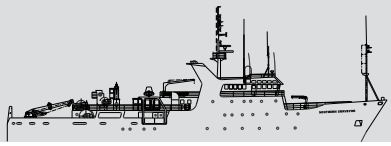

MARINE
NATIONAL FACILITY

RV *Southern Surveyor*

2010
program

CSIRO

voyage summary SS2010_v06

SS2010_t04

Continental slope and shelf processes along the south-west region of Western Australia during winter

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Voyage period

Start: 29/07/2010

End: 09/08/2010

Port of departure: Fremantle, WA, Australia

Port of return: Fremantle, WA, Australia

Responsible laboratory

School of Environmental Systems Engineering , The University of Western Australia

35 Stirling Hwy, Crawley, Western Australia

Chief Scientist

W/Prof. Charitha Pattiaratchi – School of Environmental Systems Engineering , The University of Western Australia

Scientific Objectives:

- Define the structure and in particular the volume flux of the Leeuwin Current (LC), including the geostrophic inflow
- Define the structure and the volume flux of the Leeuwin Undercurrent (LU)
- Examine the dynamics of Dense Shelf Water Cascades (DSWC) – spatial extent, transport volume, nutrient fluxes
- Determine the interaction of the LC, coastal currents, DSWC and primary production dynamics during winter
- Obtain water samples to calibrate the bio-optical WET Labs sensors on ocean gliders

Voyage Objectives

After departing Fremantle, Southern Surveyor will conduct 8 cross-shelf transects between Jurien Bay and Cape Naturaliste. For each transect, 10 - 15 CTD stations will be occupied depending on the shelf width (with a total of 98 stations over the duration of the voyage). The transects will extend from the coast (20 m isobath) to beyond the 2000 m contour to capture the entire width of the LC. As in previous SS voyages, stations will be located at 50m depth intervals, especially along the continental slope. In addition to the standard CTD and fluorescence, water samples for nutrient analyses and phytoplankton measurements will be collected using the Niskin bottles. Experimental work will likely include 14C uptake measurements and nutrient uptake measurements.

The high priority areas of operation are off Perth, Rottnest Island and the Two Rocks region. The lower priority areas are at the northern (Transect A) and southern (Transect H) portions of the proposed study track.

Results

It is difficult to provide preliminary data or results at this stage, as release of voyage data from MNF has been limited to ADCP data – we are still awaiting the remaining physical or chemical data from this voyage (CTD, nutrients, etc.). Laboratory-based analyses of all the biological datasets (detailed below) are currently underway, however similarly there are no preliminary data yet available to present.

- Define the structure and in particular the volume flux of the Leeuwin Current (LC), including the geostrophic inflow. The data collected from the ADCP and CTD casts will enable this aim to be achieved.
- Define the structure and the volume flux of the Leeuwin Undercurrent (LU). The data collected from the ADCP and CTD casts will enable this aim to be achieved.
- Examine the dynamics of Dense Shelf Water Cascades (DSWC) – spatial extent, transport volume, nutrient fluxes. DSWC features were located on the inner portions of a number of transects, and were targeted for physical, chemical and biological sampling.
- Determine the interaction of the LC, coastal currents, DSWC and primary production dynamics during winter. A total of 16 production stations were undertaken during the voyage, and targeted inshore and Leeuwin Current water, including a repeat transect at the long term monitoring region of Two Rocks at both the start and end of the voyage. Measurements included primary production rates at 4 – 6 depths, nitrogen uptake rates using 15N labelled nitrate, ammonium, urea and N2 gas, ambient nutrient levels, detailed phytoplankton pigment analyses via HPLC, picoplankton and bacterial enumeration via flow cytometry, phytoplankton species identification via light microscopy and a number of additional analyses of the particulate matter. The chlorophyll fluorescence profiles obtained at the CTD stations indicated a broad phytoplankton bloom within Leeuwin Current waters, with relatively well-mixed phytoplankton levels through the upper euphotic zone and few deep chlorophyll maxima (DCM) features. The experimental studies undertaken within this winter bloom and inshore waters will assist in identifying important mechanisms structuring the region's winter bloom and the influence of DSWC features on nutrient dynamics and phytoplankton communities.
- Obtain water samples to calibrate the bio-optical WET Labs sensors on ocean gliders. Samples for calibration of the WET Labs ECO triplet sensors were collected at a number of stations and depths, and included total suspended solids (TSS), particulate absorption, coloured dissolved material (CDOM) absorption, HPLC pigments, particulate organic carbon (POC) and size-fractionated chl a. The analyses of these samples are currently underway.

