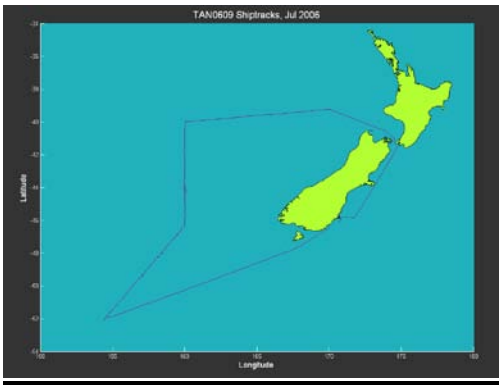
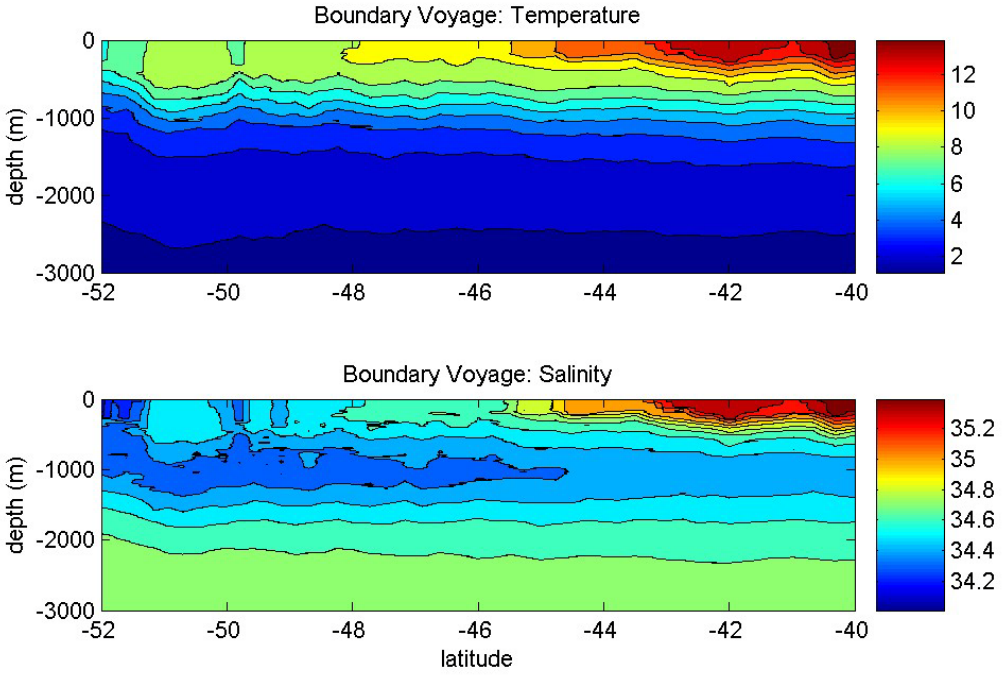
NIWA
Taihoro Nukurangi

Voyage Report
TAN0609
Tasman Boundary ConditionsVoyage

TANGAROA **12 July – 1 August 2006**





Temperature and salinity sections from the Boundary Conditions Voyage

CRUISE NUMBER: **TAN0609**

CRUISE NAME: Tasman Boundary Conditions

DEPARTED: 1500 12 July 2006

RETURNED: 1000 1 August 2006

LOCATION: Southeast Tasman Sea - largely a CTD transect running south along 160º E.

PERSONNEL:

Phil Sutton	Cruise Leader/CTD
Matt Walkington	CTD
Brett Grant	CTD/ADCP
Niki Davey	CTD
Stu Pickmere	Nutrients/Safety officer
Karen Thompson	Nutrients
Marieke Van Kooten	Nutrients
Scott Nodder	Deputy cruise leader /Particulates
Lisa Northcote	Particulates/Optics
Brian Smith	Particulates
Michael Ellwood	Metals
Luke Wallace	Metals
Dylan Ball	Metals
Kim Currie	CO_2 chemistry
Burns Macaskill	CO_2 chemistry
Andrew Marriner	Trace gases

BACKGROUND: One of the major aims of the Coasts and Oceans OBI is to build models of the New Zealand region incorporating nutrients and biology. The aim of this voyage is to support his endeavour by collecting data along the edge of the likely model domain in the Tasman Sea. This region is extremely poorly-sampled and yet is important as an inflow region, spanning the Subtropical Front and the Subantarctic Front.

OBJECTIVES: To conduct a CTD and ADCP survey of the south central Tasman Sea. The CTD and ADCP provided water property and current information. In addition, profiles of plankton, nutrients, particulates, CO_2, trace gases and pH were collected. Dedicated trace metal casts were carried out roughly twice per day. Underway measurements were also made of chlorophyll (fluorometer), temperature and salinity, dissolved CO_2 and trace gases. Underway measurements of nutrients were made for segments of the voyage: chiefly the long transits. Oceans optics casts and measurements were performed roughly once per day.

Voyage Records

Stations comprising:

- 51 CTD stations
- 20 trace metals casts
- 15 optics (SPMR + CTD) casts
- 12 Pico and bacterial casts

Plus:

Underway ADCP and thermosalinograph data
Underway pCO_2, pH and alkalinity
Underway and discrete water column trace gas (N_2O, CH_4) analyses
Underway trace metals (segments)
Underway optics.

Schedule and Operations: The research voyage track is shown in Appendix 1 and a narrative is given below.

Throughout the voyage, the ADCP was run to provide continuous upper ocean currents. Nutrient, chlorophyll and isotope samples were collected throughout the voyage along with continuous thermosalinograph data.

Voyage Narrative:

12/7/06 1800: Depart Wellington. Make passage for first station (Challenger Plateau)
13/7/06 Transit.
14/7/06 Transit to CP1.
0218: CP1. U4801.
0330: Trace metal cast. U4801b.
Transit to T1.
15/7/06 Transit to T1.
1037: Trace metal cast. (39° 44.29'S, 163° 31.08'E)
16/7/06 0226: T1. U4802. U4802b.
0532: Trace metal cast @ T1. U4802c.
0759: T2. U4803.
1055: Towfish. U4803b.
1251: T3. U4804.
1426: SPMR @ T3. U4804b.
1450: Trace metal cast @ T3. U4804c.
1700: T4. U4805.
2148: T5. U4806.
17/7/06 0132: T6. U4807.
0619: T7. U4808.
0828: Trace metal cast @ T7. U4808b.
1050: T8. U4809.
1330: SPMR @ T8. U4809b.
1334: Trace metal cast @ T8. U4809c.
1552: T9. U4810.
1738: Towfish. U4810b
1907: T10. U4811.
2313: T11. U4812.

