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**Acoustic Doppler Current Profiler observations during the
Coastal Jet Separation project on R/V Wecoma, 17–27 August 1995**

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We present velocity observations from a shipboard acoustic doppler current profiler (ADCP) on R/V *Wecoma* during cruise W9508b, 17–27 August 1995. Results from the short half-day cruise W9508c on 31 August 1995 are also shown. The ADCP processing procedures for W9508b are described in detail. This cruise was part of the Coastal Jet Separation project, funded by the National Science Foundation, to study how and why a strong alongshore coastal current turns offshore, crosses steep bottom topography, and becomes an oceanic jet. The focus of the cruise was a series of high-resolution SeaSoar (CTD) and ADCP surveys across the continental margin upstream and downstream of Cape Blanco, Oregon (43°N). The ADCP was an RD Instruments hull-mounted 153.6 kHz unit. Data were collected continuously during the 10 day period of W9508b, in a region extending about 200 km along the coast and 75 km offshore. Vertical bin length was 8 m and the typical depth range in open water was 18–350 m. To reference the velocities to earth coordinates, we used wide-area differential global positioning system navigation, supplemented by bottom-tracking where possible.

Table of Contents

Introduction	1
Table 1. RDI DAS configuration file.	2
Editing	5
Calibration	7
Navigation	7
Synopsis of uncertainties	9
Data presentation	10
Acknowledgments	10
References	11
Table 2. Line definitions and way points.	12
Reference layer and ship position time series	15
Velocity vectors at standard depths	20
Vertical sections of ADCP lines (0–350 m), <i>U</i> and <i>V</i>	30
Vertical sections of SeaSoar/ADCP lines (0–200 m), <i>U</i> or <i>V</i>	80

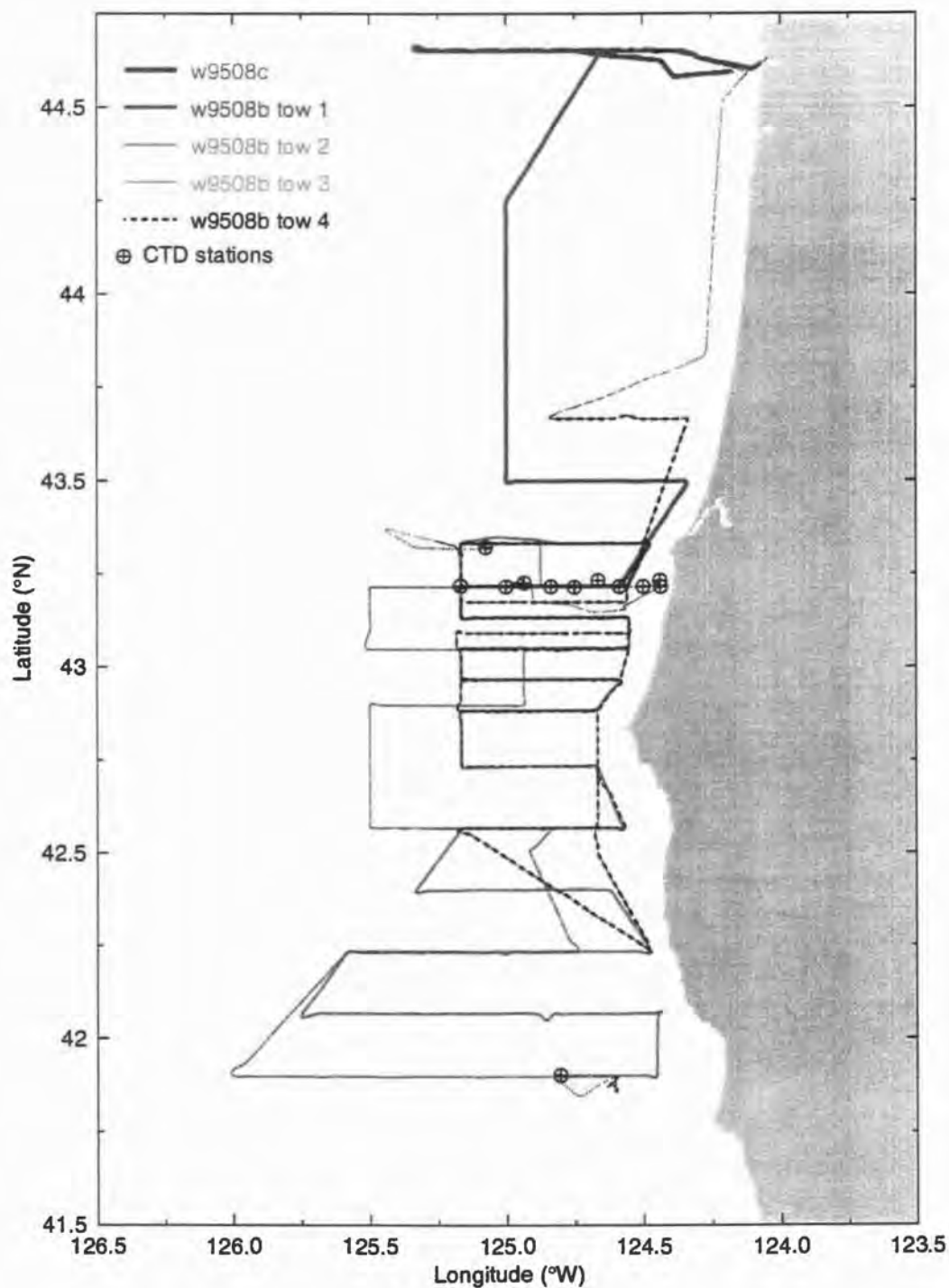


Fig. 1. W9508b,c shiptracks, SeaSoar tows, and conventional CTD stations.

INTRODUCTION

This report presents observations of velocity from a shipborne acoustic Doppler current profiler (ADCP) on the R/V *Wecoma* during cruise W9508b, 17–27 August 1995. Results from the short half-day cruise W9508c on 31 August 1995 are also shown. The W9508b cruise was part of the Coastal Jet Separation project, to study how and why a strong alongshore coastal current turns offshore, crosses steep

w9508b.cnf

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AD,SI,HUNDREDTHS 150.00 Sampling interval
AD,NB,WHOLE 64 Number of Depth Bins
AD,BL,WHOLE 3 Bin Length
AD,PL,WHOLE 12 Pulse Length
AD,BK,TENTHS 4.0 Blank Beyond Transmit
AD,PE,WHOLE 1 Pings Per Ensemble
AD,PC,HUNDREDTHS 1.00 Pulse Cycle Time
AD,PG,WHOLE 25 Percent Pings Good Threshold
XX,CD2,WHOLE 5 (SYSTEM DEFAULT, CD2)
XX,TE,HUNDREDTHS 0.00 (SYSTEM DEFAULT, TE)
AD,US,BOOLE NO Use Direct Commands on StartUp
DP,TR,BOOLE NO Toggle roll compensation
DP,TP,BOOLE NO Toggle Pitch compensation
DP,TH,BOOLE YES Toggle Heading compensation
DP,VS,BOOLE YES Calculate Sound Velocity from TEMP/Salinity
DP,UR,BOOLE YES Use Reference Layer
DP,FR,WHOLE 3 First Bin for reference layer
DP,LR,WHOLE 6 Last Bin for reference layer
DP,BT,BOOLE YES Use Bottom Track
DP,B3,BOOLE NO Use 3 Beam Solutions
DP,EV,BOOLE YES Use Error Velocity as Percent Good Criterion
DP,ME,TENTHS 100.0 Max. Error Velocity for Valid Data (cm/sec)
DR,RD,BOOLE YES Recording on disk
DR,RX,BOOLE YES Record N/S (PORT/AFT) Vel.
DR,RY,BOOLE YES Record E/W (PORT/STBD) Vel.
DR,RZ,BOOLE YES Record vertical vel.
DR,RE,BOOLE YES Record error Good
DR,RB,BOOLE YES Bytes of user prog. buffer
DR,RP,BOOLE YES Record Percent good
DR,RA,BOOLE YES Record average AGC/Bin
DR,RN,BOOLE YES Record Ancillary data
DR,AP,BOOLE NO Auto-ping on start-up
XX,LDR,TRI 3 (SYSTEM DEFAULT, LDR)
XX,RB2,WHOLE 256 (SYSTEM DEFAULT, RB2)
DR,RC,BOOLE NO Record CTD data
XX,PB,WHOLE 1 (SYSTEM DEFAULT, PB)
XX,PU,BOOLE NO (SYSTEM DEFAULT, PU)
GC,TG,TRI 1 DISPLAY (NO/GRAPH/TAB)
GC,ZV,WHOLE 0 ZERO VELOCITY REFERENCE (S/B/M/L)
GC,VL,WHOLE -50 LOWEST VELOCITY ON GRAPH
GC,VH,WHOLE 50 HIGHEST VELOCITY ON GRAPH
GC,DL,WHOLE 0 LOWEST DEPTHS ON GRAPH
GC,DH,WHOLE 500 HIGHEST DEPTHS ON GRAPH
GC,SW,BOOLE YES SET DEPTHS WINDOW TO INCLUDE ALL BINS
GC,MP,WHOLE 25 MINIMUM PERCENT GOOD TO PLOT
SG,PNS,BOOLE YES PLOT NORTH/SOUTH VEL.
SG,PEW,BOOLE YES PLOT EAST/WEST VEL.
SG,PVT,BOOLE YES PLOT VERTICAL VEL.
SG,PEV,BOOLE YES PLOT ERROR VEL.
SG,PPE,BOOLE NO PLOT PERCENT ERROR
SG,PMD,BOOLE NO PLOT MAG AND DIR
SG,PSW,BOOLE NO PLOT AVERAGE SP. W.
SG,PAV,BOOLE YES PLOT AVERAGE AGC.
SG,PPG,BOOLE YES PLOT PERCENT GOOD
SG,PD1,BOOLE NO PLOT DOPPLER 1
SG,PD2,BOOLE NO PLOT DOPPLER 2
SG,PD3,BOOLE NO PLOT DOPPLER 3
SG,PD4,BOOLE NO PLOT DOPPLER 4
SG,PW1,BOOLE NO PLOT SP. W. 1
SG,PW2,BOOLE NO PLOT SP. W. 2
SG,PW3,BOOLE NO PLOT SP. W. 3
SG,PW4,BOOLE NO PLOT SP. W. 4
SG,PA1,BOOLE NO PLOT AGC 1
SG,PA2,BOOLE NO PLOT AGC 2
SG,PA3,BOOLE NO PLOT AGC 3
SG,PA4,BOOLE NO PLOT AGC 4
SG,PP3,BOOLE NO PLOT 3-BEAM SOLUTION
SS,OD,WHOLE 5.0 Offset for Depth

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SS,OH,TENTHS -135.0 Offset for Heading
SS,OP,TENTHS 0.0 Offset for Pitch
SS,ZR,TENTHS 0.0 Offset for Roll
SS,OT,HUNDREDTHS 45.00 Offset FOR temp
SS,ST,HUNDREDTHS 50.00 Scale for Temp
SS,SL,HUNDREDTHS 32.25 Salinity (PPT)
SS,UD,BOOLE YES Toggle UP/DOWN
SS,CV,BOOLE NO Toggle concave/Convex transducerhead
SS,MA,TENTHS 30.0 Mounting angle for transducers.
SS,SS,HUNDREDTHS 1500.00 Speed of Sound (m/sec)
XX,GP,BOOLE YES (SYSTEM DEFAULT, GP)
XX,DD,TENTHS 1.0 (SYSTEM DEFAULT, DD)
XX,PT,BOOLE NO (SYSTEM DEFAULT, PT)
XX,TU,TRI 2 (SYSTEM DEFAULT, TU)
TB,FP,WHOLE 1 FIRST BINS TO PRINT
TB,LP,WHOLE 64 LAST BIN TO PRINT
TB,SK,WHOLE 6 SKIP INTERVAL BETWEEN BINS
TB,DT,BOOLE YES DIAGNOSTIC TAB MODE
DU,TD,BOOLE NO TOGGLE USE OF DUMMY DATA
XX,PN,WHOLE 0 (SYSTEM DEFAULT, PN)
DR,SD,WHOLE 3 Second recording drive
DR,PD,WHOLE 1 First recording drive (1=A,2=B: ...)
DR,PK,BOOLE NO Profiler does XYZ transform
SS,LC,TENTHS 5.0 Limit of knots change
SS,NW,TENTHS 0.5 Weight of new knots of value
GC,GM,TRI 2 GRAPHICS CONTROL 0=LO RES, 1=HI RES, 2=ENHANCED
AD,PS,BOOLE NO YES=SERIAL/NO=PARALLEL Profiler Link
XX,LNN,BOOLE YES (SYSTEM DEFAULT, LNN)
XX,BM,BOOLE YES (SYSTEM DEFAULT, BM)
XX,RSD,BOOLE NO RECORD STANDARD DEVIATION OF VELOCITIES PER BIN
XX,DRV,WHOLE 0 (SYSTEM DEFAULT, DRV)
XX,PBD,WHOLE 3 (SYSTEM DEFAULT, PBD)
TB,RS,BOOLE NO SHOW RMT STATISTIC
UX,BE,BOOLE YES ENABLE EXIT TO EXTERNAL PROGRAM
SS,VSC,TRI 0 Velocity scale adjustment
AD,DM,BOOLE NO USE DMA
TB,SC,BOOLE NO SHOW CTD DATA
AD,CW,BOOLE NO Collect spectral width
DR,RW,BOOLE NO Record average SP.W./Bin
DR,RRD,BOOLE NO Record last raw dopplers
DR,RRA,BOOLE YES Record last raw AGC
DR,RRW,BOOLE NO Record last SP.W.
DR,R3,BOOLE NO Record average 3-Beam solutions
DR,RBS,BOOLE YES Record beam statistic
XX,STD,BOOLE NO (SYSTEM DEFAULT, STD)
LR,HB,HUNDREDTHS 0.00 Heading Bias
SL,1,ARRAY5 0 1 8 NONE 9600 PROFILER
SL,2,ARRAY5 1 1 8 NONE 4800 LORAN RECEIVER
SL,3,ARRAY5 0 1 8 NONE 1200 REMOTE DISPLAY
SL,4,ARRAY5 0 1 8 NONE 1200 ENSEMBLE OUTPUT
SL,5,ARRAY5 0 1 8 NONE 1200 AUX 1
SL,6,ARRAY5 0 1 8 NONE 1200 AUX 2
DU,1,ARRAY6 100.00 100.00 60.00 0.00 0.00 YES D1
DU,2,ARRAY6 -100.00 -100.00 60.00 0.00 0.00 YES D2
DU,3,ARRAY6 200.00 200.00 60.00 0.00 0.00 YES D3
DU,4,ARRAY6 -200.00 -200.00 60.00 0.00 0.00 YES D4
DU,5,ARRAY6 200.00 19.00 60.00 0.00 0.00 YES AGC
DU,6,ARRAY6 0.00 0.00 60.00 0.00 0.00 NO SP. W.
DU,7,ARRAY6 0.00 0.00 60.00 0.00 0.00 NO ROLL
DU,8,ARRAY6 0.00 0.00 60.00 0.00 0.00 NO PITCH
DU,9,ARRAY6 0.00 0.00 60.00 0.00 0.00 NO HEADING
DU,10,ARRAY6 0.00 0.00 60.00 0.00 0.00 NO TEMPERATURE
DC,1,SPECIAL *FH00001* MACRO 1
CI,1,SPECIAL *W9508b - CJS* CRUISE ID GOES HERE
LR,1,SPECIAL * * LORAN FILE NAME GOES HERE

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Table 1. RDI DAS configuration file.

bottom topography, and becomes an oceanic jet. The cruise was organized around the collection of CTD data from a towed undulating vehicle, the SeaSoar. The SeaSoar vehicle was deployed during four periods, for a total of 8.1 days of good undulations, and 12 conventional CTD/rosette casts were also made (Figure 1). The W9508b SeaSoar data description and a cruise narrative are in a separate data report, Ebling et al. [1997]. Cruise W9508c was a 12-hour microsoar test cruise which headed west out of Newport and then returned. Similar processing methods were applied to both the W9508b and W9508c data sets, although this report only describes W9508b in detail. The reader unfamiliar with basic ADCP principles and terminology used in this report is referred to the helpful *Practical Primer*, RD Instruments [1989].

The ADCP was an RD Instruments hull-mounted 153.6 kHz narrow-band model, with 4 beams oriented 30° from vertical. The ADCP transducer was at a depth of 5 m. We set up the instrument with a pulse length of 12 m, a bin width of 8 m, and an ensemble averaging time of 2.5 min. Bottom-tracking was turned on for 19 different periods of the cruise when the bottom was visible to the ADCP. The number of pings per ensemble varied from 51–149 with a mean of 119. The error velocity threshold for raw pings during data collection was 1 m/s, the blank-beyond-transmit length was 4 m, and only 4-beam solutions were used. No corrections for pitch and roll were made; errors associated with these are likely to be small (Kosro, 1985). Table 1 is a copy of the file used to configure the data acquisition system.

The ADCP operated continuously except for short interruptions required to change system parameters or insert new diskettes. Out of the 37 short time gaps, the largest was 1.7 min and most were under 1 min. The percentage-good-pings per ensemble and amplitude (AGC) statistics appear reasonable over the entire cruise (Figure 2), with percentage-good-pings >30% down to a depth of about 350 m. More discussion of these diagnostics is in the EDITING section below.

The ADCP data were initially processed and displayed in real-time by the RDI data acquisition system running on a personal computer. Additional shipboard and shore processing were accomplished using some components of the Common Oceanographic Data Access System (CODAS) software package made available by the University of Hawaii (Firing et al., 1995), running on a Sun Sparc 10. Parts of the CODAS software required the Matlab language, and most of the figures for this report were made using the Gri package (Kelley, 1995). Conventional global positioning system (GPS) navigation from a Trimble 4000AX was integrated into the ADCP data stream using a "user exit" program. Ship's heading was by Sperry gyro compass.

For the wide-area differential GPS (WADGPS) method, raw pseudorange data from a Magellan Field-Pro V were recorded separately at 1 Hz using Magellan software running on a laptop PC. After the cruise, satellite clock corrections were obtained from the Canadian Active Control System (CACS), a network of automated Canadian and global GPS receiver stations. Satellite orbital parameters were obtained from the US Coast Guard Navigation Center. With this information, WADGPS positions are derived which have the effects of selective availability (SA) removed. These positions are interpolated post-cruise onto the ADCP ensemble times. For more information about the WADGPS method, see Pierce et al. [1997].

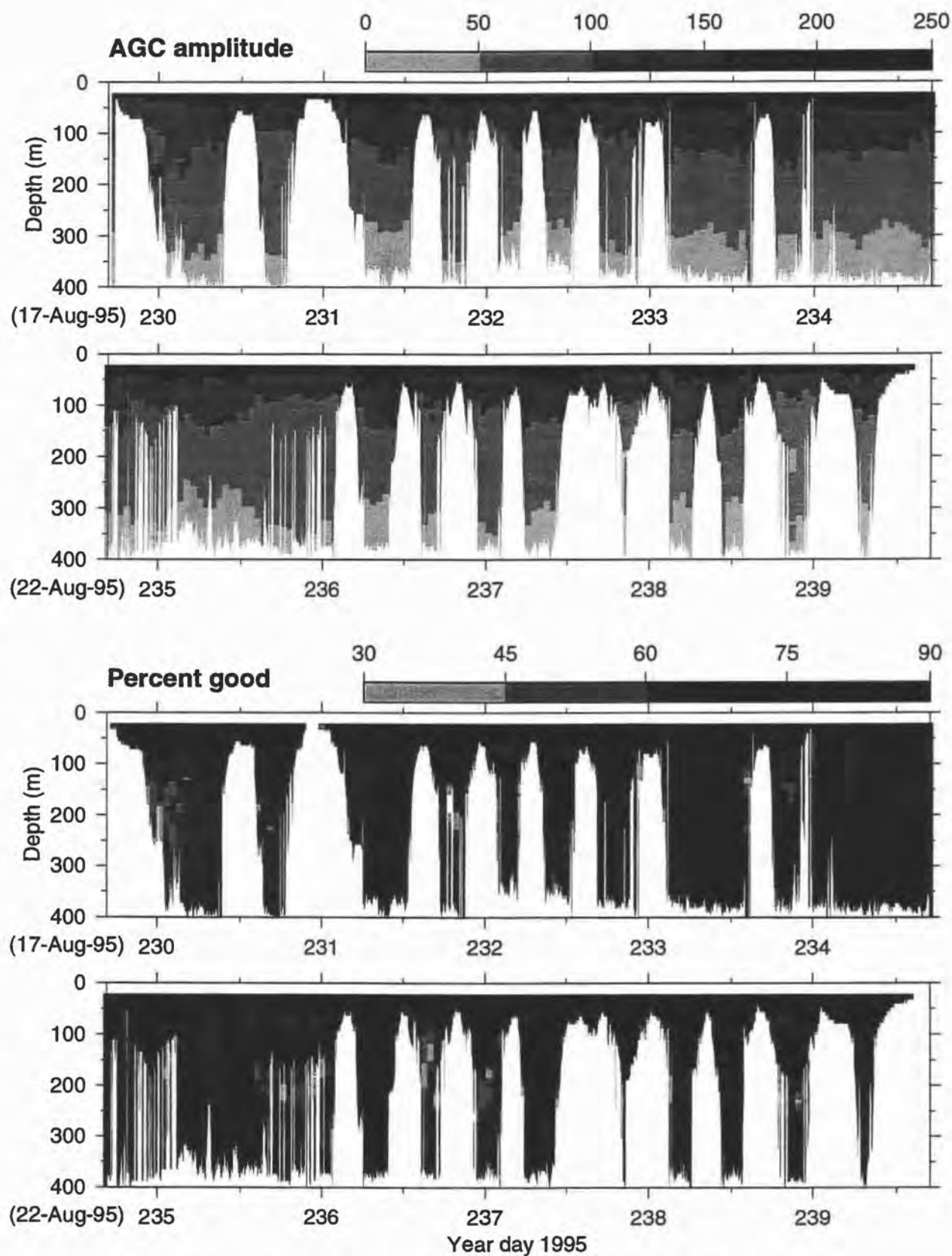


Fig. 2. Automatic gain control (AGC) and percentage-good-pings vs. time and depth.

EDITING

As the data quality decreases with depth, we must decide on the deepest usable bin for each 2.5 min ensemble. In addition, the data are edited for interference with the sea floor in shallow water and for occasional interference from the CTD hydrographic wire and other objects. To flag and remove suspect data points, several methods were used in combination during post-processing, as recommended by Firing et al. [1995] and others:

- The percentage-good-pings per ensemble cutoff was set to 30%; below this point data were not used. The %-good-pings is a record of the proportion of raw pings within the 2.5 min ensemble which are judged good internally by the RDI firmware and subsequently included in the ensemble average.
- The automatic gain control (AGC) gives an indication of the echo return signal strength, scaled such that 1 AGC count corresponds to about a 0.45 dB change in signal power. The AGC decreases with bin depth in general. A small increase with depth may simply indicate the presence of a strong scattering layer due to a large zooplankton population, while a larger increase is probably a reflection off of the sea floor. Individual ensembles were scanned for increases of AGC >25 counts, and the deepest subsequent bin where a local maximum is reached was taken as an indication of sea floor location.
- In the deep water case, where no sea floor echo is detected, the AGC will eventually stop decreasing with depth and become constant. This constant level is the noise floor; the signal of interest is no longer present. We use a noise margin of 10, retaining bins which have AGC greater than 10 above the noise floor.
- Since the ADCP initially measures velocity along the axes of four beams, which are then transformed to the 3-dimensional components u , v , and w , there is redundancy in the scheme. This redundancy is used within the RDI firmware to make two distinct estimates of the vertical velocity w . The difference between these two estimates is called the error velocity and is a useful data quality indicator. A large error velocity indicates an inconsistency among the oceanic velocities sampled by each of the 4 beams. Thus it is another way of detecting interference with one of the beams caused by an object. We reject individual bins which have an error velocity above 10 cm/s, a relatively conservative choice (Zedel and Church [1987], for example, recommend using 17 cm/s); the results are not very sensitive to the choice.
- As additional precaution against sea floor interference, the profile was cut off at 85% of the estimated depth from the above methods or at 85% of the bottom-track depth (if available), whichever was smaller. It is particularly important to guard against sea floor interference when crossing regions with steep bottom topography, as in the present case.

The result of the editing is shown in Figure 3, where good data points are plotted and missing points appear as white space. The line beneath is the ADCP bottom-track depth. Many of the minor blank regions correspond to SeaSoar deployments, recoveries, or CTD stations, where the object in the water interfered briefly with one or more of the 4 ADCP beams.

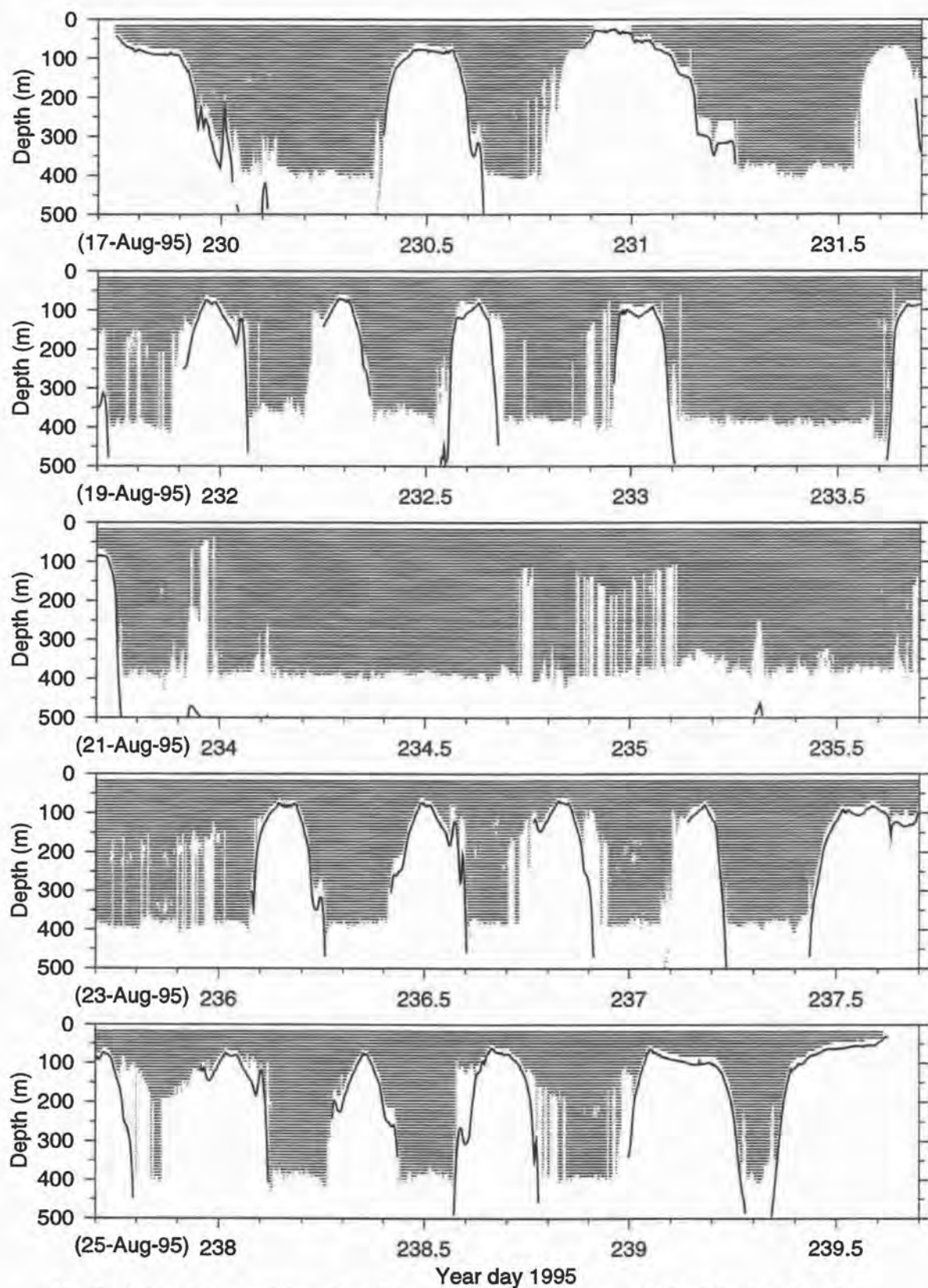


Fig. 3. Data points remaining after editing. The ADCP bottom-track depth is also plotted.

CALIBRATION

Sound speed

Initial estimates of sound speed are provided by the ADCP's own thermistor and an assumed constant salinity, but we apply better estimates in post-processing from the *Wecoma's* underway sampling system (MIDAS). Sound speed is calculated from 1 min MIDAS temperature and salinity, resampled to the 2.5 min ADCP ensemble times. The MIDAS system has temperature sensors both in the transducer well and in the flow-thru system, while the conductivity sensor is only in the flow-thru. We use salinity from the flow-thru sensors and temperature from the transducer well to figure sound speed, using the Chen & Millero formula.

T and S appear to be of good quality throughout the cruise and result in sound speeds from 1484–1513 m/s. With these relatively accurate sound speed estimates, associated uncertainties in ADCP velocity are negligible (<0.1 cm/s) compared to other sources of error. ADCP bin depths are corrected using a regional mean sound speed profile; remaining uncertainty in bin depth is about 1 m.

Sensitivity and Alignment

We use the bottom-track method to determine and correct for the sensitivity error β (where the data are scaled by $\beta + 1$) and the ADCP/gyro misalignment angle α , following Joyce [1988]. We assume that the bottom track velocity for each ensemble should be equal and opposite to the ship velocity from navigation. The degree to which this is not true provides values for α and β . On this cruise, we have 2365 ensembles of bottom-tracked data available (42% of the cruise).

Following some of the recommendations of Trump and Marmorino [1997], for calibration purposes we reject cases where either the ship speed was below 1 m/s or the ship was turning significantly (if the 2.5 min mean ship heading and the momentary heading differed by more than 2°). We also apply a simple median rejection criterion (Huber, 1996) to exclude outliers among the raw α and β estimates.

For physical reasons we expect β to be constant throughout the cruise. We find the average $\beta = 0.0042 \pm 0.0004$. At worst (at highest ship speed of 6.3 m/s), the β uncertainty implies an unknown bias of 0.3 cm/s in velocity measurement.

For α , we expect both an offset due to a fixed transducer mount misalignment and possibly some gyro compass drift with time. We do in fact detect a small gyro compass drift (Figure 4). The α offset is consistent with calibrations from previous cruises, eg. W9408 (Pierce et al., 1995). We also test for dependence of α on ship heading but find it insignificant.

The remaining uncertainty in the α calibration is estimated to be 0.1° . In the worst case (highest ship speed), this implies an unknown bias of 1.1 cm/s in velocity.

NAVIGATION

To reference the ADCP velocities to absolute (earth) coordinates, ship velocity is determined by bottom-tracking where possible (Figure 3); elsewhere it must be determined from navigation. In the latter case, the uncertainty in ship velocity is the largest source of ADCP error. The ship velocity is a noisy signal which is significantly non-stationary; when the ship is on station the local mean is approximately zero, but a few minutes later when the ship gets underway the mean can be about 6 m/s. It is particularly

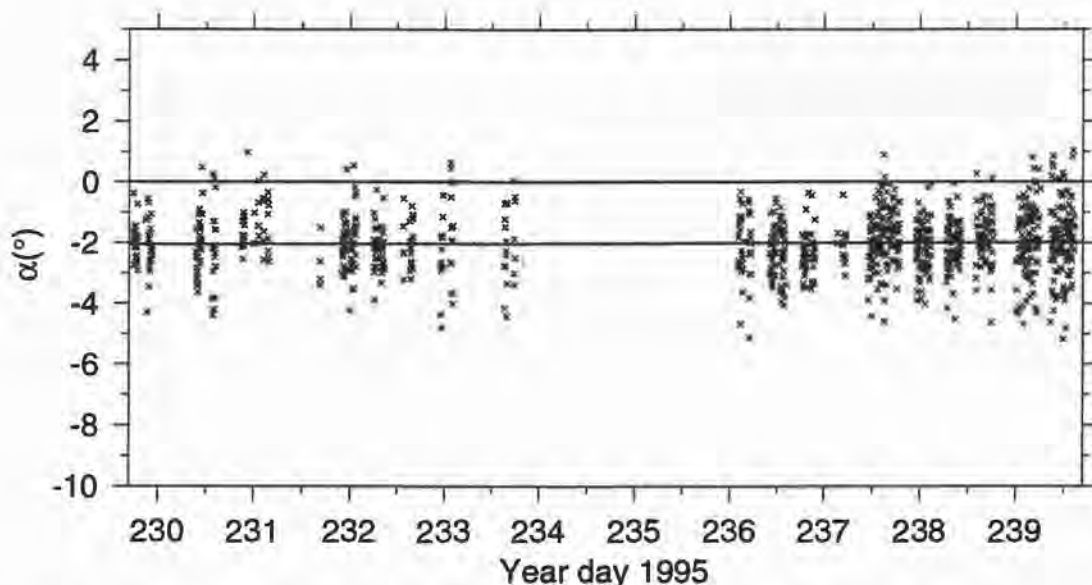


Fig. 4. Misalignment angle α , figured by comparing WADGPS navigation and bottom-tracking. The line is a least-squares fit to the points.

important to resolve such transitions during a cruise such as the present one, with frequent changes in ship speed and course.

Smoothing of ship velocity

We apply a data-adaptive smoothing technique as a pre-processing step prior to the conventional reference layer method described below. The 2.5 min ship velocities (as calculated from the WADGPS positions) are smoothed using a locally-adaptive polynomial regression method (Fan and Gijbels, 1996). The global tricube smoothing scales are determined via cross-validation to be 8 min for U and 8.5 min for V . The method locally chooses either a linear or cubic polynomial, whichever offers the best fit. The method was chosen due to its remarkable ability to conform to the local curvature properties of the data. This type of smoothing has been casually mentioned as rivaling the performance of wavelet-based methods or Kalman filtering techniques (Härdle and Schimek, 1996), although we are not aware of any careful comparison in the literature. For most audiences, it would have the advantage of simplicity over these methods.

Statistical theory suggests that local fitting of odd-order polynomials is superior to methods which test all orders (Fan and Gijbels, 1996), although some disagreement exists over the relevance of this in practice (Härdle and Schimek, 1996). We tested a method which tried 1st, 2nd, and 3rd-order polynomials on a sample of the data, and it did not perform quite as well (about 5% higher rms error based on comparison to bottom-tracking).

Reference layer method

Using a 30–62 m reference layer, we transfer the problem of smoothing ship velocity into the problem of smoothing reference layer velocity. We combine the smoothed ship velocity data and measured

ADCP layer velocities relative to the ship to calculate absolute motion of the reference layer (Kosro [1985], Wilson and Leetmaa [1988], Firing et al. [1995]). The advantage of this step is that our noisy signal is now stationary, without the large changes which the ship velocity had (see pp. 15-19). Conventional linear filtering techniques are now appropriate, and we low-pass filter in a robust manner in the time domain with a Blackman window: $w(t) = 0.42 - 0.5 \cos(2\pi t/T) + 0.08 \cos(4\pi t/T)$. The choice of the filter half-width T is discussed below. The resulting smoothed velocities are also integrated back to obtain a new consistent and smooth set of ship positions. This step uses the *smoothr* routine in the CODAS package. After this, the shear profile for each ensemble is added to the reference layer to determine absolute velocities at all depths.

We compare the resulting uncertainties with and without the prior adaptive polynomial smoothing step, confirming that this additional step is beneficial (Figure 5). For a filter half-width T of 20 min, the rms error is reduced from 4.7 to 3.9 cm/s.

At full ship speed, 20 min corresponds to a 7.6 km spatial smoothing of the reference layer velocity. Choosing a longer filter implies possible distortion of oceanic features (in the absolute velocity) of interest, while a shorter one results in more noise from navigation. We compromise on this T for the final version of the data set. The raw, 20 min smoothed, and bottom-tracked reference layer velocities are shown on pp. 15-19.

SYNOPSIS OF UNCERTAINTIES

The inherent short-term random uncertainty in an ADCP velocity for a 2.5 min ensemble and 8 m bin ranges from ± 1.1 to ± 3.3 cm/s (RDI, 1989). The range is due to variability in the number of good pings per ensemble. This form of error is reduced with further averaging. For the typical case of 5 min data, the short-term random uncertainty is at most ± 2.3 cm/s.

If bottom-tracking is used, the absolute ADCP velocity may have an unknown bias of 1 cm/s (due to inherent limitations of the bottom-track method, RDI [1989]). If bottom-tracking is not used, the absolute

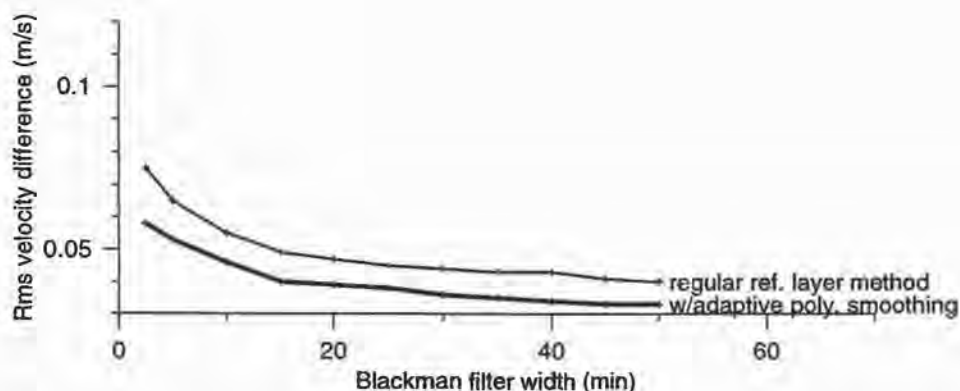


Fig. 5. Rms difference $[0.5(u_{rms}^2 + v_{rms}^2)]^{1/2}$ between absolute velocity of the reference layer from navigation and bottom-tracking, vs. low-pass filter width.

ADCP velocity may have an unknown bias of 1.4 cm/s (combination of sensitivity and alignment errors). In addition, the absolute velocity has a random error due to navigational uncertainty of ± 3.9 cm/s and is low-pass filtered to suppress motions with time scales of less than 20 min (for features present throughout the 30–62 m reference layer).

DATA PRESENTATION

First, we show the time series of raw, smoothed, and bottom-tracked reference layer velocity, with ship location plotted below (pp. 15–19).

Next (pp. 20–29), maps of ADCP vectors at 18, 50, 75, 100, 125, 150, 175, 200, 250, and 300 m depths are displayed. Each vector is a 5 km spatial average in the horizontal and 10 m in the vertical. In cases where the cruise track overlays itself, vectors from the different times are averaged together.

Vertical sections (0–350 m) of U (east) and V (north) velocity are shown for major lines (pp. 30–79). We feed 5 min ADCP data to the contouring routine, which is a Barnes objective analysis scheme with 3 iterations (eg. §3.6 of Daley [1991]). The horizontal (vertical) grid spacings are 1 km (8 m), and the successive smoothing length scales are 10 km (50 m), 5 km (25 m), and 2.5 km (12.5 m). Velocity contour units are cm/s, and negative regions are shaded. The location of each section is indicated on a small map to the right of each plot.

We also plot vertical sections (0–200 m) for comparison with the SeaSoar sections found in Ebling et al. [1997]. Either U or V is contoured, depending on the orientation of the line (pp. 80–123).

The data described in this report will be publicly available from the National Oceanographic Data Center Joint Archive for Shipboard ADCP (JASADCP). The JASADCP is accessible through the web at <http://www.soest.hawaii.edu/caldwell/>.

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REFERENCES

- Daley, R. *Atmospheric Data Analysis*, 457 pp., Cambridge Press, Cambridge, 1991.
- Fan, J., and I. Gijbels, *Local polynomial modelling and its applications*, Chapman & Hall, London, 1996.
- Firing, E., J. Ranada, and P. Caldwell, Processing ADCP data with the CODAS software system version 3.1, User's manual, 1995. (Both the manual and the software itself available via anonymous ftp at: noio.soest.hawaii.edu/pub/codas3).
- Hardle, W. and M. G. Schimek, eds., *Statistical theory and computational aspects of smoothing: proceedings of the COMPSTAT '94 satellite meeting held in Semmering, Austria, 27-28 August 1994*, Physica-Verlag, Heidelberg, 1996.
- Huber, P. J., *Robust statistical procedures*, 2nd edition, Society for Industrial and Applied Mathematics, Philadelphia, 1996.
- Joyce, T. M., On in situ calibration of shipboard ADCPs, *J. Atmos. Oceanic Technol.*, 6, 169-172, 1989.
- Kelley, D., Gri - a program to make science graphs, User's manual, 1995. (Both the manual and the software itself available via anonymous ftp at: ftp.phys.ocean.dal.ca/users/kelley/gri).
- Kosro, P. M., Shipboard acoustic profiling during the Coastal Ocean Dynamics Experiment, Ph.D. thesis, SIO Ref. 85-8, 119 pp., Scripps Inst. of Oceanogr., La Jolla, Calif., 1985.
- Ebling, T., R. O'Malley, J. A. Barth, and R. L. Smith, SeaSoar and CTD observations during Coastal Jet Separation cruise W9508b, 17-27 August 1995, Data Report, College of Oceanic and Atmospheric Sciences, Oregon State University, 1997 (in preparation).
- Pierce, S. D., J. A. Barth, and R. L. Smith, Acoustic Doppler Current Profiler observations during the Coastal Jet Separation project on R/V Wecoma, August 23 to September 2, 1994, Data Report 161, Ref. 95-3, College of Oceanic and Atmospheric Sciences, Oregon State University, 1995.
- Pierce, S. D., J. A. Barth, and R. L. Smith, Improving ADCP accuracy with WADGPS and adaptive smoothing of ship velocity, *J. Atmos. Oceanic Technol.*, 1997 (submitted).
- Pollard, R. and J. Read, A method for calibrating ship mounted acoustic Doppler profilers and the limitations of gyro compasses, *J. Atmos. Oceanic Technol.*, 6, 859-865, 1989.
- RD Instruments, Acoustic Doppler current profilers principles of operation: a practical primer, 40 pp., 1989.
- Reinsch, C. H., Smoothing by spline functions, *Numerische Mathematik*, 10, 177-183, 1967.
- Trump, C. L., and G. O. Marmorino, Calibrating a gyrocompass using ADCP and DGPS data, *J. Atmos. Oceanic Technol.*, 14, 211-214, 1997.
- Wilson, D., and A. Leetmaa, Acoustic Doppler current profiling in the equatorial Pacific in 1989, *J. Geophys. Res.*, 93, 13947-13966, 1988.
- Zedel, L. J., and J. A. Church, Real-time screening techniques for Doppler current profiler data, *J. Atmos. Oceanic Technol.*, 4, 572-581, 1987.

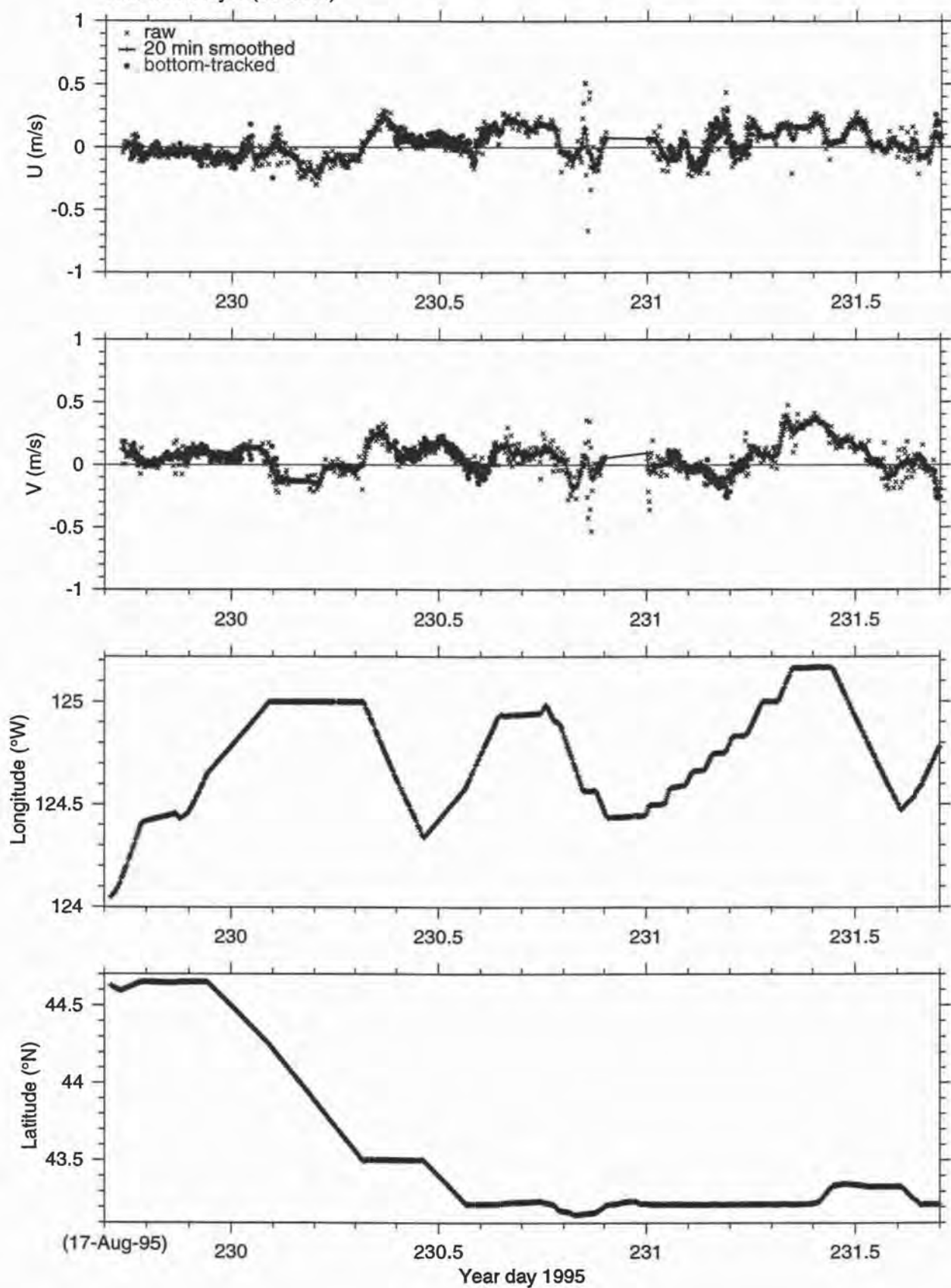
Table 2. W9508b line definitions and waypoints

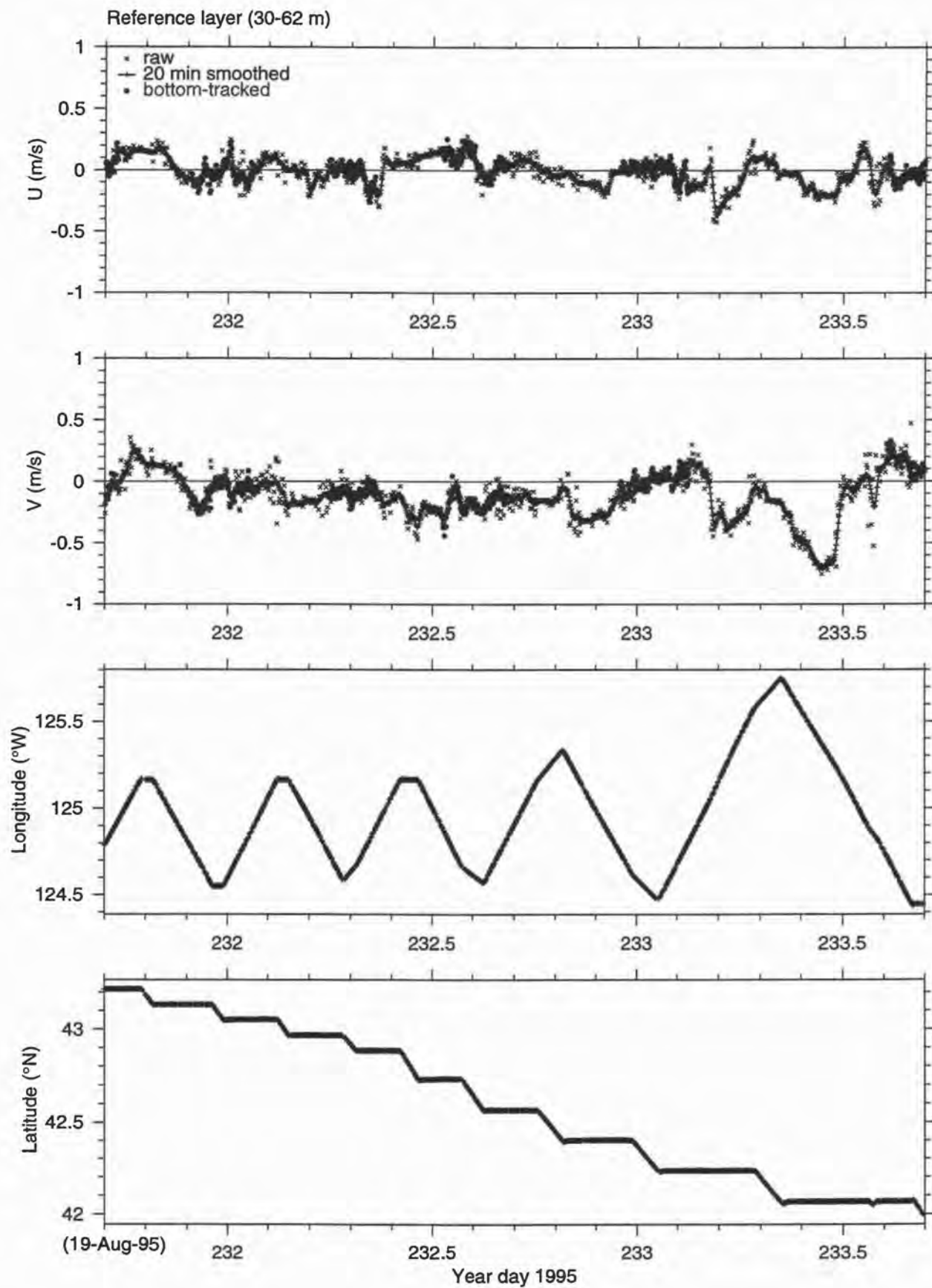
Tow	Line	Waypoints	Longitude(°W)	Latitude(°N)	Year day	Date	Time(UTC)	Depth(m)
1	a	A1	124.4527	44.6497	229.89583	5/17	2130	99
		A2	124.6468	44.6514	229.94448	5/17	2240	256
	b	A2	124.6469	44.6514	229.94449	5/17	2240	256
		A3	124.9983	44.2505	230.09128	5/18	0211	727
	c	A3	124.9983	44.2504	230.09130	5/18	0211	727
		A4	125.0011	43.4964	230.31932	5/18	0739	1162
	1	A4	125.0010	43.4964	230.31933	5/18	0739	1162
		A5	124.3365	43.4952	230.46649	5/18	1111	88
	2	A6	124.5825	43.2195	230.56513	5/18	1333	85
		A7	124.9370	43.2212	230.65241	5/18	1539	890
-	2a	A7	124.9370	43.2212	230.65241	5/18	1539	890
		FM-1	124.4347	43.2169	230.91185	5/18	2153	34
	2b	FM-1	124.4347	43.2169	230.91185	5/18	2153	34
CTD		FM-9	125.1630	43.2189	231.36389	5/19	0844	1773
2	3	B1	125.1591	43.3392	231.44847	5/19	1045	1676
		B2	124.4694	43.3305	231.60946	5/19	1437	83
	4	B3	124.5900	43.2121	231.65582	5/19	1544	89
		B4	125.1663	43.2157	231.79098	5/19	1859	1775
	5	B5	125.1622	43.1305	231.82030	5/19	1941	1728
		B6	124.5480	43.1314	231.96440	5/19	2308	84
	6	B7	124.5519	43.0490	231.99029	5/19	2346	89
		B8	125.1712	43.0473	232.12561	5/20	0300	1997
	7	B9	125.1640	42.9627	232.15069	5/20	0337	2051
		B10	124.5808	42.9643	232.28345	5/20	0648	82
	8	B11	124.6723	42.8817	232.31493	5/20	0733	99
		B12	125.1678	42.8816	232.42306	5/20	1009	2298
	9	B13	125.1613	42.7289	232.46771	5/20	1113	2748
		B14	124.6618	42.7314	232.57495	5/20	1347	130
	10	B15	124.5682	42.5664	232.62703	5/20	1502	86
		B16	125.1685	42.5641	232.75916	5/20	1813	2771
	11	B17	125.3341	42.4000	232.81843	5/20	1938	3088
		B18	124.6182	42.4001	232.99079	5/20	2346	102
	12	B19	124.4725	42.2279	233.05521	5/21	0119	99
		B20	125.5856	42.2320	233.28831	5/21	0655	3067

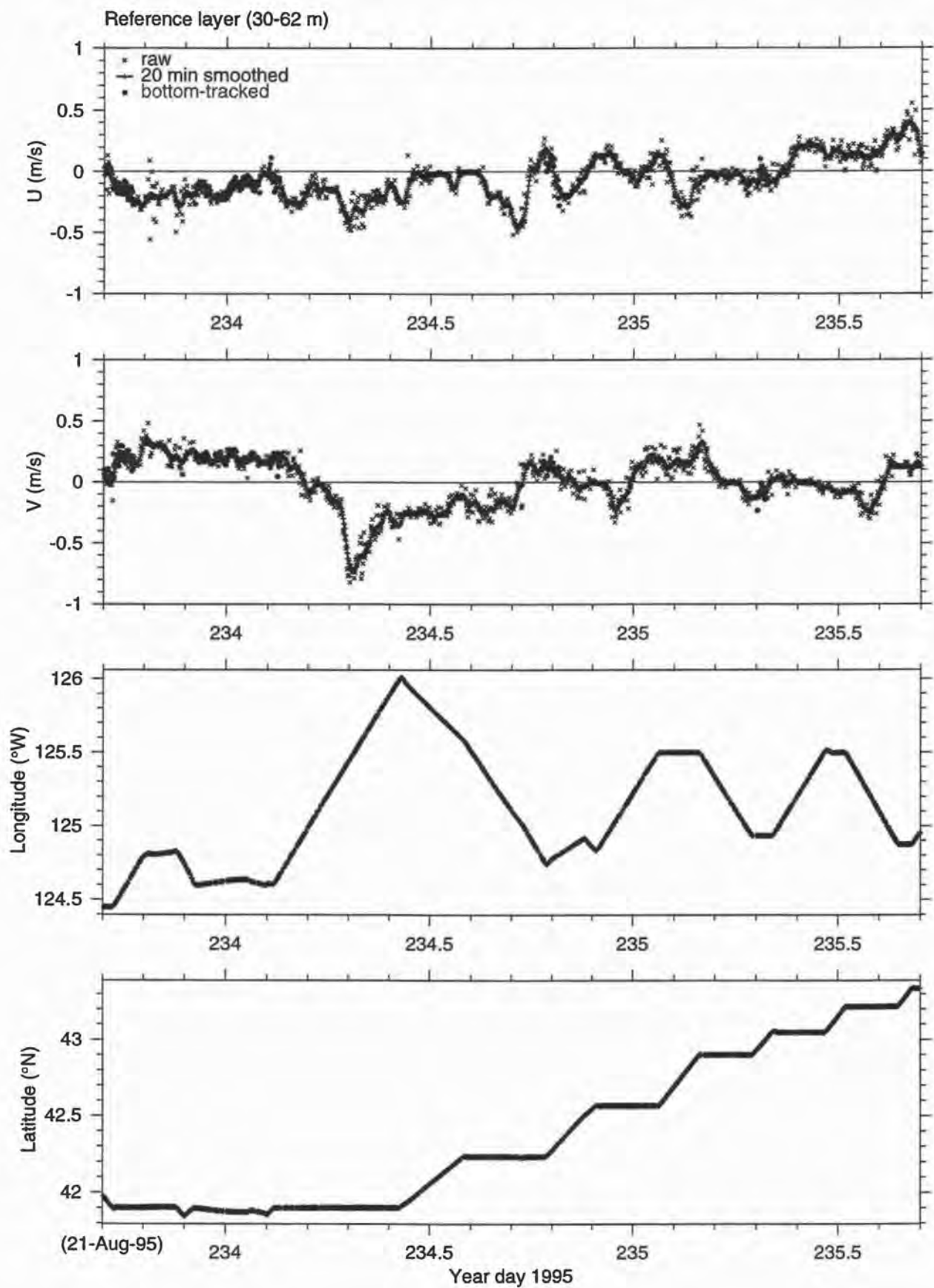
Tow	Line	Waypoints	Longitude(°W)	Latitude(°N)	Year day	Date	Time(UTC)	Depth(m)
3	13	B21	125.7544	42.0596	233.35270	5/21	0827	2855
		B22	124.4344	42.0726	233.67119	5/21	1606	90
	14a	B23	124.4537	41.8944	233.72711	5/21	1727	99
		-	124.7989	41.9017	233.80525	5/21	1919	830
	14b	CR-4	124.6031	41.8980	234.11721	5/22	0248	409
		B24	126.0100	41.9052	234.42912	5/22	1017	3140
	15	C1	125.5656	42.2368	234.58785	5/22	1406	3082
		C2	124.7398	42.2374	234.78625	5/22	1852	477
	16	C4	124.8438	42.5734	234.91417	5/22	2156	944
		C5	125.5017	42.5737	235.06662	5/23	0135	3083
	17	C6	125.4806	42.9029	235.16662	5/23	0359	3074
		C7	124.9312	42.9091	235.29434	5/23	0703	657
	18	C8	124.9480	43.0579	235.34448	5/23	0816	997
		C9	125.5180	43.0591	235.47282	5/23	1120	3074
	19	C10	125.4919	43.2189	235.52119	5/23	1230	3073
		C11	124.8710	43.2201	235.64694	5/23	1531	461
	20	C12	124.8745	43.3374	235.68098	5/23	1620	664
		C13	125.0865	43.3250	235.75028	5/23	1800	1224
4	21	D1	125.1635	43.3334	235.98744	5/23	2341	1673
		D2	124.4692	43.3303	236.14355	5/24	0326	83
	22	D3	124.5896	43.2139	236.18785	5/24	0430	88
		D4	125.1689	43.2166	236.32117	5/24	0742	1777
	23	D5	125.1668	43.1317	236.34862	5/24	0822	1734
		D6	124.5464	43.1309	236.49199	5/24	1148	83
	24	D7	124.5581	43.0509	236.51745	5/24	1225	92
		D8	125.1705	43.0495	236.66332	5/24	1555	1991
	25	D9	125.1644	42.9640	236.68913	5/24	1632	2048
		D10	124.5839	42.9528	236.82741	5/24	1951	78
	26	D11	124.6649	42.8848	236.85595	5/24	2032	94
		D12	125.1709	42.8820	236.96884	5/24	2315	2348
	27	D13	125.1650	42.7301	237.01391	5/25	0020	2793
		D14	124.6626	42.7283	237.12711	5/25	0303	134
	28	D15	124.5708	42.5601	237.18457	5/25	0425	86
		D16	125.1788	42.5644	237.31741	5/25	0737	2843
	29	D16	125.1789	42.5643	237.31742	5/25	0737	2844
		D17	124.4755	42.2260	237.51988	5/25	1228	102
	30	D17	124.4756	42.2260	237.51990	5/25	1228	102
		D18	124.6666	42.5000	237.61847	5/25	1450	122

