CRUISE REPORT SS 01/95

January 14 – February 2, 1995

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CSIRO
AUSTRALIA

DIVISION OF **FISHERIES**

ITINERARY

Departure: Hobart 1000h Saturday January 14
Arrival: Hobart 1530h Thursday February 2

AREA OF OPERATION

The cruise was carried out in waters south and west of Tasmania, including a transect from 53°00'S to 40°00'S along 140°00'E, and a transect from 140°00'E to the shelf off Cape Grim on the northwest tip of Tasmania.

RESEARCH BACKGROUND.

One of the objectives of the Marine Carbon Cycles Project, as part of the INRE Climate Change Research Program, is to identify and understand the interactions of the physical, chemical and biological processes controlling the pools and fluxes of carbon within and between the atmosphere and the ocean in the Southern Ocean in the Australian region. The sub-tropical convergence zone (STCZ), subantarctic front (SAF) and the subantarctic zone between 40° and 55°S are known to be important global sinks of atmospheric CO_2. The physical, chemical and biological factors responsible for drawing down CO_2 in surface waters in this zone are still a subject of international research. It seems probable that both physical factors (cooling of subtropical water advected south) and biogeochemical factors (biological production and export of organic carbon, supported by nutrients supplied by Antarctic water advected north) contribute to this draw-down. Quantifying these processes, and predicting their response to changes in ocean climate and circulation, will be carried out by the analysis of repeat sections of biogeochemical properties, and through the development of process-based models of carbon and nutrient cycling based on field observations and process experiments. The repeated sections are being carried out along the SR3 line as part of the WOCE series of cruises on Aurora Australis.

Previously, data have been collected in the Convergence Zone east and directly south of Tasmania. The proposed cruise will sample an area west of Tasmania where very little is known about the latitudinal variation in nutrients, trace elements, primary production and carbon dioxide north of about 50S. This region is expected to provide an interesting contrast, in that the input of subtropical water from the East Australian Current should be much reduced or absent. It is thought that inputs of iron from atmospheric aerosols to surface waters are also lower west of Tasmania. Comparisons of properties along sections and results from biological process experiments obtained east and west of Tasmania should throw light on competing hypotheses about the role of physics and biology in CO_2 draw-down, and the effects of iron in regulating phytoplankton production.

The cruise plan has been designed to provide time to occupy a latitudinal series of process stations each of 24 to 48 hours duration, allowing the deployment of free-floating sediment traps, the in situ incubation of phytoplankton samples, and the collection of water for trace metal and organic carbon analysis.

The cruise plan has also been designed to collect biogeochemical data southwest of Cape Grim, where a long time series of atmospheric chemistry measurements has been made. A number of the atmospheric variables measured at Cape Grim, including oxygen, ammonia and nitrate, potentially provide information about large scale changes in ocean biology upstream of Cape Grim. The data collected in this cruise will improve understanding of the relationship between ocean biology and atmospheric composition, and potentially help to open another window on seasonal and interannual variation in the Southern Ocean.

This cruise forms part of Australia's contribution to an international research program, the Joint Global Ocean Flux Study. Data from the cruise will be combined with data collected by other nations as part of the second phase of the JGOFS Southern Ocean Regional Study. Further, a major multi-disciplinary international experiment (ACE-1) is planned for the region west of Tasmania in November-December 1995. This experiment, sponsored by the International Global Atmospheric Chemistry Program, will primarily address atmospheric chemistry and cloud dynamics over the Southern Ocean. It will focus especially on sulphate aerosols which are thought to form the principal cloud condensation nuclei in this region, and to derive primarily from DMS produced by phytoplankton. The DMS-aerosol-cloud link is regarded as one of the major uncertainties in feedbacks in climate models. The experiment will involve a large team of US and Australian scientists, US research aircraft, and one US NOAA research vessel. A group of US oceanographers are planning to participate in the experiment, to look at atmosphere-ocean exchanges. Data collected on this cruise will contribute to the planning of Australian and international activities in ACE-1, and extend the interpretation of ACE-1 results.

CRUISE OBJECTIVES:

1. To characterise the in-situ optical properties, including spectral absorption and upwelling and down-welling spectral irradiance, in different water masses west of Tasmania. (Parslow)

2. To determine how carbon fluxes, measured by primary production, direct measures of growth rates, sedimentation, microzooplankton grazing, and

respiration vary in response to differences in chemical and physical forcing in different water masses west of Tasmania. (Parslow/Griffiths)

3. To determine dissolved and suspended particulate carbon concentrations with respect to vertical and mesoscale oceanic structure, and to compare these standing stocks with primary production estimates. (Trull)

4. To determine the isotopic composition of phytoplankton carbon and nitrogen to examine the validity of using sedimentary organic matter isotopic compositions as tracers of surface-ocean paleo-CO2 and paleo-productivity. (Trull)

5. To determine the mixed-layer distribution of dissolved Fe, Mn, and Al in relation to dissolved organic carbon concentrations and phytoplankton biomass, in order to explore the possible control of organic matter production and transformation in nutrient-rich waters by trace-metal availability. (Sedwick)

6. The acoustic backscatter of organisms at 12, 38 and 120 kHz will be recorded continuously as part of a long term study to describe the distribution and movement of
biological organisms in the Southern ocean. (Kloser)

RESULTS

Cruise objectives were generally fully met or almost fully met. The weather was kind, given the cruise location, and relatively little time was lost due to weather, and that primarily due to reduced vessel speed between stations. Underway surface data (temperature, salinity and fluorescence) were collected while steaming between Hobart and 53°00'S, 140°00'E, on the transect along 140°00'E from 53°00'S to 40°00'S, and along the transect between 40°00'S, 140°00'E and the shelf station off C. Grim. Underway surface nutrient data were also collected along most of these transects.

