RV *Investigator* Voyage Plan

Voyage #:	IN2016_V02		
Voyage title:	SOTS: Southern Ocean Time Series automated moorings for climate and carbon cycle studies southwest of Tasmania		
Mobilisation:	Hobart, Friday-Monday, 11-14 March 2016		
Depart:	Hobart, Monday, 14 March 09:55		
Return:	Hobart, Wednesday, 13 April 2015, 16:00		
Demobilisation:	Hobart, Thursday, 14 April 2016		
Voyage Manager:	Tegan Sime	**Contact details:**	Tegan.sime@csiro.au
Chief Scientist:	Tom Trull		
Affiliation:	CSIRO	**Contact details:**	Tom.trull@csiro.au
Lead Principal Investigator:	Alain Protat		
Project name:	CAPRICORN: Clouds, Aerosols, Precipitation, Radiation, and Atmospheric Composition over the Southern Ocean		
Affiliation:	Bureau of Meteorology	**Contact details:**	A.Protat@bom.gov.au
Lead Principal Investigator:	Peter Strutton		
Project name:	Eddy: Linking eddy physics and biogeochemistry in the Antarctic Circumpolar Current south of Tasmania		
Affiliation:	University of Tasmania	**Contact details:**	Pete.Strutton@Utas.edu.au

This voyage combines work from three proposals. The objectives are listed separately for each.

Scientific objectives

SOTS

The Southern Ocean has a predominant role in the movement of heat and carbon dioxide into the ocean interior moderating Earth's average surface climate. SOTS uses a set of three automated moorings to measure these processes under extreme conditions, where they are most intense and have been least studied. The atmosphere-ocean exchanges occur on many timescales, from daily insolation cycles to ocean basin decadal oscillations and thus high frequency observations sustained over many years are required. The current context of anthropogenic forcing of rapid climate change adds urgency to the work.

CAPRICORN

Cloud-aerosol-precipitation processes over the Southern Ocean (SO) are one of the largest sources of uncertainties in future climate projections. The CAPRICORN proposal aims to advance our knowledge of the SO cloud systems, aerosol properties, surface energy budget, upper ocean biological aerosol production, and atmospheric composition, in order to improve the characterization of their physical properties from satellite platforms and global models. The cloud morphological, microphysical and thermodynamical properties and boundary layer structure are very poorly observed over the SO. Climate and numerical weather prediction models also poorly represent the cloud and precipitation fields over the Southern Ocean and, as a consequence, appear to poorly predict the energy balance. The objectives of this proposal are to (i) characterize the cloud, aerosol, and precipitation properties, boundary layer structure, biological production and cycling of dimethyl sulfide (DMS) in the upper ocean, atmospheric composition, and surface energy budget, as well as their latitudinal variability; (ii) evaluate and improve satellite estimations of these properties, and (iii) evaluate and improve the representation of these properties in the Australian ACCESS regional and global model.

Eddy

Our ultimate goal is to understand how eddy circulation impacts elemental cycling, and how this scales up to the eddy field of the Southern Ocean. We will conduct a process study of two contrasting eddies, one cyclonic and one anti-cyclonic, during the MNF voyage and expand our results to the Southern Ocean more broadly through data analysis and modelling efforts.

Voyage objectives

SOTS

The primary objective is to first deploy a reduced set (SAZ and FluxPulse) and then recover a full set of SOTS moorings (SOFS, Pulse, and SAZ). Additional work will obtain ancillary information on the atmospheric and oceanographic conditions using CTD casts, underway measurements, the Triaxus towed body, and autonomous profiling "Bio-Argo" floats.

Each of the SOTS moorings delivers to specific aspects of the atmosphere-ocean exchanges, with some redundancy:

- the SAZ sediment trap mooring focuses on quantifying the transfer of carbon and other nutrients to the ocean interior by sinking particles, and collecting samples to investigate their ecological controls.

- the Southern Ocean Flux Station (SOFS) focuses on air properties, ocean stratification, waves, and currents.
- the Pulse biogeochemistry mooring focuses on processes important to biological CO2 consumption, including net community production from oxygen measurements and nitrate depletion, biomass concentrations from bio-optics and bio-acoustics, and collection of water samples for nutrient and plankton quantification.
- the FluxPulse mooring combines some elements of Pulse onto the SOFS platform to create a combined mooring, which will be deployed for the first time in 2016. This combination meets financial constraints while still measuring almost all planned parameters

CAPRICORN

- The primary objective is to collect cloud, aerosol, precipitation, radiation and atmospheric composition measurements over the Southern Ocean over 30 days, and to capture the latitudinal variability of these properties from the latitude of Hobart down to 55-60S if time allows. The Investigator will be equipped with a state-of-the art suite of instruments for that purpose (see list below).
- In order to address the "satellite validation" objectives, we need to locate the research vessel under the track of the CloudSat-CALIPSO instrument and within the larger swath of the NASA GPM and A-Train radars and radiometers. This will be achieved in coordination with the requirement to sample a mesoscale oceanic eddy using a dedicated pattern that will include satellite track following and mesoscale eddy sampling using radial transects, after the SOTS moorings are deployed and recovered.
- In order to address the "ACCESS model validation" objectives, we need to sample the sub-grid scale variability of the atmospheric properties, therefore we will undertake some periods of intensive sampling of 12*12 km2 grids with small-scale lawnmower patterns, ensuring that the aerosol measurements are not perturbed by the ship exhaust. The timing and location of these grids will be determined during the voyage.

Eddy

- Deploy a suite of floats, two different models per eddy, to obtain profiles of temperature, salinity, velocity, oxygen, nitrate, pH and bio-optics near the eddy centre while we perform spatial surveys.
- Measure the velocities and mixing in the two eddies.
- Quantify the elemental fluxes associated with the eddy circulation, including nutrient transport and air-sea CO_2 flux.
- Measure the biological response to the circulation and nutrient transport, including primary productivity, trace metal biogeochemistry, new production and the respiration of downward carbon flux (using free-drifting sediment traps).