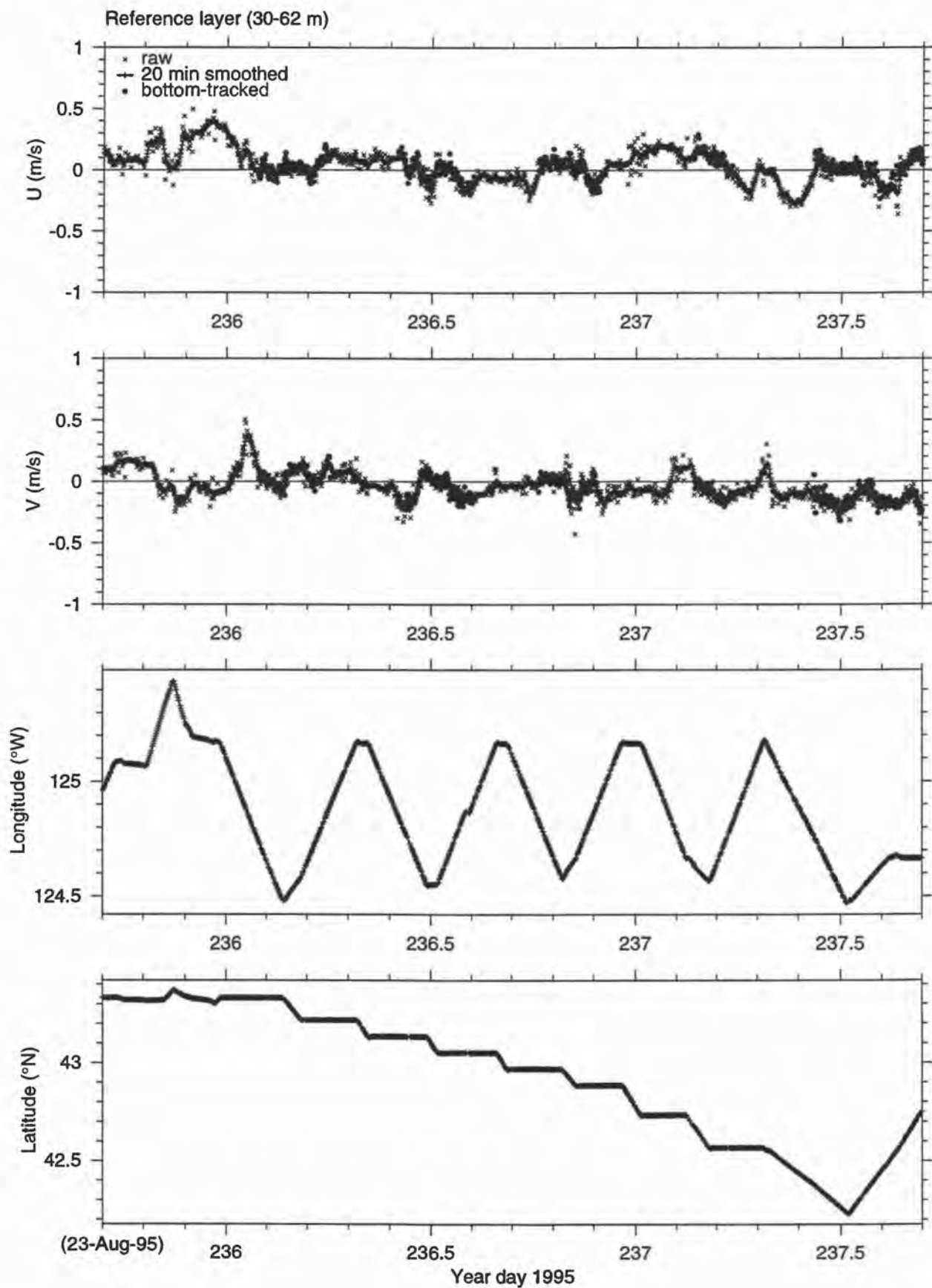
Tow	Line	Waypoints	Longitude(°W)	Latitude(°N)	Year day	Date	Time(UTC)	Depth(m)
	31	D18	124.6666	42.5000	237.61848	5/25	1450	122
		D19	124.6686	42.8858	237.73914	5/25	1744	97
	32	D19	124.6686	42.8858	237.73916	5/25	1744	97
		D20	125.1810	42.8954	237.85557	5/25	2032	2465
	33	D21	125.1541	42.9733	237.88544	5/25	2115	1998
		D22	124.5839	42.9665	238.01738	5/26	0025	84
	34	D23	124.5548	43.0555	238.04676	5/26	0107	91
		D24	125.1824	43.0534	238.18405	5/26	0425	2059
	35	D25	125.1830	43.0934	238.19668	5/26	0443	1930
		D26	124.5460	43.1003	238.35014	5/26	0824	86
	36	D27	124.5509	43.1318	238.36027	5/26	0838	86
		D28	125.1699	43.1370	238.50402	5/26	1205	1733
	37	D29	125.1668	43.1689	238.51403	5/26	1220	1723
		D30	124.5558	43.1782	238.65477	5/26	1542	83
	38	D31	125.1663	43.2157	238.91080	5/26	2151	1775
		D32	124.5526	43.2172	239.05221	5/27	0115	74
	39	D33	124.4743	43.3325	238.70822	5/26	1659	86
		D34	125.1657	43.3338	238.87351	5/26	2057	1684
	40	D31	124.5526	43.2173	239.05222	5/27	0115	74
		D35	124.3358	43.6661	239.19622	5/27	0442	110
	41	D35	124.3359	43.6662	239.19623	5/27	0442	110
		D36	124.8345	43.6682	239.30730	5/27	0722	797
	42	D36	124.8345	43.6682	239.30730	5/27	0722	797
		turn	124.2832	43.8308	239.42816	5/27	1016	98
	43	turn	124.2832	43.8308	239.42816	5/27	1016	98
		NH	124.1909	44.5308	239.59668	5/27	1419	57

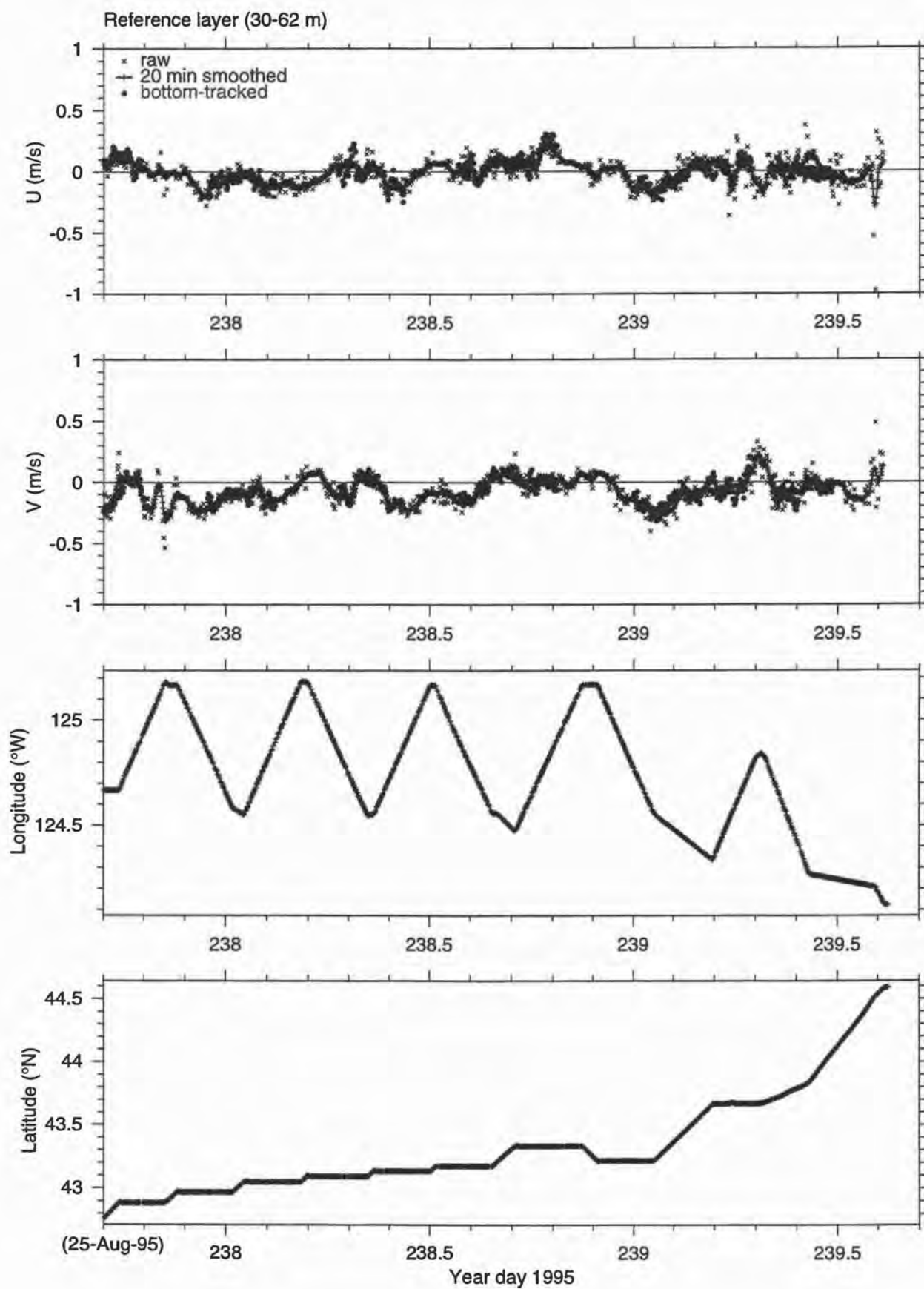
Reference layer (30-62 m)

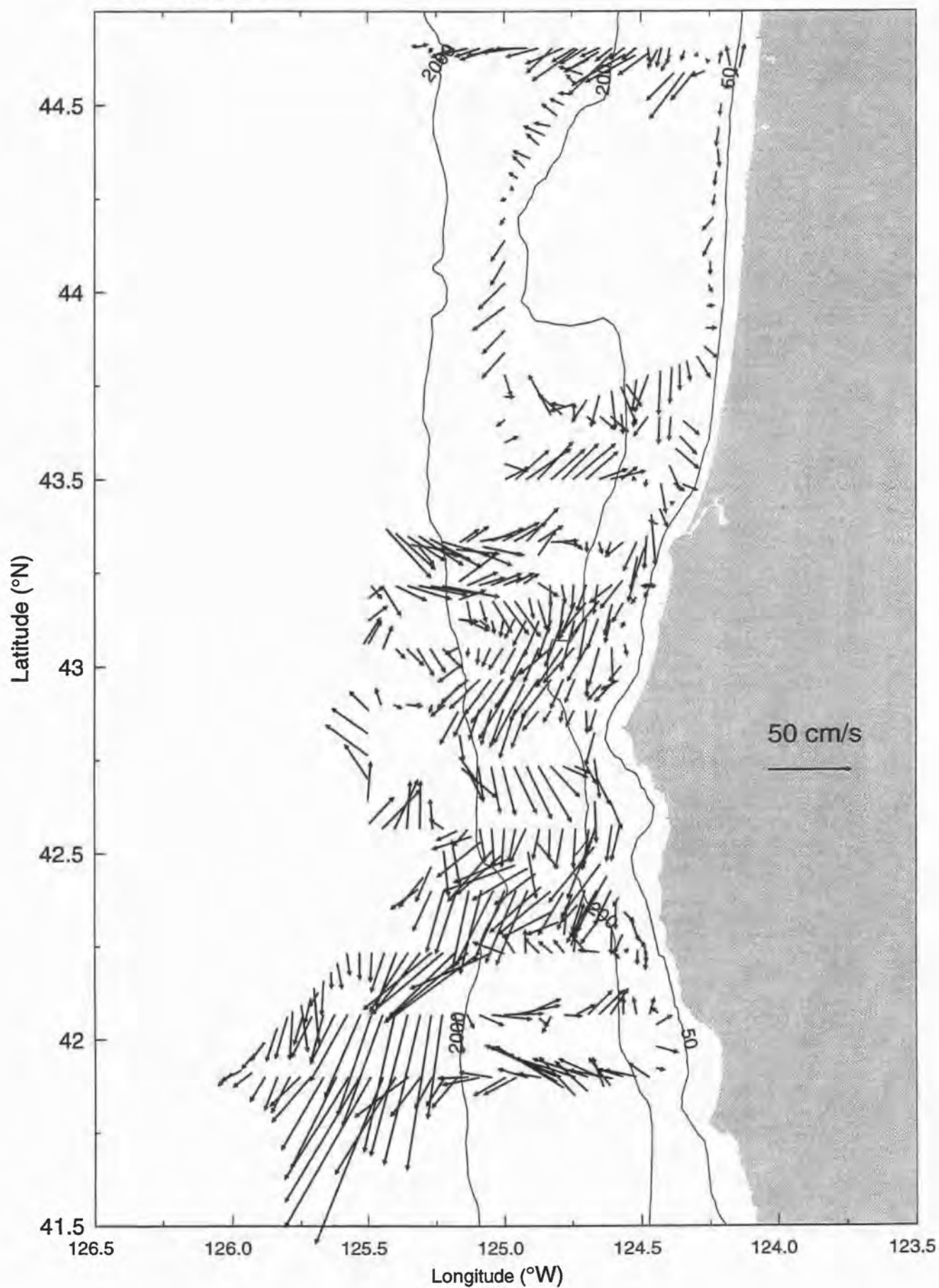


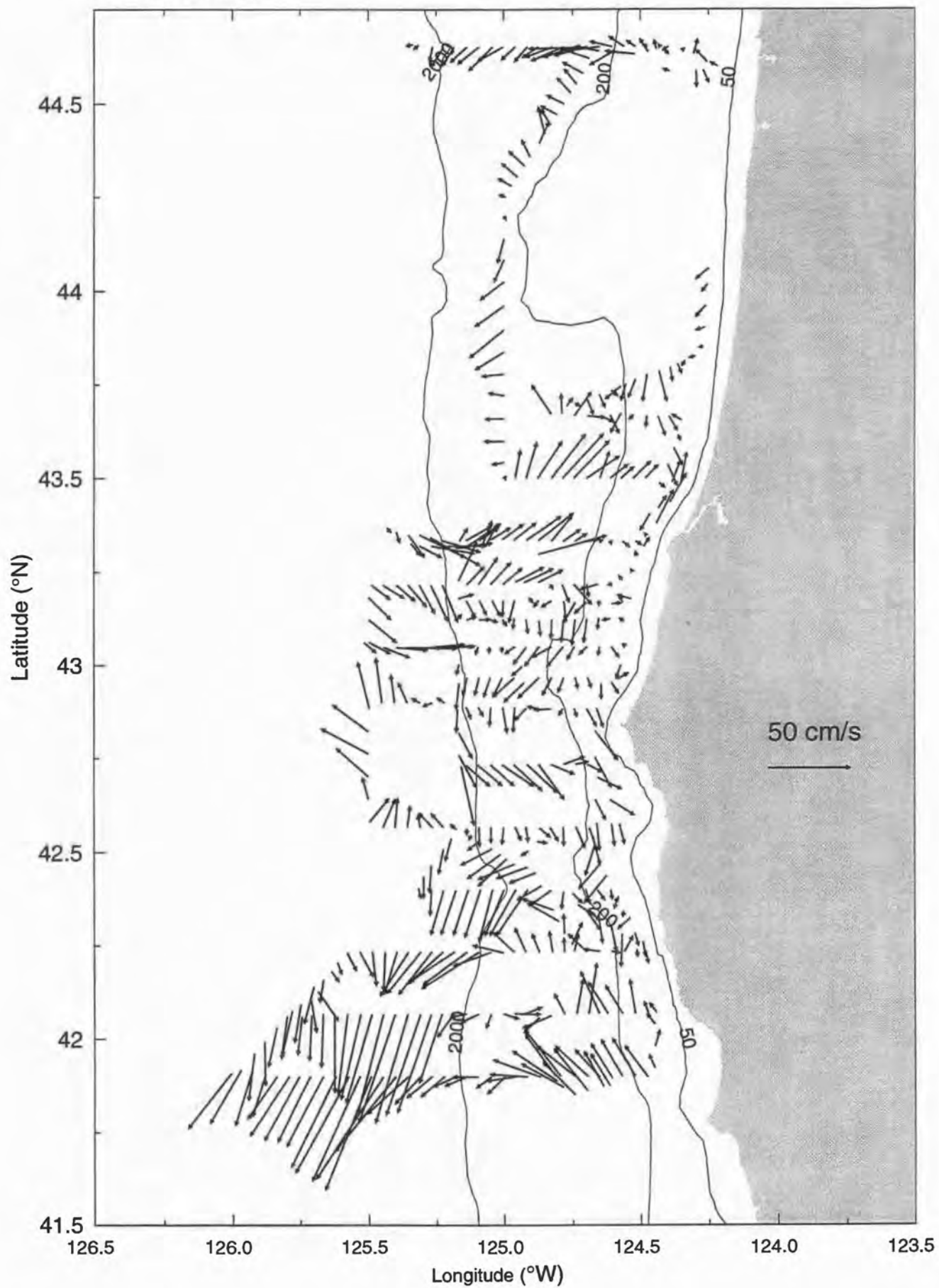


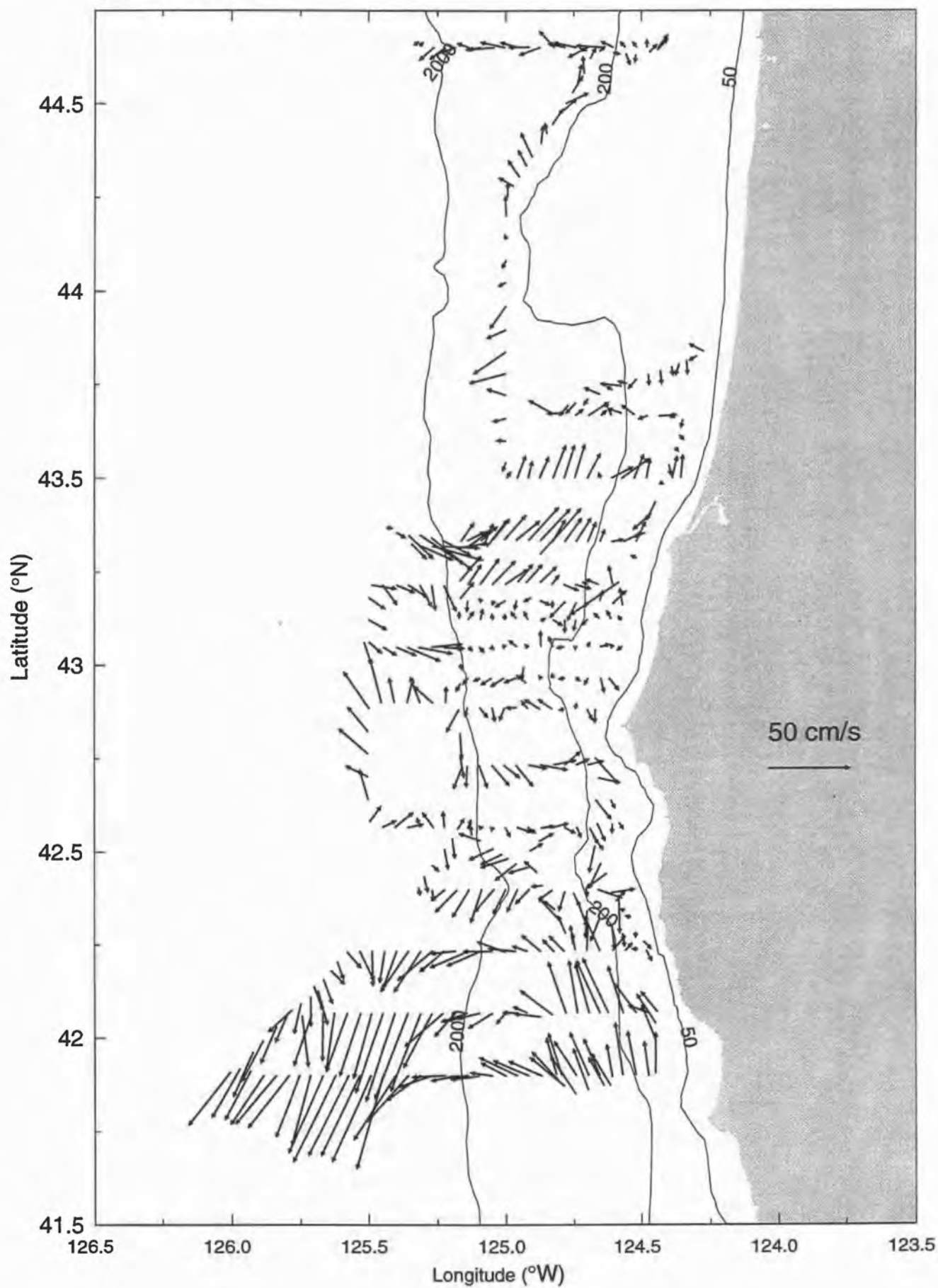


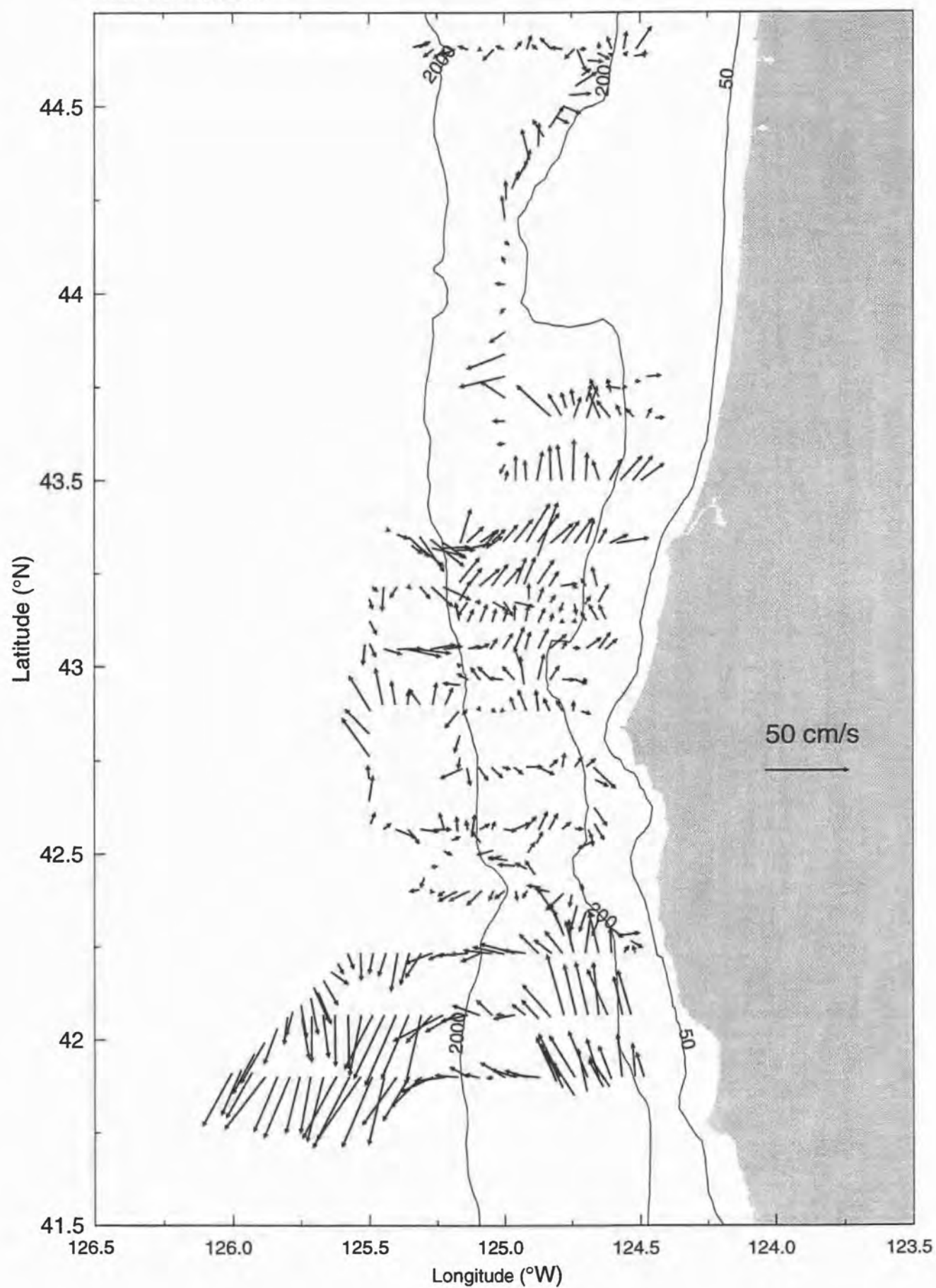


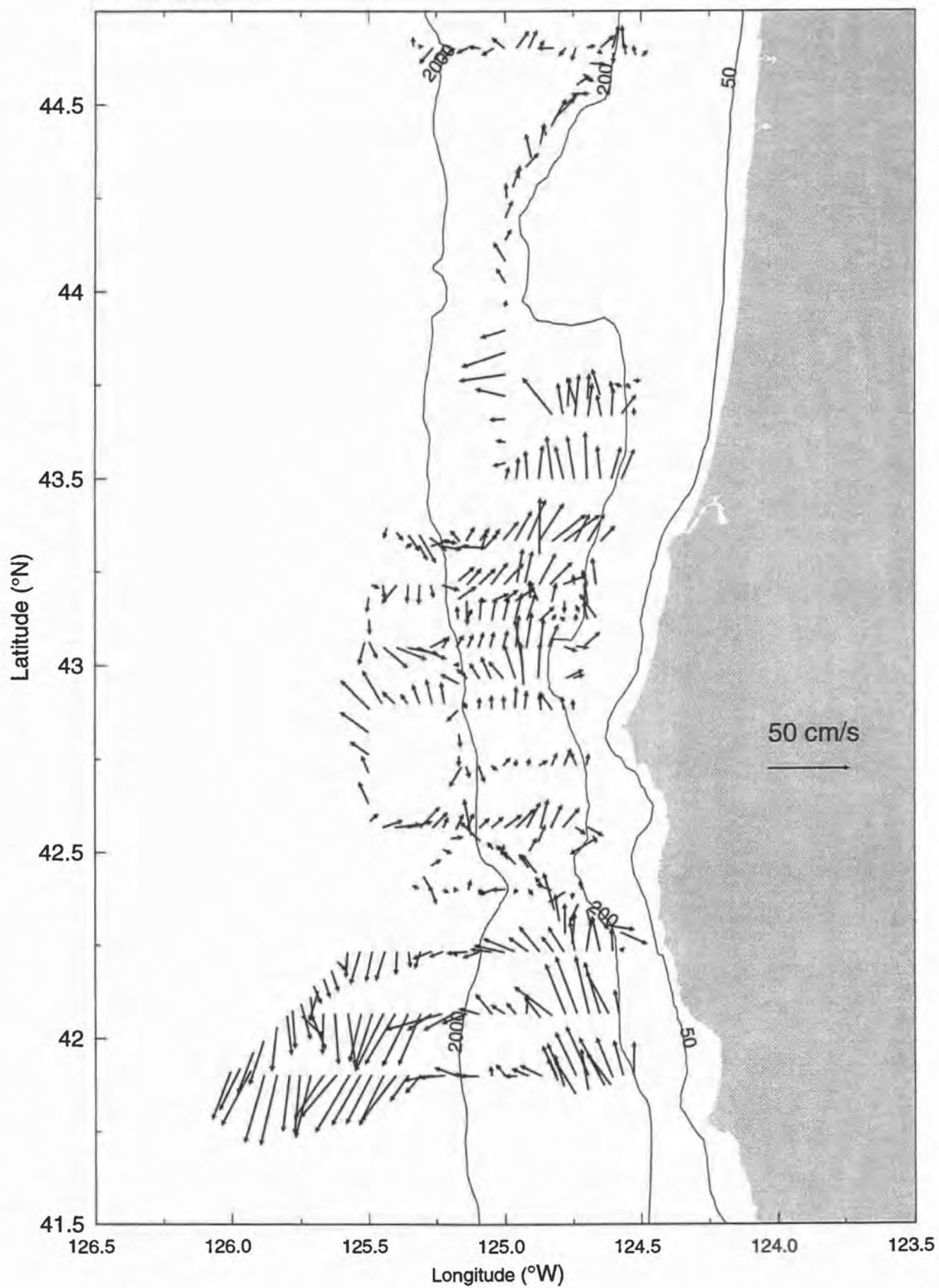


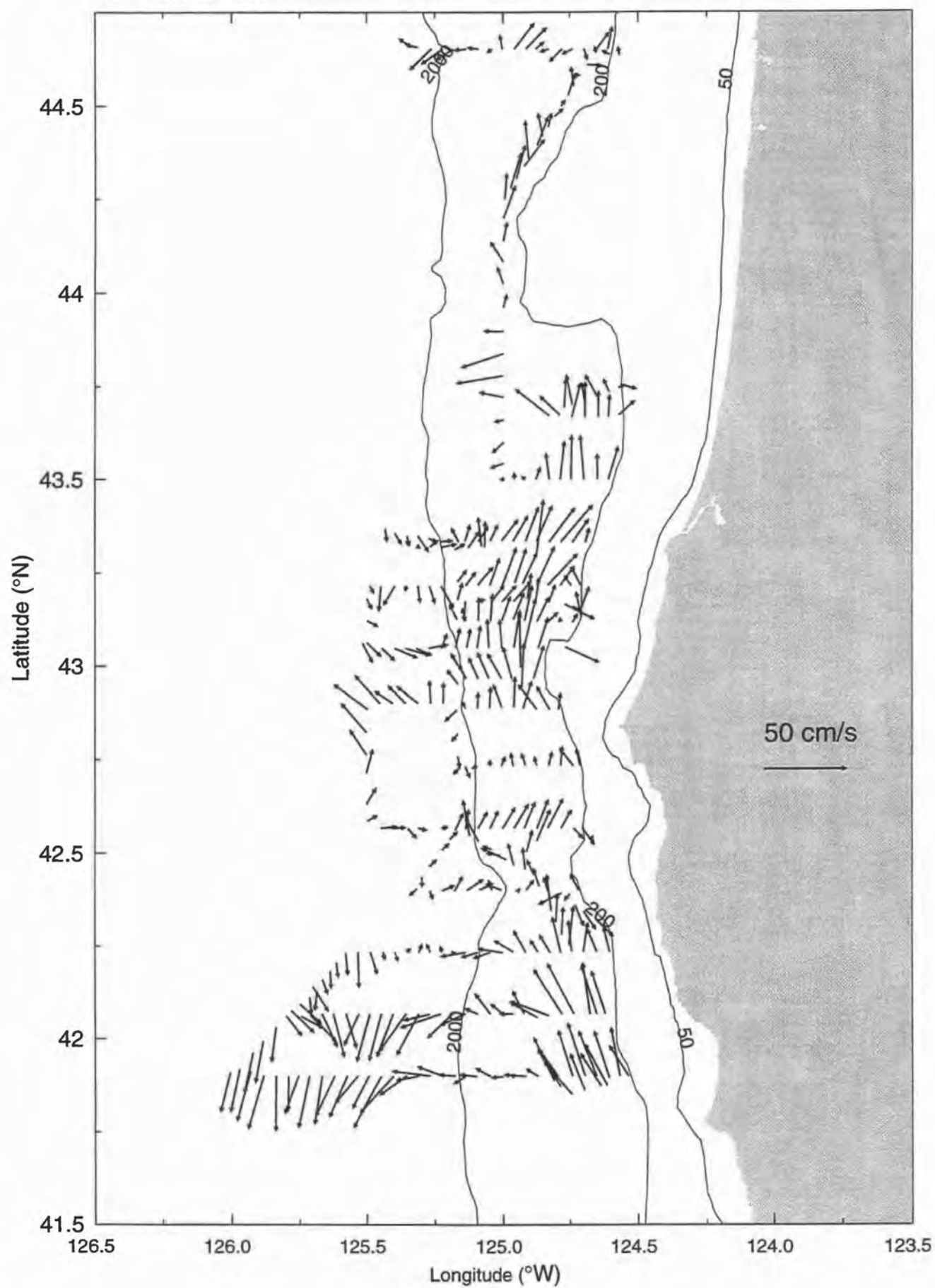


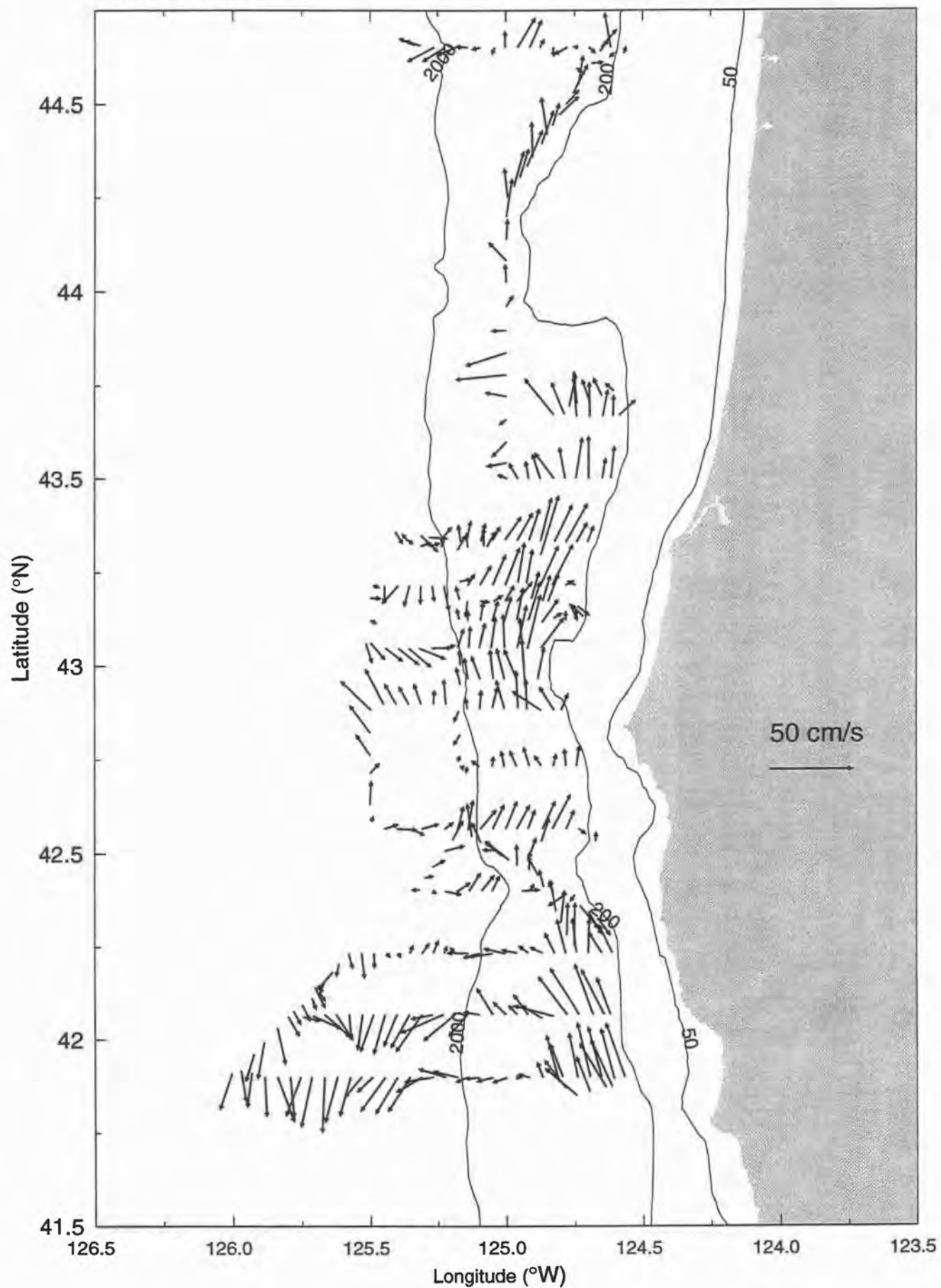


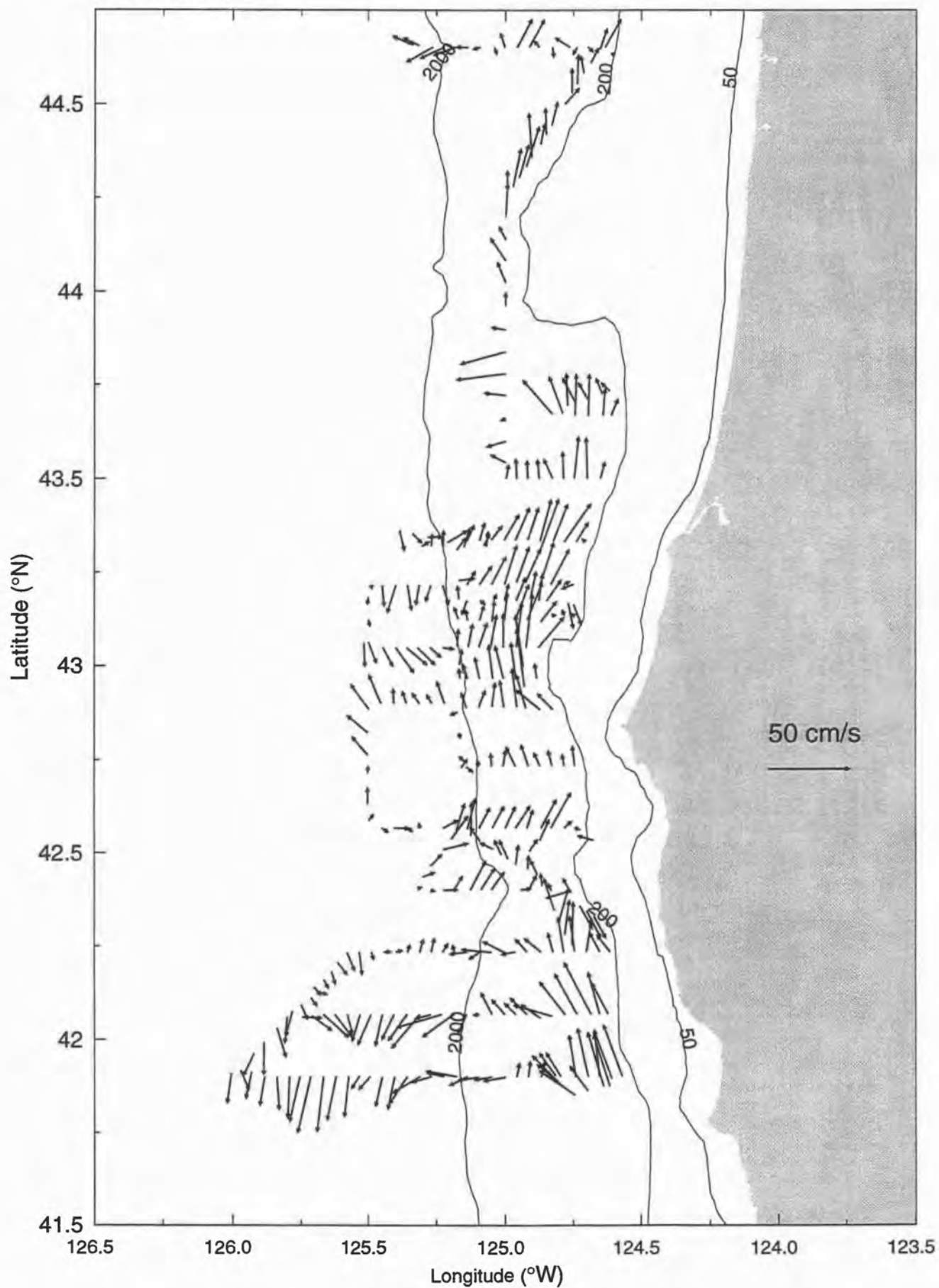


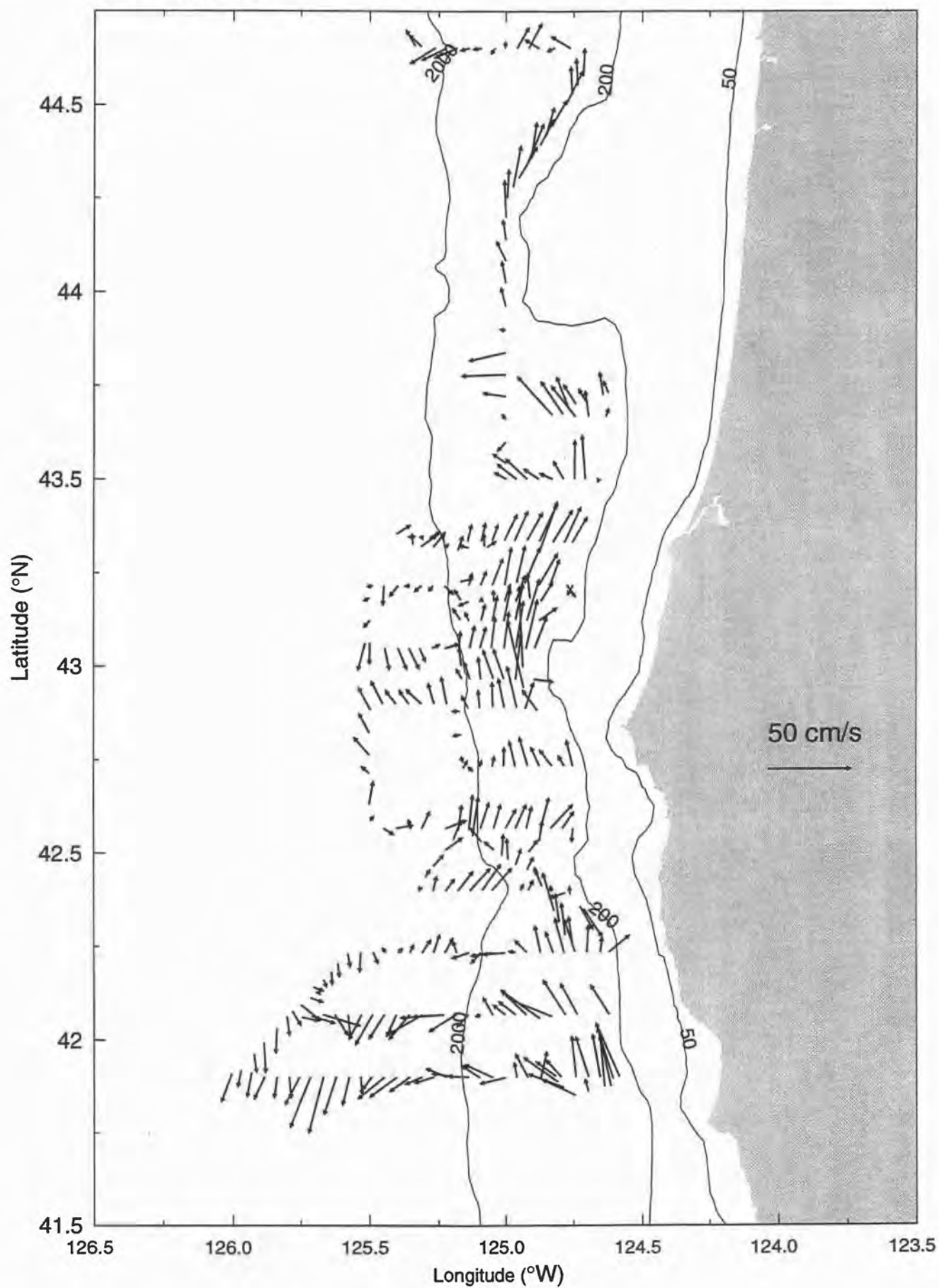


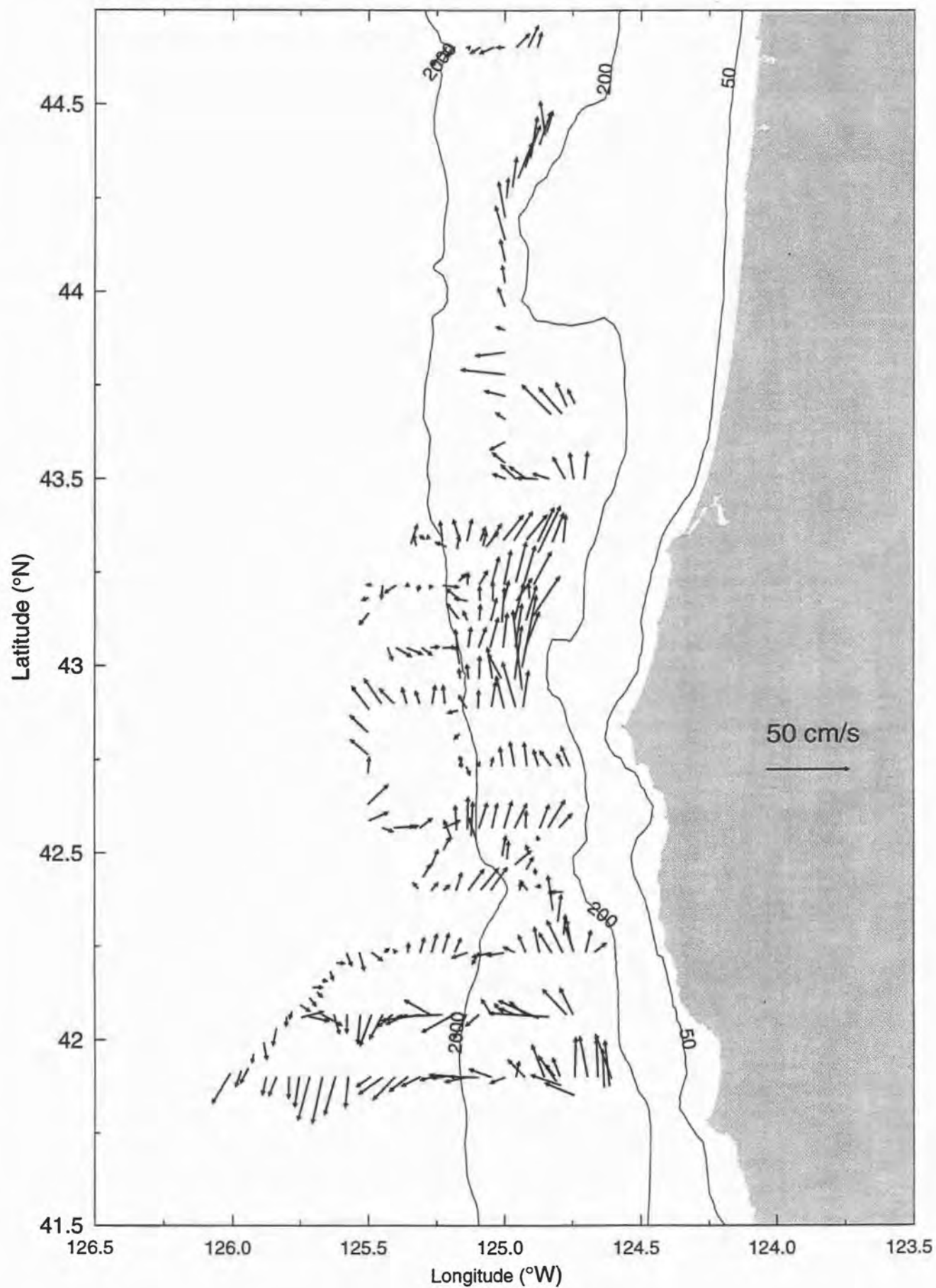










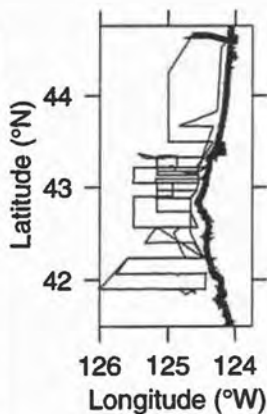
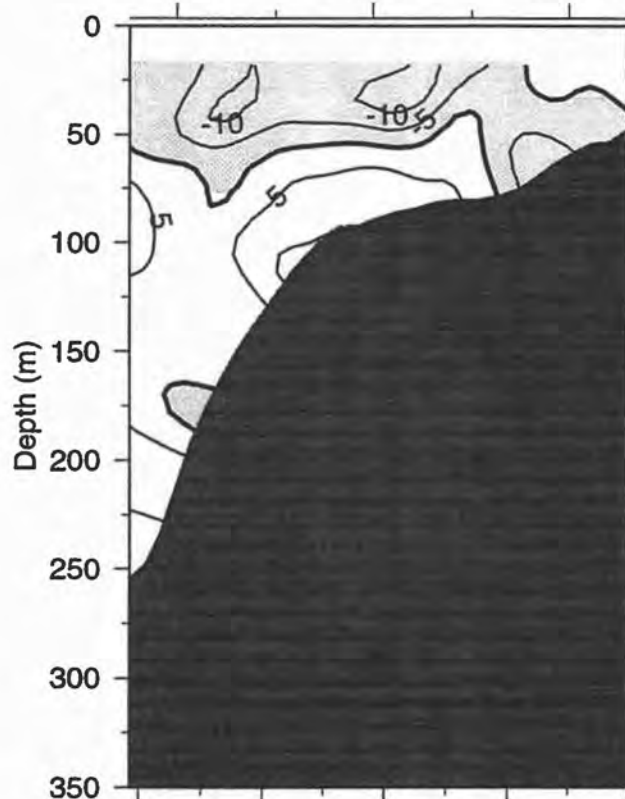


Line a ADCP, 17-Aug-95 17:11 to 17-Aug-95 22:40 (229.7163-229.9445)

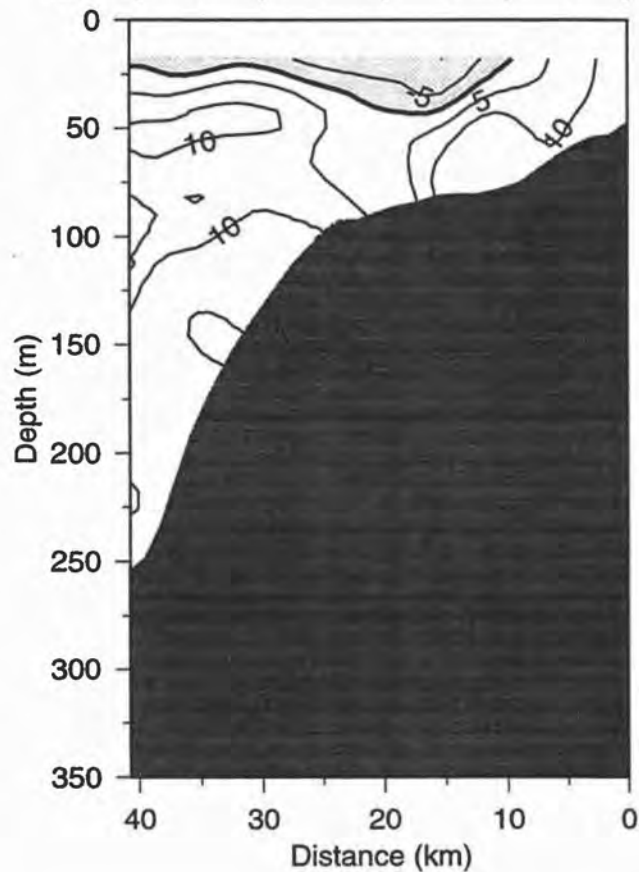
(44.62 °N)

Longitude (°W)

124.6 124.4 124.2



U



V

Line b ADCP, 17-Aug-95 22:40 to 18-Aug-95 02:11 (229.9445-230.0913)

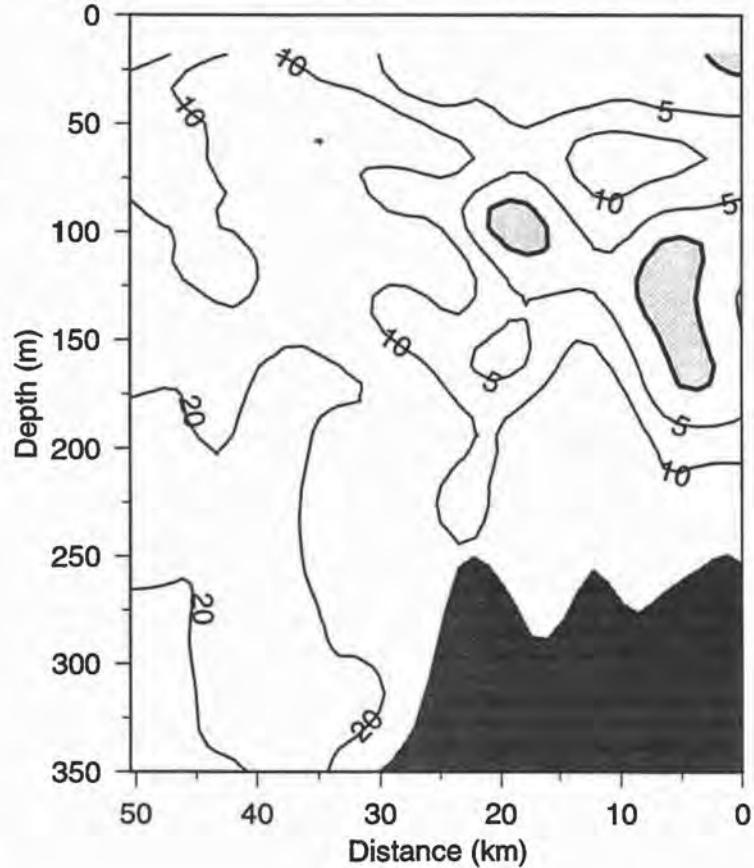
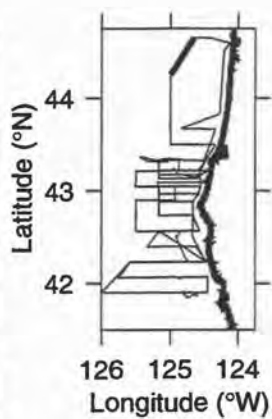
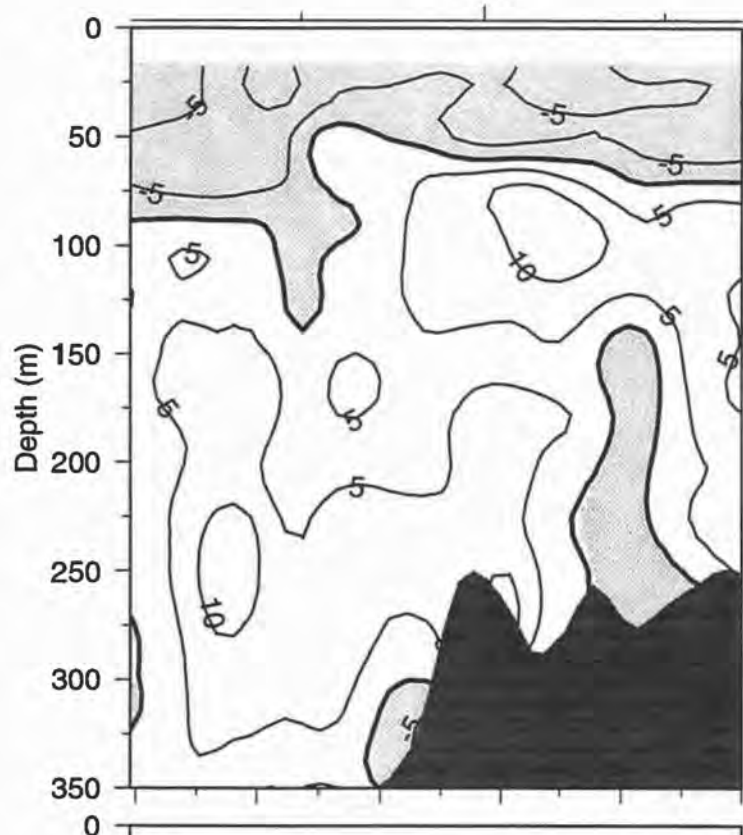
Latitude (°N)

44.4

44.6

Longitude (°W)

124.8



Line c ADCP, 18-Aug-95 02:11 to 18-Aug-95 07:39 (230.0913-230.3193)

Latitude ($^{\circ}$ N)

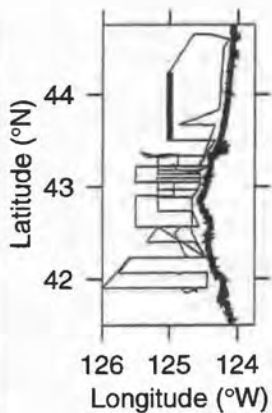
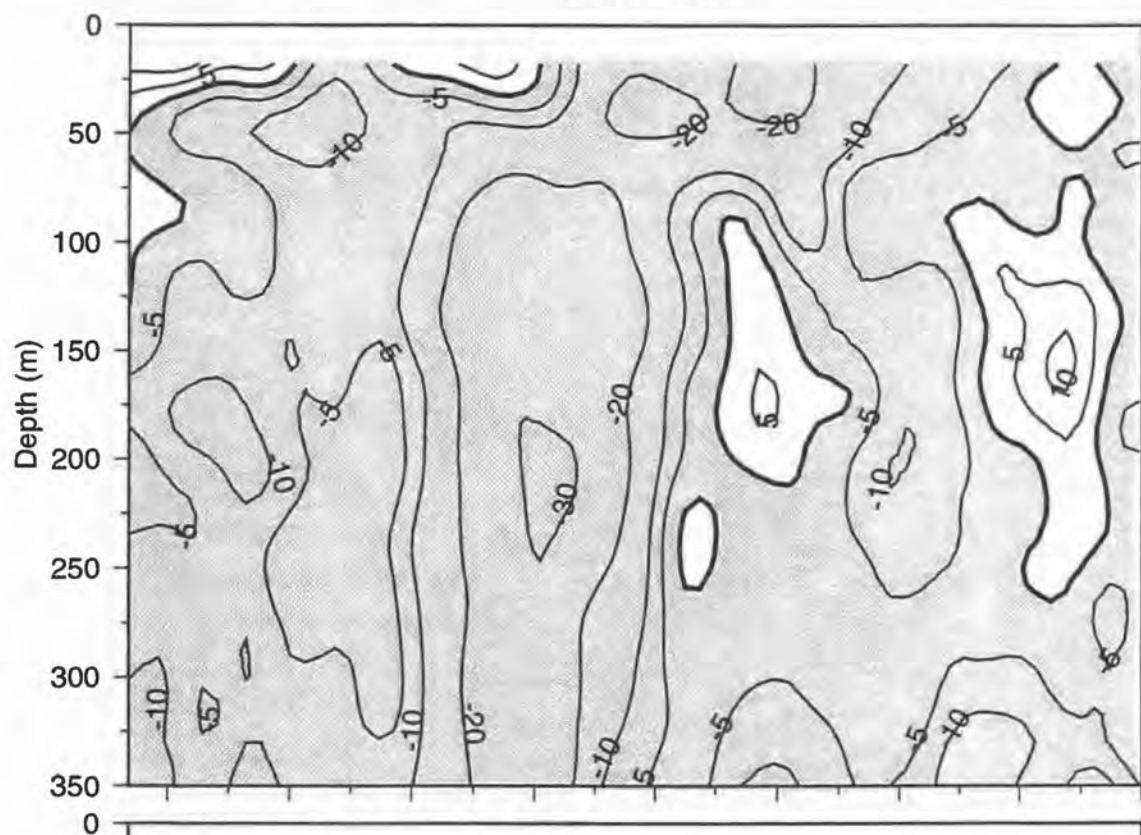
43.6

43.8

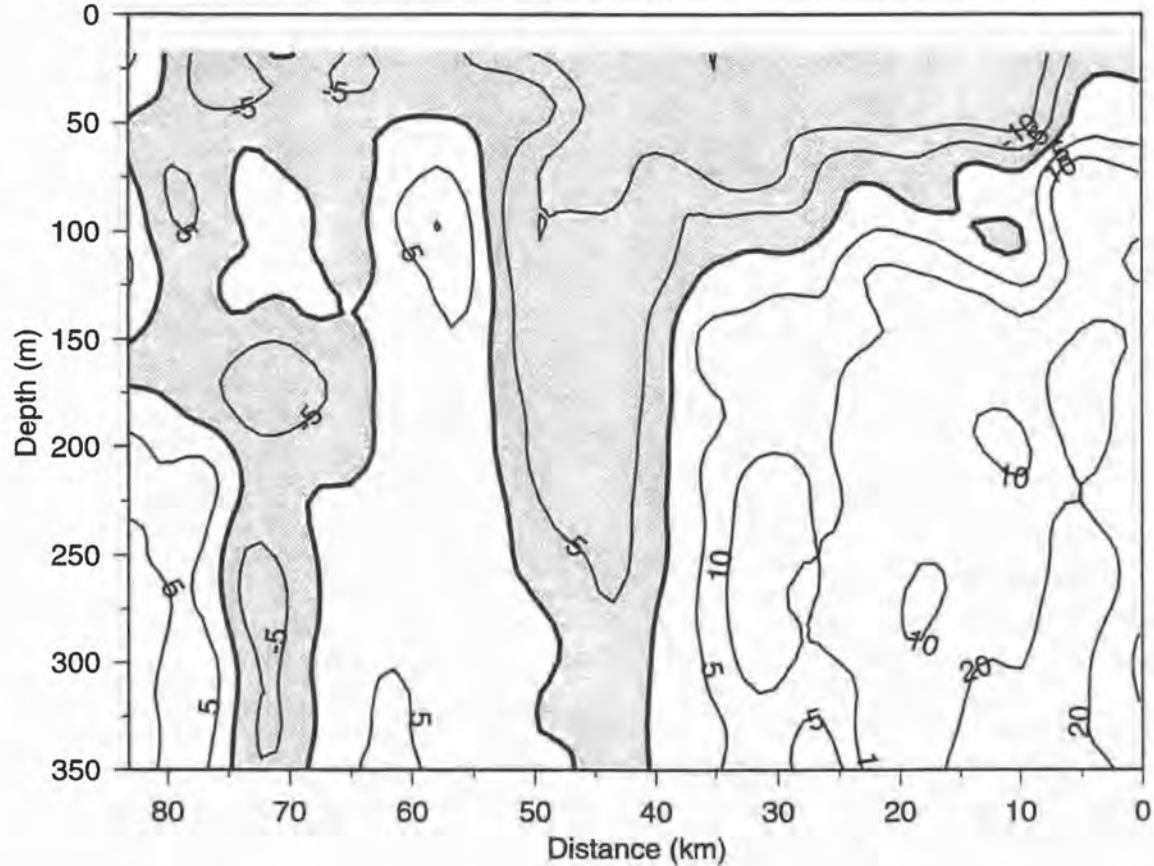
44.0

44.2

(125.00 $^{\circ}$ W)



U



V

Line 1 ADCP, 18-Aug-95 07:39 to 18-Aug-95 11:11 (230.3193-230.4665)

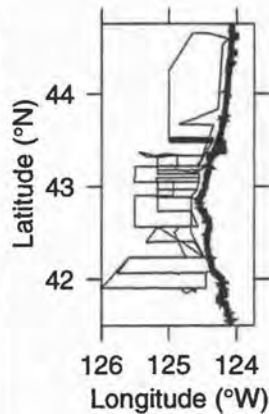
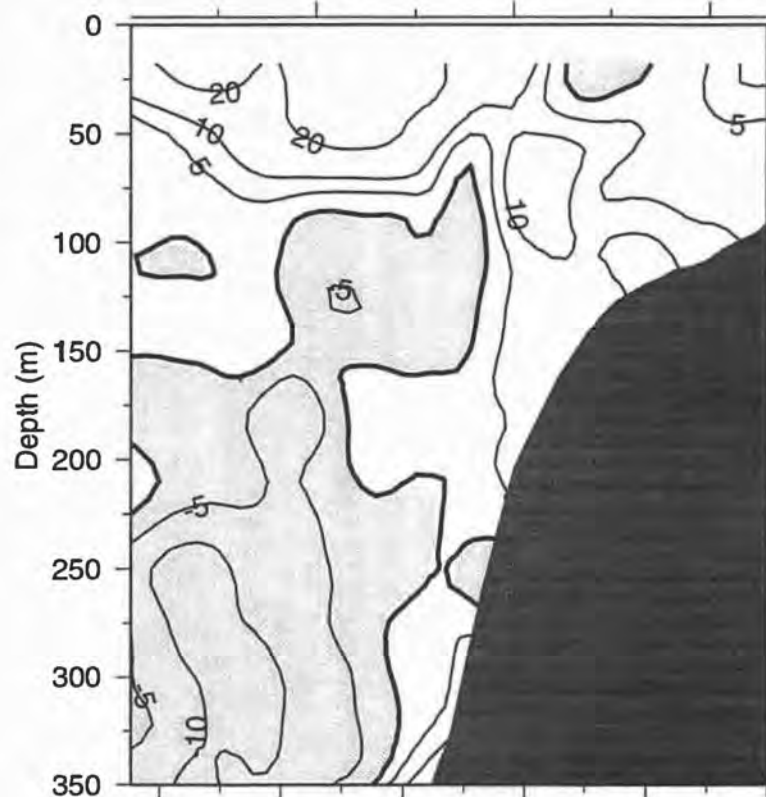
(43.50 °N)

Longitude (°W)