As planned, six process sites were occupied, at 53°00'S, 50°00'S, 45°00'S, 43°00'S, and 40°00'S along 140°00'E, and at ca 41°04'S, 143°33'E, at the 2000m contour on the slope off C. Grim. The sites were occupied for periods of ca 36 to 52 hours, depending on time of arrival and weather. It was originally planned to occupy process sites for at least 48 hours, but loss of time in transit meant that time spent at some process sites had to be reduced. By combining and rearranging some process experiments, this was achieved with very little adverse effect on objectives.

CTD stations to 1000m were conducted at all process sites, and at 1° intervals along 140°00'E between process sites. CTD stations to 1000m (or bottom) were also conducted at 41°30'S, 142°00'E, and then at 41°15'S, 142°50'E, and at the

2000m, 1000m, 200m and 100m contours on a transect toward Cape Grim. Nutrients, pigments, and in some cases DOC were measured on these CTD sections.

Process sites were chosen to sample the major water masses and fronts, based on underway and CTD data, and AVHRR SST satellite imagery. The site at 53°S lay well south of the Subantarctic Front, in water with a surface temperature of 5°C. The site at 50°S lay within the Subantarctic Front. (A satellite image showed a southward intrusion of warm water had pushed the Subtropical Front south to almost merge with the Subantarctic Front at 50°S.) The drifting trap array deployed in this front travelled slightly south of east at ca 1 knot. The next site lay in the water mass north of the Subtropical Front, and was chosen to avoid the complex mesoscale intrusion of cooler water between 46 and 48°S. However, the maximum surface fluorescence encountered on the cruise occurred between 47 and 48°S, associated with this mesoscale feature. The process site at 43°S lay in the vicinity of a front between the cooler, fresher water of 45°S, and a warmer, more saline subtropical water mass centred on 40°S. The sixth process site lay on the 2000m contour on the Cape Grim transect. This site was chosen over the slope, further offshore than desired, in case the sediment trap array drifted onshore under prevailing westerlies. In fact, the array showed little evidence of onshore drift, and appeared to be effectively drogued by the traps at 200 and 700m.

OBJECTIVE 1. CHARACTERISE IN-SITU OPTICAL PROPERTIES.

An optical package consisting of spectroradiometer, SeaTech fluorometer, and SeaCat CTD was deployed 2 to 4 times at each process site, and at the mid-shelf station off C. Grim. The spectroradiometer, an in-house prototype, showed high sensitivity and stability, and low noise. Profiles of upwelling and downwelling spectral irradiance were made to ca 80m at each station. Preliminary analysis of upwelling irradiance spectra suggests that the passive solar-stimulated fluorescence peak at 685nm was clearly detected. Samples were collected at each site for measurement of absorption spectra of particulate and dissolved constituents at 3 to 6 depths.

OBJECTIVE 2. CARBON FLUXES.

Samples for pigment analysis by HPLC were collected at (typically) 6 depths in the upper 150m at each cast where samples were used for incubation. The sample depths were adjusted at each site based on the vertical CTD fluorescence profile. This profile varied from a deep subsurface chlorophyll maximum at 53°S, to a mixed layer maximum at frontal zones, and a relatively shallow (35m to 50m) subsurface maximum at the northern end of the transect. At all process sites and a number of other CTD stations, pigment samples were collected by Mr Matsumoto to be analysed in Japan by HPLC and

spectrofluorometric techniques, as part of a collaborative Japanese-Australian project under the Japanese Global Research Network System.

At each process site, a small-bottle ^{14}C incubation technique was used to measure Photosynthesis vs Irradiance (PvsI) parameters at 3 times of day (dawn, midday and dusk), at six depths. At the first 5 process sites, an additional PvsI study was used to estimate short-term DOC release by phytoplankton. At 3 process stations, experiments were carried out to compare PvsI parameters for samples collected in Niskin bottles retro-fitted with silicone rubber, with those collected in regular Niskins. In-situ ^{14}C incubations over 24 hours were successfully conducted at 6 depths at 4 process sites, using paired light and dark 500ml polycarbonate bottles attached to the upper 100m of the line on the sediment trap array.

A number of new experimental procedures were trialled on this cruise. At each process site, simulated in-situ ^{15}N incubations were carried out for 3 hours at dusk and dawn to measure nitrate and ammonia uptake in the mixed layer, and in the subsurface chlorophyll maximum. Filtrate was collected at these stations for determination of inorganic and organic N and P.

One attempt was made to conduct 24 hour in situ oxygen uptake experiments, but the replication among duplicates was not good enough to provide useful estimates of fluxes. Subsequent tests suggested that replication may be improved, but was likely to provide only marginal precision at the in situ photosynthetic rates. Further work is needed on this technique, before it can be used as a routine measure.

