RV *Investigator* Voyage Plan

Voyage #:	**IN2016_V05**		
Voyage title:	The Great Barrier Reef as a significant source of climatically relevant aerosol particles		
Mobilisation:	Brisbane, 0800 Monday 26 September – 1700 Tuesday 27 September, 2016		
Depart:	Brisbane, 0800 Wednesday 28 September 2016		
Leg 1 Arrive:	Fitzroy Island, Tuesday October 11, 2016		
Leg 2 Depart :	Fitzroy Island, Tuesday October 11, 2016		
Leg 2 Arrive:	Magnetic Island, Sunday October 16, 2016		
Leg 3 Depart:	Magnetic Island, Sunday October 16, 2016		
Return:	Brisbane, 1700 Monday 24 October 2016		
Demobilisation:	Brisbane, 0800 Tuesday 25 October - 1700 Wednesday October 26, 2016		
Voyage Manager Legs 1, 2 & 3:	Lisa Woodward	**Contact details:**	Lisa.woodward@csiro.au
Chief Scientist Legs 1, 2 & 3:	Professor Zoran Ristovski		
Affiliation:	Queensland University of Technology	**Contact details:**	z.ristovski@qut.edu.au
Principal Investigators:	A/Prof Graham Jones - Southern Cross University Dr Alain Protat – BOM Dr Robin Beaman – James Cook University (Piggyback Project) Dr Robyn Schofield – University of Melbourne Dr Branka Miljevic – Queensland University of Technology* Dr Hiroshi Tanimoto – NIES Japan* Dr Justin Seymour – University of Technology Sydney* Dr Mike Harvey – NIWA, New Zealand* Dr Melita Keywood – CSIRO O & A* Sarah Lawson – CSIRO O & A*		
Supplementary Project			
Principal Investigator:	Karen Wild-Allen		
Project name:	Biogeochemical and optical properties of the Coral Sea and Queensland shelf		
Affiliation	CSIRO Oceans & Atmosphere		
Lead Principal Investigators	Mark Baird – CSIRO Oceans & Atmosphere Lesley Clementson – CSIRO Oceans & Atmosphere* David Blondeau-Patissier – CSIRO Oceans & Atmosphere*		

NB: ***** Indicates that PI will not be an active participant on board *Investigator* for this voyage.

Scientific objectives

Understanding the role of clouds in the warming and cooling of the planet, and how that role changes in a warming world is one of the biggest uncertainties climate change researchers face. A key feature in this regard is the influence on cloud properties of cloud condensation nuclei (CCN), the very small atmospheric aerosol particles necessary for the nucleation of every single cloud droplet. The anthropogenic contribution to CCN is known to be large in some regions; however, ***the natural processes that regulate CCN over large parts of the globe are less well understood, and particularly in the Great Barrier Reef***. The production of new aerosol particles from biogenic sources (forests, marine biota, etc.) is a frequent phenomenon capable of affecting aerosol concentrations, and therefore CCN, on both regional and global scales. ***The biogenic aerosol particles therefore have a major influence on cloud properties and hence climate and the hydrological cycle***. ***Determining the magnitude and drivers of biogenic aerosol production in different ecosystems is therefore crucial for the future development of climate models.***

The fundamental questions that this study will address are:

1. What is the significance of this ecosystem as a natural source of aerosol particles?
2. How strong is this source at the regional level?
3. What is the mechanism of particle production over the GBR?

Voyage objectives

The MNF has divided this voyage into three separate legs to enable and support all primary and supplementary scientific voyage objectives and to accommodate specialist personnel requirements. Personnel transfer locations have been chosen to align with the proposed voyage track within the Great Barrier Reef Marine Park's designated shipping area.

The main objective of the voyage is to acquire observations that will address four key science questions about the role of atmospheric composition in the GBR region:

1. Do marine aerosols along the north Queensland coast have a significant signature that is coral-derived?
2. How does this aerosol change its physicochemical properties, especially its capacity to act as CCN, as winds carry it from the reefs to the north Queensland rainforests?
3. What is the significance of this ecosystem as a source of aerosol particles and will potential degradation of the reef cause significant variations in particle number being generated over the reef.
4. Should changes in this aerosol, associated with reef degradation, be taken into account when modelling the radiative climate and rainfall?

To address the first 2 points cloud, aerosol and atmospheric composition data, uncontaminated by ship exhaust, will be collected at four dedicated atmospheric measurement stations, where the ship will remain for up to 48(or more) hours oriented into the wind. In addition data will be continuously sampled during the transient parts of the voyage. Special interest will be on the transects through the reef.

The four proposed measurement stations include:

- Two stations on the western side of the GBR. These stations will enable us to sample the air masses that have traversed over the reefs and have been enriched by the emissions from the reefs. One of the sites would cover the southern part of the reef and be placed east of the Whitsunday Islands (close to Hydrographers Passage) and the other site would be east of Dunk Island and would cover the middle part of the GBR. The positions of the stations will enable us to capture the process of atmospheric transformation and aging as the air masses traverse long distances over the reefs.
- One station on the eastern side of the GBR. As the predominant wind direction during the trade wind season is south easterlies this station will enable us to characterise the remote pacific air masses coming towards the GBR. It is preferred the station is upwind of the southern part of the GBR.
- Optics station in deep water (>200m) east of Heron Island to characterise the sea surface spectral reflectance and in water optical properties including the spectral absorption of optically active constituents in the water. These observations provide the deep water optical reference spectra to compliment inshore fieldwork undertaken at Heron Island in the previous week. Optical observations will be used to calibrate the NASA very high resolution airborne hyperspectral sensor PRISM that will be collecting data along selected transects in the GBR throughout September and October 2016. Given clear skies and good flying conditions every effort will be made to overfly the RV *Investigator* and collect synchronised data.

