



<b>Version Number:</b>	FINAL
<b>Voyage title:</b>	IN2025_V03: COAST-k – Clean Ocean Air Sampling upwind of Tasmania - Kennaook
<b>Mobilisation:</b>	Hobart, 24-28 April 2025
<b>Onboarding:</b>	Hobart, Monday 28 April 2025
<b>Depart:</b>	08:00 Hobart, Tuesday 29 April 2025
<b>Return:</b>	~08:00 Hobart, Sunday 18 May 2025
<b>Demobilisation:</b>	Hobart, 18-19 May 2025
<b>Voyage Delivery Coordinator:</b>	Max McGuire
<b>Voyage Manager:</b>	Max McGuire
<b>Chief Scientist:</b>	Ruhi Humphries
<b>Affiliation:</b>	CSIRO Environment
<b>Alternate Chief Scientist:</b>	Robyn Schofield
<b>Affiliation:</b>	University of Melbourne
<b>Principal Investigators:</b>	Paul Krummel (PI Kennaook / Cape Grim greenhouse gas program)
<b>Affiliation:</b>	CSIRO Environment
<b>Principal Investigators:</b>	Melita Keywood (PI Kennaook / Cape Grim aerosol program)
<b>Affiliation:</b>	CSIRO Environment
<b>Principal Investigators:</b>	Suzie Molloy (PI ozone program at both Kennaook / Cape Grim and RVI)
<b>Affiliation:</b>	CSIRO Environment
<b>Principal Investigators:</b>	Branka Miljevic
<b>Affiliation:</b>	Queensland University of Technology
<b>Principal Investigators:</b>	Alain Protat
<b>Project name:</b>	Southern Ocean Winter Cloud Interactions Processes (SOWCLIP)
<b>Affiliation:</b>	Bureau of Meteorology

## Scientific objectives

The World Meteorological Organization's (WMO) Global Atmosphere Watch (GAW) program consists of an observational network charged with understanding the increasing influence of human activity on the global atmosphere. The Kennaook / Cape Grim Baseline Air Pollution Station (KCGBAPS), measuring the Southern Ocean's atmosphere from the northwest tip of Tasmania, is one of three premier global GAW stations. By utilising the mobility of the RV Investigator (RVI), the world's first mobile GAW station, both stations can be compared directly and data quality improved and validated. This high-quality observational data feeds directly into improving both regional and global climate, air quality and Earth System models.

This project aims to:

1. Directly compare two world-leading WMO-GAW stations, the RVI and the KCGBAPS – a global first. This will include validating the RVI's full suite of atmospheric measurements and sampling systems against complementary measurements at the KCGBAPS, improving data quality for all locations visited by the vessel.
2. Validate how representative measurements of atmospheric composition and boundary layer structure at the KCGBAPS is of the broader Southern Ocean.
3. Provide improved characterisation of atmospheric structure and composition to inform and improve earth system, climate, air quality and smoke forecasting models.
4. Determine the best boundary conditions for air quality modelling over Australia by improving our understanding of Southern Ocean and Cape Grim baseline concentrations of a range of trace atmospheric constituents.

## Voyage objectives

### Site comparison

The vessel will transit to Kennaook / Cape Grim (KCG), spending five days as close to the station as possible to enable an intercomparison study to occur, where both platforms are sampling the same air mass in a variety of wind conditions. The chosen distance will take into consideration weather conditions and ship safety, as well as the way the atmospheric boundary layer moves over the cliff at KCG. A variety of weather conditions is ideal for this portion of the voyage, and we may utilise some of the contingency days if we determine they we have only encountered a limited range of conditions.

Note that the initial voyage plan in 2020 involved the deployment of AIRBOX – a containerized laboratory with a heated inlet and a permanently installed Radon detector. Several AIRBOX instruments, and members of the original AIRBOX consortium, are involved in this voyage and the aim of assessing discrepancies will still be achieved, without the need (or prohibitive expense) of deploying the AIRBOX laboratory space. Characterisation of inlet losses from the RVI have been undertaken and duplicate AIRBOX and guest instrumentation will be deployed aboard the RVI in the air chemistry, aerosol laboratories and on deck 5, negating the need for AIRBOX deployment to house instruments.

### Baseline verification

Once the direct intercomparison is complete, the vessel will transit south-west into the Southern Ocean as far as the time will allow. The goal here is to see how representative measurements at KCG are of the wider Southern Ocean. The chosen voyage track will balance how far south-west we can reach, as well as the ship's orientation relative to the wind during transit (in order to minimise interaction with the ship's own

exhaust). During this time, the goal is to sample air from the ship that will subsequently pass over KCG so that direct intercomparisons can take place. These matched airmasses will be assessed continuously throughout the voyage using trajectory modelling. While we don't require airmasses to be moving in this fashion continuously throughout the voyage, we will require it at intervals throughout the transit. We will be continuously assessing the air trajectories and doing real-time comparisons with data from KCG during this time to determine whether we need to alter the ship track to utilise the contingency days to wait for favourable wind conditions during this time.

## Activity plan for first 24-48 hours of voyage

Atmospheric instruments will collect continuous observations throughout the voyage and need to be running before the ship sets sail. The main ship requirement is to point the bow into the wind as often as possible to avoid contamination of the atmospheric measurements from ship exhaust.

The first 24 hours of the voyage will involve transiting to KCG from Hobart and finding a suitable location from which to safely position next to the KCG station without putting exhaust onto either the RVI atmospheric measurements or over KCG.

## Voyage track example

For the collocated measurements, the ship must be stationed near the coastal KCGBAPS site. It is noted here that baseline conditions aren't necessary while alongside the KCGBAPS, as a range of conditions is best for the comparison. However, a suitable location must be chosen such that the diesel exhaust from RVI doesn't impact on the KCGBAPS measurements, but that both platforms are sampling the same atmosphere simultaneously. The chosen location will be determined dynamically based on the wind & ocean conditions at the time. RVI must also be oriented into the wind in order that its own atmospheric measurements aren't affected by exhaust during the collocated periods.

For the baseline verification portion of the research program, RVI will travel westward into the Southern Ocean for several hundred NM. It is imperative that this phase coincides with baseline conditions at the KCGBAPS. We will collaborate closely with forecasters to predict the best time to start the transit into the Southern Ocean. The contingency days will be extremely valuable during this phase. Additional limitations are associated with getting favourable wind conditions such that RVI and the KCGBAPS are sampling the same baseline air mass (with the appropriate time delay associated with increasing distance between the stations) during the transit, and that the exhaust from RVI doesn't impact on measurements. Travelling to the west into the prevailing south-westerlies will minimize the risk of RVI sampling its own exhaust. Travelling parallel to but offset to the wind direction will minimize the exhaust impact on the KCGBAPS. Forecast air mass trajectories will be calculated in anticipation of the transit period in order to optimise the ship track, minimise the exhaust impact and ensure sampling of the same air mass.