Our combined ship-satellite-float observations will provide the most comprehensive view thus far of Southern Ocean eddies. Our work also contributes to emerging international programs in the Southern Ocean that are combining expanded autonomous observations with large scale modelling efforts.

Operational Risk Management

SOTS

Mooring operations will follow the successful stern A-frame deployment methods used during IN2015_v01. These protocols are already in the ship's Safety Management System (SMS).

CAPRICORN

Safe release of sondes using balloons will follow procedures established during the cold water sea trial. Other data collections will not require risk management.

Eddy

Over the side operations include deployment of the CTDs, Trace Metal Rosette, profiling floats, in-situ pumps, free-drifting sediment traps and TRIAXUS. All of these activities have been performed on Investigator before and standard safety protocols will be followed (for the free drifting sediment traps, a deployment/recovery procedure document will be provided - it is very similar to the sediment trap mooring procedures).

Priority-ranked list of tasks to achieve the overall objectives

SOTS

(10 days including transit to SOTS, gear and crew testing day in Adventure Bay, and 1 weather day)

1. Deploy FluxPulse-1 meteorology-biogeochemistry mooring
2. Deploy SAZ-18 sediment trap mooring
3. Recover SAZ-17 sediment trap mooring
4. Recover Pulse-11 biogeochemistry mooring
5. Recover SOFS-5 mooring
6. Do CTDs (2 casts to 2250m) at the SOTS site, including collecting samples for nutrients, oxygen, dissolved inorganic carbon, alkalinity, and particulate matter analyses.
7. Carry out underway air and water sampling and sensor measurements, including bio-acoustics.
8. Tow MacArtney Triaxus one or more nights while at SOTS site.
9. Possibly deploy 1-2 SOCCOM autonomous profiling floats at the SOTS site, subject to availability
10. Tow CPR to SOTS site

CAPRICORN

Note: all data collected during the voyage will be useful. However there will be **4 days** of dedicated but non-continuous CAPRICORN sampling, corresponding to about 60h of model subgrid-scale sampling (each lawnmower pattern takes about 4-6h, we are aiming for at least 10 patterns), and 36h of sampling under satellite swath including transit to locate the ship within the satellite track or swath.

1. Collect measurements of cloud, aerosol, precipitation, and radiation properties along latitudinal transects, including under the track of the CloudSat-CALIPSO cloud radar-lidar.
2. Collect atmospheric state measurements by releasing radiosondes at regular intervals (twice daily during daylight hours)
3. Collect such measurements at high spatial resolution over approximately 12kmx12km areas to characterize the sub-grid scale atmospheric properties

Eddy

1. Pre-cruise, identify one cyclonic and one anticyclonic eddy, around 50°S, 150°E. The radius of each eddy is likely to be about 70km. These eddy selections will preference the minimization of transit time and alignment with satellite overpasses for the CAPRICORN project. This does not require MNF resources.
2. Deploy several different types of autonomous floats in the eddies. Exact number and types of floats is still being negotiated with international partners, and may also include surface drifters and/or free-drifting sediment traps (these will need to be recovered).
3. Map each eddy in a radial pattern of TRIAXUS transects, accompanied by CTDs, Microstructure Profilers (VMPS, Trace Metal rosette CTDs and in-situ pumps at discrete locations. We anticipate 6-8 radial transects from the centre of each eddy to the perimeter. CTDs will likely be to 1500m but no shallower than 1000m, with the final depth to be decided after initial CTDs.
4. Set up shipboard incubations (iron biogeochemistry:Ellwood ANU/Boyd, IMAS), and climate change (Boyd) using incubators in the CT lab, constant environment incubators in port side forward, and the ships MNF 20 foot deck board incubator platform.
5. Deploy and recover surface tethered free drifting sediment traps to quantify particle fluxes and to compare with estimates of particle fluxes from ^{234}Th depletions (Masque lab, Edith Cowan Univ.) and the optical sensors on the SOCCOM floats. These sediment traps will be equipped with GPS transmitters and will also aid in tracking the movements of the eddy.

Overall activity plan including details for first 24 hours of voyage

Approximate timings, subject to weather and operational revision.

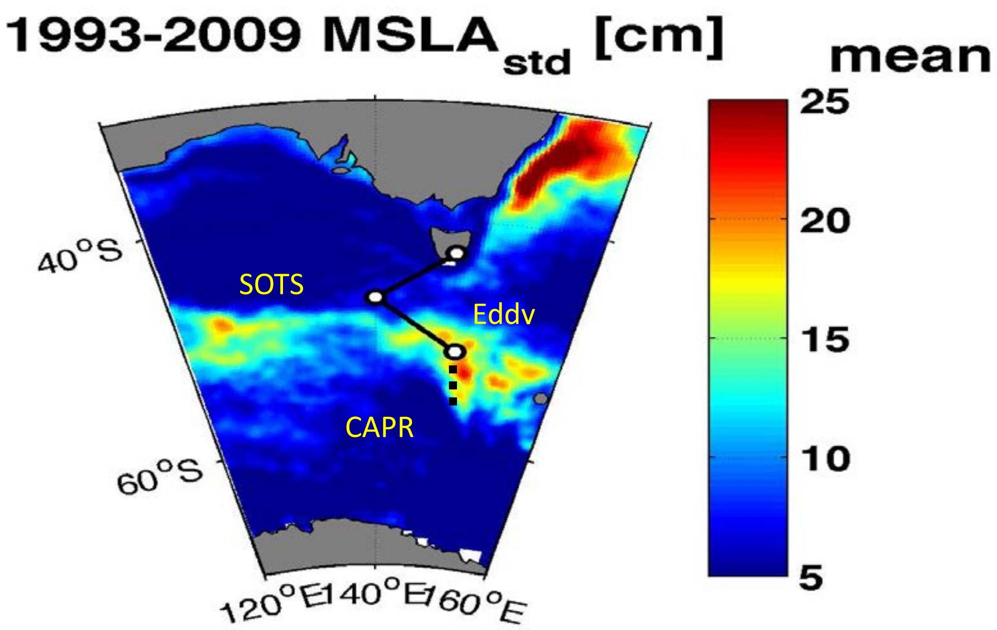
Date	Activity
11 Mar	Mobilise (order of operations is indicative only, and subject to MNF and ASP operational requirements): 1. Load CSIRO winch and lower level containers to main trawl deck: (Sedtrap, new TM, mooring half-height, TMRosette storage box) 2. Overstack old TM container to trawl deck and load containers to upper deck (Radvan, incubator platform) 3. Load other mooring gear and anchors to trawl deck, install spooling gear for netdrum winch. 4. Load Capricorn Radar-Lidar container to foredeck and aerosol instruments to aerosol and air chemistry labs. 5. Load Eddy lab gear to internal labs 6. Begin mooring set-up on trawl deck, including spooling to winches, 7. Begin CAPRICORN instrument set ups on foredeck and in aerosol and air chemistry labs. 8. Begin internal labs setup
12 Mar	Mobilise: 1. Load FluxPulse-1 surface float and remaining mooring gear to main deck 2. Load TMR Rosette to TMR Storage box 3. Load Triaxus 4. Continue aerosol lab set-up and start integrating other CAPRICORN instruments (optical disdrometer, micro-rain radar, microwave radiometer, surface flux package). 5. Install Capricorn SST towed string system; install Capricorn Helium weather balloon system 6. Continue internal labs set up
13 Mar	Complete Mobilisation, sail as soon as possible

