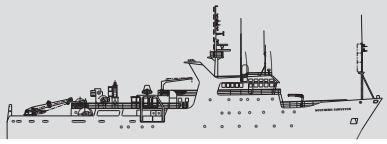

MARINE
NATIONAL FACILITY

2012 program

RV Southern Surveyor

CSIRO

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ss2012_t01

Voyage: XBT fall-rate experiments using XBT/CTD intercomparisons

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Voyage Period

Start: 11/04/2012
End: 18/04/2012
Port of departure Hobart, Australia
Port of return: Brisbane, Australia

Responsible laboratory

CSIRO Marine and Atmospheric Research
Castray Esplanade, Hobart
Australia

Chief Scientist

Rebecca Cowley

Scientific Objectives

We propose a simple and reliable experiment to assess the fall-rate and temperature biases of modern expendable bathy thermographs (XBTs) manufactured by Lockheed Martin Sippican (the major global supplier). We aim to collect concurrent temperature profiles from XBT systems and the high accuracy CTD system. We have some old (1980-2003) XBT probes which we would like to deploy to compare with modern probes.

We plan to address the questions:

Do modern XBTs have temperature and depth biases?

Do older XBTs (circa 1980-2003) show similar temperature and depth biases to those found in previous work?

Can we use depth soundings to check depth accuracy, and how do these results compare with the CTD/XBT intercomparison method?

Voyage Objectives

The Southern Surveyor will leave Hobart and begin swath mapping as soon as possible.

The XBT/CTD intercomparisons will be conducted at two sites which will be occupied for 10 to 12 hours, and these activities take priority. We would like to aim to be in water that is ~500m and 750 to 800m deep for these experiments. At the XBT/CTD stations, the CTD will be deployed to the bottom. It will be cycled multiple times. During the first part of each downcast, multiple XBTs will be deployed on four acquisition systems.

In total, we would like to complete around 10 CTD down/up cycles at each site. This will allow us to deploy ~240 probes at each site.

Swath mapping will be conducted during the entire transit and the voyage track is located along the preferred swath route. Net tows will occur at approximately every 150Nm and at these times, the ship will need to be slowed to ~3knots for approximately 1 hour.

Table 1 Summary of the planned activities.

Latitude	Longitude	Date/Time	Activity
Hobart wharf		11/04/2012 1600	Pilot
		12/04/2012 0900	Net Tow
		12/04/2012 1700	Net Tow
		13/04/2012 0000	Net Tow
		13/04/2012 1500	Net Tow
35S	150E	14/04/2012 0600	XBT/CTD deployments
		14/04/2012 1800	Net Tow
		15/04/2012 1200	Net Tow
		16/04/2012 0400	Net Tow
28S	154E	17/04/2012 0600	XBT/CTD deployments
		17/04/2012 0900	Net Tow
		17/04/2012 2000	Net Tow
Brisbane Wharf		18/04/2012 1600	Pilot

Results

1. We deployed 60 current-era XBTs during the voyage. From these deployments we will be able to determine if the fall rate agrees with that found in previous work. Because we have already collected data from similar experiments on board the Aurora Australis in the past two years, we will compile the data to expand the dataset for more accurate estimates of the current fall-rate of Sippican Deep Blue probes.

2. 753 Sippican XBTs manufactured from 1983 to 2003 were deployed with concurrent CTDs. The deployments were mostly successful, but due to the age of the probes, there were many wire-breaks and leakage failures. However, the success rate was excellent given the age of the probes, and we will be able to use much of the data to compare with the CTD data. We will be able to compare the fall rates determined in this experiment for these old probes and compare them with results from previous studies.

3. Depth soundings were collected during the XBT/CTD experiments. The advantage of using the depth sounder information to determine the fall rate of the XBTs is that the XBT data can be used even when there is a leakage failure. As long as there is a strong 'hit-bottom' signal, the XBT data is useful.

Voyage Narrative

Days 1-2 (11th/12th April 2012)

Swath mapping began from departure in Hobart. The CPR (Continuous Plankton Recorder) was deployed at ~1030 11/4/2012 (UTC). The CPR will be towed for the entire voyage, but brought on deck and the cassette changed at each XBT/CTD experimental site. A Manta net tow was conducted at ~0900 on the morning of the 12th. Some initial problems with the set up and launching were dealt with quickly and the tows were a success. During the tows, ship speed was reduced to 3knots and the CPR was hauled in to a shallower depth, but remained in the water. The second planned net tow at ~1700 on the 12th was not conducted, but another will be included off Sydney.