Voyage Narrative

The ship departed on schedule at 1800h on Thursday, 29 July 2010 from Fremantle. All underway measurements (standard meteorological, thermo-salinograph (including fluorometer), shipboard ADCP, Swath Mapper and Echo-sounder) were enabled when the ship departed and worked without any problems throughout the voyage. We employed the Seabird CTD, which in addition to the standard CTD sensors, included dissolved oxygen, fluorometer and PAR meter. A 24 10L niskin bottle rosette was used for water samples, and consisted of up to 19 bottles with the remaining bottle locations taken up by the additional sensors.

At each transect, CTD stations were generally located at the following depth contours: 30m, 50m, 100m, 150m, 200m, 250m, 300m, 500m, 750m, 1000m and 2000 m. Additional stations were completed depending on the width of the continental shelf and at deeper depths (2500m, 3000m) in the offshore regions of the Perth Canyon. A total of 111 CTD profiles were completed.

We reached Transect D (Fig. 1) approximately 12 hours after departing Fremantle, and completed 12 stations. We then undertook a Tow-yo CTD (Nacelle) transect whilst steaming to the inshore station of Transect E, and completed another 11 stations. This sampling pattern was repeated to the offshore extent of Transect G, after which we travelled from west to east through the Perth Canyon, sampling 15 stations along the canyon's axis. We then steamed to the inshore station of Transect H and continued the CTD sampling alternated with Nacelle transects to the offshore station of Transect K. At this point, due to both efficient operations and good weather, we were ahead of schedule and were able to steam back and complete a second set of CTD stations along Transect G (the Two Rocks Transect) in addition to a further Nacelle transect across an eddy feature at the Perth Canyon.

In addition to the standard nutrient sampling, at each CTD station size-fractionated chl a was measured on water samples to 150m depth. In addition, a total of 16 'production stations' (two per transect) were completed during the voyage, and were generally conducted within inshore (50m depth) and Leeuwin Current (250m depth) water. At each of these production stations, samples were collected for HPLC pigments, particulate organic carbon (POC), total suspended solids (TSS), coloured dissolved organic material (CDOM) absorption, particulate absorption, phytoplankton taxonomy via light microscopy, picoplankton/bacterial abundance via flow cytometry, and experiments were conducted for primary production rates (via 14C uptake) and nitrogen uptake rates (via 15N uptake using ammonium, nitrate, urea and N2 fixation). We also sampled for pH and alkalinity at 4 stations along the Perth Canyon (for Jim Falter/Malcolm McCulloch at UWA), and natural abundance isotopes at 2 offshore stations (for Laura Richardson at SARDI).

Unfortunately we experienced some equipment failure in the GP lab. After the first 24 hours of operation, the scintillation counter developed a mechanical fault and did not work. As a result, we needed to store our acidified samples in the fridge and process them after returning to shore. Preliminary examination of the results indicate that this did not have a detrimental effect on the data. An additional problem was encountered with the fumehoods in the GP lab, which spontaneously turned off a total of 4 times during the voyage.

The above were the only problems encountered on what we considered to be a highly successful voyage. We docked in Fremantle at 0700h on Monday, 9 August 2010.

