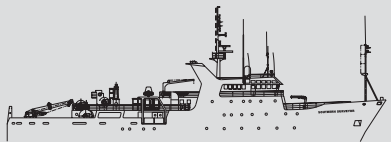

MARINE
NATIONAL FACILITY

2004 program

RV *Southern Surveyor*

CSIRO
MARINE RESEARCH

voyage summary SS08/2004

SS08/2004

High Resolution dynamics of frontal systems
and the zooplankton size spectrum.

Itinerary

Departed Sydney 1200, Thursday 2 September, 2004
Arrived Brisbane 0930, Monday 13 September, 2004

Principal Investigators

- Professor Jason Middleton (Chief Scientist)
- Associate Professor Iain Suthers
- Dr Mark Baird

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Scientific Objectives

The northern New South Wales continental shelf off Smoky cape (30°S) narrows by half in < 0.5° latitude to just 16 km wide, generating marked upwelling signatures in Sea Surface Temperature (SST) and chlorophyll a. Our two Franklin voyages in the summer of 1998/99 (FR14/1998, FR01/1999) examined the physics and biology of this feature, identifying upwelling processes and consequent stimulation of phytoplankton populations. We found that upwelling is responsible for many of Sydney's red tides as well as stimulating growth in larval trevally. Our surveys were large scale and the smaller scale structure of the front itself was not able to be resolved. Yet the smaller scale structure is indicative of the 3-dimensional circulation, which is responsible for the slow but persistent upwelling found just south of Smoky Cape.

During the voyage we intend to:

1. Observe using the SeaSoar with optical plankton counter, the detailed hydrodynamic structure of the front from its separation point near the coast, and to follow it into deeper waters,
2. Examine the bio-physical structure in the wake around a shelf island (North Solitary Island),
3. Compare the zooplankton size structure with the growth of larval fish (pilchards) over a wide range of oceanographic conditions,
4. Investigate the early life history of Pilchards in the Tasman front in comparison with the Kuroshio extension, and
5. Compare the data against a size-based mechanistic model of the pelagic ecosystem.

Voyage Objectives

1) To make CTD casts at stations along 8 cross-frontal transects of the Tasman Front, using the full rosette sampler and fluorometer. We will take standard nutrients (NOx, P, Si) at 4-8 depth intervals at each station. We anticipate there will be 8 transects, each with 7 stations, with casts to 300 or 500 m deep. Transects 1-4 will be 18 nautical miles long, approximately located along 33.5ºS, 33.0ºS, 32.5ºS and 32.0ºS. The precise scheduling will depend on the SST image recorded a week before departure. Transects 5-8 will be 8 nm long and probably between 32 and 31ºS around the East Australian Current separation area, with the shallowest stations being at the 30 m isobath;

2) To separately undertake ADCP and SeaSoar profiles along these transects at 8 knots. The SeaSoar will have the Optical Plankton Counter mounted onto it. If possible we would like to conduct some ADCP and SeaSoar transects (especially #5-8) at slower speeds for finer spatial resolution – to be discussed;

3) To take neuston net samples simultaneously with Rectangular Midwater Trawl (RMT) plankton samples from the stern, at 3 locations across each transect (locations will be named "Inshore", "frontal" and "offshore", Fig. 2). At each location a CTD cast to 300 m will be made (minimal rosette sampling), before undertaking three replicate 10 minute plankton tows at ~3 knots at each location, and then steaming onto the next location. Nearly all plankton sampling will take place at night, usually between 19:00-24:00, but where pilchard or gemfish larvae are particularly abundant we plan to sample them during the day as well. Plankton will be preserved in 5% formalin at an appropriate location on the back deck. The first and last tows of the 3 replicates will be iced and be pre-sorted for pilchard larvae for separate preservation in 95% alcohol. We anticipate that pilchard larvae will be larger and older at Transect 1 (and the plankton sizes larger), than at the separation area near Transects 5-8;

4) Notes on the RMT. It is 2 m wide and 75 cm deep, with a 7 m long net of 0.5 mm mesh. It has a top and bottom bar, with the bottom bar containing 150 kg lead, and supporting two lead rollers of 25 kg each. Within the triangle of the tow bridle there will be a small 20 cm diameter, 0.1 mm mesh plankton net with the cod end loosely attached to the RMT net, to prevent foul-ups. There are no electronics: it has a GO flow meter and a self contained time-temperature-depth recorder. We will bring two complete RMTs on board and will be testing it from a trawler in August.

