



## 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_V03
Voyage title:	COAST-k ( <i>Clean Ocean Air Sampling upwind of Tasmania – kennaook</i> )
Mobilisation:	Hobart, 24-28 April 2025
Depart:	Hobart, 0800 Tuesday, 29 April 2025
Return:	Hobart, 0800 Sunday, 18 May 2025
Demobilisation:	Hobart, 18-19 May 2025
Voyage Manager:	Max McGuire
Chief Scientist:	Ruhi Humphries
Affiliation:	CSIRO Environment
Principal Investigators:	Ruhi Humphries (CSIRO, <a href="https://orcid.org/0000-0002-4864-5321">https://orcid.org/0000-0002-4864-5321</a> ), Robyn Schofield (University of Melbourne, <a href="https://orcid.org/0000-0002-4230-717X">https://orcid.org/0000-0002-4230-717X</a> ), Paul Krummel (CSIRO, <a href="https://orcid.org/0000-0002-4884-3678">https://orcid.org/0000-0002-4884-3678</a> ), Melita Keywood (CSIRO, <a href="https://orcid.org/0000-0001-9953-6806">https://orcid.org/0000-0001-9953-6806</a> ), Suzie Molloy (CSIRO), Branka Miljevic (Queensland University of Technology, <a href="https://orcid.org/0000-0003-4408-2047">https://orcid.org/0000-0003-4408-2047</a> ), Alain Protat (Bureau of Meteorology, <a href="https://orcid.org/0000-0002-8933-874X">https://orcid.org/0000-0002-8933-874X</a> ) Alan Griffiths (ANSTO; <a href="https://orcid.org/0000-0003-1135-1810">https://orcid.org/0000-0003-1135-1810</a> )

## PART A – Voyage Highlights

### The Chief Scientist

Dr Ruhi Humphries is the lead coordinating scientist of RV Investigator's Global Atmosphere Watch station, as well as a lead scientist for the aerosol programs on both the RV Investigator and at Kennaook/Cape Grim. He has been working for over 15 years on understanding the role of aerosols in the Southern Ocean and Antarctic regions in the larger climate system. He has been involved in voyages aboard several research vessels and collaborates extensively with both Australian and international researchers.



### Title

COAST-k – Clean Ocean Air Sampling upwind of Tasmania - kennaook

### Purpose

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 (GAW ID: CGO), 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 (the world's first mobile GAW station) during this voyage, both stations were compared directly and data quality validated. The spatial representativeness of CGO was also experimentally tested for the first time, particularly with relation to aerosols, reactive gases and clouds. These high-quality observational datasets feed directly into improving regional and global climate and air quality models.

### Contribution to the nation

Accurately predicting weather, climate and air quality, particularly in the context of the significant environmental change being experienced around the world, is critical to Australia's economy, health and wellbeing. The ability to do this relies fundamentally on high quality observational datasets by which predictive models can be developed and validated. This work aims to validate the quality of the data from two world-leading observational platforms, Kennaook/Cape Grim, situated on the north-west tip of Tasmania, and the RV Investigator. Data from these stations are routinely used both scientifically and operationally in addressing national and international priorities.

Both platforms are also particularly important because they frequently measure the air that has recently been in the Southern Ocean and Antarctic regions – regions that are a particular weak-point for global models and are also critical for the weather systems that impact Australia. This has direct impacts on a variety of industries including agriculture, construction, energy production, and tourism, as examples.

The nature of the voyage also allowed the provision of ample training opportunities for students and early-career scientists.

## As a result of this voyage

1. We have improved our confidence in the data obtained from both CGO and the RVI where-ever it traverses.
2. We have a better understanding of the spatial representativeness of measurements obtained at CGO for a range of atmospheric components. This will help inform where future measurements need to focus to ensure adequate geographic representativeness.
3. We have obtained a rare aerosol – cloud – precipitation – surface radiation Southern Ocean dataset in the late autumn – existing datasets are often heavily biased to summer-time observations.
4. We have obtained data to calibrate and assess the EarthCare satellite products in the data-sparse regions of the Southern Ocean.

## Next steps

Extensive data curation and sample analysis is required for all the various datasets obtained during this voyage. Once complete, data will be made publicly available in the relevant data repositories where modelers will utilise these data to compare with model output, identify model deficiencies and determine and implement improvements. After suitable scientific analysis of both observational and model data, results will be published in the scientific literature, presented at relevant domestic and international conferences, and shared through various professional networks and their newsletters and websites. Satellite validation results will be presented to the space agencies and the science community for their awareness and for further action if required.

## PART B - Voyage Summary

### Executive summary

The COAST-k (Clean Ocean Air Sampling upwind of Tasmania – kennaook) voyage, designated as IN2025\_V03, was conducted from April 29 to May 18, 2025. The voyage was led by Chief Scientist Dr. Ruhi Humphries from CSIRO Environment, with the primary goal of enhancing our understanding of the Southern Ocean's atmosphere and its influence on global climate systems.

**Purpose and Objectives** The voyage aimed to leverage the mobility of the RV Investigator, the world's first mobile Global Atmosphere Watch (GAW) station, to directly compare atmospheric data with the Kennaook/Cape Grim Baseline Air Pollution Station (CGO). This comparison was intended to validate observational data, which is crucial for enhancing regional and global climate and air quality models. The project also sought to test the spatial representativeness of CGO measurements, particularly concerning aerosols, reactive gases, and clouds.

#### Key Achievements

1. **Data Validation:** The voyage successfully validated the data from both CGO and the RV Investigator, enhancing confidence in the observational datasets used for climate and air quality modelling.
2. **Spatial Representativeness:** The voyage provided a better understanding of the spatial representativeness of CGO measurements, informing future measurement strategies to ensure adequate geographic coverage.
3. **Unique Datasets:** The voyage collected rare datasets of the mid-Southern Ocean atmosphere during late autumn, a period typically under-sampled due to challenging weather conditions.
4. **Satellite Data Calibration and Evaluation:** Data obtained during the voyage will be used to assess the calibration of the EarthCARE instruments and assess the quality of selected EarthCARE aerosol, cloud, surface radiation, and precipitation products in the data-sparse regions of the Southern Ocean.

**Contribution to the Nation** The high-quality observational datasets obtained from this voyage are critical for accurately predicting weather, climate, and air quality, which are essential for Australia's economy, health, and wellbeing. The data will support scientific and operational efforts to address national and international priorities, particularly in regions like the Southern Ocean and Antarctic, which are vital for global climate models and weather systems impacting Australia. Additionally, the voyage provided valuable training opportunities for students and early-career scientists, contributing to the development of the next generation of researchers.

