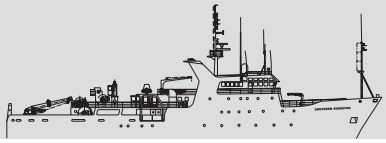

MARINE
NATIONAL FACILITY

2006 program

RV *Southern Surveyor*

voyageplan

SS03/2006

PULSE: role of mixed-layer dynamics in Southern Ocean plankton production and carbon transports, including air-sea exchange of carbon dioxide and particulate carbon fluxes to the ocean interior.

Itinerary

Depart Hobart 1000hrs, Tuesday 28 March, 2006.
Arrive Esperance 0800hrs, Monday 10 April, 2006.

Principal Investigators

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CSIRO

Scientific Objectives

The Subantarctic Zone (SAZ) of the Southern Ocean is a major sink for atmospheric carbon dioxide. Transfer of the CO_2 to the ocean interior involves both physical and biological processes. Transfer of the CO_2 through the ocean surface mixed layer (~ top 100m) is a highly dynamic process that varies dramatically on seasonal and shorter timescales. The transfer occurs via two 'pumps' - the physical pump consisting of dissolution and subsequent water mass subduction and the biological pump consisting of phytoplankton production and subsequent sinking of organic matter.

The controls on these processes are difficult to assess from short-term ship-based observations because of their temporal variations. For this reason, the primary objective of this voyage is the deployment of a mooring with automated sensors and samplers to obtain a full annual time-series of physical and biological parameters important to these carbon pumps. In concert with this deployment, additional measurements will be made to inform the interpretation of the mooring based measurements. Key measurements include dissolved nutrient, dissolved carbon dioxide (DIC) and oxygen concentrations; bio-optical measures of phytoplankton and suspended particulate organic matter; and assessment of trace-element availability important to phytoplankton health.

Voyage Objectives

1. Deployment of the PULSE mooring in the SAZ near 140ºE, 47ºS in ~4500m water depth (P.I.'s T. Trull, F.B. Griffiths, B. Tilbrook).

The PULSE mooring is an experimental mooring with a small spherical surface float decoupled from a sub-surface instrument package by an elastic line (bungy). The mooring is currently undergoing testing in coastal waters south of Hobart. The final instrument configuration will depend on the results of these tests. The available suite of instruments includes:

i) temperature loggers spaced along the mooring at 10m intervals to determine mixed layer depth.

ii) a CTD to determine mixed layer depth

iii) two PAR sensors and a spectral radiometer to determine the light environment

iii) a fluorometer to estimate phytoplankton abundance

iv) a water sampler to obtain weekly samples for nutrient and dissolved CO_2 analyses

2. Recovery and re-deployment of the SAZ sediment trap mooring near 141ºE, 47ºS (P.I. T.Trull)

3. Deployment of the CTD-Rosette at and along the transects to and from the PULSE mooring site to obtain sensor profiles of fluorescence, oxygen, and transmission, and water samples for oxygen, nutrient, DIC, chlorophyll-a (all P.I.s), and also for trace-element analyses (P.I. Edward Butler).

4. Deployment of the SEASOAR undulating towed-vehicle equipped with a PAR sensor, oxygen optode, fluorometer and transmissometer (in addition to its normal paired CTDs) to determine mixed layer and sub-mixed layer oxygen and particle distributions north and west from the PULSE mooring site (P.I.s T. Trull, B. Tilbrook, L. Pender, T. Fitchett).

