RV *Investigator* Voyage Plan

Voyage #:	IN2015_V02		
Voyage title:	Sustained monitoring of the East Australian Current: Mass, heat and freshwater transports		
Mobilisation:	0800, Hobart, Wednesday, 6 May 2015		
Depart:	1800, Sydney, Friday, 15 May 2015		
Return:	1300, Brisbane, Tuesday, 26 May 2015		
Demobilisation:	1300, Brisbane, Tuesday, 26 May 2015		
Voyage Manager:	Tegan Sime	**Contact details:**	tegan.sime@csiro.au
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Co-Principal Investigators:	Susan Wijffels, CSIRO Rebecca Cowley, CSIRO		

Scientific objectives

The East Australian Current (EAC) is a complex and highly energetic western boundary system in the south-western Pacific off eastern Australia. It provides both the western boundary of the South Pacific gyre and the linking element between the Pacific and Indian Ocean gyres. This voyage will deploy an array of full-depth current meter and property (CTD) moorings from the continental slope to the abyssal waters off Brisbane (27°S). At this location the EAC, north of the high eddy variability, the EAC approaches its maximum strength and its flow is relatively uniform and coherent. The aim of this observing system is to capture the mean and time-varying flow of the EAC.

This is a component of IMOS, and will provide an intensive reference set of measurements of the EAC flow over sustained period for monitoring EAC transport, improved understanding of relationship of EAC and the South Pacific gyre and impact of the coastal marine ecosystem, and validation and interpretation of the current system in numerous climate and ocean models. The mooring array is located on the existing long-term XBT transects, satellite altimetry and glider tracks. The EAC deep mooring array will be complemented by a Queensland- IMOS operated inshore mooring array on the continental shelf region.

Voyage objectives

This voyage will redeploy an array of six full-depth current meter and property (temperature, salinity and pressure) moorings from the continental slope to the abyssal waters off Brisbane (26°S). The observing system is designed to capture the mean and time-varying flow of the EAC. In order to resolve interannual and decadal signals we aim to maintain a multi-year deployment of the array.

The main aim of the voyage will be to deploy an array of (6) full-depth current meter/CTD moorings extending from the continental slope to the abyssal waters off Brisbane. The following specific objectives will be performed:

List of tasks

1. Carry out swath mapping from the abyssal plain to the base of the continental slope
2. Deploy each of the moorings at appropriate locations, including position triangulation of each mooring
3. Complete CTD/rosette stations at each mooring, with LADCP
4. Complete a number of Ship ADCP sections along the mooring line
5. Complete deep CTD and RBR sensor testing at a number of CTD stations
6. Complete XBT and CTD side-by-side comparisons at CTD stations

Operational Risk Management

Potentially high risk mooring operations were identified by the independent investigation into the RV *Southern Surveyor* swinging hook incident report and outlined in an action register that has been implemented into MNF operations to ensure the safe conduct of future MNF mooring operations.

The recommendations outlined in this action register have been further developed by the EAC moorings group, ASP and the MNF and implemented into RV *Investigator*'s mooring procedures. These actions have been scoped not only for future EAC mooring operations but complex operations on RV *Investigator* in general and incorporated into the ship's Safety Management System (SMS).

Overall activity plan including details for first 24 hours of voyage

Steam from Sydney to 27.05 S, 155.50E, while steaming we will complete setting up mooring gear and instruments, including preparing the back deck, winding on wire. In the morning we will undertake a test CTD/rosette station is approximately 2000m. This to familiarize everyone with the CTD operation and test the rosette bottles for leaks, LADCP system and nutrient analysis system.

Voyage track example

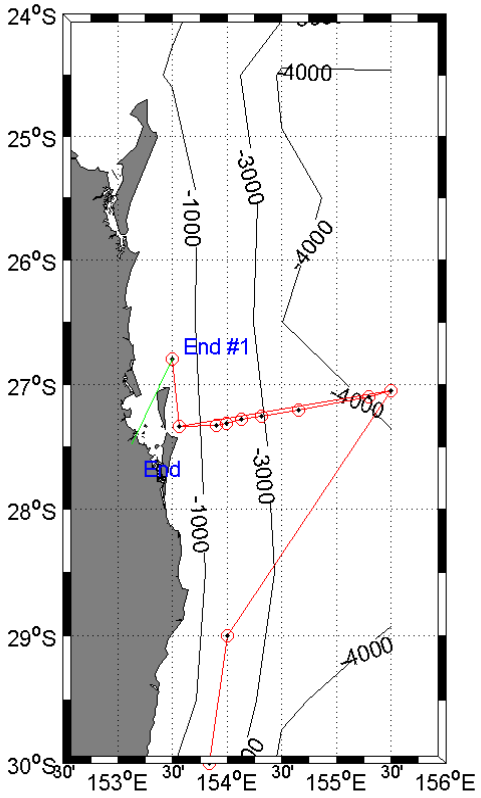

Figure 1. Voyage track:Departing Sydney and steam to the outside mooring site. The science plan is then to work from the outside mooring toward the shelf mooring.

