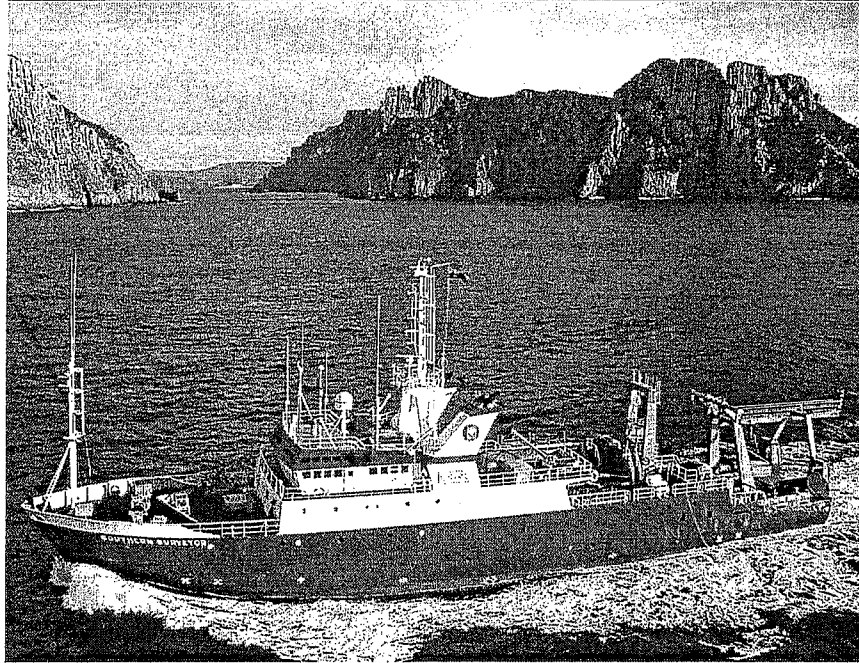
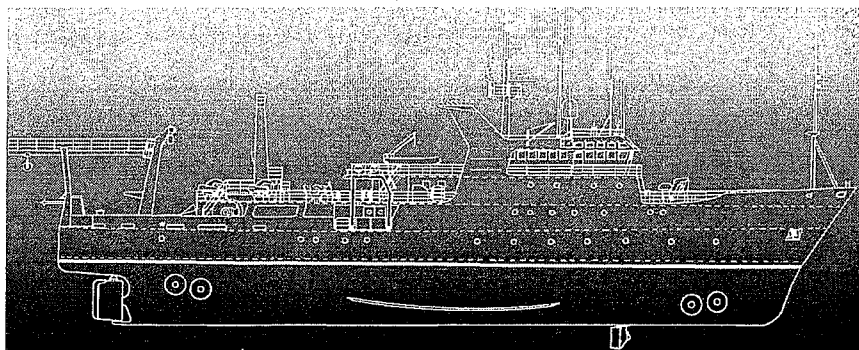


RV Southern Surveyor

CRUISE SUMMARY
SS 02/99



CSIRO
MARINE LABORATORIES
19 MAY 2017
J. W. HOGRAET



CRUISE SUMMARY

RV SOUTHERN SURVEYOR

SS02/99

Title

Carbon cycling in the sub-Antarctic Zone to the southwest of Tasmania.

Itinerary

Departed Hobart 0001 hrs, Saturday 6 February, 1999

Arrived Hobart 1000 hrs, Tuesday 16 February, 1999

Principal Investigator

Dr. Bronte Tilbrook (Chief Scientist)

Scientific Objectives

To contribute to better understanding of the carbon source/sink distributions in the region and the physical and biological controls on carbon uptake in the sub-Antarctic Zone (SAZ).

Cruise Objectives

1. Coordinate the Southern Surveyor work off Cape Grim with the atmospheric sampling as a preliminary study to better understand the link between air-sea exchange and the drawdown in CO₂ in the atmospheric boundary layer at Cape Grim.
2. Determine the summer-time distributions of biogeochemical properties (carbon nutrients and pigments) in the upper ocean between 42°S and 54°S and along 141°E, including sampling over sediment trap sites.
3. Recover sediment traps deployed at 47° and 54°S.

