Australia's Marine National Facility

VOYAGE SUMMARY ss2012_v05

2012 Integrated Marine Observing System (IMOS): Indonesian Throughflow Mooring Recovery and Deployments

Voyage period:
26/09/2012 to 09/10/2012

Port of departure:
Darwin, Australia

Port of return:
Darwin, Australia

Responsible laboratory:
CSIRO Marine and Atmospheric Research, Castray Esplanade, Hobart, TAS 7000 Australia

Chief Scientist(s)
Bernadette Sloyan

CSIRO

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Scientific Objectives

The aim of IMOS Indonesian Throughflow moorings is to sustainably and directly measure the leakage of Pacific thermocline and intermediate waters from the western equatorial Pacific into the South Indian Ocean in the two major passages – Timor Passage and Ombai Strait. The Indonesian Passages represent an important 'choke point' of the global ocean overturning circulation and the climate system. The interannual to decadal variability of the size and depth distribution of the flow through this choke point remains a troublesome unknown. In particular, changes in this flow will reflect long term changes in the Pacific and Indian Ocean wind fields, particularly any change in the Walker Circulation, as predicted by coupled climate models forced by increasing Greenhouse Gas scenarios. Changes in the associated heat flux are also anticipated at the global oceans warm. The IMOS Indonesian Throughflow array design is based on the more comprehensive INSTANT process study and is deemed the minimal required mooring array to monitor the Indonesian Throughflow. The Ombai Strait and Timor Passage Throughflow components comprise about 11Sv of the 14 Sv total interbasin exchange. This mooring array integrates with the AIMS NAOS shelf line, allowing estimates of the interbasin exchange to include the transport of very warm waters across the Australian North West Shelf. All moorings in the Timor Passage are located along a high precision swath line of the TOPEX/Jason satellite altimeter missions. These data will shed light on how best to exploit altimetric data over our shallow northern shelves, especially in data assimilating models.

Voyage Objectives

- To recover and deploy three tall flux moorings comprising the IMOS Indonesian Throughflow array in Timor Passage and Ombai Strait
- To collect needed swath bathymetric survey data near the Timor mooring sites, as well as an along array bathymetric profile (shelf break to shelf break)
- To collect highly-spatially resolved velocity sections across the Timor Passage and the southern part of Ombai Strait.
- To collect auxiliary CTD profiles for mooring sensor calibration and water mass variability studies.
- To help build Australia's capacity in marine science by providing sea-going experience to two Australian graduate students.

Results

Data from the recovered instruments are now being quality controlled and assessed. Initial inspection show that we have a good data return from each mooring.

Voyage Narrative

September 24, 2012

All gear arrived safely in Darwin, except for minor scratches on the syntactic spheres.

Danny McLaughlin and Jamie Derrick unloaded the sea containers onto a truck ready for transport to the ship on the following morning.

September 25, 2011

Danny, Jamie and RV Southern Surveyor crew began loading the vessel at 1000am. Instruments for all moorings were loaded and secured in the dry laboratory. The CMAR mooring winch was assembled and secured in place. The winch was tested and found to be in good working order. Timor Passage mooring anchors, benthos and syntactic floats were secured on the deck. ADCPs were placed in the syntactic floats. All accompanying mooring equipment was secured on deck and in the dry laboratory.

Bernadette Sloyan conducted 3 radio (ABC Darwin, commercial radio, and radio Australia) and two television interviews (ABC Darwin and Nine News). She introduced Bin Fan, Chinese Engineer to the ship crew and science personnel, meet the two Timor Leste observers, from the airport and greeted the two ANU students at the dock gate. The Timor Leste observers completed their induction.

September 26, 2012

Lift winches were installed on the A-frame and gear continued to be stowed. The Timor Sill mooring cables were wound onto the CSIRO winch. Danny, Jamie and Phil continued to setup the back deck and secure mooring equipment.

RV Southern Surveyor left Darwin around 1000 on the high tide and steamed towards a CTD test station location at the southern slope of the Timor Sill in approximately 1000m of water. Shipboard ADCP (SADCP) was in bottom track mode over the continental shelf and turned to narrowband (non-bottom track) at the edge of the shelf in about 500m of water.

