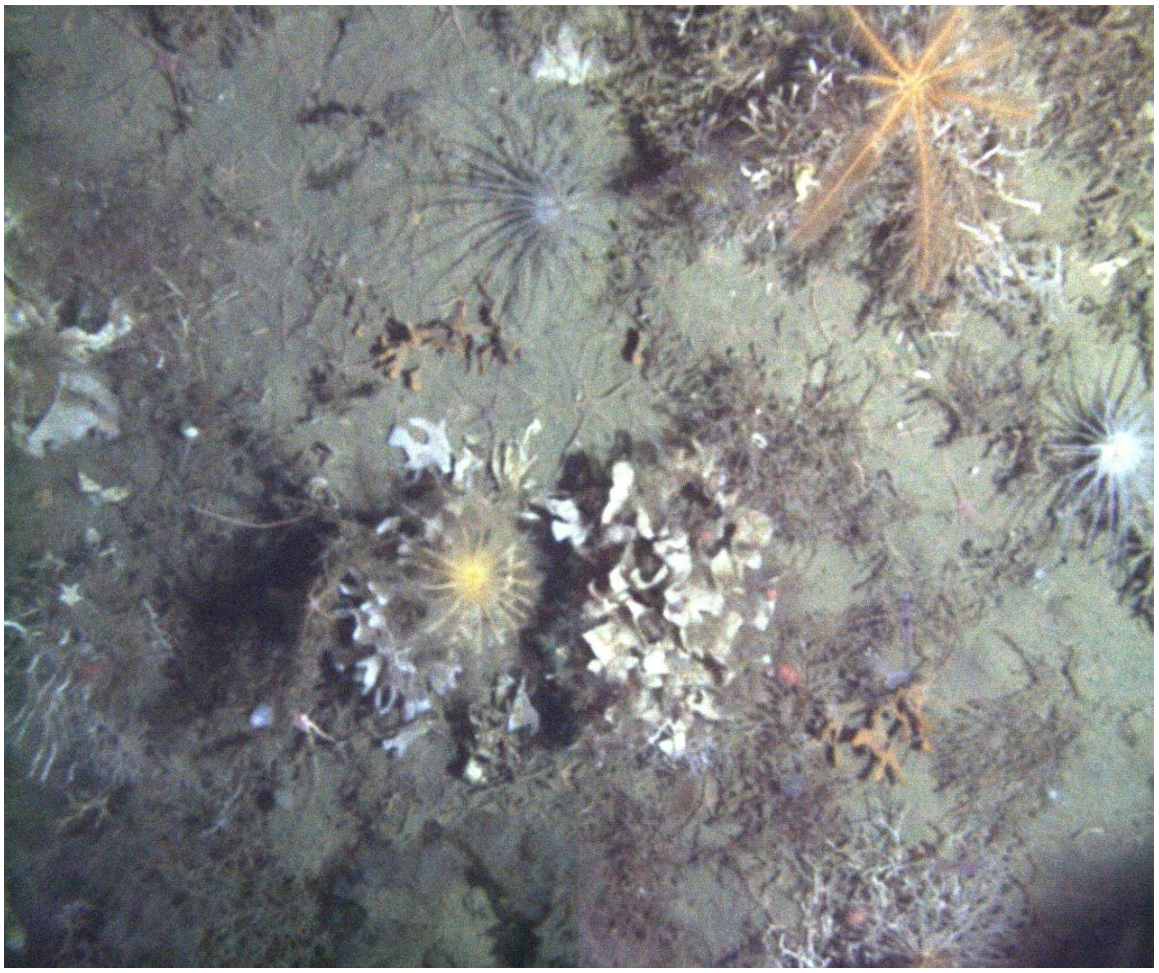
RRS James Clark Ross

JR307/308 Cruise Report



JR308: Benthic Biology of the Cold Hole

JR307: Tracing deep waters and nutrient dynamics across the WAP shelf

RRS James Clark Ross JR307/308 Cruise Report

Benthic Biology of the Cold Hole

Huw Griffiths, Peter Enderlein, Oliver Hogg, Belinda Vause, Sabrina Heiser, Hugh Venables

Tracing deep waters and nutrient dynamics across the WAP shelf

Sian Henley, Libby Jones, Jacqueline Stefels, Sabrina Heiser, Hugh Venables

Falkland Islands – Rothera – Cold Hole – Marguerite Bay – Rothera

British Antarctic Survey Cruise Report

Report of *RRS James Clark Ross* cruise JR307/308, December-January 2014/15

BAS Archive Reference Number: ES*/*/2015/*

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Contents

Summary

The aim of cruise JR308 was driven by the objectives of EvolHist, a core project at BAS studying biodiversity, biogeography, phylogeography and evolution in marine Antarctic fauna. Working in partnership with Polar Oceans, we proposed a four day scientific cruise on RRS James Clark Ross to investigate the benthic biodiversity and oceanography of a basin with temperatures 1.1 °C colder than the surrounding regions at the same depths recently discovered by the Polar Oceans glider team (Venables, Anker, Meredith) at ~67°45' S, 69°01'W. This work investigated the effect of temperature and geomorphological isolation on the faunal composition of Antarctic shelf benthos at a local scale, something that is only possible at this location due to this oceanographic anomaly.

The main objective of the biological component of this cruise was to collect benthic marine organisms from transects inside the cold basin, in the shallower region surrounding the basin and in other (warmer) neighbouring areas at the same depth as the basin for comparison. We completed a programme of work including CTDs, video transects and benthic trawls to collect animals for identification, biodiversity, abundance and population genetic analyses. We sampled in each location at depths of between 150 m and 500 m including replicate Aggasiz trawls (AGT), epibenthic sledge (EBS), shallow water underwater video(BAS's SUCS, including standalone SEABIRD SBE-37 CTD and GOPRO camera) and 24 bottle Niskin rosette CTDs. On board, the AGT samples were sorted to phylum and class level (and higher when possible) before fixation while the EBS samples were immediately fixed for sorting on return to BAS Cambridge. Before the trawling, a swath survey was carried out to select seafloor areas suitable for benthic trawling. This was done on approach to Rothera, and the data were combined with existing swath data (which had already been collected in our primary target region). During some CTDs, water samples were collected using a 24 bottle Niskin rosette.

Cruise JR307 was a key part of the three year field component of NERC Fellowship NE/K010034/1: Isotopic characterisation of nutrient dynamics and deep water behaviour in the west Antarctic Peninsula sea ice environment. Within this broad project, the specific

objective of this cruise was to trace the circumpolar deep water (CDW) nutrient source from the shelf break to the coast, and examine its modification across the shelf and delivery to productive shelf ecosystems. Cruise JR307 also provided a collaborative opportunity to examine the CDW supply of CO_2 and spatial variability in DMS production by phytoplankton.

