MNF Voyage Summary

Voyage #:	IN2021_T01
Voyage title:	Brisbane to Darwin Transit
Mobilisation:	Brisbane, Wednesday, 9 June 2021
Depart:	Brisbane, 1800 Thursday, 10 June 2021
Return:	Darwin, 1300 Wednesday, 23 June 2021
Demobilisation:	Darwin, Wednesday, 23 June 2021
Voyage Manager:	Rob Palmer
Chief Scientist:	Dr Viena Puigcorbé
Affiliation:	Edith Cowan University
Principal Investigators:	Dr Sophie Leterme
Project name:	Microplastics in the food chain: impact on the microbial and planktonic organisms
Affiliation:	Flinders University
Principal Investigators:	Dr Viena Puigcorbé
Project name:	Linking the Biological Carbon Pump flux to microbial colonisation of sinking particles in the Coral Sea
Affiliation:	Edith Cowan University
Principal Investigators:	Dr Allison McInnes
Project name:	Flow cytometric classification of the phytoplankton community across Australia's top end
Affiliation:	University of Melbourne
Principal Investigators:	Dr Matt Gordon
Project name:	Dinoflagellates & broader planktonic assemblage observation
Affiliation:	Defence Science & Technology Group
Principal Investigators:	Dr Tom Trull
Project name:	BGC-Argo Float Deployment
Affiliation:	CSIRO

Principal Investigators:	Dr Grahame Rosolen
Project name:	Cosmic Ray Measurements
Affiliation:	CSIRO
Principal Investigators:	Craig Neill
Project name:	Carbon Sampling
Affiliation:	CSIRO

Voyage Summary

Objectives and brief narrative of voyage

The primary objective of voyage IN2021_T01 is movement of RV *Investigator* from Brisbane to Darwin in preparation for IN2021_V04. Up to 72 hours of the transit voyage were allocated to conduct scientific operations across one supplementary project and six separate piggy-back projects.

RV *Investigator* departed from Brisbane on the 10th of June 2021. A test CTD station was conducted after piloting finished offshore of Brisbane. The ship headed north, off the shelf, aiming to conduct the first 4 stations in the Coral Sea section in waters deeper than 1000 m. The first station took place on the 12th of June, with the successful deployment of a 1000 m CTD followed by a net haul. Biogeochemical analyses, sampling for microplastics and for dinoflagellates were the main focus of these casts. The next two stations were similar and took place on the 14th and 15th of June. On the 16th of June we reached the northern part of the Coral Sea transect and we conducted the fourth station, which included the successful deployment of and Biogeochemical Argo Float in waters deeper than 2250 m. Pilotage guided the ship through Torres Straight prior to the mapping of a section in the West Cape York Marine Park of ~12km^2.

Three more stations were conducted in the northern transect of the voyage, which included shallow CTD casts and net hauls for microplastic and dinoflagellates measurements. During the entire voyage underway samples were collected for different purposes, including the classification of phytoplankton communities' composition and the measurements of dissolved inorganic carbon and total alkalinity. Cosmic ray flux measurements were also conducted from the departure from Brisbane until arrival to Darwin on the 23rd of June. The weather was good during the duration of the voyage, with calm seas and warm temperatures.

Scientific & Voyage Objectives

Supplementary Project 1: Microplastics in the food chain: impact on the microbial and planktonic organisms

Principal Investigator: Dr Sophie Leterme (remote), Dr. George Cresswell (participant), Woody Drummond (participant)

Microplastics consist of pieces of plastic smaller than 5 mm, such as the microbeads found in domestic and personal care products. Plastic pollution of oceanic ecosystems can be observed anywhere on the planet, but microplastics create a global biological and chemical hazard due to their propensity to be ingested by marine life that is later consumed by humans. Small plastics can also adhere onto the surface of micro-organisms that are preyed upon by higher levels of the oceanic food chain such as fish. The aims of the project are:

i. assess the amount of plastics (micro through to pico in size) present in blue waters along the transect between Brisbane to Darwin.
ii. identify their impact on microorganisms at the base of the oceanic food chain.

Seven sampling stations were completed along the track – 4 were cast to a depth of 1000 m and 3 were to a depth of 50 m (along the Gulf of Carpentaria). The CTDs to 1000 m were shared with the Dr Puigcorbé project. The shallow CTD casts were shared with the Dinoflagellate project (Dr Gordon).

Each station took the following process:

1. CTD will inform of the depth of the Deep Chlorophyll Maximum (DCM)
2. 3 Niskin bottles triggered at 3 depths, including: subsurface (S), DCM and 20 m above the bottom (B-20) (or at the maximum depth the Niskin bottles can be triggered).
3. Hydra-bios net tows (100 µm) casting out from each CTD station. Two nets were triggered at the surface, at the DCM and 20 m above the bottom (or at the maximum depth the net can be triggered), with 15 minutes towing for each net before they were triggered shut,) at a speed of approximately 1 kt.

These samples collected allowed the team to gain insight into microplastic abundance in the waters around North-East Australia and will allow them to determine the interaction between zooplankton and microplastic.

At each station, after the retrieval of the CTD rosette, each 12 L sample was sieved through a 20 µm stainless-steel sieve and retained material was transferred to a glass vial for later analysis at Flinders University.

After the Hydra-bios net tows, each net cod-end was rinsed thoroughly into a plastic container to collect all retained material. One sample from each depth was preserved in ethanol for later analysis of zooplankton communities, whilst the other sample was stored in Milli-Q water and later analysed for microplastic abaundance.

Two laboratories were used for this project, the dirty-wet laboratory and the clean-wet laboratory. Bench surfaces were well utilised in both areas and the Laminar flow hood in the clean-wet lab was used to process Niksin bottle samples. Additionally, the Milli-Q water system was constantly used throughout the transit.

ADCP data was collected daily to be used to create a microplastic particle tracking model around Australia after collection of final data.

Piggyback Project 1: Linking the Biological Carbon Pump flux to microbial colonisation of sinking particles in the Coral Sea

Principal Investigator: Dr Viena Puigcorbé (remote), Dr Rachele Bernasconi (participant)

This project was proposed to conduct preliminary research as a Piggyback project during the IN2021-T01 voyage to support the Supplementary Project “Linking the Biological Carbon Pump flux to microbial colonisation of sinking particles in the Coral Sea” that was granted to join IN2019-V04 but that could not take place due to COVID restrictions.

We wanted to conduct the research in the Coral Sea because the oligotrophic areas of the ocean, as the Coral Sea, are expected to expand with the prediction of a future warmer ocean. Yet, these oceanic regions have been disregarded when referring to carbon export estimates. Recent research has shown that subtropical regions with picoplankton-dominant food webs are characterized by enhanced export

efficiencies. Our knowledge on the role played by the microbial communities in the attenuation of the carbon export flux is in its infancy.

The advances in molecular techniques have allowed to increase dramatically the available data on microbial diversity and have made possible to answer ecological questions that refer to biogeography and community assembly, but have not yet been extensively applied to biogeochemical relevant questions involving the biological carbon pump (export of particulate organic carbon from the surface waters to the ocean's interior). With this initial project we aim to gather data to deepen our understanding on the carbon export and the impact of the microbial community in the carbon export efficiency in oligotrophic waters.

This project has two main goals:

1- Quantify carbon export by using a robust and extensively applied method based on the naturally occurring radioisotope pair ^{234}Th: ^{238}U. We will quantify carbon export fluxes and provide a comprehensive interpretation of the export fluxes by characterising the nature (i.e., organic carbon vs. biogenic silica content) of the settling particles.

