RV *Investigator* Voyage Plan

VOYAGE #:	**IN2024_V01**
Version Number:	FINAL
Voyage title:	Multidisciplinary Investigations of the Southern Ocean (MISO): Linking Physics, Biochemistry, Plankton, Aerosols, Clouds, And Climate
Mobilisation:	Thursday 28th- Sunday 31st December 2023, CSIRO Wharf PW04, Hobart
Pre-medical clearance period:	Monday 1st January – Thursday 4th January 2024, Hobart
Depart:	Friday 5th January 2024, (~0800) Selfs Point, Hobart
Return:	Tuesday 5th March 2024, Fremantle
Demobilisation:	Wednesday 6th March 2024, Fremantle
VDC and Voyage Manager:	Margot Hind
Chief Scientist:	Dr Steve Rintoul
Co-Chief Scientist & Sailing Chief Scientist	Dr Annie Foppert
Principal Investigators:	Alain Protat, Philip Boyd, Andrew Bowie, Elizabeth Shadwick, Annie Foppert

Project Abstract

The Southern Ocean and overlying atmosphere have a profound influence on regional and global climate, sea level, biogeochemical cycles, and marine biological productivity. However, present-day models used for forecasts and projections have large and persistent biases in the region. The goal of MISO is to improve our understanding of how the Southern Ocean region influences the Earth system and use this knowledge to improve models.

MISO will characterise the properties of aerosols, clouds, radiation, and precipitation over the Southern Ocean south of Australia and investigate how they are shaped by interactions between the ocean, atmosphere, and biosphere. Repeat observations will be used to discover how and why the region is changing and the consequences of Southern Ocean change for climate, biogeochemical cycles, biological productivity, and the future of the Antarctic Ice Sheet. MISO seeks new insights into the processes controlling the availability of iron and other trace elements and their role in regulating productivity in the Southern Ocean and the production of marine organic aerosols that can drive cloud nucleation. The observations and insights gained from the voyage will be used to develop, test, and implement new parameterisations for models used for weather forecasts and climate projections.

The research strategy has been developed in collaboration with the Bureau of Meteorology to ensure alignment with the Bureau's R&D Plan 2020-2030 and its strategic focus on Antarctic and the Southern Ocean. In particular, the research is targeted to address the Bureau's key priority Towards an Earth System Numerical Prediction Capability – Ocean-Atmosphere Interactions. A broad range of other national and international research users will benefit from the observations, understanding, parameterisations, and model improvements to be delivered by MISO.

Public Summary

The Southern Ocean and overlying atmosphere have a profound influence on regional and global climate, sea level, biogeochemical cycles, and marine productivity. However, present-day models used for climate projections have large and persistent biases in the region. The goal of MISO is to improve our understanding of how the Southern Ocean region influences the Earth system and use this knowledge to improve models. The voyage will investigate how interactions between the atmosphere, ocean and biosphere control processes as diverse as cloud formation, iron supply to marine life, ocean carbon uptake, and the drivers of rapid change in the deep ocean.

Scientific Objectives

The **overall objectives** of the project are:

1. To collect integrated physical, biogeochemical, and biological observations of the coupled Southern Ocean – atmosphere system needed to address gaps in scientific understanding of key processes and to understand reasons for biases in Earth System Models (ESMs).

2. To use enhanced process-level understanding and observations to test and improve earth system models and for calibration/validation of satellite measurements.

The specific research questions to be addressed are:

1. What processes and interactions account for the unique aerosol-cloud-precipitation-radiation interactions over the Southern Ocean and how can they be better represented in ESMs to reduce the large and persistent biases in clouds and absorbed solar radiation at the ocean surface?
2. How do biogenic ocean sources influence the aerosol, cloud, precipitation, and radiative properties of the Southern Ocean atmosphere and how can they be better parameterised in models?
3. To what extent do surface winds influence heat, momentum, and carbon exchange across the air-sea interface, how is the exchange influenced by surface waves, and how can these interactions be better represented in ESMs?
4. How and why is the Southern Ocean inventory of heat and carbon south of Australia evolving in time and what are the impacts on sea level rise and ocean acidification?
5. What physical and biogeochemical processes control primary productivity, community composition, and production of biogenic aerosols?
6. How is the Southern Ocean changing near Antarctica and what are the implications for the stability of the Antarctic Ice Sheet and the formation of Antarctic Bottom Water?
7. How well are cloud, aerosol and precipitation properties over the Southern Ocean represented in satellite products and how can they be used to inform data assimilation?