5) To conduct an ADCP and SeaSoar profile back along the 18 nm transect at 8 knots (generally between 24:00 and 03:00. If time permits additional RMT tows will be made at the Front, before steaming north to the next transect of CTD stations starting around 07:00. Plankton sampling may be more limited at Transects 5-8, depending on conditions.

6) To deploy two current meter moorings north (upstream) of North Solitary Island (~29º 55´ S). Moorings will be deployed for only 3 days, and will have a pick-up rope for easy retrieval. The area is a Commonwealth Marine Park and a permit has been submitted to the EA office in Coffs Harbour (May 2004).

7) To conduct ADCP and SeaSoar transects across the main axis of flow. Two transects are north of the island and 5 are south (an additional transect may be run between North Solitary and NW Rock, depending on advice).

8) To make rapid, continuous 3 minute deployments of the neuston net along some of these transects at 3 knots, at night, with the SeaSoar sampling at a set depth (10 m from the surface).

Voyage Track

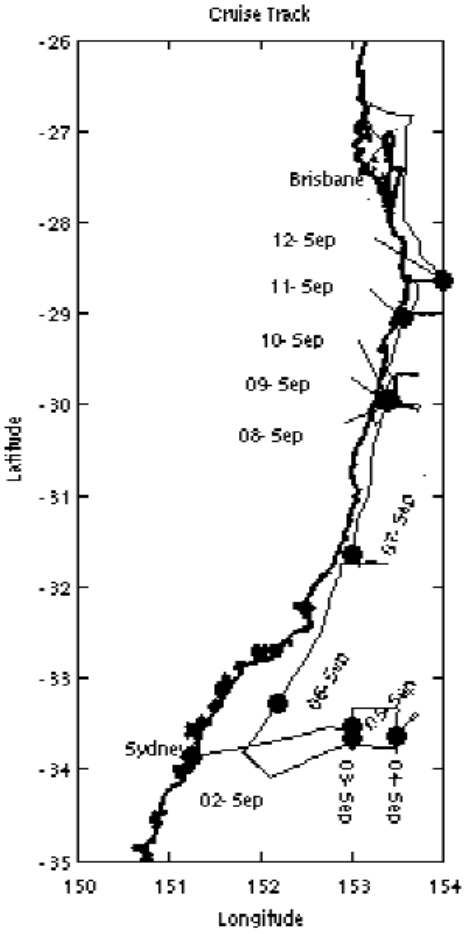

Figure 1: Voyage Track SS08/2004

Results

The voyage objectives were met logistically with the ADCP and other underway data acquisitions and CTD performing perfectly all voyage, the Seasoar performing very well, and the data from the OPC appearing to be satisfactory. The neuston nets performed well, however the Rectangular Midwater Trawl will need further development, and Jock Young is thanked for the use of one of his nets. Only one mooring was deployed in the N. Solitary wake study, and this was retrieved without incident. With 2 of the meters performing flawlessly, and recording data fully c onsistent with the ADCP data from the area.

The key scientific objectives of the voyage were also met. During the voyage we found strong physical and biological differences across the Tasman Front, which at the time continued west to east from near Sydney to nearly 300 km offshore at 153°. We found marked differences in the ichthyoplankton with a high abundance and diversity on the warmer East Australian Current side compared to the cooler Tasman Sea. The Tasman front was strong often with temperature differences of several degrees Centigrade in only a few nm horizontally. Our hypothesis that the Tasman front is biologically analogous to the well studied Kuroshio extension appears supported, with high concentrations of larval pilchard and blue mackerel found well offshore, contrary to earlier beliefs. The growth rates of these larvae in relation to the zooplankton biomass size distributions inshore (putative spawning location) and offshore remain to be determined from the samples obtained.

The separation of the East Australian current from the coast occurred farther north than expected, although this did not cause any real problems. Currents exceeded 4 kn at some locations. With sections taken at Diamond Head, N. Solitary and Evans Head, the nature of the front was also determined over the steeply sloping continental slope. The SeaSoar and ADCP data will complement the sections acquired from the earlier Franklin voyages, but most importantly will give a finer scale description of the nature of the front. For all cross -sections there was little evidence of horizontal dispersion, as the front remained tight all the way from the separation point to the Tasman Sea. In all cases there were significant differences in the catches from the midwater trawl and neuston trawls, and the Optical Plankton Counter data remain to be plotted.