2- Characterise the microbial communities using high-throughput genomics tools. These techniques generate a detailed view of community composition, including both the dominant organisms and those in low abundances. This allows following the origin of each microbial organism colonising particles in the ocean and to trace them back to their depth of colonisation. In addition to the prokaryotes (16SrDNA and 16SrRNA), we will also look at the protists in the particles through use of 18S rDNA sequencing, to elucidate if the particles are biogenic (i.e. algae, zooplankton faecal pellets), and which protists colonise the particles and feed on the attached bacteria.

Sampling strategy:

A modified sampling strategy was implemented after a reduction in personal able to join RV *Investigator* due to COVID. A total of 4 CTD deployed to 1000 m and 4 CTD deployed to 200 m (co-located) provided a good coverage of the area for our purposes. The stations were located along the voyage track targeting areas off the shelf (and its slope) with a water column deeper than 1000 m.

1000m CTD:

- *^{234}Th samples*: 13 depths along the upper 1000 m. 5 L needed

- *Microbial community*: 10 L seawater samples will be collected at the same depths where the in-situ pumps will be deployed in the upper 1000 m.

200m CTD:

- *POC samples*: 6 Niskins per sample (72 L max), with 6 samples collected between 50 and 200 m. Radionuclide analyses will be done, together with CHN analyses

Piggyback Project 2: Flow cytometric classification of the phytoplankton community across Australia's top end

Principal Investigator: Dr Allison McInnes (remote)

Phytoplankton are a diverse group of autotrophic organisms that range in size, shape, activity, and role in marine ecosystems. Understanding the composition of the phytoplankton community offers insight into the functioning of these systems. Phytoplankton Class can be determined by pigment composition, analysis of which offers compositional understanding of these important ecosystem engineers; hence much development has been done in analysis of pigments. Current methods require large volumes of water and are amalgamations of the total community pigments. The proposed research will utilise the spectral signature capability of the Cytek Aurora to classify phytoplankton using their pigment composition at the single cell level using small volumes.

Due to COVID-19 participant restrictions, the Cytek Aurora was not able to be installed onboard and a modified sampling program was included to try and facilitate this work, with samples collected to be freighted back to Brisbane upon arrival in Darwin.

Objectives:

- Classify phytoplankton community composition, to the strain level (for Prochlorococcus and synechococcus), across Australia's top end on a highly spatially resolved transect using the underway system, to investigate phototroph diversity within the Coral Sea and Arafura Sea.
- Correlate community composition with physical and chemical oceanographic measurements.

Sampling Strategy:

Samples will be collected at set time/distance intervals from the underway tap. These samples will be preserved and frozen to run on the Cytek Aurora located in Brisbane.

Piggyback Project 3: Dinoflagellates & broader planktonic assemblage observation

Principal Investigator: Dr Matt Gordon (remote)

Dinoflagellates are an ubiquitous and ecologically important component of marine phytoplankton communities, with particularly notable species including those associated with harmful algal blooms (HABs) and those that bioluminesce. High-throughput sequencing offers a novel approach compared to traditional microscopy for determining species assemblages and distributions of dinoflagellates, which are poorly known, especially in Australian waters.
The major aims for data collection activities during this voyage are:

1. Collect water samples at night for taxonomic and molecular identification of dinoflagellate species;
2. Record and compare environmental and physical characteristics (water quality parameters, sea state, wind, moonlight) against observed species composition / abundance; and
3. Record and compare environmental and physical characteristics (water quality parameters, sea state, wind, moonlight) against observed bioluminescence activity.

Due to COVID-19 participant restrictions, a field kit with instructions has been provided to facilitate this sampling by staff available onboard.

Sampling strategy

The main consideration of our research requirements is that our samples are to be taken during the night, no earlier than 2 hours after sunset and no later than 2 hours before sunrise.

Water collection - CTD requests:

- 4 L of water is requested from each discrete depth
- Night-time samples @ 5, 25, 50, 100, 150 m
- Preferable parameters to be recorded: temperature, salinity, chlorophyll, conductivity, DO, pH, and turbidity

A 1 L seawater sample for each depth listed above is to be preserved in Lugols solution and stored at ~4°C.

A further 2 L are to be processed through 1.2 µ self-preserving eDNA filters.

The final 2 L of water are to be processed through 0.45 µ filters using a vacuum pump filter system.

The UBAT (Underwater Bioluminescent Assessment Tool) that the MNF has an integration solution for, will be deployed on the 200 m CTD and allowed to run for 2 minutes at each depth.

Piggyback Project 4: BGC Argo Float

Principal Investigator: Dr Tom Trull (remote)

Biogeochemical-Argo is the extension of the Argo array of profiling floats to include floats that are equipped with biogeochemical sensors for pH, oxygen, nitrate, chlorophyll, suspended particles, and downwelling irradiance. Newly developed sensors now allow profiling floats to also observe biogeochemical properties with sufficient accuracy for climate studies. This extension of Argo will enable an observing system that can determine the seasonal to decadal-scale variability in biological productivity, the supply of essential plant nutrients from deep waters to the sunlit surface layer, ocean acidification, hypoxia, and ocean uptake of CO_2. Biogeochemical-Argo will drive a transformative shift in our ability to observe and predict the effects of climate change on ocean metabolism, carbon uptake, and living marine resource management.

The Australian contribution to global Biogeochemical-Argo is coordinated through the Australia-India Strategic Research Fund (AISRF) Indian Ocean Bio-Argo project and the IMOS Argo-Australia facility.

1 float was deployed at the head of Bligh Canyon, with a supporting CTD cast to 2,250m depth.

Piggyback Project 5: Cosmic Ray Measurements

Principal Investigator: Dr Grahame Rosolen (participant)

The aim of the research is to measure the cosmic ray flux at sea level over the range of latitudes from Brisbane to Darwin. The measurement types were divided into three categories: Aerosol lab, indoor with variable access to the sky, and outdoor on the deck with access to the sky.

The advantage of the Aerosol lab installation is that it is a fully engineered mechanical installation which can operate during wet weather and heavy seas as the equipment is mechanically stable, in a weatherproof air-conditioned environment and connected to an uninterrupted mains power source.

The disadvantage is the attenuation due to the intervening deck (8 mm of steel) and insulation material (90 mm of rockwool insulation in both vertical and horizontal planes). The experiments conducted outdoors operated in good weather for limited times due to the unavailability of power and the limited battery life (approx. 12 hours) and the need to monitor the equipment during the measurements. However, these outside measurements have the advantage of unimpeded access to the sky. The cabin or lab based cosmic ray measurements involved a temporary placement of a detector that seeks to take advantage of being out of the weather and with some access to the sky through a porthole. The project also gave opportunities for an indigenous student to be involved in the cosmic ray detector equipment configuration and some data analysis.

Piggyback Project 6: Carbon Measurements

Principal Investigator: Craig Neill (remote)

The objective of the project to acquire surface sea water samples for dissolved inorganic carbon (DIC) and total alkalinity (TA) through the Coral Sea between Brisbane and Cape York. The samples will be used as an inter-comparison with a sampling program for another vessel, the Japanese car carrier Trans Future 5, that is run by O&A.

The proposed work is to collect DIC and TA samples from the ship's underway sea water line every 6 hours from offshore of Brisbane to the continental shelf approaching Cape York. 250 ml glass bottles will be filled from the sampling tap in the underway sea water lab according to instructions provided by the Ocean Carbon Observations team. The samples will be preserved with mercuric chloride and analysed back in Hobart.

