

DIVISION OF FISHERIES

1995 RESEARCH VESSEL PROGRAM

CRUISE PLAN

FRV *SOUTHERN SURVEYOR*
CRUISE SS11/95

16 NOVEMBER - 8 DECEMBER 1995

CSIRO DIVISION OF FISHERIES
MARINE LABORATORIES
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ITINERARY

DEPART: HOBART 06:00 HR THURSDAY, 16 NOVEMBER 1995

RETURN: HOBART 06:00 HR FRIDAY, 8 DECEMBER 1995

Note the departure date has been changed from that listed on the cruise schedule to allow loading of the vessel and also to accommodate a photographic team to operate in daylight in Storm Bay during equipment trials.

AREA OF OPERATION

West and south of Tasmania between 40°S - 53°S, and 140°E and 148°E.

RESEARCH BACKGROUND

One of the objectives of the INRE Climate 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 CO₂. The physical, chemical and biological factors responsible for drawing down CO₂ 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 experiments. The repeated sections are being carried out along the SR3 line as part of the WOCE series of cruises on *Aurora Australis* and by two cruises on *Southern Surveyor*. This is the second of two process cruises on *Southern Surveyor*; the first was conducted in January/February 1995.

The Marine Carbon Cycles Project is carrying out this research as part of two international research programs, the Joint Global Ocean Flux Study (JGOFS) and the International Global Atmospheric Chemistry Project known as ACE-1. The JGOFS part of the cruise will provide a first look at the physical, chemical and biological environment, and carbon fluxes in the region west of Tasmania during the spring bloom period. The ACE-1 experiment 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 the US NOAA research vessel *Discoverer*. Work on the *Discoverer* will include a series of atmospheric chemistry measurements, aerosol physical and optical measurements, and seawater measurements. The seawater measurements being made on *Discoverer* and *Southern Surveyor* will be particularly complementary

for understanding the DMS and pCO₂ processes in this region. Several overflights of *Southern Surveyor* will be made by a light aircraft operated by CSIRO Division of Atmospheric Research, measuring CO₂ and other trace gases while the Cape Grim transect is being conducted.

This cruise will sample an area west of Tasmania where very little is known about the latitudinal and seasonal variations in nutrients, trace elements, primary production and carbon dioxide north of 50°S. This region is expected to provide an interesting contrast to areas east of Tasmania where the input of subtropical water from the East Australian Current plays a key role in summer. Results from the first of this set of two process cruises have shown that inputs of iron from atmospheric aerosols to surface waters are very low 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 CO₂ draw-down, and the effects of iron in regulating phytoplankton production. A major reason for holding this experiment west of Tasmania is the long time series of atmospheric chemistry measurements made at Cape Grim. 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 experiment 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.

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, and microzooplankton grazing vary in response to differences in chemical and physical forcing in different water masses west of Tasmania. (Griffiths/Parslow)
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, Antarctic CRC)
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, Antarctic CRC)
5. To continuously monitor and record the acoustic backscattering strength of organisms at 12, 38 and 120 kHz, to conduct MIDOC trawls as opportunities present to describe the distribution and movement of micronekton in the Southern Ocean and to test an acoustic data logger attached to the 12 kHz transducer on the EK500 for a short while in deep water (5000 m). (Kloser).

6. To identify source/sink regions for CO₂ west of Tasmania by measuring surface water fCO₂ along the cruise track using an underway system; collect surface and air samples about every 1° of latitude for analysis of ¹³C and CO₂ concentrations; and to measure DIC and alkalinity in the water column at selected stations. These data are used to investigate the magnitude of the air-sea flux along the cruise track and provide information on the factors regulating the air-sea flux of carbon (Tilbrook, Division of Oceanography).
7. To estimate the rate of DMSP and DMS production in different water masses, and estimate the air-sea flux of DMS; and to correlate DMS/DMSP with water mass physics, chemistry and biology (Curran/Jones, James Cook University).
8. To quantify aerosol nutrient and trace metal concentrations; to estimate specific growth rates of individual phytoplankton species; to identify and quantify phytoplankton species abundance and to determine the physiological status and variability in photosynthetic parameters using fast repetition rate fluorescence (Green, Texas A+M University)
9. To collect pigment samples for HPLC analysis for exchange with the Japanese Marine Science and Technology Centre (JAMSTEC) as part of a collaborative research project on ocean colour remote sensing. (Parslow/Asanuma, JAMSTEC, Japan)
10. To measure the radon concentrations in air along the cruise track to estimate how long it has been since the air masses sampled have been near land. These radon measurements will allow a uniform baseline criterion to be applied to most of the ACE-1 trace-gas measurements and will complement radon and trace gas measurements being made at Cape Grim, Baring Head, Macquarie Is and on the *Discoverer* during ACE-1. (Whittlestone, ANSTO)
11. To examine the latitudinal distribution of larval fish and phyllosoma in the surface waters. (Bruce)