Transects:

Several transects through the reef would be preferred. The voyage will avoid any areas where there is a need for a pilot. As such transects would be made through Palm Passage and Grafton or Flora Passage. The 2 passages cover different areas (width) of the reef.

CTD Stations

On the western (inner) part of the reef 2 CTD stations per day are planned (morning and evening) of the upper 250 metres sampled close to a significant biomass of reefs. Measurements of DMSw, DMSO, DMSa, DMSPt, CHL a, plankton, species and accessory pigments, nutrients, NH_4, SST, solar radiation, wind speed and direction, tidal height should be taken every 1-2 hours to assess the reef production of DMSw, DMS flux and DMSa and confirm the dominant factors affecting DMSa production to the atmosphere of the GBR.

We envisage sampling from 3 depths (surface, chlorophyll max and sub-mixed layer or Cmax) and require 12 L for DNA/RNA filtering and 1-2L for DMS, DMSP/DMSP lyase measurements. For nutrient analysis we require 0.5 - 1L of water from surface, chl.max, nutricline, and deep water; for pigment, absorption and TSS analysis we require 12L of water from surface and chl.max. A maximum cast depth of 250m should be OK so long as we cross the nutricline (expected to be between 80-150 m) into nutrient rich deep water.

In addition, several CTD stations on the eastern (outer) part of the reef are planned. The number of CTD stations will depend on the available time during transects from the stations and on synchronising these activities with the Supplementary Project's voyage objectives. At least two CTD casts outside the reef are requested to obtain water for deckboard incubation studies (Erin McParland, and Eva Fernandez).

Water requirements for UTS (Eva Fernandez) incubations: from at least 2 CTDs on the inner reef and 2 from the outer reef, Eva will require approx. 30L from the chlorophyll max. This water will be incubated either in a flow through deckboard incubator or in a temperature controlled room for up to 24 h before being processed.

Water requirements for Uni California (Erin McParland) incubations: from 2 CTDS outside of the reef, Erin will require approximately 30L from the surface (~5m depth). This water will also be incubated in the temperature controlled room for ~3 days under fluorescent PAR and UV lamps (supplied by the Levine lab). However, we would like to request access to the deckboard incubator as a backup to the temperature controlled room setup.

Summary of water samples and analysis:

Location	**Water sample depth & volume**	**Analysis**
Along voyage route	Surface, chl.max, deep water, nutricline	12L DNA & RNA 1-2L DMS, DMSP/DMSP 0.5 - 1L nutrients 12L optics
Inner Reef	Chl.max	30L Eva Fernandez Incubations
Outer Reef	Chl.max	30L Eva Fernandez Incubations
Outer Reef	Surface (~5 m)	30L Erin McParland Incubations
Heron Island Optics Station	Surface, chl.max, deep water	0.5 - 1L nutrients 12L optics
Time Series Stations	Surface, chl.max, deep water	0.5 - 1L nutrients 12L optics
Satellite/Plane Overpass	Surface, chl.max	12L optics

The estimated total number of CTDs:

1. On the western side of the reef there would be: 2 p.d. for 19 days = 38
2. On the eastern side of the reef: 2 p.d. for 5 days = 10
3. Additional CTD's during stations. At each station the Supplementary Project has requested that CTD's are done at 2 hour intervals throughout the day. As the morning and evening CTD's are included under 1 this will give an additional 4 CTD's per day. There will be 4 two days stations so in total 4x4x2 = 32. We would also like to profile the optical instrument package at each time-series station 2-3 times around mid-day coincident with the satellite/plane overpass.
4. At the Heron Island optics station 3 CTD casts and 3 optical casts are required, 1 hr before, during and 1hr after the satellite/plane overpass.
5. Total CTD's 38+10+32+3 = 83; Optical casts 9x3 = 27

The number of CTD's could be less if we see that they are interfering with atmospheric sampling which is the main objective of the voyage.

<u>Underway Sampling</u>

Underway sampling of the upper 5m will be undertaken by Erin McParland (northbound leg 1) and Graham Jones (southbound legs 2 & 3) at 8.00am, 12.00 mid-day, 4.00pm and 10.00pm. Samples will be analysed for DMSw, DMSO, DMSPt (using a sulphur chemiluminescent detector), CHL a, plankton, species and accessory pigments, nutrients, NH_4, SST, solar radiation, wind speed and direction, tidal height to assess the production of DMSw, DMS flux and NH3 flux and compared with results for four coral reefs in the GBR (G.Jones). The influence of SST, solar radiation, wind speed and tidal height on DMS flux and NH3 flux will also be assessed.

Underway samples may also be taken coincident with satellite/plane overpass when it is impractical to deploy the CTD and optical sensor package. These will be analysed for optical properties.

Tethersoundings

Helium filled helikite (balloon and kite – 7m3) to be deployed from the aft main deck, dry area possibly using the vessel's net drum with line: 500kg rated, white, dyneema, 2.5mm thick, buoyancy = 0.98 specific gravity, duty line, coupled with a block attached to the ship's A-frame or Hiab. With an ascent rate of 1 m/s one flight to 3km would take ~2 hours to complete.

