Hydrographic Properties of the Ross Sea Continental Shelf during December, 2005, and January 2006

NBP0601 – CORSACS

By Robert B. Dunbar, David A Mucciarone, Matt Long, Bettina Sohst

November 2006

Stanford University
Ocean Biogeochemistry Group, Report 06-04

1. Introduction

The Controls on Ross Sea Algal Community Structure (CORSACS) project is an inter-disciplinary study of the interactive effects of Fe, light, and CO_2 on phytoplankton community dynamics in the Ross Sea, Antarctica. The main objective in this proposed research is to investigate the relative importance and potential interactive effects of iron, light, and CO_2 levels in structuring algal assemblages and growth rates in the Ross Sea. The field program is designed to test the hypothesis that the interaction of these three variables largely determines the bottom-up control on two dominant Southern Ocean phytoplankton taxa, diatoms and *Phaeocystis*. Grazing and other loss processes are also important variables controlling the relative dominance of these two taxa; however, the CORSACS project primarily focuses on the bottom-up control mechanisms. It is important to understand such environmentally-driven taxonomic shifts in primary production, since they are expected to impact the fixation and export of carbon and nutrients, and the production of DMS, thus potentially providing both positive and negative feedbacks on climate.

Reported here are Conductivity, Temperature, Depth (CTD), C system, oxygen, and nutrient data from the CORSACS NBP0601 cruise, which were collected aboard the Research Vessel Ice Breaker *(RVIB) Nathaniel B. Palmer* between December 18, 2005 and January 25, 2006.

2. Cruise Narrative

The *RVIB Nathaniel B. Palmer* departed Lyttleton, New Zealand at December 18, 2005 and arrived at station #000 on December 24, 2005 at 00:07 UTC. There, a hydrographic cast was conducted to 608 m to test the integrity of the CTD system. No problems were detected during the overall operation of the CTD and bottle firing. However, upon inspection of the CTD sensor data, it was determined that the installed dissolved O_2 sensor was defective. This was replaced. The first hydrographic station in support of the CORSACS program was conducted at station #001 on December 27, 2005 at 00:19 UTC at -74.486°S, 179.5204°W. The cruise track proceeded into the Ross Sea polynya where a total of 102 hydrographic stations were occupied through late January, 2006. At various times during the cruise, stations were occupied along 76° 30’ S and along the Ross Ice Shelf to provide data for comparison with historical data collected along the same lines. With the exception of those minimal sampling requirements, station locations were selected based on the desire to provide the best possible synoptic survey of the region, consistent with objectives of sampling water with specified levels of Fe and/or CO_2, the prevailing ice conditions, and delays resulting from refueling or resupply requirements from McMurdo. The locations of all the CORSACS hydrographic stations are shown in Figure 1 and listed in Table 1.

3. Sampling

The *RVIB Nathaniel B. Palmer* is equipped with a SeaBird Electronics Model SBE-911*plus* conductivity, temperature, and depth instrument, which is mounted on a SeaBird, epoxy coated 24-bottle rosette sampler. The sampler is equipped with a SeaBird pylon and 10-liter Bullister bottles. Data from dual temperature, dual conductivity, pressure, oxygen, and other instruments as listed in Table 1 were transmitted in real-time to the SBE- 11 deck unit via conducting cable. Onboard, the data were recorded digitally on a Windows computer running SBE Seasave software (version 5.37d).

TABLE 1. NBP0601 CTD Sensors

Sensor	Description	Serial #	PreCruise Calibration Date	PostCruise Calibration Date	Comments
CTD Fish	SeaBird model SBE 9+	09P7536-0328	04/18/05		Installed 10/28/05
CTD Fish Pressure	Paroscientific model 410K-105 pressure sensor	53980	04/18/05		Installed 10/28/05
CTD Deck Unit	SeaBird model SBE 11+	11P19858-0490	n/a		
Primary T Sensor	SeaBird model 3-02/F	031238	3/17/05	2/27/06	
Secondary T Sensor	SeaBird model 3-02/F	032299	3/15/05	2/27/06	
Primary C Sensor	SeaBird model 4-02/0	040924	1/25/05	3/10/06	
Secondary C Sensor	SeaBird model 4C	041314	1/25/05	3/10/06	
Dissolved O_2 Sensor	SeaBird model SBE43	430150	2/2/05	4/4/06	Removed after test cast 00
Dissolved O_2 Sensor	SeaBird model SBE43	430139	12/3/05	2/16/06	Installed after test cast 00
PAR Sensor	Biospherical Instruments QSP-2300	4469	3/18/05	3/17/06	
Fluorometer	Wetlabs	AFLD-011		3/13/06	
Transmiss.	WET Labs C-Star	CST-889DR	08/08/05		
CTD Pump (Primary)	SeaBird 5T, PN 90160	051642 3.0K	12/01/04		
CTD Pump (Secondary)	SeaBird 5T, PN 90160	051645 3.0K	01/10/04		
Bottom Cont. Switch	SeaBird	#1	n/a		
Altimeter	OIS 6000 (6000m)	5117	n/a		New batt. 10/30/05
Carousel Water Sampler	SeaBird SBE-32	3214153-0140	n/a		Installed 10/25/05

Prior to the start of each hydrocast, the CTD was lowered to a depth of 10 m to allow time for the CTD pumps to activate and the sensors to equilibrate. During this washing period, the differences between the primary and secondary readings of the temperature and conductivity were monitored as well as dissolved O_2 levels. Once stability was achieved, the CTD was brought back to the surface in preparation for the hydrocast. During all hydrocasts, the CTD was lowered at a rate of 30 m min^{-1} through the upper water column (usually 150 m) and then at 50 m min^{-1} at greater depths. The distance between the sensor package and the bottom was determined using a Datasonics pinger. A mechanical safety switch notified the CTD operator when the package had reached a distance of 3 to 5 m from the bottom. We reached the seabed on about half of the hydrocasts conducted during NBP0601. The remaining casts focused on sampling the uppermost, biologically active portion of the water column. Ten-liter

Bullister bottles were tripped at selected depths on the upcast to provide in situ sampling of chemical, biological, and physical properties of the water column as well as to provide calibration data for the CTD. Once the CTD was back onboard, the temperature, conductivity, and dissolved oxygen sensors were flushed with deionized water and covered with rubber boots to minimize instrument fouling between casts.

Water samples were drawn in accord with Joint Global Ocean Flux Study (JGOFS) protocols [SCOR, 1994] with gas samples being drawn first, followed by salinity and nutrient samples and samples for biological measurements and experiments. Dissolved oxygen samples were drawn first from the Bullister bottles into calibrated 125 ml Erlenmeyer flasks. Following World Ocean Circulation Experiment (WOCE) guidelines [Culberson, 1991], O_2 flasks were rinsed three times and then slowly filled to overflowing. The samples were pickled immediately by adding 1 ml of $MnCI_2$ and 1 ml of NaOH/NaI. The stoppers were carefully inserted to ensure that no air bubbles were trapped beneath the stopper and the flasks were shaken to mix the reagents throughout the samples. To ensure that the samples were properly preserved, the samples were shaken a second time after 20 to 60 minutes. Samples were held in dark storage at 2°C prior to titration and were normally analyzed within 12 hours of their collection. Draw temperatures for all samples collected during the CORSACS cruise were in the temperature range -2°C to +2°C. For a nominal draw temperature of 0°C, the DO values reported here (units of ml l^{-1}) can be converted to DO with units of μmol kg^{-1} by using the conversion factor 0.04344 μmol kg^{-1} per ml l^{-1} of DO [Culberson, 1991].

Salinity samples were drawn from the Bullister bottles into 200 ml Borosilicate glass bottles equipped with plastic thimbles and Nalgene caps. The samples were equilibrated to room temperature for 24-72 hours before processing. Nutrient samples were drawn from Bullister bottles and filtered (5μm Acrodisc 32) into 30 ml polycarbonate bottles and were typically analyzed right after the hydrographic cast. Nutrient samples that could not be analyzed immediately were refrigerated in dark storage to minimize their degradation.

ΣCO_2 samples were collected into 250 ml glass BOD bottles with flared necks and ground glass stoppers by rinsing 3 times and then filling slowly to overflowing to avoid bubbling. All samples were poisoned with 50 μl of saturated $HgCl_2$ solution immediately after recovery. Samples were allowed to warm to room temperature before analysis, typically within 6 hours of the hydrocast.

pH samples were taken directly into 30 ml quartz glass 10 cm path length spectrophotometer cells by rinsing three times, then filling slowly to overflowing. These were then immediately capped off and warmed in a water equilibrator bath prior to immediate colorimetric analysis of pH.

4. Data Calibration and Processing

4.1 Discrete nutrient, dissolved oxygen, and salinity processing

Nutrient samples were analyzed on a Lachat Quickchem FIA+, series 8000, a bench-top instrument for automated analysis of NH_4+ (0.06-2.0 μM range), NO_3^- + NO_2^- (0.16-40 μM), SiO_2 (0.18-125 μM range), and PO_4^{+3} (0.02-2.5 μM range). Analyses of all nutrients were performed following the chemical procedures as outlined in the WOCE/JGOFS protocols for automated nutrient analysis [Gordon et al., 2001; SCOR, 1994]. The analytical methods were modified for the Lachat Quickchem system. The nutrient measurements are thought to have a precision of ~ ±1% based on a

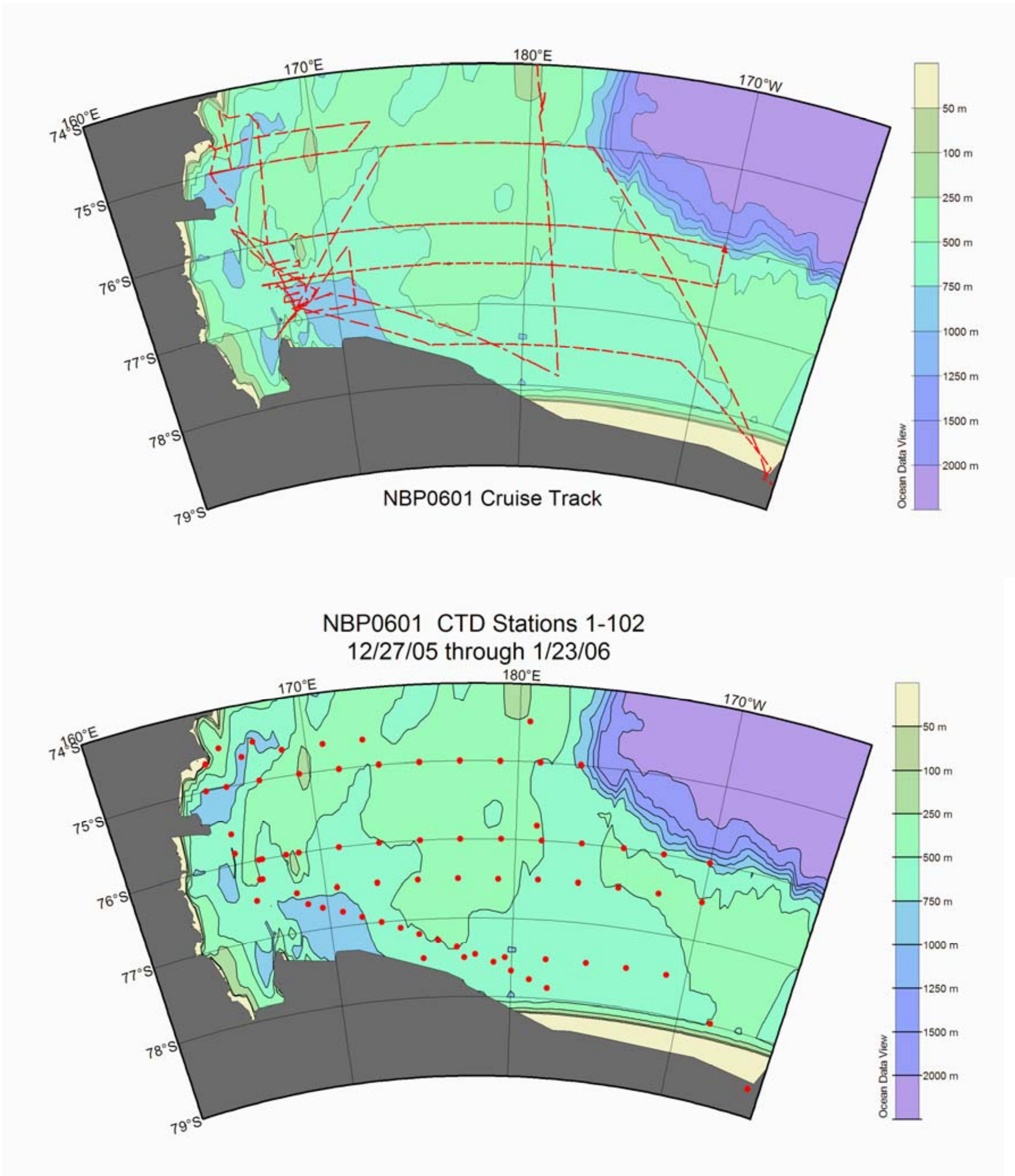


Figure 1. NBP0601 (CORSACS I) Cruise and CTD station map (stations 1-102).

comparison of identical samples. The accuracy of the nutrient measurements is believed to be of the same order.

Salinity samples were analyzed using a Guildline 8400 Autosal four-electrode salinometer (S/N NSF 04504) aboard the RVIB *Nathaniel B. Palmer*. All samples were standardized against IAPSO standard seawater (batch P146) with a fresh standard bottle opened before and after each salinity run. The Autosal system on the *Nathaniel B Palmer* is housed in a temperature controlled environment kept at 23°C. Analyses were conducted at an instrument temperature of 24°C. The Autosal has an inherent accuracy of ±0.002 psu for 24 hours without restandardization and a maximum resolution of better than 0.0002 psu at 35 psu. The standard deviation of standard seawater is about 0.0004 psu [Mantyla, 1980; Takatsuki et al., 1991], which represents the fundamental limitation of the analysis.

Discrete dissolved oxygen (DO) measurements were made with a Lamont-Doherty Earth Observatory amperometric oxygen titrator titration system [Langdon, 2003; Culberson and Huang, 1987]. Based on standards and replicate samples run during NBP0601, the resulting DO estimates are believed to be accurate to about ±0.01 ml l^{-1}. Precision is operator dependent, but is likely of the same magnitude.

Samples for ΣCO_2 analysis were collected in 250 ml BOD bottles and poisoned with 50 µl saturated $HgCl_2$ solution immediately after drawing, in accordance with JGOFS protocols (Dickson and Goyet 1994). Samples were allowed to warm to room temperature (~20^{o}C) prior to analysis which was typically performed within 3-12 hours of water collection. ΣCO_2 was measured by infrared absorption analysis of CO_2 in a nitrogen carrier gas stream using an automated injection system connected to an infrared gas analyzer (LI-COR LI7000). The injection system consists of a high-precision digital pump, which delivers a precise volume of seawater to a small sparging tube. 0.1 ml of phosphoric acid (3 N) is added by a micro-pump and the sample is bubbled with ultrahigh purity nitrogen with an in-line CO_2 scrubber. This gas stream is passed through a nafion dryer as well as a magnesium perchlorate water trap, and then directed into the LI-COR infrared gas analyzer. Integrating the infrared absorbance signal with respect to time yields the total amount of CO_2 evolved from the sample. ΣCO_2 measurements were calibrated using certified reference materials (CRM's) obtained from Andrew Dickson at UCSD-SIO (http://andrew.ucsd.edu/co2qc). CRM's were run periodically as unknowns over the course of a run to constrain instrument drift. All unknowns were run in triplicate. Precision estimated on the basis of triplicate analysis of unknown seawater samples is ±1.2 µmol kg^{-1}.

High precision pH determinations were made following the spectrophotometric method described in SOP7 of Dickson and Goyet (1994). pH samples are drawn directly from the Bullister bottles into 30 ml spectrophotometer cells that are then sealed with rubber caps. The cells are placed in a temperature equilibrator and warmed to 25°C over a period of 30 to 45 minutes immediately following the collection of water samples. The cells are placed in a temperature controlled spectrophotometer 10-cm path length holder (Ocean Optics scanning UV-VIS-IR) and blank values are measured at 730, 578, 434 nm. 50 µl of 2.2 mmol kg^{-1} m-cresol purple dye are then injected into the cell through one of the end caps and the absorbances are remeasured. pH is calculated from the absorbances and a acid dissociation constants as described in Dickson and Goyet (1994). The method is described as having a precision of better than 0.001 pH units (1 stdev). We found that our working precision, based on replicate analyses of Ross Sea water samples was ±0.002 pH units.

4.2 Temperature sensor calibration

SeaBird temperature sensors #1238 and #2299 were pre-cruise calibrated on 3/17/05 and 3/15/05, respectively. Both temperature sensors were post-cruise calibrated on 2/27/06. The pre- and post-cruise sensor calibration data provided by SeaBird Electronics are listed in Table 2. Both sensors drifted towards recording slightly lower values between pre- and post-cruise calibrations (by 0.0014°C for sensor #1238 and by 0.0002°C for sensor #2299). The pre- and post-cruise calibrations were nearly one year apart and this drift is within factory specification for these sensor heads. Post-cruise corrections will therefore make the CTD-derived temperatures slightly warmer on both sensors but the corrections are small to negligible (~0.0009°C for the primary sensor and ~0.00015°C for the secondary). This direction of drift is in the same sense as expected. The SBE data processing manual states that "SeaBird temperature sensors usually drift by changing offset, typically resulting in higher temperature readings over time for sensors with serial number less than 1050 and lower temperature readings over time for sensors with serial number greater than 1050. SeaBird's data indicates that the drift is smooth and uniform with time, allowing users to make very accurate corrections based only on pre- and post-cruise laboratory calibrations. Calibration checks at sea are advisable to ensure against sensor malfunction; however, data from reversing thermometers is rarely accurate enough to make calibration corrections that are better than those possible from shore-based laboratory calibrations. SeaBird temperature sensors rarely exhibit span errors larger than ±0.005°C over a range of -5 to +35 °C (0.005°C/(35 -[-5])C/year = 0.000125 °C/C/year), even after years of drift. A span error that increases more than ±0.0002 °C/C/year may be a symptom of sensor malfunction." Since the CTD casts on NBP0601 were all accomplished closer to the date of the post-cruise calibration, I have chosen to use these calibration coefficients and an offset correction interpolated back in time from the post-cruise calibration date. The offset correction for sensor #1238 used this way is -0.0004°C for all casts. There is no correction for the secondary sensor (#2299) since the drift is so small. The secondary sensor temperatures are used for the final data release.

The bias between the primary and secondary temperature sensors was estimated using temperature measurements collected at 1 m intervals (as described in the section on *Data Processing)* at water depths between 500 and 750 meters. The choice is somewhat arbitrary but 500 meters was chosen as the upper depth cutoff as it is well below the upper water column zone of variability in summer T and S. A depth of 750 meters was chosen for the lower depth cutoff as only a few stations from the westernmost Ross Sea had samples from greater depths and thus may have time-biased the comparison. Data used for this comparison came from stations 3 through 102. Based on this approach, the bias between the primary and secondary temperature sensors ($T_{primary}$–$T_{secondary}$) averages +0.0007°C with a standard deviation of 0.0002°C for 7,334 one-meter binned temperature measurements between 500 and 750 meters. There is no change in bias with time during the cruise. There is slight decrease in bias between the primary and secondary temperature sensors with depth, e.g., the average bias at 500 meters is ~0.0008°C, decreasing to ~0.0006°C at 750 meters. All of these values fall within the accuracy specification for SeaBird temperature sensors (±0.001°C).

4.3 Pressure sensor calibration

No corrections/adjustments were made for pressure parameters in the NBP0601 data set. The SeaBird pressure sensors have typically shown little drift during previous use on the *Nathaniel B Palmer*. In addition, no post-cruise calibration data was supplied for the pressure sensor. RPSC (Raytheon Polar Service Corporation) has adopted a practice of biennial calibration for their SBE Digiquartz pressure sensors. Therefore the next scheduled calibration for the sensor used for both NBP0601 and NBP0608 (Digiquartz SBE #53980) is in April, 2007. In addition to possible sensor drift, we note that the low average atmosphere pressure of the Ross Sea region in summer (~980 mbar) may introduce an offset in estimated pressure depth of up to 0.3 dbar. Again, until evidence of sensor drift is available from the April, 2007, calibration by SeaBird, no corrections for sensor drift or surface atmospheric pressure have been or will be applied to the released CTD data sets. Note that during post processing depth in meters is calculated based on density and pressure data. It is possible to reference all the data back to decibars if the user so desires.

4.4 Conductivity sensor calibration

SeaBird conductivity sensors #924 and #1314 were pre-cruise calibrated on 1/25/05 by SeaBird Electronics. Both sensors were post-cruise calibrated on 3/10/06. Both sensors exhibited changes in slope between the pre-cruise and post-cruise calibrations (409 days). In the case of the primary conductivity sensor (#924) this resulted in a drift towards recording slightly lower conductivities through the year between calibrations (average drift = -0.000162 S/m). For the secondary conductivity sensor (#1314) the drift between calibrations was towards very slightly higher conductivities (average drift = 0.0000429 S/m). Both of these drift rates are well below the factory specified drift limits of <0.0003 S/m/month for these sensors This kind of drift is typically corrected in post-processing by adjusting the calibration "slope" term rather than an offset value. The slope correction values given by SBE from the pre- and post-cruise calibrations are 0.9999142 for sensor #924 and 0.9999896 for sensor #1314, corresponding to slope drifts of $6x10^{-6}$ and $8x10^{-7}$. For post-processing, we use the pre-cruise conductivity calibration coefficients and interpolated "islope" values as described in SBE application note #31. The islope values used were 1.00007322 for sensor #924 and 1.00000887 for sensor #1314.

