R/V Oceanus 471-2
SEEPC Cruise #1

Cindy Van Dover
Chief Scientist

TABLE OF CONTENTS

SYNOPSIS

A 4-d research voyage on R/V Oceanus (Cruise 471, Leg 2), departing Bridgetown Barbados 17 May, returning 20 May. Three stations ~110-180 nmi south of Barbados, located at seep sites described by French colleagues in the 1990s: El Pilar, Orenoque A, Orenoque B. This cruise is preliminary to a longer cruise in 12-13 months with *Alvin* to recover moorings, collect plankton samples, and sample benthic populations.

Objectives:

1. Deploy moorings (35 m above bottom: anchor, with wood and bone bags, acoustic release, larval trap, current meter, larval trap, flotation) at each station
2. One MOCNESS tow at each station;
3. One CTD at each station (in lieu of functioning electronics on the MOCNESS)
4. Sub-bottom profiling to confirm site locations
5. XBTs during transits to characterize physical properties of the water column
6. Two CTDs on return transit spaced at ~60 nmi intervals

Outcomes:

1. All three moorings were successfully deployed (dropped directly above each target with 600 lbs weight) and confirmed to be upright on the seabed (note: Knudsen sub-bottom profiler interfered with acoustic commands to mooring). Technicap larval traps (lower on the string) did not retain the DMSO trap fluid (various reasons). Wood bags did not stay with moorings #1 and 2 (too buoyant; misplaced tie-down straps).
2. MOCNESS effort was compromised by failure to deliver the system to Bridgetown. With the help of Dennis McGillicuddy, Peter Wiebe, Robb Hugg, Al Bradley, and others, we unpacked the MOCNESS system used by Dennis on the previous cruise. It proved to have a malfunctioning board. We opted to sail without the electronics and use the system to undertake a single oblique tow through the water column. Low diversity of larvae recovered: ~25 larval types, 18 preserved for genetics, photos of all larval types captured.
3. Sub-bottom profiles confirmed accurate coordinates for seep locations. A survey line was run across El Pilar and Orenoque A; a more extended survey was undertaken for Orenoque B.
4. We used 27 XBTs and 5 CTD casts to study the deep-water effects of a mesoscale warm-core eddy moving across our study area (Figure 1).

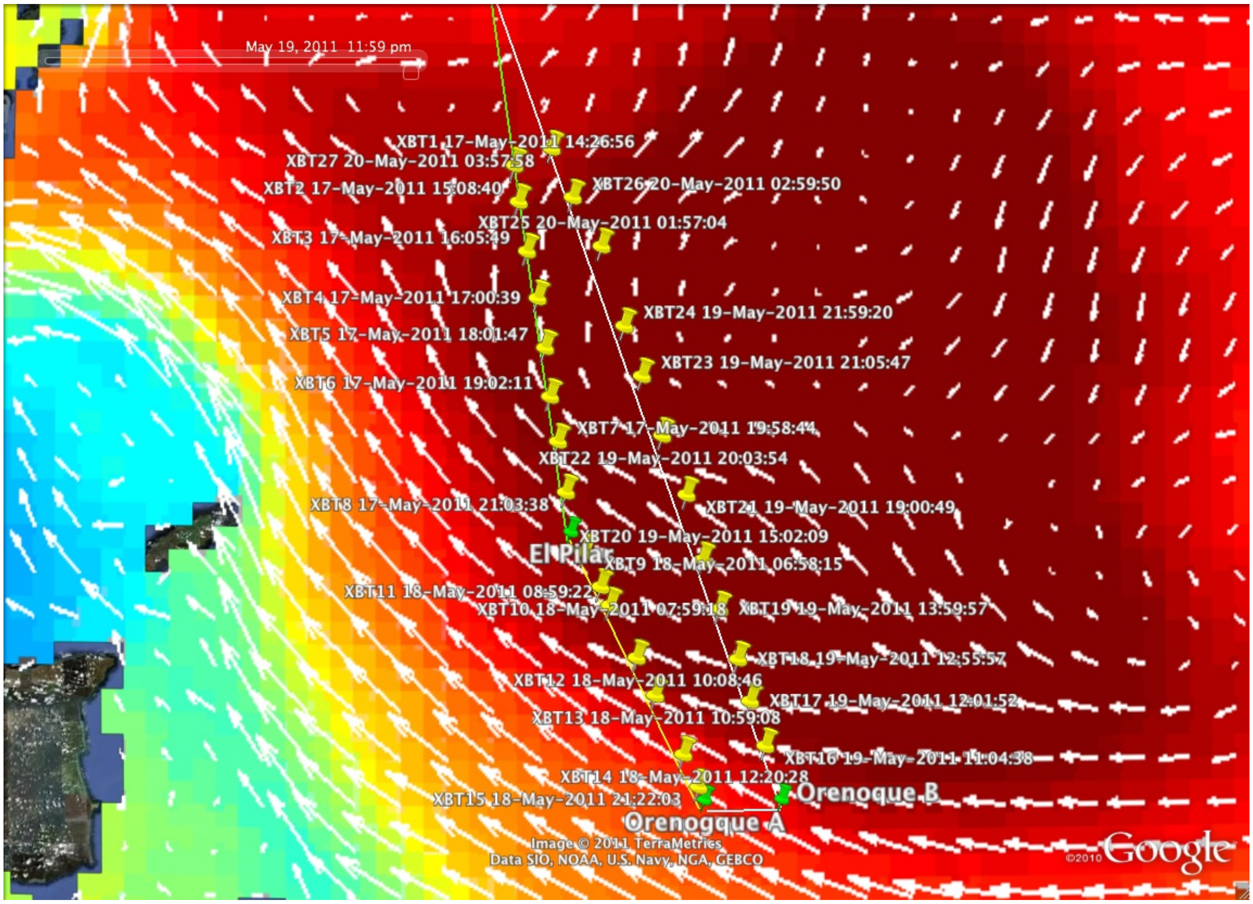


Figure 1. Hycomm sea surface height, cruise track, mooring stations, xbt stations

1. Team Leaders, Station Information, Daily Ops Plans, Hourly Log of Activities

TEAM LEADERS

MOCNESS: Craig Young (PI), Tracey Smart

MOORING: Dave Eggleston (PI), Gayle Plaia

CTD: Roy He (PI), Joe Zambon

SUB-BOTTOM: Laura Brothers

REFINED MOORING DEPLOYMENT TARGETS (15 May 2011)

Site	Dominant Mussel	Latitude	Longitude	Depth (m)
El Pilar	*Bathymodiolus* B	11°14.0	59° 20.75	1190
Orenoque A	*Bathymodiolus* B	10° 19.67	58° 53.325	1700
Orenoque B	*Bathymodiolus* A	10° 19.8	58° 37.4	2000

17-18 May (Tuesday-Wednesday) Ops

El Pilar

2200h	**CTD Target: 11° 14; 59° 20.75** Roy He	vertical cast, full depth 1190 m
2300-0200	**Oblique MOCNESS** Craig Young, Tracey Smart	2 kts; Single net only, 'dumb'; 150 um mesh
0200-0400	**Sub-bottom profiling** Laura Brothers	comfortable speed
0300-0400	**Mooring preparation** Dave Eggleston	Science party
0400-0500	**Mooring deployment** Dave Eggleston	Wood blocks and monkey fists fell off in deployment and lower larval trap did not stay full of DMSO; talking and upright
0400-0500	**Hydrophone check** Dave Eggleston	After mooring is in the water; good; vertical position
0500	**Transit to Orenoque B**	xbt's en route

18 May (Wednesday) Ops

ORENOQUE A

1430h	**Oblique MOCNESS** ***Centered on* 10 19.67, 58 53.325** Craig Young, Tracey Smart	oblique cast, full depth 1700 m SSW to NNE ending at seep site, 1705 m; great sub-bottom profile showing fault structure
1700	**Mooring preparation** Dave Eggleston	
1800	**Mooring deployment and Hydrophone check** Dave Eggleston	Wood blocks floated off again, despite double secure and correct thread; whalebone package with slack in straps. ***NB:* tag line stayed with the anchor weight instead of releasing; talking and upright**
1900	**CTD 10 19.67, 58 53.325**	1700 m
2200	**Transit to Orenoque B**	

19 May (Thursday) Ops

ORENOQUE B

0000	**CTD 10 19.8, 58 37.4**	
0100	**Sub-Bottom Profiling (5 kts)**	
0400	**Oblique MOCNESS** ***Centered on*** **10 19.8, 58 37.4**	
0800	**Mooring preparation**	
0900	**Mooring deployment and Hydrophone check**	
1000	**Transit to Barbados with *2 or 3* CTD stations** Station 4: 11° 14' 32.52"N, 58°56' 11.67"W Station 5: 12° 00'5 9.13"N, 59°12' 17.34"W	
ETA Bridgetown…..noon to 2 pm Friday		

HOURLY LOG
(pink = transit)

Tuesday 17 May 2011 1000 h	1036h: Departure Bridgetown 13° 06.51; 59° 38.21 (113 nm; 10h @ 11 kts) TRANSIT and XBT Stations
1100	
1200	
1300	
1400	1426h: XBT 1: 12° 27.373; 59° 32.709
1500	1508h: XBT 2: 12° 19.97; 59° 31802
1600	1605h: XBT 3 :12° 9.962; 59° 30.065
1700	1700h: XBT 4: 12° 0.474; 59° 27.863
1800	1802h: XBT 5: 11° 50.442; 59° 26.299
1900	1902h: XBT 6: 11° 40.593; 59° 25.258 1958h: XBT 7: 11° 31.530; 59° 23.618
2000	
2100	2103h: XBT 8: 11° 21.304; 59° 21.969
El PILAR 2200	2210h: CTD #1 deployed; 11°14.85; 59° 0.89 to ~930 m; sampled 3 bottles of deep water and 4 bottles at 230 m for clean chilled water for sampling (large surface *Trichodesmium* bloom)
2300	2316: CTD recovered; 11° 16.52; 59 °20.16 MOCNESS Prep
Wednesday 18 May 0000	MOCNESS Prep (shifting cable from CTD to MOCNESS and swapping deck positions of the gear)
0100	Sub-Bottom Profile –N to S run across the El Pilar wpt
0200	0147: MOCNESS #1 deployed 0147: 11° 11.87; 59° 22.54
0300	0300h: MOCNESS #1 passing wpt El Pilar 0321h: MOCNESS: #1 recovered: 11° 14.6; 59° 20.57 SW to NE run over the mooring site at 11° 14; 59° 20.75 Pinger attached but not useful; no sub-bottom data possible with pinger attached. Note: El Pilar shallows to 1000m.
0400	Sub-Bottom Profiling
0500	0551h: Mooring #1 deployed: 11° 14.002; 59° 20.757; 1070 m based on Knudsen 3.5 depth record; wood bags blew off as did polypro monkey fists; bottom larval trap without DMSO in tube trap; pinger indicates upright at depth
0600	TRANSIT to Orenoque A (60 nm) 0658h: XBT 9: 11° 9.337; 59° 18.069
0700	0759h: XBT 10: 11° 2.226; 5°9 14.817
0800	0859h: XBT 11: 10° 58.472; 59° 12.912
0900	
1000	1008h: XBT 12: 10° 47.887; 59° 7.419 1059h: XBT 13: 10° 40.261; 59° 3.620
1100	
1200	1220h: XBT 14: 10° 29.930; 58° 40.955
1300	Positioning for MOCNESS #2
ORENOQUE A 1400	1417h: MOCNESS #2 deployed: 10° 17.2; 58° 53.95; planned for 1700m water depth; flown at 1500 m. (SSW to NNE, does not cross wpt Orenoque A) 1445h: end oblique portion of tow.

	Good sub-bottom profile along tow line, including wpt for Orenoque A ORENOQUE A coordinates (sub bottom profile record): 10° 19.64 58° 53.4
1500	MOCNESS #2
1600	MOCNESS #2
1700	1706h: MOCNESS #2 recovered: 10° 19.63; 58° 56.64
1800	1837h: Mooring #2 deployed: 10° 19.669; 58° 53.330; 1705 m wood bag blew off; bone bag strap with slack; polypro lines intact; a length of tag line stayed with the anchor weight; ping returns were partial (4 of 7); returned to site with secured bow thruster and chirp – 15 pings - upright
1900	CTD set up
2000	2002h: CTD #2 deployed: 10° 20.098; 58° 53.567 ~1675m water depth
2100	2121h: XBT #15 10° 21 613; 58° 54.671; 1867 m; for "calibration" with CTD 2155h: re-tested mooring with bow thruster and chirp secured: 15 ping return, upright and talking
2200	TRANSIT to Orenoque B (15 nm)
2300	TRANSIT to Orenoque B (15 nm)
ORENOQUE B **Thursday 19 May** 0000	0001h: CTD #3 deployed: 10° 19.51; 58° 37.74; 2100 m
0100	0122h: CTD #3 recovered: 10° 20.47; 58° 37.63 MOCNESS Prep (cable transfer) Sub-Bottom Profile Lines
0200	Sub-Bottom Profile Lines
0300	Sub-Bottom Profile Lines
0400	0403h: MOCNESS #3 deployed: 10° 18.144; 58° 38.056; 2068 water depth; flown at 1800 m
0500	MOCNESS #3
0600	MOCNESS #3
0700	0724h: MOCNESS #3 recovered: 10° 21.29; 58° 38.13 scant sample
0800	Mooring #3 Preparation – wood bags hung on anchor line
0900	0920h: Mooring #3 deployed: 10° 19.802; 58° 37.407; bones and woods stayed with pkg as far as we can tell 0930h: Begin surface plankton tows (n=2) 0955h: Finish surface plankton tows
1000	1000h: pinger check good – upright 1010h: transit to Bridgetown (176 nmi)
1100	1105h: XBT #16 10° 29.930; 58° 40.955; 2005 m
1200	1201h: XBT #17 10.6505; 58.7349 1256h: XBT #18 10.7925; 58.777
1300	1359h: XBT #19 10.9612; 58.8407
1400	
1500	1502h: XBT #20 11.1269; 58.8975 1553h: CTD #4 deployed: NOT GOOD
1600	1600h: CTD #4 recovered
1700	1716h: CTD #4 deployed: 11° 14.799; 58° 56.078; 1388 m
1800	1816h: CTD #4 on deck 1820h: Begin surface plankton tow 1835h: End surface plankton tow
1900	1900h: XBT #21 11.3469; 58.9529
2000	2003h: XBT #22 11.5459; 59.0362
2100	2105h: XBT #23 11.7459; 59.1058 2159h: XBT #24 11.9142; 59.1664

2200	2235h: arrive at CTD station 2244h: CTD #5 deployed: 12° 01.54; 59° 11.70; 2207 m
2300	
Friday 20 May 0000	0054h: CTD #5 recovered
0100	0157h: XBT # 25 12.1828; 59.2447
0200	0259h: XBT 26: 12.3481; 59.3439
0300	0358h: XBT 27: 12.5131; 59.417
0400	
0500	
0600	
0700	
0800	0815h: Bridgetown

2. Larval Biology

Summary of Objectives. A major requirement of this NSF grant is to obtain larvae of seep animals for genetic analysis and behavioral work that informs our dispersal model. On the present cruise, we began the process of larval acquisition using two methods. First, we used a MOCNESS system to obtain larvae from various depth horizons, with the expectation that a higher proportion of the deep-water samples would consist of larvae originating from seeps and other deep-sea environments. The second method is to deploy larval traps on moorings. Three different kinds of larval traps (pumps, sediment traps, tube traps) have been used successfully in the deep sea. Larval pumps are not viable for long deployments because of battery limitations, so we planned to use both of the other methods. We employed off-the-shelf Technicap sediment traps and adapted the tube trap method to programmable Technicap carousels so we could obtain seasonal information about larval populations using both methods. One of each trap type was deployed on each mooring. We planned to drop moorings at each of three seep sites on the Barbados accretionary prism and to collect one 8-net MOCNESS sample at each site.

MOCNESS. When our MOCNESS system was delayed in the Dominican Republic, we switched to a smaller net system that had been used on the previous leg. However, because of a problem with a board in the communications can, we were not able to use the full functionality of the system. At each site we obtained one sample from a single 150 um net (0.5 m^2 mouth opening) deployed to a maximum depth 200m above the bottom. These samples integrated all depths and the net was open during both lowering and recovery. Because the net passed through the upper water column, it was filled with surface plankton including abundant copepods and the cyanobacterium *Trichodesmium*, making the samples difficult to process. The net was deployed and recovered at 20m/min with the ship speed averaging 1.5 knots. To reduce capture of surface organisms, we deployed and recovered at a wire speed of 40m/min while drifting. In all deployments, we attempted to maintain a wire angle of 45 degrees. In each deployment, the bridge determined the best track based on the swell and wind, taking care to tow over the target seep site for that tow.

The following table contains particulars:

Site	Bottom depth	Maximum tow depth	wire out	duration
El Pilar	1000-1100 m	800m	986m	2.5 h
Orenoque A	1700m	1500m	1840m	3.5h
Orenoque B	2000-2100	1800m	2204m	3.75h

Our team picked all invertebrate larvae from each sample, a process that took between 2 and 5 hours. Each larval form was assigned to a morphotype, photographed with an Olympus compound microscope using both bright-field and dark-field illumination, then preserved for either morphology or genetics. Genetic samples were frozen in single drops of water at -70 degrees. Morphological samples were fixed for SEM in 2% seawater-buffered glutaraldehyde and post-fixed in seawater-buffered 4% osmium tetroxide. The disposition of every sample is accounted for in a spreadsheet. We obtained approximately 25 different morphotypes from the following phyla or other higher taxonomic groups: polychaeta, echiura, sipuncula, mollusca, echinodermata,

LARVAL TRAPS. 500-ml plastic collection bottles for the Technicap sediment traps were filled with DMSO in a saturated solution of NaCl prior to each deployment. In the larval tube traps, we intended to also fill the actual collection tube with DMSO, with a flexible membrane covering the preservative until a fusible link dissolved after 24 hours on the bottom. However, the covers were lost during rough deployments, so all three traps were sent to the bottom without DMSO in the tube traps. It is expected that these will still act as larval collectors, though with less efficiency than we had hoped. It appears that the deployment of these traps on large moorings is problematic, though the traps would work very well as submersible-deployed devices.

El Pilar Larval Data Sheet

larval abbreviation	morphotype	same larva #	photo number(s)	Bag/Box #	Tube coordinate	FIX	Site
PI*	1	I	4to 23	1	A1	M	EP
	1	II		1	A2	G	EP
	1	III		1	A1	G	EP
NE*	1	I	25-34	1	A3	G	EP
	1	II		1	A4	G	EP
	1	III		1	A5	G	EP
	1	IV-V		1	A2	M	EP
Chaetop small*	1	I	36-50	1	A6	G	EP
	1	II		1	A7	G	EP
Chaetop medium	1	III	51-64	1	A3	M	EP
Chaetop big*	2	I	73-90	1	A8	G	EP
	2	II		1	A4	M	EP
MG	1	I	92-126	1	A9	G	EP
	1	II		1	A5	M	EP
PE	1	I	129-137	1	B1	G	EP
	1	II		1	B2	G	EP
	1	III		1	B3	G	EP
	1	IV		1	A5	M	EP
BI	1	I	139-149	1	B4	G	EP
	1	II		1	A7	M	EP
TO*	1	I	150-168	1	B5	G	EP
TO*	2?		170-179	1	B6	G	EP
Zooanthid*	1		180-190	1	B7	G	EP
Zoea	1	I	191-200, 9935,9934	1	B8	G	EP
PI	1	I	9936-9942	1	B9	G	EP
		II		1	C1	G	EP
		III		1	C2	G	EP
		IV		1	A8	M	EP
PL	2	I	187-199	1	F1	G	EP
PL	3	I	200-205	1	F2	G	EP
		II		1	F3	G	EP

FN 1: PN1 - similar tanish pilidium found in GoM plankton

FN2: Ne 1- black tamerin- dark chaete polychaete similar to golden tamerin Bahamas May '08 cruise

FN3: Chaetop 1- clear tail was photoed as small and med. (3 count) Chaetop 2- red tip was photoed as big (2 count)

FN4: TO- 2nd Torniaria differs from TO1 in lacking obvious feeding band and pinnate extensions from it.

FN5: Zooanthid- Brown golden zooanthid seen in Bahamas in '08. Photoed here as voucher for G fix

Orenoque A Larval Data Sheet

larval abbreviation	morphotype	same larva #	photo number(s)	Bag/Box #	Tube coordinate	FIX	Site
Gymno?*	1	I	20-Jan	1	C3	G	OA
		II		1	C4	G	OA
		III		1	C5	G	OA
		IV		2	A9	M	OA
Chaetop*	3	I	30-44	1	C6	G	OA
		II			A1	M	OA
Ophio Juvenile	1	I	46-58	1	C8	G	OA
		II		1	C7	G	OA
		III		2	A2	M	OA
Chaetop*	4	I	59-66	1	C9	G	OA
Chaetop*	5	I	67-71	1	D1	G	OA
PI*	1	IV, V, VI	72-76	1	D2, D3, D4	G	OA
PI	2	I	77-84	1	D5	G	OA
PE	2	I	85-97	1	D6	G	OA
		II			D7	G	OA
		III			D8	G	OA
PE*	3	I	98-118	1	D9	G	OA
TR*	1	I	119-126		E1	G	OA
		II		2	A3	M	OA
NE	1	VI			E2	G	OA
		VII			E3	G	OA
		VIII			E4	G	OA
CY	1	I	127-132	1	E5	G	OA
PE	4	I	165-187	1	E9	G	OA

Numbers reset on camera after EP

*FootNOTES:

FN1: Gymnosome gastropod. 3 distinct transverse bands, 2 baubles on dorsal or ventral surface?

FN2: Chaetop3- orange gut

FN3- Chaetop4maybe same as red tail morph2 from EP but younger than site photos

FN4: Chaetop5- maybe same as clear tail morph 1 from EP

FN5: PI1: same as morpho 1 from EP

FN6: PE3- distinguished from PE2 b/c PE3 granuales are contiguous while PE2 granules are separated by space

FN7: TR- large orange gutted, big mouth

Orenoque B Larval Data Sheet

larval abbreviation	morphotype	same larva #	photo number(s)	Bag/Box #	Tube coordinate	FIX	Site
BV	1	I	134-148	1	E6	G	OB
BV	2	I	149-156	1	E7	G	OB
BV	3		157-164	1	E8	G	OB
PL	3	II		1	F3	G	EP

Footnotes:
BV 2 and 3 looked similar so they may be same morphotype

There are a total of 5 boxes for molecular work and 3 bags for morphological work. Molecular boxes have 9 rows and 9 columns.

Location EP: El Pilar (est. depth: 1300m); OA: Orenoque A(est. depth: 1700); OB: Orenoque B (est. depth: 2000m)

Larval Abbreviation: See another page

Morphotype: each morphotype is represented by the larval abbreviation and a number.