18/7/06	0225: T12. U4813.
	0653: T13. U4814.
	0902: Trace metal cast. U4814b.
	1141: T14. U4815
	1429: SPMR @ T14. U4815b.
	1600: stop operations because of sea conditions.
19/7/06	dodging sea conditions.
20/7/06	0626: T15. U4816.
	1040: T16. U4817.
	1400: SPMR @ T16. U4817b.
	1425: Trace metal cast @T16. U4817c.
	1833: T17. U4818.
	2237: T18. U4819.
21/7/06	0618: T19. U4820.
	0817: Towfish @ T19. U4820b.
	1022: T20. U4821.
	1322: SPMR @ T20. U4821b.
	1342: Trace metal cast @ T20. U4821c.
	1638: T21. U4822.
	2049: T22. U4823.
	CTDs T1/09-T1/12
22/7/06	0126: T23. U4824.
	0606: T24. U4825.
	0956: Trace metal cast @ T24. U4825b.
	1405: T25. U4826.
	1610: SPMR @ T25. U4826b.
	1627: Trace metal cast @ T25. U4826c.
	2048: T26. U4827.
23/7/06	0316: T27. U4828.
	0947: T28. U4829.
	1257: SPMR @ T28. U4829b.
	1319: Trace metal cast @ T28. U4829c.
	1749: T29. U4830.
	2316: T30. U4831.
24/7/06	0650: T31. U4832.
	0911: Trace metal cast @ T31. U4832b.
	1304: SPMR @ T32. U4833.
	1322: T32. U4833b.
	1611: Trace metal cast @ T32. U4833c.
	2033: T33. U4834.
25/7/06	0034: T34. U4835.
	0539: T35. U4836.
	0942: T36. U4837.
	1215: SPMR @ T36. U4837b.
	1233: Trace metal cast @ T36. U4837c.
	1530: T37. U4838.
	1930: T38. U4839.
	2338: T39. U4840.
26/7/06	0325: T40. U4841.
	0802: T41. U4842.

	1005: Trace metal cast @ T41. U4842b.
	1305: SPMR @ T42. U4843.
	1321: T42. U4843b.
	1541: Trace metal cast @ T42. U4843c.
	1814: T43. U4844.
	2153: T44. U4845.
27/7/06	0141: T45. U4846.
	0512: T46. U4847.
	0916: T47. U4848.
	1106: Trace metal cast @ T47. U4848b
	1216: SPMR @ T47. U4848c.
	1403: SPMR @ T48. U4849.
	1417: T48. U4849b.
	1637: Trace metal cast @ T48. U4849c.
	1710: Towfish. U4849d.
28/7/06	1400: SPMR. U4850.
29/7/06	Transit.
30/7/06	1208: SPMR. U4851.
	2025: Munida Inshore. U4852.
	2334: Munida. U4853.
31/7/06	1222: SPMR. U5854.
01/8/06	1000: Dock Wellington.

Preliminary Results and Equipment Performance

1. CTD and thermosalinograph
2. ADCP
3. Pico and bacterial
4. Water column biogeochemical parameters
5. pCO_2, pH and alkalinity
6. Underway and discrete water column trace gas (N_2O, CH_4) analyses
7. Trace Metals
8. Optics

1). CTD and thermosalinograph (Matt Walkington)

Operational procedures associated with the Seabird Electronics Inc. (SBE) 911plus/SBE 32-based CTD/Carousel water sampler were nominal. Performance appeared nominal. Exceptions were:

1) Altimeter (Datasonics PSA900D sonar altimeter)
   Performance was inconsistent.

2) No sea-bottom landings
   No sea-bottom landings were noted in the logsheets.

3) u4802
   u4802 cast 1 was aborted at 1000 m due to extreme salinity spiking with no

associated dissolved-oxygen (DO) spiking. The cause was separation of the sensor duct at the inlet to the dissolved-oxygen sensor. For u4802 cast 2, performance was nominal.

4) Consistent no-closing at water-sampler positions 9 and 17.
   Apparent throughout entire dataset.
5) Water-sampler position 2
   The water-sampling bottle at water-sampler position 2 was noted in the logsheets as leaking on many occasions.
6) Occasional no-closing at other water-sampler positions (often probably due to mis-setting)
   Apparent throughout entire dataset.

Operational procedures associated with the measurement of salinity water samples by the Guildline Instruments AUTOSAL 8400B salinometer were nominal. There appeared to be some performance issue relative to the expected high level of accuracy and precision (see Comparison: Water-sample Salinity -vs- CTD Primary Salinity, below). However, the accuracy, precision and stability of the dual temperature and conductivity sensors means it is possible to avoid propagating any degradation in accuracy and precision into the final CTD dataset (see Comparison: CTD Primary Temperature -vs- CTD Secondary Temperature and Comparison: CTD Primary Salinity -vs- CTD Secondary Salinity, below). The exact cause of this performance issue requires further investigation. It has not been reproduced in subsequent datasets.

Operational procedures associated with the measurement of dissolved oxygen water samples with the SIO-based dissolved oxygen titrator were nominal. Performance appeared nominal.

Comparison: CTD Primary Temperature -vs- CTD Secondary Temperature

u4801 at 10 m: 0.000 +/- 0.002
u4801 at 600 m: 0.001 +/- 0.001
u4818 at 10 m: 0.000 +/- 0.001
u4818 at 2500 m: 0.001 +/- 0.001
u4835 at 10 m: 0.001 +/- 0.001
u4835 at 4500 m: 0.001 +/- 0.001
u4850 at 10 m: 0.001 +/- 0.001
u4850 at 1000 m: 0.000 +/- 0.001

Comparison: CTD Primary Salinity -vs- CTD Secondary Salinity

u4801 at 10 m: - 0.007 +/- 0.002
u4801 at 600 m: -0.008 +/- 0.001
u4818 at 10 m: -0.008 +/- 0.001
u4818 at 2500 m: -0.008 +/- 0.001
u4835 at 10 m: -0.008 +/- 0.001
u4835 at 4500 m: -0.007 +/- 0.001
u4850 at 10 m: -0.008 +/- 0.001
u4850 at 1000 m: -0.007 +/- 0.001

Comparison: Water-sample Salinity -vs- CTD Primary Salinity

Over the entire dataset:
Mean residual salinity (CTD - water sample): -0.0068
RMS residual salinity (CTD - water sample): 0.0051
Total number of samples: 194
Total number flagged good: 170
Total number flagged bad: 24
% flagged bad: 12%

2). ADCP (Brett Grant)

Ocean velocity observations were recorded by NIWA's 150 kHz Broadband Acoustic Doppler Current Profiler (ADCP), which is mounted on the Hull of RV Tangaroa. Acquisition began immediately after leaving Port Nicholson on 12th July. A bin size of eight meters was used to attain the greatest depth coverage possible, appropriate for the large depths of ocean that this voyage covered. Data collection was checked regularly throughout the voyage and data was backed up on a 12 hourly basis. Upon return to Wellington, the data was processed using the CODAS package provided by the University of Hawaii.

The ADCP had mixed performance during this voyage. There were two instances during the voyage where data was irretrievably lost; once due to a failure of the POSMV system (causing ~ 2 hours data loss) and the other due to a file-write problem with the ADCP PC (causing ~ 4 hours data loss). It is thought that the latter was due to a file being backed up whilst the PC was trying to write to it (as it was a one-off event, having not been noted in recent operation of the equipment).

Due to the weather on this voyage, a larger-than-usual proportion of the data was contaminated and therefore had to be edited out. This was largely due to the heavy swells and associated bubbles in the near-surface layer being swept under the hull of *RV Tangaroa*, and past the transducer heads. This meant that at times, readings of the upper 1-4 bins were influenced by the orientation/heading of the ship. There were a few instances where the weather was so bad that the entire profile of data was corrupted.

