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MOORED INSTRUMENT AND CTD OBSERVATIONS FROM BARROW STRAIT, 2009-2010

by

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Abstract

Pettipas, R. and J. Hamilton. 2014. Moored instrument and CTD observations from Barrow Strait, 2009-2010. Can. Data Rep. Hydrogr. Ocean Sci. 194: viii + 95 p.

Instrumented moorings deployed in the eastern end of Barrow Strait from August 2009 to August 2010 provide yearlong records of current, temperature, salinity, and ice drift extending a data time series started in August of 1998. The presented current and ice drift data have been collected with acoustic Doppler current profilers (ADCPs) and specialised instrumentation for near-pole direction measurement. Yearlong records of temperature, salinity and density for fixed depths from moored CTDs are also reported. The current and CTD data are presented as filtered and unfiltered time series, spectral and tidal analyses products, and in statistical summaries. Ice draft data collected over the yearlong deployment with a moored, upward looking sonar complete the collection of moored records presented here. Finally, temperature, salinity and density cross-sections of eastern Barrow Strait are presented, which are based on 17 ship-based CTD stations that have been sampled most years since the start of the program.

Résumé

Pettipas, R. et J. Hamilton. 2014. Moored instrument and CTD observations from Barrow Strait, 2009-2010. Rapp. stat. can. hydrogr. sci. océan. 194 : viii + 95 p.

Les amarrages équipés installés à l'extrémité est du détroit de Barrows d'août 2009 à août 2010 ont fourni des enregistrements tout au long de l'année du courant, de la température, de la salinité et de la dérive des glaces, prolongeant ainsi une série chronologique de données qui a commencé en août 1998. Les données présentées sur le courant et la dérive des glaces ont été recueillies à l'aide de profileurs de courant à effet Doppler (ADCP) et d'instruments spécialisés pour la mesure de la direction à proximité des pôles. Les enregistrements tout au long de l'année de la température, de la salinité et de la densité pour les profondeurs fixes effectués par les sondes CTP amarrées sont également indiqués. Les données sur le courant et les données de CTP sont présentées

sous la forme de séries chronologiques filtrées et non filtrées, de produits d'analyse spectrale et d'analyse de la marée, et de résumés statistiques. Les données sur la dérive des glaces recueillies au cours du déploiement d'une année complète au moyen d'un sonar à vision ascendante amarré viennent compléter la collecte des enregistrements avec instruments amarrés présentés ici. Enfin, les profils en travers de température, de salinité et de densité de l'est du détroit de Barrows sont présentés, et sont basés sur 17 stations de profils de STD à bord de navires qui ont été échantillonnées la plupart des années depuis le début du programme.

Introduction

A field program to quantify and examine the inter-annual variability of the exchange through Barrow Strait (a principal pathway between the Arctic and North Atlantic Oceans), was started by BIO investigators in August of 1998. Data from the first 11 years of this study, along with a description of the methods used, have previously been reported [Pettipas and Hamilton, 2013a, 2013b, 2013c, Pettipas et al., 2010, 2008, 2006, 2005; Hamilton et al., 2008, 2004, 2003, 2002]. Described here are moored instrument data from the twelfth year of the study.

Yearlong records of temperature, salinity and density information derived from moored Microcat CTD data are presented as unfiltered and low-pass filtered time series, and also as power spectra. Current speed and direction (from ADCPs and custom pole compasses) are presented as progressive vector plots, unfiltered and low-pass filtered time-depth plots, and as time series plots for depths corresponding to the moored CTDs. Seasonally averaged statistical summaries for both the CTD and current data are provided as graphs and in tabular form. Results of tidal analyses of the current data 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). As done in previous years, separate tidal analyses were attempted for periods of immobile, solid ice cover and periods of open water. However, for 2009-2010, results for the immobile ice condition are not reported since there were no periods of sufficient length to allow for reliable analyses at either the South or South-Central sites.

Ice drift velocity, obtained from the acoustic Doppler current profilers (ADCPs), are presented as yearlong time series. Ice draft data acquired with a moored ASL ice profiling sonar (IPS) are presented as monthly statistics and monthly histograms of ice draft.

Mooring Locations and Description

Seven instrumented moorings were distributed at 2 sites (South and South-Central) on the southern side of Barrow Strait (Figure 1) to provide the data required for extending the volume, freshwater and heat transport time series started in 1998. ADCPs manufactured by Teledyne RD Instruments and precision heading references (Watson Industries, Inc.) were mounted in streamlined buoyancy packages to provide current speed and direction information. The technique used to obtain reliable direction measurements here, where conventional compass technology is inadequate due to the proximity of the site to the magnetic pole, is described in detail by Hamilton [2004, 2001]. The 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 throughout the yearlong deployments. Two 307 kHz Workhorse Sentinel ADCPs (WHADCPs) were used at the South site, one moored mid-depth and the other near-bottom to give near full water column coverage. At the South-Central site, a 150 kHz Quartermaster ADCP (QMADCP) was moored near bottom to provide data over almost the entire water column (from 25 m to 235 m depth), and a WHADCP was moored at 78 m depth for currents over the 10 to 70 m depth interval. Concurrent direction measurements were logged separately with the precision heading reference systems, and have been merged with the ADCP speed data for presentation here. All 4 ADCP/compass systems were successfully recovered with full data sets.
SeaBird Microcat CTDs were used to measure temperature, conductivity and pressure every 30 minutes at targeted depths of 40, 80 and 150 m at both sites, as well as one near-bottom at the South-Central site, and one just under the moored Icycler profiler at the South site. All of these CTDs provided complete data sets.

The Icycler profiler [Fowler et al., 2004], which was moored at the South site to collect daily upper ocean profiles of physical and biological parameters, malfunctioned this year when its deployment brake failed to release. Icycler was previously used in this program to provide daily profiles (50 m to near-surface) of temperature, salinity, fluorescence and dissolved oxygen (yearlong records in 2003-2004 [Hamilton et al.,

2008], 2007-2008 [Pettipas et al., 2013b], and 2 months of data in 2008-2009 [Pettipas et al., 2013c]).

One of the moorings at the South site supported an *EnviroTech Microlabs* water sampler which drew and stored a 150 ml sample every 24 days from its deployment depth of 34 m. This was the third consecutive year water samples were collected in this fashion. On recovery, samples were preserved for later analyses that included processing for oxygen isotopes for water mass identification. These results are not reported here.

Finally, an Ice Profiling Sonar (IPS) was moored at the South-Central site to provide the ice draft data presented in this report.

An illustration of the 7 moorings deployed for 2009-2010 is shown in Figure 2. A summary of the 2009-2010 moorings and instrumentation, including mooring positions, instrument depths and acquired data records, is presented in Table 1.

Data Processing

Current Speed and Direction Data

The 307 kHz Workhorse ADCPs (WHADCPs) 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. These instruments were set up to average over a depth interval of 4 m. Current data above 12 m were rejected based on RDI's standard echo intensity quality criterion. These acoustic Doppler current profilers also record ice drift velocity when there is 100% or near-100% ice cover. Two 307 kHz WHADCPs were moored at the South site (~149 m) at depths of 79 m and 143 m to give near-full water column current measurement coverage. At the South-Central site where the bottom depth is 270 m, a WHADCP was moored at 78 m depth to provide currents over the upper water column. A 150 kHz Quartermaster ADCP (QMADCP) moored near bottom (244 m) provided near full water column coverage, overlapping the range of the 307 kHz unit in the top 70 m.

Direction was provided using an independent compass package mounted in the buoyancy package 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 Teledyne RDI's "RDS3 interface" to provide a turn-on pulse to the compass. The compass was programmed to take a 10 s 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 Natural Resources Canada (NRCAN) observatory in Resolute to get direction relative to true north.

Vertical excursions of the WHADCPs caused by current drag forces acting on the mooring were typically small, with maximum dips over the entire deployment period of only 4 m, and dips exceeding 3 m less than 0.2% of the time at both sites.

Moored CTD Data

SeaBird Microcat CTDs were set up to measure temperature, conductivity and pressure every 30 minutes for the yearlong deployments. Instrument dips due to current drag forces acting on the moorings were small. Vertical dip of the 40 m CTDs at both sites exceeded 3 m only 0.4% of the time.

Low-Pass Filtering

Some of the data series presented have been filtered to remove the semidiurnal and diurnal tides using a Cartwright filter. A window length of 130 hours and a high-frequency cutoff of 0.036 have been used. In processing of data presented in previous reports, a technique described by Godin (1972) was used where three simple averaging filters were applied in sequence. Although the mean of the resulting filtered data for the Cartwright or Godin methods are nearly identical, the Cartwright filter does a better job at retaining variability on the 1 to 3 day time scale, so has been chosen here.

Tidal Analysis

Harmonic tidal analyses of current data using Foreman's (1978) method are presented for the summer period of broken or no ice cover. At both the South and South-Central sites this open water period was about 9 weeks; Aug 5 to Oct 8, 2009 and Aug 6 to Oct 9 respectively. The period of consolidated, landfast ice was too short at both locations this year to allow for tidal analysis in those contrasting conditions. 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 half-hourly sampled temperature, salinity and density from the moored CTDs are shown in Figures 3 and 4. Freshening at the South site occurs from mid-September to the end of December when, at the 40 m level, the water is about 0.5 psu fresher than winter-spring values. At the South-Central site freshening is most noticeable from early November to late January. Power spectra of the moored CTD measurements (decimated to 2 hour intervals) are shown in Figures 5 and 6. At the South site a strong diurnal signal is seen in the upper water column salinity records but the strongest signal in the deep salinity record is in the semi-diurnal band. The South site temperature records show little energy in either of these bands, except for the deep temperature record, which like salinity, contains significant energy in the semi-diurnal

band. At the South-Central site, energy in the diurnal band dominates in both salinity and temperature records.

Yearlong progressive vector diagrams for all ADCPs are shown in Figures 7-9. The mean flow in the upper water column as measured by the WHADCPs (Figures 7 and 9) is eastward at both sites (95° at the South site, and 90° at the South-Central site) which is slightly counter clockwise from the along strait direction of 105°. At the South site the mean flow direction in the lower half of the water column, as measured by the deep instrument there, rotates clockwise with depth to 115° near-bottom. A comparison of the mean annual flow in the measurement overlap interval (73 m) of the two ADCPs moored at the South site are 10.2 cm/s @ 92° for the upper instrument, and 9.5 cm/s @ 105° for the lower instrument. The difference may be due to the mooring separation although they were only 0.4 km apart. It may also be related to current meter performance since for one instrument data at 73 m depth is from a bin close to the transducer, while for the other it is data from a bin at the extreme of the instrument range. A third possibility is that there is a small compass error in one system although that would not account for the speed difference also seen in the overlap interval of the 2 systems. If attributable to a measurement error in one of the ADCP/pole compass systems, the error is small enough that the effect on the along-strait estimates of volume transport (the primary use of these data) is small. At the South Central site, the QMADCP indicates a strong northward component in the lower water column (Fig 8) as observed in previous years. The annual means at the 26 m level at this site were close; 8.4 cm/s @ 84° as measured by the QMADCP and 8.1 cm/s @ 89° for the WHADCP. These instruments were also only 0.4 km apart.

Another instrument-related issue that can cause errors in reported ADCP currents is a bug in the RD Instruments firmware reported by Humfrey Melling (pers. comm.). For instruments running firmware version 16.30 or earlier that are set up to operate in “ship coordinates”, the tilt information measured by the instrument is not used to map the bins from the 4 different beams of the ADCP to the same depth, as it should. Instrument tilt therefore results in beam data from different depths being used to compute speed and direction for a specific level. If there is any vertical shear, errors in both the velocity and direction can be expected. In our case, ADCP’s are mounted in streamline buoyancy

packages that stay quite level over the full range of flows. For example, for the ADCP moored at 79 m at the South site, pitch was less than 2.5°, 85% of the time and less than 5°, 95% of the time (and rolls were far less). These tilts would result in bins at the extreme of the instrument range (~70 m) for opposite transducer beams being vertically offset by just 2 and 4 m respectively, so resulting speed and direction errors would be minimal.

Current data are shown as coloured time-depth plots in Figures 10 – 15. Data are presented in along-strait and cross-strait components, where positive values are defined as flow towards 105° and 15° true, respectively. A month of bihourly current data from the South site are presented in Figure 10, where data from the deep and mid-water ADCPs (which were moored 0.4 km apart) have been combined. Bi-hourly data from the South-Central site over most of the water column (QMADCP) and over the top 70 m (WHADCP) are shown in Figures 11 and 12. These figures reveal the strong tidal nature of the flow. Yearlong records of low-pass filtered data (tides removed) for the 4 instruments are shown in Figures 13-15. Mean flow in the upper water column is predominantly eastward at both sites as in previous years. However, a northward component is also observed throughout the water column in summer and fall at the South-Central site, and in deeper water in winter and spring. In these mean flow plots, missing data near the surface in winter are caused by a decrease in the effective range of the ADCPs due to a minimum of acoustic reflectors in the water. The smoothing filter used has smeared the impact of missing data over the filter length.

Smoothed temperature, salinity and current data (where available) are shown for each moored CTD level in Figures 16-24. Tables 2 through 13 provide a summary of the CTD and ADCP data at the CTD depths, with statistics computed over each season, and for the entire year. For the South-Central site, WHADCP data are reported in the tables for the 40 m level, while QMADCP data are reported for the deeper levels (82, 160 and 265 m). Density has been included in these statistical summaries.

Annual and seasonal mean flows are summarized in Figures 25-30, where 4 m binned values for the WHADCPs and 8 m binned values for the QMADCP are shown. Late summer along-strait mean currents at both the South and South-Central sites are higher than in the previous year but lower in the subsequent seasons, yet not as low as the

values observed in 2007-2008. Significant cross-strait (northward) currents at the South-Central site are evident as usual, particularly in deeper water, appearing in all seasons as in the previous year. The variance in the bi-hourly, and low-pass filtered current data for the yearlong ADCP records are shown in Figure 31. Slightly anomalous variance values for the 48 m bin at the South site, and 40 and 44 m bins at the South-Central site are due to acoustic interference from the top buoyancy package of the mooring. This contamination does not appear to impact the computed mean flows (Figures 25-30), except perhaps for the early summer mean at the South-Central site (Figure 30) where there is evidence of slight under-reading at the 44 m level.

Tidal analysis results for the 4 ADCP data sets are presented as profiles for the 5 largest tidal constituents in Figures 32 – 46. Analyses were done only for the open water period since the length of time over which there was immobile ice-cover was too short to allow for this type of analysis at both the South and South-Central sites. Ellipse orientations are along-strait as expected. Tidal constants are summarised in Tables 14 – 18.

Ice velocities through the year at both sites were derived from the WHADCPs (Figures 47 and 48). Sections in the record when there are no data indicate periods of open water, or partial ice cover as determined by applying the manufacturer's suggested data quality standards to the ice velocity data. In addition, the ice drift velocity estimate and the adjacent estimates were rejected when the magnitude of the "error velocity" for a particular ensemble was greater than 1 cm/s. Although there was near-full ice cover for over 8 months at both sites, the longest period of immobile ice was just 17 days at the South site and about 8 days at the South-Central site.

Ice draft was measured at the South-Central site for the fourth time in this program, the previous measurement years being 2003-2004, 2005-2006 and 2006-2007. Monthly mean, standard deviation, and maximum ice draft for 2009-2010 are shown in Figure 49 and Table 19. Monthly histograms of ice draft distribution (based on the data presented in Table 20) are shown in Figure 50. Mean ice draft reached 2.7 m in January and remained high until June, with a peak mean thickness of 3.0 m for April. With a mean thickness of between 2 and 3 m for 7 consecutive months, 2009-2010 was easily the heaviest ice year of the 4 years for which we have observations at this site. Observed

monthly maximum ice drafts were also significantly higher, being larger than 15 m for 10 of the 12 months. The maximum value in April was 36 m which is large enough that it perhaps was an iceberg rather than a sea ice ridge. The ice draft observations are consistent with what we might expect from an ice pack that was mobile for most of the year. Greater motion results in more rafting of ice which would account for higher maximum drafts and greater ice volume that would result in larger monthly mean drafts as well.

Finally, a station map for the August 2010 ship-based CTD survey is shown in Figure 51. Contour plots showing the results of a 17 station cross-section at the eastern end of the strait at the longitude of the mooring line are shown in Figure 52. The results indicate an eastward geostrophic flow along the southern half of Barrow Strait and a weaker westward flow confined near the coast in the upper 100 m on the North side. A statistical summary of CTD data is presented in Table 25.

Acknowledgements

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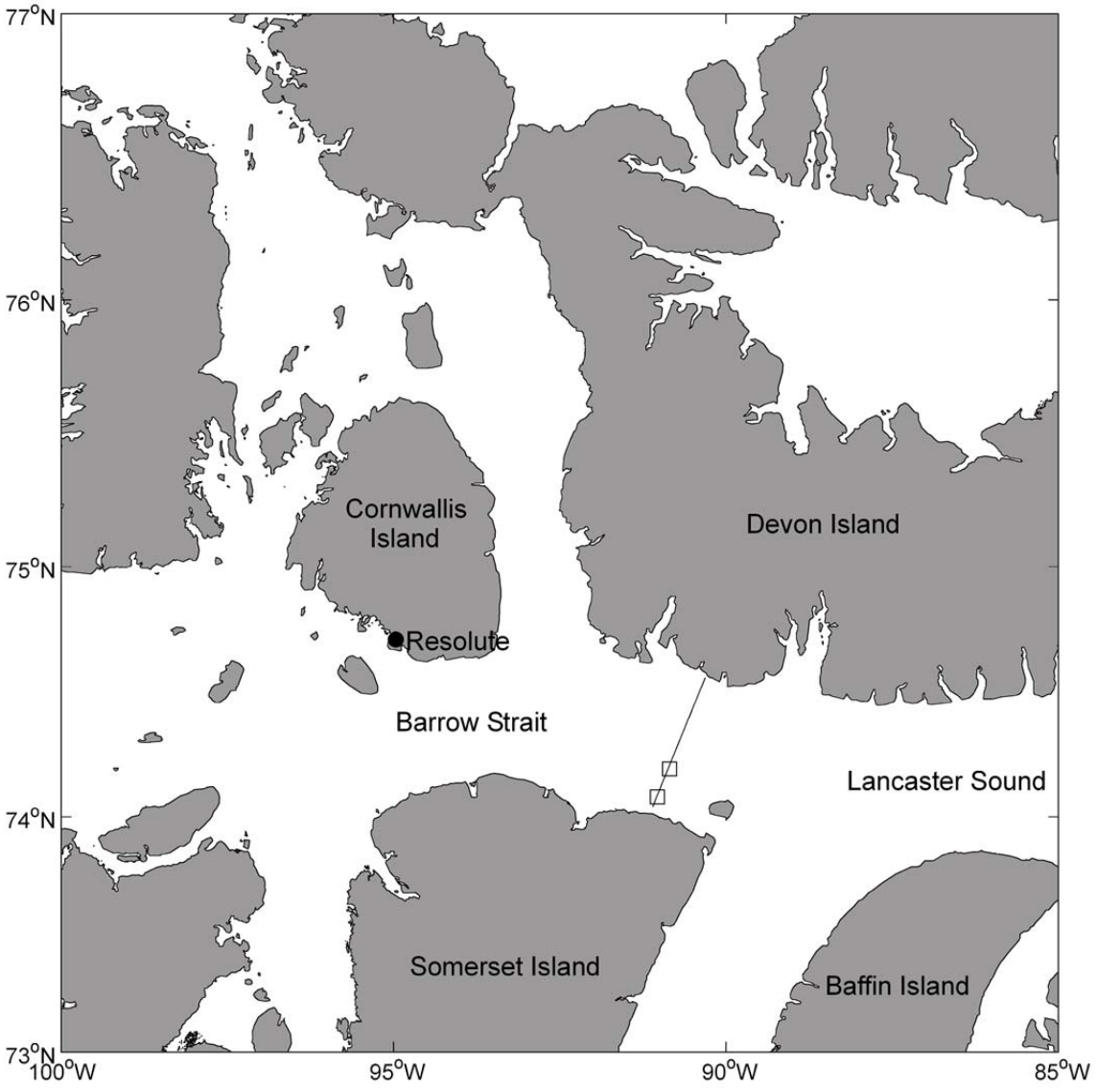
Figure 1: A map of the work area showing the location of the mooring sites (the open boxes), and the hydrographic survey line (the solid line).



<u>Figure 2</u>: Illustration of the instrumented moorings.

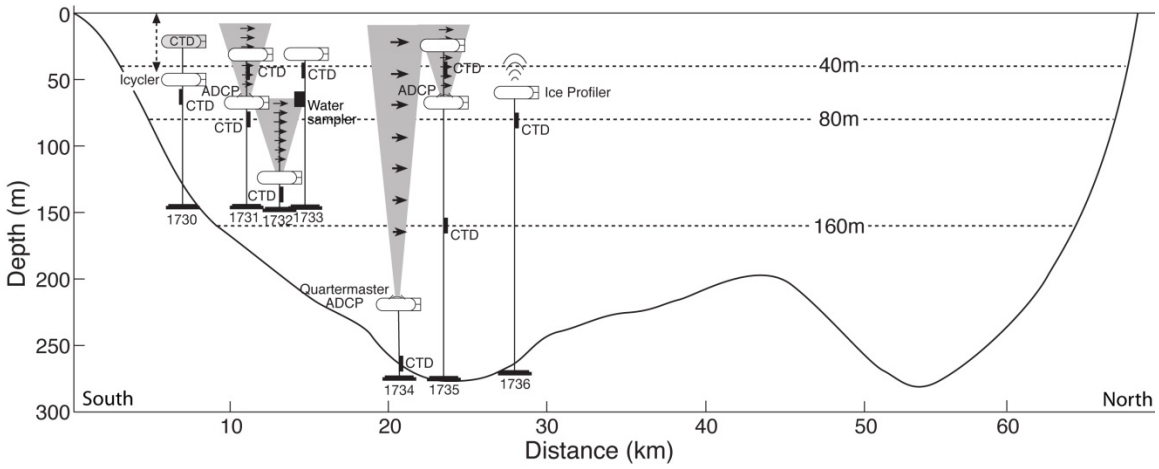


Figure 3: Moored 30 min. CTD data, South Side Barrow Strait. August 2009 – August 2010

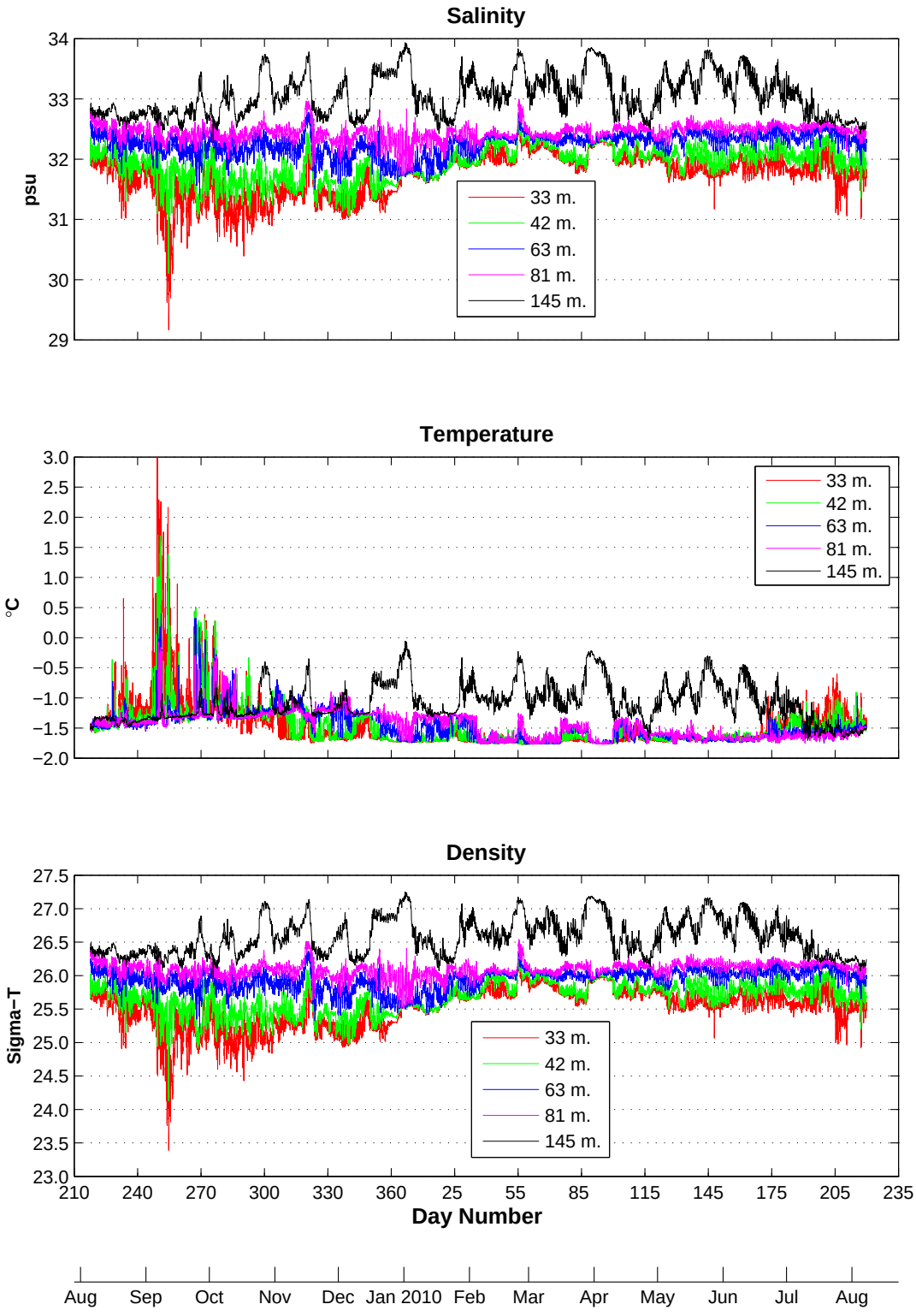


Figure 4: Moored 30 min. CTD data, South Central Barrow Strait. August 2009 – August 2010

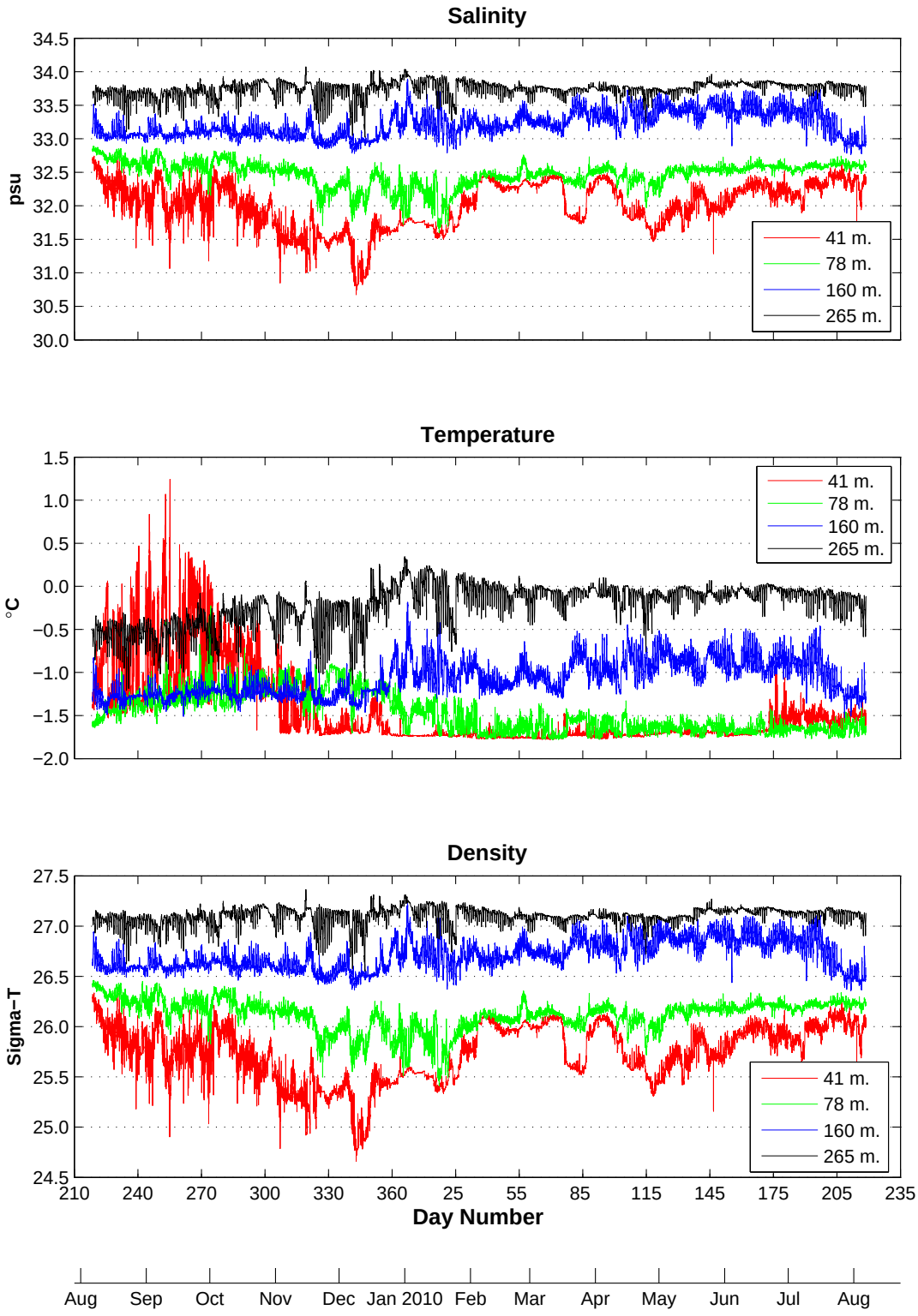


Figure 5: Power Spectra of moored bi-hourly CTD data. South Side Barrow Strait: Aug. 2009 – Aug. 2010.

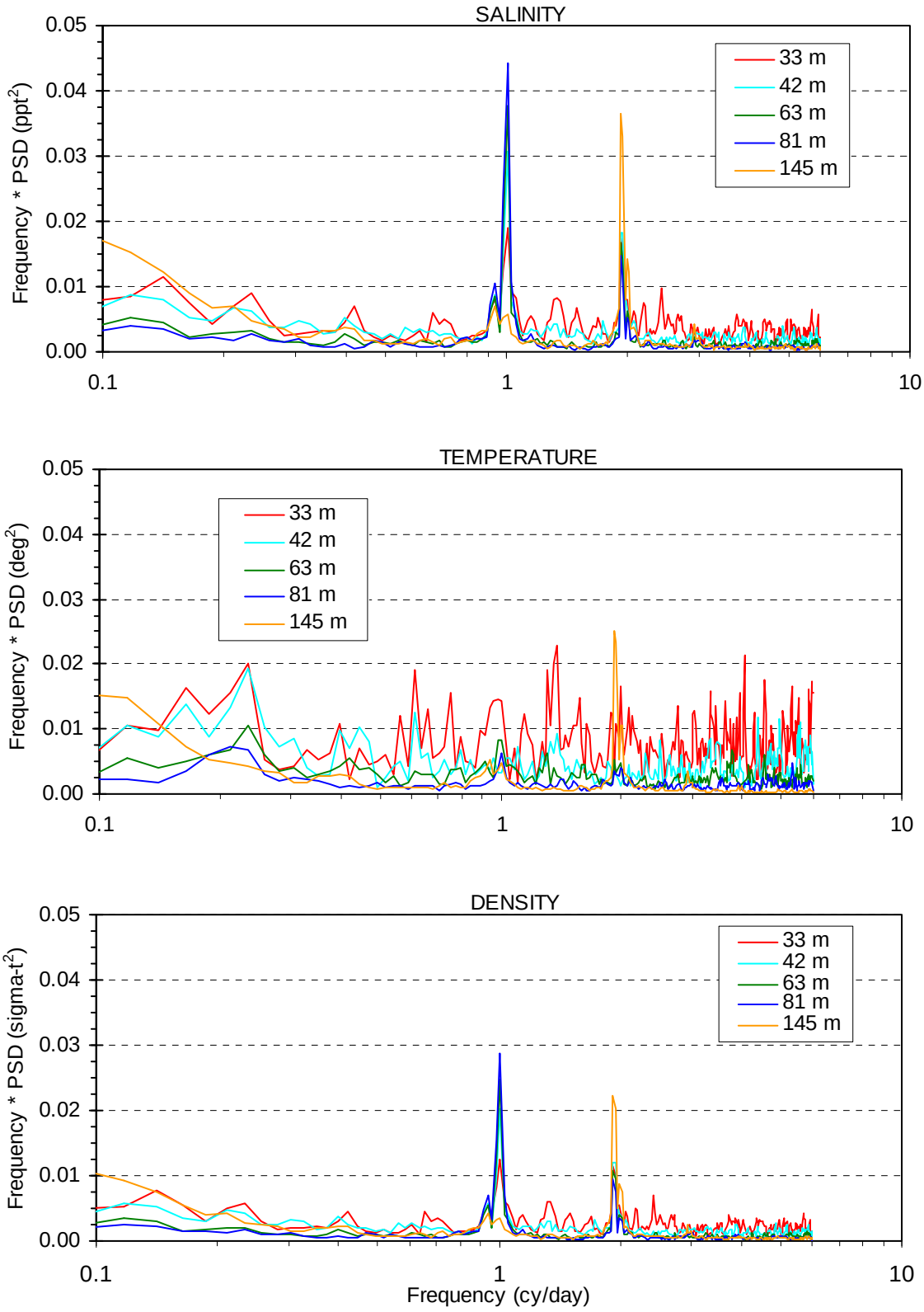


Figure 6: Power Spectra of moored bi-hourly CTD data. South Central Barrow Strait: Aug. 2009 – Aug. 2010.

