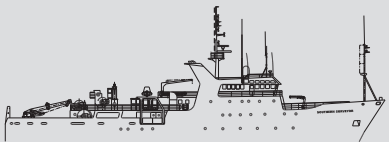

MARINE
NATIONAL FACILITY

2008 program

RV *Southern Surveyor*

CSIRO

voyage summary SS05/2008

SS05/2008

PULSE: Mooring-based measurement of Sub-Antarctic seasonal biogeochemical cycles affecting ocean uptake of carbon dioxide

Itinerary

Departed Hobart 0800 hours (local), Saturday, 5 April 2008
Arrived Hobart 1000 hours (local), Monday, 7 April 2008

Principal Investigator(s)

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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 (from the pre-Voyage Plan)

1. Recovery of the PULSE mooring (P.I. Tom Trull)

After loss of the fully instrumented PULSE mooring in January 2007, we were forced to return to a period of engineering development, and therefore deployed a modified mooring without scientific instruments in December 2007 from Aurora Australis (known as PULSE_Test_5). This voyage will recover that mooring.

2. Measurement of underway carbon dioxide partial pressure (P.I. Bronte Tilbrook)

Using the installed and automated pCO2 system this voyage will collect data useful to the overall goal of characterizing the Subantarctic Zone carbon cycle. Because late 2007 changes in shipping schedules mean that this voyage and the WOCE/CLIVAR SR3 repeat section onboard Aurora Australis will now run at the same time, the CTD based carbon cycle work will be carried out on Aurora Australis.

3. Measurement of trace-element concentrations (P.I. Edward Butler).

No work on this project will be carried out on Southern Surveyor. Because late 2007 changes in shipping schedules mean that this voyage and the WOCE/CLIVAR SR3 repeat section onboard Aurora Australis will now run at the same time, this work will be carried out on Aurora Australis.

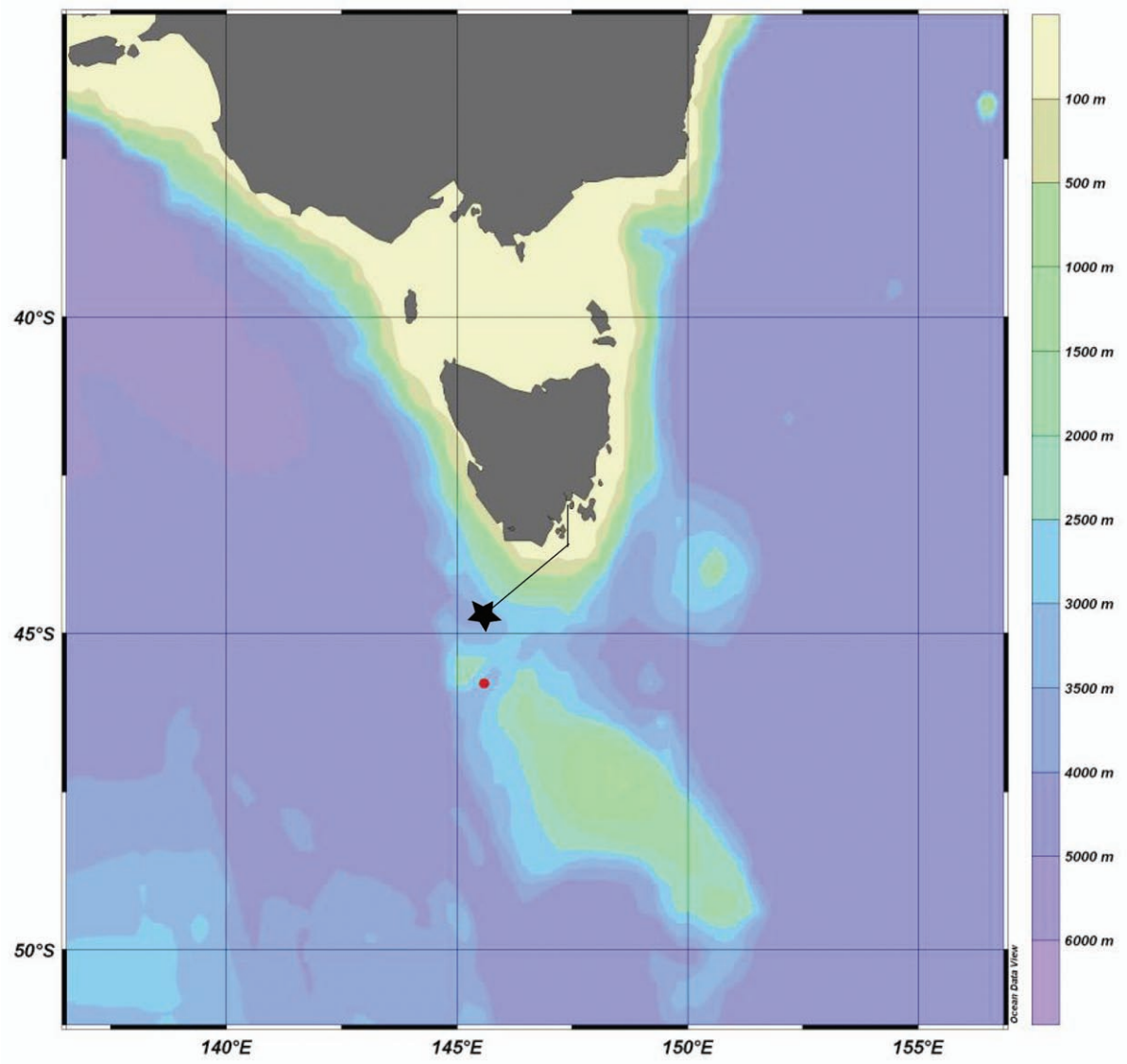
4. Refinement of filtration techniques for particulate organic carbon (POC) measurements (P.I. Tom Trull)