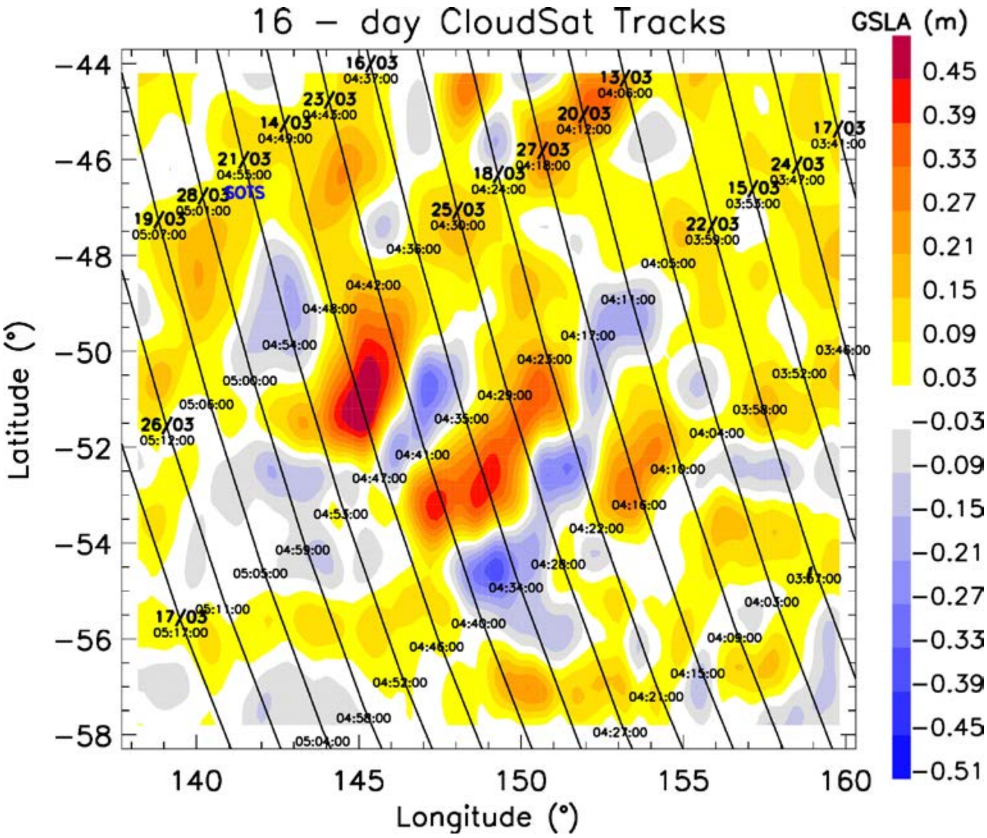
Date	Activity
14 Mar	Complete Mobilisation, sail as soon as possible
15 Mar	In Adventure Bay, test radar equipment and offload radar engineers, test CTD, trace metal CTD, Triaxus, towing of trace metal clean intake "fish" from the coring boom, and mooring procedures (deploy free-drifting sediment trap float and recover; trail FluxPulse line drogue; test new mezzanine winch spooler) begin transit to SOTS by 20:00 (on this day or any earlier departure day)
16 Mar	Transit to SOTS towing CPR doing underway sensor observations
17 Mar	SOTS: deploy FluxPulse-1 mooring / night: mooring triangulation, collect underway data
18 Mar	SOTS: spool on SAZ mooring, CTD / night: Triaxus mapping, collect underway data
19 Mar	SOTS: deploy SAZ-18 mooring / night: triangulation, Triaxus mapping, collect underway data
20 Mar	SOTS: recover Pulse-11 mooring / night: triangulation, Triaxus mapping, collect underway data
21 Mar	SOTS: spool off Pulse-11 mooring / night: Triaxus mapping, collect underway data
22 Mar	Weather day
23 Mar	SOTS: recover SAZ-17 sediment trap mooring / night: CTD cast, deploy SOCCOM float
24 Mar	SOTS: spool off SAZ-17 sediment trap mooring / night: CTD cast, deploy SOCCOM float. If time permits, deploy an Eddy free-drifting sediment trap as a test, for recovery 12-24 hours later.
25 Mar	SOTS: recover SOFS-5 mooring, depart SOTS site ~18:00
26 Mar	Eddy: transit to first eddy site nominally at 52S, 150E (40 hours at 12 knots) - Eddy location will be updated at start of voyage, CAPR: transit will be aligned to achieve satellite overpass, If possible run tow-fish while in transit to the eddy site.
27 Mar	arrive first Eddy site at ~ 22:00, tow Triaxus across eddy during night
28 Mar	Eddy: Arrive at first eddy and deploy floats, begin radial surveys with TRIAXUS, surface underway measurements, CTD, VMP and TM-CTD and in situ pump casts and where possible run tow-fish. Depending on timing collect water for incubations using the tow-fish
29 Mar	Eddy: Continue radial surveys.CAPR interleave satellite track sampling and small-scale lawnmower patterns. Depending on survey status, undertake TM-CTD and in situ pump casts and where possible run the tow-fish.
30 Mar	Eddy: Continue radial surveys. CAPR:interleave satellite track sampling and small-scale lawnmower patterns. Depending on survey status, undertake TM-CTD and in situ pump casts and where possible run the tow-fish
31 Mar	Eddy: Continue radial surveys. CAPR: interleave satellite track sampling and small-scale lawnmower patternsDepending on survey status, undertake TM-CTD and in situ pump casts and where possible run towfish. Depending on timing collect water for incubations using the tow-fish
1 Apr	Eddy: Continue radial surveys. CAPR: interleave satellite track sampling and small-scale lawnmower patterns Depending on survey status, undertake TM-CTD and in situ pump casts and where possible run the tow-fish
2 Apr	Eddy: Continue radial surveys. CAPR: interleave satellite track sampling and small-scale lawnmower patterns. Depending on survey status, undertake TM-CTD and in situ pump casts and where possible run the tow-fish.
3 Apr	Eddy: recover free-drifting sediment trap CAPR: transit along satellite overpass track to second eddy