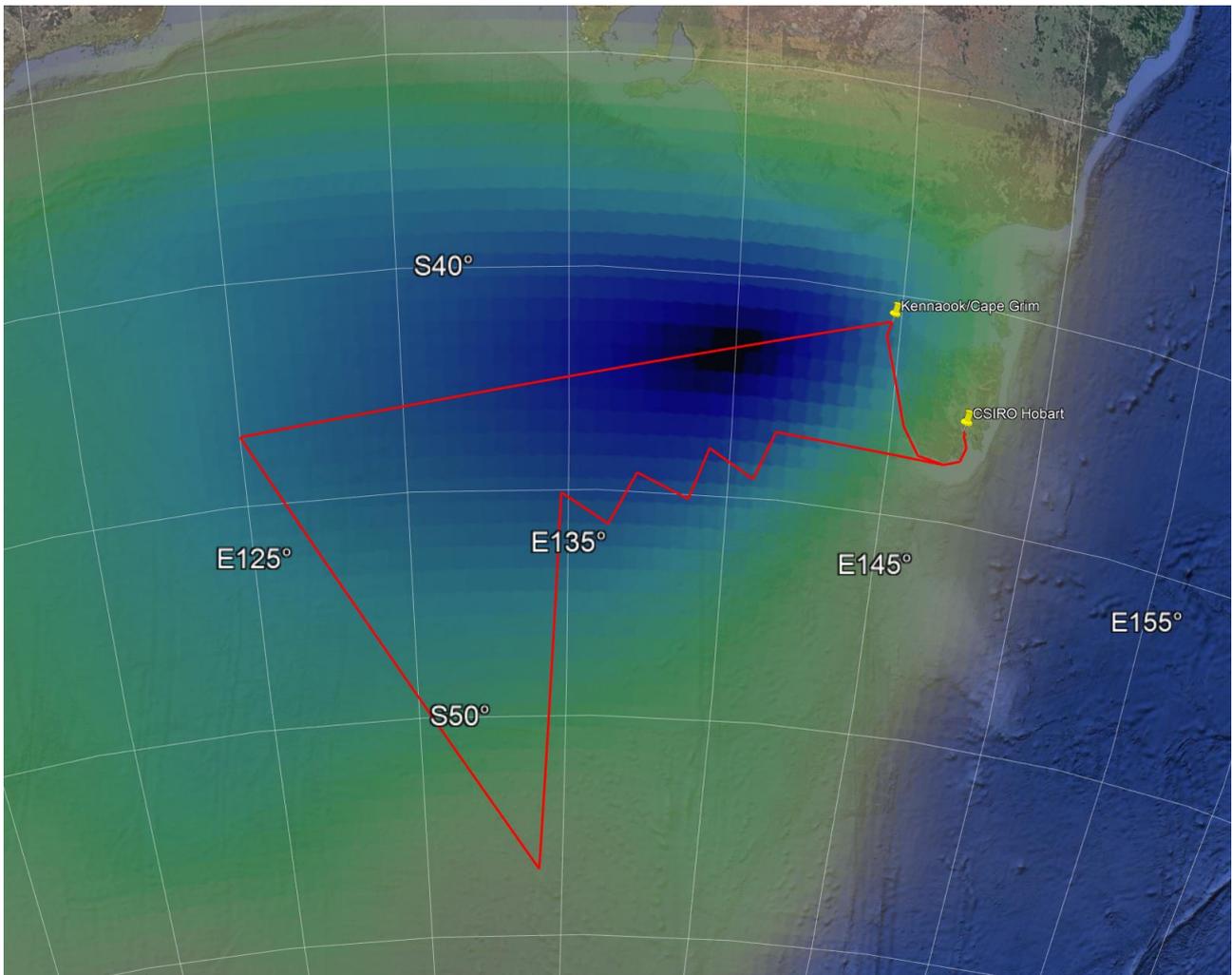
The image below shows an example of the voyage track we will undertake. The voyage track is designed to both optimise the likelihood of sampling the same air mass on the RVI and at KCG, as well as minimise the time the ship is sampling exhaust. The track is split up into a few different segments:

1. **Transit to KCG** – aim is to get to KCG as soon as possible. Exhaust impact is unlikely given the direction of travel and the prevailing wind direction.

2. **Dynamic station off KCGBAPS** – position the ship alongside KCGBAPS such that both stations are sampling the same airmass. The ship will be relocated dynamically based on wind conditions. The proximity of the ship at KCGBAPS will be determined by:
  - a. the movement of the atmospheric boundary layer over the KCG cliffs (ensuring both stations are sampling the same airmass), and
  - b. a continuous assessment by the master and MNF of current weather and ocean conditions and how close he is comfortable with getting the vessel to the shore. Important to ensure that the ship’s exhaust isn’t impacting measurements at KCG or the ship’s own measurements.
3. **Transit west** – transit away from KCG, into the prevailing wind. Exact course will be based on forecast winds. Goal is to be upwind of KCG (slightly parallel to the direct path, to avoid exhaust impinging on KCG) so that both stations are sampling the same airmass, but at different times.
4. **Transit south** – transit south into Southern Ocean. The goals here are to investigate latitudinal variability and how representative KCGBAPS’s baseline sector is of the higher latitudes, particularly in the late autumn/winter season when very limited data exists in the region. This is venturing outside the high probability trajectory region, so won’t be determined by wind trajectories with respect to KCG. This track shouldn’t have major issues with self-sampling exhaust.
5. **Transit north** – additional latitudinal transect, and movement back to high probably trajectory region for transit home to get another chance for additional direct airmass comparison data with KCGBAPS.
6. **Tack transit home** – transiting home while tacking relative to the prevailing wind with the primary purpose to avoid self-sampling exhaust while being in the high probability trajectory region. The size of the tacks can be determined based on current wind and swell conditions, as well as time constraints on returning to port.

