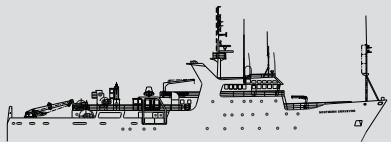


MARINE
NATIONAL FACILITY

2009 program

RV *Southern Surveyor*

CSIRO

voyage summary SS01/2009

SS01/2009

Monitoring Ocean Climate Change Around Australia: Deep Ocean Time Series Section (DOTSS) along 170oW between 50ºS and the Equator.

Voyage period
03/02/2009 to 26/02/2009 and 27/02/2009 to 24/03/2009
Port of departure: Wellington, New Zealand, Mid-voyage
Port Change-over/resupply: Nuku'alofa, Tonga
Port of return: Lautoka, Fiji

Responsible laboratory
CSIRO Marine and Atmospheric Research, Castray Esplanade Hobart 7000 Australia

Chief Scientist
Dr Bernadette Sloyan, CSIRO Marine and Atmospheric Research
Dr Susan Wijffels, CSIRO Marine and Atmospheric Research

Scientific Objectives

This project will monitor deep ocean changes via Deep Ocean Time Series Sections (DOTSS) which is Australia's contribution to the International Repeat Hydrography and Carbon Program. Specifically we will reoccupy a full depth ocean section in the Pacific along 170ºW from 50ºS to the equator with the aim to maintain full depth, high precision hydrographic, carbon and tracer measurements along key sections in the oceans surrounding Australia to monitor circulation and biogeochemical changes on multi-decadal timescales. Station spacing along the section will average about 30nm from 50°S to the equator with close spacing over steep topography.

The scientific objectives and significance of the 170ºW section are:

- Maintain a time series of full-depth repeat ocean measurements capable of resolving decadal and longer time scale changes in the circulation and property storage (including heat, freshwater, oxygen and carbon) of the oceans around Australia, from Antarctica to the equator, thus filling the monitoring gap left by Argo and satellite systems.
- Use these data to test climate model predictions and to determine whether and how fast climate is changing due to the Greenhouse Effect and/or natural decadal variability.
- Improve our understanding of basic ocean processes and fluxes through collection of full depth direct velocity measurements while conducting the repeat surveys.

Repeat full depth hydrographic and carbon sections provide data needed to detect and monitor ocean variability and changes in carbonate chemistry associated with acidification. The global network of sections is providing data on the global partitioning and evolution of carbon storage between the ocean, atmosphere and terrestrial biosphere. The high precision, full depth data, together with other data and numerical models will allow for the detection and attribution of ocean variability and the impact of the ocean on climate variability.

Voyage Objectives

- undertake full depth CTD and Niskin bottle casts that measure salinity, temperature and pressure continuously and the major nutrients discretely. We will be relying on achieving International Standard (WOCE) accuracy in order to measure what might be small but significant changes at depth.

- collected water samples will be analysed on board for the full suite of nutrients, dissolved inorganic carbon concentrations (DIC) and alkalinity. Samples will also be collected for carbon isotope analyses. Through collaboration with the NOAA PMEL and the University of Washington we will be able to measure CFC concentrations.

- for certain regions and where conditions allow, the CTD/Rosette will be reconfigured during the voyage to include the LADCP for full water column velocity profiles.

Results

We completed all planned 128 full-depth CTD and Niskin bottle stations along 170oW between 50oS and the Equator. On board processing of water sampling and analysis, including post-voyage should deliver nutrient data that generally meets international standards (WOCE). The final nutrient data is not yet available. Carbon water samples were analysed by Bronte Tilbrook (CMAR) and CFC samples were analysed by US collaborators from the University of Washington, and NOAA PMEL, Seattle, WA. This data will be finalized once the final bottle nutrient, oxygen and salinity data are provided. The up-ward and down-ward LADCP were mounted on the rosette frame for the final 10 stations that crossed the western boundary current at 17.5ºS. The raw output from the LADCP's will be processed on-shore to produce vertical velocity profiles.

The underway data (Met, velocity and EA500) worked well on the first leg of the voyage once properly configured. On the second leg the second beam of the ship-board ADCP – 75khz Ocean Surveyor – failed. This has impacted the quality of the underway velocity data. Discussion with RDI and MNF technicians have suggested a solution to the data problem but this is yet to be implemented, although we hope that we will eventually be able to rescue to the velocity data. There were also issues with the reliability of the EA500 during both legs of the voyage.

This voyage also provided the opportunity to deploy surface drifting buoys for the New Zealand weather service, Argo floats for the US and Australian programs, and address issues of XBT fall rate by collocated XBT and CTD stations.

A summary of voyage statistics is provided:
128 CTD/rosette stations
8 Argo floats deployed
10 surface drifters
3072 water samples

Preliminary analysis of the data has focussed on the abyssal temperature and comparison with previous voyages undertaken in 2001 and 1996. Sustained warming for the high latitude region is found in 2009 and the warming is now found in the mid-, and low-latitudes when compared to previous occupations of the section in 1996 and 2001 (Figure 1, Figure 2 and Figure 3). Rapid northward propagation of the warming signal from the high latitudes to the equator and the ocean dynamics involved in the propagation of the signal will be the subject of further investigation.

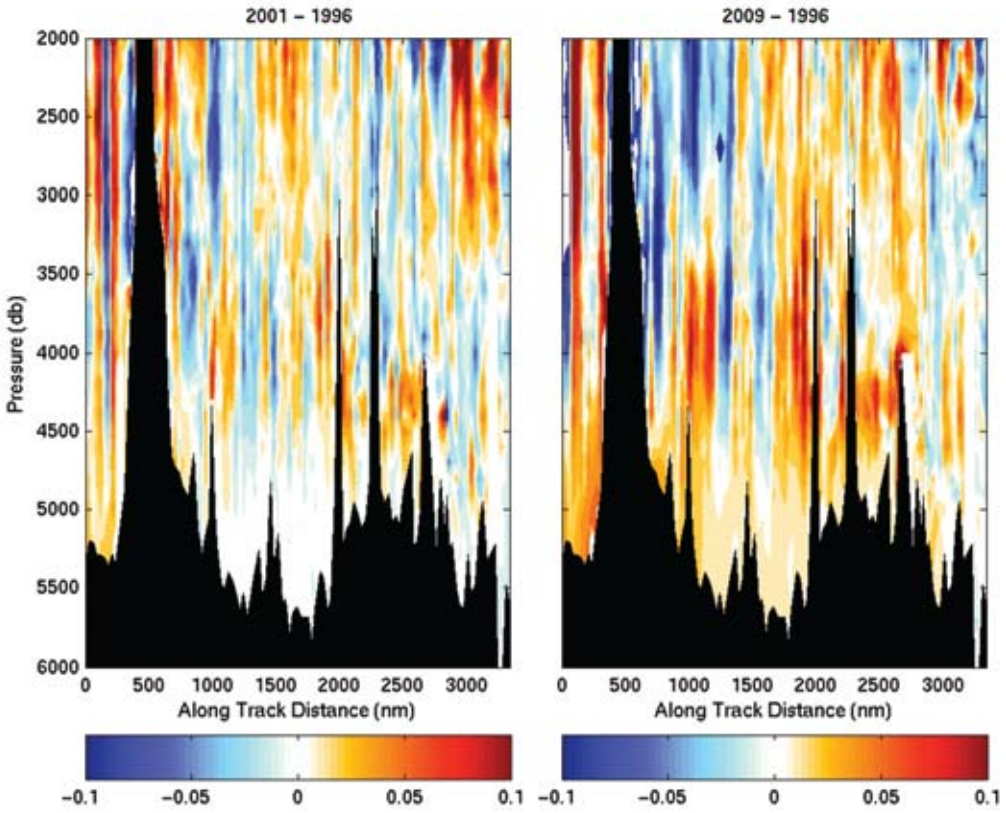


Figure 1: Potential Temperature Change (oC) for (left panel) 2001 and 1996 and (right panel) 2009 and 1996 below 2000m from 50oS to the Equator. Sustained warming for the high latitude region is found in 2009 and the warming is now found in the mid-, and low-latitudes when compared to previous occupations of the section in 1996 and 2001.

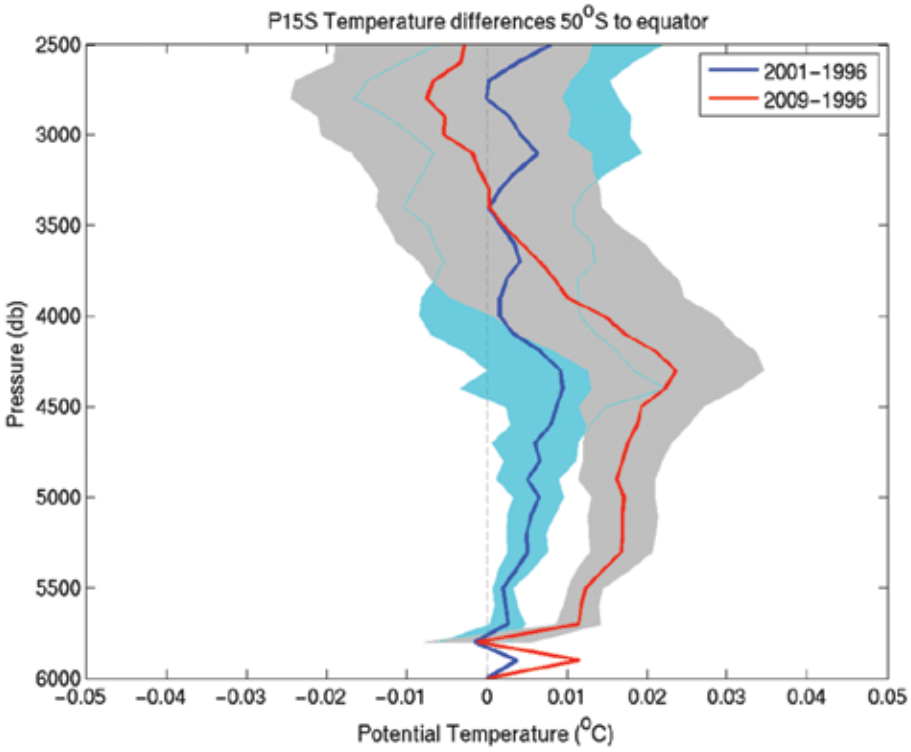


Figure 2: Section mean warming below 2500 between 2001 and 1996 (blue) and 2009 and 1996 (red).