We requested two days of ship time on RRS James Clark Ross to conduct full-depth water column sampling at ten stations along a transect from the shelf break to the long-term monitoring station of the Rothera Time Series (RaTS) in Ryder Bay. Stations were chosen to follow the deepest bathymetry (500 – 1000m depth) thought to act as a conduit for CDW across the WAP shelf. At each station full-depth physical oceanographic parameters were measured using the ship's CTD system and water samples were taken throughout the water column using the ship's 24 bottle Niskin rosette. On board, samples were taken for analysis of macronutrient concentrations, stable isotope composition of nitrate, concentration and isotope composition of particulate organic carbon and nitrogen, and RNA sequencing of organic matter. Samples were also taken for dissolved inorganic carbon system parameters, oxygen isotope composition of seawater, dimethyl sulphide (DMS) concentrations and associated parameters. Samples were filtered or fixed with preservative, for subsequent analysis at Rothera or on return to the UK or The Netherlands.

Objectives

The main aim of cruise JR308 was to sample large macro-and mega- size fractions of seabed dwelling (benthic) animals in the Cold Hole. Our sampling regime was designed to investigate patterns of biodiversity, and once compared to other sources of material, biogeography and phylogeography in the benthos of this region of the Southern Ocean.

The main aims of cruise JR307 were to trace the circumpolar deep water (CDW) nutrient source to the productive coastal ecosystems and examine its modification across the shelf, to provide a macronutrient and nitrogen isotopic end-member value for unmodified CDW for use in models, and thus to quantify the delivery of nutrients to high productivity Antarctic coastal surface waters. We also aimed to examine spatial variability in nutrient supply, uptake and primary production along a transect from the shelf break to the coast,

thus providing a spatial context to ongoing time-series work at Rothera to examine the biogeochemical response to physical climate change at the Antarctic Peninsula.

Funding

Cruise JR308 was part of the EvolHist Workpackage of the Environmental Change and Evolution Programme (BAS).

Cruise JR307 was part of the NERC Independent Research Fellowship of Dr. Sian Henley: Isotopic characterisation of nutrient dynamics and deep water behaviour in the west Antarctic Peninsula sea ice environment (NE/K010034/1).

Summary narrative for JR308

December-January 2014/15

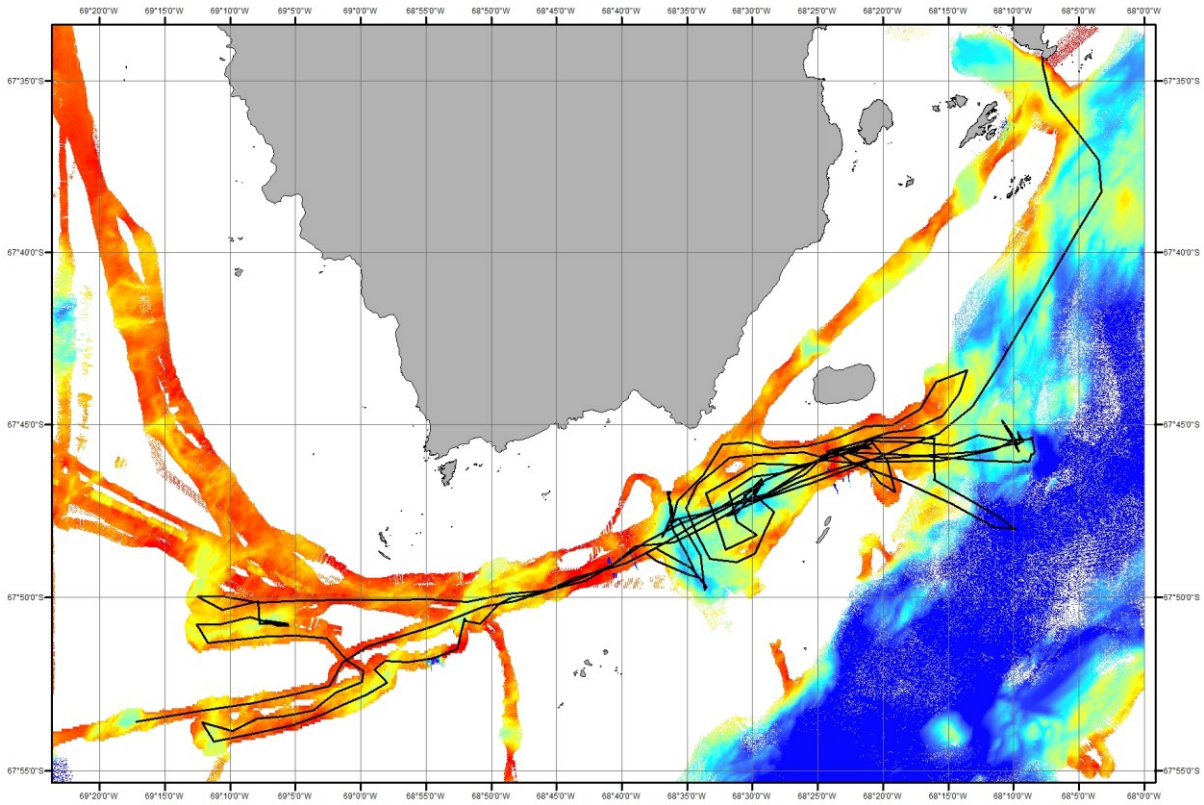
The cruise track is shown in Figure 1.

The benthic biology and physical CTDs of JR308 took place over 4 days and nights in a region just south of Adelaide Island.

Work Cold Hole progressed very well, with JR308 achieving a good coverage of benthic biology sites. CTDs were used to characterise the water masses of the Cold Hole and the regions used a comparison. The SUCS video and still camera system was a valuable tool in enabling our understanding of the seafloor environment, ecology and habitats.

New SWATH data has increased our knowledge of the geomorphology of the region.

