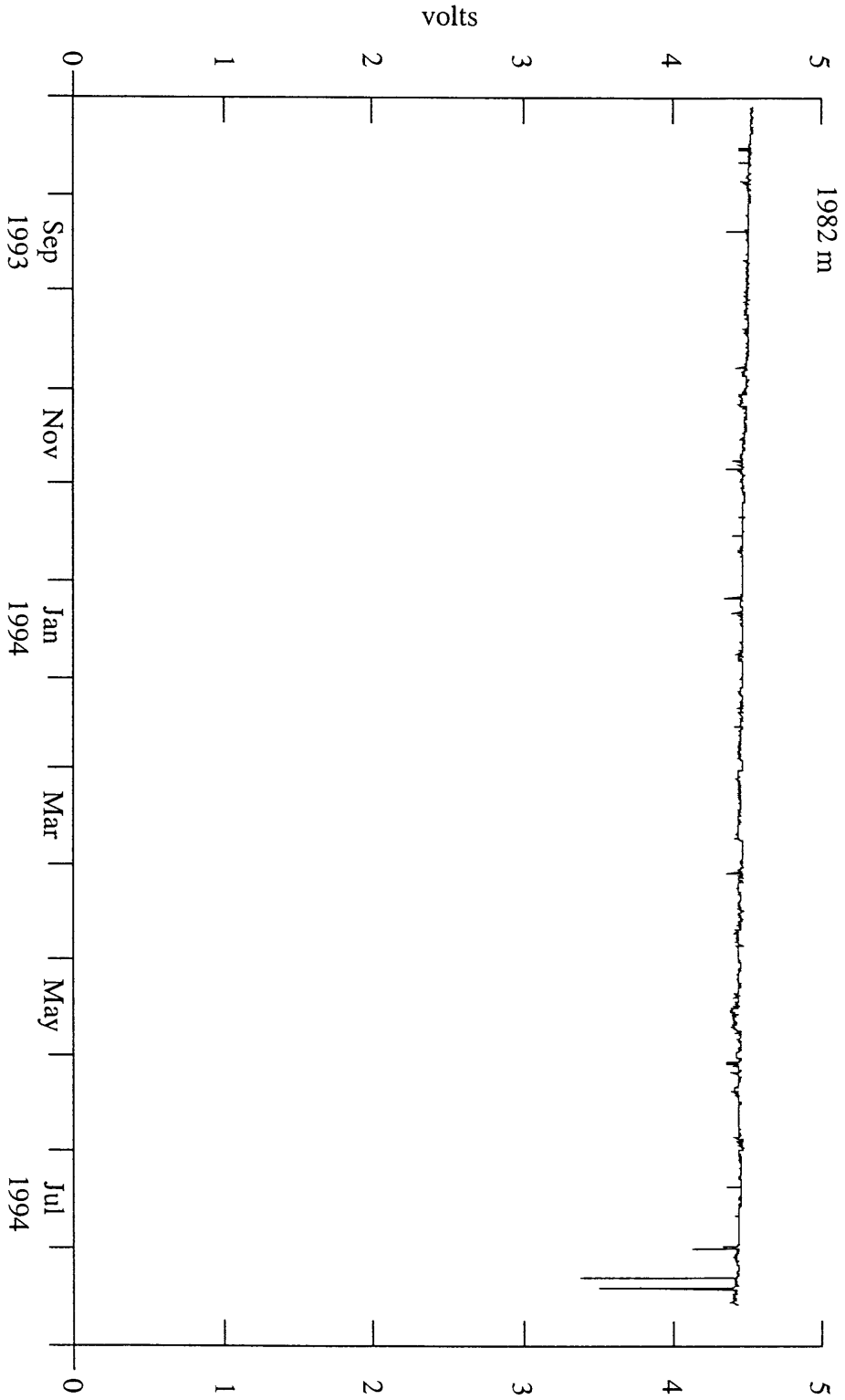

Monterey Canyon - Site NA
770 m
1350 m
volts
0
1
2
3
4
5
Sep 1993
Nov
Jan 1994
Mar
May
Jul 1994
Hour-averaged transmission



Hour-averaged transmission



Hour-averaged transmission



Hour-averaged transmission

Appendix F - Wind and sea level

Table F1. - Dates & piece length for wind & sea lev spect plots F1

Table F2. - Sea level tidal components F1

Table F3. - Lowpassed horizontal wind stress components F2

Lowpassed NODC wind stress vectors F3

Variance-conserving auto spectra winds ..... F4 - F6

Plots of subtidal synthetic subsurface pressure F7

Variance-conserving auto spectra subtidal synthetic subsurface pressure F8

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Station	Start time GMT (M/D/Y)	Stop time GMT (M/D/Y)	Piece length (hours)
Buoy winds			
Half Moon Bay (46012)	12/03/93	07/15/94	294
Bodega Bay (46013)	08/01/93	08/13/94	624
Monterey Bay (46042)	08/01/93	08/13/94	624
Sea level			
Monterey Harbor	08/0393	07/14/94	460
Port San Luis	08/03/93	07/14/94	460

Table F1. Dates and piece lengths used for wind and sea level spectral plots.

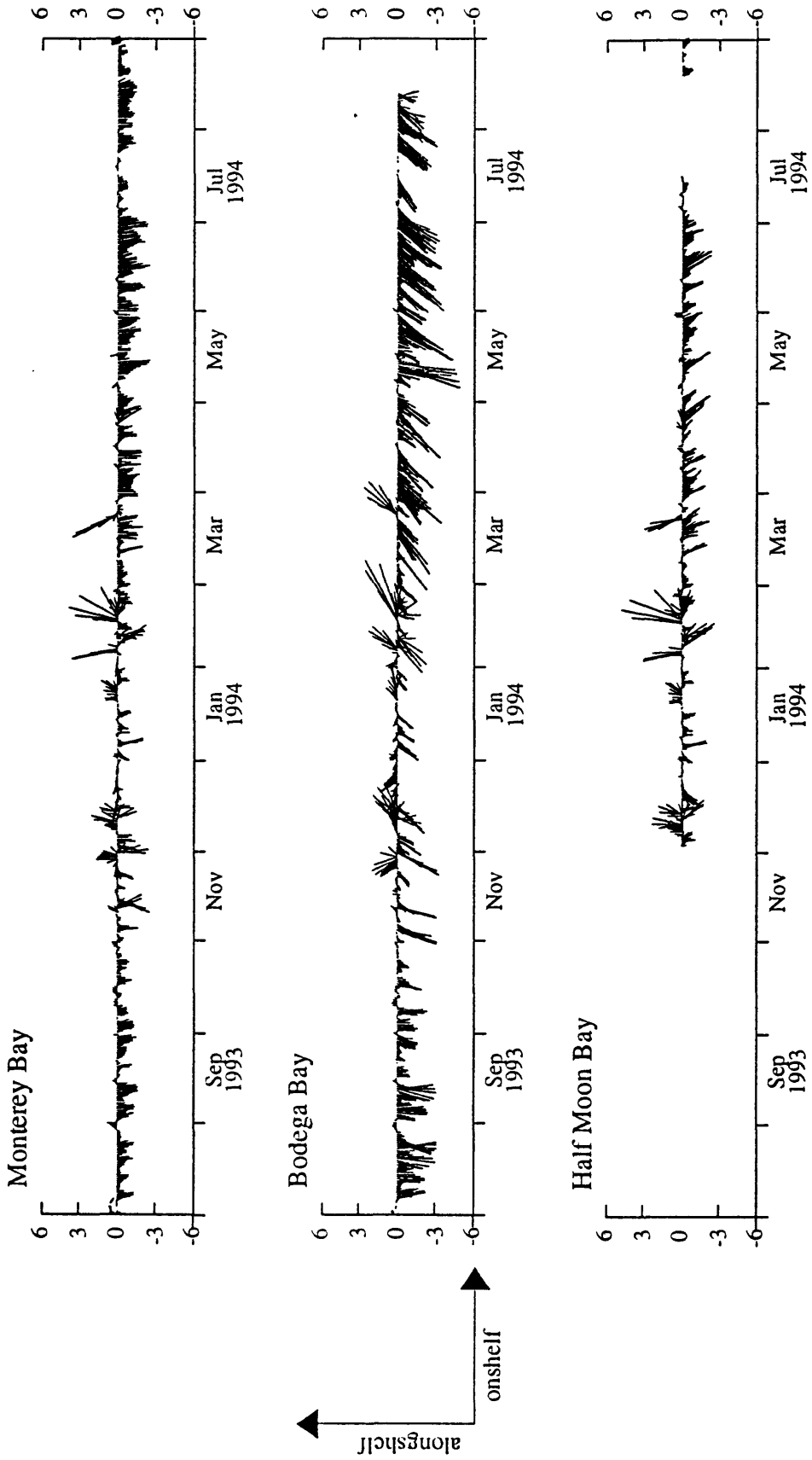
Station	Start time (GMT) (M/D/Y)	Stop time GMT (M/D/Y)	O_1 (cm)	K_1 (cm)	M_2 (cm)	S_2 (cm)
Monterey Harbor	08/01/93	07/17/94	22.9	36.6	49.2	13.6
	07/25/94	09/01/94	22.4	36.3	49.4	13.4
Port San Luis	08/01/93	09/01/94	22.2	35.7	49.4	15.4
	07/25/94	09/01/94	21.7	35.7	49.3	14.9

Table F2. Sea level tidal components.

