MARINE
NATIONAL FACILITY

2009 RV *Southern Surveyor* program

voyage summary SS04/2009

CSIRO

SS04/2009

Integrated Marine Observing System (IMOS) Facility 3. Southern Ocean Time Series (SOTS) moorings for climate & carbon cycle studies southwest of Tasmania (47ºS, 140ºE).

Voyage period

Departed Hobart 1100hrs, Tuesday 22 September 2009
Arrived Hobart 1700hrs, Wednesday 30 September 2009

Responsible laboratory

CMAR – UTAS – ACECRC
PB 80, Hobart, Tasmania, Australia

Chief Scientist(s)

Associate Professor Tom Trull – CMAR, UTAS, ACECRC, PB 80, Hobart, TAS, 7001
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Objectives and brief narrative of voyage

The overall scientific objective is to obtain frequent measurements of surface and deep ocean properties that control the transfer of CO_2 from the atmosphere to the upper ocean, and then onwards to the ocean interior in the form of sinking particles. This "biological pump" drives carbon sequestration from the atmosphere, and writes the sedimentary record. The controls on its intensity are complex and involve processes that vary on daily, weekly, seasonal, and interannual timescales. Obtaining observations with the necessary frequency is not possible from ships. For this reason the NCRIS IMOS Southern Ocean Time Series Facility seeks to obtain this information using automated sensor measurements and sample collections.

This voyage will recover and redeploy a sediment trap mooring that collects sinking particles at approximately fortnightly intervals at three depths (near 1000, 2000, and 3800 m), and deploy a second mooring that will make measurements of temperature, salinity, mixed layer depth, photosynthetically available radiation, oxygen, total dissolved gases, and phytoplankton fluorescence and backscatter. The second mooring will also collect 48 water samples for later measurement of dissolved nitrate, silicate, inorganic carbon, and total alkalinity.

The voyage also included the piggy-back project, Testing of trace-element clean CTD/Rosette, and aerosol sampling system, lead by Ed Butler and Andrew Bowie.

Voyage Objectives

1. transit to SAZ45-11 mooring site
2. recover SAZ45-11 sediment trap mooring begin refurbishment of recovered equipment
3. transit to Pulse-6 mooring site
4. deploy Pulse-6 and triangulate final position
5. near Pulse-6 site, deploy one or two ARGO floats
6. near Pulse-6 site, do 1 CTD cast to 1000m (with O2 and PAR sensor) and sample for salinity, nutrients, alkalinity, DIC.
7. transit to SAZ47-12 site
8. deploy SAZ47-12 and triangulate final position,
9. near SAZ47-12 site, repeat CTD cast as above at 6.
10. Butler-Bowie piggy-back project: do trace-element rosette casts whenever/wherever schedule allows, and install aerosol sampler.

Results

1. Deployment of ARGO floats.

This was not carried out, as the floats were recalled by the manufacturer for repair of faulty pressure sensors and were not repaired in time for the voyage. Deployment is now planned from RV *Aurora Australis* as soon as the floats are ready.

2. Recovery of SAZ45-11 sediment trap mooring.

This was achieved with difficulty. All scientific equipment was recovered, but a raft of 12 glass-ball floats and a CART acoustic transponder were lost when the mooring went under the ship and was struck by the propeller. (This loss required some reduction in scope of the redeployment of the SAZ47-12 mooring.) The five deployed sediment traps had functioned to varying degrees. Both IRS traps functioned correctly, although the controller of IRS#2 did not respond on recovery (but did after replacing the 9V on-board battery), and the pressure casing lid for IRS#1 controller was significantly corroded and will require replacement. Two of the three Mclane traps functioned correctly, but the third failed after a subset of the cups had rotated because a cup became blocked against the motor. Taping around the exterior of the ring of cups, or preferably addition of a cowling around the cups, should help to limit the chances of this occurring in future deployments.

3. Deployment of Pulse-6 mooring

The mooring was deployed successfully, with one minor modification – owing to an error, the Brankner pressure-temperature logger planned for mounting on the inertial dampener was not mounted. The surface float light and Iridium communications systems functioned correctly, and the system is reporting onl-line to the www.imos.org.au Southern Ocean Time Series Facility.

4. Deployment of SAZ47-12 Mooring

The SAZ47-12 mooring was successfully deployed, with 3 minor modifications to the planned design, to accommodate the loss of floats (8 spares were brought, but 12 were lost so that 4 needed to be removed from the design):

i) only IRS trap #1 was re-deployed, paired with the shallowest (1000m below sea-level) Mclane trap, and this IRS trap was programmed to operate in time-series mode to allow comparison of Mclane and IRS trap yields.

ii) the float pack below the deepest trap (3900m bsl) was reduced from 6 to 4 floats and the second float pack below the mid-depth trap (2000 bsl) was reduced from 4-2 floats.

iii) and the 30m wire length below the mast-float pack was increased from 30 to 50m.