Figure 1: Cruise Track for JR308



Summary narrative for JR307

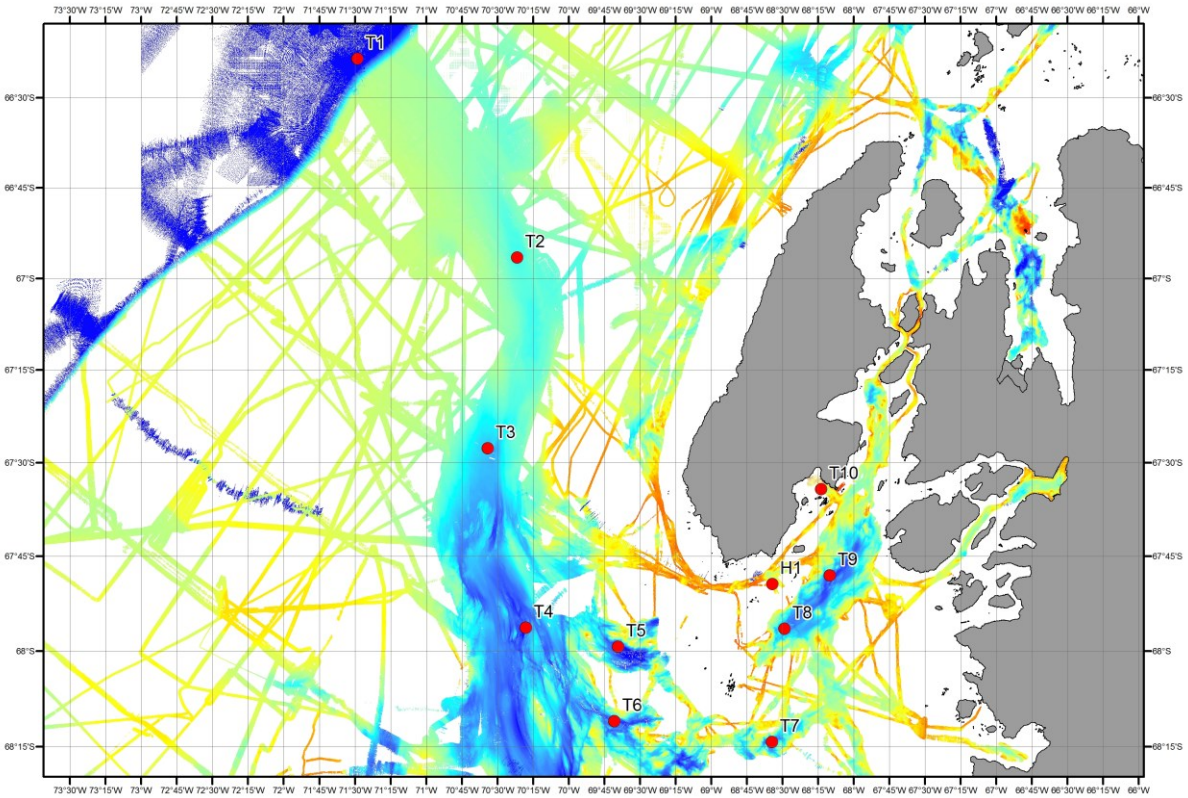
December-January 2014/15

The transect sampling stations are shown in Figure 2.

The water sampling and CTDs of JR307 took place over a total of five days scheduled around cold hole work and glider work to maximise whole cruise scientific output. Biogeochemical transect work met and exceeded our objectives and expectations, with samples and measurements collected at all intended stations across the WAP shelf and one additional station in the cold hole to provide biogeochemical data for the benthic biology team.

CTDs were used to identify water masses and property gradients along the transect and this was used to refine water sampling depths at each station. Water sampling was then undertaken to reflect variations in water column structure whilst maintaining consistency across the transect.

Figure 2: Sampling stations for JR307 and available swath bathymetry data for the WAP shelf (image courtesy of Huw Griffiths).



Timetable of Events

Date	Julian Day	Notes
31.12.14	365	Passage to Station 1 with Lifeboat training on the way. 3 SUCS deployments, 3 AGTs and 1 EBS.
01.01.15	1	Passage to Station 2. 4 SUCS, 1 AGT and 1 EBS. Passage to Station 3. 1 AGT, 1 EBS and 2 SUCS. Passage to H1 and 1 CTD (physics and chemistry).
02.01.15	2	9 CTDs (H2 – H9 physics only, T9 physics and chemistry). Passage to Station 4. 3 SUCS, 3 AGTs. Passage to Station 5 and 3 SUCS (gantry broken after last AGT, SUCS done instead of more trawls whilst gantry was fixed).
03.01.15	3	3 CTDs (H11 – H13 physics only). Passage to Station 4. 2 AGTs and 1 EBS. Passage to Station 5. 1 EBS and 3 AGTs.
04.01.15	4	2 CTDs (T1 – T2, physics and chemistry). Deployed glider 409 at T2.
05.01.15	5	CTD (T3 physics and chemistry). Recovered glider 409 at T2. 2 CTDs at T5 and T4 (physics and chemistry).
06.01.15	6	2 CTDs (T6, T7 physics and chemistry). 2 SUCS at Station 6. 1 CTD (T8 physics and chemistry).
07.01.15	7	1 CTD (T10 physics and chemistry). 3 SUCS at Station 7. Arrived back at Rothera.

Personnel

Officers and crew for JR307/308

BURGAN, Michael JS	Master
PAGE, Timothy S	Chief Officer
BOWDEN, Philippa Ann	2nd Officer
JOHNSTON, Greg GJ	3rd Officer
FAULKNER, Lucy A	Extra 3rd Officer
GLOISTEIN, Michael EP	ETO Comms
MACDONALD, Neil C	Ch Engineer
BEHRMANN, Gert	2nd Engineer
LAUGHLAN, Marc	3rd Engineer
TOLKS, Jevgenijs	4th Engineer
THOMAS, Craig GL	Deck Engineer
AMNER, Stephen P	ETO
TURNER, Richard J	Purser
PECK, David J	Bosun/Sci' Ops
BOWEN, Albert Martin	Bosun
DALE, George A	Bosun's Mate
HERNANDEZ, Francisco J	SG1A
SMITH, Sheldon T	SG1A
ROBINSON, Richard G	SG1A
RAPER, Ian	SG1A
HOWARD, Alan S	SG1A
HENRY, Glyndor Neil	MG1
PRATT, John	Chief Cook
COCKRAM, Colin C	2nd Cook
JONES, Lee J	Snr Steward
GREENWOOD, Nicholas R	Steward
RAWORTH, Graham	Steward
MORTON, Rodney B	Steward

Scientific Party for JR308

ENDERLEIN, Peter	BAS (Antarctic and Marine Engineering) (PSO)
GRIFFITHS, Huw J	BAS Marine Biologist
HOGG, Oliver T	BAS/SPRITFIRE PhD student/Marine Biologist
VAUSE, Belinda J	BAS Marine Biologist
HEISER, Sabrina	BAS Marine Assistant
VENABLES, Hugh	BAS Oceanographer
WOODROFFE, Paul	BAS (Antarctic and Marine Engineering)
ROBST, Jeremy	BAS (IT Support)

With gratitude for the considerable assistance from; Alex Brierly, Damien Desbruyeres, Sophie Fielding, Yvonne Firing, Freya Garry, Sian Henley, Libby Jones, Cristian Lopez, Damien O'Gaoithin, Paul Seagrove, Jacqueline Stefels.