Sensors on the tethered line: NIWA has Anasphere tethersonde units, 1x Ground-station and 2 x tethersonde units (ie one backup). UniMelb would bring 1 x Anasphere tethersonde unit. Anasphere logging at 1 Hz has storage for ~1 hour. This indicates we would need to log every few seconds for long flights to have sufficient data storage. Batteries rated for up to 80 hrs at 1Hz logging so power should not be an issue. For the aerosol sampling package the LOAC transmits to a M10 ground station http://www.meteomodem.com/m10.html Using the M10 sonde we will receive T,RH,GPS altitude throughout the flight, these are transmitting on 403 MHz band.

Orientation of ship whilst flying – bow to wind. Maximum operational wind speeds to be determined. The specs on a 7m3 balloon are 3.5kg lift at 0 kts, 10kg lift at 13 kts, max operating wind 40 kts, the maximum expected operational wind speed is 15 kts. Flying decision is dependent on the ship's Master, Voyage Manager, operator and forecast including forecast of winds aloft.

From the *RV Investigator* 5 x 48 hour operations are planned while the vessel is stationary:

Station 1 (20o 57' S, 150o 20' E) - 30th Sept - 2nd October

Station 2 (21o 44', 152o 50') - 3rd Oct - 5th October

Station 3 (18o35'S, 146o56'E) - 9 - 10th October

Station 3 repeat (18o35'S, 146o56'E) -14-15th October

Station 1 repeat (20o 57' S, 150o20' E) - 19th Oct - 21st October

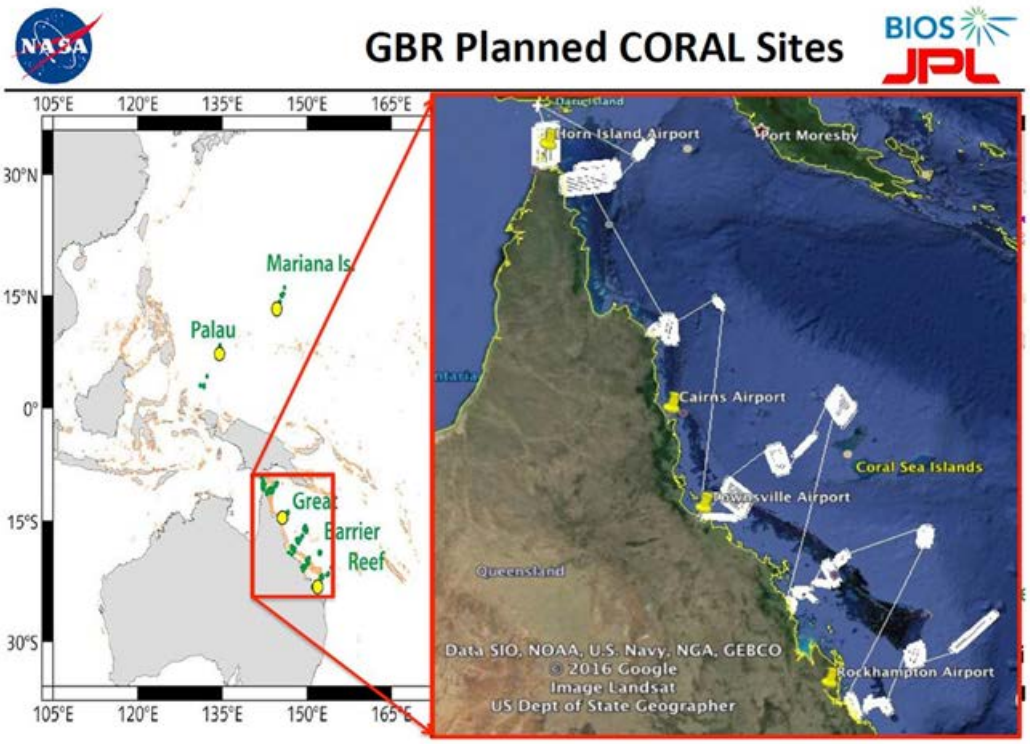
Supplementary Project

Biogeochemical and optical properties of the Coral Sea and Queensland Shelf

Lead PI: Karen Wild-Allen – CSIRO Oceans & Atmosphere
Additional PI's: Mark Baird, Lesley Clementson – CSIRO Oceans & Atmosphere

Objectives

1. To collect high resolution biogeochemical observations for validation of the 4km and 1km near real time eReefs models (https://research.csiro.au/ereefs/)
2. To get modellers in the field to better understand methods and issues associated with modern methods of data collection
3. To collect in situ optical data for the NASA CORAL project which is operating a very high resolution airborne hyperspectral sensor along selected transects in the GBR.



Observing Strategy

The principal platform of deployment will be the Triaxus augmented with CTD, optode, transmissometer, fluorometer, optical plankton counter, optical nitrate sensor, and pulsed fluorometer. Four transects are proposed:

1. Southern lagoon to mid shelf (station 2)
2. Mid shelf (station 2) to outer shelf and northwards
3. Outer-shelf north to Palm Passage and across shelf to lagoon
4. Southern lagoon south through Capricorn Eddy.