Previous PULSE voyages on Aurora Australis and Southern Surveyor have used vacuum filtration through glass fibre filters to determine suspended POC concentrations, and have compared these measurements to transmissometer measurements as part of the PULSE program of development of sensor-based carbon cycle observations. A small set of POC filtrations will be undertaken using the ship's scientific clean seawater supply to refine the interpretation of the role of absorption of dissolved organic carbon (DOC) in the estimation of POC.

Voyage Track

Hobart to PULSE TEST 5 mooring site at 44.795°S, 145.585°E and return to Hobart.

Figure 1: Voyage Track – the black star shows the mooring location (The red dot indicates the position erroneously provided in the voyage plan)



Results

1. This version of the PULSE mooring was deployed from Aurora Australis on 17 December, 2007 in the Sub-Antarctic Zone at:

44° 47.39' S
145° 35.10'E
3631m water depth

Time constraints at deployment precluded triangulation of the anchor position.

The mooring transmitted GPS positions for its surface float from the time of deployment until early March, when transmissions stopped. Figure 2. shows the movement of the surface float as indicated by these positions. Recovery of the mooring revealed a break just below the first set of subsurface floats (Figure 3).This appears to have been a secondary failure that occurred when these floats imploded as the top section of the mooring sank after loss of the surface float, based on the nature of the break (Figure 4), and the pressure record recovered from the Aanderaa current meter logger (Figure 5). The primary failure occurred in calm weather on 5 March 2008, between 0530 and 0600 UTC based on this pressure record. There are two competing hypotheses for the cause of the primary failure: **i)** loss of buoyancy in the surface float – e.g. by flooding from a failed seal, perhaps first opened during the period of relatively high current that occurred a few days prior to failure (Figure 5). **ii)** loss of the surface float because of failure of the elastic links or some other subsurface link between the surface float and the subsurface floats. This hypothesis has the disadvantage that it is not clear why this failure mode would not have allowed the surface float to continue transmitting as it drifted away, but it is possible that the surface float may have no longer remained sufficiently upright to successfully transmit.