All on board settled in and enjoyed the day steam to our test CTD location. Phil Adams, Bernadette Sloyan and Rebecca Cowley setup the SBE37SMPs, SBE 39 and Starmon Minis with all instrument clock time set to ship UTC time – thus no time offset for any of these instruments. We also checked the setup files of the Aquadopps, and ADCPs.

September 27, 2012

We completed the transit to test CTD station at 1000. We held a toolbox meeting for all people involved in CTD and then mooring operations. At the test station we fired all bottles at 1000m to test for leaking bottles. We used this station to train Isa Rosso and Kate Snow on sampling salinity and oxygen. On

completion of the CTD test station we transited to our first CTD station near the IMOS/AIMS NAOS outer-shelf mooring. Bec Cowley undertook side-by-side XBT calibrations at the CTD station. We then undertook two CTD stations between the southern shelf of the Timor Passage and the Timor Sill mooring site.

At the completion of the CTD station at 1945 (local time), we ran a swath mapping line and SADCP line across Timor Passage to the northern slope and returned to the Timor Sill mooring site at approximately 0400 on Friday 28 September 2012.

September 28, 2012 Recovery of Timor Sill and Timor North Moorings

Science began early with the ship in position of the Timor Sill mooring at 0500. We enabled the mooring releases and released the mooring at approximately 0610. Most science and ship crew were situated around the ship looking for the mooring as it surfaced. The mooring was easily spotted and we maneuvered the ship into position to grapple the top float. We began retrieving the mooring to the ship at approximately 0645.

A significant amount of fishing (long line) gear was caught on the mooring. The upper 300m of the mooring was heavily bio-fouled. The recovery of the mooring ran smoothly and was completed at 1130. After retrieval of the mooring we completed a CTD cast to 1500m. During the recovery of the mooring large schools of yellow fin Tuna, whales and a sea turtle were seen. Preliminary cleaning of the SBE 37 and 39s and Starmon Mini was undertaken and these instruments were placed a temperature bath, with the SBE37 serial number 9912 (deployed on Ombai mooring), as calibration unit. After 2 hours a frozen bottle of water was placed in the bath and the temperature was then lowered by a degree. The instruments remained in the bath for another few hours. This provided a two point temperature calibration. Finally all instruments were moved to a freshwater bath.

We then moved to the Timor North mooring site. We arrived on site at 1610 and began a CTD at 1620 prior to the recovery of the mooring. After dinner (1730) we enabled the acoustic release and released the mooring at 1740. The mooring was quickly spotted on the surface and the ship maneuvered to bring the top float on-board. Once again the upper part of the mooring was heavily fouled with fishing gear and marine creatures. Included in the fishing gear was a grapple hook that had obviously been used in an attempt to free fishing gear that was caught on the mooring. We conclude that damage to the top float Iridum, and radio antenna occurred due to the use of the grapple hook. The mooring recovery was completed at 2050.

Preliminary cleaning of the SBE 37 and 39s and Starmon mini temperature instruments was undertaken and these instruments were placed a temperature bath, with the SBE37 serial number 9912, as calibration unit. Danny, Phil and Jamie secured all gear and retired to the lounge (after a shower).

At the completion of the recovery of the Timor North Mooring we began a swath survey of the Timor Passage.

This was a very successful day that included the recovery of the Timor Sill and Timor North moorings.

September 29, 2012

The swath mapping continued all day and into the evening – mapping the Timor Passage.

The moorings were cleaned and data recovery began. Phil was extremely busy with downloading data and waving his magic electronics wand to recover data from damaged instruments (two SBE37s had bent pins). We lost three instruments due to flooding – SBE37 (serial #6265), SBE39 (serial #4778) on Timor Sill mooring and Starmon Mini (serial 3839) on Timor North mooring. These instruments– SBE 39 on Timor Sill and Starmon Mini on Timor North were to be redeployed. On the Timor Sill mooring we replaced the flooded SBE39 with SBE 37 SMP (serial #7893), and on the Timor North mooring we replaced the Starmon Mini with SBE37 SMP (serial #7759). These instruments were selected based on preliminary assessment of data quality from previous deployment.

