MNF Voyage Summary

VOYAGE #:	IN2022_V06		
Voyage title:	Integrated Marine Observing System: monitoring of East Australian Current property transports at 27° S		
Mobilisation:	Wagners Wharf, Pinkenba (Brisbane) Friday, 8 July 2022		
Quarantine and Pre-medical clearance period:	Brisbane, Monday, 4 to Monday, 11 July 2022 (inclusive)		
Continuation of mobilisation and pre-departure medical clearance period:	Tuesday, 12 to Wednesday, 13 July 2022 (inclusive)		
Depart:	Wagners Wharf, Pinkenba (Brisbane) Thursday, 14 July 2022		
Return:	Wagners Wharf, Pinkenba (Brisbane) 08:00 Saturday, 30 July 2022		
Demobilisation:	Wagners Wharf, Pinkenba (Brisbane) Saturday, 30 July 2022		
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Affiliation:	CSIRO	**Contact details:**	chris.chapman@csiro.au
Principal Investigators:	Amandine Schaeffer (UNSW)		
Project name:	Integrated Marine Observing System: monitoring of East Australian Current property transports at 27° S		
Affiliation:	UNSW	**Contact details:**	a.schaeffer@unsw.edu.au

Voyage Summary

Objectives and brief narrative of voyage

The East Australian Current (EAC) is the complex and highly energetic western boundary current of the South Pacific Ocean gyre, that shows temporal and spatial variability over a wide range of scales. Due to the narrow shelf, EAC meandering has an immediate impact on the continental shelf circulation. Exchange of heat, salt and plankton between the shelf and open ocean is achieved via EAC intrusion, submesoscale and mesoscale eddies and complex boundary layer and frontal dynamics. The dynamically driven exchange of shelf and boundary current water and EAC eddies in the western Tasman Sea affect the entire marine ecosystem from planktonic production to pelagic fish distribution and abundance by transporting oligotrophic Coral Sea water and yet stimulating upwelling along the coast and offshore.

Scientific objectives

The long-term monitoring of the EAC provides a comprehensive data set that, together with other observations, will enable improved understanding of the relationship between the EAC and the basin-scale gyre and local forcing, determine the impact of the EAC variability on the coastal circulation and the local and regional marine ecosystem. This will be achieved by production of a gridded EAC mass, and property transport time-series for use by national and global modelling groups, assimilation into high-resolution regional and coastal models currently being developed by the Australian ocean modelling community.

Voyage objectives

The following specific voyage objectives are:

- Recover 6 moorings at appropriate locations;
- CTD/rosette stations at each mooring location, as well as “instrument dip” CTDs for quality control, calibration and comparison of SBE37 and SBE39 mooring instruments;
- Triaxus and Ship ADCP sections along the mooring line and of significant oceanographic features;
- Preliminary sampling of a potentially productive submarine canyon in support of an upcoming voyage;
- Deployment of various Argo floats during the voyage (piggyback);
- Sub-bottom profiling (SBP) of a significant geological feature, the Southeast Queensland Bulge (SQB) to identify regions for future coring (piggy-back).

Results

A large amount of physical and biogeochemical data was collected during this voyage that will take several years to fully analyse. However, all primary, secondary objectives were achieved and some progress on the physical characterisation of the submarine canyon complex in northern NSW was made. Specifically:

- We successfully completed 6 mooring recoveries;
- 6 CTD/LADCP stations were completed in support of the mooring operations;
- Conducted 6 calibration CTD stations of recovered or soon to be deployed mooring instruments were completed;
- Performed numerous CTDs to characterise the interaction between the shelf waters the and the EAC;
- Conducted 5 Triaxus/SADCP and CTD sampling of the interaction between the EAC, a large meso-scale eddy and an ephemeral frontal eddy;
- A long sub-bottom profiler (SBP) transect was completed;
- Deployed 2 core Argo floats were deployed with matching CTD cast.