Weather was good initially, but coming through Bass Strait we encountered some rough weather and high winds that had not been forecast.. The bench in the wetlab where the XBT computer systems were set up was close to a scupper and drain in the side of the ship. We removed the PCs before the bad weather, but the cabling did get some water on it before it was removed. The cabling will be thoroughly cleaned and tested before the XBT/CTD trials.

The greenhouse gas experiments (run by UoW) have been going well with some minor temperature controller issues that seem to have been fixed. Some interesting signals were recorded while close to land off the east coast of Tasmania. There was some concern about water getting into the air intake on the front mast during the rough weather, but this did not seem to be a problem.

Day 3 – Friday 13th April

All activities continued as planned for the day. The weather has improved and the seas are calm. The voyage track is on time. One Manta net tow was completed this afternoon with some plastics found. The UoW team found some water in one of their water traps so cleaned the trap just as we came near the Victorian coast.

Those involved in XBT deployments had a training session on the software and how to deploy the probes. We worked out a schedule for the activities and assigned jobs. We also spent some time troubleshooting the launchers, testing the systems and preparing the log sheets with the serial numbers of the probes to be deployed on each system.

Swath mapping continues without issue. The mapper did lose the bottom when coming over a canyon.

Day 4 – Saturday 14th April

We started at 0500 by recovering the CPR and changing the cassette. Unfortunately, the spring that winds the silk was broken and the silk had come unwound outside the housing. We salvaged it as best we could. It may have been that it was left in the water too long, they need to come out at 450Nm and we had gone beyond this.

Another net tow was conducted by Julia for plastics. The tow went without incident.

Today the first half of the XBT/CTD intercomparisons was completed. We deployed a total of 404 XBTs and completed 18 CTD casts. We began at 0600 and finished at 1900. The first downcast of the CTD was delayed by about an hour because of a faulty configuration file which caused the CTD to stop talking to the computer. This meant that we had already deployed the first 12 XBTs before the CTD was ready, so these can't be compared to the first CTD downcast. The problem was resolved and we continued with an old configuration file with old temperature coefficients. The data will be re-processed with the correct coefficients during the voyage.

It was a very busy day but very successful. We had some issues with some of the old probes not connecting properly with the launcher and some fell apart on impact with the water. There were two boxes that mostly failed and this may have been because the wire wasn't re-wound prior to deployment. We had been through nearly every box, opened the connection end of the probes and sorted out tangled wire. The wire falling off the canister spool is a common problem in old Sippican probes and caused a lot of failures if the wire was not de-tangled. A clear hit-bottom signal is present on most of the XBT traces and we will use this signal to compare with the bottom depth from the ship's sounder for fall-rate analysis.

Finally, another net tow was completed and the CPR re-deployed.

Swath mapping was suspended today while we were stationary. The greenhouse gas monitoring continued.

Day 5 – Sunday 15th April

An easier day today for everyone. Two net tows were completed, the CPR continues to be towed. The weather is calm and mild. The forecast for the next two days is for some showers and then rain. We have decided to complete the XBT/CTD intercomparisons tomorrow instead of Tuesday as the weather outlook is slightly better. We are prepared for some rain, but it will be difficult if it is continuous. We have prepared the log sheets and tested the XBT systems for tomorrow. Alan Poole is concerned that there might be some electronic interference with some of the systems that causes a ~0.02C offset in a random manner. He has not been able to source the problem, but the computers will run off the UPS system tomorrow.

Swath mapping and greenhouse gas measurements continued today without incident.

Day 6 – Monday 16th April

We began the day at 0450 by bringing in the CPR and changing the cassette. It worked well, no problems. A net tow was conducted after that with no problems. We were ready to begin the XBT/CTD comparisons at 0630, but the CTD software failed again. There was a delay of about 4 hours before we could begin in earnest. It had been raining early in the morning, but had cleared by the time we began. We got through over half of the XBTs remaining before it began raining again at about 1600. Unfortunately, the place we were located in was on a steep shelf and had a considerable current (~4knots) running to the South, so it was difficult for the master to maintain a constant depth of ~500m and we had to move the ship a few times to reposition. The decision was made after the rain began to finish work for the day and move north in search of flatter bottom tomorrow morning. The rain can be problematic because the launchers need to be kept dry and therefore need covers over them after each XBT is loaded. This adds some time to the launching procedure.