The post-cruise reprocessing of the CTD downcast data into 1 meter bins yields salinities with a small bias between the primary and secondary conductivity sensors. This bias (given as calculated salinity, $S_{primary}$-$S_{secondary}$) for all bins for all stations (n = 48,258) averages -0.0021 psu with a standard deviation of 0.0055 psu. Most of the variability leading to this moderately high standard deviation is associated with significant haloclines in the uppermost water column at stations in the westernmost Ross Sea. The bias between the two conductivity sensors in downcast samples between 500 and 750 meters is similar, -0.0019 psu, but with a reduced standard deviation of 0.0006 psu (n = 7,334 one meter bins). The deepwater bias in salinity ($S_{primary}$-$S_{secondary}$) was somewhat larger for stations 1-89 (-0.0022 psu) than for stations 90-102 (-0.0004 psu). There is no obvious explanation for this change in bias as it is not correlated with salinity or with depth, only with station number. However, by comparison with the bottle salinities, the change in bias appears to reflect mainly a shift in the primary conductivity sensor characteristics starting with station 90 (Figure 2).

Post-processing of the upcast data using the same post-processing sensor corrections and post-processing procedures as used for downcast data was used to produce a bottle sheet summary that details the properties of the water sampled by each Bullister bottle for each CTD cast. During NBP0601, 905 discrete salinity samples were taken for analysis with the shipboard Guildline Autosal. These values are compared with the CTD bottle sheet salinities as a check on the reliability of the CTD salinity data.

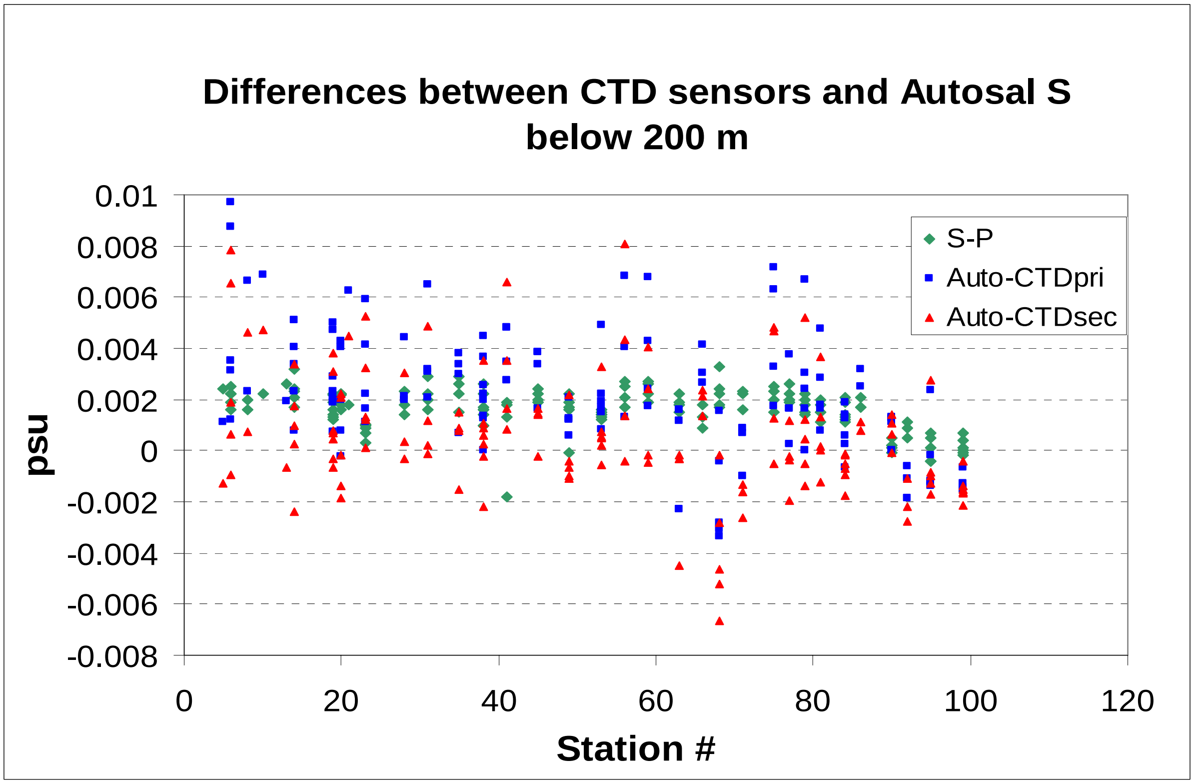


Figure 2. Difference between CTD primary and secondary conductivity sensors (given as S) and between Autosal and CTD sensor S, by station #, for samples deeper than 200 m.

The clearest indication of how the bottle salinities measured on the shipboard salinometer compare with the CTD measured conductivities/salinities during the upcasts comes from samples collected in the deeper water column. In the uppermost water column, in the presence of significant salinity stratification, significant offsets can and do exist between measured bottle salinities and the CTD salinities. These result from differences in the water sampled by the Bullister bottles and that sampled by the CTD sensors, a function of sensor position on the CTD and the integration of salinities through a depth range sampled by the CTD sensor as well as the equilibration time of the conductivity sensors. In the water column below 200 meters, vertical gradients in salinity are relatively small allowing for a direct comparison of bottle and CTD-derived salinities. Below 200 meters, the average difference (and standard deviation) between discrete Autosal bottle salinity and CTD salinity (n = 144) for the primary conductivity sensor was 0.0022 psu (stdev = 0.0024 psu) and for the secondary conductivity sensor was 0.0006 psu (stdev = 0.0024 psu). Within this same data set, the mean difference between the bottle sheet primary and secondary salinities was 0.0016 psu (stdev = 0.0008). These results indicate that the corrected secondary conductivity sensor values were closest to "true" during the NBP0601 cruise. In fact, given the average offset from the salinometer salinities of only 0.0006 psu for deep water samples, I chose not to recalculate the downcast salinities using a slope derived from the salinometer calibration but rather stay with the post-cruise sensor calibration derived interpolated "post-slope" as described above. The Autosal salinometer data is part of this data distribution should any user wish to make this small correction in the future.

The analysis presented here suggests that temperature and conductivity values have been corrected to a level of accuracy consistent with JGOFS standards of ±0.001°C for temperature and ±0.003 for salinity [SCOR, 1994]. The secondary sensor suite is used to derive all subsequent water column parameters. Only secondary sensor values are listed in the final concatenated bottle sheet files. For completeness, both primary and secondary sensor data is listed in the 1-meter downcast CTD data, but the secondary sensor data is considered closest to "true".

4.5 Dissolved oxygen sensor calibration

The initial SBE-43 oxygen sensor installed on the CTD (SBE 43 #430150) was found to be defective during our test hydrocast (CTD 000). It was removed and replaced by a new sensor that was used for the remainder of the cruise. The new DO sensor (SBE 43 #430139) was pre-cruise calibrated on 12/3/05 and post-cruise calibrated on 2/16/06 (Table 1). These sensors are known to drift significantly with time. Moreover, sensor performance is strongly dependent on the direction and rate of flushing; thus, profiled downcast data and samples collected during the stops for water collection are likely to be different. To mitigate these effects, the DO sensor was calibrated *in-situ* using titrated DO measurements from the upcast. Typically, 3 or 4 depths (of the 12 depths typically sampled during each bottle cast) were analyzed for DO by amperometric titration for each cast and compared to the corresponding CTD-derived measurements from the upcast generated bottle sheets.

Following the NBP0601 cruise, the 10 ml re-pipette used for the delivery of the KIO_3 DO standard was returned to Stanford University and recalibrated. A small offset was found between the pipette volume assumed during the cruise and the actual calibrated volume. The resulting recalculation of the shipboard titrated DO values brought the titrated values closer to the observed CTD DO values. The initial reprocessing of the CTD data using the post-cruise calibration coefficients for the O_2 sensor resulted in an increase in the SBE 43-derived oxygen concentrations, again bringing the two data sets closer to agreement. After CTD post-processing, the remaining offset was determined by examining the difference between data from CTD casts 1-102 and below 150 meters. The resulting analysis includes 109 paired titration/SBE dissolved oxygen values. The mean offset (and stdev) is 0.21 (0.07) ml l-1 with the SBE reading low. This corresponds to an offset in terms of percent of total oxygen concentration of 3.30±0.97%, a significant difference that is likely due to the SBE 43 sensor being out of calibration with either the post-cruise or pre-cruise calibration parameters. At this point I followed the protocol established in SBE Application Note 64-2 (2005) to recalibrate the sensor used during our casts with the real-time collected Winkler data. By this method, we consider Amperometric Winkler DO values from 283 Bullister Bottles collected from CTD casts 1-99. We then compare the original SBE 43 output voltages with a parameter defined as Winkler O_2/ϕ (Figure 3).The slope and intercept from a linear regression of these data pairs yields a cruise-specific calibration for the SBE 43 oxygen sensor used on our cruise as follows:

$\phi = e^{(tcor * T)} * O_2sat. * e^{(pcor*P)}$, where T = temperature and P = Pressure from CTD, and

$(DO\ (ml\ l^{-1}))/\phi = Soc * (V + V_{offset}) = M * V + B$, where Soc and V_{offset} are calibration

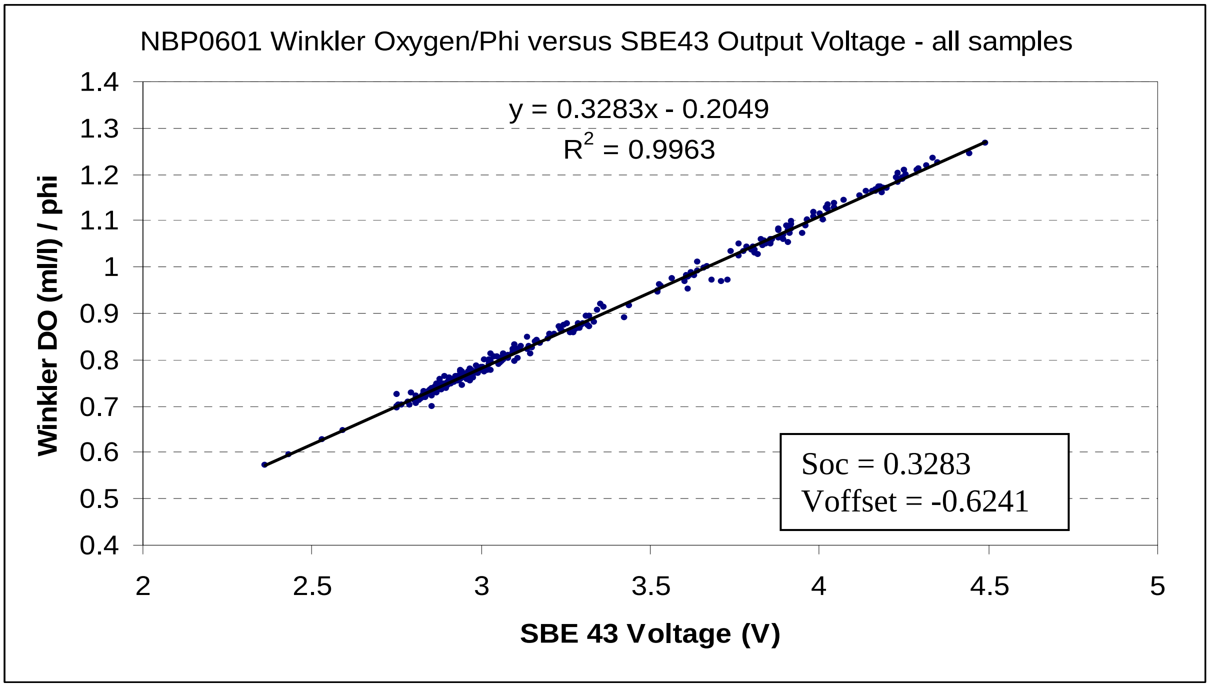


Figure 3. Plot of SBE 43 voltage (sensor #139) versus the ratio of amperometric Winkler DO values to phi (a pressure and temperature oxygen saturation term) used for deriving calibration coefficients for the CTD SBE sensor.

parameters derived from the regression described above. I chose to use Winkler data from all casts and depths for this recalibration exercise, with the caveat that I removed 4 data points where the difference between the Winkler DO and the original SBE DO exceeded 2.6 times the standard deviation of the average difference. This has the effect of removing "fliers" from the calibration data set at a level of about 1% of the data points. By this method, values of Soc = 0.3283 and Voffset = -0.6241 are used for final post-processing of the CTD data for all casts.

5. Data Profile Processing

Using the calibration coefficients and the corrections described above, the CTD profile data were processed using the SeaBird Electronics SeaSoft Software Package version 5.32a [SeaBird Electronics, 2004]. The final post-processing followed this sequence of commands: **datacnv, filter, alignctd, wildedit, wildedit, wildedit, celltm, loopedit, derive1** (for O_2), **bin average** (1 meter bins for the downcast and also for the fullcast data conversions), **derive2** (for salinity and density), **bottle summary** (rossummary), **ascii out**. All post-processing was done using a single con (configuration file) that is distributed with this data set: p601postprocallcasts.CON. All files derived from this post-processing are available as part of this data distribution. The attached header file shows the processing commands and parameters used for each of the 102 files. In most cases manufacturer recommendations were followed. The latitude and longitude at the beginning of each hydrographic cast were normally inserted into the data file at the start of the hydrographic cast by the CTD data acquisition system. These positions were obtained from the onboard Global Positioning System (GPS) and were recorded to a precision of 0.01 minutes of latitude and longitude.

6. Bottle Data Quality Control

6.1 Dissolved oxygen data

The differences between titrated and CTD-derived DO values were compared against a rejection limit of 2.6σ and differences exceeding this value were flagged for further examination. We selected a rejection threshold of 2.6σ with the knowledge that, on a statistical basis, a maximum of 1% of the good data could be flagged or misidentified as an outliers and inadvertently discarded [Millard and Yang, 1993]. For DO measurements, in some cases, especially in the upper 25 m, the sensor/Winkler difference exceeded 0.3 ml l^{-1}. However, given the slow response time of the DO sensor coupled with relatively steep DO gradients near the ocean surface, such differences are to be expected. In the end, 4 deeper water titrated DO values were removed from the final data release (contained in the final bottle sheet excel file: NBP0601 Final PostProcessed and QCed CTD Bottle Sheets ALL.xls.

6.2 Salinity data

The differences, ΔS, between the Bullister bottle Autosal and CTD-derived secondary salinities were compared against a rejection limit of 2.6σ and differences exceeding this value were flagged for further examination. In most cases the difference between CTD-derived primary and secondary salinities was much smaller than ΔS, suggesting that most of the discrepancies were due to variability in the bottle salinities. Most of the data flagged were in the upper 50 m of the water column where we observed strong S gradients. As a result, some of the observed differences could simply reflect natural variability in the water column. However, the exact source of this uncertainty could not be resolved; therefore, these data were eliminated from the final merged data files (e.g. 10 Autosal salinity values were removed).

7. Contents of the Data Set

The NBP0601 hydrographic data set consists of both discrete bottle samples and continuous downcast profile data, both upcast and fullcast. Normally, users will work with the downcast data but the upcast data may prove useful when checking specific features of water column structure and are thus provided here for completeness. The profile data are provided as individual ASCII (ASC) or TEXT (TXT) files with a single header record describing the parameters in the file. By convention these files are named *CCCCSSSlabel.ASC (or .TXT)*, where *CCCC* is the cruise number (p601), *SSS* is the station number, and label is the descriptor for the file (e.g., DowncastBinAve or FullCastBinAve) and *ASC or TXT* is the extension designating it as a SeaBird Electronics ASCII data file. E.g., p601001DownBinAve.txt is from cruise NBP0601, Cast 001, and consists of bin-averaged 1 m data from the downcast only. An ASCII header file *CCCCSSSlabel.ASC,* which contains information on the raw data and the data processing, is also provided. In additional, the final binary data conversion files (.CNV) used during the post-processing are provided. These allow users to more readily calculate additional derived variables using the SeaSoft data processing package.

We also provide several Excel spreadsheets as part of this data distribution. There is one Excel sheet that contains all the merged 1 meter bins of data from all hydrocasts conducted during NBP0601. In addition, there is a merged bottle sheet file that provides data from the CTD as well as discrete analyses of DO, S, nutrients, and C system parameters. Both CTD downcast and bottle sheet files are also made available as Ocean Data View “collections”.

Acknowledgments

Funding for the CORSACS cruises to the Ross Sea were provided by the U.S. National Science Foundation OPP- 0338097. Project P.I.’s include: G. DiTullio, University of Charleston, R. Dunbar, Stanford University, D. Hutchins, University of Delaware, P. Sedwick, BBSR, W. Smith, VIMS, P. Tortell, University of British Columbia. We thank the captain and crew of the *Nathaniel B. Palmer* during NBP0601 as well as the able and professional assistance of the RPSC CTD operators and MT’s during the cruise.

We also thank Dr. Michael Van Woert for his meticulous reporting of the ROAVERRS CTD data from the Ross Sea in 1996, 1997, and 1998. We have made direct use of his hydrographic report (Van Woert et al., 2000), both prose and style, in the preparation of this document We also followed, where possible, the same data processing protocols performed by Van Woert et al., so as to enhance comparability between the hydrographic data derived from the ROAVERRS and CORSACS programs.

References

Culberson, C. H., Dissolved Oxygen, in *WOCE Hydrographic Program Operations and Methods, WHOI Technical Report, WHOI 91-1,* edited T. Joyce, 15 pp., WOCE Hydrographic Program Office, Woods Hole, Massachusetts, July 1991.

Culberson, C.H., and S. Huang, Automated amperometric oxygen titration. *Deep-Sea Research*, 34, 875-880, 1985.

Dickson, A.G., and C.A. Goyet, *Handbook of methods for the analysis of the various parameters of the carbon dioxide system in seawater, version 2*, U.S. Department of Energy, ORNL/CDIAC-74, 1994.

Gordon, L.I., Jennings, Jr., J.C., and A.A. Ross, *A suggested protocol for continuous flow automated analysis of seawater nutrients using the Alpkem Flow Solution IV System, Chemical Protocols used in the WOCE Hydrographic Program and Joint Global Ocean Flux Study*, College of Oceanic and Atmospheric Sciences, Oregon State University, 2001.

Langdon, C., The amperometric oxygen titrator: assembly and procedure, Lamont-Doherty Earth Observatory of Columbia University, unpublished instruction manual, 2003.

Mantyla, A. W., Electrical Conductivity of Standard Sea Water Batches P29 to P84, *Deep-Sea Research,* Vol. 27A, 837-846, 1980.

Millard, R. C. and K. Yang, CTD Calibration and Processing Methods Used at Woods Hole Oceanographic Institution, *WHOI Technical Report 93-44*, Woods Hole, Massachusetts, pp. 96,1993.

SCOR, Protocols for the Joint Global Ocean Flux Study (JGOFS) Core Measurements, *UNESCO Manuals and Guides* ***no.*** *29*, 170 pp., 1994.

SeaBird Electronics, Inc., *SBE 13/22/23/30 Dissolved Oxygen Sensor Calibration and Deployment,* Applications Note No. 13-1, Rev B, Bellevue, WA, 10 pp., April 1993.

SeaBird Electronics, Inc., SBE 43 Dissolved Oxygen Sensor Calibration using Winkler Titrations. Applications Note No. 64-2, Revision August 2005.

SeaBird Electronics, Inc., *Computing Temperature and Conductivity ‘slope’ and ‘offset’ Correction Coefficients from Laboratory Calibrations and Salinity Bottle Samples,* Applications Note No. 31, Bellevue, WA, 5 pp., February 1995.

Takatsuki, Y., M. Aoyama, T. Nakano, H. Miyagi, T. Ishihara, T. Tsutsumida, Standard Seawater Comparison of Some Recent Batches, *Journal of Atmospheric and Oceanic Technology*, 8, 895-897, 1991.

Van Woert, M.L., D. Pryor, E. Quiroz, R. Slonaker, and W.A. Stone, Hydrography of the Ross Sea Contnental Shelf during the ROAVERRS, NBP96-06, cruise December 1996 – January 1997, NOAA Technical Report NESDIS 96, NOAA, Washington D.C., 278 pp., 2000.

