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

October 13, 2011

Final Cruise Report

U.S. Dept. of State Cruise No: F2010-105.

Ship Names: M/V *Island Clan* (trips 1-4), M/V *Fish With Me* (trip 5), and R/V *Hildebrand* (trips 6-7).

Dates: December 17, 2010; March 16, 2011; May 27, 2011; June 23, 2011; September 2, 2011; September 16, 2011; September 28, 2011.

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 7 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.

The new generation of dropsonde floats used 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 the cruise of September 2, 2011 the dropsonde instrument was lost on station number 4.

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 Kyle Seaton, Pedro Pena and Grant Rawson for their participation in these cruises and to the crew of the vessels M/V *Island Clan*, M/V *Fish With Me* and R/V *Hildebrand* for their reliable assistance.

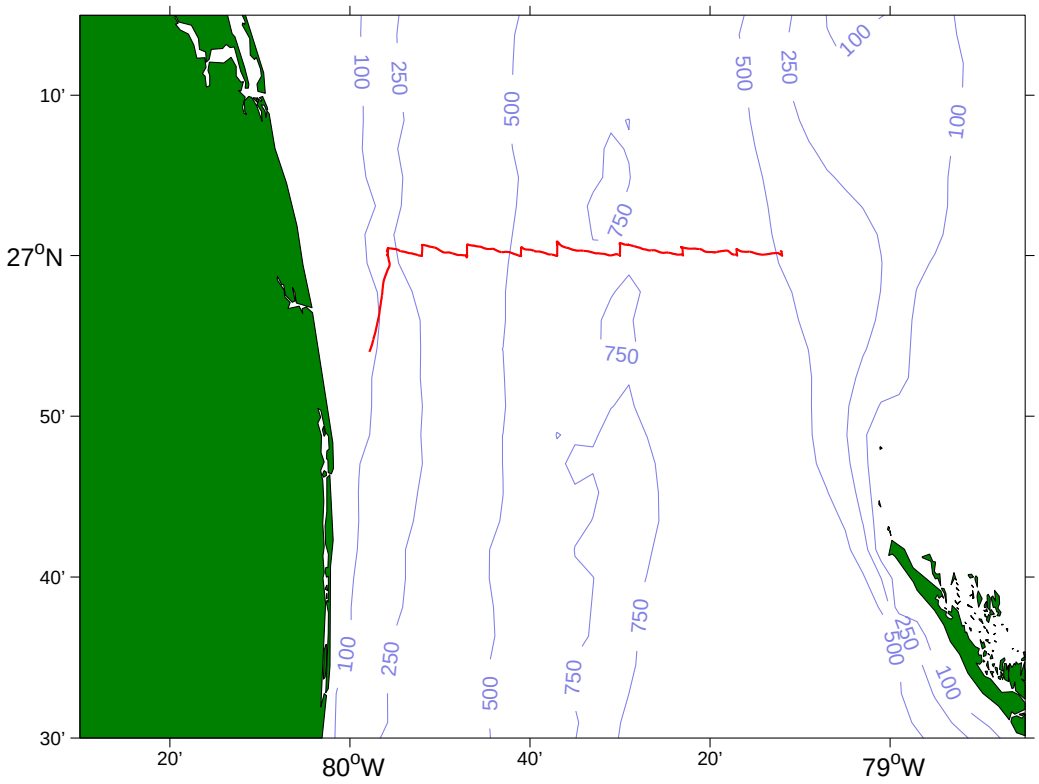


Figure 1: Typical cruise track

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
December 17, 2010								
0	12:26:13	-79.9299	27.0012	12:32: 6	-79.9299	27.0043	-0.84	95.87
1	12:47:17	-79.8662	27.0003	12:57:22	-79.8660	27.0057	2.63	98.33
2	13:15:39	-79.7830	27.0001	13:30:16	-79.7828	27.0076	3.11	95.16
3	13:49:40	-79.6829	27.0006	14: 9:35	-79.6828	27.0102	1.22	88.11
4	14:27:27	-79.6164	26.9999	14:51:45	-79.6162	27.0098	1.93	74.12
5	15:13:57	-79.4994	27.0004	15:42:39	-79.4997	27.0099	-1.36	60.60
6	16:14: 3	-79.3832	26.9999	16:38:24	-79.3833	27.0069	-1.14	52.37
7	16:57: 2	-79.2828	26.9999	17:20:24	-79.2836	27.0066	-5.88	52.04
8	17:43:33	-79.1987	27.0015	18: 1:30	-79.2006	27.0073	-17.06	59.33
March 16, 2011								
0	11:45:21	-79.9308	27.0040	11:51:14	-79.9305	27.0072	7.37	97.95