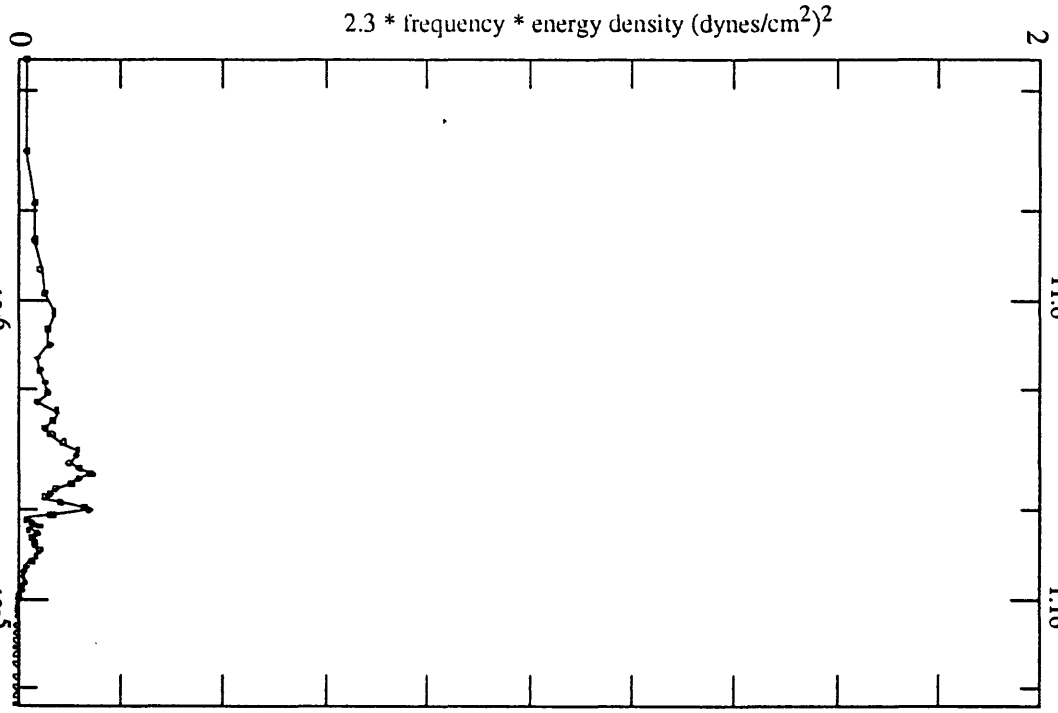
STATION	Start time GMT (M/D/Y)	Stop time GMT (M/D/Y)	Cross canyon					Along canyon				
			MEAN		SD	MAX	MIN	MEAN		SD	MAX	MIN
Half Moon Bay (46012*)	08/01/93	09/01/94	**0.1**	**±0.1**	0.3	1.7	-1.5	**-0.3**	**±0.3**	0.7	4.8	-2.6
Bodega Bay (46013)	08/01/93	08/13/94	**-0.3**	**±0.2**	0.6	3.2	-2.4	**-0.7**	**±0.3**	1.1	2.7	-4.9
Monterey Bay (46042)	08/01/93	09/01/94	0.0	±0.1	0.2	1.5	-1.2	**-0.5**	**±0.2**	0.7	3.9	-2.5

* data gap from 7/18/94 to 8/18/94

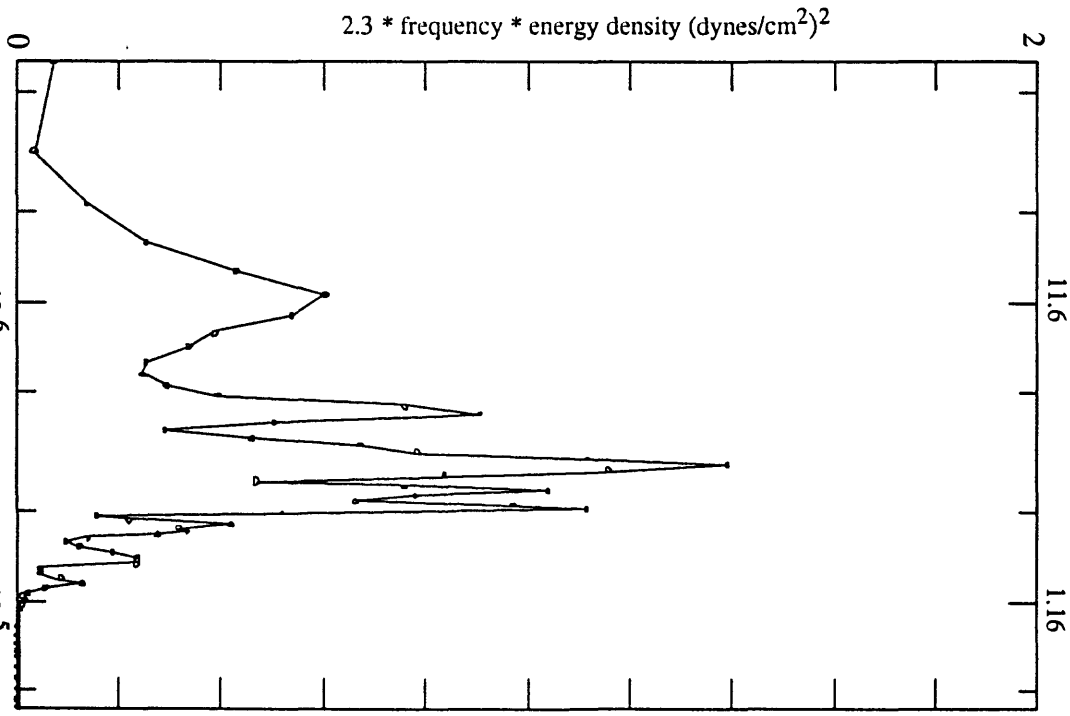
Table F3. Lowpassed horizontal wind stress components (cm/s).



