Physical and Chemical Data from the Canada Basin, August 2004

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Canadian Data Report Of Hydrography and Ocean Sciences

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Les établissements des Sciences et levés océaniques dans les régions et à l'administration centrale ont cessé de publier leurs diverses séries de rapports en décembre 1981. Une liste complète de ces publications figure dans le volume 39, Index des publications 1982, du *Journal canadien des sciences halieutiques et aquatiques*. La série actuelle a commencé avec la publication du rapport numéro 1 en janvier 1982.

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PHYSICAL AND CHEMICAL DATA FROM THE CANADA BASIN, AUGUST 2004

by

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TABLE OF CONTENTS

ABSTRACT

McLaughlin, F., Carmack, E.C., Zimmermann. S., Sieberg, D., White, L., Barwell-Clarke, J., Steel, M., and Li, W.K.W. 2008. Physical and chemical data from the Canada Basin, August 2004. Can. Data Rep. Hydrogr. Ocean. Sci. 140: vi + 185p.

The physical and chemical water properties of the Arctic Ocean's Canada Basin were measured during a Joint Ocean Ice Study (JOIS) expedition aboard the *CCGS Louis S. St-Laurent* from 29 July – 2 September, 2004 (Institute of Ocean Sciences Mission Number 2004-16). The objective of the program was to investigate the storage of freshwater in the Beaufort Gyre, water mass circulation, the inter-annual variability of water properties, and the distribution and concentration of bacteria and zooplankton. This report provides a summary of all science activities together with data collected from CTD/rosette casts. The CTD data consists of pressure, temperature, salinity, oxygen, transmission and fluorescence sensor data and the bottle data include salinity, oxygen, nutrients, ^{18}O, barium, chlorophyll a and bacteria. Sampling and analytical methods are described. Other samples collected but not included in this report are also listed.

Résumé

McLaughlin, F., Carmack, E.C., Zimmermann. S., Sieberg, D., White, L., Barwell-Clarke, J., Steel, M., and Li, W.K.W. 2008. Physical and chemical data from the Canada Basin, August 2004. Can. Data Rep. Hydrogr. Ocean. Sci. 140: vi + 185p.

Les propriétés physiques et chimiques de l'eau du bassin Canada, dans l'océan Arctique, ont été évaluées lors d'une expédition menée dans le cadre des Études conjointes sur les glaces (JOIS) à bord du NGCC *Louis S. St-Laurent*, du 29 juillet au 2 septembre 2004 (mission numéro 2004-16 de l'Institut des sciences de la mer). Le programme visait à étudier la rétention de l'eau douce dans le tourbillon de Beaufort, la circulation des masses d'eau, la variabilité interannuelle des propriétés hydriques, et la distribution et la concentration des bactéries et du zooplancton. Ce rapport présente un sommaire de toutes les activités scientifiques ainsi que les données des profils de conductivité-température-profondeur(CTP)/Rosette. Les données de CTP informent sur la pression, la température, la salinité et la teneur en oxygène, alors que les données captées par transmission et fluorescence et les « données de bouteille » (données recueillies dans des échantillons d'eau) touchent la salinité ainsi que la teneur en oxygène, en nutriments, en ^{18}O, en baryum, en chlorophylle *a* et en bactéries. Les méthodes d'échantillonnage et d'analyse sont décrites. D'autres échantillons prélevés mais non inclus dans ce rapport sont également mentionnés.

ACKNOWLEDGEMENTS

We would like to thank Captains McNeill and Klebert and the crews of the *CCGS Louis S. St-Laurent.* Their extra efforts made this trip successful and enjoyable. In addition we would like to thank the Canadian Ice Service for their support with ice and weather information, the Coast Guard for altering the crew change location, and the *CGCS Amundsen* for transferring equipment and *CGCS Sir Wilfrid Laurier* for transferring samples to IOS.

This work was supported by Fisheries & Oceans Canada.

1. INTRODUCTION

The Joint Ocean Ice Study (JOIS) is a collaboration among DFO researchers from the Institute of Ocean Sciences with colleagues from Japan and the U.S. It combines two ongoing programs: the Joint Western Arctic Climate Study (JWACS), a collaboration with Japanese scientists from the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) to conduct oceanographic surveys; and the Beaufort Gyre Exploration Project (BGEP), a collaboration with US scientists from Woods Hole Oceanographic Institution (WHOI) to deploy and service moorings. The four primary investigators are Fiona McLaughlin (DFO), Eddy Carmack (DFO), Andrey Proshutinsky (WHOI) and Koji Shimada (JAMSTEC).

The JOIS-2004 study area extended across the Arctic Ocean's southern Canada Basin up to 79°N. The program objective was to study climate variability and the relationships between the physical environment and biota across shelf break, slope and basin domains, specifically:

- To understand the impacts of global change on the physical environment by tracking and linking decadal scale perturbations in the Arctic atmosphere (e.g. Arctic Oscillation and Beaufort Gyre) to interannual basin-scale changes in water mass properties and circulation.
- To understand the impacts of global change on sea ice and other fresh water products by utilizing a suite of stable isotopes and geochemical markers to quantify freshwater components.
- To understand the impacts of global change on the distribution of biota by investigating distributions and abundances of bacteria and zooplankton.
- To investigate physical processes such as thermohaline intrusions, ventilation and nutrient flux.

The program was conducted aboard the *CCGS Louis S. St-Laurent* from 29 July to 2 September, 2004 (Institute of Ocean Sciences Mission Number 2004-16). A science team of 16 people performed rosette, mooring, expendable CTD (XCTD) and vertical net tow operations, resulting in a high resolution, full ocean-depth hydrographic data set of the southern Canada Basin.

This report provides a summary of all science activities together with data collected from CTD/rosette casts: CTD data include pressure, temperature, salinity, oxygen, transmission and fluorescence sensor data; bottle data include salinity, oxygen, nutrients, ^{18}O, barium, chlorophyll a and bacteria measurements. Other samples collected but not included in this report are also listed. Sampling and analytical methods for the CTD and water chemistry program, conducted primarily by the team from the Institute of Ocean Sciences, are reported.

1.1 FIELD WORK SUMMARY

The main science program was conducted in the Beaufort Sea and Canada Basin. Science was also conducted opportunistically in Baffin Bay and the Canadian Archipelago during the transit of the ship from its home port in Dartmouth, NS to Cambridge Bay, NU.

The program consisted of expendable CTD (XCTD) deployments, CTD/rosette casts, mooring recovery and deployments, an ice buoy deployment, vertical net tows for zooplankton, separate casts for photosynthetically active radiation (PAR) profiles, and surface drift bottle deployments. Mission #2004-16 accomplishments are summarized below. Data presented in this report are outlined in **bold font.** Specific location and time of events are listed in the appendices.

Transit from Dartmouth, NS to Resolute, NU:
15 to 24 July, 2004

- 36 XCTDs
- 105 Drifter Bottles deployed

Transit through the Canadian Archipelago
25 July to 2 August, 2004, Resolute, NU to Cambridge Bay, NU

- **15 CTD/Rosette casts from Barrow Strait to Amundsen Gulf sampling salinity, nutrients and bacteria.**
- 3 XCTDs in Bellot Strait (#37 to #39)
- 49 Drifter Bottles deployed

Canada Basin Survey
3 August to 2 September, 2004, Cambridge Bay to Cambridge Bay, NU

- **33 CTD/Rosette casts and 2 CTD Casts**
    1. **CTD: The CTD was equipped with 2 temperature sensors, 2 conductivity sensors (for salinity), SBE43 oxygen probe, transmissometer, fluorometer, bottom contact warning and an altimeter.**
    2. **Rosette: Water chemistry samples drawn from the bottles include salinity, dissolved oxygen, nitrate, silicate, phosphate,**

chlorophyll-a and phaeopigment (filtered at 0.7, 5 and 10 um), **oxygen isotope ratio (^{18}O), barium,** particulate organic carbon and nitrogen (POC/N), biogenic silica, dissolved organic carbon and nitrogen (DOC/DON), phytoplankton cell size and **bacteria**. Although total organic carbon and nitrogen (TOC/TON), dissolved inorganic carbon (DIC), colored dissolved organic matter (CDOM), carbon-13 isotope (^{13}C) were also drawn, these samples were compromised during storage and transit and were not kept.

3. LADCP: Current measurements from a downward looking lowered acoustic doppler current profiler.
4. PAR (photosyntheticly active radiation) sensor was used with a SBE-19 CTD on 22 stations.

- 80 XCTDs (#40 to #119)
- 3 BGEP moorings recovered and deployed by WHOI (Bottom depths 3824, 3821 and 3722m)
- 1 Canadian Arctic Basin Observing System (CABOS) mooring recovered and deployed for International Arctic Research Center (Bottom depth 1121m)
- 1 Profiling Ice Thickness at Station A (PITSA) mooring recovered for DFO (Bottom depth 3133m)
- 1 Ice Tethered Profiler and Ice Mass Balance Buoy deployed
- 2 buoys salvaged: JAMSTEC JCAD-7 buoy and a CRREL IMB buoy
- 64 vertical net tows at 27 stations (56 to 100 m, 8 to 500 m depth) using three mesh sizes (53µm, 150µm and 236µm)
- 83 drifter bottles deployed, typically 2 at each CTD/Rosette station

1.2 STUDY AREA

The station locations and accompanying ice conditions are shown in the figures below. Position information was collected from the ship's GPS. The GPS's NMEA string was fed directly into the cruise track software (Fugawi) and the CTD acquisition software (Seasave by Seabird Inc.). Station locations are listed in the appendix.

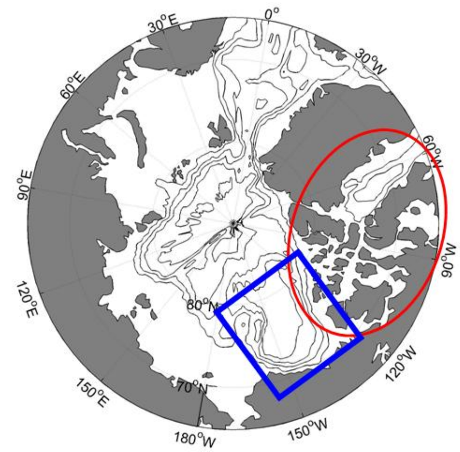


Figure 1. View of the Arctic showing Baffin Bay and the Canadian Archipelago in the red circle the Canada Basin in the blue box.

The station locations and ice concentration in Baffin Bay and the eastern archipelago are shown in figures 2 and 3.

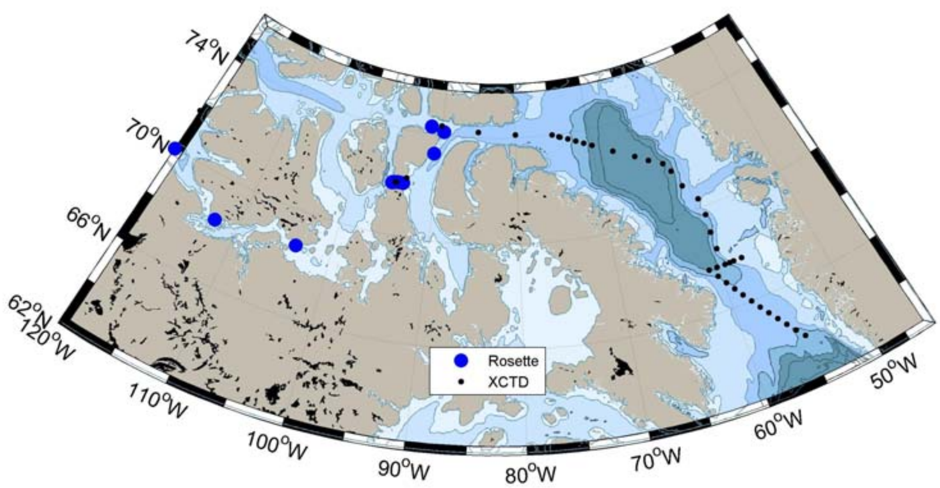


Figure 2. Station locations in Baffin Bay and the Canadian Archipelago.

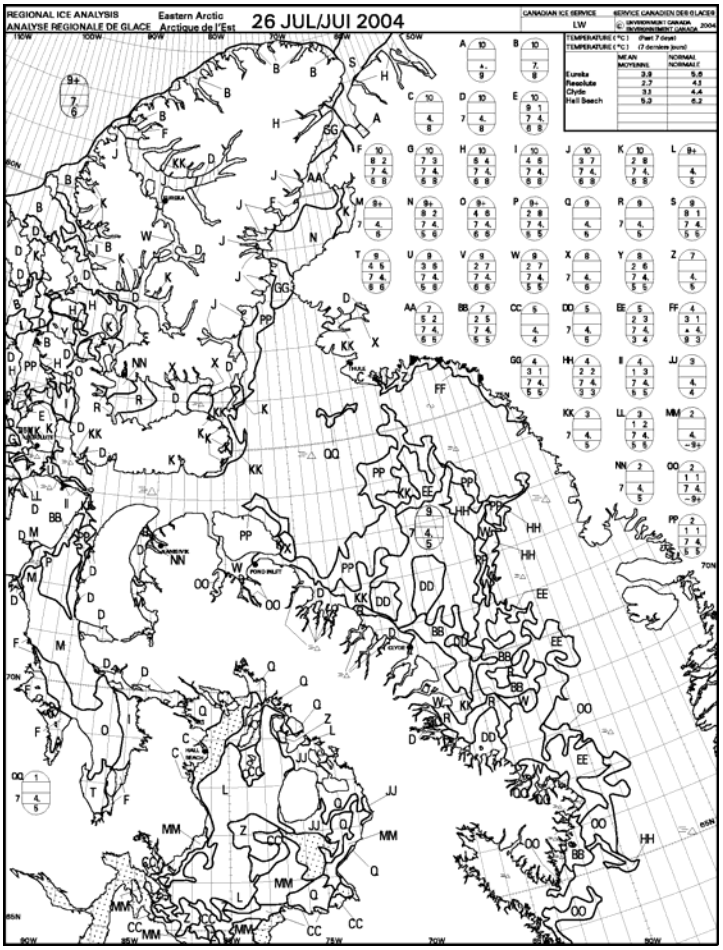


Figure 3. Regional ice analysis by the Canadian Ice Service on July 26, 2004 illustrating conditions during transit through Baffin Bay and the eastern archipelago.

The stations in the Canada Basin are shown in figure 4. Stations were occupied in a clockwise fashion from south to north along 150°W and from north to south along 140°W, with additional stations in between. This cruise track allowed the ship to work in optimal ice conditions, i.e. start in the southern ice-free area and then move to the north and east Beaufort when the ice was near the seasonal minimum. Four sections were measured in the Canada Basin, two north-south and two approximately east-west. Three of the mooring locations are at section intersections. XCTDs were deployed between the CTD/Rosette stations. Ice conditions at the start and end of the cruise are shown in figures 6 and 7. Vertical net tows were performed at 27 of the CTD/Rosette stations (figure 5).

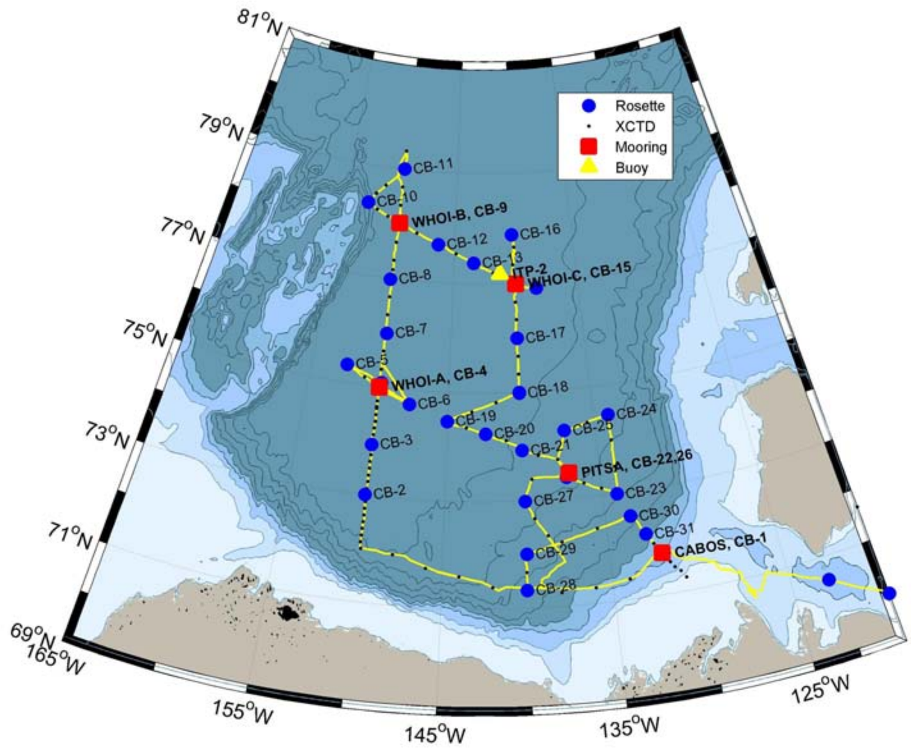


Figure 4. Cruise track and station locations in the Canada Basin.

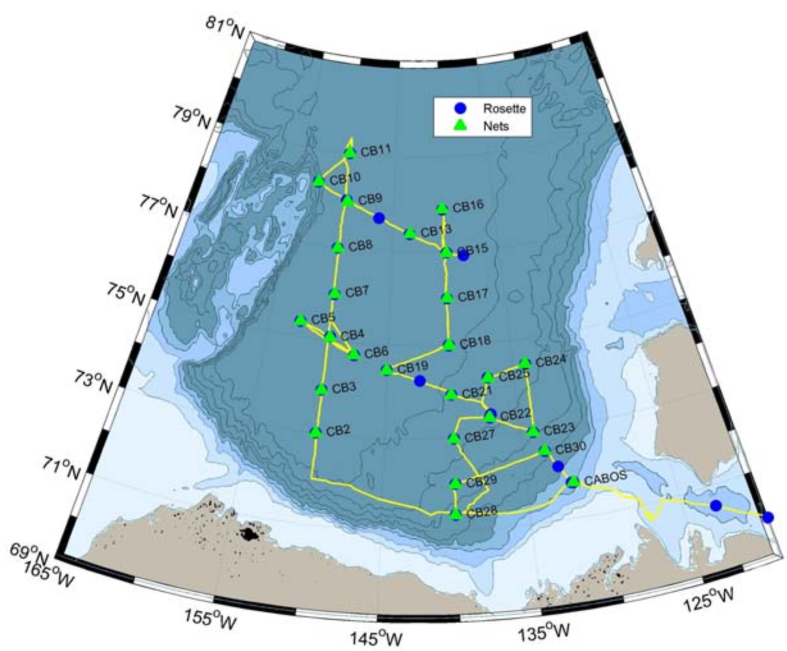


Figure 5. Vertical net tow locations in the Canada Basin.

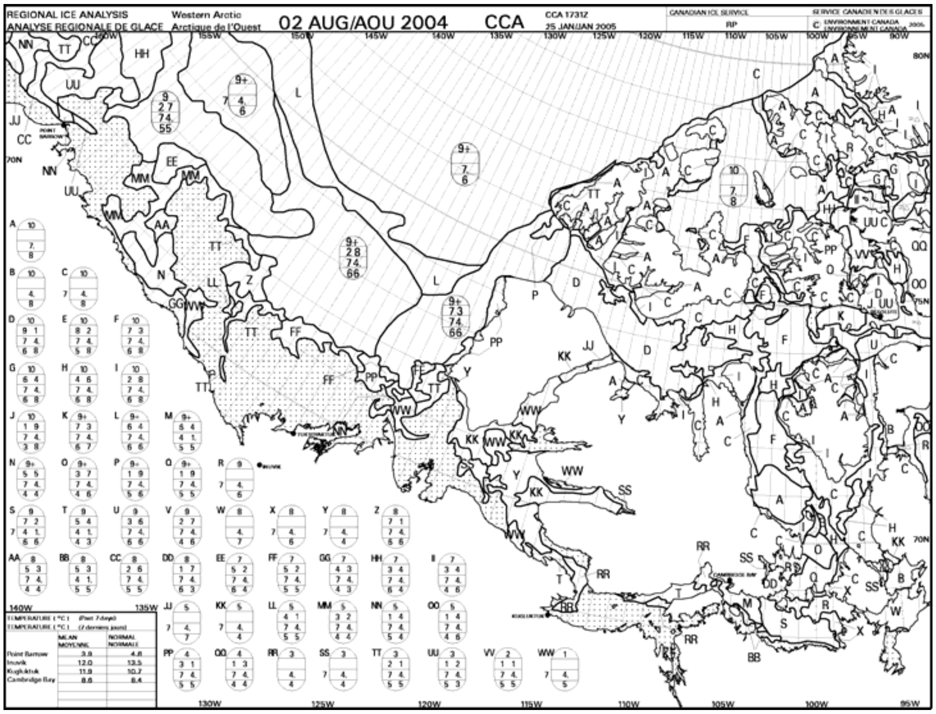


Figure 6. Regional ice analysis by the Canadian Ice Service on August 2, 2004, the start of the cruise.

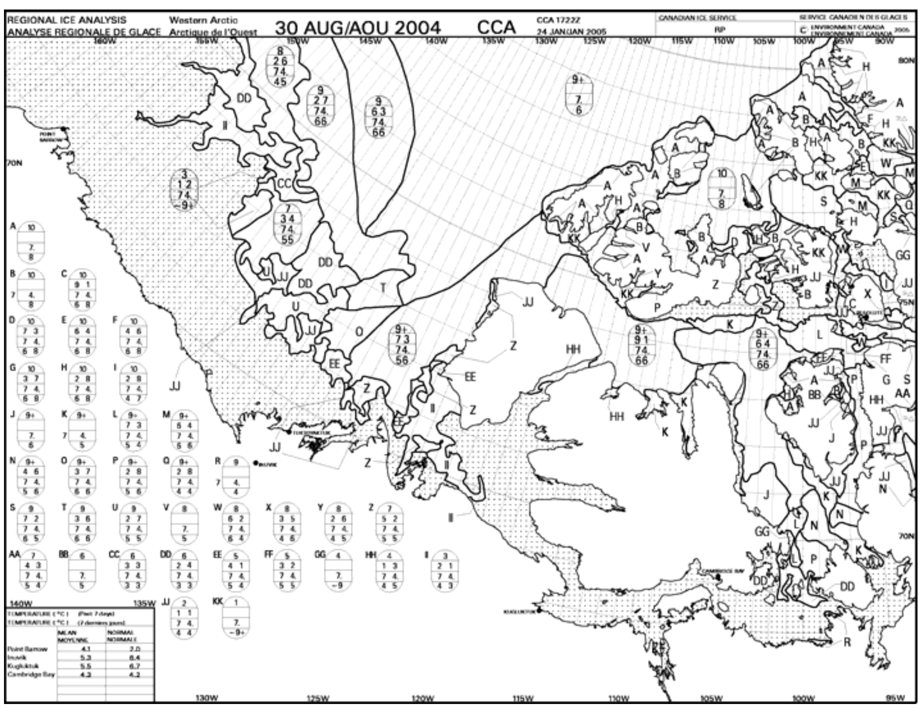


Figure 7. Regional ice analysis by the Canadian Ice Service on August 30, 2004, the end of the cruise.

2. METHODS AND ANALYSIS

2.1 SCIENCE PLATFORM: *CCGS Louis S. St-Laurent*

The *CCGS Louis S. St-Laurent* is a 26,000 HP Canadian Coast Guard icebreaker equipped with helicopter and deployable rigid hull boats. An ice specialist, a member of the ship's compliment, received Radarsat ice images and weather information from the Canadian Ice Services, made daily ice and weather observations to send back to shore, and assisted in navigation and information regarding science station locations.

Because the Canada Basin was ice covered from roughly 72ºN to the north during August, operations were dependent on the ship making openings in the ice to allow deployments and recoveries. Mooring and vertical net tow operations were performed from the ship's foredeck using the starboard crane and A-frame. CTD/Rosette casts were performed on the boat deck, mid-ships, using a starboard A-frame. The XCTDs were deployed from the aft deck by a handheld launcher. The ice buoys were deployed away from the ship, using a portable gantry set up on the ice.

The ship's forward science lab was used as a mooring instrument shop, the rosette and CTD operations were performed from the boat deck container labs, nutrient, oxygen, chlorophyll analyses were performed in the main lab, salinity analysis was performed in the more temperature stable after-lab, and zooplankton operations were split between the well-ventilated container lab on the foredeck and the after-lab.

Ships soundings were taken using an ELAC 15 kHz depth sounder displayed on paper charts. No continuous measurements were recorded.

2.2 FIELD SAMPLING: CTD/ROSETTE CASTS

Rosette casts were taken with a Seabird SBE911plus CTD system, operating at 24Hz scan rate, equipped with dual temperature sensors, dual conductivity sensors, SBE43 oxygen probe, Wetlabs CST–DR transmissometer, Seapoint pumped fluorometer, bottom contact warning device and Datasonics altimeter. Please see the appendix for sensor serial numbers, calibration dates and position on frame. In addition, an RDI lowered acoustic doppler profiler (LADCP) was mounted on the frame. Twenty-four new 10 liter Niskin bottles with internal stainless steel springs made by OceanTest Equipment, Inc., were used to collect water samples for salinity, dissolved oxygen, nitrate (NO3), silicate (SiO4), phosphate (PO4), chlorophyll-a and phaeopigment (filtered at 0.7, 5 and 10 um), oxygen isotope ratio (^{18}O), barium, particulate organic carbon and nitrogen (POC/N), dissolved organic carbon and nitrogen (DOC/DON), total organic carbon and nitrogen (TOC/TON), biogenic silica, dissolved inorganic carbon (DIC), colored dissolved organic matter (CDOM), carbon-13 isotope (^{13}C), phytoplankton cell size and bacteria.

A typical full depth cast took 3.5 hours to complete. The ship stopped near the pre-determined location to find a position that would keep the wire clear of ice during the deployment. If ice approached the wire during deployment the wire was moved closer to the ship for protection or the winch spooling stopped while the ice pushed by, preventing the wire from sawing into and getting caught in the ice. The ship's bubbler system was also used to blow ice out of the way although the bubblers' location is most suited to clear the foredeck area, forward of the CTD launch area.

The rosette was rolled out of the heated sampling container, the protective water-filled plugs removed from the temperature, conductivity and oxygen sensors, the CTD turned on to record in-air information and the rosette deployed after communication from the computer (through the single conductor winch wire to the CTD and SBE 32 water sampler), was established.

The rosette was lowered to 10m, the sensor pumps turned on and the package soaked for 3 minutes to equilibrate the oxygen sensor. The package was then raised to just below the surface and lowered to within 15m of the ocean floor. After closing the first bottle at the bottom of the cast, the package was raised at 50m/minute then slowed to 30m/minute for the upper 400m. Bottles were closed on the upcast without slowing the raising speed. This was done to capture the least disturbed water. In the upper 400m, the sample depths were chosen to match a set of salinity values. During the downcast, the depths of the salinity values were noted so that on the upcast, bottles could be closed at the pre-determined depths.

CTD data acquisition was not stopped until after the CTD was brought back on deck, again to record in-air measurements. The rosette was rolled back into the rosette room, the water-filled sensor plugs reattached and the water sampler and LADCP rinsed with fresh water. Care was taken to avoid rinsing the Niskin bottles prior to being sampled.

Water sampling took place immediately after each cast in the heated rosette room. The order of sampling was determined by drawing the samples most susceptible to temporal changes first, i.e. gases were first. Dissolved oxygen, nutrients, salinity, chlorophyll-a and phaeopigments were measured on board. All other samples were stored for analysis on shore.

2.2.1 Reported Data

2.2.1.1 Downcast CTD Files

The downcast CTD data are provided in 1-db averaged files with one file per cast. Standard Seabird processing steps were used. Pressure, primary temperature, primary conductivity and oxygen were calibrated. Data from spikes in temperature, conductivity and oxygen were replaced with linearly interpolated data. Derived variables (salinity, potential temperature, sigma-theta and sound velocity) were recalculated. Transmission, fluorescence and altimetry data were not calibrated.

2.2.1.2 Chemistry

All water sample data are presented in a single EXCEL spreadsheet with station location and time, CTD data and water sample results referenced to a unique sample number. The lag between CTD reading and water in the bottle was determined by examining the CTD and bottle salinity in the high gradient near-surface water (upper 300m). CTD data entered with the water sample data are 1 second averages, lagged by -2.6 seconds to the bottle closure. The CTD oxygen data is from the downcast, matched to the upcast bottle closure by pressure deeper than 500m and by density shallower than 500m. The target depths for the water samples in the upper 400m were chosen from standard salinity values. Salinity, oxygen, nutrients, and chlorophyll were primarily analyzed on board. The few samples collected near the end of the cruise were brought back for analyses in the lab. Barium and ^{18}O were analyzed on shore.

2.3 CTD DATA ACQUISITION, PROCESSING AND VALIDATION

2.3.1 Overview/Highlights

The CTD performed well: there was good communication between the CTD and water sampler, minimal problems with the Niskin bottles and few data spikes. The CTD wire was reterminated after casts 7 (kink in wire), 28 (wire caught in block), and 33 (wire chaffing against rollers). There were no effects on the data due to retermination.

There was a problem however with the oxygen sensor. Data from the oxygen sensor deteriorated between casts 34 to 41 then failed due to a leak in the cable connection. After repair the data quality returned to normal.

The transmissometer windows were not cleaned during the cruise except once, before cast 29. This cleaning changed the transmission values giving a false impression that the west and east sides of the basin have different transmission values.

Table 1. CTD Accuracy for 2004-16

Sensor	Accuracy	Lab Calibration Applied	Correction to Lab Calibration	Comment
Pressure	1 db	29 Oct 2002	None	
Temperature	0.001ºC	Pre cruise	None	
Conductivity	0.003 mS/cm above 500m; 0.001 mS/cm below 500m	Pre cruise	-0.0007 mS/cm.	From water sample comparisons
Salinity	0.003 PSU above 500m; 0.001 PSU below 500m	NA	NA	Recalculated with calibrated conductivity
Oxygen	0.04 ml/l	Pre cruise	Updated terms: lag, voffset, soc	From water sample comparisons
Transmission	NA	None	None	No calibration
Fluorescence	NA	None	None	No calibration
Altimeter	NA	None	None	No calibration

2.3.2 Acquisition and Processing Steps

CTD data were acquired and processed with Seabird software on a PC platform with further processing using Matlab-based routines. Acquisition occurred real -time through a conducting cable from the CTD to a PC running Seasave (Seasave Win32 V 5.28c). The ship's GPS position was added to each data scan via the NMEA interface. Upon completion of the station, the data were copied to a new directory and Seabird's Windows-based processing software, SBEDataProcessing (SBEDataProcessing-Win32_V5_29b), was used to produce 1db averaged downcast and upcast profiles. The standard processing steps were: sensor alignment through advancing conductivity; spike removal; a correction for the thermal mass of the temperature sensors; filtering; removal of pressure reversals; calculation of oxygen; averaging to 1 db levels; calculation of other derived properties; and the file separation between downcast and upcast profiles.

Final processing was completed using Matlab to calibrate, plot and remove spikes in the data. The primary conductivity sensor was calibrated to the salinity of deep water samples. The calibrated conductivity was then used to determine a standard bottle depth offset due to closing bottles 'on-the-fly' through comparisons with salinities from shallow water samples. Using the corrected bottle depths, the downcast oxygen sensor data were then calibrated with the bottle oxygen data. Data were plotted station by station to identify density inversions in the downcast. Inversions were replaced with interpolated primary temperature and conductivity sensor data, and the derived properties (salinity, density, theta) were recalculated. The interpolations are listed in the appendix. The fluorometer, transmissometer and altimeter data are unprocessed.

2.3.3 CTD Pressure

The instrument did not receive a pre- or post-cruise calibration. There is insignificant surface bias from the on-deck readings, and salinity comparisons provide no reason to suspect the deep pressure readings are inaccurate. The average surface biases at the start and end of the casts were -0.1db and -0.2db respectively. The standard deviation was low, 0.1db for each. These biases are small and have been ignored. CTD salinity differs from the water sample data by 0.001 PSU. Pressure is used in the salinity calculation. The pressure error would be approximately 2db if it were responsible for this salinity difference.

Stated SBE9plus pressure accuracy is 0.015% of full scale (1m at 6800m).

2.3.4 CTD Temperature

Pre- to post-cruise calibrations show negligible sensor drift. Over the range of temperatures sampled, -2 to 3 ºC, both sensor show a drift of less than 0.0003ºC. Comparisons between the primary and secondary sensors in the station data show very little difference throughout the cruise (0.00013ºC below 1000db with standard deviation of 0.00011ºC between casts). No adjustments other than interpolation at data spikes (described and listed below) were performed. The data presented are calibrated with the pre-cruise laboratory calibration.

Stated SBE9plus Temperature Accuracy is 0.001ºC. Results suggest this is appropriate for this data set.

2.3.5 CTD Conductivity

The conductivity sensors were very stable throughout the cruise. Lab calibrations, dual sensor comparisons and water sample comparisons were examined. For the primary conductivity sensor, lab calibrations suggest a change of +0.0004 mS/cm; however water samples suggest a change in the opposite direction of -0.0007 mS/cm. The CTD was calibrated to the water samples. Dual sensor comparisons indicate no drift during the cruise.

Laboratory Results

Pre and post cruise laboratory calibrations show small sensor drift. Over the range of conductivities measured on the cruise, 20 to 30 mS/cm, primary conductivity has drifted between 0.0004 and 0.0008 mS/cm. Secondary conductivity shows a shift in the same direction of 0.0005 mS/cm.

Dual Sensor Results

Comparisons between primary and secondary sensors show a constant offset during the cruise in the deep water. The average offset is 0.0018 mS/cm (0.0022 PSU) below 1000db with a standard deviation (STD) of 0.0001 mS/cm (0.0001 PSU). Averages of each cast were used to find the cruise average and STD. The sensor difference in the fresh, upper 200m is smaller. It is 0.0004 mS/cm (0.0004 PSU) with a STD of 0.0007mS/cm (0.0009 PSU) after removing 4 cast outliers.

Bottle Salt Results

Bottle salts were used to calibrate the primary CTD. All samples were taken on the fly during the upcast (except for two casts). To remove bottle flushing effects only the deep water, below 2950db where the vertical gradient in salinity was less than 0.0005PSU over 500m, was used for calibration. An iterative fitting routine was used with a standard deviation criterion of 2.5. The results are an offset of -0.0007 mS/cm (64 out of 66 observations used with a resulting STD of 0.0006 mS/cm) for the primary conductivity.

There is a drift in the difference between the bottles and CTD in the deep water of 0.001 PSU from the start to the end of the cruise. This change is likely an error in the salinometer readings not the CTD as the CTD has had very stable readings in the uniform deep water throughout the cruise and the results of the dual sensor comparisons have been constant throughout the cruise.

The applied correction brings the salinity of the deep Canada Basin very close to the measurements made in 2003 (34.9573 PSU compared to 34.9575 PSU).

Stated SBE9plus conductivity accuracy is 0.003mS/cm. Laboratory calibrations suggest this is appropriate for data shallower than 500db. Calibration to bottle salts suggests an accuracy of 0.001mS/cm is appropriate for the deeper water.

2.3.6 CTD Salinity

CTD salinity was recalculated from the calibrated conductivity.

Comparison of calibrated CTD salinity and water sample data for observations deeper than 500m produces a STD of 0.0011 PSU based on the residuals of 251 observations (after flagged salinities removed).

Observations shallower than 200m produce a STD of 0.1731 PSU and a mean of -0.0553 based on the residuals of 381 observations (after flagged salinities removed). Please see the description of the CTD data and bottle depths in section 2.3.11 for an explanation for the larger STD and bias.

2.3.7 CTD Oxygen

<u>Performance</u>

Casts 34 to 41 have noise in the oxygen data due to a leaking CTD bulkhead connector that was cleaned and reseated after cast 41. The bulkhead connector was not replaced until after the cruise.

There are jumps in oxygen, approximately -0.02ml/l, associated with long, 100db, drifts back to expected value. Affected casts: 21, 24, 32, 33, 34, 36, 37, 38, 40, 41, 42. Where possible these sections were interpolated over (see appendix for list of interpolations). These jumps may be associated with the leaking connector or perhaps the torn membrane discovered during the post-cruise calibration.

<u>Calibration</u>

The downcast oxygen data were calibrated to the upcast oxygen water samples, with consideration given to the sensor lag, hysteresis, and water sample quality. Coefficients were found following the Seabird method (Application Note 64-2: http://www.seabird.com/application_notes/AN64-2.htm). One set of coefficients were determined (voffset and soc) for the cruise and were applied with the remaining pre-cruise laboratory calibration coefficients. The post cruise laboratory inspection showed the sensor had a torn membrane and no calibration was performed until after a new membrane was installed.

The oxygen voltage lag was determined to be between 4 and 6 seconds by comparing similar oxygen voltage features in the down and upcasts. Part of this lag is the time it takes water to physically move from the intake to the sensor. In house lab tests show this is 1.21 seconds. Oxygen voltage was moved 6 seconds ahead of the other sensors to correct for the sensor lag.

At a given depth, upcast oxygen voltage was consistently lower than the downcast voltage. The deeper and longer the sensor was at depth, the larger the hysteresis. This variable hysteresis in the upcast was too difficult to correct, so only the downcast was calibrated. The downcast CTD data were taken at bottle depths (after the bottle flushing correction) and compared to water samples. There was some error due to the real difference between down and upcast profiles. This was minimized by using all the cruise water samples for the calibration as well as taking the CTD data from matching density, instead of depth, for the upper 500m samples.

The oxygen water sample quality was compromised at times perhaps due to the colorimeter used during the oxygen analysis. Again, the calibration error was minimized by using all the cruise water samples for the calibration. Overall, the CTD sensor was quite stable, with similar readings at depth throughout the cruise, thus helping to identify which water samples should be removed from the calibration. A set of criteria were used to remove bad comparison points: CTD and water sample salinities had to agree within 0.02 ml/l; samples had to be shallower than 2000 db; Casts 21, 30, 32, and 35 were not used; and finally, the iterative fitting routine removed comparisons where the residuals exceeded 2.5 STD.

Comparison of calibrated CTD oxygen and water sample data produces a STD of 0.04 ml/l based on the residuals of 263 observations (after outliers removed).

2.3.8 CTD Transmission

The transmissometer data were not calibrated. The windows were wiped following cast 28 and this increased the transmission readings.

2.3.9 CTD Fluorescence

The fluorometer data were not calibrated, however chlorophyll-a data could be used to perform a calibration. Water was pumped past the fluorometer, following the temperature and conductivity sensors, improving the consistency of the reading. The covered housing on the fluorometer prevented accessibility for cleaning during the cruise.

2.3.10 Data Spike Removal

Data spikes were found using the density inversion criteria listed below. Linear interpolations were performed on both temperature and conductivity if a spike was found in either property. Interpolations were all less than 10m except in casts 8, 9, and 34.

Criteria:
0 to 10m, inversions ignored
10 to 200m, inversions over 0.004 kg/m³/m
200 to 600m, inversions over 0.001 kg/m³/m
600+m, inversions over 0.0005 kg/m³/m

Casts 8 and 9, in the Canadian Archipelago, on the west side of Bellot Strait, had many density inversions from 60m down to the bottom of the cast. The inversions below 130m were too numerous to interpolate over. The dual sensors agree, showing the measurements are real, however currents may have caused the CTD package to lower at an angle, generating odd turbulent patterns that could generate the measured instabilities. Additionally, this is a dynamic area where intrusions and mixing are expected to occur.

Interpolations are listed in the appendix.

2.3.11 CTD Data at Bottle Depths for Water Chemistry File

Because the Niskin bottles were closed on-the-fly, salinity comparisons between water samples and CTD in the upper 200m were used to determine which CTD data to match with the water samples. Due to bottle flushing lags, the water in the bottles comes from slightly deeper than the depth of the CTD measurement. By applying a standard offset to the CTD data, the data were matched to the water collected in the Niskin.

The appropriate lag was found by comparing 0.2 second averaged CTD data (after applying conductivity calibration) to the bottle data. The comparisons were restricted to the upper 200m where the vertical salinity gradient is large. Lags from -10 seconds to +10 seconds were tested. Cast 16 to 35 (excluding cast 25) show a -2.4 to -2.8 second shift (between 1 to 2 db in the upper 400m) in the upcast CTD data matches bottle salts the best. Salinity differences between CTD and the bottle salinity that were over +/- 0.05 PSU (after the shift), were not used for mean and STD calculations. There remains a bias of outliers in the upper 200 m of the water column where bottle salinity is larger than CTD. This bias is a function of tripping on the fly in high salinity gradient waters. It should be noted that the alternative, stopping the package for a bottle sample, also results in a bias due to the lack of ship-rock in ice covered waters that would mechanically flush the bottles. Closing on-the-fly is thought to reduce the size of the bias, and produce a more repeatable response than stopping the package for bottle closures.

Comparisons within +/-0.05psu and 0 to 200db

No Correction	Mean = 0.02 PSU, STD =0.016 PSU
-2.6 Seconds	Mean = -0.001 PSU, STD = 0.022 PSU

2.4 CHEMISTRY SAMPLING AND ANALYSIS

2.4.1 Overview/Highlights

Samples were collected for nineteen water properties, listed in Table 2.

Of note:

- The land shipment of samples to be refrigerated from Dartmouth, NS to IOS in Sidney, BC was frozen, thus destroying the integrity of the DIC, ^{13}C, and CDOM samples (shipping company error). The salinity samples were OK after thawing. Barium and ^{18}O samples were not part of this shipment.
- The majority of TOC samples were lost due to the inadvertent storage of samples in the ship's -80 ^{o}C freezer instead of the -20 ^{o}C freezer. The glass vials could not withstand the thermal shock and cracked.
- Oxygen precision was larger than expected due to colorimeter problems.
- Salinity samples were run on an autosalinometer that had a slight drift requiring corrections based on the standard water. Samples from the later part of the cruise were saved for analysis on shore for comparison with analysis at sea.

See Appendix 4.5 for single cast plots and Appendix 4.6 for group property-property plots.

Table 2. Water Sample Summary

Parameter	Canada Basin Casts (Casts15 to 50)	Depths	Analyzed	Investigator	Comment
Salinity	All	all	ship and lab	Fiona McLaughlin (IOS)	
Nutrients (Phosphate, Nitrate, Silicate)	All	all	ship	Fiona McLaughlin (IOS)	
Oxygen	All	all	ship	Fiona McLaughlin (IOS)	
Oxygen-18 isotope (^{18}O)	all except 25,40,44,49,50	0 to 250m and 1 deep	lab	Noriyuki Tanaka (IARC)	
Barium (Ba)	all except 25,40,44,49,50	0 to 250m and 1 deep	lab	Chris Guay	
Bacteria	all except 25,40,44,49,50	0 to 250m	lab	Bill Lee (BIO)	

Colored Dissolved Organic Material (CDOM)	17,19,20,24,27,28,30,31,33,34, 35	0 to 600m		Celine G. (UBC/IOS)	No data-samples frozen
Chlorophyll-a 0.7u filter	16,17,18,19,21,22,24,27,28, 30,31,33,34,35,36,38,39,41,43, 46,47,48	0 to 250m	ship	Christine Michel (FWI)/ Fiona McLaughlin (IOS)	
Chlorophyll-a 5u filter	same as chlorophyll-a 0.7u filter	0 to 250m	ship	Christine Michel (FWI)	
Chlorophyll-a 10u filter	same as chlorophyll-a 0.7u filter	0 to 250m	ship	Christine Michel (FWI)	
Particulate Organic Carbon and Particulate Organic Nitrate (POC+PON)	same as chlorophyll-a 0.7u filter	0 to 250m	lab	Christine Michel (FWI)	
Dissolved Organic Carbon and Dissolved Organic Nitrate (DOC+DON)	same as chlorophyll-a 0.7u filter	0 to 250m	lab	Christine Michel (FWI)	
Cell Identification	same as chlorophyll-a 0.7u filter	0 to 250m	lab	Christine Michel (FWI)	
Biogenic Silica	same as chlorophyll-a 0.7u filter	0 to 250m	lab	Christine Michel (FWI)	
Carbon-13 isotope (^{13}C)	all surface and profiles at 28, 40	Surface and 2 profiles	lab	CS Wong (IOS)	No data-samples frozen
Disolved Inorcanic Carbon (DIC)	all surface and profiles at 28, 40	2 profiles	lab	Fiona McLaughlin (IOS)	No data-samples frozen
Total Organic Carbon (TOC)	46, 47, 48 (samples lost from other casts)	0 to 250m and 1 deep	lab	Fiona McLaughlin (IOS)	No data-samples frozen

Table 3. Water Sample Precision

Chemistry Sample	Precision (s_p)	Number of Replicates	Minimum Range	Maximum Range
Salinity	0.003 PSU	131	21.645 PSU	34.960 PSU
Dissolved Oxygen	0.028 ml/l	89	5.24 ml/l	9.48 ml/l
Nitrate	0.07 µM	99	0 µM	17.1 µM
Silicate	0.14 µM	98	2.0 µM	39.4 µM
Phosphate	0.01 µM	98	0.38 µM	2.16 µM
^{18}O	0.12‰	58	-5.43 ‰	0.68 ‰
Barium	1.85 nM	55	40.9 nM	118.5 nM

Total Chlorophyll-a	0.01 µg/l	208	0 µg/l	1.3 µg/l
Total Phaeo-pigment	0.01 µg/l	208	0 µg/l	0.6 µg/l

The precision of the methods was estimated by analyzing replicates and is expressed as the pooled standard deviation, s_p, which is calculated as:

$$s_p = \sqrt{\frac{SS_1 + SS_2 + ... + SS_k}{v_1 + v_2 + ... + v_k}}$$

where $v_i = n_i - 1$ is the degrees of freedom, n_i refers to the number of replicates, $SS_i = \sum(x_j - \bar{x})^2$ is the sum of differences squared for the individual components x_j. Note: when data consist of duplicate pairs $v_i = 1$, if triplicates $v_i = 2$.

2.4.1.1 Salinity

A positive drift in the shipboard autosalinometer (standard read more saline at the end of every run) required a correction to measurements made at sea. Due to this drift, samples from the later half of the cruise were brought back to IOS for analyses on the lower accuracy but more stable Portosalinometer.

<u>Analysis at Sea</u>

Onboard, samples were analyzed on the Guildline Autosalinometer Model 8400A (SN: 49463) by Andrew Hamilton. Procedure followed methods as outlined in the standard IOS protocol. Water samples were collected from Niskin bottles immediately following a rosette cast. Salinity bottles were used with a two cap system, an insert cap followed by a screw on cap. Salinity bottles and insert caps were rinsed 3 times before filling. Samples were transferred to the temperature controlled room where they were analyzed on the Autosal within one week. Room and sample temperature was maintained consistently between 21 and 23°C. Bottles were inverted and mixed prior to analysis.

IAPSO Standard Seawater (OSIL, batch P144) was measured at the beginning and end of each run to calibrate the Autosal and identify instrumental drift. The value of OSIL, batch P144 is 34.995 PSU. Data are reported in practical salinity units (PSU) (*Lewis and Perkin*, 1978).

A positive drift in the autosalinometer during the at-sea analysis required a correction to the measurements. The drift was typically 0.002 PSU but as large as 0.005 PSU (Table 4) per run. A linear correction for the drift was applied based on run number, thus the first sample run received no correction, the last sample received the full drift correction. Due to this drift, samples from the later half of the cruise were brought back to IOS for analyses on the lower accuracy but more stable Portosalinometer.

Analysis on Shore

On Shore, samples were analyzed on the Guildline Portasalinometer #59724 by Bernard Minkley. Procedure followed methods as outlined in the standard IOS protocol. The salinometer was standardized against IAPSO Standard Seawater (OSIL, batch P144). The first day, run 101, the Portosal had a calibration drift of 0.0044 PSU. All other days the instrument did not require adjustment as it was well within calibration limits. Duplicate samples measured on the first day and a following day show that applying the correction of 0.0044 PSU to all first day measurements brings the duplicate samples to within 0.001 PSU.

Precision

At sea Sp = 0.0005 PSU for 64 pairs; IOS laboratory Sp= 0.0010 PSU for 31pairs. When all onshore and at sea measurements are combined the Sp = 0.0031 PSU for 138 sets containing 2 to 4 replicates

For salts from depths greater than 2950m (homogenous bottom water): Standard deviation is 0.0005 PSU for 57 observations with an average of 34.957 PSU.

Table 4. Drift in Autosal and Portosal during analysis runs.

Run Number	Sample Numbers	Number of Samples in Run	Drift (PSU)
Samples Run On Board			
1	1 to 104	107	0.0039
2	105 to 154	49	unknown, no drift applied
3	155 to 230	83	0.0020
4	231 to 273	48	0.0022
5	274 to 295	25	0.0019
6	296 to 359	74	0.0014
7	360 to 368	16	0.0004

8	369 to 374	8	unknown, apply previous run's drift
9	375 to 425	59	0.0018
10	426 to 469	54	0.0006
11	470 to 481	13	unknown, apply previous run's drift
12	482 to 622	176	0.0057
13	623 to 627,762 to 793	49	0.0003
14	794 to 833	51	0.0016
Samples Run On Shore at IOS			
101	629-684	57	0.0044
102	885-713, 735-754	50	0.0000
103	714-734,755-789,790-873, 882-886, 903-905	154	-0.0004
104	874-881,887-902,and duplicates	48	-0.0005

2.4.1.2 Dissolved Oxygen

After the cast, once the Niskin bottle integrity was checked, samples for dissolved oxygen were drawn first. Water was drawn through rubber tubing into a calibrated volume glass flask with attached stopper. The sample was immediately pickled with 1.0 ml of manganous chloride then 1.0 ml alkaline iodide, the stopper was inserted and the flask was shaken to mix the contents. The flask was stored in the refrigerator until analysis.

<u>Analysis</u>

Dissolved oxygen samples were analyzed on board by Mary Steel within 24 hours of collection using an automated version of the Micro-Winkler Technique as described in Carpenter (1965). The methodology follows standard IOS protocol described by “Dissolved Oxygen Determination Methods and Procedures” by Bernard Minkley and George Chase, July 30, 1997. All chemical solutions were prepared at IOS. The titration was performed with a Metrohn Dosimat 665 and end point was detected using a Brinkmann probe colorimeter PC910. Software written at IOS, NewAutoOxy.exe, was used to calculate dissolved oxygen (ml/L).

A new colorimeter was installed August 9 because of drift in the original colorimeter when samples from the first two stations, AG5 and CB1, were analyzed. The readings drifted from 89.9% transmittance to 101.2% when the probe was in DMQ. A problem with the software occasionally caused the program terminate titration prematurely. The software was restarted, the titration completed and the volume of titrate used between the two runs was summed.

Standards and Accuracy

Standards and blanks were measured whenever a new bottle of reagent and/or sodium thiosulfate or potassium iodate was opened. Subsequent analyses used these new values to calculate oxygen concentration.

Sp= 0.028 ml/l, from 89 pairs after 5 outliers removed.

Comparisons with CTD oxygen and expected deep water values identified a large number of outliers and occasional groups of 2 to 3 stations with a positive offset. Deeper than 500m, the outliers were typically larger than the expected values. In the upper 500m, outliers were flagged questionable if the difference with the calibrated CTD oxygen was greater than 0.1ml/l and flagged bad if the difference was greater than 0.2ml/l. Below 500m, outliers with differences greater than 0.06 ml/l were flagged questionable and above 0.1ml/l flagged as bad. Due to possible flushing effects through steep gradients, exceptions were made if the sample value was vertically within 5m of the CTD profile (accepted as good) or within 10m (bad flags turned to questionable flags).

2.4.1.3 Nutrients

Water samples for nutrient determination were collected into glass and polystyrene test tubes after the tube and cap had been rinsed three times with the sample water.

Analysis and Results

All nutrient (silicate, nitrate plus nitrite and orthophosphate) samples collected in the Canada Basin were analyzed by Linda White onboard using a three channel Technicon AutoAnalyzer, following the methods described by Barwell-Clarke and Whitney, 1996. Frozen samples from 15 stations in the Canadian Archipelago were analyzed after the cruise at the Institute of Ocean Sciences using the same method.

Reagents were prepared onboard using water from a Nanopure system that produced 18.2 megohm-cm resistivity Type I reagent grade water. The supply water was fed with ship’s distilled water. A 3.2% weight-to-volume solution of sodium chloride (Sigma) was prepared daily and used to rinse the system between samples and to prepare standards. The pump tubing was changed after approximately 500 samples. One cadmium column was used for all samples. The AutoAnalyzer was cleaned daily as follows: rinsed with 3N NaOH and 1N HCl for approximately 5 minutes and rinsed with DMQ for over 20 minutes after all reagents and salt were disconnected at the end of the day. Data was logged by analog (chart) and also digitally on a computer using the IOS ”Newget” program.

Standards and blanks:

Nanopure water was analyzed before the initial standards and after the last standard set to check the chemical blank. Standards (low, medium and high) were made using a freshly prepared 3.2% sodium chloride solution and analyzed at the start and close of each day and every ~ 60 samples. Concentrations of the standards bracket the expected nutrient levels in the samples. A medium standard for each nutrient was analyzed between stations as an unknown sample. A Wako 20 µm/l nitrate standard and Japanese AS and AT reference samples (RS) were analyzed at the end of each day. The RS opened on the previous day was analyzed with newly opened reference sample. An onboard reference sample collected at station AG5 early in the cruise, stored at 4 ^{o}C in the dark, was also analyzed each day to provide a check on the day-to-day calibration standard. Finally, the slope term used in the quadratic equation, calculated daily, was tracked to show the amount of variability during the cruise. The replicate, standards and slope coefficient information is listed in Table 5.

Surface samples of salinities less than S=27 were analyzed for phosphate turbidity. No corrections have been made to the data. When the nitrate level in surface samples is the same or slightly lower than the 3.2% sodium chloride solution it is reported as zero.

Table 5. Quality control and assurance for nutrient samples.

Nutrient	**Nitrate + Nitrite**	**Silicate**	**Phosphate**
Sample Replicates			
Sp	0.07 µM	0.14 µM	0.01 µM
No. of duplicates	99	98	98
Medium check standard			
Calibrated value	16.1 µM	40.2 µM	2.01 µM
Average and std dev	16.2 µM +/- 0.16	40.2 µM +/- 0.01	2.01 µM +/- 0.01
No. of duplicates	27	29	29
AG5 onboard reference	14.5µM +/- 0.25	17.2 µM +/- 0.3	1.11 µM +/- 0.02
No. of duplicates	16	16	16
Wako 20 µM	20.1 µM +/- 0.2		
No. of duplicates	11		
Slope term (C2) in nutrient quadratic equation	0.028 +/-0.006	0.048 +/-0.01	0.004+/-0.003
No. of duplicates	45	43	43

2.4.1.4 Chlorophyll-a

Analysis and Results

Total Chlorophyll-a (>0.7μm) samples were collected from the surface to a maximum depth of 270m, drawn from the Niskin into insulated plastic coolers. Under the supervision of Linda White, Francoise Labonte and Ida Martin filtered 500 ml samples onto 25mm GF/F filters using low vacuum filtration. The filtration castles were rinsed to ensure cells were not left on the castle walls. The filters were put into scintillation vials with 10 ml/l of 90% acetone, labeled and put into a 4dg C cooler for 24 hours. The acetone was diluted with Nanopure water. During filtration and extraction, the samples were kept dark as much as possible.

After 24 hr extraction by acetone at 4^{o}C, the samples were brought to room temperature for an hour and chlorophyll-a and phaeo-pigment levels were measured with a Turner Design fluorometer (model 10-AU-005). The sample was acidified with 1.5N hydrochloric acid to obtain the phaeo-pigment reading. Chlorophyll-a and phaeo-pigment values were corrected for filter blanks. The blanks were treated in exactly the same way as samples and the average filter blank was subtracted from each sample as an equivalent weight (μg) of chlorophyll-a or phaeo-pigment per filter.

Standards

The fluorometer was calibrated before the cruise, 9 June, 2004 with chlorophyll a (Sigma) solutions that ranged from 0.5-100 ug/l. The slope and Fo/Fa were determined for the full range.

Duplicate samples were used to determine precision:

Sp = 0.008 μg/l Chla, 208 pairs (2 outliers removed)
Sp = 0.013 μg/l Phaeo-pigment, 208 pairs (2 outliers removed)

2.4.1.5 ^{18}O

Samples were drawn from the Niskin into 30ml (approximate) glass vials following three rinses of the vials. Once at room temperature the caps were retightened and wrapped with electrical tape for storage. Oxygen isotopes were analyzed in May 2005 at Oregon State University using the H_2O-CO_2 equilibration method on a Finnigan MAT mass spectrometer.

The oxygen isotope ratio is referenced to Vienna-Standard Mean Ocean Water (V-SMOW) and reported as follows:

(V-SMOW): $\delta^{18}O = ((H_2{}^{18}O/H_2{}^{16}O)_{sample} / (H_2{}^{18}O/H_2{}^{16}O)_{VSMOW} - 1) \times 10^3$ [‰].

Working standard seawater has a standard deviation of 0.04‰. The precision of analysis, based on re-analysis of 29 samples is 0.04‰.

Sp = 0.17‰, 53 pairs

2.4.1.6 Barium

Barium samples were drawn from the Niskin into small plastic vials following three rinses of the vials. Once at room temperature the caps were retightened and wrapped with Parafilm for storage. Barium was determined at Oregon State University by Christopher Guay, using isotope-dilution and a VG Thermo Excel Inductively coupled quadrupole mass spectrometer. The method was reported by Falkner et al., 1994, with minor modifications.

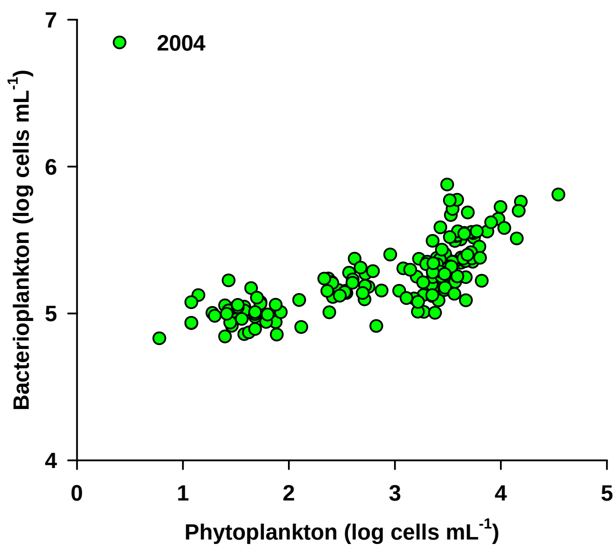
Sp= 1.85nM , 55 pairs

2.4.1.7 Bacteria

Phytoplankton and bacterioplankton were preserved in aliquots of seawater sampled from the Niskin bottles mounted on the CTD rosette. Following standard protocol (Marie et. al., 1999), 1.8 ml seawater was dispensed into a 2 ml capacity cryogenic vial and immediately fixed with 0.2 ml of 10% paraformaldehyde by vortex mixing. Samples were maintained for at least 15 min at laboratory temperature to allow fixation, and then stored at -80^{o}C until analysis at BIO. Cell concentrations of picophytoplankton, nanophytoplankton, and bacterioplankton (i.e. non-autofluorescent picoplankton) in thawed samples were analyzed by flow cytometry (Becton Dickinson FACSort) following protocols in routine use (Li and Dickie, 2001). Phytoplankton were detected by native autofluorescence using blue laser excitation (488 nm) and long-pass red emission (>650 nm). Cells smaller than 2 μm equivalent spherical diameter were classified as picoplankton and those larger as nanoplankton. In turn, picophytoplankton were partitioned into two groups according to the presence (cyanobacteria) or absence (picoeukaryotes) of the pigment phycoerythrin detected in the orange waveband (585±21 nm). Bacterioplankton were stained with SYBR Green 1 (Molecular Probes, Oregon), a nucleic-acid binding fluorochrome, and detected in the green waveband (530±15 nm).

Measurements of fluorescence and light scatter were collected using logarithmic amplification and recorded in relative units in a 4-decade range spanned by 256 channels. Fluidic flow rate was calibrated by regression of the aspirated volume versus duration of analysis. Data were extracted from listmode format using WinMDI Version 2.8 (copyright Joseph Trotter, http://facs.scripps.edu/).

The results will be examined in relation to physical and chemical oceanographic variables to discern possible environmental control of spatial variability in the distribution of these microbial plankton. Year-to-year results will be examined for evidence of change over time. Preliminary results confirm the expected correlation between the two trophic groups.



2.4.1.8 Biological Chemistry

Dissolved Organic Carbon (DOC), Total Chlorophyll-a, Chlorophyll-a at 5 and 10µm fractions, Particulate Organic Carbon (POC) and Nitrogen (PON), and Biogenic Silica (BioSi) were sampled by Francoise Labonte for Christine Michel. Please see the Fisheries & Oceans Canada data report being prepared by Christine Michel for more information.

2.5 OTHER FIELD SAMPLING

Short summaries of additional data collected but not included in this report are given below.

2.5.1 LADCP

Waldemar Walczowski, Institute of Oceanology Polish Academy of Sciences, Poland, collected data from a Lowered Acoustic Doppler Current Profiler (LADCP). Measurements were conducted during every CTD cast. The self recording RDI, 307.2 kHz device sn 3313 was attached to the rosette frame. The down-looking LADCP measured currents in 20 depth cells, each cell (bin) 10 m thick. In vicinity of the bottom, bottom track were used. Vertical speed rate of the rosette was always less than 1 m s^{-1}. LADCP data were read directly after profiling. Additionally CTD records from Seabird 9/11 device were used to determine the ship position (from NMEA protocol registered every scan) and LADCP depth (from CTD pressure and time records). LADCP data were processed using LDEO software. 38 LADCP casts were performed.

2.5.2 XCTD

An XCTD (eXpendable Conductivity Temperature and Depth) survey was conducted. The sensors, made by Tsurumi Seiki and supplied by Koji Shimada of JAMSTEC, were deployed from the stern of the ship via a hand held launcher. The probes fell freely in the water measuring temperature and conductivity every 0.15 m from the surface down to 1100 m. Data were transmitted to the ship during the freefall by a thin conducting wire extending from the XCTD to an onboard computer. To prevent sea ice from cutting the thin transmission wire, the ship slowed to 12 knots for the deployment in open water areas and completely stopped in heavy ice areas. It took 5 minutes for the XCTD to descend from the surface to 1100m.

There were 120 XCTD stations during this cruise. The accuracy of XCTD is ±0.02 degrees in temperature, ±0.03 mS/cm in conductivity (approximately ±0.04psu in salinity) and ±5-20 m in depth. The initial salinity accuracy of XCTD was improved, corrected to ±0.01psu, using the calibrated CTD data of this cruise. The salinity data were corrected by applying an offset to match the XCTD with the CTD in the deeper water.

For more information and data see the JAMSTEC website: http://www.jamstec.go.jp/e/.

2.5.3 Moorings and Buoys

Five mooring operations and two buoy deployments were performed during the cruise. Three of the moorings were from WHOI (Andrey Proshutinsky), one from IARC (Igor Polyakov) and one from DFO (Humfrey

Melling). The ice buoy was from WHOI (John Toole) and the accompanying Ice Mass Balance Buoy (IMBB) was from CRREL (Don Perovich).

The three WHOI moorings were deployed in September 2003 to profile temperature, salinity, pressure, and current using a McLane Moored Profiler (MMP). They were placed in three corners of the deep basin, profiling from 50m to 2050m. These moorings were recovered, serviced and redeployed. An inter-comparison cast was conducted to calibrate the mooring CTDs with the rosette CTD. Afterward they were remounted on the profilers and redeployed. The full method of this operation is described in Kemp et al., 2005. For more information see the web page: http://www.whoi.edu/beaufortgyre.

The Canadian Basin Observing System (CABOS) IARC mooring was also deployed in 2003 in 1100m of water in the southeast corner of the Canada Basin, measuring temperature, salinity, pressure, and current using a MMP profiling between 50m and 1050m. After recovery, a new moored profiler was installed and redeployed close to the same location. For more information see the web page http://nabos.iarc.uaf.edu/.

The Profiling Ice Thickness at Station A (PITSA) DFO mooring was recovered after a two year deployment. The mooring consisted of an Ice Profiling Sensor (IPS) to measure the bottom depth of the ice, two current meters (RDI sentinel workhorse and an RCM-9), and a thermister chain with data loggers to record the temperature structure at the upper interface of the homogenous bottom layer. The mooring was in 3100m of water, in the south-east corner of the deep Canada Basin.

An Ice Tethered Profiler (ITP) and an Ice Mass Balance Buoy (IMBB) were deployed on a slab of multiyear ice in the northwest corner of our study area. The equipment and workers were flown to the ice, ~0.25 mile from the ship, by helicopter. The two buoys were anchored into 4m thick ice and the following day we heard from the shore-based labs that both buoys were successfully transmitting data via satellite to shore. The ITP is a profiling CTD, set up to profile between 5 and 800m. The IMBB measures ice thickness and temperature, and surface air temperature, pressure and snow accumulation. For more information, please see the ITP web page: http://www.whoi.edu/itp/ and the methods and operation description by Krishfield et al., 2006.

2.5.4 Vertical Net Tows

Zooplankton sampling was conducted on board by Amanda Byrd, UAF, using a modified Bongo net system. Two large bongo frames held nets, one 150μm and one 236μm mesh and a second pair of smaller frames, fitted with

53μm mesh nets, were attached perpendicular to the bongo frames. The four nets contained unidirectional flowmeters to measure the amount of water flowing through the nets. The vertical net tows were 100m deep, with casts to 500m when time allowed. At each station there were at least two tows.

Samples from the first tow were preserved in formalin, individually for the 150 and 236μm mesh nets whereas the samples from the 53μm nets were combined into one sample. From the second tow, the 236μm net sample and the combined 53μm net sample were preserved in 100% ethanol, and the 150μm net sample was washed with 4% ammonium formate and dried at 50^{o}C for 24 hours. If there was a 3rd cast to 500m, one 53μm sample was preserved in formalin, the other in ethanol, the 150μm preserved in formalin and the 236μm preserved in ethanol.

The formalin samples are used for species identification and the ethanol samples are used for DNA sequence analysis. The dried sample provides a measurement of biomass. The samples from the 236μm mesh are being examined by John Nelson and samples from the 150μm and 53μm mesh by Russ Hopcroft, UAF. The 53μm ethanol sample will be sent to the Census of Marine Life's DNA barcoding study. Census of Marine Life is an affiliated program of the International Council of Science, Scientific Committee on Oceanic Research.

2.5.5 PAR Profiles

PAR profiles were taken by an internally recording SBE19 CTD (not calibrated for temperature or salinity), configured with a Biospherical PAR sensor. The CTD was used during net casts. The CTD was attached to the vertical net tow wire approximately 10m above the net. Casts were typically to 90m. A surface Licor PAR sensor was mounted above the bridge of the ship to collect surface reference data.

2.5.6 Drifter Bottles

An informal drifter program was carried out by ship personnel and the science party, deploying 237 drifters along the track from Dartmouth NS into the Canada Basin. Notes with distinct bottle numbers were sealed in beer bottles with corks and sealing wax. These bottles were tossed overboard, typically in groups of three, with the bottle number, position and time entered into a log. The project and results are presented in:
http://www-sci.pac.dfo-mpo.gc.ca/osap/projects/driftbottle/default_e.htm

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4. APPENDICES

4.1 SCIENCE PARTICIPANTS

Table 6. Onboard Science Team

Name	Affiliation	Position
Sarah Zimmermann	IOS	Chief Scientist
Doug Sieberg	IOS	Chief Technician
Andrew Hamilton	IOS (Student)	CTD Watchleader
Bill Williams	IOS	CTD Watchstander
Waldek Walczowski	IOPAN	LADCP Principal Investigator, CTD operator
Janet Barwell-Clarke	IOS	Water Sample Manager
Linda White	IOS	Nutrient Analysis
Mary Steel	IOS	Oxygen Analysis
Ida Martin	IOS (Student)	Chlorophyll-a Analysis
Francoise Labonté	DFO (Student)	Chlorphyll-a Analysis
Rick Krishfield	WHOI	Mooring Analysis
John Kemp	WHOI	Mooring Technician
Kris Newhall	WHOI	Mooring Technician
Motoyo Itoh	JAMSTEC	CTD Watchleader, XCTD deployment
Masuo Hosono	JAMSTEC	CTD Watchstander, XCTD deployment
Amanda Byrd	UAF (Student)	Zooplankton Net Tows

Table 7. Principal Investigators

Name	Affiliation	Program
Fiona McLaughlin	DFO -IOS	Program Lead CTD and chemistry
Eddy Carmack	DFO-IOS	CTD and drifter bottles
Andrey Proshutinsky	WHOI	WHOI moorings
Koji Shimada	JAMSTEC	XCTD
Christine Michel	DFO-FWI	Chlorophyll-a samples, PAR, POC,PON, BioSi
Chris Guay	OSU	Barium samples
Noriyuki Tanaka	IARC	^{18}O samples
C.S. Wong	IOS	^{13}C samples
Bill Li	BIO	Bacteria samples
Celine Gueguen	UBC/IOS	CDOM samples
Russ Hopcroft	UAF	Zooplankton net tows
John Nelson	UVic/DFO	Zooplankton net tows
Igor Polyakov	IARC	CABOS mooring
Humfrey Melling	IOS	PITSA mooring

Mary-Louise Timmermann	WHOI	PITSA mooring

Table 8. Affiliation Abbreviation

BIO	DFO, Bedford Institute of Oceanography, NS
DFO	Department of Fisheries and Oceans, Canada
IARC	International Arctic Research Center, Alaska
IOPAN	Institute of Oceanology Polish Academy of Sciences, Poland
IOS	DFO, Institute of Ocean Sciences, BC
JAMSTEC	Japan Agency for Marine-Earth Science Technology, Japan
UAF	University of Alaska Fairbanks, Alaska
UBC	University of British Columbia, BC
UVic	University of Victoria, BC
WHOI	Woods Hole Oceanographic Institution, Massachusetts

4.2 CTD SETUP SPECIFICATIONS

The two CTD systems are described with relevant laboratory calibration dates.

Primary CTD SBE9plus s/n 0724
Pressure s/n 90559, 29Oct02
Primary Temperature SBE 3plus s/n 03P4322, 25May04, 05Oct04
Secondary Temperature SBE 3plus s/n 03P4239, 25May04, 05Oct04
Primary Conductivity SBE 4 s/n 04-2809, 25May04, 05Oct04
Secondary Conductivity SBE 4 s/n 04-2810, 25May04, 05Oct04
Oxygen SBE 43 (pumped, configured with primary sensors)
s/n 430435 18Mar03, A/D voltage 6
Transmissometer Wetlabs C-Star s/nCST-662DR, 20Mar03, A/D voltage2
Fluorometer Seapoint (pumped, configured with secondary sensors) s/n 2569 gain set at 30x (hope correct cable was used) A/D voltage 0
Altimeter Datasonics PSO-916T #640, A/D voltage 4 (WHOI supplied)
Primary Pump s/n 053610
Secondary Pump s/n 053615
Water Sampler SBE 32 s/n 3235152
Deck Unit SBE 11plus s/n 11P31679-0649

Backup CTD SBE9plus s/n 0756
Pressure s/n 91164, 18Mar04
Primary Temperature s/n 4397, 12Mar04
Secondary Temperature s/n 4402, 06Mar04
Primary Conductivity s/n 2992, 11Mar04

Secondary Conductivity s/n 2984, 11Mar04
Water Sampler SBE 32 s/n 3231679-0452
Deck Unit SBE 11plus s/n 11P35152-0680

Heights and Dimensions:
Intake of temperature probes 7” above bottom of frame.
LADCP base 2” above bottom of frame
Temperature probes 8” apart
Transmissometer is mounted above the CTD, in obstructed flow.
Bottom of Niskin 10” above bottom of frame
Top of Niskin is 45” above bottom of frame
Bottle center is 10 + 35/2 = 27.5” above the bottom of the frame
Bottle center is 27.5”-7” = 20.5” (0.52m) above the sensors intakes.

4.3 CTD CAST NOTES

Table 9. Comments on CTD Casts

Cast #	Comments on the casts :
1	Station pre 2004-16-1. Lancaster Sound. Bottles 1 and 2 stopped to trip, bottles 3 - 8 tripped on the fly at 30 m/min. Config file changed after cast because had wrong channel for oxy. Bacteria not sampled because fixative had not been thawed. No bottom contact alarm - we did not get within 5 m of bottom.
4	Strong currents in narrow channel, so we had to perform cast quickly. No bottom alarm.
5	In Bellot Strait, mixed top to bottom. Bottom alarm.
6	In Bellot Strait, stopped on downcast at 110 db, then continued down. No bottom alarm. Bottom came up quickly as we drifted along. We moved quite a bit even though the cast was short.
7	Station pre 2004-16-7. West of Bellot Strait. In ice 3/4 m thick, in one solid sheet. No bottom alarm. Entered ice between casts 6 and 7. Broke opening, lowered CTD into small hole. No proper labels for first set of samples. Cast 1 - 7, nutrient tubes may be over full and not frozen in upright position. Wire reterminated after 7 due to kink put in wire while laying out wire after station 6. Heavy ice for next 24 hrs 10/10 of first year and multi year, under pressure. 16 miles in 12 hours.
11	Station pre 2004-16-11. Bottles 1 - 24 tripped to test for bottle quality. Bottle 20 did not close, lanyard did not release.

12	Station 2004-16-12. Bottles 1 - 10 were tripped. Stopped for 1 min every 50 m to compare SBE 19 to SBE9+. SBE 19 has not been calibrated for 2.5 years. No samples drawn.
14	Station 2004-16-14. Bottles 1 - 8 tripped up/no stop. Bacteria, nuts, sal. Laid package on bottom. Very slow speed. Bottom contact switch never turned on.
15	Station AG5. Bottles 1 tripped at bottom, 2 – 8 at 600 m and 9 - 24 up/no stop. Oxygen drawn from all bottles to test accuracy of bottle + measurement. Began waiting 3minutes at 5m at start of cast to stabilize and soak CTD oxygen sensor. Effluent being discharged while rosette going down. Chlorophylls collected but not analyzed due to paper labels left in sampling containers.
16	Station Canada Basin (CB)-1. Bottles 1 - 20 tripped up/no stop. CTD paused at 600 m deep to check readouts. Drifter bottles 155, 156, and 159 deployed. Bottle #15 dripped for 10 seconds when valve opened. Starting to record event number for every over the side operations (XCTDs, moorings, nets, beer bottles) and cast number for CTD and rosette casts only.
17	Station CB-2. Bottle 17 removed to install WHOI CTD for calibration. Bottles 1 - 24 (minus 17) tripped up/no stop. Large hysterisis in oxygen sensor at depth. Collected deep water to fill WHOI sediment trap.
18	Station CB-3. Bottle 17 removed to install WHOI EM CTD for calibration. Bottles 1 - 24 (minus 17) tripped on way up without stopping. Slowed ascent rate at 500 m. CTD stopped at 7 depths, also on upcast (different to bottle depths), to cross calibrate with WHOI.
19	Station CB-4. Bottle 17 removed to install WHOI EM CTD for calibration. CTD stopped on descent for calibration points, however EM CTD data were no good, re-do at next cast. Bottles 1 - 24 (minus 17) tripped on way up. Slow down at 500 m. Scan 13380. Bottle O18 #231 broken.
20	Station CB-5. Bottle 17 removed to install WHOI CTD for calibration. This EM CTD just came off of mooring WHOI - A MMP (monkey moored profiler), "companion cast" btw CTD and EM CTD. Cast started, realized at 25 m pump not turned on. Pump turned on, package raised to surface and relowered. Salinity depths not recorded on downcast so on way up the CTD was stopped at 11:45 (~3400 db), acquisition stopped. Replayed station to find depth. New file started for the rest of the upcast and one bottle fired to match the bottle already fired at the bottom. File 200416-020.dat: downcast to 3911. CTD raised at 1 m/s until 70 m deep, then raised at 0.5 m/s. Protocol is to slow down to 0.5 m/s at 400 m deep on the upcast. Chlorophyll max was between 43 and 49 m, so 40 m was not at the max. Changed display to show 0 - 100 m initially so that chl max can be identified. Dissolved oxy sensoR has large hysteresis between up and down casts below ~ 1000 m. We

	waited 15 m at 3500 m on the way up. The DO2 reading did not approach downcast value, and did not change much. Bottles 1 - 24 (minus 17) tripped on way up. Slowed down to 0.5 m/s from 1.0 m/s at 40 m. Should have been at 400 m. PAR sensor attached to net tow, but cover cap left on so no profile.
21	Station CB-6. Bottle 17 removed for EM CTD calibration. CTD stopped on downcast for calibration points. Mooring release test done. Bottles 1 - 24 (minus 17) tripped on way up no stopping. PAR data collected on net cast using SBE-19 CTD.
22	Niskin bottle 17 back on rosette prior to cast 22 (CB-7) and EM CTD and battery pack removed. Station CB-7 bottles 1 - 24 tripped on way up. There was a white discharge from the boat between the fore-deck and the CTD. The bridge discovered it to be seawater, but did not know why it was white. They suggested very small bubbles made it white. PAR data collected on net cast using SBE-19 CTD.
23	Started cast - surface to 5 m, then back on deck due to ice flow. Try again after 2 hours. Bottles 1 - 24 tripped on up. Bottle 15 leaked - top o'ring not seated properly, water poured out of spigot when it was opened. PAR data collected on net cast using SBE-19 CTD.
24	STN CB-9 (1) bottles 1 - 24 tripped up cast no stopping. Brown water being pumped over at start of cast. 2.5 m off bottom, but no bottom alarm.
25	Stn CB-9 (2) bottles 1 - 24 tripped, stopping on the way up. PAR data collected on net cast using SBE-19 CTD.
26	Stn CB-10. Bottle 17 removed to calibrate EM CTD. Bottles 1 - 24 tripped (minus 17) up/no stop. PAR data collected on net cast using SBE-19 CTD.
27	Stn CB-11. Bottles 1 - 10 tripped for biology cast. Hung in air for 5 min at start to wait for ice to move. Niskin bottle 17 re-attached after calibration cast. CTD was not rinsed after CB-10. There were crystals of salt on the bottles before CB-11(1) and also the bottle release levers were a little sticky. Rosette was rinsed before putting in water. Bottle # 3 (sal 33.1) did not trip.
28	Stn CB-11(2). Bottles 1 - 24 tripped up/no stop. TCO2, C13, TOC, plus routine sampling, Biology from bottle 17. TOC samples #432 and 427 were broken after freezing - too full. After sampling, manually closed all the bottles, opened the release levers, and rinsed for about 5 minutes. We're on the southern edge of solid ice pack made of first year (6/10), second year (2/10), mulityear (2/10). As we steam north from CB-11 it gets more solid and thick with fewer melt ponds. PAR data collected on net cast using SBE-19 CTD.

