

MARINE
NATIONAL FACILITY

2009

RV Southern Surveyor
program



voyagesummaryss02/2010

SS02/2010

IMOS-Southern Ocean Time Series Facility

Voyage period

Start: 16/03/2010

End: 22/03/2010

Port of departure: Hobart, Tasmania, Australia

Port of return: Hobart, Tasmania, Australia

Responsible laboratory

Antarctic Climate and Ecosystems Cooperative Research Centre

PB 80, University of Tasmania, Hobart, 7001 Australia

Chief Scientist(s)

Thomas W. Trull, ACE CRC, University of Tasmania,
and CSIRO Marine and Atmospheric Research

Scientific Objectives

The overall scientific objective of the Integrated Marine Observing System Southern Ocean Time Series facility is to obtain frequent measurements of surface and deep ocean properties that control the transfer heat, moisture, energy and CO₂ from the atmosphere to the upper ocean to improve understanding of climate and carbon processes. The facility also obtains measurements of the onward transfer of carbon to the ocean interior in the form of sinking particles. This “biological pump” drives carbon sequestration from the atmosphere, and writes the sedimentary record, and thus offers a means to evaluate models of climate and carbon cycling over longer timescales than instrumental records. The controls on the biological pump 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.

The voyage deployed for the first time the Southern Ocean Flux Station (SOFS-1) mooring to obtain in-air and in-sea measurements to better understand the exchange of heat, moisture, and gases between the ocean and atmosphere. It also recovered the Pulse-6 mooring that has been making measurements of temperature, salinity, mixed layer depth, photo- synthetically available radiation, oxygen, total dissolved gases, and phytoplankton fluorescence and backscatter. The Pulse-6 mooring also collected 24 pairs of surface water samples, approximately weekly, for later measurement of dissolved nitrate, silicate, inorganic carbon, total alkalinity, and phytoplankton identification.

Voyage Objectives (bold) and Results (italics)

[times are local Australian Eastern daylight savings time, which was 11 hours ahead of UTC]

1. test A-frame and winch hydraulics in port

Completed successfully.

2. do test CTD cast, and lower acoustic releases for in-water test, in Storm Bay

Completed successfully.

Test cast carried out south of Storm Bay off edge of shelf to 500m depth. Acoustic releases responded correctly. Two problems occurred with CTD sensors:

- i) transmissometer readout was not correct – fixed after recovery by plugging it into proper channel.*
- ii) primary temperature signal was lost at ~200m depth – fixed after recovery by cleaning and reseating plug.*

3. transit to SOFS-1 deployment site

Completed successfully.

Arrived 21:00 Wednesday, set up 8nm northeast of anchor target.

4. deploy SOFS-1 mooring, triangulate final position

Completed successfully.

Deployment using crane started ~22:00 local-time Wednesday, completed ~06:00 Thursday morning. The dual ASIMET meteorological packages are functioning correctly, but two components of the ancillary sensor systems are not fully functional:

i) the CSIRO module operating the in-air PAR sensor, in-water fluorometer and oxygen optode, in-buoy motion reference unit (accelerometers), and tension cell ceased transmitting during transit and could not be repaired prior to deployment. Partial repair by Karl Forcey (MNF electronics support) allowed in-air PAR sensor to be made functional, but not other elements.

ii) the NOAA pCO₂ module successfully reported via Iridium network, but data indicate a problem.

Triangulation of final position done after Pulse-6 recovery.

Deployed mooring position as estimated by triangulation of acoustic releases:

SOFS-1 46° 43.377' S 140° 57.211' E 4624 m

This anchor position is accurate within approximately 70m east-west and 40m north-south.

The mooring length (6087m) is much longer than the water depth (4624m), and thus the surface buoy moves within a 'watch circle' at the surface of radius ~3960m = 2.1 nautical miles.