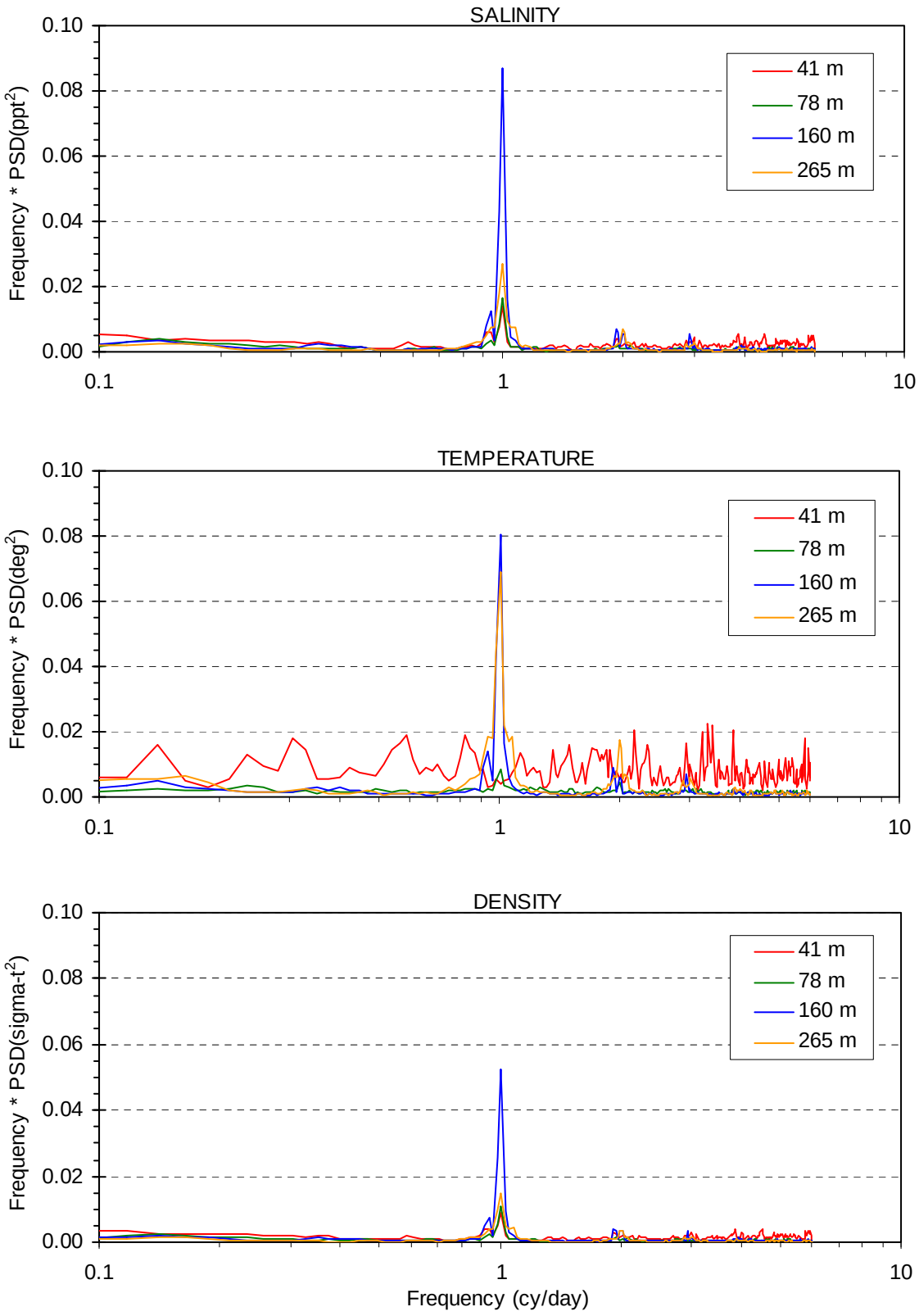


Figure 7: Progressive Vector Diagram, South Side Barrow Strait. Aug. 5, 2009– Aug. 7, 2010

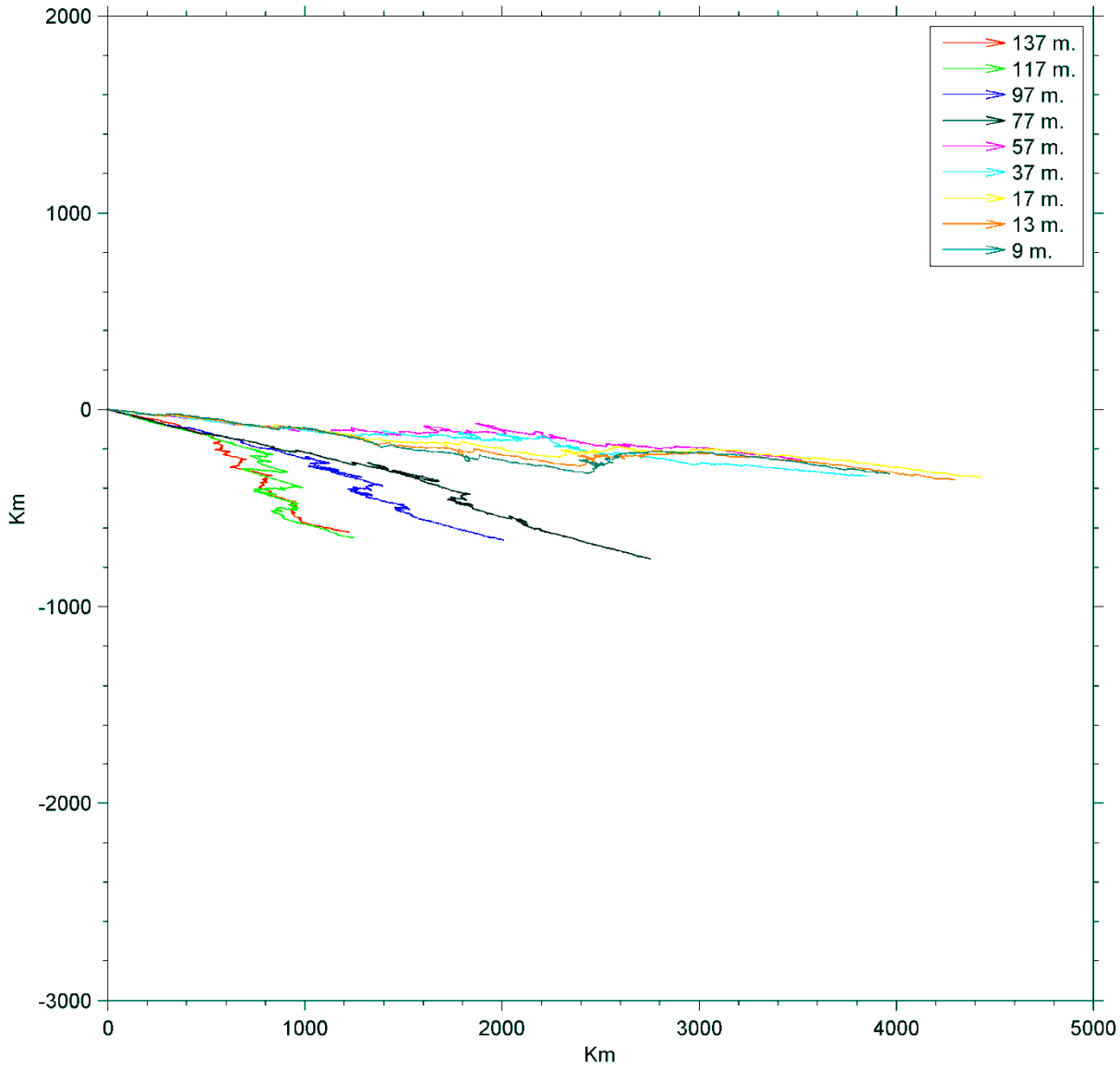


Figure 8: Progressive Vector Diagram, South Central Barrow Strait. (Quarter Master ADCP) Aug. 6, 2009 – Aug. 6, 2010

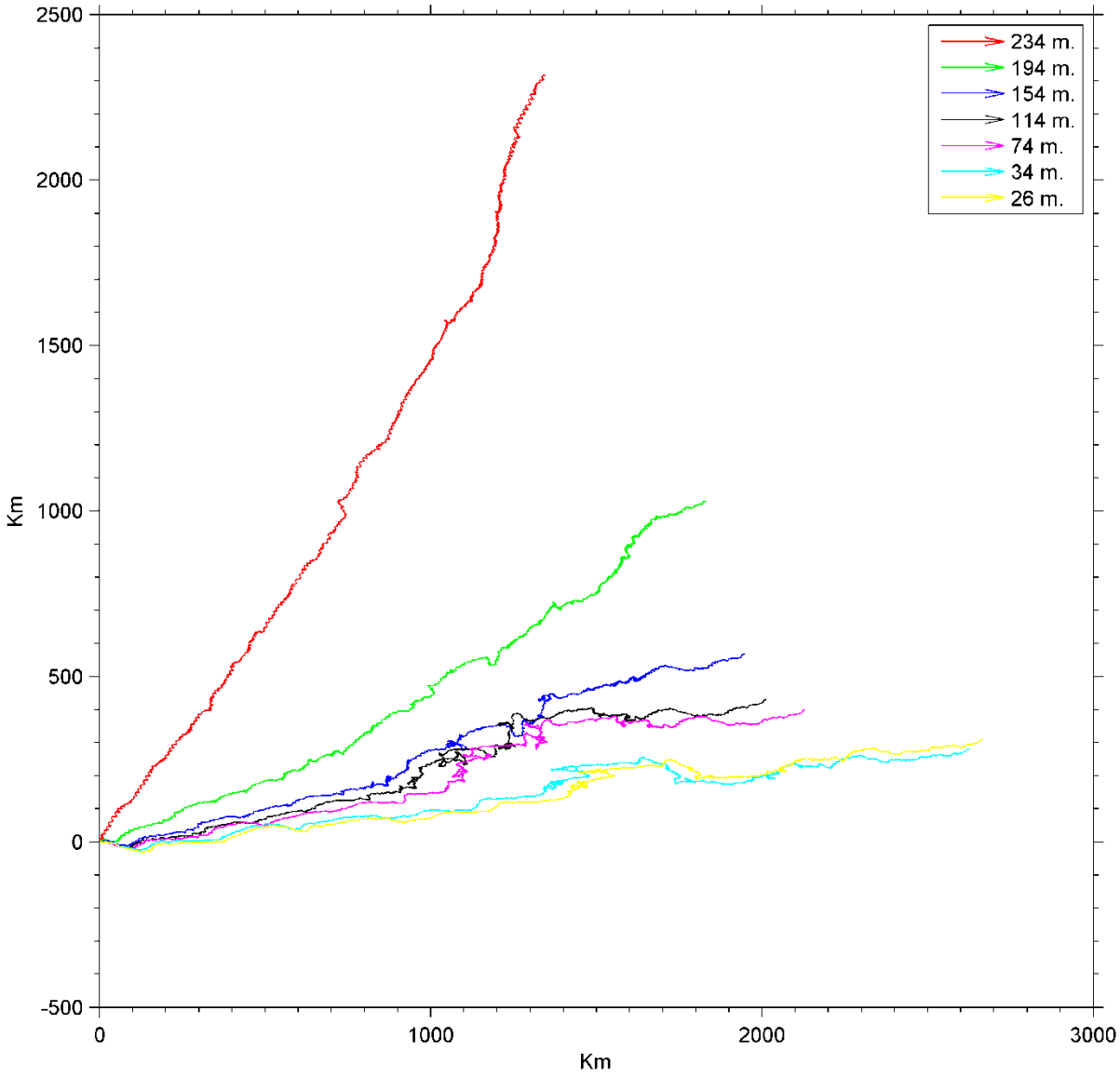


Figure 9: Progressive Vector Diagram, South Central Barrow Strait. (Workhorse ADCP) Aug. 6, 2009 – Aug. 6, 2010

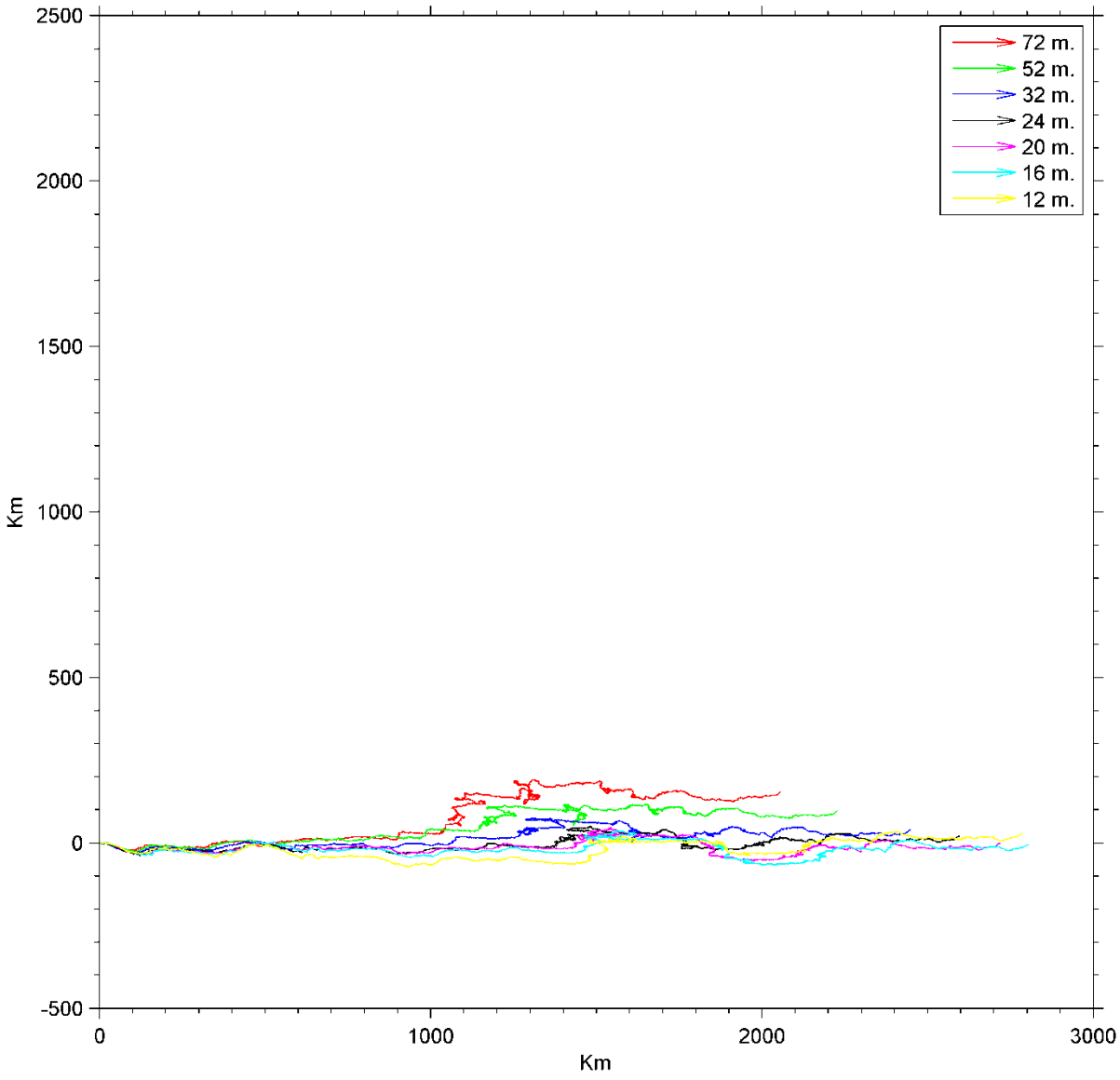


Figure 10: Bi-hourly current data, South Side Barrow Strait. Sep. 1, 2009 – Sep. 30, 2009

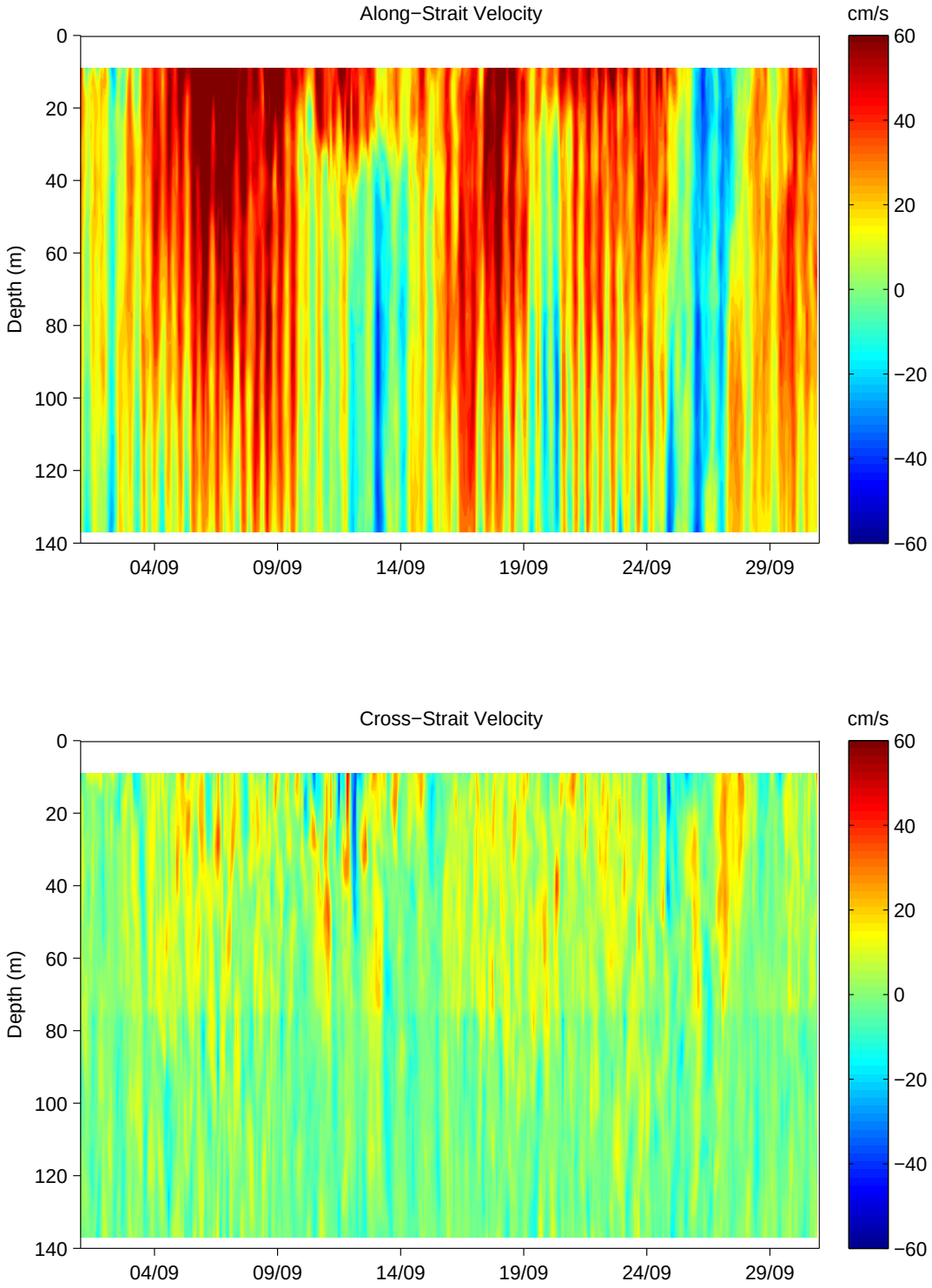


Figure 11: Bi-hourly current data, South Central Barrow Strait. (Quarter Master ADCP), Sep. 1, 2009 – Sep. 30, 2009

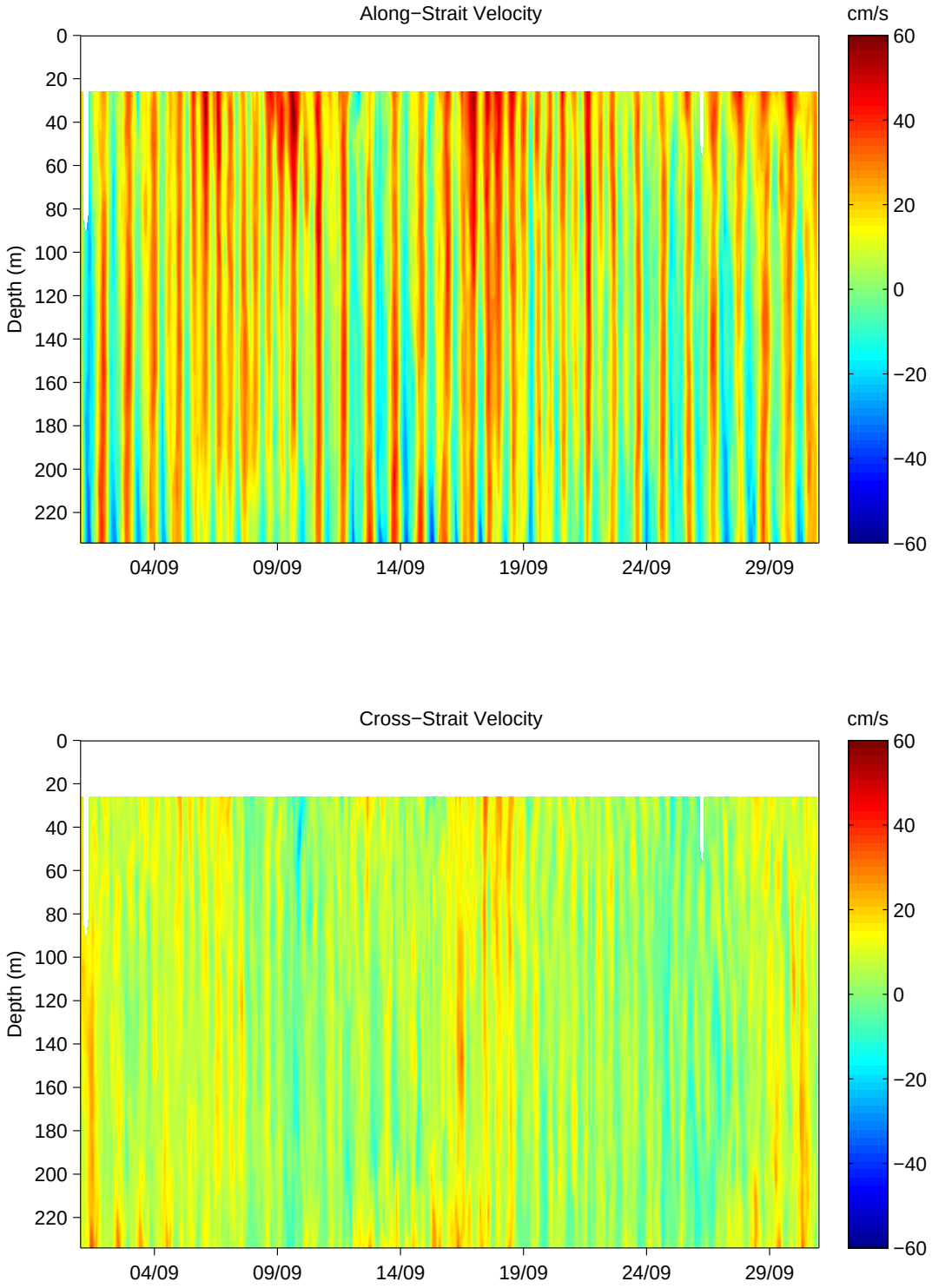


Figure 12: Bi-hourly current data, South Central Barrow Strait. (Workhorse ADCP) Sep. 1, 2009 – Sep. 30, 2009

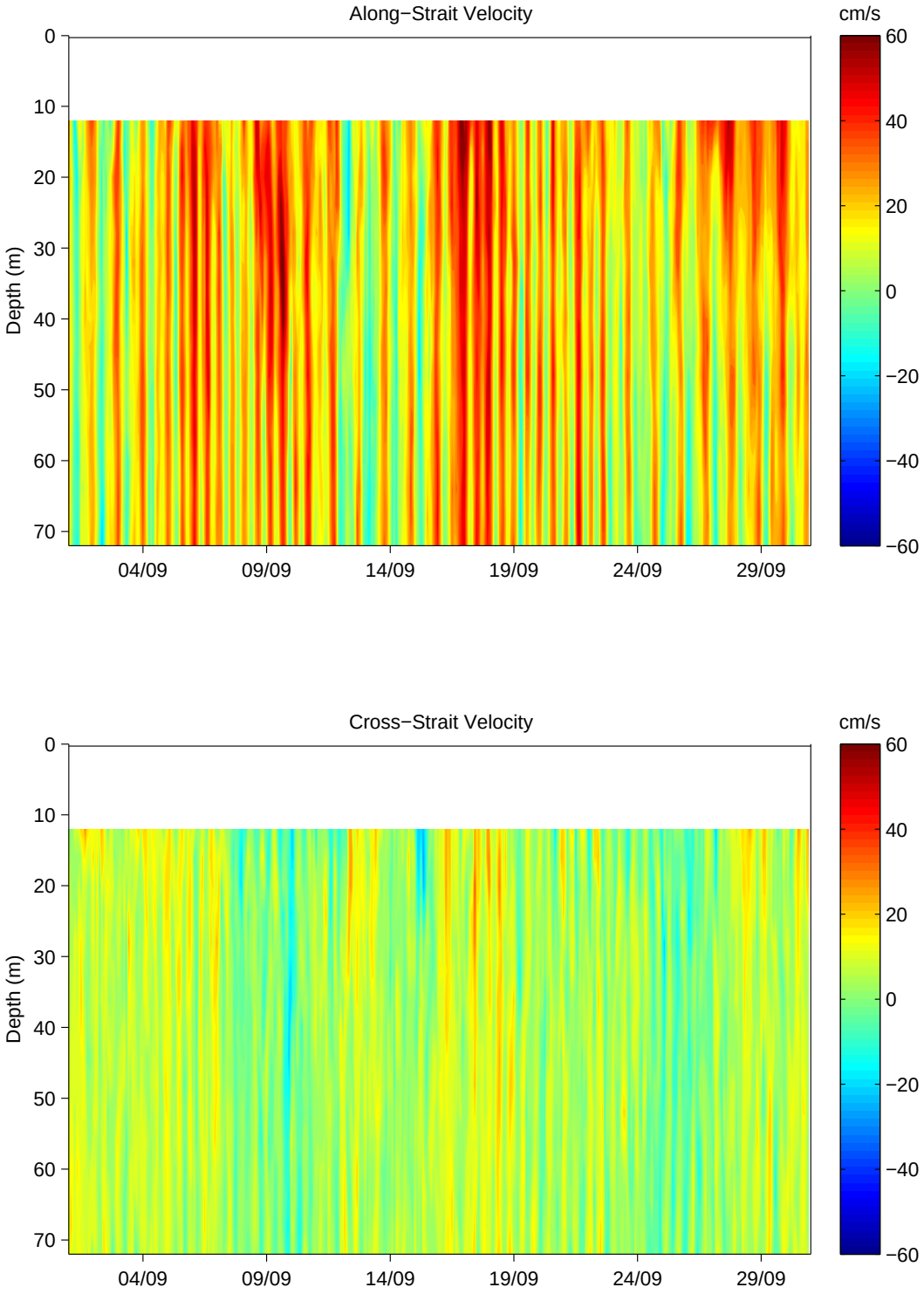


Figure 13: Low-pass filtered currents, South Side Barrow Strait. August 2009 – August 2010

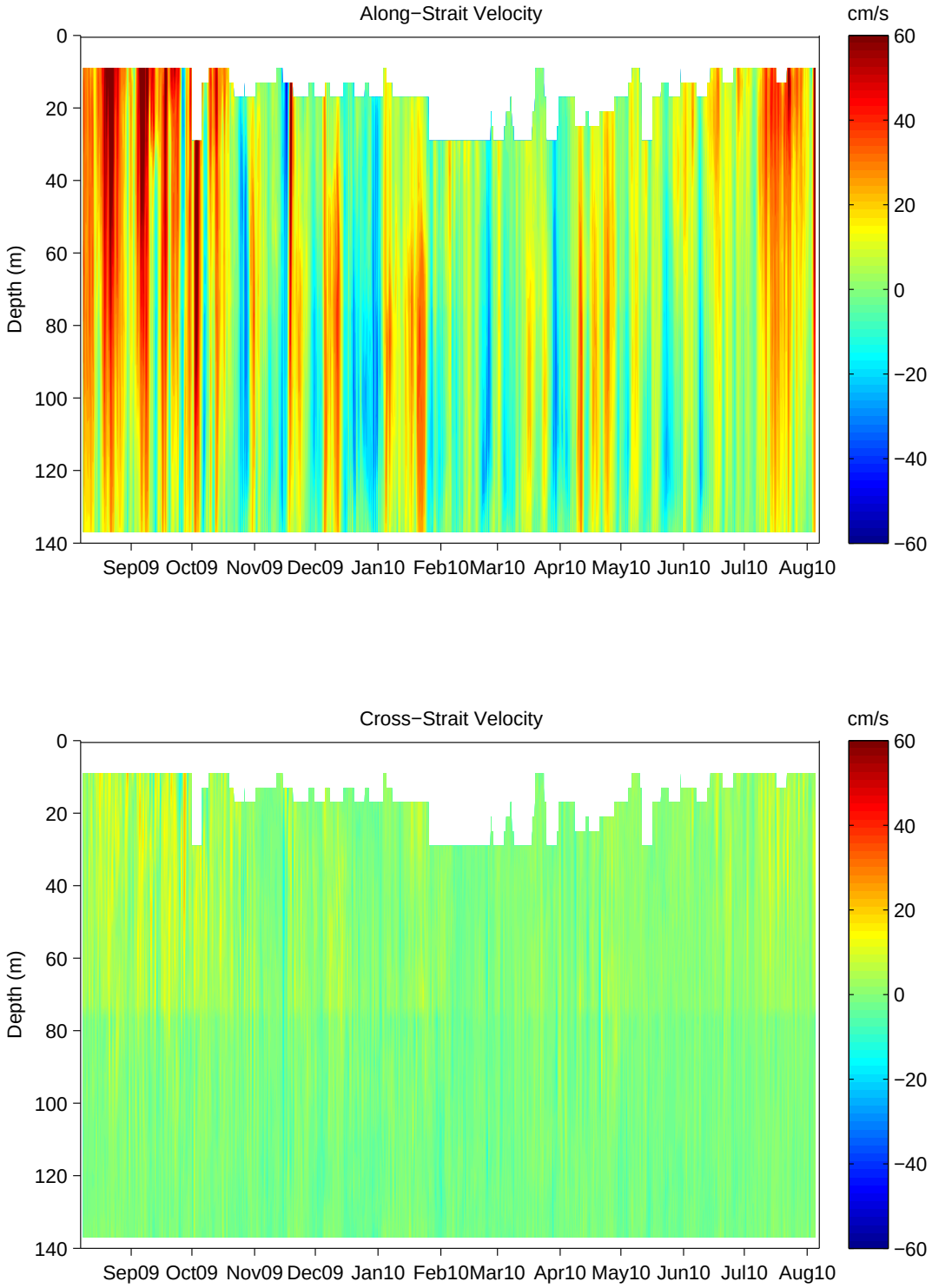
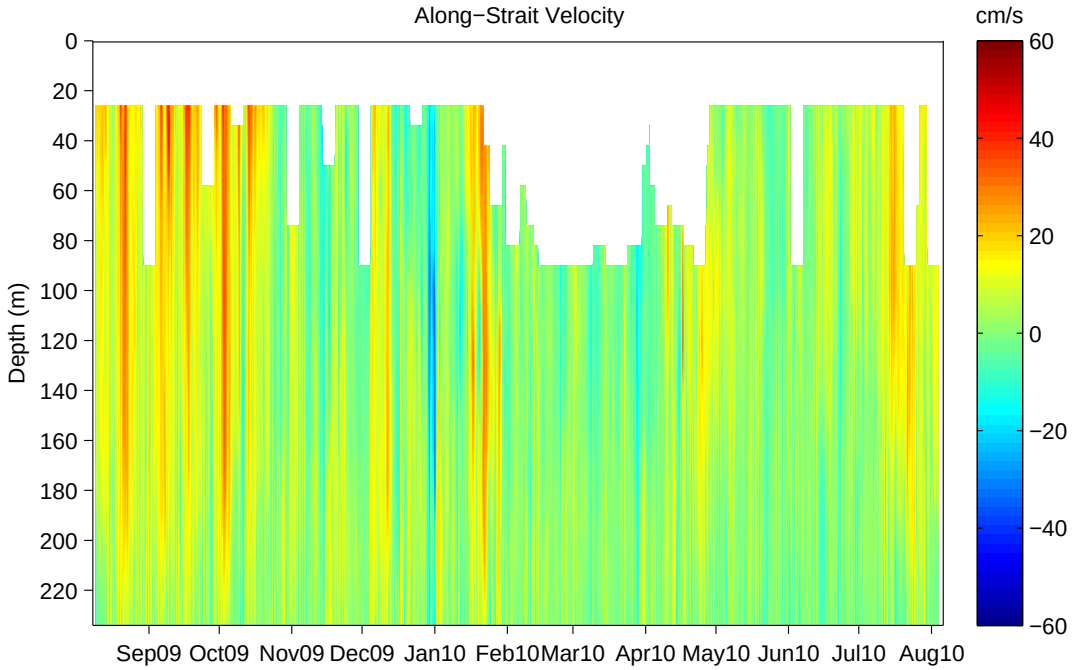


Figure 14: Low-pass filtered currents, South Central Barrow Strait. (Quarter Master ADCP) August 2009 – August 2010



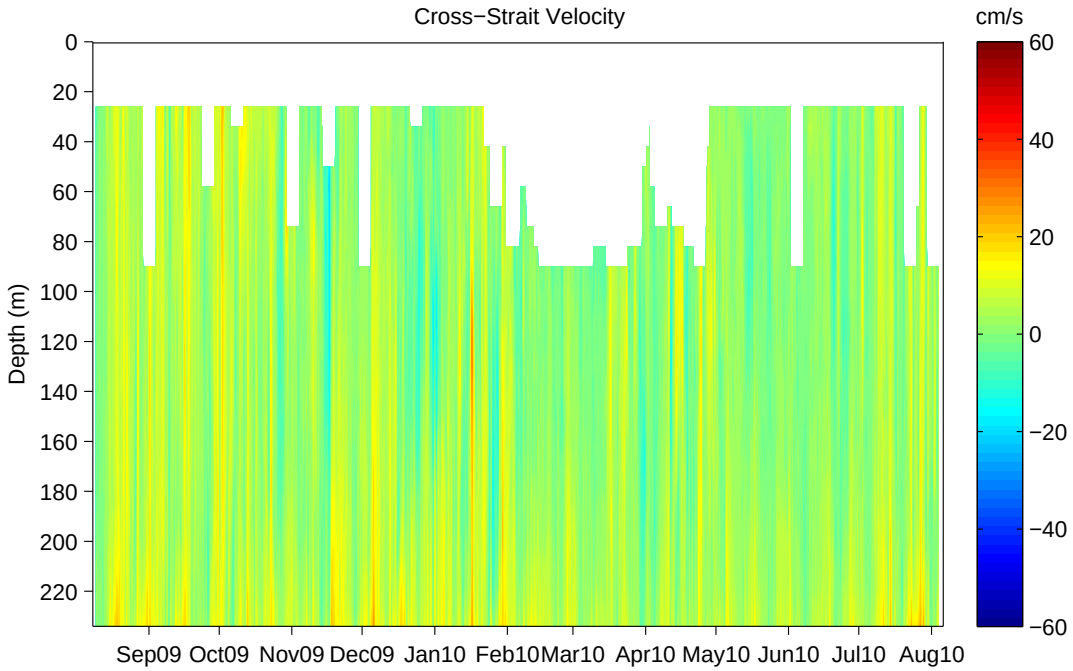


Figure 15: Low-pass filtered currents, South Central Barrow Strait. (Workhorse ADCP) August 2009 – August 2010

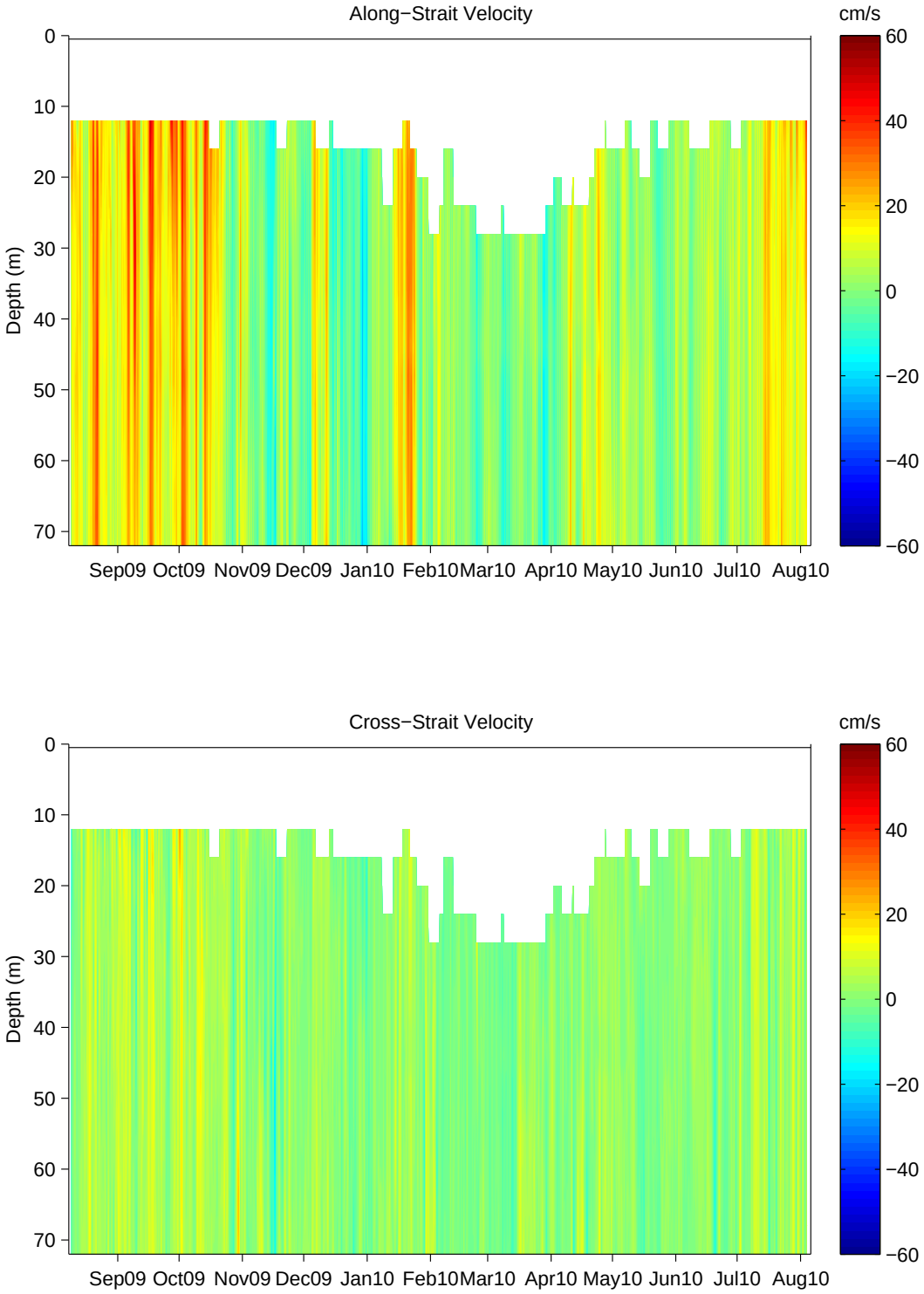


Figure 16: Low-pass filtered T,S (33 m.) and current data (33 m.). South Side Barrow Strait: August 2009 - August 2010.