	16 Aug 2300. Cast at 79 20 aborted. Wire pinched in shiv during deployment. Wire reterminated due to wire being caught in shive. Visible pinch and outer armour wire out of place. CTD transmissometer windows cleaned for the first time during cruise. 200416_trans_cleaning_17Aug.dat shows before and after cleaning. ~ 4 bottles had to be removed during re-termination.
29	Stn CB-12. Bottles 1 - 24 tripped up/no stop. OXY sampled from bottle 24 to 1. C13 stoppered before HgCl2 added, so opened again, added HgCl2 and re-stoppered.
30	Stn CB-13. Bottles 1 - 24 tripped up/no stop. Biology cast, TOC and CDOM. PAR data collected on net cast using SBE-19 CTD.
31	Stn CB-14 Bottles 1 - 24 tripped up/no stop. 0 - 40 m forgot to turn on pump. Bring up to surface 40 to 0 m then bottom. Biology, TOC and CDOM.
32	Stn CB-15. Bottles 17 removed to calibrate EM CTD. CTD stopped on downcast for calibration points. Bottles 1 - 24 tripped up/no stop. No biology. Doug noticed chaffing on CTD wire, due to wire angle during deployment and recovery as it runs through the winch rollers. He will adjust roller height at the next opportunity and reterminate soon. The wire is running through at a higher point and rubbing against the top plate. PAR data collected on net cast using SBE-19 CTD.
33	Stn CB-16. Bottles 1 - 24 tripped up/no stop. Biology, TOC and CDOM. Niskin 17 re-installed. PAR data collected on net cast using SBE-19 CTD.
34	Stn CB-17. Bottles 1 - 24 tripped up/no stop. Biology, TOC, CDOM. Wire reterminated prior to cast (see chaffing issue for CB-15). Three releases attached for testing (2 edgetech, one oceano). Oxygen sensor behaving strangely around 2500 m. PAR data collected on net cast using SBE-19 CTD.
35	Stn CB-18. Bottles 1 - 24 tripped up/no stop. Biology, TOC, CDOM. Three releases (2 edgetech for CABOS mooring, 1 oceano to test deck unit from the Amundsen) attached to outside of frame. PAR data collected on net cast using SBE-19 CTD.
36	Stn CB-19. Bottle 20 leaking. Bottles 1 - 24 tripped up/no stop. Biology, TOC. PAR data collected on net cast using SBE-19 CTD.
37	Stn CB-20. Bottles 1 - 24 tripped up/no stop. No biology. Bad wraps on th3e winch beginning ~ 1500 m. Numerous stops with some backtracking. DO2 sensor bad on downcast between 500 and 1500 m. Erroneous jumps to lower DO2 values.
38	Stn CB-21. Bottles 1 - 24 tripped up/no stop. Biology, TOC. Salinity samples collected from bottle 2. Oceano release attached to frame for testing Tom Juhasz's deck unit at 3538 dbar, 2990 dbar, 1974 dbar, 978

	dbar. PAR data collected on net cast using SBE-19 CTD.
39	Stn CB-22. Bottles 1 - 13 tripped for shallow biology cast at Site A. PAR data collected on net cast using SBE-19 CTD.
40	Stn CB-22(2). Bottles 1 - 24 tripped up/no stop. Oxygen spike around 800 dbar. Raised up to 512, stopped, lowered to 522, stopped and then raised. This may be a good point for studying CTD oxygen. PAR data collected on net cast using SBE-19 CTD.
41	Stn CB-23 Bottles 1 - 24 tripped up/no stop. Bottle # 2 fired at 2250 dbar rather than 2500 dbar. Noise in O2 sensor on the way down at about 500 dbar. After cast Doug Seiberg removed several niskin bottles to check oxygen (SBE 430) probe connectors. He found water leak and corrosion on the CTD bulkhead connector to the SBE 43 cable. He cleaned connection and replugged. If problem persists he will change out the bulkhead connector.
42	Stn CB-24 bottles 1 - 24 tripped up/no stop. Winch has trouble - CTD stay 50 min at 20 m above the bottom. Oxygen looks fine. PAR data collected on net cast using SBE-19 CTD.
43	Stn CB-25 Bottles 1 - 24 tripped up/no stop. Bottle 9 mistakenly fired at 700 dbar rather than 600 dbar. No glitches in DO2 data. CTD stopped on upcast btw 0 and 500 3 times. PAR data collected on net cast using SBE-19 CTD.
44	Stn CB-26 Bottles 1 - 24 tripped up/**stopping**. Study of 2300 - 3100 m water. Wait 2 minutes before closing each niskin bottle. Upper water bottles will provide comparison for no-stop casts. PAR data collected on net cast using SBE-19 CTD.
45	Stn CB-27 Bottles 1 - 24 tripped up/no stop.
46	Stn CB-28 bottles 1 - 24 tripped up/no stop. On upcast, CTD brought up to 970, back to 1010 and brought up again, tripping bottle at 1003. May be good to observe effect on oxygen. PAR data collected on net cast using SBE-19 CTD.
47	Stn CB-29 Bottles 1 - 24 tripped up. CTD stopped several times because of ice. Wire angles of 30, 45 and 50 degrees achieved. Captain brought to the bridge whereupon ice receded. PAR data collected on net cast using SBE-19 CTD.
48	Stn CB-30 Bottles 1 - 24 tripped up/no stop. PAR data collected on net cast using SBE-19 CTD.
49	Stn CB-31 CTD only, no bottles.
50	Stn CB-32 CTD only, no bottles. Intrusion at 175 db (T incr Ox incr) seen on way down and up. At 150 m wire is crossing over on drum and may be responsible for salinity spike at 150 db. Relowered at 0.5 m/s,

	down to 200 m, to remove cross-over and also revisit intrusion. Then raised at 0.5 m/s to surface. PAR data collected on net cast using SBE-19 CTD.

Table 10. List of linear interpolations made to CTD data.

Cast	Start (db)	End (db)	Interval (db)	Property
4	12	21	9	Temperature and Conductivity
4	29	32	3	Temperature and Conductivity
5	11	13	2	Temperature and Conductivity
5	15	20	5	Temperature and Conductivity
5	23	25	2	Temperature and Conductivity
6	1	5	4	Temperature and Conductivity
6	128	134	6	Temperature and Conductivity
6	214	216	2	Temperature and Conductivity
7	11	17	6	Temperature and Conductivity
7	51	53	2	Temperature and Conductivity
7	80	83	3	Temperature and Conductivity
7	106	107	1	Temperature and Conductivity
8	62	65	3	Temperature and Conductivity
8	68	74	6	Temperature and Conductivity
8	93	95	2	Temperature and Conductivity
8	98	101	3	Temperature and Conductivity
8	104	106	2	Temperature and Conductivity
8	109	134	25	Temperature and Conductivity
9	11	14	3	Temperature and Conductivity
9	19	21	2	Temperature and Conductivity
9	105	107	2	Temperature and Conductivity
9	115	132	17	Temperature and Conductivity
9	132	135	3	Temperature and Conductivity
9	149	160	11	Temperature and Conductivity
10	9	11	2	Temperature and Conductivity
10	13	15	2	Temperature and Conductivity
12	277	279	2	Temperature and Conductivity
13	3	6	3	Temperature and Conductivity
13	13	15	2	Temperature and Conductivity
13	95	97	2	Temperature and Conductivity
14	9	12	3	Temperature and Conductivity
18	13	16	3	Temperature and Conductivity
21	23	27	4	Temperature and Conductivity
22	26	28	2	Temperature and Conductivity
25	12	19	7	Temperature and Conductivity
25	22	24	2	Temperature and Conductivity

26	12	15	3	Temperature and Conductivity
26	248	252	4	Temperature and Conductivity
27	9	11	2	Temperature and Conductivity
27	216	217	1	Temperature and Conductivity
30	10	12	2	Temperature and Conductivity
30	19	21	2	Temperature and Conductivity
30	25	27	2	Temperature and Conductivity
32	12	14	2	Temperature and Conductivity
32	29	31	2	Temperature and Conductivity
33	9	12	3	Temperature and Conductivity
33	13	15	2	Temperature and Conductivity
33	16	18	2	Temperature and Conductivity
33	21	24	3	Temperature and Conductivity
33	819	822	3	Temperature and Conductivity
34	2239	2280	41	Temperature and Conductivity
34	2515	2520	5	Temperature and Conductivity
35	3016	3018	2	Temperature and Conductivity
37	708	712	4	Temperature and Conductivity
38	1292	1296	4	Temperature and Conductivity
39	13	16	3	Temperature and Conductivity
39	305	306	1	Temperature and Conductivity
40	767	775	8	Temperature and Conductivity
41	443	449	6	Temperature and Conductivity
42	370	373	3	Temperature and Conductivity
43	10	12	2	Temperature and Conductivity
47	11	15	4	Temperature and Conductivity
49	1355	1359	4	Temperature and Conductivity
50	8	14	6	Temperature and Conductivity
50	17	19	2	Temperature and Conductivity
41	440	485	45	Oxygen
40	760	1038	278	Oxygen
38	1285	1425	140	Oxygen
37	700	960	260	Oxygen
37	1240	1480	240	Oxygen
36	780	1180	400	Oxygen
36	503	521	18	Oxygen
35	2054	2350	296	Oxygen
35	1127	1165	38	Oxygen
35	602	690	88	Oxygen
34	2556	3400	844	Oxygen
34	2511	2530	19	Oxygen
34	2235	2290	55	Oxygen
34	609	630	21	Oxygen
33	1628	1664	36	Oxygen
33	815	912	97	Oxygen
32	2840	3730	890	Oxygen

18	3735	3845	110	Oxygen

4.4 LOCATION OF SCIENCE STATIONS

Locations of CTD/Rosette, XCTD, and zooplankton vertical net casts, as well as the mooring and buoy recovery and deployments are listed in the tables below.

Table 11. Mooring and Buoy Locations

Mooring Designation	Investigator	Water Depth (m)	Recovery Location	Recovery Time	Deployment Location	Deployment Time
BGFE-A	WHOI A. Proshutinsky	3824	75° 00.39'N 149° 58.752'W	10-Aug 14:34 UTC	75° 00.242' N 149° 57.742'W	12-Aug 19:58 UTC
BGFE-B	WHOI A. Proshutinsky	3821	78° 01.491'N 149° 49.378'W	15-Aug 13:23 UTC	78° 00.967'N 149° 51.544'W	17-Aug 17:59 UTC
BGFE-C	WHOI A. Proshutinsky	3722	76° 59.254'N 139° 54.229'W	20-Aug 18:57 UTC	76° 59.457'N 139° 58.407'W	22-Aug 19:31 UTC
ITP & IMB	WHOI A. Proshutinsky	(location is ship's position ~500 m from site)	x	x	77° 10.4'N 141° 13.0'W	19-Aug 15:00 UTC
CABOS	UAF/IARC I. Polyakov	1121	71° 46.672'N 131° 53.195'W	07-Aug 19:37 UTC	71° 46.506'N 131° 52.711'W	30-Aug 20:01 UTC
PITSA	IOS H. Melling	3133	73° 27.874'N 136° 59.816'W	25-Aug 16:00 UTC	x	x

Table 12. CTD/Rosette Casts

Cast #	Station Name	CAST START TIME (UTC)	Lat De g	Lat Min	Lon Deg	Lon Min	Cast Depth (db)	Sample #'s
			N	N	W	W		
1	1	2004/07/25 14:56	74	6.96	89	39.62	223	1 to 8
2	2	2004/07/25 19:33	73	16.21	90	38.34	340	9 TO 19
3	3	2004/07/26 00:00	71	59.96	93	54.56	75	20 TO 24
4	4	2004/07/26 04:00	71	59.88	94	23.88	57	25 TO 28
5	5	2004/07/26 04:30	72	0.36	94	34.56	98	29 TO 34
6	6	2004/07/26 05:26	71	59.18	94	52.45	215	35 TO 42
7	7	2004/07/26 06:53	71	57.5	95	13.91	106	43 TO 48
8	8	2004/07/27 20:24	71	57.77	95	11.49	248	49 TO 57
9	9	2004/07/27 21:11	71	58.52	95	3.63	394	58 TO 69
10	10	2004/07/28 16:14	74	16.11	91	25.5	322	70 TO 80
11	11	2004/07/28 17:19	74	15.7	91	24.54	300	81 TO 104

13	13	2004/08/03 18:32	68	41.76	103	45.79	99.5	105 - 110
14	14	2004/08/04 14:08	68	23.53	112	29.41	191	111 TO 118
15	AG5	2004/08/05 22:19	70	33.15	122	54.4	648	119 TO 142
16	CB-1	2004/08/07 14:31	71	46.6	131	46.16	1090	143 to 162
17	CB-2	2004/08/09 09:55	73	0.21	150	4.22	3740	163 to 186
18	CB-3	2004/08/09 22:35	73	56.22	150	1.53	3900	187 to 210
19	CB-4	2004/08/10 21:16	75	4.9	149	49.99	3831	211 to 234
20	CB-5	2004/08/11 09:32	75	19.86	152	28.37	3911	235 to 258
21	CB-6	2004/08/12 00:37	74	44.88	147	45.05	3865	259 TO 282
22	CB-7	2004/08/13 06:11	75	59.5	149	53.35	3824	283 to 306
23	CB-8	2004/08/13 23:05	76	59.2	150	5.87	3897	307 to 330
24	CB-9	2004/08/14 18:52	78	0.8	149	46.59	3894	331 to 354
25	CB-9(2)	2004/08/14 23:32	77	59.42	149	43.14	3893	355 to 378
26	CB-10	2004/08/16 00:27	78	19.06	152	52.44	3492	379 to 402
27	CB-11(1)	2004/08/16 13:02	79	0	150	0.38	206	403 to 412
28	CB11(2)	2004/08/16 14:30	78	59.98	150	0.02	3888	413 to 436
29	CB-12	2004/08/18 03:10	77	41.46	146	24.65	3879	437 to 460
30	CB-13	2004/08/18 14:23	77	22.42	143	22.58	3855	461 to 484
31	CB-14	2004/08/20 03:08	76	53.68	138	19.12	3755	485 TO 508
32	CB-15	2004/08/20 23:29	76	58.52	139	55.19	3790	509 to 532
33	CB-16	2004/08/21 17:34	77	53.3	140	10.08	3816	533 to 556
34	CB-17	2004/08/23 06:04	75	59.66	140	0.64	3761	557 to 580
35	CB-18	2004/08/23 17:20	74	59.82	140	0.87	3690	581 to 604
36	CB-19	2004/08/24 05:55	74	28.36	145	3.25	3805	605 to 628
37	CB-20	2004/08/24 13:41	74	15.06	142	24.62	3737	629 to 652
38	CB-21	2004/08/24 22:38	73	56.26	139	59.23	3548	653 to 676
39	CB-22	2004/08/25 20:23	73	23.54	137	10.11	300	677 to 689
40	CB-22(2)	2004/08/25 22:41	73	23.49	137	90.15	3143	690 to 713
41	CB-23	2004/08/26 08:43	72	59.34	134	5.08	2574	714 to 737
42	CB-24	2004/08/26 22:57	74	27.61	133	59.61	3196	738 to 761
43	CB-25	2004/08/27 09:15	74	15.49	137	3.87	3363	762 to 785
44	CB-26	2004/08/27 18:44	73	28.14	137	2.95	3174	786 to 809
45	CB-27	2004/08/28 05:46	72	59.35	139	54	3263	810 to 833
46	CB-28	2004/08/28 22:48	71	19.99	140	0.18	2355	834 to 857
47	CB-29	2004/08/29 06:55	72	0.37	139	56.14	2716	858 to 881
48	CB-30	2004/08/29 23:01	72	32.67	133	26.32	2169	882 to 905
49	CB-31	2004/08/30 04:45	72	10.32	132	40.06	1627	X
50	CB-32	2004/08/30 13:53	71	46.73	131	54.56	1139	X

Table 13. XCTD Locations

Filename	Date	Time	Latitude			Longitude		
000	2004/07/19	12:52:00	63	59.7140	N	54	59.3020	W
001	2004/07/19	14:21:00	64	19.3800	N	55	31.1070	W
002	2004/07/19	15:51:00	64	39.9300	N	56	3.8720	W
003	2004/07/19	17:19:00	64	59.9900	N	56	36.0330	W
004	2004/07/19	19:01:00	65	19.8960	N	57	7.9160	W
005	2004/07/19	20:29:00	65	40.0340	N	57	40.0890	W
006	2004/07/19	22:09:00	65	59.9200	N	58	11.8510	W
007	2004/07/19	23:56:00	66	19.8360	N	58	43.7300	W
008	2004/07/20	02:07:00	66	40.2190	N	59	16.0690	W
009	2004/07/20	04:10:00	66	59.7120	N	59	48.1040	W
010	2004/07/20	05:56:00	67	19.8140	N	60	19.1740	W
011	2004/07/20	09:00:00	67	39.5180	N	60	58.7850	W
012	2004/07/20	11:09:00	67	39.9240	N	60	7.8270	W
013	2004/07/20	13:25:00	67	39.8610	N	59	16.2680	W
014	2004/07/20	14:08:00	67	39.7660	N	58	47.3340	W
015	2004/07/20	14:49:00	67	39.9060	N	58	22.6370	W
016	2004/07/20	16:00:00	67	40.0180	N	57	30.9100	W
017	2004/07/20	19:34:00	68	19.9390	N	59	29.6630	W
018	2004/07/20	21:58:00	68	59.7490	N	59	29.6950	W
019	2004/07/21	02:17:00	69	41.2640	N	59	18.9210	W
020	2004/07/21	06:09:00	70	20.0310	N	59	28.0010	W
021	2004/07/21	09:13:00	70	59.8130	N	60	39.7270	W
022	2004/07/21	11:57:00	71	39.9530	N	61	20.0520	W
023	2004/07/21	14:26:00	72	1.8540	N	61	59.0610	W
024	2004/07/21	17:23:00	72	18.9060	N	63	30.2520	W
025	2004/07/21	20:41:00	72	35.8520	N	65	0.3650	W
026	2004/07/22	03:08:00	73	0.0680	N	67	30.2330	W
027	2004/07/22	06:57:00	73	22.9980	N	70	0.2040	W
027	2004/07/22	08:19:00	73	30.8990	N	70	59.3540	W
029	2004/07/22	09:38:00	73	39.0040	N	71	59.9670	W
030	2004/07/22	10:56:00	73	45.9000	N	72	59.3260	W
031	2004/07/22	12:05:00	73	53.1050	N	73	59.9490	W
032	2004/07/22	12:17:00	73	54.0950	N	74	8.2000	W
033	2004/07/22	13:23:00	73	59.9320	N	74	59.5370	W
034	2004/07/22	19:45:00	74	6.0800	N	79	58.8810	W
035	2004/07/24	01:15:00	74	12.0190	N	85	0.5560	W
036	2004/07/24	06:44:00	74	20.1600	N	90	2.8780	W
037	2004/07/28	00:21:00	71	59.237	N	94	52.8600	W
039	2004/07/28	00:35:00	72	0.058	N	94	45.7530	W
040	2004/07/28	03:29:00	72	12.9430	N	93	34.0350	W
041	2004/08/08	01:58:00	71	22.8220	N	133	59.1790	W

042	2004/08/08	04:38:00	71	17.7330	N	136	0.1330	W
043	2004/08/08	07:35:00	71	15.2740	N	138	0.1350	W
044	2004/08/08	10:08:00	71	19.5360	N	139	59.2410	W
045	2004/08/08	12:51:00	71	23.9530	N	142	0.3400	W
046	2004/08/08	15:45:00	71	35.9470	N	144	0.3070	W
047	2004/08/08	18:27:00	71	43.7070	N	145	59.1770	W
048	2004/08/08	21:41:00	71	56.6340	N	147	59.8240	W
049	2004/08/09	01:31:00	72	0.0910	N	149	57.1770	W
050	2004/08/09	02:34:00	72	7.4000	N	150	0.3680	W
051[	2004/08/09	03:31:00	72	14.8380	N	150	0.0580	W
052	2004/08/09	04:28:00	72	22.3760	N	149	59.9840	W
053	2004/08/09	04:25:00	72	29.9420	N	149	58.7160	W
054	2004/08/09	06:22:00	72	37.3210	N	149	59.9540	W
055	2004/08/09	07:14:00	72	44.9950	N	149	59.9140	W
056	2004/08/09	08:13:00	72	52.5830	N	150	0.2120	W
057	2004/08/09	13:37:00	73	7.0350	N	150	0.1300	W
058	2004/08/09	14:51:00	73	15.0400	N	150	0.1540	W
059	2004/08/09	15:55:00	73	22.2040	N	149	59.7370	W
060	2004/08/09	17:02:00	73	29.9690	N	149	59.5990	W
061	2004/08/09	17:06:00	73	29.9690	N	149	59.7110	W
062	2004/08/09	18:15:00	73	37.5760	N	150	0.2260	W
063	2004/08/09	19:25:00	73	45.0670	N	149	59.9580	W
064	2004/08/09	20:42:00	73	52.5350	N	149	59.5140	W
065	2004/08/10	03:44:00	74	7.5750	N	150	0.0610	W
066	2004/08/10	05:31:00	74	14.8840	N	149	59.2280	W
067	2004/08/10	06:22:00	74	22.5160	N	149	58.1550	W
068	2004/08/10	06:26:00	74	22.5360	N	149	57.8510	W
069	2004/08/10	07:44:00	74	29.9340	N	149	59.0510	W
070	2004/08/10	08:53:00	74	38.8670	N	149	59.3950	W
071	2004/08/10	08:57:00	74	36.8750	N	149	59.3800	W
072	2004/08/10	00:00:00	74	44.9730	N	149	59.7890	W
073	2004/08/10	11:11:00	74	52.7220	N	149	59.2740	W
074	2004/08/11	15:52:00	75	8.9990	N	151	5.4414	W
075	2004/08/12	22:56:00	75	19.8040	N	149	59.5380	W
076	2004/08/13	02:05:00	75	40.0330	N	149	57.1980	W
077	2004/08/13	12:41:00	76	19.9960	N	149	59.5400	W
078	2004/08/13	15:34:00	76	40.0910	N	149	59.5620	W
079	2004/08/14	03:55:00	77	9.9230	N	149	59.2120	W
080	2004/08/14	06:02:00	77	20.3920	N	149	59.8970	W
081	2004/08/14	09:14:00	77	40.2150	N	149	59.3530	W
082	2004/08/15	19:44:00	78	7.1050	N	150	58.749	W
083	2004/08/15	22:00:00	78	13.1200	N	152	0.100	W
084	2004/08/16	06:53:00	78	30.0020	N	152	17.3550	W
085	2004/08/16	07:03:00	78	30.0820	N	152	17.0470	W

086	2004/08/16	09:07:00	78	40.0280	N	151	31.6520	W
087	2004/08/16	22:49:00	79	19.5930	N	150	0.6450	W
088	2004/08/17	07:02:00	78	40.4280	N	149	58.7040	W
089	2004/08/17	09:48:00	78	20.6030	N	149	58.4160	W
090	2004/08/17	21:30:00	77	52.3980	N	148	18.7400	W
091	2004/08/18	09:00:00	77	32.3900	N	144	51.7350	W
092	2004/08/18	23:01:00	77	12.2120	N	141	45.8430	W
093	2004/08/21	21:40:00	77	39.7160	N	140	0.9560	W
094	2004/08/22	04:54:00	77	20.5810	N	140	10.3770	W
095	2004/08/22	22:50:00	76	39.7210	N	140	2.1460	W
096	2004/08/23	02:11:00	76	20.1120	N	140	1.5390	W
097	2004/08/23	11:15:00	75	40.0540	N	139	59.6870	W
098	2004/08/23	13:36:00	75	20.2140	N	140	0.7260	W
099	2004/08/23	23:16:00	74	49.9390	N	141	41.0680	W
100	2004/08/24	02:22:00	74	39.5350	N	143	22.2010	W
101	2004/08/24	11:00:00	74	22.0370	N	143	43.2280	W
102	2004/08/24	19:20:00	74	7.6040	N	141	0.8690	W
103	2004/08/25	04:15:00	73	50.1160	N	138	54.3490	W
104	2004/08/25	08:09:00	73	44.2930	N	137	39.5690	W
105	2004/08/26	03:35:00	73	15.6120	N	136	6.2710	W
106	2004/08/26	06:19:00	73	7.5670	N	135	1.1710	W
107	2004/08/26	14:40:00	73	29.8610	N	134	0.0180	W
108	2004/08/26	18:24:00	73	59.3910	N	133	59.1700	W
109	2004/08/27	05:34:00	74	22.1070	N	135	27.7310	W
110	2004/08/28	03:08:00	73	23.6050	N	139	25.2150	W
110	2004/08/28	09:42:00	72	39.7980	N	139	21.6580	W
111	2004/08/28	11:56:00	72	19.8870	N	138	35.9130	W
112	2004/08/29	02:58:00	71	39.8510	N	139	58.3600	W
113	2004/08/29	13:49:00	72	11.8910	N	137	46.2790	W
114	2004/08/29	18:10:00	72	23.4590	N	135	32.9200	W
115	2004/08/30	07:51:00	71	58.4860	N	132	16.4710	W
116	2004/08/30	22:15:00	71	34.9620	N	131	29.6580	W
117	2004/08/30	23:29:00	71	28.7110	N	131	16.2910	W
118	2004/08/31	00:35:00	71	23.3500	N	130	58.4670	W
119	2004/08/31	02:25:00	71	15.1540	N	130	43.5430	W

Table 14. Zooplankton Casts

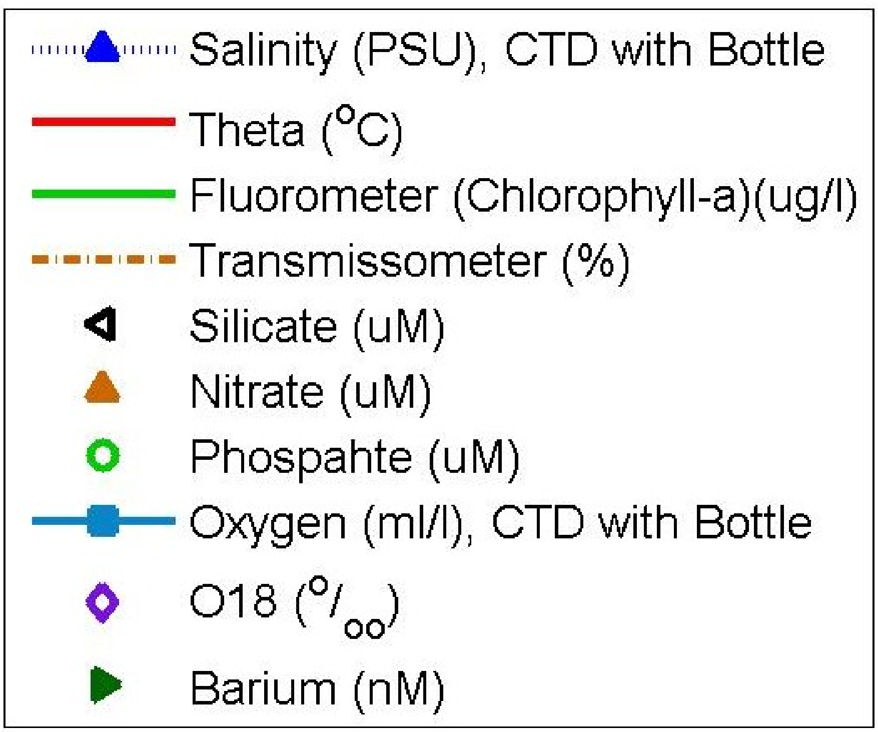
Date	Station Name	Net event	Time (UTC)	Approx. Depth (m)	Lat (N)	Long (W)	Notes
			Hr.Min		Deg.Minute.DecimalSecond		
07/08/2004	CABOS	1	14.2	100	71.46.649	131.46.024	
		2	15.06	100	71.46.670	131.45.670	
09/08/2004	CB2	3	10.07	100	73.00.16	150.04.38	
		4	11	100	73.00.31	150.04.35	
		5	11.22	500	73.00.40	150.04.21	
09/08/2004	CB3	6	22.41	100	73.56.222	150.01.560	
		7	23.09	500	73.56.056	150.01.161	
		8	23.52	100	73.55.778	150.01.044	
10/08/2004	CB4	9	20.34	100	75.04.89	149.50.18	Sample not kept, nets not fished well
		10	21.05	100	75.04.842	149.51.823	
		11	21.17	100	75.04.907	149.49.805	
		12	22.39	500	75.04.922	149.46.343	
11/08/2004	CB5	13	9.57	100	75.19.840	152.27.377	
		14	10.25	100	75.19.804	152.26.213	
		15	10.51	500	75.19.743	152.25.140	
12/08/2004	CB6	16	0.57	100	74.44.656	147.45.817	
		17	1.25	100	74.44.471	147.44.278	Net not used, not fished well
		18	1.4	100	74.44.582	147.43.955	
		19	1.58	500	74.44.268	147.43.420	
13/08/2004	CB7	20	7.02	100	75.59.548	149.52.237	did not use net, no water on deck
		21	7.55	100	75.59.591	149.51.110	
		22	8.57	100	75.59.741	149.50.333	
13/08/2004	CB8	23	21.47	100	76.59.473	150.05.378	
		24	22.1	100	76.59.360	150.05.484	
14/08/2004	CB9	25	3.55	100	77.59.039	149.40.213	
		26	4.35	100	77.59.028	149.39.666	
15/08/2004	CB10	27	3.49	100	78.19.256	152.50.476	
		28	4.2	100	78.19.313	152.50.158	
		29	4.39	500	78.19.351	152.50.842	
16/08/2004	CB11	30	16.05	100	78.59.963	149.59.825	236 sample thrown away, too much ice
		31	17.5	100	78.59.967	149.59.689	
17/08/2004	CB13	32	17.24	100	77.22.643	143.19.637	
		33	17.45	100	77.22.665	143.19.378	
20/08/2004	CB15	34	23.53	500	76.58.487	139.55.075	
		35	3.15	100	76.58.087	139.54.748	
		36	3.28	100	76.58.074	139.54.813	
21/08/2004	CB16	37	16.1	500	77.53.726	140.09.598	
		38	16.52	100	77.53.528	140.09.937	

		39	17.09	100	77.53.412	140.09.888
22/08/2004	CB17	40	5.23	100	75.59.696	140.00.167
		41	5.44	100	75.59.676	140.00.400
23/08/2004	CB18	42	16.12	100	75.00.021	140.00.275
		43	16.51	100	75.00.014	140.00.371
24/08/2004	CB19	44	6.01	100	74.28.346	145.03.226
		45	6.2	100	74.28.623	145.03.190
24/08/2004	CB21	46	22.05	100	73.56.44	139.58.82
		47	22.21	100	73.56.352	139.58.989
25/08/2004	CB22	48	20.37	100	73.23.555	137.10.168
		49	20.54	100	73.23.545	137.10.342
26/08/2004	CB23	50	9.54	100	72.59.156	134.04.927
		51	10.13	100	72.59.090	134.04.808
26/08/2004	CB24	52	22.16	100	74.27.682	133.59.871
		53	22.31	100	74.27.670	133.59.826
27/08/2004	CB25	54	11.49	100	74.15.220	137.01.487
		55	12.06	100	74.15.180	137.01.202
28/08/2004	CB27	56	5.53	100	72.59.358	139.54.003
		57	6.1	100	72.59.424	139.54.128
28/08/2004	CB28	58	22.32	100	71.19.983	140.00.303
		59	22.5	100	71.20.015	140.00.165
29/08/2004	CB29	60	6.59	100	72.00.419	139.56.214
		61	7.31	100	72.00.572	139.56.100
29/08/2004	CB30	62	23.07	100	72.32.598	133.26.292
		63	23.27	100	72.32.346	133.26.187
30/08/2004	CABOS	64	20.25	100	71.46.295	131.49.201

4.5 INDIVDUAL STATION PLOTS

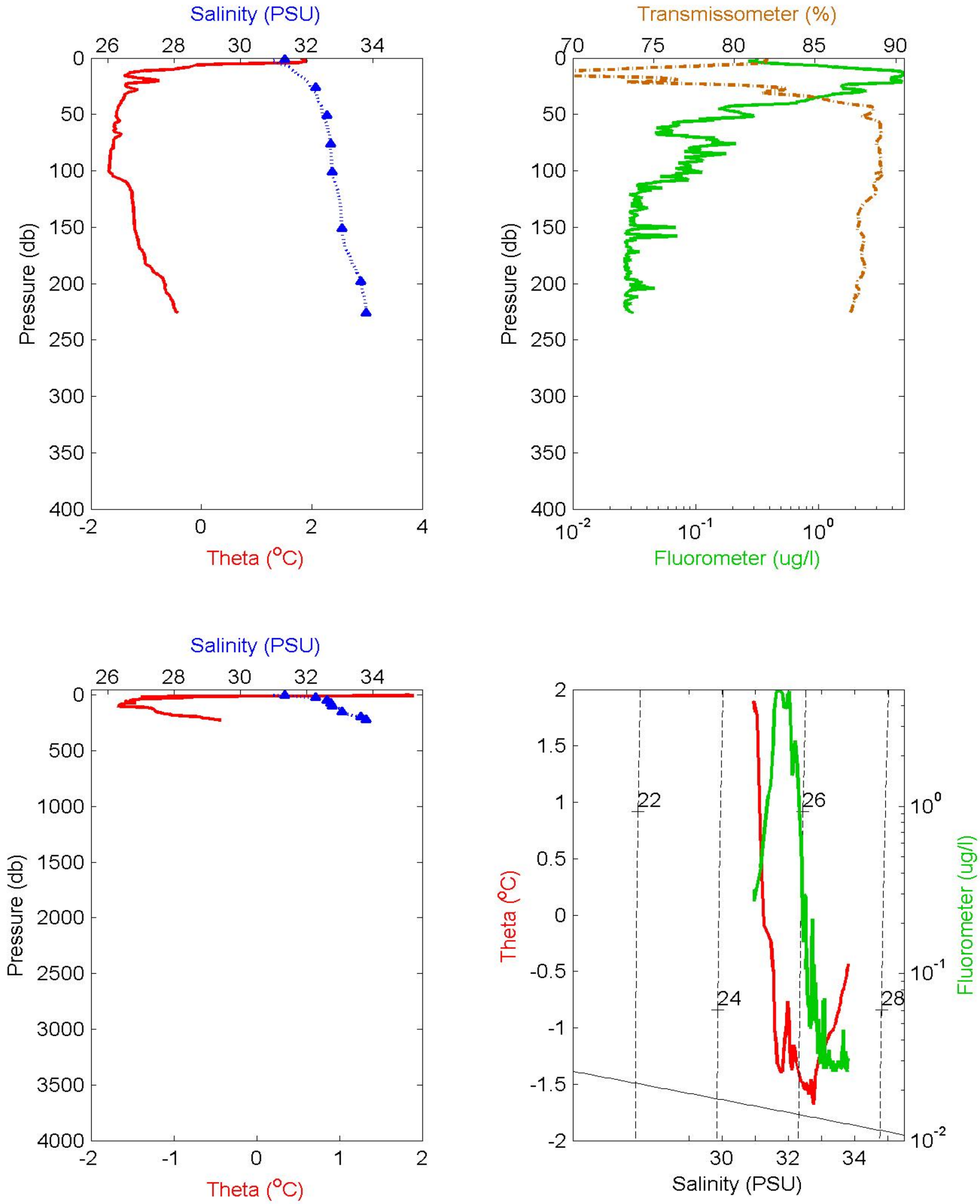
The following section contains data plots for each CTD cast taken on the 2004-16 cruise. CTD and chemistry data are plotted in eight figures per cast with primarily CTD properties on the even pages and chemistry properties on the odd pages.

Axis changes occur between groups casts 1 to 15, and 16 to 50. Salinity, oxygen and transmission ranges are larger for casts 1 to 15.

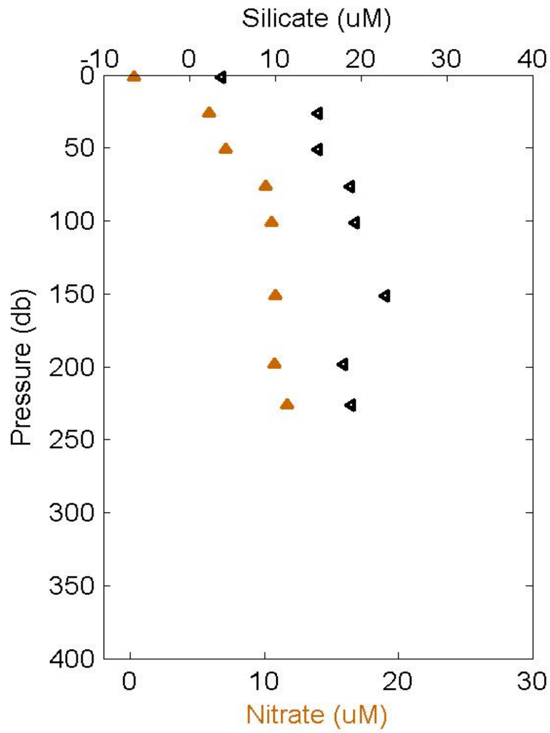


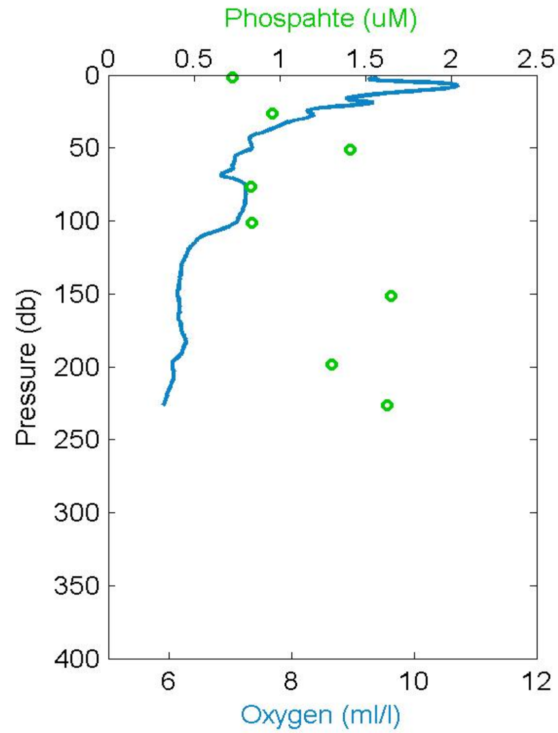
Property legend for the following individual station plots.

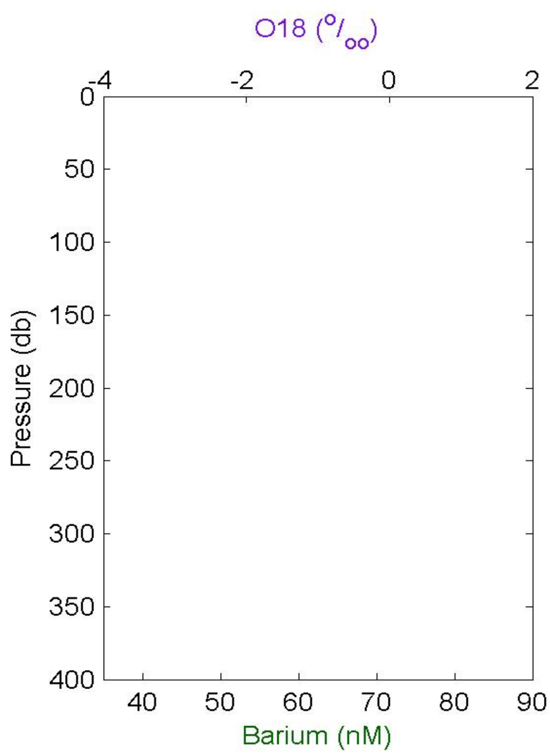
2004-16: Cast 1 Station 1

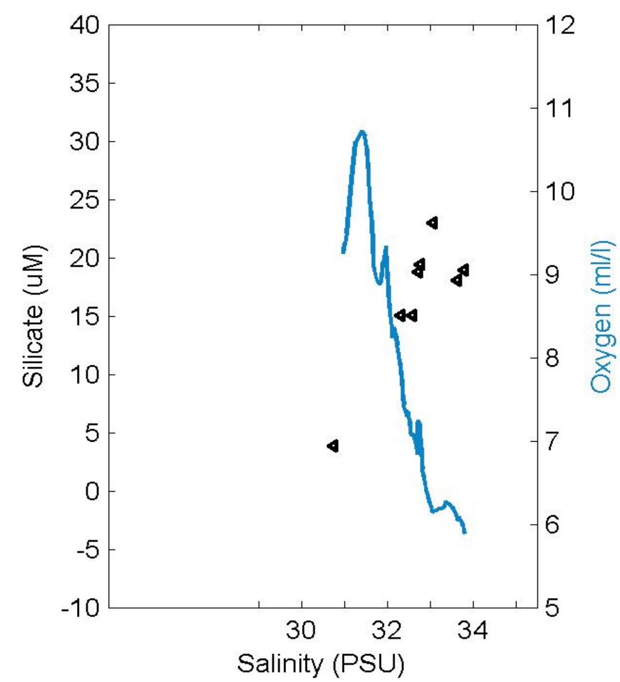


2004-16: Cast 1 Station 1

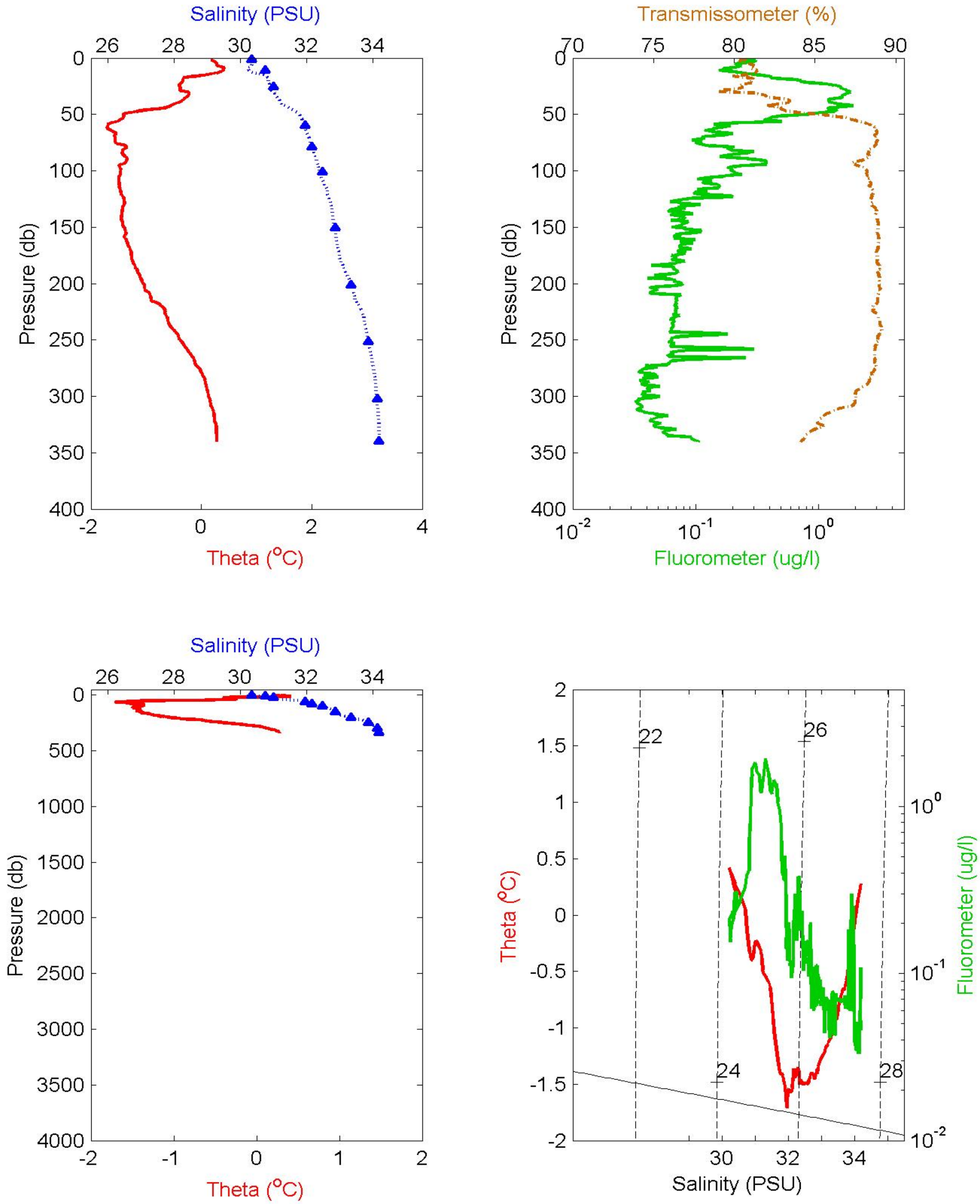




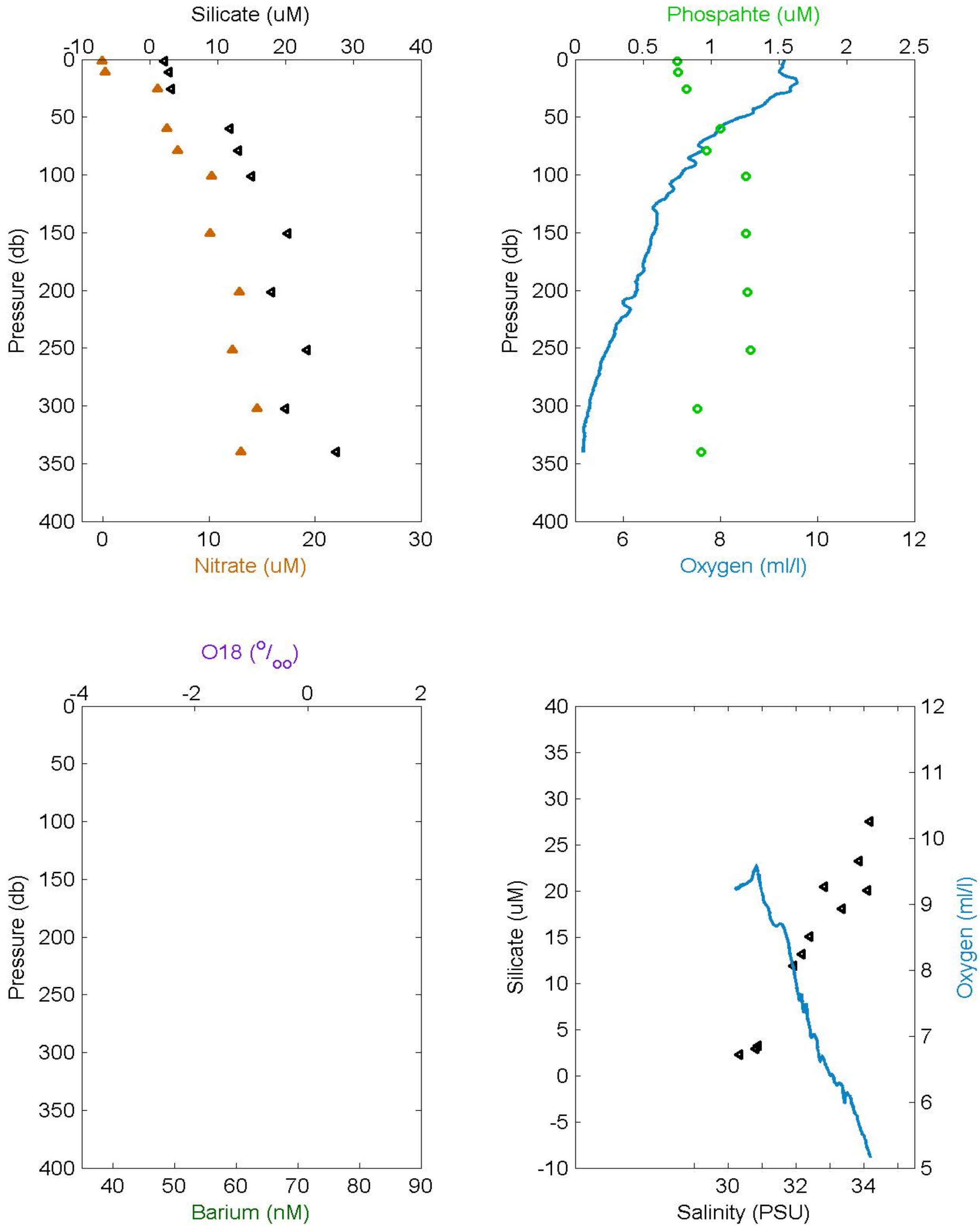




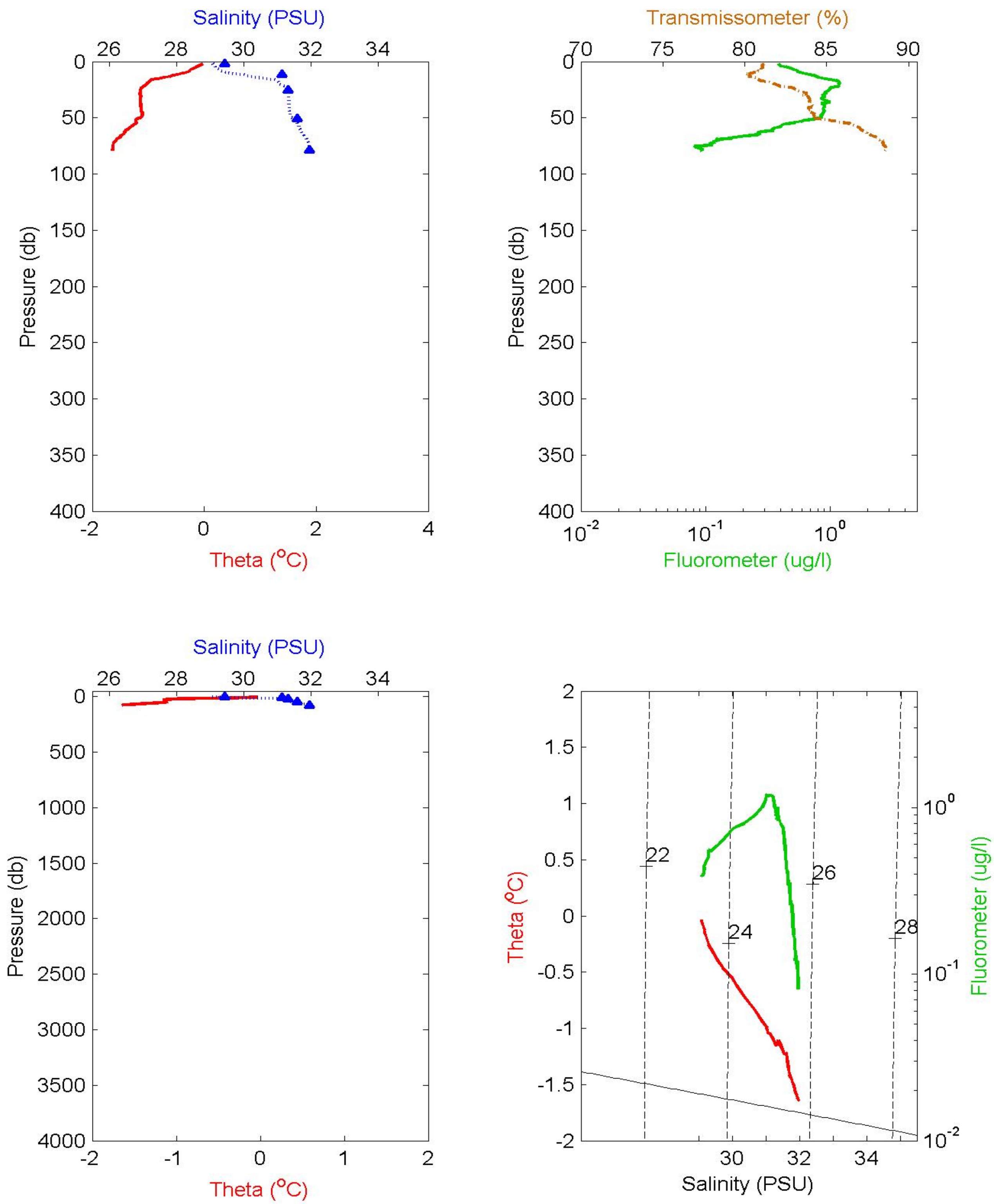
2004-16: Cast 2 Station 2



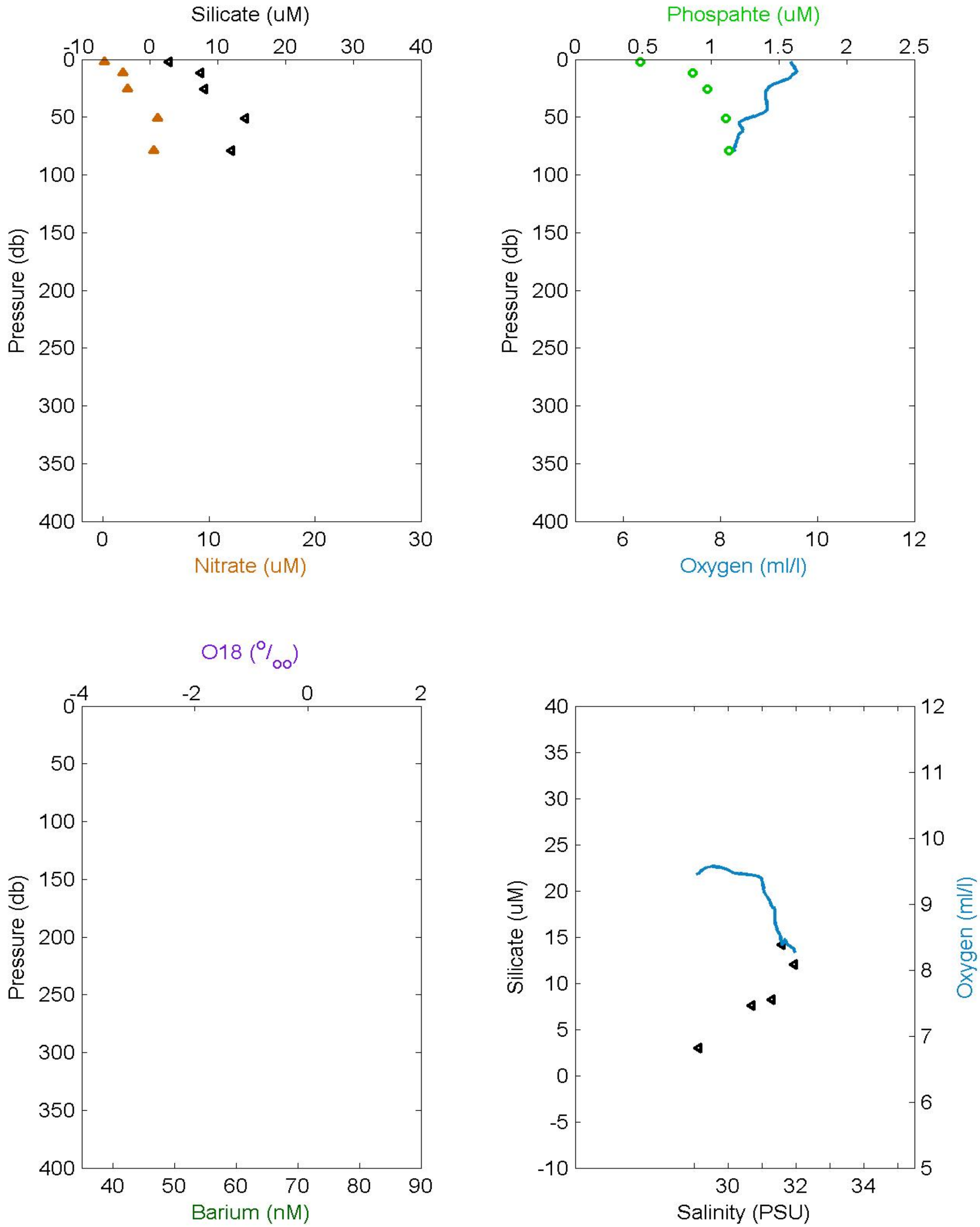
2004-16: Cast 2 Station 2



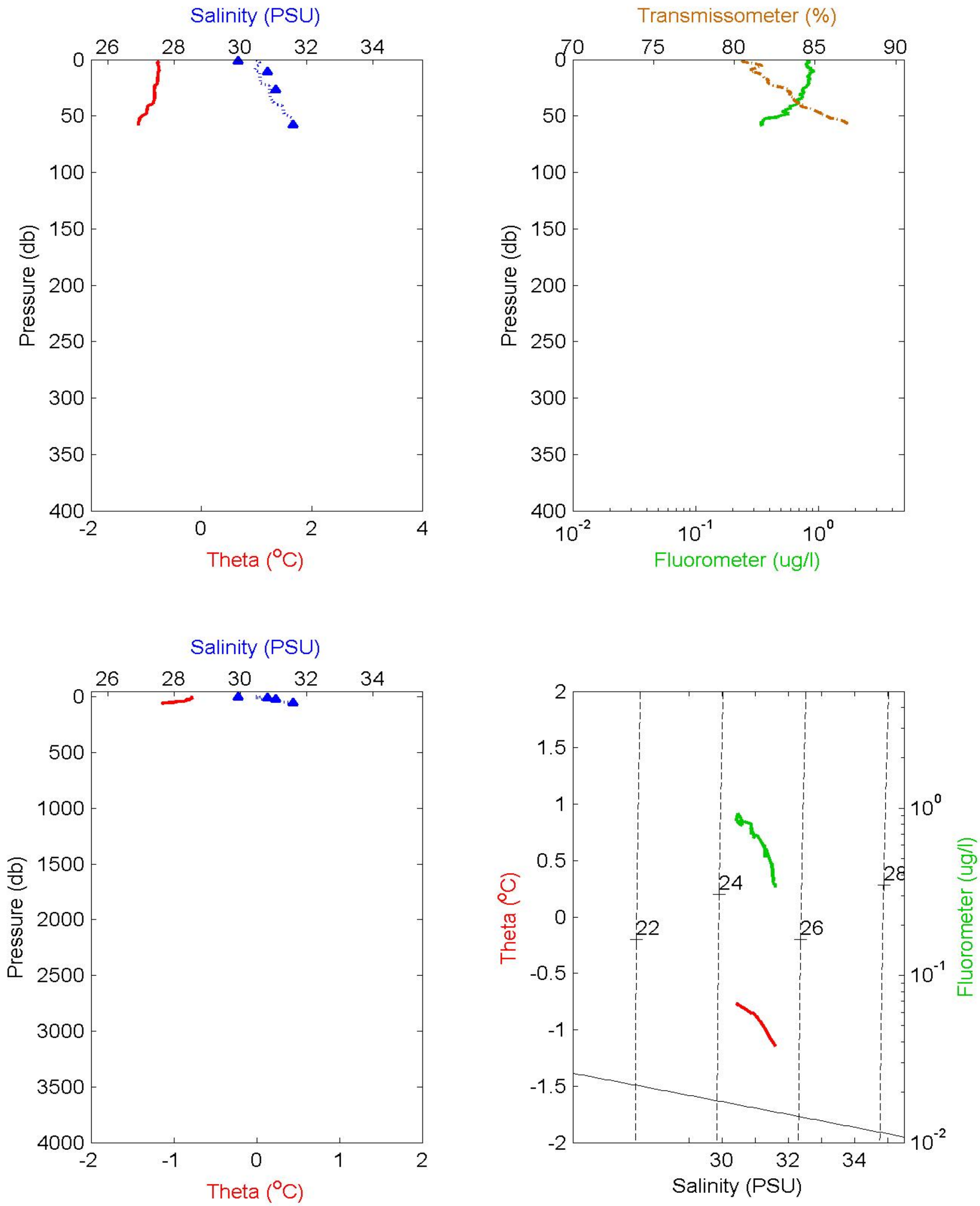
2004-16: Cast 3 Station 3



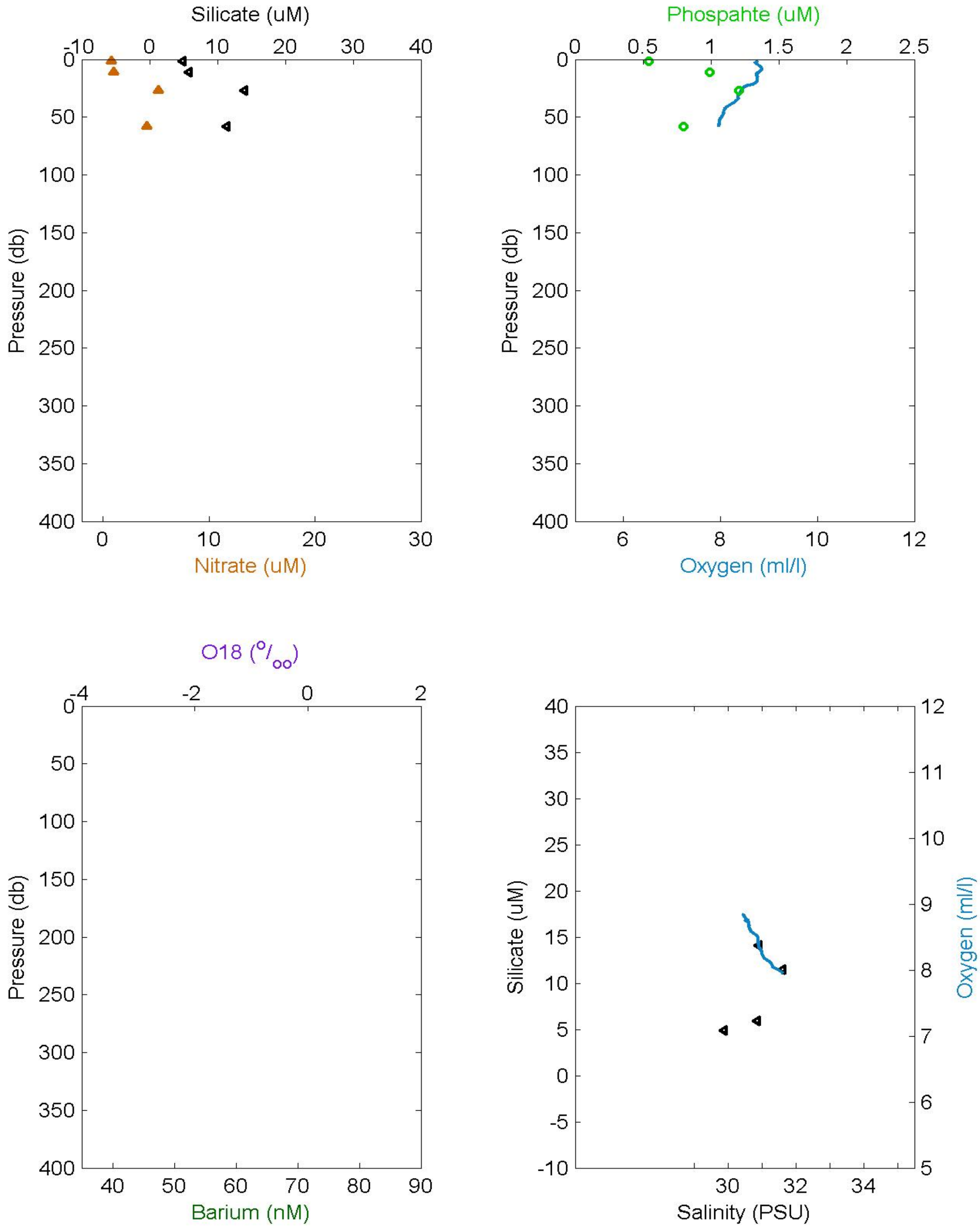
2004-16: Cast 3 Station 3



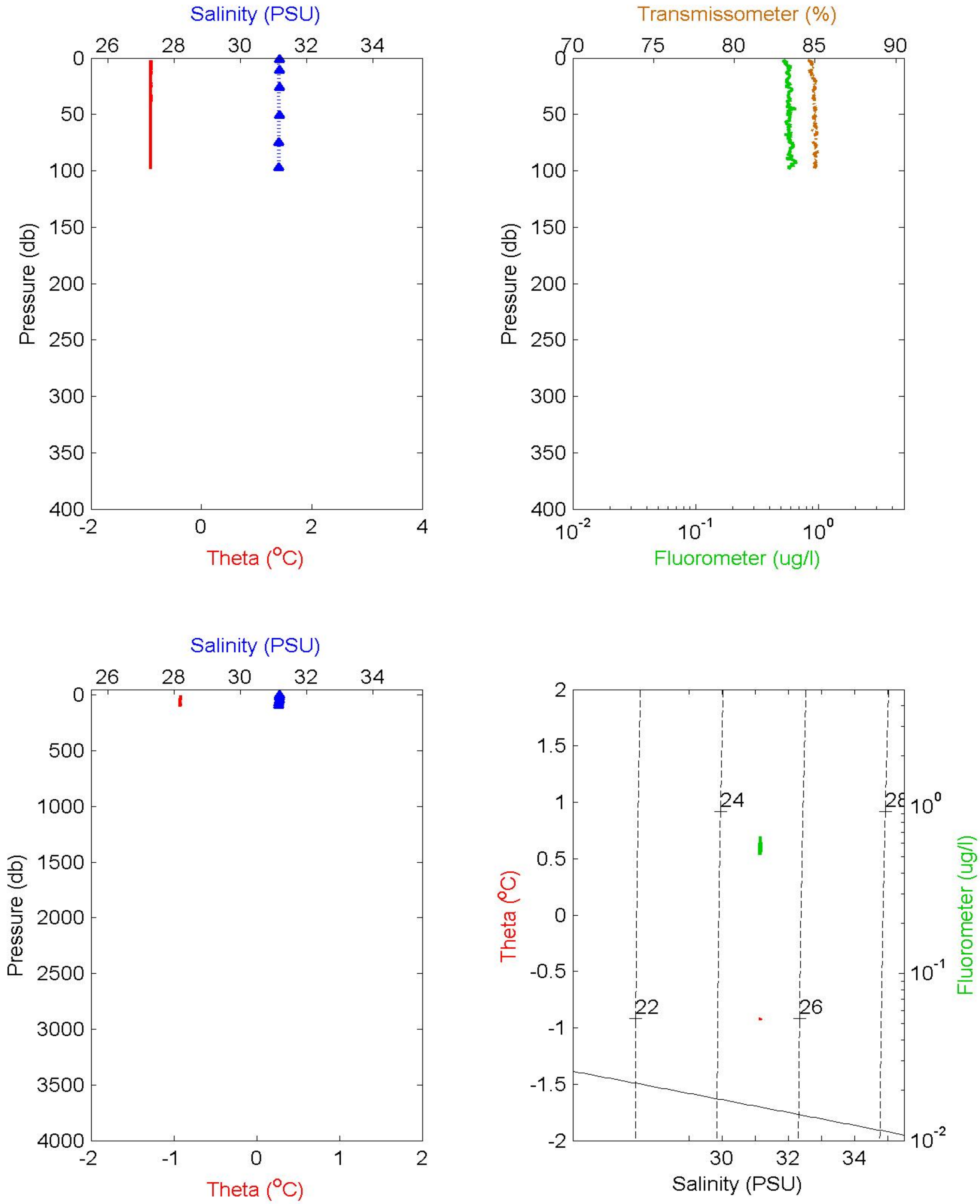
2004-16: Cast 4 Station 4



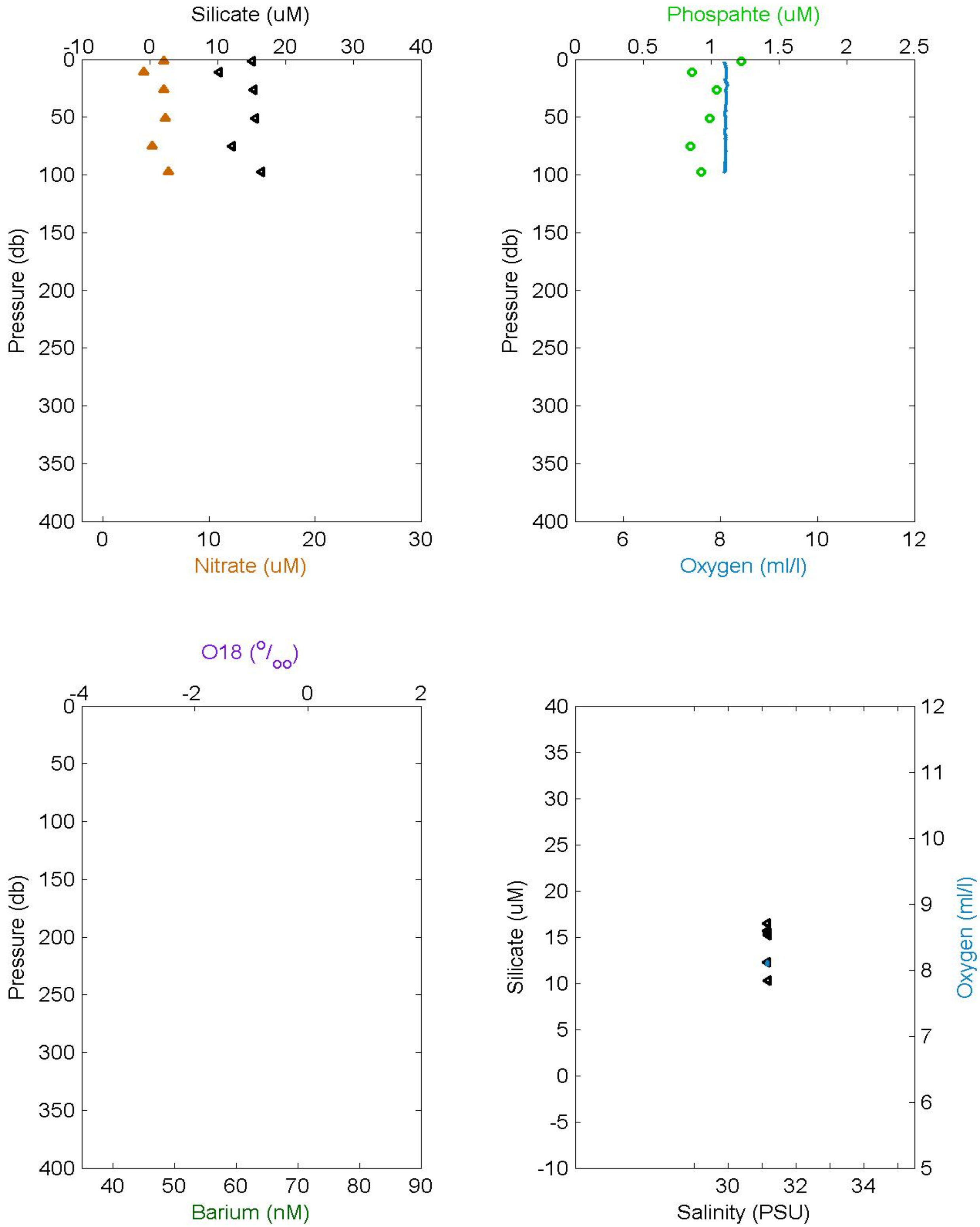
2004-16: Cast 4 Station 4



2004-16: Cast 5 Station 5



2004-16: Cast 5 Station 5



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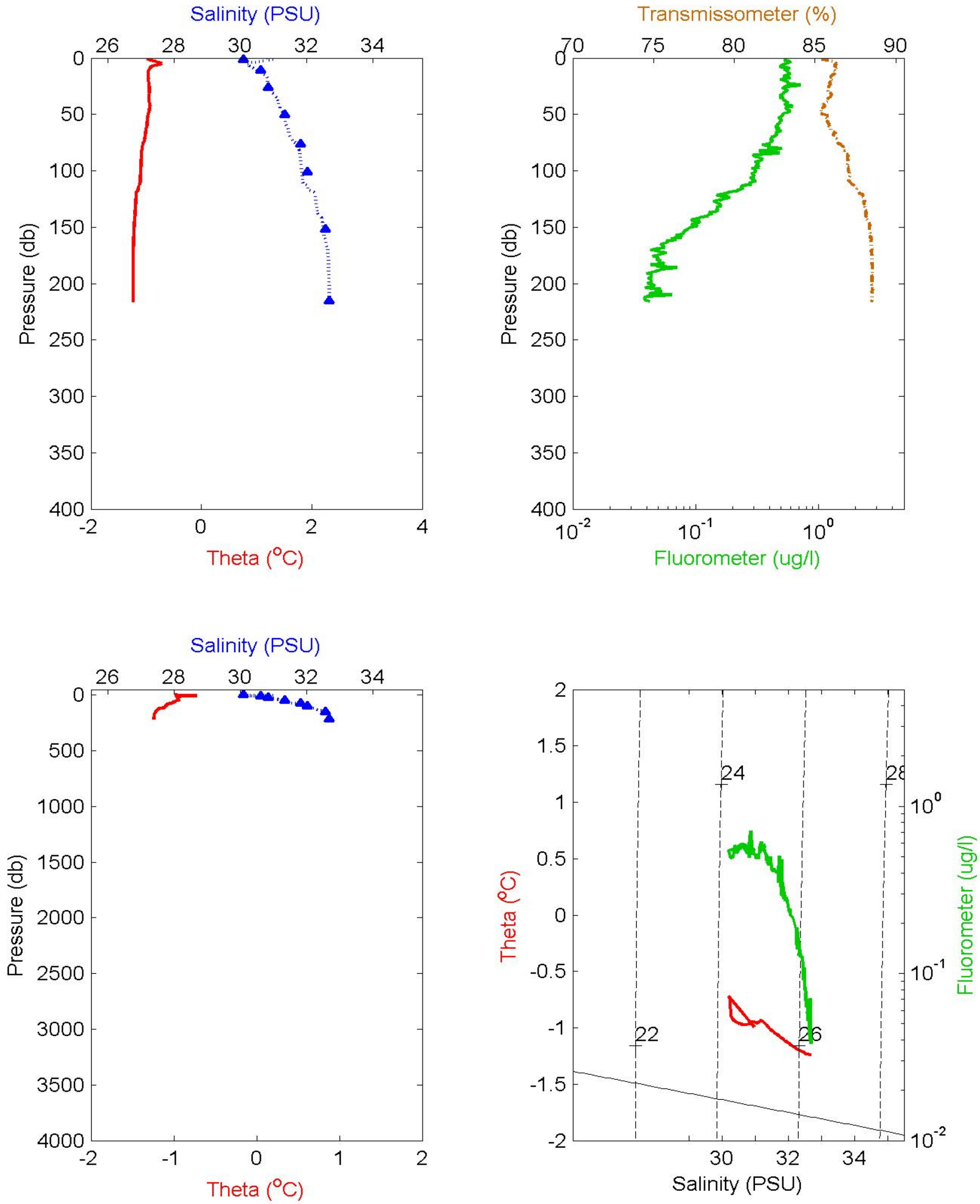

