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

January 15, 2020

Final Cruise Report

U.S. Dept. of State Cruise No: F2016-061.

Ship Names: R/V Angler Management (trip 1); R/V Rhode Trip (trips 2-8).

Dates: March 30, 2017; June 15, 2017; July 6, 2017; July 24, 2017; August 3, 2017; August 11, 2017; August 16, 2017; August 29, 2017.

Project Investigators: Molly Baringer and Christopher Meinen

Chief Scientist (for cruises): Christopher Meinen

Foreign Participants: None

Operating Institution: NOAA/AOML

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

Project Title: Western Boundary Time Series.

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 or sphere 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 as part of this project, the dropsonde measurements are augmented by XBT casts at all nine of the nominal station locations to measure the vertical temperature profile.

Data Observations and Samples Collected:

This report refers to the last 8 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 sphere housing a Garmin GPS 18x PC receiver/logger (or equivalent), RDF beacon, pinger, and batteries. A second Magellan 5000 Pro GPS receiver (or equivalent) 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 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:

Serious electronics issues with both instruments, dropsonde and XBT, occurred during this period. Electronics issues during the cruise on March, the two cruises on July, and the cruise on August 29, 2017 resulted in the failure of the velocity estimates at one or more stations. During this period, the XBT system failed to record data in at least one of the stations during each cruise as shown in the figures in the Appendix.

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

Acknowledgements: A sincere thanks to Pedro Pena, Grant Rawson, Zachary Barton, and Tom Sevilla for their participation in these cruises and to the crew of the Angler Management and Rhode Trip for their reliable assistance.