Bec Cowley provided the first look at the data. Isa and Kate were everywhere – cleaning instruments, looking at data and helping with swath mapping. Danny and Jamie continued with the cleaning and inspection of mooring equipment. After lunch they began to set up for the deployment of the Timor North mooring. Bernadette mapped the swath data in the region of the Timor North mooring and selected a mooring site that is reasonably flat in 1100m of water. Danny and Jamie removed 73 metres from the mooring. The mooring length is now designed for 1100m of water.

The Sydney Swans won the AFL Grand Final – not that anyone was really interested.

September 30, 2012 Deployment of Timor North Mooring

We ended the swathing of the Timor Passage in the early hours of the morning and proceeded to the Timor North mooring site. We arrived at the mooring site at approximately 0800 and commenced a CTD station at the northern edge of the Passage. At the completion of the CTD station the ship moved to the Timor North mooring location. The science and ship crew finalised preparation for the mooring deployment.

We began the mooring deployment at approximately 1400 (local time). Mooring operations went smoothly and the mooring anchor was deployed at 1700. The mooring anchor position was determined (triangulation method) and a CTD station was completed.

At the completion of the CTD we transited back to the northern Passage CTD site and undertook further swath mapping and several SADCPs sections across the entire Timor Passage.

Timor North Mooring	Latitude	Longitude	Depth (m)	Date, time (UTC)
Target Position	8° 51.456'S	127° 11.454'E	1100	
Anchor Release	8° 51.568'S	127° 11.655'E		30/09/2012 0843
Ranged in Mooring Position	8° 51.582'S	127° 11.586'E	1105	

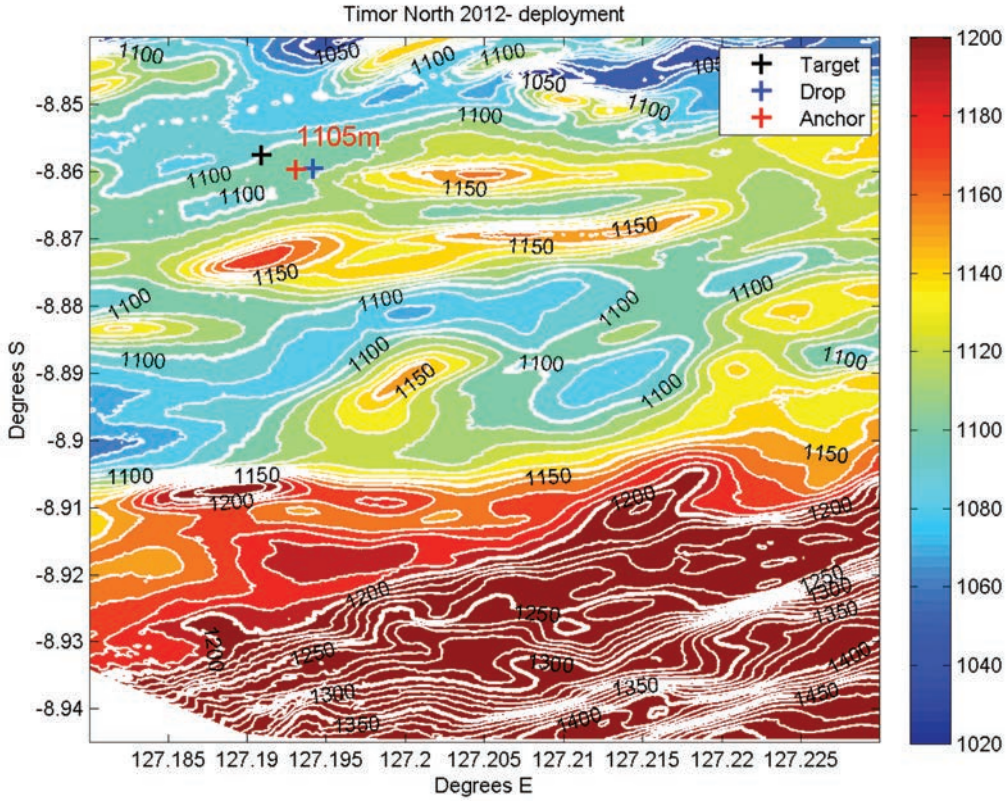

Figure 1. Map of bathymetry (m) in the region of the Timor North mooring based on data collected by the RV Southern Surveyor. The red cross shows the final anchor position (see Table), the blue cross the drop point and the black cross the target site. Depth is contoured every 10m with every 50m bolded.