Two attempts were made to conduct in situ zooplankton grazing dilution studies, using paired 2 litre polycarbonate bottles attached to the sediment trap array at three depths. Only one set was successfully retrieved, and this produced equivocal results. Again, further testing of this technique is required.

Attempts were made to deploy the free-floating sediment traps at all process sites. At 53°S, the deployment had to be aborted due to high and increasing winds (35 to 40 knots). At the last site off Cape Grim, the array was successfully deployed, and then lost ca 9 hours later when the line was accidentally severed during an attempt to reattach a string of surface floats. A number of traps were smashed on deck during the first two deployments, so that a reduced number of samples were obtained at each depth. Nonetheless, samples were successfully obtained from the other 4 process sites. Large amphipods were commonly observed as swimmers in the deep traps at most sites.

Drop net zooplankton samples (0-100m) were obtained at process sites, and at some other stations between sites. Large numbers of pyrosomes were observed in surface waters at night, and in drop net samples, on the 140°E transect.

Phytoplankton samples were collected and preserved for SEM analysis from the surface and chlorophyll maximum at all process sites.

OBJECTIVE 3,4. DISSOLVED AND PARTICULATE ORGANIC CARBON AND ISOTOPE COMPOSITION.

DOC samples were collected and analysed in both upper layer and 1000m casts at all process sites, and at most other CTD stations on the transect. Most of these samples were analysed on board, using a Shimadzu high-temperature catalytic combustion system. On the southern half of the transect, DOC samples were generally low and close to deep ocean background, even in surface waters. Surface levels increased to the north, and in shelf/slope waters.

At all process sites, large volumes were collected at 6 depths in the top 200m, and from 700m, and filtered through GFF filters, to measure POC concentration and isotope composition.

OBJECTIVE 5. TRACE METALS.

A Superbraid non-metallic hydrowire and epoxy-coated winch was set up for trace-metal sampling with custom-built CSIRO 6-L polycarbonate bottles. The system worked well, with samples collected from 6 depths at 5 process sites. In addition, surface water samples were collected at each site (while steaming at ~2 knots) using bottles mounted on an aluminium pole. Shipboard determinations of dissolved iron and manganese were carried out in the clean container in the aft deck using flow injection analysis, and samples preserved for later analysis of total-dissolvable metals. At southern stations, Fe concentrations were low (~0.2 nM) in surface waters. Iron concentrations increased to around 0.8 nM in surface waters off the slope.

OBJECTIVE 6. ACOUSTIC BACK SCATTER.

The ship's acoustic system was run throughout the cruise, both underway and at process sites, and logged digitally for post-cruise analysis.

CRUISE NARRATIVE.

SATURDAY, 14 JANUARY.

Southern Surveyor departed Hobart at 1000h. At ca 1300h, a test station was conducted in the sheltered waters of Storm Bay. The CTD, Kevlar and radiometer deployment systems all worked correctly. However, the CTD salinity sensor was found to be covered by a brown film when the protective cap was removed, and the sensor malfunctioned, even after cleaning with

10%HCL. At 1440h, the test station was completed, and the ship headed south and west for 53°S, making good speed in calm seas.

SUNDAY, 15 JANUARY.

Southern Surveyor continued SSW, making good speed in a slowly increasing swell. Two CTD casts to 1000m were conducted at 1000h to leak-test the Niskins. A number of bottles leaked, especially those retrofitted with silicone rubber closures. After tightening the silicon rubber closures and swapping some components, a set of 12 leak-proof silicone-fitted Niskins were eventually produced. The new salinity sensor appeared to read at least 1 PSU too high before calibration. The ship resumed steaming at 1230h, but the weather deteriorated, with wind increasing to 30 knots, and speed decreasing to ca 7 knots.

MONDAY, 16 JANUARY.

The ship continued SSW, with weather improving. A deep CTD cast was conducted at 1000h to obtain a set of salinities to calibrate the new salinity sensor. After calibration, the new sensor performed well throughout the remainder of the cruise. Weather and sea continued to improve, and ship speed increased to 10 knots. The ship crossed a major front during the afternoon, at about 50°S, with surface temperature dropping from 11°C to 8°C.

TUESDAY, 17 JANUARY.

The ship arrived at the first process site (53°00'S, 140°00'E) at 1030h. A CTD cast to 1000m was carried out for OMS nutrients, oxygen and DOC. Conditions were moderately rough, and one Niskin was lost, and another badly damaged during CTD recovery. These were the only losses during CTD operations for the cruise. Four shallow CTD casts were carried out from 1200h to 2120h for POC samples, PvsI and preparation for in situ incubations. A spectroradiometer profile was obtained at 1300h.

WEDNESDAY, 18 JANUARY.

Deployment of the sediment trap array commenced at 0200h, but was aborted at 0300h, as a wind squall and rising swell made it impossible to hold the ship's stern into the wind. CTD casts for PvsI incubations were carried out at 0540h, 1210h and 1900h, and ^{15}N incubations and POC release experiments were carried out using samples from the 1900h CTD cast. Spectroradiometer profiles were obtained at 1020h and 1245h. Samples for absorption spectra were obtained from the 1230h CTD cast. Kevlar casts for trace metals were conducted at 0840h and 1050h. A zooplankton drop net sample was obtained at 1200h. A deep CTD cast for POC was conducted at 1645h. The ship departed the site at 2030h.

