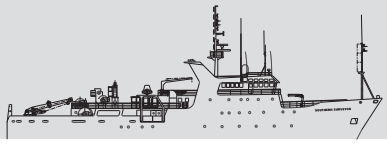


MARINE
NATIONAL FACILITY

2009 program

RV *Southern Surveyor*

voyageplan
SS1-2009

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

Itinerary

Mobilise Wellington, New Zealand 0800hrs 2 February 2009
Depart Wellington, New Zealand 1000hrs 3 February 2009
Arrive Nuku'alofa, Tonga 0800hrs 26 February 2009, resupply and science crew change over
Depart Nuku'alofa, Tonga 1600hrs 26 February 2009
Arrive Suva, Fiji 0800hrs 24 March 2009 and demobilise

Principal Investigators

Dr. Bernadette Sloyan, Chief Scientist (Leg 2)
– CSIRO Marine and Atmospheric Research, GPO Box 1538, Hobart 7001
Email: bernadette.sloyan@csiro.au **Phone:** (03) 6232 5152

Dr Susan Wiffjels, Alternative Chief Scientist (Leg 1
– CSIRO Marine and Atmospheric Research, GPO Box 1538, Hobart, 7001
Email: susan.wijffels@csiro.au **Phone:** (03) 6232 5450

Dr. Bronte Tilbrook, CSIRO Marine and Atmospheric Research

CSIRO

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.

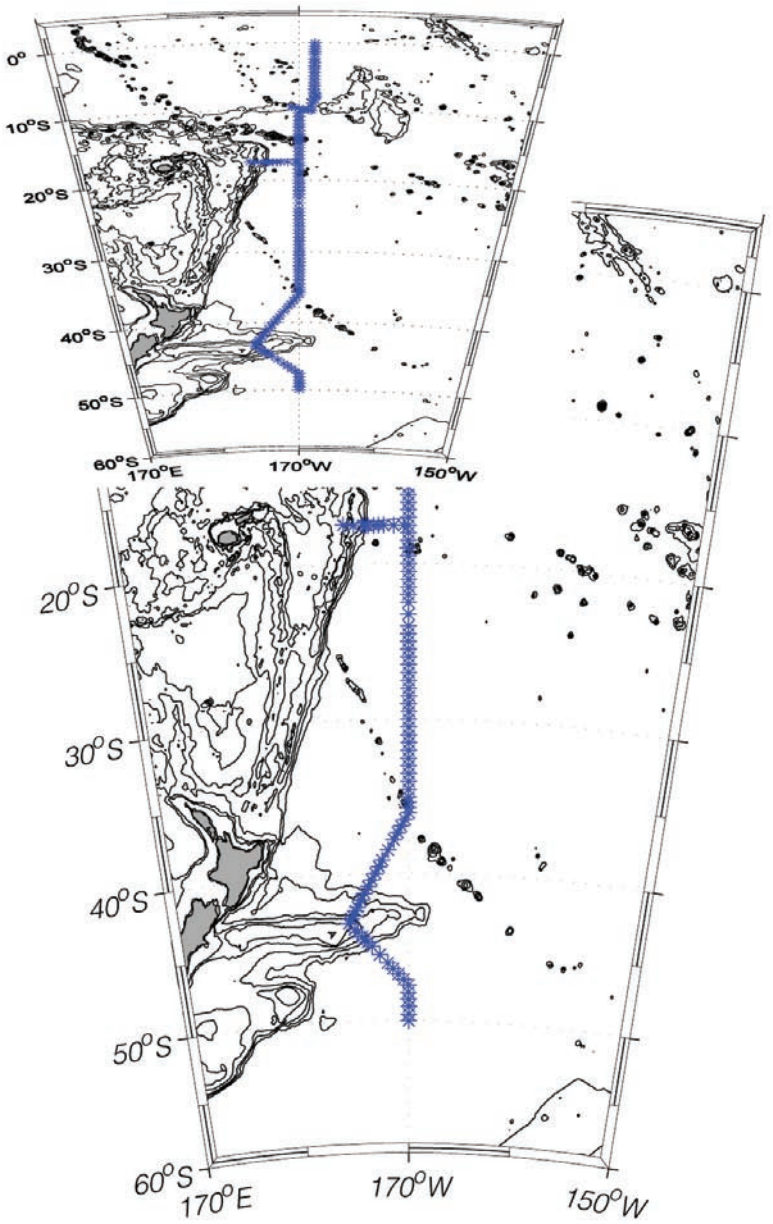
Voyage Objectives

The voyage objectives will be met by undertaking 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.