Lowpassed NODC wind stress vectors



Onshelf

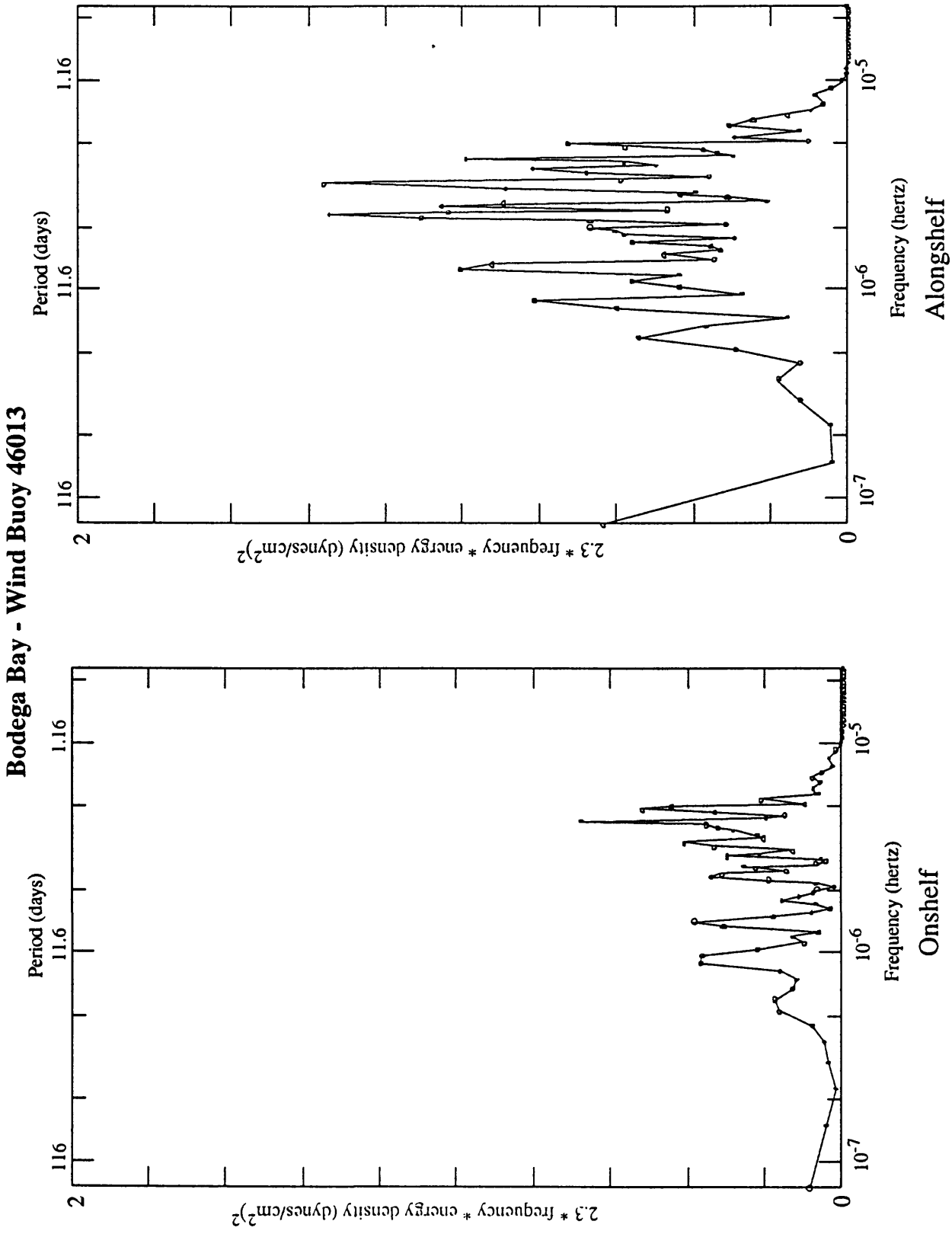


Alongshelf

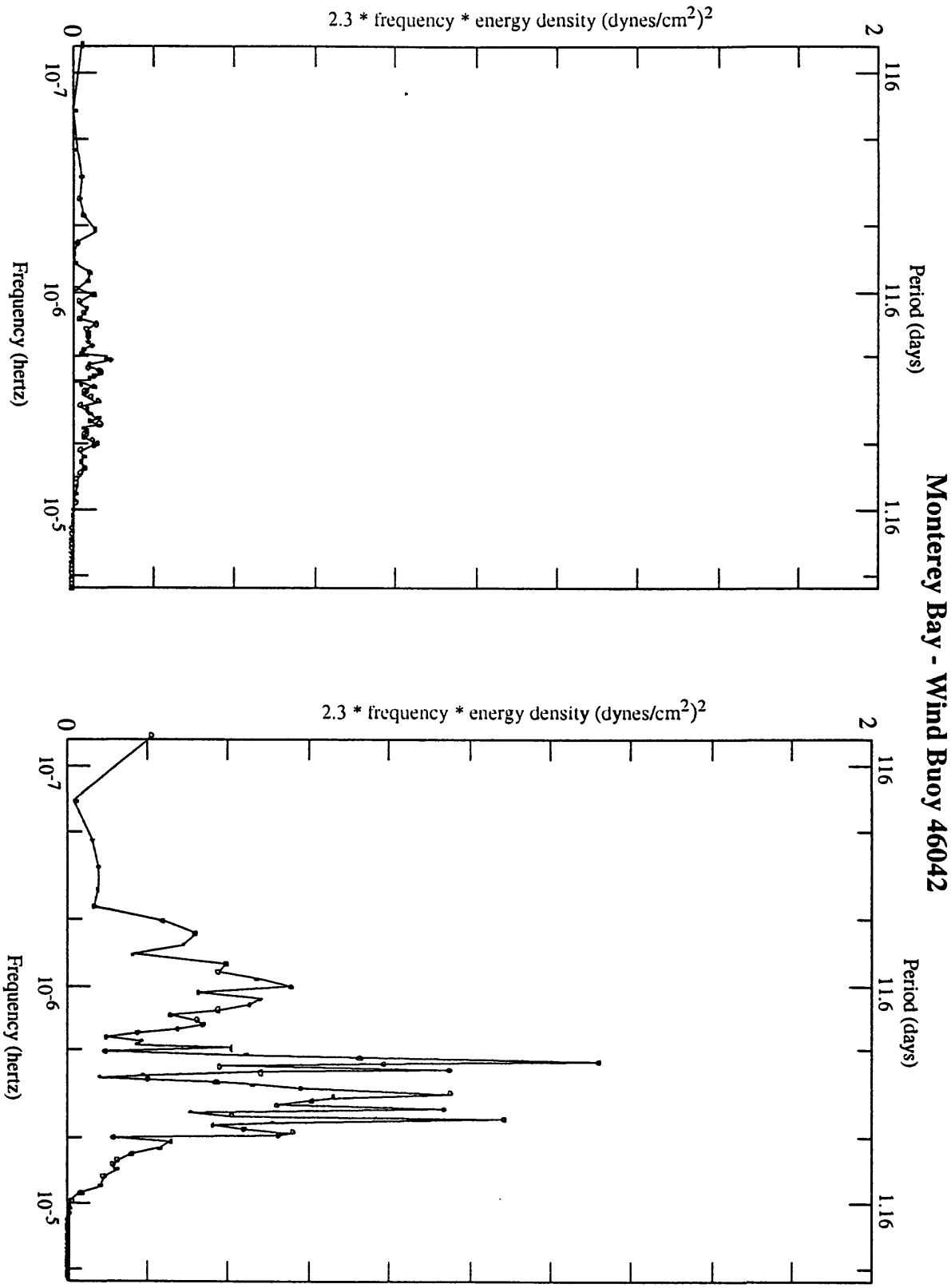
Half Moon Bay - Wind Buoy 46012

Variance conserving autospectra - Lowpassed wind stress

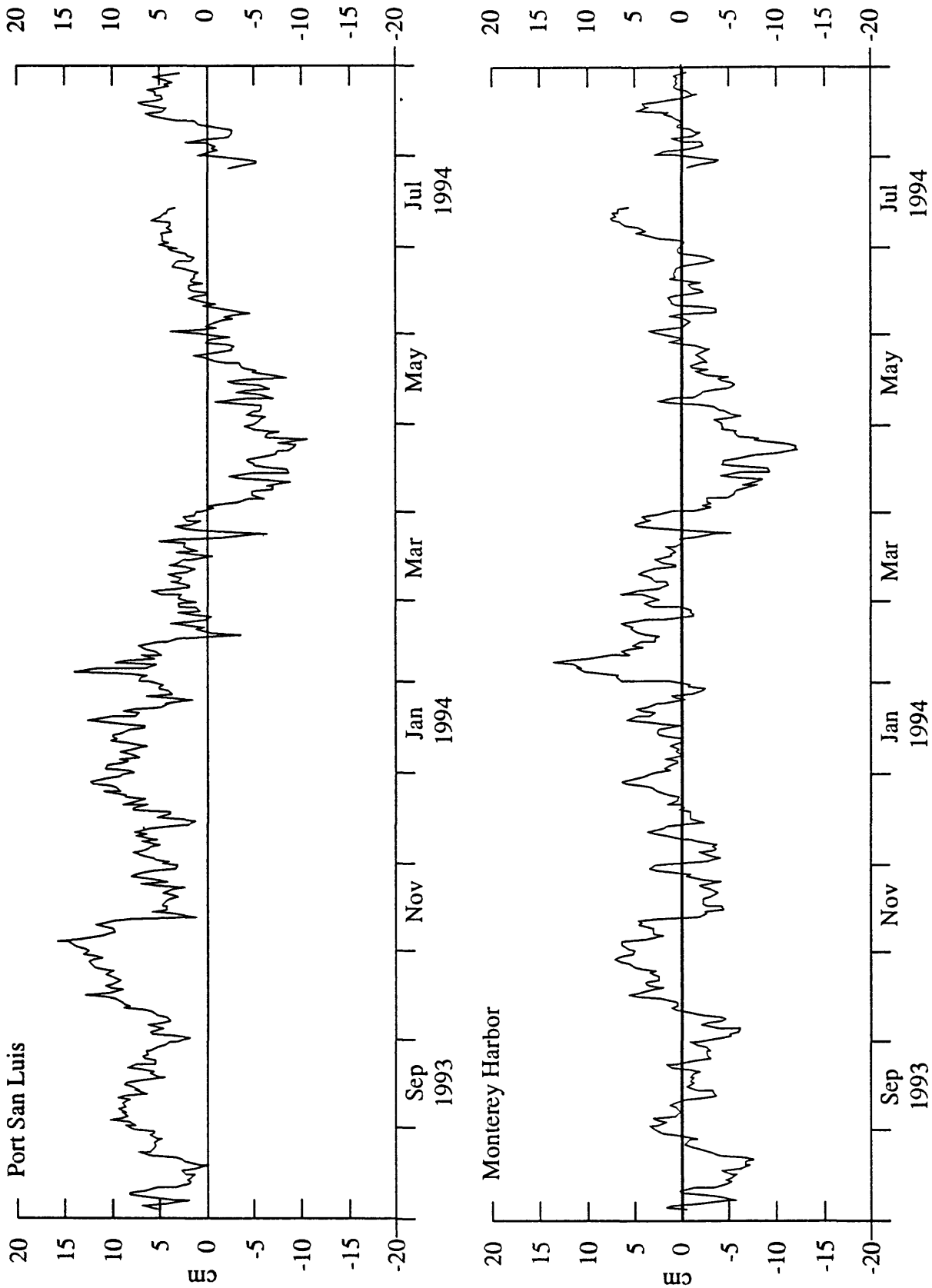
Piece length is shorter then 46013 and 46042 because record length is shorter, 12/93 to 7/94.



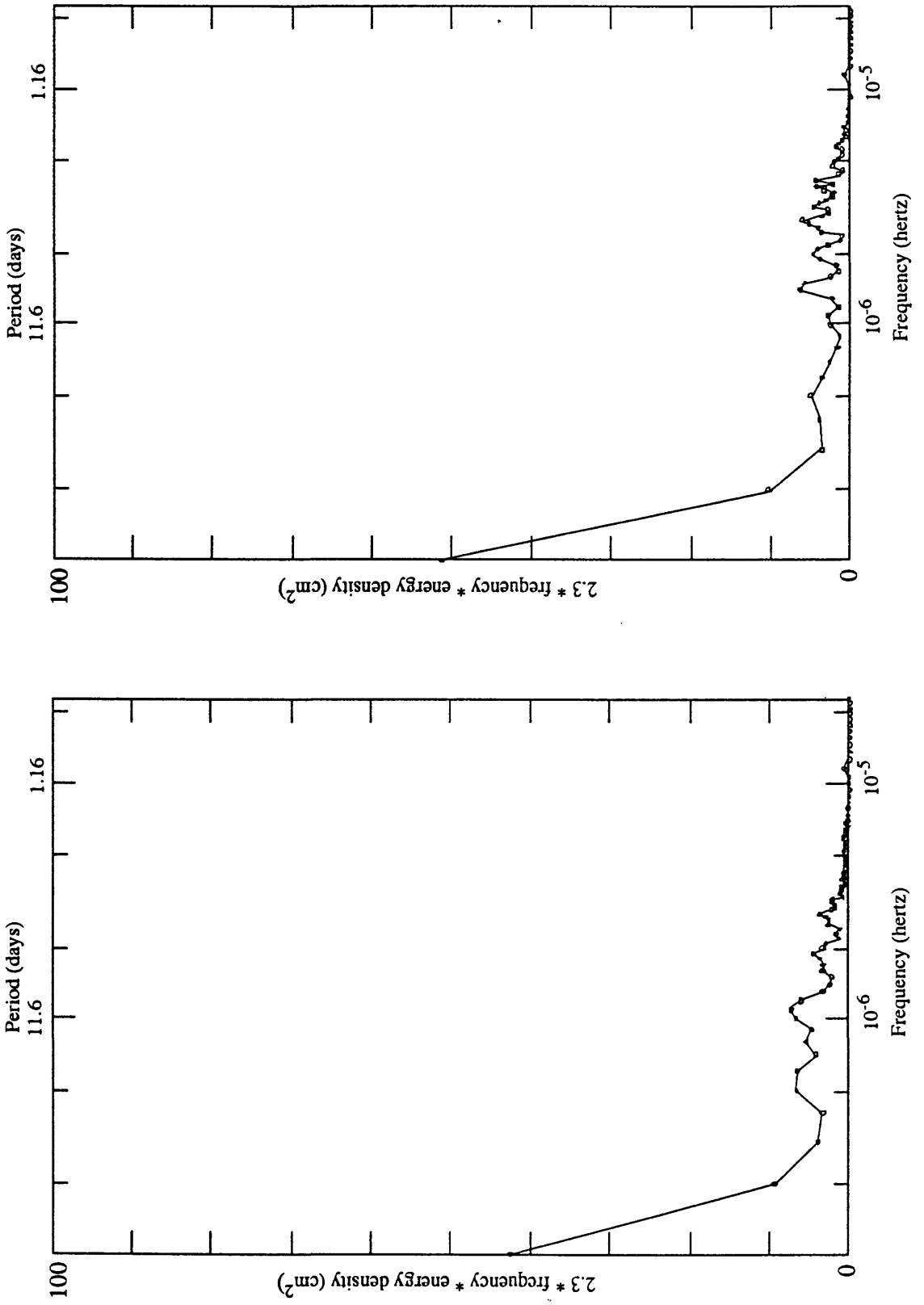
Variance conserving autospectra - Lowpassed wind stress



Variance conserving autospectra - Lowpassed wind stress



Subtidal synthetic subsurface pressure



Variance conserving autospectra - Subtidal synthetic subsurface pressure

The lowpassed data was used for these plots so that the record would not be dominated by the tides.

