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MOORED CURRENT METER AND CTD OBSERVATIONS FROM BARROW STRAIT, 2000-2001

by

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Abstract

Hamilton, J., S. Prinsenberg and L. Malloch. 2004. Moored current meter and CTD observations from Barrow Strait, 2000-2001. Can. Data Rep. Hydrogr. Ocean Sci. 165 : v + 59 p.

An array of 9 instrumented moorings deployed in the eastern end of Barrow Strait from August 2000 to August 2001 provides yearlong records of current, ice drift, temperature and salinity that extend a data time series started in August of 1998. Current data collected with Acoustic Doppler Current Profilers and specialised instrumentation for near-pole direction measurement, are presented as contour plots of both bihourly and low-pass filtered observations. Results of a tidal analysis of the current data are also presented. Temperatures, salinities and densities obtained from moored CTDs are displayed as time series plots for both bihourly and low-pass filtered data, and as power spectra. Statistical results include means, extrema and standard deviations of all measured parameters.

Résumé

Hamilton, J., S. Prinsenberg and L. Malloch. 2004. Moored current meter and CTD observations from Barrow Strait, 2000-2001. Can. Data Rep. Hydrogr. Ocean Sci. 165 : v + 59 p.

Entre août 2000 et août 2001, une batterie de neuf stations instrumentales ancrées dans l'embouchure est du détroit de Barrow a enregistré des données sur le courant, la dérive de la glace, et la température et la salinité de l'eau. Ces douze mois de données prolongent une série analogue débutée en août 1998. Nous présentons les cartes de contour des observations prises à toutes les deux heures par des profileurs de courant à effet Doppler et des instruments spécialisés pour la mesure des directions près du pôle. Nous présentons également des cartes de contour de ces mêmes données après leur lissage. Nous faisons l'analyse de marée des données sur le courant. Nous présentons les graphiques des données aux deux heures et des données lissées de la température, de la salinité et de la densité, mesurées avec les sondes CTP ancrées, ainsi que leur spectre de fréquence. Nous donnons les résultats statistiques suivants : les moyennes, les extrêmes et les écarts-types de tous les paramètres mesurés.

Introduction

A field program to quantify and examine the inter-annual variability of the exchange through Barrow Strait, and more generally, to improve our understanding of the circulation within the Arctic Archipelago, was started by BIO investigators in August of 1998. Data from the first 2 years of this study, along with a description of the methods used, have previously been reported [Hamilton et al., 2003, Hamilton et al., 2002]. Described here are moored instrument data from the third year of the study.

Yearlong records of current rate and direction, ice drift, temperature, salinity and density from Barrow Strait are presented as unfiltered and low-pass filtered time series plots along with relevant statistical summaries for each season. CTD data are also presented as power spectra. Results of tidal analyses give tidal amplitudes, phase and ellipse orientation as a function of depth for each of the 5 main tidal constituents (K1, M2, O1, S2, P1). Separate tidal analyses have been done for a 5 month period when there is solid ice cover, and the 10 week period of open water.

No ship-based CTDs were done during the 2001 field work because of ship time constraints, so the hydrographic sections completed in 1998, 1999 [Hamilton et al. 2002] and 2000 [Hamilton et al. 2003] were not repeated.

Mooring Locations and Description

A total of 9 moorings were deployed at the eastern end of Barrow Strait, with instrumentation concentrated around the 200 m contours on both the north and south sides of the Strait (See Figure 1). An illustration of the moorings deployed is shown in Figure 2. Acoustic Doppler Current Profilers (ADCPs) and precision heading references were mounted in streamlined buoyancy packages to provide current rate and direction information. A unique measurement strategy was required to obtain reliable direction measurements in this area because of the proximity of the site to the magnetic pole, and is described in detail by Hamilton [2001]. Two current measurement systems were moored about 1.5 km apart, on both the north and south sides of the Strait to provide coverage over 160 m of the 200 m water column. (The range of the RDI Inc., 300 kHz WorkHorse Sentinel ADCPs used is typically 70 to 80 m in the clear Arctic waters, but drops to 60 m in winter.) Measurements of temperature, conductivity and pressure at 5 levels on both sides of the Strait were also made, using moored SeaBird MicroCat CTDs. Instrumentation was distributed over 4 moorings at each site as a risk management strategy to minimise the impact of potential losses to ice ridging and icebergs.

Upward looking ADCPs logged average speeds from 100 pings over a 5 minute on-period every 2 hours, and also provided a simultaneous ice drift speed over the yearlong deployment. Concurrent direction measurements were logged separately with the precision heading reference system, and have been merged with the ADCP speed data for presentation here. CTDs recorded a single temperature, conductivity and pressure every hour. Post-deployment calibration revealed good stability from all 10 of the recovered moored CTDs.

A ninth mooring was deployed to measure the variation in magnetic declination, which is significant near the magnetic pole. Magnetic declination is also measured at the NRCAN Geomagnetic Observatory in Resolute, and it is actually those data, transformed to our mooring locations, that have been used to adjust the current direction data for this variation. Our declination measurements from 1999-2000 were found to be in excellent agreement with simultaneous Resolute Observatory data [Hamilton et al., 2003] meaning either data source could have been used here for this declination adjustment.

All instrumentation (4 ADCP/compass systems and 10 CTDs) was successfully recovered, although substantial ice cover on the south side of the Strait in August necessitated a second visit on a different ship in September to complete recovery operations. The ADCPs and CTDs all provided good quality data for the entire deployment period. However, direction from the deep ADCP/compass system on the south side of the Strait was unreliable, because of a memory corruption problem that occurred with the Watson compass during sensor calibration. Directions for this record have been recreated using the fact that measurements made with the deep, and nearby

(1.2 km) shallow ADCP/pole compass systems should be the same over the depth interval where the 2 systems' ranges overlap.

Data Processing

Current Speed and Direction Data

The ADCPs were mounted in streamlined buoyancy packages (A2 "SUBs" manufactured by Open Seas Inc.) and set up to measure current relative to the instrument axes, ignoring their own compass information. Instruments were set up to average over a depth interval of 4 m. Typically, the highest useful depth average in the data sets from the upper ADCP instruments was centered around 10 m. Current data above this level were rejected based on RDI's standard echo intensity quality criterion. The upper ADCPs also recorded ice drift speed.

Direction was provided using an independent compass package mounted in the A2 tail to give the orientation of the ADCP relative to magnetic north. Initiation of a compass sample cycle was triggered by the commencement of the bihourly ADCP measurement by making use of RDI's "RDS3 interface" to provide a turn-on pulse to the compass. The compass was programmed to take a 30s sample in the middle of the 5 minute ADCP sampling interval. This conserved compass battery power, and took advantage of previous experience that current direction does not change significantly over 5 minutes at the study location [Hamilton et al., 2003].

Direction records were then adjusted for the variation in magnetic declination using magnetic observatory data from the NRCAN observatory in Resolute to get direction relative to true north.

The deep (168m) ADCP/Pole compass system on the south side of the Strait did not provide reliable direction data due to a compass EEPROM memory corruption problem. In this case, bihourly current directions from the lowest bin of the nearby

ADCP/pole compass system moored at 75m depth, are ascribed to the corresponding depth bin (or the nearest bin for which there is reliable rate data) of the deep ADCP. Only 25% of the time is the range of the lower instrument great enough that the direction transfer is being done at a depth where both ADCP instruments are providing reliable data, so the accuracy of this procedure depends on the directional shear in the middle of the water column. This shear is low. Looking at the relative direction difference between bins for the lower instrument alone (which does not rely on any compass), the average difference and standard deviation on the difference between adjacent bins is 0.3°±6° when current speed is greater than 10 cm/s. 73% of the time the highest reliable bin is within 6 bins (24 m) of the upper instrument's lowest bin. Over 6 depth bins the average difference is 1.5° ± 20° for current speeds greater than 10 cm/s.

Vertical excursions of the ADCPs caused by current drag forces acting on the mooring were small. For the 2 ADCP/pole compass systems moored at about 80 m depth, the standard deviation in the depth over the year was only 0.6 (north side) and .75 m (south side), with the bulk of the variance accounted for by tidal height variation. However, there were rare occasions of substantial mooring dip particularly on the south side (12 m on one occasion). Corrections for mooring dip have been applied where necessary using depth information from the moored CTDs, so that reported current speeds are at the correct absolute depth.

The ADCPs also provide ice drift velocity when there is solid or near-solid ice cover.

Moored CTD Data

SeaBird MicroCat CTDs were set up to measure temperature, conductivity and pressure every hour for the yearlong deployments. Moorings supporting the 25 m and 31 m level CTDs were subjected to the greatest dip due to current drag forces acting on the mooring. For the mooring supporting the shallowest CTD on the south side where the currents are strongest, the standard deviation in instrument depth over the yearlong deployment was 1.7 m, with tidal height variation accounting for about 1/3 of this variation. Through August and September there were several events that caused dips of 5 to 10 m, and 2 strong events causing dips of up to 26 m.

Low-Pass Filtering

Some of the data series presented have been filtered to remove the semidiurnal and diurnal tides using the technique described by Godin (1972). The technique uses three simple averaging filters applied in sequence. Godin, working with hourly observations, recommends two consecutive applications of a filter that averages over 24 samples, followed by one that averages over 25 samples. Here, the hourly MicroCat CTD data have been decimated to match the bihourly sampling of currents, and averaging filters of 12 and 13 samples are then applied to all the data sets.

Tidal Analysis

Harmonic tidal analysis of north side current data using Foreman's (1978) method is presented separately for a 20 week period of solid ice cover, and a 10 week period of broken or no ice. The tidal ellipse axes amplitudes, orientations and phases for the main tidal constituents (K1, M2, O1, P1 and S2) are plotted as a function of depth.

The periodic vector function describing a particular constituent, traces an ellipse over a tidal cycle with major and minor amplitudes defined by the length of the semi-major and semi-minor axes. The major axis amplitude is always positive. The sign of the minor axis amplitude defines the rotation sense of the current ellipse. When positive the vector traces the ellipse in a counter-clockwise direction; when negative, the rotation sense is clockwise.

Ellipse orientation is the angle measured counter-clockwise from east to the semi-major axis.

The phase is a measure of the timing of high water referenced to astronomic positions over the Greenwich meridian. Phase is measured counter-clockwise from this chosen reference.

Data Presentation

Yearlong time series of hourly temperature, salinity and density from the moored CTDs are shown in Figures 3 and 4. As in previous years [Hamilton et al., 2002, Hamilton et al., 2003] warming and freshening of the top 50 m occurs in late summer. Temperatures in the upper water column drop abruptly to near-freezing values in early fall, but salinity increases until late January due to salt rejection from the growing pack ice. This maximum seen in the upper 2 CTDs on both sides of the Strait ends with a 0.25 (south side) - 0.5 (north side) ppt salinity decrease several weeks later, to values that persist for the remainder of winter and spring. Although this somewhat abrupt salinity maximum feature was seen in the 98-99 north side record, it is the first year that it is observed on the south side. Also on the south side, the salinity at 25 m remains very close to measured values at 43 m through the winter. This was not the case in previous years when the water was typically 0.2 to 0.7 ppt fresher at the upper instrument on the south side.

As in previous years, warmer, saltier Atlantic water is detected by the deep instruments on both sides of the Strait. On the south side this water appears sporadically, and in 00-01 these deep intrusions are far less frequent than in the previous 2 years.

Power spectra of the moored CTD measurements (Figures 5 and 6) reveal a strong tidal signal in the diurnal band with greatest variance at the deeper instruments, but only a weak signal (except for the deep instrument on the south side) at the semi-diurnal frequency. In the upper water column on the north side, variance in the meteorological band shows up at 4 days for temperature, but variance in salinity is centered at about 2 days. This can be accounted for by seasonal differences between salinity and temperature gradients in the top 50 m (for example, no temperature gradient from January to August between the upper 2 CTDs but a salinity gradient remains) combined with seasonal differences in the period of the meteorological forcing.

Current data are shown as contour plots in Figures 7-10. Data from the deep and mid-water ADCPs have been combined, for both the north and south sides. Data are presented in along-strait and cross-strait components, where positive values are defined as flow towards 105° true and 15° true, respectively. Figures 7 and 8 display two months of unsmoothed data, revealing both the tidal and lower frequency character of the flow.

Low-pass filtered data (tides removed) are shown in Figures 9 and 10. Mean flow is predominantly eastward on the south side of the Strait with particularly strong flow in late fall and early summer. On the north side the low-pass filtered along-strait flow is weakly eastward (unlike the previous year where the flow direction frequently reversed), except from mid-August to late October when the flow is westward.

Missing data near the surface from mid-winter through to late spring (Figures 9 and 10) are caused by a decrease in the effective range of the ADCPs when the water is at its clearest, and contains a minimum of acoustic reflectors. (The manufacturer's suggested data quality acceptance criteria have been applied.) The smoothing method used has smeared the impact of missing raw data over the filter length.

Smoothed temperature, salinity and current data are shown for each moored CTD level in Figures 11-20. The extended period of no current data in Figures 13 and 18 is the result of the way the low-pass filter deals with missing raw data that occur at the outer range limit of the ADCP. Tables 1 through 12 provide a summary of the CTD and ADCP data at the CTD depths, with statistics computed over each season, and for the entire year. Density has been included in these statistical summaries.

Salinity at the 25 m depth on the south side is 0.2 to 0.4 ppt fresher in late summer of 2000 than in previous years, and fresher still in the late summer of 2001. The salinity maximum on both sides is reached in late January after gradually increasing from early November, as salt is rejected from growing ice.

On the north side at the 31 m level, early fall water temperature is 2° colder and salinity is 1 ppt higher than in 1998. (No 1999 data are available for comparison because of a lost mooring that year.) The fall and early winter temperature at the 83 m level on the north side though is 0.2° warmer than in previous years, and takes a rapid 0.4° drop in early February that was not seen in previous years.

Annual and seasonal mean flows are summarised in Figures 21-26. For clarity, only every fifth ADCP depth bin has been used to generate the graphs. Eastward flow on the south side is stronger than in each of the previous years. For example, late summer speeds are 25% higher than in 1999, and well over 2 times greater than in 1998. In the fall, currents do not show the shear seen in previous years and are roughly twice that of 1999, and 3 to 4 times greater than in 1998.

On the north side in 2000-2001, westward flow in the late summer and fall is followed by eastward flow in the winter, spring and early summer resulting in a annual mean flow of close to nil. In both of the previous years, there was a weak westward annual mean flow.

The variance in the bihourly, and low-pass filtered current data for the entire ADCP records are shown in Figure 27. On the south side, tides account for about half of the total variance in the along-strait current speeds, while on the north side, the tides account for an even larger portion.

Tidal analysis results for the ADCP data collected on the southern (Figures 28-32) and northern (Figures 33-37) sides of the Strait are presented as profiles for the 5 largest tidal constituents. Separate analyses have been done for ice-free and solid ice periods. The K1 and M2 constituents are comparable in magnitude, and ellipse orientations are generally along-strait as expected. Tidal constants are summarised in Tables 13 - 17.

Ice velocities on the north and south sides of the Strait as measured by the upper ADCPs are shown in Figures 38 and 39. Since the ice drift measurement quality is degraded by the presence of open water, there are periods in the time series where no data are presented. The manufacturer's suggested data quality standards have been applied to the ice drift data. An additional criterion applied here is that where the magnitude of the "error velocity" for a particular ensemble is greater than 1 cm/s, the ice drift velocity estimate and the adjacent estimates are rejected.

Ice stopped moving by mid-February which is about at the same time as in 1999, but 2 months later than in 2000. Break-up commenced around July 10, which is within a week of break-up in each of the previous years.

Acknowledgements

We thank Brian Petrie and Peter Jones for their reviews of this report, and Larry Newitt (NRCAN) for providing the Resolute Observatory magnetic declination data.

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Foreman, M.G.G., 1978. *Manual for tidal currents analysis and prediction*. Pacific Marine Science Report 78-6. Institute of Ocean Sciences, Sidney, B.C., 70pp.

Godin, G, 1972. *The Analysis of Tides*. Liverpool: Liverpool University Press, 264pp.

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Hamilton, J. M., 2001. Accurate Ocean Current Direction Measurements Near the Magnetic Poles, in *Proceedings of the Eleventh (2001) International Offshore and Polar Engineering Conference*, 656-660. ISOPE: Stavanger, Norway.

Figure 1. A map of the work area showing the location of the northern and southern mooring sites (the open boxes). The dashed lines represent the hydrographic survey lines done in previous years, but not in 2001.

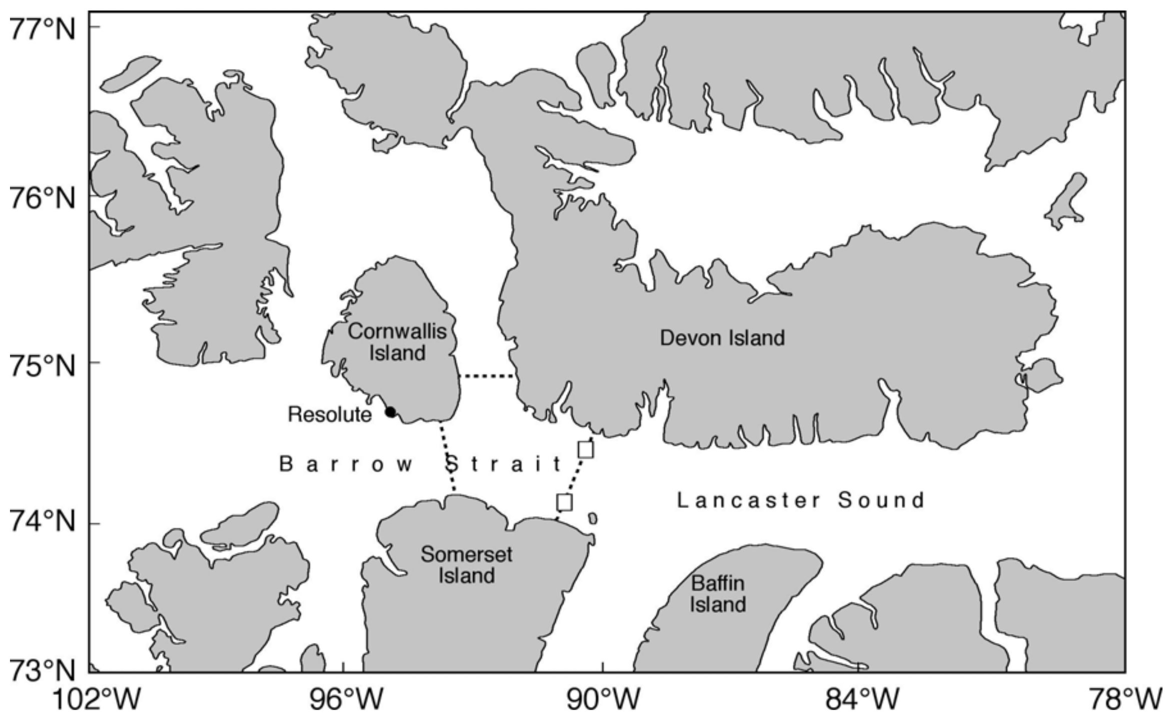


Figure 2. Illustration of the instrumented moorings deployed around the 200 m contour on both sides of Barrow Strait. A ninth mooring (not shown) was deployed to measure the variation in the position of the north magnetic pole.

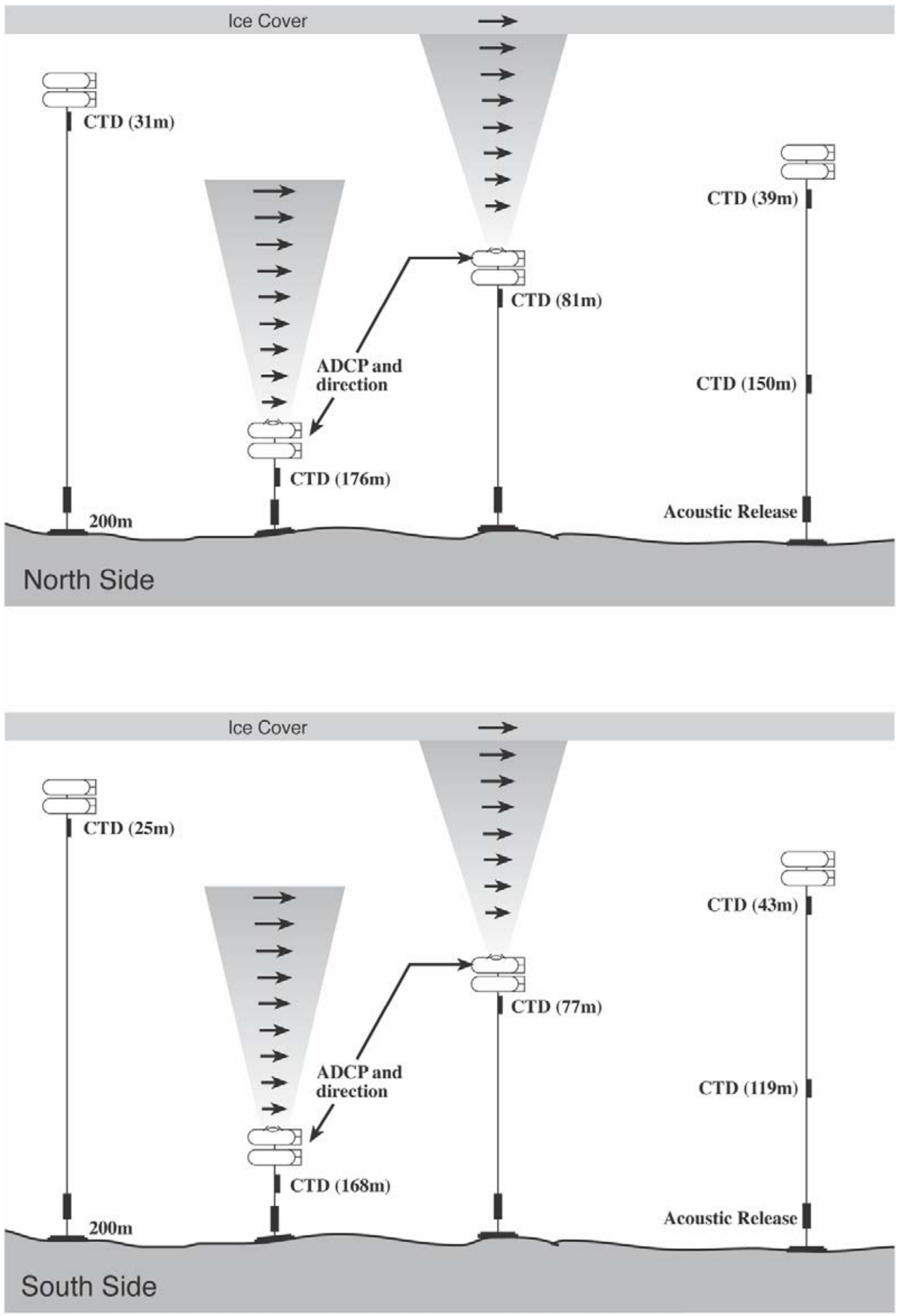


Figure 3 - Moored bihourly CTD data from South side of Barrow Strait: Aug 2000 - Sept 2001.

