FRANKLIN

National Facility
Oceanographic Research Vessel

RESEARCH SUMMARY

CRUISE FR 4/94

Sailed	Newcastle:	0700 Hrs	4 April 1994
Called	Sydney	0600 Hrs	11 April 1994
Arrived	Hobart:	0700 Hrs	14 April 1994

COASTAL DYNAMICS AND ICHTHYOPLANKTON DISTRIBUTIONS IN THE SYDNEY REGION

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Mr. Peter Tate
Environmental Investigation Unit, Sydney Water Board

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ESTIMATING OCEAN CURRENTS BY MAGNETIC PROFILES

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R.V. Franklin
FR 4/94

Research Summary

1. Itinerary

Sailed	Newcastle	0700 h	4 April 1994
Called	Sydney	0600 h	11 April 1994
Arrived	Hobart	0700 h	14 April 1994

2. Scientific Programme

Extending the results of cruise FR 2/94, the objectives of the cruise were to determine the reasons for the daily variability in physical and biological oceanography off the Sydney coast. We were particularly interested in the baroclinic current flow, and the propagation of internal waves from the shelf break shorewards, and in the corresponding effects of varying deep water masses on ichthyoplankton composition. Three current meter moorings deployed during FR 2/94 were retrieved the week before this cruise. Another concurrent set of current meters and thermistor strings operated by the Sydney Water Board will be collected in mid April.

Our operations consisted of CTD casts for salinity, temperature, fluorescence, dissolved oxygen, nitrate and phosphate, along with HIAC particle counts and chlorophyll extractions. Acoustic Doppler Current Profiles were made repeatedly along "the Bondi transect" running from Ben Buckler to 20 nautical miles offshore. Two days work included parallel data collection with the Sydney Water Board's shark cat "Wollami". At night, plankton samples were collected using surface nets and the EZ multiple opening and closing net at 5 stations over the same transect.

3. Principal Investigators

Professor Jason Middleton and Dr Iain Suthers,
Centre for Marine Science, University of New South Wales,
and
Mr Peter Tate
Environmental Management and Investigation Unit,
Sydney Water Board.

4. Results and Summary

Our cruise track (Fig. 1) shows our activity concentrated along a 20 nautical mile long transect normal to the coast, out to the 600 m isobath. The current structure was dominated by a surface 1 knot southward current, which tended to vary offshore during mid-cruise.

The physical oceanography component of the cruise was designed to investigate the baroclinic activity on the Sydney continental shelf. The dominant currents during the period of the cruise were southbound with variability increasing with distance offshore. Remote SST images

indicated minimal EAC forcing over the region. The across shore structure suggested that the alongshore currents were associated with Coastal Trapped Wave activity. Wind driven circulation was small as a result of the lack of prolonged strong winds prior to, and over the period of the cruise.

Repeated ADCP and CTD transects along the Bondi line were performed in an attempt to obtain as close as possible real time concurrent ADCP/CTD sections. The CTD sections captured what appeared to be onshore propagating low frequency internal waves, one of the objectives of the cruise. Both first and second mode structures were observed (Fig. 2). Analysis of the ADCP data will give insight into the propagation and structure of these oscillations. The intensive observation of the nearshore zone should give insight into the boundary characteristics of the internal waves with particular reference to effluent dispersion.

Biological sampling confirmed that while the plankton distributions were highly variable, the variance may be tractable with overlapping physical oceanographic information. We established that single sampling occasions are insufficient to assess, for example, environmental impacts of sewage plumes. Plankton distributions varied from night to night at each station, but a consistent faunal break between the 80 m - 120 m depth stations was observed. The deepest net bin had the lowest zooplankton biomass (except the shallowest station), and larval fish abundance increased offshore. Larval fish offshore appeared dominated by gonorynchids ("beaked salmon").

Replicated samples were also made within some nights, to ensure that cross shelf variability was due to oceanographic variation, and not due to within station sampling variation. Repeated samples made during the day revealed a marked decrease in zooplankton abundance in the neuston, yet with no concomitant increase in the deepest net bin.

We thank all scientific and ship's personnel, who undertook their tasks cheerfully and professionally throughout the cruise.

5. Cruise Narrative

In this narrative dates and times are expressed in Eastern Standard Time (local) except where explicitly mentioned otherwise.