**Next Steps** Extensive data curation and sample analysis are required for the various datasets obtained during the voyage. Once complete, the data will be made publicly available in relevant repositories, enabling modelers to compare with model outputs, identify deficiencies, and implement improvements. The results will be published in scientific literature, presented at conferences, and shared through professional networks.

## 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 (CGO), 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 CGO – a global first. This will include validating the RVI's full suite of atmospheric measurements and sampling systems against complementary measurements at the CGO, improving data quality for all locations visited by the vessel.
2. Validate how representative measurements of atmospheric composition and boundary layer structure at the CGO 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 (CGO), spending five days as close to the station as possible to enable an intercomparison study to occur, where both platforms are sampling the same airmass 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 CGO. 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 while 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 CGO 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 (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 CGO 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 CGO 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.

## Results

It is important to note that analysis of data and samples is still ongoing, and only preliminary results can be provided at this stage. Most data were obtained in real-time throughout the voyage using automated instrumentation (see Curation Report section below for full list). To complement these continuous datasets, additional samples/deployments occurred which included:

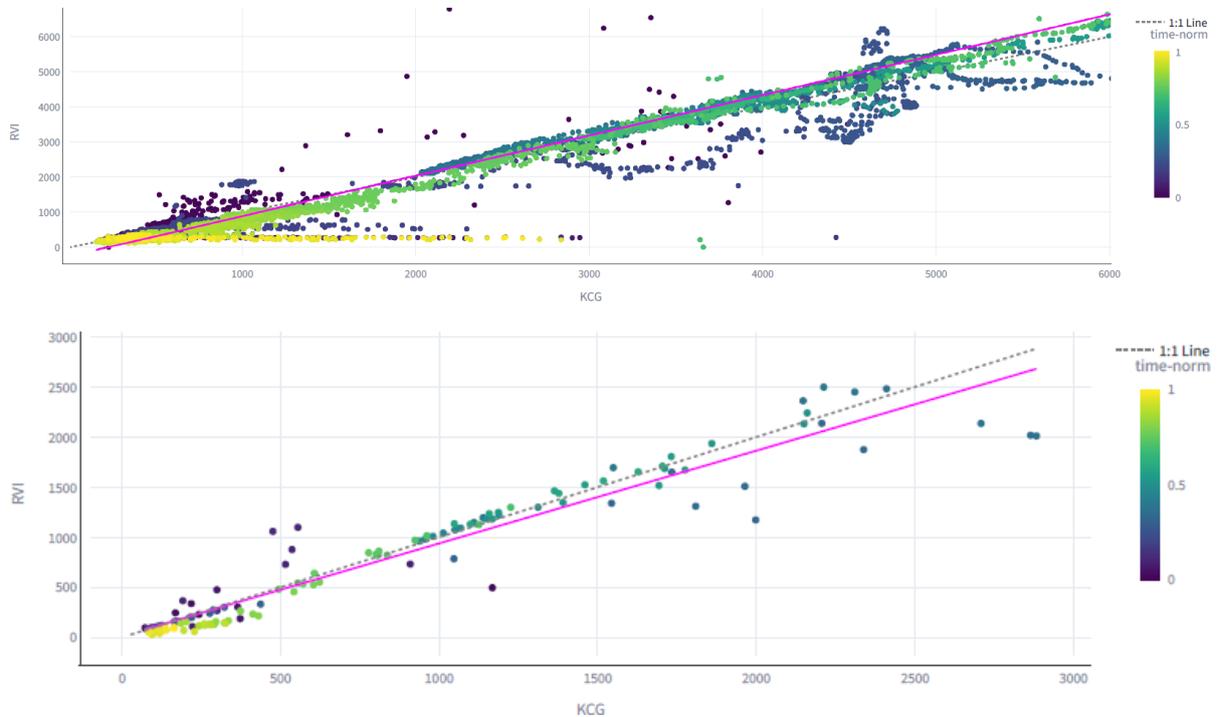
1. 35 radiosonde launches (approximately 8am, 2pm and 8pm daily),
2. 41 filters for aerosol composition
3. 18 filters for Ice Nucleating Particle concentrations
4. 16 filters for atmospheric aerosol acidity
5. 8 filters and 2 rainwater samples for trace metal aerosol composition
6. 5 argo floats deployments
7. 5 EarthCARE satellite overpasses.

A general overview of preliminary results is provided below.

## Site comparison

The goal of a direct station-vessel intercomparison was a great success. Prevailing weather systems meant that we were able to measure the full dynamic range of air types typically measured at CGO, including polluted urban/continental air coming from the Australian continent to the north, coastal southerly airmasses, as well as the pristine baseline conditions the station is known for. Obtaining this full range meant utilising some of the contingency days during this period and spending more time at CGO than the original voyage plan (7 days compared to the original planned 5). Operationally we were able to get much closer to the coast than originally anticipated, being stationed typically at 1 NM from the coast, assisted by favourable weather conditions and expert crew ensuring the safety of the vessel.

Figure 1 shows preliminary correlation plots between two key aerosol parameters measured simultaneously at both platforms and show that data lie nicely on the 1:1 correlation line, showing excellent agreement and a linear correlation. Note that these data have not yet been fully quality controlled, and periods where the intercomparison is not entirely valid have yet to be removed. Comparison across the range of parameters measured during the voyage is an item of future work.



**Figure 1:** Correlation plots comparing data obtained at CGO (x-axis) and aboard the RVI (y-axis) while the vessel was stationed alongside the coastal station. Top: Number concentrations of aerosols larger than 3 nm. Bottom: Number concentrations of Cloud Condensation Nuclei measured at 0.5% supersaturation.

### Baseline verification

Comparison of the two stations at distance requires significant post-processing to temporally align the data and understand any chemical and microphysical transformations that may have occurred between the two measurement points. This is a future task once dataset quality control and assurance has occurred.

### Southern Ocean aerosol, cloud, precipitation and surface radiation dataset in late autumn

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 regularly launched (between 2 and 3 per day) to capture the atmospheric conditions conducive to cloud and precipitation.

Remote sensing instruments collected data nearly continuously throughout the voyage with very few outages. This included 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). In total, 35 radiosondes were successfully launched to provide the basic state of the atmosphere associated with these observations.

### **EarthCARE Satellite Verification**

Putting RV Investigator under the track of the EarthCARE cloud radar – lidar combination was an optional objective of this campaign (part of the SOWCLIP piggyback project). It turned out to be a very successful one, with five successful EarthCARE overpasses. This satellite carries a 95 GHz cloud radar and a multi-frequency lidar similar to what was deployed on RV Investigator. Together with the two successful overpasses achieved during IN2025\_V02, these are the very first observations collected from a research vessel under the EarthCARE track to our knowledge. A sample the comparison data is shown in Figure 2.