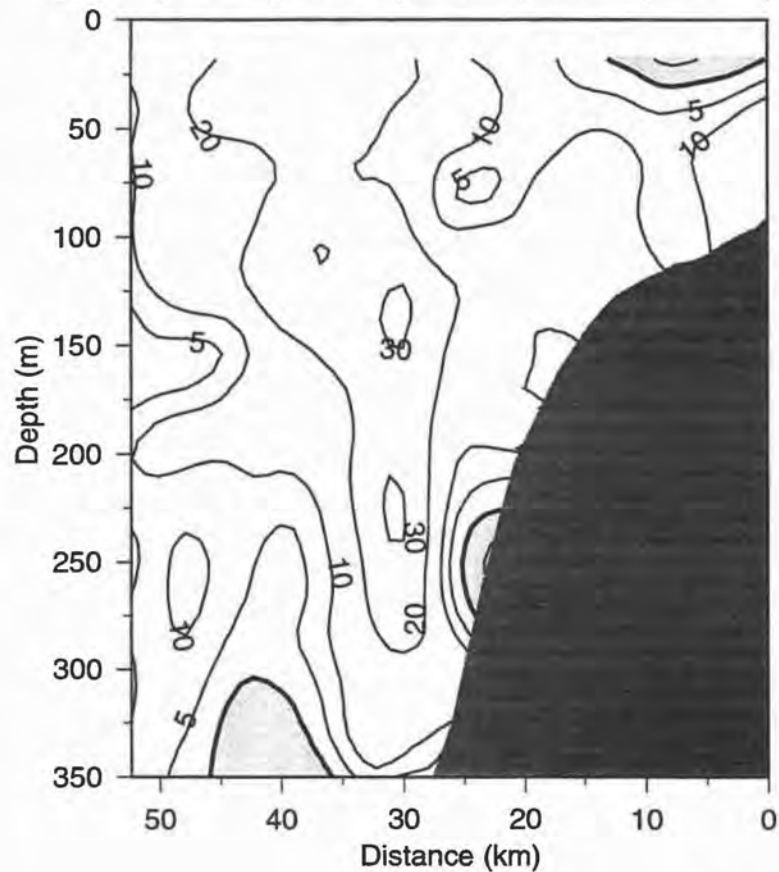
124.8

124.6

124.4



U



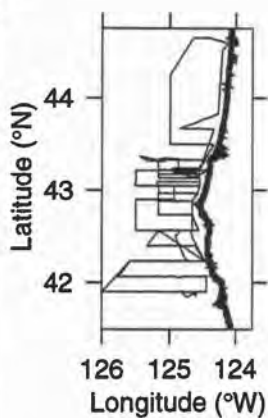
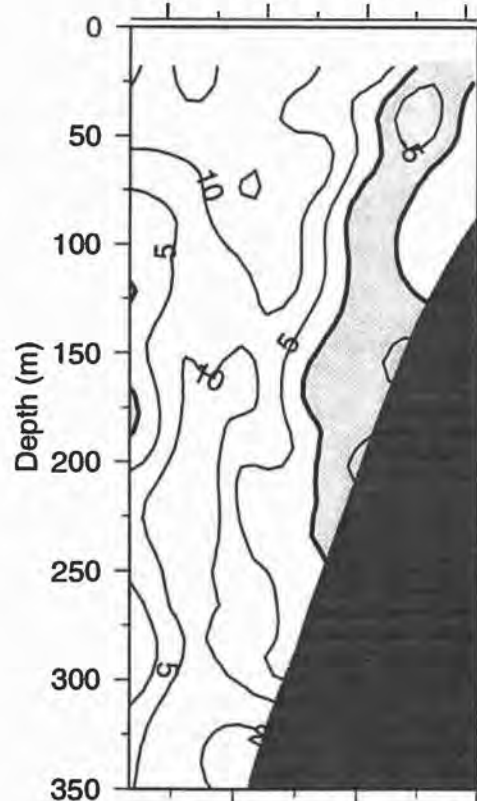
V

Line 2 ADCP, 18-Aug-95 13:33 to 18-Aug-95 15:39 (230.5651-230.6524)

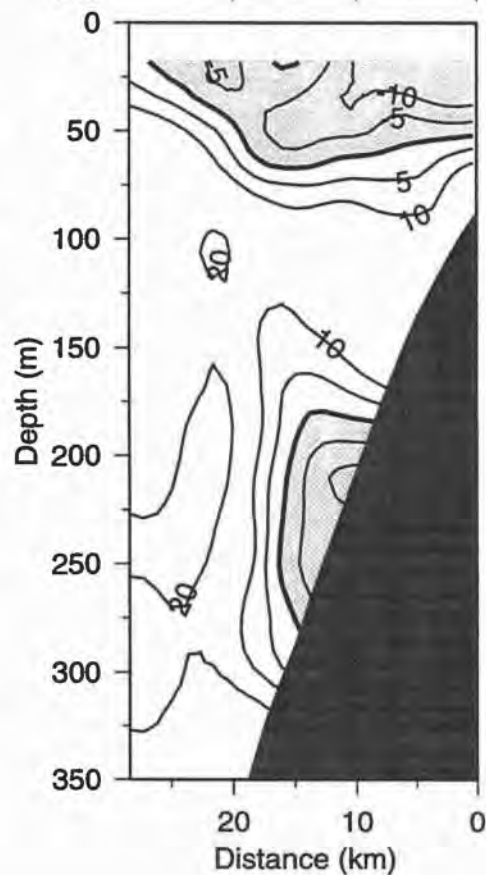
(43.22 °N)

Longitude (°W)

124.9 124.8 124.7 124.6



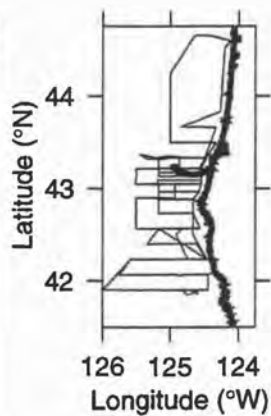
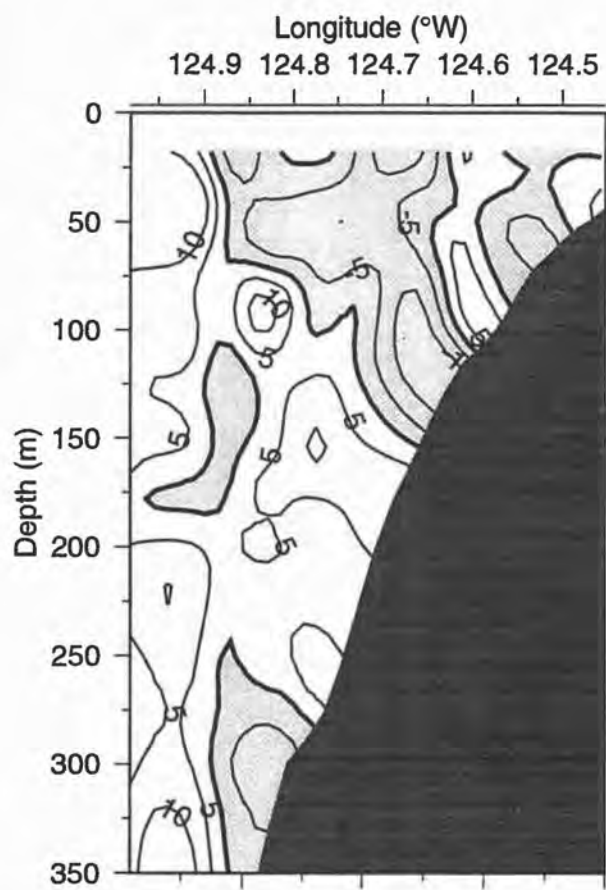
U



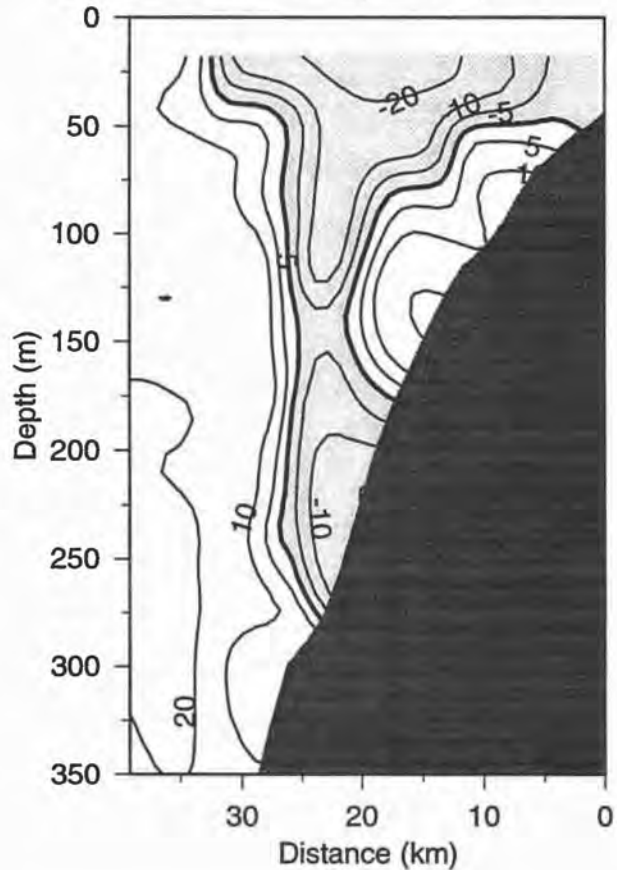
V

Line 2a ADCP, 18-Aug-95 15:39 to 18-Aug-95 21:53 (230.6524-230.9118)

(43.19 °N)

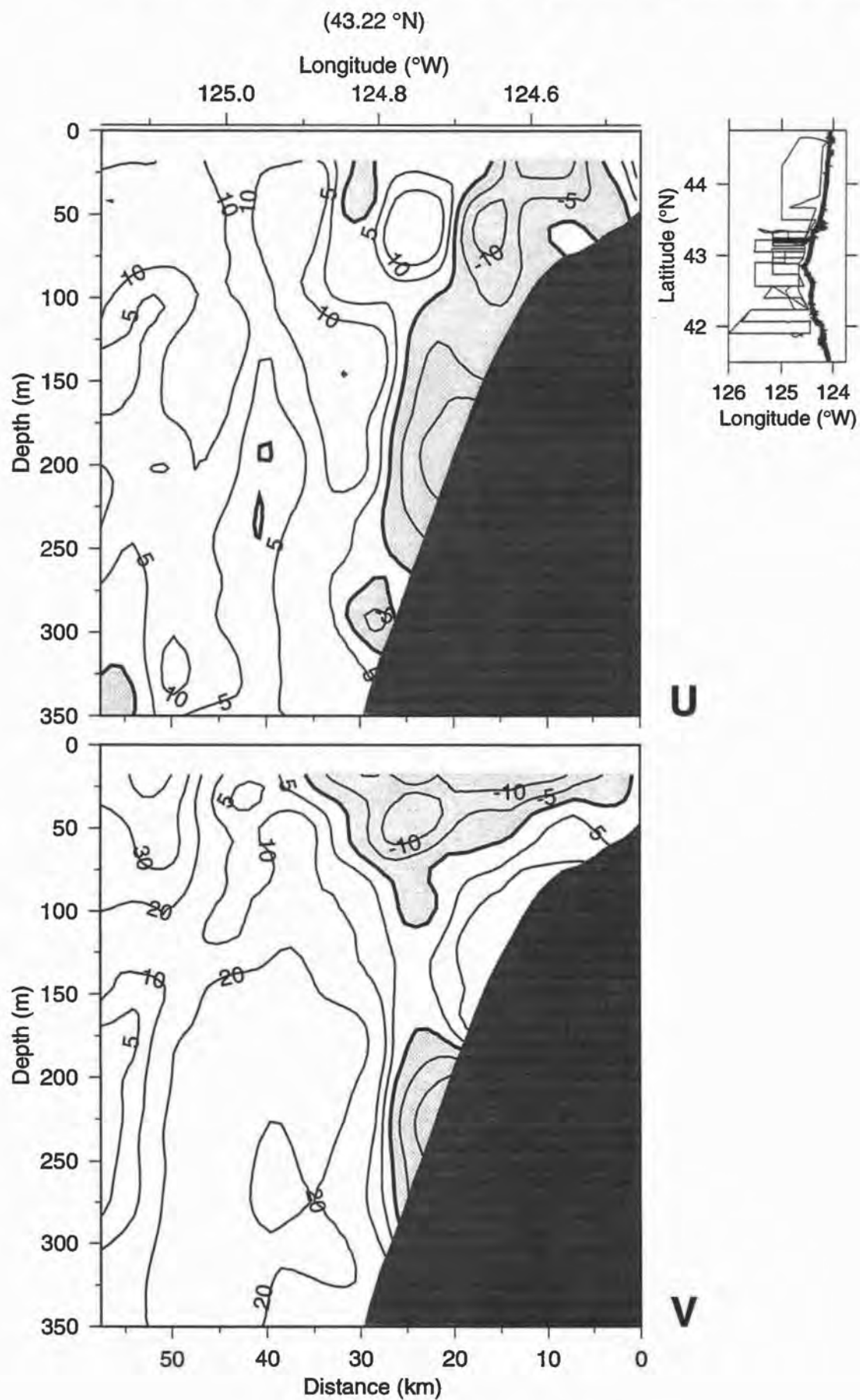


U



V

Line 2b ADCP, 18-Aug-95 21:53 to 19-Aug-95 08:44 (230.9118-231.3639)



Line 3 ADCP, 19-Aug-95 10:45 to 19-Aug-95 14:37 (231.4485-231.6095)

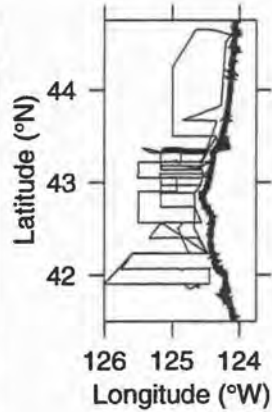
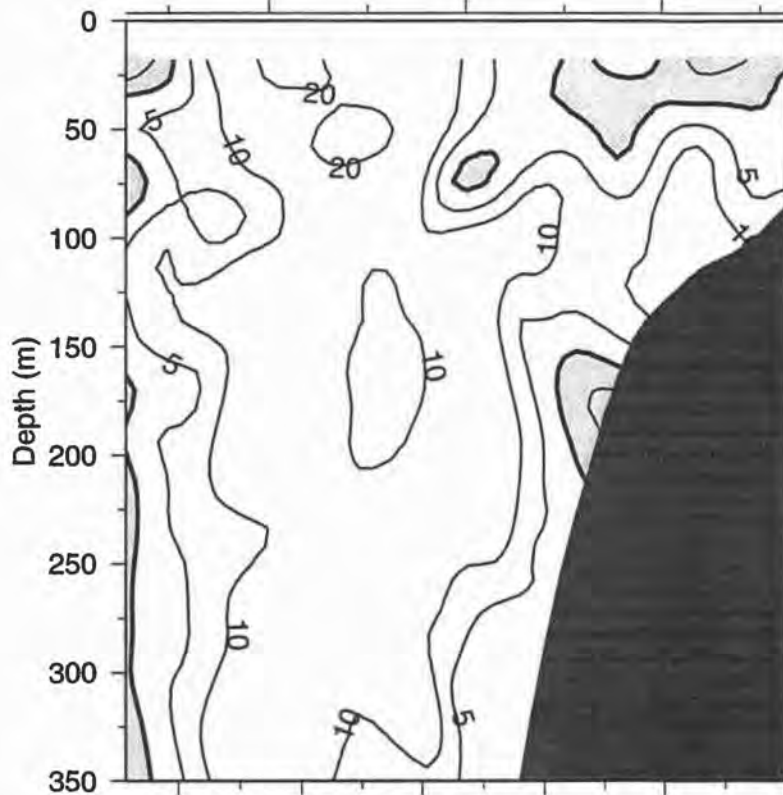
(43.34 °N)

Longitude (°W)

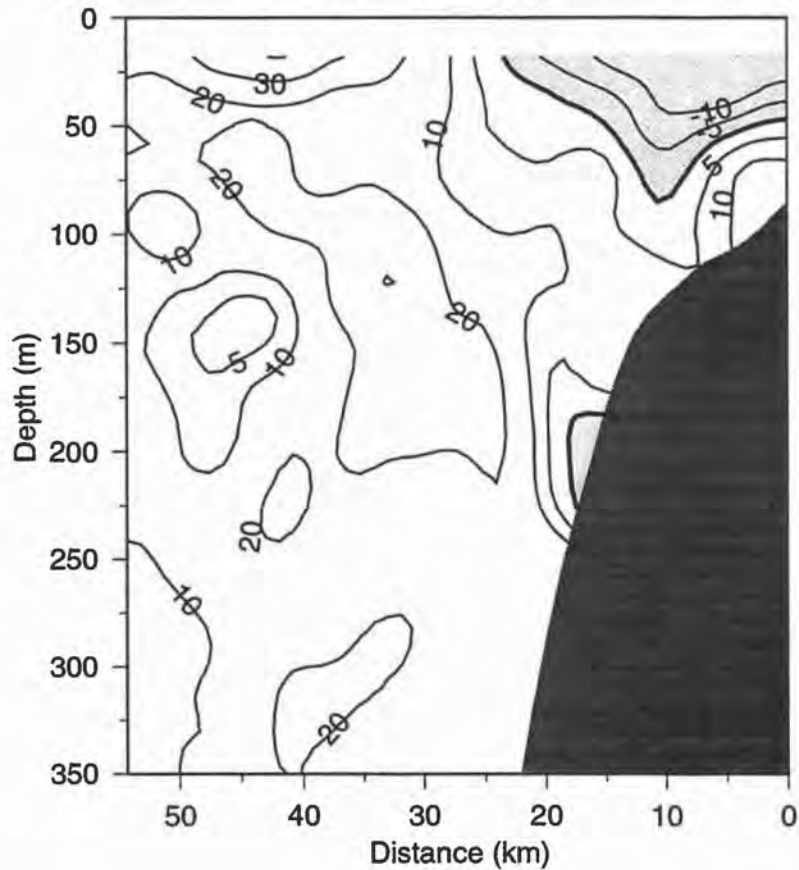
125.0

124.8

124.6



U



V

Line 4 ADCP, 19-Aug-95 15:44 to 19-Aug-95 18:59 (231.6558-231.7910)

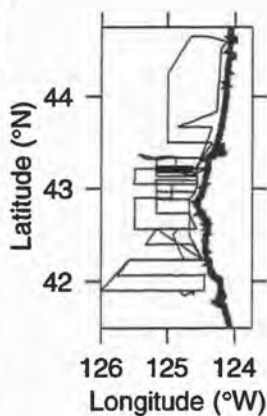
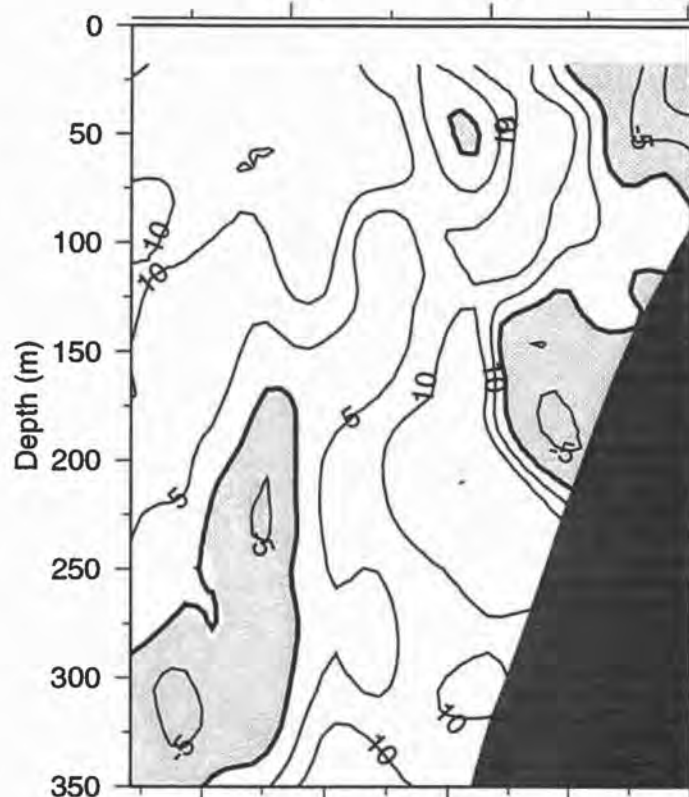
(43.22 °N)

Longitude (°W)

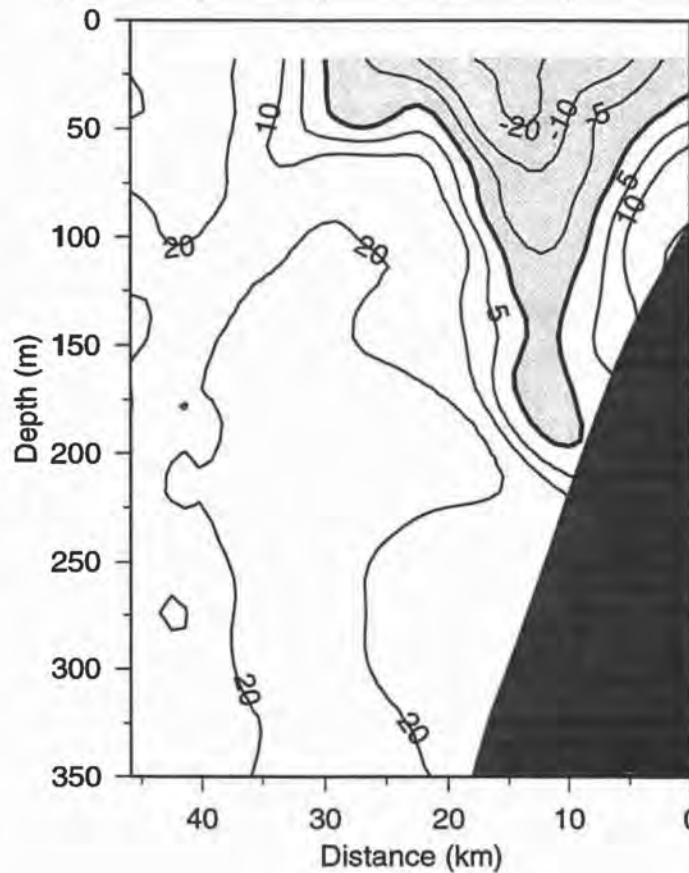
125.0

124.8

124.6



U



V

Line 5 ADCP, 19-Aug-95 19:41 to 19-Aug-95 23:08 (231.8203-231.9644)

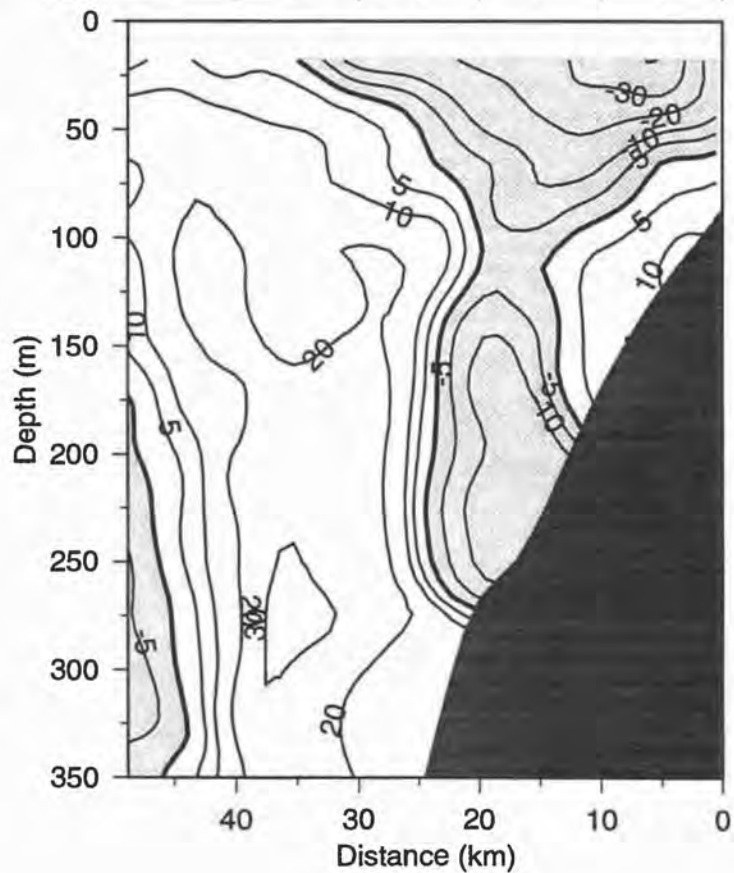
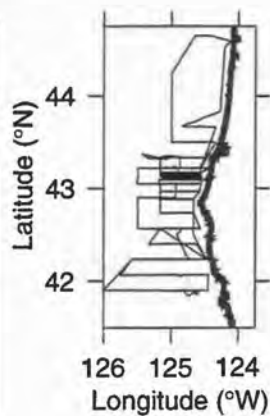
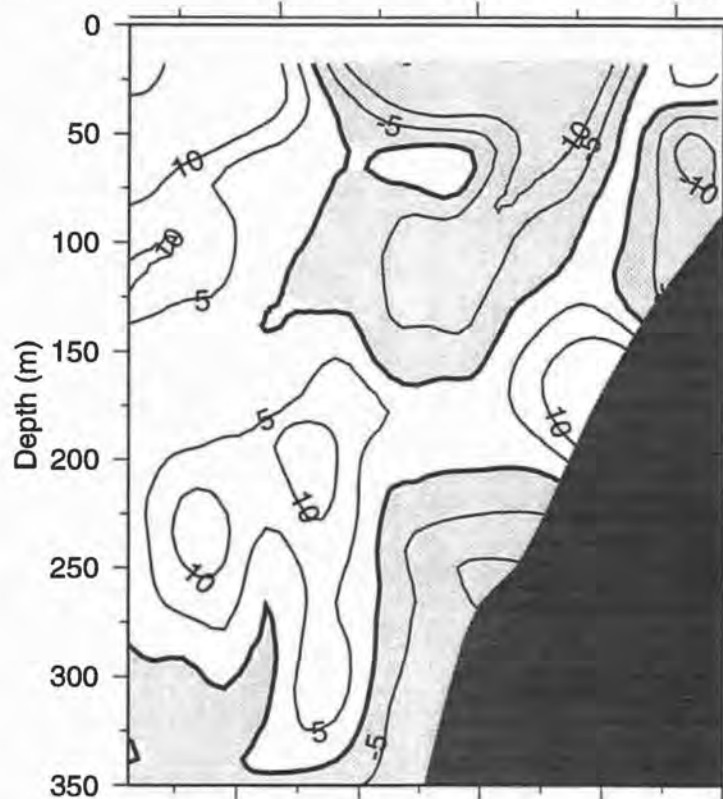
(43.13 °N)

Longitude (°W)

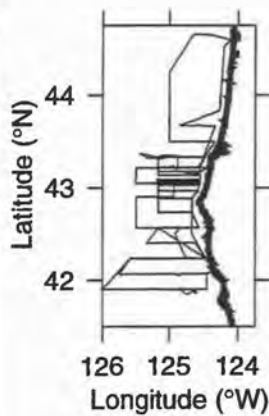
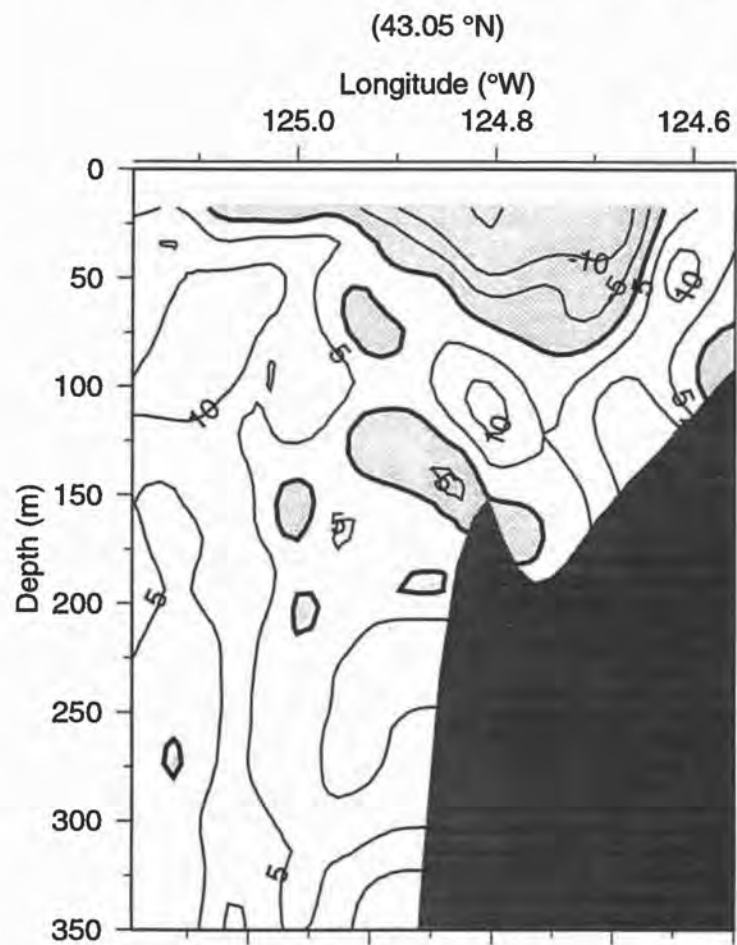
125.0

124.8

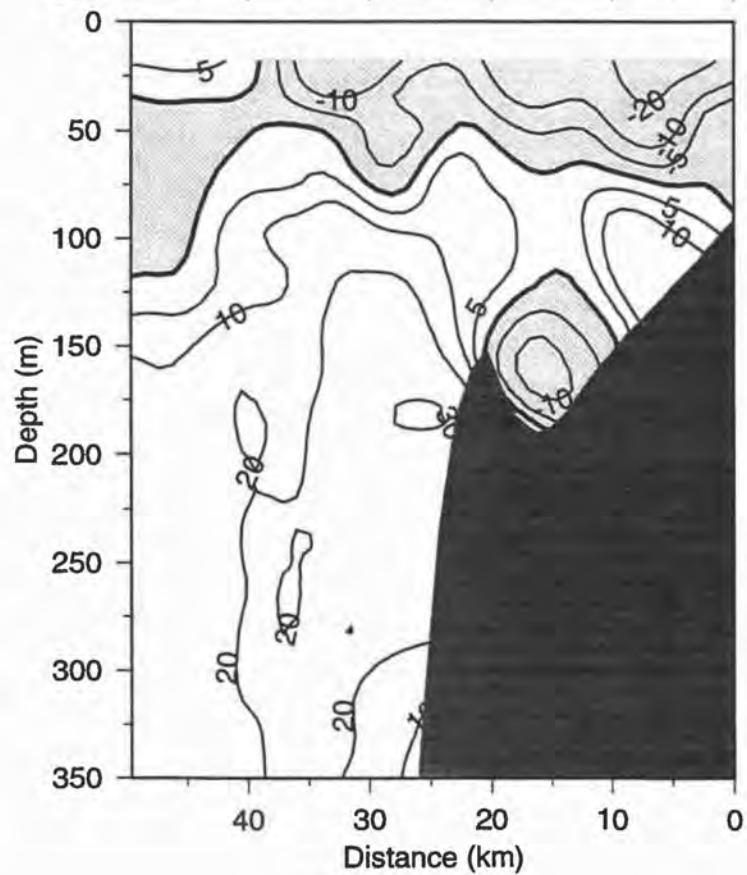
124.6



Line 6 ADCP, 19-Aug-95 23:46 to 20-Aug-95 03:00 (231.9903-232.1256)



U



V

Line 7 ADCP, 20-Aug-95 03:37 to 20-Aug-95 06:48 (232.1507-232.2834)

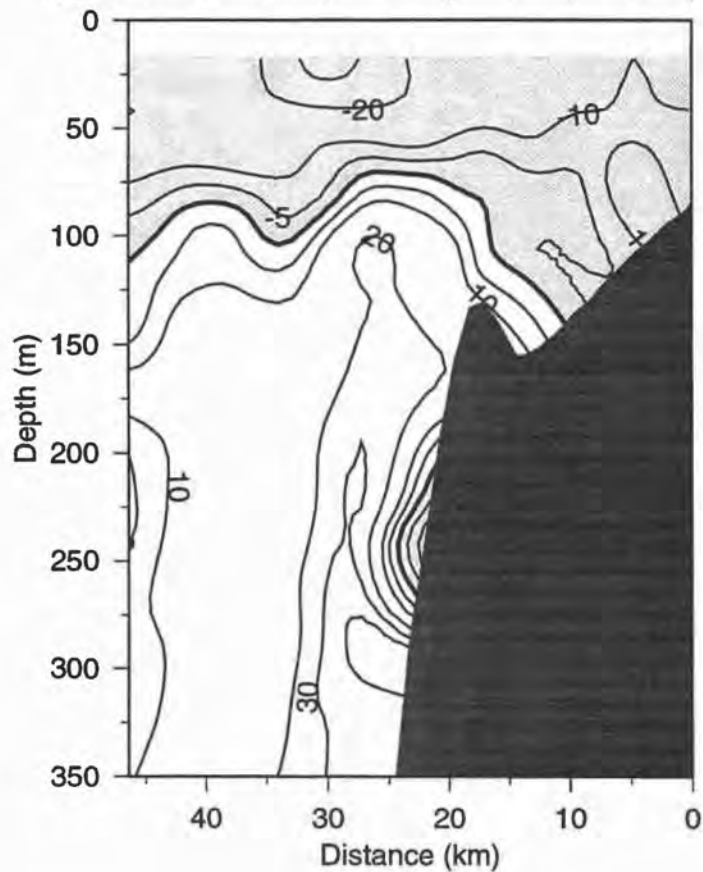
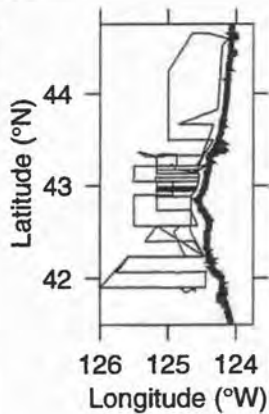
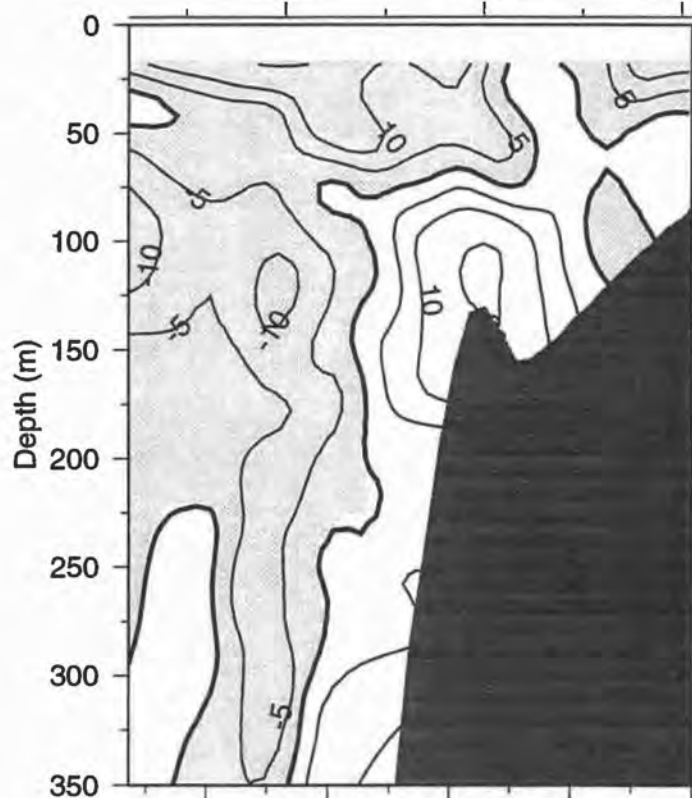
(42.96 °N)

Longitude (°W)

125.0

124.8

124.6

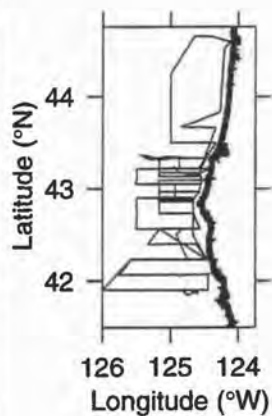
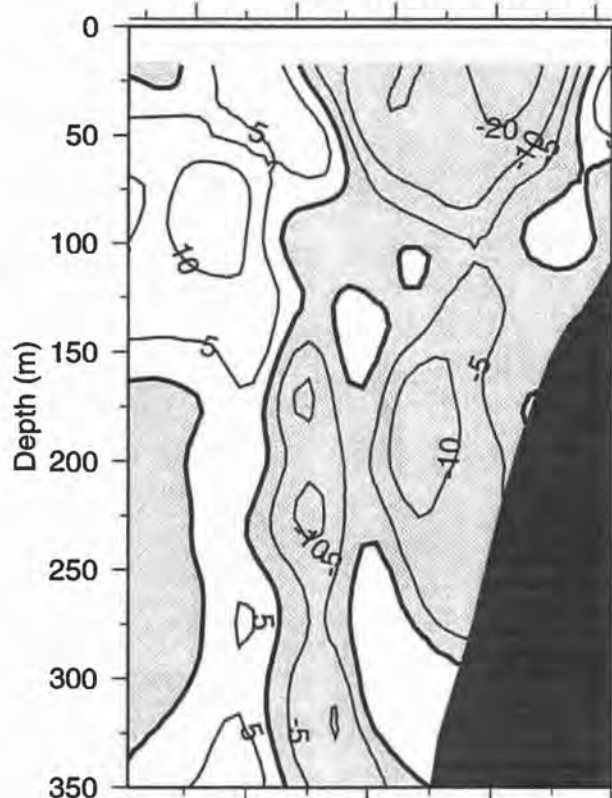


Line 8 ADCP, 20-Aug-95 07:33 to 20-Aug-95 10:09 (232.3149-232.4231)

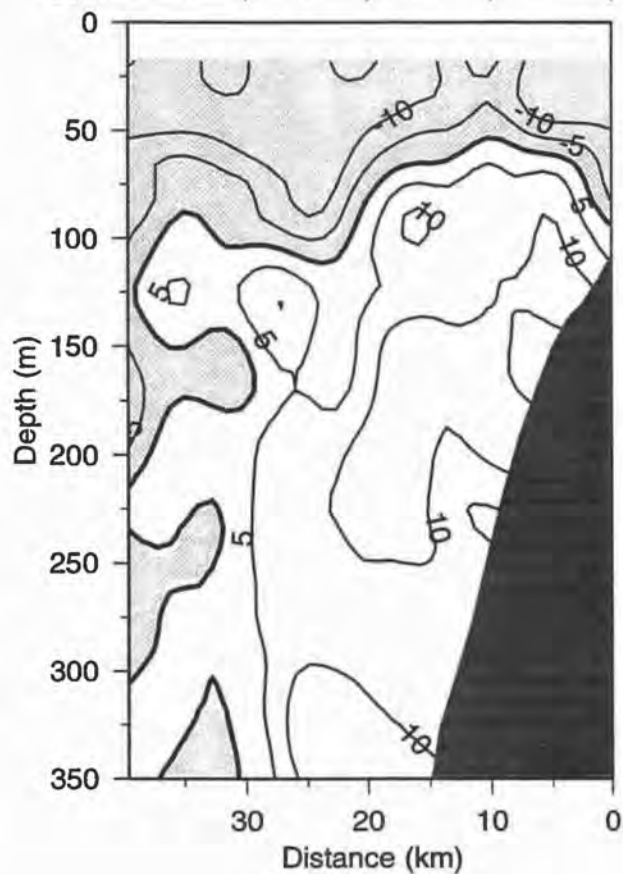
(42.88 °N)

Longitude (°W)

125.1 125.0 124.9 124.8 124.7



U



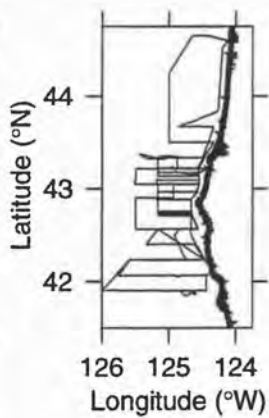
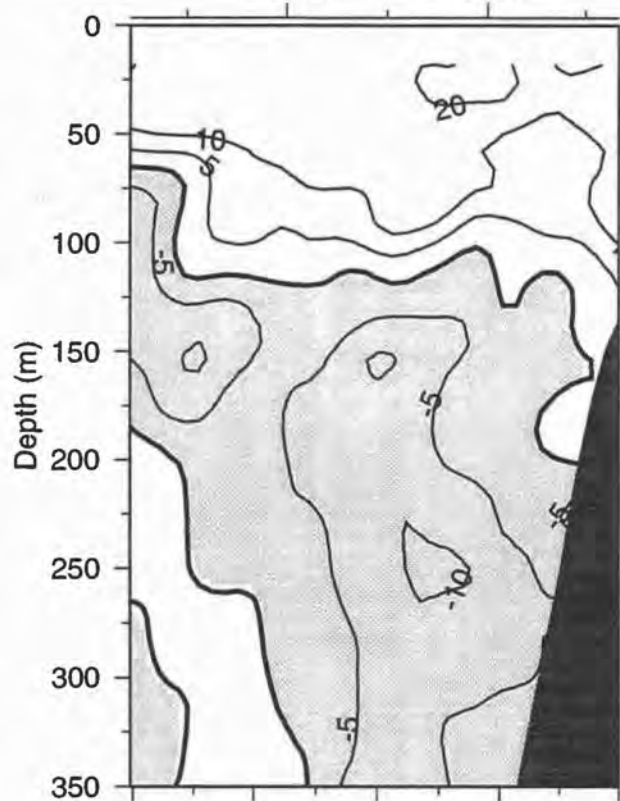
V

Line 9 ADCP, 20-Aug-95 11:13 to 20-Aug-95 13:48 (232.4677-232.5750)

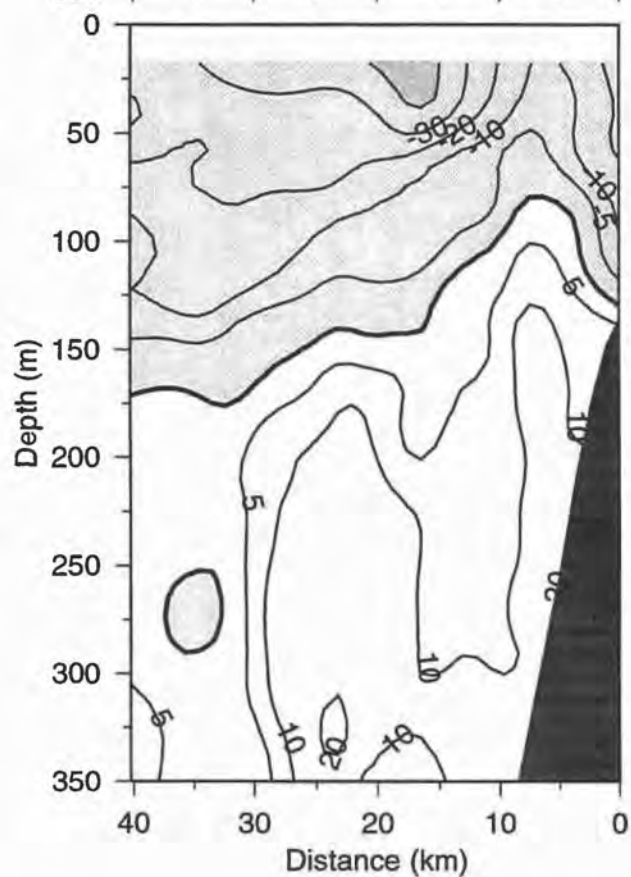
(42.73 °N)

Longitude (°W)

125.0 124.8

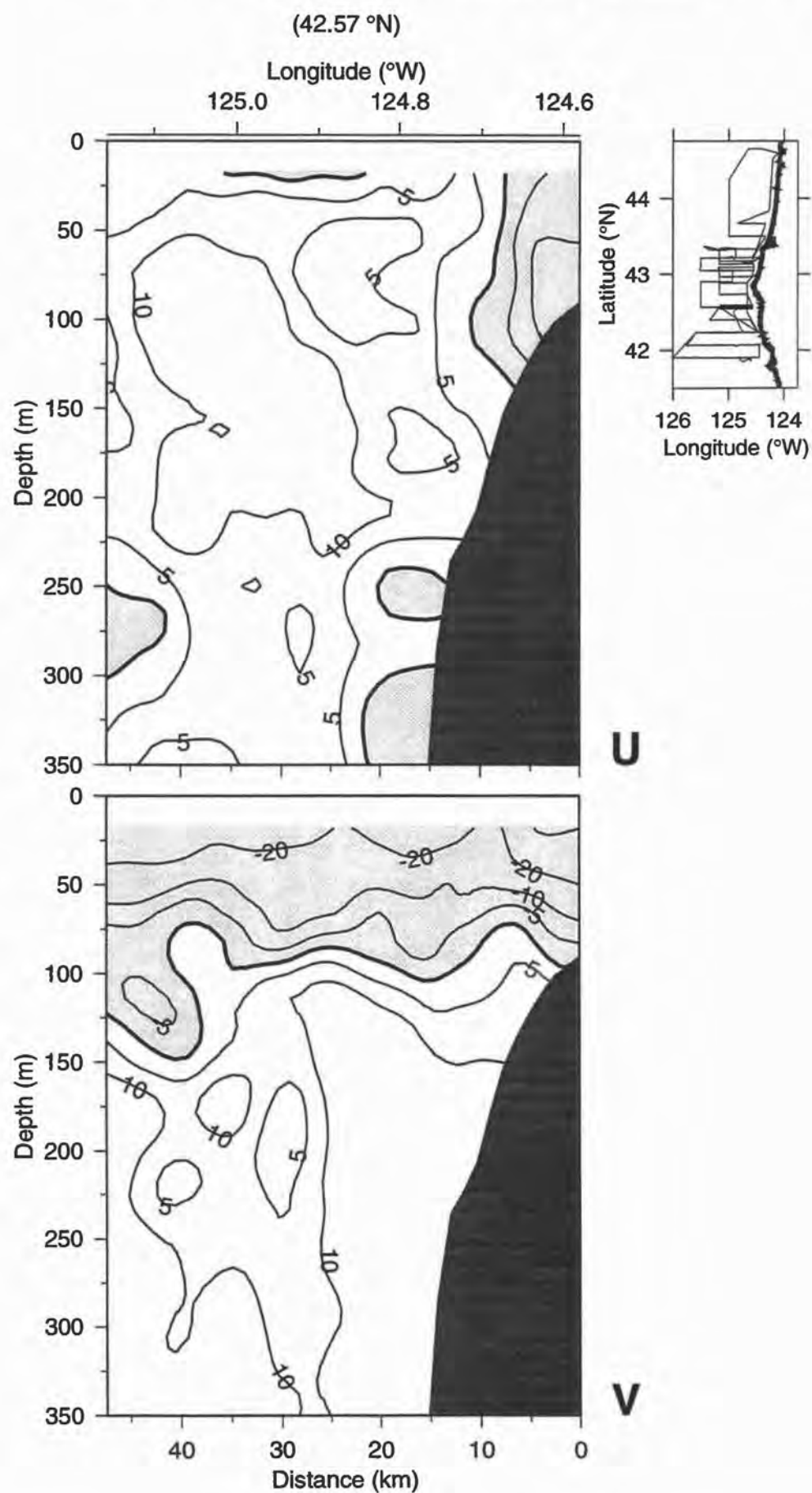


U



V

Line 10 ADCP, 20-Aug-95 15:02 to 20-Aug-95 18:13 (232.6270-232.7592)



Line 11 ADCP, 20-Aug-95 19:38 to 20-Aug-95 23:46 (232.8184-232.9908)

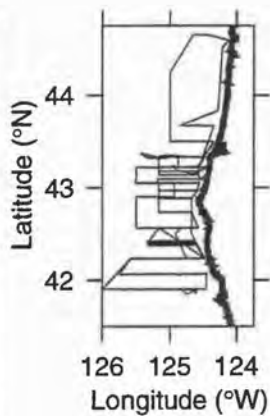
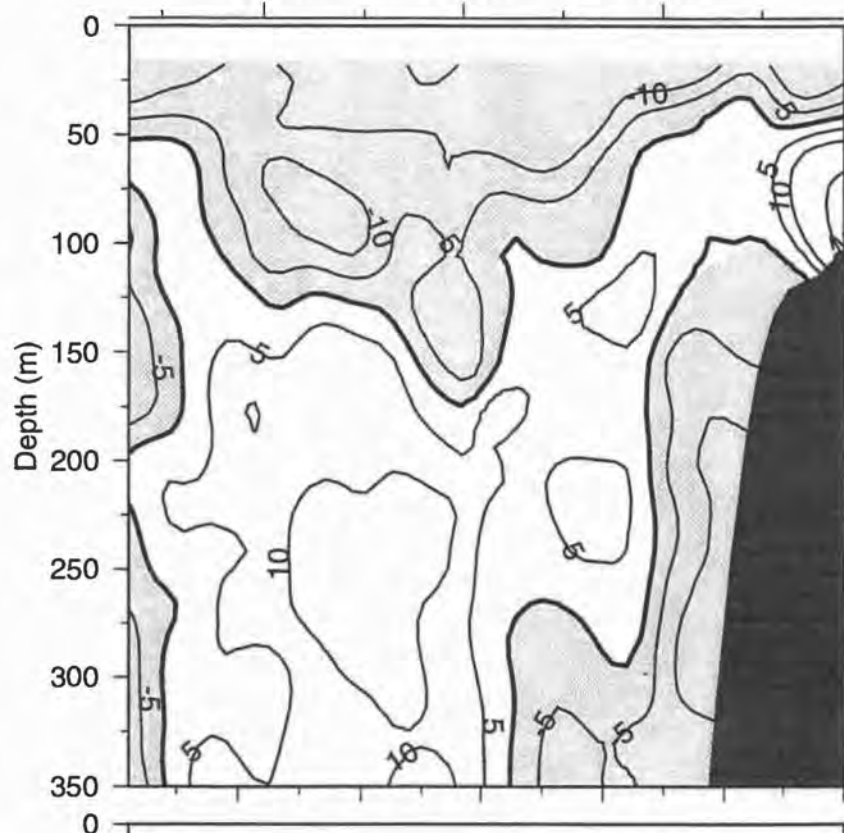
(42.40 °N)

Longitude (°W)

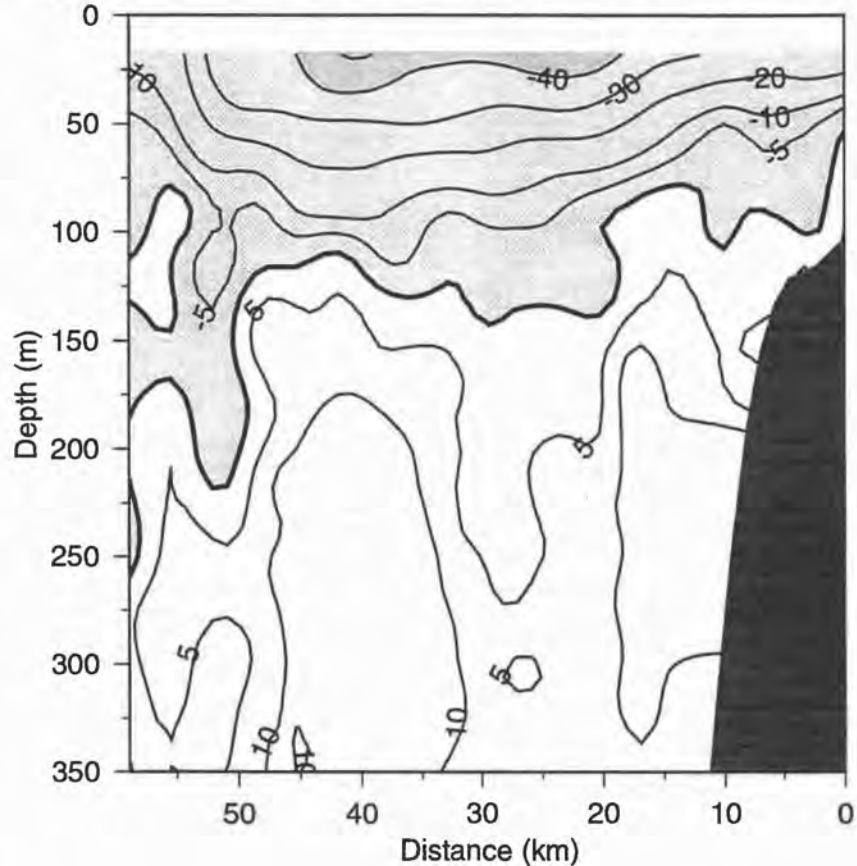
125.2

125.0

124.8



U



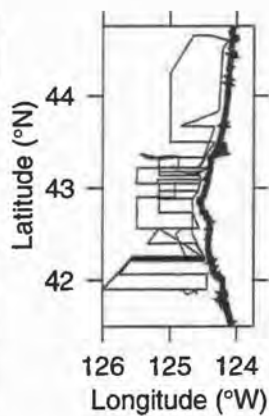
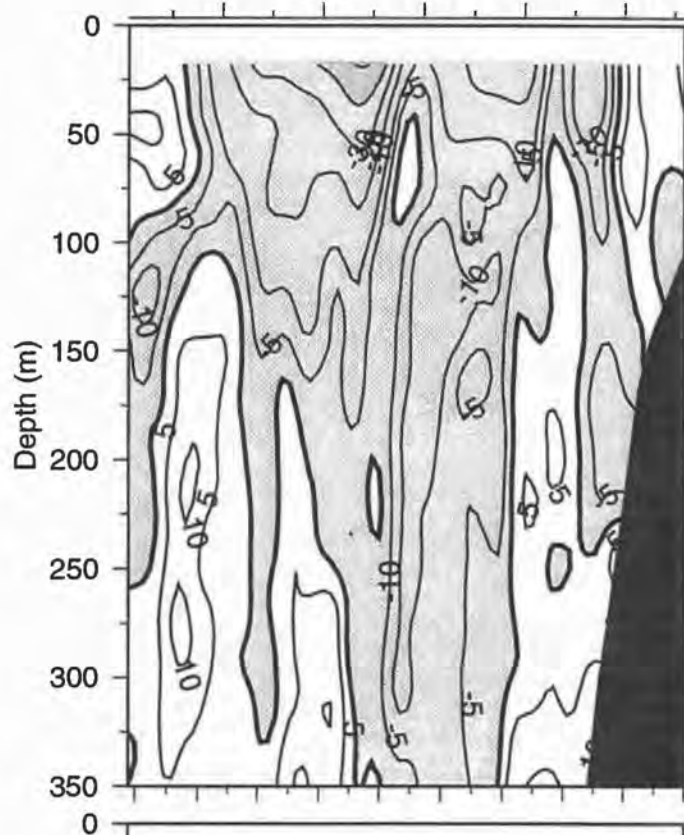
V

Line 12 ADCP, 21-Aug-95 01:19 to 21-Aug-95 06:55 (233.0552-233.2883)

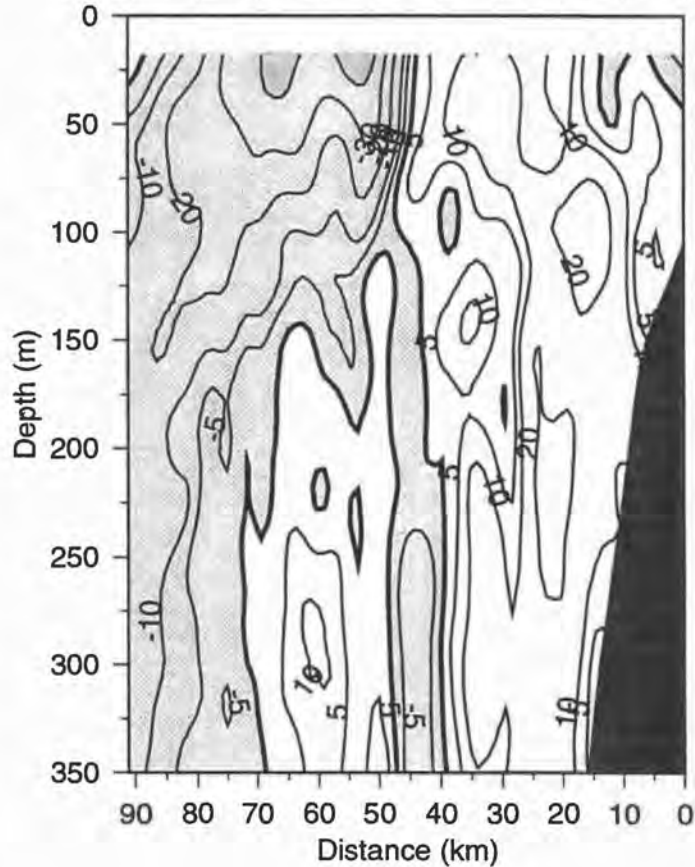
(42.23 °N)

Longitude (°W)

125.4 125.2 125.0 124.8 124.6



U



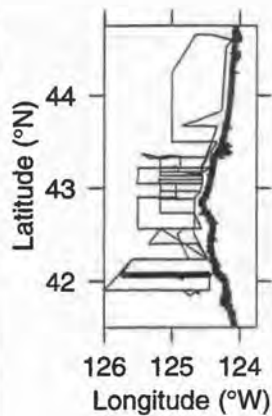
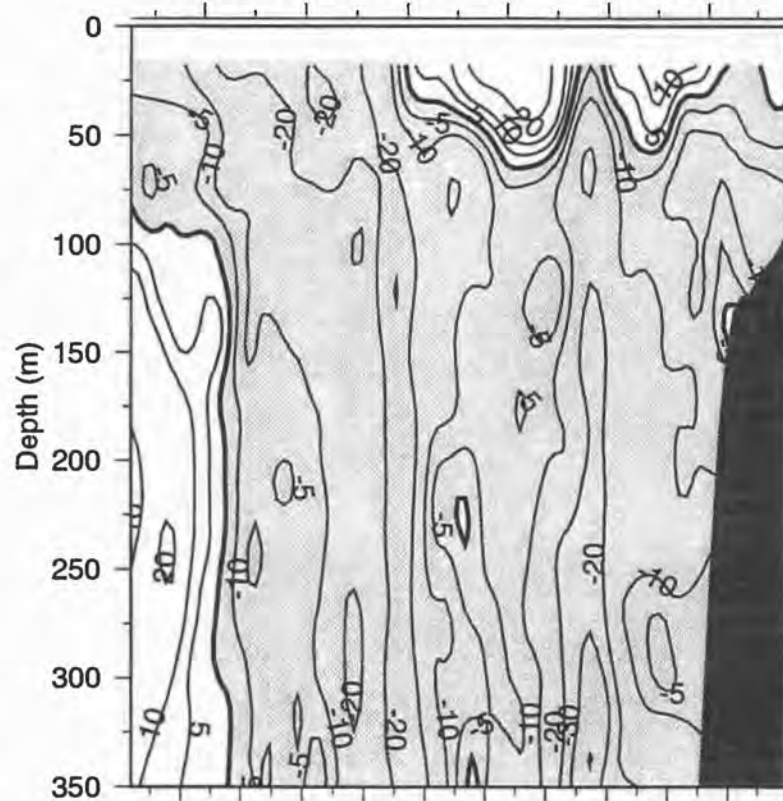
V

Line 13 ADCP, 21-Aug-95 08:27 to 21-Aug-95 16:06 (233.3527-233.6712)

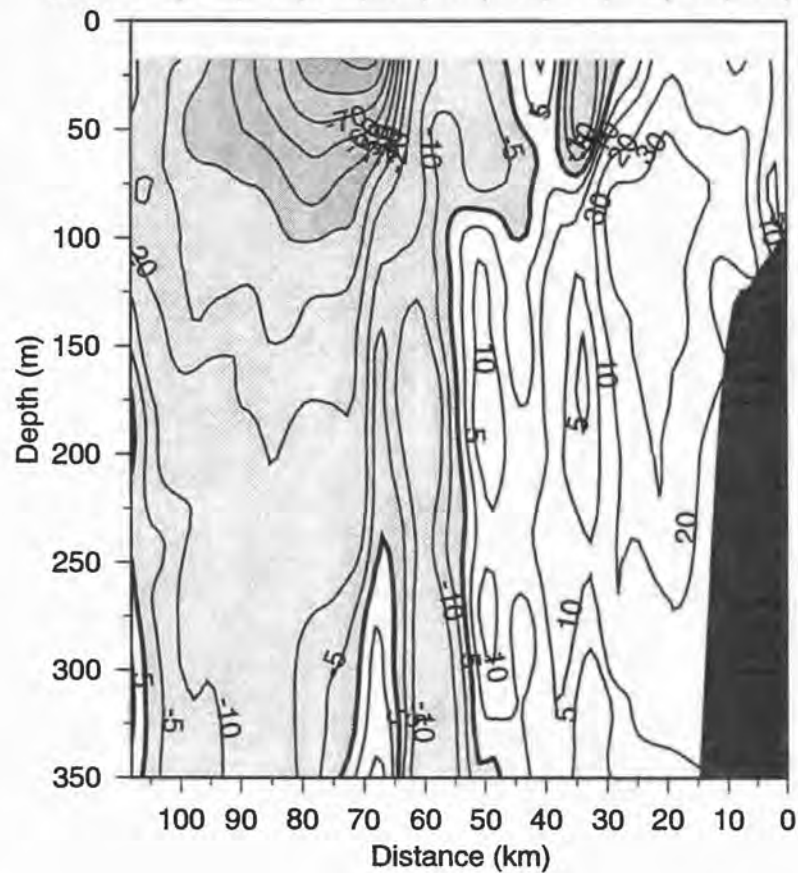
(42.06 °N)

Longitude (°W)