Monday, 4 April 1994

Franklin cleared the harbour entrance at 0730 and proceeded to off Barenjoey for a practise CTD cast to 50 m, and while minor engine repairs where made. Muster stations, and other emergency procedures were made at 0830. During the steam, a large pod of dolphins were observed at about 0800. The weather was fine and clear, with a light NE breeze by 1300. The test cast was made off Barenjoey Lighthouse in 60 m of water at 1239, before proceeding to Ben Buckler. CTD stations started at 1500 local time (CTD 2), with full CTD casts with salinity, temperature, DO, nitrate and phosphate. Unfortunately worked ceased at 0100 local when the CTD cable parted and the entire instrument lost.

A normal CTD cast had been completed and the CTD was being recovered onto the deck. As the CTD was lifted out of the water with the A-frame fully extended, the cable broke and the CTD was lost. The cable appears to have sheared in the termination at a point close to where the collets grip the cable.

The position was 33°59.62'S:151°30.14'E in a depth of ~150 m. The instrument was fitted with a 16 channel digitiser, O_2 sensor, fluorometer and battery pack, altimeter, 9 niskin bottles, and 12 position rosette.

Tuesday, 5 April

The vessel repositioned off Ben Buckler, and commenced an ADCP transect at 8 knots from 0323 to 0439 (from inshore to offshore, UNSW station 1-12, ADCP file 4), returned to Ben Buckler for another transect (0825 - 1043, file 6), and returned to Ben Buckler for a third transect (1302-1519, file 8). We were interested in the inshore - offshore direction to detect any onshore moving packets of internal waves, that can potentially travel at 8 knots. At 1600 a practise EZ tow was made offshore, near UNSW station C, before moving inshore to station. A for our first EZ transect (stations A-E, and then repeating station C twice). Using the 325 um mesh, three depth bins were sampled (Table 2) with simultaneous surface net tows. More plankton and small fish were observed at stations C-E than A-B. The EZ net worked without a hitch, and the weather fine with 15-20 kts NE breeze.

Wednesday, 6 April

At 0700 we met the Water Board's shark cat Wollami at the Ocean Reference Station. As CTD2 unit was not yet operational, the *Franklin* made an ADCP transect at 3-4 knots offshore along the Bondi transect, while the Wollami made parallel CTD casts with an SDL from their hydro winch, at stations 13-19 (a reversal of the vessels' originally planned tasks). Each cast with the SDL was made in concert with the *Franklin*, and was marked on the ADCP file (files 11 & 12). The weather was perfect, and at approximately 1000 we were buzzed by Jason Middleton in an aircraft. Transect was completed at 1100, and we returned inshore to complete two ADCP runs (file 12/13, UNSW stations 1-12, returning back to Ben Buckler, and file 13, UNSW stations 1-9). Meanwhile, Dave Edwards, ably assisted by Greg Nippard and Bob Griffiths heroically got CTD#2 going, and a test cast was made at 1739 (CTD12).

After minor repairs to the floor of the net in teeming rain, EZ tows began at station A at 2000. The rain eased, and the remainder of the night was cool and pleasant with 10-20 kts south westerly breeze. Station B suffered from 2 lost cod-ends on the bottom nets, and a broken swage on net-bar #7 (top net). Stations C and D were without incident, but station E was aborted due to unusual net openings and was repeated satisfactorily. The repeat of station B was aborted due to a loose flowmeter cable, and was then repeated without incident just on dawn.

Thursday, 7 April

The vessel then steamed slowly to the Ocean Reference Station and at 0800 began CTD profiles at 30-40 min. intervals along UNSW stations 13-19 (CTD 13-19), while the Wollami slowly steamed in parallel at 3-4 knots with its high resolution ADCP (the UNSW SDL suffered from a broken temperature sensor). The weather was calm and foggy (actually dust) off Bondi, but the wind increased to 20 kts SW by station 19, although the Wollami was still getting reasonable data. *Franklin* continued the transect to CTD station 22 by 1445.

The vessel began another ADCP transect along UNSW stations 1-22, before returning for EZ tows at A-E at 1900. The weather was cool and clear, but by station B, the net was retrieved in a squall and teeming rain. The retrieval during stations C and D was difficult due to the vessels pitching, as the wind gusted to 30 knots. Net bars were shaken off their triggers during the tows at stations D and E due to violent pitching of the net, so station E was abandoned at 0230, for a slow steam back to Ben Buckler, in the increasingly rough seas. Nevertheless, the EZ and surface net samples revealed that while considerable variability was evident from night to night, there was an apparent faunal change between stations B and C, with B dominated by small zooplankton and filamentous green algae, and C dominated by euphausids and larger zooplankton, extending to D and E where we observed enhanced numbers of larval fish.