October 1, 2012

We completed the swath mapping of the Timor Passage. Bernadette selected a site for the deployment of the Timor Sill mooring. The depth of the mooring site is 3306 m. Danny and Jamie corrected the length of the mooring and spooled all wire onto the mooring winch.

Danny, Jamie and Phil made final preparations for the mooring deployment. Bernadette, Bec, Isa and Kate completed a CTD station at the mid-point between the Timor North and Timor Sill moorings locations. The ship then undertook a number of SADCP sections across the Timor Passage.

October 2, 2012 Deployment of Timor Sill Mooring

We arrived at the Timor Sill mooring site at 0500 (local time). We stayed on station to gauge the strength of the surface current and ship drift.

Mooring deployment operations began at approximately 0700 and proceeded smoothly with all instruments and wire deployed by 1130. While we waited for the anchor drop zone, everyone had lunch. The mooring anchor was deployed at approximately 1330.

The anchor position was triangulated and a CTD was completed. The mooring operations were finished at 2100 and the ship set a course for Ombai Strait.

October 3, 2012 Transit to Ombai Strait

We continued our transit to the Ombai Strait mooring site, passing in sight of the Timor Leste and Indonesian islands. On route we finalised deck operations ready for the recovery of the Ombai mooring tomorrow morning.

We arrived at the Ombai mooring site at approximately 1600 hrs. We then completed three CTD stations from the Ombai mooring site to the 1100 m depth contour off Timor Leste.

During the evening Phil, Bernadette, Bec and Lindsay setup the interface between the computer and benthos deck unit in anticipation of communicating with the PIES prior to the mooring recovery.

Overnight we undertook swath mapping of the Ombai Strait.