### **Challenges**

Navigating weather systems: the goal of getting south near 55°S was not possible due to the frequent low pressure weather systems in the Southern Ocean that brought significant swell and wind to the region. Some of these systems were so large that they spanned almost the entire latitudinal breadth of the Southern Ocean. Due to concerns about the safety and well-being of the vessel and its passengers, several decisions were made to stay further north. This still achieved most of the voyage objectives but didn't get as far south as would have been ideal. However, due to the successful intercomparison of data between CGO and the RVI, data from other voyages can now be compared with confidence to better understand the latitudinal representativeness of the CGO baseline observations.

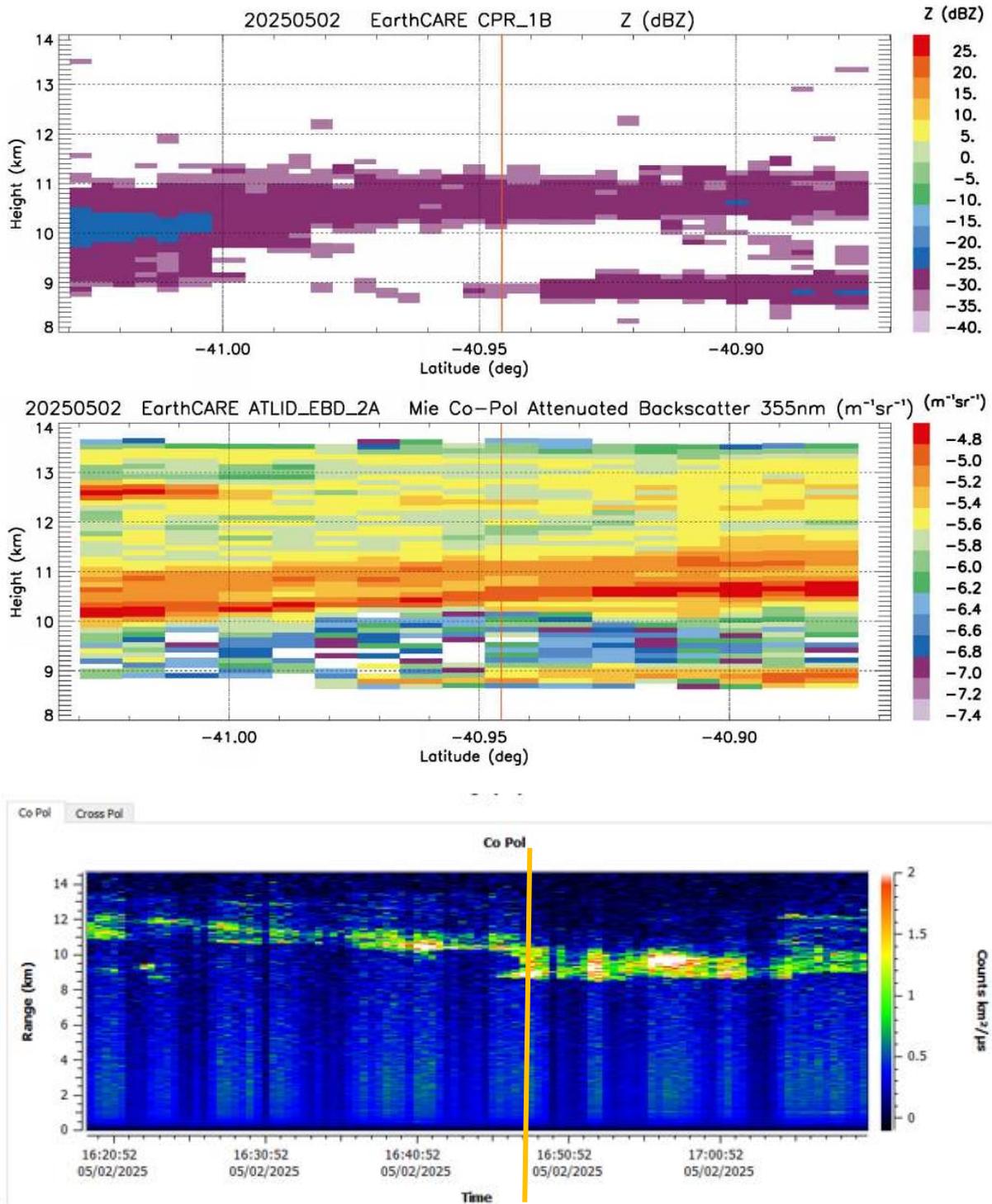


Figure 2: (top) EarthCARE cloud radar reflectivity, (middle) EarthCARE lidar attenuated backscatter, and (bottom) University of Melbourne miniMPL lidar attenuated backscatter at time of overpass. The orange line highlights the approximate time of overpass.

## Voyage narrative

The voyage began with a transit to the baseline air pollution station at Kennaook/Cape Grim where the ship was dynamically positioned between 1 and 3 NM off the coast for 7 days. During this period, the ship's position and orientation was carefully chosen to ensure there was no contamination of atmospheric data at either CGO or aboard the RVI, but in such a way that both stations could be said to be sampling the same airmass and so that data from duplicate instruments at both stations were directly comparable. The duration of the station was determined by the prevailing weather conditions, with the goal of sampling air from a range of directions and conditions, which meant we needed to wait for various weather systems to pass through the region. We managed to sample southerly coastal air, followed by an extended period of warm continental air from the north, and finally pristine baseline marine air from the south-west.

During this period, we had more-than-enough northerly air to achieve the primary voyage objectives, so we utilised some of this time waiting for the right weather conditions to obtain objectives of two of the piggyback projects: an EarthCARE satellite overpass of a cirrus cloud on 2 May at (40.96°S, 143.55°E, 16:47 UTC, orbit 5270) and some shallow seafloor mapping at (40.71°S, 144.63°E).

Once the direct intercomparison period was concluded, we proceeded south-west into the Southern Ocean, choosing a path that minimised exhaust impact on measurements made both on the vessel, and at CGO. The goal during this period was to get as far away from the station as possible while remaining in the upwind sector of CGO so as to measure the same airmasses at both stations. This understandably was highly dependent on the actual weather systems that passed through the region and resulted in significant deviation from the planned voyage track which was based on a climatological average of baseline-selected backward airmass trajectories.