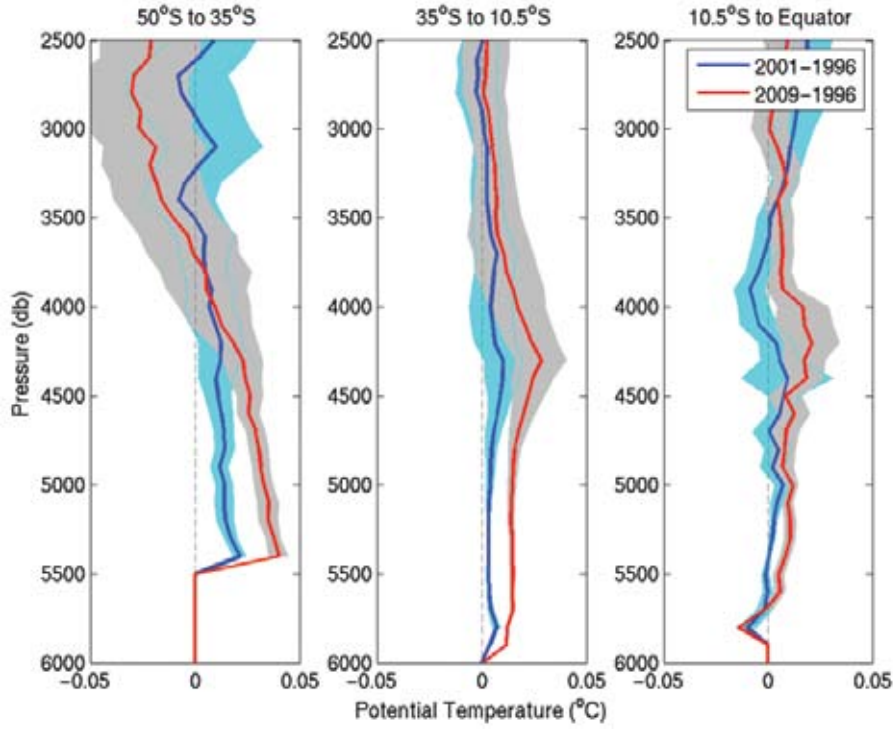


Figure 3: Latitudinal division of abyssal warming between 2001 and 1996 (blue) and 2009 and 1996 (red) for region from (left panel) 50°S to 35°S, (middle panel) 35°S to 10.5°S and, (right panel) 10.5°S to Equator.

Voyage Narrative

Leg 1: Wellington, New Zealand (GMT+1300)
Narrative by Susan Wijffels

2 February 2009: Science crews started to join the ship in the morning and start setting up the laboratories. Some members of the science team had come across on the transit leg from Sydney. We decided to rebuild the niskin/rosette system using the NOAA/PMEL 12L bottles as the petcocks on the CSIRO bottles pointed downwards making drawing the CFC's too difficult and dangerous (glass syringes impacting the deck). We half completed the build (PMEL bottles on CSIRO frames) by evening. Most of the science team dined uptown.

3 February 2009: All science crew were aboard around 0900. Planned departure at 1000 had to be delayed due to several maintenance problems (a few oil leaks, seawater cooling intake fouled with small mussels). Due to the hard work of the crew and contractors we were able to sail at 1600 to begin our transit to the test station location (in ~2100m on the line towards the start of the section). Before leaving at 1300 we completed a safety induction by the First Mate. The chemical laboratories teams continued to set up. The CTD watch finished rebuilding the rosette – with help from Peter Dunn on manufacturing some lanyard guides.

We were approaching the test station around 1930. A toolbox meeting was held on the bridge with both CTD watches present, the master, bosun and IR. After the meeting, we proceeded downstairs with the bosun to discuss safety in the wetlab and setup for the station while the master manoeuvred the ship on to station. The CTD started at 2014, with the watches being trained on how to start and run the new acquisition system and fill out the log sheets. We reached 2000db at 2050, brought the rosette to 1700db and fired all 24 bottles successfully. The rosette was at the surface 2133. Unfortunately the rosette dropped while the A-frame was bringing it aboard, and thus it slammed into the ship's hull, impacting just above the petcocks near rosette positions 22-23. The package was then brought aboard and into the wetlab. There was no obvious damage to the niskins – though we will have to be diligent in checking for leaks in the bottles near RP 22-23 where the impact occurred.

The CTD watches were then trained in sampling methods while Fred Menzia trained his partner Nancy in CFC sampling. Dave Terhell trained us in oxygen sampling (to be done by Don McKenzie and Ann Thresher). Kate Berry trained us in DIC and alkalinity sampling (Kial Stewart and Catia Domingues). Both oxygen and DIC sampling requires a 3rd person to assist in temperature measurements/notes and in poisoning the DIC sample. We have asked Peter Dunn and Hiski Kippo to assist the watch for this time. The samplers were then trained in nutrient and salt (Don McKenzie and Ann Thresher) sampling by Dave Terhell. The hydrochemistry team then collected 20L of the seawater to use for their bulk QC. From this cast we collected nutrients, CFCs and salinities for analysis – no oxygen and DIC/alkalinities will be determined. Only one member of the science team was suffering mild sea-sickness.

4 February 2009: Transiting to the start of the P15S section at 50°S in calm mild swells and overcast conditions. Many albatross and petrels are following the ship.

0906 we deployed the first of the SVP drifters for the
New Zealand Meteorological Agency.

(see Table 1). Chemistry labs continue to set up and test their equipment. Alicia Navidad trained Kail Stewart in analyzing the salt samples from the test station. Once the laboratory temperature stabilized, Kail found a highly consistent results (+/- 0.001) suggesting that none of the bottles leaked, which is a good result!

2105 we deployed the second SVP drifter successfully.
Swell is long but continuing to build.

Ship board ADCP acquisition started ~ 2300?

5 February 2009: Transit continues to the beginning of the line. We are making good speed with a following wind. Salts analysis for the test station was completed by Kial Stewart and Alicia Navidad. The results are excellent with all bottles within 0.001 of the standard, indicating that the bottles were not leaking. The first analysis was affected by unstable laboratory temperatures.

Chem labs continue to set up. The swell has grown overnight and the CTD deck and aft deck are now awash. We have closed off the wetlab. All deck operations/visits now require a crew member to be in attendance and the bridge be informed. A strong safety line has been set up to help the CFC chemists safely transit from the CTD wetlab to their van on the aft deck. The bridge will also call down to the van every hour to check that they are ok.

1044 Third SVP drifter deployed.

1130 ADCP acquisition stopped and instrument configured for narrow-band long-ranging to achieve maximum range (config file nb16).

Building SW swell on the beam – uncomfortable for all with most getting little sleep. Decks remain closed. CFC team are always escorted along lifeline to their van. Lots of gear coming loose (including a laundry machine that flung itself into the hall). Rolls up to 45° during the night.

6 February 2009: 0055 Deployed another SVP drifter successfully.

Ship had a rough night of running abeam of big south westerly swells, and thus rolled a lot (~45°). Alicia Navidad noticed that the Guildline Autosal was moving and creaking, and had it tied down properly. Well done Alicia.

Transit speed has remained good though and we expect to begin the section late today. A second Toolbox meeting was held for the first deep cast and around winch handling and bottom approach.

DIC/Alkalinity and nutrient labs are now in business and running samples after numerous problems were solved. CFC lab continues to experience problems. A software controlled valve appears to have failed and no spare can be found. Fred Menzia may be able to operate without it.

2230 another SVP drifter was deployed as we approached the first actual station of the section. First deployment started well in mild swell and building winds. During the down cast the crew stopped the winch and brought it up ~2000db and again ~4500db. On the second stop the crew swapped hydraulic pumps, but it seems to have caused a problem and the CTD was stalled for over 1.2 hours. Finally continued down to the bottom. Due to a strong wire angle we had over 6000m of wire out in 5300m of depth. We took the package down to the pressure of 10m above the bottom, but there was no signal from the altimeter. We fired the first bottle (30 second delay). Unfortunately, the tension control on the winch gave out and the crew were not able to bring the package up. It was 'stuck' near the bottom in this precarious situation for over an hour before the crew were able to manually adjust the tension control and bring the package up and away from the bottom. Luckily, the sensor traces remained clear and so we believe the package did not hit the bottom. It was a rather tense wait for all. This very long cast (> 6 hours) finally came aboard around 5am. Details of the CTD casts can be found in Table 2. Due to continuing difficulty with broken equipment in the CFC laboratory, no CFC's were sampled during this cast.