THURSDAY, 19 JANUARY.

The ship arrived at 52°S at 0300h, where a CTD cast to 1000m for OMS and pigments, and a zooplankton drop net were conducted. Increasing wind ahead of a weather front reduced ship speed and the next CTD station was reached at 1300h, where a 1000m CTD cast was conducted. The ship steamed north into a strong northerly, and arrived at 50°20'S at 2010h. Another 1000m station was completed, and it was decided to move on and locate the next process site in the middle of the Subantarctic Front, to obtain a greater contrast in water mass characteristics. The process site was eventually located at 49°57'S, at a surface temperature of ca 9°C, and a salinity of 34.6.

FRIDAY, 20 JANUARY.

The ship arrived at the selected process site at 0000h, and a CTD cast to 1000m was conducted. Shallow CTD casts were conducted at 0530h and 1210h for PvsI, pigments, and ^{15}N on the morning cast. Shallow CTD casts were made at 0820h and 1050h for POC. Radiometer casts were conducted at 1000h and 1300h, and absorption spectra samples taken on the 1210h cast. A CTD cast was made at 1640h for deep POC, and a shallow cast at 2000h to prepare for in situ incubations. The sediment trap array deployment commenced at 2230h, and was completed successfully despite wind squalls to 30 knots and more.

SATURDAY, 21 JANUARY.

Shallow CTD casts were conducted at 0620h for PvsI (DOC release) and at 1910h for PvsI and ^{15}N incubations. The Kevlar casts scheduled for the morning were cancelled because of adverse weather and the risk of losing the drifting array. The sediment trap array moved rapidly ESE throughout the day at ca 1 knot. This is not surprising, as the front should form the northern core of the Antarctic Circumpolar Current.

SUNDAY, 22 JANUARY.

The sediment trap array was recovered under favourable conditions (wind ca 20 knots and low seas). Kevlar casts for trace metals were carried out between 0200h and 0600h, when the ship departed the site. The wind increased to 30 knots ahead of the next weather front, and the ship made slow time, arriving at 49°S at 1450h, where a CTD to 1000m was carried out for OMS, pigments, and DOC, and a zooplankton drop net sample obtained. The ship continued northwards at ca 7 knots into a strong northerly wind, reaching 48°S at 2400h. A 1000m CTD cast for OMS, pigments and DOC, and a zooplankton drop net were conducted, and a PvsI experiment carried out.

MONDAY, 23 JANUARY.

The ship arrived at 47°S at 0900h and a CTD cast for OMS, pigments, DOC and PvsI, and a zooplankton drop net were conducted. The weather front passed about 1200h and the wind turned southerly at 10 to 20 knots. Ship speed increased to 10 knots, and the ship arrived at 46°S at 1600h. Again, a CTD cast

to 1000m for OMS, pigments, DOC and PvsI, and a drop net, were conducted. The ship arrived at the next process site, at 45°S, 140°E, at 2200h, and a shallow CTD cast was conducted to prepare for the in situ incubation. The sediment trap array was deployed successfully under favourable conditions starting at 2350h.

TUESDAY, 24 JANUARY.

Shallow CTD casts were conducted at 0515h and 1900h for pigments, PvsI and ^{15}N incubations, and a shallow cast at 1230h for pigments, PvsI, and spectral absorption. Spectroradiometer profiles were obtained at 1000h and 1300h. Two shallow CTD casts were made at 0810h and 1050h, and a deep cast at 1500h, for POC.

WEDNESDAY, 25 JANUARY.

The sediment traps were successfully retrieved at 0030h. The array at this site drifted slowly WNW, consistent with the westerly flow observed south of Tasmania on WOCE transects. A CTD cast to 1000m for OMS and DOC was made at 0200h, and Kevlar casts for trace metals between 0300 and 0730h. A shallow CTD cast was conducted at 0740h for pigments, PvsI (DOC release), and the ship left the process site at 0815h in calm conditions under overcast skies, arriving at 44°S at 1300h. A CTD station was conducted to 1000m for OMS, pigments and DOC, and a zooplankton drop net sample obtained. A satellite image received on the ship showed a strong temperature front near 43°S, and it was decided to conduct the next process site at that front. The ship arrived at 43°S at 1940h, and a 1000m cast for OMS and DOC was followed by a shallow cast at 2150h for in situ incubations. The sediment trap array was deployed at 2330h in favourable conditions.

THURSDAY, 26 JANUARY.

The weather continued calm and overcast. A zooplankton drop net was conducted at 0100h. CTD casts were conducted at 0510h and 1900h for pigments, PvsI, ^{15}N, and at 1230h for pigments, PvsI and spectral absorption. Spectroradiometer profiles were obtained at 1000h and 1300h. Shallow CTD casts were conducted at 0800h and 1040h, and a deep cast at 1500h, for POC. The sediment traps were successfully recovered at 2330h.

FRIDAY, 27 JANUARY.