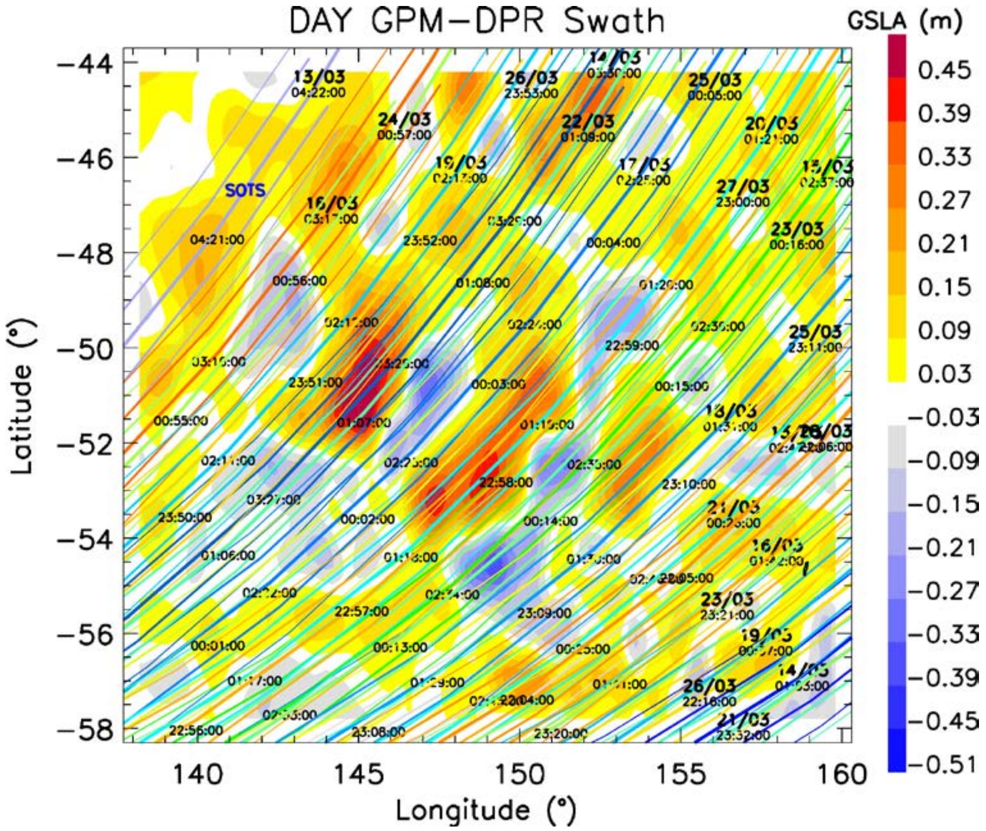
Date	Activity
4 Apr	CAPR: transit along satellite overpass track to second Eddy, If possible run tow-fish while in transit to eddy site.
5 Apr	Eddy: Arrive at second eddy and deploy floats, begin radial surveys with TRIAXUS, surface underway measurements, CTD, VMP and TMCTD and where possible run tow-fish. Depending on timing collect water for incubations using the tow-fish
6 Apr	Eddy: Continue radial surveys. CAPR: interleave satellite track sampling and small-scale lawnmower patterns. Depending on survey status, undertake TM-CTD and in situ pump casts and where possible run the tow-fish.
7 Apr	Eddy: Continue radial surveys. CAPR: interleave satellite track sampling and small-scale lawnmower patterns. Depending on survey status, undertake TM-CTD and in situ pump casts and where possible run the tow-fish.
8 Apr	Eddy: Continue radial surveys. CAPR: interleave satellite track sampling and small-scale lawnmower patterns. Depending on survey status, undertake TM-CTD and in situ pump casts and where possible run the tow-fish.
9 Apr	Eddy: Continue radial surveys. CAPR: interleave satellite track sampling and small-scale lawnmower patterns. Depending on survey status, undertake TM-CTD and in situ pump casts and where possible run the tow-fish.
10 Apr	Eddy: Continue radial surveys. CAPR: interleave satellite track sampling and small-scale lawnmower patterns. Depending on survey status, undertake TM-CTD and in situ pump casts and where possible run the tow-fish.
11 Apr	Recover free-drifting sediment trap, depart Eddy site by 18:00 (46 hours at 12 knots return to Hobart), CAPR: transit along satellite overpass track
12 Apr	Transit to Hobart along satellite overpass track. Slow to tow Triaxus across Eddy 1 if time and eddy locations permit.
13 Apr	Arrive Hobart - 16:00 target time
14 Apr	Demobilisation