Summary

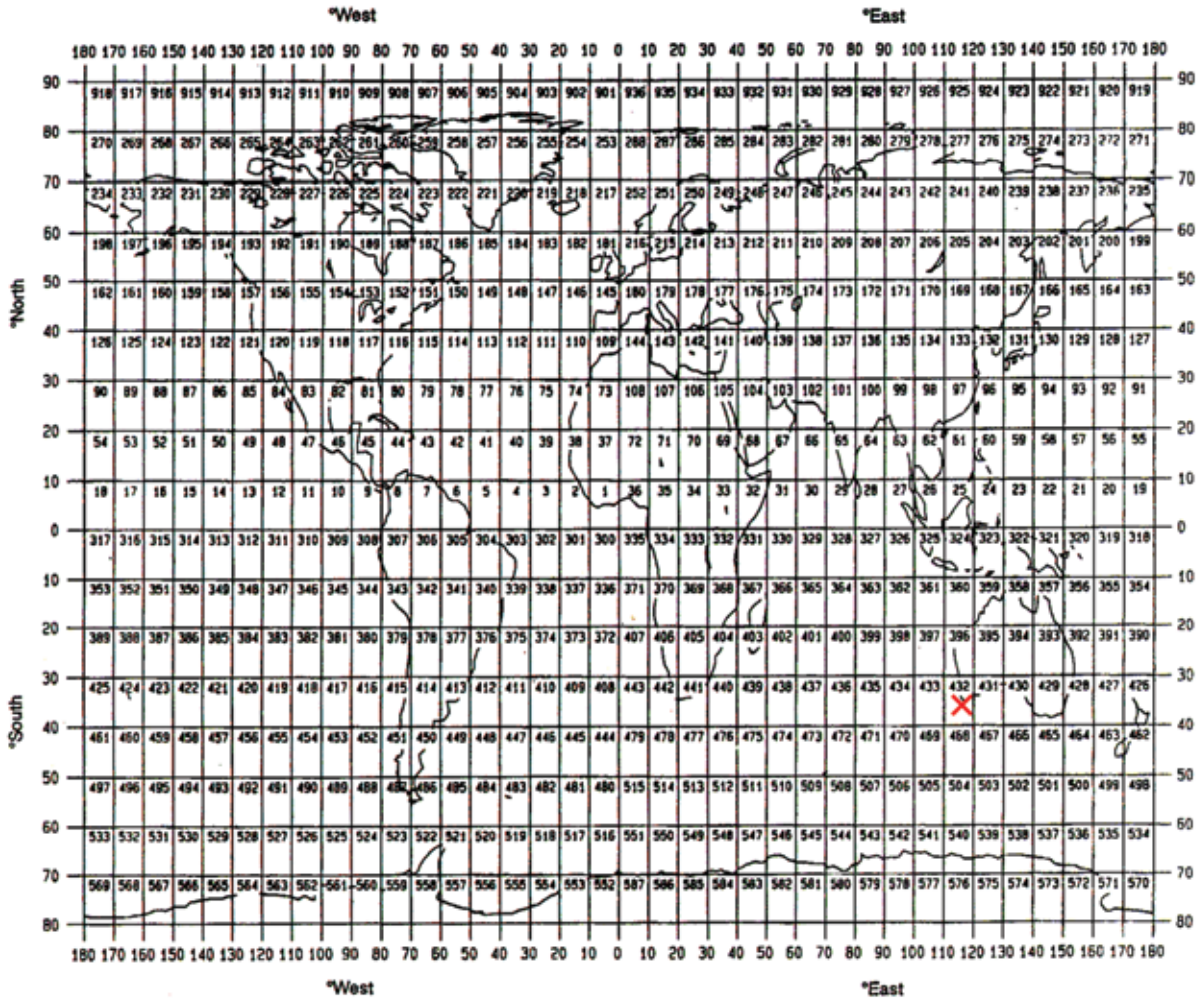
This voyage was one of the first to examine the winter oceanography off southwestern Autralia. The Leeuwin Current is strongest in winter and only a few studies have been undertaken on the structure and volume transport of the Current during this time of year. Results from our experimental program will also help to answer questions about the mechanisms important to the formation of the winter phytoplankton bloom in this region. The voyage was planned to maximise the data streams arising from the West Australian node (WAIMOS) of the Integrated Marine Observation System (IMOS), with a large number of the transects conducted within the WAIMOS study region including a repeat transect (at the beginning and ending of the voyage) off Two Rocks. The data obtained from the voyage will be merged with HF Radar derived surface currents, ocean gliders and shelf/slope moorings concurrently deployed within the study region. Use of the relatively recent 75kHz shipborne ADCP also allowed for the first time direct measurements of the Leeuwin Undercurrent and its interaction with the Leeuwin Current. The weather during our voyage was excellent, as was the support and co-operation of the ship's crew and MNF personnel, which all combined to make this a very successful voyage.