The Kevlar cast scheduled for 0200h was cancelled for this process site, due to a sample processing backlog. A CTD cast was conducted at 0630h for pigments and PvsI (DOC release). The ship left the process site at 0730h, making good speed ahead of a 20 knot southerly. A temperature front was crossed at ca 42°40'S, and a 1000m CTD cast for OMS and pigments conducted on arriving at 42°S at 1300h. The ship arrived at 41°S at 1920h, where a 1000m CTD cast was again obtained. The wind speed increased to 30 knots from the SE, due to a

low near Adelaide. It was decided to to locate the northernmost process site well within warmer "subtropical" water at 40°S.

SATURDAY, 28 JANUARY.

The ship arrived at the process site at 0300h, and a CTD cast to 1000m for OMS was conducted immediately. Shallow CTD casts were conducted at 0530h for PvsI and ^{15}N incubations, and at 1310h for PvsI and spectral absorption. Kevlar casts for trace metals were made at 0730h and 1030h, and spectroadiometer profiles obtained at 1000h and 1340h. A zooplankton drop net sample was obtained at 1300h. Two shallow CTD casts for POC were made at 1500h and 1700h. A shallow CTD cast for pigments and in situ incubations was made at 1905h, and the sediment trap array was deployed at 2140h in calm conditions.

SUNDAY, 29 JANUARY.

A shallow CTD cast was made at 0420h to analyse the precision in analysis of replicate oxygen samples, and a further cast at 0530h for pigments and PvsI (DOC release). A deep cast was made at 0800h for POC, and a shallow cast at 1300h to obtain samples for an intercomparison of HPLC measurements using samples stored in liquid nitrogen, and samples frozen in di-methyl formamide. Radiometer profiles were obtained at 1000h and 1330h, under calm and sunny conditions. A shallow CTD cast was conducted at 1900h for pigments, PvsI, ^{15}N. The sediment trap array was recovered in calm conditions at 2200h, and the ship left the site at 2330h.

MONDAY, 30 JANUARY.

The ship made a transect from 40°00'S, 140°00'E to 41°30'S, 142°00'E, where it arrived at 0930h and a CTD cast to 1000m was conducted for OMS, DOC, and PvsI. This station represented the start of an offshore-onshore transect approaching Cape Grim from the WSW. Further deep CTD casts were made at 41°15'S, 142°50'E at 1430h, at 41°04'S, 143°33'E (the 2000m contour) at 1815h, and at 41°01'S, 143°45'E (the 1000m contour) at 2025. It was decided to return to the 2000m station for the process site, because of concern that the sediment trap array might drift onto the shelf under a strong westerly air flow. A shallow CTD cast was conducted at 41°04'S, 143°32'E at 2235h for in situ incubations.

TUESDAY, 31 JANUARY.

The sediment trap array was successfully deployed under moderate conditions (ca 25 knots of wind) at 0100h. A zooplankton drop net sample was obtained at 0300h, and shallow CTD casts made for PvsI and ^{15}N at 0530h and 1900h. A Kevlar cast was made for trace metals at 0730h. At ca 1030h, during an attempt to reattach a string of small floats which had become detached from the free-floating trap array, a further set of floats (critical for buoyancy) was sucked into the stern thruster and the line severed, leading to the loss of the array, including traps and in situ bottles, in ca 2000m of water. The second Kevlar cast was made at 1115h, and a zooplankton drop net sample obtained at 1300h.

Spectroradiometer profiles were obtained at 1100h and 1400h, and a shallow CTD cast for pigments, PvsI and spectral absorption made at 1330h. At 1500h and 1700h, shallow CTD casts were made for POC. On the first cast, a cloudy discharge from the ship on the starboard side aft of the CTD A-frame was observed to wash forward over the CTD, and two bottles fired in the surface were observed to smell strongly of oil. These were subsequently washed carefully in detergent before the next cast. A deep CTD cast for POC was conducted at 2250h.

WEDNESDAY, 1 FEBRUARY.

A shallow CTD cast was conducted at 0600h for PvsI, pigments. The ship resumed the C. Grim transect following this cast, repeating the CTD station on the 1000m contour at 0835h, and carrying out CTD casts at 40°55'S, 143°49'E (the 200m contour) at 1045h, and at 40°48'S, 144°13'E (ca halfway across the shelf) at 1400h. At this shelf station, samples were taken for POC, pigments, PvsI and spectral absorption, and a spectroradiometer profile and drop net sample were obtained. At 1500h, the ship set course for Hobart. In the evening, a large number of jack mackerel schools were observed on the shelf north of Macquarie Harbour.

THURSDAY, 2 FEBRUARY.

The ship arrived in Hobart at 1530h.

SUMMARY.

Objectives were generally completely or almost completely met. CTD sections and underway T,S and F data were obtained as planned along 140°E, and along a section from offshore to onshore WSW of Cape Grim. Six process sites were occupied, where a comprehensive suite of physical, chemical and biological measures were made. The data when analysed should provide a clear picture of the latitudinal and vertical distribution of properties through the Subantarctic Front and Subtropical Convergence west of Tasmania in summer, and the relative role of mixing, light limitation, and micro and macronutrient limitation of phytoplankton production and carbon flux in this region.