Scientific Party for JR307

HENLEY, Sian	NERC Independent Research Fellow, University of Edinburgh, marine biogeochemist (PSO)
JONES, Libby	Postdoctoral researcher, University of Groningen, marine chemist
STEFELS, Jacqueline	Senior scientist, University of Groningen, marine biologist
HEISER, Sabrina	BAS Marine Assistant
VENABLES, Hugh	BAS Oceanographer

We are grateful to Paul Woodroffe, Yvonne Firing, Damien Desbruyeres, Freya Garry, Cristian Lopez, Belinda Vause, Jeremy Robst, Huw Griffiths and Peter Enderlein for assistance during CTD and water sampling operations.

Cruise participants. Photograph by Richard Turner.

Peter Enderlein, Huw Griffiths, Oliver Hogg, Belinda Vause, Sabrina Heiser, Alex Brierly, Damien Desbruyeres, Sophie Fielding, Jeremy Robst, Yvonne Firing, Freya Garry, Sian Henley, Libby Jones, Cristian Lopez, Damien O'Gaoithin, Paul Seagrove, Jacqueline Stefels, Saskia Van Leuween, Bart Meijer and Willem Oosthoek.

Project Reports for JR308:

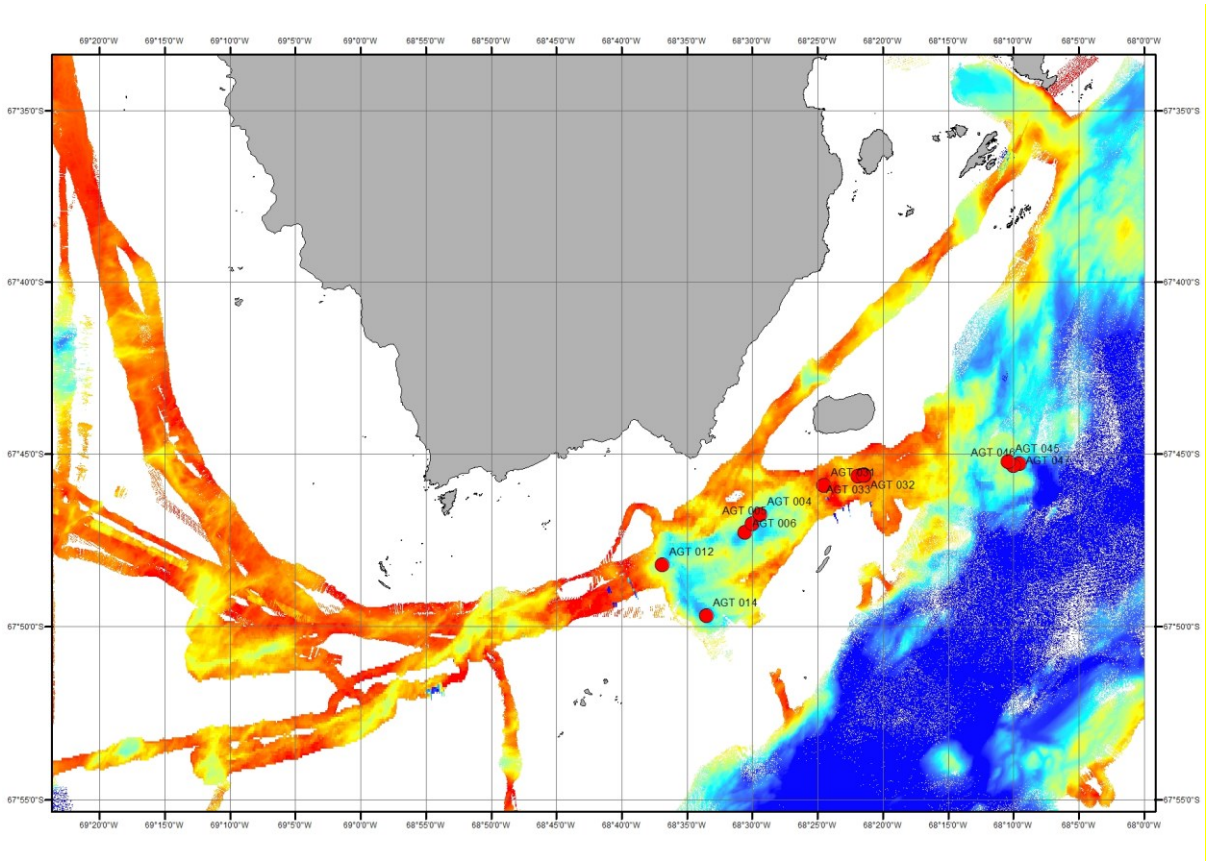


Figure 3: Sampling locations for JR308.

Agassiz Trawl (AGT)

Huw Griffiths, Peter Enderlein, Oliver Hogg, Belinda Vause, Sabrina Heiser

Our apparatus, an Agassiz trawl (AGT), was used to sample animals approximately 1 cm and larger in length, which comprise the larger macro- and megafauna, but did capture some smaller animals as well. Each of the stations comprised of three replicate trawls.

Our Agassiz trawl used a mesh size of 1 cm and had a mouth width of 2 m. At each station the seabed topography was examined prior to trawl deployment using multibeam sonar (swath). The deployment protocol was standardised. While the AGT was lowered, the ship had to compensate for the wire lowering speed of 45 m.min-1 by steaming at 0.3 knots until the AGT reached the seabed and at 0.5 knots until the full trawling wire length was put out.

The full trawling cable length we used was 1.5 times the water depth. The net was then trawled at 1 knot for between 2 and 10 minutes (depending on depth, seabed type and the condition of the animals in the initial trawl). With the ship stationary, the AGT was hauled at 30 m.min-1 in order to avoid damaging the gear. When the AGT had left the seafloor, the hauling speed was increased to 45 m.min-1 and the ship speed to 0.3 knots.

Once on board, the samples were photographed as total catch and then hand-sorted into groups varying from Phylum to species level collections. The wet-mass (biomass) of the different taxa was assessed by using calibrated scales (with accuracy and resolution of 0.001 kg). Animals were either preserved in 96% ethanol or frozen at –20ºC.

There were a total of 11 AGT deployments in the Cold Hole region including 5 withing the cold hole, 3 on the shallow ridge and 3 in 500m outside the Cold Hole.

Preliminary Results

One of the first analyses done after the AGT catches were sorted and fixed was to count the number of phyla present in the catch, to assess the richness at Phylum level of the trawled area (Table 1). Total numbers of phyla varied between 8 and 11. Nine of the trawls contained ten or more phyla .

Six Phyla were found in all 55 catches (Annelida, Cnidaria, Crustacea, Echinodermata, Mollusca and Porifera). Sipunculida and Foraminifera were only reported from single trawls.