The study of the wake at N. Solitary proved effective, and the wake was seen to extend downstream at least 5 nm in the strongly flowing (1 - 1.3 kn) East Australia Current. An unforseen element of complexity was the horizontal shear upstream of and incident to the island. This will add interest to the projected modelling studies. Vertical and horizontal structure in the plankton was apparent from 70 3-minute tows made during 3 transects across the wake. During the associated sections at 30° S, and steep and deep canyon was identified, with an amazing temperature gradient of 9° C in about 30m vertically seen during a CTD cast. There appears to be a significant recirculation, and possibly upwelling within this canyon, and an exploratory SeaSoar section was undertaken to further identify the physical properties.

Voyage narrative

In this narrative, all times are eastern Standard Time (GMT+10)

Thursday 2nd September

The scientific party boarded the previous evening, and spent the morning stowing gear. At 1100 all scientists were given an induction briefing, including a tour of the ship to identify key emergency exits and firefighting equipment locations. The Surveyor departed Darling Harbour at 1300, heading east. At 1515 all scientists and operations crew met to discuss Job Hazard Assessments for scientific operations including CTD operations, the SeaSoar and net tows. Directly following at 1600 all scientists were briefed on ship's safety issues, including fire and muster signals. At 1630 a practice muster was held with all scientists participating, along with crew which were off duty at that time.

At 1900 a practice CTD station (CTD001) was held to 1000m depth to test the operation of the CTD and to train scientists in CTD deployment, logging, and water sampling. The Rectangular Midwater Trawl (RMT) net was then prepared on the afterdeck, and deployed in a practice deployment at 22:22, followed by the surface net at 2305. The RMT is 1.5 x 0.75 m, 0.5 mm mesh net, with 270 kg of lead on the lower bar. It has a GO flow meter and a VEMCO time-depth recorder, and a 20 cm diameter 0.1 mm mesh net was deployed within the tow bridle. The surface (neuston) net is a 0.75 x 0.75 m square net with 0.5 mm mesh, towed from a 2-3 m beam off the bow and deployed from the CTD A frame.

The ship proceeded to 33° 30´ S, 153° 00´ E arriving just after midnight, hoping to locate the EAC front, which was expected to be oriented in an east-west, as inferred from the previous days NOAA SST images.

Friday 3rd September

On arrival at the 153° E meridian, the ship headed due south to locate cooler water. Water of SST 19.5° C was found at 33° 31´ S, while water of 16.7° C was found at 33° 37´ S. It was decided to deploy Rectangular Midwater Trawl (RMT) and surface neuston nets in cooler water at 33° 40´ S, frontal water at 33° 35´ S, and warmer EAC water at 33° 28´ S (Transect #1). Unfortunately some RMT net eyelets broke and so the warmer EAC waters were sampled with the surface neuston net only. The nets were filled with a thick green slime (the spring bloom). Very few larval fish were found in the Tasman waters, but high diversity found in the EAC. This activity was completed around 0430, and the ship repositioned at 33° 27´ to begin a series of CTD stations, running at 2 nm intervals across the front. This was begun at 0700 with CTD002, and continued to 1400 with CTD006.

The first SeaSoar section was begun at 1700, tracking north along 153° E, and concluded at 1830, crossing the front.

The ship then headed east to the 153° 30´ E meridian, and deployed a light-trap at 33° 20.8´ S, 153° 30.2´ E at 2134. Estimated current was 1 kn in a direction of 105°.It was planned to pick it up at dawn.

A SeaSoar transect to 120m depth was begun at 2155, heading southbound and ended at 0050 on 4th September, to identify the frontal structure at this longitude. The SeaSoar performed flawlessly, and the optical plankton counter seemed to be sending up correct data but incompatible with existing software. The front on the southern end of the transect was dramatic.

Saturday 4th September

The RMT net was replaced by a 1 m square, 1 mm mesh net, with the flow meter, TDR and the 20 cm diameter, 0.1 mm mesh net towed within it. Through the early hours net tows were taken at three locations, 33° 48´ S ("Tasman"), 33° 44´ S ("frontal") and 33° 36´ S ("EAC", Transect #2). The samples contained significantly less green slime than those of last night.