Same larva number: we need three of each morphotype for molecular fixation- this is to keep track.
Photo number: for the photographer to keep track of the photo number before transporting it to a computer and renaming it.

Coordinate: Each molecular box has 9 rows and 9 columns. Organized into rows of letters and columns of numbers.

Fix: What type of fix? Molecular (G), Morphology (M).
Genetic samples frozen at -70 in 1 drop of water. Morphogical samples fixed for SEM in Millonig buffered glutaraldehyde followed by osmium postfix.

LABELING:

Label on tube: BOX #, COORDINATE # (EXAMPLE: 1C8)
Larval Morphotype Code: 2 letter abbrev., morphotype, Location, depth,, larval # (EXAMPLE: , GV, III,AB, 2000, 1)

PHOTO LABELING- FILE NAME: 2 letter abbrev., morphotype, Box #, Coordinate # (LABEL ON TUBE)

First tube label refers to the photo taken,the rest are just locations of tube

ORGANISM	**ABBREVIATION**
Gastropod veliger	GV
Pelagosphaera	PE
Bivalve veliger	BV
Bipinnaria	BI
Brachiolaria	BR
Ophiopluteus	OP
Echinopluteus	EC
Trochophore	TR
Entoprocts	EN
Nectochaete	NE
Mitraria	MI
Cyphonautes	CY
Auricularia	AU
Pentacula	PN
Planulae	PL
Tornaria	TO
Pilidium	PI
Mullers	MU
Tadpoles	TA
Doliolaria	DO
Planuliform	PA
Actinotroch	AC
Brachiopods	BR
Megalopa	MG
Zoea	Z

3. Mooring Deployments

	El Pilar	**Orenoque A**	**Orenoque B**
Deployment	**1**	**2**	**3**
Date	5/18/2011	5/18/2011	5/19/2011
Time	05:51	18:32	09:20
Latitude	11 14.002	10 19.666	10 19.806
Longitude	59 20.757	58 53.330	058 37.403
Depth	1070 m	1705m	
Float #	1-small	2-small	3-big
Sediment Trap #	# 0061	0059	0060
Current Meter #	17386apr04--"Larry"	15908jan02--"Curley"	17396apr04--"Moe"
Larval Trap #	1	**2**	**3**
Acoustic Release #	34608	34606	34607
Enable	136223	136124	136162
Disable	136246	136141	136200
Release	134621	134560	134602
Comments	• 2 wood bags came off during deployment • Larval trap set to 0 instead of #1-unable to fill collection tube. • Disable command successfully sent to acoustic release (at ~1/2mile away) reply was "upright"	• 2 wood bags came off during deployment. • Larval trap set to #1. Collection tube filled but leaked and got knocked around. • Tag lines wrapped around larval trap. • Larval trap and current meter frame banged around. • Lines on train wheel • Attempted disable command at 0.5 and 0.2nmi from site; unsuccessful (at most 3 return pings). • Attempted disable command on site unsuccessful (at most 4 return pings). • Disable command successful (15pings) when engines and depth sounder shut off.	• Big float was chosen for deepest site. • Larval trap set to #1. Collection tube filled while hanging over the side-leaked out. • Deployment done in 3 parts to fill tubes at last minute and minimize height. • Disable command successful with depth sounder shut off.

Current Meter
Falmouth Sci 2ACM-CBP-D
3 hour sampling
5 minute average
Start date and time: May 20, 2011 GMT 00:00
Estimated battery life: 500 days
Estimated memory use: 20%

Sediment Trap
Technicap PPS 4/3
Start date and time: May 20, 2011 05:00=00:00GMT
Start on #0-first rotation on May 20
Program: deployment pgm 5-2011.PTc
31 day intervals
Bottle filling: bottles filled to shoulder with 500mls of 20% DMSO in 4M NaCl. The rest of the volume up to the teflon rotation plate was filled with tap water to minimize leakage of DMSO.

Craig Young Larval Traps (ConTRAPtions)
Start on #1 to prevent loss of preservative in collection column.
First rotation on June 20
Program = craigdeployment pgm 5-2011.PTc

Both types of traps programed to end May 26, 2012
Ran test program on each.
Ran 4-sample program (1/HR) on #1.

Acoustic Release
ORE Offshore PORT (low frequency)
Deck box: EdgeTech XDCR Transponder
Tested enable, disable, and release commands--all ok before deployment.

Acoustic Release Notes: About 30 mins after the mooring deployment the Acoustic Release was tested by sending the disable command. After deployment #1`the boat was about 0.5nmi from the site. The command was sent and 15 return pings were received but they were far apart. After the second deployment 0-4 return pings (far apart) were detected from different positions on the boat (stern, port side and further forward on the port side) from 0.5 and 0.2nmi from the site. Later the ship returned to the site and shut down components of the engines that might interfere and also made sure the depth sounder was shut off. We got 15 return pings spaced much closer together. After the third deployment the ship returned to the site and we got 12 close return pings then one more, later ping. Only the depth sounder was shut off then.

Deployment Notes: The design of the mooring provided some challenges for deployment. Because the mooring needed to be as close to the bottom as possible, the distances between instruments was too short to hang over the side and the total length caused interference with the A-frame. Also the larval trap was delicate and both it and the Techicap sediment trap had to remain upright during the deployment.

Two methods were used to deploy the mooring:

Method #1 used for deployments 1 and 2.
The float and 25m cable was staged on the port stern of the ship connected to the winch. The crane line was attached to the top pear link of the Technicap trap and the whole string was lifted to the water. Slip lines were placed on the anchor(2 lines on each side), top of the Technicap trap and the top of the Larval trap. The mooring was lowered into the water until the top of the technicap trap was reachable from the deck. The 25m cable from the float was brought around the stern and attached to the top of the Technicap trap and a quick release from the A-frame was was exchanged with the crane line. The float was lifted overboard with the winch and allowed to float off the stern. The Technicap trap was lowered into the water then released when it was over the site.

The major advantage of this method was its relative simplicity. Only one connection had to be made while the mooring was dangling. The main disadvantage was that equipment could bang into the A-frame and all the motion and interferance caused the larval trap tube to loose the preservative. The taglines also got tangled in the hardware during deployment #2 due to inadequate slack given to the anchor tag lines while the anchor was being lifted. We had fairly calm seas ~3-4' during these deployments.

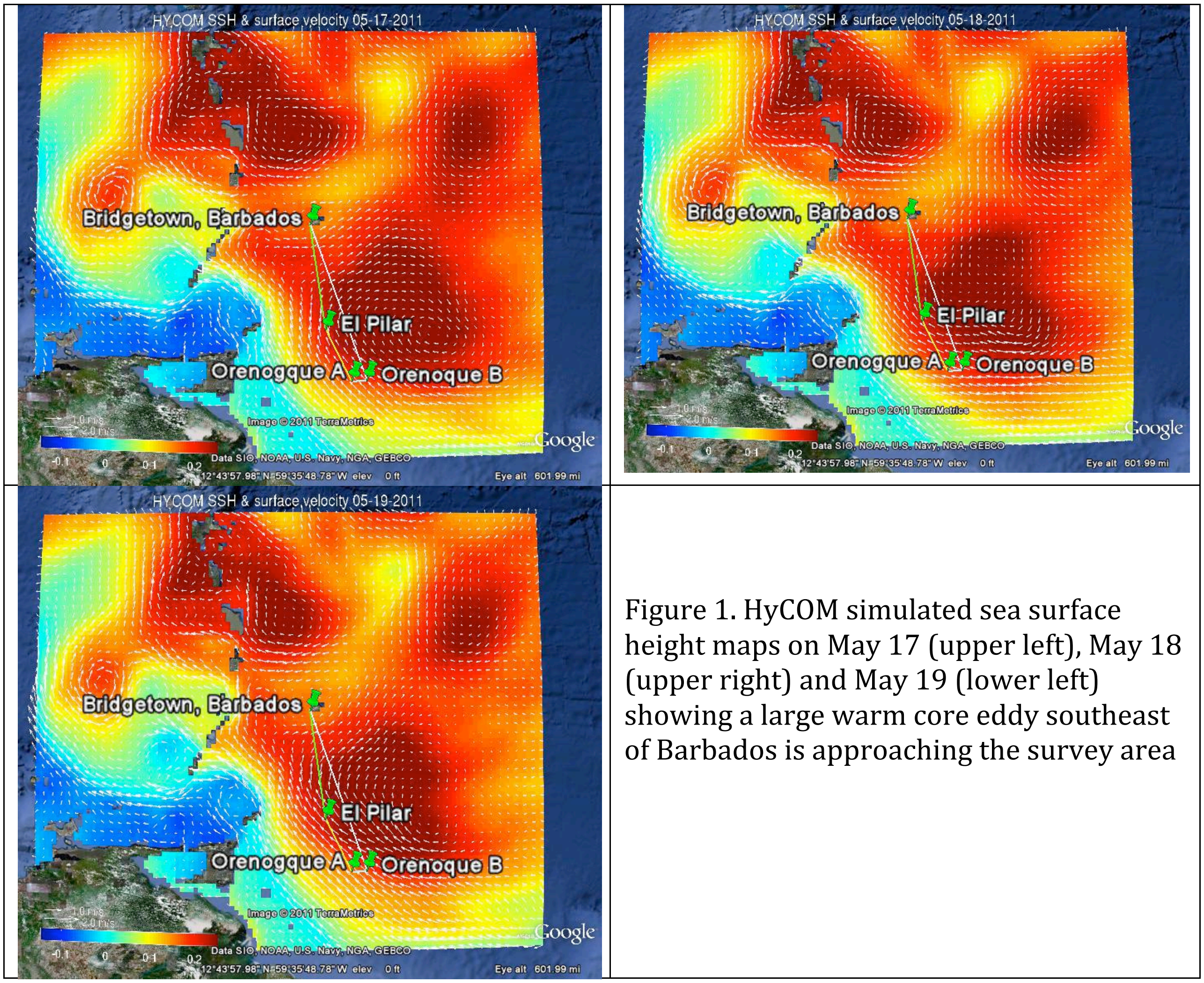
Method #2 used for the third deployment.
The deployment was done in 3 stages. The float was staged as above. The crane was connected to the top end of the chain connected to the top of the larval trap. The anchor, release and larval trap were lowered over the stern. The preservative was poured into the larval trap tube right before it went over the stern but the membrane cover for the tube failed and preservative leaked out. Then the second part of the mooring (current meter and Technicap trap) was connected to the chain and the crane line was switched to the top of the Technicap Trap. The mooring was lowered until the top of the technicap trap was reachable from the deck. The 25m cable from the float was brought around the stern and attached to the top of the Technicap trap and a quick release from the A-frame was exchanged with the crane line. The float was lifted overboard with the winch and allowed to float off the stern. The Technicap trap was lowered into the water then released when it was over the site.

This method was more complicated and took longer, but the crew felt that there was better control and less potential for equipment damage. It was more difficult to connect the chain to the bottom of the current meter because the shackle was much smaller than the one on the float line that is connected to the Technicap trap. Again the sea state was not bad (`4' a little choppier than before), but the crew felt it would be better to do it this way in worse conditions.

4. Hydrographic Data

4A. Background

The examination of data assimilative HyCOM global ocean model prediction shows a large warm core eddy southeast of Barbados is approaching our survey area (Figure 1). It appears that the western edge of this eddy will be over stations where three moorings will be deployed. The clockwise rotating surface circulation and convergence associated with the warm core eddy may provide a transport and retention mechanism for plankton and fish larvae. A recent study in east Pacific by Adams et al. (2011) also suggested such episodic surface eddy can energize deep ocean circulation, allowing pronounced advection of benthic species. It is interesting to investigate whether similar mechanism may work in the northwest Atlantic SEEP region as well. Year-long velocity measurements from to-be-deployed bottom mounted current meters, along with time series of surface eddy activities observed from satellite altimeters can be used to analyze this hypothesis. The science team decides to conduct underway XBT and CTD casts along the cruise track to at least partially sample the hydrographic conditions of this warm core eddy and quantify it vertical scale.


HYCOM SSH & surface velocity 05-17-2011

HYCOM SSH & surface velocity 05-18-2011

HYCOM SSH & surface velocity 05-19-2011

Figure 1. HyCOM simulated sea surface height maps on May 17 (upper left), May 18 (upper right) and May 19 (lower left) showing a large warm core eddy southeast of Barbados is approaching the survey area

4B. XBT Survey

Starting May 17, 18:26 GMT, We began underway XBT casts roughly every hour (~ every 10 nm apart between stations). A total of 27 XBT casts was made during the survey. Figure 2 shows their locations, while Table 1 provides exact coordinate and time (in GMT) of each cast. Note the west transect ran southward from Bridgetown, Barbados to Orenogque A (passing El Pilar), whereas the east transect ran northward from Orenoque B to Bridgetown. XBT data (Figure 3 and 4) show the ocean thermocline is at depth of ~ 120 m. The signature of warm core eddy is clearly seen in the southern portion of the west transect. Here the thermocline deepens by 50-75 meters, reaching approximately 200m depth. Detailed temperature profiles from all 27 XBT stations are provided in Appendix.

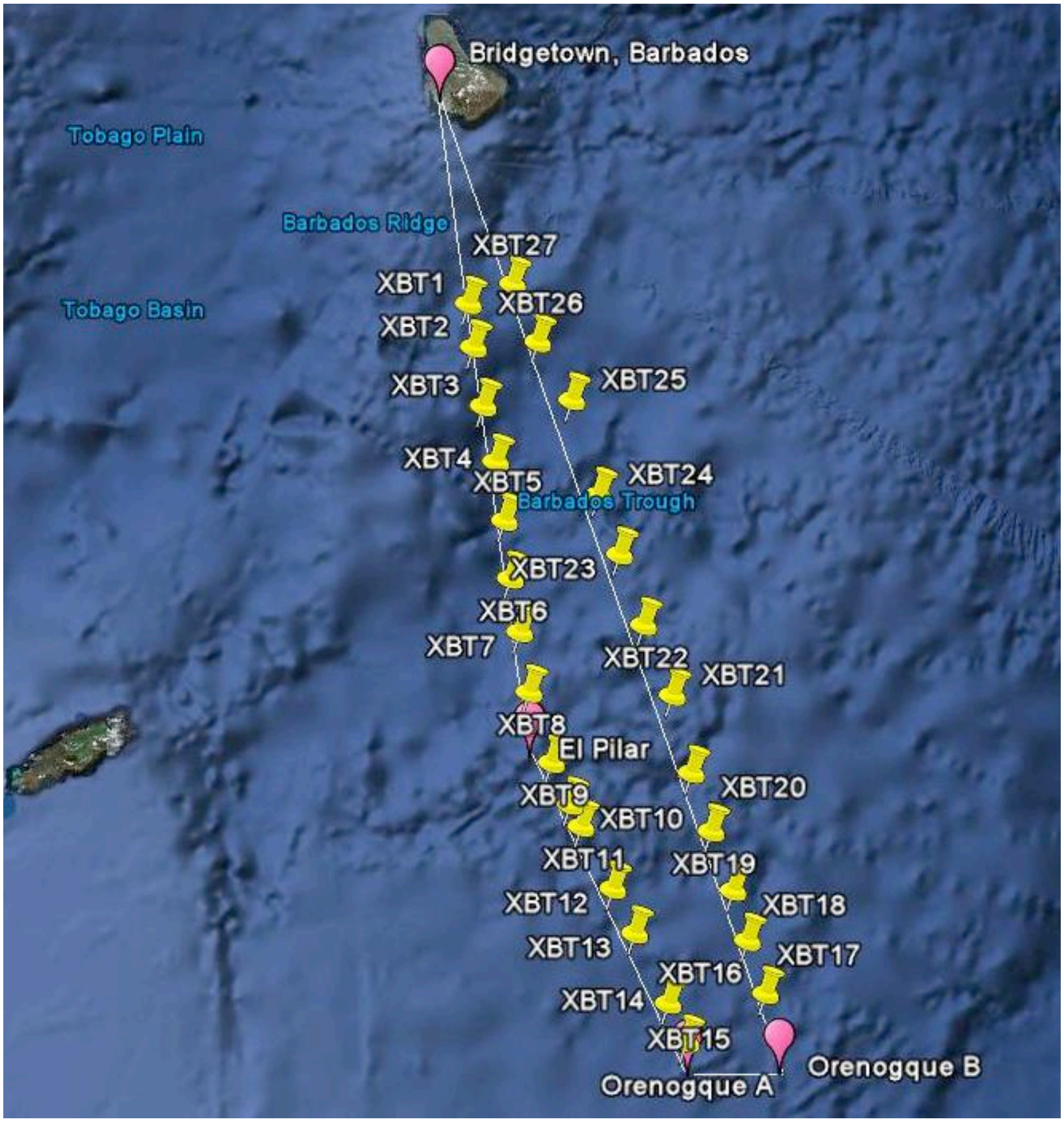


Figure 1. A map showing locations of 27 XBT cast.

Station	Date	Time (GMT)	Latitude	Longitude	Filename	Notes
XBT 1	17-May	18:26	12.4562	-59.5451	T7_00001.EDF	
XBT 2	17-May	19:08	12.3328	-59.5300	T7_00002.EDF	
XBT 3	17-May	20:05	12.1660	-59.5011	T7_00003.EDF	
XBT 4	17-May	21:00	12.0079	-59.4644	T7_00005.EDF	
XBT 5	17-May	22:01	11.8407	-59.4383	T7_00006.EDF	
XBT 6	17-May	23:02	11.6766	-59.4210	T7_00007.EDF	
XBT 7	17-May	23:58	11.5255	-59.3936	T7_00008.EDF	
XBT 8	18-May	1:03	11.3551	-59.3662	T7_00009.EDF	
XBT 9	18-May	10:58	11.1556	-59.3011	T7_00010.EDF	
XBT 10	18-May	11:59	11.0371	-59.2469	T7_00011.EDF	
XBT 11	18-May	12:59	10.9745	-59.2152	T7_00012.EDF	
XBT 12	18-May	14:08	10.7981	-59.1236	T7_00014.EDF	
XBT 13	18-May	14:59	10.6710	-59.0603	T7_00015.EDF	
XBT 14	18-May	16:20	10.4710	-58.9637	T7_00016.EDF	
XBT 15	19-May	1:22	10.3604	-58.9113	T7_00017.EDF	
XBT 16	19-May	15:04	10.4988	-58.6826	T7_00018.EDF	
XBT 17	19-May	16:01	10.6505	-58.7349	T7_00019.EDF	
XBT 18	19-May	16:55	10.7925	-58.7770	T7_00020.EDF	
XBT 19	19-May	17:59	10.9612	-58.8407	T7_00021.EDF	
XBT 20	19-May	19:02	11.1269	-58.8975	T7_00022.EDF	
XBT 21	19-May	23:00	11.3469	-58.9529	T7_00023.EDF	
XBT 22	20-May	0:03	11.5459	-59.0362	T7_00024.EDF	
XBT 23	20-May	1:05	11.7459	-59.1058	T7_00025.EDF	
XBT 24	20-May	1:59	11.9142	-59.1664	T7_00026.EDF	
XBT 25	20-May	5:57	12.1828	-59.2447	T7_00027.EDF	
XBT 26	20-May	6:59	12.3481	-59.3439	T7_00028.EDF	
XBT 27	20-May	7:57	12.5131	-59.4170	T7_00029.EDF	Noisy data, attempted twice

Table 1: Time (in GMT) and coordinate of each XBT cast.

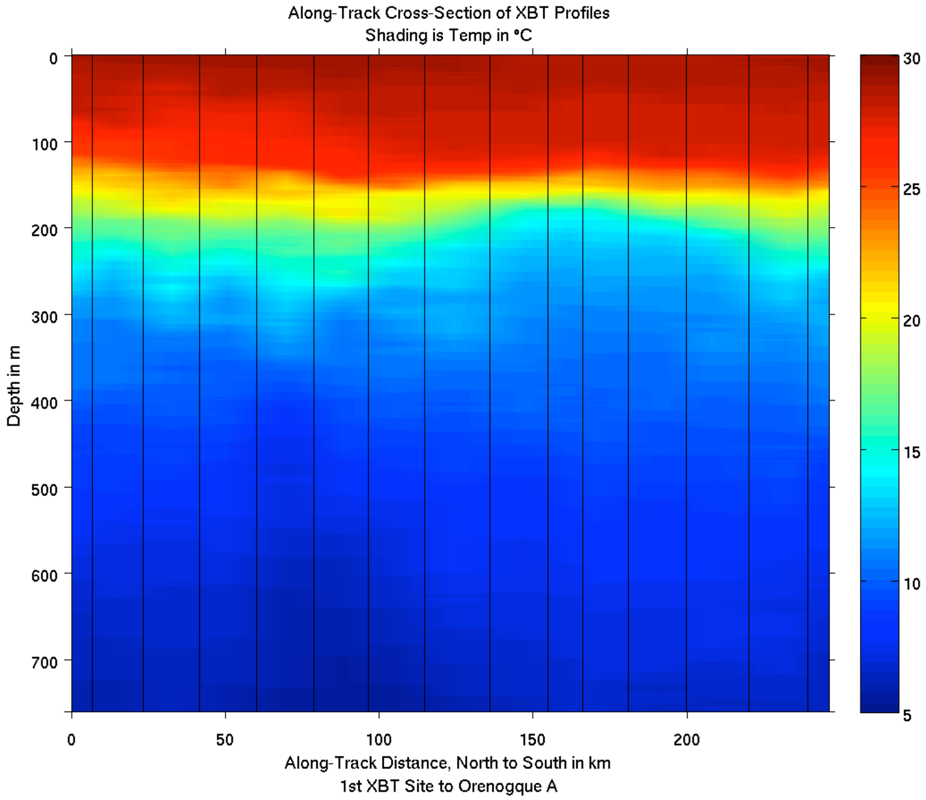


Figure 3. The subsurface temperature field along the west transect.

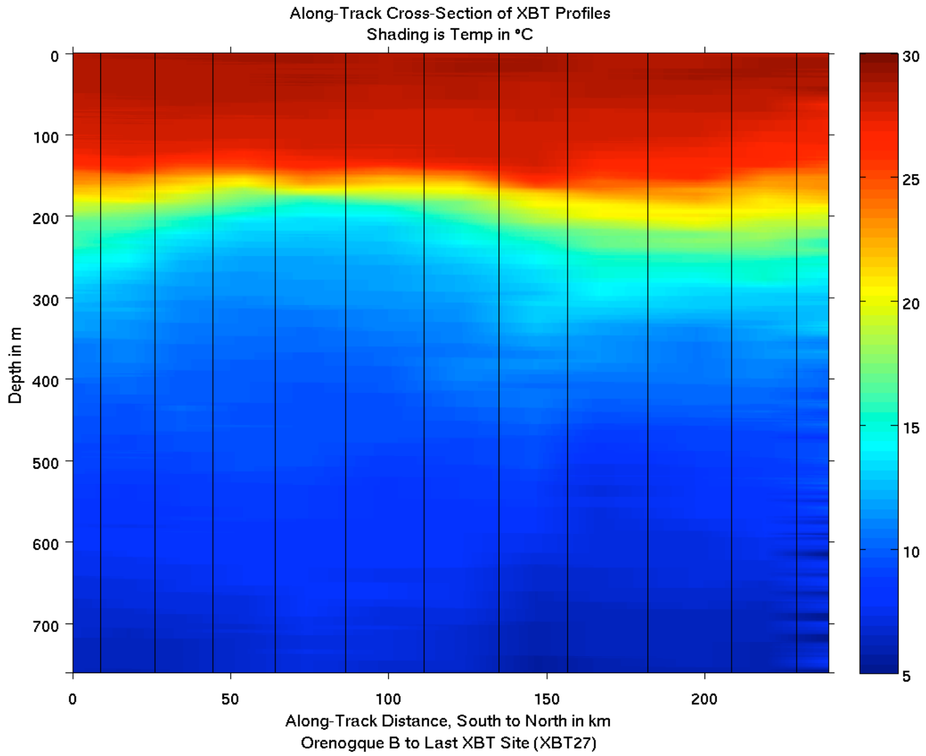


Figure 4. The subsurface temperature field along the east transect.

