



RV Investigator Voyage Summary

| Voyage #: | IN2016_T02 | | |
|-----------------------------|---|---------------------|--------------------------|
| Voyage title: | Transit – Hobart to Sydney | | |
| Mobilisation: | Hobart, 0800 Wednesday, 24 August 2016 | | |
| Depart: | Hobart, 1000 Thursday, 25 August 2016 | | |
| Return: | Sydney, 1000 Monday, 29 August 2016 | | |
| Demobilisation: | Sydney, 1000 Monday, 29 August 2016 | | |
| Voyage Manager: | Tegan Sime | Contact details: | Tegan.sime@csiro.au |
| Chief Scientist: | A/Prof Andrew Bowie | | |
| Affiliation: | IMAS/ACE CRC, University of Tasmania | Contact details: | Andrew.Bowie@utas.edu.au |
| Primary project: | Natural iron fertilisation of the oceans around Australia: linking terrestrial dust and bushfires to marine biogeochemistry | | |
| Piggyback project names: | Australasian Seabird Group Australian Hydrographic Office | | |

Objectives and brief narrative of voyage

Scientific objectives

Natural iron fertilisation of the oceans around Australia: linking terrestrial dust and bushfires to marine biogeochemistry

Oceans play a vital role in Earth's climate through the control of atmospheric CO2. An important component of this system is the iron cycle, in which iron-rich aerosols are transported from land via atmosphere to ocean. Iron is a key micronutrient for marine phytoplankton, the scarcity of which controls essential biogeochemical processes. This project will facilitate an integrated shipbased atmospheric observational program for trace elements in oceans around Australia. During the voyages, we will sample and conduct experiments on atmospheric particles containing terrestrial dust, bushfire smoke and anthropogenic emissions that are transported from Australia to its surrounding oceans. This will provide the critical information on atmospheric iron supply for ocean fertility and health, providing the science for predicting a key factor in the future impact of the oceans on climate. The project supports the training and research of two postgraduate PhD students

Voyage objectives

Transit Objective

The main objective of this transit voyage is to move the vessel from Hobart to Sydney prior to IN2016_V04. The objectives listed below are complementary with the transit.

Natural iron fertilisation of the oceans around Australia: linking terrestrial dust and bushfires to marine biogeochemistry

We will install an atmospheric sampling system for the clean collection of particles in the ship's aerosol lab. 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), 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 using different filters on different lines. A newer more sophisticated version of this aerosol sampling system (including PM1, PM2.5, and TSP size selective inlets) is being developed at CSIRO and should be ready for installation on RV Investigator in the latter part of 2016.

Samples will be collected on a range of different filter types (polycarbonate, Whatman-41, cellulose, Teflon) suitable for different analytical needs. Filters will be changed approximately daily, depending on the aerosol loading, flow rates and amount of time the air inlet is in a suitable 'clean' air sector and sampling takes place. The sector sampling switch records the date/times and waypoints when the wind is 'in sector'. A range of procedural and field exposure blanks will be collected at sea, as well as preliminary leaching and dissolution experiments. Sampled filters will be stored frozen and returned to the shore-based laboratory for further experiments and analyses.

We will also opportunistically collect event-based clean rainwater samples using either a polyethylene funnel and collection bottle (when conditions allow) or a Dual Chimney Precipitation Sampler (N-Con Systems model 00-127; currently on order), to quantify the trace metal deposition in the 'bulk' and 'precipitate-only' fractions. Ideally samples would be collected on upper and forward decks, either above the bridge or at the bow when heading into the wind.

The project also requests access to the RV *Investigator* trace metal clean underway supply system (preferably the outlet in the clean wet lab which has been designed for clean filtration and sampling in the laminar flow hood). This will enable us to correlate the atmospheric flux of trace elements with the surface in-water concentrations. Surface seawater will also be used for leaching and dissolution experiments on the collected atmospheric particles.

