Cruise Summary

FGB Rapid Response 2016 (FGB-RR16)
30 July – 2 August 2016

Vessel: R/V Manta
Cruise duration: 3 days

Mobilization: Galveston Texas	30 July 2016
At sea:	30 July – 2 August 2016
Demobilization: Galveston Texas	2 August 2016

Cruise Summary:

A research cruise was conducted to obtain oceanographic observations in the northwestern Gulf of Mexico, 28 July – 2 August 2016,. The primary objective was to estimate oceanographic properties in the vicinity of Flower Garden Banks National Marine Sanctuary. This was a Rapid Response Cruise to investigate the environmental conditions associated with a massive die off event in the sanctuary. The cruise designator for this cruise is FGB-RR16.

Measurement Objectives:

1. Perform 25 CTD stations in the vicinity of FGBNMS;
2. Collect hydrographic profiles of temperature/salinity/dissolved oxygen/fluorometer/turbidity using a Seabird SBE25 CTD;
3. Collect underway surface properties using the ship's flowthrough system;
4. Collect dissolved nutrients, bottle oxygen, and salinity samples for chemical analysis;
5. Collect samples for phytoplankton classification;
6. Collect samples for post-cruise 16S rRNA analysis;
7. Collect samples for CO2 system analysis.

<u>Cruise Synopsis:</u>

The cruise transited from Galveston, Texas, to the Flower Garden Banks National Marine Sanctuary on 30 July 2016. A total of 39 CTD stations were performed in a 5x5 grid that encompassed the East and West FGB. CTD Station locations are given in the following table (Table 1). Stations are listed in order of preferred sequence. Naming convention is FGB-RRXX, where XX is column-row of station. Same stations were repeated to collect sufficient water samples for analysis. Three stations were performed near the coral head (20 m depth) of East Bank. The ship returned to Galveston early on 2 August 2016.

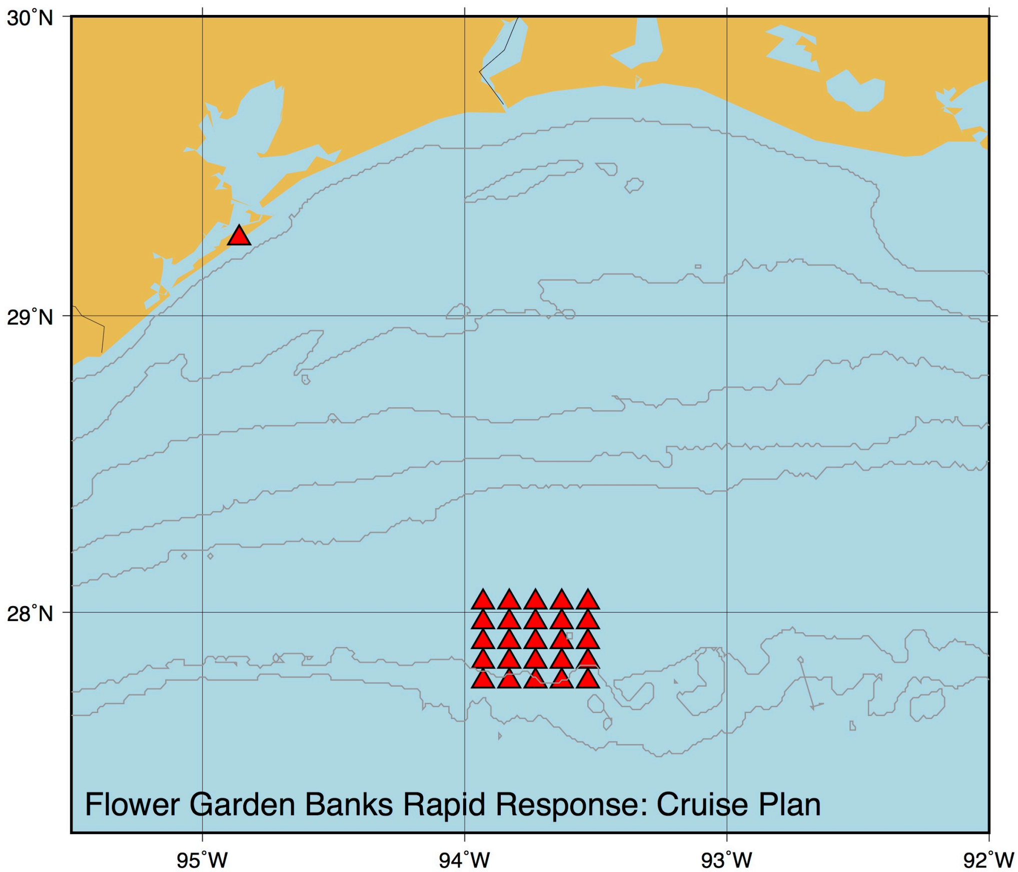


Figure 1. Planned location of 25 CTD stations near FGBNMS.

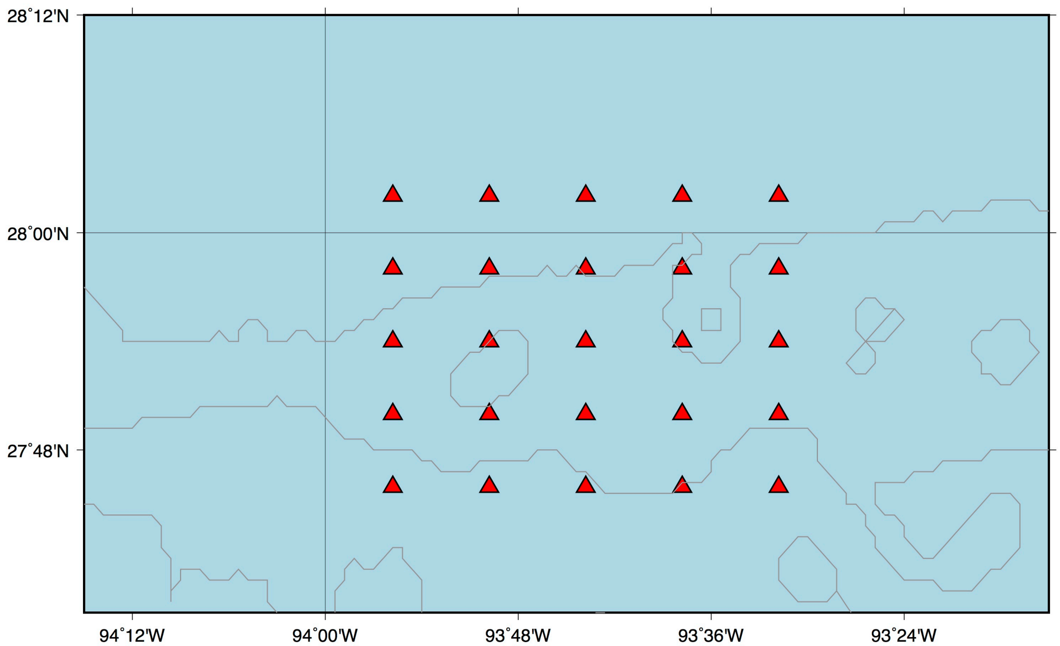


Figure 2. Detail of planned FGB-RR16 cruise CTS locations.

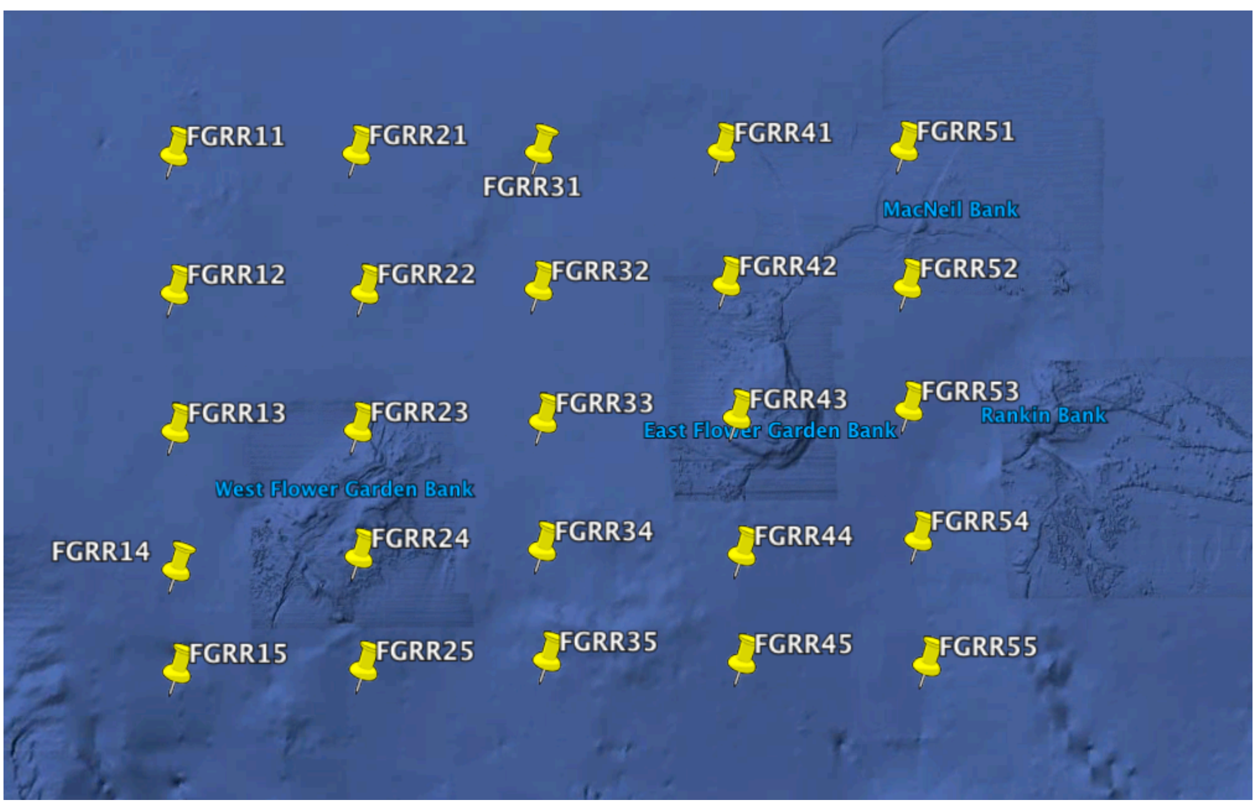


Figure 3. GoogleEarth map of planned FGB-RR16 CTD stations and station names.

Table 1. Planned Position and Station names.