Water samples (24 per cast) collected by niskin bottles at discrete depth in the water column, 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 PMEL and the University of Washington we will be able to measure chlorofluorocarbons (CFCs) concentrations.

In addition to the standard rosette, shipboard ADCP will deliver underway direct estimate of velocity data along the voyage track. At the direction of the Chief Scientist the CTD/Rosette will be reconfigured during the voyage to include the LADCP for full water column velocity profiles.

Figure 1: Station position of CTD/ Rosette casts for SS01/2009. The voyage will be divided into two legs with port call at Nuku'alofa, Tonga. See Figure 2 and 3 for details of leg1 and leg2.



Time Estimates

Time estimates based on a streaming speed of 10 knots.

LEG 1

Leave Wellington, and upon reaching waters > 2000m,
carry out a CTD test station on day 1.

Total number of CTD stations completed: 64

Total number of surface drifter and Argo float deployments: 14

Transit to first station (50S): 3 days, 11hr

Transit plus Science steaming time: 12 days, 8 hr (steaming between stations)

Science station time: 9 days, 16hr

Weather time: 1 day

Transit last station to Nuku'alofa: 1 day 6 hrs

TOTAL TIME LEG 1: 22days 23 hrs

PORT CALL: Nuku'alofa 0800hrs to 1600hrs

LEG 2

Transit Nuku'alofa to first station (21.5S): 1 day, 6hrs

Total number of CTD stations completed: 63

Total number of Argo float deployments: 4

Transit plus Science steaming time: 14 days, 14hr (steaming between stations)

Science station time: 9 days, 20hr

Weather time: 0 day 12 hr

Transit last station to Suva: 1 day 18 hrs

TOTAL TIME LEG 2 : 24 days 22 hrs

Piggy-back Projects

The CTD watch will be responsible for these activities. The bridge will be consulted a few days in advance of each of these activities

1) Deployment of 8 Argo floats – these will be in international waters or in the waters of nations that have given concurrence to deployment of Argo floats and will be released over the ship's side during the CTD cast, not adding any additional time to the voyage. Floats will undergo transmission tests on the fantail a few days before deployment. Four Australia Argo floats have already been loaded aboard the ship. Four US Argo floats (Scripps Institution of Oceanography) will be loaded on the ship in Wellington. Information about the Argo program can be found at www.argo.net or www.imos.org.au. Ann.Thresher@csiro.au is coordinating the float deployments. Approximate locations for float deployments are indicated in the activity tables below.

2) Deployment of 10 surface drifting buoys for marine meteorology on behalf of the Australian Bureau of Meteorology. Deployments are quick and simple and will be carried out underway between stations. Drifters will be loaded on the ship in Wellington prior to the transit leg. Ann. Thresher@csiro.au is coordinating the float deployments

3) XBT/CTD intercomparison measurements. Recent analyses suggest that XBT fallrates are changing with manufacturing practices at the XBT factory. Thus, ongoing depth calibrations against CTD casts are required. On this cruise we will aim to drop about 12-15 XBT probes during a CTD cast roughly every 5° of latitude, pending suitable weather. Thus we will do intercomparisons during only 11 out of the total of 129 CTD stations. The XBT probes will be loaded in Sydney before the transit leg to Wellington, New Zealand. Ann.Thresher@csiro.au and Susan.Wijffels@csiro.au is coordinating the XBT intercomparisons

Southern Surveyor Equipment

Simrad EK 500 for bottom detection
ADCP – shipboard
Hydrochemistry Lab
Wet Lab
CTD/hydro winches with 6500m of wire
Acoustic Pinger
Altimeter
CTD (Seabird SBE 911plus, and spares)
Rosette 24 bottle 10 litre, and spare part and replacement bottles
Dissolved Oxygen sensor
Lowered ADCP
Milli-Q water supply

User Equipment

DIC/alkalinity measurement equipment supplied by Dr. Bronte Tilbrook (CMAR) and;
CFC laboratory container supplied by John Bullister PMEL/NOAA, Seattle WA. USA

Personnel List

List all scientific participants, their affiliation and position on the voyage.