[Additional details of deployment conditions, procedures, and the triangulation estimates are in a separate longer report: *Southern Surveyor voyage SS1002 (voyage 2, 16/03/2010 TO 22/03/2010)SOFS-1 mooring deployment and pulse-6 mooring recovery*, Mark Rosenberg, Tom Trull, Stephen Bray, Danny McLaughlan, and Eric Schulz, March 2010]

5. obtain ship-based meteorological measurements near SOFS-1 mooring, by holding ship head-to- weather near mooring for up to 24 hours (schedule permitting)

Completed successfully.

6. do CTD cast to 1000m at SOFS-1 site (with O₂, PAR, transmission sensors) and sample for salinity, nutrients, alkalinity, DIC.

Completed successfully (later in schedule), after Pulse-6 mooring recovery. Samples also taken for particulate organic carbon (POC) and 18O-H₂O.

7. transit to Pulse-6 mooring site

Completed successfully.

Arrived ~11:00am Thursday.

8. recover Pulse-6 mooring

Completed successfully.

Mooring arrived on surface with acoustic releases to east of surface float, as expected from the generally westward set of the surface float relative to the anchor throughout the deployment. We grappled the acoustic releases by backing the ship into the westerly winds and seas, which minimized risk of the mooring going under the ship, but made for a wet back deck. Mooring was onboard ~20:00.

9. do CTD cast to 1000m at Pulse-6 site (with O2, PAR, transmission sensors) and sample for salinity, nutrients, alkalinity, DIC.

Completed successfully.

Samples also taken for particulate organic carbon (POC) and 18O-H2O.

10. near SOFS-1 or Pulse-6 site, deploy one or two ARGO floats

Completed successfully.

One APEX APF9I float with Seabird SBE43 O2 sensor deployed.

11. sample underway clean seawater supply

Completed successfully.

Operated continuous logging of transmission (Wetlabs C-Star), dissolved oxygen concentration (Aanderaa optode) and dissolved O2/Ar ratios (Pfeiffer Quadstar Equilibrator Inlet Mass Spectrometer). Samples taken for nutrients, DIC, Alkalinity, POC on the return transit.

12. Near SOFS-1 or Pulse 6 site, deploy ANFOG ocean glider to provide spatial context for moored observations.

Completed successfully.

Glider deployed near SOFS-1 site from stern A-frame using release hook. In addition, Swath mapping of bathymetry was completed, including following specific waypoints across the Tasmanian shelf break.

Voyage Narrative

Our Tuesday departure was delayed 1 hour when science participant Jeff Lord had to withdraw for medical reasons. Transit to the test CTD cast and SOFS-1 site occurred with good weather, and we arrived at ~21:00 Weds. night. The SOFS-1 mooring was deployed in moderate conditions, finishing at ~06:00. We then moved directly on to recover the Pulse-6 mooring ahead of an approaching front, in rising seas, on Thursday. We completed the CTD at the Pulse-6 site in marginal conditions on Thursday evening, and then returned to the SOFS-1 site. On Friday morning we located SOFS1 and performed ship-buoy meteorology inter-comparisons until mid-day. We then completed triangulation of the anchor position for SOFS-1 and waited out the weather overnight with more meteorology inter-comparisons before completing the final CTD, launch of the ANFOG sea-glider, and deployment of the APEX Oxygen Profiling Float on Saturday. We began our return to Hobart Saturday ~14:00.

Summary

The voyage was very successful in achieving its objectives. The moorings were deployed and recovered as planned. The SOFS-1 mooring did experience loss of some capability prior to deployment – the CSIRO module failed during the transit for unknown reasons (see the Voyage Achievements for details). The durability of the Pulse design is now proven – it returned on deck in near pristine condition after 6 months in the Southern Ocean. Assessment of the overall success of the Pulse-6 science package awaits examination of the sensor records and samples on return to port. The CTD worked well after fixing minor problems identified during the test cast. The underway observing sensors worked as planned.