NBP0601 CTD stations

Stn	GMT	GMT	Long	Lat	Z	Stn	GMT	GMT	Long	Lat	Z
1	12/27/2005	0:12	-179.520	-74.486	300	52	1/9/2006	10:28	168.900	-76.000	455
2	12/27/2005	23:49	-178.946	-75.815	420	53	1/9/2006	18:53	166.839	-76.000	664
3	12/28/2005	14:06	-177.878	-77.866	660	54	1/9/2006	20:22	166.839	-76.000	664
4	12/28/2005	16:35	-178.936	-77.766	671	55	1/10/2006	20:15	175.000	-77.500	719
5	12/28/2005	19:20	-180.000	-77.667	661	56	1/10/2006	22:09	175.000	-77.500	712
6	12/28/2005	20:49	-180.000	-77.667	670	57	1/11/2006	4:34	177.307	-77.500	681
7	12/29/2005	5:25	178.970	-77.563	688	58	1/11/2006	11:10	179.618	-77.500	681
8	12/29/2005	7:52	177.933	-77.464	694	59	1/11/2006	18:32	-178.059	-77.500	653
9	12/29/2005	10:30	176.900	-77.369	594	60	1/11/2006	20:06	-178.059	-77.500	653
10	12/29/2005	13:00	175.862	-77.276	492	61	1/12/2006	3:55	-175.745	-77.501	562
11	12/29/2005	15:17	174.824	-77.188	431	62	1/12/2006	9:46	-173.438	-77.500	532
12	12/29/2005	17:39	173.815	-77.091	476	63	1/12/2006	18:36	-171.127	-77.501	474
13	12/29/2005	20:04	172.800	-77.000	605	64	1/12/2006	19:47	-171.127	-77.501	474
14	12/29/2005	21:34	172.800	-77.000	605	65	1/13/2006	6:15	-168.014	-77.982	576
15	12/29/2005	23:58	171.780	-76.909	676	66	1/13/2006	18:34	-164.750	-78.649	543
16	12/30/2005	2:21	170.762	-76.819	717	67	1/13/2006	19:55	-164.750	-78.652	543
17	12/30/2005	10:09	170.761	-76.819	719	68	1/15/2006	1:21	-177.011	-74.999	552
18	12/30/2005	19:44	169.717	-76.733	769	69	1/15/2006	2:41	-176.993	-75.001	552
19	12/30/2005	23:12	169.717	-76.733	770	70	1/15/2006	10:22	-178.936	-75.000	521
20	12/31/2005	21:30	166.321	-76.502	640	71	1/15/2006	18:36	179.137	-74.999	435
21	12/31/2005	23:46	166.327	-76.500	628	72	1/15/2006	19:37	179.137	-74.999	435
22	1/1/2006	8:52	168.470	-76.500	728	73	1/15/2006	23:01	177.201	-75.000	363
23	1/1/2006	18:50	170.608	-76.500	655	74	1/16/2006	2:30	175.270	-75.001	285
24	1/1/2006	20:23	170.608	-76.500	655	75	1/16/2006	5:48	173.332	-74.999	485
25	1/2/2006	3:22	172.750	-76.500	624	76	1/16/2006	7:10	173.332	-74.999	485
26	1/2/2006	10:50	174.895	-76.500	457	77	1/18/2006	3:47	168.974	-76.657	813
27	1/2/2006	12:35	174.895	-76.500	457	78	1/18/2006	10:13	166.833	-76.250	715
28	1/2/2006	20:17	177.033	-76.500	383	79	1/18/2006	18:35	165.724	-75.611	799
29	1/2/2006	21:47	177.033	-76.500	383	80	1/18/2006	20:20	165.724	-75.611	799
30	1/3/2006	6:20	179.157	-76.508	292	81	1/19/2006	2:22	165.000	-75.000	899
31	1/3/2006	18:40	-178.748	-76.500	621	82	1/19/2006	6:35	164.991	-75.000	899
32	1/3/2006	20:00	-178.748	-76.500	621	83	1/19/2006	10:12	165.250	-74.666	554
33	1/4/2006	3:34	-176.616	-76.500	547	84	1/19/2006	18:34	166.967	-74.667	1004
34	1/4/2006	10:05	-174.478	-76.500	546	85	1/19/2006	20:21	166.967	-74.667	1004
35	1/4/2006	18:37	-172.335	-76.499	461	86	1/20/2006	0:25	168.867	-74.666	454
36	1/4/2006	20:07	-172.335	-76.499	461	87	1/20/2006	1:37	168.867	-74.666	454
37	1/5/2006	6:29	-170.000	-76.502	604	88	1/20/2006	5:14	170.801	-74.667	308
38	1/5/2006	18:35	-170.001	-76.000	854	89	1/20/2006	8:52	172.667	-74.667	529
39	1/5/2006	20:33	-170.001	-76.000	854	90	1/20/2006	18:40	171.429	-75.002	540
40	1/6/2006	7:00	-172.386	-76.000	452	91	1/20/2006	21:42	171.431	-75.004	540
41	1/6/2006	18:35	-174.468	-76.000	520	92	1/21/2006	3:57	169.514	-74.999	329
42	1/6/2006	19:45	-174.468	-76.000	520	93	1/21/2006	5:08	169.514	-74.999	329
43	1/7/2006	3:22	-176.617	-76.000	566	94	1/21/2006	10:11	167.600	-75.000	466
44	1/7/2006	9:46	-178.680	-76.000	555	95	1/21/2006	23:01	166.000	-75.000	1026
45	1/7/2006	18:37	179.249	-76.000	492	96	1/22/2006	0:41	166.000	-75.000	1026
46	1/7/2006	19:51	179.249	-76.000	492	97	1/22/2006	4:21	166.001	-74.500	568
47	1/8/2006	2:58	177.178	-75.999	443	98	1/22/2006	10:36	167.600	-74.500	890
48	1/8/2006	9:40	175.112	-76.000	561	99	1/22/2006	19:52	167.000	-76.000	671
49	1/8/2006	18:32	173.038	-76.000	565	100	1/22/2006	21:58	167.000	-76.000	671
50	1/8/2006	19:57	173.038	-76.000	565	101	1/23/2006	2:49	165.701	-75.860	538
51	1/9/2006	3:53	170.978	-75.999	595	102	1/23/2006	7:07	166.699	-76.251	707

Table 2. Pre and Post Cruise CTD calibration coefficients - NBP0601

Primary Temperature Sensor, Model 3-02F, #1238						
pre-cruise calibration date: 17 Mar 05				post-cruise calibration date: 27 Feb 06		
g	4.82467117E-03			4.82484656E-03		
h	6.70736079E-04			6.70977642E-04		
i	2.56763932E-05			2.57750761E-05		
j	2.04860441E-06			2.06165518E-06		
f0	1000.0			1000.0		
offset from 3/17/05 = 1.40 mdeg C						

Secondary Temperature Sensor, Model 3-02F, #2299						
pre-cruise calibration date: 15 Mar 05				post-cruise calibration date: 27 Feb 06		
g	4.33175714E-03			4.33176595E-03		
h	6.43377305E-04			6.43395520E-04		
i	2.32961654E-05			2.33000471E-05		
j	2.22625027E-06			2.22381344E-06		
f0	1000.0			1000.0		
offset from 3/15/05 = 0.07 mdeg C						

Primary Conductivity Sensor, Model 4-02/0, #0924						
pre-cruise calibration date: 25 Jan 05				post-cruise calibration date: 10 Mar 06		
g	-4.25433269E+00			-4.25603312E+00		
h	5.69146773E-01			5.69614909E-01		
i	-5.27279657E-04			-6.23387933E-04		
j	5.95157100E-05			6.50573839E-05		
CPcor	-9.57E-08			-9.57E-08		
CTcor	3.25E-06			3.25E-06		
Data slope correction from 25 Jan 05: 0.9999142						

Secondary Conductivity Sensor, Model 4C, #1314						
pre-cruise calibration date: 25 Jan 05				post-cruise calibration date: 10 Mar 06		
g	-4.07306392E+00			-4.07536260E+00		
h	4.70619624E-01			4.70981561E-01		
i	1.46589188E-05			-5.52972693E-05		
j	2.52643431E-05			2.88272015E-05		
CPcor	-9.57E-08			-9.57E-08		
CTcor	3.25E-06			3.25E-06		
Data slope correction from 25 Jan 05: 0.9999896						

Dissolved Oxygen Sensor, Model SBE43, #0139						
pre-cruise calibration date: 3 Dec 05				post-cruise calibration date: 18 Feb 06		
Soc	3.06900000E-01			3.14400000E-01		
Boc	0.00000000E+00			0.00000000E+00		
Voffset	-5.98000000E-01			-5.95500000E-01		
Tcor	1.60000000E-03			1.60000000E-03		
Pcor	1.35E-04			1.35E-04		
Note: significant difference in residual slope						

PAR Sensor, Model QSP200L4S, #4469						
pre-cruise calibration date: 18 Mar 05				post-cruise calibration date: 17 Mar 06		
Dry Cal	8.90E+12	1.48E-05		7.30E+12	1.21E-05	
Wet Cal	1.50E+13	2.49E-05		1.23E+13	2.04E-05	

Flourometer Sensor, #AFLD-011						
pre-cruise calibration date: unknown				post-cruise calibration date: 13 Mar 06		
Dark Counts				0.143 v		
CEV				2.914 v		
SF				9.022		
FSV				5.45 v		

Table 3. Contents of p601postprocallcasts.CON, used to post-process al NBP0601 data sets.

```
Configuration report for SBE 911/917 plus CTD
---------------------------------------------

Frequency channels suppressed : 0
Voltage words suppressed      : 0
Computer interface            : RS-232C
Scans to average              : 1
Surface PAR voltage added     : Yes
NMEA position data added      : Yes
Scan time added               : Yes

1) Frequency, Temperature

   Serial number : 1238
   Calibrated on : 27-Feb-06
   G             : 4.82484656e-003
   H             : 6.70977642e-004
   I             : 2.57750761e-005
   J             : 2.06165518e-006
   F0            : 1000.000
   Slope         : 1.00000000
   Offset        : -0.0004

2) Frequency, Conductivity

   Serial number : 0924
   Calibrated on : 25-Jan-05
   G             : -4.25433269e+000
   H             : 5.69146773e-001
   I             : -5.27279657e-004
   J             : 5.95157100e-005
   CTcor         : 3.2500e-006
   CPcor         : -9.57000000e-008
   Slope         : 1.00007322
   Offset        : 0.00000

3) Frequency, Pressure, Digiquartz with TC

   Serial number : 0328
   Calibrated on : 18-Apr-05
   C1            : -5.847002e+004
   C2            : 6.910390e-001
   C3            : 1.753360e-002
   D1            : 4.241600e-002
   D2            : 0.000000e+000
   T1            : 3.026040e+001
   T2            : -1.938830e-004
   T3            : 4.330190e-006
   T4            : 2.020250e-009
   T5            : 0.000000e+000
   Slope         : 1.00004000
   Offset        : -0.74260
   AD590M        : 1.133000e-002
   AD590B        : -8.475920e+000
```

```
4) Frequency, Temperature, 2

   Serial number : 2299
   Calibrated on : 27-Feb-06
   G             : 4.33176595e-003
   H             : 6.43395520e-004
   I             : 2.33000471e-005
   J             : 2.22381344e-006
   F0            : 1000.000
   Slope         : 1.00000000
   Offset        : 0.0000

5) Frequency, Conductivity, 2

   Serial number : 1314
   Calibrated on : 25-Jan-05
   G             : -4.07306392e+000
   H             : 4.70619624e-001
   I             : 1.46589188e-005
   J             : 2.52643431e-005
   CTcor         : 3.2500e-006
   CPcor         : -9.57000000e-008
   Slope         : 1.00000887
   Offset        : 0.00000

6) A/D voltage 0, Altimeter

   Serial number : 497
   Calibrated on : N/A
   Scale factor  : 5.000
   Offset        : 0.000

7) A/D voltage 1, Free

8) A/D voltage 2, Oxygen, SBE 43

   Serial number : 0139
   Calibrated on : 10-Jan-06
   Soc           : 3.2830e-001
   Boc           : 0.0000
   Offset        : -0.6241
   Tcor          : 0.0005
   Pcor          : 1.35e-004
   Tau           : 0.0

9) A/D voltage 3, Free

10) A/D voltage 4, Fluorometer, Wetlab ECO-AFL/FL

    Serial number : AFLT-016D
    Calibrated on : 24-Mar-05
    Vblank        : 0.1770
    Scale factor  : 9.42300000e+000
```

11) A/D voltage 5, Transmissometer, Chelsea/Seatech/Wetlab CStar

```
Serial number : CST-889
Calibrated on : 08-Aug-05
M             : 22.6020
B             : -1.2660
Path length   : 0.003
```

12) A/D voltage 6, PAR/Irradiance, Biospherical/Licor

```
Serial number        : 4469
Calibrated on        : 18-Mar-05
M                    : 1.00000000
B                    : 0.00000000
Calibration constant : 4016064257.00000000
Multiplier           : 1.00000000
Offset               : -0.35000000
```

13) A/D voltage 7, Free

14) SPAR voltage, Unavailable

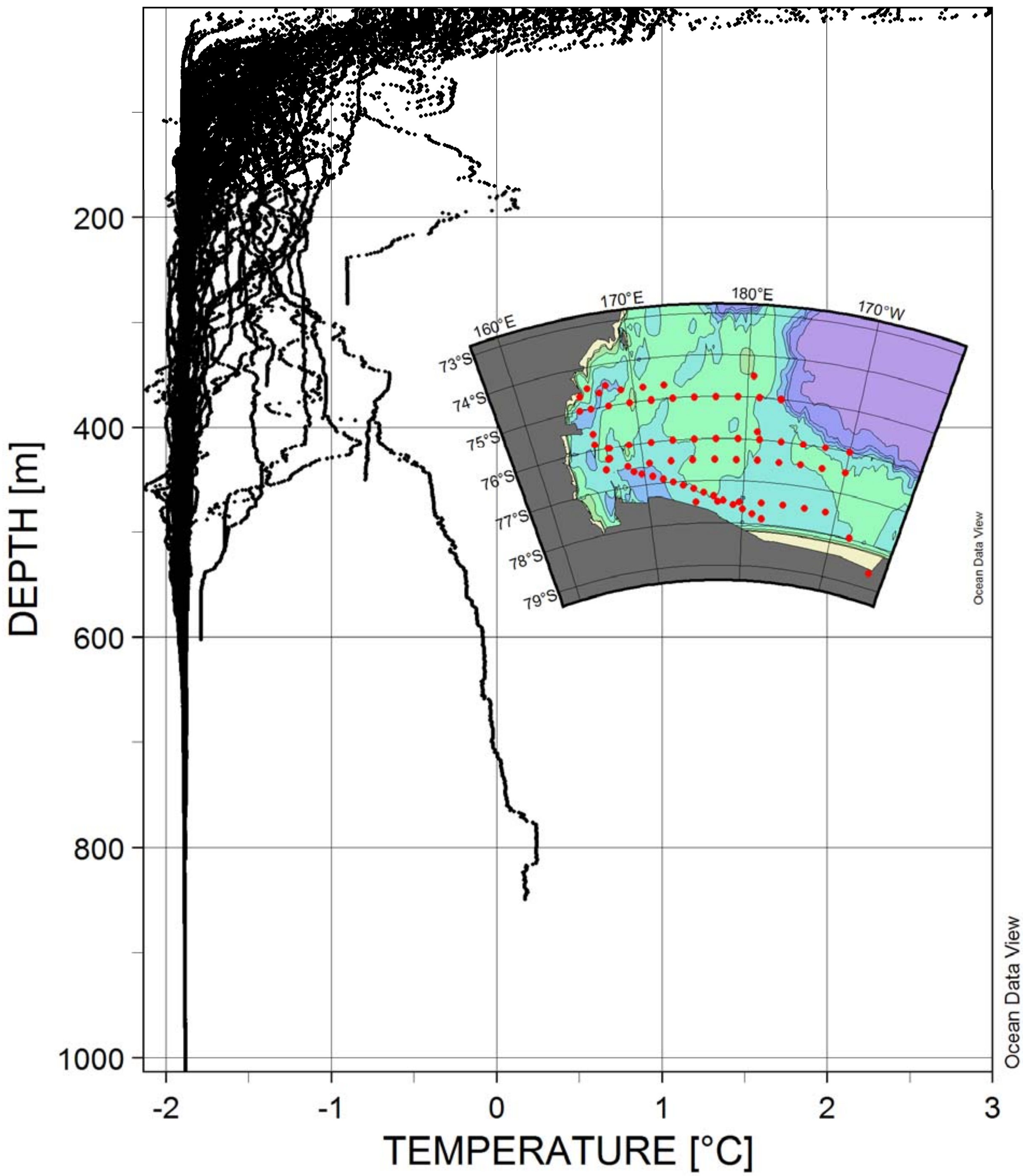
15) SPAR voltage, SPAR/Surface Irradiance

```
Serial number     : 6356
Calibrated on     : 16-May-05
Conversion factor : 1595.53220373
Ratio multiplier  : 1.00000000
```

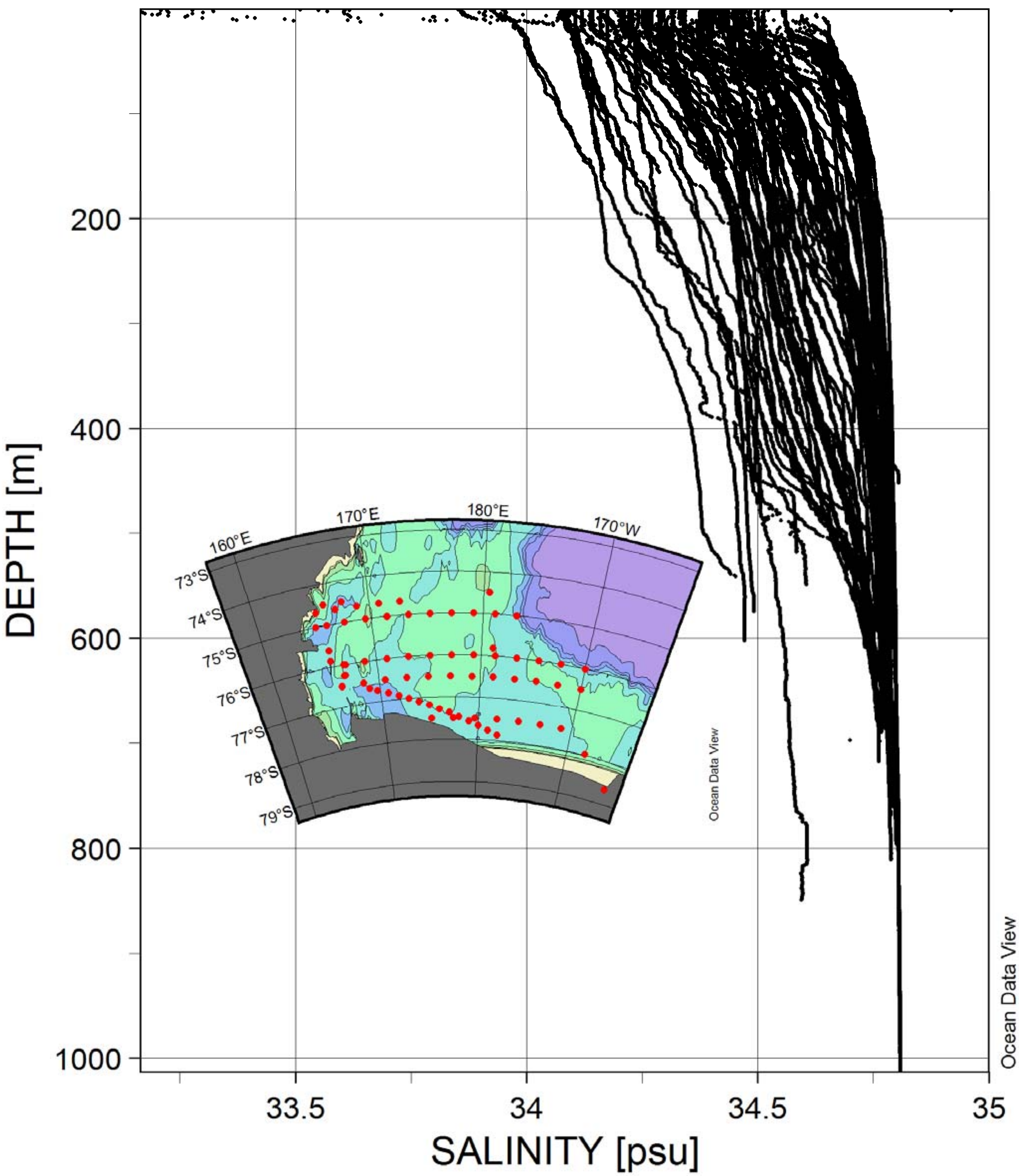
Table 4. Processing sequence used with final post-processing of NBP0601 CTD data.