The most numerous Phylum of animals caught were the annelid worms with 1,719 individual animals caught. Both the bryozoans and echinoderms had high numbers of individual specimens recorded, 1,371 and 975 respectively. The molluscs totalled 533 individuals, although this total is likely to increase when the epifaunal animals found on the

sea urchins are counted in detail. The echinoderms (mostly holothurians) accounted for around 8.6 kg of wet mass and were the highest mass of animals recorded.

The region with the highest total number of individual animals (when averaged over the total number of trawls in that region, corrected to a 1000 m trawl length) was the shallow ridge surrounding the cold hole. This coincided with the highest total wet weight of animals (mostly echinoderms and sponges) from the same region (see figure 5). In general, the deeper stations had lower total numbers of animals although this did not always equate to a low total biomass. Stations within the Cold Hole had the lowest Phylum level diversity, lowest biomass and the lowest abundances of the three regions studied. The opposite was generally true for the shallow ridge. The deeper region outside of the Cold Hole had higher diversity, biomass and abundances than regions of the same depth within the hole.

Table 1: Distribution of phyla caught by AGT.

Station	Annelida	Brachiopoda	Bryozoa	Chelicerata	Chordata	Cnidaria	Crustacea	Echinodermata	Foraminifera	Mollusca	Nemertea	Porifera	Sipuncula	Unknown	Total
004	X					X	X	X		X	X	X		X	8
005	X			X	X	X	X	X		X	X	X			9
006	X		X	X	X	X	X	X		X	X	X			10
012	X		X	X	X	X	X	X	X	X		X		X	11
014	X		X	X	X	X	X	X		X	X	X		X	11
031	X	X	X	X	X	X	X	X		X		X			10
040	X	X	X	X	X	X	X	X		X	X	X			11
041	X	X	X	X	X	X	X	X		X		X			10
045	X		X		X	X	X	X		X	X	X	X	X	11
046	X		X	X	X	X	X	X		X	X	X		X	11
047	X			X	X	X	X	X		X	X	X		X	10
Total	11	3	8	9	10	11	11	11	1	11	8	11	1	6	

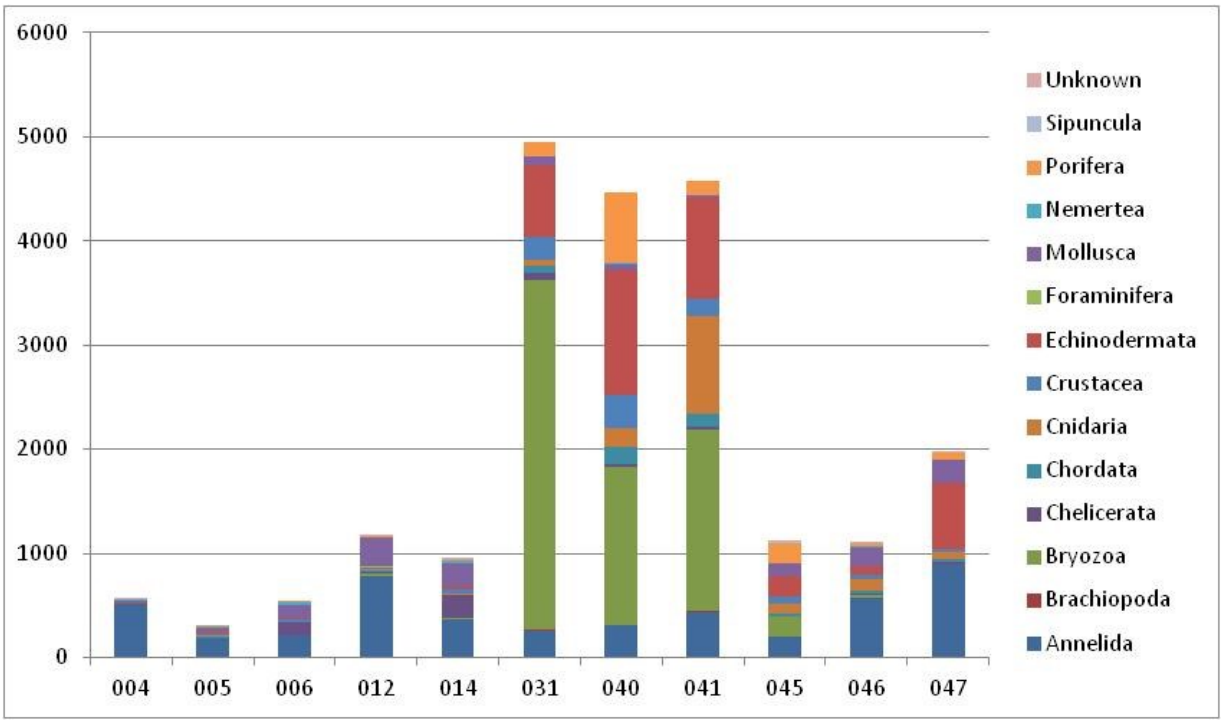


Figure 4. Mean numbers of animals from each location (numbers corrected to a 1000 m long trawl). 4-14 inside the Cold Hole, 31-41 on the ridge and 45-47 at 500m outside of the Cold Hole.

