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

January 11, 2010

Final Cruise Report

U.S. Dept. of State Cruise No: 2009-089.

Ship Names: M/V *Island Clan* (trips 1, 3, 4, 6-11), and M/V *La Vida* (trip 2, 5).

Dates: October 2, 2008; October 9, 2008; December 5, 2008; December 30, 2008; February 13, 2009; March 17, 2009; June 12, 2009; June 19, 2009; July 15, 2009; September 10, 2009; September 23, 2009.

Chief Scientists: Molly Baringer and Christopher Meinen

Foreign Participants: None

Operating Institution: NOAA/AOML

Cruise Report by: Rigoberto Garcia, Christopher Meinen, Molly Baringer, and Ulises Rivero

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 11 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 tested during the last five 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 13-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. Data from this new generation dropsonde floats is presented only in the cruise of June 12, 2009 in this report.

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 one cruise (December 30, 2008) was cancelled due to bad weather and another (June 19, 2008) due to mechanical failure of the ship. The XBT computer also failed in 6 cast in the cruise on October 9, 2008. The XBT system also failed during the July 15, 2009 cruise and no XBT data were collected.

Information Address: Dr. Molly O'Neil Baringer
NOAA/AOML
4301 Rickenbacker Causeway
Miami, FL, 33149
(305) 361-4345
E-mail: Molly.Baringer@noaa.gov

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

Acknowledgements: A very sincere thanks to Pedro Pena, Kyle Seaton, Andrew Stefanick and Ulises Rivero for their participation in these cruises and to the crew of the vessels M/V *Island Clan*, and M/V *La Vida* for their reliable assistance.

