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Hydrographic Measurements Collected in 2021 During Western Boundary Time Series Cruises in the Florida Current aboard the UNOLS Ship R/V *F. G. Walton Smith*, (FC2104, FC2105)

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The findings and conclusion on this report are those of the authors and do not necessarily represent the views of the funding agency.

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Abstract

This report presents final calibrated conductivity, temperature, depth (CTD) data collected in the Florida Straits during three Western Boundary Time Series project (WBTS) research cruises conducted in 2021. These cruises took place aboard the UNOLS ship R/V *F. G. Walton Smith* (FC2104, FC2105). Funded through the Climate Program Office (CPO) of the National Oceanic and Atmospheric Administration (NOAA), these WBTS surveys were completed as part of a long term effort to monitor the strength and water mass properties of the Florida Current at 27°N in the Florida Straits.

1 Introduction

In 1982, NOAA began to regularly monitor the Florida Current across 27°N in the Florida Straits in an effort to develop a long-term record of the current's transport and water mass properties. As a leg of the Gulf Stream system in the North Atlantic Ocean, the Florida Current is the last component of this important western boundary current which is constrained by shallow channel bathymetry, as it flows through the Straits of Florida, making the section at 27°N an ideal location for a monitoring program.

It was recognized that a better understanding of the current's behavior and characteristics, including temporal and spatial modes of variability, is critical to determining the strength and variability of the North Atlantic Subtropical Gyre. The powerful Gulf Stream system transports heat, salt, carbon, and nutrients from lower latitudes poleward in the North Atlantic Ocean. The flow is comprised of water recirculating within the Subtropical Gyre as well as components from farther regions of the global ocean. For this reason, documenting the natural variations and characteristics of the current helps scientists to gain a better understanding of variations in the earth's climate and can potentially provide an early warning to anomalous changes.

NOAA's Atlantic Oceanographic and Meteorological Laboratory (AOML) in Miami, Florida, manages the WBTS project and monitors the Florida Current using a submarine cable, running across the Straits of Florida, which provides daily transport estimates of the current; regular small boat cruises at 27°N, which measure the current transport using a GPS dropsonde device, and regular hydrographic surveys at 27°N using larger research vessels. Moored instruments have also been used to estimate current transport over portions of the project's history.

This report documents final CTD data collected during WBTS hydrographic surveys of 27°N in 2021. It also provides some additional details regarding other measurements conducted during these research cruises. In 2021, three hydrographic surveys were completed. These were conducted using the University of Miami's R/V *F. G. Walton Smith* (FC2104, FC2105).

On each survey, a CTD package, equipped with sensors designed to measure pressure, temperature, conductivity (to derive salinity), dissolved oxygen, and water velocity (via an attached lowered acoustic Doppler profiler, LADCP, system), was lowered from the surface to 10-20 m above the sea floor, at 9 historical locations extending across the Florida Straits between West Palm Beach, Florida and the Bahamas (Figure 1 and Tables 1 - 2). During each CTD cast, water samples were also collected at various depths. Of these, samples collected for salinity and dissolved oxygen analysis were used to calibrate CTD sensor data to a final state. These methods are detailed further in subsequent sections of this report. NOTE: During FC2105 a total of 8 expendable bathythermograph (XBT) probes, used to measure temperature throughout the water column, were deployed during CTD stations to test a new XBT data interface developed at AOML to replace the Mark 21 interface.

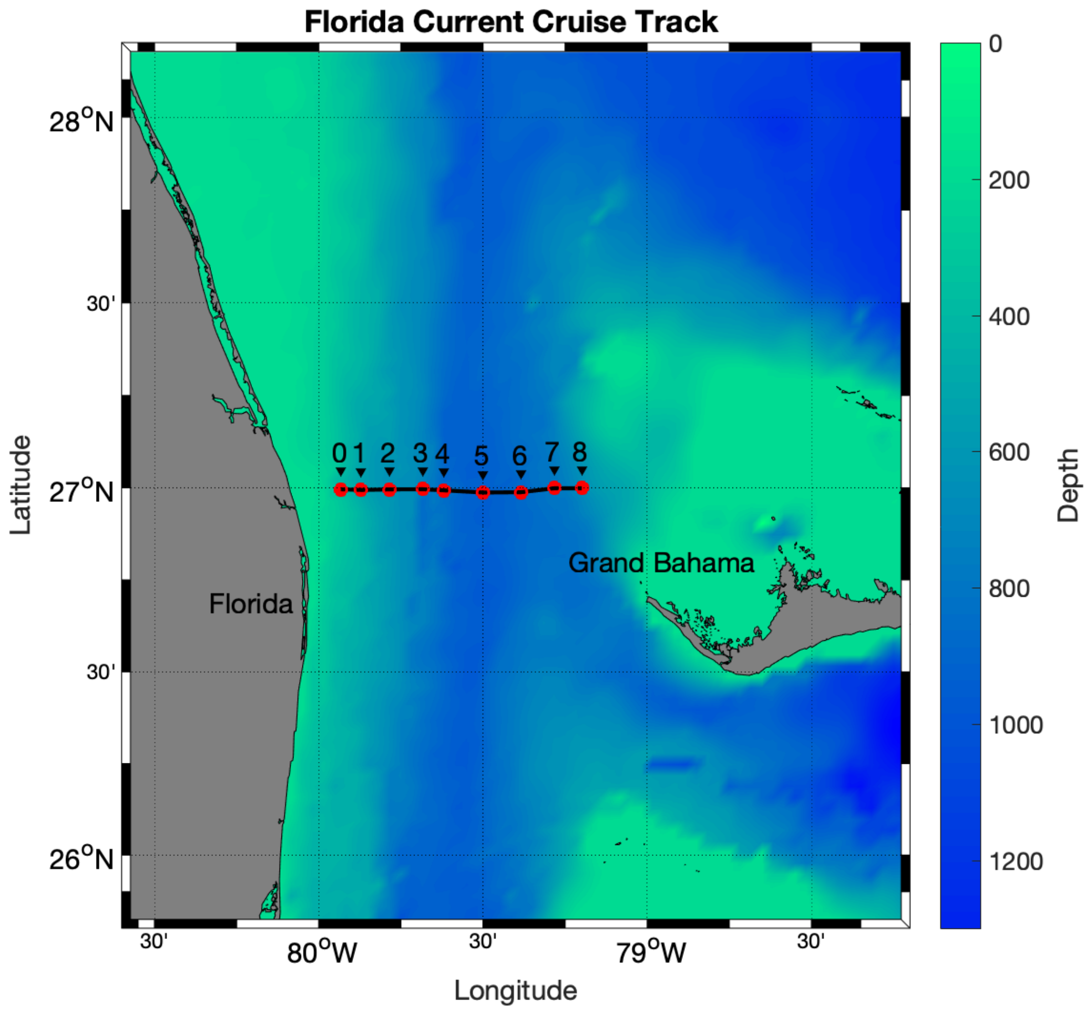


Figure 1: Historical sampling stations across the Straits of Florida at 27°N are shown above (red dots). CTD casts were conducted at each location (0-8) during each research cruise.

Table 1: Florida Current (FC2104) – CTD Cast Summary

Station	Date	Time (GMT)	Latitude	Longitude	Pressure
0	04/22/20	09:29:18	26.995N	79.928W	137
1	04/22/20	07:55:01	27.001N	79.859W	262
2	04/22/20	06:22:15	26.998N	79.781W	372
3	04/22/20	04:40:02	27.005N	79.683W	522
4	04/22/20	03:23:18	26.999N	79.618W	630
5	04/22/20	01:49:01	26.993N	79.499W	741
6	04/22/20	00:11:02	26.994N	79.380W	646
7	04/21/20	22:41:40	27.000N	79.282W	602
8	04/21/20	21:18:39	26.993N	79.195W	463

Table 2: Florida Current (FC2105) – CTD Cast Summary

Station	Date	Time (GMT)	Latitude	Longitude	Pressure
0	05/12/20	09:17:00	26.997N	79.933W	141
1	05/12/20	08:14:22	26.997N	79.871W	250
2	05/12/20	06:52:37	27.000N	79.785W	369
3	05/12/20	05:27:53	27.000N	79.684W	531
4	05/12/20	04:12:26	26.997N	79.618W	638
5	05/12/20	02:37:57	26.991N	79.500W	755
6	05/12/20	01:06:10	26.991N	79.384W	683
7	05/11/20	23:42:43	27.001N	79.283W	613
8	05/11/20	22:28:33	27.000N	79.199W	470

2 Standards and Pre-Cruise Calibrations

The CTD system is a real-time data acquisition system with the data from a Sea-Bird Electronics, Inc. (SBE) 9plus underwater unit transmitted via a conducting cable to a SBE11plus deck unit (V2). The serial data from the underwater unit is sent to the deck unit in RS-232 NRZ format. The deck unit decodes the serial data and sends it to a networked Windows computer for display and data storage using Sea-Bird Seasave software.

The SBE911plus system transmits data from primary, secondary and auxiliary sensors in the form of binary numbers equivalent to the frequency or voltage outputs from those sensors. These are referred to as the raw data. The SBE software performs the calculations required to convert raw data to engineering units.

The SBE911plus system is electrically and mechanically compatible with the standard, unmodified carousel water sampler, also made by Sea-Bird Electronics, Inc. A modem and carousel interface allows the 911plus system to control the operations of the carousel directly without interrupting the flow of data from the CTD.

The SBE9plus underwater unit is configured with dual standard modular temperature (SBE3plus) and conductivity (SBE4) sensors, which are mounted near the lower end cap. The conductivity cell entrance is co-planar with the tip of the temperature sensor probe. The pressure sensor is mounted inside the underwater unit main housing. A centrifugal pump module flushes water through sensor tubing at a constant rate independent of the CTD's motion to improve dynamic performance. Dual dissolved oxygen sensors (SBE43) are added to the pumped sensor configuration following the temperature-conductivity (TC) pair. A list of sensors used during the cruise can be seen in Table 3.

Table 3: FC2021 - Equipment used during CTD casts.

Instrument	SN	Stations	Use	Comment
AOML orange frame		0-8		FC2104, 2105
Sea-Bird SBE 32 24-palce Carousel Water Sampler	32 - 0980	0-8		FC2104, 2105
Sea-Bird SBE9plus CTD	1165	0-8		FC2104, 2105
Paroscientific Digiquartz Pressure Sensor	128030	0-8		
Sea-Bird SBE3plus Temperature Sensor	5140	0-8	Primary	FC2104, 2105
Sea-Bird SBE3plus Temperature Sensor	1692	0-8	Secondary	FC2104, 2105
Sea-Bird SBE4C Conductivity Sensor	1387	0-8	Primary	FC2104, 2105
Sea-Bird SBE4C Conductivity Sensor	1374	0-8	Secondary	FC2104, 2105
Sea-Bird SBE43 Dissolved Oxygen Sensor	2942	0-8	Primary	FC2104, 2105
Sea-Bird SBE43 Dissolved Oxygen Sensor	2085	0-8	Secondary	FC2104, 2105
Simrad 807 Altimeter	gold	0-8	scale: 2.928	FC2104, 2105
RDI LADCP - 300 kHz Workhorse (AOML)	15329	0-8	Upward	FC2104, 2105
RDI LADCP - 300 kHz Workhorse (AOML)	24472	0-5	Downward	FC2104
RDI LADCP - 300 kHz Workhorse (AOML)	10198	6-8	Downward	FC2104
RDI LADCP - 300 kHz Workhorse (AOML)	24472	0-8	Downward	FC2105

2.1 Pressure

The Paroscientific series 4000 Digiquartz high pressure transducer uses a quartz crystal resonator whose frequency of oscillation varies with pressure induced stress measuring changes in pressure as small as 0.01 parts per million with an absolute range of 0 to 10,000 psia (0 to 6885 dbar). Repeatability, hysteresis and pressure conformance are 0.002% of full-scale. The nominal pressure frequency (0 to full scale) is 34 to 38 kHz. The nominal temperature frequency is 172 kHz ± 50 ppm/°C.

The pressure sensor utilized during the Florida Straits cruises was s/n 1165. Pre-cruise sensor calibrations were performed at Sea-Bird Electronics, Inc. in Bellevue, Washington. The calibration date and coefficients in Table 4 were entered into SEASAVE R using the configuration file.

Pressure coefficients are first formulated into:

$$\begin{aligned} c &= c_1 + c_2 * U + c_3 * U^2 \\ d &= d_1 + d_2 * U \\ t_0 &= t_1 + t_2 * U + t_3 * U^2 + t_4 * U^3 + t_5 * U^4 \end{aligned}$$

where U is temperature in degrees Celsius. Pressure is computed according to:

$$P\ (psia) = c * \left(1 - \frac{t_0^2}{t}\right) * \left[1 - d * \left(1 - \frac{t_0^2}{t}\right)\right]$$

where t is pressure period (μs). SEASAVE R automatically implements this equation.

Table 4: FC2021 – Pressure Calibration Date and Coefficients.

s/n 1165 October 30, 2019
c_1 = -3.955514e+04
c_2 = -4.332890e-01
c_3 = 1.291600e-02
d_1 = 3.518300e-02
d_2 = 0.000000e+00
t_1 = 2.988000e+01
t_2 = -3.947610e-04
t_3 = 4.178490e-06
t_4 = 2.677760e-09
t_5 = 0.000000e+00
Slope = 0.99999
Offset = -2.79502
AD590M = 1.279100e-02
AD590B = -9.005810e+000

2.2 Temperature

The temperature-sensing element is a glass-coated thermistor bead, pressure protected by a stainless steel tube. The sensor output frequency ranges from 5–13 kHz corresponding to temperatures from -5 to 35°C. The output frequency is inversely proportional to the square root of the thermistor resistance, which controls the output of a patented Wien Bridge circuit. The thermistor resistance is exponentially related to temperature. The SBE3plus thermometer has a typical accuracy/stability of ±0.004°C per year and resolution of 0.0003°C at 24 samples per second. The SBE3plus thermometer has a fast response time of 0.070 seconds.

Two temperature sensors were used during the 2021 Florida Straits cruises, s/n 5140 and 1692. Pre-cruise sensor calibrations were performed at Sea-Bird Electronics, Inc. in Bellevue, Washington. The calibration dates and coefficients in Table 5 were entered into SEASAVE® using the configuration file. SEASAVE® automatically implements the equation below and converts between ITS-90 and IPTS-68 temperature scales as desired. The Temperature (ITS-90) is computed from g, h, i, j and f_0 and f is the instrument frequency (kHz) coefficients as follows:

$$T\,(^{\circ}C) = \frac{1}{\left\{g + h * \left[\ln\left(\frac{f_0}{f}\right)\right] + i * \left[\ln^2\left(\frac{f_0}{f}\right)\right] + j * \left[\ln^3\left(\frac{f_0}{f}\right)\right]\right\}} - 273.15$$

Table 5: FC2021 – Temperature Calibration Dates and Coefficients.

s/n 5140 March 12, 2021	s/n 1692 March 10, 2021
g = 4.36423287e-03	g = 4.80214421e-03
h = 6.40097185e-04	h = 6.72257505e-04
i = 2.16995618e-05	i = 2.57357787e-05
j = 1.94643607e-06	j = 2.04265333e-06
f_0 = 1000.0	f_0 = 1000.0

2.3 Conductivity

The flow-through conductivity-sensing element is a glass tube (cell) with three platinum electrodes (SBE4). The resistance measured between the center electrode and the end electrode pair is determined by the cell geometry and the specific conductance of the fluid within the cell, and controls the output frequency of a Wein Bridge circuit. The sensor has a frequency output of approximately 3 to 12 kHz corresponding to conductivity from 0 to 7 Siemens/meter (0 to 70 mmho/cm). The SBE4 has a typical accuracy/stability of ±0.0003 $S \cdot m^{-1}$/month and resolution of 0.00004 $S \cdot m^{-1}$ at 24 scans per second.

Two conductivity sensors were used during the 2021 Florida Straits cruises, s/n 1387 and 1374. Pre-cruise sensor calibrations were performed at Sea-Bird Electronics, Inc. in Bellevue, Washington. The calibration dates and coefficients shown in Table 6 were entered into Seasave R using the configuration file.

Conductivity calibration certificates show an equation containing the appropriate pressure-dependent correction term to account for the effect of hydrostatic loading (pressure) on the conductivity cell:

$$C\ (Siemens/meter) = \frac{(g + h * f^2 + i * f^3 + j * f^4)}{[10 * (1 + c_{t_{cor}} * t + c_{p_{cor}} * p)]}$$

where g, h, i, j, $c_{t_{cor}}$, and $c_{p_{cor}}$ are the calibrations coefficients shown above, f is the instrument frequency (kHz), t is the water temperature (degrees Celsius), and p is the water pressure (dbar). SEASAVE R automatically implements this equation.

Table 6: FC2021 – Conductivity Calibration Dates and Coefficients.

s/n 1387 March 12, 2021	s/n 1374 March 12, 2021
g = -1.06488655e+01	g = -4.07422430e+00
h = 1.59113254e+00	h = 4.96639214e-01
i = 2.71219676e-04	i = 1.83246660e-04
j = 9.32461560e-05	j = 2.24531227e-05
CPcor = -9.5700e-08	CPcor = -9.5700e-08
CTcor = 3.2500e-06	CTcor = 3.2500e-06

2.4 Dissolved Oxygen

The SBE 43 dissolved oxygen sensor uses a membrane polarographic oxygen detector (MPOD). Oxygen sensors determine the dissolved oxygen concentration by counting the number of oxygen molecules per second (flux) that diffuse through a membrane. By knowing the flux of oxygen and the geometry of the diffusion path, the concentration of oxygen can be computed. The permeability of the membrane to oxygen is a function of temperature and ambient pressure. In order to minimize the errors in the oxygen measurement due to the temperature differences between the water and the oxygen sensor, a temperature compensation is calculated using a temperature measured near the active surface of the sensor. The interface electronics output voltages proportional to the temperature-compensated oxygen current. Initial computation of dissolved oxygen in engineering units is done in the software. The range for dissolved oxygen is 120% of surface saturation in all natural waters, fresh and salt, and the nominal accuracy is 2% of saturation.

Under extreme pressure, changes can occur in gas permeable Teflon membranes that affect their permeability characteristics. Some of these changes (plasticization and amorphous/crystalinity ratios) have long time constants and depend on the sensor's time-pressure history. These slow processes result in hysteresis in long, deep casts. The hysteresis correction algorithm operates through the entire data profile and corrects the oxygen voltage values for changes in membrane permeability as pressure varies. At each measurement, the correction to the membrane permeability is calculated based on the current pressure and how long the sensor spent at previous pressures.

Sea-Bird has implemented an optional hysteresis correction for dissolved oxygen data. The correction algorithm requires a continuous time series of data, with no temporal data gaps (although a continuous time series is necessary, a constant sampling interval is not required). Prior to processing, do not remove any data from the downcast or upcast (if to be used), other than a surface soak at the beginning of the downcast.

Two oxygen sensors were used during the 2021 Florida Straits cruises, s/n 2942 and 2085. Pre-cruise sensor calibrations were performed at Sea-Bird Electronics, Inc. in Bellevue, Washington. The calibration dates and coefficients in Table 7 were entered into SEASAVE R using the configuration file.

Table 7: FC2021 – Oxygen Calibration Dates and Coefficients.

s/n 2942 March 18, 2021	s/n 2085 March 18, 2021
Soc = 0.44014	Soc = 0.45851
Voffset = -0.5239	Voffset = -0.4934
Tau20 = 1.13	Tau20 = 1.34
A = -5.6204e-03	A = -4.9897e-03
B = 2.7397e-04	B = 2.6941e-04
C = -4.7706e-06	C = -4.6268e-06
$E_{nominal}$ = 0.036	$E_{nominal}$ = 0.036

The use of these constants in linear equations of the form $I = mV + b$ and $T = kV + c$ yield sensor membrane current and temperature (with maximum error of about 0.5 °C) as a function of sensor output voltage.

Dissolved oxygen concentration is calculated according to:

$$O\ (ml/l) = \{Soc * (V + V_{offset} + tau(T,S) * \frac{\delta v}{\delta t}) + p1 * station\}$$
$$*(1.0 + A * T + B * T^2 + C * T^3) * OXSAT(T,S) * e^{E*(\frac{P}{K})}$$

where Soc, V_{offset}, tau, A, B, C, E and $p1$ are the calibration coefficients shown above and V is the instrument voltage (V). T, S and P are the temperature, salinity and pressure measured by the CTD. K is the temperature in the absolute scale (K), $\delta v/\delta t$ is the oxygen voltage time derivative, $station$ is the station number, and $OXSAT$ is the oxygen saturation value calculated according to (Weiss, 1970):

$$OXSAT(\theta, S) = \exp\left\{A_1 + A_2 * \left(\frac{100}{\theta}\right) + A_3 * \ln\left(\frac{\theta}{100}\right) + A_4 * \left(\frac{\theta}{100}\right)\right.$$
$$\left. + S * \left[B_1 + B_2 * \left(\frac{\theta}{100}\right) + B_3 * \left(\frac{\theta}{100}\right)^2\right]\right\}$$

where θ is the absolute temperature (K); and

$$\begin{aligned} A_1 &= -173.4292 & B_1 &= -0.033096 \\ A_2 &= 249.6339 & B_2 &= 0.014259 \\ A_3 &= 143.3483 & B_3 &= -0.00170 \\ A_4 &= -21.8492. \end{aligned}$$

SEASAVE® automatically implements this equation.

The hysteresis correction is calculated, using the oxygen voltages, with the following algorithm:

$$D = 1 + H_1 * (e^{(\frac{P(i)}{H2})} - 1)$$

$$C = e(-1 * \left(\frac{Time(i) - Time(i-1))}{H3}\right)$$

$$O_V(i) = O_{volt}(i) + V_{offset}$$

$$O_{newvolts}(i) = a * \frac{a}{D}$$

$$O_{finalvolts}(i) = O_{newvolts}(i) - V_{offset}$$

Where:

i = indexing variable (must be a continuous time series to work; can be performed on bin averaged data), where i = 1:end (end is largest data index point plus 1).
$P(i)$ = pressure (decibars) at index point i .
$Time(i)$ = time (seconds) from start of index point i.
$O_{volt}(i)$ = SBE 43 oxygen voltage output directly from sensor, with no calibration or hysteresis corrections, at index point i.
V_{offset} = correction for an electronic offset that is applied to voltage output of sensor. V_{offset} correction is always negative (see factory calibration sheet for this coefficient). V_{offset} is added to raw voltages prior to hysteresis correction. At end of hysteresis corrections, V_{offset} is removed prior to data conversion using SBE 43 calibration equation (see $O_{finalvolts}(i)$).
$O_V(i)$ = dissolved oxygen voltage value with V_{offset} correction (made prior to hysteresis correction) at index point i.
D and C are temporary variables used to simplify expression in processing loop.
$H1$ = amplitude of hysteresis correction function. Default = -0.033, range = -0.02 to -0.05 (varies from sensor to sensor).
$H2$ = function constant or curvature function for hysteresis. Default = 5000.
$H3$ = time constant for hysteresis (seconds). Default = 1450, range = 1200 to 2000 (varies from sensor to sensor).
$O_{newvolts}(i)$ = hysteresis-corrected oxygen value at index point i.
$O_{finalvolts}(i)$ = hysteresis-corrected oxygen value at index point i with V_{offset} removed.

This step is necessary prior to computing oxygen concentration using SBE 43 calibration equation.

3 CTD Data Acquisition

CTD casts were performed with a package consisting of a 24-place, 10-liter rosette frame (AOML's orange frame), a 24-place water sampler pylon (SBE32) and 24, 10-liter Bullister-style Niskin bottles. This package was deployed on all casts. Underwater electronic components consisted of a SBE9plus CTD with dual pumps and the following sensors: dual temperature (SBE3plus), dual conductivity (SBE4), dual dissolved oxygen (SBE43) and an altimeter. The additional underwater electronic components consisted of two RDI 300 kHz LADCPs, one upward facing instrument and one downward facing instrument to measure water velocities. A total of 18 CTD casts were conducted during the four cruises usually to within 10-20 m of the bottom.

The CTD's supplied a standard Sea-Bird format data stream at a data rate of 24 frames/second. The SBE9plus CTD was connected to the SBE32 24-place pylon providing for single-conductor sea cable operations. Power to the SBE9plus CTD, SBE32 pylon, auxiliary sensors, and altimeter was provided through the sea cable from the SBE11plus deck unit in the computer lab. The CTD frame was suspended from a UNOLS-standard three-conductor 0.322" electro-mechanical sea cable.

The CTD was mounted vertically attached to the bottom center of the rosette frame. All SBE4 conductivity and SBE3plus temperature sensors and their respective pumps were mounted vertically as recommended by SBE, outboard of the CTD. The CTD was outfitted with dual pumps. Primary temperature, conductivity, and dissolved oxygen were plumbed on one pump and secondary temperature, conductivity, and dissolved oxygen on the other. Pump exhausts were attached to outside corners of the CTD cage and directed downward. The altimeter was mounted on the inside of the support struts adjacent to the bottom frame ring. The LADCP's were vertically mounted inside the bottle rings with one 300 kHz pointing down, the other 300 kHz transducer pointing up. The R/V *F. G. Walton Smith's* stern A-frame CTD winch was used with the 24-place 10-liter rosette for all station/casts during FC2104 and FC2105. However, at most 23 water samples are collected due to the presence of an upward looking ADCP in place of one Niskin bottle. O-rings were changed as necessary and Niskin bottle maintenance was performed each day to insure proper closure and sealing. Valves were inspected for leaks and repaired or replaced as needed.

3.1 CTD Operations

Prior to each cast, the deck watch prepared the CTD rosette for sampling. All valves, vents, and lanyards were checked for proper orientation. Niskin bottles were cocked, and all hardware and connections rechecked. Fifteen minutes or so prior to station, the deck unit was powered on and an on-deck pre-cast pressure was obtained. Once on station, the syringes were removed from the CTD sensor intake ports. Tag lines were used if necessary for both deployments and recoveries during the cruises. As directed by the deck watch leader, the CTD was lowered to 10 m for a 2-minute soak to remove any air bubble from the sensor lines and to make sure the sensors were behaving appropriately. The CTD was then brought back to just below the surface, with the console operator recording a Mark Scan just prior to beginning the descent. The profiling rate was no more than 30 m/min to 100 m and no more than 60 m/min deeper than 100 m. Upon recovery, the CTD deck unit was turned off once the on-deck pressure was recorded. The CTD frame was left on deck for sampling. The bottles and rosette were examined before samples were taken and anything unusual was noted on the sample log.

A console operator monitored the progress of the deployment and quality of the CTD data through interactive graphics and operational displays of the Seasave software. Additionally, the operator created a sample log for each cast, to be used later used to record the correspondence between rosette bottles and analytical samples taken. The altimeter channel, CTD pressure, wire-out and bathymetric depth were all monitored to determine the distance of the CTD package from the bottom, usually allowing a safe approach to within 10-20 m.

On the up-cast, the winch operator stopped at each predetermined bottle trip depth following instructions from the CTD console operator. The CTD console operator then waited 30 seconds before closing a bottle. The data acquisition system responded with trip confirmation messages and the corresponding CTD data in a rosette bottle trip window on the display. All tripping attempts were noted on the console log. The console operator then directed the winch operator to raise the package up to the next bottle trip location. After the last bottle was tripped, the console operator directed the deck watch to bring the CTD package back on deck.