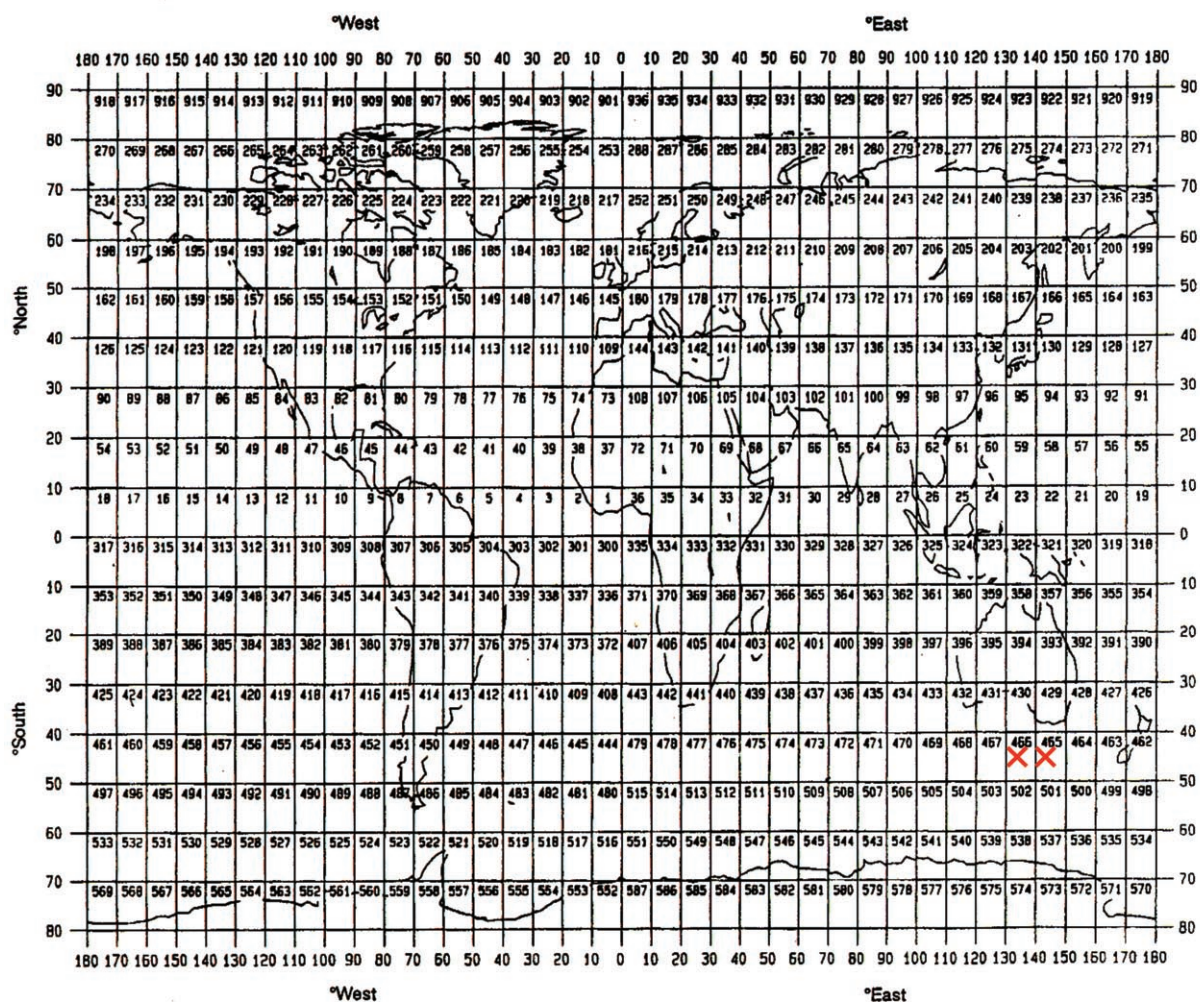
Project name: IMOS Southern Ocean Time Series Facility

Coordinating body: Integrated Marine Observing System (IMOS)

