National Oceanic and Atmospheric Administration
Atlantic Oceanographic and Meteorological Laboratory
4301 Rickenbacker Causeway
Miami, FL 33149-1097

October 26, 2010

Final Cruise Report

U.S. Dept. of State Cruise No: 2009-087.

Ship Names: M/V *Island Clan* (trips 1-3, 5-7, 9), and M/V *Fish With Me* (trip 4, 8).

Dates: December 10, 2009; March 24, 2010; June 6, 2010; June 16, 2010; July 28, 2010; August 5, 2010; August 13, 2010; August 23, 2010; September 10, 2010.

Chief Scientists: Molly Baringer and Christopher Meinen

Foreign Participants: None

Operating Institution: NOAA/AOML

Cruise Report by: Rigoberto Garcia, Christopher Meinen, Molly Baringer.

Project Title: Atlantic Climate Change Program: Volunteer Observing Ship High Resolution XBT line AX7 and Direct Observations in Support of Operational Monitoring in the Straits of Florida.

Clearance Countries: Bahamas

Port Calls: West Palm Beach, FL to West Palm Beach, FL.

Description of the Scientific Program:

Voltages induced on a submarine cable by the Florida Current have been shown to be proportional to the total current transport. In order to calibrate the cable measurements, direct transport observations are needed at a few times during each year. A dropsonde is an instrument consisting of an expendable weight and a glass tube containing electronic sensors, including a Global Positioning System (GPS) receiver. The instruments determine vertically-averaged horizontal velocity by sinking to the ocean bottom, dropping the weight, and then rising to the ocean surface, with the GPS providing an accurate location for the start and end of the profile. Using the dropsonde technique, horizontal velocity is estimated at nine stations across the Straits. AOML has obtained these vertically-averaged velocities across the Strait of Florida on several cruises during this year, and horizontal-integration of the velocity values has yielded calibration values for submarine cable transport measurements. Cable voltages have been monitored and daily total transport values obtained since 1982.

Beginning in 1995 the cable calibration effort was augmented in support of the Volunteer Observing Ship Program (VOS) that deploys expendable bathythermographs (XBTs) in the interior Atlantic. The goal of this VOS/XBT program is to study the upper ocean thermal structure of the subtropical North Atlantic using volunteer observing merchant ships. Repeat XBT sections, approximately every 3 months, have been conducted since October 1984 with the intent of determining and monitoring the seasonal-to-interannual variability of the upper ocean heat content. The ship-track, which roughly follows along 30°N, is designated as AX7 and it is ideal for monitoring heat flux variability in the Atlantic because it lies near the center of the subtropical gyre, which has been shown to be the latitude of the maximum heat flux in the ocean. The upper ocean thermal structure obtained using the expendable temperature probes (XBTs) is being used to correlate the subtropical gyre intensity with atmospheric forcing as well as for determining the heat transport.

Essential to the goal of monitoring the meridional heat transport is a measure of the heat content and transport within the Florida Straits. Therefore, on each of the cable calibration cruises completed using the vessels charted through Sailfish Marina, the dropsonde measurements are augmented by XBT casts at all nine of the nominal station locations to measure the vertical temperature profile. Two crossings are typically attempted during each quarterly AX7 cruise, roughly one week apart, in an attempt to capture an estimate of the mean transport of the Florida Current that is not contaminated by the seven to ten day waves observed in the Straits.

Data Observations and Samples Collected:

This report refers to the last 9 cruises performed in the Florida Current. On a typical cruise a single AOML participant drives to Palm Beach the evening prior to the departure. The boat departs Palm Beach at about 0600, conducts a total of seven hours of work at the nine stations plus five hours of steaming time, and returns to Palm Beach at roughly 1700. The AOML participant then returns to Miami that same day. Expendable Bathythermographs (XBTs) are launched at each station to obtain temperature profiles of the water column beneath the ship. The XBTs are numbered as the station numbers, whose positions are given in Table 1. Plots of the XBT temperature sections are shown in the Appendix.

The GPS/dropsonde used in all 9 stations is a glass tube housing a Garmin GPS 18x PC receiver/logger, RDF beacon, pinger, and batteries. A second Magellan 5000 Pro GPS receiver is used to determine the ship positions on all cruises. In addition to vertically integrated velocities, after surfacing the GPS/dropsonde is allowed to drift for five minutes to obtain a surface velocity estimate.