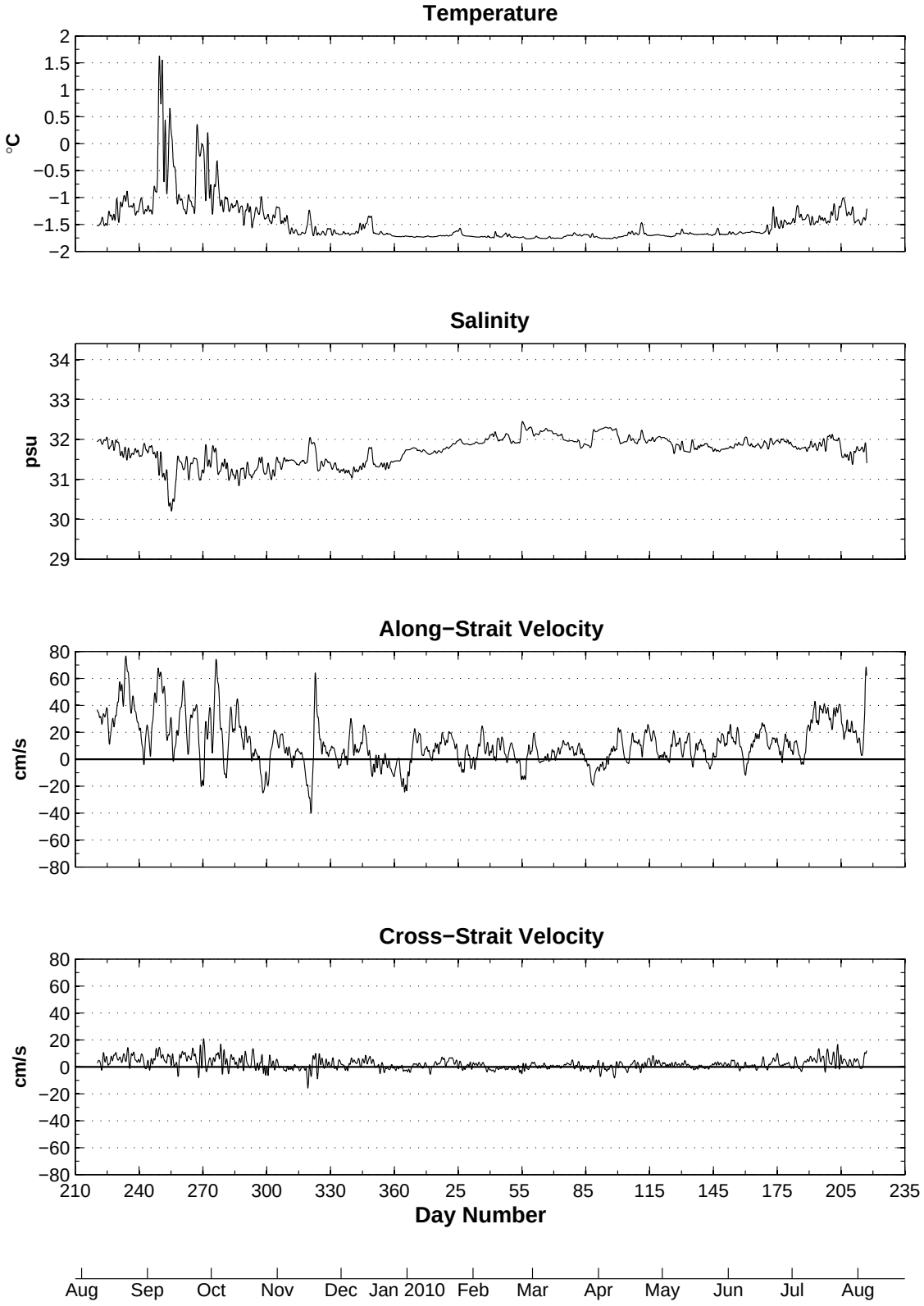
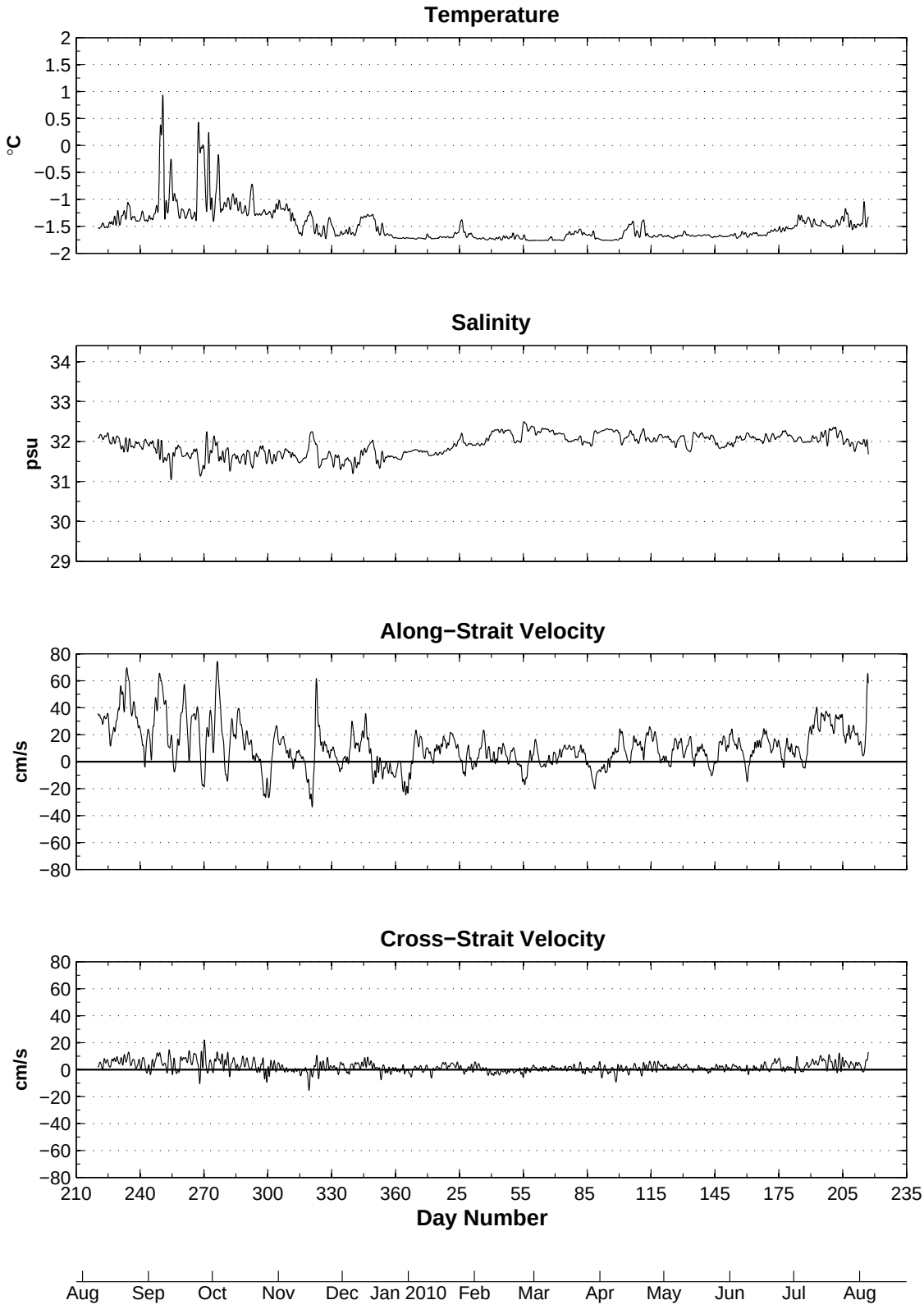
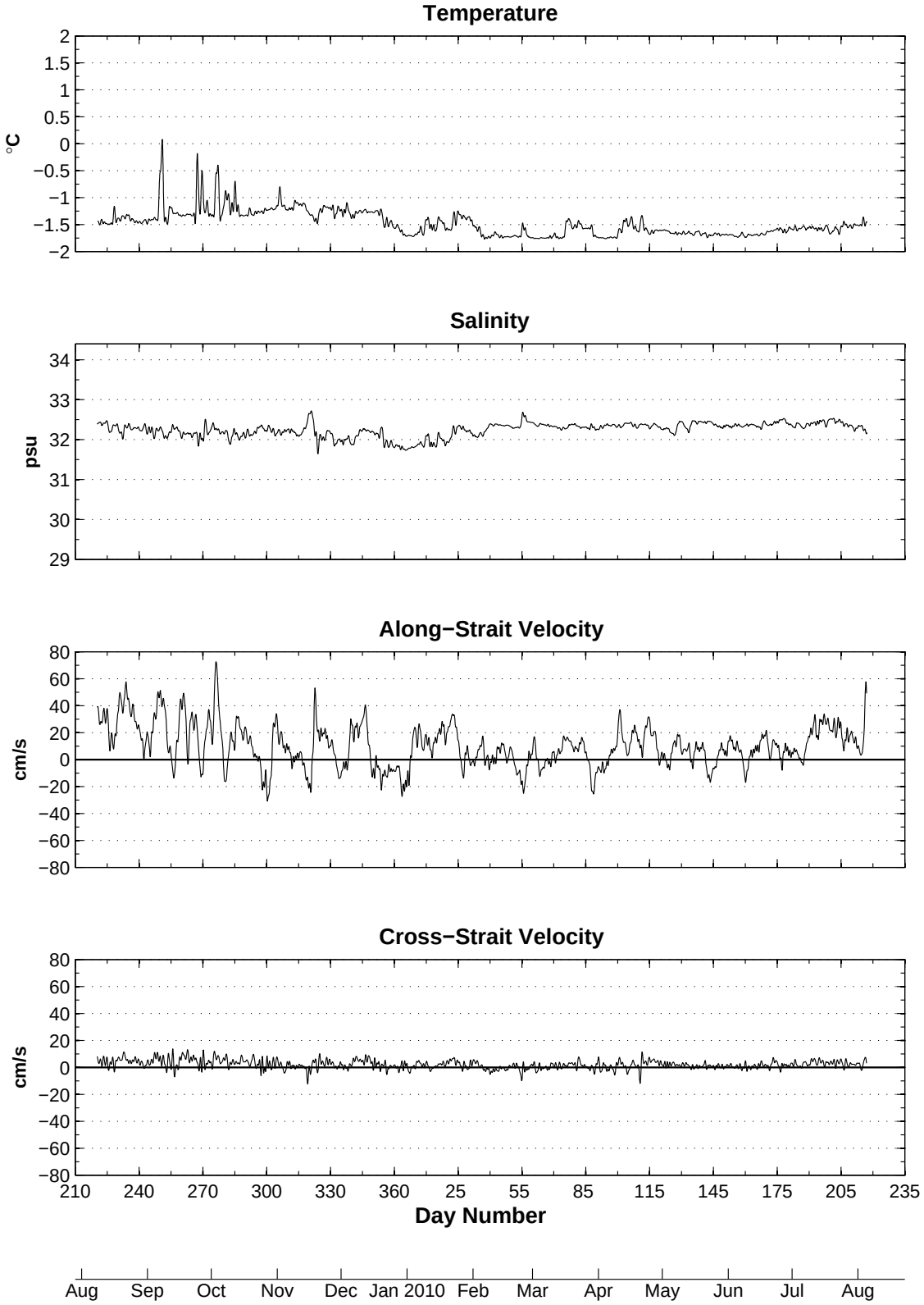


Figure 17: Low-pass filtered T,S (42 m.) and current data (41 m.). South Side Barrow Strait: August 2009 – August 2010.



<u>Figure 18</u>: Low-pass filtered T,S (63 m.) and current data (65 m.). South Side Barrow Strait: August 2009 – August 2010.



<u>Figure 19</u>: Low-pass filtered T,S data (81 m.) and current data (81 m.) South Side Barrow Strait: August 2009 – August 2010.

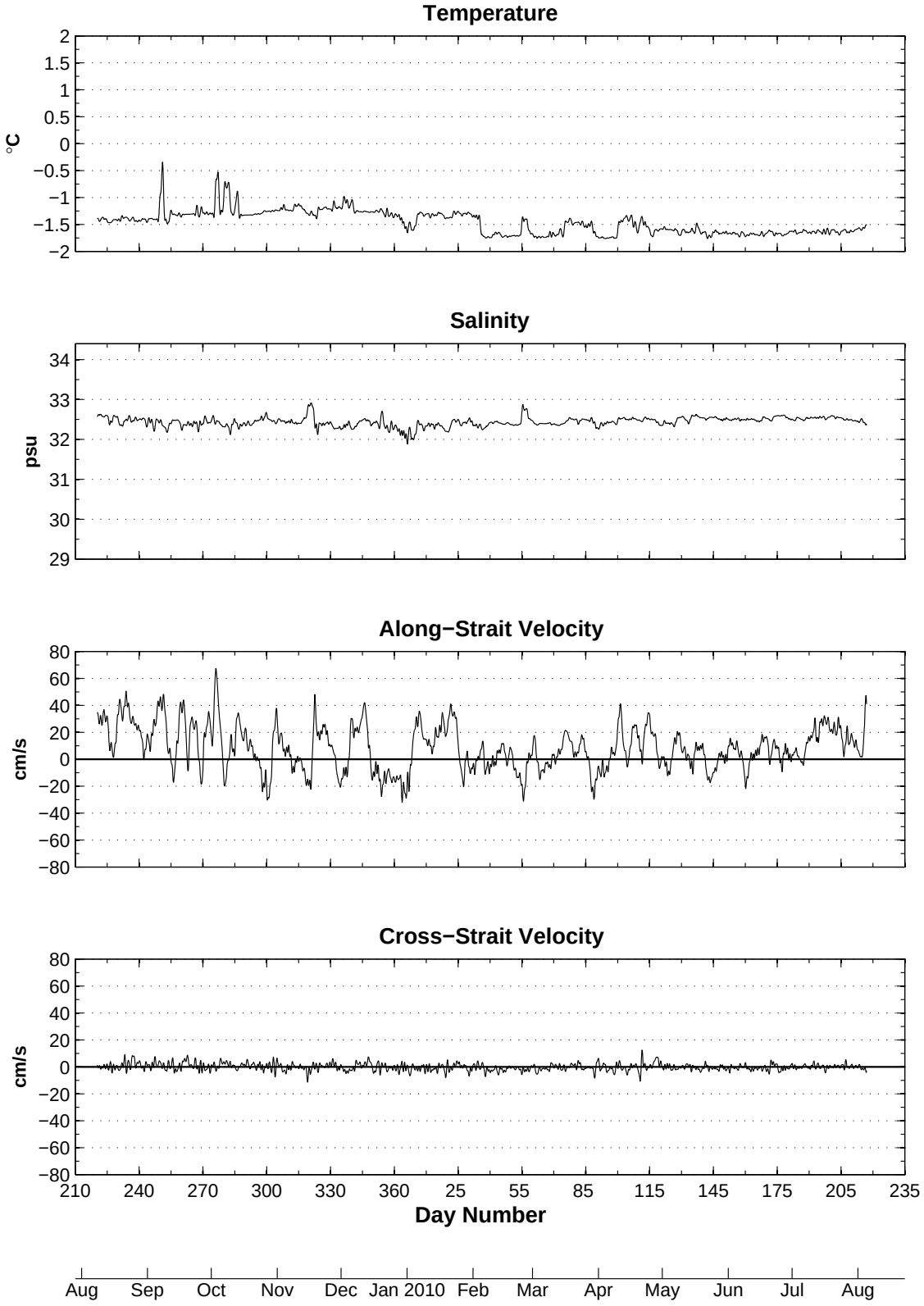


Figure 20: Low-pass filtered T,S data (145 m.) and current data (137 m.) South Side Barrow Strait: August 2009 – August 2010.

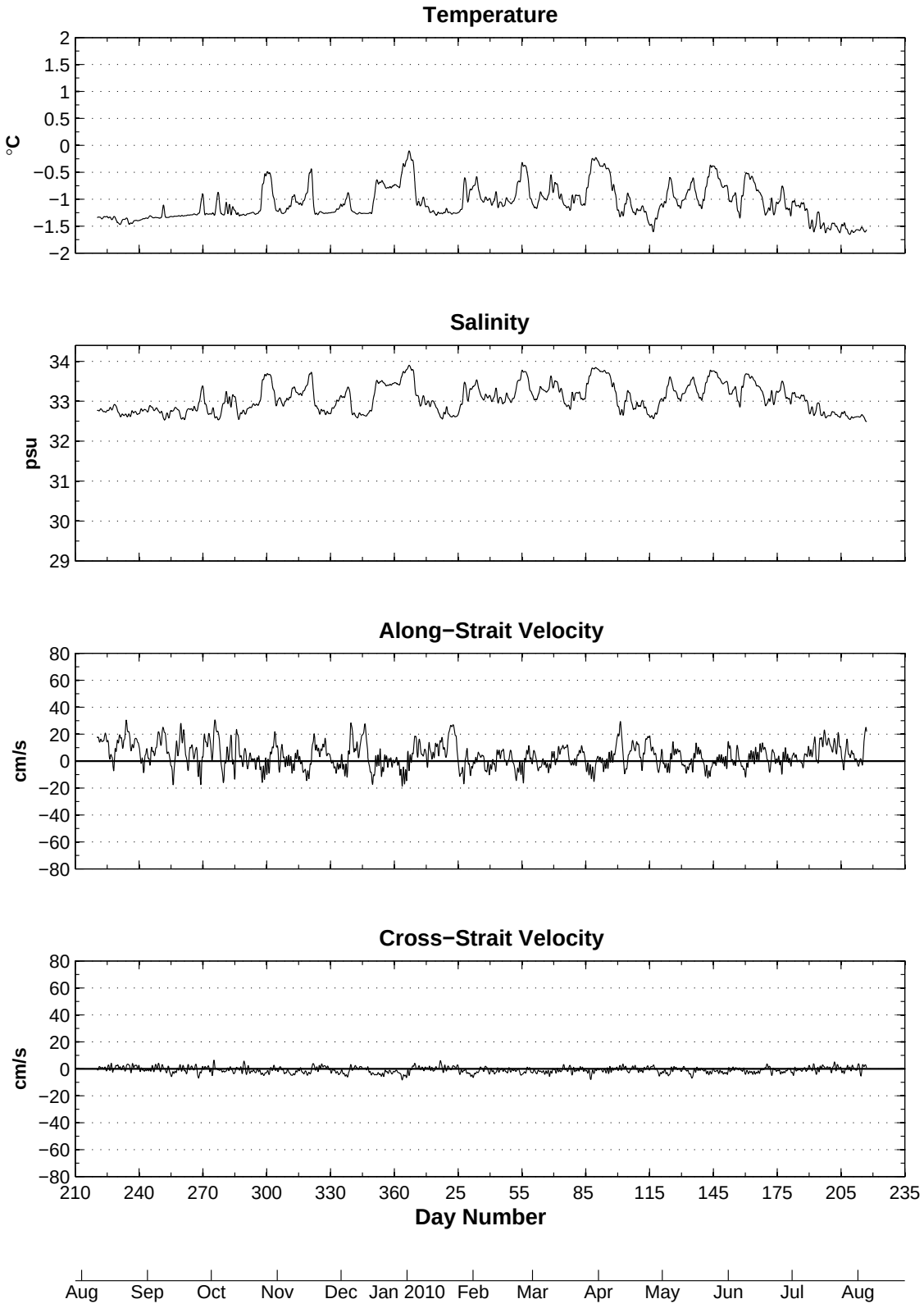
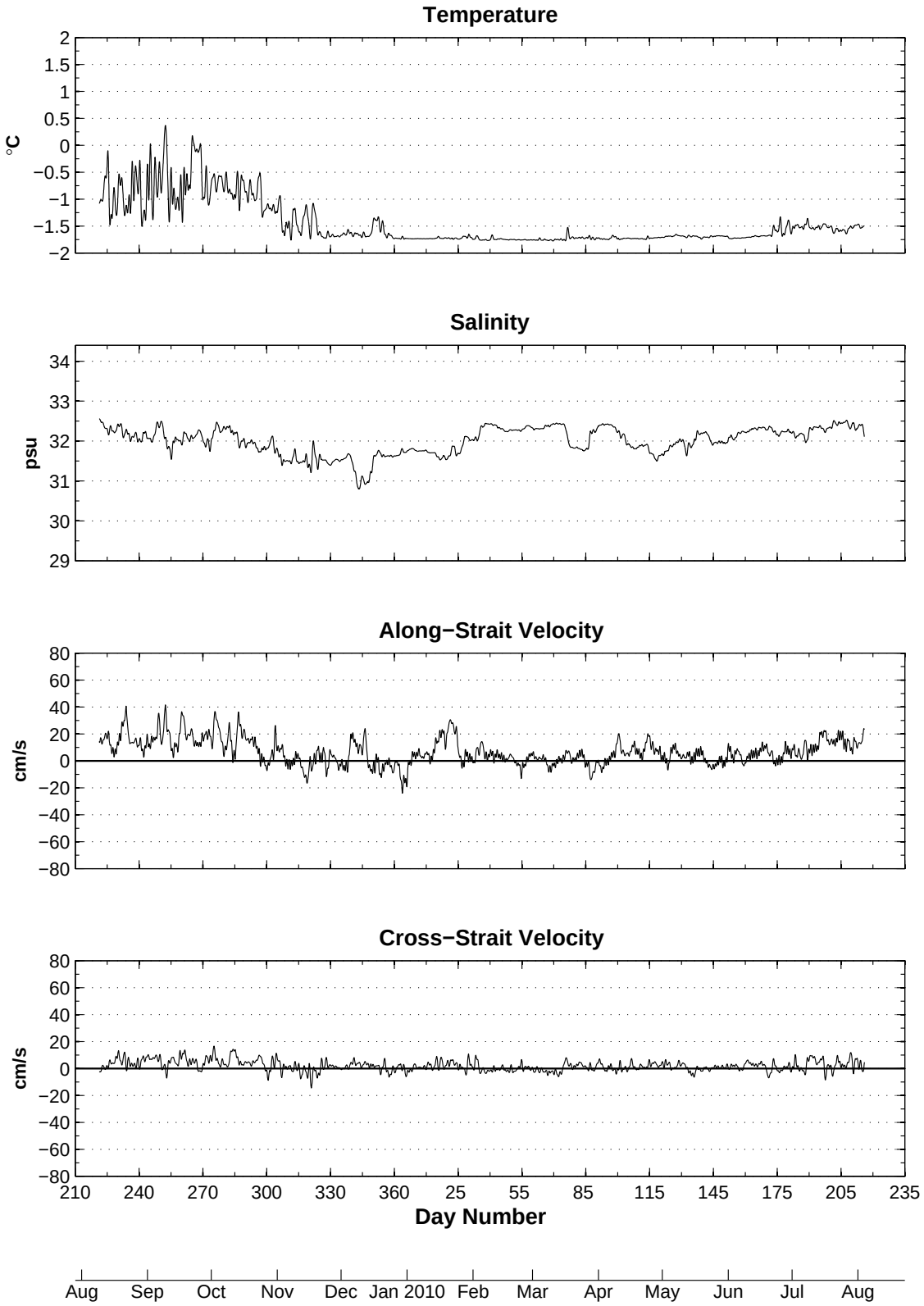
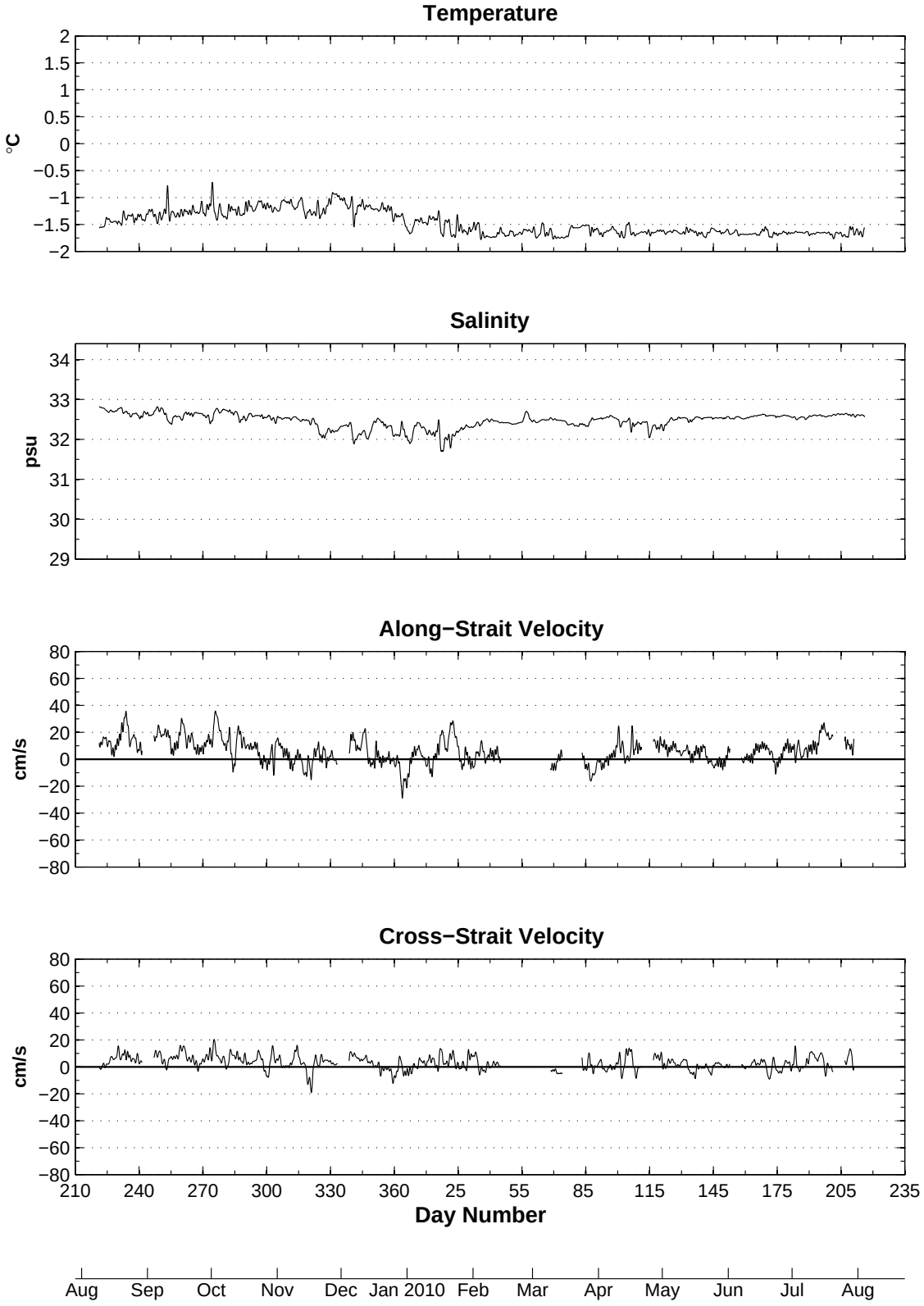


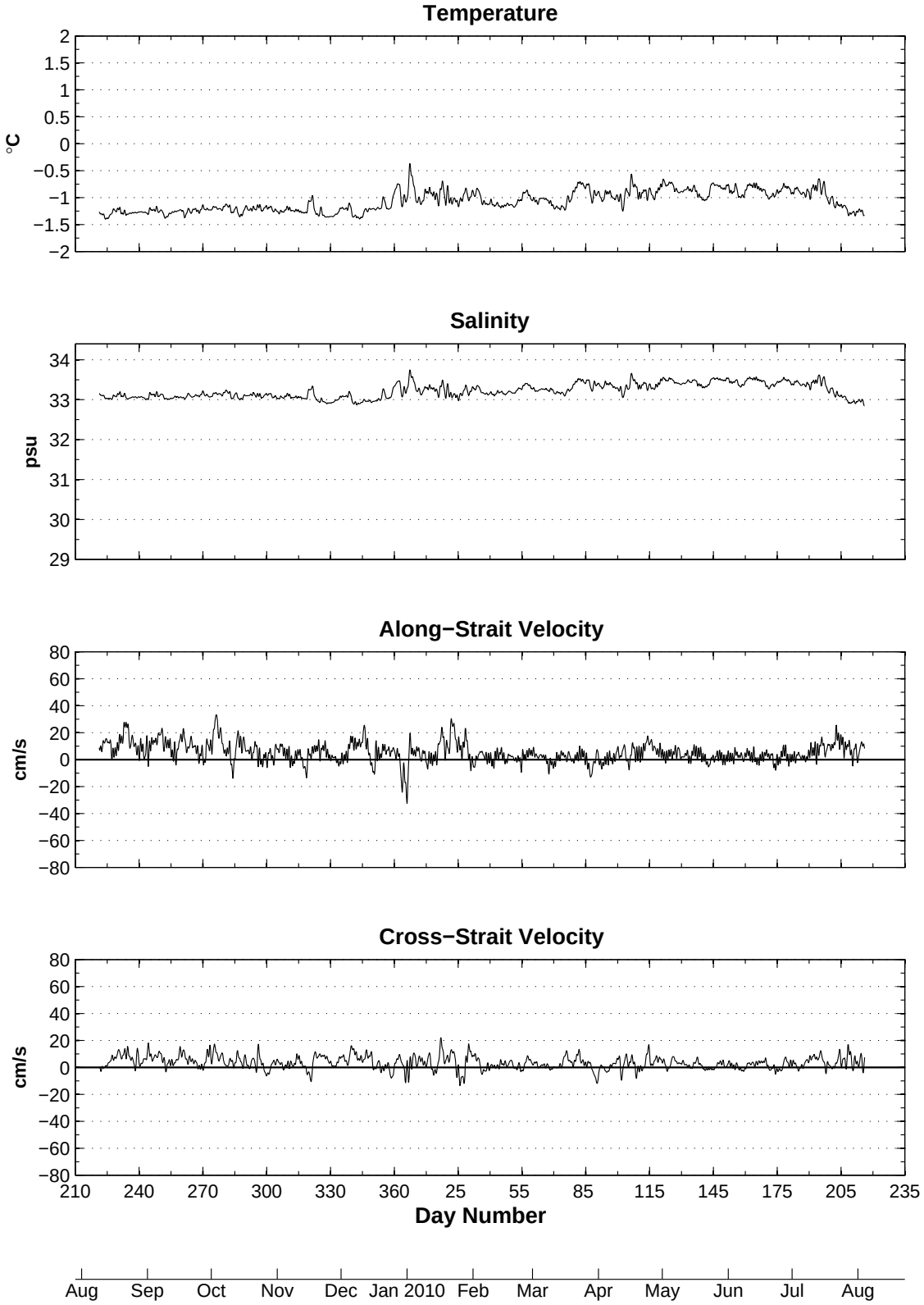
Figure 21: Low-pass filtered T,S (41 m.) and current data (40 m.). South Central Barrow Strait: August 2009 - August 2010.



<u>Figure 22</u>: Low-pass filtered T,S (78 m) and current data (82 m.). South Central Barrow Strait: August 2009 - August 2010.



<u>Figure 23</u>: Low-pass filtered T,S (160 m.) and current data (162 m). South Central Barrow Strait: August 2009 – August 2010.



<u>Figure 24</u>: Low-pass filtered T,S (265 m.) and current data (234 m.). South Central Barrow Strait: August 2009 – August 2010.

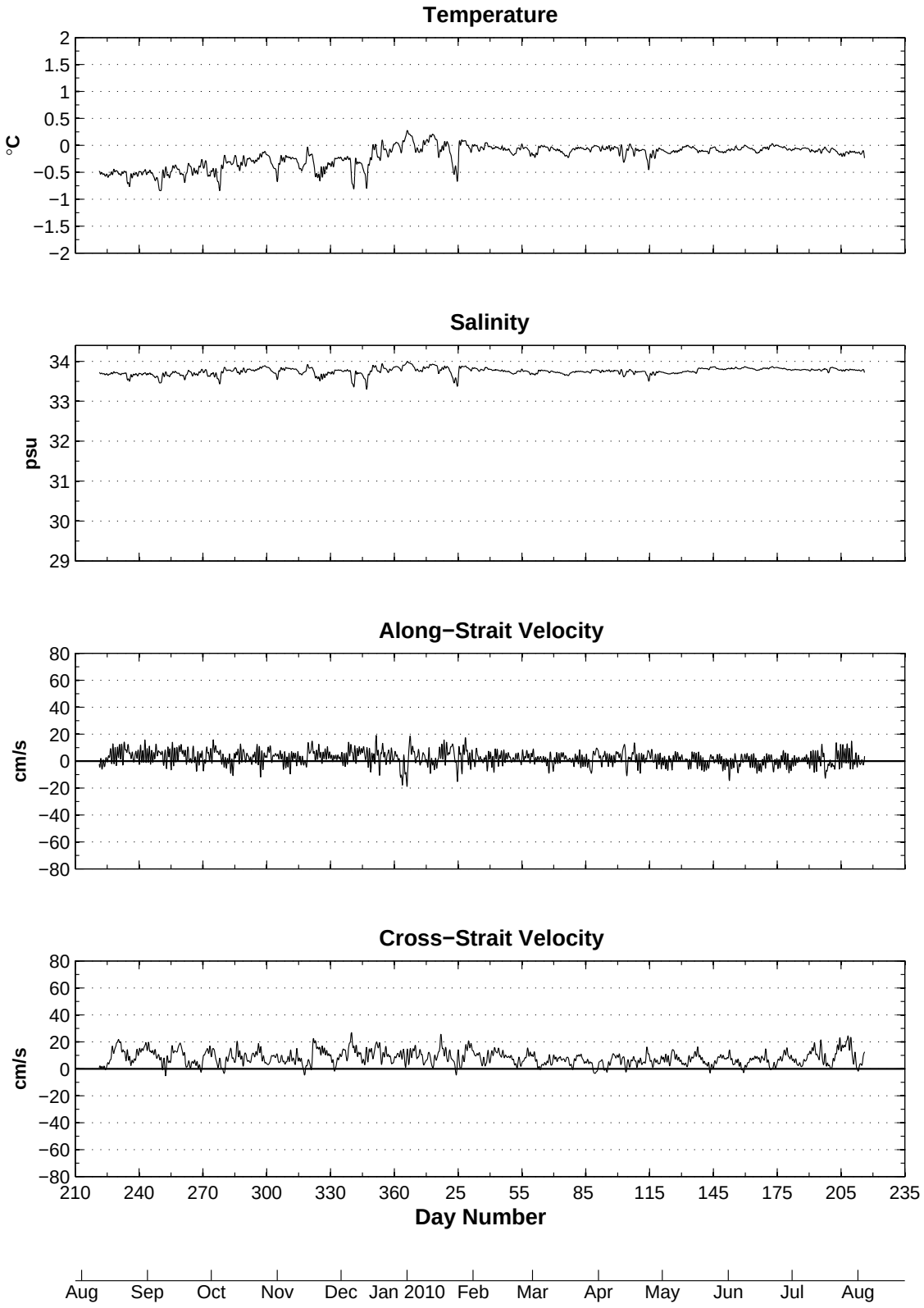


Figure 25: Mean Flows, August 2009 to August 2010.