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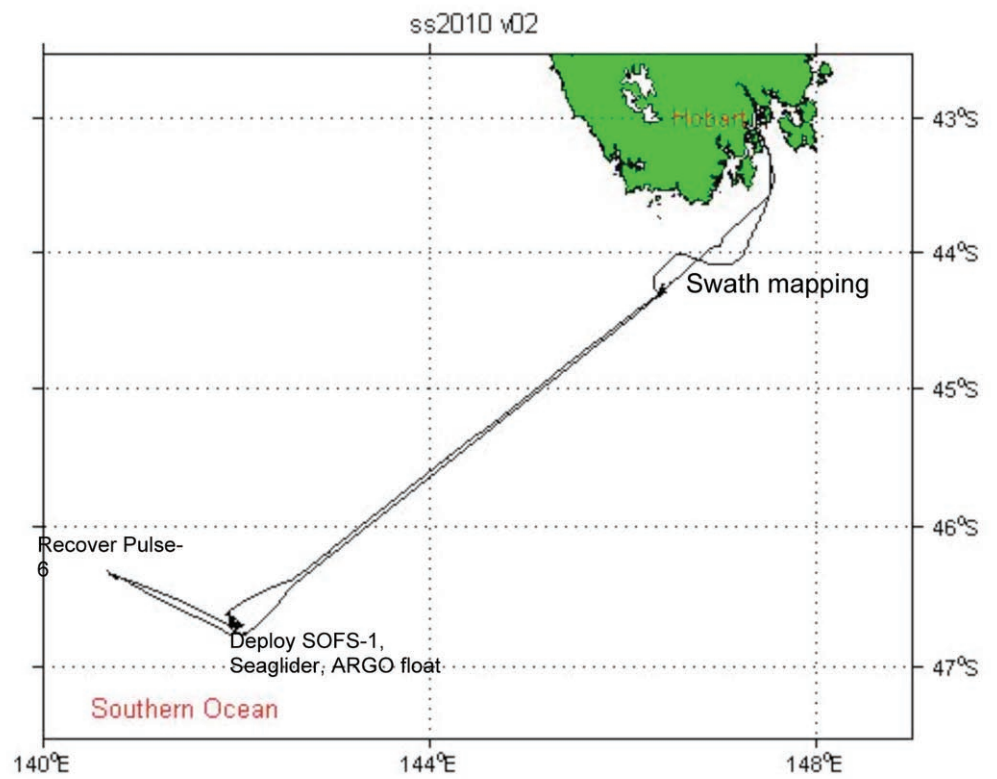
GEOGRAPHIC COVERAGE - INSERT 'X' IN EACH SQUARE IN WHICH DATA WERE COLLECTED



MOORINGS, BOTTOM MOUNTED GEAR AND DRIFTING SYSTEMS									
Item No	PI See page above.	APPROXIMATE POSITION						DATA TYPE enter code(s) from list on last page.	Description
		LATITUDE			LONGITUDE				Identify, as appropriate, the nature of the instrumentation the parameters (to be) measured, the number of instruments and their depths, whether deployed and/or recovered, dates of deployments and/or recovery, and any identifiers given to the site.
		deg	min	N/S	deg	min	E/W		
1	B	46	43.377	S	140	57.211	E	M02, M06, M90,H71, D01	SOFS-1 anchored meteorological mooring with large surface tower buoy. Surface buoy moves within a ‘watch circle’ of 2.1 nmile and has a light that flashes every 6 seconds Deployed 17 March 2010 for recovery in approximately 1 year.
2	A	46	43.377	S	140	57.211	E	D06	ARGO Float – free drifting, profiling to 1000m Deployed 20 March 2010 UTC.
3	A	46	43.377	S	140	57.211	E	D06	Seaglider – engaged in piloted mission diving to 1000m depth and expected to return to Hobart over approximately next 2 months. Deployed 20 March 2010 UTC.
4	A	46	19.344	S	140	40.653	E	H90	Pulse-6 anchored biogeochemistry mooring with small surface float. Recovered 18 March 2010 for redeployment in September 2010.