Lat (N)	Lon (W)	Station
28.0340	93.9300	FGRR-11
27.9670	93.9300	FGRR-12
27.9000	93.9300	FGRR-13
27.8330	93.9300	FGRR-14
27.7660	93.9300	FGRR-15
28.0340	93.8300	FGRR-21
27.9670	93.8300	FGRR-22
27.9000	93.8300	FGRR-23
27.8330	93.8300	FGRR-24
27.7660	93.8300	FGRR-25
28.0340	93.7300	FGRR-31
27.9670	93.7300	FGRR-32
27.9000	93.7300	FGRR-33
27.8330	93.7300	FGRR-34
27.7660	93.7300	FGRR-35
28.0340	93.6300	FGRR-41
27.9670	93.6300	FGRR-42
27.9000	93.6300	FGRR-43
27.8330	93.6300	FGRR-44
27.7660	93.6300	FGRR-45
28.0340	93.5300	FGRR-51
27.9670	93.5300	FGRR-52
27.9000	93.5300	FGRR-53
27.8330	93.5300	FGRR-54
27.7660	93.5300	FGRR-55

Point of CONTACT INFORMATION

Steven F. DiMarco, Professor
Department of Oceanography
Texas A&M University
College Station, TX 77845
Office: 979-862-4168
Cell: 979-324-5336
FAX: 979-847-8879
Email: sdimarco@tamu.edu

SCIENCE PARTY

LIST of PARTICIPANTS AND AFFILIATIONS

Chief Scientist
  Dr. Matthew Howard, Texas A&M University
Senior Scientists
  Dr. Jamie Steichen, Texas A&M University at Galveston
  Dr. Laura Bretherton, Texas A&M University at Galveston
  Ms. Heather Zimmerle, Data Cop, Texas A&M University
Research Assistant
  Mr. Tyler Byrne, CTD Operator, Texas A&M University
Graduate Students
  McKenzie Daugherty (Phytoplankton) Texas A&M University
  Emily Whitaker (Microbial Processes) Texas A&M University
  John Schiff (CO_2 System) Texas A&M University
Undergraduate Students
  Brian Buckingham (Water Sampling) Texas A&M University

<u>Instrumentation</u>

CTD/rosette system: SBE-25
  Six Niskin Rosette (4-L)
  Seabird CTD: SBE-25
  Wetlabs Fluorometer/Turbidity/PAR
  Deckbox
  Computer
  Sample bottles/plastic syringes
  SBE-43 Oxygen sensor on package DID NOT WORK

Winkler Titration system
  Titrator
  Computer
  Flasks/tubing
  Chemicals

Flow-through system: thermosalinograph, Chelsea fluorometer

The following series of images were taken from the OOF numerical model:
http://pong.tamu.edu/oof_v2/main/forecast.php

The OOF model is a real-time nowcast/forecasr numerical modeling system run by R. Hetland at TAMU. The model is funded in part by NOAA and Texas GLO.

Texas Automated Buoy Data are available at tabs.gerg.tamu.edu.

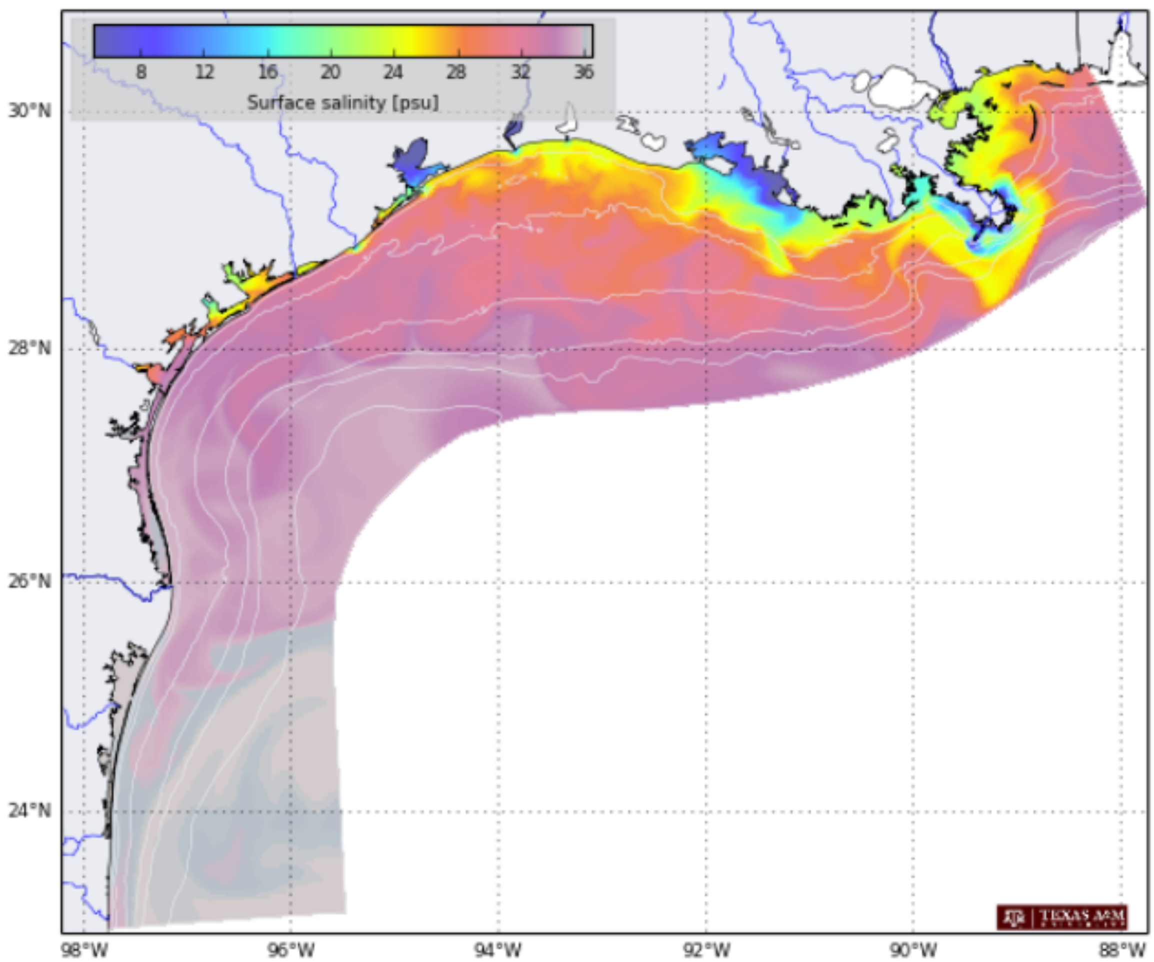


Figure 01. Sea surface salinity 29 July 2016 from OOF model system. Image courtesy R. Hetland TAMU.

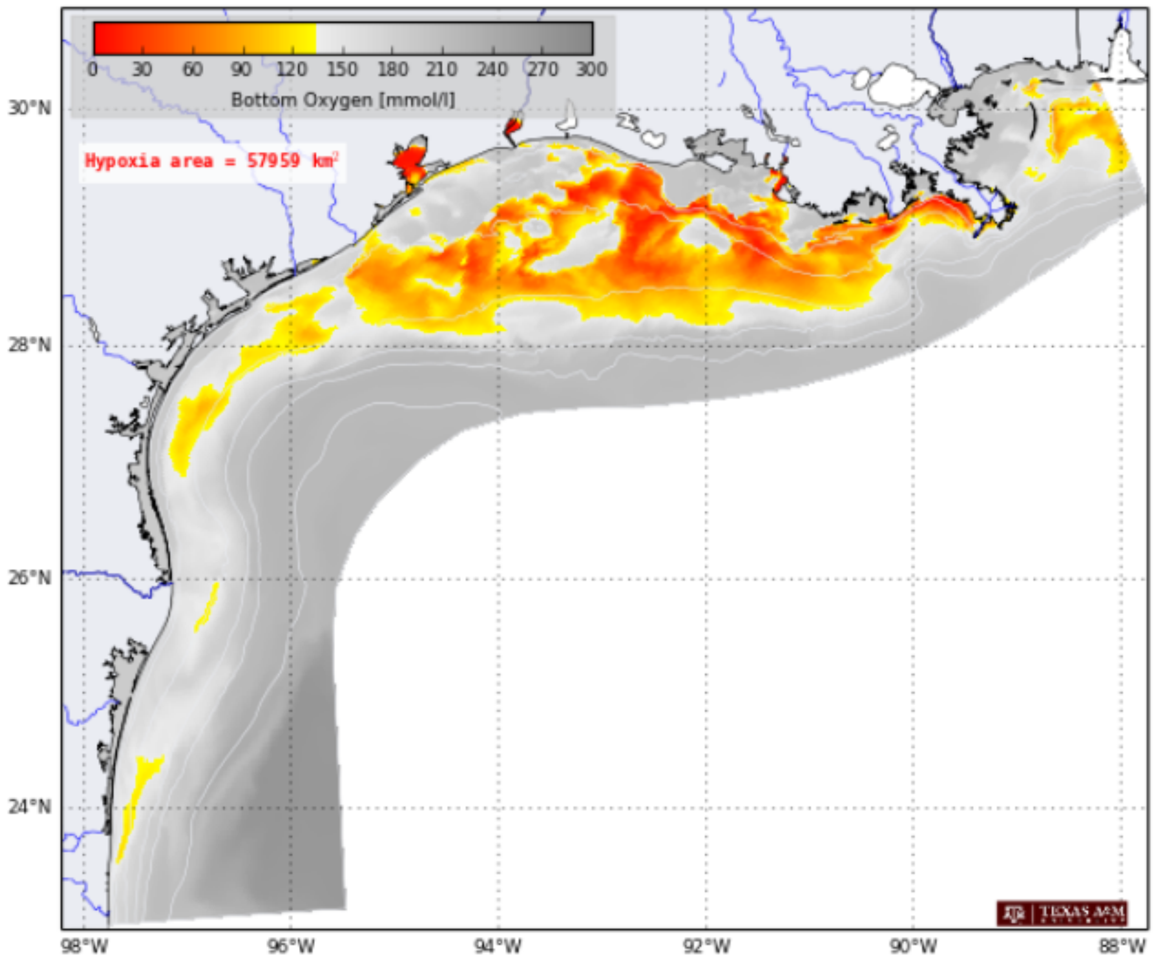
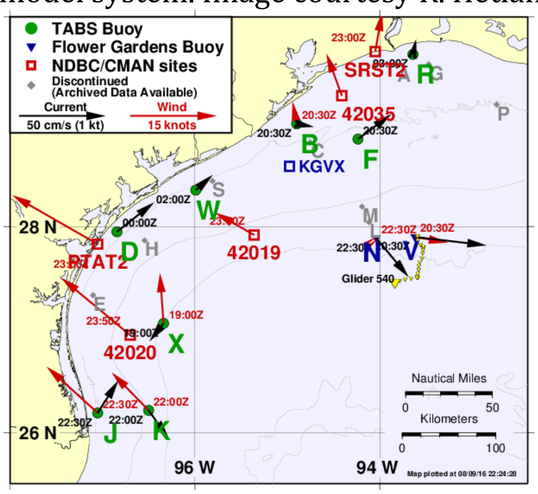


Figure O2. Near bottom dissolved oxygen concentration 29 July 2016 from OOF model system. Image courtesy R. Hetland TAMU.



TABS Buoys locations.