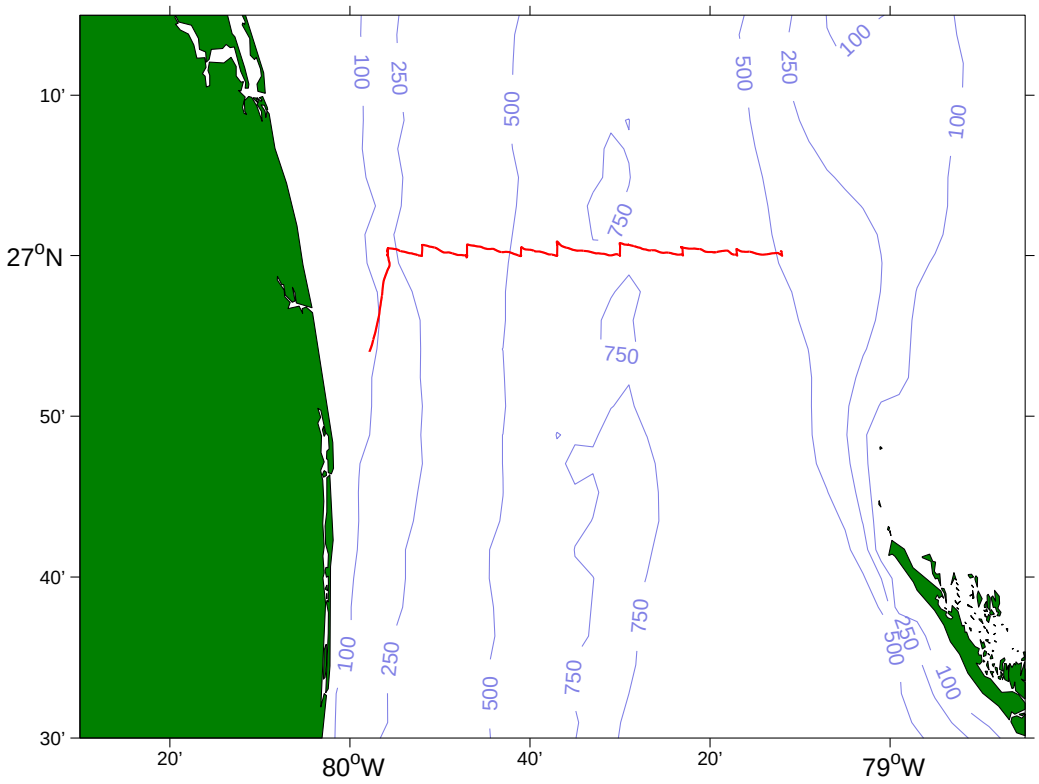


Figure 1: Typical cruise track

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
October 2, 2008								
0	11:39:50	-79.9300	27.0003	11:46:38	-79.9302	27.0027	-4.59	63.09
1	12: 5:15	-79.8669	27.0002	12:16: 2	-79.8673	27.0028	-6.27	43.86
2	12:40: 9	-79.7834	26.9999	12:55:32	-79.7837	27.0052	-3.85	63.36
3	13:17:54	-79.6830	27.0006	13:39: 8	-79.6831	27.0093	-1.75	76.19
4	13:56:28	-79.6166	27.0002	14:21:20	-79.6165	27.0116	0.72	85.21
5	14:51: 2	-79.4998	27.0013	15:20:44	-79.5009	27.0140	-6.20	79.27
6	15:45:45	-79.3842	26.9999	16:12:50	-79.3853	27.0096	-6.71	66.74
7	16:32:34	-79.2831	26.9998	16:56: 8	-79.2843	27.0052	-9.05	42.32
8	17:20:38	-79.2000	27.0003	17:39:38	-79.2016	27.0045	-14.18	41.68
October 9, 2008								
0	11:32:52	-79.9301	27.0012	11:38:33	-79.9304	27.0022	-8.52	32.76
1	11:59:20	-79.8663	27.0003	12: 9:38	-79.8667	27.0029	-7.30	45.56
2	12:31:49	-79.7822	27.0003	12:47:20	-79.7825	27.0079	-3.31	89.55
3	13:11:13	-79.6811	27.0008	13:32:13	-79.6809	27.0124	1.13	101.17
4	13:51:33	-79.6164	27.0004	14:17: 2	-79.6162	27.0134	1.26	93.50
5	14:43:44	-79.4993	27.0001	15:14:32	-79.4999	27.0139	-3.36	81.88
6	15:42: 1	-79.3834	27.0007	16: 8: 2	-79.3846	27.0091	-8.31	59.02
7	16:31:34	-79.2817	27.0003	16:55:50	-79.2830	27.0061	-8.81	44.39
8	17:16:46	-79.1989	27.0010	17:34:31	-79.2005	27.0055	-14.17	46.91
December 5, 2008								
0	12:24:40	-79.9304	27.0013	12:30:52	-79.9303	27.0055	2.34	125.34
1	12:55:34	-79.8671	27.0015	13: 6:14	-79.8668	27.0081	5.14	112.88
2	13:32: 2	-79.7835	27.0006	13:47:38	-79.7838	27.0095	-2.90	104.48
3	14:19:54	-79.6834	27.0012	14:41:19	-79.6832	27.0141	1.77	110.34
4	15:12: 8	-79.6184	27.0026	15:38: 2	-79.6180	27.0163	2.90	96.90
5	16:16:22	-79.5011	27.0014	16:45:50	-79.5009	27.0135	1.07	75.21
6	17:28: 1	-79.3845	27.0008	17:54: 8	-79.3851	27.0098	-3.60	63.08
7	18:32:37	-79.2836	27.0008	18:57:20	-79.2852	27.0087	-10.51	58.58
8	19:26:23	-79.1998	27.0000	19:45:44	-79.2015	27.0049	-13.96	46.95
February 13, 2009								
0	12:26: 4	-79.9273	27.0041	12:32:55	-79.9272	27.0092	2.50	136.42
1	12:48:44	-79.8663	27.0005	12:59:49	-79.8659	27.0083	6.86	128.67
2	13:23:56	-79.7813	27.0001	13:40:24	-79.7810	27.0105	2.67	116.62
3	14: 2: 8	-79.6825	27.0004	14:24:37	-79.6818	27.0144	4.91	114.20
4	14:42:33	-79.6153	26.9996	15:10: 1	-79.6145	27.0144	5.05	98.70
5	15:34:10	-79.5000	27.0001	16: 5: 1	-79.4993	27.0123	4.08	72.84
6	16:30:14	-79.3814	27.0009	16:58:49	-79.3811	27.0098	1.83	57.28
7	17:20:54	-79.2859	27.0003	17:45:55	-79.2864	27.0070	-2.67	50.09
8	18: 8:30	-79.2008	26.9998	18:28: 7	-79.2019	27.0037	-8.95	36.57

