

**MARINE**  
**NATIONAL FACILITY**

# 2010

*RV Southern Surveyor*  
program



**voyagesummaryss2010\_v07**

## **SS2010\_v07**

### **Southern Ocean Time Series Moorings**

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#### **Voyage period**

Start: 07/09/2010

End: 15/09/2010

Port of departure: Hobart, Australia

Port of return: Hobart, Australia

#### **Responsible laboratory**

Antarctic Climate and Ecosystems Cooperative Research Centre (ACE CRC)

Hobart, 7001 Australia

#### **Chief Scientist(s)**

Tom Trull, ACE CRC – UTAS – CMAR – CAWCR

Eric Schulz BOM – CAWCR

## **Scientific Objectives:**

The overall scientific objective of the Southern Ocean Time Series is to obtain frequent measurements of surface and deep ocean properties that control the transfer of CO<sub>2</sub> 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 inter-annual 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 goals are:**

- i) Deploy the Pulse-7 mooring to make measurements of temperature, salinity, mixed layer depth, photosynthetically available radiation, oxygen, total dissolved gases, phytoplankton fluorescence and backscatter, and dissolved nitrate. The Pulse-7 mooring will also collect 24 paired water samples, approximately weekly, for later measurement of dissolved nitrate, silicate, inorganic carbon, and total alkalinity.
- ii) Recover the SAZ47-12 (and redeploy as SAZ47-13) deep ocean sediment trap mooring that collects samples to quantify the transfer of particulate carbon and other materials to the ocean interior
- iii) Service the Southern Ocean Flux Station (SOFS-1) mooring deployed on SS2010\_v02 in April 2010 that measures properties that control the exchange of heat, moisture, and gases between the ocean and atmosphere
- iv) Carry out underway and CTD based measurements of water column stratification for comparison to the moored instruments.
- v) Deploy autonomous profiling floats and an ocean glider to obtain spatially distributed measurements of temperature, salinity, oxygen, phytoplankton fluorescence and particle backscatter in the vicinity of the moorings.

## Voyage Objectives and Results

1. In Port:
  - test A-frames and winch hydraulics
  - spool on Pulse-7 mooring, and set up trawl deck for mooring work
  - launch workboat and evaluate procedure for man-overboard recoveryAll tasks successful.
2. On first day in Storm Bay or off shelf at a convenient site and time do test CTD cast and lower SAZ47-13 acoustic releases for in-water test. All tasks successful, Pulse-7 releases also tested.
3. Map bathymetry around new Pulse-7 mooring site, deploy Pulse-7 at this site or if new site not suitable then at old Pulse-6 mooring site, triangulate final position. All tasks successful; Pulse-7 deployed at the new site.
4. Recover SAZ47-12 mooring, refurbish, redeploy at same site, triangulate final position. All tasks successful.
5. Undertake two CTD casts to 1000m (with O<sub>2</sub>, PAR, transmissometer sensors) and sample for salinity, nutrients, alkalinity, DIC. (one near Pulse-7, one near SAZ47-12). Task not completed – precluded by rough weather.
6. Service SOFS-1 mooring – this requires launching the work boat and placing 1 to 2 people on the mooring. Service tasks are i) replace pCO<sub>2</sub> equilibrator and hose, ii) replace humidity sensor. Task not completed – precluded by rough weather.
7. Obtain ship-based meteorological measurements near SOFS-1 mooring, by holding ship head-to-weather near mooring for up to 24 hours (schedule permitting) Task successfully completed.
8. Deploy one or two ARGO floats. Task successfully completed. Two Teledyne/Webb APEX IPF9I floats with SBE 43 O<sub>2</sub> and Wetlabs FLBBAP2 bio-optical sensors deployed. Hull i.d.s 4986 and 4987.
9. Deploy ANFOG ocean glider. Task successfully completed. iRobot glider i.d.
10. Sample underway clean seawater supply – using transmissometer set-up in Controlled Temperature Lab, and POC filtration rig set up in Fish Lab. Task partially completed – for nutrients, DIC, and alkalinity samples. Transmissometer and POC observations not carried out because this project will be carried out on RV *Astrolabe* instead – because of scientific synergies with other sampling programs.

## **Voyage Narrative**

**(times in this section are local = GMT+10)**

**Tuesday 7 Sep.** Departure was on time and transit to the test CTD cast and tentative new Pulse-7 site was rapid in good weather.

**Wednesday 8 Sep.** Vessel arrived at the new site at ~1700, and began the bathymetric survey. By 2200 we were able to conclude that the site was acceptable, although the area of appropriate depth and smoothness was only ~2 mile north-south and 4-mile east-west in size.

**Thursday 9 Sep.** The morning had sufficiently rough seas that we delayed deployment until they could be assessed in daylight, and we then began deployment of Pulse-7 at ~09:00. The deployment was carried out on a heading of ~330 starting 6 miles from the target and the anchor was deployed very close to the target. The deployment was uneventful despite degrading weather. However, the anchor lift which was done using the synthetic working braid on the net drum and the elastic loading on this line caused the release hook trigger line to be pulled up very rapidly – striking and bruising Stephen Bray along the right arm.