CRUISE PLAN

Southern Surveyor will leave Hobart and head for Storm Bay or into the D'Entrecasteaux channel for equipment trials. The departure date and time have been put back about 12 hours from that listed in the cruise schedule because of the photographic team that will be on board. As *Southern Surveyor* is scheduled to arrive in Hobart from Darwin and Weipa on 14 November I anticipate there may be some delay in departure time due to the amount of equipment that needs to be installed before we can go to sea. The photographic unit will be dropped at Recherche Bay when the equipment trials are complete. We will then head for Cape Grim, with a stop to leak test the niskin bottles. The first station is at about 40° 45S, 144° 30E near Cape Grim. The ship will work two process stations, each lasting about 30 hours, as it moves south-west towards 42° S, 140° E and one extended CTD station. The DAR aircraft should rendezvous with *Southern Surveyor* to conduct CO₂ and trace gas sampling whilst we are on this transect. From 42° S, 140° E, we will steam south-east, with stations at 1 of latitude to about 50° S, 147° 16E. We will turn south and steam to 53° S, with stations at approximately 1° of latitude

intervals. Process stations will be worked at about 42 ° S, 45 ° S, 48 ° S, 50 ° S and 53 ° S: actual sites will depend on prevailing oceanographic conditions. When this is completed we will steam to Hobart. In addition, we will participate in the ACE-1 Lagrangian experiment, scheduled to start when weather conditions are favourable, sometime after 21 November. The starting date is dependent on when *Discoverer* can reach 50 ° S, 135 ° E from Macquarie Island, and when clean maritime air will cross the sampling area south of Tasmania. Meteorological balloon releases from *Southern Surveyor* during the cruise will contribute to determining when the Lagrangian experiment will start, and the track of the two ships under the tagged air parcel that will be tracked and repeatedly sampled by the NCAR C-130 aircraft. We also plan to map the mesoscale temperature, salinity, and fluorescence features of the Subantarctic Front, near 51 ° S, using the Aquashuttle and CTD. As time permits, CTD casts will be made at intervals of 1° of latitude to a depth of 1000m to provide a section along 140°E and the thermosalinograph, fluorometer and autoanalyser will be run to obtain surface temperature, salinity, fluorescence and nutrients. CTD casts to 1000m and one additional 24 hour station may be worked along the Cape Grim transect if time permits.

Each process station will involve multiple CTD casts and the deployment of two free-floating moorings (one for sediment traps and one for in-situ primary production). The extended station on the Cape Grim transect will consist of 4 CTD casts (for P-I studies, high-resolution DIC/DOC/alkalinity/nutrient profiles, and a spectroradiometer profile. An number of casts will be made using the prototype spectroradiometer during daylight along the cruise track.

The suggested cruise track and station time allocations are as follows:

STEAMING TIMES

DEPART	ARRIVE	DISTANCE (N.MI)	TIME
Hobart	Cape Grim (40 °47S, 144 °13E)	327	32 hr @ 10 kt
Cape Grim	42 ° S, 140 ° E	204	20 hr @ 10 kt
42S, 140E	53 °S, 147 °16E	750	75 hr @ 10 kt
53 °S, 147 °16E	Hobart	605	60 hr @ 10 kt

STATION TIMES AND STEAMING SUMMARY

JOBS	REQUIREMENTS	TOTALS (HOURS)
Total steaming time		187
Station time	6 * 30 hr stations	180
	10 * 1000m casts	20
	12 hr gear trails and photography	12
Lagrangian Experiment	Steaming	60
	2 * 1000m casts	4
Mapping at Subantarctic Front	Steaming	48
	3 * CTD casts	6
Total time required		517
Total time available (06:00 16 Nov - 06:00 8 Dec.)		528
Weather allowance		11

PERSONNEL

Mr Brian Griffiths (Chief Scientist)
Mr Don McKenzie
Ms Pru Bonham
Ms Kate Berry
Mr Matt Sherlock
Mr Rudy Kloser
Mr Dave Terhell (Division of Oceanography, OMS)
Mr Mark Rayner (Division of Oceanography, OMS)
Dr Bronte Tilbrook (Division of Oceanography)
Dr Tom Trull (Antarctic CRC, University of Tasmania)
Mr Mark Curran (James Cook University)
Dr Rick Green (Texas A and M University)

