MNF Voyage Highlights and Summary

NOTE - The Chief Scientist should send the Voyage Highlights and Summary Report to the MNF Voyage Delivery Coordinator within 40 business days of the completion of the voyage. The Voyage Highlights and Summary needs to be submitted electronically as a Microsoft Word document so we can align formatting across all reports. **All guidance text in blue should be deleted**.

The below details can be copied from the first page of the Voyage Plan:

Voyage #:	IN2025_V02
Voyage title:	**SOTS:** Southern Ocean Time Series automated moorings for climate and carbon cycle studies southwest of Tasmania
Mobilisation:	Hobart, Monday, 24 March to Tuesday, 25 March 2025
Depart:	Hobart, (Time TBD) Wednesday, 26 March 2025
Return:	Hobart, (Time TBD) Wednesday, 16 April 2025
Demobilisation:	Hobart, Thursday, 17 April to Friday 18 April 2025
Voyage Manager:	Margot Hind
Chief Scientist:	Elizabeth Shadwick
Affiliation:	CSIRO
Principal Investigators:	Ben Scoulding
Project name:	Monitoring the recovery of a globally unique deep-sea eel aggregation in the Huon Marine Park
Affiliation:	CSIRO
ORCID iD:	
Principal Investigators:	Philippe Vandenbossche
Project name:	Evolution of the Seafloor of the Australian-Antarctic Southern Ocean
Affiliation:	CSIRO
ORCID iD:	
Principal Investigators:	Alain Protat
Project name:	Southern Ocean Winter Cloud Interactions processes (SOWCLIP)
Affiliation:	BoM
ORCID iD:	
Principal Investigators:	Pete Jansen
Project name:	Profiling Echosounder
Affiliation:	CSIRO

ORCID iD:	
Principal Investigators:	Andrew Bowie
Project name:	Natural Iron Fertilisation of the Southern Ocean: Linking terrestrial dust and bushfires to marine biogeochemistry
Affiliation:	Utas
ORCID iD:	
Principal Investigators:	George Rowland
Project name:	Quantifying Dust Fluxes in the Southern Ocean Time Series using Thorium Isotopes in Seawater
Affiliation:	UTas
ORCID iD:	

Voyage Highlights

The Chief Scientist

Dr Elizabeth Shadwick is a marine biogeochemist and a Principal Research Scientist at CSIRO. Elizabeth completed a PhD in Chemical Oceanography in 2010 at Dalhousie University in Canada, and a post-doctoral fellowship at the Antarctic Climate and Ecosystems Cooperative Research Centre in Hobart. She then moved to the Virginia Institute of Marine Science as an Assistant Professor and joined CSIRO in 2018. Elizabeth's research has focused on air-sea exchange, the marine carbon system, and ocean acidification across many environments from the North Atlantic, to the Arctic, to the Southern Ocean. Her research relies on autonomous sensors deployed on moorings, shipboard observations, and laboratory analyses. Elizabeth Co-Leads the IMOS Southern Ocean Time Series Facility and the Biogeochemistry Project Australian Antarctic Program Partnership (AAPP).

Title

SOTS: Southern Ocean Time Series automated moorings for climate and carbon cycle studies southwest of Tasmania

Purpose

The Southern Ocean Time Series project deployed a new set of moorings and recovered the existing moorings. The SAZ sediment trap mooring collects samples to quantify the production and transfer of carbon and other nutrients to the ocean interior by sinking particles, and investigate their ecological controls. The Southern Ocean Flux Station (SOFS) mooring measures meteorological and ocean properties important to air-sea exchanges, ocean stratification, waves, currents, biological productivity and ecosystem structure. In addition, water samples were collected for more detailed investigations of nutrient and plankton characteristics, and their contributions to CO2 uptake by the ocean.

Contribution to the nation

The SOTS research improves understanding of the global climate system by focussing on a key region –the Southern Ocean. Careful sustained observations over the last decade and into the next increases our knowledge of how the ocean interacts with the atmosphere. Improved understanding is essential to enhance advice to the nation on climate variability affecting us now, develop future scenarios and impact assessments, and to make optimal decisions that will affect the nation's future. The work also directly addresses the issue of how ocean biogeochemistry and productivity respond to ocean dynamics, which is an important input to projecting future biogeochemical and ecosystem states. In addition, enhanced understanding of process occurring in the region related to clouds, ocean mixing, waves and rain will also lead to improved forecasts and warnings issued to the public.

As a result of this voyage, we have re-deployed the Southern Ocean Time Series moored platforms to provide an integrated and ongoing assessment of the seasonality of the processes that control air-sea exchanges important to climate, and upper ocean processes important to Subantarctic productivity. This analysis extends from the physics of ocean mixing and insolation, to the chemistry of ocean nutrients and the biological responses of phytoplankton, zooplankton and fish. Many of the observations are available in real-time via the internet (www.imos.org.au). .

As a result of this voyage

We have sustained the longest time series of Southern Ocean observations operated by any nation, contributing to the global effort to understand ocean dynamics and their role in climate and responses to anthropogenic emissions. This work is part of the OceanSITES global array of time series observations (www.OceanSITES.org) which is a network within the United Nations mandated Global Ocean Observing System (https://www.goosocean.org/) .

Next steps

Sensor records from the moored instruments will now go through careful quality control procedures and then be made freely available via the Australian Ocean Data Network (https://portal.aodn.org.au/). Readers interested in future outputs as a result of the voyage, can find all the data via this portal. Scientific outputs based on the data are produced by researchers from multiple agencies within Australia and around the world, and are compiled by the Integrated Marine Observing System and showcased via their Impact Database (http://imos.org.au/news/impact-database).

Voyage Summary

Executive summary

Scientific objectives

Southern Ocean Time Series (SOTS)

The Southern Ocean has a predominant role in the movement of heat and carbon dioxide into the ocean interior moderating Earth's average surface climate. The IMOS SOTS sub-facility uses a set of two automated moorings to measure these processes under extreme conditions, where they are most intense and have been least studied. The atmosphere-ocean exchanges occur on many timescales, from daily insolation cycles to ocean basin decadal oscillations and thus high frequency observations sustained over many years are required. The current context of anthropogenic forcing of rapid climate change adds urgency to the work.

Monitoring the recovery of a globally unique deep-sea eel aggregation in the Huon Marine Park

The Huon MP has been identified as the only known location of a spawning aggregation of the basketwork eel, Diastobranchus capensis – a globally distributed and ecologically important deep-sea species. In the austral autumn, the spawning aggregation is large and likely the regional-scale spatial anchor for the species. As such it represents a key natural value in Australia – one with a hypothesised trajectory of 'improving status' following decades long impact from bottom trawling before the Huon MP was established.

Evolution of the Seafloor of the Australian-Antarctic Southern Ocean

Areas to the west and south of the SOTS site are unmapped; extending the seafloor mapping coverage in the region will provide valuable new bathymetry data that will be used to analyse the seafloor morphology and tectonic fabric (and contribute to the International Seabed 2030 initiative).

No physical rock dating is known to exist to the south of the SOTS study area; magnetic data will provide valuable indicative ages of the seafloor crust across the region (to cover an anticipated seafloor age range of ~24 Ma to 10 Ma).

Southern Ocean Winter Cloud Interactions processes (SOWCLIP)

Cloud microphysical properties produced from the competition between supercooled liquid and ice particles for water vapour in subfreezing cumulus clouds over the Southern Ocean and off the coast of Antarctica have been directly linked to errors in absorbed solar radiation at the sea surface, which have been further linked to uncertainty in predicting global climate sensitivity under CO_2 warming and sea surface temperature biases in climate models.