Friday, 8 April

At 0517 an ADCP transect (file 21) from UNSW stations 1 to 22 (which were to be CTD'd next) was completed at 0700. The weather was perfect, with a 10 kt SE, and a moderate SE swell. The vessel began a return trip along the transect with rapid CTD's, CTD stations 23 to 35 (3 bottles each, salinity, DO and particle counts only). The vessel then returned along the transect for an ADCP run, UNSW stations 1 to 22 (file 23). At 1700 we returned to UNSW station 20 for a series of 3 CTDs at the same location (CTD stations 36-38).

At 1930 we began EZ tows, stations E to A (i.e. offshore to inshore), praying for less pitching. The weather was perfect, and all stations, including a repeat at station C were completed at 0430. The plankton appeared overall to be more uniform from E to A, with only a few of the characteristic euphausids at C.

Saturday, 9 April

The vessel repositioned off Ben Buckler at 0500 for an ADCP transect from UNSW station 1-22 (file 26), before returning to Ben Buckler at 0900. In perfect weather, the vessel then completed full CTD's 39-50 (inshore-offshore, UNSW stations 1-22), by 1715. The vessel then steamed to begin repeated EZ net tows at stations B and C.

Sunday, 10 April

EZ tows continued at stations B and C until 1200, thus completing 6 pairs of stations. Temporal and diel variation from this sampling will help assess the spatial patterns we have observed from stations A to E. The vessel returned to Ben Buckler at 1230, and completed the last CTD transect from UNSW stations 1 to 22, finishing at 2000.

Franklin returned to the site of the CTD loss, and made a number of passes over the area with the sonar at 2030. We then returned to Ben Buckler for the final ADCP run to UNSW station 22.

Monday, 11 April

We arrived at Sydney Heads at 0530 to meet the pilot, and unloaded into the Wollami in Watsons Bay. Prof. Ted Lilley (ANU) joined the vessel to test a magnetometer on the passage to Hobart.

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Estimating Ocean Currents by Magnetic Profiles

F.E.M.(Ted) Lilley
Research School of Earth Sciences, ANU, Canberra.

Between Sydney and Hobart, a magnetometer enclosed in a Benthos glass capsule was lowered on the end of the hydrology cable to the maximum depth of that cable, and then hauled back up to the surface again. The purpose was to test the magnetometer package, which is at present under development. The long-term purpose of the instrument is to observe very small magnetic signals which are generated by the dynamo action of the electrically-conducting sea water moving, as ocean currents, through the magnetic field of Earth.

The results of the test carried out are basically very pleasing. The instrument, delicate in its glass sphere, was deployed safely by the skilled personnel on *Franklin*, and, at the end of the cast, recovered intact. The magnetometer has functioned quite well (not perfectly) and the data recorded have been downloaded safely. From an initial scan of the data it is evident that they give important information on:

1. The depth (order 150 m) at which the magnetic effects of the ship cease to be important;
2. The very smooth vertical gradient in Earth's main magnetic field at the recording site;
3. The need to reduce stray magnetic effects from within the recording package even further;
4. The importance of monitoring the depth of the package; and
5. From a break in the gradient of the magnetic field with depth, evidence of a change in the magnitude of the ocean current at a depth estimated in a preliminary manner to be 400 m.

Scientists Participants:

Iain Suthers	UNSW	Chief Scientist
Peter Barnes	UNSW	
Tim Dempster	UNSW	
Simon Evans	UNSW	
Mark Gibbs	UNSW	
Greg Nipard	UNSW	
Dave Rissik	UNSW	
Kim Smith	UNSW	
Clive Holden	Water Board	
Ted Lilley	ANU	Sydney - Hobart
Maxime Fern	CSIRO	Sydney - Hobart
Dave Edwards	CSIRO -	Cruise Manager
Bob Beatie	CSIRO - ORV	
Bob Griffiths	CSIRO - ORV	

Ship's Crew:

Neil Cheshire (Master)	Dick Dougal (First Mate)
Ian Menzies (Second Mate)	John Scott (Chief Engineer)
Peter Harding (Second Engineer)	Don Roberts (Electrical Engineer)
Tony Bernardin (Greaser)	Jannick Hansen (Bosun)
Klaus Hopp(AB)	Bluey Hughes (AB)
Jack Caldwell (AB)	Gary Hall (Chief Cook)
Bob Clayton (Second Cook)	Reg Purcell (Chief Steward)

April 1994

Table 1. CTD log FR 04/94 - lats and longs correspond to start position. Bondi transect # refers to the 12 standard physical oceanographic stations, and the 5 standard EZ net stations. Times include date.