Appendix G - Additional data for Monterey Fan mooring 1994-1995

Figure G1 - Mooring set-up for fan G1

Figure G2. - Timelines G2

Table G1. - Data available G3

Table G2. - Hour-averaged horizontal current components G4

Table G3. - Lowpassed horizontal currentcomponents G4

Table G4. - Hour-averaged temperature and salinity G5

Table G5. - Lowpassed temperature and salinity G5

Table G6. - Diurnal tidal currents G6

Table G7. - Semi-diurnal tidal currents G7

Plots of hour-averaged currents ..... G8 - G9

Plots of subtidal currents ..... G10 - G11

Plots of subtidal current vectors G12

Table G8. - Dates and piece lengths used for current spectral plots G13

Variance conserving auto spectra ..... G14 - G15

Plots of hour-averaged temperature G16

Plots of lowpassed temperature G17

Plots of hour-averaged salinity G18

Plots of lowpassed salinity G19

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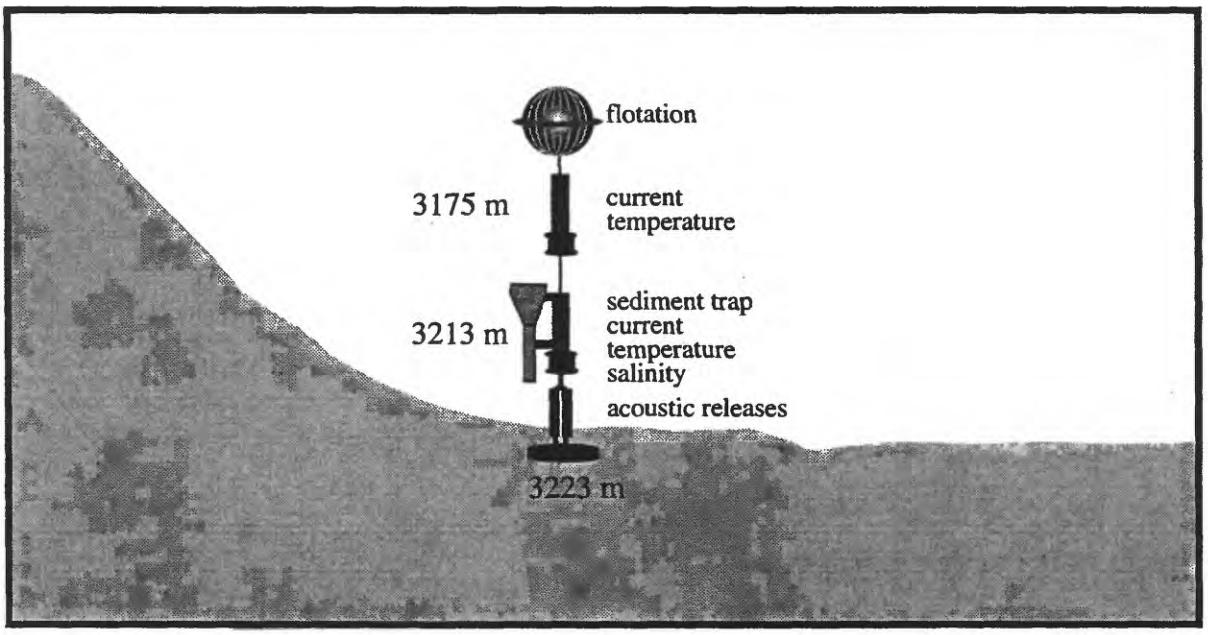


Figure G1. Cross section view of mooring (1994-1995) set-up on Monterey Fan.

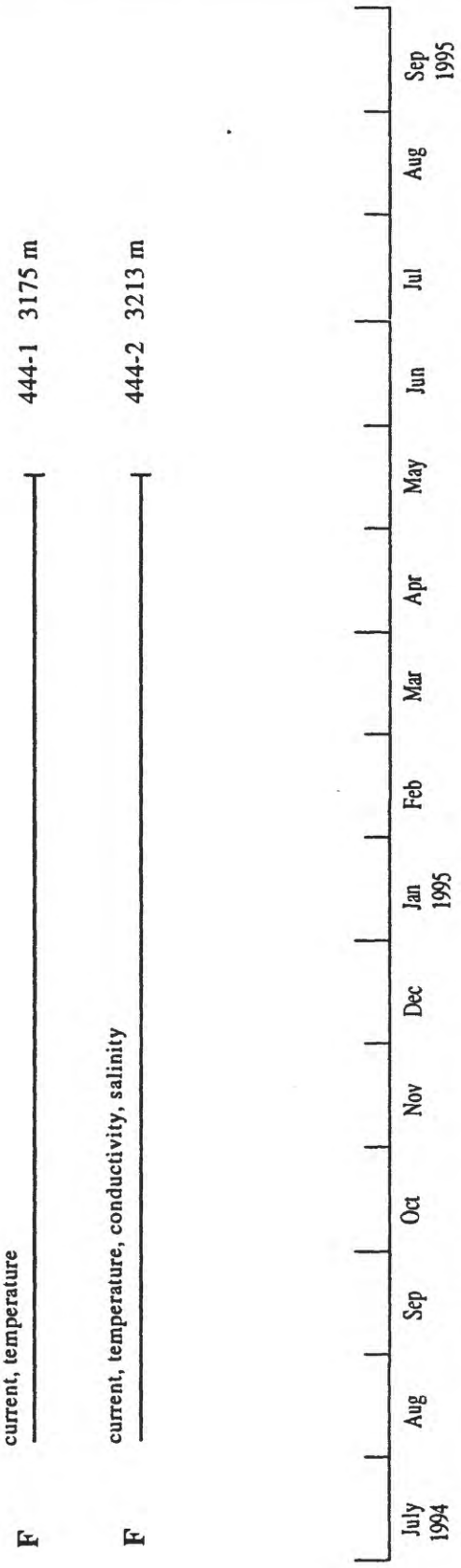


Figure G2. Timelines showing dates when valid current, temperature, conductivity and salinity data exist for Monterey Fan from August 1994 to May 1995.

Site	Mooring	Water Depth (m)	Start Time (M/D/Y)	Stop Time (M/D/Y)	Instrument	Position		Sensor Depth (m)	Data Type	Sample Interval (minutes)
						Latitude	Longitude			
F	444-1	3223	08/21/94	05/15/95	VACM	36 27.47 N	122 37.51 W	3175	C,T	15
F	444-2	3223	08/21/94	05/15/95	VTCT	36 27.47 N	122 37.51 W	3213	C,T,S	15

Table G1. - Data availability for all moorings for 1994-1995.

VACM = Vector averaging current meter (measures current and temperature)
VTCT = Vector averaging current meter (measures current, temperature and transmission)

A = attenuation
S = salinity
TR = transmission

C = current data
T = sea temperature

Site	Mooring	Water Depth (m)	Start Time GMT (M/D/Y)	Stop Time GMT (M/D/Y)	Instrument	Sensor Depth (m)	Cross canyon					Along canyon					Max Speed
							Mean		SD	Max	Min	Mean		SD	Max	Min	
F	444-1	3223	08/21/94	05/15/95	VACM	3175	**-0.3**	**±0.1**	4.0	11.3	-119	**0.3**	**±0.2**	4.6	16.6	-15.1	16.8
F	444-2	3223	08/21/94	05/15/95	VTCT	3213	**-0.4**	**±0.1**	3.7	12.3	-137	**0.3**	**±0.2**	4.6	17.7	-16.2	18.0

Table G2. - Hour-averaged horizontal current components (cm/s). Means in bold type are significantly different from zero at the 95% confidence level.

VACM = Vector averaging current meter (measures current and temperature)
VTCT = Vector averaging current meter (measures current, temperature and transmission)

Site	Mooring	Water Depth (m)	Start Time GMT (M/D/Y)	Stop Time GMT (M/D/Y)	Instrument	Sensor Depth (m)	Onshelf					Alongshelf				
							Mean		SD	Max	Min	Mean		SD	Max	Min
F	444-1	3223	08/21/94	05/15/95	VACM	3175	**-0.3**	**±0.1**	0.5	1.0	-2.2	**0.3**	**±0.2**	1.8	8.8	-42
F	444-2	3223	08/21/94	05/15/95	VTCT	3213	**-0.4**	**±0.1**	0.6	1.4	-3.0	**0.4**	**±0.2**	1.8	9.2	-41

Table G3. - Lowpassed horizontal current components (cm/s). Means in bold type are significantly different from zero at the 95% confidence level.

VACM = Vector averaging current meter (measures current and temperature)
VTCT = Vector averaging current meter (measures current, temperature and transmission)

Site	Mooring	Water Depth (m)	Start Time GMT (M/D/Y)	Stop Time GMT (M/D/Y)	Instrument	Sensor Depth (m)	Temperature (C)				Salinity (ppt)			
							Mean	SD	Max	Min	Mean	SD	Max	Min
F	444-1	3223	08/21/94	05/15/95	VACM	3175	**1.6 ±0.0**	0.0	**1.6**	**1.6**	-- --	--	--	--
F	444-2	3223	08/21/94	05/15/95	VTCT	3213	**1.6 ±0.0**	0.0	1.7	1.6	**34.7 ±0.0**	0.0	34.7	34.6

Table G4. - Hour-averaged temperature and salinity. Means in bold type are significantly different from zero at the 95% confidence level.

VACM = Vector averaging current meter (measures current and temperature)
VTCT = Vector averaging current meter (measures current, temperature and transmission)

Site	Mooring	Water Depth (m)	Start Time GMT (M/D/Y)	Stop Time GMT (M/D/Y)	Instrument	Sensor Depth (m)	Temperature (C)				Salinity (ppt)			
							Mean	SD	Max	Min	Mean	SD	Max	Min
F	444-1	3223	08/21/94	05/15/95	VACM	3175	**1.6 ±0.0**	0.0	1.6	1.6	-- --	--	--	--
F	444-2	3223	08/21/94	05/15/95	VTCT	3213	**1.6 ±0.0**	0.0	1.6	1.6	**34.7 ±0.0**	0.0	34.7	34.6

Table G5. - Lowpassed temperature and salinity . Means in bold type are significantly different from zero at the 95% confidence level.

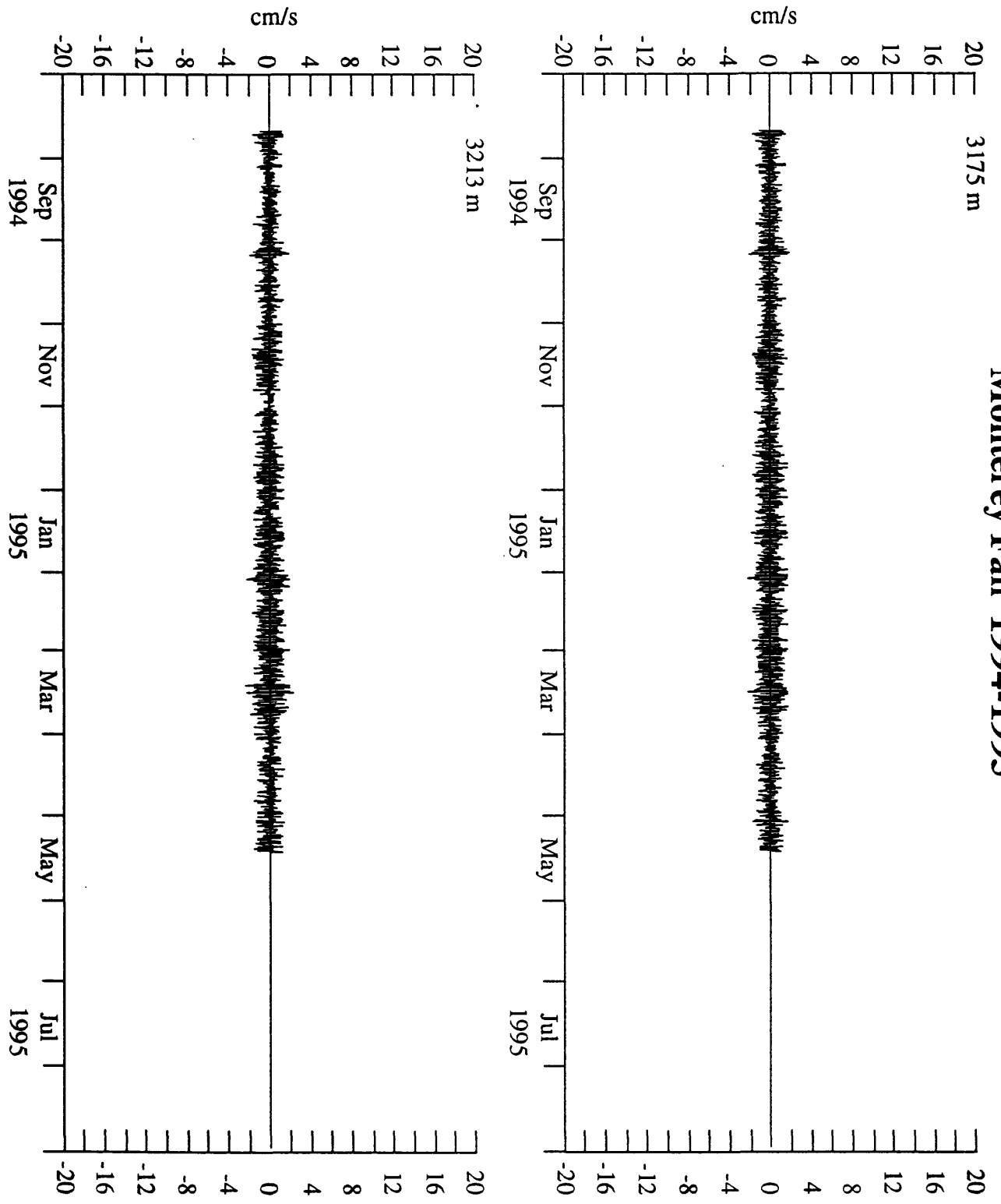
VACM = Vector averaging current meter (measures current and temperature)
VTCT = Vector averaging current meter (measures current, temperature and transmission)