Voyage objectives

Atmosphere: We will use shipboard and satellite instruments to investigate the latitudinal variability of cloud, aerosol, and radiative properties.

Air-sea interface: Ocean-atmosphere interactions will be measured with underway instruments. Air-sea fluxes of CO_2 and sea spray will be measured continuously along the ship track.

Ocean physics: We will re-occupy the I9S repeat hydrographic section at 115°E to assess changes in ocean properties and circulation. We will also track the ongoing and rapid change in Antarctic Bottom Water (AABW) by completing short sections across the AABW export pathway at 132°E, 140°E and 150°E. Argo floats (Deep and Biogeochemical) will be deployed.

Ocean biogeochemistry: Carbon chemistry will be measured throughout the water column. Iron and other trace elements and isotopes (TEIs) will be measured using clean techniques. We will occupy 4 stations for ~3 days to track the evolution of iron biogeochemistry, measuring fluxes of particulate and dissolved iron pools, to investigate processes controlling strong opposing fluxes of iron regeneration and scavenging, organic ligand release, authigenic iron production, and biological uptake and recycling in the upper and mesopelagic ocean.

Ocean biology: Underway measurements will be used to map zonal and meridional distributions of phytoplankton stocks, community structure, physiological status, and biogenic gas concentrations (e.g. DMS). Process studies will focus on the marginal ice zone where phytoplankton blooms are anticipated to supply biogenic precursors to aerosol, CCN, and Ice Nucleating Particles (INPs). During process stations, incubation experiments will be conducted on board to quantify the biological production of organic compounds and how they act as precursors for new formation of aerosols.

Satellite calibration/validation: Opportunistic observations collected during satellite overpasses will be used to evaluate and refine satellite aerosol, cloud, and precipitation products from the Himawari-8, A-Train and GPM missions.

Additional information

Drifter and ARGO Float Deployment

13 deep Argo floats and 10 BGC Argo floats will be deployed over the course of the voyage.

Triaxus

The Triaxus will be deployed at each of the process stations and will be used an exploratory tool to expand on the CTD depth profiles in characterising the water mass that we are sampling at the process stations. It will be deployed following the deployment of a drifter and will undulate from ~15-150m depth. Direction and location of the Triaxus is determined by movement of the drifter, with the ship following it's movements by the safest and most efficient means.

Measurements from a suite of sensors on the towbody will include nitrate (SUNA UV-spectrometer, SBE), oxygen (SBE 43 electrodes plumbed in line with the CTD intakes) duplicate Sea-Bird SBE911 CTDs and a calibrated Sea-Bird ECO-Triplet FLBBCD2K measuring chlorophyll fluorescence (470/695nm excitation/emission), optical backscatter (700nm), and dissolved organic matter fluorescence (370/460 nm) (Sea-Bird Electronics, Bellevue, USA).

Bongo Nets

Bongo nets will be deployed using the Moorings Jayden winch off the starboard side. Target depth is 50-70m with dedicated flagging on the rope indicating depths, using 335micron mesh and 335micron hard codends. Tow time will be 10-15minutes before recovering the nets and preserving half samples in 10% formalin and half in TM clean seawater.

DALEC

DALEC deployed off port side towing boom ~0600 and retracted ~1700 weather dependent. DALEC deployment to be approved by bridge prior to deployment.