1	12: 8:59	-79.8673	27.0012	12:19:42	-79.8669	27.0078	6.44	111.70
2	12:41:33	-79.7832	27.0002	12:55:53	-79.7825	27.0090	8.96	112.82
3	13:18:47	-79.6838	26.9990	13:39: 8	-79.6830	27.0096	6.66	95.39
4	13:55:44	-79.6175	27.0005	14:21: 2	-79.6169	27.0124	4.01	85.88
5	14:46: 7	-79.5010	26.9991	15:15:43	-79.5012	27.0088	-0.95	60.49
6	15:42:24	-79.3822	27.0027	16:10:10	-79.3832	27.0111	-5.46	55.67
7	16:31:24	-79.2821	26.9998	16:55:51	-79.2833	27.0055	-7.86	42.85
8	17:15: 5	-79.2000	27.0014	17:35:41	-79.2006	27.0049	-4.59	31.74
May 27, 2011								
0	11:17:39	-79.9303	27.0004	11:23:57	-79.9303	27.0033	-0.60	84.92
1	11:42:33	-79.8660	27.0010	11:53:11	-79.8660	27.0070	1.48	103.87
2	12:16:14	-79.7831	27.0007	12:32:23	-79.7835	27.0095	-3.98	99.23
3	12:58:34	-79.6835	27.0004	13:20:24	-79.6849	27.0110	-9.96	88.08
4	13:38:45	-79.6172	27.0001	14: 4:18	-79.6192	27.0109	-13.43	77.80
5	14:31: 0	-79.4998	27.0000	15: 1:56	-79.5015	27.0108	-8.75	63.66
6	15:31:41	-79.3834	26.9991	16: 0: 9	-79.3843	27.0082	-5.06	58.12
7	16:22:49	-79.2833	27.0000	16:47:28	-79.2840	27.0074	-5.08	55.24
8	17: 6:52	-79.2006	27.0001	17:27:30	-79.2017	27.0044	-8.82	39.20
June 23, 2011								
0	11:23:59	-79.9311	26.9997	11:30:23	-79.9312	27.0037	-2.49	113.33
1	11:46:44	-79.8659	27.0013	11:57:13	-79.8659	27.0067	-0.56	94.48
2	12:18: 7	-79.7827	27.0007	12:34:16	-79.7831	27.0084	-2.35	88.55
3	13:16:40	-79.6831	27.0003	13:37:57	-79.6830	27.0118	1.02	98.52
4	13:54:42	-79.6170	26.9990	14:18:58	-79.6168	27.0112	0.73	91.71
5	14:47:22	-79.4998	27.0002	15:19:22	-79.5001	27.0131	-1.66	73.80
6	15:46:25	-79.3840	26.9996	16:14:43	-79.3841	27.0095	-1.52	65.18
7	16:42:11	-79.2829	27.0000	17: 7:15	-79.2835	27.0067	-2.83	49.00
8	17:24:20	-79.2003	26.9996	17:43:31	-79.2018	27.0044	-12.99	46.21