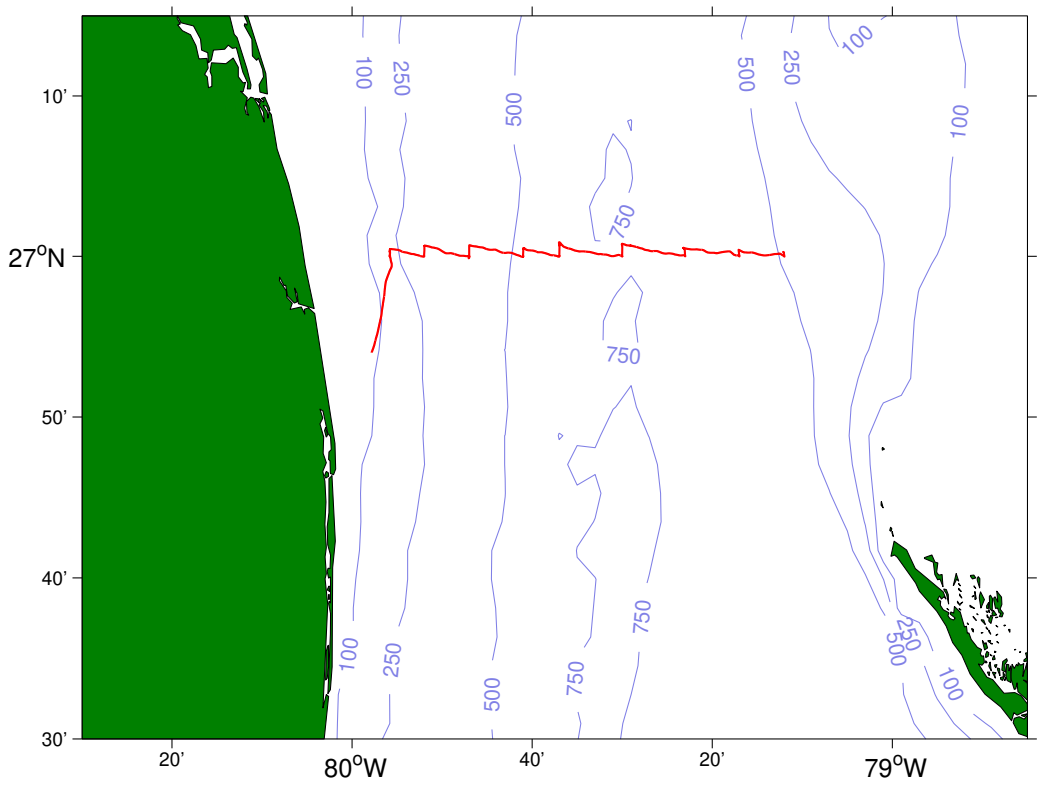


Figure 1: Typical cruise track

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
March 3, 2017								
0	7:21: 4	-79.9300	27.0001	7:29:33	-79.9300	27.0019	0.75	38.45
1	8:16: 5	-79.8667	27.0001	8:30:54	-79.8669	27.0048	-2.26	56.57
2	8:51:38	-79.7836	26.9998	9:13:45	-79.7839	27.0097	-2.43	81.31
3	9:36:36	-79.6834	27.0001	10: 7: 0	-79.6841	27.0158	-4.60	94.81
4	10:26:12	-79.6167	27.0000	11: 2:25	-79.6171	27.0196	-1.57	99.20
5	11:32:49	-79.4999	27.0001	12:14:51	-79.5007	27.0178	-2.59	77.45
6	12:43:42	-79.3834	27.0001	13:21:41	-79.3843	27.0131	-3.79	62.90
7	13:46:33	-79.2833	27.0001	14:20:55	-79.2856	27.0126	-11.20	67.50
8	99:99: 0	-79.2000	27.0000	99:99: 0	-79.2000	27.0000	-999.00	-999.00
June 15, 2017								
0	19:42:17	-79.9167	27.0014	19:52: 3	-79.9166	27.0067	2.36	98.38
1	19: 4:59	-79.8667	27.0022	19:20:32	-79.8662	27.0114	3.91	108.58
2	18:13:55	-79.7837	27.0015	18:37:10	-79.7832	27.0157	3.67	110.89
3	17:14:39	-79.6837	27.0010	17:45:49	-79.6828	27.0196	4.81	109.31
4	16:15: 3	-79.6163	27.0013	16:51:14	-79.6160	27.0205	1.87	97.42
5	15: 1:33	-79.5000	27.0005	15:45:20	-79.5006	27.0196	-2.37	79.55
6	13:53: 0	-79.3834	27.0007	14:32: 4	-79.3838	27.0158	-1.90	70.93
7	12:53:16	-79.2835	27.0004	13:29:20	-79.2849	27.0127	-7.11	63.01
8	12: 3:42	-79.2000	26.9999	12:31:16	-79.2013	27.0056	-7.81	37.93
July 6, 2017								
0	20:19:25	-79.9168	27.0013	20:30:16	-79.9172	27.0058	-7.03	75.09
1	19:42:44	-79.8672	27.0014	19:59:30	-79.8673	27.0086	-0.34	77.57
2	99:99: 0	-79.7833	27.0000	99:99: 0	-79.7833	27.0000	-999.00	-999.00
3	17:54: 2	-79.6831	27.0004	18:28:20	-79.6822	27.0212	4.83	111.13
4	16:45: 0	-79.6161	27.0010	17:28: 2	-79.6145	27.0250	5.63	102.34
5	15:28:41	-79.4995	27.0014	16:16:39	-79.4987	27.0242	2.46	86.98
6	99:99: 0	-79.3833	27.0000	99:99: 0	-79.3833	27.0000	-999.00	-999.00
7	14: 8:18	-79.2835	27.0006	14:45:56	-79.2845	27.0109	-4.47	49.91
8	13:11:36	-79.1999	27.0005	13:40:47	-79.2012	27.0060	-7.79	35.49
July 24, 2017								
0	99:99: 0	-79.9333	27.0000	99:99: 0	-79.9333	27.0000	-999.00	-999.00
1	99:99: 0	-79.8667	27.0000	99:99: 0	-79.8667	27.0000	-999.00	-999.00
2	99:99: 0	-79.7833	27.0000	99:99: 0	-79.7833	27.0000	-999.00	-999.00
3	99:99: 0	-79.6833	27.0000	99:99: 0	-79.6833	27.0000	-999.00	-999.00
4	99:99: 0	-79.6167	27.0000	99:99: 0	-79.6167	27.0000	-999.00	-999.00
5	20:57:18	-79.5008	27.0012	21:49:45	-79.4988	27.0293	5.98	98.66
6	19:33:41	-79.3838	27.0011	20:29:40	-79.3827	27.0207	2.39	64.68
7	18:22:14	-79.2833	27.0006	19:10:45	-79.2835	27.0110	-1.05	39.07
8	17:23:21	-79.1997	26.9995	17:57:11	-79.2008	27.0034	-5.60	21.39