The CTD and rosette will also be deployed at time-series stations to resolve the vertical structure in the water column and collect samples to confirm sensor calibration. At CTD stations during daylight hours, a vertical cast of optical sensors will also be deployed to observe spectral absorption, scattering and up-and down-welling light. XBT's will also be deployed opportunistically during the transit to and from the Port of Brisbane outside of the Great Barrier Reef Marine Park.

Underway sensors will also be used to determine surface water characteristics along the voyage track, specifically gradients across inshore, lagoon, shelf and offshore water bodies with respect to carbon chemistry, phytoplankton fluorescence and optically active particles.

A strong motivation for our work is to get modellers into the field to better understand the methods of data collection and issues associated with sample collection, processing, storage and analysis. To this end expert modellers will work alongside experienced observationalists and assist in the deployment of sensors, and collection and processing of samples. Existing capability in the group will be utilised and augmented as team members learn new skills, for example in the deployment and operation of the CTD & Triaxus and the on board data processing and visualisation of these data streams.

Operational Risk Management

Safe deployment of sondes using tethered balloons will follow procedures established during the cold water sea trial and those discussed and agreed with ASP Ship Management, NIWA, University of Melbourne, MNF Ship Manager and the MNF Operations team during the voyage planning process.

Other data collections will not require risk management

Over the side operations include CTD deployments, deployments of Triaxus for the supplementary voyage and retrieval. All of these activities have been performed on *Investigator* before and standard safety protocols will be followed.

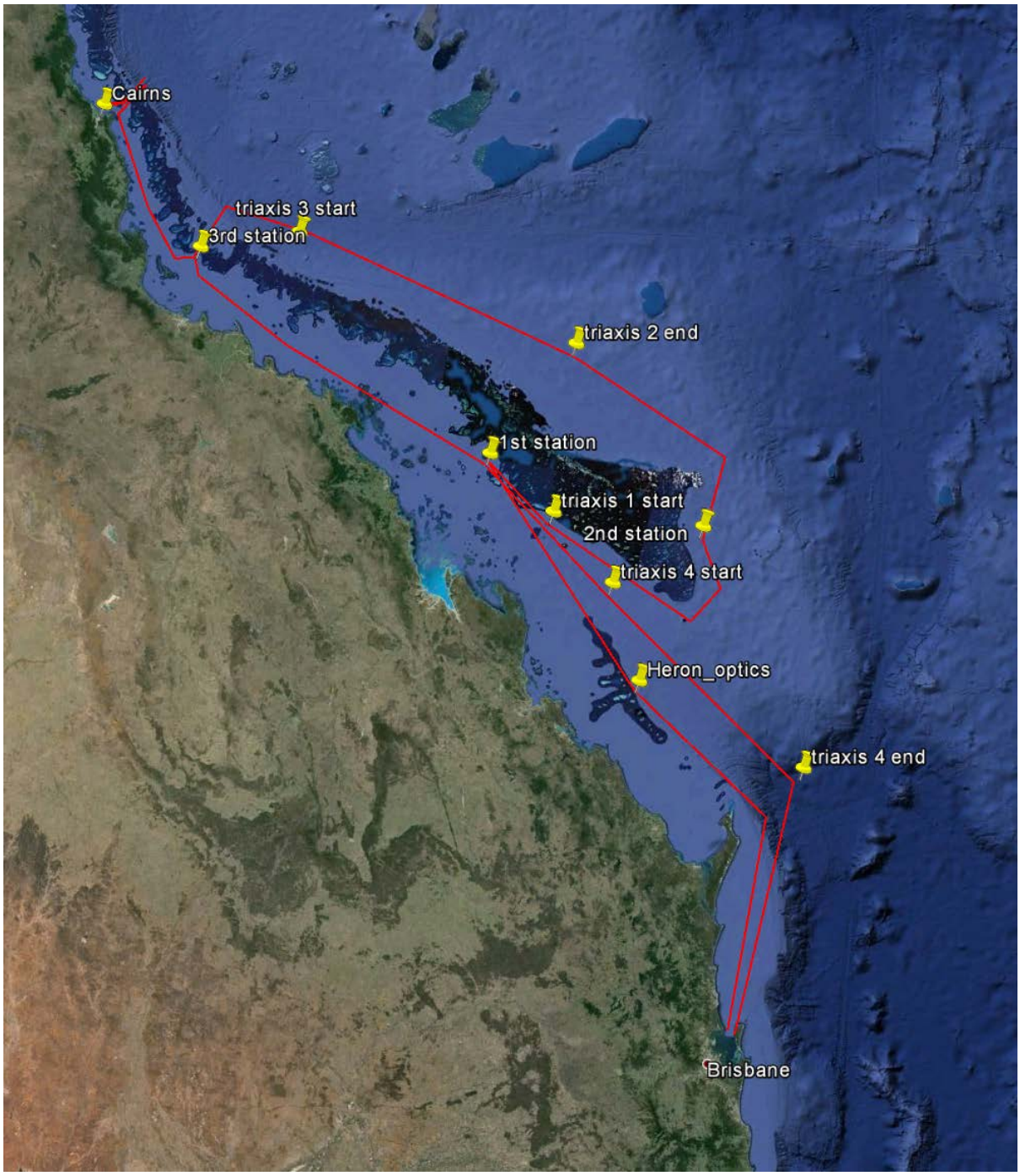
Radioactive sources:

-Existing aerosol neutralisers that are in the Aerosol lab.
-X-ray source for the CIMS (QUT) to be placed in the aerosol lab.
-Tritiated leucine and thymidine for bacterial production – UTS: Justin Seymour and Bonnie Laverock

Overall activity plan of voyage

26	Sep	Mobilise: 1. Load 2. Check
27	Sep	Mobilisation
28	Sep	Complete Mobilisation, sail as soon as possible (<0900)
29	Sep	Transit to the optics station off Heron Island for CTD & optical station (between 1000-1500)
29	Sep	Transit to the 1st station close to Hydrographers passage (20° 57'S, 150° 20'E)
30	Sep	At station (CTD). Keep the vessel oriented towards the wind sample for 48 hours. Tethersoundings Ops
1	Oct	At station – Tethersoundings Ops
2	Oct	Leave for 2nd station on the outside part of the reef (21°44'S, 152°50'E); deploy Triaxus (1) en-route; total voyage 260NM
3	Oct	Arrive at 2nd station. This is the first station on the East side of the reef.
4	Oct	At station. Tethersoundings Ops
5	Oct	Deploy Triaxus (2) and Sail north along the east side of the reef towards Palm Passage. Total voyage 450NM
6	Oct	In transit.
7	Oct	Re-deploy Triaxus (3) on outer shelf for Palm Passage transect
8	Oct	Arrive at Palm Passage. Cross Palm Passage. Head to 3rd station (18°35'S, 146°56E)
9	Oct	At Station. Tethersoundings Ops
10	Oct	At Station. Tethersoundings Ops
11	Oct	Transit to Fitzroy Island off Cairns (126NM). Exchange personnel. Transect reef at Flora passage and station on the outside of the reef.
12	Oct	At noon transect through the Flora passage. If possible have a short station in the middle and deploy UAV's. On way towards 3rd station
13	Oct	Arrive at 3rd station.
14	Oct	At station. Tethersoundings Ops
15	Oct	At station. Tethersoundings Ops
16	Oct	On way towards 1st station. Cruise at lower speed. Transit towards Magnetic Island for personnel exchange from Townsville off Magnetic Island (v/l approx. position: 19°06.57'S, 146°54.16'E) by small charter vessel from Northern Conquest Charters. (250NM)
17	Oct	Underway. Address the objectives of the supplementary voyage.
18	Oct	Arrive at 1st station
19	Oct	At Station
20	Oct	At station
21	Oct	At station
22	Oct	Deploy Triaxus (4)
23	Oct	Underway
24	Oct	Arrive at Brisbane
25	Oct	Demobilisation
26	Oct	Demobilisation

Voyage track example



Waypoints and stations

Transit time estimates vary from 10 knots to 7 knots depending on towing the Triaxus or not.

	Latitude	Longitude	Distance (nm)	Total Distance (nm)	Steaming time (hrs)	Total Steam (hrs)
Brisbane	27.23S	153.10E				
1st supplementary station (Heron optics)	23° 26'S	152° 06'E	270	270	27	27
1st station	20° 57'S	150° 20'E	180	450	18	45
Triaxus 1 start	21° 35'S	151° 05'E	60	510	6	51
2nd station (Triaxus 1 end; Triaxus 2 start)	21°44'S	152°50'E	170	680	24	75
Triaxus 2 end	19° 45'S	151° 20'E	170	850	24	99
Triaxus 3 start	18° 30'S	148° 05'E	200	1050	20	119
3rd station (Triaxus 3 end)	18°35'S	146°56'E	100	1150	14	133
Cairns	17°55'S	147°49'E	140	1290	14	147
3rd station via Flora passage	18°35'S	146°56'E	200	1490	20	167
1st station	20° 57'S	150° 20'E	250	1740	25	192
Triaxus 4 start	22° 25'S	151° 45'E	120	1860	12	204
Triaxus 4 end	24° 21'S	154° 04'E	170	2030	24	228
Brisbane	27.23S	153.10E	190	2220	19	247

Time estimates

See above

Piggy-back Project

Project 3DGBR - Multibeam bathymetry mapping of the Great Barrier Reef and Coral Sea

Principal Investigators: Dr Robin Beaman (James Cook University), Dr James Daniell (James Cook University) and AProf Jody Webster (University of Sydney)

The scientific and voyage objectives of Project 3DGBR are:

1. To acquire high-resolution multibeam bathymetry, backscatter and water column data along the voyage track for the duration of the voyage. The new bathymetry data will be used to improve the accuracy of the 100 m-resolution DEM for the Great Barrier Reef and Coral Sea, called the 'gbr100' grid: http://www.deepreef.org/bathymetry/65-3dgbr-bathy.html

2. On an opportunity basis and subject to workload, acquire sub-bottom profile data using the SBP120 profiler during the voyage. The sub-bottom profiler data will be used in conjunction with the multibeam data for ongoing marine geoscience projects in the Great Barrier Reef and Coral Sea.

While on the continental shelf in depths <200 m and within the GBR Marine Park, the sound velocity profiles required for accurate multibeam operations will be generated from the data provided by the stationary CTD casts conducted on the shelf. During transits offshore and in depths >300 m, and where stationary CTD casts are impractical, expendable bathythermographs (XBTs) may be used to generate sound velocity profiles, at no more than 2 per day.