Opportunistic Mapping: Parks Australia

The National Park Zone has been identified as a priority (1) area for bathymetric mapping by Parks Australia. To contribute to previous mapping, an area traversing both the Habitat Protection Zone (HPZ) and National Park Zone is proposed, capturing an elevated seafloor feature in the HPZ. An elevated seafloor feature may provide habitat that supports higher biological diversity in this part of the park. With the time available, the solid orange area in

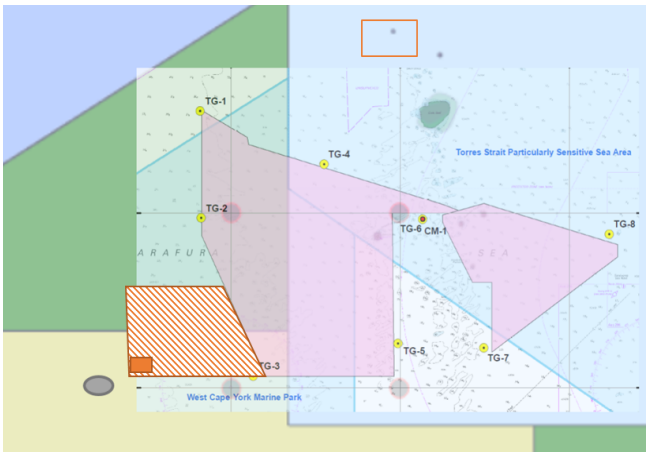


Figure 1 was the goal. This area was completed with an example image extracted in Figure 2.

Figure 1: Proposed area to be mapped (orange striped area), including feature of interest (orange sold area) nearby to previously mapped Carpentaria Shoal (grey solid circle)

Figure 2 : West Cape York surveying – possible bio-turbation holes (Image: CSIRO)

Results

It is too early to show quantitative results for most of the projects but some preliminary data and underway data have been compiled.

The underway data show that there are visible changes in temperature, salinity fluorescence and dissolved oxygen along the voyage path (Figure 3). From Brisbane to Torres Strait the temperature increased and salinity and dissolved oxygen decreased. Westward, from Torres Strait to Darwin, temperature and fluorescence were high and salinity and dissolved oxygen decreased further.

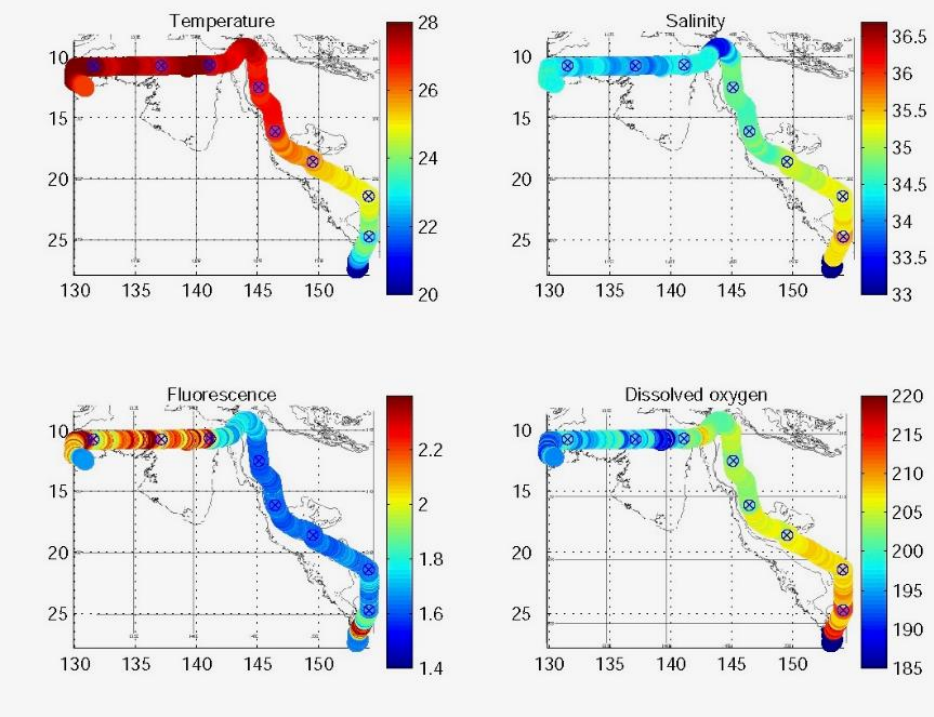


Figure 3 : Longitude and latitude are depicted on the x and y-axis. The coloured coloums to the right, from left to right and top to bottom depict temperature, salinity, fluorescence and dissolved oxygen along the voyage path. CTD positions are marked on the panels in dark blue open circles with a X in the center (Credit: G. Cresswell - Flinders University).

Twelve CTD casts were made at 8 stations (including the test-station – Station 1), highlighting the different conditions at each of the sampling points (Figure 4). At stations 6, 7 and 8, there is evidence of strong mixing.