The resulting voyage track was decided dynamically based on the desire to sample the same airmass as CGO, to gather as significant a regional footprint as possible, as well as due consideration for ship safety with the prevailing extreme weather systems transiting the region. Some deviations occurred in order to achieve the objectives of the piggyback project SOWCLIP, which involved positioning the ship under overpasses of the EarthCARE satellite. These deviations added significant scientific benefit with no compromise to the primary voyage objectives. A total of 5 EarthCARE overpasses were successfully achieved, providing an excellent variety of clouds for the validation, and 35 radiosondes were launched to support the analysis of the observations.

## Outreach, education and communications activities

The COAST-k voyage engaged extensively with outreach activities.

### **ECR Training**

The make-up of onboard science participants exhibited 50% that were early-career scientists and students, with others working closely with them as trainers and mentors.

### **Traditional media**

A full list of the media can be found at [this link](#) and the CSIRO-led media release at [this link](#). This resulted in numerous media interviews, some of which are highlighted below:

1. [ABC radio](#)
2. [ABC radio news](#)
3. [ABC online](#)
4. [ABC Perth](#)
5. [ABC Regional](#)
6. [Channel 10 News](#)
7. [WIN TV](#)

A [CSIRO blog](#) was also published which as of 2 July 2025 was read 1363 times.

**Statistics:** a total of around 40 media items reached an audience close to 400K.

Additional outputs not included in the above statistics are listed below:

- [ABC Online article by Tyne Logan](#) which typically has a readership of 1.9 million.
- [Lab Notes Podcast](#) (released 1 July, 2025). Modified versions of these episodes were broadcast on ABC Radio National on 1 July, 2025, and included on the ABC Radio Science Show.

### **Social media**

Social media pieces reached an audience of more than 80K:

1. <https://www.facebook.com/CSIROnews/videos/how-do-clouds-form-in-the-vast-southern-ocean/581984991600192/>
2. <https://www.facebook.com/reel/2068501833625361>

## Summary

This was an ambitious voyage that due to the dynamic nature of the weather systems being studied, demonstrated the responsive and flexible nature of the RV Investigator and her team. Despite some major challenges with having the essential infrastructure and instrumentation operational at both the Kennaook/Cape Grim station and aboard the RV Investigator, the voyage achieved its objectives and can be considered highly successful. Valuable data were obtained in a region of the world that is drastically under-sampled, during a late shoulder season which is almost never sampled due to the challenging weather conditions.

The voyage objectives were achieved successfully and the highly complementary piggyback projects chosen for the voyage amplified the science of the primary project and added ample benefit to the investment in this voyage. The delay of the voyage that occurred because of the COVID-19 pandemic created a significant opportunity where the voyage overlapped with another major project at Kennaook/Cape Grim ([CAPE-k](#)). Both campaigns benefited significantly from having each other occurring simultaneously, resulting in a science output multiplier.

The voyage was a success because of the hard work and dedication of the vessel's crew, MNF teams and the extensive science and technical teams both onboard and onshore. The daily consultative process with the voyage leadership team was a highlight of this collaboration.

## 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
1	Cloud Condensation Nuclei Concentrations (DMT CCNC-100)	Raw data in voyage archive (RVI-GAW dataset)	Data Librarian (raw), DAP (processed)	Ruhi Humphries ( <a href="mailto:Ruhi.Humphries@csiro.au">Ruhi.Humphries@csiro.au</a> )
2	Aerosol number concentrations >3 nm (TSI CPC3756)	Raw data in voyage archive (RVI-GAW dataset)	Data Librarian (raw), DAP (processed)	Ruhi Humphries ( <a href="mailto:Ruhi.Humphries@csiro.au">Ruhi.Humphries@csiro.au</a> )
3	Aerosol number concentrations >10 nm (TSI CPC3772)	Raw data in voyage archive (RVI-GAW dataset)	Data Librarian (raw), DAP (processed)	Ruhi Humphries ( <a href="mailto:Ruhi.Humphries@csiro.au">Ruhi.Humphries@csiro.au</a> )
4	Sub-micron Aerosol Size Distribution (TROPOS MPSS)	Raw data in voyage archive (RVI-GAW dataset)	Data Librarian (raw), DAP (processed)	Ruhi Humphries ( <a href="mailto:Ruhi.Humphries@csiro.au">Ruhi.Humphries@csiro.au</a> )
5	Aerosol absorption (Magee AE33)	Raw data in voyage archive (RVI-GAW dataset)	Data Librarian (raw), DAP (processed)	Ruhi Humphries ( <a href="mailto:Ruhi.Humphries@csiro.au">Ruhi.Humphries@csiro.au</a> )
6	Ozone mixing ratios (Thermo)	Raw data in voyage archive (RVI-GAW dataset)	Data Librarian (raw), DAP (processed)	Suzie Molloy ( <a href="mailto:Suzie.Molloy@csiro.au">Suzie.Molloy@csiro.au</a> )
7	Greenhouse gas (CO <sub>2</sub> and CH <sub>4</sub> ) mixing ratios (Picarro 2301)	Raw data in voyage archive (RVI-GAW dataset)	Data Librarian (raw), DAP (processed)	Zoe Loh ( <a href="mailto:Zoe.Loh@csiro.au">Zoe.Loh@csiro.au</a> )
8	Radon concentration	Raw data in voyage archive (RVI-GAW dataset)	Data Librarian (raw), DAP (processed)	Scott Chambers ( <a href="mailto:szc@ansto.gov.au">szc@ansto.gov.au</a> )
9	Super-micron aerosol size distribution (TSI APS)	Raw data in voyage archive	Data Librarian (raw), DAP (processed)	Ruhi Humphries ( <a href="mailto:Ruhi.Humphries@csiro.au">Ruhi.Humphries@csiro.au</a> )