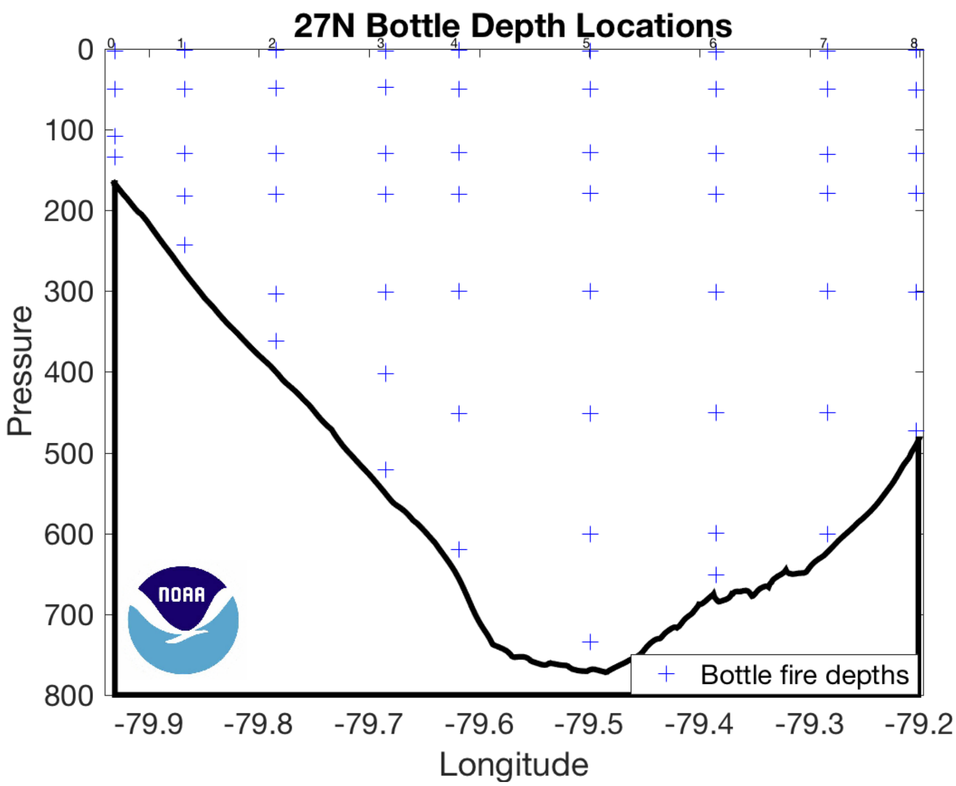


Figure 2: Nominal bottle locations for 27°N section in the Florida Straits.

3.2 Shipboard CTD Data Processing

Shipboard CTD data processing was performed automatically at the end of each deployment using SEABIRD SBE Data Processing version 7.26.7.121 and AOML Matlab processing software. The raw CTD data and bottle trips acquired by SBE Seasave on the Windows 10 workstation were copied onto the CTD-PROC workstation, and processed to a 1-dbar series and a 1-second time series. Bottle trip values were extracted and a 1-decibar (dbar) down cast pressure series created.

Raw data are acquired from the instruments and are stored unmodified. The conversion module DATCNV uses the instrument configuration and pre-cruise factory calibration coefficients to create a converted engineering unit data file that is utilized by all SBEDataProc R post processing modules. Unless otherwise noted, all calibration parameters given are factory default values recommended by Sea Bird Electronics, Inc. The following is the SBEDataProc R processing module sequence and specifications for calibrated data (1 dbar averages) in order for reduction of CTD/O2 data from this cruise:

1. DATCNV converts raw data into engineering units and creates a .ROS bottle file. Both down and up casts were processed for scan, elapsed time(s), depth, pressure, t0 ITS-90 C, t1 ITS-90 C, c0 S/m, c1 S/m, salinity (PSU), salinity 2 (PSU), oxygen voltage V, oxygen 2 voltage V, altimeter, optical sensor, oxygen umol/kg, oxygen 2 umol/kg, oxygen ml/l, oxygen 2 ml/l, oxygen dv/dt, oxygen dv/dt 2, latitude, and longitude. MARKSCAN was used to determine the number of scans acquired on deck and while priming the system to exclude these scans from processing.

2. ALIGNCTD aligns temperature, conductivity, and oxygen measurements in time relative to pressure to ensure that derived parameters are made using measurements from the same parcel of water. Primary and secondary conductivity were automatically advanced by 0.073 seconds. Primary and secondary oxygen were advanced by 1.073.

3. FILTER applies a low pass filter to pressure with a time constant of 0.15 seconds. In order to produce zero phase (no time shift), the filter is first run forward through the file and then run backwards through the file.

4. LOOPEDIT removes scans associated with pressure slowdowns and reversals. If the CTD velocity is less than 0.25 m/s or the pressure is not greater than the previous maximum scan, the scan is omitted.

5. CELLTM uses a recursive filter to remove conductivity cell thermal mass effects from measured conductivity. In areas with steep temperature gradients the thermal mass correction is on the order of 0.005 PSS-78. In other areas the correction is negligible. The value used for the thermal anomaly amplitude (alpha) was 0.03°C. The value used

for the thermal anomaly time constant (1/beta) was 7.0°C.

6. WILDEDIT computes the standard deviation of 100 point bins, and then makes two passes through the data. The first pass flags points that differ from the mean by more than 2 standard deviations. A new standard deviation is computed excluding the flagged points and the second pass marks bad values greater than 20 standard deviations from the mean.

7. BOTTLESUM creates a summary of the bottle data. Bottle position, date, and time were output automatically. Pressure, temperature, conductivity, salinity, oxygen voltage and preliminary oxygen values were averaged over a 5 second interval.

8. DERIVE uses pressure, temperature, and conductivity to compute primary and secondary salinities, potential temperatures and densities. Oxygen voltage is used to calculate oxygen concentrations.

9. BINAVG averages the data into 1 dbar bins. Each bin is centered on an integer pressure value, e.g., the 1 dbar bin averages scans where pressure is between 0.5 dbar and 1.5 dbar. There is no surface bin. The number of points averaged in each bin is included in the data file.

10. TRANS converts the binary data file into ASCII format.

11. SPLIT separates the cast into upcast and downcast values.

CTD data were examined at the completion of each deployment for clean corrected sensor response and any calibration shifts. As bottle salinity and oxygen results became available, they were used to refine shipboard conductivity and oxygen sensor calibrations.

A total of 18 casts were processed.

3.3 CTD Calibration Procedures

Laboratory calibrations of the CTD pressure, temperature, conductivity, and oxygen sensors were all performed at SBE. The calibration dates are listed in Table 3.

A dual sensor configuration was employed on the CTD for temperature (T), conductivity (C), and dissolved oxygen (DO2). The secondary sensor set served as a calibration check for the primary sensors. During every cast, in-situ salinity and DO2 bottle samples were collected for use in calibrating both the primary and secondary C and O2 sensors. During FC2104, it was determined that the secondary temperature, conductivity and dissolved oxygen sensors each behaved more stably than their primary counterparts. During FC2105, it was determined that the primary temperature, conductivity and dissolved oxygen sensors each behaved more stably than their secondary counterparts.

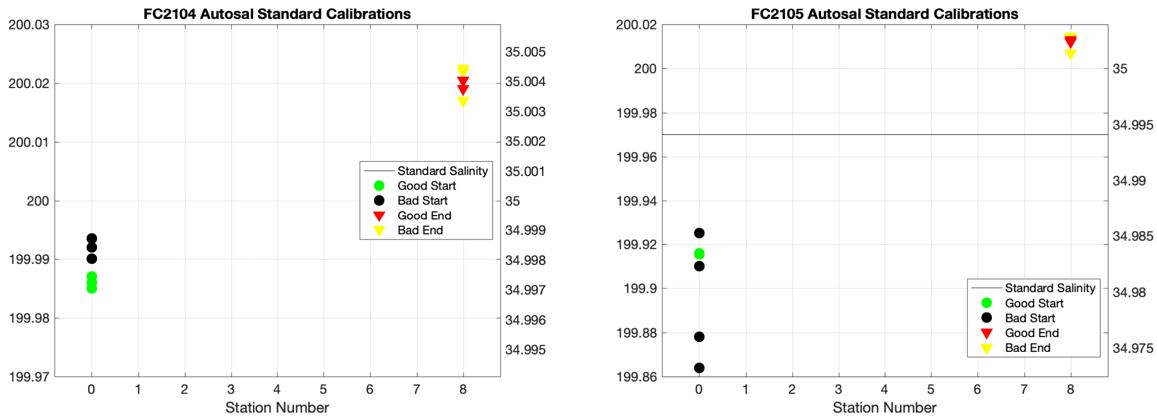
3.3.1 Salinity Analysis

A Guildline Autosal, model 8400B laboratory salinometer, located in the climate-controlled salt van outside of AOML was used to determine the salinity of all water samples collected. Salinometer data output was logged to a computer file using Ocean Scientific International's (OSI) logging hardware and software interface. As a standard operating practice, the Autosal's water bath temperature was maintained at 24°C. In conjunction with this, to help further stabilize the Autosal and to improve measurement accuracy, the climate-controlled laboratory temperature was maintained at 1 to 2 degrees below 24°C. Salinity analyses were performed after samples had equilibrated to laboratory temperature, usually within a couple days after collection. The salinometer was routinely *standardized* for each group of salinity samples analyzed (up to 58 samples) using two bottles of standard seawater: one at the beginning, and one at the end of each group of samples. For each calibration standard, the salinometer cell was initially flushed 6 times before a set of conductivity ratio reading was taken. For each salinity sample, the salinometer cell was initially flushed at least 3 times before a set of conductivity ratio readings were taken. The analyst flushed the cell of the Autosal and changed samples as prompted by the OSI software. Before each analysis session (or *run*) a sub-standard flush of the Autosal, with approximately 200 ml of seawater, was performed prior to the standardization mentioned above. This assured that any deionized water that may have been stored in the cell of the Autosal between extended periods of inactivity was completely flushed from the system.

IAPSO Standard Seawater Batch P-163 (FC2104, FC2105) was used to standardize all casts (Tables 8).

Table 8: FC2021 - Nominal values for the batches of IAPSO standard seawater.

P-163
Use By: April 2022
K15: 0.99985
Salinity: 34.994



(a) FC2104 (b) FC2105

Figure 3: Standard vial calibrations throughout the cruise before and after each Autosal run. The green dots and red triangles are the good values used before and after each run to calculate salinity and drift corrections, respectively. The black dots and yellow triangles are the bad values not used.

Salinity samples were collected in 200 ml Kimax high-alumina borosilicate bottles that had been rinsed at least three times with sample water prior to filling. The bottles were sealed with polypropylene screw caps fitted with *Polyseal* poly cone inserts to prevent sample evaporation. PSS-78 salinity [UNES81] was calculated for each sample from the measured conductivity ratios. The offset between the initial standard seawater value and its reference value was applied to each sample. Then the difference (if any) between the initial and final vials of standard seawater was applied to each sample as a linear function of elapsed run time. The corrected salinity data was then incorporated into the cruise dataset. When duplicate measurements were deemed to have been collected and run properly, they were averaged and submitted with a quality flag of 6. On the four Florida Straits cruises, a total of 115 salinity measurements were taken.

The running standard calibration values are shown in Figure . For FC2104 the autosal standards drift were moderate (about 0.006 in salinity). For FC2105 the autosal standards drifts were larger (about 0.015 in salinity). For FC2105 it was determined the beginning standard calibration was bad and only the ending calibrations was used to correct the salinity values using a constant offset.

3.3.2 Oxygen Analysis

Dissolved oxygen samples were drawn from Niskin bottles into calibrated 125 iodine titration flasks using silicon tubing. Bottles were rinsed three times and filled from the bottom via the tubing, overflowing three volumes while taking care not to entrain any bubbles. 1 ml of $MnCl_2$ and 1 ml of $NaOH/NaI$ were added immediately after drawing the sample was concluded using a ThermoScientific REPIPET II. The flasks were then stoppered and well shaken. Deionized water was added to the neck of each flask to create a water seal. 194 oxygen samples were collected during the 3 cruises, including 25 duplicate samples (up to two duplicates taken randomly during each cast). Samples were stored on the ship in plastic totes and brought back to the AOML oxygen lab for analysis. The result was 131 oxygen samples were used, including 15 duplicates.

Dissolved oxygen analyses were performed with an automated titrator using amperometric end-point detection (Langdon, 2010). The titrator was interfaced with a computer running LabView software customized by Ulises Rivero (NOAA/AOML). The software handled the sample titration and data logging; it also provided a graphical display of the data for the analyst. Thiosulfate (17.5 g per 500 ml) was dispensed by a 2 ml Gilmont burette driven with a stepper motor controlled by the titrator. The titration methodology follows techniques outlined by Carpenter (1965) and Culberson et al. (1991). Four replicate 10 ml iodate standards were run initially or once the thiosulfate bottle had reached half its volume, which ever came first. The reagent blank (the difference between thiosulfate volumes required to titrate two 1 ml aliquots of the iodate standard) was determined at the lab prior to running the oxygen samples. Thiosulfate normality was calculated from the laboratory temperature for each sample run. The dispenser used for the standard solution (SOCOREX Calibrex 520) and the burette were calibrated gravimetrically immediately prior to the cruise. Oxygen flask volumes were also determined gravimetrically with degassed deionized water at AOML prior to use.

The data collected from the oxygen titrations performed were incorporated into the cruise dataset shortly after analysis.

4 Post-Cruise Calibrations

Post cruise sensor calibrations were not done at Sea-Bird Electronics, Inc. Secondary temperature, conductivity and dissolved oxygen sensors served as calibration checks for the reported primary sensors. In-situ salinity and dissolved oxygen samples collected during each cast were used to calibrate the conductivity and dissolved oxygen sensors. The same pressure sensor as well as primary and secondary temperature, conductivity and oxygen sensors were used during the cruises as listed in Table 3. For Florida Current cruise FC2104 the secondary T, C, and O were selected and for FC2105 the primary T, C, and O were selected for final data reduction.

4.1 CTD Data Processing

In addition to the Seasave R processing modules, a group of Matlab script files collectively referred to as the AOML/CTDCAL Toolbox were used. These scripts are based on earlier work of different groups and modern statistical tools. They cover all the steps of the CTD data processing, from the preliminary comparisons between sensors or bottle samples, to data reductions and final sensors calibrations.

- FILL_SURFACE was used to copy the first good value of salinity, temperature, oxygen and oxygen current back to the surface. The program then calculated potential temperature and conductivity, and zeroed doc/dt of oxygen current for those records.
- DESPIKE1 removed spikes from primary temperature, salinity and oxygen data. Data were linearly interpolated over de-spiked records. Conductivity was back calculated, and sigma-theta and potential temperature were recomputed for the interpolated records.
- DESPIKE2 removed spikes from secondary sensors in the same method as DESPIKE1.
- CTD package slowdown and reversals due to ship roll can move mixed water in tow in front of the CTD sensors. This mixture can create artificial density inversions and other artifacts. In addition to the Seasave R module LOOPEDIT, DELOOP, computes values of density locally referenced between every 1 dbar of pressure to compute N^2 = (- g/p) (dp/dz) and linearly interpolated measured parameters over those records where $N^2 \leq$ -1.0 e -05 s^{-2}.

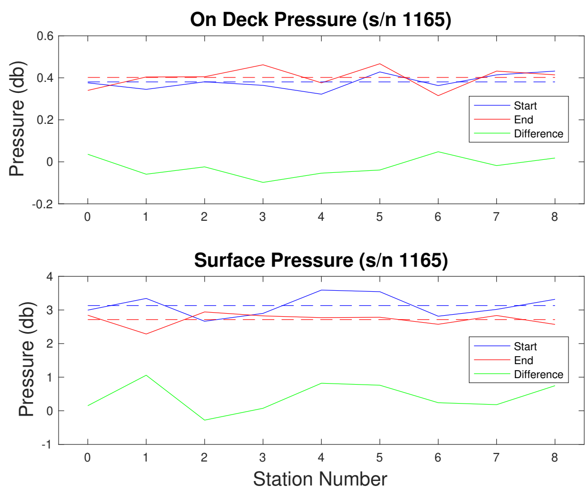
Final calibrations are applied to delooped data files. ITS-90 temperature, PSS-78 salinity, and oxygen are computed, and WOCE quality flags are created (these flags and other CTD processing standards were established during the World Ocean Circulation Experiment in the 1990's).

4.2 CTD Pressure

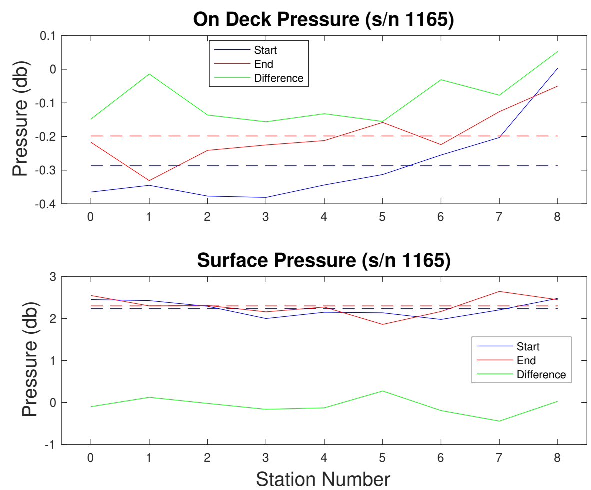
The Seabird pre-cruise pressure sensor calibration coefficients were applied to raw pressure data during each cast. Residual pressure offsets (the difference between the first and last submerged pressures) were examined to check for calibration shifts (see Figure 4 and Tables 9 - 10. All cruises used pressure sensor s/n 1165. Prior to each cruise a pressure offset of -0.524 (FC2104) and -1.124 (FC2105) were applied to the original offset, -2.271, in the pressure configuration file for a total pressure offset of -2.795 (FC2104) and -3.395 (FC2105). On deck pressures recorded before and after each cast are plotted in Figure 4.

For FC2104 the on deck pressure before and after the cast was stable at 0.38 ± 0.04 dbar and 0.4 ± 0.05 dbar (median ± standard deviation). No pressure correction offset was necessary before final calibration of the data. Near surface pressure values (which is taken as the near-surface pressure at the markscan and the last fired bottle pressure) showed little variability over the cruise (3.13 ± 0.33 dbar before and 2.71 ± 0.20 dbar after).

For FC2105 the on deck pressure before and after the cast was stable at -0.29 ± 0.12 dbar and -0.20 ± 0.08 dbar (median ± standard deviation). No pressure correction offset was necessary before final calibration of the data. Near surface pressure values (which is taken as the near-surface pressure at the markscan and the last fired bottle pressure) showed little variability over the cruise (2.23 ± 0.19 dbar before and 2.30 ± 0.23 dbar after).



(a) FC2104



(b) FC2105

Figure 4: Top panel are the pressures (s/n 1165) measured on deck before the cast (blue), at the end of the upcast (red) and differences (green). Bottom panel are the near sea surface pressure values measured at the start of the downcast (blue), at the end of the upcast (red) and the difference (green).

Table 9: FC2104 - Near surface Pressure values and scan number used to remove surface soak and on-deck values (-999s are data no recorded).

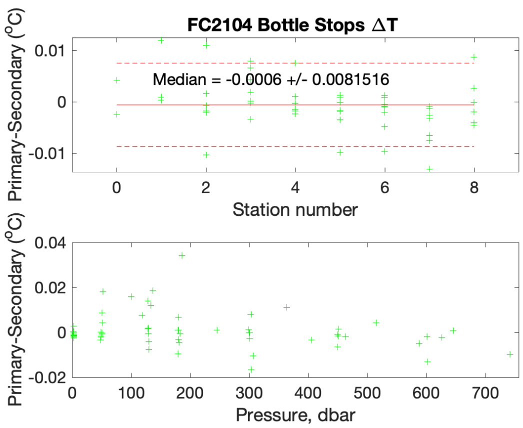
Station	Markscan	Deck Prs Start	Deck Prs End	Sfc Prs Start	Sfc Prs End
0	2363	0.3760	0.3400	2.9955	2.8440
1	3134	0.3450	0.4040	3.3433	2.2850
2	2958	0.3810	0.4050	2.6641	2.9420
3	2760	0.3640	0.4620	2.8983	2.8240
4	2195	0.3220	0.3760	3.5920	2.7720
5	2887	0.4280	0.4670	3.5440	2.7830
6	4328	0.3630	0.3150	2.8143	2.5740
7	3311	0.4140	0.4320	3.0171	2.8350
8	4464	0.4320	0.4140	3.3171	2.5700

Table 10: FC2105 - Near surface Pressure values and scan number used to remove surface soak and on-deck values (-999s are data no recorded).

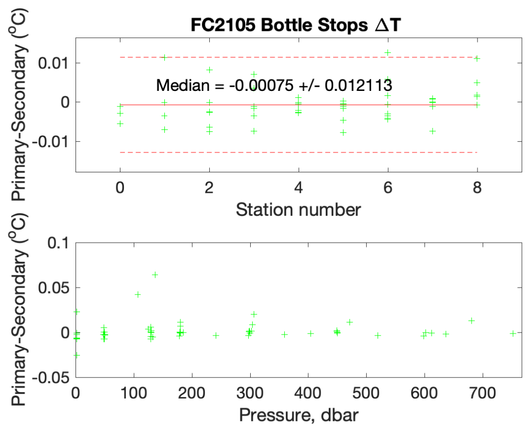
Station	Markscan	Deck Prs Start	Deck Prs End	Sfc Prs Start	Sfc Prs End
0	2917	-0.3650	-0.2170	2.4500	2.5468
1	3535	-0.3450	-0.3310	2.4250	2.2991
2	3390	-0.3770	-0.2410	2.2900	2.3092
3	3467	-0.3810	-0.2250	1.9990	2.1586
4	4278	-0.3440	-0.2120	2.1480	2.2724
5	4275	-0.3130	-0.1580	2.1350	1.8591
6	4690	-0.2550	-0.2240	1.9770	2.1665
7	4003	-0.2030	-0.1260	2.2040	2.6436
8	4188	0.0030	-0.0500	2.4780	2.4466

4.3 CTD Temperature

Temperature sensor calibration coefficients derived from the pre-cruise calibrations were applied to raw primary and secondary temperature data during each cast. Data accuracy, reproducibility and stability were examined by tabulating the difference between the two different temperature sensors over a range of pressures (bottle trip locations) for each cast. These comparisons are summarized in Figure 5, which shows the median temperature difference between the two sensors. For FC2104 there was a median of -0.0006 °C and a standard deviation of 0.008 °C. For FC2105 there was a median of -0.0008 °C and a standard deviation of 0.012 °C.



(a) FC2104



(b) FC2105

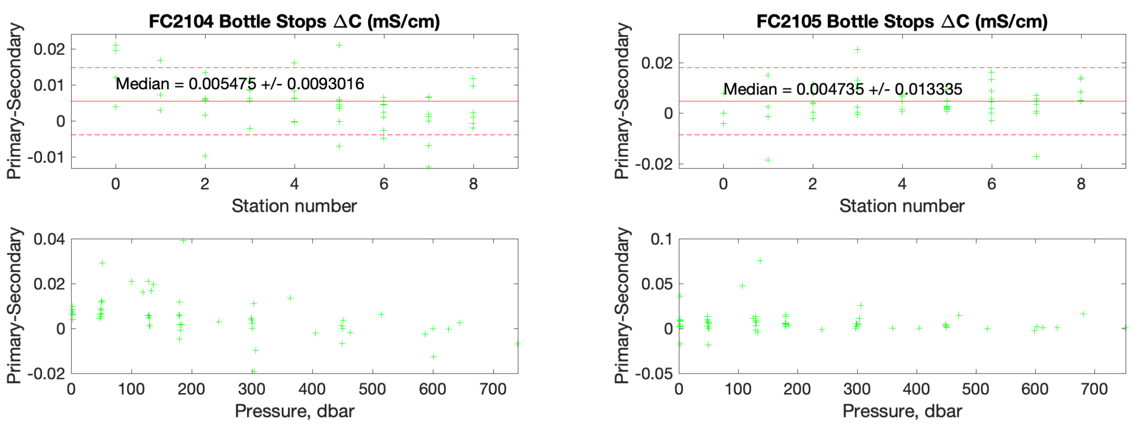
Figure 5: Temperature differences between sensors by station number (top) and pressure (bottom). The green represents all the cruise data. The red solid line represents the median with the red dashed representing the standard deviation (same for top and bottom).

4.4 Conductivity

The Seabird pre-cruise conductivity sensor calibration coefficients were applied to raw primary and secondary conductivity data during each cast. Comparisons between the primary and secondary sensors and between each of the sensors to conductivity calculated from bottle salinities were used to derive conductivity corrections. Uncorrected C1-C2 are shown in Figure 6 to help identify sensor drift. The AOML/CTDCAL Toolbox automatically applies a quality control to the data based on comparison with a normal distribution.

For FC2104 the sensors show a median difference of 0.005 mS/cm and a standard deviation of 0.009 mS/cm (Figure 6). Both sensors showed reasonable values for the residuals. The secondary sensor, s/n 1374, was used for all the final data values (Figure 7).

For FC2105 the sensors show a median difference of 0.005 mS/cm and a standard deviation of 0.013 mS/cm (Figure 6). Both sensors showed reasonable values for the residuals. The primary sensor, s/n 1387, was used for all the final data values (Figure 7).



(a) FC2104 (b) FC2105

Figure 6: Conductivity upcast bottle stop (mS/cm) differences between sensors by station (top) and pressure (bottom). The green represents all the cruise data. The red solid line represents the median with the red dashed representing the standard deviation.

In order to calibrate the CTD conductivity data against the sample conductivity we assume a constant additive correction (offset), multiplicative correction (slope), time drift correction (represented by station number) and where needed, a linear pressure-dependent term. A non-linear function is used to derive these coefficients and are applied to

$$C_{new} = [m * C_{CTD} + (p_1 * station) + b + pcor * P]$$

with

FC2104 s/n 1374	FC2105 s/n 1387
m= 9.991257E-01	m= 9.993343E-01
p_1= 0	p_1= 0
b= 5.040882E-02	b= 2.897749E-02
$pcor$= -1.865275E-05	$pcor$= -5.797700E-06

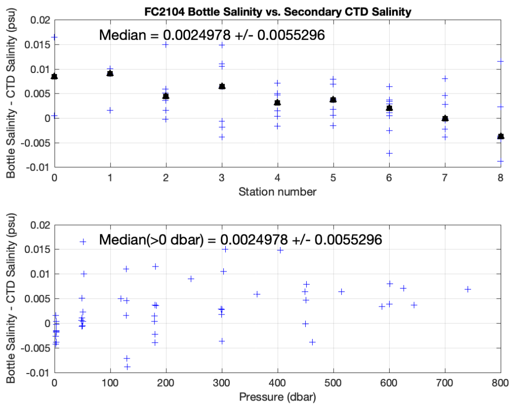
Table 11: Conductivity calibration coefficients applied for final calibration.

where C_{bottle} is bottle conductivity (S/m), C_{CTD} is pre-cruise calibrated CTD conductivity (S/m), m is the conductivity slope, b is the offset (S/m), P is the pressure, $pcor$ is the pressure correction coefficient, $station$ is the station number and p_1 is the polynomial coefficient. The fit is also weighted in such way that the final solution is preferentially forced to fit the data below a specified depth, in this case 1000 dbar. Final calibration coefficients are listed in Tables 11.

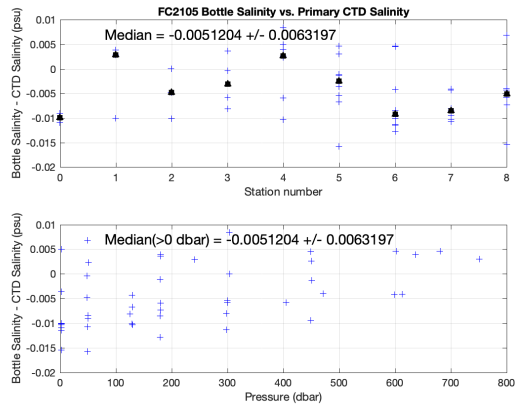
For FC2104 the coefficients estimated by the equation above were then applied to the CTD conductivities and the final results (Figure 8 to Figure 9) show a median of -5.2 · 10-4 psu and a standard deviation of 0.005 psu. After data reduction 52 data points (89.7 %) were used in the final calculations.