Yet another issue on this voyage that affected the quality of ADCP data, was that of CTD wire interference. On a number of occasions throughout the voyage, a layer approximately 30m thick at around 80m depth seemed to show spuriously large velocity fields. By later correlating the timing of these events and matching them with stations on the voyage, it was found that they only occurred when the CTD was in the water (but not at every CTD station). This suggests that whether or not the ADCP was interfered with depended on the orientation of the ship – as the ship tends to sit with the CTD in the lee of the wind, it can drift over the package meaning that the CTD and/or the connecting wire fall underneath the ADCP beams. These "shear zones" were edited out during processing.

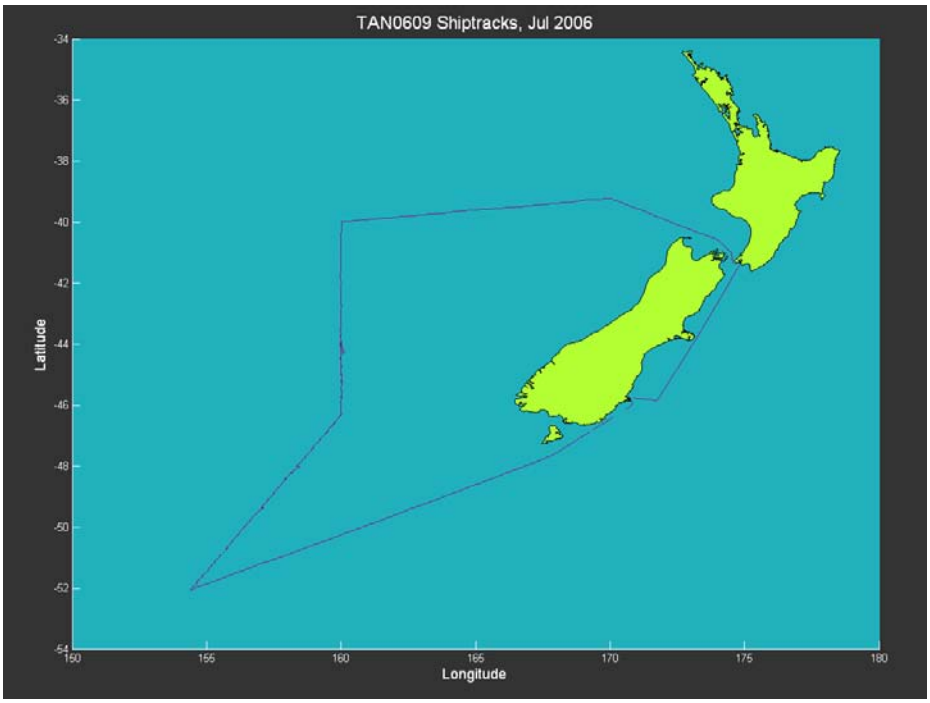


Figure 1: Tan0609 Shiptrack

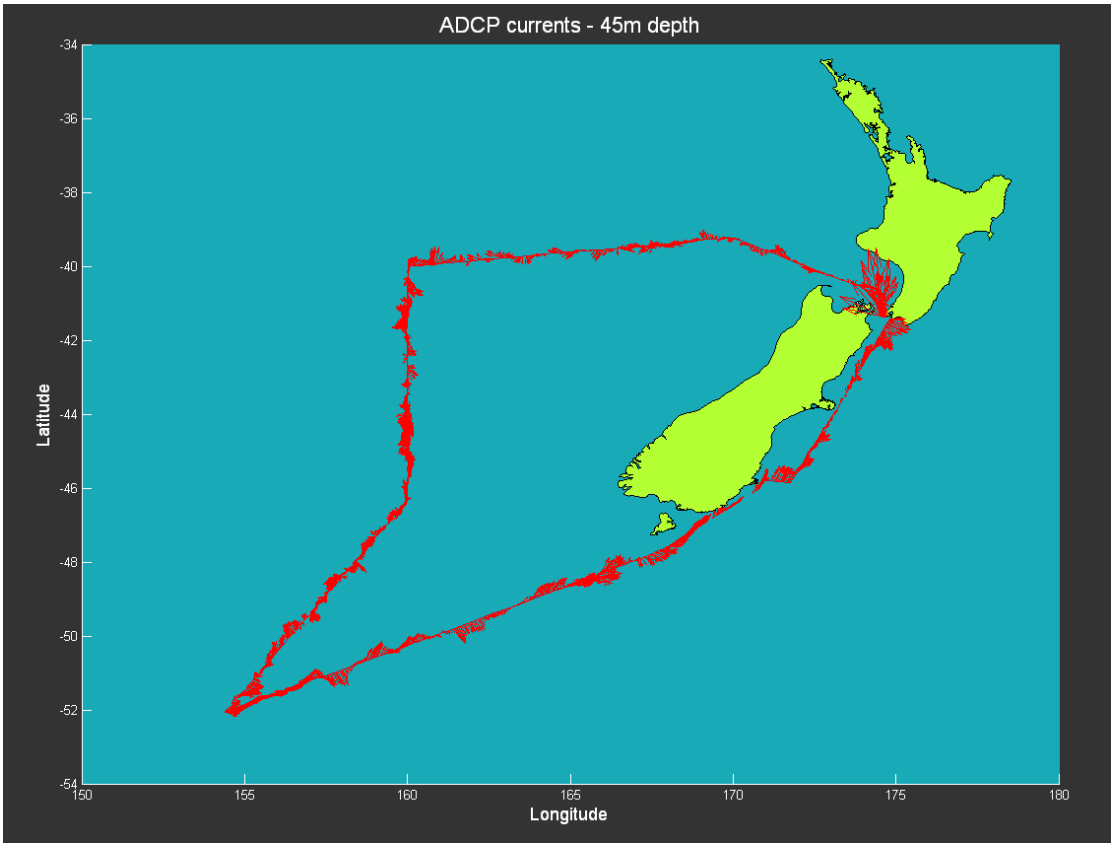


Figure 2: ADCP vectors

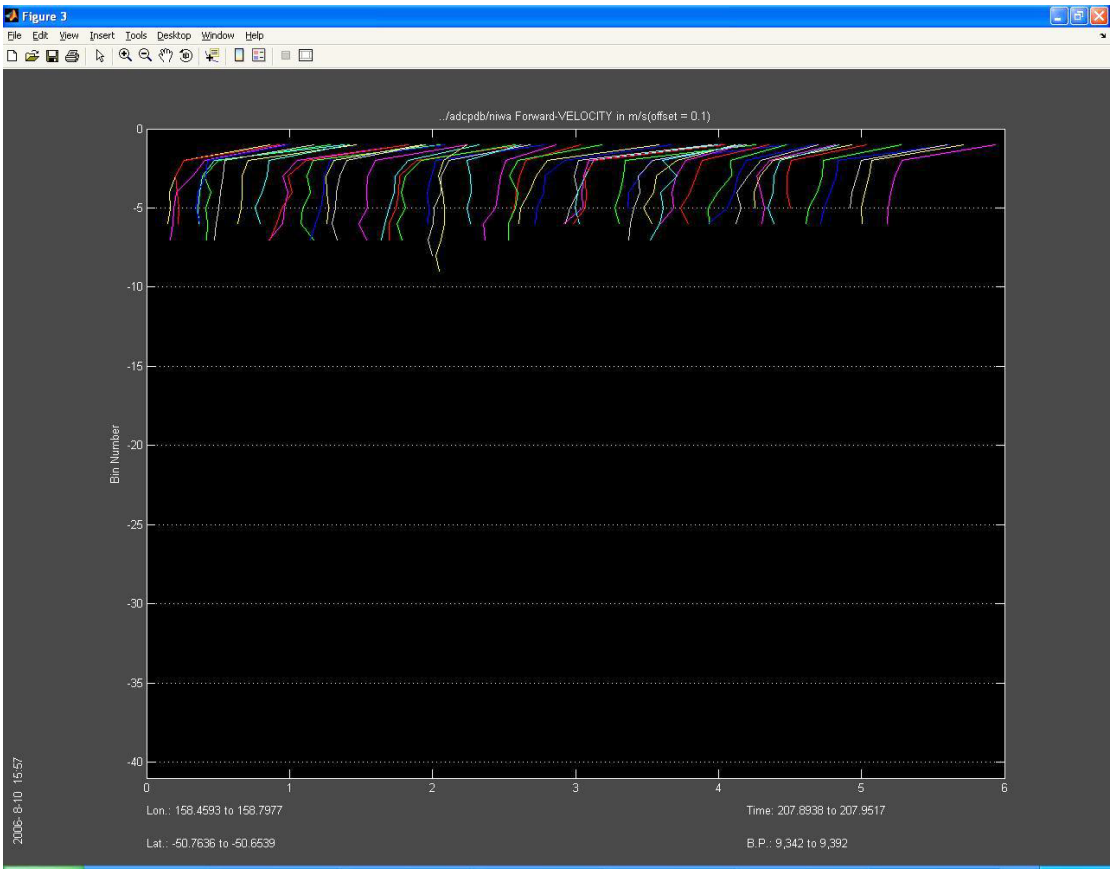


Figure 1: Contaminated data in the upper bins caused by bad weather - bubbles passing under the transducers.

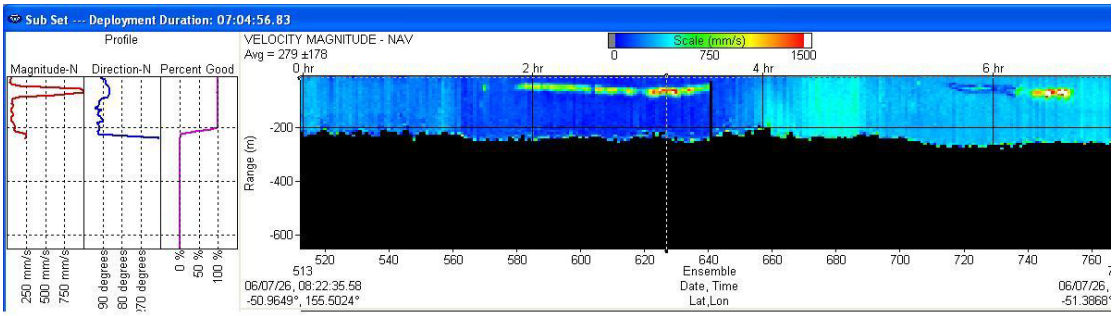


Figure 2: Spurious velocities caused by CTD interference

3). Pico and bacterial summary (Karen Thompson)

Site	Station	Approximate Depth (m)	Average Bacteria Events/mL	Average (Procaryotic Picoplankton) Synechococcus Events/mL	Average Eucaryotic Picoplankton Events/mL
T4	U4805	100m	474,371	9,058	15,936
		50m	476,011	8,927	19,226
		30m	370,921	9,269	19,299
		5m	493,105	10,244	18,369
T8	U4809	100m	454,962	7,082	10,070
		50m	280,766	7,825	14,113
		30m	476,818	6,524	14,954
		5m	312,167	7,502	16,149
T12	U4813	100m	432,325	12,248	11,827
		50m	372,472	17,040	19,845
		30m	609,784	16,103	23,658
		5m	475,413	13,449	22,498
T16	U4817	100m	365,766	4,681	13,762
		50m	363,103	3,386	12,791
		30m	326,983	2,398	12,391
		5m	328,283	3,979	15,311
T20	U4821	100m	382,794	8,575	8,163
		50m	377,316	9,336	11,970
		30m	422,214	8,986	14,961
		5m	450,406	8,941	11,176