SUMMARY OF MEASUREMENTS AND SAMPLES TAKEN					
Item No.	PI see page above	NO see above	UNITS see above	DATA TYPE Enter code(s) from list on last page	Description
					Identify, as appropriate, the nature of the data and of the instrumentation/ sampling gear and list the parameters measured. Include any supplementary information that may be appropriate, e. g. vertical or horizontal profiles, depth horizons, continuous recording or discrete samples, etc. For samples taken for later analysis on shore, an indication should be given of the type of analysis planned, i.e. the purpose for which the samples were taken.
1	A	3	stations	H10	1 test CTD cast to 500m (no samples), and 2 CTD casts to 1000m (with Niskin bottle samples). Sensors mounted for temperature, salinity, oxygen, photosynthetically available radiation, phytoplankton fluorescence, transmission. Samples taken at 12 depths for onshore analysis of salinity, nutrients, dissolved inorganic carbon, alkalinity, and particulate organic carbon (POC - 6 depths only), for comparison with Pulse-6 mooring results.
2	A&B	700	miles	H71	Continuous monitoring of underway seawater supply for temperature, salinity, transmission, oxygen, argon for study of surface ocean productivity and physical heat and mass flux
3	A	3	launches	H13	Expendable Bathythermographs (XBTs) for sound speed and equipment testing
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

CURATION REPORT	
Item No.	Description
1	Samples analysed at CSIRO Marine and Atmospheric Research (CMAR); Data to be provided to Australian IMOS Ocean Data Portal
2	CMAR data to be collated with other voyages and provided to Australian IMOS Ocean Data Portal
3	CMAR data to be collated with other voyages and provided to Australian IMOS Ocean Data Portal
4,5,6	Data is part of underway system and is managed by MNF. Data is also post-processed by Bureau of Meteorology for IMOS and archived in Australian IMOS Ocean Data Portal.
7	Data to be lodged with Bureau of Meteorology.



GENERAL OCEAN AREA(S)

Southern Ocean – Indian sector

SPECIFIC AREAS

Ocean southwest of Tasmania, Australia.

Project Personnel

Tom Trull	CMAR-UTAS-ACE	Chief Scientist
Stephen Bray	ACE	mooring acoustics
Mark Rosenberg	ACE	Pulse-6 recovery leader
Marie Jouandet	ACE	underway sensor systems
Dan McLaughlan	CMAR	SOFS-1 deployment leader
Eric Schulz	BOM	SOFS principle investigator
Anoosh Sarraf	MNF-CMAR	Computing support
Karl Forcey	MNF-CMAR	Computing/electronics support
Tony Veness	MNF-CMAR	Swath mapping
Lisa Woodward	MNF-CMAR	Voyage management

Ship Personnel

Sandy Yeats	Master
John Boyes	Chief Mate
Rob Ferries	Second Mate
Mike Yorke-Barber	Chief Engineer
Howard Vernals	First Engineer
Grant Page	Second Engineer
John Howard	Bosun CIR
Matt Connelly	IR
Chris Softley	IR
Graham McDougall	IR
Kel Lewis	IR
Jason Wall	Chief Cook
Robert Dittko	Second Cook
Cassandra Rowse	Chief Steward

Acknowledgements

Many thanks to Master, Crew, MNF staff, and the onboard Science Team. This is the most successful *Southern Surveyor* voyage in which I have participated. Ship handling was superb; deck operations were easy and quick. Computing, electronic, and voyage management support was top-class. 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, Joe Adelstein, Lindsay Pender, Matt Sherlock, Mark Rayner, Diana Davies, and Tim Lynch for robust design, construction, procurement, preparation, and project management, to Jeff Lord and Paul Bouchard from WHOI for the SOFS-1 preparation in Hobart, and to Ben Hollings and ANFOG for glider preparation.

Tom Trull

Chief Scientist

23 March 2010

Figure 1: PULSE-6 mooring, upper part.