Leg 1

Susan Wijffels	CMAR	Chief Scientist
Kail Stewart	ANU	CTD watch stander
Catia Domingues	CMAR	CTD watch stander
Ann Thresher	CMAR	CTD watch stander
Don McKenzie	CSIRO MNF	CTD watch stander/Voyage Manager
Nancy Williams	PMEL, USA	CFC chemist
Fred Menzia	PMEL, USA	CFC chemist
Kate Berry	CMAR	DIC chemist
Bronte Tilbrook	CMAR	DIC chemist
Peter Hughes	CMAR	Hydrochemist
Pete Dunn	CMAR/MNF	MNF Electronics Support
Hiski Kippo	CMAR/MNF	MNF Computing support
Dave Terhell	CMAR/MNF	MNF Hydrochemistry Support
Alicia Navidad	CMAR/MNF	MNF Hydrochemistry Support

Leg 2

Bernadette Sloyan	CMAR	Chief Scientist
Maxwell Gonzalez	UNSW	CTD watch stander
Mark Rosenberg	ACE CRC	CTD watch stander
Clothilde Langlais	CMAR/UTAS	CTD watch stander
Rebecca Cowley	CMAR	CTD watch stander
Kate Berry	CMAR	DIC chemist
John Akl	CMAR	DIC chemist
Fred Menzia	PMEL, USA	CFC chemist
Nancy Williams	PMEL, USA	CFC chemist
Peter Hughes	CMAR	Hydrochemist
Drew Mills	CMAR/MNF	MNF Voyage Manager/Electronics Support
Bernadette Heaney	CMAR/MNF	MNF Computing Support
Alicia Navidad	CMAR/MNF	MNF Hydrochemistry Support
Dave Terhell	CMAR/MNF	MNF Hydrochemistry Support

There are 14 personnel in the science party for both leg 1 and leg 2.

As per AMSA requirements for additional berths on Southern Surveyor, the following personnel are designated as System Support Technicians and are required to carry their original AMSA medical and AMSA Certificate of Safety Training on the voyage:

Name	**AMSA Certificate of Safety Training No.**
Drew Mills	AS02348
Pete Dunn	AS03164
Hiski Kippo	AS02377
Bernadette Heaney	AS02397
Alicia Navidad	AS04836
Dave Terhell	AS02843
Don McKenzie	AS02764

This voyage plan is in accordance with the directions of the Marine National Facility Steering Committee for the Research Vessel Southern Surveyor.