**Friday 10 Sep.** After overnight transit to the SAZ47-12 site, we released the SAZ47-12 mooring at ~0645. Recovery was very smooth – with the ship moving in beautifully to bring the pick-up line onto the starboard quarter where it was retrieved with the first shot of the air-cannon grapple. The ship then fell off the wind to port and brought the line smoothly astern the ship. Because the top end of the mooring was lying to the east of the lower sections, we then recovered stern-to-weather. This proceeded rapidly and smoothly until a massive tangle was encountered above the 3rd sediment trap – with 5 lines leading into the water. Considerable time was spent untangling and working this through the block and onto the net-drum (including cutting out a section of badly knotted wire after it was on the drum). All of this work was done in fairly difficult conditions of rising seas (5-6m), winds (30-35 knots), with waves frequently running up the deck; filling boots and blasting spray over all involved. In the end all equipment was successfully recovered without damage and all SAZ sediment traps exhibited complete and excellent sample recovery.

**Saturday 11 Sep** was consumed by preparing SAZ47-13 for deployment and triangulation of Pulse-7 that evening.

**Sunday 12 Sep** dawned with winds above 30 knots, seas above 5 metres, and rain squalls. In consultation with the crew we held off until 0900 to track the sea state, and then concluded that while it would be “pushing the envelope” we would proceed with deployment because conditions for Monday did not look likely to improve. The Master’s suggestion to carry out the craning down of the sediment traps from the upper to lower deck while running with the wind and waves was excellent and this work went smoothly. Deployment began ~6 miles from the target, again along a heading of ~330. Seas and winds rose throughout the work

period, and just after the deployment of the 3rd and final sediment trap a blast of icy rain hit us from the starboard bow with gusts recorded to 57 knots. This pushed the ship sideways and we had to hold the deployment while we worked the ship back to the northeast to get the mooring line trailing aft again. Seas by this point were 7-8m, and the strain on the line was significant. Whether this towing will have damaged any gear will only be known after recovery (planned for August 2011). The main concern is for the attachment of the sediment trap bottles, which would benefit from the construction of a shield for such rough conditions. The final anchor launch was done using a sacrificial rope loop stoppered to the deck cleat, so that the tension from the deployed portions of the mooring pulled the anchor off the deck without having to attempt a lift in the seriously difficult conditions of winds above 50 knots. Triangulation of the mooring was completed successfully Sunday evening.

**Monday 13 Sep.** Seas were too rough to allow CTDs, and we spent the day undertaking short transits near the SOFS-2 mooring for sensor intercomparisons. The two ARGO+ floats were deployed manually from the back deck during down wind transits, and the glider using the stern A-frame. Conditions were winds of 30-35 knots, with higher gusts and seas of 6-7 metres with swell from both north and south of west. Underway seawater samples were collected as we departed the mooring site to return to Hobart

## Summary

The voyage was very successful in achieving its objectives. The Pulse-7 and SAZ47- 13 moorings, two profiling floats, and the ANFOG glider were deployed as planned. The SOFS-1 mooring could not be repaired or the CTDs completed owing to rough weather. The combination of the floats and collection of underway samples covered many of the objectives of the uncompleted CTDs. Considering the very difficult conditions, these achievements are a very strong testament to the abilities and fortitude of the crew, science team, and ship.