CTD no.	Bondi trsct#	Time UTC	Time local	Latitude		Longitude		Depth cast	bath mtry
1	test	0239/4	1239/4	33	37.99	151	27.10	55	66
2	(1)	0503/4	1503/4	33	53.93	151	17.87	45	53
3	(2)	0550/4	1550/4	33	54.00	151	18.06	52	60
4	(3)	0652/4	1652/4	33	54.17	151	18.50	60	70
5	(4)	0757/4	1757/4	33	54.44	151	19.01	55	69
6	(5)	0857/4	1857/4	33	54.60	151	19.46	60	70
7	(6)	1000/4	2000/4	33	55.30	151	21.09	70	82
8	(7)	1100/4	2100/4	33	56.09	151	22.99	95	100
9	(8)	1222/4	2222/4	33	56.92	151	25.01	120	132
10	(9)	1337/4	2337/4	33	57.84	151	27.01	120	132
11	(10)	1454/4	0054/5	33	59.06	151	30.08	140	150
12	test*	0739/6	1539/6	33	57.73	151	27.11	110	133
13	(13)	2142/6	0742/7	33	53.79	151	17.76	30	45
14	(14)	2229/6	0829/7	33	54.56	151	20.03	60	72
15	(15)	2305/6	0905/7	33	55.30	151	22.39	80	90
16	(16)	2341/6	0941/7	33	56.14	151	24.54	110	123
17	(17)	0020/7	1020/7	33	56.84	151	26.71	125	132
18	(18)	0100/7	1100/7	33	57.72	151	29.10	140	144
19	(19)	0140/7	1140/7	33	58.53	151	31.39	140	152
20	(20)	0228/7	1228/7	33	59.03	151	33.13	170	173
21	(21)	0320/7	1320/7	33	59.70	151	35.18	240	247
22	(22)	0409/7	1409/7	34	00.36	151	37.17	240	345
23	(22)	2102/7	0702/8	34	00.55	151	37.39	355	363
24	(21)	2202/7	0802/8	33	59.97	151	53.23	250	262
25	(20)	2255/7	0855/8	33	59.22	151	33.12	170	175
26	(19)	2334/7	0934/8	33	58.48	151	30.94	144	149
27	(18)	0012/8	1012/8	33	57.44	151	28.93	140	145
28	(17)	0049/8	1049/8	33	56.83	151	26.60	125	131
29	(16)	0124/8	1124/8	33	56.01	151	24.45	110	115
30	(15)	0211/8	1211/8	33	55.37	151	22.38	83	89
31	(14)	0243/8	1243/8	33	54.60	151	19.93	67	73
32	(4*)	0309/8	1309/8	33	54.50	151	18.90	60	66
33	(4)	0337/8	1337/8	33	54.40	151	18.99	60	68
34	(3)	0359/8	1359/8	33	54.23	151	18.47	65	70
35	(1)	0426/8	1426/8	33	54.83	151	17.80	40	49
36	(20)	0738/8	1738/8	33	59.04	151	33.18	160	172
37	(20)	0808/8	1808/8	33	59.05	151	33.01	160	169
38	(20)	0836/8	1836/8	33	59.04	151	32.82	150	162
39	(1)	2313/8	0913/9	33	53.90	151	17.75	40	48