Day 7 – Tuesday 17th April

We brought the CPR in at 0800 this morning and began a net tow. By 1000 we were ready to begin the last set of XBT/CTD intercomparisons. Unfortunately, the current was very strong again and the first CTD cast the ship had to hold station to avoid getting into water >550m. There were no hit-bottom signals on the XBTs dropped at this station, so we moved further north onto a plateau at about 440m. The final CTD cast for the T4 and T6 probes was done successfully. We then moved further north-east to 700m water to finish the last boxes of T7 and Deep Blue probes. The last casts commenced at ~1330 and were completed at 1730. This site was most successful as we had a constant bottom depth and could drift a little with the current and not worry about it getting too deep or shallow.

Day 8 – Wednesday, 18th April

No work conducted today. The pilot boarded at 0900 and we arriving at the berth in Brisbane at 1500.

Summary

813 XBT probes were deployed during this experiment and will be compared to 34 CTD casts. In addition, the ship's sounder records will be used to compare the hit-bottom signals on the XBTs. The method of comparing hit-bottom signals with sounder depth will be particularly useful for the XBTs that were failures due to leakage. These failures cannot be used in the method of comparing temperature gradients with the CTD.

A preliminary review of the XBT data shows that we have had a large number of XBT failures, but also many successes. We expected many failures given the age of the probes. Much preparation was put into ensuring the XBTs were deployable and this has proved to be worth the effort. We will be able to determine a fall rate for the Sippican T4 probes used in the mid-1980s and Sippican T7 and Deep Blue probes from the early 2000s and compare these with work done in previous studies.

The probes deployed on this voyage were the last of their age available in the world, so the results are important for pinning down the fall rate variations over time. In turn, these results will help to correct the historical XBT record which will improve estimations of the changes in global ocean heat content and sea level over the last ~50 years that XBTs have been in use.

The piggy-back projects were also very successful. The greenhouse gas monitoring equipment functioned well and continuously and all manta net tows were successful. Both project's data will be analysed at a later date

Table 1. Summary of activities completed

Date/Time (LOCAL)	Time (LOCAL)	Latitude	Longitude	Activity
11-Apr-12	10:30	-43.2	147.7	Deploy CPR
12-Apr-12	8:19	-41.74	148.52	Manta net tow
13-Apr-12	14:00	-37.71	150.32	Manta net tow
13-Apr-12	0:30	-39.64	148.86	Manta net tow
14-Apr-12	5:00	-35.51	150.83	Manta net tow
14-Apr-12	6:00	-35.41	150.83	Retrieve CPR
14-Apr-12	9:00:00	-35.41	150.83	CTD/XBT experiments
14-Apr-12	19:30:00	-35.41	150.83	Deploy CPR
15-Apr-12	6:00	-33.89	152	Manta net tow
15-Apr-12	13:00	-33.17	152.69	Manta net tow
16-Apr-12	5:40	-31.03	153.37	Manta net tow
16-Apr-12	6:00	-30.83	153.32	Retrieve CPR
16-Apr-12	11:00	-30.83	153.32	CTD/XBT experiments
16-Apr-12	17:00	-30.83	153.32	Deploy CPR
17-Apr-12	8:00	-28.355	153.91	Retrieve CPR
17-Apr-12	8:13	-28.355	153.91	Manta net tow
17-Apr-12	10:00	-28.23	153.955	CTD/XBT experiments
17-Apr-12	17:30	-28.23	154	Deploy CPR
18-Apr-12	7:40	-26.72	153.37	Retrieve CPR
18-Apr-12	8:00	-26.72	153.37	Manta net tow