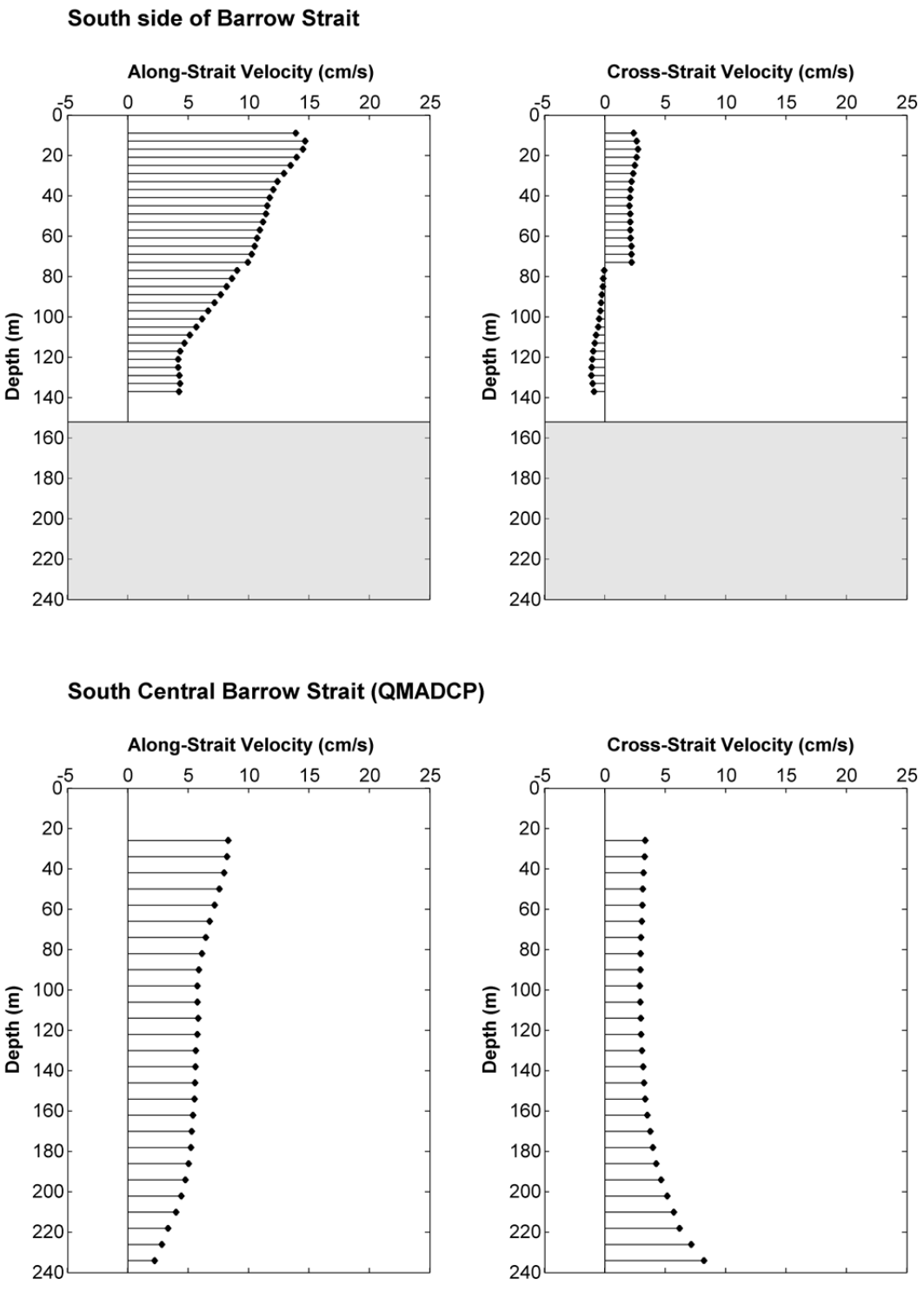


Figure 25: Mean Flows, August 2009 to August 2010. (continued)

South Central Barrow Strait (WHADCP)

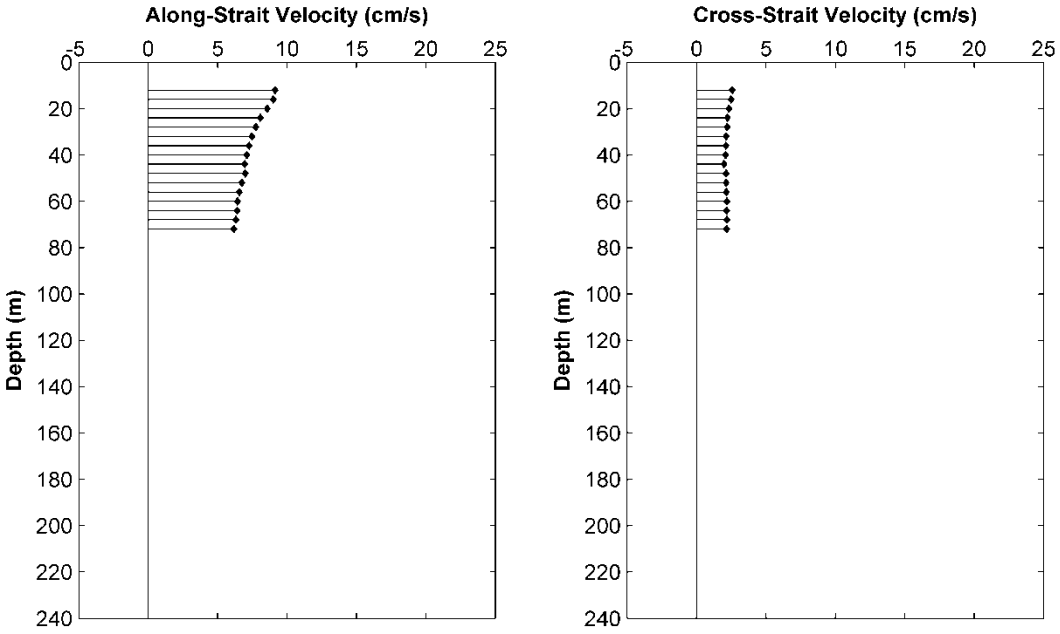


Figure 26: Mean Flows, Late Summer: Aug. 2009 to Sep. 2009.

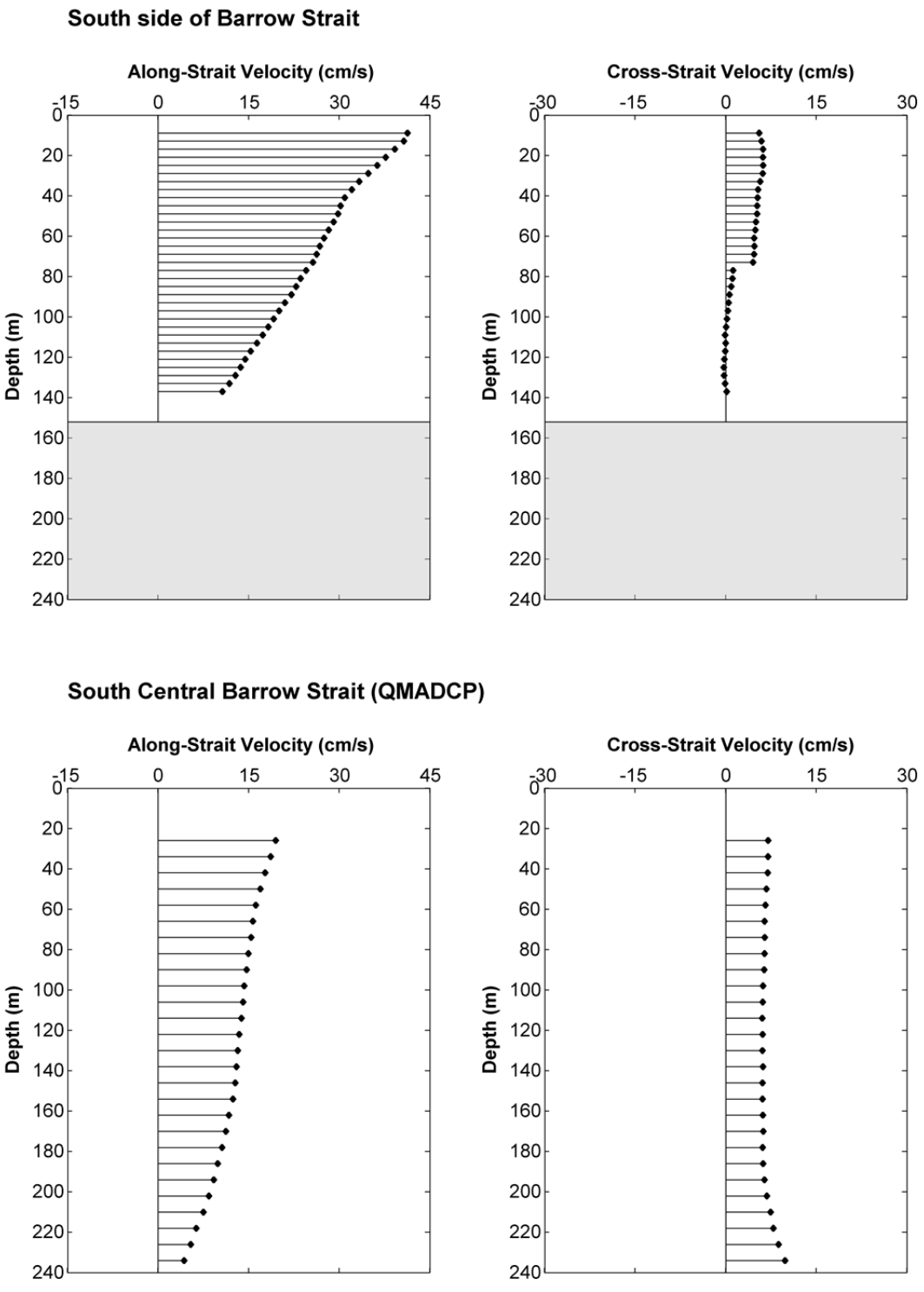


Figure 26: Mean Flows, Late Summer: Aug. 2009 to Sep. 2009 (continued)

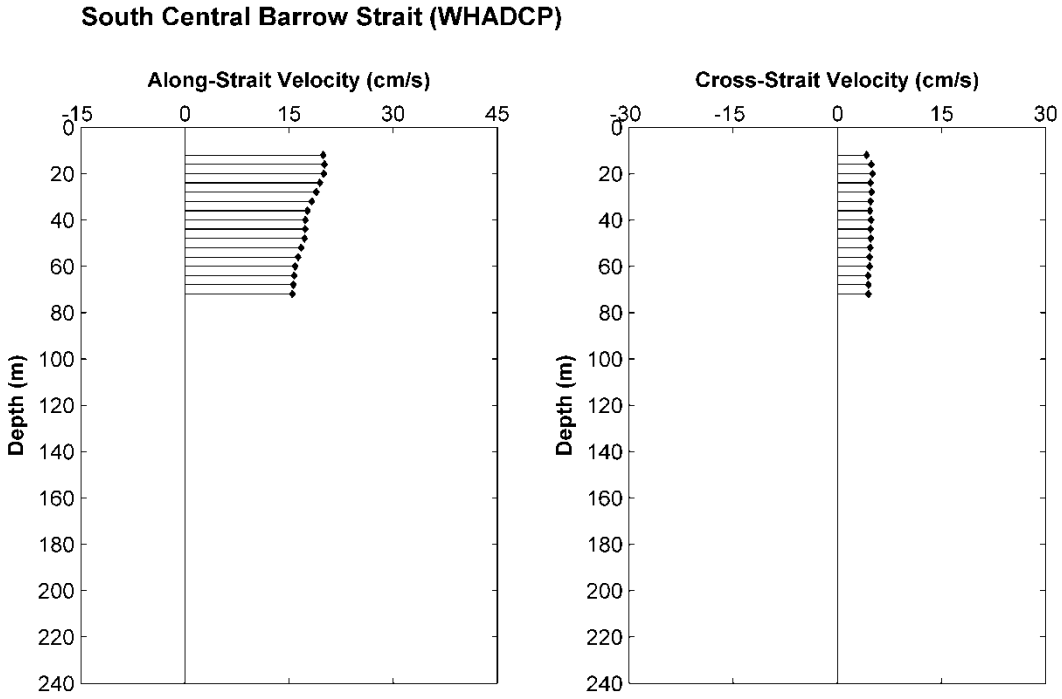


Figure 27: Mean Flows, Fall: Sep. 2009 to Dec. 2009.

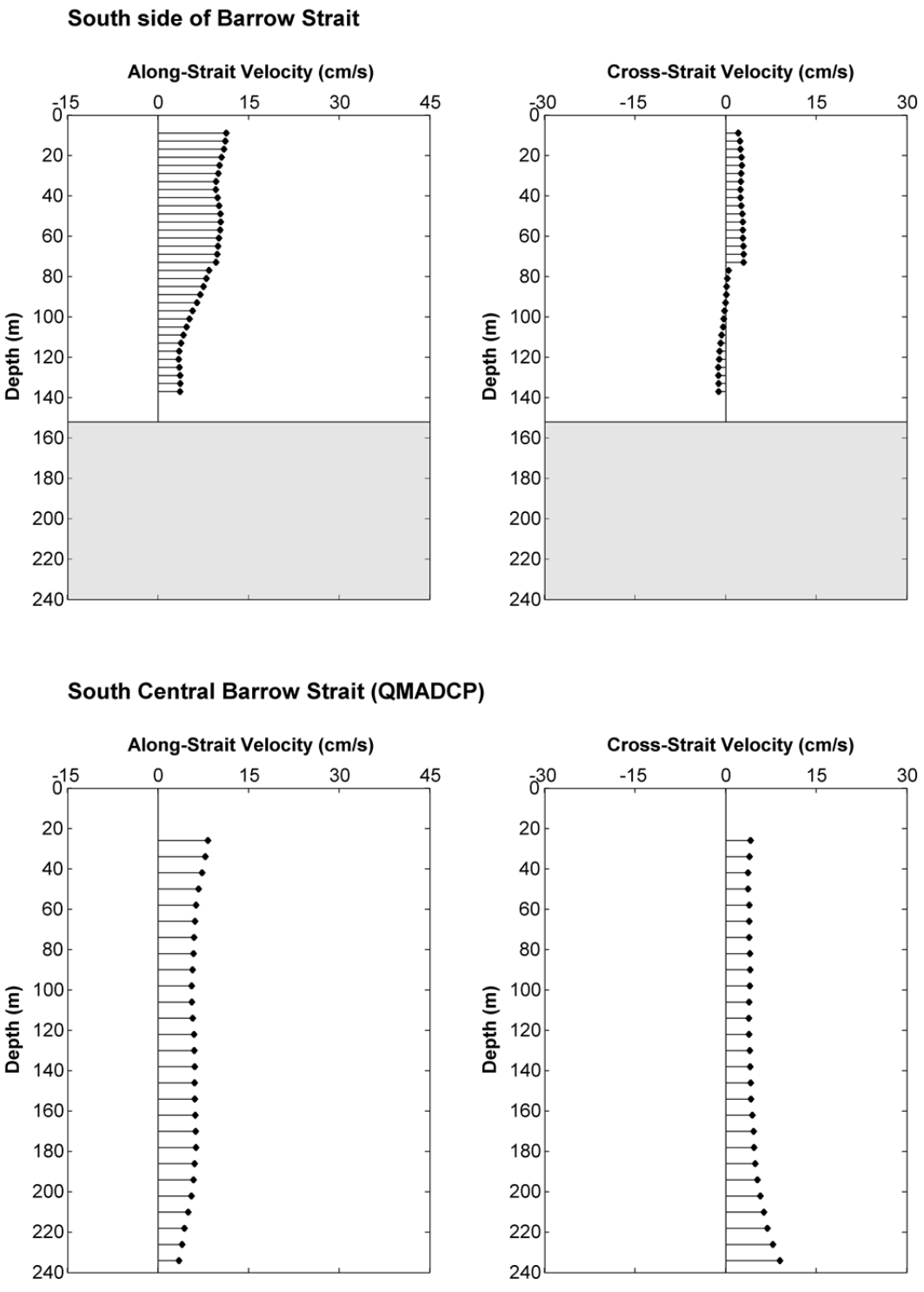


Figure 27: Mean Flows, Fall: Sep. 2009 to Dec. 2009 (continued).

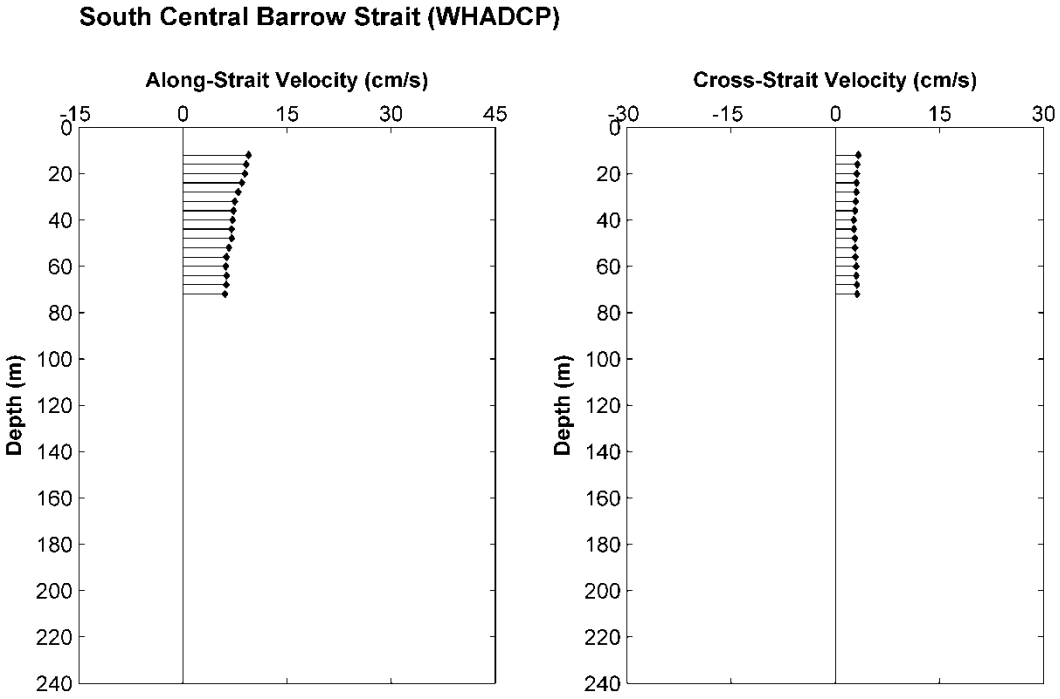


Figure 28: Mean Flows, Winter: Dec. 2009 to Mar. 2010.

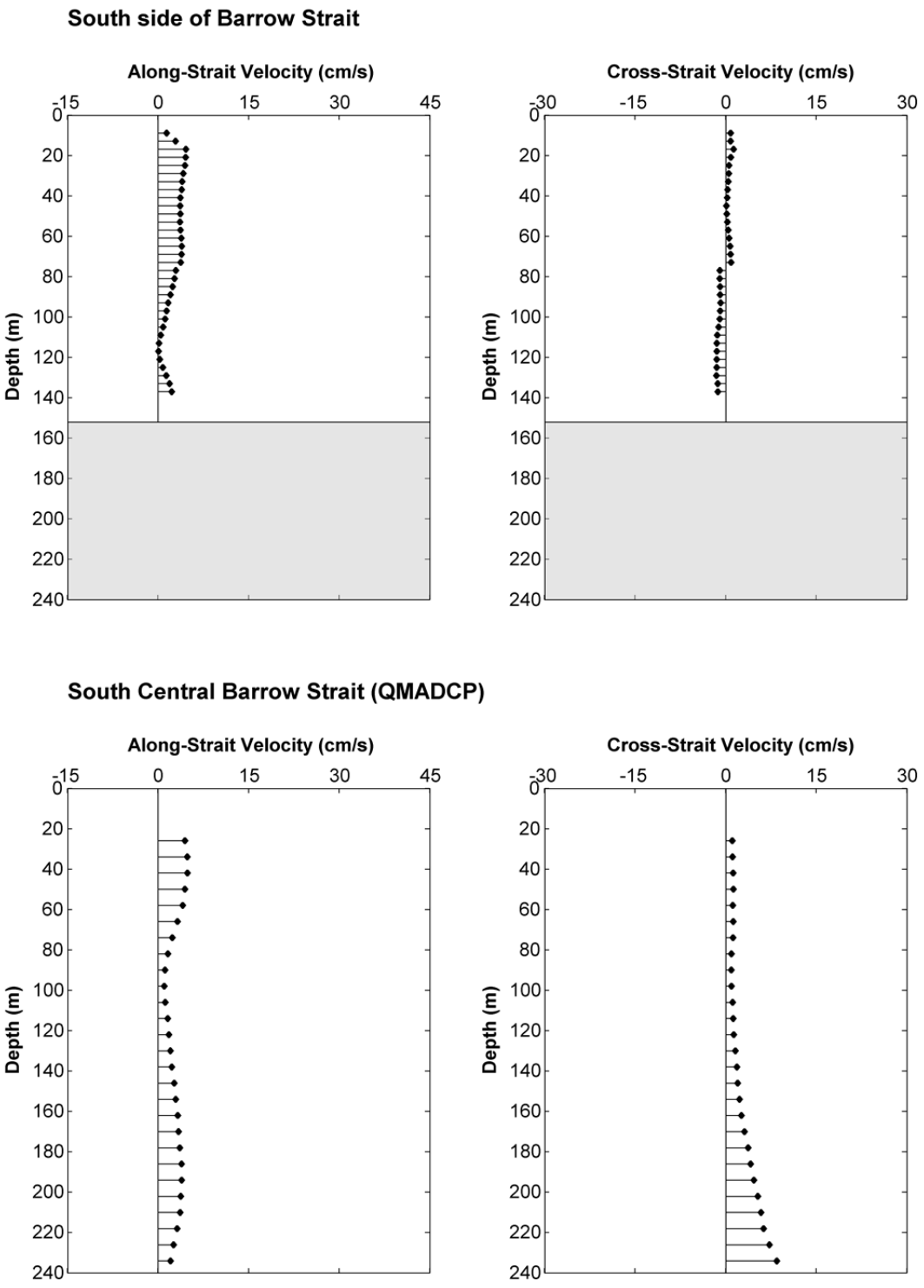


Figure 28: Mean Flows, Winter: Dec. 2009 to Mar. 2010 (continued).

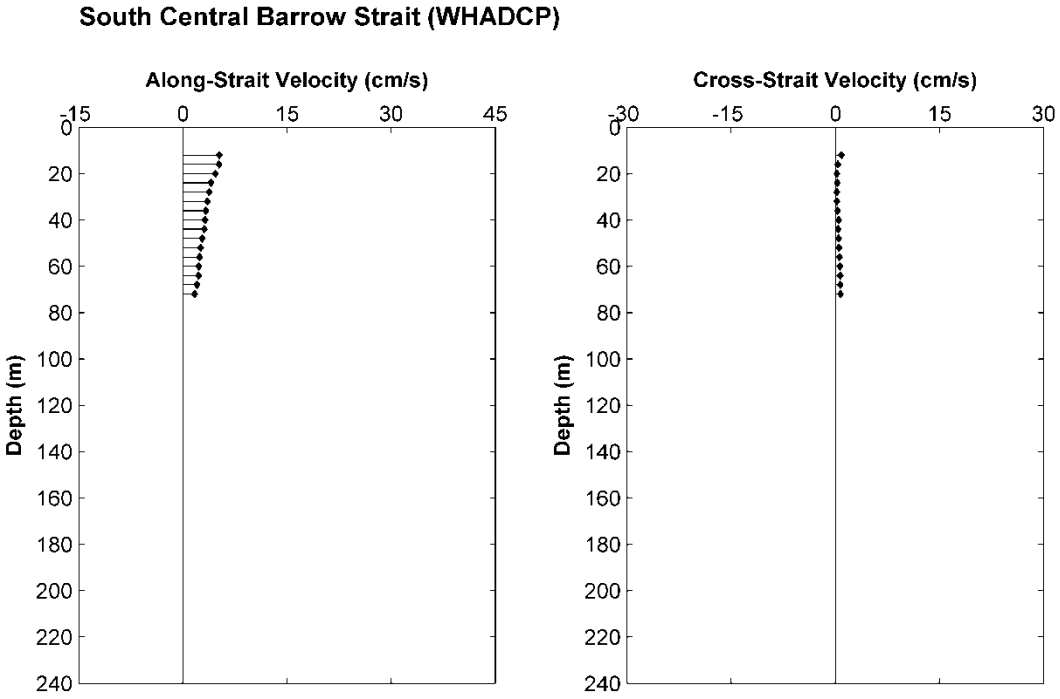


Figure 29: Mean Flows, Spring: Mar. 2010 to Jun. 2010.

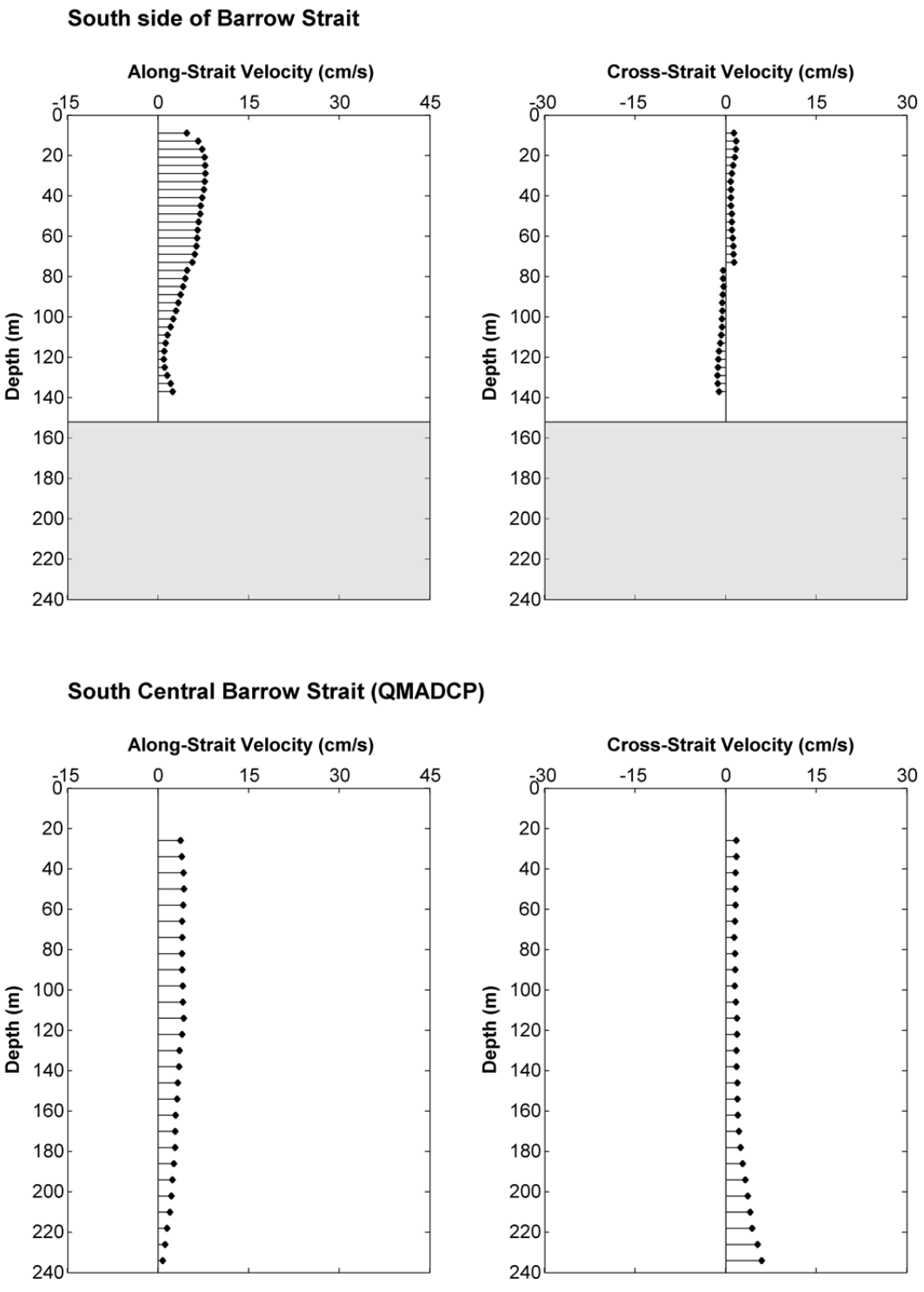


Figure 29: Mean Flows, Spring: Mar. 2010 to Jun. 2010 (continued).

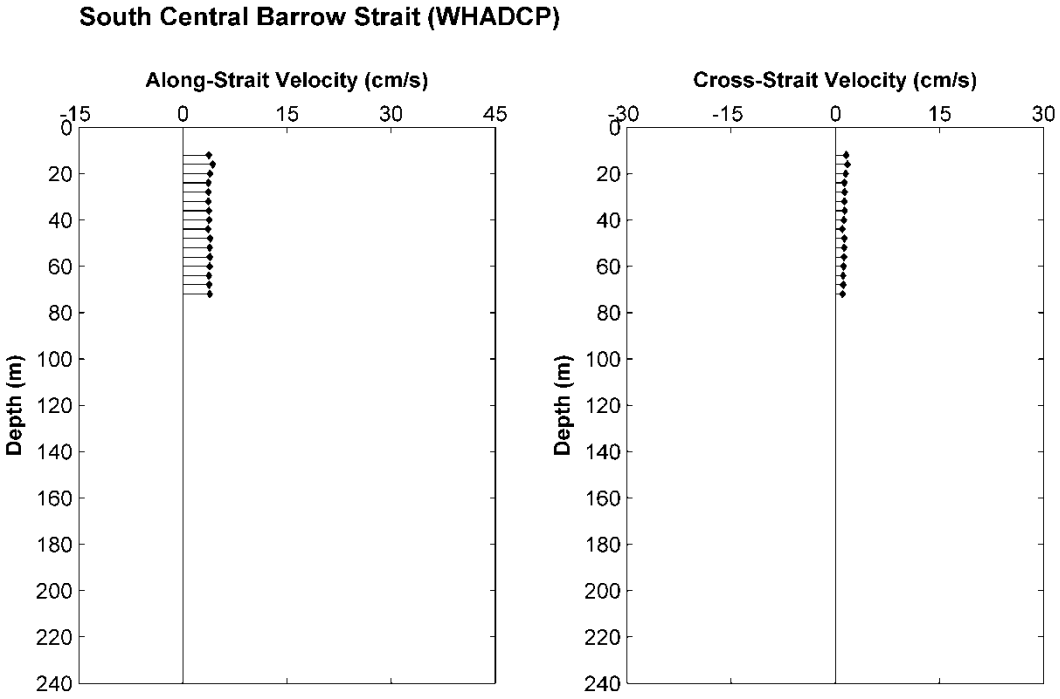


Figure 30: Mean Flows, Early Summer: Jun. 2010 to Aug. 2010.

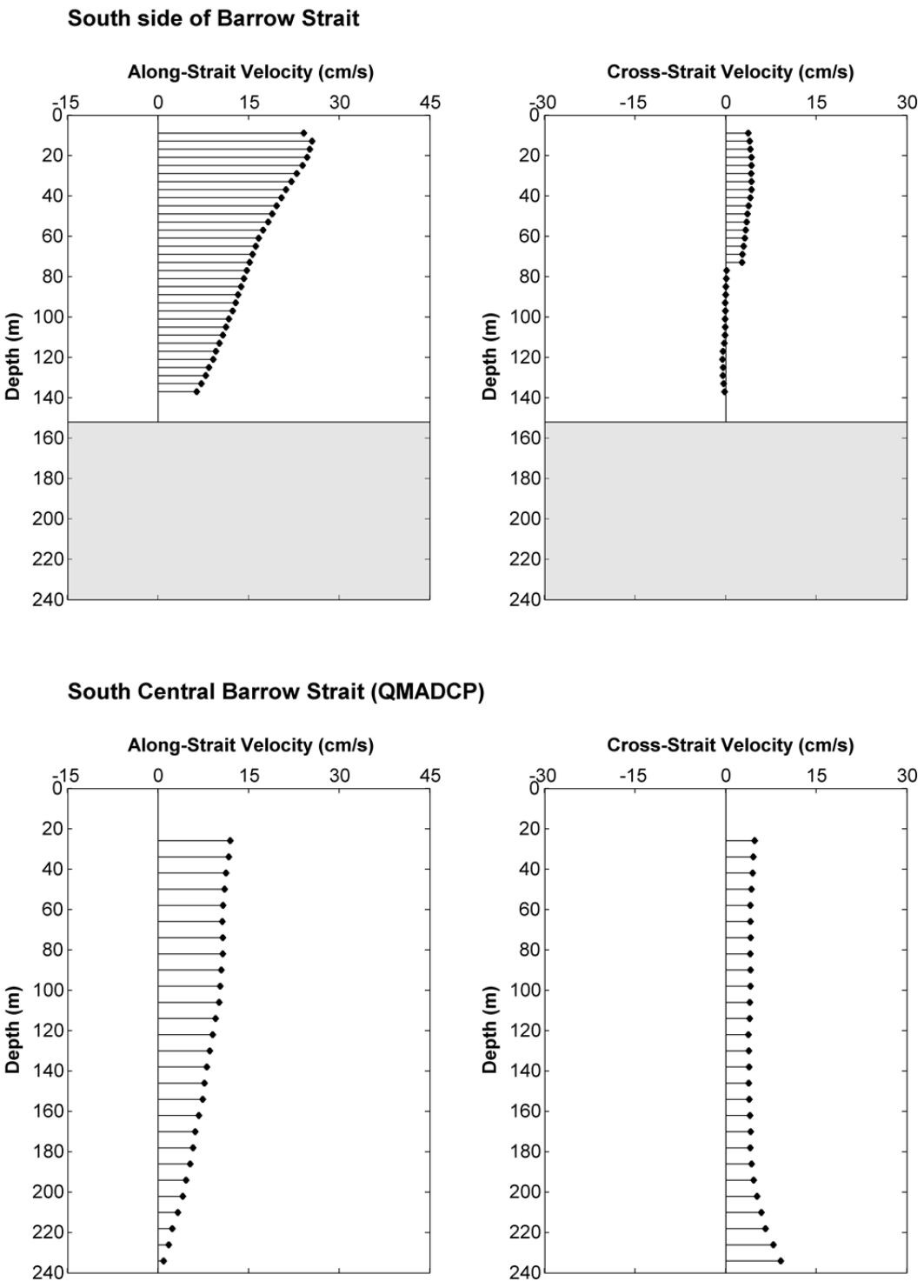


Figure 30: Mean Flows, Early Summer: Jun. 2010 to Aug. 2010 (continued).

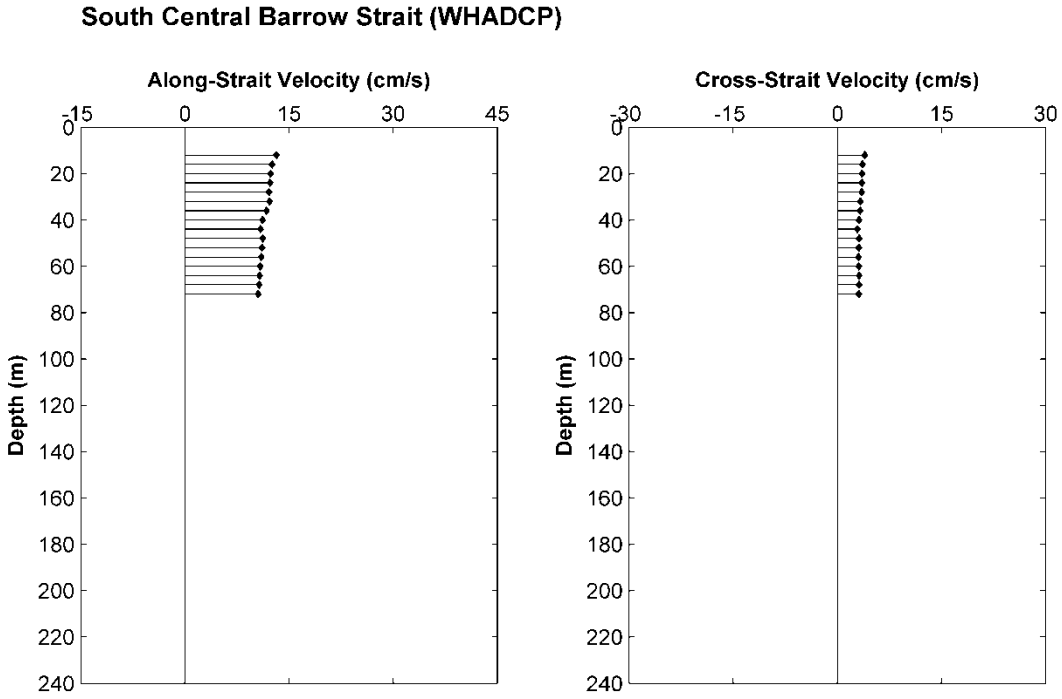


Figure 31: Variance in bi-hourly and low-pass filtered currents. Aug. 2009 to Aug. 2010.