3. CTD Survey

Because XBTs only provide temperature measurement, 5 CTD casts were made to observe vertical profiles of other physical and biochemical properties. 3 of these casts were made at mooring stations (El Pilar, Orenogque A and B), and 2 other casts were made on the transit back to Barbados, approximately 60 nm apart. Figure 5 shows their locations, while Table 2 lists the exact location and time of these casts. Given the depths of these stations, each CTD cast took approximately 1 hour to complete.

CTD profiles at all 5 stations (Figure 6-10) show some common features:

(1) the thermocline is at ~ 120 m;
(2) there is a subsurface (~150 m) salinity maxima, which is about 1-2 psu saltier than surface salinity;
(3) there is a subsurface chl-a maxima at about 100-120m;
(4) profiles from downcast and upcast agree to each other very nicely, suggesting a rather stable vertical structure in hydrographic condition.

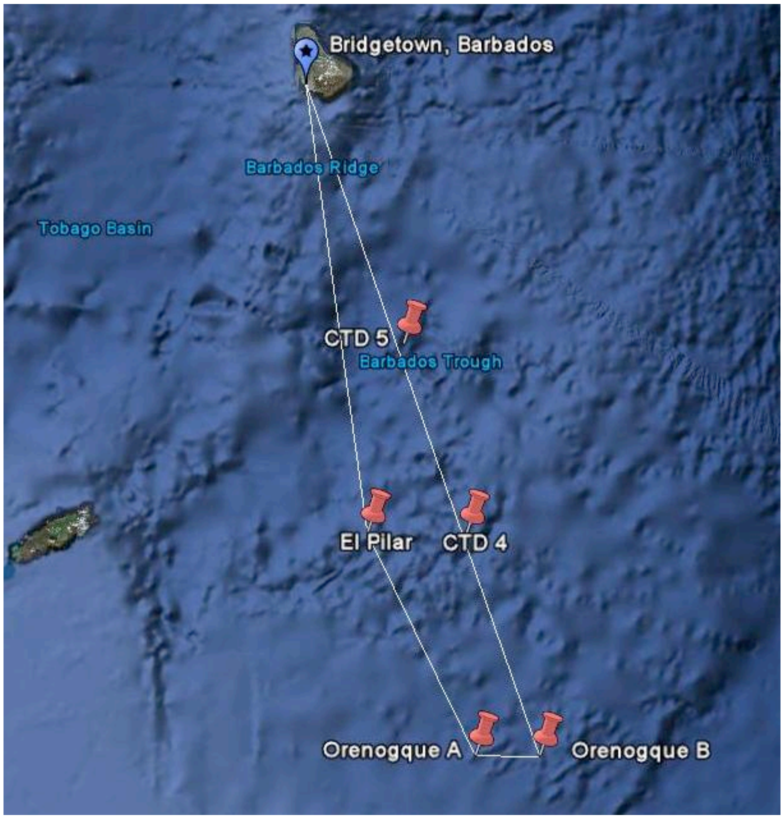
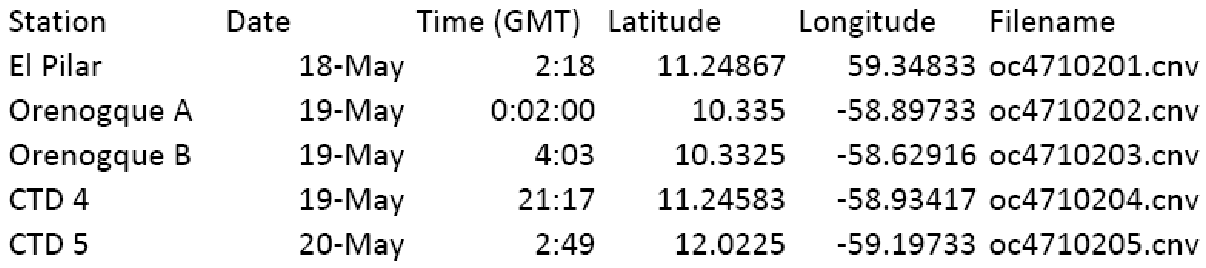


Figure 5. Locations of 5 CTD stations.



Station	Date	Time (GMT)	Latitude	Longitude	Filename
El Pilar	18-May	2:18	11.24867	59.34833	oc4710201.cnv
Orenogque A	19-May	0:02:00	10.335	-58.89733	oc4710202.cnv
Orenogque B	19-May	4:03	10.3325	-58.62916	oc4710203.cnv
CTD 4	19-May	21:17	11.24583	-58.93417	oc4710204.cnv
CTD 5	20-May	2:49	12.0225	-59.19733	oc4710205.cnv

Table 2. Location and time (in GMT) of each CTD cast.

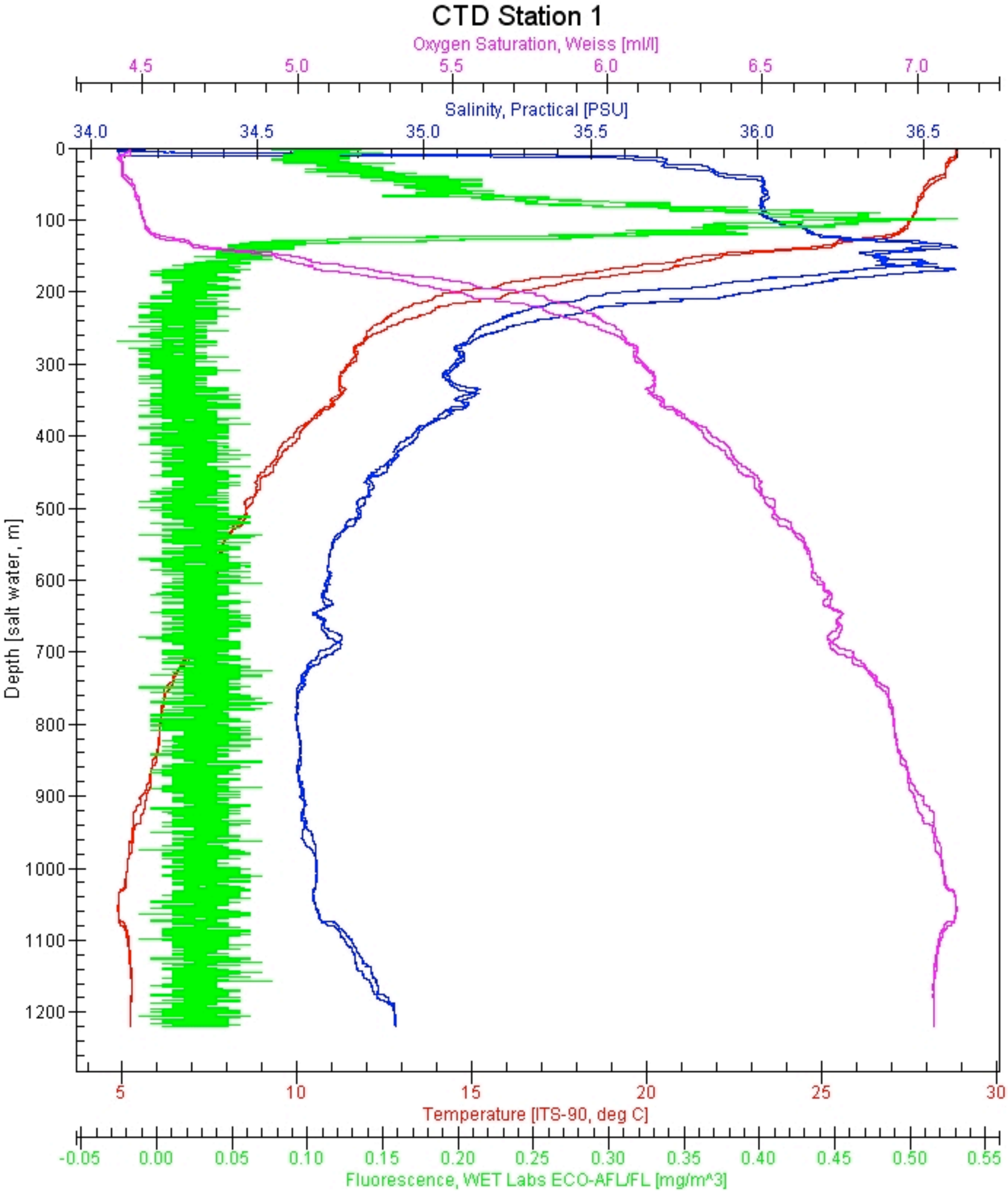


Figure 6. Profiles of temperature, salinity, oxygen and florescence at CTD station 1.

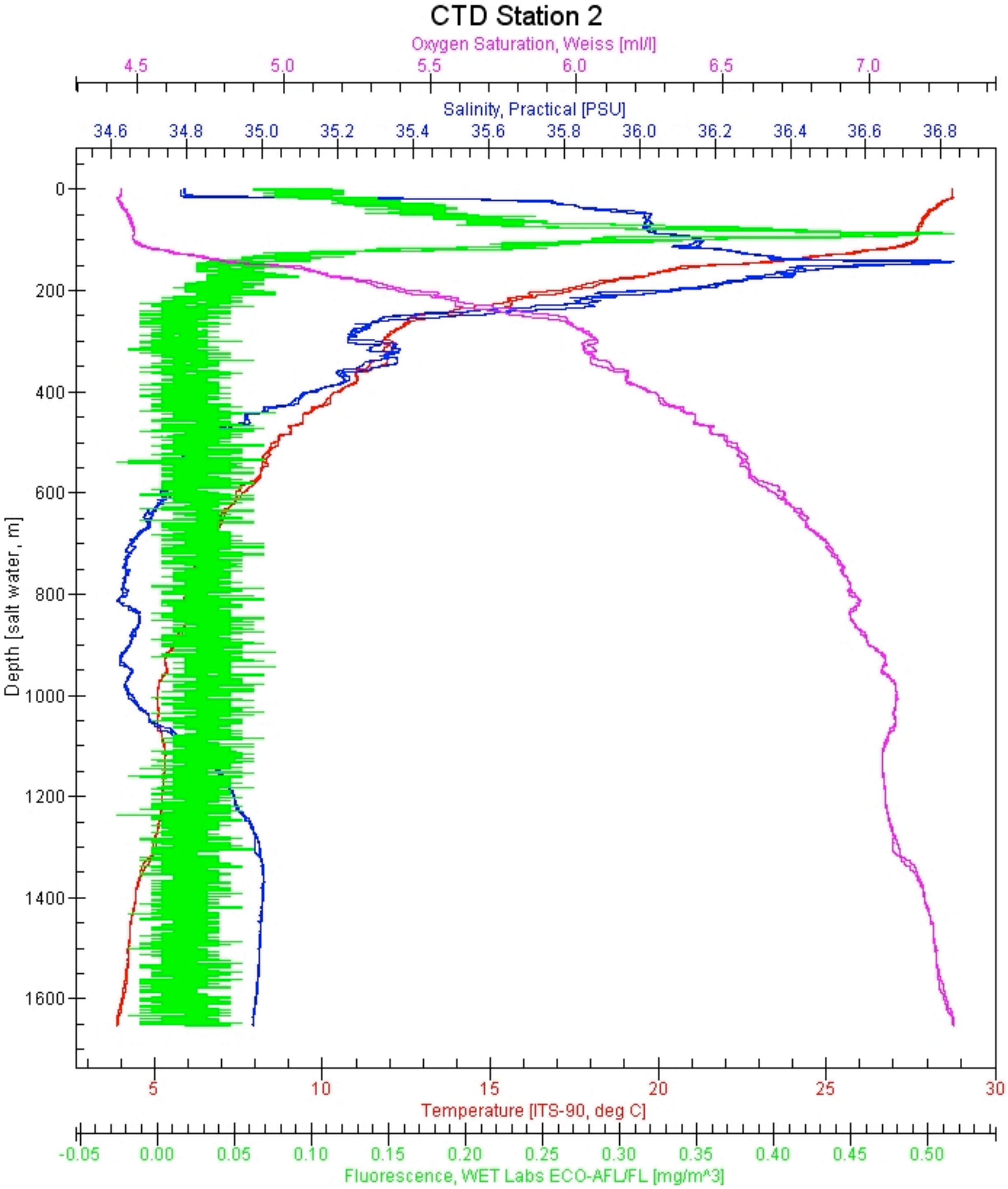


Figure 7. Profiles of temperature, salinity, oxygen and florescence at CTD station 2.

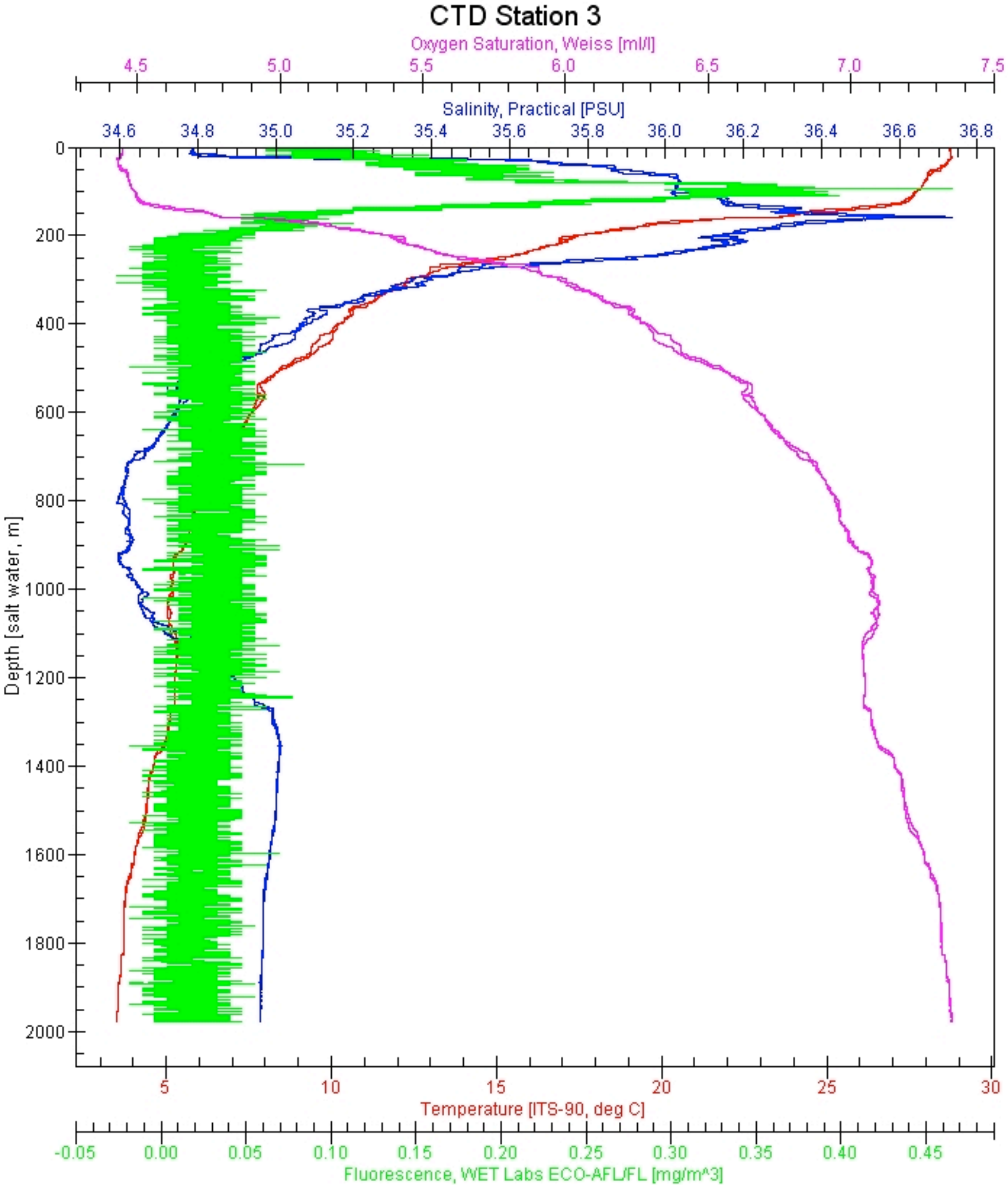


Figure 8. Profiles of temperature, salinity, oxygen and florescence at CTD station 3.

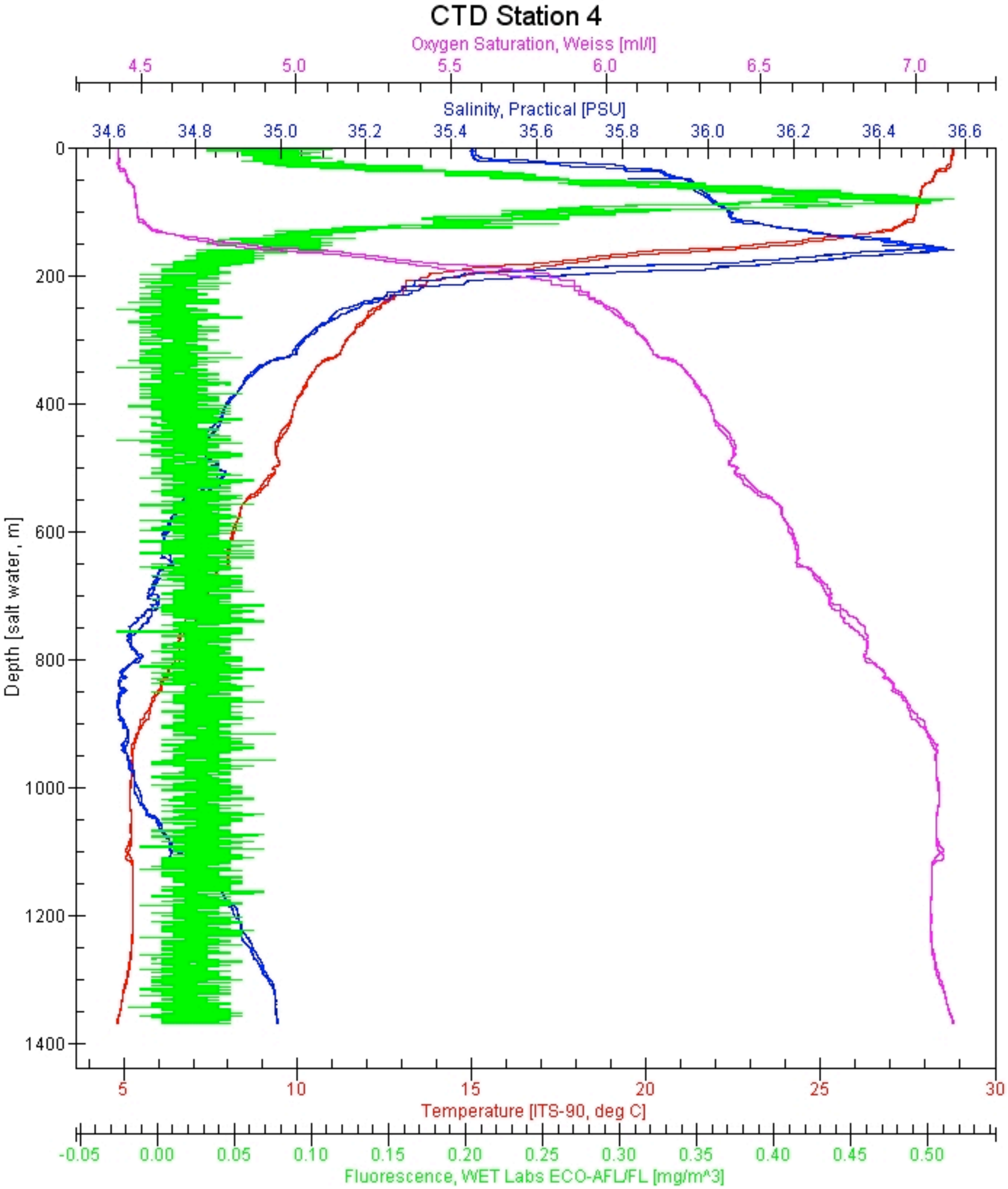


Figure 9. Profiles of temperature, salinity, oxygen and florescence at CTD station 4.