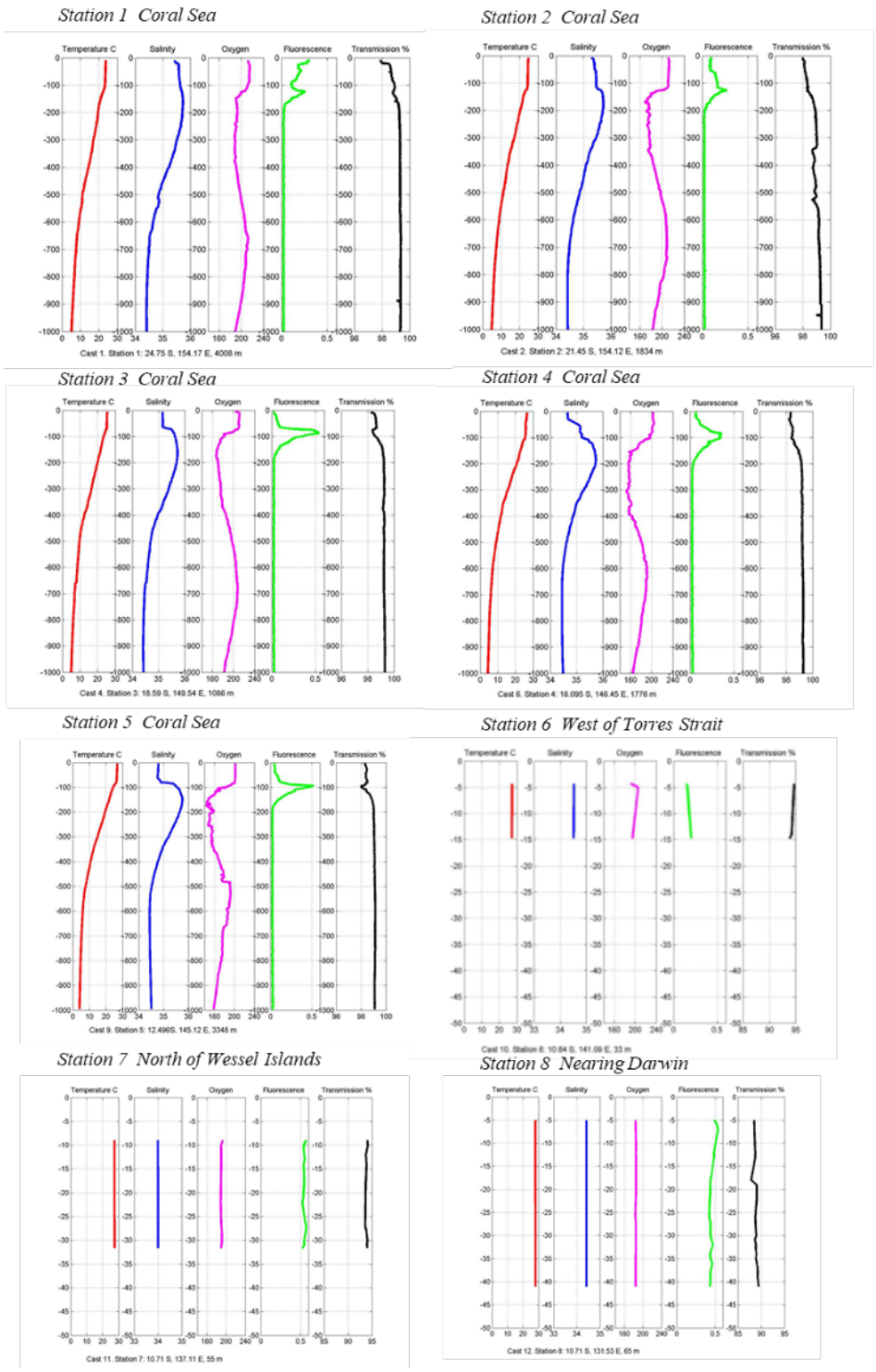


Figure 4 : CTD profiles of temperature (red), salinity (blue), oxygen (pink), fluorescence (green) and transmission (black), for the 8 sites samples along the voyage path. Profiles were given for the deepest casts at each station, when there was more than one cast at a station, on onboard the RV Investigator during the research voyage along the coast of QLD and NT. (Credit: G. Cresswell – Flinders University).

Leterme's project will use the data collected from the Acoustic Doppler Current Profiler (ADCP) to develop a better understanding of the oceanic features present at the time of sampling. This will allow for the correlation with data of the plastic fragments and depths they were found, providing an understanding of the sub-surface transportation of plastic fragments. The information collated will be used in the development of a predictor model which utilises the weight and plastic rise velocities of

collected plastic fragments in conjunction with oceanographic data; potentially allowing for the identification of aggregation points on shores around Australia.

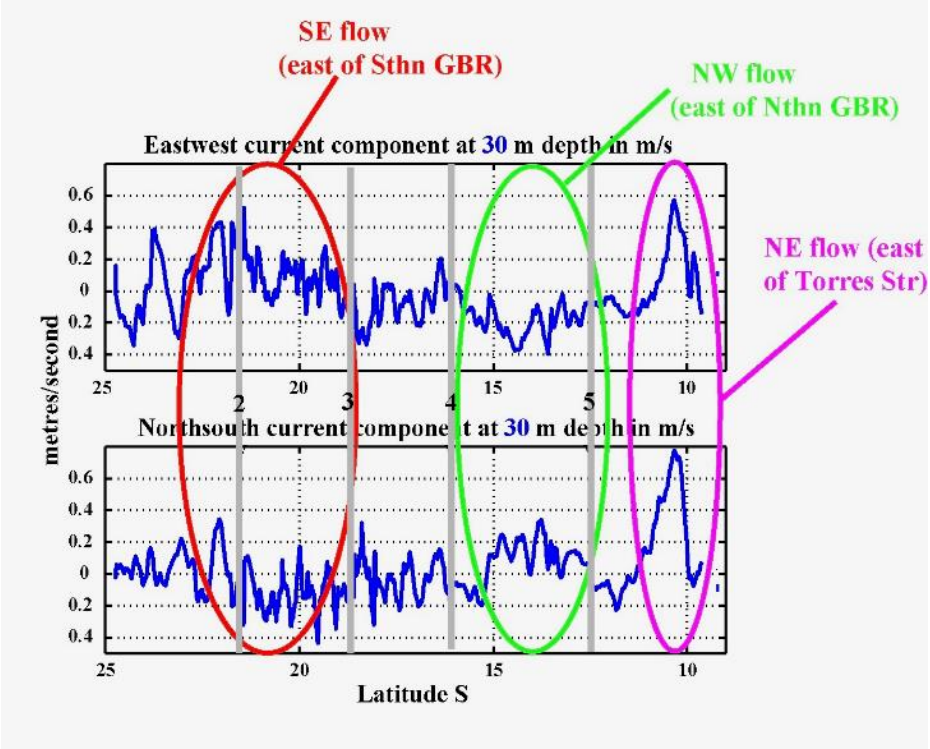


Figure 5 :The Acoustic Doppler Current Profiler (ADCP) data was used to show in blue the eastwest and northsouth current components at about 30 m depth. The coloured ellipses identify current regimes in the Coral Sea. The "noise" on the signals could be tidal currents. The grey vertical lines mark the positions of stations 2-5. (Credit: G. Cresswell – Flinders University).

Figure 5 visualises the changes in the eastwest and northsouth current components at about 30 m depth. This information is further explored in Figure 6, which is available as an animation on request to George Cresswell <gcresswell1@bigpond.com>. This animation is a compilation of the 32 frames (15 minute averages per frame) to visualise the complexity in the vertical structure and time. Figure 6 shows the complex vertical structures of the waterbody, visible in whichever way one looks. These ADCP measurements from stations 2-5 visualise the change in currents with depth.

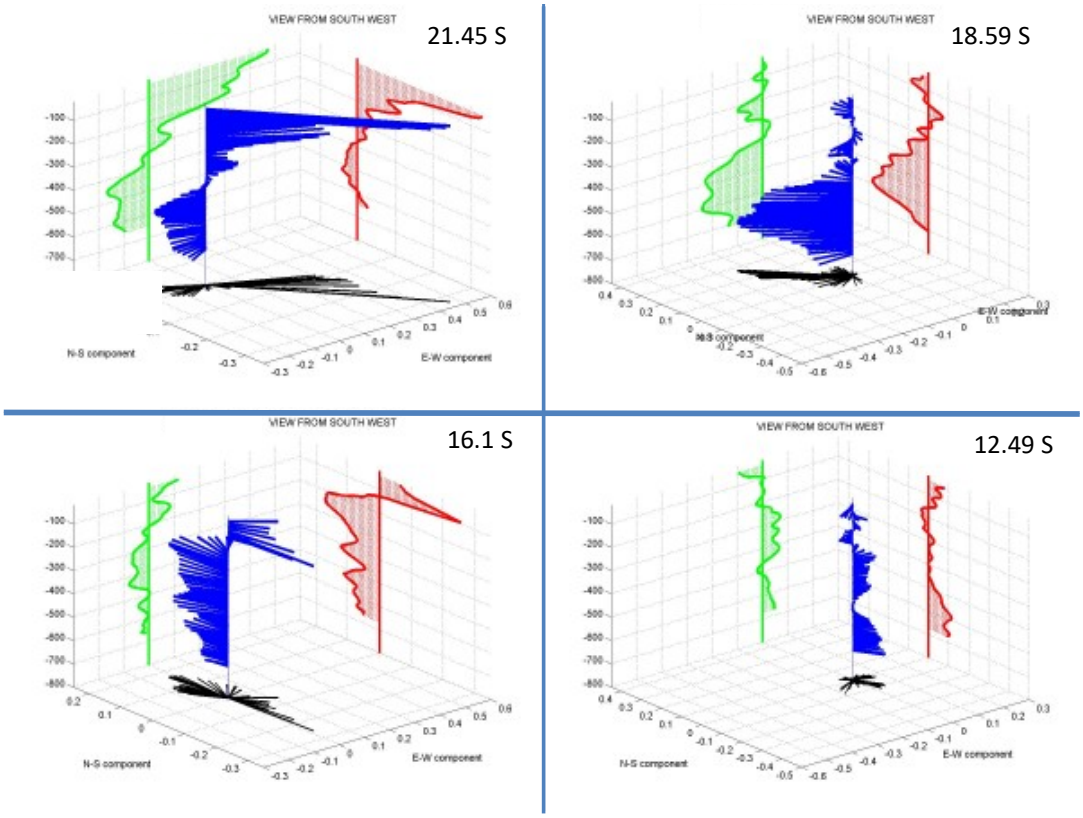


Figure 6 : The four figures here represent one of 32, 15-minute averaged ADCP current measurements. The the top left is station 2, top right is station 3, bottom left is station 4, bottom right is station 5. The blue "sticks" are current vectors plotted in 3 dimensions. The north-south component of the currents appears in red on the right, and the east-west on the left. The black sticks give all the blue vectors projected onto one plane. (Credit: G. Cresswell – Flinders University).