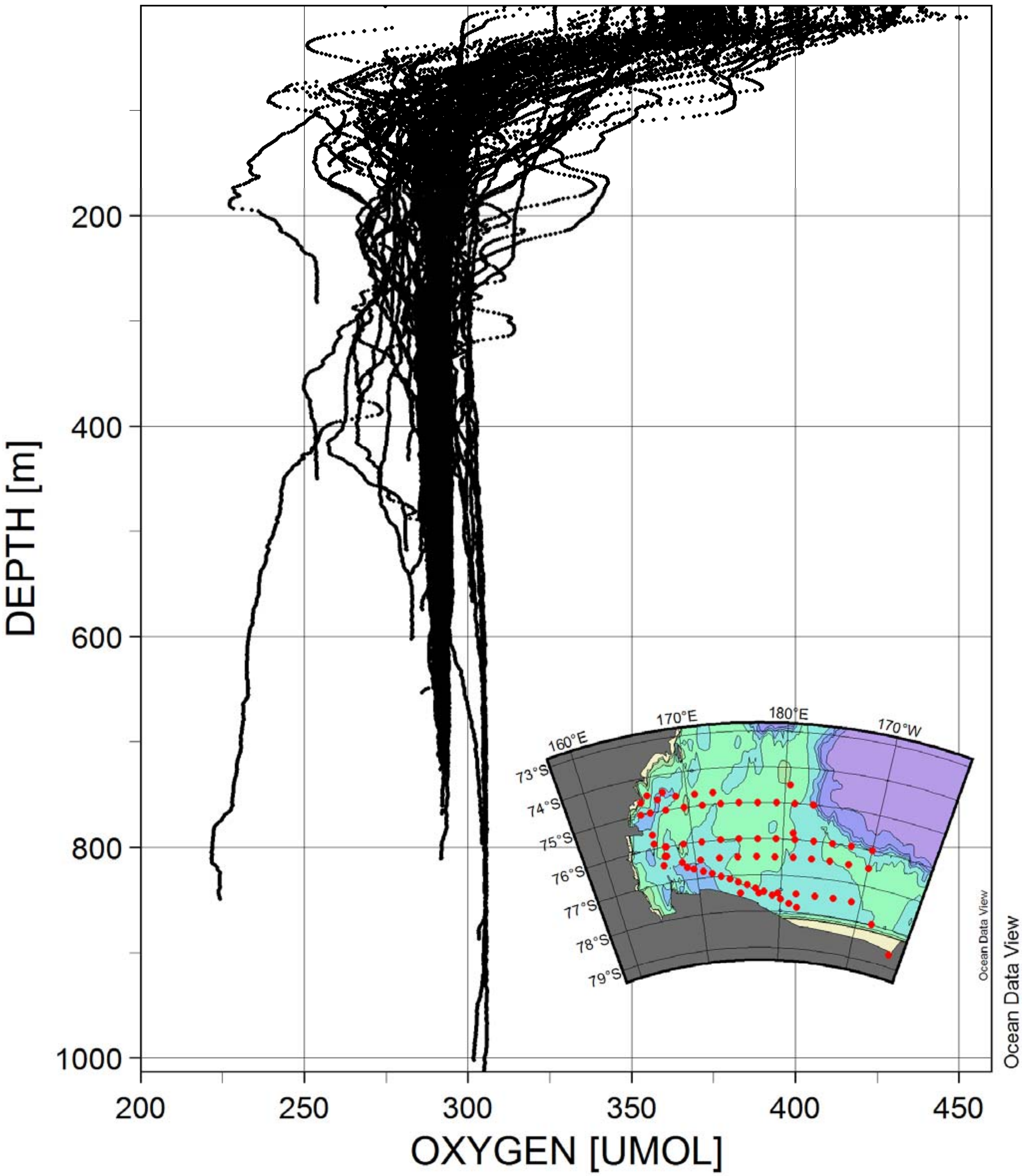
```
# datcnv_date = Nov 07 2006 19:22:39, 5.32a
# datcnv_in = C:\Documents and Settings\owner\Desktop\NBP0601CTD
processing\NBP0601 post-processing CTD work area\raw CTD data from
cruise data DVD\p601001.dat C:\Documents and
Settings\owner\Desktop\NBP0601CTD processing\NBP0601 post-processing
CTD work area\raw CTD data from cruise data
DVD\p601postprocallcasts.CON
# datcnv_skipover = 0
# filter_date = Nov 07 2006 19:29:53, 5.32a
# filter_in = C:\Documents and Settings\owner\Desktop\NBP0601CTD
processing\NBP0601 post-processing CTD work area\Processed Derive
1\p601001.cnv
# filter_low_pass_tc_A = 0.030
# filter_low_pass_tc_B = 0.150
# filter_low_pass_A_vars = c0S/m c1S/m
# filter_low_pass_B_vars = prDM
# alignctd_date = Nov 07 2006 19:33:26, 5.32a
# alignctd_in = C:\Documents and Settings\owner\Desktop\NBP0601CTD
processing\NBP0601 post-processing CTD work area\Processed Derive
1\p601001.cnv
# alignctd_adv = sbeox0V 5.000
# wildedit_date = Nov 07 2006 19:37:12, 5.32a
# wildedit_in = C:\Documents and Settings\owner\Desktop\NBP0601CTD
processing\NBP0601 post-processing CTD work area\Processed Derive
1\p601001.cnv
# wildedit_pass1_nstd = 2.0
# wildedit_pass2_nstd = 10.0
# wildedit_pass2_mindelta = 0.000e+000
# wildedit_npoint = 12
# wildedit_vars = latitude longitude prDM t090C t190C c0S/m c1S/m
flECO-AFL bat par spar sbeox0V
# wildedit_excl_bad_scans = yes
# wildedit_date = Nov 07 2006 19:37:58, 5.32a
# wildedit_in = C:\Documents and Settings\owner\Desktop\NBP0601CTD
processing\NBP0601 post-processing CTD work area\Processed Derive
1\p601001.cnv
# wildedit_pass1_nstd = 2.0
# wildedit_pass2_nstd = 10.0
# wildedit_pass2_mindelta = 0.000e+000
# wildedit_npoint = 100
# wildedit_vars = latitude longitude prDM t090C t190C c0S/m c1S/m
flECO-AFL bat par spar sbeox0V
# wildedit_excl_bad_scans = yes
# wildedit_date = Nov 07 2006 19:39:14, 5.32a
# wildedit_in = C:\Documents and Settings\owner\Desktop\NBP0601CTD
processing\NBP0601 post-processing CTD work area\Processed Derive
1\p601001.cnv
# wildedit_pass1_nstd = 2.0
# wildedit_pass2_nstd = 10.0
# wildedit_pass2_mindelta = 0.000e+000
# wildedit_npoint = 50
# wildedit_vars = latitude longitude prDM t090C t190C c0S/m c1S/m
flECO-AFL bat par spar sbeox0V
# wildedit_excl_bad_scans = yes
```

```
# celltm_date = Nov 07 2006 19:41:01, 5.32a
# celltm_in = C:\Documents and Settings\owner\Desktop\NBP0601CTD
processing\NBP0601 post-processing CTD work area\Processed Derive
1\p601001.cnv
# celltm_alpha = 0.0300, 0.0300
# celltm_tau = 7.0000, 7.0000
# celltm_temp_sensor_use_for_cond = secondary, secondary
# loopedit_date = Nov 07 2006 19:42:59, 5.32a
# loopedit_in = C:\Documents and Settings\owner\Desktop\NBP0601CTD
processing\NBP0601 post-processing CTD work area\Processed Derive
1\p601001.cnv
# loopedit_minVelocity = 0.250
# loopedit_excl_bad_scans = yes
# Derive_date = Nov 07 2006 19:45:44, 5.32a
# Derive_in = C:\Documents and Settings\owner\Desktop\NBP0601CTD
processing\NBP0601 post-processing CTD work area\Processed Derive
1\p601001.cnv C:\Documents and Settings\owner\Desktop\NBP0601CTD
processing\NBP0601 post-processing CTD work area\raw CTD data from
cruise data DVD\p601postprocallcasts.CON
# derive_time_window_docdt = seconds: 2
# binavg_date = Nov 07 2006 19:48:43, 5.32a
# binavg_in = C:\Documents and Settings\owner\Desktop\NBP0601CTD
processing\NBP0601 post-processing CTD work area\Processed Derive
1\p601001.cnv
# binavg_bintype = decibars
# binavg_binsize = 1
# binavg_excl_bad_scans = yes
# binavg_skipover = 0
# binavg_surface_bin = yes, min = 0.000, max = 0.000, value = 0.000
# Derive_date = Nov 07 2006 19:52:35, 5.32a
# Derive_in = C:\Documents and Settings\owner\Desktop\NBP0601CTD
processing\NBP0601 post-processing CTD work area\Post-Process
Out\p601001DownBinAve.cnv C:\Documents and
Settings\owner\Desktop\NBP0601CTD processing\NBP0601 post-processing
CTD work area\raw CTD data from cruise data
DVD\p601postprocallcasts.CON
# file_type = binary
*END*
```

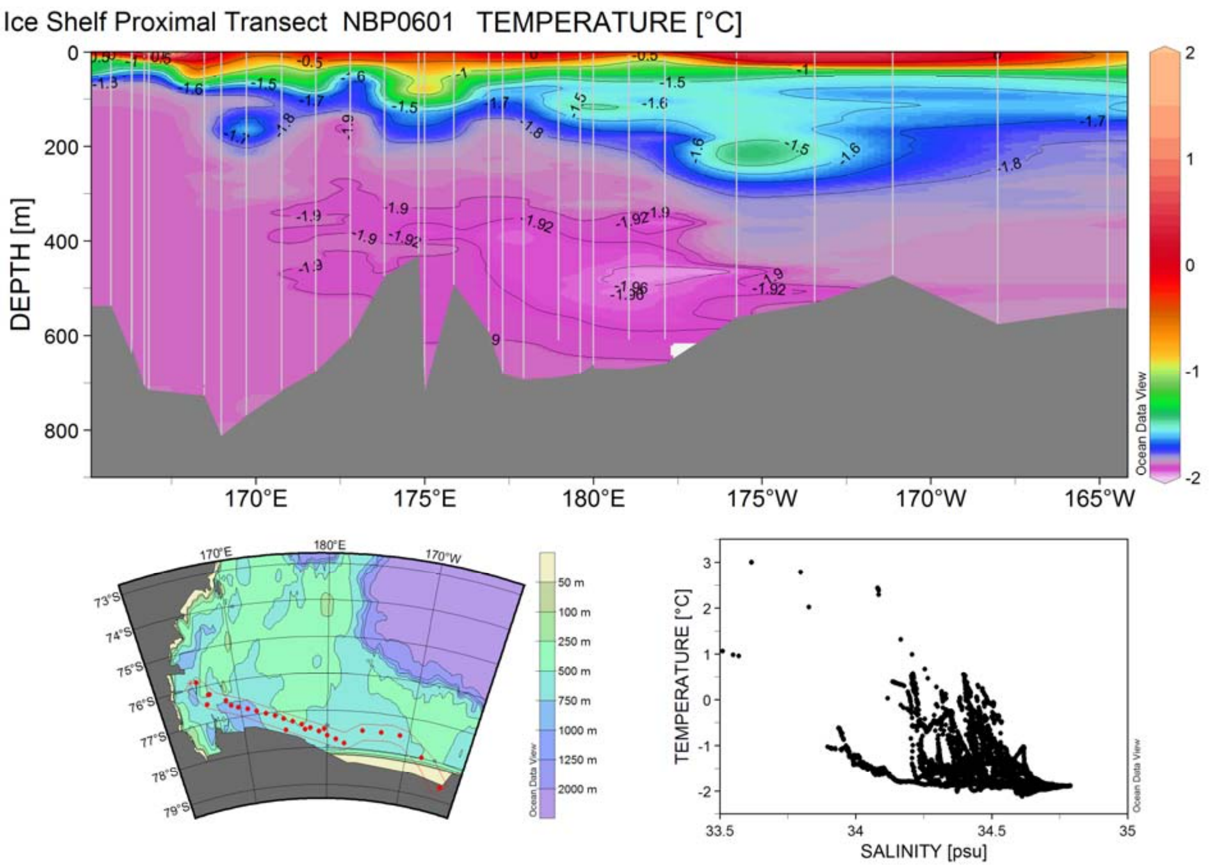


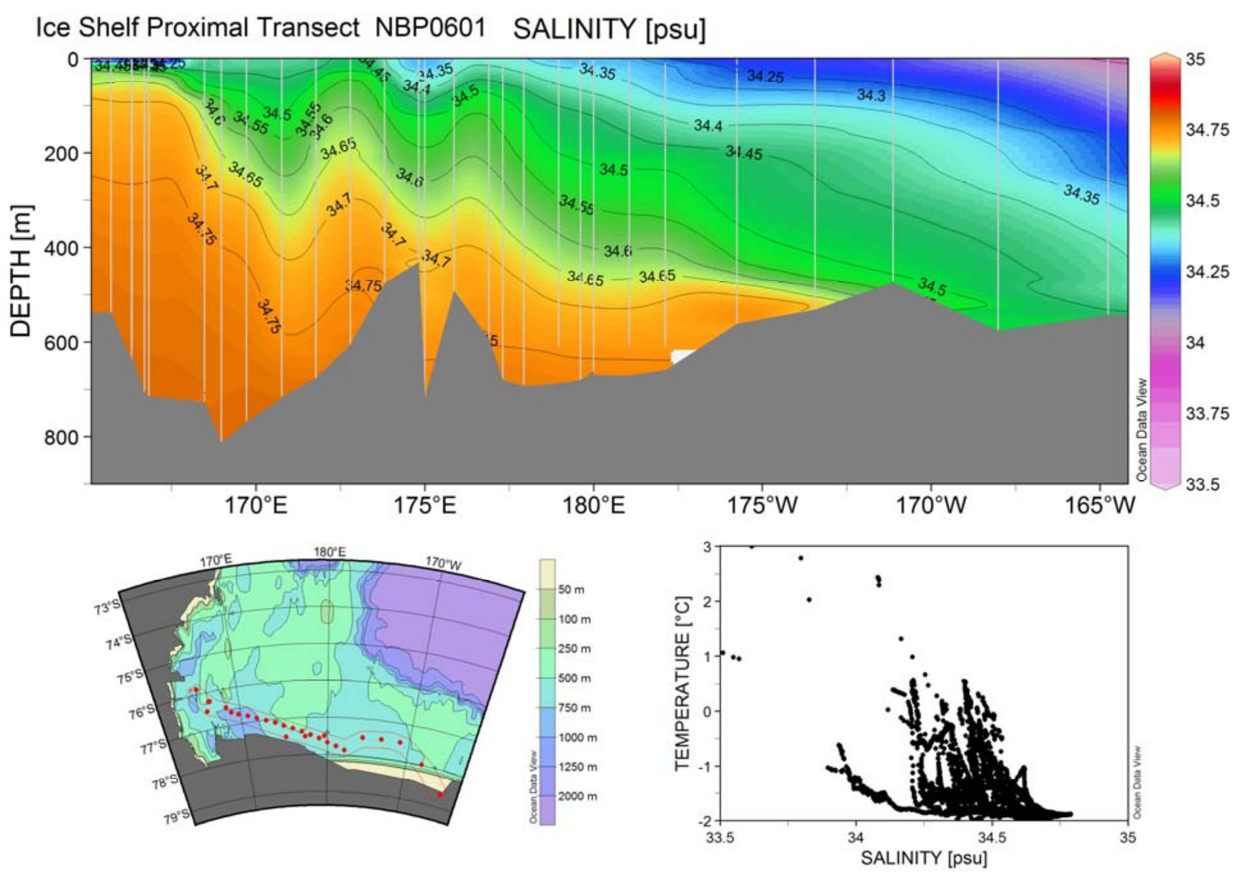
DEPTH [m]
200
400
600
800
1000
-2
-1
0
1
2
3
TEMPERATURE [°C]
160°E
170°E
180°E
170°W
73°S
74°S
75°S
76°S
77°S
78°S
79°S
Ocean Data View
Ocean Data View

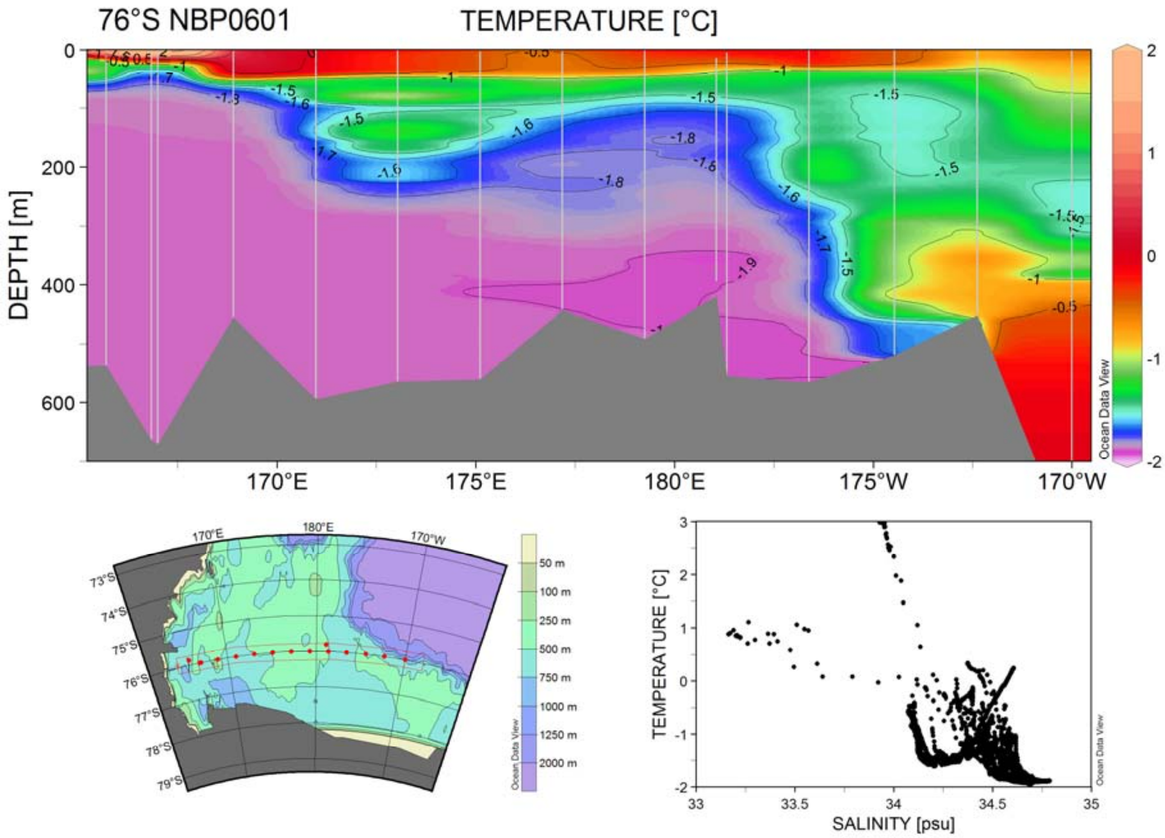

200
400
600
800
1000
DEPTH [m]
33.5
34
34.5
35
SALINITY [psu]
Ocean Data View
160°E
170°E
180°E
170°W
73°S
74°S
75°S
76°S
77°S
78°S
79°S
Ocean Data View

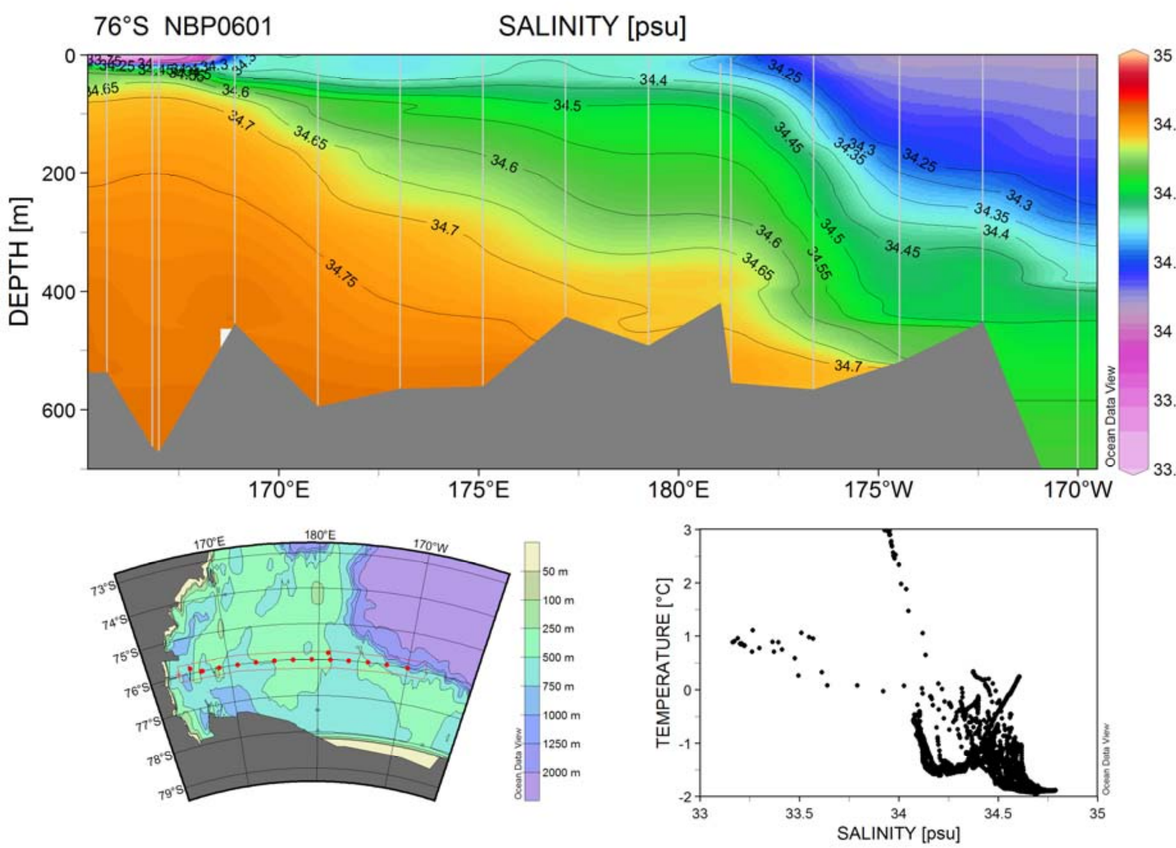


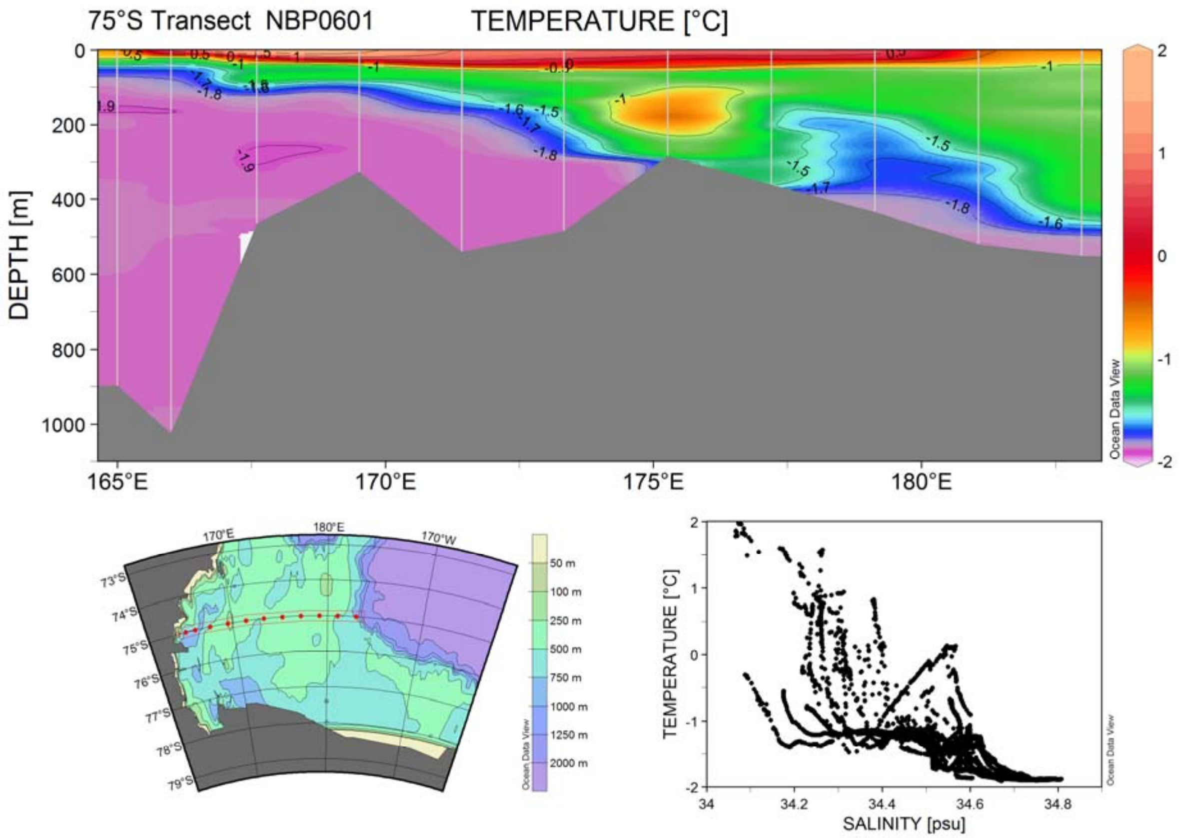
DEPTH [m]
200
400
600
800
1000
200
250
300
350
400
450
OXYGEN [UMOL]
160°E
170°E
180°E
170°W
73°S
74°S
75°S
76°S
77°S
78°S
79°S
Ocean Data View
Ocean Data View