125.6 125.4 125.2 125.0 124.8 124.6



U



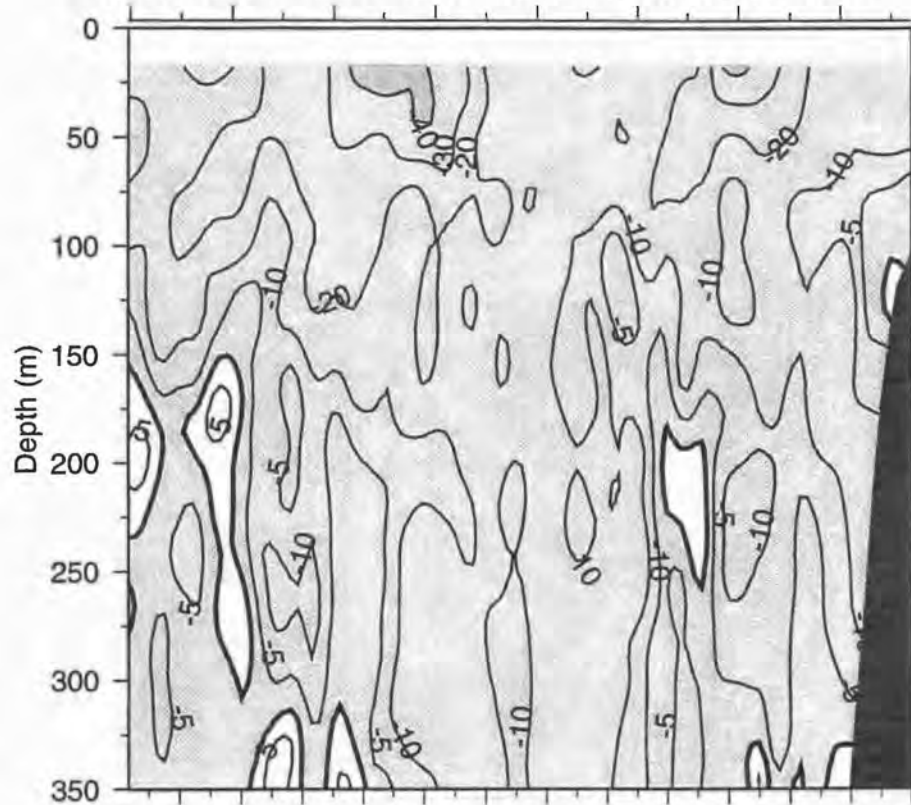
V

Line 14 ADCP, 21-Aug-95 17:27 to 22-Aug-95 10:17 (233.7271-234.4291)

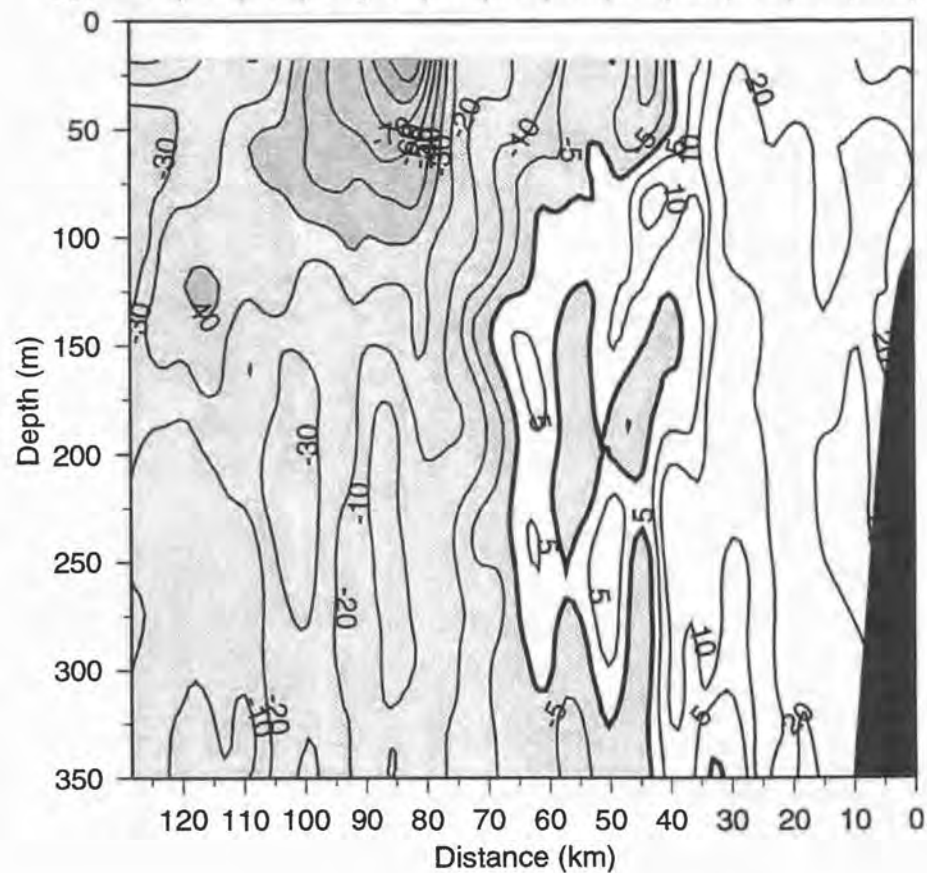
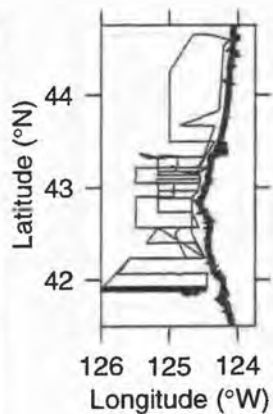
(41.88 °N)

Longitude (°W)

126.0 125.8 125.6 125.4 125.2 125.0 124.8 124.6



U



V

Line 15 ADCP, 22-Aug-95 14:06 to 22-Aug-95 18:52 (234.5879-234.7862)

(42.23 °N)

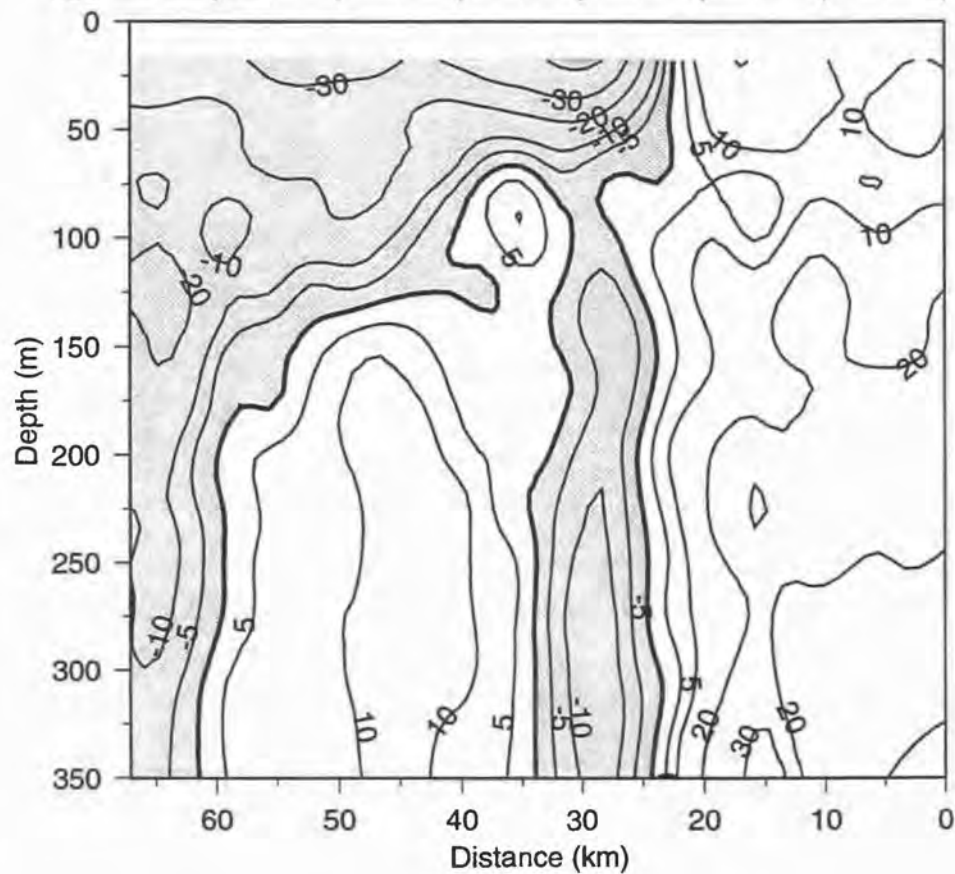
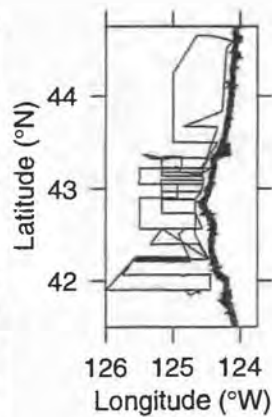
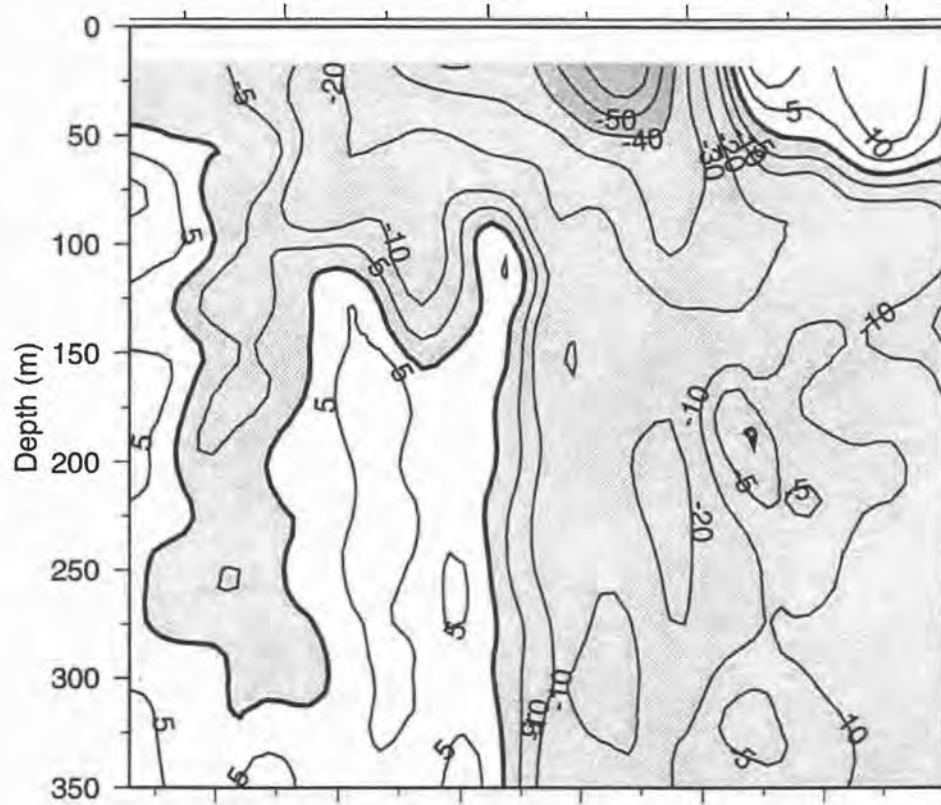
Longitude (°W)

125.4

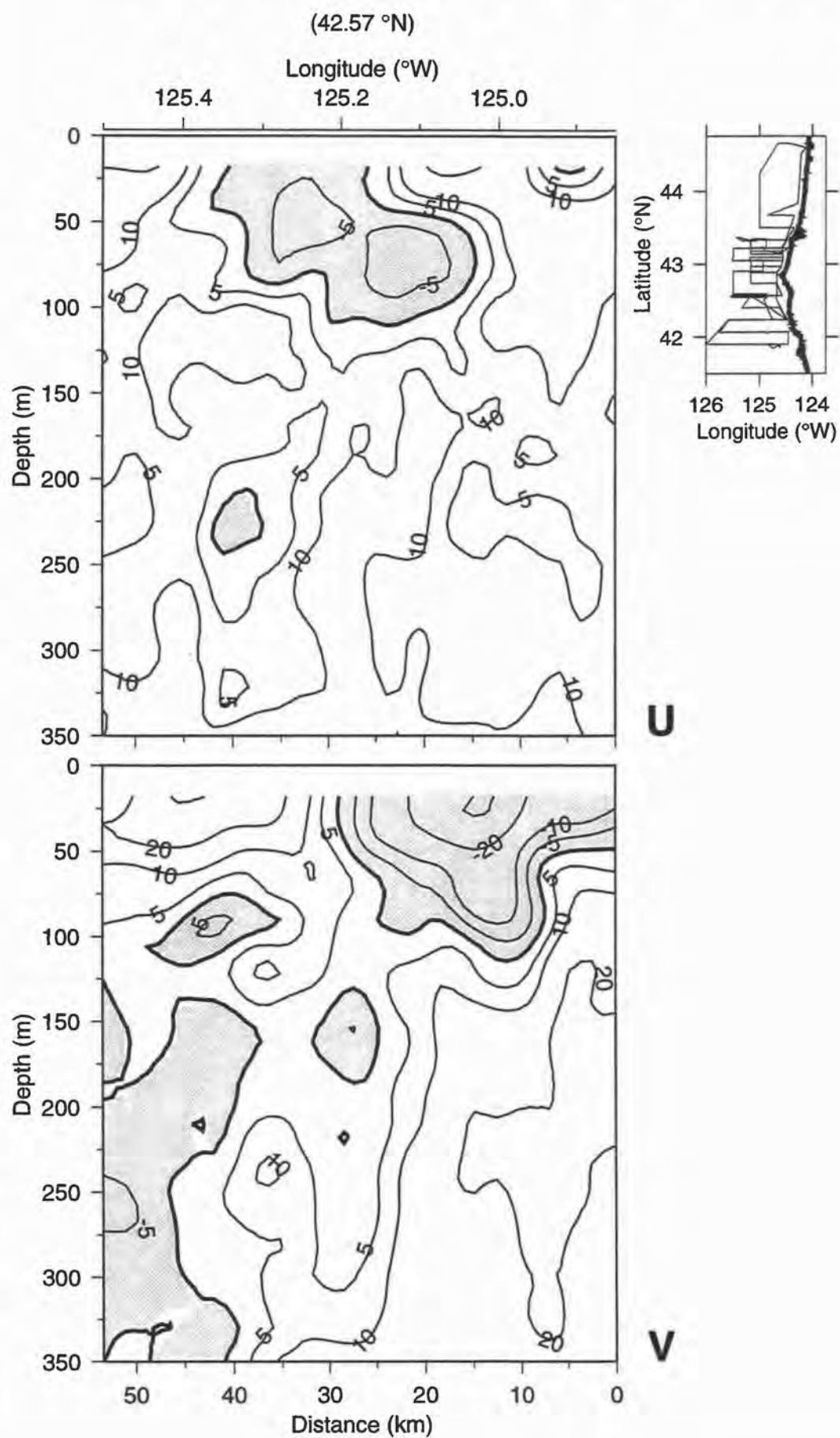
125.2

125.0

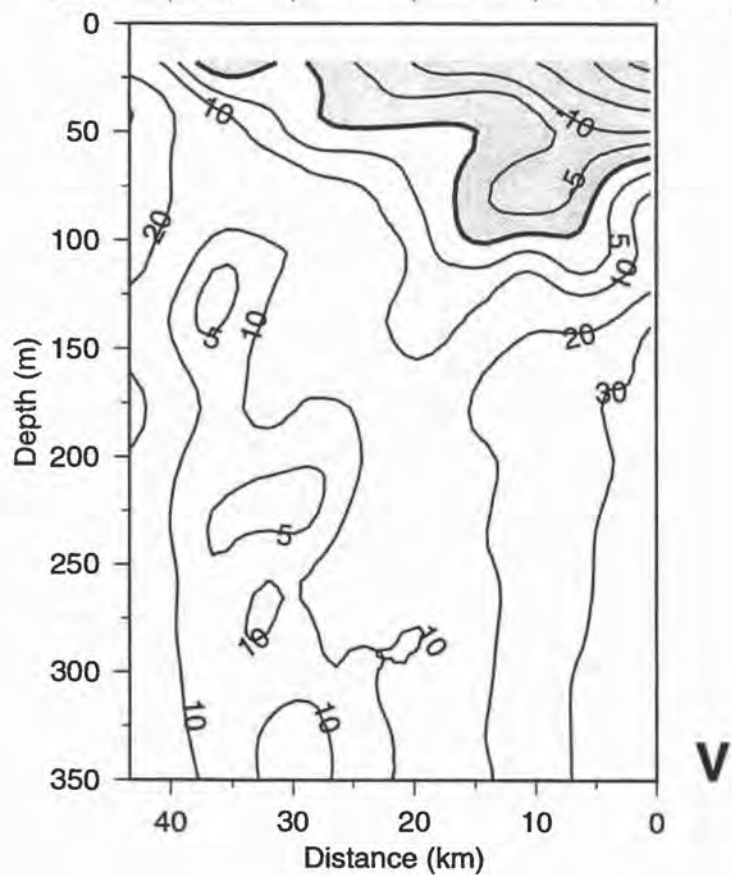
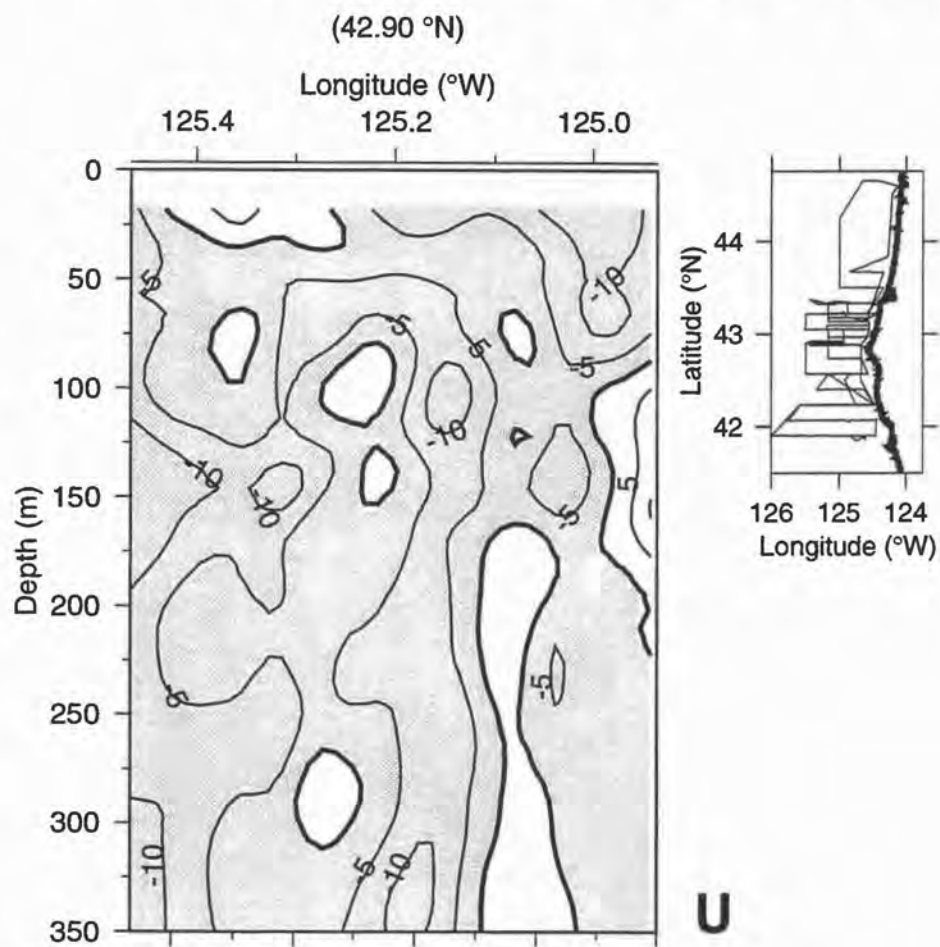
124.8



Line 16 ADCP, 22-Aug-95 21:56 to 23-Aug-95 01:35 (234.9142-235.0666)



Line 17 ADCP, 23-Aug-95 03:59 to 23-Aug-95 07:03 (235.1666-235.2943)

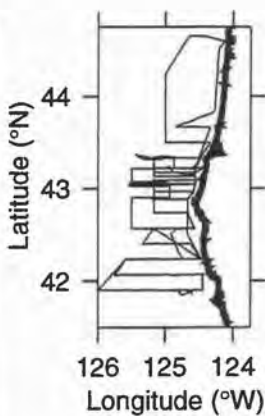
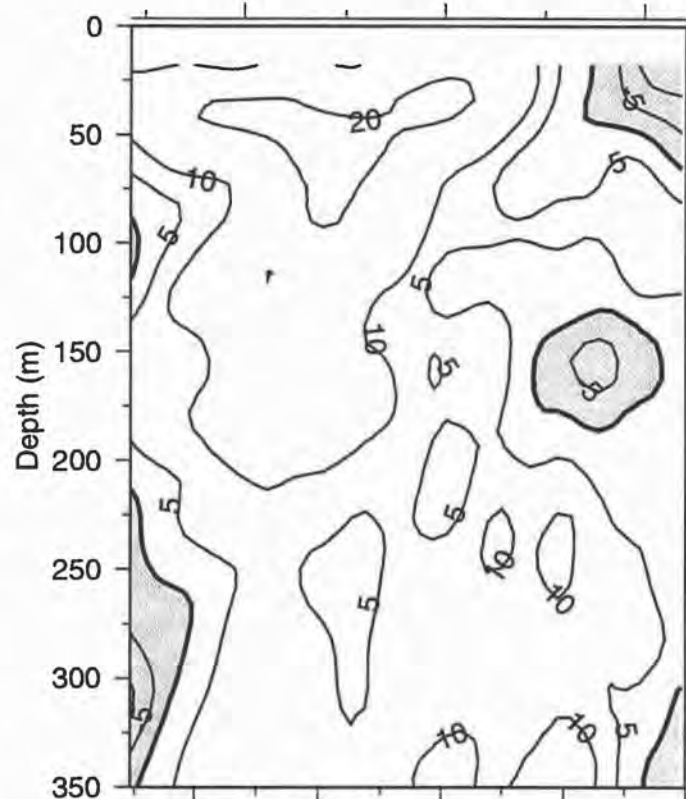


Line 18 ADCP, 23-Aug-95 08:16 to 23-Aug-95 11:20 (235.3445-235.4728)

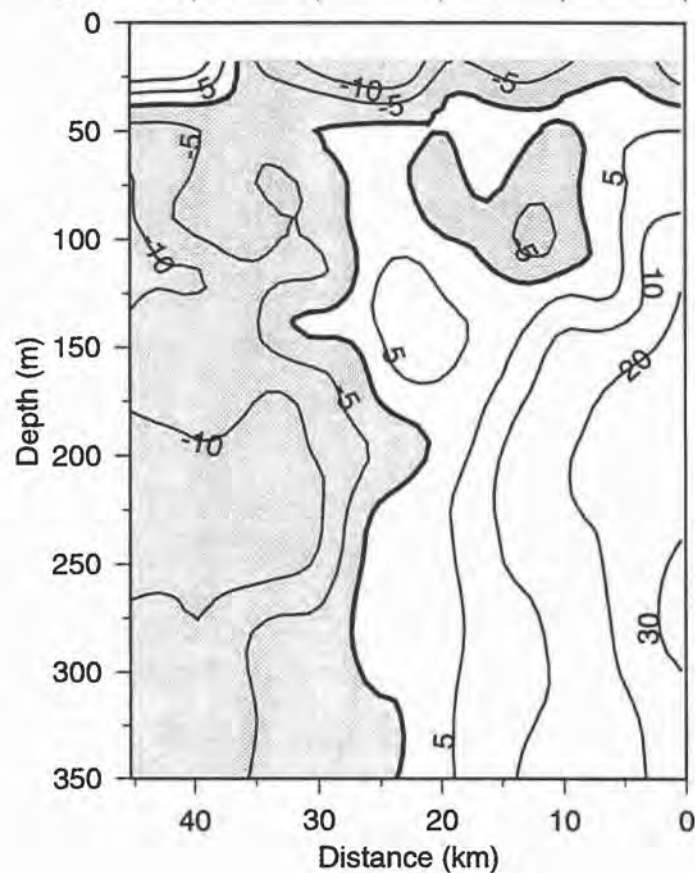
(43.05 °N)

Longitude (°W)

125.4 125.2 125.0



U



V

Line 19 ADCP, 23-Aug-95 12:30 to 23-Aug-95 15:31 (235.5212-235.6469)

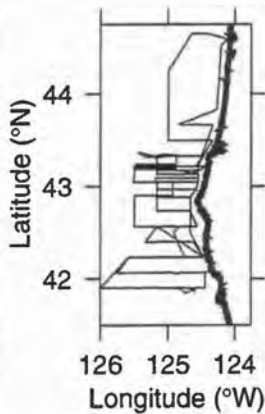
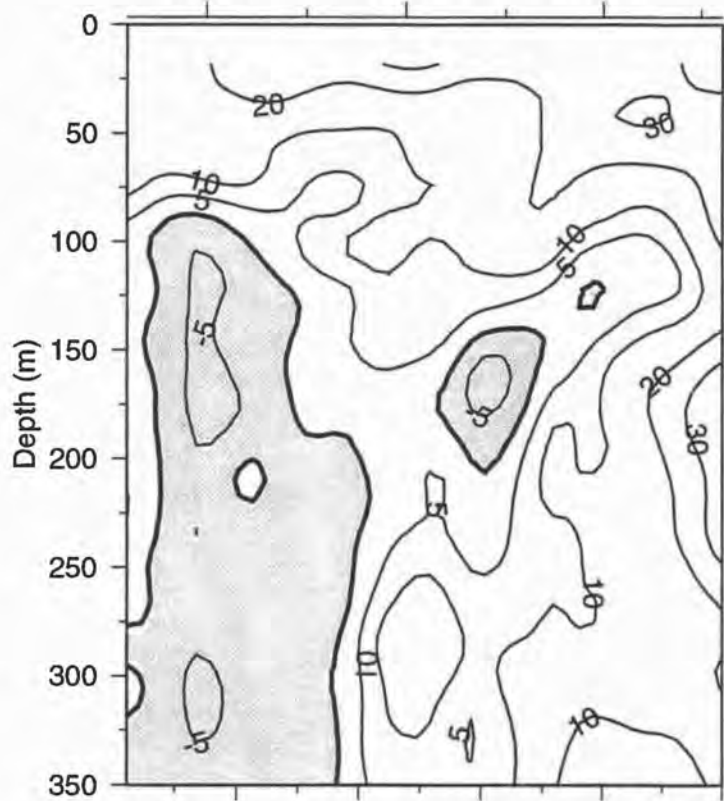
(43.22 °N)

Longitude (°W)

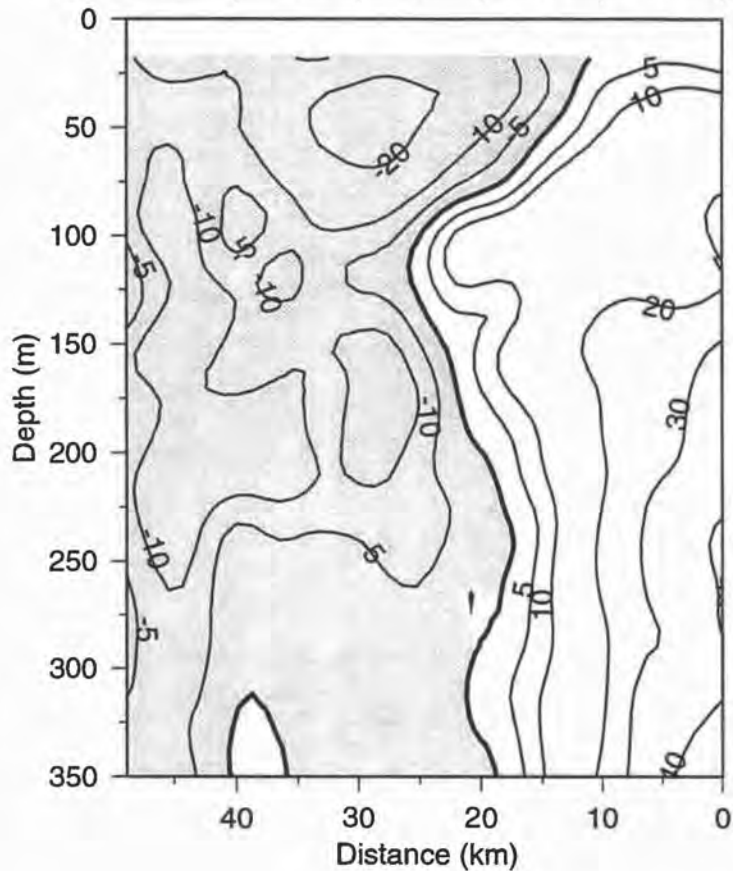
125.4

125.2

125.0



U

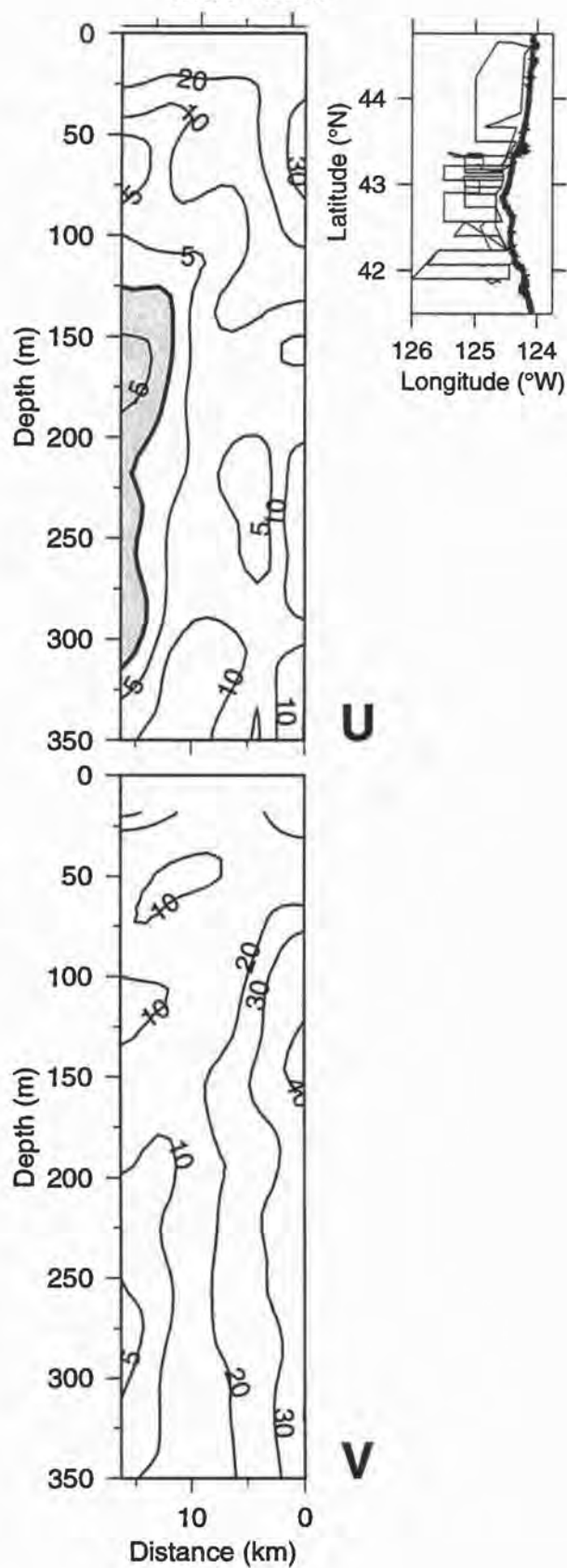


V

Line 20 ADCP, 23-Aug-95 16:20 to 23-Aug-95 18:00 (235.6810-235.7503)

(43.33 °N)

Longitude (°W)
125.0 124.9



Line 21 ADCP, 23-Aug-95 23:41 to 24-Aug-95 03:26 (235.9874-236.1436)

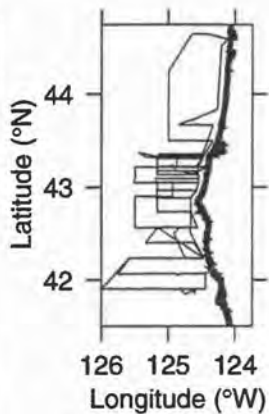
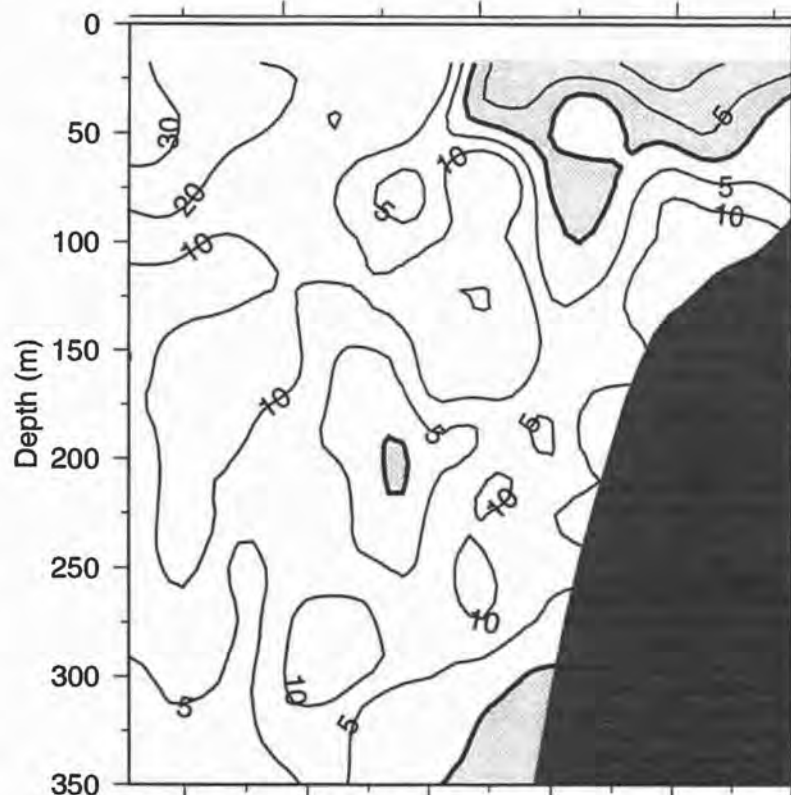
(43.33 °N)

Longitude (°W)

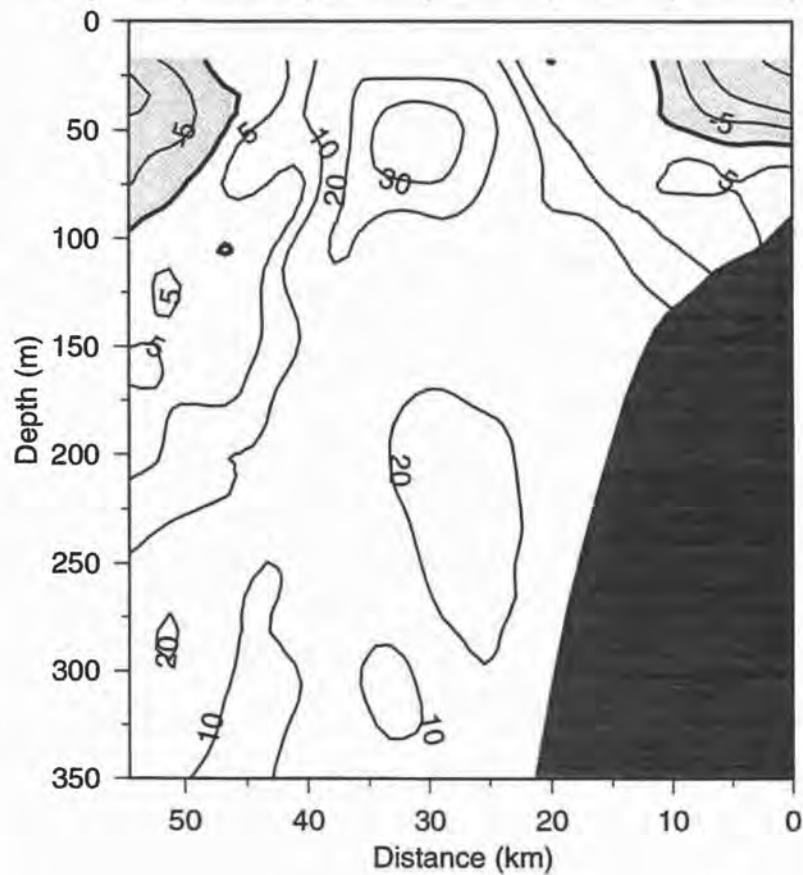
125.0

124.8

124.6



U



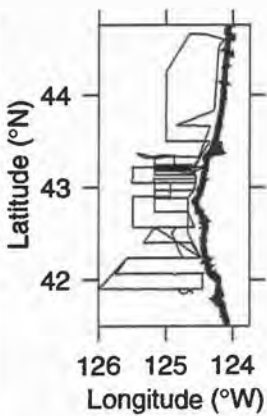
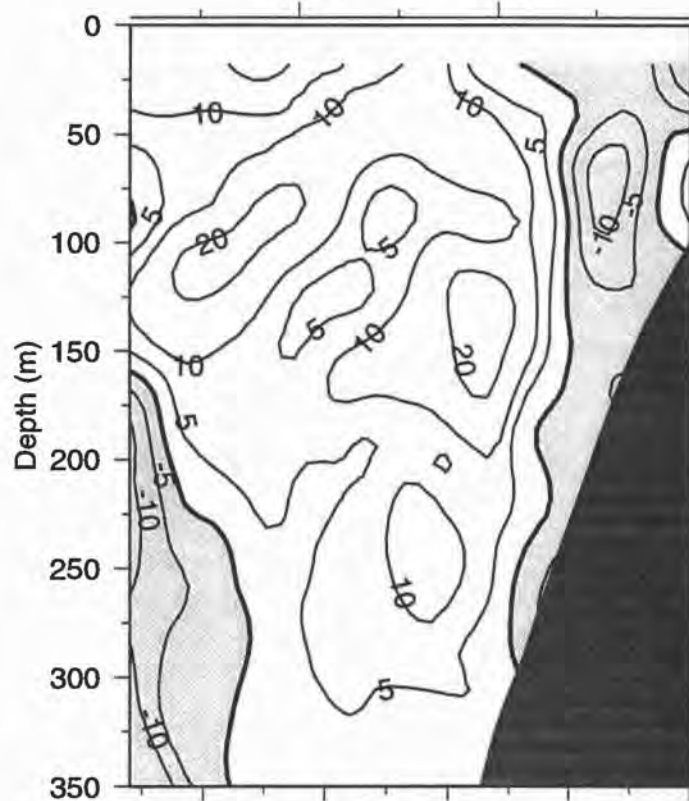
V

Line 22 ADCP, 24-Aug-95 04:30 to 24-Aug-95 07:42 (236.1878-236.3212)

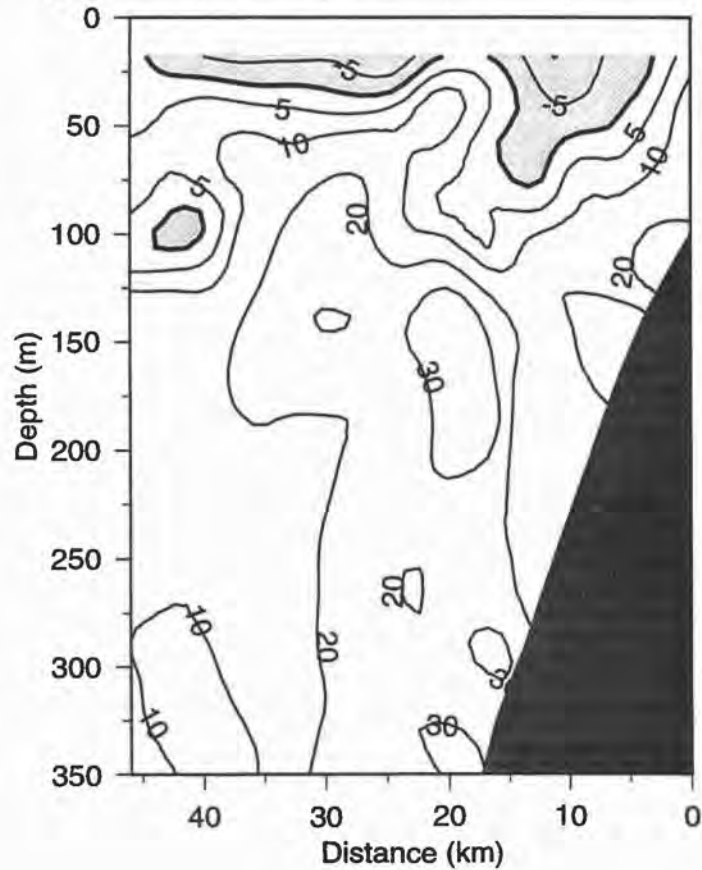
(43.22 °N)

Longitude (°W)

125.0 124.8



U



V

Line 23 ADCP, 24-Aug-95 08:21 to 24-Aug-95 11:48 (236.3486-236.4920)

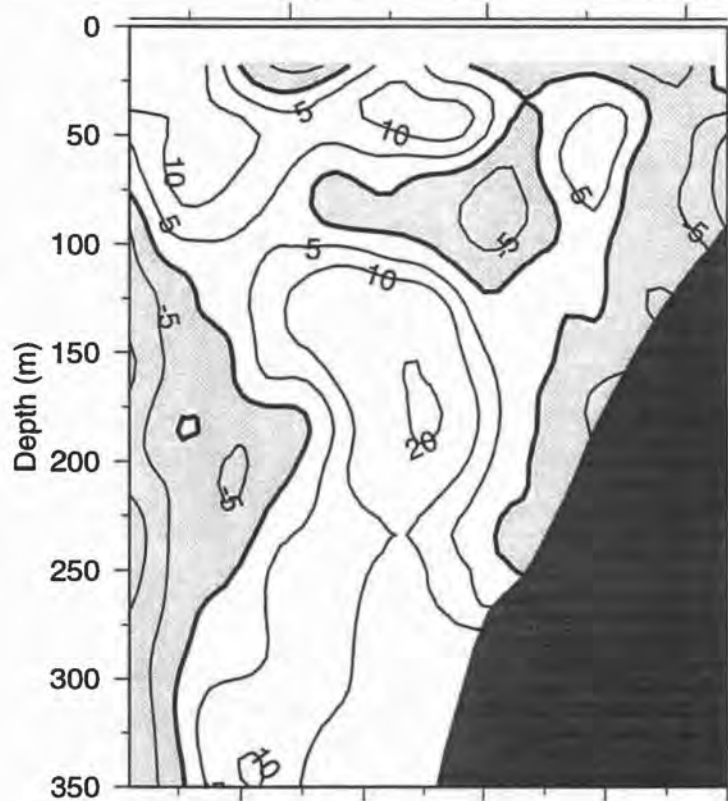
(43.13 °N)

Longitude (°W)

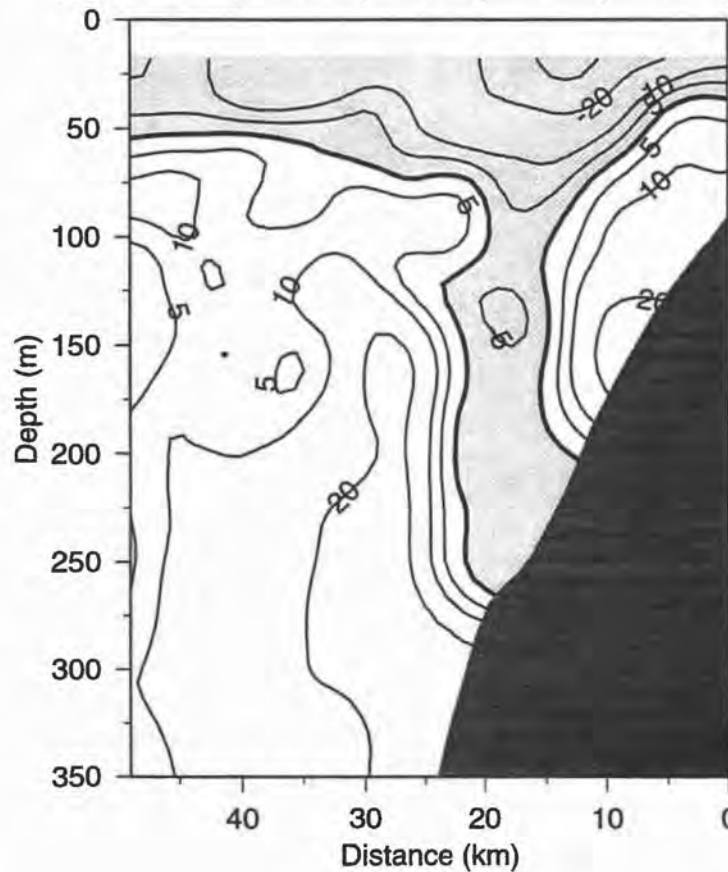
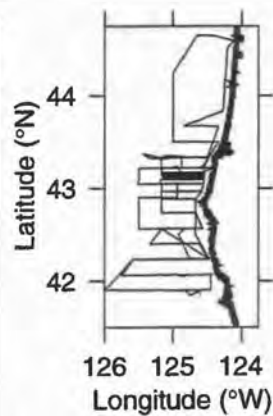
125.0

124.8

124.6



U



V

Line 24 ADCP, 24-Aug-95 12:25 to 24-Aug-95 15:55 (236.5174-236.6633)

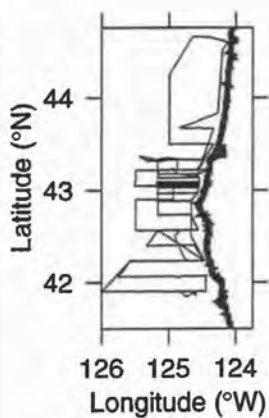
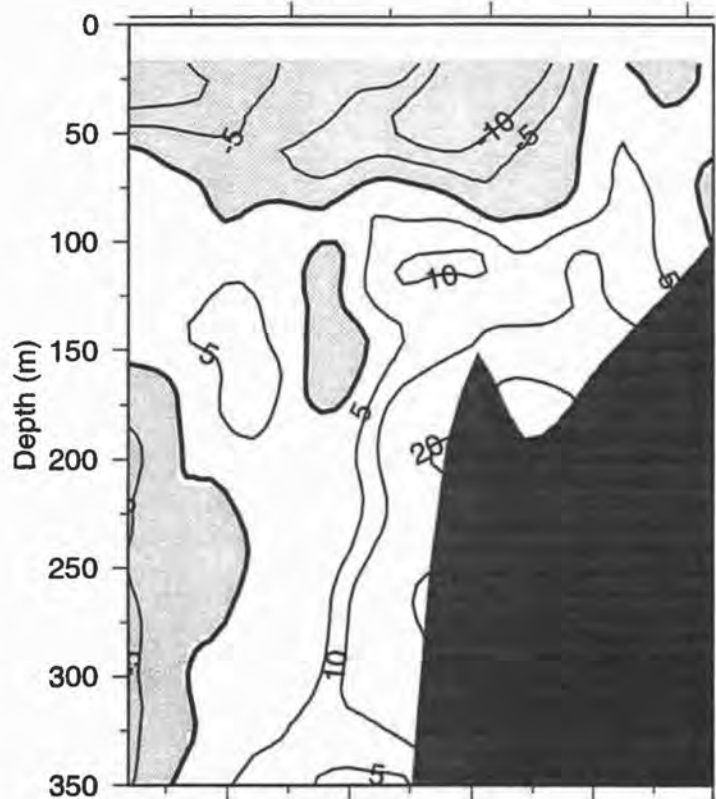
(43.05 °N)

Longitude (°W)

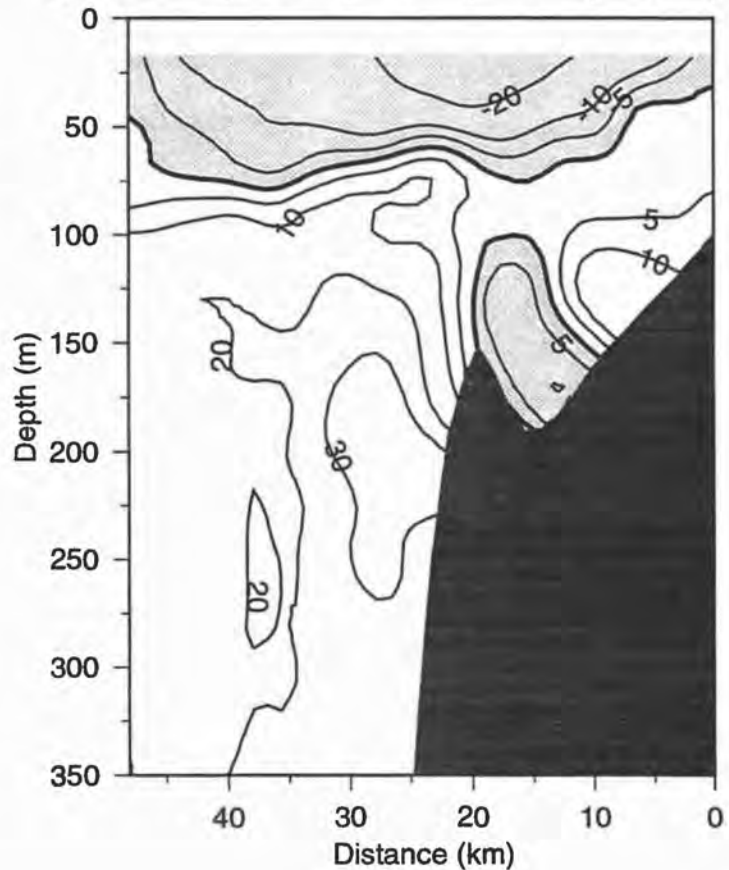
125.0

124.8

124.6



U



V

Line 25 ADCP, 24-Aug-95 16:32 to 24-Aug-95 19:51 (236.6891-236.8274)

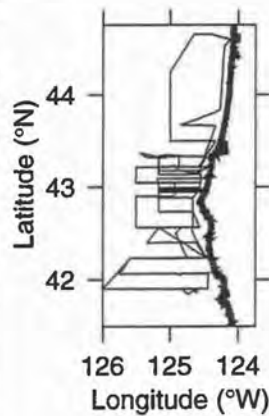
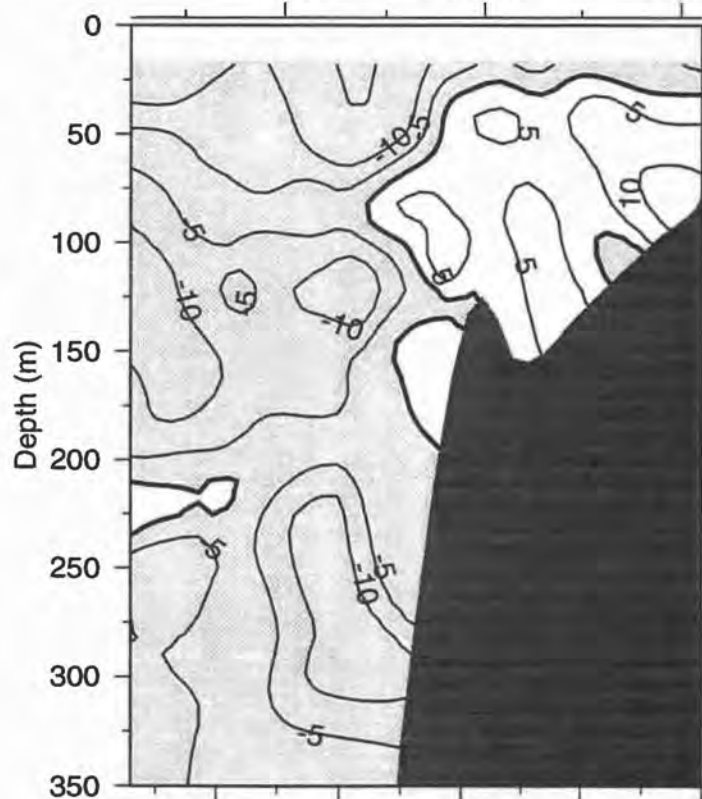
(42.96 °N)

Longitude (°W)

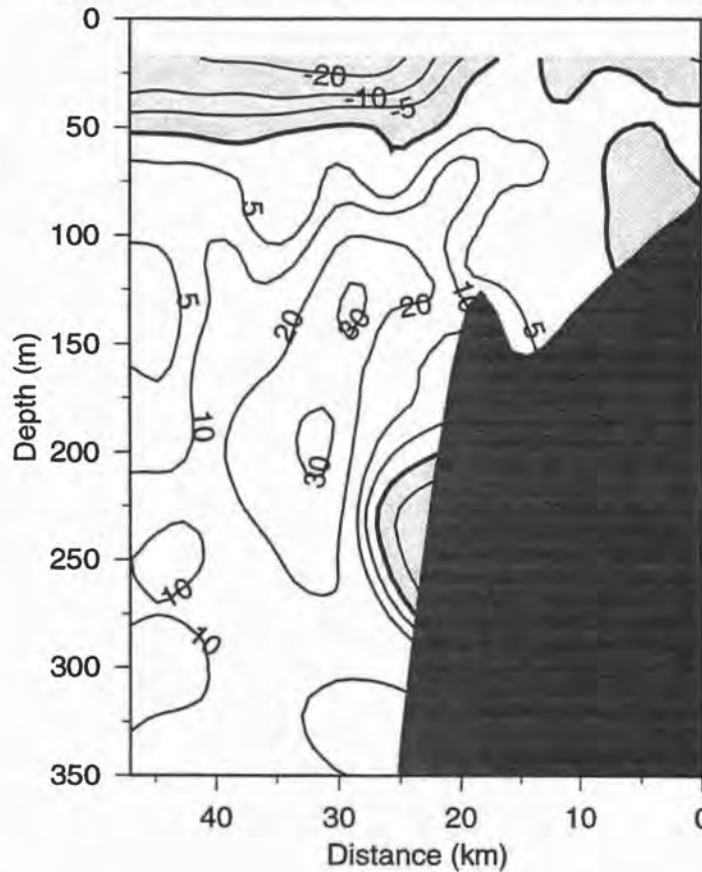
125.0

124.8

124.6



U



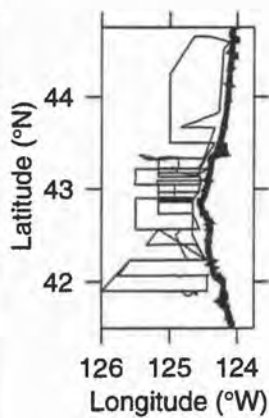
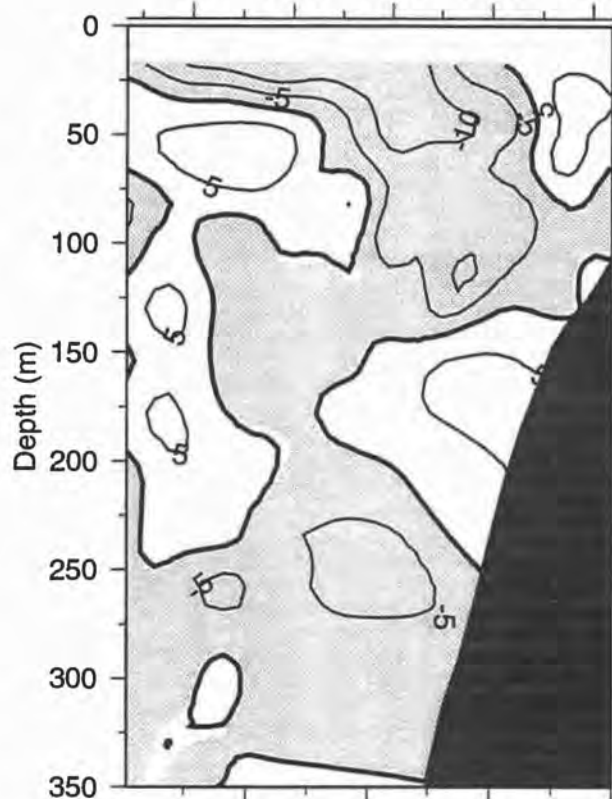
V

Line 26 ADCP, 24-Aug-95 20:32 to 24-Aug-95 23:15 (236.8560-236.9688)

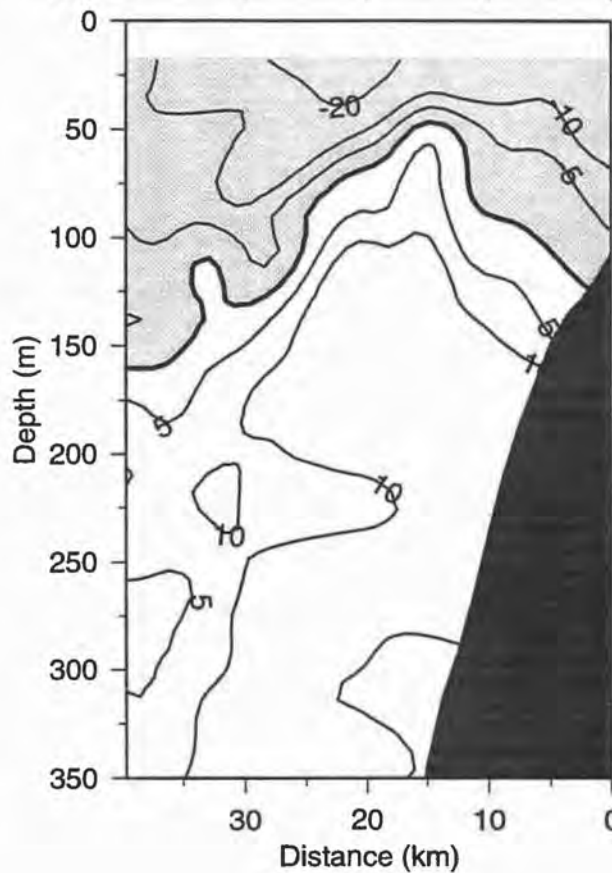
(42.88 °N)

Longitude (°W)

125.1 125.0 124.9 124.8 124.7



U



V

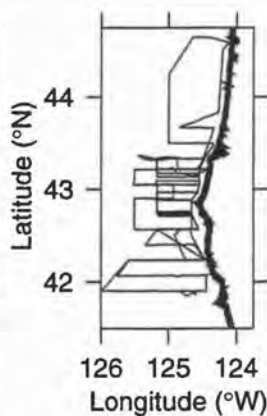
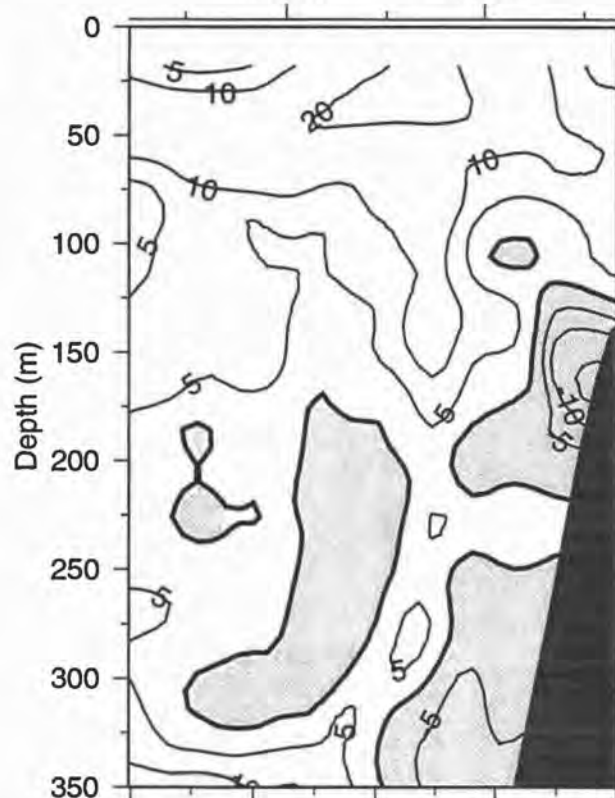
Line 27 ADCP, 25-Aug-95 00:20 to 25-Aug-95 03:03 (237.0139-237.1271)

(42.73 °N)

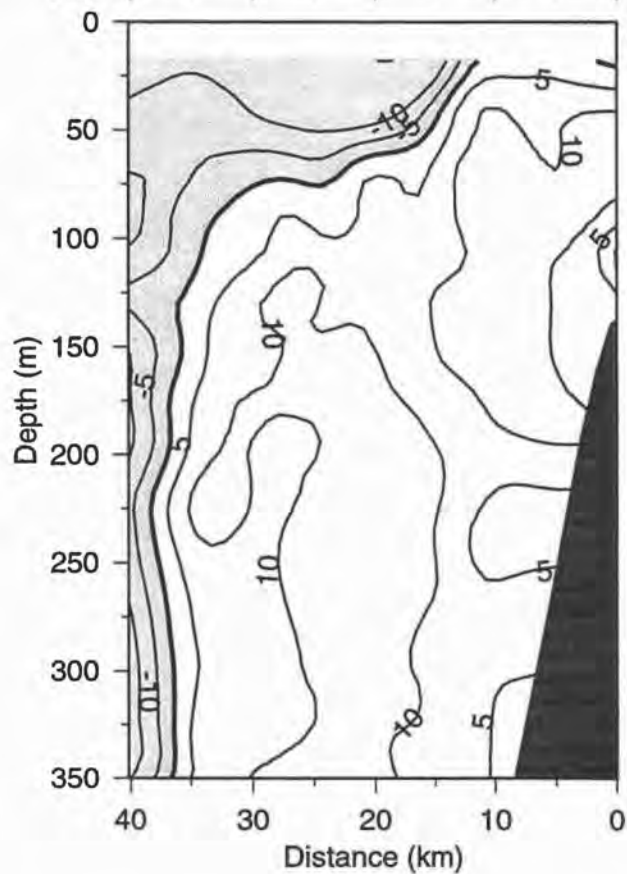
Longitude (°W)