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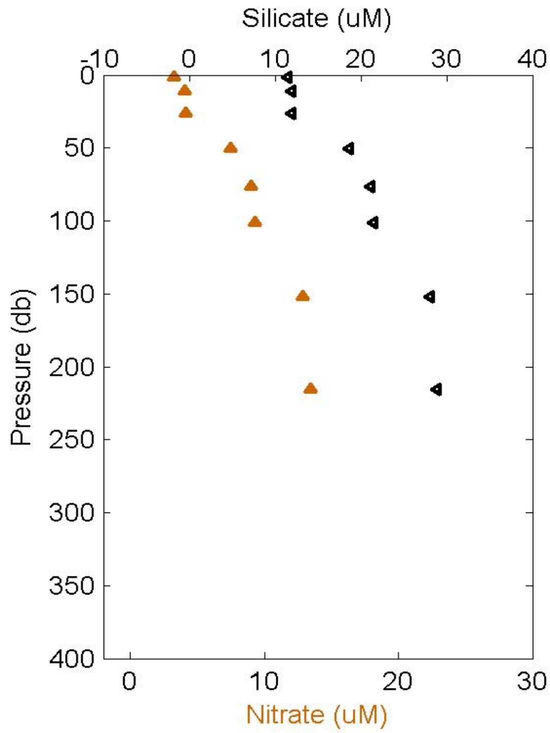
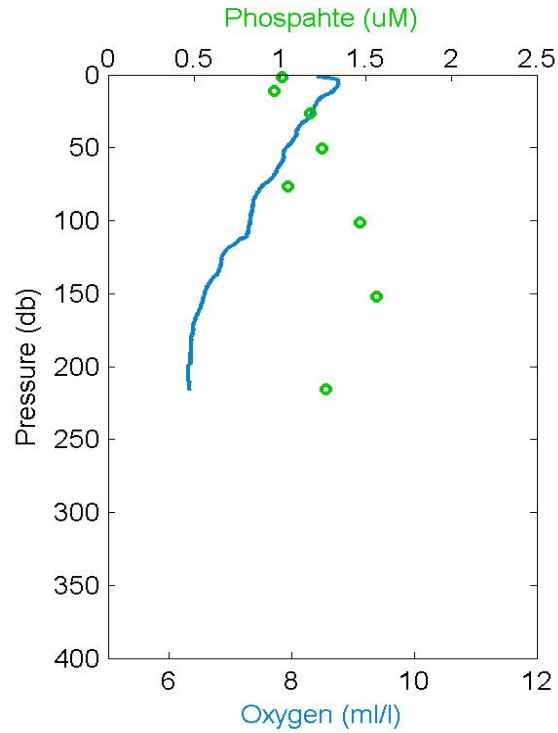
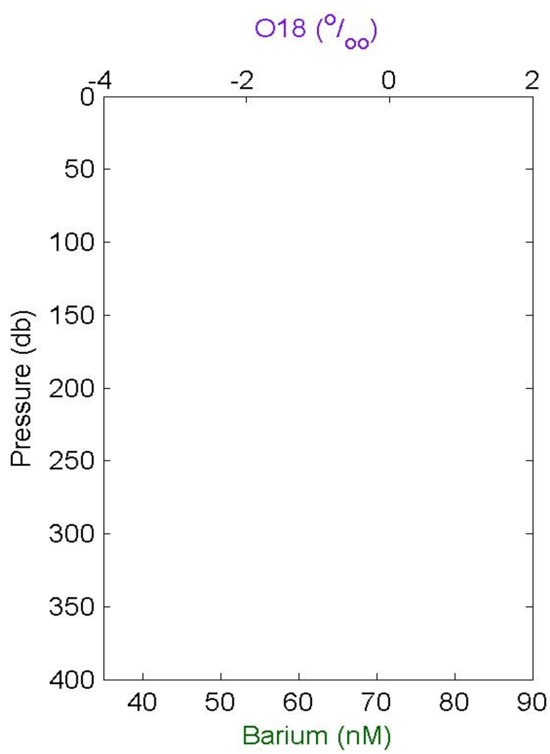
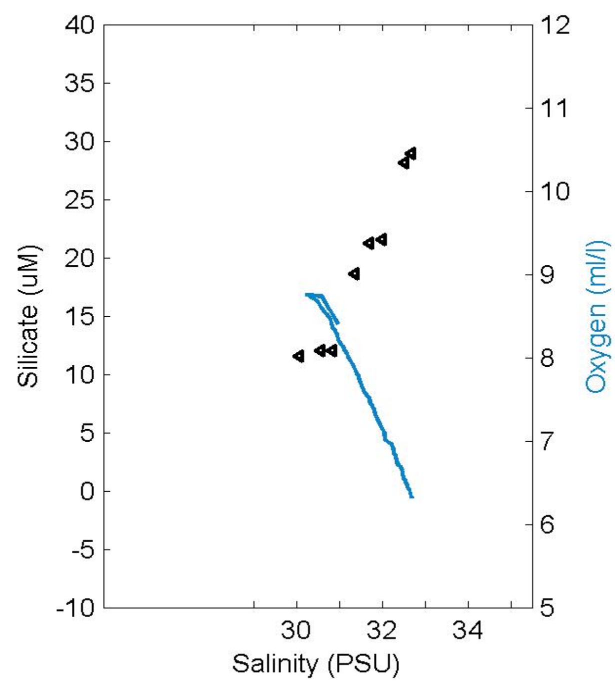
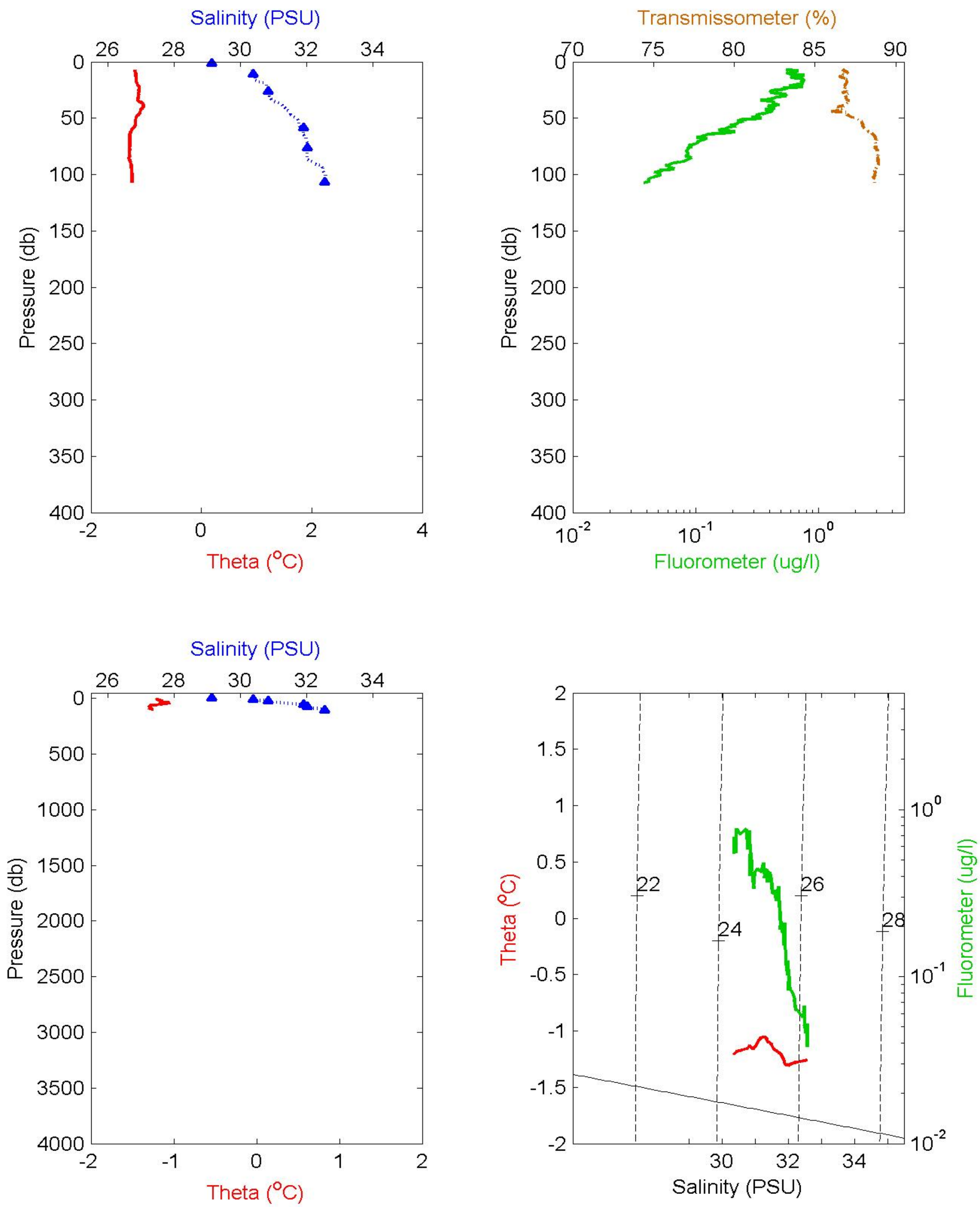




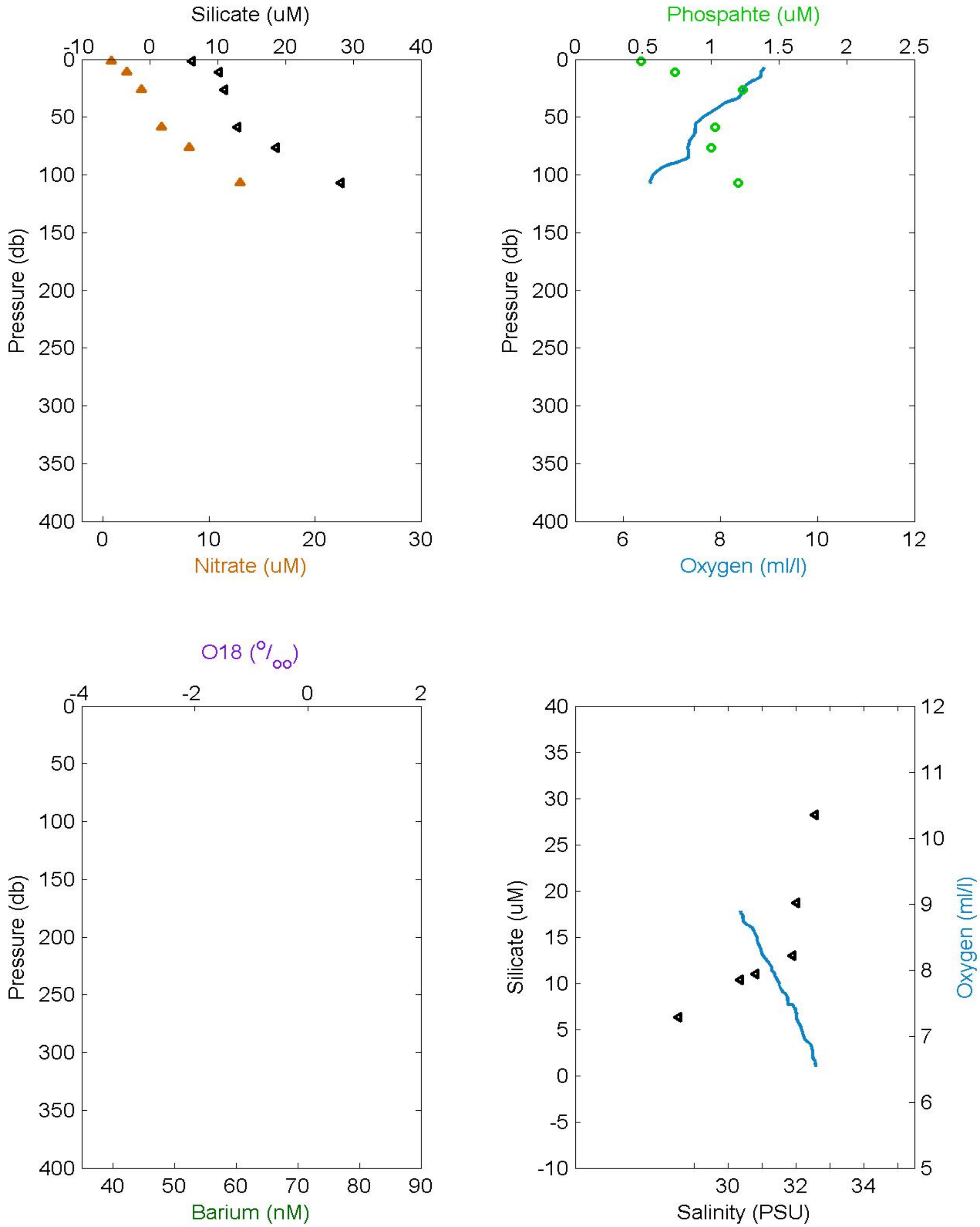




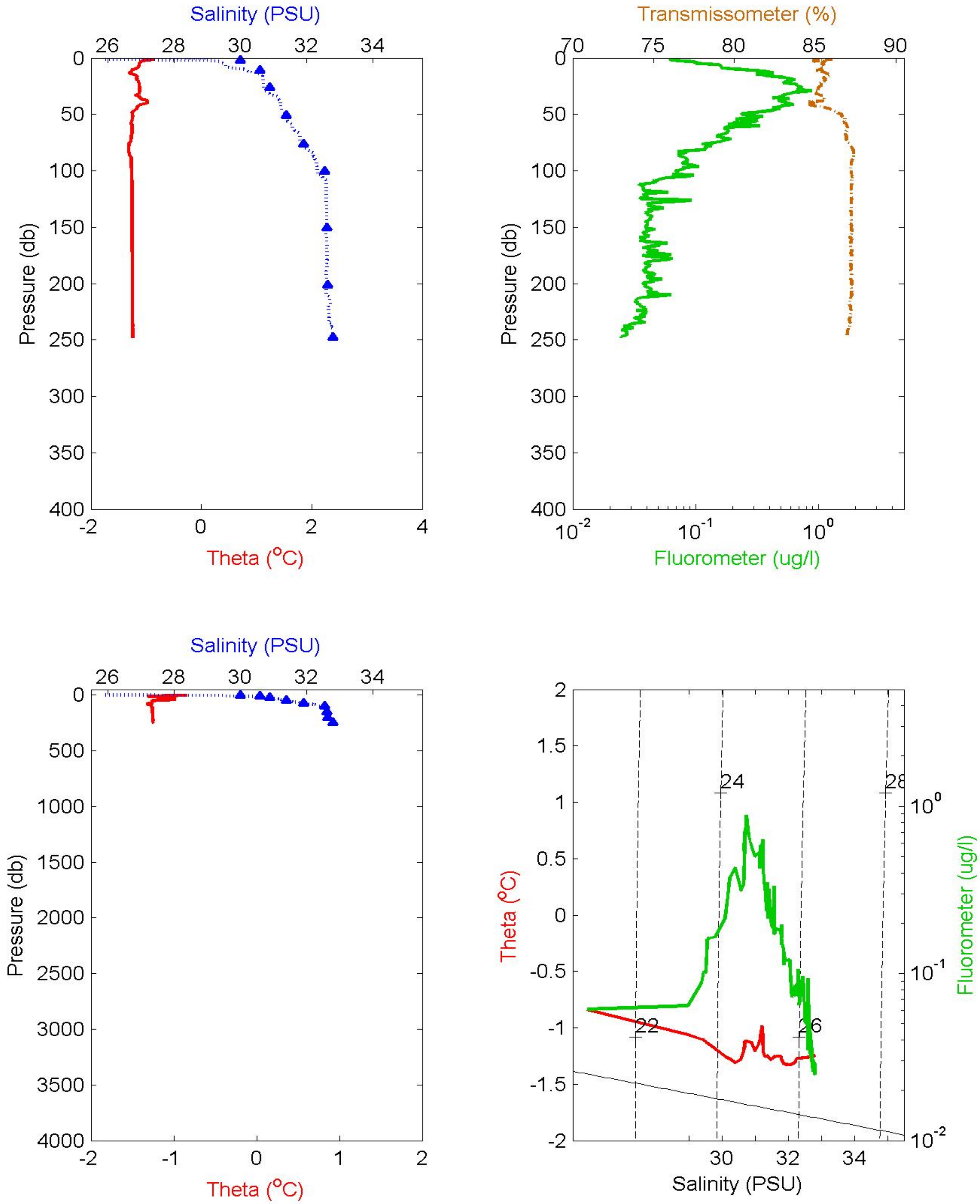
2004-16: Cast 7 Station 7



2004-16: Cast 7 Station 7



2004-16: Cast 8 Station 8



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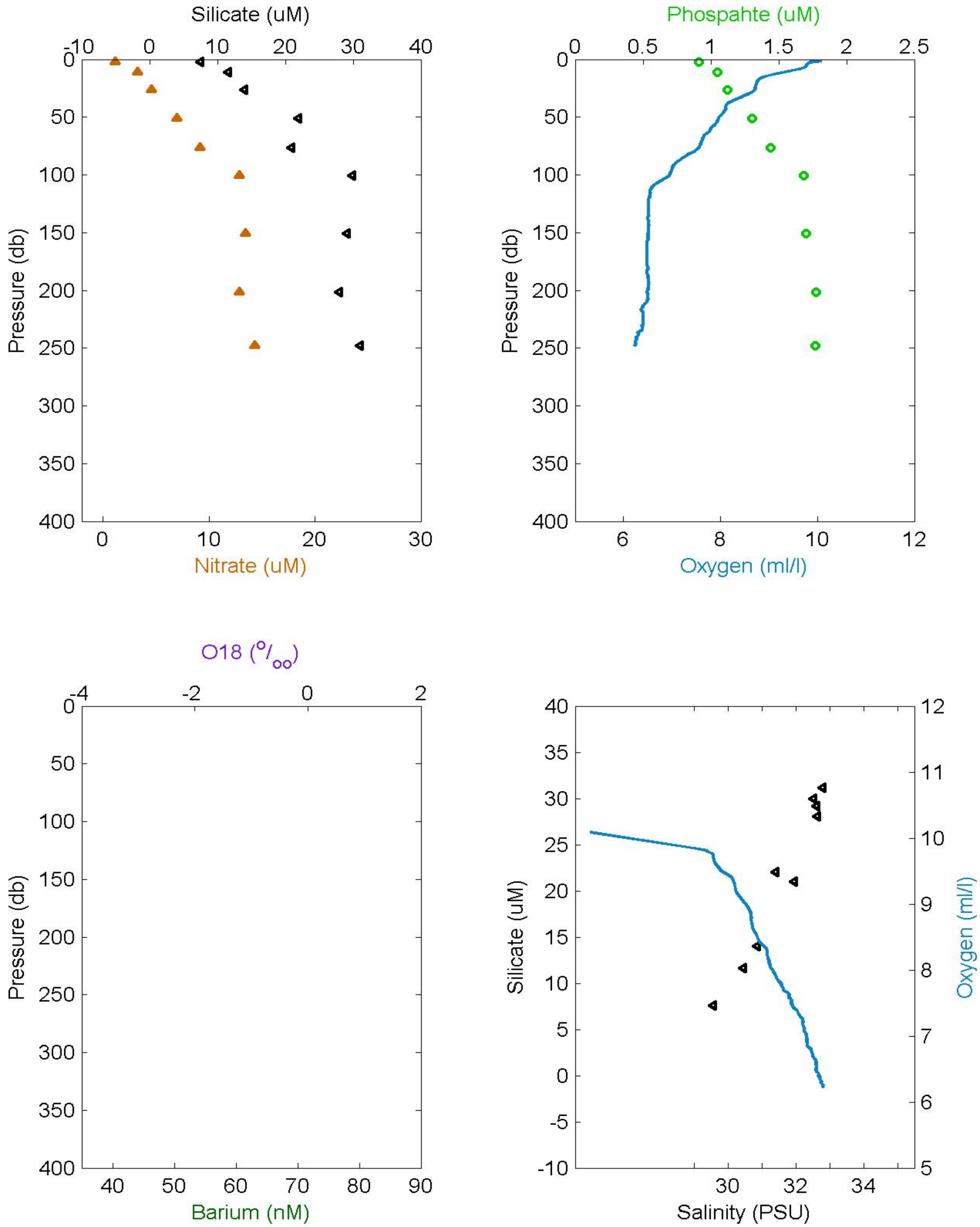
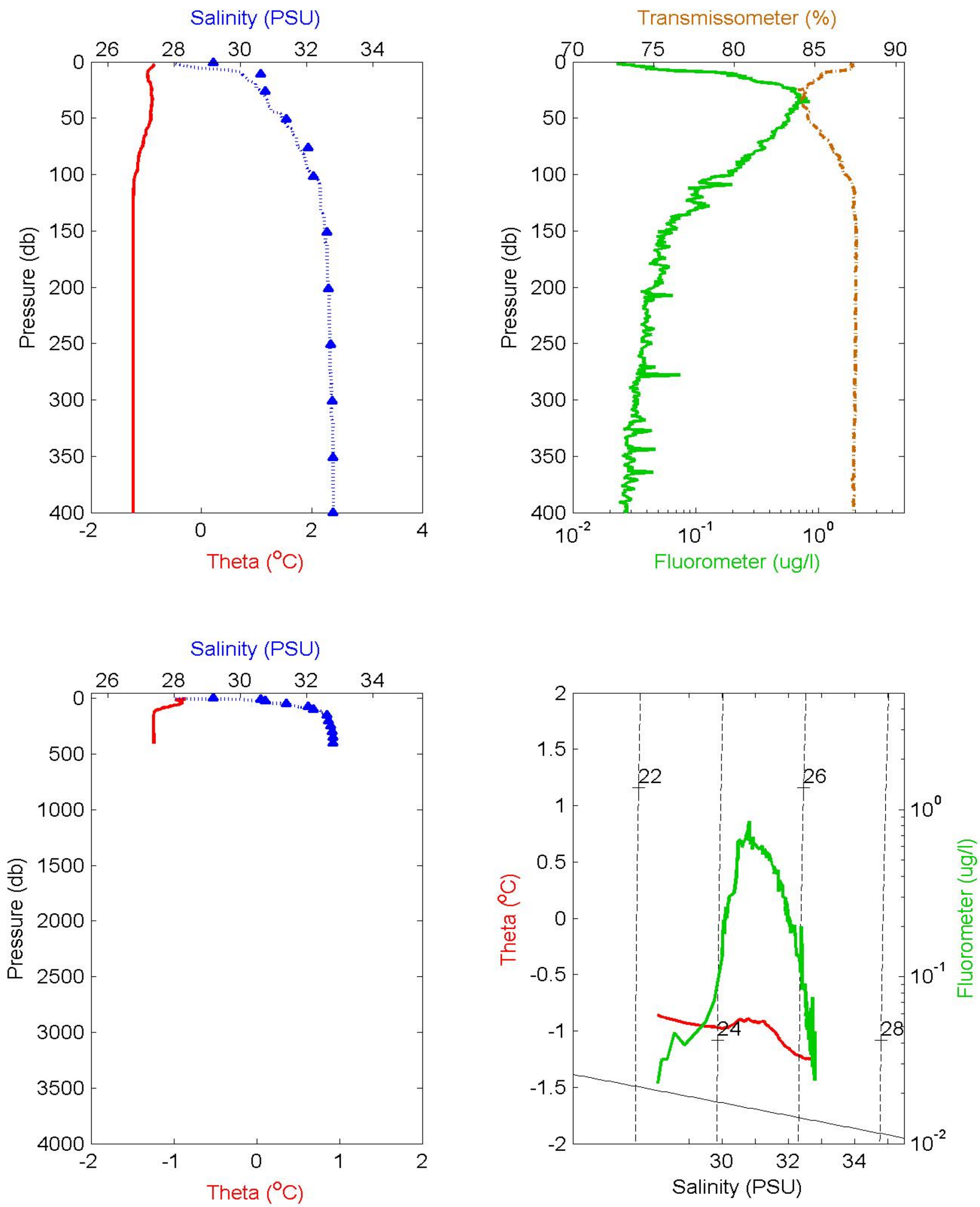
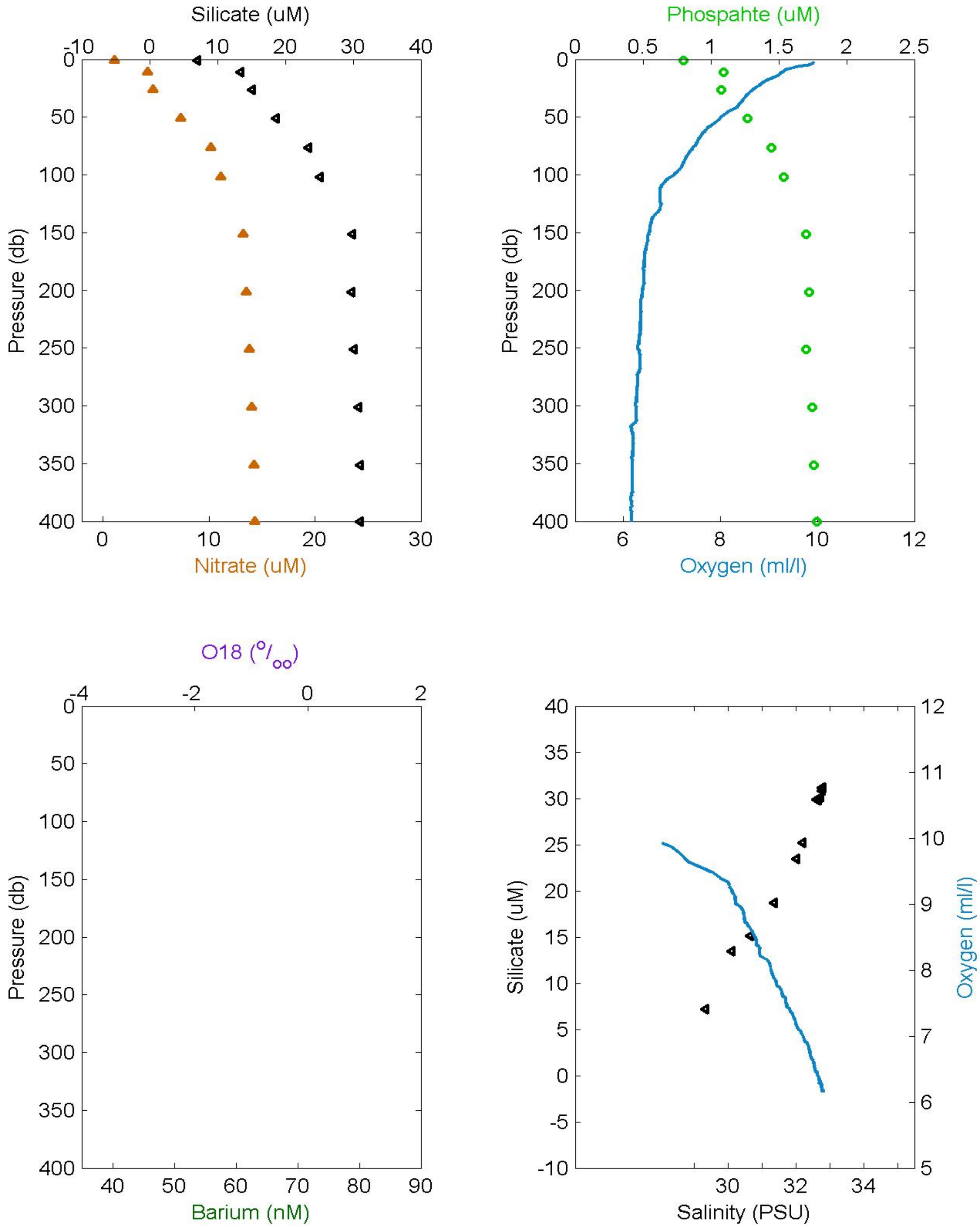


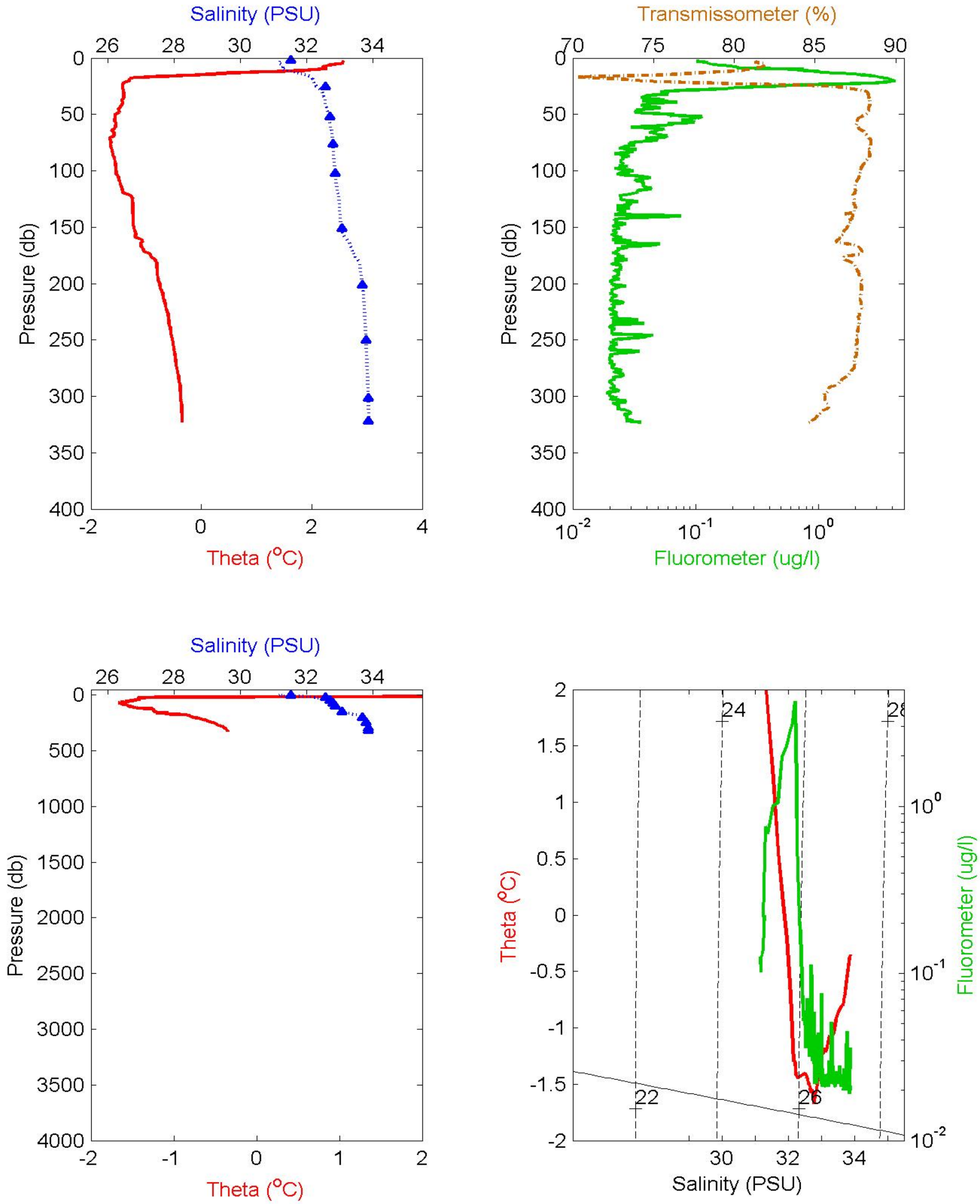
2004-16: Cast 9 Station 9



2004-16: Cast 9 Station 9



2004-16: Cast 10 Station 10



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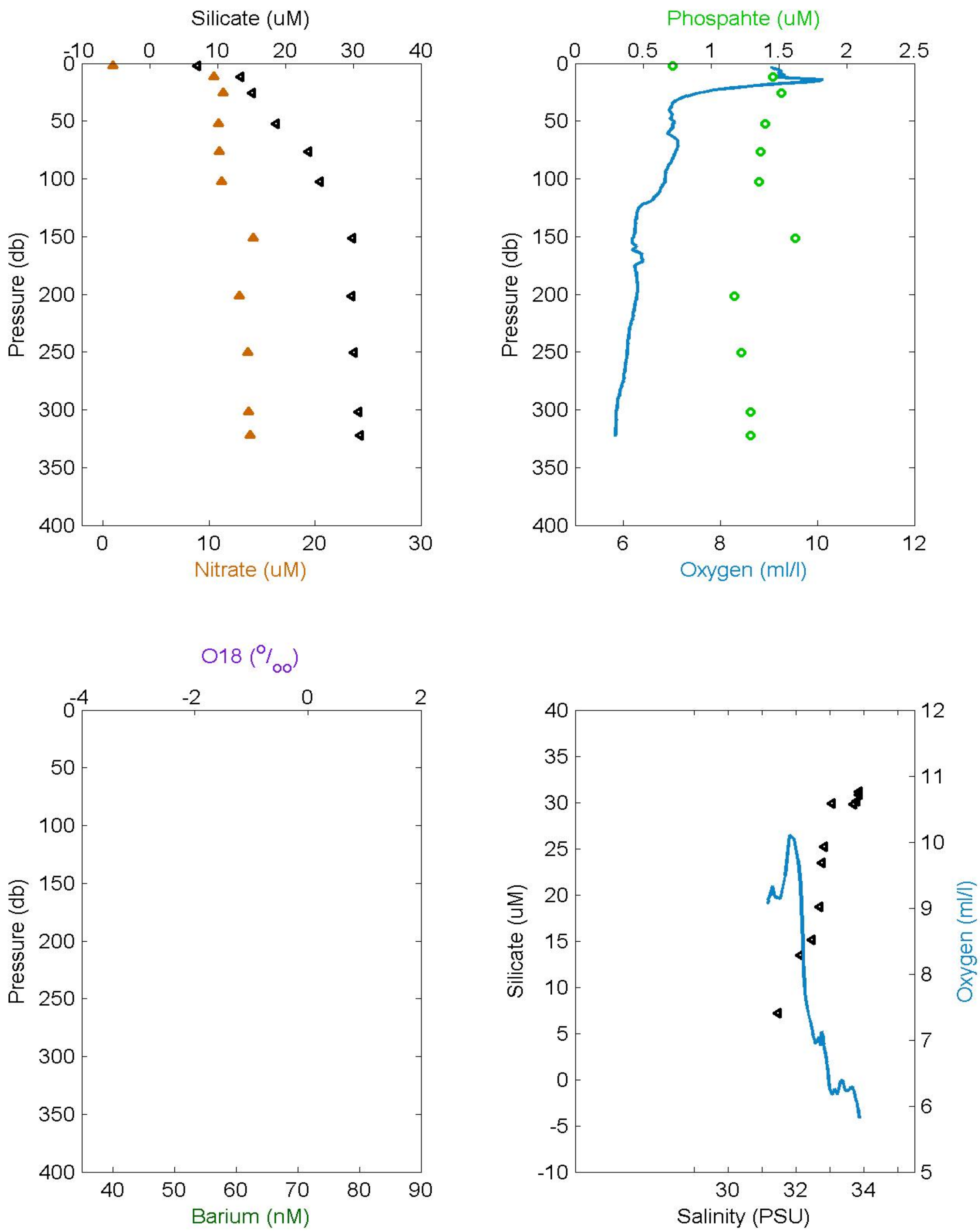
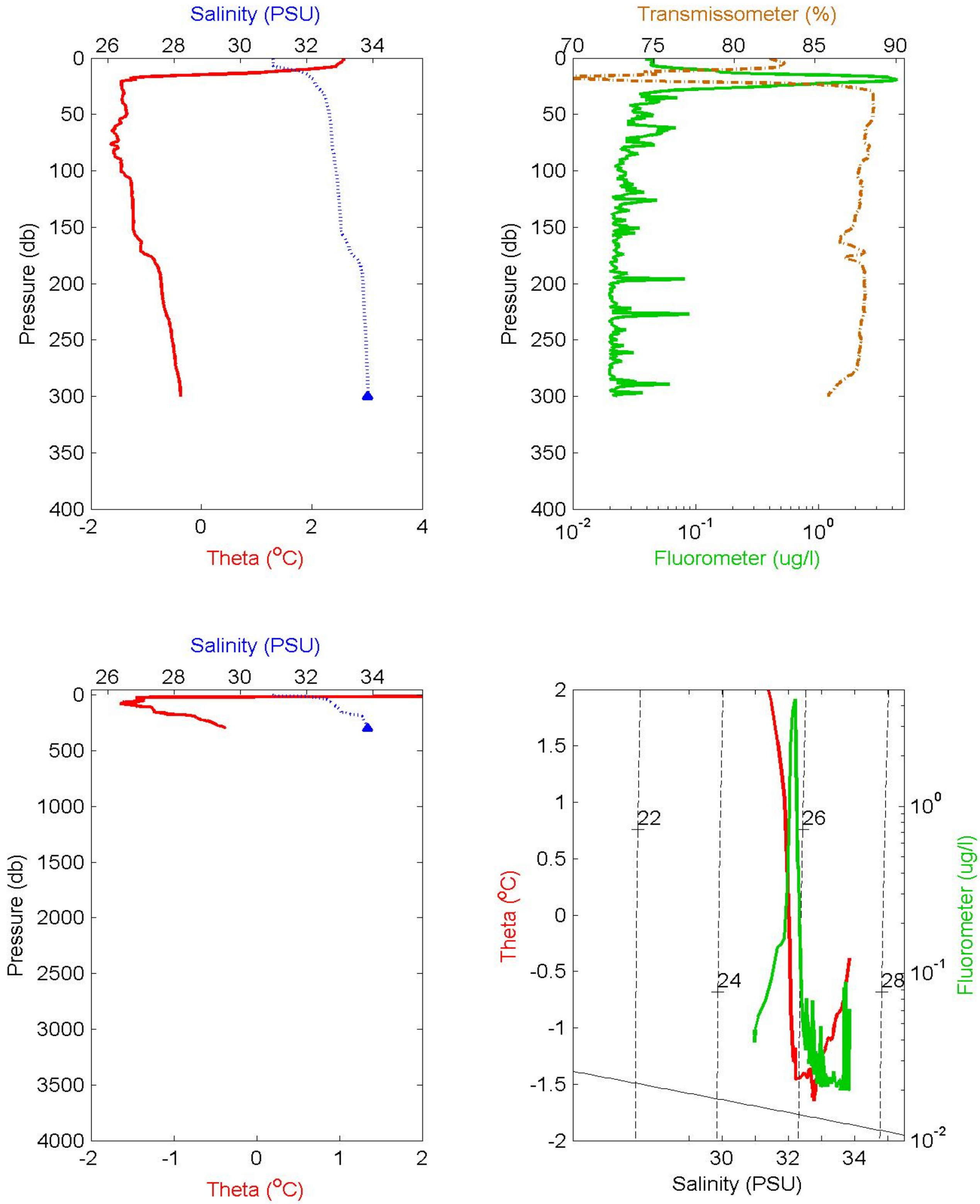


2004-16: Cast 11 Station 11



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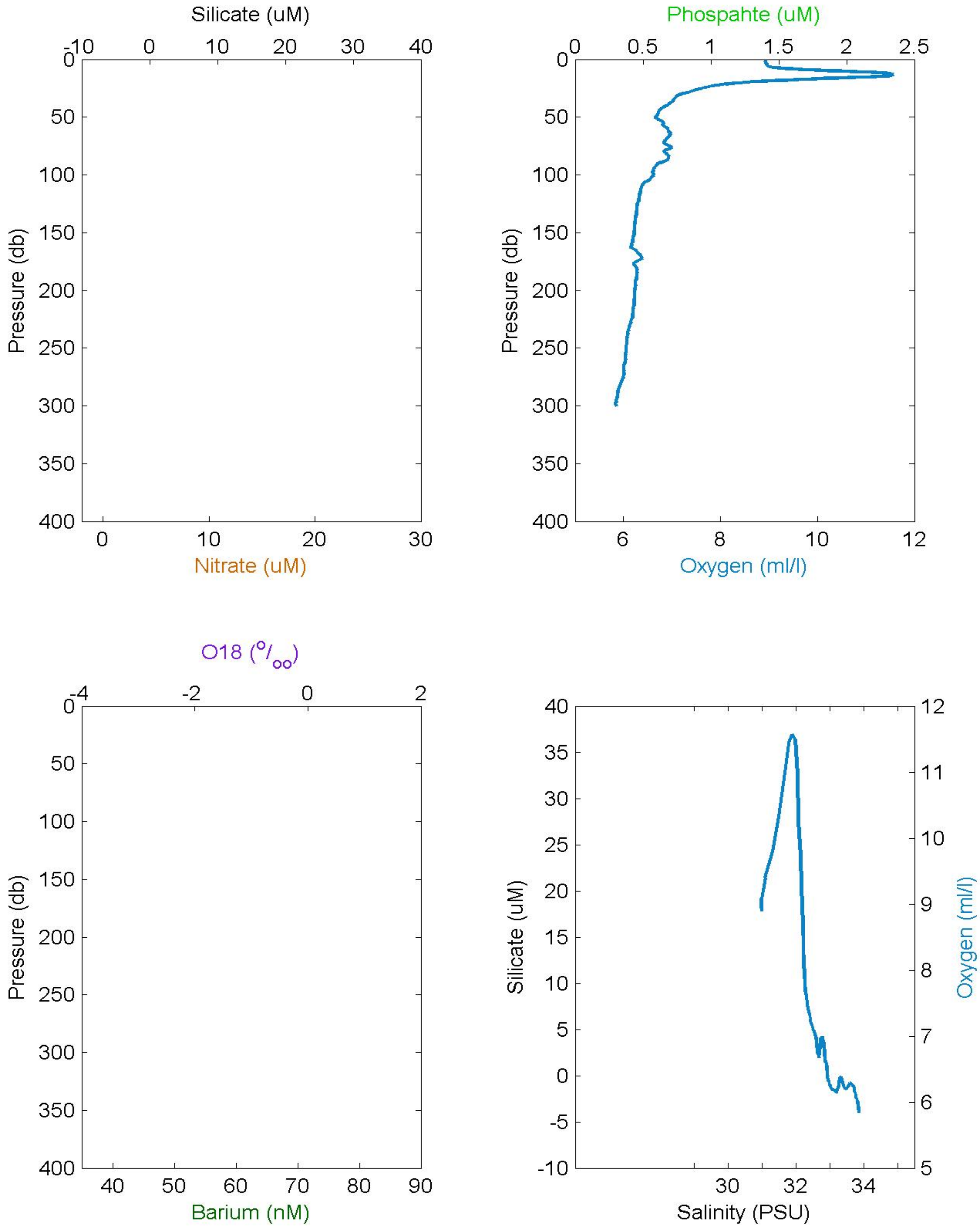

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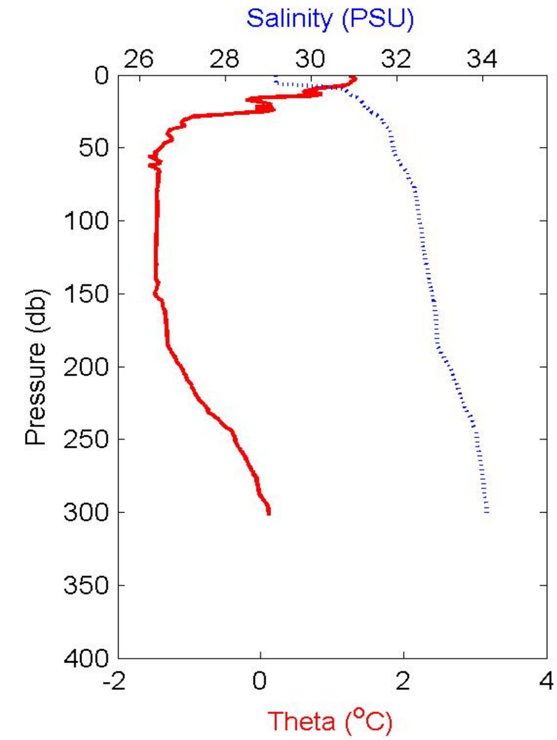

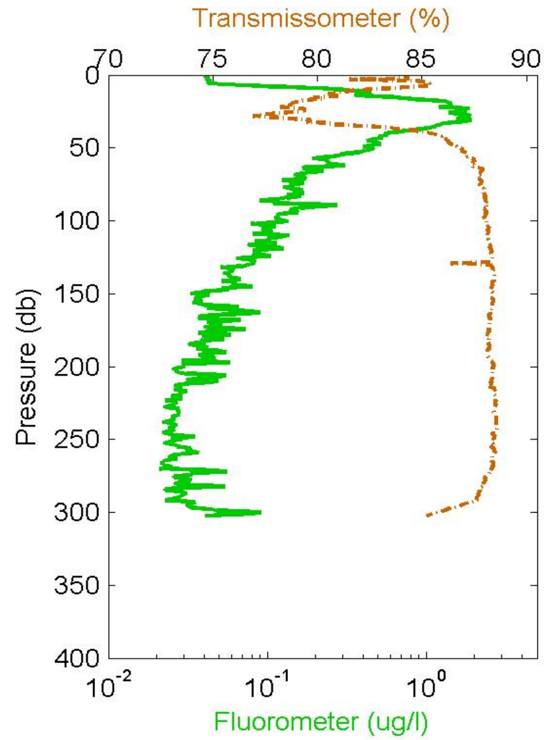

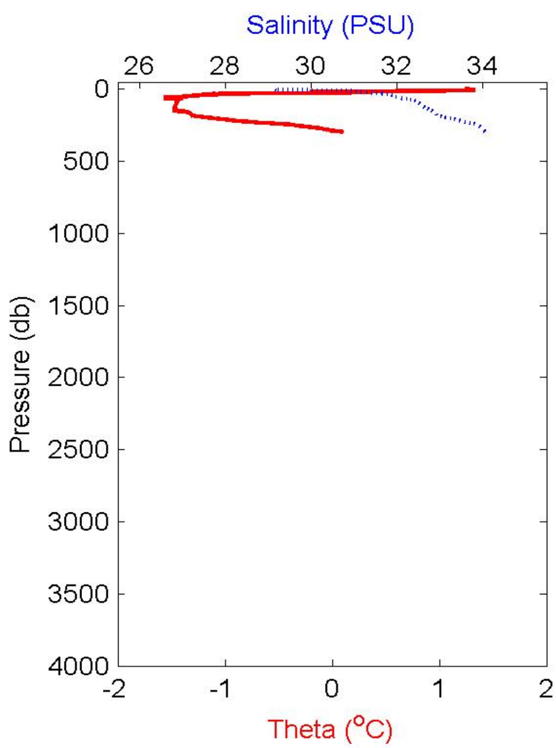

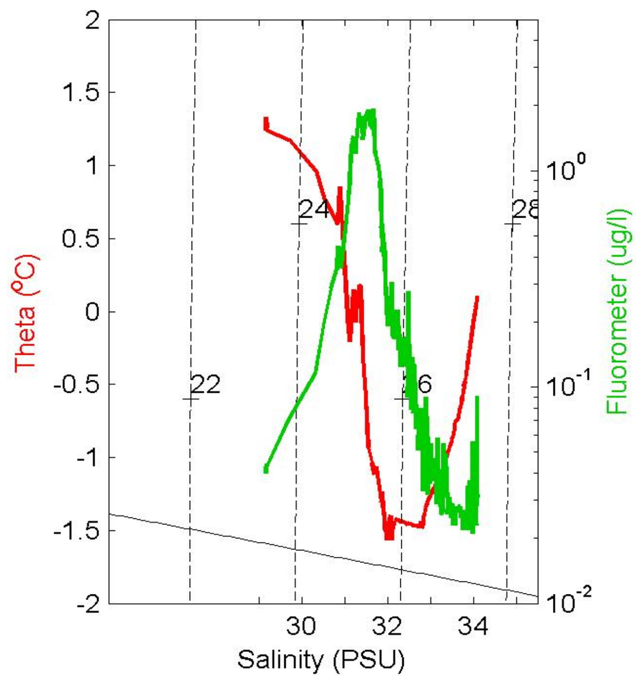

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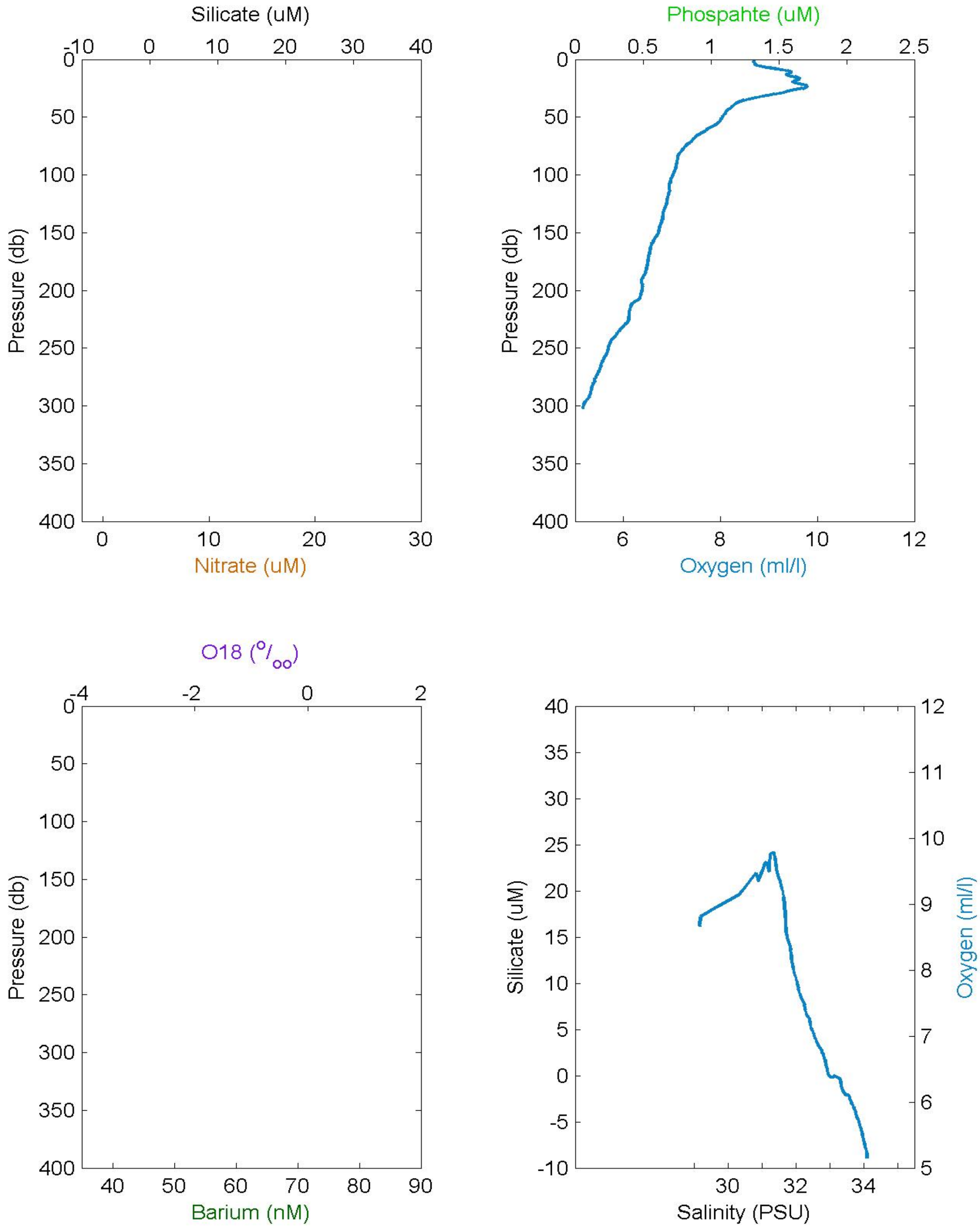

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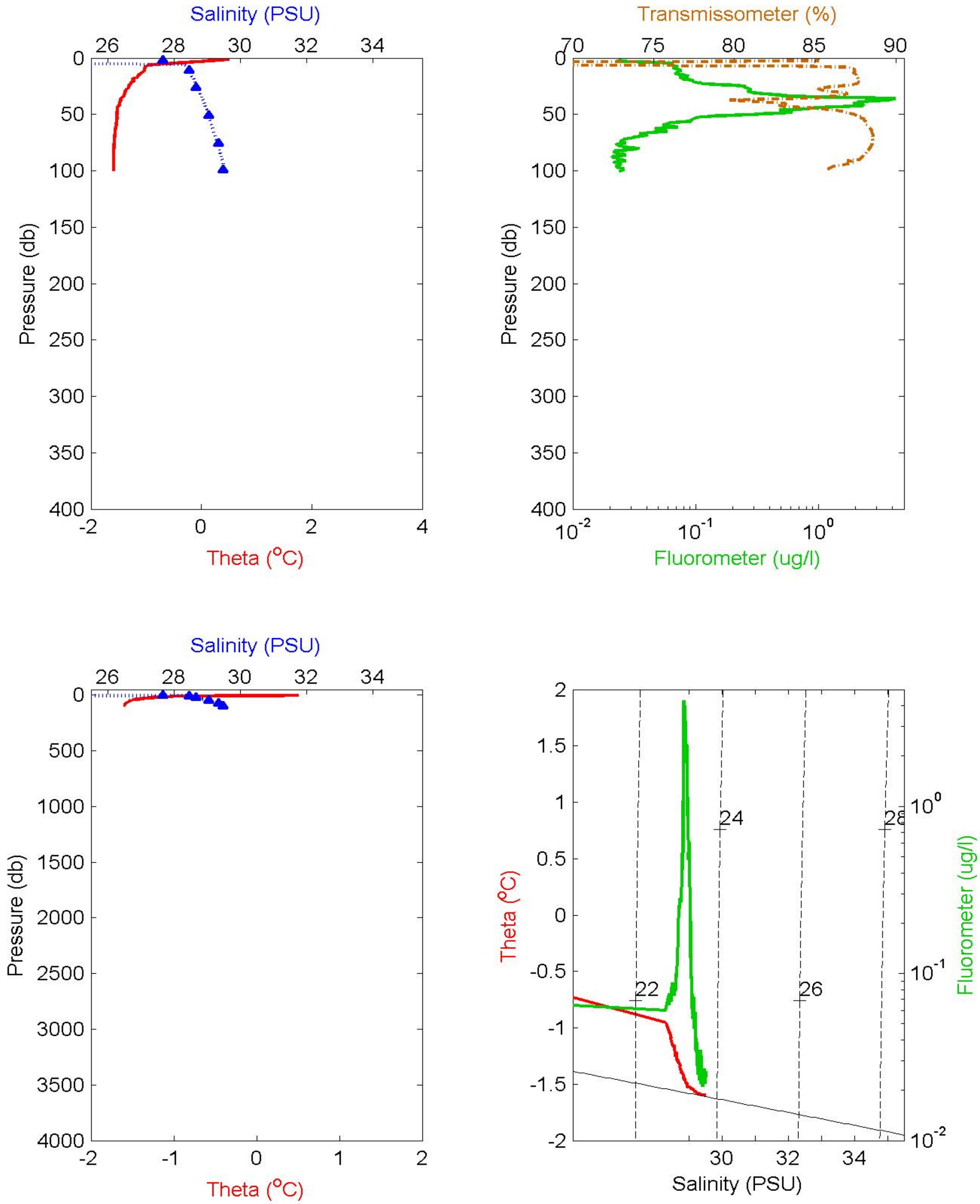

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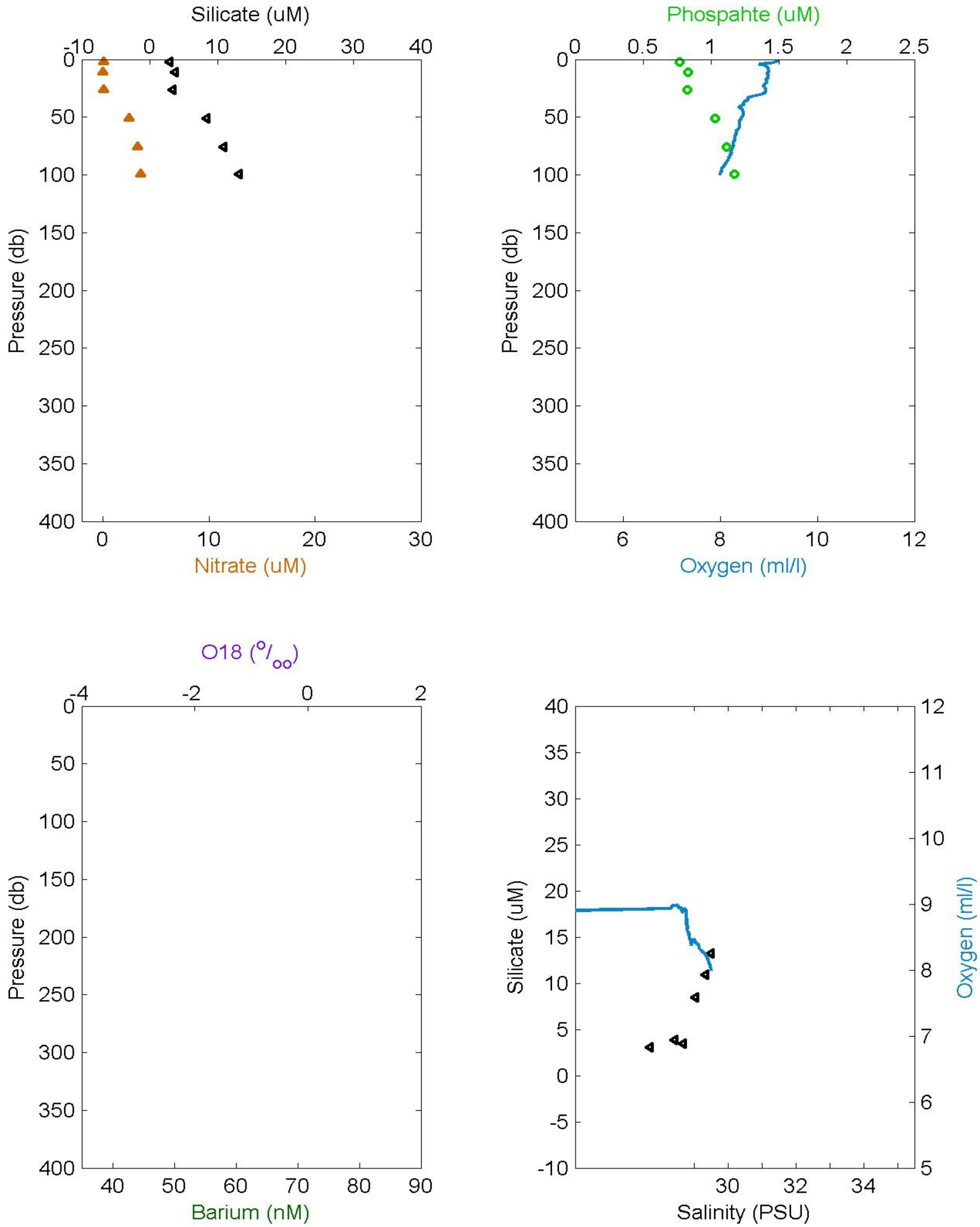

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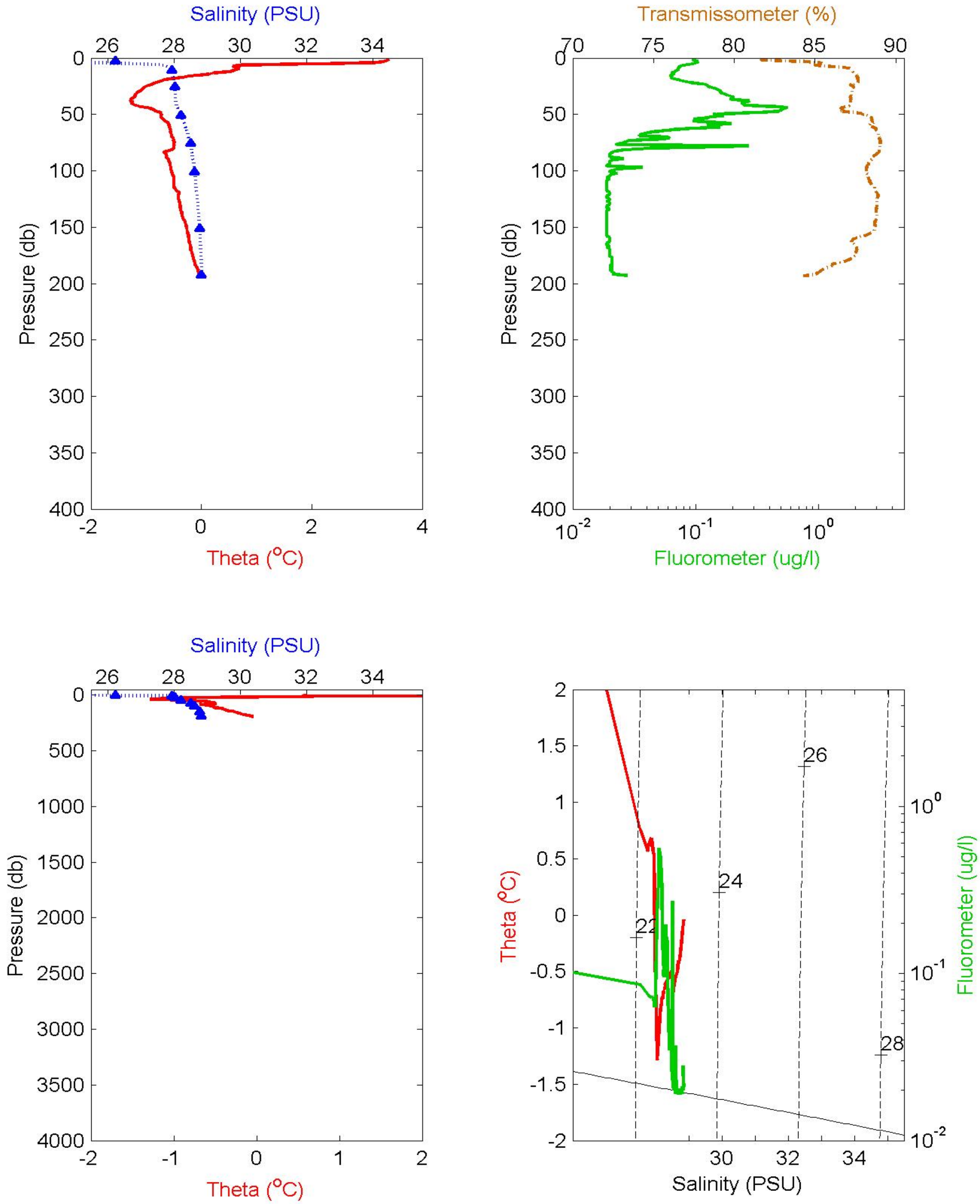

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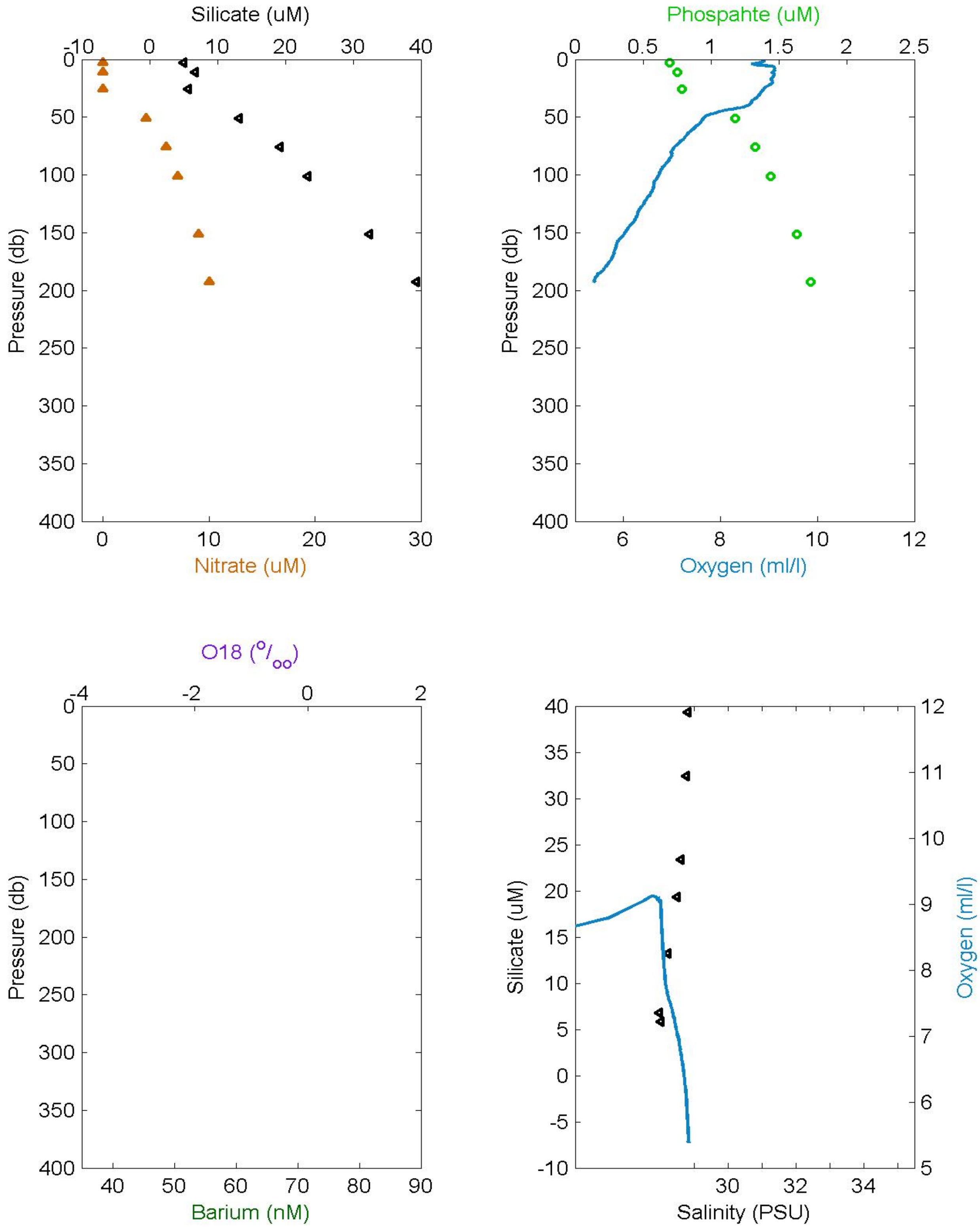

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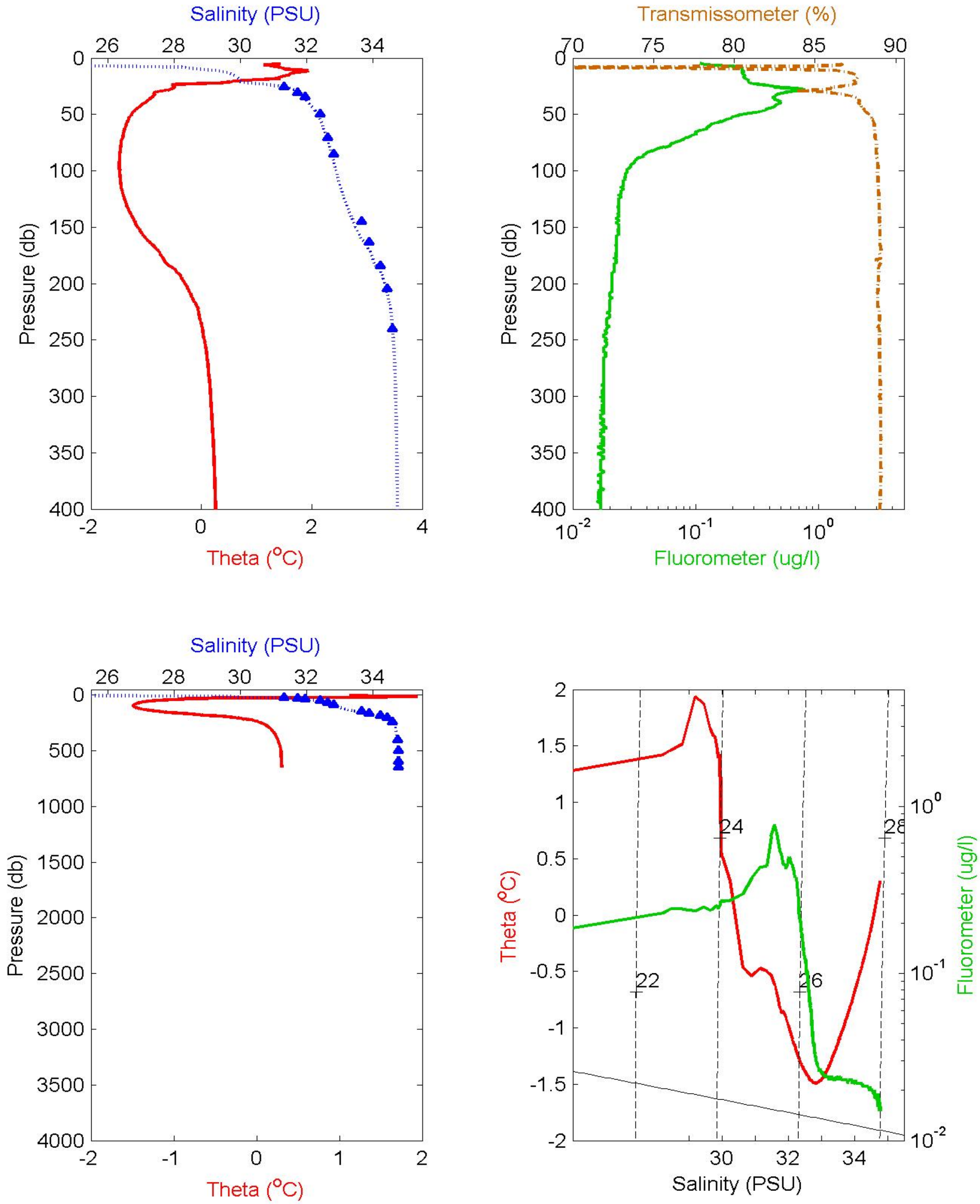
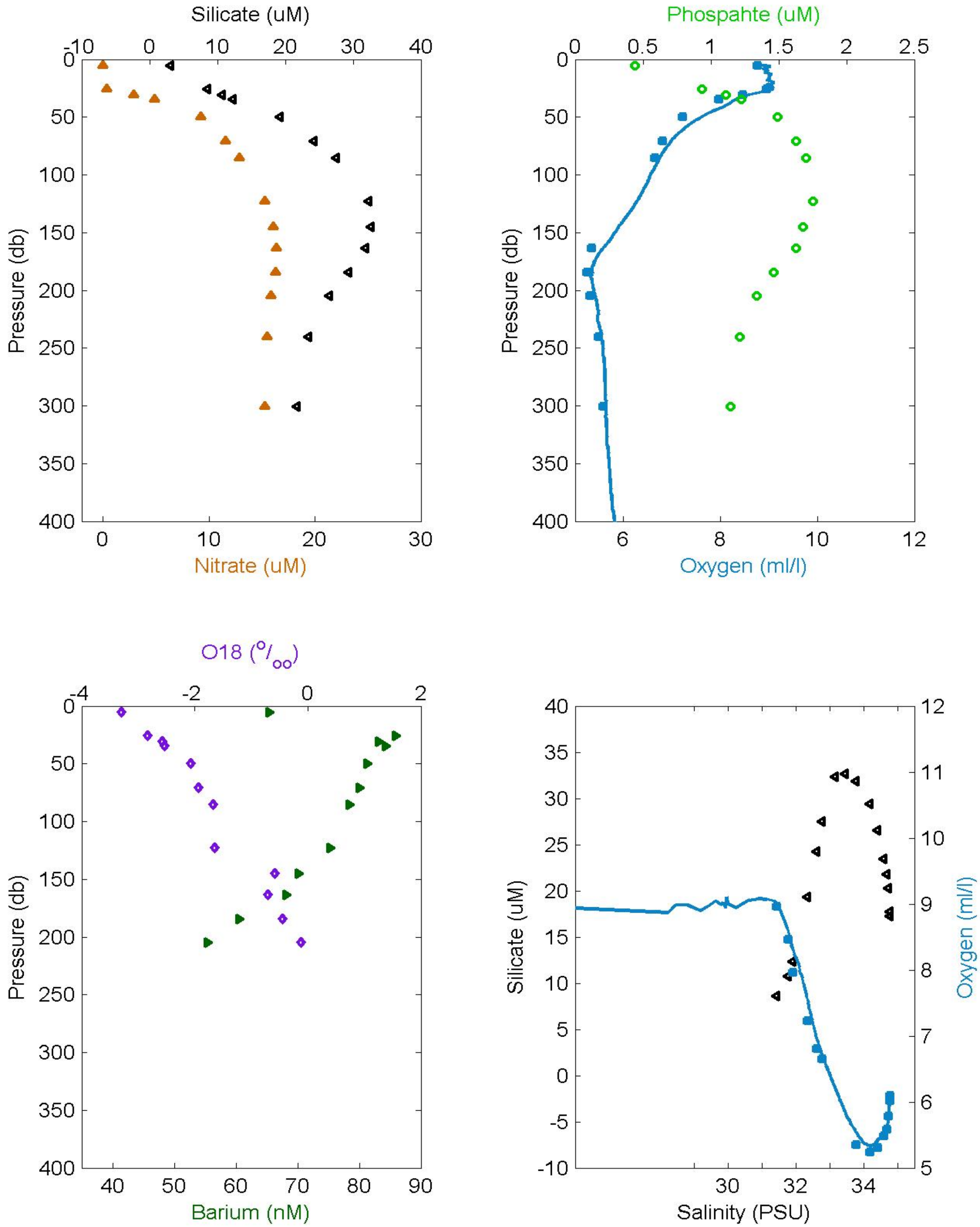
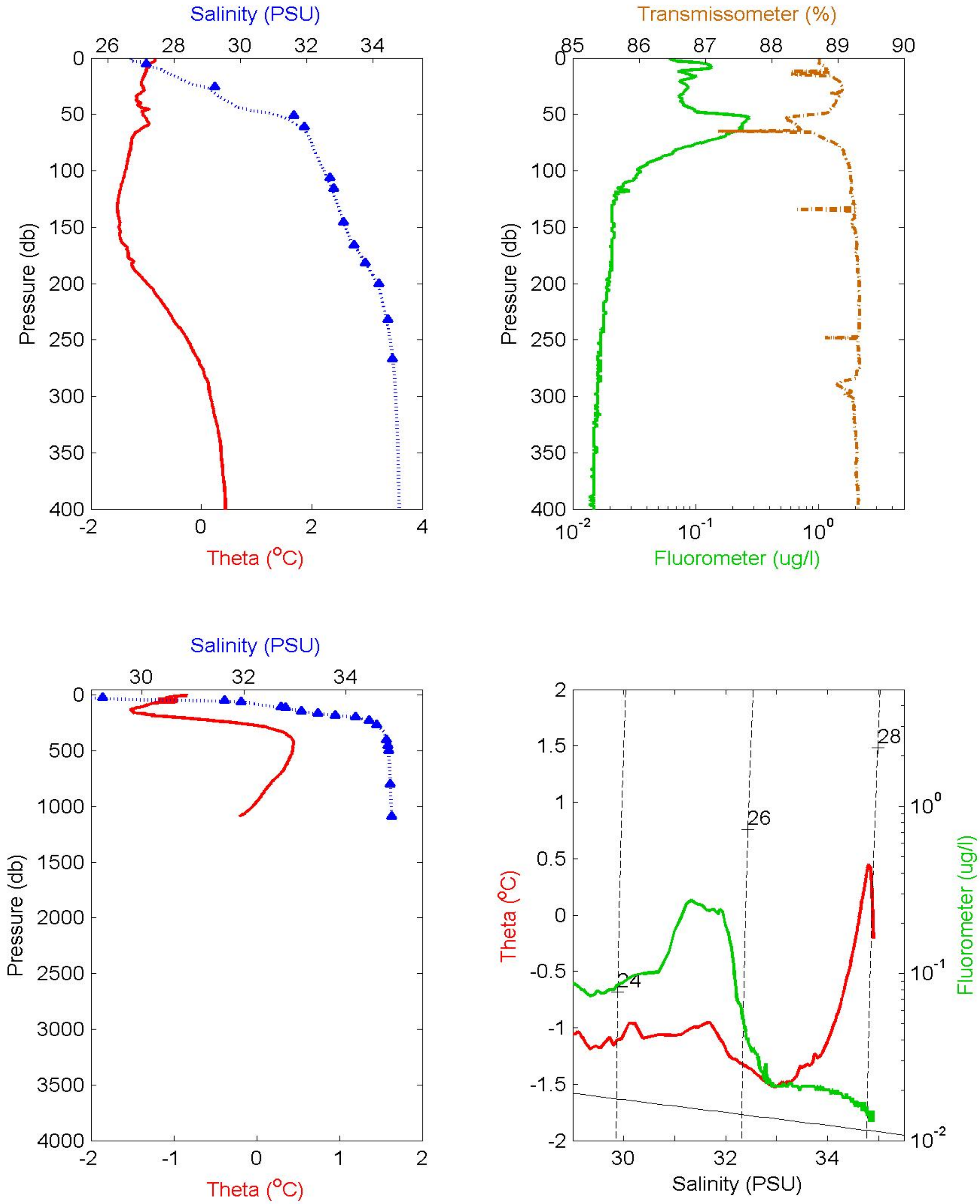
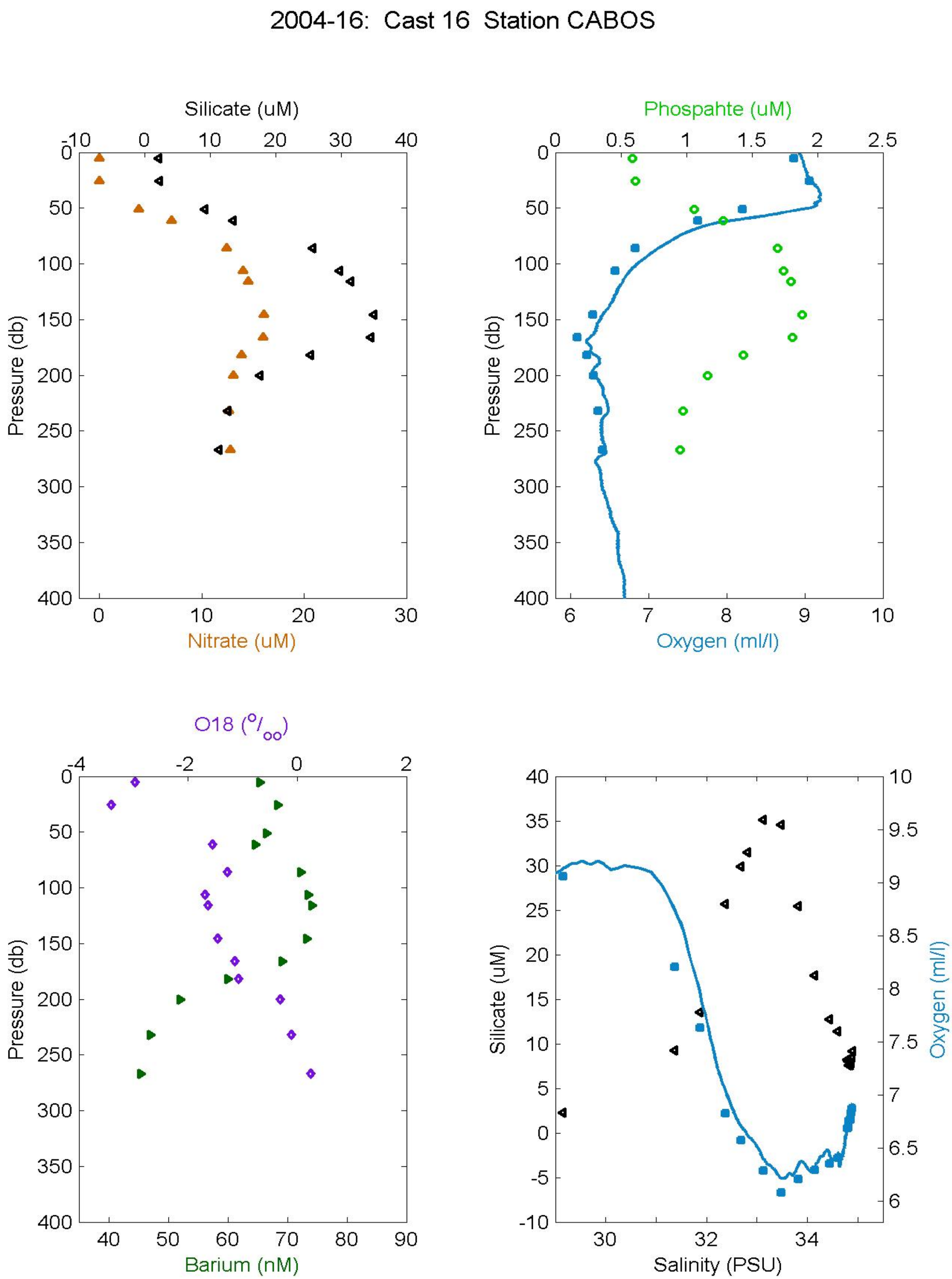