Sediment traps were successfully deployed and recovered at four of the six process sites, including two frontal sites. In situ ^{14}C incubations were successfully carried out at four process sites, allowing an intercalibration of in situ based production estimates with estimates based on shipboard PvsI parameters. Further development of grazing dilution and oxygen incubation techniques is required. Upwelling and downwelling spectral irradiance profiles were obtained at all process sites, along with samples for particulate and dissolved absorption spectra, HPLC pigments, and PvsI parameters. ^{15}N incubations for nitrate and ammonia uptake were conducted at process sites.

PERSONNEL

(Note: unless otherwise indicated,
personnel are staff of the CSIRO Division of Fisheries).

Dr John Parslow (Cruise Leader)
Brian Griffiths
Don McKenzie
Kate Berry
Matt Sherlock
Lindsay Macdonald
Val Latham (CSIRO Division of Oceanography)
Dr Tom Trull (University of Tasmania)
Dr Peter Sedwick (University of Tasmania)
Mr Michael Mackey (University of Tasmania)
Mr Ross Edwards (University of Tasmania)
Mr Kazuhiko Matsomoto (JAMSTEC, Japan)

SHIP'S COMPANY

Bruce Wallis, Master
Roger Pepper, First Mate
John Boyes, Second Mate
Pat Gibbons, Chief Engineer
Ian Murray, First Engineer
John Hinchcliffe, Second Engineer
Tony Fearne, Bosun
Alan Brownlie, A.B.
Colin Heebick, A.B.
Mal McDougall, A.B.
John Spinks, A.B.
Len Darling, A.B.
Lou Jacomos, A.B.
Drew Meincke, Grsr.
Noel Anderson, Chief Steward
Jamie Robertson, Chief Cook
Don Collins, Second Cook

ACKNOWLEDGEMENTS

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John Parslow
Cruise Leader

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Date:

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DISTRIBUTION

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Ship's company

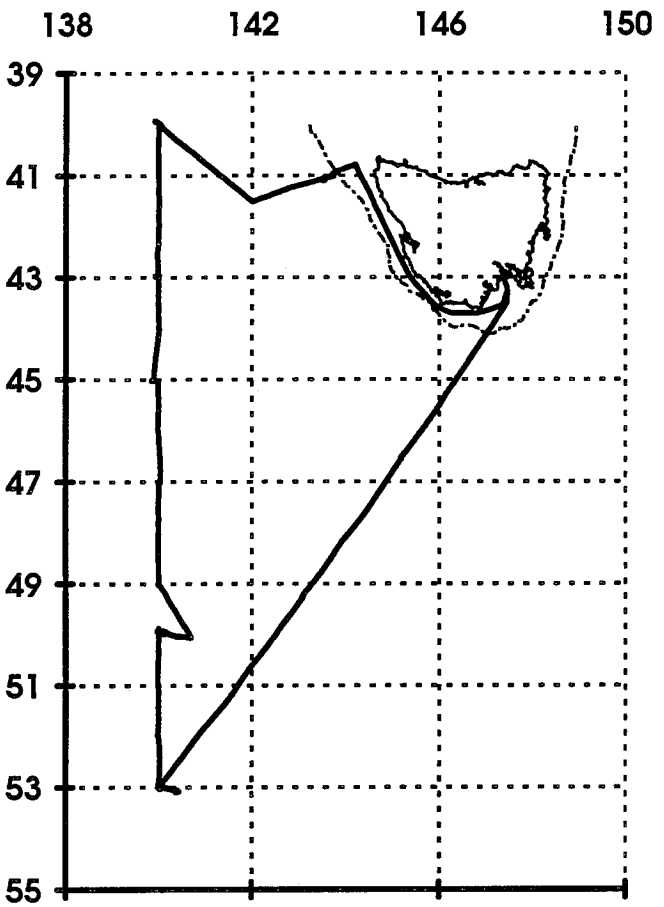

Fig. 1 Cruise Track.