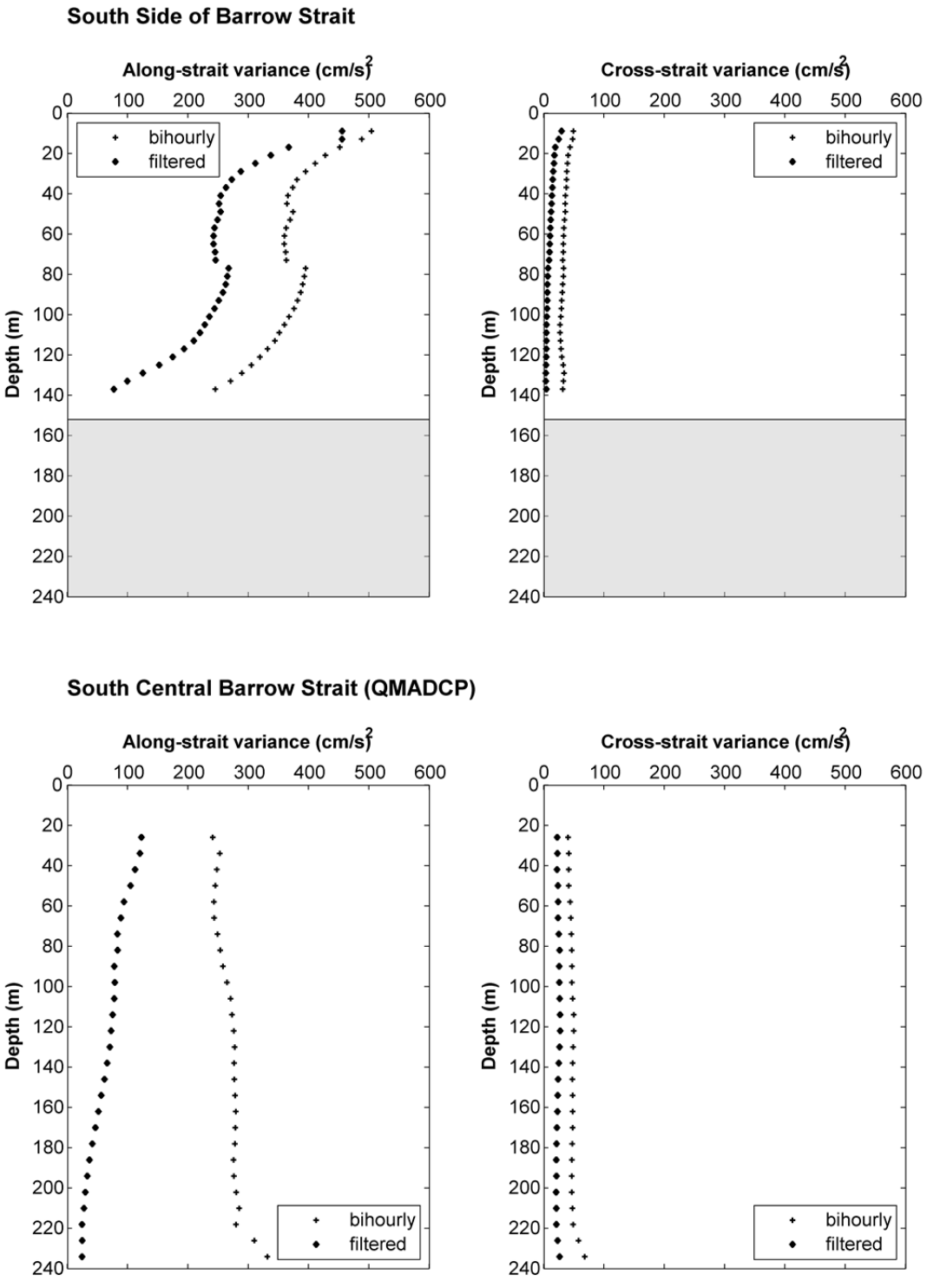


Figure 31: Variance in bi-hourly and low-pass filtered currents Aug. 2009 to Aug. 2010 (continued).

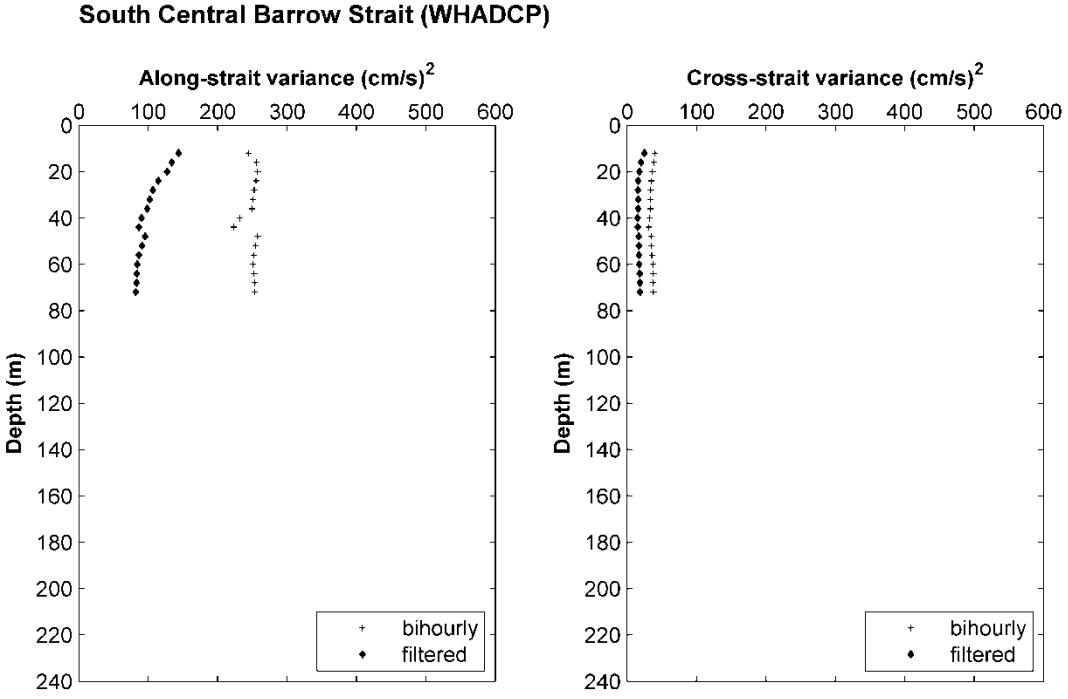
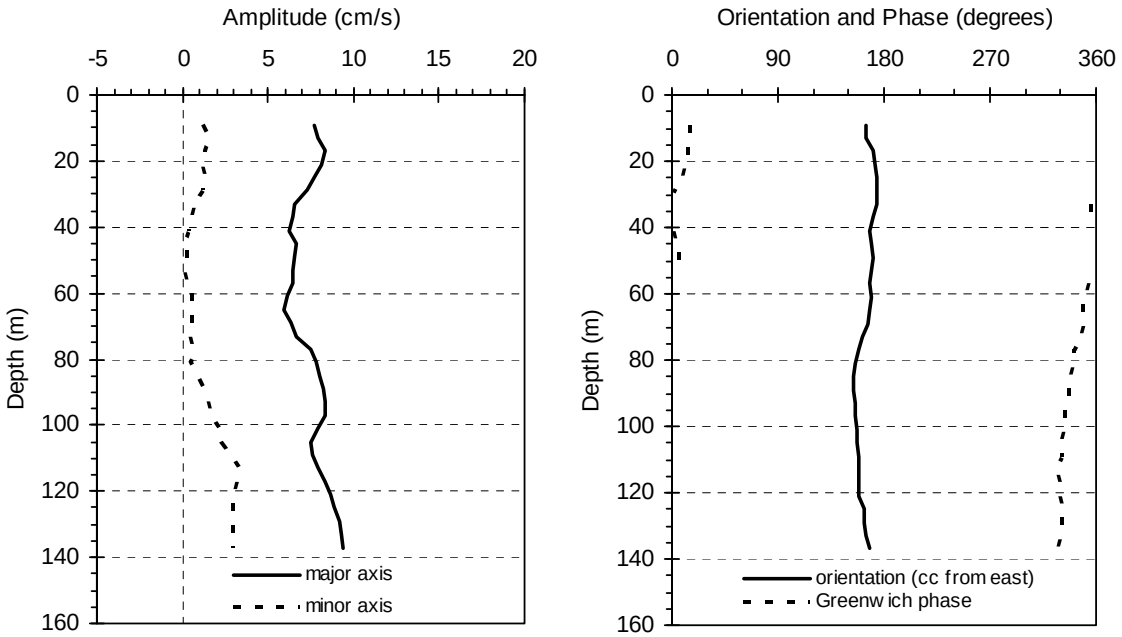


Figure 32: K1 Tidal Constituent, South Side of Barrow Strait

For Ice Free Period (Aug. 5, 2009 to Oct. 8, 2009):



For Solid Ice Period

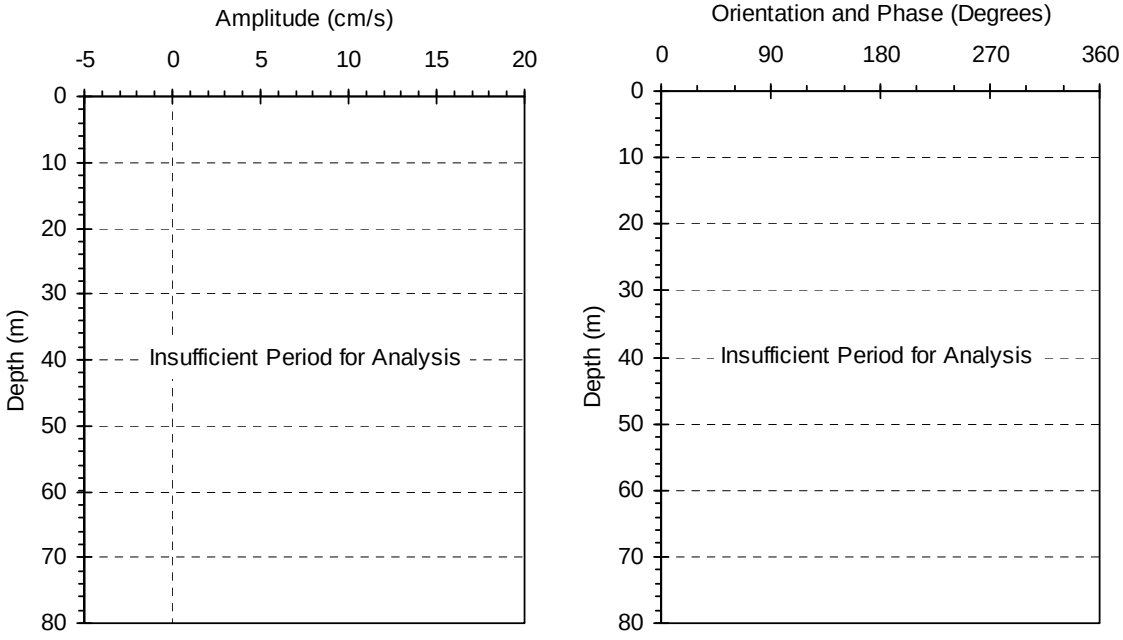
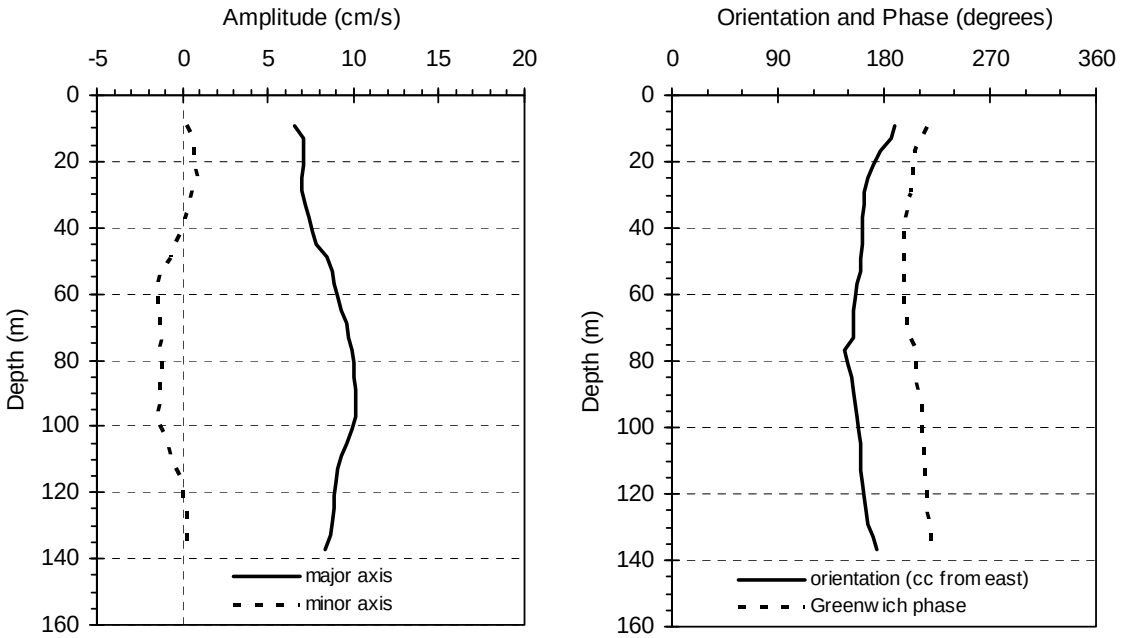


Figure 33: M2 Tidal Constituent, South Side of Barrow Strait

For Ice Free Period (Aug. 5, 2009 to Oct. 8, 2009):



For Solid Ice Period

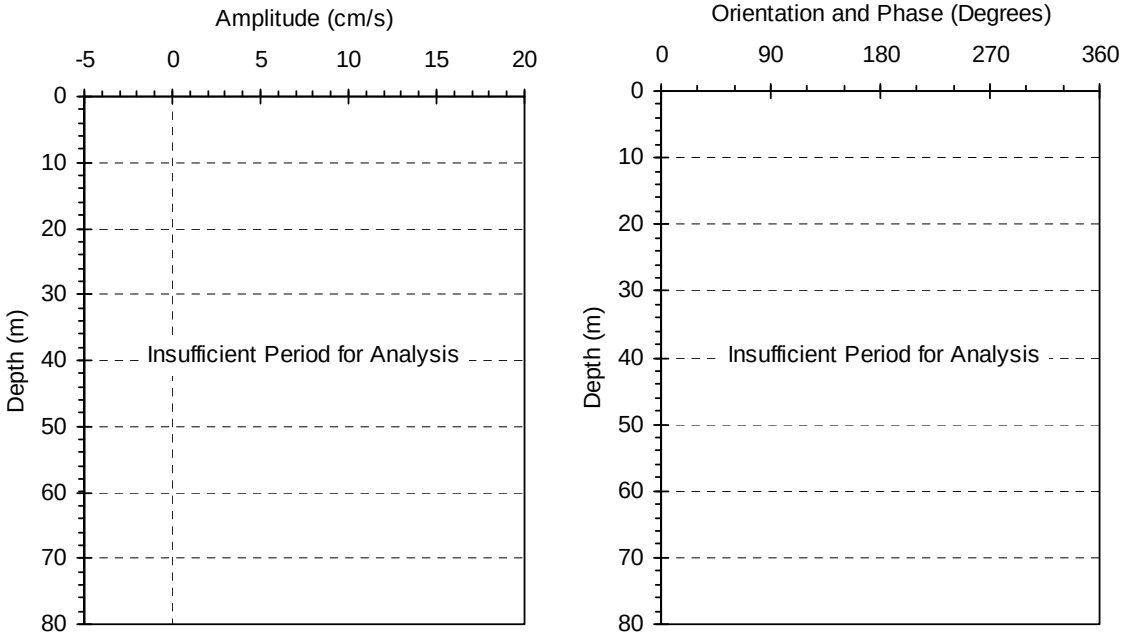
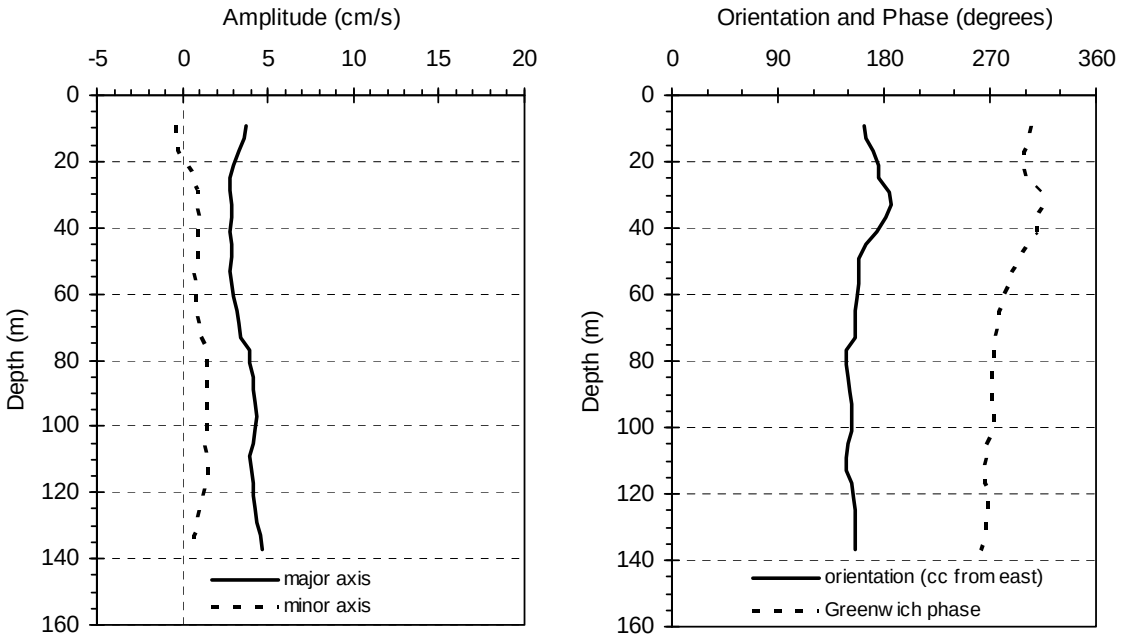


Figure 34: O1 Tidal Constituent, South Side of Barrow Strait

For Ice Free Period (Aug. 5, 2009 to Oct. 8, 2009):



For Solid Ice Period

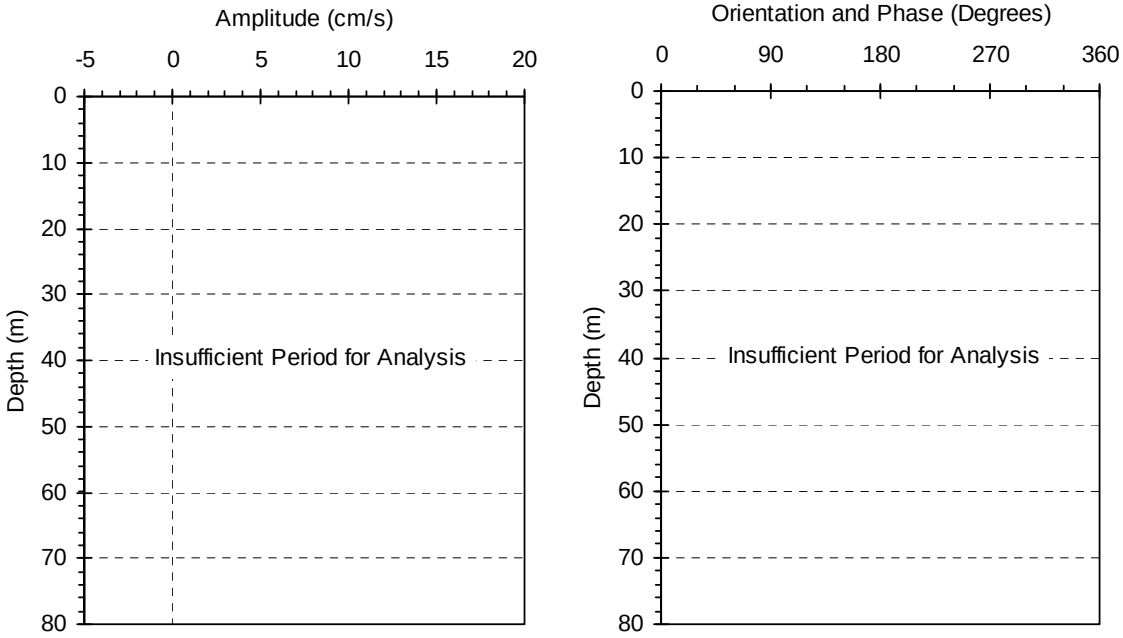
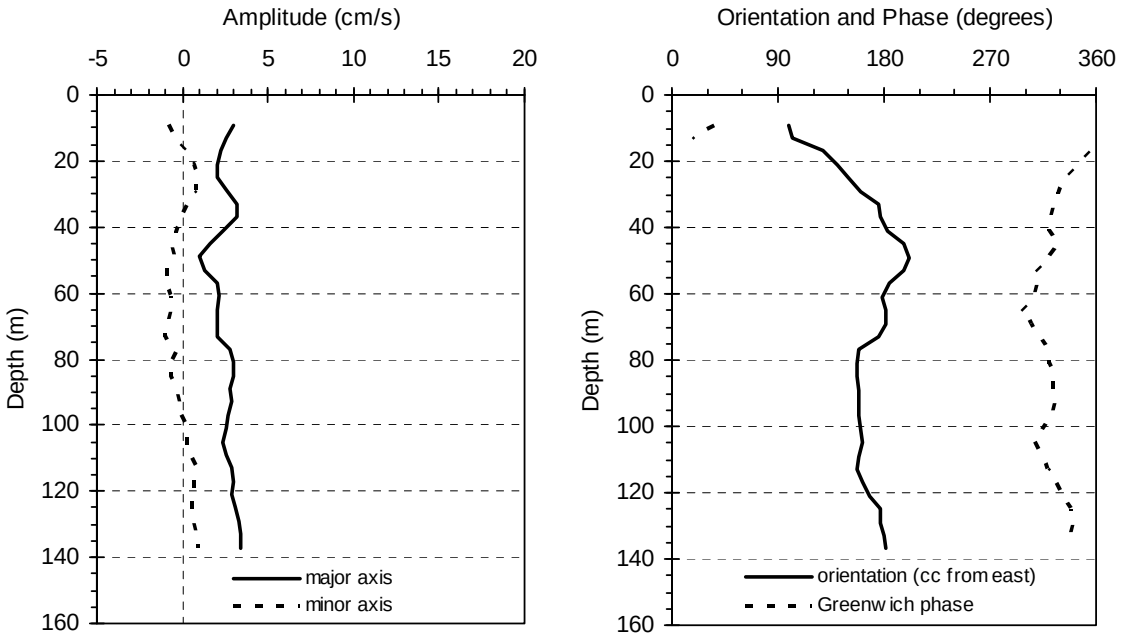


Figure 35: P1 Tidal Constituent, South Side of Barrow Strait

For Ice Free Period (Aug. 5, 2009 to Oct. 8, 2009):



For Solid Ice Period

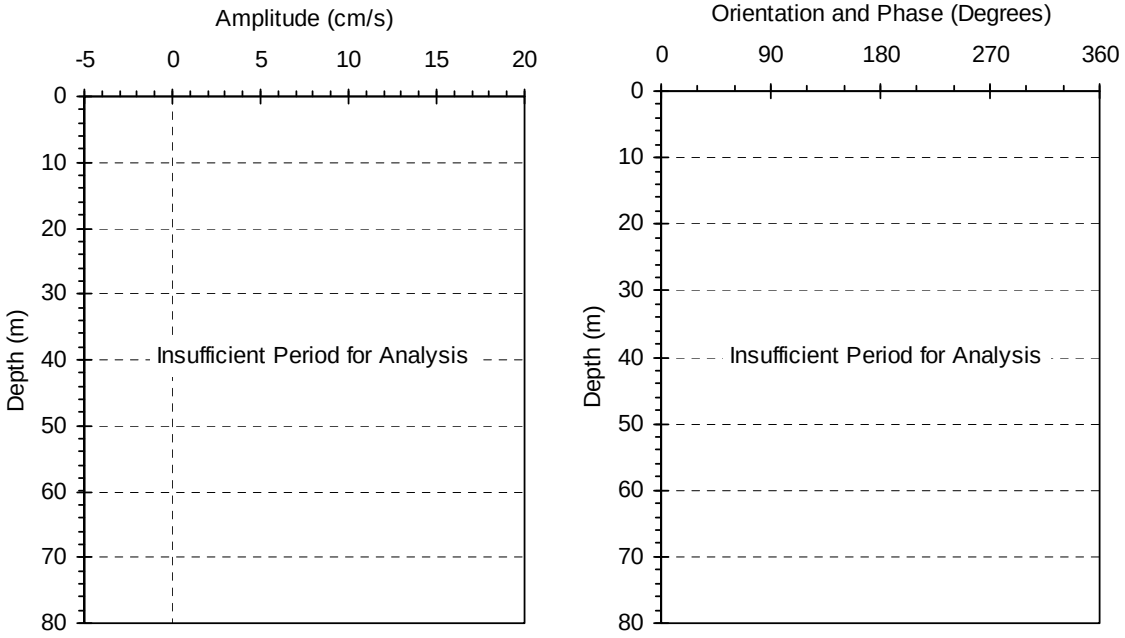
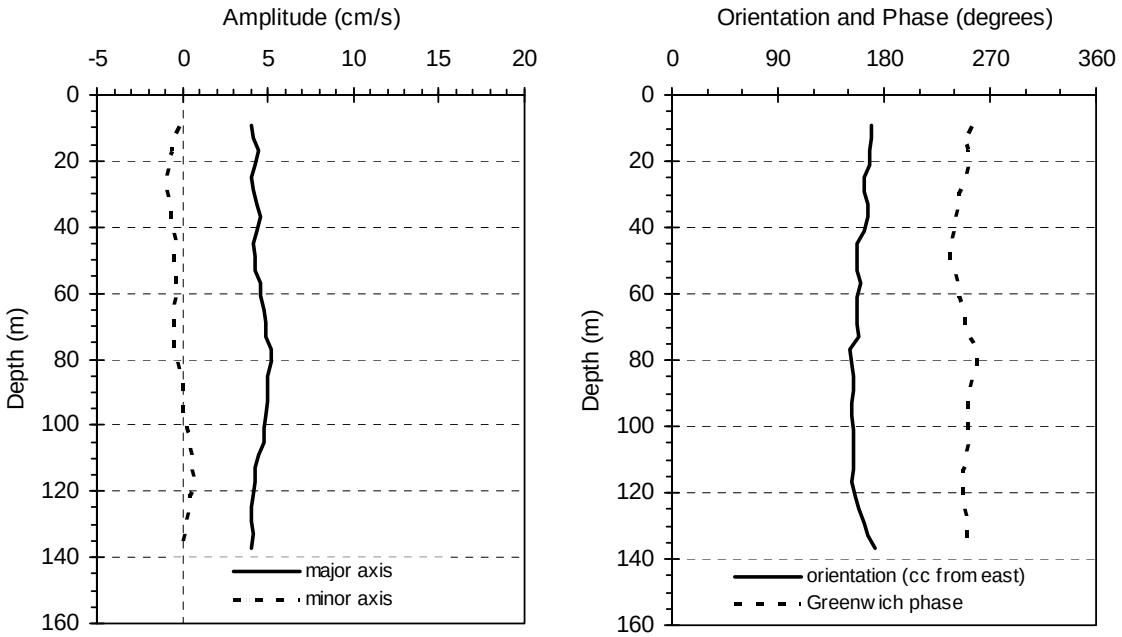


Figure 36: S2 Tidal Constituent, South Side of Barrow Strait

For Ice Free Period (Aug. 5, 2009 to Oct. 8, 2009):



For Solid Ice Period

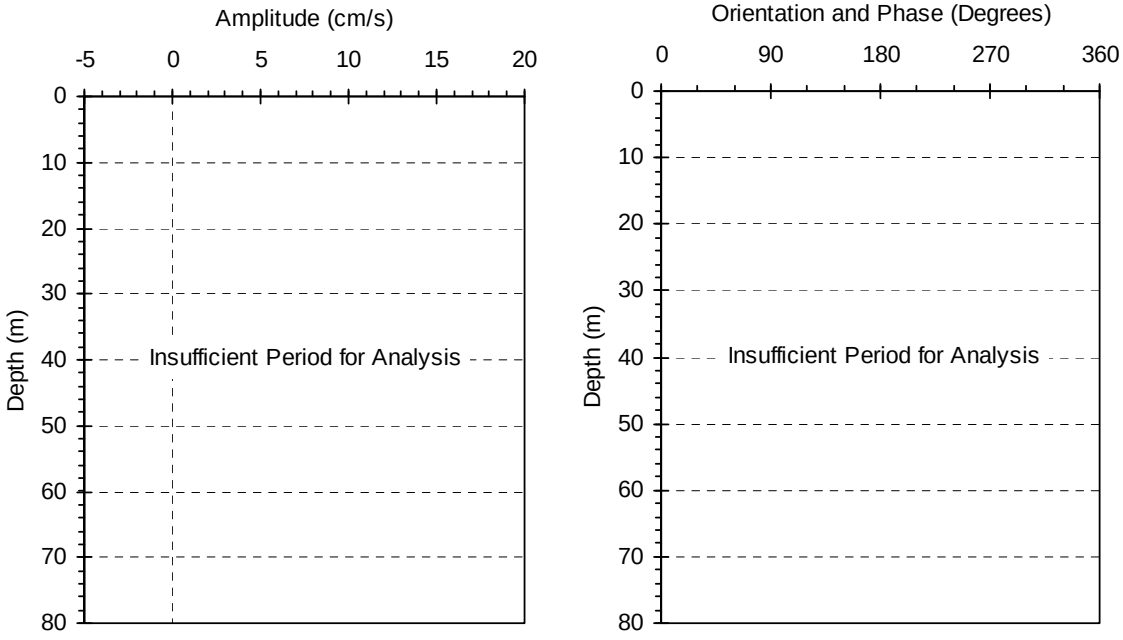
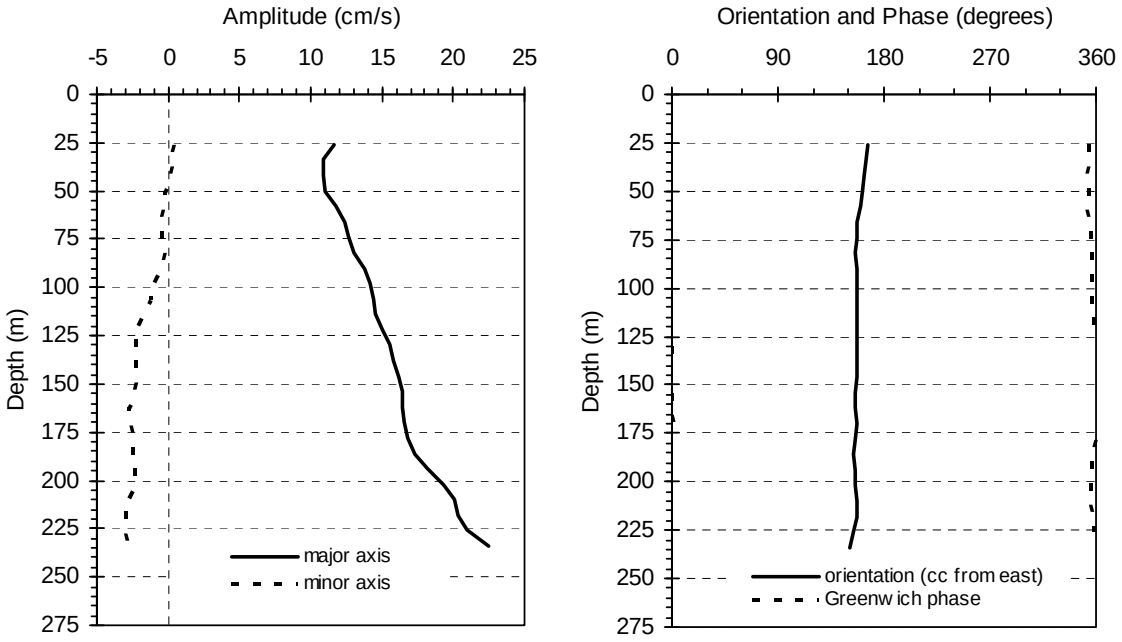


Figure 37: K1 Tidal Constituent, South Central Barrow Strait (Quarter Master ADCP)

For Ice Free Period (Aug. 6, 2009 to Oct. 9, 2009):



For Solid Ice Period

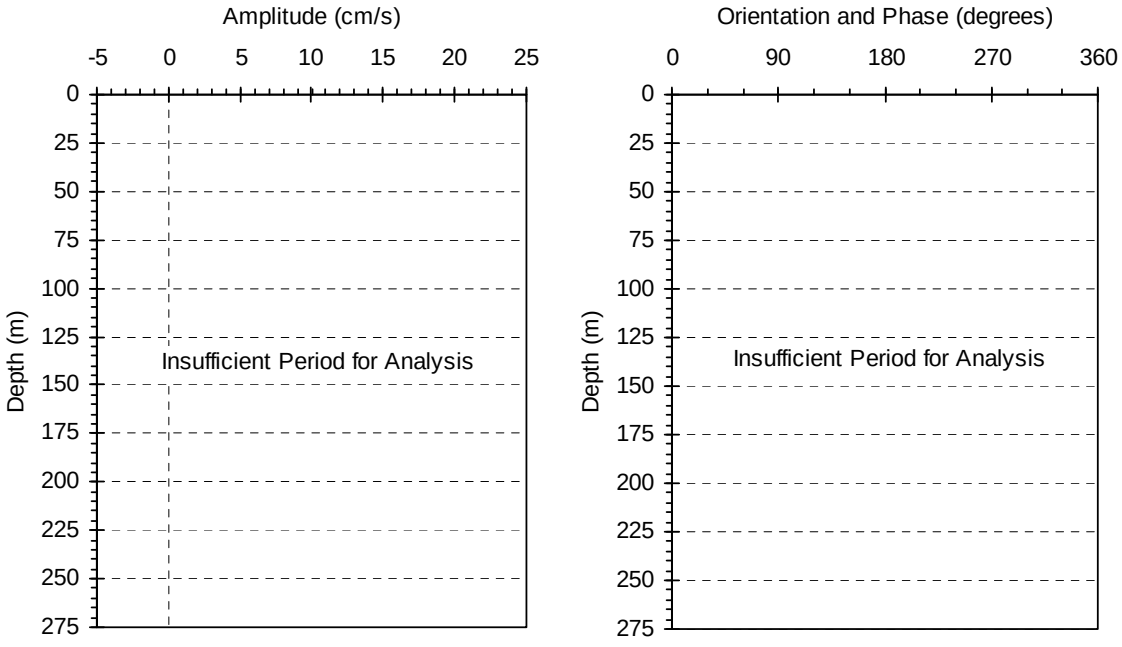
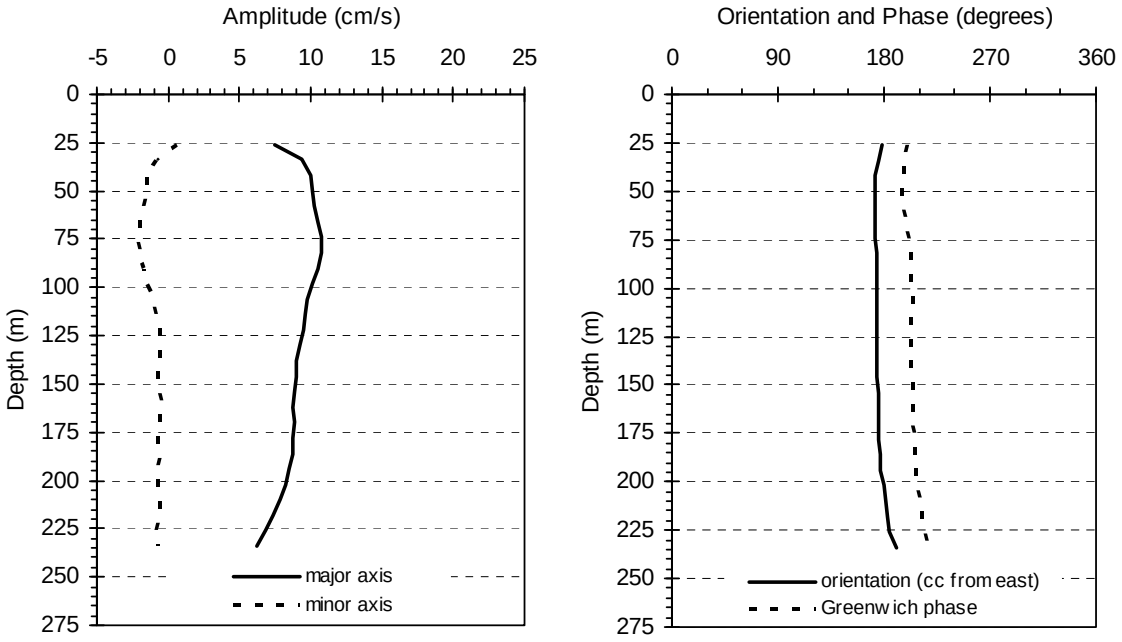