40	(3)	2340/8	0940/9	33	54.28	151	18.49	65	70
41	(4)	0009/9	1009/9	33	54.42	151	19.01	60	69
42	(14)	0042/9	1042/9	33	54.48	151	20.04	67	73
43	(15)	0118/9	1118/9	33	55.38	151	22.29	83	89
44	(16)	0210/9	1210/9	33	56.11	151	24.32	115	122
45	(17)	0257/9	1257/9	33	56.80	151	26.66	125	132
46	(18)	0343/9	1343/9	33	57.58	151	28.98	140	144
47	(19)	0425/9	1425/9	33	58.20	151	31.09	144	148
48	(20)	0511/9	1511/9	33	59.00	151	33.23	160	172
99	(21)	0556/9	1556/9	33	59.65	151	35.24	235	247
49	(22)	0706/9	1706/9	34	00.46	151	37.34	340	355
50	(1)	0242/10	1242/10	GPS out				40	47
51	(2)	0307/10	1307/10	33	54.00	151	17.93	65	54
52	(4)	0332/10	1332/10	33	54.38	151	19.02	63	65
53	(14)	0358/10	1358/10	33	54.57	151	19.95	67	72
54	(15)	0435/10	1435/10	33	55.34	151	22.16	80	88
55	(16)	0509/10	1509/10	33	56.04	151	24.44	115	121
56	(17)	0542/10	1542/10	33	56.81	151	26.74	125	132
57	(18)	0618/10	1618/10	33	57.67	151	29.01	135	144
58	(19)	0652/10	1652/10	33	58.29	151	31.05	140	149
59	(20)	0732/10	1732/10	33	59.06	151	33.21	160	173
60	(21)	0813/10	1819/10	33	59.78	151	35.22	240	151
61	(22)	0900/10	1909/10	34	00.41	151	37.32	341	353

(* discard)

Table 2. EZ log FR 04/94 (same as FR02/94)

Station	Latitude	Longitude	depth	depth bins (+surface)
A	33 56.7	151 17.5	67	50-40, 40-30, 30-15
B	33 57.5	151 20.0	83	70-60, 60-40, 40-15
C	33 57.0	151 26.6	130	120-80, 80-40, 40-15
D	34 00.0	151 35.0	250	120-80, 80-40, 40-15
E	34 02.5	151 40.0	600	120-80, 80-40, 40-15