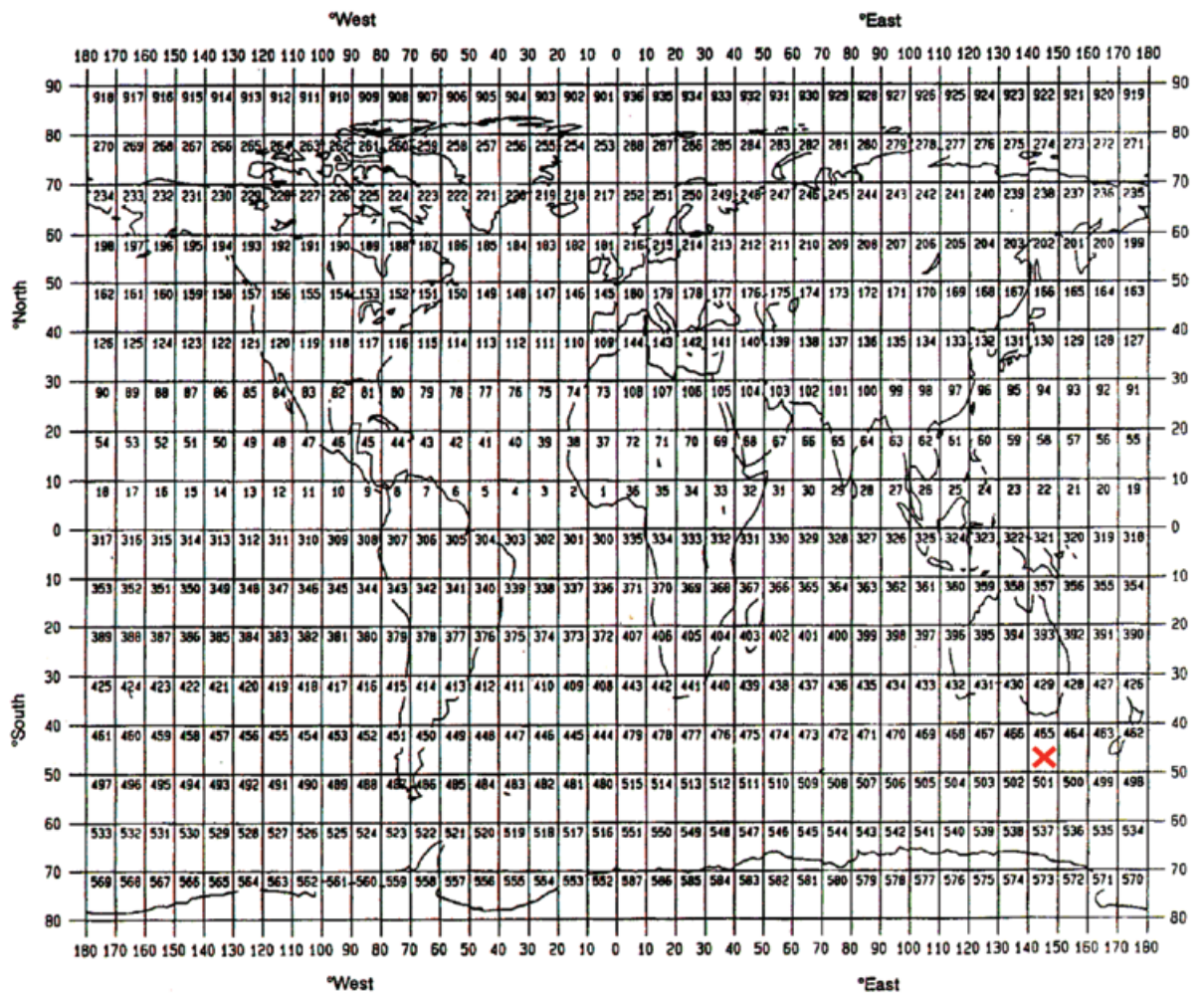
## Project

Project name: Australian Bluewater Observing System Southern Ocean Time Series  
Coordinating body: Australian Integrated Marine Observing System

## Principal investigators

A. Tom Trull, ACE CRC – UTAS – CMAR-CAWCR, Tom.Trull@utas.edu.au  
B. Eric Schulz, BOM-CAWCR, E.Schulz@bom.gov.au

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



| MOORINGS, BOTTOM MOUNTED GEAR AND DRIFTING SYSTEMS |                    |                      |        |     |           |        |     |  |   |
|--|--------------------|----------------------|--------|-----|-----------|--------|-----|--|---|
| Item No  | PI See page above. | APPROXIMATE POSITION |        |     |           |        |     | DATA TYPE                              | Description   |
|  |                    | LATITUDE             |        |     | LONGITUDE |        |     |  |   |
|  |                    | deg                  | min    | N/S | deg       | min    | E/W |  |   |
| 1  | A                  | 46                   | 49.824 | S   | 141       | 38.981 | E   | B73                                    | SAZ47-12 sediment trap mooring recovered and redeployed as SAZ47-13 sediment trap mooring. Both moorings have 3 Mclane Research Labs Parflux-21cup-carousel conical funnel sediment traps at approximately 1000, 2000, 3800m depth, and a single current meter at ~1000m depth.. SAZ47-12 also carried a Prime Focus Indented Rotating Sphere sediment trap at ~1000m that was not redeployed. The top of the mooring is ~800m below the surface.   |
| 2  | A                  | 46                   | 56.084 | S   | 142       | 15.396 | E   | H17<br>H21<br>H24<br>H33<br>H72<br>D01 | <p>Pulse-7 surface biogeochemical mooring deployed for recovery in April 2011. This mooring is longer than the water depth and the small 1m diameter surface float moves in a circle of ~1.1mile radius. Most Instruments are concentrated in a sub-surface package at ~35m depth :</p> <p>1. Wetlabs ECO PAR sensor<br/>2. Wetlabs FLNTUS sensor<br/>3. ISUS Nitrate senso<br/>4. Seabird 16+ CTD<br/>5. SBE43 O2 electrode<br/>6. Aanderaa O2 optode<br/>7. Pro-Oceanus gas tension device<br/>8. Melane RAS 500 water sampler (48 half-litre samples collected sequentially).</p> <p>In addition there are temperature loggers placed at ~10 m intervals from 40 to 150m depth to define mixed layer depth. The surface float has accelerometers to determine wave motions and a surface PAR sensor.</p> |
| 3  | A                  | 46                   | 42.433 |     | 141       | 46.573 |     | H11<br>H17<br>H21                      | Two free-drifting autonomous profiling (ARGO) floats with CTD , oxygen, fluorescence and backscatter sensors that will not be recovered (Hull numbers 4896 and 4897). One unpowered (iRobot) ocean glider piloted towards Tasmania for recovery before end 2010.  |