Figure 38: M2 Tidal Constituent, South Central Barrow Strait (Quarter Master ADCP)

For Ice Free Period (Aug. 6, 2009 to Oct. 9, 2009):



For Solid Ice Period

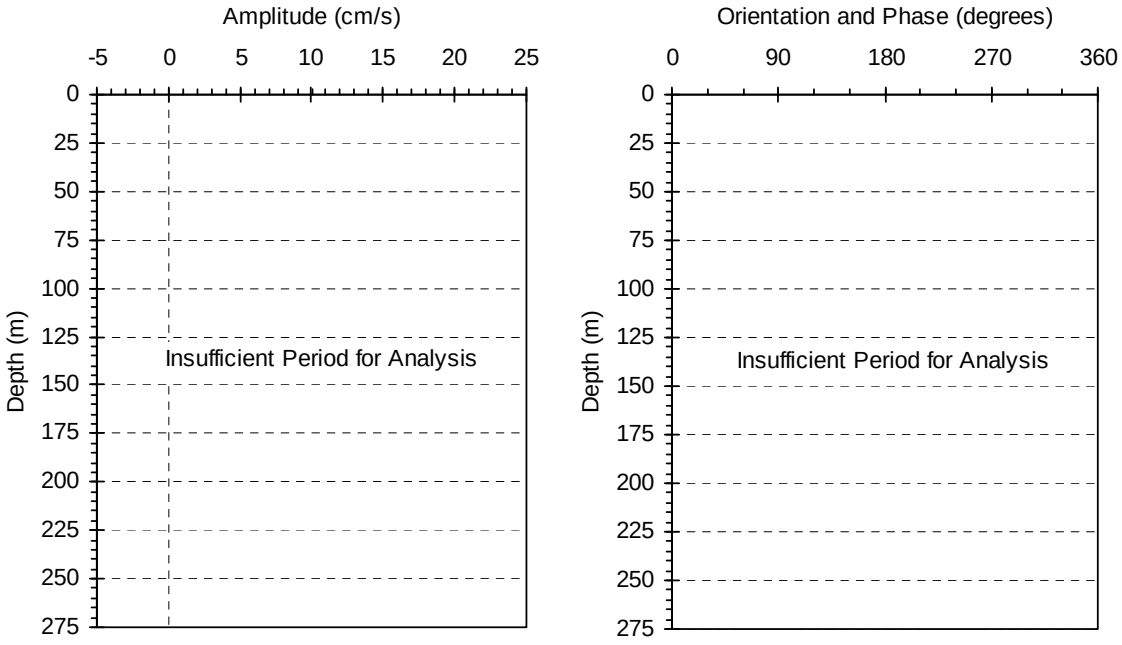
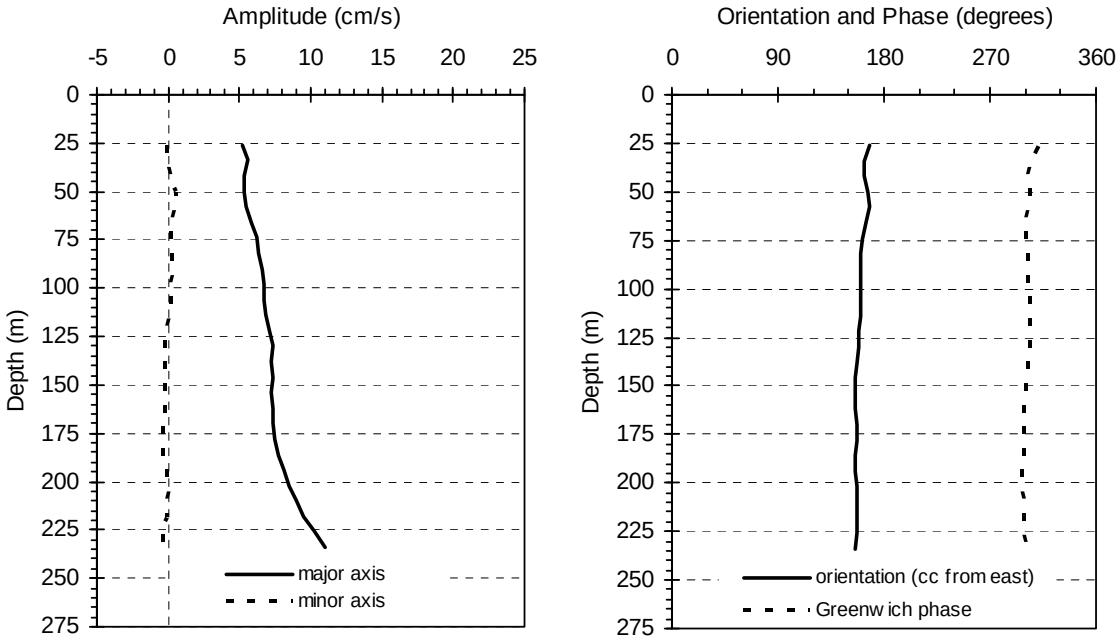


Figure 39: O1 Tidal Constituent, South Central Barrow Strait (Quarter Master ADCP)

For Ice Free Period (Aug. 6, 2009 to Oct. 9, 2009):



For Solid Ice Period

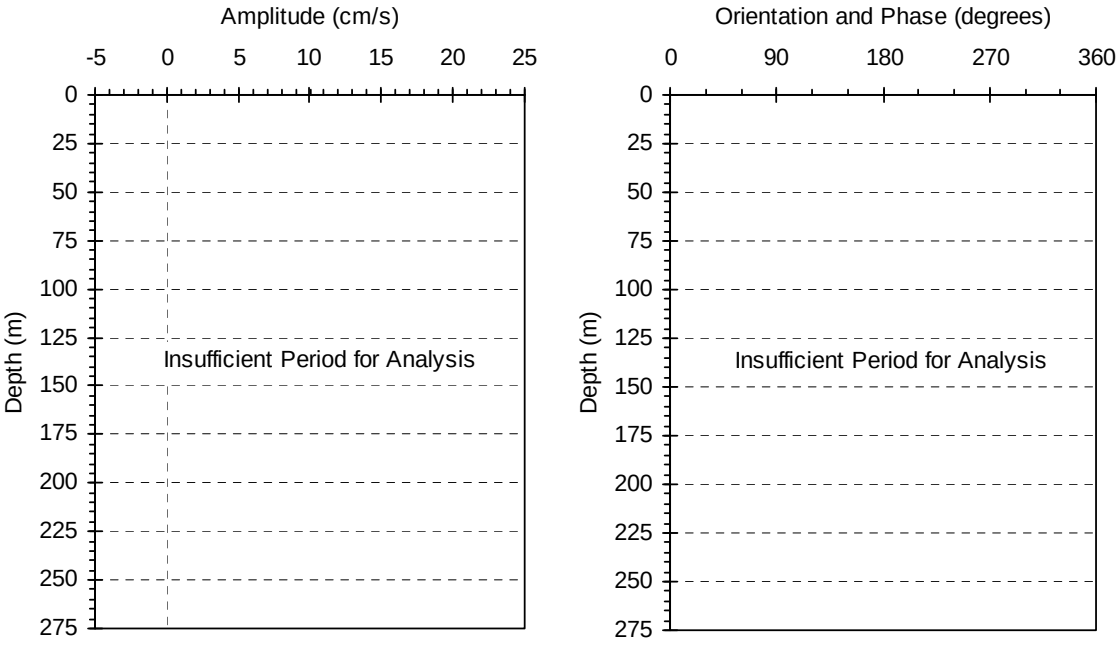
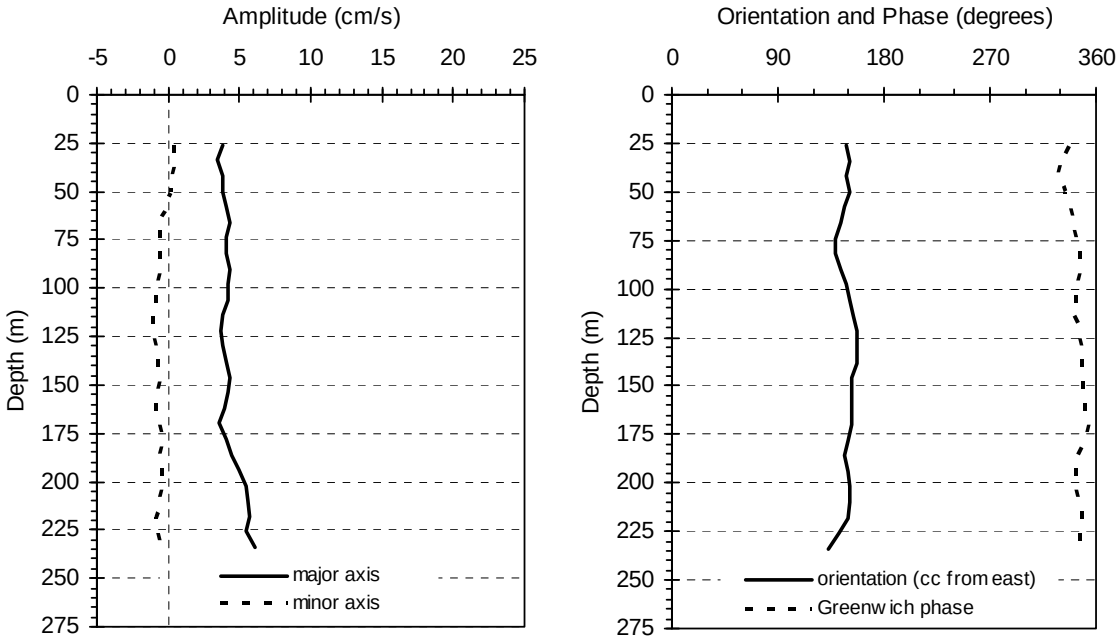


Figure 40: P1 Tidal Constituent, South Central Barrow Strait (Quarter Master ADCP)

For Ice Free Period (Aug. 6, 2009 to Oct. 9, 2009):



For Solid Ice Period

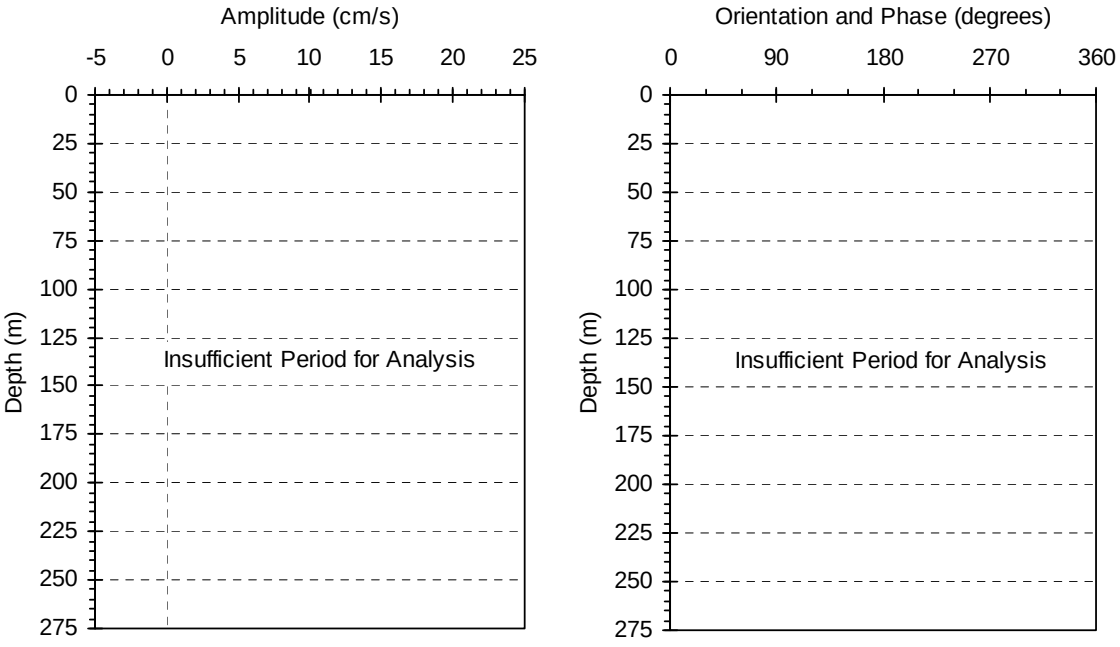
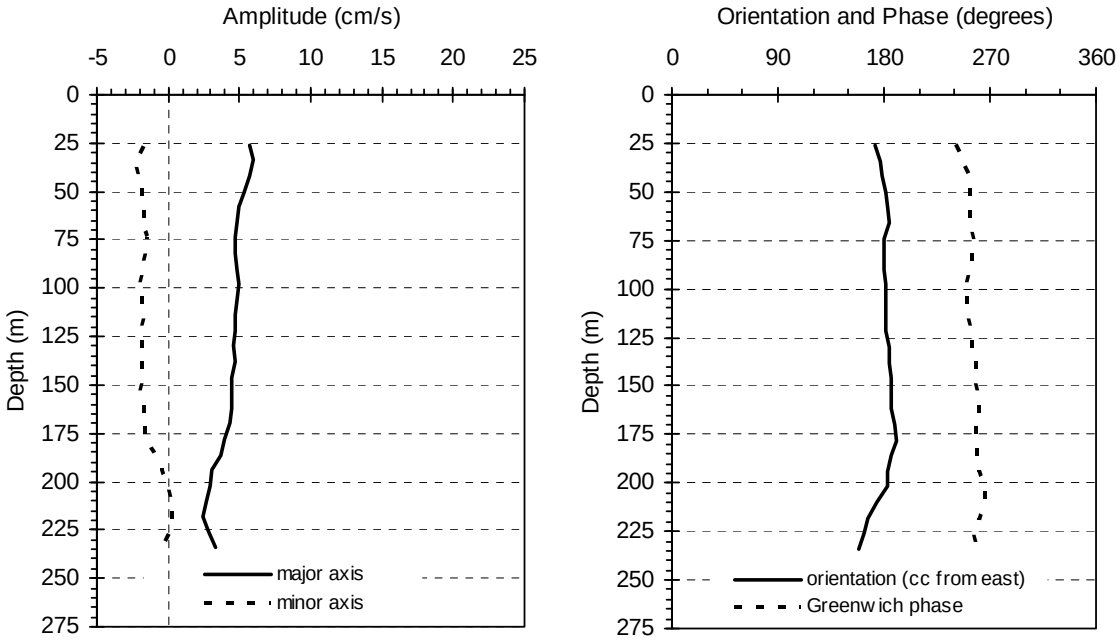


Figure 41: S2 Tidal Constituent, South Central Barrow Strait (Quarter Master ADCP)

For Ice Free Period (Aug. 6, 2009 to Oct. 9, 2009):



For Solid Ice Period

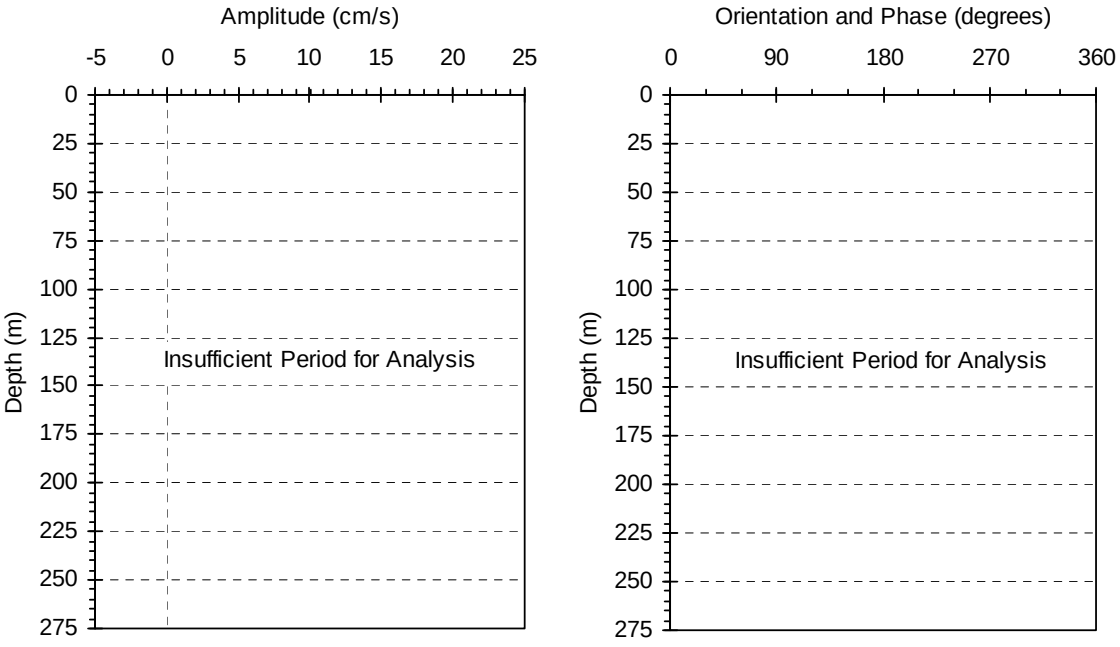
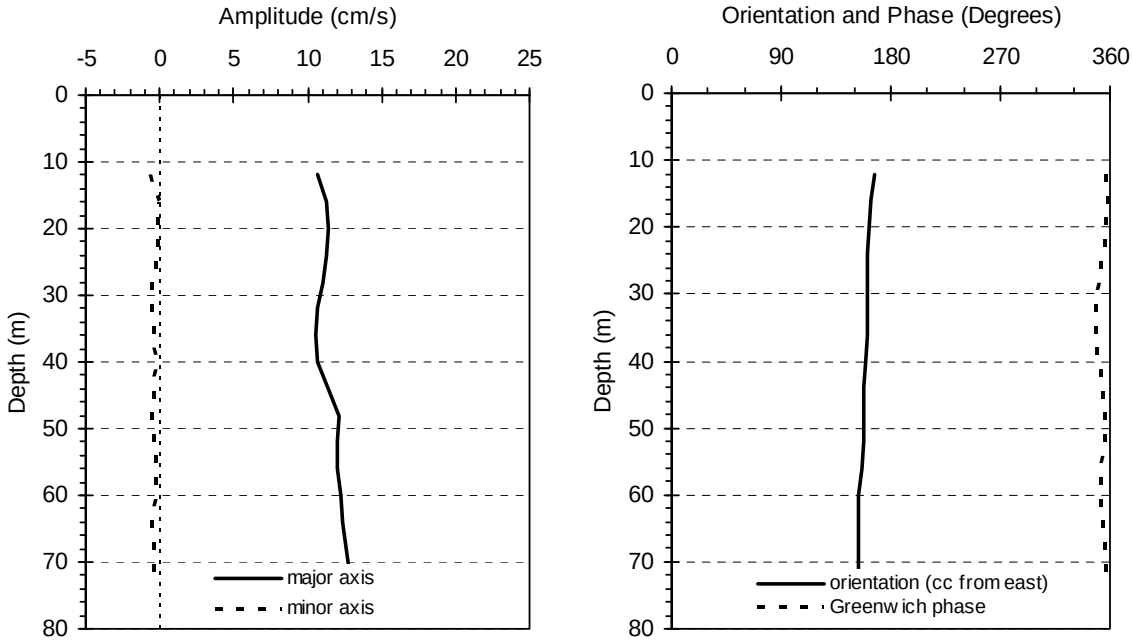


Figure 42: K1 Tidal Constituent, South Central Barrow Strait (Workhorse ADCP)

For Ice Free Period (Aug. 6, 2009 to Oct. 9, 2009):



For Solid Ice Period

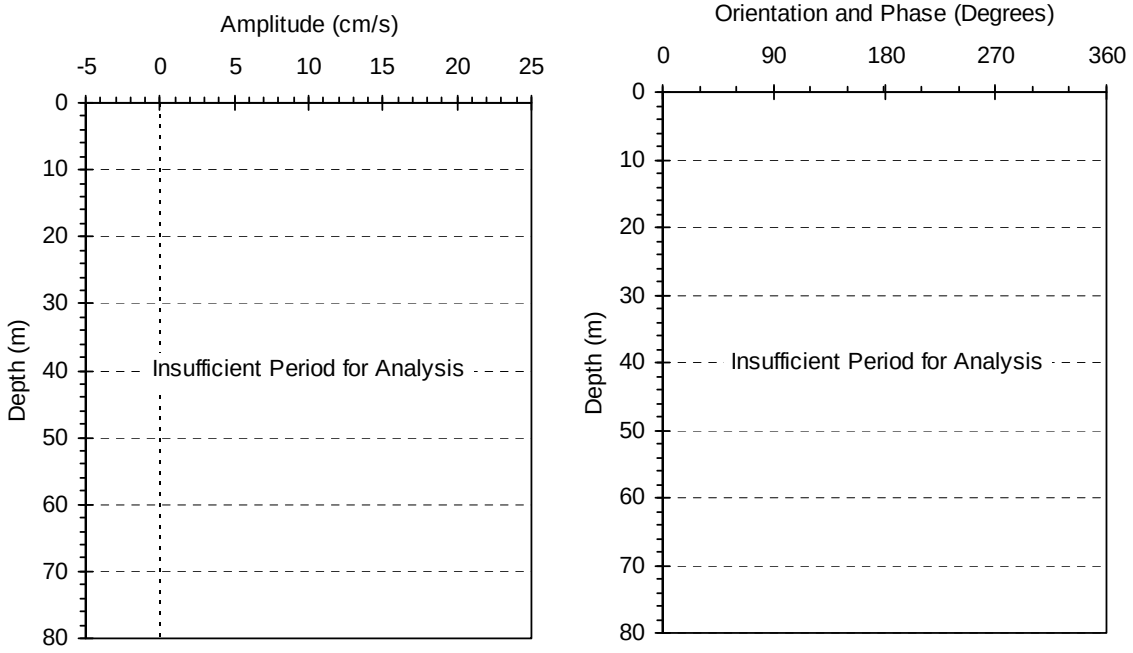
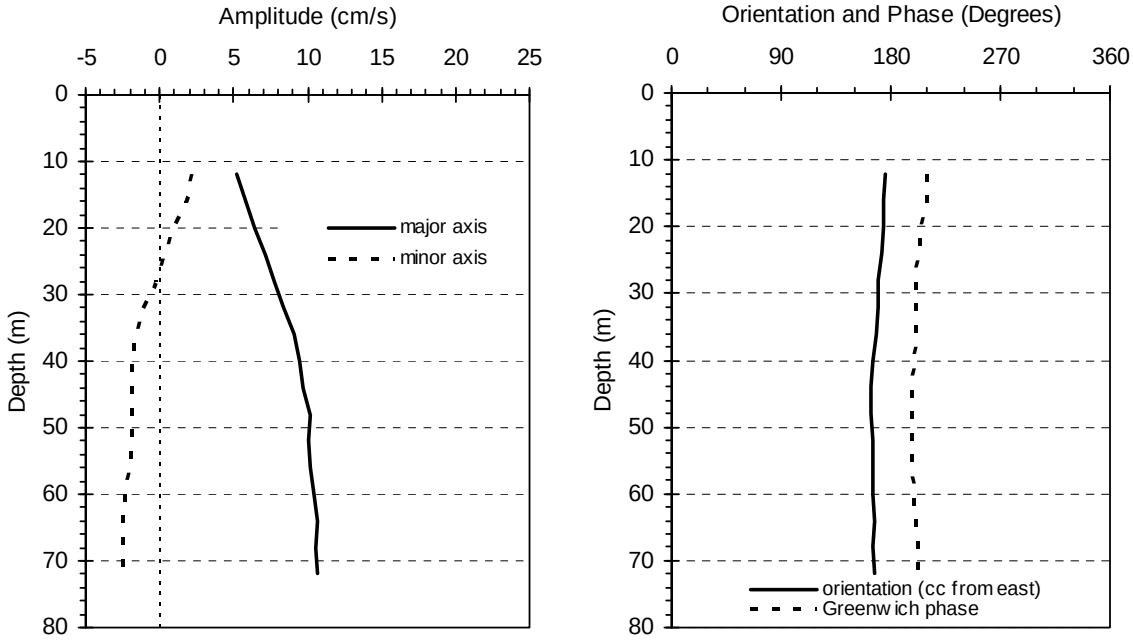


Figure 43: M2 Tidal Constituent, South Central Barrow Strait (Workhorse ADCP)

For Ice Free Period (Aug. 6, 2009 to Oct. 9, 2009):



For Solid Ice Period

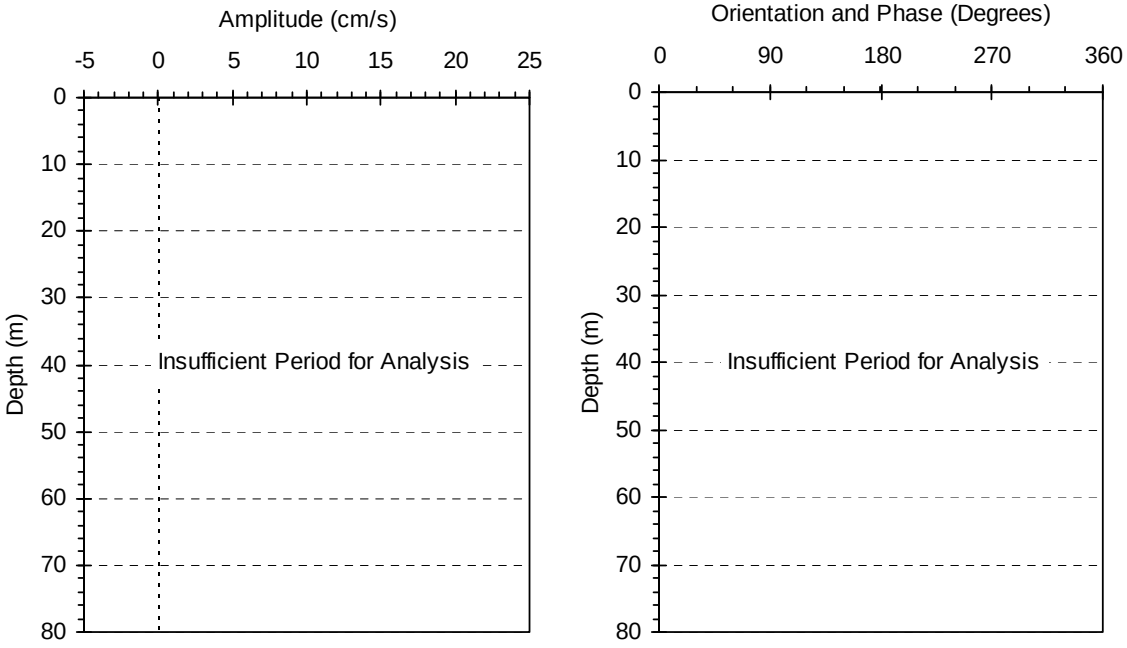
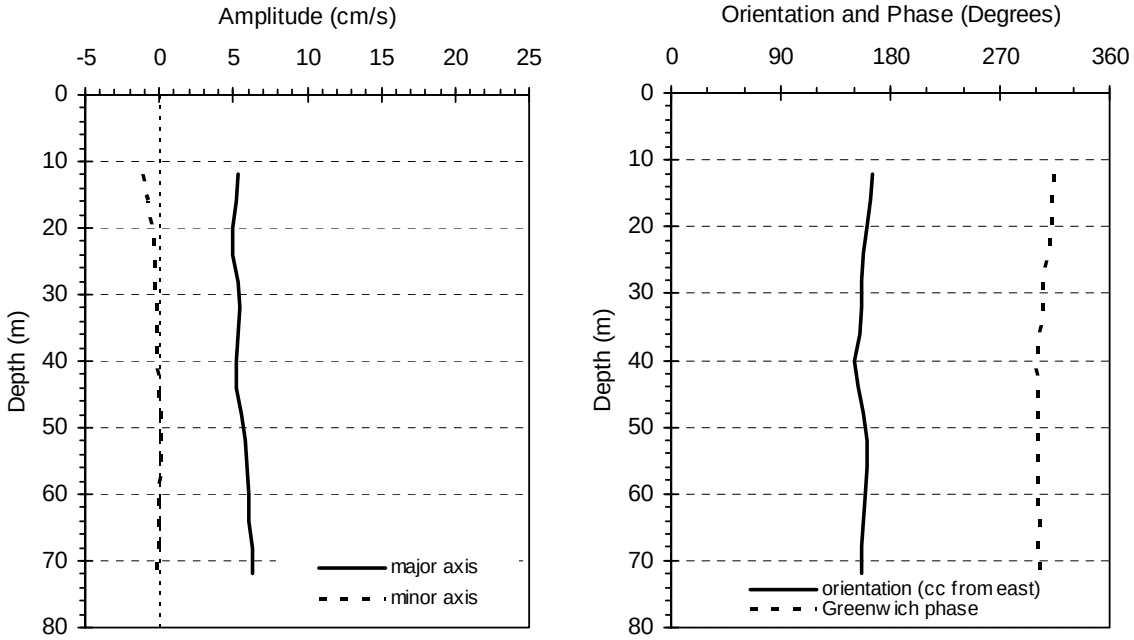


Figure 44: O1 Tidal Constituent, South Central Barrow Strait (Workhorse ADCP)

For Ice Free Period (Aug. 6, 2009 to Oct. 9, 2009):



For Solid Ice Period

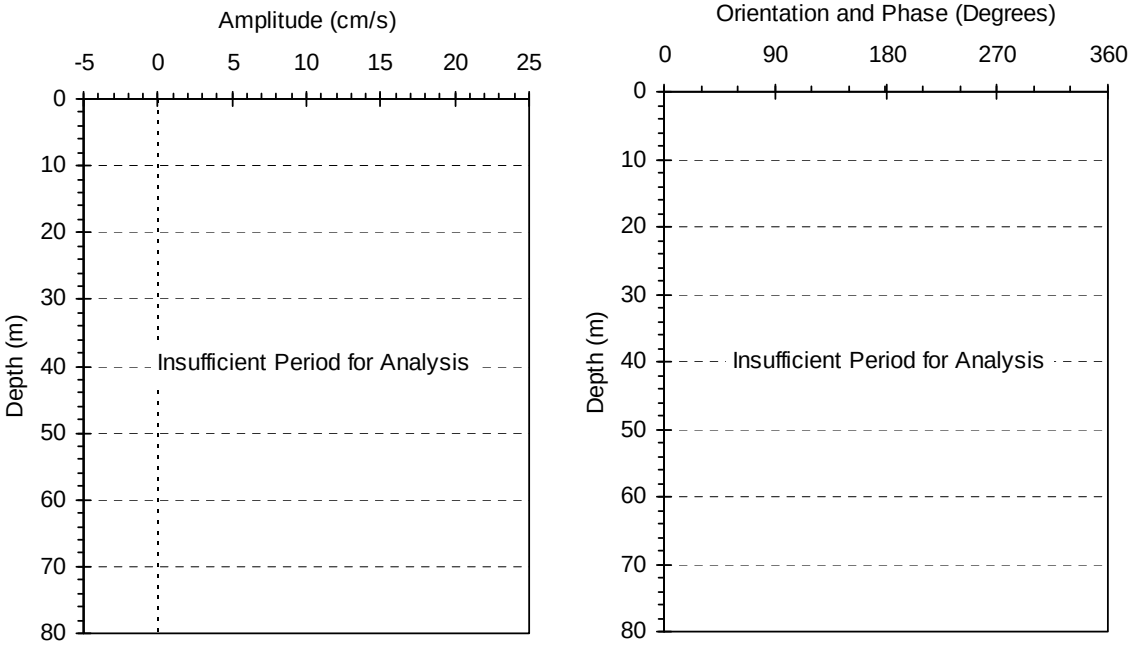
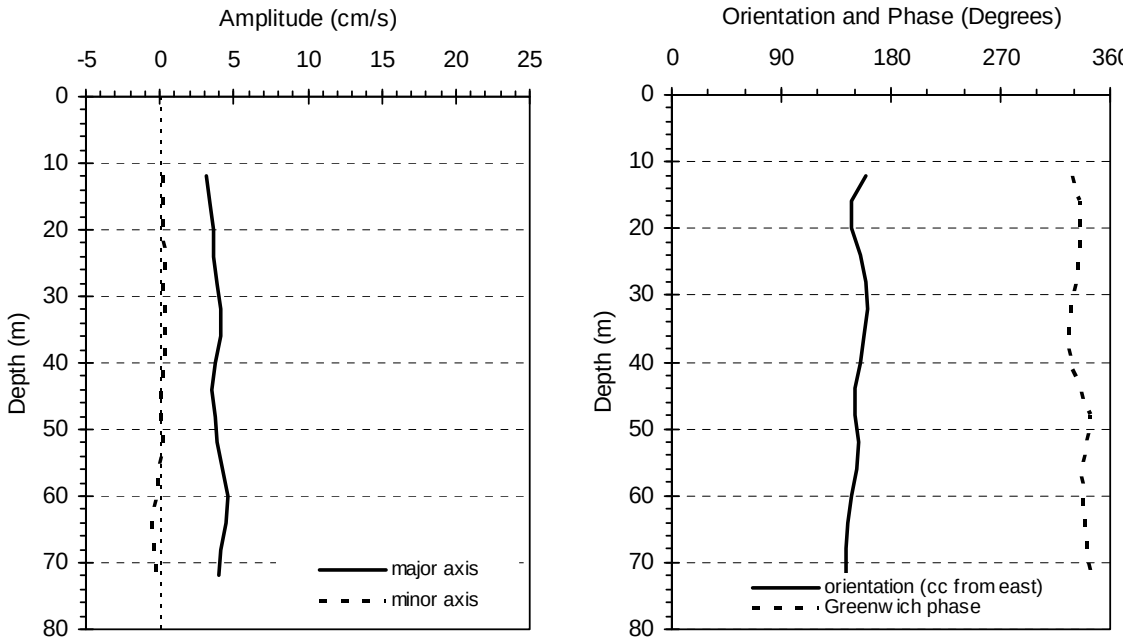


Figure 45: P1 Tidal Constituent, South Central Barrow Strait (Workhorse ADCP)

For Ice Free Period (Aug. 6, 2009 to Oct. 9, 2009):