Site	Instrument depth	Mooring	Start time GMT (M/D/Y)	Stop time GMT (M/D/Y)	O_1			K_1		
					Major axis (cm/s)	Minor axis (cm/s)	Inclination (degrees)	Major Axis (cm/s)	Minor axis (cm/s)	Inclination (degrees)
F	3175	444-1	08/21/94	05/15/95	0.2	0.1	082.6	0.9	0.2	076.2
F	3213	444-2	08/21/94	05/15/95	0.2	0.1	090.3	0.8	0.2	088.6

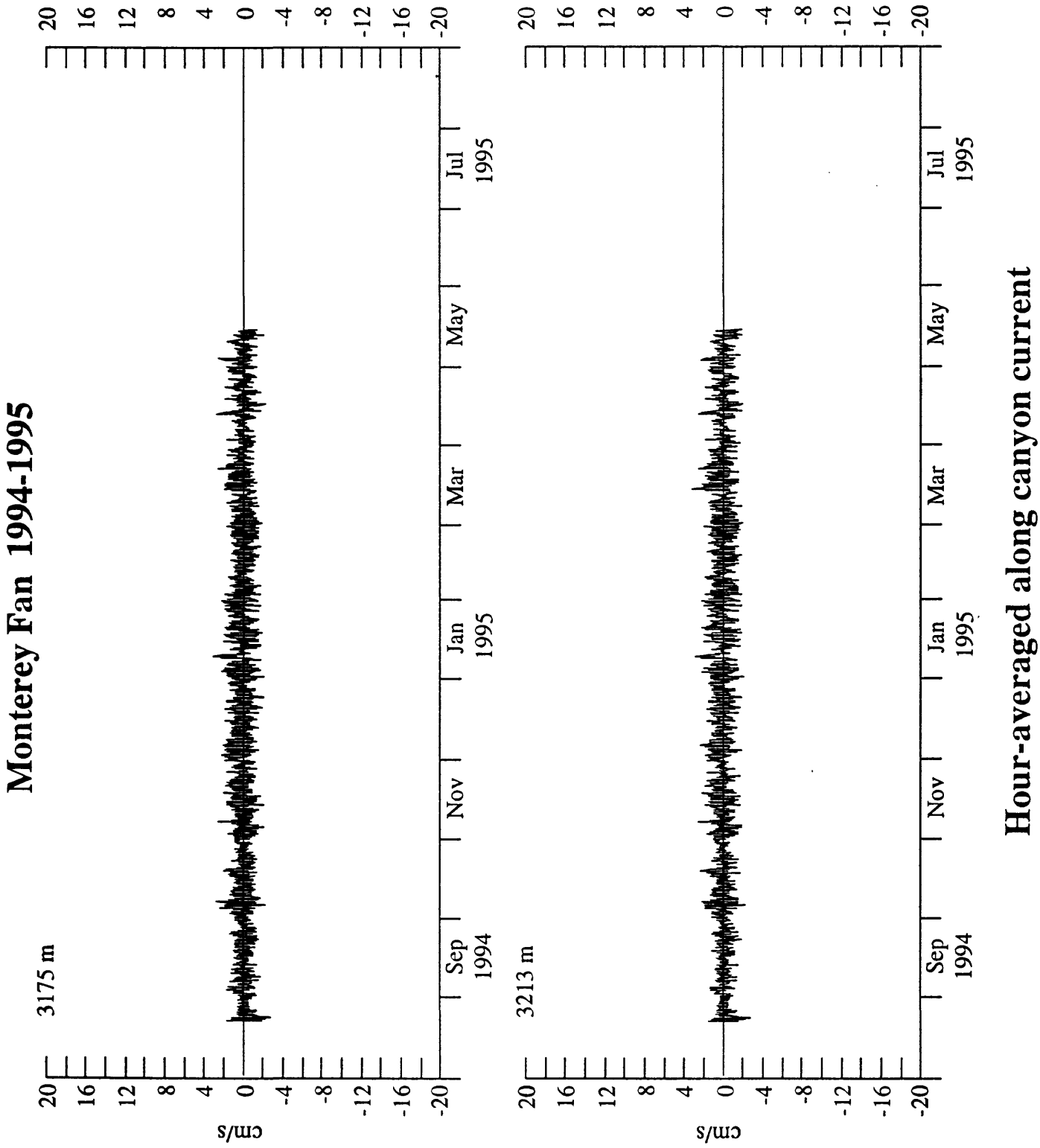
Table G6. - Diurnal tidal currents. A negative minor axis indicates a clockwise rotation for the tidal currents. The inclination angle is counterclockwise from east.

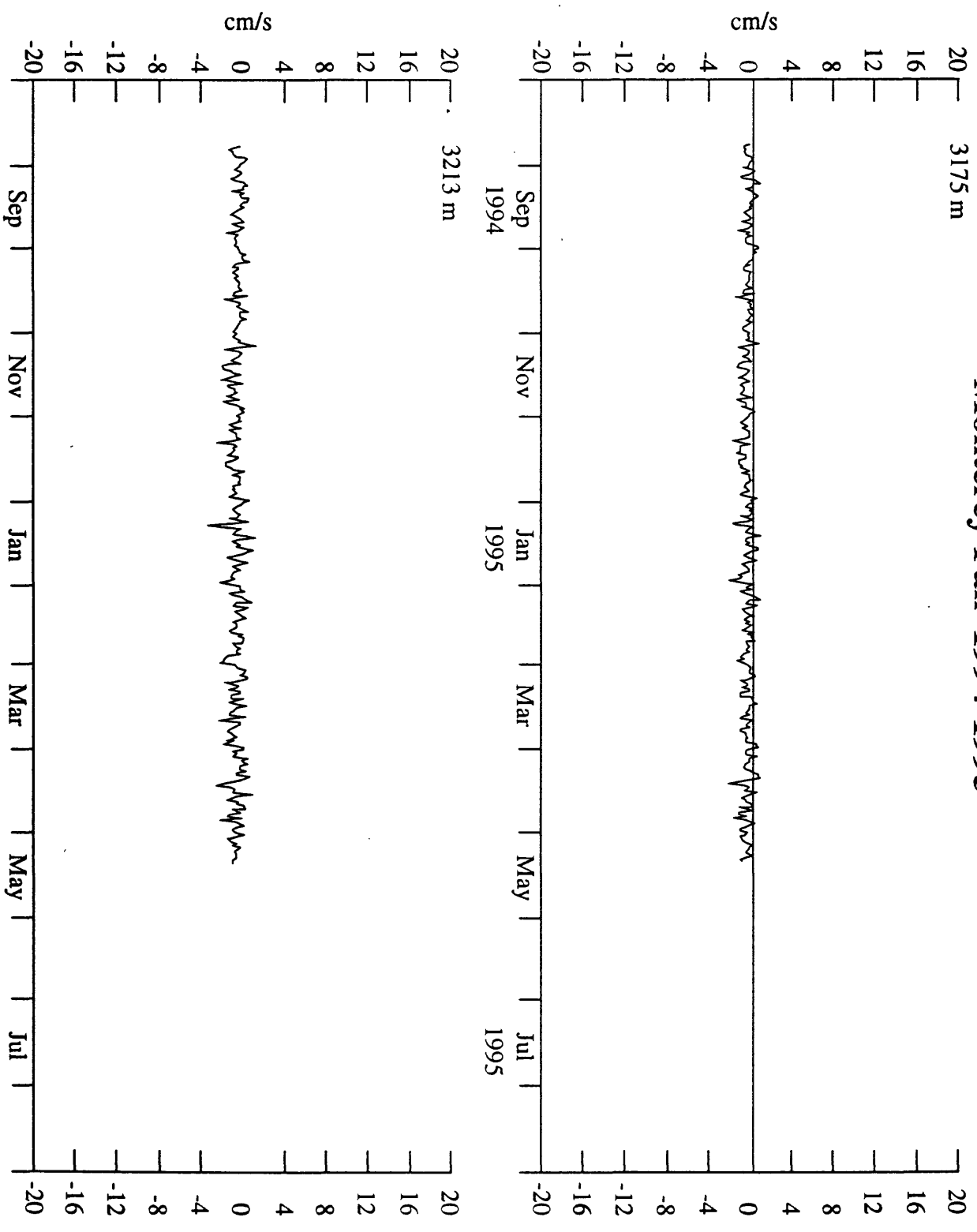
Site	Instrument depth	Mooring	Start time GMT (M/D/Y)	Stop time GMT (M/D/Y)	M_2 Major axis (cm/s)	M_2 Minor axis (cm/s)	M_2 Inclination (degrees)	S_2 Major Axis (cm/s)	S_2 Minor axis (cm/s)	S_2 Inclination (degrees)
F	3175	444-1	08/21/94	05/15/95	5.6	-3.5	110.3	1.5	-0.7	099.6
F	3213	444-2	08/21/94	05/15/95	5.3	-3.1	104.3	1.5	-0.6	093.4

Table G7. - Semidiurnal tidal currents. A negative minor axis indicates a clockwise rotation for the tidal currents. The inclination angle is counterclockwise from east.