| SUMMARY OF MEASUREMENTS AND SAMPLES TAKEN |                      |                 |                    |   |  |
|---|----------------------|-----------------|--------------------|---|--|
| Item No.                                  | PI<br>see page above | NO<br>see above | UNITS<br>see above | DATA TYPE<br>Enter code(s) from list on last page | DESCRIPTION  |
| 1   | A                    | 1               | cast               | H10   | CTD test cast to 500m, no other CTDs owing to rough weather  |
| 2   | A                    | 8               | station            | H22<br>H24<br>H26<br>H27<br>H74                   | Water samples taken from underway surface supply for shore-based analyses of nutrients, salinity, DIC, alkalinity . Locations of these samples are listed below this table.. |
| 3   | B                    | 700             | miles              | H71   | Continuous monitoring of underway seawater supply for temperature, salinity for study of physical heat and mass flux   |
| 4   | B                    | 700             | miles              | M02   | Continuous monitoring of incoming short and long-wave radiation for heat fluxes  |
| 5   | B                    | 700             | miles              | M06   | Continuous monitoring of routine meteorological observations (wind, air temperature, humidity and pressure) for heat, mass and momentum fluxes                               |
| 6   | B                    | 700             | miles              | M90   | Continuous monitoring of precipitation for mass fluxes   |
| 7   | B                    | 700             | miles              | H71   | Continuous monitoring of skin sea surface temperature during calm rain-free conditions   |

#### Underway Sample List (salinity, 2xnutrients, DIC, Alk at each site, labeled SS1007\_1 to \_8)

SS1007. All samples taken from underway supply at exit from fluorometer by T.Trull

| Site | UTC time | UTC date   | Lat       | Lon        | T/S Temp | T/S salinity | EA500 depth | Salts | Nutrients |
|------|----------|------------|-----------|------------|----------|--------------|-------------|-------|-----------|
| 1    | 7:21     | 13/09/2010 | 46 40.972 | 141 49.108 | 9.2      | 34.54        | 4554        | none  | 1         |
| 2    | 8:14     | 13/09/2010 | 46 35.398 | 141 59.204 | 9.9      | 34.72        | 4172        | D2    | 2         |
| 3    | 8:51     | 13/09/2010 | 46 32.289 | 142 6.577  | 10       | 34.557       | 4641        | D3    | 3         |
| 4    | 9:55     | 13/09/2010 | 46 26.344 | 142 19.308 | 10.5     | 34.612       | 4491        | D4    | 4         |
| 5    | 10:57    | 13/09/2010 | 46 20.688 | 142 31.477 | 11       | 34.814       | 4965        | D5    | 5         |
| 6    | 13:01    | 13/09/2010 | 46 8.355  | 142 55.718 | 10.8     | 34.767       | 4588        | D6    | 6         |
| 7    | 13:53    | 13/09/2010 | 46 2.722  | 143 35.45  | 10.6     | 34.789       | 4530        | D7    | 7         |
| 8    | 14:53    | 13/09/2010 | 45 56.44  | 143 16.35  | 11.5     | 34.954       | 4784        | D8    | 8         |

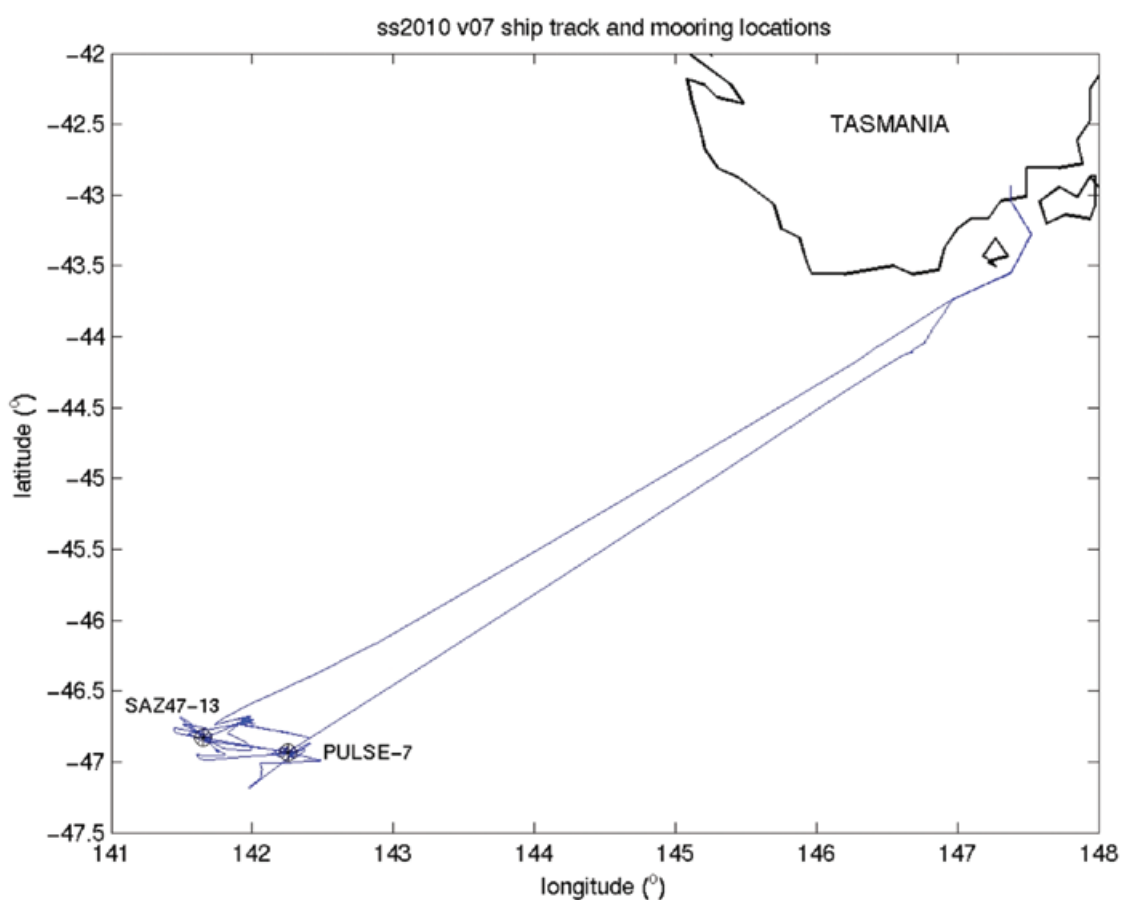
| CURATION REPORT |   |
|-----------------|---|
| Item No.        | Description   |
| 1               | Samples of sinking particles collected by the deep moored sediment traps from the SAZ47-12 mooring are curated by the ACE CRC SAZ-Project and retained indefinitely. Samples are collected directly into mercuric chloride poisoned brines in the sediment traps to render them sterile. In the ACE CRC laboratory they are divided into fractions for analysis and archiving.. |
| 2               | Water samples collected from the ship's underway seawater supply are returned to CSIRO Marine and Atmospheric Research for nutrient, salinity, DIC, and Alkalinity measurements and then discarded.   |