Cruise Track

The cruise track is shown in figure 1. Circles show CTD station locations. Sediment trap sites are shown by diamonds. All CTD casts are listed in Table 1. Casts to 150m were to allow high volume biological sampling for particulate matter and pigment analyses. Casts to 1000m or greater were sampled for carbon, nutrients and oxygen.

Stn	Latitude	Longitude	Date	Time (UTC)	Depth (db)	CTD Depth (db)
01	43°48.21'S	145°02.87'E	06-FEB-1999	0214	2935	1008
02	43°47.44'S	145°02.55'E	06-FEB-1999	0338	2957	1006
03	40°46.01'S	144°06.65'E	07-FEB-1999	0334	2568	76
04	41°22.28'S	142°51.76'E	07-FEB-1999	1622	2935	1006
05	41°40.50'S	142°12.39'E	07-FEB-1999	2137	3200	1004
06	42°00.06'S	141°30.09'E	08-FEB-1999	0240	3489	154
07	41°59.60'S	141°30.58'E	08-FEB-1999	0333	3504	1010
08	42°29.31'S	141°29.30'E	08-FEB-1999	0930	4424	1004
09	43°02.88'S	141°30.93'E	08-FEB-1999	1437	4431	154
10	43°02.38'S	141°31.22'E	08-FEB-1999	1526	4502	156
11	43°01.91'S	141°31.38'E	08-FEB-1999	1625	4620	1006
12	43°30.16'S	141°30.28'E	08-FEB-1999	2043	4578	156
13	43°29.41'S	141°30.10'E	08-FEB-1999	2114	4569	1012
14	44°00.03'S	141°30.22'E	09-FEB-1999	0153	4468	154
15	43°59.78'S	141°30.33'E	09-FEB-1999	0250	4444	1004
16	44°30.12'S	141°29.85'E	09-FEB-1999	0707	3485	1004
17	44°59.94'S	141°29.07'E	09-FEB-1999	1104	3532	152
18	44°59.64'S	141°27.37'E	09-FEB-1999	1201	3513	1002
19	45°29.78'S	141°29.74'E	09-FEB-1999	1648	4655	154
20	45°30.51'S	141°28.46'E	09-FEB-1999	1751	4450	1006
21	46°00.86'S	141°30.18'E	10-FEB-1999	0106	3506	154
22	46°00.75'S	141°29.52'E	10-FEB-1999	0202	3574	1004
23	46°41.72'S	141°59.00'E	10-FEB-1999	0810	4604	152
24	46°42.26'S	141°58.61'E	10-FEB-1999	0857	4667	1004
25	46°44.10'S	141°57.93'E	10-FEB-1999	1107	4620	156
26	46°44.82'S	141°57.86'E	10-FEB-1999	1151	4572	1012
27	47°29.71'S	141°45.83'E	11-FEB-1999	1001	4397	152
28	47°32.32'S	141°46.61'E	11-FEB-1999	1056	4331	1006
29	48°15.03'S	141°44.98'E	11-FEB-1999	1605	3489	1004
30	49°34.86'S	141°46.08'E	12-FEB-1999	0036	3982	164
31	49°35.42'S	141°48.03'E	12-FEB-1999	0123	3950	1004
32	50°29.78'S	141°45.99'E	12-FEB-1999	0739	3500	1004
33	51°14.38'S	141°45.76'E	12-FEB-1999	1256	3776	154
34	51°14.99'S	141°47.06'E	12-FEB-1999	1345	3782	1006
35	52°00.06'S	141°44.40'E	12-FEB-1999	1923	3490	158
36	52°00.30'S	141°43.67'E	12-FEB-1999	1954	3636	1008
37	52°58.05'S	141°47.20'E	13-FEB-1999	0226	2873	1008
38	53°41.72'S	141°43.73'E	13-FEB-1999	0745	3204	156
39	53°41.67'S	141°44.79'E	13-FEB-1999	0842	3490	1008
40	53°40.92'S	141°44.27'E	13-FEB-1999	1041	3038	156
41	53°40.67'S	141°43.82'E	13-FEB-1999	1134	3504	2012
42	53°44.61'S	141°45.91'E	13-FEB-1999	1609	2222	1006
43	53°44.88'S	141°45.78'E	13-FEB-1999	1743	2430	1010

TABLE 1. Station locations for all CTD casts during SS0299.