We will use a number of tools for making the decision for the voyage track throughout the voyage. These include:

- HYSPLIT forecast trajectories utilising a range of input meteorological forecasts including:
  1. GDAS
  2. CCAM
  3. ECMWF
  4. Bureau of Meteorology
  5. GFS
- Operational exhaust indicator (a data stream in the underway dataset of the RVI)

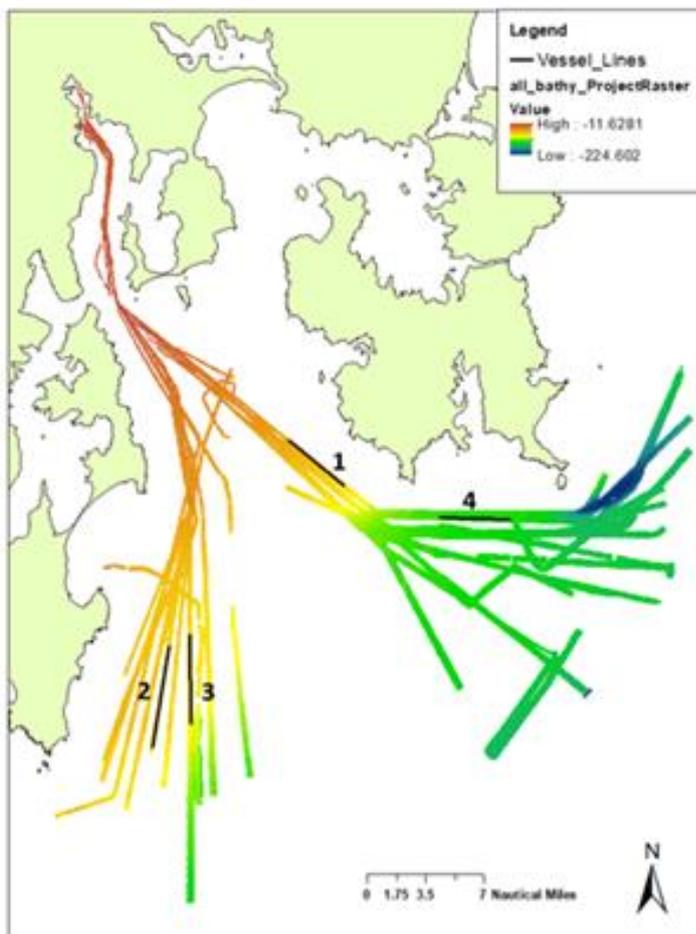


## Waypoints and stations

SITE	DEGREES DECIMAL MINUTES LATITUDE (°S)	DEGREES DECIMAL MINUTES LONGITUDE (°E)	DISTANCE (NM)	TOTAL DISTANCE (NM)	STEAMING TIME (HRS)	TOTAL STEAM (HRS)
Hobart	42° 52.2	147° 21.0				
GSM calibration line #2 start	43° 24.478	147° 27.939	6.22			
GSM calibration line #2 end	43° 30.632	147° 26.618				
GSM calibration line #3 start	43° 23.824	147° 29.656	4.55			
GSM calibration line #3end	43° 28.37	147° 29.713				
Kennaook / Cape Grim	40° 40.7	144° 40.5	300	300	28	28
	Dynamic station here for 5 days					

SITE	DEGREES DECIMAL MINUTES LATITUDE (°S)	DEGREES DECIMAL MINUTES LONGITUDE (°E)	DISTANCE (NM)	TOTAL DISTANCE (NM)	STEAMING TIME (HRS)	TOTAL STEAM (HRS)
Western point	43°	125°	900	1200	81	109
Southern point	53°	134°	700	1900	63	172
Back to within high probability trajectories	45°	134°	500	2400	45	217
Hobart	42° 52.2	147° 21.0	750	3150	68	285

- GSM Calibration lines - exiting/entering Storm Bay to the SW we will likely transit over GSM calibration line 2/3 as per below grab
- An EM2040 multibeam is now permanently mobilised on the vessel. This is our shallow water seafloor mapping system we'll potentially be using for Piggyback proposal.



## Time estimates

The following time estimates are based on a steaming speed of 11 knots which, as agreed, may not be possible operating in the Southern Ocean.

Time estimates are given based on the red track above in the above diagrams.

In addition, sonde launches will not affect the time estimates as these take only minutes of the ship only slightly slowing down, depending on the current wind conditions.

DATE	TIME	ACTIVITY
29 April	08:00	Depart Hobart, transit to KCGBAPS
30 April	12:00	Arrive at Cape Grim, staying around station for 5 days
5 May	12:00	Depart Cape Grim, begin south-west transit into Southern Ocean
8 May	21:00	Reach western waypoint, begin southern transit
11 May	12:00	Reach southern waypoint, begin northern transit
13 May	09:00	Back within high probability trajectory zone, start tacking towards Hobart.
18 May	08:00	Arrive in Hobart

## Piggyback projects

Name of #1 Project: Southern Ocean Winter Cloud Interactions Processes (SOWCLIP)

Principal Investigators:

1. Alain Protat (Bureau of Meteorology)
2. Gerald "Jay" Mace (University of Utah)
3. Simon Alexander (Australian Antarctic Division)
4. Steven Siems (Monash University)
5. Jessie Creamean (Colorado State University)

Number of Berths requested: 5

1. Alain Protat (senior scientist, Bureau of Meteorology)
2. Nasim Alinejadtabrizi (PhD student, Monash University)
3. Samantha Greeney (PhD student, Colorado State University)
4. Mark Curtis (senior software engineer, Bureau of Meteorology)
5. Luis Ackermann (senior scientist, Bureau of Meteorology)

Support from Chief Scientist:

Yes (Ruhi Humphries) for COAST-k

## Objectives:

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<sub>2</sub> warming and sea surface temperature biases in climate models.

Strikingly, the latest climate simulations using improved knowledge gained on the frequency of occurrence of supercooled liquid water from earlier voyages (IN2015\_V02, IN2016\_V02, IN2018\_V01, IN2018\_V02, IN2022\_V03, IN2023\_V03) indicate the existence of two distinct large surface shortwave radiation biases of opposite sign north or south of about 55°S latitude. From the IN2018\_V01 and most recent IN2024\_V01 observations collected closer to the coast of Antarctica, we have gathered evidence that emissions of aerosol precursors from over Antarctica produce very high concentrations of aerosols and different cloud properties from further north and from when air masses bring pristine air from the open ocean. However, our number of samples remain quite limited to draw statistically significant conclusions. Past voyages have further revealed a change in the thermodynamic profile of the atmosphere across the 55°S latitude, i.e., the Antarctic Ocean polar front. At high latitudes the upper air soundings reveal that the free troposphere has a greater relative humidity supporting multiple cloud layers. The surface heat fluxes also vary strongly across this divide with suppressed sensible and latent heat fluxes across the high latitudes.

The other major result obtained from past voyages is the potentially important role of ocean productivity (linked to phytoplankton blooms, dimethyl sulphide and resulting atmospheric particles, see recent IN2024\_V01 "MISO" voyage) in the local production of aerosols leading to cloud formation and driving cloud microphysical properties. However, only partial observations were collected during earlier voyages, which did not fully capture the suite of interactions. What remains nearly unexplored is the seasonal response in cloud and precipitation properties during Autumn and winter when the ocean productivity declines and the aerosol background changes from sulphate dominant to sea salt dominant. Further, the role of precipitation from shallow convection in removing aerosols and changing the cloud macrophysical properties remains poorly understood.