For FC2105 the coefficients estimated by the equation above were then applied to the CTD conductivities and the final results (Figure 8 to Figure 9) show a median of -1.4 · 10-3 psu and a standard deviation of 0.005 psu. After data reduction 48 data points (85.7 %) were used in the final calculations.

A final verification about the quality of the data was made by comparing the results of this cruise with some historical data (Figure 10 & 11).

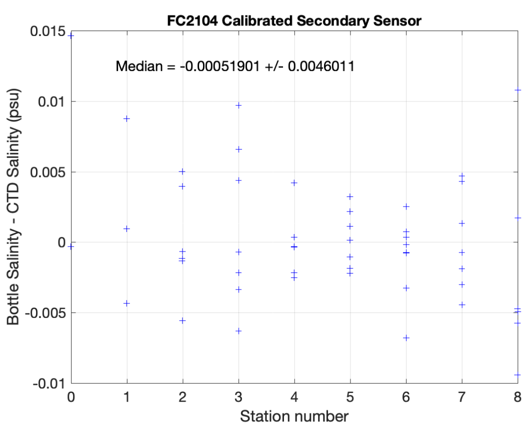


(a) FC2104

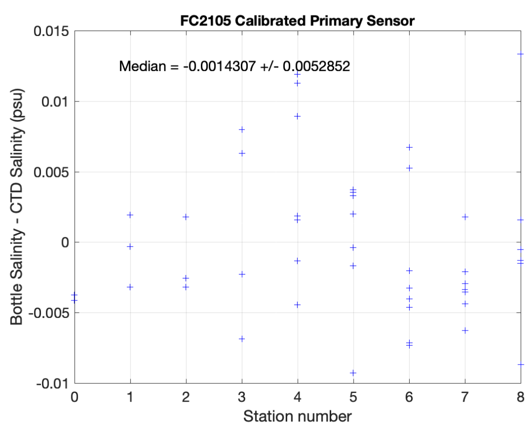


(b) FC2105

Figure 7: Bottle and uncalibrated CTD salinity differences plotted by station and pressure. The blue crosses represent all data points and the black square represent the median for each station. The overall median and standard deviation was calculated using all data points.

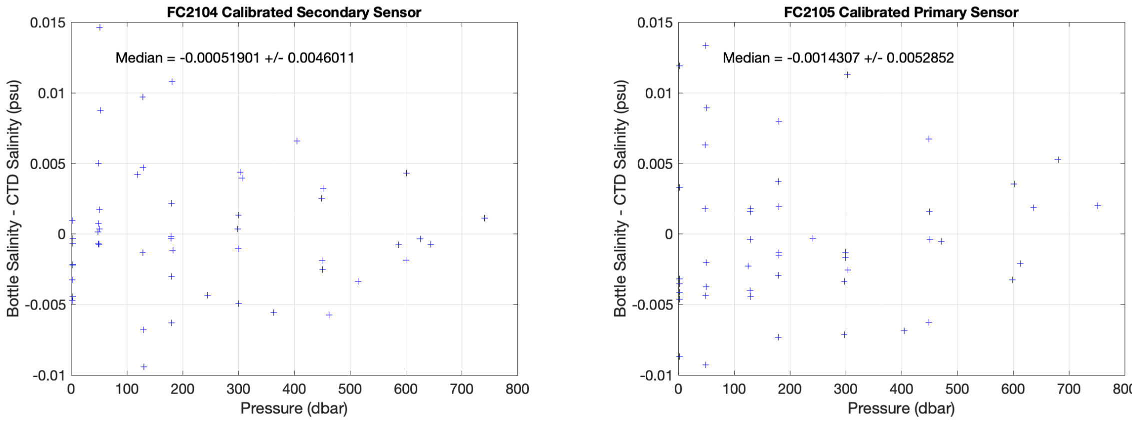


(a) FC2104



(b) FC2105

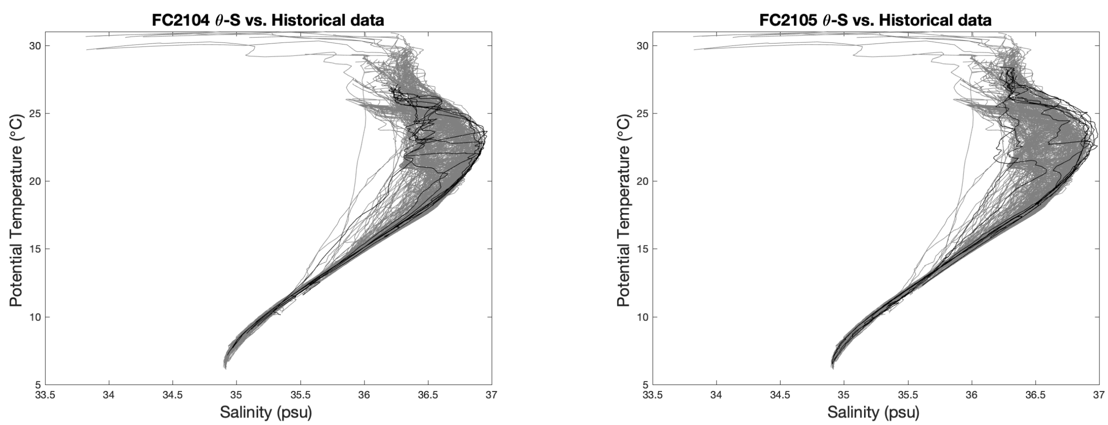
Figure 8: Bottle and calibrated CTD salinity differences plotted vs. station. The blue crosses represent all data points. The median values shown were calculated using all data.



(a) FC2104

(b) FC2105

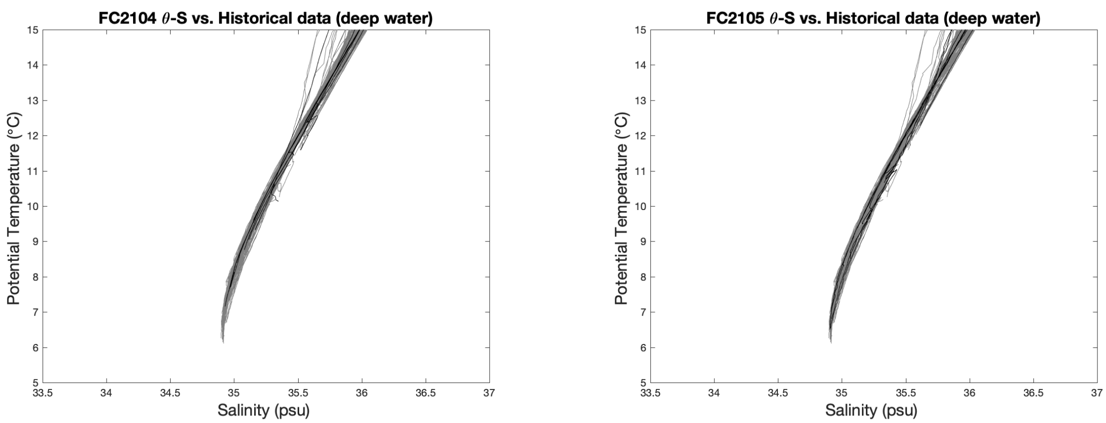
Figure 9: Bottle and calibrated CTD salinity differences plotted vs. pressure. The blue crosses represent all data points. The median values shown were calculated using all data.



(a) FC2104

(b) FC2105

Figure 10: Potential Temperature (θ) - Salinity diagram for all stations. The solid black lines are the data collected during the 2021 cruises. Solid gray lines are historical data collected during the project.



(a) FC2104 (b) FC2105

Figure 11: Potential Temperature (θ) - Salinity diagram for all stations (deep water). The solid black lines are the data collected during the 2021 cruises. Solid gray lines are historical data collected during the project.

4.5 Dissolved Oxygen

Three SBE43 dissolved O_2 (DO) sensors were used these four cruises (Table 3). Due to a hysteresis problem with the oxygen sensors, the oxygen sensors were calibrated to dissolved O_2 samples by matching the up cast bottle trips to down cast CTD data along neutral density surfaces, calculating CTD dissolved O_2, and then minimizing the residuals using a non-linear least-squares fitting procedure.

The algorithm used for converting oxygen sensor current and probe temperature measurements as described, requires a non-linear least squares regression technique in order to determine the best fit coefficients of the model for oxygen sensor behavior to the water sample observations. A non-linear least squares regression using the Gauss-Newton algorithm with Levenberg-Marquardt modifications for global convergence is used to profiles to the bottle data. This algorithm is independent of the first coefficients guess and demonstrates excellent convergence. This `oxfit.m` routine includes an optional time drift term (related with the station number), allowing all stations to be calibrated without breaking into discrete groupings. The Owens and Millard (1985) algorithm was modified as follows:

$$O\ (ml/l) = \{Soc * (V + V_{offset} + tau(T,S) * \frac{\delta v}{\delta t}) + p1 * station\}$$
$$*(1.0 + A * T + B * T^2 + C * T^3) * OXSAT(T,S) * e^{E*(\frac{P}{K})}$$

with

	FC2104 S/N 2085	FC2105 S/N 2942
Soc	0.446430	0.402614
V_offset	-0.495504	-0.525732
A	0.006055	-0.000598
B	-0.000397	0.000020
C	7.997587E-06	1.139512E-06
E	0.038181	0.047159
tau	0.786008	0.366170
$p1$	0	0

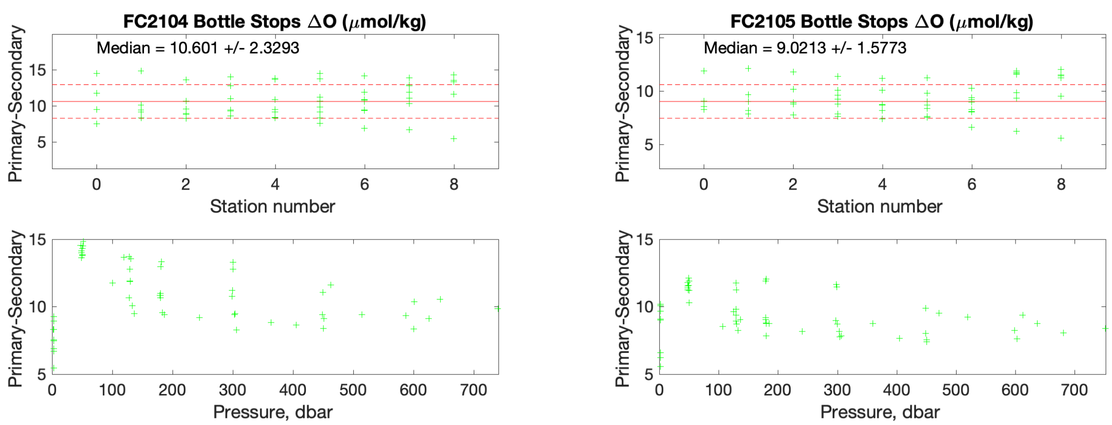
where Soc, tau, V_{offset}, A, B, C, E and $p1$ are the calibration coefficients shown above and V is the instrument voltage (V). T, S and P are the temperature, salinity and pressure measured by the CTD. K is the temperature in the absolute scale, $station$ is the station number, and $OXSAT$ is the oxygen saturation.

For FC2104 a comparison between the primary and secondary sensors (Figure 12) was evaluated. The sensors show a median difference of 10.6 $umol/kg$ and a standard deviation of 2.33 $umol/kg$. The secondary sensor, s/n 2085, was used for all the final data values (Figure

13). After data reduction 52 data points (92.86%) were used in the final calculations. By minimizing the differences between the oxygen samples and the CTD oxygen estimated from the equation described in this section, the new coefficients above were calculated and then applied to the CTD original data (Figure 14 to Figure 15). The median is -0.14 *umol/kg* and the standard deviation 0.83 *umol/kg*.

For FC2105 a comparison between the primary and secondary sensors (Figure 12) was evaluated. The sensors show a median difference of 9.02 *umol/kg* and a standard deviation of 1.58 *umol/kg*. The primary sensor, s/n 2942, was used for all the final data values (Figure 13). After data reduction 53 data points (92.98%) were used in the final calculations. By minimizing the differences between the oxygen samples and the CTD oxygen estimated from the equation described in this section, the new coefficients above were calculated and then applied to the CTD original data (Figure 14 to Figure 15). The median is 0.02 *umol/kg* and the standard deviation 1.05 *umol/kg*.

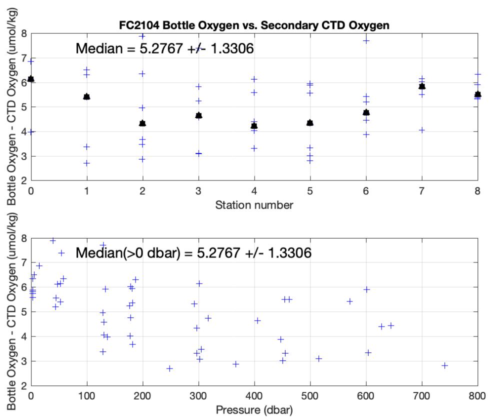
A final verification about the quality of the data, like in the salinity data, was made by comparing the results of this cruise with some historical data available at the location of the Florida Straits section (Figure 16 & 17).



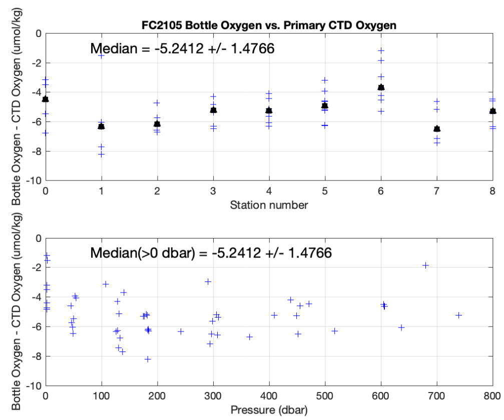
(a) FC2104

(b) FC2105

Figure 12: Dissolved oxygen upcast bottle stop differences between sensors by station (top) and pressure (bottom). The green represents all the cruise data. The red solid line represents the median with the red dashed representing the standard deviation.

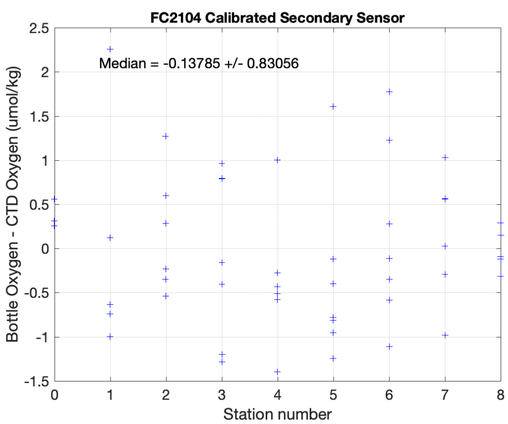


(a) FC2104

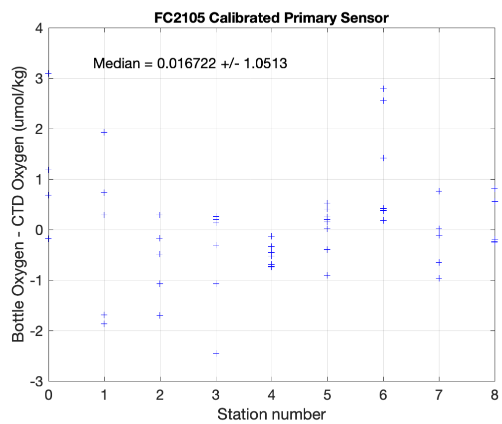


(b) FC2105

Figure 13: Bottle and uncalibrated CTD oxygen differences plotted by station and pressure. The blue crosses represent all data points and the black square represent the median for each station. The overall median and standard deviation was calculated using all data points.

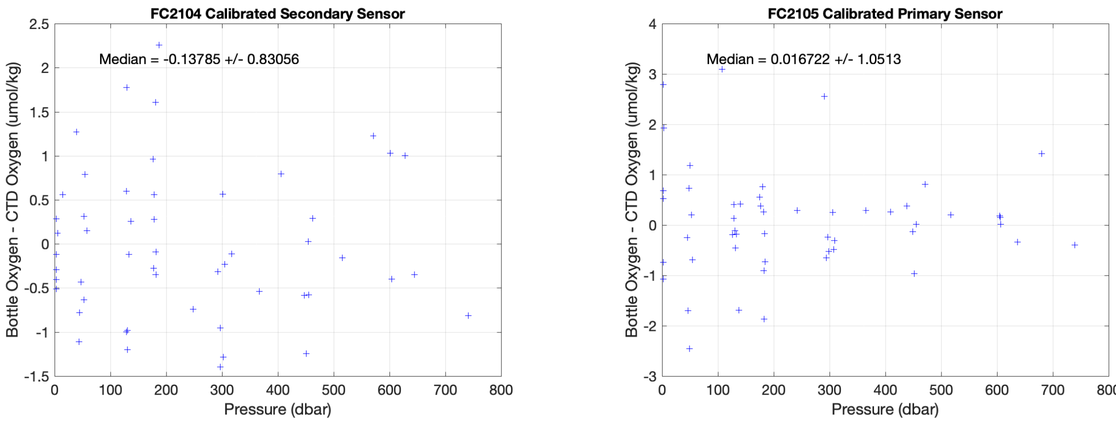


(a) FC2104



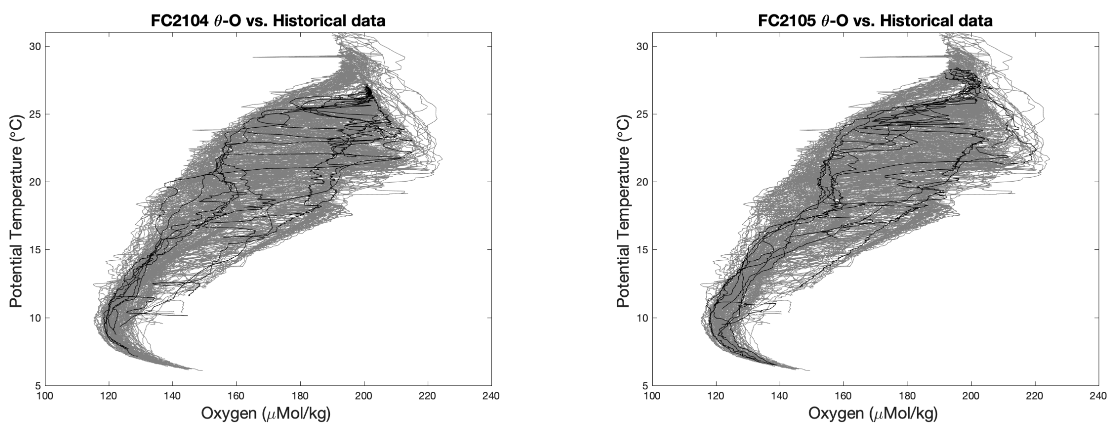
(b) FC2105

Figure 14: Bottle and calibrated CTD oxygen differences plotted vs. station. The blue crosses represent all data points. The median values shown were calculated using all data.



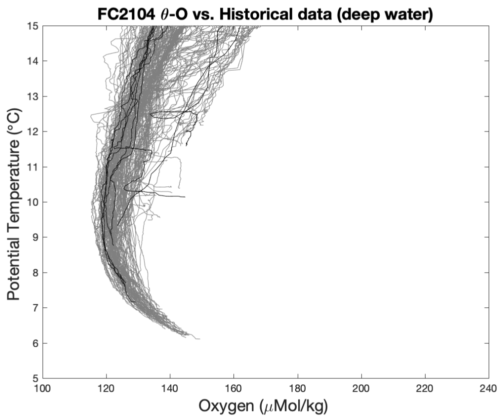
(a) FC2104 (b) FC2105

Figure 15: Bottle and calibrated CTD oxygen differences plotted vs. pressure. The blue crosses represent all data points. The median values shown were calculated using all data.

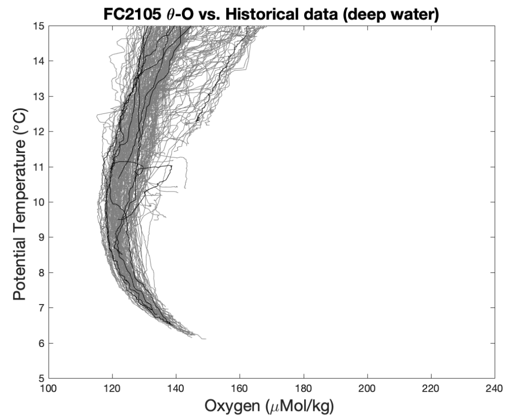


(a) FC2104 (b) FC2105

Figure 16: Potential Temperature (θ) - Oxygen diagram for all stations. The solid black lines are the data collected during the 2021 cruises. Solid gray lines are historical data collected during the project.



(a) FC2104



(b) FC2105

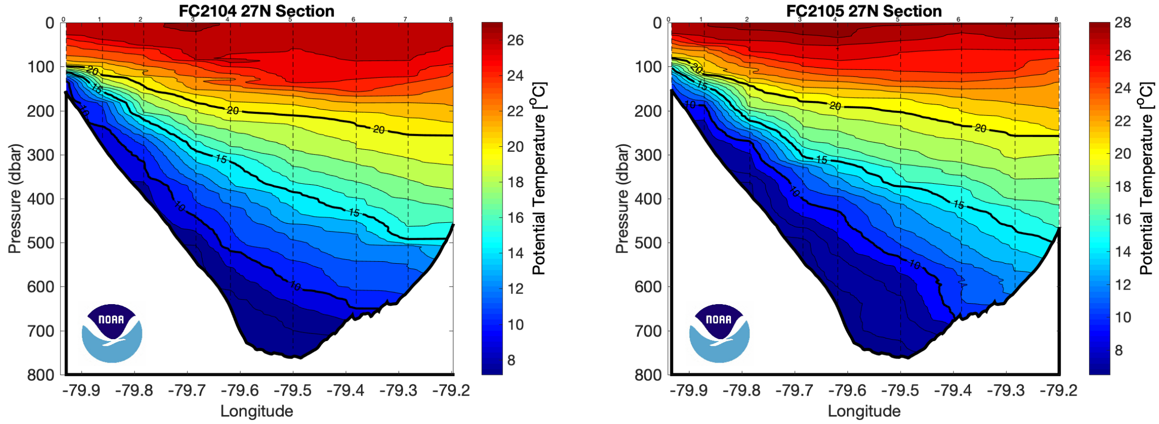
Figure 17: Potential Temperature (θ) - Oxygen diagram for all stations (deep water). The solid black lines are the data collected during the 2021 cruises. Solid gray lines are historical data collected during the project.

5 *Final CTD Data Presentation*

Post-cruise calibrations, determined from bottle data, were applied to CTD data associated with bottle data using Matlab sub-routines (`apply_calibration.m`). WOCE quality flags were appended to bottle data records. “bad values” (WOCE quality control value = 4) were flagged if the bottle samples failed the initial quality control and were not used for the calibration (which meant they fell outside 2.57 standard deviations of the difference between samples and uncalibrated CTD values). A second pass was applied, using the value of 2.5 times the standard deviation of the difference between calibrated CTD values and bottle samples, where bottle values may be flagged as “bad values”.

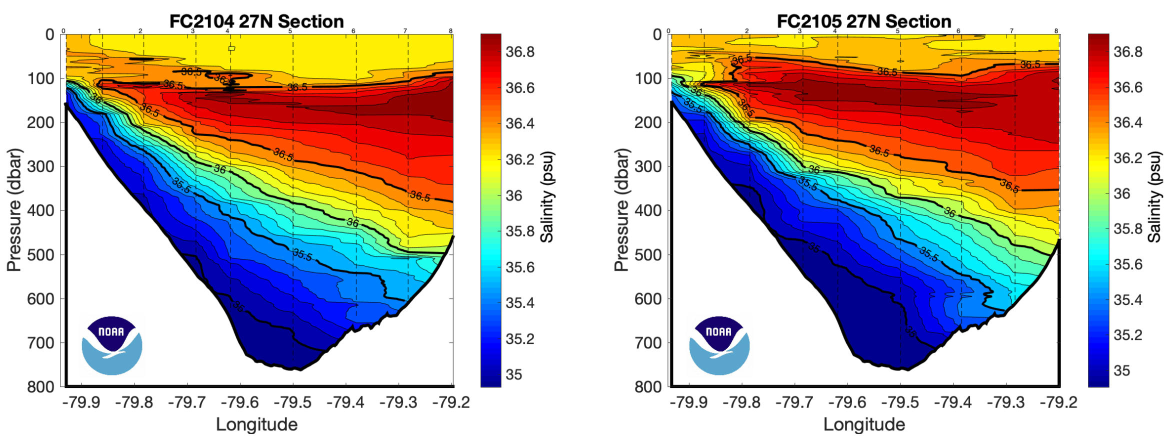
The final calibrated CTD data files were used to produce the section plots that follow and the tables and station profile plots presented in the appendices. Vertical sections of potential temperature, CTD salinity, potential density, and CTD oxygen are contoured with pressure as the vertical axis. The Florida Current Section uses longitude as the horizontal axis (Figure 18 to Figure 21).

In Appendix A, for each CTD station, the upper table presents “standard depths” of the CTD cast, while the lower table lists the bottle CTD trip depths for the cast. Following the two tables, a page of 4 plots illustrate the data collected of the stations. Niskin bottle depths are indicated on the right side of the larger profile plot and bottle salinity and oxygen values are plotted as points in the three smaller plots. A WOCE formatted CTD cast summary file is shown in Appendix B. It lists information regarding the beginning, middle (bottom of the cast), and end of each CTD cast. Finally, a bottle summary file (WOCE formatted) is presented in Appendix C. This table lists the specific details associated with each Niskin bottle trip over the course of the entire cruise. The -999’s in the tables represent missing data.



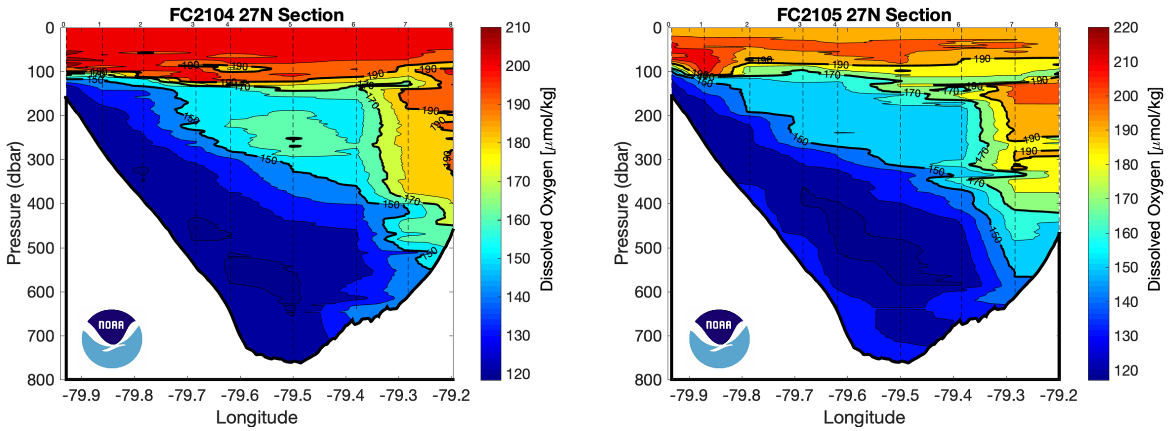
(a) FC2104 (b) FC2105

Figure 18: Potential Temperature (°C) for the 27°N section. Dashed vertical lines are the CTD station locations.