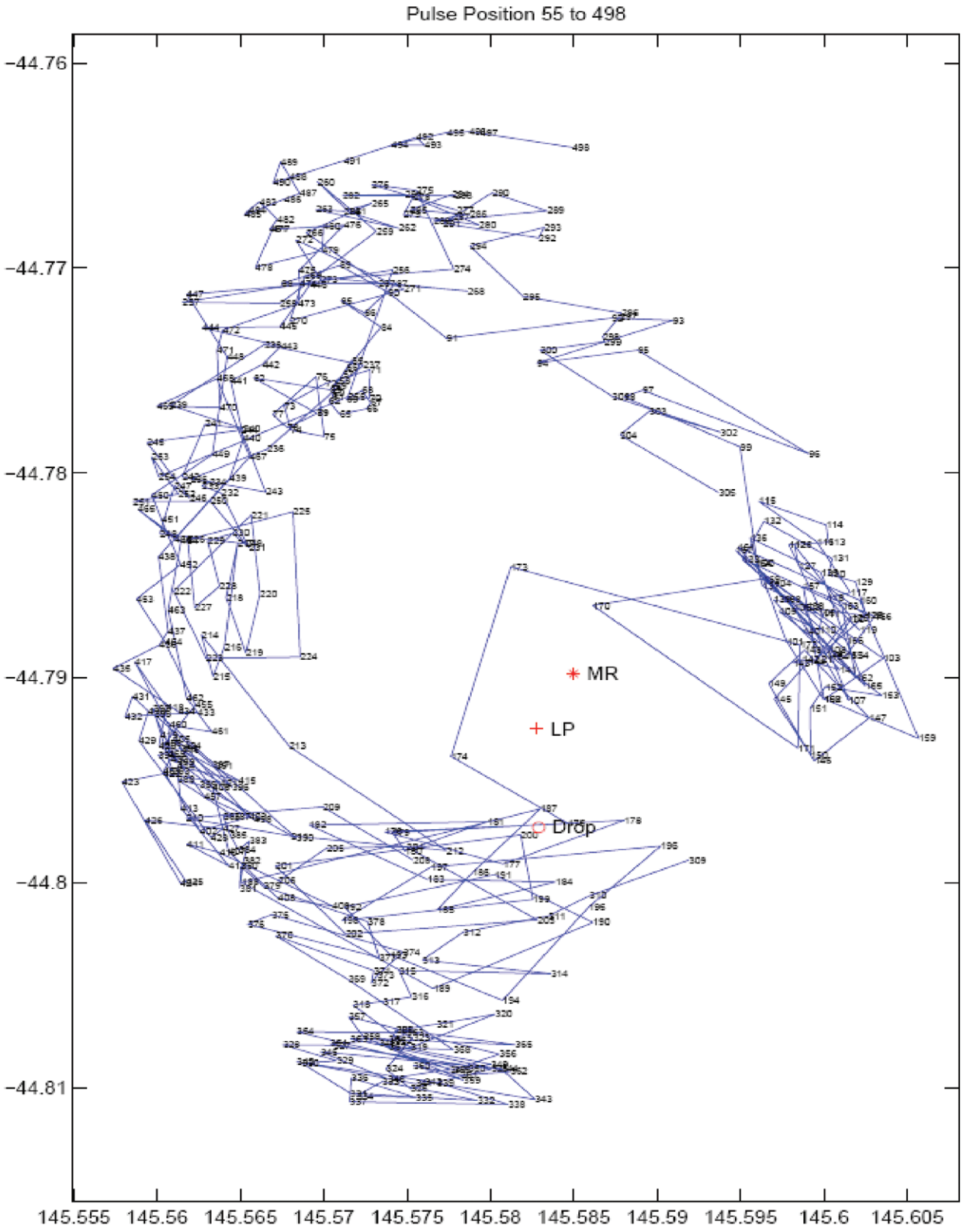


Figure 2: Surface float GPS positions from Iridium telemetry (4 hourly until failure). The marks indicate the position of anchor deployment from the ship and two estimates of its probable position on the bottom.