Profiling Echosounder

Mesopelagic micronekton are increasingly appreciated as playing pivotal roles in ocean ecosystems but also remain a key area of uncertainty in current understanding of ocean ecosystem structure and function, with current global biomass estimates varying by a factor of 10 (1-18 Gt), due to a lack of information globally. Here we aim to address this knowledge gap by integrating commercially available, battery-powered, broadband, multi-channel echosounders into profiling floats, equivalent to Argo floats.

Natural Iron Fertilisation of the Southern Ocean: Linking terrestrial dust and bushfires to marine biogeochemistry

Shipboard observational data acquired in this project on the trace element composition of aerosol particles will be combined with ongoing land-based time-series measurements led by the Project PI, to support research to quantify the importance of the deposition of iron-rich aerosols from Australia into surface ocean waters and how they impact marine biogeochemistry and ocean ecosystem health.

Quantifying Dust Fluxes in the Southern Ocean Time Series using Thorium Isotopes in Seawater

This project aims to quantify the flux of mineral dust and associated nutrients supplied to the Southern Ocean using measurements of thorium in seawater. One isotope (^{232}Th) traces dust, while another (^{230}Th) is a time-keeper. The data will be used to assess agreement between different methods of dust flux estimation, including sediment traps and dust deposition models (which are associated with large uncertainties).

Voyage objectives

Southern Ocean Time Series (SOTS)

The primary objective is to first deploy a new set of SOTS moorings (SOFS-14 and SAZ-27) and then recover the existing SOTS moorings (SOFS-13, and SAZ-26). Each of the SOTS moorings delivers to specific aspects of the atmosphere-ocean exchanges:

- the SAZ sediment trap mooring collects samples to quantify the transfer of carbon and other nutrients to the ocean interior by sinking particles and investigate their ecological controls.
- the Southern Ocean Flux Station (SOFS) mooring measures meteorological and ocean properties important to air-sea exchanges, ocean stratification, waves, currents and biological productivity and ecosystem structure. Water samples are collected for more detailed nutrient and plankton investigations after recovery.

Ancillary work will obtain supporting information on atmospheric and oceanographic conditions using CTD casts, and underway measurements.

1. Deploy SOFS-14 meteorology/biogeochemistry mooring
2. Deploy SAZ-27 sediment trap mooring
3. Recover SOFS-13 meteorology/biogeochemistry mooring
4. Recover SAZ-26 sediment trap mooring
5. CTD sampling (3 cast to 4550m, 2 to 600m) at the SOTS site, including collecting samples for nutrients, oxygen, dissolved inorganic carbon, alkalinity, and eDNA analyses
6. Ship meteorological observations at SOFS buoys for comparisons
7. Deployment of BGC-Argo Float (with additional UVP sensor recently refurbished after the SOLACE float was recovered).
8. Recovery of ACC-SWOT mooring at 55S site (deployed on the FOCUS IN2023_V07 voyage).
9. Deployment of BoM drifters at site of ACC-SWOT mooring recovery; CTD cast for post-calibration of recovered sensors.
10. Carry out underway air and water sampling and sensor measurements, including bio-optics and bio-acoustics

Monitoring the recovery of a globally unique deep-sea eel aggregation in the Huon Marine Park

1. Acoustic data will be collected following IMOS protocols with the vessel travelling at 10 knots along transects crossing the Patience Seamount. Acoustic data will be collected using the RVIs hull mounted EK80 echosounders, operating at 18 and 38 kHz only.
2. Perform towed camera transects to further explore any features identified in the acoustic measurements.

Evolution of the Seafloor of the Australian-Antarctic Southern Ocean

1. Acquire towed magnetometer data between ~47.3°S, 143.78°E and ~51.7°S, 145.4°E. This will cover an estimated seafloor age range of ~24 Ma to 10 Ma.
2. Acquire multibeam bathymetry data in areas previously unmapped. Areas to primarily target lie to the west and south of the SOTS site.

Southern Ocean Winter Cloud Interactions processes (SOWCLIP)

1. Collect a suite of aerosol, cloud, surface radiation and precipitation observations.
2. Launch radiosondes with an expected frequency of twice a day.
3. Collect cloud radar – lidar and precipitation observations under the European Space Agency EarthCARE mission satellite track.

Profiling Echosounder

1. Deployment and recovery of profiling echo sounder, attached to profiling float.

Natural Iron Fertilisation of the Southern Ocean: Linking terrestrial dust and bushfires to marine biogeochemistry

1. Install an aerosol sampling system for the clean collection of particles in the ship's aerosol lab.
2. Collect samples on Whatman-41 filters
3. Opportunistically collect event-based clean rainwater samples

Quantifying Dust Fluxes in the Southern Ocean Time Series using Thorium Isotopes in Seawater

1. Analyse 5–10 L of seawater per sample collected from the CTD rosette, quantifying dust fluxes through the whole water column, with a particular focus on resolving details in the upper ocean.

Results

For each objective, state the degree of success. Elaborate on unexpected discoveries. Include a succinct presentation of preliminary data that clearly illustrates a discovery. You may also include any problems (e.g., with equipment, weather etc.) encountered which had a significant impact on your ability to achieve the voyage objectives. Include appropriate context of the issue readers can clearly understand what went wrong and why. Please note that any other problems you may have experienced should be detailed in the Chief Scientist's Operational Report.

Southern Ocean Time Series (SOTS)

All objectives were achieved. The existing SOFS-13 and SAZ-26 moorings were recovered and replaced by the new SOFS-14 and SAZ-27 moorings which are scheduled to be recovered in May 2026. The CTDs were also completed to support moored sensor interpretations. The ship-SOFS meteorological comparisons were performed. The ACC-SWOT mooring was recovered. Four drifters and an Argo glider were deployed.

Deployed Mooring Locations	Latitude	Longitude	Depth
SOFS-14	**46.97297° S**	**141.35444° E**	**4645.7 m**
SAZ-27	**46.82555° S**	**141.65668° E**	**4602.3m**

We now have sufficient water samples (from the McLane RAS-500 unit located in the SOFS float, Fig. 1) to construct climatological seasonal cycles of the phytoplankton community composition (Fig. 2). This seasonality includes both the calcifying and non-calcifying populations, identified by scanning electron (Fig. 3), and light, microscopy, respectively.

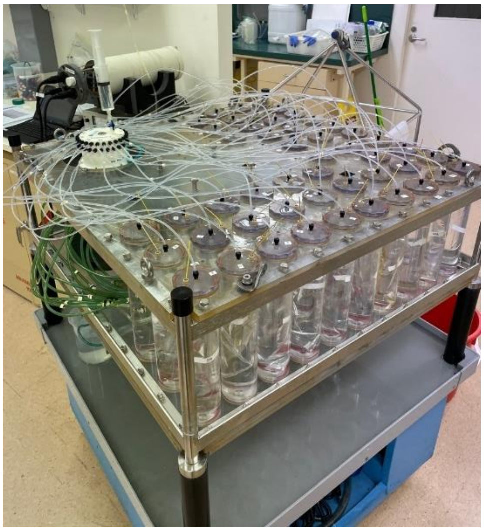


Figure 1: the McLane RAS-500 water sampler is prepared in the laboratory at CSIRO before installation in the SOFS-14 float. There are 48 acrylic tubes that contain 500mL sample bags which are collected with roughly fortnightly resolution over a 12-month deployment at the SOTS site.