Item #	Description	Storage	Access	Custodian
10	Continuous aerosol chemical composition (Aerodyne ToF-ACSM)	Raw data in voyage archive	Data Librarian (raw), DAP (processed)	Ruhi Humphries ( <a href="mailto:Ruhi.Humphries@csiro.au">Ruhi.Humphries@csiro.au</a> )
11	Continuous volatile organic compound concentrations (Aerodyne VOCUS)	Raw data in voyage archive	Data Librarian (raw), DAP (processed)	Branka Miljevic ( <a href="mailto:b.miljevic@qut.edu.au">b.miljevic@qut.edu.au</a> )
12	Aerosol hygroscopicity	Raw data in voyage archive	Data Librarian (raw), DAP (processed)	Juha Solo ( <a href="mailto:juha.sulo@qut.edu.au">juha.sulo@qut.edu.au</a> )
13	Size distribution of air ion clusters (NAIS)	Raw data in voyage archive	Data Librarian (raw), DAP (processed)	Juha Solo ( <a href="mailto:juha.sulo@qut.edu.au">juha.sulo@qut.edu.au</a> )
14	Gaseous Elemental Mercury Concentrations (Tekran X and B)	Raw data in voyage archive	Data Librarian (raw), DAP (processed)	Jennifer Powell ( <a href="mailto:Jennifer.Powell@csiro.au">Jennifer.Powell@csiro.au</a> )
15	Trace gas, aerosol and cloud atmospheric profiles (Mini-MPL)	Raw data in voyage archive	Data Librarian (raw), DAP (processed)	Robyn Schofield ( <a href="mailto:Robyn.Schofield@unimelb.edu.au">Robyn.Schofield@unimelb.edu.au</a> )
16	Trace gas and aerosol atmospheric profiles (MAX-DOAS)	Raw data in voyage archive	Data Librarian (raw), DAP (processed)	Robyn Schofield ( <a href="mailto:Robyn.Schofield@unimelb.edu.au">Robyn.Schofield@unimelb.edu.au</a> )
17	Atmospheric Water Isotope concentration (Picarro)	Raw data in voyage archive	Data Librarian (raw), DAP (processed)	David Noone ( <a href="mailto:david.noone@auckland.ac.nz">david.noone@auckland.ac.nz</a> ), Robyn Schofield
18	Aerosol chemical composition (filters)	CSIRO Aspendale	DAP (once published)	Ruhi Humphries ( <a href="mailto:Ruhi.Humphries@csiro.au">Ruhi.Humphries@csiro.au</a> ), Sally Taylor, Melita Keywood
19	Ice Nucleating Particle Concentration (filters analysed with INSEKT)	Karlsruhe Institute of Technology	DAP (once published)	Andreas Schmitt ( <a href="mailto:utqxl@student.kit.edu">utqxl@student.kit.edu</a> ), Ottmar Möhler ( <a href="mailto:ottmar.moehler@kit.edu">ottmar.moehler@kit.edu</a> )
20	Continuous Ice Nucleating Particle Concentrations (PINE)	Karlsruhe Institute of Technology	DAP (once published)	Andreas Schmitt ( <a href="mailto:utqxl@student.kit.edu">utqxl@student.kit.edu</a> ), Ottmar Möhler ( <a href="mailto:ottmar.moehler@kit.edu">ottmar.moehler@kit.edu</a> )

Item #	Description	Storage	Access	Custodian
21	Ice Nucleating Particle Concentrations (filters analysed by cold stage)	Colorado State University	DAP (once published)	Jessie Creamean ( <a href="mailto:jessie.creamean@colostate.edu">jessie.creamean@colostate.edu</a> )
22	Atmospheric DNA (filters)	Colorado State University	DAP (once published)	Jessie Creamean ( <a href="mailto:jessie.creamean@colostate.edu">jessie.creamean@colostate.edu</a> )
23	Clouds: Hydrometeor radar properties (OceanPol C-Band Weather Radar)	Raw data in voyage archive (MNF underway dataset)	Data Librarian (raw), DAP (processed)	Alain Protat ( <a href="mailto:Alain.Protat@bom.gov.au">Alain.Protat@bom.gov.au</a> )
24	Clouds: Vertically pointing radar reflectivity and doppler velocity (Mini BASTA W-Band Doppler Radar)	Raw data in voyage archive	Data Librarian (raw), DAP (processed)	Simon Alexander ( <a href="mailto:simon.alexander@aad.gov.au">simon.alexander@aad.gov.au</a> ), Alain Protat ( <a href="mailto:Alain.Protat@bom.gov.au">Alain.Protat@bom.gov.au</a> )
25	Clouds: Lidar attenuated backscatter and depolarisation (RMAN Raman Lidar)	Raw data in voyage archive	Data Librarian (raw), DAP (processed)	Alain Protat ( <a href="mailto:Alain.Protat@bom.gov.au">Alain.Protat@bom.gov.au</a> )
26	Clouds: Attenuated backscatter and cloud base (Vaisala CT-25 ceilometer)	Raw data in voyage archive	Data Librarian (raw), DAP (processed)	Simon Alexander ( <a href="mailto:simon.alexander@aad.gov.au">simon.alexander@aad.gov.au</a> )
27	Clouds: K-band vertically point radar reflectivity (Micro-Rain Radar)	Raw data in voyage archive	Data Librarian (raw), DAP (processed)	Alain Protat ( <a href="mailto:Alain.Protat@bom.gov.au">Alain.Protat@bom.gov.au</a> )
28	Cloud Drop Size Distribution and rainfall rate (ODM470 distrometer)	Raw data in voyage archive (MNF underway dataset)	Data Librarian (raw), DAP (processed)	Alain Protat ( <a href="mailto:Alain.Protat@bom.gov.au">Alain.Protat@bom.gov.au</a> )
29	Cloud Drop Size Distribution and rainfall rate (Parsivel-2 Disdrometer)	Raw data in voyage archive	Data Librarian (raw), DAP (processed)	Simon Alexander ( <a href="mailto:simon.alexander@aad.gov.au">simon.alexander@aad.gov.au</a> )

Item #	Description	Storage	Access	Custodian
30	Eddy surface fluxes (Sonic anemometer)	Raw data in voyage archive	Data Librarian (raw), DAP (processed)	Jason Monty ( <a href="mailto:Jason.Monty@unimelb.edu.au">Jason.Monty@unimelb.edu.au</a> )
31	Clouds: 23 and 31 GHz brightness temperature (microwave radiometer)	Raw data in voyage archive	Data Librarian (raw), DAP (processed)	Jay Mace ( <a href="mailto:Jay.Mace@utah.edu">Jay.Mace@utah.edu</a> )
32	Atmospheric thermodynamic profiles (radiosondes)	Raw data in voyage archive	Data Librarian (raw), DAP (processed)	Alain Protat ( <a href="mailto:Alain.Protat@bom.gov.au">Alain.Protat@bom.gov.au</a> ), Jay Mace ( <a href="mailto:Jay.Mace@utah.edu">Jay.Mace@utah.edu</a> )
33	Aerosol Optical Depth (Microtops)	NASA Maritime Aerosol Network	NASA Maritime Aerosol Network	Alexander Smirnov ( <a href="mailto:alexander.smirnov-1@nasa.gov">alexander.smirnov-1@nasa.gov</a> )
34	Aerosol trace metal concentrations (filters)	University of Tasmania	University of Tasmania	Andrew Bowie ( <a href="mailto:andrew.bowie@utas.edu.au">andrew.bowie@utas.edu.au</a> )

A list of the 35 radiosonde launches is provided below, including launch dates and times (YYYYMMDD HHMM, UTC), latitude and longitude:

- |   |   |   |
|---|---|---|
| 1. 20250502 1559 -40.874725 143.525375  | 13. 20250510 1706 -45.145832 132.804306 | 25. 20250514 0411 -43.242199 142.175583 |
| 2. 20250507 2158 -41.432426 143.412857  | 14. 20250510 2216 -44.442913 132.834122 | 26. 20250514 1007 -43.642960 143.590988 |
| 3. 20250508 0103 -41.662235 143.142319  | 15. 20250511 0351 -43.590740 132.925583 | 27. 20250515 0235 -44.101089 148.062271 |
| 4. 20250508 0402 -41.789848 142.754684  | 16. 20250511 1002 -42.636761 133.015335 | 28. 20250515 0606 -44.100990 148.118622 |
| 5. 20250508 0916 -41.741234 141.786789  | 17. 20250511 2205 -41.530125 133.173508 | 29. 20250515 1004 -44.101395 148.119110 |
| 6. 20250508 1205 -41.756985 141.225296  | 18. 20250512 0345 -42.147789 133.148041 | 30. 20250516 0041 -44.699005 147.149582 |
| 7. 20250508 2207 -43.226254 140.451340  | 19. 20250512 1003 -42.490559 133.804352 | 31. 20250516 0541 -44.692505 147.140411 |
| 8. 20250509 0300 -43.677143 140.125580  | 20. 20250512 1700 -42.491245 134.713409 | 32. 20250516 0958 -44.692249 147.140823 |
| 9. 20250509 0914 -43.760841 139.549850  | 21. 20250512 2206 -42.126987 135.489044 | 33. 20250516 2206 -44.692448 147.143799 |
| 10. 20250509 2204 -44.350887 136.707108 | 22. 20250513 0401 -41.570404 136.900940 | 34. 20250517 0302 -44.688244 147.137344 |
| 11. 20250510 0401 -44.654453 135.223343 | 23. 20250513 1001 -41.164131 138.266312 | 35. 20250517 0604 -44.688015 147.137665 |
| 12. 20250510 1004 -44.867702 134.176620 | 24. 20250513 2203 -42.402435 140.979874 |   |

List of EarthCARE overpass dates and times (HH:MM, UTC) are provided below:

1. Orbit 5270 20250502 16:47
2. Orbit 5371 20250509 04:09
3. Orbit 5395 20250510 17:34
4. Orbit 5418 20250512 04:39
5. Orbit 5426 20250512 17:24

### Track Chart

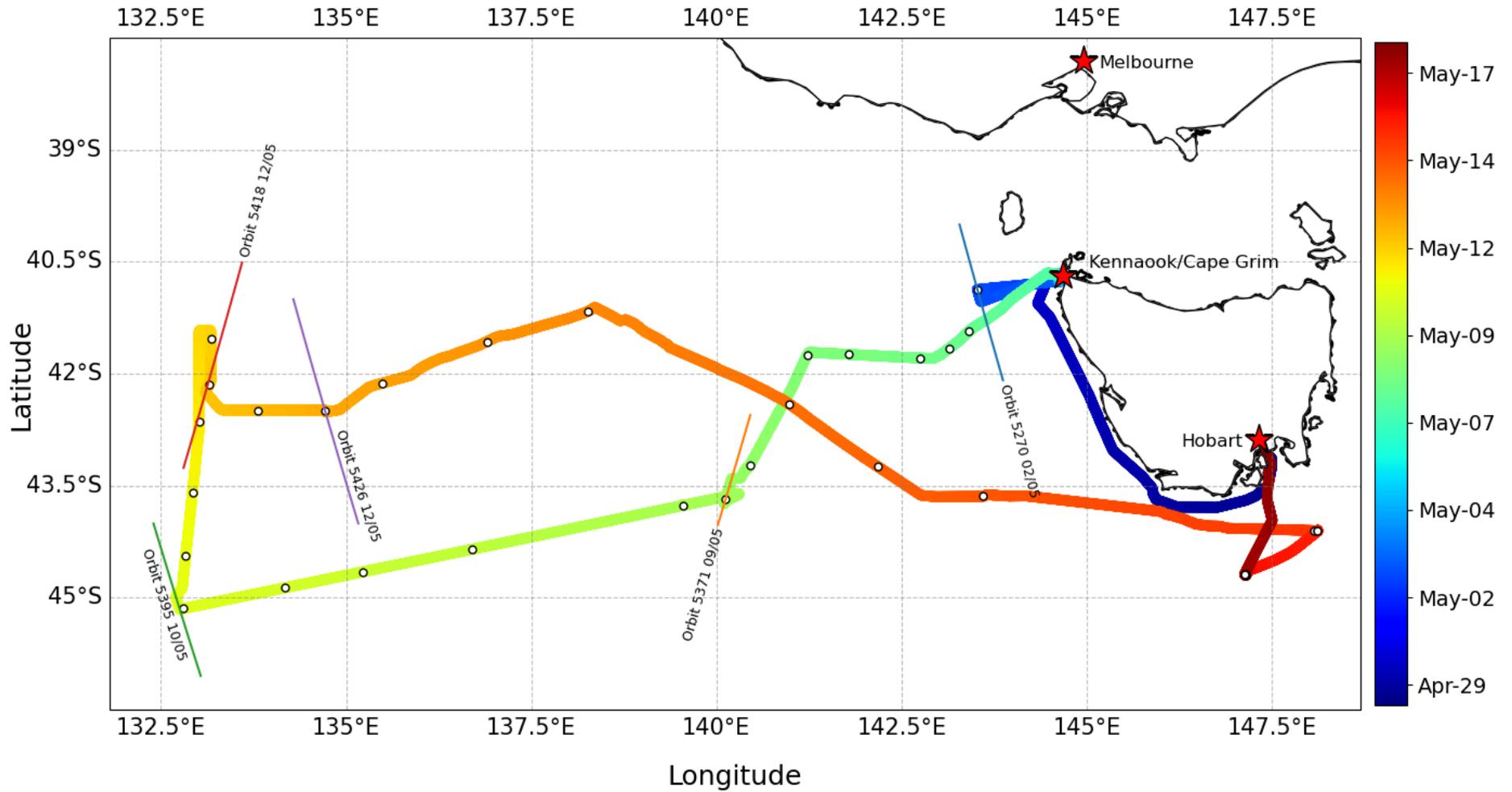


Figure 3: Voyage track of COAST-k, coloured by voyage date. White dots indicate the release points of radiosondes enroute, while coloured lines indicate the flight track of the EarthCARE satellite that was targeted throughout the voyage.