2004-16: Cast 15 Station 15

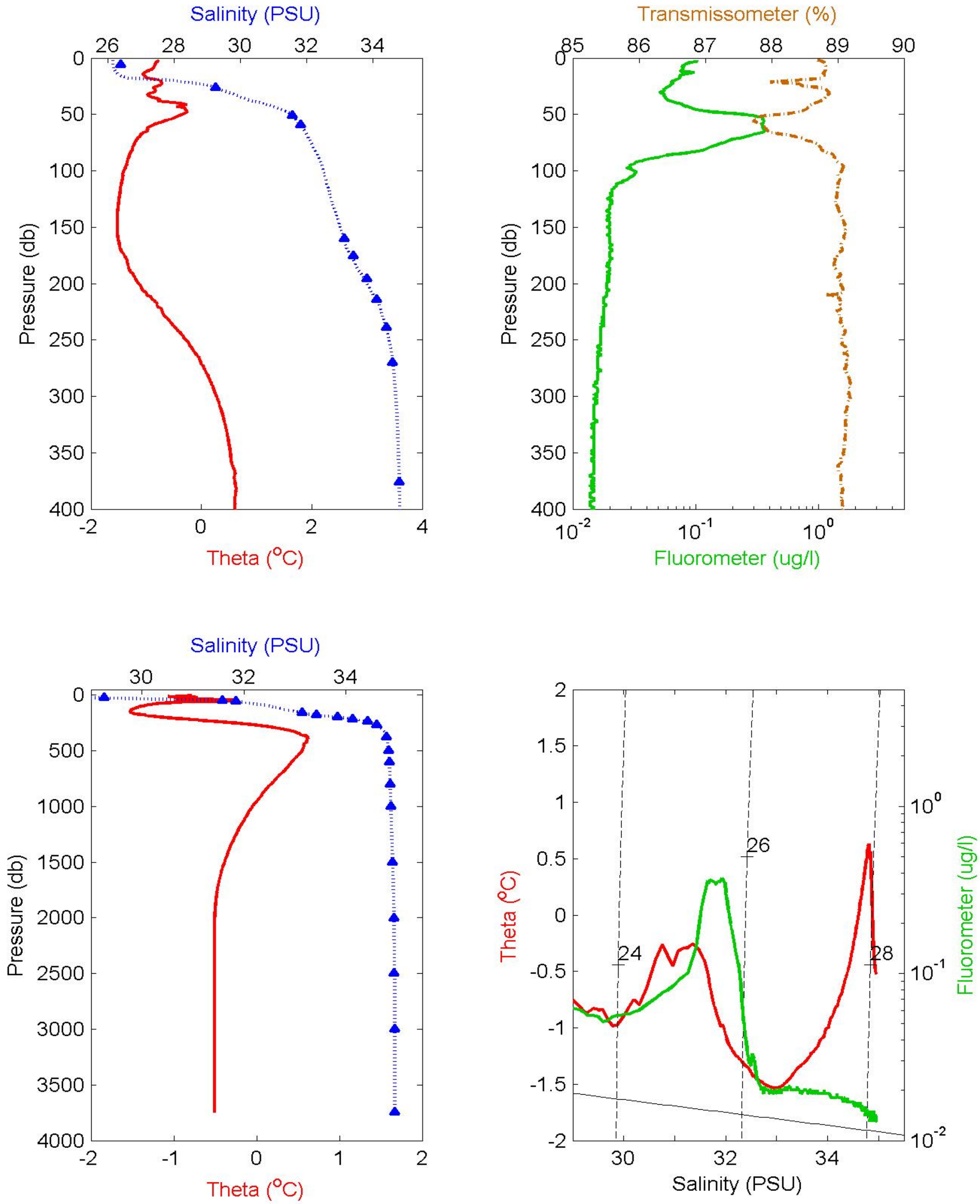


2004-16: Cast 16 Station CABOS

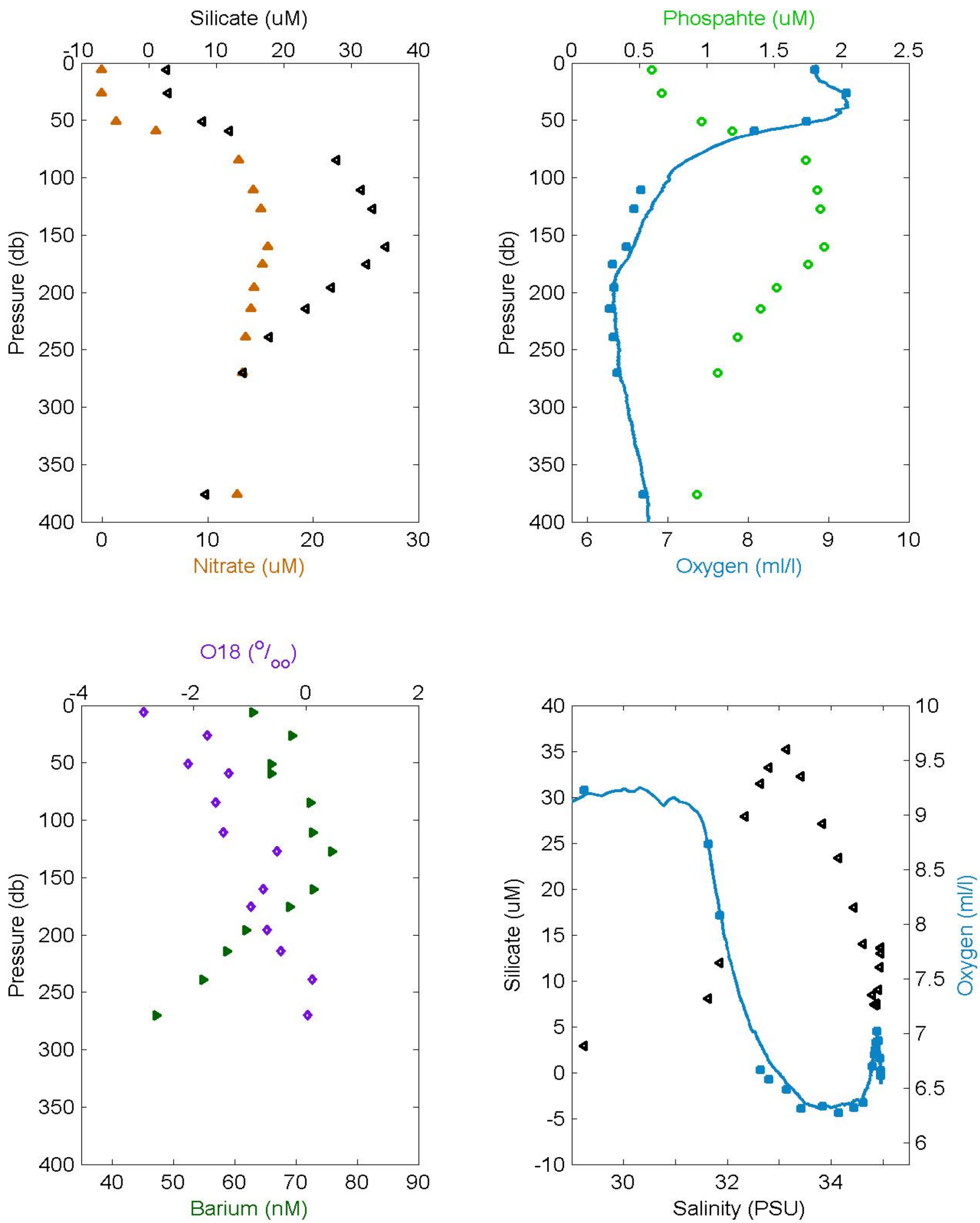



2004-16: Cast 16 Station CABOS
Silicate (uM)
Nitrate (uM)
Pressure (db)
Phospahte (uM)
Oxygen (ml/l)
Pressure (db)
O18 (°/oo)
Barium (nM)
Pressure (db)
Silicate (uM)
Oxygen (ml/l)
Salinity (PSU)

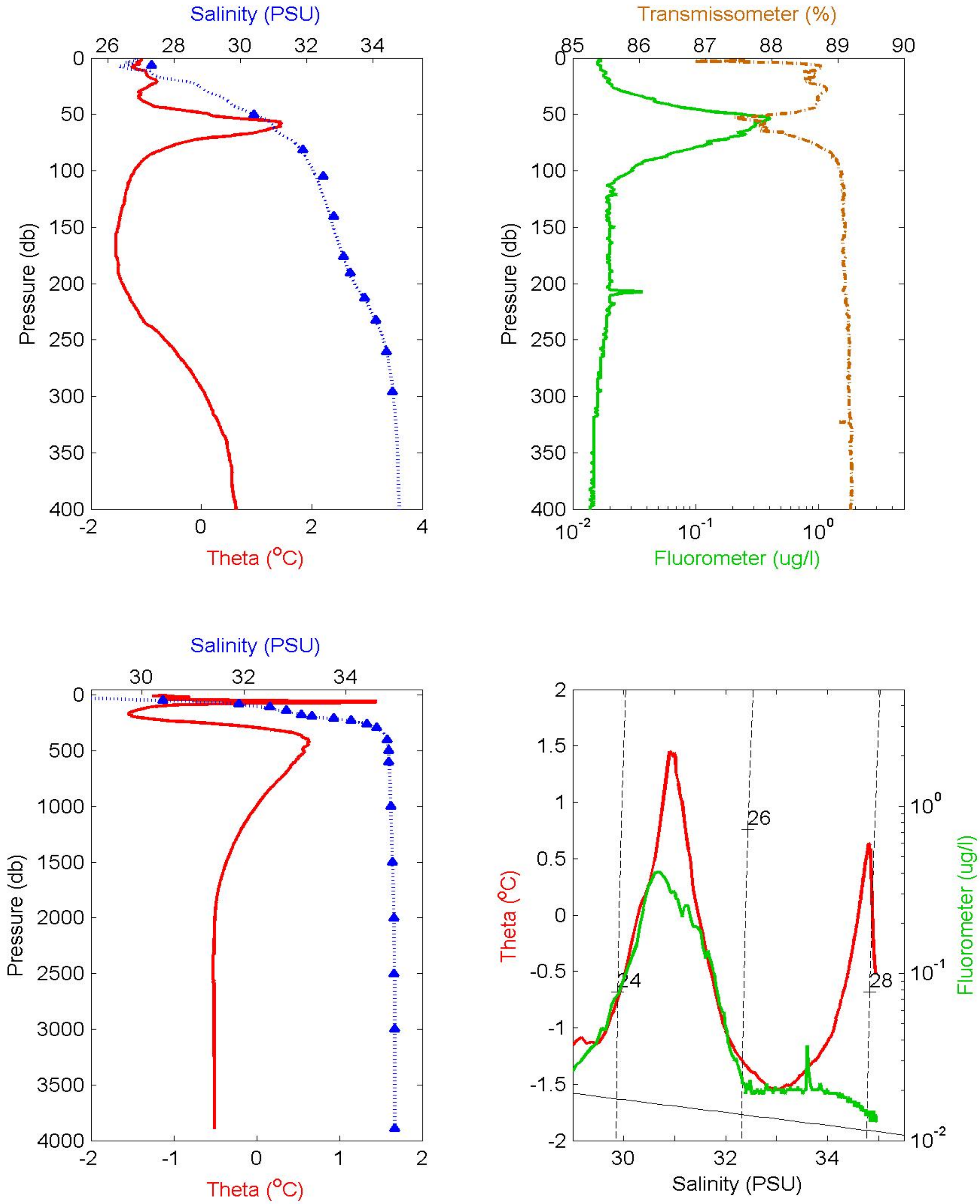
2004-16: Cast 17 Station CB-2



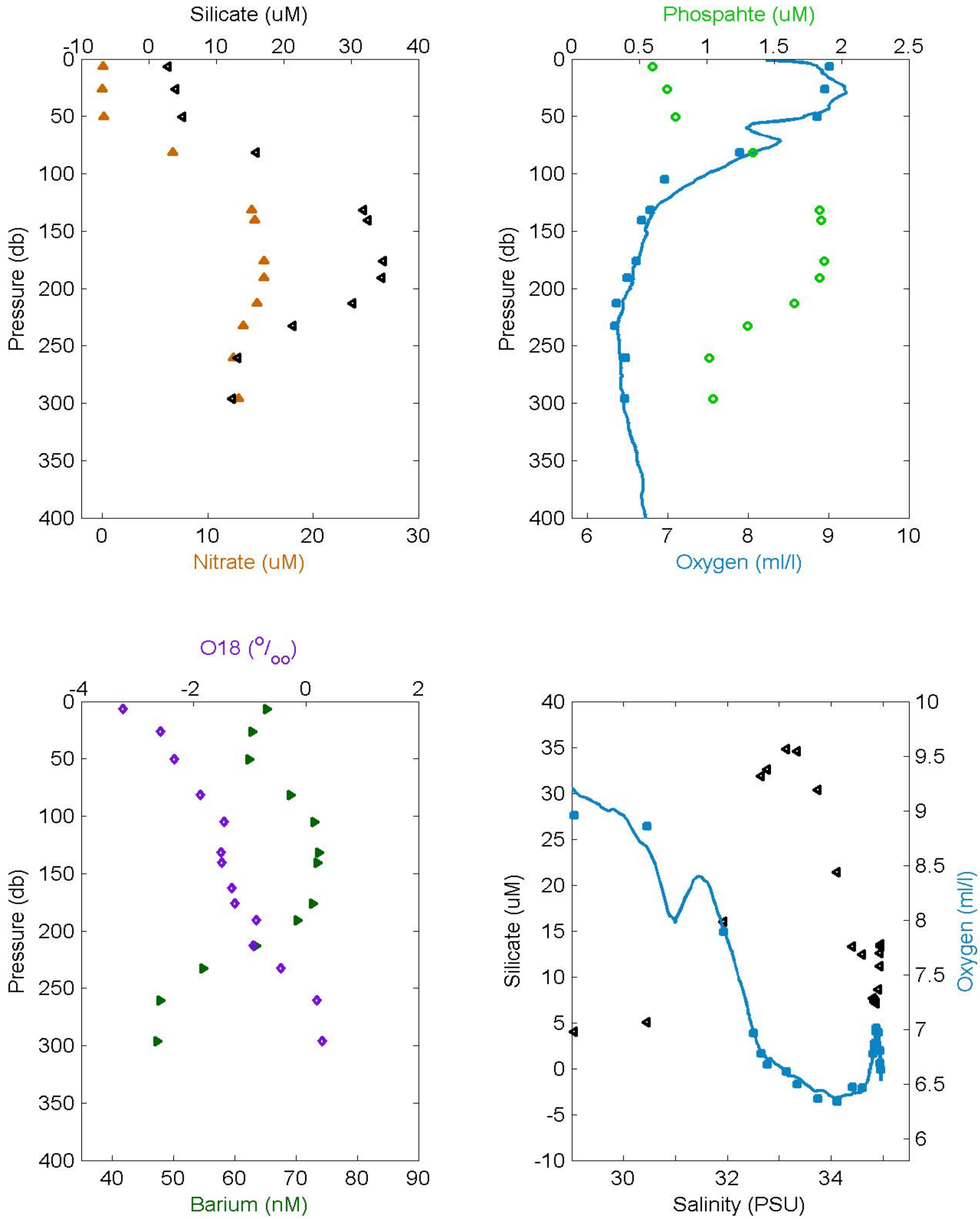
2004-16: Cast 17 Station CB-2



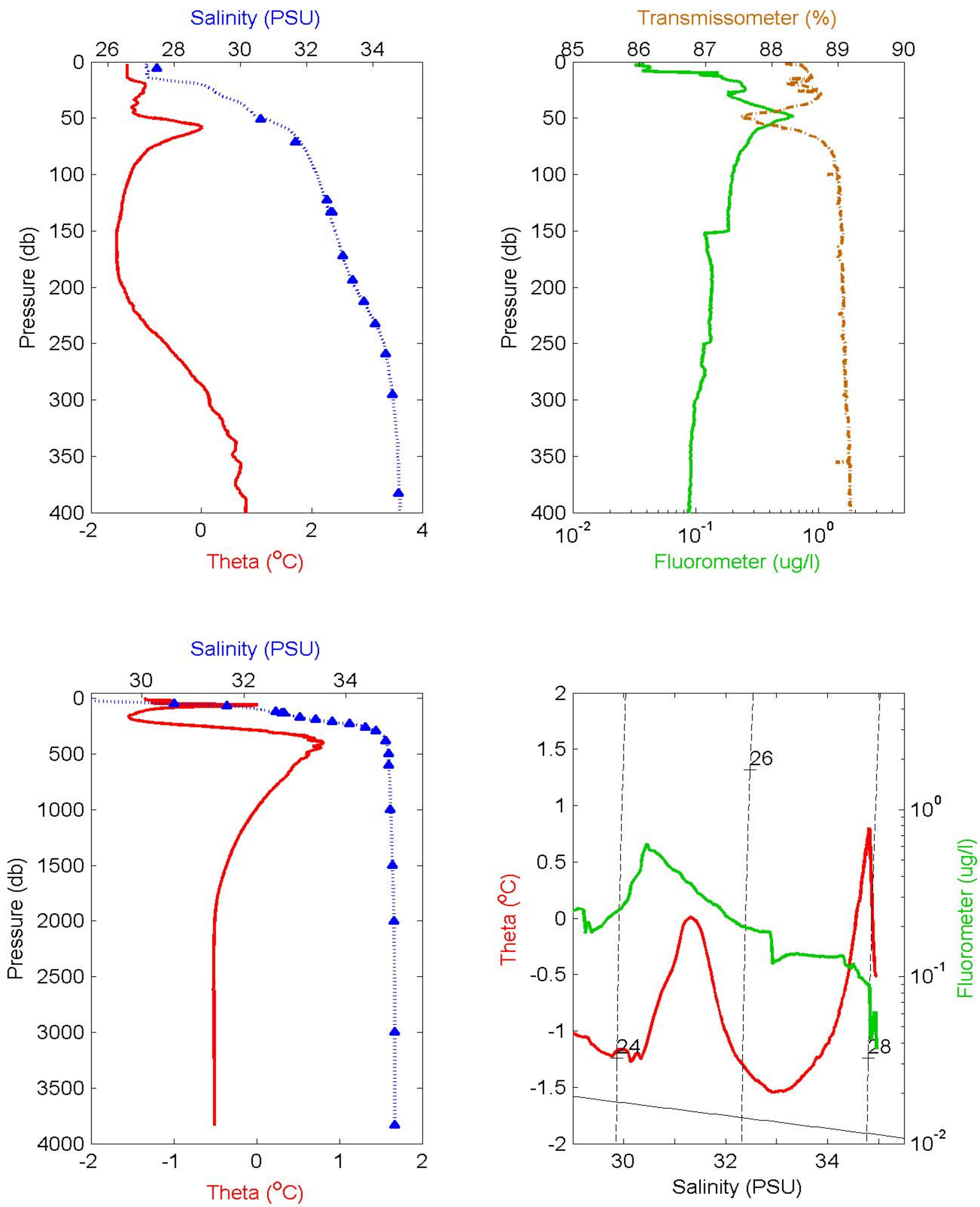
2004-16: Cast 18 Station CB-3



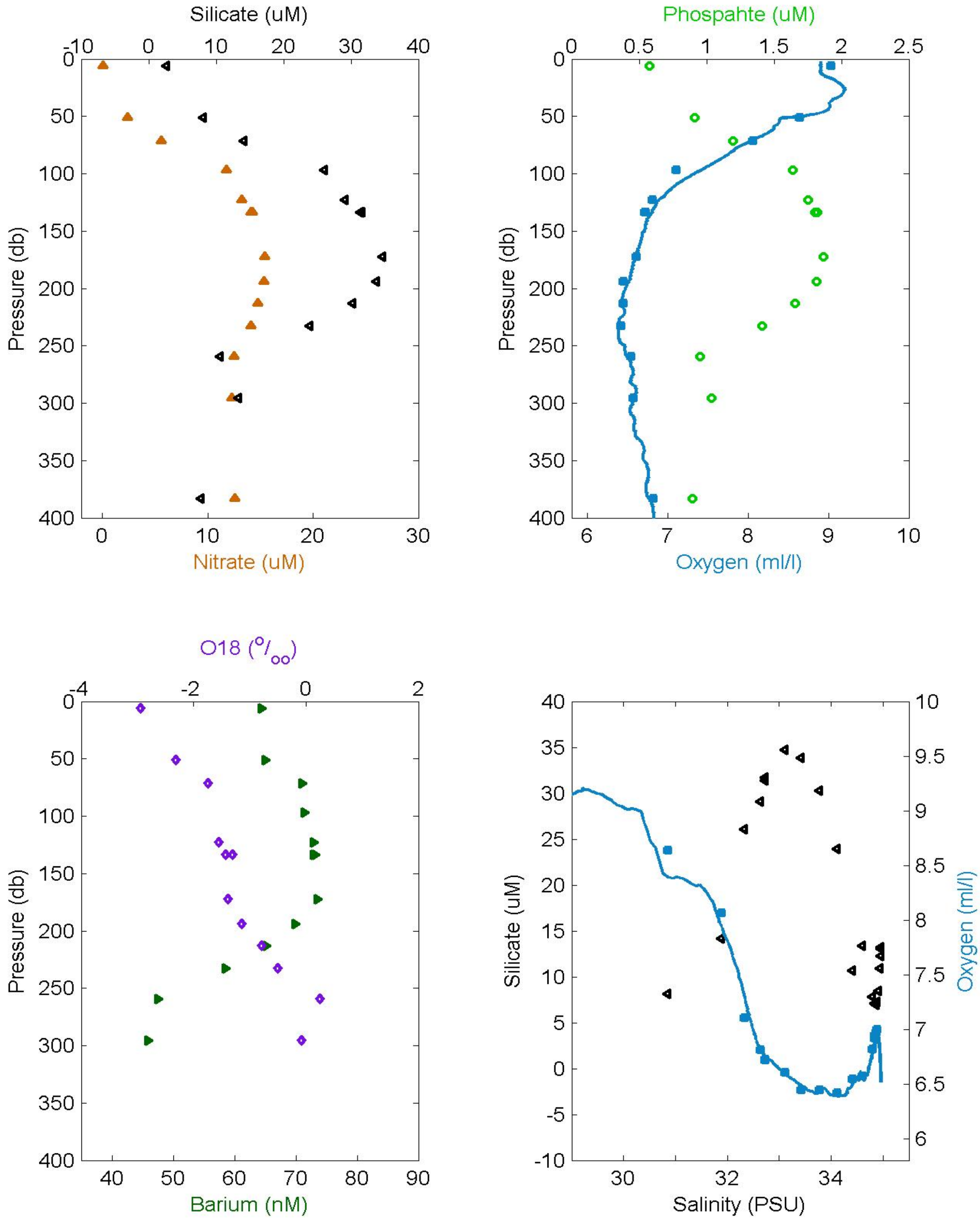
2004-16: Cast 18 Station CB-3



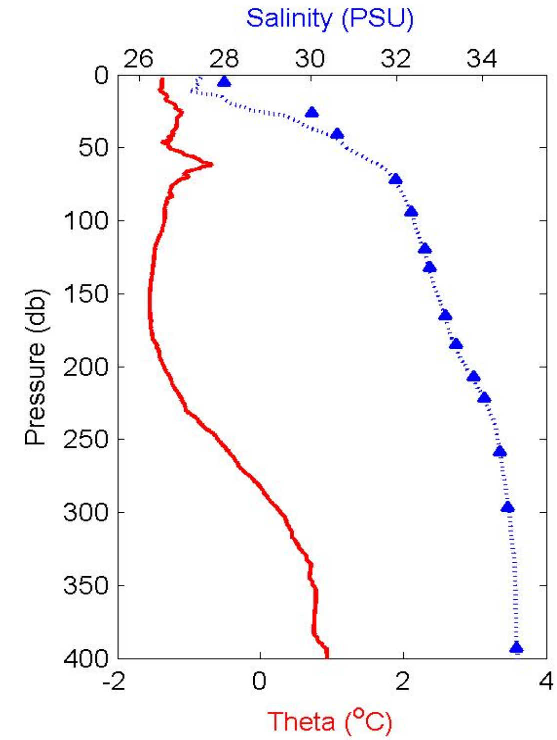
2004-16: Cast 19 Station CB-4

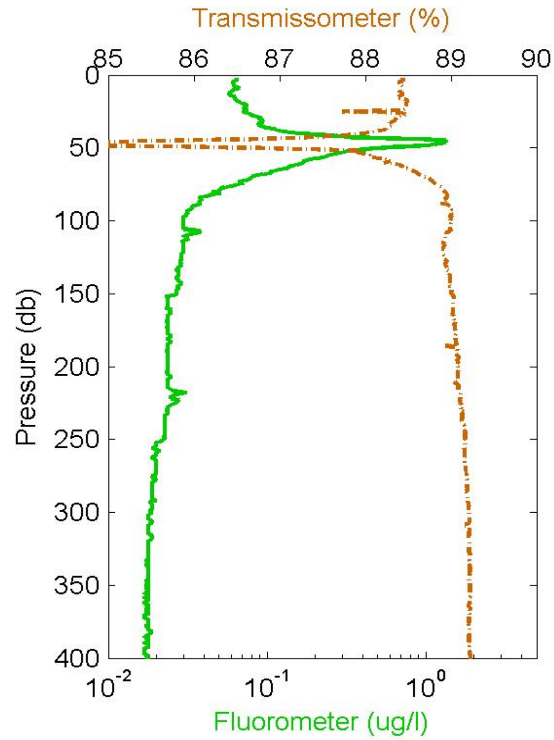


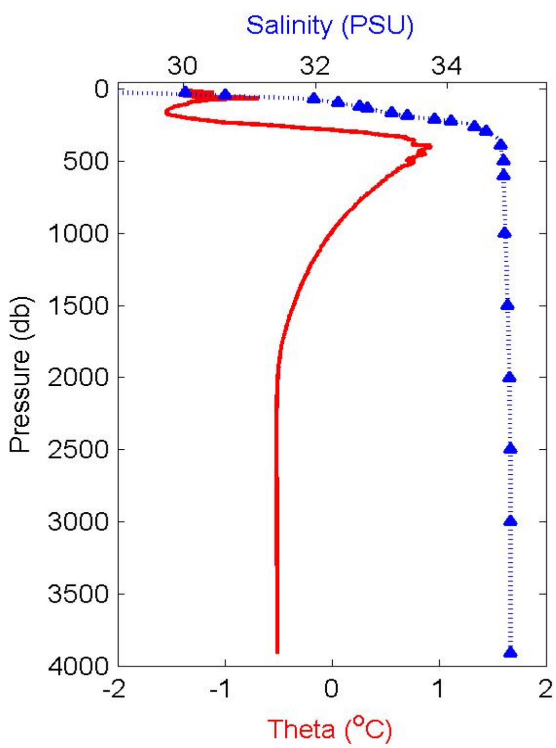
2004-16: Cast 19 Station CB-4

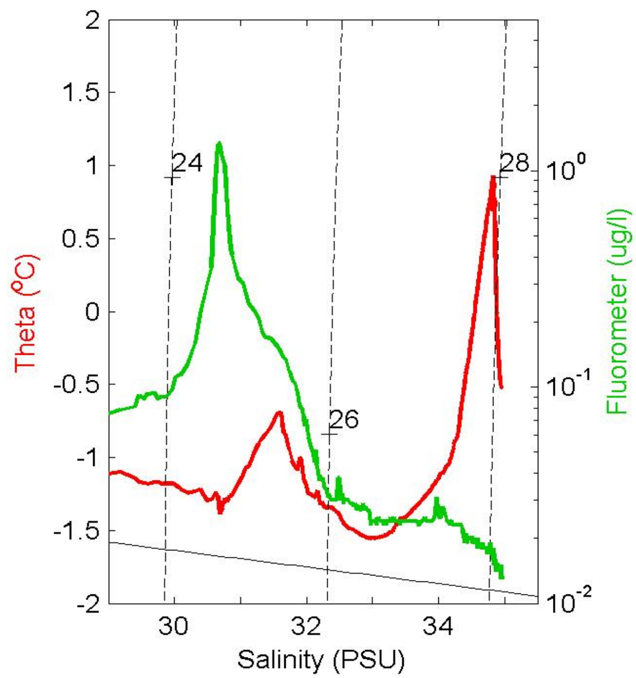


2004-16: Cast 20 Station CB-5

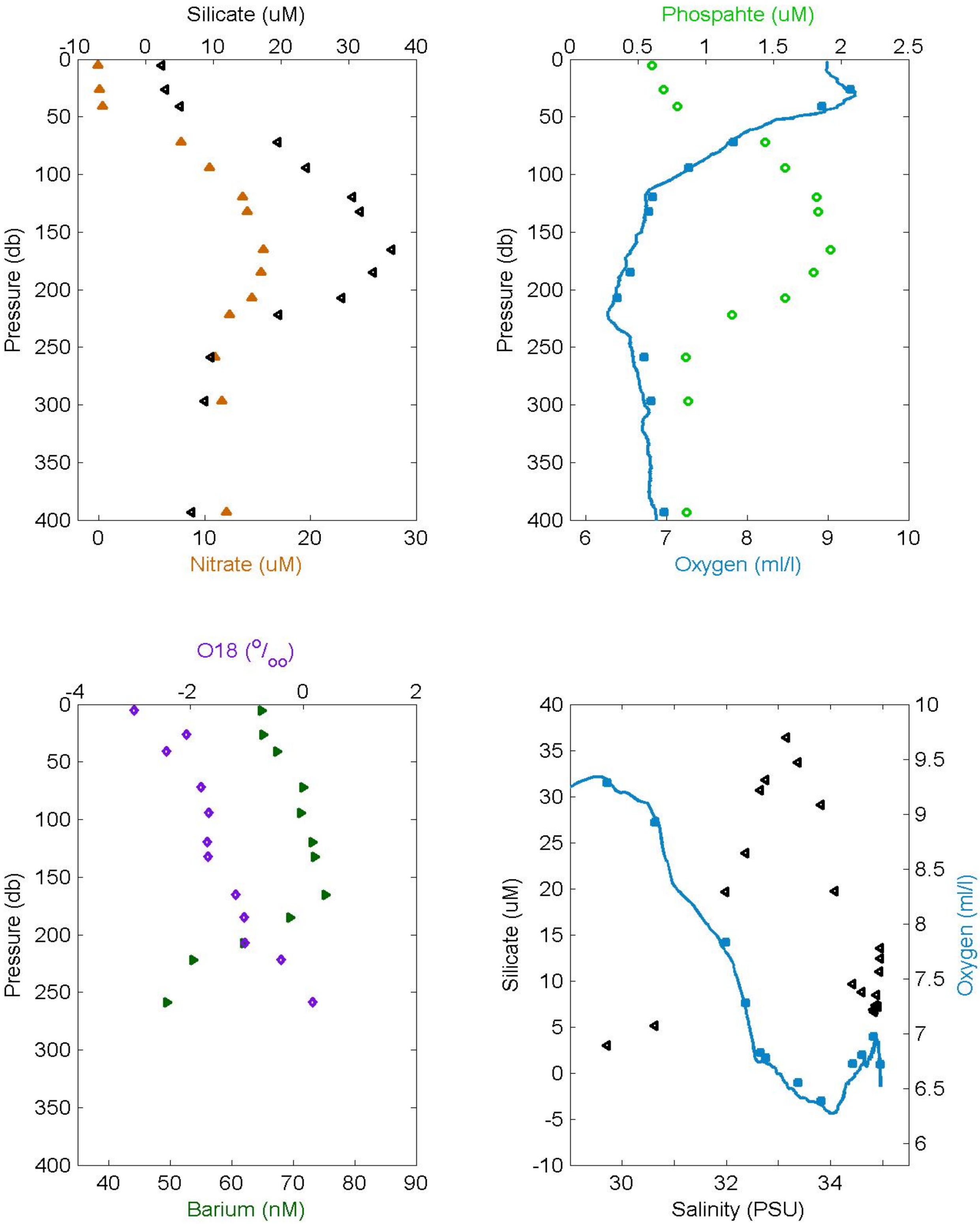




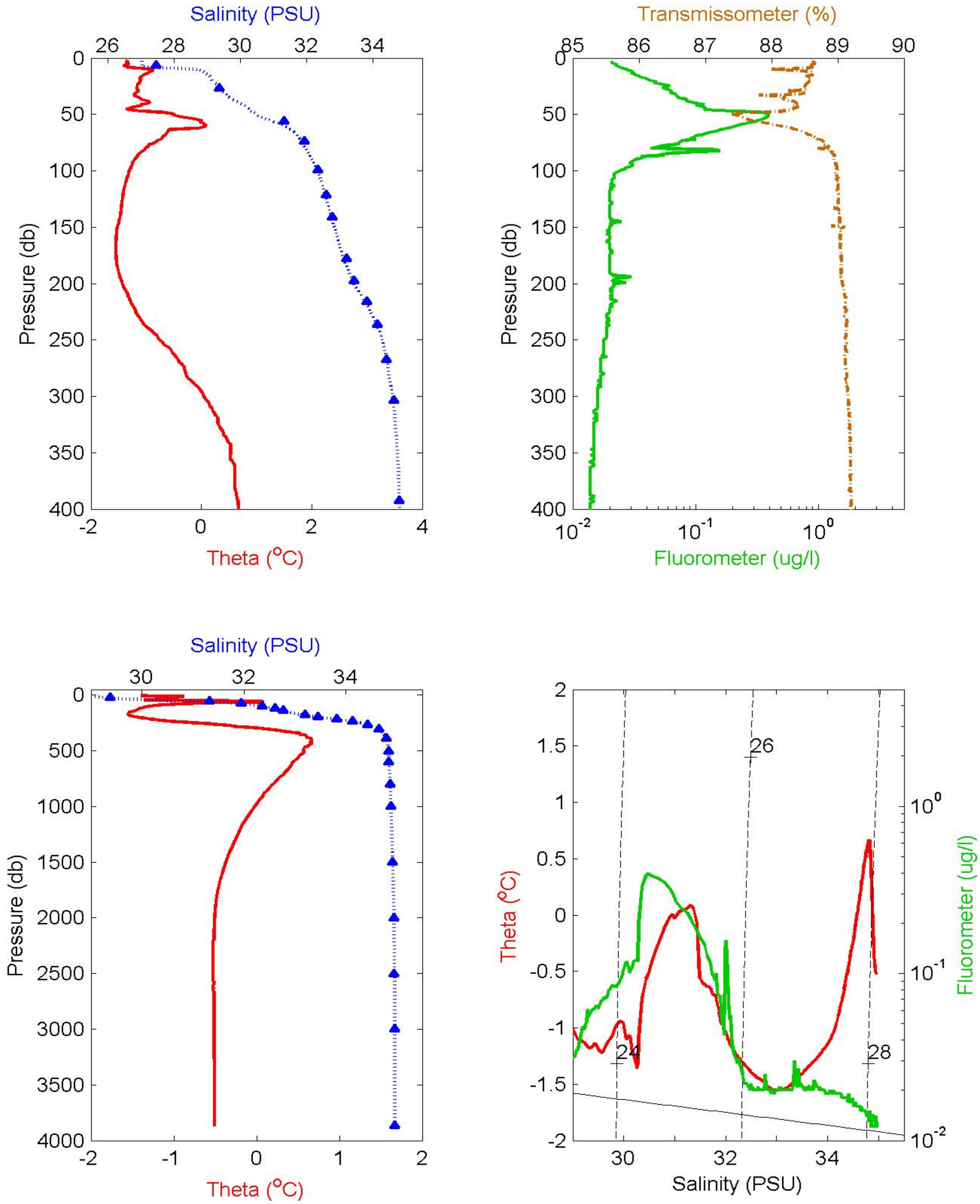




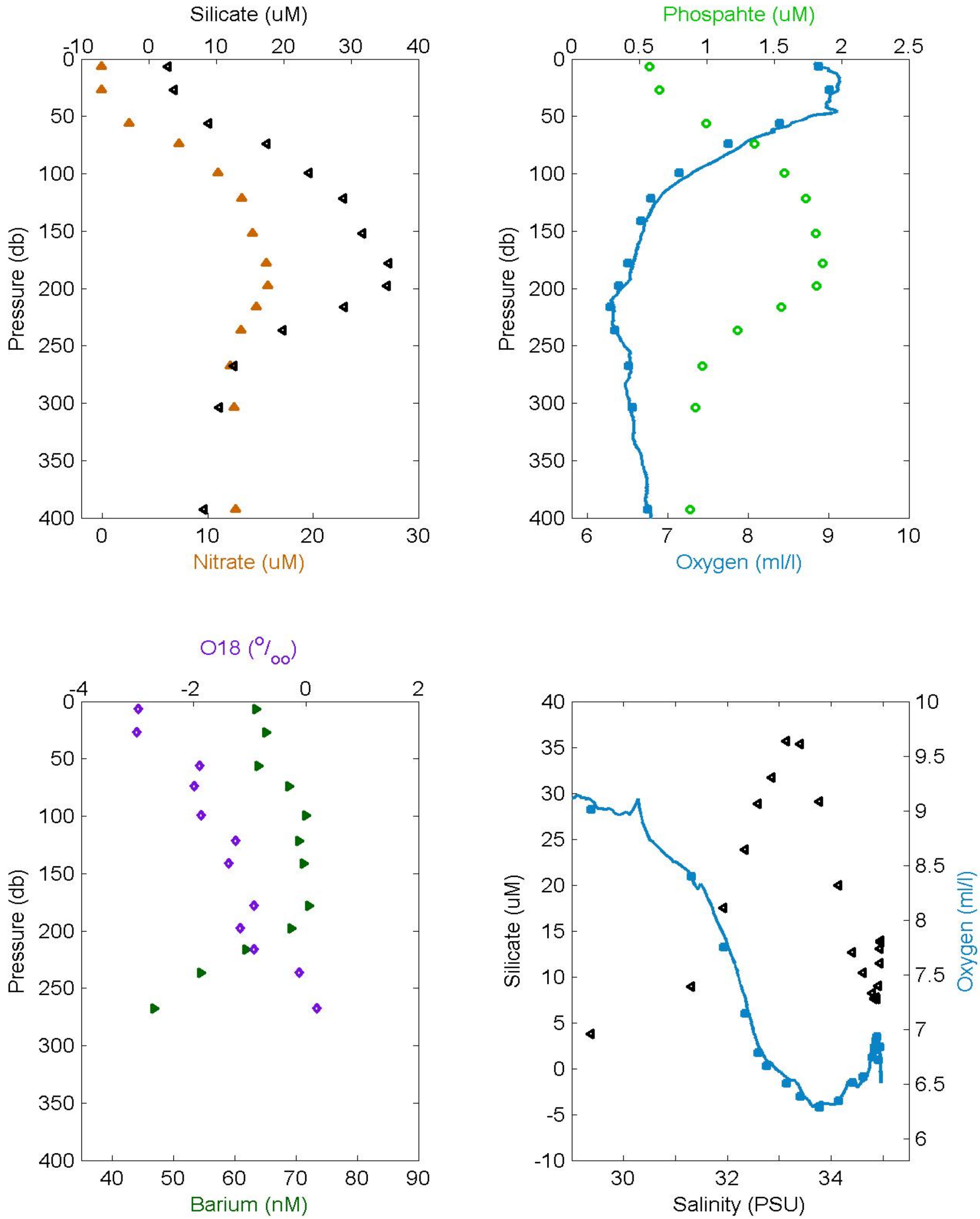
2004-16: Cast 20 Station CB-5



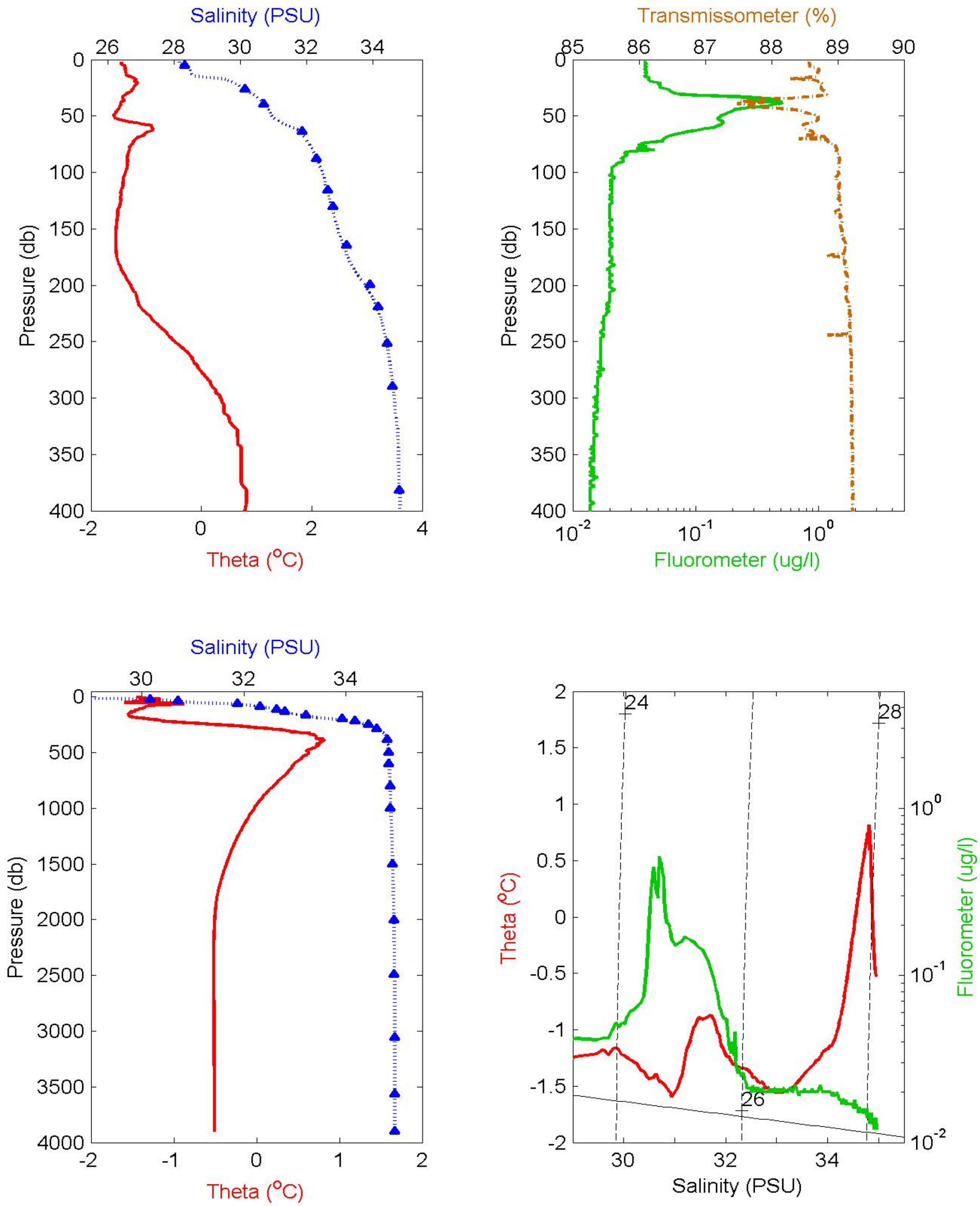
2004-16: Cast 21 Station CB-6



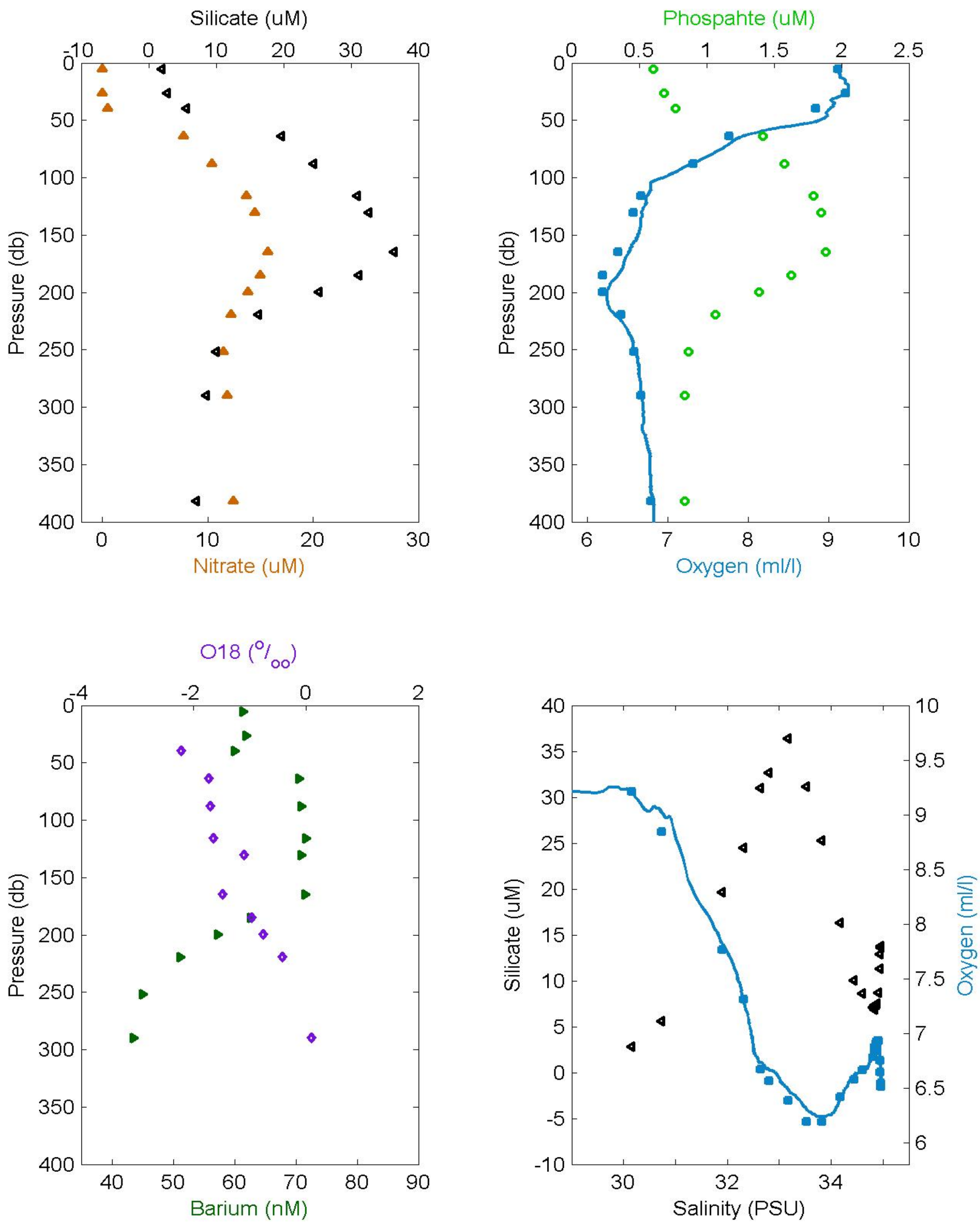
2004-16: Cast 21 Station CB-6



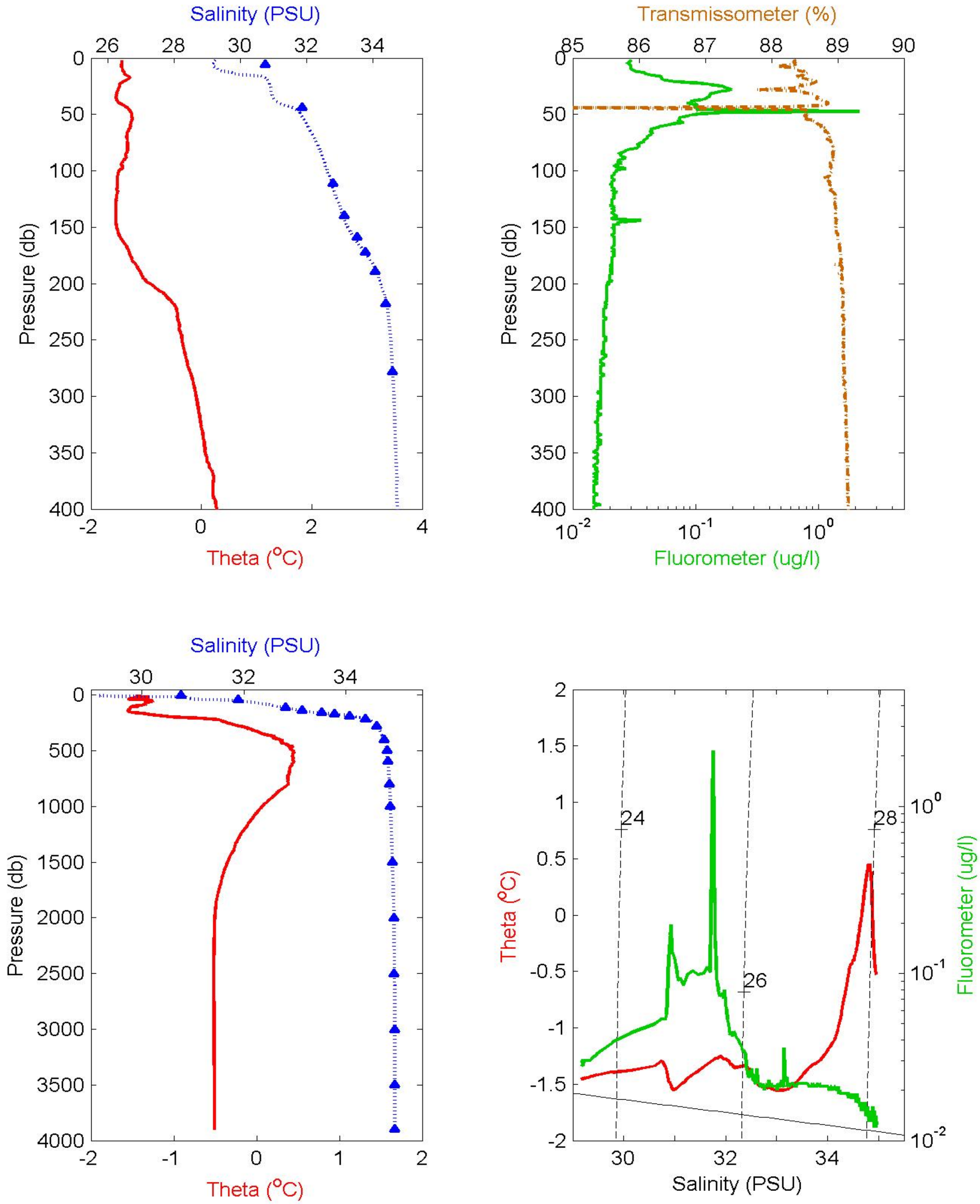
2004-16: Cast 22 Station CB-7



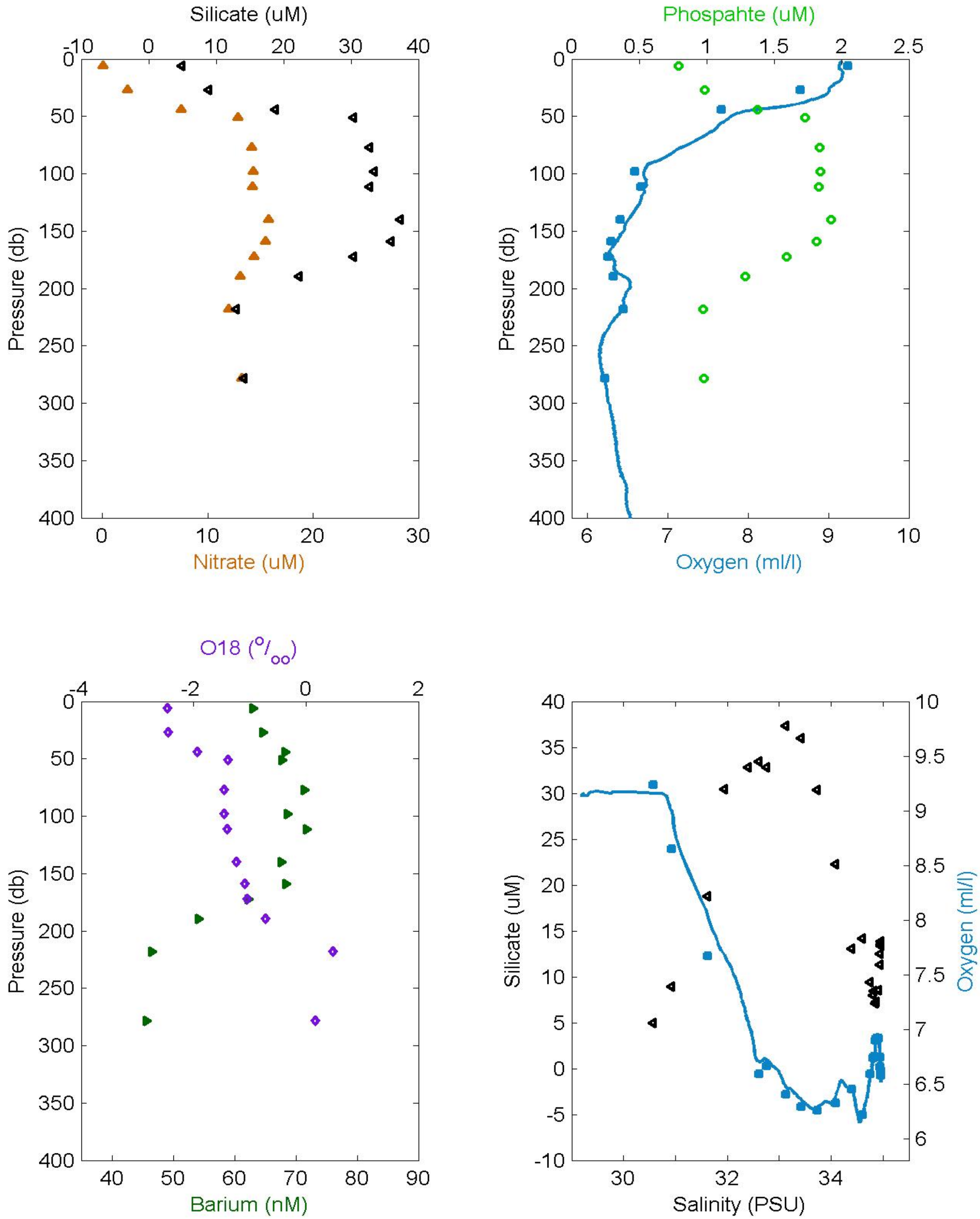
2004-16: Cast 22 Station CB-7



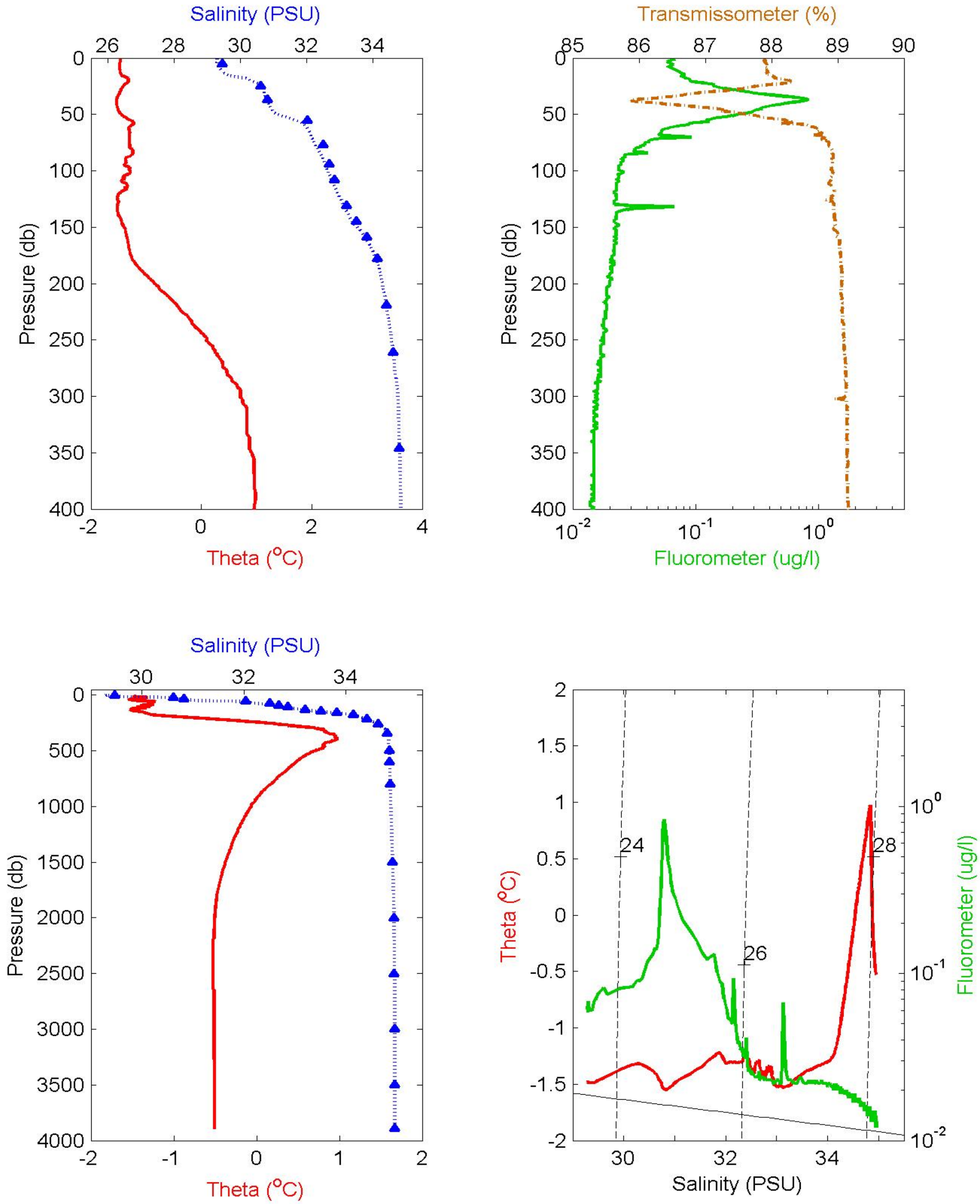
2004-16: Cast 23 Station CB-8



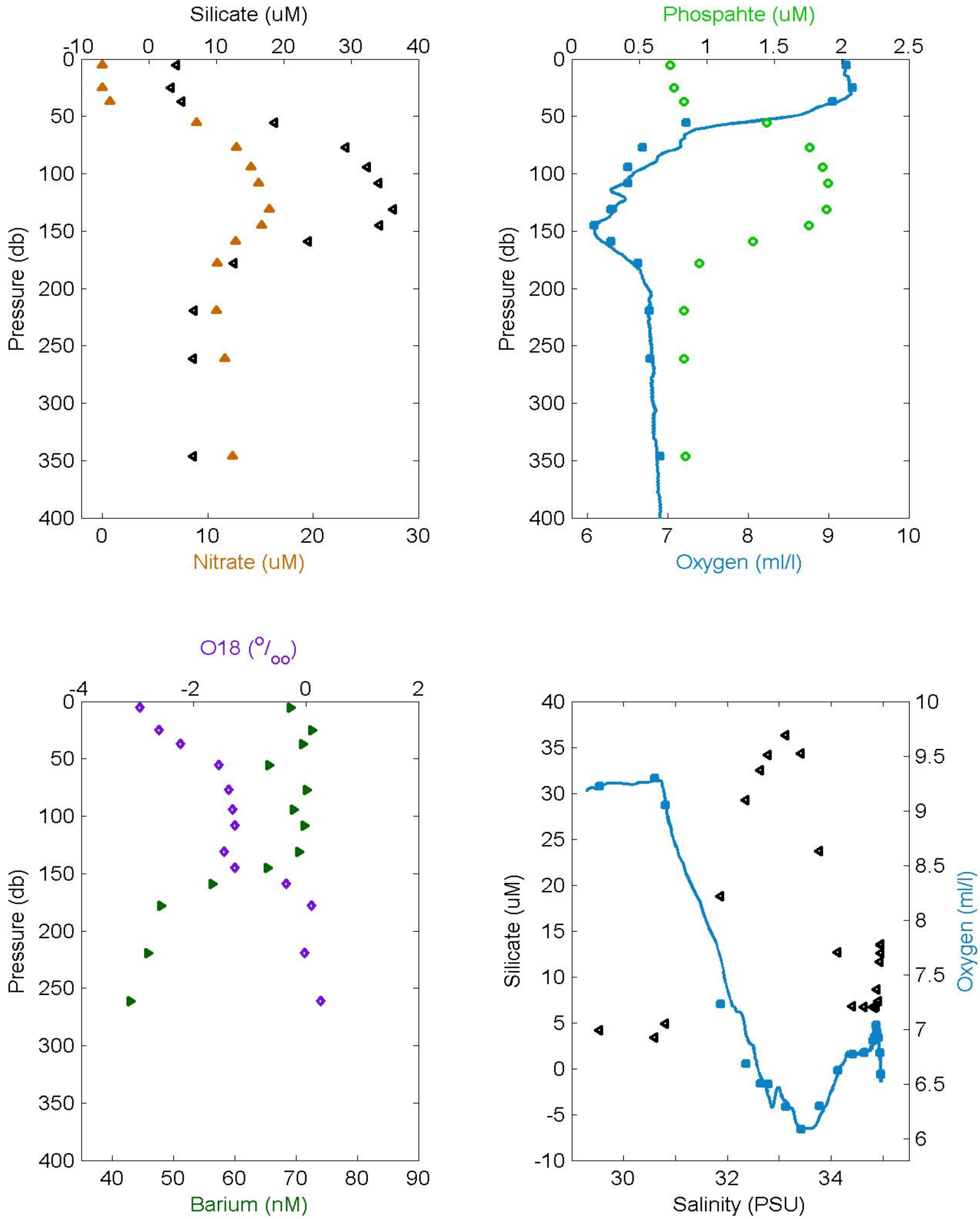
2004-16: Cast 23 Station CB-8



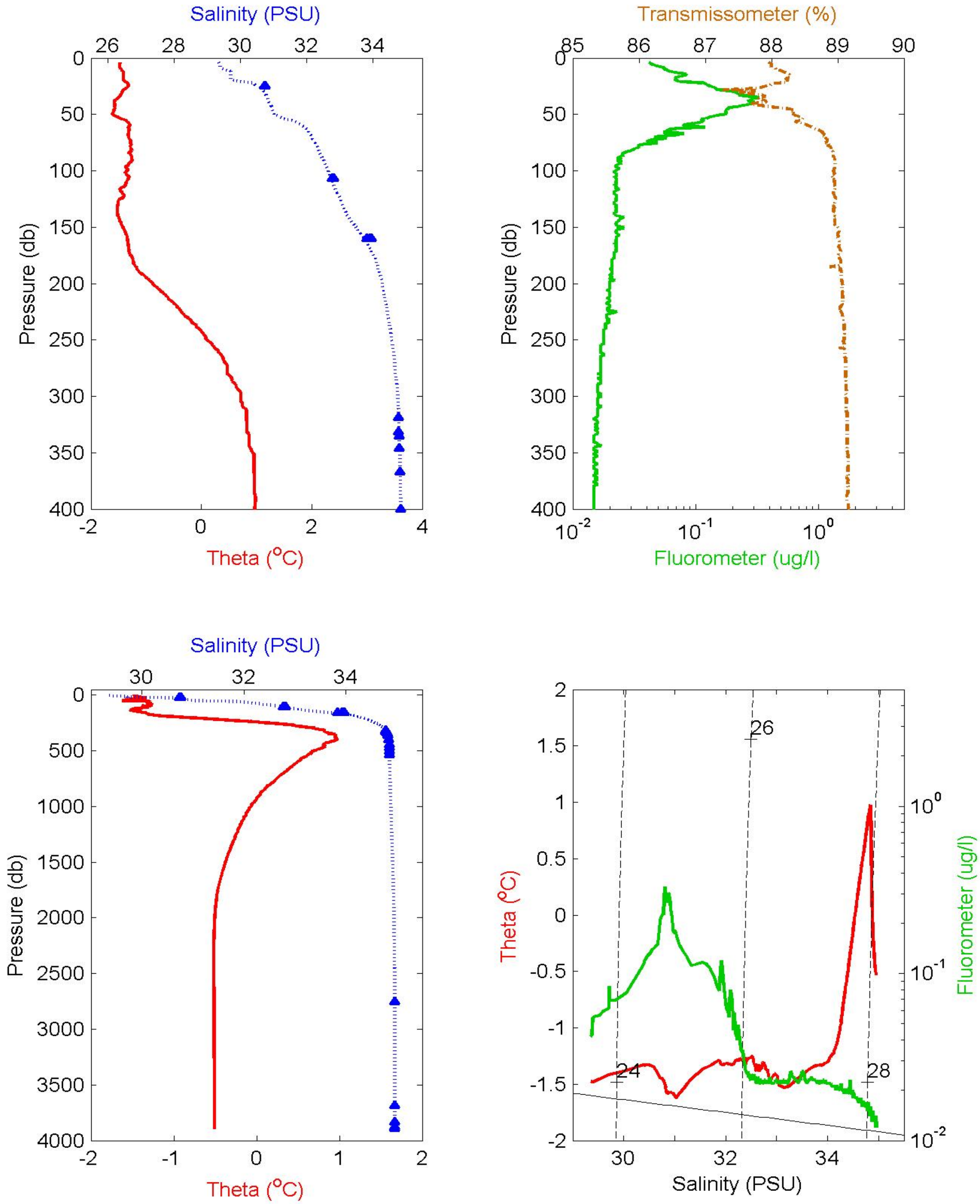
2004-16: Cast 24 Station CB-9



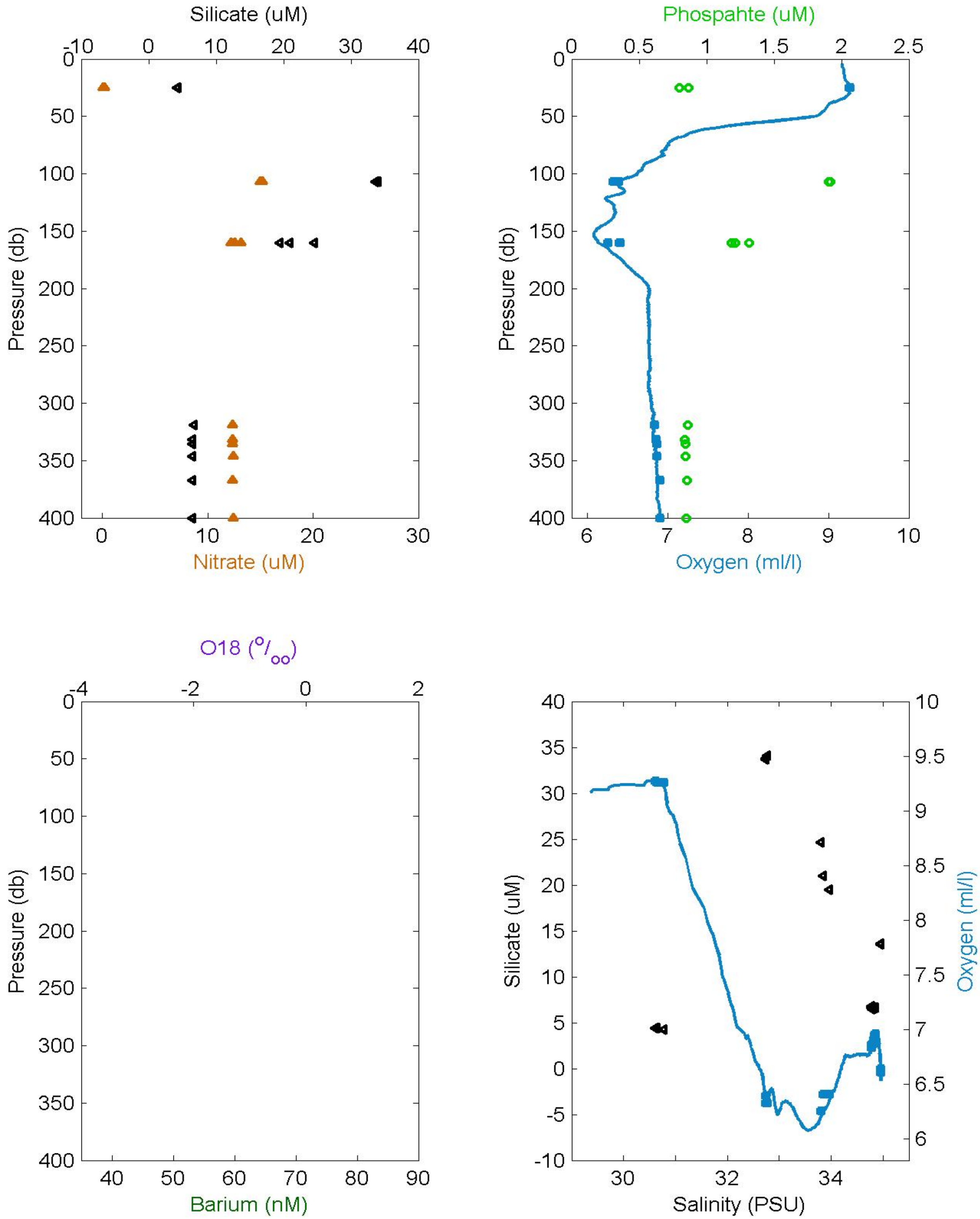
2004-16: Cast 24 Station CB-9



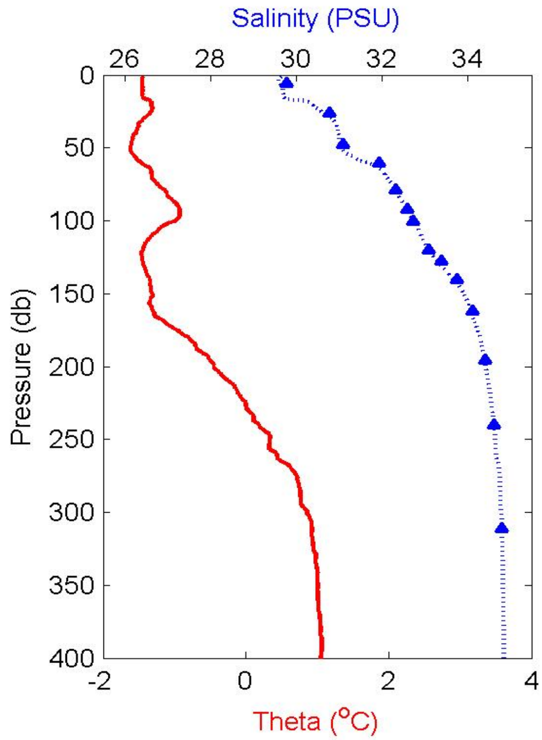
2004-16: Cast 25 Station CB-9(2)

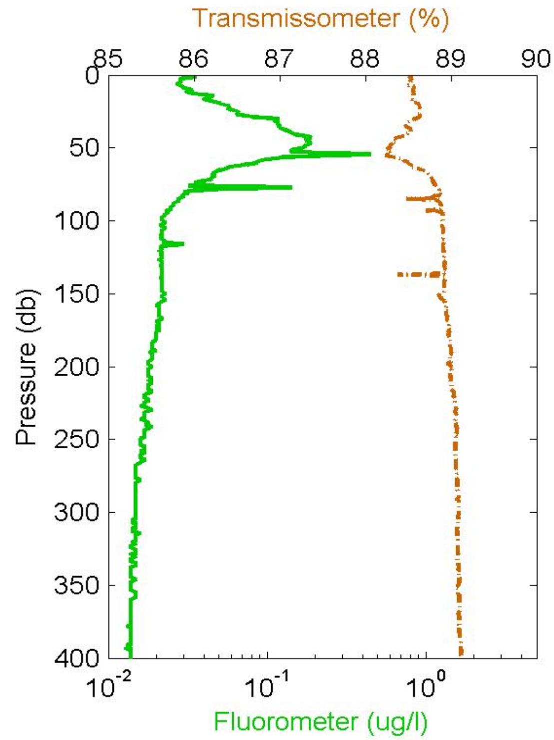


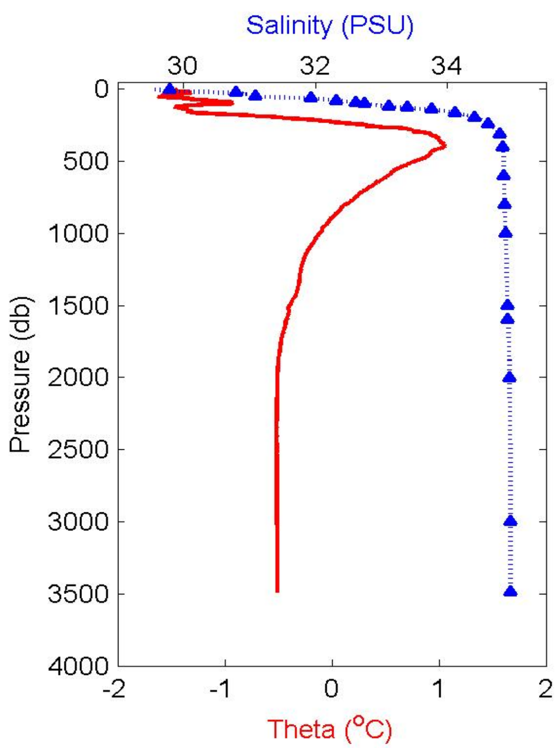
2004-16: Cast 25 Station CB-9(2)