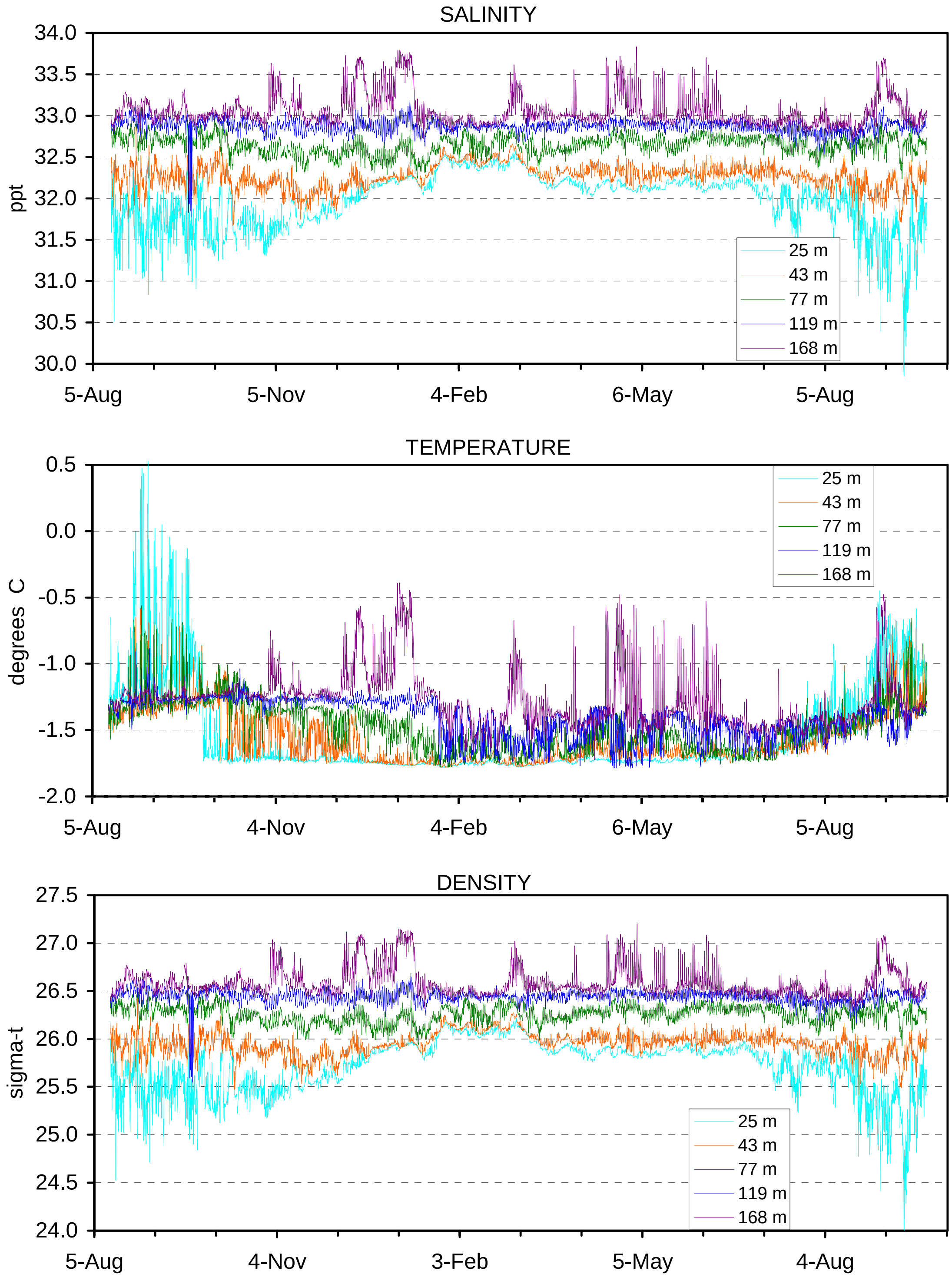


Figure 4 - Moored bihourly CTD data from North side of Barrow Strait: Aug 2000 - Aug 2001.

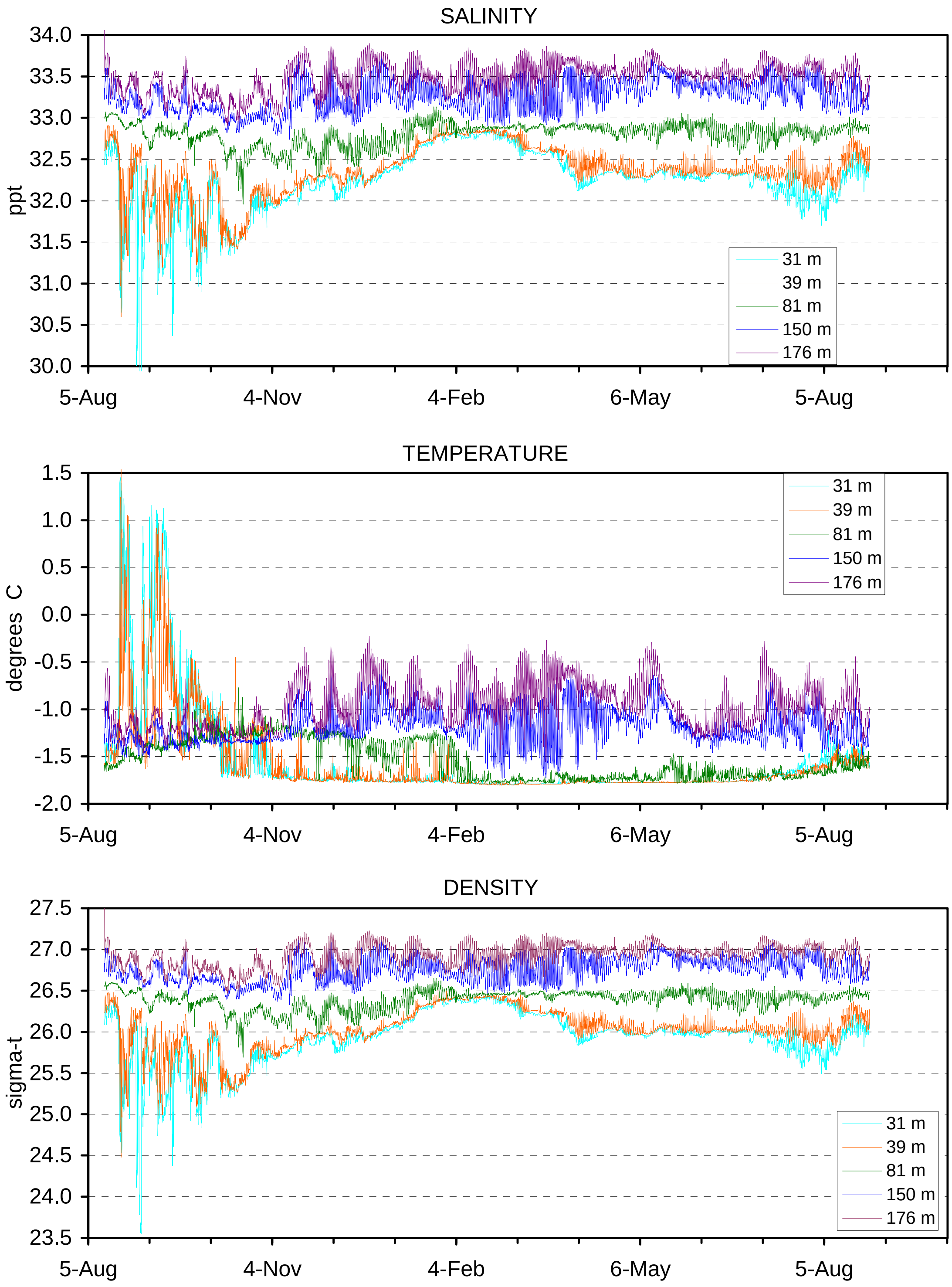
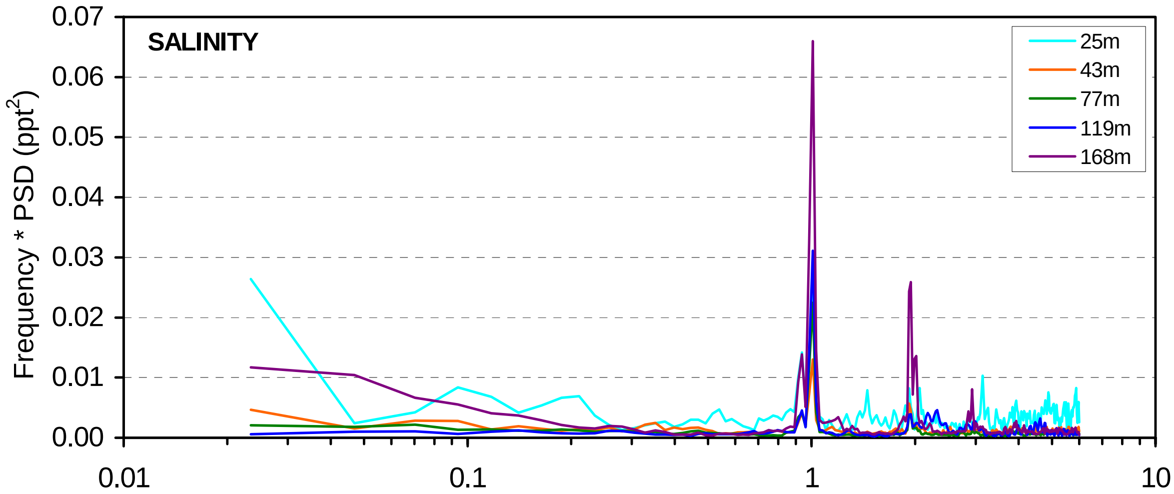
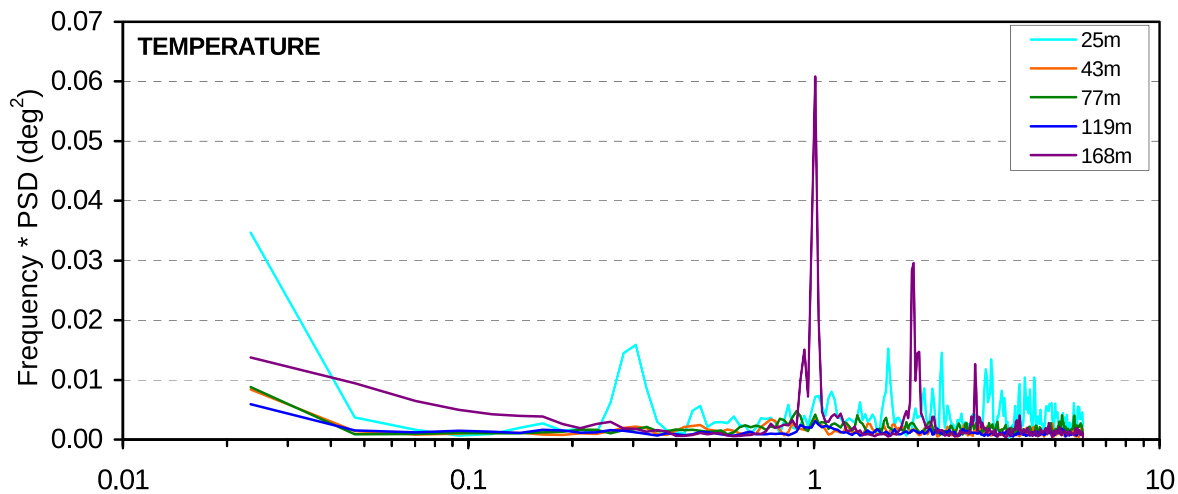


Figure 5 - Power Spectra of moored bihourly CTD data from South Side of Barrow Strait: Aug 2000 - Sept 2001.





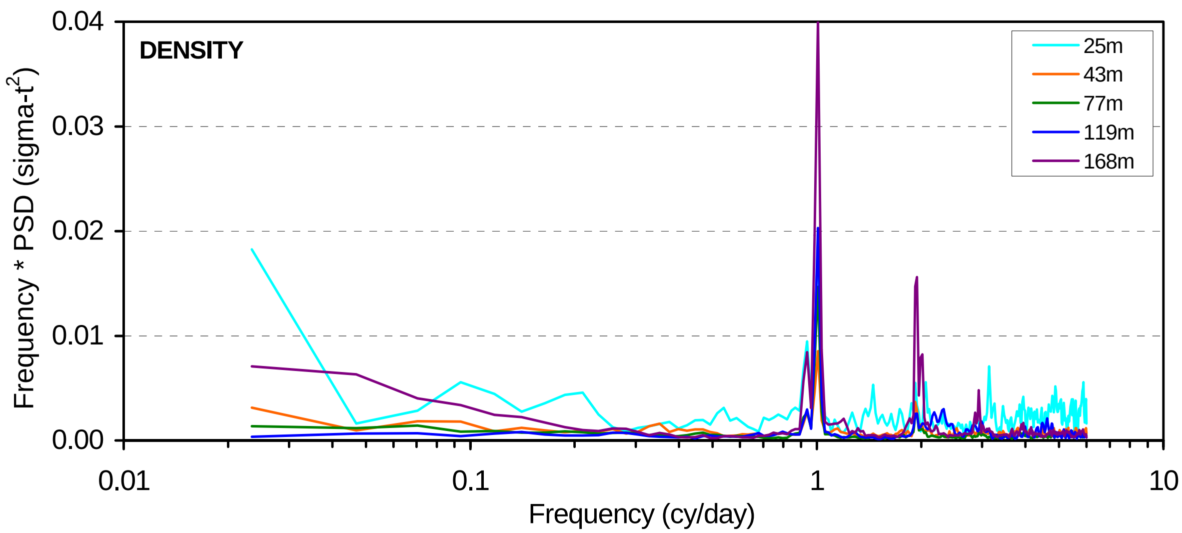
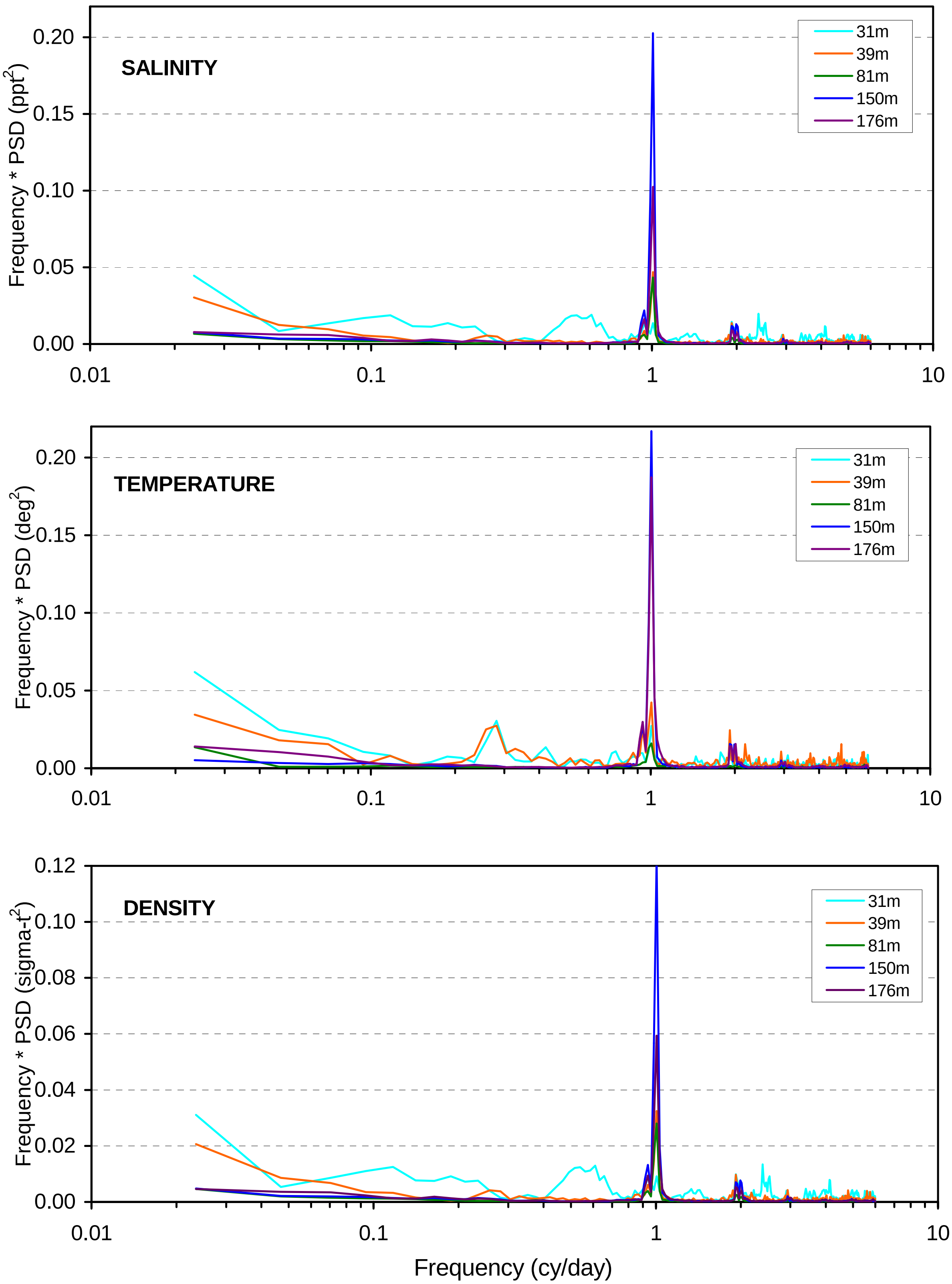
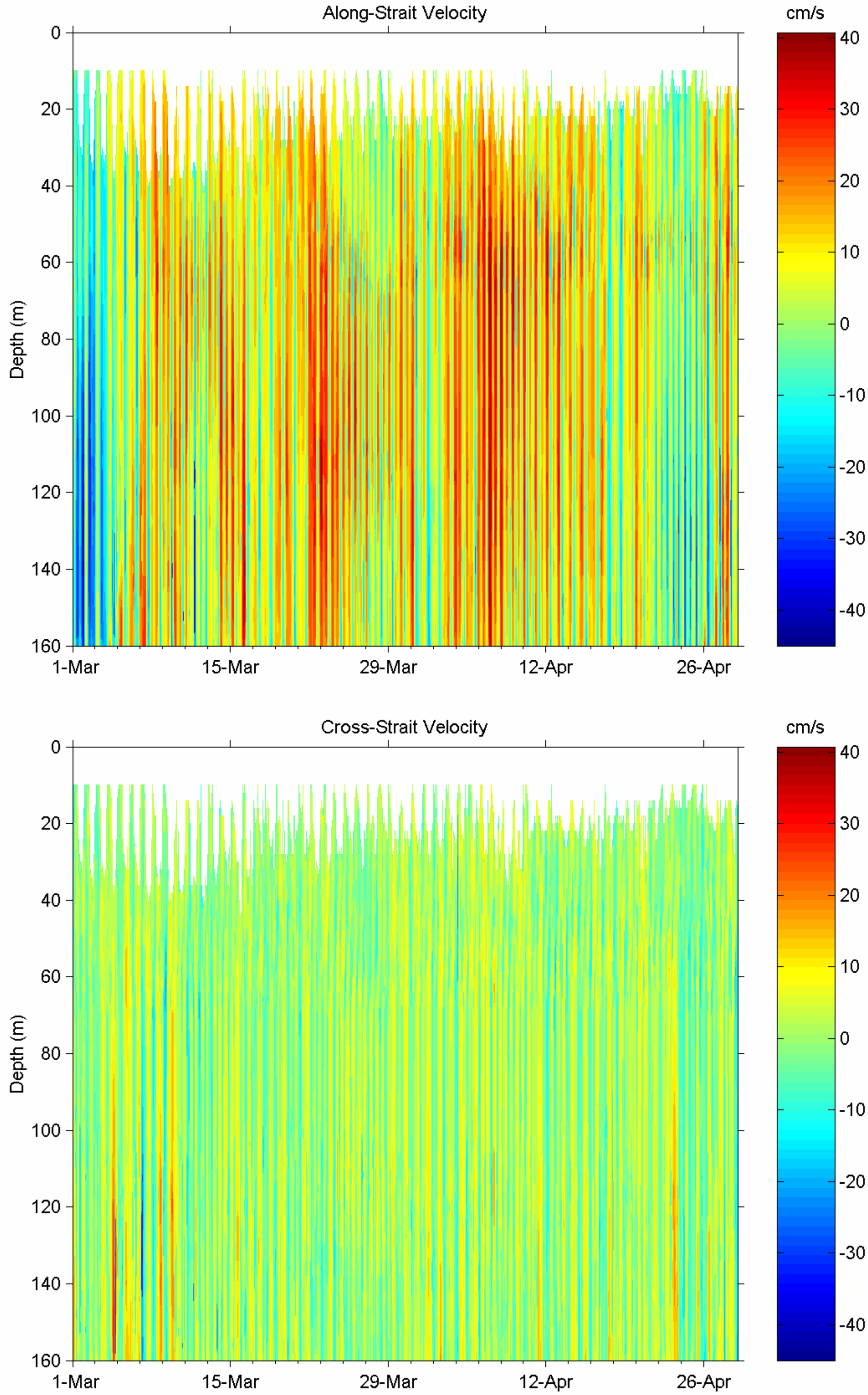


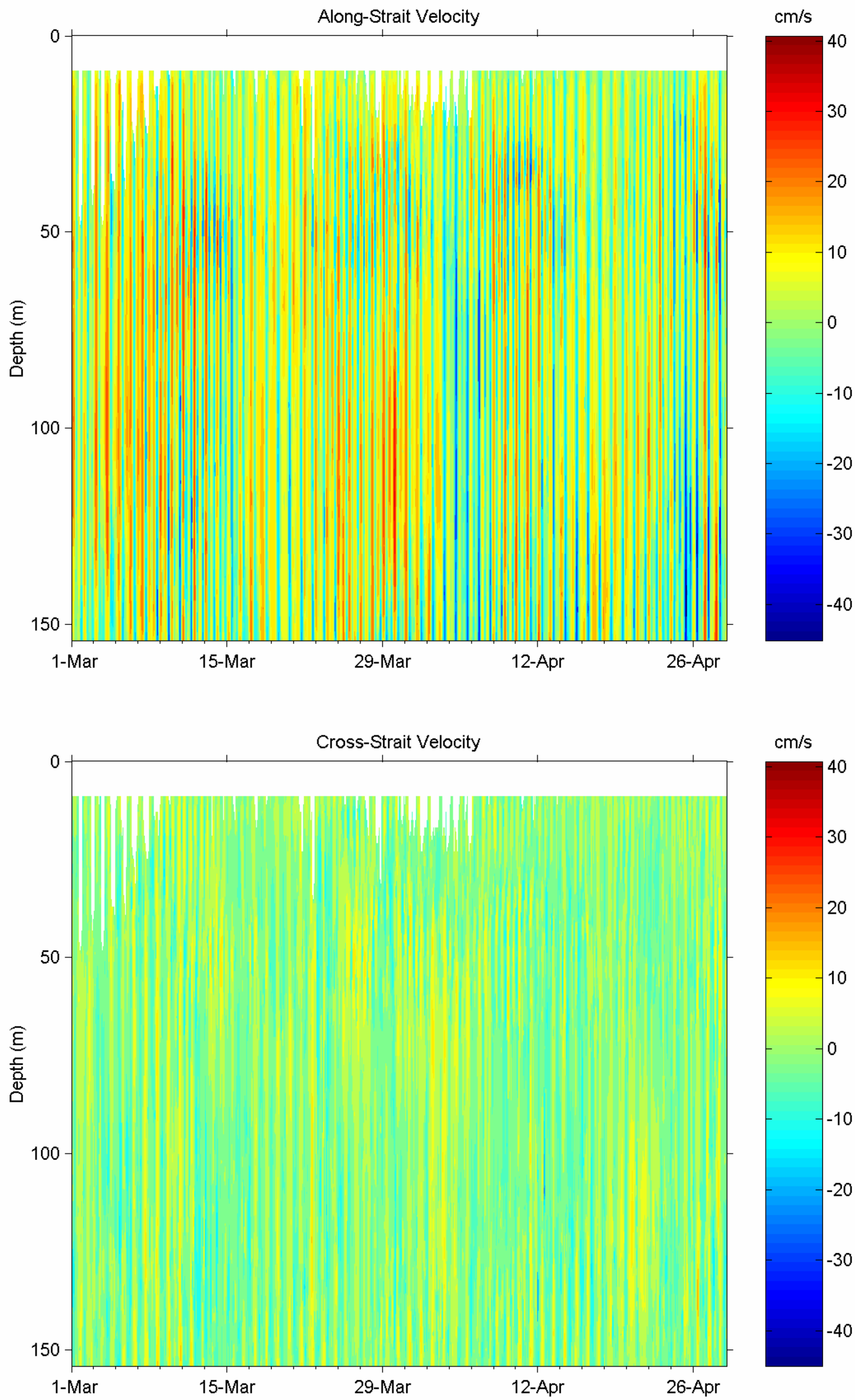
Figure 6 - Power Spectra of moored bihourly CTD data from North Side of Barrow Strait: Aug 2000 - Aug 2001.