Activity plan for Medical Clearance period

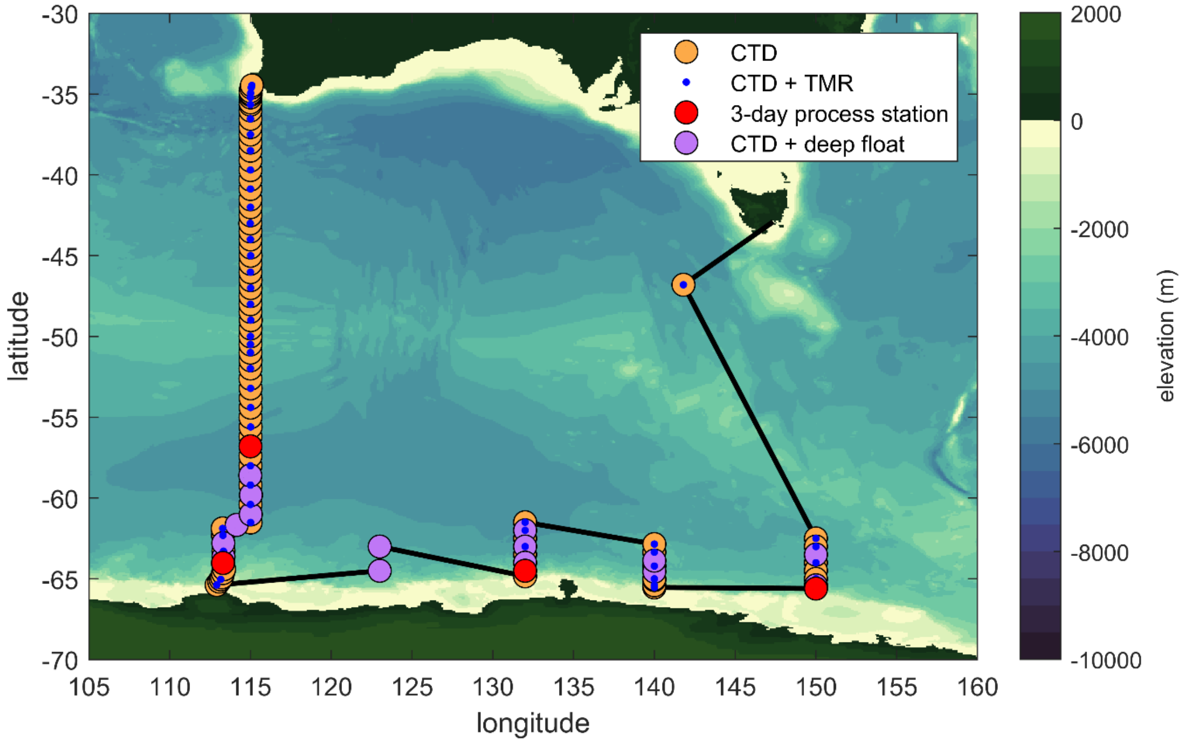
Date	Activity
Monday 1st January 2024	MMA Crew Change, IN2024_V01 Science Party & CSIRO Support Staff boards RVI
Tuesday 2nd January 2024	RVI Departs Princes Wharf # 4 for 1000m isobath for Trace Metal test and clean, utilising medical clearance period.
Wednesday 3rd January 2024	Commence test and clean of TMR and ISPs: **TMR test and clean cast** – 1000 m isobath outside of Storm Bay, dip TMR to 200 m and fill Niskins between 100 and 88 m on upcast. Filled Niskins weekly acidified and left to soak in clean container for at least 24 h [2 h] **ISP test** – deploy 2 ISPs (one dual head and one single head) at 1000 m isobath to a bottom depth of (say) 200 m (pumps will be shallower e.g., 50 and 100 m), with pumping for 10 mins [2 h] Return to Hobart (Selfs Point) after operations completed to await bunkers
Thursday 4th January 2024	RVI alongside Selfs Point taking bunkers
Friday 5th January 2024	Vessel departs Selfs Point for IN2024_V01

Activity plan for first 24-48 hours of voyage Departure

Date	Activity
Friday 5th January 2024	Departure from Selfs Point - time TBC

Saturday 6th January	TMR rinse en route to SOTS in water deeper than 2000m. Dip TMR to 400m and rinse Niskins and refill on upcast between 150-50m. Analyse iron in all 12 Niskins on board ship (1.5hr) Deploy and tow CPR to SOTS
Sunday 7th January	Arrive at SOTS Recover CPR Full depth CTD Full depth TMR (~5hrs)
Commence transit to 62.55S, 150E	

Voyage track example



Waypoints and stations

Station plan for IN2024_V01 (MISO voyage)

- Deep CTD at each station unless otherwise specified.