125.0

124.8



U



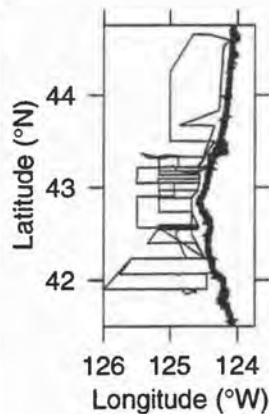
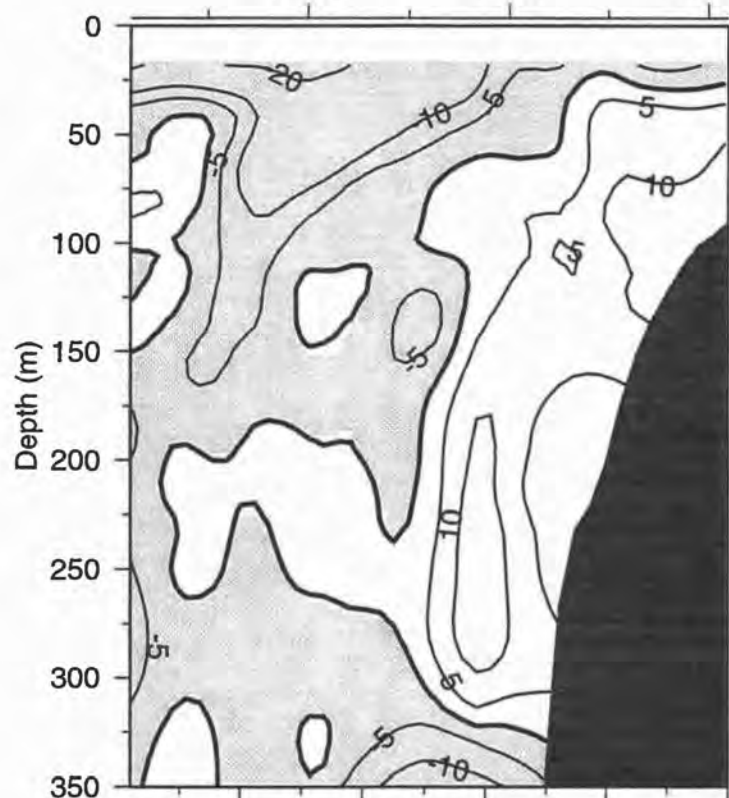
V

Line 28 ADCP, 25-Aug-95 04:25 to 25-Aug-95 07:37 (237.1846-237.3174)

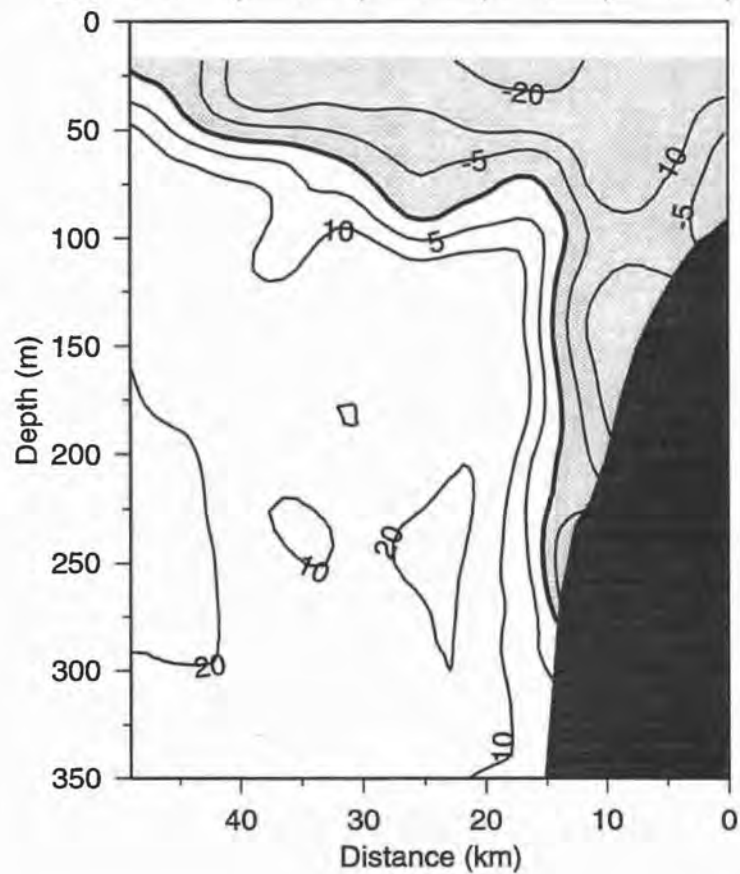
(42.57 °N)

Longitude (°W)

125.0 124.8 124.6



U



V

Line 29 ADCP, 25-Aug-95 07:37 to 25-Aug-95 12:28 (237.3174-237.5199)

Latitude (°N)

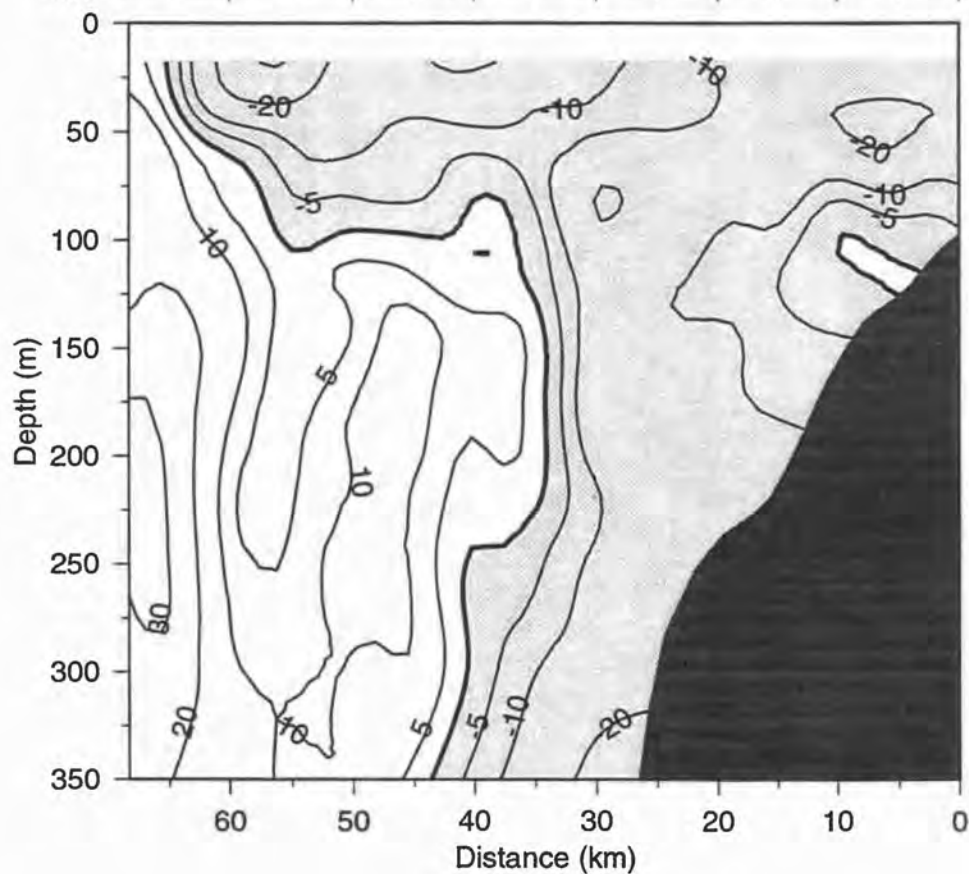
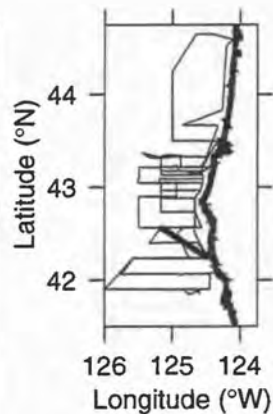
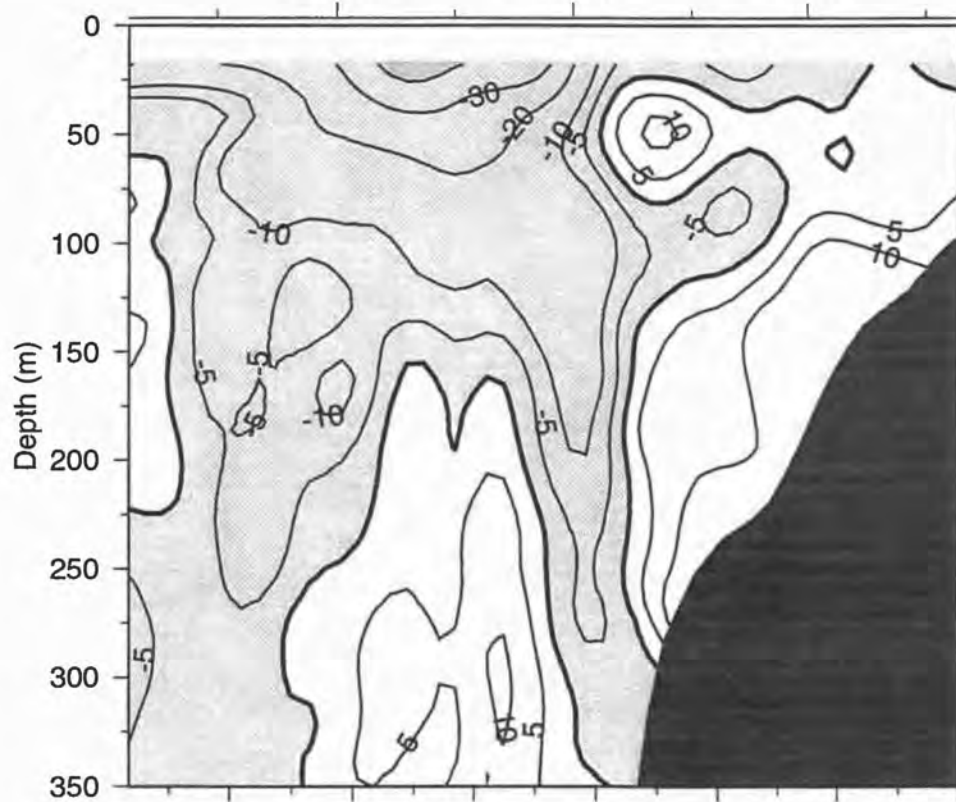
42.4

Longitude (°W)

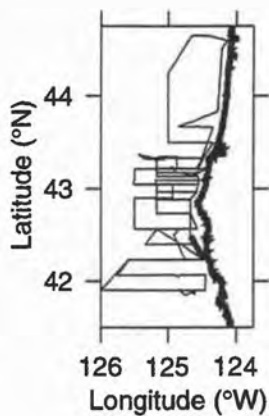
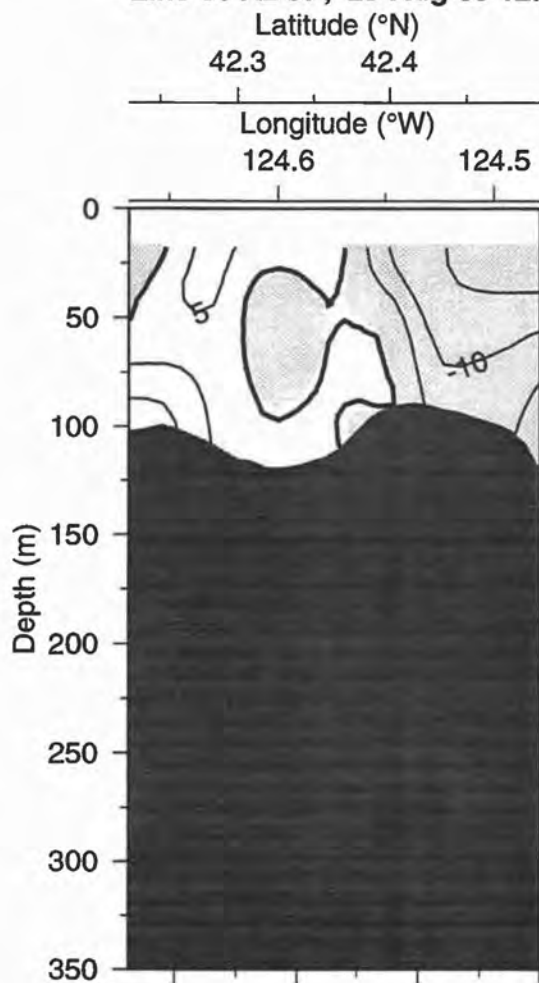
125.0

124.8

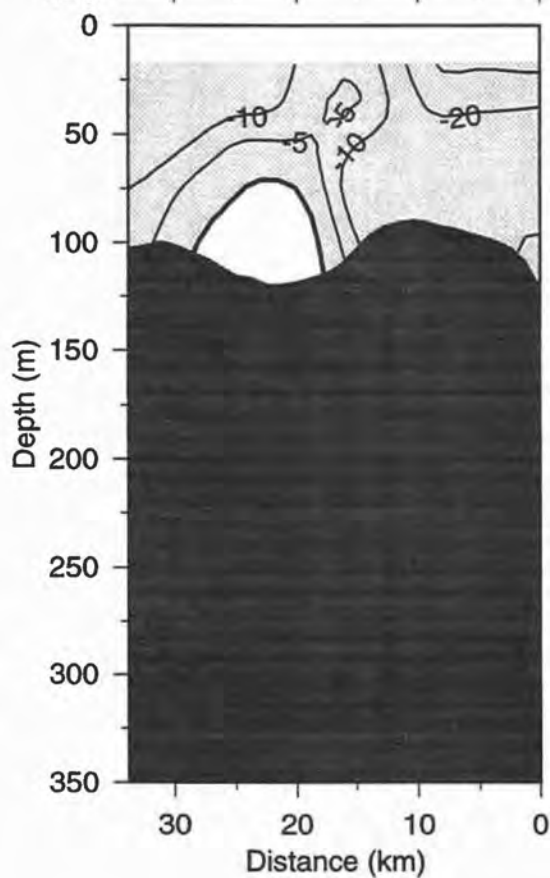
124.6



Line 30 ADCP, 25-Aug-95 12:28 to 25-Aug-95 14:50 (237.5199-237.6185)



U



V

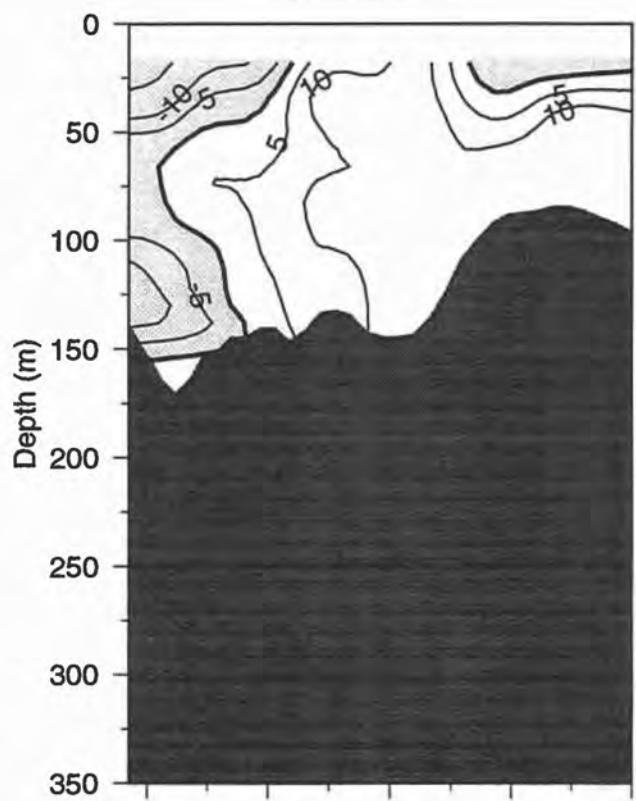
Line 31 ADCP, 25-Aug-95 14:50 to 25-Aug-95 17:44 (237.6185-237.7391)

Latitude ($^{\circ}$ N)

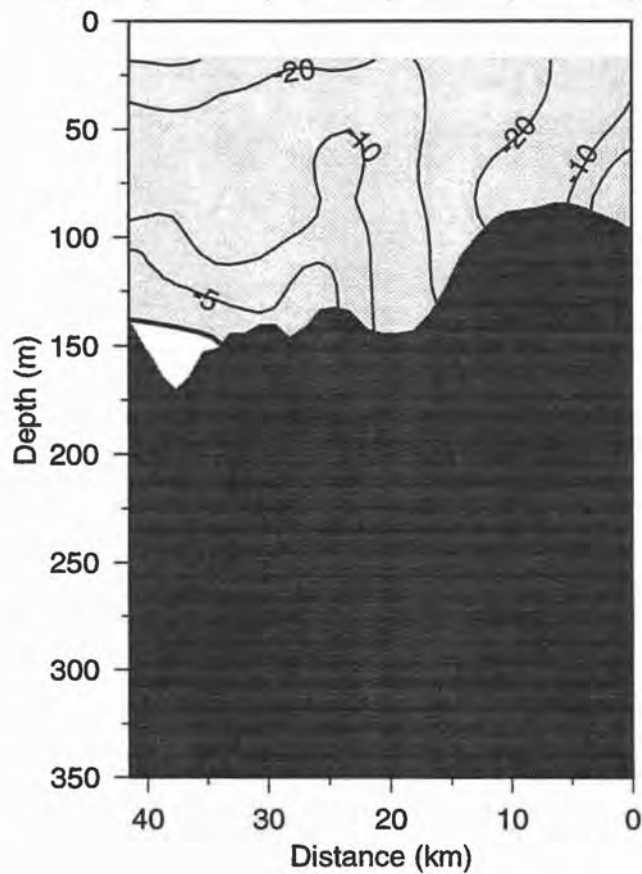
42.6

42.8

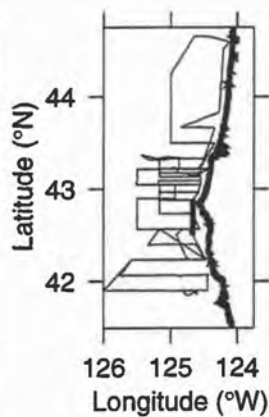
(124.67 $^{\circ}$ W)



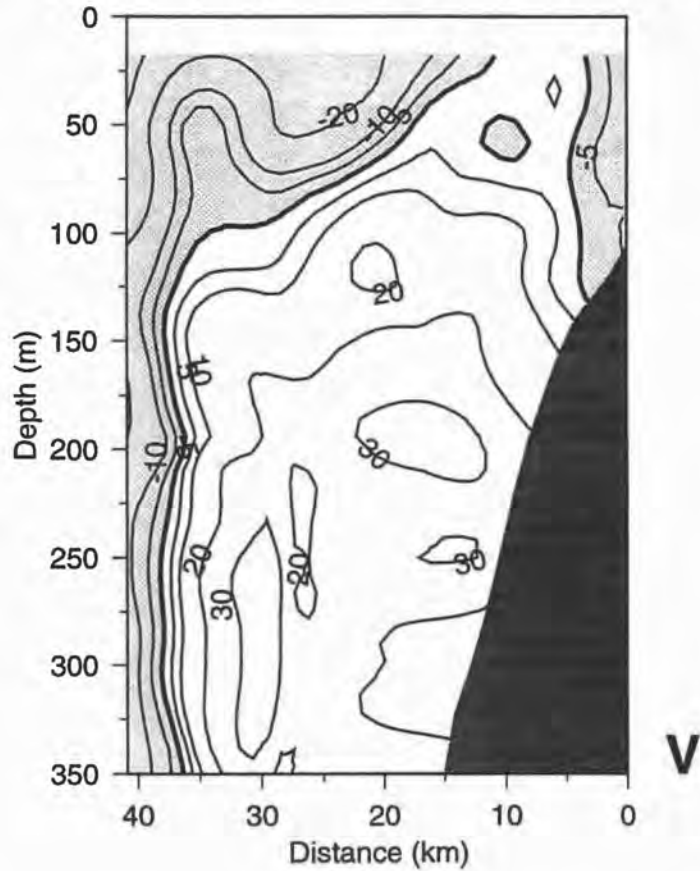
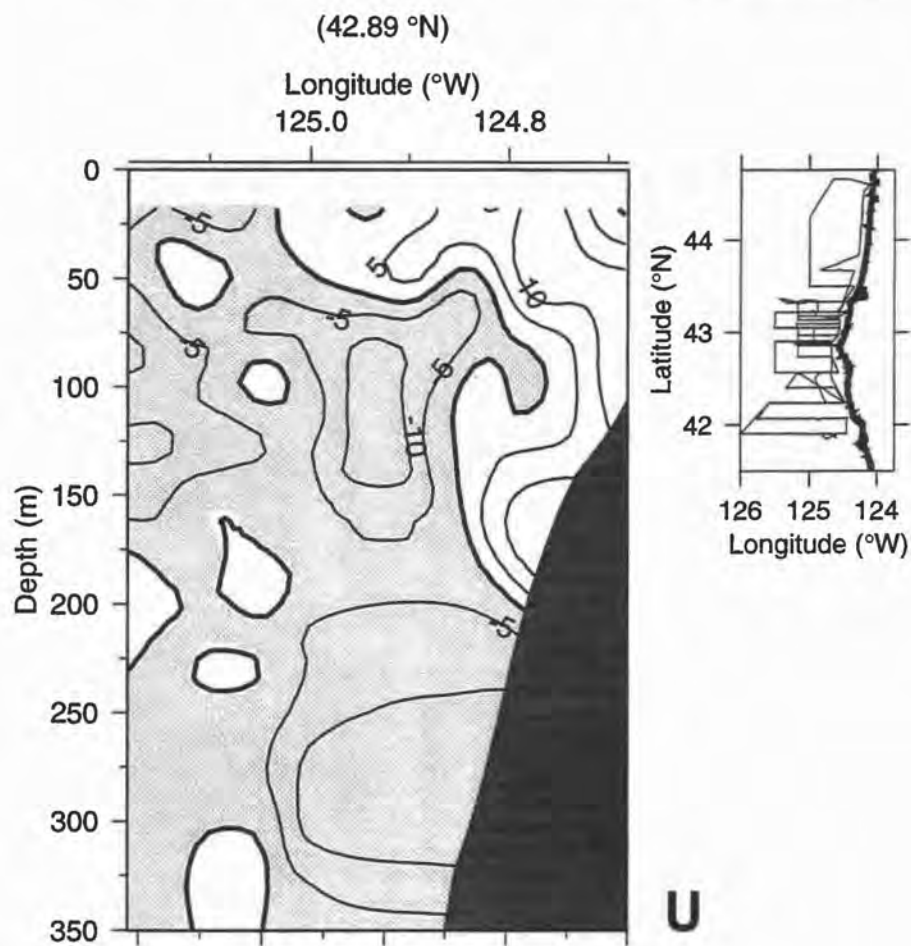
U



V



Line 32 ADCP, 25-Aug-95 17:44 to 25-Aug-95 20:32 (237.7392-237.8556)

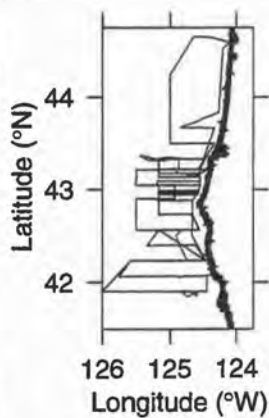
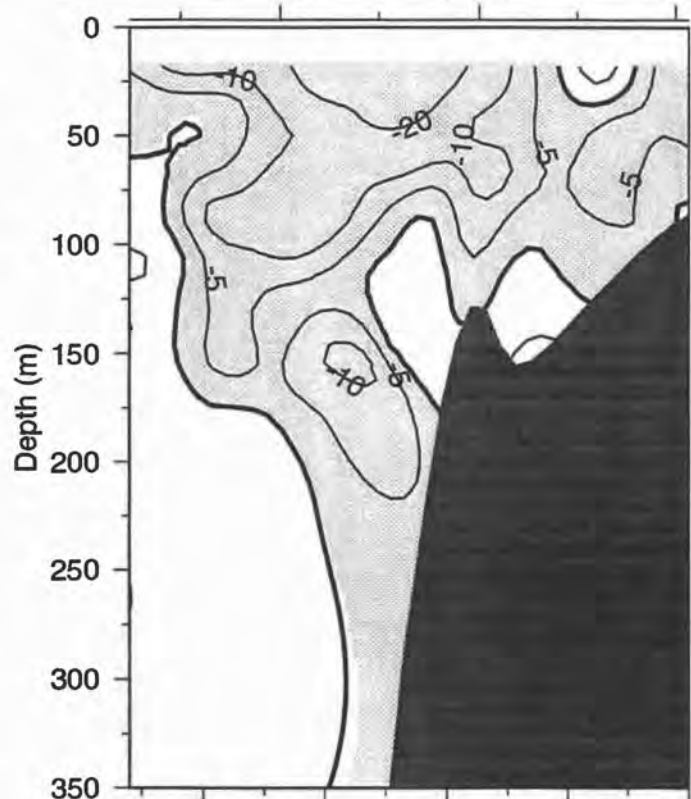


Line 33 ADCP, 25-Aug-95 21:14 to 26-Aug-95 00:25 (237.8854-238.0174)

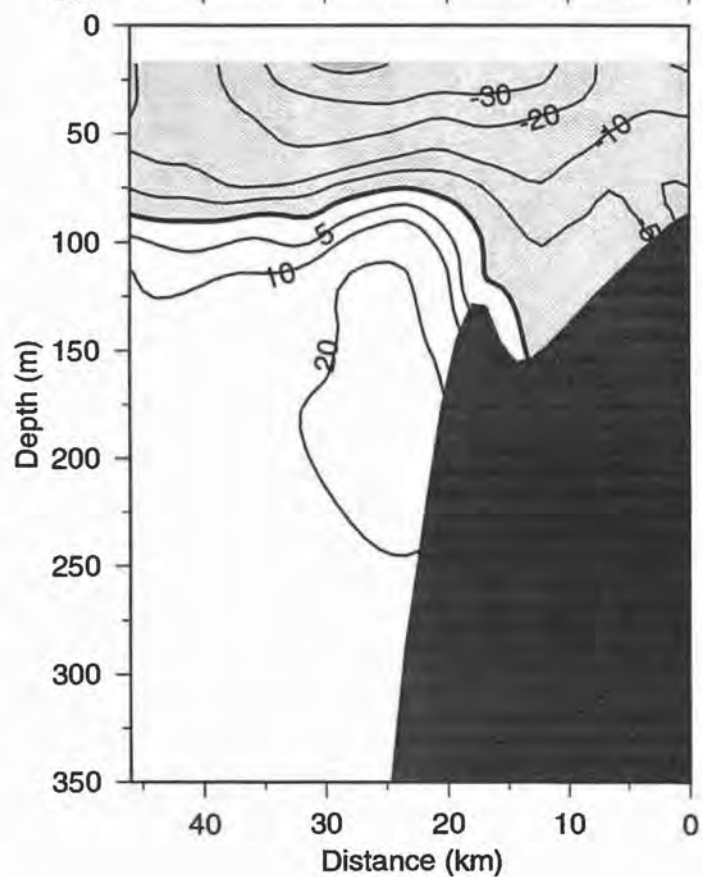
(42.97 °N)

Longitude (°W)

125.0 124.8 124.6

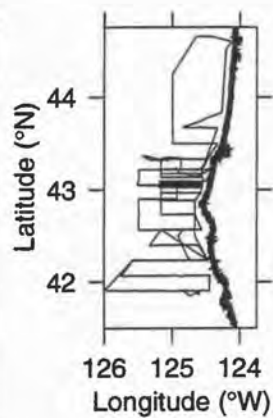
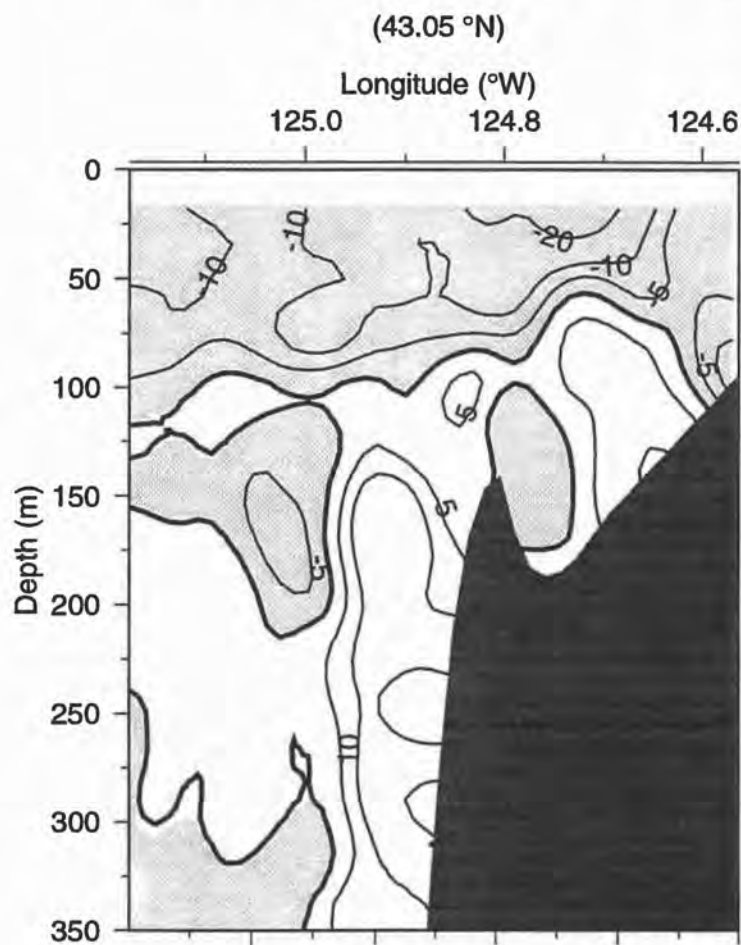


U

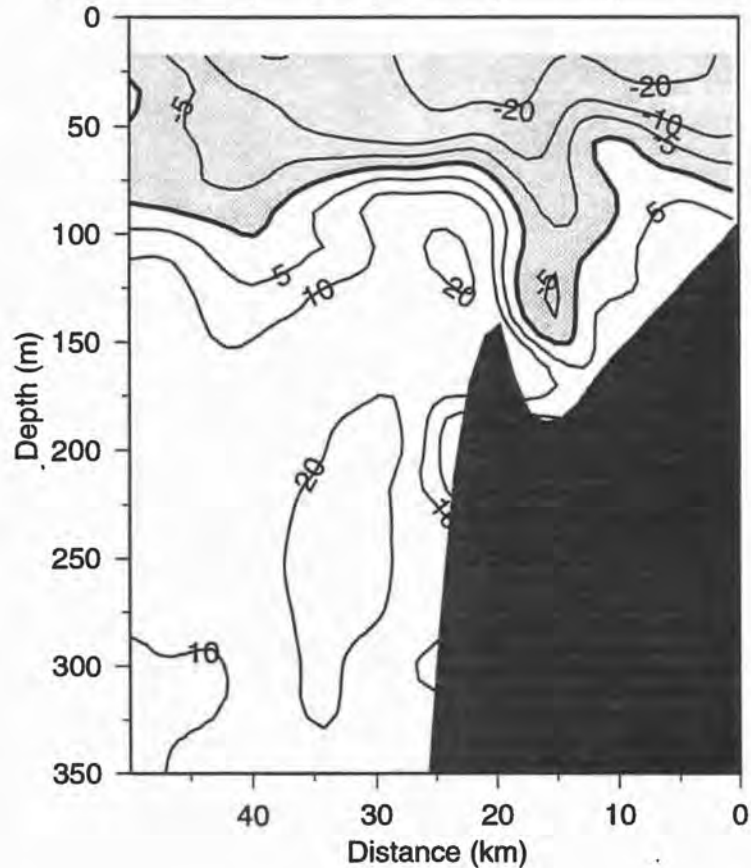


V

Line 34 ADCP, 26-Aug-95 01:07 to 26-Aug-95 04:25 (238.0468-238.1841)



U



V

Line 35 ADCP, 26-Aug-95 04:43 to 26-Aug-95 08:24 (238.1967-238.3501)

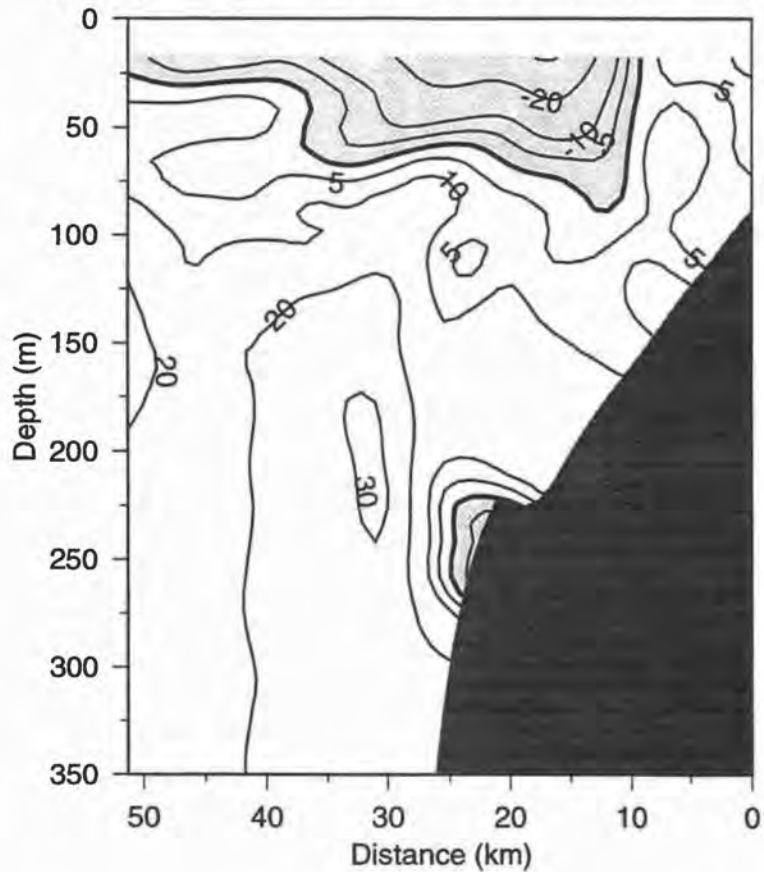
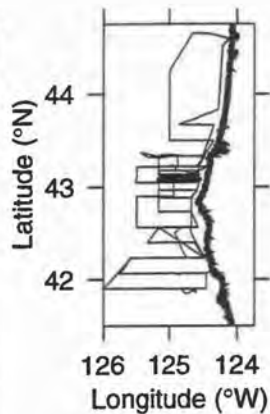
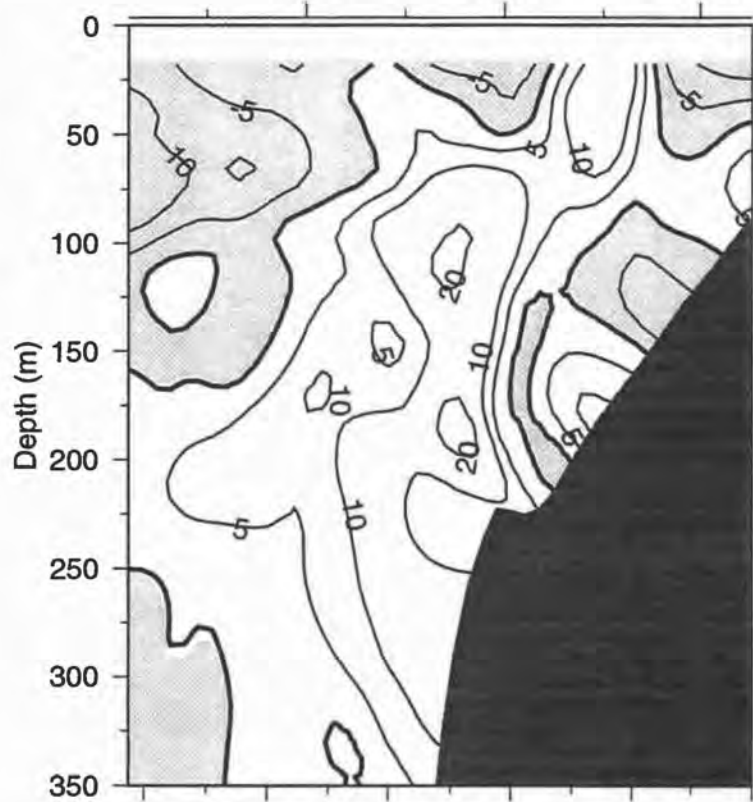
(43.09 °N)

Longitude (°W)

125.0

124.8

124.6



Line 36 ADCP, 26-Aug-95 08:38 to 26-Aug-95 12:05 (238.3603-238.5040)

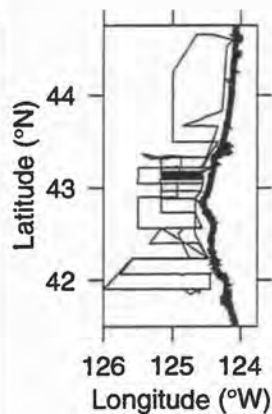
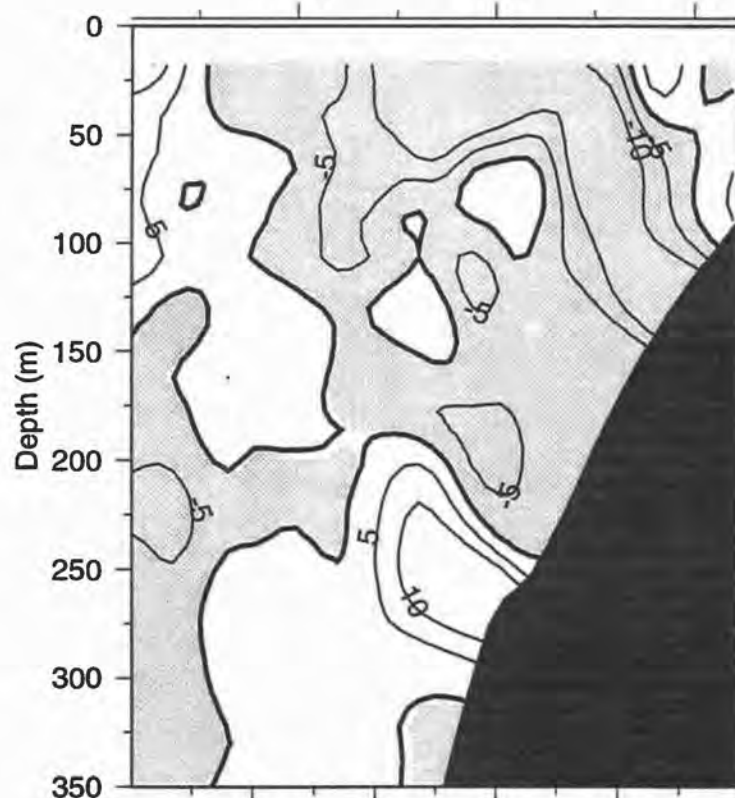
(43.13 °N)

Longitude (°W)

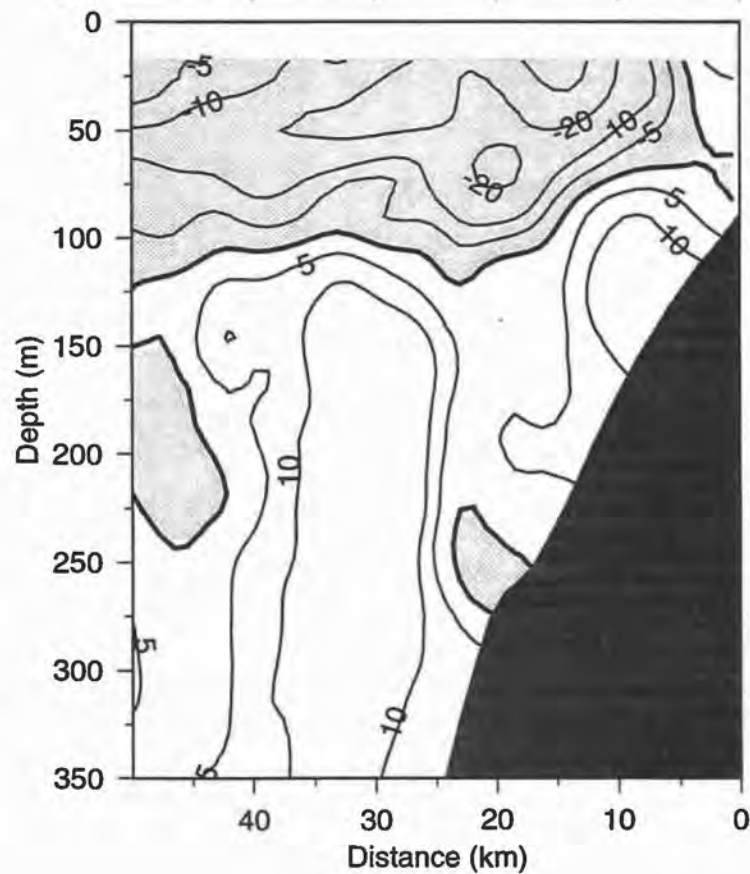
125.0

124.8

124.6



U



V

Line 37 ADCP, 26-Aug-95 12:20 to 26-Aug-95 15:42 (238.5140-238.6548)

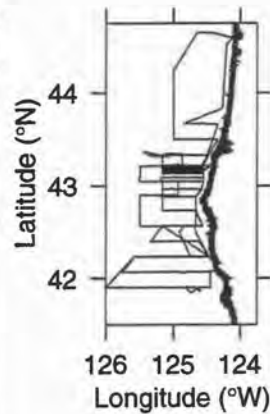
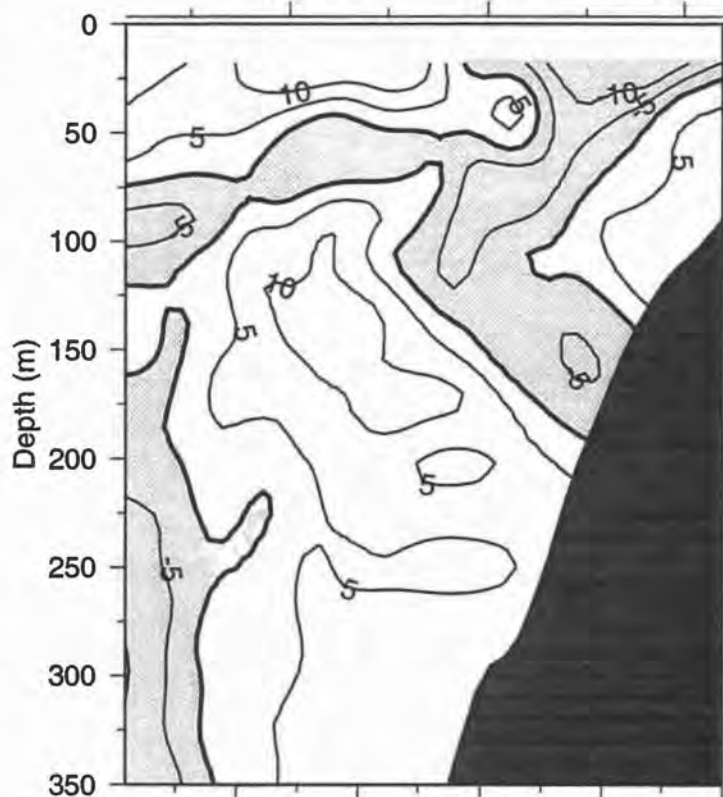
(43.17 °N)

Longitude (°W)

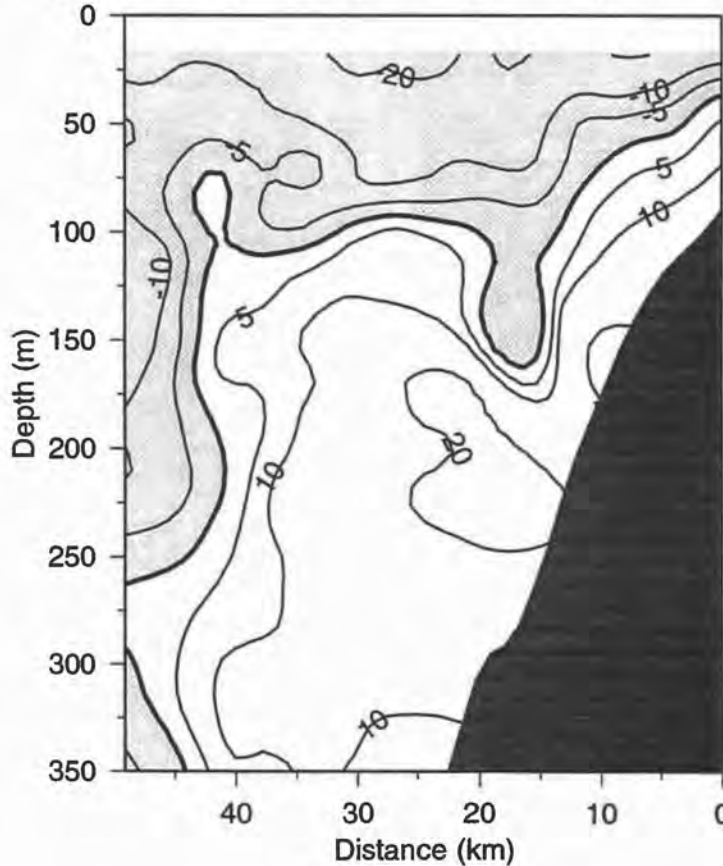
125.0

124.8

124.6



U



V

Line 38 ADCP, 26-Aug-95 21:51 to 27-Aug-95 01:15 (238.9108-239.0522)

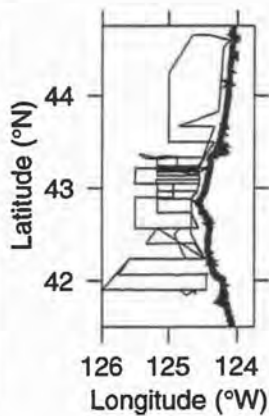
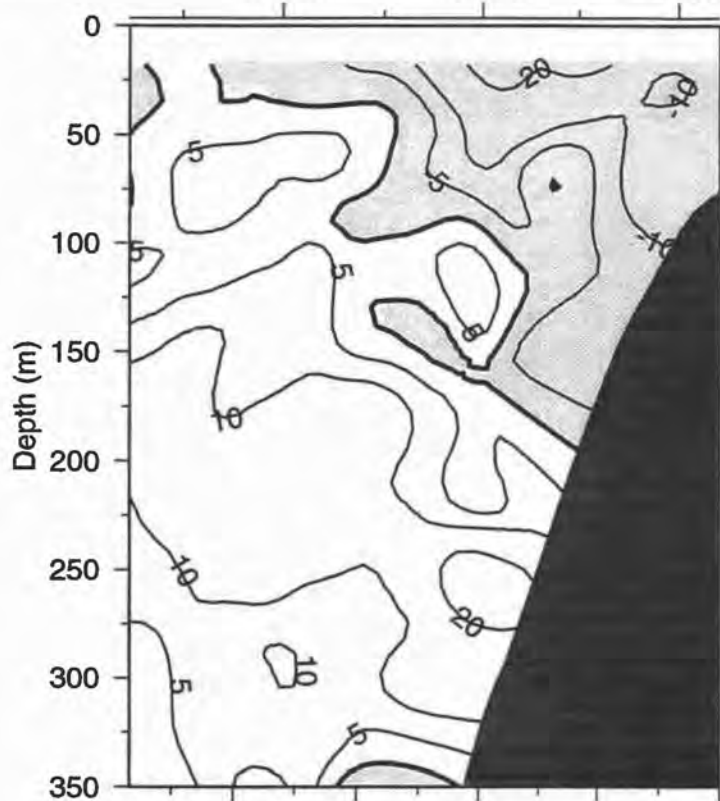
(43.22 °N)

Longitude (°W)

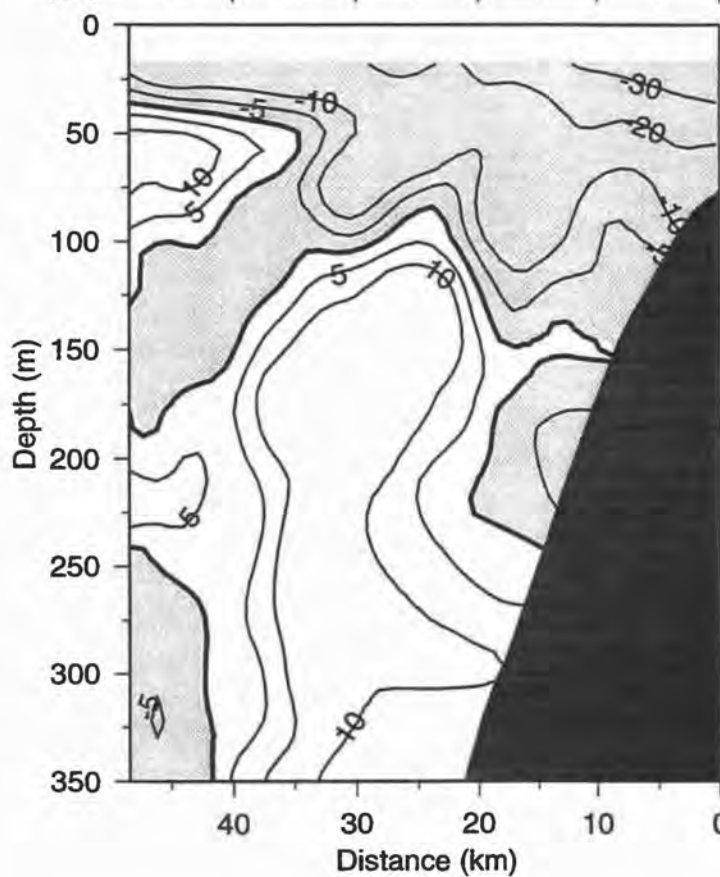
125.0

124.8

124.6



U



V

Line 39 ADCP, 26-Aug-95 16:59 to 26-Aug-95 20:57 (238.7082-238.8735)

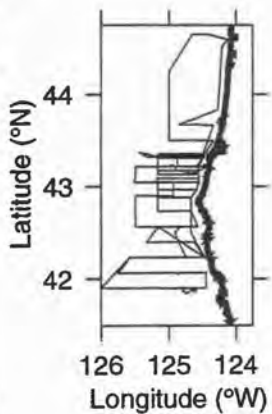
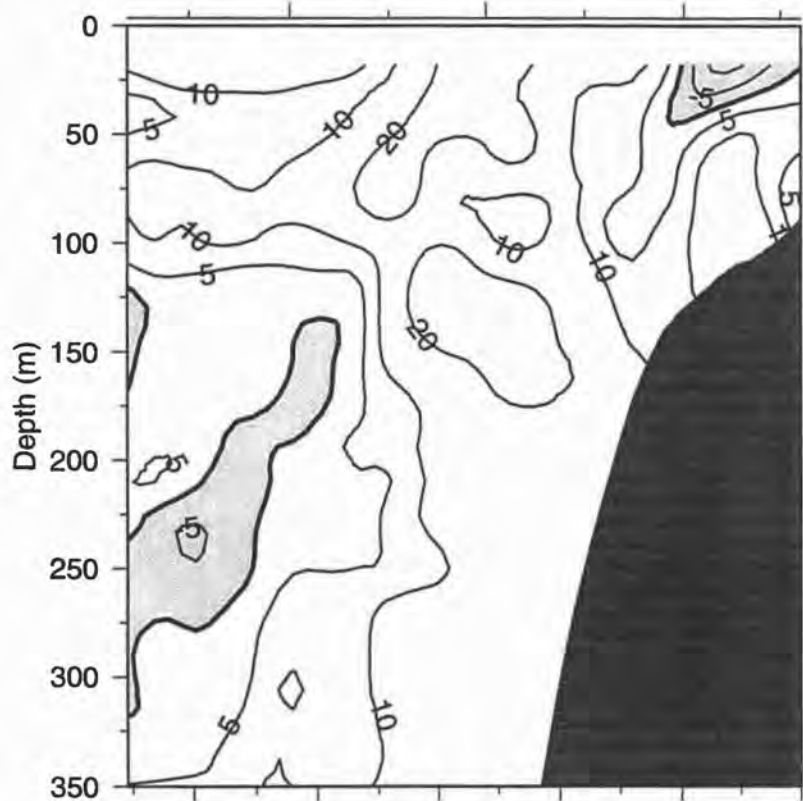
(43.33 °N)

Longitude (°W)

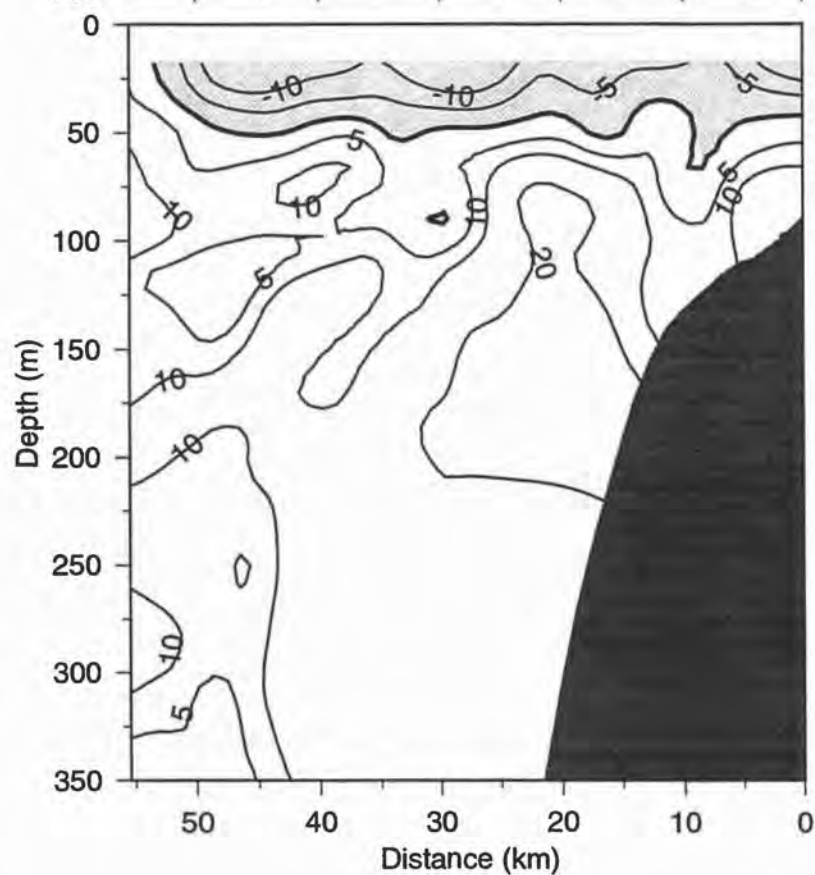
125.0

124.8

124.6



U



V

Line 40 ADCP, 27-Aug-95 01:15 to 27-Aug-95 04:42 (239.0522-239.1962)

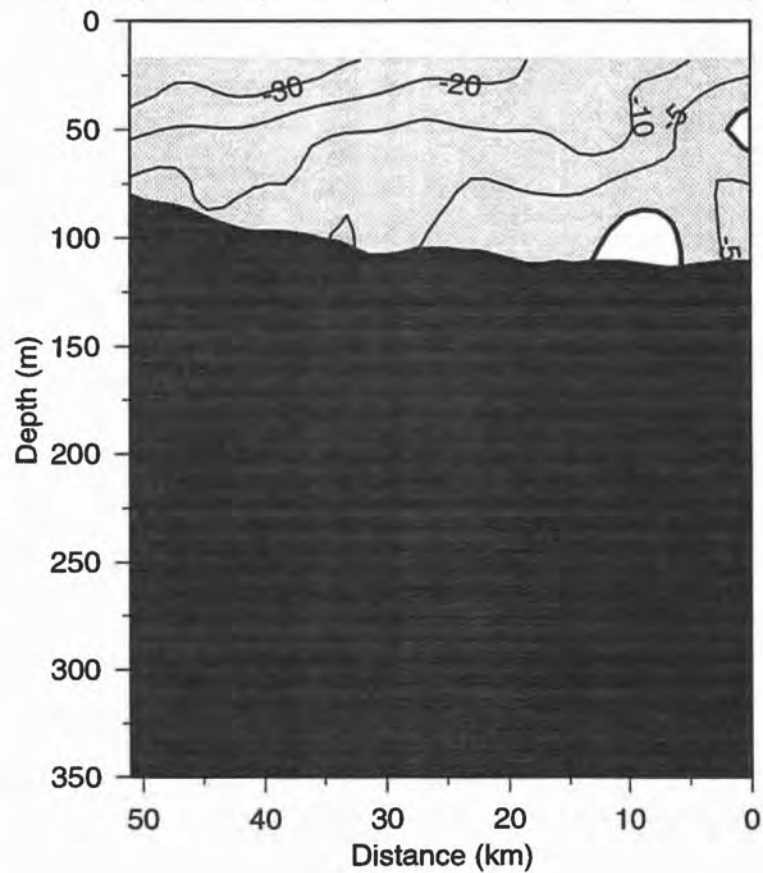
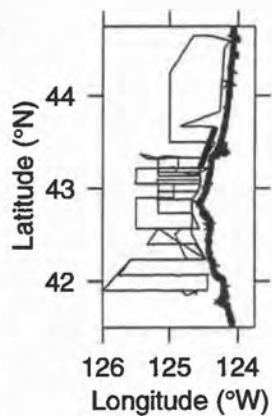
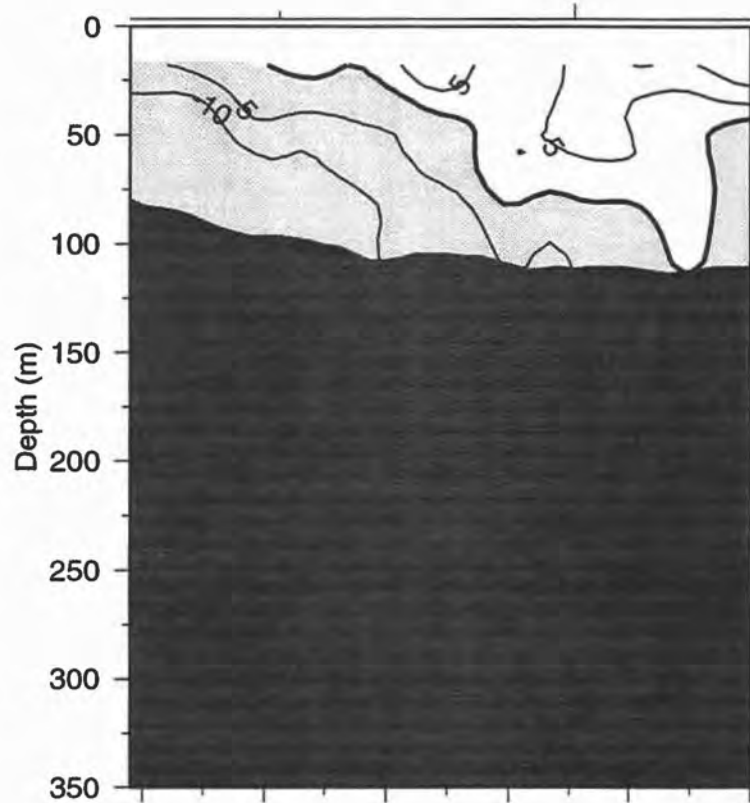
Latitude (°N)

43.4

43.6

Longitude (°W)

124.4

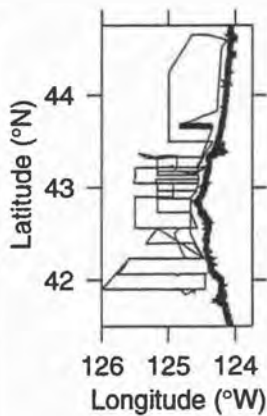
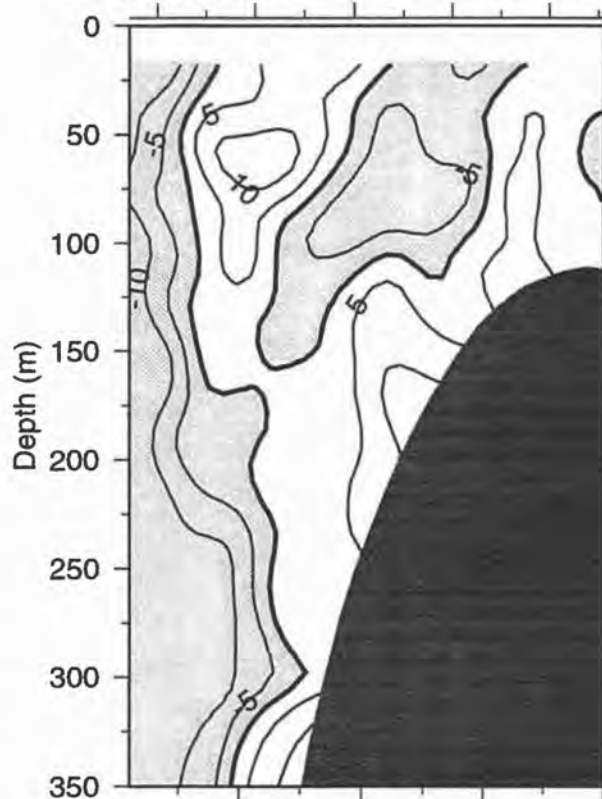


Line 41 ADCP, 27-Aug-95 04:42 to 27-Aug-95 07:22 (239.1962-239.3073)

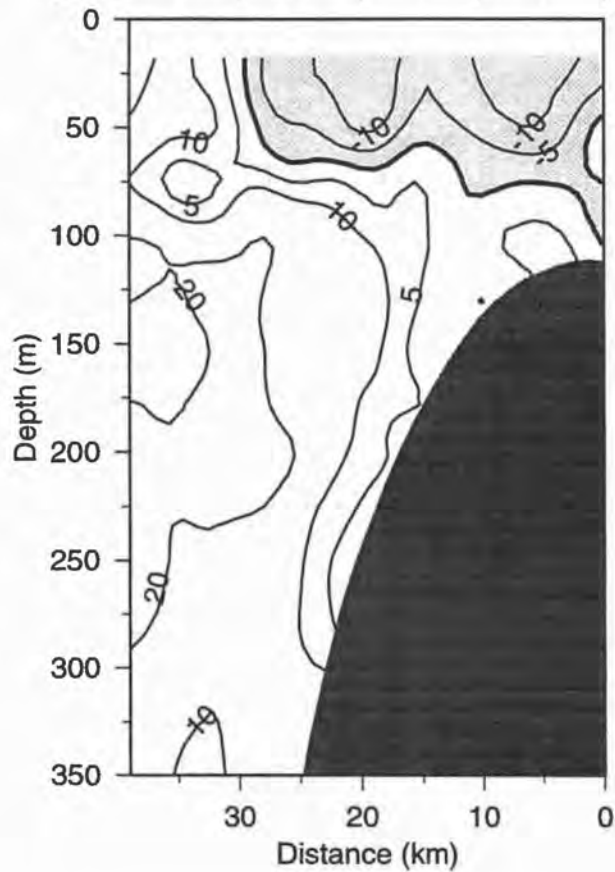
(43.67 °N)

Longitude (°W)

124.8 124.7 124.6 124.5 124.4



U



V

Line 42 ADCP, 27-Aug-95 07:22 to 27-Aug-95 10:16 (239.3073-239.4282)

Latitude (°N)