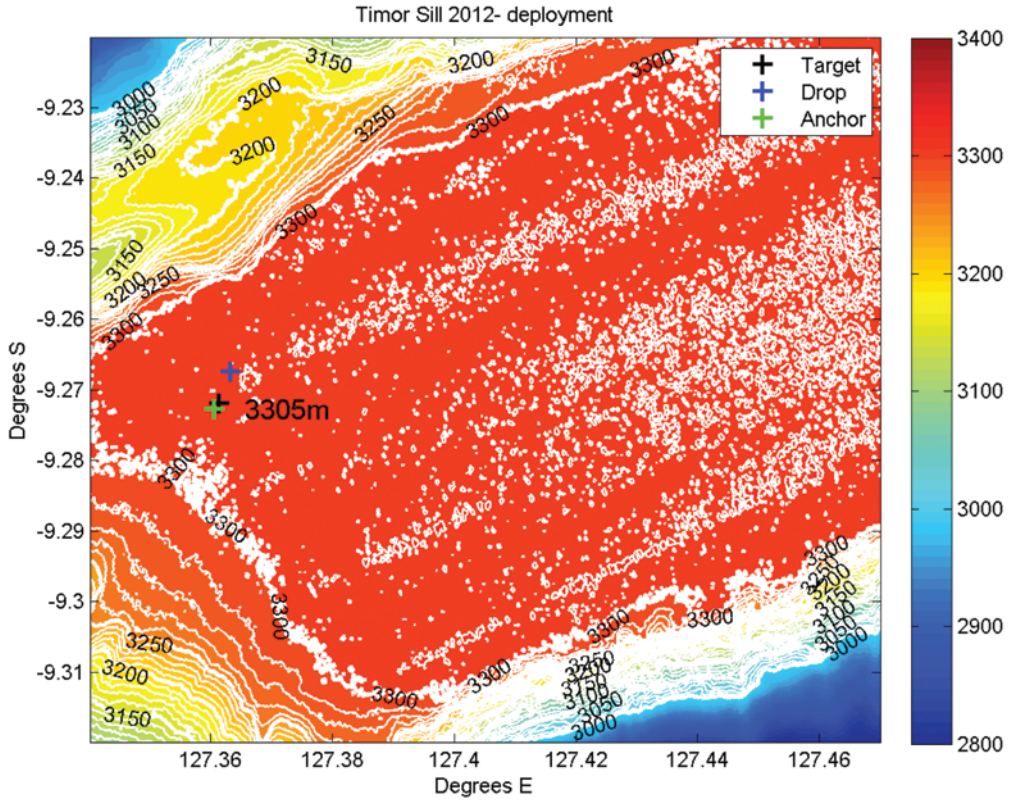

Figure 2 Map of bathymetry (m) in the region of the Timor Sill mooring based on data collected by the RV Southern Surveyor. The green cross shows the final anchor position (see Table), the blue cross the drop point and the black cross the target site. Depth is contoured every 10m with every 50m bolded.

Timor North Mooring	Latitude	Longitude	Depth (m)	Date, time (UTC)
Target Position	9° 16.314'S	127° 21.678'E	3306	
Anchor Release	9° 16.050'S	127° 21.799E		02/10/2012 03:53
Ranged in Mooring Position	9° 16.368'S	127° 21.636'E	3305	

October 4, 2012 Recovery of Ombai Mooring

We were all up early (0500) to open communications with the PIES. There was no response from the instrument. We checked the anchor location (which was correct), moved off the estimated anchor location and again tried to communicated with the PIES - without success. We ceased working on establishing communication with the PIES at 0630 and finalised the mooring recovery operations.

The mooring was released at 0700, and was very quickly sighted on the surface. The ship was maneuvered into position and the tag line was attached to the mooring. The mooring recovery went smoothly and was completed by 1130. After the recovery of the mooring we undertook a number of ship ADCP sections from the mooring location to the Timor Leste coast. We completed an at-sea two point temperature calibration for all temperature and salinity instruments.

Danny and Jamie started to clean the mooring equipment. Phil started to download the data. Kate and Isa cleaned instruments and Bec began to look at data.

Between 1745 and 2200 we attempted to find the PIES. This included returning to the estimated anchor location and then progressively stepping out from the anchor site at 500m intervals. We were still unable to communicate with the instrument.

At 2200 we resumed swath mapping the Ombai Strait.

October 5, 2012

Large pods of pilot whales and dolphins entertained us during the morning as we continued to clean instruments and mooring gear.

Using ship ADCP observed surface velocity, collected over a number of days, Isa and Kate determined the timing of the tidal cycle and interaction between tide and current. The ITF is strong resulting in the maintence of a surface westward current at all times. We will use this to determine the setup for the mooring deployment. Maximum amplitude of the current and tide was 2.4 m/s and the direction of the tide and current was 210 degrees.

We completed the swath mapping at approximately 1030. We then setup a

grid pattern to search for the PIES. The grid pattern was completed at 1800 with no response from the PIES. We must assume that the PIES instrument is lost and will not be recovered.

Bernadette combined the Southern Surveyor swath data with previous INSTANT swath data and repositioned the mooring location in 3224 m of water. The mooring wire and tether were spooled onto the winch and all instruments were configured.

At the completion of the PIES search grid we began SADCP sections between the mooring site and the Timor Leste coast. We undertook a number of these overnight.

October 6, 2012 Ombai Mooring deployment

Overnight the Master and Mates tested the expected layup and ship drift. We expect surface velocity to build during the morning, peaking between 1100 and 1200. We were at the lay-up site by 0730 and mooring deployment operations began just before 0800. The mooring deployment operations went smoothly, but unfortunately the tide didn't build as expected and we had a two hour wait for the ship to drift back onto the mooring drop location. We deployed the mooring at 1430.