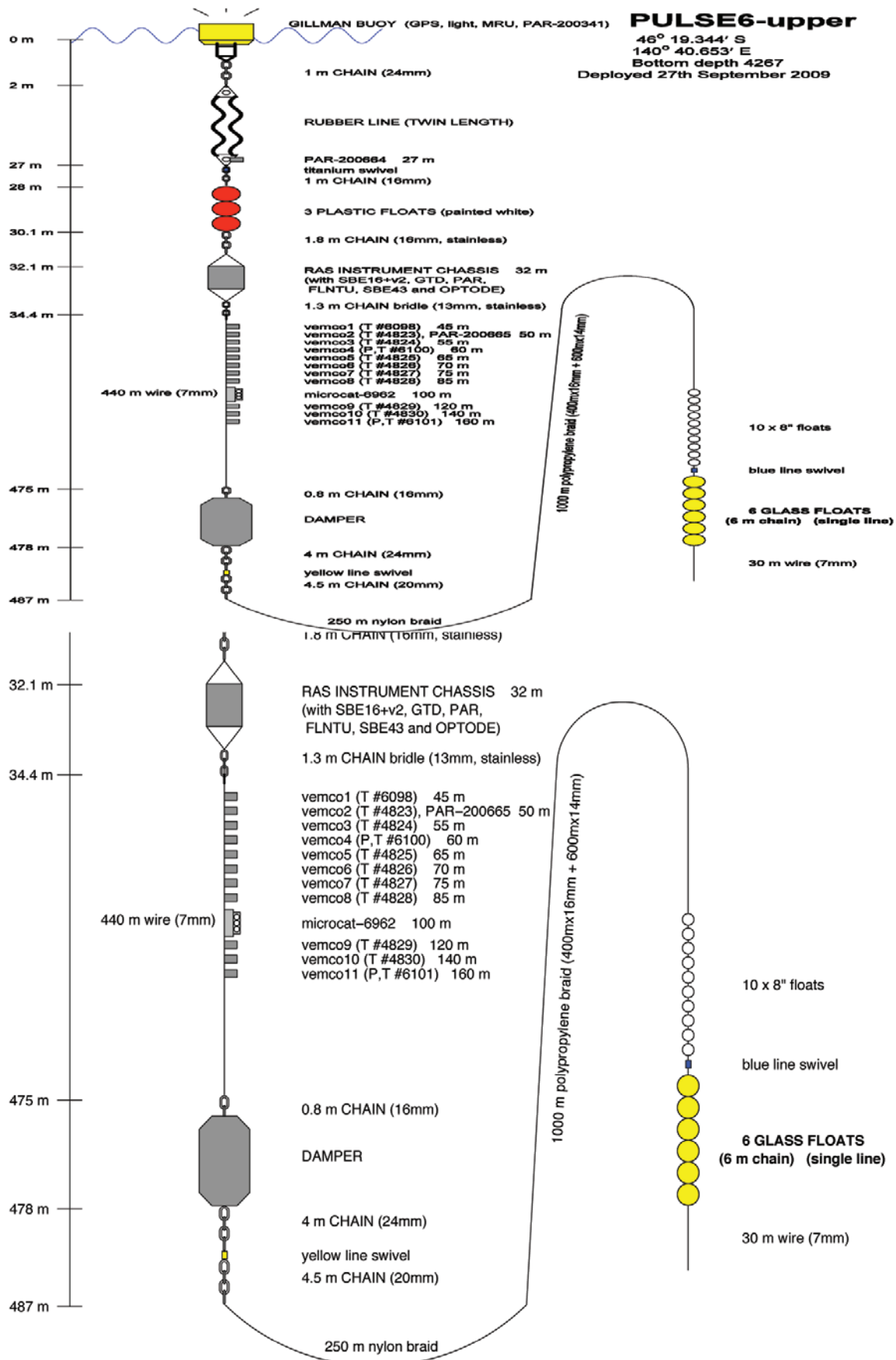
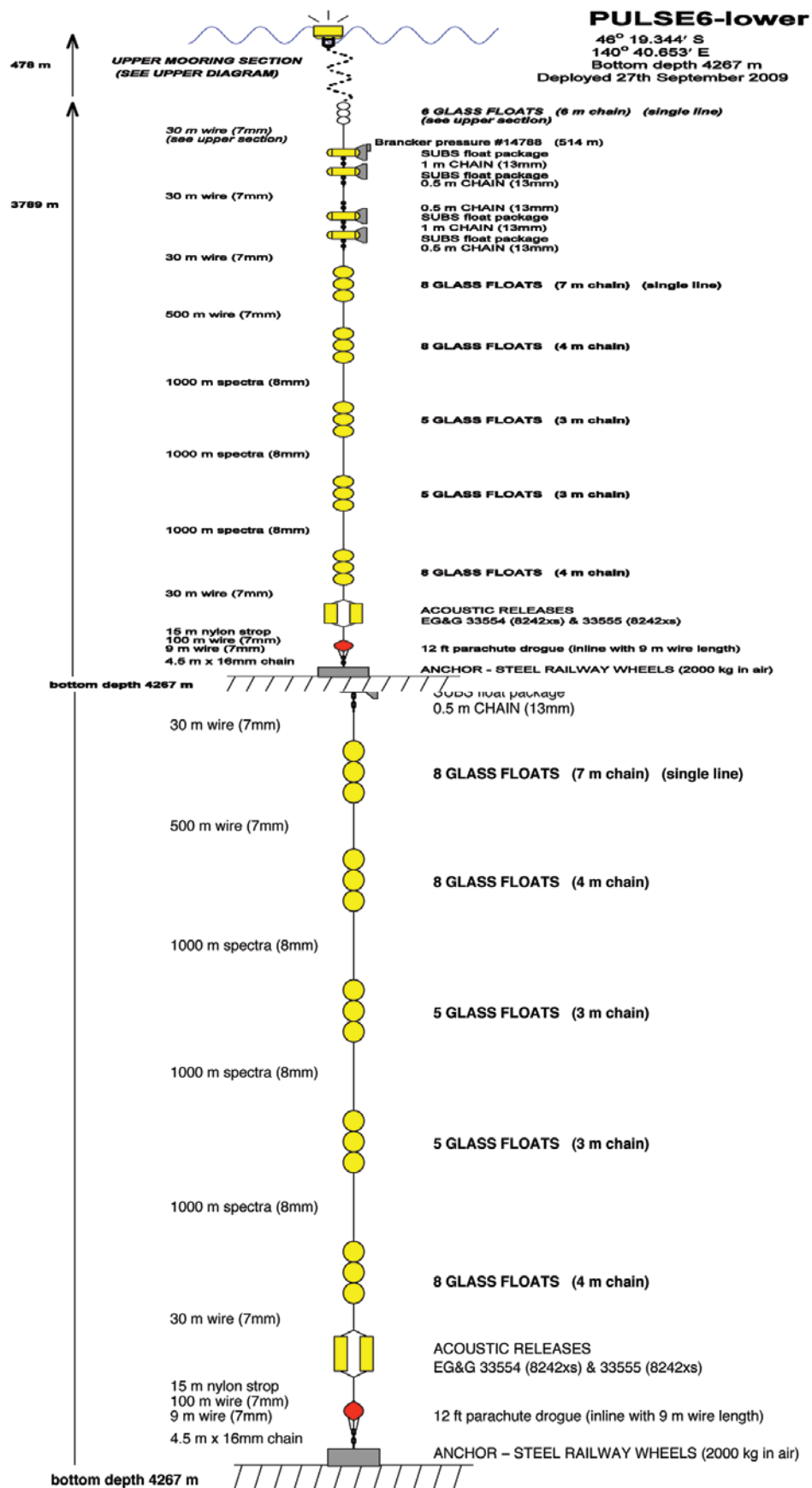
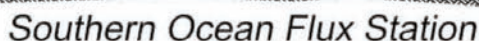