7 February 2009: Proceeded to next station in mild swell and slightly elevated winds. The ride is much better now that we are heading north. We overshot the station and had to return south. CTD station 3 went into the water after lunch (~1200) and after a smooth operation, was back on deck around 3pm. The ships' engineers worked on winch tension controller and appear to have fixed it. Winch operations and handling were flawless during this station.

Progress was made by Fred Menzia and Peter Dunn in trouble shooting and fixing the CFC equipment. It appears it is now working. Hence CFC's were sampled during this station.

Transited to CTD station 4 which started at 2207. Just before putting the CTD over the side, the hydraulic winch circuit breaker cutting power to the winches. There was an hour or so delay before deployment – we paused acquisition several times before the winches were finally fixed and the station proceeded smoothly.

8 February 2009: Swell is abating a little and we even had some sunshine today. Albatross (Royals and Wandering?) and petrels continue to follow the ship.

Station 5 was in the water at ~0345 and proceeded smoothly, back on deck around 0715. Two bottles did not fire and so we tested the pylon a few times – some of the releases were sticking.

Approaching Station 6 we deployed another SVP drifter. Station 6 went in the water around 1021 in mild conditions and was back on deck around 1415. All bottles fired normally. During this station we attempted to collect XBT intercomparison information by simultaneously launching 3 systems. Due to poor radio communication and acquisition system problems we acquired few good casts. Also, only launches over the stern appeared to deliver full profiles while the others cut off near 100m. We will aim to refine our approach!

Reached next station (CTD 7) around 1710 and CTD was in the water 1721 and continued smoothly.

9 February 2009: CTD station 8 started 0030 and was completed in building winds and swell. Sampling was completed in 2 hours and 15 minutes for all parameters (CFC, DIC, oxygens, salts, nutrients). Due to a head wind and large swell, transit speed was down to 8 knots.

CTD 9 was in the water at 0846 and retrieved later in the morning, while CTD 10 was completed in the later afternoon and evening. Fog is setting in, swells are mild. CTD 11 was started near midnight. The winch speed was slowed down as the bridge could not see the wire angle at all.

10 February 2009: Transit to CTD 12 was slow as the ship speed was down due to very heavy fog. Otherwise swell and wind conditions are easing. CTD 12 was started around 0800 and aboard by 1110. CTD 13 was completed in the afternoon, and CTD 14 in the late evening.

11 February 2009: CTD 15 completed in the wee hours. We are making our way up the long slope of the Chatham Rise. The fog has lifted and transit speeds are back to normal. Numerous petrels and albatross follow and surround the ship during station. The hydrochemistry team are having difficulty with the nitrate channel and have lost 12 hours of analysis time trouble shooting this. It may be necessary to drop a few stations of fresh nutrient samples to allow them to catch up. Bronte Tilbrook requested that these be stations where DIC/Alkalinity/CFC measurements are NOT made.

CTD 16 was started around 0612 and was aboard at 0810. These are shallow stations coming up to and over the Chatham Rise. An SVP drifter was deployed in the transit to CTD 17, which went into the water at 1029 and was aboard at 1128. CTD 18 was started at 1332 right over the Rise in ~800m of water. This is an ideal depth for XBT intercomparisons as the hit-bottom signature can be compared with the ship's depth sounder (EA500 set with sound speed of 1500m/s constant). Ann Thresher led a successful XBT intercomparison with 12 XBT's dropped, 11 of which appeared to hit bottom. Beautiful sunny day with lots of inquisitive feathered friends.

12 February 2009: Great progress during the night with CTD stations 20-22 completed.

Rainy, foggy day with more wind. Slight pause during start of station 24 due to slight hydraulic fluid leak. CTD 25 was completed in the afternoon.

Strongly intensifying low pressure system crossed Cook Strait today and is heading south and east of us. It will bring fairly big winds and seas. The ship will slow down and we may have to heave-to for a while.

13 February 2009: CTD 26 completed in the morning in strengthening NW wind and swell conditions. After sampling the rosette the and with the ship underway around 715, a large swell rolled the ship violently and Hiski Kippo was thrown across the galley, colliding with one of the galley chairs. His shoulder was badly hurt. We hove to to attend to Hiski, whose arm was put in a sling and he was supported and taken to an examination in the ship's hospital. Hiski retained consciousness and was aware and bright. After examination and recording of the incident Hiski then moved to the operations room for some rest. He will be observed for the next few days. The ships' Master and crew have been fantastic at taking care of Hiski.

Hiski's injury requires a rearrangment of the watches. Peter Dunn will move to the 2am watch and share a cabin with Don McKenzie. Susan Wijffels will take Don's place on the 2pm watch.

The ship remained hove-to until the expected SW change arrived around 1110. We then were able to resume steaming to the next station. CTD 27 was completed in heavy swells and freshening winds in the middle of the day, and CTD 28 completed that evening.

14 February 2009: Continued to work with fresh winds and quite large swells – ships rolling continues to be a challenge. CTDs 29 and 30 completed. On CTD 29 we carried out a test (as per a request from John Bullister, CFC PI) of the SF6 blank – rosette position 8 was fired in the CFC minimum with RP 7. RP 8 was not sampled immediately but removed from the rosette to age and replaced with a CSIRO bottle. The CFC sampled from the CSIRO bottle would be used to check whether the PMEL bottles have a higher SF6 blank.

15 February 2009: Completed CTD #32-34. Swells still large.

16 February 2009: CTDs 35 and 36 completed in the morning. After CTD #37 we changed out the secondary conductivity and temperature sensors as both had been spiking and dropping out since cast 2. New calibration coefficients were entered into the CTD Acquisition Program (CAP). We also checked the calibration coefficients for the primary sensors, and it turned out that the coefficients for the primary conductivity sensor were different from the predeployment laboratory calibrations. We entered the predeployment values from Steve Thomas' calibration folder.

So far on the voyage, Serial Numbers for sensors are:
Station 1-36: T1 4718, C1 3309 (incorrect coefficients), T2 4722, C2 3311
Station 37 - : T1 4718, C1 3309 (correct coefficients), T2 4682, C2 3168

Results for station 37 still showed noise on the secondary T and C channels. Thus we replaced the sea-cables between the sensors and the main unit. This appears to have fixed the problem for the secondary temperature (which agrees with the primary unit ~ 0.001°C). The C2 channel is still noisy and should be checked in Tonga – a connection clean or cable swap may be worth trying again.

Ann Thresher oversaw the successful deployment of one case of XBT's using two Devil acquisition systems during Cast 37. The intercomparison data look promising.

We also closely checked the bottle salinities against the CTD results. The too warm laboratory temperature badly impacted the AutoSal results for stations 5-13. These data should not be used and should be qc'd 'bad'. See summary below from Kial Stewart on the AutoSal operations.

17 February 2009: CTD's 39-41 completed in abating conditions. The first Argo float was deployed off the fan tail coming into station 41.

18 February 2009: Completed stations 42-44.

Kate Berry reported that old underway logging system went down which affects the data stream of the PCO2 system, as was being synchronized with the thermosalinograph and GPS time and position data. This problem was tracked down to a corruption of the disk on one of the old Sun servers (SS2). Bronte Tilbrook's PCO2 data stream can be integrated with the TSG and GPS data stream in post-processing, though this is not ideal. Hiski Kippo and Bob Beattie (remotely) are working to fix this.

19 February 2009: Stations 45-47 completed.

During station 46, and around 0300, the UPS power system went down during the downcast near 2700db. All systems in the operations room went down, including the communications to the cathouse and bridge. The cast was halted at 2700db. Peter Dunn worked to by-pass the UPS, which he did with the help of Seamus (ship's Engineer). Hiski Kippo was woken to help rebuild the operations system which involves physically switching on and off numerous computers and interconnect devices, both in the operations room and bridge – this took about 30 minutes. The lack of a start up procedure meant this was a bit hit and miss – for instance we do not know how to get the meteorological logging system back on line as there are units somewhere on the ship to reboot that we have not found. Also the email went out as that system needed rebooting on the bridge. After powering up most of the systems again, however, the engineers were checking their electrical systems in the engine room, and caused another power failure. This required another entire reboot/rebuild. The total delay was only one hour.

20 February 2009: Station 50 completed during the morning. We are now in the trade-winds and are seeing more sunshine. During the cast some wrapping problems on the forward winch drum were noticed on the downcast, but appeared to resolve themselves on the upcast. Stations 51 and 52 were completed.

21 February 2009: Rainy and overcast as subtropical fronts pass us. Stations 52-55 completed. XBTs dropped during station 54.

22 February 2009: More rain and some larger swell. Stations 56-58 completed. XBTs intercomparisons are becoming quicker and easier – past problems have been due to an unstable host-laptop. When replaced with Ann's laptop, the system works much better. We are now dropping XBTs before the CTD goes into the water to tighten the time difference between the XBTs and CTD passing through the upper 800m.

23 February 2009: Seas moderating and weather becoming hot and steamy.

Slight winch cable laying problems – we had to slow down at the ends of each wrap on the upcast. Stations 59 -62 completed. We noticed severe lanyard wear where the bottom cap lanyards pass over the edge of the rosette frame. We replaced 8 lanyards and will have to keep checking and replacing others as the need arises. We also taped the frame edges to reduce the abrasion on the lanyards. The length of the PMEL sample bottles relative to our frame makes this unavoidable.