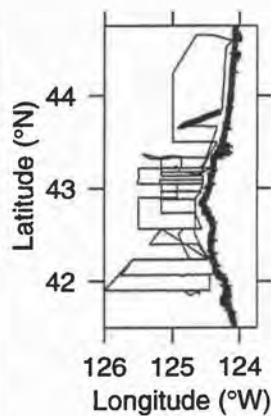
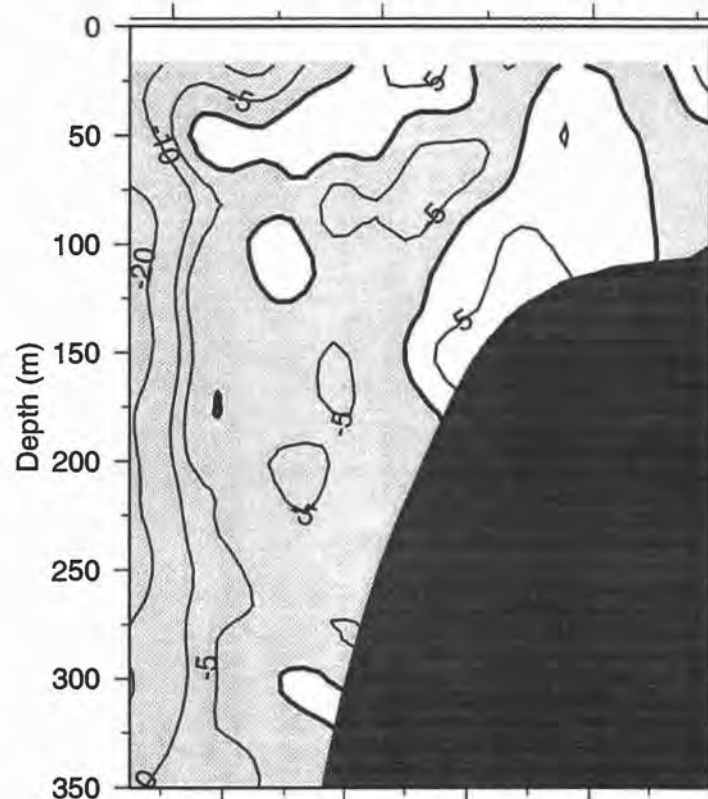
43.8

Longitude (°W)

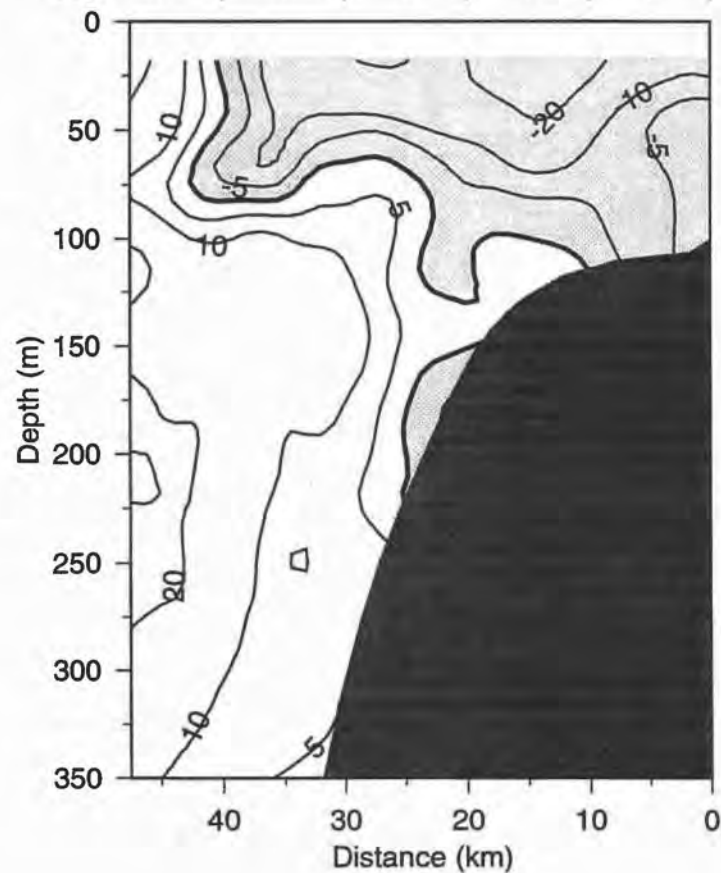
124.8

124.6

124.4



U



V

Line 43 ADCP, 27-Aug-95 10:16 to 27-Aug-95 14:19 (239.4282-239.5967)

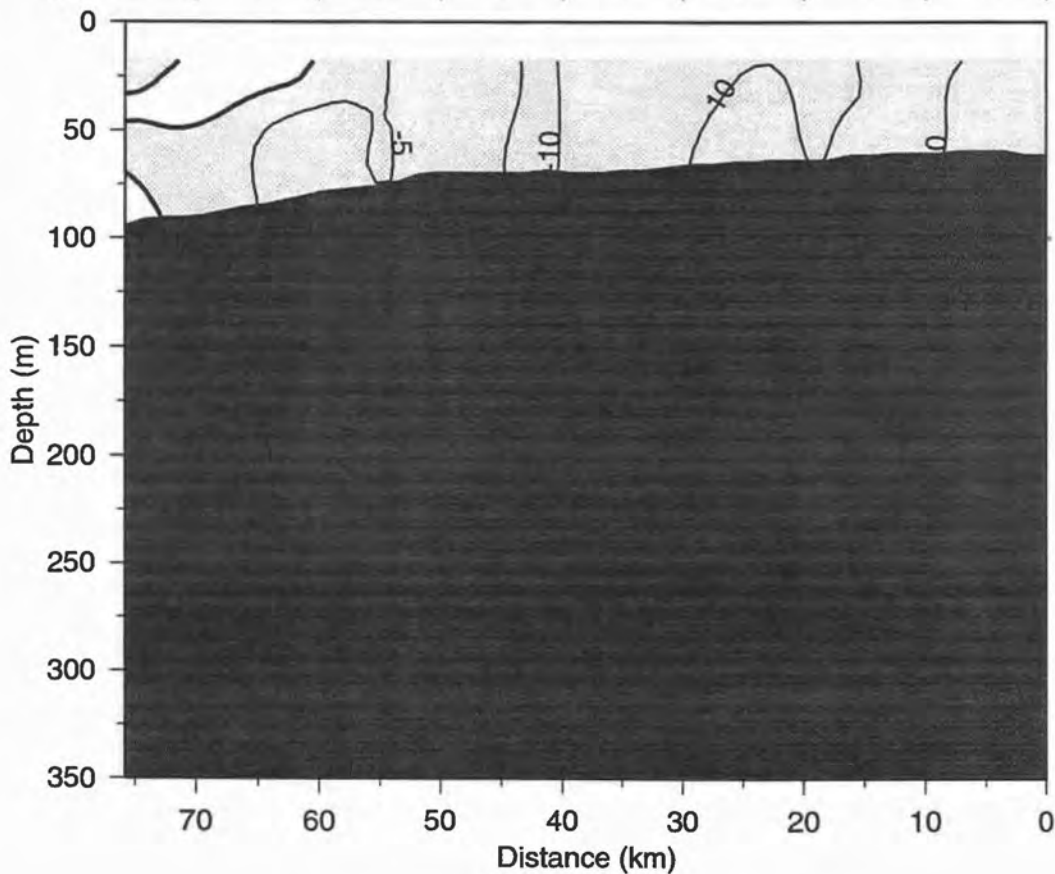
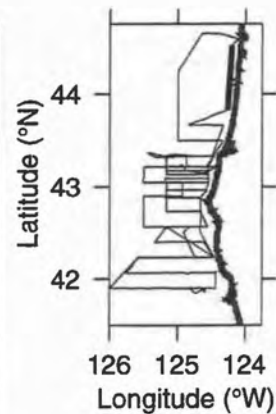
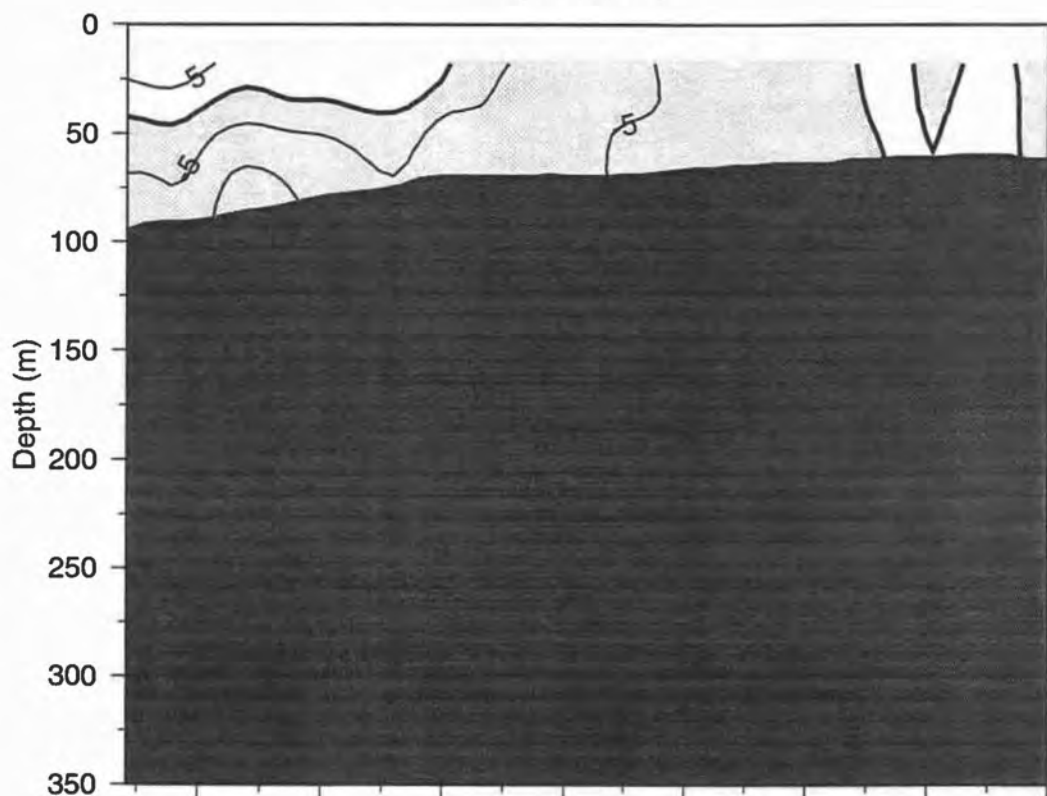
Latitude (°N)

44.0

44.2

44.4

(124.24 °W)

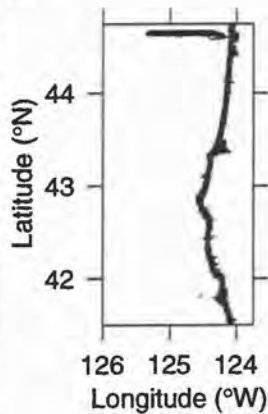
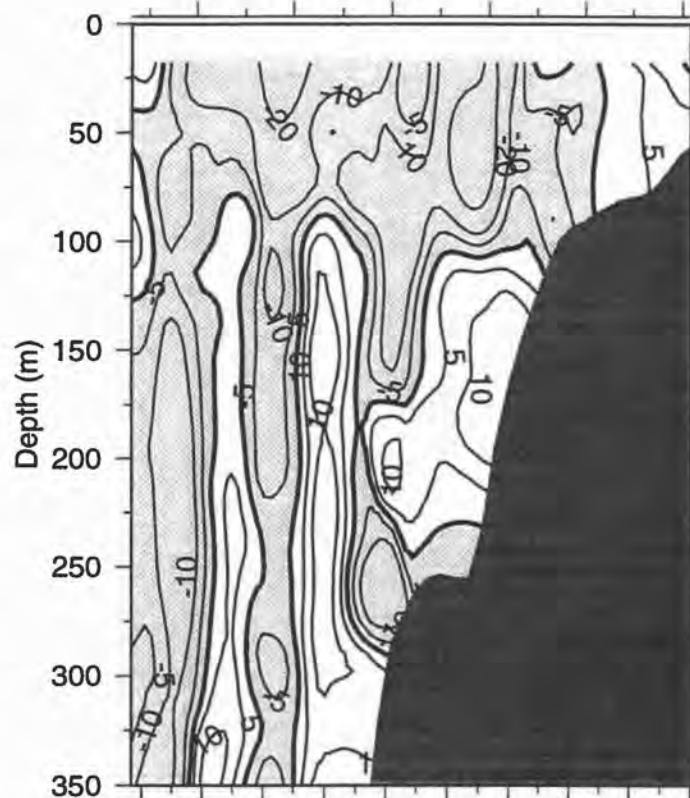


W9508c out ADCP, 31-Aug-95 03:43 to 31-Aug-95 10:06 (243.1551-243.4209)

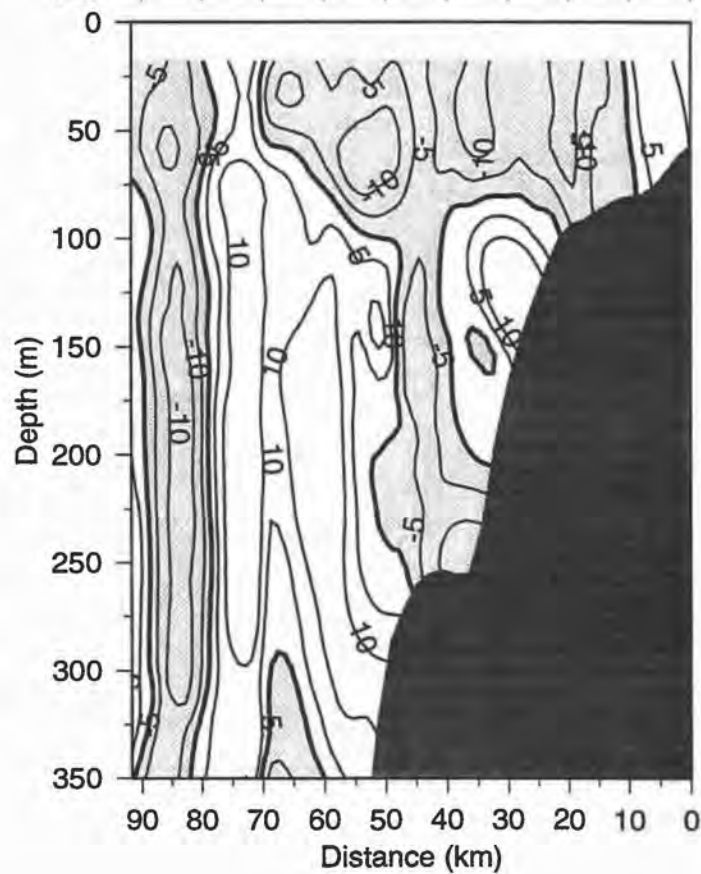
(44.64 °N)

Longitude (°W)

125.2 125.0 124.8 124.6 124.4 124.2



U



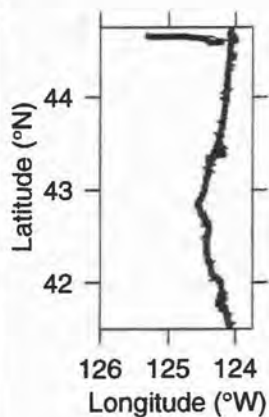
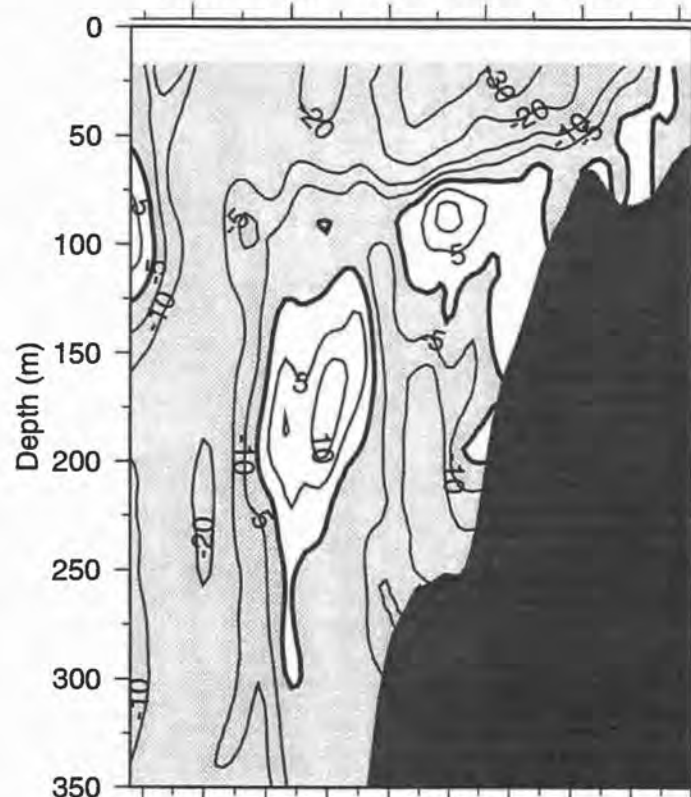
V

W9508c in ADCP, 31-Aug-95 10:06 to 31-Aug-95 15:51 (243.4209-243.6608)

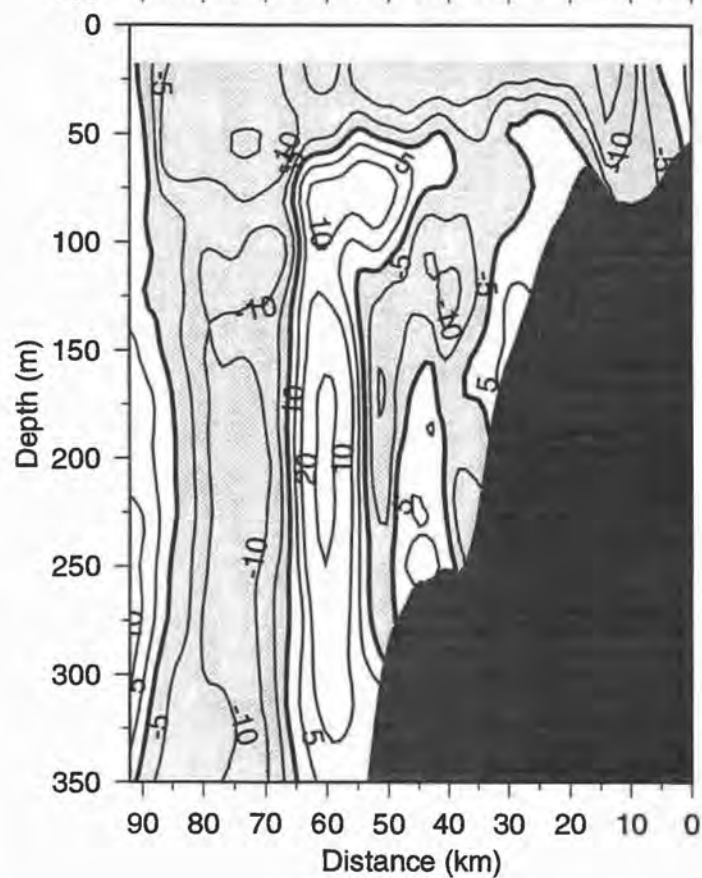
(44.62 °N)

Longitude (°W)

125.2 125.0 124.8 124.6 124.4 124.2

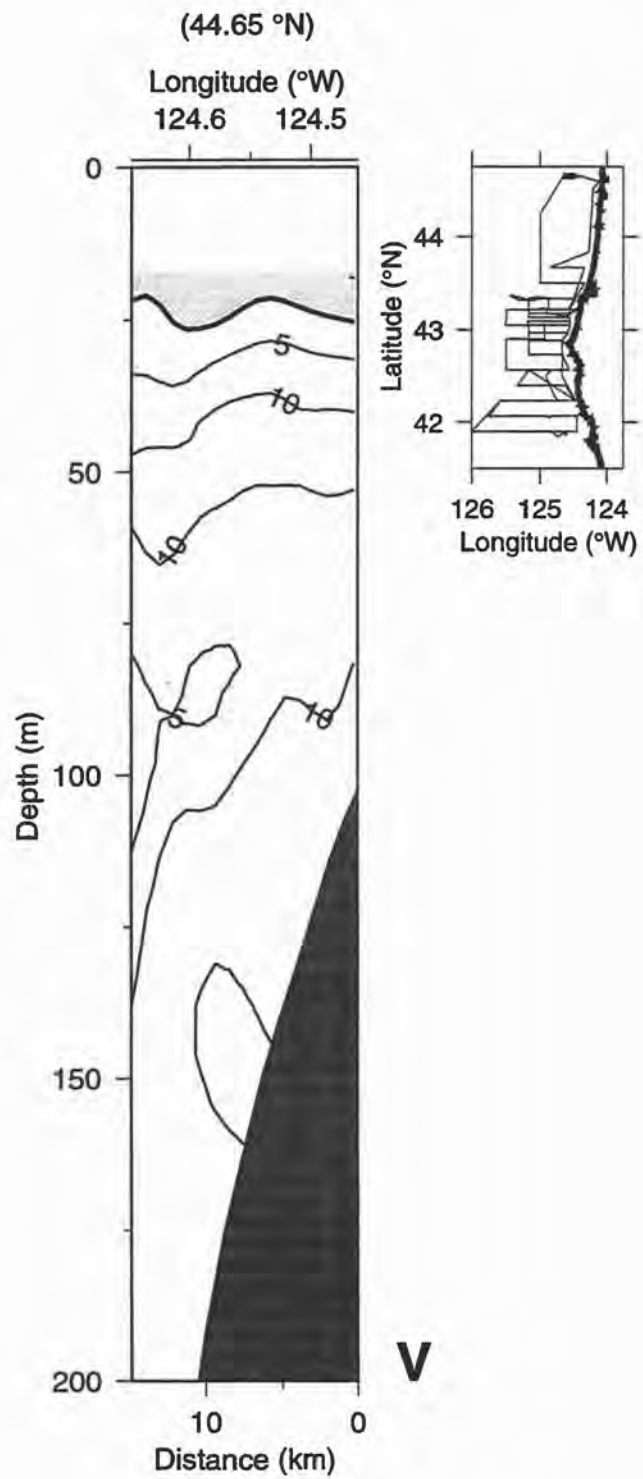


U



V

Line a ADCP, 17-Aug-95 21:29 to 17-Aug-95 22:40 (229.8958-229.9445)



Line b ADCP, 17-Aug-95 22:40 to 18-Aug-95 02:11 (229.9445-230.0913)

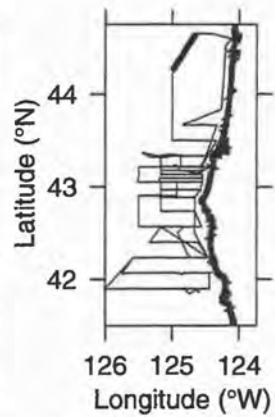
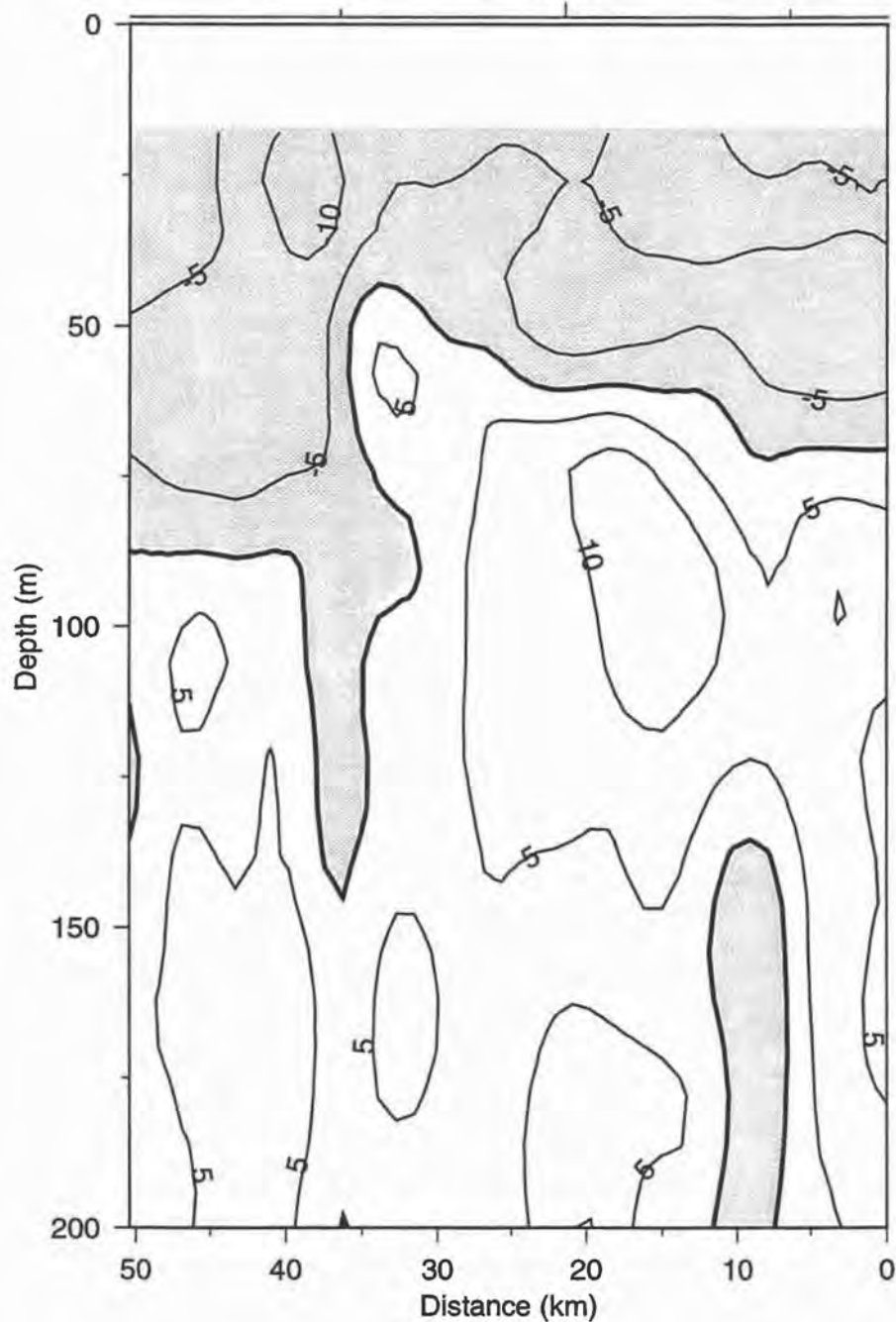
Latitude (°N)

44.4

44.6

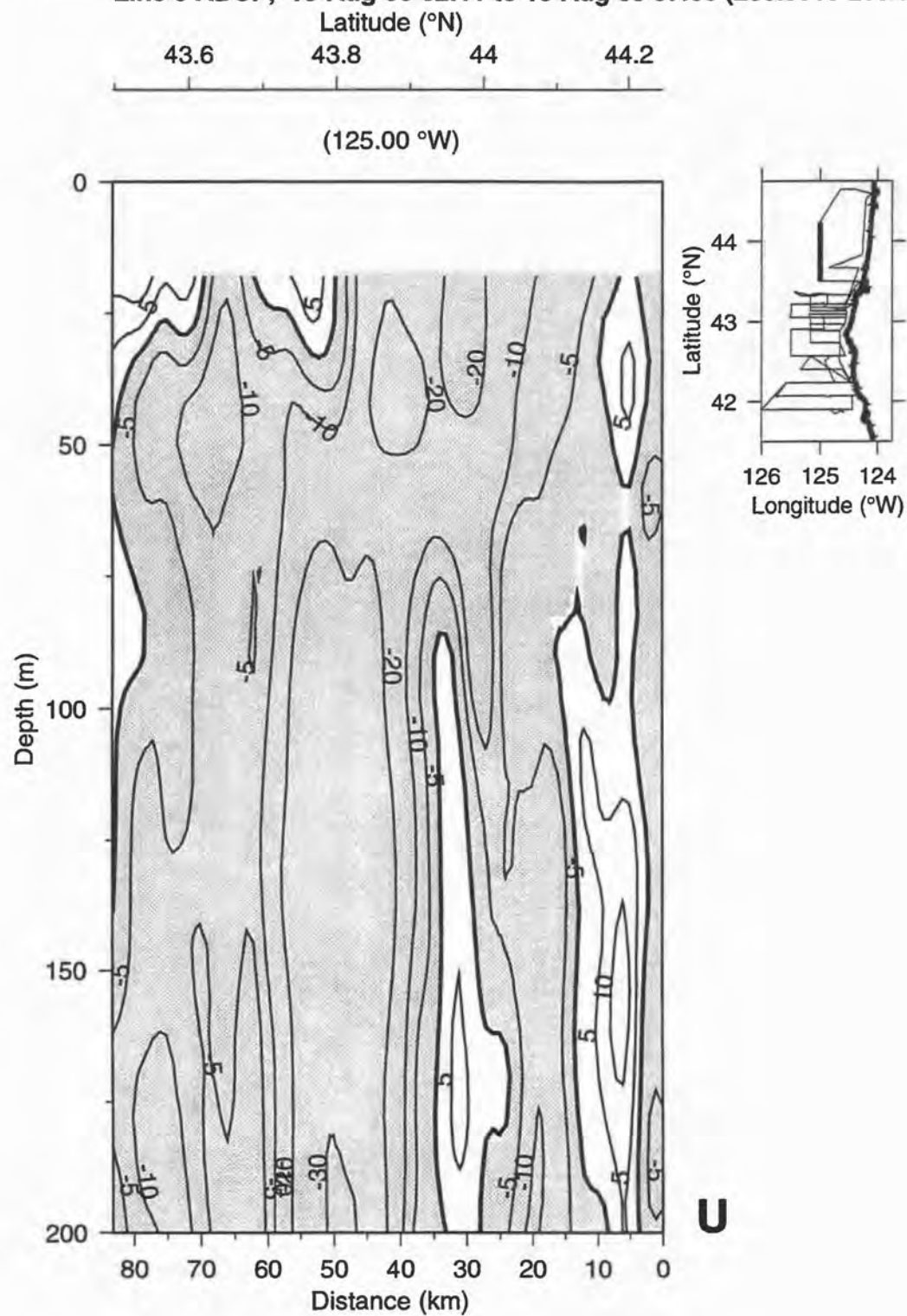
Longitude (°W)

124.8



U

Line c ADCP, 18-Aug-95 02:11 to 18-Aug-95 07:39 (230.0913-230.3193)



Line 1 ADCP, 18-Aug-95 07:39 to 18-Aug-95 11:11 (230.3193-230.4665)

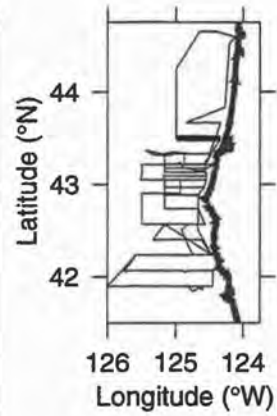
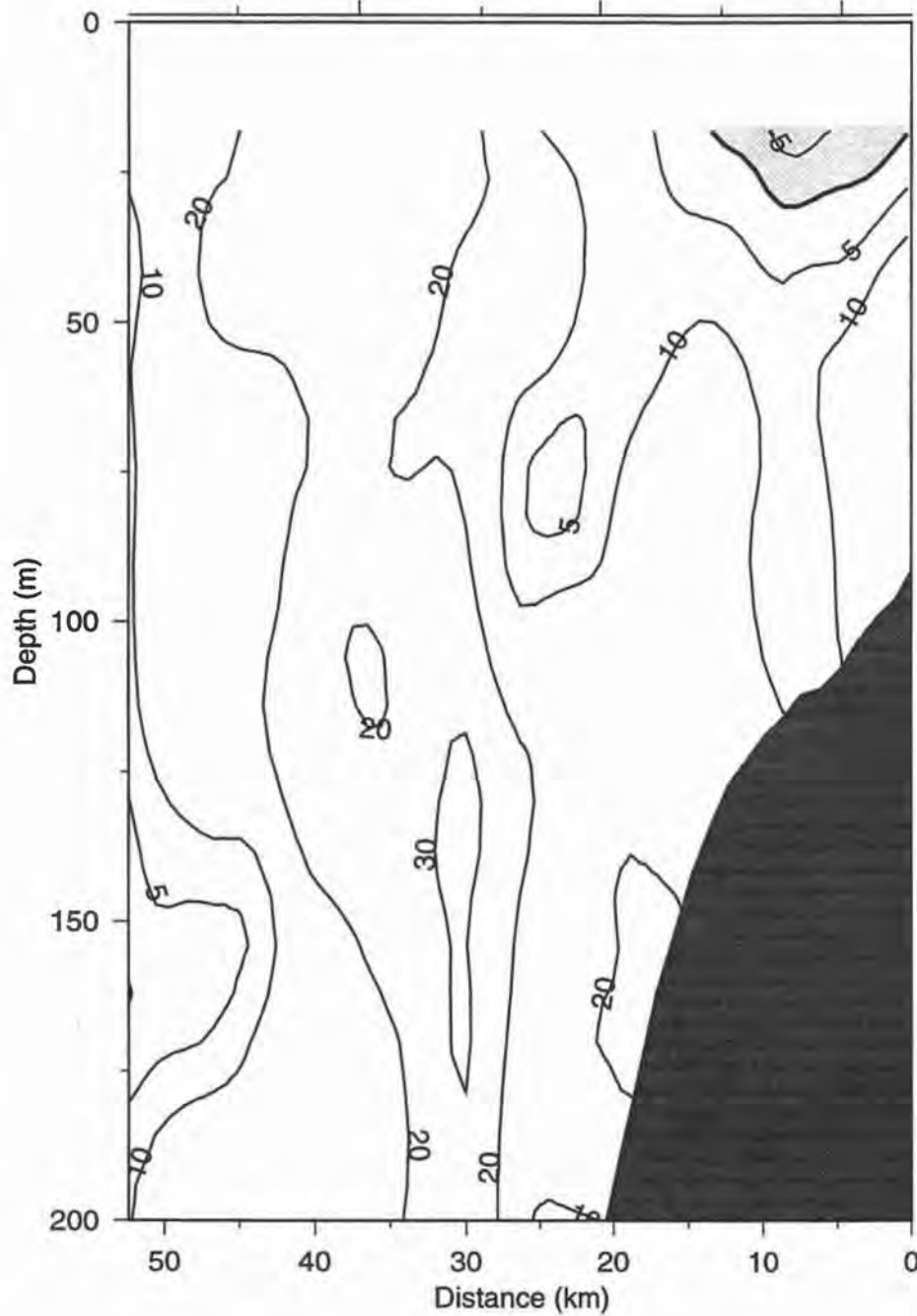
(43.50 °N)

Longitude (°W)

124.8

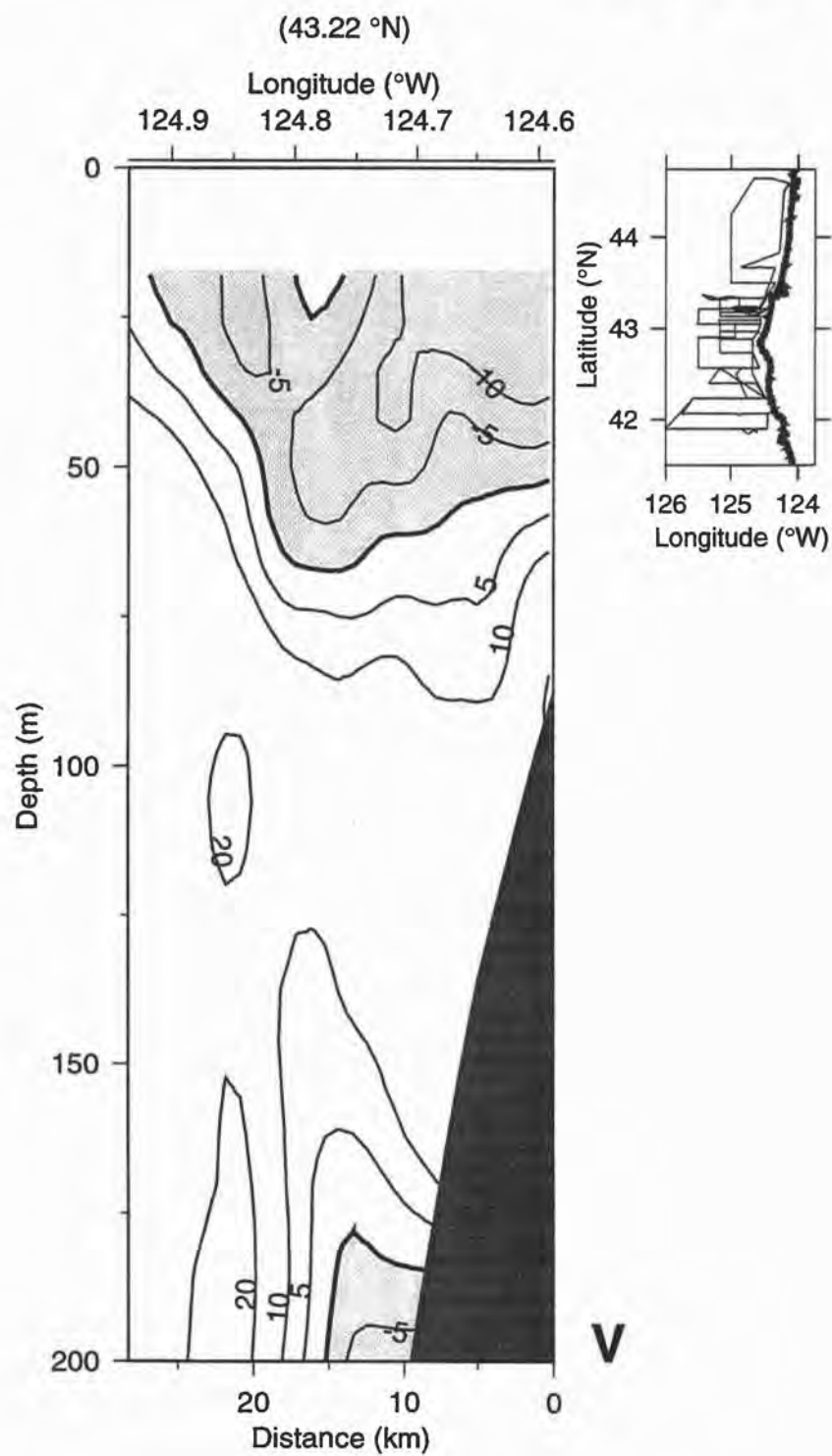
124.6

124.4

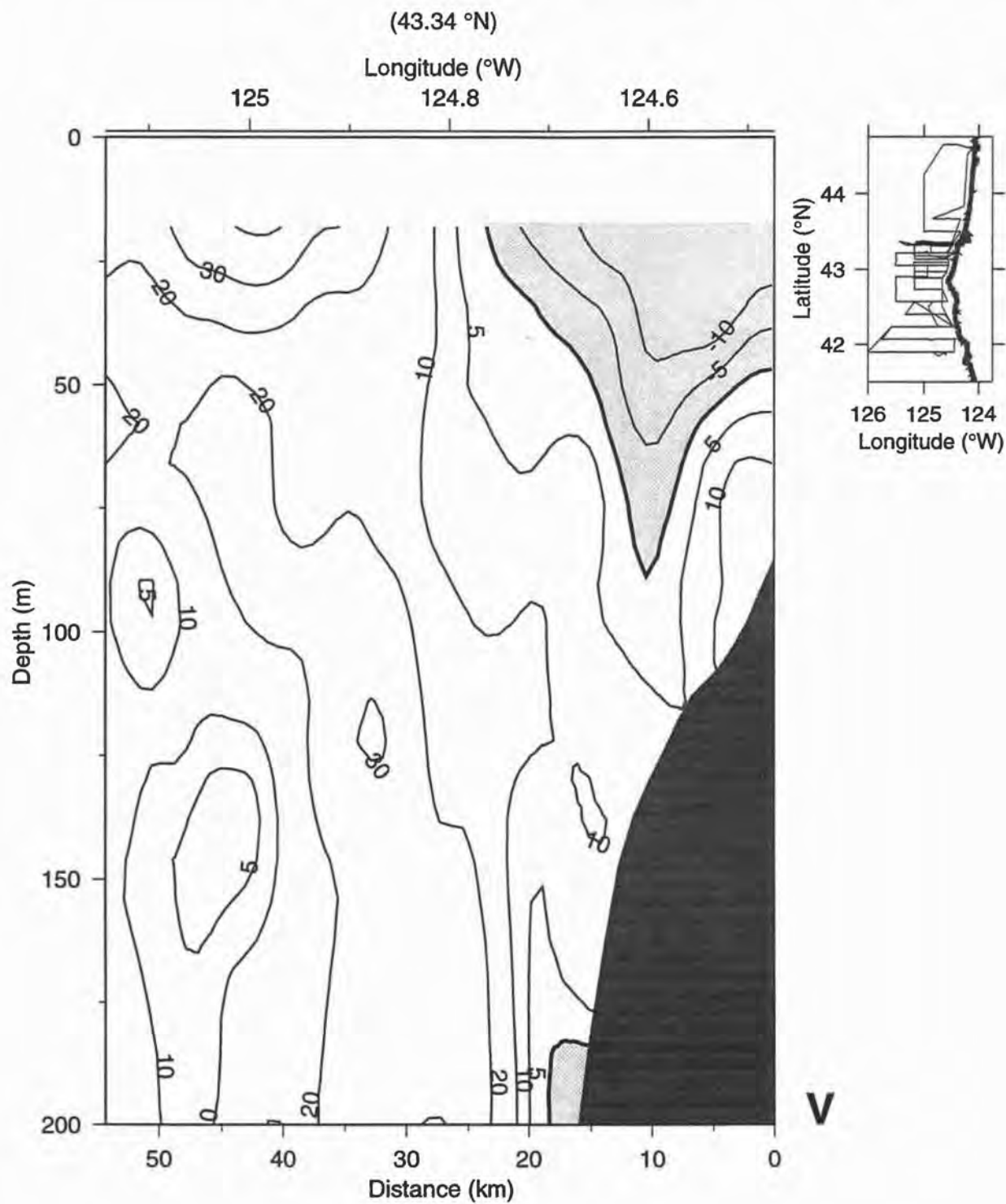


V

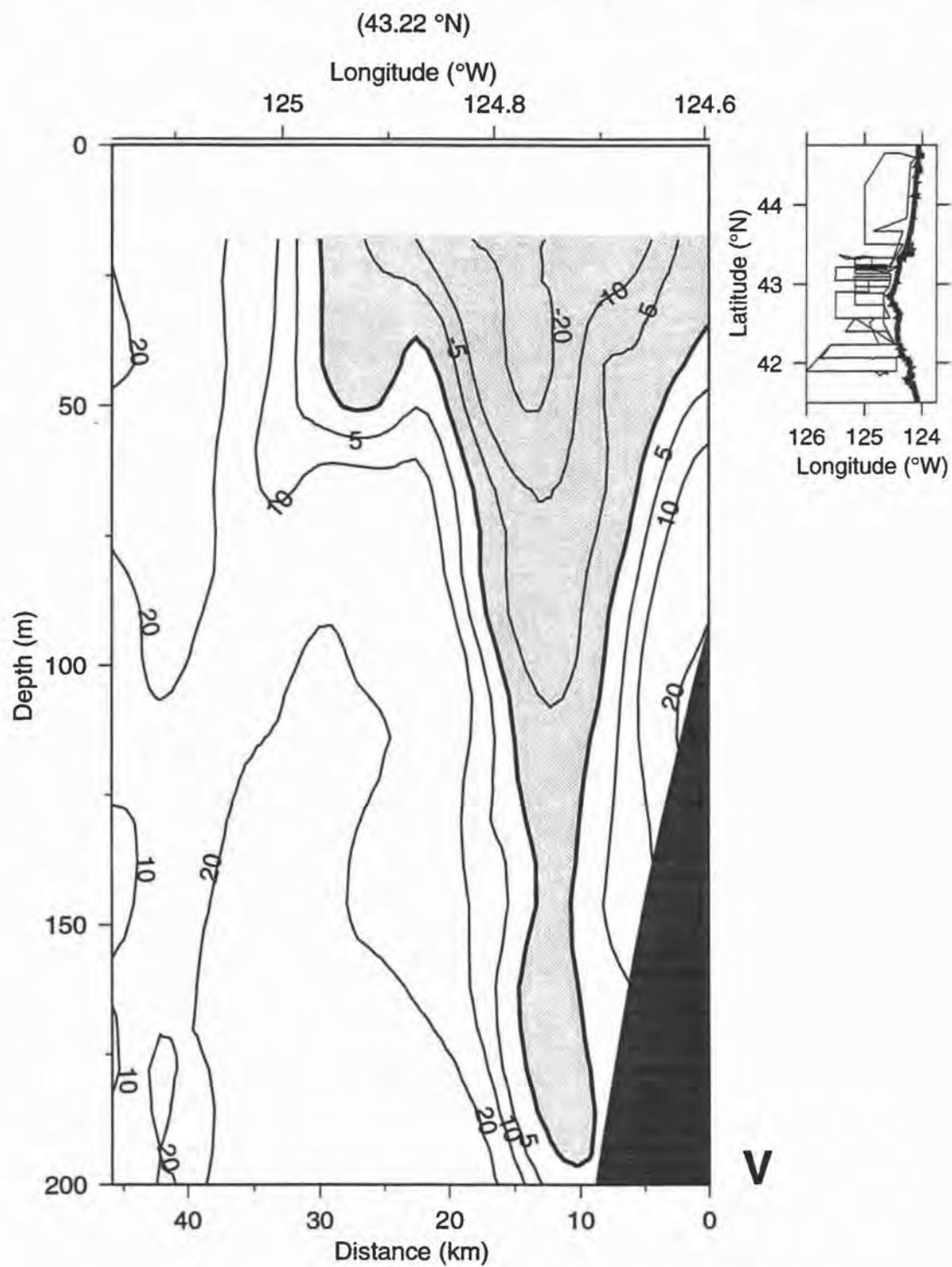
Line 2 ADCP, 18-Aug-95 13:33 to 18-Aug-95 15:39 (230.5651-230.6524)



Line 3 ADCP, 19-Aug-95 10:45 to 19-Aug-95 14:37 (231.4485-231.6095)



Line 4 ADCP, 19-Aug-95 15:44 to 19-Aug-95 18:59 (231.6558-231.7910)



Line 5 ADCP, 19-Aug-95 19:41 to 19-Aug-95 23:08 (231.8203-231.9644)

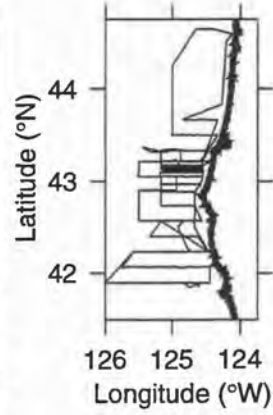
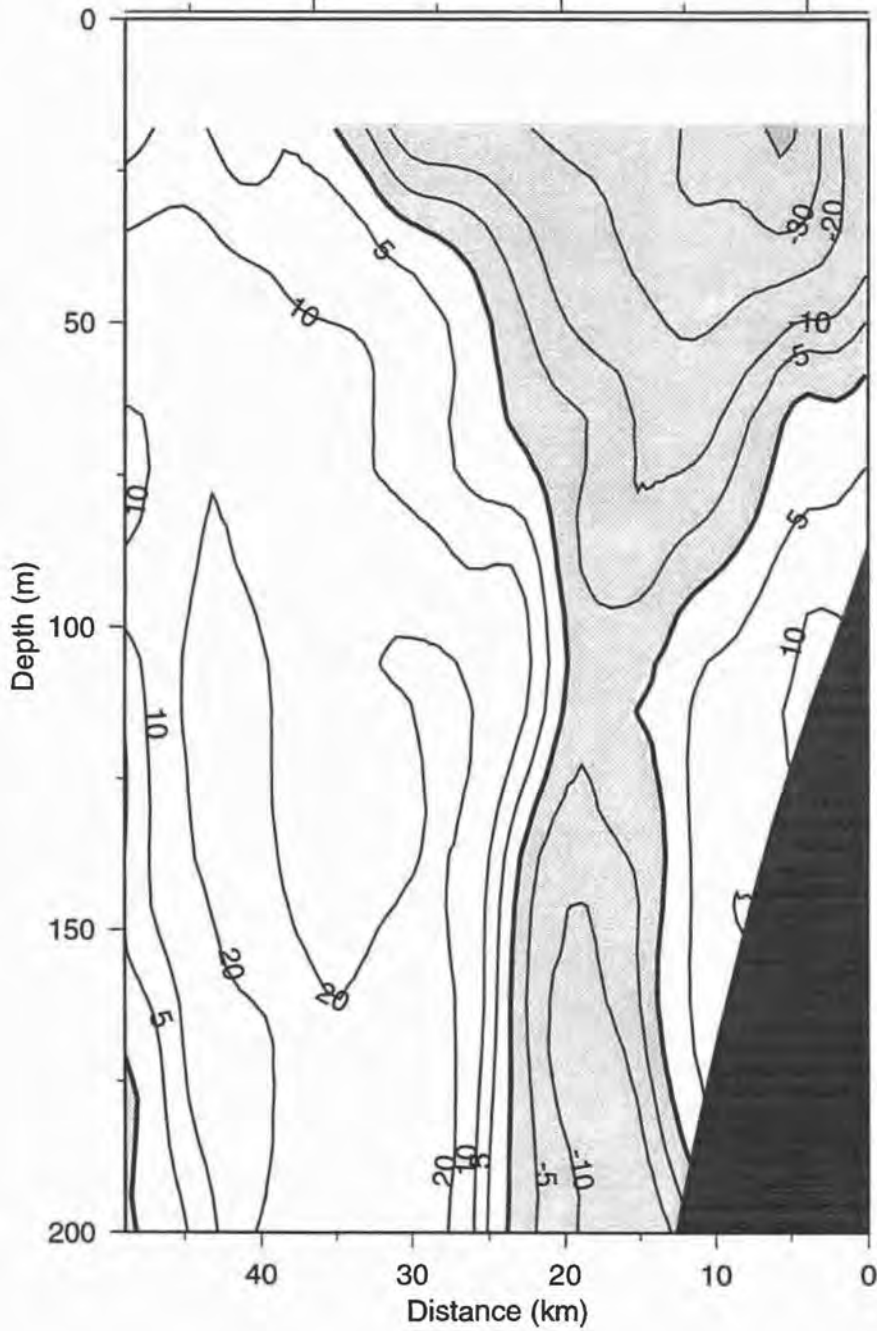
(43.13 °N)

Longitude (°W)

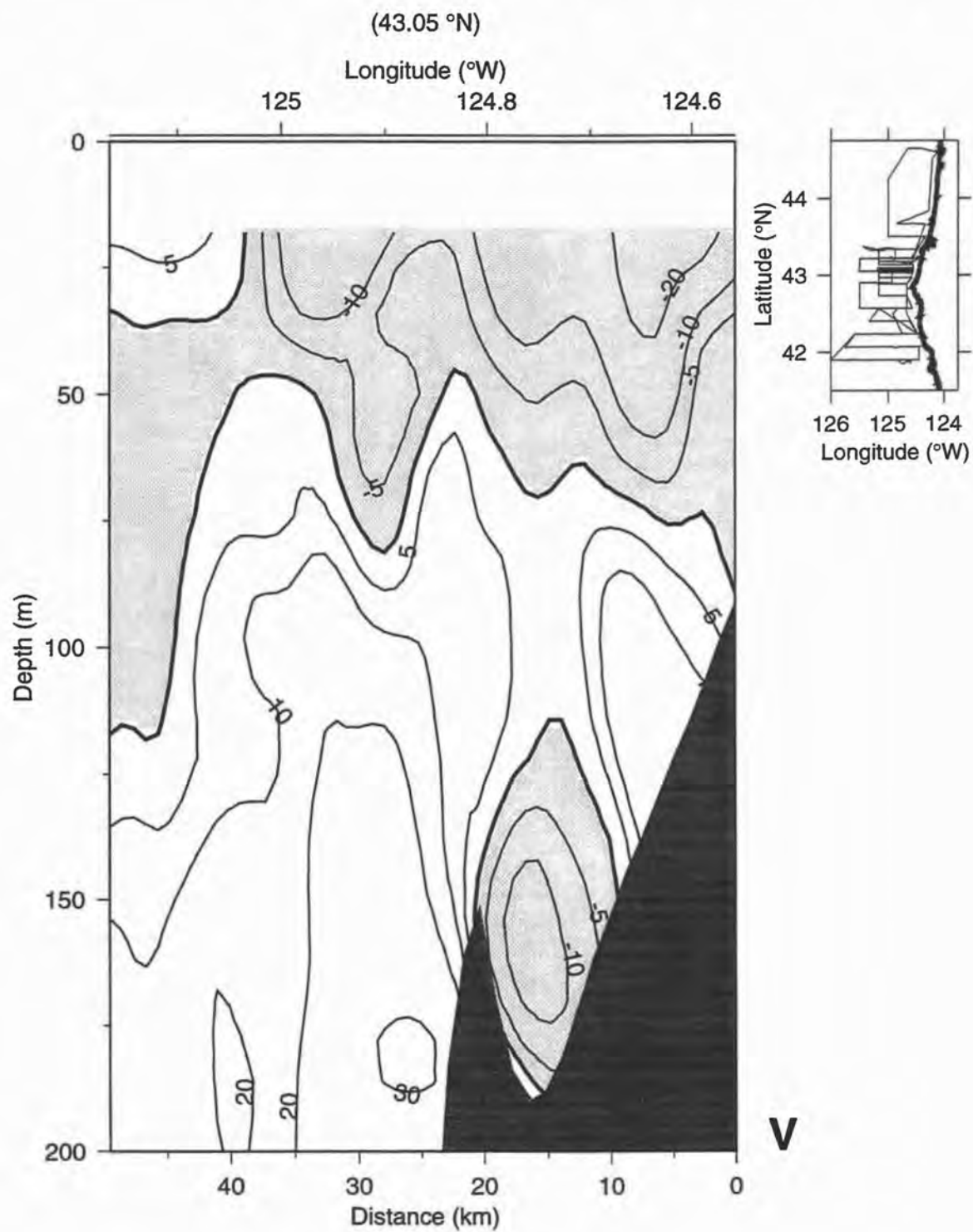
125

124.8

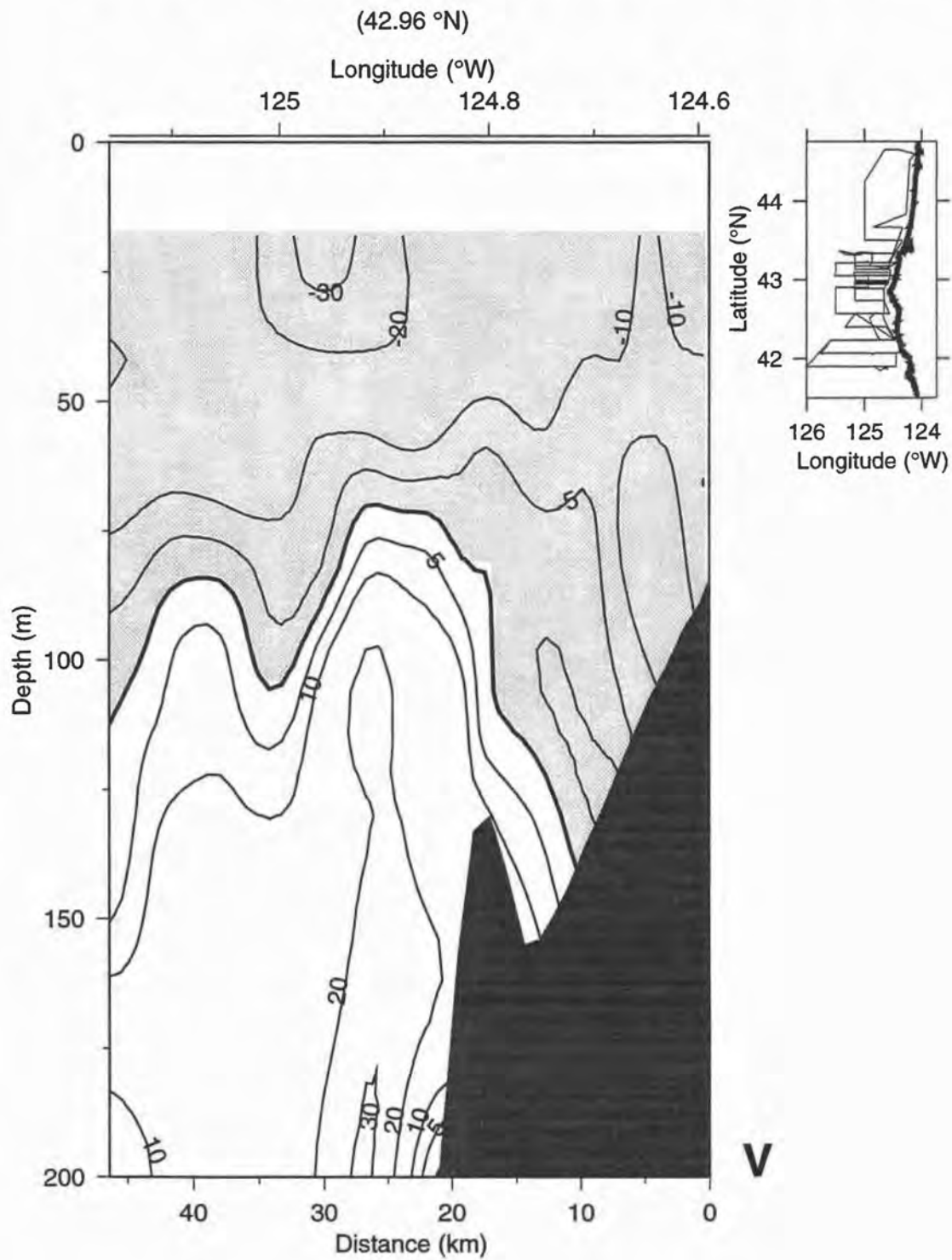
124.6



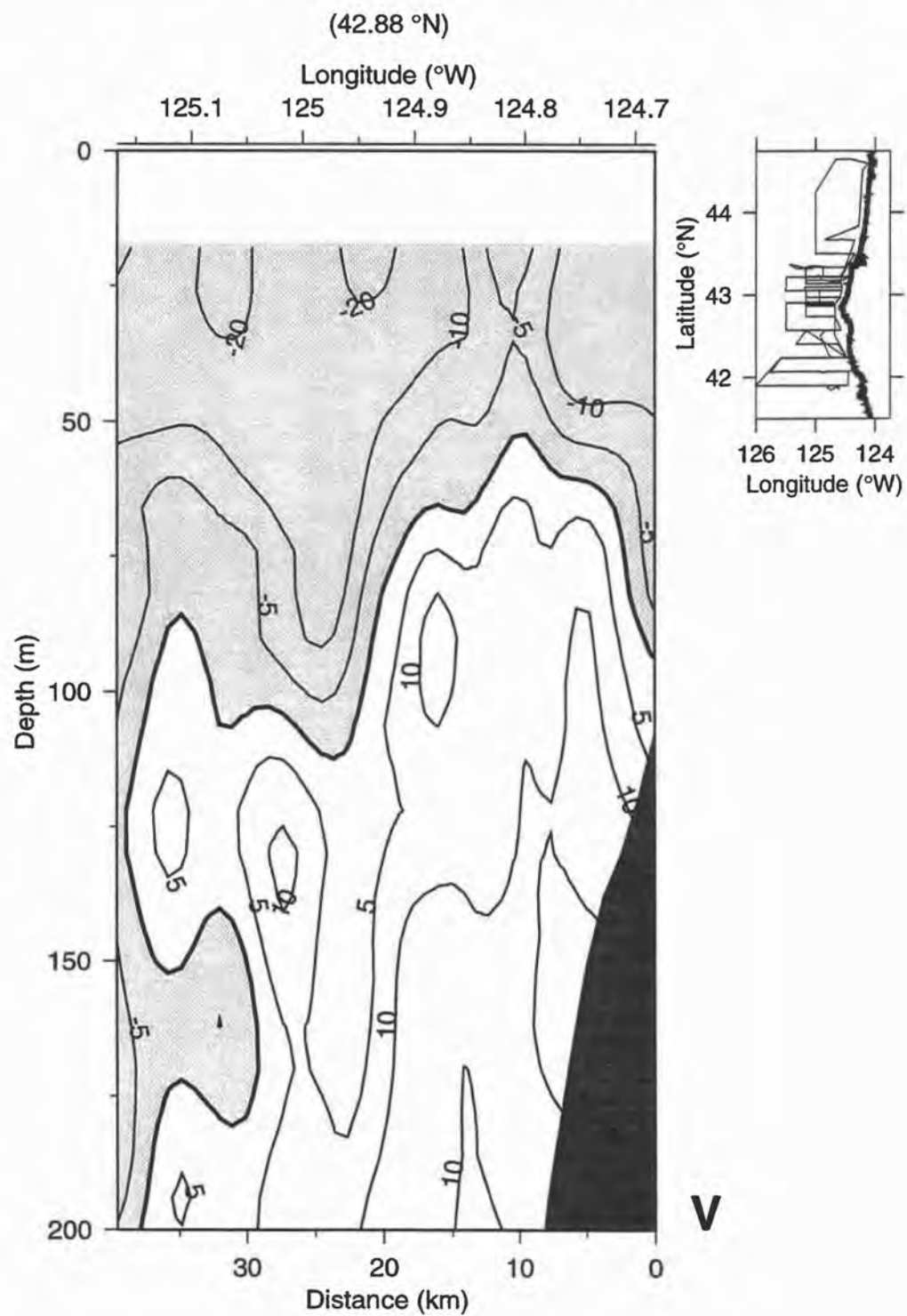
Line 6 ADCP, 19-Aug-95 23:46 to 20-Aug-95 03:00 (231.9903-232.1256)



