

MARINE
NATIONAL FACILITY

2012

RV Southern Surveyor
program



voyagesummaryss2012_t01

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

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 $\sim 0.02\text{C}$ 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 |

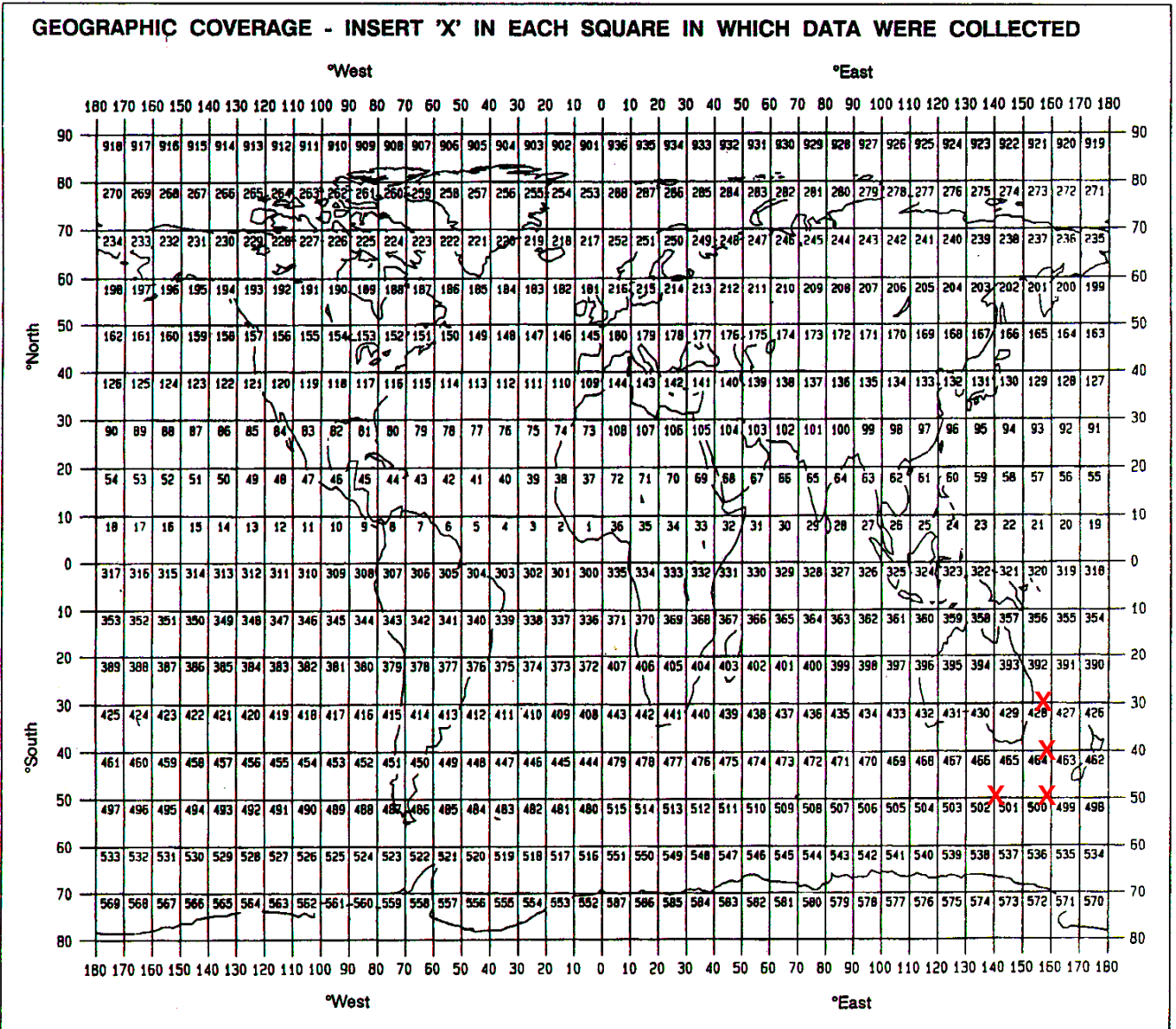
Principal Investigators

- 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

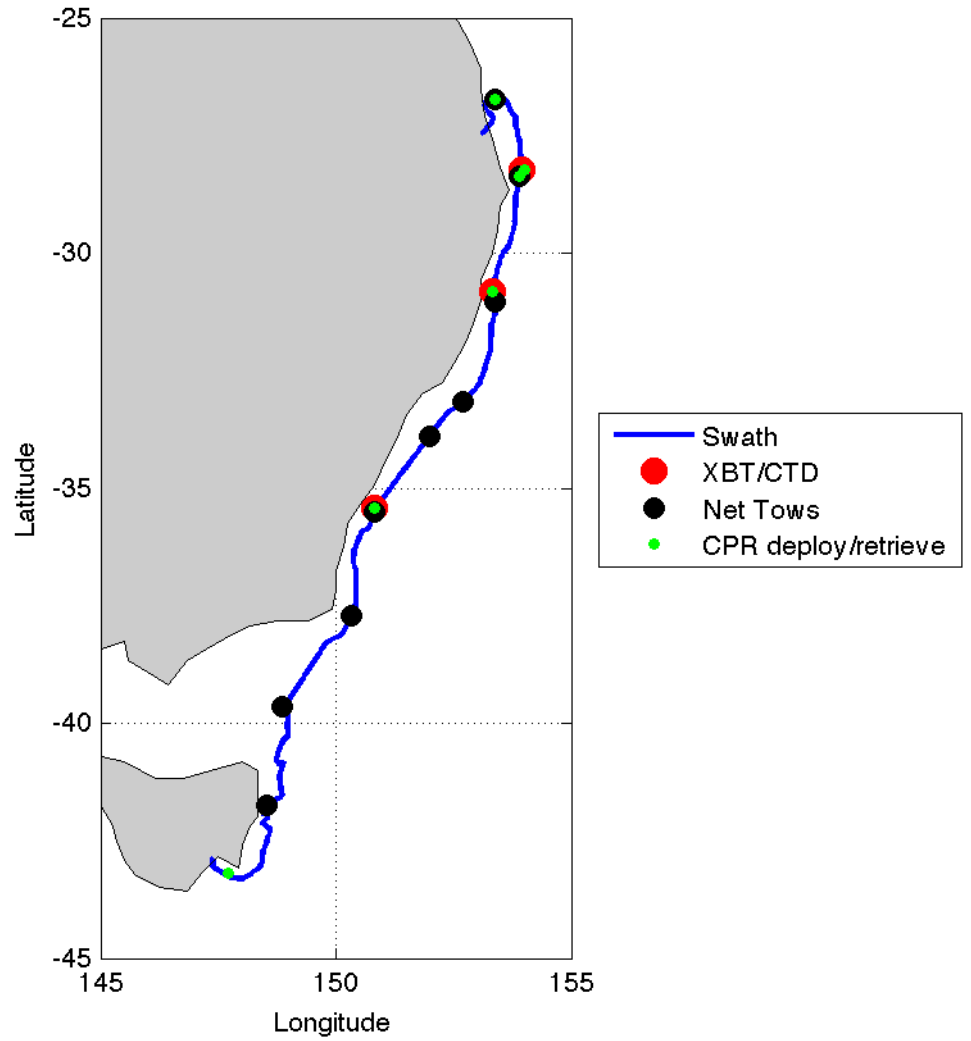


| Summary of measurements and samples taken | | | | | |
|---|----------------|-----------|-----------|--------------------------------------|---|
| Item No. | PI | NO | UNITS | DATA TYPE | DESCRIPTION |
| | see page above | see above | see above | Enter code(s) from list on last page | |
| 1 | D | 1,270 | 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 distribution 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 CO ₂ , CO, N ₂ O, CH ₄ , O ₃ |

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 | 1 st Officer |
| Simon Smeaton | 2 nd Officer |
| Fred Rostron | Chief Engineer |
| Michael Yorke- Barber | 1 st Engineer |
| Paul Buffett | 2 nd 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 | 2 nd 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.