24 February 2009: ~0700 Trouble with forward CTD winch on CTD 63 upcast – a big clunk was heard and the winch then briefly free-spooled out before the operator (Kel) caught it with the brake. On the subsequent retrieval the wire spooling gear did not appear to work well, and the wire had to be let out and rewound again several time. This caused a loss of an hour and the wire wraps on the forward winch are a bit of a mess.

During the transit to CTD 64, the rosette/frame was transferred to the aft CTD winch by Peter Dunn and the Bosun, Tony. Meanwhile the ship's engineers were in touch with the winch makers, Taylor Bros. in Hobart to get some advice. We were stopped on the location of CTD 64 for some time while the hydraulics on the aft winch were checked. We then proceeded with station 64.

The EM300 depth sounder has lost a strong bottom signal and is often out for minutes at a time. We are not sure if this is due to a problem with the sounder or due to a very soft bottom. We will see if this rectifies itself on the steam to Tonga.

We encountered some spooling problems on the upcast of station 65.

Due to the lost time over winch problems, we shall take the last station (65) 10' of latitude south of the original location to ensure we arrive outside Nuku 'Alofa to meet the pilot at 0600.. Left for Tonga on completing CTD station 65 at 1045 local.

Hiski Kippo slowly improved during the voyage and was well cared for by the ship's crew. He was able to keep working for some hours per day either in his cabin or the operations room, but also got a lot of healing sleep. He worked hard during the power outage crisis and also on recovering the crash of the old servers ss1 and ss2.

Leg 2: Nuku'alofa, Tonga (GMT+1300)
Narrative by Bernadette Sloyan

26 February 2009: Ship arrived in Nuku'alofa at approximately 0800. On-coming science personnel were not allowed to enter the wharf until a list of joining personnel was obtained. We produced a copy of the voyage plan and noted the names of oncoming and off-going science personnel and were given access to the wharf. A hand-over of CTD operations from leg 1 to leg 2 was completed by 1500hrs.

Bunkering began shortly after the ship arrived at the wharf as was completed by 1900hrs. However, the ship's engineer and local contractors, repairing the air conditioning unit that failed two days prior to arriving in port, were being delayed and frustrated by additional problems with the unit. The unit was still being repaired at 2100hrs. All ship's air conditioning units were shut down during the day. This resulted in very hot conditions in the science and crew cabins, galley, and other areas of the ship. At a meeting between the master (Les), Drew (MNF manager) and myself , we resolved to postpone departure until 0800 27 February based on : a) all watchkeepers were nearing or exceeding STCW cutoffs, and b) crew fatigue as no rest was possible during the day because of the excessive temperature in the cabins.

A number of science and crew personnel slept in areas on the ship that were cooled by the remaining functioning air conditioning unit. These areas included the video lounge and CFC van.

27 February 2009: While work resumed on completing the repair of the air conditioner in the morning, the engine room prepared for an immediate departure once the air conditioning was functioning. Repairs to the unit were completed at 1130. We sailed with the unit working and gassed the unit while at sea. We departed Nuku'alofa at 1200, 20 hours behind schedule, in calm conditions. Transit speed has averaged 10 knots.

During the afternoon the on-coming CTD watch keepers were shown the bottle sampling route by carbon and hydrography chemists, and also CTD deployment, watch, and recovery procedures. Science personnel began watches at 1400hrs.

28 February 2009: Transit to station 66 was slightly hindered by a 15-18 knot easterly breeze, but we still maintained an average speed of about 9.5 knots. During the transit final preparation for the resumption of the P15S sections were completed. A toolbox meeting was held at 1100. All science and ships crew involved in CTD operations were present. The CTD operations will be similar to leg 1, apart from initial soak of package will occur at 10m. The CTD package is then brought up to the surface and descends to the target depth.

Chief Scientist, MNF Voyage Manager, Master and Chief Engineer briefing occurred. Fuel issues were raised. This will be monitored during the first week. The science party again reiterated our tight time line and need to maintain at least 10 knots during transit. The Chief Engineer strongly advises that we remain on the aft-winch drum and not change to forward drum unless the need arises. Care will have to be taken when hauling in the final 300-2500m of wire to ensure that the wire spools correctly. The major problem is at the cheek ends of the drum. Winch operators will be advised to slow-down when laying wire near the ends of the drum.

1 March 2009: We reviewed the 2001 CFC and Carbon sampling and determined that the best coincident station sampling will occur on leg 2 when CFC and Carbon maintain an odd stations sampling program. We arrived at Station 66 at 0030hrs. Both CTD watches participated in the launch of the CTD package. The downcast and upcast secondary conductivity was offset from primary cell between 200 and 800 dbar. Problems with wire spooling occurred at 2000 and 1400 dbar. Small amount of wire was paid-out at both depths with only a short delay to cast.

Stations 66 - 68 completed. On both stations the downcast and upcast secondary conductivity was offset from primary cell between 200 and 800 dbar. The CTDs were thoroughly rinsed after station 67. Problem with secondary conductivity sensor persisted at station 68.

Bernadette Heaney fixed the format of the .cro files. Burst sample CTD data now is date stamped with time of bottle firing. All old .cro files were removed from R:\data\ctd\raw and deleted R:\data\bottle\nutrients\cro. The correct .cro files are now in R:\data\bottle\crofiles.

2 March 2009: Prior to station 69 the secondary CTD cable was changed in order to fix noisy secondary data and the CTD configuration file was amended in CAP to remove redundant sensors (PAR, fluoroence) and add optode oxygen probe to ActiveSensorIndex.

All stations prior to station 69 have a discrepancy in the *Ctd.nc files between sensor type and activeSensorIndex and actual sensors on the CTD package. Downcast trace comparison of oxygen sensors indicated that the Optode sensor is highly suspect. Optode oxygen data prior to station 69 is most likely stored in CTD.auxchannel.

Stations 69 - 72 completed. An XBT comparison was completed at Station 71 with 6 XBT pairs launched at the beginning of the downcast, we noted that XBT2 broke at between 250 and 500m. This station was complete in sight of Nuie.

On transit between stations 72 and 73 beam 2 of the ADCP – 75khz Ocean Surveyor – had reduced power and impacted the quality of the direct velocity measurements. In the following week email messages between the Chief Scientist, Jules Hummon and Eric Firing (U. Hawaii) tried to ascertain whether accurate velocity data could be derived from a three beam solution. Jules and Eric provided input into the problem and all correspondence was forwarded to Bernadette Heaney and Drew Mills. Drew also contacted RDI for assistance. (See further notes below).

3 March 2009: Power clinch in early hours (3seconds) fried the hard disk on oxygen computer in the hydrolab. Drew Mills is working on recovering the hard drive. The Carbon laboratory is getting too hot. We have put fans in the room to improve air circulation. The ship's air conditioning is working to maximum capacity.

Station 73 - 76 were completed. A reduced number of salinity samples were taken at Station 74, did not sample bottles fired in the thermocline.

A new bottle sampling scheme was introduced at station 75. The new scheme increases the bottle resolution above 800 m, decreases resolution at mid-water depths and maintains bottom resolution.

4 March 2009: Bernadette Heaney completed the calibration of the CTD conductivity for stations 37 to 68. There is an offset in the bottle salinity and primary burst CTD salinity for station 37 and higher. On the first leg they changed the coefficients of the primary conductivity sensor to those in the coefficient folder. The reason for the offset will be investigated but we suspect the coefficients are incorrect. We also have an offset in the primary and secondary conductivity cells which will be investigated and may be related to the problem between the burst average CTD salinity and bottle salinity.

Stations 77 – 80 were completed. An XBT comparison was conducted on station 79. Again XBT2 stopped recording at 550m for first three drops. This was due to wrong setting on Devil program – it was set toT4. This was correct and the last XBT dropped reached approximately 850m.

5 March 2009: Sunny and calm day. Stations 81 – 84 were completed with some stations undertaken in sight of America Samoa. We are having problems keeping the temperature in the Carbon Laboratory stable. Engineers are working to improve air-conditioning and fans were placed in the room to improve air flow.

Drew Mills communicated with Mark Underwood regarding calibration of conductivity sensors. A significant constant off-set between bottle salinity and CTD salinity is found from station 37 onwards. There is also an off-set between the primary and secondary conductivity sensors. The sensors themselves appear to be stable.

6 March 2009: Stations 85 – 88 were completed. Successful XBT comparison was conducted on station 87.

Further comparison between the salt bottle and CTD salinity confirmed significant increase in difference between the bottle and burst CTD (see Appendix B – This report was sent to Mark Underwood, CSIRO). Prior to station 88 we changed the primary sensor conductivity coefficients (serial number 3309) back to the SBE calibration coefficients reported on 18/1/2007. These are the coefficients used in Station 1 to 36.

The primary CTD conductivity sensor (Serial No: 3309) malfunctioned near the bottom of the downcast. Up-cast salinity values at bottle stopped were taken from the secondary CTD conductivity sensor (Serial No: 3168). The secondary CTD sensor will be used to produce final CTD data for this station.

7 March 2009: Stations 89 - 91 were completed. Prior to station 89 the Primary CTD conductivity sensor was replaced with serial No: 3311. Calibration coefficients are from Seabird, 18/01/2007. Before deployment of the CTD/rosette at Station 90 the IR (Kel) noticed the sheaf on the aft-block had a lot of movement and appeared worn. This was replaced with forward block. The bearing on the aft-block was shattered and there was a lot of XBT copper wire in the bearing. The shattered bearing is not likely due to the XBT wire, but we will have to revise deployment procedure for XBTs. There are more bearings on the ship and the bosun and IR will repair the block.