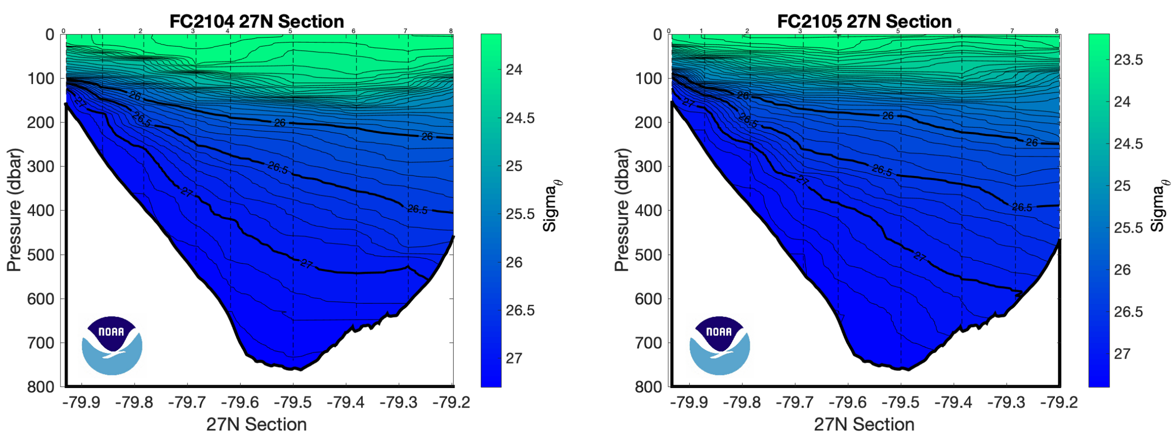
(a) FC2104 (b) FC2105

Figure 19: Salinity (PSS 78) for the 27°N section. Dashed vertical lines are the CTD station locations.



(a) FC2104 (b) FC2105

Figure 20: Dissolved Oxygen (μmol/kg) for the 27°N section. Dashed vertical lines are the CTD station locations.



(a) FC2104 (b) FC2105

Figure 21: Neutral density (kg/m3) for the 27°N section. Dashed vertical lines are the CTD station locations.

6 Acknowledgements

The successful completion of the cruise relied on dedicated assistance from many individuals on shore and at sea. Western Boundary Time Series project members were instrumental in planning and executing the cruise, and we offer special thanks to our research cruise participants in 2021: Uli Rivero, Pedro Pena, Christian Saiz and Diego Ugaz. Additionally we would like to thank the captain and crew of the R/V *F. G. Walton Smith*, who exhibited a high degree of professionalism and assistance to accomplish our work, while at the same time making us feel at home during the voyages. We also thank NOAA program managers for their continued support of our efforts. This research was also made possible with support of the Cooperative Institute for Marine and Atmospheric Studies (CIMAS), a Cooperative Institute of the University of Miami and NOAA via cooperative agreement #NA20OAR4320472. Additional support was provided by OAR's Atlantic Oceanographic and Meteorological Laboratory. SPECIAL NOTE: A portion of this research was conducted within the jurisdictional waters of the Bahamas. Bahamian research clearance was obtained prior to conducting the research outlined in this report. We thank the Bahamian government for granting our request to conduct research in Bahamian waters.

7 References

Carpenter, J. H., 1965a: The accuracy of the Winkler method for dissolved oxygen analysis, *Limnology and Oceanography*, **10**, 135-140.

Carpenter, J. H., 1965b: The Chesapeake Bay Institute Technique for the Winkler dissolved oxygen method, *Limnology and Oceanography*, **10**, 141-143.

Culberson, C. H., G. Knapp, M. C. Stalcup, R. T. Williams, and F. Zemlyak, 1991: A Comparison of methods for the determination of dissolved oxygen in seawater. *Woods Hole Oceanogr. Inst. WHPO*, **91-2**, 77p.

Langdon, C., 2010: Determination of dissolved oxygen in seawater by Winkler titration using the amperometric technique, *IOCCP Report*, **14-134**, 18p.

Weiss, R. F., 1970: The solubility of nitrogen, oxygen and argon in water and seawater, *Deep-Sea Res.*, **17**, **4**, Pages 721-735.

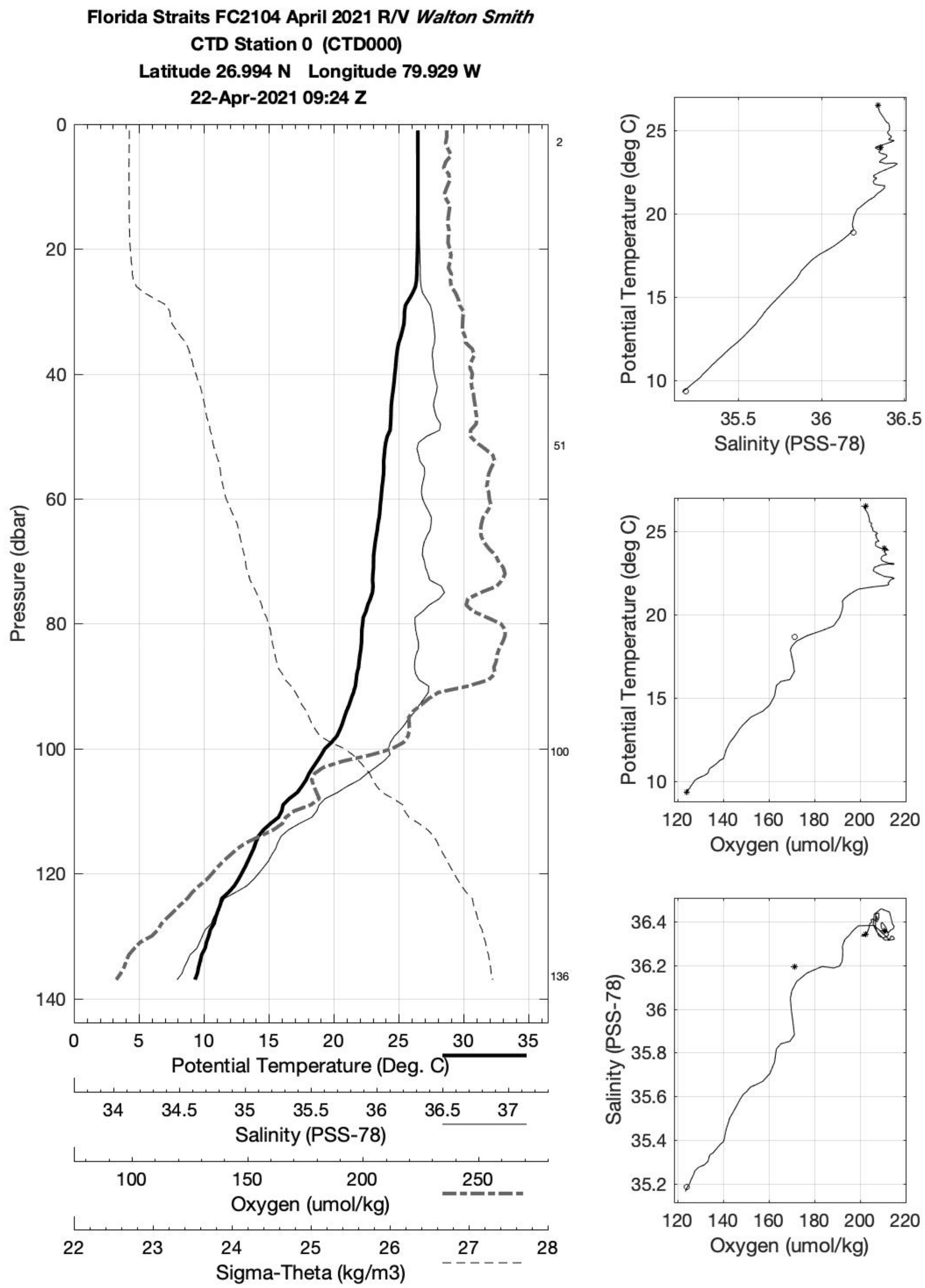
A Hydrographic CTD Data

A.1 FC2104 - April 2021

Florida Straits FC2104 April 2021 R/V *Walton Smith*
CTD Station 0 (CTD000)
Latitude 26.994N Longitude 79.929W
22-Apr-2021 09:24Z

Pressure	Temp90	PoTemp90	Salinity	Oxygen	DynHt	SigT
dbar	°C	°C	PSS-78	$\mu mol \cdot kg^{-1}$	$m^2 \cdot s^{-2}$	$kg \cdot m^{-3}$
1	26.466	26.466	36.336	200.4	0.004	23.895
10	26.471	26.469	36.335	200.6	0.040	23.893
20	26.451	26.446	36.338	203.5	0.080	23.903
30	25.451	25.444	36.395	206.7	0.119	24.259
50	24.155	24.144	36.368	207.9	0.188	24.635
75	22.984	22.968	36.455	208.5	0.267	25.047
100	19.363	19.345	36.173	186.6	0.333	25.829
125	11.301	11.285	35.378	138.7	0.372	27.018

Pressure	Niskin	Temp90	PoTemp90	Salinity	Oxygen
dbar		°C	°C	PSS-78	$\mu mol \cdot kg^{-1}$
136	1	9.388	9.372	35.185	124.2
100	2	18.890	18.872	36.195	171.5
51	3	23.975	23.964	36.360	210.6
3	4	26.454	26.454	36.341	202.5

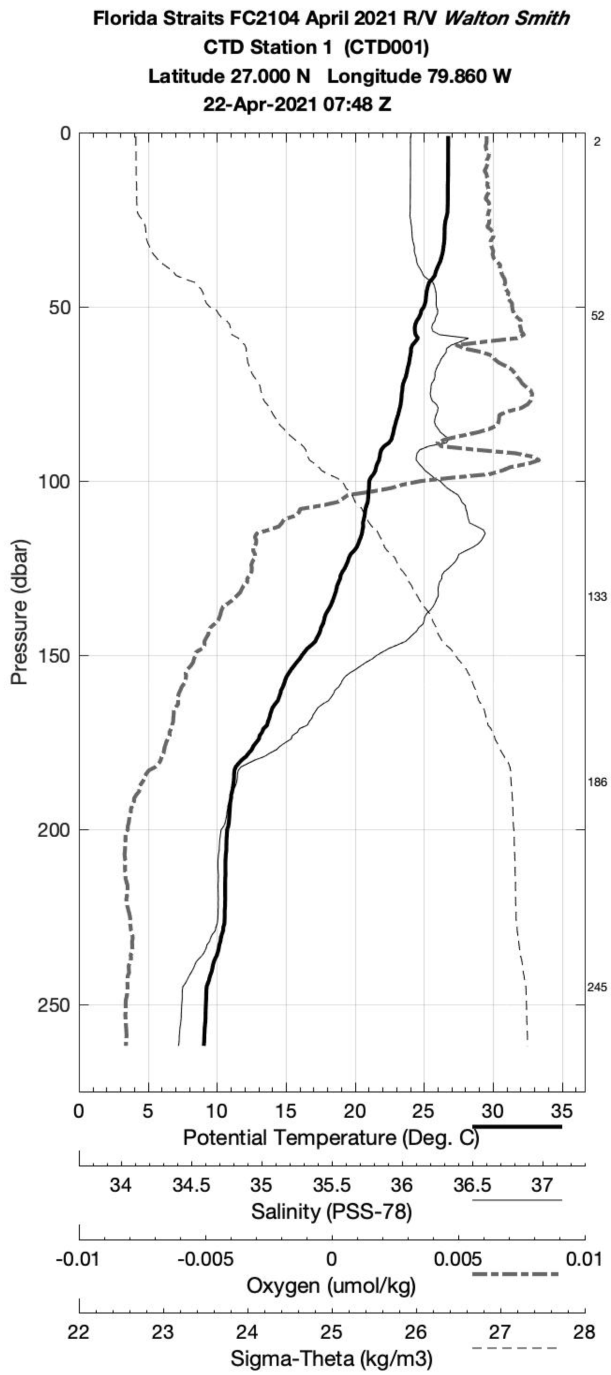


Florida Straits FC2104 April 2021 R/V *Walton Smith*
CTD Station 0 (CTD000)
Latitude 26.994 N Longitude 79.929 W
22-Apr-2021 09:24 Z
Pressure (dbar)
Potential Temperature (Deg. C)
Salinity (PSS-78)
Oxygen (umol/kg)
Sigma-Theta (kg/m3)
Potential Temperature (deg C)
Salinity (PSS-78)
Potential Temperature (deg C)
Oxygen (umol/kg)
Salinity (PSS-78)
Oxygen (umol/kg)

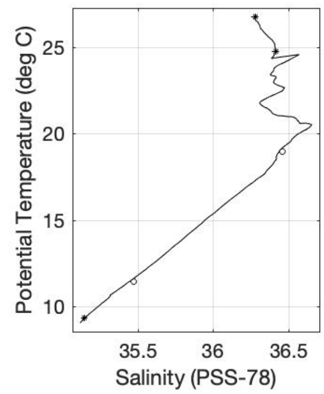
Florida Straits FC2104 April 2021 R/V *Walton Smith*
CTD Station 1 (CTD001)
Latitude 27.000N Longitude 79.860W
22-Apr-2021 07:48Z

Pressure	Temp90	PoTemp90	Salinity	Oxygen	DynHt	SigT
dbar	°C	°C	PSS-78	μmol·kg^{-1}	m^2·s^{-2}	kg·m^{-3}
1	26.759	26.759	36.281	199.4	0.004	23.760
10	26.754	26.752	36.280	200.2	0.041	23.762
20	26.740	26.735	36.279	202.6	0.083	23.766
30	26.501	26.495	36.288	205.0	0.124	23.850
50	25.012	25.001	36.406	207.9	0.200	24.404
75	23.415	23.399	36.376	212.0	0.281	24.861
100	21.057	21.038	36.425	183.4	0.352	25.569
125	19.305	19.283	36.465	148.8	0.407	26.069
150	16.209	16.185	36.100	136.5	0.451	26.551
200	10.772	10.748	35.327	122.5	0.511	27.076
250	9.232	9.205	35.133	121.7	0.560	27.189

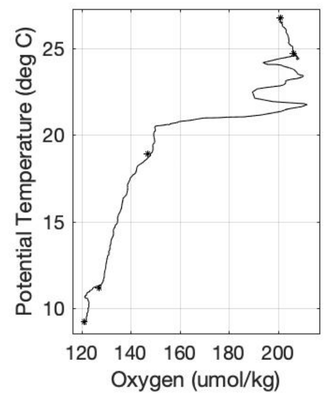
Pressure	Niskin	Temp90	PoTemp90	Salinity	Oxygen
dbar		°C	°C	PSS-78	μmol·kg^{-1}
245	1	9.352	9.325	35.140	121.0
186	2	11.447	11.423	35.473	127.0
133	3	18.960	18.936	36.460	147.0
52	4	24.744	24.732	36.419	206.4
2	5	26.748	26.748	36.278	201.0



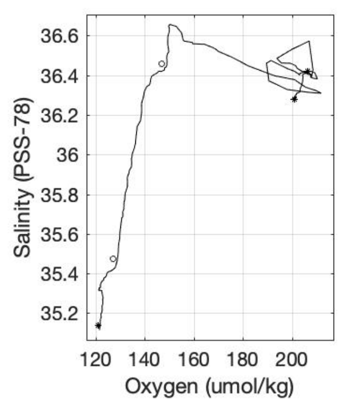
Florida Straits FC2104 April 2021 R/V *Walton Smith*
CTD Station 1 (CTD001)
Latitude 27.000 N Longitude 79.860 W
22-Apr-2021 07:48 Z
Pressure (dbar)
Potential Temperature (Deg. C)
Salinity (PSS-78)
Oxygen (umol/kg)
Sigma-Theta (kg/m3)



Potential Temperature (deg C)
Salinity (PSS-78)



Potential Temperature (deg C)
Oxygen (umol/kg)

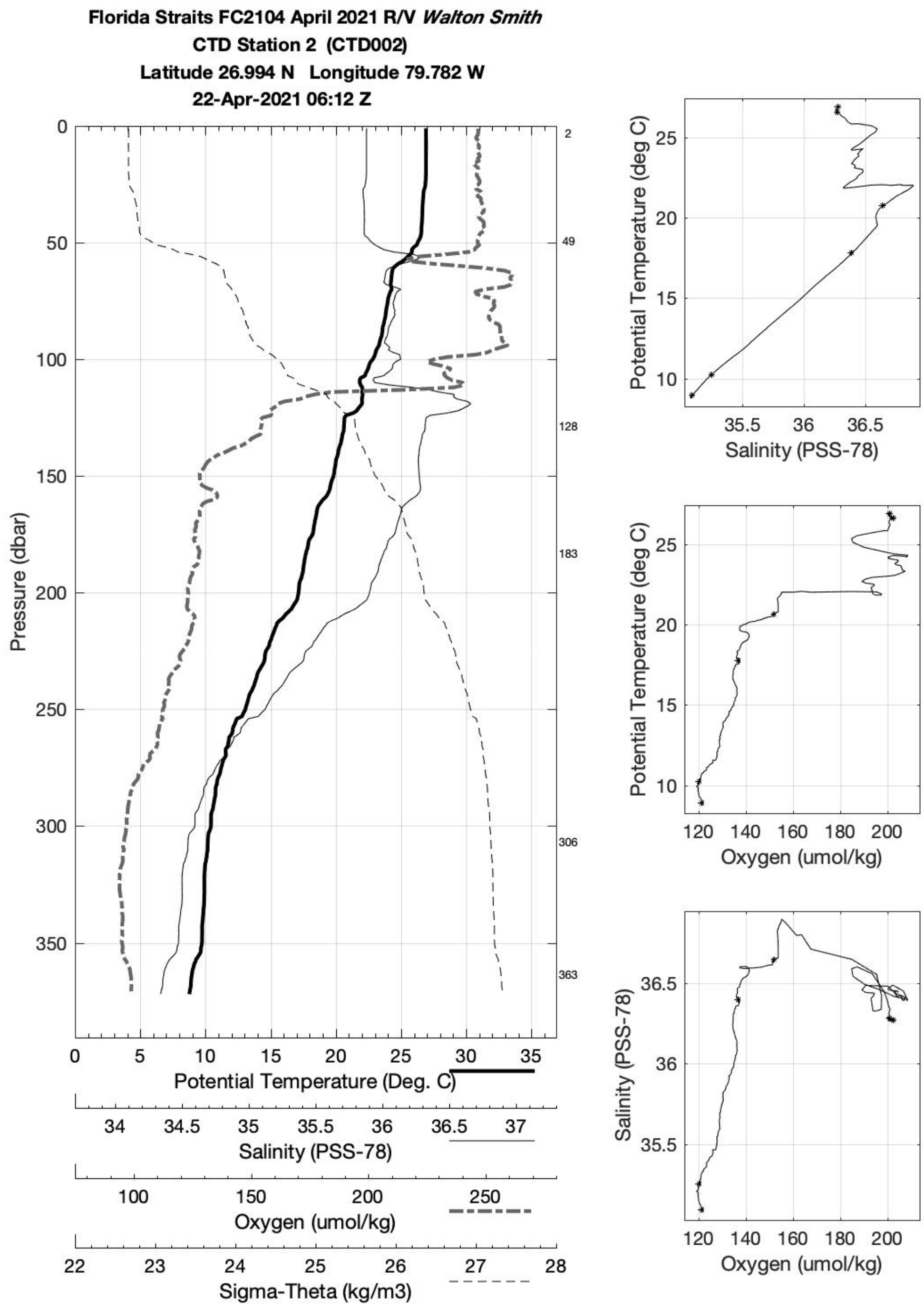


Salinity (PSS-78)
Oxygen (umol/kg)

Florida Straits FC2104 April 2021 R/V *Walton Smith*
CTD Station 2 (CTD002)
Latitude 26.994N Longitude 79.782W
22-Apr-2021 06:12Z

Pressure	Temp90	PoTemp90	Salinity	Oxygen	DynHt	SigT
dbar	°C	°C	PSS-78	μmol·kg^{-1}	m^2·s^{-2}	kg·m^{-3}
1	26.917	26.917	36.286	198.9	0.004	23.714
10	26.922	26.919	36.286	199.8	0.042	23.712
20	26.922	26.918	36.285	202.3	0.084	23.712
30	26.720	26.713	36.266	204.5	0.125	23.764
50	26.285	26.274	36.318	203.2	0.207	23.942
75	24.003	23.988	36.443	205.2	0.293	24.738
100	22.856	22.835	36.479	189.5	0.371	25.103
125	20.690	20.666	36.633	151.2	0.435	25.829
150	19.854	19.826	36.591	137.2	0.489	26.022
200	17.173	17.139	36.301	135.0	0.577	26.480
250	13.102	13.067	35.690	129.5	0.645	26.914
300	10.452	10.416	35.280	121.1	0.699	27.098

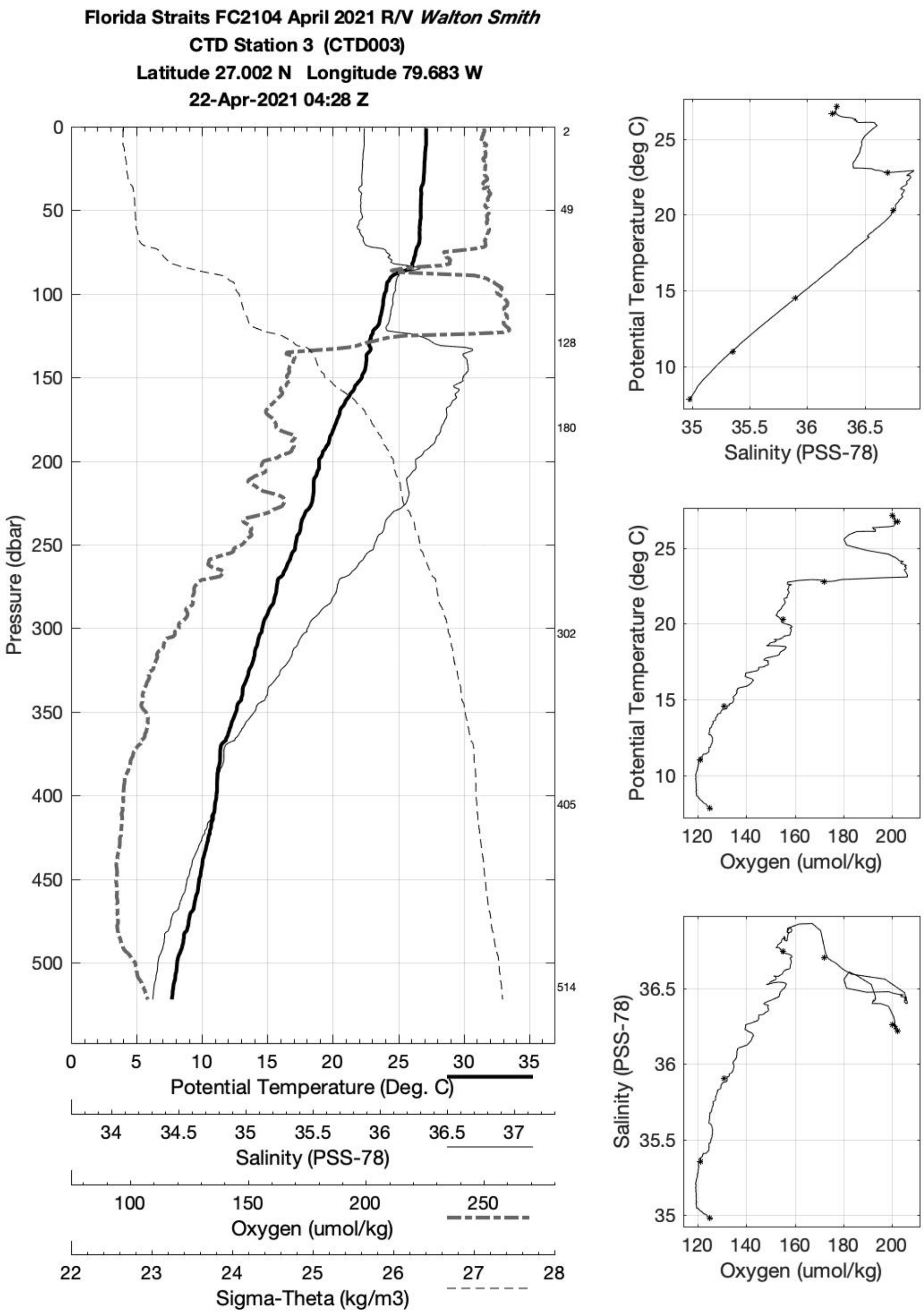
Pressure	Niskin	Temp90	PoTemp90	Salinity	Oxygen
dbar		°C	°C	PSS-78	μmol·kg^{-1}
364	1	9.013	8.973	35.094	121.4
307	2	10.266	10.230	35.252	120.4
183	3	17.845	17.813	36.394	137.1
129	4	20.773	20.749	36.646	152.2
49	5	26.581	26.570	36.272	202.4
3	6	26.914	26.913	36.280	201.2


Florida Straits FC2104 April 2021 R/V *Walton Smith*
CTD Station 2 (CTD002)
Latitude 26.994 N Longitude 79.782 W
22-Apr-2021 06:12 Z
Pressure (dbar)
0
50
100
150
200
250
300
350
2
49
128
183
306
363
0 5 10 15 20 25 30 35
Potential Temperature (Deg. C)
34 34.5 35 35.5 36 36.5 37
Salinity (PSS-78)
100 150 200 250
Oxygen (umol/kg)
22 23 24 25 26 27 28
Sigma-Theta (kg/m3)
Potential Temperature (deg C)
10 15 20 25
35.5 36 36.5
Salinity (PSS-78)
Potential Temperature (deg C)
10 15 20 25
120 140 160 180 200
Oxygen (umol/kg)
Salinity (PSS-78)
35.5 36 36.5
120 140 160 180 200
Oxygen (umol/kg)

Florida Straits FC2104 April 2021 R/V *Walton Smith*
CTD Station 3 (CTD003)
Latitude 27.002N Longitude 79.683W
22-Apr-2021 04:28Z

Pressure dbar	Temp90 °C	PoTemp90 °C	Salinity PSS-78	Oxygen $\mu mol \cdot kg^{-1}$	DynHt $m^2 \cdot s^{-2}$	SigT $kg \cdot m^{-3}$
1	27.126	27.125	36.266	199.5	0.004	23.631
10	27.130	27.128	36.265	198.7	0.043	23.630
20	27.027	27.023	36.255	202.7	0.085	23.656
30	26.951	26.944	36.249	203.5	0.127	23.677
50	26.727	26.716	36.244	205.1	0.211	23.746
75	26.338	26.321	36.398	194.3	0.314	23.987
100	23.972	23.951	36.442	205.4	0.403	24.748
125	22.955	22.930	36.591	180.8	0.481	25.161
150	22.251	22.221	36.868	157.8	0.546	25.575
200	18.984	18.948	36.576	151.3	0.650	26.240
250	17.183	17.141	36.324	147.0	0.737	26.497
300	14.641	14.596	35.914	133.4	0.811	26.766
400	11.153	11.103	35.365	121.0	0.933	27.041
500	8.147	8.095	35.005	123.3	1.035	27.263

Pressure dbar	Niskin	Temp90 °C	PoTemp90 °C	Salinity PSS-78	Oxygen $\mu mol \cdot kg^{-1}$
515	1	7.890	7.838	34.977	125.1
405	2	11.029	10.978	35.352	121.3
303	3	14.549	14.503	35.902	130.8
180	4	20.332	20.299	36.747	155.1
129	5	22.791	22.764	36.700	172.2
49	6	26.647	26.636	36.217	202.2
3	7	27.120	27.119	36.259	200.4