Following these conclusions, our proposal here is to collect a suite of aerosol, cloud, surface radiation and precipitation observations during early Autumn (IN2025\_V03). This new dataset will be combined with the existing ones collected in the period 2016 - 2024 to continue to build a comprehensive understanding of the relationship between ocean productivity, aerosol formation, cloud microphysics, cloud dynamics, and link that understanding to rainfall properties and surface radiation. If at all possible, we would like to contribute to the early calibration effort of the cloud radar and lidar launched in space as part of the European Space Agency EarthCARE mission by collecting cloud radar – lidar and precipitation observations under the satellite track.

**Data Collection:** Tables 1 and 2 list the proposed instruments and critical measurements that are needed for this project. Please note that funding for radiosondes (planning for two per day to capture the basic atmospheric state) is still being sought. All instruments will operate continuously under supervision of on-board scientist Protat, who has ample experience in manning this instrumentation on Southern Ocean voyages. We would also like to take this piggyback opportunity to train three young scientists for future voyages.

## Voyage Track:

If there is flexibility in the voyage tracks of these voyages, we would like to request to try and capture overpasses from the EarthCARE satellite in order to commence validation of EarthCARE over the Southern Ocean. Since we will know in advance when and where the satellite will fly over our region of interest,

slight deviations to the voyage track (during transit for instance) could be planned ahead. If no flexibility is allowed, we will be happy to go where the initial voyage track goes, as our objectives will be met regardless and are not compromised by lack of co-incident satellite profiles.

**Mobilisation:**

Instruments will be mobilised during the IN2025\_V02 mobilisation period and left on the ship until after IN2025\_V03. Demobilisation in Hobart. Radiosondes for both campaigns will require (pending funding) to have 3 to 4 G-size bottles of Helium available on the back deck per voyage.

Table 1. Principal Investigators and Responsibilities

Name	Project Role	Instrument(s)	Affiliation and Location
Alain Protat	Principal Investigator Radar and Lidar calibration, science analysis PI onboard.	BASTA W-band Cloud Radar RMAN Lidar, Micro Rain radar, radiosondes	Bureau of Meteorology, Melbourne
Jay Mace	Co-Investigator MWR data processing, Radar and Lidar Science analysis	miniMPL lidar, 2-channel Microwave radiometer, radiosondes	University of Utah, Salt Lake City, Utah
Simon Alexander	Co-Investigator Lidar data processing Science analysis	Micro Rain Radar Parsivel disdrometer	Australian Antarctic Division, Hobart
Steven Siems	Co-Investigator Surface heat flux (turbulent and bulk) analysis		Monash University
Jessie Creamean	Co-Investigator Ice Nucleating Particles and DNA analysis	INP and DNA filters	Colorado State University

Table 2. Critical Instrumentation

Instrument	Measurement(s)	Owner	Ship Location	Current Location
------------	----------------	-------	---------------	------------------

OceanPol C-Band Weather Radar	Hydrometeor radar properties	MNF	Monkey Island	Ship
Aerosol and Air Chemistry Lab Instruments	Aerosol Measurements	MNF / CSIRO	Aerosol and Air Chemistry Lab	Ship
Mini BASTA W-Band Doppler Radar	Vertically pointing radar reflectivity and Doppler velocity	Simon Alexander / Alain Protat	Stabilized platform container (Level 2, forward deck, starboard side)	Hobart
RMAN Raman Lidar	Lidar attenuated backscatter and depolarisation	Alain Protat	Deck 5 railing	Melbourne
Vaisala CT-25 ceilometer	Attenuated backscatter and cloud base	Simon Alexander	Deck 5 railing	Hobart (AAD)
Micro Rain Radar	K Band vertically pointing radar reflectivity	Alain Protat	Deck 5 railing	Cape Grim
ODM470 disdrometer	Drop size distribution, rainfall rate	MNF / Alain Protat	Main mast	Ship
Parsivel-2 Disdrometer	Drop size distribution, rainfall rate	Simon Alexander	Deck 5 railing	Hobart (AAD)
Sonic anemometer and fast temperature and humidity sensors (for eddy flux calculations)	Eddy surface fluxes	MNF / Jason Monty / Eric Schulz	Main mast	Ship
23 and 31 GHz Microwave Radiometer	23 and 31 GHz brightness temperature	Jay Mace	Deck 5 Railing	Cape Grim
Radiosondes	Thermodynamic profiles	Jay Mace and Alain Protat	Launch 2xday from back deck	Hobart

## #2 Project: Revealing offshore records of Cainozoic volcanism at Kennaook/Cape Grim: Dr Jodi Fox, UTAS

We will map and investigate the morphology of the seafloor offshore, using standard underway hydroacoustic techniques, from Kennaook/Cape Grim (KCG). KCG was the location of basaltic submarine volcanism ca 24 myrs ago and the sequence of volcanic rocks there likely extend into the ocean.

1. Continuous swath mapping using the Kongsberg multibeam systems (EM124, EM712 or EM2040 MKII as deemed appropriate by the Geophysical Survey and Mapping team).
2. Concurrent Kongsberg SBP 29 Sub-bottom profiler survey

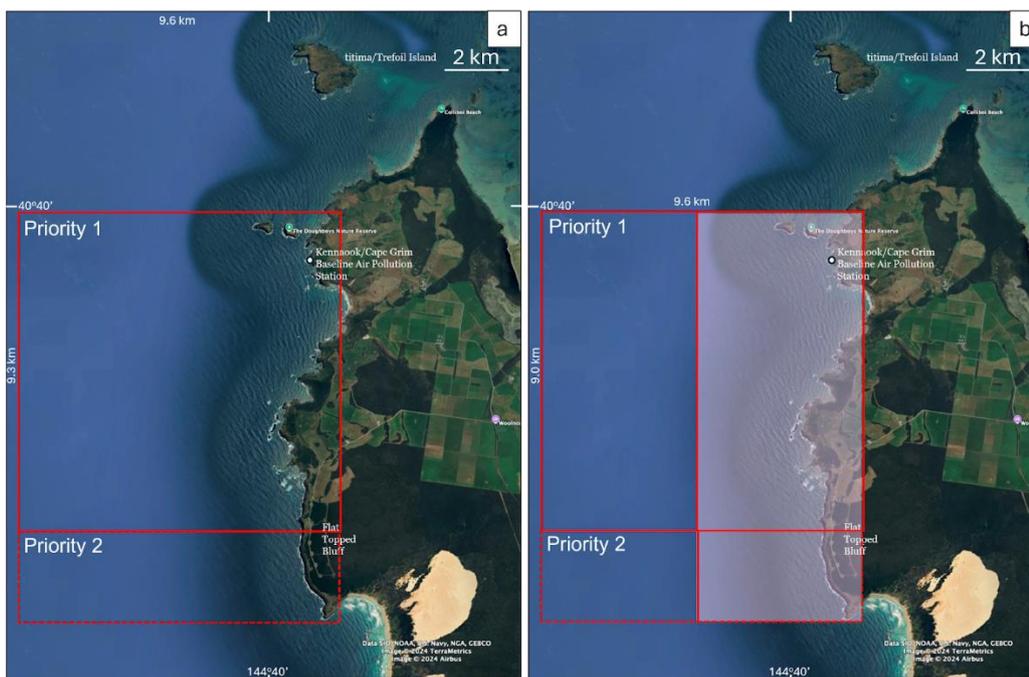
*Pre-voyage activities* include compilation of bathymetric and geophysical maps to identify off-shore targets for high-resolution mapping (completed). On-shore data for the KCG has also been compiled.