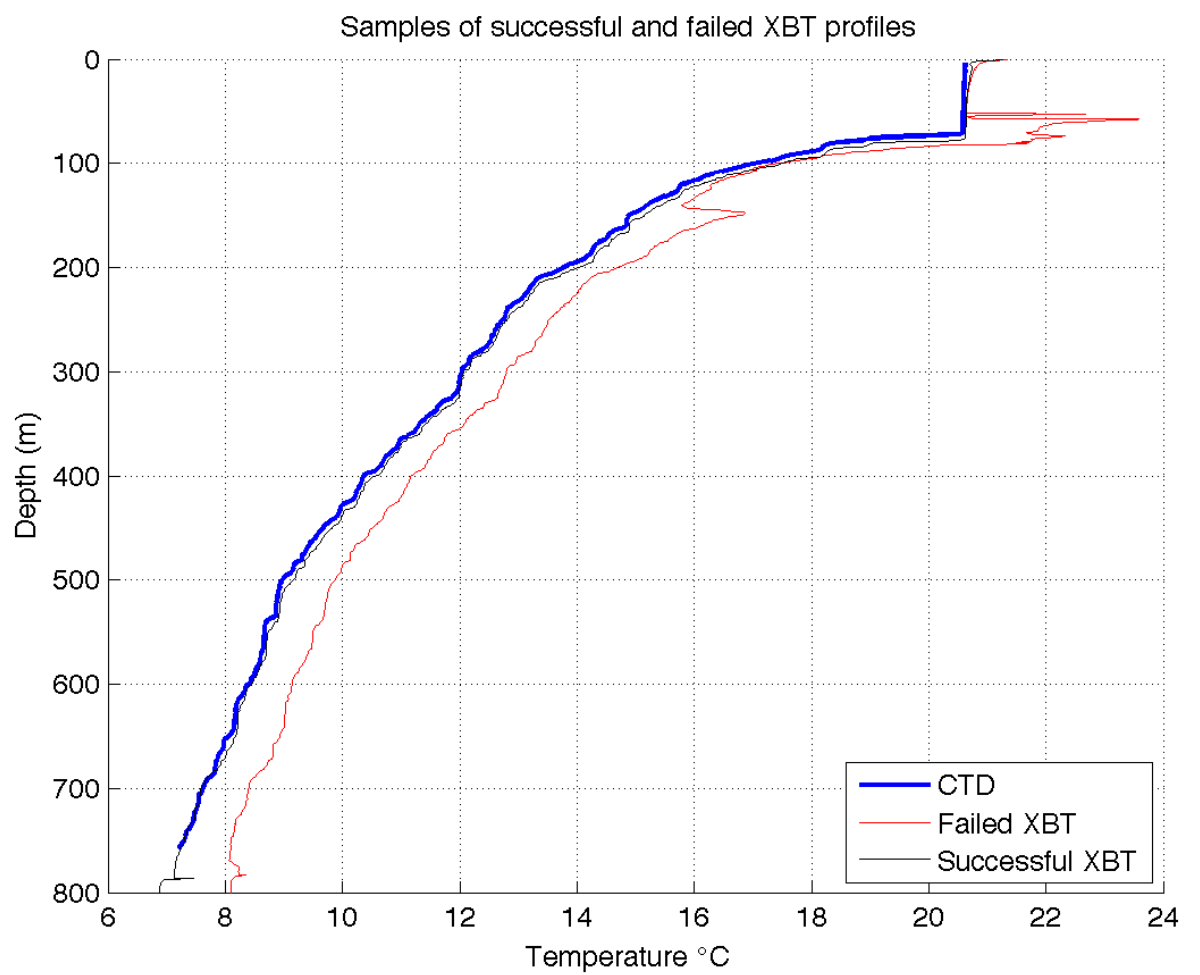
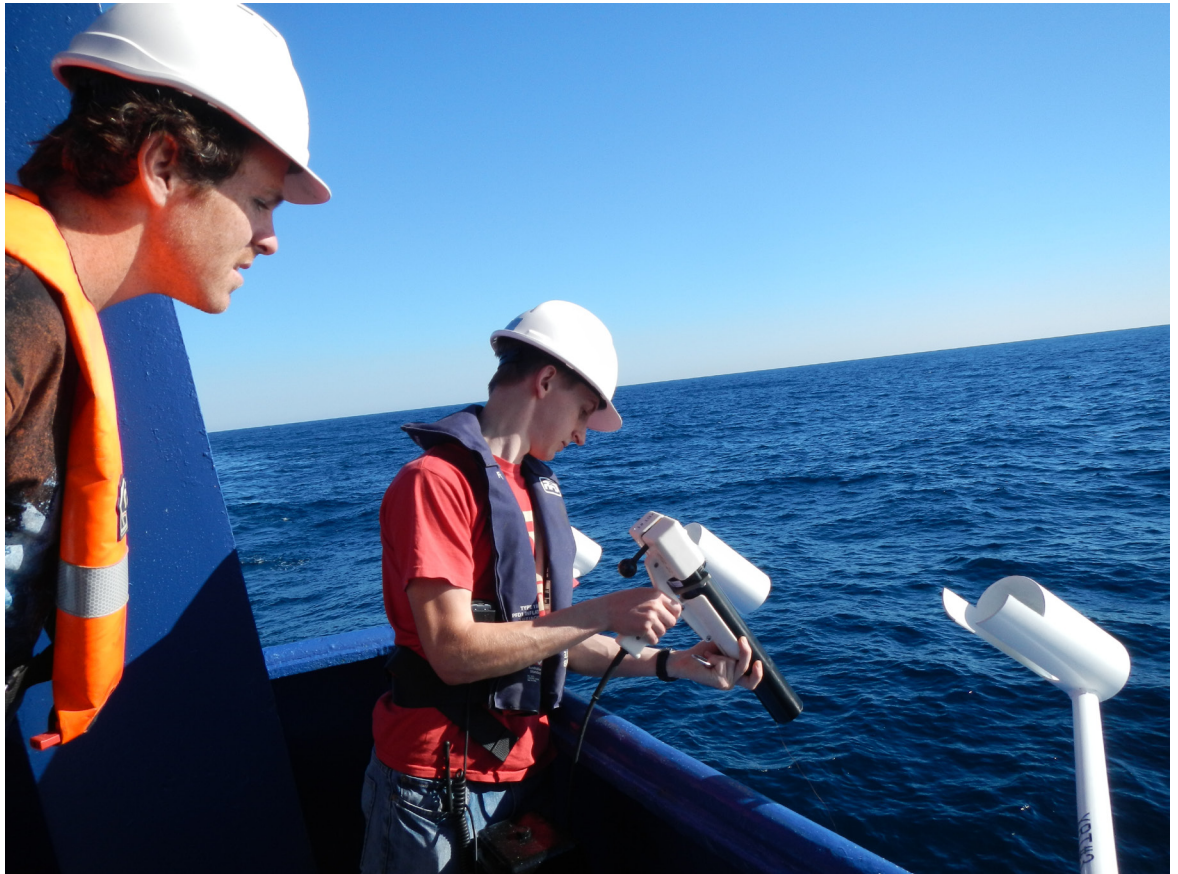


Figure 3. Deploying XBTs on SS2012 _ t01



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/drifted 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 |