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
March 17, 2009								
0	11:13:18	-79.9303	27.0004	11:19:44	-79.9303	27.0040	0.38	101.22
1	11:34:49	-79.8664	26.9997	11:46: 1	-79.8661	27.0058	4.49	98.72
2	12: 2:39	-79.7831	26.9999	12:19:30	-79.7822	27.0097	8.05	106.61
3	12:40:16	-79.6829	26.9998	13: 2:49	-79.6820	27.0114	6.50	94.53
4	13:18:19	-79.6164	27.0000	13:45:42	-79.6156	27.0120	5.21	80.20
5	14: 8:19	-79.4993	26.9999	14:38:49	-79.4990	27.0116	1.36	70.39
6	15: 4: 4	-79.3830	26.9999	15:30:31	-79.3832	27.0092	-1.32	65.21
7	15:52: 2	-79.2829	26.9993	16:16: 1	-79.2839	27.0077	-7.50	65.25
8	16:33:54	-79.1993	27.0000	16:53: 6	-79.2006	27.0045	-12.26	44.09
June 12, 2009								
0	11: 7:46	-79.9300	27.0016	11:15:16	-79.9299	27.0057	1.67	97.82
1	11:39: 9	-79.8669	27.0005	11:52: 0	-79.8667	27.0062	2.26	80.28
2	12: 8:56	-79.7831	27.0001	12:28: 3	-79.7826	27.0088	3.83	82.70
3	12:47: 9	-79.6838	26.9997	13:13:37	-79.6834	27.0113	2.16	79.85
4	13:30: 6	-79.6166	26.9997	14: 0:18	-79.6163	27.0118	1.03	73.20
5	14:24:11	-79.4999	26.9987	15: 1:42	-79.4998	27.0097	-0.05	53.97
6	15:23:46	-79.3829	26.9994	15:56:21	-79.3823	27.0067	2.40	40.99
7	16:16:48	-79.2826	26.9994	16:46:37	-79.2838	27.0068	-7.44	46.03
8	17:10:36	-79.1995	26.9998	17:33:11	-79.2005	27.0040	-8.14	34.61
July 15, 2009								
0	11:10:53	-79.9284	27.0059	11:16:23	-79.9287	27.0097	-8.48	126.76
1	12:17:11	-79.8675	27.0063	12:26: 1	-79.8679	27.0116	-7.74	111.02
2	12:47:18	-79.7832	26.9997	13: 0:49	-79.7840	27.0081	-8.87	114.48
3	13:23:23	-79.6828	26.9982	13:42:31	-79.6836	27.0098	-7.29	111.61
4	14: 1:37	-79.6171	26.9998	14:22:54	-79.6177	27.0114	-4.68	100.68
5	14:50:35	-79.4997	26.9987	15:16:43	-79.5006	27.0100	-6.13	79.31
6	15:41:38	-79.3833	26.9993	16: 4:19	-79.3842	27.0070	-6.20	61.86
7	16:27:38	-79.2824	27.0004	16:47:19	-79.2838	27.0061	-11.36	53.30
8	17: 8:21	-79.1991	27.0010	17:24:48	-79.2004	27.0045	-13.49	40.30
September 10, 2009								
0	11:22:22	-79.9306	27.0019	11:28:44	-79.9307	27.0067	-0.66	138.33
1	11:45:43	-79.8671	27.0000	11:56:49	-79.8672	27.0079	-0.80	132.21
2	12:22:55	-79.7832	27.0010	12:38:31	-79.7834	27.0108	-1.51	115.46
3	13: 2:23	-79.6838	26.9994	13:23:25	-79.6839	27.0113	0.09	104.17
4	13:47:50	-79.6166	26.9986	14:15:37	-79.6170	27.0119	-1.99	88.19
5	14:43:54	-79.5001	26.9994	15:14: 7	-79.5012	27.0089	-6.16	58.36
6	15:44:59	-79.3834	27.0000	16:13:24	-79.3847	27.0070	-7.33	45.31
7	16:36:10	-79.2828	26.9994	17: 0:30	-79.2840	27.0053	-8.63	44.81
8	17:25:15	-79.1997	26.9992	17:44:43	-79.2008	27.0020	-9.06	27.32