WP #	Station Type	Latitude (decimal)	Longitude (decimal)
Hobart		-42.87	147.35
SOTS	Deep TMR.	-46.8	141.8
1	Deep TMRs along 150	-62.5	150
2	Deep TMRs along 150	-63	150
3		-63.5	150
4	Deep TMRs along 150	-64	150
5		-64.5	150
6	Deep TMRs along 150	-65	150
7	Deep TMRs along 150	-65.4	150
8	Process station (includes GEOTRACES superstation activities: 2 x TMR, 1 x ISP, 1 x Bongo). SR3 2018 location was here at 65.6, 150. If we don't reach this station because of sea ice, the process could be at 65, 150	-65.6	150
9	Deep TMRs along 140	-65.53	140
10	Superstation (2 x TMR, 1 x ISP, 1 x Bongo); SR3 superstation was here at 65.4, 140	-65.4	140
11		-65.07	140
12	Deep TMRs along 140	-65	140
13		-64.55	140
14	Deep TMRs along 140	-64.21	140
15		-63.87	140
16	Deep TMRs along 140	-63.35	140
17	Deep TMRs along 140	-62.85	140
18	Deep TMRs along 132	-61.5	132
19	Deep TMRs along 132	-62	132
20		-62.5	132

21	Deep TMRs along 132	-63	132
22		-63.5	132
23	Deep TMRs along 132	-64	132
24	Process station (includes GEOTRACES superstation activities: 1 x TMR as shallow, 1 x ISP, 1 x Bongo). SR3 2018 location was here at 64.5, 132	-64.5	132
25	Deep TMRs along 132	-64.84	132
26		-63	123
27		-64.5	123
28	Deep TMR	-65.38	112.91
29		-65.17	113.07
30	Superstation (1 x TMR, 1 x ISP, 1 x Bongo)	-65.03	113.16
31		-64.9	113.24
32	Deep TMR	-64.64	113.3
33		-64.4	113.37
34		-64.02	113.3
35	Process station (includes GEOTRACES superstation activities: 2 x TMR, 1 x ISP, 1 x Bongo)	-64.02	113.3
36		-63.64	113.33
37	Shallow TMR	-63.29	113.33
38		-62.79	113.32
39	Shallow TMR (unless next superstation cancelled, then deep TMR)	-62.31	113.3
40	Superstation (2 x TMR, 1 x ISP, 1 X Bongo)	-61.88	113.28
41		-61.66	114.15
42	Shallow TMR	-61.51	115.01
43		-61.01	115.02
44	Deep TMR	-60.4	115
45		-59.81	115.03
46		-59.2	115
47	Process station (includes GEOTRACES superstation activities: 2 x TMR, 1 x ISP, 1 x Bongo)	-59.2	115

48		-58.6	114.99
49	Shallow TMR	-58	115
50		-57.4	115
51	Process station (includes GEOTRACES superstation activities: 2 x TMR, 1 x ISP, 1 x Bongo)	-56.8	115
52		-56.2	115
53	Shallow TMR	-55.6	115.01
54		-55	115
55		-54.4	115.01
56	Superstation (2 x TMR, 1 x ISP, 1 X Bongo)	-54.4	115.01
57		-53.81	115.01
58	Shallow TMR	-53.21	115.01
59		-52.61	115
60	Deep TMR	-51.98	115
61		-51.47	115.01
62	Deep TMR	-51	115
63	Superstation (2 x TMR, 1 x ISP, 1 x Bongo), SE Indian ridge	-50.49	115
64	Deep TMR	-49.99	115
65		-49.5	115.01
66	Deep TMR	-48.99	115.02
67		-48.47	115
68	Shallow TMR	-48	115
69		-47.5	115
70	Superstation (2 x TMR, 1 x ISP, 1 x Bongo)	-47	115.01
71		-46.51	115.01
72	Shallow TMR	-46.02	115
73		-45.5	115
74	Deep TMR	-45	115.01
75		-44.49	115