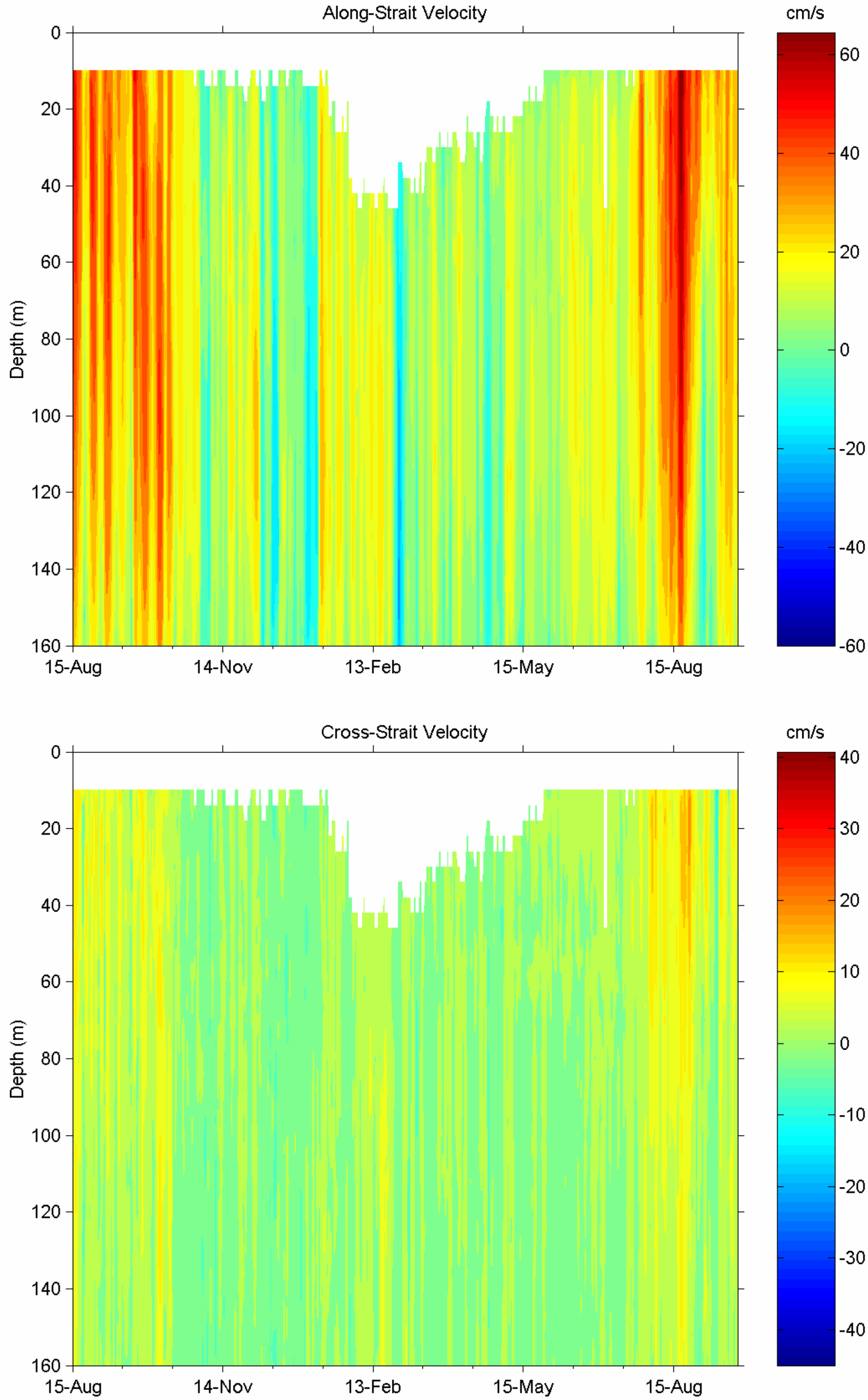
<u>Figure 7</u> - Bihourly current data, South side of Barrow Strait: March 1, 2001 – Apr 29, 2001.



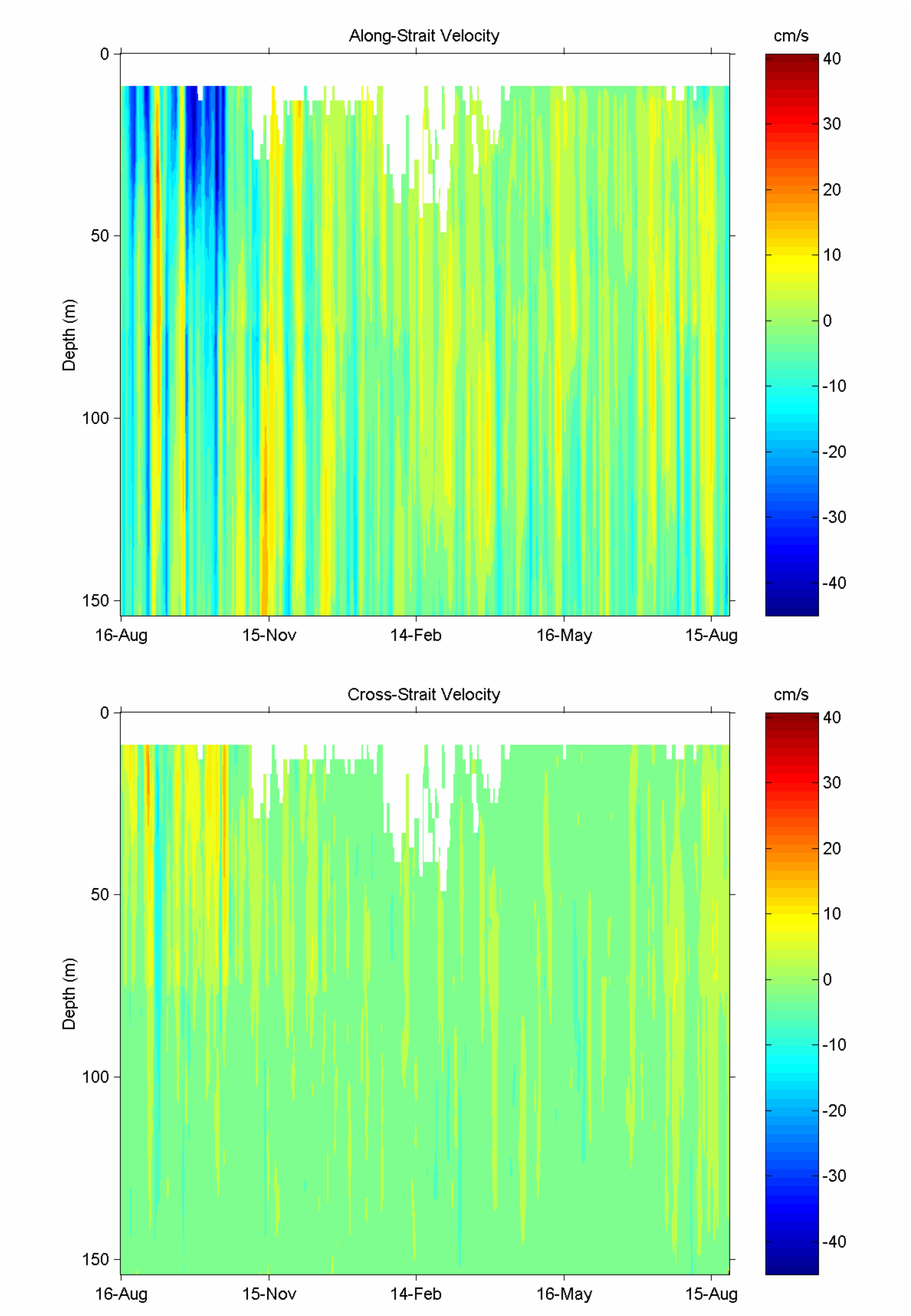
<u>Figure 8</u> - Bihourly current data, North side of Barrow Strait: March 1, 2001 – April 29, 2001.



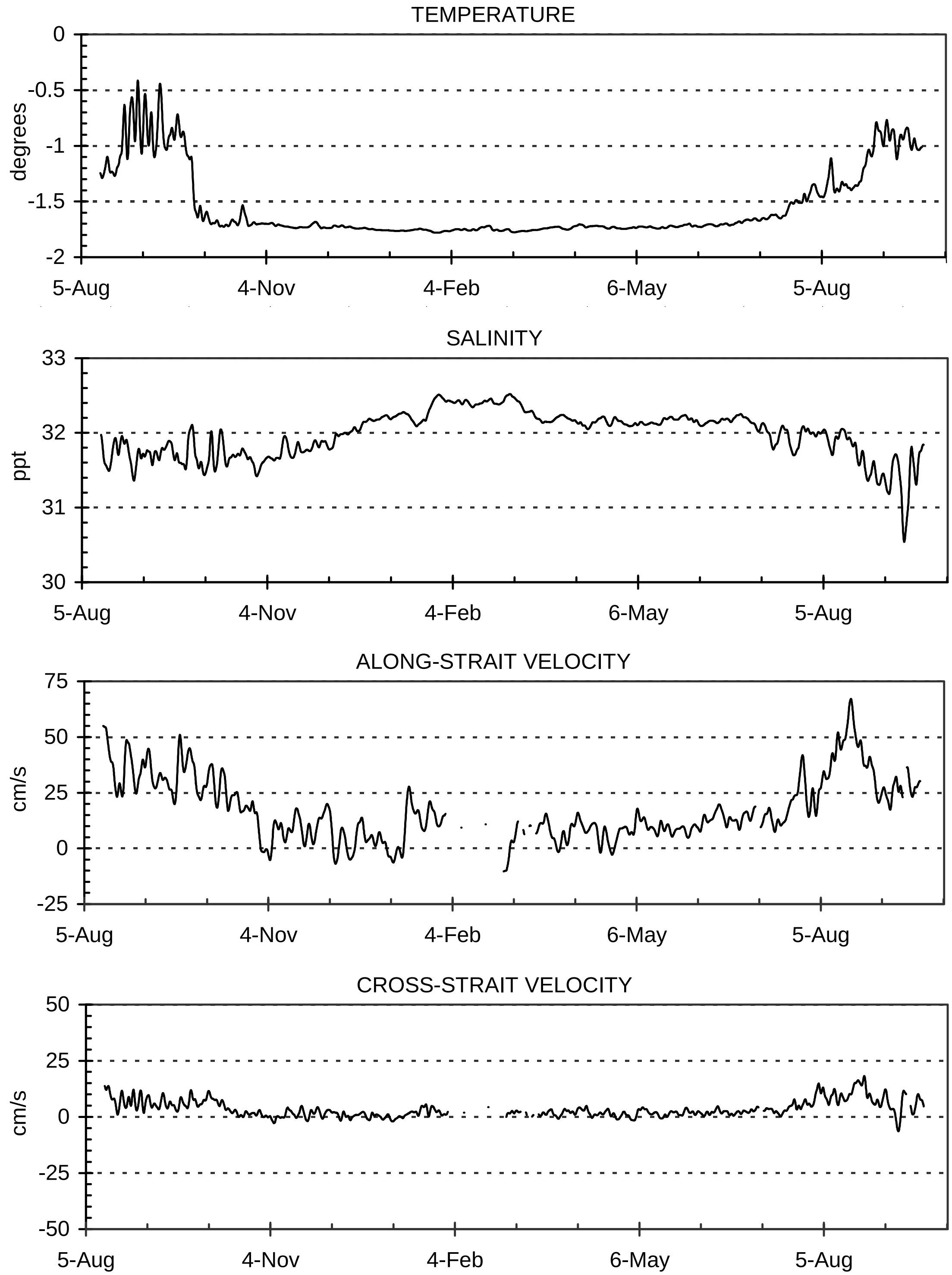
<u>Figure 9</u> – Low-pass filtered currents, South side of Barrow Strait: Aug 2000 – Sept 2001.



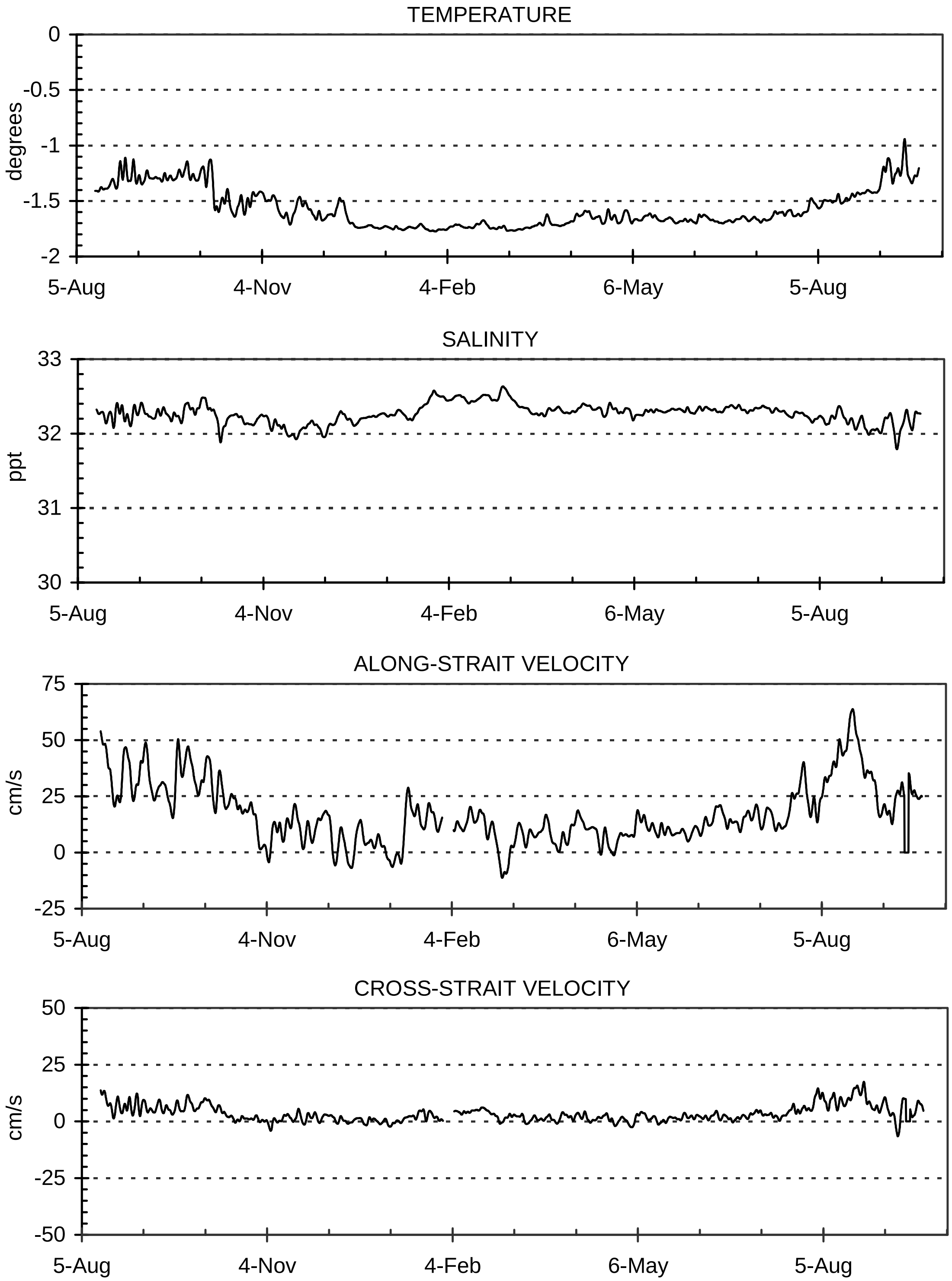
<u>Figure 10</u> – Low-pass filtered currents, North side of Barrow Strait: Aug 2000 – Aug 2001.



<u>Figure 11</u> - Low-pass filtered T,S and current data from 25 m depth, South side of Barrow Strait: Aug 2000 - Sept 2001.



<u>Figure 12</u> - Low-pass filtered T,S and current data from 43 m depth, South side of Barrow Strait: Aug 2000 - Sept 2001.



<u>Figure 13</u> - Low-pass filtered T,S and current data from 77 m depth, South side of Barrow Strait: Aug 2000 - Sept 2001.

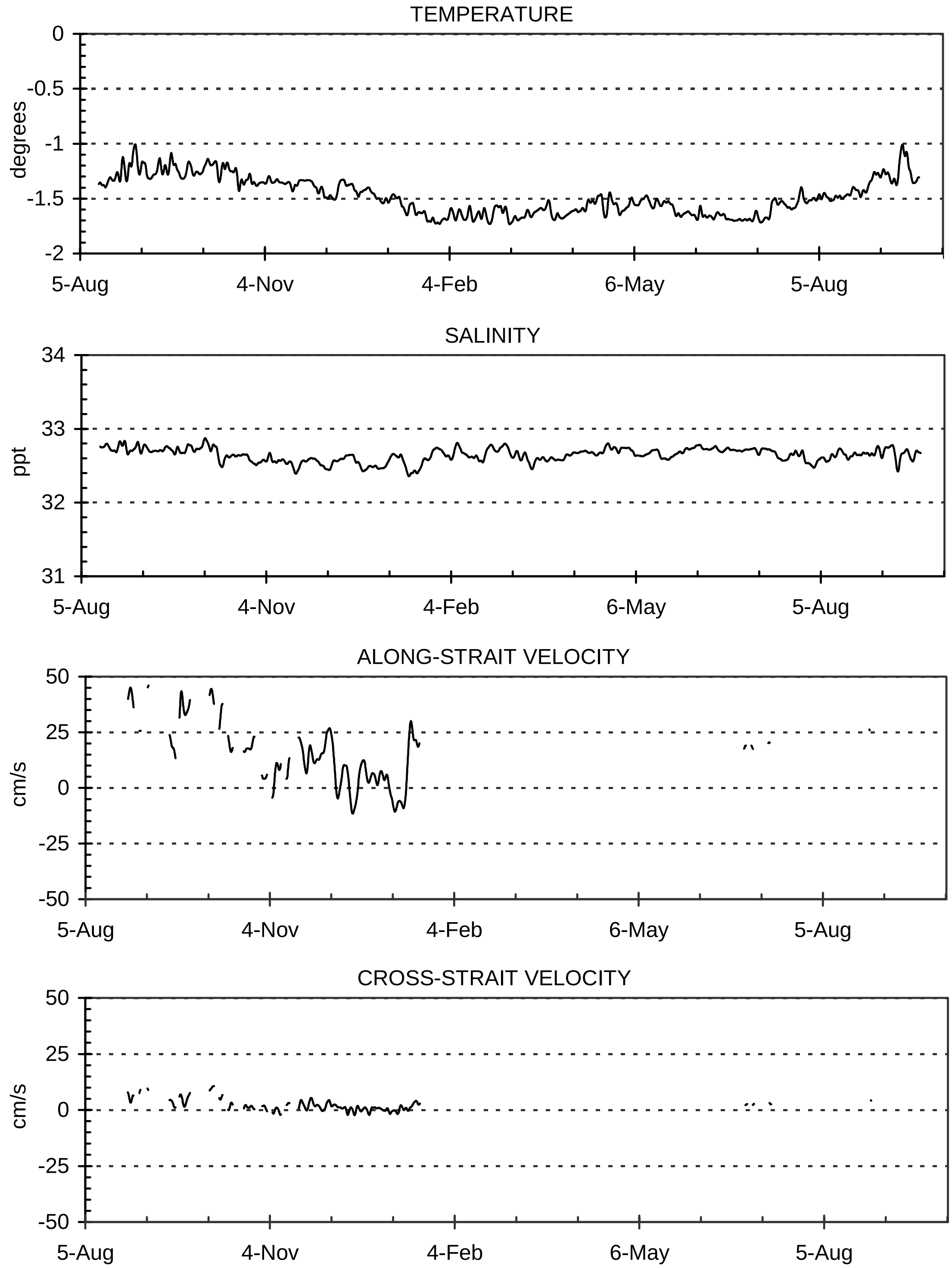
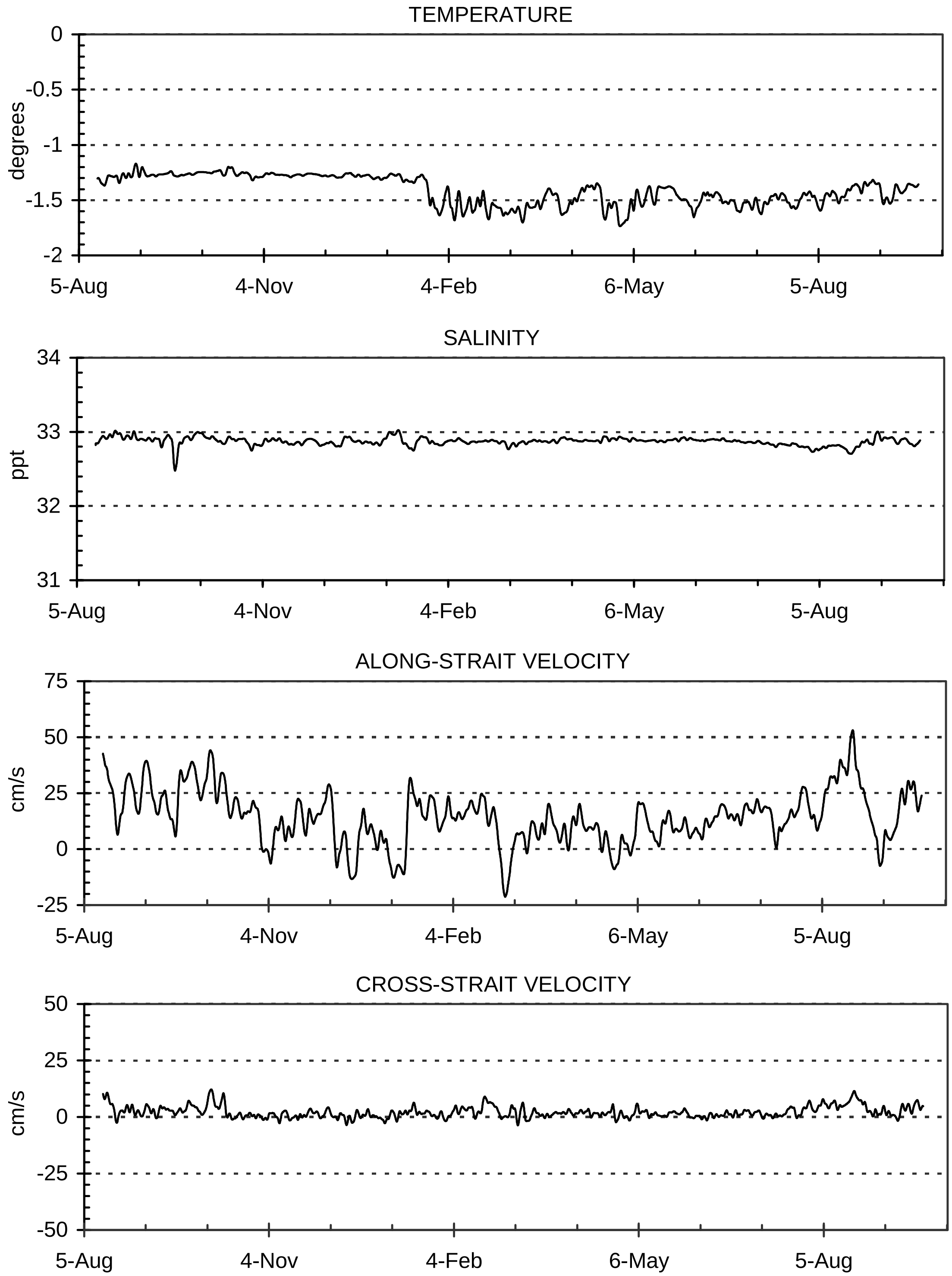
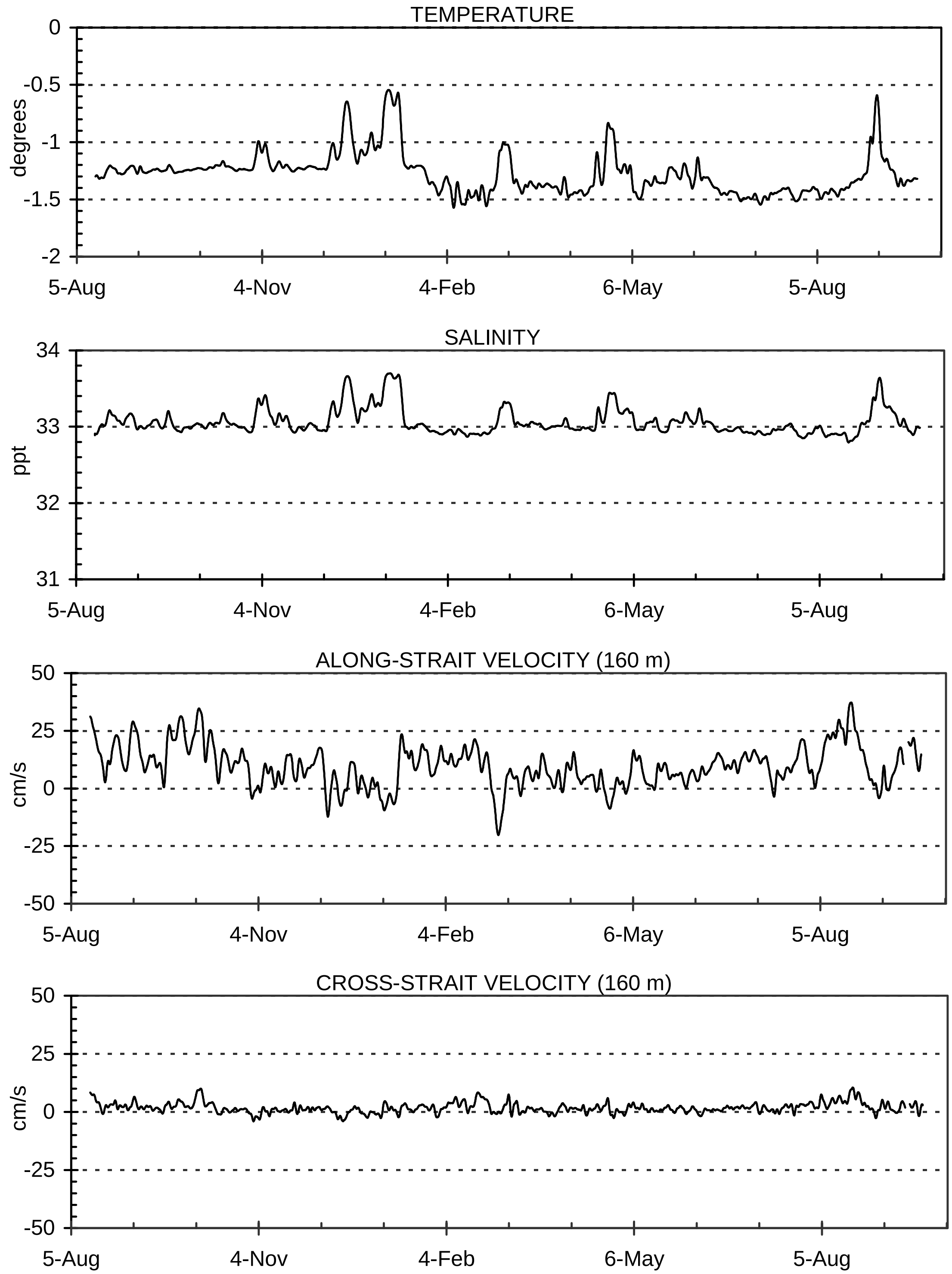