Principal Investigators

A. Rebecca Cowley, CSIRO Marine and Atmospheric Research (XBT/CTD intercomparisons)

B. Claire Murphy, University of Wollongong (Greenhouse gases)

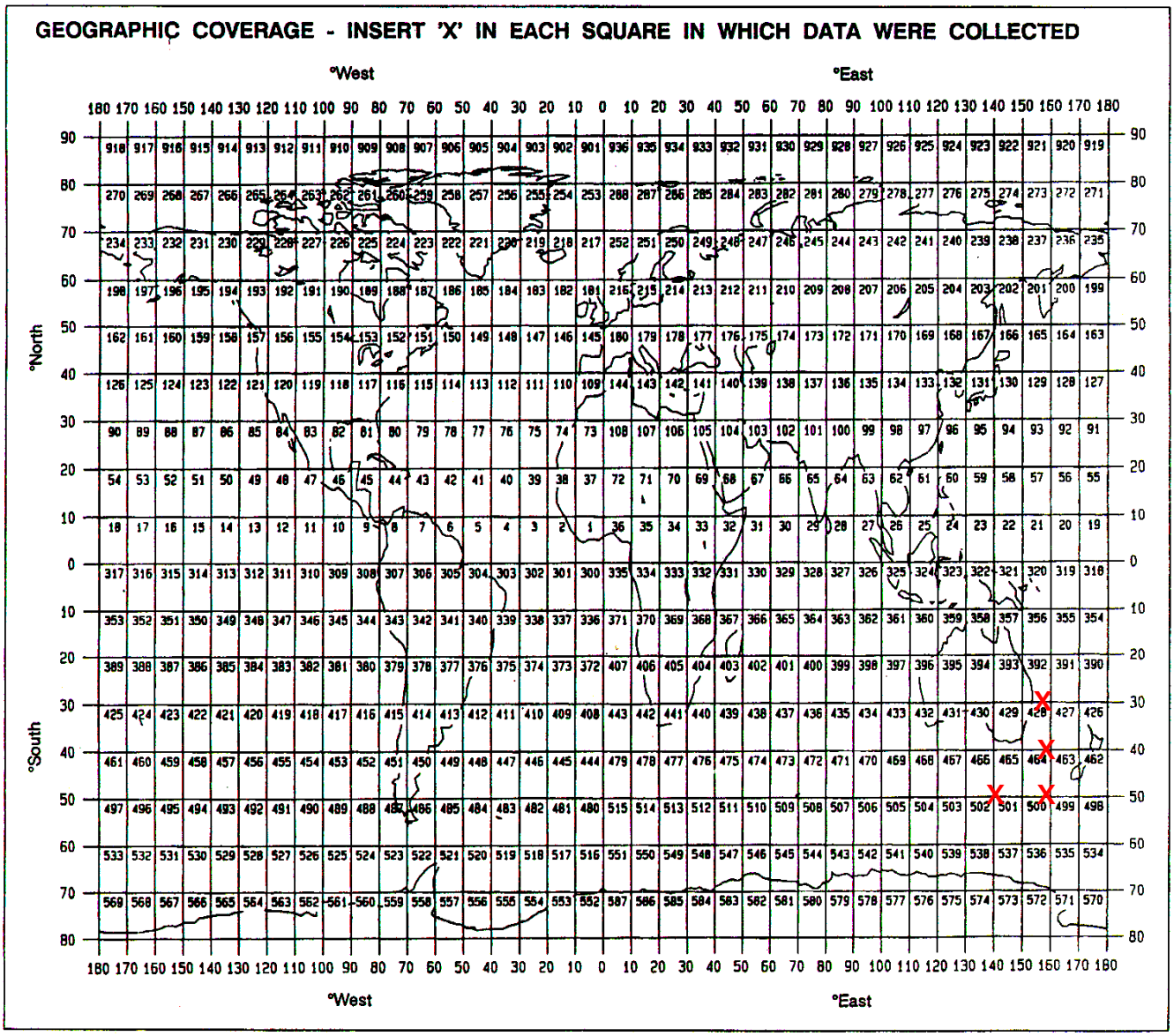
C. Julia Reisser, CSIRO Marine and Atmospheric Research (Plastics in the marine environment)