*Voyage activities* will involve continuous swath mapping using the mid-water and shallow-water multibeam systems (as appropriate) and sub-bottom profiler to collect high resolution data to characterise seafloor geomorphology. We propose that the mapping survey of our area of interest be conducted opportunistically. For example, when the primary voyage ship track coincides with our area of interest, during ship turns and re-positions and when/if the primary voyage activities cannot be conducted due to weather conditions or other interruptions. The successful acquisition of any data from the indicated area of interest will be useful and important as there is currently no high resolution data from the region.

The weather will be the most important factor for this operation with MMA determining the appropriate the depth contours to determine how close to the shore we can go with regards to the prevailing conditions.

*Post voyage activities* will include the post-processing of bathymetric data using Fledermaus, CARIS and ArcGIS/QGIS. UTAS holds licences for all required software. Data will be integrated with existing data sets, including marine and onshore-data sets, and used to interpret the volcanic geomorphology of the seafloor.

Data and outputs from this project will be supplied to the Information and Data Centre at the CSIRO National Collections and Marine Infrastructure in keeping with Marine National Facility requirements.



**Figure 1.** Location of proposed bathymetric survey at Kennaook/Cape Grim. a. Priority 1 and Priority 2 survey locations. b. Priority 1 and Priority 2 survey locations with 2 nm from coastline indicated (shaded area). Survey lengths in line kilometres and duration are indicated in Table 1.

**Table 1.** Bathymetric survey line spacing, length and duration required to fully map the areas of interest indicated in Figure 1.

Survey	Survey Speed	Line Spacing	Total Survey Length	Survey Duration
Priority 1 Area Full Survey	7 knots	100 m	884 km	68 hours
Priority 1 Area Survey >2 nm from coast	7 knots	100 m	442 km	34 hours
Priority 2 Area Full Survey	7 knots	100 m	256 km	20 hours
Priority 2 Area Survey >2 nm from coast	7 knots	100 m	128 km	10 hours

#3 Project: Natural iron fertilisation of the Southern Ocean: linking terrestrial dust and bushfires to marine biogeochemistry: Professor Andy Bowie, UTAS

Oceans play a vital role in Earth's climate through the control of atmospheric carbon dioxide. An important component of this system is the iron cycle, in which iron-rich aerosols are transported from land via the atmosphere to the ocean. Iron is a key micronutrient for marine phytoplankton, the scarcity of which controls essential biogeochemical processes.

This project will sample for trace elements in aerosol particles using the RV *Investigator's* state-of-the-art aerosol sampling facilities and laboratories to evaluate the atmospheric contribution to trace element delivery to the remote Southern Ocean. As done on many occasions previously, we will install a simple pump and filtration system in the RV *Investigator* aerosol lab (approximately 2 m of bench space is required) to sample trace metals in aerosols collected from the ship's air intake line. This system consists of vacuum pumps (Thomas Sheboygan 2107CD18), flow meters (DiTGM ML-2500) and filtration systems (Savillex PFA). The manifold is connected to air intake lines fed from the sampling nozzle located ~10 m above sea level on the foremast at the bow of the vessel. Samples will be collected on filters housed in 47 mm filtration holders located within a laminar flow hood (AirClean Systems) to avoid contamination. The system is controlled by automated sector control switch (pump controller) to ensure the system only samples 'clean' air from the forward sector (nominally between 270° port and 90° starboard, and above a wind speed threshold), avoiding air impacted by the ship's exhaust. The system is capable of running up to 4 flow lines in parallel, to enable replicate sampling or to sample for different parameters on different lines.

This project does not need the vessel to deviate off the planned route in the subantarctic Southern Ocean south of Australia, nor requires station time. Sampling will be conducted whilst the ship is both underway and on-station.

Samples and data from this project will be archived and stored securely following established protocols, and in accordance with routine policies for research voyages undertaken through the Marine National Facility.

This project will extend an integrated ship-based atmospheric observational program on RV *Investigator* that has been in operation on voyages in the Southern Ocean south of Australia since 2016. 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. The project will sample and conduct experiments on atmospheric particles containing terrestrial dust and bushfire smoke that are transported south from Australia to the Southern Ocean. The observational data from this project will be shared with atmospheric and ocean modelling colleagues in Japan and the United Kingdom to optimise model predictions of the land–atmosphere–ocean iron cycle in the Southern Ocean using new parameterisations normalised for contemporary southern hemisphere conditions.

Project outputs include provision of the critical information on atmospheric iron deposition for ocean fertility and health, providing the science for predicting a key factor in the future impact of the oceans on climate. Project outcomes include provision of a scientific basis for managing the complex role of iron in sustaining marine ecosystem biodiversity and for informing government policy on ocean fertilisation as a carbon mitigation strategy.

The project supports the training and research of a postgraduate student from IMAS-UTAS and has full support of COAST-k Chief Scientist Dr Ruhi Humphries.

#4 Project: Deployment of Argo floats including Australian core, deep and BGC and floats from international partners: Dr Gabi Semolini Pilo, CSIRO (main contact)

Dr Christina Schallenberg, CSIRO

Pat McMahon confirming float logistics including mobilisation, storage and deployment requirements.

Deployments of BGC American and Core Australian floats are flexible and only need to align with specified longitudes. The BGC Australia Float does need to be deployed at the SOTS mooring site (if possible).

Type	Latitude	Longitude	Location
Core Australian float	-43	125	SGAB
BGG Australian float (unlikely to arrive in time)	-47	140	SOTS mooring site
BGC American float	-41.2	143	SGAB
BGC American float	-42.4	135	SGAB
BGC American float	-46	127	SGAB
BGC American float	-53	134	SGAB

#### Permits

This voyage will traverse through the following Marine Parks:

Franklin, Tasman Fracture & Huon Marine Parks

However, no operations have been planned in these areas under the current approved permits.