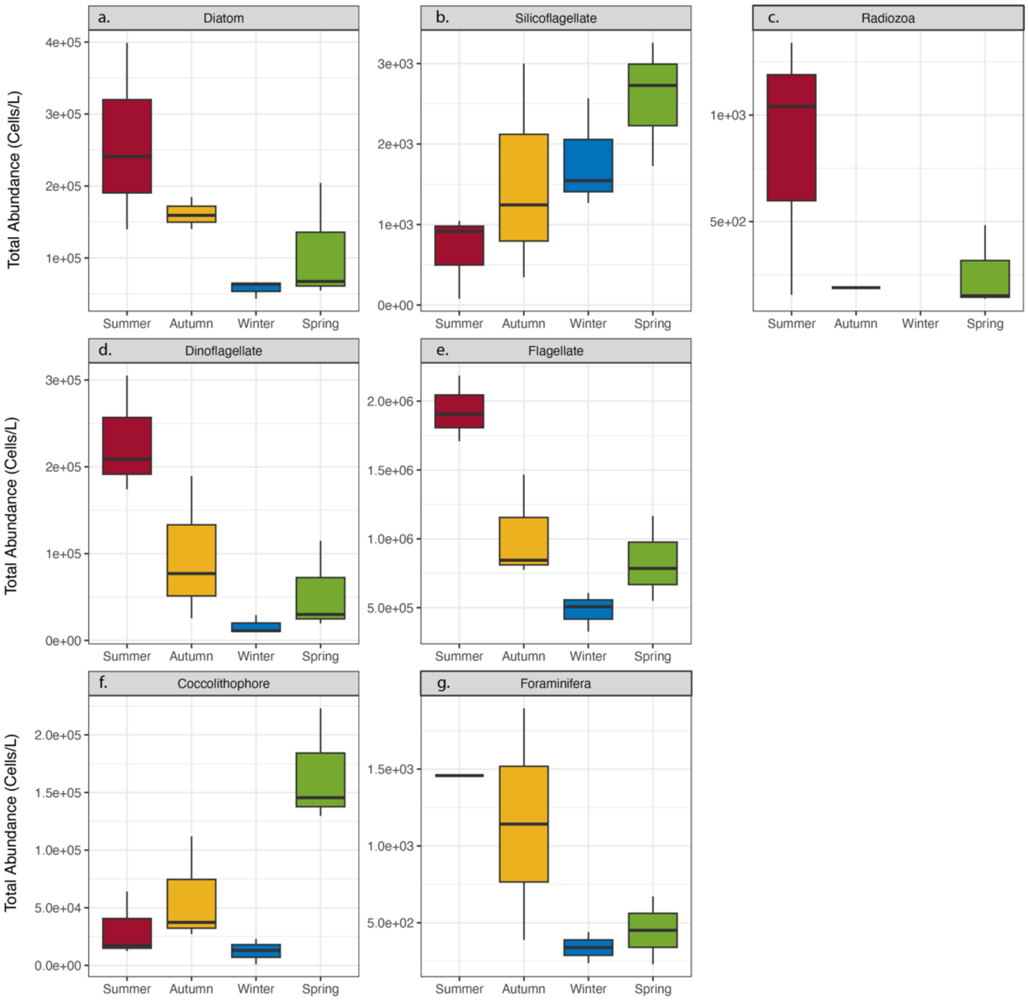


Figure 2: Climatological seasonal cycles of the dominant micro-plankton taxa at the SOTS site. Top row: silicifiers including a) diatoms, b) silicoflagellates and c) radiozoa; middle row: flagellate taxa including d) dinoflagellates and e) flagellates; and bottom row: calcifying taxa including f) coccolithophores and g) foraminifera.

All major phytoplankton groups are present throughout the year (Fig. 2), with subtle shifts in composition likely tied to the distinct stages in the development of the mixed-layer. Deep mixing and associated light limitation are associated with relatively low abundances in spring. Mixed layer shoaling in summer, before the onset of nutrient limitation is associated with peak abundances, while an extended period of stratification in summer and early autumn is associated with abundances that are still elevated, relative to the winter season minima. It is interesting to note that the silicoflagellates do not mimic the diatom seasonality. Note that the total abundances of the silicoflagellates are low, typically 2 orders of magnitude lower than that of the total diatoms; the diatoms possibly outcompete the silicoflagellates for available silica in summer, contributing to their low abundances.

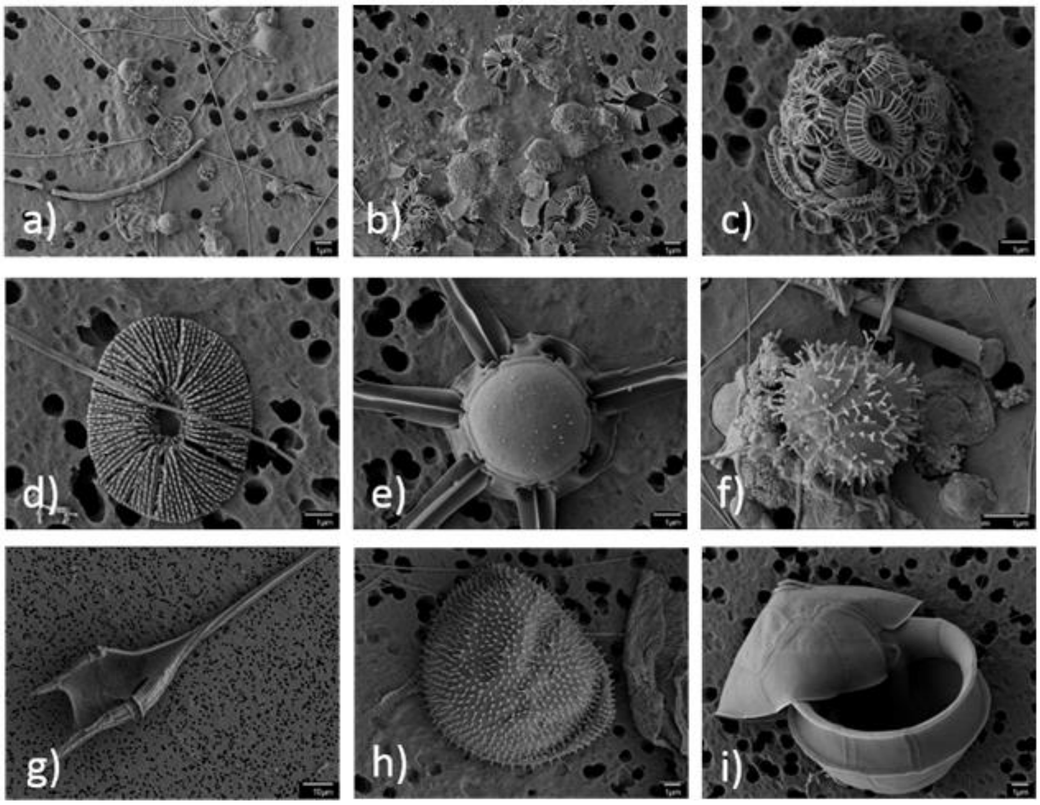


Figure 3: Scanning Electron Microscopy (SEM) images showing a range of taxonomic groups. a) flagellate form of *Phaeocystis antarctica* with characteristic star array; b) collapsed coccolithophorid cell including both heterococcolith and halococccoliths; c) calcification morphotype B/C for *Emiliania huxleyi*; d) individual lith of calcifying species *Umbellosphaera tenuis*; e) siliceous *Corethron pennatum* (diatom); f) siliceous *Triparma strigata* (parmales); g) dinoflagellate *Tripos lineatus*; h) dinoflagellate *Prorocentrum cf compressum;* and i) dinoflagellate *Scripsiella trochidea*.

Monitoring the recovery of a globally unique deep-sea eel aggregation in the Huon Marine Park

Acoustic data was collected along the planned transects across the Patience Seamount (Fig. 4) and a possible aggregation of eels identified to the northwest.