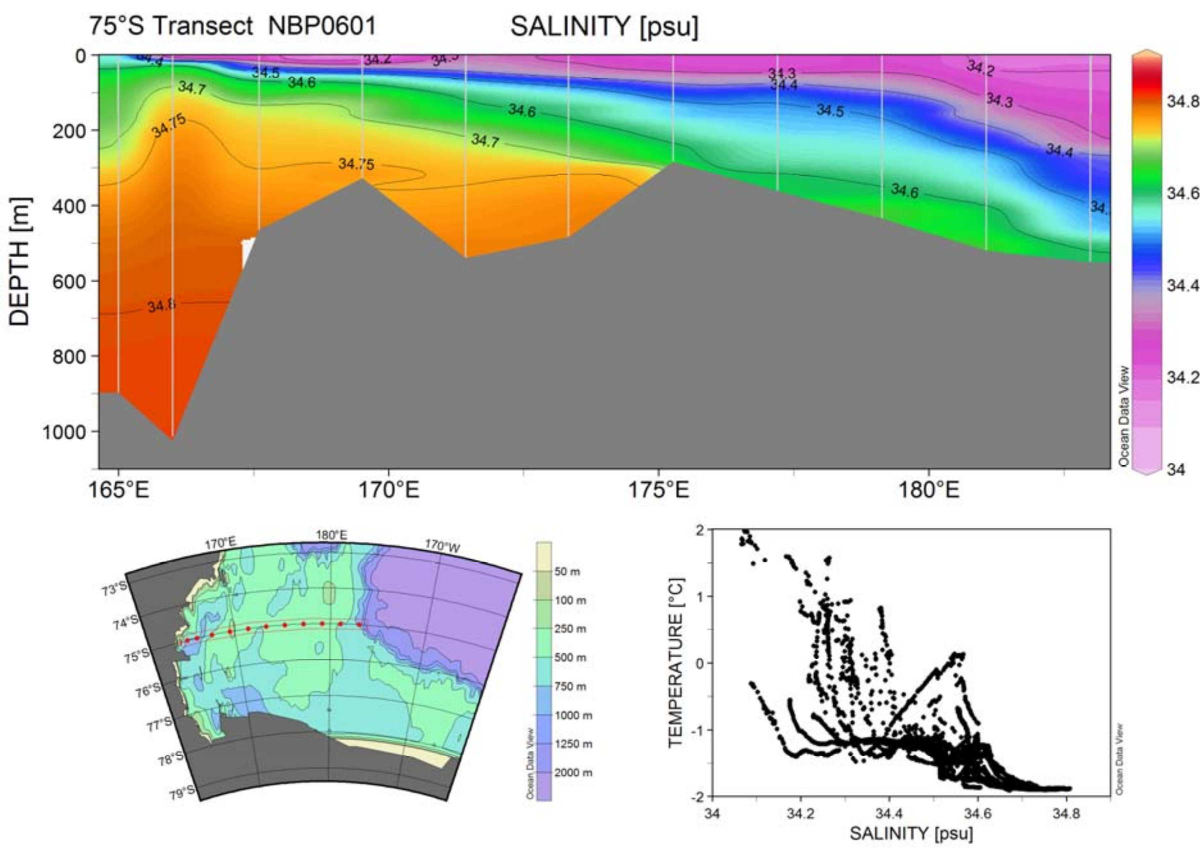

Ice Shelf Proximal Transect NBP0601 TEMPERATURE [°C]
DEPTH [m]
170°E
175°E
180°E
175°W
170°W
165°W
Ocean Data View
TEMPERATURE [°C]
SALINITY [psu]

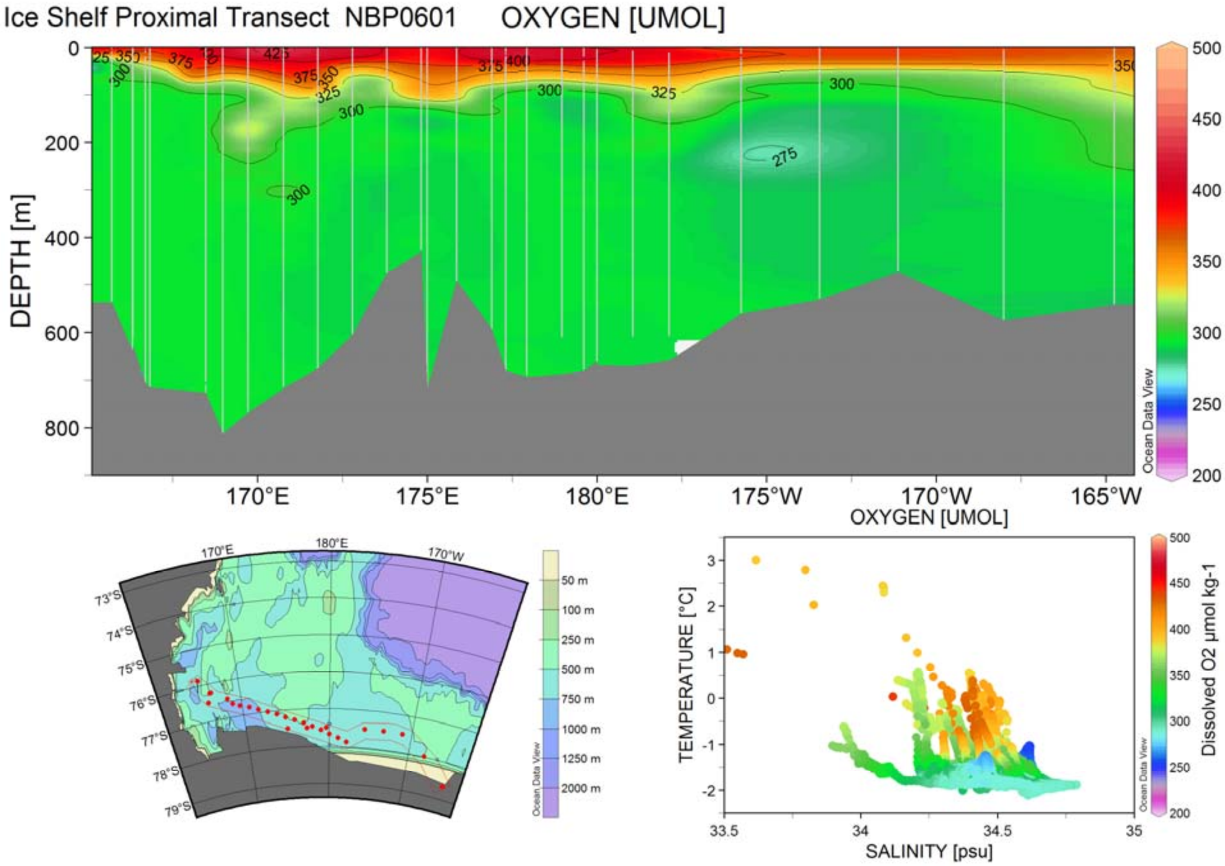

Ice Shelf Proximal Transect NBP0601 SALINITY [psu]
DEPTH [m]
170°E
175°E
180°E
175°W
170°W
165°W
Ocean Data View
TEMPERATURE [°C]
SALINITY [psu]

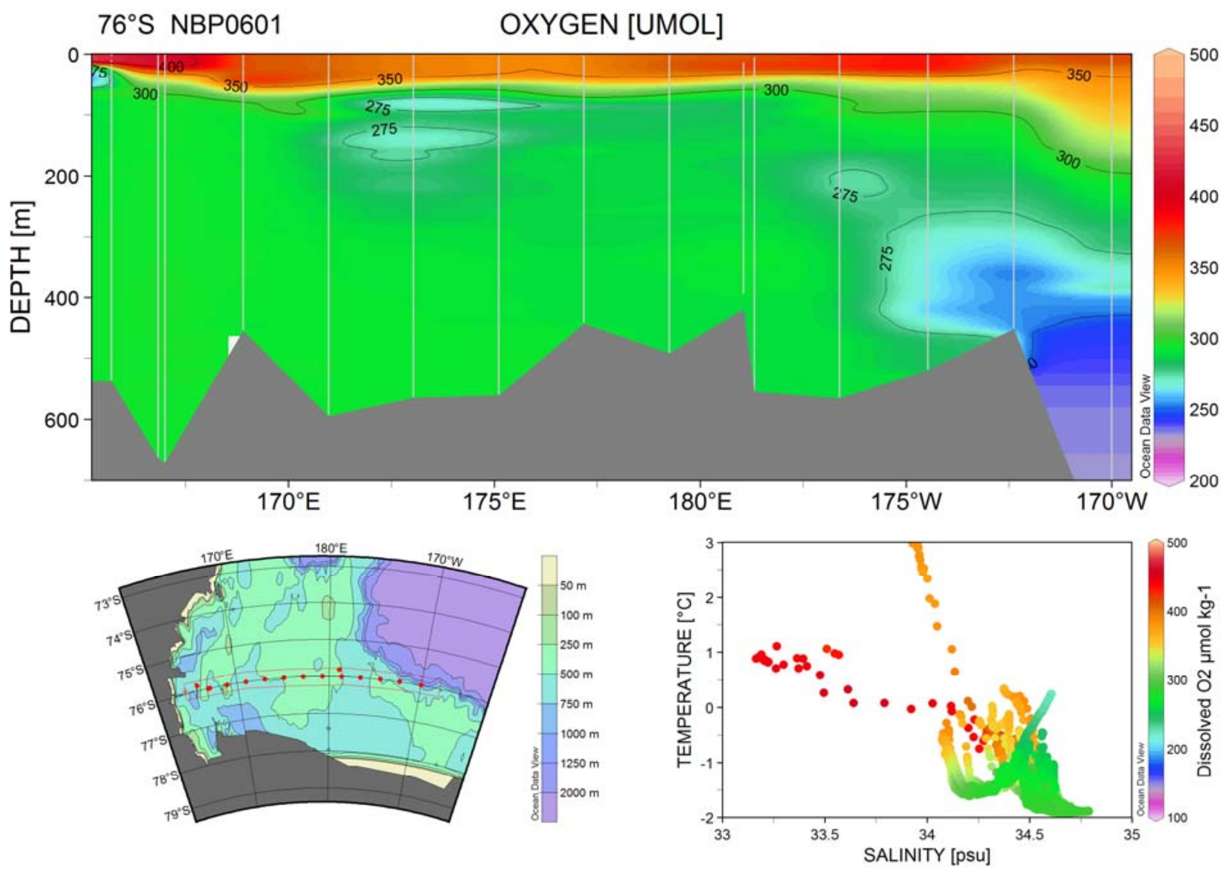

76°S NBP0601
TEMPERATURE [°C]
DEPTH [m]
170°E
175°E
180°E
175°W
170°W
Ocean Data View
50 m
100 m
250 m
500 m
750 m
1000 m
1250 m
2000 m
TEMPERATURE [°C]
SALINITY [psu]

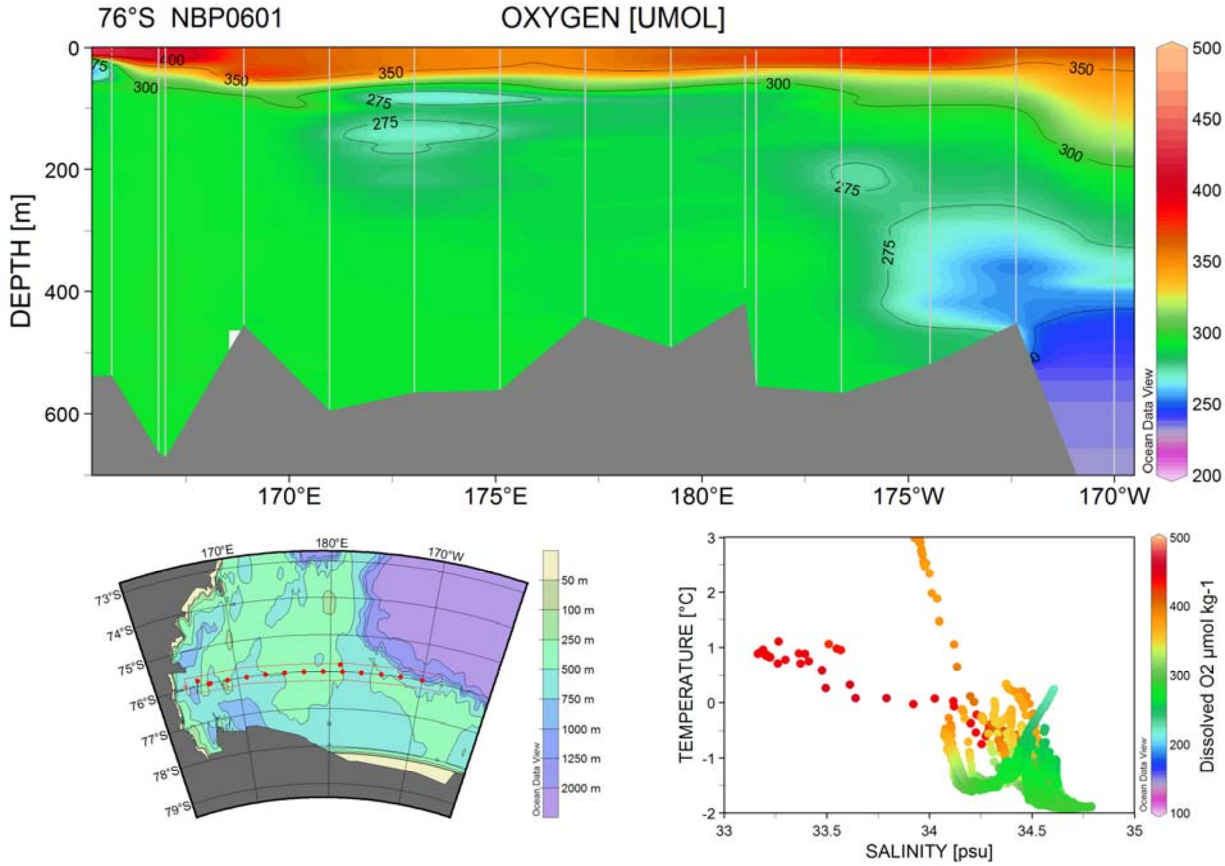

76°S NBP0601
SALINITY [psu]
DEPTH [m]
170°E
175°E
180°E
175°W
170°W
Ocean Data View
50 m
100 m
250 m
500 m
750 m
1000 m
1250 m
2000 m
TEMPERATURE [°C]
SALINITY [psu]

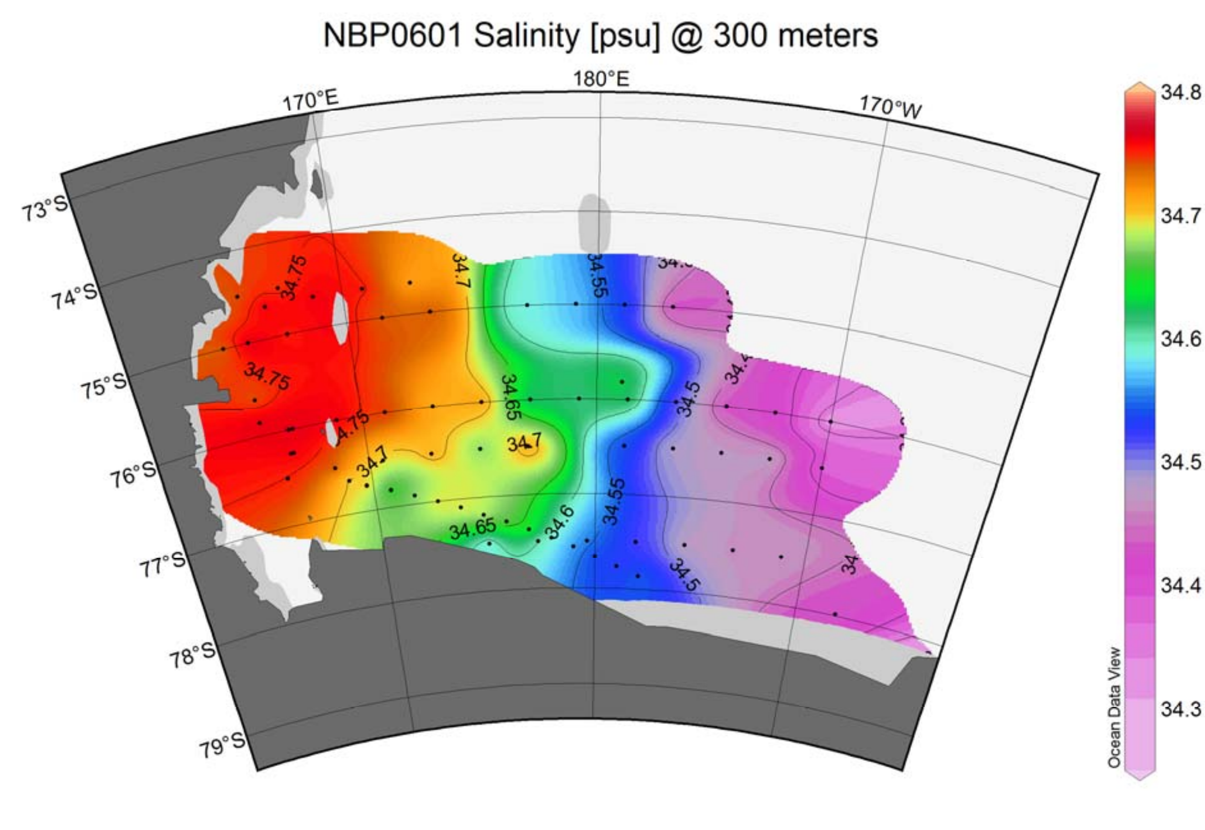

75°S Transect NBP0601
TEMPERATURE [°C]
DEPTH [m]
165°E
170°E
175°E
180°E
Ocean Data View
TEMPERATURE [°C]
SALINITY [psu]

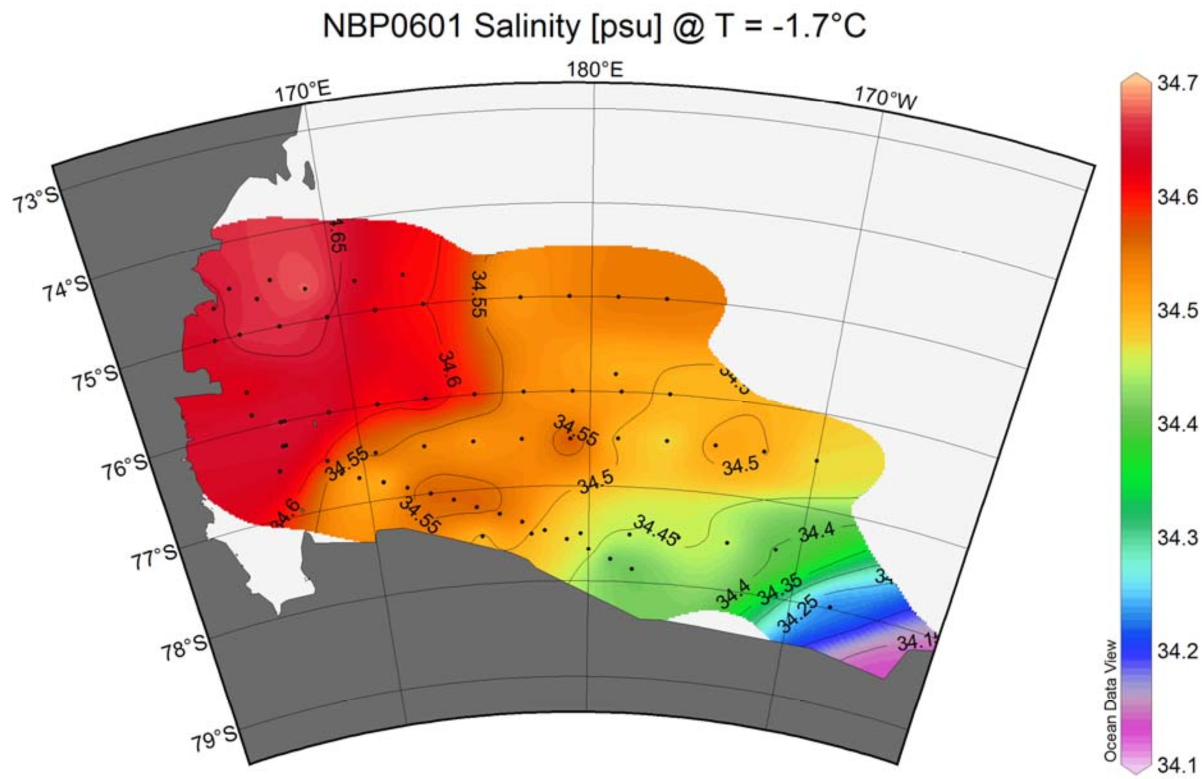

75°S Transect NBP0601
SALINITY [psu]
DEPTH [m]
165°E
170°E
175°E
180°E
Ocean Data View
TEMPERATURE [°C]
SALINITY [psu]