This voyage is operating under the following permits:

Parks Australia (MNF multi-network)

Other

And the following operations are planned in these areas under the current approved permits:

Area	Activity
Throughout voyage	Additional radioactive sources will be brought onboard in order to run additional instruments. These require notification to CSIRO RSOs and ARPANSA.
Throughout voyage	DAFF permits will be required for importing samples of air and air filter samples from outside Australia's EEZ.
Throughout voyage	Radiosonde releases may require permits, but this needs to be confirmed based on deployment plans

## Signature

<b>Your name</b>	Ruhi Humphries
<b>Title</b>	Chief Scientist
<b>Signature</b>	
<b>Date:</b>	8 April 2025

## List of additional figures and documents

- a. Appendix A - MNF Equipment
- b. Appendix B - User Supplied Equipment
- c. Document A
- d. Document B
- e. Figure 1
- f. Figure 2

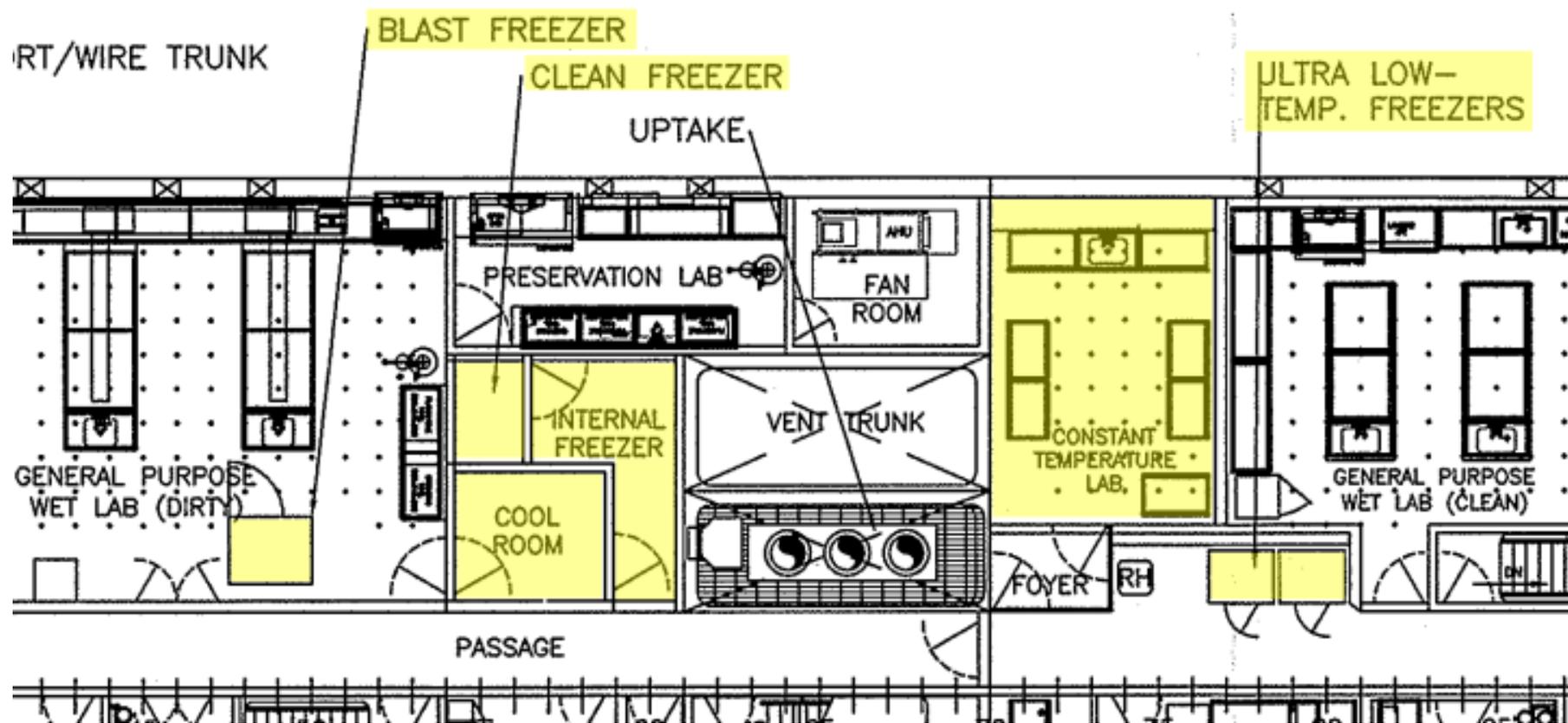
# Appendix A

## Scientific equipment and facilities provided by the Marine National Facility

Some equipment items on the list may not be available at the time of sailing. Applicants will be notified directly of any changes. Indicate what equipment and facilities you require from the Marine National Facility by placing an **X** in the relevant box.

STANDARD LABORATORIES AND FACILITIES		
NAME	REQUIRED	NOTES/COMMENTS
Aerosol Sampling Lab	X	Atmospheric sampling
Air Chemistry Lab	X	Atmospheric sampling
Preservation Lab		Please indicate the intended activity in this lab
Constant Temperature Lab (Min temp: ~4°C / Max temp ~35°C)		Please indicate the intended activity in this lab Please indicate the required setpoint temperature
Underway Seawater Analysis Laboratory		
GP Wet Lab (Dirty)	X	Preparation of radiosondes
GP Wet Lab (Clean)		Please indicate the intended activity in this lab
GP Dry Lab (Clean)	X	For processing filter samples and storing them in the freezer in this lab
Sheltered Science Area	X	Helium storage and balloon inflation (if possible, otherwise, back deck somewhere)
Observation Deck 07 Level		Please indicate the intended activity in this area
Internal Freezer (Dirty Wet lab) (Min temp -25°C / Max temp 0°C) Volume: >20m <sup>3</sup>		Please indicate the intended activity in this area Please indicate the required setpoint temperature
Clean Freezer (Dirty Wet lab) (Min temp -25°C / Max temp 0°C)		Please indicate the intended activity in this area Please indicate the required setpoint temperature

STANDARD LABORATORIES AND FACILITIES		
NAME	REQUIRED	NOTES/COMMENTS
Volume: >2.5m <sup>3</sup> Co-located within the Internal freezer and separated by a door		
Blast Freezer (Dirty Wet lab) (Min temp -30°C / Max temp 0°C) Internal volume >1.5m <sup>3</sup> Capable of reducing the temperature of 150kg of water from +20C to -30C in one hour.		Please indicate the intended activity in this area Please indicate the required setpoint temperature
Cool Room (Dirty Wet lab) (Min temp 0°C / Max temp 10°C)		Please indicate the intended activity in this area Please indicate the required setpoint temperature
Ultra-Low Temperature Freezers x2 (Main Deck) Min temp -80°C / Max temp -80°C)		Please indicate the intended activity in this area
YODA Freezers (x2) (Clean Dry lab) (Min temp -20°C / Max temp 10°C)	X	INP & Aerosol Filter storage in one freezer at -20oC



MOBILE LABORATORY AND FACILITIES (MAY REQUIRE ADDITIONAL SUPPORT)			
NAME	ESSENTIAL	DESIRABLE	NOTES/COMMENTS
Modular Isotope Laboratory			If nominated, additional processes to be completed.
Trace Metal Niskin Sampling Container (TM1-blue - 20ft)			Used for the determination of trace metal concentrations. It is a clean laboratory containing laminar flow cabinets and is stored on the main deck (if possible).