## Links to Further Data and Information

[NCMI Information and Data Centre \(csiro.au\)](http://ncmi.csiro.au)

[Data Trawler \(csiro.au\)](http://data.csiro.au) – Data Extraction tools for Voyage Data

[MNF Reporting \(csiro.au\)](http://mnf.csiro.au) – Publications and reports from research on vessels run by the Marine National Facility

[Marlin3 - Marlin - CSIRO Oceans and Atmosphere Metadata Catalogue](http://marlin3.csiro.au)

[Open Access to Ocean Data \(aodn.org.au\)](http://aodn.org.au)

[AusSeabed \(ausseabed.gov.au\)](http://ausseabed.gov.au)

[CSIRO Data Access Portal \(data.csiro.au\)](http://data.csiro.au)

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

Description	Link
World Data Centre for Aerosols	<a href="https://www.gaw-wdca.org/">https://www.gaw-wdca.org/</a>
World Data Centre for Greenhouse Gases	<a href="https://gaw.kishou.go.jp/">https://gaw.kishou.go.jp/</a>
World Data Centre for Reactive Gases	<a href="https://www.gaw-wdcrg.org/">https://www.gaw-wdcrg.org/</a>

## Acknowledgements

The project team would like to thank the Marine National Facility for access and use of the Research Vessel, the science support teams who helped commission and maintain the ship's science systems and to the incredibly supportive, flexible and professional crew who worked closely with the voyage team to achieve the voyage objectives in challenging and dynamic conditions. The team would also like to thank the technical and scientific teams at Kennaook/Cape Grim who have, over a period of almost 50 years, established the most consequential record of atmospheric chemistry and composition in the Southern Hemisphere, and who, despite significant infrastructure challenges in the weeks leading up to the voyage, managed to have everything operational at the station to enable the voyage objectives to be completed successfully. We would also like to thank the CAPE-k team for their collaborative support of the voyage. In particular, the meteorological expertise of Jay Mace and Sarah Prior was critical in making operational decisions onboard the vessel. CSIRO scientists would like to thank the Climate, Atmosphere and Oceans Interaction Program of the Environment Research Unit for continued funding to enable participation in the voyage. The project team would also like to acknowledge the support from the Australian Antarctic Program Partnership (AAPP).

## Signature

Your name:	Ruhi Humphries
Title:	Chief Scientist
Signature:	
Date:	22 July, 2025

## Appendix A – Photographs

Photos from voyages are valuable for documenting the conduct of the voyage and for engagement or promotional use. Voyage photos may be published in the MNF Annual Report and the voyage gallery on the MNF website or used for education or promotion purposes by CSIRO.

Please provide a set of high-resolution photos from your voyage (a maximum of 10-20 per voyage) as .jpg, .png or .tif files and include a short caption and an image credit with each. Image credits must include the photographer and the institution, where the institution is a copyright owner. In supplying these photos, you agree to CSIRO using them, with attribution, for the purposes described above.

If referring to significant equipment items in the text, supply a photo or diagram so that readers can gain a sense of what has been done. Where possible, we encourage you to include people (particularly students) in photos, however only with permission from the subject.

Seek to represent people in a positive way and avoid release of inappropriate content. Images supplied should demonstrate best practice in meeting HSE requirements on board.

View recent [Annual Reports](#) for ideas on what type of photos to supply.



Figure 4: Sunrise at Kennaook/Cape Grim, as seen from the RV Investigator while stationed 1 NM offshore during COAST-k. Credit: Alex Wood.



Figure 5: Panorama of sunrise at Kennaook/Cape Grim, as seen from the RV Investigator while stationed 1 NM offshore during COAST-k. Credit: Alex Wood



Figure 6: Atmospheric sampling and remote sensing instrumentation on Deck 5 of the RV Investigator at sunset while stationed offshore of Kennaook/Cape Grim. The islands in the centre of picture are the Koindrim / The Doughboys. Credit: Alex Wood



Figure 7: The air sample distribution system in the Aerosol Laboratory at the bow of the ship. Air is drawn down from an inlet 18 m above sea level, and splits into several different branches where instruments measure various properties of the air and its aerosol. This small lab was the key work place for this voyage, and was packed to the brim. Credit: Alex Wood.



Figure 8: The sampling tower (left) pictured with the RV Investigator stationed 1 NM offshore, taken from near the cliffs just north of the Kennaook/Cape Grim station. Credit: Melita Keywood



Figure 9: The RV Investigator while stationed 1 NM offshore during COAST-k, taken through telescope from west coast Marrawah township, Perminghana Indigenous Protected Area in the foreground. Credit: Sarah Prior



Figure 10: Dolphins racing the ship during the transit along Tasmania's west coast on the way to Kennaook/Cape Grim. Credit: Alex Wood



Figure 11: The RV Investigator while stationed 1 NM offshore during COAST-k, as seen from the roof-deck of the Kennaook/Cape Grim station with an aerosol sampler in the foreground. Credit: Melita Keywood



Figure 12: The RV Investigator's sampling mast as we pointed the ship into the prevailing baseline wind to ensure sampling of the pristine air. Credit: Alex Wood