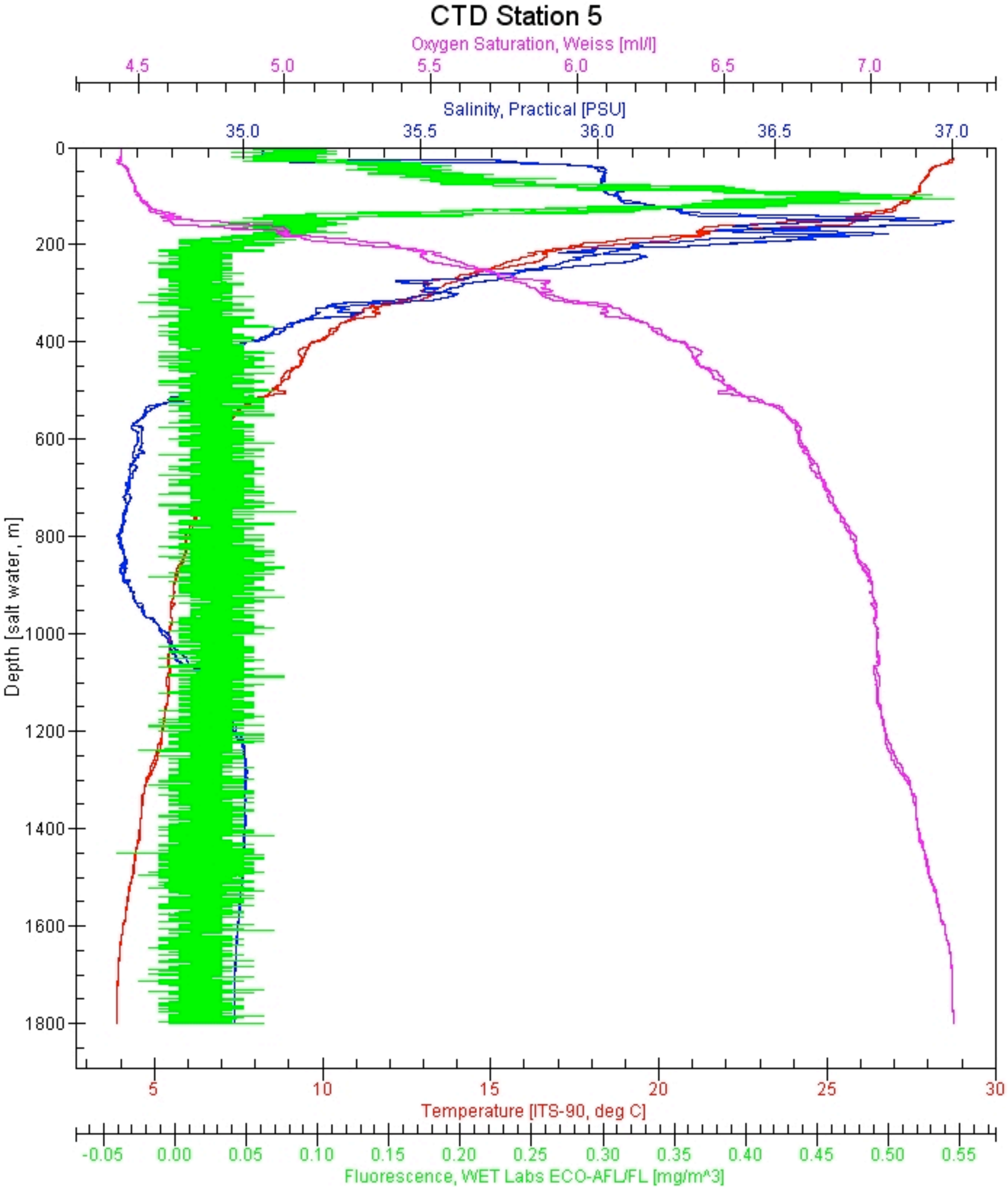


Figure 10. Profiles of temperature, salinity, oxygen and florescence at CTD station 5.

5. Sub-Bottom Profiling

The Barbados Ridge Complex develops as a result of the subduction of the North and South American plates beneath the Caribbean plate (Peter and Westbrook, 1976). Channels, diapiric structures (e.g., mud volcanoes, shale diapirs, etc.) and back basins characterize the tectonically active area (Huyghe et al., 2004), and biological seep communities are well documented in the region (e.g., Olu et al., 1997). Southern Barbados prism's geologic framework provides an ideal laboratory for the assessment of tectonic controls on sediment mobilization and fluid escape features. Within this context Research Cruise 471-2 collected 743 km of seismic reflection profile data using the R/V Oceanus' hull-mounted 3260 Knudsen CHIRP operating at 3.5 kHz (Figure 1). Data were acquired using Knudsen's Soundersuite software and have been preliminarily examined using Knudsen's EchoPostSurvey software. Most data collection occurred in transit between port and mooring locations at a speed of ~10 knots, while a detailed survey consisting of 37-km of tracklines spaced 200-500 m apart took place over Orenoque B (Figure 2). Irregular bathymetry shows numerous mud volcanoes and domes populate the Southern Barbados prism (Figures 3-4) including areas not previously mapped (Figure 5) (c.f., Deville et al., 2006); while subsurface features such as acoustic turbidity, enhanced reflectors and faulting indicate gas and likely migration pathways (Figure 6). Seismic data confirmed approximate locations of all three mooring sites, and suggest seep activity. Further morphological and subsurface analysis of the data will be put into the regional tectonic and thermal context in attempts to constrain better the relationship between diapiric features and regional tectonic activity.

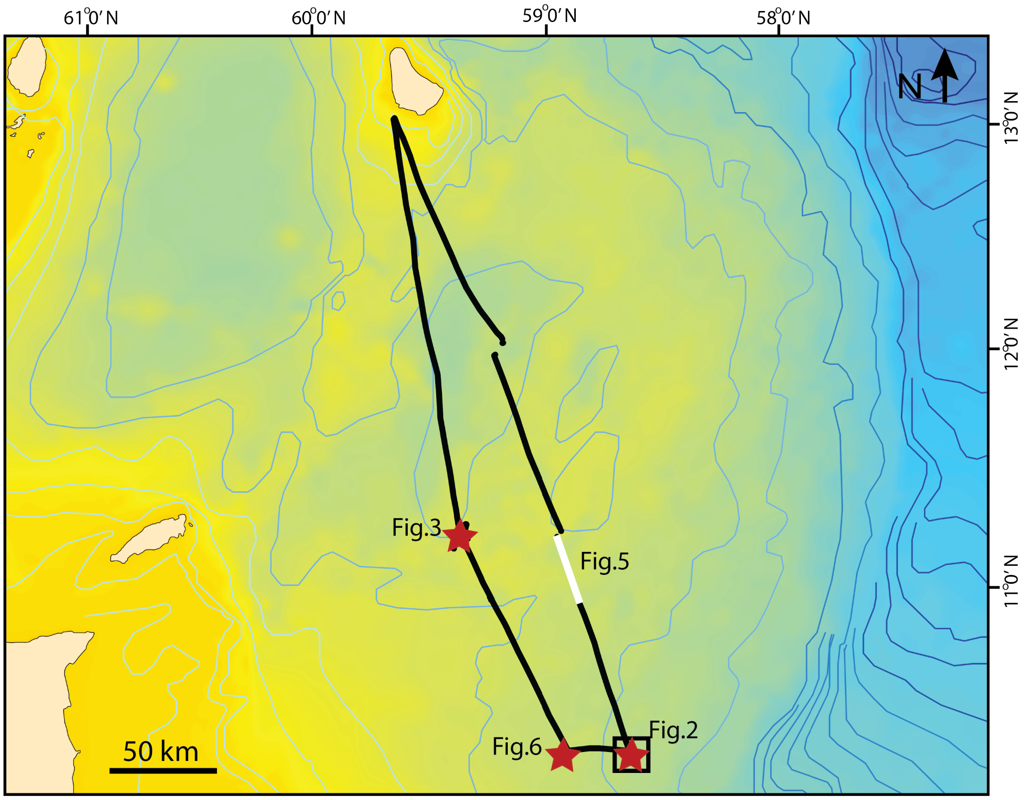


Figure 1: Location map of Cruise 471-2 with regional bathymetry ranging from -5 to -5000 m. Warmer colors are shallower areas while cooler colors are deeper,. Black lines represent locations where CHIRP seismic data were collected. Red stars indicate mooring deployments. Box and white line denote other figure locations.

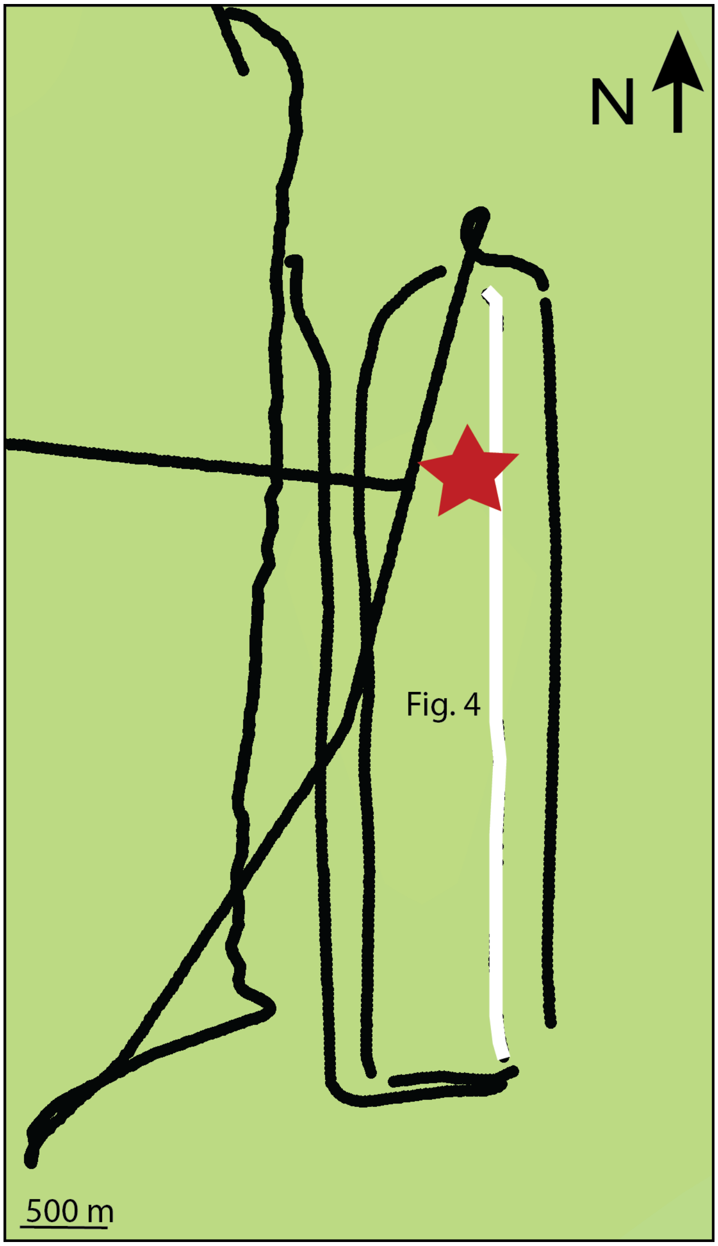


Figure 2: Site and tracklines for Orenoque B survey. Red star is the mooring. White line denotes Figure 4 location.

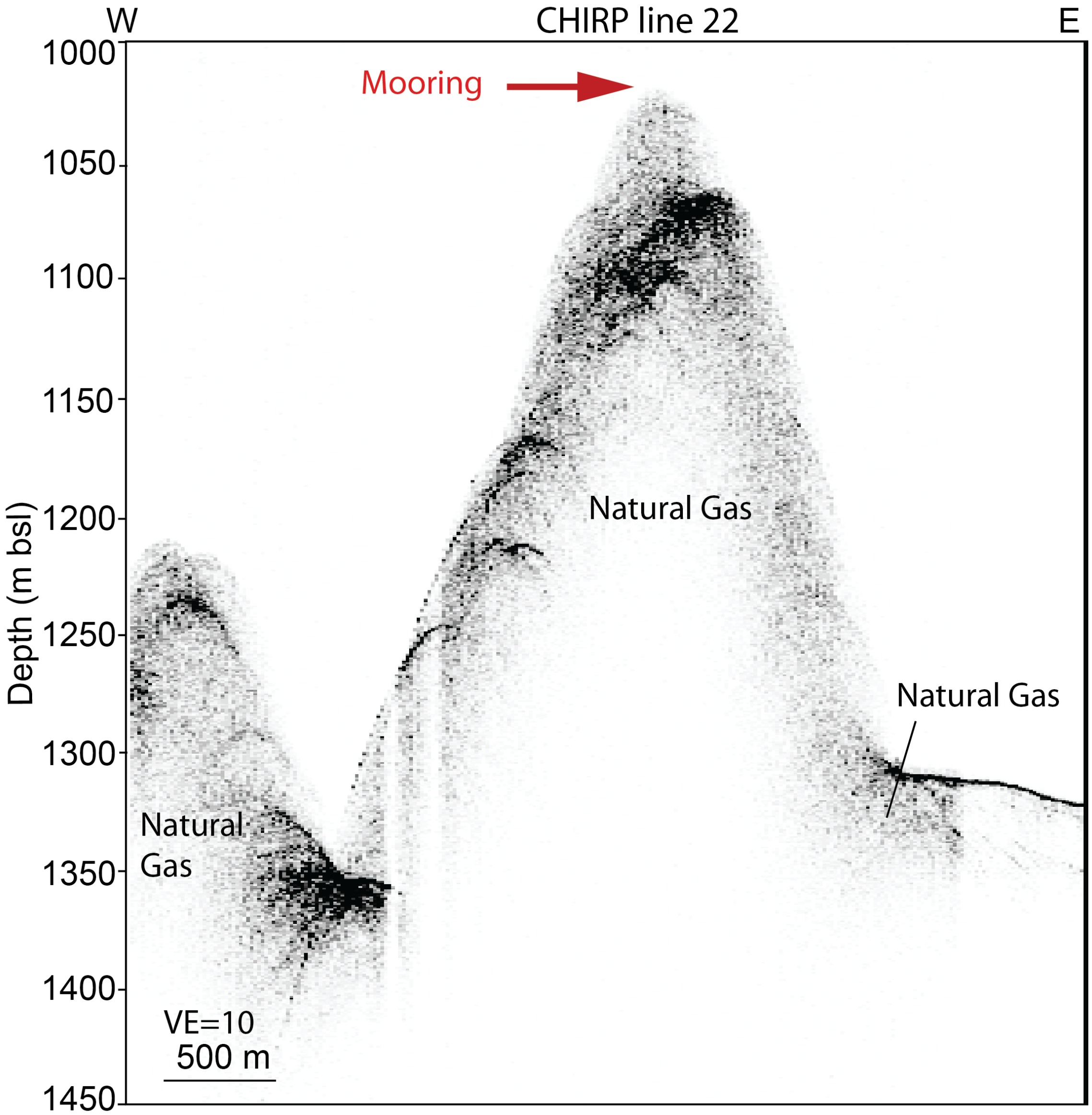


Figure 3: Seismic reflection profile with preliminary interpretations of the El Pilar dome and approximate mooring location (red arrow). Depth below sea level (bsl) was calculated using sound velocity of 1500 m/s in both the water column and sediment. Blurred seismic signatures at the peaks of the mud volcano and dome suggest soft and/or gassy sediments characterize those surfaces. Acoustic turbidity (blurred interior reflector) within the domes indicates subsurface gas. Vertical Exaggeration = 10.

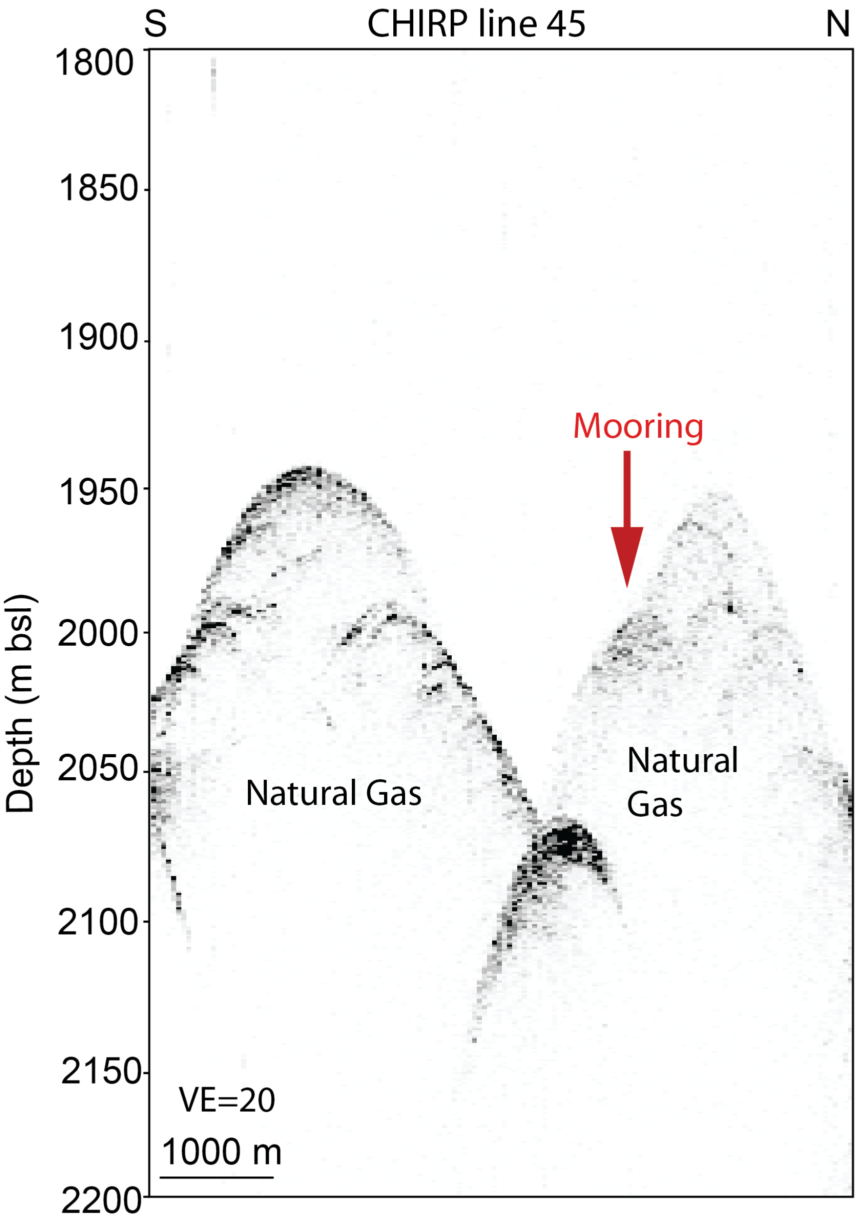


Figure 4: The red arrow indicates where the Orenoque B mooring was deployed on the flank of a diapiric dome. Minimal subsurface resolution likely results from the presence of gas within the diapiric structures. Vertical Exaggeration = 20.

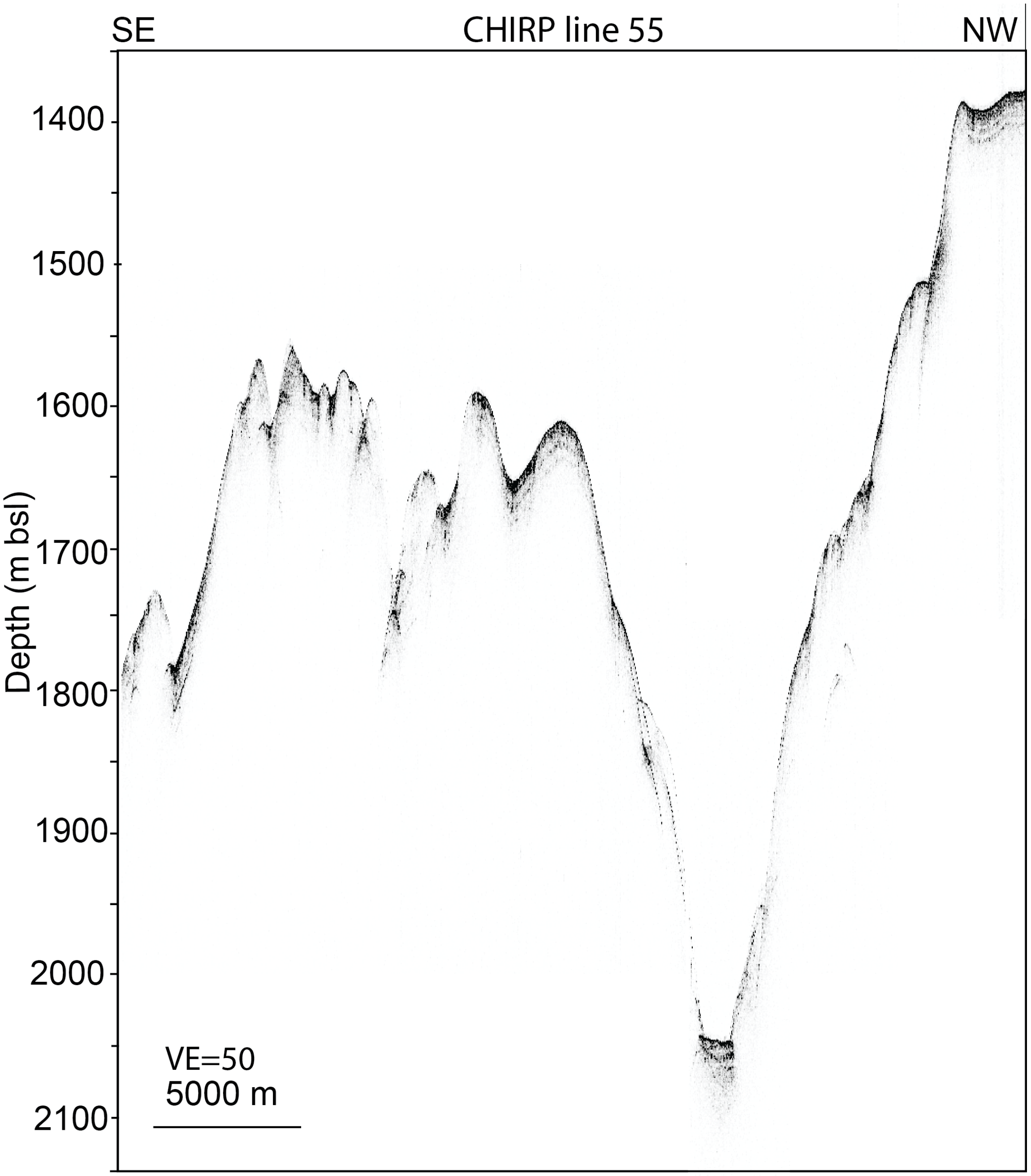


Figure 5: Seismic reflection profile indicates diapiric structures, channels and basins extend beyond previously mapped portions of the Southern Barbados Prism (e.g., Huyghe et al., 2004). Vertical Exaggeration = 50.

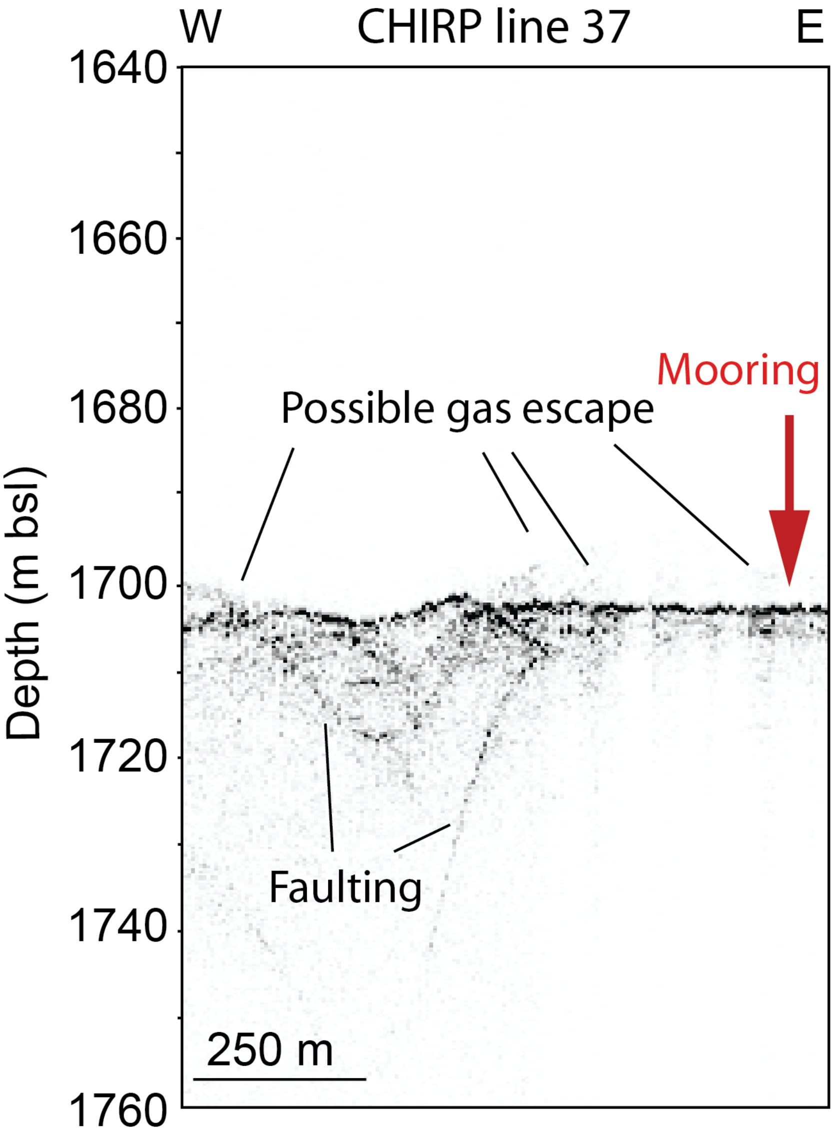


Figure 6: Proximate location of the Orenoque A mooring (red arrow). Subsurface shallow faulting and blurred reflectors above the seafloor suggest active gas seepage.