Table 2: Continued.

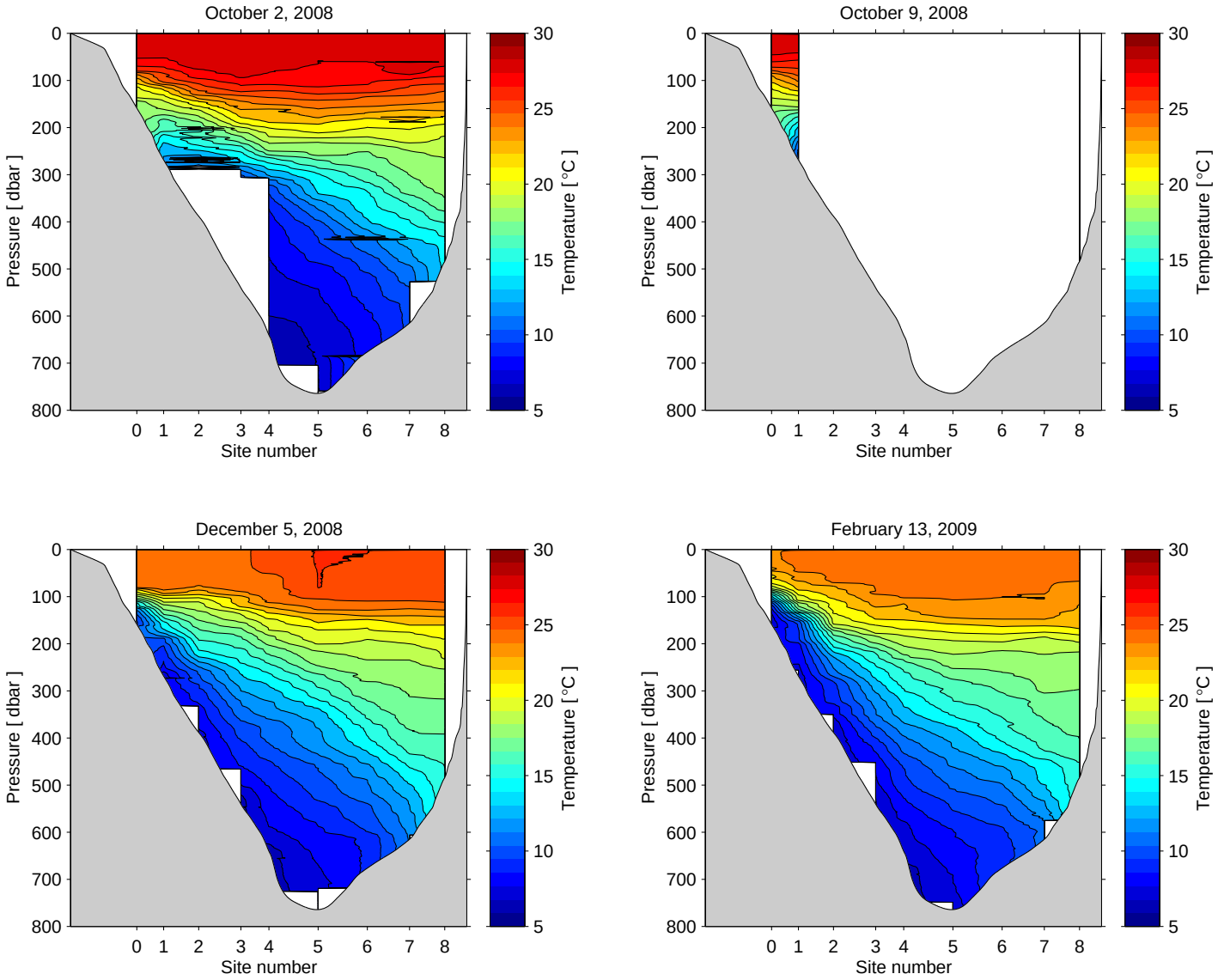
Sta	Deployed			Surfaced			Mean Velocities	
	Time (GMT)	Lon	Lat	Time (GMT)	Lon	Lat	U cm/s	V cm/s
September 23, 2009								
0	11:25:49	-79.9293	27.0016	11:32:19	-79.9289	27.0047	10.59	88.01
1	11:52:47	-79.8670	27.0006	12: 3:55	-79.8662	27.0073	10.98	112.38
2	12:25:42	-79.7834	27.0004	12:41:43	-79.7827	27.0101	7.59	111.75
3	13: 9:55	-79.6831	27.0013	13:31:43	-79.6827	27.0135	2.88	103.52
4	13:56:33	-79.6170	27.0013	14:22: 1	-79.6169	27.0137	0.55	89.67
5	14:58:32	-79.5001	27.0005	15:29:37	-79.5012	27.0115	-5.86	65.26
6	16: 3:46	-79.3829	26.9998	16:30:31	-79.3839	27.0066	-6.05	46.84
7	16:56:33	-79.2829	27.0004	17:21:36	-79.2839	27.0056	-5.90	38.32
8	17:44:40	-79.1998	27.0007	18: 4:37	-79.2008	27.0040	-7.98	30.26