5. CTD casts

No casts were possible owing to problems with the cable spooling. Unfortunately this means that no data were obtained regarding the state of the vernal water column for comparison with the Pulse mooring results.

6. Butler-Bowie Piggy Back Project

Trace clean rosette was deployed 3 times. The first time only partial closure of the set of bottles occurred. Modifying the lanyards led to successful closure on the second cast. The third cast produced acceptable dissolved Fe results consistent with pre-existing observations, confirming that the equipment can deliver the required level of cleanliness for use in the upcoming Tasman Sea voyage (SS01/2010). Salinity and nutrient samples were also collected from this third cast. However, the rosette did show some signs of fatigue cracks on the bottle-bridles and corrosion on the bottle retaining screws, and these issues will be addressed on return to port.

The Lear-Siegler Hi-Vol dust sampler was mounted on the forward starboard side of the monkey island, with the ultrasonic wind-speed, wind-direction sensor mounted forward and to the right of the sampler, on the rail. The regular umbilical (20 m) was affixed along the starboard rail of the monkey island and passed into the starboard rear of the bridge via the watertight gland beside the rear door to the bridge. The controller was mounted on the floor under the computer systems cabinet. All exposed connectors were made as waterproof as possible using insulating tape covered by vulcanising tape. The WSWD sensor was grounded to the monkey-island rail.

Voyage Narrative

Departure was delayed from Monday afternoon 21 Sept. to Tuesday morning 22 Sept. to complete preparation of winches and blocks. Transit to the SAZ45-11 site was uneventful under an easterly wind and swell. Acoustic communication with the SAZ45-11 mooring was successful using the hull-mounted hydrophone – and this was a very significant improvement over the previous requirement to use hand-held hydrophones, both in terms of operator comfort and in terms of acoustic quietness. Using the new system, it was not necessary to declutch the propeller, providing for a much safer operation. Many thanks to Steve Thomas for implementing the new system following our recommendations in 2006.

Sept. 23, conditions for recovery of SAZ45-11 were challenging, with winds of 30-35 knots and seas of 4-5 meters, and poor visibility under light and at times moderate rain. The mooring came to the surface and strung out nicely under the easterly winds with its 50m pickup line laying out nicely to the west for what looked to be an easy recovery, but proved to be very difficult. Four attempts were made before final recovery:

1. approaching head to weather from the left of the mooring string, the pickup line was grappled on the starboard side. But, before it could be transferred to the line leading around from the stern A-frame the pickup line passed under the bow, as the mooring string drifted downweather towards the ship. The pickup floats were reattached and the pickup line cast-off. It passed safely under the hull.

2. the second approach was by backing down onto the pickup float and grappling from the stern. The pickup float was pushed to starboard by propeller and/or thruster wash and the ship continued backing. Then the floating line was caught by the wash and pushed out to port, carrying the pickup line into the propeller, where it was cut off, about 10m from the top of the mooring.

3. the third attempt targeted the top of the mast on the top float pack of the mooring, again by steaming forward and grappling from the aft quarter of the starboard side. This float was grappled, and eventually recovered. But as with the first attempt, the next section of the mooring was carried under the ship, and this time the next pack of 12 glass ball floats were struck by the propeller and broken away. Thus the mast float pack was recovered, but the rest of the mooring drifted away. The contact with the propeller raised concerns about possible damage, which were then determined to be minimal after approximately an hour of engineering assessments. .

4. as the easterly winds decreased, and the sun emerged in the late afternoon, the fourth attempt successfully grappled the bottom (acoustic release) end of the mooring from the port aft quarter and it was then recovered.

Recommendations for improving the ease of recovery include:

i) using a longer wire length between the mast-float pack and the next set of floats, so that if the pickup float is lost, the second option of grappling the mast-float pack can be attempted with greater room to manoeuvre the ship – accordingly this was increased from 30 to 50m for the SAZ47-12 redeployment. However, as this wire sinks, the float spacing may not be much improved, and lengthening this wire further comes at a cost, as keeping the mooring top as far below the ocean surface as possible is desirable.

ii) adding a larger ring to the mast-float pack to allow for easier grappling should this second option be required – this will be pursued in future.

iii) executing a "dry-run" in which the ship is brought close to the mooring and then safely away without attempting the grappling, in order to get a sense of how the ship and mooring are moving relative to each other under the conditions on the day.