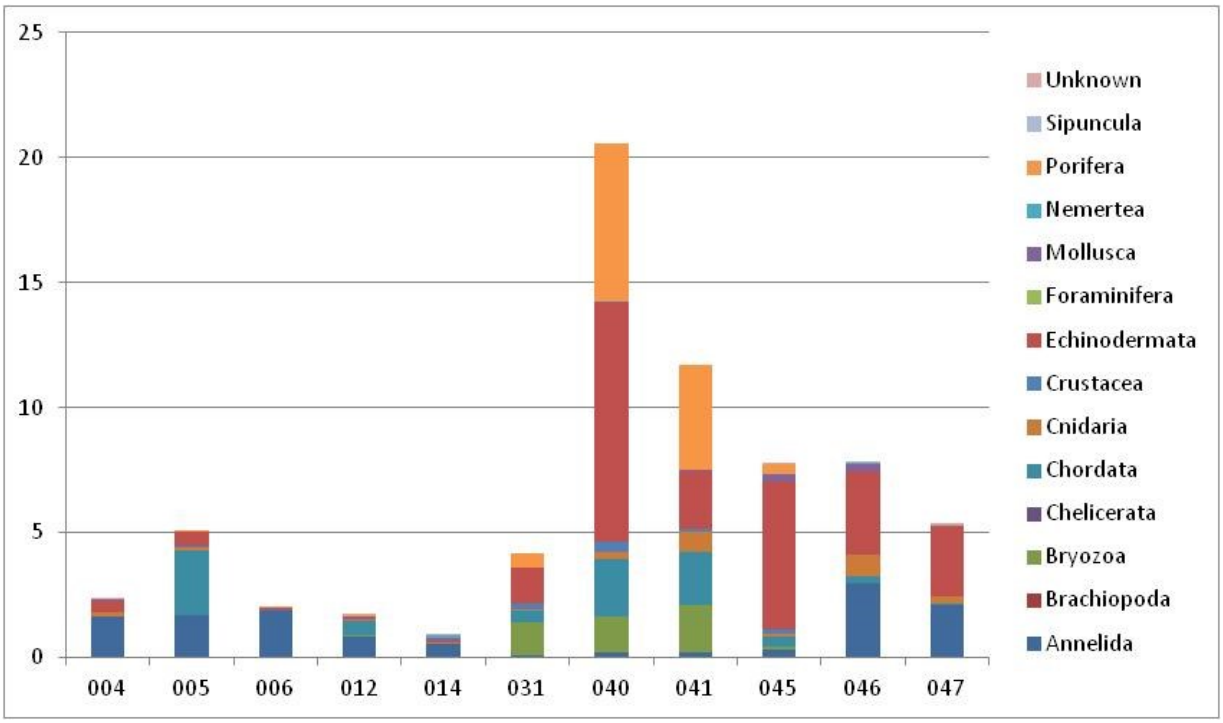


Figure 5. Mean wet weight (kg) of animals from each location (numbers corrected to a 1000 m long trawl). 4-14 inside the Cold Hole, 31-41 on the ridge and 45-47 at 500m outside of the Cold Hole.

Epibenthic Sledge (EBS)

Huw Griffiths, Peter Enderlein, Oliver Hogg, Belinda Vause, Sabrina Heiser

A single Epi-Benthic Sledge (EBS) was deployed at each station. Samples were collected by means of a modified epibenthic sledge (Brenke, 2005). Sampling consisted of a total of 5 deployments, 3 within the Cold Hole 1 on the shallow ridge and 1 in 500m outside the Cold Hole.

The EBS (EBS, Fig. 20) is a proven apparatus for sampling small benthic macrofauna. The sledge is equipped with an epi-net (below) and a supra-net (above). The mesh size of the nets is 500 µm. The cod ends are equipped with net-buckets containing a 300 µm mesh window (Brenke, 2005). The EBS was trawled for 10 min. on the sea bed on each occasion (except for event 36 due to a problem with deployment and event 40 due to a limited sampling area). In total, the operation time of each deployment ranged between 0.5 to 1 hours.

Samples were sieved with cold sea water, and immediately fixed in 96% pre-cooled ethanol and kept for 48 hours in -20 °C for later DNA extraction. As the samples were not examined at sea during JR308 there are no preliminary results to report.

SUCS

Oliver Hogg, Peter Enderlein, Huw Griffiths, Belinda Vause, Sabrina Heiser

SUCS Setup

During summer 2014 the SUCS (shallow underwater camera system) was upgraded, replacing the pre-existing coax cable with a fibre-optic system. The main aim of this upgrade was to rectify an issue whereby the software frequently crashed as a result of sudden changes in tension on the data cable (caused mainly be landing the system on the sea bed or through the roll of the ship in rough weather). Additional benefits to the new cable also included an increase in the system's depth rating from 300m to 1000m, higher definition video, and a higher resolution, live colour feed.

The SUCS for JR308 comprises three units:

1. The UIC unit consisting of (i) the PC with monitor, (ii) the cable metering sheave indicator and (iii) the deck box.

2. The deck unit consisting of (i) the winch, (ii) UW-cable, (ii) the deck monitor and (iii) the metering sheave on the mid-ships gantry.

3. The UW-unit of the tripod consisting of (i) the UW-housing including the camera, booster and power distribution board, (ii) the UW-light, (iii) the USBL pinger, (iv) CDT and (v) GoPro camera with 1000m depth-rated housing.

New components to the SUCS system for 2014 included 1000m of fibre-optic cable, fibre-optic connections at both the deck box and camera housing end, new 1000m depth rated glass for the camera housing, and a slip-ring to accommodate separate power and fibre-optic cables. Further additions to the system for JR308 were the inclusion of a Seabird SBE-37 CDT attached to the tripod frame and a GoPro camera fixed adjacent to the main UW-housing in its own purpose built 1000m depth-rated housing.

The modification of the LabView code together with the fibre-optic upgrade enabled for the first time high-resolution photo stills (2448 x 2050) and video footage (720 x 480) to be taken simultaneously.

Using SUCS during JR308

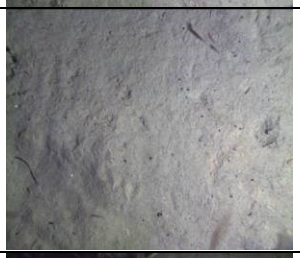
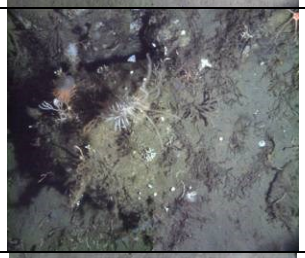
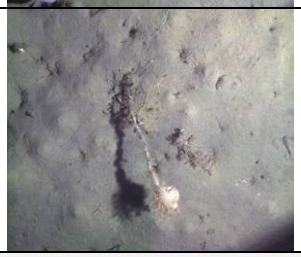
The SUCS can be used to estimate faunal density, biomass and species abundance of the benthos, which is otherwise difficult to achieve because of the selectivity and semi-quantitative nature of capture by the AGT. In addition it gives an overview of the conditions of the underwater landscape. Hence SUCS transects were also performed to investigate the unknown topography of the benthic environment in and around the cold hole ahead of every series of Agassiz trawls. The SUCS and Agassiz gears, when both deployed at the same

site, increase the value of the data obtained. This is because specimens trawled in the latter and identified by detailed morphological inspection or using molecular methods improve the likelihood and confidence of correct identifications of individuals seen in the SUCS images.

During JR308 1528 high-resolution photo stills and 172 videos were taken across 19 transects (see table 1). The stand out benefits of the new system (vs. the old coax setup) was the rapid processing time for each photo and consequently the speed at which photo transects could be conducted, and the ability to simultaneously capture HD photo stills and video. JR308 offered the first opportunity to test the SUCS beyond its previous depth limitation of 300m with the camera successfully deployed to 600m. In contrast to previous cruises involving SUCS deployments (JR262; JR287; JRTri008), during JR308 the new system proved to be stable and reliable with only a very limited number of software crashes, and none during any of the landings on the seabed.