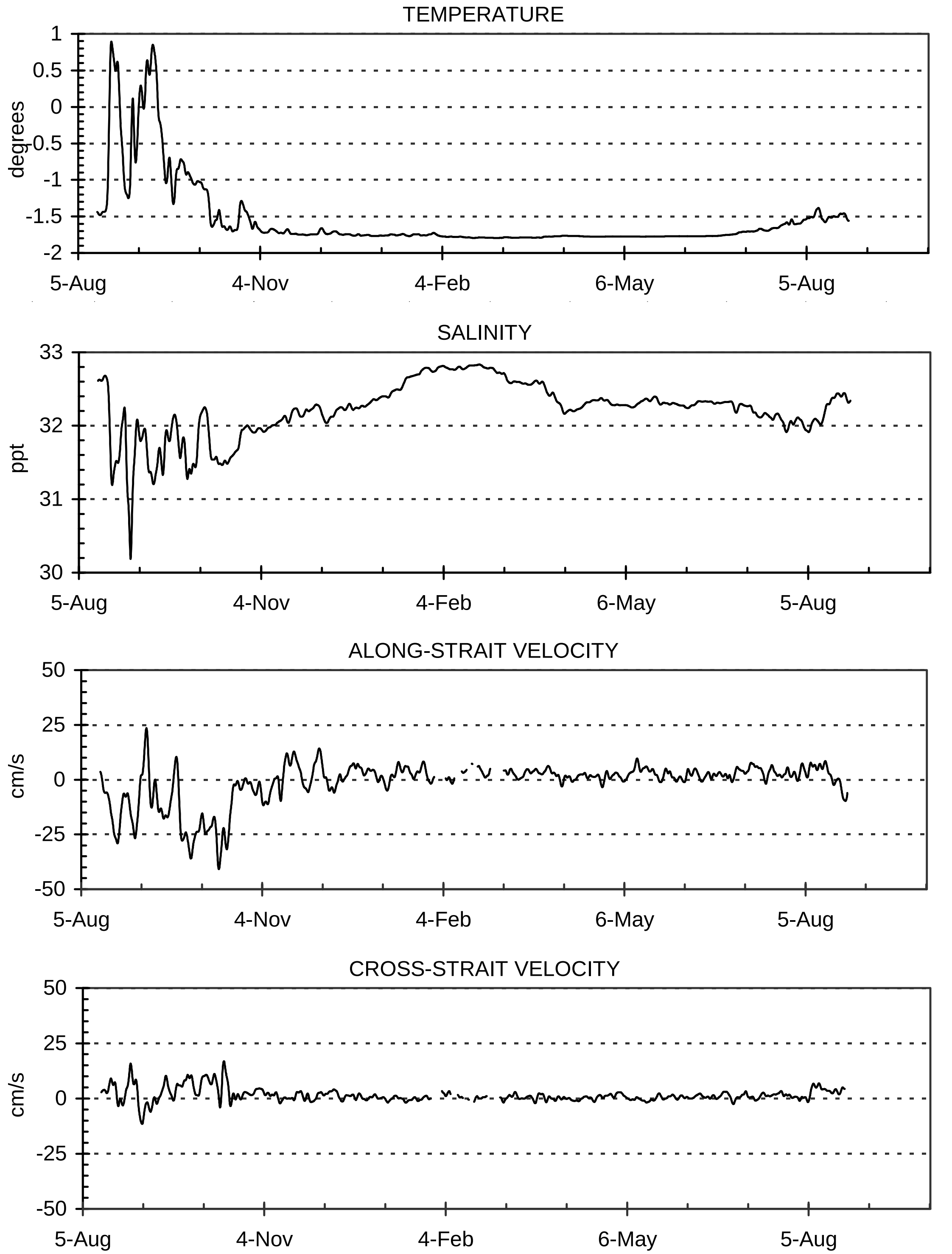
Figure 14 - Low-pass filtered T,S and current data from 119 m depth, South side of Barrow Strait: Aug 2000 - Sept 2001.



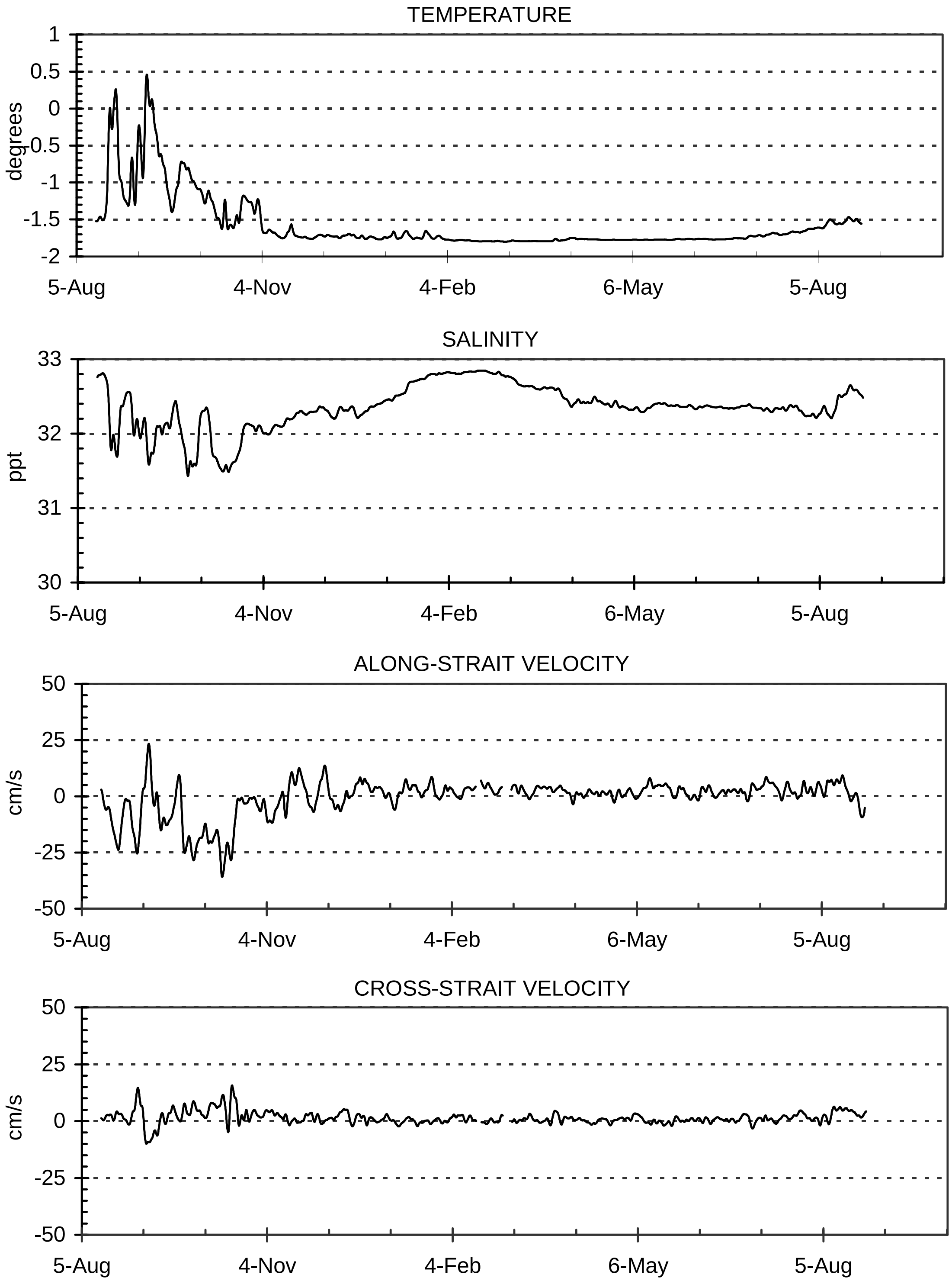
<u>Figure 15</u> - Low-pass filtered T,S and current data from 168 m depth, South side of Barrow Strait: Aug 2000 - Sept 2001.



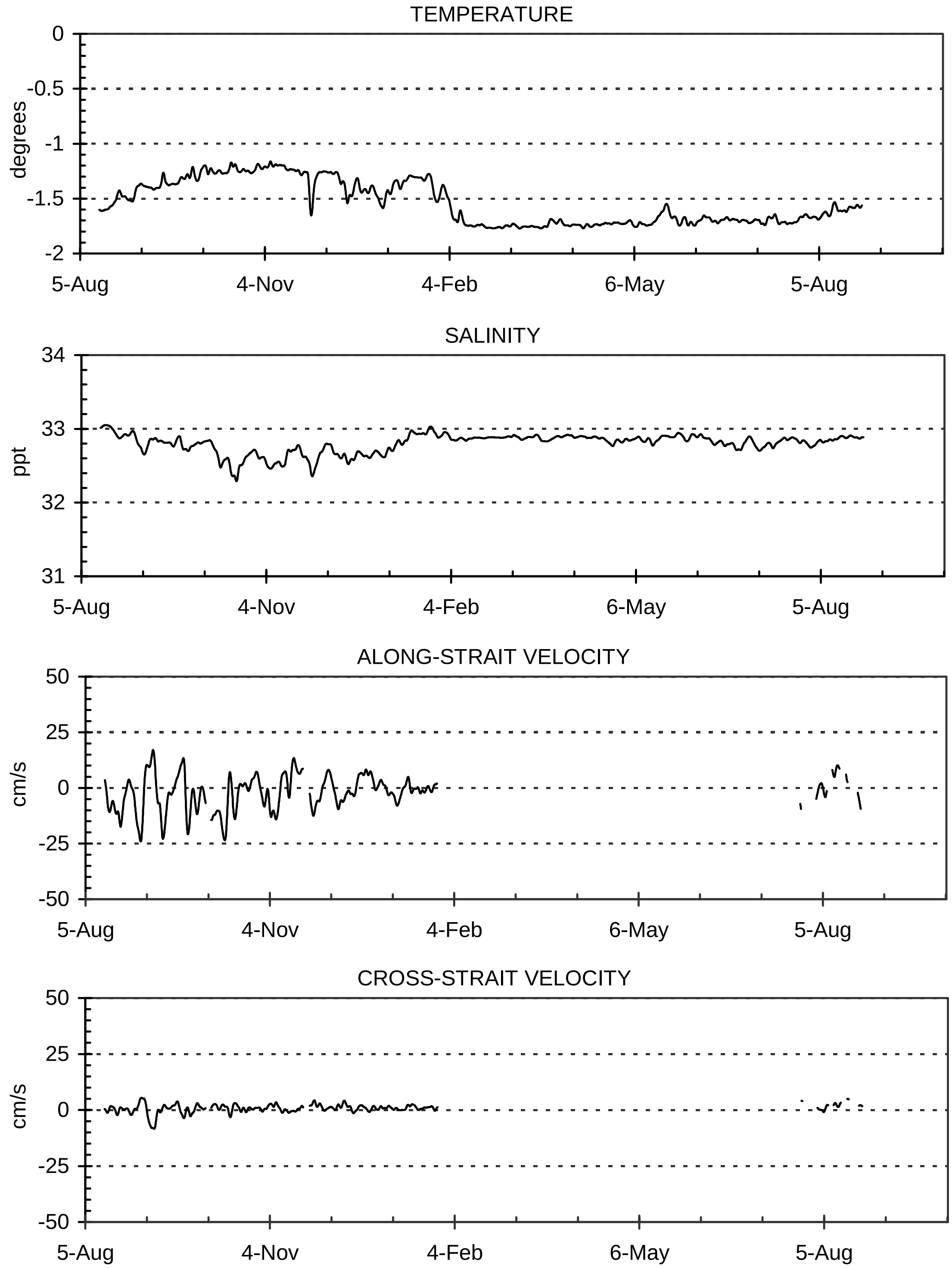
<u>Figure 16</u> - Low-pass filtered T,S and current data from 31 m depth, North side of Barrow Strait: Aug 2000 - Aug 2001.



<u>Figure 17</u> - Low-pass filtered T,S and current data from 39 m depth, North side of Barrow Strait: Aug 2000 - Aug 2001.



<u>Figure 18</u> - Low-pass filtered T,S and current data from 81 m depth, North side of Barrow Strait: Aug 2000 - Aug 2001.



<u>Figure 19</u> - Low-pass filtered T,S and current data from 150 m depth, North side of Barrow Strait: Aug 2000 - Aug 2001.

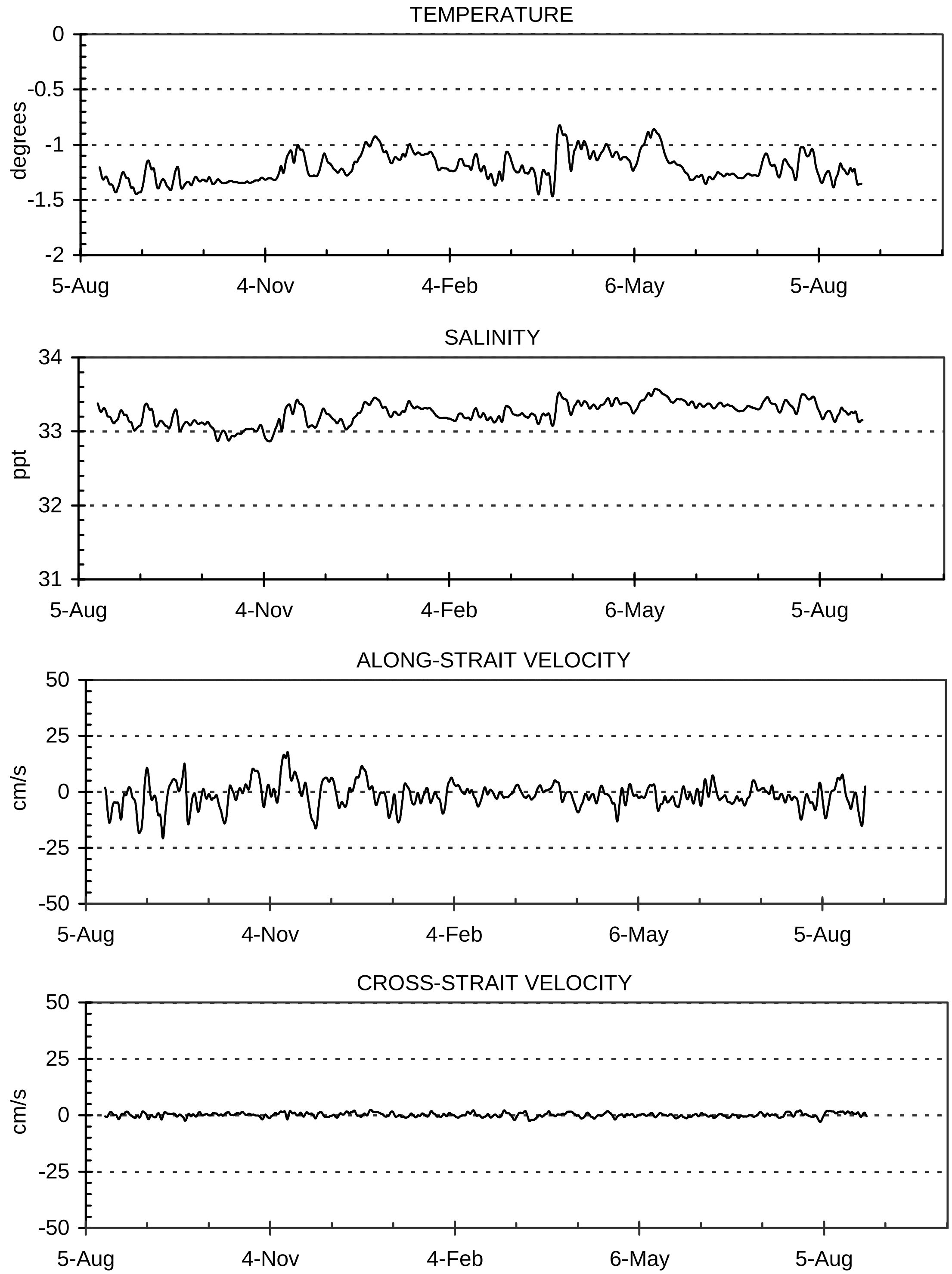


Figure 20 - Low-pass filtered T,S and current data from 176 m depth, North side of Barrow Strait: Aug 2000 - Aug 2001.

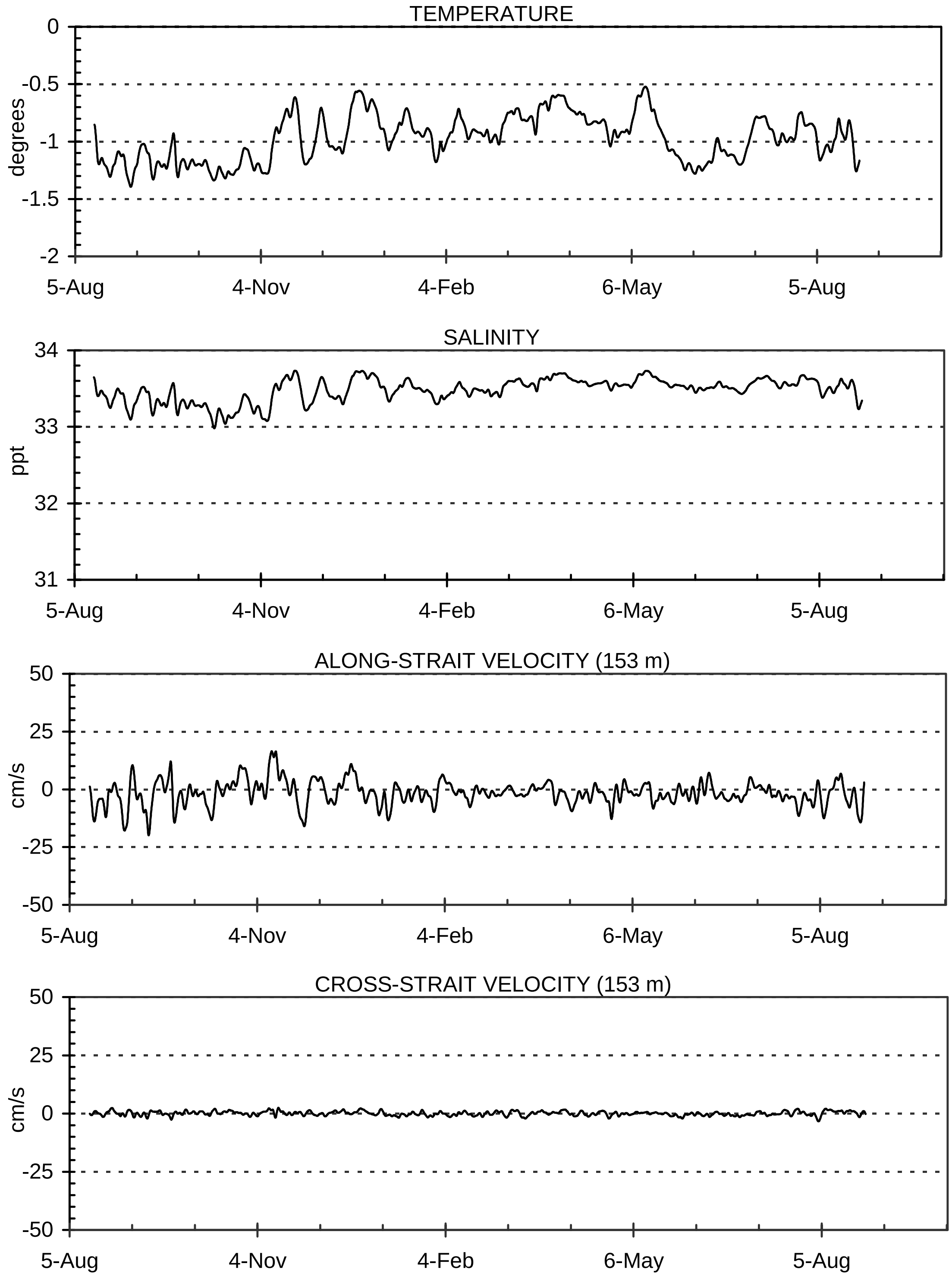
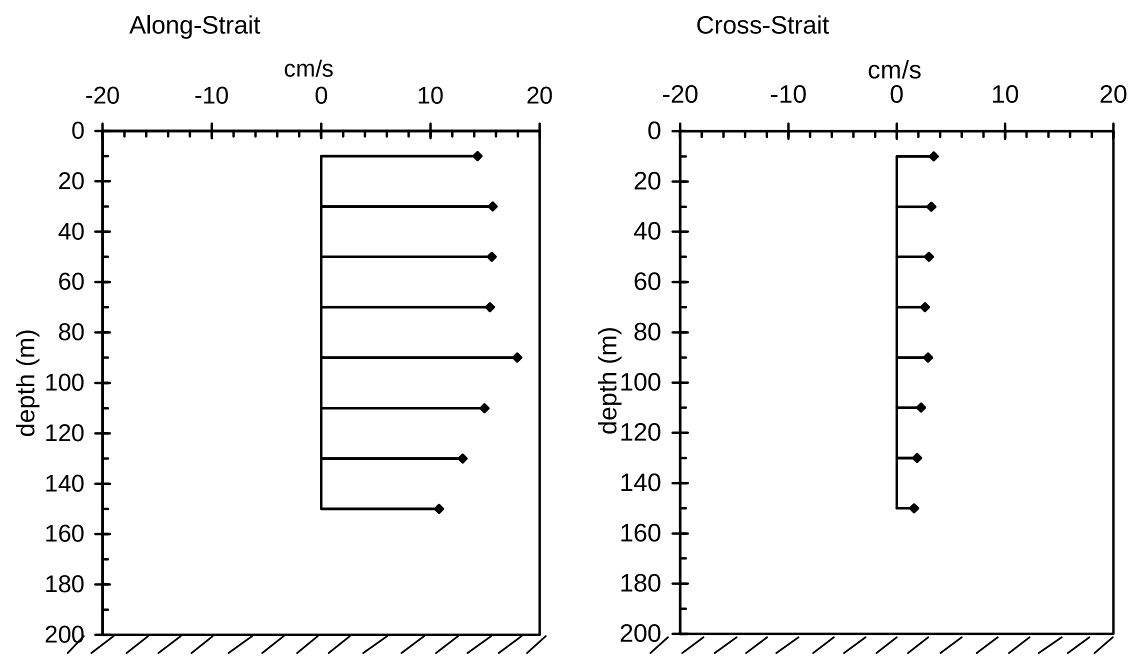


Figure 21: Annual Mean Flows, Aug 2000 - Aug 2001.