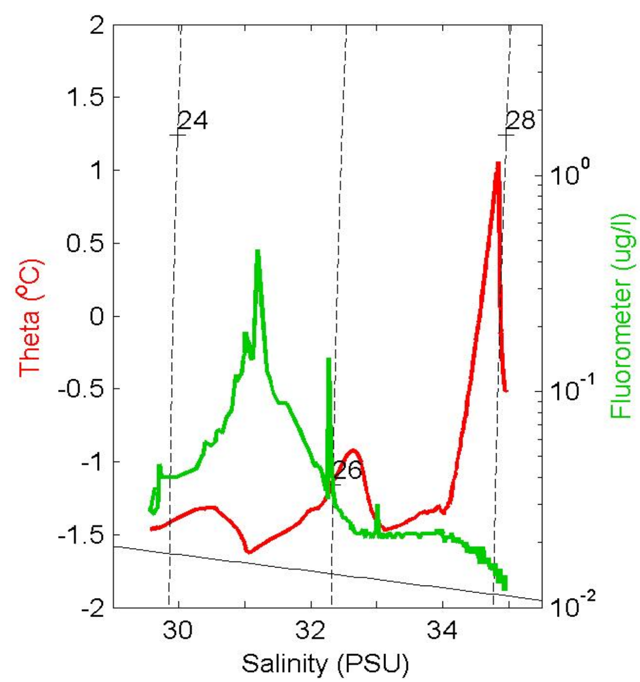


2004-16: Cast 26 Station CB-10

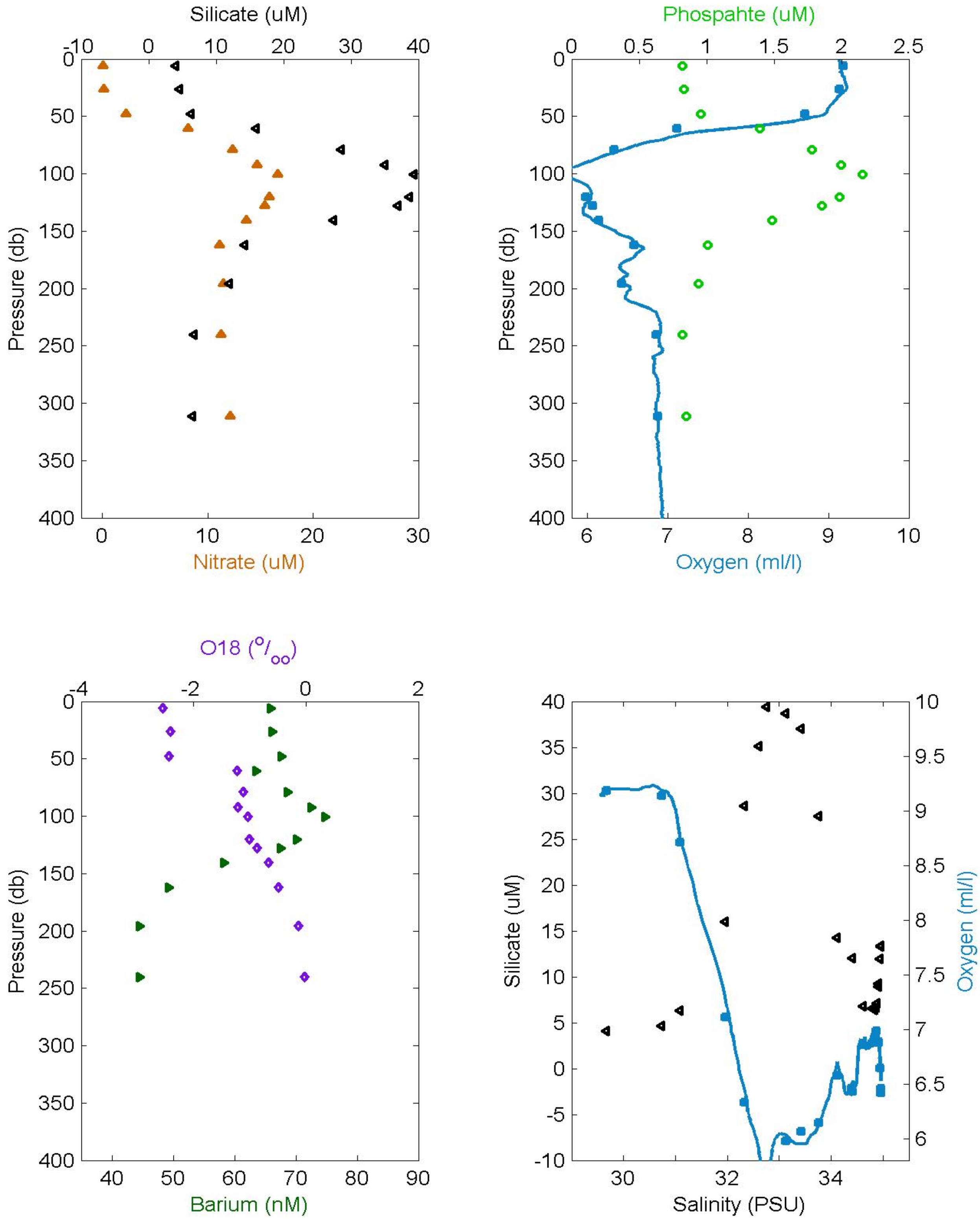




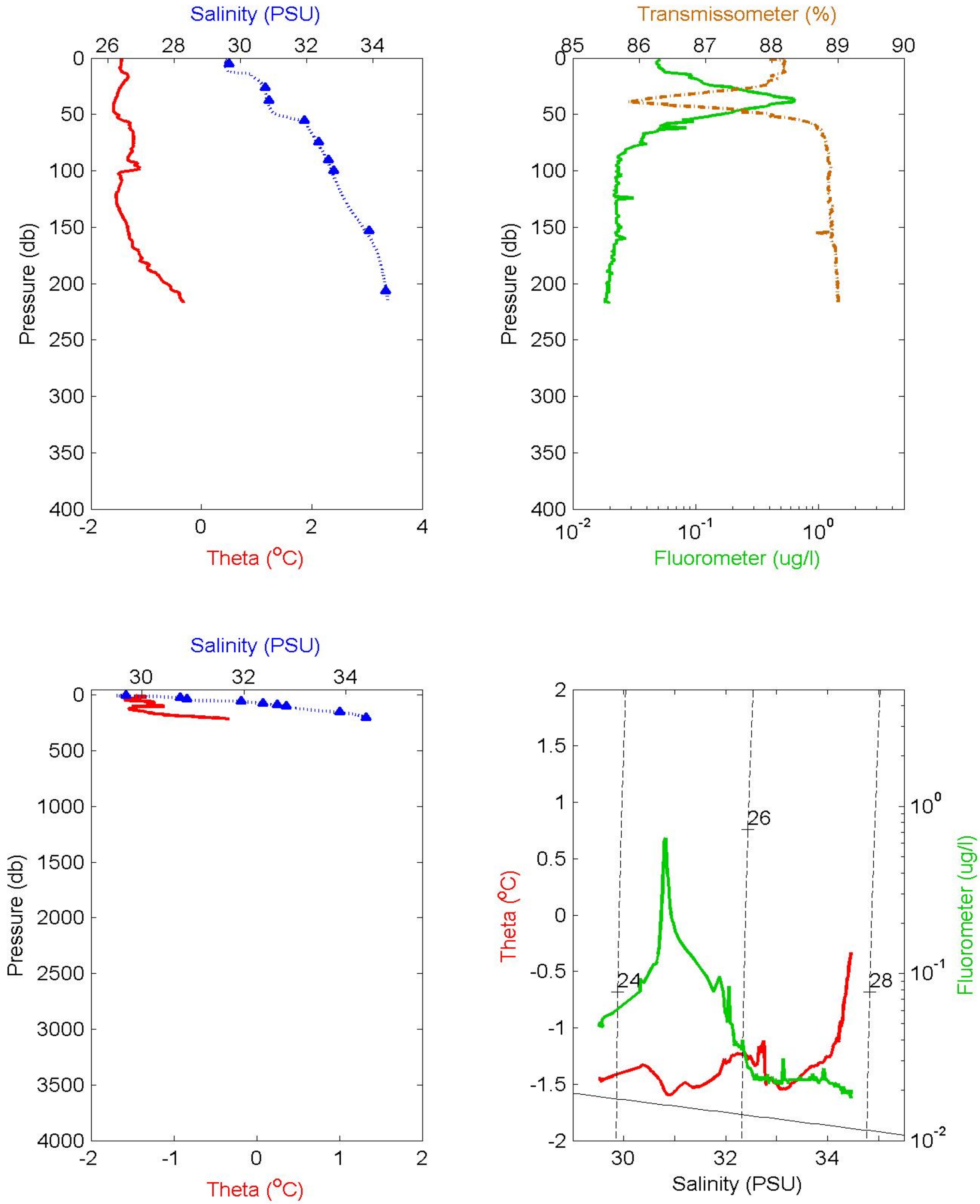




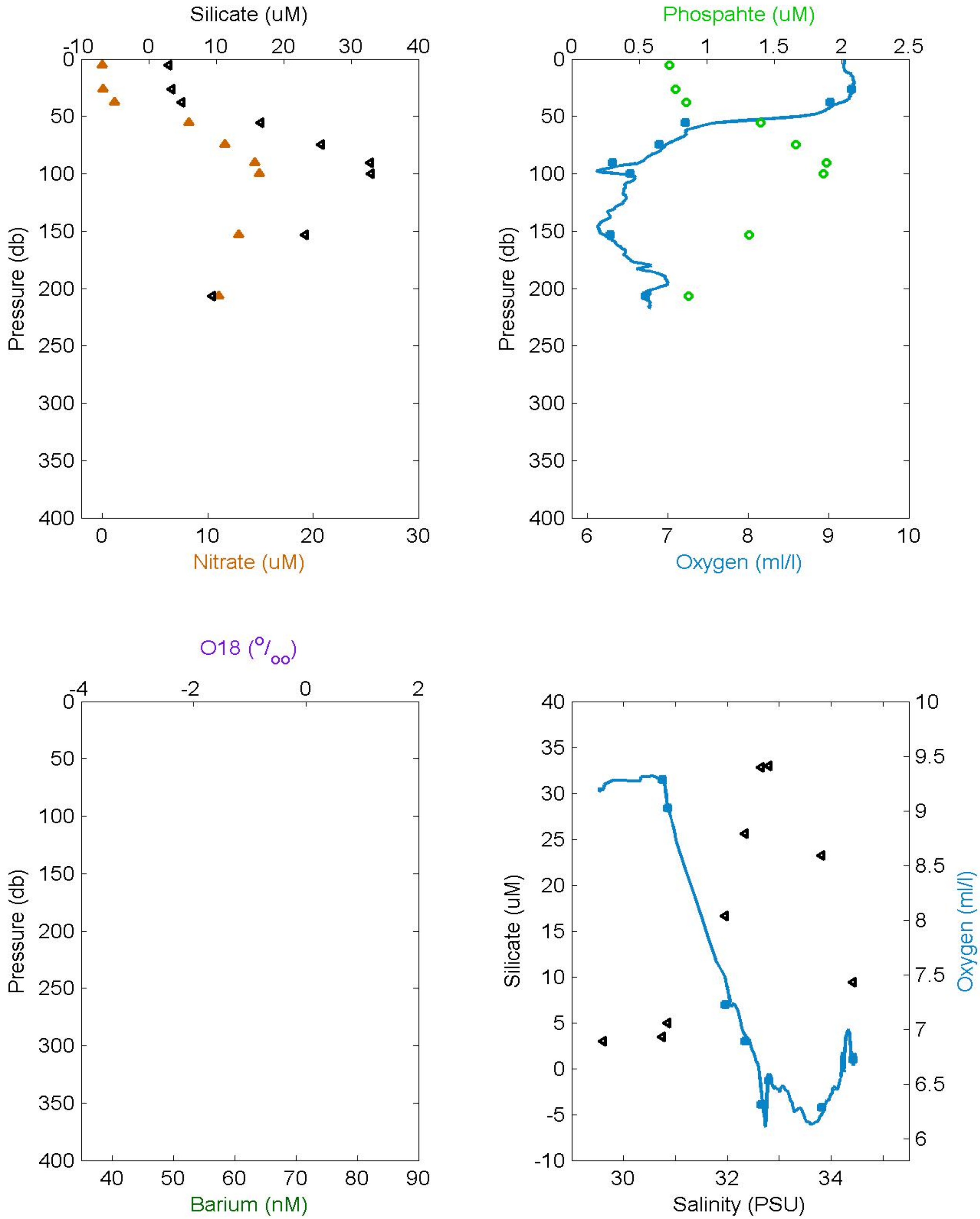
2004-16: Cast 26 Station CB-10



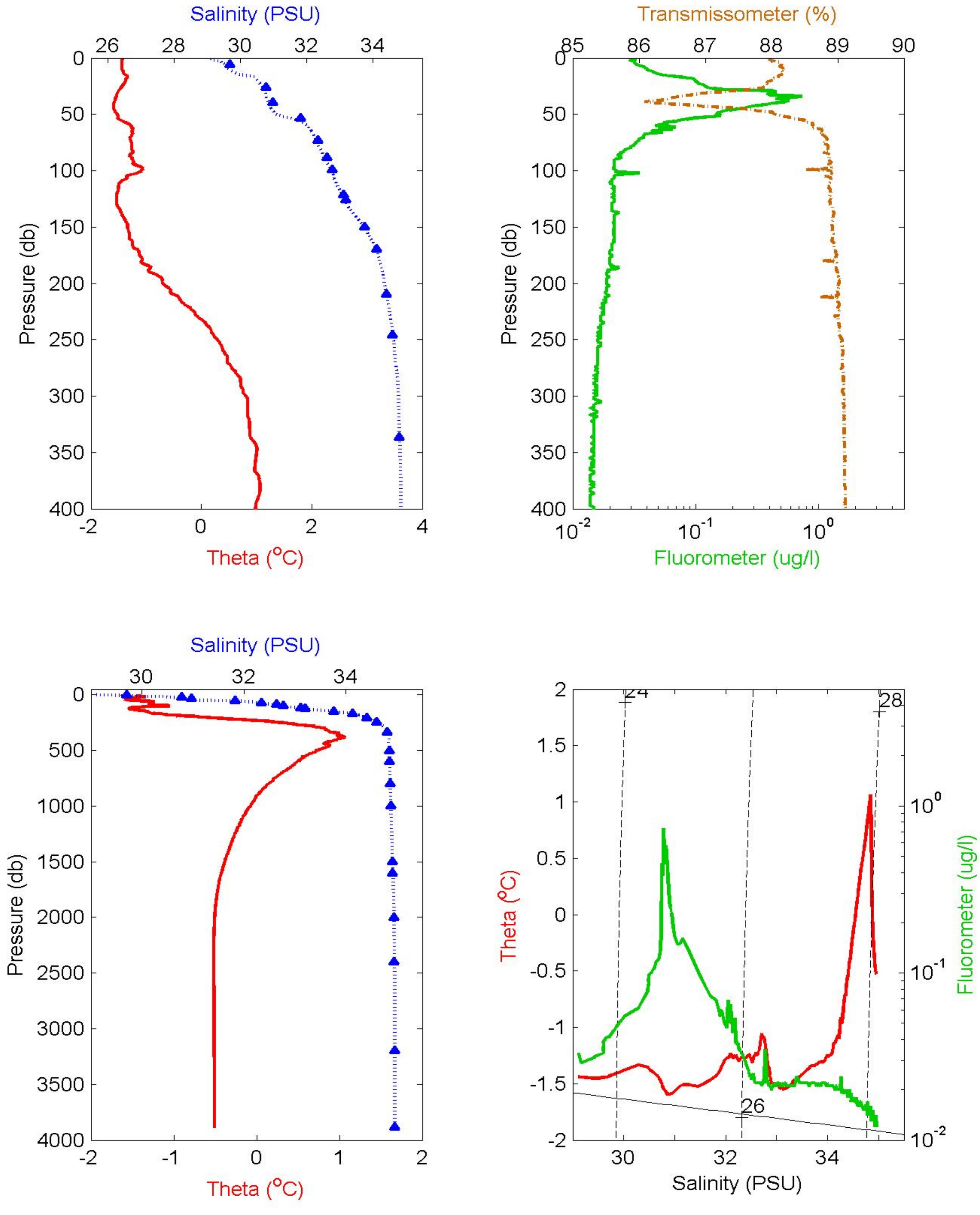
2004-16: Cast 27 Station CB-11



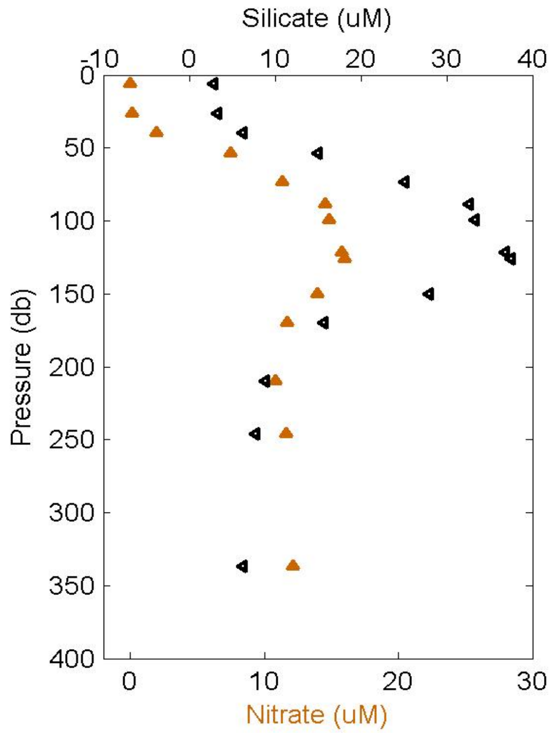
2004-16: Cast 27 Station CB-11

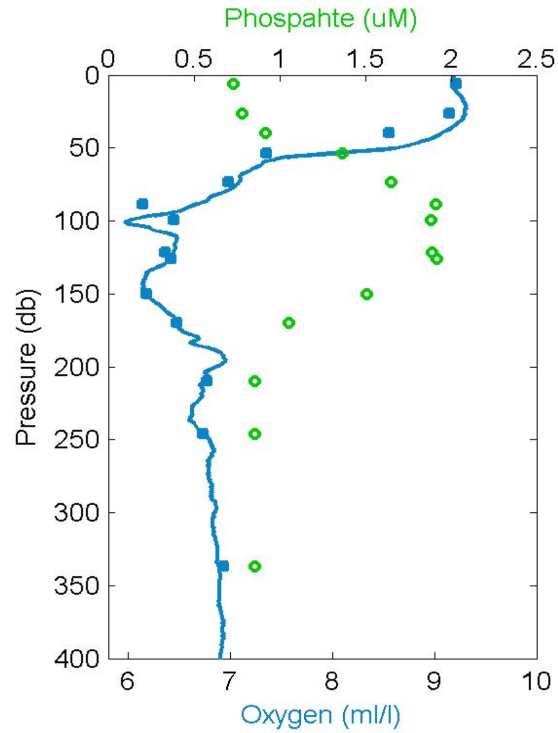


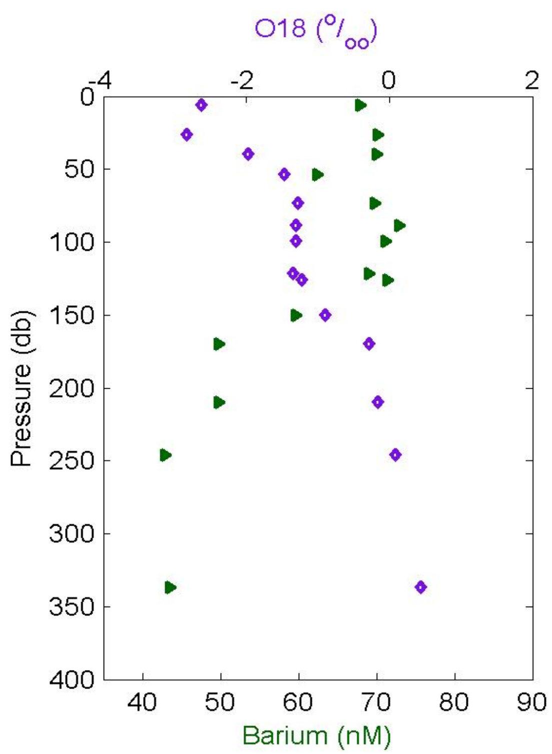
2004-16: Cast 28 Station CB-11(2)

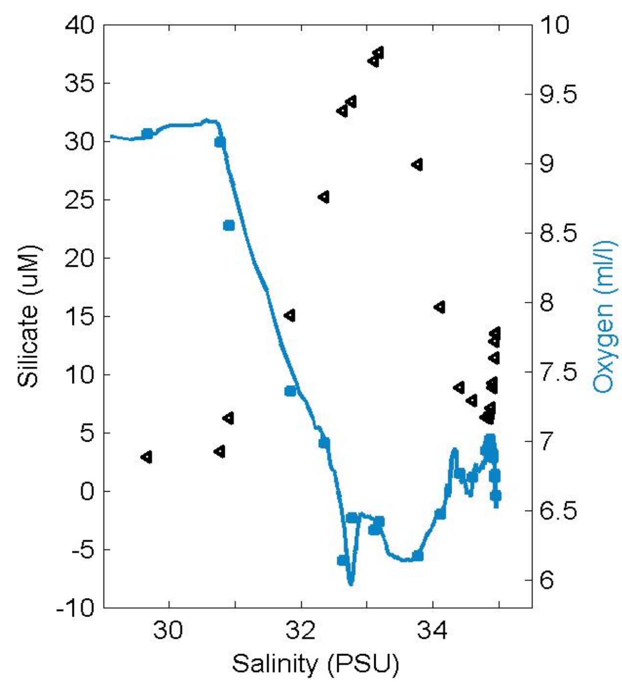


2004-16: Cast 28 Station CB-11(2)









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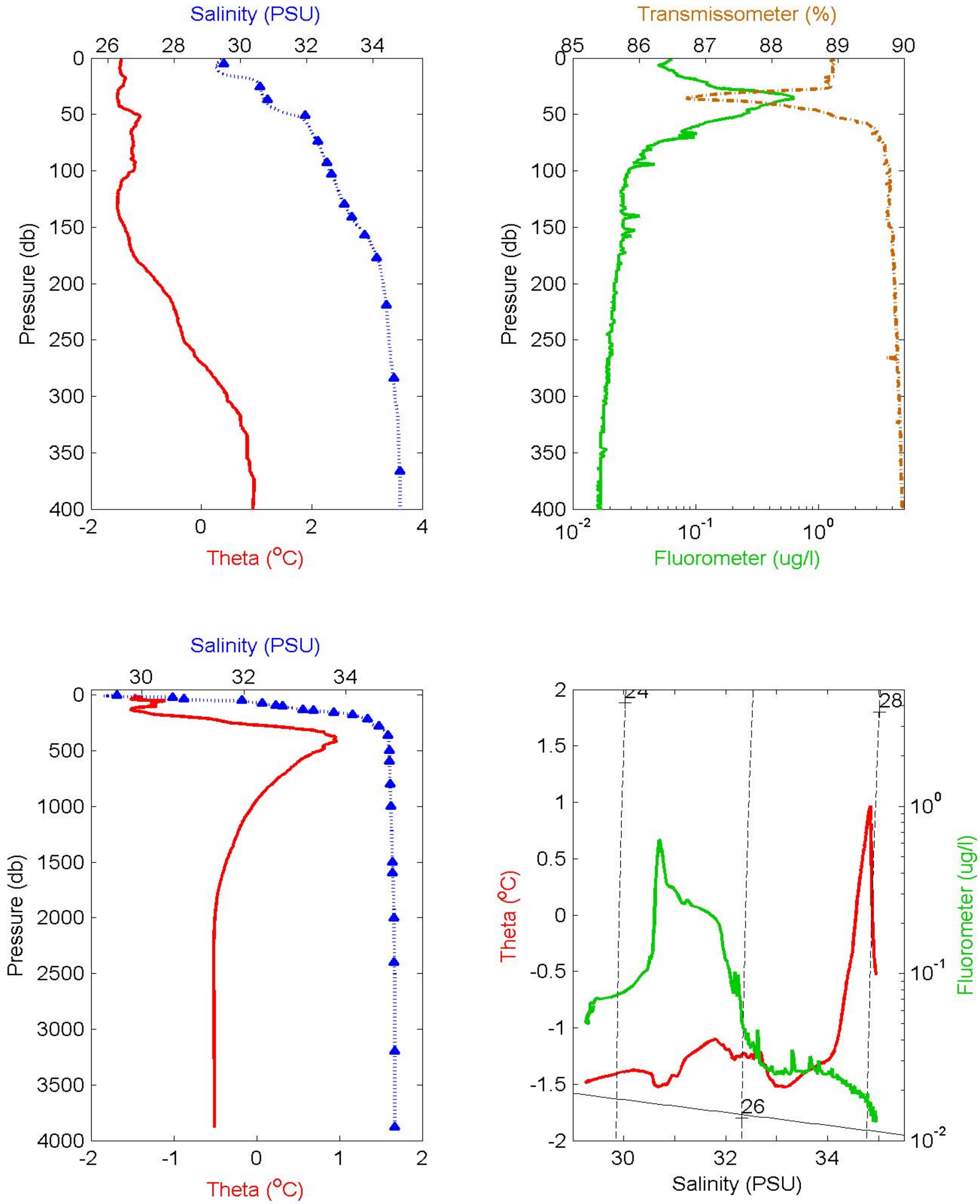

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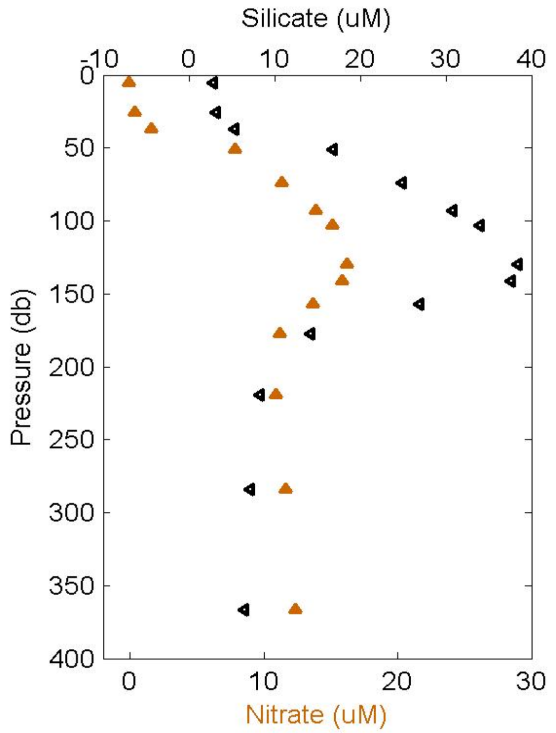
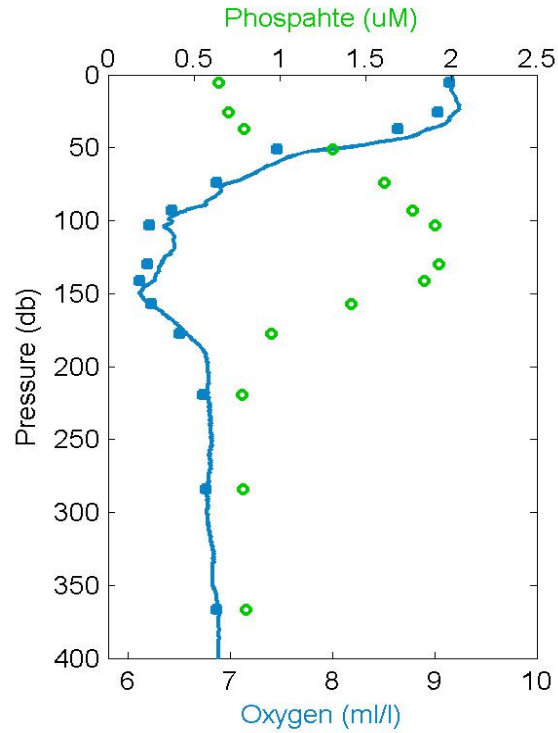
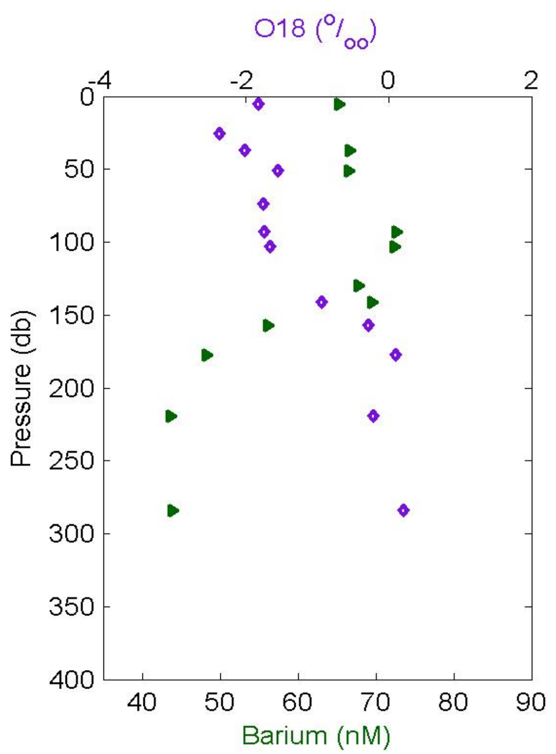
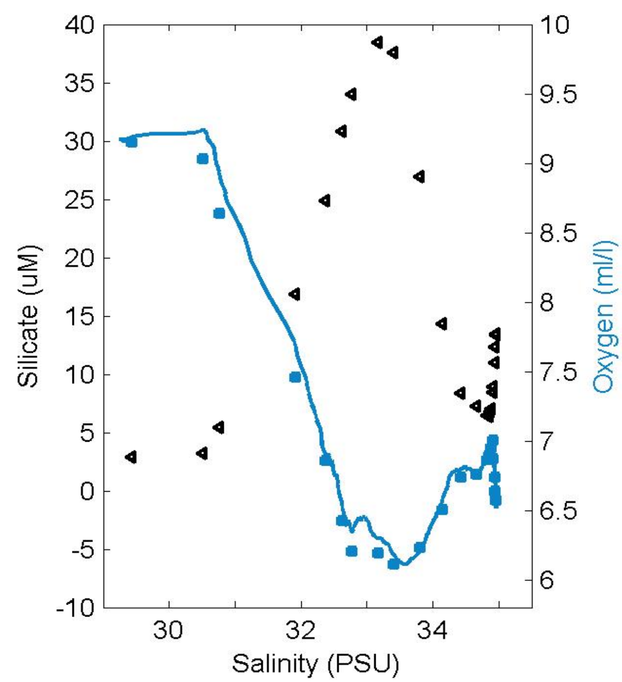
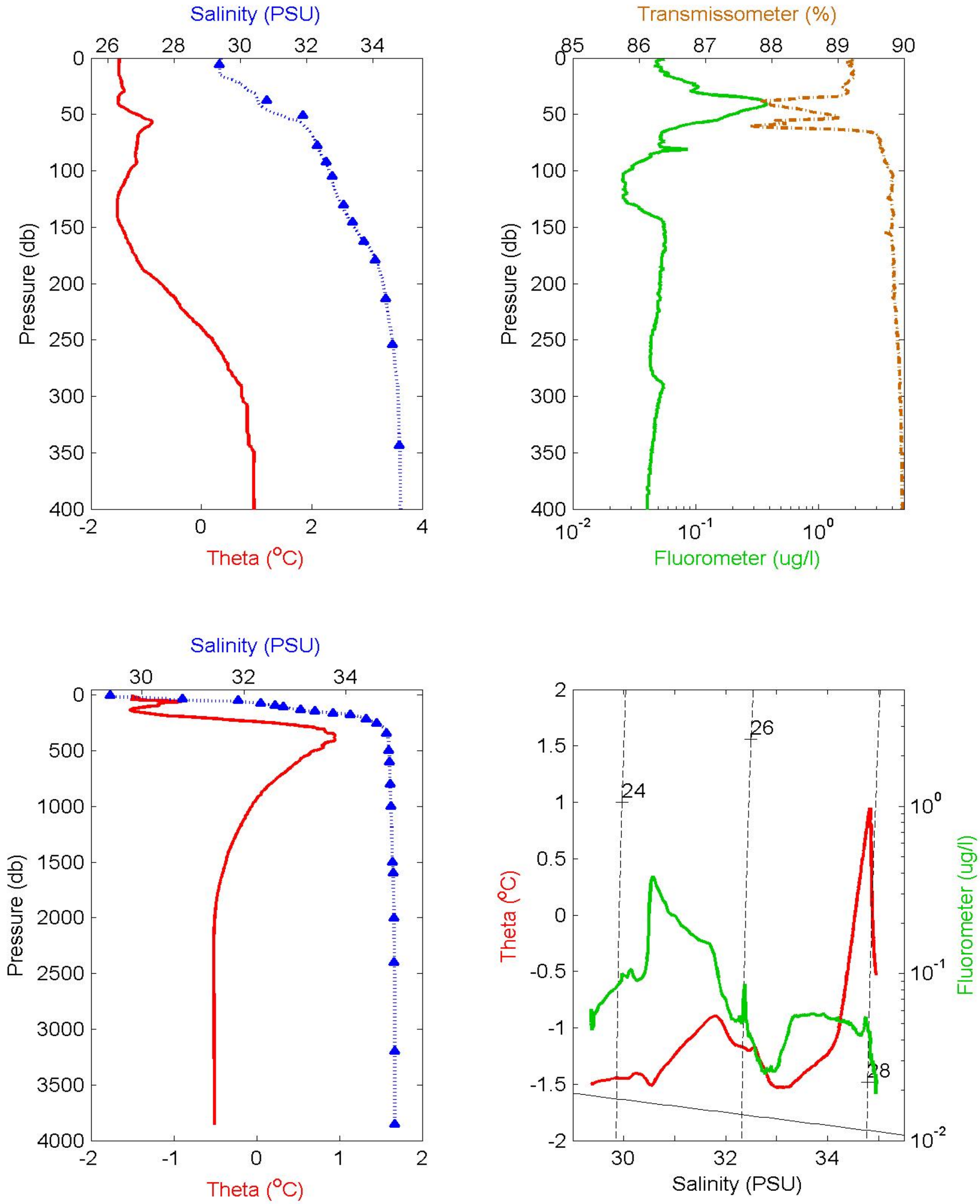