T24	U4825	100m	399,960	11,048	7,181
		50m	429,607	11,757	10,434
		30m	431,156	10,719	10,860
		5m	373,288	11,947	9,040
T28	U4829	100m	288,731	7,390	5,643
		50m	293,355	6,954	9,189
		30m	288,639	5,564	5,183
		5m	264,548	6,506	6,517
T32	U4833	100m	258,288	2,644	7,860
		50m	244,186	2,685	9,280
		30m	209,671	2,920	7,143
		5m	223,999	2,642	7,837
T36	U4837	100m	206,732	1,173	8,514
		50m	196,058	1,010	6,299
		30m	190,754	2,724	6,013
		5m	222,941	2,845	7,207
T40	U4841	100m	233,292	831	3,306
		50m	198,052	1,050	4,296
		30m	211,073	1,236	4,208
		5m	209,514	957	3,992
T44	U4845	100m	199,538	945	3,914
		50m	215,642	1,054	2,674
		30m	209,820	1,396	2,564
		5m	198,002	1,277	2,563
T48	U4849	100m	214,595	933	4,268

		50m	234,806	1,291	7,767
		30m	223,920	990	8,767
		5m	213,602	1,029	12,614

4). Water column biogeochemical parameters (particulates and nutrients) (Scott Nodder)

CTD casts alternated between full water column (~4500-5000m water depth) to shallower, mid-water column profiles (~3000m). Seawater from 10 litre Niskin bottles on the CTD-rosette was transferred immediately into acid-cleaned, DIW-washed 10 litre carboys via acid-cleaned Tygon tubing.

Particulate organic carbon and nitrogen (POCPN) and nutrient samples were collected at every sample depth on each CTD cast conducted along the central Tasman Sea transect. On every 2nd 3000m CTD cast duplicate samples at all depths were run. For POCPN, 1 litre samples were filtered through pre-combusted (400°C for 8 hrs), 25mm-diameter GFF filters, rinsed with 4ml of 0.1 N H_2SO_4 acid and filtered seawater (0.2µm), folded in half and placed in Secol envelopes and then snap frozen in liquid nitrogen or placed immediately in a -20°C freezer.

Samples for nutrient analyses were collected from the filtrate of POCPN filtrations. Samples were analysed onboard for NO_3+NO_2 ("nitrate"), dissolved reactive phosphorus (DRP), dissolved reactive silica (DRSi) and ammonium (NH_4) using the Astoria Pacific API300 nutrient auto-analyser.