Station	Deployment	Photos	Quadrats	Video	GoPro
1	1	109	9	21	Yes
	2	86	10	15	Corrupted
	3	90	10	4	Yes
2	1	49	7	8	Yes
	2	80	10	11	Yes
	3	100	10	9	Yes
3	1	81	9	8	Yes
	2	79	10	9	Corrupted
4	1	55	10	3	Yes
	2	72	10	1	Yes
	3	104	15	17	Yes
5	1	145	10	4	Yes
	2	80	10	3	Yes
	3	128	15	12	Yes
6	1	40	10	8	Yes
	2	61	10	10	Yes
7	1	64	10	9	Yes
	2	41	10	11	Yes
	3	64	10	9	Yes
Total	19	1528	195	172	17

In addition to the SUCS footage, during each deployment high resolution (1080p; 24 fps), wide-angle video footage was recorded using the mounted GoPro camera. This footage isn't so easy to quantitatively analyse (compared with the SUCS camera) due to the distorting effects of its fisheye lens. It does however record very valuable high-resolution video footage to compliment that of the main SUCS to characterise the seabed.

Station	Deployment 1	Deployment 2	Deployment 3
1			
2			
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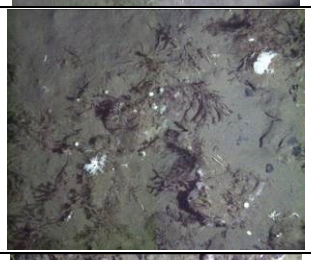
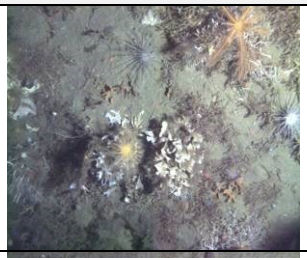
4			
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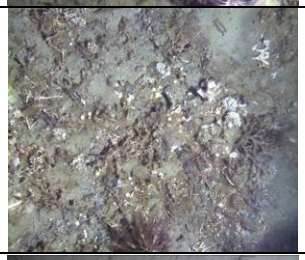
6			
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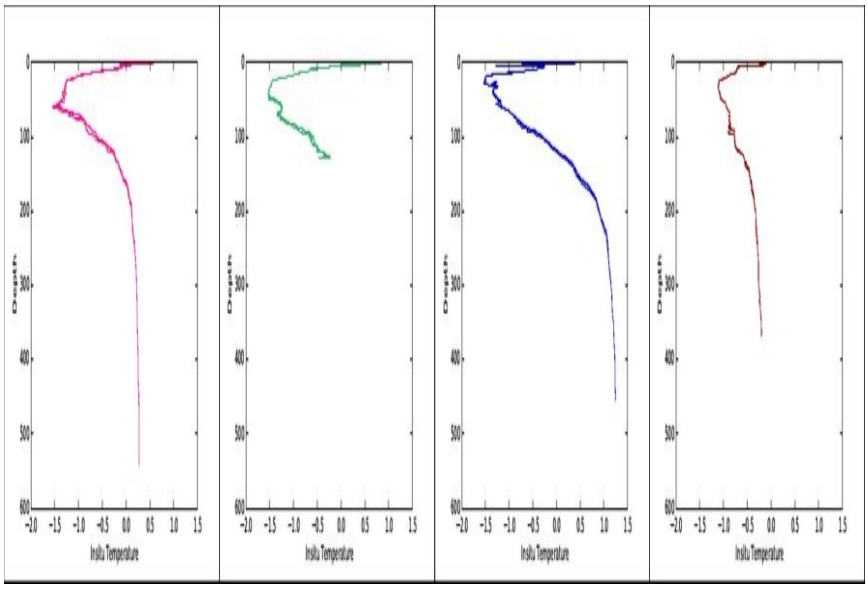
CTD

CTD DEPLOYMENT AND DATA ACQUISITION

Hugh Venables



Introduction

A Conductivity-Temperature-Depth (CTD) unit was used to vertically profile the water column. 22 casts were carried out in total. CTD positions are included in Appendix 1. CTD profiles were numbered consecutively and also between the different types of station. Thus, the some CTD file numbers do not correspond with numbered station positions, and reference should be made to Appendix 1 when accessing CTD data for CTD number, station name and event number.

CTD instrumentation and deployment

An SBE32 carousel water sampler, holding 24 12-litre niskin bottles, an SBE9Plus CTD and an SBE11Plus deck unit were used. The SBE9Plus unit held dual SBE3Plus temperature and SBE4 conductivity sensors and a Paroscientific pressure sensor. An SBE35 Deep Ocean Standards Thermometer makes temperature measurements each time a bottle is fired, and time, bottle position and temperature are stored, allowing comparison of the SBE35 readings with the CTD and bottle data. Additional sensors included an altimeter, a fluorometer, an oxygen sensor, a photosynthetically active radiation (PAR) sensor and a transmissometer. The altimeter returns real time accurate measurements of height off the seabed within approximately 100m of the bottom. This allows more accurate determination of the position of the CTD with respect to the seabed than is possible with the Simrad EA600 system, which sometimes loses the bottom or reverts to default

values (approximately multiples of 500m) and, in deep water, often returns depths that are several tens of metres different from the true bottom depth. A fin attached to the CTD frame reduced rotation of the package underwater. The CTD package was deployed from the mid-ships gantry on a cable connected to the CTD through a conducting swivel.

CTD data were collected at 24Hz and logged via the deck unit to a PC running Seasave Win32 version ??? (Sea-Bird Electronics, Inc.), which allows real-time viewing of the data. The procedure was to start data logging, deploy the CTD, then stop the instrument at 10m wireout, where the CTD package was left for at least two minutes to allow the seawater-activated pumps to switch on and the sensors to equilibrate with ambient conditions. The pumps consistently switched on 60 seconds after the instrument entered the water, as they should.

After the 10m soak, the CTD was raised to as close to the surface as sea conditions allowed and then lowered to within 10m of the seabed. Bottles were fired on the upcast, where the procedure was to stop the CTD winch, hold the package in situ for a few seconds to allow sensors to equilibrate, and then fire a bottle. The CTD was left at this depth for ≈10 seconds to allow the SBE35 temperature sensor to take readings over 8 data cycles. The sensor averages these readings to produce one value for each bottle fire. If duplicate bottles were fired at any depth the SBE35 does not take readings unless there is a 20 second gap between firings. The unit needs time to recharge between firings but can cope with two in succession.

Data acquisition and preliminary processing

The CTD data were recorded using SeaSave Win32 version ???, which created four files:

jr307_308_[NNN].hex hex data file

jr307_308_[NNN].XMLCON ascii configuration file containing calibration information

jr307_308_[NNN].hdr ascii header file containing sensor information

jr307_308_[NNN].bl ascii file containing bottle fire information

where NNN is the CTD number (column 1 in Table 2.5.1).