South side of Barrow Strait:



North Side of Barrow Strait:

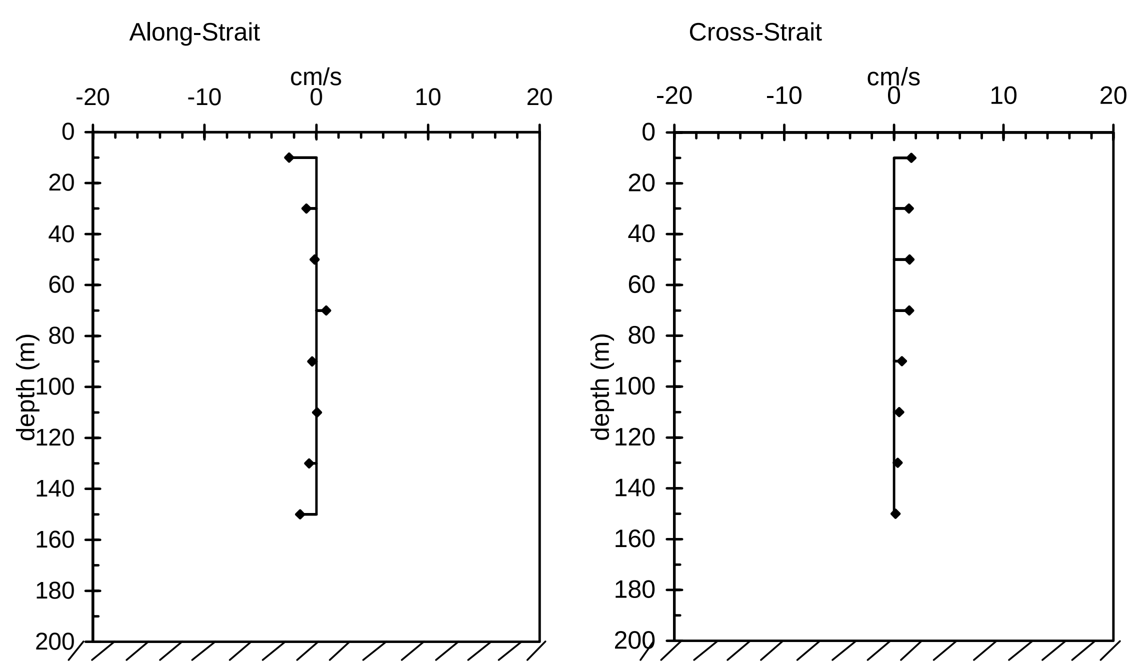
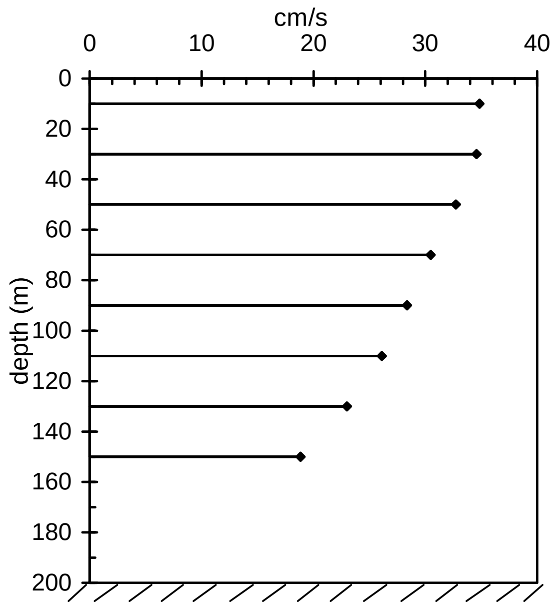


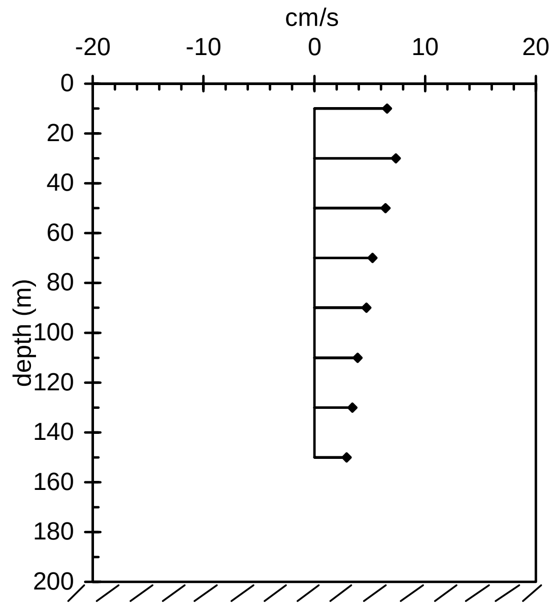
Figure 22: Mean Flows, Late Summer: Aug 2000 - Sep 2000.

South side of Barrow Strait:

Along-Strait

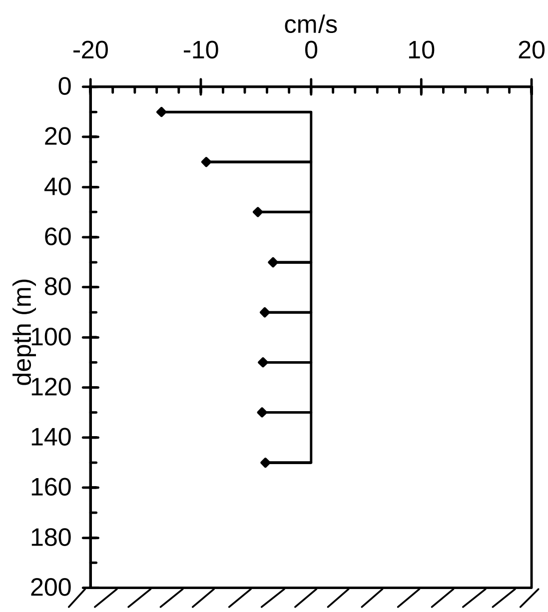


Cross-Strait



North Side of Barrow Strait:

Along-Strait



Cross-Strait

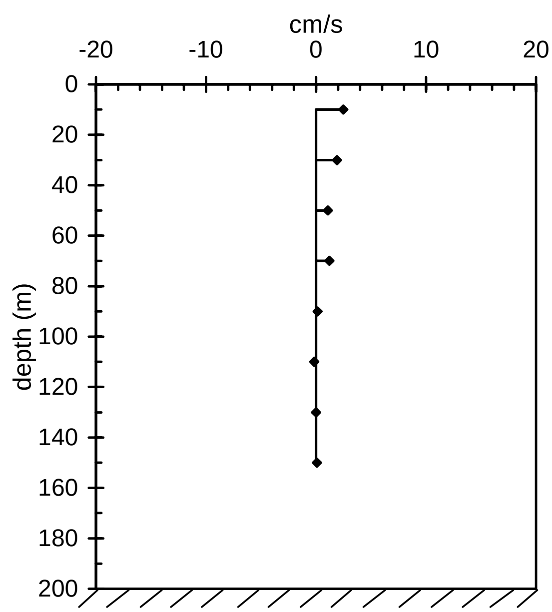
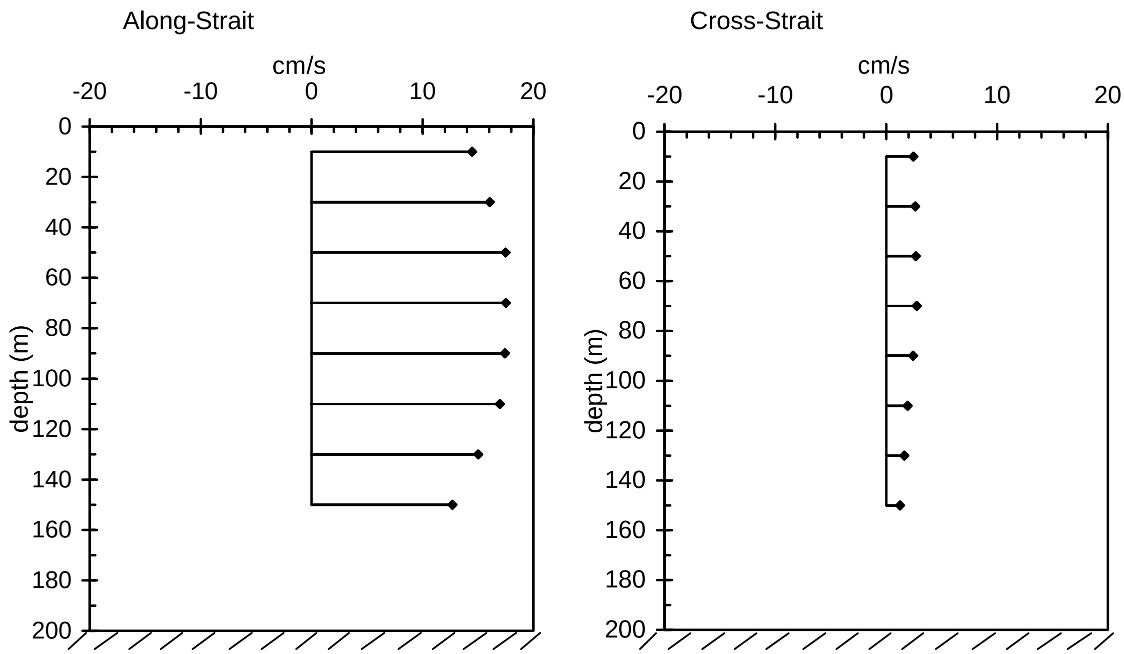


Figure 23: Mean Flows, Fall: Sep 2000 - Dec 2000.

South side of Barrow Strait:



North Side of Barrow Strait:

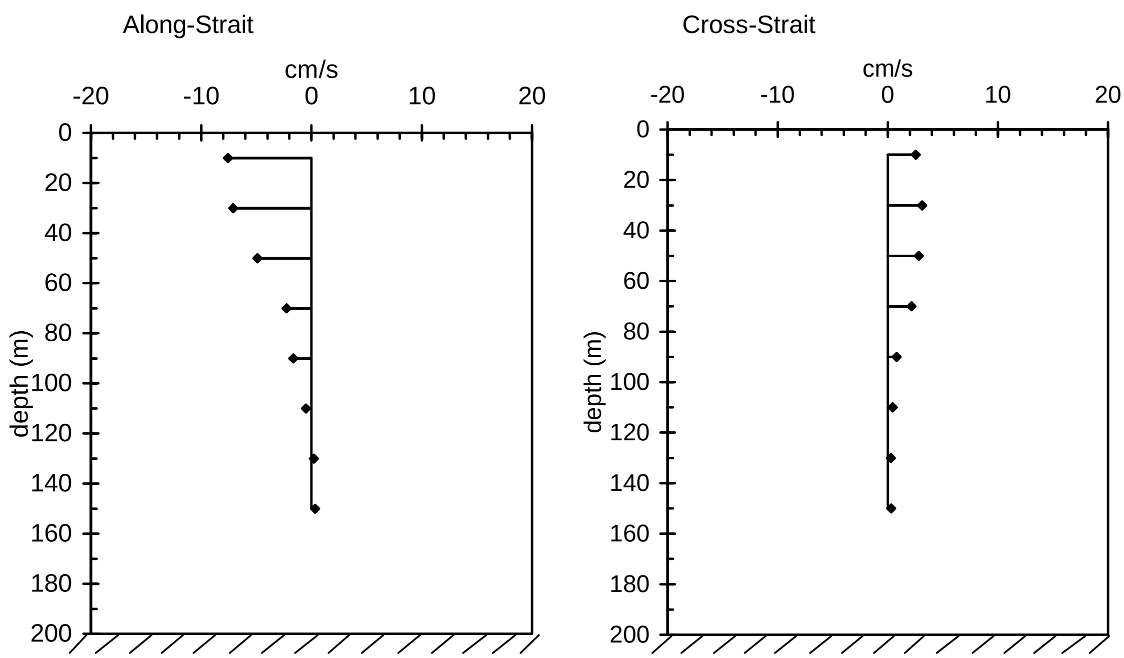
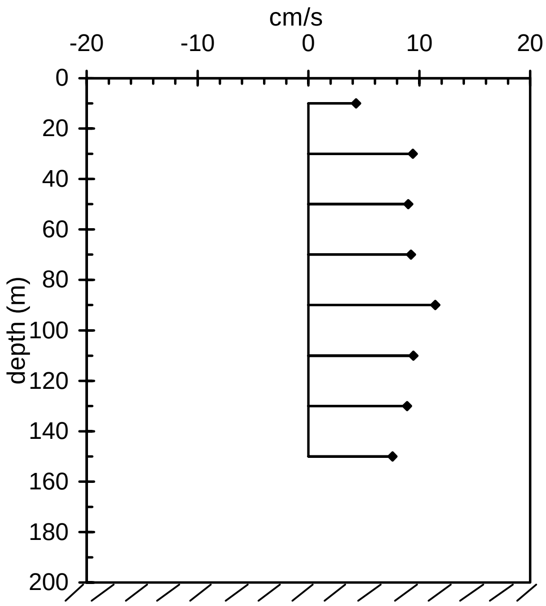


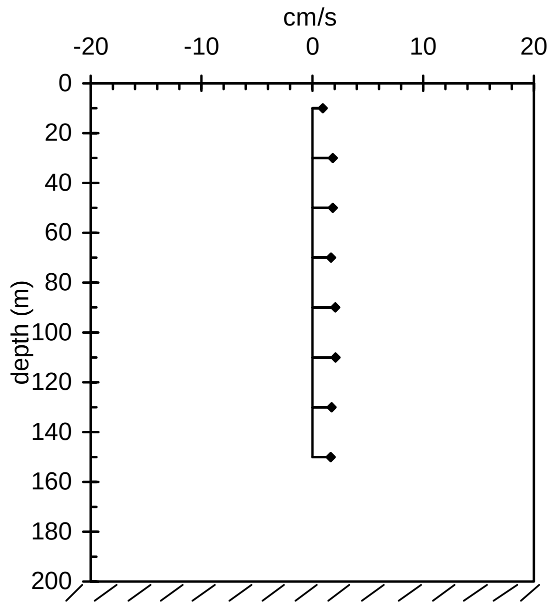
Figure 24: Mean Flows, Winter: Dec 2000 - Mar 2001.

South side of Barrow Strait:

Along-Strait

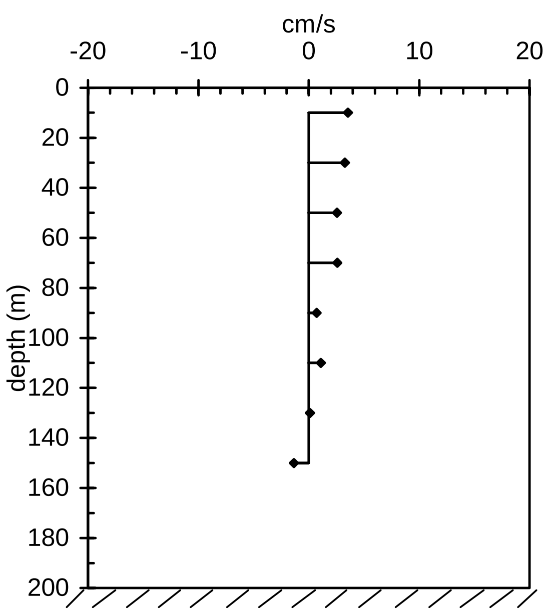


Cross-Strait



North Side of Barrow Strait:

Along-Strait



Cross-Strait

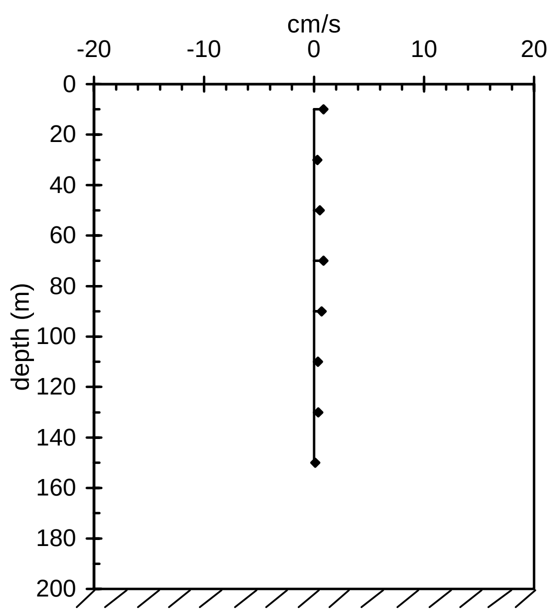
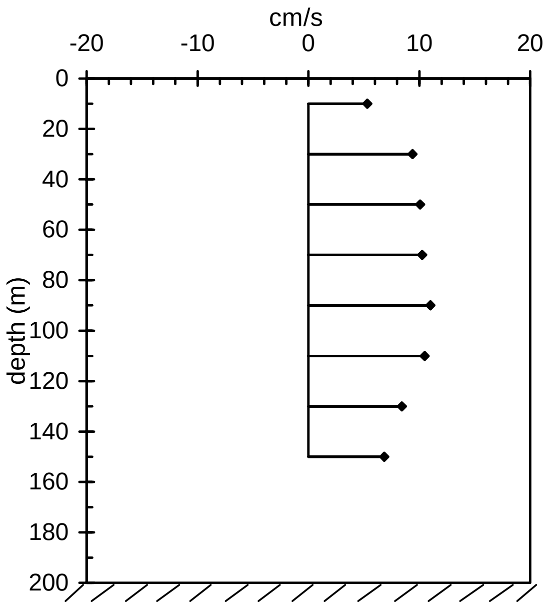


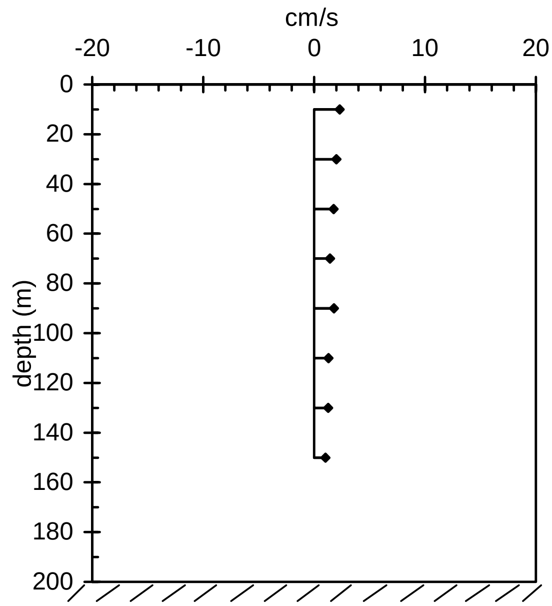
Figure 25: Mean Flows, Spring: Mar 2001 - Jun 2001.

South side of Barrow Strait:

Along-Strait

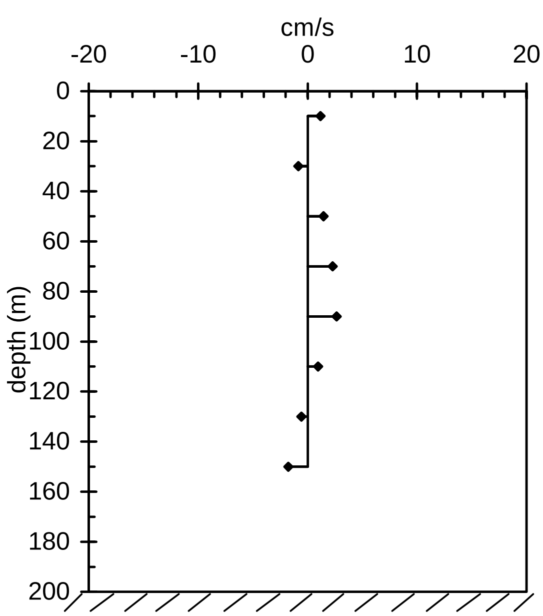


Cross-Strait



North Side of Barrow Strait:

Along-Strait



Cross-Strait

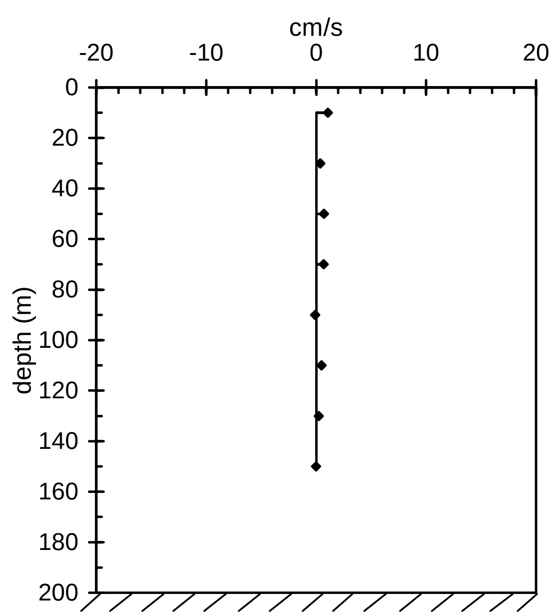
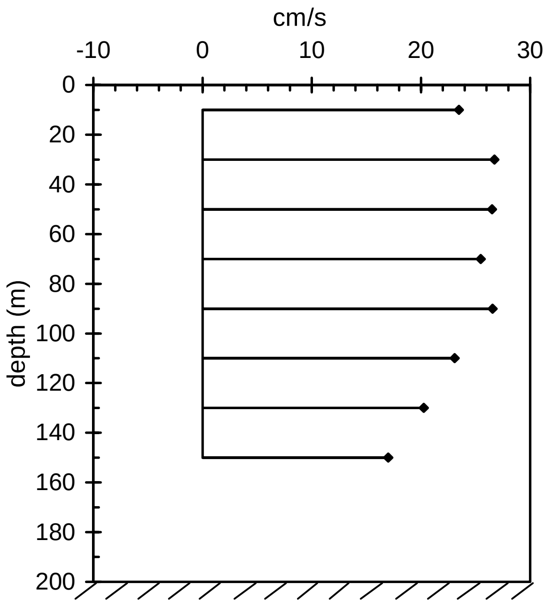


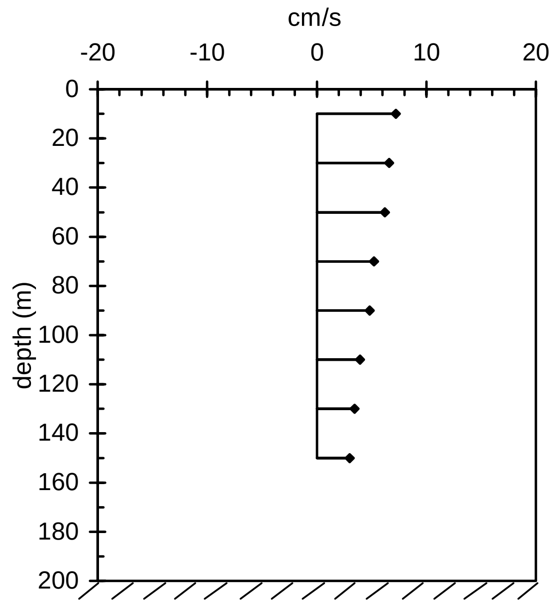
Figure 26: Mean Flows, Early Summer: Jun 2001 - Aug 2001.

South side of Barrow Strait:

Along-Strait

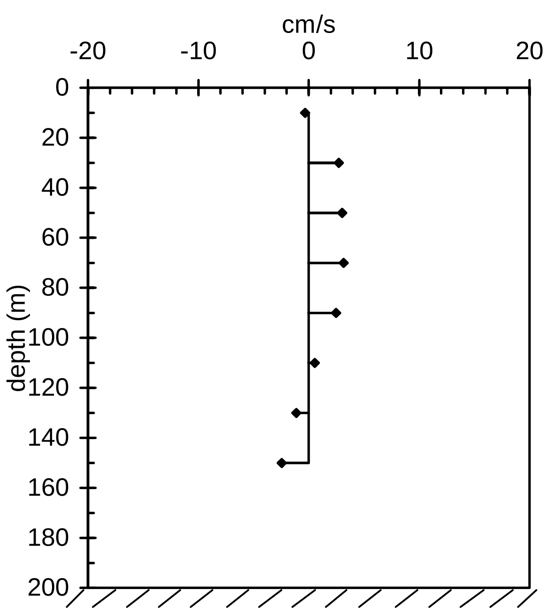


Cross-Strait

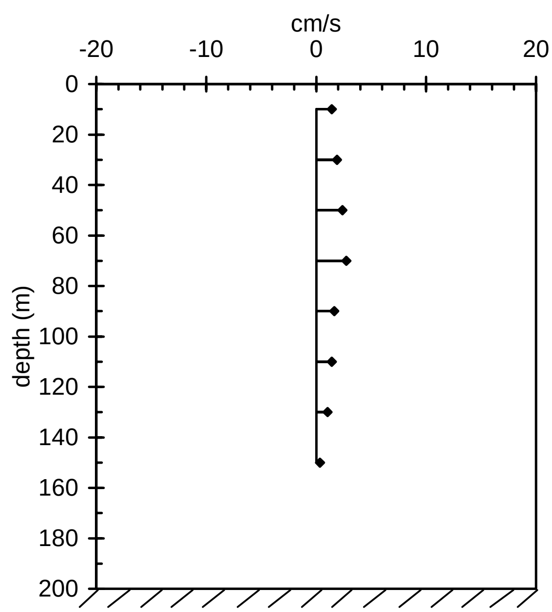


North Side of Barrow Strait:

Along-Strait



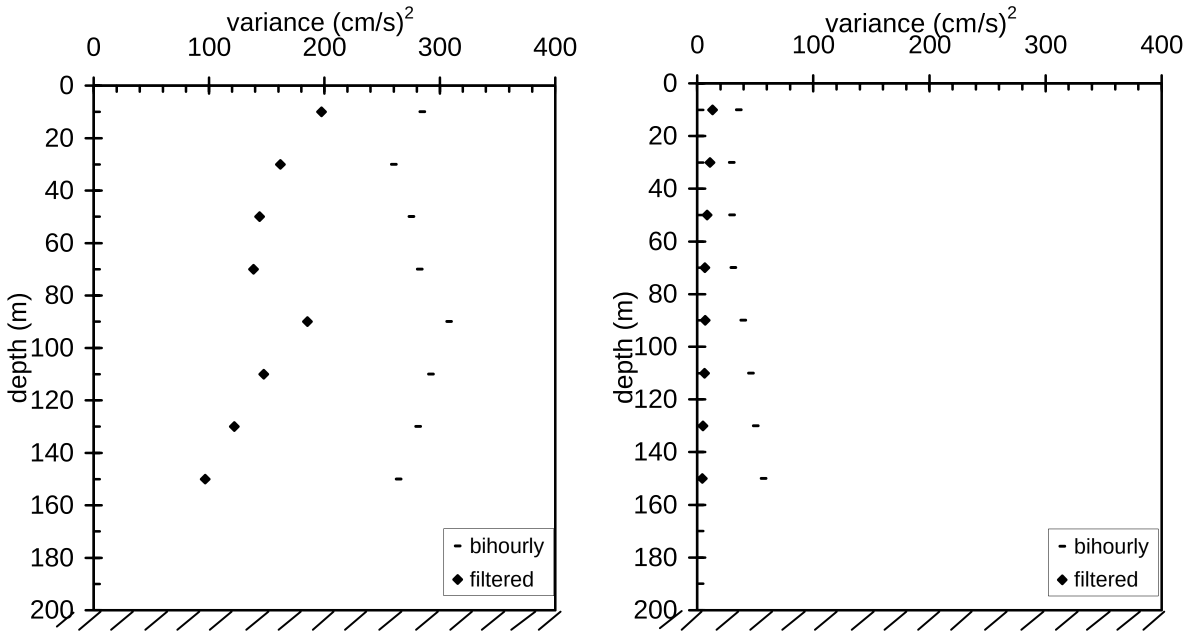
Cross-Strait



<u>Figure 27:</u> Variance in bihourly and low-pass filtered currents, computed over yearly records (Aug 2000 - Aug 2001).