Results

Objective 1:

An atmospheric tracer (HFC134a) was released from the *Southern Surveyor* during the voyage up the West Coast of Tasmania. The experiment was planned in collaboration with CSIRO Atmospheric Research and was designed as a feasibility study to determine if an air mass could be tagged with a tracer. The technique could

then be used to evaluate the influence of air-sea gas exchange on CO₂ and possibly other trace gas concentrations in air masses. For the experiment, the tracer was to be released to the southwest of Cape Grim Observatory, where measurements of the tracer are made as part of the atmospheric monitoring program. The release area was chosen because under normal atmospheric conditions, winds blow from the southwest quadrant over Cape Grim for most of February. A tracer released to the southwest of Cape Grim would then be expected to mix into the atmospheric boundary layer and eventually pass over Cape Grim. Aircraft sampling was planned in the boundary layer above and offshore of Cape Grim provided weather conditions were good and the tracer was being detected at the observatory. For the experiment, estimates of forward air-mass trajectories were sent to the ship during the cruise to help in identifying if the air mass passing over the ship was likely to move over Cape Grim. Unfortunately, winds during the cruise were mostly from the north and east. Strong westerly winds occurred for a short time during the cruise north towards Cape Grim and a release was attempted. Conditions were far from ideal for the release and no tracer was detected at Cape Grim observatory. Although tracer was not detected due to unusual atmospheric conditions, the method has great potential for future development.

Objective 2:

A total of 43 CTD's were completed between 42°S and 54°S and a series of biogeochemical parameters were measured on samples taken from the CTD casts. The cruise track was chosen to resample a section made in March 1998, on the SRV *Aurora Australis*. The data from this and earlier cruises will be combined to develop an understanding of the seasonal and regional changes in biogeochemical tracers. The combined data sets are being used to determine the physical and biological processes controlling large seasonal changes in CO₂ uptake in the SAZ, and to better quantify the net air-sea carbon flux in the region. The major parameters measured on CTD casts and responsible PI's are given in Table 2.

Additional casts were made over the sediment trap sites to obtain larger water volumes for particulate matter samples.

Between CTD stations, the aquashuttle was used to obtain information on the distribution of fluorescence, T and S in the upper 50m of the water column. These data will be particularly useful for understanding the relationship between phytoplankton biomass and the complex pattern of fronts and eddies that are seen in satellite SST images for the region.

Objective 3:

The sediment traps were successfully recovered from both trap sites. The particulate matter collected in the traps is being analysed by Dr. Trull, Antarctic CRC.

Cruise Narrative

The cruise left Hobart at 1401Z on February 5, 1999 and headed offshore before turning northerly towards Cape Grim (40° 41'S 144° 41'E). Two test CTD casts at about 43° 48'S 145°E were made to test the CTD and the Niskin bottles. Many of the bottles leaked, but a complete set of good Niskin bottles were identified.

The tracer release was begun at 0735Z February 6, 1999, at about 43° 32'S 144° 34'E. The release was eventually stopped about 0100Z February 8, 1999, when the ship was west of Cape Grim (about 41° 50'S 141° 53'E).

A CTD section was begun when the ship arrived off Cape Grim. The first cast of the section was at 40°46.01'S 144°06.65'E. Shallow (about 150db) and mid-depth CTD's (about 1000db) were then carried out, with a series of aquashuttle deployments between stations. Parameters analysed from the CTD are listed in Table 2. When the ship reached the vicinity of the northernmost sediment trap mooring site (about 46° 44'S 141° 58'E), four CTD casts were made. The casts were finished in the late evening and the trap mooring was searched for during the night of February 10 and early hours of February 11, 1999. The traps were eventually located and recovered at about 0600Z February 11, 1999.