MOBILE LABORATORY AND FACILITIES (MAY REQUIRE ADDITIONAL SUPPORT)			
NAME	ESSENTIAL	DESIRABLE	NOTES/COMMENTS
Trace Metal Seawater Analysis Laboratory (TM2-white - 20ft)			Used for wet sampling of trace metal clean Niskins and is stored on the main deck (if possible). Cannot be overstacked
Trace Metal Rosette and Niskin Storage Container			10-foot container
Modular Hazchem Locker			
Stabilised Platform Container	X		AAD's mini BASTA cloud radar will be installed on the stabilised platform. We need to discuss with SIT what needs to be done to secure this smaller version of the cloud radar on the platform.
Clothing Container			The use of this container will be identified by MNF

STANDARD SAMPLING EQUIPMENT			
NAME	ESSENTIAL	DESIRABLE	NOTES/COMMENTS
Continuous Plankton Recorder (CPR)			*note: Use of this item must be flagged with the relevant CSIRO Oceans & Atmosphere team responsible for CPR cassette preparation and sample processing. Please discuss your planned CPR use with your VDC, who will assist in liaising with the CPR team.

SPECIALISED SAMPLING EQUIPMENT			
NAME	ESSENTIAL	DESIRABLE	NOTES/COMMENTS (THESE ITEMS MAY REQUIRE ADDITIONAL MNF SUPPORT STAFF)
TRIAXUS – Underway Profiling CTD			Triaxus is a pilotable towed vehicle capable of carrying a variety of instrumentation. Constant depth towing or undulating profiles (e.g. cyclic depth pattern from the surface to 200m) are possible. Towing speed depends on the tow profile, instrumentation payload and prevailing conditions. Typically, undulations

SPECIALISED SAMPLING EQUIPMENT			
NAME	ESSENTIAL	DESIRABLE	NOTES/COMMENTS (THESE ITEMS MAY REQUIRE ADDITIONAL MNF SUPPORT STAFF)
			<p>from the surface to 200m are possible at 8knt, with slower speeds for deeper profiles and faster for constant-depth towing. Maximum achievable depth typically 300m to a distance of approximately 1.5km from the ship.</p> <p>Triaxus is normally configured with the following sensors as a minimum:</p> <p>Dual temperature, conductivity and dissolved oxygen (SBE9plus and dual pumped temperature/conductivity/dissolved oxygen circuits)</p> <p>PAR</p> <p>Chlorophyll-A, CDROM, optical backscatter (Eco-triplet – 2000m Max)</p> <p>Plankton counter (Laser Optical Plankton Counter)</p> <p>Transmissometer</p> <p>Contact MNF for further details on other instrumentation and capability.</p>
Desired towing profile:			
Additional instrumentation: (please supply, make and model and datasheets and a contact person for discussion on integration)			
Piston Coring System			
Gravity Coring System			
Multi Corer			
Kasten Corer			
Smith Mac Grab			
Rock Dredges			

SPECIALISED SAMPLING EQUIPMENT			
NAME	ESSENTIAL	DESIRABLE	NOTES/COMMENTS (THESE ITEMS MAY REQUIRE ADDITIONAL MNF SUPPORT STAFF)
Rock Saw			Requires trained science personnel
Seaspy Magnetometer			
Portable Pot Hauler			
Equipment to measure seawater sound velocity/CTD:			
XBT System			2 per day provided
Valeport Rapid SV			
Valeport Rapid CTD			
Valeport SVX2			
Trace Metal Rosette and Bottles			
Trace Metal In-situ Pumps (x6)			See non-MNF owned section below for additional 2 units. Science team to organise and pay for battery packs for this system (+ spare). They can be sourced through a supplier such as 'Batteryworld Hobart' (Graham Cowie, 03 6272 3900) who has made these previously. The science teams need to calculate how long they will be deployed and bring enough batteries to cover their deployment times. They are rated to 30 Amp hours, which equals to 36,000 litres of sea water being filtered.
Deep Towed Camera			
Drop Camera			
Sherman Epibenthic Sled			Stern ramp must be removed to operate this system.
Brenke Sled			

SPECIALISED SAMPLING EQUIPMENT			
NAME	ESSENTIAL	DESIRABLE	NOTES/COMMENTS (THESE ITEMS MAY REQUIRE ADDITIONAL MNF SUPPORT STAFF)
Hydro-Bios MultiNet (Mammoth) (1m x 1m) <i>(has replaced the EZ net)</i>			Please specify 100-micron, 335-micron, or 500-micron mesh Can be used in a vertical or horizontal operations
Surface Net (1m x 1m)			Please specify 335-micron, 500-micron, or 1,000-micron mesh
Bongo Net			750mm frame, 500-micron mesh net and 335-micron cod end
Beam Trawl			
MIDOC			Multiple opening/closing net system with cod ends- suitable for pelagic trawls
Pelagic Trawl System (net, doors)			Contact MNF to discuss net and mesh dimensions
Demersal Trawl System (net, doors)			Contact MNF to discuss net and mesh dimensions
RMT-8 (Rectangular Midwater Trawl) Utilises a single warp so can be deployed on the general-purpose towing wire in self-contained mode. Must be deployed with stern ramp covered.			8m <sup>2</sup> mouth area Tow speed ≤2 knots
RMT-16 (Rectangular Midwater Trawl) Utilises a single warp so can be deployed on the general-purpose towing wire in self-contained mode. Must be deployed with stern ramp covered.			16m <sup>2</sup> mouth area Tow speed ≤2 knots
Trawl Monitoring Instrumentation (ITI) (2,000m depth limit)			MNF to identify this need, dependent on pelagic or demersal trawling requirement
Stern ramp	<b>EXPOSED</b>	<b>INSTALLED</b>	MNF to identify this requirement

RESEARCH SUPPORT INFRASTRUCTURE			
NAME	ESSENTIAL	DESIRABLE	NOTES/COMMENTS
Saltwater Ice Machine (Dirty Wet lab)			
Radiosonde Receiver System	X		Note that this has recently had issues and may need an upgrade prior to the voyage
Laboratory Incubators (Clean Dry lab)			
Deck Incubators			Temperature controlled deck incubators
Milli-Q System	X		
Sonardyne USBL System			
Lab oven	X		

SCIENTIFIC / SAMPLE ANALYSIS SYSTEMS				
MICROSCOPES:				NOTES/COMMENTS
BRAND / MODEL	TYPE	ESSENTIAL	DESIRABLE	Refer to the "MNF microscopes procedure" for more information
Leica / M80	Dissecting			
Leica / M80	Dissecting			
Leica /MZ6	Dissecting			
Olympus / CH	Compound			
Olympus /CH	Compound			
Leica / MTU282	Camera tube			
Adapters for tube / Nikon	Pentax			
Ring Light *2 / MEB121	LED			
Heavy Duty Electronic Balance (80kg)				