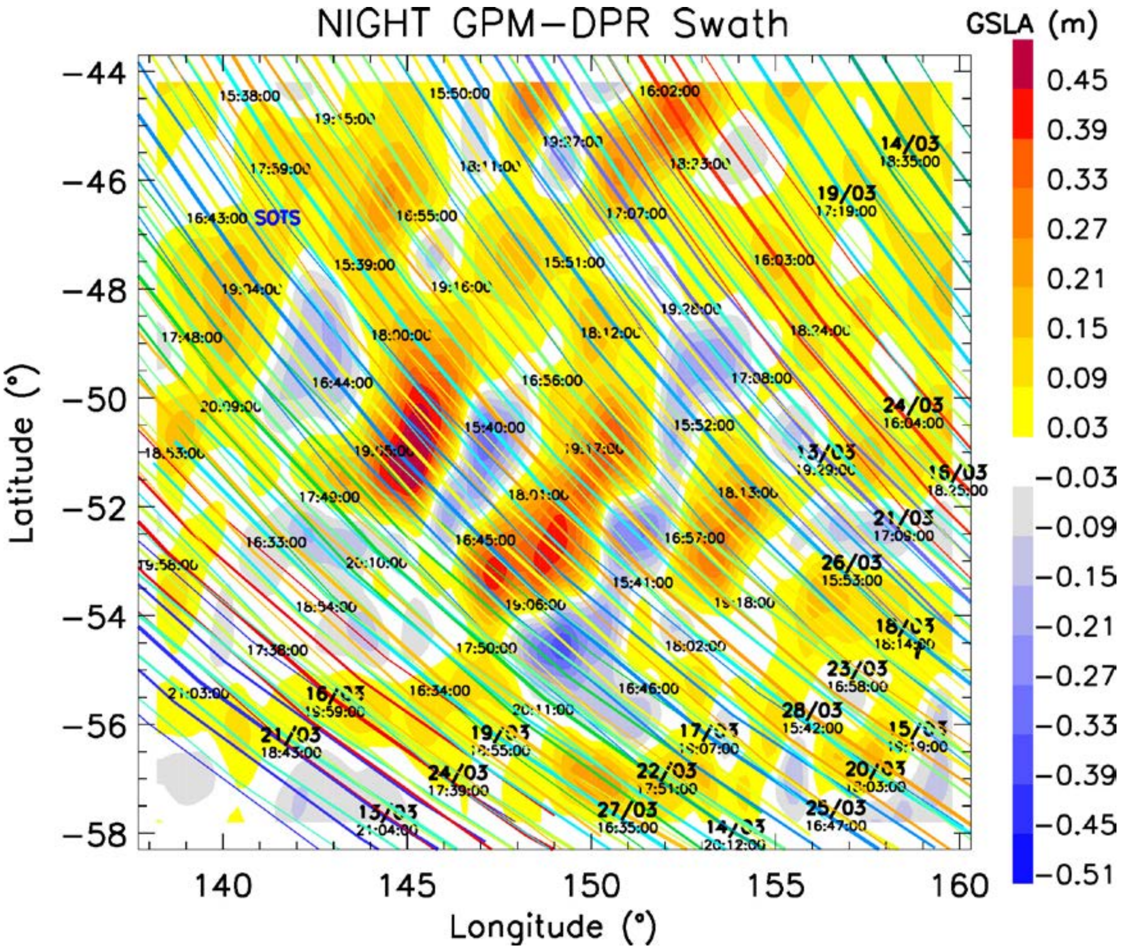
Voyage track example

To meet time constraints the voyage will visit SOTS only once. The precise location of the two eddies for the Eddy study will be finalized from satellite remote sensing prior to the voyage. They are expected to be similar to a red/blue pair as shown. Selection will favour a location that minimizes transit and maximizes overlap with CAPRICORN sampling during satellite over-passes (also shown below). We will use updated information on eddy location and satellite tracks to work out our refined ship track during the SOTS work. **Because time constraints are very tight, we will depart as early as possible during the mobilization, return as late as possible to Hobart, and maintain 12 knots during all transits.**




16 – day CloudSat Tracks
GSLA (m)
Latitude (°)
Longitude (°)
SOTS
−44
−46
−48
−50
−52
−54
−56
−58
140
145
150
155
160
0.45
0.39
0.33
0.27
0.21
0.15
0.09
0.03
−0.03
−0.09
−0.15
−0.21
−0.27
−0.33
−0.39
−0.45
−0.51


DAY GPM−DPR Swath
GSLA (m)
Latitude (°)
Longitude (°)
SOTS
−44
−46
−48
−50
−52
−54
−56
−58
140
145
150
155
160
0.45
0.39
0.33
0.27
0.21
0.15
0.09
0.03
−0.03
−0.09
−0.15
−0.21
−0.27
−0.33
−0.39
−0.45
−0.51



Figures: CloudSat satellite tracks and GPM dual-frequency precipitation radar swath (day and night) overlaid on the current location (as of 03/03/2016) of the mesoscale eddies. These plots will be refined as we sail.

NASA has developed a website where the latest overpasses near the Investigator are updated daily: http://gpm-gv.gsfc.nasa.gov/Tier1/ and select CAPRICORN from the pull-down menu at the top of the page. We will provide coordinates of the two mesoscale eddies when finalized.

Waypoints and stations

Transit time estimates at 12 knots.
Eddy locations are indicative for planning purposes and will be refined from satellite observations shortly before the voyage. Transit distances and times are great circle routes for planning purposes, but in practice will be aligned with satellite overpasses whenever possible.