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

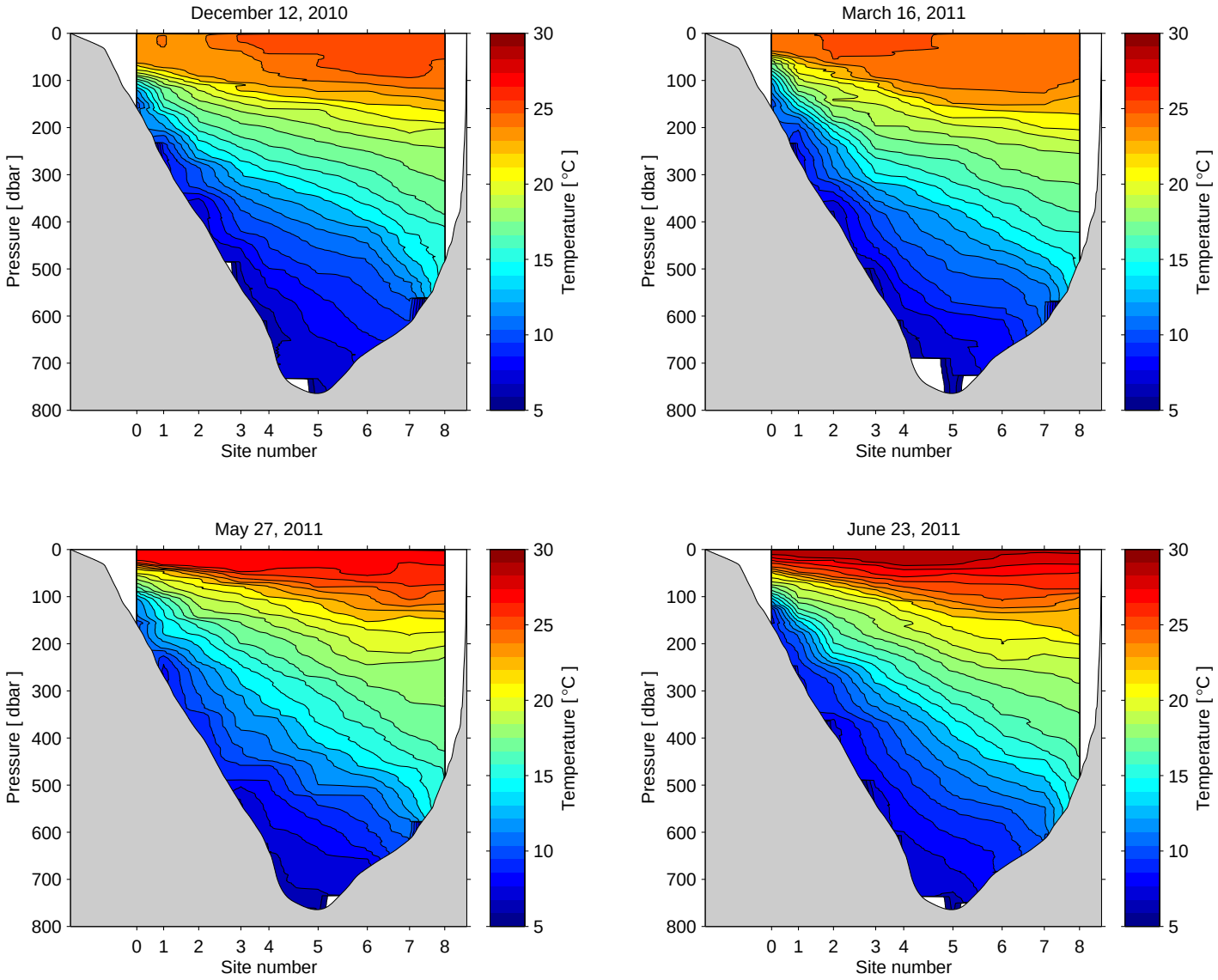
Sta	Deployed			Surfaced			Mean Velocities	
	Time (GMT)	Lon	Lat	Time (GMT)	Lon	Lat	U cm/s	V cm/s
September 16, 2011								
0	11:11: 4	-79.9296	27.0017	11:20: 9	-79.9291	27.0063	9.73	92.66
1	11:44:26	-79.8663	27.0009	12: 0:23	-79.8655	27.0092	7.88	95.17
2	12:28:50	-79.7827	27.0008	12:49:12	-79.7818	27.0129	7.06	109.15
3	13:19: 9	-79.6835	26.9998	13:47:39	-79.6821	27.0168	7.85	108.38
4	14:15:29	-79.6171	26.9983	14:49:43	-79.6161	27.0164	5.53	96.81
5	15:36:37	-79.5002	26.9997	16:16:51	-79.5007	27.0152	-1.99	70.21
6	16:59:25	-79.3835	26.9993	17:35:44	-79.3852	27.0092	-7.54	50.64
7	18:10:10	-79.2832	26.9992	18:42:34	-79.2853	27.0050	-10.60	33.68
8	19: 9:50	-79.2000	26.9992	19:35:32	-79.2017	27.0035	-10.61	32.03
September 28, 2011								
0	23:27:26	-79.9303	27.0005	23:35: 6	-79.9306	27.0049	-5.55	104.93
1	22:52:32	-79.8671	27.0010	23: 5:44	-79.8676	27.0078	-6.88	93.95
2	22: 6:44	-79.7835	27.0006	22:27:53	-79.7842	27.0127	-4.73	105.21
3	21: 8:48	-79.6834	27.0010	21:36:46	-79.6843	27.0162	-4.74	99.38
4	20:10:26	-79.6161	27.0030	20:43:45	-79.6170	27.0207	-4.47	97.34
5	18:50:44	-79.5003	27.0003	19:32:19	-79.5018	27.0174	-5.62	75.44
6	17:36:23	-79.3838	27.0007	18:13:31	-79.3858	27.0098	-8.70	45.55
7	16:31:34	-79.2836	26.9999	17: 4:13	-79.2852	27.0070	-7.38	40.32
8	15:39:20	-79.2003	27.0001	16: 4:21	-79.2016	27.0037	-8.39	27.34