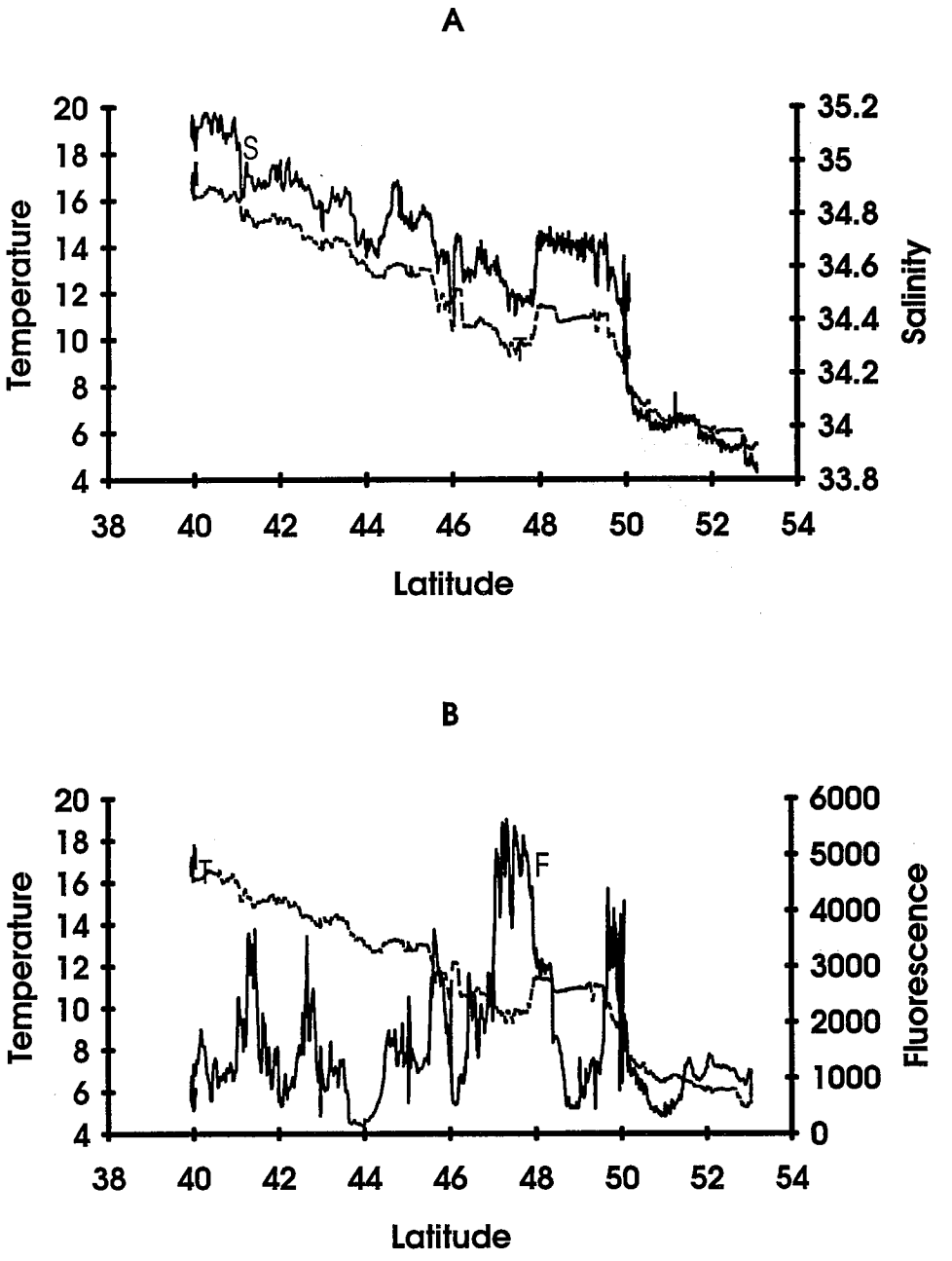

Fig. 2 (A) Underway surface temperature(T), salinity(S) along the 140°E transect. (B) Underway surface temperature(T), fluorescence(F) along the 140°E transect.

APPENDIX 1. DETAILS OF SAMPLING STATIONS.

STN NO.	LAT (°S)	LONG (°E)	DATE	TIME	DEPTH	DESCRIPTION OF OPERATION / SAMPLING
1	46°33.0'	145°10.8'	15/1/95	1000h	3482	CTD (1000m), leak test
2	49°16.1'	143°05.8'	16/1/95	0855h	3950	CTD (1200m), calibration.
3	53°00.2'	140°01.0'	17/1/95	1052h	3088	CTD (1000m)
4	52°59.5'	140°07.6'	17/1/95	1324h	2983	CTD (100m)
5	53°01.2'	140°11.1'	17/1/95	1545h	2460	CTD (150m)
6	53°02.1'	140°14.1'	17/1/95	1730h	2160	CTD (150m)
7	53°03.3'	140°19.9'	17/1/95	2120h	2992	CTD (150m)
8	53°04.3'	140°21.0'	18/1/95	0540h	3075	CTD (300m), Kevlar Cast, Radiometer
9	53°03.7'	140°24.6'	18/1/95	1256h	3147	CTD(150m),Radiometer,Drop net.
10	52°59.9'	140°01.0'	18/1/95	1700h	3142	CTD (1000m)
11	53°02.2'	140°02.5'	18/1/95	2000h	2877	CTD (300m)
12	52°00.1'	139°59.7'	19/1/95	0258h	1906	CTD (1000m)
13	51°00.4'	140°00.5'	19/1/95	0145h	3497	CTD (1000m)
14	50°19.9'	140°00.1'	19/1/95	2000h	3858	CTD (1000m)
15	49°56.8'	140°02.0'	19/1/95	2355h	3740	CTD (1000m)
16	49°57.3'	140°00.5'	20/1/95	0530h	3741	CTD (300m)
17	49°57.3'	140°00.3'	20/1/95	0820h	3730	CTD (100m), Radiometer
18	49°59.5'	140°04.9'	20/1/95	1050h	3768	CTD (200m)
19	49°56.7'	139°59.1'	20/1/95	1308h	3725	CTD (125m),Drop Net,Radiometer
20	49°56.5'	140°08.4'	20/1/95	1630h	3826	CTD (700m)
21	49°57.2'	139°59.9'	20/1/95	2000h	3714	CTD (125m), Drop Net
22	49°58.6'	140°06.4'	21/1/95	0615h	3836	CTD (300m), Radiometer
23	50°01.8'	140°20.5'	21/1/95	1915h	4293	CTD (150m)
24	50°03.8'	140°04.0'	22/1/95	0200h		Kevlar Cast
25	49°00.0'	140°00.0'	22/1/95	1445h	3895	CTD (1000m)
26	48°00.1'	139°59.8'	23/1/95	0000h	4581	CTD (1000m)
27	47°00.1'	140°00.2'	23/1/95	0905h	4750	CTD (1000m)
28	46°00.8'	139°58.9'	23/1/95	1615h	4607	CTD (1000m)
29	45°04.5'	139°59.7'	23/1/95	2200h		CTD (150m)
30	45°02.1'	139°57.0'	24/1/95	0515h	4909	CTD (200m)
31	45°02.1'	139°56.5'	24/1/95	0800h	4906	CTD (200m), Radiometer
32	45°01.9'	139°55.9'	24/1/95	1055h	4930	CTD (200m)
33	45°01.7'	139°55.5'	24/1/95	1250h	4987	CTD (125m),Drop Net,Radiometer
34	45°01.6'	139°54.4'	24/1/95	1520h	4923	CTD (700m)
35	45°01.5'	139°52.7'	24/1/95	1905h	4938	CTD (150m)
36	45°01.8'	139°51.7'	25/1/95	0155h	3906	CTD (1000m), Kevlar Cast
37	44°59.7'	139°54.1'	25/1/95	0740h	4108	CTD (300m)
38	44°00.2'	139°59.9'	25/1/95	1330h	4044	CTD (1000m)
39	43°00.0'	140°00.3'	25/1/95	1950h	3909	CTD (1000m)
40	42°59.5'	140°00.3'	25/1/95	2130h	4826	CTD (150m), Drop Net
41	42°58.6'	139°59.2'	26/1/95	0505h	4396	CTD (200m)
42	42°58.7'	139°59.2'	26/1/95	0800h	4376	CTD (100m), Radiometer
43	42°59.0'	139°59.4'	26/1/95	1040h	4271	CTD (200m)
44	42°58.4'	139°59.0'	26/1/95	1250h	4419	CTD (150m),Drop Net,Radiometer
45	42°58.5'	139°59.0'	26/1/95	1505h	4445	CTD (700m)