A new generation of GPS/dropsonde has been used during the last four cruises of this report. The new generation of dropsonde floats are equipped with self contained conductivity, pressure and temperature sensors that are interfaced to a 12-inch glass sphere. The glass sphere contains a micro-controller, a GPS receiver, a 900 MHz radio transceiver and supporting electronics. The sensors on the instrument output high accuracy data: 0.0002 S/m conductivity, 0.002 degrees Celsius, and 0.02 full-scale pressures. They also have a very fast response time: 5.0 cm at 1 m/sec for conductivity, 150 msec for pressure and 25 msec for temperature. The conductivity is measured without the need for a pump (no electrodes). The new generation of GPS also has six 12-Bits A/Dchannels and it is capable of outputting digital data via a direct serial line or wireless RF-link.

The station locations are listed in Table 1 and a typical cruise trackline is shown in Figure 1. Table 2 lists the dropsonde deployment and surface time positions, and the computed

vertically integrated velocities for each cruise. Surface positions are determined using the dropsonde GPS record. The midpoint time for all profiles is used as the time for the cruise. Table 3 lists the observed meridional surface velocities for each station.

Problems/issues observed during cruises:

During this fiscal year two cruise (June 16, 2010 and August 5, 2010) the dropsonde instrument failed and we were not able to estimate the transport. In July 28, 2010 cruise the old generation dropsonde instrument was lost on the last station. The XBT system also failed during the cruises of March 3 and August 5 of 2010 and no XBT data were collected.

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Schedule of Delivery of Data and Reports: All data are contained herein. No further report is planned.

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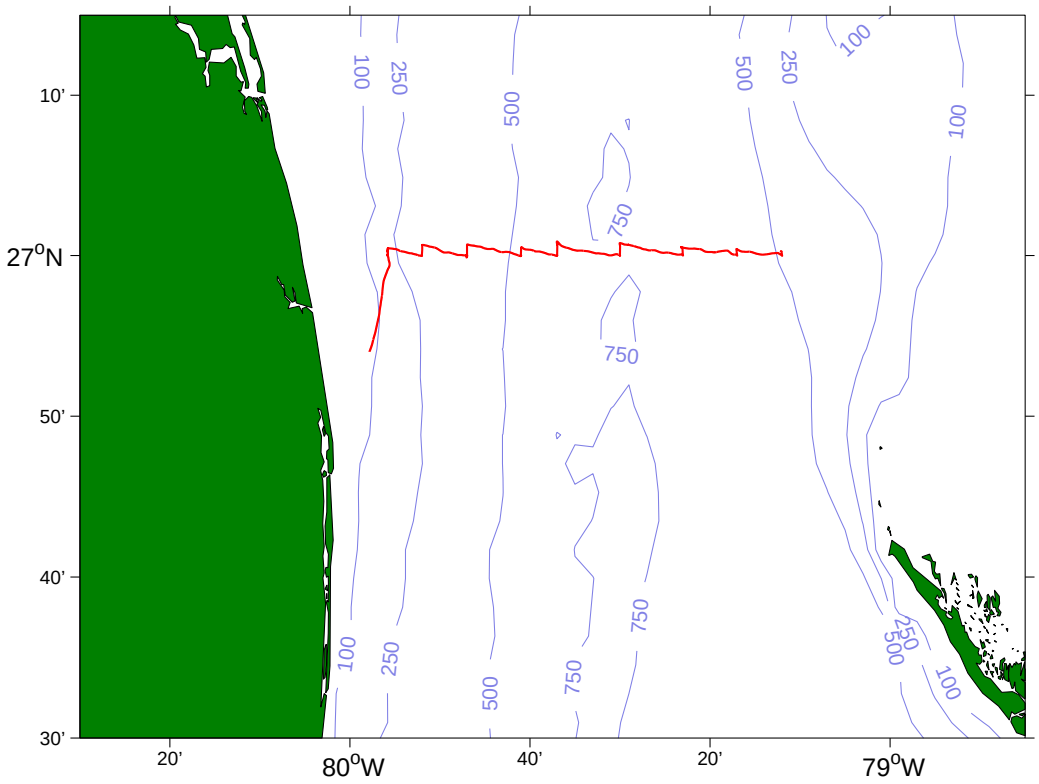