Our sampled aerosols will include terrestrial dust, processed soils, particles generated through biomass burning and industrial processes, and marine aerosols. Analyses and lab-based experiments will provide observations on 'bulk' measurements of micronutrient trace elements (including iron), their solubility in fresh and saline waters (Buck et al., 2006; Mackie et al., 2006; Baker and Jickells, 2006), their processing during long-range transport and cycling (Sedwick et al., 2008), and their bioavailability to marine phytoplankton. Isotopic tracers (radon-222, δ 56Fe) and back-trajectories will be used to differentiate the source, fetch and air type.

Spatial and temporal variability in the distribution and abundance of seabirds

Seabirds are distributed patchily over the ocean both in space and in time. While the deployment of remote tracking devices on breeding birds has provided a window into their at-sea movements, they do not report on non-breeding or juvenile birds. It is often the survival of these stages that can have dramatic impacts on population dynamics. The long term monitoring of at-sea distribution of seabirds in the oceans around Australia can facilitate a better understanding of the dynamics of these species in an often unpredictable environment. The proposed study using at-sea observations collected along-side oceanographic data will improve our understanding of seabirds and the way in which they relate to our changing ocean environments.

Seabird at sea data will be collected according to the method described by the BIOMASS Working Party on Bird Ecology (1985). Seabird observations will be made continuously while the vessel is underway during daylight hours from the observation deck on board *RV Investigator*.

Australian Hydrographic Office

A 24 hour hydrographic survey east of Flinders Island of an area around an unconfirmed sounding named "Minnie Carmichael rock" will be conducted for the Australian Hydrographic Service.

Results

All voyage objectives were completed satisfactorily for the primary project and two piggyback projects.

The transit trip IN2016_T02 traversed from Hobart (departed 10:00 25/08/16) to Sydney (arrived 10:00 29/08/16). The primary scientific objective of the transit voyage was to undertake studies of natural iron fertilisation of the oceans. A suite of aerosol samples was collected for the analysis of trace elements in atmospheric particles. No rain water was sampled due to lack of precipitation. Two new PhD students were trained in the methodologies and equipment used to study the atmospheric deposition of trace elements. This work contributed to a wider integrated ship-based atmospheric observational program for trace elements in oceans around Australia.

There was no evidence of "Minnie Carmichael rock" east of Flinders Island.

Chief Scientist Bowie provided training to the group from UTS and Macquarie University of the use of the trace metal rosette (TMR) and in situ pumps (ISPs) in preparation for the following voyage IN2016_V04.

The Australasian Seabird Group (ASG) project's aim was to collect data to be used for analyses to quantify the variability in the distribution and abundance of seabirds in the oceans around Australia over a broad range of temporal and spatial scales. The survey on IN2016_T02 traversed the shelf break on four occasions, affording two periods of high seabird abundance to be logged. Two further crossings were during periods of darkness. Highlights included a southern distribution point for the pan-tropical Wedge-tailed Shearwater (*Puffinus carneipes*) off the north-eastern coast of Tasmania. This species is common north the Victorian - NSW border. Additionally, a rare sighting was made of a Common Diving-petrel off Sydney Heads; the species is generally considered a cool to cold water species, and is more often recorded south of NSW waters. A total 33 species was logged during the voyage. A total of 524 individuals were observed with Fairy prion (*Pachyptila turtur*) the most common. As this was the initial voyage of the program, the extant data are of insufficient volume to make any conclusions regarding spatial and temporal variation in the species seen.

Voyage Narrative

The short voyage was enjoyed by all on-board, with good sailing conditions. A daily evening seminar series provided insights into the work of the different teams on-board.

Summary

Satisfactory completion of all voyage objectives.