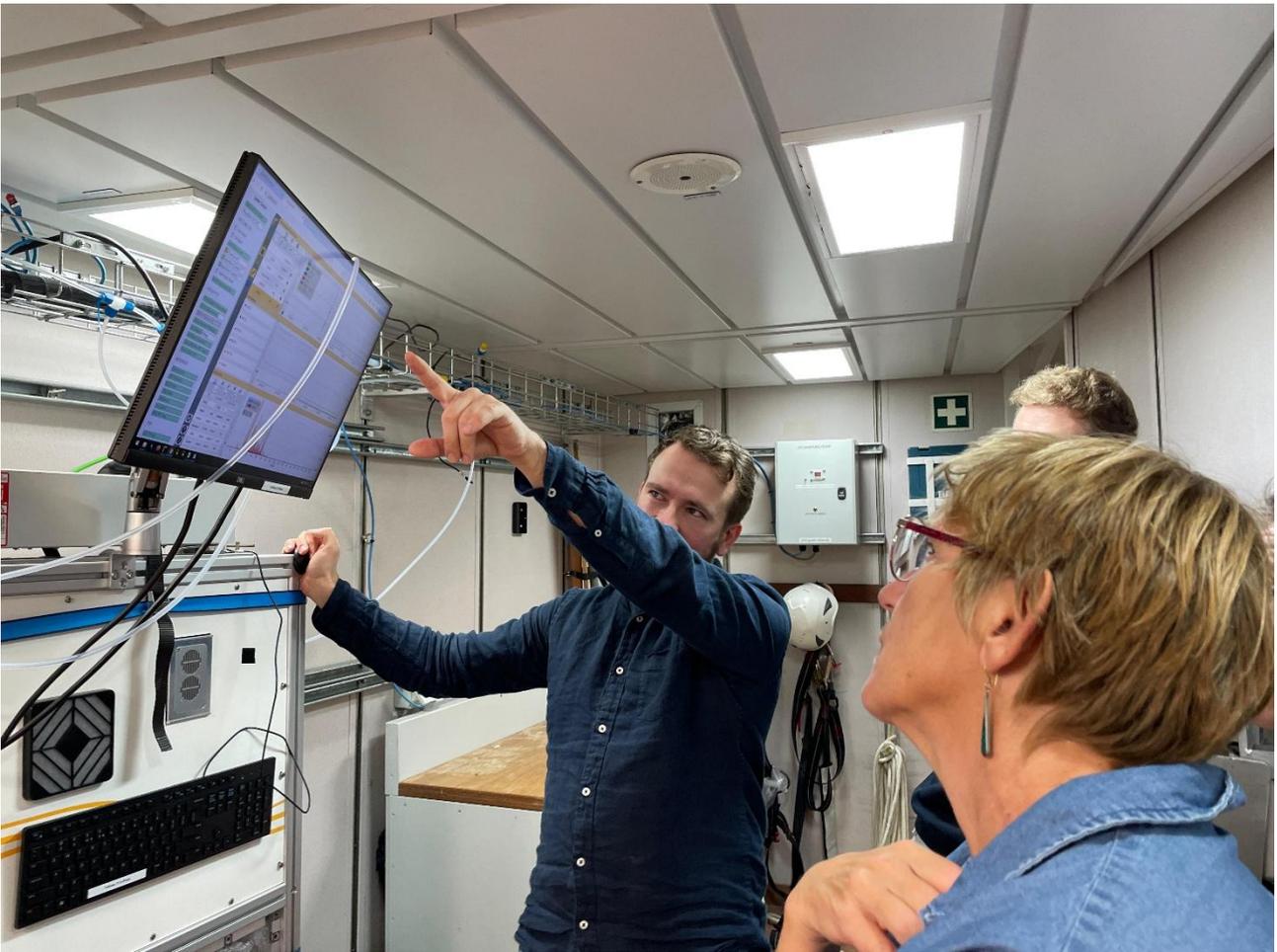


Figure 13: Scientist Juha Sulo showing colleagues the finer details of the mass spectrometer measuring volatile organic compounds in the RV Investigator's Air Chemistry Laboratory. Credit: Alex Wood.

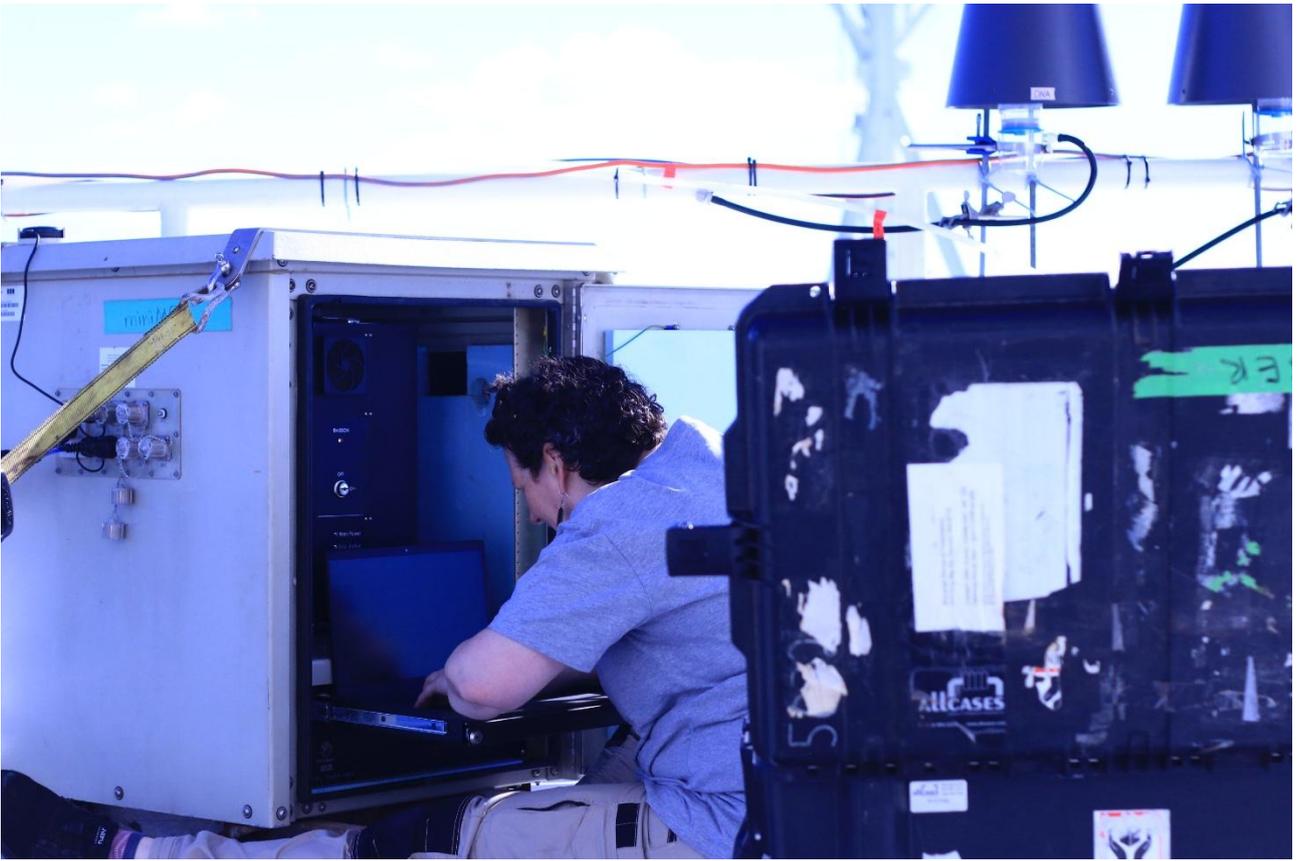


Figure 14: Scientist Robyn Schofield performing calibrations on the micropulse lidar on the RV Investigator's deck 5 during calm weather. Credit: Alex Wood.



Figure 15: kennaook/Cape Grim station, as seen from the RV Investigator while stationed 1 NM offshore during COAST-k. Credit: Alex Wood.



Figure 16: Sunset on the RV Investigator while stationed 1 NM offshore during COAST-k. Credit: Alex Wood



Figure 17: ARM Technician Tom Day maintaining the MAERI as part of CAPE-k with RVI nearshore. Credit: Frank Zurek