Voyage narrative

EAC Mooring operations (Team Leader -Chris Chapman)

A total of 6 moorings were recovered. These moorings were deployed during the IN2021_V03 by the CSIRO mooring team. Moorings were first located using the acoustic releases attached to the anchors to guide ship positioning, then released. Moorings to be recovered were first grappled using the CSIRO pneumatic grapple gun, then carefully brought on board over the stern. A tow speed of 1 to 2 knots relative to the water was used to ensure that the mooring would stream behind the ship to reduce the chance of inducing “wuzzels”. Once safely attached to the CSIRO mooring winch, the remainder of the mooring was brought on board using the CSIRO mooring winch and the A-frame by the CSIRO mooring team and the ASP crew, with assistance from the physical oceanography science team.

Wuzzels occurred on one recovery (EAC4800) during this voyage due to slack current, which was well handled by the mooring technical team and ASP crew.

The M6 (EAC4800) and M4 (EAC4200) moorings were found to have lost equipment upon recovery. The M6 mooring was found to be missing only the top beacon float and a single SEB37 instrument, previously recovered in northern NSW. The M4 mooring had lost two floatation devices and 7 SBE 37 instruments. This drifting mooring was spotted by the Royal Australian

Physical Oceanography (Team Leaders - Chris Chapman, Amandine Schaeffer)

We deployed the MNF Triaxus, the CTD/Rosette, Vale Rapidcast and the underway seawater to sample a number of important oceanographic features during the voyage:

The Triaxus was deployed with the standard instrument payload: SBE 911+CTD 23, A Biospherical QCP2300-HP PAR, and a WetLabs C-STAR Transmissometer, ECO Triplet and Laser Optical Plankton Counter. The data obtained from the SBE911+ were processed using Seabird Scientific’s Seasave software, while custom software was used to process the data from the SUNA, ECO Triplet and LOPC. The LOPC was found to be malfunctioning during the first tow, with the problem identified as water in the cable. The LOPC functioned normally on the second tow until approximately 10 minutes before recovery. The problem with the instrument was rapidly identified and repaired by the SIT.

The CTD was deployed using the large, 36 bottle Rosette. A standard CTD payload was carrier (Sea-Bird SBE911+. Biospherical PAR, Tritech Altimeter, C-Star Transmissometer, WET Labs CDOM, WET Labs ECO Scattering, and WET Labs ECO Chlorophyll sensor). Niskin bottles were sampled for dissolved oxygen, nutrients and salinity.

On CTD cast #3, conducted on the 15th July, abnormal "spikes" were noticed on the secondary SBE911+ unit. SIT and DAP number of attempts to identify and correct these possible errors. These included replacement of the conductivity sensors between casts #3 and #4 on the 15th of July, replacement of the pump on the secondary sensor between casts #4 and #5 on the 17th of July, and replacement of an O-ring on the secondary pump between casts #16 and #17 on the 20th of July. The issue appear to substantially improve after the replacement of the CTD pump on the 17th of July. However, the root cause of the issue has yet to be definitively identified.

A new Suna nitrate sensor was attached to the CTD rosette for casts #20, #21 and #22 in order to verify the functioning of the instrument and potentially compare its output with bottle samples processed by the hydrochemistry team.

"Routine" CTD casts were performed in support of mooring operations and Argo float deployments. Pre mooring recovery CTDs were performed to ensure the data quality of the deployed mooring instruments.

In addition to "routine" CTDs, targeted physical oceanographic observations using the Triaxus, CTD, SADCP and EK80 were taken to sample the following features:

- A large eddy interacting with the East Australian Current on the 16th July;
- An ephemeral frontal eddy sampled on the shelf to the east of Moreton/Mulgumpin;
- A submarine canyon system (Richmond canyon) using SADCP and EK80 systems.

A 50 nautical mile long SBP transect was undertake n to support the identification of potential sites for deep coring. 14 XBTs were dropped in support of that effort in order to improve the sound-speed profile and ultimately the data quality.