Bernadette Sloyan
Chief Scientist

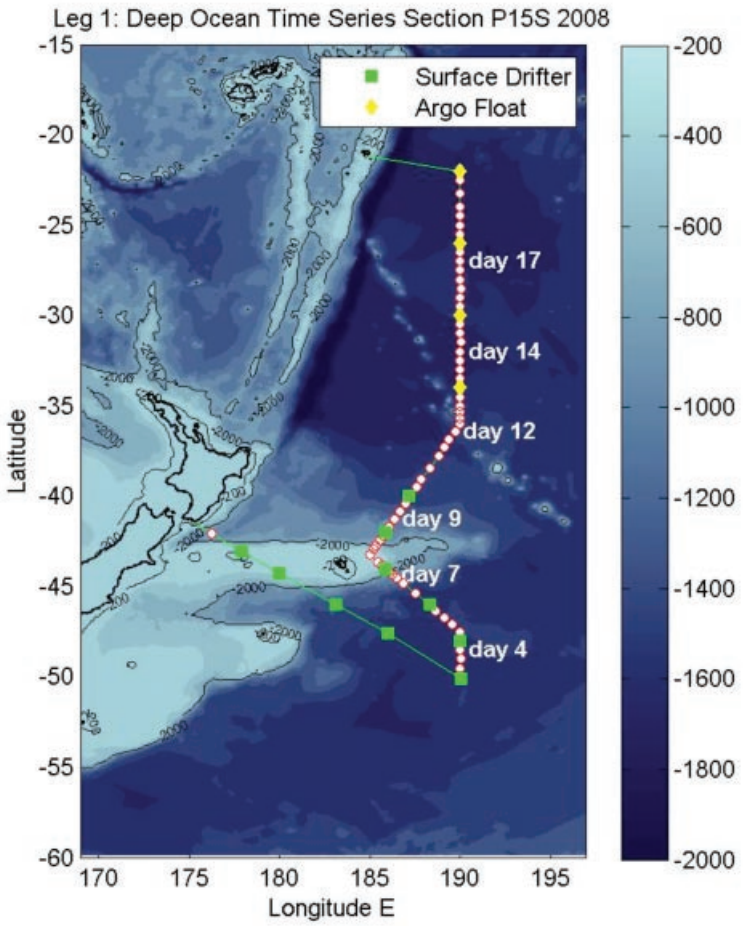


Figure 2: Map of Leg 1. Starting port Wellington and end port Nuku'alofa. Hydrographic stations will be occupied between 50S and 23S. Ten surface drifters will be deployed (green squares) and 4 Argo floats (yellow diamonds).

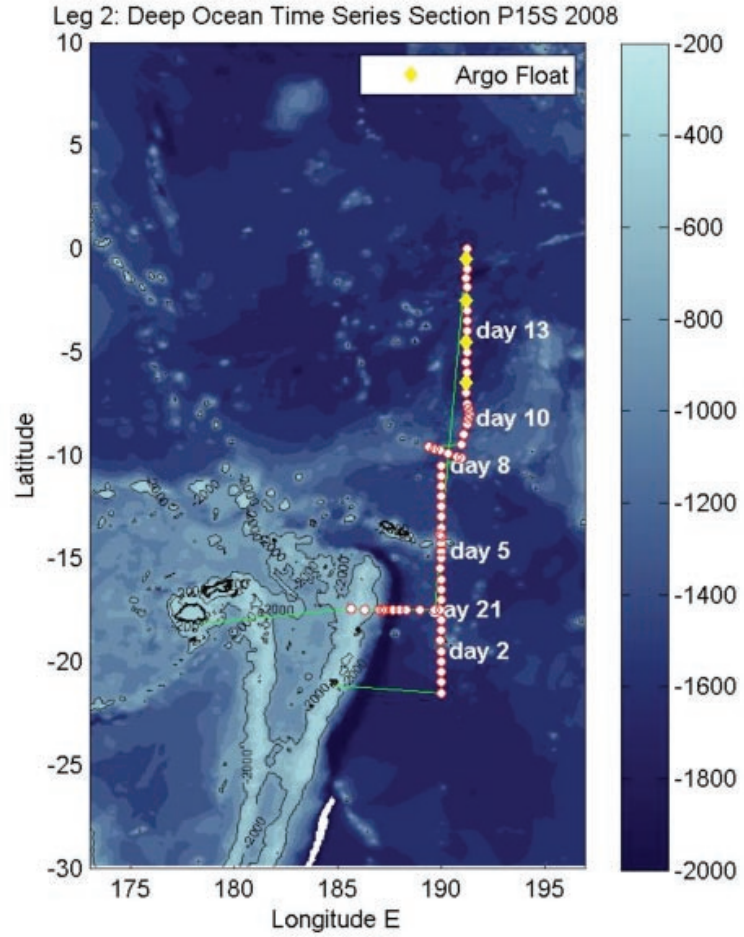


Figure 2: Map of Leg 2. Starting port Nuku'alofa and end port Suva. Hydrographic stations will be occupied between end of Leg1 and the equator. Station at 17S between 170W and 176W will be complete if time permits. Four Argo floats will be deployed.