References:

Deville, E., Guerlais, S-H., Callec, Y., Griboulard, R., Huyghe, P., Lallemant, S., Mascle, A., Noble, M., Schmitz, J., Caramba working group, 2006, Liquefied vs stratified sediment mobilization processes: Insight from the South of Barbados accretionary prism. Tectnophysics 428: 33-47.

Huyghe, P., Foata, M., Deville, E., Mascle, G., Caramba working group, 2004, Channel profiles through the active thrust front of the southern Barbados prism. Geology 32: 429-432.

Olu, K., Sibuet, M., Harmegnies, F., Foucher, J-P., Fiala-Medioni,A., 1996., Spatial distribution of diverse cold seep communities living on various diapiric structures of the southern Barbados prism. Prog. Oceanog. 38:347-36.

Peter, G., and Westbrook, G.K., 1976, Tectonics of southwestern North Atlantic and Barbados Ridge Complex: American Association of Petroleum Geologists Bulletin 60: 1078-1106.

Lessons Learned:

- weld bag rings onto wagon wheels;
- mooring split into thirds for launch; sub-bottom profiler has to be off for talking to the release;
- soak wood before deployment
- technicaps – during deployments, covers dropped off – need to fix
- dry assembly, deck assembly, then drop
- study remote sensing images in advance to understand life history, configuration, velocities
- not enough people or time to process MOCNESS samples
- guide books for plankton larvae
- have luck on your side

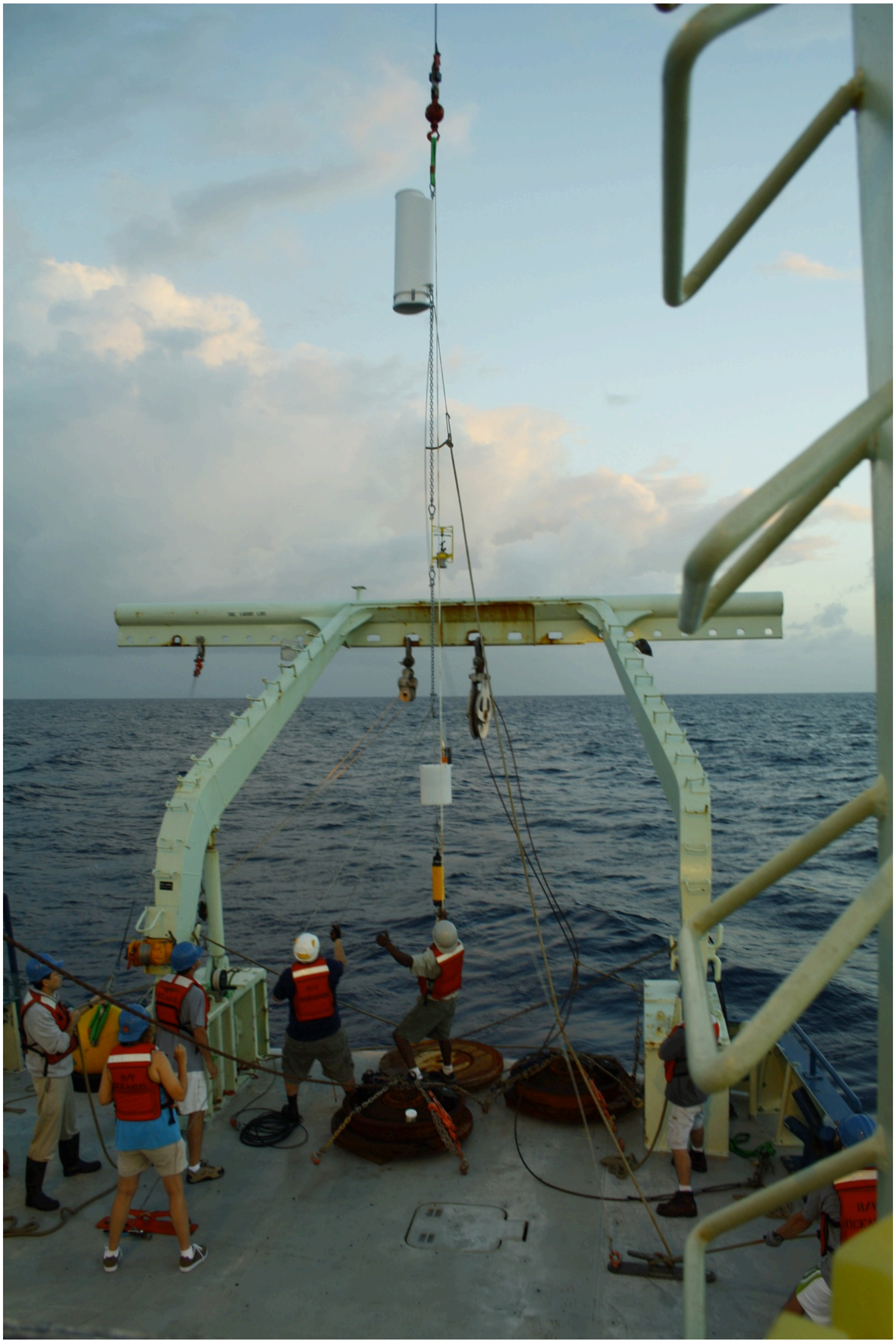


Photo 1. Mooring deployment, El Pilar

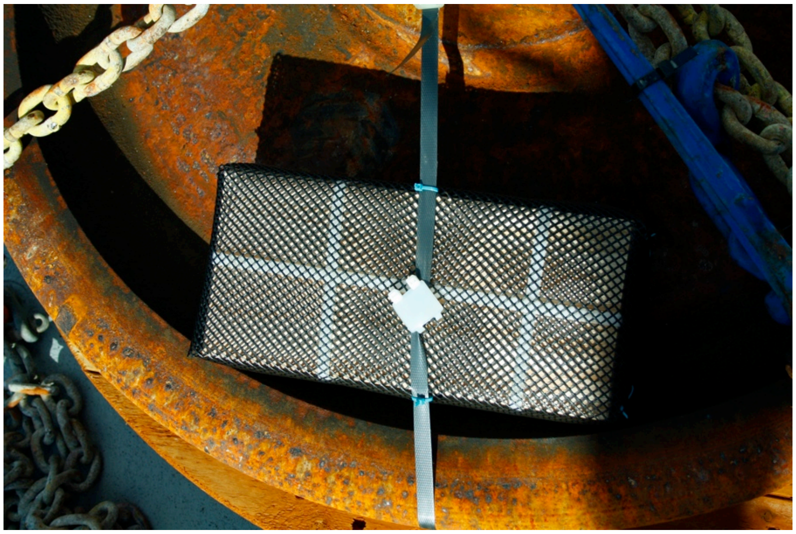
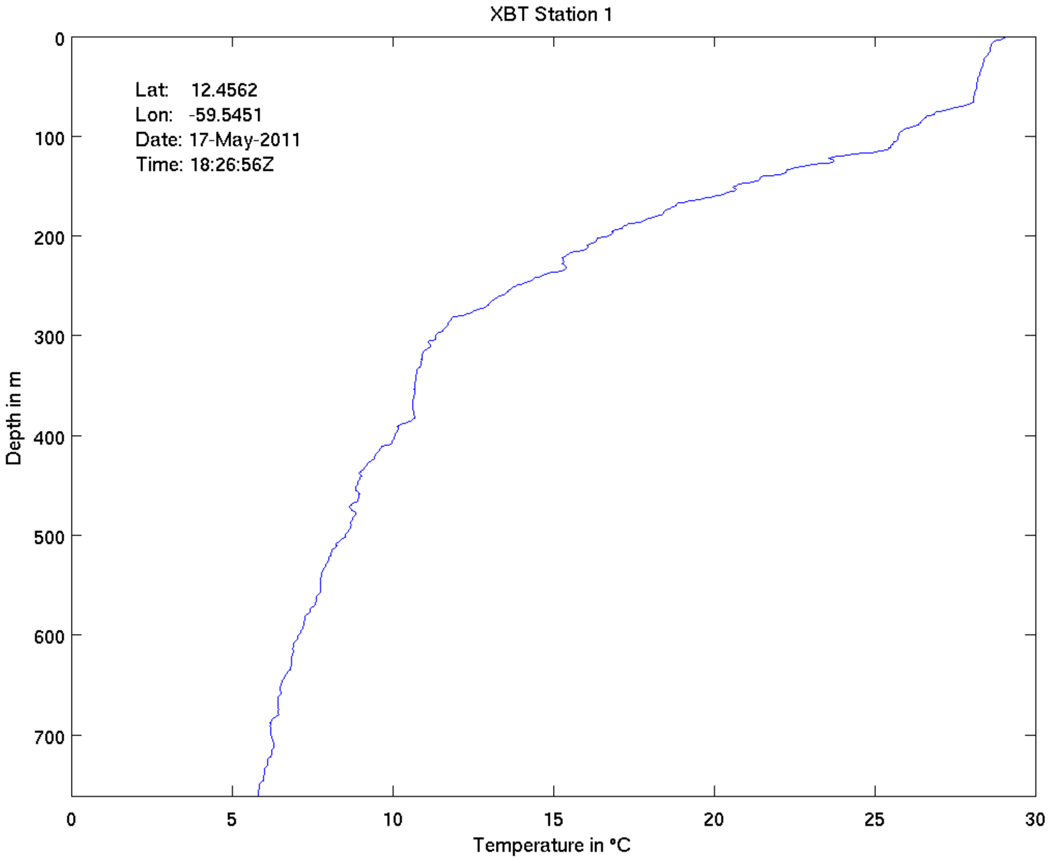
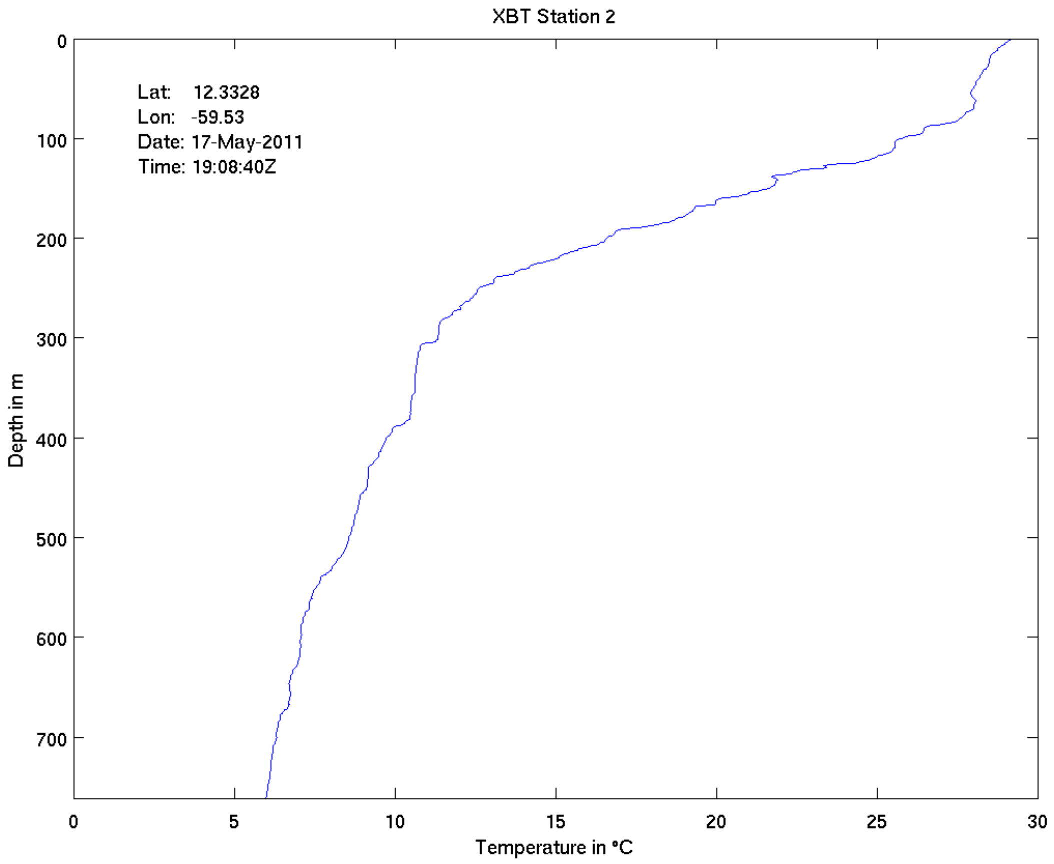


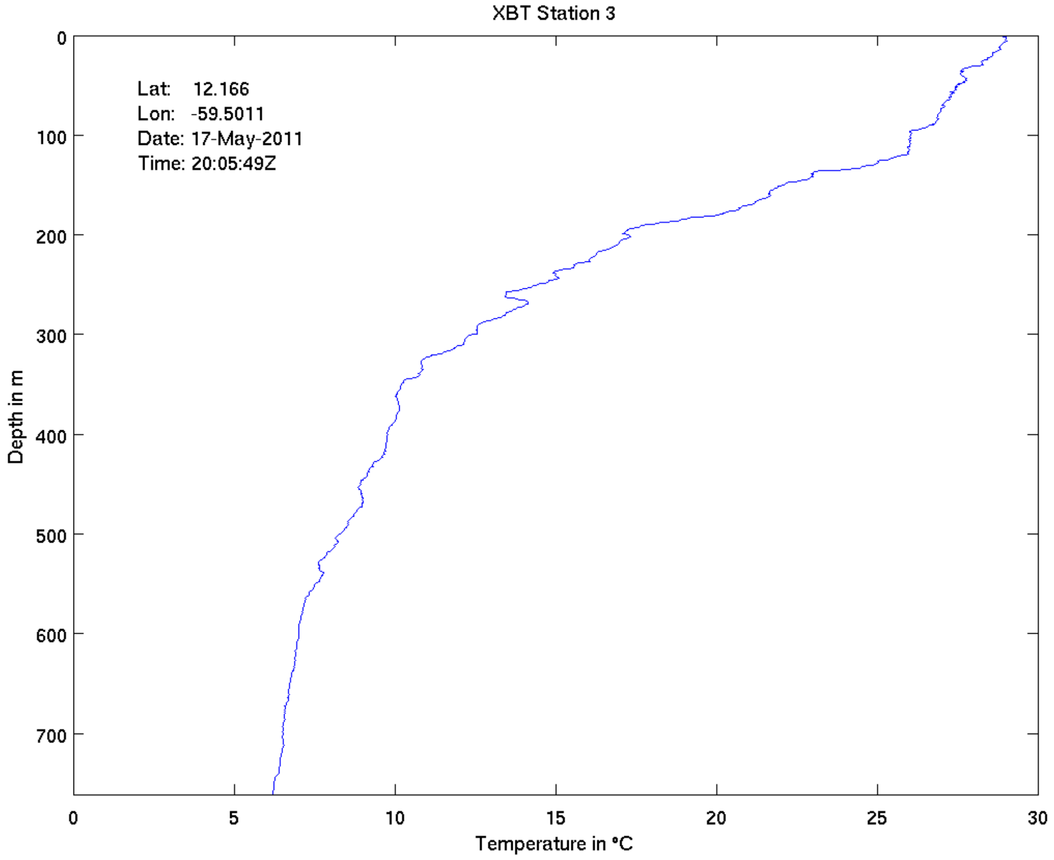
Photo 2. Wood Bag. Blue = oak

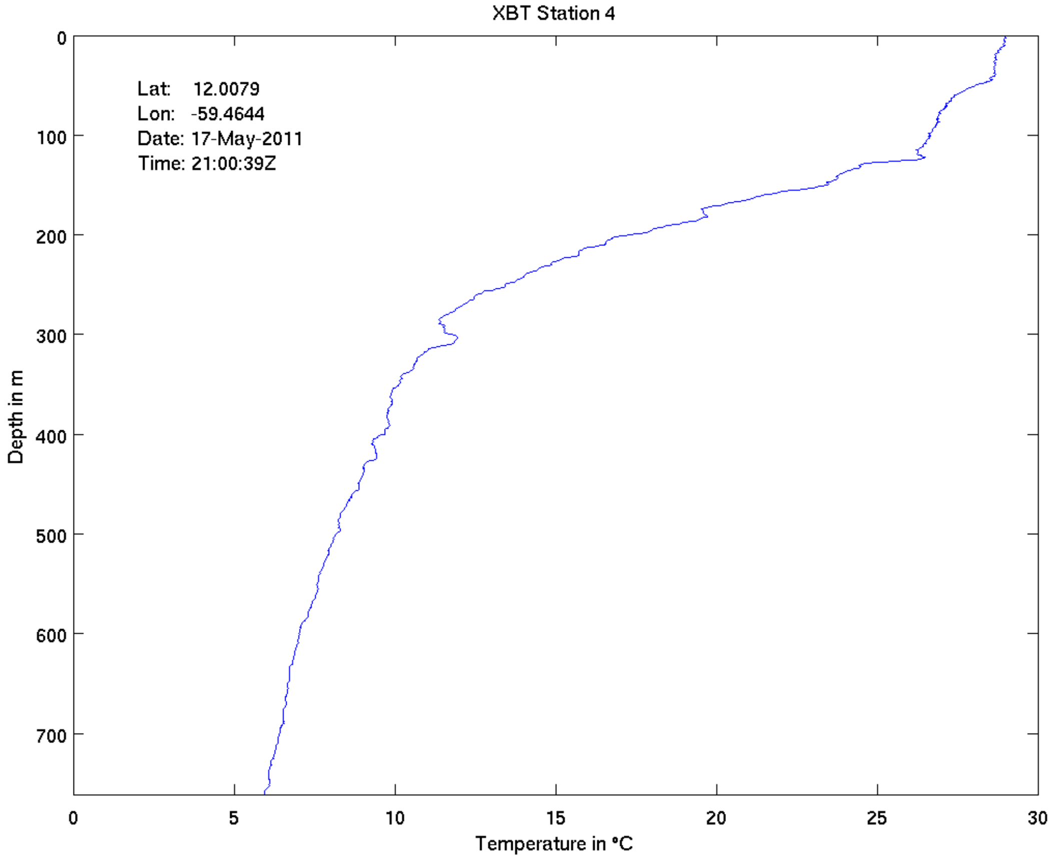
Figure 2. Science Party: Dave, Craig, Gayle, Abbe, Jameson, Paul, Roy, Tracey, April, Kristina, Laura, Joe, Laurel, Amy, Cindy, Sophie, Richard, Brandon

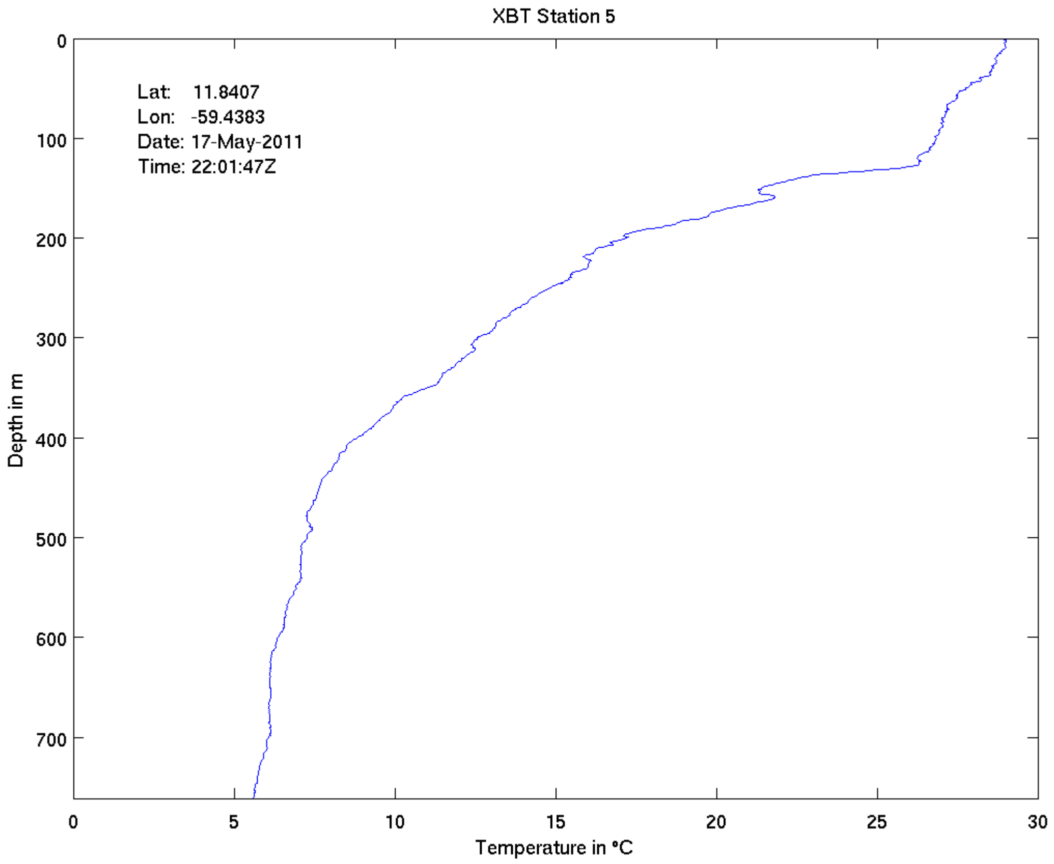
Appendix: XBT temperature profiles (at station 1 to 27)