Geology/Paleoclimate (Team Leaders – Helen Bostock, Chris Chapman)

A 50nm long Sub-bottom profiler transect was completed on the evening of the 20th of July. The purpose of this transect was to investigate the geomorphology and subsurface properties of a large geological feature, named the Southeast Queensland Bulge. This transect had a starting longitude of 154.19E, a starting latitude of 28.12S, an ending longitude of 154.195E, and ending latitude of 154.195S. In support of this effort, 14 XBTs were dropped at approximately 30 minute intervals (approximately 3 nm @ a representative SOG of 6kts), in order to improve the vertical sound speed profiles and hence the reliability of the eventual sub-bottom reconstruction. Assistance from Cisco Navidad and Justy Siwabessy of the GSM team is gratefully acknowledged.

Figure 1: Example SBP reconstruction, showing deep, striated sediments, obtained during the "bulge" transect

Summary

Upon boarding, mobilisation was completed and muster drills and lab custodian inductions were held during this time. RV Investigator departed from Wagners Wharf on the 14th of July, one day later than scheduled due to COVID protocols. A strong southerly swell and winds of up to 50kts impeded scientific operations until the afternoon of the 15th July. Conditions were assessed as too rough for to go ahead with planned recovery of the EAC4800 mooring. Pre mooring recovery CTDs were performed at the EAC4800 and EAC4700 mooring locations. By the 16th of July, weather and sea conditions had improved substantially, allowing for the recovery of EAC4800. The mooring was released at shortly after 0730 and was quickly spotted and brought on board rapidly. Mooring recovery was completed by 1500, followed by the deployment of two Argo floats. CTD operations continued throughout the evening.

With weather conditions expected to deteriorate later in the week, it was decided to complete the recovery of the EAC4700 mooring on the 17th of July. While undertaking mooring recoveries on consecutive days is not standard operating procedure, it was decided that, having already lost two days due to COVID protocol and unfavourable weather, to undertake back-to-back recovery operations. Recovery of the EAC4200 occurred on the 19th of July, prior to a sustained period of poor weather due to an unseasonal sub-tropical East Coast Low halting most scientific activities between the evening of the 20th of July and the morning of the 24th of July. During this period of time, the RV Investigator headed south to a region due east of Byron Bay, allowing for the planned high resolution SBP/XBT transect along the South East QLD “bulge” (starting longitude 154.19, starting latitude: -28.12, ending longitude: 154.1951, ending latitude:154.1951) and an SADCP/EK80 survey of the Richmond Submarine Canyon Complex.

Following the passage of the East Coast Low, mooring operations recommenced on the 24th of July with the recovery of the EAC3200 mooring, followed by recoveries of the EAC2000 and EAC500 moorings on the 26th of July. Following the completion of the mooring operations, All mooring recoveries were conducted safely and professionally by the CSIRO mooring team and the ASP officers and deck crew, under the watchful eyes of the now formalised “safety observer”, ably undertaken by the MNF voyage management team.