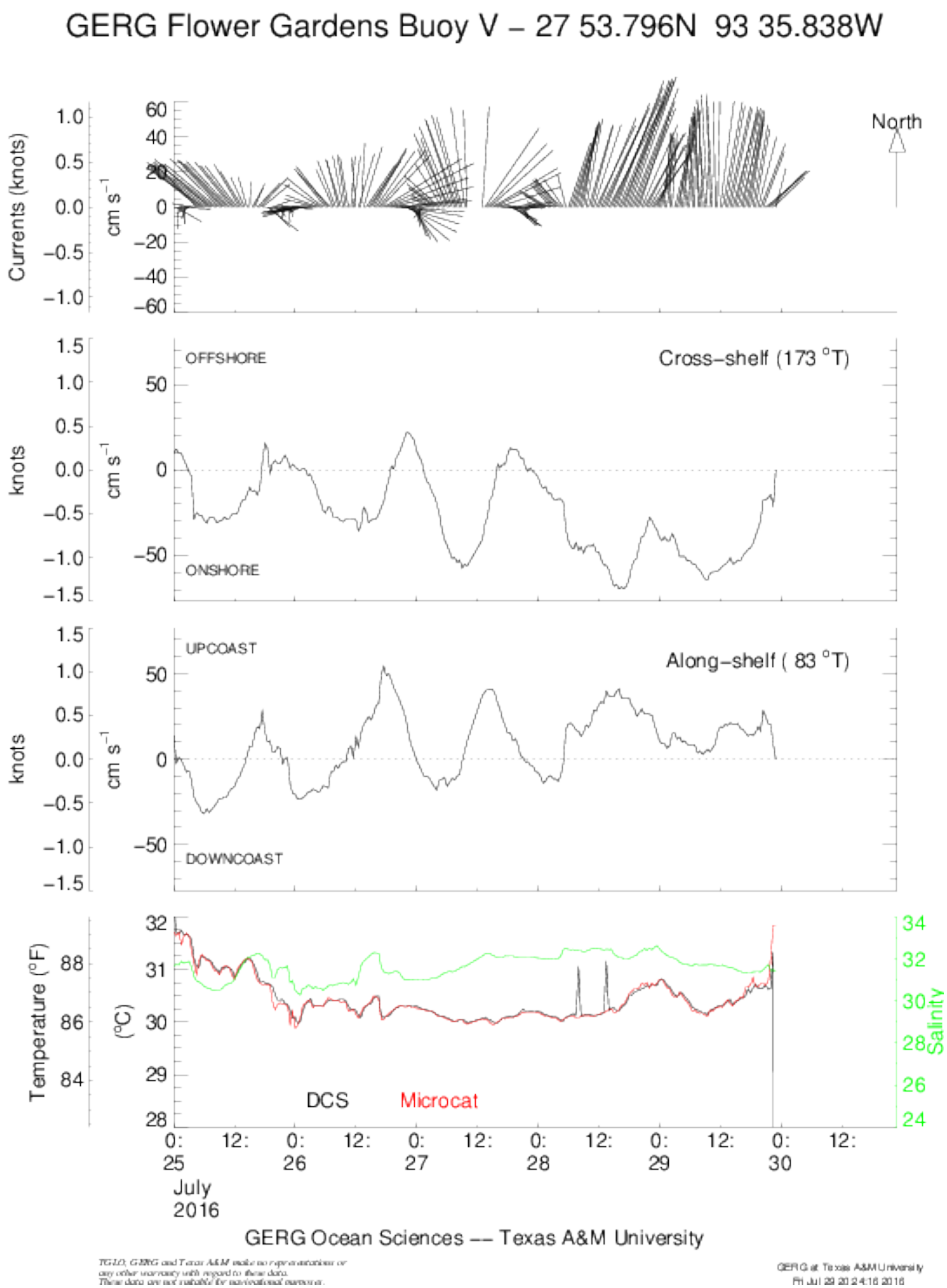


Figure O3. Observations at TABS Buoy V. (West side of sanctuary).

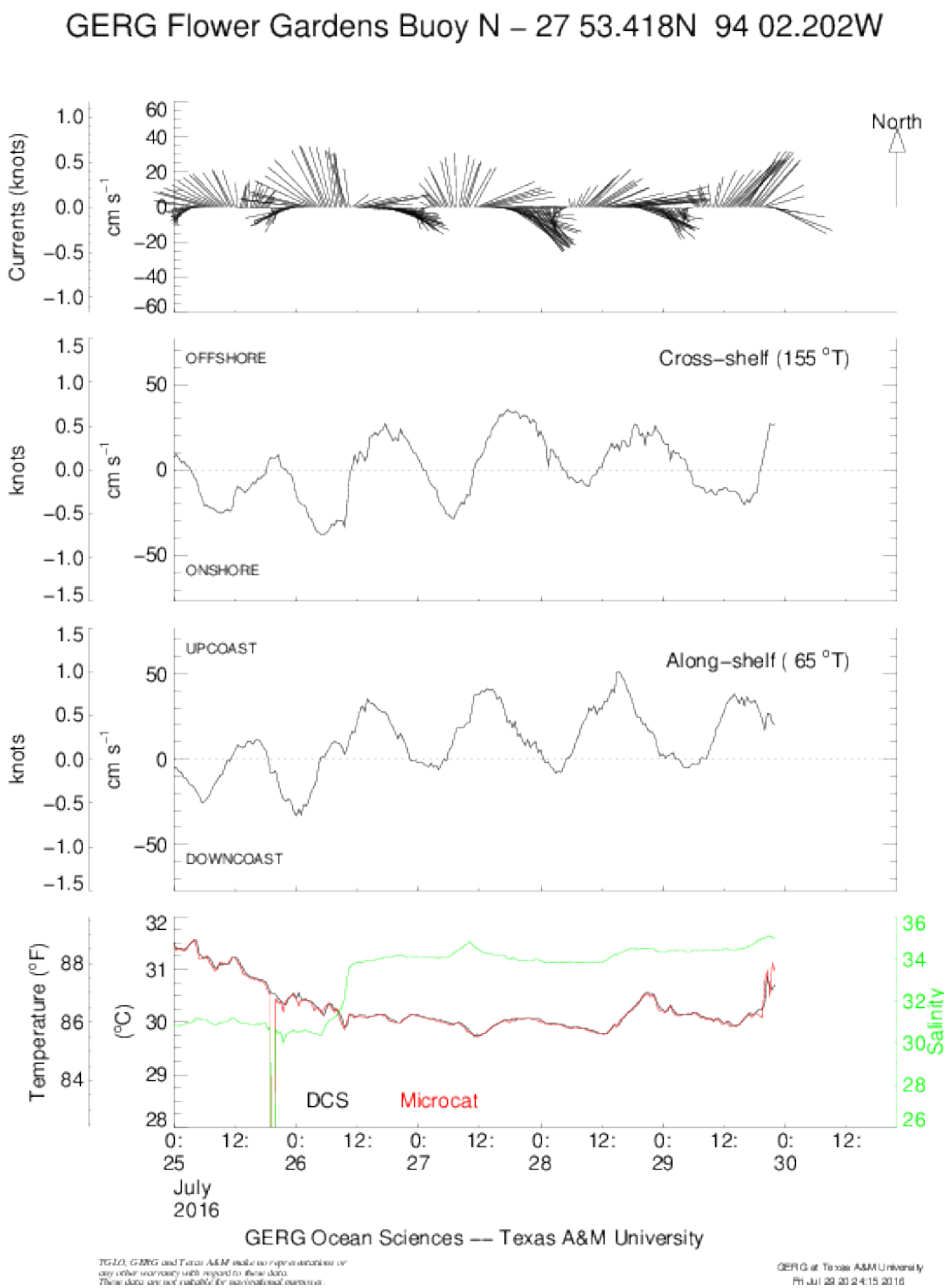


Figure O4. Observations at TABS Buoy N. East side of sanctuary.

RESULTS

The locations, depth and sequence number for the 39 CTD casts are given in the following table. This information is in the accompanying 'ACTUALS' file.

```
# Flower Garden Banks Rapid Response 2016 (FGBRR16)
# R/V Manta
# CTD Data
# Bottom depth (m) is the bottom of the CTD cast from the pressure
sensor
# Bottom Depth can be revised from the CTD operator's log
# Last Revision of this file 03-Aug-2016
# Matthew Howard mkhoward@tamu.edu
# Point of Contact Dr. Steven DiMarco sdimarco@tamu.edu
# END
```

Station	Date-Time (UTC)	Lat	Lon	Seq	Bottom
FGRR-11	2016-07-31T11:45:31Z	28.0346	93.9292	001	67.5
FGRR-11a	2016-07-31T14:03:35Z	28.0350	93.9287	002	65.5
FGRR-12	2016-07-31T15:11:13Z	27.9667	93.9296	003	82.0
FGRR-13	2016-07-31T16:23:48Z	27.9000	93.9295	004	105.5
FGRR-13a	2016-07-31T16:57:17Z	27.9002	93.9302	005	106.5
FGRR-14	2016-07-31T17:36:59Z	27.9000	93.9295	004	105.5
FGRR-14a	2016-07-31T18:10:31Z	27.8316	93.9267	007	148.5
FGRR-15	2016-07-31T19:03:53Z	27.7654	93.9276	008	233.5
FGRR-15a	2016-07-31T19:51:59Z	27.7658	93.9280	009	237.5
FGRR-25	2016-07-31T20:49:03Z	27.7657	93.8292	010	230.0
FGRR-25a	2016-07-31T21:16:10Z	27.7640	93.8271	011	232.0
FGRR-25b	2016-07-31T21:59:27Z	27.7656	93.8299	012	233.5
FGRR-24	2016-08-01T00:23:28Z	27.8325	93.8279	013	116.0
FGRR-24a	2016-08-01T01:08:32Z	27.8312	93.8299	014	112.0
FGRR-24b	2016-08-01T01:47:26Z	27.8331	93.8335	015	113.0
FGRR-23	2016-08-01T02:39:37Z	27.8999	93.8280	016	89.0
FGRR-22	2016-08-01T03:36:33Z	27.9682	93.8326	017	92.5
FGRR-21	2016-08-01T04:35:18Z	28.0345	93.8302	018	73.5
FGRR-31	2016-08-01T05:35:31Z	28.0345	93.7313	019	86.5
FGRR-32	2016-08-01T06:35:44Z	27.9678	93.7290	020	96.5
FGRR-33	2016-08-01T07:40:16Z	27.9006	93.7305	021	102.5
FGRR-34	2016-08-01T08:47:01Z	27.8344	93.7319	022	145.0
FGRR-35	2016-08-01T09:54:22Z	27.7675	93.7311	023	207.0
FGRR-45	2016-08-01T10:55:34Z	27.7674	93.6315	024	191.0
FGRR-44	2016-08-01T11:46:42Z	27.8338	93.6298	025	126.0
FGRR-44a	2016-08-01T12:07:26Z	27.8346	93.6290	026	125.0
FGRR-43	2016-08-01T12:57:17Z	27.9005	93.6300	027	99.0
FGRR-43a	2016-08-01T13:20:32Z	27.8997	93.6300	028	98.0
FGRR-43b	2016-08-01T14:46:26Z	27.9001	93.6300	029	60.5
FGRR-43BC1	2016-08-01T15:56:58Z	27.9092	93.5998	030	20.0
FGRR-43BC2	2016-08-01T16:48:35Z	27.9102	93.5982	031	20.0
FGRR-43BC3	2016-08-01T17:37:36Z	27.9072	93.5989	032	17.5
FGRR-42	2016-08-01T18:19:54Z	27.9666	93.6306	033	93.0
FGRR-41	2016-08-01T19:09:08Z	28.0327	93.6294	034	88.5
FGRR-51	2016-08-01T20:06:51Z	28.0331	93.5298	035	87.0
FGRR-52	2016-08-01T20:49:55Z	27.9663	93.5317	036	101.5
FGRR-53	2016-08-01T21:38:43Z	27.8996	93.5300	037	140.5
FGRR-54	2016-08-01T22:31:36Z	27.8294	93.5326	038	189.5
FGRR-55	2016-08-01T23:21:07Z	27.7661	93.5228	039	241.5