D. Rudy Kloser, CSIRO Marine and Atmospheric Research (Swath mapping)

MARSDEN SQUARES

Move a red "x" into squares in which data was collected

X

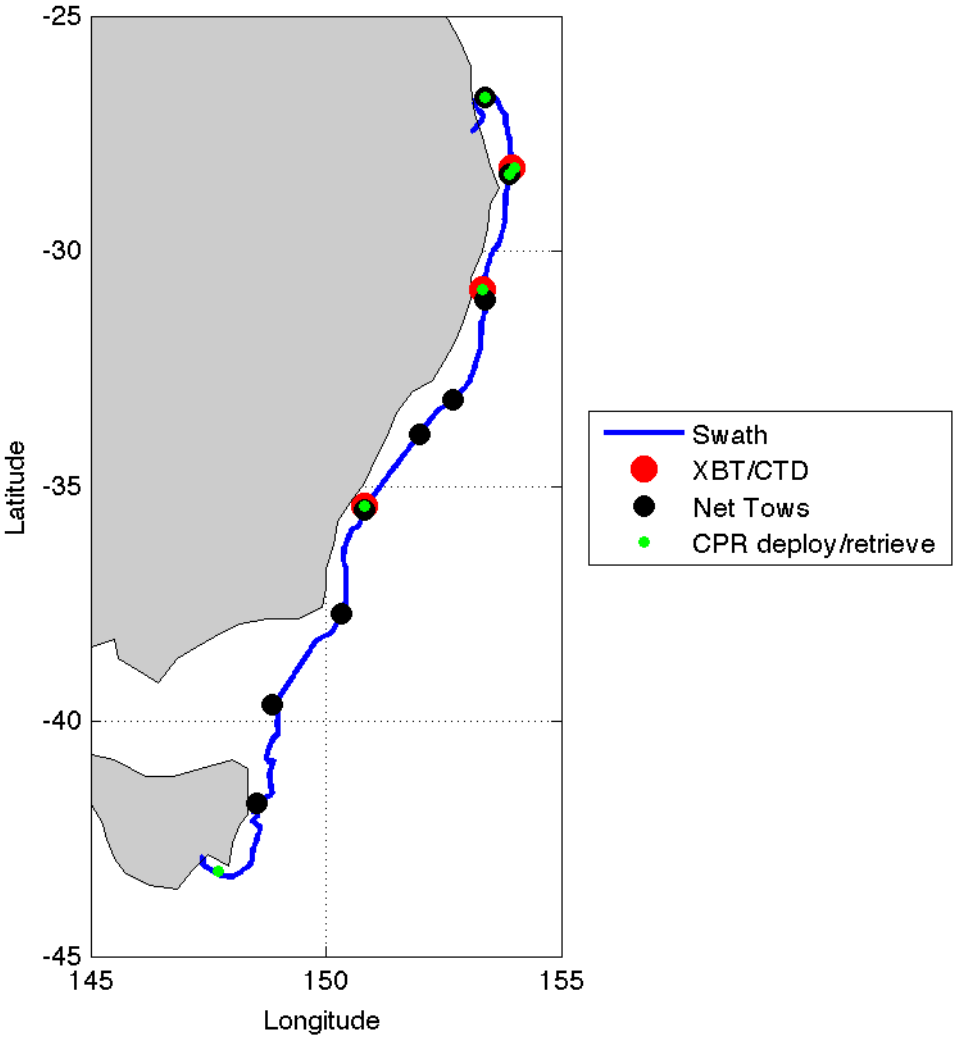


Summary of measurements and samples taken					
Item No.	PI see page above	NO see above	UNITS see above	DATA TYPE Enter code(s) from list on last page	DESCRIPTION
1	D	1,270	Nm	G74	Swath Mapping, continuous for the entire voyage track. Data to be processed by the Marine National Facility.
2	C	27	tows	P90	Manta net tows for plastics in the marine environment, part of PhD work (Julia Reisser). Area and volume (flowmeter) sampled. Density of microplastics (pieces/m^2) will be calculated.
3	E	3	tows	B08	CPR (continuous plankton recorder) tow, IMOS monitoring network. Phytoplankton and zooplankton were sampled continuously using a Continuous Plankton Recorder (CPR) deployed whenever steaming between Hobart and Brisbane. The samples collected will add to our understanding of the abundance distrubution of plankton in the East Australian Current region and will form part of the AusCPR Survey; an IMOS project monitoring plankton in Australian coastal waters and the Southern Ocean.
4	A	38	Casts	H10	CTD casts including temperature, salinity, pressure measurements. The data will be processed and archived by the CSIRO Marine and Atmospheric Research Data Centre. The data will be used to help determine fall rates of XBTs over time.
5	A	813	profiles	H13	XBT profiles from Sippican T4, T7 and Deep Blue probes from the mid-1980s, early 2000s and the current period. The fall rate of these probes will be determined by comparison with the CTD and depth sounder.
6	E	1,270	Nm	H71	Underway T/S, depth sounder, other continuous measurements run by the Marine National Facility.
7	B	1,270	Nm	M90	Underway air monitoring for greenhouse gases, continuous for entire voyage track. Measurements of CO2, CO, N2O, CH4, O3