The mooring position was determined and a CTD was completed at the mooring site. We then completed two ship ADCP sections between the mooring site and the coast of Timor Leste. At the completion of the SADCP sections we ran a final swath mapping line on the northern side of the Ombai Strait and began our transit to Darwin.

October 7-9, 2012

We completed a final ship ADCP section along the Timor Passage mooring line between Timor Leste and the Australian continental shelf. During the transit to Darwin all mooring gear and instruments were packed and made ready for demobilisation. Swath data was finalised.

A copy of swath, recovered mooring data and location of CTD station, deployed moorings and mooring operation log sheets was provided to the Timor Leste observers.

Ombai Mooring	Latitude	Longitude	Depth (m)	Date, time (UTC)
Target Position	8° 31.920'S	125° 03.600'E	3224	
Anchor Release				06/10/2012 0618
Ranged in Mooring Position	8° 31.626'S	125° 05.244'E	3239	

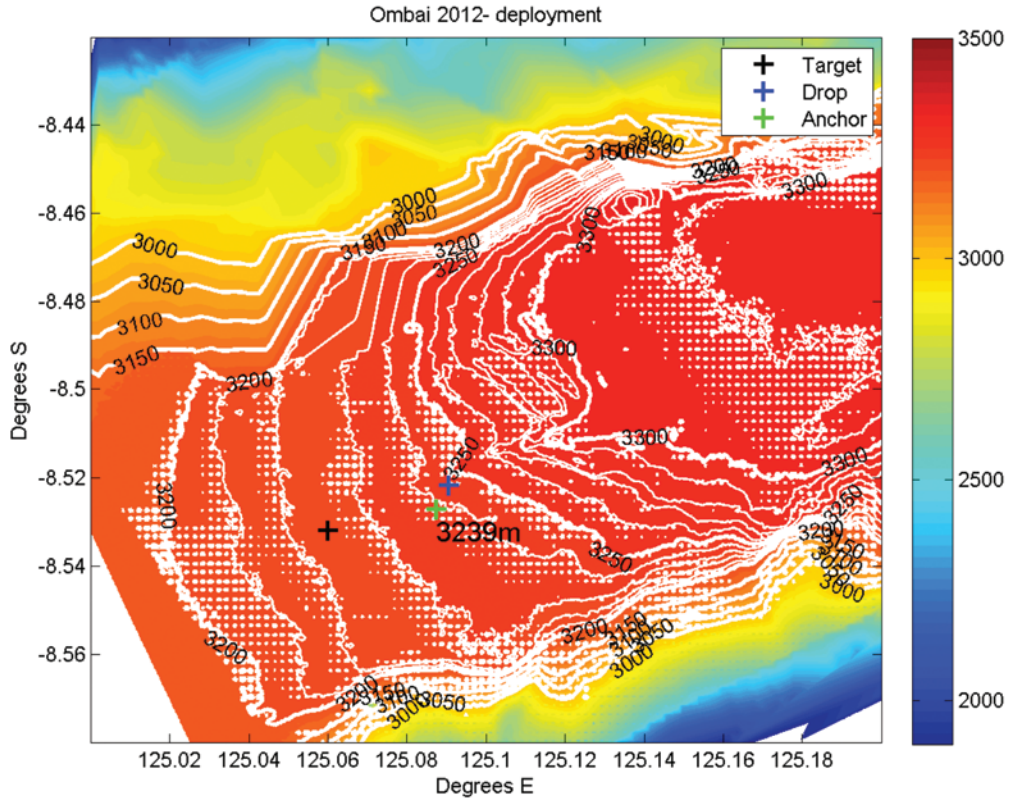

Figure 3. Map of bathymetry (m) in the region of the Ombai mooring based on data collected by the RV Southern Surveyor. The green cross shows the final anchor position (see Table), the blue cross the drop point and the black cross the target site. Depth is contoured every 10m with every 50m bolded.