These were completed at 0500, and the ship headed to pick up the light trap. This was taken aboard at 0630 at 33° 23.4´ S, 153° 41.0´, resulting in an average current of approximately 1.06kn in a direction of 106°. Only one pelagic juvenile tuna was caught, but the half moon was particularly bright.

The ship then repositioned to the 153° 30´ E meridian, and began at set of CTD stations beginning at CTD007 at 33° 36´ S, with 2 nm intervals. This finished at Station 12 at 33° 46´ latitude. On completion the Surveyor headed west to intercept the 153° 00´ meridian. The SeaSoar was deployed in colder Tasman Sea water (only just - a delayed start) at 1707 at 33° 42´ S and headed north into the EAC water, being retrieved at around 0845. Following this, a set of net tows was taken at Transect 3, EAC, front, Tasman Sea, and back on Transect 3.2 at Tasman Sea, front, and EAC water, completing by 0500. Many pilchards and Scomber were in the EAC water, with many sauries in the neuston net. At the Tasman Sea stations, the nets came up green with phytoplankton and with few larval fish (myctophids).

Sunday 5th September

Net tows were continued until dawn, and the ship repositioned at 153° 00´ E, 33° 34´S to begin the third CTD section along the 153° 00´ meridian. This began with CTD 013 at 33° 34´ S, and continued south at 2 nm intervals, finishing at CTD018.

Plankton samples were collected along Transect #4, starting at around 2208 local, on the NNW-SSE transect from the EAC side ("EAC") in 19.5° C, at "frontal" at 19.3° C, and on Tasman Sea side at 17.2° C. Sampling was complemented by a spectacular lightning display over Sydney, and our own hail stones.

Monday 6th September

At completion of the plankton sampling, we began a CTD transect of 5 stations along the same SSE-NNW transect, which was completed by about 0630. We then began a 12 hour steam to Diamond Head where in 1998/99 we found a consistently spectacular upwelling (the SST image indicated a weaker front of between 17-19° C).

We arrived at Diamond Head at around 1900 and began a 2 hour SeaSoar transect (#5) from around 60 m depth to the offshore. A 20-30 knot wind picked up during the tow. After retrieval of the SeaSoar a hydraulic hose burst, but the engineers had it repaired within 2 hours. It took us another 2 hours to have us back in position for plankton tows.

Tuesday 7th September

We made our way back to the 110 m isobath and made plankton collections along Transect #5 at 3 stations ("EAC", 19.6° C, 01:47), (Frontal, 18.8° C, 02:49) and ("upwelled", 18.1° C, 03:37).

At 0400 we began a CTD transect from near Diamond Head offshore, completed by 0900. We then began a 10 hour steam to North Solitary Island arriving at 30° 00´ S at 2130, and deployed the SeaSoar (#6) for a 2 hour transect into the EAC (on the basis of an excellent SST image from 6 September). The SeaSoar showed remarkably well mixed water of 20° C down to 50 m, and at the 125 m isobath drop-off, temperature increased to 21.5° C.

Wednesday 8th September

Net tows were conducted at 4 stations along the 30° 00´ S latitude east of Nth Solitary Is, at 153° 36´, 153° 33´, 153° 28´ and 153° 23´ E (with the last station due south of the island; Transect #6). The ship then moved to the nominal mooring location and the bottom was judged to be sandy and smooth from the swath-mapper display. The Surveyor returned to the lee of the island where mooring weights were transferred to the stern, and the mooring was built. The mooring was subsequently deployed at 1215 pm local (0215Z) at the planned location (Bridge 29° 51.926´ S, 153° 23.019´ E; AfterDeck 29° 51 942´ S, 153° 23.024´ E) with ship heading very slowly N Northeast. Estimated position is this very slightly south of the Afterdeck position.

Following this the ship relocated to begin a SeaSoar survey of the N Solitary wake, however the SeaSoar was declared U/S and a CTD section was begun along the 30° 00´ S parallel, starting at station CTD031 at 153° 27´ E and working eastward. This continued into the evening ending with CTD038, at 2300.

Thursday 9th September

The ship then repositioned to conduct net tows at 4 stations surveyed by CTD the previous evening; however a front passed through and with 40 kn winds the net tows were cancelled. After the front the Surveyor completed a small two-section ADCP wake survey south of the island.