Curation Report

Item No.	DESCRIPTION
1	Data Centre, CSIRO Marine and Atmospheric Research, Hobart
2	Julia Reisser, PhD student, University of Western Australia/CSIRO Marine and Atmospheric Research. Preserved in alcohol, retained for an unknown period.
3	The CPR samples will be processed at CSIRO in Brisbane (Dutton Park) by AusCPR analysts and the resultant data will be stored in a CSIRO developed database. The data will also be freely available online at the IMOS data portal. Samples will be archived in a formalin solution and stored at CSIRO Brisbane (Dutton Park) as part of the AusCPR sample archive.
4	Data will be processed and archived by the Data Centre, CSIRO Marine and Atmospheric Research, Hobart
5	Rebecca Cowley, Marine National Facility, CSIRO Marine and Atmospheric Research, Hobart. After processing, these will be archived with the Data Centre at CSIRO Marine and Atmospheric Research. The raw data will also be shared with Gustavo Goni, AOML (US).
6	Data Centre, CSIRO Marine and Atmospheric Research, Hobart
7	Claire Murphy, archived at University of Wollongong, Australia.

Track Chart



General Ocean Area(S)

Tasman Sea, Bass Strait.

Specific Areas

At ~300 to ~700m contours along the east coast of Australia from Hobart (Tasmania) to Brisbane (Queensland).

Personnel List

Scientific Participants

Participant	Affiliation	Position
Rebecca Cowley	CMAR	Chief Scientist
Alan Poole	CMAR	XBT equipment expert
Felicity Graham	CMAR	XBT team member
Veronique Lago	CMAR	XBT team member
Trevor Goodwin	CMAR	XBT team member
Weston Coby	US Navy	XBT team member
Tara Martin	CMAR	MNF Swath Mapping support
Sascha Frydman	CMAR	MNF Swath Mapping support
Julia Reisser	CMAR	Marine debris
Dagmar Kubistin	UoW	Greenhouse gases
Chris Caldow	UoW	Greenhouse gases
Stephen McCullum	CMAR	Voyage Manager
Pamela Brodie	CMAR	MNF Computing support
Rod Palmer	CMAR	Electronics, MNF support
John East	P& O	Observer

Marine Crew

Name	Role
Michael Watson	Master
John Boyes	1st Officer
Simon Smeaton	2nd Officer
Fred Rostron	Chief Engineer
Michael Yorke- Barber	1st Engineer
Paul Buffett	2nd Engineer
Graham McDougall	Chief IR
Kel Lewis	IR
Jonathan Lumb	IR
Rod Langham	IR
Wayne Finch	IR
Michael O'Connor	Chief Steward
Robert Dittko	Chief Cook
Rebecca Lee	2nd Cook

Acknowledgements

Gustavo Goni, AOML, NOAA, US and Curtis Collins, US Navy for supply of old XBT probes for this study.

Rebecca Cowley
Chief Scientist

Figure 1. An XBT

Figure 2. Samples of failed and successful XBT profiles.