### General ocean area:

Southern Ocean – Indian Sector

### Specific areas:

Subantarctic Zone southwest of Tasmania



## Personnel list

### Science Personnel

|                    |               |   |
|--------------------|---------------|---|
| Tom Trull          | CMAR-UTAS-ACE | IMOS-ABOS Facility Leader - Chief Scientist |
| Stephen Bray       | ACE           | SAZ mooring leader                          |
| Mark Rosenberg     | ACE           | deck operations leader                      |
| Pier van der Merwe | ACE           | deck operations trainee                     |
| Peter Jansen       | IMOS-UTAS     | IMOS-ABOS Project Manager                   |
| Eric Schulz        | BOM           | SOFS mooring leader / chief scientist       |
| Pamela Brodie      | CMAR          | MNF Computing support /<br>Voyage manager   |
| Pete Dunn          | CMAR          | MNF Electronics support                     |
| Stephen McCullum   | CMAR          | observer                                    |

### Ship Personnel

|                   |                             |
|-------------------|-----------------------------|
| Michael Watson    | Master                      |
| John Boyes        | Chief Mate                  |
| Tom Watson        | Second Mate                 |
| Mike Yorke-Barber | Chief Engineer              |
| Robert Cave       | First Engineer              |
| Jason Searle      | Second Engineer             |
| John Howard       | Bosun CIR                   |
| Rod Langham       | IR                          |
| Rose Croasdale    | IR                          |
| Ellen Smith       | IR                          |
| Kel Lewis         | IR                          |
| Geri Byrne        | Chief Cook                  |
| Robert Dittko     | Second Cook                 |
| Kate Gould        | Chief Steward               |
| Tim Asome         | P&O Ship Manager (observer) |

## Acknowledgements

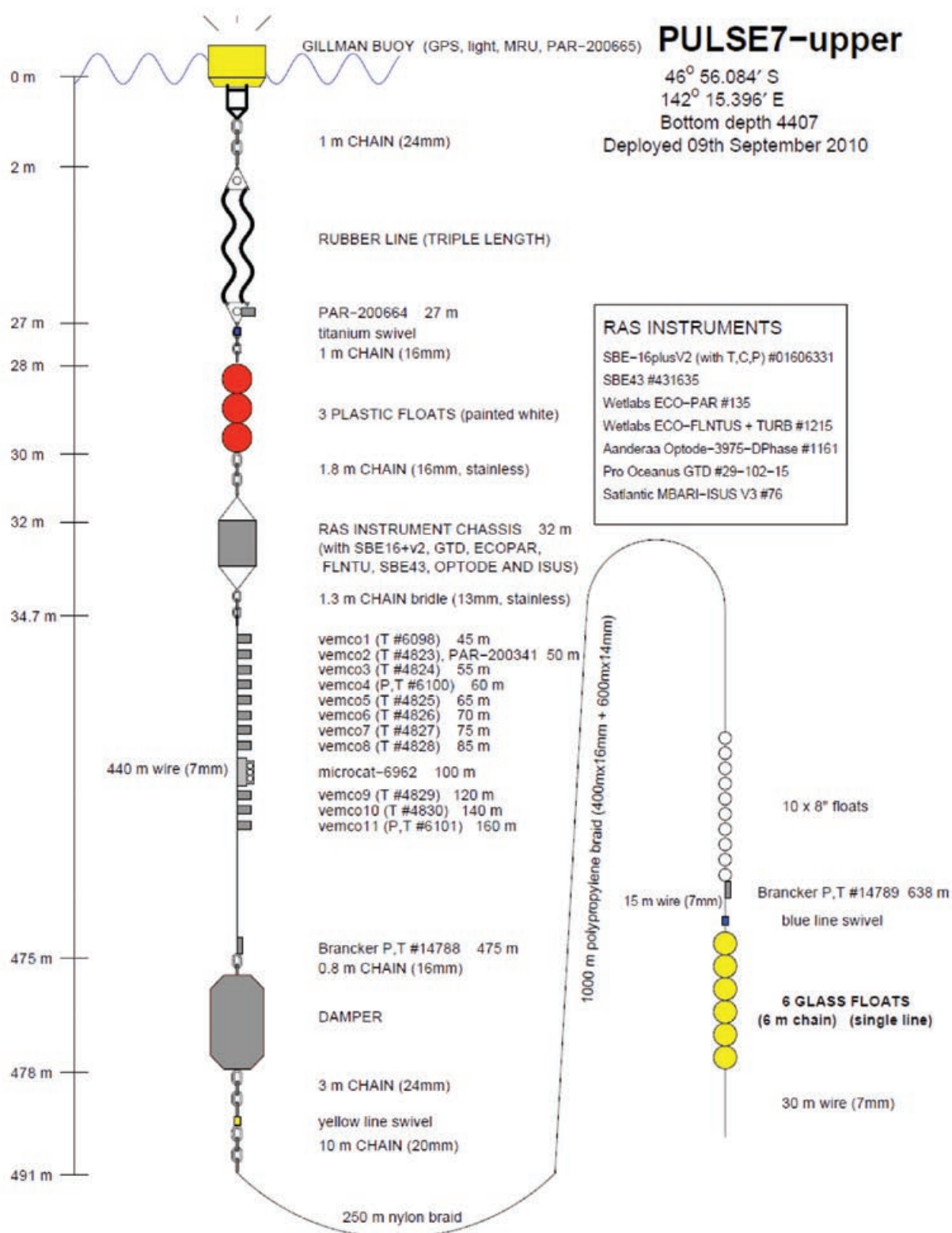
Many thanks to Master, Crew, MNF staff, and the onboard Science Team. Ship handling was superb; deck operations were easy and quick. Computing, electronic, and voyage management support was good. The food was great. The positive attitudes and professionalism of all participants is gratefully acknowledged. Many thanks also to SOTS team landside contributors Dave Cherry, Dave Hughes, Lindsay Pender, Matt Sherlock, Diana Davies, and Phil Adams for robust design, construction, procurement, preparation, and project management. Thanks also; to Vito Dirita, Bob Weldon and Ann Thresher for profiling float preparation and support; and to Ben Hollings and ANFOG for glider preparation and support.