Principal investigators

A. Charitha Pattiaratchi
B. Christine Hanson

MARSDEN SQUARES

GEOGRAPHIC COVERAGE - INSERT 'X' IN EACH SQUARE IN WHICH DATA WERE COLLECTED



SUMMARY OF MEASUREMENTS AND SAMPLES TAKEN					
Item No.	**PI** see page above	**NO** see above	**UNITS** see above	**DATA TYPE**	**DESCRIPTION**
1	A	111	casts	H10	Conductivity, temperature, depth, fluorescence, dissolved oxygen, nitrate, irradiance, backscatter
2	A	111	stations	H09	Water bottle stations
3	A	-750	samples	H22	Phosphate
4	A	-750	samples	H24	Nitrate
5	A	-750	samples	H25	Nitrite
6	A	-110	samples	H76	Ammonium
7	A	-750	samples	H26	Silicate
8	A	-50	samples	H21	Oxygen
9	A	111	casts	H17	Underwater light
10	A	11	days	D71	ADCP
11	B	16	stations	B01	Primary production
12	B	-500	samples	B02	Size-fractionated chlorophyll a
13	B	45	samples	B02	HPLC pigments
14	B	64	samples	B08	Preserved phytoplankton for light microscopic identification
15	B	32	samples	B71	Particulate organic material (POM)
16	B	-200	samples	B07	Pelagic bacteria and viruses for flow cytometric identification
17	B	16	stations	B90	Nitrogen uptake via 15N
18	B	64	samples	P01	Total suspended solids
19	B	24	samples	P05	Coloured dissolved organic matter (CDOM)

CURATION REPORT	
Item No.	**Description**
1-10	Marine National Facility
11-19	School of Environmental Systems Engineering, The University of Western Australia

Voyage track

Eastern Indian Ocean
Southwestern Australia

Figure 1: voyage track SS2010-v06

Scientific Participants

Name	Affiliation	Role
Charitha Pattiaratchi	UWA	Chief Scientist, Physical Oceanography
Christine Hanson	UWA	Biological Oceanography
Mun Woo	UWA	Physical Oceanography
Shari Gallop	UWA	Physical Oceanography
Soheila Taebi	UWA	Physical Oceanography
Yasha Hetzel	UWA	Physical Oceanography
Thisara Welhena	UWA	Physical Oceanography
Asha De Vos	UWA	Biological Oceanography
Liza Roger	UWA	Biological Oceanography
Anton Kuret	UWA	Biological Oceanography
Matilda Taylor	UWA	Biological Oceanography
Drew Mills	CMAR	MNF Voyage Manager/Electronics support
Hiski Kippo	CMAR	MNF Computing support
Mark Rayner	CMAR	MNF Hydrochemistry support
Sue Reynolds	CMAR	MNF Hydrochemistry support

Marine Crew

Name	Role
Les Morrow	Master
John Boyes	Chief Mate
Rob Ferries	Second Mate
James Hickie	Chief Engineer
Nick Fleming	First Engineer
Graeme Perkins	Second Engineer
Nathan Arahanga	IR
Gareth Gunn	IR
Jonathan Lumb	IR
Daniel Nicholson	IR
Tony Hearne	CIR
Charmayne Aylett	Chief Steward
Scott Nichols	Chief Cook
Lynette McLaren	Second Cook