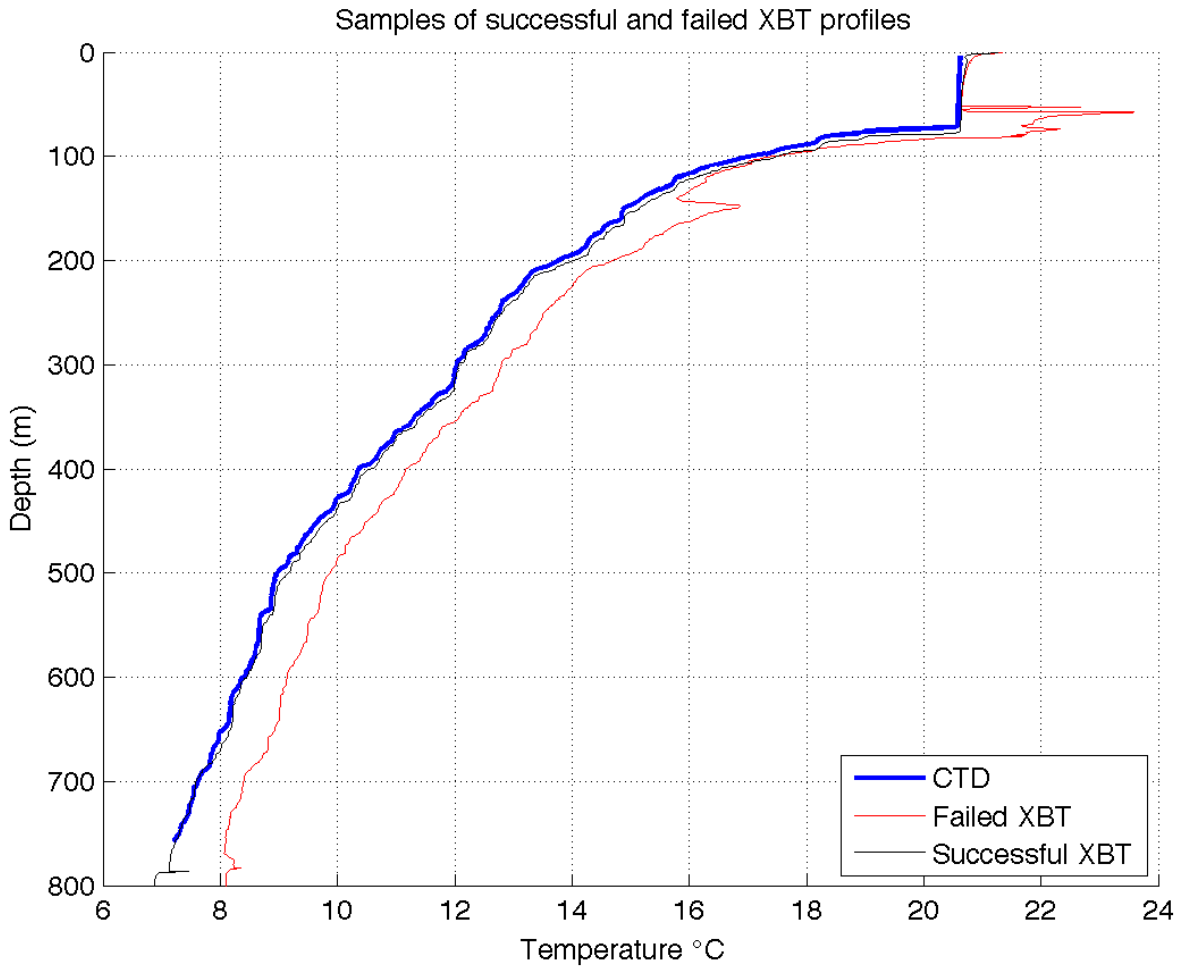
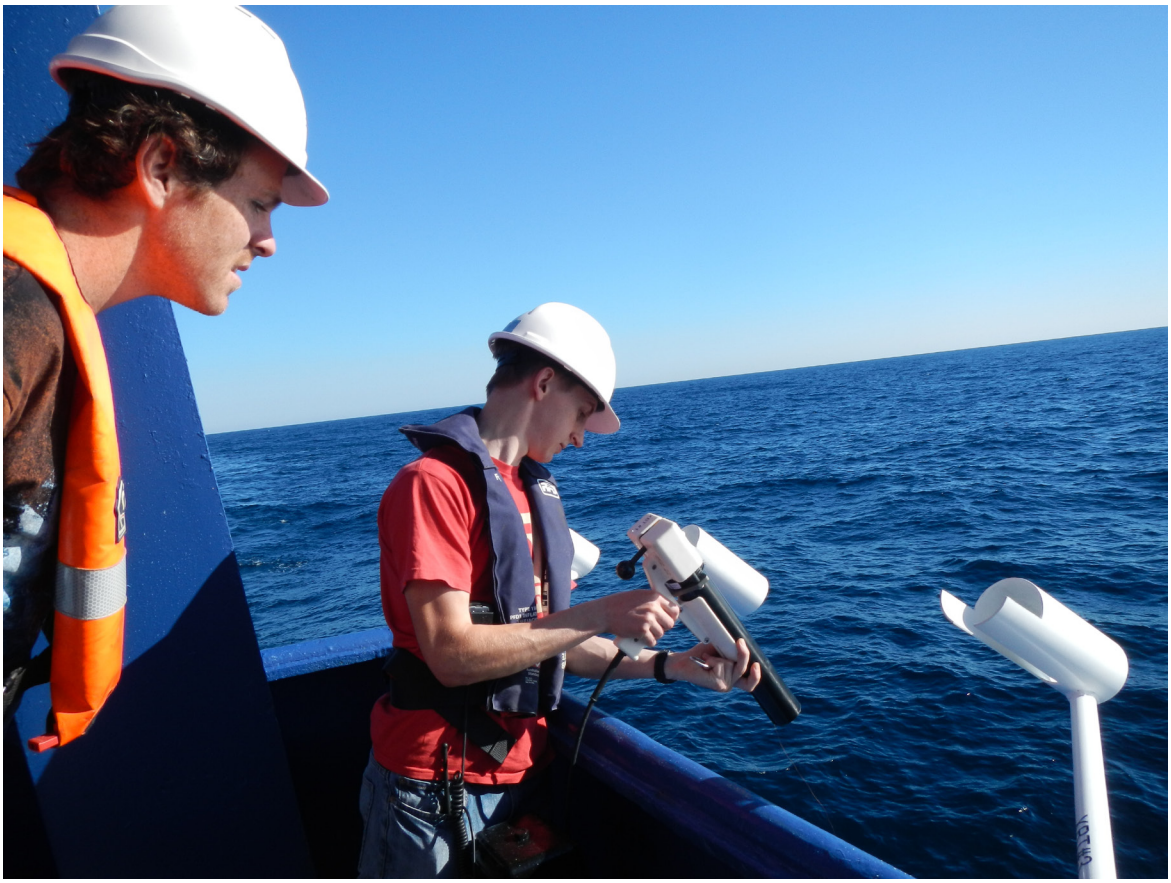