8 March 2009: Stations 92 - 95. At station 92, bottle 16 had a high temperature value with dissolved oxygen, it was not leaking, and may have fired somewhere between bottle 17 and 18. On station 93, bottle 2 had the lanyard of bottle 1 caught in its end cap. It was not sampled. Bottle 18 leaked on station 94 and was not sampled. A short transit between stations 94 and 95 enabled only a cursory investigation of cause for leak – top vent and spigot. The leak could not be sourced and the bottle was replaced with a new PMEL bottle.

Nutrient analyzer fault finding has put some strain on the hydrochemist's ability to keep up with analysis of stations.

IR reported burning smell in winch control room during station 94. The card that controls the winch speed was over heating due to incorrect installation. This was corrected before next station.

9 March 2009:

Temperature in Carbon laboratory fluctuated during the night. Second Engineer was up to increase gas pressure in air-conditioning unit. Engineers assessed the issue thoroughly during the day and resulted in during off the cycling program of the air-conditioning unit. Temperature in the laboratory stabilized during the afternoon.

Beam 2 of the LADCP is not working. Bernadette Heaney noticed a drop in % good reading during a transit in the early morning. We still have three good beams.

Stations 96-98 were completed.

10 March 2009: Stations 99- 103 were completed.

Chief Scientist emailed Jules Hummon (U Hawaii) regarding the ability of UHDAS SADCP software to produce reliable surface velocity profile from three beam data. Her response was that it was possible but she queried why only one beam was failing given that the Ocean Surveyor is a phased array. I forwarded to her reply to Drew Mills and he concurred with Jules' comments. He emailed RDI seeking advice.

11 March 2009: Stations 104 – 106 were completed. Prior to station 104 the secondary conductivity sensor calibration coefficients were change to Seabird 08/03/06 report.

Primary sensor gave unrealistic conductivity results at approximately 5500m on the upcast of station 104. Drew Mills was woken at about 0800 after sampling was completed. We are suspicious of cabling from sensors to CTD. A test on the cable showed that it was compromised; we replaced the cable – cable taken from back-up CTD/rosette. The primary conductivity sensor was also changed to serial No: 3309 (which was on the primary CTD prior to station 89). Deployment of station 105 was delayed by approximately 15 minutes. Over the first 500 dbar of station 105 the primary and secondary conductivity sensor difference increased from 0.2 at the surface to 0.7 by 500 dbar. We suspect primary conductivity sensor is malfunctioning and aborted the cast. The primary conductivity sensor was replaced (serial no: 2312) and the station was begun again. At 1000 dbar the block on the A-frame was found to be broken. The cast was aborted and the CTD retrieved to the deck. While the ship's crew worked to replace the A-frame block, Bernadette Heaney spoke to Lindsay Pender in Hobart to get instruction on how to modify CAP when there are multiple casts at one station. On Lindsay's advice we removed aborted station 105 files from deployment log, scan and raw directories. When the CTD was ready for deployment we began a new deployment in CAP. CAP incremented to the correct station, deployment number (105) and we produced as normal. The combined CTD and A-frame block issues resulted in a delay of 1 hour.

We have no more spare CTD cable.

Argo float (SIO SOLO 2855) was deployed at the end of station 105.

Station 106 six pairs of XBTs were launched as within 1nm of stations and ship speed of 3 knots. Procedure for launch of XBTs was modified to reduce XBT copper wire getting caught on CTD/rosette.

12 March 2009: Stations 107 – 109 were completed.

LADCP is not producing reliable results. Drew Mills lifted the ADCP during station 109 and replaced the cable which we suspect is the most likely cause of the bad data.

Argo float (SIO SOLO 2856) was deployed at the end of station 108.

13 March 2009: Stations 110 – 113 completed. XBT comparison was undertaken at Station 112. XBT were launch on station prior to the CTD being deployed. Argo float (2857) was deployed at the completion of station 113.

The LADCP is still not producing reliable velocity. There are still problems with the signal strength of beam 2. Drew Mills has contacted RDI and is working on the problem.

The salinometer became unstable and was replaced with the spare after unsuccessfully trying to determine the problem.

14 March 2009: Stations 114 – 116 were completed. Drew Mills is still working on LADCP. Station 115 descent was stopped with 3 turns left of 3rd lay of wire on spool. Maximum pressure reached was 6535 dbar. Station 116 hit the bottom. Altimeter failed to provide a depth-off-bottom trace. First sporadic altimeter readings were at 6 and 4 m off bottom. EA500 bottom depth estimate was unreliable. It has been deteriorating for the last few days. Winch speed had been slowed to 30-20m/min at 5700 dbar (initial target pressure). Large T1-T2 and C1-C2 difference on upcast. Once we began the up-cast Drew Mills set to work at getting the EA500 working. It appears the transducer is not working and we will have to provide conservative initial target pressure and slowly approach the bottom – and hope that the altimeter provides reliable estimates of depth off bottom. At station 116 bottle 16 failed to close when fired and closed in near the surface.

CAP software crashing more often in last week.

15 March 2009: Stations 117 and 118 completed. Station 118 is the last station of the P15S hydrographic sections. Argo SOLO float (2681) was deployed at the end of station 117 and an XBT comparison was conducted at station 118 prior to the deployment of the CTD. Station 118 was completed at 23:41 UTC 14 March 2009.

We began the steam south to 17.5 S.

16 March 2009: Transit to 17.5S at approximately 11 knots or greater.

16 March 2009: Transit to 17.5S. Mark Rosenberg installed LADCP and battery onto CTD/Rosette.

17 March 2009: Transit to 17.5S. During the afternoon we packed up XBT laptops and launchers, and SIO Argo equipment. Drew Mills and Mark Rosenberg completed installation of LADCP on the rosette frame. The maximum pressure of the LADCP is 6000 dbar. Four 10-litre PMEL niskin bottle were removed from rosette, and we replaced two with a General Oceanics 5-litre (rosette position 1) and 10-litre (rosette position 22) CSIRO niskin bottles. Total bottles on rosette is 22, with conservative water usage we should be able to sample all properties from the 5-litre niskin.

18 March 2009: Transit to 17.5S. XBT laptops and other equipment packed for return to Hobart.

19 March 2009: Began station 119 at approximately 1130 and completed at 1600 (end of sampling). LADCP data was downloaded in time taken to complete water samples. There was enough water in the 5-litre niskin bottle for all water samples (CFC, carbon, oxygen, salt and nutrients). Bottle 21 was leaking and replaced prior to next station. Stations 119 and 120 completed.

20 March 2009: Stations 121 – 124 were completed. The knife on the winch was replaced at the completion of station 122. Maximum pressure of station 123 was limited to 6000 dbar due to LADCP pressure rating. Bottom depth at this station was 7593m.

21 March 2009: Stations 125 – 128 were completed. The final station (128) completed the short section across the deep western boundary current at 17.5S. The CTD/rosette package was washed and left to dry overnight.

22 March 2009: PMEL niskin bottles were removed from the CTD/ rosette package. CSIRO fixtures and clamps were removed and attached to CSIRO niskin bottles. XBT waste was placed in Argo wooden box and will be stored in green room. Began packing of CFC van and carbon laboratory.