Figure 1: Typical cruise track

Station	Latitude	Longitude	Depth
0	27 00.00 N	79 55.80 W	139 M
1	27 00.00 N	79 52.00 W	261 M
2	27 00.00 N	79 47.00 W	389 M
3	27 00.00 N	79 41.00 W	540 M
4	27 00.00 N	79 37.00 W	661 M
5	27 00.00 N	79 30.00 W	783 M
6	27 00.00 N	79 23.00 W	708 M
7	27 00.00 N	79 17.00 W	624 M
8	27 00.00 N	79 12.00 W	485 M

Table 1: Station Locations.

Sta	Deployed			Surfaced			Mean Velocities	
	Time (GMT)	Lon	Lat	Time (GMT)	Lon	Lat	U cm/s	V cm/s
December 10, 2009								
0	12:22: 2	-79.9294	27.0000	12:27:11	-79.9290	27.0012	13.64	42.46
1	12:43:24	-79.8666	27.0005	12:52:37	-79.8662	27.0041	6.69	69.57
2	13:11:40	-79.7832	27.0010	13:25: 1	-79.7834	27.0079	-1.71	94.43
3	13:55:19	-79.6858	27.0041	14:14: 6	-79.6865	27.0140	-5.40	95.71
4	14:32:49	-79.6167	27.0000	14:55: 7	-79.6174	27.0119	-4.84	98.08
5	15:18: 1	-79.5000	26.9993	15:43:18	-79.5009	27.0107	-5.77	82.35
6	16: 9:22	-79.3833	26.9995	16:32:19	-79.3843	27.0077	-7.39	65.07
7	16:52:30	-79.2831	26.9992	17:12:12	-79.2842	27.0048	-9.83	51.85
8	17:29:45	-79.1998	26.9975	17:45:43	-79.2010	27.0015	-12.17	46.03
March 3, 2010								
0	11:40:21	-79.9293	27.0012	11:46:43	-79.9292	27.0049	2.65	107.49
1	12:13:20	-79.8672	26.9996	12:24:37	-79.8670	27.0061	3.53	106.50
2	12:44:58	-79.7839	26.9993	13: 1: 1	-79.7839	27.0085	0.27	105.33
3	13:24:19	-79.6836	26.9996	13:45: 1	-79.6835	27.0110	1.22	101.24
4	14: 7:33	-79.6170	26.9998	14:34:25	-79.6171	27.0135	-0.01	93.88
5	15: 1:10	-79.5001	26.9990	15:31:25	-79.5009	27.0111	-4.02	73.73
6	15:56:31	-79.3835	26.9998	16:25: 0	-79.3846	27.0095	-6.24	62.95
7	16:48:52	-79.2829	26.9991	17:12:13	-79.2846	27.0074	-12.03	65.72
8	17:32:30	-79.2003	26.9991	17:52:49	-79.2022	27.0051	-14.97	55.86
June 3, 2010								
0	11:16:58	-79.9295	27.0007	11:23:25	-79.9295	27.0014	-1.69	18.64
1	11:39:13	-79.8660	27.0001	11:50: 0	-79.8660	27.0012	-0.88	18.22
2	12: 7:51	-79.7830	27.0004	12:23:55	-79.7833	27.0060	-2.67	64.18
3	12:43:51	-79.6822	27.0002	13: 5: 1	-79.6827	27.0115	-3.73	96.98
4	13:22: 9	-79.6170	27.0006	13:49: 1	-79.6176	27.0157	-3.57	102.26
5	14:17:24	-79.4995	26.9999	14:50:15	-79.4999	27.0172	-2.55	95.19
6	15:20:16	-79.3826	27.0001	15:53:36	-79.3834	27.0150	-4.47	82.16
7	16:12:53	-79.2842	27.0003	16:39: 6	-79.2858	27.0098	-10.31	66.62
8	16:57:46	-79.1990	27.0000	17:17:42	-79.2007	27.0057	-14.37	53.55
August 5, 2010								
0	11:18:26	-79.9299	27.0023	11:25:16	-79.9300	27.0049	-2.04	67.39
1	11:44:22	-79.8660	27.0015	11:56:46	-79.8659	27.0074	1.51	85.34
2	12:18:34	-79.7833	27.0013	12:38:56	-79.7832	27.0128	0.62	103.61
3	13: 4:39	-79.6834	27.0009	13:30:19	-79.6829	27.0164	3.36	111.04
4	13:59: 4	-79.6171	27.0089	14:34:16	-79.6164	27.0286	3.16	102.96
5	99:99: 0	-79.5000	27.0000	99:99: 0	-79.5000	27.0000	-999.00	-999.00
6	99:99: 0	-79.3833	27.0000	99:99: 0	-79.3833	27.0000	-999.00	-999.00
7	99:99: 0	-79.2833	27.0000	99:99: 0	-79.2833	27.0000	-999.00	-999.00
8	99:99: 0	-79.2000	27.0000	99:99: 0	-79.2000	27.0000	-999.00	-999.00