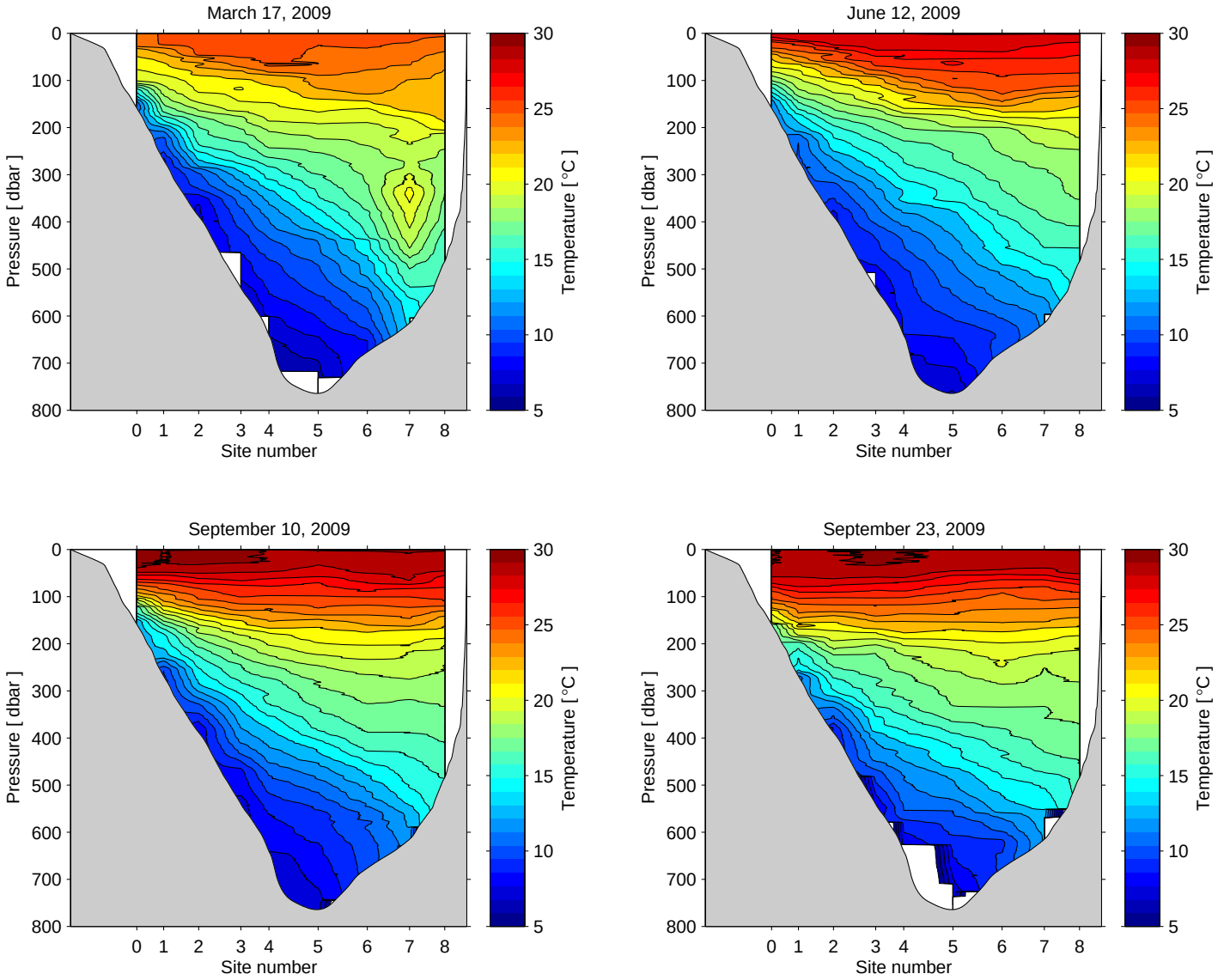
Table 2: Continued.