By 0630 the ship had repositioned at 30° 01´ S, 153° 27´ E, and began a full wake survey. The first two transects were undertaken with SeaSoar U/S, but after repairs, the survey continued through the day. This survey was begun 0700, and continued through the day although the SeaSoar malfunctioned on several occasions.

After dinner the ship repositioned to 29° 40´ S, north of N.Solitary Is and began a set of CTD stations beginning at longitude 153° 22´ E and heading east. This began with CTD039 and ended with CTD045. This continued into the evening and was followed by net tows at 153° 43´ E, 153° 39´ E, and 153° 30´ E between 0206 - 0511 (Transect 7).

Friday 10th September

Following the CTD section net tows were undertaken until dawn, and the ship repositioned to 30.00 S to begin a third wake survey for North Solitary Island. This was completed at 1130, and the ship repositioned to the mooring site. The mooring was recovered at 0130, and a set of CTD casts was taken, two upstream of the Island, and 3 downstream.

On completion the ship repositioned to 30° 00´ S, and began a short SeaSoar section east out to the canyon at 153° 33´ E, then 7 miles seaward, turning north and re-intercepting the 30° 00´ S latitude heading west. The intense thermocline was again seen in the canyon as observed in the earlier CTD station. Following this the ship returned to undertake a time (or space) series of 3 minute surface neuston net trawls across the island wake, beginning at 2200. The 0.75 x 0.75 neuston net, with 0.5 mm mesh had a 20 cm diameter ring net with 0.1 mm mesh inside it, along with a time-temperature-depth recorder. The turnaround time for each 3 min deployment was approximately 2 minutes.

We completed 3 transects at 3 knots across the wake along 29° 57.5´ S, approximately 2 nm downstream, from 153° 27´ to 153° 21´ E. We made 24 deployments on the first leg from east to west (Transect 8); 24 deployments on the second leg (Transect 9) and 22 deployments on the third leg (Transect 10).

Saturday 11th September

On completion of the surface net tows across the N. Solitary wake, the ship headed north to 29° S latitude, just north of Evans Head, to undertake the last section of surveys. Arriving at 1030, the SeaSoar was deployed heading east into the East Australia Current. On completion CTD stations were undertaken beginning at 153° 54´ E, and heading westward, beginning at CTD052 and ending at the final CTD station, CTD061 at 2000. The ship then repositioned for net tows at 20:31 and these were undertaken until dawn (Transect 11). We sampled at 4 stations from the cooler, coastal, upwelled water mass (19.5° C, 153° 35´ E and also at 40´), at the frontal water mass (20.5° C) and at the EAC water mass (21.6° C). We turned around and repeated the net tows at the 4 stations.

Sunday 12th September

On completion of the net tows at 0500, the ship then traversed north to Cape Byron, and a final SeaSoar transect was undertaken from 0730 to 0930. Following this the ship headed for Brisbane, arriving Monday 13th September at 0930 at Forgacs Cairncross Shipyard, Brisbane River.

Summary

The principal voyage objectives were met admirably, with 7 full cross sections of the East Australia Current front and Tasman front surveyed physically and biologically. All equipment worked very well, and there were no major equipment malfunctions or safety incidents. While a number of scientific objectives must await detailed data analyses and modelling, the voyage was perceived by all to be very valuable, and we believe the scientific results will add significantly to the literature on fronts and the reasons for their biological productivity.

Personnel

Scientific Personnel

Prof Jason Middleton – UNSW, Chief Scientist
A/Prof Iain Suthers – UNSW, Principal Investigator
Dr Mark Baird – UNSW, Principal Investigator
Dr Patrick Timko – UNSW
Greg Nippard – UNSW
Tom Mullaney – UNSW
Peter Burns – UNSW
Deborah Cox – UNSW
Melanie OByrne – ANU
Dr Tony Miskiewicz – Wollongong City
Dr Lindsay Pender – CMR, Voyage Manager, Computing, Seasoar
Mark Underwood – CMR, Electronics, Seasoar
Neale Johnstone – CMR, Hydrochemistry
Drew Mills – CMR, Electronics trainee

Marine Crew

Capt Les Morrow – Master
John Boyes – Chief Officer
Drew Meincke – Second Officer
Roger Thomas – Chief Engineer
Rob Cave – First Engineer
John Hinchliffe – Second Engineer
Graham McDougall – Bosun
Dean McPherson – IR
Manfred Germann – IR
Malcolm Cleworth – IR
Phillip French – Greaser
Peter Williams – Chief Steward
Andy Goss – Chief Cook
Geraldine Byrne – Second Cook
Paul Creely – TIR