Site	Dec. Lat.	Dec. Lon.	Distance (km)	Distance nm	Total Distance	Hours Steaming	Total transit hrs
Hobart	42.87	147.35					
Adv. Bay	43.33	147.35	51	28	28	2	2
SOTS	46.80	141.00	630	340	368	28	31
Eddy (nominal 1)	52.00	150.00	870	470	838	39	70
Eddy (nominal 2)	54.00	155.00	402	217	1054	18	88
Hobart	42.87	147.35	1358	733	1788	47	149

Individual Mooring Locations

Mooring	Latitude	Longitude	Depth
FluxPulse-1 target:	46° 46.628'S	141° 59.586'E	4650m
SAZ-18 target:	46° 47.623'S	141° 48.962'E	4550m
Pulse-11 current:	46° 56.430'S	142° 19.566'E	4240m
SAZ-17 current:	46° 49.494'S	141° 39.354'E	4502m
SOFS-5 current:	46° 40.020'S	142° 04.392'E	4664m

Piggy-back projects

1. Southern Ocean Carbon Cycling Observations and Modeling (SOCCOM)
Lynne Talley, Scripps Institution of Oceanography
Jorge Sarmiento, Princeton University
SOCCOM consortium (www.soccom.org)
Deploy 2 autonomous profiling floats at SOTS and/or Eddy sites
Each float to be supported with a prior CTD to 2250m depth.

The scientific objectives are to determine the interactions between changing Southern Ocean circulation and stratification and the physical and biological uptake of carbon dioxide and associated ecosystem impacts. The approach is to deploy autonomous profiling floats with new generation sensors in bio-optical sensors for microbial biomass, oxygen sensors to determine ocean ventilation, pH sensors to examine ocean acidification, and nitrate sensors to track biological productivity.

Investigator equipment

SOTS

Trawl Deck Equipment and Support

- MNF netdrum spooling gear for SOFS-5 recovery and FluxPulse-1 deployment – requires 4 m^3 drum storage, minimum 500kg lifting capacity.
- Stern-ramp cover ("dance-floor") without overhanging lip on aft surface installed with gap protectors and mounts for user-supplied Bull Horns fairlead.
- A-frame utility winches refitted with non-elastic polymer cables and light weight heads and lifting hooks for safe working conditions.
- Tagging line cleat attachment points fitted.
- 2 container slots free for installation of user-supplied containers and deck clear for installation of a third container on starboard aft quarter

O2 Deck Equipment and Support

- Mezzanine winch in working order, with non-elastic polymer working line fitted, for pick-up of SOFS-5 surface float (alternatively can use Gilson winches).

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, sensors mounted.
- Lowered ADCP with all heads working and logging
- CTD voltage inputs calibrated to correctly log sensor inputs
- MNF supplied hydrochemists to carry out oxygen sensor calibrations on land and analyses at sea (priority), as well as salinity and nutrient analyses. SOTS requires ~150 oxygen, salinity, and nutrient analyses.
- WOCE/Go-Ship compliant CTD data processing and output files to be provided, including error estimates for oxygen and nutrient parameters

TRIAXUS Equipment and Support

- Triaxus towed body and towed body winch, equipped with:
  - MNF supplied electronics, data display and logging, and piloting support
  - MNF dual CTs with oxygen electrodes
  - MNF-LOPC
  - user-supplied SUNA, PAR, and FIRE sensors

Underway Equipment and Support

- Multibeam/Multifrequency bio-acoustic system, with MNF supplied electronics, computing, and operational support
- Working and logging underway echosounder with bottom detection and real-time display
- Working and logging underway ADCP, with real-time display
- Working and logging underway thermosalinograph and fluorometer and real-time display
- Working hull mounted 12 kHz transducer for use with acoustic release deck unit
- Working drop keel for thermosalinograph and ADCP data gathering
- Working and logging meteorological instruments including ISAR SST radiometer

CAPRICORN

- Cloud radar-lidar container on the fore deck (same item as listed under User Equipment)
- 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 – joint with Eddy.

Eddy

CTD, Triaxus, and Underway equipment and support needs are covered by the SOTS request above.

- Space for the MNF radiation van, MNF deckboard platform beside rad van, and two MNF trace metal vans – all will already on board during Heard island voyage.
- Support for, including deployment winch for, MNF in-situ pumps, MNF TM rosette, user-supplied trace metal CTD rosette.
- MNF dynex winch for VMP Microstructure Profiler deployment from starboard hydraulic boom.
- Hydrochemistry support. Eddy requires ~ 1500 oxygen, salinity, and nutrient analyses.
- Use of MNF zooplankton net. ~300um mesh size as discussed with Mark Lewis. Set up for vertical tows from about 200m to surface.

User Equipment

SOTS

For Installation on Trawl Deck (see deck loading plan)

- Bullhorn mooring fairlead to be mounted on ship stern – ***this will mean that great care will be needed to avoid it for Triaxus deployments and recoveries***.
- CSIRO mooring winch - requires hydraulic leads to power supply installed in shelter-shed
- MNF netdrum winch spooling gear for SOFS-5 recovery and FluxPulse-1 deployment
- 1xhalf-height open-top containers to hold mooring equipment
- Full height container for storing and working on sediment traps, RAS instrument package, SOCCOM and other floats – requires monophase 240V 15-30 amp power supply. This container will also house the in-situ pumps for use during Eddy component.
- SOFS/FluxPulse float and recovery cradle
- Pulse float and recovery cradle
- Recovered Pulse damper and UBE 3-float pack
- Recovered Pulse RAS instrument package
- 4 mooring anchor stacks – 3 to be combined into FluxPulse anchor, plus single stack for SAZ anchor
- ~6 cage pallets of mooring equipment
- Handheld and deck mounted pneumatic line throwers (“grappling guns”)
- Video cameras installed on trawl deck

For Installation in Shelter Shed

- Power Supply for CSIRO Mooring Winch
- TRIAXUS
- Pallet of mooring gear

For Installation in Ops room

- acoustic release deck unit to be mounted in the Ops room (and spare unit stored)

For Installation in Underway Lab

- Tilbrook O_2/Ar mass spectrometer, pCO_2 system (both will be on board IN2016_v01), Trull/Boyd/Strutton FIRe fluorescence instrument.