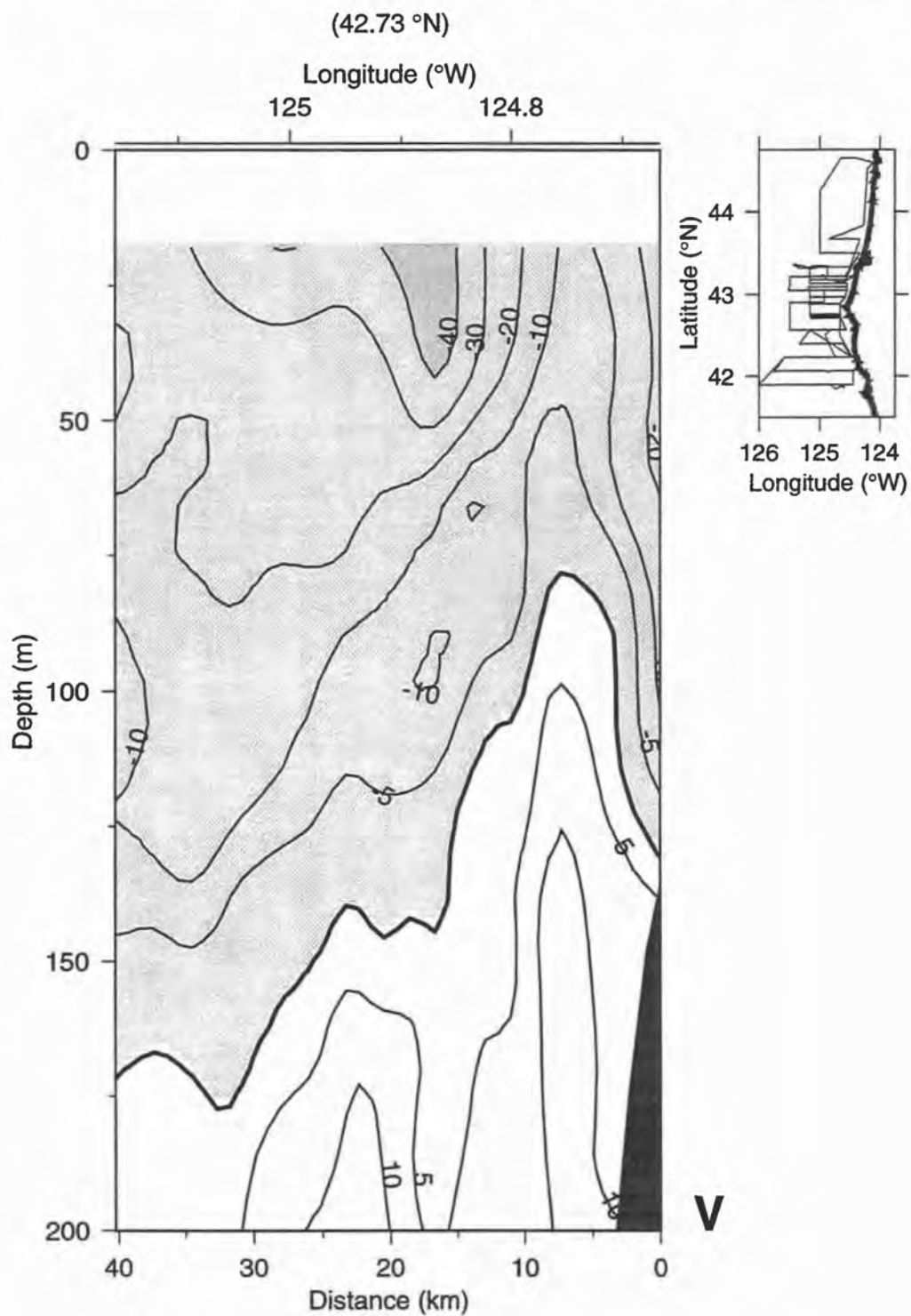
Line 7 ADCP, 20-Aug-95 03:37 to 20-Aug-95 06:48 (232.1507-232.2834)



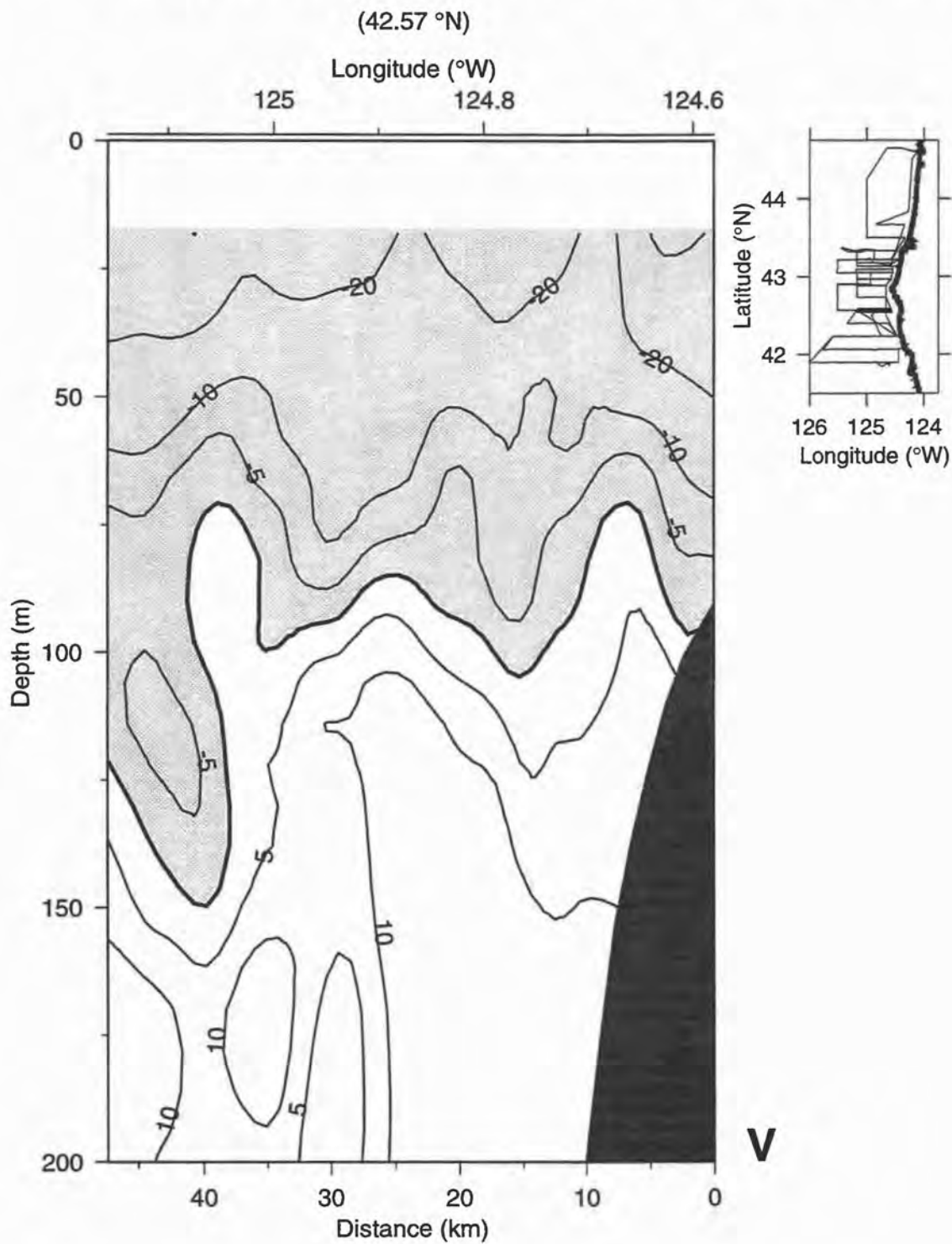
Line 8 ADCP, 20-Aug-95 07:33 to 20-Aug-95 10:09 (232.3149-232.4231)



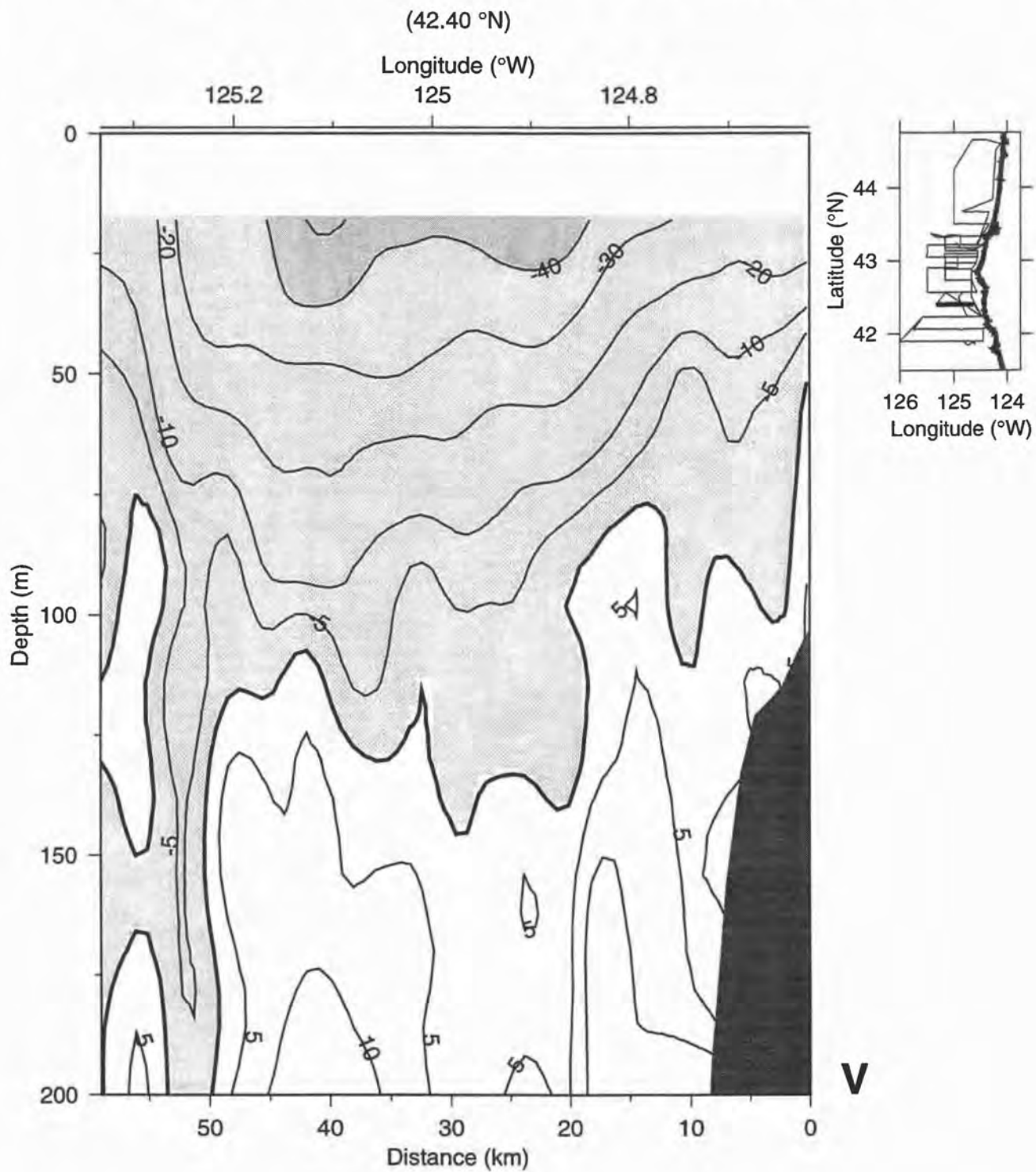
Line 9 ADCP, 20-Aug-95 11:13 to 20-Aug-95 13:48 (232.4677-232.5750)



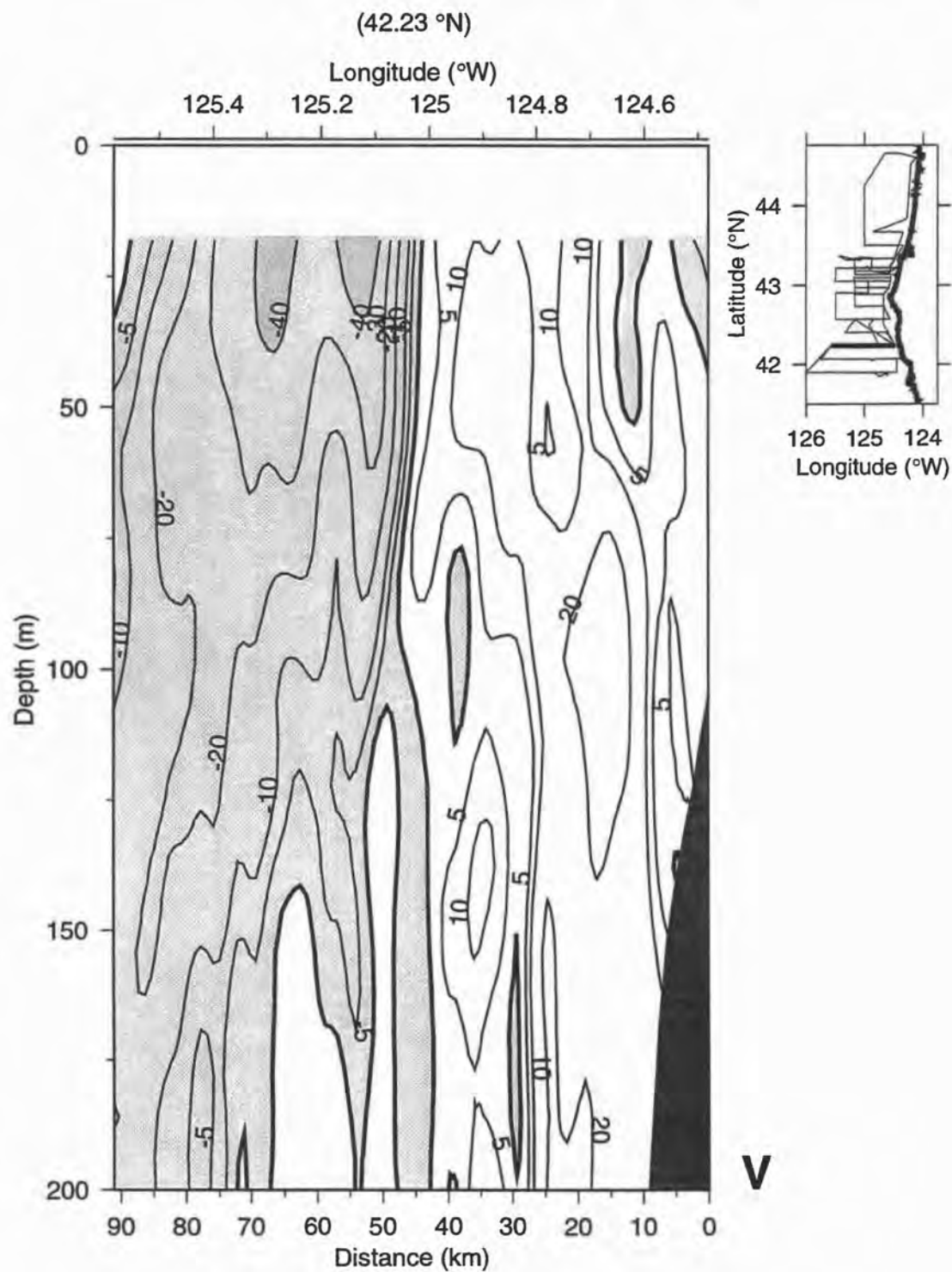
Line 10 ADCP, 20-Aug-95 15:02 to 20-Aug-95 18:13 (232.6270-232.7592)



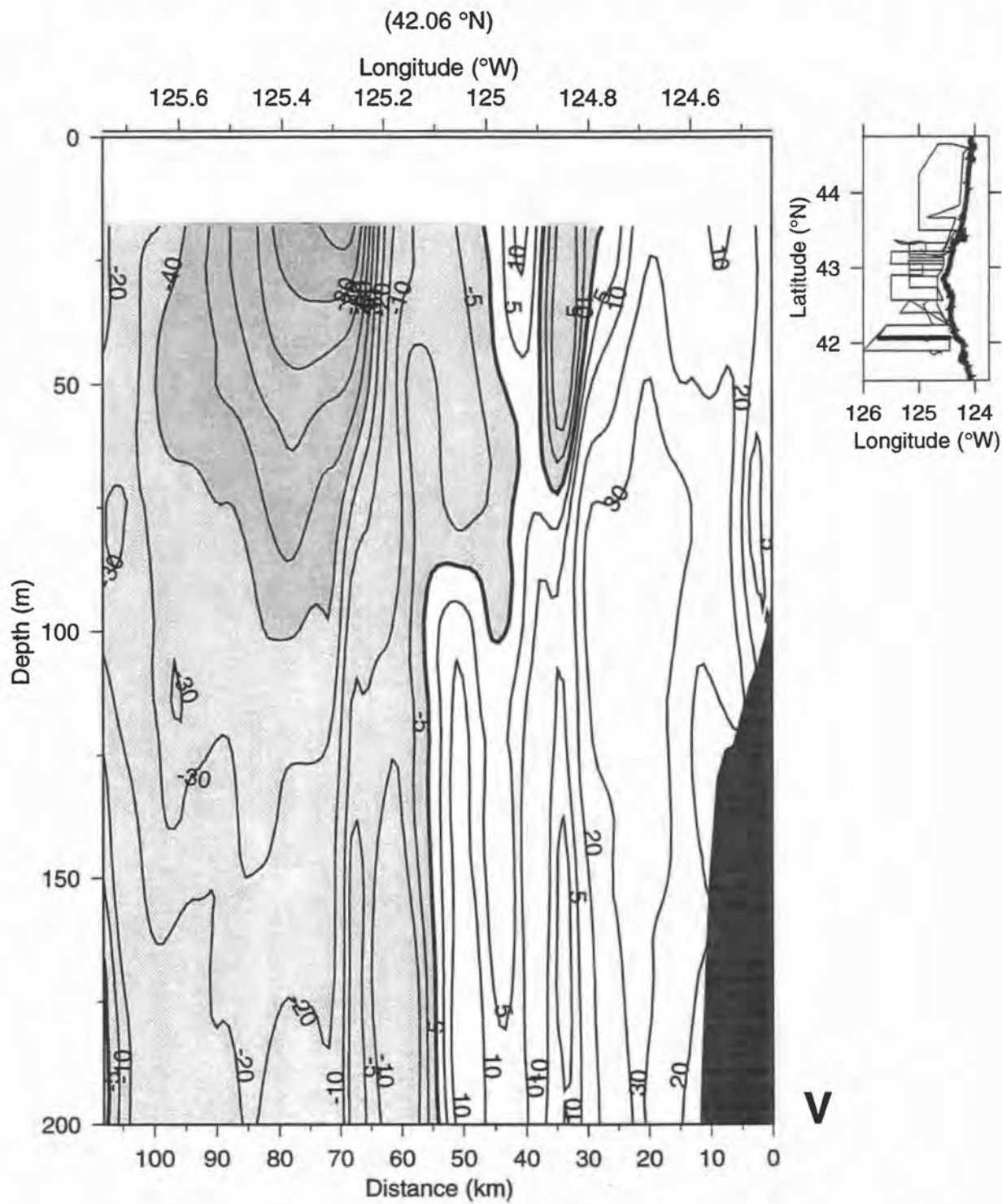
Line 11 ADCP, 20-Aug-95 19:38 to 20-Aug-95 23:46 (232.8184-232.9908)



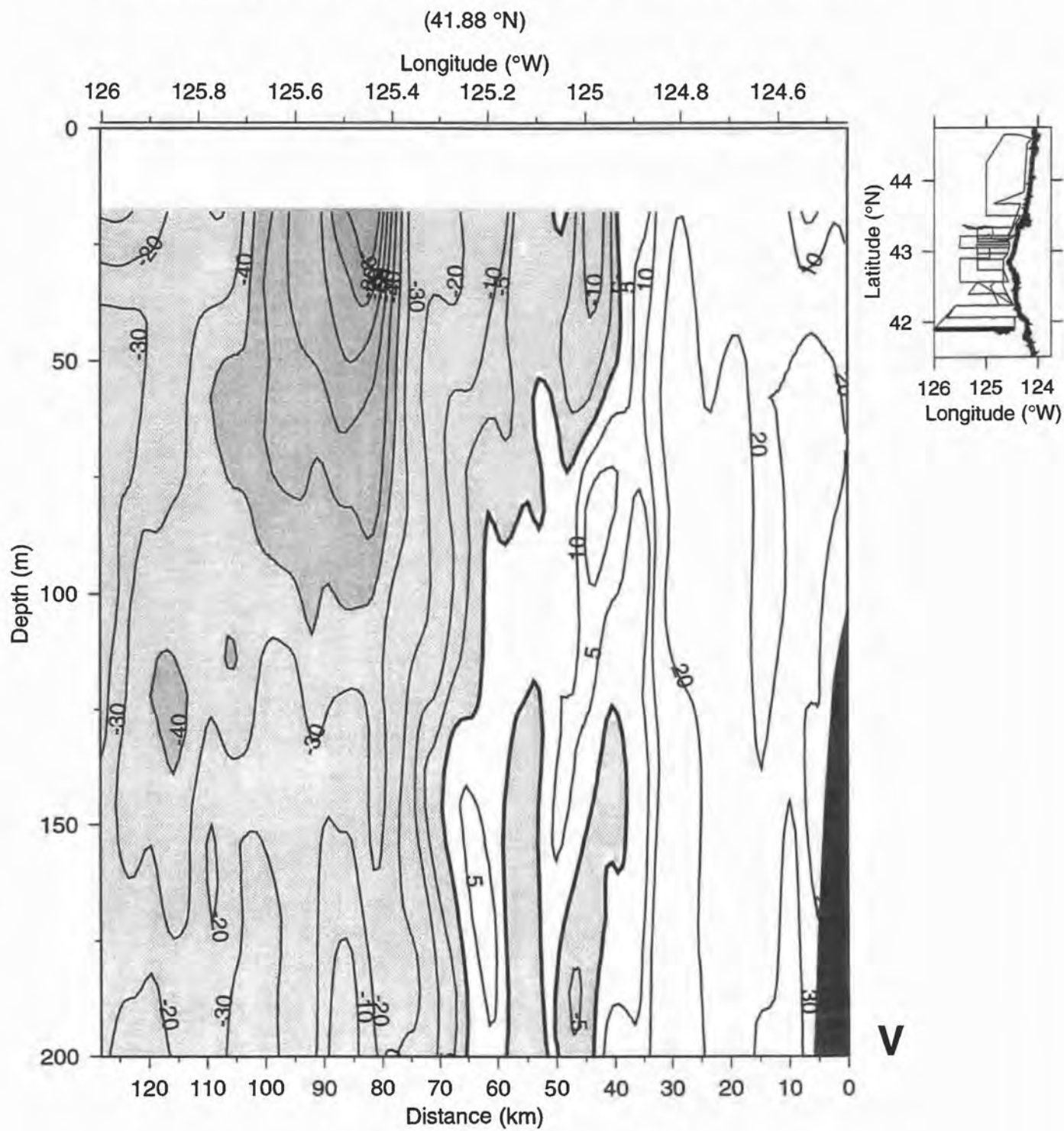
Line 12 ADCP, 21-Aug-95 01:19 to 21-Aug-95 06:55 (233.0552-233.2883)



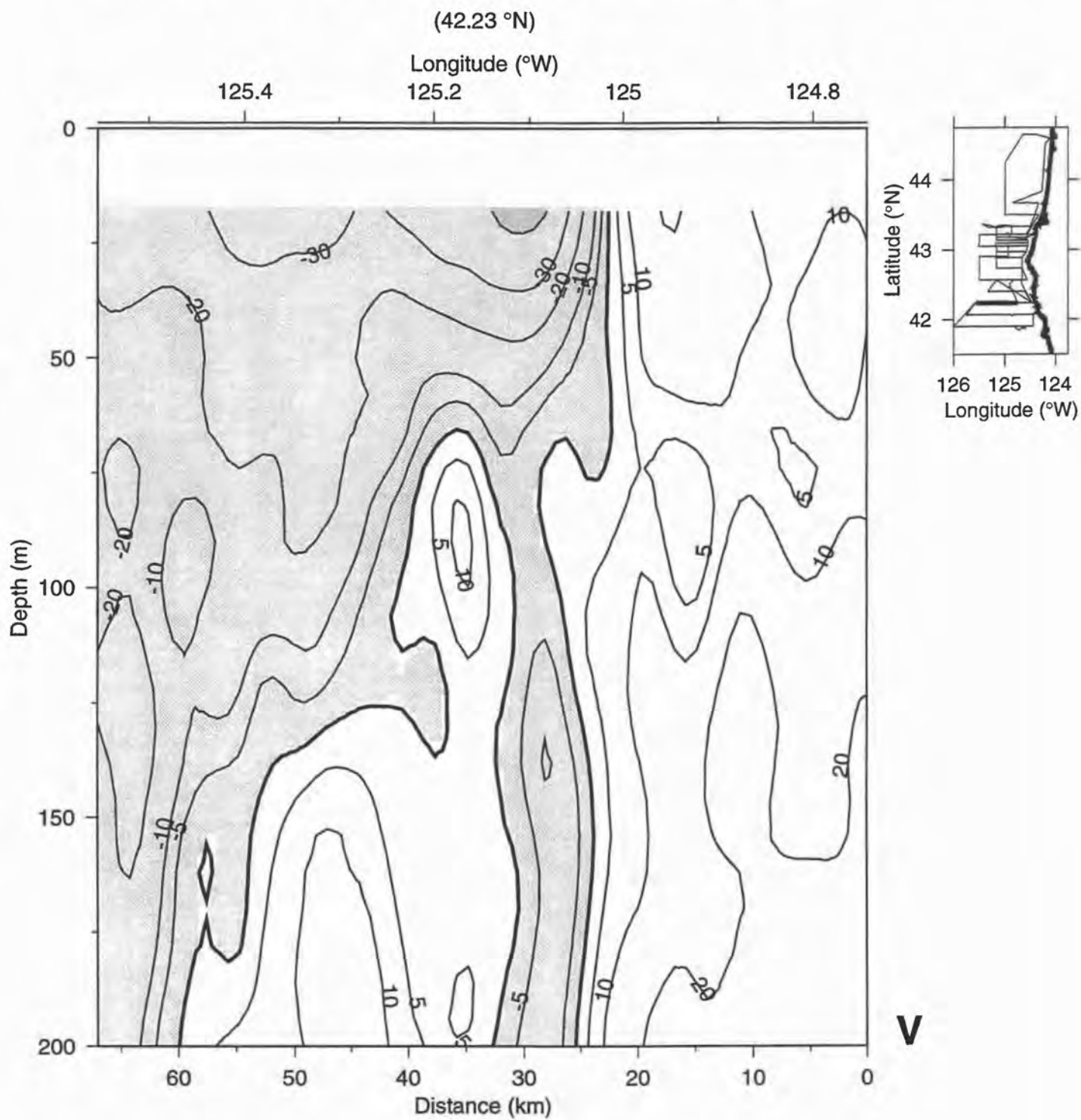
Line 13 ADCP, 21-Aug-95 08:27 to 21-Aug-95 16:06 (233.3527-233.6712)



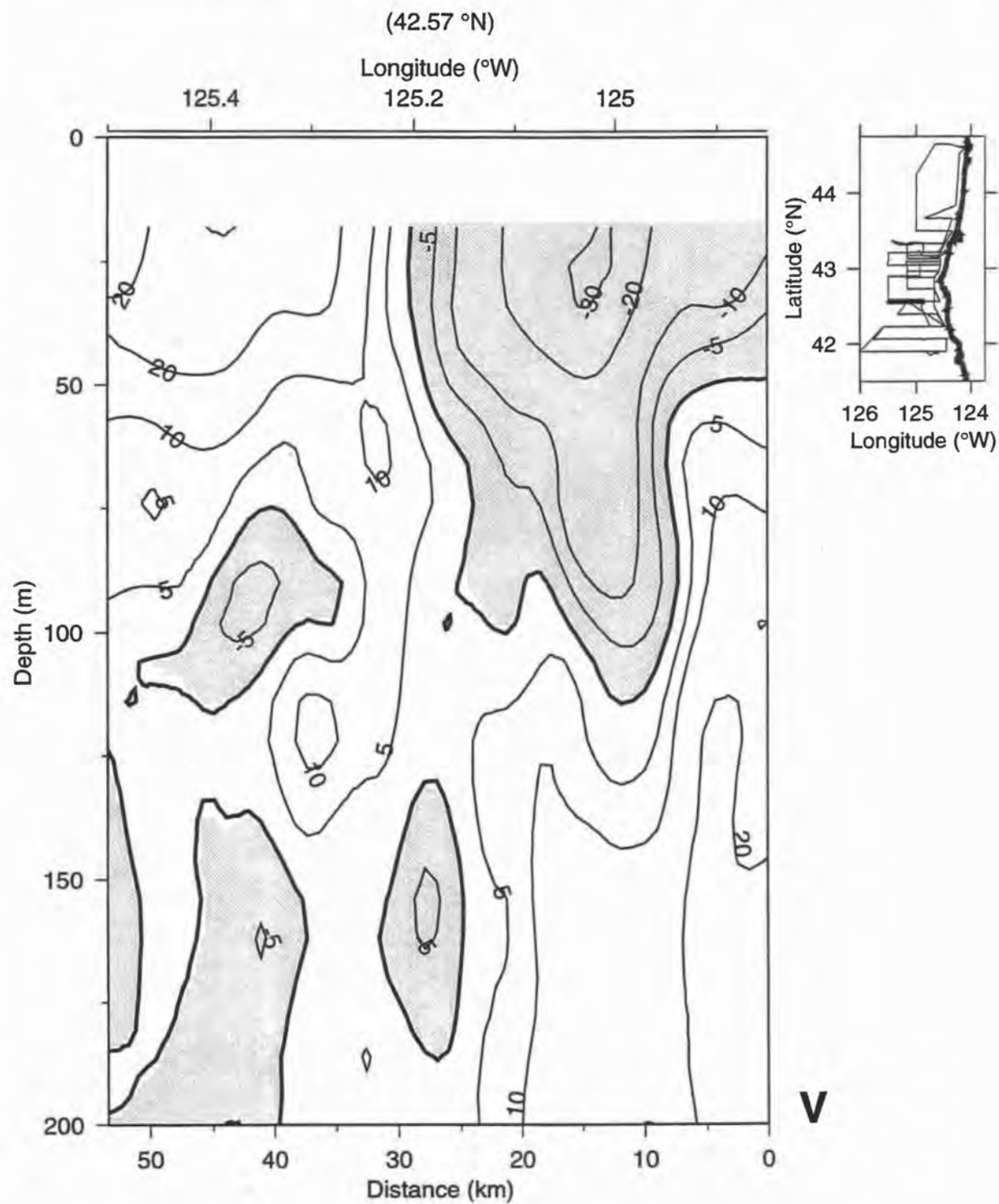
Line 14 ADCP, 21-Aug-95 17:27 to 22-Aug-95 10:17 (233.7271-234.4291)



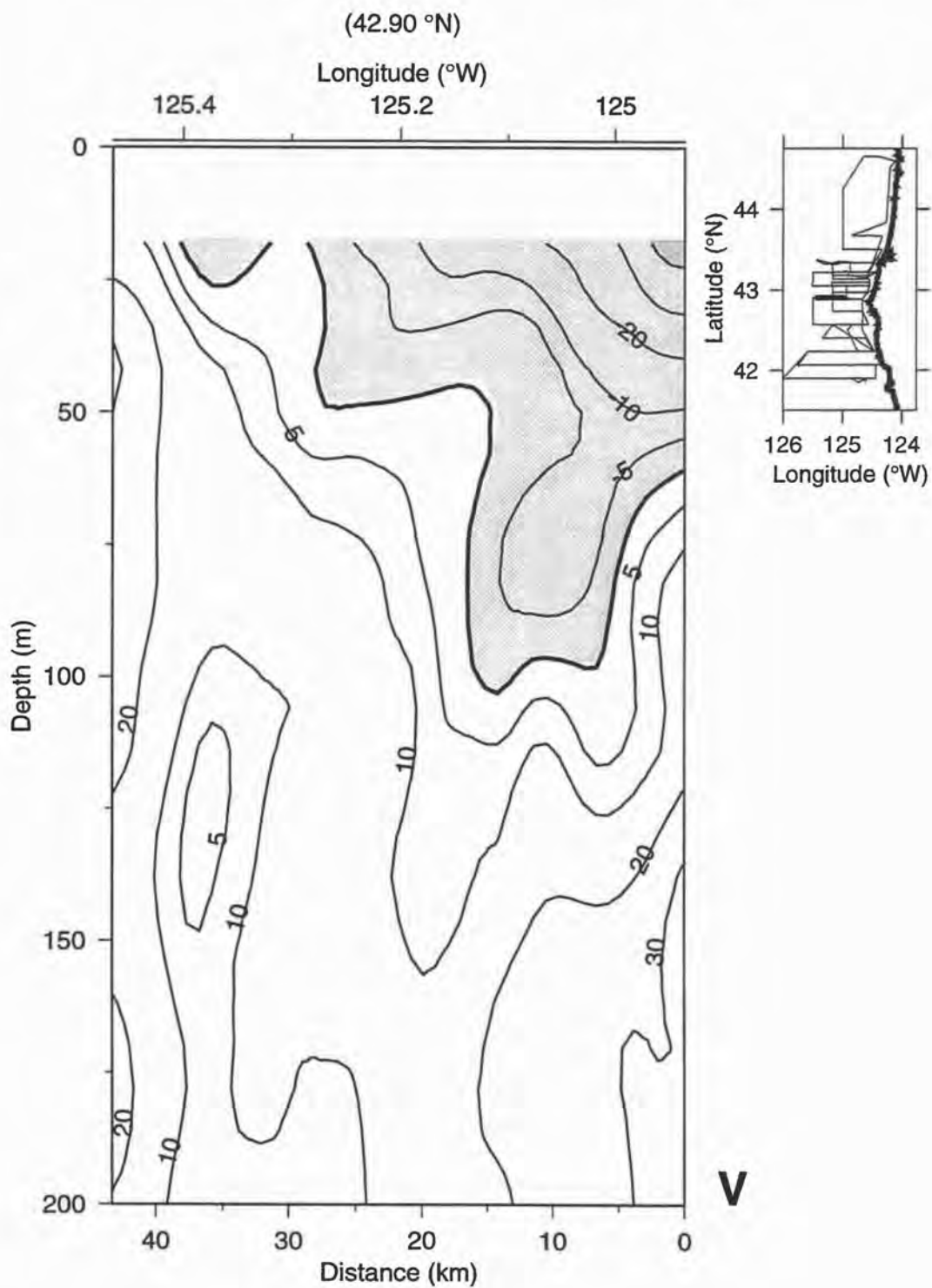
Line 15 ADCP, 22-Aug-95 14:06 to 22-Aug-95 18:52 (234.5879-234.7862)



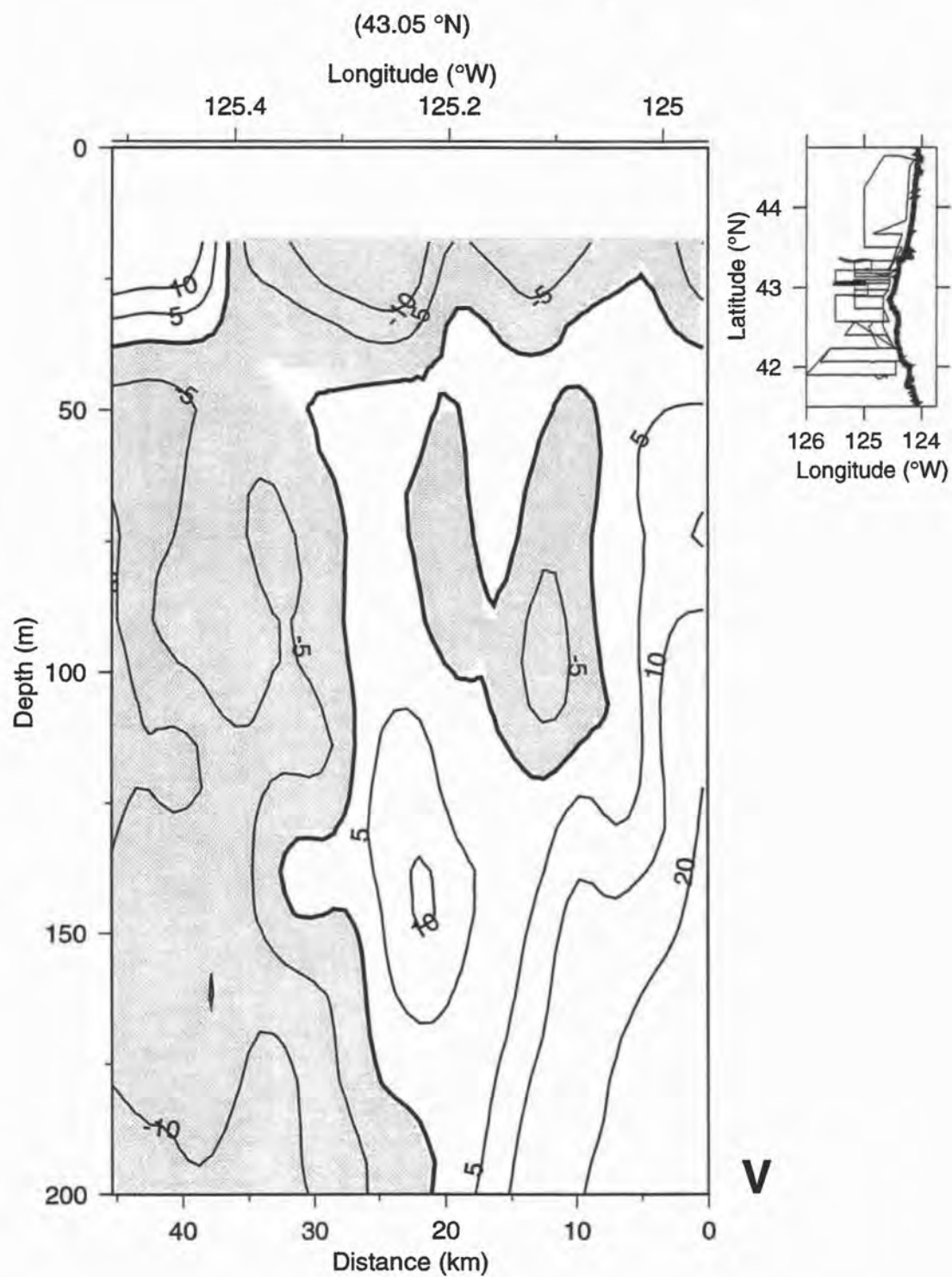
Line 16 ADCP, 22-Aug-95 21:56 to 23-Aug-95 01:35 (234.9142-235.0666)



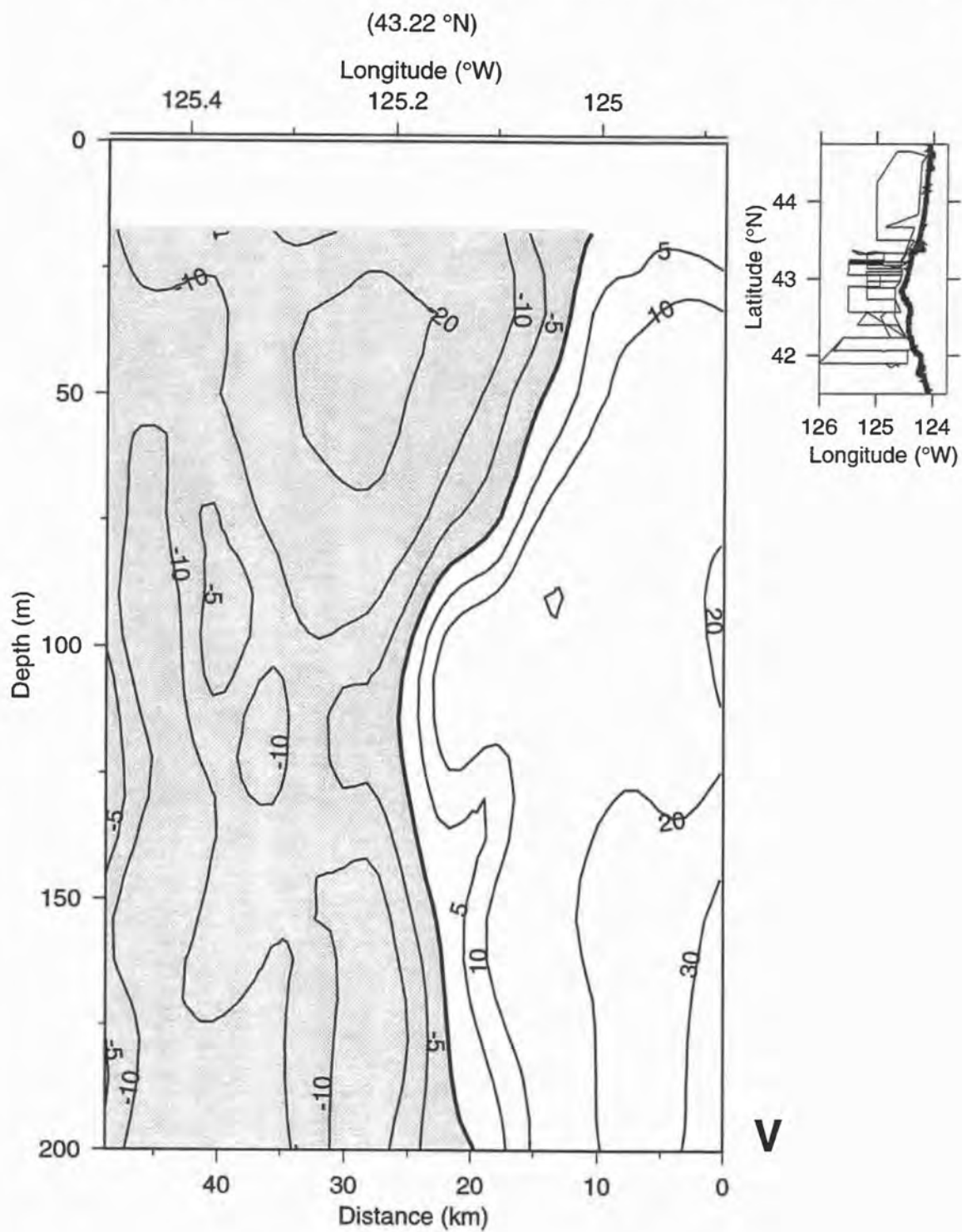
Line 17 ADCP, 23-Aug-95 03:59 to 23-Aug-95 07:03 (235.1666-235.2943)



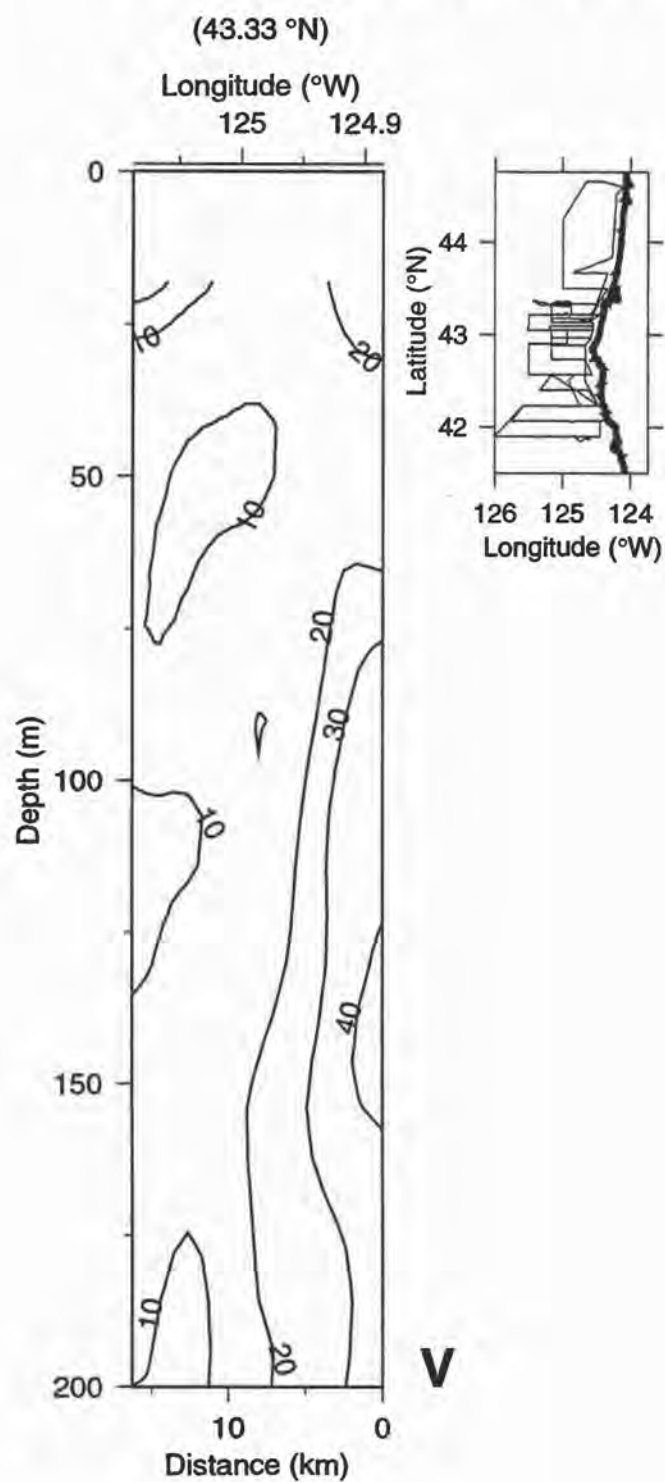
Line 18 ADCP, 23-Aug-95 08:16 to 23-Aug-95 11:20 (235.3445-235.4728)



Line 19 ADCP, 23-Aug-95 12:30 to 23-Aug-95 15:31 (235.5212-235.6469)



Line 20 ADCP, 23-Aug-95 16:20 to 23-Aug-95 18:00 (235.6810-235.7503)



Line 21 ADCP, 23-Aug-95 23:41 to 24-Aug-95 03:26 (235.9874-236.1436)

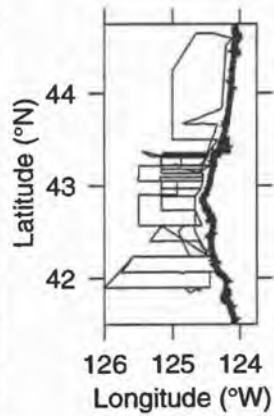
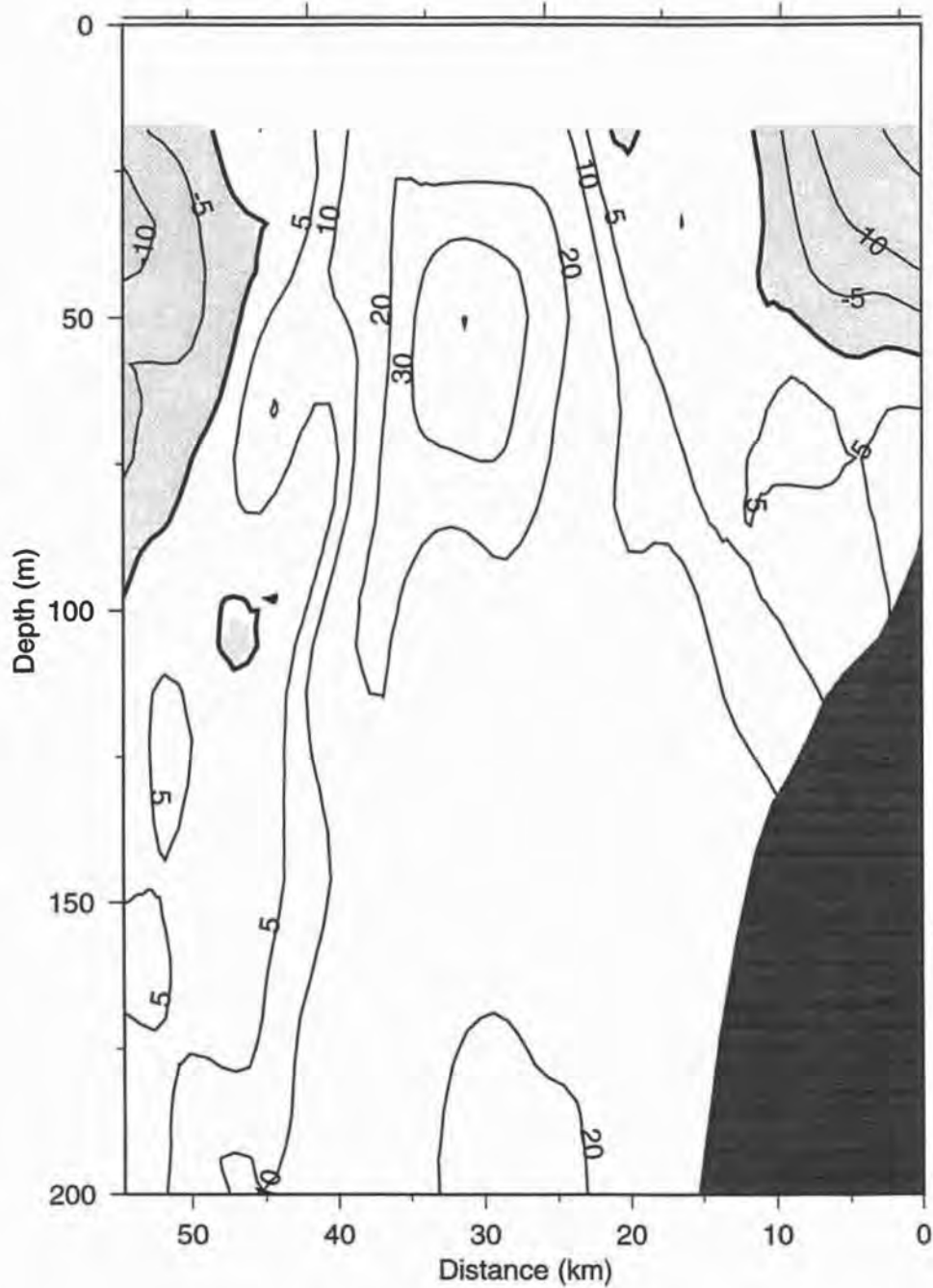
(43.33 °N)

Longitude (°W)

125

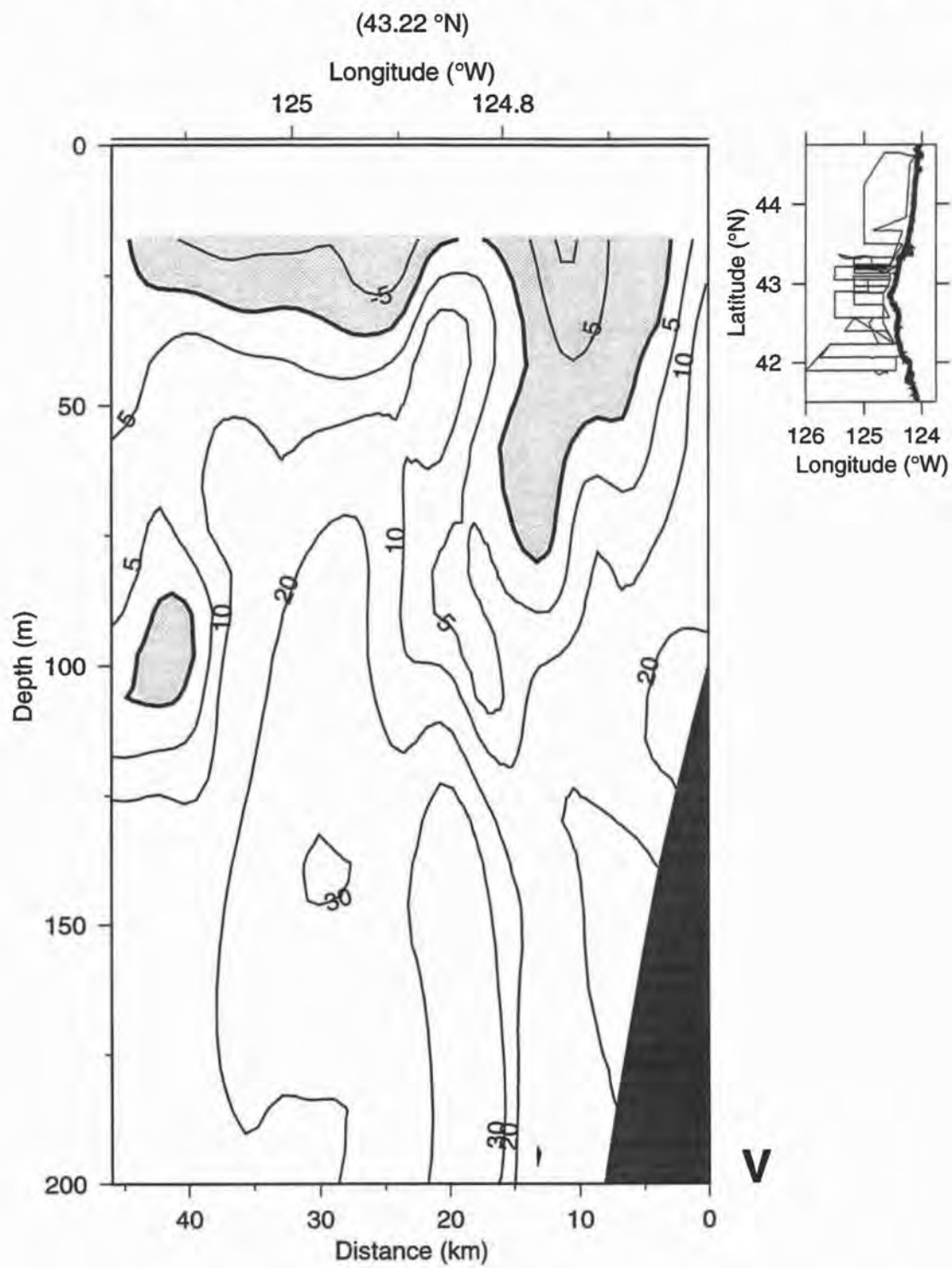
124.8

124.6



V

Line 22 ADCP, 24-Aug-95 04:30 to 24-Aug-95 07:42 (236.1878-236.3212)



Line 23 ADCP, 24-Aug-95 08:21 to 24-Aug-95 11:48 (236.3486-236.4920)

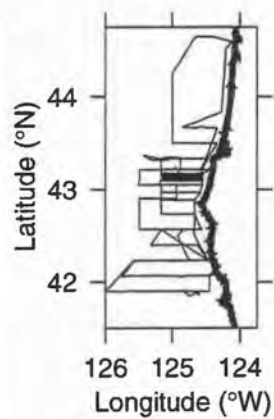
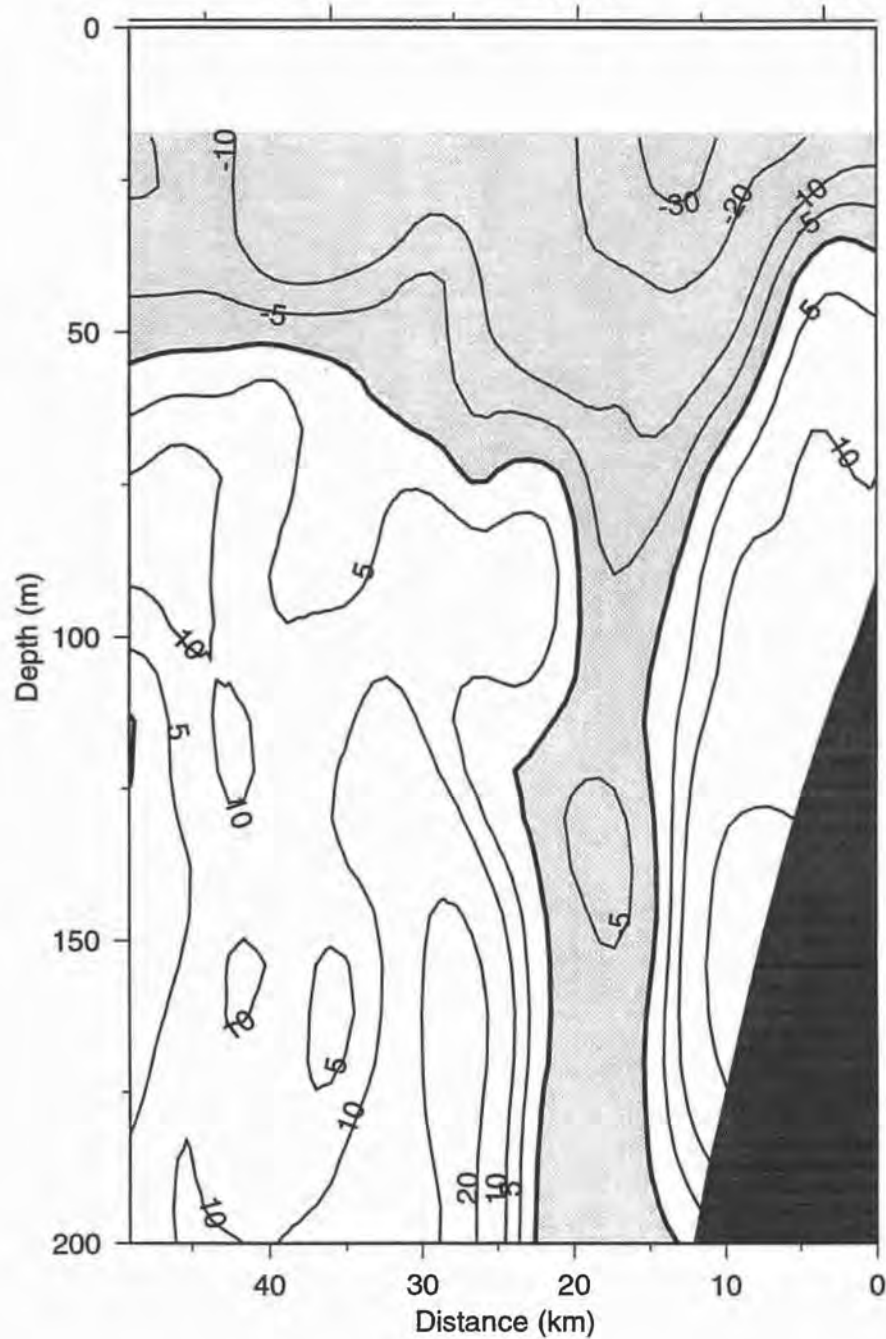
(43.13 °N)

Longitude (°W)