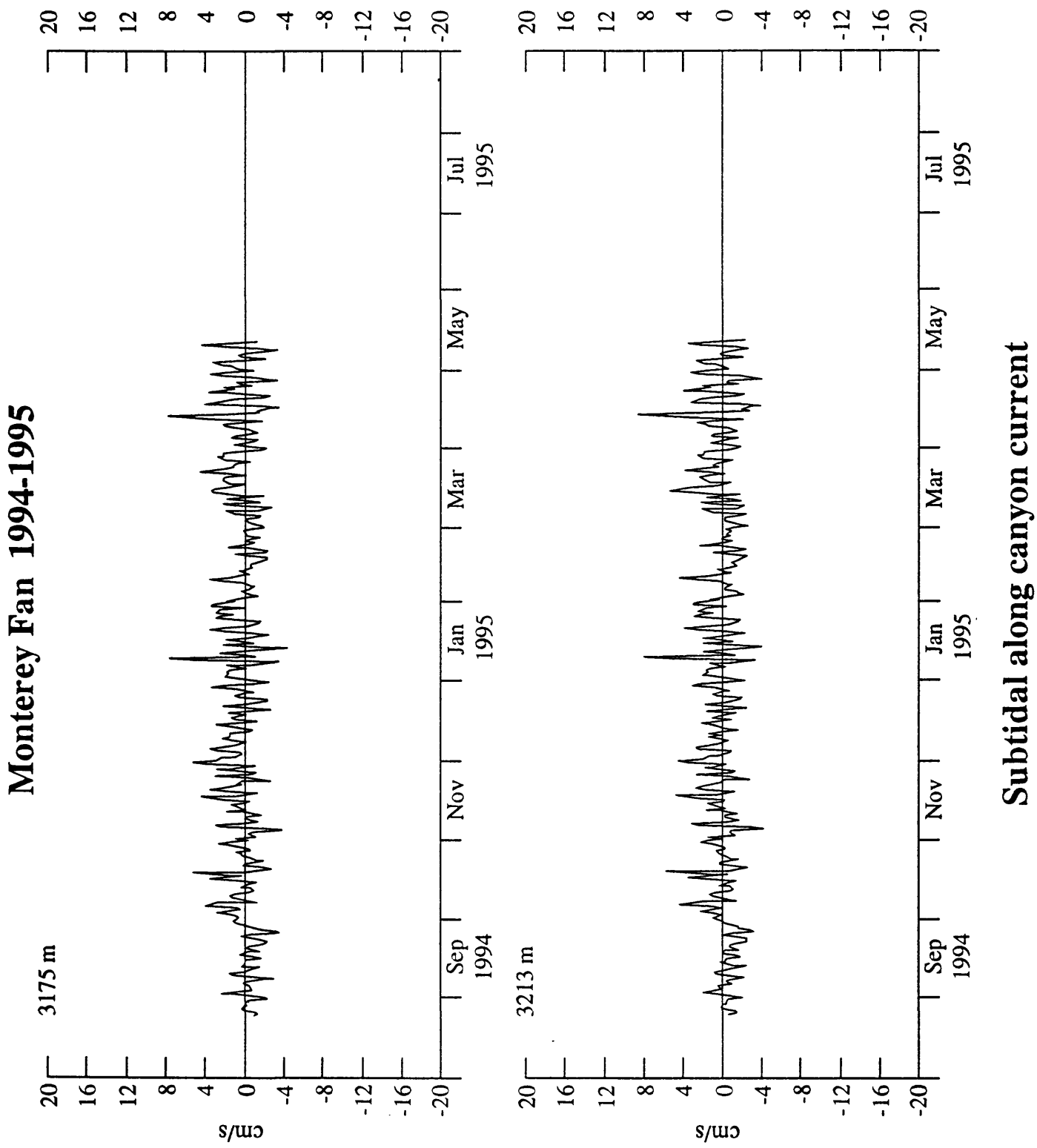


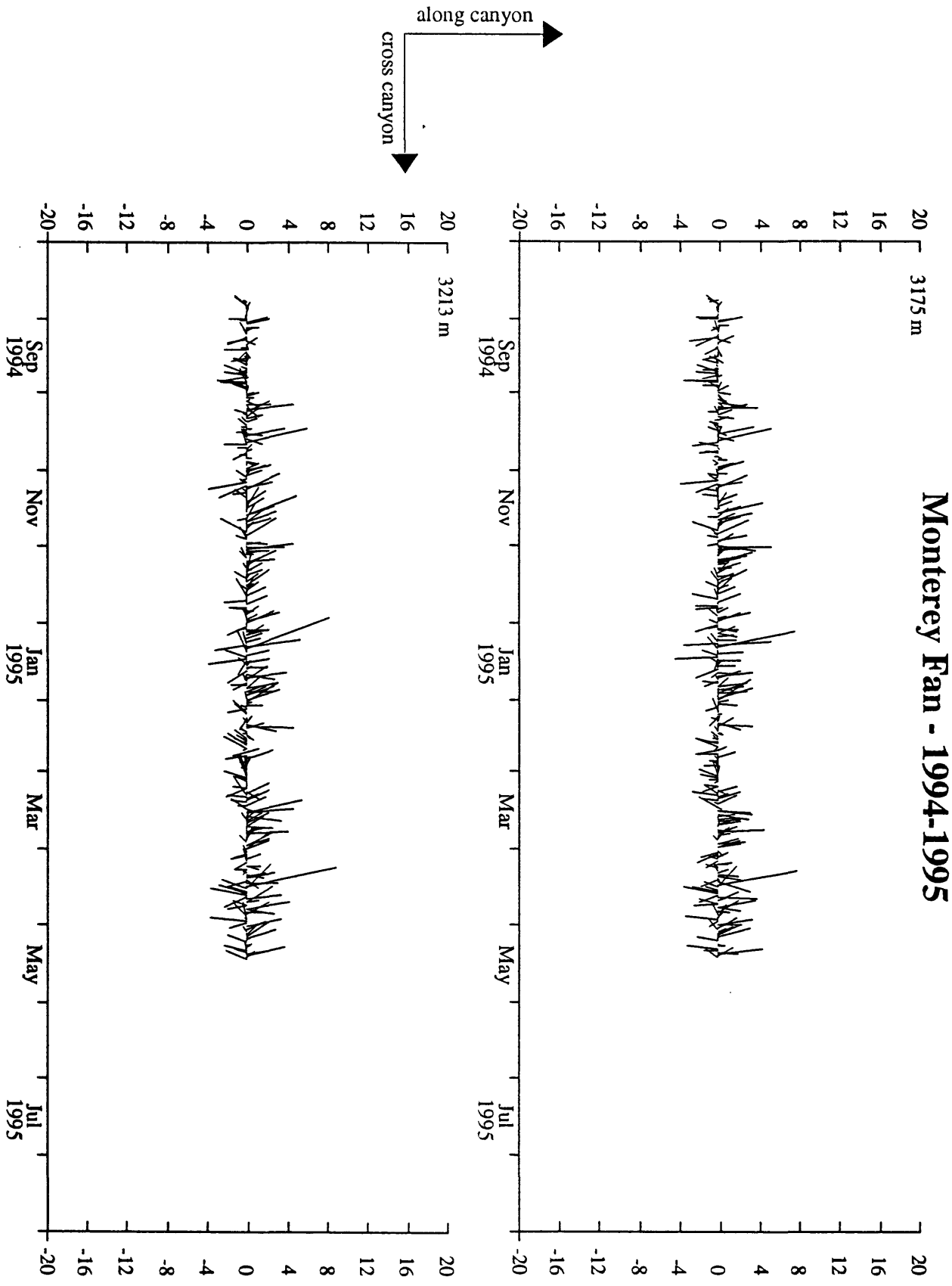
Hour-averaged cross canyon current


Monterey Fan 1994-1995
3175 m
3213 m
cm/s
20
16
12
8
4
0
-4
-8
-12
-16
-20
Sep 1994
Nov
Jan 1995
Mar
May
Jul 1995
Hour-averaged along canyon current



Subtidal cross canyon current

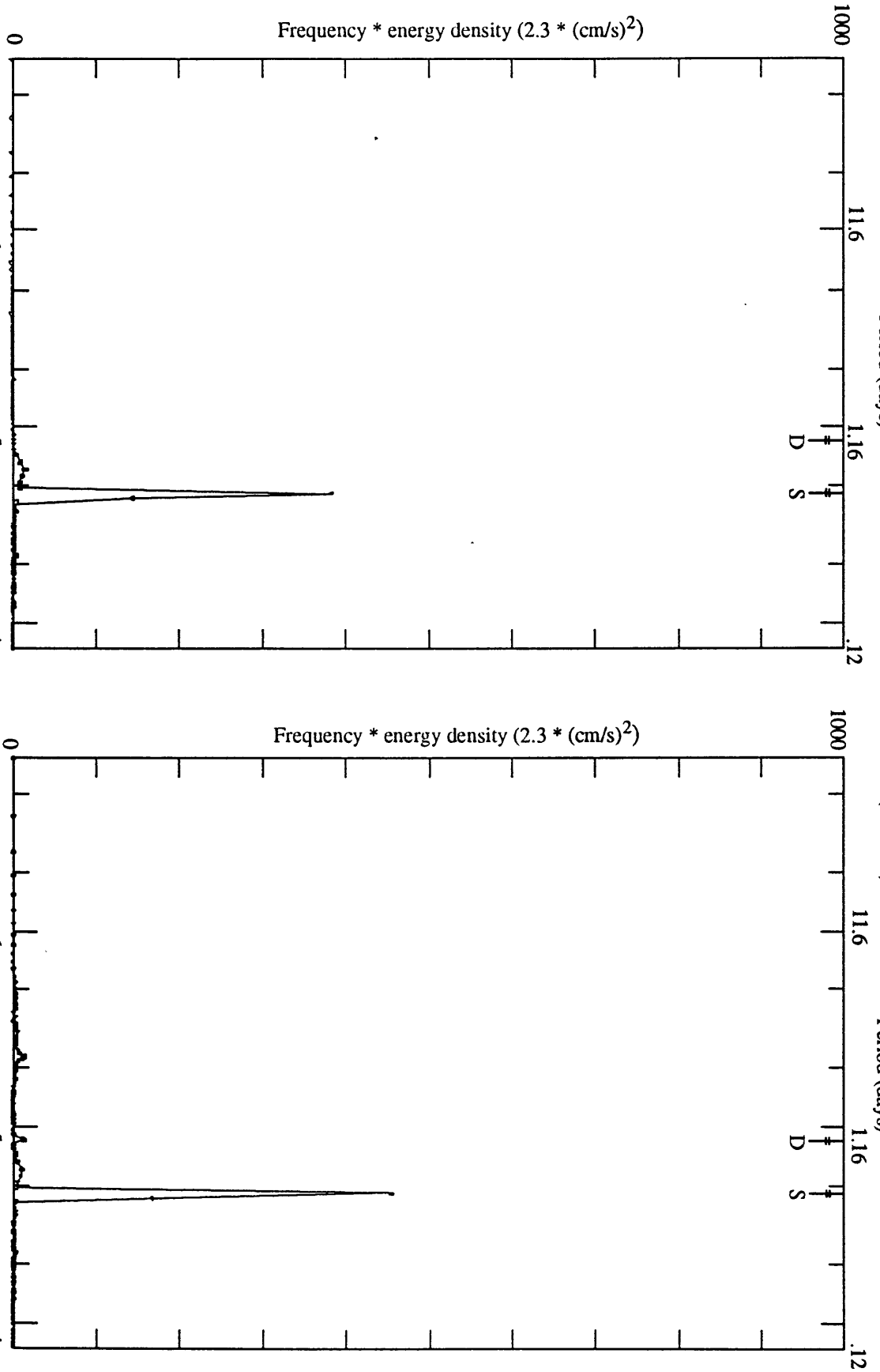

Monterey Fan 1994-1995
3175 m
3213 m
cm/s
20
16
12
8
4
0
-4
-8
-12
-16
-20
Sep 1994
Nov
Jan 1995
Mar
May
Jul 1995
Subtidal along canyon current