Table 2: Dropsonde Data: Values of -999 indicate instrument failure.

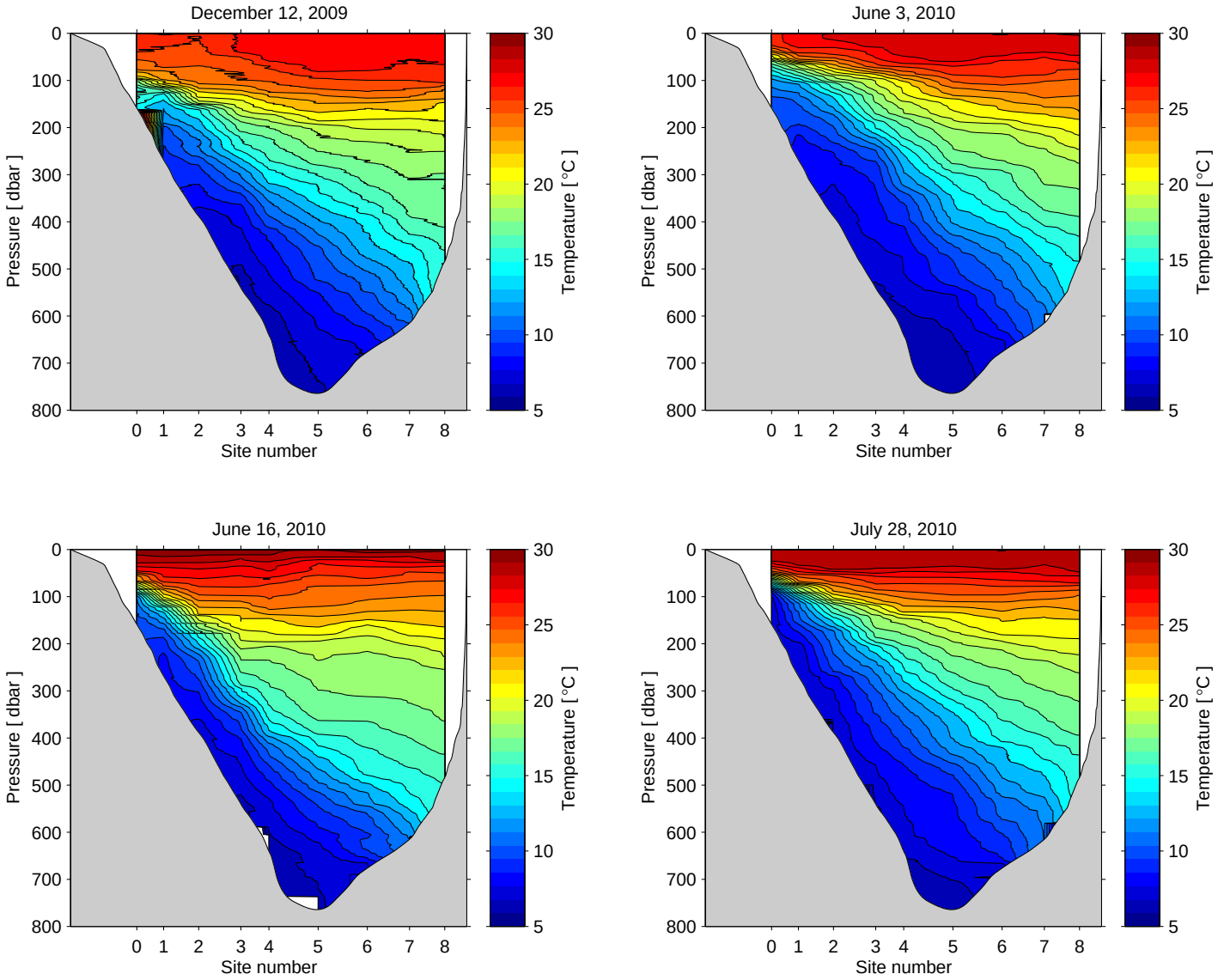
Sta	Deployed			Surfaced			Mean Velocities	
	Time (GMT)	Lon	Lat	Time (GMT)	Lon	Lat	U cm/s	V cm/s
August 13, 2009								
0	11: 7: 4	-79.9298	27.0010	11:12:57	-79.9299	27.0043	-3.97	105.86
1	11:31:45	-79.8664	27.0003	11:41:56	-79.8665	27.0063	-1.66	107.71
2	12: 1:21	-79.7831	27.0001	12:16:13	-79.7836	27.0087	-5.88	106.15
3	12:37:23	-79.6824	27.0003	12:59:10	-79.6825	27.0128	-1.02	105.83
4	13:16:26	-79.6160	27.0009	13:42:24	-79.6164	27.0158	-3.10	105.31
5	14: 7: 6	-79.4996	27.0005	14:38: 0	-79.5000	27.0150	-2.42	86.64
6	15: 5:33	-79.3828	27.0003	15:33:21	-79.3833	27.0111	-3.74	71.07
7	16: 7:36	-79.2815	27.0007	16:32:23	-79.2829	27.0091	-10.38	62.90
8	16:51:43	-79.1987	27.0005	17:12: 1	-79.2001	27.0051	-11.51	42.12
August 23, 2010								
0	18: 7:15	-79.9298	27.0009	18:13:17	-79.9295	27.0050	6.16	124.23
1	17:42:43	-79.8665	27.0007	17:52:42	-79.8663	27.0071	3.87	116.18
2	17: 0:47	-79.7831	27.0011	17:15:32	-79.7828	27.0104	3.26	115.39
3	16:15: 0	-79.6828	27.0008	16:37: 9	-79.6825	27.0162	1.16	127.00
4	15:31:20	-79.6161	27.0005	15:57:15	-79.6158	27.0158	1.79	107.66
5	14:38:13	-79.5003	27.0003	15: 7:44	-79.5003	27.0139	-0.18	84.41
6	13:44:58	-79.3832	27.0002	14:12: 3	-79.3832	27.0103	-0.42	68.03
7	12:58: 2	-79.2836	27.0001	13:20:32	-79.2845	27.0057	-7.05	46.01