South side of Barrow Strait:

Along-Strait Cross-Strait



North Side of Barrow Strait:

Along-Strait Cross-Strait

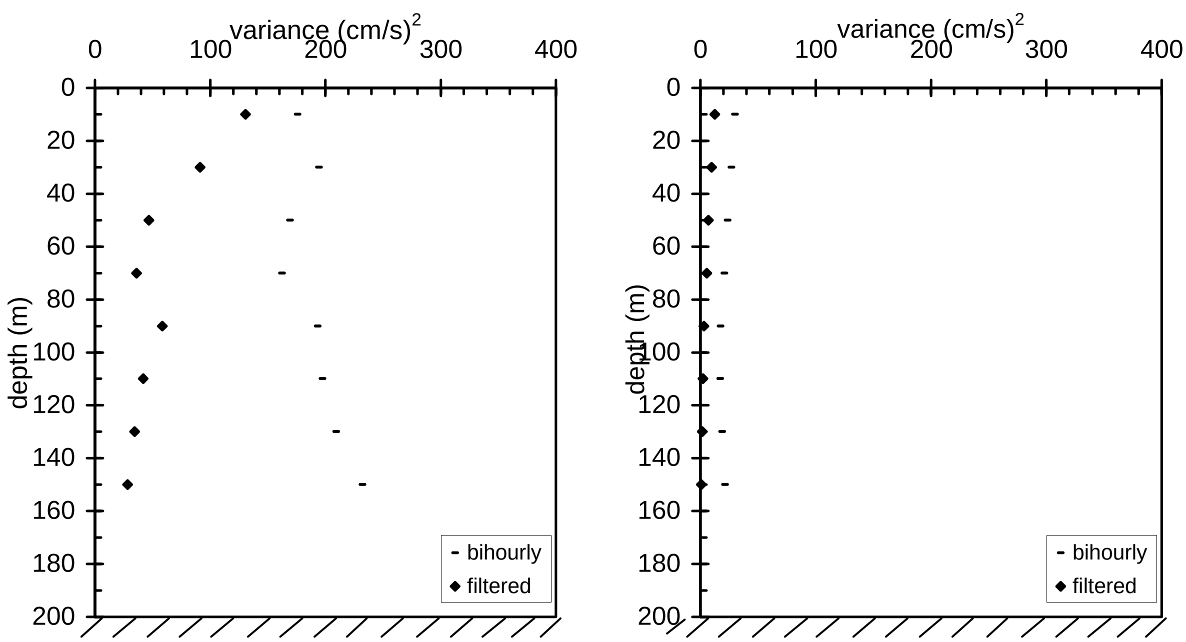
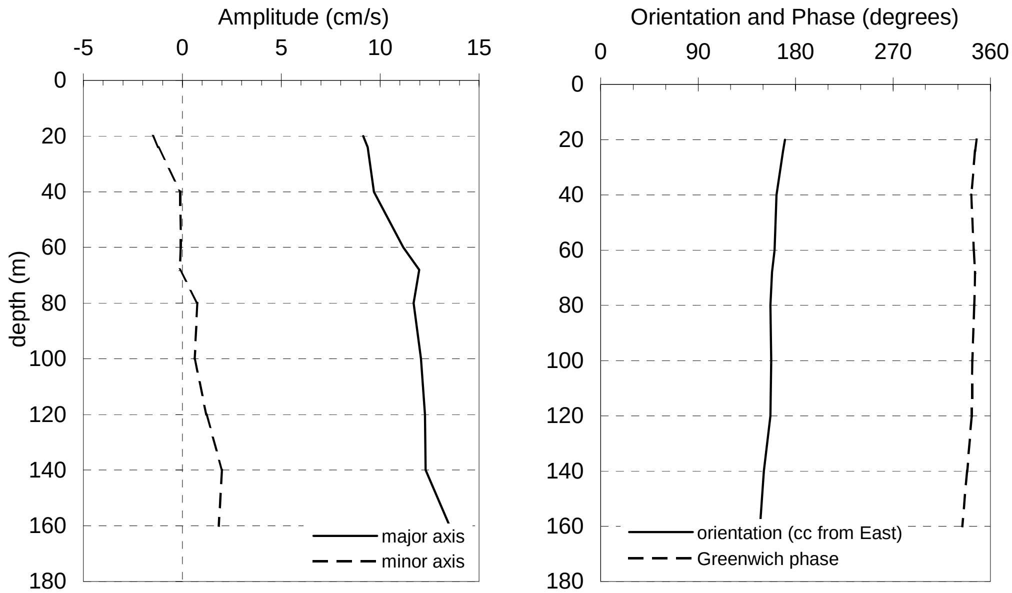
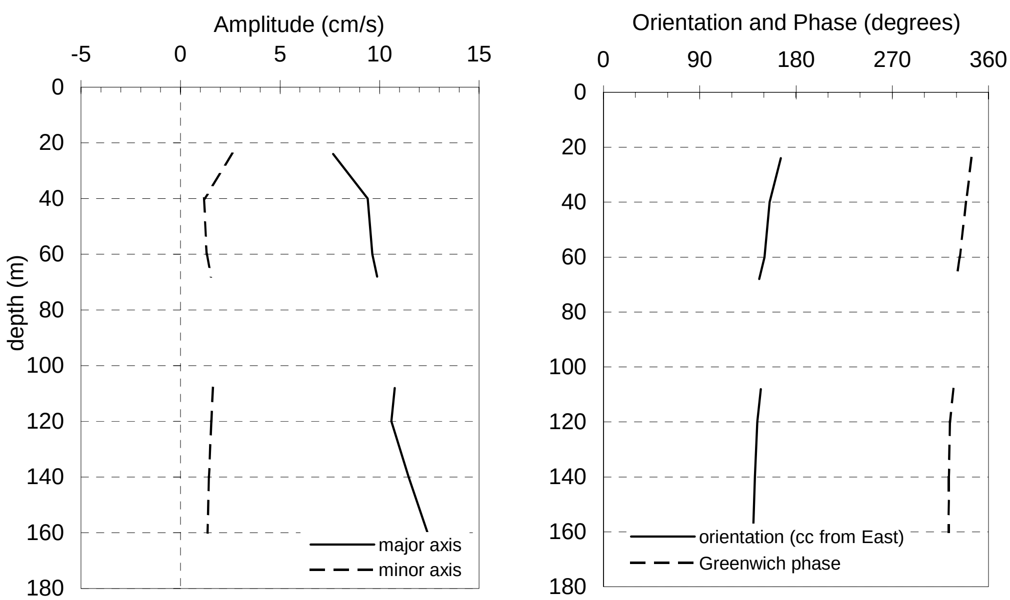


Figure 28 - K1 Tidal constituent, South side of Barrow Strait

For ice-free period (Aug 15, 2000 to Oct 19, 2000):

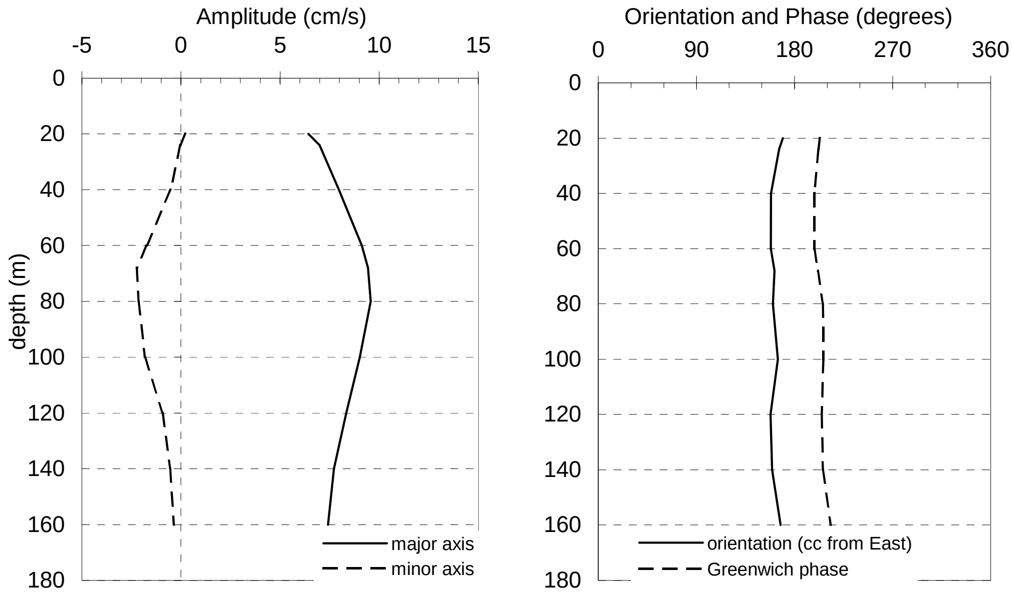


For solid-ice period (Feb 16, 2001 to Jul 10, 2001):



<u>Figure 29</u> - M2 Tidal constituent, South side of Barrow Strait

For ice-free period (Aug 15, 2000 to Oct 19, 2000):



For solid-ice period (Feb 16, 2001 to Jul 10, 2001):

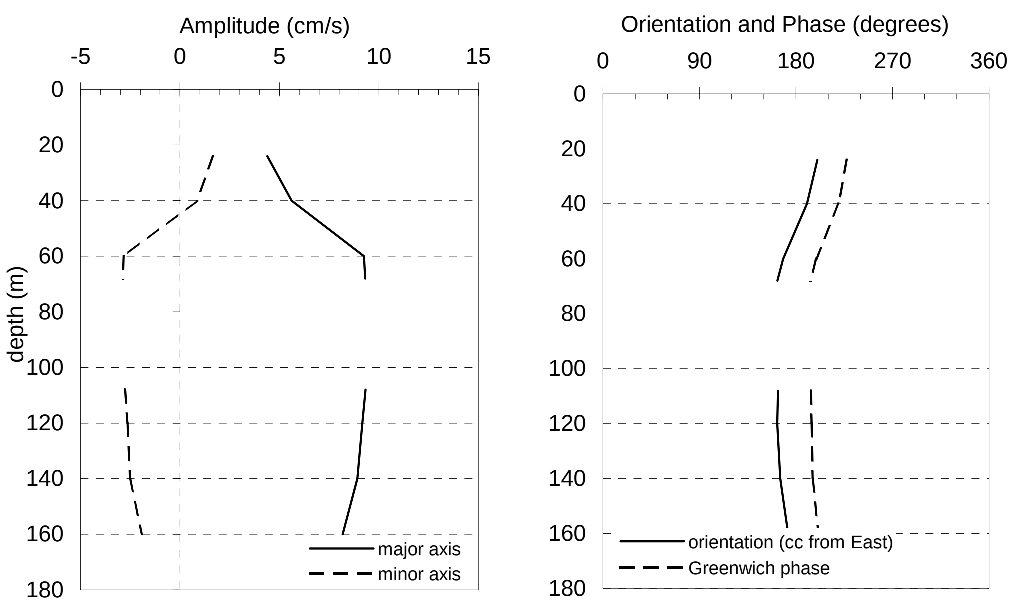
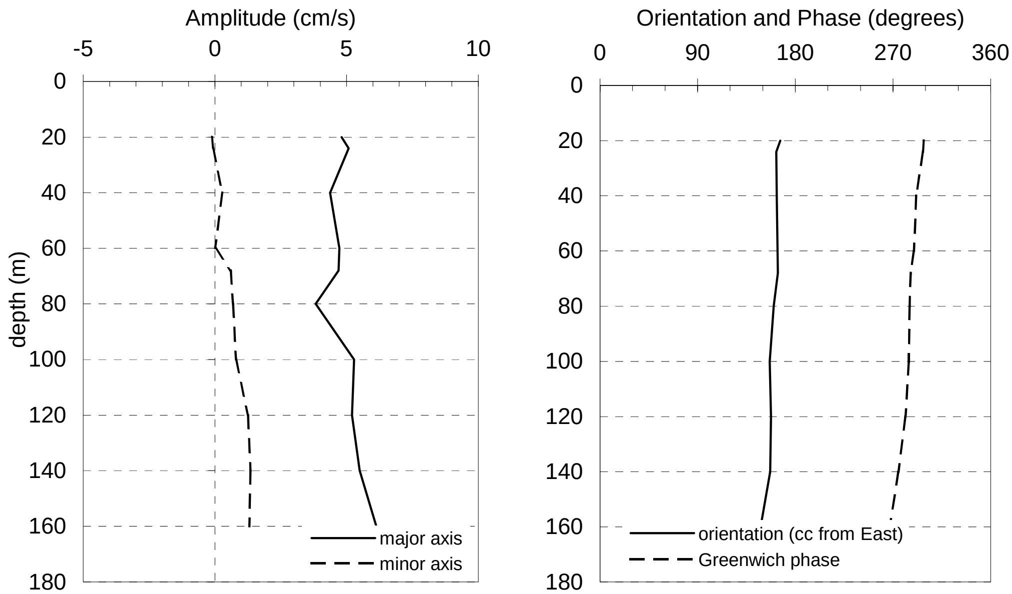


Figure 30 - O1 Tidal constituent, South side of Barrow Strait

For ice-free period (Aug 15, 2000 to Oct 19, 2000):



For solid-ice period (Feb 16, 2001 to Jul 10, 2001):

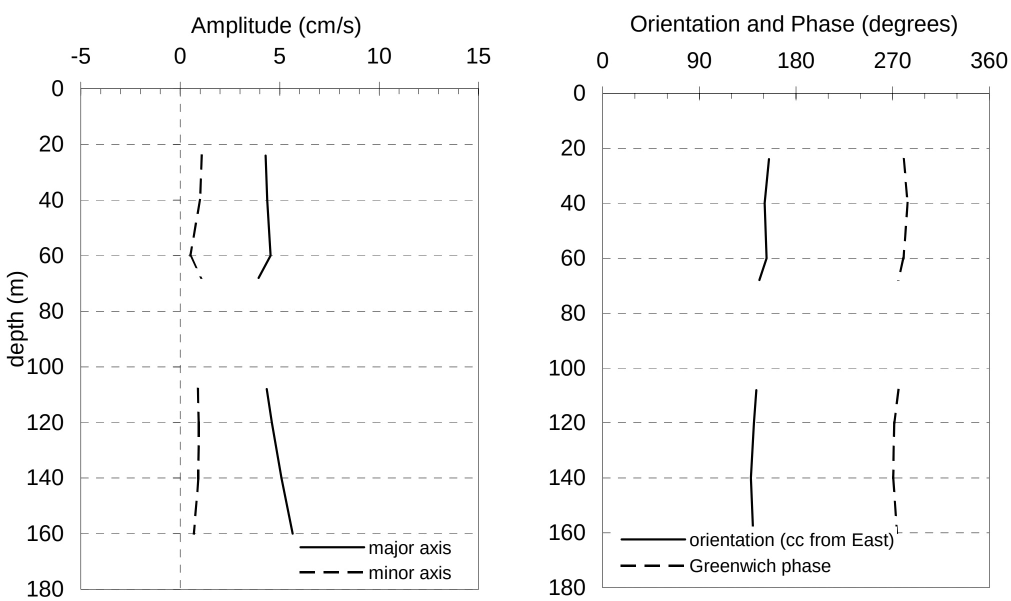
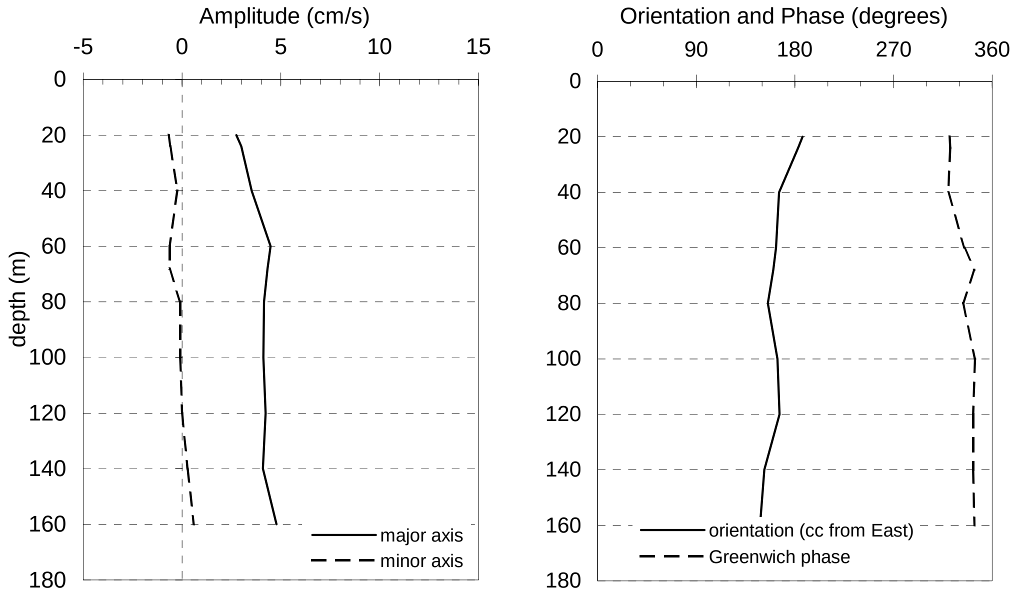


Figure 31 - P1 Tidal constituent, South side of Barrow Strait

For ice-free period (Aug 15, 2000 to Oct 19, 2000):



For solid-ice period (Feb 16, 2001 to Jul 10, 2001):

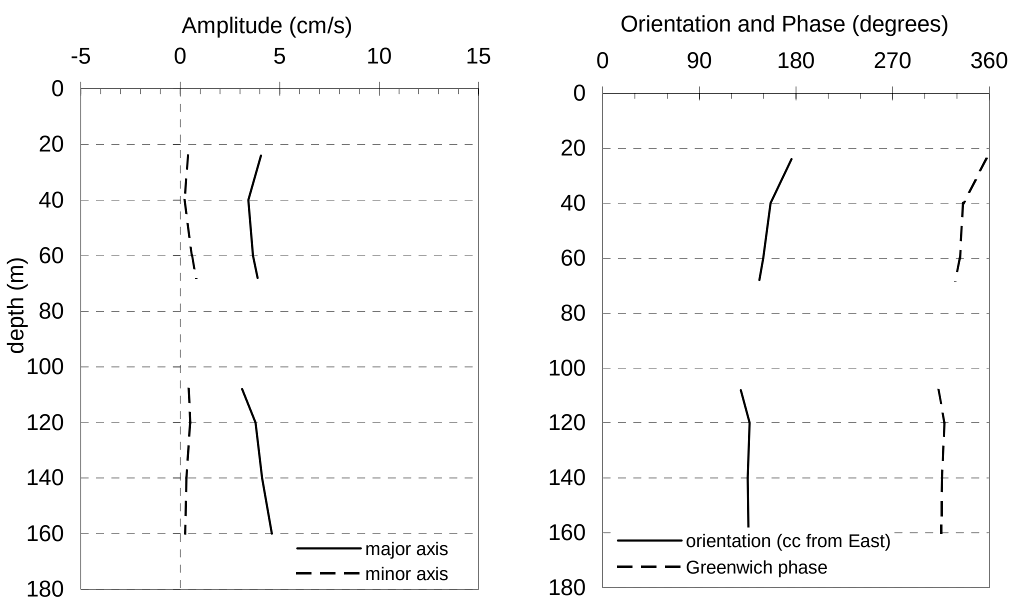
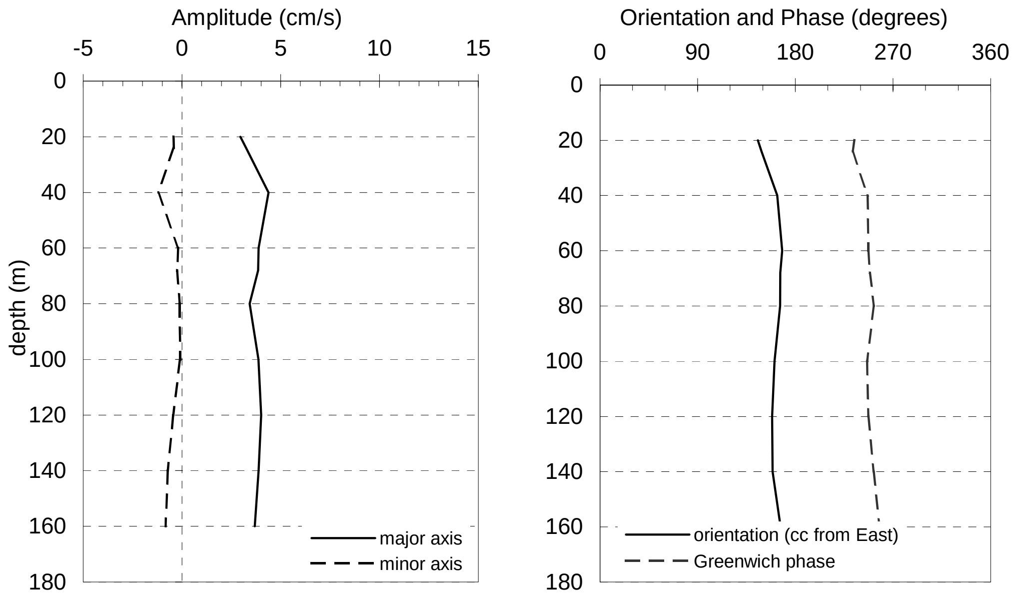


Figure 32 - S2 Tidal constituent, South side of Barrow Strait

For ice-free period (Aug 15, 2000 to Oct 19, 2000):



For solid-ice period (Feb 16, 2001 to Jul 10, 2001):

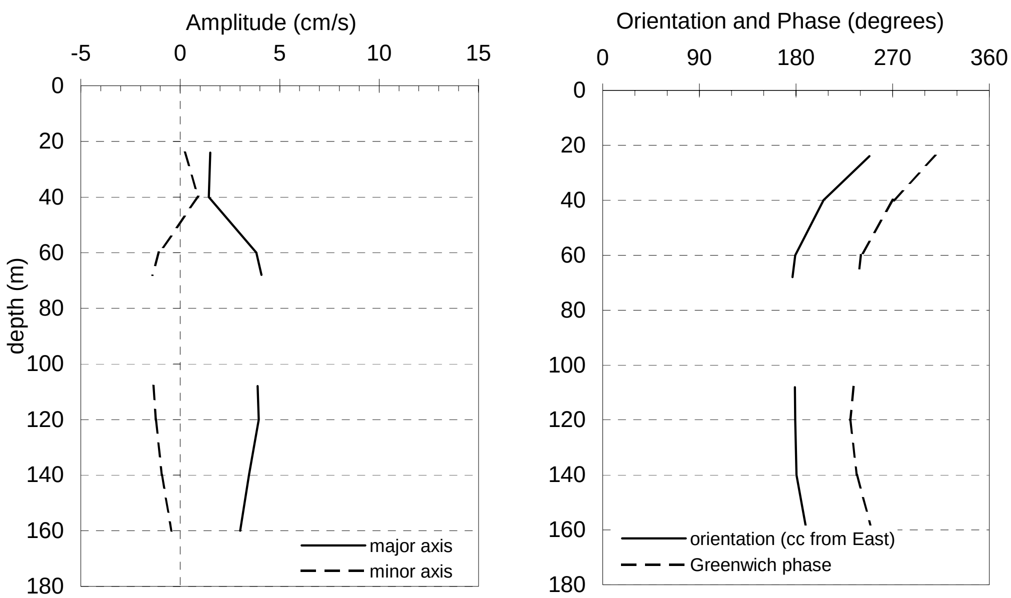
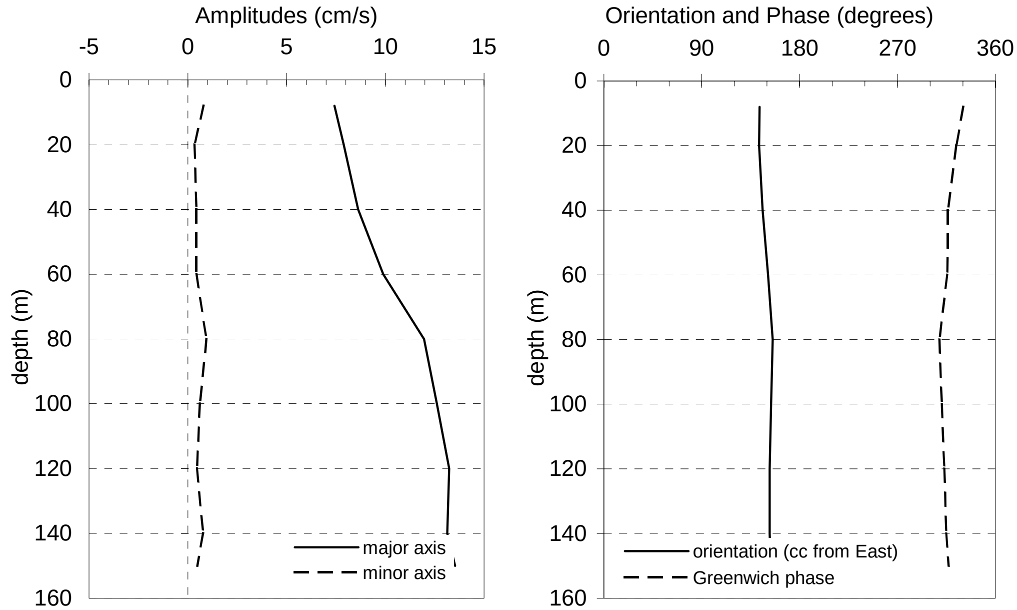


Figure 33 - K1 Tidal constituent, North side of Barrow Strait

For ice-free period (Aug 14, 2000 to Oct 23, 2000).