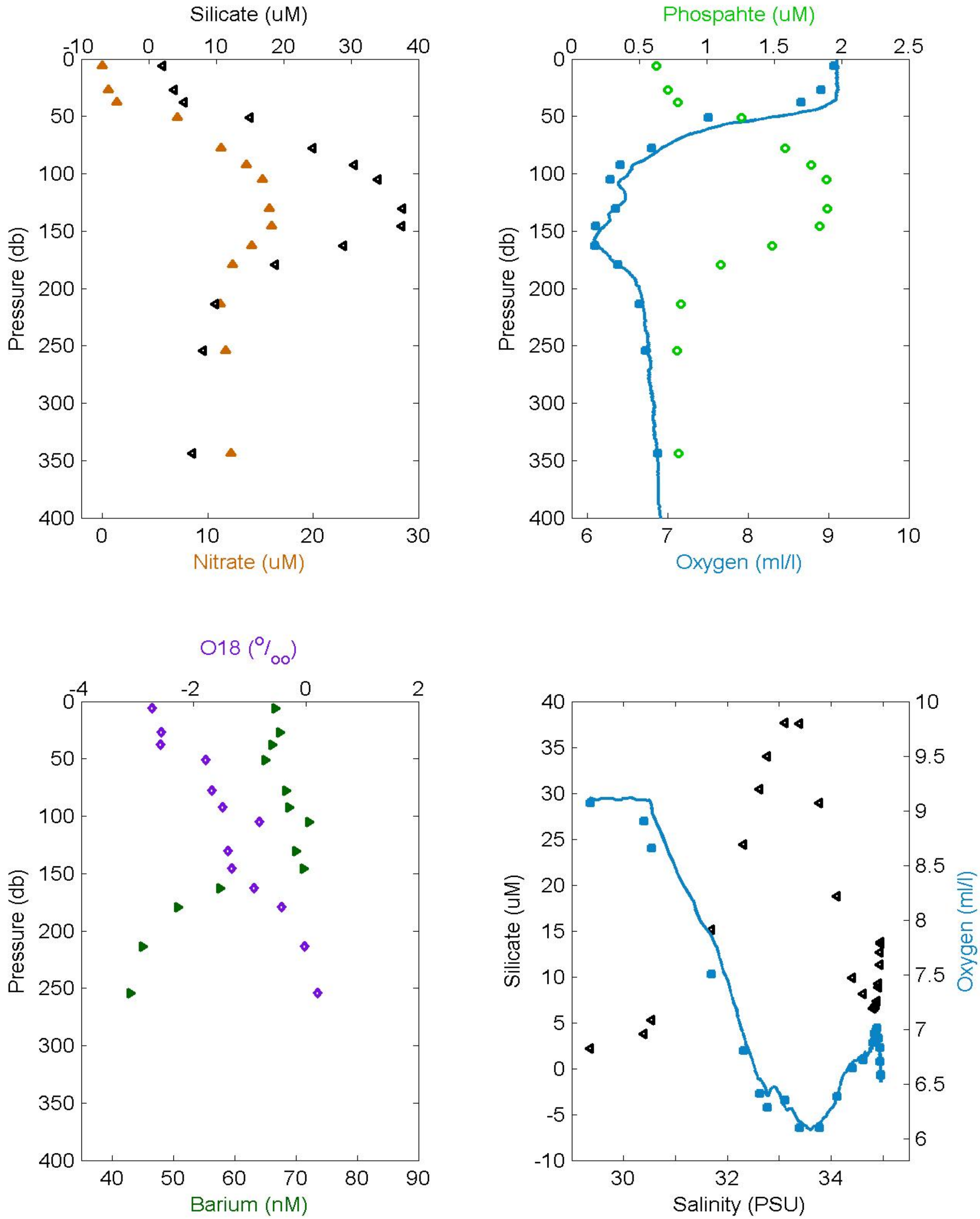




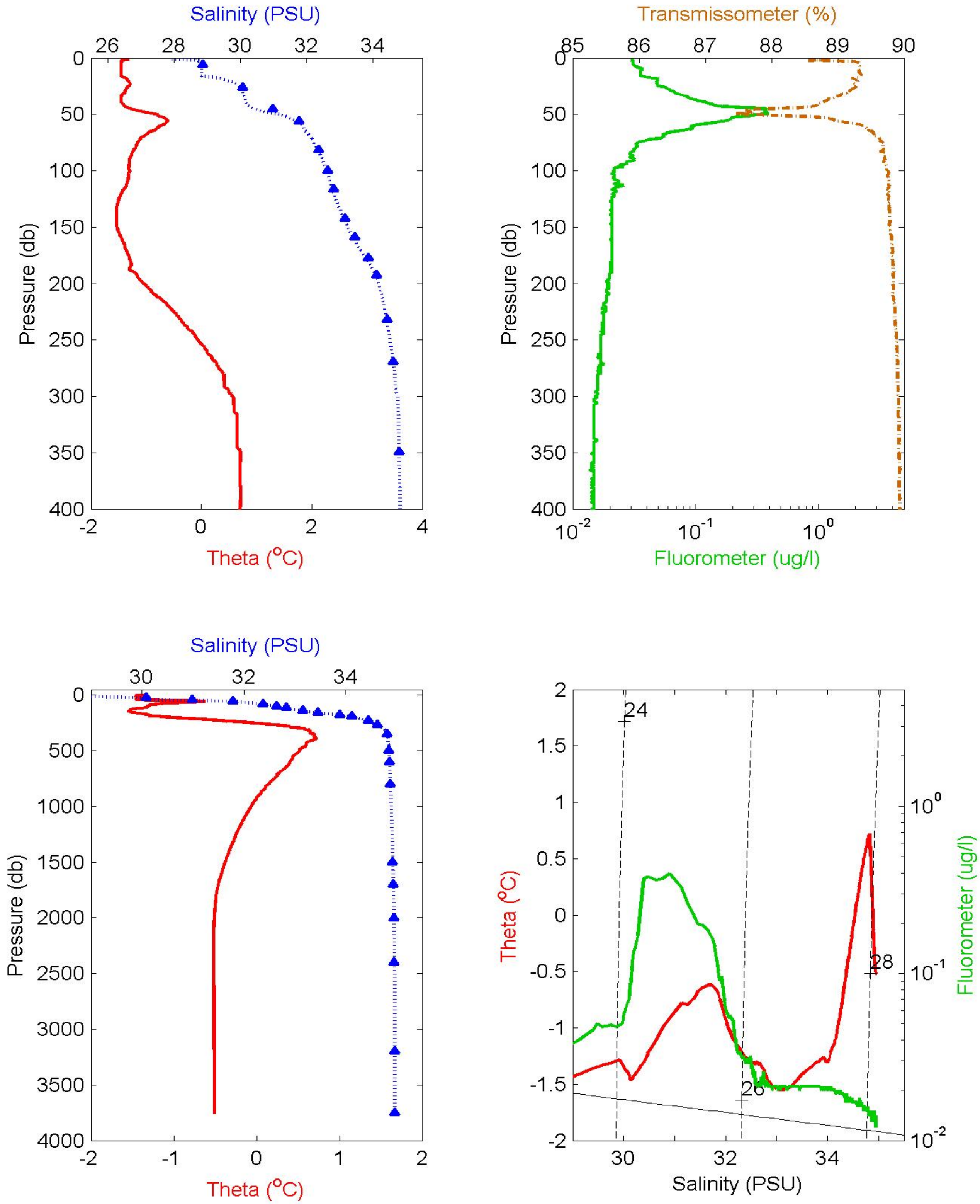
2004-16: Cast 30 Station CB-13



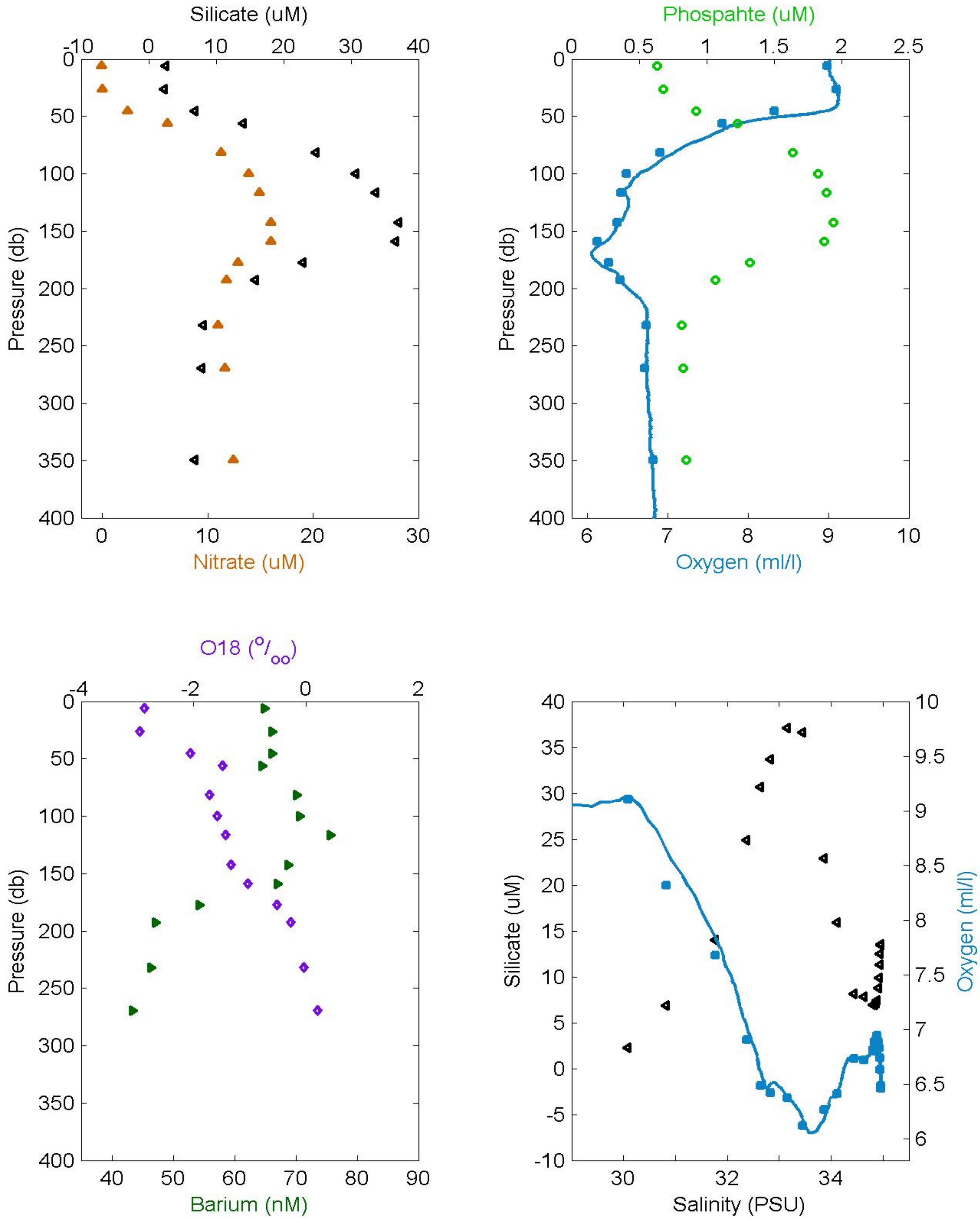
2004-16: Cast 30 Station CB-13



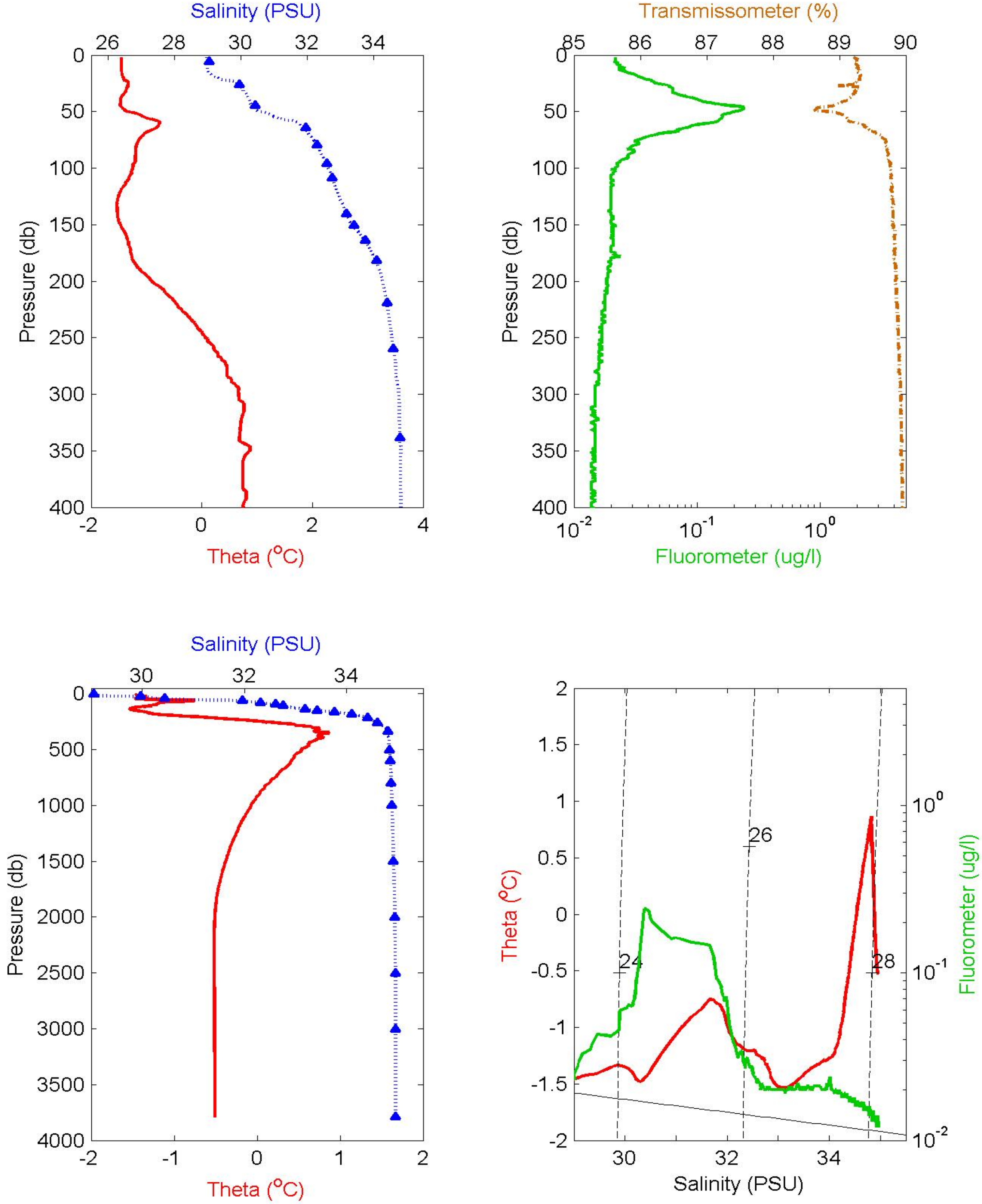
2004-16: Cast 31 Station CB-14



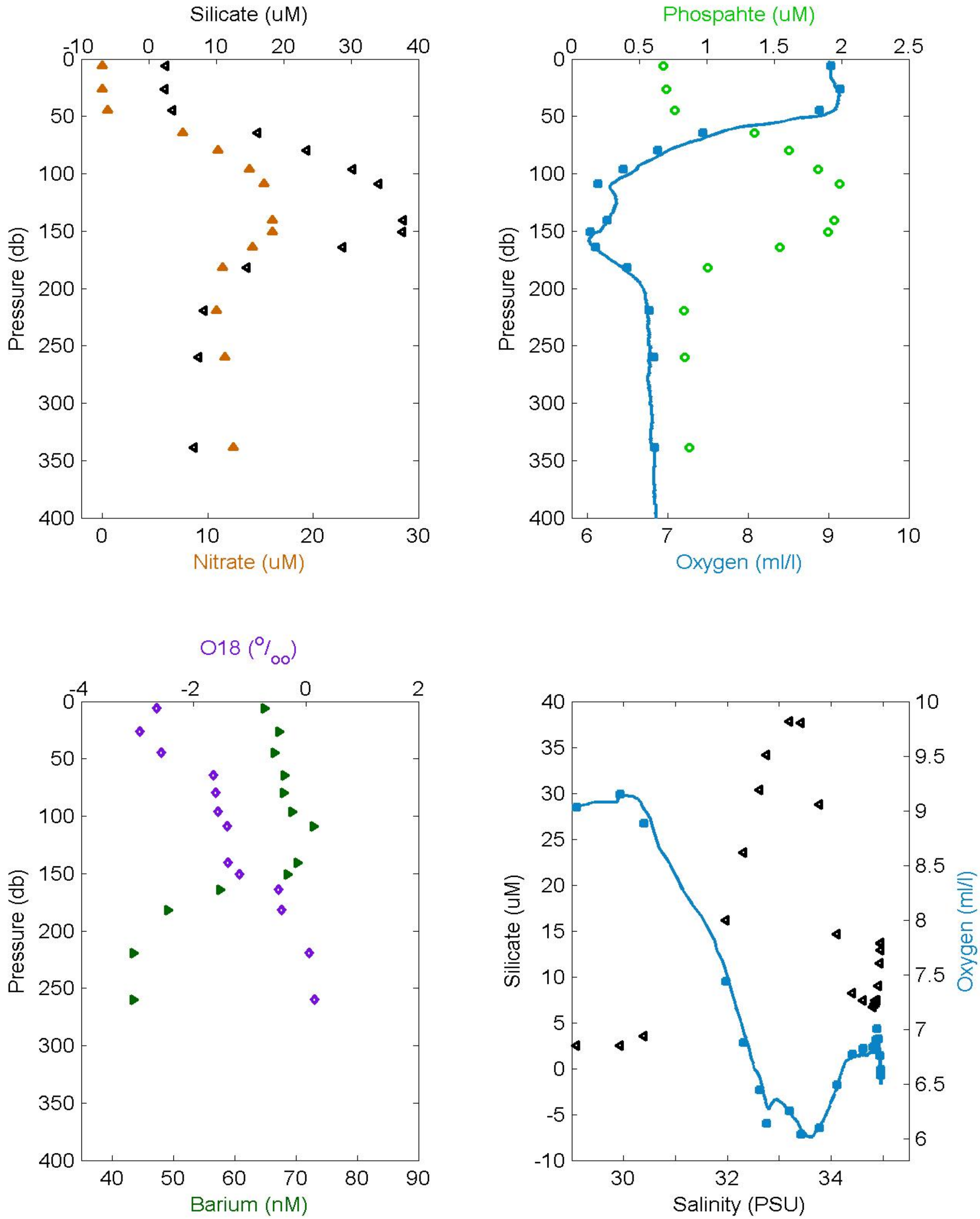
2004-16: Cast 31 Station CB-14



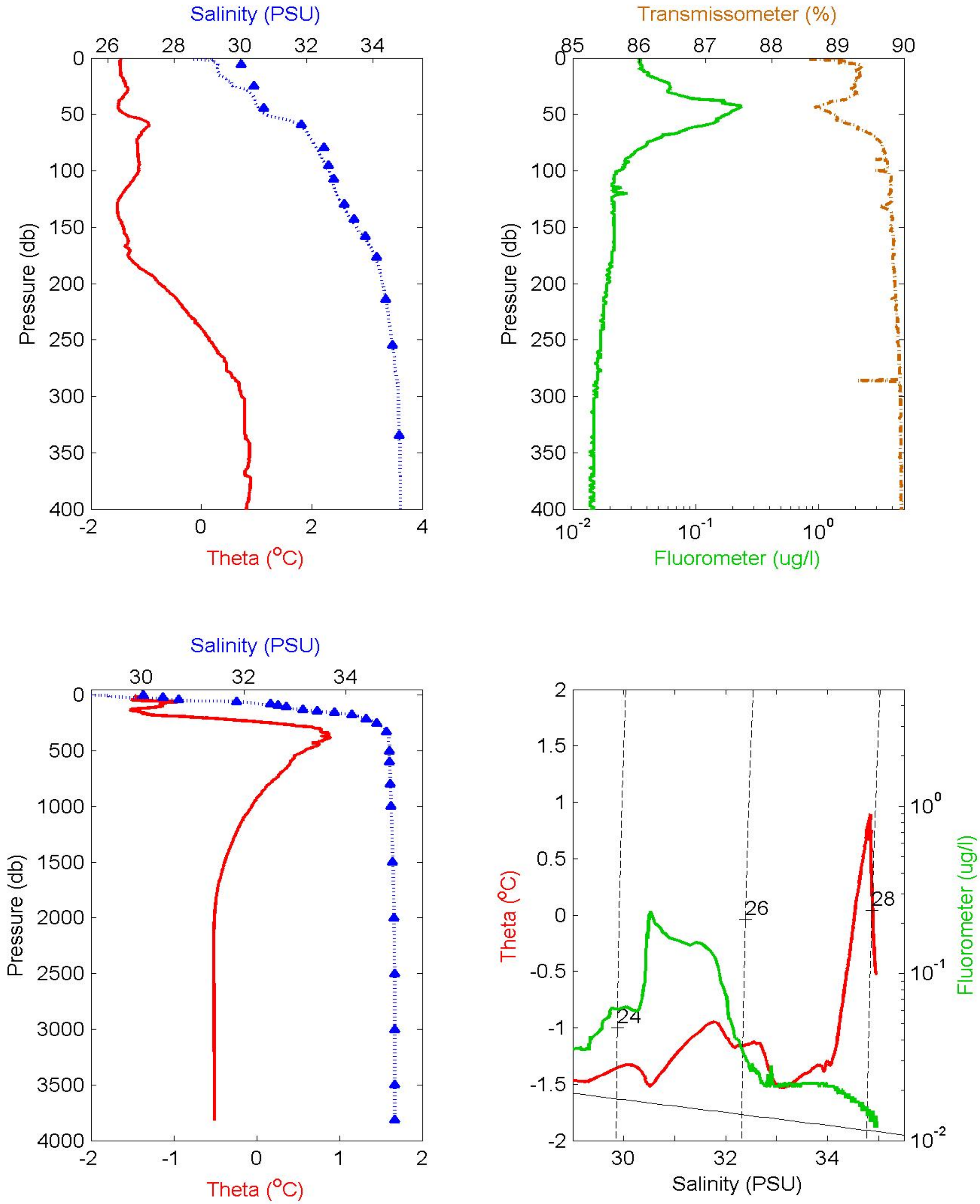
2004-16: Cast 32 Station CB-15



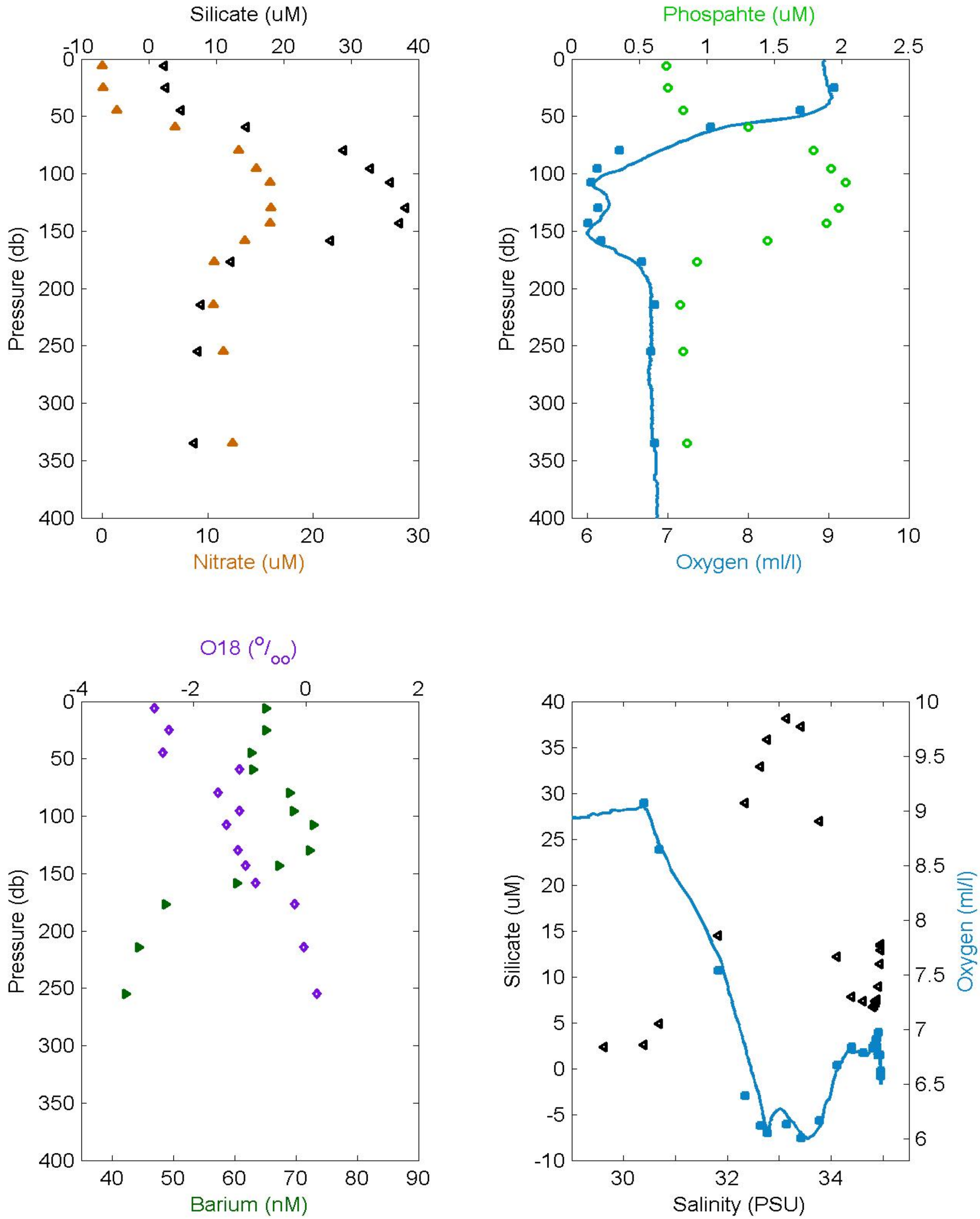
2004-16: Cast 32 Station CB-15



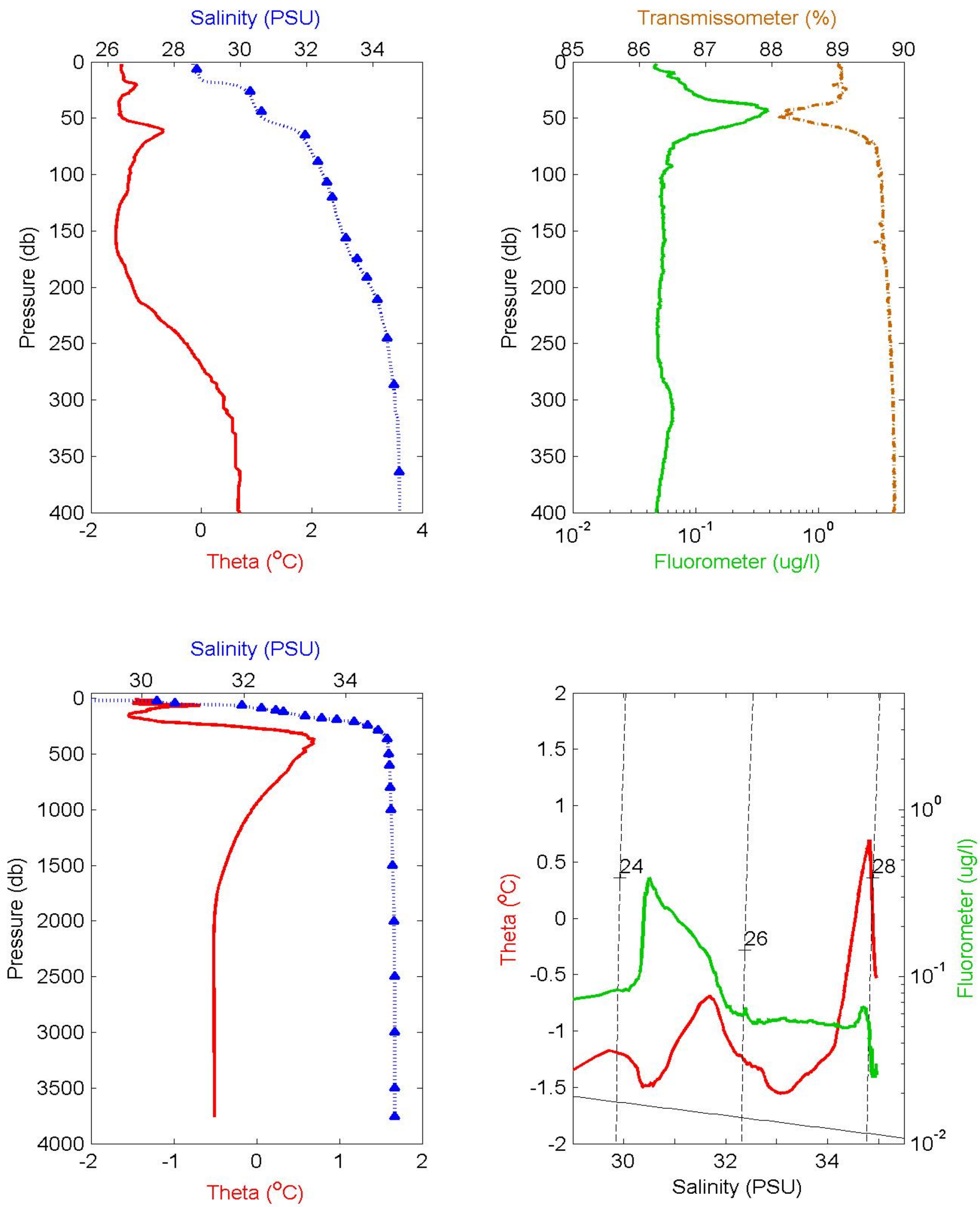
2004-16: Cast 33 Station CB-16



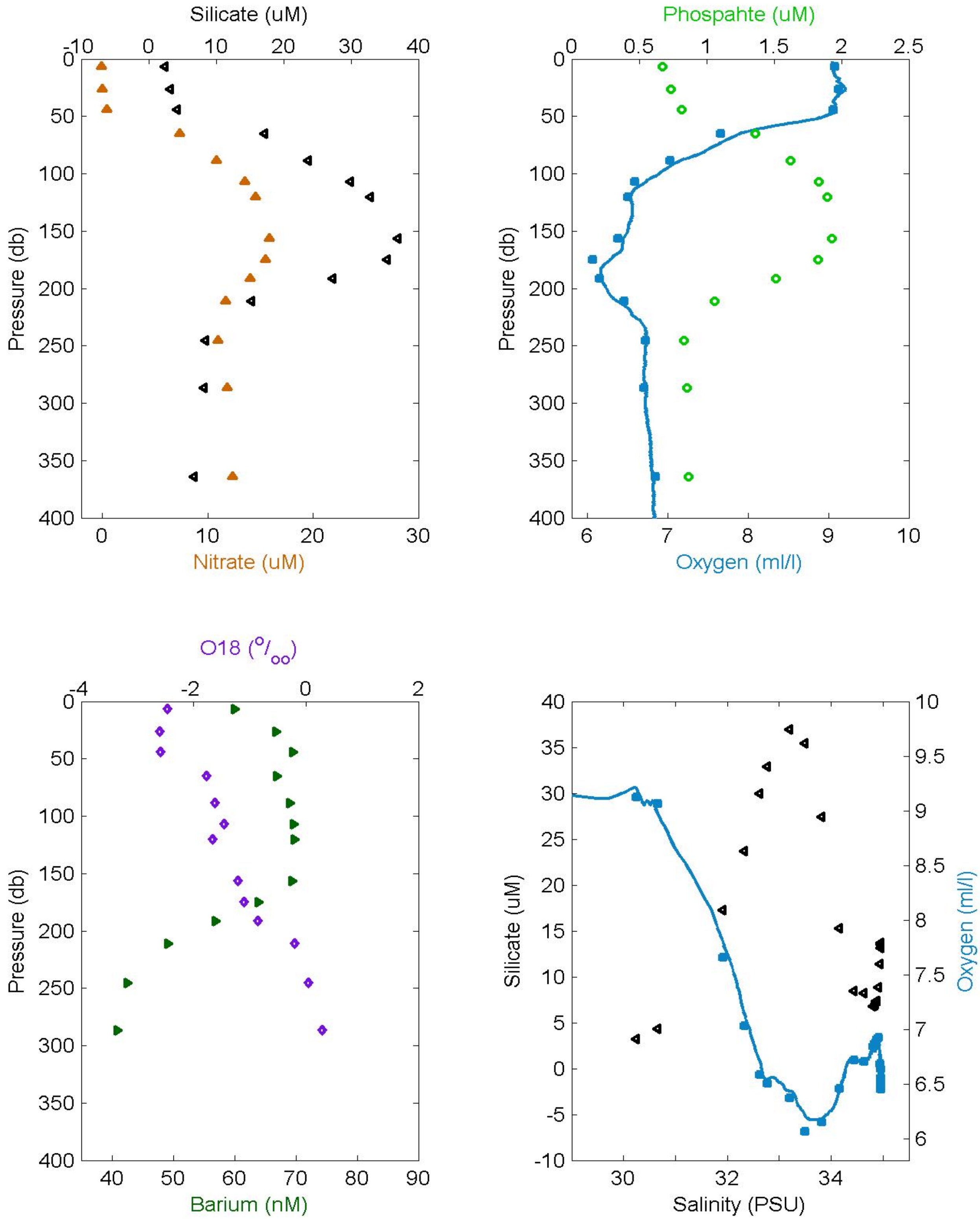
2004-16: Cast 33 Station CB-16



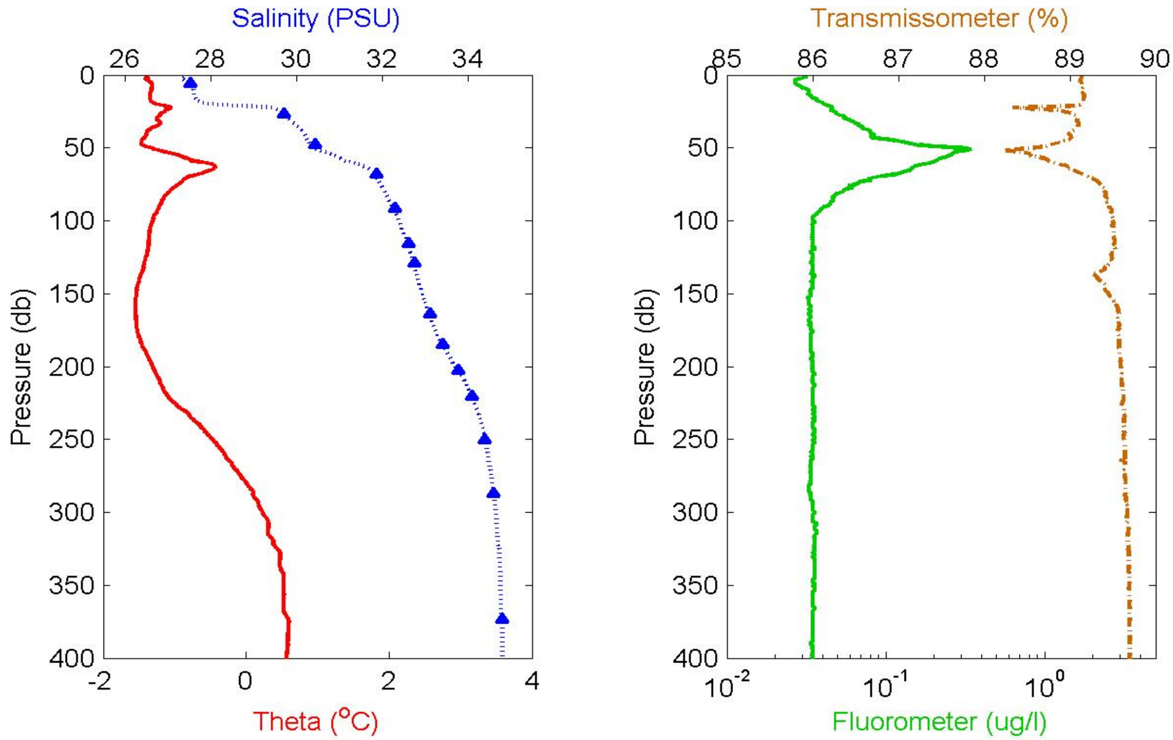
2004-16: Cast 34 Station CB-17

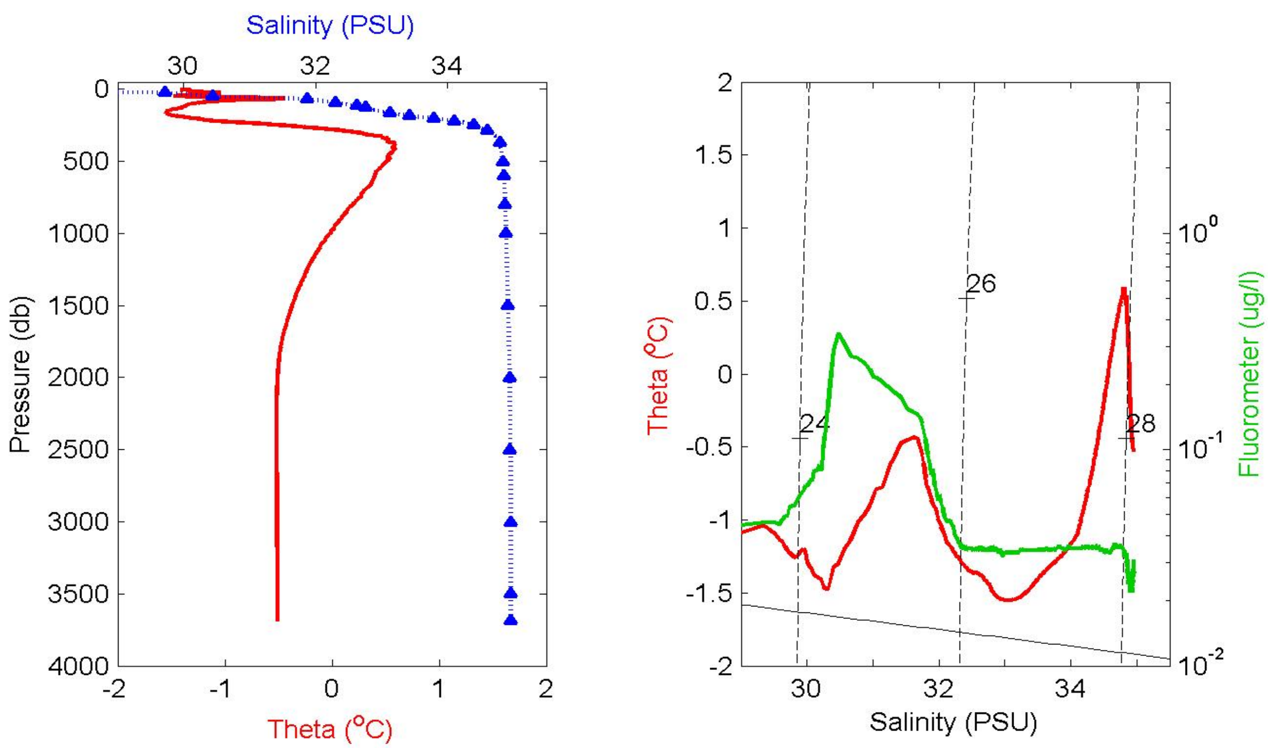


2004-16: Cast 34 Station CB-17

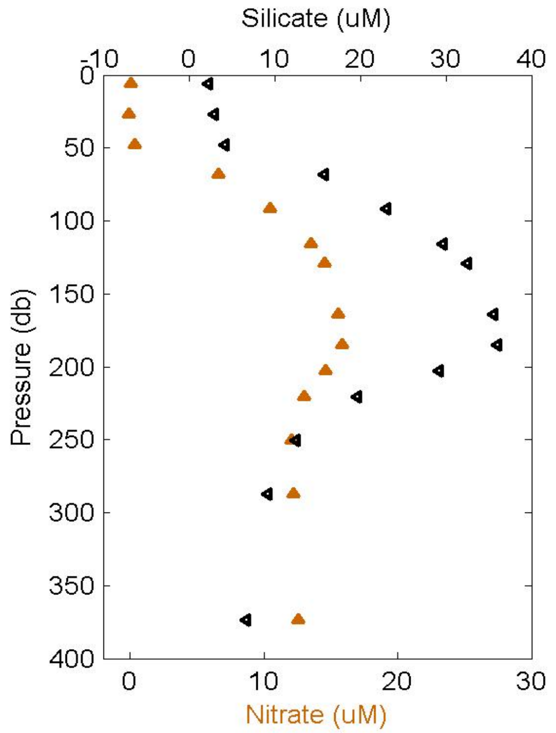


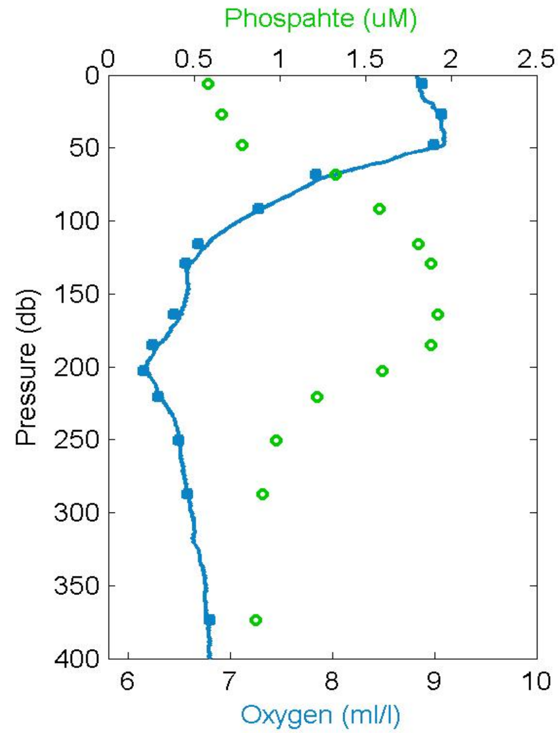
2004-16: Cast 35 Station CB-18

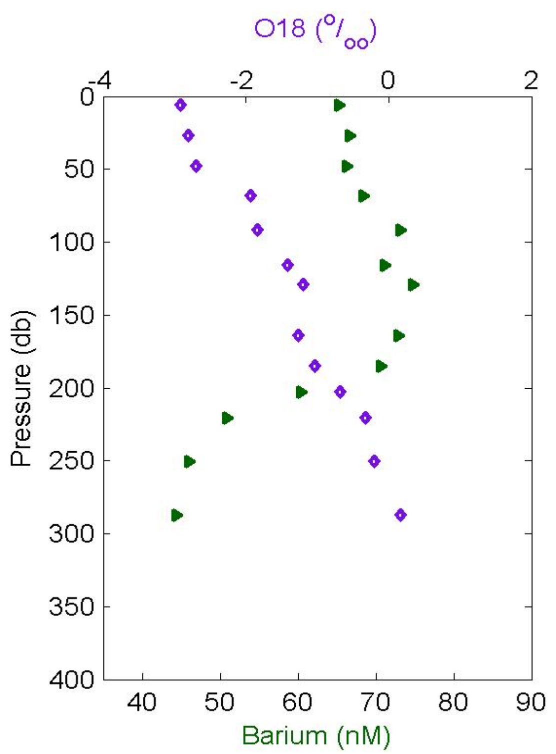


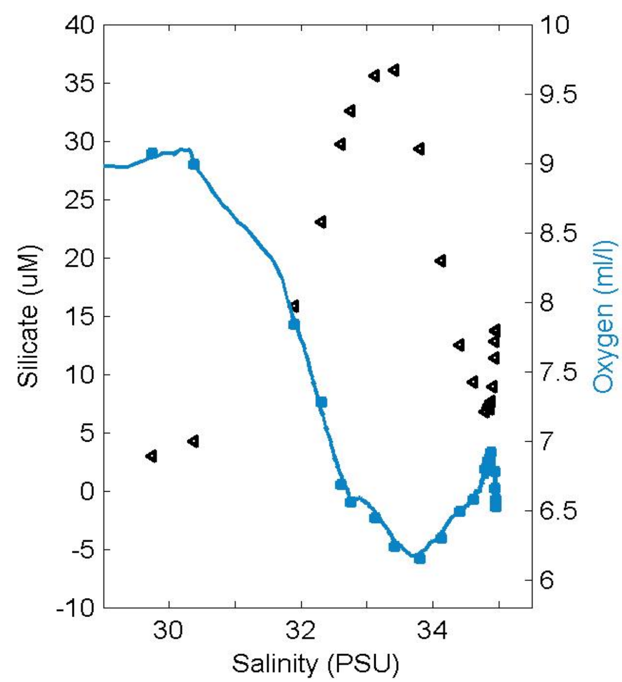


2004-16: Cast 35 Station CB-18

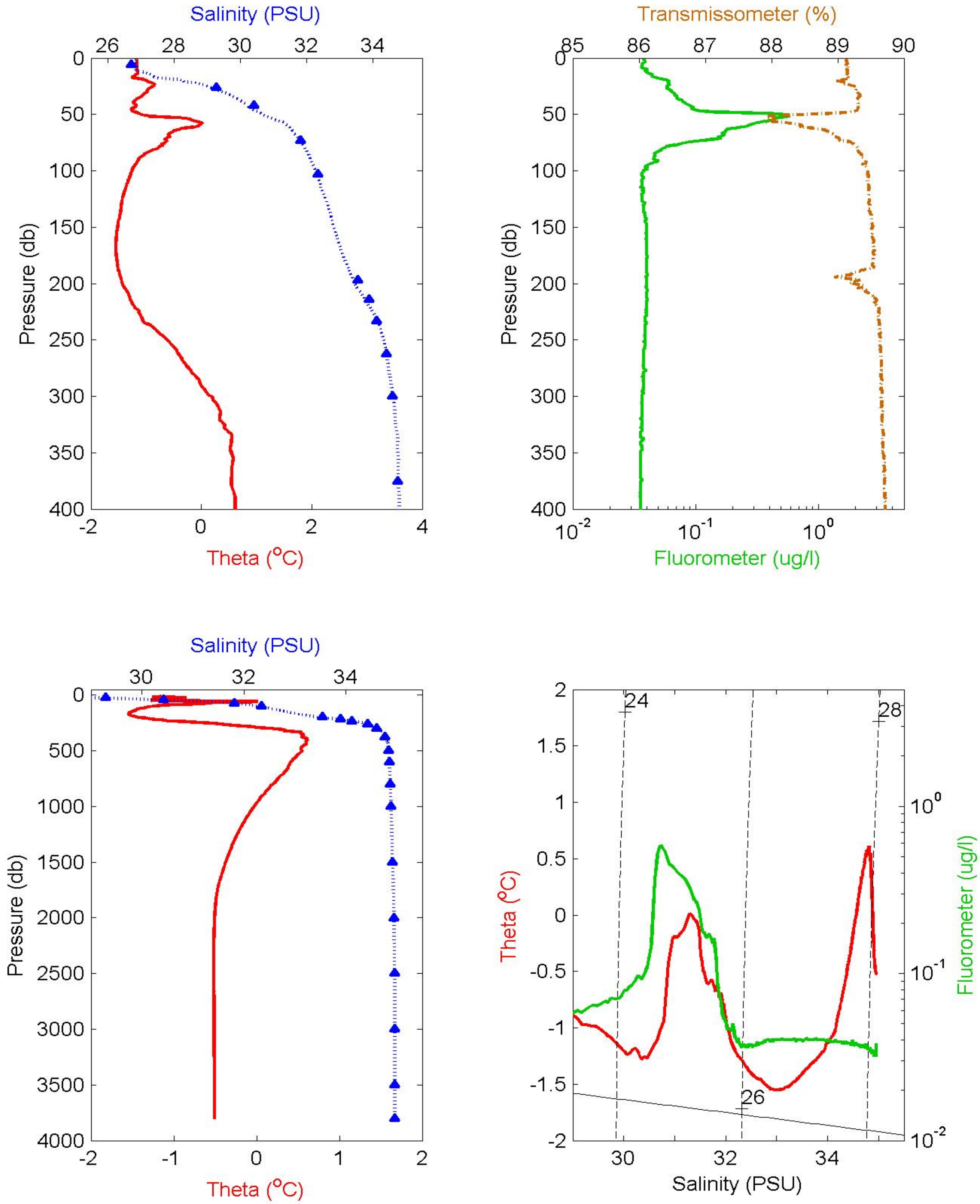




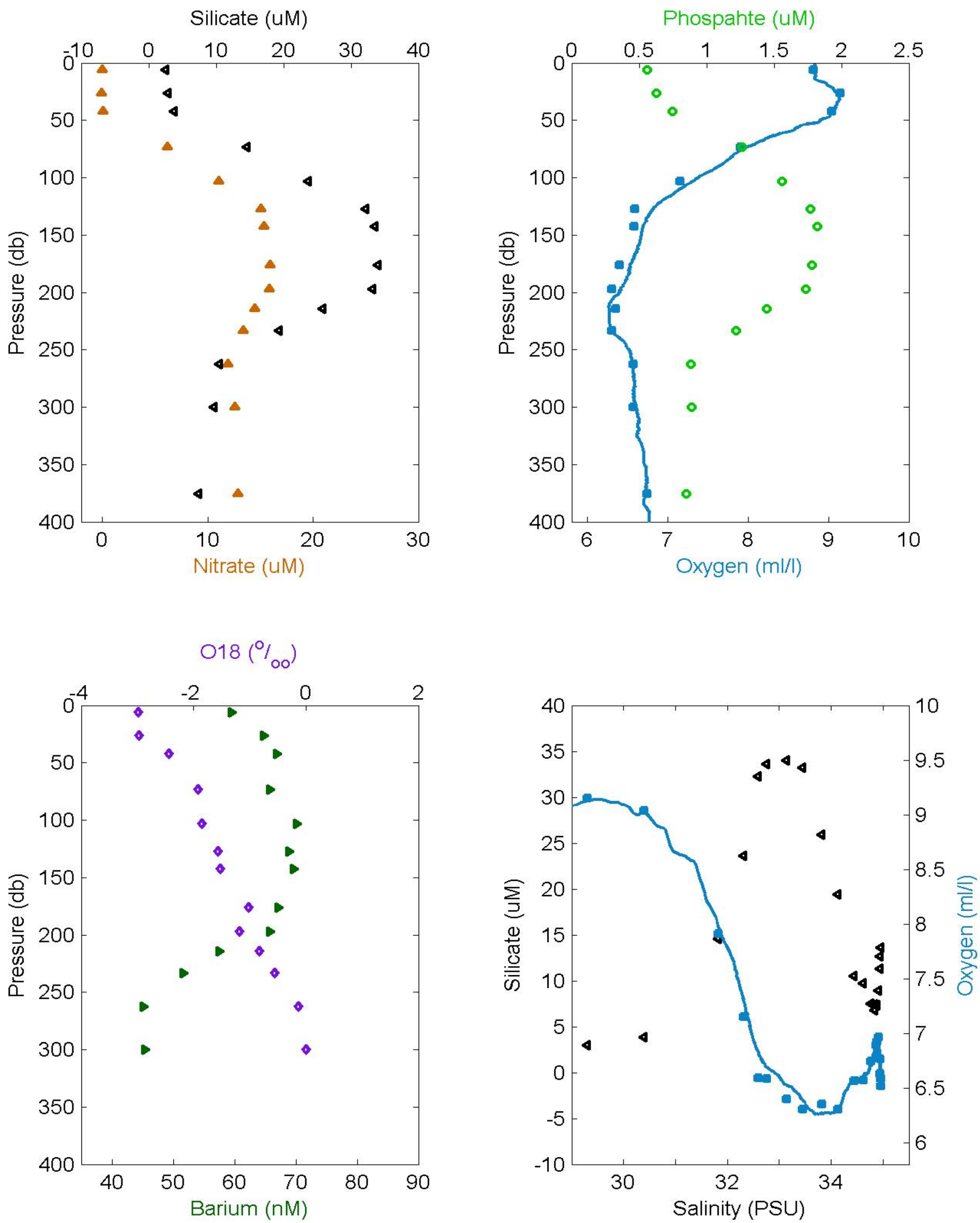




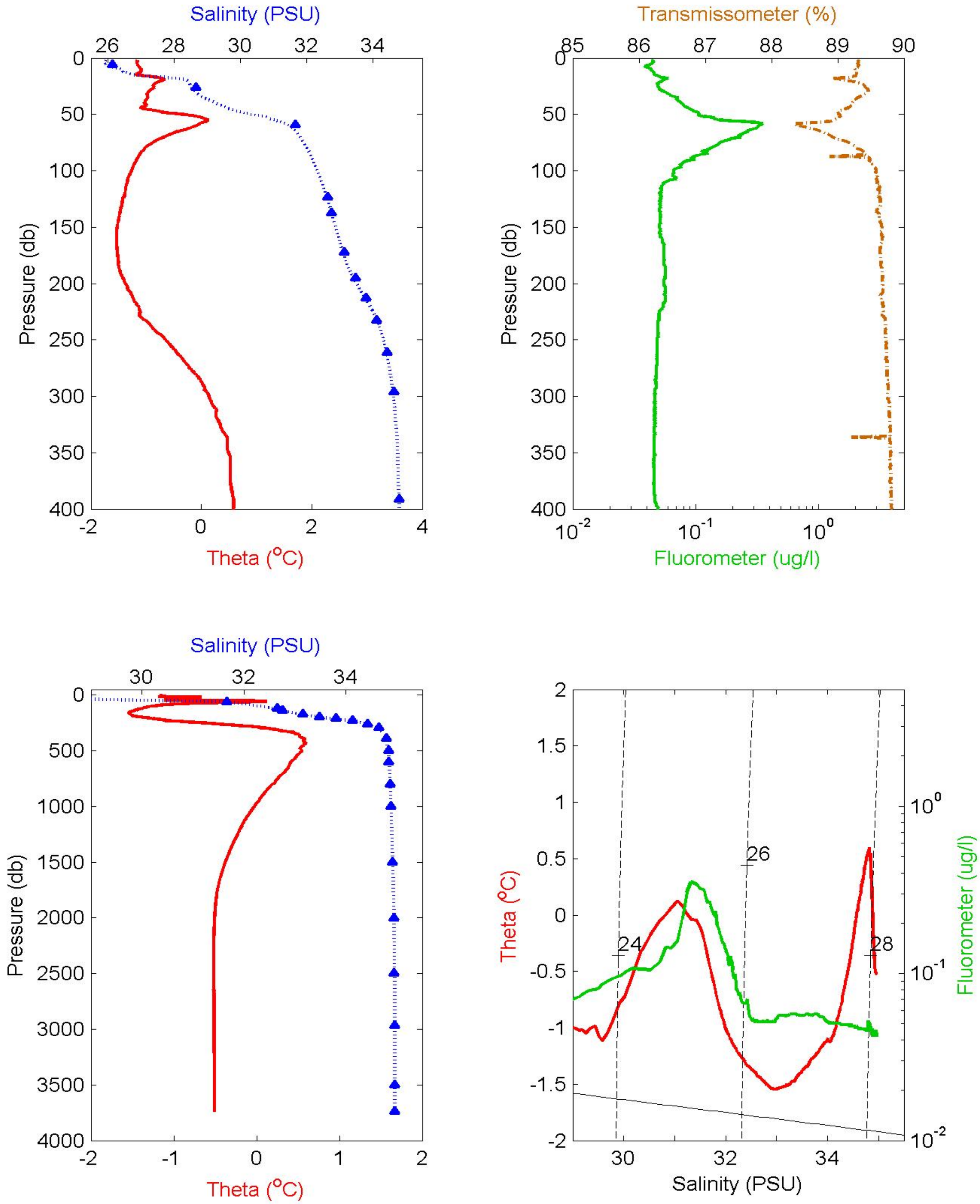
2004-16: Cast 36 Station CB-19



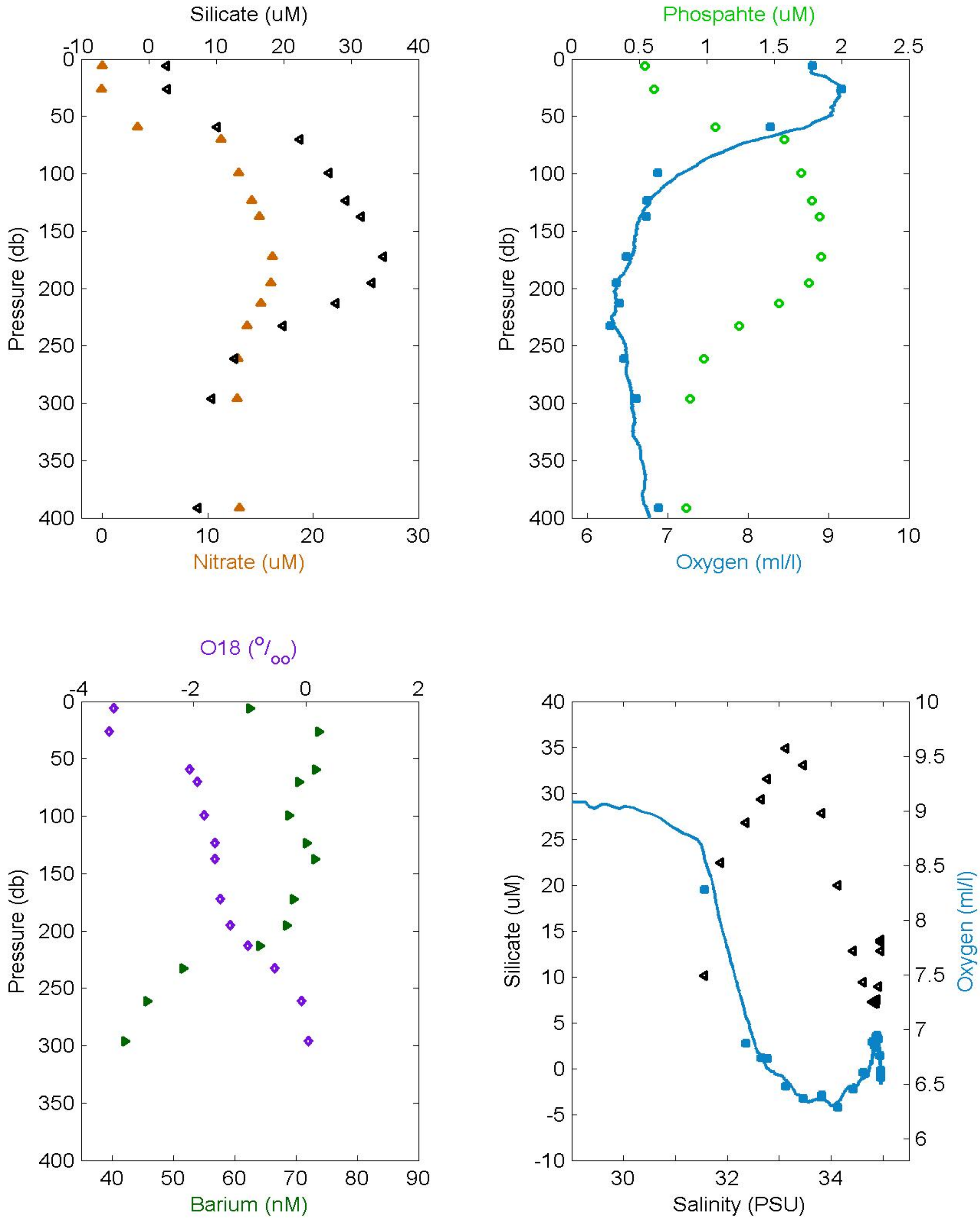
2004-16: Cast 36 Station CB-19



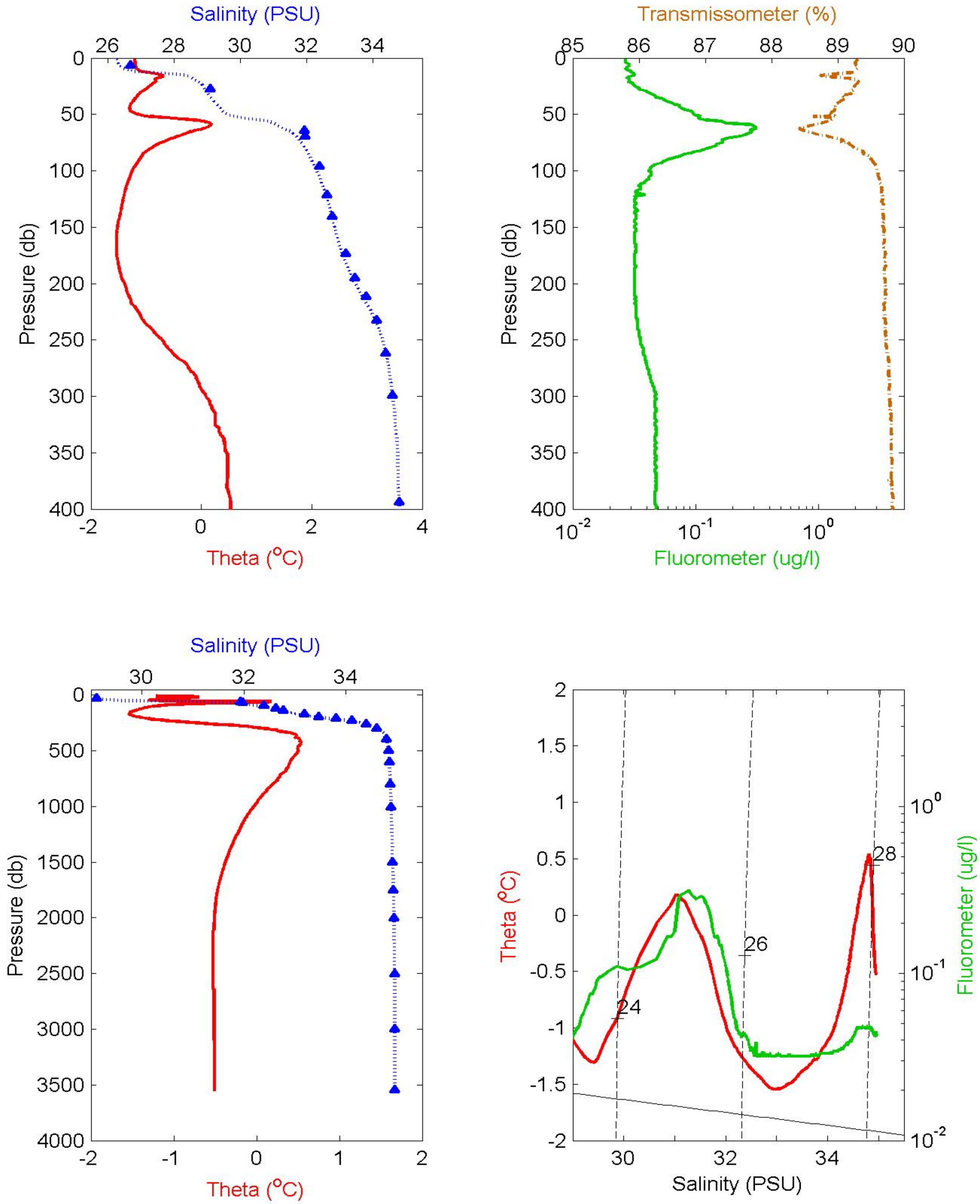
2004-16: Cast 37 Station CB-20



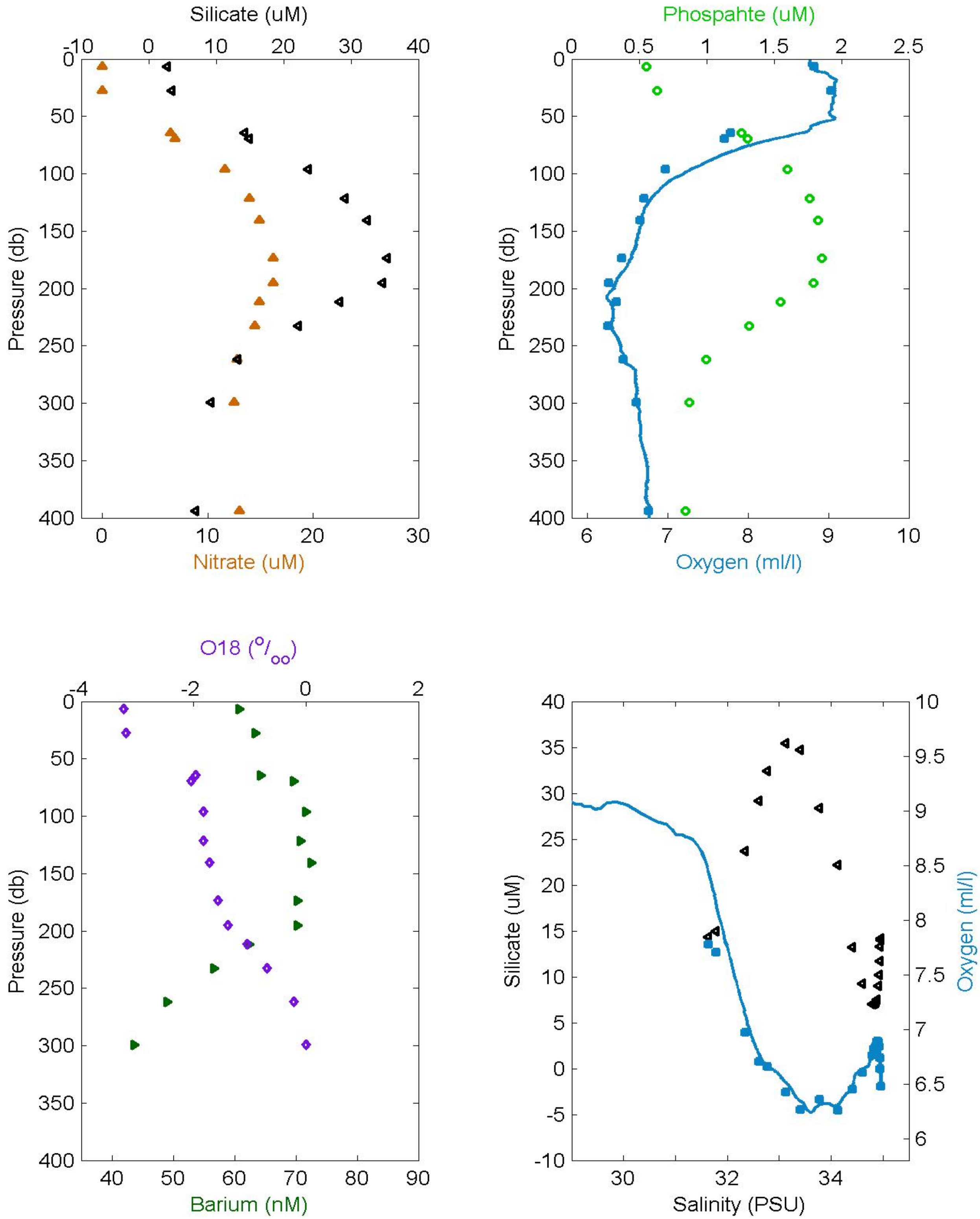
2004-16: Cast 37 Station CB-20



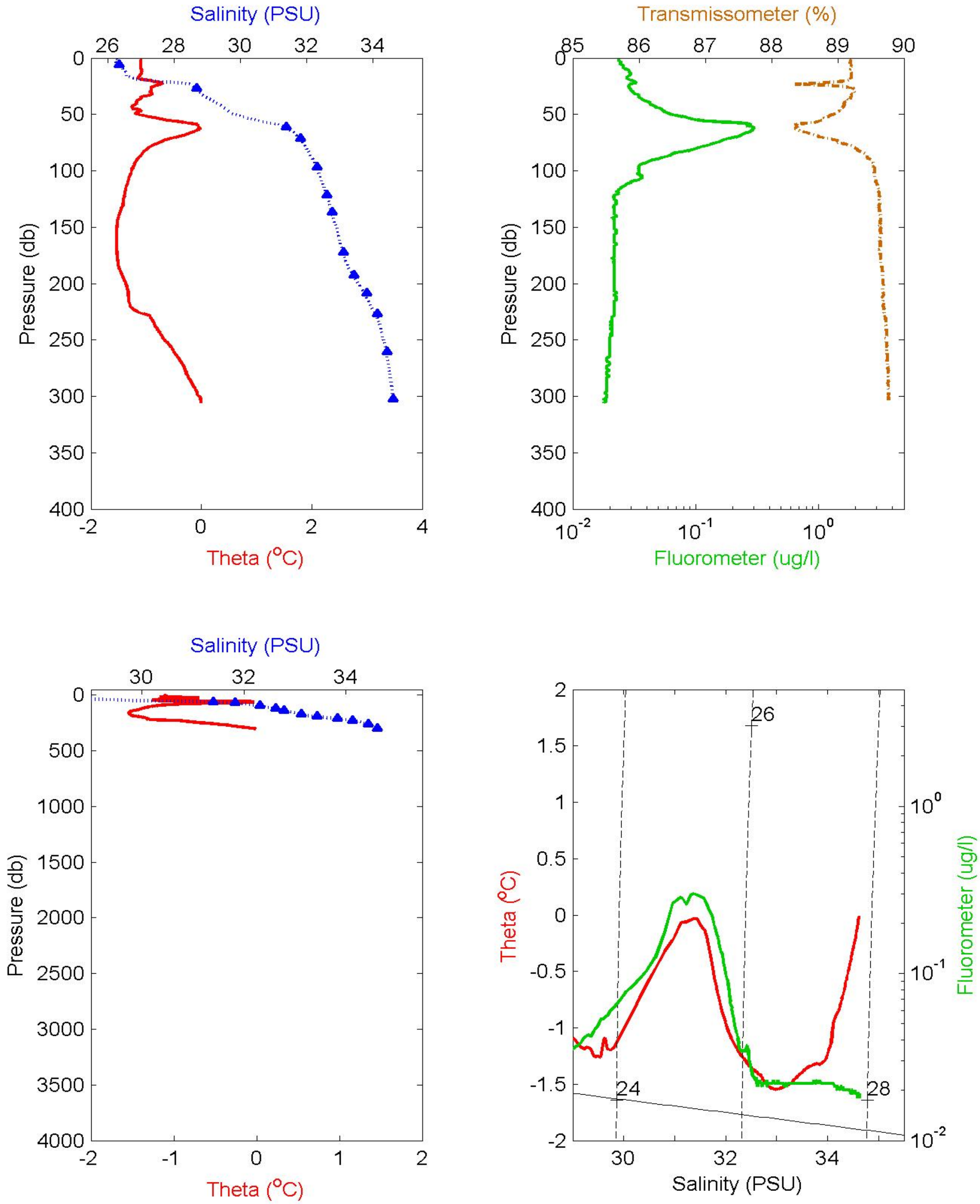
2004-16: Cast 38 Station CB-21



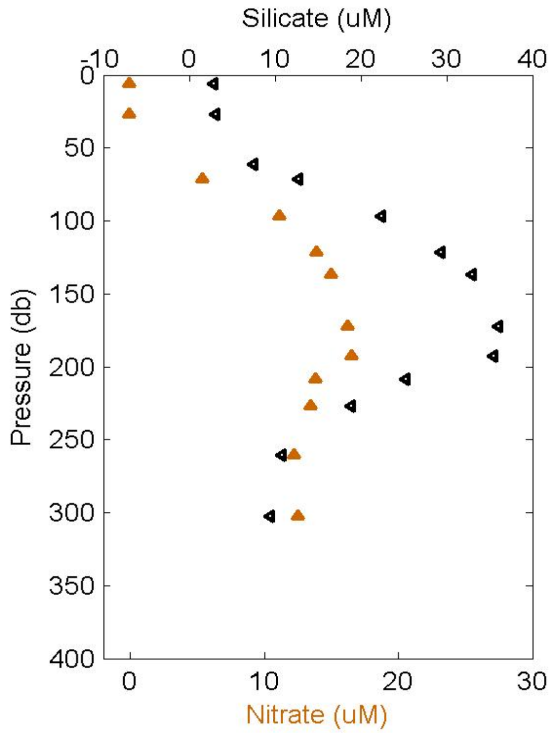
2004-16: Cast 38 Station CB-21

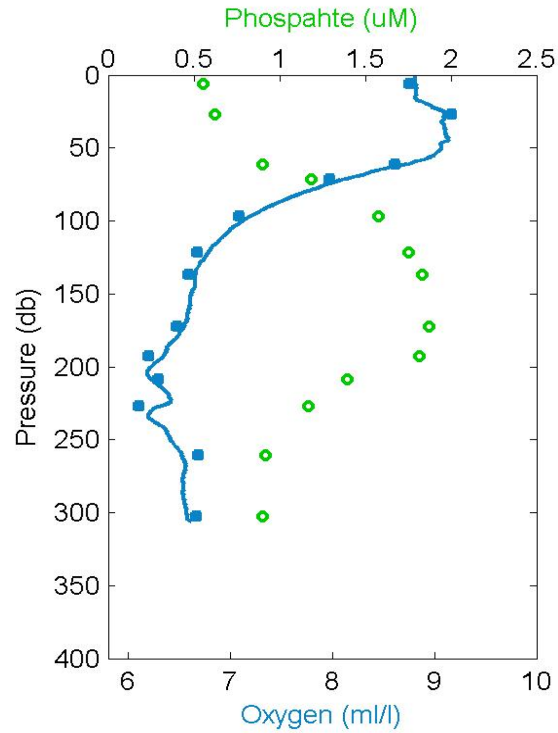


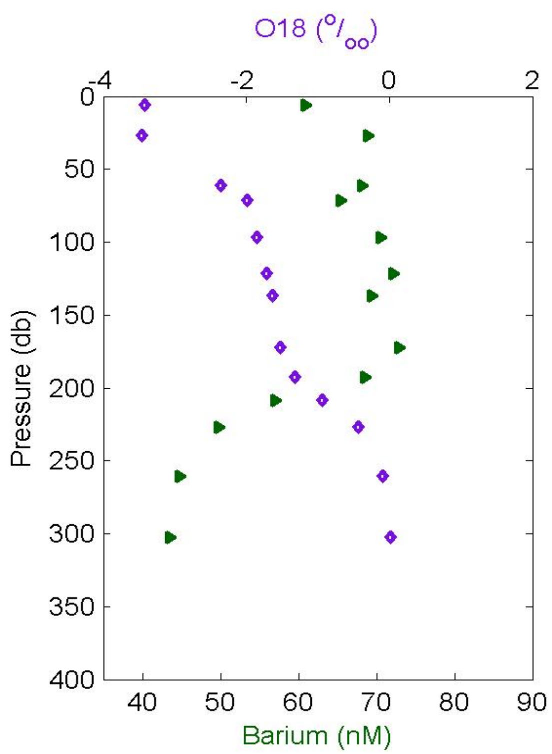
2004-16: Cast 39 Station CB-22

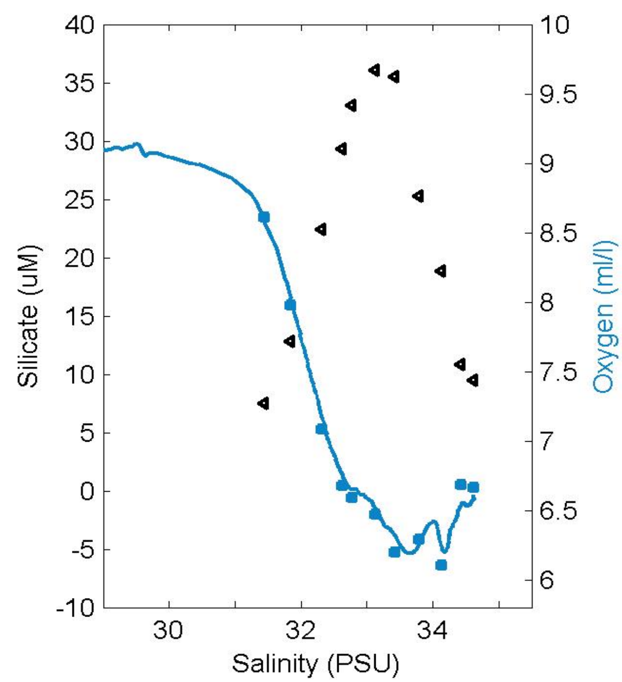


2004-16: Cast 39 Station CB-22

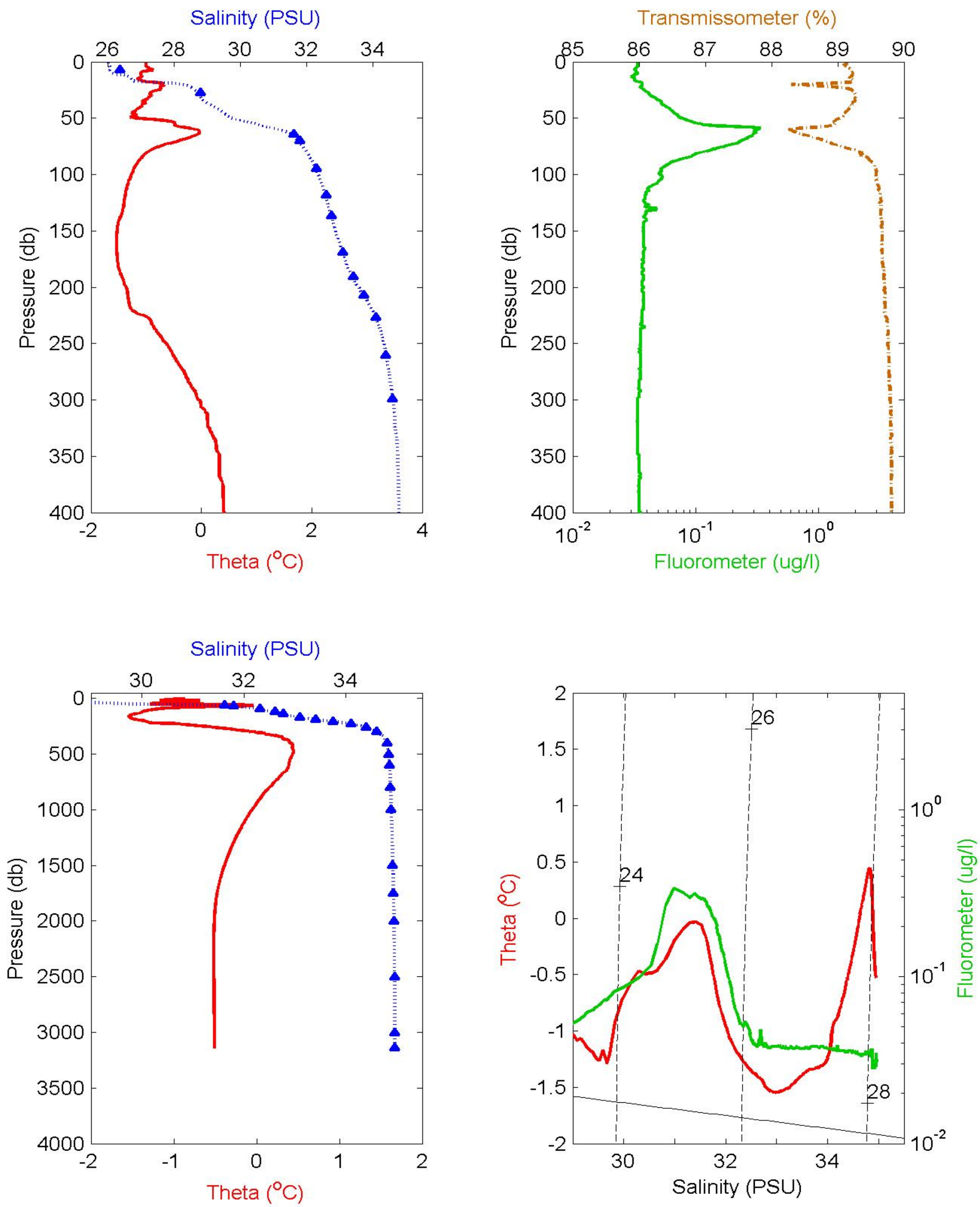




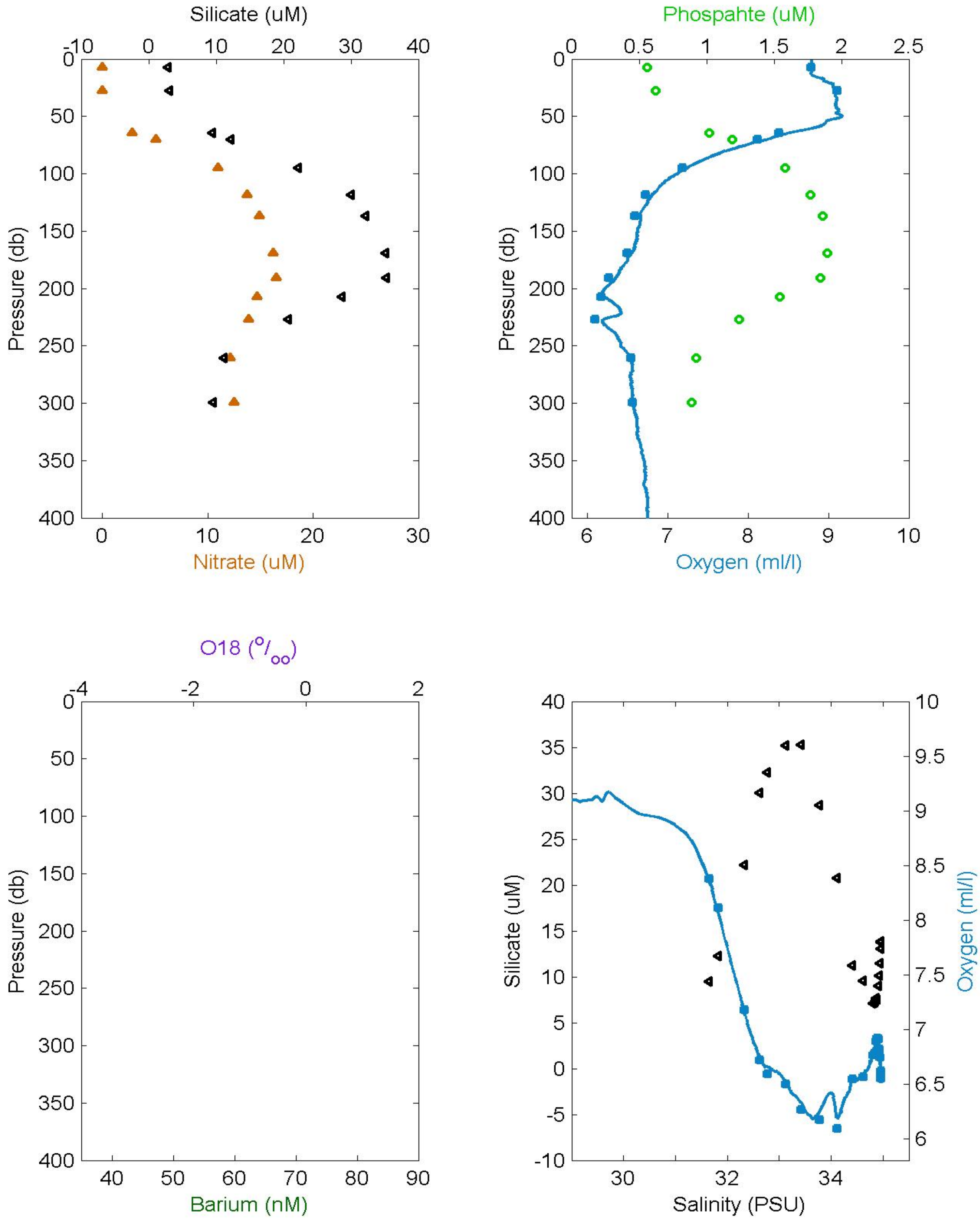




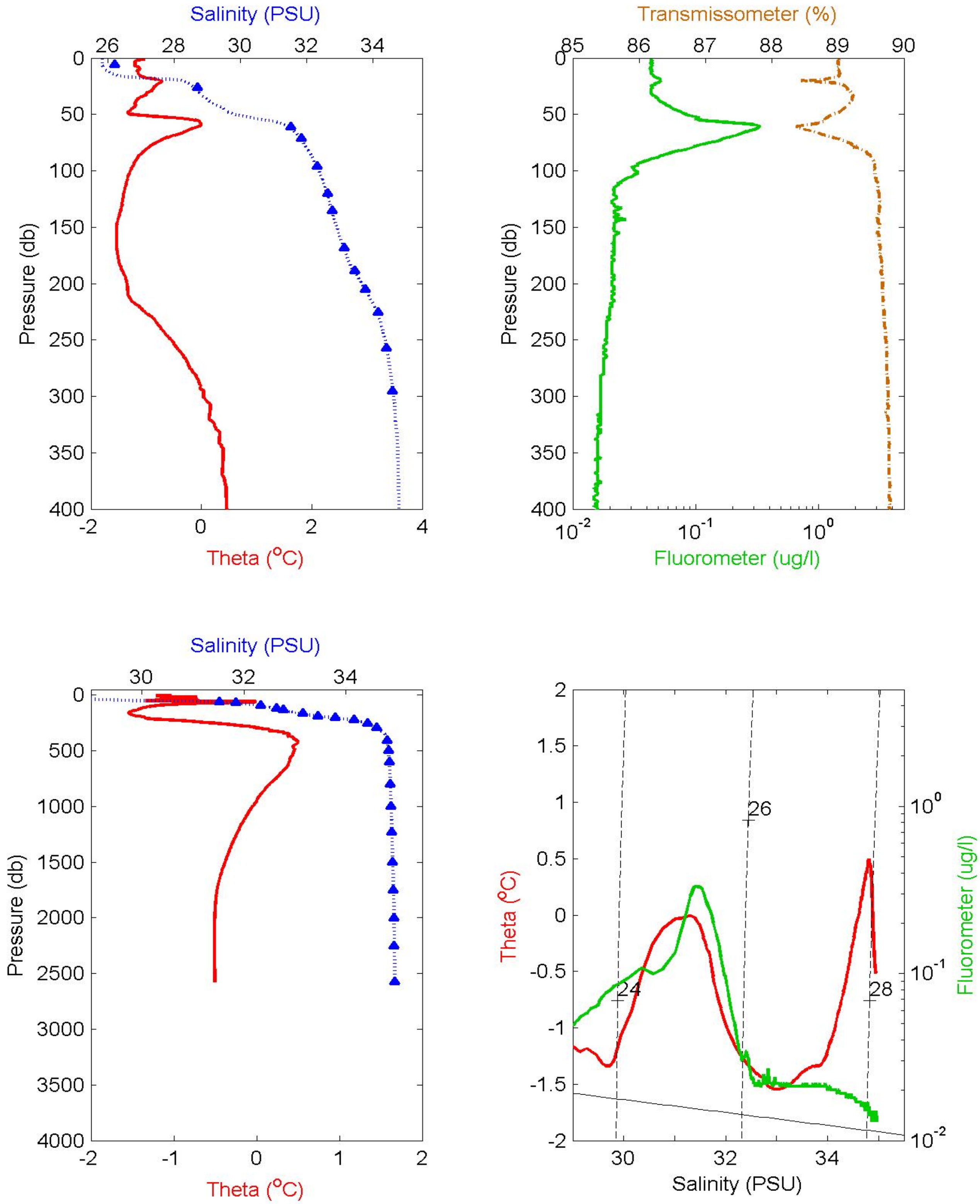
2004-16: Cast 40 Station CB-22(2)



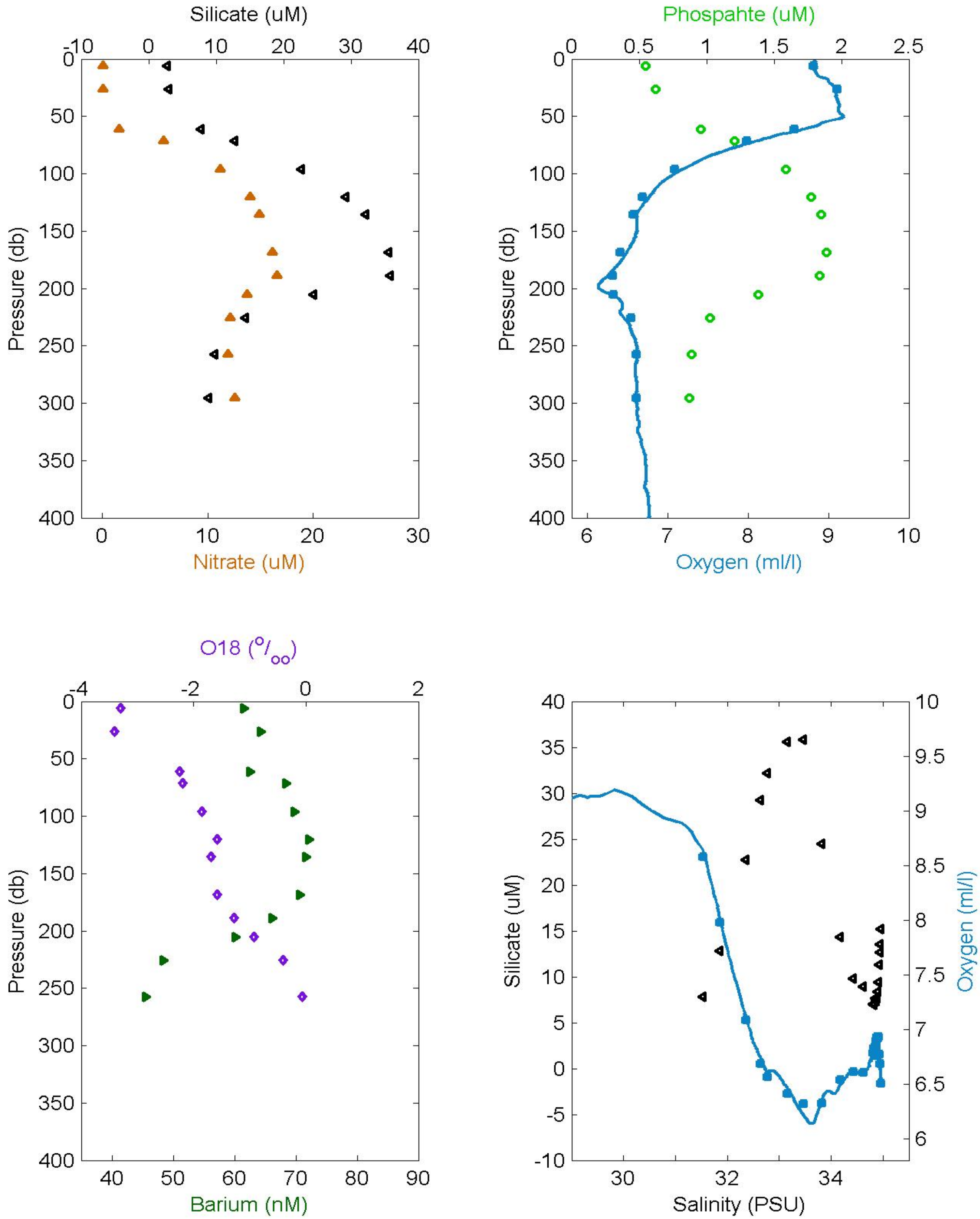
2004-16: Cast 40 Station CB-22(2)