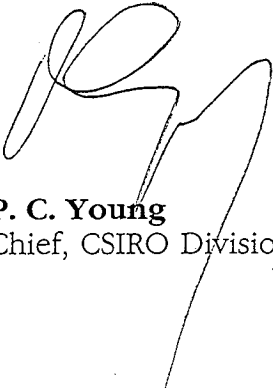
CONTACTS

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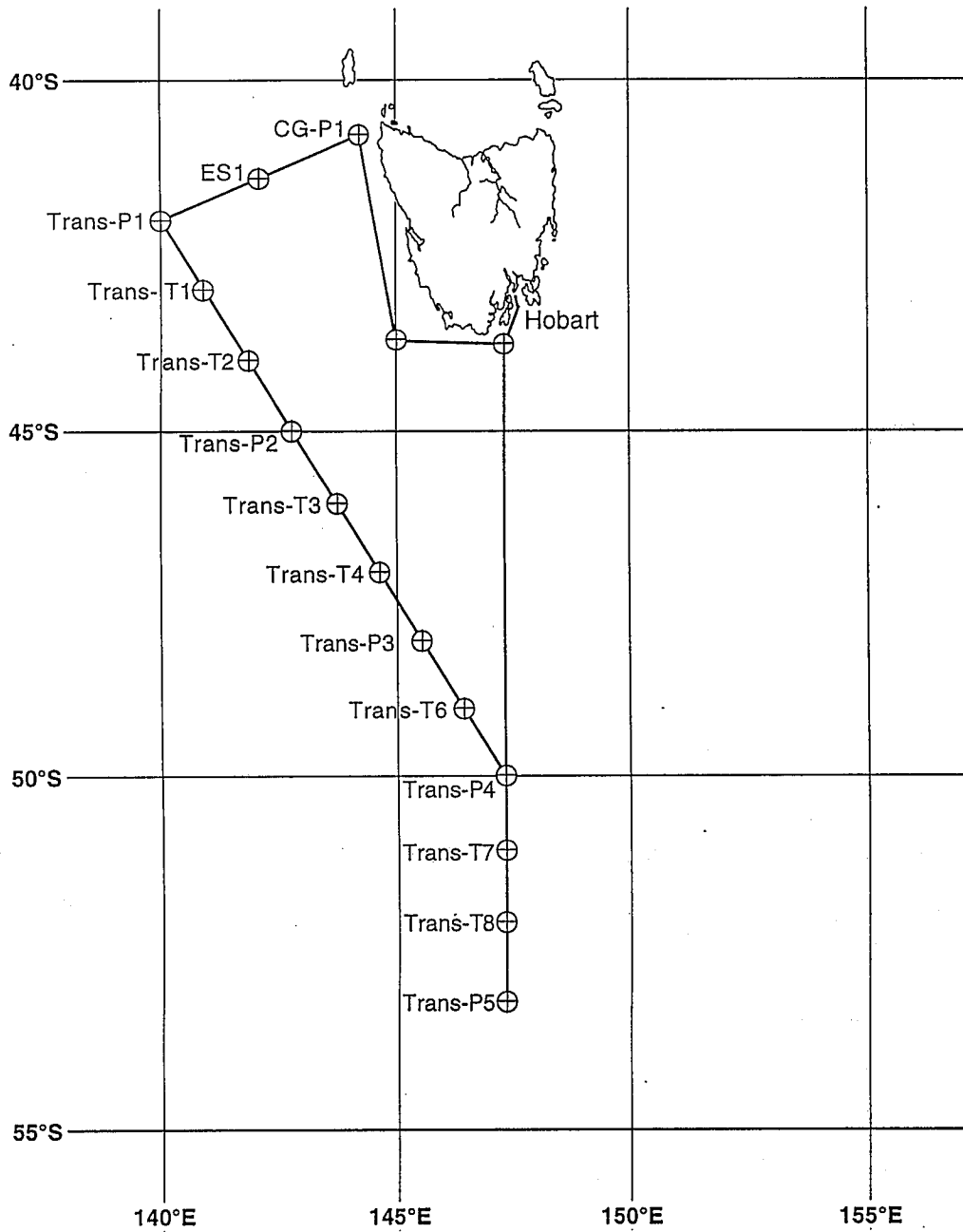
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November 1995



CRUISE TRACK FOR SS 11/95