8	12:19: 8	-79.2001	26.9992	12:38:46	-79.2010	27.0022	-8.13	27.13
September 10, 2010								
0	11:25:10	-79.9302	27.0006	11:31:22	-79.9302	27.0025	-0.21	54.25
1	11:48:26	-79.8668	26.9996	11:59: 9	-79.8664	27.0031	5.68	58.87
2	12:20:18	-79.7829	26.9995	12:34:52	-79.7824	27.0046	6.86	62.99
3	12:56:28	-79.6837	27.0000	13:17:56	-79.6830	27.0105	5.53	89.92
4	13:34:28	-79.6171	26.9999	13:59:15	-79.6166	27.0110	3.80	82.46
5	14:23:43	-79.5000	26.9988	14:54: 7	-79.4997	27.0094	1.47	63.67
6	15:19:27	-79.3841	26.9986	15:46: 1	-79.3844	27.0062	-1.61	52.13
7	16: 5:49	-79.2831	27.0005	16:30:38	-79.2837	27.0062	-4.17	41.91
8	16:48: 8	-79.1996	26.9996	17: 8:45	-79.2005	27.0030	-7.64	30.16

Table 2: Continued.

Date	Station #								
	0	1	2	3	4	5	6	7	8
December 10, 2009	84.83	146.37	169.07	198.73	166.08	136.72	110.52	66.58	28.39
March 24, 2010	125.43	160.71	168.82	146.97	141.59	107.00	64.20	44.13	-4.23
June 3, 2010	114.70	93.56	115.90	240.76	226.42	305.54	127.89	103.35	54.41
August 5, 2010	192.00	202.25	208.20	181.32	161.60	-999.00	-999.00	-999.00	-999.00
August 13, 2010	1.03	160.18	159.75	139.58	142.50	131.36	112.40	60.22	36.26
August 23, 2010	264.45	272.42	255.10	230.01	194.76	163.47	123.07	70.94	49.45
September 10, 2010	183.68	163.42	133.49	137.91	120.67	114.75	86.35	53.59	35.49

Table 3: Meridional Surface Velocities in cm/s. Values of -999 indicate instrument failure.