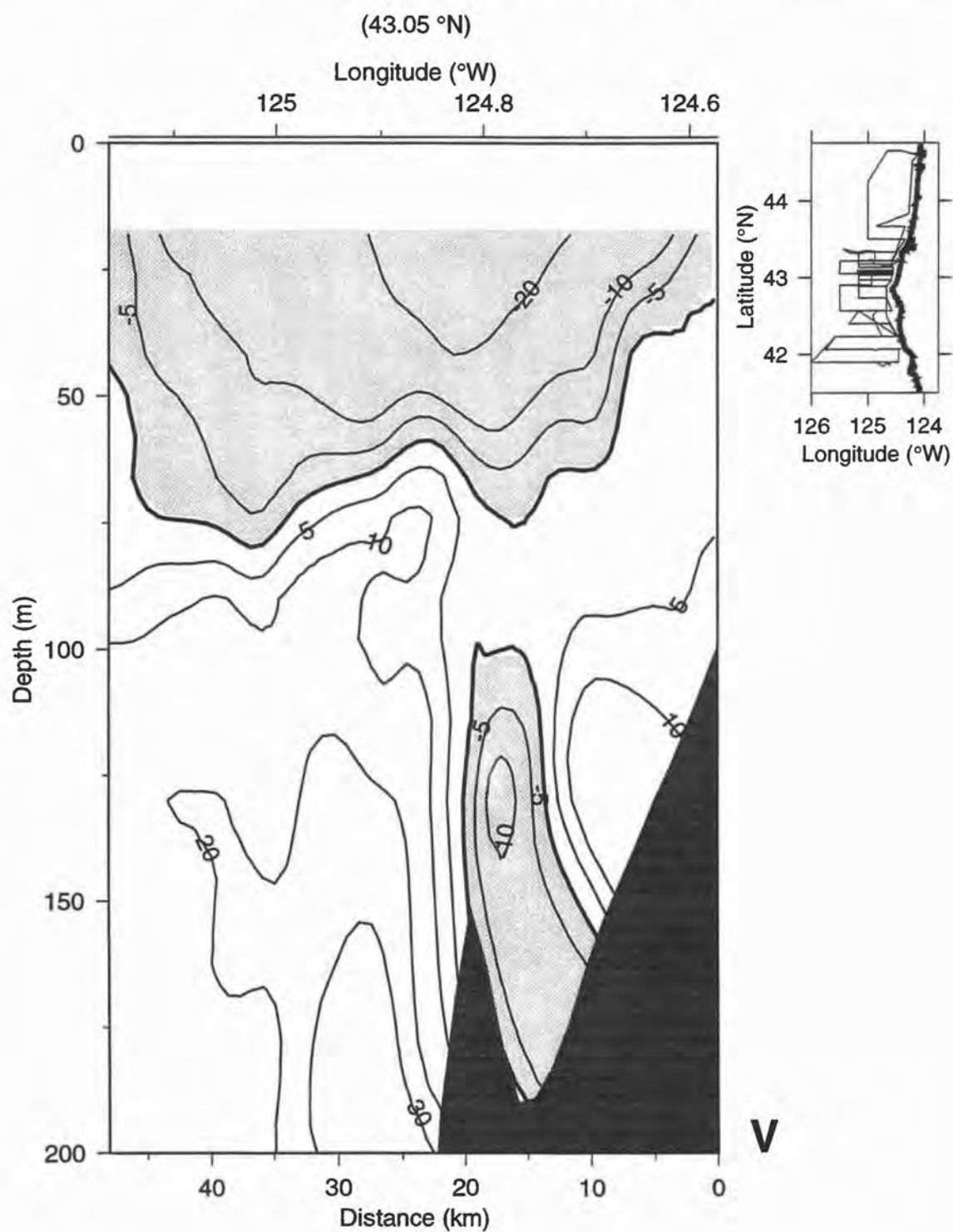
125

124.8

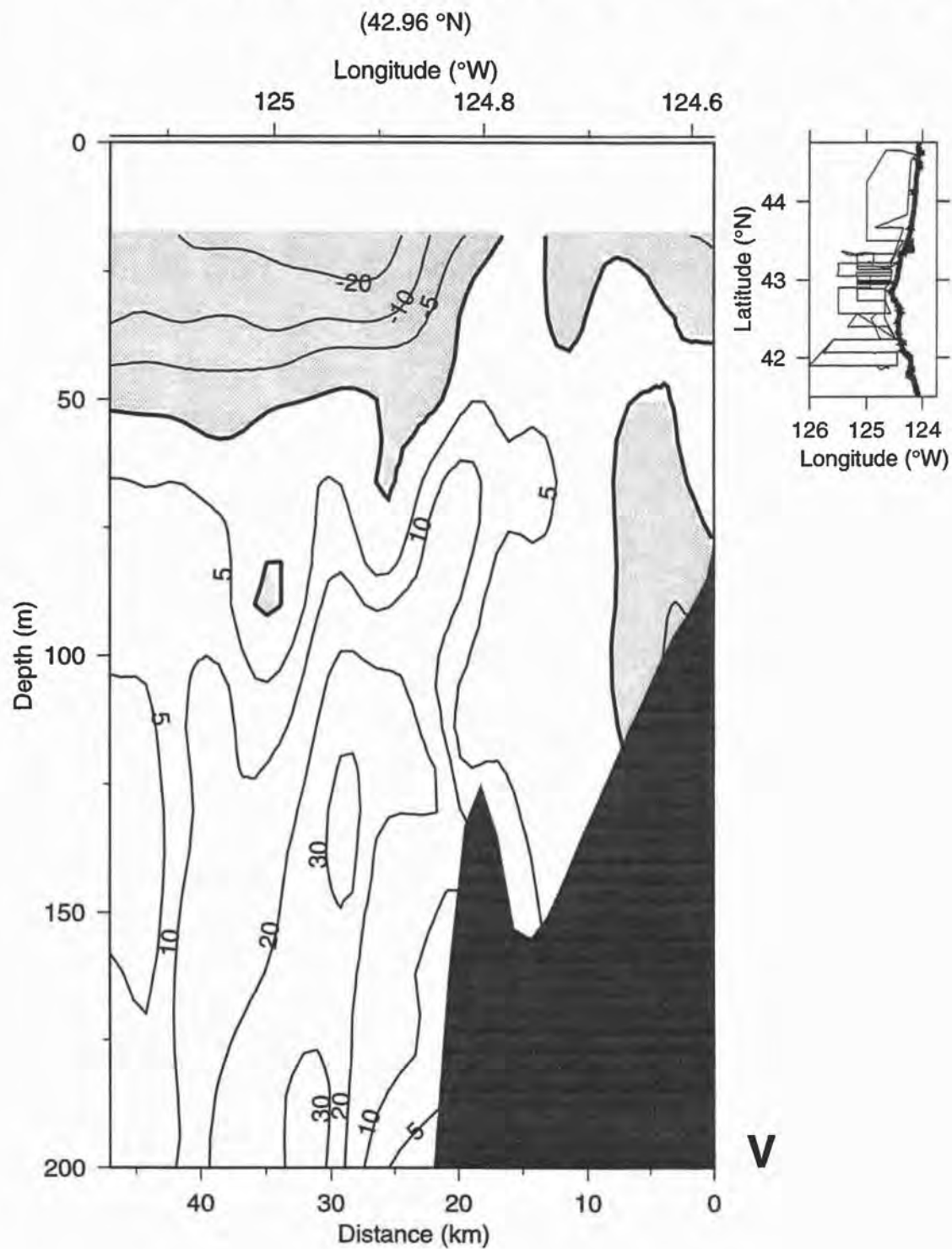
124.6



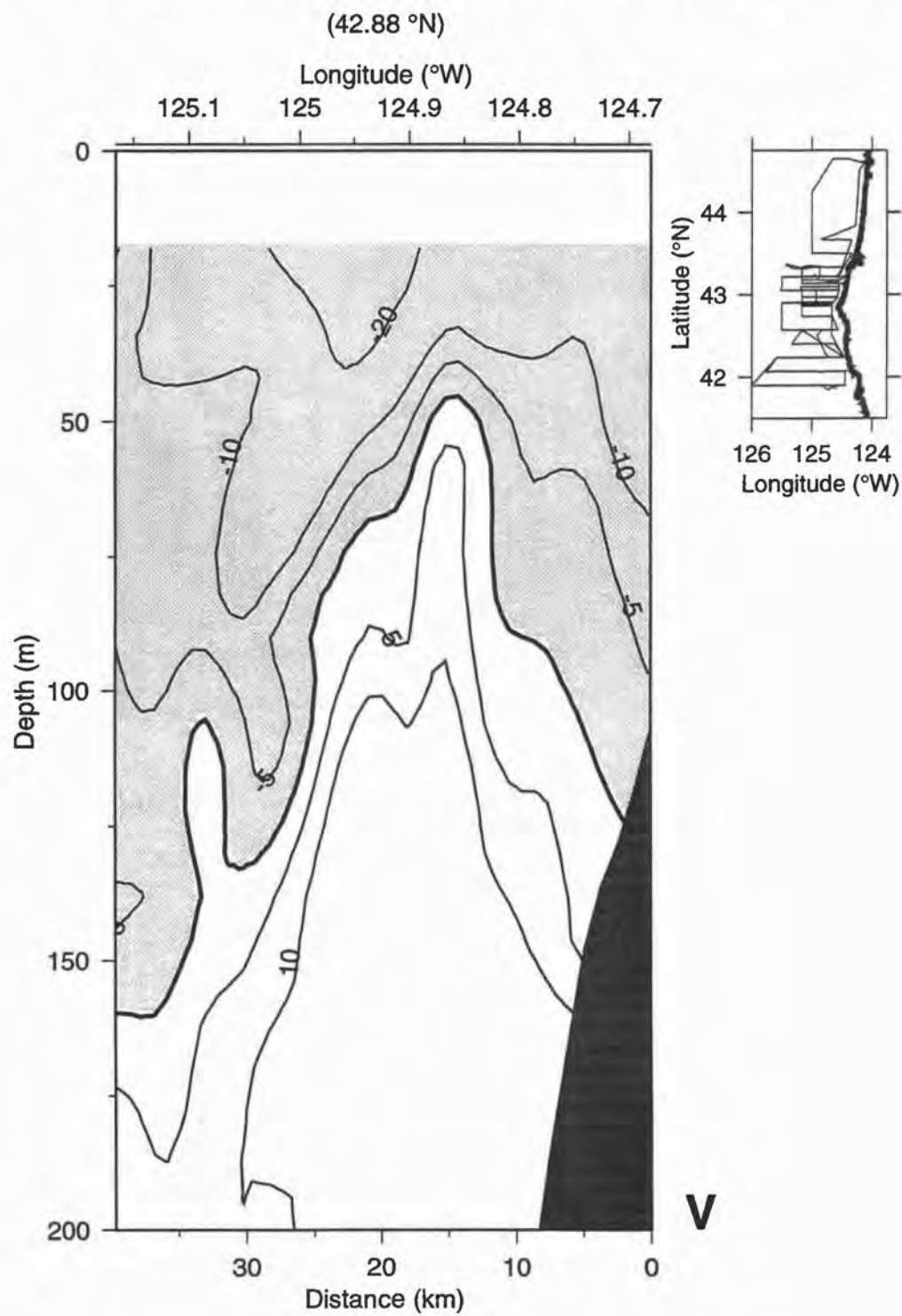
Line 24 ADCP, 24-Aug-95 12:25 to 24-Aug-95 15:55 (236.5174-236.6633)



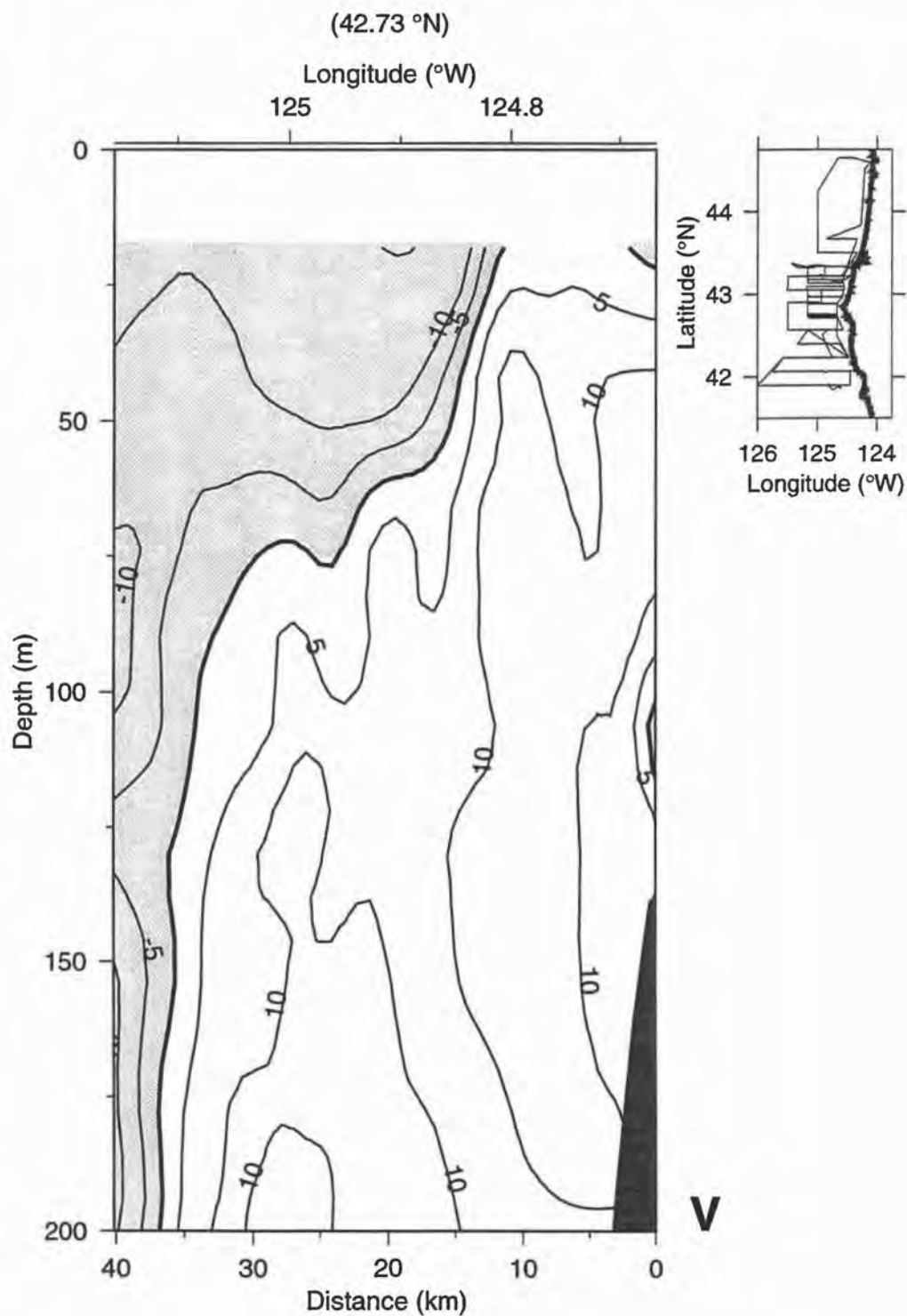
Line 25 ADCP, 24-Aug-95 16:32 to 24-Aug-95 19:51 (236.6891-236.8274)



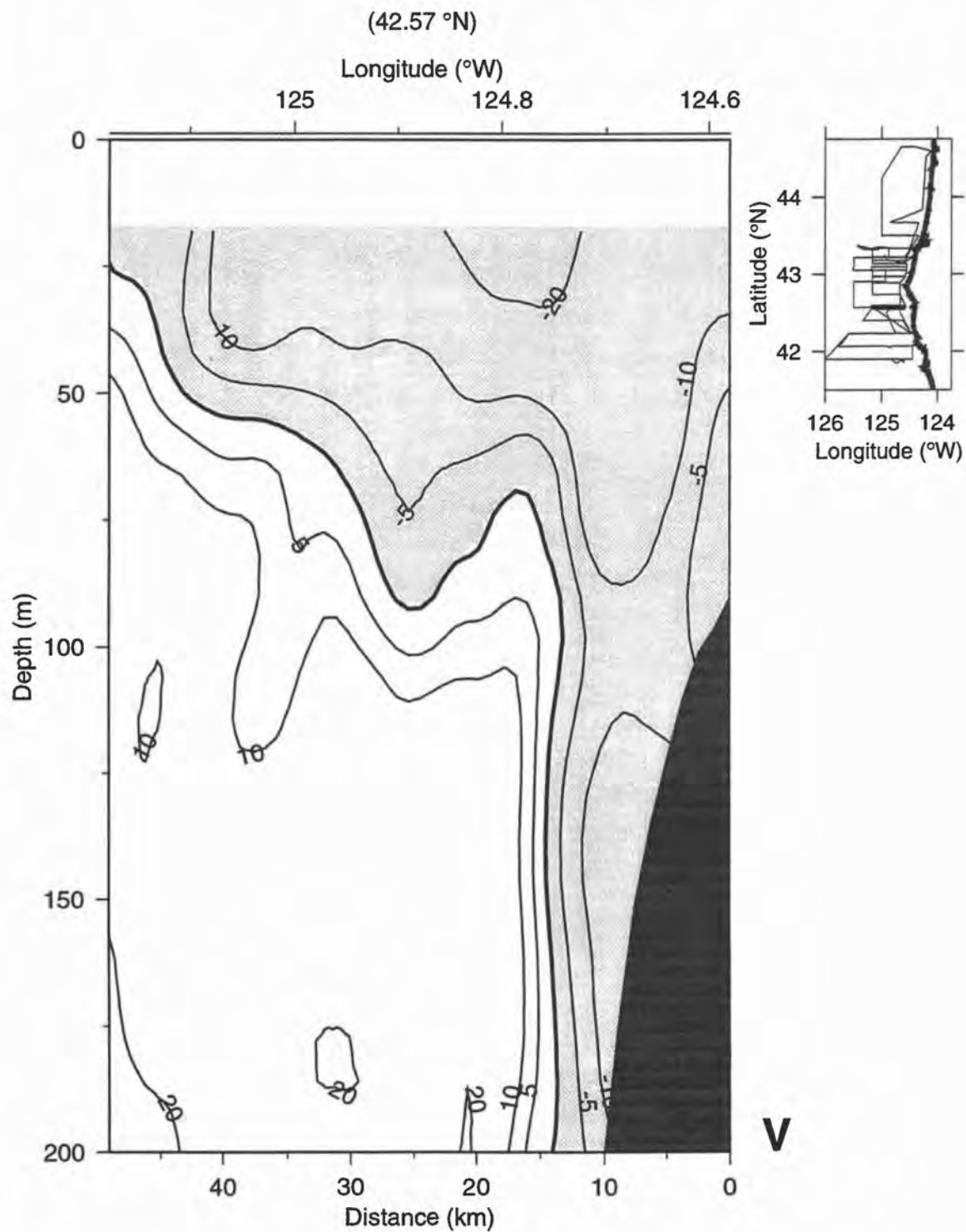
Line 26 ADCP, 24-Aug-95 20:32 to 24-Aug-95 23:15 (236.8560-236.9688)



Line 27 ADCP, 25-Aug-95 00:20 to 25-Aug-95 03:03 (237.0139-237.1271)



Line 28 ADCP, 25-Aug-95 04:25 to 25-Aug-95 07:37 (237.1846-237.3174)



Line 29 ADCP, 25-Aug-95 07:37 to 25-Aug-95 12:28 (237.3174-237.5199)

Latitude (°N)

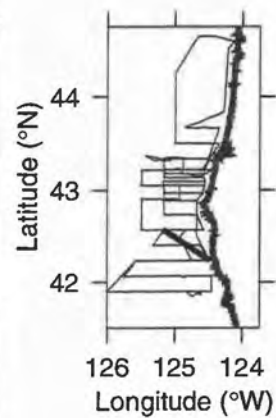
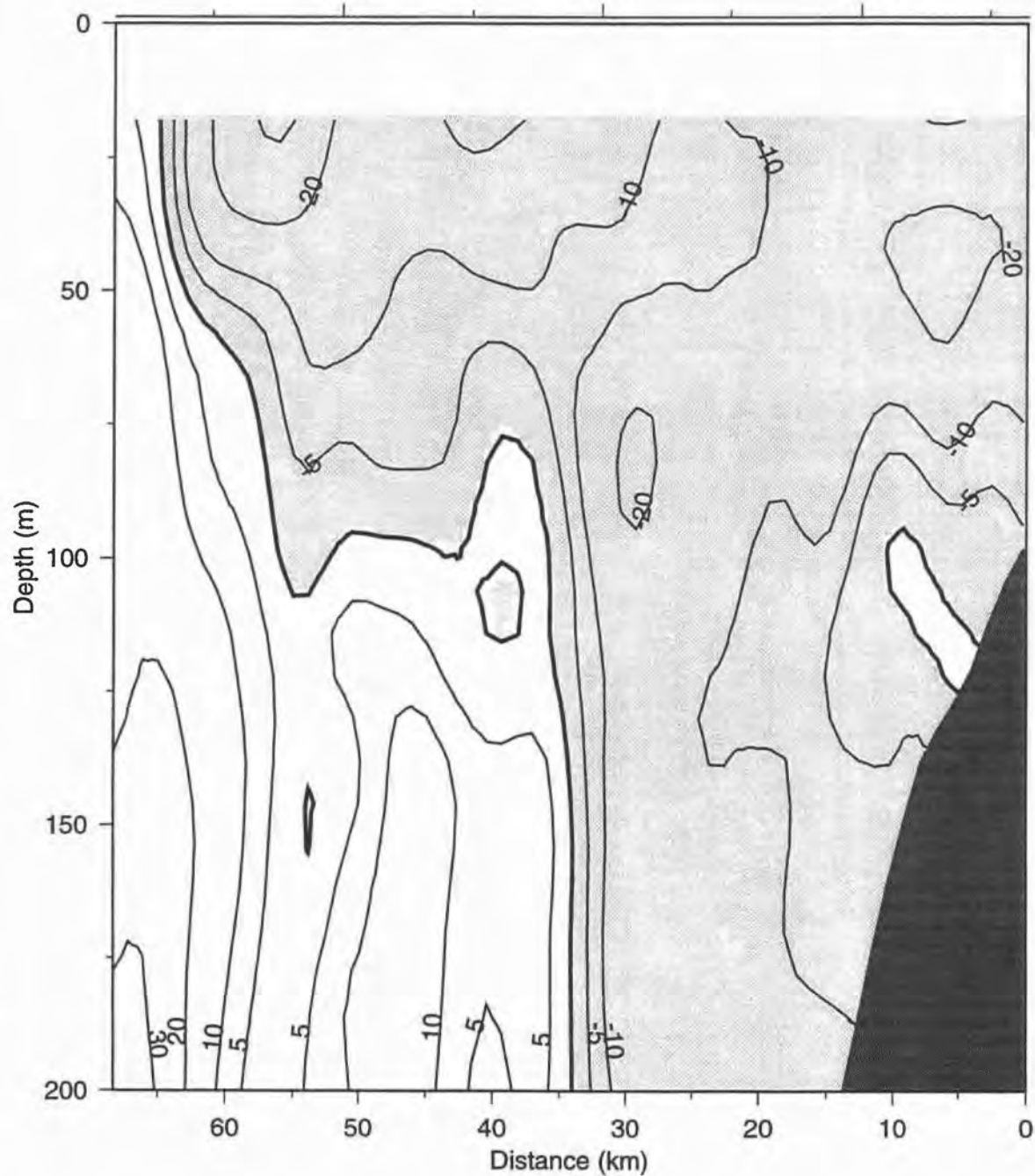
42.4

Longitude (°W)

125

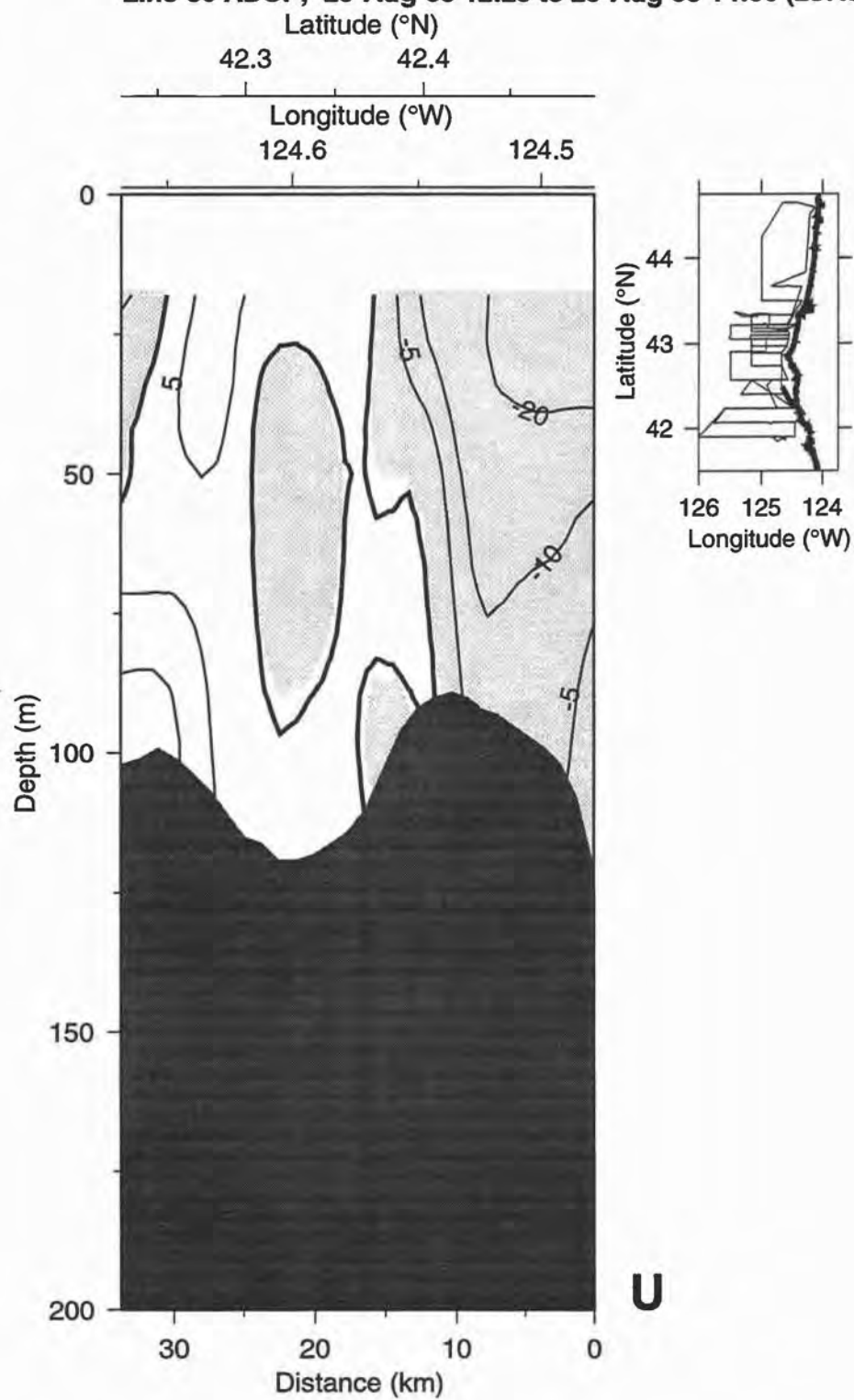
124.8

124.6



V

Line 30 ADCP, 25-Aug-95 12:28 to 25-Aug-95 14:50 (237.5199-237.6185)



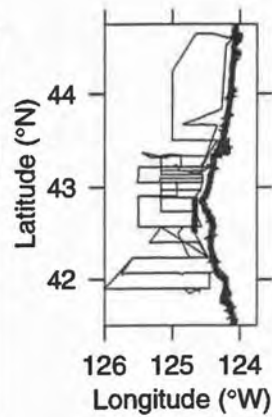
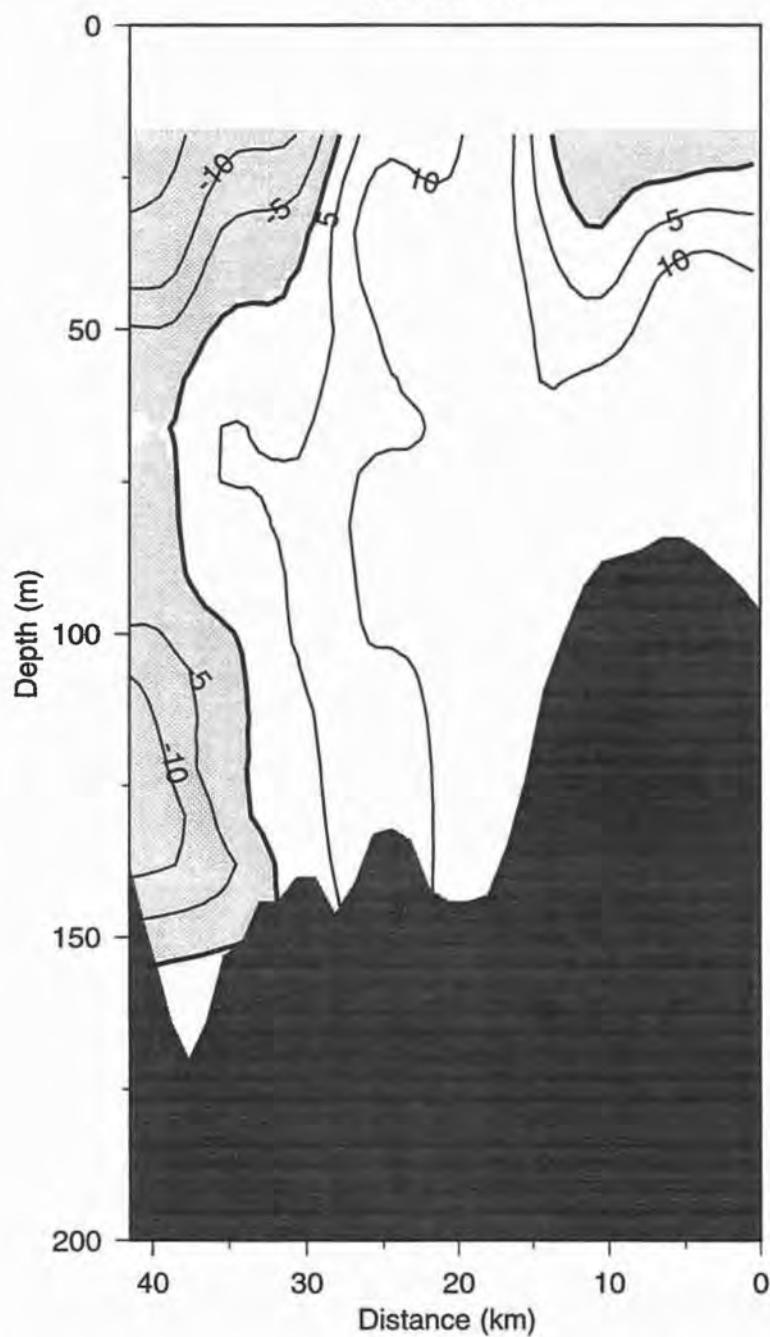
Line 31 ADCP, 25-Aug-95 14:50 to 25-Aug-95 17:44 (237.6185-237.7391)

Latitude ($^{\circ}$ N)

42.6

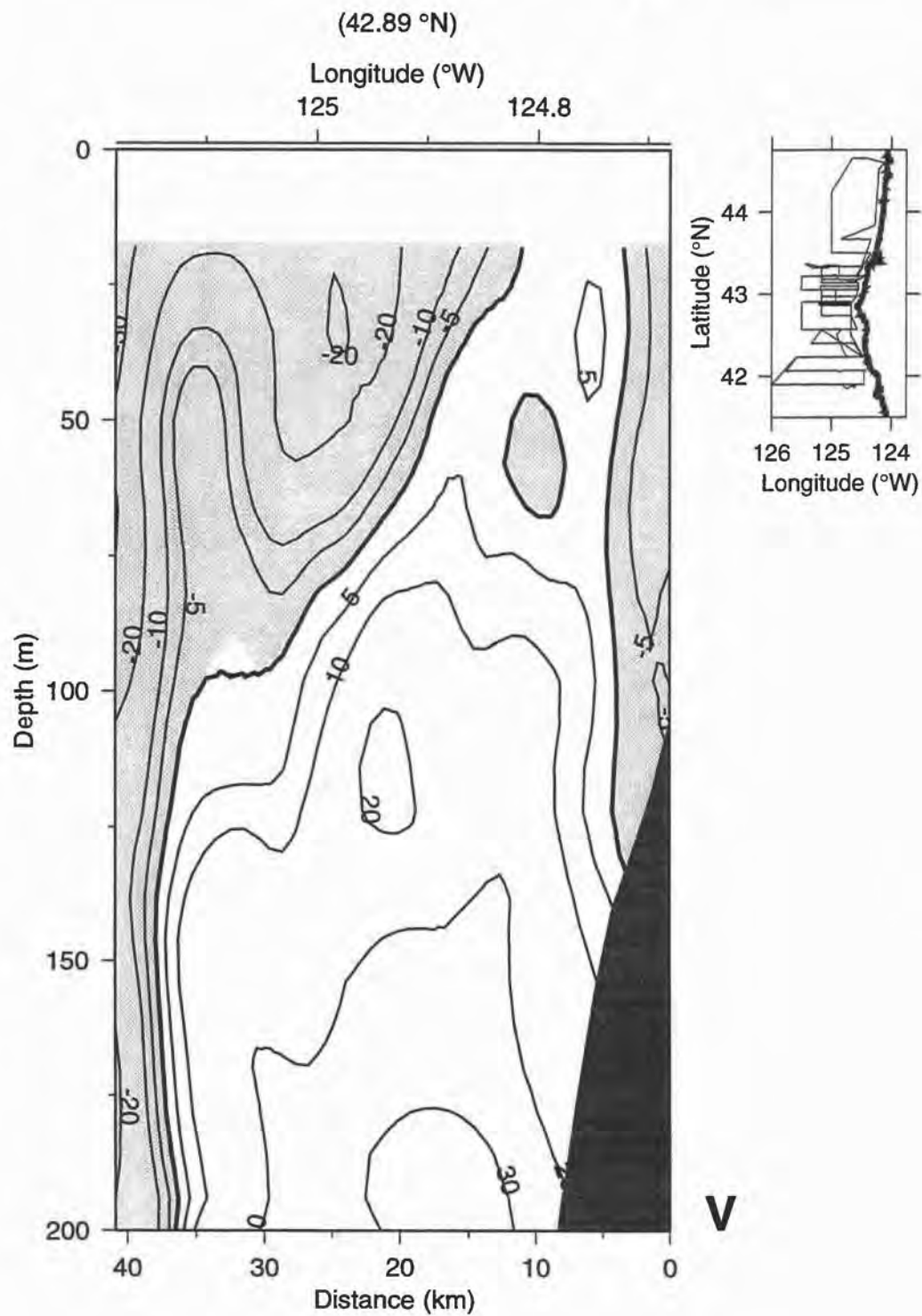
42.8

(124.67 $^{\circ}$ W)

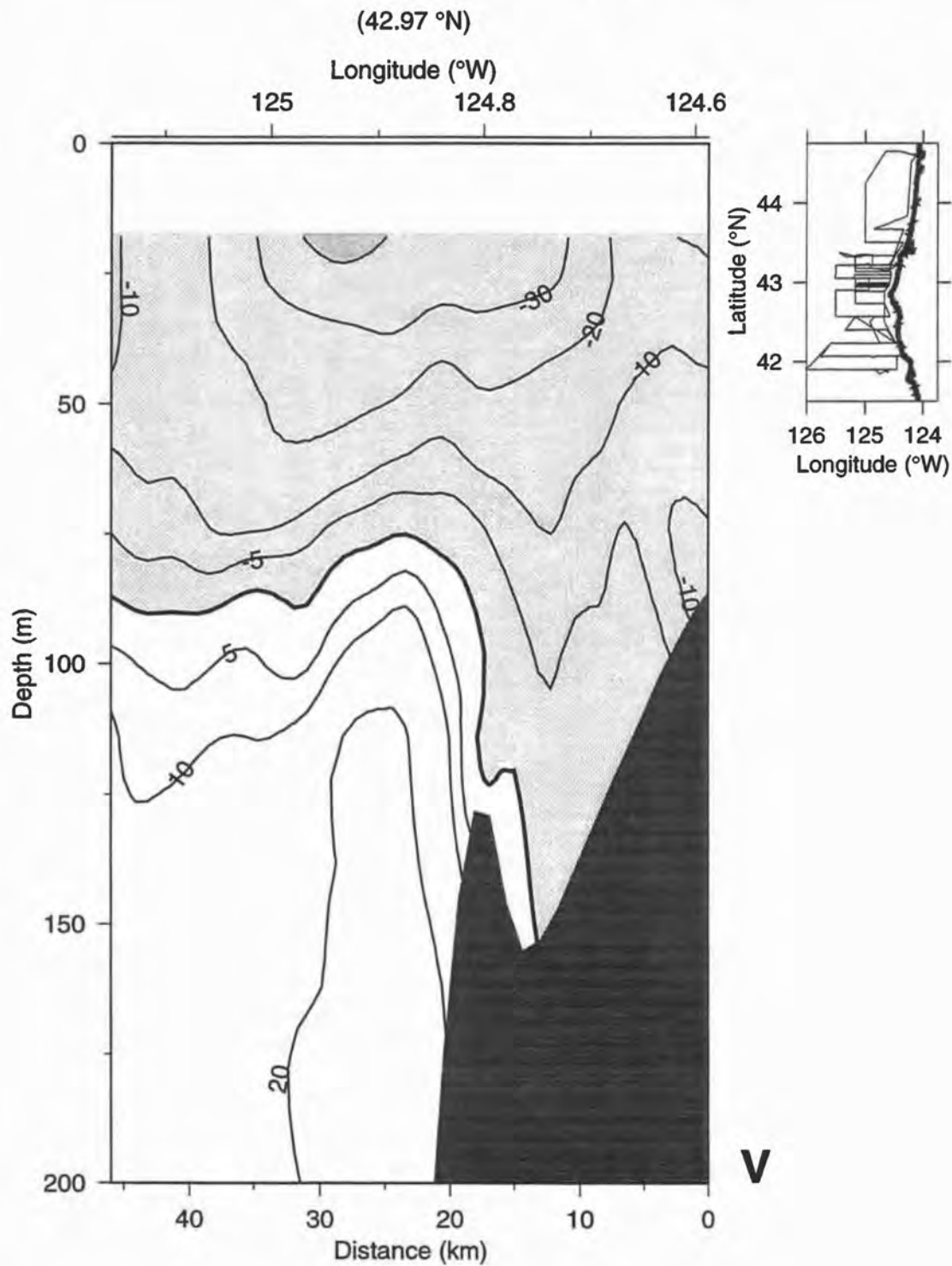


U

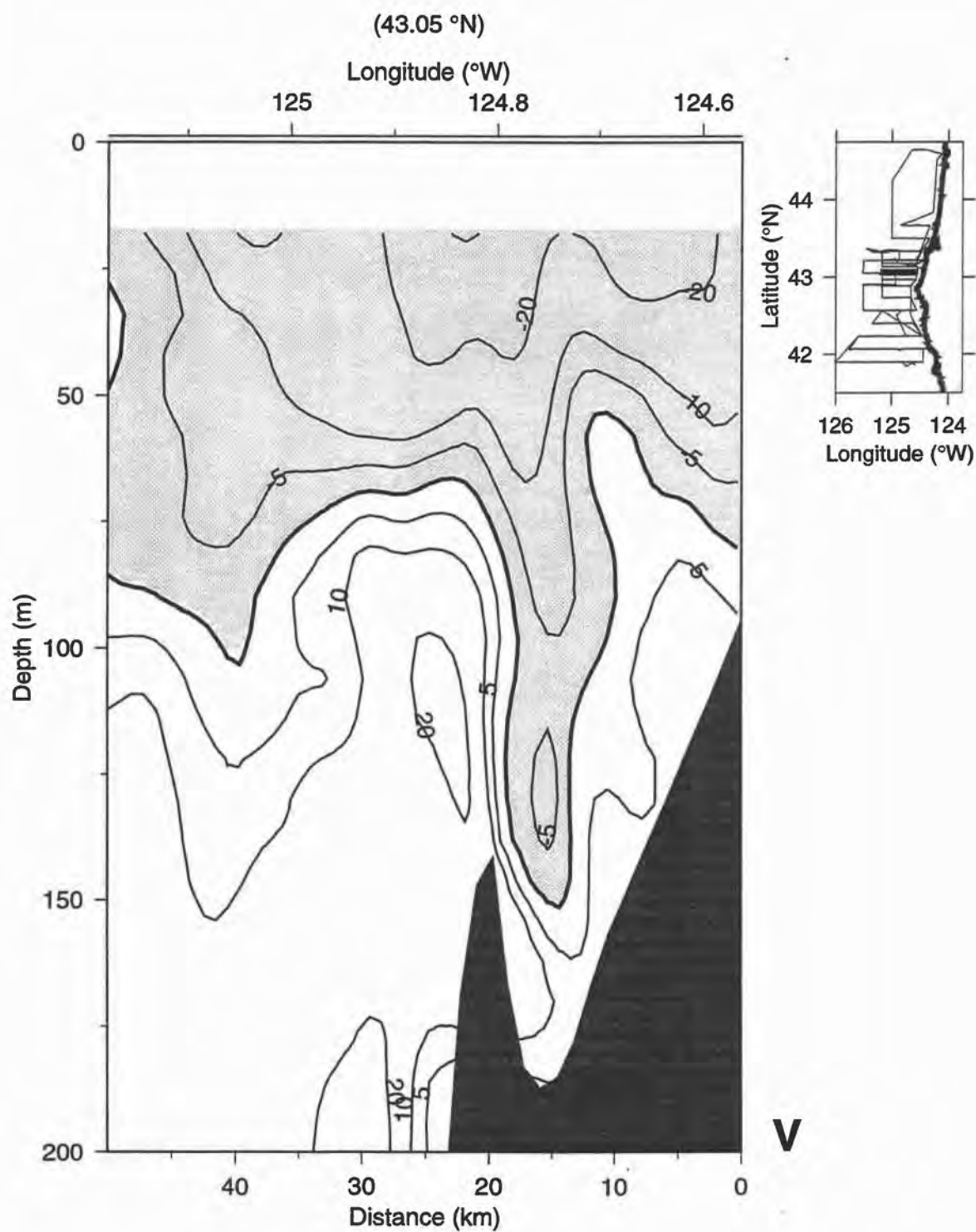
Line 32 ADCP, 25-Aug-95 17:44 to 25-Aug-95 20:32 (237.7392-237.8556)



Line 33 ADCP, 25-Aug-95 21:14 to 26-Aug-95 00:25 (237.8854-238.0174)



Line 34 ADCP, 26-Aug-95 01:07 to 26-Aug-95 04:25 (238.0468-238.1841)



Line 35 ADCP, 26-Aug-95 04:43 to 26-Aug-95 08:24 (238.1967-238.3501)

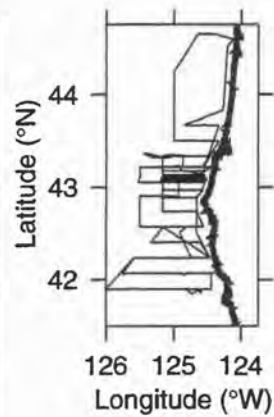
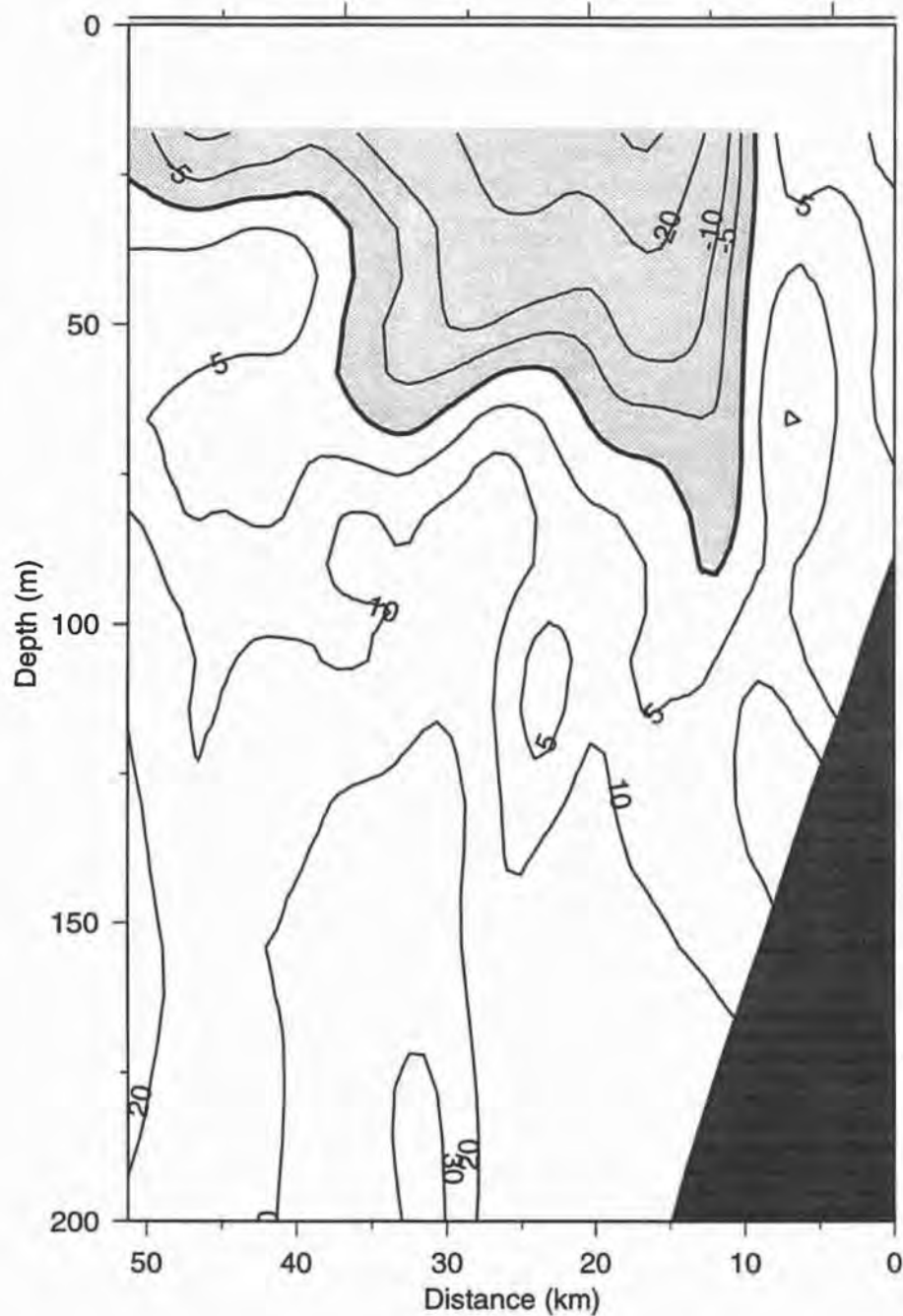
(43.09 °N)

Longitude (°W)

125

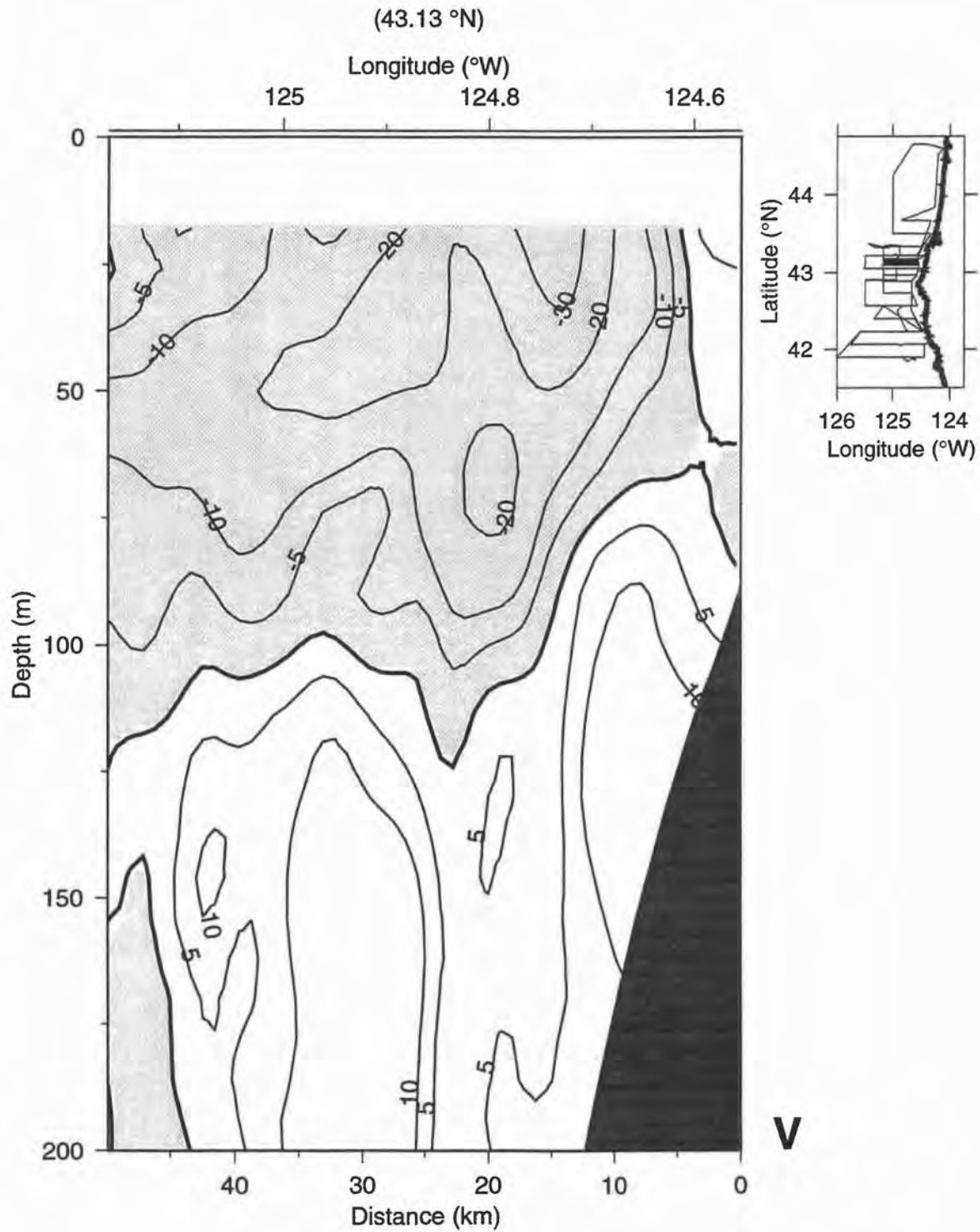
124.8

124.6



V

Line 36 ADCP, 26-Aug-95 08:38 to 26-Aug-95 12:05 (238.3603-238.5040)



Line 37 ADCP, 26-Aug-95 12:20 to 26-Aug-95 15:42 (238.5140-238.6548)

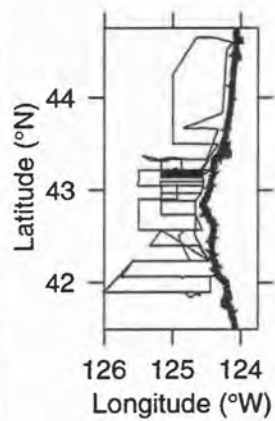
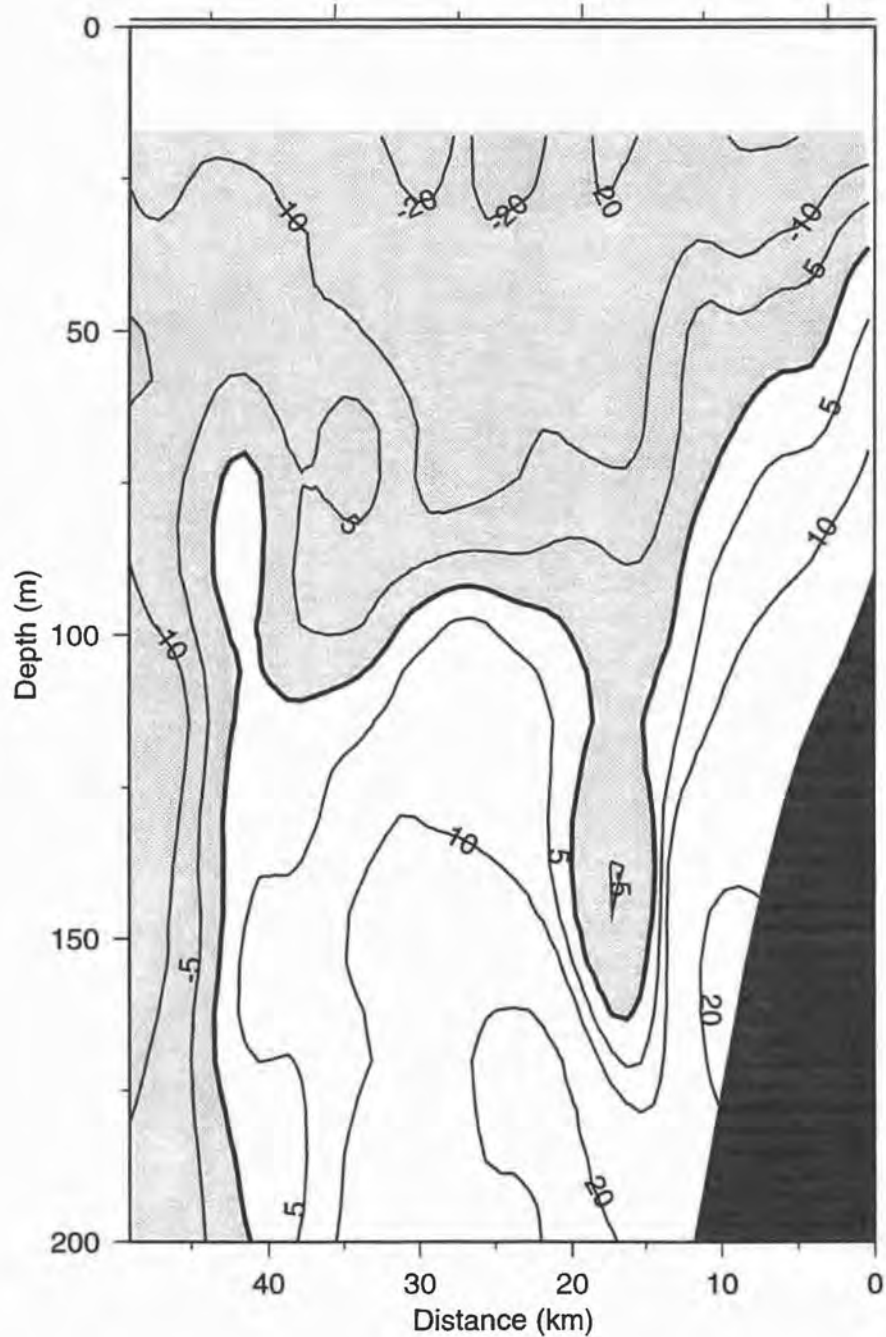
(43.17 °N)

Longitude (°W)

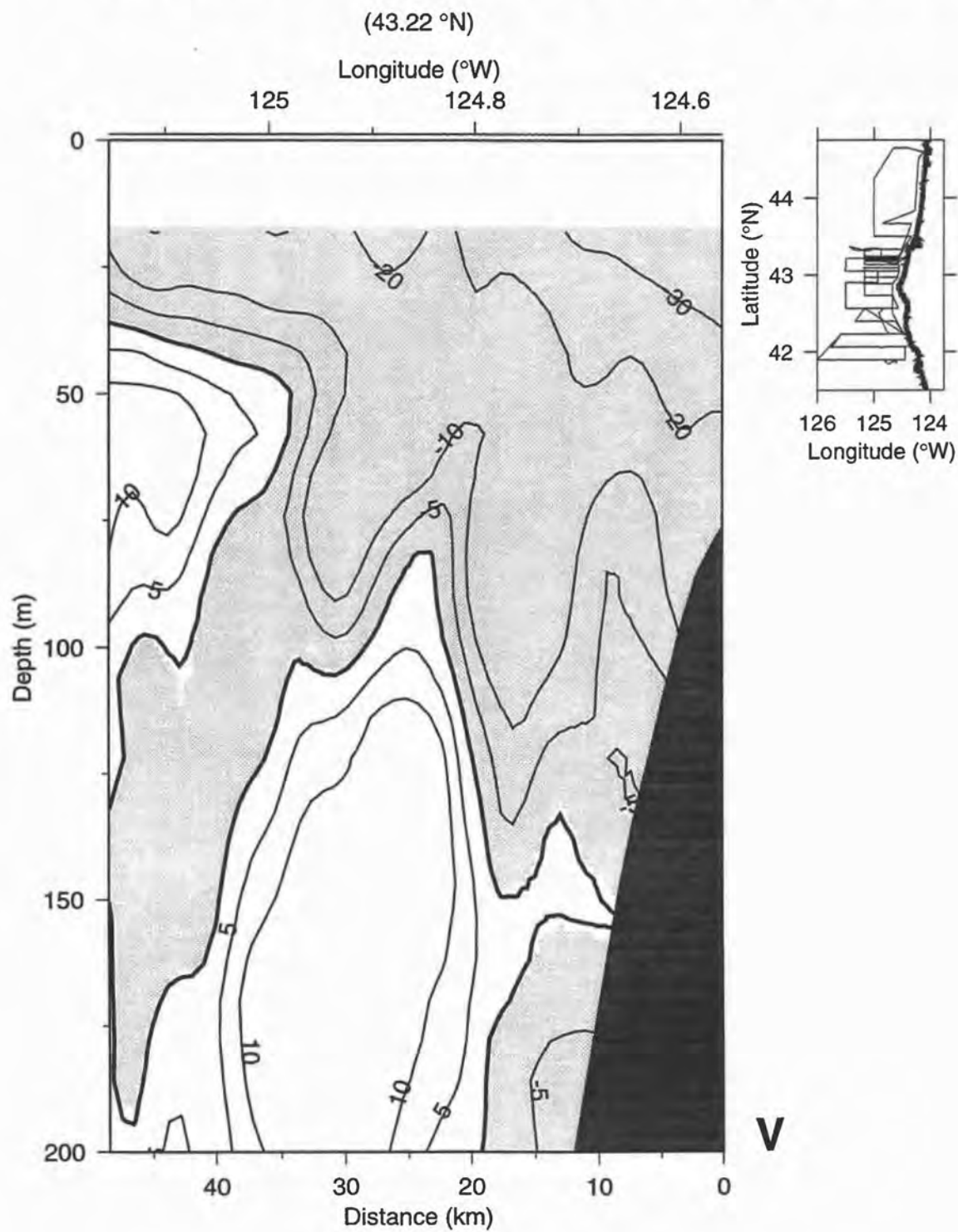
125

124.8

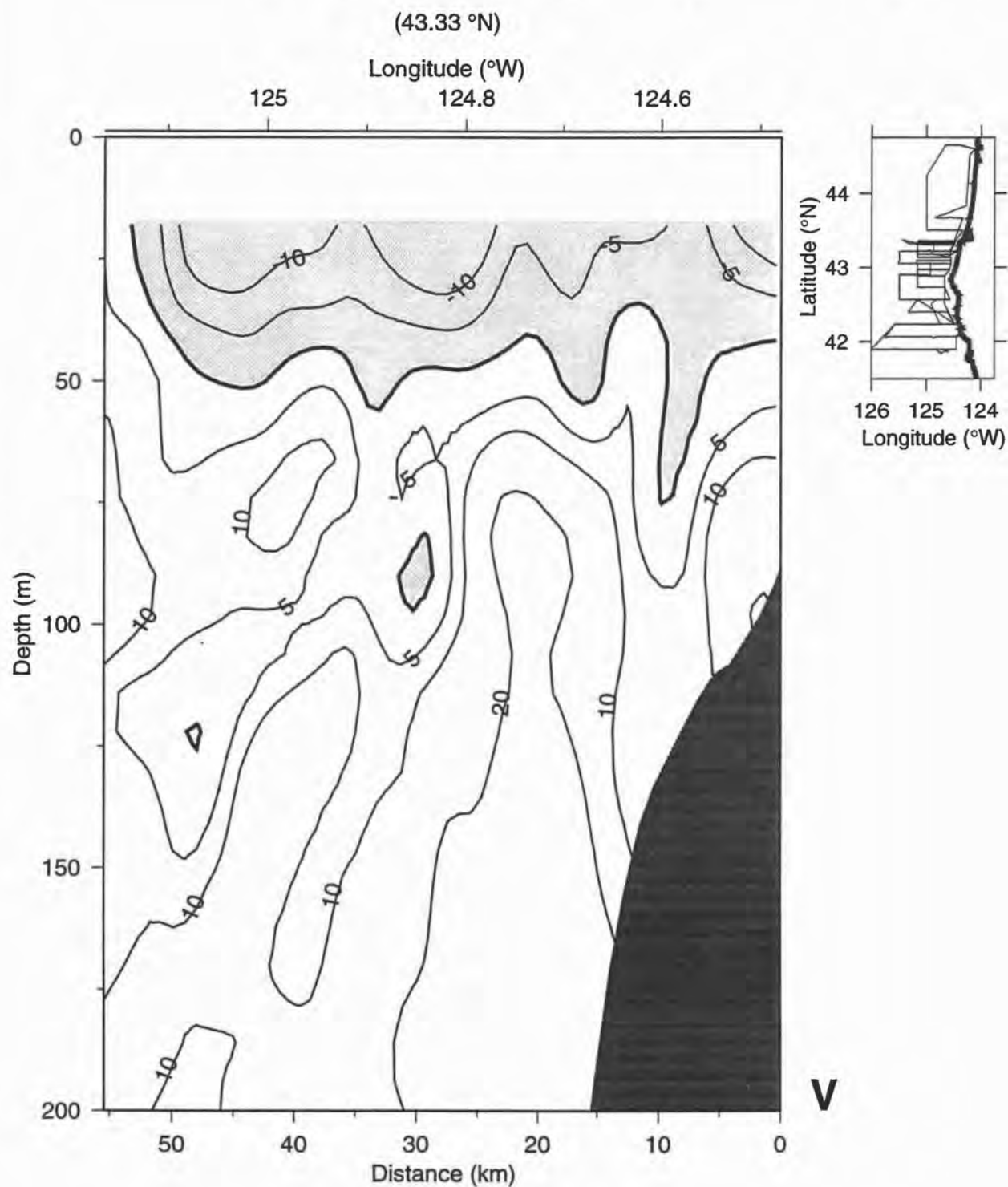
124.6



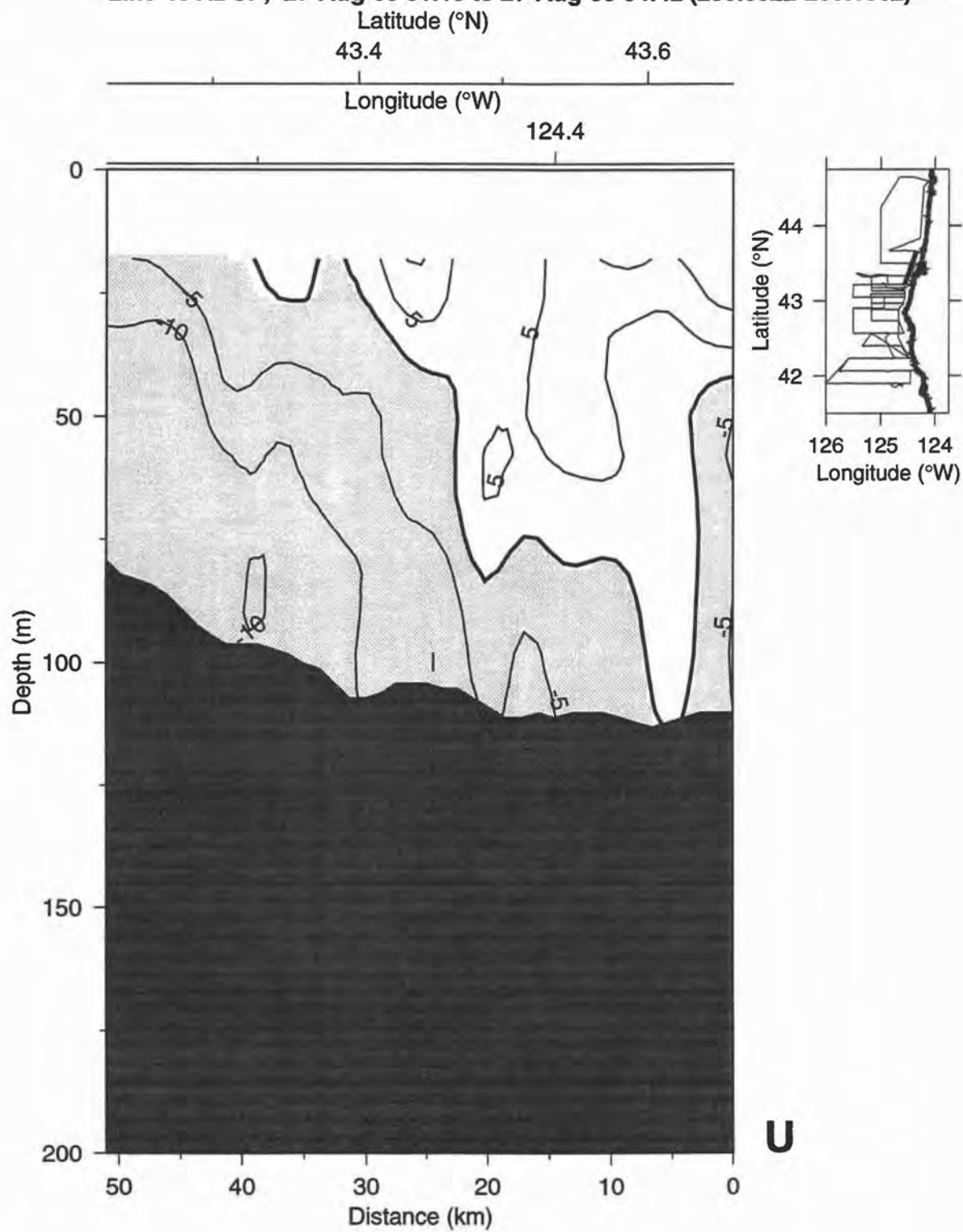
Line 38 ADCP, 26-Aug-95 21:51 to 27-Aug-95 01:15 (238.9108-239.0522)



Line 39 ADCP, 26-Aug-95 16:59 to 26-Aug-95 20:57 (238.7082-238.8735)



Line 40 ADCP, 27-Aug-95 01:15 to 27-Aug-95 04:42 (239.0522-239.1962)



Line 41 ADCP, 27-Aug-95 04:42 to 27-Aug-95 07:22 (239.1962-239.3073)