Waypoints and stations

Mooring deployment location

	EAC_500	EAC_2000	EAC_3200	EAC_4200	EAC_4700	EAC_4800
Longitude	153.8993 (153° 53.958'E)	153.9921 (153° 59.526' E)	154.1332 (154° 7.992' E)	154.31 (154° 18.600' E)	154.6471 (154° 38.826' E)	155.2993 (155° 17.958' E)
Latitude	-27.327 (27° 19.620' S)	-27.3064 (27° 18.384' S)	-27.2826 (27° 16.956' S)	-27.2575 (27° 15.450' S)	-27.2086 (27° 12.516' S)	-27.102 (27° 6.120' S)
Depth (m)	535.30	1957.40	3254.30	4259.0	4768.20	4780.30

CTD/rosette Stations at Mooring Locations

CTD Station	Latitude	Longitude	Depth (m)
Test CTD and XBT NB: or where suitable given requirement to have all science personnel involved in CTD operation present	To be undertaken on Day (May 16). Station to be undertaken during daylight at a time convenient for shop operations.	To be undertaken on Day 2 (May 16). Station to be undertaken during daylight at a time convenient for ship operations.	2000
Mooring EAC_4800	-27.10	155.30	4780
Mooring EAC_4700	-27.21	154.65	4768
Mooring EAC_4200	-27.26	154.31	4259
mooring EAC_3200	-27.28	154.13	3254
mooring EAC_2000	-27.31	153.99	1957
mooring EAC_500	-27.33	153.90	500

Additional CTD sensor test stations to 2000 m and full depth CTD stations along the mooring line will be undertaken when possible. It is anticipated that these CTD stations will most likely occur during the night. XBT side-by-side comparisons will be undertaken during these CTD stations.

Ship ADCP Sections along the mooring array.

Ship ADCP section	Latitude	Longitude
1	-27.34 to -27.05	`153.56 to 155.50
2	-27.05 to -27.34	155.50 to 153.56
3	-27.34 to -27.05	153.56 to 155.50
4	-27.05 to -27.34	155.50 to 153.56

Time estimates

- Day 1 (15 May) Leave Sydney 1800. Distance Sydney to EAC_4800 is 457.4 nm. This is a 38 hour steam at 12 knots.
- Day 2 (16 May) While steaming to first way point (27.10 S, 155.30E) undertake a test CTD/XBT station in at least 2000 m of water. Time of test CTD and XBT system should be such that all science party can participate for familiarisation. Undertake a science, master and crew meeting to explain the science requirement of the voyage and the mooring operations. We will carry out a walk-through and toolbox meeting for mooring operation with the CSIRO, MNF and ship personnel. This will include a rehearsal of moving anchors and syntactic sphere on the back-deck and testing of remote winch controls. We will design a grid for swath mapping of the abyssal basin in the area of EAC_4800 and EAC_4700.
- Day 3 (17May) We anticipate arriving at the EAC_4800 mooring site (27.10 S, 155.30E) at approximately 0800 and will begin the swath mapping grid to determine the exact depth to EAC_4800 and EAC_4700. Finish swath mapping of deep abyssal plain. Process swath data and provide the mooring team with precise depth of mooring locations – EAC_4800, EAC_4700 and EAC_4200. Setup back deck for deployment of EAC_4800.
- Day 4 (18 May) Arrive at EAC_4800 m mooring location at approximately 0400. Assess weather and forecast conditions and if appropriate deploy EAC_4800. At the completion of each mooring deployment triangulate the mooring position and undertake a CTD/Rosette station. After mooring deployment operations have been completed, reorder back deck and prepare for deployment EAC_4700. If required, steam to EAC_4200 location and complete swath mapping or complete CTD sensor testing stations and XBT side-by-side comparisons between EAC_4800 and EAC_4700 mooring locations.
- Day 5 (19 May) Arrive at EAC_4700 m mooring location at approximately 0400. Assess weather and forecast conditions and if appropriate deploy EAC_4700. At the completion of each mooring deployment triangulate the mooring position and undertake a CTD/Rosette station. After mooring deployment operations have been completed, reorder back deck and prepare for deployment EAC_4200.. Complete the CTD sensor testing stations and full-depth stations, and XBT side-by-side comparisons between EAC_4700 and EAC_4200.
- Day 6 (20 May). Arrive at EAC_4200 m mooring location at approximately 0400. Assess weather and forecast conditions and if appropriate deploy EAC_4200. At the completion of each mooring deployment triangulate the mooring position and undertake a CTD/Rosette station. After completion of mooring operations swath area around EAC_3200 to obtain accurate bottom depth.
- Day 7 (21 May) Complete swath mapping of EAC_3200 area and determine accurate mooring depth. Prepare back deck for deployment of EAC_3200. Undertake Ship ADCP sections along the mooring line section.
- Day 8 (22 May) Arrive at EAC_3200 mooring location by approximately 0400 and undertake a CTD sensor test station. Assess weather and forecast conditions and if appropriate deploy EAC_3200. At the completion of each mooring deployment triangulate the mooring position and undertake a CTD/Rosette station. Prepare for deployment of EAC_2000 and EAC_500. Overnight undertake Ship ADCP section along the mooring line.
- Day 9 (23 May) Arrive at EAC_2000 m mooring location at approximately 0400. Assess weather and forecast conditions and if appropriate deploy EAC_2000. At the completion of each mooring deployment triangulate the mooring position and undertake a CTD/Rosette station. Move to EAC_500 m location. Assess time to deploy mooring and weather conditions. If appropriate deploy EAC_500. At the completion of each mooring deployment triangulate the mooring position and undertake a CTD/Rosette station. Begin Ship ADCP section.