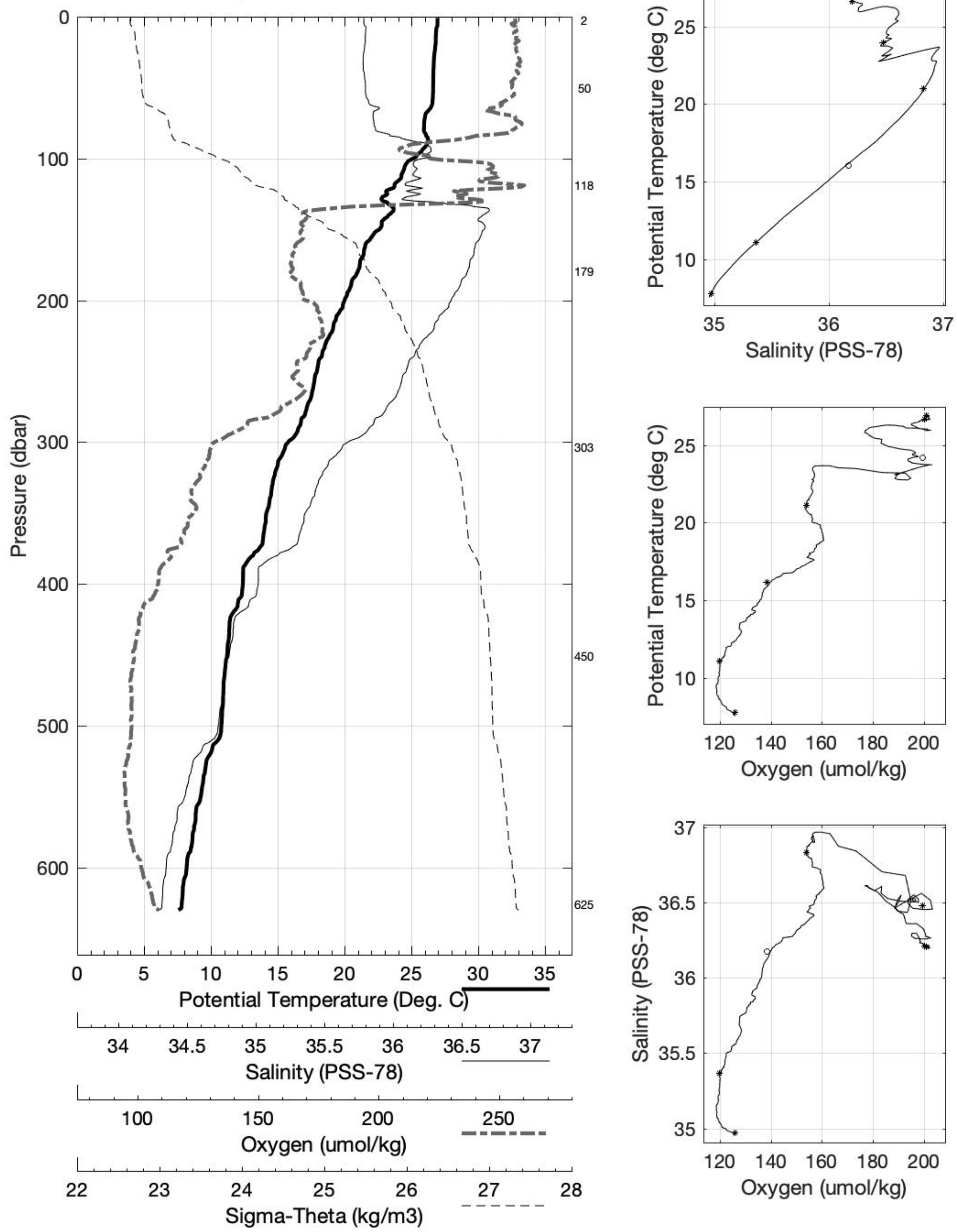

Florida Straits FC2104 April 2021 R/V *Walton Smith*
CTD Station 3 (CTD003)
Latitude 27.002 N Longitude 79.683 W
22-Apr-2021 04:28 Z
Pressure (dbar)
Potential Temperature (Deg. C)
Salinity (PSS-78)
Oxygen (umol/kg)
Sigma-Theta (kg/m3)
2
49
128
180
302
405
514
Potential Temperature (deg C)
Salinity (PSS-78)
Potential Temperature (deg C)
Oxygen (umol/kg)
Salinity (PSS-78)
Oxygen (umol/kg)

Florida Straits FC2104 April 2021 R/V *Walton Smith*
CTD Station 4 (CTD004)
Latitude 26.995N Longitude 79.618W
22-Apr-2021 03:09Z

Pressure	Temp90	PoTemp90	Salinity	Oxygen	DynHt	SigT
dbar	°C	°C	PSS-78	μmol·kg^{-1}	m^2·s^{-2}	kg·m^{-3}
1	26.942	26.942	36.202	199.2	0.004	23.642
10	26.845	26.843	36.212	198.8	0.042	23.682
20	26.789	26.785	36.206	202.1	0.084	23.696
30	26.684	26.677	36.196	204.9	0.126	23.722
50	26.628	26.617	36.210	203.5	0.210	23.752
75	25.960	25.943	36.262	204.8	0.311	24.004
100	25.147	25.125	36.555	184.7	0.406	24.479
125	23.036	23.010	36.484	192.1	0.487	25.057
150	22.640	22.609	36.929	156.6	0.555	25.511
200	20.031	19.994	36.728	156.7	0.665	26.082
250	17.977	17.934	36.455	154.9	0.757	26.404
300	15.836	15.789	36.100	137.2	0.838	26.643
400	12.442	12.388	35.557	125.8	0.972	26.947
500	10.848	10.786	35.316	119.9	1.086	27.060
600	8.250	8.187	35.000	122.0	1.187	27.246

Pressure	Niskin	Temp90	PoTemp90	Salinity	Oxygen
dbar		°C	°C	PSS-78	μmol·kg^{-1}
626	1	7.880	7.816	34.972	126.0
451	2	11.180	11.123	35.365	120.0
303	3	16.121	16.072	36.174	138.5
179	4	21.050	21.015	36.829	154.0
119	5	23.982	23.957	36.479	199.7
51	6	26.630	26.618	36.208	200.4
3	7	26.907	26.906	36.201	200.9

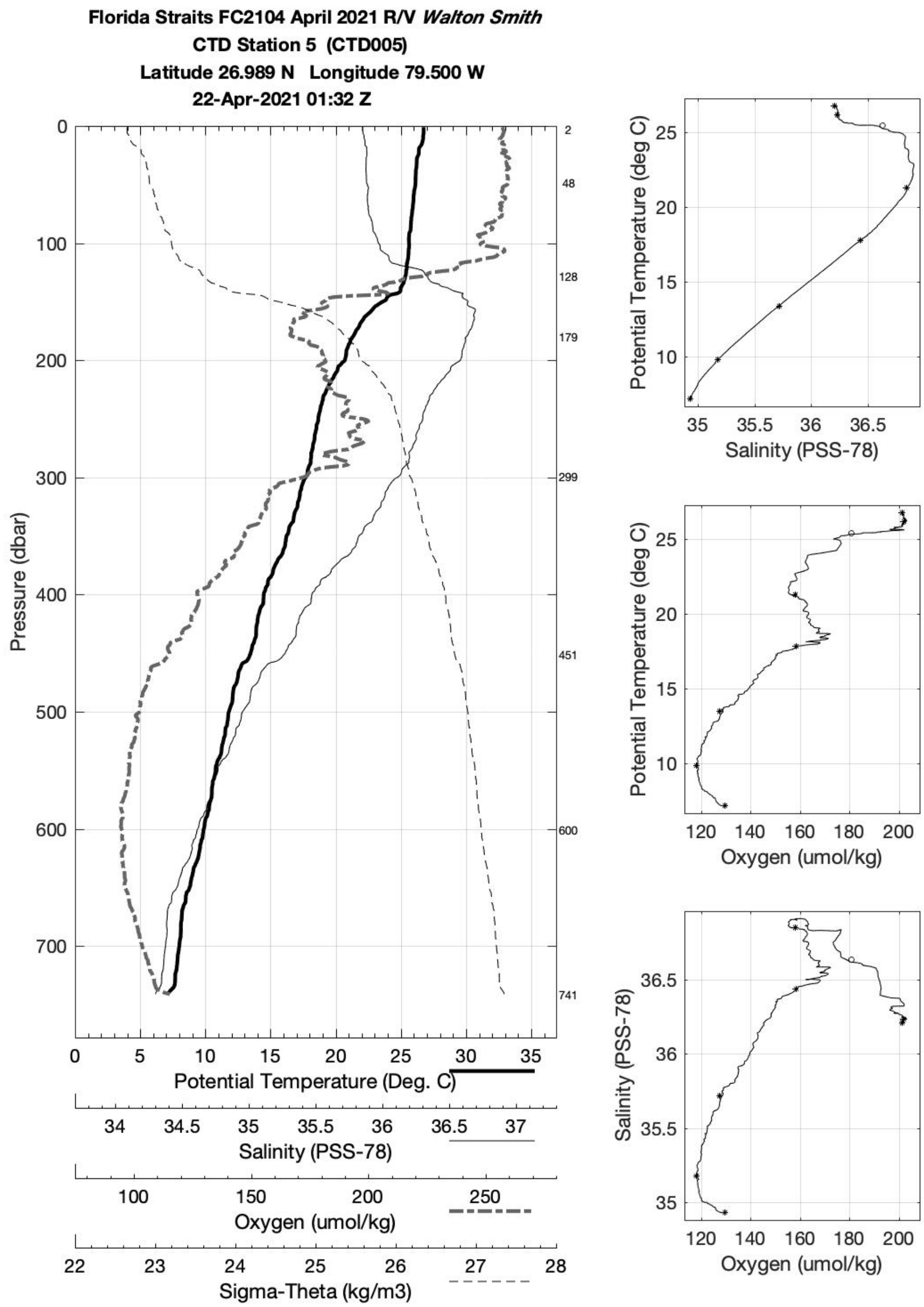
Florida Straits FC2104 April 2021 R/V *Walton Smith*
CTD Station 4 (CTD004)
Latitude 26.995 N Longitude 79.618 W
22-Apr-2021 03:09 Z



Florida Straits FC2104 April 2021 R/V *Walton Smith*
CTD Station 5 (CTD005)
Latitude 26.989N Longitude 79.500W
22-Apr-2021 01:32Z

Pressure dbar	Temp90 °C	PoTemp90 °C	Salinity PSS-78	Oxygen $\mu mol \cdot kg^{-1}$	DynHt $m^2 \cdot s^{-2}$	SigT $kg \cdot m^{-3}$
1	26.731	26.731	36.220	199.1	0.004	23.723
10	26.712	26.710	36.220	199.2	0.042	23.730
20	26.387	26.382	36.236	202.9	0.083	23.846
30	26.226	26.219	36.232	203.8	0.123	23.895
50	26.125	26.114	36.240	204.9	0.203	23.933
75	25.869	25.852	36.248	203.4	0.302	24.022
100	25.645	25.623	36.308	199.2	0.398	24.138
125	25.434	25.407	36.592	188.6	0.492	24.420
150	23.635	23.603	36.859	163.1	0.574	25.168
200	20.739	20.701	36.813	163.3	0.691	25.957
250	18.714	18.670	36.581	171.9	0.786	26.315
300	17.746	17.694	36.421	158.0	0.874	26.437
400	14.541	14.481	35.895	135.2	1.028	26.776
500	11.858	11.792	35.464	122.5	1.158	26.990
600	9.949	9.878	35.189	118.8	1.271	27.120
700	8.073	7.999	34.991	122.7	1.371	27.267

Pressure dbar	Niskin	Temp90 °C	PoTemp90 °C	Salinity PSS-78	Oxygen $\mu mol \cdot kg^{-1}$
741	1	7.213	7.140	34.931	129.7
601	2	9.874	9.803	35.176	118.3
451	3	13.439	13.374	35.716	127.7
300	4	17.828	17.776	36.437	158.5
180	5	21.304	21.269	36.847	158.0
129	6	25.450	25.422	36.633	181.1
48	7	26.133	26.122	36.232	202.1
3	13	26.734	26.733	36.209	201.5

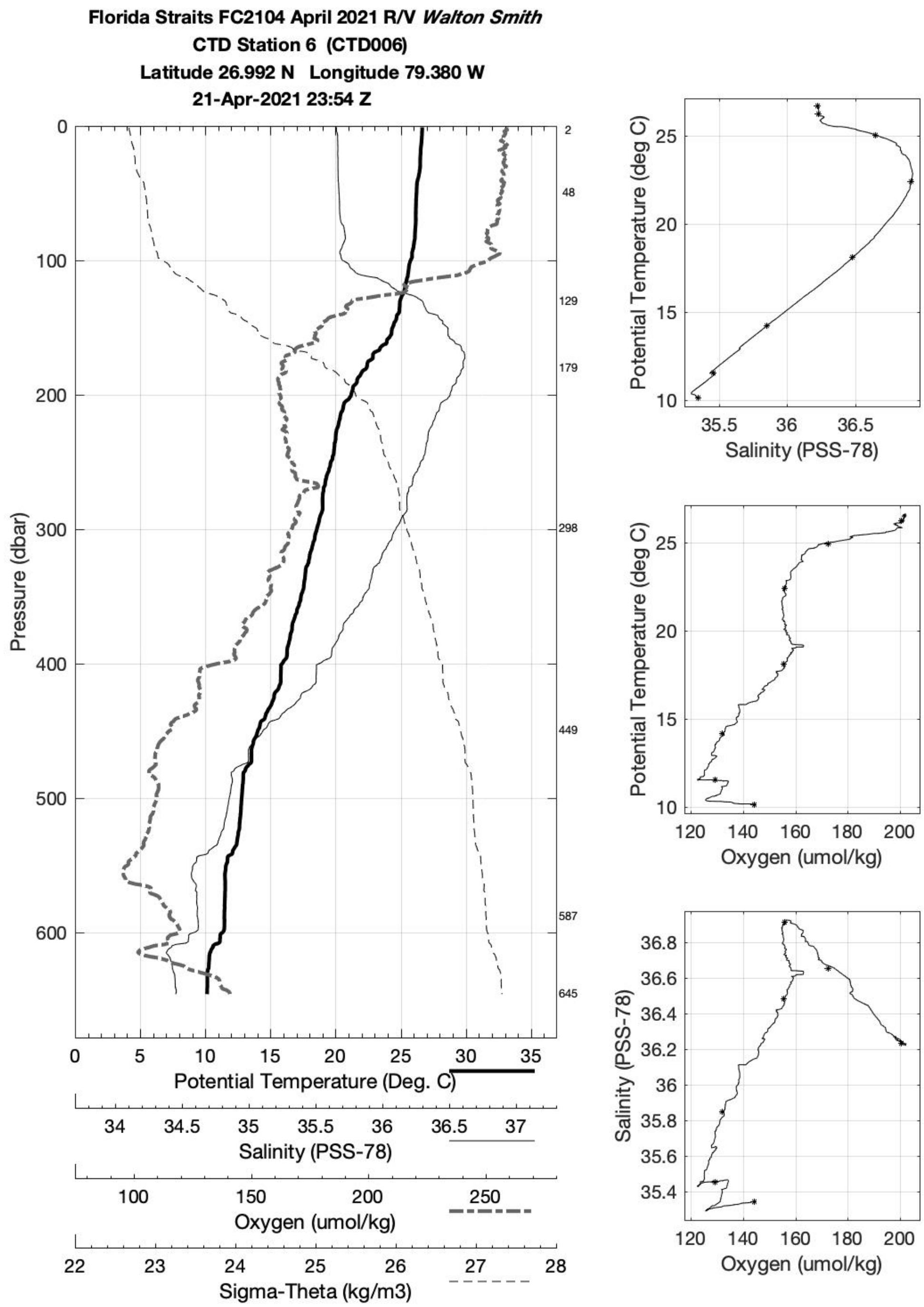


Florida Straits FC2104 April 2021 R/V *Walton Smith*
CTD Station 5 (CTD005)
Latitude 26.989 N Longitude 79.500 W
22-Apr-2021 01:32 Z
Pressure (dbar)
Potential Temperature (Deg. C)
Salinity (PSS-78)
Oxygen (umol/kg)
Sigma-Theta (kg/m3)
2
48
128
179
299
451
600
741
Potential Temperature (deg C)
Salinity (PSS-78)
Potential Temperature (deg C)
Oxygen (umol/kg)
Salinity (PSS-78)
Oxygen (umol/kg)

Florida Straits FC2104 April 2021 R/V *Walton Smith*
CTD Station 6 (CTD006)
Latitude 26.992N Longitude 79.380W
21-Apr-2021 23:54Z

Pressure dbar	Temp90 °C	PoTemp90 °C	Salinity PSS-78	Oxygen μmol·kg^{-1}	DynHt m^2·s^{-2}	SigT kg·m^{-3}
1	26.642	26.642	36.223	198.8	0.004	23.753
10	26.608	26.605	36.229	197.5	0.041	23.770
20	26.529	26.525	36.229	200.6	0.082	23.795
30	26.496	26.490	36.230	203.2	0.123	23.808
50	26.221	26.210	36.236	203.6	0.204	23.900
75	26.147	26.130	36.262	200.8	0.305	23.945
100	25.771	25.749	36.253	201.1	0.404	24.058
125	25.206	25.178	36.605	180.4	0.496	24.500
150	24.402	24.370	36.828	164.3	0.578	24.915
200	21.240	21.201	36.841	155.4	0.708	25.841
250	19.675	19.629	36.680	157.8	0.811	26.142
300	18.623	18.570	36.546	157.1	0.905	26.313
400	15.981	15.917	36.126	141.7	1.072	26.633
500	12.855	12.785	35.634	129.6	1.211	26.927
600	11.444	11.366	35.450	134.5	1.331	27.059

Pressure dbar	Niskin	Temp90 °C	PoTemp90 °C	Salinity PSS-78	Oxygen μmol·kg^{-1}
645	1	10.207	10.130	35.343	144.4
587	2	11.587	11.511	35.453	129.3
449	3	14.258	14.191	35.848	132.0
299	4	18.157	18.105	36.481	155.6
180	5	22.447	22.411	36.912	156.0
130	6	25.072	25.043	36.652	172.5
49	7	26.286	26.275	36.231	200.6
3	13	26.709	26.708	36.221	−999.0


Florida Straits FC2104 April 2021 R/V *Walton Smith*
CTD Station 6 (CTD006)
Latitude 26.992 N Longitude 79.380 W
21-Apr-2021 23:54 Z
Pressure (dbar)
Potential Temperature (Deg. C)
Salinity (PSS-78)
Oxygen (umol/kg)
Sigma-Theta (kg/m3)
Potential Temperature (deg C)
Salinity (PSS-78)
Potential Temperature (deg C)
Oxygen (umol/kg)
Salinity (PSS-78)
Oxygen (umol/kg)

Florida Straits FC2104 April 2021 R/V *Walton Smith*
CTD Station 7 (CTD007)
Latitude 26.999N Longitude 79.282W
21-Apr-2021 22:27Z

Pressure dbar	Temp90 °C	PoTemp90 °C	Salinity PSS-78	Oxygen μmol·kg^{-1}	DynHt m^2·s^{-2}	SigT kg·m^{-3}
1	26.807	26.807	36.229	197.4	0.004	23.705
10	26.712	26.709	36.223	197.4	0.042	23.732
20	26.618	26.614	36.224	199.1	0.083	23.764
30	26.576	26.569	36.225	201.3	0.124	23.778
50	26.372	26.360	36.233	203.8	0.207	23.850
75	26.104	26.087	36.262	200.5	0.307	23.958
100	25.442	25.420	36.449	187.3	0.403	24.308
125	24.796	24.769	36.776	170.2	0.490	24.755
150	23.486	23.454	36.934	196.4	0.564	25.268
200	21.468	21.429	36.868	186.6	0.689	25.798
250	20.148	20.101	36.747	187.2	0.796	26.068
300	19.258	19.203	36.652	183.0	0.895	26.232
400	17.132	17.064	36.322	159.8	1.071	26.514
500	14.332	14.258	35.893	154.1	1.227	26.823
600	11.672	11.593	35.521	145.4	1.345	27.072

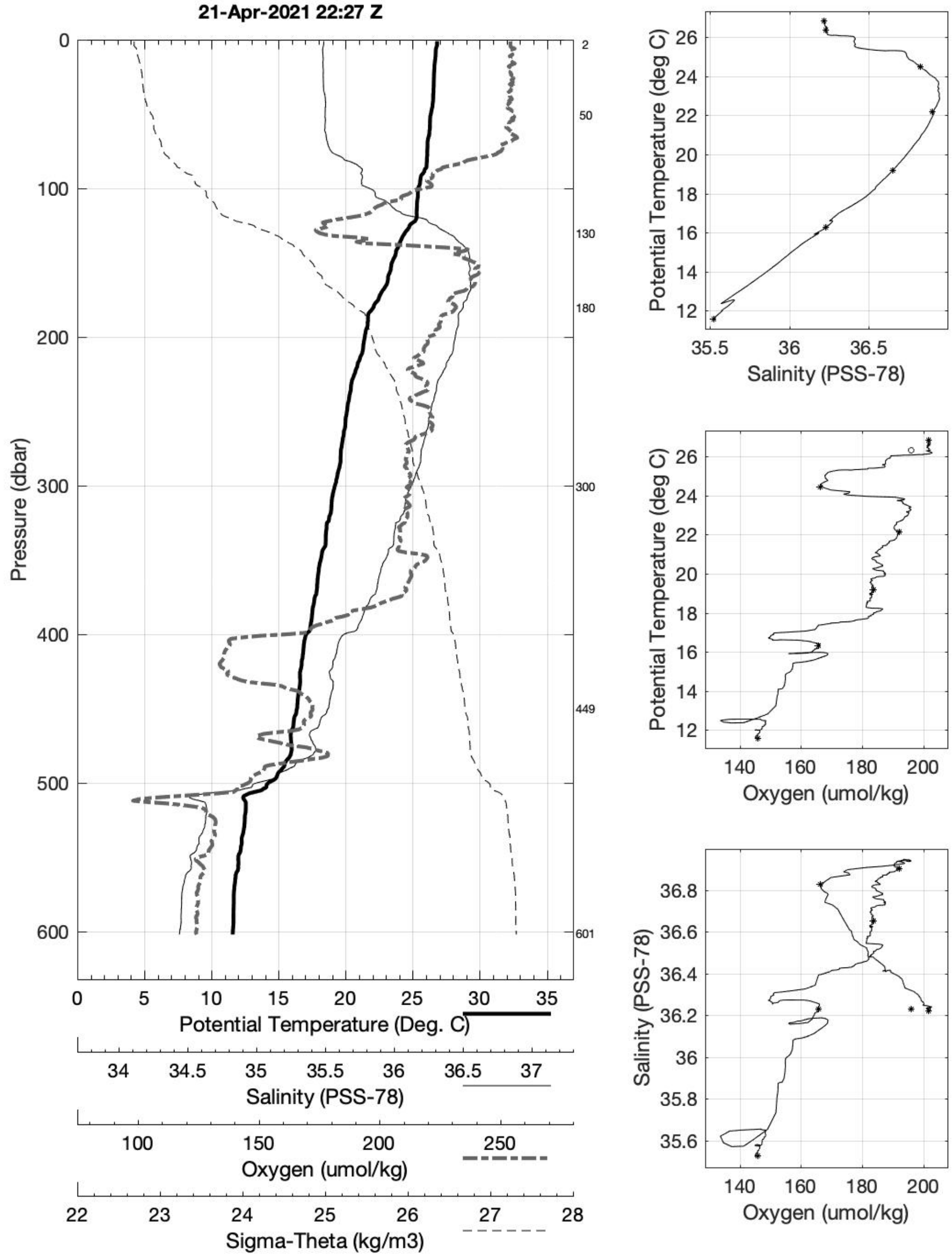
Pressure dbar	Niskin	Temp90 °C	PoTemp90 °C	Salinity PSS-78	Oxygen μmol·kg^{-1}
601	1	11.656	11.578	35.524	146.1
450	2	16.341	16.267	36.230	165.7
301	3	19.240	19.185	36.653	183.6
180	4	22.205	22.169	36.905	192.1
130	5	24.493	24.465	36.827	166.3
50	6	26.358	26.346	36.231	196.0
3	7	26.802	26.802	36.221	201.6

Florida Straits FC2104 April 2021 R/V *Walton Smith*

CTD Station 7 (CTD007)

Latitude 26.999 N Longitude 79.282 W

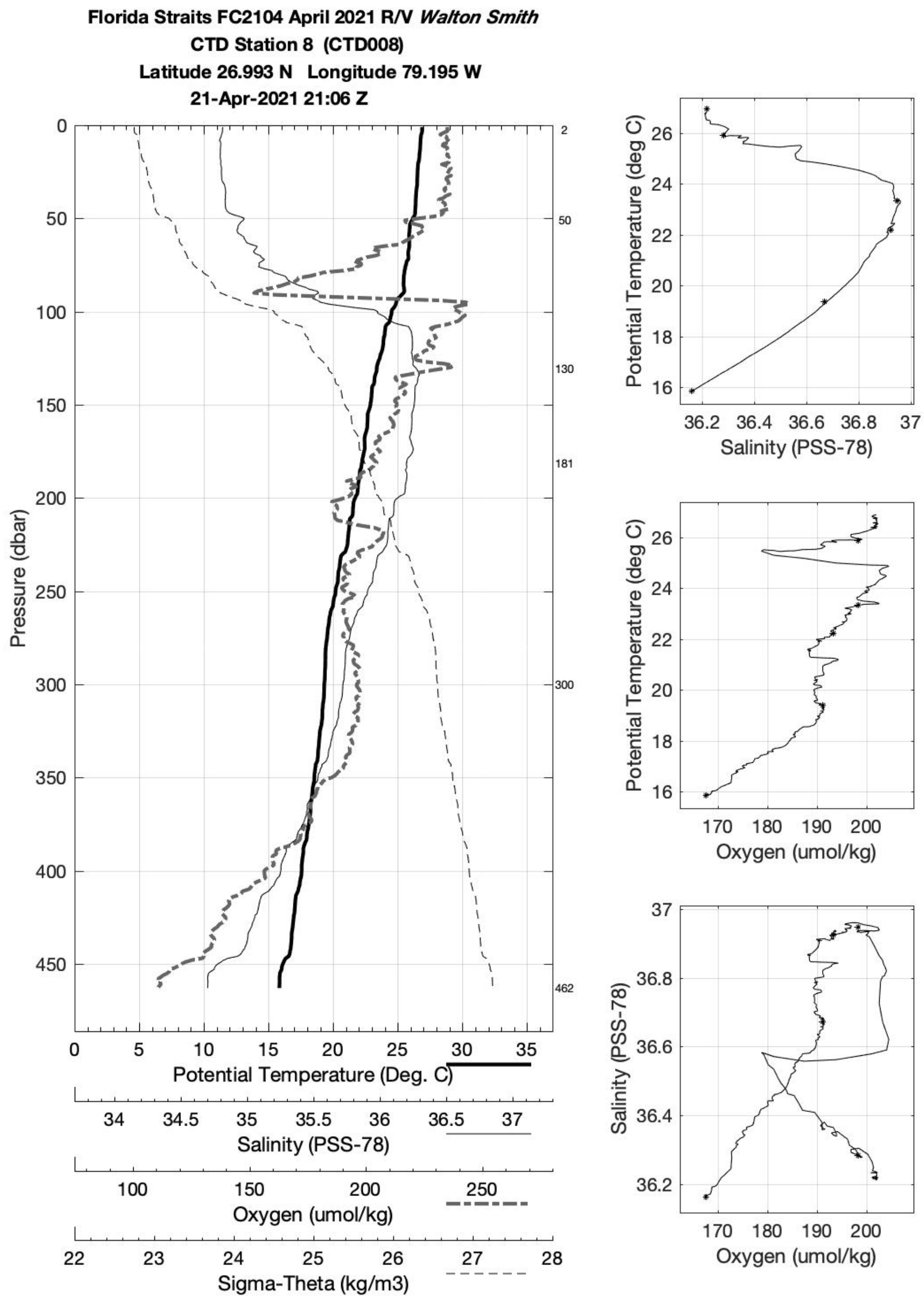
21-Apr-2021 22:27 Z



Florida Straits FC2104 April 2021 R/V *Walton Smith*
CTD Station 8 (CTD008)
Latitude 26.993N Longitude 79.195W
21-Apr-2021 21:06Z