Figure 2: PULSE-6
mooring, lower part.



14 VOYAGE SUMMARY – SS02/2010



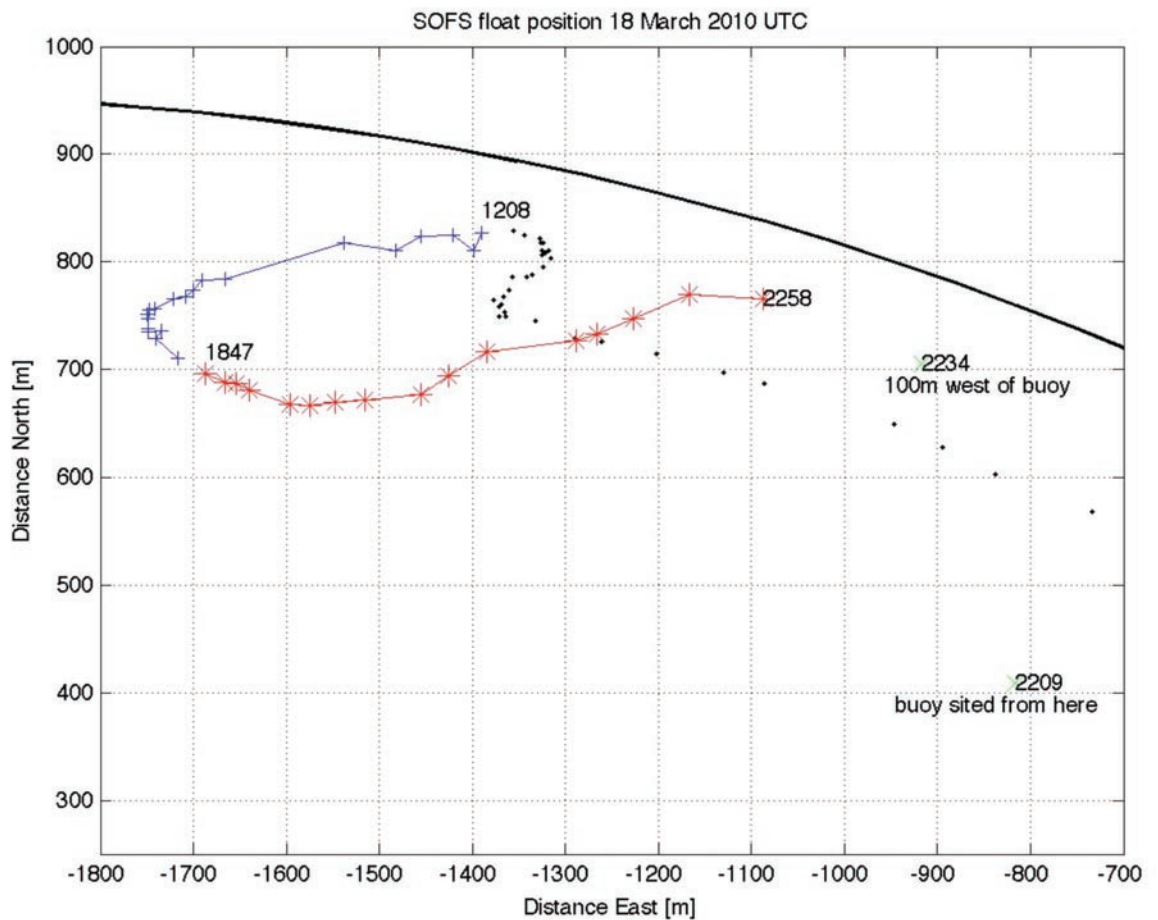


Figure 4: Initial movements of SOFS-1 mooring

Buoy transmitted position from the ship deck (black dots) show approach to deployment start at 1208 UTC. The buoy was towed slowly southwest behind the ship (blue crosses) while the mooring lines were deployed. The anchor was deployed at 1831 UTC and the buoy then drifted to the east (red stars starting from first buoy transmission at 1847 UTC) in response to wind and wave forcing. Ship position when the buoy was sighted the following morning and on station for meteorological comparisons are indicated (green x). The SOFS buoy was close to its maximum allowable departure or "watch circle" (black line) about the estimated anchor position. Triangulation of the anchor on the bottom indicates 'fallback' of ~215m or 4% of the mooring length.