Two towed camera runs were performed along transect 10 with a number of eels identified (Fig. 5)

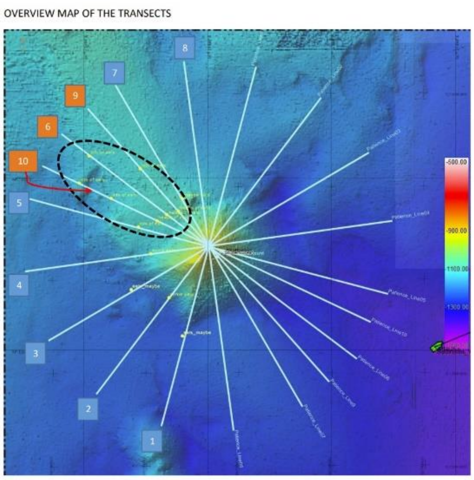


Figure 4: Transects across Patience Seamount.

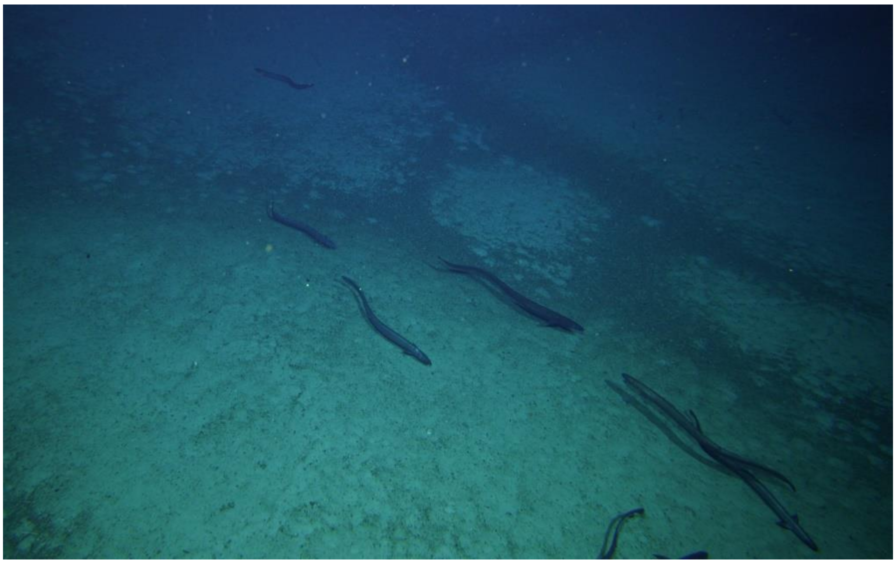


Figure 5: Eels identified by the towed camera at the Patience Seamount.

Evolution of the Seafloor of the Australian-Antarctic Southern Ocean

The piggyback primary objective of acquiring magnetometer data along a pre-defined transect was successfully completed. A total of 274 nautical miles (or ~507 km) of magnetic data were collected along the planned route (including a run in), spanning from ~47.3°S, 143.78°E to ~51.7°S, 145.4°E (Fig. 6). The efforts of the Chief Scientist, Voyage Manager, and Crew were instrumental in achieving this successful outcome, and their contributions are greatly appreciated.

Given the favourable sea conditions upon arrival at SOTS, the primary focus was naturally aimed at deploying, recovering and monitoring the moorings. There was limited opportunity to travel further afield to conduct additional mapping. However, since this was a secondary objective of the piggyback project, it does not negatively affect the overall progress of the project.

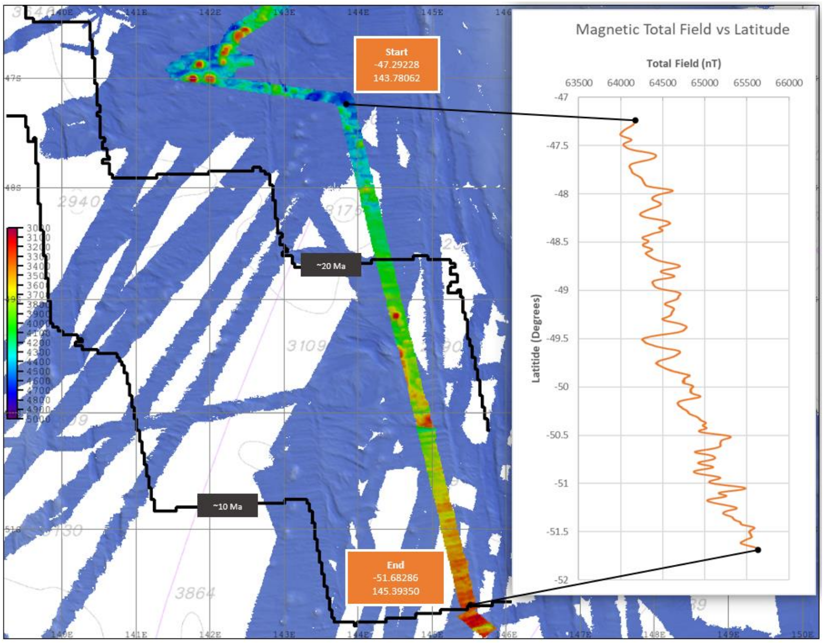


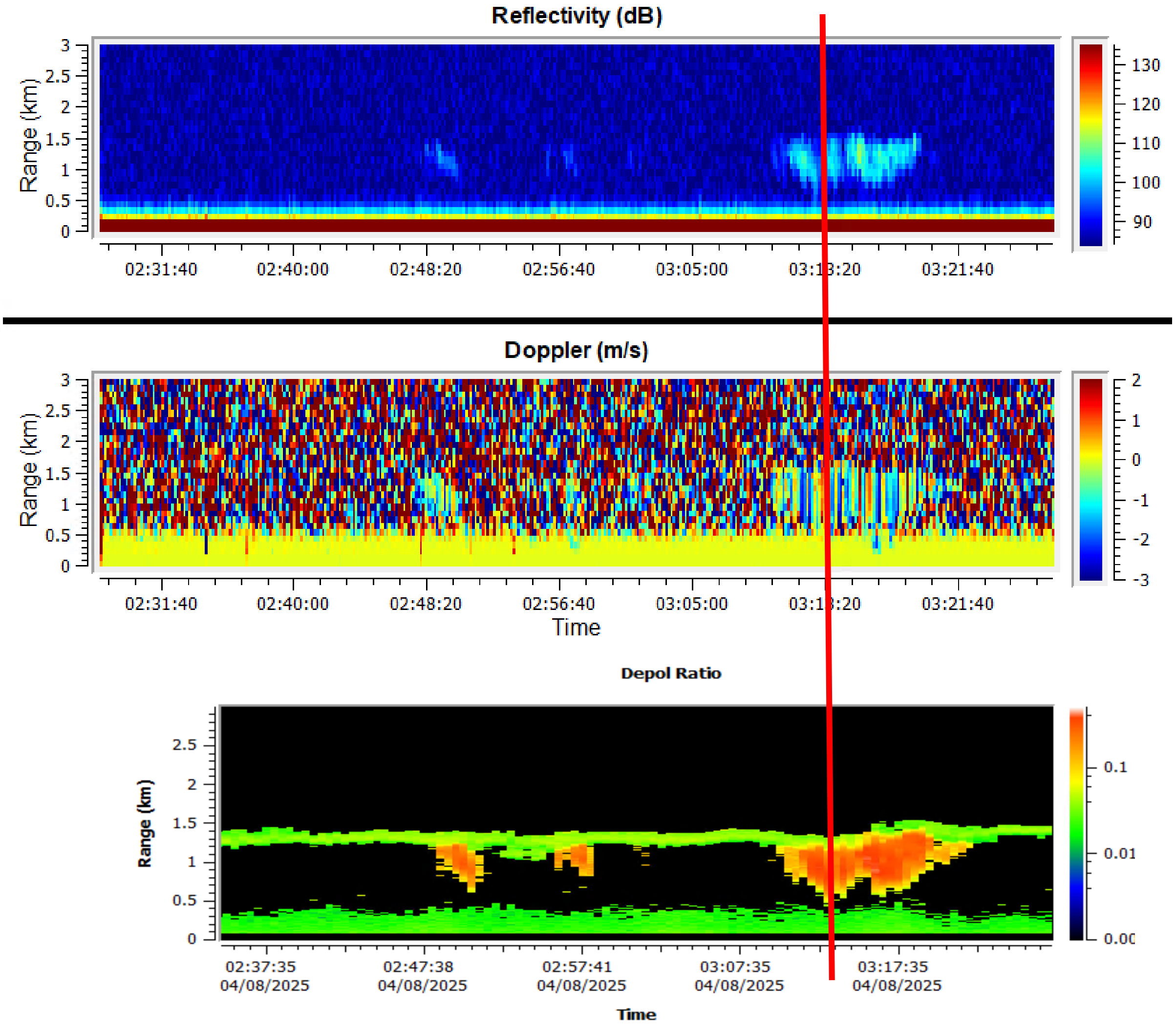
Figure 6: Magnetometer transect completed on IN2025_V02 (~500 km). Main map shows the multibeam bathymetry coverage along the route, and inset shows the preliminary magnetic Total Field data (orange graph)