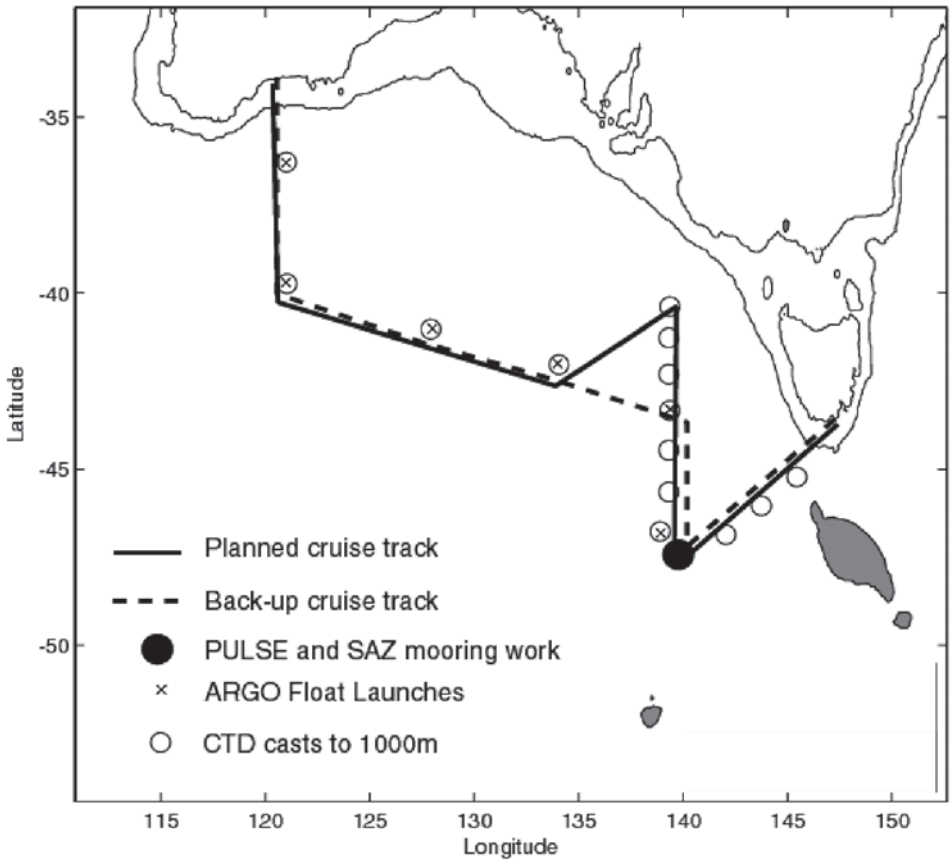
5. Deployment of 1 ARGO profiling float equipped with an oxygen optode and transmissometer at the mooring site. (P.I.s T. Trull, B. Tilbrook).

6. Deployment of 5 standard ARGO floats along the transect west from the mooring site to Esperance. (P.I. T. Trull, M.Rosenberg).

7. Measurement of underway biogeochemical and bio-optical properties underway along the entire transect using the ship's clean scientific seawater supply, including CO_2 partial pressure (pCO_2; P.I. Bronte Tilbrook), fluorescence, fast-repetition-rate fluorometry (FRRF, P.I. Brian Griffiths), particulate organic matter (POM; T. Trull, T. Fitchett), and trace-element samples (P.I.'s Edward Butler, Michael Grose).

Voyage Track

The planned track is as shown by the solid line. If weather, equipment, or other logistic issues preclude its completion, the more direct track shown by the dashed line will be carried out. CTDs will be carried out on the transit to the mooring site, and then north along ~140ºE. SeaSoar will be towed from the mooring site north and then west for as long as time allows. At the mooring site the PULSE mooring will be deployed and the SAZ mooring recovered and redeployed. CTD and SeaSoar test deployments will be undertaken in Storm Bay.



Time Estimates

			Lat.	Lon.	Km	Nm	Hrs. SEASOAR @8kn.	Hrs. Steam @11kn.	Days
Steaming									
Start	Hobart		43	147.5					
	Test Station		44.0	147.5	111	60		5	
	Mooring Site		47.0	140.0	673	363	Begin SeaSoar	33	
	End North transect		40.0	140.0	778	420	53		
	Return south of STF		42.5	134.0	573	310	39		
	End West transect		40.0	122.0	1040	562	70	End Seasoar	
End	Esperance		34.0	122.0	667	360		33	
Total Steam						**2075**	**161**	**71**	**9.7**
Operations									
	Test Station		4hr						0.2
	CTDS		12x2hr						1.0
	PULSE Deploy		12hr						0.5
	SAZ Recover		12hr						0.5
	SAZ Deploy		12hr						0.5
	Argo Deploy		6x2hr						0.5
Total Ops									**3.2**
Total Voyage									**12.9**

Piggy-back Projects

Alan Williams (CMAR) has requested the collection of SWATH observations on the shelf south of Esperance in 400-1300m water depth, including additional east-west coverage if time permits.