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 3, 2017								
0	19:31:45	-79.9162	27.0005	19:41: 2	-79.9161	27.0058	1.92	106.69
1	19: 0: 0	-79.8664	27.0014	19:14:25	-79.8664	27.0094	-0.02	101.80
2	18:16:46	-79.7842	27.0003	18:37:29	-79.7845	27.0129	-2.02	111.75
3	17:20:58	-79.6826	27.0010	17:50:30	-79.6828	27.0182	-1.09	107.99
4	16:23:11	-79.6162	27.0011	16:59:27	-79.6163	27.0210	-0.67	101.04
5	15:12:13	-79.5001	27.0002	15:52:53	-79.5018	27.0183	-7.12	81.64
6	14: 4:29	-79.3836	27.0008	14:41:39	-79.3859	27.0113	-10.43	51.54
7	13: 7:32	-79.2833	27.0001	13:40:38	-79.2853	27.0076	-9.93	42.39
8	12:20:48	-79.1983	27.0004	12:46: 7	-79.2001	27.0051	-12.16	35.01
August 11, 2017								
0	11: 6:28	-79.9165	27.0009	11:16: 1	-79.9162	27.0071	5.98	118.06
1	11:34:59	-79.8664	27.0004	11:51: 0	-79.8657	27.0117	6.73	129.07
2	12:12: 8	-79.7835	27.0003	12:33:26	-79.7837	27.0126	-1.48	105.55
3	12:57:23	-79.6833	26.9990	13:27: 2	-79.6838	27.0138	-2.44	91.62
4	13:47:43	-79.6164	26.9994	14:22:38	-79.6173	27.0141	-4.77	77.08
5	14:46: 3	-79.4996	27.0003	15:26:21	-79.5008	27.0162	-5.65	72.33
6	15:49: 3	-79.3823	26.9992	16:26:14	-79.3822	27.0126	0.31	66.12
7	16:48:38	-79.2829	26.9995	17:23: 9	-79.2831	27.0078	-0.47	44.02
8	17:42:41	-79.1994	26.9994	18: 8:51	-79.2006	27.0052	-8.04	42.06
August 16, 2017								
0	10:56: 8	-79.9162	27.0007	11: 5:42	-79.9161	27.0056	0.48	93.72
1	11:22:50	-79.8665	27.0001	11:38:45	-79.8663	27.0080	2.17	89.84
2	12:30:26	-79.7832	26.9997	12:53:20	-79.7829	27.0130	2.36	105.75
3	13:11:13	-79.6835	27.0003	13:42: 0	-79.6828	27.0189	3.39	110.93
4	13:56:21	-79.6165	27.0003	14:33:45	-79.6157	27.0200	3.10	96.44
5	14:56:30	-79.4998	27.0001	15:37:22	-79.5001	27.0188	-1.56	83.81
6	16: 5:28	-79.3834	26.9994	16:45:40	-79.3835	27.0163	-1.16	77.39
7	17: 5: 6	-79.2828	27.0000	17:42: 3	-79.2838	27.0118	-4.74	59.02
8	17:56:47	-79.1998	26.9995	18:22:43	-79.2017	27.0053	-12.40	41.51
August 29, 2017								
0	11:21:53	-79.9165	27.0009	11:32:53	-79.9161	27.0076	5.89	111.52
1	18:28:53	-79.8662	27.0010	18:42:37	-79.8653	27.0088	10.73	103.24
2	11:57: 9	-79.7836	27.0009	12:20: 1	-79.7832	27.0154	2.87	117.28
3	12:43:36	-79.6833	27.0008	13:14:18	-79.6831	27.0183	0.94	105.11
4	13:30:44	-79.6165	27.0006	14: 4:58	-79.6165	27.0175	-0.88	91.15
5	14:28:24	-79.4995	27.0008	15: 9:14	-79.4999	27.0157	-1.37	67.39
6	99:99: 0	-79.3833	27.0000	99:99: 0	-79.3833	27.0000	-999.00	-999.00
7	15:43:10	-79.2826	26.9999	16:15: 9	-79.2841	27.0079	-8.33	45.95
8	16:34:54	-79.1999	27.0007	17: 0:16	-79.2016	27.0062	-10.71	40.29

Table 2: Continued.