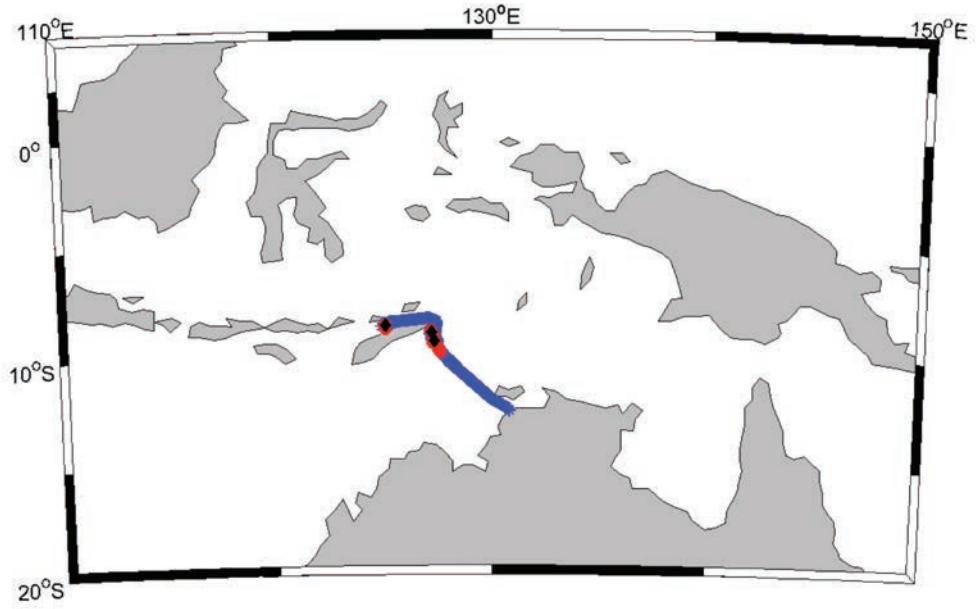

Figure 4. Regional map of voyage track (blue line) and position of CTD stations (red circle) and mooring locations (black diamond). See figure 5 for small scale map.

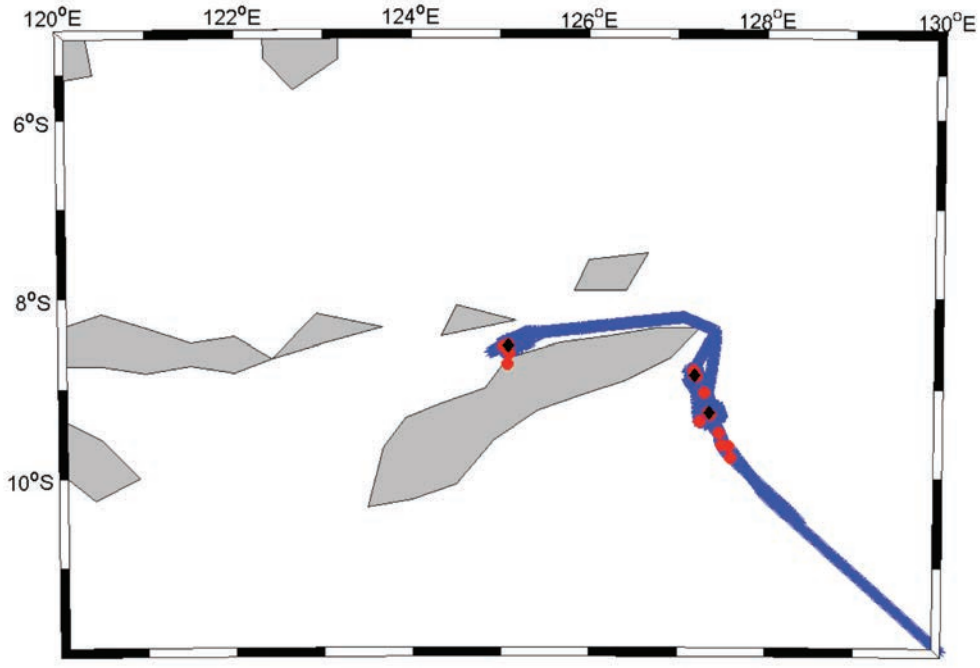

Figure 4. Map of voyage track (blue line) and position of CTD stations (red circle) and mooring locations (black diamond).