The samples and information collected on IN2021_T01 contributes to the growing datasets and will be supplemented by future voyage. These opportunities strengthen the quality of information gathered and allow the objectives of several projects to be addressed.

Voyage narrative

Friday 11th June 2021

1200 Pos: 26-34.8S 153-17.0E, Wind: SW @ 1-3 kts, Seas: SW @ 1 ft

Investigator departed Brisbane at 1820 10 June ahead of our planned ETD of 1300 12 June and proceeded to the outer anchorage off Brisbane to remain in port limits while we waited for full clearance to depart.

Saturday 12th June 2021

1200 Pos: 22-42.1S 154-10.3E, Wind: SE @ 7-10 kts, Seas: SE @ 1-2 ft

Investigator was continuing underway to our first 1000m CTD test site at noon yesterday. As per schedule however we arrived on station for the first CTD test cast at 0022 and the rosette was in the water at 0028. The instrument was taken to 1014m before recovery on deck at 0120. Underway sampling commenced.

Sunday 13th June 2021

1200 Pos: 20-29.8S 152-34.1E, Wind: SE @ 7-10 kts, Seas: SE @ 1-2 ft

Ship arrived on station at 1830 and the CTD was in the water at 1840. After going to a depth of 1060m it was recovered on board at 1936. Following the completion of water collection it was redeployed again at 2142 to a depth of 200m and was back on board at 2214. The first operational deployment of the Hydrobios multinet was started at 2306 with the instrument deployed out to 1000m at a tow speed of 1 kt for 3 hours.

Monday 14th June 2021

1200 Pos: 18-35.3S 149-32.0E, Wind: NNE @ 4-6 kts, Seas: NE @ 1-2 ft

Arrived for CTD station #2 at 0900. A quick survey was run to check that depths were greater than 1000m for the length of an intended 1nm Hydrobios net trawl. Ship was back on station at 1053 and the CTD was in the water at 1104. After reaching a depth of 1000m at 1126 the CTD rosette was back on deck for sampling at 1215. The ship was repositioned for a second cast to 200m. Water sampling was completed from the 1st cast and the rosette in the water again at 1400. A quick cast to 200m was completed, the CTD was back aboard at 1425 and we moved on to a Hydrobios net tow. The Hydrobios was deployed off the A-frame on the towed body wire at 1448 and went to a maximum wire out of 1365m during the tow at 1 kt. It was recovered on board at 1812 and we were underway a few minutes later to station 3 for a transit overnight.

Tuesday 15th June 2021

1200 Pos: 14-04.4S 146-05.2E, Wind: SE @ 11-16 kts, Seas: SE @ 2-3 ft

The CTD was in the water at 1748 and was recovered on deck at 1845 after reaching a depth of 1000m. We remained on station while sampling of the rosette was completed and at 2005 the rosette went back in for a 200m cast. Recovery on board came at 2030 and we set up course and speed for a Hydrobios tow. The Hydrobios was in the water at 2112 and was recovered at 0024 after a challenging 3 hour tow at 1 kt through the water.

Wednesday 16th June 2021

1200 Pos: 14-04.4S 146-05.2E, Wind: SE @ 11-16 kts, Seas: SE @ 2-3 ft

We spent the day in transit to Station 4, arriving at 2205 and the first CTD cast was in the water at 2228 for a cast to 2250m. The bottom of the cast was reached around 2310 and was back on deck at 0027. While sampling of the Niskin bottles was started we proceeded to launch the Hydrobios multitrawl at 0046. Following a three hour trawl the Hydrobios was back on deck at 0342. We repositioned back to the original CTD site for a 1000m CTD cast that was deployed at 0425. The CTD was back aboard at 0530 after reaching 1000m at 0445. As we got underway for the Dalrymple Island PBG we deployed a BGC ARGO float at 0548.

Thursday 17th June 2021

In transit.

Friday 18th June 2021

1200 Pos: 10-43.5S 141-06.4E, Wind: SE @ 11-16 kts, Seas: SE @ 1-2 ft

Investigator was transiting the Torres Strait under reef pilot assistance at noon yesterday. The transit was uneventful with the science and support staff finally getting some views of those tropical islands and reef-covered waters they'd been asking for since departure from Brisbane. The transit went well with good weather along the way and pilot disembarking at 1749. The ship continued on to West Cape York Marine Park targeting a high density, high resolution swath survey with the survey starting at 2340 and completed the following afternoon.

Saturday 19th June 2021

1200 Pos: 10-43.5S 141-06.4E, Wind: SE @ 11-16 kts ,Seas: SE @ 1-2 ft

Survey completed and back to the track line to nex arrive at Station 5, where a shallow CTD cast was conducted in preparation for a shallow hydro-bios cast which lasted just over 90 min in approx. 13 m of water.

Sunday 20th June 2021

We arrived at Station 6 at 2030 and the CTD was in ~50m of water at 2052 for a shallow cast and was back aboard at 2114. A Hydrobios multitrawl followed with the instrument deployed at 2133 for a two hour tow that was back on deck at 2328. We were underway a few minutes later at 2330 for Station 7.

Monday 21st June 2021

In transit.

Tuesday 22nd June 2021

1200 Pos: 10-47.1S 131-24.3E, Wind: E @ 11-16 kts, Seas: E @ 2-3 ft

Arrival at Station 7 this morning at 0830. CTD was in the water for a shallow cast in 60m of water at 0836 and it was back on board at 0854. The 7th and final Hydrobios multitrawl was deployed down

the ramp at 0913 and recovered on board at 1050. The deck was secured marking an end to science ops for the transit to Darwin.

Wednesday 23rd June 2021

Darwin arrival.

Outreach, education and communications activities

CSIRO and the Marine National Facility (MNF) are striving to increase access to STEM (science, technology, engineering, and mathematics) opportunities for Aboriginal and Torres Strait Islander students.

ITSS offers Aboriginal and Torres Strait Islander university students a unique opportunity to gain experience on a world-class marine research vessel, supporting Australia's atmospheric, oceanographic, biological and geoscience research from the tropics to the Antarctic ice-edge. ITSS brings students on board RV Investigator to work alongside scientists and technicians to assist with research and gain valuable at-sea research experience. ITSS supported two students on this voyage. They assisted in the underway sampling, CTD water sampling and cosmic ray data collection and analysis.