Subtidal current vectors

Site	Mooring	Sensor Depth (m)	Start time GMT (M/D/Y)	Stop time GMT (M/D/Y)	Piece length hours
F	444-1	3175	08/21/94	05/15/95	2112
F	444-2	3213	08/21/94	05/15/95	2112

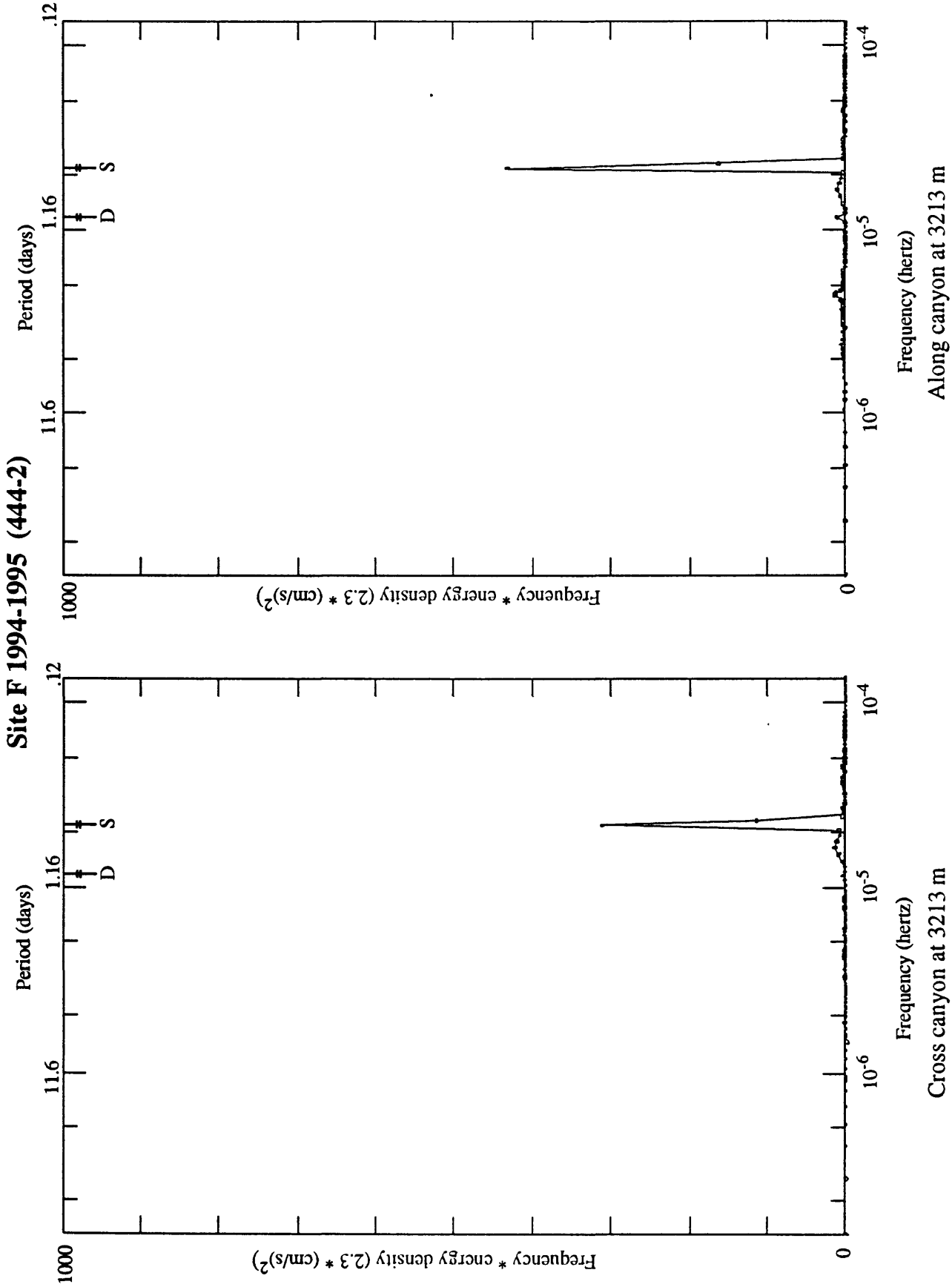
Table G8 Dates and piece lengths used for the spectral plots for fan mooring 1994-1995.



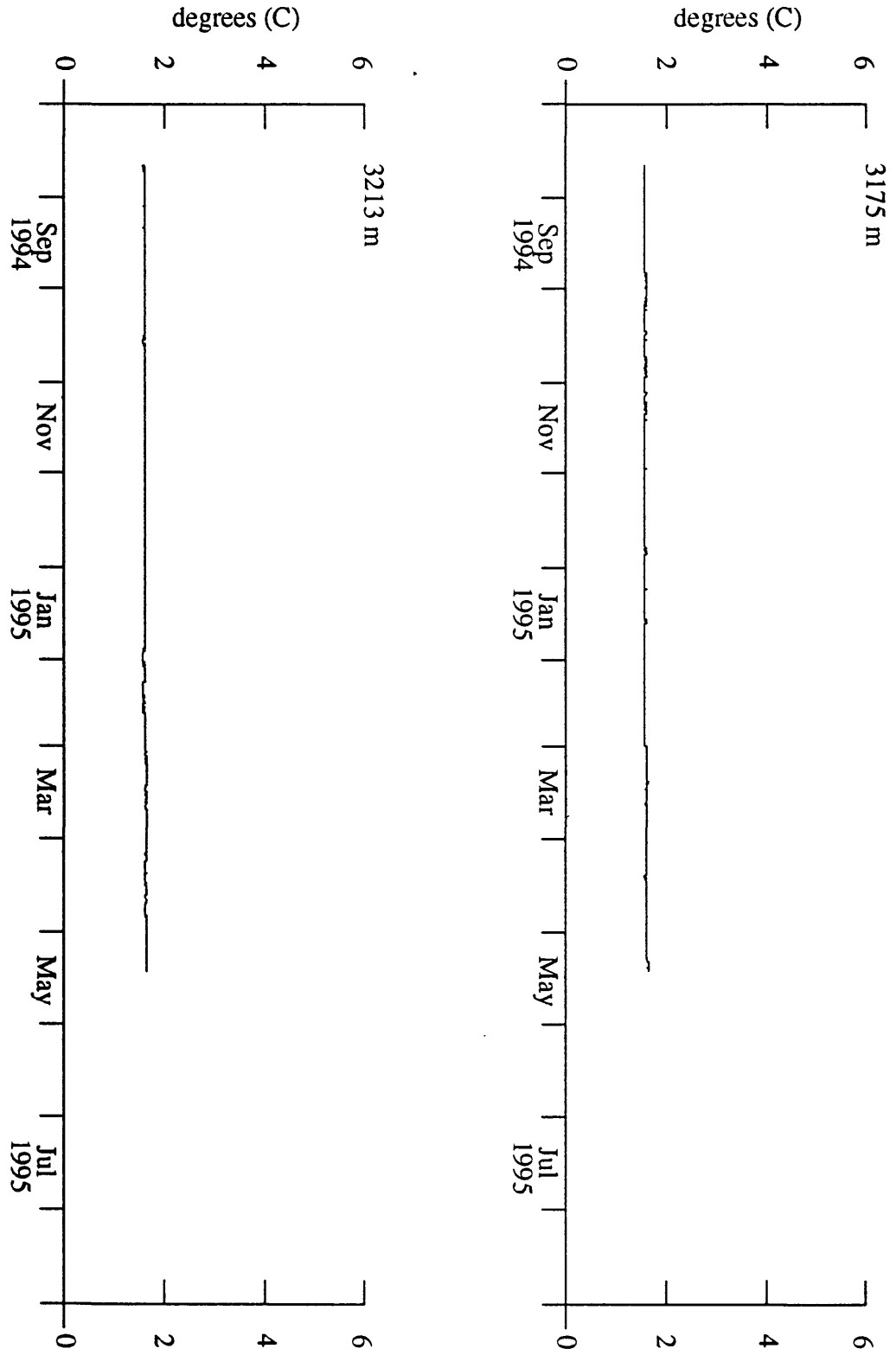
Site F 1994-1995 (444-1)