Southern Ocean Winter Cloud Interactions processes (SOWCLIP)

The SOWCLIP project included collecting aerosol, cloud and precipitation data to better understand the interactions between these atmospheric components and the resulting impact on downwelling surface radiation, which is a major source of error in climate models. Weather balloons were also regularly launched (between 2 and 3 per day) to capture the atmospheric conditions conducive to cloud and precipitation.

The remote sensing instruments have all collected data nearly continuously with very little outages. This includes the BOM cloud radar, BOM RMAN 355nm lidar, the University of Melbourne mini MPL lidar, and the University of Utah 2-channel microwave radiometer, the MNF micro rain radar (MRR-PRO), the MNF ODM disdrometer on the mast, and the MNF C-band weather radar (OceanPOL). A total of 42 radiosondes were successfully launched.

A highlight of the voyage for SOWCLIP was the successful collection of data right under the European Space Agency EarthCARE satellite track in two occasions (08/04 and 10/04). This satellite carries a 95 GHz cloud radar and a multi-frequency lidar similar to what was deployed on RV Investigator. To our knowledge, these are the very first observations collected from a research vessel under the EarthCARE track. Figure (7) shows (from top to bottom) the RV Investigator cloud radar reflectivity, Doppler velocity, and lidar depolarisation ratio (with green values indicating liquid and orange indicating ice), and the EarthCARE cloud radar reflectivity and Doppler velocity along the satellite track. The red line indicates the approximate time of overpass. All these observations are raw data and will need to undergo significant post-processing before quantitative comparisons can be made. This type of clouds (stratocumulus clouds with a liquid top producing ice precipitation) is very typical of the Southern Ocean cloud population and is the type of clouds thought to be inaccurately represented in climate models, causing the downwelling surface shortwave radiation bias.


Reflectivity (dB)
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130
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Range (km)
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Time

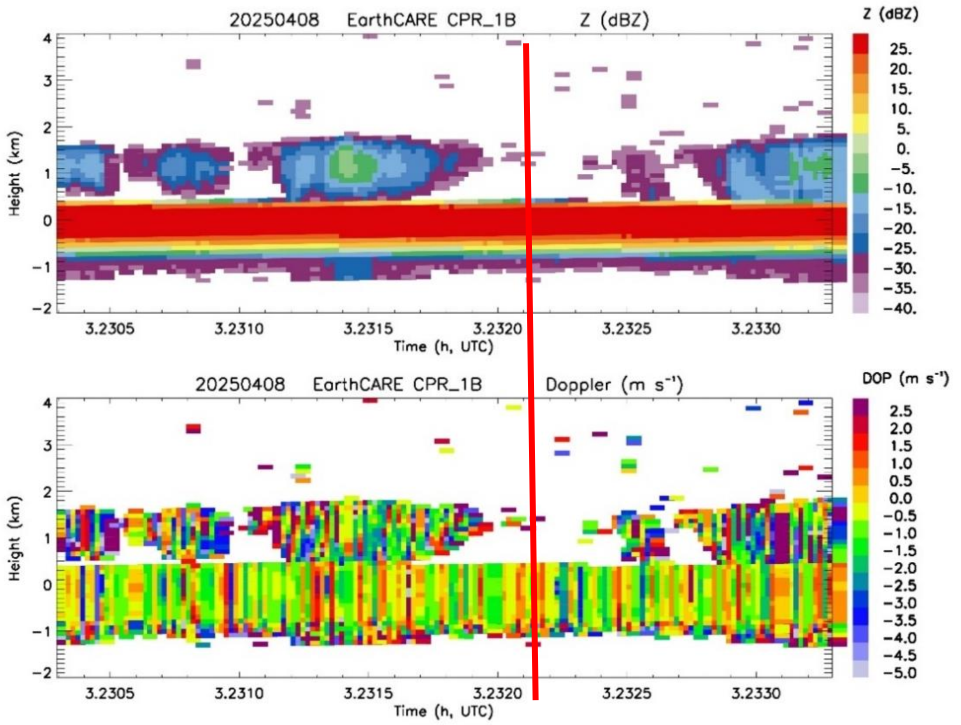

20250408 EarthCARE CPR_1B Z (dBZ)
Z (dBZ)
Height (km)
Time (h, UTC)
20250408 EarthCARE CPR_1B Doppler (m s⁻¹)
DOP (m s⁻¹)
Height (km)
Time (h, UTC)

Figure 7: shows (from top to bottom) the RV Investigator cloud radar reflectivity, Doppler velocity, and lidar depolarisation ratio (with green values indicating liquid and orange indicating ice), and the EarthCARE cloud radar reflectivity and Doppler velocity along the satellite track. The red line indicates the approximate time of overpass.

Profiling Echosounder

This project did not proceed due to unprepared science team equipment.

Natural Iron Fertilisation of the Southern Ocean: Linking terrestrial dust and bushfires to marine biogeochemistry

Aerosol particle filtering commenced during the transit to the SOTS region on 26/03 (43.9°S, 147.3°E). An initial problem with the aerosol collection sector control was solved, and the system functional by 04:46. Four sets of two filter papers were collected during the voyage, with pumped air volumes between ~60–100 m^3 optimised to ensure sufficient sample mass for analysis. Filter papers were stored at −80°C after collection.

Rain samples were collected during infrequent precipitation events during the transit to the ACC-SWOT mooring site. At least one sample was of sufficient volume to allow analysis (>200 ml). High winds and precipitation falling as snow hindered sample collection near 55°S.

Quantifying Dust Fluxes in the Southern Ocean Time Series using Thorium Isotopes in Seawater

Three CTD casts were sampled for Th depth profiles: two in the vicinity of SOTS site and one near ACC-SWOT mooring site (Fig. 8). A primary sampling objective to obtain duplicate samples in the upper ~500 m was realised in the vicinity of the SOTS site. An additional CTD cast (CTD6) was sampled five times at a single depth to provide replicate samples for analytical quality control.

The samples recovered will be analysed for thorium concentration at IMAS, UTAS. The results will be incorporated into an ongoing GEOTRACES process study and time-series of thorium samples near the SOTS site. The resulting data will be used to assess lithogenic nutrient inputs and to investigate intricacies of using thorium to estimate dust fluxes. Initial qualitative analysis of fluorescence and turbidity scans from the CTD casts indicates differences in biological productivity and particle content between the two sites - features that will likely correlate with differences in thorium cycling between the two sites.