Seqence	Niskin #	Station #	Latitude	Longitude	Date	Time	Max Depth(m) log	Max Depth(m) data	Depth(m)	Bottles Fired	DO	Nutrients	Salt	Total alk. - John	Microb. Cell - Emily	Phyto - Campbell	Phyto - Quigg	CO2 - Hu	Hydrocarbon (water sample)	RNA
1	SB	11	28.2.053	93.55.781	7/31/16	11:43	69	ND		3										
	6																			
	5																			
	4																			
	3																			
	2																			
	1																			
2	SB	11a	28.2.027	93.55.784	7/31/16	14:07	69	65	Surface	6		1	373							
	6								1.01		332	7		246			X			
	5								10.59		130	6		245			X			
	4								20.8		319	5		244			X			
	3								36		15	4		243			X			
	2								51		2	3		242			X			
	1								65		121/31	2		241			X			
3	SB	12	27.58.001	93.55.799	7/31/16	15:10	82	79.5	Surface	6		8	365							
	6								1.14		22	14		252			X			
	5								9.25		16	13		251			X			
	4								19.98		127	12		250			X			
	3								39.5		342	11		249		X	X			
	2								59.12		305	10		248			X			
	1								79.5		306	9		247		X	X			
4	SB	13	27.53.998	93.55.774	7/31/16	16:21	103	104.88	Surface	6		15	669			X				
	6								0.81		72	21			X		X			
	5								18.73		45	20					X			
	4								39.08		30	19					X			
	3								65.5		142	18			X	X				
	2								81.28		320	17			X		X			
	1								104.88		116	16			X	X	X			
5	No SB	13a	27.54.008	93.55.814	7/31/16	16:58	106.31	106.63		6										
	6								0.91					258						
	5								19.04					257						
	4								39.95					256/260						
	3								66.13					255			X			
	2								82.31					254/259						
	1								106.31					253						
6	SB	14	27.49.867	93.55.595	7/31/16	17:39	148	148	Surface	6		22	618							
	6								28.5											
	5								28.5		5	27								
	4								53.75		149	26				X				
	3								76.83		137	25			X					
	2								105.34		20	24			X					
	1								148.17		132	23			X	X				
7	SB	14a	27.49.892	93.55.584	7/31/16	18:12	147.8	146.8	Surface	6										
	6								0.702					332	X					
	5								28.41					323						
	4								53.66					324						
	3								80.14					325						
	2								101.48											
	1								146.8					329			X			
8	SB	15	27.45.934	93.55.666	7/31/16	19:10	233.44	233.44	Surface	6		28	606							
	6								1.21		238	34		331						X
	5								37.17		108	33		332						X
	4								64.48		172	32		333		X				X
	3								109.6		171	31		326						X
	2								159		43	30		327						X
	1								233.44		46	29		328		X				X
9	SB	15a	27.45.948	93.55.681	7/31/16	19:53	237.4	237.4	Surface	6										
	6								1.01						X					
	5								39.75											
	4								64.17								X			
	3								110.2						X		X			
	2								160.75						X					
	1								237.4						X					
10	SB	25	27.45.944	93.49.757	7/31/16	20:44	233	230.14	Surface	6										
11	SB	25a	27.45.946	93.49.629	7/31/16	21:15	233	231.68	Surface	6		35	703			X				
	6								Surface		136	36			X					
	5								20		303	37								
	4								47		19	38				X				
	3								100		32	39			X					
	2								181		24	40			X					
	1								230		35	41			X	X				
12	SB	25b	27.45.935	93.49.792	7/31/16	22:00	234	232.61	Surface	6										
	6								0.906					222/231						
	5								23.76				341/221	341/221						
	4								52.11					339/340						
	3								109.05					337/338						
	2								178.52					335/336						
	1								232.61					334/330						
13	SB	24	27.49.950	93.49.673	8/1/16	0:22	119.3	116.2	Surface	6		42	612			X				
	6								1.14		20	43		238	X					
	5								27.97		6	44		222	X					
	4								47.66		36	45		227	X		X			X
	3								67.88		349	46		232	X					
	2								87.87		3	47		237	X					
	1								116.2		50	48		236	X	X				
14	No SB	24a	27.49.877	93.49.796	8/1/16	1:09	112	111.68	Surface	6										
	6								1.01								X	G-6		
	5								21.87								X			
	4								46.55								X			
	3								61.39								X			X
	2								87.4								X			
	1								111.68								X	G-5		X
15	No SB	24b	27.49.981	93.50.011	8/1/16	1:45	115	112.9	Surface	5										
	5								68.09											
	4								68.09								X			
	3								112.9											
	2								112.9										X	
	1								112.9										X	
16	SB	23	27.53.995	93.49.670	8/1/16	2:44	89	87.4	Surface	6		49	143							
	6								1.11		332	50		233						
	5								15.84		306	51			X					
	4								36.14		15	52		228	X					
	3								53.76		2	53			X	X	X			
	2								70.97		31	54			X					
	1								87.4		121	55		223	X	X	X			
17	SB	22	27.58.097	93.49.960	8/1/16	3:38	92	92.5	Surface	6		56	243							
	6								1.01		16	57		234						
	5								16.05		127	58								
	4								36.45		342	59					X			
	3								60.87		305	60		229	X	X				

Table of Niskin water sample collection. See accompanying xls spreadsheet for details.

	2								80.66		319	61			X					
	1								92.5		130	62		224	X	X	X			
18	SB	21	28.2.074	93.49.818	8/1/16	4:37	74	73.03	Surface	6		63	313							
	6								1.42		72	64		230						
	5								11.21		132	65								
	4								20.98		142	66		225						
	3								36.76		320	67					X			
	2								53.66		116	68								
	1								73.03		22	69		239			X			
19	SB	31	28.2.080	93.43.879	8/1/16	5:38	87	86.12	Surface	6		70	619							
	6								1.93		5	71		216	X					
	5								16.46		149	72		211						
	4								39.96		137	73		206						
	3								56.23		50	74		201	X		X			
	2								70.97		30	75		240	X					
	1								86.12		45	76		235	X		X			
20	SB	32	27.58.075	93.43.740	8/1/16	6:37	97	96.53	Surface	6		77	579			X				
	6								1.62		131	78		212	X					
	5								20.8		147	79								
	4								35.21		801	80				X	X			
	3								51.6		123	81		202	X					
	2								76.64		181	82			X					
	1								96.53		175	83		207	X	X	X			
21	SB	33	27.54.054	93.43.826	8/1/16	7:43	109	101.27	Surface	6		84	962							
	6								1.11		128	85		208	X					
	5								16.05		327	86								
	4								36.24		1	87		217						
	3								46.86		304	88			X	X	X			
	2								80		180	89			X					
	1								101.27		159	90		203	X	X	X			
22	SB	34	27.50.076	93.43.149	8/1/16	8:49	149	144.3	Surface	6		91	657			X				
	6								1.42		835	92		218	X			G-3		
	5								20.79		162	93								
	4								46.5		119	94		213						
	3								61.49		353	95			X	X	X			
	2								100.2		21	96			X					
	1								144.3		103	97		204	X	X	X	G-4		
23	SB	35	27.46.050	93.43.856	8/1/16	9:55	208	206.52	Surface	6		98	602			X		G-9		
	6								1.27		138	99		215	X					
	5								20.79		94	100		220				G-8		
	4								50.67		97	101		219	X	X	X			
	3								151.57		167	102		214	X					
	2								206.52		156	103		209						
	1								206.52						X	X		G-7		
24	SB	45	27.46.042	97.37.890	8/1/16	10:52	192	190.44	Surface	6		104	876			X				
	6								0.902		108	105		59	X			G-10		
	5								11.52		172	106								
	4								41.01		171	107		58	X	X	X	G-2		
	3								76.85		43	108		57	X		X			
	2								190.44		46	109		56						
	1								190.44						X	X	X	G-1		
25	SB	44	27.50.028	93.37.792	8/1/16	11:47	126.5	125.8		2										
26	SB	44a	27.50.080	93.37.741	8/1/16	12:13	126	125.6	Surface	6		110	611G							
	6								1.01		19	111		54				G-13		
	5								16.46		32	112						G-12		
	4								41.19		24	113		55						
	3								66.44		35	114		FGB1						
	2								125.6		338	115		60				G-11		
	1								125.6											
27	SB	43	27.54.036	93.37.793	8/1/16	12:58	99.5	97.68	Surface	2										
	2								97.68											
	1								97.86											
28	SB	43a	27.54.020	93.37.795	8/1/16	13:30	99.3	98.59	Surface	6		116	616			X				
	6								1.01		349	117		49	X		X	G-16		
	5								11.52		3	118		50	X		X			
	4								39.21		50	119		51	X	X		G-15		
	3								61.59		136	120		52	X		X			
	2								98.59		303	121		FGB1			X			
	1								98.59					53	X	X		G-14		
29	SB	43b	27.54.002	93.37.800	8/1/16	14:50	99	60.46	Surface	4										
	4								39.64					45/46			X			
	3								39.64								X			
	2								39.64					48/49			X			
	1								60.46											
30	SB	43-BC1	27.54.554	93.35.988	8/1/16	15:49	20	19.3	Surface	6		122	318					G-18		
	6								1.21		20	125		44						
	5								13.68		6	124		43						
	4								19.3										#4	
	3								19.3										#3	
	2								19.3					41						
	1								19.3		36	123					X	G-17		
31	SB	43-BC2	27.54.622	93.35.874	8/1/16	17:06	21	20.07	Surface	6		126	709G							
	6								1.52		175	127								
	5								1.52			128								
	4								20.07											
	3								20.07										#6	
	2								20.07										#5	
	1								20.07		33	129								
32	SB	43-BC3	27.54.433	93.35.927	8/1/16	17:39	18.7	17.39	Surface	6										
	6								0.805		801							G-30		
	5								6.88		123									
	4								17.39									G-24		
	3								17.39										#8	
	2								17.39										#7	
	1								17.39		181									
33	SB	42	27.57.992	93.37.831	8/1/16	18:21	96	93.23	Surface	6		130	917			X				
	6								1.93		306	131		81	X			G-22		
	5								16.98		15	132		82						
	4								30.78		2	133		83	X	X	X			
	3								67.4		31	134		84	X		X			
	2								93.23			135		85				G-29		
	1								93.23		121	136			X	X	X			
34	SB	41	28.1.998	93.37.802	8/1/16	19:12	89	88.3	Surface	6		137	590							
	6								0.8053		342	138		88				G-33		
	5								23.4		305	139								
	4								48.4		5	140		87			X			
	3								64		130	141								
	2								88.3									G-27		
	1								88.3		332	142		86			X			
35	SB	51	28.1.994	93.31.776	8/1/16	20:09	86.8	86.63	Surface	6		143	653							
	6								1.32		320	144		91	X			G-26		
	5								16.25		116	145			X					
	4								31.19		22	146			X					

	3								51.18		16	147		90	X		X			
	2								86.63					89	X			G-32		
	1								86.63		127	148					X			
36	SB	52	27.57.977	93.51.900	8/1/16	20:51	102	100.9	Surface	6		149	614			X				
	6								1.21		30	150		96	X			G-21		
	5								25.63		45	151		95	X					
	4								57.68		8	152		94	X	X	X			
	3								76.3		132	153		93	X					
	2								100.9					92	X		X	G-28		
	1								100.9		142	154				X				
37	SB	53	27.53.989	93.31.802	8/1/16	21:41	146	140.6	Surface	6		155				X				
	6								1.11		131	156		99	X			G-34		
	5								25.22		147	157			X					
	4								49.81		149	158		98	X		X			
	3								102		137	159			X					
	2								140.6						X		X	G-25		
	1								140.6		74	160		97		X				
38	SB	54	27.49.727	93.32.000	8/1/16	22:35	190	189.6	Surface	6		161				X				
	6								0.9		327	162		261	X			G-36		
	5								25.22		1	163		262						
	4								57.37		304	164		263	X	X	X			
	3								101.3		180	165		264	X					
	2								189.6					FGB2 265			X	G-35		
	1								189.6		159	166			X	X				
39	SB	55	27.45.943	93.31.384	8/1/16	23:23	244	241.2	Surface	6		167				X				
	6								1.42		119	168		266				G-20		
	5								25.63		353	169		267						
	4								61.08		21	170		268		X	X			
	3								126.1		103	171		269						
	2								241.2					220		X		G-23		
	1								241.2		128	172					X			

Figure R1. Spatial distribution of near-bottom observations of dissolved oxygen concentration (ml/L). Data obtained from Winkler titration of water samples from Niskin bottles. Triangles are planned station locations; red circles are actual station locations. Bathymetry lines are indicated on isopleths.