For installation in the General Purpose (Dry Clean) Laboratory, forward inboard bench

- Trull particle filtration system and drying oven, also requires use of laminar flow bench in this lab

For installation on the Triaxus towed body

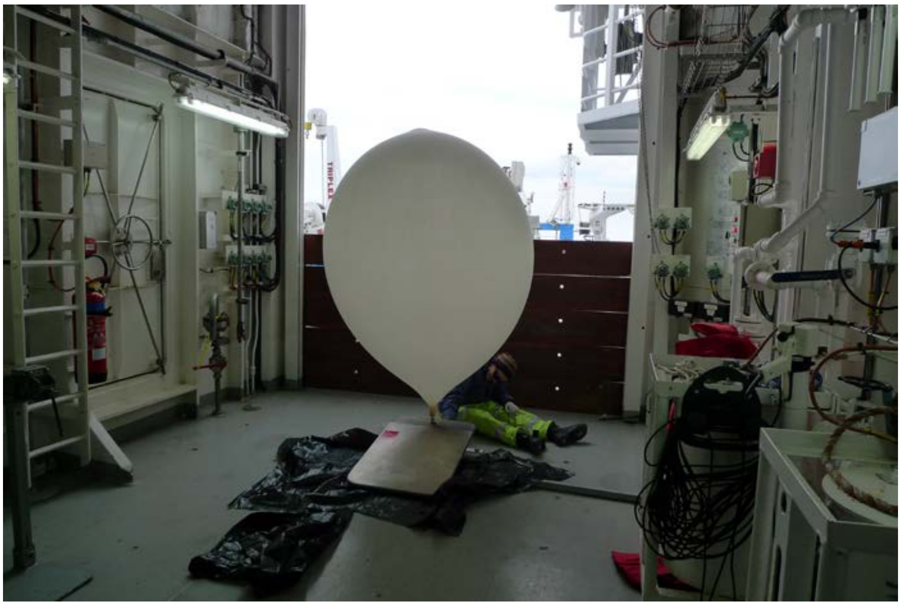
- SUNA nitrate sensor
- FIRE fluorescence induction and relaxation sensor (maximum depth 200m)
- SATLANTIC PAR sensor

CAPRICORN

- The Cloud radar – lidar container (BOM/MNF)
- The 2-channel microwave radiometer (University of Utah, needs to be installed near the cloud radar – lidar, MNF to advise, maybe on the observation platform, or the monkey island?)
- The MRR-2 Micro-rain radar (NASA, needs to be strapped somewhere, preferably near the cloud radar-lidar, MNF to advise, maybe on the observation platform, or the monkey island)
- The OceanRAIN disdrometer (University of Hamburg, on the front mast, second level from top would be ideal). *This equipment is expected to be installed earlier for IN2016_v01.*
- The NOAA Surface energy flux package and the University of Melbourne CSAT3 sonic anemometer. System includes several weatherproof boxes for dataloggers, power supplies, data interfaces. A laboratory for two data acquisition and processing computers. Cable runs from mast and forward deck into the lab. These instruments will be installed at two different locations on the ship:
  - At the top of the front mast: two sonic anemometers, motion system, Licor7500 fast humidity sensor (within 1 meter from the sonic anemometers), laser wave height sensor, Vaisala mean T/RH sensor in aspirator.
  - Somewhere on the forward deck: Pyranometer (solar flux), pyrgeometer (IR flux), mean pressure sensor, STi optical raingauge, GPS heading, and towed floating SST thermistor.
- The towed floating SST thermistor needs to be deployed from a boom. NOAA can supply one as shown in the photo, or alternatively a ship boom may be used. The SST thermistor string is expected to be able to tow at 12 knots, and can be recovered quickly if this becomes untenable.

- In the Air Chemistry Lab: VH-TDMA (QUT), ToF Aerosol Chemical Speciation Monitor (ACSM), Proton transfer mass spectrometer (PTRMS), VOC Sequencer, Scanning Mobility Particle Sizer (SMPS) , TEM Nano aerosol sampler (QUT)
- In the Aerosol Lab: The Neutral cluster Air Ion Spectrometer (NAIS) (QUT), Particle sizers (nanoSMPS), Cloud condensation Nuclei counter, Particle counter (x2), Aerosol Aerodynamic Particle Sizer (CSIRO), Continuous Flow Diffusion Chamber (CFDC), Aerosol concentrator, and WIBS-4A (CSU).
- On the Level 5 Deck: Cascade Impactor Aerosol sampler and Ice Spectrometer (IS) filter, MOUDI (provided by CSIRO and CSU), secured to a rail deck outside; requires sample conditioning switch, as during the maiden voyage.
- Radiosonde balloon filling pan within the sheltered science space for 300g and 600g balloons - see pictures below - this was previously bolted to the floor and worked well. Two He gas bottles to be installed in sheltered science space for radiosonde filling, and remainder stored nearby for convenient swapping of empty cylinders.
- Radiosonde ground station (Digicora) in the Monkey Island, with VHF antenna and GPS antenna installed nearby.



Eddy

For installation on Trawl Deck

- 3 profiling floats to be stored in sedtrap container.
- VMP Microstructure profiler and space in the Wet lab for downloading data.
- Free-drifting sediment traps

For Installation in Underway Lab

- Trull/Boyd/Strutton FIRe fluorescence instrument.

For installation in the General Purpose (Wet Clean) Laboratory

- Strutton filtration package. Could be in dirty wet lab.