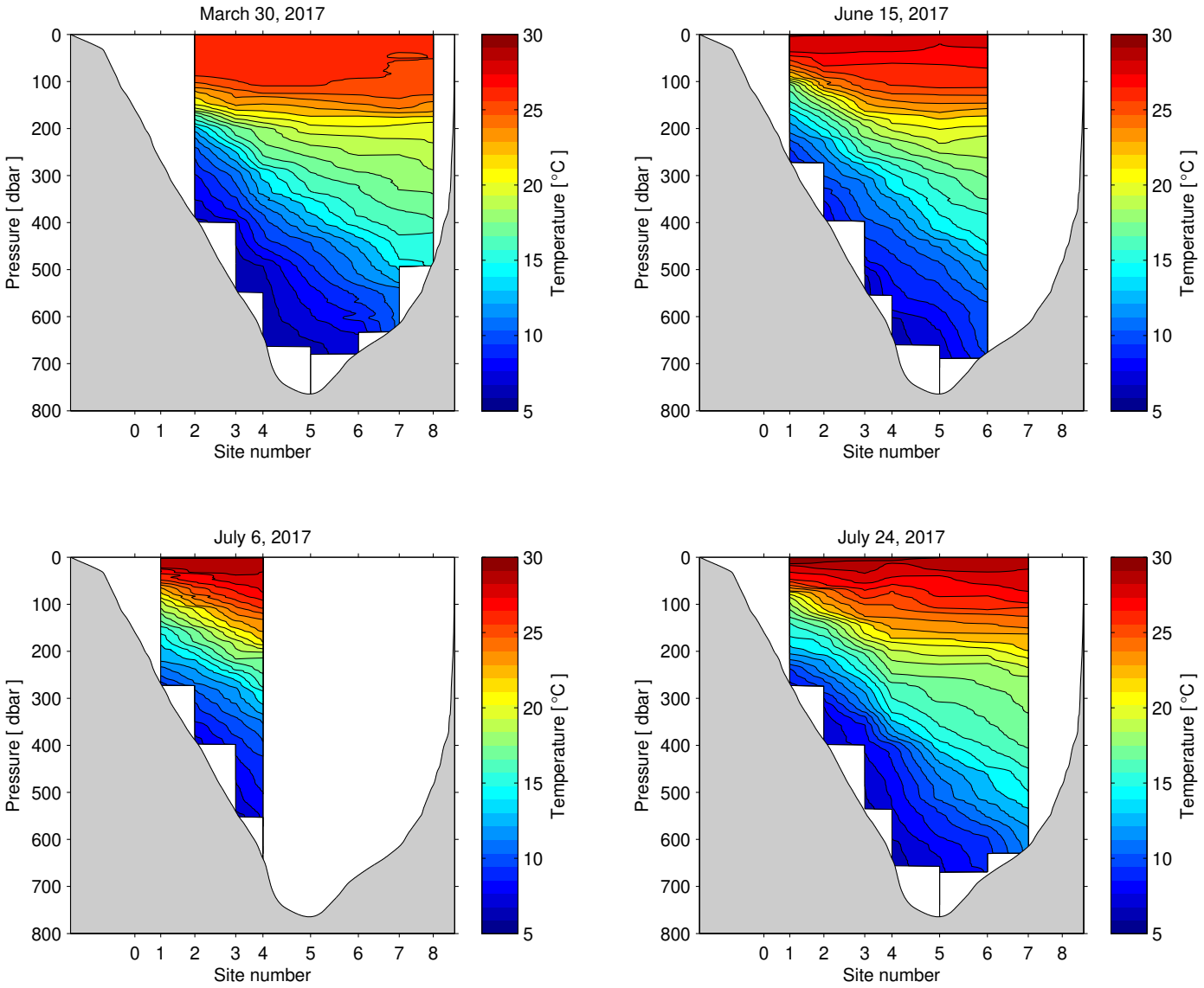
Table 3: Dropsonde Data: Values of -999 indicate instrument failure.

Date	Station #								
	0	1	2	3	4	5	6	7	8
March 30, 2017	113.95	199.54	177.43	156.70	156.93	123.88	114.74	68.85	-999.00
June 15, 2017	237.17	213.73	229.41	204.32	187.59	155.35	109.42	71.80	57.96
July 6, 2017	209.69	195.18	-999.00	207.46	179.23	173.25	-999.00	80.25	-1.77
July 24, 2017	-999.00	-999.00	-999.00	-999.00	-999.00	145.30	90.16	63.01	20.03
August 3, 2017	60.94	193.19	187.59	139.58	162.28	117.70	93.33	18.93	28.08
August 11, 2017	207.90	205.51	191.63	156.57	171.72	135.16	95.85	86.65	0.17
August 16, 2017	198.94	222.84	205.51	193.33	169.31	136.21	120.08	71.79	5.03
August 29, 2017	173.85	181.90	177.43	156.93	120.44	91.54	-999.00	47.07	35.04

Table 4: Meridional Surface Velocities in cm/s. Values of -999 indicate instrument failure.