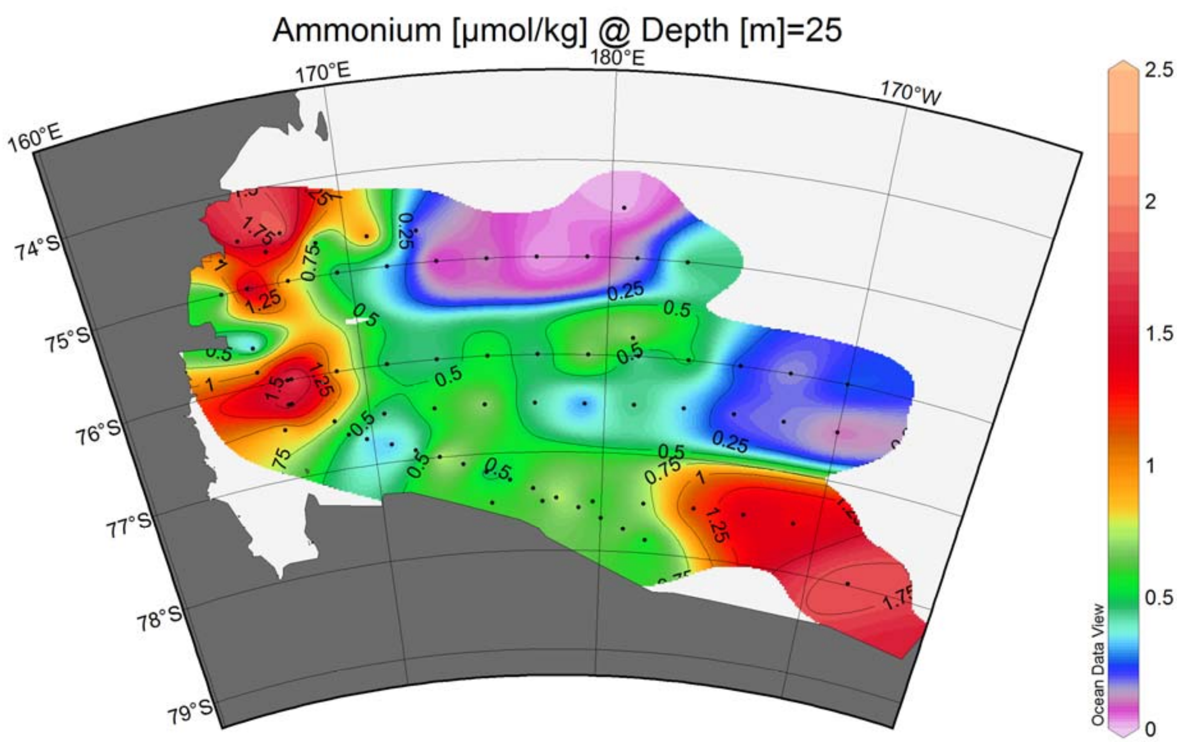

Ice Shelf Proximal Transect NBP0601 OXYGEN [UMOL]
DEPTH [m]
170°E
175°E
180°E
175°W
170°W
165°W
OXYGEN [UMOL]
TEMPERATURE [°C]
SALINITY [psu]
Dissolved O2 µmol kg-1
Ocean Data View

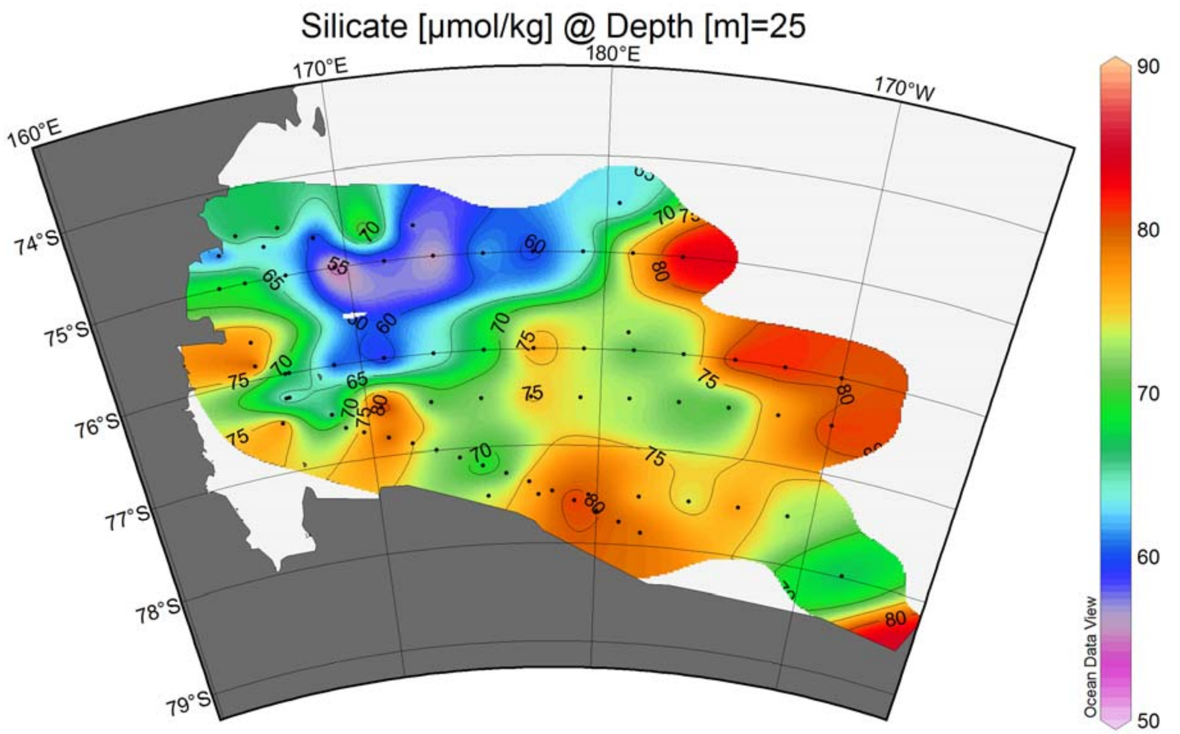

76°S NBP0601 OXYGEN [UMOL]
DEPTH [m]
170°E
175°E
180°E
175°W
170°W
TEMPERATURE [°C]
SALINITY [psu]
Dissolved O2 µmol kg-1
Ocean Data View


76°S NBP0601
OXYGEN [UMOL]
DEPTH [m]
TEMPERATURE [°C]
SALINITY [psu]
Dissolved O2 µmol kg-1
Ocean Data View

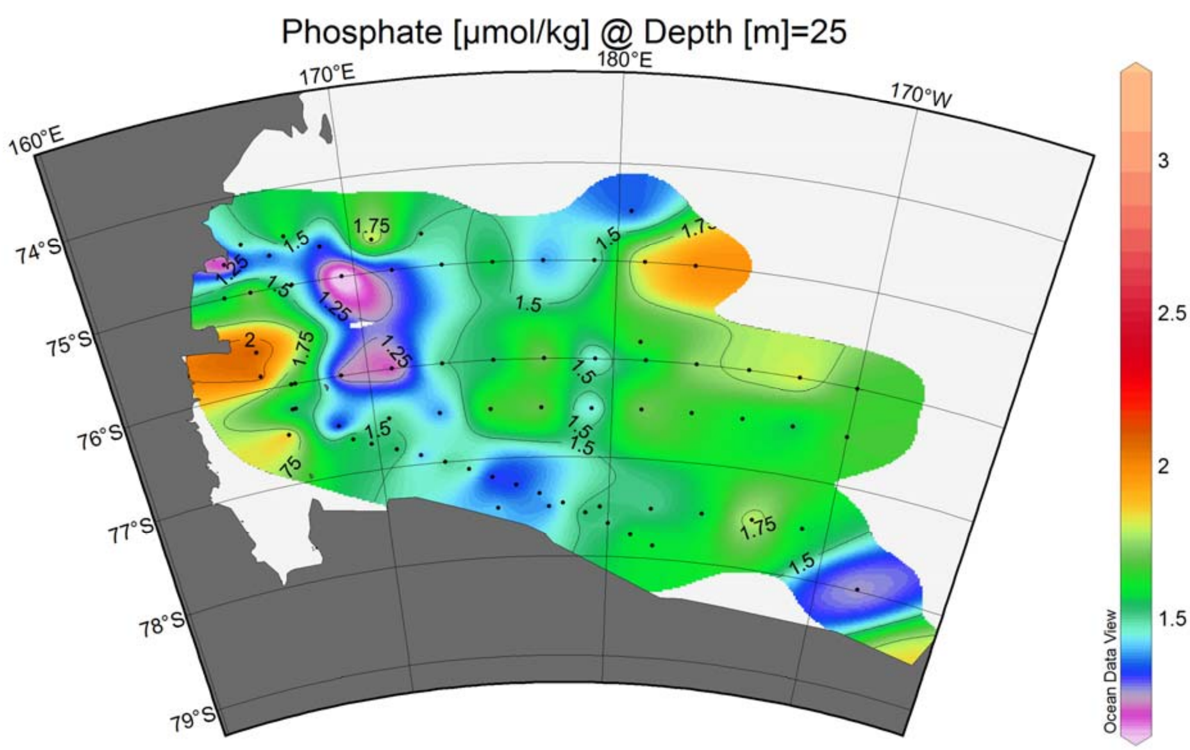

NBP0601 Salinity [psu] @ 300 meters
180°E
170°E
170°W
Ocean Data View


NBP0601 Salinity [psu] @ T = -1.7°C
170°E
180°E
170°W
73°S
74°S
75°S
76°S
77°S
78°S
79°S
34.7
34.6
34.5
34.4
34.3
34.2
34.1
Ocean Data View

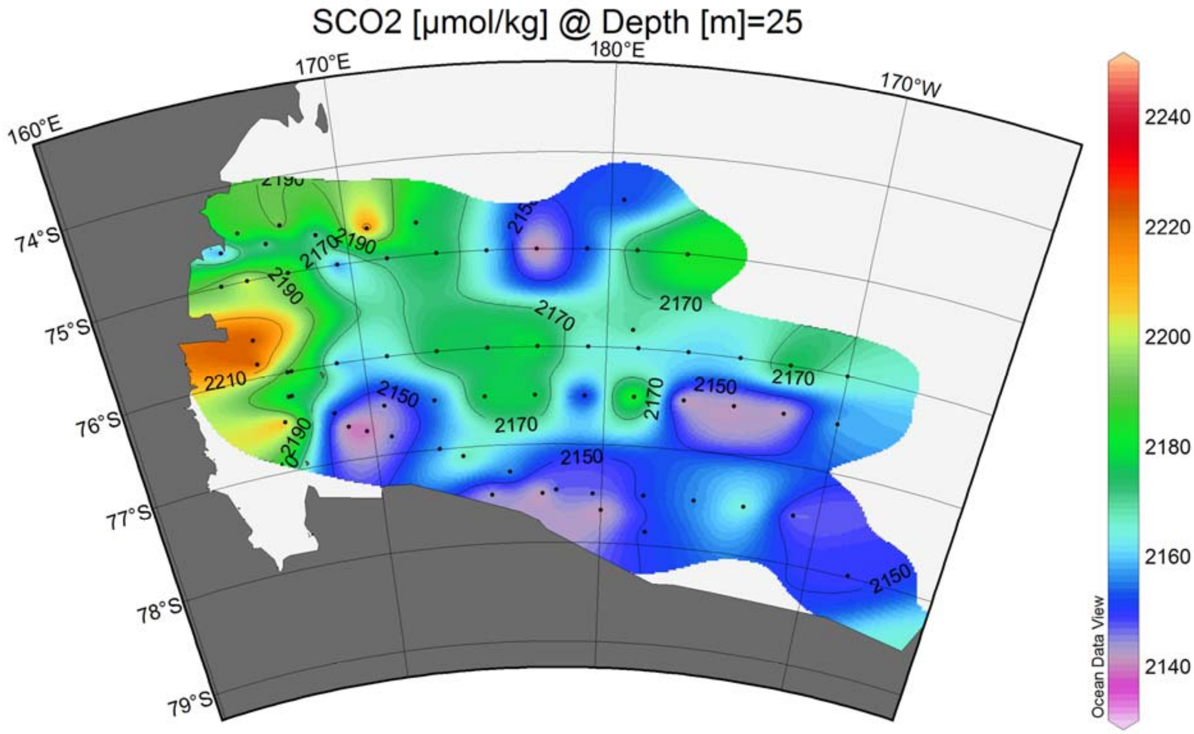

Ammonium [µmol/kg] @ Depth [m]=25
170°E
180°E
170°W
160°E
74°S
75°S
76°S
77°S
78°S
79°S
2.5
2
1.5
1
0.5
0
Ocean Data View

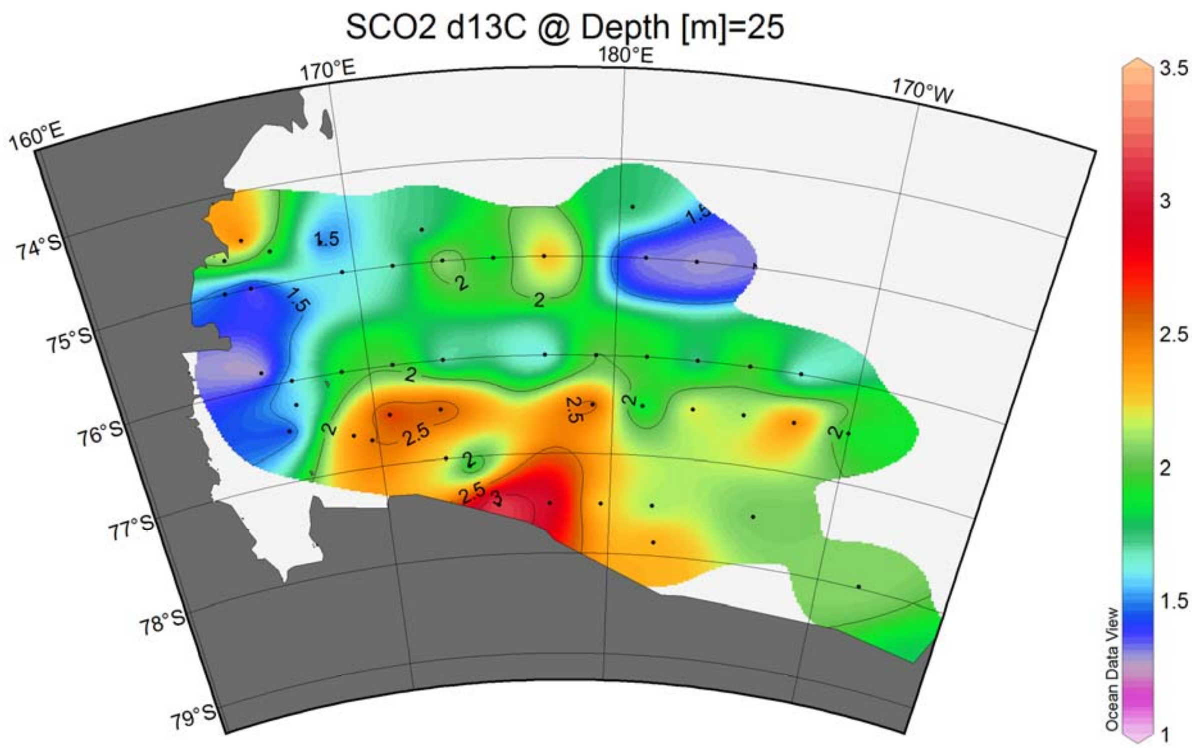


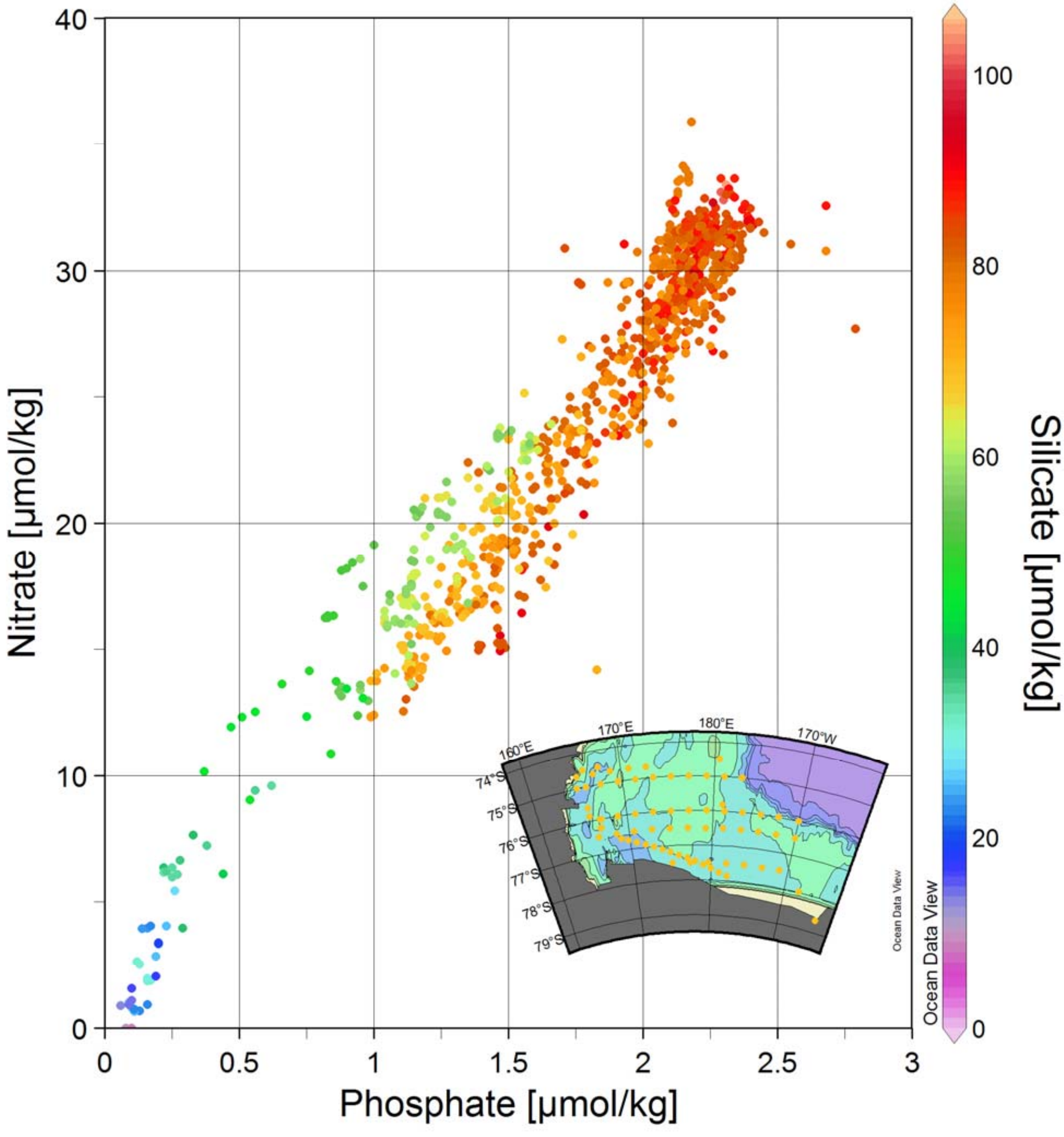
Silicate [µmol/kg] @ Depth [m]=25
170°E
180°E
170°W
160°E
74°S
75°S
76°S
77°S
78°S
79°S
90
80
70
60
50
Ocean Data View