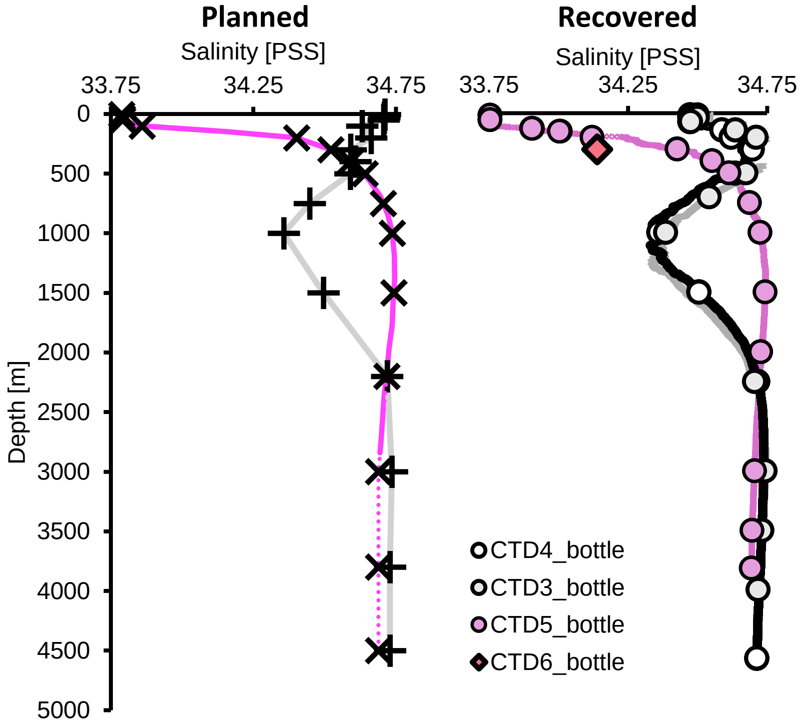


Figure 8: Depths of proposed (crosses) vs. recovered (filled symbols) samples for thorium analysis during IN2025_V02, plotted against salinity and depth.

Voyage narrative

We departed Hobart 0800 (all times in local time zone) on Wednesday 26th March and conducted a test CTD in the afternoon in open ocean around 1700, followed by a balloon launch at 1900 before deploying the CPR and commencing the transit to the SOTS site. Balloon launches were conducted in the morning, middle and end of the day when other operations and weather permitted throughout the voyage.

On Thursday we continued the transit under moderate conditions, arriving at the SOTS site around midnight.

Due to ideal conditions, we commenced deploying the SOFS-14 mooring at first light, with the surface float deployed by midday, and the anchor released at 2000. After triangulating the final anchor location the ship moved 1 NM down wind of the SOFS-14 float to conduct overnight meteorological observation comparisons.

On Saturday 29th March a shallow 300m CTD was performed in the morning to calibrate the SAZ-27 instruments, followed by a deep 4000m CTD commencing at 1400 and completed by 1800. We then transited to the SAZ-27 site and set up in preparation for deployment.

A go decision was reached on the bridge at 0645 and deployment of SAZ-27 commenced after breakfast. Under moderate wind and wave conditions from the west the operation went smoothly with anchor deployment at 1553. After triangulation we moved over to SOFS-13 and commenced overnight meteorological comparisons at 2130.

On Monday 31st March we commenced SAZ-26 recovery with the anchor released at 0730 and the mooring sited around 0830. The mooring was grappled at 0930 under light conditions and recovery complete around 1530. We then moved over to SOFS-13 and continued meteorological comparisons for the afternoon and overnight.

We moved off 10 NM down weather at 0730 and conducted a full depth CTD. An inquisitive Southern Wright whale was sighted nearby. In the afternoon we returned to 1NM down wind of SOFS-13 and continued meteorological comparisons overnight.

On Wednesday 2nd April SOFS-13 recovery commended after breakfast with light winds for the North and moderate swell from the West. The surface float was secured an onboard by 1000, and the recovery completed at 1500. The vessel transited back to SOFS-14, taking up station 1NM down weather in the evening and performing overnight comparison observations.

On Thursday morning we departed the SOTS site at 0930, transiting 90 NM West to the start of the magnetometer tow line. The magnetometer was deployed in the late afternoon and towed throughout the night.

We continued traveling Southwest under slowly deteriorating conditions throughout Friday. The magnetometer tow was completed in the evening as we continued towards the SWOT ACC mooring recovery site at 55.5°S 153°E.

On Saturday 5th April we continued transiting under rough conditions and continued past the site before turning into the weather in the evening.

Monday was spent hove-too.

Tuesday 7th April the SWOT-ACC mooring recovery commenced with the release triggered at 0730 with 5m seas from the SW and light winds. Grappling commenced around 0830 with numerous attempts failing, before succeeding on the 5th attempt with the mooring secured at 1105 and all recovered by 1700. A deep CTD was performed between 1900 to 2300.

We moved 70 NM west to the Earth Care satellite overpass position and performed a shallow 300m post recovery calibration CTD dip of the SOFS-13 sensors at 0830. Two pairs of drifting buoys and an Argo float were deployed 0930 to 1100. The satellite overpass occurred around 1313 while we steamed North East. We departed the site at 1600 heading northwest.

Wednesday 9th April was spent transiting into rough conditions.

Thursday was spent transiting into rough conditions.

Friday 11th Aril was spent hove-too.

Conditions moderated sufficiently early Saturday morning for us to resume transit and we arrived at Patience Seamount at midnight.

On Sunday 13th April an acoustic survey of the seamount was undertaken in the early morning. The deep towed camera was deployed around 1100 in light conditions and completed by 1700 before we continued transiting to Hobart.

We arrived in Storm Bay during the morning and back at the wharf in Hobart at 1230 on Monday 14th April 2025.

Outreach, education and communications activities

The voyage was featured on ABC Radio Hobart – Tasmanian Afternoons with Joel Rheinberger; Elizabeth Shadwick was interviewed live about the voyage activities on 8 April, at 2:20pm (https://www.abc.net.au/listen/programs/hobart-your-afternoon).

A blog post about the SAZ sediment trap mooring preparation in advance of the voyage was published by the Australian Antarctic Program Partnership (AAPP), who provide funding to the IMOS SOTS program, and make use of SOTS observations for research programs and HDR student programs (https://aappartnership.org.au/southern-ocean-time-series-caring-for-your-sediment-trap/).