Acknowledgements

The scientific party would like to acknowledge the professional expertise of Captain Les Morrow, and all officers and crew of RV Southern Surveyor, and thank them for their friendly help at all times. The MNF personnel (Drew Mills (Voyage Manager/ Electronics Support), Hiski Kippo (Computing Support) and the hydrochemists, Mark Rayner and Sue Reynolds) were thoroughly competent and co-operative. Their continual cheerfulness and skill in all situations enabled non-stop data gathering and a very high data return. Compliments are also due to the Cooks, Scott Nichols and Lynette McLaren, for their excellent and varied menus throughout the voyage.

C Pattiaratchi
Chief Scientist

CSR/ROSCOP PARAMETER CODES

M01	Upper air observations
M02	Incident radiation
M05	Occasional standard measurements
M06	Routine standard measurements
M71	Atmospheric chemistry
M90	Other meteorological measurements

	PHYSICAL OCEANOGRAPHY
H71	Surface measurements underway (T,S)
H13	Bathythermograph
H09	Water bottle stations
H10	CTD stations
H11	Subsurface measurements underway (T,S)
H72	Thermistor chain
H16	Transparency (eg transmissometer)
H17	Optics (eg underwater light levels)
H73	Geochemical tracers (eg freons)
D01	Current meters
D71	Currentt profiler (eg ADCP)
D03	Currents measured from ship drift
D04	GEK
D05	Surface drifters/drifting buoys
D06	Neutrally buoyant floats
D09	Sea level (incl. Bottom pressure & inverted echosounder)
D72	Instrumented wave measurements
D90	Other physical oceanographic measurements

	CHEMICAL OCEANOGRAPHY
H21	Oxygen
H74	Carbon dioxide
H33	Other dissolved gases
H22	Phosphate
H23	Total – P
H24	Nitrate
H25	Nitrite
H75	Total – N
H76	Ammonia
H26	Silicate
H27	Alkalinity
H28	PH
H30	Trace elements
H31	Radioactivity
H32	Isotopes
H90	Other chemical oceanographic measurements

	MARINE CONTAMINANTS/POLLUTION
P01	Suspended matter
P02	Trace metals
P03	Petroleum residues
P04	Chlorinated hydrocarbons
P05	Other dissolved substances
P12	Bottom deposits
P13	Contaminants in organisms
P90	Other contaminant measurements
B01	Primary productivity
B02	Phytoplankton pigments (eg chlorophyll, fluorescence)
B71	Particulate organic matter (inc POC, PON)
B06	Dissolved organic matter (inc DOC)
B72	Biochemical measurements (eg lipids, amino acids)
B73	Sediment traps
B08	Phytoplankton
B09	Zooplankton
B03	Seston
B10	Neuston
B11	Nekton
B13	Eggs & larvae
B07	Pelagic bacteria/micro-organisms
B16	Benthic bacteria/micro-organisms
B17	Phytobenthos
B18	Zoobenthos
B25	Birds
B26	Mammals & reptiles
B14	Pelagic fish
B19	Demersal fish
B20	Molluscs
B21	Crustaceans
B28	Acoustic reflection on marine organisms
B37	Taggings
B64	Gear research
B65	Exploratory fishing
B90	Other biological/fisheries measurements

	MARINE GEOLOGY/GEOPHYSICS
G01	Dredge
G02	Grab
G03	Core – rock
G04	Core – soft bottom
G08	Bottom photography
G71	In-situ seafloor measurement/sampling
G72	Geophysical measurements made at depth
G73	Single-beam echosounding
G74	Multi-beam echosounding
G24	Long/short range side scan sonar
G75	Single channel seismic reflection
G76	Multichannel seismic reflection
G26	Seismic refraction
G27	Gravity measurements
G28	Magnetic measurements
G90	Other geological/geophysical measurements