76	Shallow TMR	-43.99	115
77		-43.5	115
78	Superstation (2 x TMR, 1 x ISP, 1 x Bongo)	-43	114.99
79		-42.5	115
80	Shallow TMR	-42	115
81		-41.51	115
82	Deep TMR	-40.87	115
83		-40.29	115
84	Shallow TMR	-39.7	115
85		-39.11	115
86	Superstation (2 x TMR, 1 x ISP, 1 x Bongo)	-38.5	115
87		-38	115
88	Shallow TMR	-37.5	115
89		-37.04	115
90	Deep TMR	-36.53	115
91		-36.01	115
92	Shallow TMR	-35.65	115
93		-35.51	115
94	Superstation (1 x TMR, 1 x ISP, 1 x Bongo)	-35.2	115
95		-35.05	115.01
96	Shallow TMR	-34.95	115.01
97		-34.82	115
98	Shallow TMR	-34.6	115.05
99	Shallow TMR	-34.46	115.09
Fremantle		-32.05	115.76

Order of Operations:

A) If CTD and TMR; CTD first, then TMR
B) Superstation: shallow TMR, deep CTD, ISPs, deep TMR
C) Process stations: see Appendix D for timeline.

   a) If CTD and TMR: CTD first, then TMR

b) Superstation: Shallow TMR, deep CTD, ISPs, Deep TMR

c) Process station: See appendix E

CTD Configuration

	PLEASE SELECT:
Fundamentals:	
Which CTD rosette to be used for this voyage (24 or 36 Niskin bottles):	36
Likely total number of casts:	120
Likely maximum depth of deepest cast:	5829dbar
Lowered ADCP required:	Yes
Standard CTD Configuration - Instrumentation (All 8 auxiliary channels Used) 6000m 1 x SBE9+ (CTD) 2 x SBE3P Temperature Sensors 2 x SBE4C Conductivity Sensors 2 x SBE5T pumps 2 x SBE43 Dissolved Oxygen Sensors	Yes
1 x Tritech PA500 Altimeter 1 x Biospherical QCP2300HP PAR Sensor 1 x Wetlabs C-Star 25cm Transmissometer 1 x Wetlabs ECO FLCDRTD Fluorometer – CDOM (370/460nm) 1 x Wetlabs ECO FLBBRTD Fluorometer – Chlorophyll-a & Back Scatter (2 x Channels)	yes
Alternative Instruments (Can be substituted from standard configurations highlighted in blue):	no
Seapoint Turbidity Meter – Nephelometer:	no
Chelsea Aquatracka III (430/685nm) Fluorometer – Chlorophyll-a:	no
Seabird SUNA – Ultraviolet Nitrate Analyzer (**Serial Connection - 2000 m**):	yes
Standard LADCP Configuration – Instrumentation: 6000 m 1 x Teledyne 300 kHz LADCP (Slave - Up) 1 x Teledyne 150 kHz LADCP (Master - Down) 1 x 48V Deep Sea Battery	Yes
Alternative LADCP Configuration - Instrumentation: 6000 m 1 x Teledyne 300 kHz LADCP (Slave - Up) 1 x Teledyne 300 kHz LADCP (Master - Down) 1 x 48V Deep SeaBattery	No
Hydrochemistry Analyses:	
Salinity	yes

	PLEASE SELECT:
Dissolved Oxygen	yes
Nutrients: Nitrate	yes
Nutrients: Phosphate	yes
Nutrients: Silicate	yes
Nutrients: Nitrite	yes
Nutrients: Ammonia	yes

Time estimates

WP #	latitude (decimal)	longitude (decimal)	depth (dbar)	distance (nm)	Steaming time from previous station (hrs @ 10.5 kn)	cumulative time (hours)	cumulative time (days)	Deep Argo (float id)	SOCCOM floats	comments	GEOTRACES comments
Hobart	-42.87	147.35				0.0					
SOTS	-46.8	141.8	4632	333.7	31.8	40.9	1.7			SOTS site/test cast	Deep TMR. No ISP here but ISP test dip needs to be added somewhere
1	-62.5	150	3912	984.1	93.7	140.6	5.9			northern limit of gamma>28.30 @150E	Deep TMRs along 150
2	-63	150	4000	30	2.9	149.5	6.2				Deep TMRs along 150
3	-63.5	150	3758	30	2.9	154.6	6.4	Arvor 1		max bottom gamma @150E	
4	-64	150	3694	30	2.9	164.0	6.8				Deep TMRs along 150
5	-64.5	150	3598	30	2.9	169.7	7.1				
6	-65	150	3306	30	2.9	178.8	7.5				Deep TMRs along 150
7	-65.4	150	2908	24	2.3	187.1	7.8	Arvor 2		max bottom salinity @150E	Deep TMRs along 150
8	-65.6	150	2522	12	1.1	263.1	11.0			max bottom salinity @150E; process station: bloom/sea ice may shift location	Process station (includes GEOTRACES superstation activities: 2 x TMR, 1 x ISP, 1 x Bongo). SR3 2018 location was here at 65.6, 150. If we don't reach this station