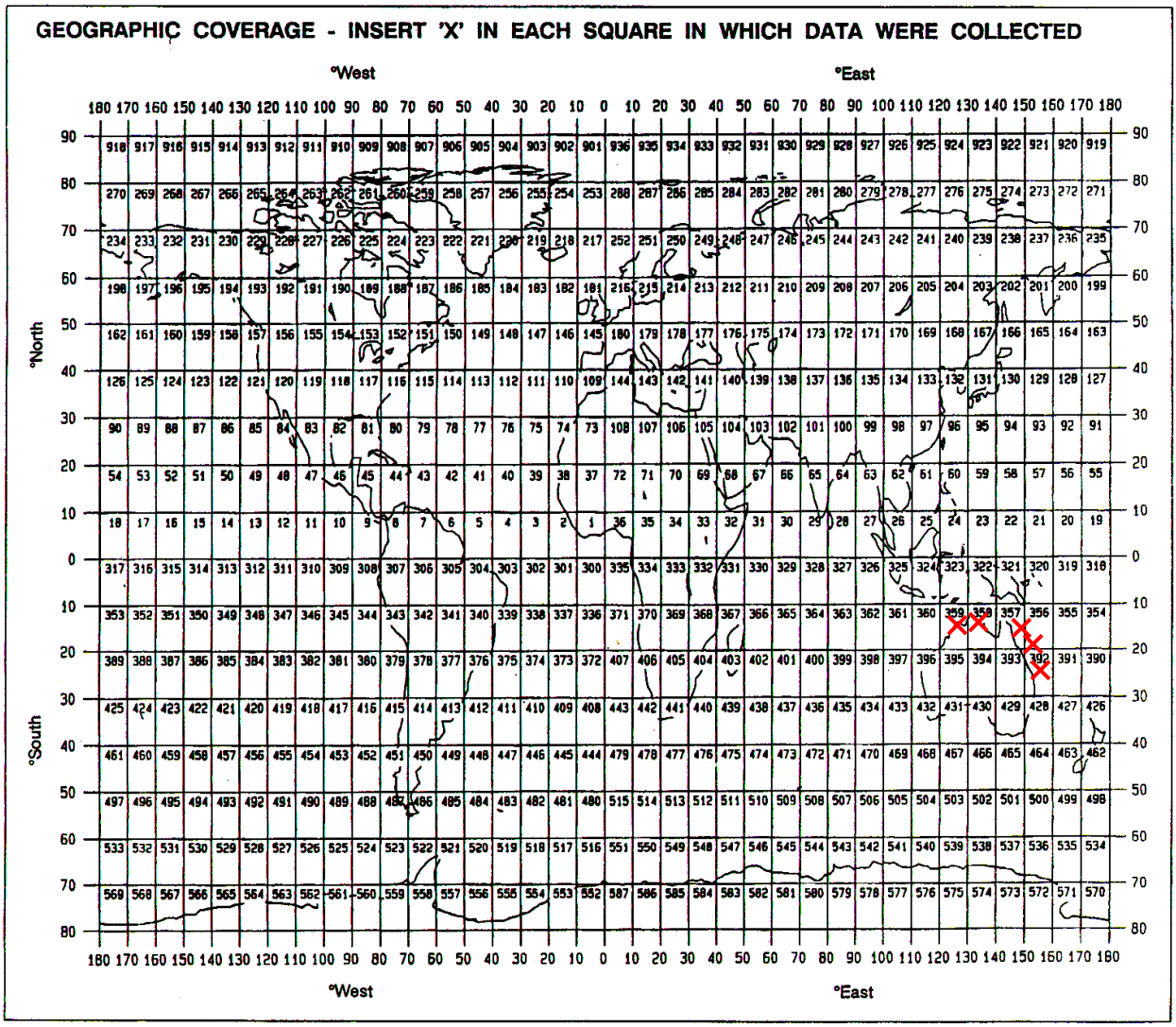
Summary

This was a challenging voyage due to the limitations imposed by COVID restriction prior to the voyage, but also due to the lockdown that left half of the scientific team on land, including two PIs and the Chief Scientist. Nevertheless, the voyage went ahead and it was a success thanks to the support from the MNF personnel and the collaboration within the scientific team onboard. The suppot provided by the two Indigenous Time at Sea Scholarship awardees facilitated the data acquisition for two projects for which the participants were unable to join the voyage.

Scientific objectives of the microplastics team were met and the process allowed for the fine tuning for opportunistic sampling on future voyages. The team should have further results within the next year.

All the scientific projects achieved their objectives regarding their sampling requests and opportunistic mapping was also conducted. Therefore, despite the difficulties encountered prior to the departure, the voyage provided valuable samples and informative data and it can be considered a success.

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				Identify, as appropriate, the nature of the instrumentation, the parameters measured, the number of instruments and their depths, whether deployed and/or recovered, dates of deployments and/or recovery, and any site identifiers.
		deg	min	N/S	deg	min	E/W		
BGC-Argo Float	Dr Tom Trull	12	29.6	S	145	7.5	E	D05	

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 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.
CTD casts	Dr Sophie Leterme	7 stations	Microplastics	H10, H09, B02, B08, B09, B11, B13, P13, P90	Microplastics will be extracted from plankton samples. Small microplastics will be extracted from the Niksin Bottle samples and where possible characterised under a microscope. These will then be identified using a combination of ATR-FTIR, Transmission FTIR and RAMAN Spectroscopy.
CTD casts	Dr Sophie Leterme	7 stations	Zooplankton	H10, H09, D71, B02, B08, B09	Zooplankton community identification. ADCP data will be paired with a growing dataset to develop a predictor model
Hydro-bios net	Dr Sophie Leterme	7 tows	Plankton and microplastics	B08, B09, B11, B13, P13, P90	Plankton samples collected for microplastics and zooplankton analyses
CTD casts	Dr Viena Puigcorbé	4 stations	Radionuclides	H10, H09, H16, H22, H24, H25, H76, H26, H31	Vertical profiles down to 1000 m, with continuous recording for salinity, oxygen, fluorescence, CDOM, density, transmissivity and discrete samples that were taken for later analyses on shore for ^{234}Th analyses
CTD casts	Dr Viena Puigcorbé	4 stations	Particles	H10, H09, H16, H22, H24, H25, H76, H26, H71	Vertical profiles down to 1000 m, with continuous recording for salinity, oxygen, fluorescence, CDOM, density, transmissivity and discrete samples that were taken for later analyses on shore for POC analyses
CTD casts	Dr Viena Puigcorbé	4 stations	Bacteria	H10, H09, H16, H22, H24, H25, H76, H26, B07	Vertical profiles down to 1000 m, with continuous recording for salinity, oxygen, fluorescence, CDOM, density, transmissivity. Discrete samples that were taken for later analyses on shore for bacterial community analyses
Surface water intake measurments	Dr Allison McInnes	36 samples	Phytoplankon	B08	Samples collected from the underway system for Flow Cytometry. Analyses to be conducted on shore
Surface water intake measurments	Craig Neill	20 samples	DIC and TA	H21 & H27	Samples collected from the underway system for dissolved inorganic carbon (DIC) and total alkalinity (TA) measurements. Analyses conducted on shore

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 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.
2021-05-03_11_29_GCR000_DSQ3_BNE-DRW_RVI	Dr Grahame Rosolen	14 days	Counts vs time	M90	Cosmic ray detector located in the Aerosol laboratory with the detector element mounted horizontally.
2021-06-10_18_13_GCR002_DSQ2_BNE-DRW_RVI	Dr Grahame Rosolen	13 days	Counts vs time	M90	Cosmic ray detector located in the whale watching area on level 7 with the detector element mounted horizontally on the detector seat bracket.
2021-06-11_11_48_GCR003_DSQ4_BNE-DRW_RVI	Dr Grahame Rosolen	12 days	Counts vs time	M90	Cosmic ray detector located in cabin 113 on level 7 with the detector element placed horizontally on the porthole shelf.
CTD casts	Dr Matt Gordon	24 samples	eDNA filters	H09, H10 B08 & B09	The self preserving eDNA filters allow species present in the plankton to be identified from 'trace amounts' of their DNA. Vertical stratification of samples between 5 and 200 m collected at 5 stations.
CTD casts	Dr Matt Gordon	3 samples	Plankton samples	H09, H10 B08 & B09	Plankton is traditionally identified using light microscopy. These samples are water samples that have been preserved in Lugols Solution so that species can be identified using their morphology. Collected at 5 m depth at 3 stations
UBAT	Dr Matt Gordon	4 profiles	UBAT profile	H17, H10	The UBAT (Underwater Bioluminescence Assessment Tool) quantifies the amount of bioluminescence found within the water it filters. Vertical profile of samples between 5 and 200 m. Data obtained at 4 stations

Curation Report

Item #	Description	Storage	Access	Custodian
1.	Th-234	Destructive analyses	Through peer-review publication or contacting the custodian	Viena Puigcorbé
2.	POC	Destructive analyses	Through peer-review publication or contacting the custodian	Viena Puigcorbé
3.	Bacterial communities	Destructive analyses	Through peer-review publication or contacting the custodian	Viena Puigcorbé
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				

Track Chart

Figure 7 : Track for IN2021_T01, transit from Brisbane to Darwin

Acknowledgements

All the scientific teams would like to acknowledge the ITSS recipients for their support with sample collection, particularly for those participants that we not able to join the voyage. The scientific party is also grateful to MNF personnel on board and to those that helped with the voyage preparation, as well as all the crew of R/V Investigator.