Figure 3. Deploying XBTs on SS2012 _ t01



CSR/ROSCOP Parameter CodeS

	Meteorology
M01	Upper air observations
M02	Incident radiation
M05	Occasional standard measurements
M06	Routine standard measurements
M71	Atmospheric chemistry
M90	Other meteorological measurements

	Physical Oceanography
H71	Surface measurements underway (T,S)
H13	Bathythermograph
H09	Water bottle stations
H10	CTD stations
H11	Subsurface measurements underway (T,S)
H72	Thermistor chain
H16	Transparency (eg transmissometer)
H17	Optics (eg underwater light levels)
H73	Geochemical tracers (eg freons)
D01	Current meters
D71	Current profiler (eg ADCP)
D03	Currents measured from ship drift
D04	GEK
D05	Surface drifters/drifting buoys
D06	Neutrally buoyant floats
D09	Sea level (incl. Bottom pressure & inverted echosounder)
D72	Instrumented wave measurements
D90	Other physical oceanographic measurements

	Chemical Oceanography
H21	Oxygen
H74	Carbon dioxide
H33	Other dissolved gases
H22	Phosphate
H23	Total - P
H24	Nitrate
H25	Nitrite
H75	Total - N
H76	Ammonia
H26	Silicate
H27	Alkalinity
H28	PH
H30	Trace elements
H31	Radioactivity
H32	Isotopes
H90	Other chemical oceanographic measurements

	Marine Contaminants/Pollution
P01	Suspended matter
P02	Trace metals
P03	Petroleum residues
P04	Chlorinated hydrocarbons
P05	Other dissolved substances
P12	Bottom deposits
P13	Contaminants in organisms
P90	Other contaminant measurements

	Marine Biology/Fisheries
B01	Primary productivity
B02	Phytoplankton pigments (eg chlorophyll, fluorescence)
B71	Particulate organic matter (inc POC, PON)
B06	Dissolved organic matter (inc DOC)
B72	Biochemical measurements (eg lipids, amino acids)
B73	Sediment traps
B08	Phytoplankton
B09	Zooplankton
B03	Seston
B10	Manta
B11	Nekton
B13	Eggs & larvae
B07	Pelagic bacteria/micro-organisms
B16	Benthic bacteria/micro-organisms
B17	Phytobenthos
B18	Zoobenthos
B25	Birds
B26	Mammals & reptiles
B14	Pelagic fish
B19	Demersal fish
B20	Molluscs
B21	Crustaceans
B28	Acoustic reflection on marine organisms
B37	Taggings
B64	Gear research
B65	Exploratory fishing
B90	Other biological/fisheries measurements

	Marine Geology/Geophysics
G01	Dredge
G02	Grab
G03	Core - rock
G04	Core - soft bottom
G08	Bottom photography
G71	In-situ seafloor measurement/sampling
G72	Geophysical measurements made at depth
G73	Single-beam echosounding
G74	Multi-beam echosounding
G24	Long/short range side scan sonar
G75	Single channel seismic reflection
G76	Multichannel seismic reflection
G26	Seismic refraction
G27	Gravity measurements
G28	Magnetic measurements
G90	Other geological/geophysical measurements