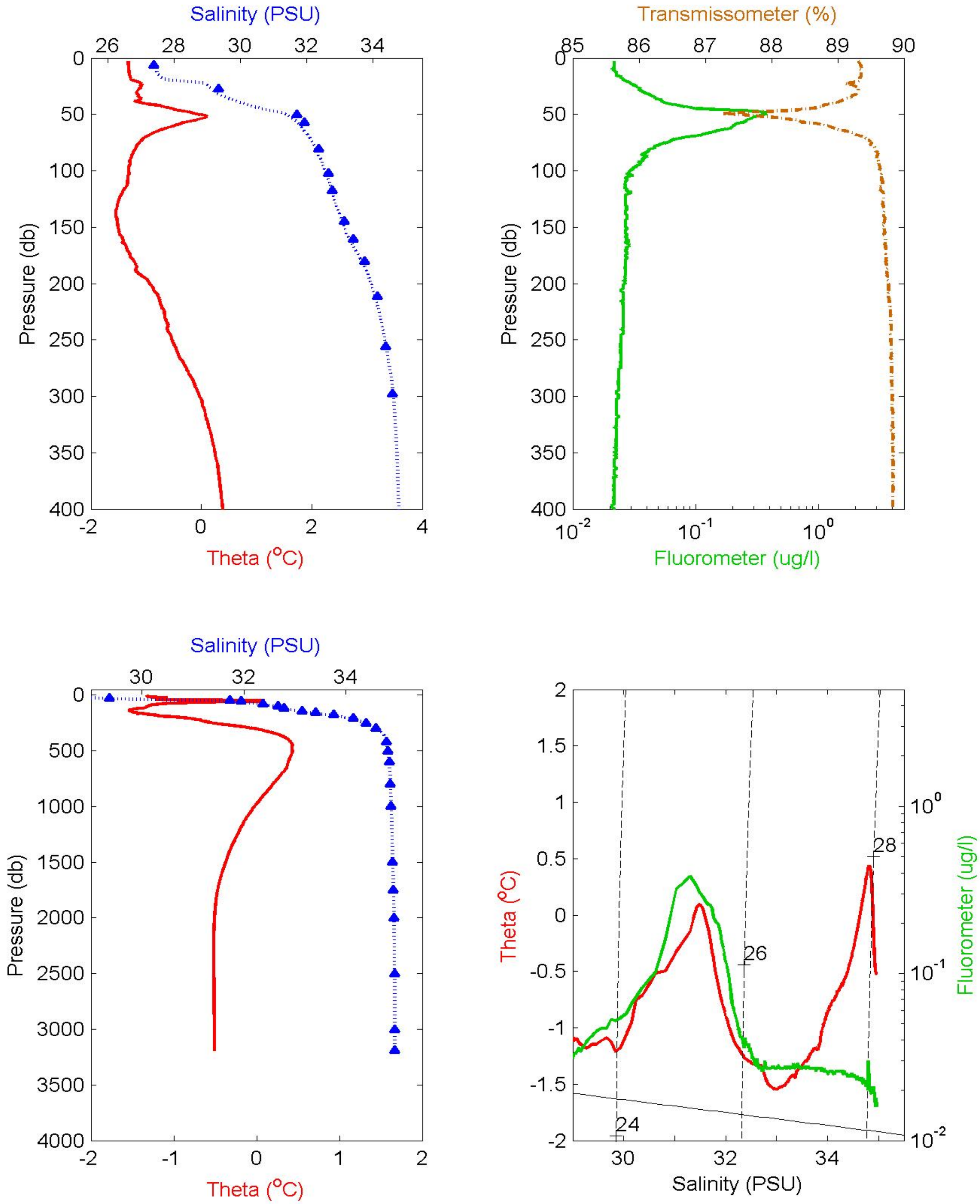
2004-16: Cast 41 Station CB-23



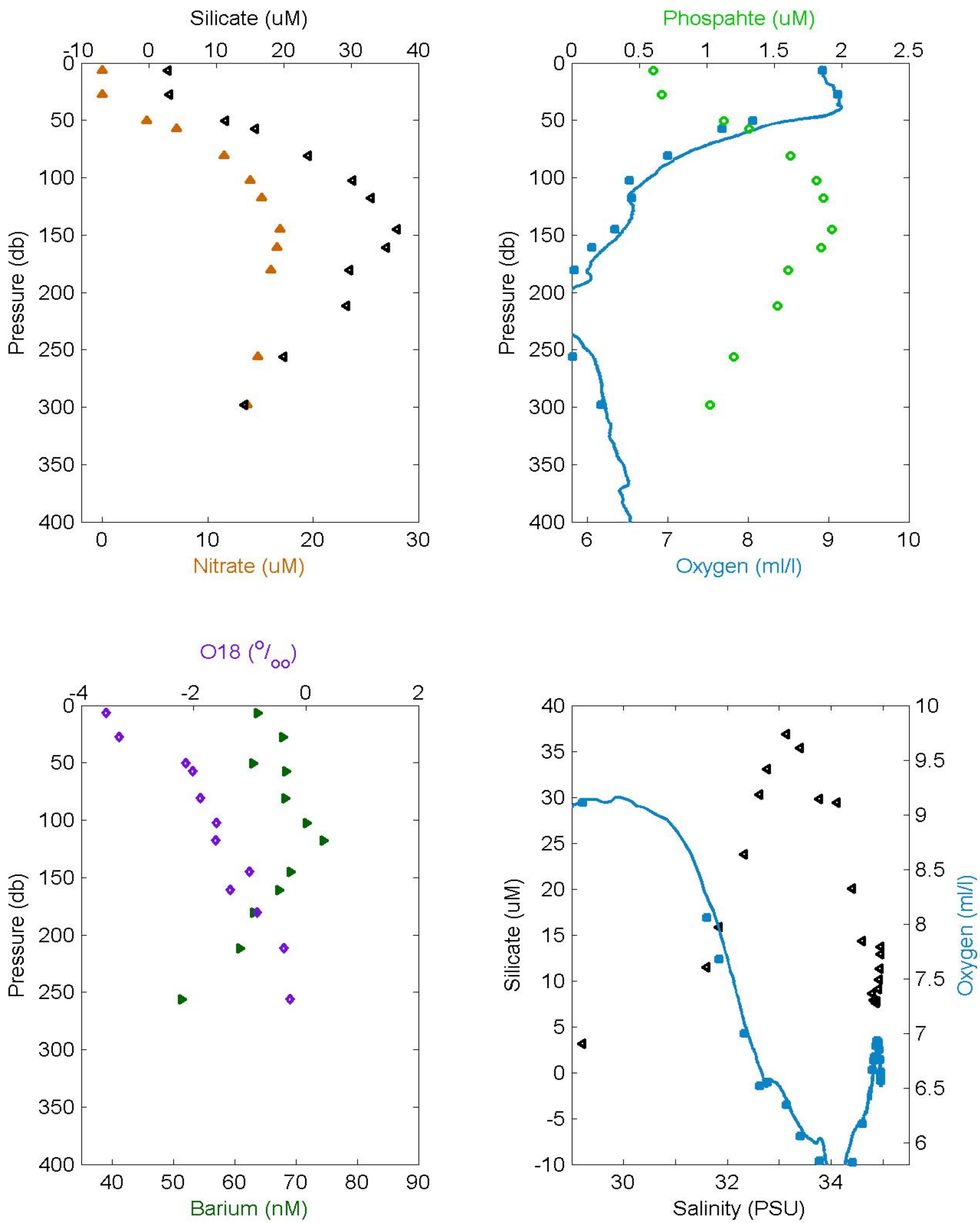
2004-16: Cast 41 Station CB-23



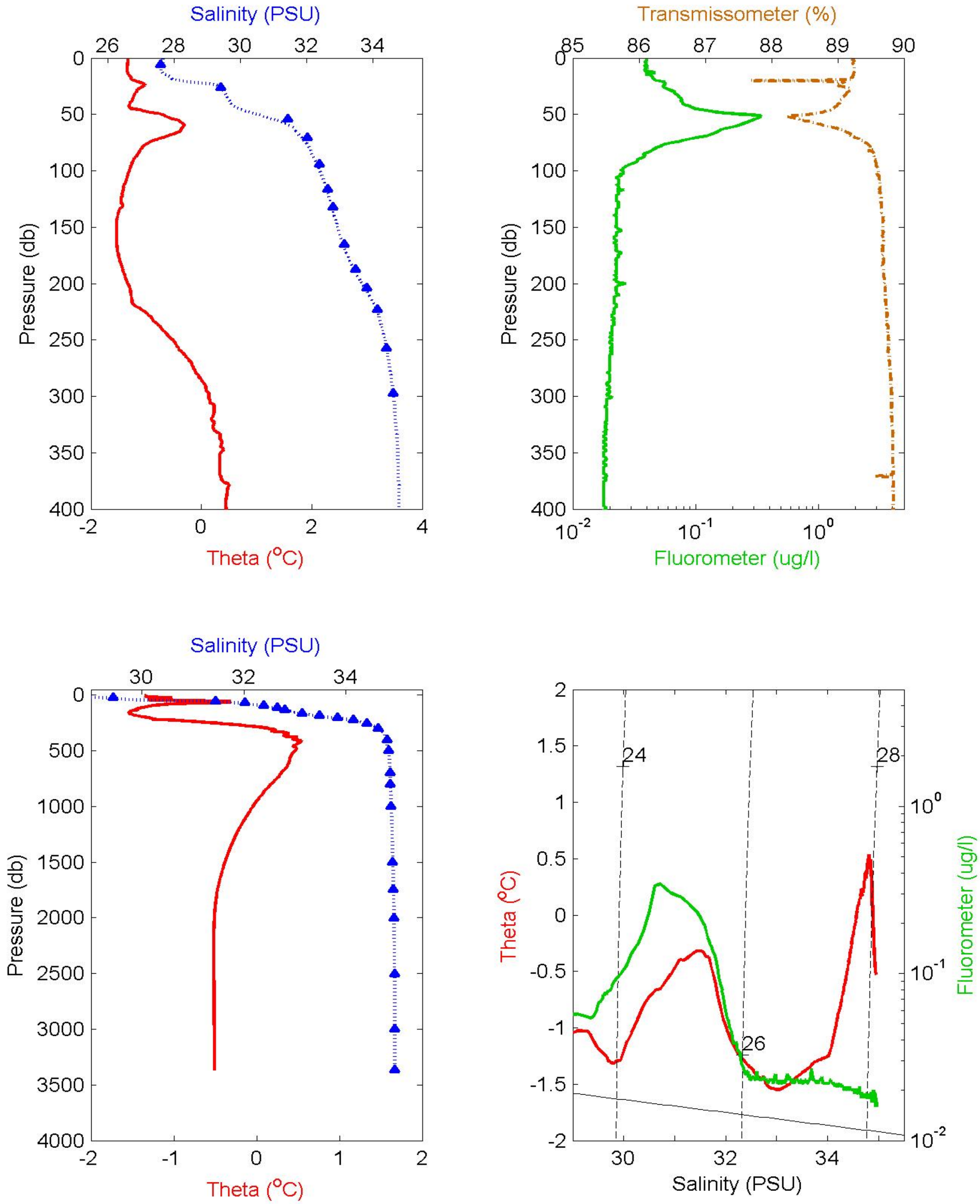
2004-16: Cast 42 Station CB-24



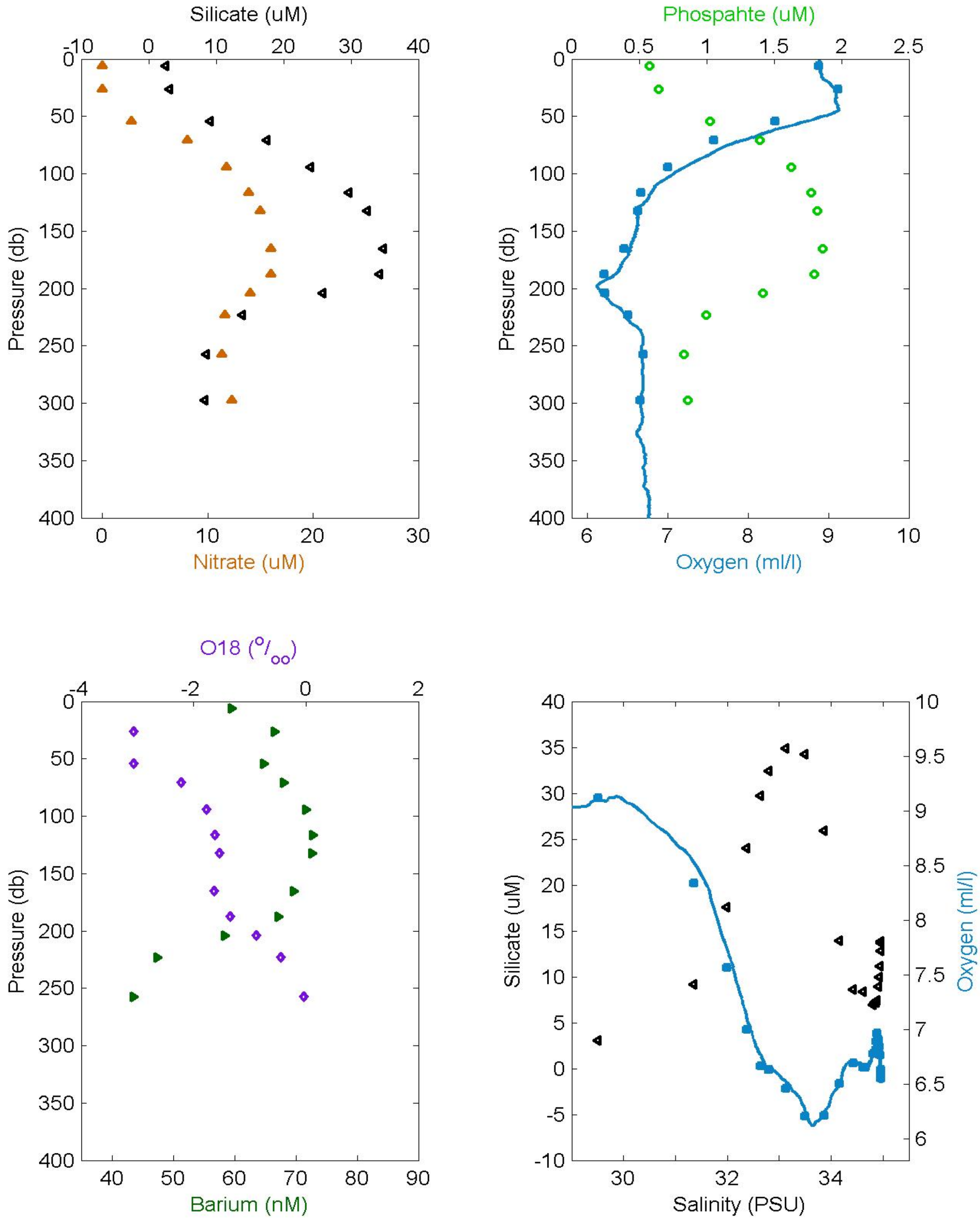
2004-16: Cast 42 Station CB-24



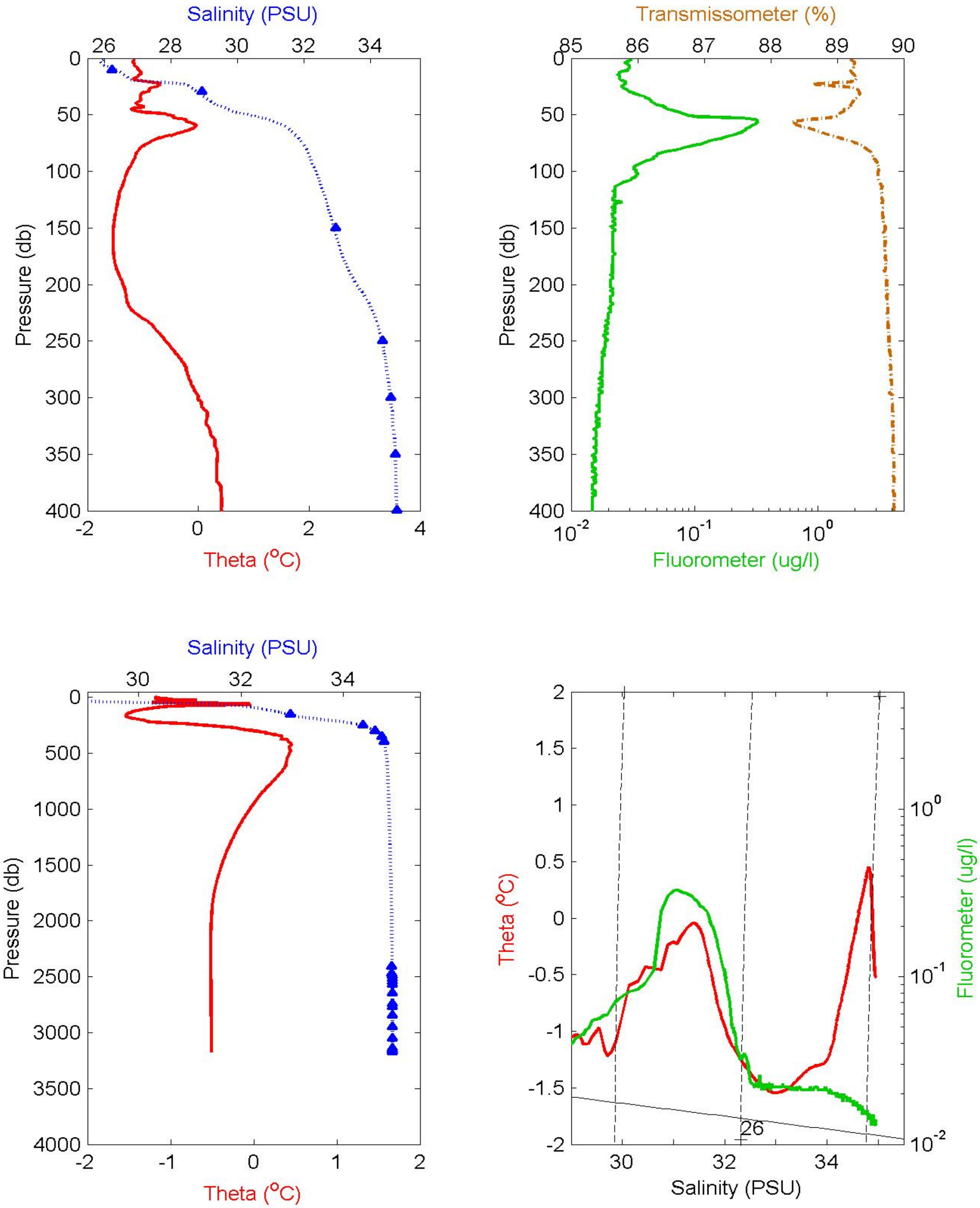
2004-16: Cast 43 Station CB-25



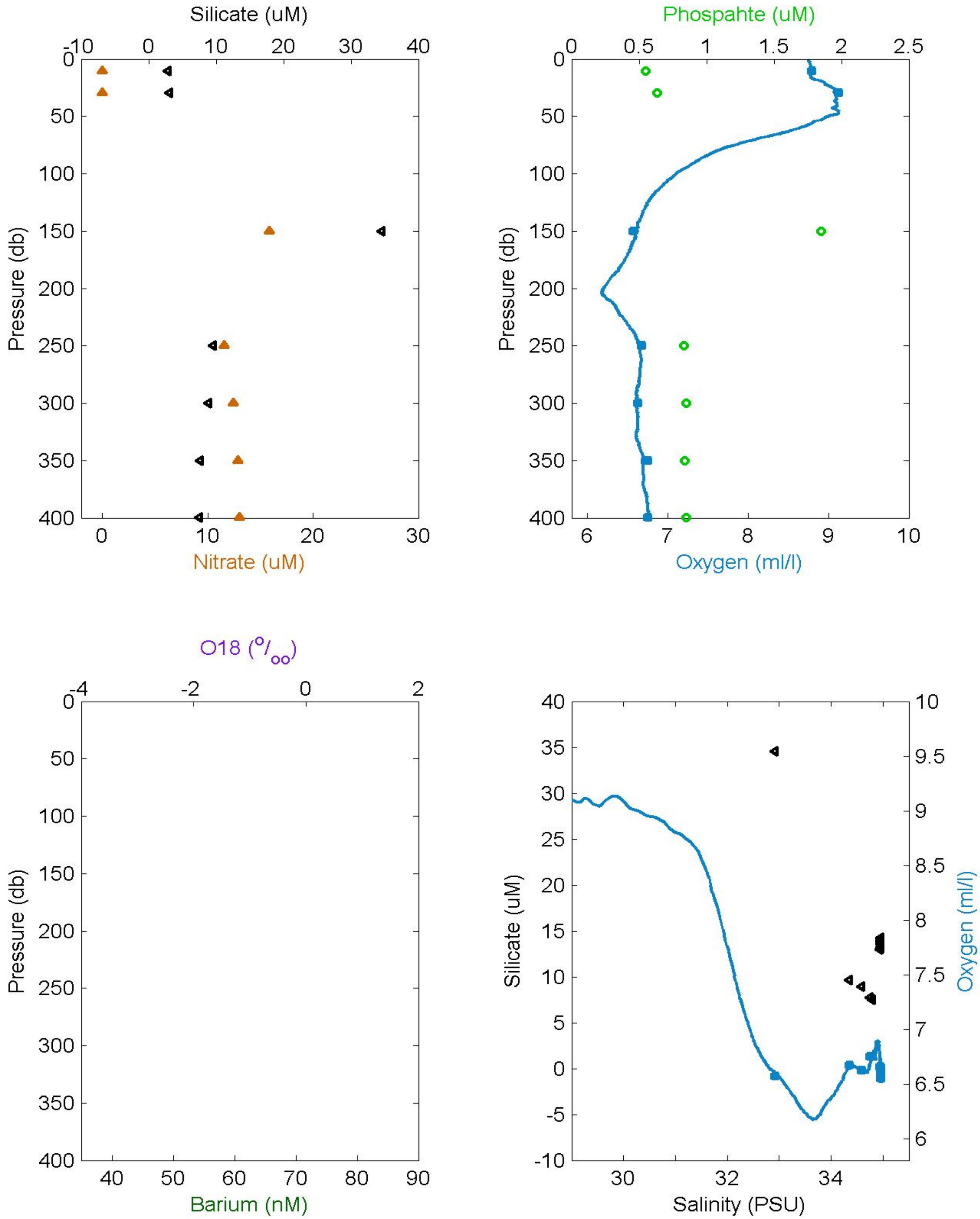
2004-16: Cast 43 Station CB-25



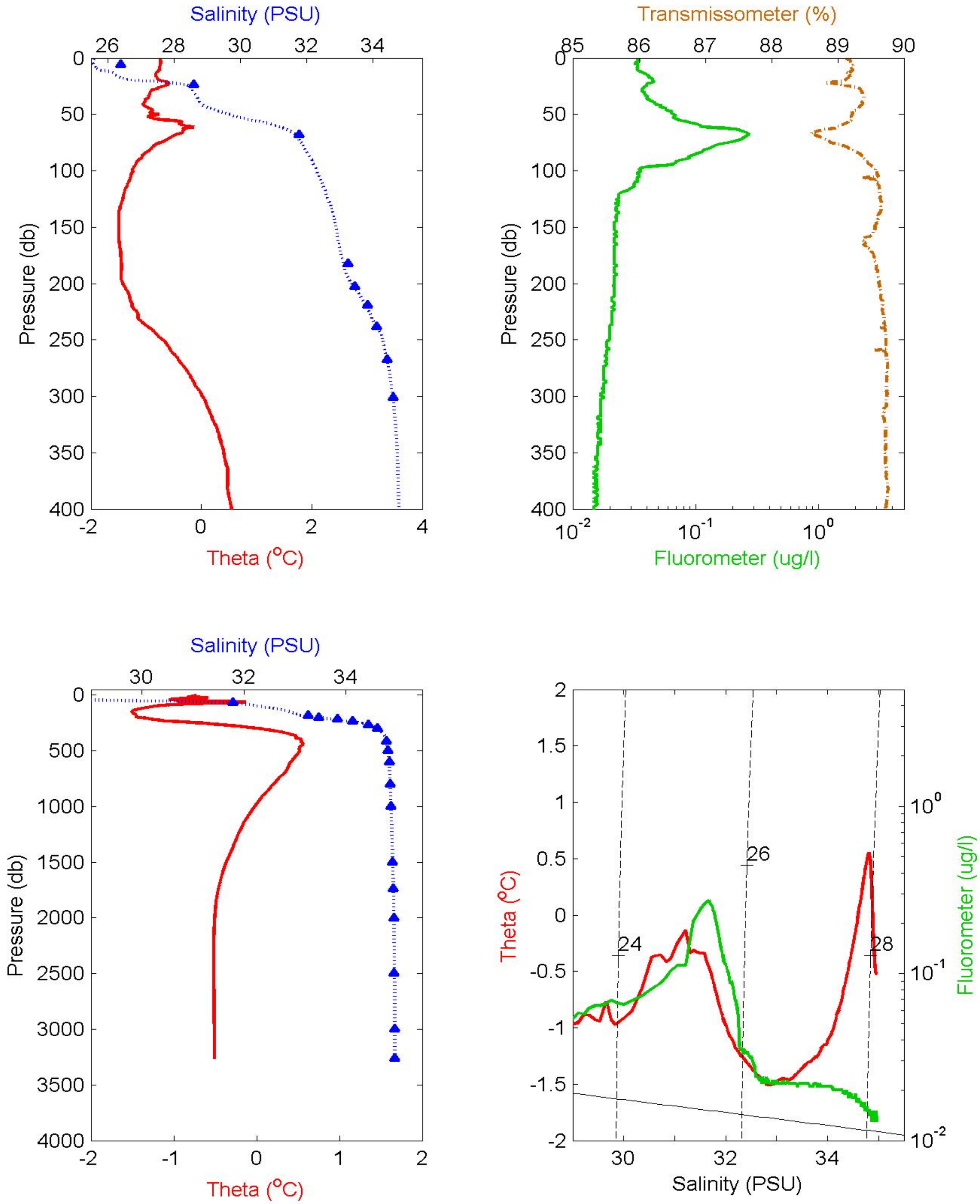
2004-16: Cast 44 Station CB-26



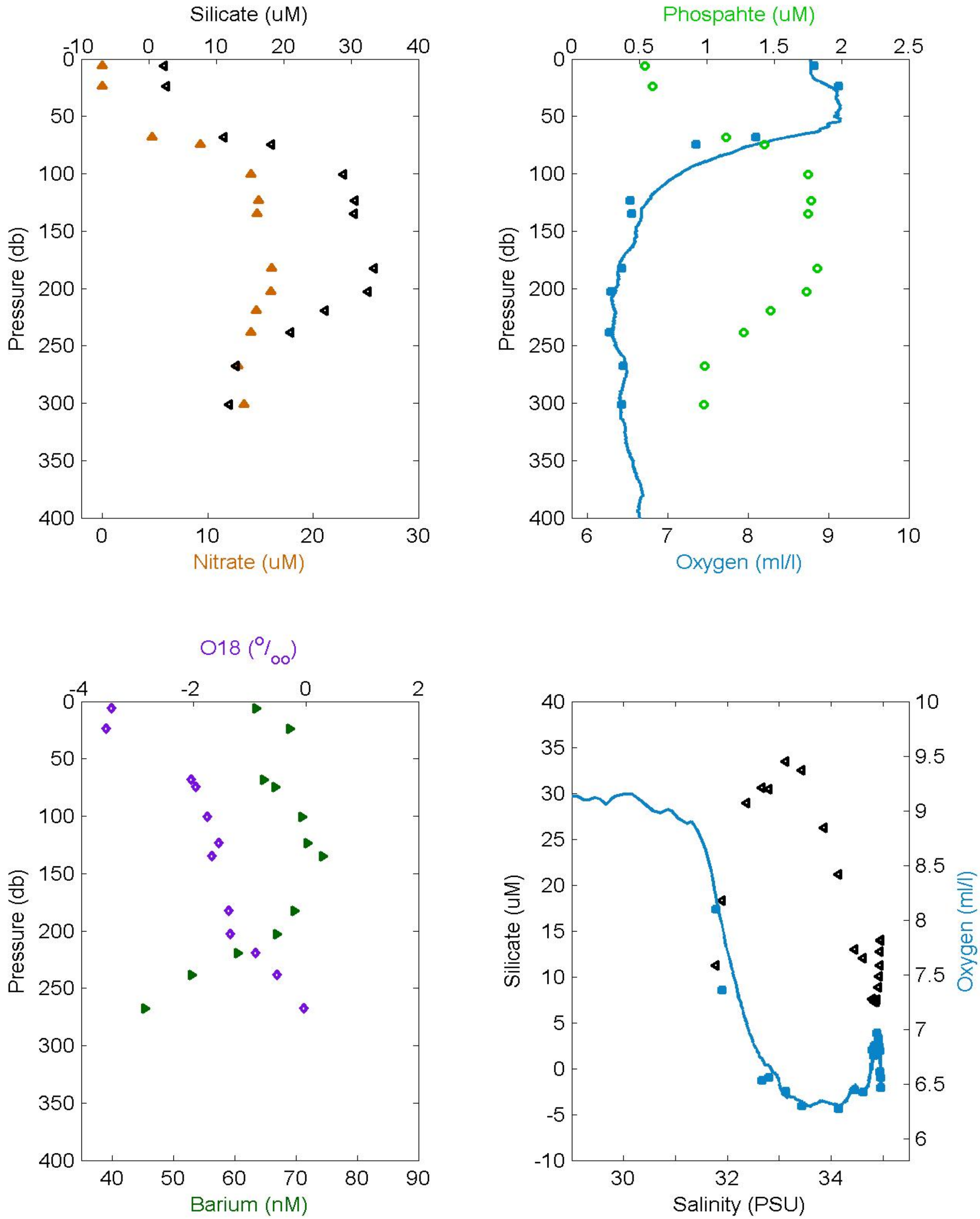
2004-16: Cast 44 Station CB-26



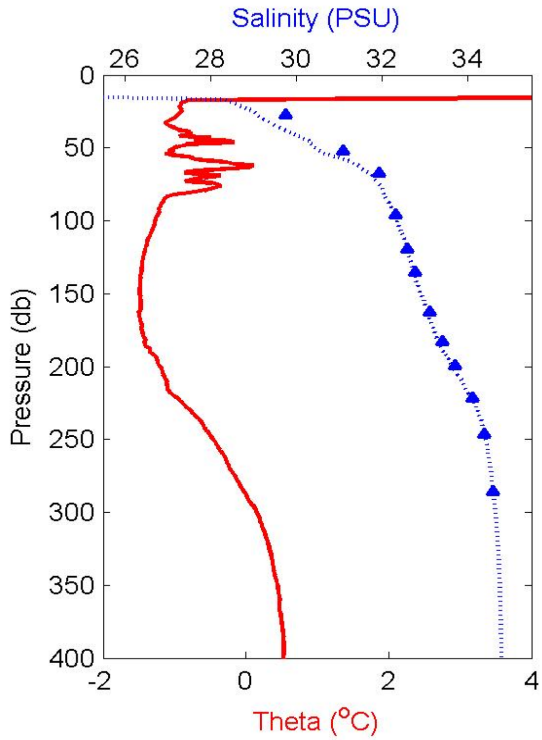
2004-16: Cast 45 Station CB-27

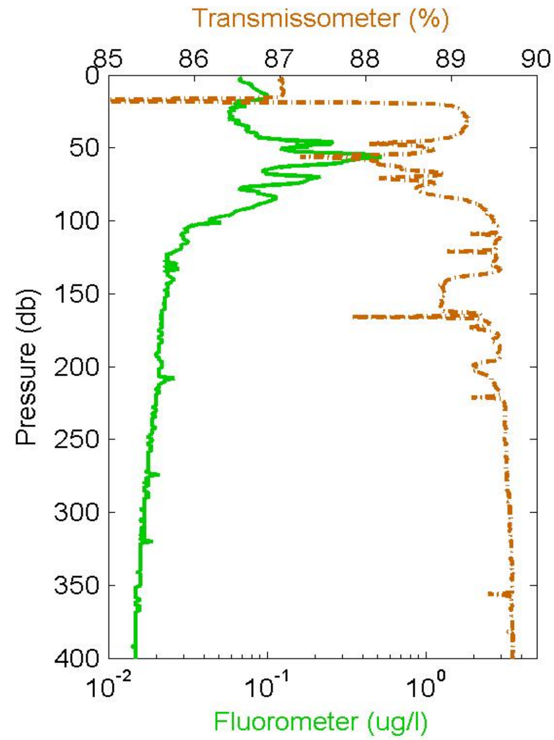


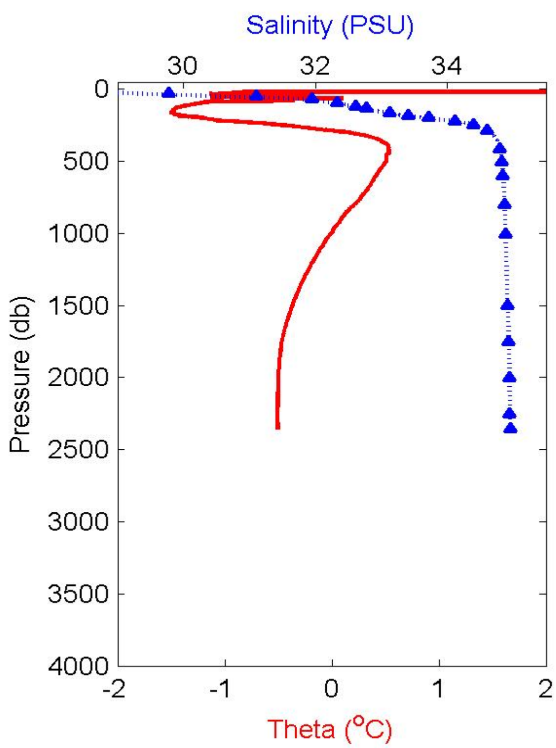
2004-16: Cast 45 Station CB-27

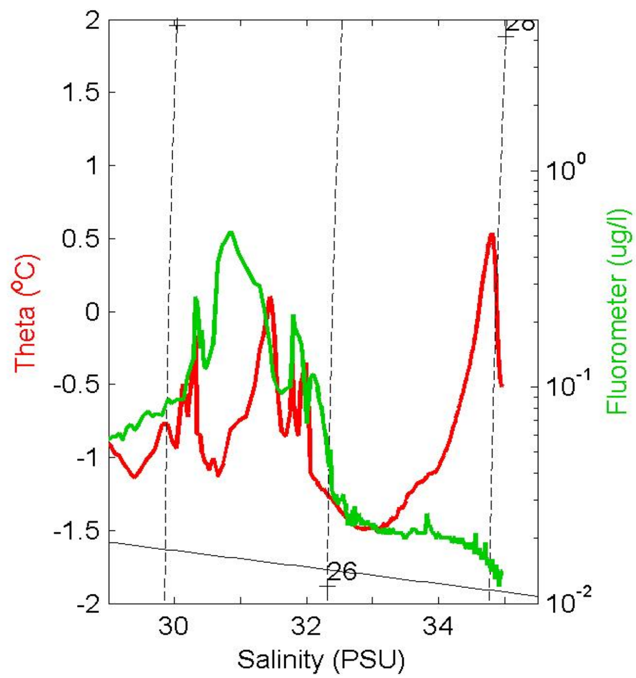


2004-16: Cast 46 Station CB-28

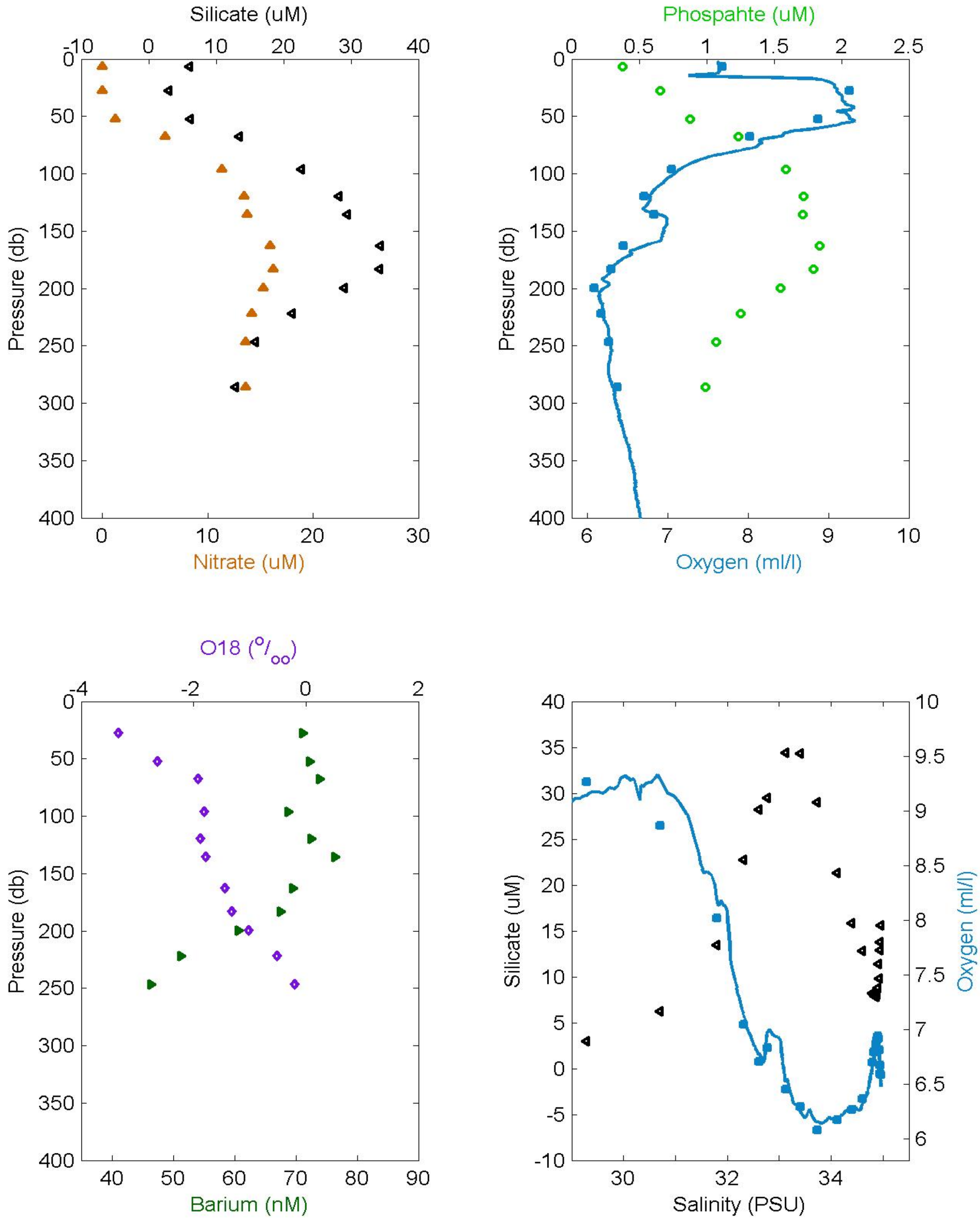




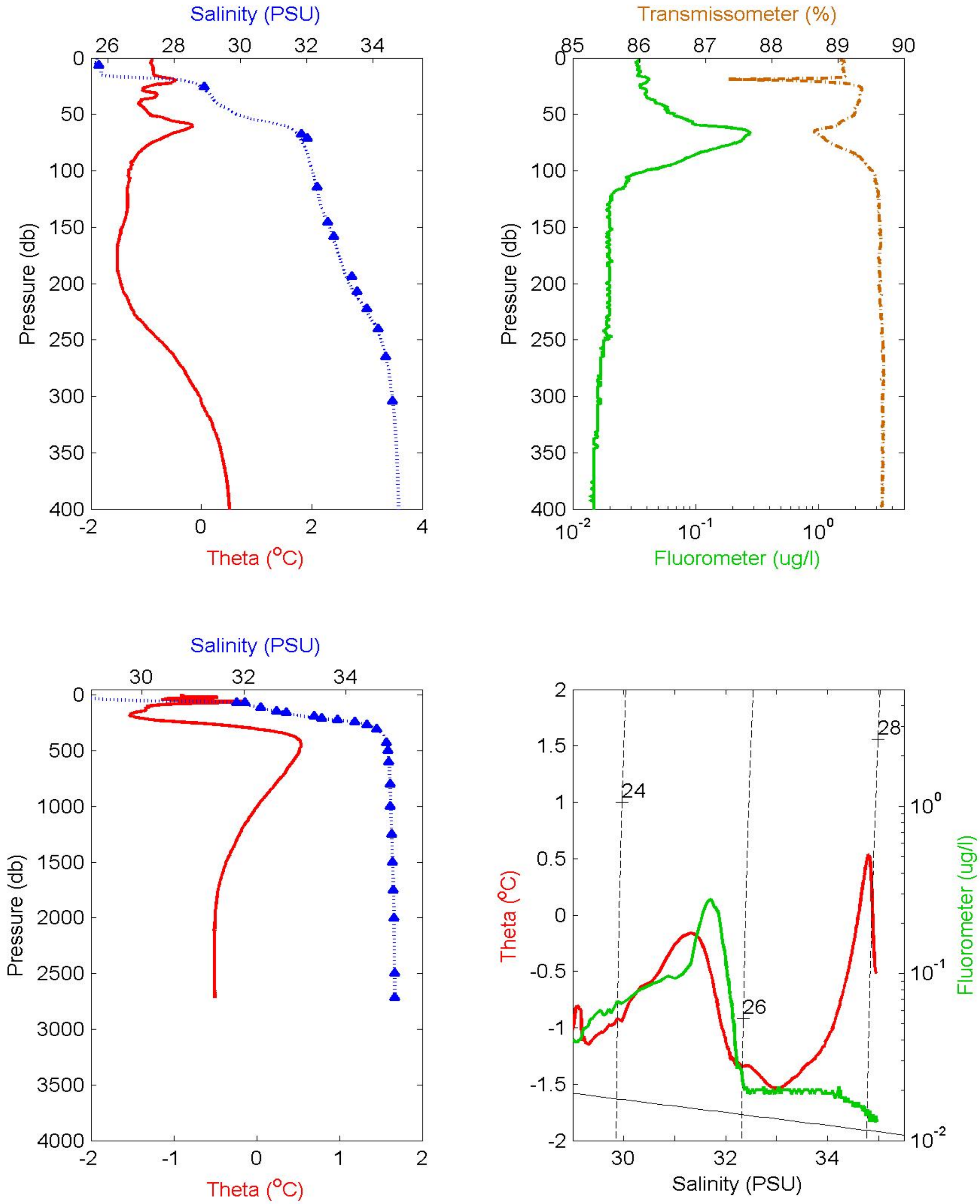




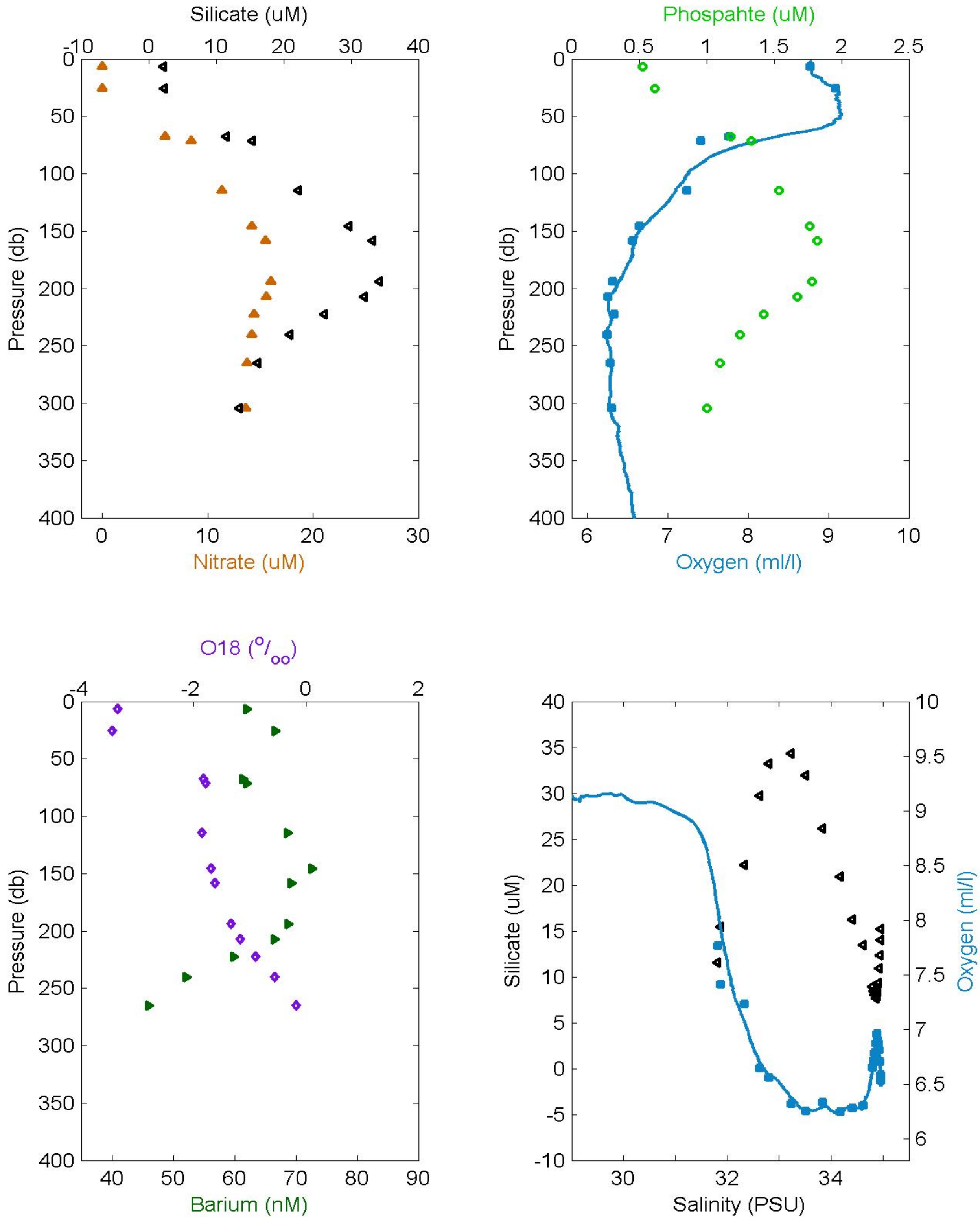
2004-16: Cast 46 Station CB-28



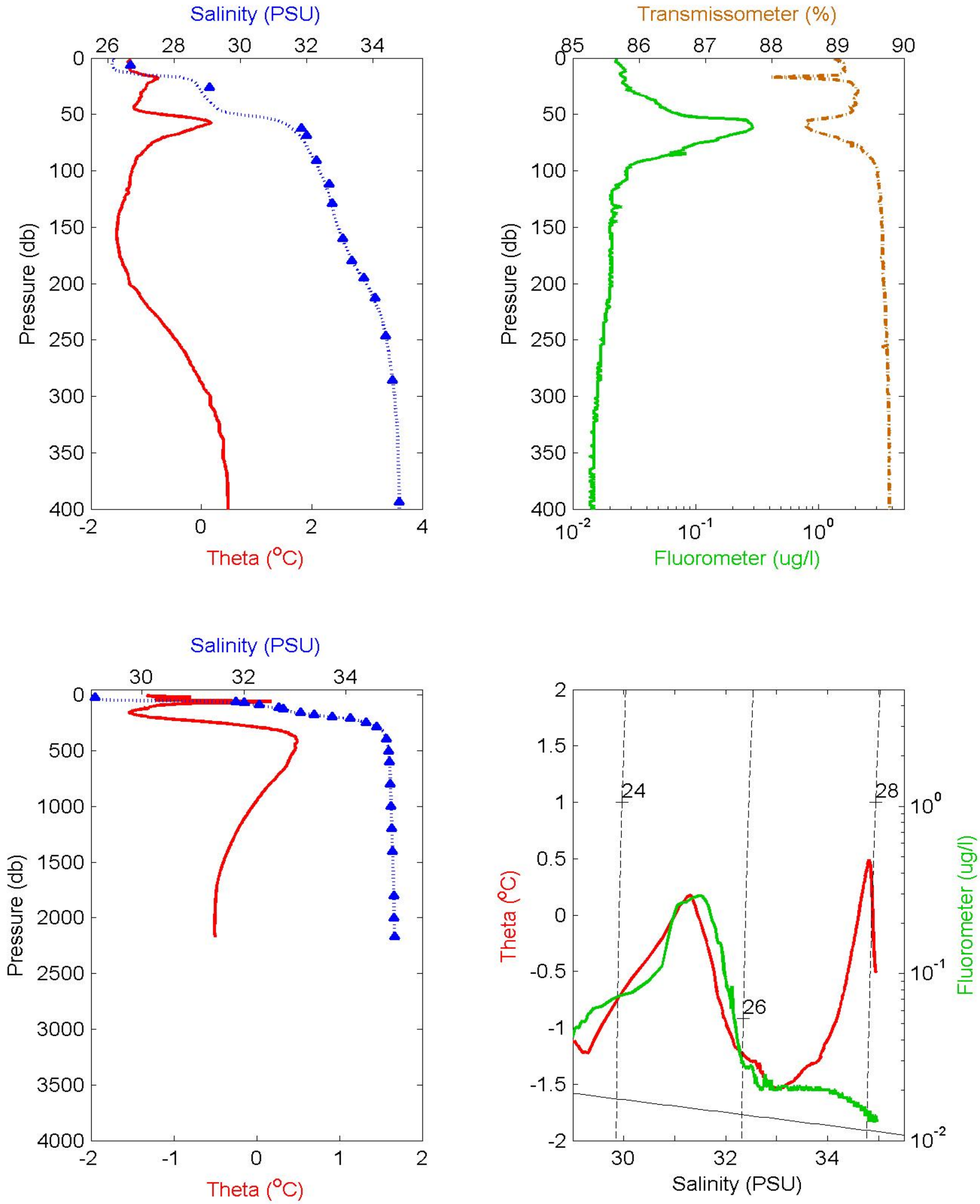
2004-16: Cast 47 Station CB-29



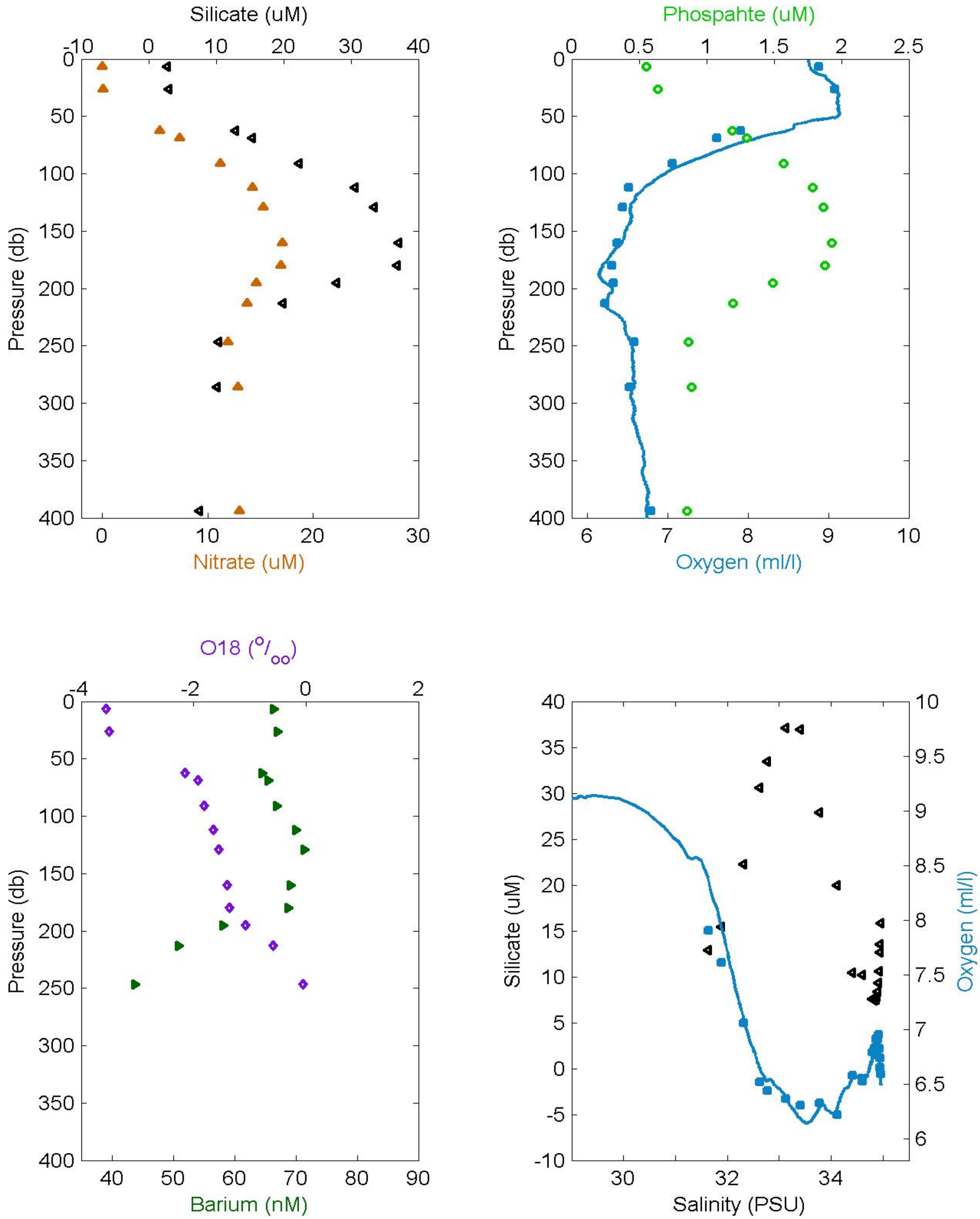
2004-16: Cast 47 Station CB-29



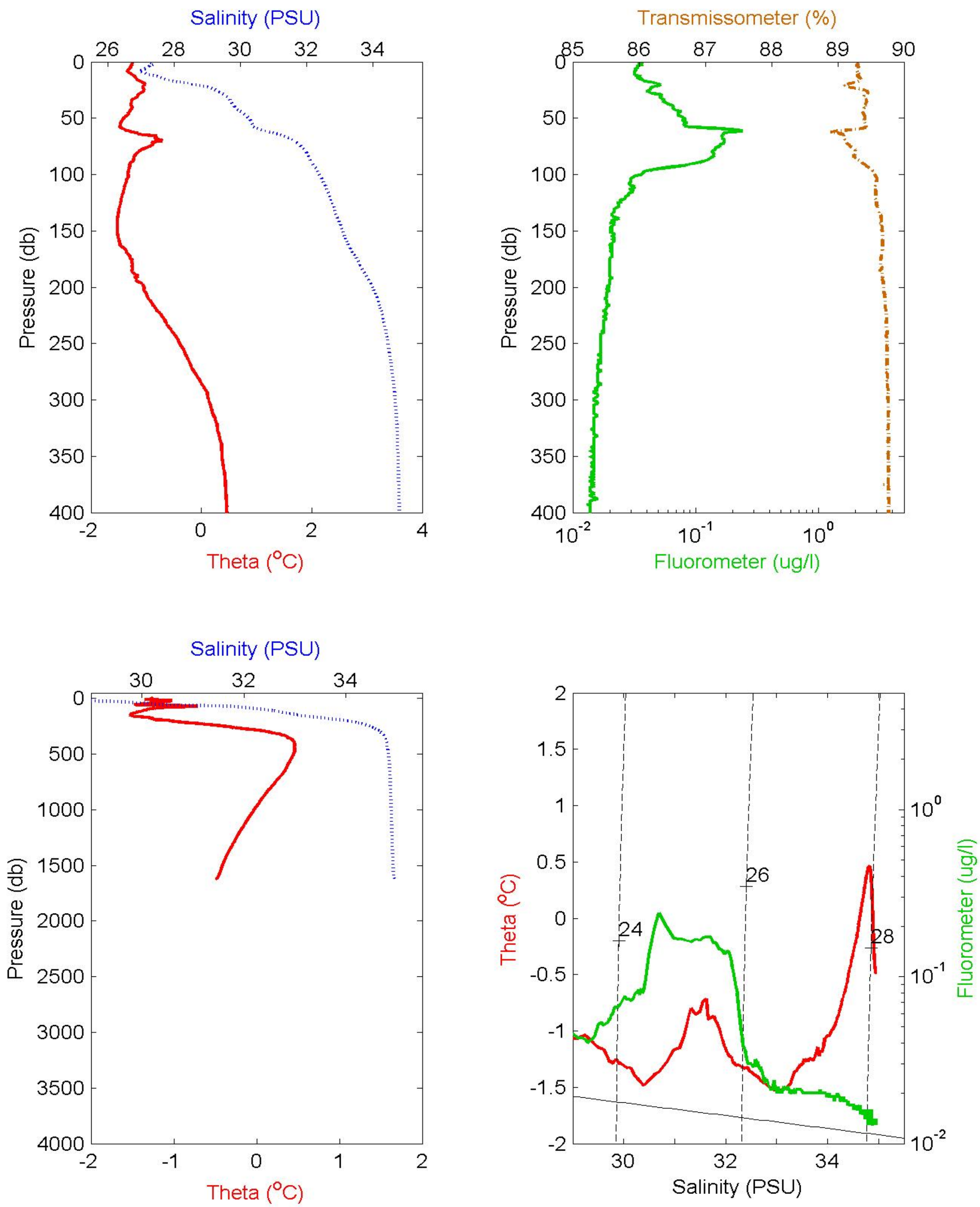
2004-16: Cast 48 Station CB-30



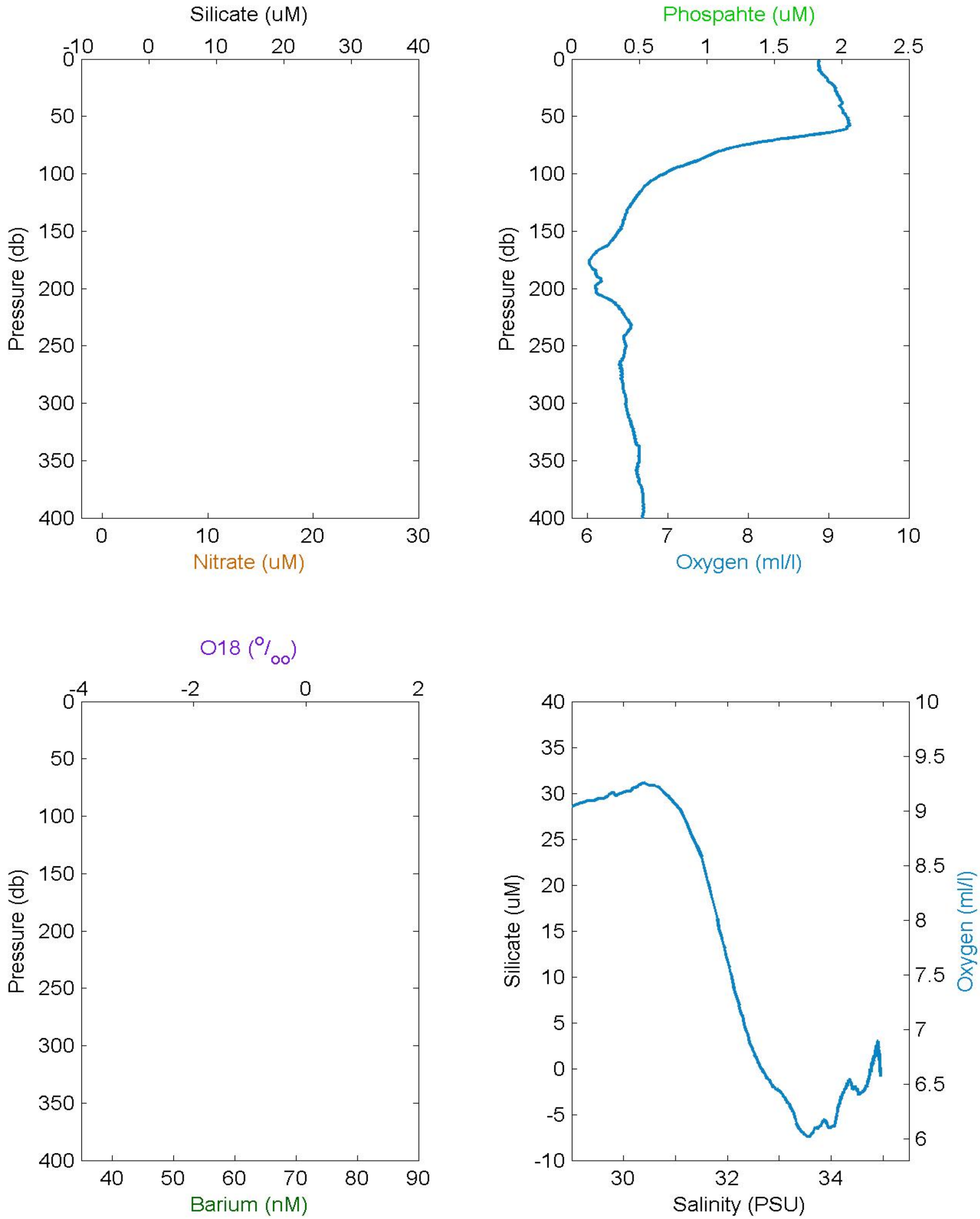
2004-16: Cast 48 Station CB-30



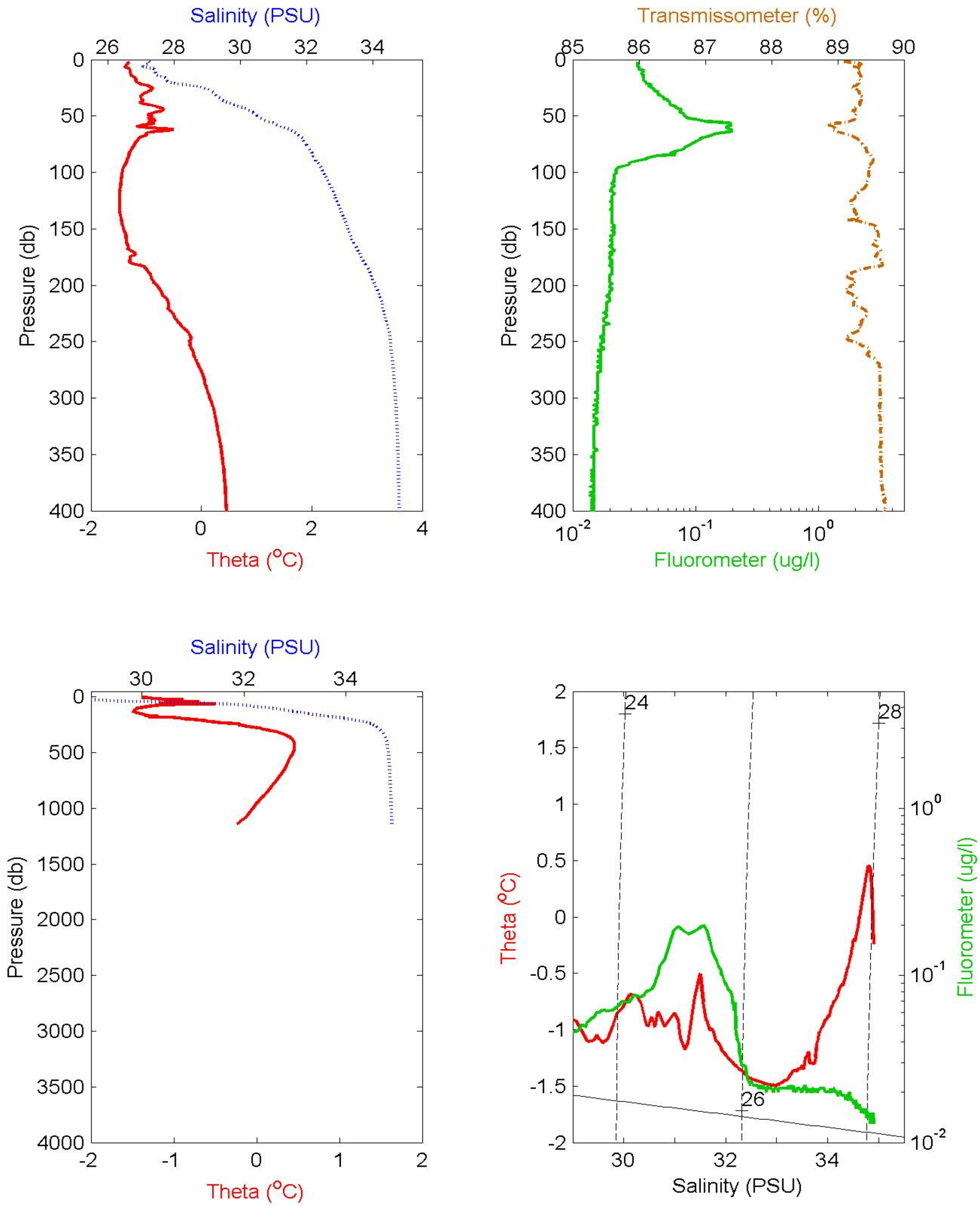
2004-16: Cast 49 Station CB-31



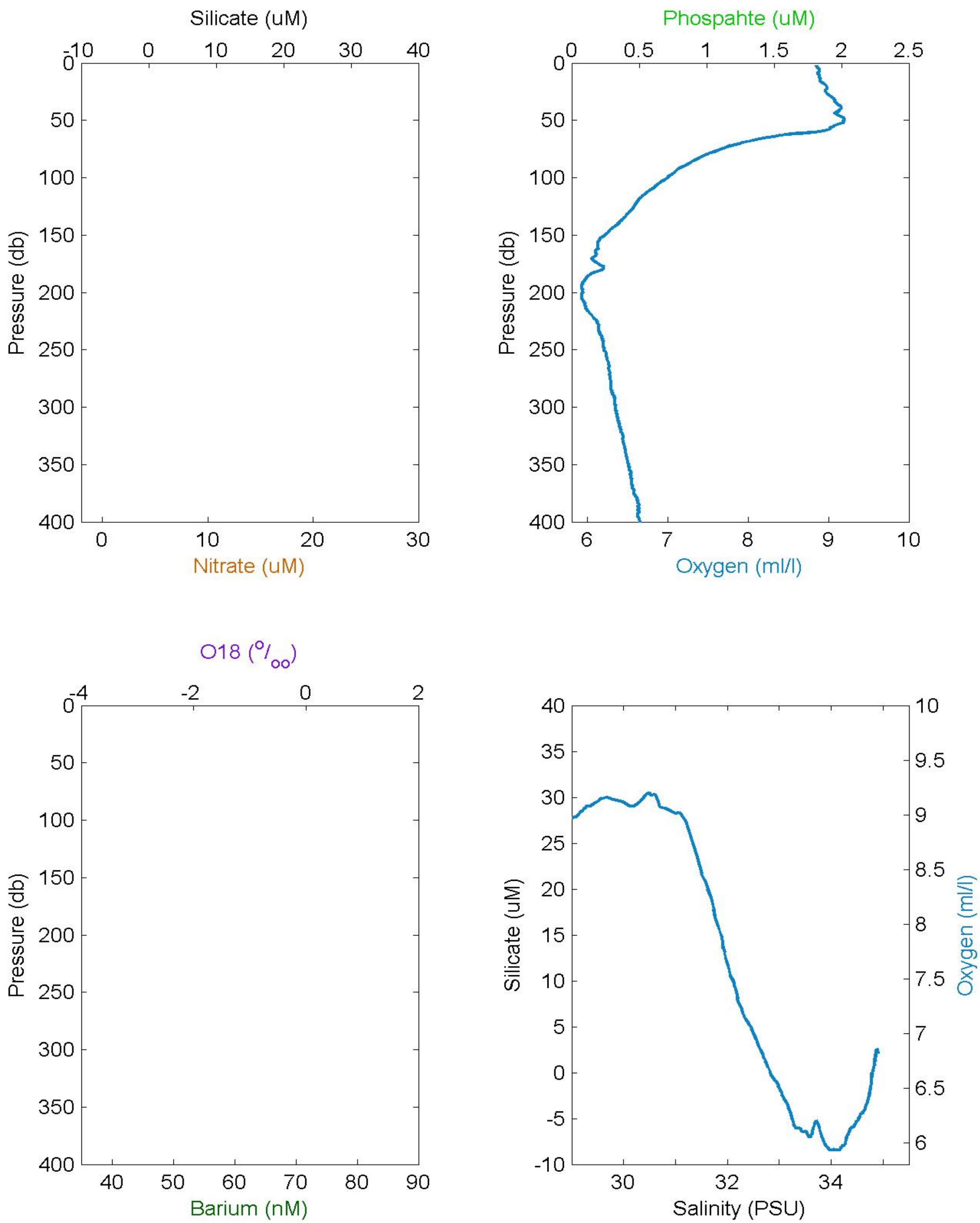
2004-16: Cast 49 Station CB-31



2004-16: Cast 50 Station CABOS/CB-32



2004-16: Cast 50 Station CABOS/CB-32



4.6 STATIONS PLOTTED BY GROUP

The data have been divided into three groups. The first two groups: casts from the Canada Basin west of 145ºW and casts east of 145ºW have been colored by latitude with the blue indicating south and red to the north. The figures are ordered by property with the west group shown on the left facing page and the east group on the right facing page. The third group, casts from the Canadian Arctic Archipelago, has been colored by longitude with blue indicating east and red indicating west.

The plotted parameters:

CTD:
- Theta (potential temperature)
- Salinity
- Dissolved Oxygen
- Fluorescence
- Transmission

Chemistry:
- Salinity
- Dissolved oxygen
- Silicate
- Orthophosphate
- Nitrate and Nitrite
- Chlorophyll a
- Phaeo-pigments
- Barium
- O18

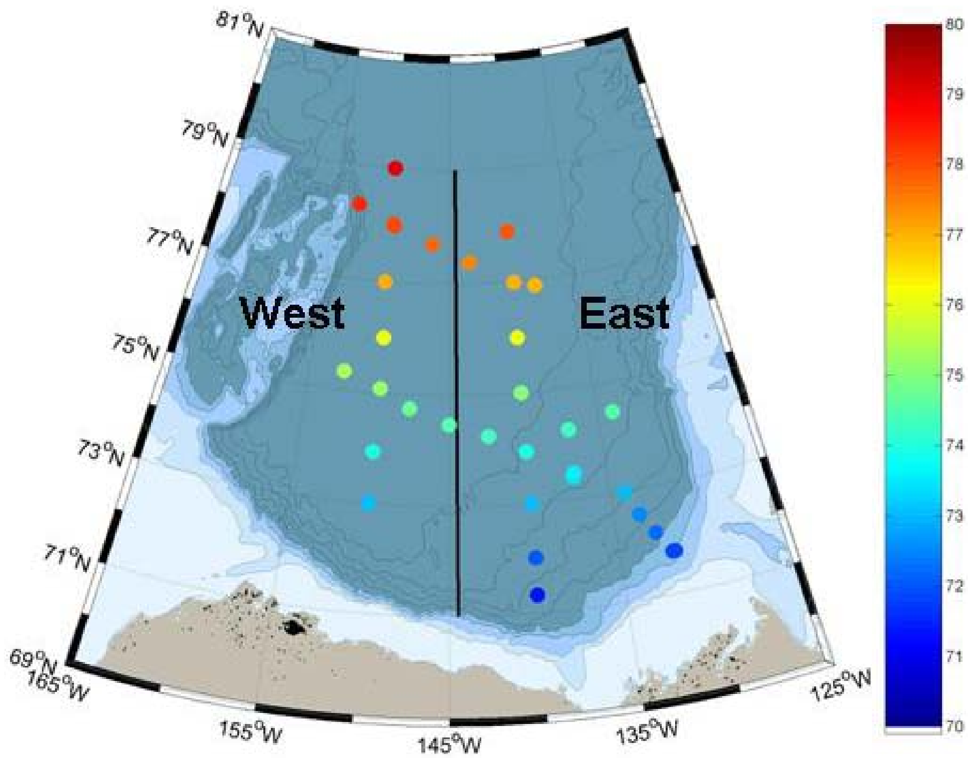
For each parameter the data are plotted:
- A profile from 0 to 400m
- A profile from 0 to 4000m
- Against CTD salinity from 25.5 to 35.5 PSU
- Against CTD salinity from 34 to 35 PSU

Table 15. Cast list within each group

Group 1: West of 145ºW		**Group 2: East of 145ºW**		**Group 3: Canadian Archipelago**	
Cast	**Station**	**Cast**	**Station**	**Cast**	**Station**
17	CB-2	16	CABOS	1	1
18	CB-3	30	CB-13	2	2
19	CB-4	31	CB-14	3	3
20	CB-5	32	CB-15	4	4
21	CB-6	33	CB-16	5	5
22	CB-7	34	CB-17	6	6

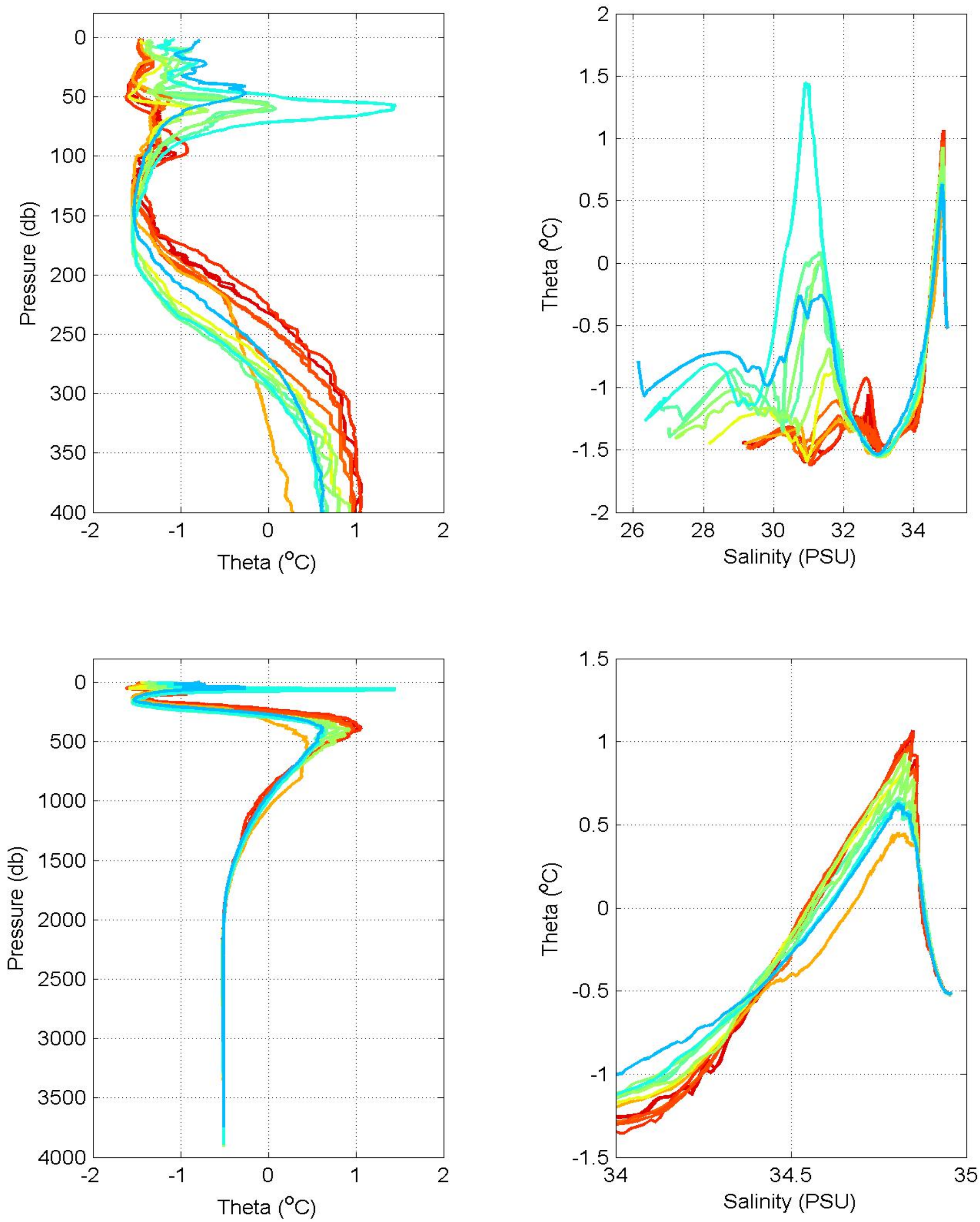
23	CB-8	35	CB-18	7	7
24	CB-9	37	CB-20	8	8
25	CB-9(2)	38	CB-21	9	9
26	CB-10	39	CB-22	10	10
27	CB-11	40	CB-22(2)	11	11
28	CB-11(2)	41	CB-23	12	12
29	CB-12	42	CB-24	13	13
36	CB-19	43	CB-25	14	14
		44	CB-26	15	15
		45	CB-27		
		46	CB-28		
		47	CB-29		
		48	CB-30		
		49	CB-31		
		50	CABOS/CB-32		

4.6.1 Casts in the Canada Basin

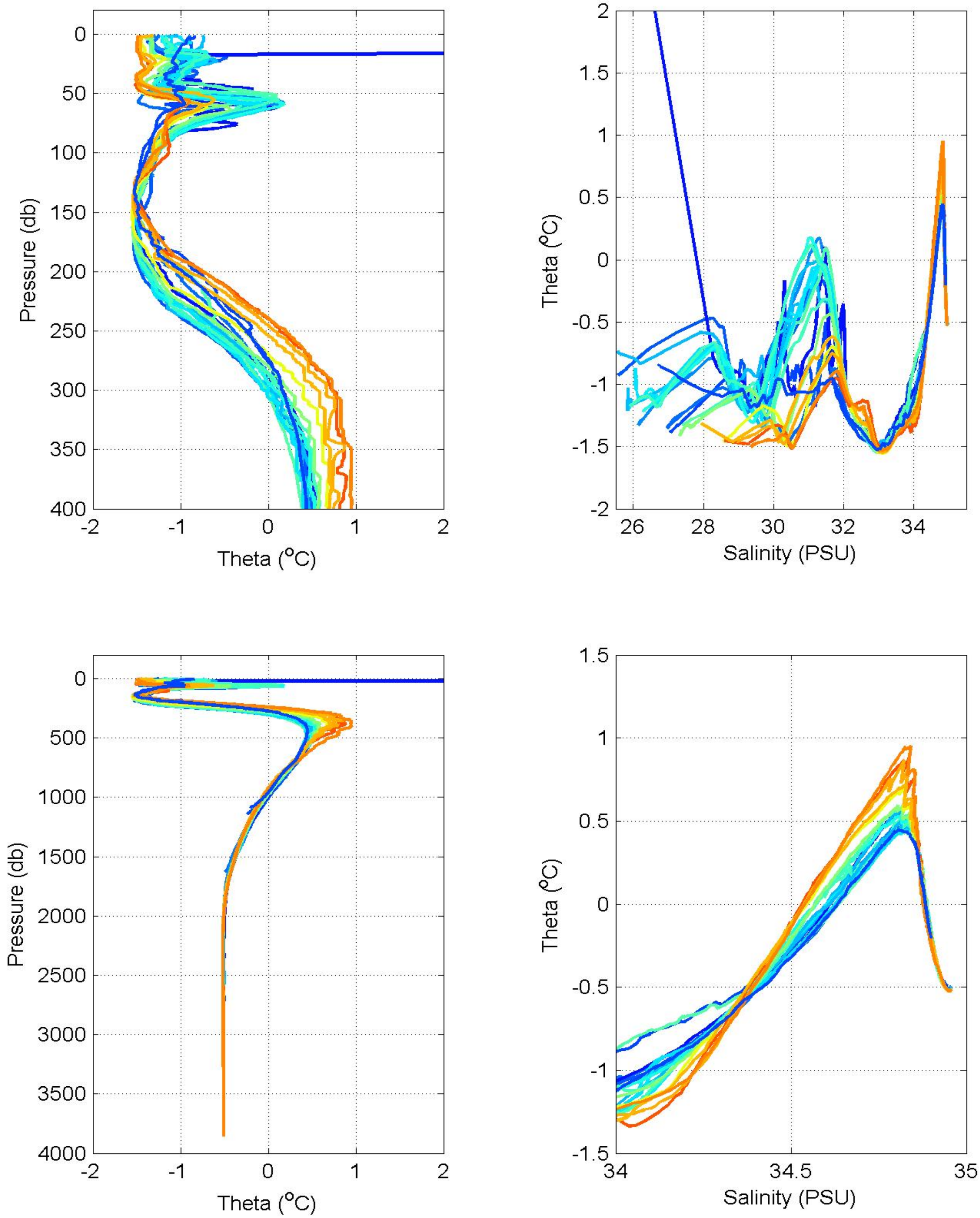


The Canada Basin is divided into two groups, the east side and the west side. The division line at 145°W is drawn in black. Plotted colors are the same as used in the figures below. Colors refer to latitude (°N) and are labeled in color bar.

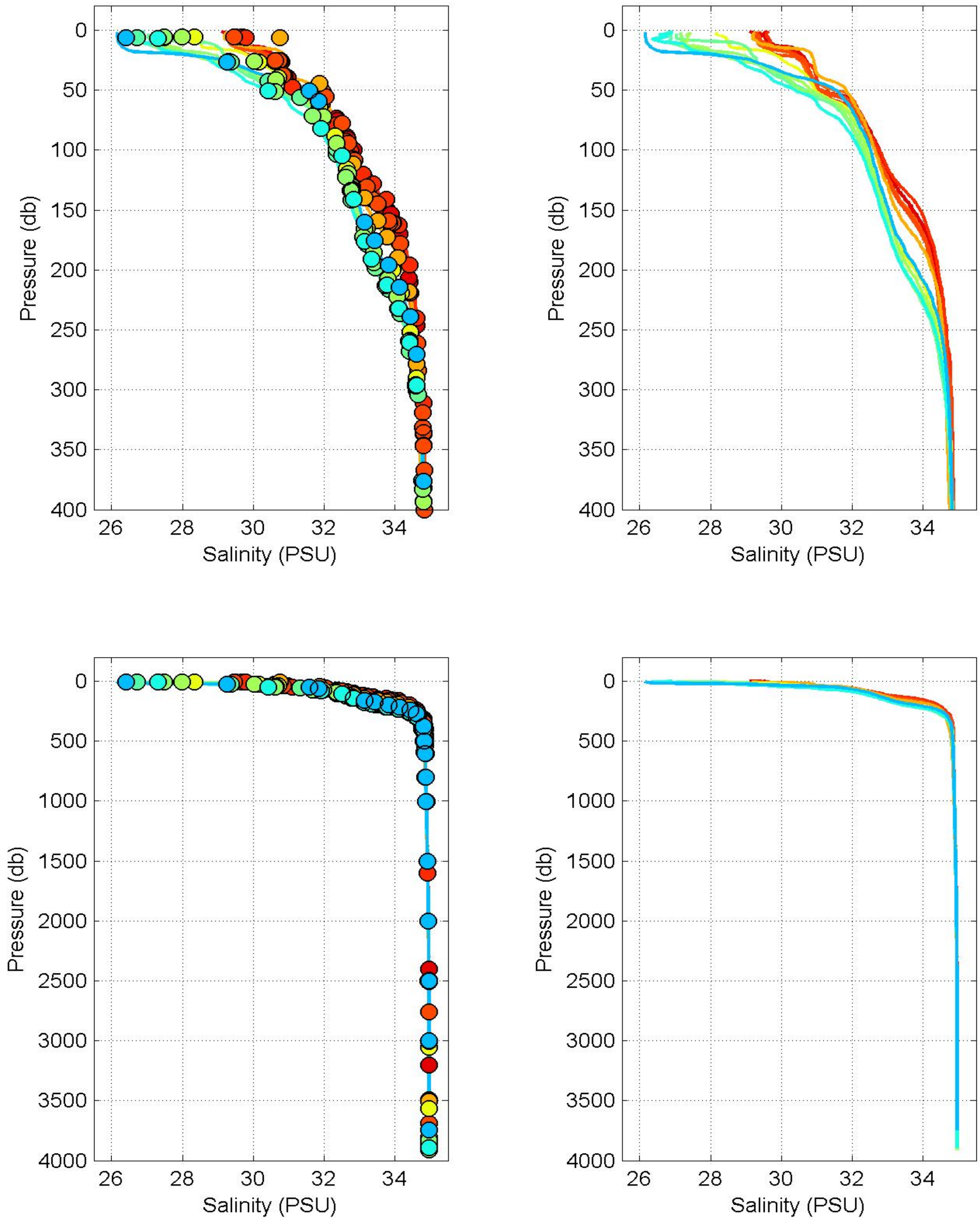
2004-16 Group: West of 145°W, Property: Theta



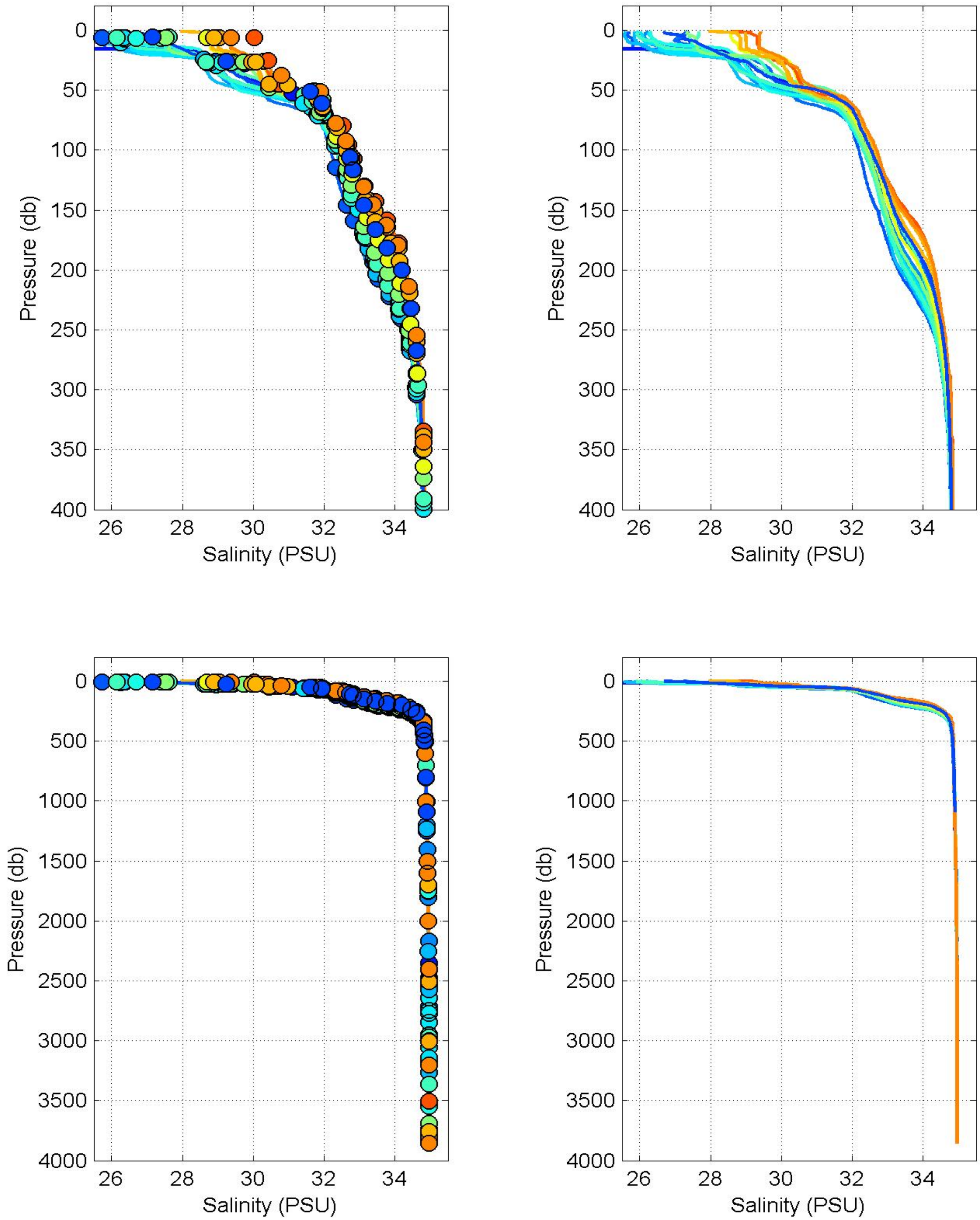
2004-16 Group: East of 145°W, Property: Theta



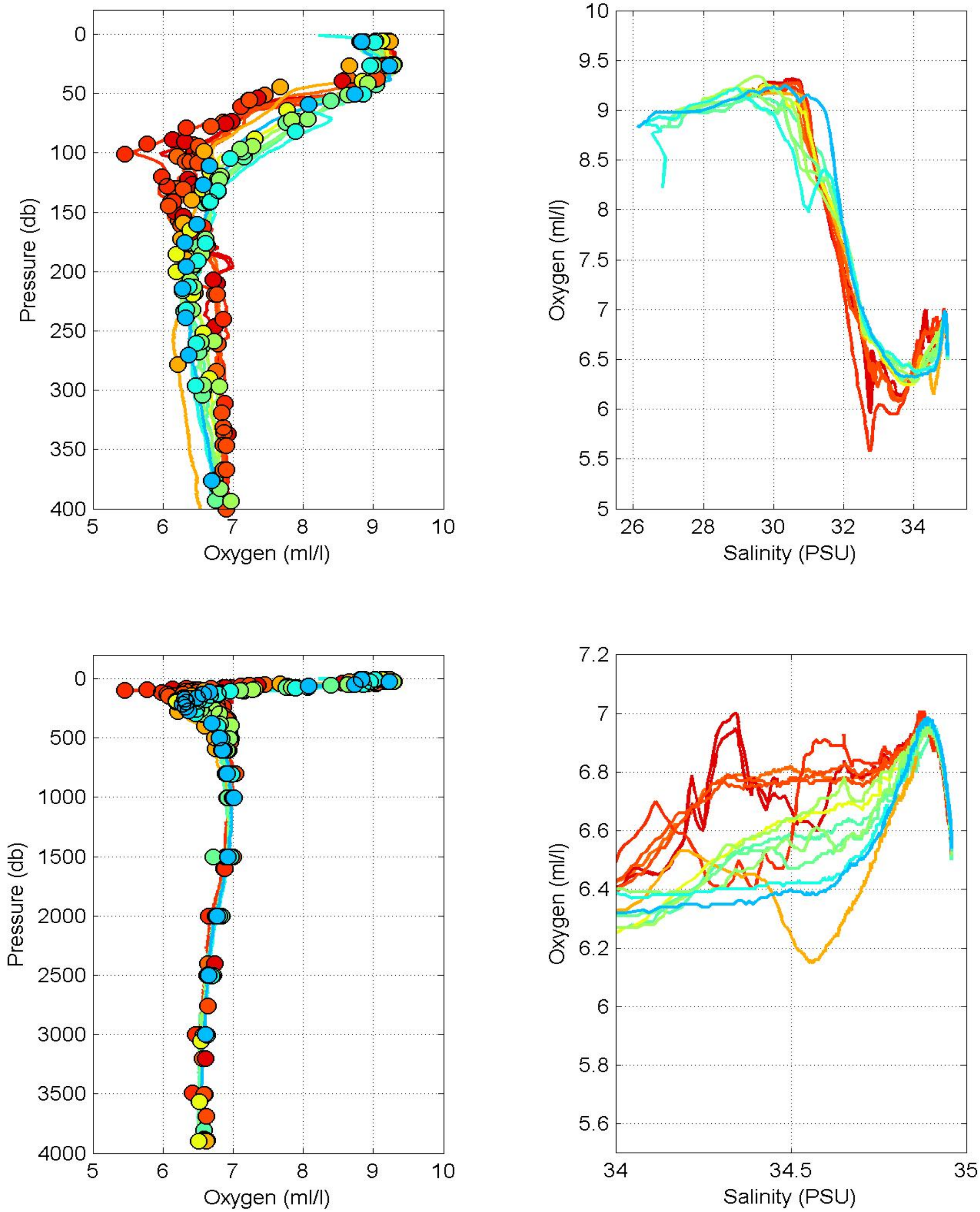
2004-16 Group: West of 145°W, Property: Salinity



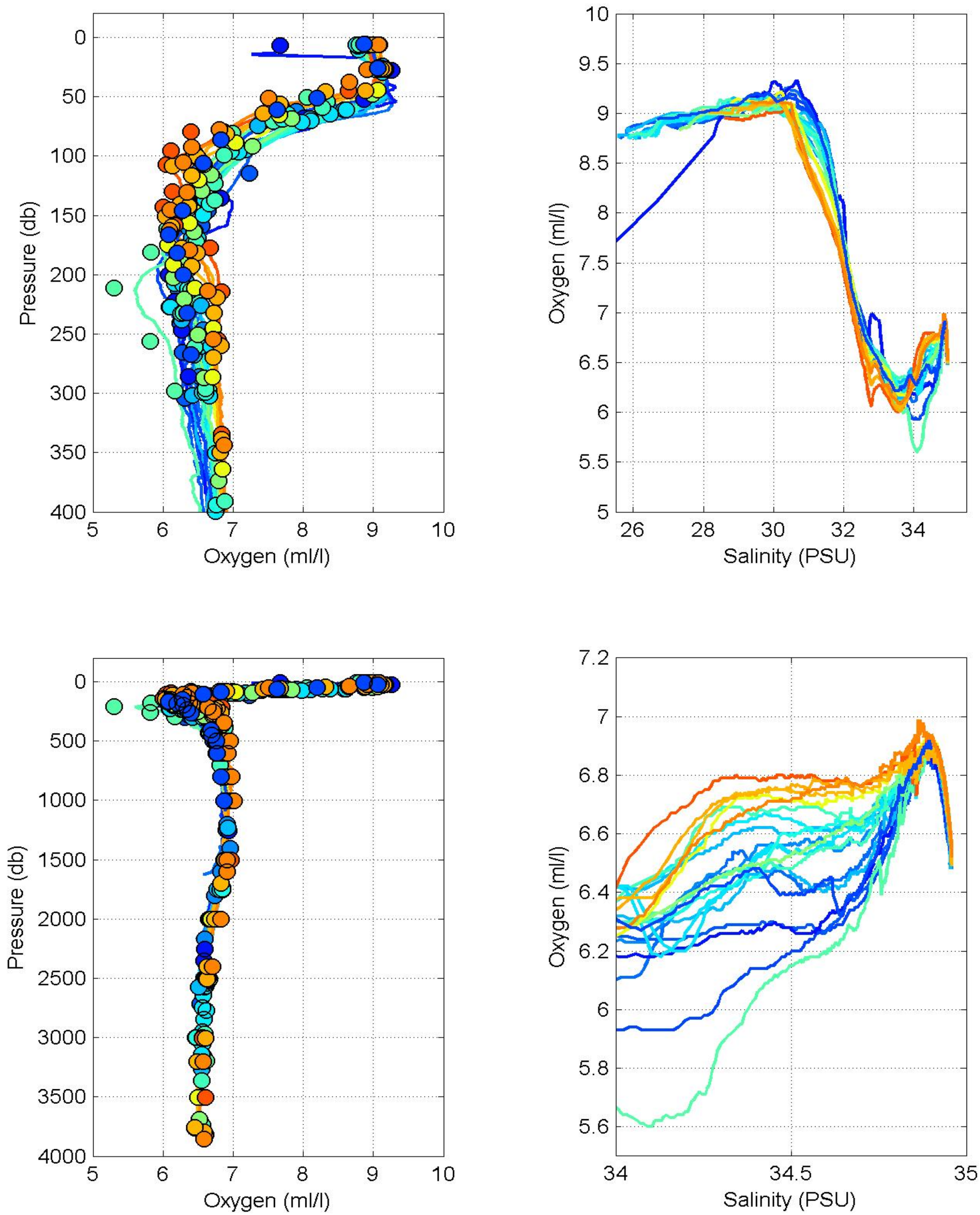
2004-16 Group: East of 145°W, Property: Salinity



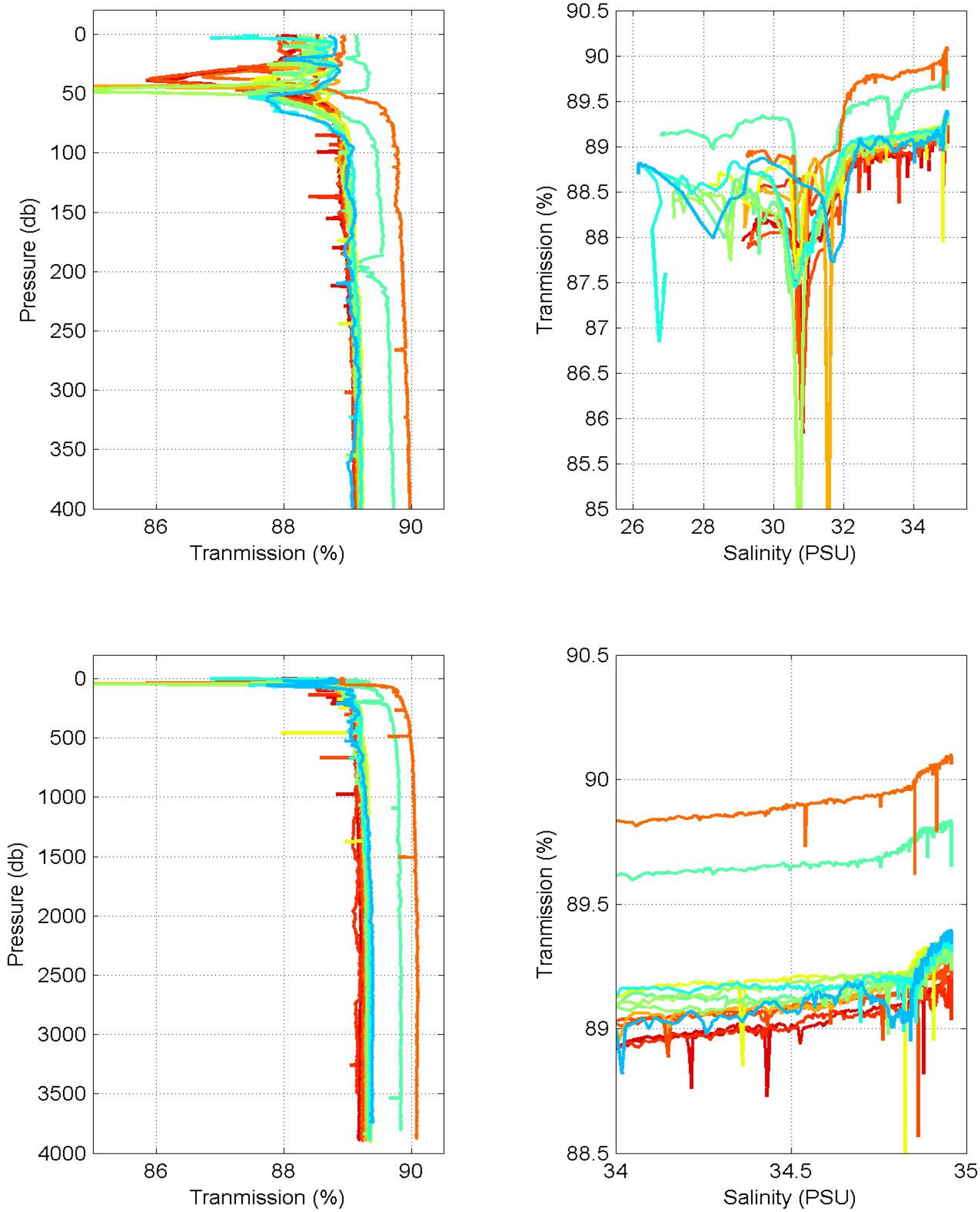
2004-16 Group: West of 145°W, Property: Oxygen



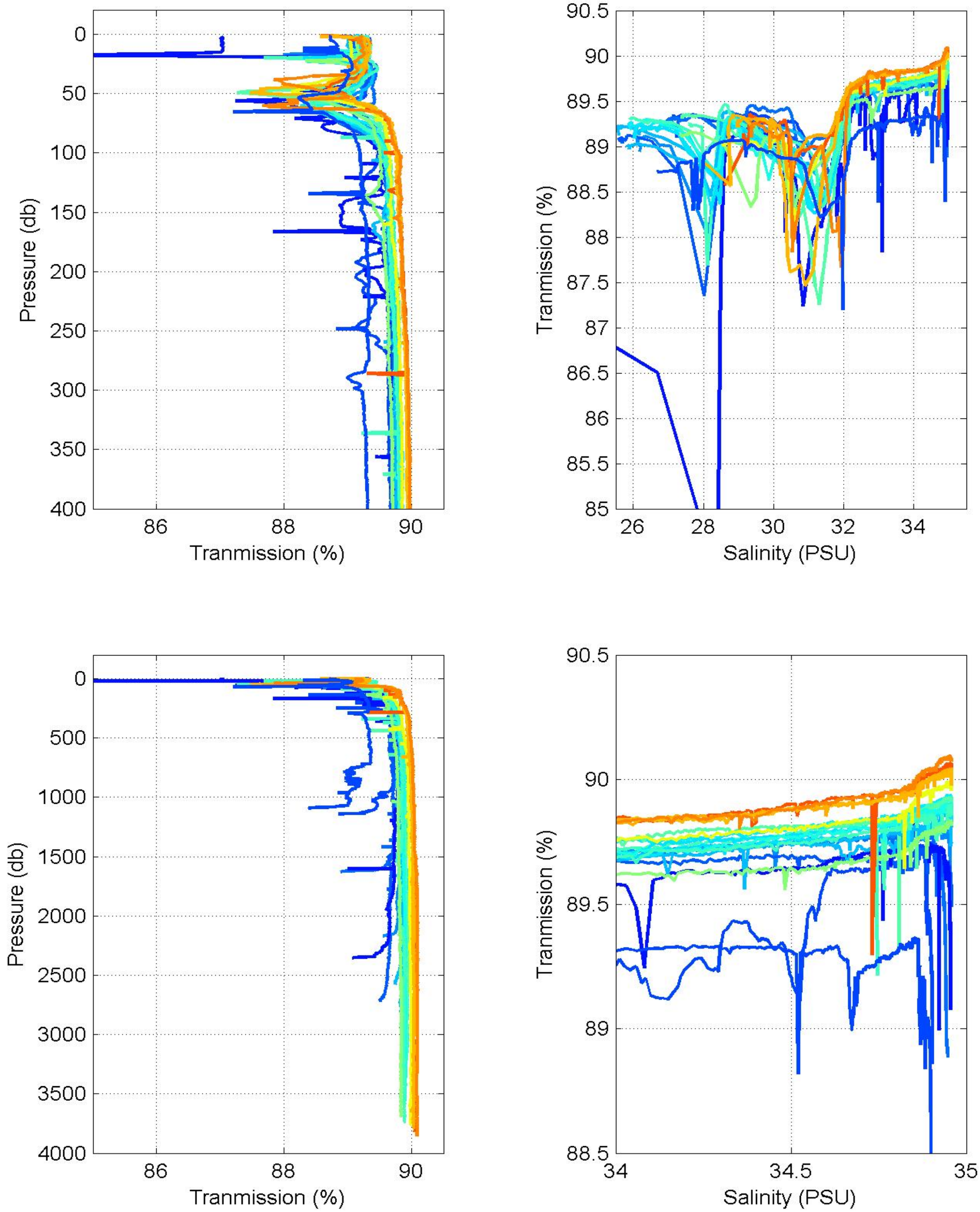
2004-16 Group: East of 145°W, Property: Oxygen



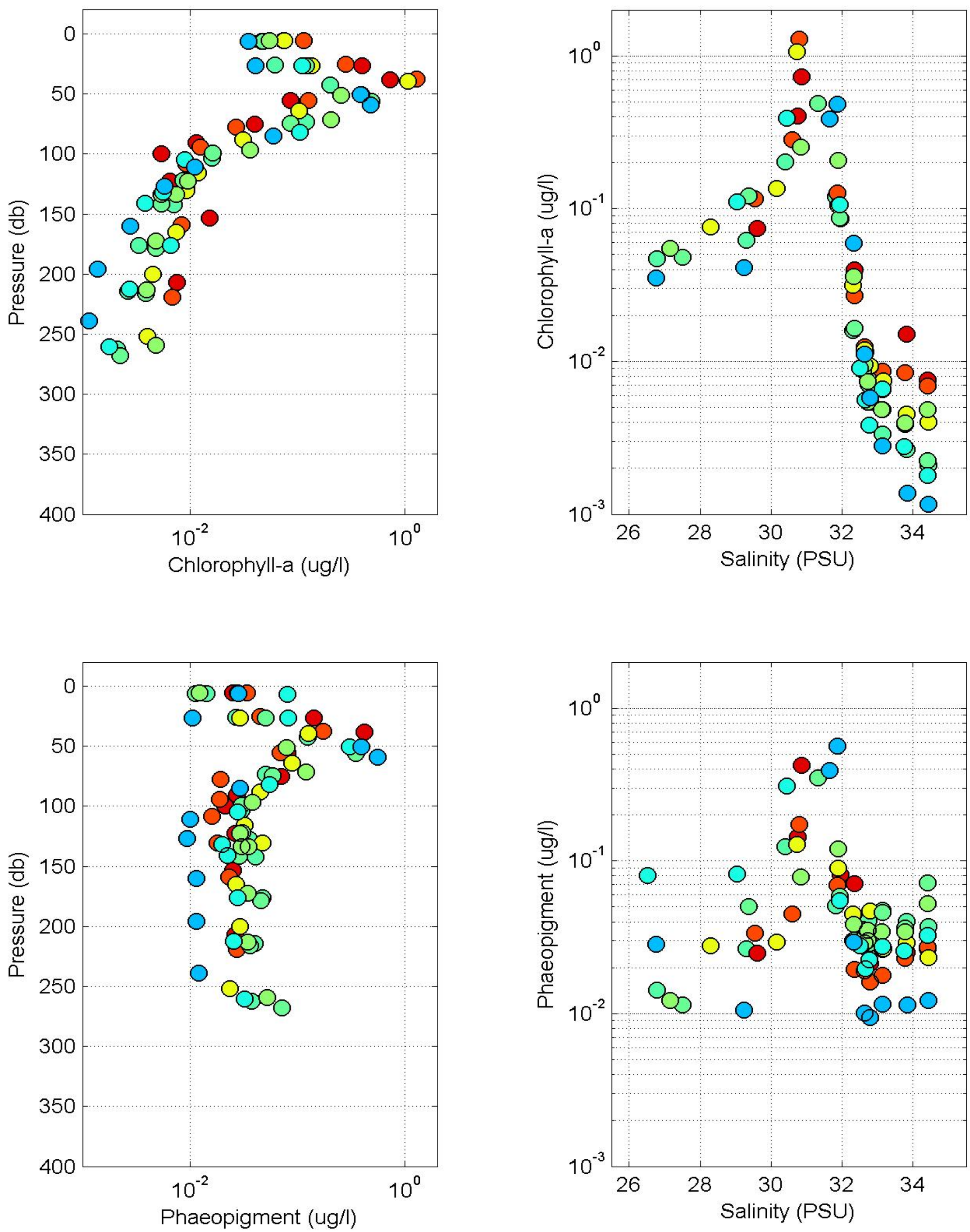
2004-16 Group: West of 145°W, Property: Transmission



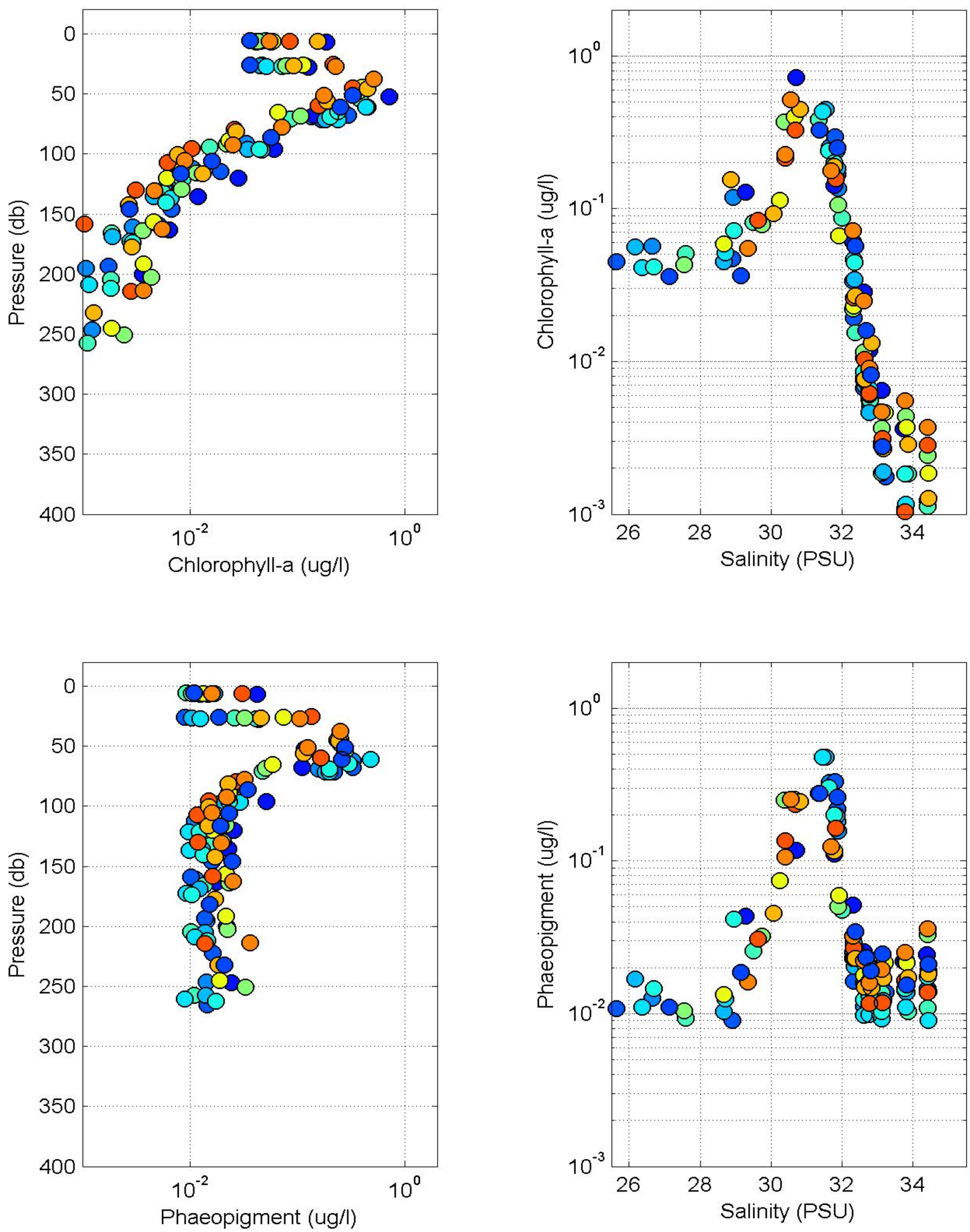
2004-16 Group: East of 145°W, Property: Transmission



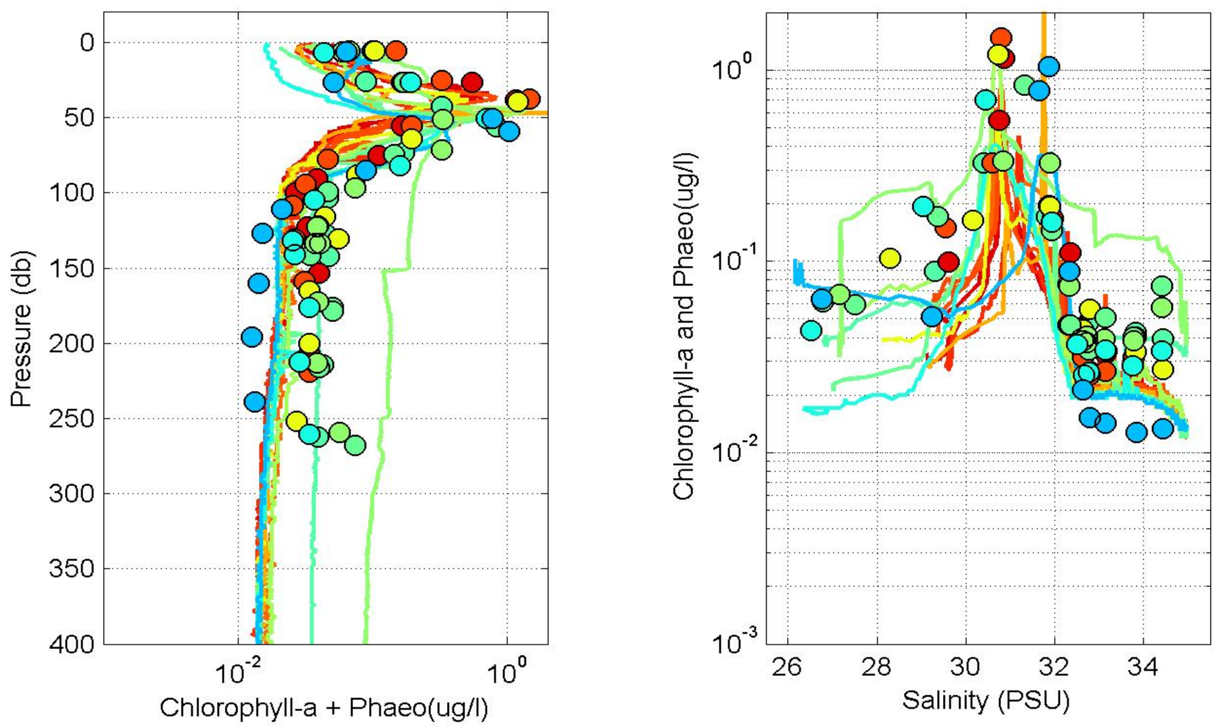
2004-16 Group: West of 145°W, Property: Chlorophyll-a, Phaeopigment



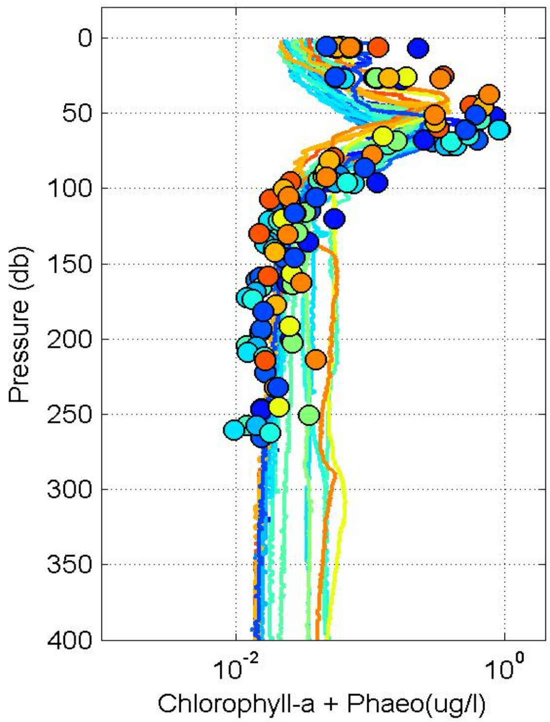
2004-16 Group: East of 145^{o}W, Property: Chlorophyll-a, Phaeopigment