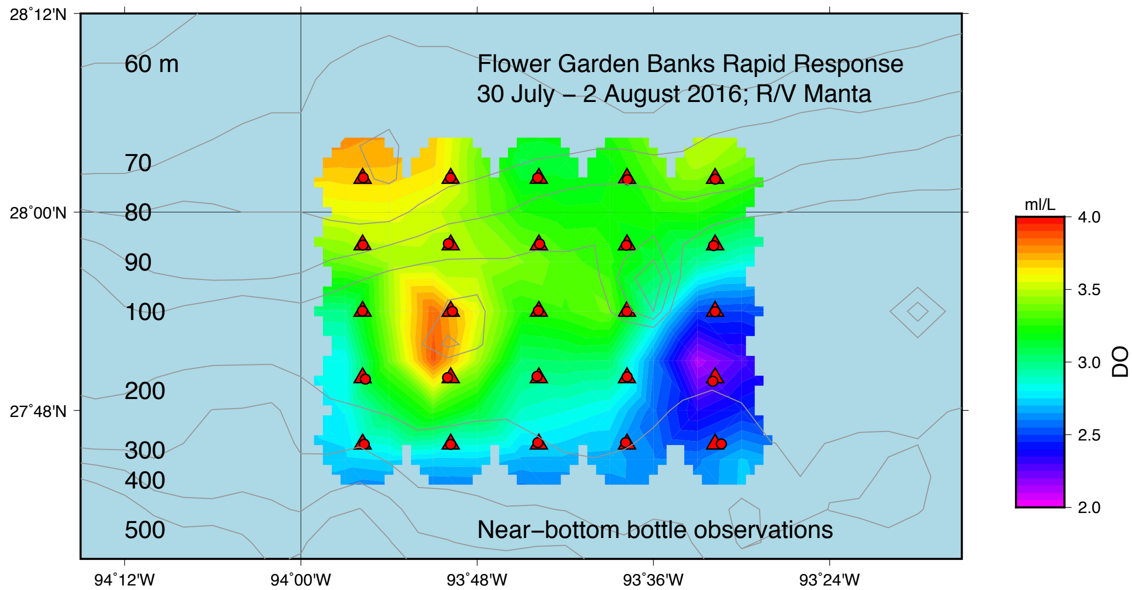


Figure R2. Spatial distribution of near-bottom observations of density (kg/m3). Data obtained from deepest CTD bin. Triangles are planned station locations; red circles are actual station locations. Bathymetry lines are indicated on isopleths.

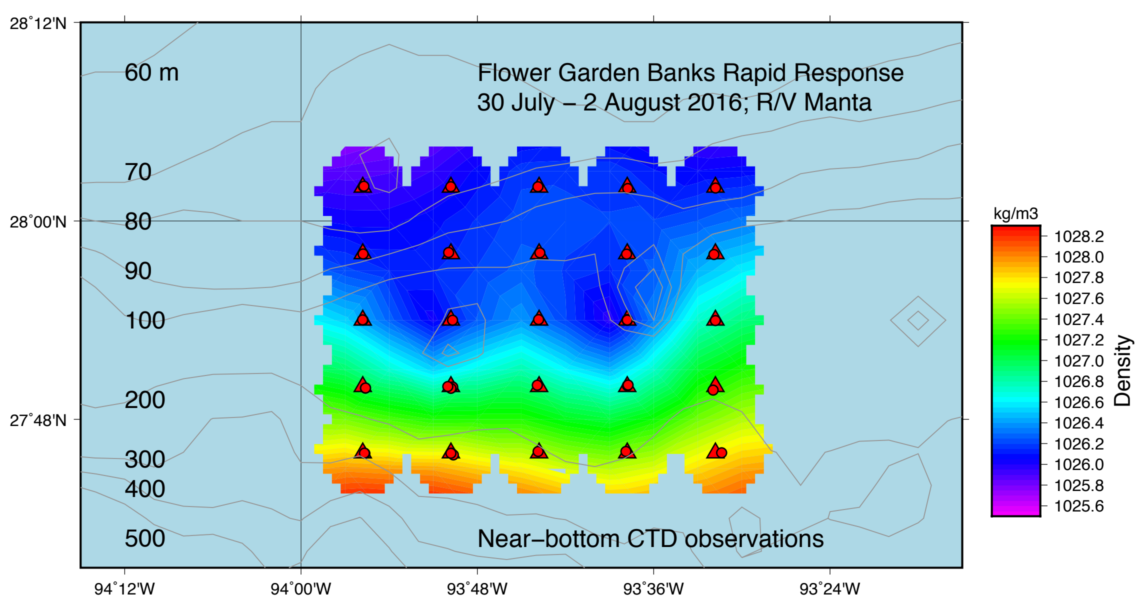


Figure R3. Detail of spatial distribution of near-bottom observations of dissolved oxygen concentration (ml/L). Data obtained from Winkler titration of water samples from Niskin bottles. Black dots are actual station locations.

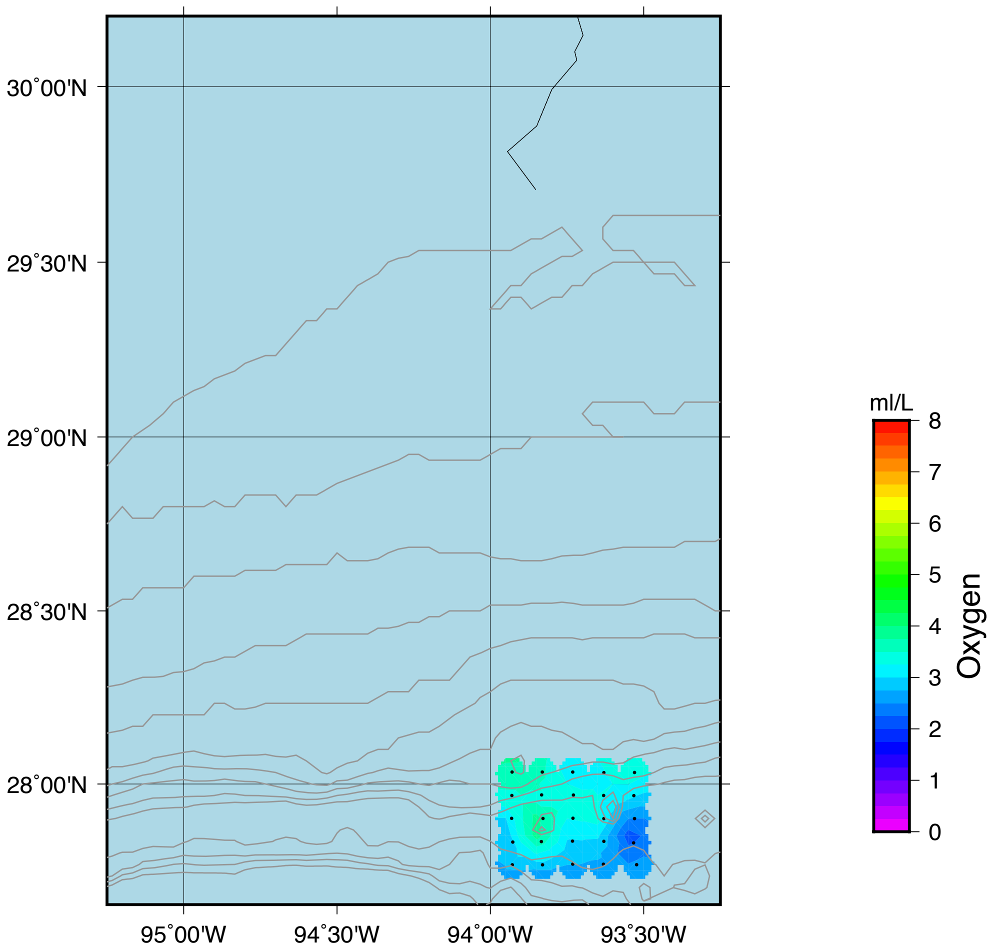


Figure R4. Spatial distribution of near-bottom observations of chlorophyll fluorescence (mg/L). Data obtained from deepest CTD bin. Triangles are planned station locations; red circles are actual station locations. Bathymetry lines are indicated on isopleths.

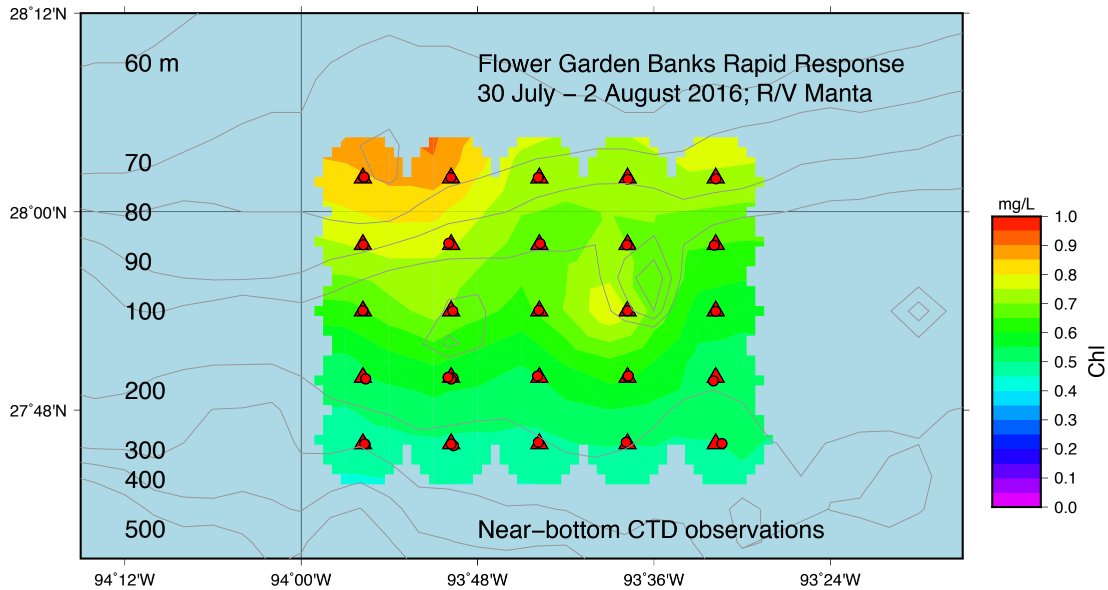
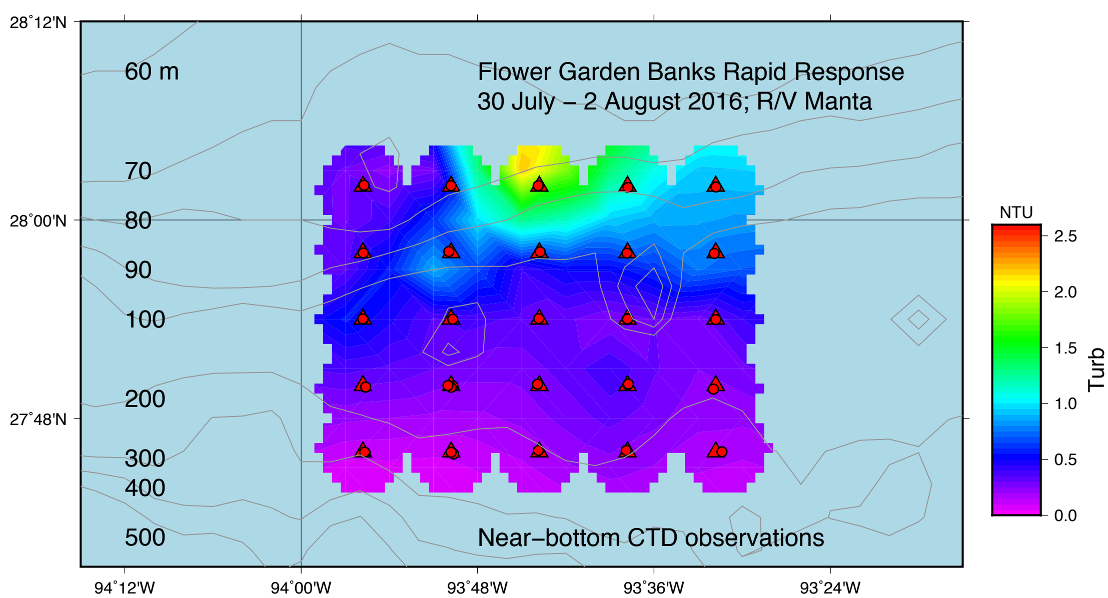


Figure R5. Spatial distribution of near-bottom observations of turbidity (NTU). Data obtained from deepest CTD bin. Triangles are planned station locations; red circles are actual station locations. Bathymetry lines are indicated on isopleths.