Southern Surveyor Equipment

1. Project Support Services and Facilities

Communications

A basic e-mail service is provided to all projects. All communications above this level are charged to users at cost recovery rates. Voice, fax and data communication is available from the ship in all operational areas. Required

Data Products

Underway data is collected for the following parameters: time, ship position; bathymetric depth; meteorological data (air temperature, humidity, wind speed and direction, barometric pressure and light); sea surface temperature and salinity. Required

Facilities

The Operations Room provides: general computing facilities; ship charting package; and 10/100 Ethernet. Required

2. Standard Services and Equipment Provided On Request

The following services and equipment are on board the vessel but applicants need to indicate which are required.

Equipment

Use of the following equipment can be provided on request.

Seapath Seatex 200 – for accurate heading, pitch and roll and heave	Required
Simrad EK500 sounder (12, 38 and 120 kHz)	Required
Simrad EA500 sounder (12kHz)	Required
ADCP - measures current vectors beneath the vessel	Required

Laboratory and other Facilities

Laboratories and other facilities on board require some preparation for use prior to sailing. Applicants should specify which laboratories or facilities they require, note that some can be utilised for different purposes, so please specify what use you require. All laboratories have access to the ship's computer network.

General purpose laboratory (includes fume hoods, fridge, freezer)	Required
Controlled temperature laboratory /cool room – please specify temperature required	Required
Hydrochemistry laboratory	Required
Wet laboratory/CTD room	Required
Fish laboratory/geoscience laboratory	Required

Photographic/preservation laboratory

Blast freezer – for quick freezing of samples	Required
Sensors to measure: tension, winch speed and wire out from CTD, trawl or coring winches	Required

Winches, A-frames and Crane

Applicants should consult the Operations Officer on carrying capacities and other technical details.

Trawl winches with 5,000m of 24mm wire	Required
Coring winch with 5,000m of 19mm wire	Required
CTD/Hydro winches each with 7,000m of 8mm single core conducting cable	Required
Towed-body winch with 3,000m of 12mm 7 core conducting cable	Required
Hydrographic A-frame	Required
Stern A-frame (SWL 15 tonnes)	Required
7.0 tonne knuckleboom crane	Required
Gilson winches (15 tonne, 5 tonne)	Required
General purpose winch on stern A-frame (5 tonne)	Required

Data Products

The following data can be provided on request

ADCP: standard data provided as 20 minute averages, 8 m bins from 8m to 300m	Required
ADCP log (photocopy)	Required
Ship's heading and speed over ground.	Required
Ship attitude – heave, pitch, roll and heading	Required
Data from winch sensors (tension, winch speed and wire out)	Required
Bridge log (photocopy)	Required

3. Specialised equipment and services requiring some additional support

The following equipment requires some additional technical support and preparation.

Scientific Equipment

CTD Profiling

The Marine National Facility offers a standard CTD profiling package comprising the CTD and rosettes. Users should specify which rosette they wish to use.

CTD (Seabird SBE 911 plus)	Required
Rosette (12 bottles up to 10 litres)	
Rosette (24 bottles up to 10 litres)	Required

Data Products available on request

CTD data	Required
CTD log (photocopy)	Required

4. Specialised Equipment and Services Requiring Extensive Additional Support

The following services and equipment require significant support from Marine National Facility technical staff or extensive preparation prior to use. They may require further support or a financial contribution from users.

CTD/Chemical Analyses

Niskin bottles: users should specify size needed.	
10 litre Niskin bottles	Required
2.5 litre Niskin bottles	

The following chemical analyses can be undertaken on-board ship. Marine National Facility hydrochemists will be required if any of these analyses is requested. If possible please indicate how many CTD casts and the number of samples/cast are required.