Summary

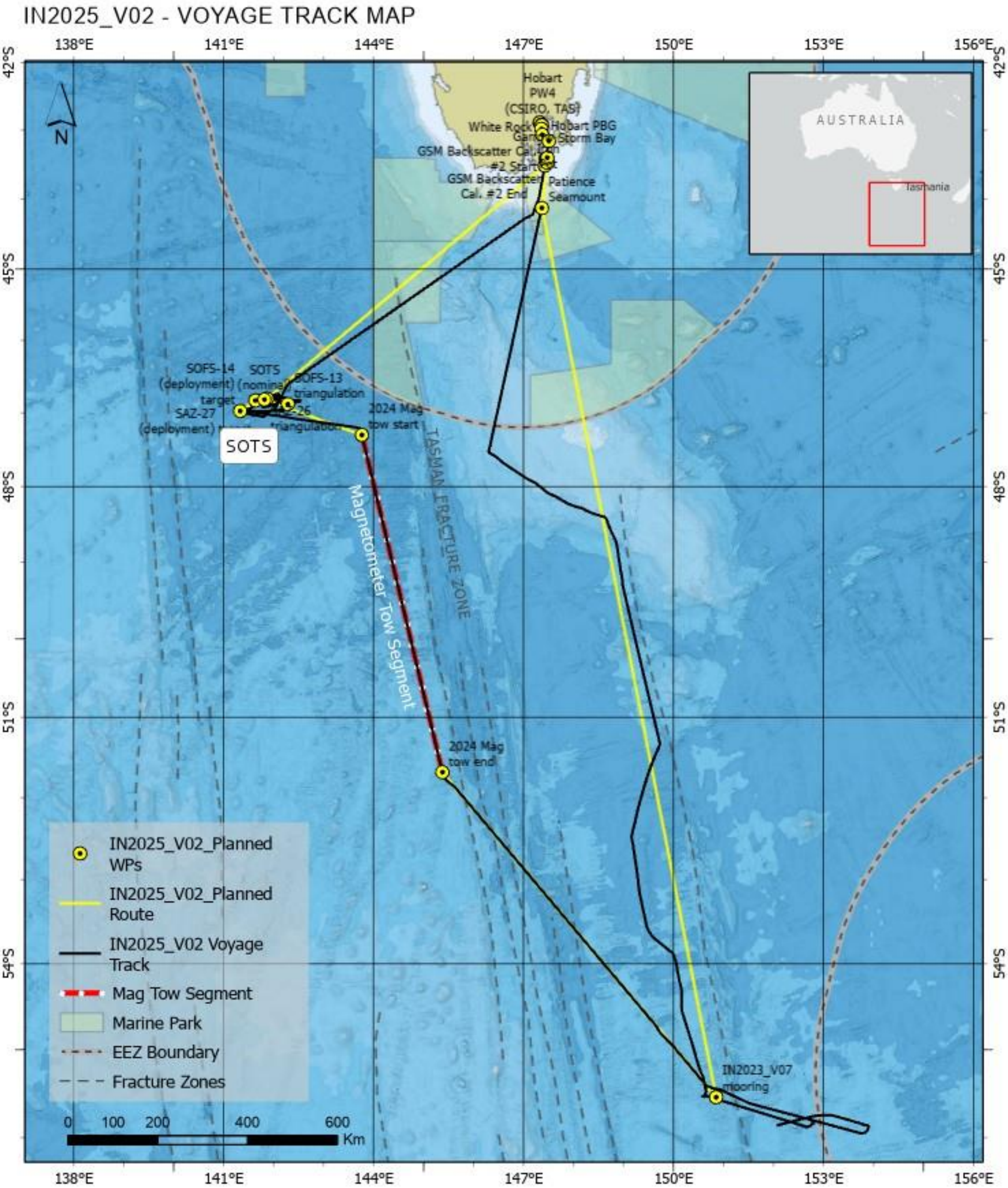
The voyage was successful. We continue to maintain an ocean observatory in the inhospitable and remote Southern Ocean to advance our scientific understanding of how the environment is changing. We have maintained this presence since 1996 for the SAZ sediment trap mooring and 2010 for the Southern Ocean Flux Station mooring. A number of one-off and recurring piggyback projects continue to be successfully combined with the SOTS voyages.

Curation Report

Delete section if not applicable. Describe the storage location for all data/samples collected during the voyage, with each data/sample type included on a separate row. Details should include where the data/samples are being archived/curated, who is responsible for their curation, how the data/samples will be made accessible and to whom, and any further analyses that are underway/will commence.

Item #	Description	Storage	Access	Custodian
	SOTS Project: Water and particle samples collected from the CTD, underway seawater supply, and the SOFS-13 RAS water sampler.	returned to CSIRO Marine and Atmospheric Research for chemical analyses and then discarded following quarantine protocols.	AODN	Elizabeth Shadwick, Cathryn Wynn-Edwards
	SOTS Project: Moored sediment trap samples recovered from the SAZ-26 mooring.	Processed at the University of Tasmania IMAS/AAPP laboratories. 7/10 of each sample is consumed by analyses for particulate organic carbon, particulate inorganic carbon, and biogenic silica. These results are provided for public use via the IMOS Ocean Data Portal. 2/10 of each sample is archived and can be made available for biogeochemical/biological studies by various groups via agreement with SOTS Chief Scientist Elizabeth Shadwick. 1/10 is archived at the IMAS/AAPP laboratoires.	AODN	Elizabeth Shadwick, Cathryn Wynn Edwards

Track Chart


IN2025_V02 - VOYAGE TRACK MAP
138°E
141°E
144°E
147°E
150°E
153°E
156°E
42°S
45°S
48°S
51°S
54°S
N
Hobart
PW4
(CSIRO, TAS)
White Rock
Hobart PBG
Storm Bay
GSM Backscatter Cal.
#2 Start
GSM Backscatter
Cal. #2 End
Patience
Seamount
AUSTRALIA
Tasmania
SOFS-14
(deployment)
SOTS
SOFS-13
triangulation
SAZ-27
(deployment)
SOTS
2024 Mag
tow start
Magnetometer Tow Segment
TASMAN FRACTURE ZONE
2024 Mag
tow end
IN2023_V07
mooring
IN2025_V02_Planned WPs
IN2025_V02_Planned Route
IN2025_V02 Voyage Track
Mag Tow Segment
Marine Park
EEZ Boundary
Fracture Zones
0
100
200
400
600
Km

Links to Further Data and Information

NCMI Information and Data Centre (csiro.au)

Data Trawler (csiro.au) – Data Extraction tools for Voyage Data

MNF Reporting (csiro.au) – Publications and reports from research on vessels run by the Marine National Facilty

Marlin3 - Marlin - CSIRO Oceans and Atmosphere Metadata Catalogue

Open Access to Ocean Data (aodn.org.au)

AusSeabed (ausseabed.gov.au)

CAAB - Codes for Australian Aquatic Biota (csiro.au)

Ocean Biodiversity Information System - Australia (obis.org.au)

Atlas of Living Australia (ala.org.au)

CSIRO Data Access Portal (data.csiro.au)

Global Biodiversity Information Facility (GBIF) (gbif.org)

Insert below any links to further information and data from your voyage.

Description	**Link**
SOTS Annual Reports	https://catalogue-imos.aodn.org.au/geonetwork/srv/eng/catalog.search#/metadata/afc166ce-6b34-44d9-b64c-8bb10fd43a07
SOTS Data at the AODN	https://catalogue-imos.aodn.org.au/geonetwork/srv/eng/catalog.search#/metadata/723a3e85-04ae-40e6-ac2a-237a93d84abe

Acknowledgements

We are grateful to the MNF for excellent support at sea. We thank the directors of the MNF, IMOS, and the various partner organisation that make the voyage a success.

Signature

Your name:	Elizabeth Shadwick
Title:	Chief Scientist
Signature:	
Date:	14 April 2025

Appendix A – Photographs

SOFS-14 Deployment team. Paul Petersen, Murray Lord, Darren Capon, Craig Hanstein, Jonathan Lumb, Pete Jansen, Tim Lane, Elizabeth Shadwick, Eric Schulz, Corey Hazelwood, Margot Hind and Haifeng Zhang

Appendix B – Mooring debrief notes

SOFS-14 Deployment

The operation went smoothly and followed the procedure with minimal issues, good communications focussed effort and no rushing. The weather was ideal, enabling textbook execution and the early start set us up for a successful day with the float hooked up before lunch. The crew changeover was seamless. The safety observer role was effective. The operation took around 13 hours which is the shortest on record. There was discussion on the desire to reduce the need to climb on the float to attach and later remove the crane lifting sling.