### Tom Trull

#### *Chief Scientist*

*23 September 2010*

Figure 2. Pulse-7 mooring diagram (upper S-section and lower stiff sections shown separately)



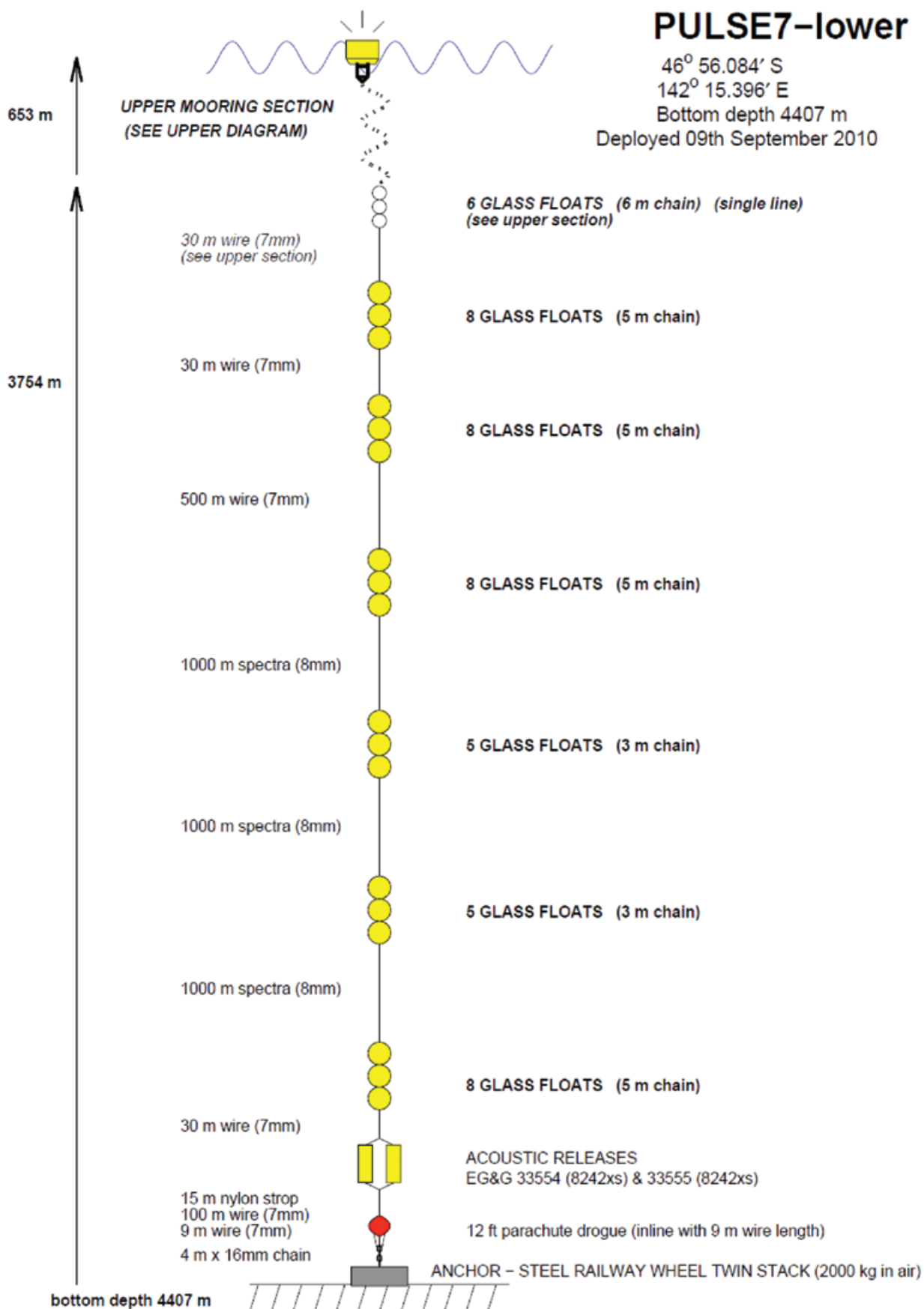
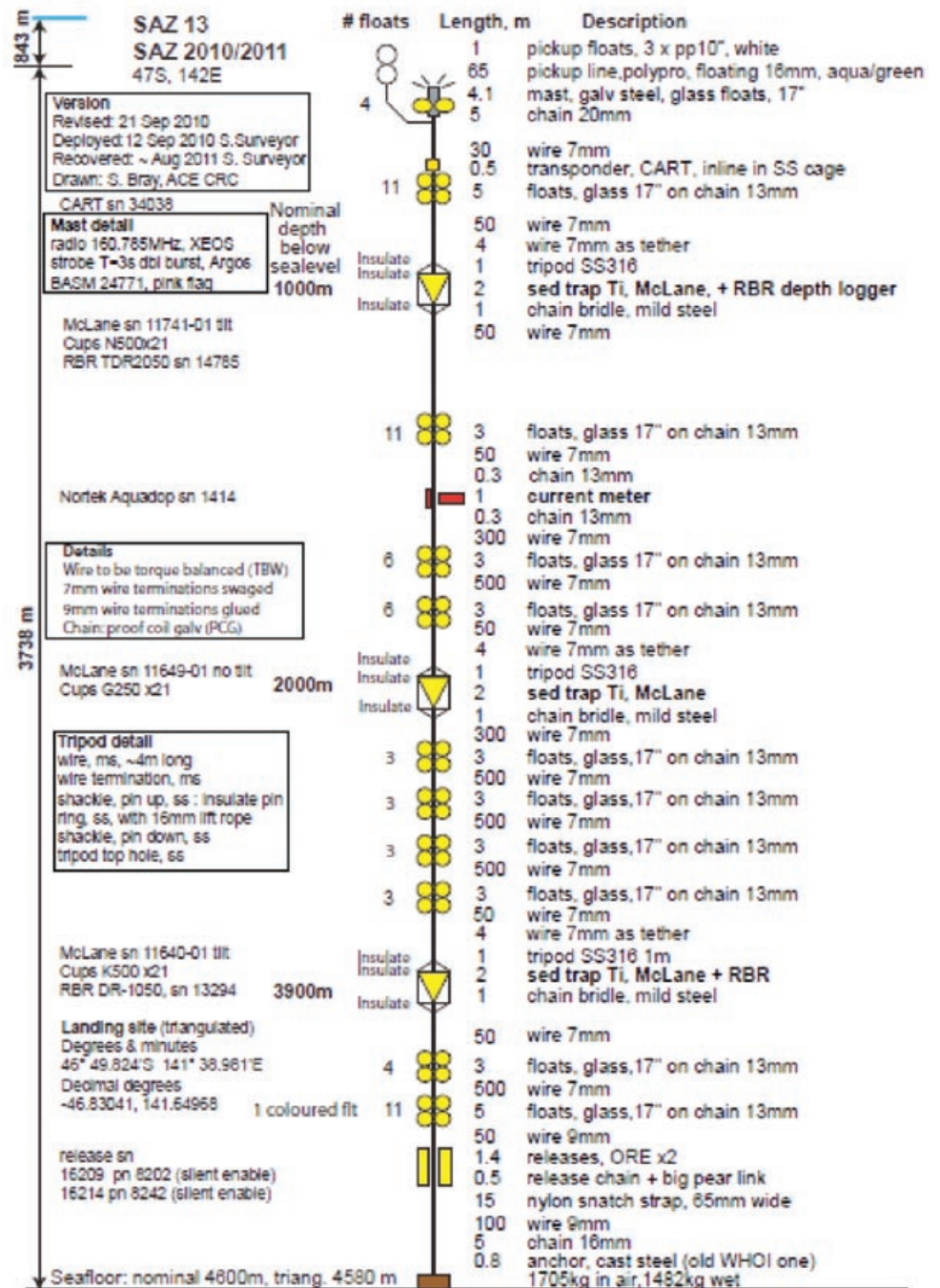