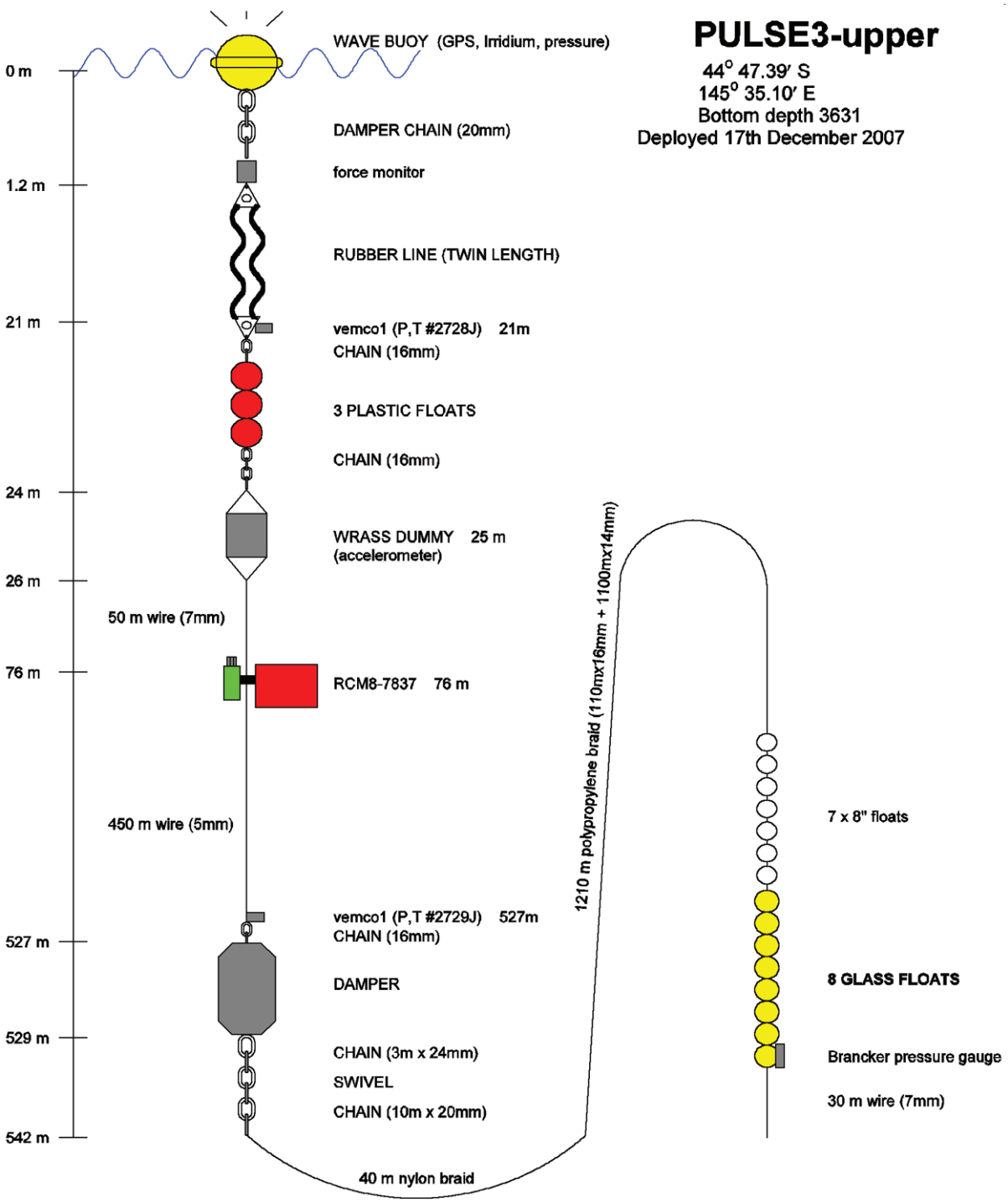


Figure 3a: Schematic of top-portion of mooring. The break occurred at the bottom of the 3 red sub-surface floats in the steel shaft that they were mounted on, just where it joined the eye connected to the chain below.