Total number of CTD casts required.	12
Number of samples/cast.	12 to 24 -duplicates at some depths
Salinity – analyses as required to calibrate CTD	Required
Oxygen – analyses as required to calibrate CTD	Required
Nitrate (please note levels may be <2uM in surface and require low-level standards)	Required
Nitrite	Required
Silicate (please note levels may be <2uM in surface and require low-level standards)	Required
Phosphate (please note levels may be <.2uM in surface and require low-level standards)	Required

Other CTD Sensors

The following sensors are available for use with the CTD

Transmissometer (to 6,000m depth)	Required
Profiling fluorometer – requires support from users for calibration during the voyage (6,000m depth)	Required
Light (PAR) (to 500m depth) – prefer sensor capable of 1000m – will attempt to supply	Required, may be able to supply alternate sensor

Dissolved oxygen (to 6,000m depth). Requires support of Marine National Facility hydrochemist for calibration.	Required
Underway fluorometer to measure sea surface fluorescence. Collection of data requires support from users for calibration of the equipment during the voyage.	Required
Scintillation counter – this equipment can only be operated with user support.	
Milli-Q water supply	Required
Radiation Sensors – these also require user contribution and support.	Required
SeaSoar – towed undulating CTD system. Use requires an additional Marine National Facility technician. The SeaSoar may also be used as a platform for other small sensor packages. You should discuss your requirements with the Operations Officer.	Required
Clean Container Laboratory – This is the ideal approach for the trace-element sample processing, but costs to return the container from Esperance are high. We may pursue an alternate approach based on installing laminar flow benches and plastic curtains in the ship.	Preferred, but concern over costs.
Swath mapper (please see description under piggy-back projects)	If feasible
Kongsberg EM300 swath mapping system. Use of the swath mapper requires at least one person for technical support. Users should specify what level of support they require.	If feasible
Swath bathymetry	If feasible
Swath seabed reflectance	If feasible
Swath water column data	If feasible
Seasoar – with fluorometer, transmissometer, oxygen optode	Required with additional sensors
Hydrology	Required
Swath bathymetry – see piggy back project description	if feasible
Swath seabed reflectance – see piggy back project description	if feasible

User Equipment

1. PULSE and SAZ mooring components – to be stored on deck and in aft laboratories

2. 6 ARGO floats

3. pCO_2 system – includes gas standard bottles (4; compressed air), and requires clean 240V power and clean seawater supply (~20l/min) with a maximum warming between the intake and instrument of 0.5C. The seawater supply line and a suitable location for the instrument needs to be identified. A clean air supply line (3/8" o.d. tubing) needs to be plumbed to the instrument from the mast on the ship's bow.

4. Liquid N2 in large volume (170 l) storage Dewar, and small volume (35 l) working Dewar.

5. We may install laminar flow benches and plastic curtains in the ship, if costs associated with returning the preferred Clean Laboratory Container from Esperance are too large.

Personnel List

1. Tom Trull		CMAR/UTAS/ACE Chief Scientist
2. Brian Griffiths	CMAR/ACE	Mooring and underway bio-optics
3. Edward Butler	CMAR/ACE	trace-element sampling and measurements
4. Mark Rosenberg	ACE	Mooring, ARGO float operations
5. Lindsay Pender	CMAR	Mooring, CTD, SEASOAR Operations
6. Kate Berry	CMAR	pCO2, DIC, carbon system measurements
7. Michael Grose	IASOS UTAS	trace-element and halocarbon sampling
8. Tory Fitchett	IASOS UTAS	POM, transmissometer, O2 optodes
9. Student TBA	IASOS UTAS	underway bio-optics
10. Student TBA	IASOS UTAS	trace-element sampling and analyses
11. Pamela Brodie	MNF/CMAR	Voyage Manager and Computing Support (SST)
12. Drew Mills	MNF/CMAR	Electronic support (SST)
13. David Terhell	MNF/CMAR	Hydrochemistry – nutrients, oxygen (SST)
14. Alicia Navidad	MNF/CMAR	Hydrochemistry Support
15. Ian Hawkes	MNF/CMAR	Systems analyst

MNF = Marine National Facility; CMAR = CSIRO Marine and Atmospheric Research; ACE = Antarctic Climate and Ecosystem Cooperative Research Centre; IASOS UTAS = Institute of Antarctic and Southern Ocean Studies; SST = Systems Support Technician

Declaration

This voyage plan is in accordance with the directions of the National Facility Steering Committee for the Research Vessel RV *Southern Surveyor*.

Thomas W. Trull
Chief Scientist

CMAR-UTAS Joint Associate Professor of Marine Biogeochemistry
21 December, 2005