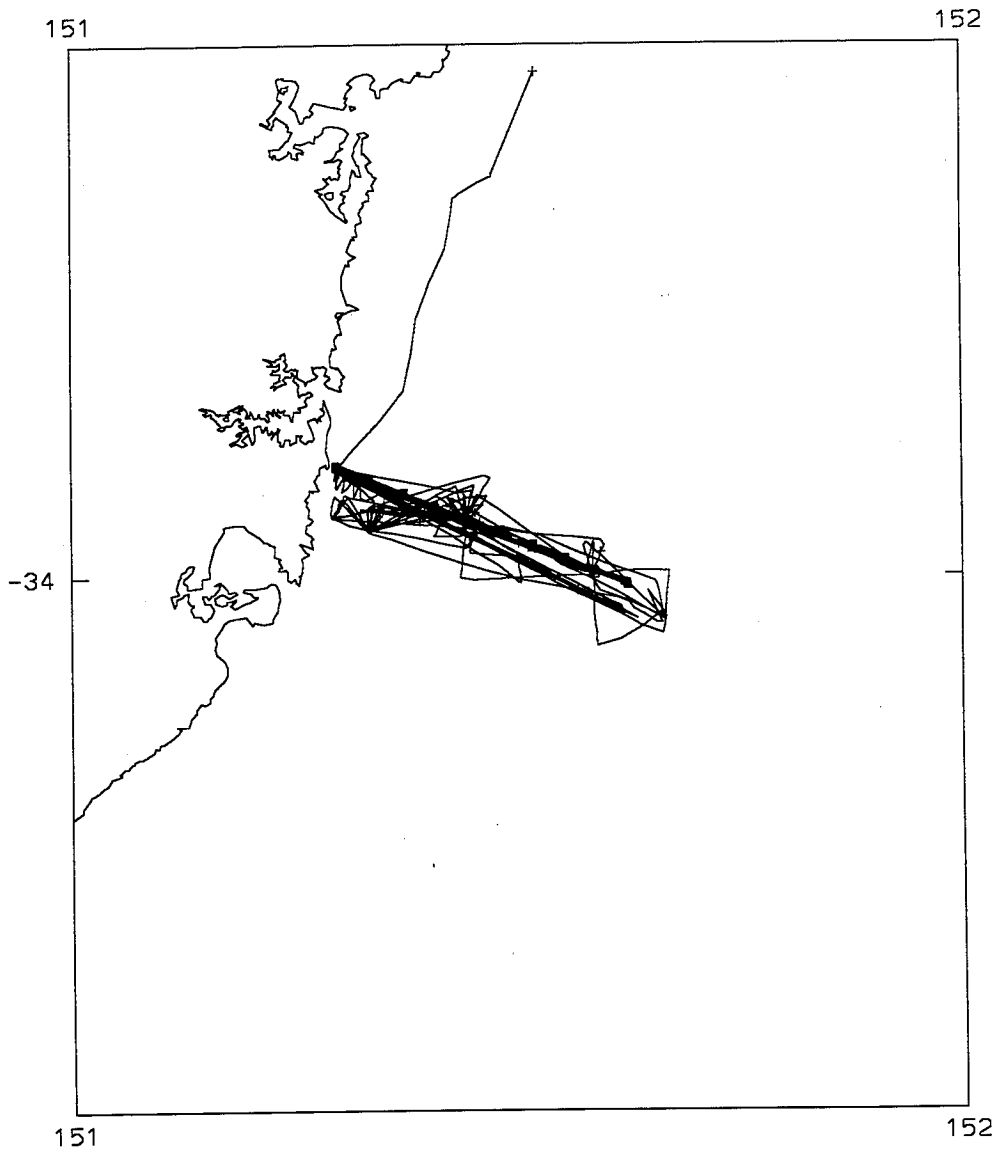

Fig. 1. Cruise track of FR4/94

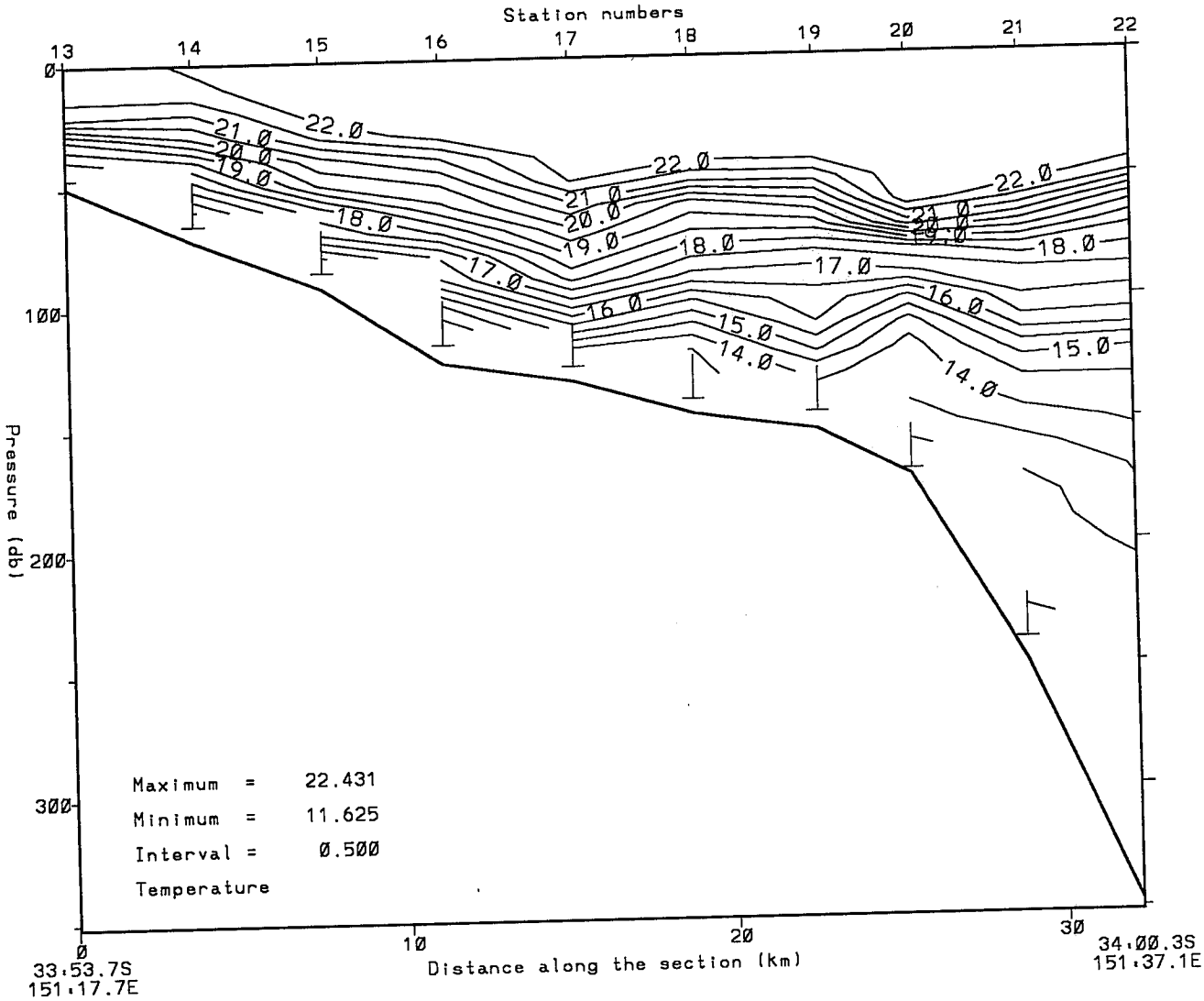

Fig. 2a) Temperature profiles from CTD casts along the Bondi transect. 7 April 1994 (local), illustrating possible first and second mode