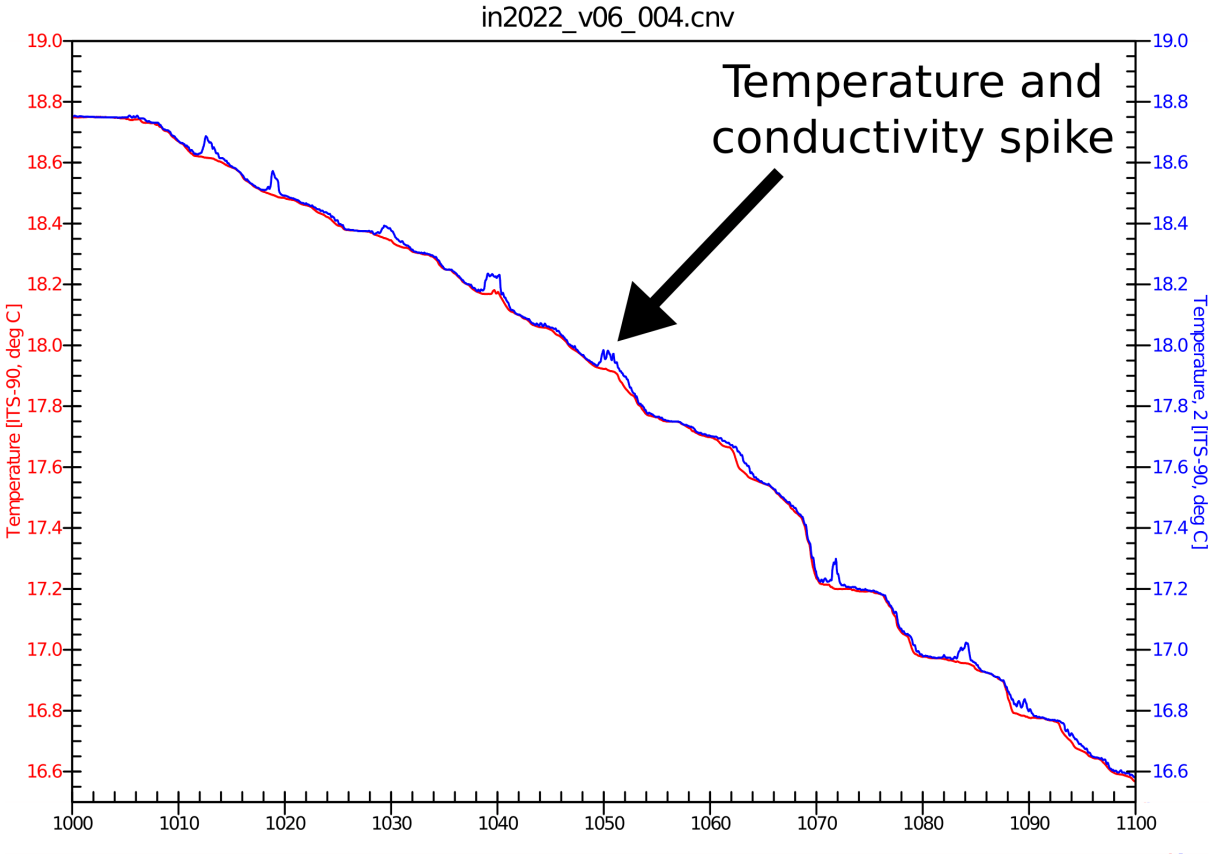


Figure 2: CTD cast #4 showing an example of the CTD conductivity "spiking" behaviour.

Overnight, we made extensive use of the towed-body wire, with numerous Triaxus/SADCP or rapid-cast/traditional CTD sections being undertaken. This included substantial work over the continental shelf region east of North Stradbroke Island where we actively attempted to characterise shelf waters and sample the “meandering” nature of the EAC when it interacts with large mesoscale eddies.

Science operations were stopped on the evening of the 28th of June, and cleaning/packing up was completed. We arrived at the Moreton Bay pilot boarding ground at 0800 on the 29th July, and were alongside at the Brisbane Cruise Terminal, Pinkenba, Queensland on 30th July. Demobilisation was completed by the evening of the same day.