ACTIVITY PLAN, POSITIONS AND ESTIMATED FINISH TIME FOR LEG 1

CTD No	Position		Depth(m)	ETD Port/Station
Wellington	175.229	-41.455		2009/ 2/ 3 10: 0: 0
1	176.260	-42.059	2500	2009/ 2/ 3 15:52: 2 TEST STATION
Drifter 1	177.940	-43.050		2009/ 2/ 4 3:40:16
Drifter 2	180.020	-44.290		2009/ 2/ 4 15:32: 8
Drifter 3	183.110	-46.010		2009/ 2/ 5 8:21:35
Drifter 4	185.980	-47.600		2009/ 2/ 5 23:41:25
Drifter 5	190.040	-50.070		2009/ 2/ 6 21:41:28
2	190.000	-50.000	5200	2009/ 2/ 6 22:18:19
3	190.005	-49.522	5200	2009/ 2/ 7 5: 2:21
4	190.030	-48.992	5207	2009/ 2/ 7 12: 5:16
5	189.995	-48.497	5292	2009/ 2/ 7 18:55:48
6	189.959	-48.003	3495	2009/ 2/ 8 1:49: 5
Drifter 6	190.000	-48.000		2009/ 2/ 8 4:51:14
7	189.995	-47.500	3503	2009/ 2/ 8 8: 1:10
8	189.567	-47.102	5360	2009/ 2/ 8 13:51: 4
9	189.107	-46.725	5277	2009/ 2/ 8 20:45:19
10	188.643	-46.347	5356	2009/ 2/ 9 3:38:13
Drifter 7	188.310	-46.000		2009/ 2/ 9 10: 5:43
11	188.195	-45.951	5077	2009/ 2/ 9 10:49:26
12	187.529	-45.388	4872	2009/ 2/ 9 19: 0:12
13	186.875	-44.828	3853	2009/ 2/10 3: 1:51
14	186.509	-44.531	3415	2009/ 2/10 8:28:53
15	186.250	-44.326	3113	2009/ 2/10 12:57:53
16	186.059	-44.158	1918	2009/ 2/10 16:54:45
Drifter 8	185.870	-44.000		2009/ 2/10 20: 6:55
17	185.703	-43.852	817	2009/ 2/10 21:25:28
18	185.464	-43.648	797	2009/ 2/11 0:31:37
19	184.999	-43.252	795	2009/ 2/11 5: 9:11
20	185.211	-42.930	1066	2009/ 2/11 8:47:52
21	185.342	-42.746	1597	2009/ 2/11 11:32:20
22	185.598	-42.405	2675	2009/ 2/11 15:38:38
23	185.749	-42.166	2874	2009/ 2/11 19:37:22
Drifter 9	185.910	-42.000		2009/ 2/11 23:21:29
24	186.056	-41.713	3138	2009/ 2/12 1:22: 3
25	186.358	-41.268	3329	2009/ 2/12 7: 1:29
26	186.673	-40.824	4175	2009/ 2/12 12:49:20
27	186.978	-40.396	4575	2009/ 2/12 19: 0:38
Drifter 10	187.150	-40.000		2009/ 2/13 1: 0:55
28	187.298	-39.965	4722	2009/ 2/13 1:53:44
29	187.576	-39.516	4756	2009/ 2/13 8:28: 6
30	187.872	-39.086	4832	2009/ 2/13 14:59:58
31	188.351	-38.424	4925	2009/ 2/13 23:12:33
32	188.815	-37.766	4613	2009/ 2/14 7:25:58
33	189.125	-37.314	5117	2009/ 2/14 14: 2:39
34	189.406	-36.874	5288	2009/ 2/14 20:49:33
35	189.721	-36.443	5164	2009/ 2/15 3:44:26
36	190.005	-36.012	5047	2009/ 2/15 10:30:46
37	189.988	-35.677	4343	2009/ 2/15 16:18: 4
38	190.011	-35.328	4970	2009/ 2/15 21:46: 2
39	189.996	-35.004	5211	2009/ 2/16 3:26:51
40	189.994	-34.499	5465	2009/ 2/16 10:20:55
Argo 1	190.000	-34.000		2009/ 2/16 17:21:46
41	190.005	-33.996	5512	2009/ 2/16 17:33:57
42	190.003	-33.499	5193	2009/ 2/17 0:35:47
43	190.011	-32.993	5460	2009/ 2/17 7:29:36
44	189.999	-32.502	5499	2009/ 2/17 14:27:19
45	190.017	-32.000	5643	2009/ 2/17 21:30:54
46	190.024	-31.487	5532	2009/ 2/18 4:43: 3
47	190.011	-30.997	5600	2009/ 2/18 11:43:11
48	190.007	-30.498	5513	2009/ 2/18 18:48:34
Argo 2	190.000	-30.000		2009/ 2/19 1:50:53
49	190.010	-29.996	5398	2009/ 2/19 2: 4:14