Pressure dbar	Temp90 °C	PoTemp90 °C	Salinity PSS-78	Oxygen μmol·kg^{-1}	DynHt m^2·s^{-2}	SigT kg·m^{-3}
1	26.891	26.891	36.222	191.3	0.004	23.674
10	26.751	26.749	36.214	191.8	0.042	23.713
20	26.590	26.586	36.213	193.8	0.084	23.764
30	26.511	26.504	36.219	198.3	0.125	23.794
50	26.164	26.152	36.301	198.4	0.206	23.967
75	25.652	25.635	36.357	191.9	0.303	24.172
100	24.547	24.526	36.801	203.7	0.391	24.847
125	23.632	23.606	36.931	197.8	0.464	25.221
150	22.910	22.879	36.937	195.4	0.531	25.439
200	21.749	21.710	36.875	189.3	0.654	25.725
250	20.234	20.187	36.762	189.2	0.764	26.057
300	19.373	19.318	36.670	190.4	0.861	26.216
400	17.635	17.566	36.437	180.3	1.042	26.481

Pressure dbar	Niskin	Temp90 °C	PoTemp90 °C	Salinity PSS-78	Oxygen μmol·kg^{-1}
463	1	15.930	15.856	36.161	167.5
300	2	19.420	19.365	36.671	191.1
181	3	22.232	22.196	36.923	193.4
130	4	23.369	23.342	36.948	198.4
51	5	25.909	25.898	36.283	198.4
3	6	26.959	26.958	36.220	−999.0


Florida Straits FC2104 April 2021 R/V Walton Smith
CTD Station 8 (CTD008)
Latitude 26.993 N Longitude 79.195 W
21-Apr-2021 21:06 Z
Pressure (dbar)
Potential Temperature (Deg. C)
Salinity (PSS-78)
Oxygen (umol/kg)
Sigma-Theta (kg/m3)
2
50
130
181
300
462
Potential Temperature (deg C)
Salinity (PSS-78)
Potential Temperature (deg C)
Oxygen (umol/kg)
Salinity (PSS-78)
Oxygen (umol/kg)

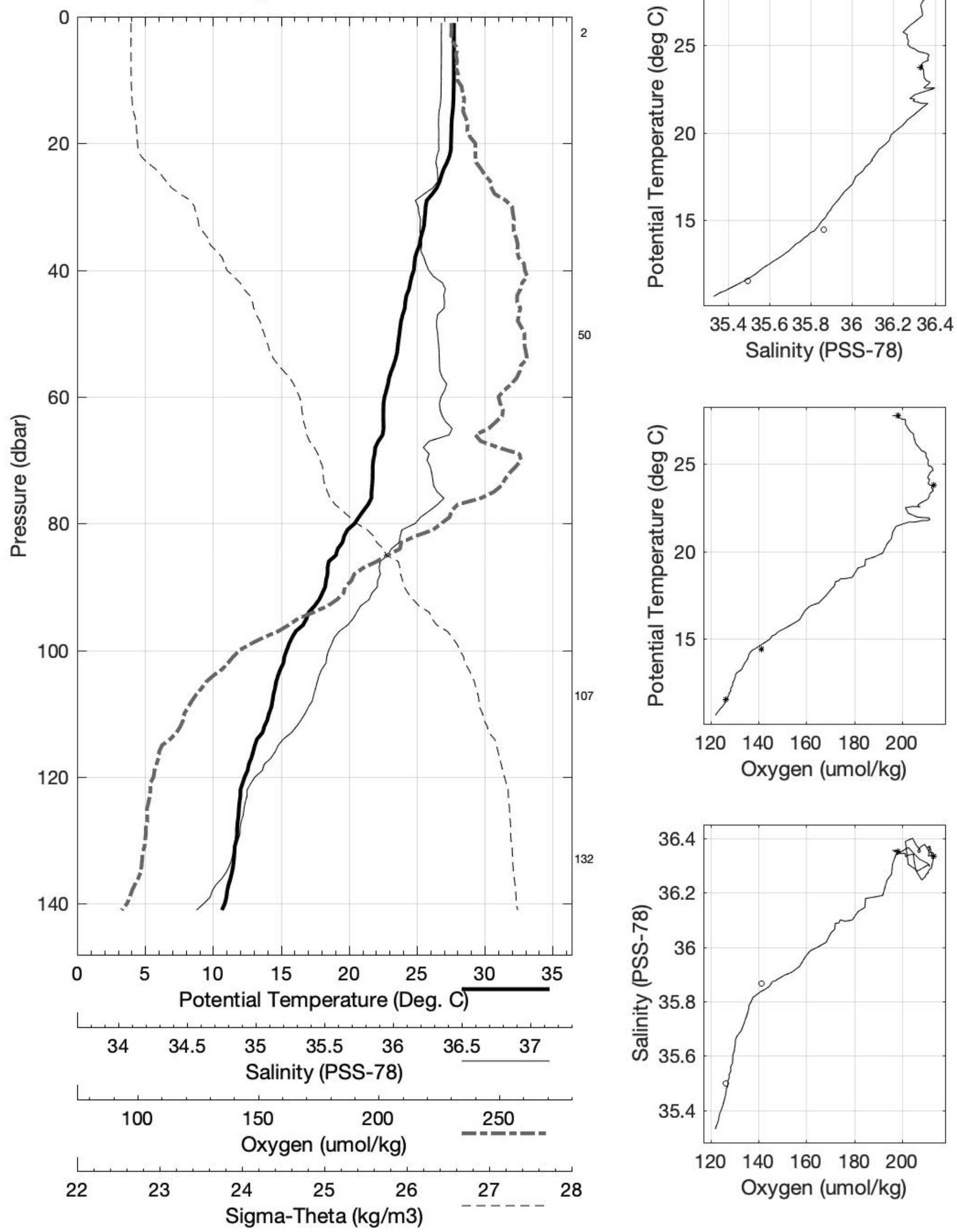
A.2 FC2105 - May 2021

Florida Straits FC2105 May 2021 R/V *Walton Smith*
CTD Station 0 (CTD000)
Latitude 26.996N Longitude 79.932W
12-May-2021 09:12Z

Pressure	Temp90	PoTemp90	Salinity	Oxygen	DynHt	SigT
dbar	°C	°C	PSS-78	$\mu mol \cdot kg^{-1}$	$m^2 \cdot s^{-2}$	$kg \cdot m^{-3}$
1	27.739	27.739	36.356	196.0	0.004	23.500
10	27.735	27.732	36.355	197.4	0.044	23.502
20	27.530	27.526	36.344	201.4	0.087	23.561
30	25.664	25.658	36.258	209.7	0.128	24.090
50	23.740	23.730	36.340	212.5	0.198	24.737
75	21.689	21.674	36.338	205.6	0.271	25.326
100	15.447	15.432	35.884	148.4	0.322	26.558
125	11.925	11.909	35.530	127.6	0.353	27.018

Pressure	Niskin	Temp90	PoTemp90	Salinity	Oxygen
dbar		°C	°C	PSS-78	$\mu mol \cdot kg^{-1}$
133	1	11.547	11.530	35.497	126.3
107	2	14.508	14.492	35.865	141.2
50	3	23.756	23.745	36.335	213.4
2	4	27.749	27.748	36.352	198.2

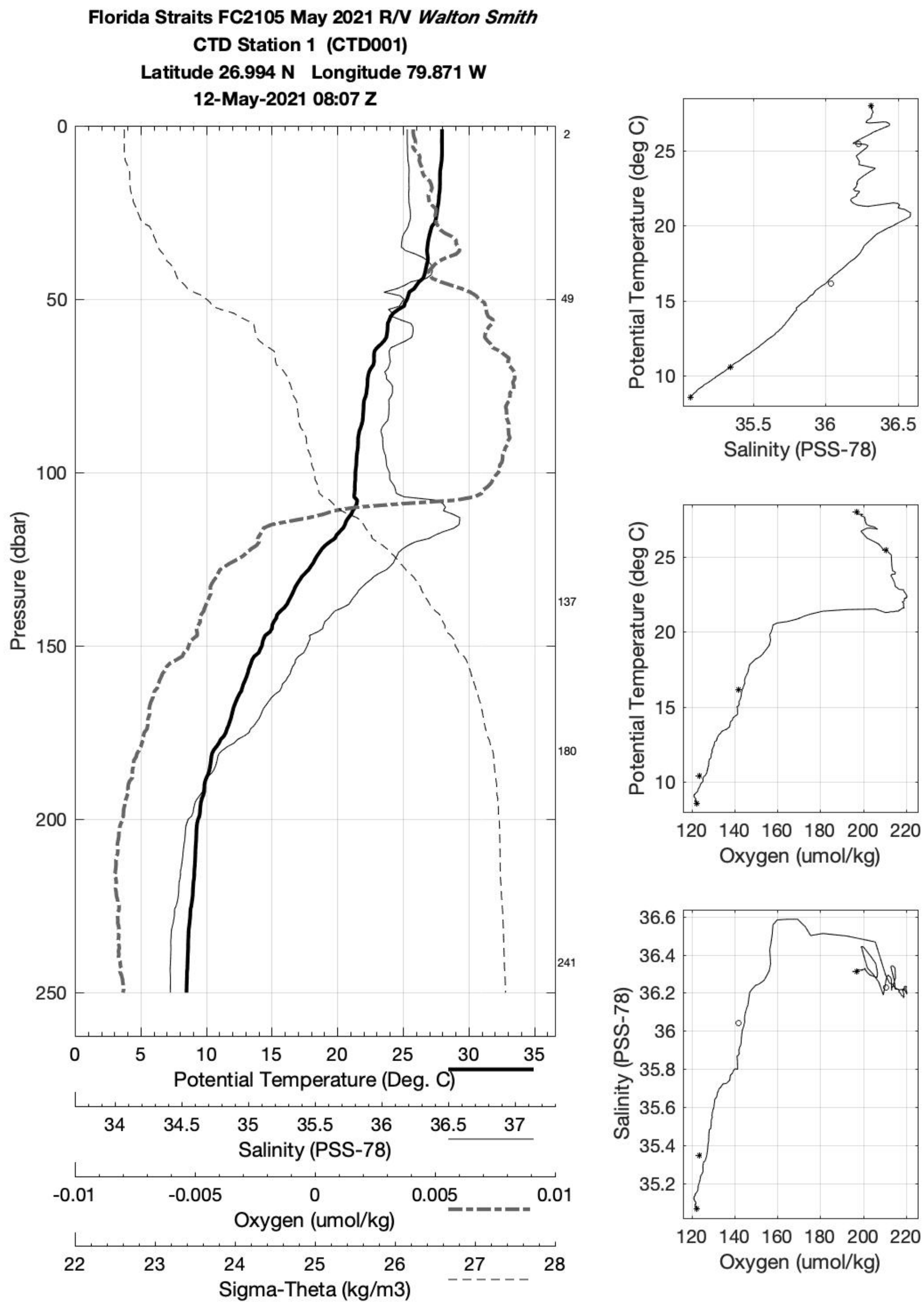
Florida Straits FC2105 May 2021 R/V *Walton Smith*
CTD Station 0 (CTD000)
Latitude 26.996 N Longitude 79.932 W
12-May-2021 09:12 Z



Florida Straits FC2105 May 2021 R/V *Walton Smith*
CTD Station 1 (CTD001)
Latitude 26.994N Longitude 79.871W
12-May-2021 08:07Z

Pressure	Temp90	PoTemp90	Salinity	Oxygen	DynHt	SigT
dbar	°C	°C	PSS-78	μmol·kg^{-1}	m^2·s^{-2}	kg·m^{-3}
1	27.976	27.976	36.311	195.2	0.004	23.389
10	27.955	27.953	36.314	196.6	0.045	23.399
20	27.758	27.754	36.318	198.9	0.089	23.467
30	27.130	27.123	36.307	201.9	0.133	23.663
50	25.333	25.322	36.293	211.5	0.213	24.220
75	22.302	22.287	36.233	220.2	0.293	25.074
100	21.394	21.375	36.218	216.3	0.363	25.318
125	18.328	18.307	36.246	151.5	0.421	26.150
150	14.275	14.253	35.786	139.3	0.461	26.740
200	9.417	9.395	35.161	122.9	0.514	27.180
250	8.530	8.504	35.067	122.9	0.558	27.249

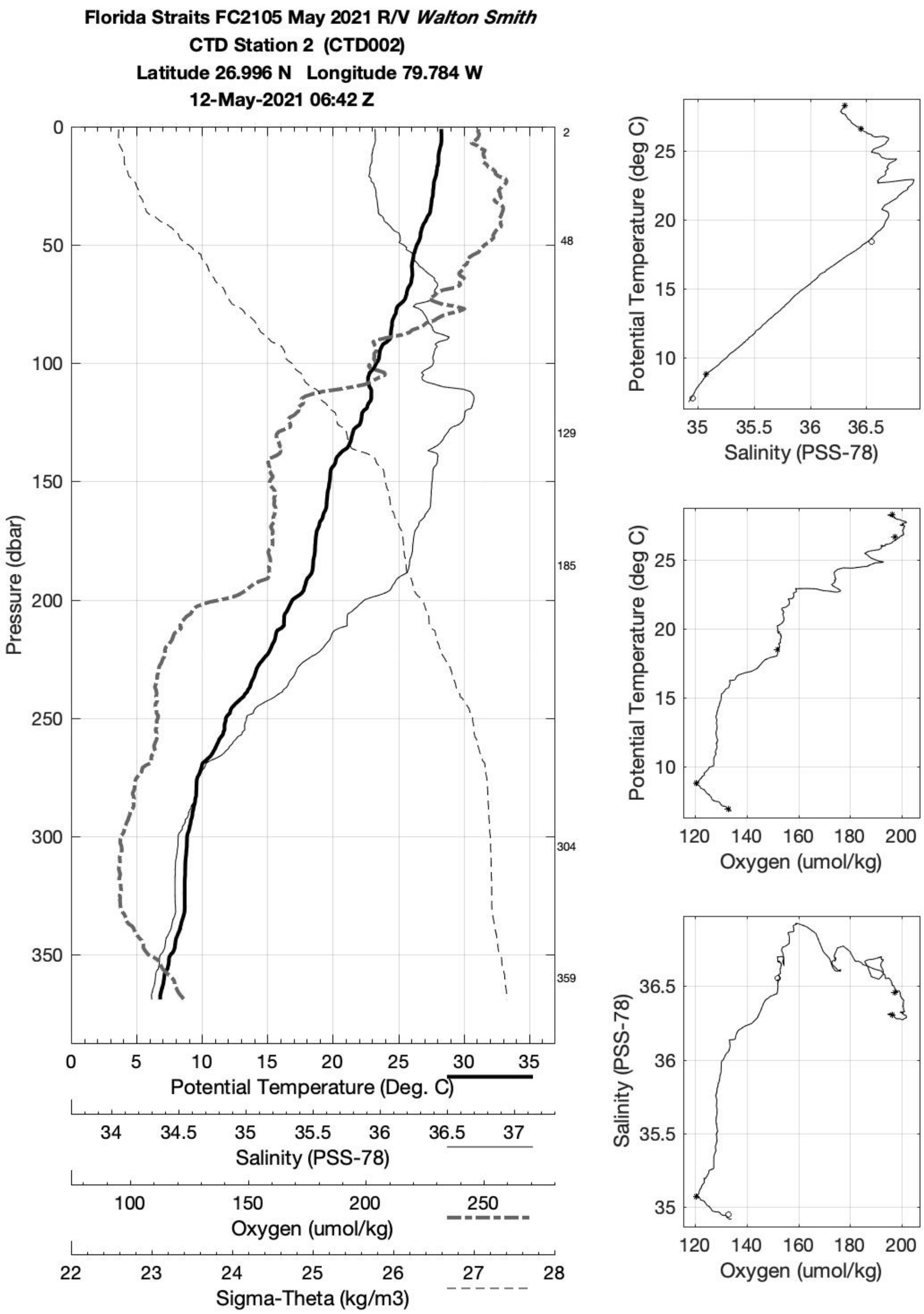
Pressure	Niskin	Temp90	PoTemp90	Salinity	Oxygen
dbar		°C	°C	PSS-78	μmol·kg^{-1}
241	1	8.605	8.579	35.066	122.5
180	2	10.590	10.569	35.344	123.8
137	3	16.158	16.136	36.039	142.0
50	4	25.429	25.418	36.226	210.8
2	5	27.958	27.958	36.312	197.2


Florida Straits FC2105 May 2021 R/V *Walton Smith*
CTD Station 1 (CTD001)
Latitude 26.994 N Longitude 79.871 W
12-May-2021 08:07 Z
Pressure (dbar)
0
50
100
150
200
250
2
49
137
180
241
0 5 10 15 20 25 30 35
Potential Temperature (Deg. C)
34 34.5 35 35.5 36 36.5 37
Salinity (PSS-78)
-0.01 -0.005 0 0.005 0.01
Oxygen (umol/kg)
22 23 24 25 26 27 28
Sigma-Theta (kg/m3)
Potential Temperature (deg C)
Salinity (PSS-78)
35.5 36 36.5
Potential Temperature (deg C)
Oxygen (umol/kg)
120 140 160 180 200 220
Salinity (PSS-78)
Oxygen (umol/kg)
120 140 160 180 200 220

Florida Straits FC2105 May 2021 R/V *Walton Smith*
CTD Station 2 (CTD002)
Latitude 26.996N Longitude 79.784W
12-May-2021 06:42Z

Pressure	Temp90	PoTemp90	Salinity	Oxygen	DynHt	SigT
dbar	°C	°C	PSS-78	μmol·kg^{-1}	m^2·s^{-2}	kg·m^{-3}
1	28.285	28.284	36.310	196.0	0.005	23.287
10	28.149	28.146	36.296	197.3	0.046	23.321
20	27.910	27.906	36.276	199.5	0.091	23.386
30	27.599	27.591	36.319	200.6	0.135	23.520
50	26.427	26.416	36.488	197.2	0.218	24.025
75	25.161	25.145	36.565	188.2	0.310	24.480
100	23.335	23.314	36.673	173.5	0.388	25.111
125	22.142	22.117	36.848	156.3	0.454	25.590
150	19.783	19.755	36.665	152.2	0.509	26.097
200	16.964	16.931	36.247	142.0	0.599	26.488
250	11.856	11.823	35.510	128.7	0.667	27.019
300	8.898	8.865	35.085	120.9	0.717	27.207

Pressure	Niskin	Temp90	PoTemp90	Salinity	Oxygen
dbar		°C	°C	PSS-78	μmol·kg^{-1}
360	1	7.079	7.044	34.951	133.0
304	2	8.827	8.794	35.074	120.4
185	3	18.496	18.463	36.552	152.1
129	4	21.517	21.622	−999.000	−999.0
48	5	26.662	26.651	36.455	197.4
2	6	28.281	28.281	36.307	196.3



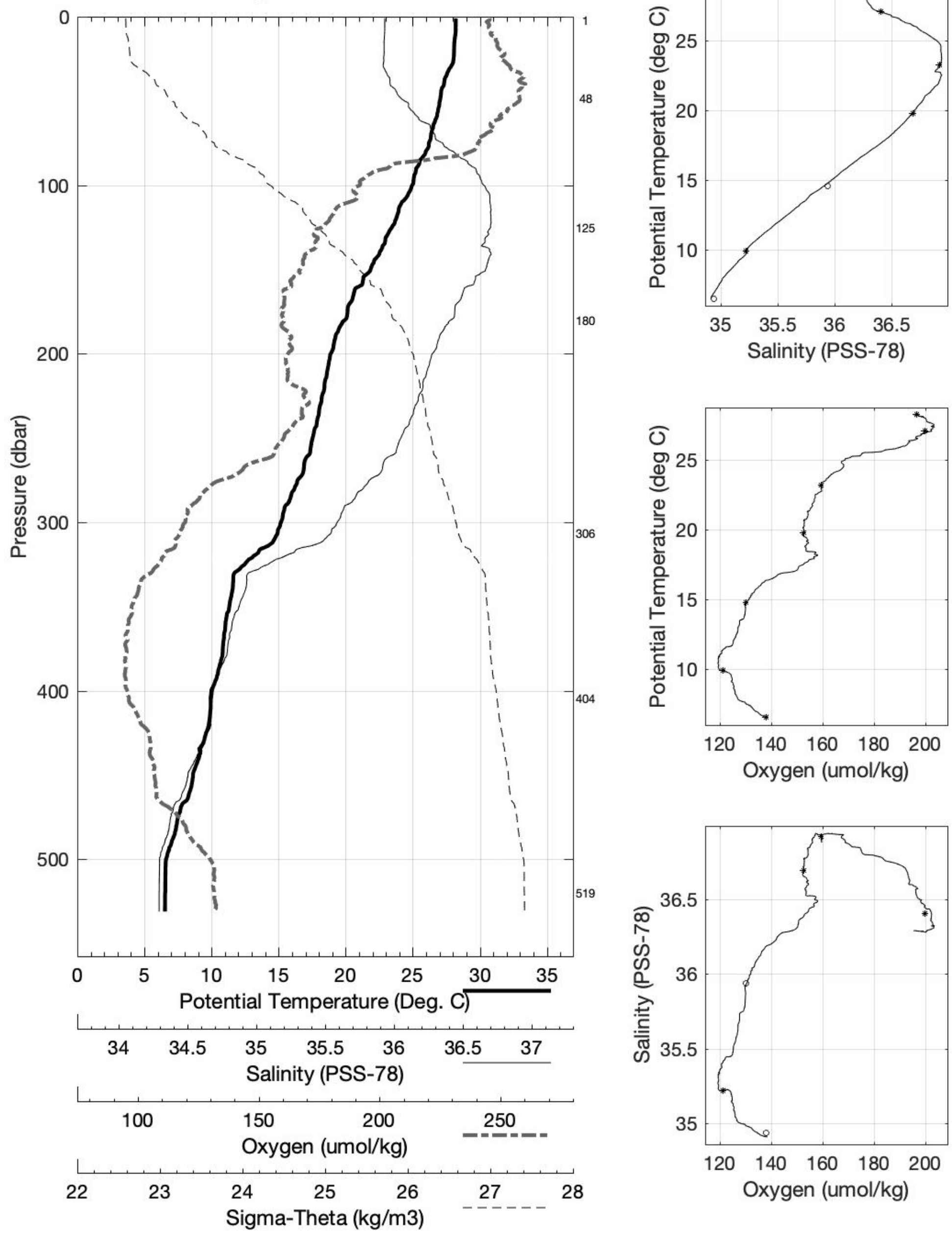
Florida Straits FC2105 May 2021 R/V *Walton Smith*
CTD Station 2 (CTD002)
Latitude 26.996 N Longitude 79.784 W
12-May-2021 06:42 Z
Pressure (dbar)
Potential Temperature (Deg. C)
Salinity (PSS-78)
Oxygen (umol/kg)
Sigma-Theta (kg/m3)
2
48
129
185
304
359
Potential Temperature (deg C)
Salinity (PSS-78)
Oxygen (umol/kg)

Florida Straits FC2105 May 2021 R/V *Walton Smith*
CTD Station 3 (CTD003)
Latitude 26.996N Longitude 79.684W
12-May-2021 05:16Z

Pressure dbar	Temp90 °C	PoTemp90 °C	Salinity PSS-78	Oxygen μmol·kg^{-1}	DynHt m^2·s^{-2}	SigT kg·m^{-3}
1	28.208	28.208	36.291	196.1	0.005	23.297
10	28.187	28.185	36.289	196.2	0.046	23.304
20	28.084	28.079	36.286	198.5	0.091	23.336
30	27.827	27.820	36.283	200.5	0.136	23.419
50	27.023	27.012	36.412	202.4	0.222	23.778
75	26.218	26.201	36.643	193.6	0.320	24.211
100	24.984	24.962	36.896	168.8	0.406	24.787
125	23.471	23.445	36.938	160.8	0.480	25.274
150	21.885	21.855	36.907	156.2	0.543	25.708
200	18.916	18.880	36.581	153.6	0.645	26.261
250	17.581	17.538	36.389	152.7	0.732	26.450
300	15.224	15.178	36.000	132.0	0.809	26.704
400	10.079	10.031	35.222	119.7	0.925	27.120
500	6.658	6.611	34.913	137.2	1.015	27.404

Pressure dbar	Niskin	Temp90 °C	PoTemp90 °C	Salinity PSS-78	Oxygen μmol·kg^{-1}
520	1	6.598	6.550	34.934	138.1
405	2	10.002	9.955	35.222	121.2
307	3	14.662	14.616	35.940	130.0
180	4	19.797	19.764	36.691	152.7
125	5	23.250	23.224	36.920	159.4
48	6	27.035	27.024	36.406	200.0
2	7	28.200	28.200	−999.000	−999.0

Florida Straits FC2105 May 2021 R/V *Walton Smith*
CTD Station 3 (CTD003)
Latitude 26.996 N Longitude 79.684 W
12-May-2021 05:16 Z

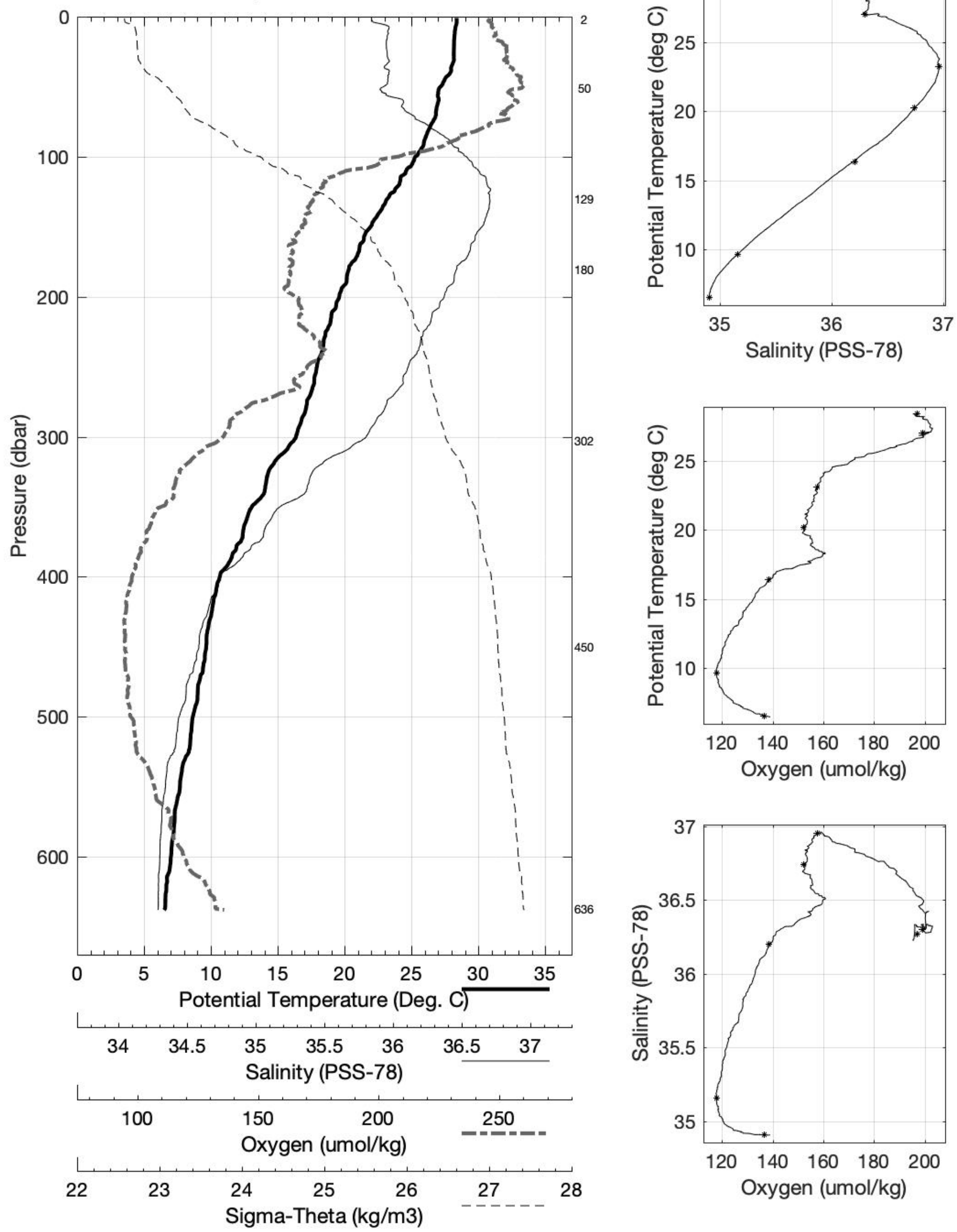


Florida Straits FC2105 May 2021 R/V *Walton Smith*
CTD Station 4 (CTD004)
Latitude 26.993N Longitude 79.618W
12-May-2021 03:58Z