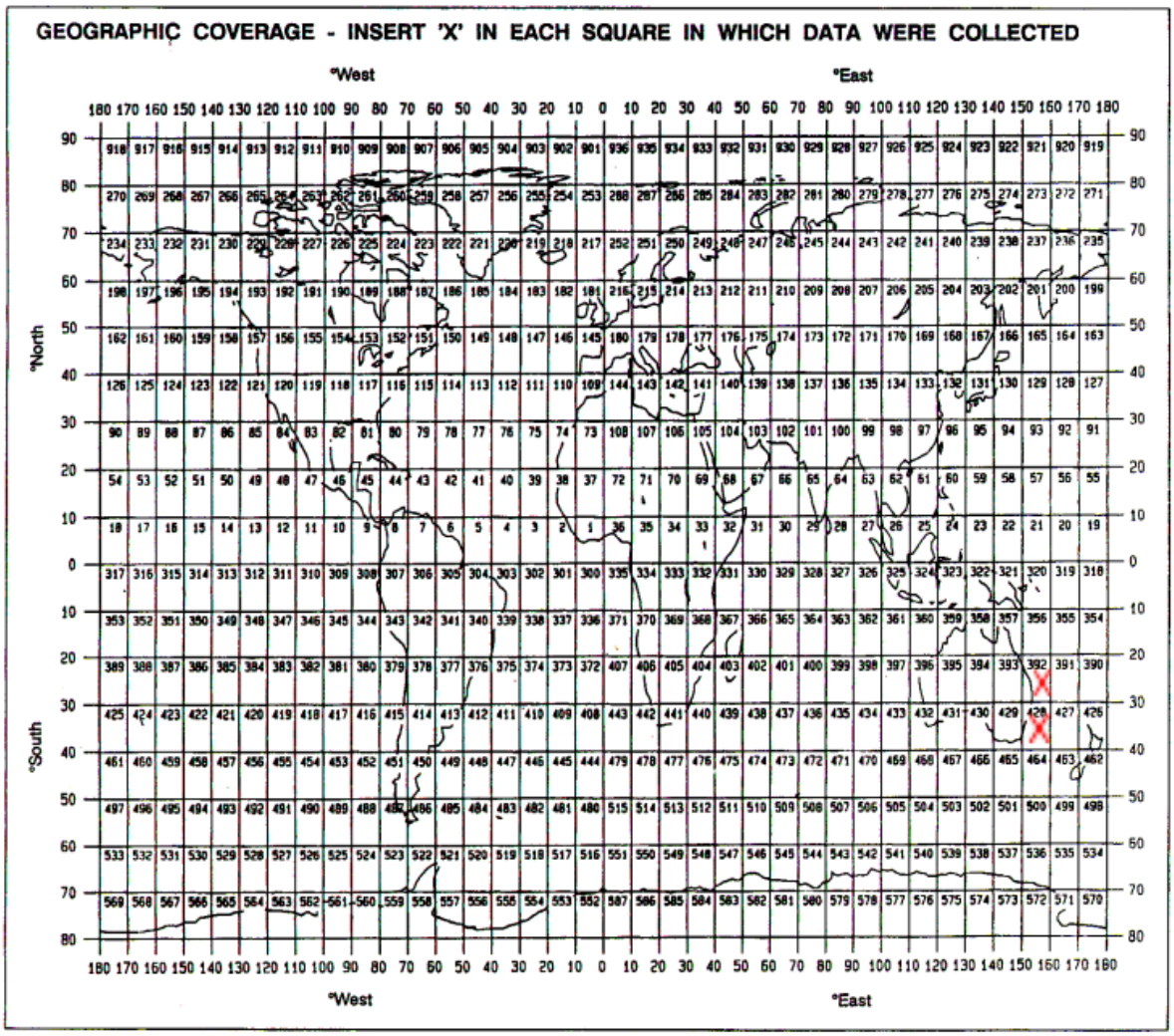
Despite challenging conditions thrown up by COVID and weather, this voyage managed to complete all of its primary objectives, partially completed the tertiary objective of surveying the Richmond canyon and completed two smaller piggyback projects. The data obtained from this voyage will take months to years to analyse.

Outreach, education and communications activities

Aboriginal and Torres Strait Islander university students Taleatha Pell and Lakiesha Wear, participated on this voyage and had a unique opportunity to gain experience on a world-class marine research vessel, whilst supporting the science objectives.

They worked alongside scientists and technicians and gained valuable at-sea research experience which facilitated their skill development and networking, working with onboard and onshore mentors. Their efforts, good humour, and valuable insights contributed enormously to the success of the voyage and were much appreciated by the science party.