For Solid Ice Period

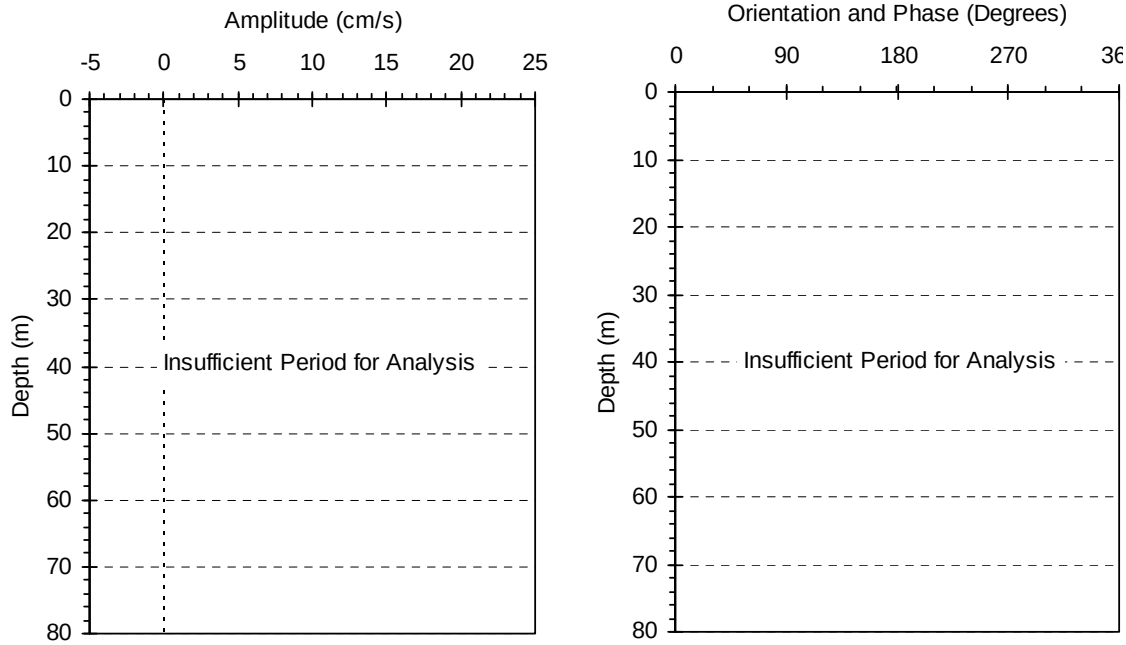
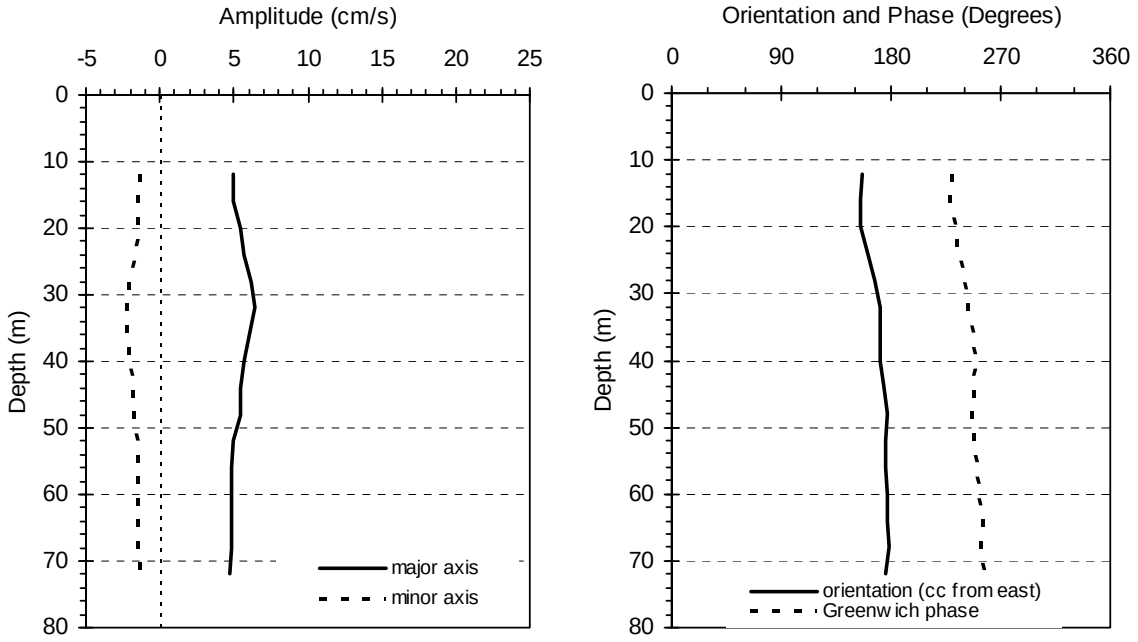


Figure 46: S2 Tidal Constituent, South Central Barrow Strait (Workhorse ADCP)

For Ice Free Period (Aug. 6, 2009 to Oct. 9, 2009):



For Solid Ice Period

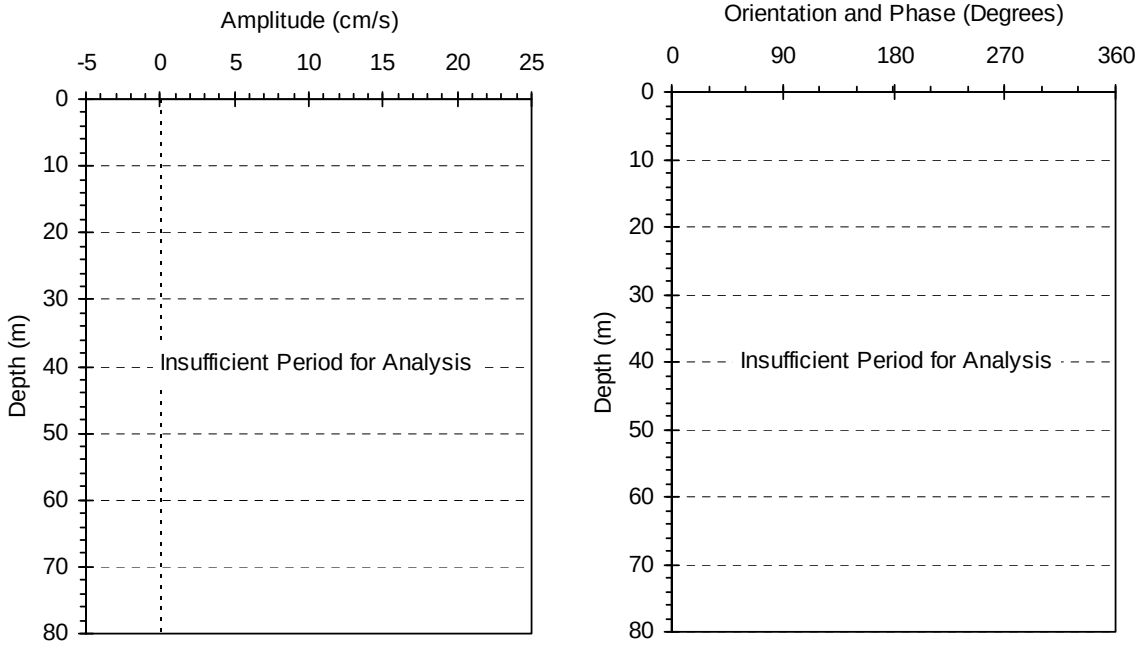


Figure 47: Ice velocity data, South side of Barrow Strait
August 2009 – August 2010

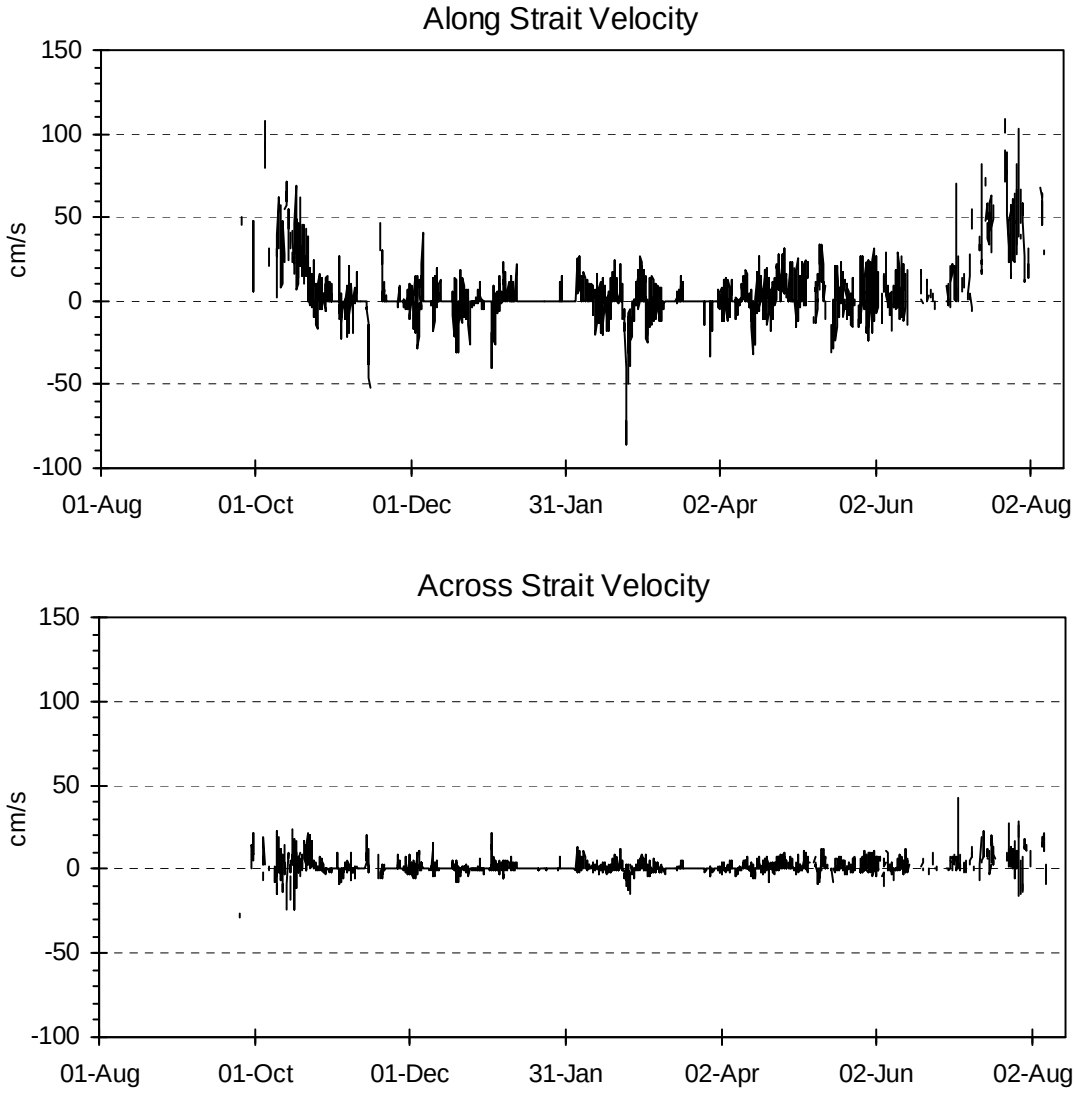


Figure 48: Ice velocity data, South Central Barrow Strait (Workhorse ADCP) August 2009 – August 2010

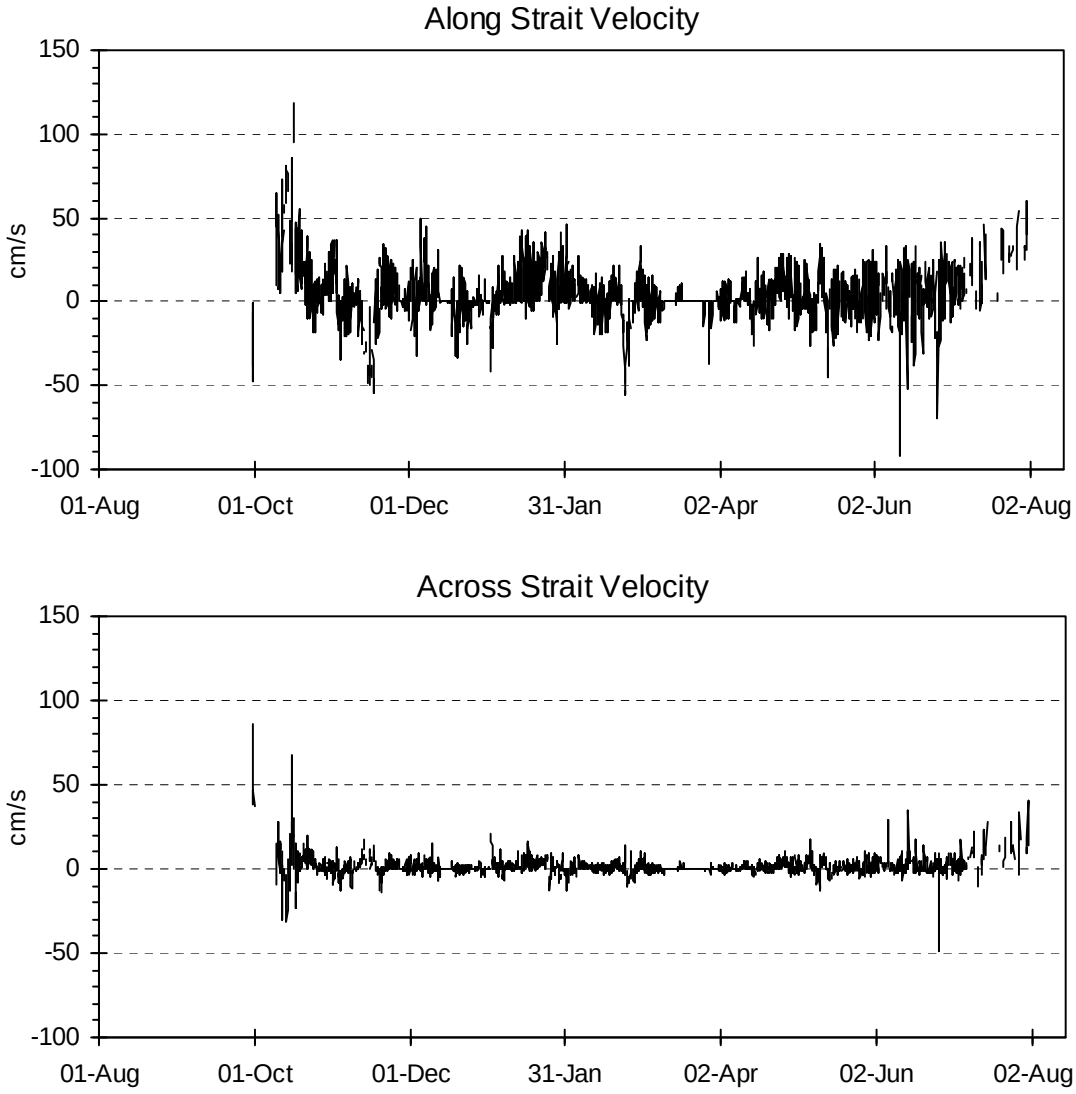
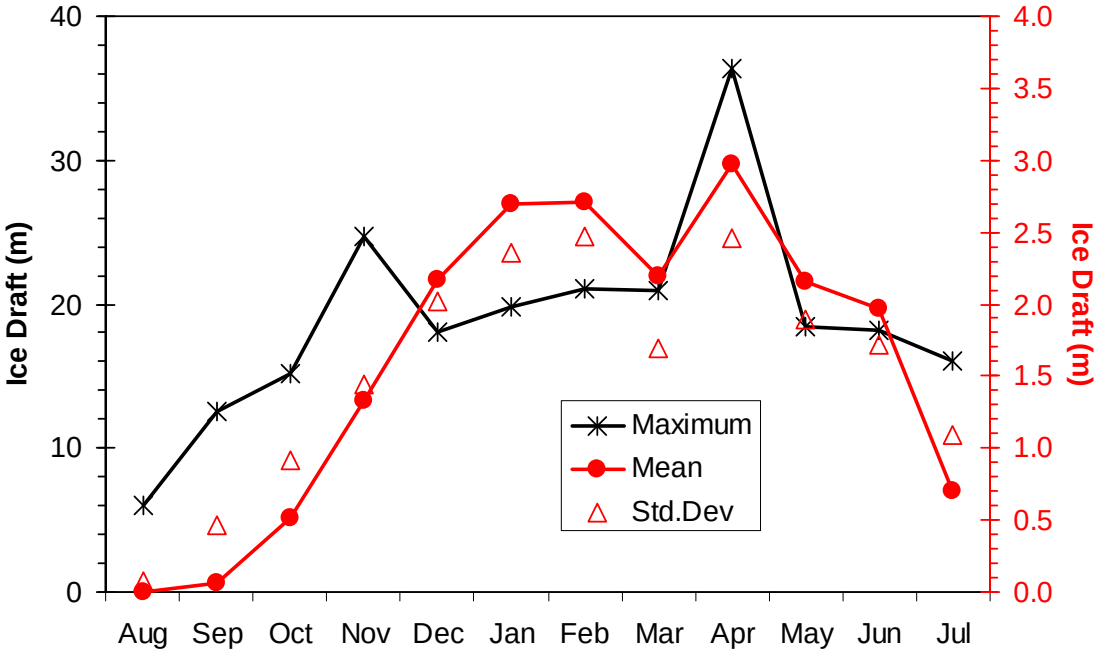


Figure 49: Ice Draft Statistics from Ice Profiling Sonar
South-Central Barrow Strait, August 2009 – July 2010



<u>Figure 50</u>: Frequency of Occurrence vs. Ice Draft in meters
South-Central Barrow Strait, August 2009 – July 2010

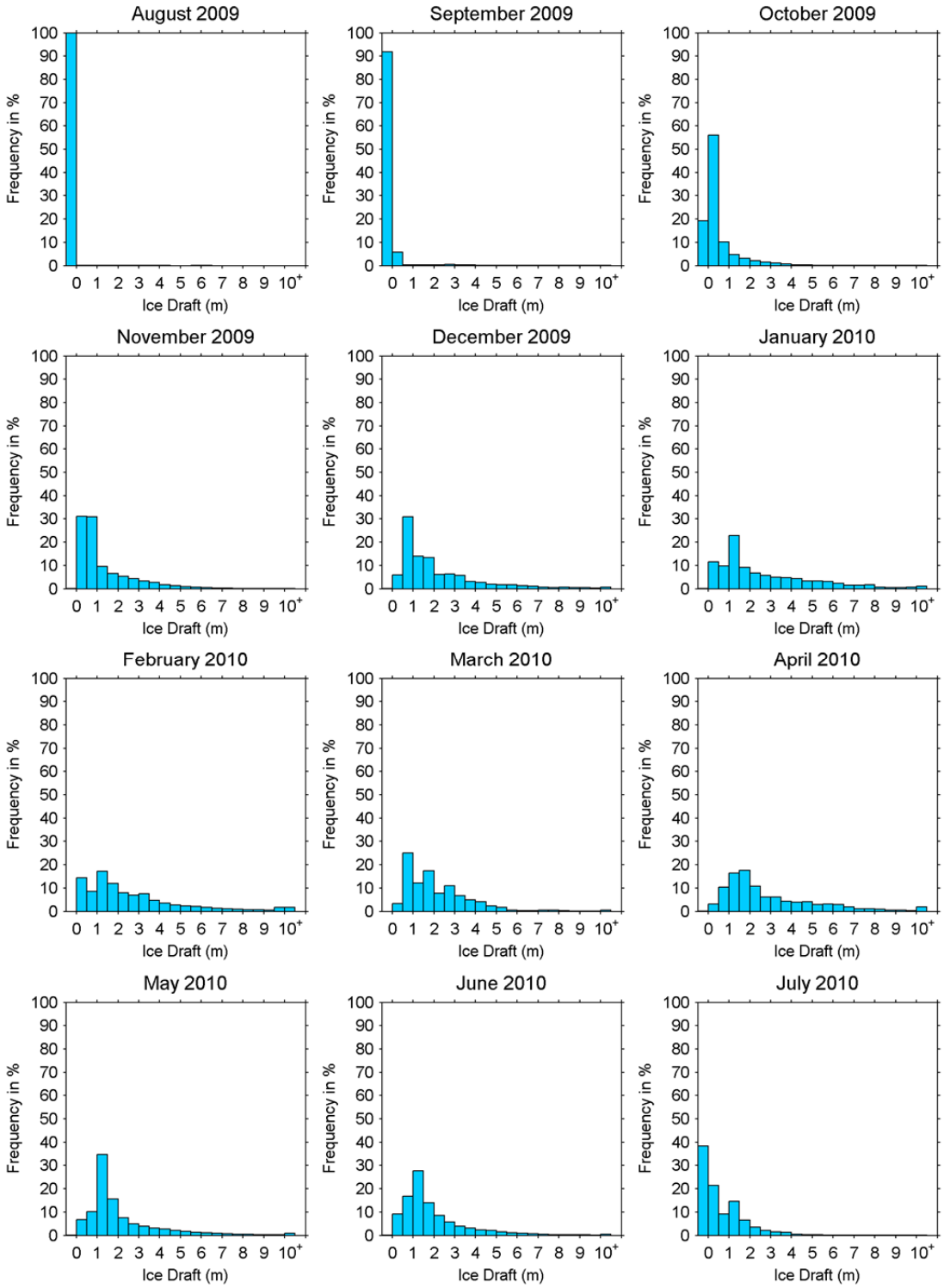


Figure 51: CTD Station Positions, August 2010

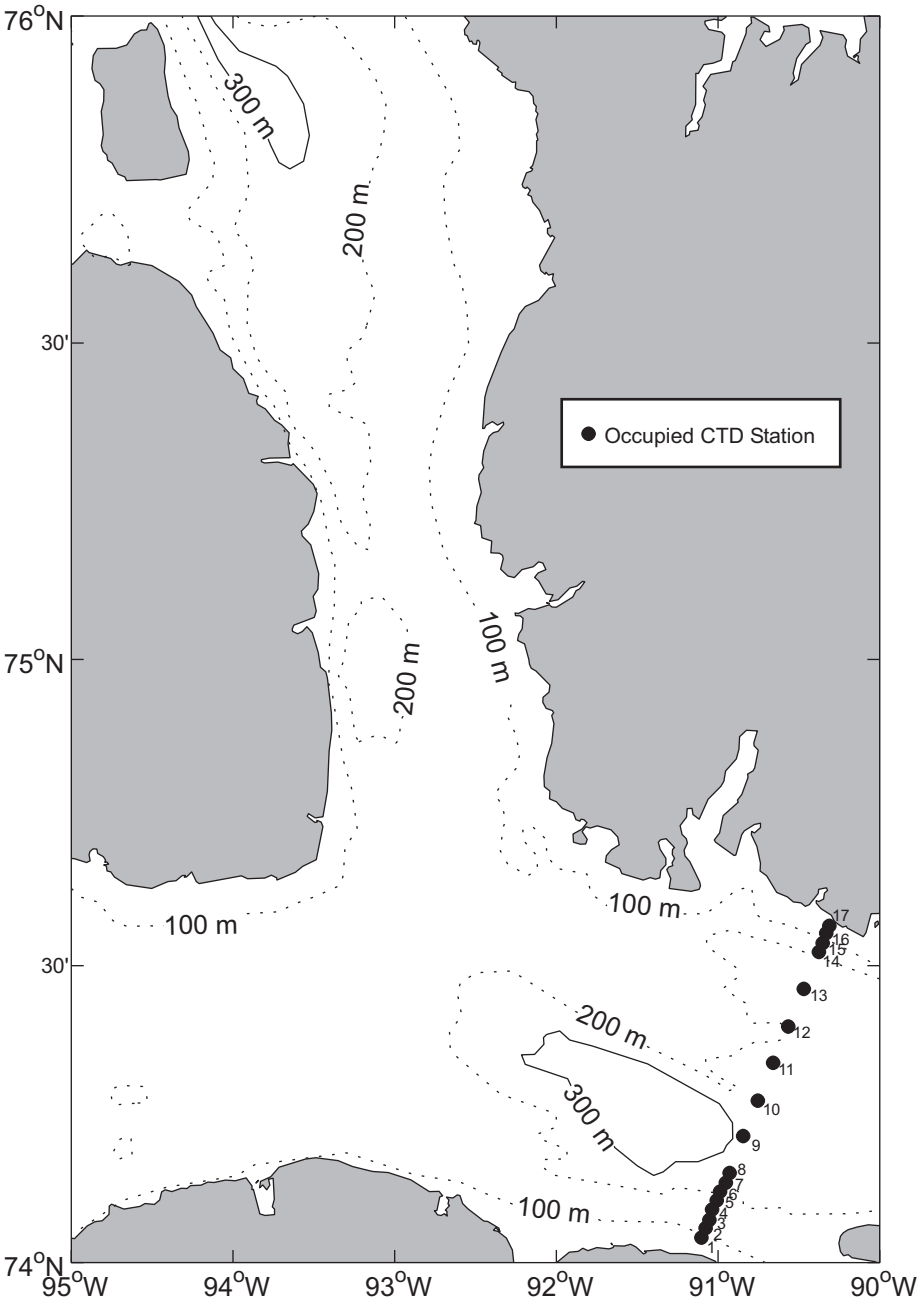


Figure 52: Eastern Barrow Strait CTD Line, Aug. 11-12, 2010

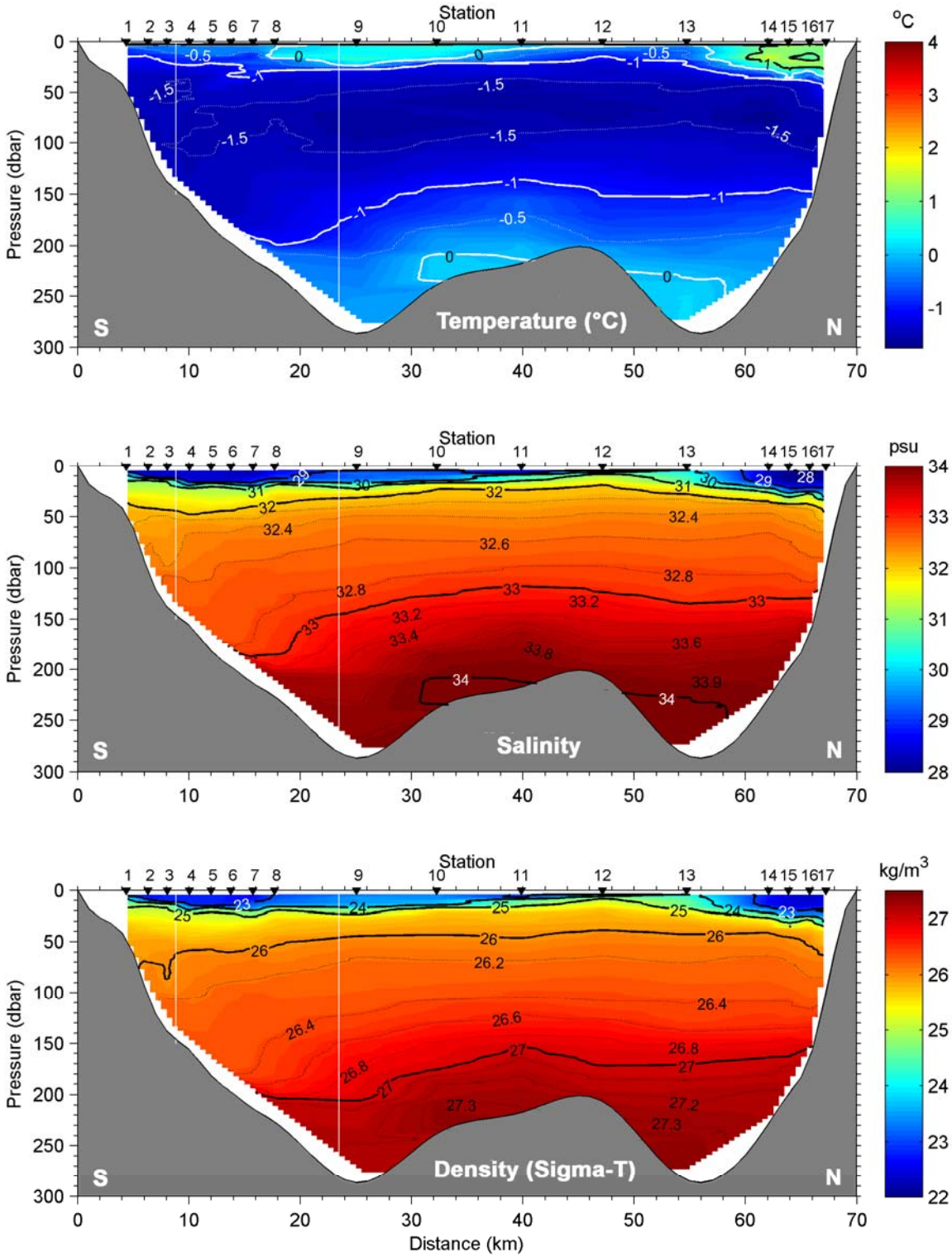


Table 1: Mooring Table Summary, 2009-2010

South Barrow Strait

BIO Consecutive Mooring Number	Instrument Type	Moored Depth (m)	Sounding (m)	Latitude (N)	Longitude (W)	Start Date-Time (GMT)	End Date-Time (GMT)	Sampling Interval (Seconds)
†1730	ICYCLER	52	152	74.0827	-91.0143	06-Aug-2009 16:00	31-May-2010 15:57	86400
1730	MCTD	62	152	74.0827	-91.0143	05-Aug-2009 20:00	07-Aug-2010 22:30	1800
1731	MCTD	42	149	74.0835	-91.0428	05-Aug-2009 14:30	07-Aug-2010 19:30	1800
1731	WHADCP	79	149	74.0835	-91.0428	05-Aug-2009 16:00	07-Aug-2010 18:00	7200
1731	MCTD	81	149	74.0835	-91.0428	05-Aug-2009 14:30	07-Aug-2010 19:30	1800
1732	WHADCP	143	147	74.0817	-91.0329	05-Aug-2009 16:00	07-Aug-2010 20:00	7200
1732	MCTD	145	147	74.0817	-91.0329	05-Aug-2009 15:30	07-Aug-2010 20:00	1800
1733	MCTD	33	146	74.0797	-91.0292	05-Aug-2009 13:30	07-Aug-2010 22:00	1800
1733	WATER SAMPLER	34	146	74.0797	-91.0292	05-Aug-2009 13:30	07-Aug-2010 22:00	24 days

South Central Barrow Strait

BIO Consecutive Mooring Number	Instrument Type	Moored Depth (m)	Sounding (m)	Latitude (N)	Longitude (W)	Start Date-Time (GMT)	End Date-Time (GMT)	Sampling Interval (Seconds)
1734	QMADCP	244	269	74.1956	-90.8495	06-Aug-2009 16:00	06-Aug-2010 18:00	7200
1734	MCTD	265	269	74.1956	-90.8495	06-Aug-2009 15:00	06-Aug-2010 18:30	1800
1735	MCTD	41	270	74.1989	-90.8466	06-Aug-2009 14:30	06-Aug-2010 16:30	1800
1735	WHADCP	78	270	74.1989	-90.8466	06-Aug-2009 16:00	06-Aug-2010 16:00	7200
1735	MCTD	160	270	74.1989	-90.8466	06-Aug-2009 14:30	06-Aug-2010 16:30	1800
1736	IPS	53	269	74.1942	-90.8558	06-Aug-2009 13:05	06-Aug-2010 19:54	3
1736	MCTD	78	269	74.1942	-90.8558	06-Aug-2009 13:30	06-Aug-2010 19:30	1800

† Instrument malfunctioned..

Table 2: South Barrow Strait, Microcat/ADCP statistical summary
Late summer: August 5, 2009 - September 20, 2009

Depth (m)		Temperature (°C)				Salinity (ppt)				Density (Sigma-T)				Along-Strait Velocity (cm/s)				Cross-Strait Velocity (cm/s)			
Micro Cat	ADCP	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max
33	33	-0.96	0.74	-1.58	3.27	31.56	0.46	29.17	32.31	25.36	0.39	23.39	25.98	33.28	19.77	-16.77	91.80	5.70	7.76	-32.18	39.48
42	41	-1.21	0.46	-1.57	1.71	31.88	0.25	30.11	32.36	25.63	0.21	24.13	26.03	30.89	19.70	-17.84	93.04	5.27	7.01	-25.50	39.32
63	65	-1.34	0.25	-1.55	0.40	32.26	0.14	31.76	32.73	25.94	0.11	25.54	26.30	26.76	18.58	-28.45	86.88	4.73	6.30	-17.76	24.27
81	81	-1.36	0.17	-1.55	-0.06	32.46	0.13	32.05	32.79	26.11	0.10	25.78	26.37	23.58	18.42	-38.49	81.36	1.10	6.62	-20.88	19.65
145	137	-1.35	0.06	-1.54	-0.93	32.74	0.09	32.43	32.94	26.33	0.08	26.07	26.49	10.65	13.38	-32.98	44.39	0.16	5.48	-16.44	20.08

Table 3: South Central Barrow Strait, Microcat/ADCP statistical summary
Late summer: August 6, 2009 - September 20, 2009

Depth (m)		Temperature (°C)				Salinity (ppt)				Density (Sigma-T)				Along-Strait Velocity (cm/s)				Cross-Strait Velocity (cm/s)			
Micro Cat	ADCP	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max
41	40	-0.84	0.49	-1.53	1.24	32.19	0.24	31.06	32.83	25.87	0.20	24.90	26.39	17.34	14.95	-25.65	62.79	4.85	6.56	-21.58	23.59
78	82	-1.37	0.14	-1.64	-0.41	32.66	0.11	32.24	32.89	26.27	0.09	25.92	26.46	14.95	15.03	-19.33	56.12	6.41	6.44	-12.45	30.61
160	162	-1.27	0.08	-1.51	-0.83	33.08	0.09	32.92	33.51	26.61	0.07	26.48	26.94	11.72	15.75	-27.98	47.95	6.14	6.64	-13.12	28.83
265	234	-0.53	0.14	-1.21	-0.25	33.67	0.09	33.10	33.82	27.05	0.07	26.62	27.16	4.31	19.58	-45.69	45.68	9.81	9.34	-21.90	42.43

Table 4: South Barrow Strait, Microcat/ADCP statistical summary
Fall: September 21, 2009 - December 20, 2009

Depth (m)		Temperature (°C)				Salinity (ppt)				Density (Sigma-T)				Along-Strait Velocity (cm/s)				Cross-Strait Velocity (cm/s)			
Micro Cat	ADCP	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max
33	33	-1.33	0.43	-1.75	0.51	31.35	0.24	30.39	32.27	25.21	0.20	24.43	25.95	9.59	20.86	-56.73	89.13	2.50	7.31	-21.88	30.33
42	41	-1.26	0.39	-1.73	0.51	31.64	0.23	31.04	32.44	25.44	0.19	24.92	26.09	9.85	21.01	-48.15	92.18	2.44	7.35	-28.86	28.53
63	65	-1.20	0.22	-1.66	0.32	32.16	0.18	31.33	32.78	25.86	0.15	25.15	26.36	9.92	20.99	-56.45	86.67	2.92	6.56	-20.41	30.54
81	81	-1.21	0.16	-1.58	-0.29	32.43	0.14	31.89	32.97	26.07	0.12	25.64	26.51	7.99	21.91	-60.28	74.12	0.27	6.10	-18.37	16.90
145	137	-1.12	0.22	-1.33	-0.35	33.00	0.31	32.28	33.78	26.54	0.24	25.96	27.14	3.64	17.14	-47.17	42.38	-1.18	5.38	-37.66	14.74

Table 5: South Central Barrow Strait, Microcat/ADCP statistical summary
Fall: September 21, 2009 - December 20, 2009

Depth (m)		Temperature (°C)				Salinity (ppt)				Density (Sigma-T)				Along-Strait Velocity (cm/s)				Cross-Strait Velocity (cm/s)			
Micro Cat	ADCP	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max
41	40	-1.19	0.49	-1.73	0.33	31.72	0.38	30.67	32.60	25.50	0.30	24.66	26.21	7.13	16.25	-34.14	62.01	2.64	6.24	-15.74	22.42
78	82	-1.18	0.14	-1.70	-0.23	32.46	0.20	31.71	32.82	26.10	0.17	25.50	26.40	5.87	16.45	-39.67	51.75	3.99	6.95	-25.37	24.61
160	162	-1.23	0.09	-1.46	-0.75	33.06	0.11	32.78	33.51	26.59	0.08	26.36	26.94	6.16	16.73	-37.88	52.48	4.39	6.69	-18.18	26.71
265	234	-0.34	0.20	-1.13	0.26	33.73	0.13	33.02	34.07	27.10	0.10	26.55	27.36	3.46	17.97	-38.94	47.24	8.96	8.33	-14.15	40.86

Table 6: South Barrow Strait, Microcat/ADCP statistical summary
Winter: December 21, 2009 - March 20, 2010