											because of sea ice, the process could be at 65, 150
9	-65.53	140	1500	248.2	23.6	290.8	12.1				Deep TMRs along 140
10	-65.4	140	2005	7.8	0.7	303.0	12.6			southern edge of gamma>28.33	Superstation (2 x TMR, 1 x ISP, 1 x Bongo); SR3 superstation was here at 65.4, 140
11	-65.07	140	2597	19.8	1.9	307.8	12.8				
12	-65	140	0	4.2	0.4	311.2	13.0				Deep TMRs along 140
13	-64.55	140	3096	27	2.6	316.9	13.2	Arvor 3		max gamma ALBW core (>28.34)	
14	-64.21	140	3551	20.4	1.9	326.2	13.6			max gamma ALBW core (>28.34)	Deep TMRs along 140
15	-63.87	140	3769	20.4	1.9	331.7	13.8	SOLO 1		max gamma ALBW core (>28.34)	
16	-63.35	140	3831	31.2	3.0	342.2	14.3				Deep TMRs along 140
17	-62.85	140	3223	30	2.9	351.3	14.6			Hakurei Seamount	Deep TMRs along 140
18	-61.5	132	4618	238	22.7	382.0	15.9				Deep TMRs along 132
19	-62	132	4559	30	2.9	392.9	16.4	SOLO 2			Deep TMRs along 132
20	-62.5	132	4521	30	2.9	399.8	16.7				
21	-63	132	4330	30	2.9	410.5	17.1	SOLO 3			Deep TMRs along 132
22	-63.5	132	4095	30	2.9	417.1	17.4				
23	-64	132	3264	30	2.9	426.2	17.8	Arvor 4			Deep TMRs along 132
24	-64.5	132	1479	30	2.9	503.2	21.0				Process station (includes GEOTRACES superstation activities: 1 x TMR as

											shallow, 1 x ISP, 1 x Bongo). SR3 2018 location was here at 64.5, 132
25	-64.84	132	866	20.4	1.9	507.9	21.2				Deep TMRs along 132
26	-63	123	4000	261.8	24.9	536.5	22.4	SOLO 4			
27	-64.5	123	3500	90	8.6	548.4	22.9	SOLO 5			
28	-65.38	112.91	663.6	261.9	24.9	576.0	24.0				Deep TMR
29	-65.17	113.07	1474.8	13	1.2	579.4	24.1				
30	-65.03	113.16	1477.3	9.3	0.9	589.4	24.6				Superstation (1 x TMR, 1 x ISP, 1 x Bongo)
31	-64.90	113.24	1463.3	7.8	0.7	592.3	24.7				
32	-64.64	113.30	1936.3	15.7	1.5	598.2	24.9				Deep TMR
33	-64.40	113.37	2478.5	14.4	1.4	602.3	25.1				
34	-64.02	113.30	3020.7	22.8	2.2	607.6	25.3				
35	-64.02	113.30	0	0	0.0	679.6	28.3			process station	Process station (includes GEOTRACES superstation activities: 2 x TMR, 1 x ISP, 1 x Bongo)
36	-63.64	113.33	3312.5	22.7	2.2	685.0	28.5	SOLO 6			
37	-63.29	113.33	3563.1	21.4	2.0	692.4	28.9				Shallow TMR
38	-62.79	113.32	3884.5	29.8	2.8	698.9	29.1	SOLO 7			
39	-62.31	113.30	4138.2	29.1	2.8	707.4	29.5				Shallow TMR (unless next superstation cancelled, then deep TMR)
40	-61.88	113.28	4262.3	25.7	2.4	723.7	30.2				Superstation (2 x TMR, 1 x