A similar sampling strategy, as for POCPN, was adopted for chlorophyll *a* (Chl *a*), except that only 500ml samples were filtered and only from six depths in the upper 200m of the water column. Chl *a* samples were filtered through 25mm-diameter GFF filters, rinsed with filtered seawater (0.2µm), folded in half and placed in Secol envelopes and then snap frozen in liquid nitrogen. In addition, size-fractionated, surface Chl *a* samples (0-5m water depths) were collected at a total of twelve sites. Size-fractions were >20µm, 2-20µm (1 litre) and <2µm (500ml), obtained using a tower set-up and polycarbonate membrane filters (Nuclepore, Osmosis).

Particulate phosphorus and nitrogen (PPPN) were collected at 13 sample depths on every 5000m CTD cast and 10 depths on every 3000m CTD cast conducted along the central Tasman Sea transect. On every 2nd 3000m CTD cast duplicate samples were run from 10 depths. For PPPN, 1 litre samples were filtered through pre-combusted, acid-washed (10% HCl), DIW-rinsed, 25mm-diameter GFF filters, rinsed with filtered seawater (0.2µm), folded in half and placed in Secol envelopes and then snap frozen in liquid nitrogen or placed immediately in a -20°C freezer.

Particulate silica (PSi) samples were collected at the same sample depths as PPPN on every 2nd 5000m CTD cast conducted along the central Tasman Sea transect. No duplicate samples were run. For PSi samples, 1 litre samples were filtered through 0.8µm, 25mm-diameter polycarbonate membrane filters (Nuclepore, Osmosis), rinsed with filtered seawater (0.2µm), folded and placed in cryo-vials and then snap frozen in liquid nitrogen or placed immediately in a -20°C freezer.

In addition, dissolved organic carbon (DOC) samples were collected at from 10 depths on every 2nd 5000m CTD cast conducted along the central Tasman Sea transect. 50ml of seawater was taken directly from the Niskin bottle (after trace gas sampling), filtered in-line through a pre-combusted, 47mm-diameter GFF filters into a pre-combusted Schott bottle, sealed and stored frozen (-20°C).

On every 2nd 5000m CTD cast conducted along the central Tasman Sea transect, 1 litre of seawater from four depths in the upper 100m was collected for phytoplankton and microzooplankton identifications and poisoned with 10ml of Lugol's iodine solution. Prior to adding Lugol's, duplicate 2ml samples were taken for later picophytoplankton and bacteria sample analysis using flow cytometry. These flow cytometry samples were stored in liquid nitrogen.

At three selected stations, full water column profiles of $\delta^{18}O$ and ^{14}C were collected on behalf of Dr Helen Neil (NIWA) in nominally subtropical, Subtropical Front and subantarctic waters. This sampling involved taking seawater directly from the Niskin bottles (without tubing) into 100ml glass, screw-cap, rectangular bottles for $\delta^{18}O$ and 1000ml Schott bottles with mercuric chloride added for ^{14}C. Samples were stored in a cool, dark place (Chem lab).

Full water column duplicate nutrient and Chl *a* samples were also collected at a 625m deep station (U4801) in central Challenger Plateau for Dr Vanessa Sherlock (NIWA) and on the last station at the end of the Munida transect off Otago Peninsula (U4850) for Dr Kim Currie (NIWA). Underway nutrient and duplicate Chl *a* samples were also collected along the Munida transect.

A malfunction of the underway sampling valve meant that limited underway nutrients were collected by discreet samples at approximately 30 minute intervals while the vessel was in transit across the Challenger Plateau to the start of the central Tasman Sea transect, and along the Munida line ((~45°50'S, U4850).

No underway fluorometry data were collected on TAN0609 due to flooding of the unit on the second day of the voyage.

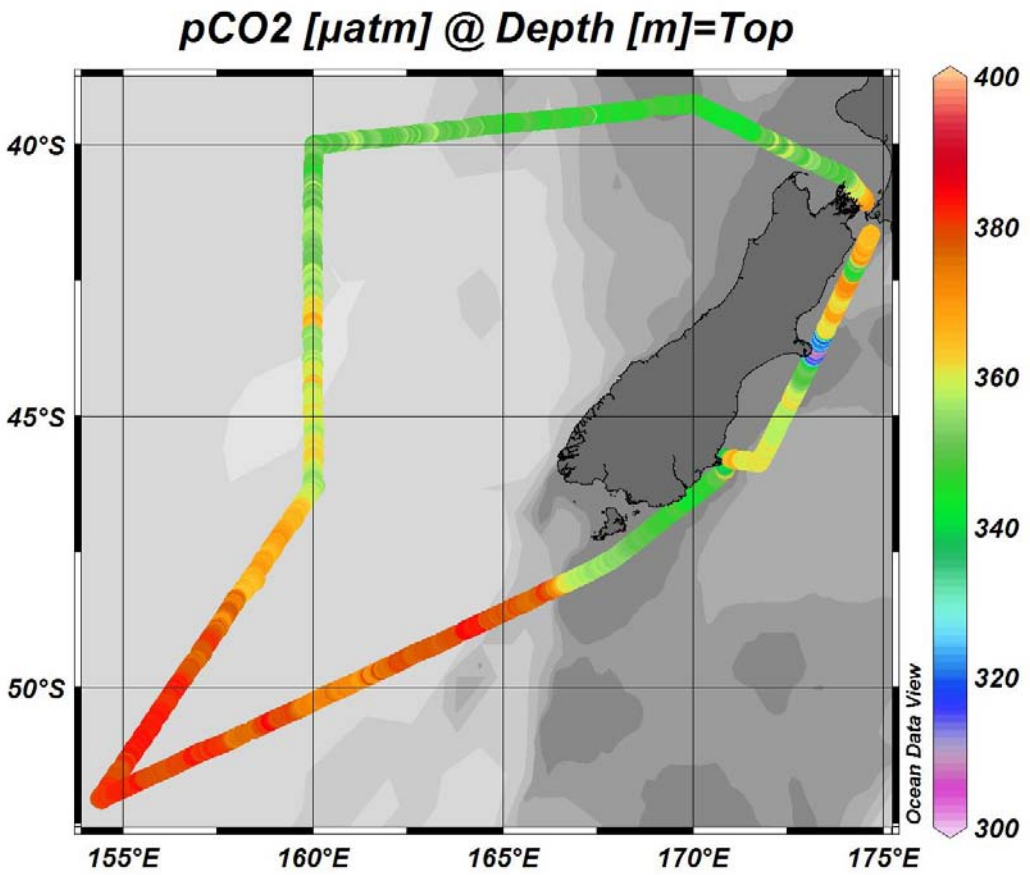
NIWA sample lab identifications for POCPN, nutrients, Chl *a*, DOC, picophytoplankton, bacteria and microzooplankton samples ranged from EJ6 to EJ499 (stations U4802-U4832) and EJ1501 to 1772 (U4832-U4849). For PPPN, PSi, Chl *a* and size-fractionated Chl *a*, sample IDs were EJ500 to EJ1075 (U4802-U4849). For the nutrient and Chl *a* samples from Challenger Plateau (U4801), samples were designated EJ1-EJ5 while for the Munida transect and the station at the end of that transect (U4850), the following EJ numbers were used for nutrient and Chl *a* samples: EJ1076-1088.