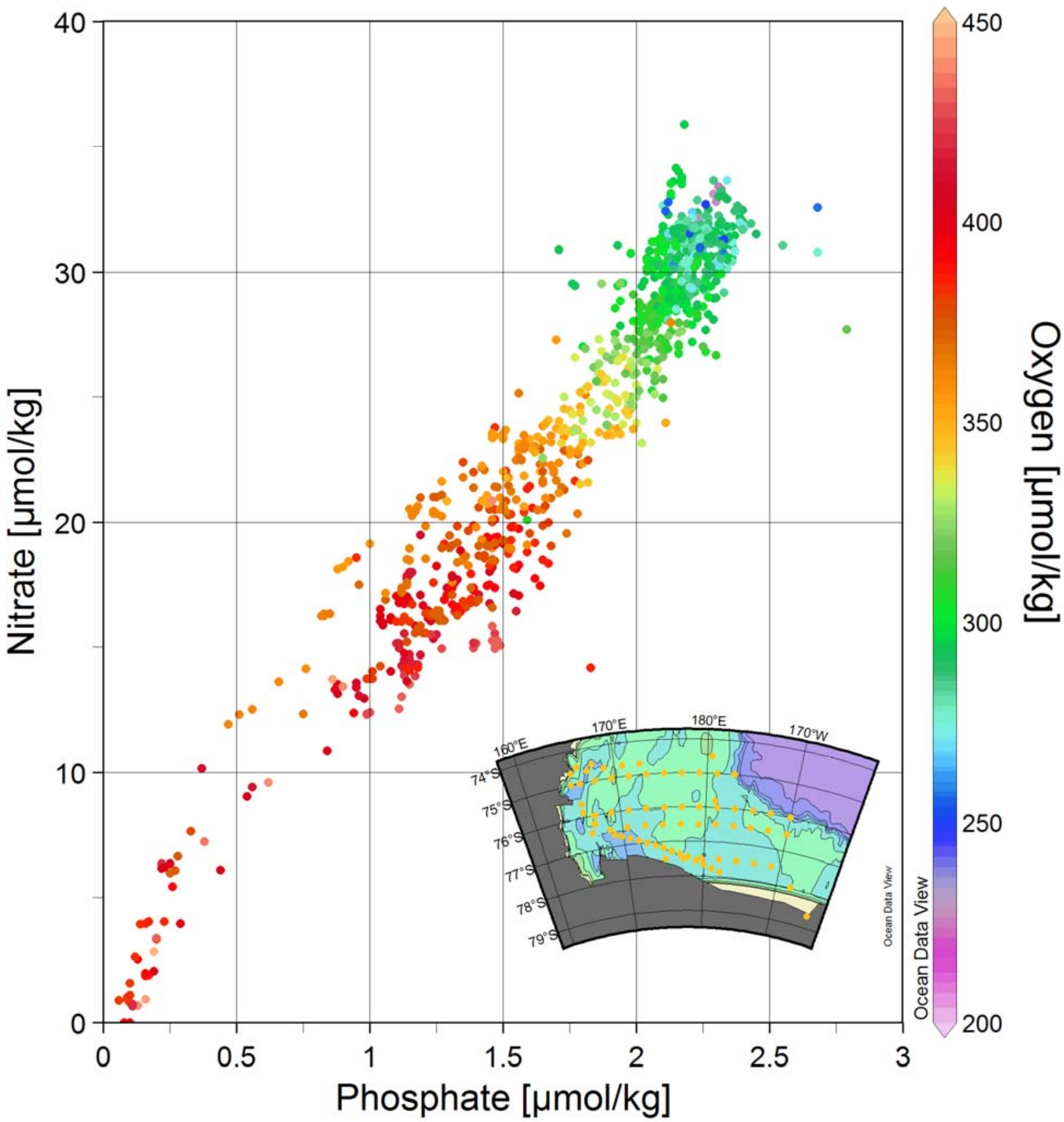
Phosphate [µmol/kg] @ Depth [m]=25
170°E
180°E
170°W
160°E
74°S
75°S
76°S
77°S
78°S
79°S
3
2.5
2
1.5
Ocean Data View


SCO2 [µmol/kg] @ Depth [m]=25
170°E
180°E
170°W
160°E
74°S
75°S
76°S
77°S
78°S
79°S
2190
2170
2150
2210
2240
2220
2200
2180
2160
2140
Ocean Data View

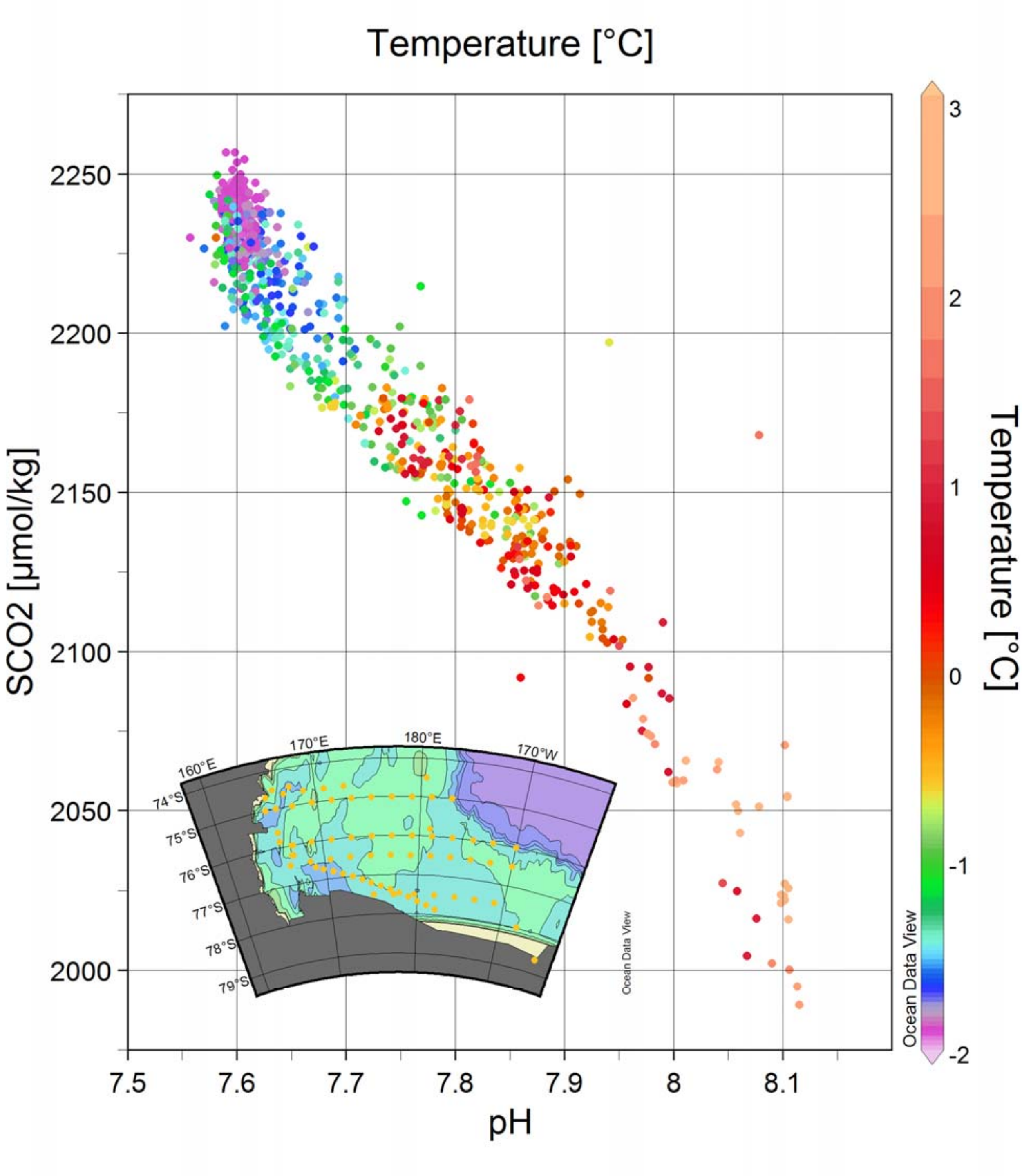

SCO2 d13C @ Depth [m]=25
170°E
180°E
170°W
160°E
74°S
75°S
76°S
77°S
78°S
79°S
1.5
2
2.5
3
3.5
1
Ocean Data View

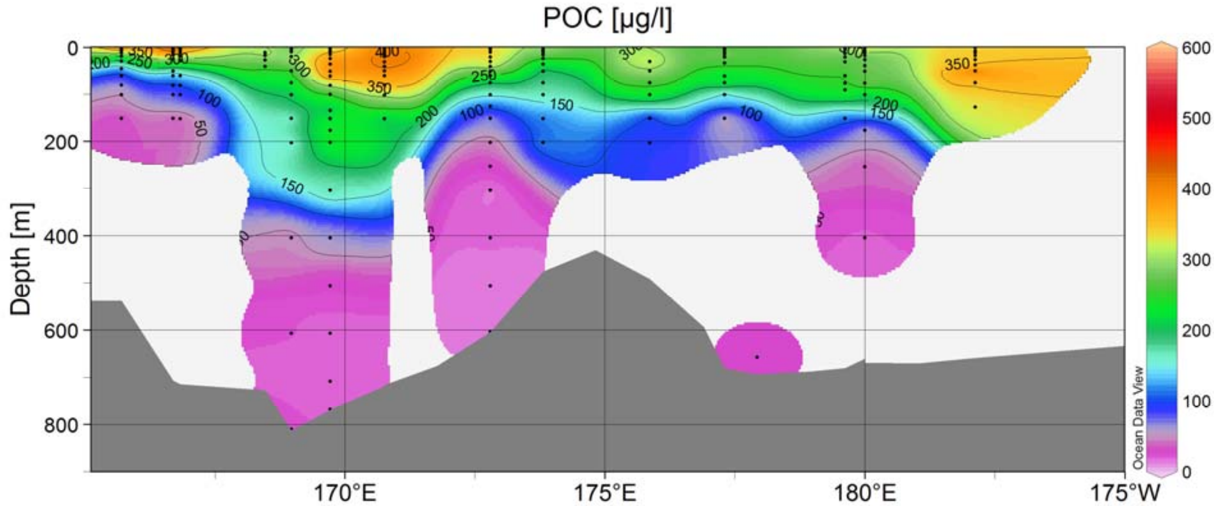


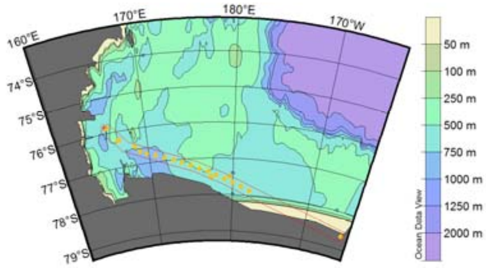
40
30
20
10
0
0
0.5
1
1.5
2
2.5
3
Phosphate [µmol/kg]
Nitrate [µmol/kg]
Silicate [µmol/kg]
100
80
60
40
20
0
Ocean Data View
160°E
170°E
180°E
170°W
74°S
75°S
76°S
77°S
78°S
79°S
Ocean Data View



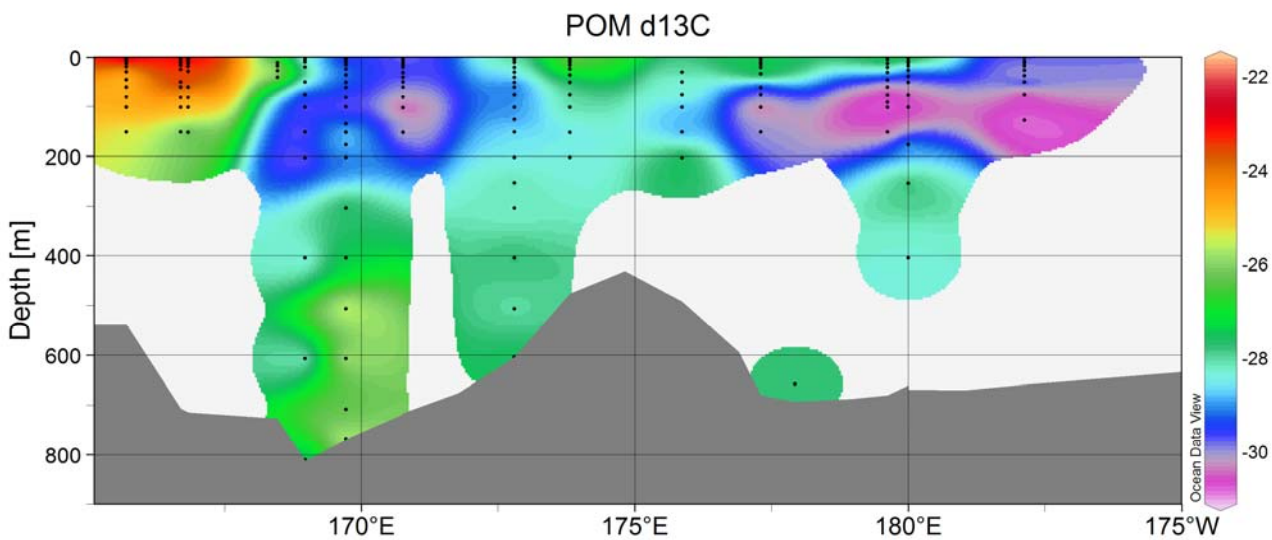
40
30
20
10
0
0
0.5
1
1.5
2
2.5
3
Phosphate [µmol/kg]
Nitrate [µmol/kg]
Oxygen [µmol/kg]
450
400
350
300
250
200
160°E
170°E
180°E
170°W
74°S
75°S
76°S
77°S
78°S
79°S
Ocean Data View
Ocean Data View

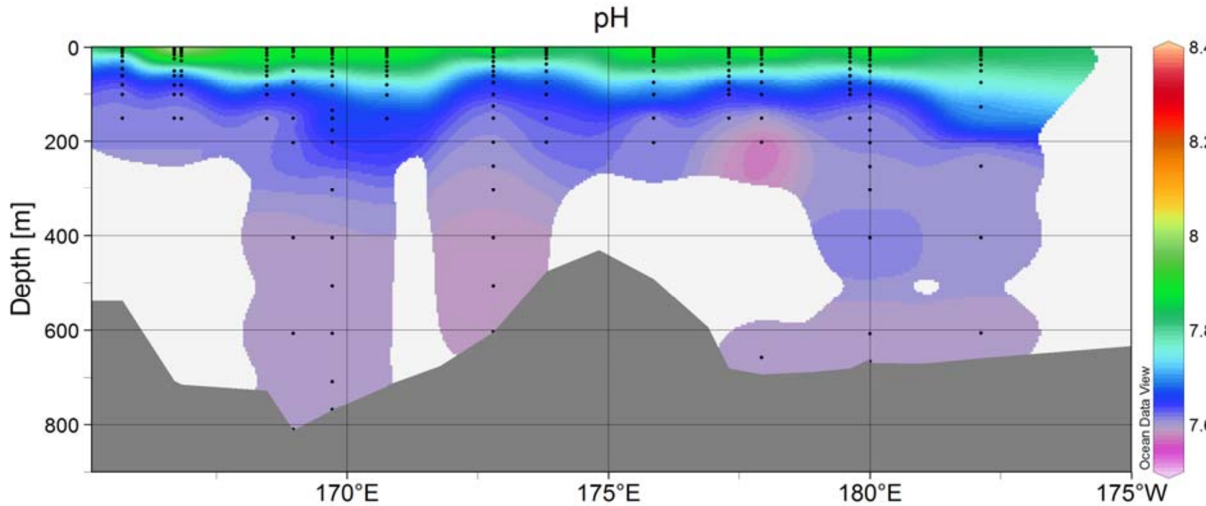

Temperature [°C]
SCO2 [µmol/kg]
pH
2250
2200
2150
2100
2050
2000
7.5
7.6
7.7
7.8
7.9
8
8.1
3
2
1
0
-1
-2
160°E
170°E
180°E
170°W
74°S
75°S
76°S
77°S
78°S
79°S
Ocean Data View