											ISP, 1 X Bongo)
41	-61.66	114.15	4356.1	27.8	2.6	730.3	30.4	SOLO 8			
42	-61.51	115.01	4407.5	26.5	2.5	738.7	30.8				Shallow TMR
43	-61.01	115.02	4470	29.8	2.8	745.5	31.1	SOLO 9			
44	-60.40	115.00	4538.7	36.8	3.5	758.0	31.6				Deep TMR
45	-59.81	115.03	4576.6	35.3	3.4	765.4	31.9	SOLO 10			
46	-59.20	115.00	4609	36.4	3.5	772.9	32.2				
47	-59.20	115.00	0	0	0.0	783.9	32.7			process station	Process station (includes GEOTRACES superstation activities: 2 x TMR, 1 x ISP, 1 x Bongo)
48	-58.60	114.99	4617.1	36	3.4	791.4	33.0	SOLO 11			
49	-58.00	115.00	4644.4	36	3.4	800.9	33.4				Shallow TMR
50	-57.40	115.00	4631.8	36	3.4	808.4	33.7				
51	-56.80	115.00	4605.2	35.9	3.4	887.9	37.0	SOLO 12			Process station (includes GEOTRACES superstation activities: 2 x TMR, 1 x ISP, 1 x Bongo)
52	-56.20	115.00	4734.2	36.5	3.5	895.5	37.3				
53	-55.60	115.01	4693.6	35.8	3.4	905.0	37.7				Shallow TMR
54	-55.00	115.00	4565.3	35.7	3.4	912.4	38.0				
55	-54.40	115.01	4246.5	36.3	3.5	919.7	38.3				
56	-54.40	115.01	0	0	0.0	929.7	38.7			process station	Superstation (2 x TMR, 1 x ISP, 1 X Bongo)
57	-53.81	115.01	4069.3	35.5	3.4	936.8	39.0				
58	-53.21	115.01	4033.2	36.1	3.4	946.0	39.4				Shallow TMR
59	-52.61	115.00	3826.3	35.8	3.4	951.1	39.6				
60	-51.98	115.00	3733.2	38	3.6	962.2	40.1				Deep TMR

61	-51.47	115.01	3566.3	30.1	2.9	968.5	40.4					
62	-51.00	115.00	4065.1	28.5	2.7	976.7	40.7					Deep TMR
63	-50.49	115.00	3096.3	30.7	2.9	991.5	41.3				SE Indian ridge	Superstation (2 x TMR, 1 x ISP, 1 x Bongo), SE Indian ridge
64	-49.99	115.00	3925.7	29.8	2.8	1002.0	41.8					Deep TMR
65	-49.50	115.01	3468	29.3	2.8	1008.2	42.0					
66	-48.99	115.02	4011.8	30.9	2.9	1018.8	42.4					Deep TMR
67	-48.47	115.00	3969.5	31.2	3.0	1025.4	42.7					
68	-48.00	115.00	3660.4	28.2	2.7	1033.6	43.1					Shallow TMR
69	-47.50	115.00	3788.8	29.6	2.8	1040.0	43.3					
70	-47.00	115.01	3992.1	30.3	2.9	1057.5	44.1					Superstation (2 x TMR, 1 x ISP, 1 x Bongo)
71	-46.51	115.01	4202.6	29.3	2.8	1064.1	44.3					
72	-46.02	115.00	4177.4	29.7	2.8	1072.7	44.7					Shallow TMR
73	-45.50	115.00	4264.6	31.2	3.0	1079.5	45.0					
74	-45.00	115.01	4348.3	29.6	2.8	1090.3	45.4					Deep TMR
75	-44.49	115.00	4496	30.9	2.9	1097.2	45.7					
76	-43.99	115.00	4400.8	29.9	2.8	1106.0	46.1					Shallow TMR
77	-43.50	115.00	4518.3	29.3	2.8	1112.7	46.4					
78	-43.00	114.99	4460.7	29.8	2.8	1130.5	47.1					Superstation (2 x TMR, 1 x ISP, 1 x Bongo)
79	-42.50	115.00	4396	29.9	2.8	1137.3	47.4					
80	-42.00	115.00	4616.4	30.5	2.9	1146.3	47.8					Shallow TMR
81	-41.51	115.00	4706.3	28.9	2.8	1153.1	48.0					
82	-40.87	115.00	4722.9	38.4	3.7	1165.9	48.6					Deep TMR
83	-40.29	115.00	4777	34.8	3.3	1173.4	48.9					
84	-39.70	115.00	4833.5	35.8	3.4	1183.0	49.3					Shallow TMR
85	-39.11	115.00	4916	35.5	3.4	1190.6	49.6					
86	-38.50	115.00	4769.5	36.4	3.5	1209.2	50.4					Superstation (2 x TMR, 1 x ISP, 1 x Bongo)