46	42°58.8'	139°57.8'	26/1/95	1900h	4432	CTD (150m)
47	42°58.8'	139°59.1'	27/1/95	0635h	4420	CTD (300m)
48	42°00.0'	140°01.0'	27/1/95	1255h	4890	CTD (1000m)
49	41°00.1'	140°00.2'	27/1/95	1920h	4406	CTD (1000m)
50	40°00.0'	140°00.6'	28/1/95	0250h		CTD (1000m)
51	40°01.6'	140°02.6'	28/1/95	0540h	5061	CTD (200m)
52	39°59.7'	140°02.5'	28/1/95	0730h		Kevlar Cast, Radiometer
53	39°57.9'	139°59.3'	28/1/95	1315h	5050	CTD (150m),Drop Net,Radiometer
54	39°57.5'	139°58.2'	28/1/95	1510h	5049	CTD (100m)
55	39°57.4'	139°57.2'	28/1/95	1705h	5046	CTD(100m)
56	39°57.3'	139°56.7'	28/1/95	1905h	5046	CTD (150m)
57	39°57.5'	139°57.5'	29/1/95	0435h	5049	CTD (100m)
58	39°57.2'	139°57.9'	29/1/95	0535h	5047	CTD (300m)
59	39°58.0'	139°59.0'	29/1/95	0805h	5050	CTD (1000m)
60	39°59.3'	140°00.5'	29/1/95	1305h	5057	CTD (100m), Radiometer
61	40°01.8'	140°02.3'	29/1/95	1800h	5061	CTD (150m)
62	41°30.2'	141°59.6'	30/1/95	0930h	4592	CTD (1000m)
63	41°15.0'	142°50.2'	30/1/95	1405h	3932	CTD (1000m)
64	41°04.3'	143°32.9'	30/1/95	1815h	1969	CTD (1000m)
65	41°00.4'	143°45.0'	30/1/95	2025h	1026	CTD (900m)
66	41°04.4'	143°31.8'	30/1/95	2235h	2060	CTD (150m)
67	41°05.5'	143°33.7'	31/1/95	0530h	2085	CTD (200m), Drop Net
68	41°04.7'	143°33.3'	31/1/95	0730h		Kevlar Cast, Radiometer
69	41°03.0'	143°33.8'	31/1/95	1305h	1971	CTD(150m),Drop Net, Radiometer
70	41°05.2'	143°33.1'	31/1/95	1515h	2050	CTD (100m)
71	41°03.8'	143°33.0'	31/1/95	1720h	1990	CTD (300m)
72	41°05.0'	143°32.9'	31/1/95	1910h	2027	CTD (150m)
73	41°03.6'	143°34.8'	31/1/95	2250h	1883	CTD (1000m)
74	41°04.4'	143°34.2'	01/2/95	0600h	1970	CTD (300m)
75	40°59.9'	143°44.1'	01/2/95	0820h	1061	CTD (1000m)
76	40°55.1'	143°49.1'	01/2/95	1045h	210	CTD (200m), Drop Net
77	40°47.6'	144°13.0'	01/2/95	1344h	95	CTD (80m), Radiometer, Drop net