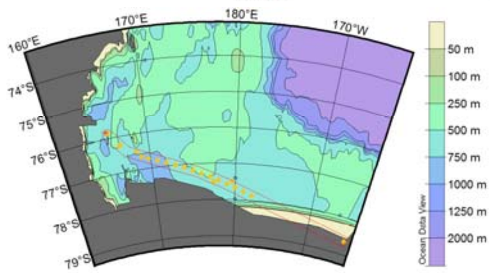




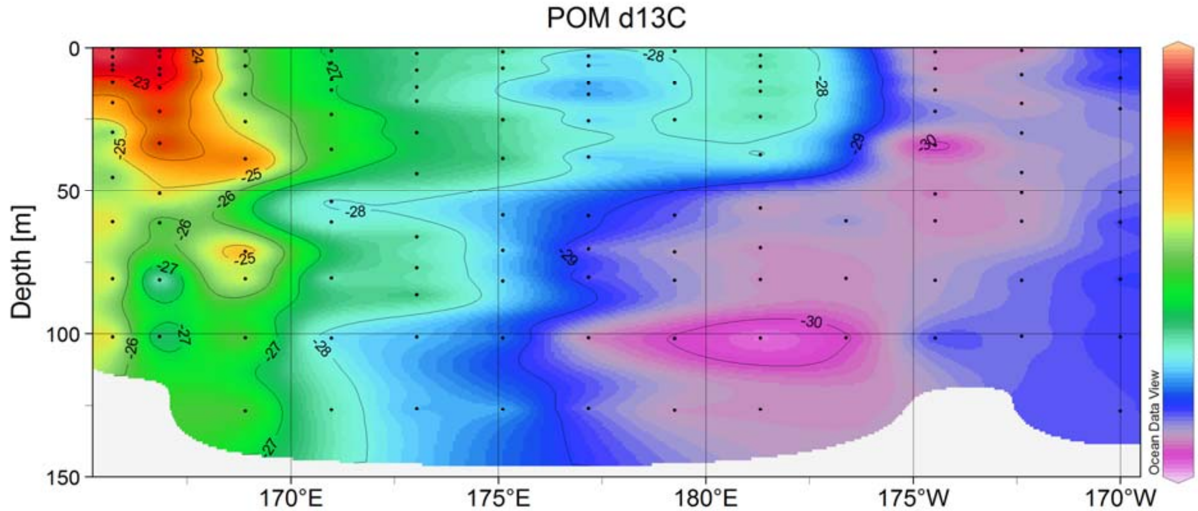
NBP0601 Ice Shelf Section

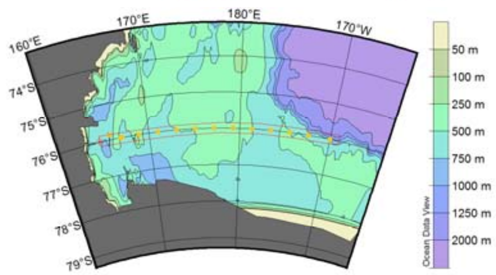




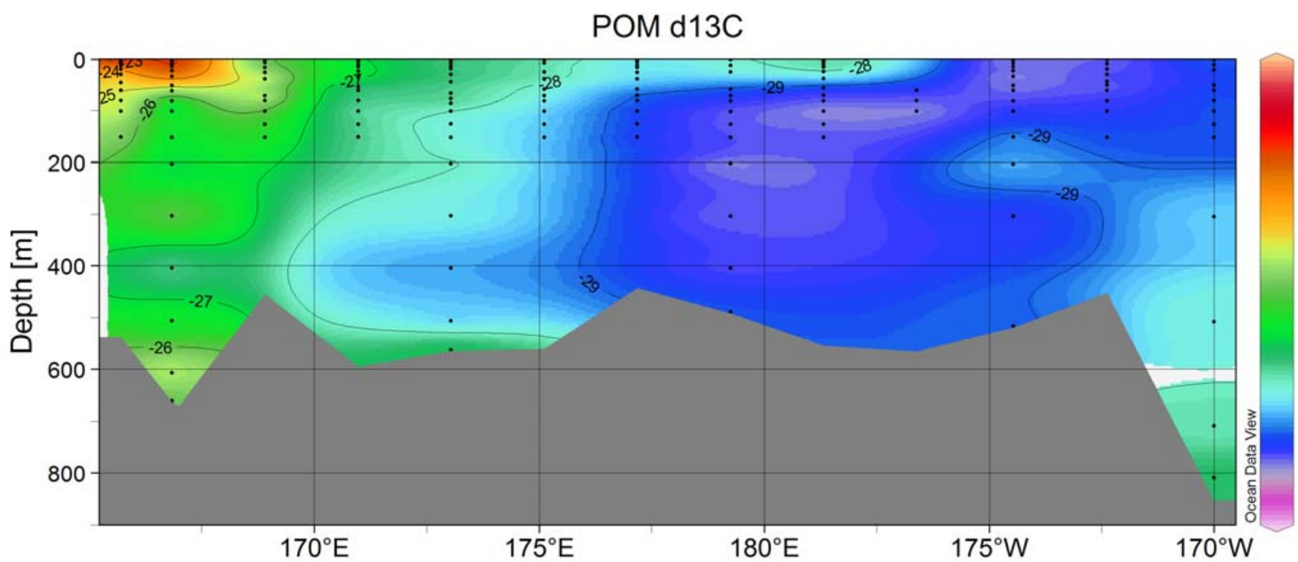


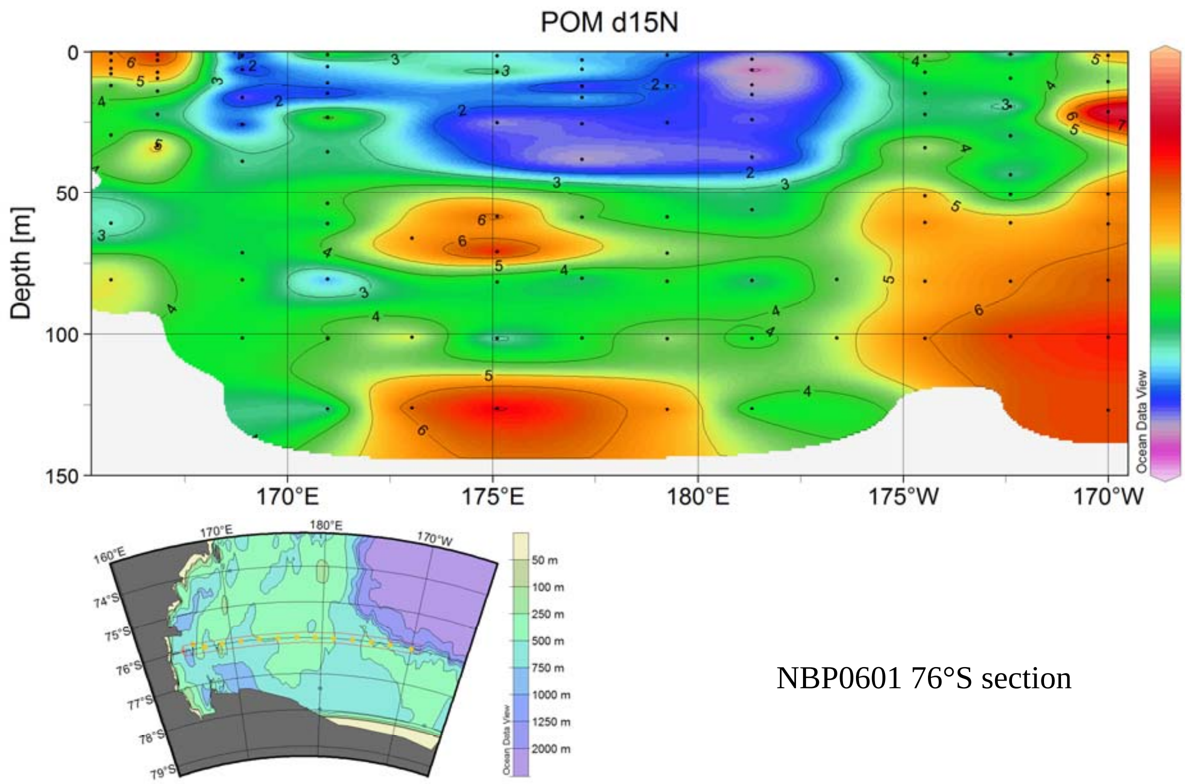
NBP0601 Ice Shelf Section



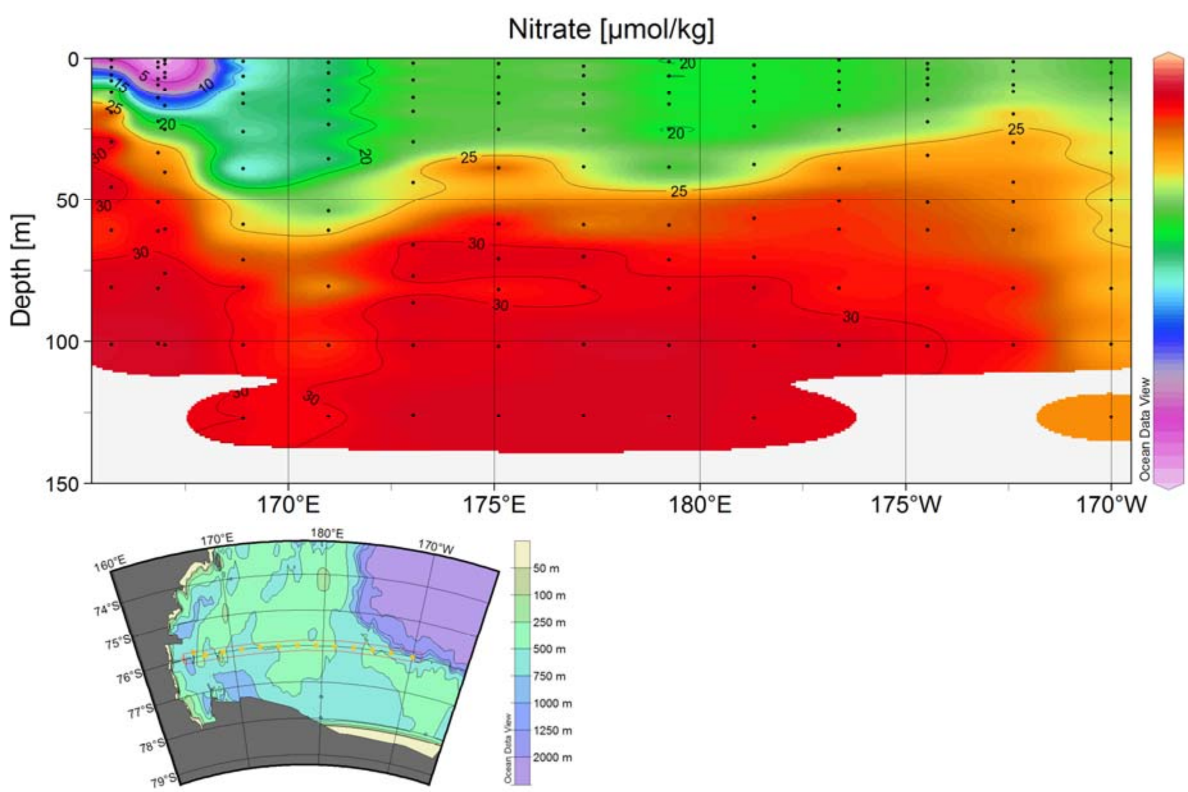


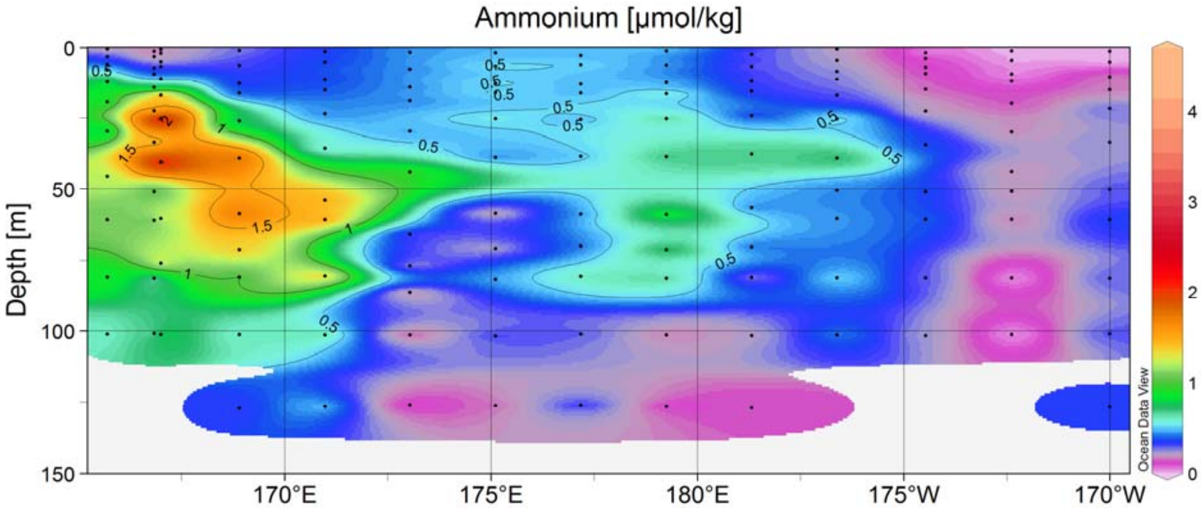
NBP0601 76°S section

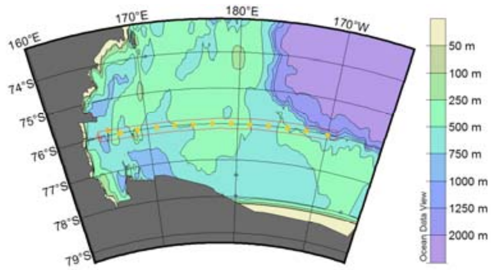




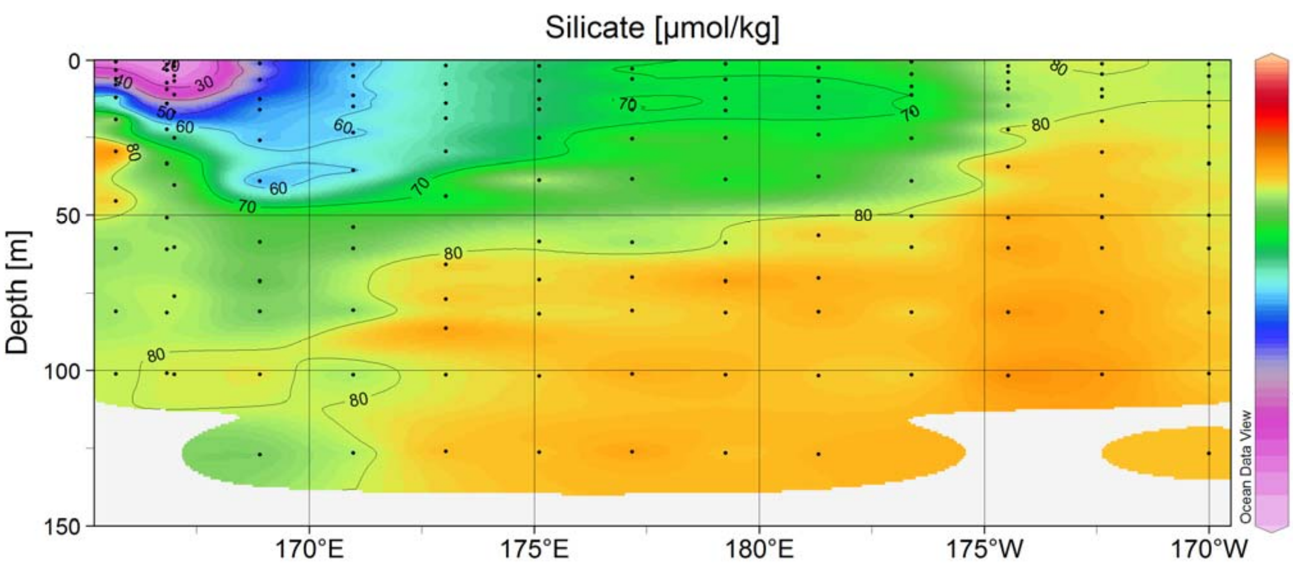
NBP0601 76°S section

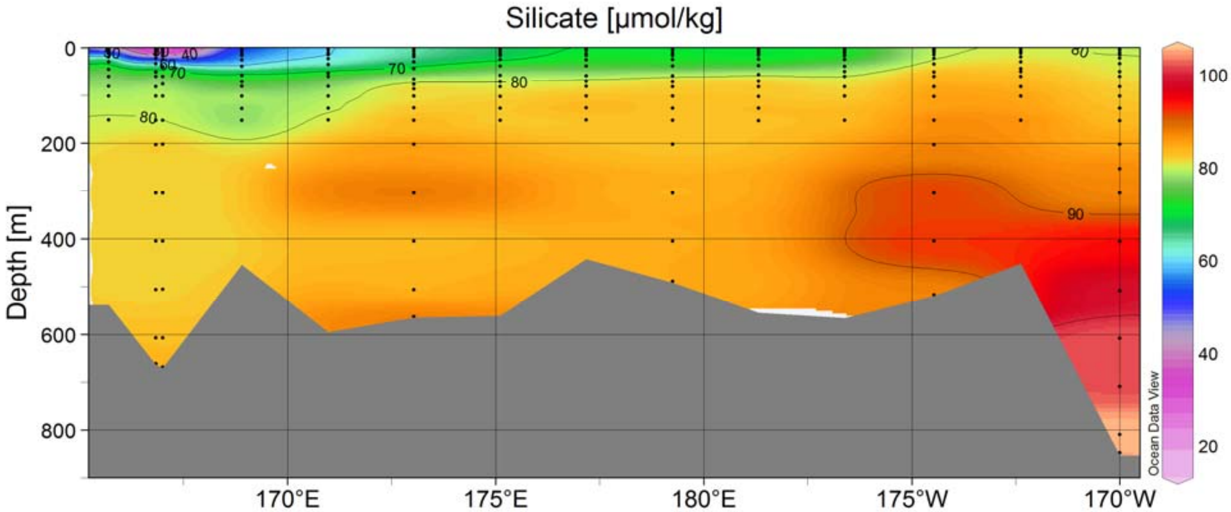


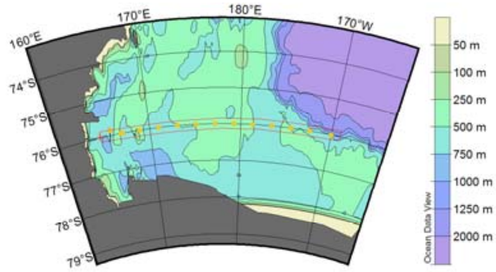




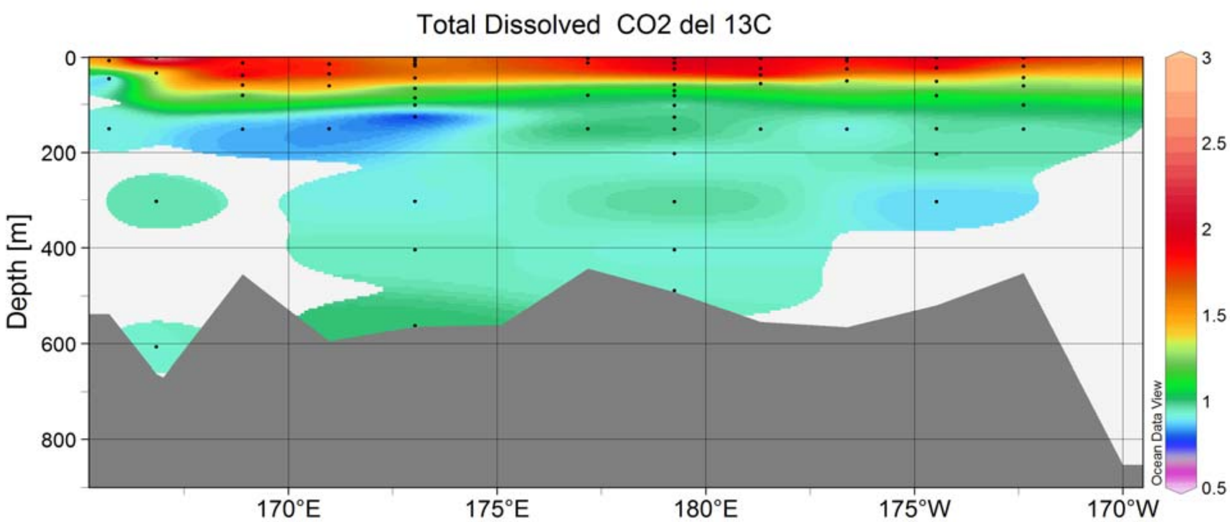
NBP0601 76°S section

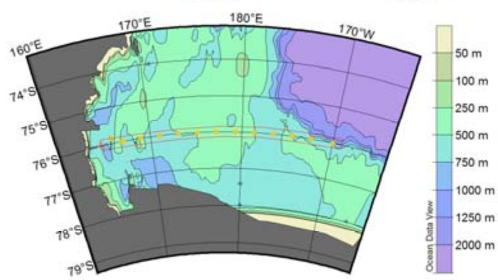


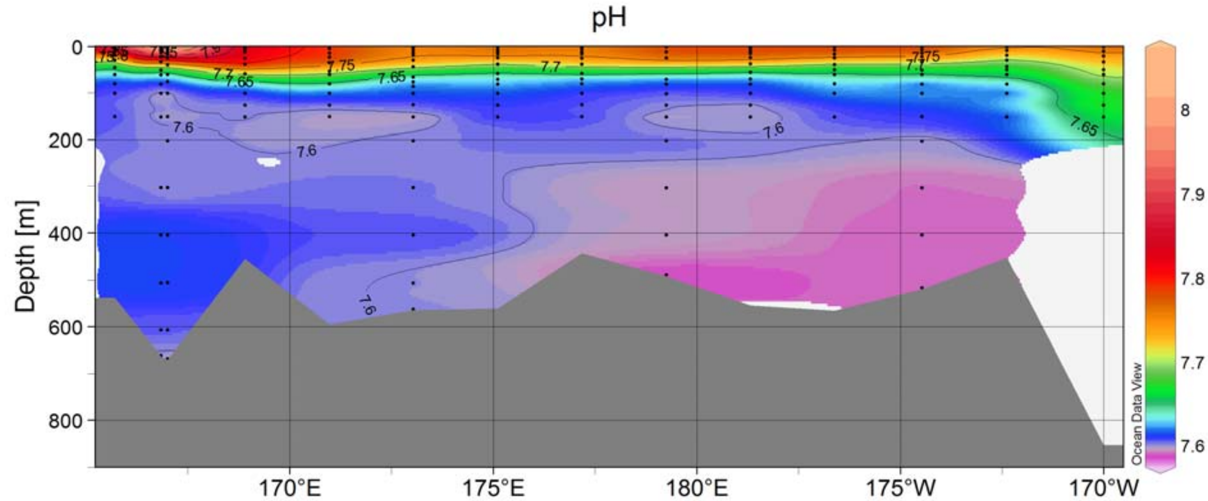


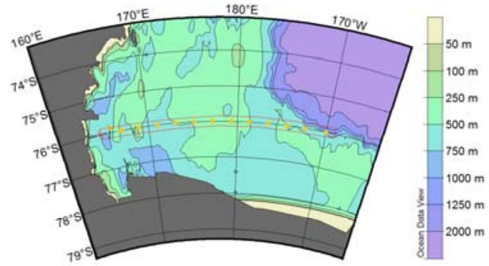


NBP0601 76°S section

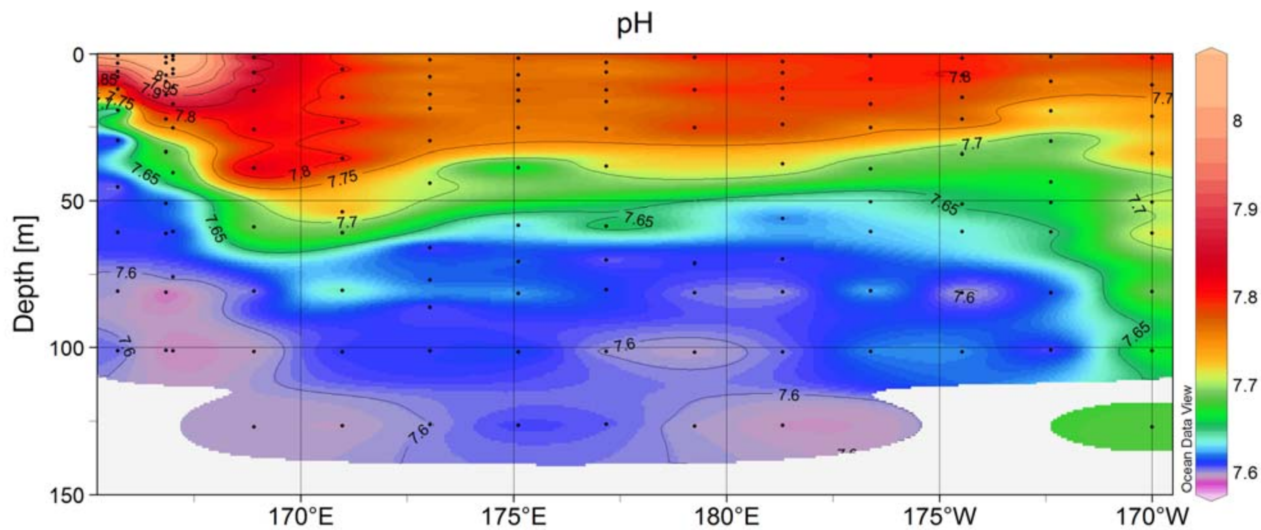


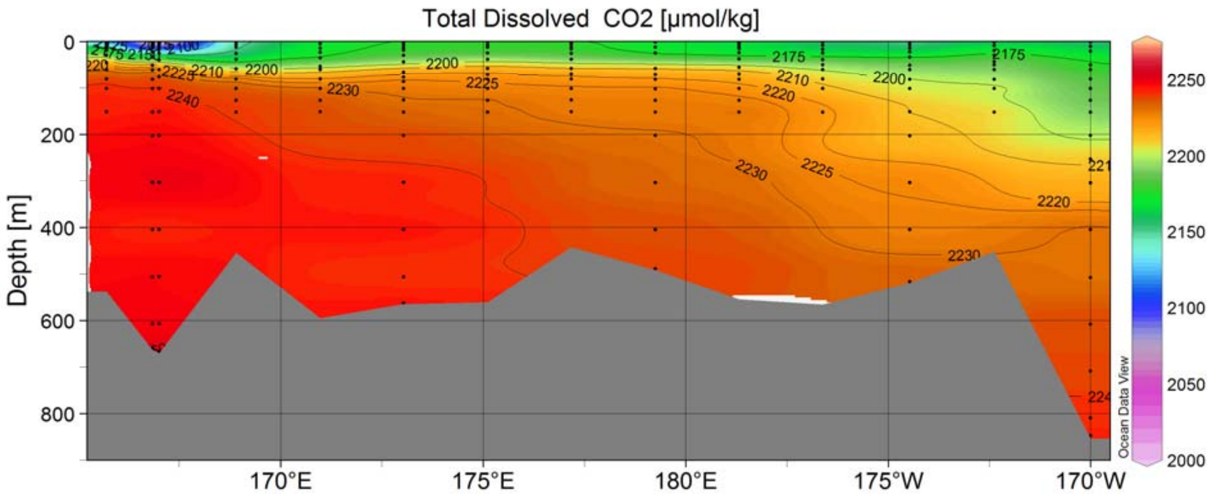


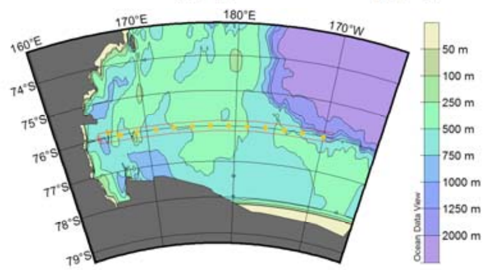




NBP0601 76°S section







NBP0601 76°S section