Time estimates: The objective is to collect multibeam bathymetry, backscatter and full water column data for the duration of the voyage, and wherever the vessel travels irrespective of the speed of advance. Where logistically possible, another objective is to operate the sub-bottom profiler concurrently with the multibeam system. To achieve this will require at least two geophysical personnel to work alternative 12 hour shifts throughout the voyage. These personnel will be required to monitor the quality of data during acquisition, log metadata, and conduct preliminary post-processing of the multibeam data.

Personnel changes Legs 1, 2 & 3

A personnel change is scheduled for the 11th of October off Fitzroy Island near Cairns. A Cairns based vessel will transport embarking science personnel from Cairns to *RV Investigator* positioned off Fitzroy Island and to bring disembarking science personnel from the *RV Investigator* to Cairns.

The following scientific and support personnel will be transported from Cairns to *RV Investigator*:

Graham Jones:	SCU
Robert Ryan:	Uni Melb
Robyn Schofield:	Uni Melb
Gavin Broadbent:	QUT
Tommaso Francesco Villa:	QUT
Dirk Lessner:	QUT
Janet Anstee:	CSIRO

Timothy Pasmore	QUT
Kathy McLeish	ABC News
Steve Keen	ABC News

The following science personnel will be transported from RV *Investigator* to Cairns:

Sonya Fiddes:	Uni Melb
Claire Vincent:	Uni Melb
Ian Hawkes:	MNF DAP Support
Nicole Morgan:	MNF SIT Support
Nagur Cherukuru:	CSIRO
Rob Beaman:	JCU

A second personnel change is scheduled for the 16th of October off Magnetic Island (v/l approx. position: 19°06.57'S, 146°54.16'E) near Townsville. A Townsville based vessel has been chartered from Northern Conquest Charters to transport embarking science personnel from Townsville to *RV Investigator* and to bring disembarking science personnel from the *RV Investigator* to Townsville.

The following science personnel will be transported from Townsville to *RV Investigator:*

Mark Baird:	CSIRO
Emlyn Jones:	CSIRO
Jenny Skerratt:	CSIRO

The following science personnel will be transported from *RV Investigator* to Townsville:

Karen Wild-Allen:	CSIRO
Farhan Rizwi:	CSIRO
Mathieu Mongin:	CSIRO
Dirk Lessner	QUT
Gavin Broadbent	QUT
Timothy Pasmore	QUT
Kathy McLeish	ABC News
Steve Keen	ABC News

Investigator equipment (MNF)

CTD Equipment and Support

- 24-bottle CTD-rosette with 10L Niskin bottles and MNF-O_2, MNF-PAR, MNF-transmissometer, Strutton-backscatter, and US SOCCOM fluorometer, MNF-ISUS (optical nitrate), sensors mounted.
- Triaxus
- Lowered ADCP with all heads working and logging
- CTD voltage inputs calibrated to correctly log sensor inputs
- WOCE/Go-Ship compliant CTD data processing and output files to be provided, including error estimates for oxygen and nutrient parameters

Other

- The MNF dual-polarization Doppler radar
- The two surface downwelling SW and LW radiation stations
- Aerosol sampling lab (with CSIRO/MNF instruments, see list below)
- Air chemistry lab (with CSIRO/MNF instruments, see list below)
- Underway Seawater Analysis Laboratory
- Multibeam EM122, EM710
- Sub-bottom profiler
- Isotope containerised lab (Radvan) is requested for bacterial production measurements using tritiated leucine/thymidine (radioisotopes) and nitrogen fixation measurements using 15N (stable isotope)
- Deck board incubators with flow through water systems
- -80°C freezers (including bio-optical sample storage)
- Clean dry lab for filtration and microbial rate measurements
- Wet lab space for bio-optical filtration equipment set up and use
- Temperature controlled room for microbial incubations. As a backup alternative access to the deckboard flow-through incubators is requested.
- Vaisala radiosounding telemetry system (requires *RV Investigator* to extend their ACMA radio license to include radio channels for this sounding system). Uni Melb will coordinate with BoM operators at Brisbane airport to avoid using same channels for launches and receive their daily soundings. CASA needs notification of launches only within 3 nautical miles of an aerodrome. Will undertake intensive radiosoundings (3 hourly, at station 1 (both times) and station 2. Daily launches otherwise. Expecting ~65 soundings
- XBT's - various

User Equipment

- Chemical Ionisation Mass Spectrometer (CIMS) (provided by QUT, will be located in the Aerosol Lab)
- Particle Size Magnifier (PSM) (provided by Fudan University, China, will be located in the Aerosol Lab)
- Nano Aerosol Sampler (NAS) (provided by QUT, will be located in the Aerosol Lab)
- 2 UAV's (provided by QUT) will be launched from the aft main deck.
- Particle sizers (nanoSMPS), Cloud condensation Nuclei counter, Particle counter (provided by CSIRO, all in the aerosol lab)
- ToF Aerosol Chemical Speciation Monitor, Proton transfer mass spectrometer, Sequencer, (provided by CSIRO, all in air chemistry lab)
- Cascade Impactor Aerosol sampler (provided by CSIRO, secured to a rail deck outside (observation deck); requires sample conditioning switch, as during the maiden voyage)
- Lidar (BoM, Container on foredeck starboard (02)). Backend in Air Chemistry laboratory (02))
- OceanRAIN disdrometer (Univ. Hamburg, already installed for IN2016_V01, V02 and V03 on the foremast)
- Microwave radiometer (Provided by U. Utah, Level 4 (already installed for IN2016_V02 and V03))
- CSAT sonic anemometer and humidity sensor (provided by UniMelb to be located up the aerosol mast at the landing. Will require science support to access the logger duration the voyage to change the memory card.)