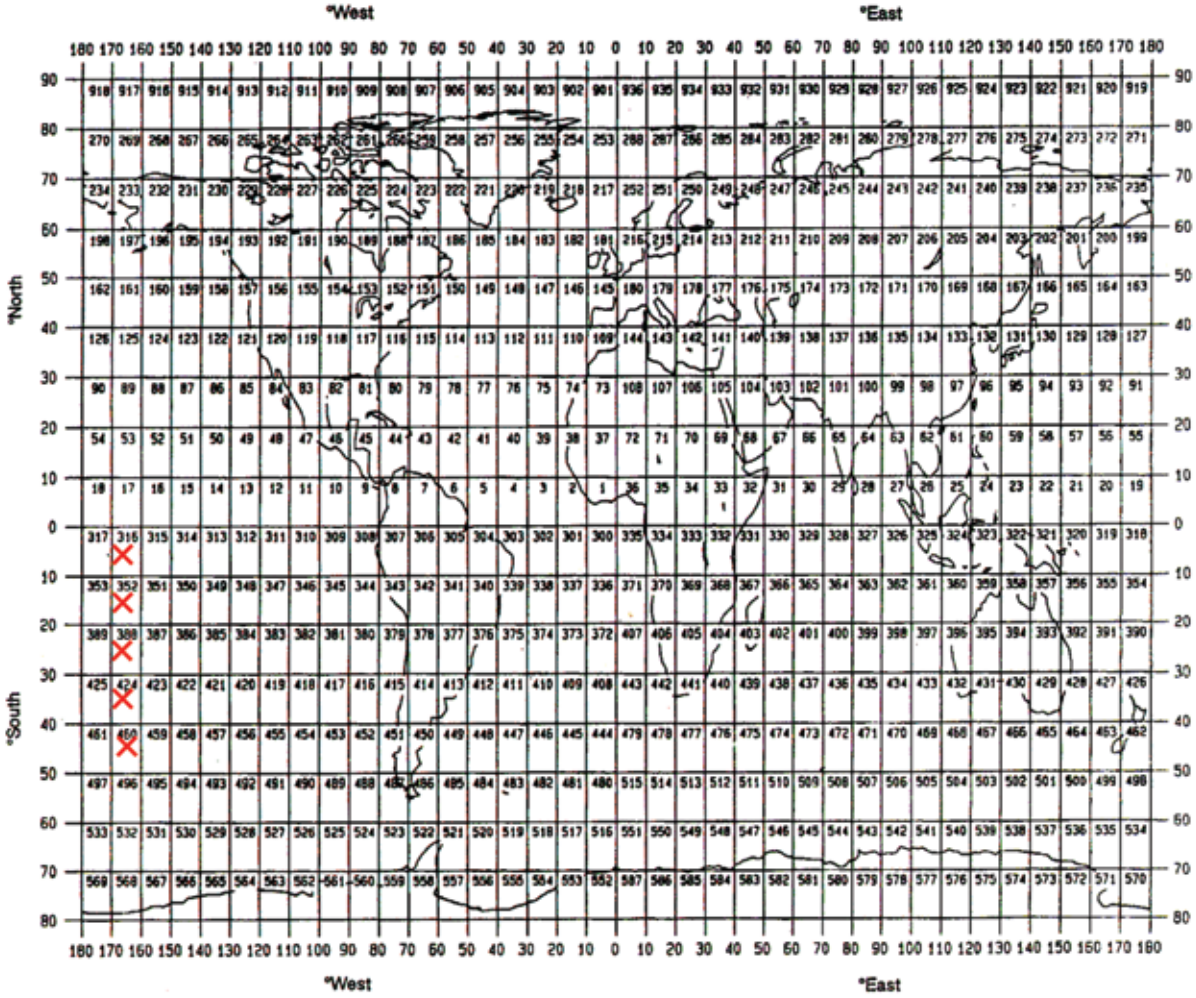
PRINCIPAL INVESTIGATORS

A. Bernadette Sloyan, CMAR Bernadette.Sloyan@csiro.au – CTD, nutrient and velocity

B. Bronte Tilbrook, CMAR Bronte.Tilbrook@csiro.au - Carbon

C. John Bullister, NOAA-PMEL, USA, John.L.Bullister@noaa.gov – CFC and SF6

GEOGRAPHIC COVERAGE - INSERT 'X' IN EACH SQUARE IN WHICH DATA WERE COLLECTED



CURATION REPORT

Table 1: Information of surface drifters and Argo floats deployed on the voyage

	Date/Time (GMT)	Position	other information
SVP drifter SN 83380	03/02/2009 2106	178° 0.458'E 43° 04.540'S	Transmitting ok
SVP drifter SN 83389	04/02/2009 0705	179° 59.861'E 44° 17.328'S	Transmitting ok
SVP drifter SN 83381	04/02/2009 2144	176° 59.716'E 46° 03.580'S	Transmitting ok
SVP drifter SN 83383	05/02/2009 2155	174° 00.324'E 47° 47.104'S	Transmitting ok
SVP drifter SN 83384	06/02/2009 0930	169° 59.790'E 50° 00.059'S	Transmitting ok
SVP drifter SN 83388	07/02/2009 2105	170° 02.43'E 48° 00.19'S	Transmitting ok
SVP drifter SN 83386	09/02/2009 0915	171° 40.30'E 45° 59.94'S	Transmitting ok
SVP drifter SN 83385	10/02/2009 2200	174° 7.70'E 44° 00.10'S	Transmitting ok
SVP drifter SN 83387	11/02/2009 2237	174° 08.70'E 44° 00.00'S	Transmitting ok
SVP drifter SN 83382?	13/02/2009 07:25	172° 44.82'E 39° 59.80'S	Transmitting ok
Argo Float Hull No 3668	17/02/2009 02:06	170° 00.01'E 33° 59.82'S	Transmitting ok
Argo Float Hull No 3670	19/02/2009 15:03	169° 59.35'E 29° 59.35'S	Transmitting ok
Argo Float Hull No 3672	21/02/2009 23:05	169° 59.35'E 26° 00.00'S	Transmitting ok
Argo Float Hull No 3674	24/02/2009 09:53	169° 59.85'E 22° 09.59'S	Transmitting ok

Table 2: Locations, times (UTC) and depths of CTD casts completed on Leg 1. Bottle oxygen, salinities and major nutrient samples were analysed on all casts. The last two columns indicate chlorofluorocarbon and dissolved carbon/alkalinity sampling – Y indicates the full set of bottles were sampled, P indicates on a subset of bottles were sampled.

No	Start Date/Time (UTC)	Latitude	Longitude	Depth (m)	Comments	CFC	DIC
1	03/02/2009 08:06	41° 52.42′S	175 °31.55′E	2406	Test Station		
2	06/02/2009 09:40	50° 00.02′S	169° 59.71′E	5347	Very long due to winch problems		Y
3	06/02/2009 23:06	49° 31.40′S	169° 59.23′E	5202		Y	
4	07/02/2009 09:07	49° 00.50′ S	169° 00.51′E	5216		Y	Y
5	07/02/2009 14:45	48° 29.78′ S	170° 00.13′E	5422			
6	07/02/2009 21:21	47° 59.04′ S	170° 01.74′E	5294	13 XBTs dropped during cast	Y	Y
7	08/02/2009 04:21	47° 29.94′ S	169° 59.40′E	5351			
8	08/02/2009 11:30	47° 06.53′ S	170° 53.39′E	5356		Y	Y
9	09/02/2009 19:46	46° 43.30′ S	170° 25.95′E	5279			
10	09/02/2009 02:55	46° 20.90′ S	171° 21.40′ E	5094			Y
11	09/02/2009 10:10	45° 56.98′S	171° 48.23′ E	5137		Y	
12	09/02/2009 18:44	45° 23.34′ S	172° 28.03′ E	4870		Y	Y
13	09/02/2009 02:00	44° 49.73′ S	173° 07.56′ E	3853		Y	
14	10/02/2009 07:12	44° 31.81′ S	173° 29.49′ E	3417		Y	Y
15	10/02/2009 12:25	44° 19.67′ S	173° 45.62′ E	3110		Y	Y
16	10/02/2009 17:12	44° 09.22′ S	173° 54.94′ E	1938	19 bottles. Surface bottle contaminated by ship's sewage due to retrieval delay for ship repositioning	Y	Y
17	10/02/2009 21:29	43° 51.04′ S	174° 17.96′ E	824	17 bottles	Y	
18	11/02/2009 00:32	43° 38.86′ S	174° 32.10′ E	794	16 bottles. 11 XBT's dropped during cast.		
19	11/02/2009 04:49	43° 15.14′ S	175° 00.00′ E	796	15 bottles.	Y	Y
20	11/02/2009 08:12	42° 55.76′ S	174° 47.35′ E	1067	17 bottles. No fresh nutients		
21	11/02/2009 11:11	42° 44.87′ S	174° 39.60′ E	1529	21 bottles.		Y
22	11/02/2009 15:03	42° 24.31′ S	174° 24.08′ E	2677	24 bottles.		
23	11/02/2009 19:03	42° 10.37′ S	174° 17.42′ E	2877		Y	Y
24	12/02/2009 00:42	41° 42.73′ S	173° 58.55′ E	3140			
25	12/02/2009 06:58	41° 16.19′ S	173° 38.41′ E	3322		Y	Y
26	12/02/2009 13:27	40° 49.47′ S	173° 19.53′ E	4171			
27	13/02/2009 01:27	40° 22.26′ S	173° 02.06′ E	4579		Y	Y
28	13/02/2009 08:06	39° 57.82′ S	172° 41.89′ E	4720			
29	13/02/2009 14:53	39° 30.86′ S	172° 25.42′ E	4758	Rosette Position 8 reserved for CFC blank test	Y	Y
30	13/02/2009 08:06	39° 05.01′ S	172° 07.55′ E	4840			
31	14/02/2009 05:52	38° 25.35′ S	171° 38.96′ E	4840	CAP crash near cast end.	Y	Y
32	14/02/2009 14:41	37° 45.90′ S	171° 10.99′ E	4640			
33	14/02/2009 21:14	37° 18.77′ S	170° 52.57′ E	5121		Y	Y
34	15/02/2009 04:06	36° 52.37′ S	170° 35.72′ E	5285	20mins delay due to winch problems. CAP crash – needed complete restart and bottle refires		