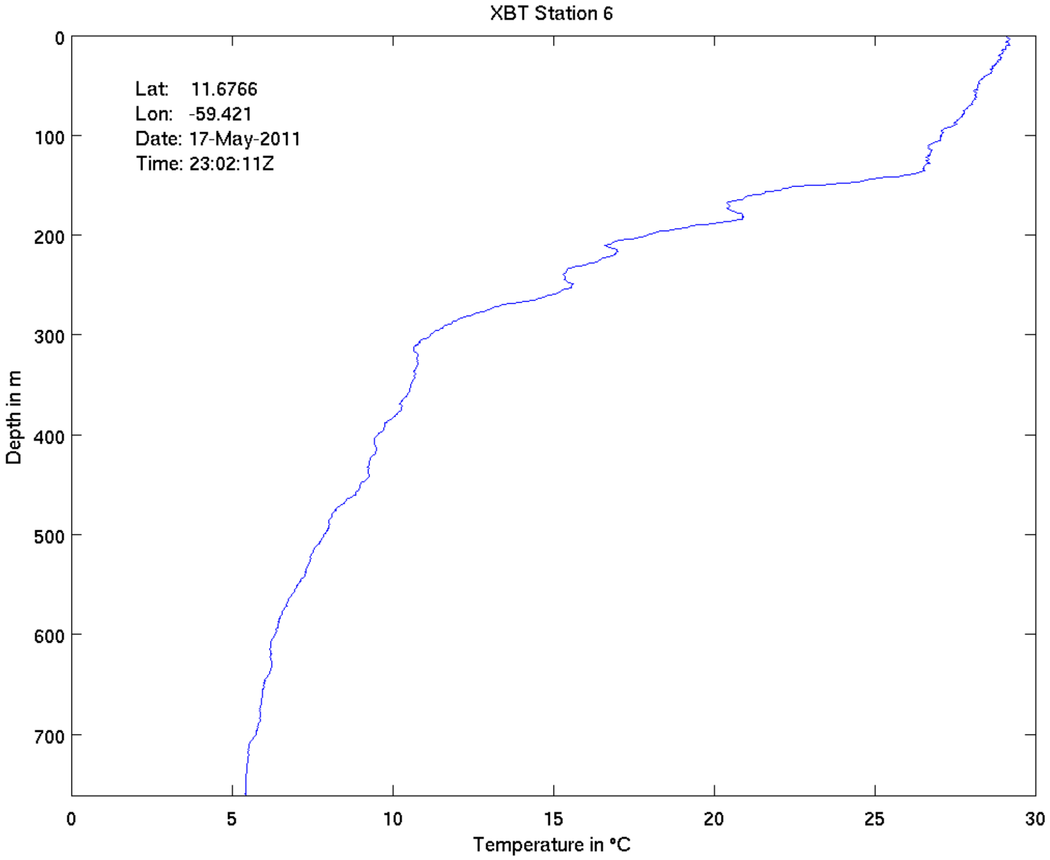


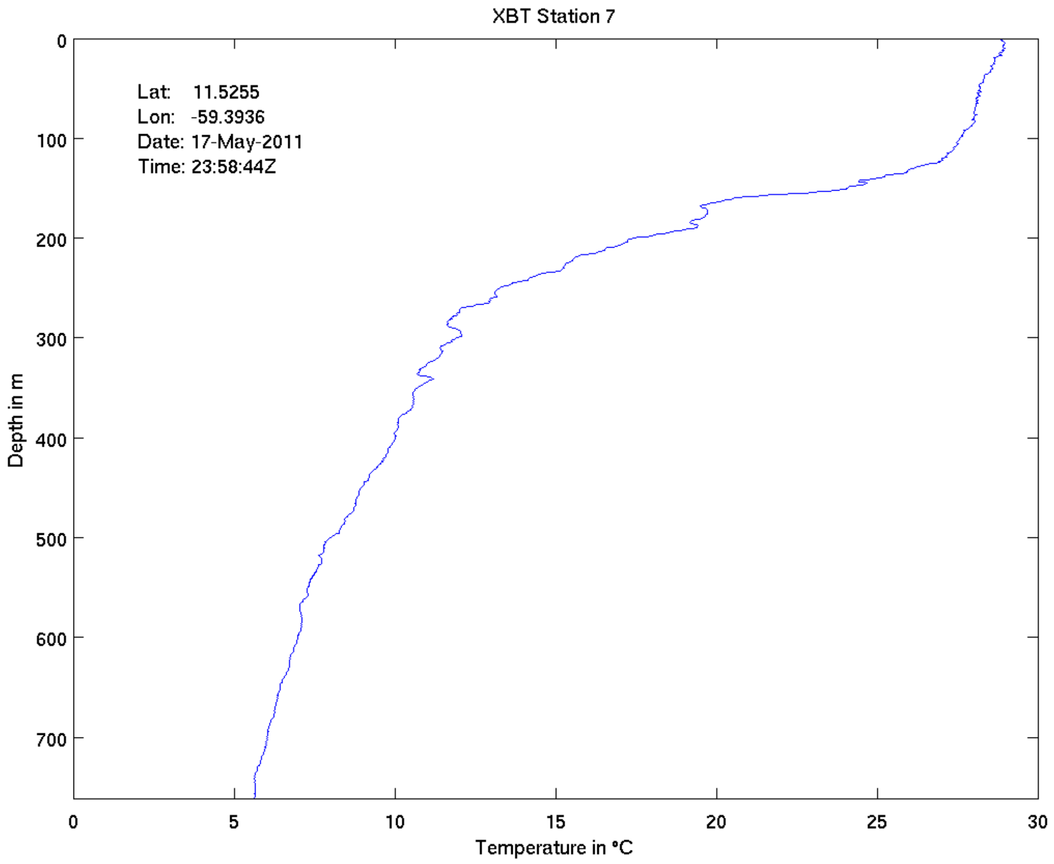

XBT Station 2
Lat: 12.3328
Lon: -59.53
Date: 17-May-2011
Time: 19:08:40Z
Depth in m
0
100
200
300
400
500
600
700
Temperature in °C
0
5
10
15
20
25
30

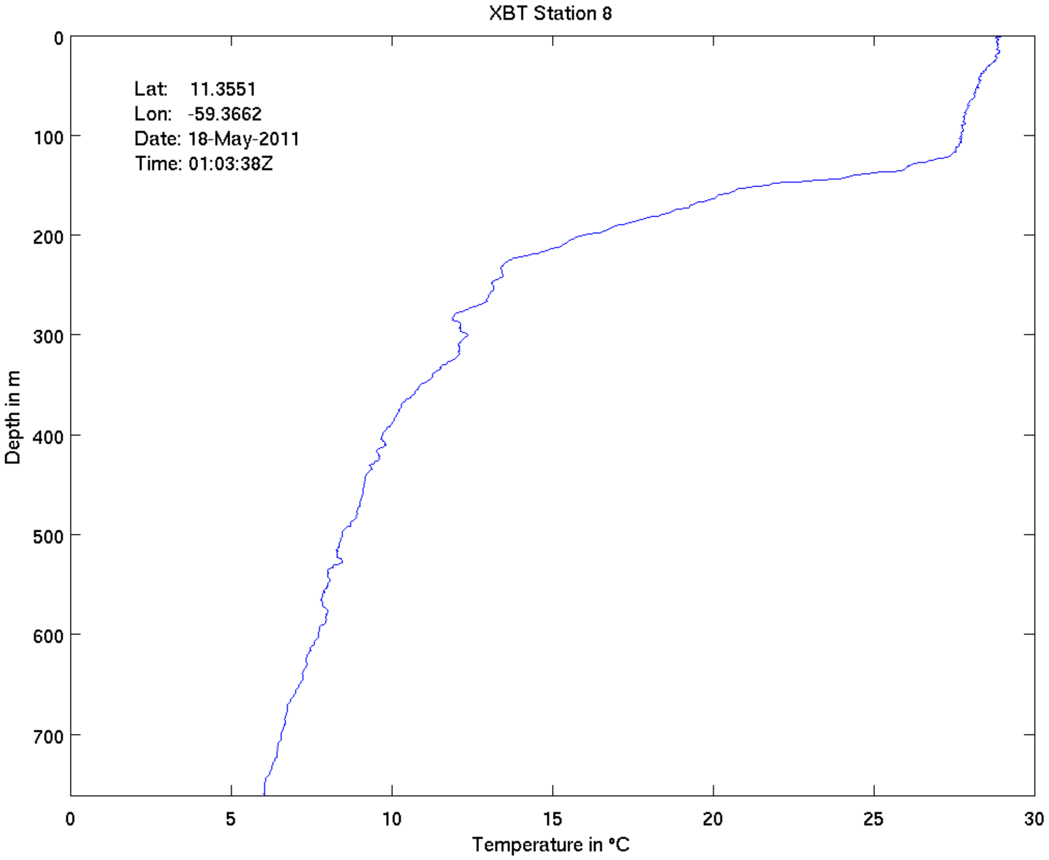

XBT Station 3
Lat: 12.166
Lon: -59.5011
Date: 17-May-2011
Time: 20:05:49Z
Depth in m
0
100
200
300
400
500
600
700
0
5
10
15
20
25
30
Temperature in °C

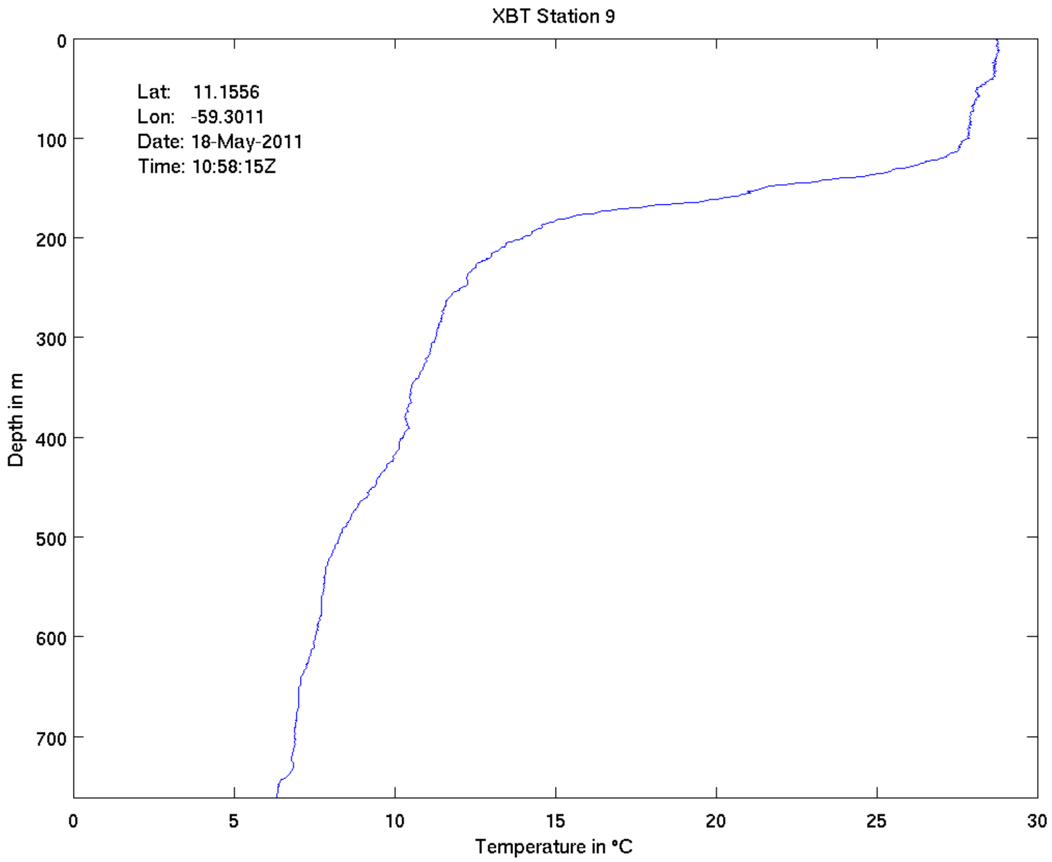

XBT Station 4
Lat: 12.0079
Lon: -59.4644
Date: 17-May-2011
Time: 21:00:39Z
Depth in m
0
100
200
300
400
500
600
700
0
5
10
15
20
25
30
Temperature in °C

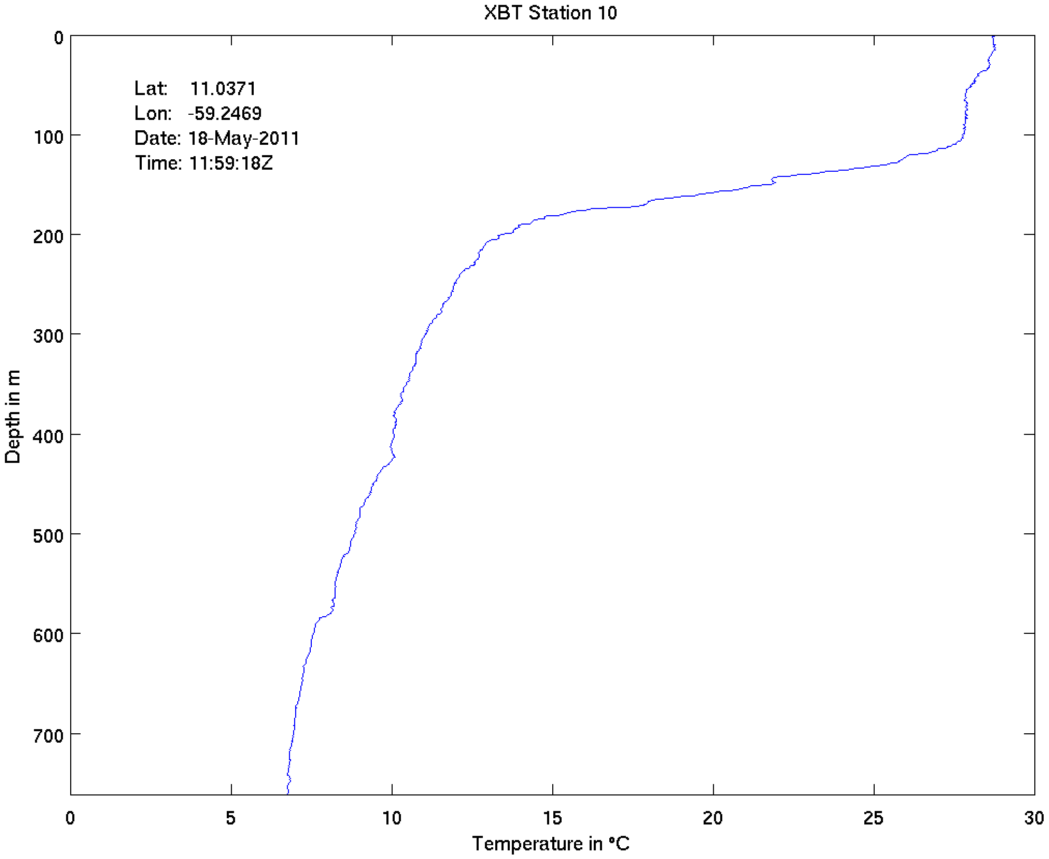

XBT Station 5
Lat: 11.8407
Lon: -59.4383
Date: 17-May-2011
Time: 22:01:47Z
Depth in m
0
100
200
300
400
500
600
700
0
5
10
15
20
25
30
Temperature in °C

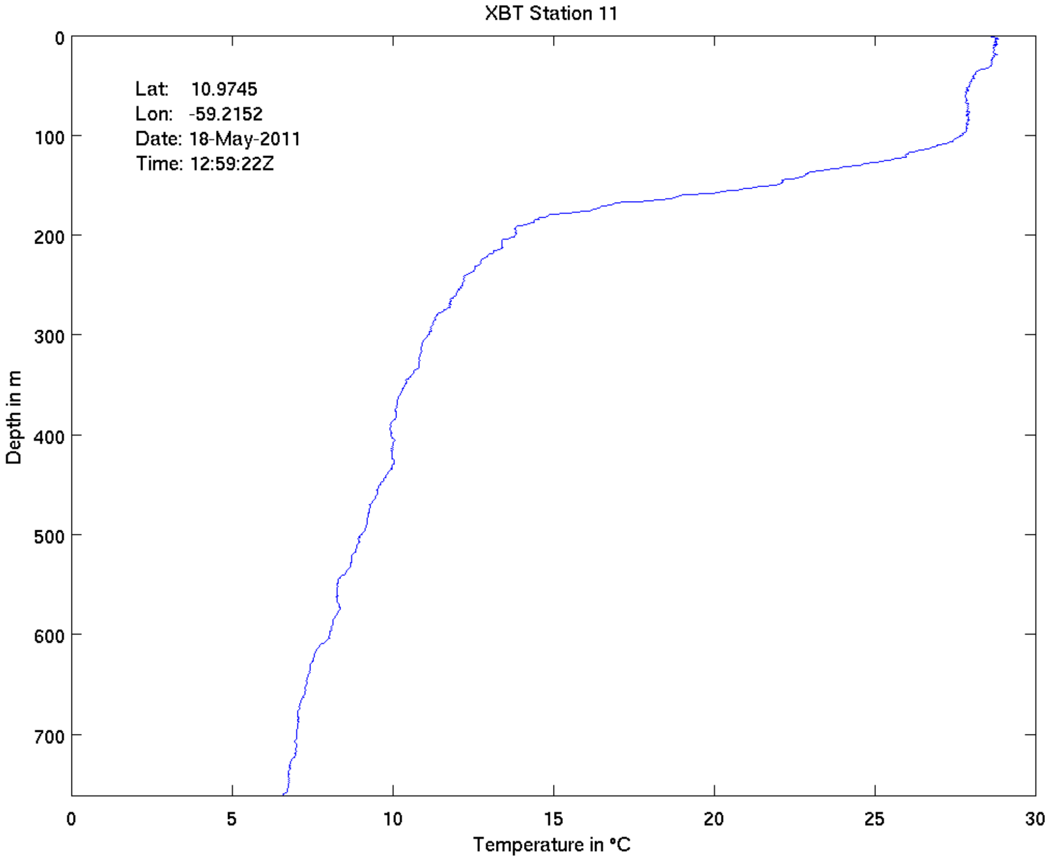

XBT Station 6
Lat: 11.6766
Lon: -59.421
Date: 17-May-2011
Time: 23:02:11Z
Depth in m
0
100
200
300
400
500
600
700
0
5
10
15
20
25
30
Temperature in °C

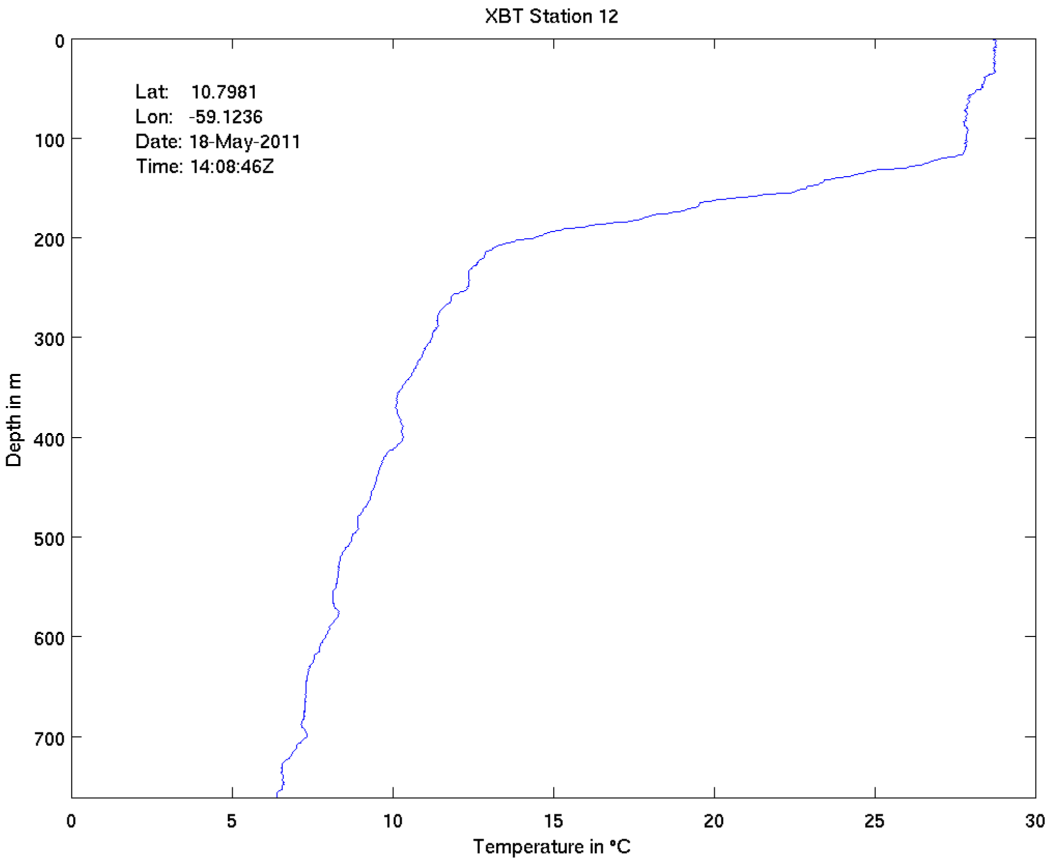

XBT Station 7
Lat: 11.5255
Lon: -59.3936
Date: 17-May-2011
Time: 23:58:44Z
Depth in m
0
100
200
300
400
500
600
700
Temperature in °C
0
5
10
15
20
25
30

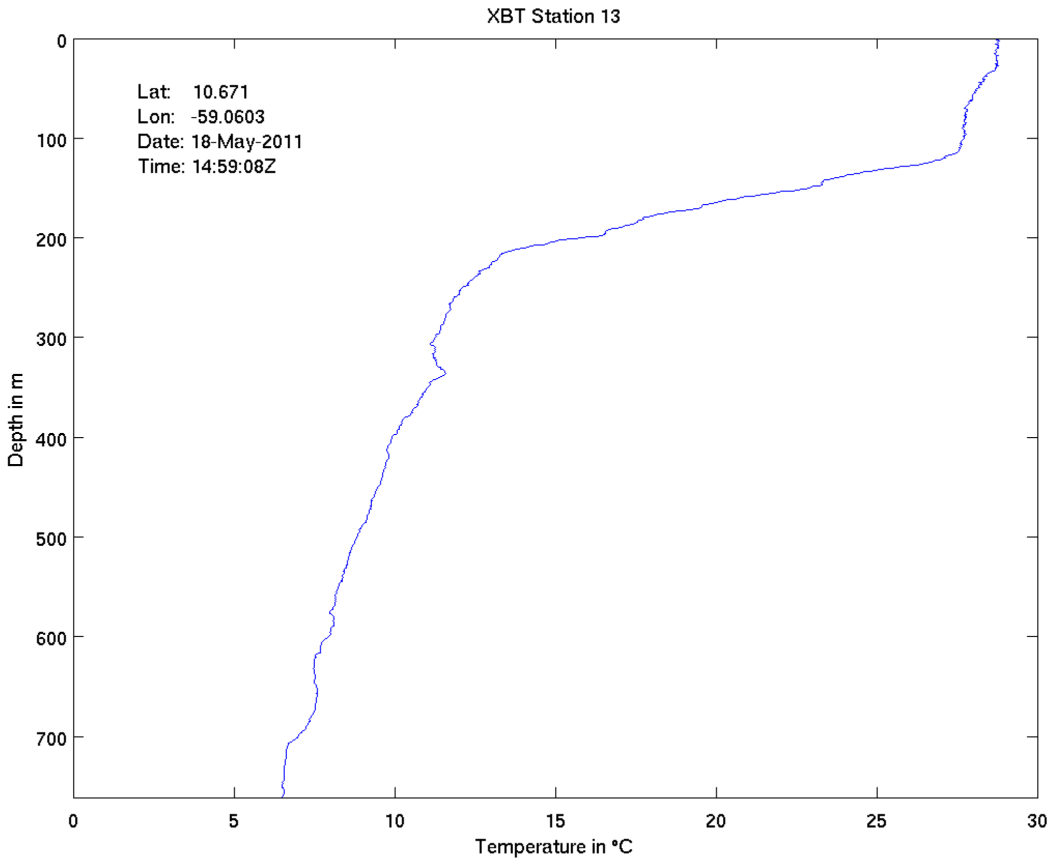

XBT Station 8
Lat: 11.3551
Lon: -59.3662
Date: 18-May-2011
Time: 01:03:38Z
Depth in m
0
100
200
300
400
500
600
700
0
5
10
15
20
25
30
Temperature in °C