Marsden Squares



Moorings, bottom-mounted gear and drifting systems

Item Name, Identifier (e.g. serial number)	Principal Investigator (see Title Page)	APPROXIMATE POSITION (as degrees, decimal minutes)						DATA TYPE enter code(s) from list in Appendix A	DESCRIPTION
		LATITUDE			LONGITUDE				Nature of the instrumentation
		deg	min	N/S	deg	min	E/W		
EAC_4800	Sloyan and Chapman	27	06.158	S	155	18.138	E	H11, D01, D71	Recovery of EAC_4800 (M_6) Deployed Date : 17 May 2021. Recovered: 16 July 2022
EAC_4700	Sloyan and Chapman	27	12.092	S	154	38.34	E	H11, D01, D71	Recovery of EAC_4700 (M_5) Deployed : 20 May 2021. Recovered: 17 July 2022
EAC_4200	Sloyan and Chapman	27	14,699	S	154	17.183	E	H11, D01, D71	Deployment of EAC_4200 (M4) Deployed : 24 May 2021. Recovered: 19 July 2022
EAC_3200	Sloyan and Chapman	27	16.8672	S	154	8.0862	E	H11, D01, D71	Recovery of EAC_3200 (M_3) Deployed: 27 May 2021. Recovery: 25th July 2022
EAC_0500	Sloyan and Chapman	27	19.537	S	153	53.982	E	H11, D01, D71	Deployment of EAC_500 (M_1) Deployed: 1 May 2021 Recovery: 26th July 2022
EAC_2000	Sloyan and Chapman	27	18.756	S	153	0.136	E	H11, D01, D71	Deployment of EAC_2000 (M_2) Deployed: 2 May 2021 Recovery:26th July 2022

Item Name, Identifier (e.g. serial number)	Principal Investigator (see Title Page)	APPROXIMATE POSITION (as degrees, decimal minutes)						DESCRIPTION
		LATITUDE			LONGITUDE			
		deg	min	N/S	deg	min	E/W	
Argo Float 1335	Chris Chapman /Peter Oke	27	4.864	S	155	17.7844	E	Water Depth (m): 4774, deployed 2022-07-15 06:27:08 UTC
Argo Float 11097	Chris Chapman/Peter Oke	26	4.4620	~~S~~	155	17.8452	E	Water Depth (m): 4774, deployed 2022-07-15 06:26:03