For solid-ice period (Feb 16, 2001 to Jul, 10 2001).

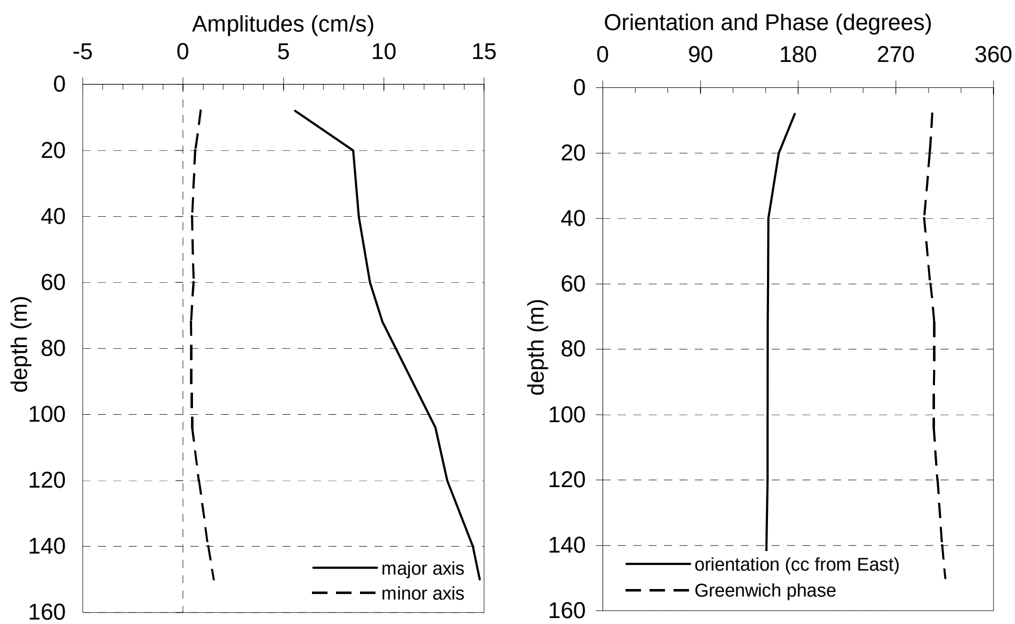
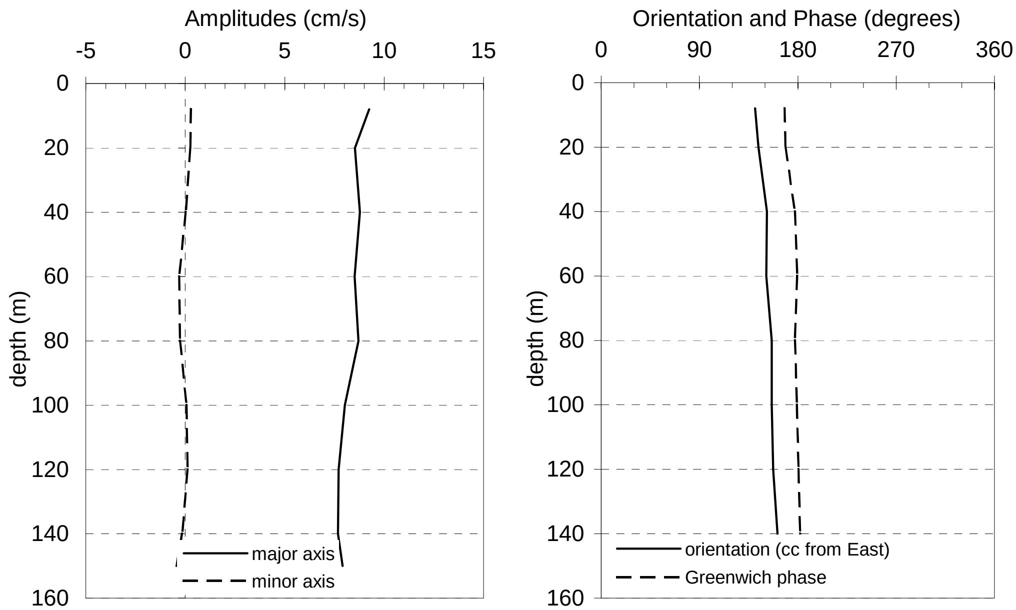


Figure 34 - M2 Tidal constituent, North side of Barrow Strait

For ice-free period (Aug 14, 2000 to Oct 23, 2000).



For solid-ice period (Feb 16, 2001 to Jul 10, 2001).

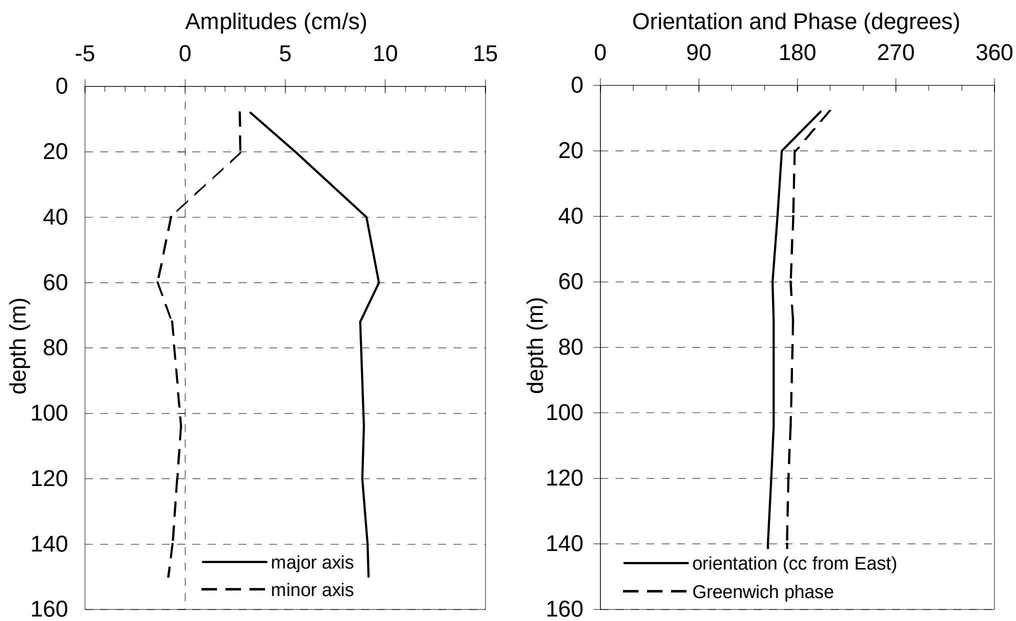
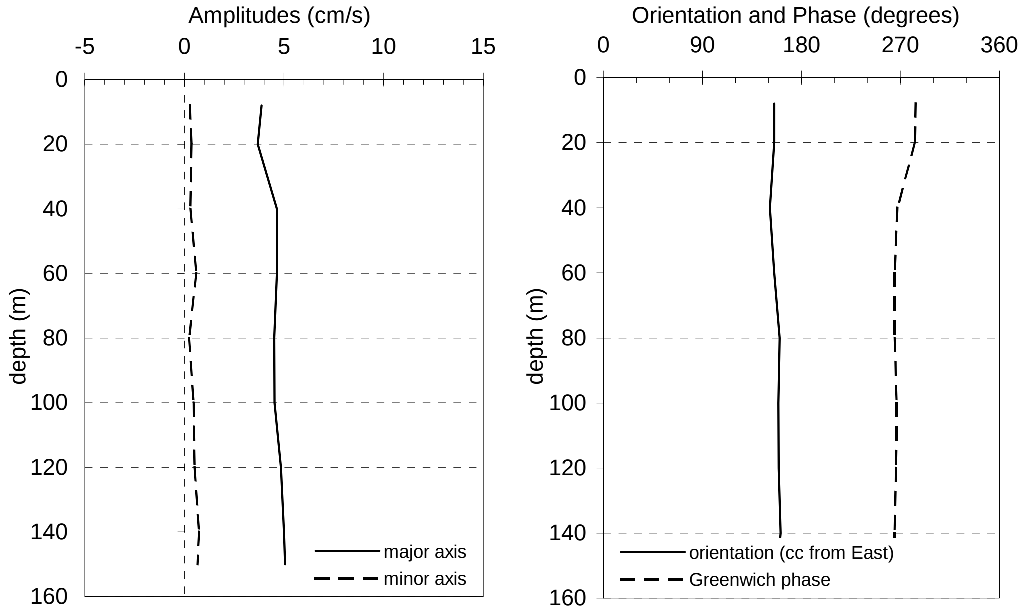
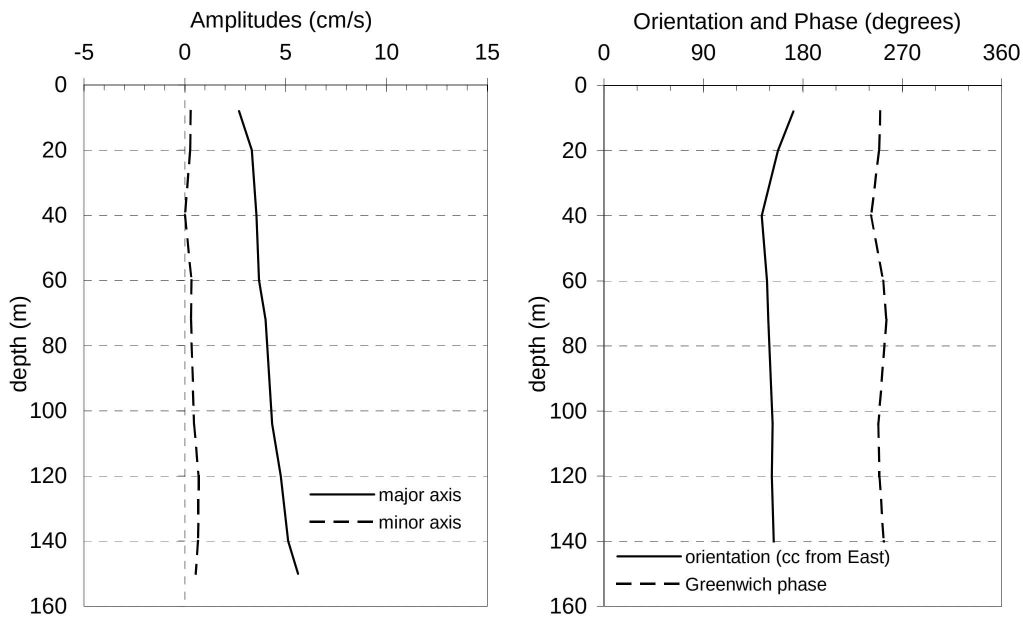


Figure 35 - O1 Tidal constituent, North side of Barrow Strait

For ice-free period (Aug 14, 2000 to Oct 23, 2000).

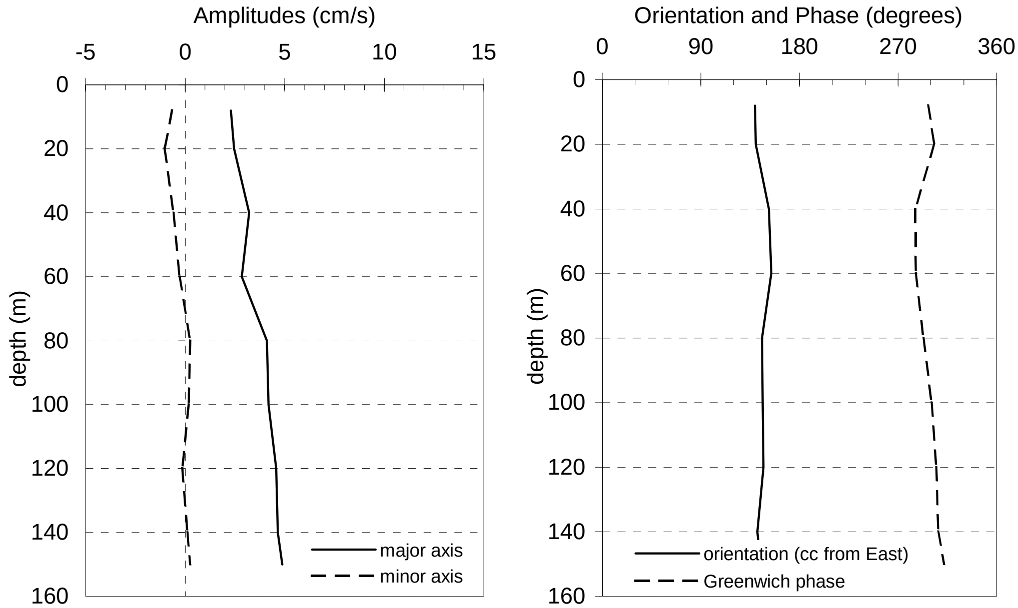


For solid-ice period (Feb 16, 2001 to Jul 10, 2001).



<u>Figure 36</u> - P1 Tidal constituent, North side of Barrow Strait

For ice-free period (Aug 14, 2000 to Oct 23, 2000).



For solid-ice period (Feb 16, 2001 to Jul 10, 2001).

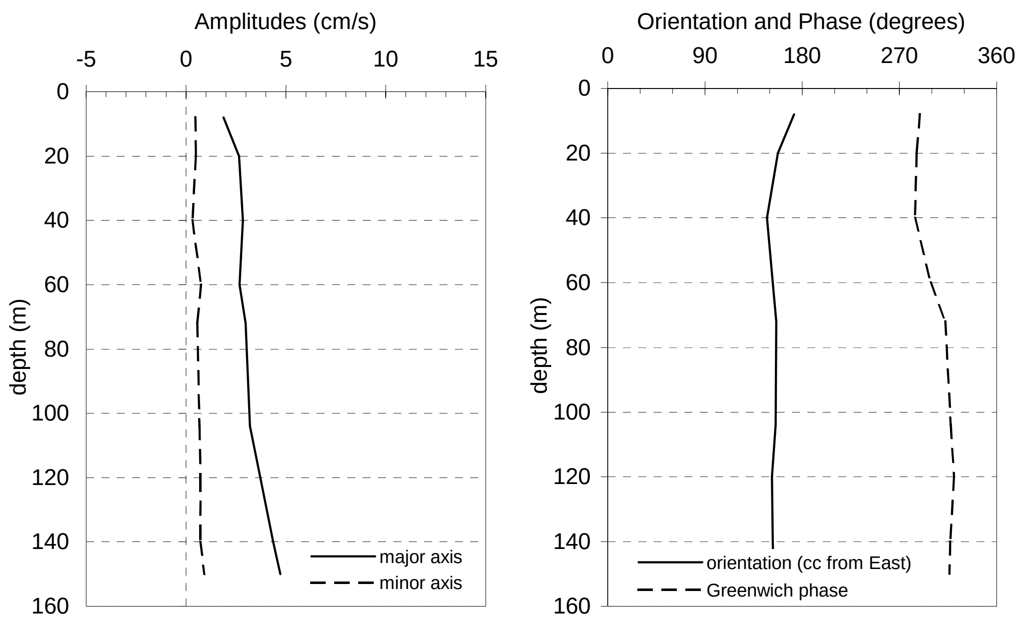
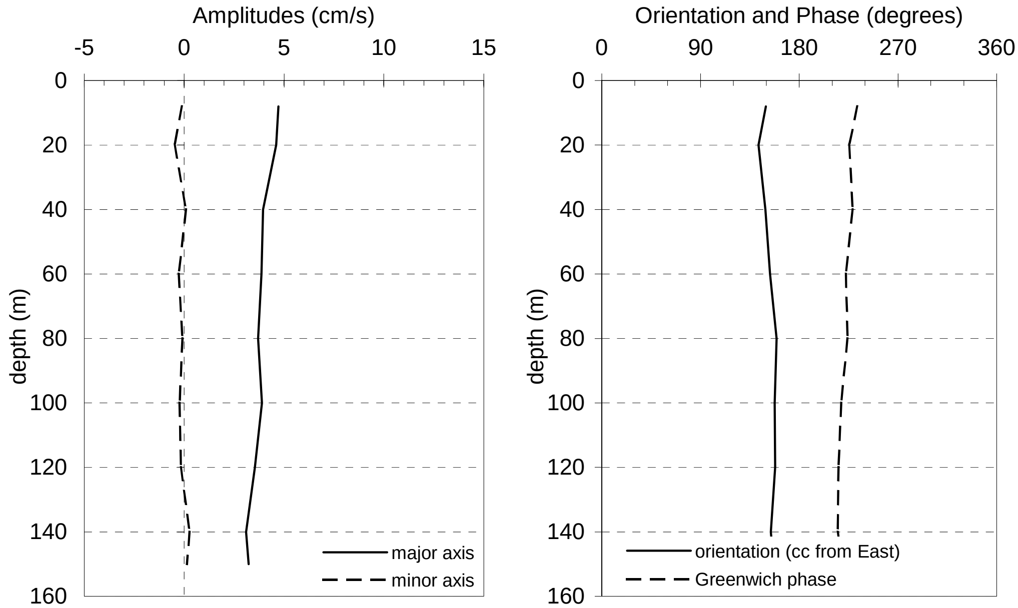
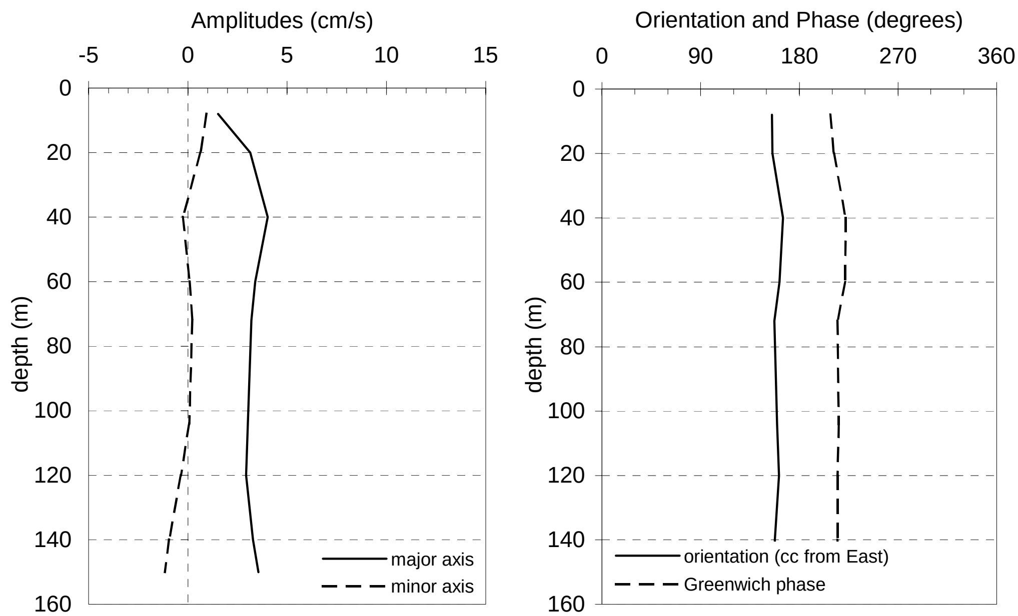


Figure 37 - S2 Tidal constituent, North side of Barrow Strait

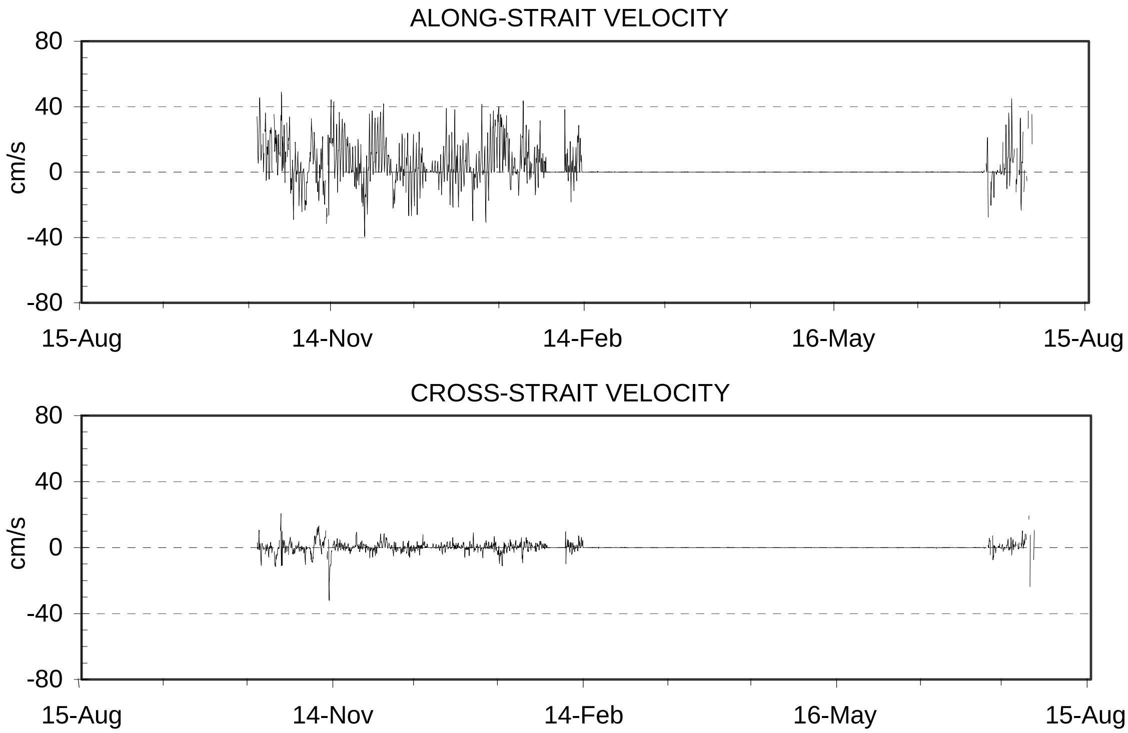
For ice-free period (Aug 14, 2000 to Oct 23, 2000).



For solid-ice period (Feb 16, 2001 to Jul 10, 2001).



<u>Figure 38</u> - Ice velocity data, South side of Barrow Strait: Aug 2000 - Aug 2001.



<u>Figure 39</u> - Ice velocity data, North side of Barrow Strait: Aug 2000 - Aug 2001.