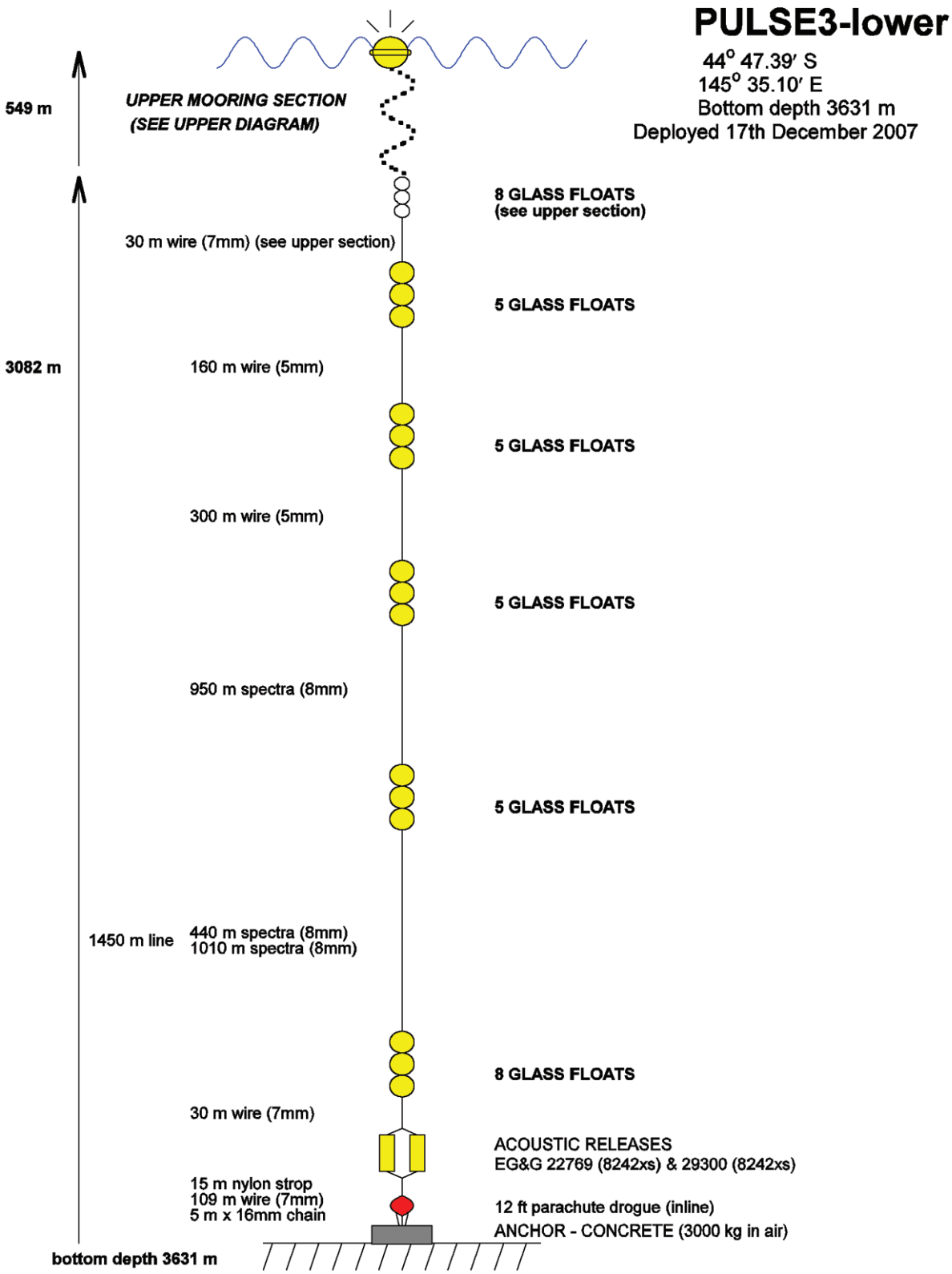


Figure 3b: Schematic of bottom-portion of mooring. The mooring was grappled just below the uppermost section of 5 glass floats (shown in yellow). The mooring was separated into two portions at the shackle below these floats and the top half recovered first.

Figure 4: Broken steel shaft from sub-surface buoy assemble – believed to have been fractured by their implosion after loss of surface float.