- Aerosol Hi-Vol (provided by NIWA, secured to a rail deck outside (observation deck))
- LOAC Lightweight optical aerosol spectrometer (provided by NIWA, to be flown on the QUT provided UAV)
- Ceilometer CL31 (provided by NIWA, secured on level 04 observation deck or on top of Alain's container)
- Ice nuclei sampler (provided by NIWA, in Aerosol lab)
- Bacterial Sampler (provided by NIWA, in Aerosol lab if sufficient flow is available, if not a separate inlet will be required)
- PCASP (provided by NIWA, in Aerosol lab)
- Particle Counter CPC3010 (provided by NIWA, in Air Chem lab)
- Shelf-edge delta systems on the northern Great Barrier Reef: Underwater camera (provided by JCU)
- Gas chromatograph (GC) (UTS) + required gas tanks for helium, hydrogen and air (G size tanks) [located in air chemistry lab if possible]
- Liquid nitrogen dewer (50L) to be stored on deck- liquid N required for GC operation
- Spectrophotometer (UTS)
- Peristaltic pumps (x2) for filtering DNA/RNA – clean/dry laboratory (UTS)
- Sulphur chemoluminescence device – connection to flow through seawater requested
- Vacuum pump for filtering seawater
- 6-place filtration manifold for filtering seawater (UTS)
- Equilibrator Inlet-PTR-MS (provided by NIES), will be located in Wet Lab, will use underway seawater as sample.
- Bio-Optical Instrument package Hydroscat, ACS or AC9, DH4, WQM, Satlantic up & downward looking spectral radiometers (CSIRO AqRS)
- Bio-optical ancillaries, batteries, cables, computers
- FIRe, SUNA for Triaxus (CSIRO/UTAS)
- Profiling Hyperpro-II system (NOAA)
- Spectrophotometer with integrating sphere (possibly from AIMS)
- 6-place filtration manifold for filtering seawater, tubing & pump (CSIRO AqRS)
- 2 glass filtration set for CDOM & DOC & pump (CSIRO AqRS)
- Eskies for sample storage & shipping (CSIRO AqRS)
- Dry Shipper (to be filled in Brisbane at end of cruise to transport samples from -80 freezer) (CSIRO AqRS)
- 2 x winch units (30kg each)
- 2 x helikites (6m3 and 7m3 – uninflated minimal storage required, inflated 2.5 x 3.5m)

Special Requests

Branka Miljevic

Nitrogen (G size tanks) will be required for the CIMS that will be in the Aerosol lab.

Zoran Ristovski for Ling Wang

Diethylene glycol (about 15 bottles, 500mL capacity, analytical reagent)

Butanol (Note the need for an additional 7.5L)

Pure air or purity nitrogen (the supply pressure ≥ 20psi, 1.0 lpm) is needed for PSM

Justin Seymour

Gases (air, helium and hydrogen – G size tanks) will be required for running the gas chromatograph – gas cylinder holders in the air chemistry lab will be required.

We wish to store a liquid nitrogen dewer (50L) on the deck.

The deckboard incubators are requested for running incubation experiments.

The Isotope Lab (Radvan) will be required for performing bacterial production measurements with tritiated leucine/thymidine.

Hiroshi Tanimoto

For Equilibrator Inlet-PTR-MS that will be in a general wet lab.

2 gas cylinders (10 L) are standards in nitrogen.

3 gas cylinders (47 L) of nitrogen are used for carrier gas.

Robyn Schofield

Balloon helium : 16 G size tanks. 3G size tanks can be stored in the sheltered science space at a given time with the remainder in a gas cage on the aft main deck – this will allow for considerable contingency.

Installation of the CSAT3 sonic anemometer on the front mast.

Farhan Rizwi / Mark Baird

Daily communication with high performance computer centre in Melbourne/Hobart for download of latest remotely sensed images and selected model output of the voyage region.

Mike Harvey

The Ceilometer CL31 (provided by NIWA) needs to be secured on level 04 observation deck or on top of Alain's container

Aerosol Hi-Vol (provided by NIWA) needs to be secured to a rail deck outside level 04 observation deck.

Permits

RV Investigator is extending their ACMA radio license to receive the radio channel on their new telemetry system.

The Research Application for the Great Barrier Reef Marine Park Authority (GBRMPA) permit was submitted on the 22/06/2016.