structures of intenal waves. Note 14-16°C isotherms, and 22° C isotherm. Note also, the rise in the 18° isotherm over 30km.

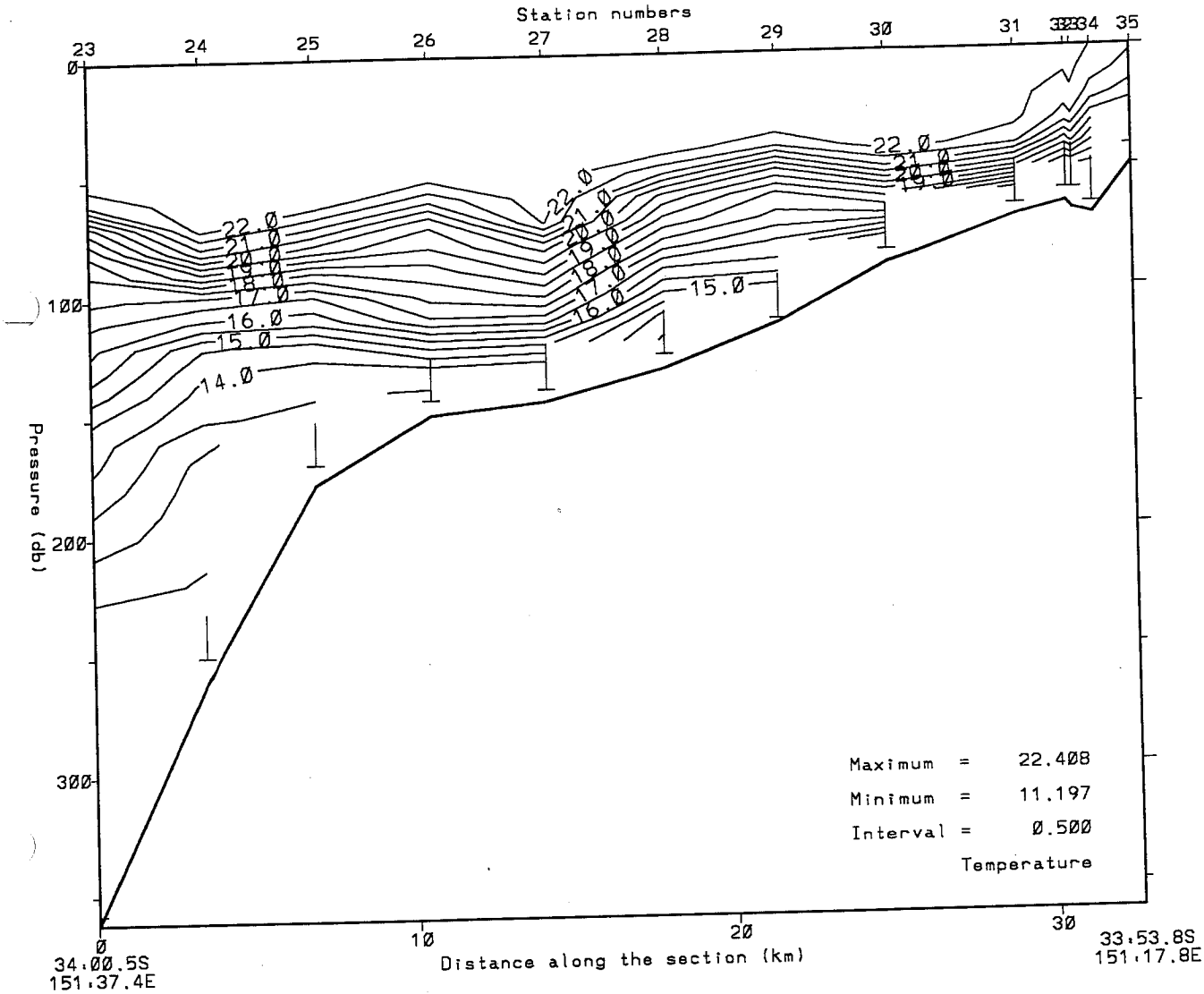

Fig. 2b) Temperature profile from CTD casts along the Bondi transect, 8 April 1994 (local).