CTD Station	Start Date and Time (UTC)	Latitude (deg, min)	Longitude (deg, min)	Bottom Depth (m)
2	27/09/2012 02:41:33	9 39.260 S	127 34.422 E	1051
3	27/09/2012 04:57:43	9 46.565 S	127 36.060 E	482
4	27/09/2012 06:45:08	9 38.595 S	127 30.014 E	967
5	27/09/2012 09:01:14	9 29.984 S	127 28.295 E	1228
6	28/09/2012 02:26:09	9 22.298 S	127 15.141 E	2776
7	28/09/2012 06:52:04	8 51.466 S	127 11.601 E	1093
8	29/09/2012 22:18:17	8 47.993 S	127 10.815 E	939
9	30/09/2012 09:40:23	8 51.928 S	127 12.621 E	1105
10	01/10/2012 01:58:39	9 03.170 S	127 17.762 E	1491
11	01/10/2012 04:58:23	9 17.558 S	127 22.003 E	3216
12	02/10/2012 05:42:34	9 16.771 S	127 20.582 E	3299
13	03/10/2012 05:17:21	8 32.161 S	125 05.369 E	3241
14	03/10/2012 06:15:51	8 31.511 S	125 05.104 E	3239
15	03/10/2012 09:28:44	8 34.904 S	125 04.472 E	2902
16	03/10/2012 12:38:13	8 37.216 S	125 05.946 E	1422
17	06/10/2012 08:43:18	8 32.653 S	125 02.153 E	3209

Table 1: The time, position and bathymetry depth of the start of the CTD stations that were undertaken on the RV Southern Surveyor in September and October 2012.

Marine Crew

Name	Position
Mike Watson	Master
John Boyes	First Mate
Simon Smeaton	Second Mate
Fred Rostron	Chief Engineer
Mike Yorke-Barber	First Engineer
Bill Bourne	Second Engineer
Leon Evans	Chief Cook
Brett Brooker	Second Cook
Darcy Chalker	Chief Steward
Graham McDougall	Boatswain (CIR)
Nathan Arahanga	IR
Kel Lewis	IR
Jonathon Lumb	IR
Rod Langham	IR

Science Participants

Bernadette Sloyan	CMAR – Chief Scientist
Rebecca Cowley	CMAR – Principal Investigator
Danny McLaughlin	CMAR – mooring engineer
Phil Adams	CMAR – electronics
Jamie Derrick	CMAR – mooring engineer
Kate Snow	ANU – student
Fan Bin	1st Institute Oceanography, China – Senior Engineer
Isabella Rosso	ANU – student
Nelio Arnaldo	Ministry of Fisheries, Timor Leste – Observer
Akasio dos Santos	Ministry of Fisheries, Timor Leste – Observer
Pamela Brodie	MNF Voyage Manager
Tara Martin	MNF Swath Mapping Support
Lindsay Macdonald	MNF Electronics Support
Alicia Navidad	MNF Hydrochemistry Support
Hugh Barker	MNF Computing Support

Principal Investigators

A. Bernadette Sloyan (Bernadette.Sloyan@csiro.au)

B. Rebecca Cowley (Rebecca.Cowley@csiro.au)

Summary

The cruise objectives were achieved safely and on time. The bathymetric survey of the Timor Passage revealed a deep, relatively flat 'U' shaped trench that gradually shoaled in the westward direction. The proposed location of the Timor Sill mooring was within the wider, flat bottom region. The bathymetric survey of the Timor north mooring site revealed a relatively smooth saddle within the proposed mooring region. The bathymetric survey concentrated on this saddle and a suitable mooring site was determined. All mooring operations – recovery and deployment - were safely and successfully completed. CTD stations at mooring locations and in the Timor Passage and Ombai Strait and ship ADCP sections were completed as planned.

The success of this voyage was due to the dedicated and thorough preparation of the CMAR mooring group (Danny McLaughlin, Jamie Derrick and Phil Adams) and professional deck operation and ship handling between the CMAR mooring team and RV Southern Surveyor Master and crew.

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	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
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