Special Requests

Please see above *Investigator* Equipment and User Equipment lists for support requests.

Separate documents provide detailed procedures and risk management for:

SOTS

- Mooring deployments

Eddy

- Radiation van, deck board incubation van, 2 TM MNF vans, plus MNF in situ pumps, TM rosette

CAPRICORN

- Operation and maintenance of the OceanRAIN disdrometer.
- MRR-2 manual
- CSU instrumentation details

Permits

SOTS

- Collection of seawater and sediment trap samples for return to Hobart under ACE CRC Quarantine permit #IP15013655.
- Mooring locations and buoy marking details will be provided to AMSA for notice to mariners.

Eddy

- Collection of seawater and sediment trap samples for return to Hobart under IMAS Quarantine permit #IP15015807.

Personnel List

List all scientific participants, their affiliation and role on the voyage

1.	Tegan Sime	MNF	Voyage Manager
2.	Steve Thomas	MNF	SIT electronics support
3.	Will Ponsonby	MNF	SIT electronics support
4.	Pamela Brodie	MNF	DAP computing support
5.	Stewart Wilde	MNF	DAP computing support
6.	Dave Watts	MNF	GSM support
7.	Cassie Schwanger	MNF	Hydrochemist
8.	Kendall Sherrin	MNF	Hydrochemist
9.	Ben Baldwinson	MNF	SIT electronics support
10.	Tom Trull	CSIRO-ACE	SOTS: Chief Scientist
11.	Eric Schulz	BOM	SOTS: Co-Chief Scientist, Dogger
12.	Peter Jansen	IMOS-UTAS	SOTS: Managing Engineer
13.	Jamie Derrick	CSIRO	SOTS: Mooring Technical Supervisor
14.	Gary Curtis	CSIRO	SOTS: Mooring Technical Supervisor
15.	Jim LaDuke	CSIRO	SOTS: Mooring deck work
16.	Alice della Penna	UTAS-UParis	SOTS: Triaxus sensors, particle filtrations
17.	Alain Protat	BOM	CAPR: PI+cloud data collection
18.	Ruhi Humphries	CSIRO	CAPR: Aerosol PI+data collection
19.	Luke Cravigan	QUT	CAPR: Aerosol QUT data collection
20.	Christina McCluskey	CSU	CAPR: Aerosol CFDC+ IS data collection
21.	Murray Hamilton	Univ. Adelaide	CAPR: radiosonde launch
22.	Yi Huang	Monash Uni	CAPR: radiosonde launch
23.	Gerald G. Mace	Univ. Utah	CAPR: cloud radar
24.	Byron Blomquist	NOAA	CAPR: Surface Energy Fluxes
25.	Kaitlyn Lieschke	Uni. Wollongong	CAPR: radiosonde launch + aerosol
26.	Peter Strutton	UTAS	Eddy: PI, New production and optics
27.	Sebastien Moreau	UTAS	Eddy: New production and optics
28.	Philip Boyd	UTAS	Eddy: Microbial processes
29.	Matthieu Bressac	UTAS	Eddy: Microbial processes
30.	Marion Fourquez	UTAS	Eddy: Microbial processes
31.	Helen Phillips	UTAS	Eddy: CTD and underway physics, VMP
32.	Eldene Oshea	UTAS	Eddy: CTD and underway physics, VMP
33.	Michael Ellwood	ANU	Eddy: Trace metals
34.	Robert Strzepek	ANU	Eddy: Trace metals
35.	Sam Eggins	ANU	Eddy: Trace metals
36.	Viena Puigcorbe	ECU	Eddy: Th-based export
37.	Gloria Salgado Gispert	ECU	Eddy: Th-based export
38.	Joan Llort	UTAS	Eddy: Underway and TRIAXUS optics
39.	Ramkrushnbhai Patel	UTAS	Eddy: Underway and TRIAXUS optics

Certification

Thomas W Trull
IN2016_V02 Chief Scientist
ACE CRC Carbon Program Leader
CSIRO Oceans & Atmosphere Senior Scientist

4 March 2016

List of additional figures and documents

Mooring diagrams provided separately:

- Figure 1. SOFS-5 mooring
- Figure 2. Pulse-11 mooring
- Figure 3. SAZ-18 mooring
- Figure 4. SAZ-17 mooring
- Figure 5. FluxPulse-1 mooring

Procedures provided previously to MNF (for IN2015_v01) that are now part of ship management system (updates of these documents will be provided separately for IN2016_v01):

- SOFS/FluxPulse Mooring Deployment/Recovery Procedure
- Pulse Mooring Deployment/Recovery Procedure
- SAZ Mooring Deployment/Recovery Procedure

New procedures provided separately:

- Eddy Project: Radiation Van procedure
- Eddy Project: Free-drifting sediment trap Deployment/Recovery Procedure Argo float deployment procedure (to be provided by Argo Facility / MNF)

- In-situ pump deployment procedure detailed here:

Mclane pump deployment and retrieval

Deployment

1. Couple pumps top computer, program and insert new batteries (if necessary)
2. Spool hydrowire through block and attached weights (~100 kg)
3. Deploy weight by paying out ~50 m of wire
4. Move wire close to side of vessel
5. Attach lower Mclane pump clamp to hydrowire (see figures below)
6. Lift Mclane pump (~50 kg) and locate lower pin through eye on pump – requires three people
7. Secure upper clamp on pump – third person job while 1 and 2 hold pump, attach safety line
8. Attach pressure sensor (RBR logger) to hydrowire – determines the pump depth – and CTD (tbc)
9. Move hyrdowire away from vessel and then lower to desired depth – need monitor amount of wire out
10. Repeat from step 3 for next 4 pumps at chosen depths

Retrieval

1. Spool hydrowire
2. Once pump is at deck level move hydrowire close to vessel
3. Undo upper clamp – persons 1 and 2 hold pump while the third person undoes clamp
4. Lift pump off lower clamp
5. Remove lower clamp