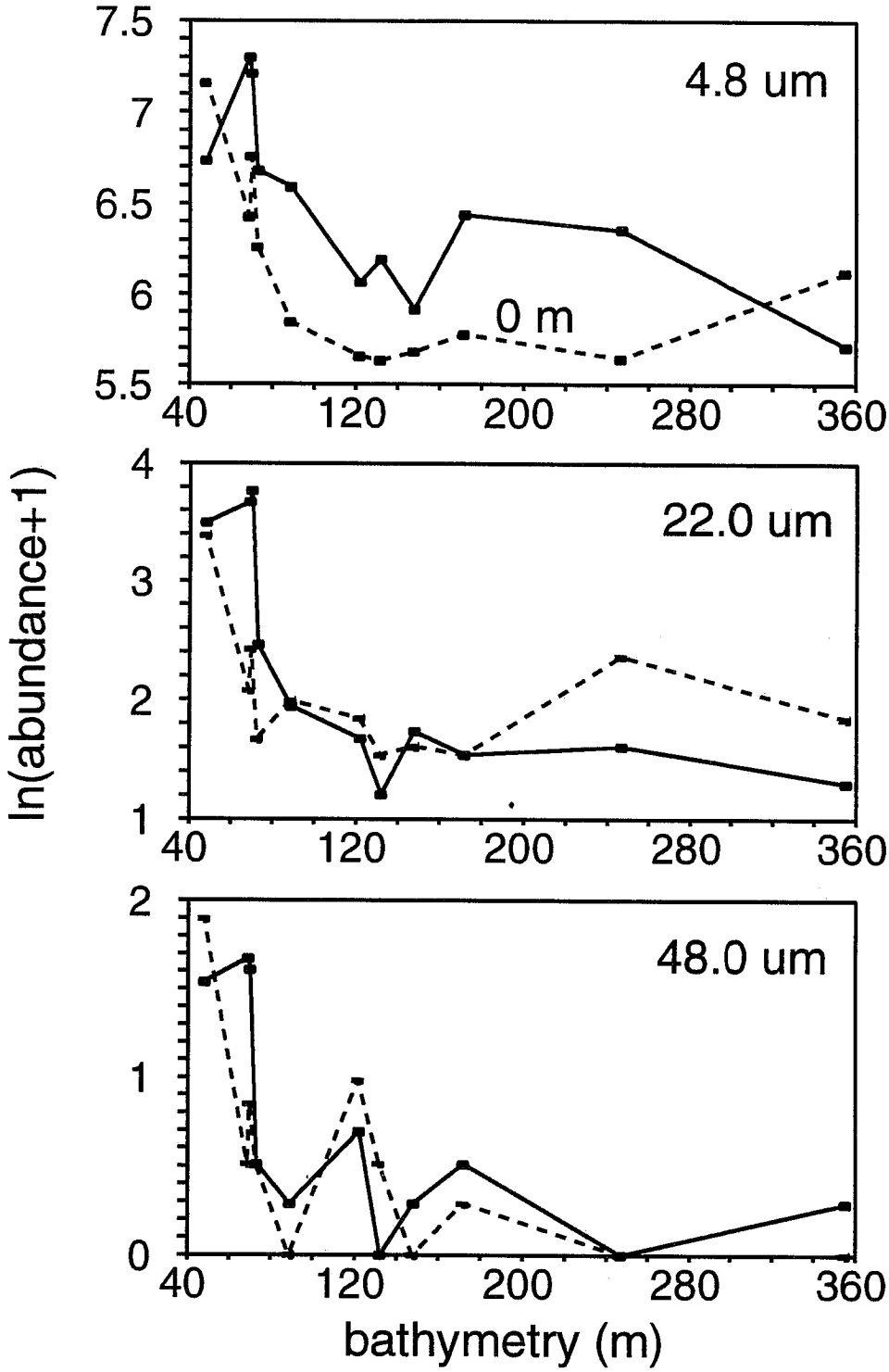

Fig.3 HIAC particle counts in 10 ml across the Bondi transect, on April 9 1994, at the surface (dotted) and beneath the mixed layer (solid line). Three representative sizes from 9 channels were suggested from principal component analysis.