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ECU School of Science and ECU foundation provided funds for Dr Puigcorbé's project and Tom Trull (CSIRO) and Peter Strutton (UTAS-IMAS) facilitated material to conduct their sampling.

Signature

Your name:	Viena Puigcorbé
Title:	Chief Scientist
Signature:	
Date:	20 August 2021

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 (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

	MARINE BIOLOGY/FISHERIES
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

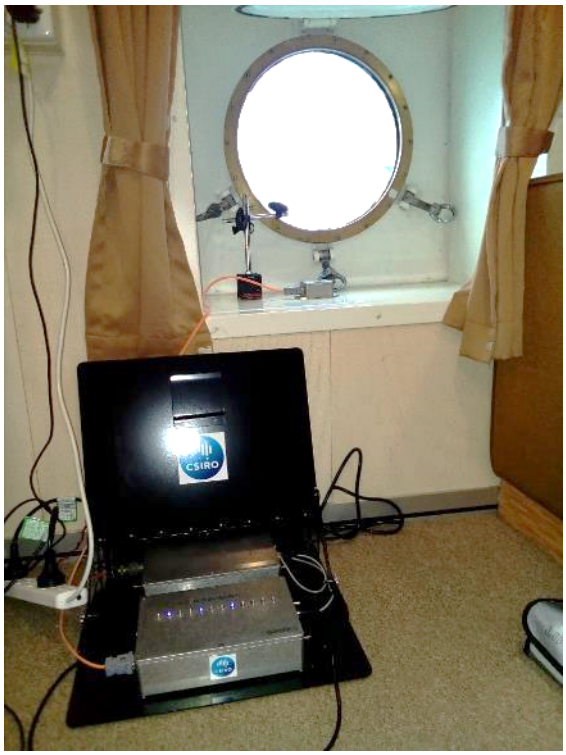
	MARINE GEOLOGY/GEOPHYSICS
G01	Dredge
G02	Grab

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

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

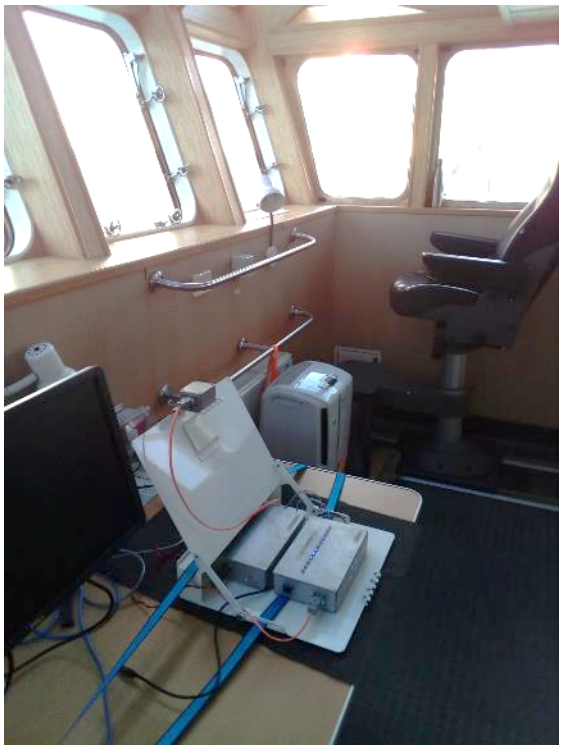
	MARINE CONTAMINANTS/POLLUTION
P01	Suspended matter
P02	Trace metals
P03	Petroleum residues
P04	Chlorinated hydrocarbons
P05	Other dissolved substances
P12	Bottom deposits
P13	Contaminants in organisms
P90	Other contaminant measurements

Appendix B – Photographs

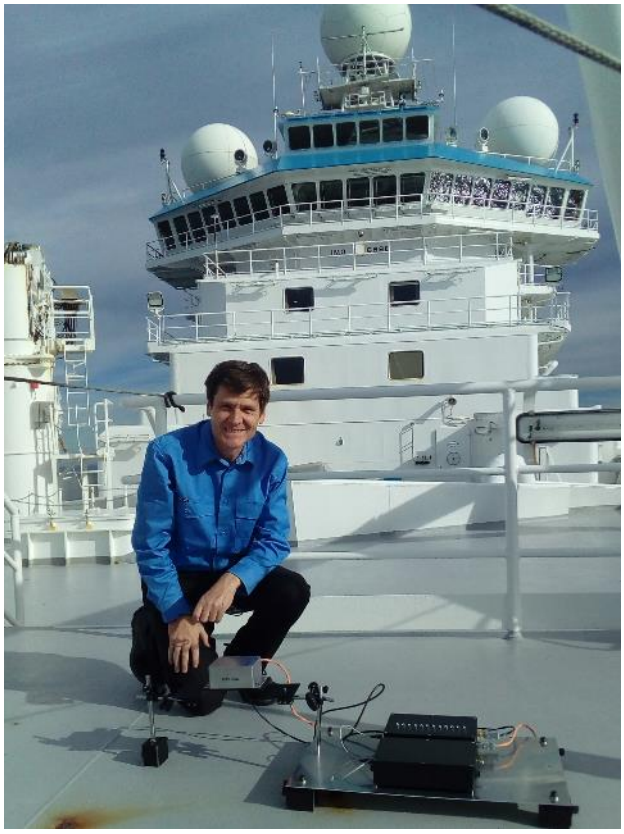


Cosmic ray detector located in cabin (Photo: G.Rosolen)