87	-38.00	115.00	4861.1	30.1	2.9	1216.3	50.7					
88	-37.50	115.00	5320.2	30	2.9	1225.7	51.1					Shallow TMR
89	-37.04	115.00	5829.4	27.7	2.6	1233.1	51.4					
90	-36.53	115.00	5481	30.6	2.9	1245.6	51.9					Deep TMR
91	-36.01	115.00	5342.7	31.2	3.0	1253.1	52.2					
92	-35.65	115.00	5180.3	21.3	2.0	1261.5	52.6					Shallow TMR
93	-35.51	115.00	2458.9	8.6	0.8	1265.1	52.7					
94	-35.20	115.00	1532	18.5	1.8	1276.0	53.2					Superstation (1 x TMR, 1 x ISP, 1 x Bongo)
95	-35.05	115.01	759.7	8.9	0.8	1278.5	53.3					
96	-34.95	115.01	212.3	6.1	0.6	1281.5	53.4					Shallow TMR
97	-34.82	115.00	133.3	8.2	0.8	1283.6	53.5					
98	-34.60	115.05	92.1	13	1.2	1287.1	53.6					Shallow TMR
99	-34.46	115.09	37.6	9	0.9	1290.2	53.8					Shallow TMR
Fremantle	-32.05	115.76	0	148.3	14.1	1304.3	54.3					
Weather/contingency (5 days)							59.3					

Timetable for 72 h process stations for BioGeoSCAPES / Atmospheric incubations

[Note: timing below assumes arrival on station at midnight (0000). The “shallow CTD/bio-optics cast” needs to be done close to mid-day. Other operations do not need to be done at a particular time, so the order of operations may change to allow a mid-day shallow CTD.]

Day 1

0000	arrive on site
0015	drifter deployed (ship to follow drifter during process station)
0030	trace metal fish deployed
0030 – 0130	flush trace metal fish
0130 – 1230	collect water using trace metal fish for mesocosm incubations
1230	shallow CTD/bio-optics cast (2 hr, to 1500 m)
1430	shallow TMR (2 hrs, to 1500 m)
1730	deep CTD for radiogenic samples
2200	Bongo net (night)
2300	Triaxus tow (5.5 hr)

Day 2

0430	deploy TMR to collect water for small volume and NPP incubations
0800	Set up deckboard incubations
0800	ISPs (5 hr)
1300	shallow CTD/bio-optics cast (1 hr, to 500 m)
1400	Bongo net (day)
1500	deep CTD (4 hr)
1900	deep TMR (6 hr)

Day 3

0200	Triaxus tow (5.5 hr)
0900	underway to next station

Permits

Antarctic Treaty – Notification of Determination
Permit Antarctic Treaty (Environmental Protection), Science, Expiry 31 May 2027
Permit Antarctic Treaty (Environmental Protection), CSIRO, Expiry 31 May 2025

MNF Marine Parks Permit
Transit through South-east Network – PA2020-00041-1 (variation PA2020-00041-7)
Operations within South-west Network - PA2020-00041-2 (variation PA2020-00041-8)

AAPP Import Permit
Quarantine import permit – AAPP 00038136

Signature

Your name	Annie Foppert
Title	Chief Scientist
Signature	Annie Foppert
Date:	30 December 2023