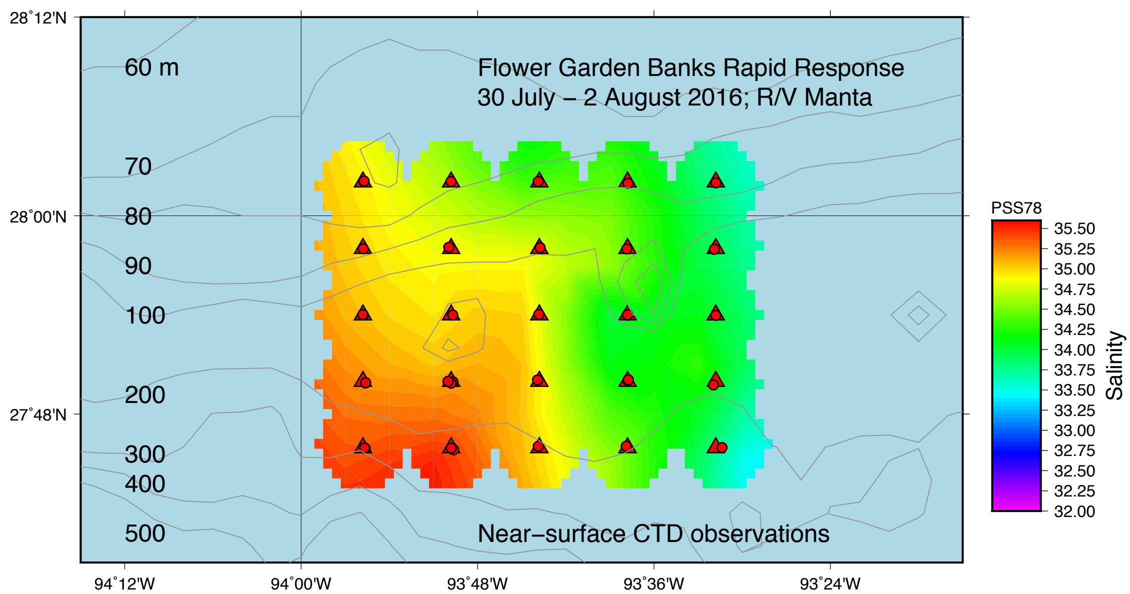


Figure R6. Spatial distribution of near-surface observations of salinity (PSS78). Data obtained from 5-m CTD bin. Triangles are planned station locations; red circles are actual station locations. Bathymetry lines are indicated on isopleths

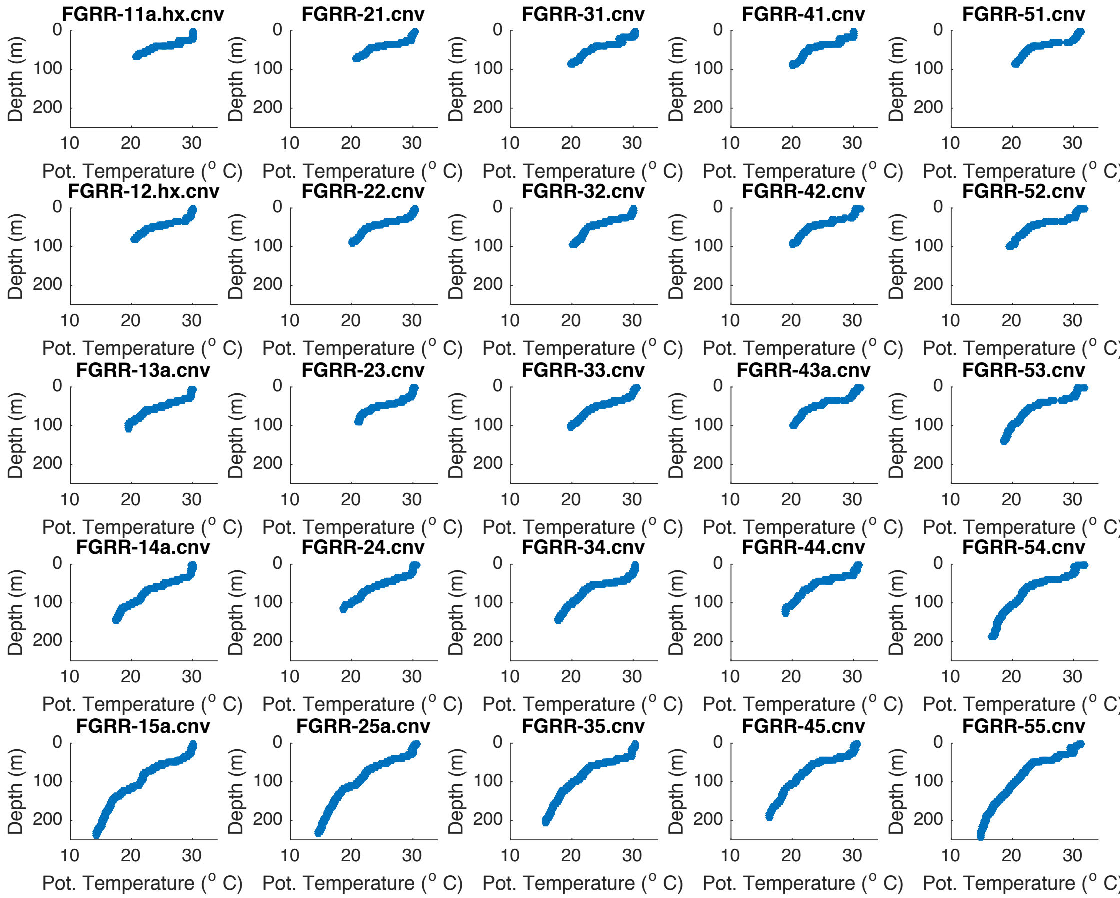


Figure R7. Profiles of potential temperature from 5x5 grid of CTDs at FGBNMS FG-RR16 cruise. Top to bottom are lines 1 thru 5, left to right are columns 1 thru 5.

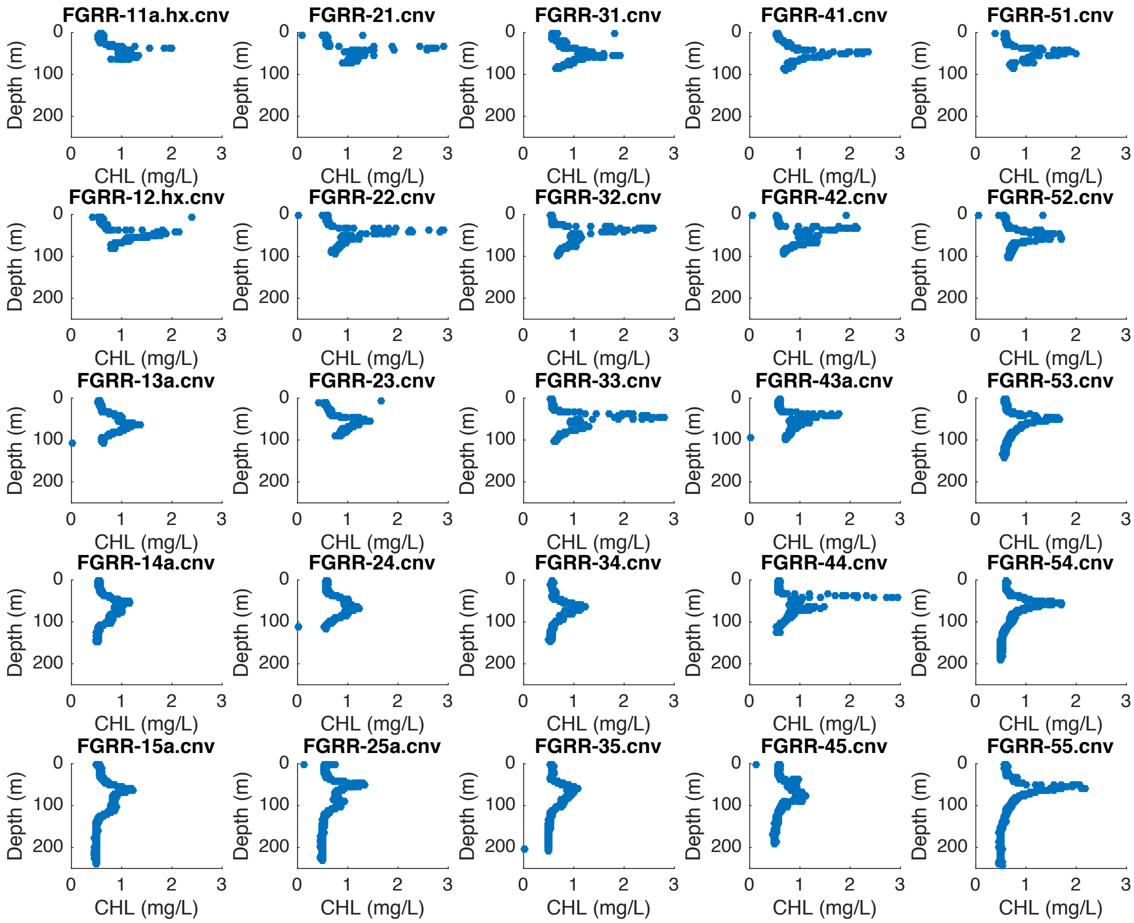


Figure R8. Profiles of chlorophyll fluorescence from 5x5 grid of CTDs at FGBNMS FG-RR16 cruise. Top to bottom are lines 1 thru 5, left to right are columns 1 thru 5.

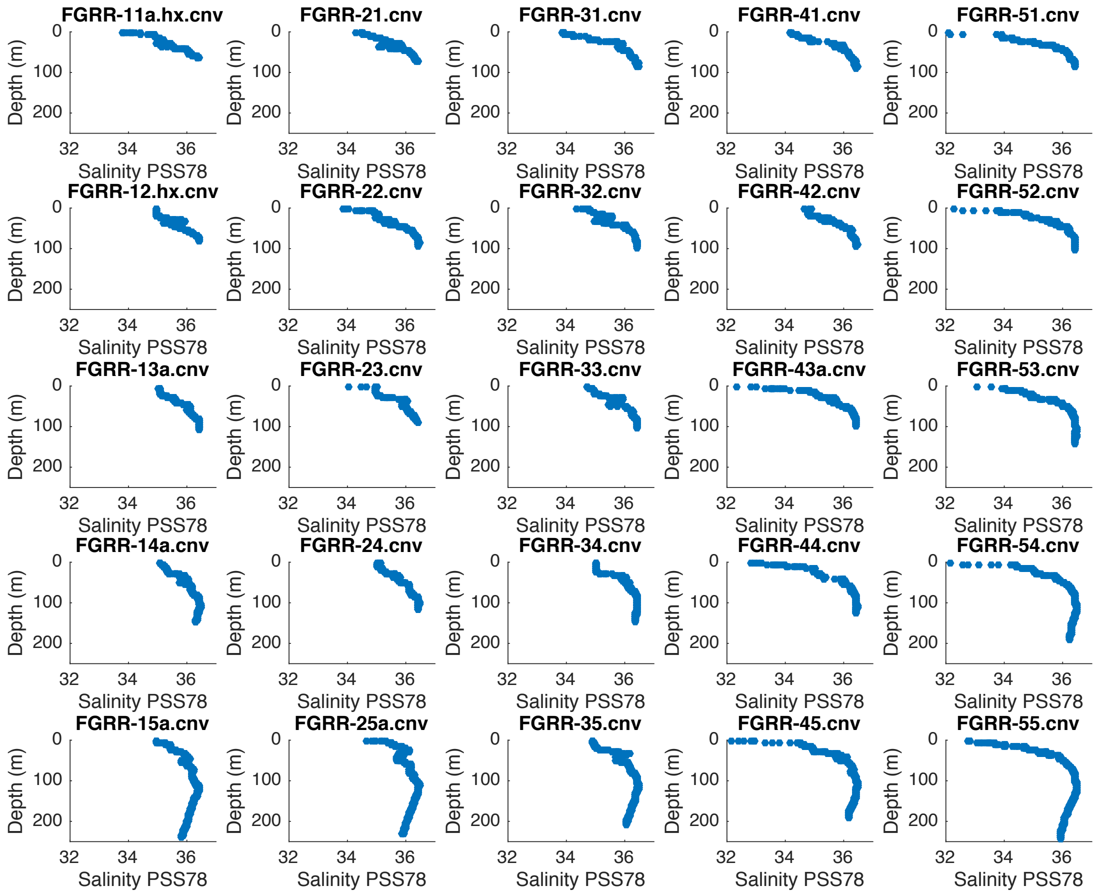


Figure R9. Profiles of practical salinity from 5x5 grid of CTDs at FGBNMS FG-RR16 cruise. Top to bottom are lines 1 thru 5, left to right are columns 1 thru 5.