Pressure	Temp90	PoTemp90	Salinity	Oxygen	DynHt	SigT
dbar	°C	°C	PSS-78	μmol·kg^{-1}	m^2·s^{-2}	kg·m^{-3}
1	28.373	28.373	36.227	195.5	0.005	23.194
10	28.243	28.240	36.326	196.5	0.046	23.313
20	28.180	28.175	36.317	198.6	0.092	23.328
30	28.173	28.166	36.329	198.9	0.137	23.339
50	27.184	27.173	36.301	202.6	0.226	23.643
75	26.619	26.601	36.532	196.6	0.328	24.000
100	25.300	25.278	36.812	176.0	0.419	24.626
125	23.731	23.705	36.956	158.8	0.496	25.211
150	21.971	21.941	36.910	155.4	0.559	25.686
200	19.623	19.586	36.675	154.3	0.665	26.149
250	17.970	17.927	36.453	156.7	0.756	26.404
300	16.409	16.360	36.193	138.8	0.837	26.582
400	10.711	10.662	35.294	119.4	0.965	27.065
500	8.705	8.651	35.036	119.2	1.067	27.202
600	7.063	7.005	34.917	130.5	1.156	27.353

Pressure	Niskin	Temp90	PoTemp90	Salinity	Oxygen
dbar		°C	°C	PSS-78	μmol·kg^{-1}
637	1	6.648	6.588	34.910	136.9
450	2	9.692	9.640	35.158	117.9
303	3	16.403	16.353	36.205	138.6
180	4	20.260	20.226	36.741	152.4
130	5	23.221	23.194	36.956	157.5
51	6	26.986	26.974	36.300	199.0
2	7	28.366	28.365	36.269	196.8

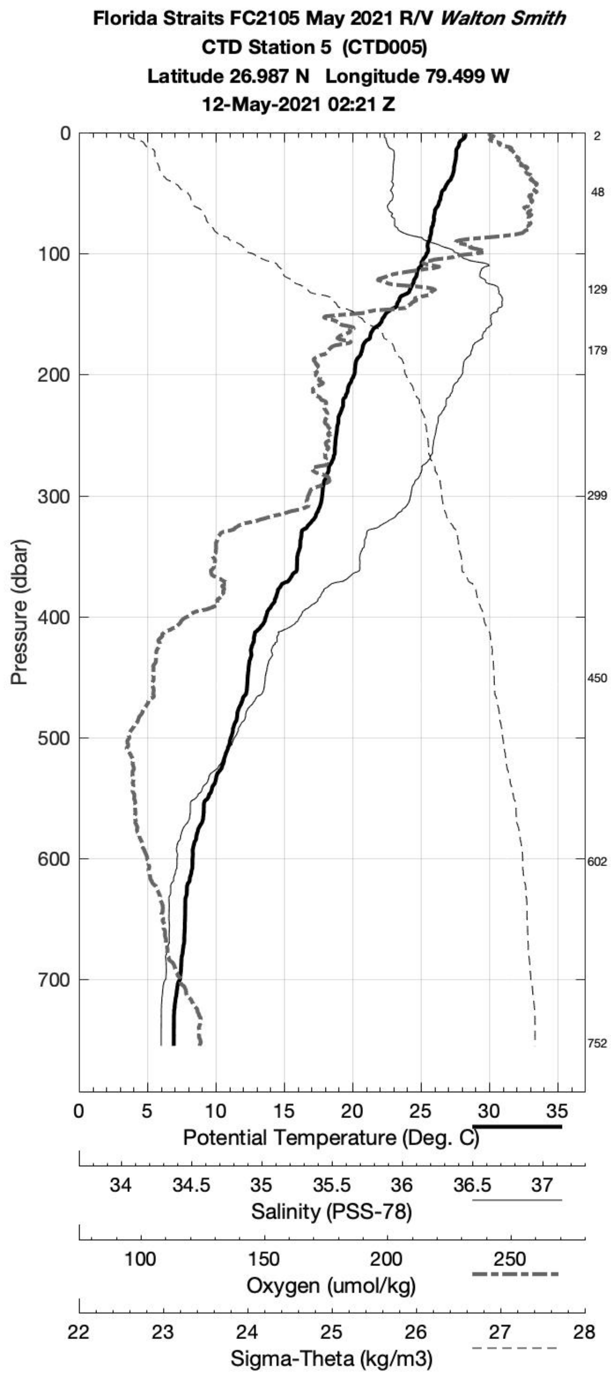
Florida Straits FC2105 May 2021 R/V *Walton Smith*
CTD Station 4 (CTD004)
Latitude 26.993 N Longitude 79.618 W
12-May-2021 03:58 Z



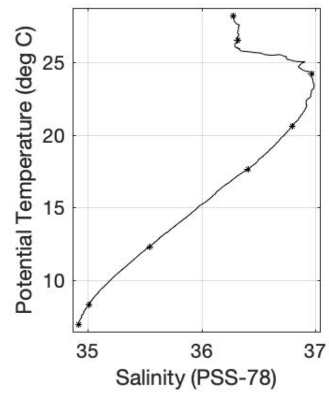
Florida Straits FC2105 May 2021 R/V *Walton Smith*
CTD Station 5 (CTD005)
Latitude 26.987N Longitude 79.499W
12-May-2021 02:21Z

Pressure	Temp90	PoTemp90	Salinity	Oxygen	DynHt	SigT
dbar	°C	°C	PSS-78	μmol·kg^{-1}	m^2·s^{-2}	kg·m^{-3}
1	28.259	28.258	36.272	193.2	0.005	23.267
10	27.802	27.799	36.292	195.2	0.045	23.432
20	27.588	27.583	36.332	198.8	0.089	23.533
30	27.438	27.431	36.326	200.9	0.132	23.578
50	26.541	26.530	36.320	202.5	0.216	23.862
75	25.925	25.908	36.335	201.8	0.315	24.070
100	25.453	25.431	36.725	190.4	0.407	24.513
125	24.452	24.425	36.906	172.0	0.488	24.958
150	22.468	22.437	36.926	164.3	0.556	25.558
200	20.177	20.139	36.744	156.7	0.666	26.056
250	18.868	18.823	36.581	159.2	0.761	26.276
300	17.845	17.793	36.433	155.1	0.850	26.421
400	13.748	13.690	35.760	129.8	1.002	26.840
500	11.181	11.118	35.362	117.5	1.124	27.036
600	8.373	8.309	35.013	121.2	1.228	27.237
700	7.455	7.385	34.944	128.4	1.318	27.320

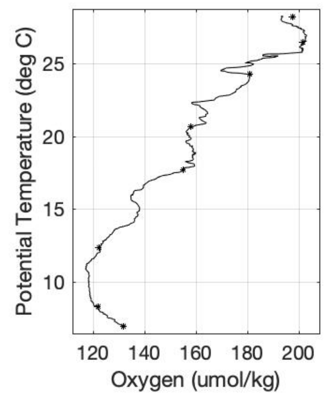
Pressure	Niskin	Temp90	PoTemp90	Salinity	Oxygen
dbar		°C	°C	PSS-78	μmol·kg^{-1}
752	1	7.020	6.947	34.918	131.8
602	2	8.331	8.267	35.011	121.8
450	3	12.363	12.302	35.541	122.2
300	4	17.715	17.663	36.408	155.1
180	5	20.630	20.595	36.795	158.0
129	6	24.264	24.236	36.966	181.0
49	7	26.544	26.533	36.318	201.7
2	13	28.195	28.195	36.278	197.8



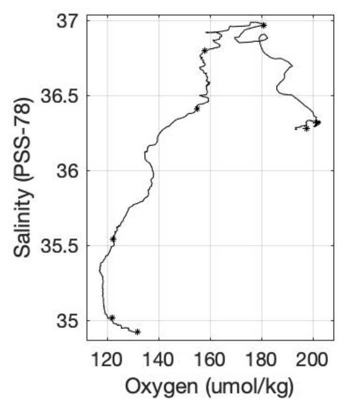
Florida Straits FC2105 May 2021 R/V *Walton Smith*
CTD Station 5 (CTD005)
Latitude 26.987 N Longitude 79.499 W
12-May-2021 02:21 Z
Pressure (dbar)
Potential Temperature (Deg. C)
Salinity (PSS-78)
Oxygen (umol/kg)
Sigma-Theta (kg/m3)



Potential Temperature (deg C)
Salinity (PSS-78)



Potential Temperature (deg C)
Oxygen (umol/kg)

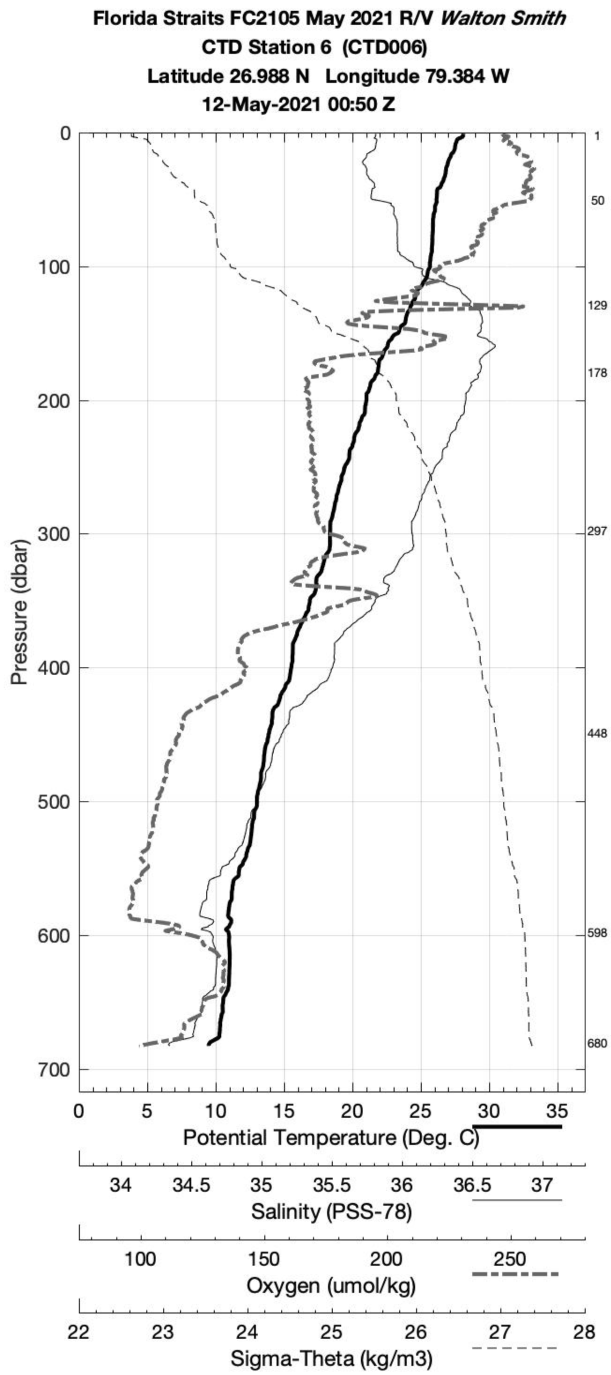


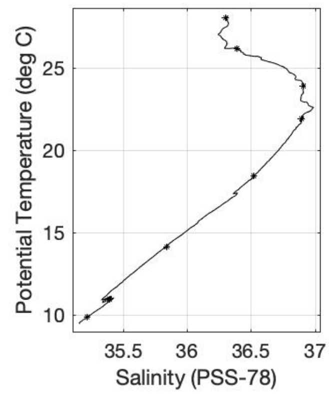
Salinity (PSS-78)
Oxygen (umol/kg)

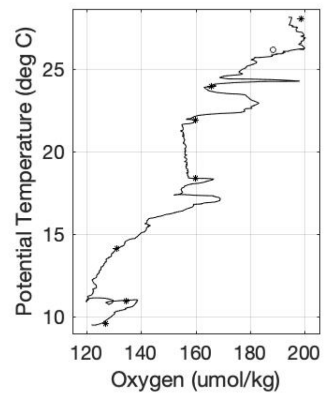
Florida Straits FC2105 May 2021 R/V *Walton Smith*
CTD Station 6 (CTD006)
Latitude 26.988N Longitude 79.384W
12-May-2021 00:50Z

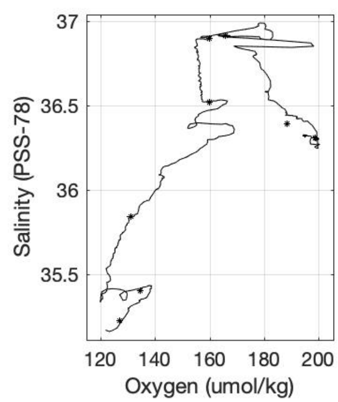
Pressure	Temp90	PoTemp90	Salinity	Oxygen	DynHt	SigT
dbar	°C	°C	PSS-78	μmol·kg^{-1}	m^2·s^{-2}	kg·m^{-3}
1	28.097	28.097	36.318	194.3	0.005	23.354
10	27.523	27.521	36.318	195.8	0.044	23.543
20	27.081	27.076	36.256	199.8	0.087	23.640
30	26.826	26.820	36.267	200.1	0.129	23.730
50	26.159	26.148	36.298	199.6	0.210	23.967
75	25.890	25.874	36.438	189.9	0.305	24.159
100	25.692	25.669	36.532	181.6	0.399	24.293
125	24.569	24.542	36.840	170.5	0.484	24.872
150	23.376	23.345	36.894	178.7	0.557	25.271
200	21.070	21.031	36.822	155.5	0.675	25.873
250	19.489	19.443	36.651	156.4	0.779	26.169
300	18.413	18.360	36.522	159.4	0.871	26.348
400	15.599	15.536	36.077	143.2	1.034	26.682
500	13.091	13.021	35.655	125.4	1.170	26.896
600	11.047	10.971	35.404	131.8	1.291	27.095

Pressure	Niskin	Temp90	PoTemp90	Salinity	Oxygen
dbar		°C	°C	PSS-78	μmol·kg^{-1}
681	1	9.949	9.868	35.222	126.9
598	2	11.036	10.960	35.400	134.5
449	3	14.206	14.139	35.842	131.0
298	4	18.501	18.448	36.518	160.0
179	5	21.909	21.873	36.896	160.0
129	6	23.892	23.864	36.911	165.7
50	7	26.157	26.146	36.388	188.6
2	13	27.978	27.978	36.305	198.7


Florida Straits FC2105 May 2021 R/V *Walton Smith*
CTD Station 6 (CTD006)
Latitude 26.988 N Longitude 79.384 W
12-May-2021 00:50 Z
Pressure (dbar)
Potential Temperature (Deg. C)
Salinity (PSS-78)
Oxygen (umol/kg)
Sigma-Theta (kg/m3)


Potential Temperature (deg C)
Salinity (PSS-78)


Potential Temperature (deg C)
Oxygen (umol/kg)

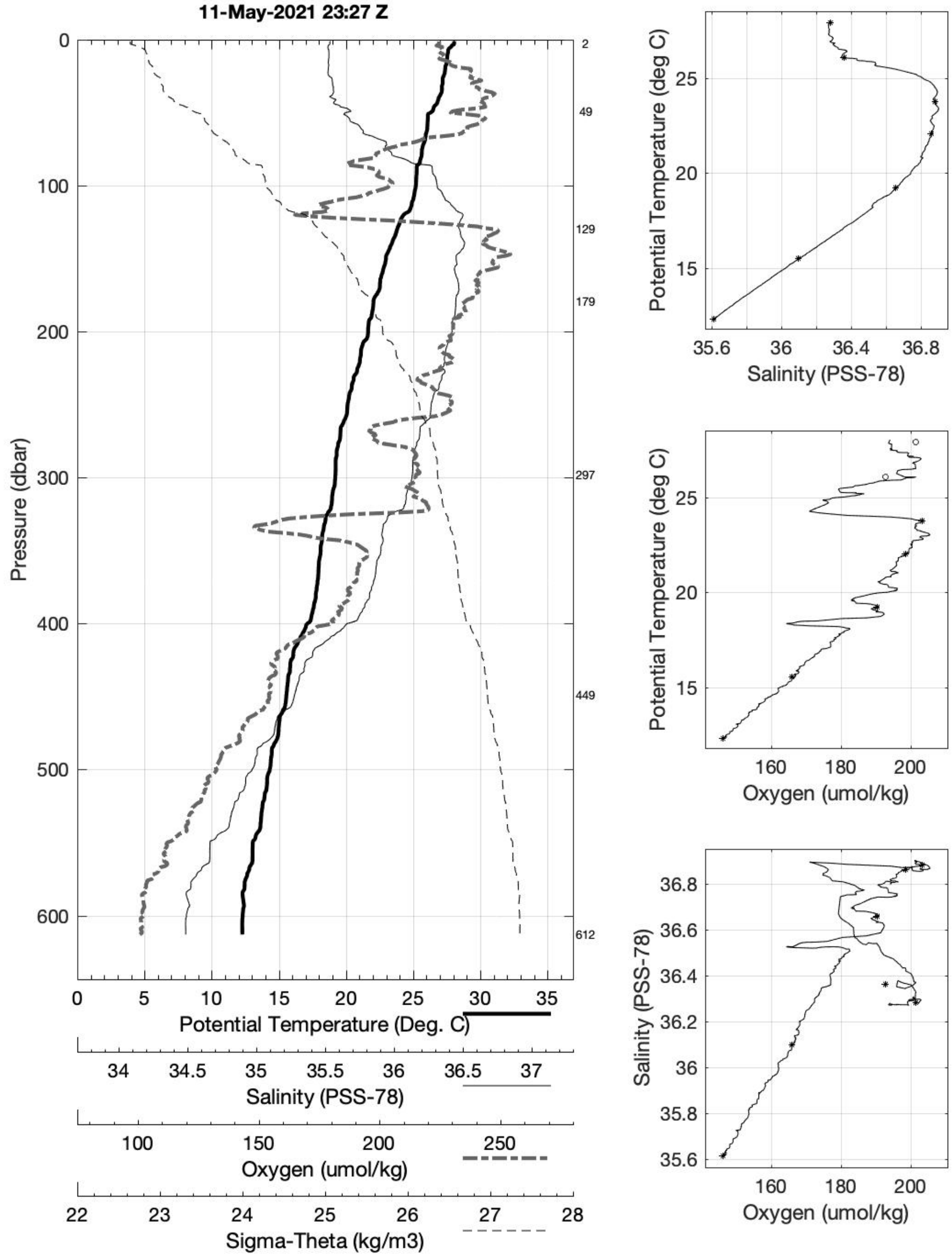

Salinity (PSS-78)
Oxygen (umol/kg)

Florida Straits FC2105 May 2021 R/V *Walton Smith*
CTD Station 7 (CTD007)
Latitude 26.999N Longitude 79.283W
11-May-2021 23:27Z

Pressure dbar	Temp90 °C	PoTemp90 °C	Salinity PSS-78	Oxygen $\mu mol \cdot kg^{-1}$	DynHt $m^2 \cdot s^{-2}$	SigT $kg \cdot m^{-3}$
1	28.058	28.058	36.280	194.1	0.005	23.338
10	27.570	27.568	36.275	194.8	0.045	23.495
20	27.396	27.392	36.272	199.2	0.088	23.550
30	27.209	27.202	36.292	199.3	0.131	23.627
50	26.297	26.286	36.351	195.9	0.214	23.963
75	25.678	25.662	36.547	185.5	0.309	24.307
100	25.226	25.204	36.775	186.1	0.396	24.620
125	24.043	24.016	36.879	190.7	0.475	25.060
150	23.008	22.977	36.862	203.1	0.545	25.353
200	21.691	21.651	36.843	196.3	0.670	25.717
250	20.166	20.119	36.747	195.9	0.779	26.063
300	19.258	19.204	36.658	190.3	0.876	26.237
400	17.192	17.124	36.358	177.1	1.053	26.527
500	14.394	14.319	35.920	158.5	1.200	26.830
600	12.389	12.307	35.617	146.9	1.328	27.009

Pressure dbar	Niskin	Temp90 °C	PoTemp90 °C	Salinity PSS-78	Oxygen $\mu mol \cdot kg^{-1}$
613	1	12.376	12.292	35.612	146.4
449	2	15.578	15.507	36.099	165.9
298	3	19.278	19.224	36.656	190.4
179	4	22.136	22.100	36.860	198.7
129	5	23.833	23.806	36.881	203.2
49	6	26.142	26.131	36.363	192.9
2	7	27.974	27.974	36.279	201.6

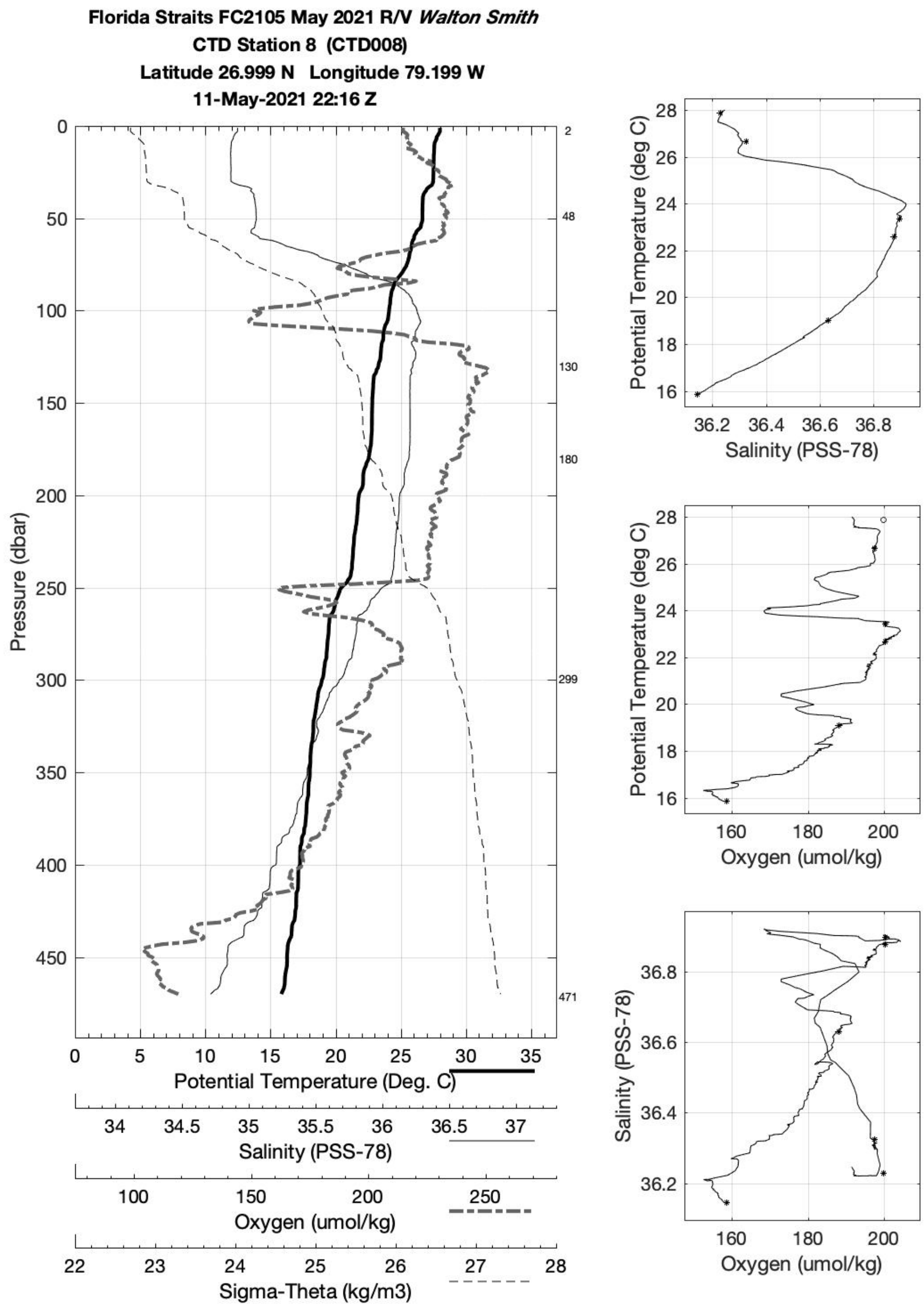
Florida Straits FC2105 May 2021 R/V *Walton Smith*
CTD Station 7 (CTD007)
Latitude 26.999 N Longitude 79.283 W
11-May-2021 23:27 Z



Florida Straits FC2105 May 2021 R/V *Walton Smith*
CTD Station 8 (CTD008)
Latitude 26.999N Longitude 79.199W
11-May-2021 22:16Z

Pressure dbar	Temp90 °C	PoTemp90 °C	Salinity PSS-78	Oxygen μmol·kg^{-1}	DynHt m^2·s^{-2}	SigT kg·m^{-3}
1	28.003	28.003	36.246	191.5	0.005	23.331
10	27.579	27.577	36.223	192.7	0.045	23.453
20	27.528	27.524	36.221	195.0	0.089	23.469
30	27.496	27.489	36.222	198.0	0.133	23.481
50	26.673	26.662	36.315	197.9	0.216	23.816
75	25.471	25.455	36.643	183.2	0.312	24.443
100	24.125	24.103	36.908	169.2	0.390	25.056
125	23.471	23.445	36.903	200.5	0.461	25.247
150	22.846	22.815	36.882	201.5	0.528	25.416
200	21.822	21.782	36.845	196.5	0.655	25.682
250	20.482	20.434	36.779	173.0	0.770	26.003
300	18.996	18.942	36.620	186.8	0.867	26.275
400	17.329	17.261	36.387	176.3	1.040	26.516

Pressure dbar	Niskin	Temp90 °C	PoTemp90 °C	Salinity PSS-78	Oxygen μmol·kg^{-1}
471	1	15.907	15.831	36.145	158.7
299	2	19.081	19.027	36.631	188.2
180	3	22.641	22.604	36.878	200.3
130	4	23.370	23.343	36.896	200.4
49	5	26.676	26.665	36.325	197.6
2	6	27.875	27.875	36.229	199.7


Florida Straits FC2105 May 2021 R/V *Walton Smith*
CTD Station 8 (CTD008)
Latitude 26.999 N Longitude 79.199 W
11-May-2021 22:16 Z
Pressure (dbar)
Potential Temperature (Deg. C)
Salinity (PSS-78)
Oxygen (umol/kg)
Sigma-Theta (kg/m3)
Potential Temperature (deg C)
Salinity (PSS-78)
Potential Temperature (deg C)
Oxygen (umol/kg)
Salinity (PSS-78)
Oxygen (umol/kg)