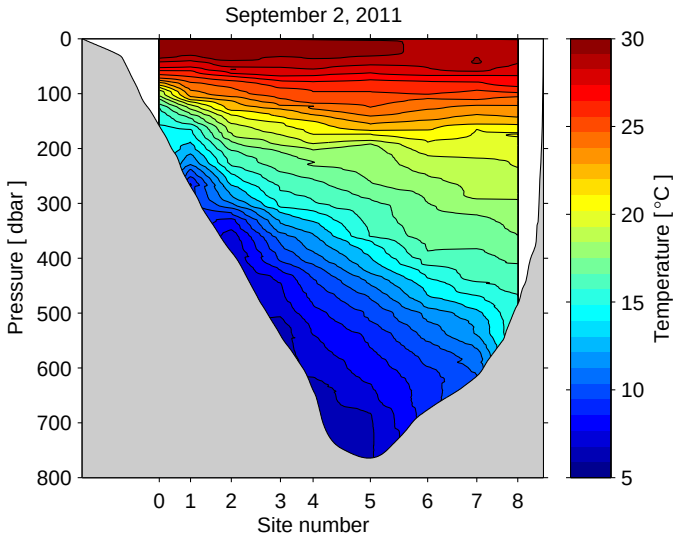
Table 2: Continued.

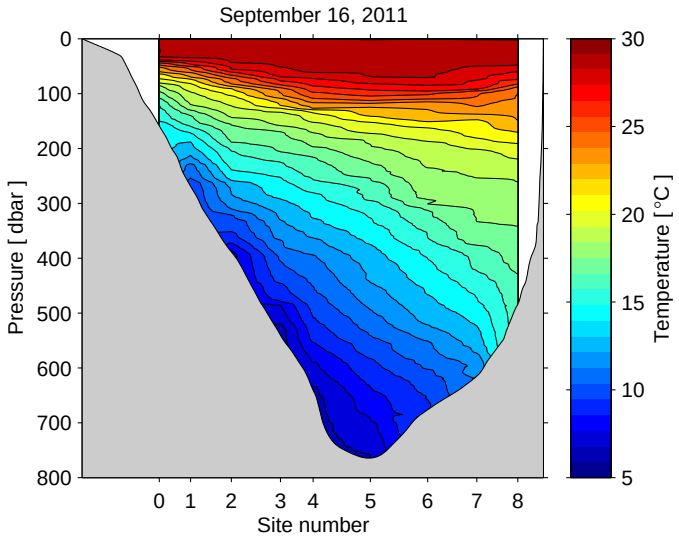
Date	Station #								
	0	1	2	3	4	5	6	7	8
December 17, 2010	143.38	176.24	54.02	176.84	155.74	109.93	103.95	89.36	88.13
March 16, 2011	217.46	200.73	192.60	148.90	129.59	63.71	93.20	62.42	25.47
May 27, 2011	212.21	169.67	167.74	190.81	140.47	136.21	122.47	82.99	31.90
June 23, 2011	159.87	183.94	68.58	183.09	169.15	155.33	53.62	72.26	62.97
September 16, 2011	148.61	170.93	222.24	214.47	173.85	135.02	48.03	-1.01	-11.48
September 28, 2011	203.12	176.02	183.94	187.84	174.11	120.68	61.20	2.34	6.88

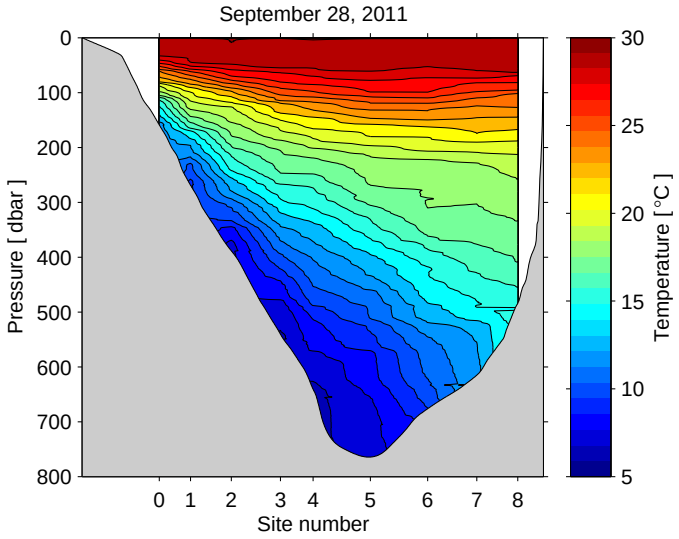
Table 3: Meridional Surface Velocities in cm/s. Values of -999 indicate instrument failure.

APPENDIX


December 12, 2010
March 16, 2011
May 27, 2011
June 23, 2011
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


September 2, 2011
Pressure [dbar]
0
100
200
300
400
500
600
700
800
0 1 2 3 4 5 6 7 8
Site number
Temperature [°C]
30
25
20
15
10
5


September 16, 2011
Pressure [dbar]
0
100
200
300
400
500
600
700
800
0 1 2 3 4 5 6 7 8
Site number
Temperature [°C]
30
25
20
15
10
5


September 28, 2011
Pressure [dbar]
0
100
200
300
400
500
600
700
800
0 1 2 3 4 5 6 7 8
Site number
Temperature [°C]
30
25
20
15
10
5