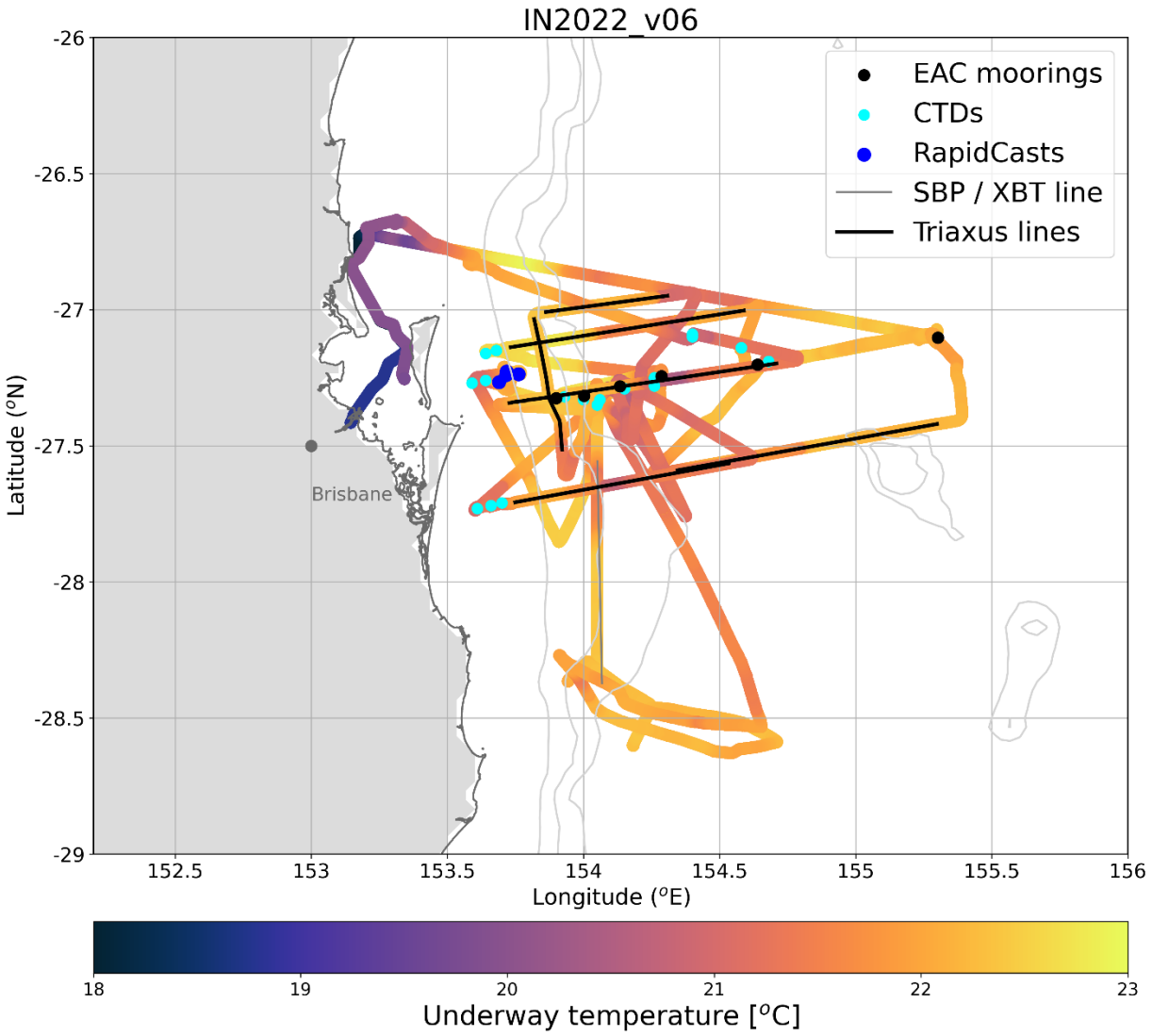
Summary of data and samples collected

Item Name, Identifier (e.g. serial number)	Principal Investigator (see Title Page)	NO (see above)	UNITS (see above)	DATA TYPE Enter code(s) from list in Appendix A	DESCRIPTION
1	Chapman	22	CTD Stations	H09/H10	24 bottles on the 36 bottle rosette. At each CTD station (with the exception of shallow casts) water samples were collected for nutrients, salinity and oxygen.
2	Schaeffer	4	Towed undulating CTD profiles	H09/H10	Pressure, temperature, conductivity, oxygen and other sensors (EcoTriplet, LOPC, Suna) were deployed on the Triaxus
3	Schaeffer	4	Valeport RapidCast CTD	H10/H11	Used GSM Valeport RapidCast CTD sensor to collect CTD data during to complement ship ADCP sections
4	Chapman/Schaeffer/Bostock	14	XBT	H11	XBT deployments in support of the Sub Bottom Profiler transect
5	Bostock/Chapman	1	SBP	G73	Approximately 50 mile long SBP transect of the Southeast Queensland “Bulge”.
6	Bostock/Chapman/Crosby	24	Flasks	H21	CTD casts #20 and #22 were sampled for d18O. The falcon flasks were stored at 4 degrees C and transported in cooler bags to the University of Queensland for further analysis.

Curation Report

Item #	Description	Storage	Access	Custodian
	24 Falcon fasks of D018	University of Queensland	Access via Dr. Helen Bostock	Dr. Helen Bostock

Track Chart



Acknowledgements

The science party gratefully acknowledges the support of the Integrated Marine Observing System (IMOS) for their support of the East Australian Current Deep Water Array since 2015. This voyage would not have been possible without it.

Signature

Your name:	Chris Chapman
Title:	Chief Scientist
Signature:	
Date:	01/08/2022

Appendix A – CSR/ROSCOP Parameter Codes

	METEOROLOGY
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 (e.g. transmissometer)
H17	Optics (e.g. underwater light levels)
H73	Geochemical tracers (e.g. freons)
D01	Current meters
D71	Current profiler (e.g. 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

	MARINE BIOLOGY/FISHERIES
B01	Primary productivity
B02	Phytoplankton pigments (e.g. chlorophyll, fluorescence)
B71	Particulate organic matter (inc POC, PON)
B06	Dissolved organic matter (inc DOC)
B72	Biochemical measurements (e.g. 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

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

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