Table 2. Parameters measured at CTD sites during SS0299. At each location, pigments, bio-optics and particulate material were sampled on shallow casts to about 150m, and dissolved carbon and hydrochemistry measurements were made on samples collected from deeper casts (see Table 1).

Parameter	Contact	Affiliation
Salinity, temperature, nutrients, oxygen	Tilbrook	CSIRO Marine Research
DIC, alkalinity, 13C in DIC	Tilbrook	CSIRO Marine Research
Pigments, bio-optics	Parslow	CSIRO Marine Research
POC/PON, 13C in POC	Trull	Antarctic CRC
15N-nitrate	Trull	Antarctic CRC

The ship then continued south to the second sediment trap site with CTD casts and aquashuttle deployments along the way. Six CTD casts were made at the second trap mooring (about 53° 44'S 141° 46'E). The mooring was located and recovered successfully. The ship left for Hobart at about 2300Z February 13, 1999.

Damage to an aquashuttle wing, the loss of faring on the cable connecting it to the ship, and rough weather, prevented use of the aquashuttle on the return leg to Hobart.

Continuous underway measurements of the fugacity of carbon dioxide were made along the entire cruise track.

Summary

The tracer released off Cape Grim (objective 1) was not detected, but this was most likely due to unusual weather conditions. Experience gained from the tracer release will be useful in designing similar work in the future. All other work was successfully completed. The original cruise plan did not involve work south of 50°S, or allow time for the recovery of sediment traps. The extension of the cruise to include the sediment trap recoveries at 47°S and 50°S greatly improved our data coverage.

The ship is well designed for mooring recoveries, and operated well in the Southern Ocean. The crew was very skilled at handling the moorings. While some equipment needs to be upgraded, the ship is excellent for the type of work carried out.

Personnel

Scientific Participants

B. Tilbrook	Chief Scientist, carbon chemistry	CSIRO Marine Research
D. McKenzie	management, aquashuttle	CSIRO Marine Research
N. White	CTD watch, data processing	CSIRO Marine Research
M. Pretty	carbon chemistry	CSIRO Marine Research
G. Critchley	hydrochemistry	CSIRO Marine Research
D. Terhell	hydrochemistry	CSIRO Marine Research
N. Johnson	hydrochemistry trainee	CSIRO Marine Research
L. MacDonald	electronics	CSIRO Marine Research
L. Trenerry	pigment sampling	CSIRO Marine Research
K. Welch	carbon chemistry	CSIRO volunteer
M. Gross	carbon chemistry	CSIRO volunteer
S. Bray	sediment traps, particle sampling	Antarctic CRC

Ships Company

I. Taylor	Master
R. Pepper	Chief Mate
J. Boyes	2nd Mate
I. Murray	Chief Engineer
P. Dickson	1st Engineer
J. Hinchliffe	Electrical Engineer
T. Condon	Chief Cook
W. Hatton	2 nd Cook
B. Sherriff	Steward
M. McDougall	Bosun
G. McDougall	IR
L. Jacomos	IR
G. O'Doherty	IR
S. Murtagh	IR
A. Hearne	IR
N. Irvine	IR
W. Wallace	Greaser

Acknowledgments:

The ship's crew, ship's management, and the scientific crew did an excellent job of making sure the cruise was successful. Ian Helmond was particularly helpful in making alterations to the aquashuttle prior to the cruise that greatly improved its depth range and stability. Neil White was an essential participant and made sure good quality CTD and underway data were collected during the cruise. Don McKenzie and Lindsay MacDonald spent many hours during the cruise working on keeping the aquashuttle and CTD functioning. The efforts of the hydrochemistry group in sampling and analysis were also appreciated.

Dr. Bronte Tilbrook
Chief Scientist.

Figure 1. Cruise track for SS0299. The solid circles are CTD stations and the diamonds represent sediment trap mooring sites.