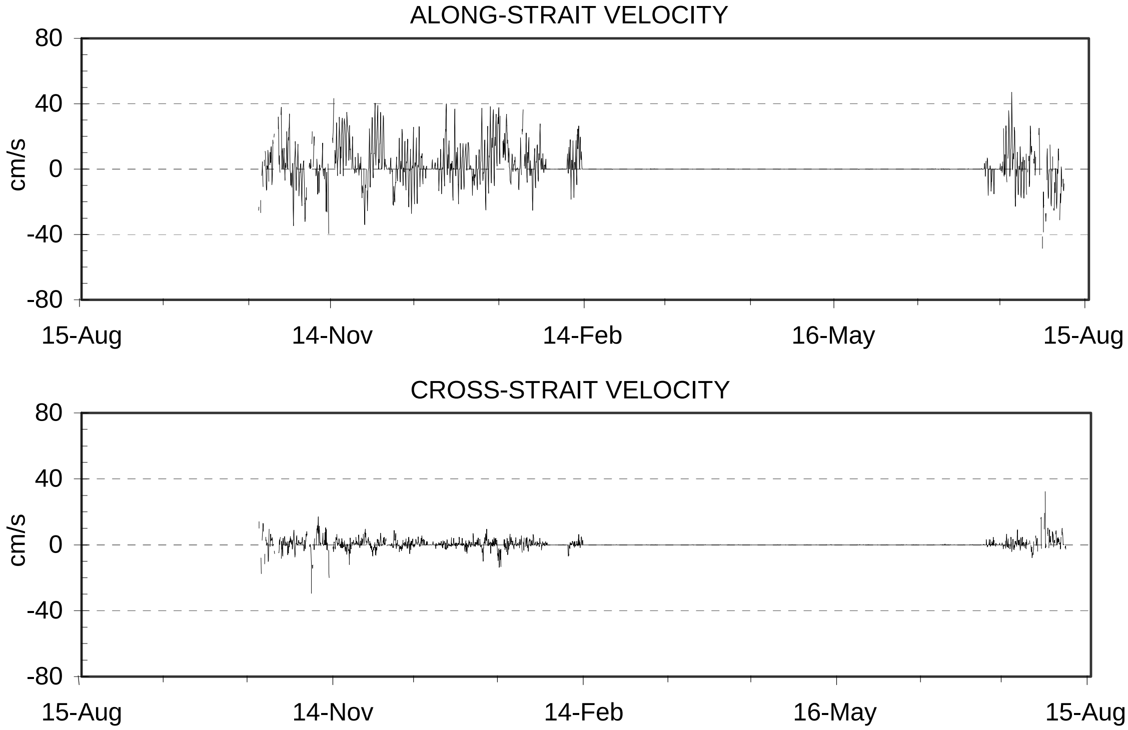


Table 1: North Side Barrow Strait, CTD/ADCP statistical summary
Late Summer : 14/08/2000-20/09/2000

	Temperature (degrees C)				Salinity (ppt)				Density (sigma-t)				Along-Strait Velocity (cm/s)				Cross-Strait Velocity (cm/s)			
Depth M	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max
31	-0.34	0.88	-1.57	1.45	31.76	0.68	29.32	32.80	25.50	0.56	23.55	26.39	-9.48	15.63	-49.98	38.37	1.91	8.24	-18.77	30.02
39	-0.74	0.72	-1.63	1.56	32.20	0.43	30.60	32.91	25.87	0.37	24.48	26.48	-6.54	15.27	-47.23	39.87	1.10	7.21	-17.37	24.01
81	-1.46	0.10	-1.66	-1.03	32.88	0.11	32.61	33.07	26.45	0.09	26.22	26.61	-4.27	15.54	-47.71	37.32	0.09	4.56	-13.92	11.84
150	-1.33	0.10	-1.52	-0.91	33.19	0.13	32.96	33.61	26.69	0.10	26.52	27.02	-4.14	13.79	-52.02	27.17	0.08	3.69	-10.49	18.35
153													-4.01	13.78	-51.59	27.28	0.10	3.95	-9.78	18.65
176	-1.17	0.14	-1.46	-0.57	33.37	0.15	33.04	34.26	26.84	0.12	26.57	27.56								

Table 2: South Side Barrow Strait, CTD/ADCP statistical summary
Late Summer : 13/08/2000-20/09/2000

	Temperature (degrees C)				Salinity (ppt)				Density (sigma-t)				Along-Strait Velocity (cm/s)				Cross-Strait Velocity (cm/s)			
Depth M	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max
25	-0.95	0.40	-1.51	0.69	31.73	0.26	30.51	32.50	25.50	0.22	24.53	26.14	35.00	15.13	-2.36	83.34	6.95	6.95	-13.27	28.22
43	-1.31	0.14	-1.52	-0.58	32.27	0.14	31.76	32.93	25.95	0.11	25.54	26.48	33.36	16.03	-1.16	82.80	6.79	6.55	-10.89	26.18
77	-1.25	0.18	-1.57	-0.56	32.73	0.08	32.46	32.94	26.32	0.06	26.10	26.49	29.63	16.05	-6.43	76.92	5.06	5.68	-11.73	25.79
119	-1.28	0.06	-1.50	-0.88	32.92	0.09	31.58	33.11	26.47	0.08	25.39	26.63	24.29	15.50	-12.94	74.32	3.57	6.58	-17.53	23.87
160													15.63	14.36	-27.57	51.44	2.81	6.89	-17.38	26.88
168	-1.25	0.04	-1.38	-1.09	33.05	0.10	32.81	33.31	26.58	0.08	26.39	26.79								

Table 3: North Side Barrow Strait, CTD/ADCP statistical summary
Fall: 21/09/2000-20/12/2000

	Temperature (degrees C)				Salinity (ppt)				Density (sigma-t)				Along-Strait Velocity (cm/s)				Cross-Strait Velocity (cm/s)			
Depth M	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max
31	-1.53	0.32	-1.78	-0.36	31.95	0.30	30.90	32.41	25.70	0.24	24.83	26.06	-7.03	16.69	-61.47	31.99	3.10	6.21	-18.60	26.10
39	-1.48	0.32	-1.78	-0.45	32.06	0.30	31.22	32.60	25.79	0.24	25.09	26.22	-6.31	15.30	-54.52	30.77	3.06	5.76	-17.37	27.74
81	-1.28	0.11	-1.76	-0.77	32.64	0.15	31.96	32.95	26.25	0.12	25.69	26.50	-2.41	13.80	-43.78	28.57	0.82	4.12	-17.33	12.66
150	-1.26	0.12	-1.46	-0.62	33.10	0.17	32.74	33.73	26.62	0.13	26.33	27.12	0.33	15.63	-45.73	52.19	0.29	4.02	-18.73	16.98
153													0.39	15.75	-44.48	50.82	0.25	4.07	-15.29	16.47
176	-1.08	0.22	-1.39	-0.33	33.35	0.21	32.91	33.87	26.82	0.16	26.47	27.21								

Table 4: South Side Barrow Strait, CTD/ADCP statistical summary
Fall: 21/09/2000-20/12/2000

	Temperature (degrees C)				Salinity (ppt)				Density (sigma-t)				Along-Strait Velocity (cm/s)				Cross-Strait Velocity (cm/s)			
Depth M	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max
25	-1.63	0.24	-1.76	-0.13	31.76	0.21	30.91	32.35	25.54	0.17	24.84	26.00	15.77	17.36	-33.77	69.48	2.69	5.45	-13.89	26.82
43	-1.49	0.18	-1.76	-0.86	32.17	0.15	31.67	32.63	25.88	0.12	25.47	26.24	17.18	17.82	-41.18	70.82	2.67	5.46	-14.87	26.60
77	-1.33	0.12	-1.68	-0.77	32.61	0.11	32.32	32.99	26.22	0.09	25.99	26.53	17.82	17.88	-45.32	61.23	2.65	5.98	-19.45	22.26
119	-1.27	0.03	-1.41	-1.04	32.87	0.12	31.78	33.11	26.44	0.10	25.55	26.63	16.01	18.48	-46.93	59.79	1.72	7.18	-20.19	27.16
160													11.20	17.19	-49.29	50.74	1.27	8.48	-33.92	21.90
168	-1.18	0.14	-1.30	-0.57	33.09	0.19	32.81	33.73	26.61	0.15	26.39	27.12								

Table 5: North Side Barrow Strait, CTD/ADCP statistical summary
Winter : 21/12/2000-20/03/2001

	Temperature (degrees C)				Salinity (ppt)				Density (sigma-t)				Along-Strait Velocity (cm/s)				Cross-Strait Velocity (cm/s)			
Depth M	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max
31	-1.77	0.02	-1.80	-1.66	32.62	0.18	32.19	32.85	26.25	0.15	25.89	26.43	3.17	10.71	-35.94	28.97	0.32	3.75	-10.98	26.28
39	-1.76	0.06	-1.80	-1.35	32.67	0.18	32.18	32.98	26.28	0.15	25.89	26.53	2.76	10.83	-32.78	29.77	0.38	3.74	-10.08	28.51
81	-1.57	0.20	-1.79	-1.22	32.85	0.12	32.50	33.14	26.43	0.09	26.14	26.65	0.60	12.48	-46.62	31.50	0.55	4.41	-19.02	21.90
150	-1.15	0.19	-1.73	-0.56	33.25	0.16	32.90	33.75	26.74	0.13	26.46	27.13	-1.35	14.90	-52.79	36.46	0.10	5.54	-13.68	17.86
153													-1.77	15.19	-52.51	33.68	-0.12	5.80	-13.98	20.68
176	-0.86	0.21	-1.55	-0.23	33.51	0.16	32.99	33.90	26.94	0.12	26.54	27.23								

Table 6: South Side Barrow Strait, CTD/ADCP statistical summary
Winter : 21/12/2000-20/03/2001

	Temperature (degrees C)				Salinity (ppt)				Density (sigma-t)				Along-Strait Velocity (cm/s)				Cross-Strait Velocity (cm/s)			
Depth M	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max
25	-1.76	0.01	-1.78	-1.69	32.32	0.12	32.04	32.59	26.00	0.10	25.77	26.22	8.37	12.56	-23.10	51.49	1.87	4.27	-12.32	14.95
43	-1.74	0.03	-1.78	-1.61	32.38	0.13	32.10	32.66	26.05	0.10	25.82	26.28	8.93	13.04	-32.92	52.18	1.96	4.26	-11.53	15.38
77	-1.61	0.11	-1.78	-1.34	32.60	0.13	32.24	32.85	26.23	0.10	25.94	26.43	11.51	16.09	-42.33	61.03	1.83	5.57	-14.08	20.96
119	-1.46	0.16	-1.76	-1.18	32.87	0.07	32.61	33.18	26.44	0.06	26.23	26.69	9.27	17.09	-48.46	56.08	1.78	7.33	-28.28	31.33
160													6.62	16.17	-43.69	40.50	1.73	8.93	-31.80	27.62
168	-1.23	0.27	-1.68	-0.39	33.11	0.24	32.72	33.79	26.63	0.19	26.32	27.15								

Table 7: North Side Barrow Strait, CTD/ADCP statistical summary
Spring : 21/03/2001-20/06/2001

	Temperature (degrees C)				Salinity (ppt)				Density (sigma-t)				Along-Strait Velocity (cm/s)				Cross-Strait Velocity (cm/s)			
Depth M	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max
31	-1.77	0.01	-1.79	-1.73	32.32	0.09	32.12	32.64	26.00	0.07	25.84	26.26	2.19	9.64	-25.42	24.20	0.36	3.07	-7.85	9.11
39	-1.77	0.01	-1.79	-1.70	32.40	0.10	32.21	32.68	26.07	0.08	25.91	26.30	1.99	10.52	-29.53	26.37	0.50	3.81	-13.10	12.28
81	-1.71	0.06	-1.79	-1.47	32.86	0.06	32.61	33.06	26.44	0.05	26.24	26.59	0.38	9.40	-21.45	20.74	0.18	3.34	-8.39	8.02
150	-1.13	0.20	-1.69	-0.62	33.38	0.14	32.91	33.70	26.84	0.11	26.48	27.09	-1.78	14.58	-41.79	32.56	-0.01	4.31	-14.10	15.19
153													-1.80	14.62	-38.09	33.31	-0.12	4.30	-15.21	15.41
176	-0.89	0.24	-1.33	-0.29	33.58	0.09	33.27	33.84	27.00	0.07	26.75	27.20								

Table 8: South Side Barrow Strait, CTD/ADCP statistical summary
Spring : 21/03/2001-20/06/2001

	Temperature (degrees C)				Salinity (ppt)				Density (sigma-t)				Along-Strait Velocity (cm/s)				Cross-Strait Velocity (cm/s)			
Depth M	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max
25	-1.73	0.01	-1.76	-1.66	32.15	0.05	32.02	32.30	25.87	0.04	25.76	25.99	8.97	9.60	-19.93	31.44	1.66	4.34	-21.34	15.60
43	-1.66	0.05	-1.75	-1.48	32.31	0.07	32.09	32.53	25.99	0.06	25.82	26.17	9.98	10.61	-18.58	37.02	1.45	4.31	-22.05	15.36
77	-1.59	0.09	-1.76	-1.33	32.68	0.07	32.45	32.87	26.29	0.06	26.10	26.45	10.41	12.30	-20.82	38.25	1.86	6.26	-20.55	15.26
119	-1.49	0.12	-1.79	-1.32	32.89	0.04	32.75	33.02	26.46	0.04	26.34	26.56	9.05	13.30	-28.09	42.85	1.27	6.43	-20.33	22.48
160													5.74	13.07	-30.54	38.54	0.95	7.56	-24.99	22.88
168	-1.32	0.21	-1.73	-0.48	33.06	0.18	32.84	33.84	26.59	0.14	26.42	27.20								

Table 9: North Side Barrow Strait, CTD/ADCP statistical summary
Early Summer : 21/06/2001-27/08/2001

	Temperature (degrees C)				Salinity (ppt)				Density (sigma-t)				Along-Strait Velocity (cm/s)				Cross-Strait Velocity (cm/s)			
Depth m	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max
31	-1.62	0.11	-1.77	-1.18	32.19	0.16	31.70	32.61	25.89	0.13	25.49	26.23	2.73	11.82	-35.37	32.16	1.89	4.42	-12.77	15.76
39	-1.65	0.09	-1.77	-1.37	32.37	0.13	32.07	32.78	26.04	0.11	25.80	26.37	2.67	11.89	-32.23	31.38	1.99	4.27	-12.21	17.53
81	-1.66	0.06	-1.77	-1.38	32.83	0.08	32.55	33.01	26.41	0.07	26.19	26.56	2.72	13.90	-41.10	28.70	2.10	4.33	-11.80	48.80
150	-1.23	0.14	-1.49	-0.69	33.31	0.14	33.03	33.73	26.79	0.11	26.57	27.12	-2.45	16.36	-51.28	31.10	0.35	4.98	-14.19	18.80
153													-2.61	16.43	-50.28	31.01	0.07	4.96	-13.17	20.97
176	-0.97	0.18	-1.36	-0.28	33.54	0.12	33.13	33.82	26.97	0.09	26.65	27.17								

Table 10: South Side Barrow Strait, CTD/ADCP statistical summary
Early Summer : 21/06/2001-27/08/2001

	Temperature (degrees C)				Salinity (ppt)				Density (sigma-t)				Along-Strait Velocity (cm/s)				Cross-Strait Velocity (cm/s)			
Depth m	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max
25	-1.50	0.17	-1.72	-0.85	31.96	0.22	30.82	32.34	25.70	0.18	24.78	26.01	26.54	19.35	-13.88	89.50	6.49	6.82	-10.71	33.01
43	-1.58	0.09	-1.72	-1.01	32.26	0.11	31.61	32.53	25.95	0.09	25.41	26.17	26.63	18.77	-19.10	84.73	6.26	6.76	-10.58	30.54
77	-1.56	0.11	-1.74	-1.14	32.65	0.09	32.36	32.83	26.26	0.07	26.03	26.41	26.52	18.22	-22.80	99.51	5.12	6.62	-17.04	27.24
119	-1.49	0.08	-1.73	-1.30	32.82	0.07	32.54	33.02	26.40	0.06	26.17	26.56	21.43	17.16	-21.79	92.28	3.57	7.27	-20.53	30.52
160													14.36	16.54	-32.22	61.72	3.09	7.93	-24.65	34.49
168	-1.44	0.06	-1.64	-1.04	32.93	0.08	32.68	33.22	26.49	0.06	26.29	26.72								

Table 11: North Side Barrow Strait, CTD/ADCP statistical summary
Year : 15/08/2000-14/08/2001

	Temperature (degrees C)				Salinity (ppt)				Density (sigma-t)				Along-Strait Velocity (cm/s)				Cross-Strait Velocity (cm/s)			
Depth M	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max
31	-1.54	0.53	-1.80	1.45	32.22	0.41	29.32	32.85	25.91	0.34	23.55	26.43	-0.89	13.88	-61.47	38.37	1.37	5.14	-18.77	30.02
39	-1.58	0.42	-1.80	1.56	32.35	0.32	30.60	32.98	26.02	0.26	24.48	26.53	-0.56	13.32	-54.52	39.87	1.33	4.94	-17.37	28.51
81	-1.54	0.21	-1.79	-0.77	32.80	0.14	31.96	33.14	26.38	0.12	25.69	26.65	-1.14	13.99	-47.71	37.32	0.75	4.33	-19.02	48.80
150	-1.20	0.18	-1.73	-0.56	33.25	0.18	32.74	33.75	26.74	0.14	26.33	27.13	-1.44	15.23	-52.79	52.19	0.14	4.62	-18.73	18.35
153													-1.55	15.34	-52.51	50.82	0.01	4.72	-15.29	20.68
176	-0.97	0.24	-1.55	-0.23	33.48	0.18	32.91	33.90	26.92	0.14	26.47	27.23								

Table 12: South Side Barrow Strait, CTD/ADCP statistical summary
Year : 15/08/2000-14/08/2001

	Temperature (degrees C)				Salinity (ppt)				Density (sigma-t)				Along-Strait Velocity (cm/s)				Cross-Strait Velocity (cm/s)			
Depth M	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max
25	-1.60	0.30	-1.78	0.69	32.03	0.28	30.51	32.59	25.76	0.23	24.53	26.22	15.07	16.23	-33.77	83.34	3.05	5.50	-21.34	32.18
43	-1.59	0.17	-1.78	-0.58	32.28	0.14	31.67	32.93	25.97	0.11	25.47	26.48	15.62	16.36	-41.18	82.80	2.96	5.44	-22.05	30.47
77	-1.49	0.18	-1.78	-0.56	32.64	0.11	32.24	32.99	26.26	0.09	25.94	26.53	18.26	17.50	-45.32	75.38	2.99	5.98	-20.55	25.79
119	-1.41	0.15	-1.79	-0.88	32.87	0.09	31.58	33.18	26.44	0.07	25.39	26.69	13.74	16.96	-48.46	74.32	1.97	7.00	-28.28	31.33
160													9.26	15.88	-49.29	51.44	1.63	8.17	-33.92	27.62
168	-1.27	0.21	-1.73	-0.39	33.06	0.19	32.72	33.84	26.59	0.15	26.32	27.20								

<u>Table 13</u> - Tidal Constants for K1 constituent

<u>North Side</u>

For ice-free period (Aug 14, 2000 to Oct 23, 2000).

Depth m	Major Amplitude cm/s	Minor Amplitude cm/s	Orientation degrees cc from East	Greenwich Phase degrees
8	7.4	0.8	143	331
60	9.9	0.4	151	316
100	12.6	0.6	154	311
150	13.5	0.5	153	317

For solid-ice period (Feb 16, 2001 to Jul, 10 2001).

Depth m	Major Amplitude cm/s	Minor Amplitude cm/s	Orientation degrees cc from East	Greenwich Phase degrees
8	5.6	0.9	177	304
60	9.3	0.5	152	302
104	12.6	0.4	152	305
150	14.8	1.5	151	316

<u>South Side</u>

For ice-free period (Aug 15, 2000 to Oct 19, 2000):

Depth m	Major Amplitude cm/s	Minor Amplitude cm/s	Orientation degrees cc from East	Greenwich Phase degrees
20	9.1	-1.5	170	347
80	11.7	0.8	157	345
120	12.3	1.2	157	343
160	13.5	1.8	147	334

For solid-ice period (Feb 16, 2001 to Jul 10, 2001):

Depth m	Major Amplitude cm/s	Minor Amplitude cm/s	Orientation degrees cc from East	Greenwich Phase degrees
24	7.7	2.6	166	344
68	9.9	1.5	146	330
120	10.6	1.6	144	324
160	12.4	1.4	140	323

Table 14 - Tidal Constants for M2 constituent

North Side

For ice-free period (Aug 14, 2000 to Oct 23, 2000).

Depth m	Major Amplitude cm/s	Minor Amplitude cm/s	Orientation degrees cc from East	Greenwich Phase degrees
8	9.2	0.3	141	168
60	8.5	-0.3	151	179
100	8.0	0.1	156	179
150	7.9	-0.4	162	183

For solid-ice period (Feb 16, 2001 to Jul, 10 2001).

Depth m	Major Amplitude cm/s	Minor Amplitude cm/s	Orientation degrees cc from East	Greenwich Phase degrees
8	3.3	2.7	201	210
60	9.7	-1.4	157	174
104	8.9	-0.2	158	174
150	9.2	-0.8	153	171

South Side

For ice-free period (Aug 15, 2000 to Oct 19, 2000):

Depth m	Major Amplitude cm/s	Minor Amplitude cm/s	Orientation degrees cc from East	Greenwich Phase degrees
20	6.4	0.2	169	203
80	9.6	-2.1	160	206
120	8.3	-0.9	158	205
160	7.4	-0.4	167	213

For solid-ice period (Feb 16, 2001 to Jul, 10 2001).

Depth m	Major Amplitude cm/s	Minor Amplitude cm/s	Orientation degrees cc from East	Greenwich Phase degrees
24	4.4	1.7	200	227
68	9.3	-2.9	163	193
120	9.2	-2.6	163	194
160	8.2	-1.9	173	201

Table 15 - Tidal Constants for O1 constituent

North Side

For ice-free period (Aug 14, 2000 to Oct 23, 2000).

Depth m	Major Amplitude cm/s	Minor Amplitude cm/s	Orientation degrees cc from East	Greenwich Phase degrees
8	3.9	0.3	155	284
60	4.7	0.6	155	265
100	4.5	0.5	159	267
150	5.1	0.7	158	265

For solid-ice period (Feb 16, 2001 to Jul, 10 2001).

Depth m	Major Amplitude cm/s	Minor Amplitude cm/s	Orientation degrees cc from East	Greenwich Phase degrees
8	2.7	0.3	171	250
60	3.7	0.3	148	253
104	4.3	0.4	153	248
150	5.6	0.5	153	255

South Side

For ice-free period (Aug 15, 2000 to Oct 19, 2000):

Depth m	Major Amplitude cm/s	Minor Amplitude cm/s	Orientation degrees cc from East	Greenwich Phase degrees
20	4.8	-0.1	166	298
80	3.8	0.7	160	285
120	5.2	1.3	158	281
160	6.1	1.3	148	267

For solid-ice period (Feb 16, 2001 to Jul 10, 2001):

Depth m	Major Amplitude cm/s	Minor Amplitude cm/s	Orientation degrees cc from East	Greenwich Phase degrees
24	4.3	1.1	155	280
68	3.9	1.1	146	275
120	4.6	0.9	141	272
160	5.7	0.7	140	274

Table 16 - Tidal Constants for P1 constituent

North Side

For ice-free period (Aug 14, 2000 to Oct 23, 2000).

Depth m	Major Amplitude cm/s	Minor Amplitude cm/s	Orientation degrees cc from East	Greenwich Phase degrees
8	2.3	-0.7	139	297
60	2.8	-0.3	154	286
100	4.2	0.2	146	301
150	4.9	0.3	144	312

For solid-ice period (Feb 16, 2001 to Jul, 10 2001).

Depth m	Major Amplitude cm/s	Minor Amplitude cm/s	Orientation degrees cc from East	Greenwich Phase degrees
8	1.9	0.5	173	289
60	2.7	0.8	153	299
104	3.2	0.7	155	318
150	4.7	0.9	153	316

South Side

For ice-free period (Aug 15, 2000 to Oct 19, 2000):

Depth m	Major Amplitude cm/s	Minor Amplitude cm/s	Orientation degrees cc from East	Greenwich Phase degrees
20	2.8	-0.7	187	321
80	4.1	-0.1	155	333
120	4.2	0.0	166	343
160	4.8	0.6	148	344

For solid-ice period (Feb 16, 2001 to Jul 10, 2001):

Depth m	Major Amplitude cm/s	Minor Amplitude cm/s	Orientation degrees cc from East	Greenwich Phase degrees
24	4.1	0.4	176	358
68	3.9	0.8	146	328
120	3.8	0.5	137	318
160	4.6	0.2	136	315

Table 17 - Tidal Constants for S2 constituent

North Side

For ice-free period (Aug 14, 2000 to Oct 23, 2000).

Depth m	Major Amplitude cm/s	Minor Amplitude cm/s	Orientation degrees cc from East	Greenwich Phase degrees
8	4.7	-0.1	150	233
60	3.9	-0.3	153	223
100	3.9	-0.2	158	218
150	3.2	0.1	157	219

For solid-ice period (Feb 16, 2001 to Jul, 10 2001).

Depth m	Major Amplitude cm/s	Minor Amplitude cm/s	Orientation degrees cc from East	Greenwich Phase degrees
8	1.5	0.9	155	208
60	3.4	0.1	162	222
104	3.0	0.1	160	216
150	3.6	-1.2	158	216

South Side

For ice-free period (Aug 15, 2000 to Oct 19, 2000):

Depth m	Major Amplitude cm/s	Minor Amplitude cm/s	Orientation degrees cc from East	Greenwich Phase degrees
20	3.0	-0.4	146	235
80	3.4	-0.1	166	252
120	4.0	-0.4	159	247
160	3.7	-0.8	166	258

For solid-ice period (Feb 16, 2001 to Jul 10, 2001):

Depth m	Major Amplitude cm/s	Minor Amplitude cm/s	Orientation degrees cc from East	Greenwich Phase degrees
24	1.5	0.2	248	310
68	4.1	-1.4	177	238
120	4.0	-1.2	179	231
160	3.0	-0.4	190	251