JCU Multibeam Surveying Limited Impact Permit

**RV Investigator* does not require a GBRMPA Permit to operate within the marine park's designated shipping zones.

Personnel List – Northbound Leg 1

1.	Lisa Woodward	Voyage Manager	CSIRO MNF
2.	Ian McRobert	SIT Support	CSIRO MNF
3.	William Ponsonby	SIT Support	CSIRO MNF
4.	Nicole Morgan	SIT Support	CSIRO MNF
5.	Matt Boyd	GSM Support	CSIRO MNF
6.	Bernadette Heaney	GSM Support	CSIRO MNF
7.	Kendall Sherrin	Hydrochemistry	CSIRO MNF
8.	Cassie Schwanger	Hydrochemistry	CSIRO MNF
9.	Anoosh Sarraf	DAP Support	CSIRO MNF
10.	Ian Hawkes	DAP Support	CSIRO MNF
11.	Francis Chui	DAP Support	CSIRO MNF
12.	Zoran Ristovski	Chief Scientist	QUT
13.	Luke Cravigan	PhD student	QUT
14.	Chiemeriwo Osuagwu	PhD student	QUT
15.	Erin McParland	PhD student	Uni California (SCU)
16.	Bonnie Laverock	Postdoc	UTS
17.	Eva Fernandez	PhD Student	UTS
18.	Stephen Archer	Researcher	NIWA
19.	Sonya Fiddes	PhD student	Uni Melb
20.	Claire Vincent	Postdoc	Uni Melb
21.	Yuko Omori	Postdoc	Uni of Tsukuba, Japan
22.	Alain Protat	PI	BoM
23.	Karen Wild-Allen	Supplementary PI	CSIRO
24.	Nagur Cherukuru	Supplementary scientist	CSIRO
25.	Mathieu Mongin	Carbon Chemistry & Optics	CSIRO
26.	Farhan Rizwi	Data processing	CSIRO
27.	Charles Kovach	Optics	NOAA
28.	Robin Beaman	CI – Piggy back voyage	JCU
29.	Tony Bromley	Winch Operator	NIWA
30.	Sally Gray	Winch Operator	NIWA

Personnel List – Southbound Leg 2

1.	Lisa Woodward	Voyage Manager	CSIRO MNF
2.	Ian McRobert	SIT Support	CSIRO MNF
3.	William Ponsonby	SIT Support	CSIRO MNF
4.	Matt Boyd	GSM Support	CSIRO MNF
5.	Bernadette Heaney	GSM Support	CSIRO MNF
6.	Kendall Sherrin	Hydrochemistry	CSIRO MNF
7.	Cassie Schwanger	Hydrochemistry	CSIRO MNF
8.	Anoosh Sarraf	DAP Support	CSIRO MNF
9.	Francis Chui	DAP Support	CSIRO MNF
10.	Zoran Ristovski	Chief Scientist	QUT
11.	Luke Cravigan	PhD student	QUT
12	Chiemeriwo Osuagwu	PhD student	QUT
13.	Erin McParland	PhD student	Uni California (SCU)
14.	Bonnie Laverock	Postdoc	UTS
15.	Eva Fernandez	PhD student	UTS
16.	Stephen Archer	Researcher	NIWA
17.	Graham Jones	PI	SCU
18.	Robert Ryan	PhD student	Uni Melb
19.	Robyn Schofield	PI	Uni Melb
20.	Gavin Broadbent	Technician – UAV's	QUT
21.	Tommaso Francesco Villa	PhD student – UAV's	QUT
22.	Dirk Lessner	Technician – UAV's	QUT
23.	Yuko Omori	Postdoc	Uni of Tsukuba, Japan
24.	Alain Protat	PI	BoM
25.	Karen Wild-Allen	Supplementary PI	CSIRO
26.	Janet Anstee	Supplementary PI	CSIRO
27.	Mathieu Mongin	Carbon Chemistry & Optics	CSIRO
28.	Farhan Rizwi	Data processing	CSIRO
29.	Charles Kovach	Optics	NOAA
30.	Tony Bromley	Winch Operator	NIWA
31.	Sally Gray	Winch Operator	NIWA
32.	Kathy McLeish	ABC News	ABC
33.	Timothy Pasmore	QUT Comms	QUT
34.	Dean Caton	ABC News	ABC

Personnel List – Southbound Leg 3

1.	Lisa Woodward	Voyage Manager	CSIRO MNF
2.	Ian McRobert	SIT Support	CSIRO MNF
3.	William Ponsonby	SIT Support	CSIRO MNF
4.	Matt Boyd	GSM Support	CSIRO MNF
5.	Bernadette Heaney	GSM Support	CSIRO MNF
6.	Kendall Sherrin	Hydrochemistry	CSIRO MNF
7.	Cassie Schwanger	Hydrochemistry	CSIRO MNF
8.	Anoosh Sarraf	DAP Support	CSIRO MNF
9.	Francis Chui	DAP Support	CSIRO MNF
10.	Zoran Ristovski	Chief Scientist	QUT
11.	Luke Cravigan	PhD student	QUT
12.	Chiemeriwo Osuagwu	PhD student	QUT
13.	Erin McParland	PhD student	Uni California (SCU)
14.	Bonnie Laverock	Postdoc	UTS
15.	Eva Fernandez	PhD student	UTS
16.	Stephen Archer	Researcher	NIWA
17.	Graham Jones	PI	SCU
18.	Robert Ryan	PhD student	Uni Melb
19.	Robyn Schofield	PI	Uni Melb
20.	Tommaso Francesco Villa	PhD student – UAV's	QUT
21.	Yuko Omori	Postdoc	Uni of Tsukuba, Japan
22.	Alain Protat	PI	BoM
23.	Mark Baird	Supplementary PI	CSIRO
24.	Janet Anstee	Supplementary PI	CSIRO
25.	Emlyn Jones	Carbon Chemistry & Optics	CSIRO
26.	Jenny Skerratt	Data processing	CSIRO
27.	Charles Kovach	Optics	NOAA
28.	Tony Bromley	Winch Operator	NIWA
29.	Sally Gray	Winch Operator	NIWA

Signature

Your name	Zoran Ristovski
Title	Chief Scientist
Signature	
Date:	27/07/2016