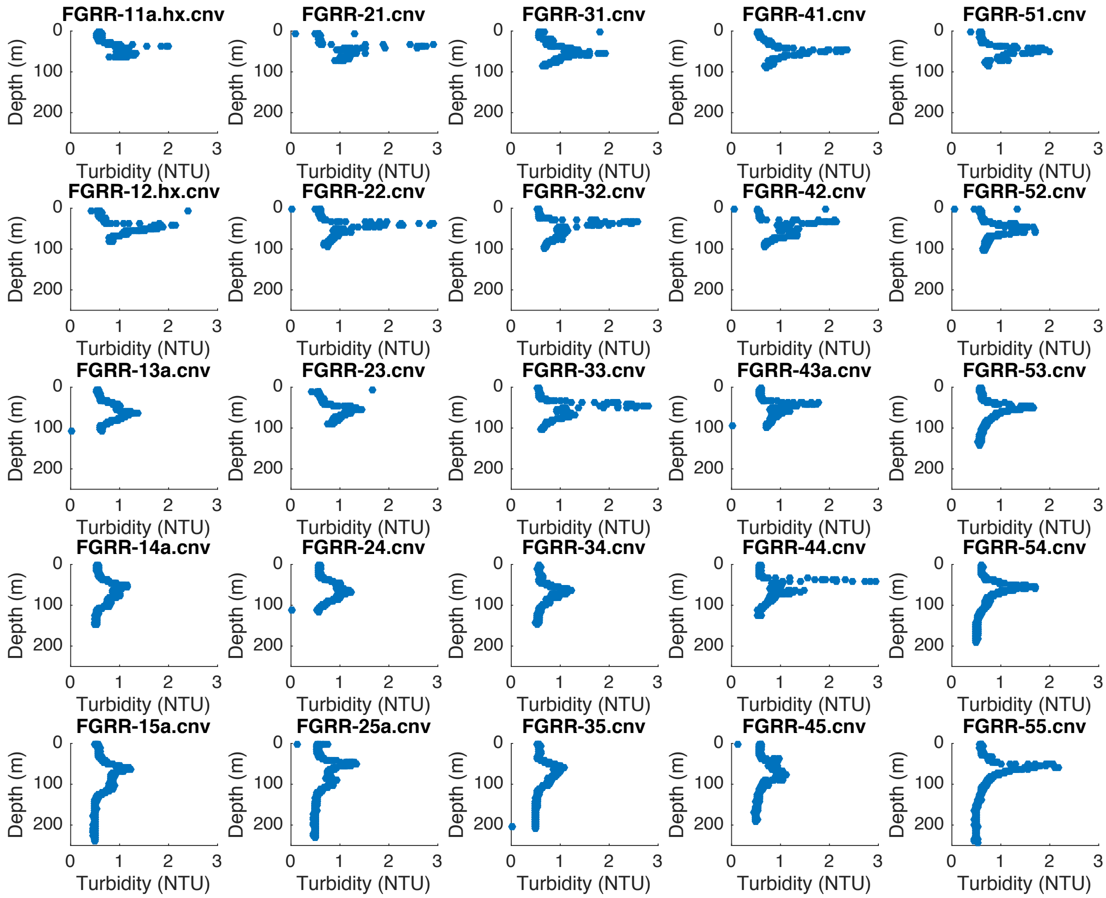


Figure R10. Profiles of turbidity from 5x5 grid of CTDs at FGBNMS FG-RR16 cruise. Top to bottom are lines 1 thru 5, left to right are columns 1 thru 5.

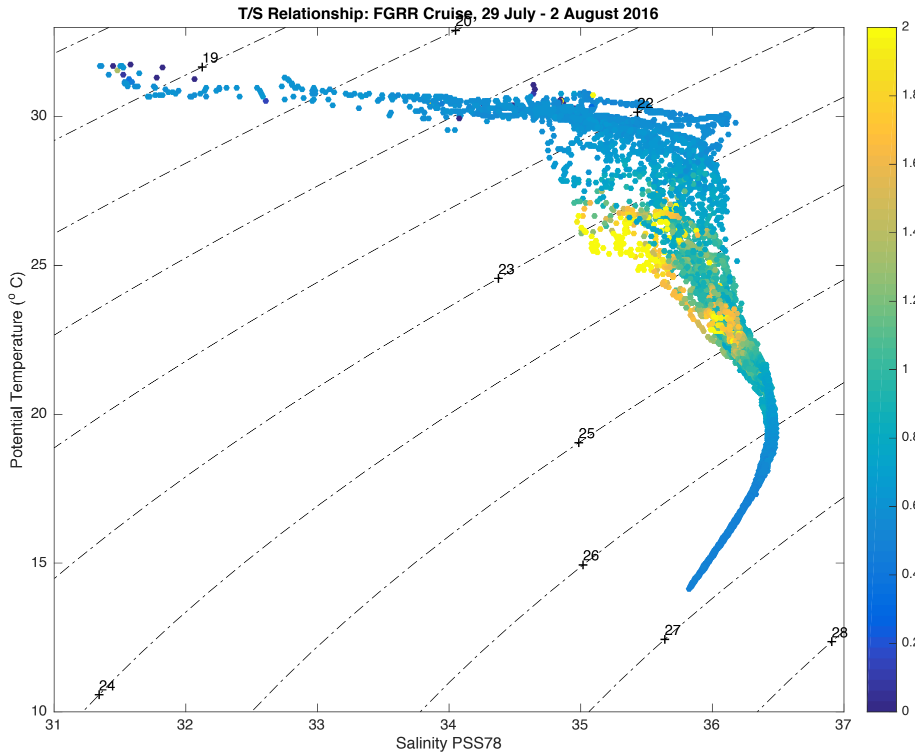


Figure R11. T-S relationship for all CTD profiles taken on FG-RR16 cruise. Color bar is turbidity data. Dashed lines are isopleths of sigma-theta.

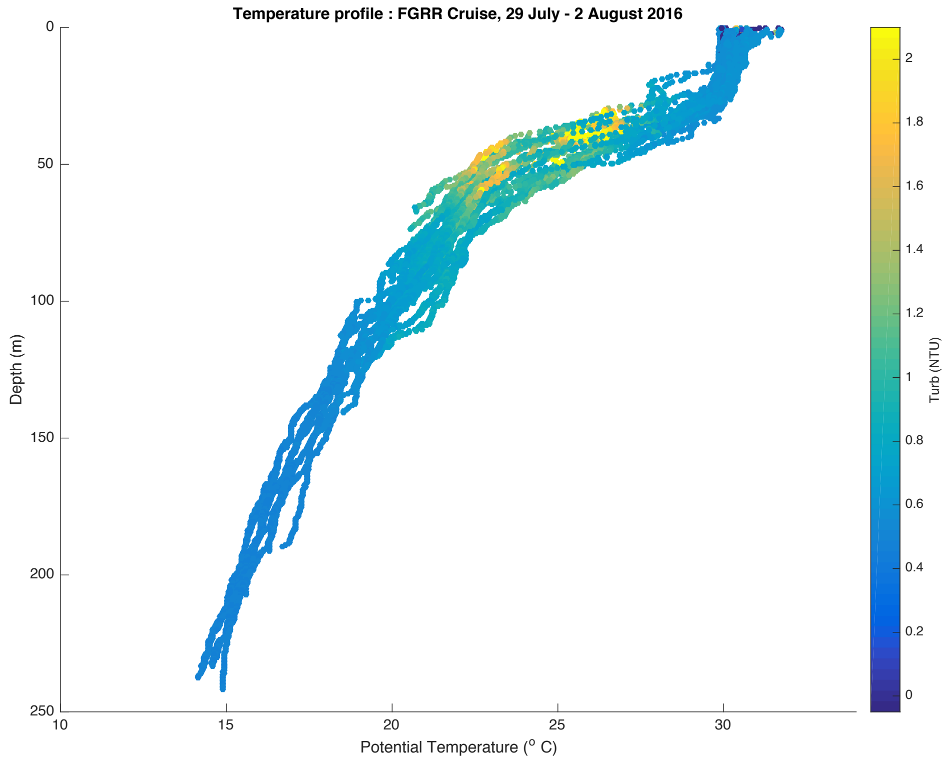


Figure R12. Temperature profiles for all CTD stations on FG-RR16 cruise. Color bar is turbidity data from CTD.

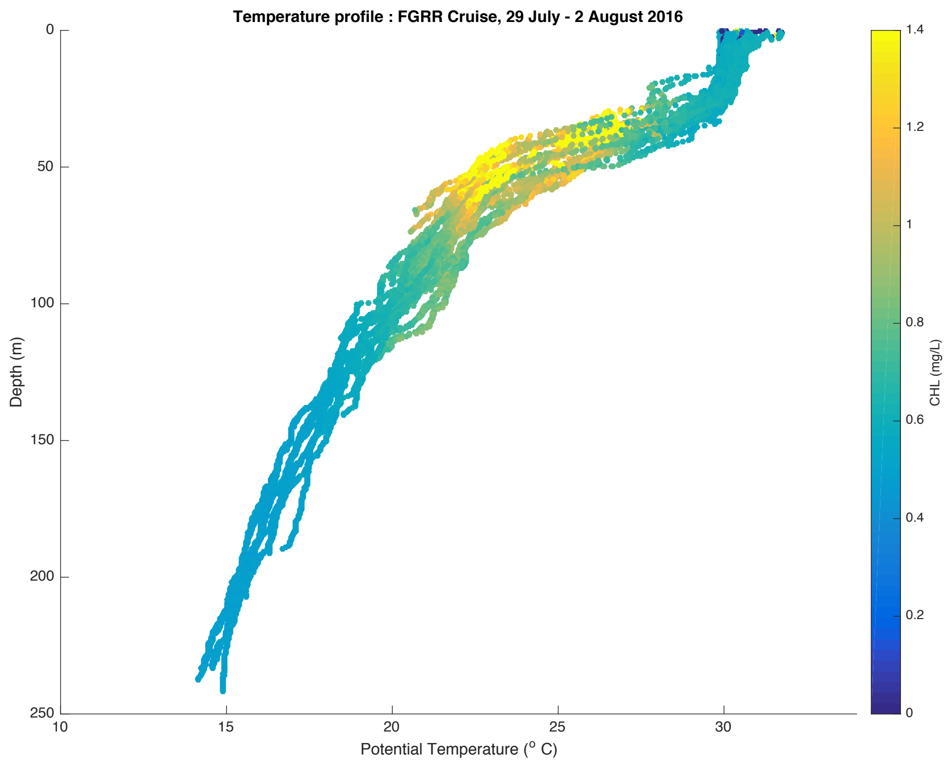


Figure R13. Temperature profiles for all CTD stations on FG-RR16 cruise. Color bar is chlorophyll fluorescence data from CTD.