Date	Station #								
	0	1	2	3	4	5	6	7	8
October 2, 2008	100.70	92.60	93.20	91.84	107.00	85.00	53.31	14.45	4.37
October 9, 2008	65.06	92.14	124.86	156.52	152.94	128.40	106.46	71.69	48.59
December 5, 2008	173.25	170.52	160.71	161.90	174.45	132.63	81.85	57.04	12.74
February 13, 2009	224.03	215.61	174.45	166.68	138.29	82.67	68.61	41.36	8.96
March 17, 2009	162.87	201.33	181.02	154.55	134.42	124.26	77.48	46.60	1.52
June 12, 2009	167.28	175.04	169.41	165.71	147.56	94.36	74.17	48.75	23.99
July 15, 2009	220.45	219.25	192.60	169.67	148.76	117.09	91.26	44.21	35.49
September 10, 2009	184.27	179.82	164.66	146.82	119.48	75.48	69.90	41.08	17.78
September 23, 2009	123.05	19.03	125.93	120.08	100.46	60.02	44.81	45.90	48.75

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

APPENDIX


October 2, 2008
October 9, 2008
December 5, 2008
February 13, 2009
Pressure [dbar]
Site number
Temperature [°C]
0
100
200
300
400
500
600
700
800
0 1 2 3 4 5 6 7 8
30
25
20
15
10
5


March 17, 2009
June 12, 2009
September 10, 2009
September 23, 2009
Pressure [dbar]
Site number
Temperature [°C]
0
100
200
300
400
500
600
700
800
0 1 2 3 4 5 6 7 8
30
25
20
15
10
5