B WOCE Summary File

B.1 FC2104 - April 2021

Table 12: FC2104 – WOCE Summary File

SHIP/CRS EXPOCODE	WOCE SECT	STN	CAST	CAST TYPE	CAST DATE	UTC TIME	EVENT CODE	LAT	LON	NAV	UNC DPH	HT ABV BTM	MAX PRS	NO. BTLS	PARA-METERS
FCTSWS	FC2104	0	1	ROS	04/22/2021	09:24:18	BE	26.993N	79.930W	GPS					
FCTSWS	FC2104	0	1	ROS	04/22/2021	09:29:18	BO	26.995N	79.928W	GPS	135	23	137	4	1,2
FCTSWS	FC2104	0	1	ROS	04/22/2021	09:36:11	EN	26.998N	79.925W	GPS					
FCTSWS	FC2104	1	1	ROS	04/22/2021	07:48:25	BE	26.997N	79.862W	GPS					
FCTSWS	FC2104	1	1	ROS	04/22/2021	07:55:01	BO	27.001N	79.859W	GPS	243	36	262	5	1,2
FCTSWS	FC2104	1	1	ROS	04/22/2021	08:07:12	EN	27.012N	79.855W	GPS					
FCTSWS	FC2104	2	1	ROS	04/22/2021	06:12:19	BE	26.989N	79.784W	GPS					
FCTSWS	FC2104	2	1	ROS	04/22/2021	06:22:15	BO	26.998N	79.781W	GPS	361	30	372	6	1,2
FCTSWS	FC2104	2	1	ROS	04/22/2021	06:38:10	EN	27.012N	79.778W	GPS					
FCTSWS	FC2104	3	1	ROS	04/22/2021	04:28:49	BE	26.996N	79.684W	GPS					
FCTSWS	FC2104	3	1	ROS	04/22/2021	04:40:02	BO	27.005N	79.683W	GPS	511	26	522	7	1,2
FCTSWS	FC2104	3	1	ROS	04/22/2021	04:58:53	EN	27.021N	79.680W	GPS					
FCTSWS	FC2104	4	1	ROS	04/22/2021	03:10:02	BE	26.990N	79.618W	GPS					
FCTSWS	FC2104	4	1	ROS	04/22/2021	03:23:18	BO	26.999N	79.618W	GPS	621	21	630	7	1,2
FCTSWS	FC2104	4	1	ROS	04/22/2021	03:43:28	EN	27.014N	79.616W	GPS					
FCTSWS	FC2104	5	1	ROS	04/22/2021	01:33:00	BE	26.984N	79.500W	GPS					
FCTSWS	FC2104	5	1	ROS	04/22/2021	01:49:01	BO	26.993N	79.499W	GPS	735	18	741	8	1,2
FCTSWS	FC2104	5	1	ROS	04/22/2021	02:12:03	EN	27.005N	79.500W	GPS					
FCTSWS	FC2104	6	1	ROS	04/21/2021	23:54:18	BE	26.989N	79.380W	GPS					
FCTSWS	FC2104	6	1	ROS	04/22/2021	00:11:02	BO	26.994N	79.380W	GPS	640	23	646	8	1,2
FCTSWS	FC2104	6	1	ROS	04/22/2021	00:31:21	EN	27.001N	79.379W	GPS					
FCTSWS	FC2104	7	1	ROS	04/21/2021	22:27:23	BE	26.998N	79.282W	GPS					
FCTSWS	FC2104	7	1	ROS	04/21/2021	22:41:40	BO	27.000N	79.282W	GPS	597	19	602	7	1,2
FCTSWS	FC2104	7	1	ROS	04/21/2021	23:01:10	EN	27.003N	79.283W	GPS					
FCTSWS	FC2104	8	1	ROS	04/21/2021	21:06:34	BE	26.994N	79.196W	GPS					
FCTSWS	FC2104	8	1	ROS	04/21/2021	21:18:39	BO	26.993N	79.195W	GPS	459	19	463	6	1,2
FCTSWS	FC2104	8	1	ROS	04/21/2021	21:37:32	EN	26.994N	79.195W	GPS					

Note:Parameter 1 - salinity sampled, Parameter 2 - oxygen sampled

B.2 FC2105 - May 2021

Table 13: FC2105 – WOCE Summary File

SHIP/CRS EXPOCODE	WOCE SECT	STN	CAST	CAST TYPE	CAST DATE	UTC TIME	EVENT CODE	LAT	LON	NAV	UNC DPH	HT ABV BTM	MAX PRS	NO. BTLS	PARA-METERS
FCTSWS	FC2105	0	1	ROS	05/12/2021	09:12:27	BE	26.993N	79.932W	GPS					
FCTSWS	FC2105	0	1	ROS	05/12/2021	09:17:00	BO	26.997N	79.933W	GPS	132	19	141	4	1,2
FCTSWS	FC2105	0	1	ROS	05/12/2021	09:25:55	EN	27.005N	79.934W	GPS					
FCTSWS	FC2105	1	1	ROS	05/12/2021	08:07:22	BE	26.989N	79.870W	GPS					
FCTSWS	FC2105	1	1	ROS	05/12/2021	08:14:22	BO	26.997N	79.871W	GPS	239	18	250	5	1,2
FCTSWS	FC2105	1	1	ROS	05/12/2021	08:27:10	EN	27.008N	79.873W	GPS					
FCTSWS	FC2105	2	1	ROS	05/12/2021	06:43:03	BE	26.990N	79.784W	GPS					
FCTSWS	FC2105	2	1	ROS	05/12/2021	06:52:37	BO	27.000N	79.785W	GPS	357	30	369	6	1,2
FCTSWS	FC2105	2	1	ROS	05/12/2021	07:06:59	EN	27.012N	79.785W	GPS					
FCTSWS	FC2105	3	1	ROS	05/12/2021	05:16:40	BE	26.990N	79.684W	GPS					
FCTSWS	FC2105	3	1	ROS	05/12/2021	05:27:53	BO	27.000N	79.684W	GPS	516	21	531	7	1,2
FCTSWS	FC2105	3	1	ROS	05/12/2021	05:46:05	EN	27.015N	79.685W	GPS					
FCTSWS	FC2105	4	1	ROS	05/12/2021	03:58:35	BE	26.986N	79.618W	GPS					
FCTSWS	FC2105	4	1	ROS	05/12/2021	04:12:26	BO	26.997N	79.618W	GPS	632	9	638	7	1,2
FCTSWS	FC2105	4	1	ROS	05/12/2021	04:32:59	EN	27.013N	79.621W	GPS					
FCTSWS	FC2105	5	1	ROS	05/12/2021	02:22:12	BE	26.982N	79.498W	GPS					
FCTSWS	FC2105	5	1	ROS	05/12/2021	02:37:57	BO	26.991N	79.500W	GPS	746	12	755	8	1,2
FCTSWS	FC2105	5	1	ROS	05/12/2021	03:01:21	EN	27.004N	79.503W	GPS					
FCTSWS	FC2105	6	1	ROS	05/12/2021	00:51:11	BE	26.984N	79.383W	GPS					
FCTSWS	FC2105	6	1	ROS	05/12/2021	01:06:10	BO	26.991N	79.384W	GPS	675	11	683	8	1,2
FCTSWS	FC2105	6	1	ROS	05/12/2021	01:28:18	EN	27.001N	79.386W	GPS					
FCTSWS	FC2105	7	1	ROS	05/11/2021	23:27:53	BE	26.995N	79.282W	GPS					
FCTSWS	FC2105	7	1	ROS	05/11/2021	23:42:43	BO	27.001N	79.283W	GPS	608	10	613	7	1,2
FCTSWS	FC2105	7	1	ROS	05/12/2021	00:02:30	EN	27.006N	79.283W	GPS					
FCTSWS	FC2105	8	1	ROS	05/11/2021	22:16:45	BE	26.998N	79.199W	GPS					
FCTSWS	FC2105	8	1	ROS	05/11/2021	22:28:33	BO	27.000N	79.199W	GPS	468	10	470	6	1,2
FCTSWS	FC2105	8	1	ROS	05/11/2021	22:46:13	EN	27.003N	79.199W	GPS					

Note:Parameter 1 - salinity sampled, Parameter 2 - oxygen sampled

C WOCE Bottle Summary File

C.1 FC2104 - April 2021

Table 14: FC2104 – WOCE Bottle Summary File

SHIP/CRS EXPOCODE	WOCE SECT	STN	CAST	BTL#	BTL# Flag	DATE	UTC TIME	LAT	LON	DEPTH	CTD PRS	CTD TMP	CTD SAL	SAL FLAG	BTL SAL	SAL FLAG	CTD OXY	OXY FLAG	BTL OXY	OXY FLAG
FCTSWS	FC2104	0	1	1	2	20210422	0930	26.995N	79.928W	135	136	9.369	35.156	2	35.185	4	123.9	2	124.2	2
FCTSWS	FC2104	0	1	2	2	20210422	0932	26.996N	79.927W	100	100	18.874	36.175	2	36.195	4	168.1	2	171.5	4
FCTSWS	FC2104	0	1	3	2	20210422	0933	26.997N	79.926W	51	51	23.970	36.345	2	36.360	2	210.3	2	210.6	2
FCTSWS	FC2104	0	1	4	2	20210422	0936	26.999N	79.925W	3	3	26.457	36.342	2	36.341	2	201.9	2	202.5	2
FCTSWS	FC2104	1	1	1	2	20210422	0757	27.004N	79.858W	243	245	9.351	35.145	2	35.140	6	121.7	2	121.0	2
FCTSWS	FC2104	1	1	2	2	20210422	0759	27.006N	79.858W	185	186	11.412	35.425	2	35.473	4	124.8	2	127.0	2
FCTSWS	FC2104	1	1	3	2	20210422	0802	27.008N	79.857W	132	133	18.948	36.434	2	36.460	4	148.0	2	147.0	2
FCTSWS	FC2104	1	1	4	2	20210422	0804	27.010N	79.856W	52	52	24.726	36.411	2	36.419	2	207.0	2	206.4	2
FCTSWS	FC2104	1	1	5	2	20210422	0807	27.013N	79.855W	2	2	26.748	36.277	2	36.278	2	200.9	2	201.0	2
FCTSWS	FC2104	2	1	1	2	20210422	0624	27.000N	79.781W	361	364	9.002	35.100	2	35.094	6	122.0	2	121.4	2
FCTSWS	FC2104	2	1	2	2	20210422	0626	27.002N	79.781W	304	307	10.277	35.248	2	35.252	2	120.6	2	120.4	2
FCTSWS	FC2104	2	1	3	2	20210422	0631	27.006N	79.780W	182	183	17.845	36.396	2	36.394	2	137.4	2	137.1	2
FCTSWS	FC2104	2	1	4	2	20210422	0633	27.008N	79.780W	128	129	20.772	36.647	2	36.646	2	151.6	2	152.2	2
FCTSWS	FC2104	2	1	5	2	20210422	0635	27.010N	79.779W	49	49	26.583	36.267	2	36.272	2	201.2	2	202.4	6
FCTSWS	FC2104	2	1	6	2	20210422	0638	27.013N	79.778W	3	3	26.916	36.281	2	36.280	2	200.9	2	201.2	2
FCTSWS	FC2104	3	1	1	2	20210422	0442	27.007N	79.683W	511	515	7.886	34.980	2	34.977	6	125.3	2	125.1	6
FCTSWS	FC2104	3	1	2	2	20210422	0445	27.010N	79.683W	402	405	11.032	35.345	2	35.352	2	120.6	2	121.3	2
FCTSWS	FC2104	3	1	3	2	20210422	0449	27.013N	79.682W	301	303	14.541	35.898	2	35.902	2	132.1	2	130.8	2
FCTSWS	FC2104	3	1	4	2	20210422	0452	27.016N	79.682W	179	180	20.326	36.753	2	36.747	2	154.1	2	155.1	2
FCTSWS	FC2104	3	1	5	2	20210422	0454	27.018N	79.681W	128	129	22.789	36.691	2	36.700	2	173.4	2	172.2	2
FCTSWS	FC2104	3	1	6	2	20210422	0456	27.020N	79.680W	49	49	26.647	36.218	2	36.217	2	201.5	2	202.2	2
FCTSWS	FC2104	3	1	7	2	20210422	0459	27.022N	79.680W	3	3	27.120	36.261	2	36.259	2	200.8	2	200.4	2
FCTSWS	FC2104	4	1	1	2	20210422	0325	27.001N	79.618W	621	626	7.882	34.973	2	34.972	2	125.0	2	126.0	2
FCTSWS	FC2104	4	1	2	2	20210422	0330	27.004N	79.618W	447	451	11.181	35.368	2	35.365	6	120.6	2	120.0	2
FCTSWS	FC2104	4	1	3	2	20210422	0333	27.007N	79.617W	301	303	16.138	36.150	2	36.174	4	139.9	2	138.5	6
FCTSWS	FC2104	4	1	4	2	20210422	0336	27.009N	79.617W	178	179	21.049	36.829	2	36.829	2	154.2	2	154.0	2
FCTSWS	FC2104	4	1	5	2	20210422	0338	27.011N	79.616W	118	119	23.974	36.475	2	36.479	2	189.8	2	199.7	4
FCTSWS	FC2104	4	1	6	2	20210422	0340	27.013N	79.616W	50	51	26.630	36.208	2	36.208	2	200.8	2	200.4	2
FCTSWS	FC2104	4	1	7	2	20210422	0343	27.015N	79.615W	3	3	26.908	36.203	2	36.201	2	201.4	2	200.9	2
FCTSWS	FC2104	5	1	1	2	20210422	0151	26.994N	79.500W	735	741	7.223	34.930	2	34.931	2	130.5	2	129.7	2
FCTSWS	FC2104	5	1	2	2	20210422	0155	26.996N	79.499W	596	601	9.876	35.178	2	35.176	2	118.7	2	118.3	2
FCTSWS	FC2104	5	1	3	2	20210422	0159	26.998N	79.499W	448	451	13.438	35.713	2	35.716	2	129.0	2	127.7	2
FCTSWS	FC2104	5	1	4	2	20210422	0202	27.000N	79.499W	297	300	17.828	36.438	2	36.437	2	159.5	2	158.5	6
FCTSWS	FC2104	5	1	5	2	20210422	0205	27.001N	79.500W	179	180	21.303	36.845	2	36.847	2	156.4	2	158.0	2
FCTSWS	FC2104	5	1	6	2	20210422	0207	27.002N	79.500W	128	129	25.436	36.600	2	36.633	4	179.0	2	181.1	4
FCTSWS	FC2104	5	1	7	2	20210422	0209	27.004N	79.500W	48	48	26.136	36.232	2	36.232	6	202.9	2	202.1	2
FCTSWS	FC2104	5	1	13	2	20210422	0211	27.006N	79.500W	3	3	26.736	36.212	2	36.209	2	201.6	2	201.5	2
FCTSWS	FC2104	6	1	1	2	20210422	0012	26.995N	79.380W	640	645	10.207	35.343	2	35.343	2	144.8	2	144.4	6
FCTSWS	FC2104	6	1	2	2	20210422	0014	26.996N	79.380W	583	587	11.592	35.453	2	35.453	2	128.1	2	129.3	2
FCTSWS	FC2104	6	1	3	2	20210422	0018	26.997N	79.379W	446	449	14.258	35.846	2	35.848	6	132.6	2	132.0	2
FCTSWS	FC2104	6	1	4	2	20210422	0021	26.998N	79.379W	297	299	18.156	36.481	2	36.481	2	155.7	2	155.6	2
FCTSWS	FC2104	6	1	5	2	20210422	0024	26.999N	79.379W	178	180	22.457	36.913	2	36.912	2	155.8	2	156.0	2
FCTSWS	FC2104	6	1	6	2	20210422	0026	27.000N	79.379W	129	130	25.072	36.659	2	36.652	2	170.7	2	172.5	2
FCTSWS	FC2104	6	1	7	2	20210422	0028	27.001N	79.379W	49	49	26.288	36.230	2	36.231	2	201.7	2	200.6	2
FCTSWS	FC2104	6	1	13	2	20210422	0030	27.001N	79.379W	3	3	26.709	36.224	2	36.221	2	195.9	2	-999.0	9
FCTSWS	FC2104	7	1	1	2	20210421	2242	27.000N	79.282W	597	601	11.670	35.520	2	35.524	2	145.0	2	146.1	2
FCTSWS	FC2104	7	1	2	2	20210421	2247	27.001N	79.282W	446	450	16.347	36.232	2	36.230	2	165.7	2	165.7	6
FCTSWS	FC2104	7	1	3	2	20210421	2251	27.001N	79.282W	299	301	19.242	36.652	2	36.653	6	183.1	2	183.6	2
FCTSWS	FC2104	7	1	4	2	20210421	2254	27.002N	79.282W	179	180	22.208	36.908	2	36.905	2	191.5	2	192.1	2
FCTSWS	FC2104	7	1	5	2	20210421	2256	27.002N	79.283W	129	130	24.501	36.822	2	36.827	2	167.2	2	166.3	2
FCTSWS	FC2104	7	1	6	2	20210421	2258	27.003N	79.283W	50	50	26.358	36.232	2	36.231	2	195.8	2	196.0	4
FCTSWS	FC2104	7	1	7	2	20210421	2300	27.003N	79.283W	3	3	26.804	36.226	2	36.221	2	201.9	2	201.6	2
FCTSWS	FC2104	8	1	1	2	20210421	2119	26.993N	79.195W	459	463	15.932	36.167	2	36.161	2	167.2	2	167.5	2
FCTSWS	FC2104	8	1	2	2	20210421	2125	26.994N	79.195W	298	300	19.420	36.676	2	36.671	2	191.4	2	191.1	2
FCTSWS	FC2104	8	1	3	2	20210421	2129	26.994N	79.195W	180	181	22.237	36.913	2	36.923	2	193.5	2	193.4	2
FCTSWS	FC2104	8	1	4	2	20210421	2131	26.994N	79.195W	130	130	23.373	36.958	2	36.948	2	198.5	2	198.4	6
FCTSWS	FC2104	8	1	5	2	20210421	2134	26.994N	79.195W	50	51	25.901	36.282	2	36.283	2	198.3	2	198.4	2
FCTSWS	FC2104	8	1	6	2	20210421	2137	26.994N	79.195W	3	3	26.956	36.224	2	36.220	2	195.7	2	-999.0	9

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Table 15: FC2105 – WOCE Bottle Summary File

SHIP/CRS EXPOCODE	WOCE SECT	STN	CAST	BTL#	BTL# Flag	DATE	UTC TIME	LAT	LON	DEPTH	CTD PRS	CTD TMP	CTD SAL	SAL FLAG	BTL SAL	SAL FLAG	CTD OXY	OXY FLAG	BTL OXY	OXY FLAG
FCTSWS	FC2105	0	1	1	2	20210512	0918	27.000N	79.933W	132	133	11.547	35.469	2	35.497	4	126.5	2	126.3	6
FCTSWS	FC2105	0	1	2	2	20210512	0921	27.002N	79.933W	106	107	14.508	35.818	2	35.865	4	138.2	2	141.2	2
FCTSWS	FC2105	0	1	3	2	20210512	0924	27.004N	79.934W	50	50	23.756	36.339	2	36.335	2	212.3	2	213.4	2
FCTSWS	FC2105	0	1	4	2	20210512	0925	27.006N	79.934W	2	2	27.749	36.356	2	36.352	2	197.5	2	198.2	2
FCTSWS	FC2105	1	1	1	2	20210512	0816	26.998N	79.871W	239	241	8.605	35.066	2	35.066	2	122.3	2	122.5	2
FCTSWS	FC2105	1	1	2	2	20210512	0819	27.001N	79.872W	179	180	10.590	35.342	2	35.344	2	125.7	2	123.8	2
FCTSWS	FC2105	1	1	3	2	20210512	0822	27.004N	79.872W	136	137	16.158	35.996	2	36.039	4	143.6	2	142.0	2
FCTSWS	FC2105	1	1	4	2	20210512	0825	27.007N	79.872W	49	50	25.429	36.301	2	36.226	4	210.1	2	210.8	2
FCTSWS	FC2105	1	1	5	2	20210512	0827	27.009N	79.873W	2	2	27.958	36.315	2	36.312	2	195.3	2	197.2	6
FCTSWS	FC2105	2	1	1	2	20210512	0654	27.001N	79.785W	357	360	7.079	34.932	2	34.951	4	132.7	2	133.0	6
FCTSWS	FC2105	2	1	2	2	20210512	0656	27.003N	79.785W	302	304	8.827	35.077	2	35.074	2	120.9	2	120.4	2
FCTSWS	FC2105	2	1	3	2	20210512	0700	27.006N	79.785W	184	185	18.496	36.518	2	36.552	4	152.3	2	152.1	2
FCTSWS	FC2105	2	1	4	2	20210512	0702	27.008N	79.785W	129	129	21.517	36.747	2	NaN	9	-999.0	9	-999.0	9
FCTSWS	FC2105	2	1	5	2	20210512	0705	27.011N	79.785W	48	48	26.662	36.453	2	36.455	2	199.1	2	197.4	2
FCTSWS	FC2105	2	1	6	2	20210512	0706	27.013N	79.786W	2	2	28.281	36.310	2	36.307	2	197.4	2	196.3	2
FCTSWS	FC2105	3	1	1	2	20210512	0530	27.002N	79.684W	516	520	6.598	34.905	2	34.934	4	137.9	2	138.1	2
FCTSWS	FC2105	3	1	2	2	20210512	0533	27.004N	79.684W	402	405	10.002	35.229	2	35.222	2	120.9	2	121.2	2
FCTSWS	FC2105	3	1	3	2	20210512	0536	27.007N	79.684W	304	307	14.662	35.911	2	35.940	4	130.3	2	130.0	2
FCTSWS	FC2105	3	1	4	2	20210512	0539	27.010N	79.685W	179	180	19.797	36.683	2	36.691	2	152.4	2	152.7	2
FCTSWS	FC2105	3	1	5	2	20210512	0541	27.012N	79.685W	124	125	23.250	36.922	2	36.920	2	159.3	2	159.4	2
FCTSWS	FC2105	3	1	6	2	20210512	0543	27.014N	79.685W	48	48	27.035	36.399	2	36.406	2	202.5	2	200.0	2
FCTSWS	FC2105	3	1	7	2	20210512	0545	27.016N	79.685W	2	2	28.200	36.290	2	NaN	9	197.7	2	196.6	2
FCTSWS	FC2105	4	1	1	2	20210512	0415	26.999N	79.618W	632	637	6.648	34.908	2	34.910	2	137.2	2	136.9	2
FCTSWS	FC2105	4	1	2	2	20210512	0419	27.002N	79.619W	447	450	9.692	35.157	2	35.158	2	118.1	2	117.9	2
FCTSWS	FC2105	4	1	3	2	20210512	0423	27.004N	79.619W	301	303	16.403	36.193	2	36.205	2	139.1	2	138.6	2
FCTSWS	FC2105	4	1	4	2	20210512	0426	27.007N	79.619W	179	180	20.260	36.742	2	36.741	2	153.1	2	152.4	2
FCTSWS	FC2105	4	1	5	2	20210512	0428	27.009N	79.620W	129	130	23.221	36.960	2	36.956	2	158.0	2	157.5	6
FCTSWS	FC2105	4	1	6	2	20210512	0430	27.011N	79.620W	50	51	26.986	36.291	2	36.300	2	199.7	2	199.0	2
FCTSWS	FC2105	4	1	7	2	20210512	0432	27.014N	79.621W	2	2	28.366	36.257	2	36.269	2	197.6	2	196.8	2
FCTSWS	FC2105	5	1	1	2	20210512	0240	26.992N	79.501W	746	752	7.020	34.916	2	34.918	2	132.2	2	131.8	2
FCTSWS	FC2105	5	1	2	2	20210512	0244	26.994N	79.501W	598	602	8.331	35.007	2	35.011	2	121.6	2	121.8	2
FCTSWS	FC2105	5	1	3	2	20210512	0248	26.996N	79.501W	447	450	12.363	35.542	2	35.541	2	122.2	2	122.2	2
FCTSWS	FC2105	5	1	4	2	20210512	0252	26.998N	79.502W	298	300	17.715	36.409	2	36.408	2	154.8	2	155.1	6
FCTSWS	FC2105	5	1	5	2	20210512	0255	27.000N	79.502W	178	180	20.630	36.792	2	36.795	2	158.9	2	158.0	2
FCTSWS	FC2105	5	1	6	2	20210512	0256	27.001N	79.503W	128	129	24.264	36.967	2	36.966	2	180.6	2	181.0	2
FCTSWS	FC2105	5	1	7	2	20210512	0259	27.003N	79.503W	48	49	26.544	36.327	2	36.318	2	201.5	2	201.7	2
FCTSWS	FC2105	5	1	13	2	20210512	0301	27.004N	79.504W	2	2	28.195	36.275	2	36.278	2	197.3	2	197.8	2
FCTSWS	FC2105	6	1	1	2	20210512	0108	26.992N	79.385W	675	681	9.949	35.217	2	35.222	2	125.5	2	126.9	2
FCTSWS	FC2105	6	1	2	2	20210512	0111	26.993N	79.385W	594	598	11.036	35.403	2	35.400	2	134.3	2	134.5	2
FCTSWS	FC2105	6	1	3	2	20210512	0114	26.994N	79.385W	446	449	14.206	35.835	2	35.842	2	130.6	2	131.0	6
FCTSWS	FC2105	6	1	4	2	20210512	0118	26.996N	79.385W	296	298	18.501	36.525	2	36.518	2	157.4	2	160.0	2
FCTSWS	FC2105	6	1	5	2	20210512	0121	26.997N	79.385W	178	179	21.909	36.904	2	36.896	2	159.6	2	160.0	2
FCTSWS	FC2105	6	1	6	2	20210512	0123	26.998N	79.386W	128	129	23.892	36.915	2	36.911	6	165.3	2	165.7	2
FCTSWS	FC2105	6	1	7	2	20210512	0125	27.000N	79.386W	50	50	26.157	36.391	2	36.388	2	199.6	2	188.6	4
FCTSWS	FC2105	6	1	13	2	20210512	0128	27.001N	79.387W	2	2	27.978	36.309	2	36.305	2	196.0	2	198.7	2
FCTSWS	FC2105	7	1	1	2	20210511	2344	27.001N	79.283W	608	613	12.376	35.614	2	35.612	2	146.4	2	146.4	2
FCTSWS	FC2105	7	1	2	2	20210511	2348	27.003N	79.283W	446	449	15.578	36.105	2	36.099	2	166.9	2	165.9	6
FCTSWS	FC2105	7	1	3	2	20210511	2352	27.004N	79.282W	296	298	19.278	36.660	2	36.656	2	191.0	2	190.4	2
FCTSWS	FC2105	7	1	4	2	20210511	2355	27.005N	79.282W	178	179	22.136	36.863	2	36.860	2	197.9	2	198.7	2
FCTSWS	FC2105	7	1	5	2	20210511	2357	27.005N	79.283W	129	129	23.833	36.879	2	36.881	2	203.3	2	203.2	2
FCTSWS	FC2105	7	1	6	2	20210512	0000	27.006N	79.283W	49	49	26.142	36.367	2	36.363	2	206.1	2	192.9	4
FCTSWS	FC2105	7	1	7	2	20210512	0002	27.007N	79.283W	2	2	27.974	36.283	2	36.279	2	199.3	2	201.6	4
FCTSWS	FC2105	8	1	1	2	20210511	2231	27.000N	79.199W	468	471	15.907	36.145	2	36.145	2	157.9	2	158.7	2
FCTSWS	FC2105	8	1	2	2	20210511	2235	27.001N	79.199W	297	299	19.081	36.632	2	36.631	2	188.4	2	188.2	2
FCTSWS	FC2105	8	1	3	2	20210511	2239	27.002N	79.199W	179	180	22.641	36.880	2	36.878	2	199.7	2	200.3	2
FCTSWS	FC2105	8	1	4	2	20210511	2241	27.002N	79.199W	129	130	23.370	36.895	2	36.896	2	200.6	2	200.4	2
FCTSWS	FC2105	8	1	5	2	20210511	2243	27.003N	79.199W	49	49	26.676	36.312	2	36.325	2	197.8	2	197.6	2
FCTSWS	FC2105	8	1	6	2	20210511	2245	27.003N	79.199W	2	2	27.875	36.238	2	36.229	2	199.2	2	199.7	4