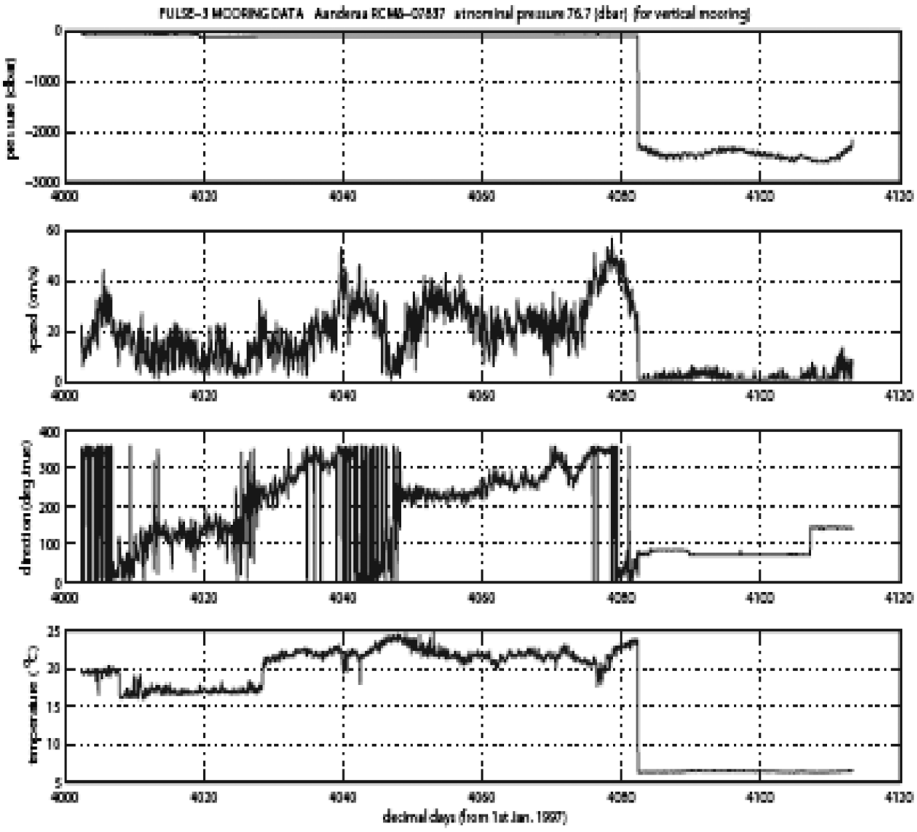


Figure 5: Aanderaa current meter record.
Top to bottom: pressure, speed, direction, unscaled/uncalibrated temperature.

Voyage Narrative

We departed Hobart on April 5, 2008 into moderate southwesterly winds and swell, which became rougher as we cleared Storm Bay and slowed our progress to ~ 9 knots. We arrived at the PULSE mooring site at midnight, and attempted communication with the acoustic releases at ~3500m at the base of the mooring. Despite attempts from the beam, stern and bow of the ship, under minimum way, the propeller noise was too loud to allow us to hear the morning. Given the sea-state we awaited daylight to declutch the engine to allow for quieter communication. From 0800hrs to 1200hrs on April 6 local time, we attempted communication in brief bursts as follows. The ship was set up bow to the swell and the hydrophone lowered from the starboard beam, and the engine then declutched for about 2 minutes while the interrogation signal was sent and the return listened for. The noise reduction with the engine declutched was dramatic but on the first 3 attempts communication was still unsuccessful. This may have been in part because the CSIRO supplied EG&G deck units were not functioning optimally. One unit died completely at this point, and the other ceased ranging, although the hydrophone could still be heard. In addition the release codes provided by CSIRO were incorrect for one release, but fortunately this error was discovered in a last ditch trawling through of emails, and the correct release code as supplied by Mark Rosenberg and Steve Bray (ACE CRC) then allowed successful communication with one release. Two further communications were undertaken to locate the mooring and the release code was sent at 1230hrs local time. (There was insufficient remaining daylight to allow careful triangulation of the position.) The mooring was spotted about 20 minutes later, and after ~90 minutes 5 float rafts were visible on the surface. It was not possible to establish just which end was which, but at ~1500hrs we grappled one end using the air-powered and then hand grapples, and began recovery. Recovery was completed at ~1930hrs local time, and we returned to port.

Summary

The voyage succeeded in its primary objective – recovery of the PULSE mooring.

Personnel

Tom Trull	UTAS-CSIRO-ACECRC	Chief Scientist
Lindsay Pender	CMAR	mooring recovery leader, MNF computing support/Voyage Manager
Steve Bray	ACECRC	mooring recovery support
Joe Adelstein	ACECRC-IMOS	mooring recovery support
Drew Mills	CMAR	MNF electronics support

We thank the Officers, Engineers, Crew, and Cooks and Stewards of the Southern Surveyor and the Marine National Facility staff for their efforts.

Tom Trull
Chief Scientist
April 9, 2008