Acknowledgements

Thanks go to the Master Les Morrow and his most capable crew, who worked tirelessly and with good humour to ensure our voyage objectives were fully met. Thanks also to the National Facility personnel, particularly Lindsay Pender and Mark Underwood who ensured the OPC/SeaSoar system was operational, and remained so. Lindsay gets the Chief Scientist's award for "Close Contour Flying". We also thanks Neal Johnstone and Drew Mills for ongoing and effective support. The Southern Surveyor proved to be an effective performer in supporting our tasks.

Prof Jason Middleton
Chief Scientist

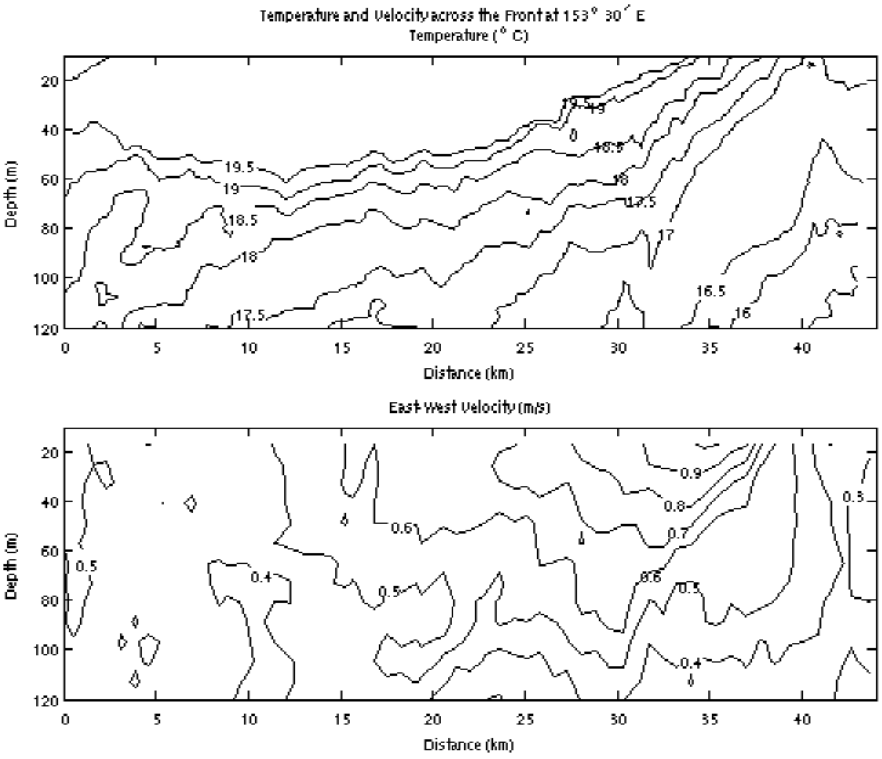

Figure 2: Temperature (SeaSoar section 2) and velocity (ADCP) across the front at 153° 30´ E.