No	Start Date/Time (UTC)	Latitude	Longitude	Depth (m)	Comments	CFC	DIC
35	15/02/2009 11:31	36° 26.49′ S	170° 52.57′ E	5121		Y	Y
36	16/02/2009 18:38	36° 00.76′ S	169° 59.73′ E	5048			
37	16/02/2009 00:35	35° 40.62′ S	170° 00.76′ E	4342	12 XBTs dropped during CTD. New secondary T and C sensors fitted. Winch problems 1 hour into cast.	Y	Y
38	16/02/2009 06:14	35° 19.46′ S	169° 59.25′ E	4988	Changed sea-connectors between secondary T/C and main unit		
39	16/02/2009 12:06	35° 00.20′ S	170° 00.12′ E	5214		Y	Y
40	16/02/2009 19:20	34° 29.88′ S	170° 00.38′ E	5466			
41	17/02/2009 02:13	33° 59.78′ S	169° 59.78′ E	5516	Argo float deployment just before	Y	Y
42	17/02/2009 09:22	33° 29.82′ S	169° 59.88′ E	5396	No fresh nutrients		
43	17/02/2009 16:10	32° 59.43′ S	169° 59.27′ E	5447		Y	Y
44	17/02/2009 22:57	32° 29.95′ S	170° 00.00′ E	5518			P
45	18/02/2009 06:03	31° 59.94′ S	169° 59.10′ E	5644	Replaced bottle in RP 5.	Y	Y
46	18/02/2009 13:45	31° 29.16′ S	169° 58.68′ E	5560	UPS failed and crashed all acquisition systems. Downcast stopped for 1 hour at 2775db. Many underway logging systems were down for many hours it took to reboot all elements.		
47	18/02/2009 21:15	30° 59.94′ S	169° 58.38′ E	5592		Y	Y
48	19/02/2009 04:21	30° 29.88′ S	169° 59.61′ E	5518	Replaced bottle in RP 4.		P
49	19/02/2009 11:19	29° 59.43′ S	169° 59.43′ E	5399	Argo float deployment leaving the station	Y	Y
50	19/02/2009 18:28	28° 29.93′ S	169° 58.81′ E	5025			P
51	19/02/2009 01:19	29° 00.01′ S	170° 00.27′ E	5564	12 XBTs dropped during cast	Y	Y
52	20/02/2009 18:16	28° 30.51′ S	169° 58.28′ E	5432	Replaced bottle in RP 24.		P
53	20/02/2009 15:14	28° 00.30′ S	169° 59.48′ E	4829		Y	Y
54	20/02/2009 21:53	27° 29.96′ S	169° 59.10′ E	5367	12 XBTs dropped during cast		P
55	21/02/2009 05:11	26° 59.65′ S	169° 59.09′ E	5146		Y	Y
56	21/02/2009 12:06	26° 29.30′ S	169° 59.7′ E	5599			P
57	21/02/2009 19:30	26° 00.15′ S	169° 59.59′ E	5574	20 XBTs dropped during cast. Argo float deployed on leaving station	Y	Y
58	21/02/2009 19:30	26° 00.15′ S	169° 59.59′ E	5574	12 XBTs dropped during cast. No water samples. Rosette valves left open.		
59	22/02/2009 09:46	25° 00.47′ S	170° 00.05′ E	5618	Slow upcast due to poor lay on CTD winch	Y	Y
60	22/02/2009 17:11	24° 30.47′ S	170° 00.01′ E	5619	12 XBTs dropped during cast. Lanyards show severe wear on frame – many replaced	P	
61	23/02/2009 00:52	23° 58.90′ S	170° 00.29′ E	5628	Winch spooling knife changed	Y	Y
62	23/02/2009 08:10	23° 29.93′ S	170° 00.03′ E	5642			P
63	23/02/2009 14:28	22° 59.80′ S	170° 00.29′ E	5408	Slow upcast due to care needed to spool wire on correctly. Loud bang from winch – and brief free spool - reason unknown	Y	Y
64	23/02/2009 23:58	22° 29.28′ S	169° 59.94′ E	5672	23 XBTs dropped during cast. Changed to aft CTD winch.	P	
65	24/02/2009 0X:58	22° 09.28′ S	169° 59.94′ E	5	Last CTD on Leg 1..	Y	Y

Table 3: Information of Argo floats deployed on SS200901-leg2

Date/Time (GMT)	Position	other information	
Argo Float Hull No 2855	11/03/2009 03:00	168° 45'98'W 06° 29.28'S	Transmitting ok
Argo Float Hull No 2856	12/03/2009 07:40	168° 45.71'W 04° 29.24'S	Transmitting ok
Argo Float Hull No 2857	13/03/2009 1104	168° 46.37'E 02° 28.82'S	Transmitting ok
Argo Float Hull No 2861	14/03/2009 16:17	168° 44.41'E 0° 28.79'S	Transmitting ok

Table 4: Locations, times (UTC) and depths of CTD casts completed on Leg 2. Bottle oxygen, and major nutrient samples were analysed on all casts. Salinity samples were collected from 24 bottle for stations 66 to 73, after which a samples in the thermocline were not taken. The last two columns indicate chlorofluorocarbon and dissolved carbon/alkalinity sampling – Y indicates the full set of bottles were sampled, P indicates on a subset of bottles were sampled.

No	Start Date/Time (UTC)	Latitude	Longitude	Depth (m)	Comments	CFC	DIC
66	28/02/2009 15:16	21° 29.90'S	170° 00.00'E	5397	First Station of Leg 2.		P
67	28/02/2009 22:25	20° 58.46'S	169° 59.47'E	5650		Y	Y
68	01/03/2009 05:28	20° 29.44'S	170° 00.03'E	5584			P
69	01/03/2009 12:43	19° 59.79'S	170° 00.15'E	5315	Replaced secondary CTD cable prior to stations	Y	Y
70	01/03/2009 19:11	19° 29.90'S	170° 00.36'E	4899			P
71	02/03/2009 00:50	18° 59.74'S	170° 03.33'E	2942	8 XBTs dropped during cast.	Y	Y
72	02/03/2009 07:40	18° 30.02'S	170° 00.52'E	5247			P
73	02/03/2009 14:37	17° 59.10'S	170° 00.66'E	4971		Y	Y
74	02/03/2009 21:08	17° 30.54'S	170° 01.54'E	5092			P
75	03/03/2009 03:57	16° 59.31'S	170° 00.22'E	4949		Y	Y
76	03/03/2009 10:38	16° 29.04'S	170° 00.69'E	5057			P
77	03/03/2009 17:??	15° 59.04'S	170° 00.78'E	5122		Y	Y
78	04/03/2009 00:08	15° 30.04'S	170° 01.23'E	5068			P
79	04/03/2009 06:45	15° 00.21'S	170° 00.40'E	4809	12 XBT dropped during cast	Y	Y
80	04/03/2009 11:53	14° 39.09'S	169° 59.90'E	3150			P
81	04/03/2009 16:48	14° 17.11'S	170° 00.46'E	3546		Y	Y
82	04/03/2009 21:30	13° 58.19'S	170° 00.62'E	2738	CAP crashed during cast, restart via append		P
83	05/03/2009 01:21	13° 49.28'S	170° 00.69'E	4299		Y	Y
84	05/03/2009 06:49	13° 30.07'S	170° 00.52'E	4868			P
85	05/03/2009 13:26	12° 58.92'S	170° 00.80'E	4958		Y	Y
86	05/03/2009 19:45	12° 28.93'S	169° 59.66'E	4915			P
87	06/03/2009 02:14	11° 59.72'S	170° 01.08'E	5081	12 XBT dropped during cast	Y	Y

No	Start Date/Time (UTC)	Latitude	Longitude	Depth (m)	Comments	CFC	DIC
88	06/03/2009 0857	11° 29.56′S	170° 01.44′E	5039	Primary conductivity calibration coefficient change to Seabird cal report 18/01/07. Primary conductivity malfunctioned on approach to bottom. Use secondary sensors		P
89	06/03/2009 15:35	10° 59.74′S	170° 01.32′E	5106	Change primary conductivity sensor to serial no: 3311. Cal from Seabird report 18/01/07	Y	Y
90	06/03/2009 22:27	10° 29.83′S	170° 01.24′E	4982			P
91	07/03/2009 08:36	10° 08.13′S	168° 59.28′E	4617		Y	Y
92	07/03/2009 13:49	10° 02.96′S	169° 12.67′E	5193	Bottle 2 leaked – lanyard from bottle 1. Bottle 16 high temperature possible mistrip.		P
93	07/03/2009 20:01	09° 55.07′S	169° 38.49′E	5192	Bottle accidentally fired at 250dbar	Y	Y
94	08/03/2009 02:10	09° 46.00′S	170° 03.91′E	4550	Bottle 18 leaking. Replaced prior to next cast.		P
95	08/03/2009 07:07	09° 41.41′S	170° 19.56′E	4298	Bottle 18a - 12035	Y	Y
96	08/03/2009 12:04	09° 35.16′S	170° 36.25′E	4042			P
97	09/03/2009 00:56	09° 27..74′S	169° 00.47′E	5279	IR and bosun checked sheaf at beginning of cast. CAP crashed after firing bottle 24	Y	Y
98	09/03/2009 07:22	08° 59.16′S	168° 53.12′E	4771	Bottle 22 fired on the fly		P
99	09/03/2009 14:06	08° 28.73′S	168° 46.76′E	5156	Started CTD data acquisition just as CTD entered water. Bottle 22 fired between 170 and 110m	Y	Y
100	09/03/2009 18:54	08° 14.46′S	168° 42.76′E	4876			P
101	09/03/2009 23:59	07° 59.60′S	168° 37.79′E	4550		Y	Y
102	10/03/2009 05:11	07° 45.10′S	168° 41.04′E	4988	Secondary conductivity calibration change to CMAR 03/9/2007. Off-se tot primary larger than previous stations.		P
103	10/03/2009 10:45	07° 29.16′S	168° 45.45′E	5288		Y	Y
104	10/03/2009 17:38	06° 45.94′S	168° 45.92′E	5476	Changed secondary calibration coefficients to seabird 08/03/2006. Primary conductivity failed at 5500 on up-cast		P
105	11/03/2009 02:45	06° 29.72′S	168° 46.22′E	5670	First two attempts at cast aborted due to CTD and mechanical problems, respectively (see daily report)	Y	Y
106	11/03/2009 10:41	05° 59.38′S	168° 45.47′E	5634	Argo float - SIO SOLO 2855 deployed		P
107	11/03/2009 17:27	05° 29.87′S	168° 46.14′E	4988	Six pairs of XBT launched within 1n.m. of stations	Y	Y
108	12/03/2009 00:35	04° 59.97′S	168° 45.99′E	5543	Argo float - SIO SOLO 2856 deployed		P
109	12/03/2009 07:32	04° 29.72′S	168° 45.84′E	5485		Y	Y
110	12/03/2009 14:16	03° 59.16′S	168° 45.76′E	4987			P
111	12/03/2009 20:36	03° 29.06′S	168° 45.42′E	4981		Y	Y