- Day 10 (24 May) If all mooring deployed undertake ship ADCP sections along the mooring line and undertake CTD section across the mooring line.
- Day 11 (25 May) Complete CTD section and undertake Ship ADCP sections across the mooring line
- Day 12 (26 May) Complete Ship ADCP section and be at pick up location of Brisbane pilot by 0700. Arrive Brisbane 1300. Begin demobilisation.

N.B. Mooring Deployment will be weather dependant; as such voyage operations will need to be flexible.

Piggy-back projects (if applicable)

- Deep CTD sensor Test (Susan Wijffels) - no additional time requirements.
- CTD-XBT Side-by-side comparisons (Rebecca Cowley) - no additional time requirements.
- Whale Survey (Joshua Reinke and Johan Gustafson, Griffith University) - no additional time requirements.
- During day-light hours we will undertake whale survey.

Investigator equipment (MNF)

- 24 bottle CTD and rosette
- XBT system
- LADCP
- SADCP and other underway data
- Hydrochemistry Lab
- Clean Lab
- Wet Lab
- Sheltered Science Lab.

User Equipment

- CSIRO mooring consumables including winch (Jamie Derrick)
- RBR CTD and other instruments to be secured to the rosette (Susan Wijffels)
- XBTs and additional launchers (Rebecca Cowley)
- Science personnel laptops

Special Requests

XBT/CTD Side-by-side comparisons:

At each CTD site, we will be undertaking XBT and CTD side-by-side comparisons. We will launch XBTs from the stern and the bridge wings or an equivalent suitable position on the vessel to get a range of deployment heights above water. We will supply a detailed experiment outline and work with the Master to ensure all location site are approved.

New CTD sensor tests:

This will require the mounting of an internally recording CTD sensor to the frame. Wijffels with liaise with the MNF CTD team on how this can be achieved. The package uses an inductive sensor for conductivity and thus will need to be mounted in clear water away from the other sensors. The presence of this test sensor should not change CTD operations very much. On the CTD sensor test casts, will have a maximum depth of 2000 m and may involve longer bottle soaks of the sensor package at bottle stops. We will download and recharge the sensor during the day while mooring operations are underway.

Permits

Nil.

Personnel List

1.	Tegan Sime	CSIRO	Voyage Manager
2.	Stephen McCullum	CSIRO	Deputy Voyage Manager
3.	Ian McRobert	CSIRO	SIT
4.	Nicole Morgan	CSIRO	SIT
5.	Pamela Brodie	CSIRO	DAP
6.	Steve Van Graas	CSIRO	DAP
7.	Amy Nau	CSIRO	GSM
8.	Cassie Schwanger	CSIRO	Hydrochem
9.	Peter Hughes	CSIRO	Hydrochem
10.	Bernadette Sloyan	CSIRO	Chief Scientist/moorings/CTD
11.	Susan Wijffels	CSIRO	Principle Scientist (CTD senor testing)
12.	Rebecca Cowley	CSIRO	Principle Scientist (Moorings/XBT)
13.	Jamie Derrick	CSIRO	Chief Mooring Tech
14.	Darren Moore	CSIRO	Mooring Tech
15.	Jim La Duke	CSIRO	Mooring Instrument Tech
16.	Phil deBoer	CSIRO	Mooring Tech
17.	Gabriela Semolini Pilo	UTAS	CTD,XBT
18.	Joshua Reinke	Griffith University	Whale watching
19.	Johan Gustafson	Griffith University	Whale watching
20.	Tim Austin	UNSW	Mooring tech
21.	Stuart Milburn	UNSW	Mooring tech
22.	Eduardo Vitarelli	UNSW	Student, CTD,XBT
23.	Nina Ribbat	UNSW	Student, CTD, XBT
24.	Anthony Gramoulle	UNSW	Student, CTD, XBT
25.	Ken Ridgway	CSIRO	Mooring, CTD