SAZ-27 Deployment

It was noted that the deployment went very smoothly, and that communications between the moorings team and the deck crew were efficient. While the SAZ mooring is in some ways less complicated than the SOFS mooring in terms of deployment, it is not without challenges, which were worked through according to the procedures.

Communications with the bridge were smooth throughout the day, and the position of the ship well short of the target anchor location was managed with a break for the deck crew before rigging the anchor.

An adjustment to the set back distance (currently 12 miles) was discussed, but ultimately, it was agreed that it is best to arrive early and have a short distance to tow, then to feel rushed and potentially overshoot the target deployment location.

SAZ-26 Recovery

The deployment went smoothly, and safely, and all elements were recovered successfully and without damage.

The top float and line associated with the ecosounder continues to be challenging, requiring the float to be connected to the ship (once grappled) from the bottom.

The CIR (Darren) and the Moorings Lead (Tim) worked thoughtfully and carefully through the initial connection with the float once it was behind the ship.

The lightweight grapple line snapped on deck just after the larger hand grapple had been secured from the back deck. All personnel were in appropriate places, and wearing suitable PPE, and thus the risk was low and the broken line had no consequences for the operation.

The choice of grappling line used with the pneumatic rope launcher will be revisited next year.

Hooking the hand grapple line up to the winch (requiring a longer line) was discussed as a potential improvement to this part of the procedure.

SOFS-13 Recovery

The operation went smoothly – described as a 'textbook' recovery.

The weather conditions were good (somewhat atypical with the float in the NNW part of the watch circle, winds from the north, seas from the west, and a modest current to the NW), and led to a decision to revert to the 'No Tow' option after connecting to the surface float.

Ship handling to get a hold of the float was very smooth and we were close enough to the float to connect a line onto the lifting bale in one shot.

The decision not to tow the float resulted in a shorter day on deck and was appreciated. Similarly, the tether recovery was very efficient (Z-block set up and level winder for net drum) and most manual handling has been avoided.

The team worked effectively on deck and roles and responsibilities of both the moorings team and the deck crew were defined and clear.

There was a discussion about the grit on the deck and how it makes dragging the float pack to the container more difficult.

ACC-SWOT Recovery:

The operation went well, and after a frustrating start getting a connection of the top of the mooring to the ship, proceeded smoothly.

Several challenges were encountered with the grappling, including difficulty making a connection, changes in tension on the lightweight grapple line exacerbated by relatively large (~6m) swell, and mooring design (wire, rather than rope to grapple). Problem-solving discussion on deck were constructive, and the team worked through issues patiently, ultimately taking a break for morning tea, before a final successful grapple and connection to the ship.

The team work and contributions from the larger deck crew were noted, and the day progressed smoothly and without issues once the top float was safely on board the ship.

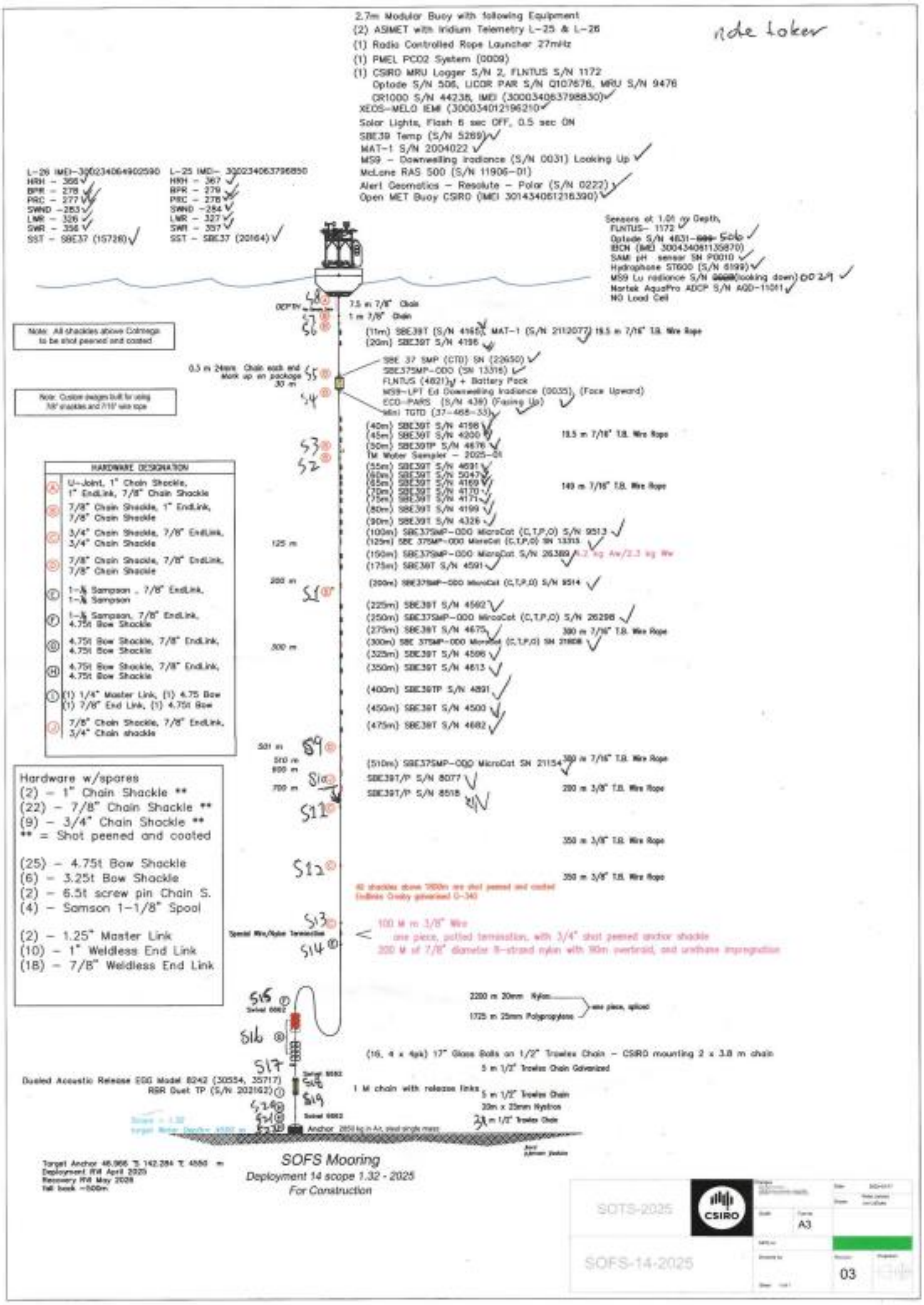
The downsides of using light weight gear for grappling, particularly with this mooring design were discussed. The risks of snapping lines and tension once the heavy grapple is connected were discussed. The procedure for the SAZ recovery was robust and useful for this operation, but not necessarily fit-for-purpose at each step

For consideration in updating procedures:

1. Consider ways to mitigate risk associated with climbing on the float to disconnect the A-frame and crane.
2. Winch seemed to struggle under the load of the SOFS wire on one side. Consider a more equal split of the wire on both sides of the winch.
3. Transition was spooled onto the net drum (see point 2), which was effective.
4. Disconnecting instruments from the wire on the dance floor saves time and can be done safely with careful management of tethers and people on the deck.
5. Add reference to various F.Ops and E&T RIS documents to procedures.
6. Add reference to RIS documents for $HgCl_2$.
7. Consider changing ‘Toolbox’ to ‘5x5’ for consistency with MMA terminology
8. Consider adding detail to the ‘Grappling’ section of the SOFS/SAZ procedures.
9. Review the MMA ‘open deck protocol’ and ensure that the use of tethers for the SOTS mooring operations has been captured.

Appendix C – Mooring Diagrams

SOFS-14 Deployment



SAZ-27 Deployment