Sept. 24, while clean-up of the SAZ45-11 mooring equipment continued, a clean rosette cast (Butler-Bowie piggy-back project) was carried out. The use of Kevlar braid on the aft CTD winch worked well, but the new clean rosette only functioned partially – with some bottles closing correctly and others not. The winds and seas then rose and precluded any further casts or other activities other than deck work. The ship held position until approximately midnight while spooling on of the Pulse mooring was carried out on the trawl deck, and preparation of sediment traps (including use of mercuric chloride) was carried out successfully in the sediment trap container laboratory on the shelter deck.

Sept. 25-26, moderate to high north-westerly winds and seas precluded any further Clean Rosette deployments but work continued on deck to prepare for the Pulse 6 deployment, while under slow transit to that site to allow for safe working conditions.

Sept. 27, successful deployment of Pulse-6 and triangulation; successful second deployment of Clean Rosette using modified lanyards, although banged into A-frame during recovery in chaotic 4-5 m seas. Failed attempt at first CTD because of cable spooling problem – this turned out to be something that could not be fixed at sea, and thus no CTDs were achieved during the voyage.

Sept. 28, successful third deployment of Clean Rosette; successful deployment of SAZ47-12; difficult triangulation of SAZ47-12 owing to deep water depth (~4600m) being similar to maximum range for acoustic communication.

Sept. 29-30, return to port.

Summary

The voyage was largely successful in achieving its objectives, despite very difficult weather and a very heavy workload. The moorings were successfully recovered and redeployed (albeit with some loss of equipment – 12 glass floats and a CART acoustic transponder). Unfortunately the CTD program could not be completed, owing to a winch-cable spooling problem, which appears to have arisen during maintenance in port prior to the voyage. The piggy-back project was successful. Overall, the working conditions were some of the most difficult that I have experienced, both in terms of the poor and very fatiguing weather and the heavy workload. The heavy workload arose in part from the sequence of events which required us to recover SAZ45-11 prior to deploying Pulse-6. This sequence was designed to minimize the length of the ship-track, but in future plans, minimizing the fatigue of the at-sea team will need to be a higher priority. Based on this voyage, the time allocated was a bare minimum and given the frequency of difficult weather in this region in spring, future voyages would benefit by the addition of an extra day to improve the ability to be able to wait out difficult conditions.

Deployed mooring positions as estimated by triangulation of acoustic releases:

PULSE-6	46° 19.344'S	140° 40.653'E	4267 m
SAZ47-12	46° 50.010'S	141° 39.417’E	4599 m

[Full details of deployment conditions, procedures and the triangulation estimates are in a separate longer report: *Southern Surveyor* voyage SS0904 (VOYAGE 4, 22/09/2009 TO 30/09/2009) Pulse Mooring Deployment and SAZ Mooring Turnaround, Mark Rosenberg, Tom Trull and Stephen Bray. Sept. 2009]

Personnel list

Science Party

Tom Trull	CMAR-UTAS-ACE	Chief Scientist
Stephen Bray	ACE	Sediment trap program leader
Mark Rosenberg	ACE	Oceanographer/mooring leader
Edward Butler	CMAR-ACE	Deputy-Chief /Piggy-Back Leader
Andrew Bowie	ACE	Piggy-Back co-leader
Tom Remenyi	ACE	Mooring/clean-rosette deployments
Carrie Bloomfield	ACE	Piggy-back trace analysis
Geoff Watson	ACE	Mooring/sediment trap assistance
Dave Cherry	CMAR	Mooring deployments
Anoosh Sarraf	CMAR	MNF Computing support
Ian Hawkes	CMAR	MNF Computing support
Peter Dunn	CMAR	MNF Voyage manager /Electronics support

Ship Crew

Les Morrow	Master
John Barr	Chief Mate
Rob Ferries	Second Mate
Rob Cave	Chief Engineer
Arthur King	First Engineer
Jamie Wheatcroft	Second Engineer
John Howard	Bosun CIR
Matt Barrett	IR
Gareth Gunn	IR
Rod Langham	IR
Paul McLucas	IR
Peter Sharman	Chief Cook
Ken Rawson	Second Cook
Charmayne Aylett	Chief Steward

Acknowledgements

Many thanks to Master and Crew, and the onboard Science Team for long hours and positive attitudes. Special thanks to piggy-back project co-leader Andy Bowie for his substantial contributions to the main project. Many thanks to landside contributors Danny Mclaughlin, Dave Hughes, Joe Adelstein, Lindsay Pender, Matt Sherlock, Mark Rayner, Diana Davies, and Tim Lynch for robust design, construction, procurement, preparation, and project management.

Tom Trull
Chief Scientist

CSR/ROSCOP PARAMETER CODES

METEOROLOGY

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 Current 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

MARINE BIOLOGY/FISHERIES

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