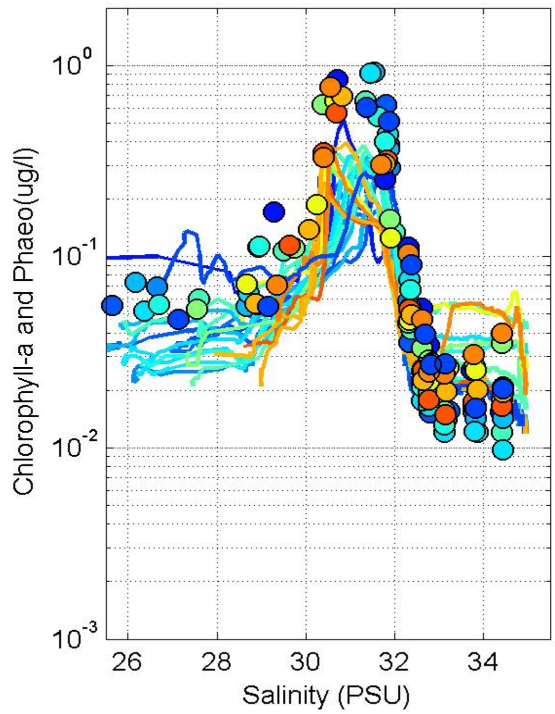


2004-16 Group: West of 145°W, Property: Combined Chlorophyll-a and Phaeopigment

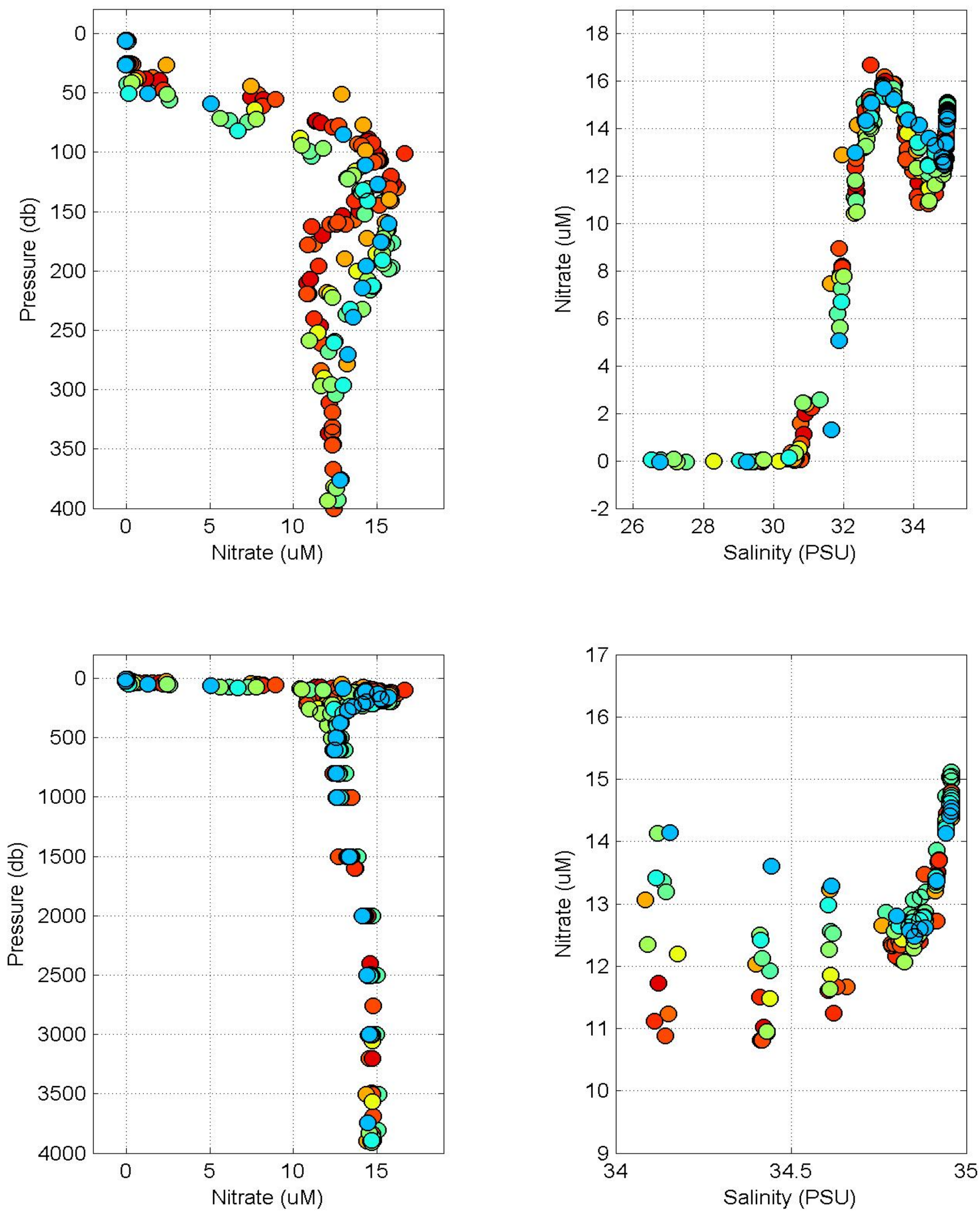


2004-16 Group: East of 145°W, Property: Combined Chlorophyll-a and Phaeopigment

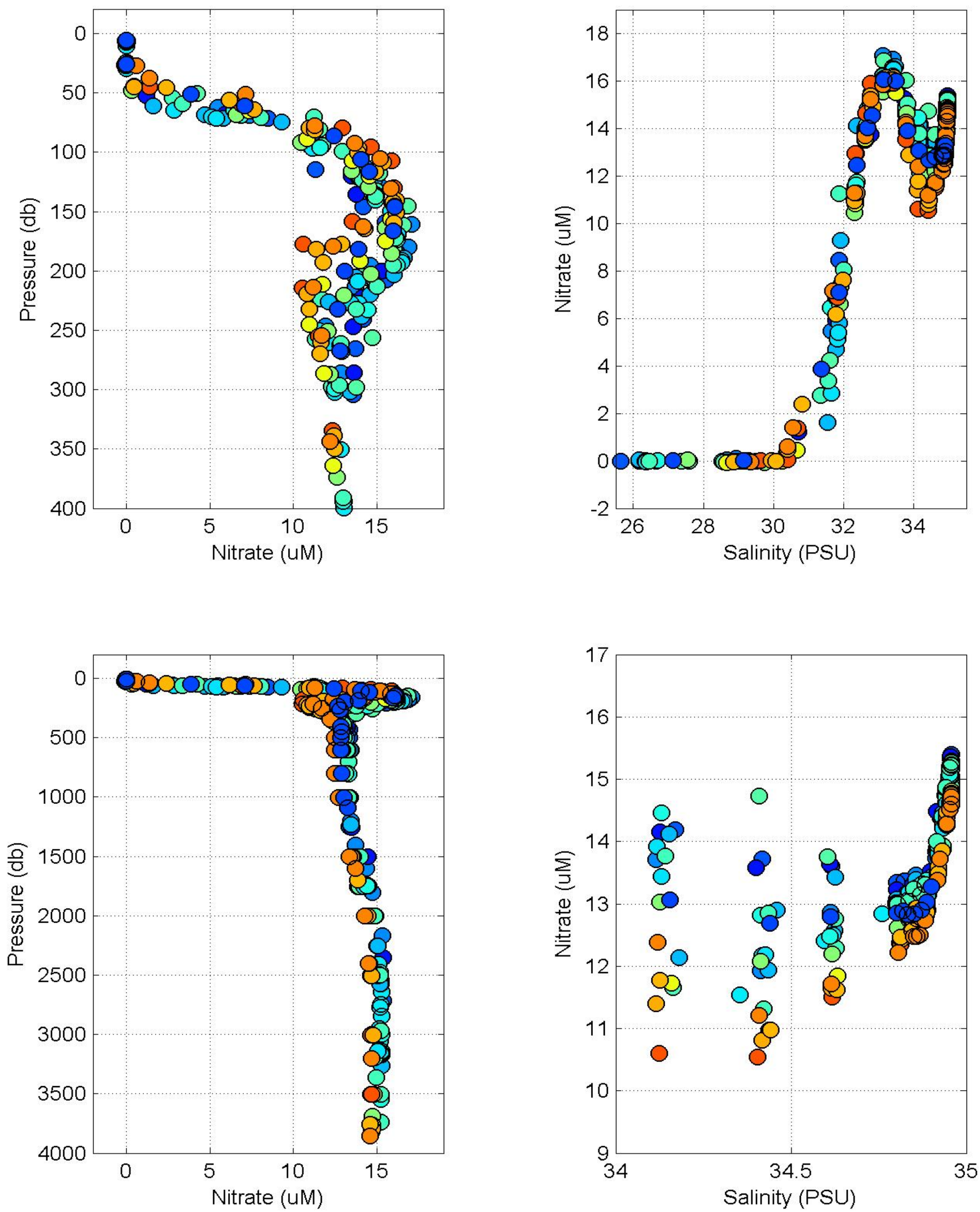




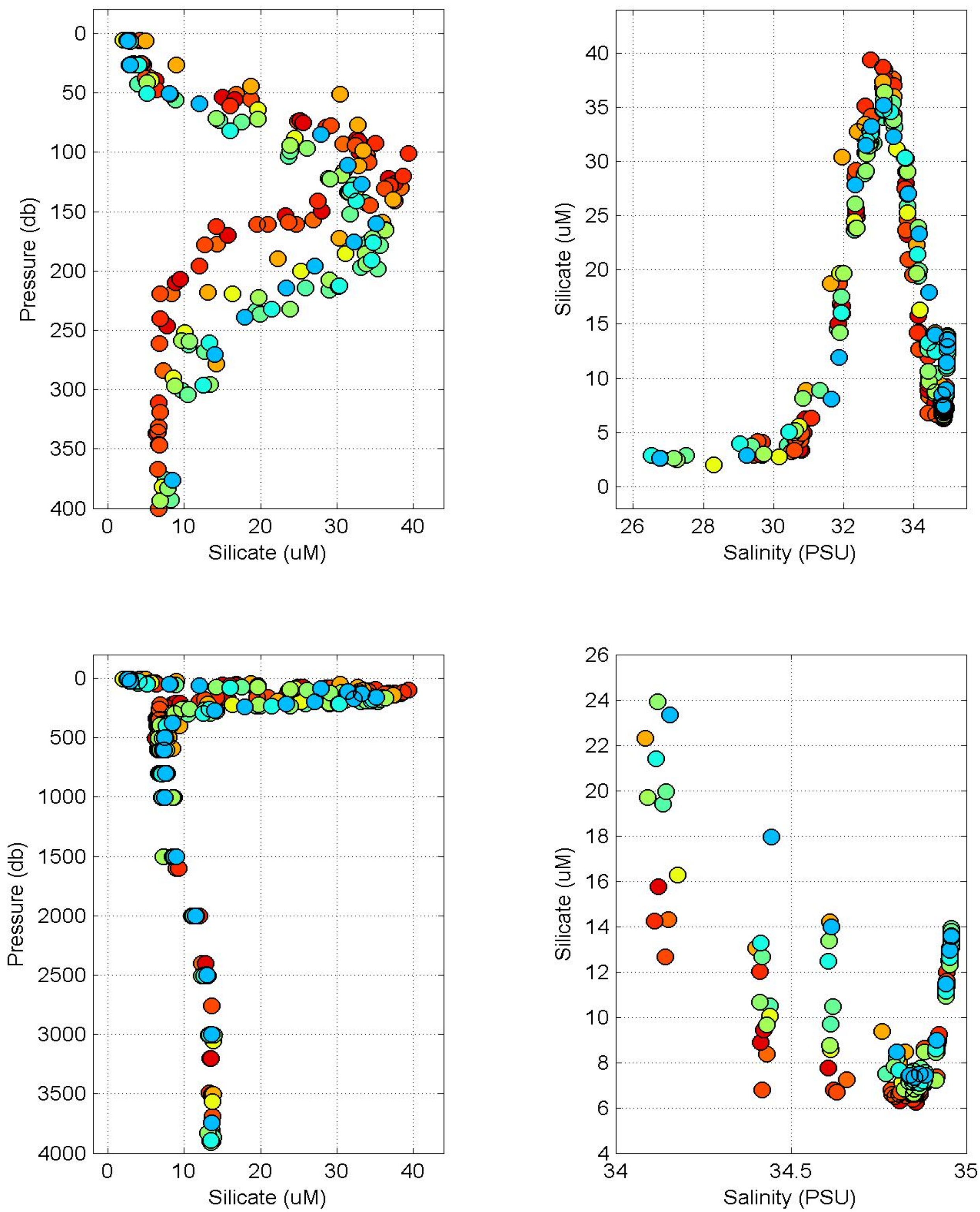
2004-16 Group: West of 145°W, Property: Nitrate and Nitrite



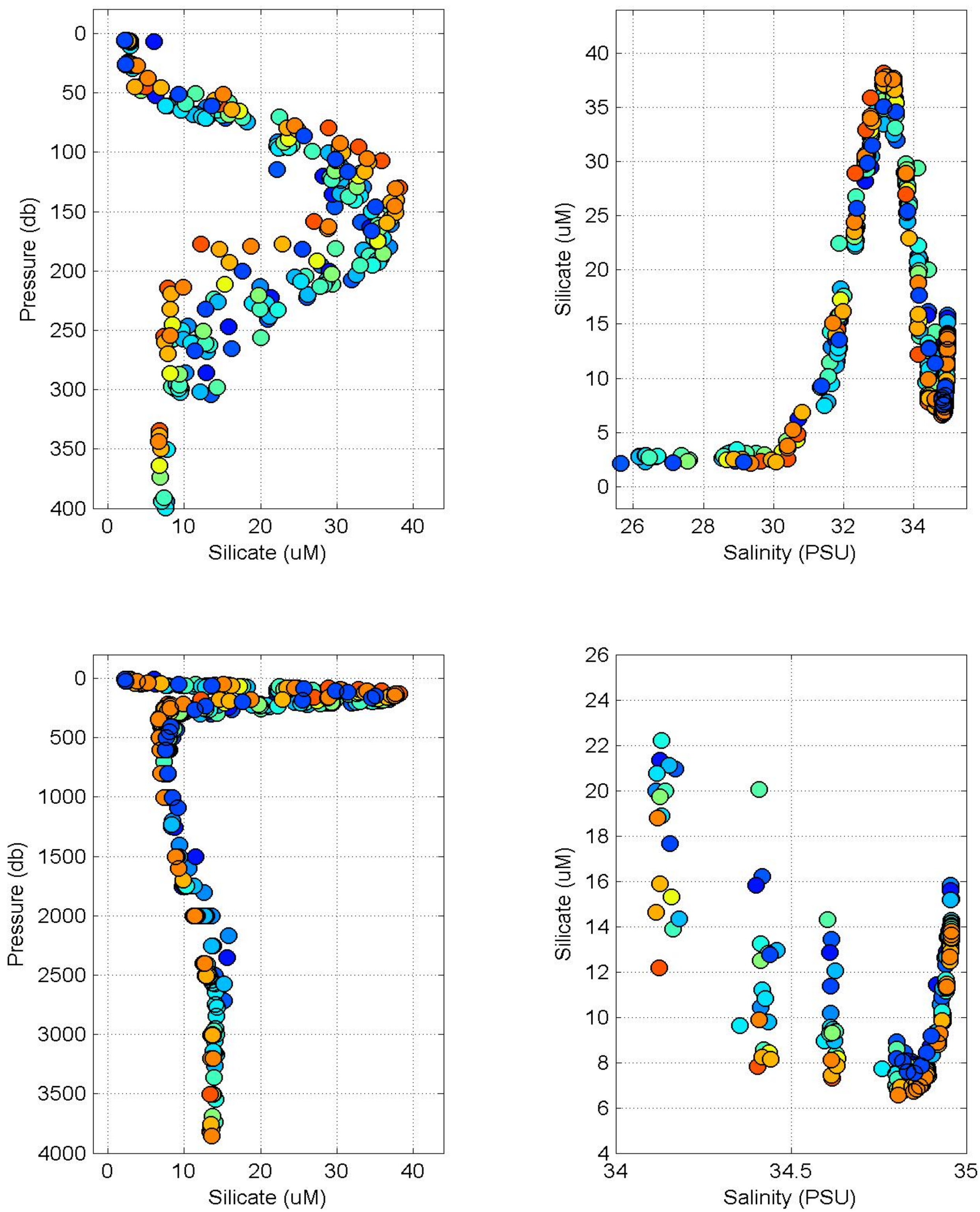
2004-16 Group: East of 145°W, Property: Nitrate and Nitrite



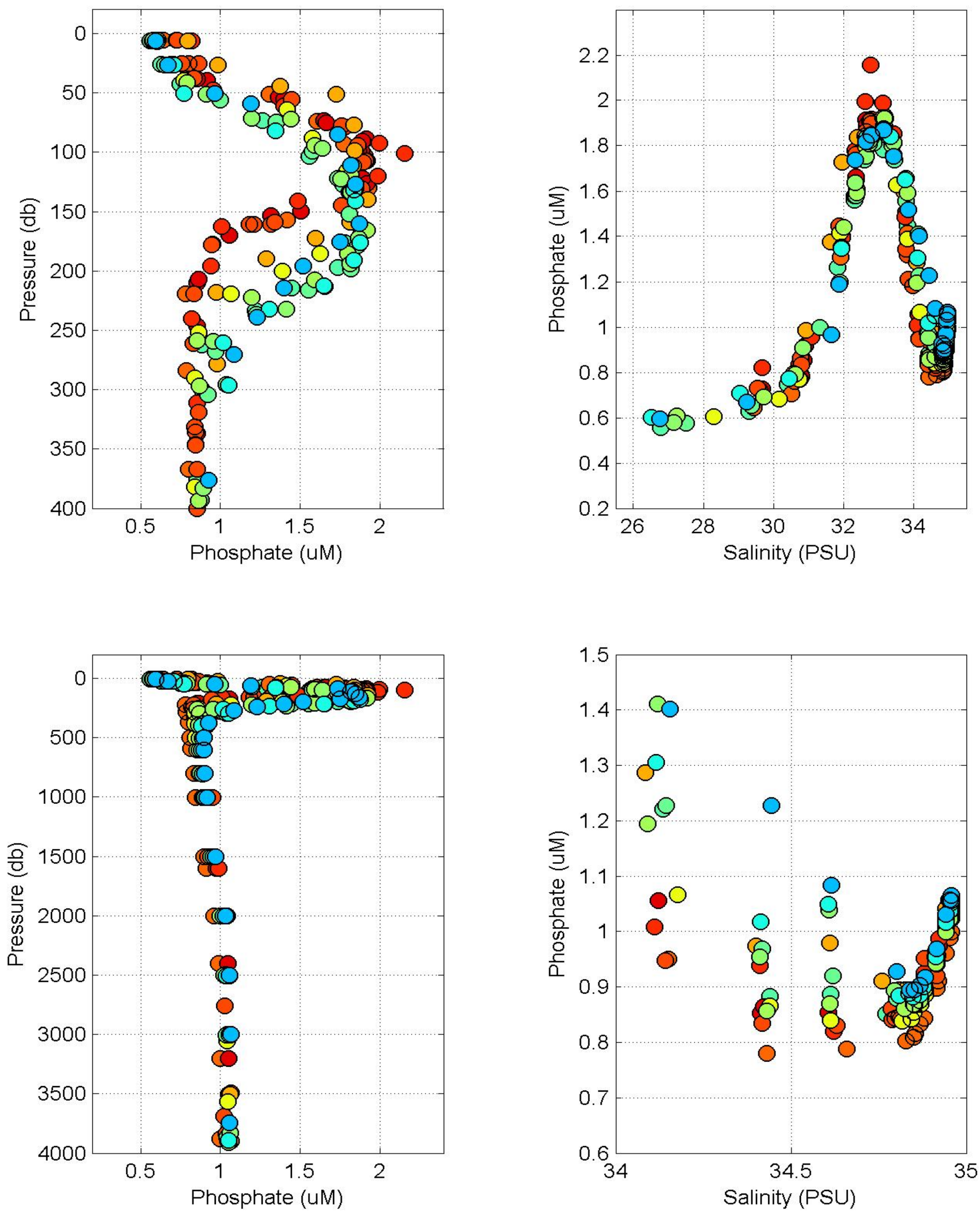
2004-16 Group: West of 145°W, Property: Silicate



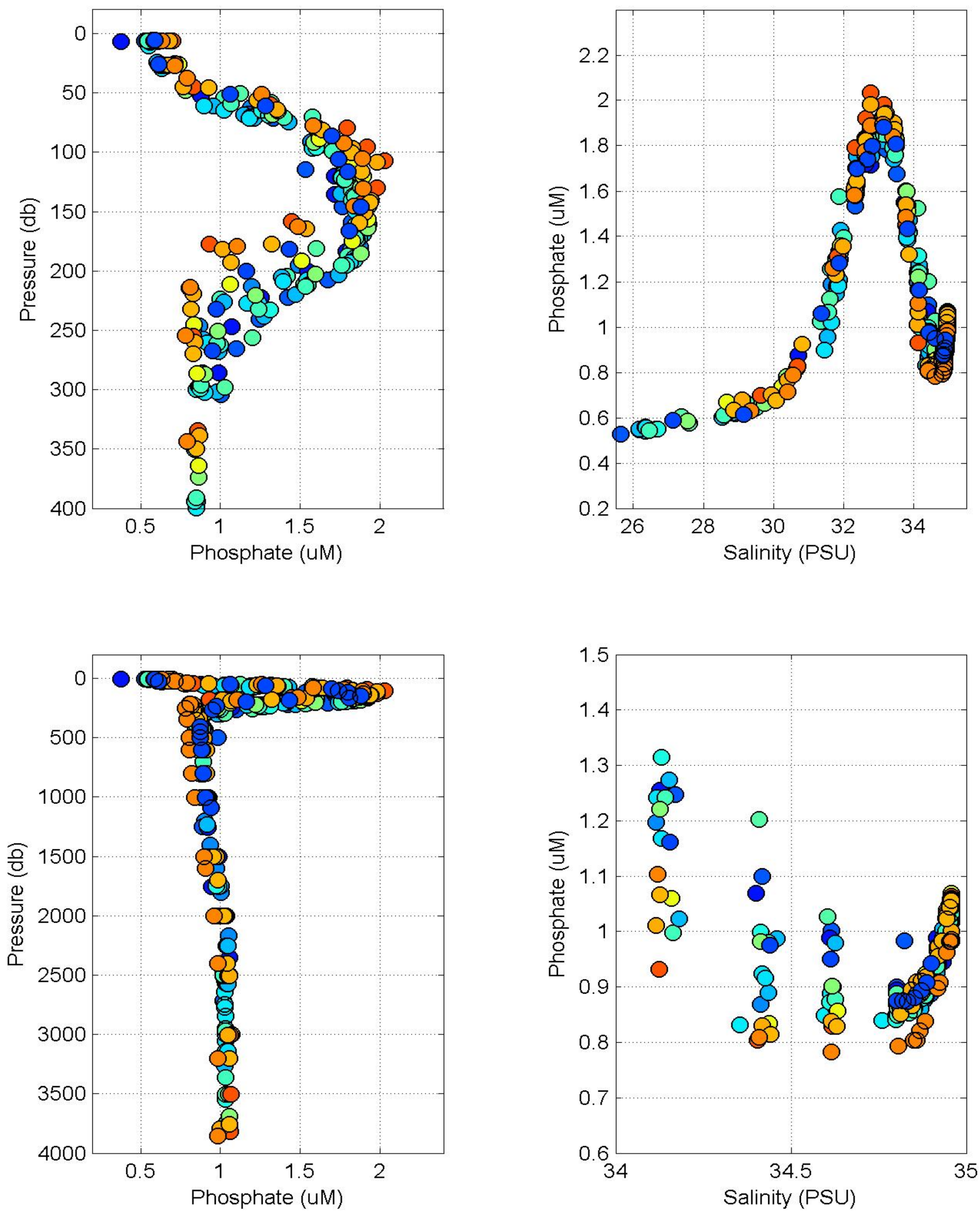
2004-16 Group: East of 145°W, Property: Silicate



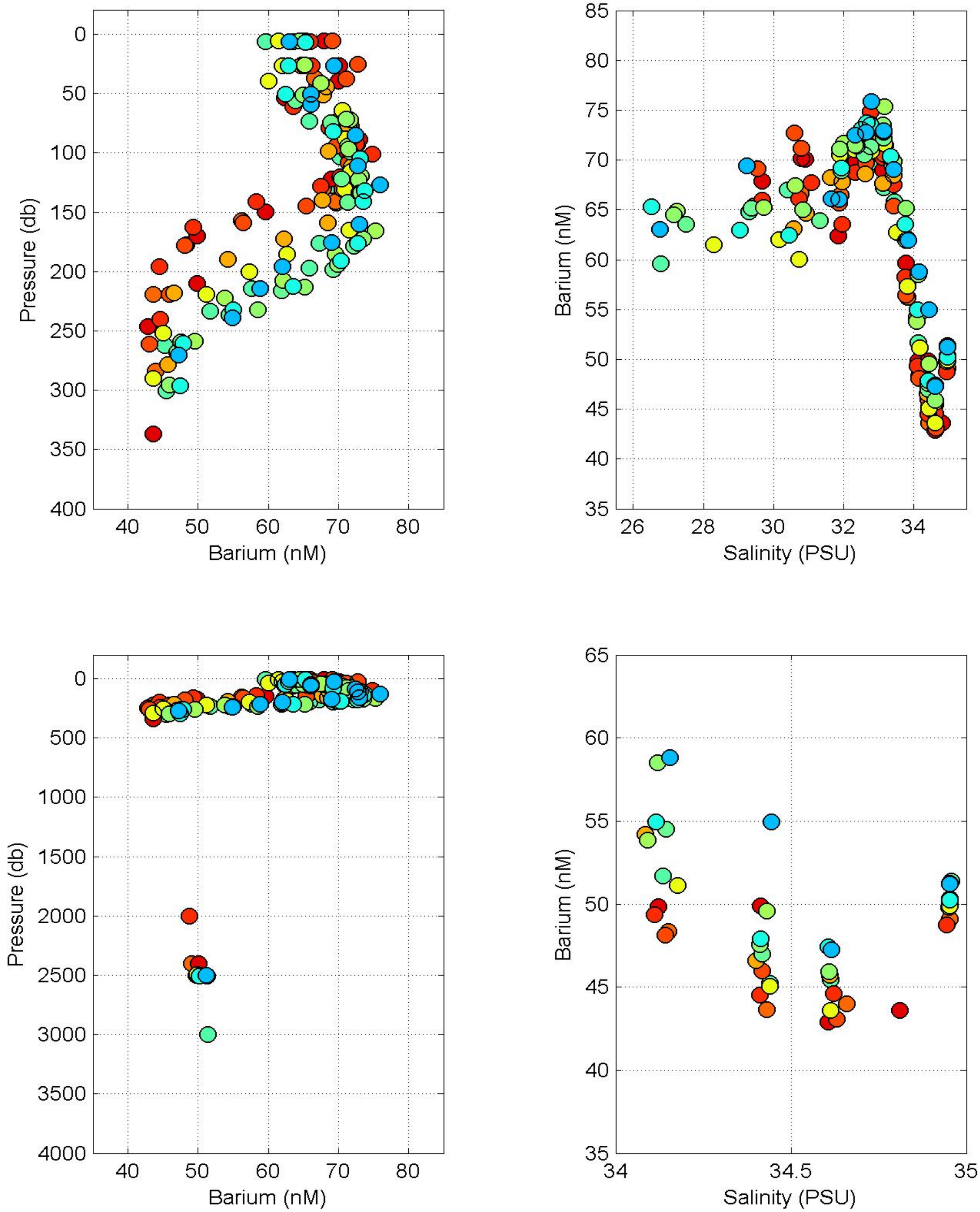
2004-16 Group: West of 145°W, Property: Phosphate



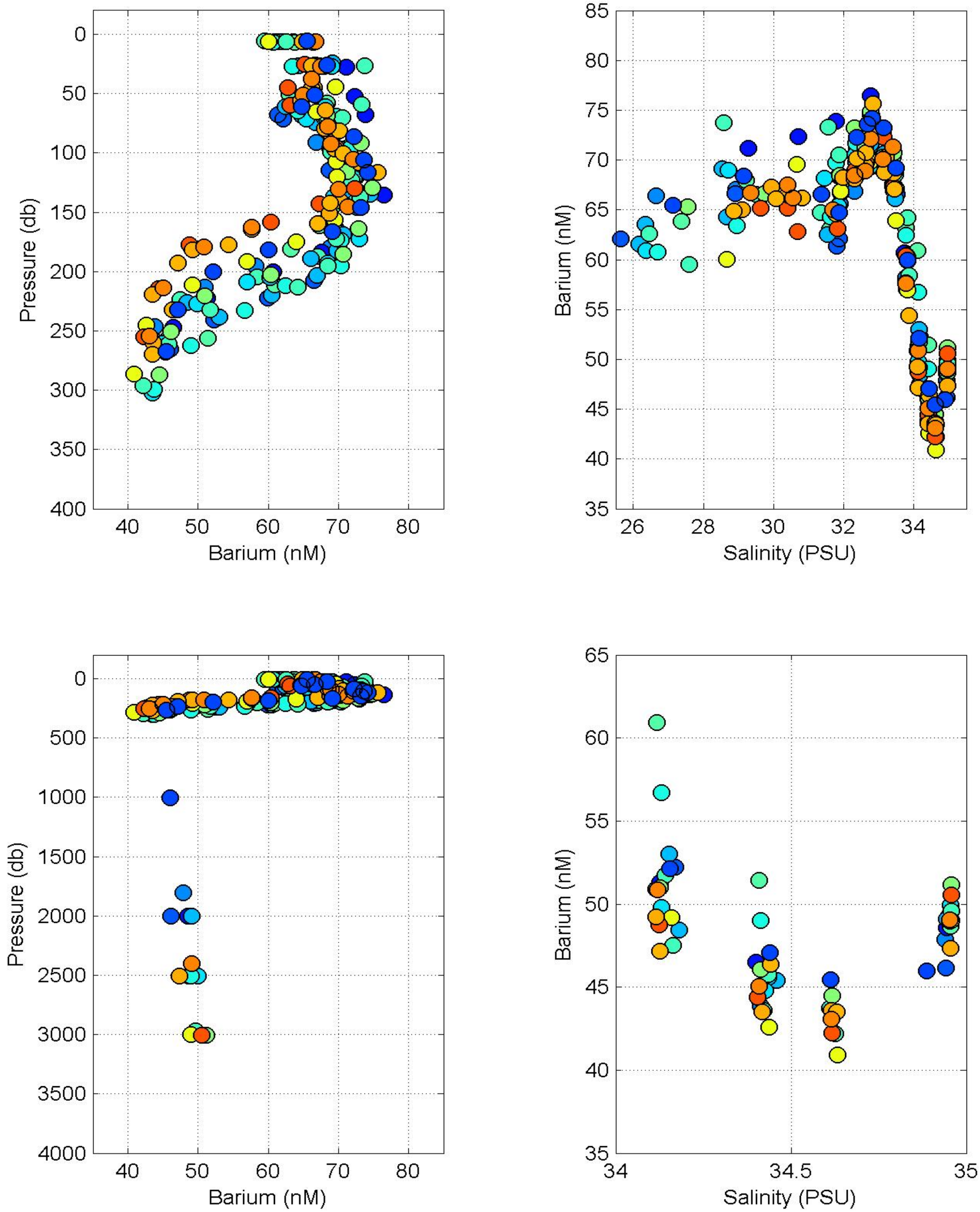
2004-16 Group: East of 145°W, Property: Phosphate



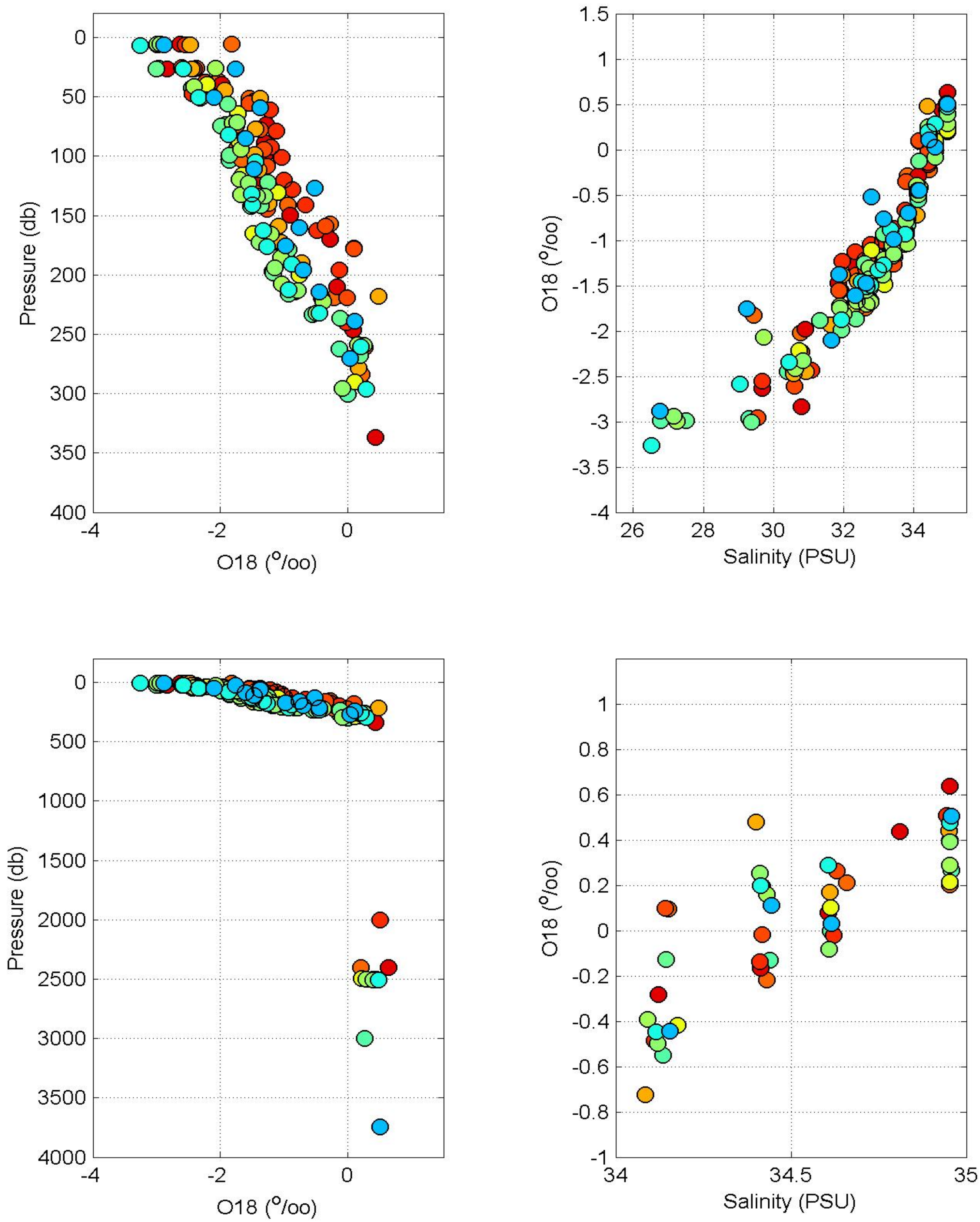
2004-16 Group: West of 145°W, Property: Barium



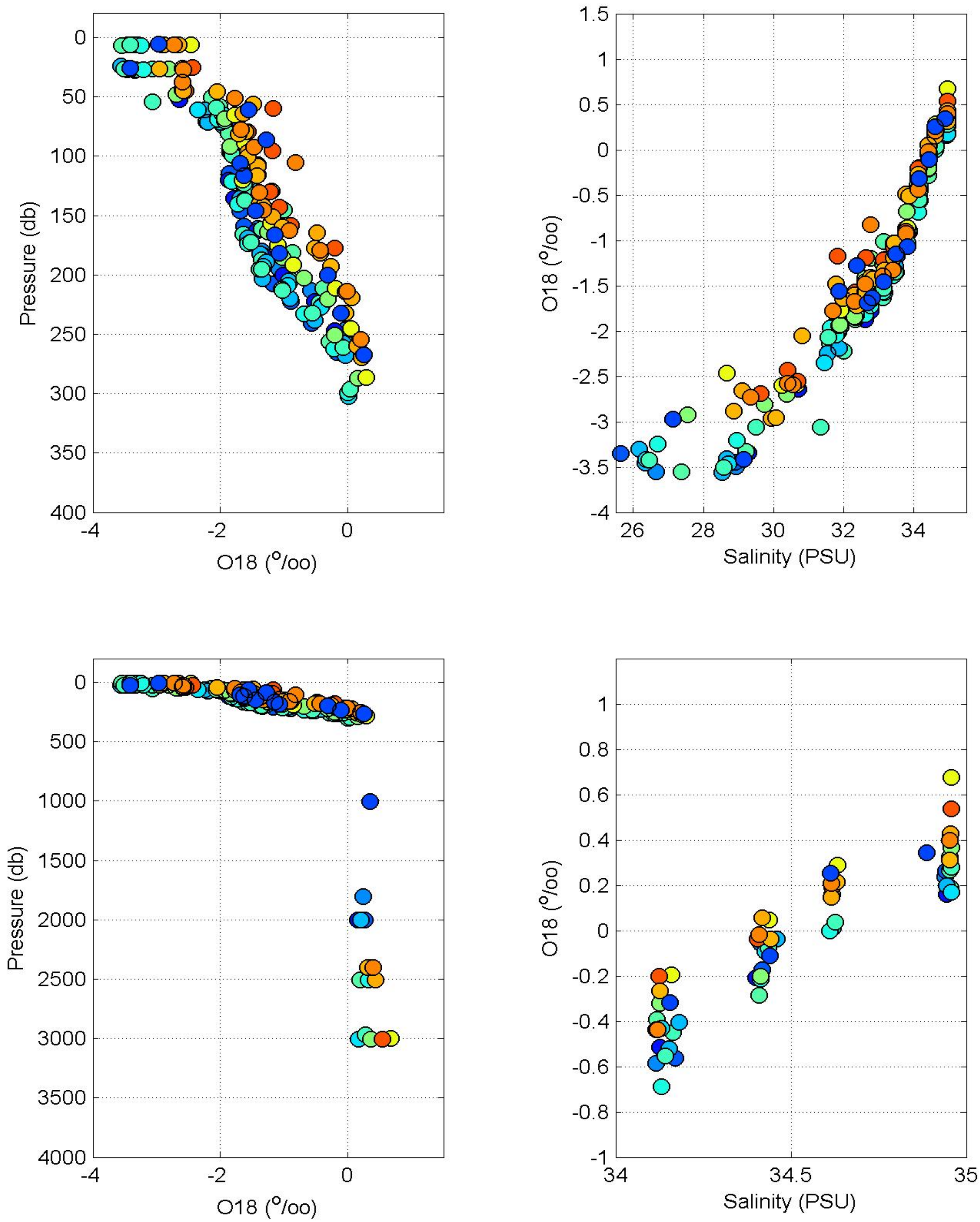
2004-16 Group: East of 145°W, Property: Barium



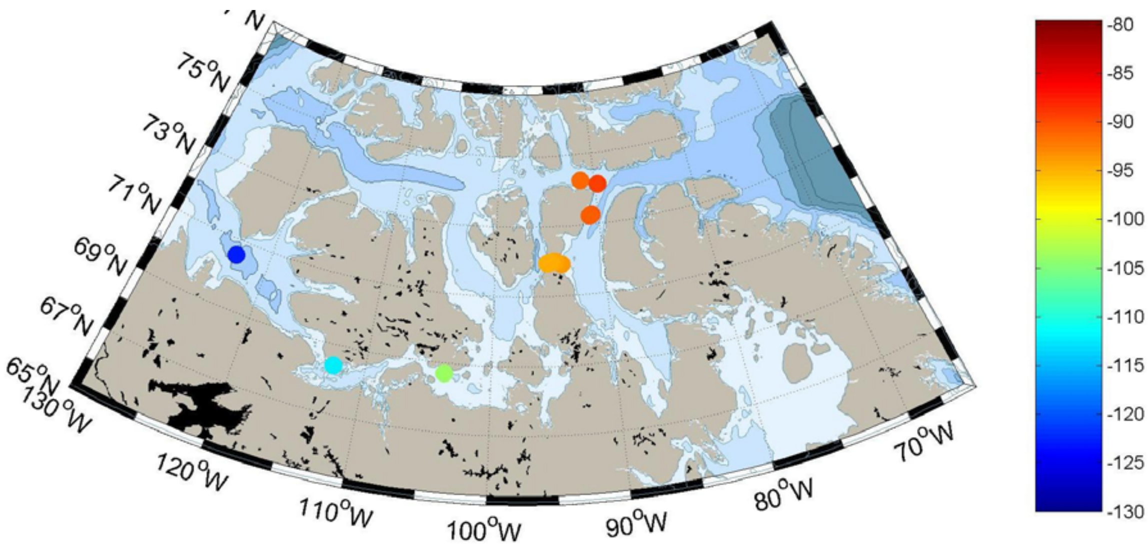
2004-16 Group: West of 145°W, Property: O18



2004-16 Group: East of 145°W, Property: O18

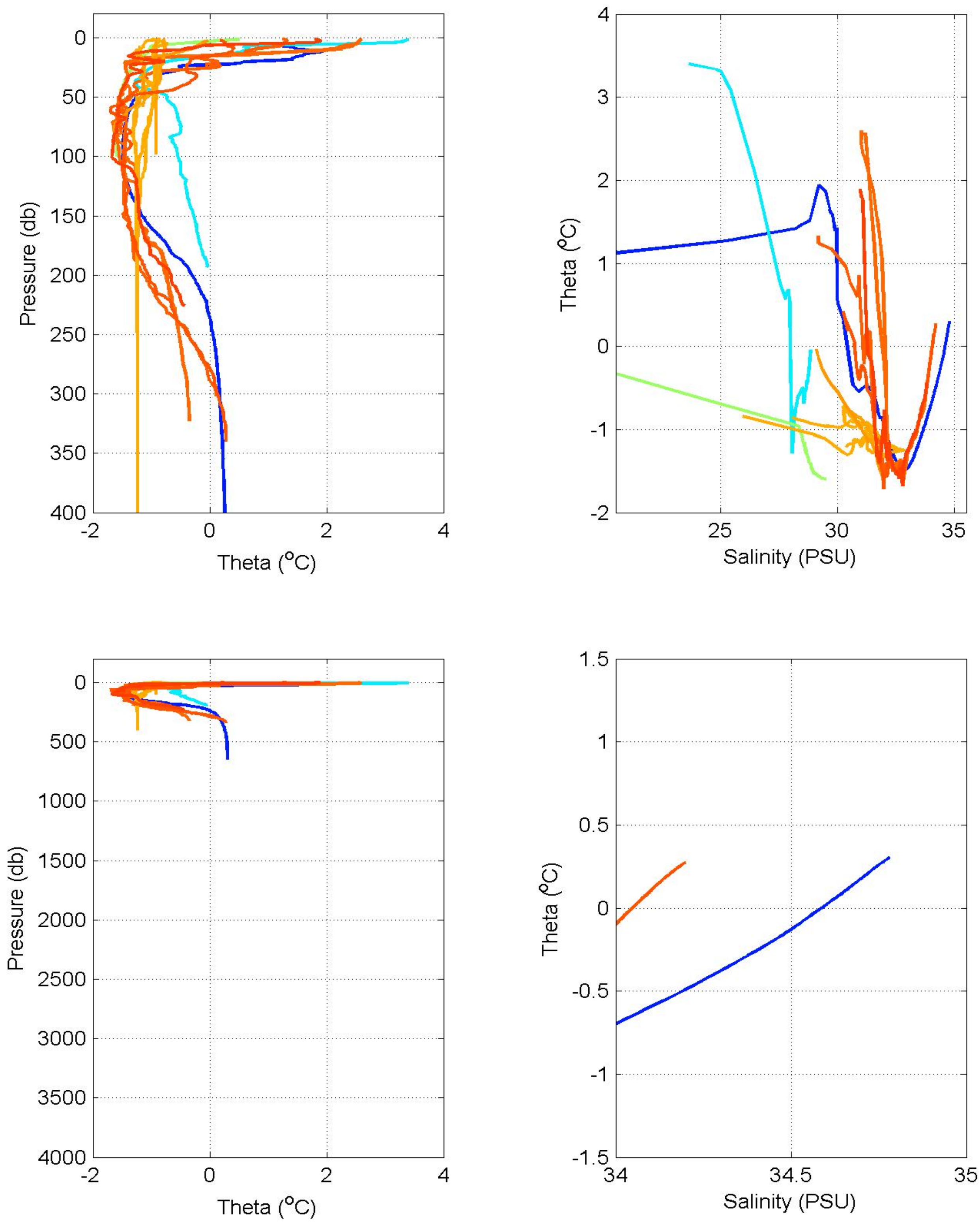


4.6.2 Casts in the Canadian Archipelago

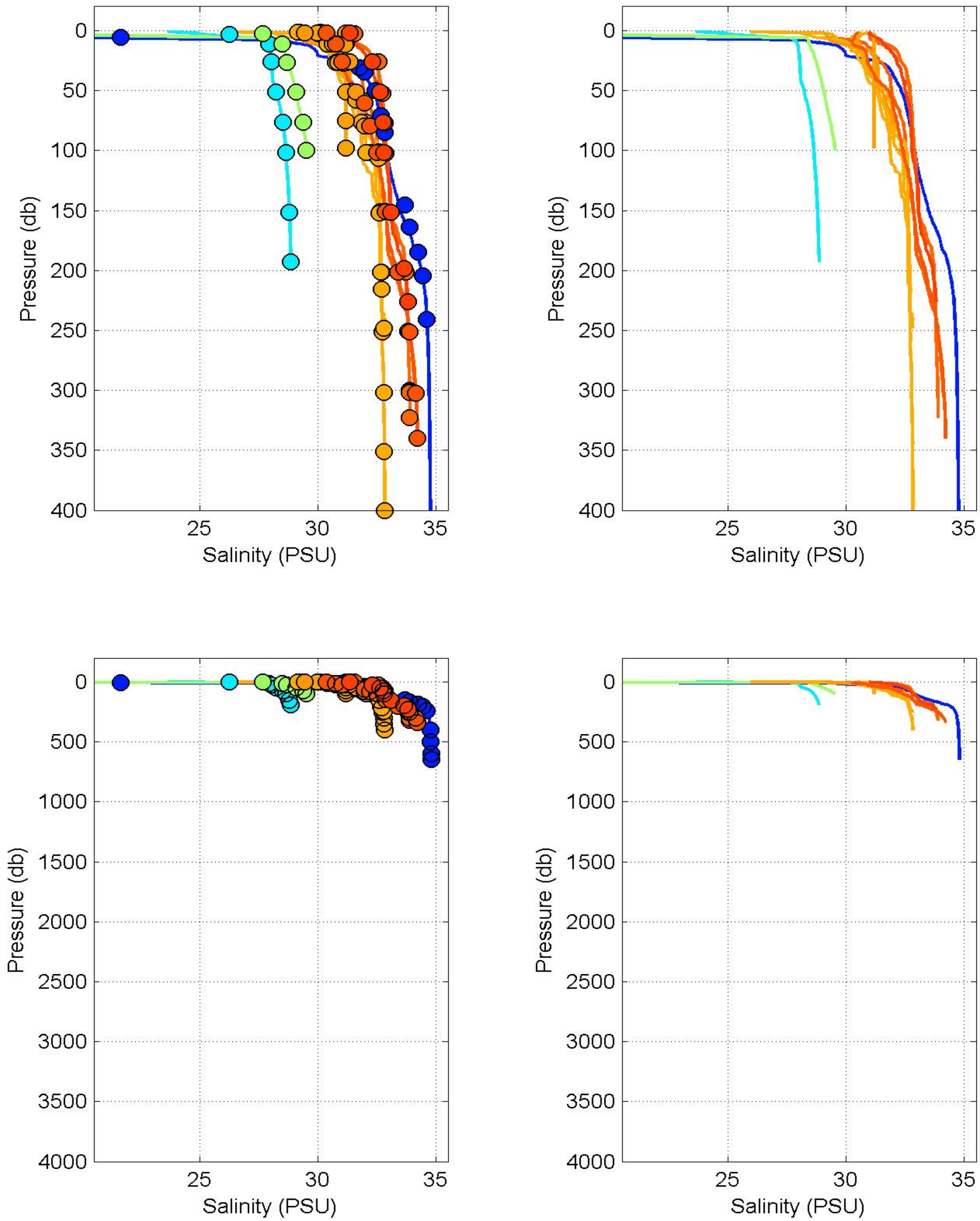


Group plots for the Canadian Archipelago. Cast locations are plotted in the same colors in the following group plots. Colors refer to longitude and are labeled in color bar.

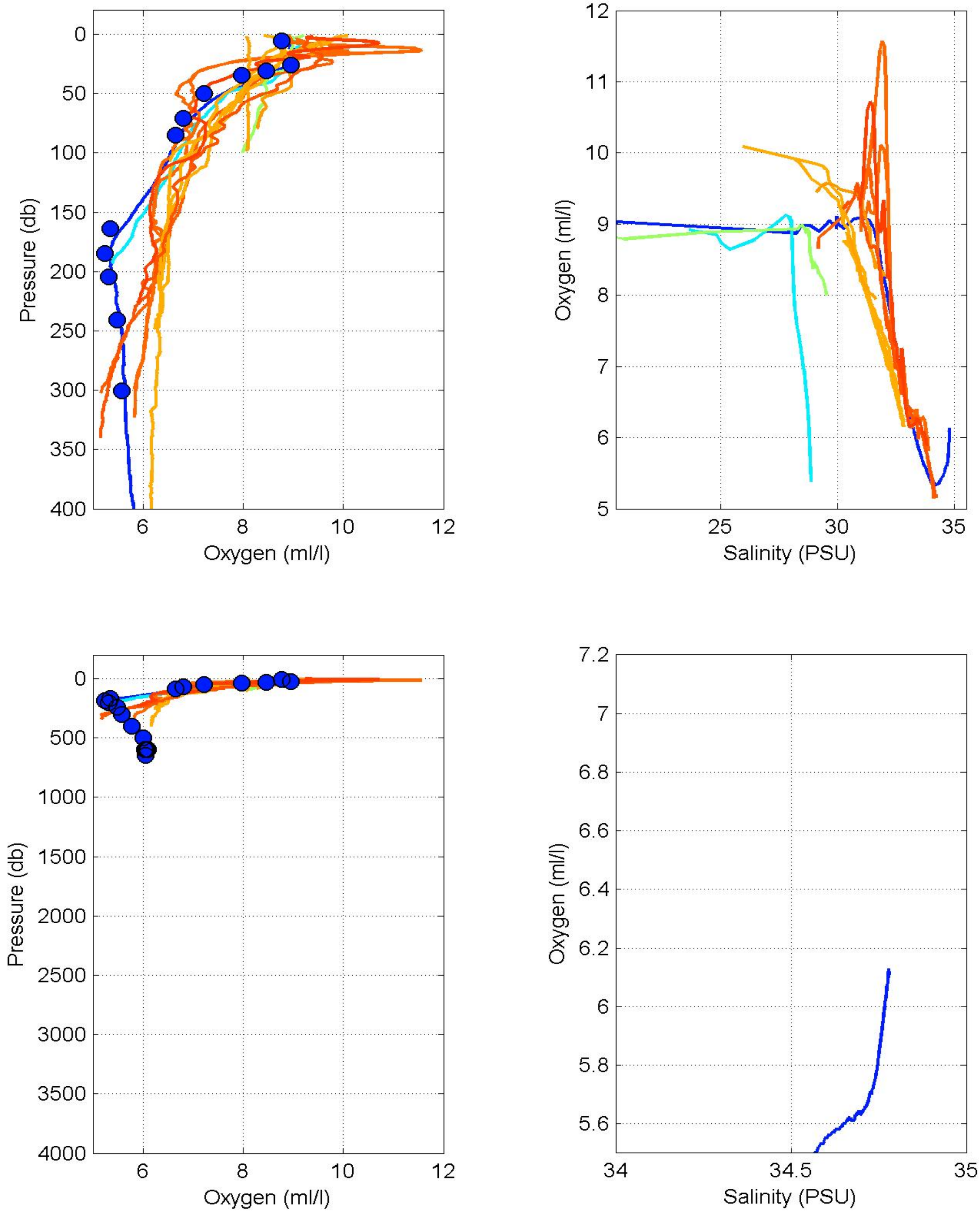
2004-16 Group: Canadian Archipelago, Property: Theta



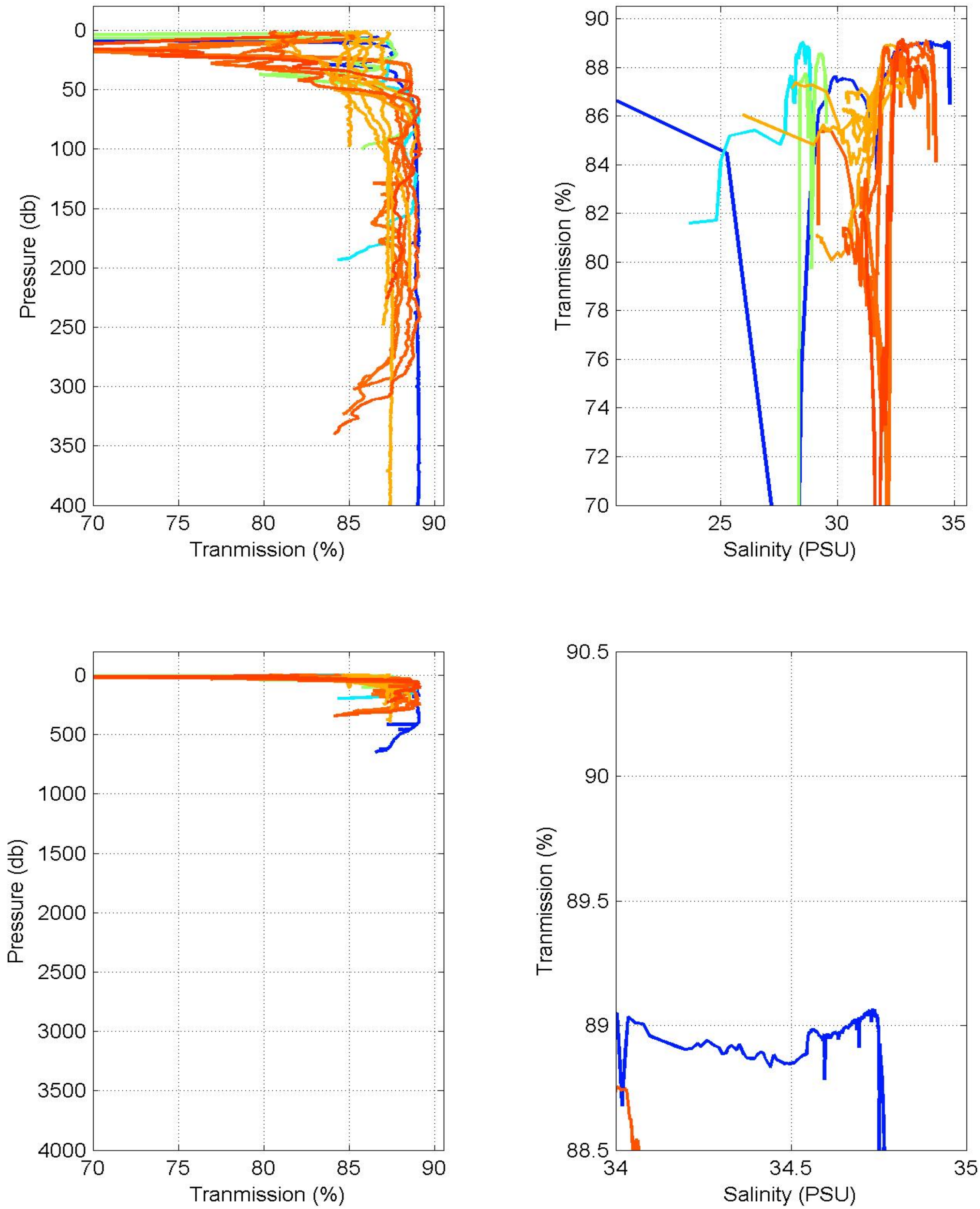
2004-16 Group: Canadian Archipelago, Property: Salinity



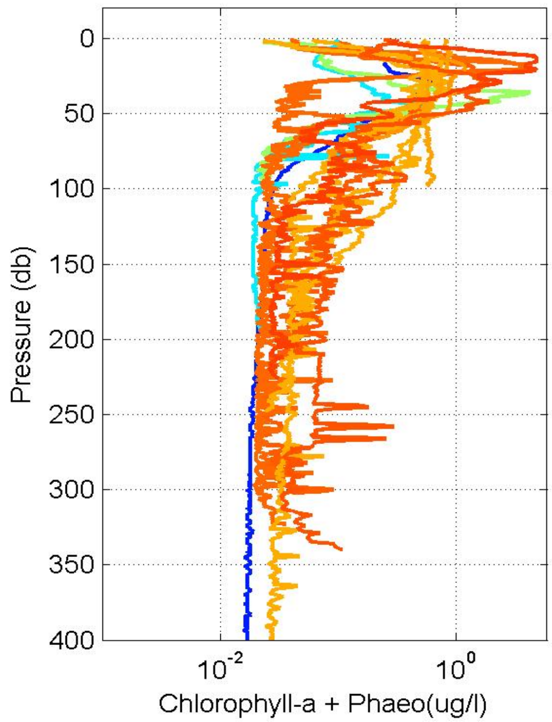
2004-16   Group: Canadian Archipelago, Property: Oxygen

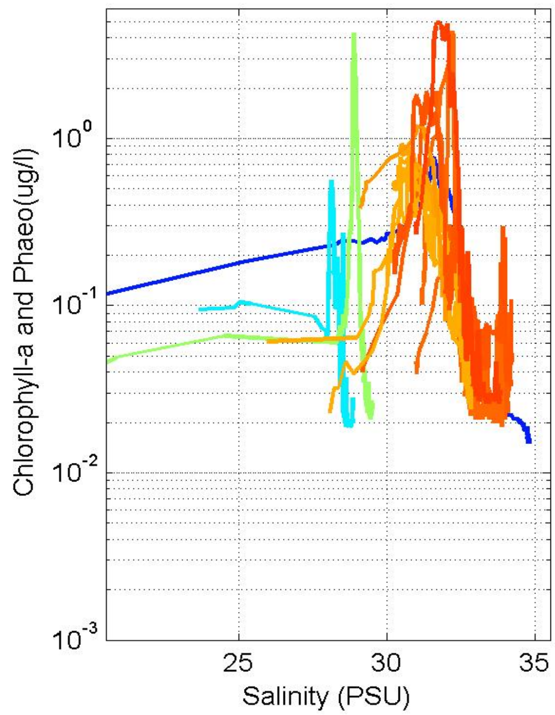


2004-16 Group: Canadian Archipelago, Property: Transmission

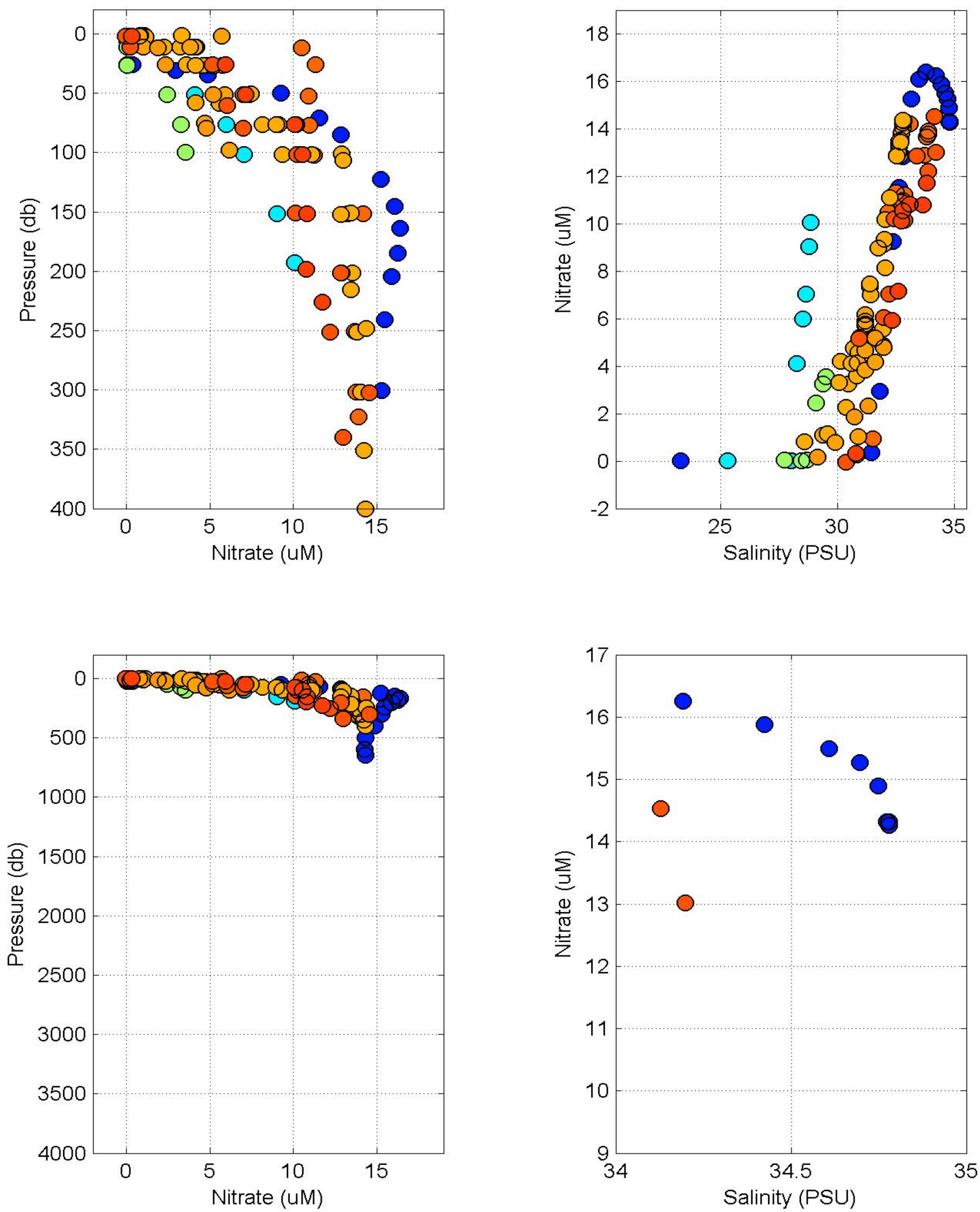


2004-16 Group: Canadian Archipelago, Property: Combined Chlorophyll-a and Phaeopigment

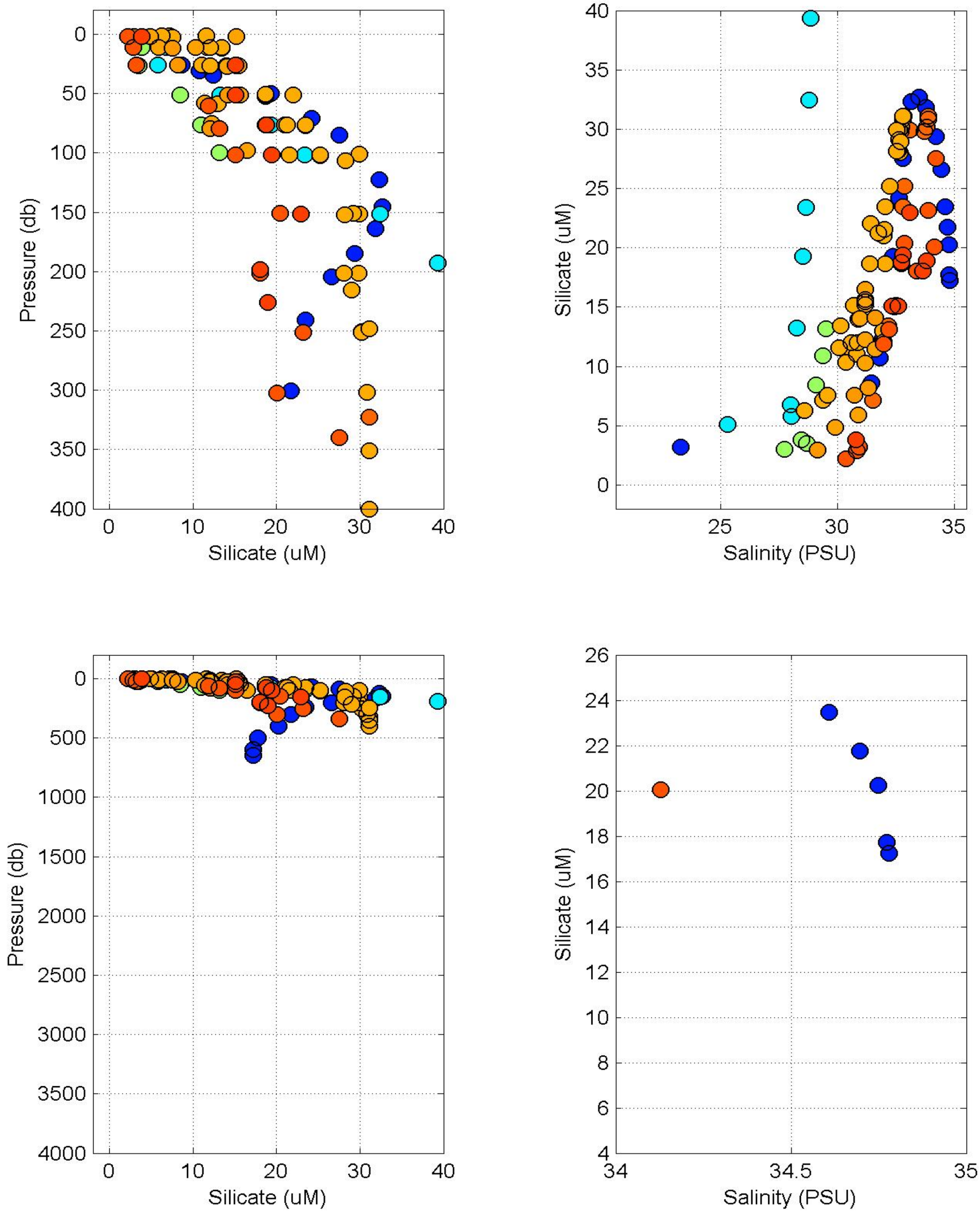




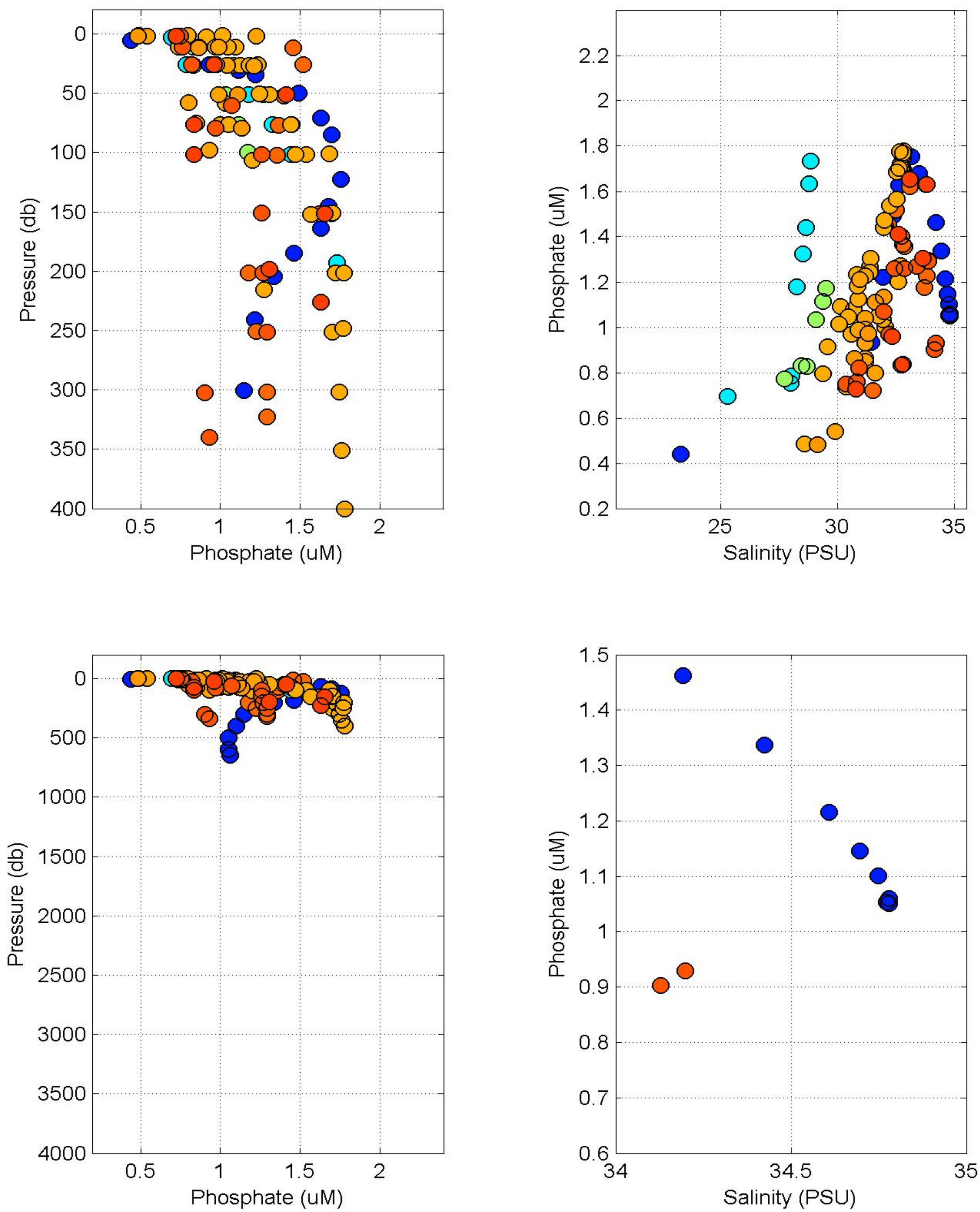
2004-16 Group: Canadian Archipelago, Property: Nitrate and Nitrite



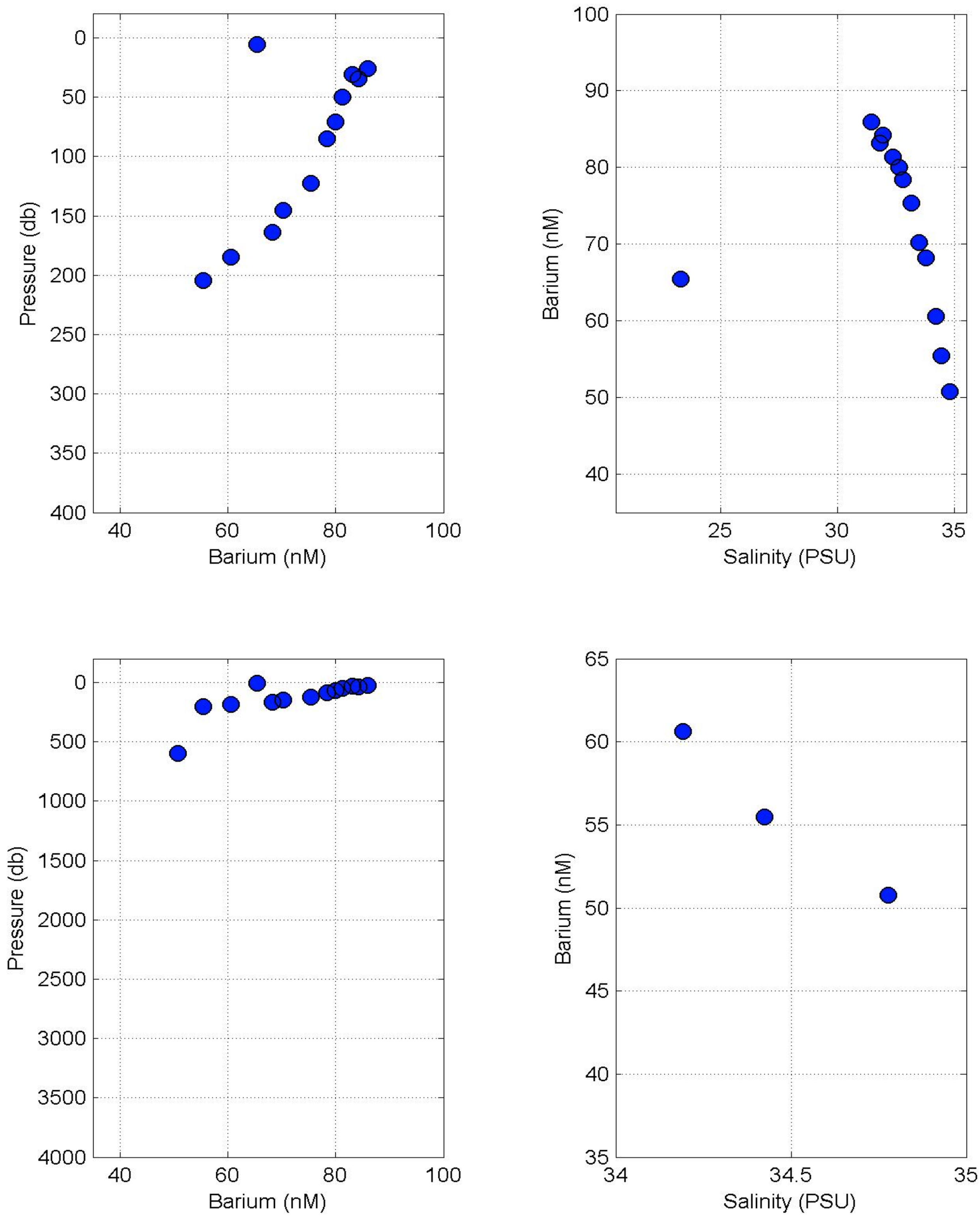
2004-16 Group: Canadian Archipelago, Property: Silicate



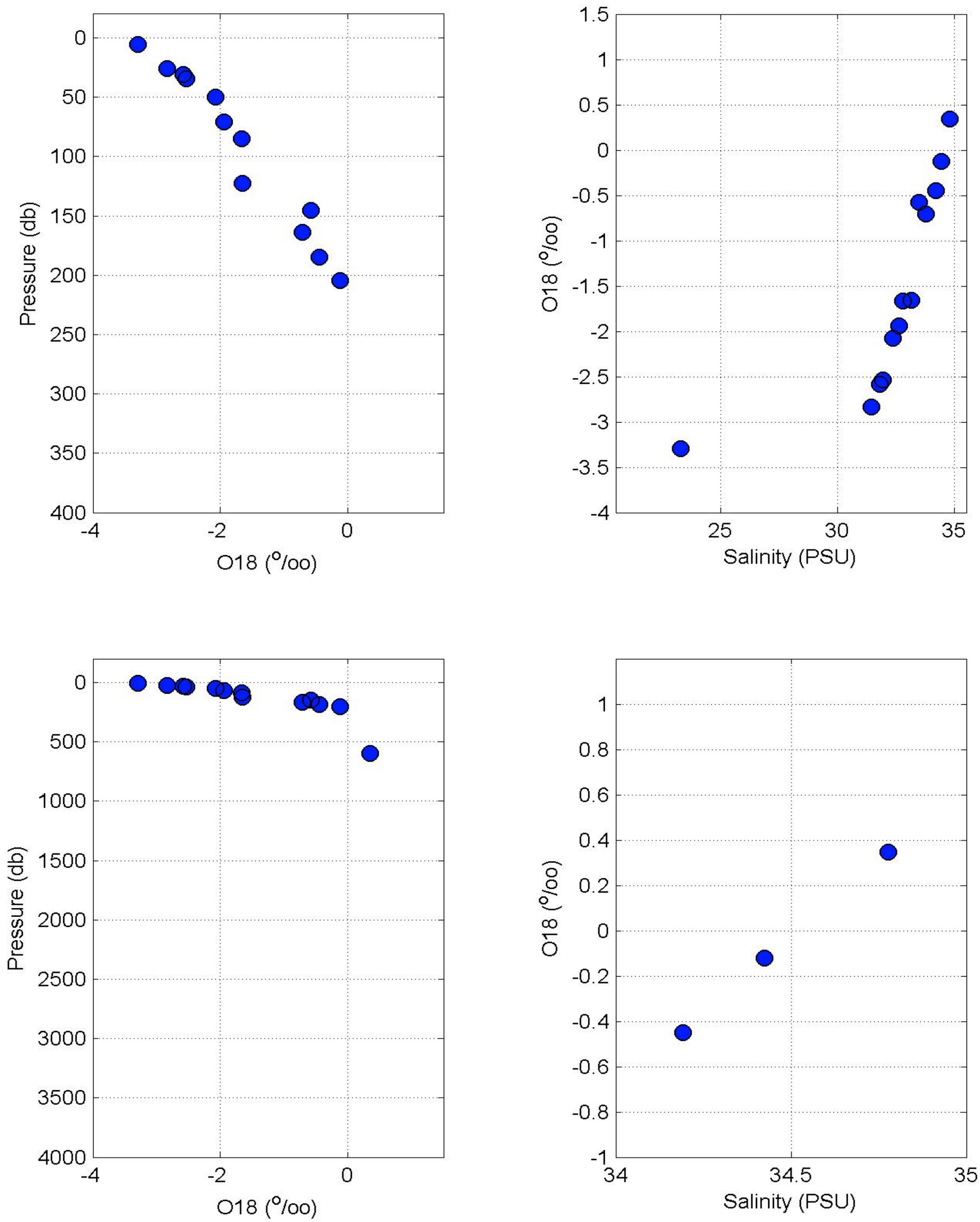
2004-16 Group: Canadian Archipelago, Property: Phosphate



2004-16 Group: Canadian Archipelago, Property: Barium



2004-16 Group: Canadian Archipelago, Property: O18



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Carmack, E., Papadakis, J.E., Macdonald, D.M., and Macdonald, R.W. 1989. NOGAP B.6. Volume 6, Physical data collected in the Beaufort Sea, summer, 1987. *Can. Data Rep. Hydrogr. Ocean Sci.* 60(6): 219 p.

Carmack, E.C., Macdonald, R.W., O'Brien, M., Pearson, R., Timmermans, L., Sieberg, D., Von Hardenberg, B., Sutherland, N., Tuele, D., Jackson, F., and L. White, L. 1996. Physical and chemical data collected in the Beaufort Sea and the Canadian archipelago, August-September 1995. *Can. Data Rep. Hydrogr. Ocean Sci.* 147: 281 p.

Cornford, A.B., Lemon, D.D., Fissel, D.B., Melling, H., Smiley, B.D., Herlinveaux, R.H., and Macdonald, R.W., 1982. Arctic data compilation and appraisal. Volume 1, Beaufort Sea : physical oceanography : temperature, salinity, currents and water levels. *Can. Data Rep. Hydrogr. Ocean Sci*: 5(1): 279 p.

Cuypers, L.E., Blaskovich, A.W., Carmack, E.C., and R.W. Macdonald, R.W. 1988. NOGAP B.6 : physical data collected in the Beaufort Sea, September 1986. *Can. Data Rep. Hydrogr. Ocean Sci* 59: 149 p.

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