No	Start Date/Time (UTC)	Latitude	Longitude	Depth (m)	Comments	CFC	DIC
112	13/03/2009 03:52	02° 59.50′S	168° 44.98′E	5341	6 pairs of XBT launched on station prior to CTD deployment		P
113	13/03/2009 10:54	02° 29.10′S	168° 46.39′E	5341	Argo float - SIO SOLO 2857 deployed	Y	Y
114	13/03/2009 18:46	01° 50.84′S	168° 44.85′E	5056			P
115	14/03/2009 02:33	01° 24.34′S	168° 44.66′E	6532	Stopped descent with 3 turn on 3rd layer of wire. Estimate less than 100m off bottom	Y	Y
116	14/03/2009 09:30	00° 58.54′S	168° 44.67′E	5672?	Hit bottom. No steady altimeter reading. EA500 not providing reliable depth.		P
117	14/03/2009 16:06	00° 29.15′S	168° 44.26′E	5428	Argo float – SIO SOLO 2861 deployed	Y	Y
118	14/03/2009 23:41	00° 00.96′N	168° 43.86′E	6532	6 pairs of XBT launched on station prior to CTD deployment. Last Station of P15S	Y	Y
119	19/03/2009 01:37	17° 30.05′S	170° 19.95′E	5232	Bottle 21 leaking, replaced. LADCP on rosette	Y	Y
120	19/03/2009 08:57	17° 30.43′S	171° 00:01′E	5084			P
121	19/03/2009 15:56	17° 29.02′S	171° 39:15′E	4902		Y	Y
122	19/03/2009 21:56	17° 29.52′S	172° 00:13′E	5698	Winch knife replaced at end of station	P	P
123	20/03/2009 03:52	17° 29.96′S	172° 19:50′E	7593	No LADCP interference on altimeter below approx. 5500m. LADCP stopped binging?	Y	Y
124	20/03/2009 09:30	17o 29.41	172o 41.34	4718		P	P
125	20/03/2009 14:24	17o 29.75	172o 50.27	4242		Y	Y
126	20/03/2009 17:29	17o 29.41	173o 00.60	2534		P	P
127	20/03/2009 23:12	17o 30.21	173o 40.92	1362		Y	Y
128	21/03/2009 04:28	17o 24.84	174o 20.02	1489	Last stations of 17.5 S across western boundary		P

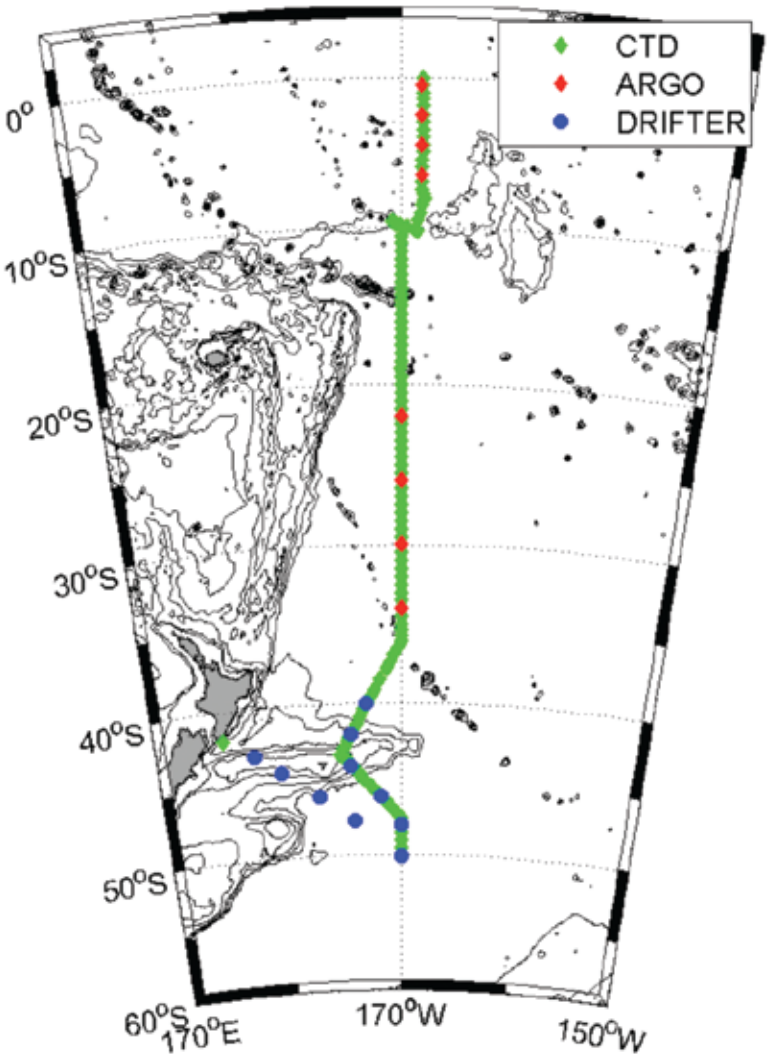


Figure 4. Location of CTD/rosette stations (green) and, deployment position of surface drifters (blue) and Argo floats (red) for leg 1 and leg2 of SS012009

GENERAL OCEAN AREA(S)

Southern Ocean and South Pacific Ocean.

PERSONNEL LIST

Scientific Participants

Leg 1 Scientific Participants

Name	Affiliation	Role
Susan Wijffels	CMAR	Chief Scientist
Ann Thresher	CMAR	Watch leader/CTD
Kail Stewart	ANU	CTD watch/ salt analysis
Hiski Kippo	CMAR	MNF Computing Support
Kate Berry	CMAR	Carbon Analysis
Alicia Navidad	CSIRO MNF – salary and sea-time paid by project	Nutrients
Fred Menzia	NOAA PMEL, USA	CFC Analysis
Nancy Williams	University of Washington, WA USA	CFC Analysis
Catia Domingues	CMAR	Watch leader/ CTD
Don McKenzie	CSIRO MNF	CTD watch/ MNF Voyage Manager
Peter Dunn	CSIRO MNF	MNF Electronics Support
Bronte Tilbrook	CMAR	Carbon Analysis
Peter Hughes	CSIRO MNF	MNF Hydrochemistry Support
Dave Terhell	CSIRO MNF	MNF Hydrochemistry Support

Leg 2 Scientific Participants

Name	Affiliation	Role
Bernadette Sloyan	CMAR	Chief Scientist
Rebecca Cowley	CMAR	Watch leader/CTD
Max Gonzalez	UNSW	CTD watch
Bernadette Heaney	CSIRO MNF	MNF Computing Support
Kate Berry	CMAR	Carbon Analysis
Alicia Navidad	CSIRO MNF – salary paid by project	Nutrients
Fred Menzia	NOAA PMEL, USA	CFC Analysis
Nancy Williams	University of Washington, WA USA	CFC Analysis
Mark Rosenberg	ACE CRC	Watch leader/ CTD
Clothilde Langlais	CMAR/UTAS QMS	CTD watch/ salts analysis
Drew Mills	CSIRO MNF	Voyage manager/MNF Electronics Support
Bronte Tilbrook	CMAR	Carbon Analysis
Peter Hughes	CSIRO MNF	MNF Hydrochemistry Support
Dave Terhell	CSIRO MNF	MNF Hydrochemistry Support

Marine Crew

Leg 1 Marine Crew

1. MASTER	LES MORROW
2. CHIEF OFFICER	JOHN BARR
3. 2ND OFFICER	ROB FERRIES
4. CHIEF ENGINEER	ROGER THOMAS
5. 1ST ENGINEER	ROB CAVE
6. 2ND ENGINEER	SEAMUS ELDER
7. BOSUN	TONY HEARNE
8. I.R.	JOHN HOWARD
9. I.R.	GARETH GUNN
10. I.R.	KEL LEWIS
11. I.R.	PAUL O'NEILL
12. CHIEF STEWARD	JOHN FABICS
13. CHIEF COOK	ANDY GOSS
14. 2ND COOK	LUKE RILEY

Leg 2 Marine Crew

15. MASTER	LES MORROW
16. CHIEF OFFICER	MICHAEL TUCK
17. 2ND OFFICER	JOHN BOYES
18. CHIEF ENGINEER	JOHN MORTON
19. 1ST ENGINEER	DAVE JONKER
20. 2ND ENGINEER	SEAMUS ELDER
21. BOSUN	TONY HEARNE
22. I.R.	STEVE SALTER
23. I.R.	GARETH GUNN
24. I.R.	KEL LEWIS
25. I.R.	PAUL O'NEILL
26. CHIEF STEWARD	ASHLEIGH POLLOCK
27. CHIEF COOK	ANDY GOSS
28. 2ND COOK	LUKE RILEY

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Bernadette Sloyan
Chief Scientist

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 Neuston
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