5). pCO_2, pH and alkalinity (Kim Currie)

pCO_2 and pH in the surface water were measured continuously throughout the voyage, water was taken from the scientific supply, and no sign of contamination was detected. The seawater was equilibrated with a closed air loop, and the carbon dioxide concentration (pCO_2) measured using an infrared gas analyser. pH was analysed using a stop flow spectrophotometric method with cresol blue dye.

pCO_2 in the subtropical waters of the Tasman Sea was undersaturated with respect to the atmosphere, with values of 340 – 350 µatm. pCO_2 increased by 30 - 40 µatm to 380 µatm in the subantarctic surface waters . A pCO_2 minimum was observed at the Mernoo Gap, with values as low as 310 uatm.

Alkalinity and pH were measured on discrete samples taken from throughout the water column on every second deep cast (approximately). Alkalinity was measured on board, in a closed cell by potentiometic titration. Discrete pH was measured using a spectrophotometric method. Samples for the determination of CT, (the concentration of dissolved inorganic carbon, DIC) were collected from seven deep casts, for later shore-based analysis, using an acidification / coulometirc detection method. All systems performed well, no problems were encountered.



6). Underway and discrete water column trace gas (N_2O, CH_4) analyses (Andrew Marriner)

Underway nitrous oxide and methane data were collected in surface waters and atmospheric samples each at 5 minute intervals throughout the transit to and from the Tasman line. This was achieved using an automated system with air samples pumped down from the mast, and surface water continuously pumped through a spiral jet equilibrator. The equilibrator headspace was continuously cycled through two sample loops, which were injected onto chromatographic columns with subsequent analysis of nitrous oxide by ECD-GC and methane by FID-GC.

The new scientific surface water supply functioned well and showed no signs of trace gas contamination. However due to weather conditions (wind and waves on the starboard quarter and boat heeling to port) the scientific supply strainer was prone to air build up which in turn air-locked our pump which was pumping from the top of the strainer and stopped the sea water flow to our equilibrator. This particularly affected the transect from Wellington to the Challenger Plateau, with the underway system being shutdown over night. Fred installed a dip tube into the strainer and this reduced the rate of air bubble build up but the pump still needed to be bled occasionally to release any air in rough seas.

Transect surface trace gas data sets:
Wellington heads to Challenger Plateau:
12 July 06: 1940 to 2135,
12 July 06: 2141 to 2245, Pump flow problems
12 July 06: 2251 to 2349, Switched to scientific supply, then off overnight
Back to new pump:13 July 06: 0813 to 14 July 0814, 3 water flow off occurrences
(Ships scientific supply turned off from 1030 to 1100 for installation of dip tube
Pump on from 1100 to start of underway, flow OK)
Challenger Plateau to Tasman Line:
14 July 06: 1653 to 14 July 2005, water flow dying, system off overnight
15 July 06: 0908 to 16 July 0403,
Tasman line to Munida line:
27 July 06: 1726 to 28 July 1341, underway system stopped to run profile samples
28 July 06: 2019 to 30 July 2325,
Munida to Wellington:
31 July 06: 0418 to 1 August 0511

Vertical profiles of both trace gases were taken at the Challenger station, along the Tasman line and at the Munida station. On the 16th of July repair of a heater sensor fault on the ECD resulted in contamination of the ECD, and this was not resolved until 20th of July. In the meantime surface samples were collected and poisoned along the Tasman line. The failure resulted in the loss of around 4 trace gas profile stations at the start of the Tasman line. Trace gas profiles were analysed on board on the following stations:
Challenger Plateau: U4801
Tasman Line (13 depths): U4803, U4817, U4821, U4825, U4829, U4832, U4833, U4837, U4841, U4847, U4849
Munida: U4850

We are extremely grateful to the engineers, thanks to Fred for his help with the pump sea water supply and Alan for his help with the ECD, 1st mate Alex for his help with the fax and satellite phone and Cliff Law for his support and assistance with the ECD.
.

Highlights of the trace gas work included:-

Good extended underway data sets for previously unmapped region of the EEZ
11 vertical profile stations along the Tasman line
Elevated surface methane plume off the north east corner of the South Island.
At-sea repair of the heating unit and contamination of the ECD

7). Trace Metals (Michael Elwood)

Water samples were collected for metals analysis using the trace metal rosette system purchased in 2005/6. Of the 20 casts attempted 12 were successful. In addition to profile samples, surface trace metal samplers were collected using the torpedo fish system. These samples are currently awaiting analysis. The results from this voyage will aid in understanding metal concentrations in the waters to the west of NZ and their association with plankton productivity.

In addition to the trace metal samples, 12 deep-water profiles collected using the standard rosette system on Tangaroa were collected and archived. These samples have been shipped to Australia for analysis. One profile has been analysed for germanium (figure 1). The other samples are slated for analysis in the near future.

To complement the water samples collected, plankton samples were also collected during the voyage. The aim is to see whether there is any relationship between the metal content of the plankton and in the water in which they grew. Analysis of these samples will begin in the near future.

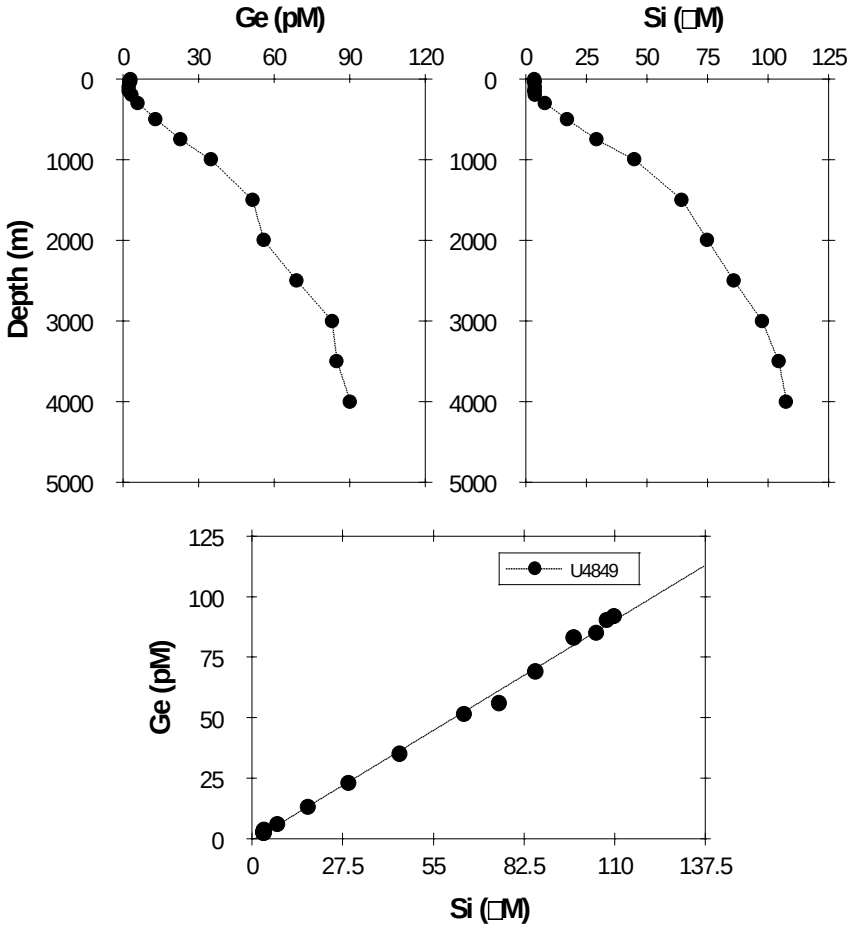


Figure 1. Germanium and silicon results versus depth. Germanium versus silicon concentration.