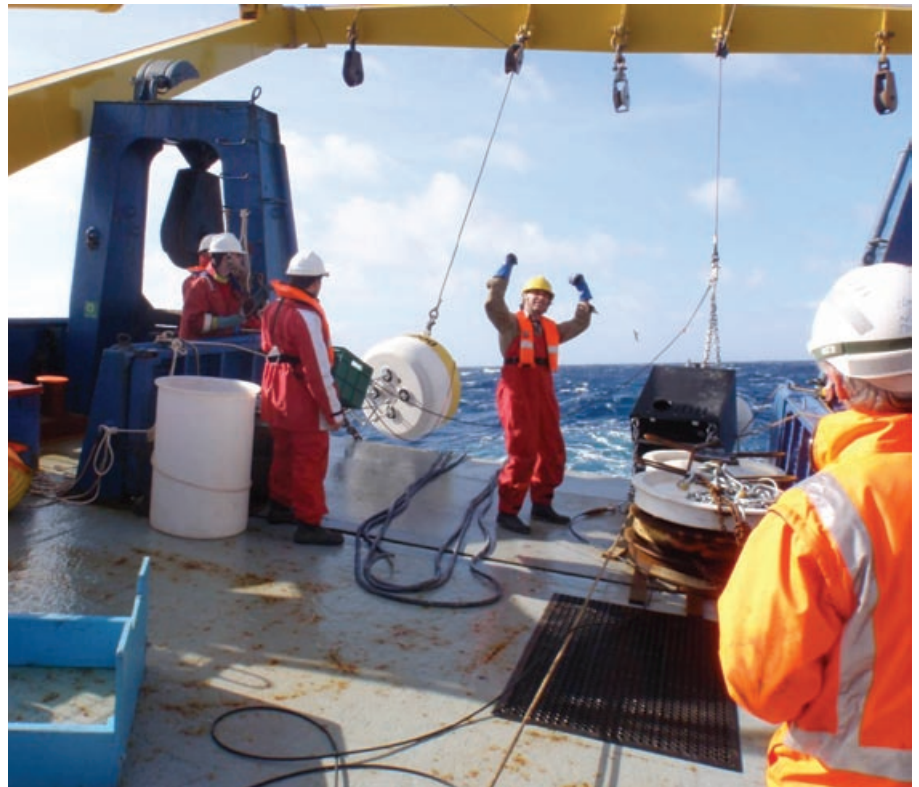
Figure 3. SAZ47-13 Mooring Diagram





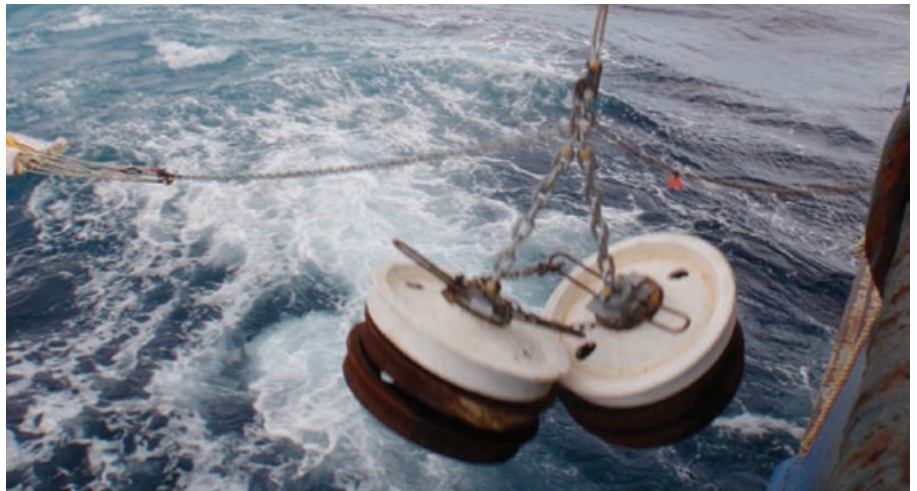
**Figure 4. Simultaneous deployment of the Pulse-7 surface float (at left) and RAS mixed layer instrument pack (at right).**

Mark Rosenberg, deployment leader, signals to the crew to take the A-frame outboard while the science team stands ready to trigger the release hooks when the elements are clear of the ship and each other. The tri-part elastic tether that protects the instruments from surface waves is laid out on the deck between these elements. Motion Reference Units in the surface float record accelerations to evaluate waves. The RAS pack has sensors for temperature, salinity, dissolved oxygen, total dissolved gases, nitrate, phytoplankton fluorescence, particle backscatter, and photosynthetically active radiation. It also collects 48 half-litre water samples for laboratory nutrient, alkalinity, dissolved carbon dioxide and phytoplankton identification measurements.



**Figure 5. Deployment of the large Pulse-7 double-anchor.**

Use of inexpensive train wheels requires two stacks for stability on deck and this makes deployment difficult and also crowds the deck. More compact cast anchors are preferable, but expensive and hard to source in Australia. The parachute at left slows the sinking rate to protect the ~6km long mooring from dynamic stresses as it is pulled from its horizontal position trailing behind the ship into its vertical deployment position.



**Figure 6. SAZ47-13 Deployment team.**

Behind the team are 3 large sediment trap moorings that must be lifted overboard as the mooring is trailed aft. Deployments in rough weather require smooth coordination between the officers controlling the ship, the crew operating the winches and the A-frame, and the science party assembling the mooring, plus eyes out for waves and each other. Voyages with multiple deployments require large teams to limit fatigue, and benefit greatly from the willingness of MNF staff to serve as observers, recorders, and photographers. Every shackle, component, and join is photographed as the kilometres of mooring are sent into the sea, to document the correct assembly of the complex structure.