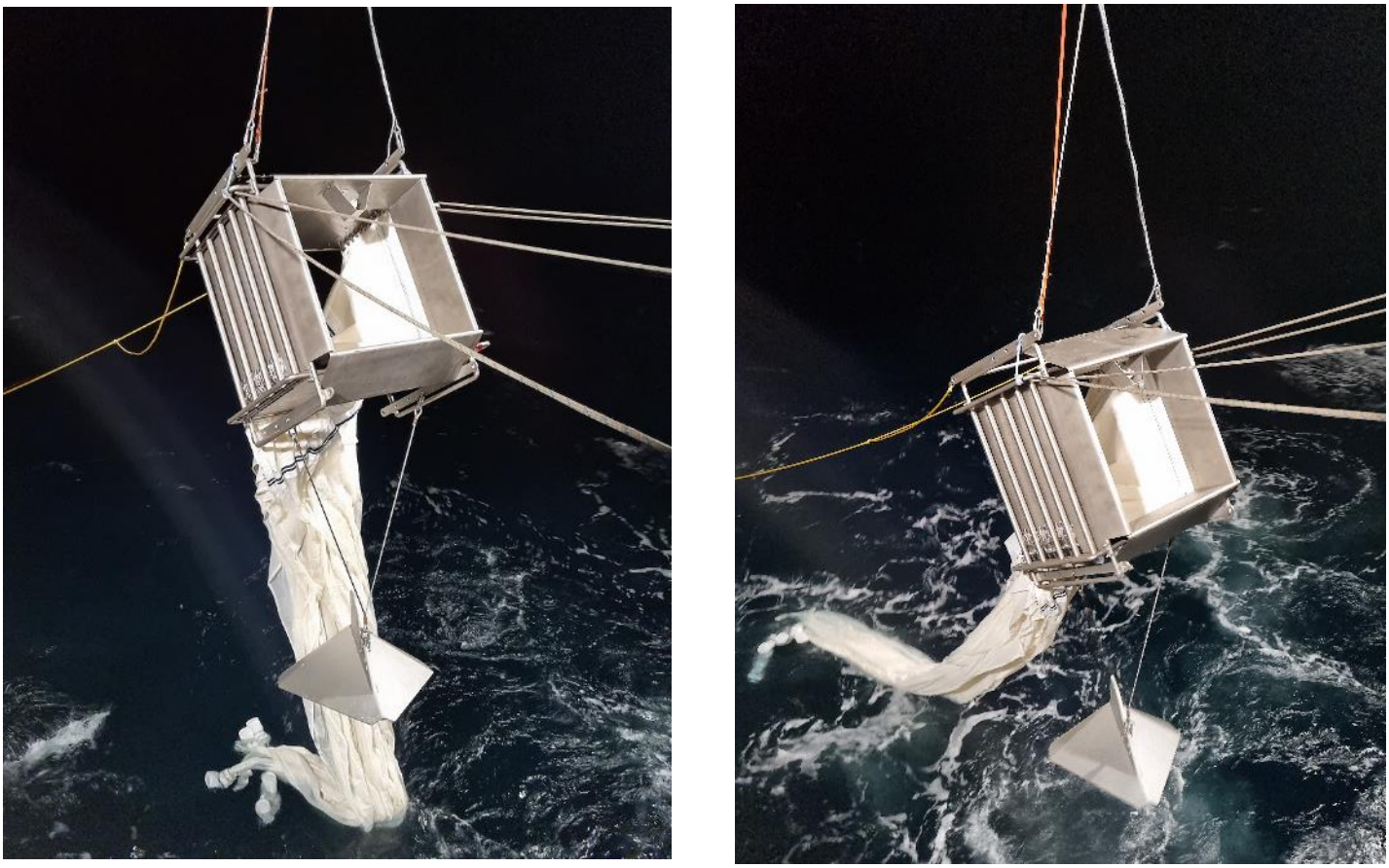
.



Cosmic ray detector located in the whale watching area (Photo: G.Rosolen)

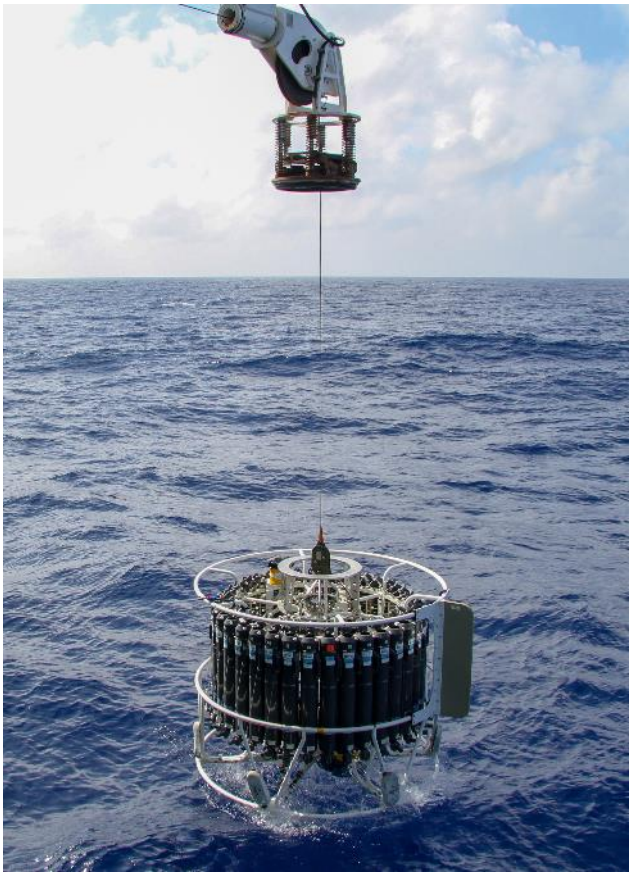


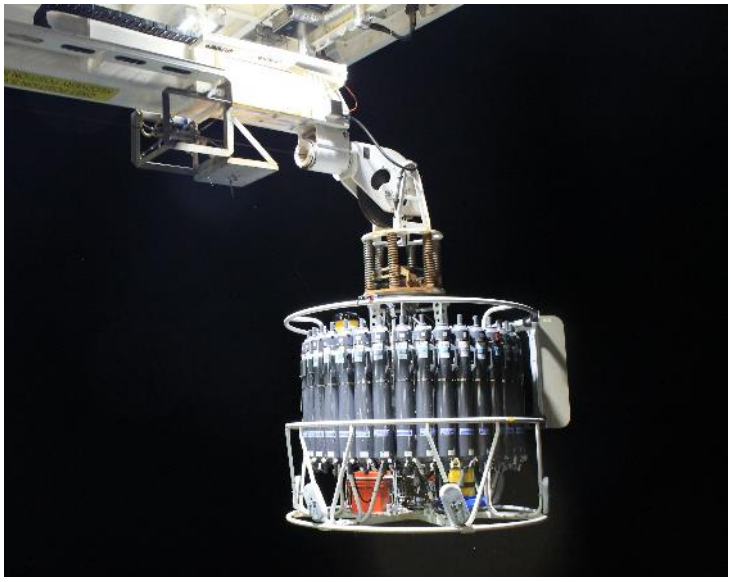
Dr Grahame Rosolen with a cosmic ray detector on the deck of the RV Investigator (Photo: G.Rosolen)

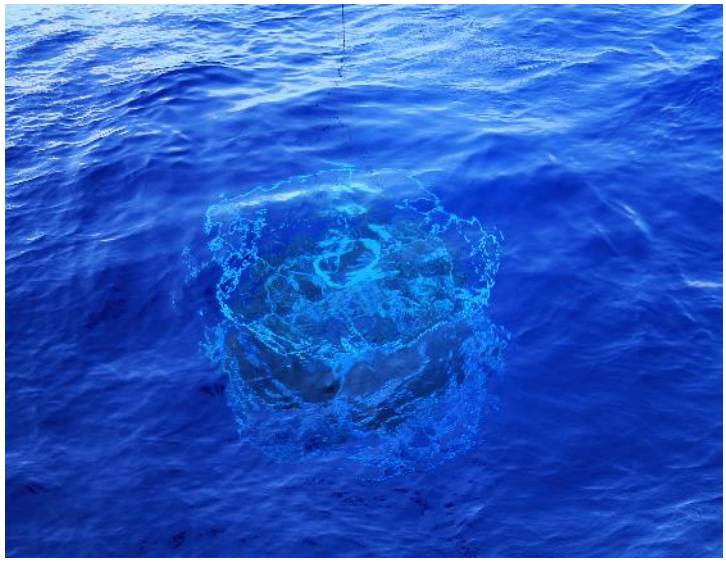


Hydro-bios net being deployed at the stern of the RV Investigator. (Photo: CSIRO)

Example of organisms collected using the Hydro-bios net. (Photo: Woody Drummond)







CTD rosette during deployment in the Coral Sea.
(Photo: Woody Drummond)

Woody Drummond of Finders University collecting a water sample from a Niksin Bottle (Photo: CSIRO)