8). Optics (Lisa Northcote)

a) Station work

Full optical sampling was carried out at fifteen stations: At each station, 3 casts of the SPMR, to ~100m, 60 m, 60 m were carried out.

At 8 optics stations, the ship CTD was used to collect surface (2–10 m) water sample for analysis (2x10 litre rosette bottles). Water from the scientific underway supply, located in the fish factory was used for the remaining 7 optics stations. As well as after optical casts, water was filtered twice daily in duplicate, using the underway supply. The samples were processed for:

- Fluorometric chlorophyll-a concentration (duplicate: Hamilton lab)
- HPLC phytoplankton pigment concentrations (duplicate: Mark Gall, Chch)
- Particulate absorption by filter-paper method "PABS" (duplicate: Mark Gall, Chch)
- Total suspended matter gravimetric concentration on 0.4 μm 47 mm polycarbonate filters (duplicate: Lisa Northcote, Well)
- Dissolved organic matter absorption (duplicate: laboratory spectrophotometric analysis, Mark Gall, Chch)

The frozen samples were stored in liquid nitrogen, while the CDOM samples were refrigerated.

b) Underway work

a) AC9 underway measurements

The AC9 was set up in the Tangaroa fish-factory to measure the absorption and attenuation of water on a continuous basis through the voyage. Measurements were made for close to 24 h per day for all days of the voyage. These data will be of significant value for the validation of inherent optical properties derived from satellite ocean data observations in New Zealand open ocean waters.

The CTD of the AC9 was installed downstream of the AC9 on the flow-through supply. This data will be compared with the ship's standard thermosalinograph record from the voyage. Location data will be taken from the ship DAS system, which incorporates GPS. Data will be merged on time. Checks were made of the drift of the PC clock.

The AC9 was cleaned and an air calibration carried out approximately daily. No contamination was observed visually. It is likely that cleaning is necessary only once every 2–3 days in New Zealand oceanic water in winter.

b) Incident irradiance

Incident irradiance was measured continuously between dawn and dusk during the voyage by the Satlantic reference sensor.

Health and Safety
No incidents.

Acknowledgements:
The voyage was very successful thanks to efforts of everyone involved. In particular, I would like to acknowledge the efforts of the master and crew of Tangaroa and the vessel company in dealing with a complicated mobilisation very efficiently, thereby enabling us to sail on the evening of our mobilisation day. The crew of Tangaroa were, as always, helpful and professional and all of the deck work was carried out perfectly. The science party also performed up to high expectations.

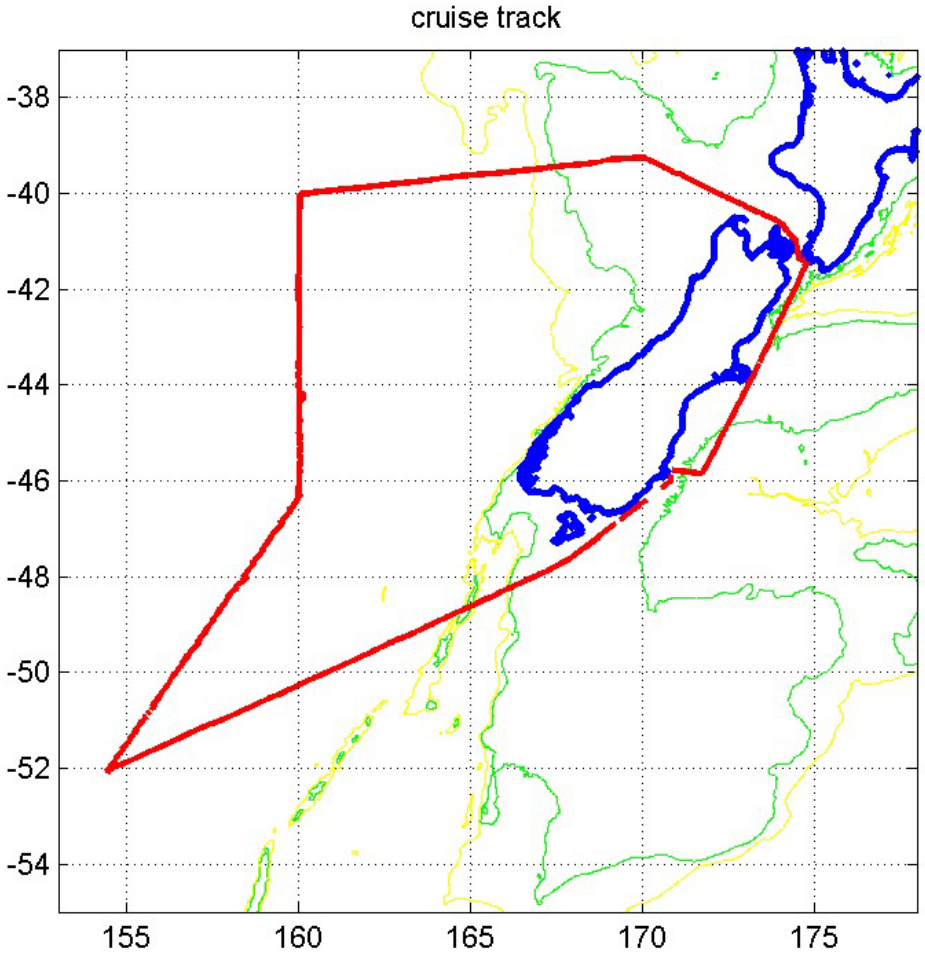
Appendices

A1 Voyage Track

A2 CTD Station Positions Log

A3 Trace metals Positions Log.

Appendix A1: Voyage Track



Appendix A2: CTD Station Positions Log:

stn	cast	lat	lon	date	time	sounder depth	min ctd press	max ctd press
u4801	1	-39 14.93	170 03.20	14-Jul-2006	02:11	623	0	628
u4802	1	-39 59.87	160 01.94	16-Jul-2006	02:21	4955	2	1100
u4802	2	-39 59.89	160 01.83	16-Jul-2006	03:18	4955	2	3050
u4803	1	-40 18.85	160 01.25	16-Jul-2006	07:55	4755	0	4840
u4804	1	-40 39.94	160 00.17	16-Jul-2006	12:49	NaN	2	3048
u4805	1	-40 58.24	160 00.25	16-Jul-2006	16:56	4687	2	4970
u4806	1	-41 19.94	160 00.26	16-Jul-2006	21:47	4916	2	3048
u4807	1	-41 39.86	160 00.05	17-Jul-2006	01:29	4834	2	4928
u4808	1	-41 59.81	160 00.60	17-Jul-2006	06:16	NaN	2	3048
u4809	1	-42 14.42	160 00.27	17-Jul-2006	10:48	NaN	4	4948
u4810	1	-42 29.77	160 00.10	17-Jul-2006	15:45	4794	0	3052
u4811	1	-42 44.35	160 00.55	17-Jul-2006	19:04	4968	2	5056
u4812	1	-42 59.74	160 00.05	17-Jul-2006	23:12	4923	2	3050
u4813	1	-43 14.86	160 00.13	18-Jul-2006	02:21	5019	0	5112
u4814	1	-43 29.95	159 59.83	18-Jul-2006	06:49	5081	0	3050
u4815	1	-43 45.04	160 00.00	18-Jul-2006	11:40	4954	0	5038
u4816	1	-44 00.23	159 59.76	20-Jul-2006	06:24	5188	2	3050
u4817	1	-44 16.01	160 00.05	20-Jul-2006	10:38	5085	8	5198
u4818	1	-44 30.63	159 58.65	20-Jul-2006	18:27	5050	2	3050
u4819	1	-44 45.87	160 00.96	20-Jul-2006	22:36	4930	4	5004
u4820	1	-45 00.86	160 00.13	21-Jul-2006	06:16	4986	0	3048
u4821	1	-45 15.68	160 00.13	21-Jul-2006	10:20	4949	0	5048
u4822	1	-45 30.08	159 59.91	21-Jul-2006	16:35	5010	4	3050
u4823	1	-45 46.11	159 59.48	21-Jul-2006	20:47	5027	2	5112
u4824	1	-46 00.24	159 58.81	22-Jul-2006	01:23	5022	0	3050
u4825	1	-46 20.26	159 58.74	22-Jul-2006	06:02	4988	2	5088
u4826	1	-46 36.65	159 42.66	22-Jul-2006	14:01	4937	0	3050
u4827	1	-46 53.47	159 26.42	22-Jul-2006	20:46	4940	2	5020
u4828	1	-47 09.82	159 10.05	23-Jul-2006	03:11	4940	0	3052
u4829	1	-47 27.05	158 52.85	23-Jul-2006	09:46	4717	6	4772
u4830	1	-47 43.37	158 38.20	23-Jul-2006	17:46	4949	2	3048
u4831	1	-48 00.89	158 20.31	23-Jul-2006	23:14	4850	4	5030
u4832	1	-48 13.46	158 07.79	24-Jul-2006	06:48	4794	4	3048
u4833	1	-48 27.08	157 53.87	24-Jul-2006	13:17	4798	2	4886
u4834	1	-48 41.77	157 41.08	24-Jul-2006	20:32	4031	4	3052
u4835	1	-48 54.58	157 28.58	25-Jul-2006	00:31	4685	2	4768
u4836	1	-49 07.74	157 15.36	25-Jul-2006	05:36	4406	2	3052
u4837	1	-49 22.43	157 01.25	25-Jul-2006	09:40	4528	2	4620
u4838	1	-49 34.49	156 49.25	25-Jul-2006	15:28	4678	4	3050
u4839	1	-49 47.97	156 35.94	25-Jul-2006	19:27	4709	0	4826
u4840	1	-50 01.29	156 22.66	25-Jul-2006	23:37	4514	2	3050
u4841	1	-50 15.10	156 09.49	26-Jul-2006	03:21	4571	0	4644
u4842	1	-50 28.50	155 56.34	26-Jul-2006	08:00	4745	2	3050
u4843	1	-50 42.02	155 43.10	26-Jul-2006	13:18	4406	2	4468
u4844	1	-50 55.61	155 29.91	26-Jul-2006	18:12	4597	2	3050
u4845	1	-51 08.98	155 16.57	26-Jul-2006	21:52	4490	20	4584
u4846	1	-51 22.67	155 03.14	27-Jul-2006	01:41	4278	2	3056
u4847	1	-51 35.97	154 49.79	27-Jul-2006	05:09	4429	0	4460
u4848	1	-51 49.52	154 36.33	27-Jul-2006	09:15	4474	2	3052
u4849	1	-52 02.94	154 23.62	27-Jul-2006	14:14	4338	2	4394
u4850	1	-45 50.07	171 29.87	30-Jul-2006	23:33	1276	0	1228

Appendix A3:Trace metals Positions Log:

Date	time	Lat S	Long E	CTD no#	Cast	Rosette Bottle	Depth
15/07/2006	10.37am	39 44.29	163 31.08		1	12	30
						11	50
						10	70
						9	90
						8	110
						7	130
						6	150
						5	170
						4	190
						3	210
						2	230
						1	250
16/07/2006	5am	39 59.55	160 01.59	U4802	2	12	30
						11	60
						10	80
						9	100
						8	150
						7	200
						6	250
						5	300
						4	350
						3	400
						2	450
						1	500
16/07/2006	11.30am	40 26.23	160 00.03				surface
16/07/2006	2pm	40 40.83	160 59.86	U4805	3	12	30
						11	60
						10	80
						9	100
						8	150
						7	200
						6	250
						5	300
						4	350
						3	400
						2	450
						1	500
17/07/2006	1.40pm	42 16.25	159 59.57	U4810	4	12	30
						11	60
						10	80
						9	100
						8	150
						7	200
						6	250
						5	300
						4	350
						3	400
						2	450
						1	500
17/07/2006	6.03 pm	42 34.43	159 59.44				surface
18/07/2006	8.30am	43 29.07	159 58.11	U4814	5	12	30

								11	60
								10	100
								9	150
								8	200
								7	300
								6	450
								5	600
								4	750
								3	900
								2	1050
								1	1200
21/07/2006	8.40am	45	01.52	160	0053				surface
21/07/2006	1.30pm	45	12.78	160	02.37	U4821	6	12	30
								11	60
								10	80
								9	100
								8	150
								7	200
								6	250
								5	300
								4	350
								3	400
								2	450
								1	500
22/07/2006	4pm	46	35.03	159	46.34	U4826	7	12	30
								11	60
								10	80
								9	100
								8	150
								7	200
								6	250
								5	300
								4	350
								3	400
								2	450
								1	500
23/07/2006	1.30pm	47	25.12	158	57.38	U4829	8	12	30
								11	60
								10	100
								9	200
								8	300
								7	400
								6	500
								5	600
								4	700
								3	800
								2	900
								1	1000
24/07/2006	9am	48	12.66	158	12.05	U4832	9	12	30
								11	60
								10	80
								9	100
								8	150
								7	200

							6	250
							5	300
							4	350
							3	400
							2	450
							1	500
25/07/2006	12.30pm	49	22.01	157	05.46	U4837	10	12	30
								11	60
								10	100
								9	200
								8	300
								7	400
								6	500
								5	600
								4	700
								3	800
								2	900
								1	1000
26/07/2006	3.10pm	50	41.55	155	46.43	U4843	11	12	30
								11	60
								10	80
								9	100
								8	150
								7	200
								6	250
								5	300
								4	350
								3	400
								2	450
								1	500
27/07/2006	4.30pm	52	03.875	154	25.42	U4849	12	12	30
								11	60
								10	80
								9	100
								8	150
								7	200
								6	250
								5	300
								4	350
								3	400
								2	450
								1	500
27/07/2006	6.30pm	51	55.39	154	49.033				surface
27/07/2006	11.35pm	51	31.30	156	03.05				surface
28/07/2006	6.10am	51	00.45	157	41.59				surface
28/07/2006	12.20pm	50	31.34	159	11.54				surface
28/07/2006	5.50 pm	50	07.25	160	24.51				surface
29/07/2006	12am	49	40.26	161	48.44				surface
29/07/2006	6.00 am	49	13.37	163	11.19				surface