Variance conserving autospectra currents

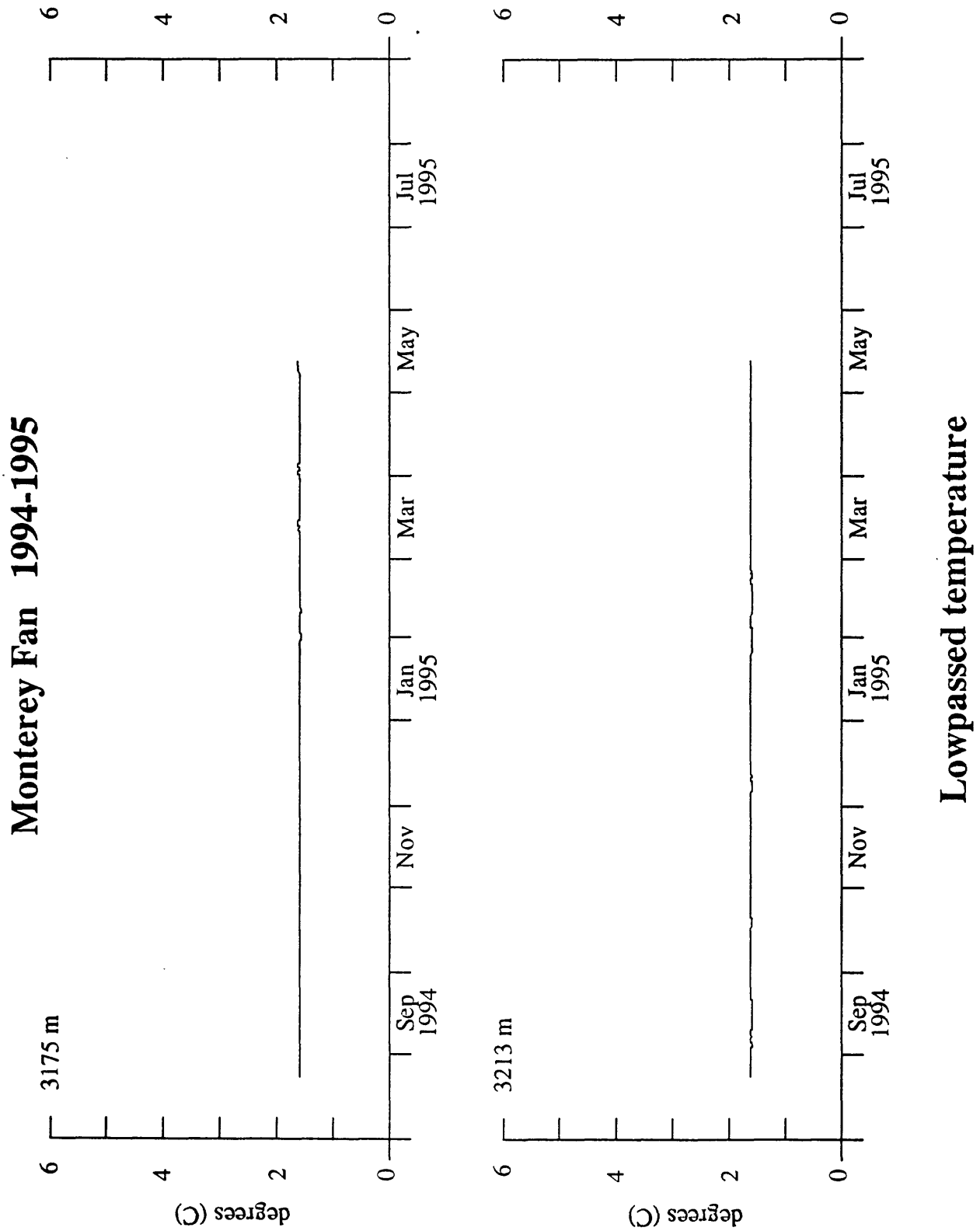
(D = diurnal, S = semidiurnal)

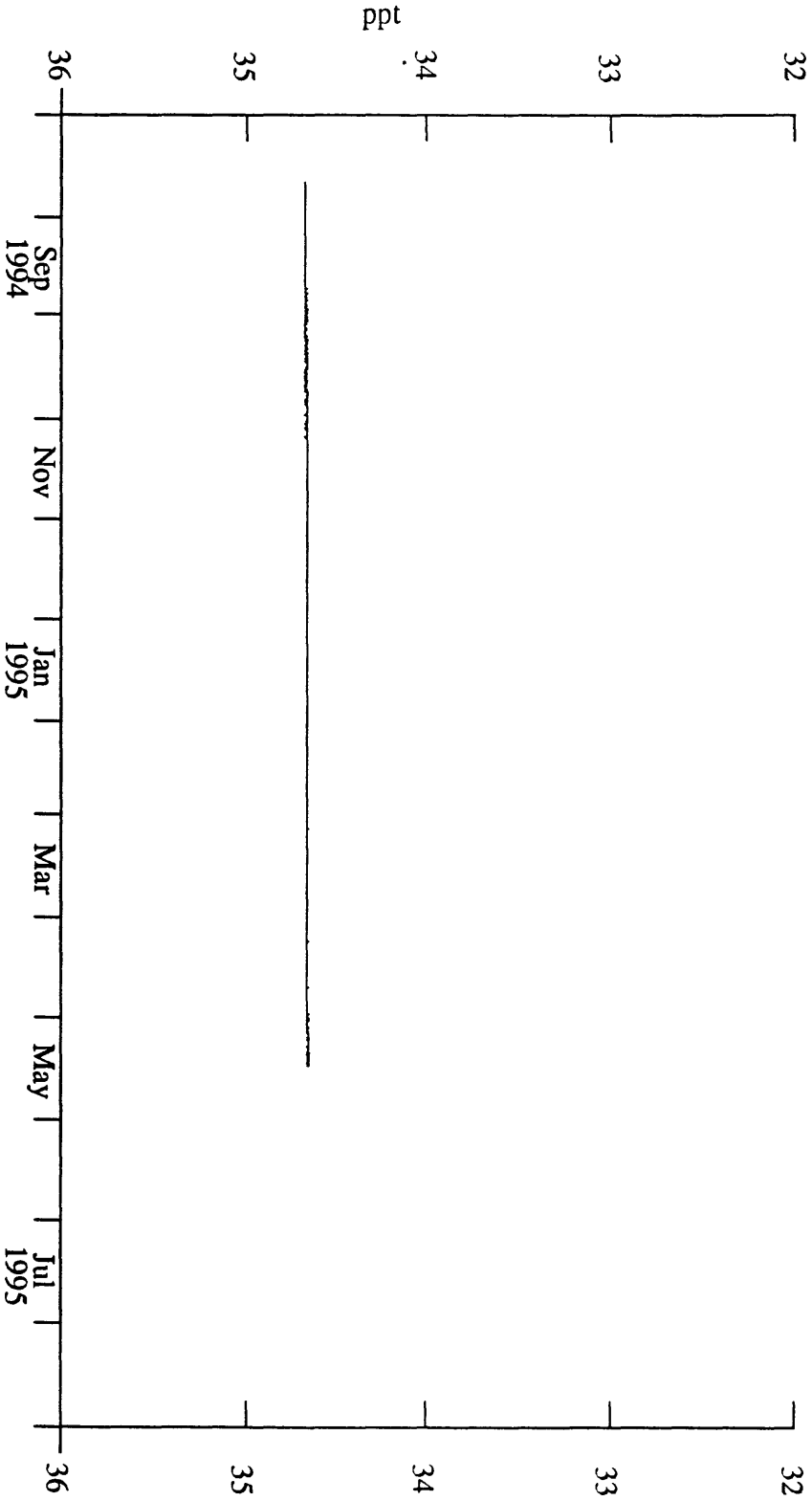


Variance conserving autospectra currents
(D = diurnal, S = semidiurnal)

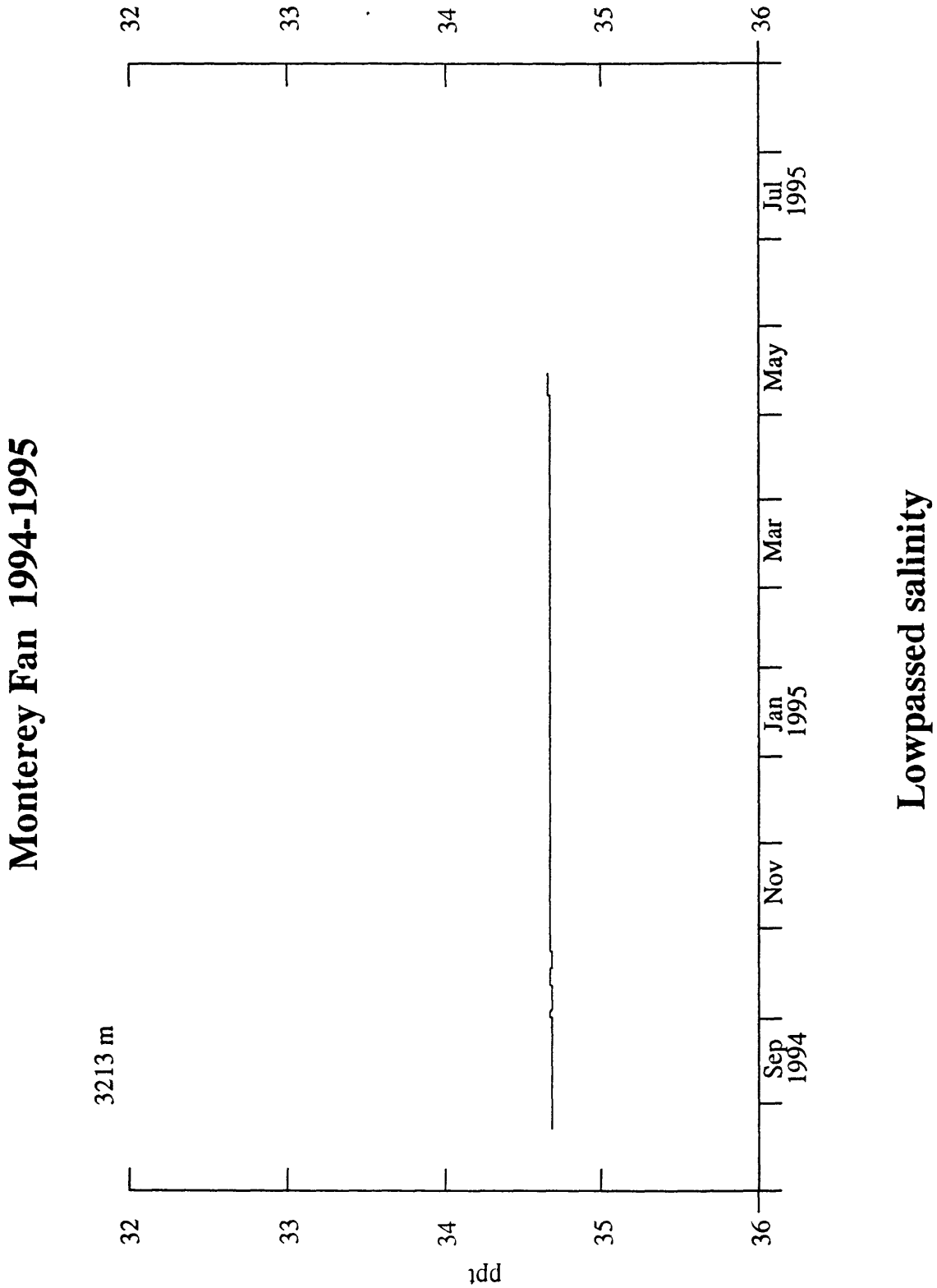


Hour-averaged temperature


Monterey Fan 1994-1995
3175 m
3213 m
degrees (C)
degrees (C)
0
2
4
6
Sep 1994
Nov
Jan 1995
Mar
May
Jul 1995
Lowpassed temperature



Hour-averaged salinity


Monterey Fan 1994-1995
3213 m
32
33
34
35
36
ppt
Sep 1994
Nov
Jan 1995
Mar
May
Jul 1995
Lowpassed salinity