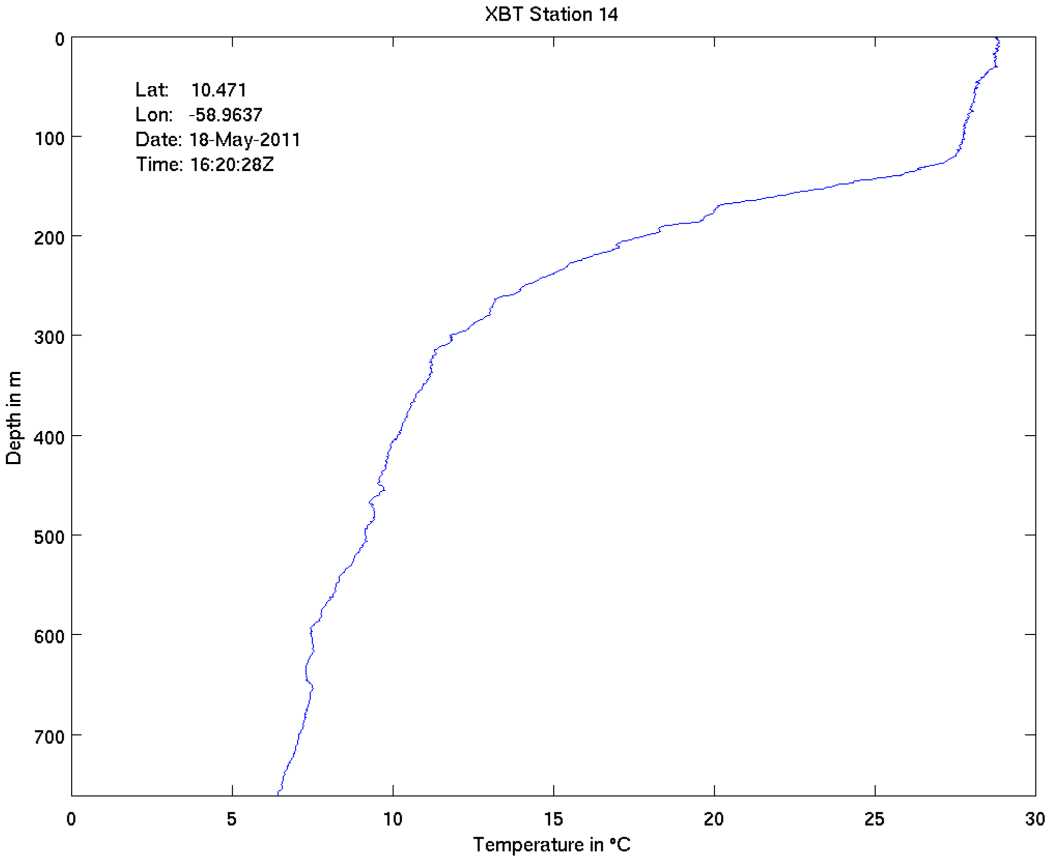

XBT Station 9
Lat: 11.1556
Lon: -59.3011
Date: 18-May-2011
Time: 10:58:15Z
Depth in m
0
100
200
300
400
500
600
700
0
5
10
15
20
25
30
Temperature in °C

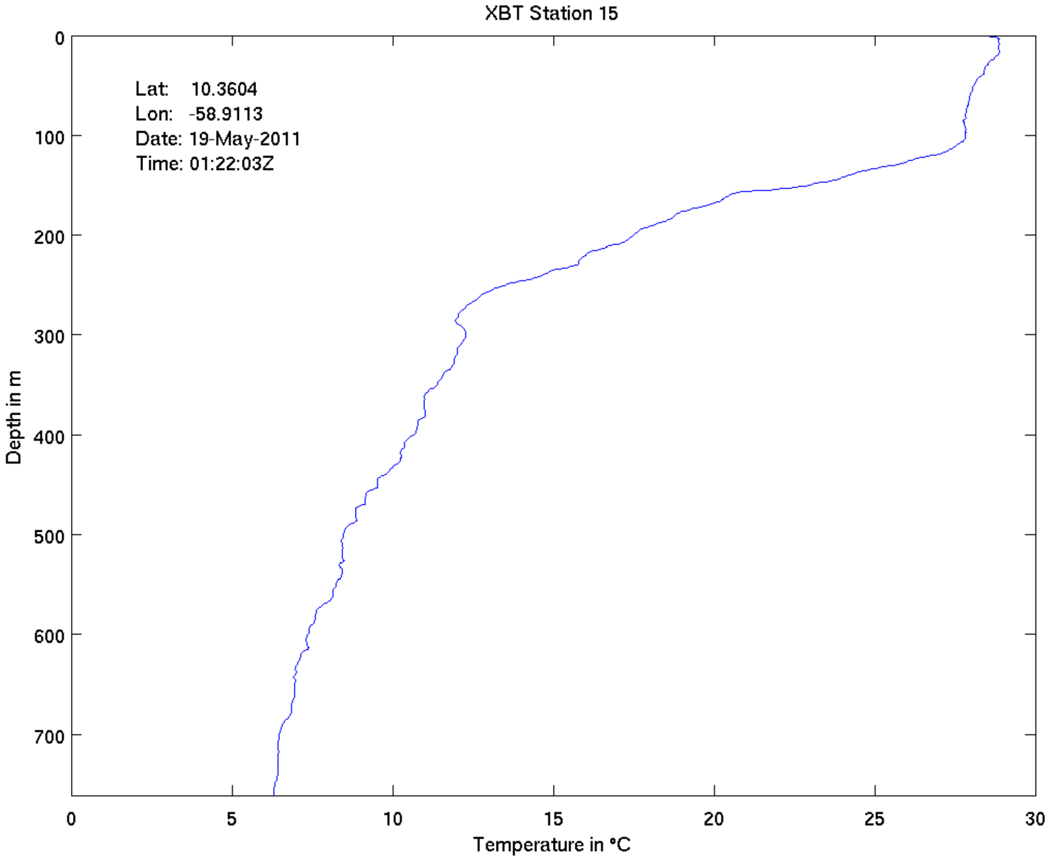

XBT Station 10
Lat: 11.0371
Lon: -59.2469
Date: 18-May-2011
Time: 11:59:18Z
Depth in m
0
100
200
300
400
500
600
700
0
5
10
15
20
25
30
Temperature in °C

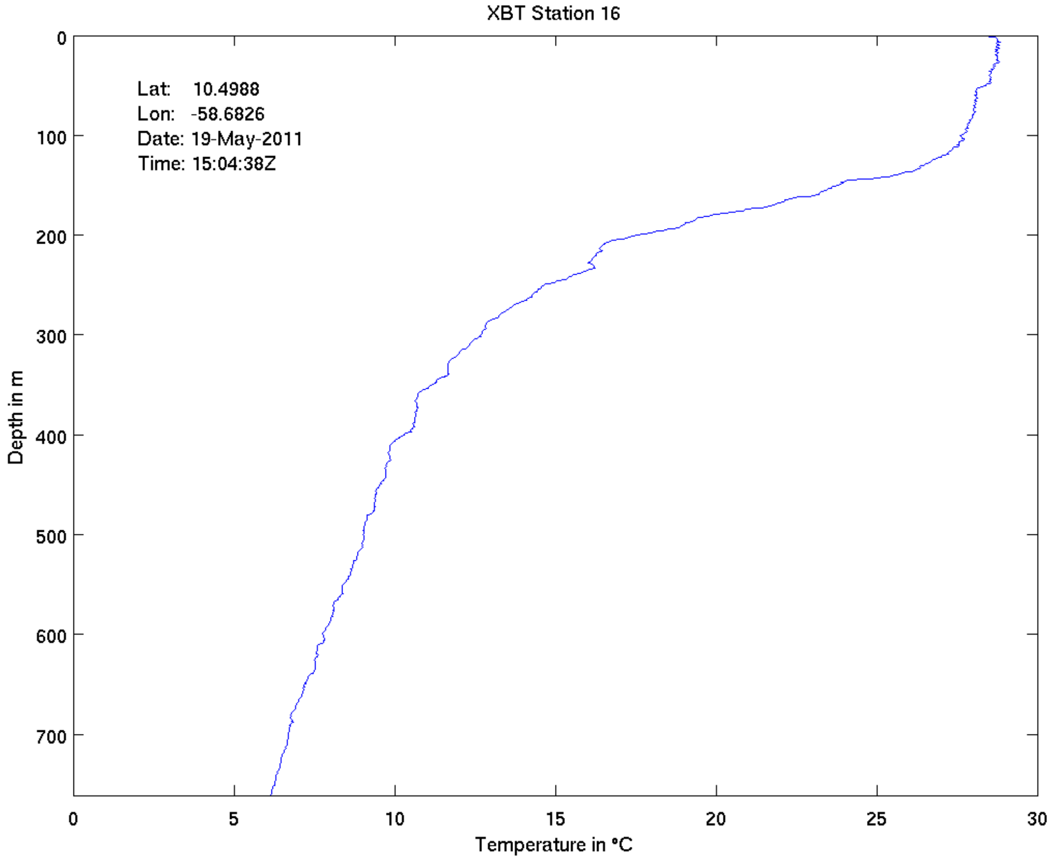

XBT Station 11
Lat: 10.9745
Lon: -59.2152
Date: 18-May-2011
Time: 12:59:22Z
Depth in m
0
100
200
300
400
500
600
700
Temperature in °C
0
5
10
15
20
25
30

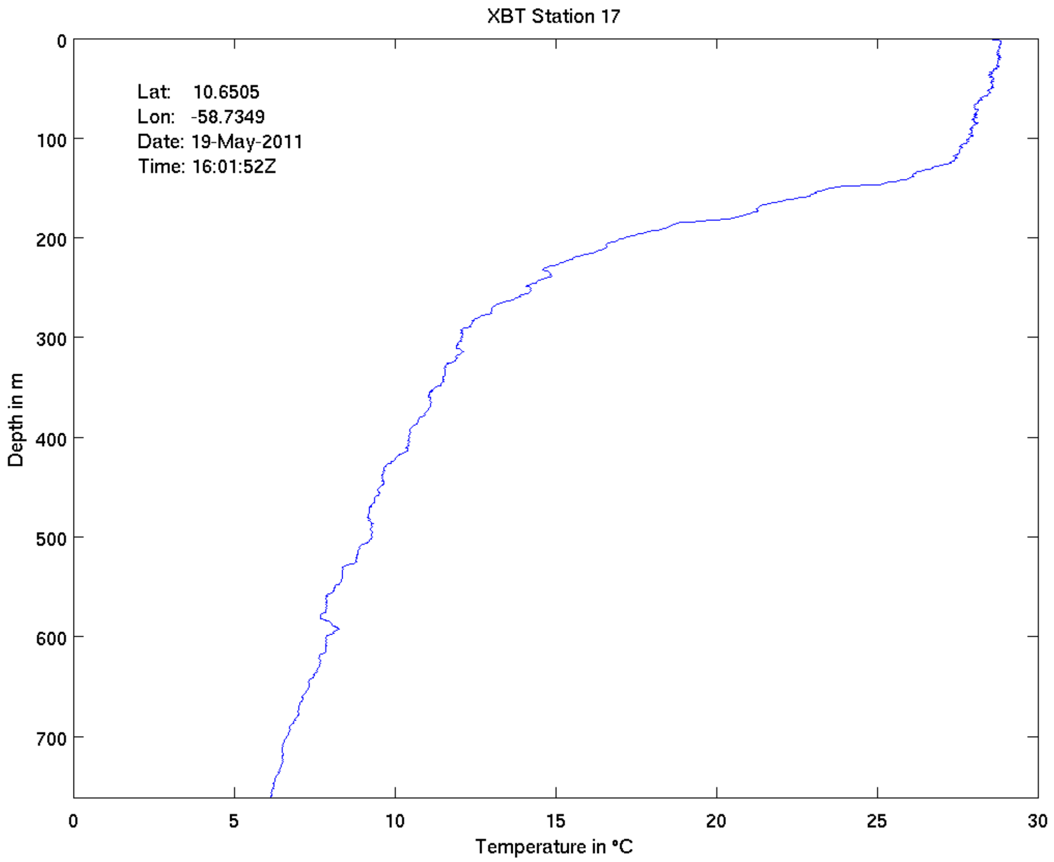

XBT Station 12
Lat: 10.7981
Lon: -59.1236
Date: 18-May-2011
Time: 14:08:46Z
Depth in m
0
100
200
300
400
500
600
700
Temperature in °C
0
5
10
15
20
25
30

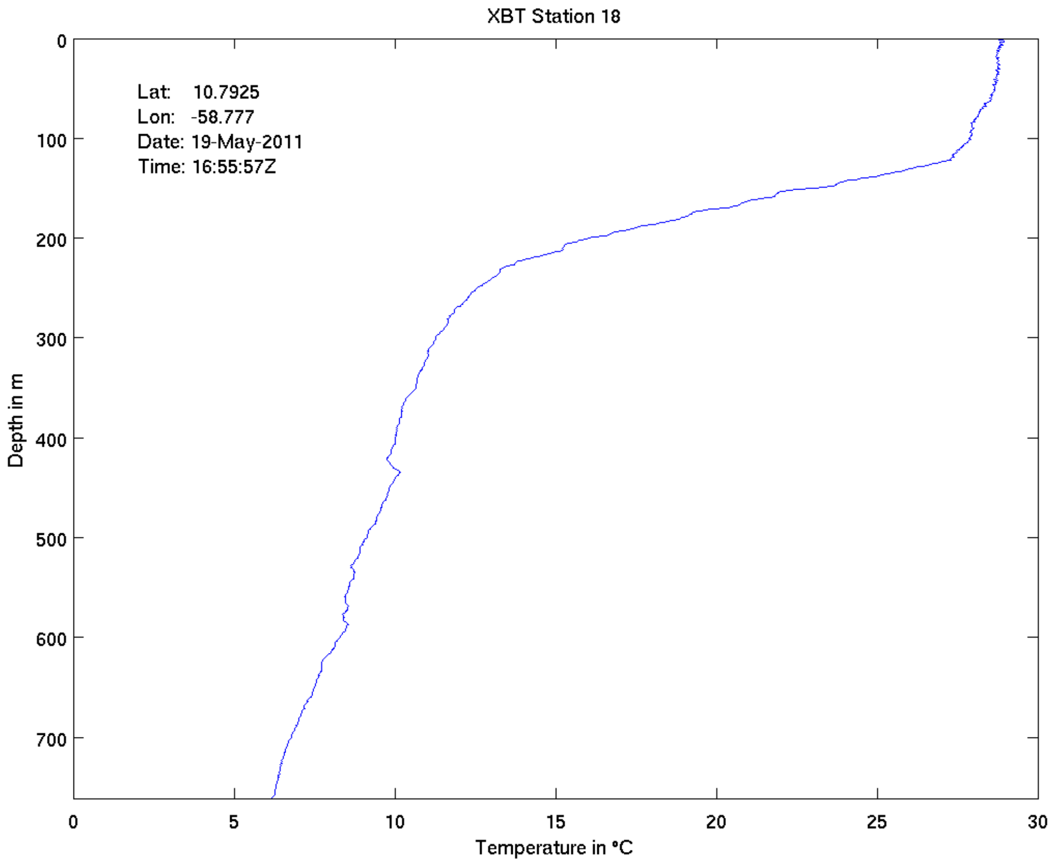

XBT Station 13
Lat: 10.671
Lon: -59.0603
Date: 18-May-2011
Time: 14:59:08Z
0
100
200
300
400
500
600
700
Depth in m
0
5
10
15
20
25
30
Temperature in °C

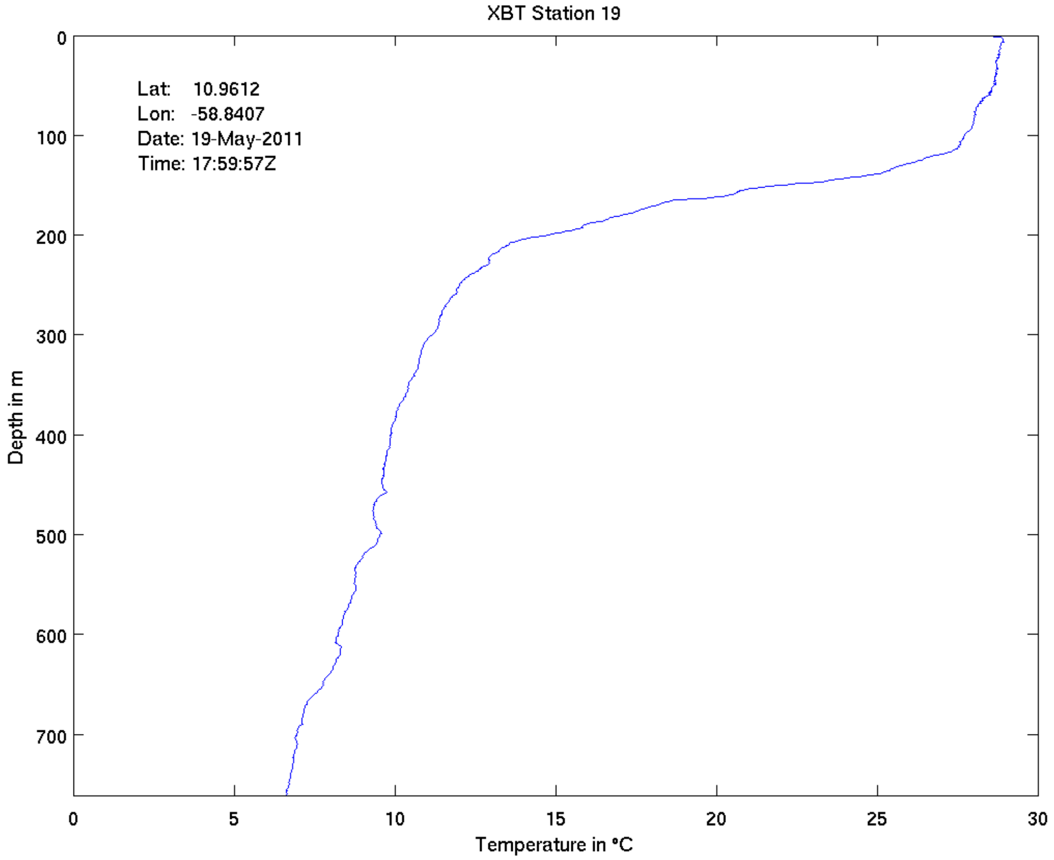

XBT Station 14
Lat: 10.471
Lon: -58.9637
Date: 18-May-2011
Time: 16:20:28Z
Depth in m
0
100
200
300
400
500
600
700
Temperature in °C
0
5
10
15
20
25
30

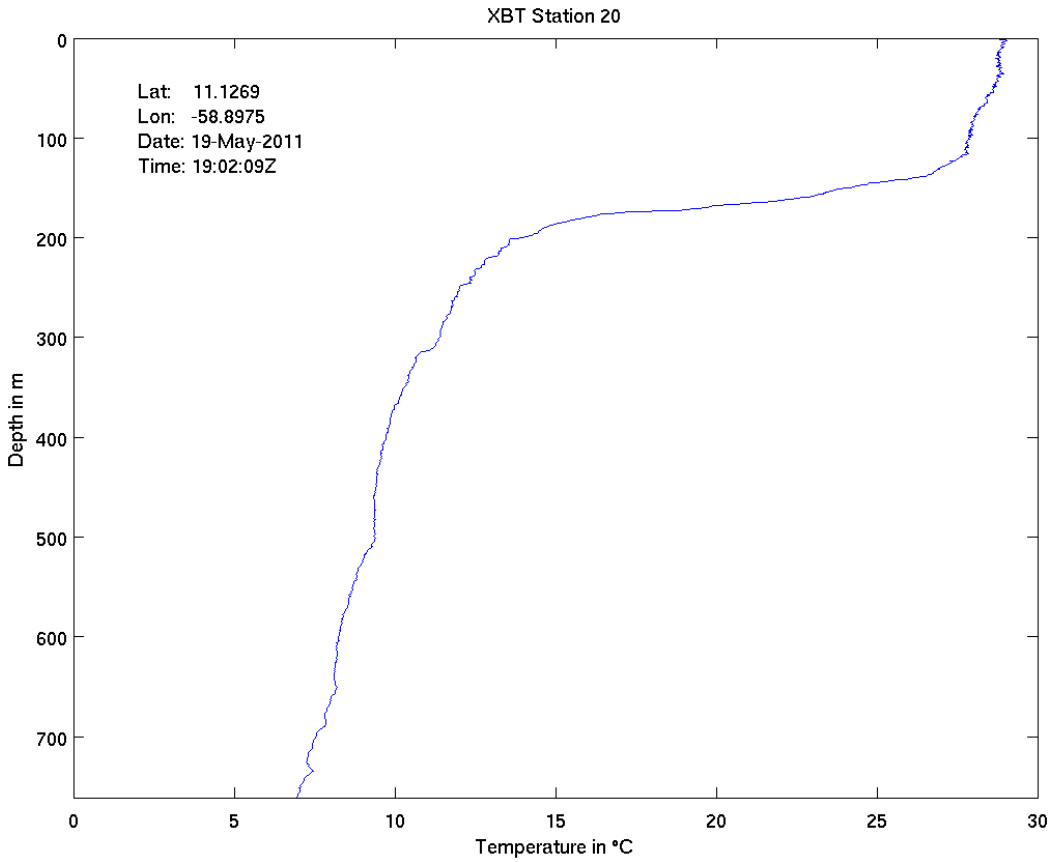

XBT Station 15
Lat: 10.3604
Lon: -58.9113
Date: 19-May-2011
Time: 01:22:03Z
Depth in m
0
100
200
300
400
500
600
700
0
5
10
15
20
25
30
Temperature in °C