Figure S1. Four panel figure of T-S data from GISR cruises G01, G04, G06, G09. All data are available through GRIIDC (GoMRI). Color bar is dissolved oxygen concentration from CTD.

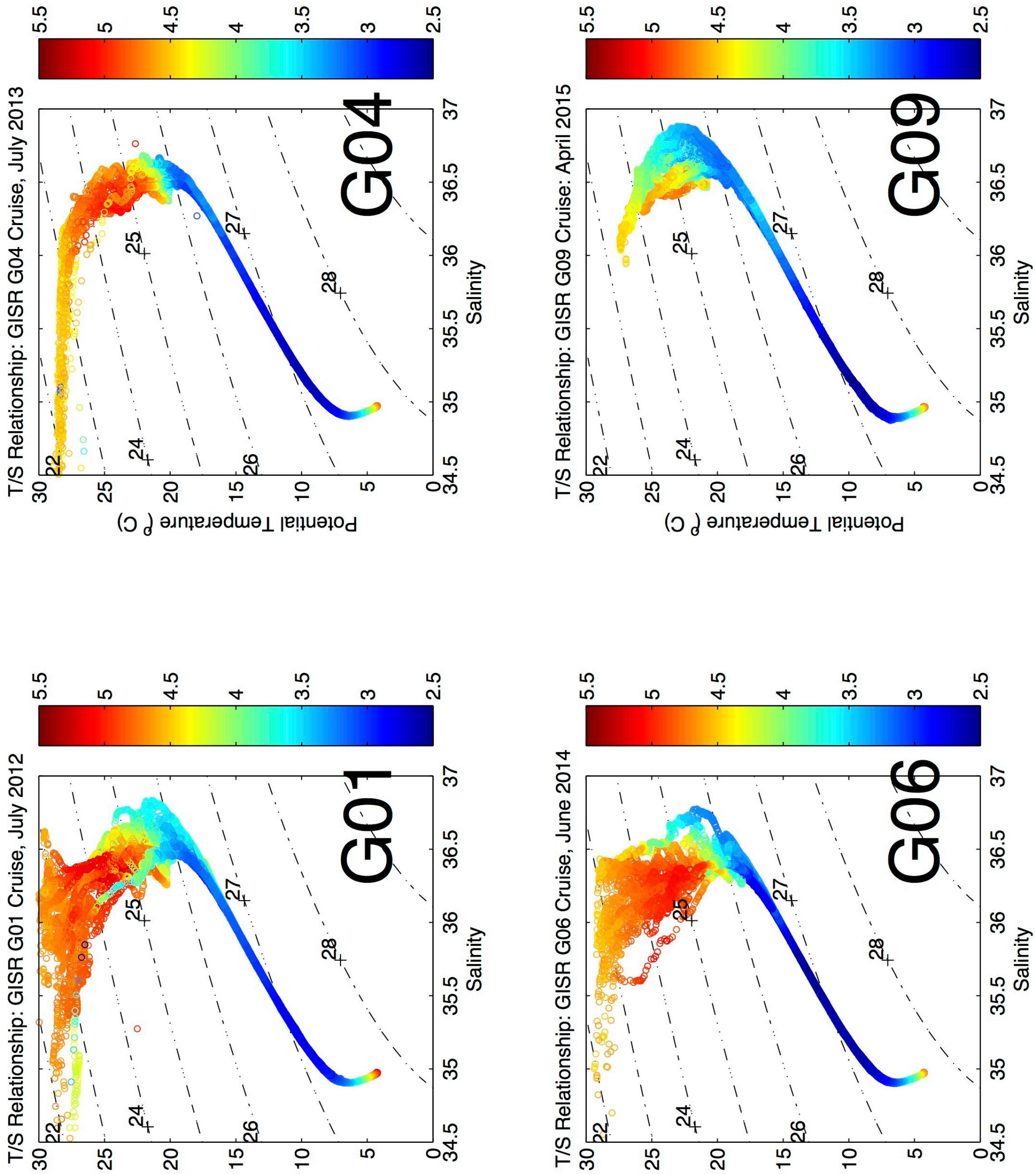
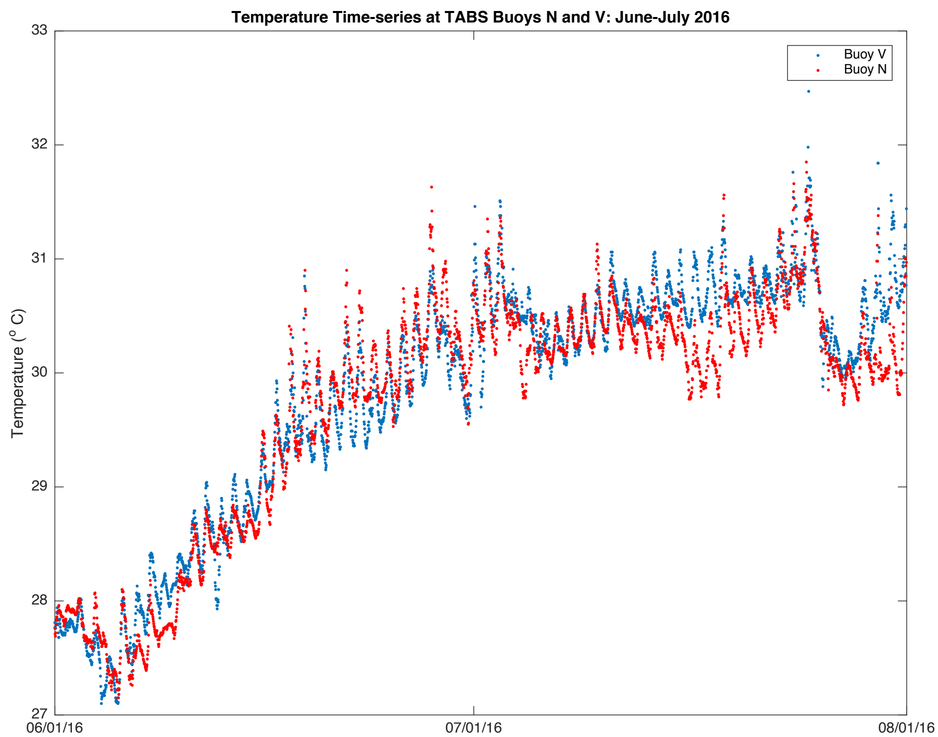
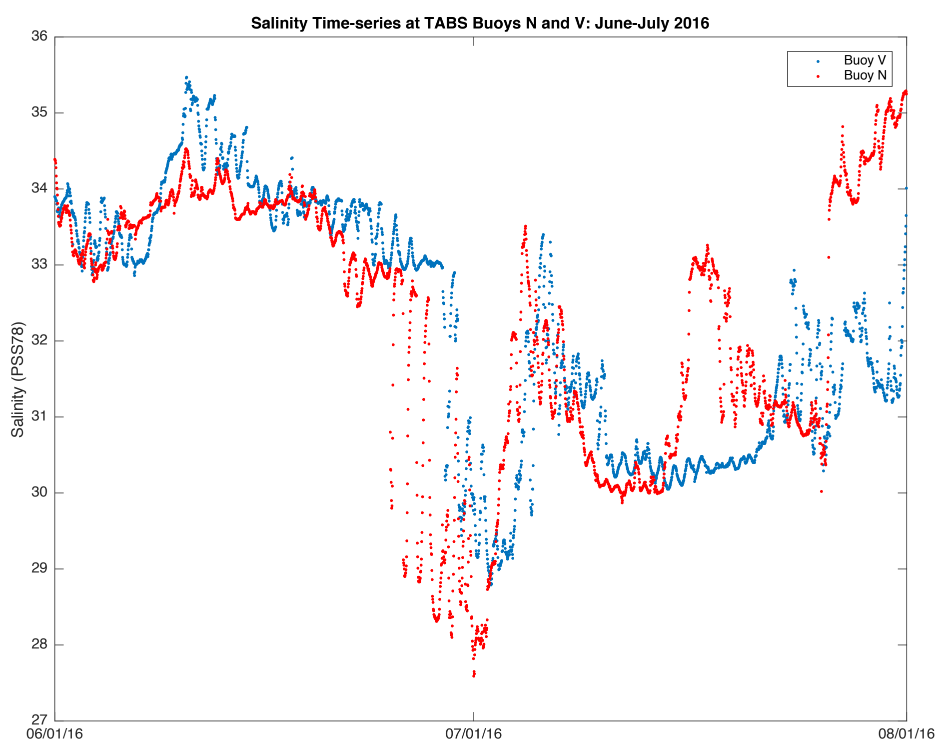


Figure S2, S3. Time series of temperature and salinity at TABS Buoys N and V during June and July 2016.





Impressions

- Unfortunately, the SBE-43 oxygen sensor on the CTD did not work during this cruise. However, the T-S relationship shown in Figure S1 shows that the top of the Oxygen Minimum Zone (OMZ) in the Gulf of Mexico is near the 20°C isotherm (~100-150 m depth, Figure R12, see Spencer et al. 2016, JGR-Oceans).
- The spatial distribution of near-surface salinity shows clear differences between the east and west banks (Figure R6). A fresh water mass is clearly present on the east side of the study area.
- The spatial distribution of near-bottom oxygen shows low concentrations on the seaward eastern stations (Figure R1).
- The spatial distribution of near-bottom density shows evidence of upwelling of offshore waters on the eastern side of the study area (Figure R2).
- The profiles of temperature and salinity of the western stations show less stratification than the eastern stations.

Two factors have led to increased stratification on the eastern side of the study region. 1) The presence of a surface freshwater plume, which advected southward from the inner Texas-Louisiana shelf. 2) The upwelling of cool dense water from offshore. The upwelling was manifest as shoreward movement of the cooler benthic waters into the FGBNMS. There is no apparent surface expression of this water in the CTD data. The stratification of the eastern water column would have inhibited the ventilation of the sub-pycnocline waters and contributed to the observation of depleted near-bottom oxygen concentration on the east side.

Because the upwelled waters are consistent (density/depth/temperature) with waters at the top of the OMZ, the waters were presumably already somewhat oxygen depleted, local respiration of organic material would presumably lead to further oxygen depletion. This point is admittedly speculative and needs further refinement based on analysis results from phytoplankton, inorganic, and microbial water samples.

The surface salinity and temperature observations from TABS buoys N and V (Figures S2, S3) show the surface waters were significantly fresh ($S < 35$) for nearly 8 weeks. Comparison to previous years indicates the persistence and magnitude of the freshwater plume is unusual for this offshore location. The surface temperature time series shows temperatures exceeded 30°C since mid-June. At times, temperature approached 32°C. Future analysis will include surface velocity observations from the TABS buoys.

Stable isotopes of oxygen will be run on surface samples to determine whether the freshwater is from Texas or Louisiana terrestrial/river sources (DiMarco et al 2012, Aquatic-Geochemistry).

My impression of these data is that it is unlikely that a benthic hypoxic water mass advected southward from the inner shelf. The densities of the waters affected are of deepwater origin (not from lighter inshore water) and reflect the presence of the vertical process of oxygen depletion rather than a horizontal advective process (Hetland and DiMarco 2008, JMS). Nutrient analysis is pending and will help clarify this point.

There are many questions that remain to be addressed; however the investigation of upwelling dynamics on the northern slope/shelf should be investigated. We are actively analyzing the TAMU coupled physical-biogeochemical numerical model (PI's: R. Hetland, TAMU and K. Fennel, Dalhousie) for indications of the upwelling mechanism.

A glider is currently deployed in the vicinity of the FGBNMS to help monitor water quality conditions in and around the sanctuary perimeter.