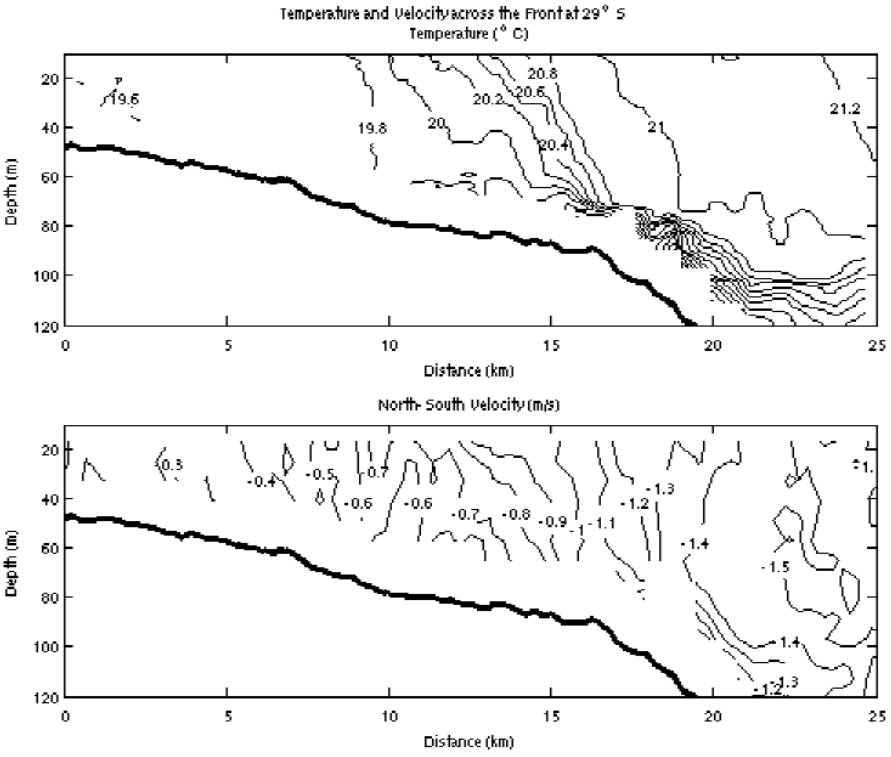

Figure 3: Temperature (SeaSoar section 10) and Velocity (ADCP) across the front at 29° S.

Table 1: CTD Log SS08/2004

CTD No	Date (Z)	Time (Z)	Lat (S)	Lon (E)	Depth(m)	Comments
1	2 Sept	0900	33 39	152 23	1000	Test/1000m
2	2 Sept	2050	33 27	153 00	500	Sect 1 153 00E
3	2 Sept	2240	33 30	153 00	500	Sect 1
4	3 Sept	0030	33 32	152 59	500	Sect 1
5	3 Sept	0157	33 34	153 00	500	Sect 1
6	3 Sept	0323	33 36	153 00	500	Sect 1
7	3 Sept	2238	33 36	153 30	500	Sect 2 15
8	4 Sept	0030	33 38	153 30	500	Sect 2
9	4 Sept	0156	33 40	153 30	500	Sect 2
10	4 Sept	0305	33 42	153 30	500	Sect 2
11	4 Sept	0422	33 44	153 30	500	Sect 2
12	4 Sept	0535	33 46	153 30	500	Sect 2
13	4 Sept	1944	33 34	153 00	500	Sect 3
14	4 Sept	2112	33 36	153 00	500	Sect 3
15	4 Sept	2305?	33 38	153 00	500	Sect 3
16	5 Sept	0024	33 40	153 00	500	Sect 3
17	5 Sept	0140	33 42	153 00	500	Sect 3
18	5 Sept	0302	33 44	153 00	500	Sect 3
19	5 Sept	1546	33.57.6	151 57.5	500	Sect 4 Sydney
20	5 Sept	1652	33 55.9	151 56.2	500	Sect 4
21	5 Sept	1755	33 54.0	151 53.9	500	Sect 4
22	5 Sept	1902	33 52.1	151 52.2	500	Sect 4
23	5 Sept	2017	33 50.1	151 50.0	500	Sect 4
24	6 Sept	1820	31 45	152 53	50	Sect 5 Diamond Hd
25	6 Sept	1909	31 45	152 55	70	
26	6 Sept	1949	31 45	152 57	75	
27	6 Sept	2025	31 45	152 59	88	
28	6 Sept	2105	31 45	153 02	95	
29	6 Sept	2147	31 45	153 03	100	
30	6 Sept	2236	31 45	153 05	125	
31	8 Sept	0340	30 00	153 27	75	Sect 6 N Solitary
32	8 Sept	0530	30 00	153 29	83	
33	8 Sept	0613	30 00	153 31	85	
34	8 Sept	0658	30 00	153 33	110	
35	8 Sept	0817	30 00	153 35	500	
36	8 Sept	0931	30 00	153 37	300	
37	8 Sept	1044	30 00	153 39	500	
38	8 Sept	1222	30 00	153 41	900	