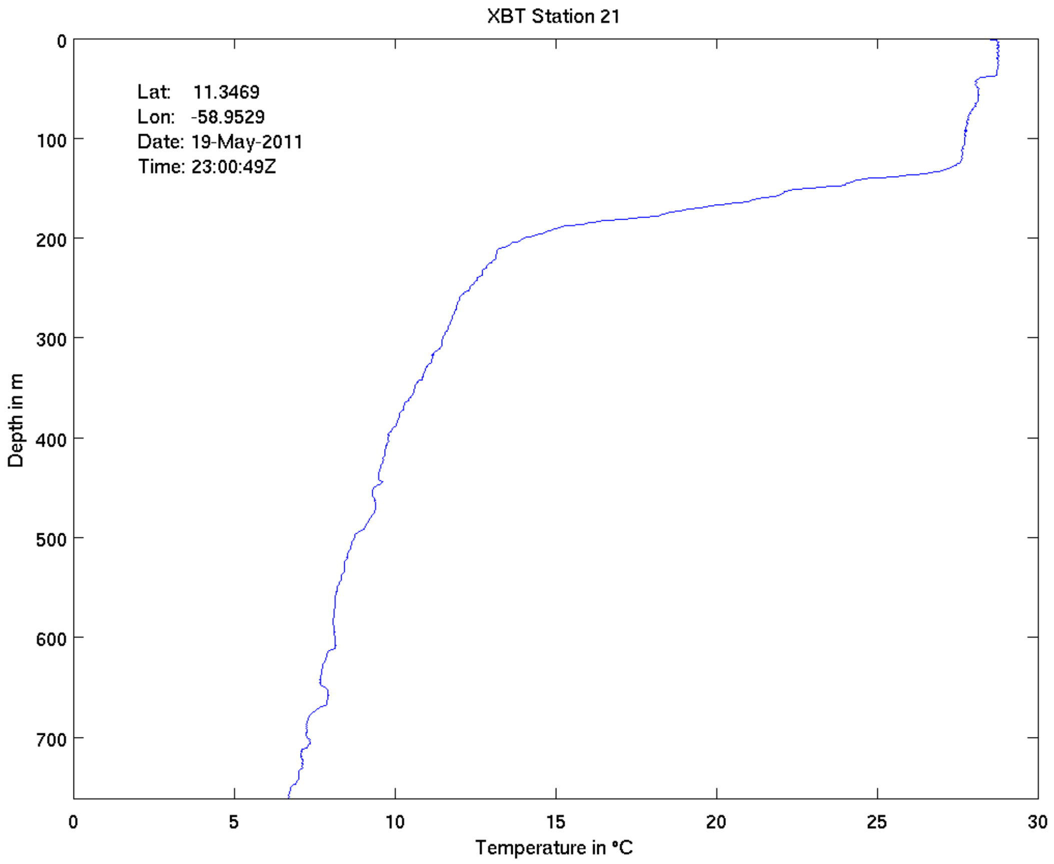

XBT Station 16
Lat: 10.4988
Lon: -58.6826
Date: 19-May-2011
Time: 15:04:38Z
Depth in m
0
100
200
300
400
500
600
700
0
5
10
15
20
25
30
Temperature in °C

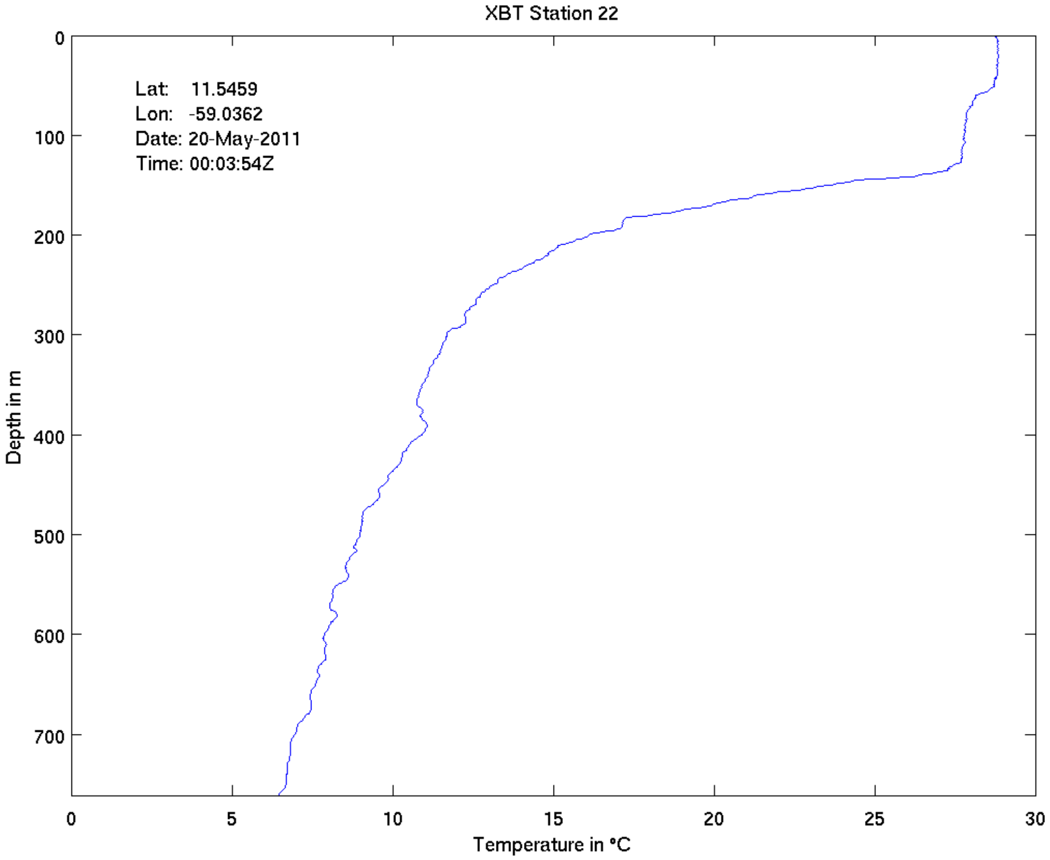

XBT Station 17
Lat: 10.6505
Lon: -58.7349
Date: 19-May-2011
Time: 16:01:52Z
Depth in m
0
100
200
300
400
500
600
700
Temperature in °C
0
5
10
15
20
25
30

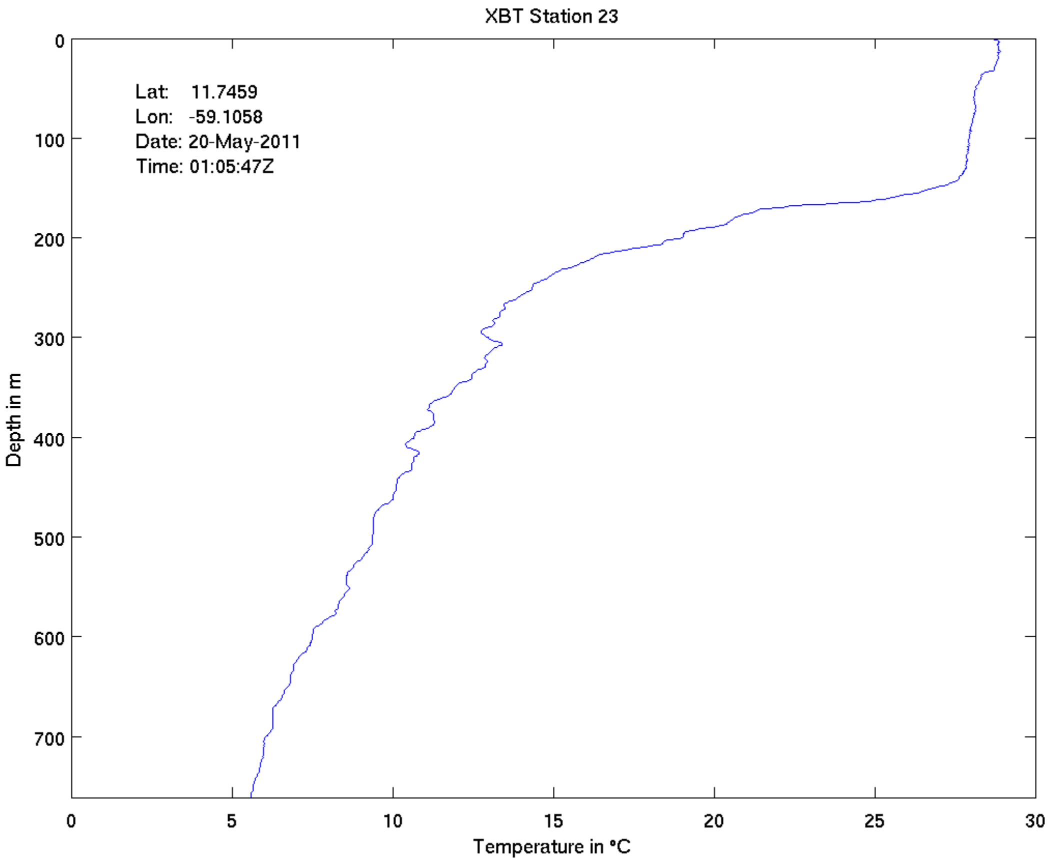

XBT Station 18
Lat: 10.7925
Lon: -58.777
Date: 19-May-2011
Time: 16:55:57Z
Depth in m
0
100
200
300
400
500
600
700
Temperature in °C
0
5
10
15
20
25
30

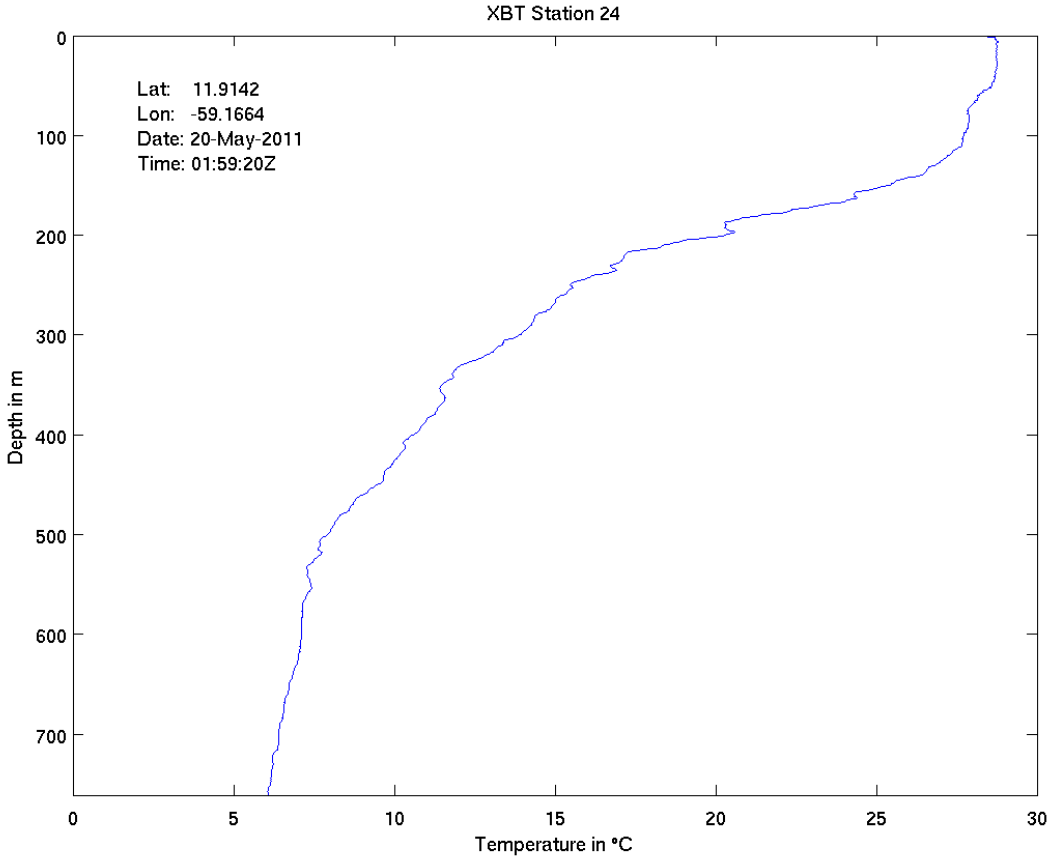

XBT Station 19
Lat: 10.9612
Lon: -58.8407
Date: 19-May-2011
Time: 17:59:57Z
Depth in m
0
100
200
300
400
500
600
700
0
5
10
15
20
25
30
Temperature in °C

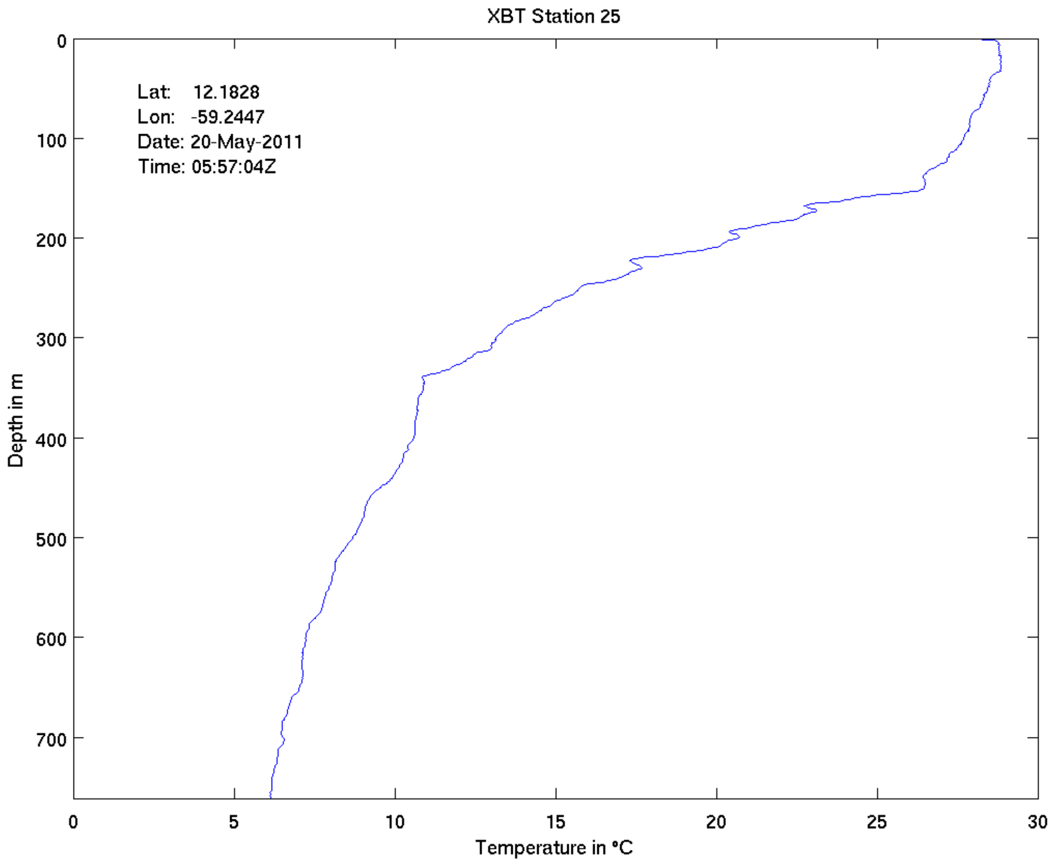

XBT Station 20
Lat: 11.1269
Lon: -58.8975
Date: 19-May-2011
Time: 19:02:09Z
Depth in m
0
100
200
300
400
500
600
700
Temperature in °C
0
5
10
15
20
25
30

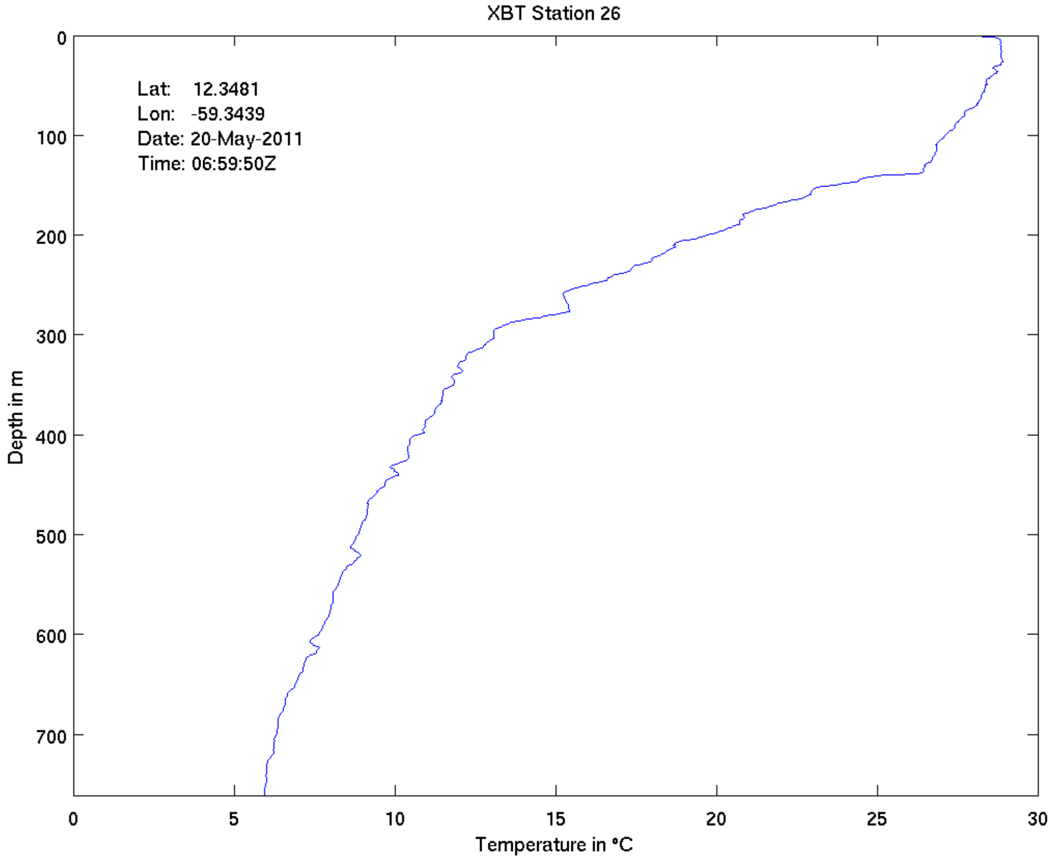

XBT Station 21
Lat: 11.3469
Lon: -58.9529
Date: 19-May-2011
Time: 23:00:49Z
Depth in m
0
100
200
300
400
500
600
700
Temperature in °C
0
5
10
15
20
25
30

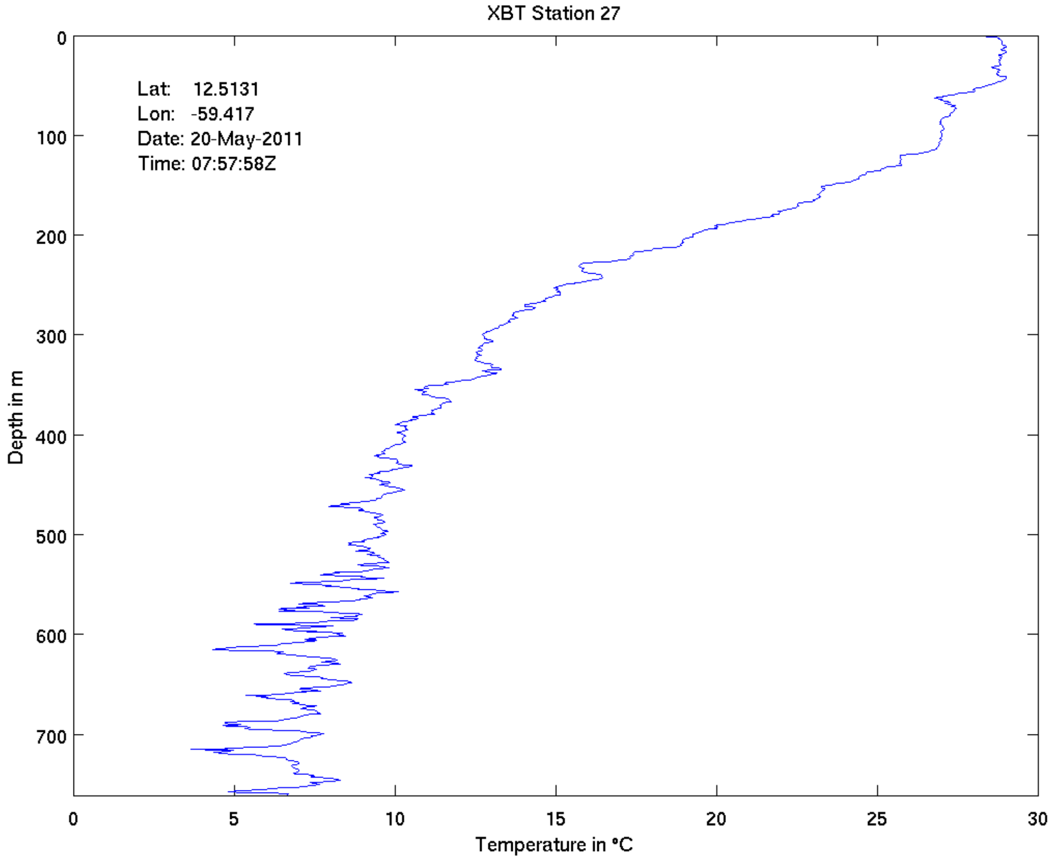

XBT Station 22
Lat: 11.5459
Lon: -59.0362
Date: 20-May-2011
Time: 00:03:54Z
Depth in m
0
100
200
300
400
500
600
700
0
5
10
15
20
25
30
Temperature in °C


XBT Station 23
Lat: 11.7459
Lon: -59.1058
Date: 20-May-2011
Time: 01:05:47Z
Depth in m
0
100
200
300
400
500
600
700
0
5
10
15
20
25
30
Temperature in °C


XBT Station 24
Lat: 11.9142
Lon: -59.1664
Date: 20-May-2011
Time: 01:59:20Z
Depth in m
0
100
200
300
400
500
600
700
Temperature in °C
0
5
10
15
20
25
30


XBT Station 25
Lat: 12.1828
Lon: -59.2447
Date: 20-May-2011
Time: 05:57:04Z
Depth in m
0
100
200
300
400
500
600
700
Temperature in °C
0
5
10
15
20
25
30


XBT Station 26
Lat: 12.3481
Lon: -59.3439
Date: 20-May-2011
Time: 06:59:50Z
Depth in m
0
100
200
300
400
500
600
700
0
5
10
15
20
25
30
Temperature in °C


XBT Station 27
Lat: 12.5131
Lon: -59.417
Date: 20-May-2011
Time: 07:57:58Z
Depth in m
0
100
200
300
400
500
600
700
0
5
10
15
20
25
30
Temperature in °C