50	190.018	-29.499	5255	2009/ 2/19 9: 1:55
51	189.993	-28.999	5561	2009/ 2/19 15:55:55
52	190.030	-28.509	5431	2009/ 2/19 22:57:27
53	190.009	-28.005	4773	2009/ 2/20 5:59: 7
54	190.016	-27.496	5393	2009/ 2/20 12:39:16
55	190.015	-26.994	5142	2009/ 2/20 19:38:44
56	190.009	-26.489	5597	2009/ 2/21 2:30:37
Argo 3	190.000	-26.000		2009/ 2/21 9:32:36
57	190.006	-26.000	5565	2009/ 2/21 9:44:35
58	189.997	-25.500	5788	2009/ 2/21 16:49:16
59	190.000	-25.000	5593	2009/ 2/22 0: 1:50
60	189.983	-24.501	5622	2009/ 2/22 7: 7:12
61	189.996	-23.981	5683	2009/ 2/22 14:21:12
62	189.995	-23.249	5688	2009/ 2/22 22:53:48
63	190.000	-22.489	5671	2009/ 2/23 7:36:28
Argo 4	190.000	-22.000		2009/ 2/23 14:40:57
64	189.982	-21.993	5591	2009/ 2/23 14:57:18
Tonga	184.800	-21.133		2009/ 2/25 0:25:28

Number of CTD stations is 64
Number of other deployments is 14
Total ctd time is 9.4098 days
Total distance is 2925.9046 nm
Time at 10 knots is 12.1913 days
Total cruise time is 21.601 days

ACTIVITY PLAN, POSITIONS AND ESTIMATED FINISH TIME FOR LEG 1

CTD No	Position		Depth(m)	ETD Port/Station
Tonga	184.800	-21.133		2009/ 2/26 16: 0: 0
1	190.000	-21.502	5397	2009/ 2/27 21: 9: 0
2	190.005	-21.000	5430	2009/ 2/28 4: 8:43
3	190.001	-20.492	5599	2009/ 2/28 11:11:43
4	190.004	-20.003	5572	2009/ 2/28 18:13:28
5	189.994	-19.499	4587	2009/ 3/ 1 1:20: 1
6	189.944	-18.992	2900	2009/ 3/ 1 7:54: 3
7	189.991	-18.500	5246	2009/ 3/ 1 13:23:15
8	189.989	-17.993	5085	2009/ 3/ 1 20:19:29
9	189.977	-17.512	5090	2009/ 3/ 2 3: 0:40
10	189.997	-16.990	4949	2009/ 3/ 2 9:56:42
11	189.993	-16.492	5037	2009/ 3/ 2 16:39:14
12	189.987	-16.003	5118	2009/ 3/ 2 23:21:43
13	189.978	-15.496	5060	2009/ 3/ 3 6:13:25
14	189.994	-15.003	4803	2009/ 3/ 3 12:58: 4
15	190.000	-14.656	3191	2009/ 3/ 3 18:40:58
16	189.992	-14.285	3545	2009/ 3/ 3 23:36: 8
17	189.994	-13.973	2932	2009/ 3/ 4 4:22:27
18	189.986	-13.820	4297	2009/ 3/ 4 7:50:19
19	189.992	-13.502	4865	2009/ 3/ 4 13: 5:13
20	189.998	-12.993	4952	2009/ 3/ 4 19:48:37
21	190.008	-12.487	4893	2009/ 3/ 5 2:34:12
22	189.989	-12.001	5079	2009/ 3/ 5 9:10:43
23	189.993	-11.493	5040	2009/ 3/ 5 16: 1:26
24	189.989	-10.999	5094	2009/ 3/ 5 22:45:38
25	189.998	-10.501	4865	2009/ 3/ 6 5:32:56
26	191.019	-10.140	4639	2009/ 3/ 6 15:37:37
27	190.795	-10.060	5224	2009/ 3/ 6 20:34:24
28	190.367	-9.923	5201	2009/ 3/ 7 3: 6:56
29	189.949	-9.781	4993	2009/ 3/ 7 9:35:36
30	189.673	-9.690	4301	2009/ 3/ 7 15: 3:45
31	189.399	-9.587	4042	2009/ 3/ 7 20: 8:21
32	191.000	-9.493	5296	2009/ 3/ 8 8:49: 2
33	191.122	-8.993	4797	2009/ 3/ 8 15:49:26