Marsden Squares

Move a red "x" into squares in which data was collected



Summary of Measurements and samples taken

| ltem No. | PI | NO | UNITS | DATA TYPE | DESCRIPTION |
|----------|-------|----|----------------|------------------|-------------------------|
| 1 | Bowie | 4 | Sample filters | M71 | Aerosol trace elements |
| 2 | Bowie | | Underway | B02 | Fluorometer |
| 3 | Bowie | | Underway | H11 | TSG (thermosalinograph) |

Curation Report

| Item No. | DESCRIPTION |
|----------|------------------------------------|
| 1. | Archived by IMAS, GEOTRACES GDAC |
| 2. | Archived by MarLIN, GEOTRACES GDAC |
| 3. | Archived by MNF, AODN |



Track Chart

Personnel List

| | Name | Organisation | Role |
|-----|----------------------|-------------------------|---------------------------------------|
| 1. | Tegan Sime | CSIRO MNF | Voyage Manager |
| 2. | Stephen Thomas | CSIRO MNF | SIT Support |
| 3. | Rod Palmer | CSIRO MNF | SIT Support |
| 4. | Matt Boyd | CSIRO MNF | GSM Support |
| 5. | Amy Nau | CSIRO MNF | GSM Support |
| 6. | Steve Van Graas | CSIRO MNF | DAP Support |
| 7. | Francis Chui | CSIRO MNF | DAP Support |
| 8. | Peter Shanks | CSIRO MNF | DAP Support |
| 9. | Andrew Bowie | IMAS-UTAS/ACECRC | Chief Scientist |
| 10. | Morgane Perron | IMAS-UTAS/ACECRC | Aerosols (natural iron fertilisation) |
| 11. | Michal Strzelec | IMAS-UTAS/ACECRC | Aerosols (natural iron fertilisation) |
| 12. | Nicholas Carlile | Environment NSW | Bird Survey |
| 13. | Mick Roderick | Environment NSW | Bird Survey |
| 14. | Matt Marrison | CSIRO MNF | Communications |
| 15. | Ann Jones | ABC | Reporter |
| 16. | Marian Wiltshire | IMOS | Communications |
| 17. | Warrick Glynn | IMOS | Communications |
| 18. | Ben Arthur | CSIRO | Education and Outreach |
| 19. | Chris Krishna-Pillay | CSIRO | Education and Outreach |
| 20. | Ron Plaschke | MNF Director | Observer |
| 21. | Matt Kimber | CSIRO MNF | TMR/ISP training |
| 22. | Owen Craig | CSIRO | Communications |
| 23. | Martin Ostrowski | Macquarie University | TMR/ISP training |
| 24. | Leonardo Laiolo | UTS | TMR/ISP training |
| 25. | Kim-Arne Groneng | Rapp Hydema | Rapp Hydema Tech |
| 26. | Bard-Morten Pederson | Rapp Hydema | Rapp Hydema Tech |

Marine Crew

| Name | Role |
|------------------|-------------------------|
| Gurmukh Nagra | Master |
| Rod Quinn | Chief Mate |
| Adrian Koolhof | Second Mate |
| Tom Watson | Third Mate |
| Chris Minness | Chief Engineer |
| Sam Benson | First Engineer |
| Mike Sinclair | Second Engineer |
| Ryan Agnew | Third Engineer |
| Shane Kromkamp | Electrical Engineer |
| Gary Hall | Chief Caterer |
| Emma Lade | Caterer |
| Keith Shepherd | Chief Cook |
| Matt Gardiner | Cook |
| Graham McDougall | Chief Integrated Rating |
| Dennis Bassi | Integrated Rating |
| Rod Langham | Integrated Rating |
| Paul Langford | Integrated Rating |
| Peter Taylor | Integrated Rating |
| Darren Capon | Integrated Rating |
| Matthew McNeill | Integrated Rating |

Acknowledgements

We are grateful to the MNF and ASP for ship access prior to the mobilisation day, and for excellent support at sea. We thank the directors of the MNF, ACE CRC and IMAS for support of the primary scientific activity, which was funded by the Australian Research Council.

The ASG wish to acknowledge the assistance and co-operation of the CSIRO Marine National Facility in providing access to the *RV Investigator* for the voyage.

| Your name | A/Prof Andrew Bowie |
|-----------|---------------------|
| Title | Chief Scientist |
| Signature | Ardrew Boms |
| Date: | 09 September 2016 |