Depth (m)		Temperature (°C)				Salinity (ppt)				Density (Sigma-T)				Along-Strait Velocity (cm/s)				Cross-Strait Velocity (cm/s)			
Micro Cat	ADCP	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max
33	33	-1.72	0.04	-1.78	-1.45	31.90	0.24	31.11	32.46	25.66	0.20	23.39	25.98	3.98	13.31	-41.50	39.06	0.42	4.28	-13.64	13.04
42	41	-1.70	0.06	-1.77	-1.34	31.98	0.25	31.48	32.61	25.73	0.20	25.01	26.12	3.69	13.39	-43.47	37.07	0.24	4.25	-15.06	13.83
63	65	-1.61	0.15	-1.77	-1.23	32.17	0.24	31.61	32.78	25.87	0.19	25.32	26.23	3.92	16.64	-52.33	52.18	0.72	5.32	-16.47	20.98
81	81	-1.50	0.19	-1.77	-1.09	32.37	0.16	31.72	33.00	26.03	0.13	25.42	26.37	2.73	18.98	-59.64	52.34	-0.99	5.66	-23.36	20.36
145	137	-0.93	0.28	-1.36	-0.06	33.19	0.32	32.43	33.93	26.68	0.25	25.51	26.54	2.26	15.86	-53.36	41.44	-1.31	5.63	-20.71	16.53

Table 7: South Central Barrow Strait, Microcat/ADCP statistical summary
Winter: December 21, 2009 - March 20, 2010

Depth (m)		Temperature (°C)				Salinity (ppt)				Density (Sigma-T)				Along-Strait Velocity (cm/s)				Cross-Strait Velocity (cm/s)			
Micro Cat	ADCP	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max
41	40	-1.73	0.04	-1.78	-1.47	32.03	0.31	31.50	32.47	25.77	0.26	25.33	26.12	3.17	13.74	-43.85	43.94	0.45	4.47	-15.81	18.53
78	82	-1.57	0.16	-1.78	-1.08	32.33	0.19	31.60	32.76	26.00	0.16	25.41	26.36	1.63	15.05	-46.49	43.64	0.93	6.78	-24.93	28.29
160	162	-1.02	0.16	-1.31	-0.18	33.23	0.14	32.79	33.89	26.72	0.11	26.37	27.22	3.26	16.45	-61.93	58.98	2.59	7.27	-26.14	29.37
265	234	-0.05	0.16	-0.76	0.35	33.78	0.10	33.27	34.04	27.12	0.08	26.74	27.31	2.06	17.06	-43.73	50.86	8.44	7.34	-11.22	44.45

Table 8: South Barrow Strait, Microcat/ADCP statistical summary
Spring: March 21, 2010 - June 20, 2010

Depth (m)		Temperature (°C)				Salinity (ppt)				Density (Sigma-T)				Along-Strait Velocity (cm/s)				Cross-Strait Velocity (cm/s)			
Micro Cat	ADCP	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max
33	33	-1.68	0.05	-1.76	-1.39	31.93	0.17	31.17	32.33	25.68	0.14	25.07	26.01	7.72	13.42	-35.71	44.38	0.82	4.30	-13.27	12.93
42	41	-1.66	0.07	-1.76	-1.36	32.08	0.14	31.67	32.38	25.80	0.12	25.47	26.05	7.31	13.51	-34.78	44.27	0.86	4.56	-13.63	15.50
63	65	-1.64	0.09	-1.77	-1.32	32.35	0.08	32.04	32.56	26.02	0.07	25.77	26.19	6.34	14.70	-41.77	46.53	1.25	4.90	-18.53	16.21
81	81	-1.62	0.11	-1.77	-1.32	32.48	0.08	32.22	32.73	26.13	0.06	25.91	26.33	4.50	16.05	-42.54	49.40	-0.44	5.33	-20.74	21.85
145	137	-0.90	0.32	-1.65	-0.22	33.27	0.34	32.49	33.85	26.75	0.26	26.13	27.19	2.41	15.03	-39.96	37.36	-1.11	5.89	-22.40	17.32

Table 9: South Central Barrow Strait, Microcat/ADCP statistical summary
Spring: March 21, 2010 - June 20, 2010

Depth (m)		Temperature (°C)				Salinity (ppt)				Density (Sigma-T)				Along-Strait Velocity (cm/s)				Cross-Strait Velocity (cm/s)			
Micro Cat	ADCP	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max
41	40	-1.71	0.03	-1.77	-1.56	32.04	0.24	31.28	32.48	25.77	0.19	25.16	26.13	3.78	12.93	-29.92	41.51	1.23	4.40	-12.70	14.73
78	82	-1.64	0.07	-1.78	-1.33	32.48	0.11	31.97	32.74	26.13	0.09	25.72	26.34	3.96	14.30	-41.76	48.90	1.54	5.97	-18.14	22.56
160	162	-0.88	0.14	-1.25	-0.45	33.41	0.13	32.90	33.73	26.86	0.10	26.44	27.10	2.90	15.84	-34.53	40.84	1.99	6.09	-16.37	25.99
265	234	-0.09	0.09	-0.76	0.10	33.76	0.07	33.24	33.96	27.11	0.05	26.72	27.27	0.77	16.39	-41.81	40.28	5.94	6.60	-14.37	31.97

Table 10: South Barrow Strait, Microcat/ADCP statistical summary
Early Summer:June 21, 2010 – Aug 5, 2010

Depth (m)		Temperature (°C)				Salinity (ppt)				Density (Sigma-T)				Along-Strait Velocity (cm/s)				Cross-Strait Velocity (cm/s)			
Micro Cat	ADCP	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max
33	33	-1.38	0.15	-1.65	-0.60	31.83	0.18	31.02	32.37	25.59	0.15	24.92	26.04	22.06	18.15	-20.41	87.99	4.25	5.95	-15.42	25.75
42	41	-1.45	0.12	-1.67	-0.91	32.07	0.16	31.35	32.41	25.79	0.13	25.20	26.07	20.42	17.53	-24.09	80.07	4.07	5.58	-14.40	24.95
63	65	-1.56	0.08	-1.74	-0.96	32.39	0.11	31.90	32.66	26.05	0.09	25.65	26.27	16.16	15.80	-31.78	69.34	2.95	4.12	-11.24	15.54
81	81	-1.63	0.06	-1.76	-1.42	32.52	0.06	32.14	32.68	26.16	0.05	25.85	26.29	14.21	15.85	-35.62	64.63	0.09	4.50	-15.49	17.41
145	137	-1.37	0.24	-1.70	-0.58	32.84	0.27	32.41	33.66	26.41	0.21	26.07	27.05	6.39	13.60	-40.76	37.54	-0.19	5.54	-18.09	15.96

Table 11: South Central Barrow Strait, Microcat/ADCP statistical summary
Early Summer:June 21, 2010 – Aug 6, 2010

Depth (m)		Temperature (°C)				Salinity (ppt)				Density (Sigma-T)				Along-Strait Velocity (cm/s)				Cross-Strait Velocity (cm/s)			
Micro Cat	ADCP	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max
41	40	-1.53	0.09	-1.72	-0.92	32.29	0.13	31.58	32.61	25.97	0.11	25.40	26.24	11.18	14.93	-25.18	49.97	3.13	6.51	-14.61	26.56
78	82	-1.66	0.05	-1.77	-1.40	32.59	0.04	32.43	32.74	26.22	0.03	26.08	26.34	10.71	15.82	-24.21	52.27	4.05	6.80	-20.86	27.63
160	162	-1.01	0.21	-1.52	-0.46	33.26	0.24	32.76	33.73	26.74	0.19	26.36	27.11	6.75	17.87	-32.26	48.88	4.00	7.56	-15.76	30.65
265	234	-0.10	0.09	-0.58	0.03	33.79	0.05	33.48	33.87	27.13	0.04	26.90	27.19	0.92	22.12	-55.39	47.89	9.10	10.42	-18.87	45.65

Table 12: South Barrow Strait, Microcat/ADCP statistical summary
Complete Record:Aug 5, 2009 – Aug 7, 2010

Depth (m)		Temperature (°C)				Salinity (ppt)				Density (Sigma-T)				Along-Strait Velocity (cm/s)				Cross-Strait Velocity (cm/s)			
Micro Cat	ADCP	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max
33	33	-1.47	0.43	-1.78	3.27	31.72	0.35	29.17	32.46	25.51	0.29	23.39	26.12	12.37	19.51	-56.73	91.80	2.20	6.16	-32.18	39.48
42	41	-1.49	0.33	-1.77	1.71	31.92	0.27	30.11	32.61	25.67	0.22	24.13	26.23	11.74	19.12	-48.15	93.04	2.07	6.03	-28.86	39.32
63	65	-1.48	0.25	-1.77	0.40	32.25	0.19	31.33	32.78	25.94	0.16	25.15	26.37	10.49	18.96	-56.45	86.88	2.20	5.71	-20.41	30.54
81	81	-1.46	0.22	-1.77	-0.06	32.44	0.13	31.72	33.00	26.09	0.11	25.51	26.54	8.62	19.81	-60.28	81.36	-0.14	5.73	-23.36	21.85
145	137	-1.08	0.32	-1.70	-0.06	33.06	0.35	32.28	33.93	26.58	0.27	25.96	27.25	4.24	15.66	-53.36	44.39	-0.89	5.63	-37.66	20.08

Table 13: South Central Barrow Strait, Microcat/ADCP statistical summary
Complete Record:Aug 6, 2009 – Aug 6, 2010

Depth (m)		Temperature (°C)				Salinity (ppt)				Density (Sigma-T)				Along-Strait Velocity (cm/s)				Cross-Strait Velocity (cm/s)			
Micro Cat	ADCP	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max	Avg	SD	Min	Max
41	40	-1.46	0.44	-1.78	1.24	32.01	0.35	30.67	32.83	25.74	0.28	24.66	26.39	7.10	15.24	-43.85	62.79	2.08	5.68	-21.58	26.56
78	82	-1.48	0.23	-1.78	-0.23	32.47	0.19	31.60	32.89	26.12	0.16	25.41	26.46	6.13	15.92	-46.49	56.12	2.95	6.84	-25.37	30.61
160	162	-1.07	0.21	-1.52	-0.18	33.22	0.20	32.76	33.89	26.71	0.15	26.36	27.22	5.39	16.71	-61.93	58.98	3.51	6.94	-26.14	30.65
265	234	-0.20	0.22	-1.21	0.35	33.75	0.10	33.02	34.07	27.11	0.08	26.55	27.36	2.22	18.21	-55.39	50.86	8.19	8.25	-21.90	45.65

Table 14: Tidal Constants for K1 Constituent

South Side Barrow Strait

For Ice Free Period (Aug. 5, 2009 – Oct. 8, 2009):

Depth (m)	Major Amplitude (cm/s)	Minor Amplitude (cm/s)	Orientation (degrees cc from East)	Greenwich Phase (degrees)
9	7.68	1.15	165	15
13	7.91	1.62	165	15
17	8.30	1.30	171	14
21	8.16	1.17	173	12
25	7.69	1.29	174	9
29	7.31	1.17	174	2
33	6.55	0.67	173	355
37	6.45	0.62	171	356
41	6.27	0.39	168	1
45	6.63	0.11	169	5
49	6.52	0.21	171	6
53	6.46	0.17	169	1
57	6.40	0.33	168	354
61	6.15	0.62	169	350
65	5.93	0.61	168	349
69	6.38	0.54	166	349
73	6.70	0.50	161	347
77	7.49	0.64	158	341
81	7.81	0.51	156	340
85	8.00	0.85	155	338
89	8.22	1.21	155	336
93	8.39	1.48	155	336
97	8.38	1.73	155	335
101	7.90	2.15	157	332
105	7.49	2.28	158	332
109	7.61	2.76	159	331
113	7.95	3.27	158	328
117	8.36	3.21	159	330
121	8.61	3.07	159	330
125	8.84	2.99	163	331
129	9.15	3.01	163	330
133	9.28	2.97	165	329
137	9.35	2.95	168	329

For Solid Ice Period

Insufficient Period for Analysis

Table 14: Tidal Constants for K1 Constituent (continued)

South Central Barrow Strait (Workhorse ADCP)

For Ice Free Period (Aug. 6, 2009 – Oct. 9, 2009):

Depth (m)	Major Amplitude (cm/s)	Minor Amplitude (cm/s)	Orientation (degrees cc from East)	Greenwich Phase (degrees)
12	10.63	-0.64	167	358
16	11.22	-0.06	164	359
20	11.43	-0.15	162	357
24	11.32	-0.13	161	354
28	11.00	-0.46	161	351
32	10.72	-0.51	161	349
36	10.52	-0.36	160	349
40	10.70	-0.20	160	351
44	11.36	-0.44	158	354
48	12.12	-0.46	158	356
52	11.96	-0.41	158	355
56	11.96	-0.25	156	353
60	12.27	-0.29	154	353
64	12.40	-0.51	153	354
68	12.59	-0.43	153	356
72	12.85	-0.41	153	357

For Solid Ice Period

Insufficient Period for Analysis

Table 14: Tidal Constants for K1 Constituent (continued)

South Central Barrow Strait (Quarter Master ADCP)

For Ice Free Period (Aug. 6, 2009 – Oct. 9, 2009):

Depth (m)	Major Amplitude (cm/s)	Minor Amplitude (cm/s)	Orientation (degrees cc from East)	Greenwich Phase (degrees)
26	11.63	0.36	166	354
34	10.92	0.25	164	354
42	10.91	0.15	163	352
50	11.07	-0.17	162	353
58	11.76	-0.29	160	353
66	12.41	-0.59	158	354
74	12.63	-0.41	157	355
82	13.01	-0.17	156	356
90	13.72	-0.42	157	357
98	14.10	-0.92	157	356
106	14.44	-1.22	157	357
114	14.58	-1.71	156	358
122	15.01	-2.28	157	359
130	15.49	-2.27	157	0
138	15.79	-2.20	157	0
146	16.18	-2.06	157	360
154	16.38	-2.35	156	0
162	16.39	-2.68	156	0
170	16.51	-2.58	157	1
178	16.82	-2.34	156	359
186	17.28	-2.42	155	358
194	18.19	-2.37	156	356
202	19.29	-2.32	156	355
210	20.14	-2.71	157	356
218	20.31	-2.97	156	358
226	21.03	-3.03	154	358
234	22.51	-2.81	151	0

For Solid Ice Period

Insufficient Period for Analysis

Table 15: Tidal Constants for M2 Constituent

South Side Barrow Strait

For Ice Free Period (Aug. 5, 2009 – Oct. 8, 2009):

Depth (m)	Major Amplitude (cm/s)	Minor Amplitude (cm/s)	Orientation (degrees cc from East)	Greenwich Phase (degrees)
9	6.61	0.26	190	216
13	7.07	0.52	186	210
17	7.06	0.68	177	206
21	7.08	0.71	171	204
25	6.99	0.84	166	204
29	6.92	0.57	164	204
33	7.18	0.37	163	200
37	7.41	0.15	162	199
41	7.64	-0.19	162	197
45	7.84	-0.46	162	197
49	8.41	-0.72	160	197
53	8.78	-1.23	159	197
57	8.90	-1.42	157	197
61	9.07	-1.38	156	198
65	9.32	-1.46	155	198
69	9.55	-1.34	154	200
73	9.71	-1.27	154	203
77	9.93	-1.46	147	207
81	10.01	-1.26	150	207
85	10.07	-1.31	153	208
89	10.13	-1.28	154	210
93	10.14	-1.32	156	211
97	10.11	-1.38	157	212
101	9.97	-1.20	158	212
105	9.64	-0.92	159	213
109	9.31	-0.71	160	214
113	9.03	-0.37	160	215
117	8.94	0.03	162	215
121	8.83	0.05	163	217
125	8.87	0.22	164	217
129	8.76	0.23	166	218
133	8.64	0.24	170	220
137	8.35	0.34	174	220

For Solid Ice Period

Insufficient Period for Analysis

Table 15: Tidal Constants for M2 Constituent (continued)

South Central Barrow Strait (Workhorse ADCP)

For Ice Free Period (Aug. 6, 2009 – Oct. 9, 2009):

Depth (m)	Major Amplitude (cm/s)	Minor Amplitude (cm/s)	Orientation (degrees cc from East)	Greenwich Phase (degrees)
12	5.21	2.16	176	209
16	5.77	1.78	174	209
20	6.41	1.00	174	205
24	7.19	0.29	172	203
28	7.72	-0.27	170	200
32	8.34	-1.06	169	201
36	9.11	-1.64	168	200
40	9.46	-1.86	166	199
44	9.66	-1.82	164	197
48	10.19	-1.89	164	197
52	10.04	-1.82	165	197
56	10.20	-2.03	165	197
60	10.36	-2.29	165	199
64	10.61	-2.46	166	200
68	10.54	-2.44	166	202
72	10.66	-2.51	166	202

For Solid Ice Period

Insufficient Period for Analysis

Table 15: Tidal Constants for M2 Constituent (continued)

South Central Barrow Strait (Quarter Master ADCP)

For Ice Free Period (Aug. 6, 2009 – Oct. 9, 2009):

Depth (m)	Major Amplitude (cm/s)	Minor Amplitude (cm/s)	Orientation (degrees cc from East)	Greenwich Phase (degrees)
26	7.46	0.60	178	200
34	9.31	-0.87	175	197
42	10.06	-1.49	172	196
50	10.09	-1.47	172	195
58	10.22	-1.70	172	196
66	10.54	-1.92	173	199
74	10.81	-2.16	173	201
82	10.79	-1.96	174	202
90	10.48	-1.67	174	203
98	10.09	-1.49	173	204
106	9.80	-1.09	173	204
114	9.58	-0.89	174	203
122	9.44	-0.60	174	203
130	9.22	-0.53	174	203
138	8.95	-0.54	174	203
146	8.93	-0.65	174	204
154	8.89	-0.53	175	204
162	8.74	-0.47	175	204
170	8.81	-0.61	175	204
178	8.74	-0.65	175	206
186	8.75	-0.65	176	207
194	8.55	-0.66	177	208
202	8.19	-0.74	180	209
210	7.82	-0.63	182	210
218	7.40	-0.64	183	212
226	6.85	-0.81	185	215
234	6.19	-0.72	190	219

For Solid Ice Period

Insufficient Period for Analysis

Table 16: Tidal Constants for O1 Constituent

South Side Barrow Strait

For Ice Free Period (Aug. 5, 2009 – Oct. 8, 2009):

Depth (m)	Major Amplitude (cm/s)	Minor Amplitude (cm/s)	Orientation (degrees cc from East)	Greenwich Phase (degrees)
9	3.77	-0.33	163	304
13	3.64	-0.33	164	303
17	3.28	-0.28	171	299
21	3.03	0.21	175	299
25	2.81	0.66	176	301
29	2.77	0.89	184	312
33	2.84	0.88	187	315
37	2.88	0.94	181	310
41	2.75	0.91	174	310
45	2.83	1.04	165	301
49	2.92	0.85	159	294
53	2.74	0.69	158	288
57	2.88	0.81	158	285
61	2.95	0.80	157	280
65	3.18	0.83	156	278
69	3.25	0.94	156	277
73	3.40	1.09	155	275
77	3.94	1.36	148	273
81	3.97	1.40	148	272
85	4.09	1.45	149	271
89	4.10	1.38	151	271
93	4.24	1.38	152	272
97	4.30	1.38	153	273
101	4.19	1.40	152	271
105	4.11	1.35	149	267
109	3.97	1.41	148	266
113	4.01	1.48	148	266
117	4.14	1.43	152	266
121	4.09	1.23	154	268
125	4.22	1.03	155	268
129	4.34	0.89	156	267
133	4.51	0.66	156	266
137	4.71	0.75	156	262

For Solid Ice Period

Insufficient Period for Analysis

Table 16: Tidal Constants for O1 Constituent (continued)

South Central Barrow Strait (Workhorse ADCP)

For Ice Free Period (Aug. 6, 2009 – Oct. 9, 2009):

Depth (m)	Major Amplitude (cm/s)	Minor Amplitude (cm/s)	Orientation (degrees cc from East)	Greenwich Phase (degrees)
12	5.28	-1.16	165	315
16	5.24	-0.77	164	313
20	4.92	-0.48	161	313
24	4.97	-0.21	158	310
28	5.35	-0.32	156	306
32	5.44	-0.20	156	306
36	5.38	-0.12	154	303
40	5.21	-0.17	151	300
44	5.21	-0.02	154	301
48	5.58	0.14	159	301
52	5.82	0.11	161	301
56	5.98	0.07	161	301
60	6.01	-0.05	160	302
64	6.08	-0.03	158	302
68	6.31	-0.04	157	301
72	6.32	-0.13	156	302

For Solid Ice Period

Insufficient Period for Analysis

Table 16: Tidal Constants for O1 Constituent (continued)

South Central Barrow Strait (Quarter Master ADCP)

For Ice Free Period (Aug. 6, 2009 – Oct. 9, 2009):

Depth (m)	Major Amplitude (cm/s)	Minor Amplitude (cm/s)	Orientation (degrees cc from East)	Greenwich Phase (degrees)
26	5.24	-0.13	168	311
34	5.54	-0.03	164	305
42	5.30	0.22	163	303
50	5.35	0.51	166	303
58	5.52	0.45	167	302
66	5.89	0.27	165	300
74	6.17	0.23	162	301
82	6.41	0.28	161	302
90	6.59	0.25	160	302
98	6.67	0.14	160	302
106	6.75	0.17	160	303
114	6.86	0.06	160	304
122	7.07	-0.12	159	303
130	7.32	-0.22	158	303
138	7.29	-0.23	158	302
146	7.33	-0.26	156	301
154	7.26	-0.20	156	300
162	7.29	-0.19	156	299
170	7.31	-0.38	157	298
178	7.49	-0.32	157	299
186	7.67	-0.30	156	298
194	8.13	-0.09	155	297
202	8.52	0.01	156	298
210	8.96	-0.07	157	298
218	9.45	-0.07	157	299
226	10.28	-0.30	157	300
234	11.01	-0.33	156	300

For Solid Ice Period

Insufficient Period for Analysis

Table 17: Tidal Constants for P1 Constituent

South Side Barrow Strait

For Ice Free Period (Aug. 5, 2009 – Oct. 8, 2009):

Depth (m)	Major Amplitude (cm/s)	Minor Amplitude (cm/s)	Orientation (degrees cc from East)	Greenwich Phase (degrees)
9	2.95	-0.81	100	35
13	2.60	-0.48	102	17
17	2.23	0.14	129	354
21	2.02	0.69	141	343
25	2.00	0.93	149	332
29	2.53	0.82	160	328
33	3.21	0.24	175	323
37	3.22	-0.05	177	323
41	2.38	-0.36	184	320
45	1.60	-0.64	196	328
49	1.04	-0.53	202	317
53	1.34	-0.93	196	308
57	2.04	-0.94	185	310
61	2.18	-0.74	179	306
65	2.07	-0.74	181	296
69	2.05	-0.81	182	305
73	2.06	-1.03	175	312
77	2.82	-0.38	159	318
81	2.95	-0.70	157	320
85	2.93	-0.66	157	323
89	2.82	-0.33	158	324
93	2.86	-0.17	159	325
97	2.67	-0.05	159	322
101	2.55	0.25	160	313
105	2.38	0.21	161	308
109	2.54	0.51	159	314
113	2.87	0.77	157	318
117	2.93	0.69	162	327
121	2.90	0.67	168	331
125	3.08	0.61	177	338
129	3.27	0.63	176	339
133	3.38	0.80	179	338
137	3.37	0.89	181	340

For Solid Ice Period

Insufficient Period for Analysis

Table 17: Tidal Constants for P1 Constituent (continued)

South Central Barrow Strait (Workhorse ADCP)

For Ice Free Period (Aug. 6, 2009 – Oct. 9, 2009):

Depth (m)	Major Amplitude (cm/s)	Minor Amplitude (cm/s)	Orientation (degrees cc from East)	Greenwich Phase (degrees)
12	3.19	0.19	159	329
16	3.33	0.24	148	335
20	3.61	0.24	148	335
24	3.66	0.31	154	335
28	3.84	0.26	159	332
32	4.10	0.33	161	327
36	4.06	0.31	158	326
40	3.75	0.38	155	328
44	3.53	0.06	150	335
48	3.71	0.08	150	343
52	3.91	0.19	154	341
56	4.28	0.02	152	337
60	4.54	-0.28	148	338
64	4.46	-0.45	145	339
68	4.15	-0.35	144	340
72	3.94	-0.32	144	343

For Solid Ice Period

Insufficient Period for Analysis

Table 17: Tidal Constants for P1 Constituent (continued)

South Central Barrow Strait (Quarter Master ADCP)

For Ice Free Period (Aug. 6, 2009 – Oct. 9, 2009):

Depth (m)	Major Amplitude (cm/s)	Minor Amplitude (cm/s)	Orientation (degrees cc from East)	Greenwich Phase (degrees)
26	3.80	0.42	148	337
34	3.40	0.39	151	329
42	3.86	0.33	149	328
50	3.78	0.16	150	334
58	4.11	-0.14	147	339
66	4.37	-0.69	143	342
74	4.12	-0.65	140	343
82	4.07	-0.56	139	346
90	4.28	-0.45	144	346
98	4.17	-0.71	147	344
106	4.14	-0.82	151	344
114	3.77	-1.08	154	342
122	3.68	-1.14	157	346
130	3.84	-0.81	158	349
138	4.07	-0.66	157	348
146	4.34	-0.61	153	349
154	4.20	-0.76	152	350
162	3.93	-0.84	152	351
170	3.61	-0.55	153	354
178	4.02	-0.42	150	350
186	4.51	-0.64	147	345
194	5.00	-0.44	149	344
202	5.47	-0.40	150	344
210	5.64	-0.64	151	346
218	5.65	-0.82	149	348
226	5.48	-0.69	141	347
234	6.05	-0.52	132	347

For Solid Ice Period

Insufficient Period for Analysis

Table 18: Tidal Constants for S2 Constituent

South Side Barrow Strait

For Ice Free Period (Aug. 5, 2009 – Oct. 8, 2009):

Depth (m)	Major Amplitude (cm/s)	Minor Amplitude (cm/s)	Orientation (degrees cc from East)	Greenwich Phase (degrees)
9	4.05	-0.12	169	255
13	4.14	-0.45	169	249
17	4.47	-0.55	168	251
21	4.20	-0.75	168	251
25	3.99	-0.86	163	248
29	4.14	-0.86	163	243
33	4.36	-0.84	167	242
37	4.52	-0.74	166	241
41	4.36	-0.46	164	239
45	4.19	-0.42	158	238
49	4.26	-0.53	158	237
53	4.29	-0.41	157	241
57	4.54	-0.34	160	242
61	4.57	-0.41	158	244
65	4.74	-0.46	157	247
69	4.91	-0.52	157	249
73	4.89	-0.48	159	251
77	5.17	-0.50	152	258
81	5.20	-0.26	153	259
85	4.98	-0.08	154	256
89	5.02	0.01	154	253
93	4.96	0.02	153	252
97	4.83	0.09	153	251
101	4.76	0.27	154	252
105	4.76	0.41	154	252
109	4.44	0.59	154	249
113	4.23	0.59	154	247
117	4.22	0.63	153	248
121	4.18	0.46	155	247
125	4.04	0.36	158	248
129	4.05	0.22	163	250
133	4.09	0.15	167	250
137	4.08	0.04	172	251

For Solid Ice Period

Insufficient Period for Analysis

Table 18: Tidal Constants for S2 Constituent (continued)

South Central Barrow Strait (Workhorse ADCP)

For Ice Free Period (Aug. 6, 2009 – Oct. 9, 2009):

Depth (m)	Major Amplitude (cm/s)	Minor Amplitude (cm/s)	Orientation (degrees cc from East)	Greenwich Phase (degrees)
12	4.90	-1.42	156	230
16	5.02	-1.48	154	229
20	5.49	-1.52	155	233
24	5.66	-1.65	162	237
28	6.16	-2.09	167	240
32	6.38	-2.19	171	244
36	6.04	-2.17	171	248
40	5.71	-1.96	171	250
44	5.49	-1.85	175	247
48	5.42	-1.75	177	247
52	4.99	-1.49	176	248
56	4.83	-1.51	176	250
60	4.89	-1.49	178	253
64	4.89	-1.44	178	255
68	4.79	-1.51	179	254
72	4.73	-1.36	176	256

For Solid Ice Period

Insufficient Period for Analysis

Table 18: Tidal Constants for S2 Constituent (continued)

South Central Barrow Strait (Quarter Master ADCP)

For Ice Free Period (Aug. 6, 2009 – Oct. 9, 2009):

Depth (m)	Major Amplitude (cm/s)	Minor Amplitude (cm/s)	Orientation (degrees cc from East)	Greenwich Phase (degrees)
26	5.68	-1.71	172	241
34	6.01	-2.28	177	247
42	5.75	-2.04	179	252
50	5.35	-1.89	182	254
58	4.93	-1.74	182	253
66	4.86	-1.70	184	254
74	4.75	-1.50	181	257
82	4.65	-1.63	180	254
90	4.80	-1.84	180	253
98	4.93	-1.96	182	251
106	4.85	-1.83	182	250
114	4.71	-1.76	181	252
122	4.71	-1.88	182	253
130	4.62	-1.90	184	255
138	4.68	-1.83	184	258
146	4.48	-1.82	186	258
154	4.41	-1.96	186	260
162	4.45	-1.79	187	260
170	4.36	-1.65	190	257
178	3.95	-1.54	190	258
186	3.64	-0.90	187	260
194	3.04	-0.42	183	261
202	2.90	-0.08	183	266
210	2.63	0.15	174	265
218	2.47	0.24	166	260
226	2.85	-0.01	164	257
234	3.29	-0.33	159	257

For Solid Ice Period

Insufficient Period for Analysis

Table 19: Ice Profiling Sonar, Ice Draft Monthly Statistics
South-Central Barrow Strait, August 2009 – July 2010

		Ice Draft (m)		
Year	**Month**	**Mean**	**Maximum**	**Std.Dev**
2009	August	0.00	6.01	0.07
	September	0.07	12.50	0.46
	October	0.51	15.11	0.91
	November	1.33	24.70	1.44
	December	2.17	18.04	2.01
2010	January	2.70	19.81	2.36
	February	2.71	21.08	2.47
	March	2.19	20.91	1.70
	April	2.97	36.35	2.45
	May	2.15	18.39	1.90
	June	1.97	18.14	1.72
	July	0.70	16.10	1.09

Table 20: Ice Profiling Sonar, Ice Draft Percent Frequency by Month
South-Central Barrow Strait, August 2009 – July 2010

	2009					2010						
Ice Draft (m)	**August**	**September**	**October**	**November**	**December**	**January**	**February**	**March**	**April**	**May**	**June**	**July**
Open Water	99.92	91.92	19.27	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.11	38.30
0.0-0.5	0.01	5.74	56.10	31.01	5.98	11.51	14.41	3.32	3.19	6.78	9.10	21.38
0.5-1.0	0.00	0.30	10.26	30.94	30.89	9.78	8.59	25.11	10.44	10.22	16.71	9.09
1.0-1.5	0.00	0.21	4.65	9.60	13.90	22.81	17.27	12.09	16.39	34.67	27.68	14.57
1.5-2.0	0.01	0.24	3.16	6.53	13.36	9.25	12.03	17.44	17.59	15.55	14.05	6.54
2.0-2.5	0.02	0.32	2.14	5.32	6.17	6.81	7.90	7.72	10.73	7.57	8.57	3.54
2.5-3.0	0.02	0.42	1.44	4.35	6.39	5.74	6.88	10.95	6.06	4.83	5.68	2.21
3.0-3.5	0.02	0.30	1.01	3.28	5.67	4.99	7.54	6.72	6.10	3.94	3.98	1.47
3.5-4.0	0.01	0.21	0.64	2.68	3.13	4.79	4.64	4.92	4.36	3.20	3.14	1.25
4.0-4.5	0.00	0.14	0.39	1.73	2.75	4.24	3.45	4.18	3.89	2.67	2.41	0.57
4.5-5.0	0.00	0.07	0.30	1.30	1.98	3.23	2.62	2.41	4.11	2.10	2.06	0.33
5.0-5.5	0.00	0.06	0.19	0.88	1.80	3.26	2.23	1.76	2.83	1.76	1.57	0.21
5.5-6.0	0.00	0.03	0.13	0.66	1.64	3.19	2.07	0.54	3.04	1.38	1.20	0.16
6.0-6.5	0.00	0.03	0.09	0.43	1.31	2.30	1.64	0.33	2.87	1.11	0.83	0.12
6.5-7.0	0.00	0.01	0.06	0.30	1.06	1.56	1.30	0.38	1.98	0.86	0.65	0.07
7.0-7.5	0.00	0.01	0.04	0.22	0.78	1.42	1.08	0.52	1.16	0.67	0.51	0.04
7.5-8.0	0.00	0.00	0.02	0.16	0.55	1.66	0.82	0.49	1.07	0.56	0.37	0.03
8.0-8.5	0.00	0.00	0.03	0.12	0.63	0.61	0.73	0.31	0.88	0.44	0.30	0.03
8.5-9.0	0.00	0.00	0.02	0.09	0.48	0.51	0.72	0.12	0.55	0.36	0.25	0.02
9.0-9.5	0.00	0.00	0.01	0.06	0.44	0.51	0.58	0.09	0.45	0.28	0.23	0.01
9.5-10.0	0.00	0.00	0.01	0.04	0.38	0.76	1.70	0.08	0.38	0.22	0.14	0.01
>=10.0	0.00	0.00	0.05	0.11	0.70	1.07	1.79	0.53	1.92	0.82	0.46	0.05
Missing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 21: CTD Statistics

Station Number	Date/Time (GMT)	Latitude ^{o}N	Longitude ^{o}W	Minimum Pressure (dbar)	Maximum Pressure (dbar)	Minimum Temperature (Deg.C)	Maximum Temperature (Deg.C)	Minimum Salinity (psu)	Maximum Salinity (psu)	Minimum Sigma-T (kg/m^3)	Maximum Sigma-T (kg/m^3)
1	11-Aug-2010 17:44	74.0424	-91.1032	2.0	54.5	-1.4741	2.3646	28.5741	32.1614	22.9275	25.8659
2	11-Aug-2010 17:21	74.0587	-91.0773	3.0	99.5	-1.5008	1.2202	28.2296	32.4976	22.6564	26.1394
3	11-Aug-2010 16:55	74.0727	-91.0540	2.5	133.5	-1.5227	3.2044	28.4109	32.7072	22.8022	26.3084
4	11-Aug-2010 15:01	74.0903	-91.0370	3.0	148.0	-1.5283	0.9433	28.3841	32.7403	22.7799	26.3343
5	11-Aug-2010 14:35	74.1059	-91.0086	3.0	166.0	-1.5483	1.0461	28.4382	32.7669	22.8226	26.3556
6	11-Aug-2010 14:04	74.1210	-90.9874	3.0	179.5	-1.5657	1.7534	28.3253	32.7965	22.7328	26.3790
7	11-Aug-2010 13:29	74.1359	-90.9518	2.0	199.0	-1.5586	2.4223	28.2188	33.6781	22.6446	27.0627
8	11-Aug-2010 12:29	74.1523	-90.9285	2.5	215.0	-1.5350	2.4459	28.6684	33.7718	23.0025	27.1337
9	11-Aug-2010 18:54	74.2149	-90.8449	2.5	277.0	-1.6559	3.8956	29.1674	33.9107	23.3868	27.2344
10	11-Aug-2010 22:08	74.2745	-90.7536	2.5	230.0	-1.6007	2.4777	29.1895	34.0578	23.3979	27.3400
11	12-Aug-2010 12:13	74.3381	-90.6594	2.5	210.0	-1.6169	1.8159	28.5304	33.9929	22.8850	27.2943
12	12-Aug-2010 13:22	74.3988	-90.5662	2.5	194.5	-1.6687	2.6823	28.5092	33.7669	22.8659	27.1364
13	12-Aug-2010 14:04	74.4617	-90.4698	2.0	273.5	-1.5393	3.0495	28.7356	34.0752	23.0573	27.3520
14	12-Aug-2010 14:40	74.5230	-90.3758	2.0	220.5	-1.7350	2.4226	28.2723	33.9100	22.6210	27.2364
15	12-Aug-2010 15:04	74.5377	-90.3529	2.0	192.0	-1.5895	2.5718	28.0184	33.8198	22.4234	27.1735
16	12-Aug-2010 17:20	74.5539	-90.3305	2.5	154.0	-1.5899	3.5972	27.9418	33.5980	22.3672	27.0068
17	12-Aug-2010 17:41	74.5660	-90.3121	2.0	94.5	-1.5229	2.6951	28.0708	32.6208	22.4720	26.2393