APPENDIX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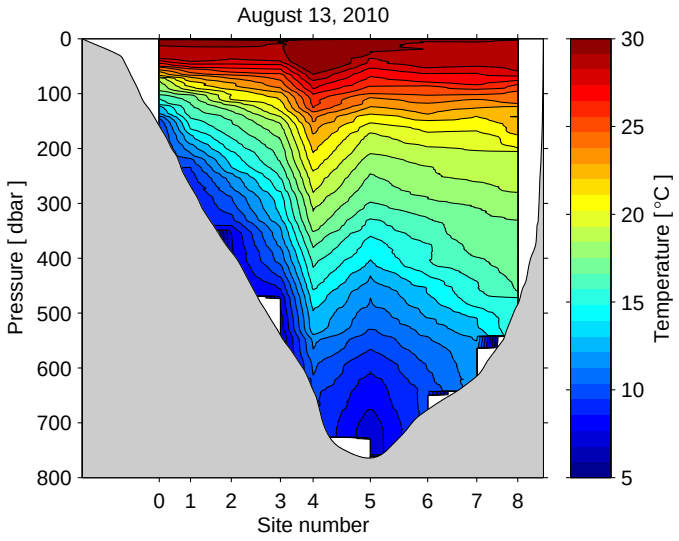
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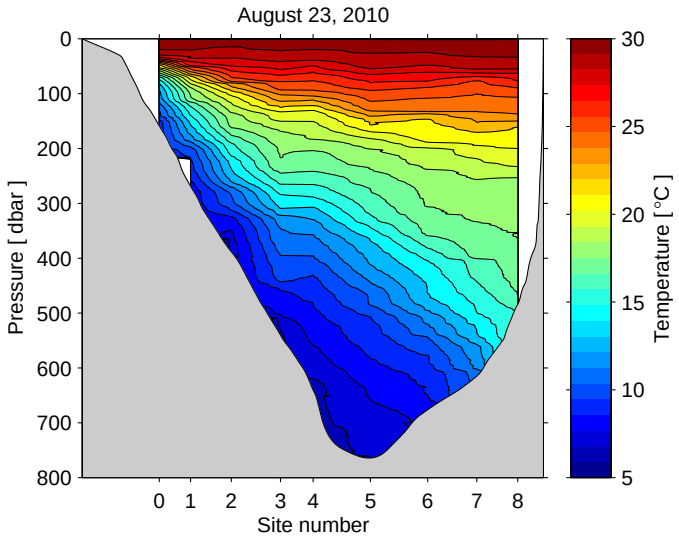
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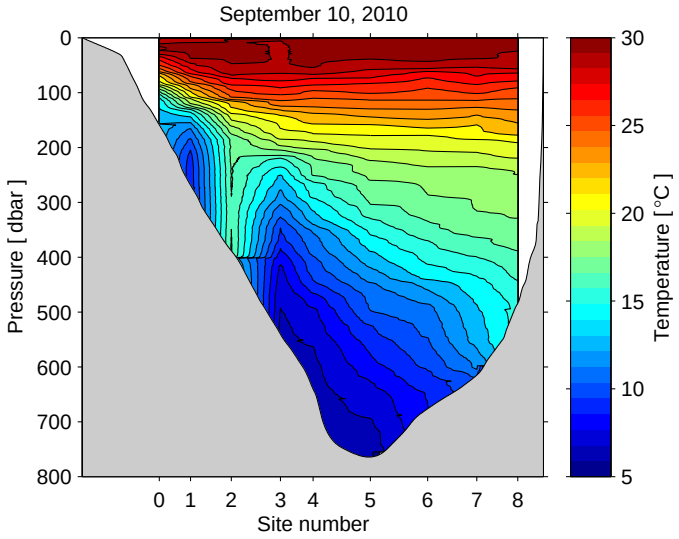
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