.

APPENDIX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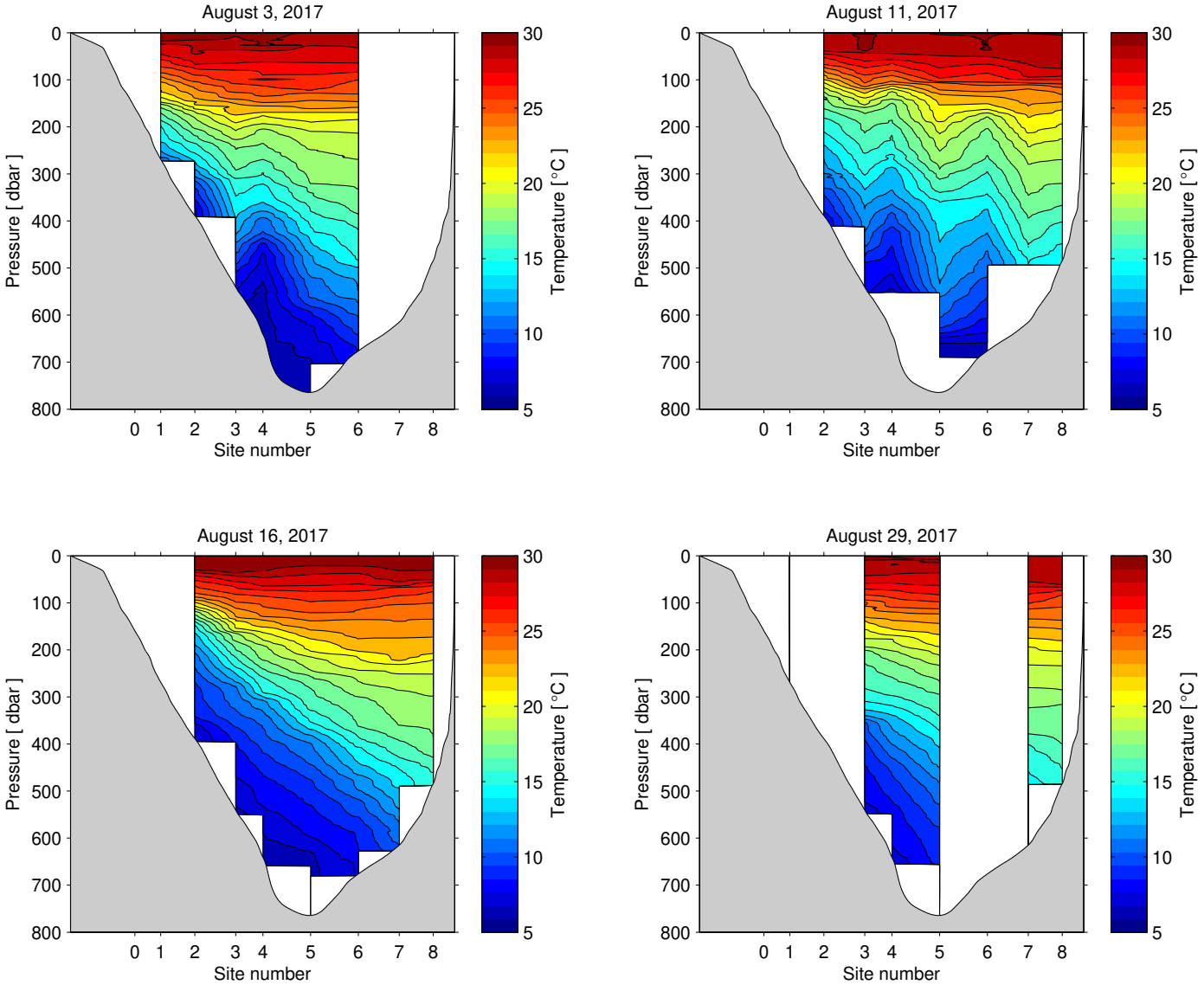
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