39	9 Sept	1003	29 40	153 30	63	Sect 7 Wooli
40	9 Sept	1108	29 40	153 33	68	
41	9 Sept	1215	29 40	153 35	75	
42	9 Sept	1259	29 40	153 37	75	
43	9 Sept	1347	29 40	153 39	85	
44	9 Sept	1520	29 40	153 43	200	
45	9 Sept					T/S calibration cast
46	10 Sept	0440	29 52	153 22	26	Sect 8 N Solitary upstream
47	10 Sept	0518	29 52	153 25	54	
48	10 Sept	0620	29 57.5	153 25	64	N solitary downstream
49	10 Sept	0659	29 57.5	153 23	42	
50	10 Sept	0737	29 57.5	153 21	37	
51	10 Sept	0808	29 58	153 22.5	41	
52	11 Sept	0311	29 00	153 54	500	Evans head 29 00S
53	11 Sept	0428	29 00	153 52	200	
54	11 Sept	0516	29 00	153 50	175	
55	11 Sept	0558	29 00	153 48	100	
56	11 Sept	0637	29 00	153 46	75	
57	11 Sept	0735	29 00	153 44	75	
58	11 Sept	0812	29 00	153 42	67	
59	11 Sept	0843	29 00	153 40	50	
60	11 Sept	0911	29 00	153 38	43	
61	11 Sept	0942	29 00	153 35	35	

Table 2: SeaSoar log

No	Date	Time (local)	Lat	Long	Comments
1	3 Sept	1700		153	5 pm local, tracking north 153 E across front, to 18:30, trial run!!
2	3 Sept	2155		153 30´	21:55 heading S Ending 00:50 on 4th sept. before plankton tows
3	4 Sept	1907		153	From Tasman side of front (only just, lat 33 42') into EAC before plankton tows
4	5 Sept	19:00 approx		152	Front off Port Stephens
5	6 Sept	19:00		153 11´	From Diamond Hd
6	7 Sept	2130	30S		From Nth Solitary into EAC
7	8 Sept	0700-1700			N Solitary wake * 2
8	9 Sept	0800-1100			N Solitary wake * 1
9	10 Sept	1830	30S		Canyon section
10	11 Sept	1030-1230	29S		Evans Head Section
11	12 Sept	0730-0930	27S		Cape Byron Section

Table 3: Net Tow Log (100 sample # series are surface nets; 300 sample # series are RMT/box net or 0.1 mm plankton net samples)

No	Sept-ember	Transect stn	Time (local)	Lat	Long	Comments
1						Test, 101, 301, 302
2	2	1,T			153	16.74C, 103,104, 303,304,
3	2	1,F			153	16.67C; 105,106, 305,
4	2	1,EAC			153	19.89C, 107,108
5	3/4	2,T				109,110, 309, 310
6	3/4	2,F				111,112, 311, 312
7	3/4	2,EAC				113, 114, 313, 314
8	4	3, EAC			153	115, 315, 116, 316
9	4	3, front			153	117, 317, 118, 318
10	4	3, Tas			153	119, 319, 120, 320
11	4/5	3.2, Tas			153	121, 321, 122, 322
12	4/5	3.2, front			153	123, 323, 124, 324
13	4/5	3.2 EAC			153	125, 325, 126, 326
14	5/6	4, EAC			~151.5	Off Sydney 127, 327, 128, 328
15	5/6	4,front			~151.5	129, 329, 130, 330
16	5/6	4, Tas			~151.5	131, 331, 132, 332
17	6/7	5, EAC	01:47	31.45	152 54	Diamond Hd transect 133, 333, 134, 334
18	6/7	5, frontal	02:49		152 56	135, 335, 136, 336
19	6/7	5, upwell	03:37		152 03	137, 337, 138, 338
20	7/8	6	02:06	30 00	153 36	Sth of Nth Solitary transect 139, 339, 140, 340
21	7/8	6	02:51	30 00	153 33	141, 341, 142, 342
22	7/8	6	03:52	30 00	153 28	143, 343, 144, 344
23	7/8	6	04:54	30 00	153 23	145, 345, 146, 346
24	9/10	7	02:04	29 40	153 43	Nth of Nth Solitary Is., 147, 347, 148, 348
25	9/10	7	03:02		153 39	149, 349, 150, 350
26	9/10	7	03:23		153 30	151, 351, 152, 352
27	10/11	8-Leg 1	20:13	29.57.5	153, 27' to 21'	Nth Solitary Is. wake traverse east to west; 153-176
28	10/11	9-Leg2	00:23	29.57.5		177-200, west to east
29	10/11	10-Leg3	02:46	29.57.5		201-222; east to west
30	11/12	11	20:31	29 00	153 35	Evans Head transect; 223, 323, 224, 324
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34	11/12	11.2	01:27		153 50	231, 331, 232, 332
35	11/12	11.2	02:39		153 45	233, 333, 234, 334
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