SCIENTIFIC / SAMPLE ANALYSIS SYSTEMS			
MICROSCOPES:			NOTES/COMMENTS
Medium Duty Electronic Balance (15kg/5g resolution)			
Light Duty Electronic Balance (3kg/1g resolution)			

### Underway systems

ACOUSTIC UNDERWAY SYSTEMS			
NAME	ESSENTIAL	DESIRABLE	NOTES/COMMENTS
75kHz ADCP			
150kHz ADCP			
Multi Beam Echo Sounder EM122 12kHz (100m to full ocean depth)			
Multi Beam Echo Sounder EM710 70-100kHz (0-1000m approx.)			
Sub-Bottom Profiler SBP120			
Scientific Narrowband Echo Sounders EK60 (6 bands, 18kHz-333kHz)			EK60s will be onboard for use as a backup for EK80s and set in narrowband mode Quantitative measurements from scientific echosounders requires sphere calibration in the watermass of sampling
Scientific Narrowband/Broadband Echo Sounders EK80 (6 bands, 18kHz-333kHz)			EK80s will be used in narrowband mode unless otherwise requested Quantitative measurements from scientific echosounders requires sphere calibration in the watermass of sampling
Multibeam Scientific Echo Sounder ME70 (70-100 kHz)			

ACOUSTIC UNDERWAY SYSTEMS			
NAME	ESSENTIAL	DESIRABLE	NOTES/COMMENTS
Omnidirectional Echo Sounder SH90			
Gravity Meter			

ATMOSPHERIC UNDERWAY SENSORS			
NAME	ESSENTIAL	DESIRABLE	NOTES/COMMENTS
Nephelometer	X		
Magee Aethelometer (AE33)	X		Note this instrument will have been upgraded from a MAAP to an AE33 by this voyage
Mobility Particle Size Spectrometer (MPSS)	X		Note this instrument will have been upgraded from a SMPS to a MPSS by this voyage
Radon Detector	X		In conjunction with back trajectories radon observations on the RVI and at KCGBAPS will be key to verifying that the stations are seeing similar air masses.
Ozone Detector	X		

ATMOSPHERIC UNDERWAY SENSORS			
NAME	ESSENTIAL	DESIRABLE	NOTES/COMMENTS
Condensation Particle Counter (CPC)	X		
Picarro G2301 Spectrometer (analysis of CO <sub>2</sub> /CH <sub>4</sub> /H <sub>2</sub> O)	X		
Picarro 5310 Spectrometer (analysis of N <sub>2</sub> O/CO/H <sub>2</sub> O)	X		Note this instrument will have been upgraded from an aerodyne to a Picarro 5310 by this voyage
Cloud Condensation Nuclei (CCN)	X		
Polarimetric Weather Radar	X		
Filter Aerosol Sampling units (FAS) x 3	3X		Used for collecting physical aerosol samples on filters.  FAS includes pumps, filter holders, flow controllers, totalizer, Very Sharp Cut Cyclone (VSCC) PM1 and PM2.5.
MNF Metek MRR-PRO	X		
MNF ODM470 disdrometer (mast)	X		
Air-sea flux instruments	X		

UNDERWAY SEAWATER SYSTEMS AND INSTRUMENTATION			
NAME	ESSENTIAL	DESIRABLE	NOTES/COMMENTS
Thermosalinograph		X	
Fluorometer		X	
Optode			
pCO2		X	

SEAWATER SYSTEMS			
NAME	ESSENTIAL	DESIRABLE	NOTES/COMMENTS
Trace metal clean seawater supply	X		
Scientific clean seawater supplied to laboratories	X		
Raw seawater available on deck and in laboratories			

EQUIPMENT AND SAMPLING GEAR REQUIRING EXTERNAL SUPPORT (MAY REQUIRE ADDITIONAL SUPPORT FROM APPLICANTS)			
NAME	ESSENTIAL	DESIRABLE	PLEASE GIVE THIS CAREFUL CONSIDERATION, AS THERE IS NO GUARANTEE THAT THESE RESOURCES WILL BE AVAILABLE UNLESS SPECIFICALLY REQUESTED. LIAISE WITH YOUR VOYAGE OPERATIONS MANAGER AS REQUIRED. ADDITIONAL STAFF MAY BE REQUIRED FOR THESE ACTIVITIES.
Seismic Compressors			Additional crew and seismic acquisition personnel will be required to be onboard to support this system. Number of personnel TBD by the MNF. The science party is to provide an onboard seismic data processing resource.
Seismic Acquisition System			Additional crew and seismic acquisition personnel will be required to be onboard to support this system. Number of personnel TBD by the MNF.

<b>EQUIPMENT AND SAMPLING GEAR REQUIRING EXTERNAL SUPPORT (MAY REQUIRE ADDITIONAL SUPPORT FROM APPLICANTS)</b>			
<b>NAME</b>	<b>ESSENTIAL</b>	<b>DESIRABLE</b>	<b>PLEASE GIVE THIS CAREFUL CONSIDERATION, AS THERE IS NO GUARANTEE THAT THESE RESOURCES WILL BE AVAILABLE UNLESS SPECIFICALLY REQUESTED. LIAISE WITH YOUR VOYAGE OPERATIONS MANAGER AS REQUIRED. ADDITIONAL STAFF MAY BE REQUIRED FOR THESE ACTIVITIES.</b>
			The science party is to provide an onboard seismic data processing resource.

<b>NON-MNF OWNED EQUIPMENT WHICH MAY BE ACCESSED</b>			
<b>NAME</b>	<b>ESSENTIAL</b>	<b>DESIRABLE</b>	<b>PLEASE GIVE THIS CAREFUL CONSIDERATION, AS THERE IS NO GUARANTEE THAT THESE RESOURCES WILL BE AVAILABLE UNLESS SPECIFICALLY REQUESTED. LIAISE WITH YOUR VOYAGE OPERATIONS MANAGER AS REQUIRED. ADDITIONAL STAFF MAY BE REQUIRED FOR THESE ACTIVITIES.</b>
D & N Francis winch			15mm electro-optical cable
Box Corer			
UTAS In-Situ Pumps (x2)			
EM2040			Shallow water multibeam echosounder system



# Appendix B

## User Supplied Equipment

The table below will include information provided by the Chief Scientist / Principal Investigators in the '*Equipment Manifest-user supplied voyage specific*' document. The Chief Scientist will co-ordinate the completion of this Manifest with all PIs and forward the completed document to the Voyage Operations Manager.

NOTE: User supplied equipment will remain the responsibility of the science party throughout the voyage. The MNF technicians and ship's crew endeavour to assist wherever possible, however the MNF take no responsibility for the pre-deployment checks or repairs and maintenance of this equipment

This information will also be used for the mobilisation list and deck plan for the voyage.

Owner	Item name	Weight	Dimensions	Location on Vessel
MNF use only				