34	191.243	-8.502	5149	2009/ 3/ 8 22:29:17
35	191.302	-8.250	4906	2009/ 3/ 9 3:52:38
36	191.372	-8.004	5087	2009/ 3/ 9 9: 6:25
37	191.322	-7.754	5272	2009/ 3/ 9 14:26:11
38	191.243	-7.500	5208	2009/ 3/ 9 19:56:23
39	191.237	-6.984	5505	2009/ 3/10 2:54:22
40	191.240	-6.501	5575	2009/ 3/10 9:50:53
Argo 1	191.200	-6.500		2009/ 3/10 14:10:25
41	191.245	-5.992	5632	2009/ 3/10 17:23:52
42	191.235	-5.506	5282	2009/ 3/11 0:26:12
43	191.241	-4.995	5539	2009/ 3/11 7:24:47
Argo 2	191.200	-4.500		2009/ 3/11 14:27:38
44	191.242	-4.495	5308	2009/ 3/11 14:52:46
45	191.249	-3.998	5089	2009/ 3/11 21:47:31
46	191.244	-3.489	4947	2009/ 3/12 4:38:52
47	191.247	-2.996	5341	2009/ 3/12 11:19:32
Argo 3	191.200	-2.500		2009/ 3/12 18:15:51
48	191.240	-2.490	5275	2009/ 3/12 18:40:35
49	191.253	-1.844	5218	2009/ 3/13 2:27:42
50	191.236	-1.406	6525	2009/ 3/13 8:58: 7
51	191.242	-0.991	6227	2009/ 3/13 16: 5:54
Argo 4	191.200	-0.500		2009/ 3/13 23:31:12
52	191.252	-0.496	5471	2009/ 3/14 0: 0: 0
53	191.248	0.005	5582	2009/ 3/14 7: 1:59 Transit to 17S
54	189.665	-17.503	5228	2009/ 3/18 20:35:29
55	189.002	-17.497	5088	2009/ 3/19 4:15:56
56	188.346	-17.483	4901	2009/ 3/19 11:49:24
57	188.001	-17.491	5708	2009/ 3/19 17:29:21
58	187.675	-17.499	7500	2009/ 3/19 23:31:18
59	187.313	-17.490	4710	2009/ 3/20 6:48: 7
60	187.159	-17.497	4224	2009/ 3/20 11:15:46
61	186.992	-17.490	2545	2009/ 3/20 15:31: 2
62	186.326	-17.499	1362	2009/ 3/20 21:38:54
63	185.668	-17.414	1485	2009/ 3/21 3: 4:30
Fiji	178.417	-18.133		2009/ 3/22 22:25:49

Number of CTD stations is 63
Number of other deployments is 4
Total ctd time is 9.7012 days
Total distance is 3496.0053 nm
Time at 10 knots is 14.5667 days
Total cruise time is 24.2679 days