The SBE Data Processing Data_cnv was used to convert the hex file to ascii. Align was then used to account for the time lag of the oxygen sensor, with data being advanced by 5 seconds. Wildedit was then run to remove outlying values (pass 1: 2sd, 500 scans; pass 2: 10sd, 500 scans). Cell thermal mass module was then used to remove the conductivity cell thermal mass effects from the measured conductivity. This re-derives the pressure and conductivity, taking into account the temperature of the pressure sensor and the action of pressure on the conductivity cell. The output of this process is an ascii file, named as jr307_CTD_[NNN]_awctm.cnv.

SBE35 high precision thermometer

Data from the SBE35 thermometer were usually uploaded after every cast using the SeaTerm program. Once the readings had been written to an ascii file, the file was opened and the contents checked to make sure the correct number of readings had been stored. The memory of the SBE35 was then cleared using the 'samplenum=0' command. To check that the memory was clear, the command 'ds' was entered, which displays the number of data points stored in the instrument's memory. This number should be 0. The date and time are also shown by the ds command and these should be checked and corrected if needed.

Salinity samples

Salinity samples were taken from deep areas with little salinity gradient and the mixed layer depth. Many casts were shallow, so few samples were taken. Once analysed, the conductivity ratios were entered by hand into jr307_master.xls, converted to salinities and used for further CTD data processing.

CTD data processing

Further processing of CTD data was carried out in Matlab using existing programs, predominantly written by Mike Meredith and Karen Heywood, with modifications by numerous others, and further significant changes made on JR177 and JR307. The processing routines were split into two subsets: those that could be carried out in the absence of salinity calibration data and those that required the jr307_master.xls file containing the salinometer readings. The first subset of programs was run following each CTD cast and allowed a visual check of the data to ensure that the instruments were working correctly. The second subset was run for those CTDs for which salt samples had been collected, following the salinity analysis. The first subset of Matlab routines applied to the CTD data is as follows:

• ctdread307 invokes the cnv2mat routine written by Rich Signell to read in the jr307_ctd_NNN_awctm.cnv file. Data are stored in Matlab arrays and named accordingly. Latitude and longitude are now written into the file during data capture. The output file is of the form jr307_ctdNNN.cal.

• editctd307 reads in jr307_ctdNNN.cal and allows manual removal of both the 10m soak prior to the CTD cast, and any data collected at the end of the upcast when the CTD was out of the water. The selected data points are set to NaN for all variables. Primary and secondary conductivity and temperature are then despiked using the interactive editor, with selected data points being set to NaN. These points are also set to NaN for PAR, fluorescence, oxygen and transmission. Output is jr307_ctdNNN.edt.

• interpol307 reads in jr307_ctdNNN.edt and uses linear interpolation to fill data gaps generated by editctd307. Output is jr307_ctdNNN.int.

• salcalapp checks whether bottle files have been generated from salinity samples (see the second subset of routines, below). If it does not find the required file, it loads jr307_ctdNNN.int and calculates salinity, potential temperature and σθ, σ2 and σ4 as per the UNESCO 1983 algorithms by invoking the routines sw_salt, sw_ptmp and sw_pden. θ and salinity are calculated for both the primary and secondary sensors, whilst σ is calculated using primary temperature and conductivity, except for casts 23 and 38 where the secondary sensors are used. Output is jr307_ctdNNN.var.

• splitcast reads in jr307_ctdNNN.var and splits the downcast and upcast into jr307_ctdNNN.var.dn and jr307_ctdNNN.var.up.

• fallrate was added on JR307 (after retrospectively being applied to JR161 and JR177 data). It is a matlab version of the seapath loopedit script. It has to be run after the initial soak is removed as it removes any datapoint on the downcast where pressure is less than one previously recorded or if the fall rate is <0.25 ms-1. Loopedit flags such points (excluding the initial soak if set to) but these flags were not subsequently used in the processing and often did erroneously include the initial soak. This process results in smoother density profiles with fewer apparent overturns. Input and output is jr307_ctdNNN.var.dn – it is not run on the upcast as it will remove bottle stops.

• gridctd reads in both jr307_ctdNNN.var.dn and jr307_ctdNNN.var.up, and averages the data into 2dbar bins. Data are padded with NaNs to 5999dbar, thereby ensuring that arrays for all CTDs are the same size. Outputs are jr307_ctdNNN.2db.mat and jr307_ctdNNN.2db.up.mat.

• fill_to_surf reads in jr307_ctdNNN.2db.mat and jr307_ctdNNN.2db.up.mat and allows any missing data at the surface to be filled with values from the next non-NaN line. This should only be carried out where the upper water column is well mixed. Missing values for the time stamp and PAR are left as NaNs. The output file is the same as the input file.

• ctdplot307 reads in jr307_ctdNNN.2db.mat and plots profiles of θ and salinity (both primary and secdondary), σθ, fluorescence, transmission, oxygen and PAR. Plots are output for the entire CTD depth and for only the upper 307m of the cast. These plots are saved as png files and printed.

The second subset of Matlab programs is as follows:

• makebot307 reads in jr307_ctdNNN.ros, jr307_ctdNNN.BL and jr307_ctdNNN.int, and extracts CTD pressure, temperature (1 & 2), conductivity (1 & 2), transmission, fluorescence, oxygen and PAR for each bottle fired. It also calculates the standard deviation for pressure, temperature and conductivity, and writes a warning to the screen if those for temperature and conductivity are greater than 0.001. Salinity and potential temperature are calculated from both primary and secondary temperature and conductivity using ds_salt and ds_ptmp. Results are saved in jr307botNNN.1st.

• readsal307 extracts salinity calibration data from jr307_master.xls and reads in jr307botNNN.1st. Data from duplicate salinity samples are stored in niskinsalts.mat, and if the standard deviation of these samples is >0.002, a warning is written to the screen. Output is jr307salNNN.mat.

• addsal307 reads in jr307botNNN.1st and jr307salNNN.mat, and stores all salinity information in jr307botNNN.sal.

• setsalflag307 loads jr307botNNN.sal and flags those bottles with high standard deviations for temperature and conductivity. Output is jr307botNNN.sal.

• salplot307 loads jr307_ctdNNN.int and jr307botNNN.sal, and plots sample salinities on top of the CTD salinity profiles, allowing a visual check of the data. Plots of conductivity and temperature standard deviations against CTD salinity minus sample salinity are also generated.

• sb35read307 loads jr307sbeNNN.asc, jr307botNNN.1st and jr307_ctdNNN.cal, and plots SBE35 temperature minus CTD temperature (1 & 2) for a visual check. The SBE35 data are saved in jr307botNNN.sb35 and SBE35 temperature minus CTD temperature is saved in tempcals.all.mat. This script must be run prior to salcal307.

• salcal307 loads jr307botNNN.sal, jr307_ctdNNN.int and tempcals.all.mat, and uses sample salinities and SBE35 temperatures to calculate conductivity offsets for both CTD sensors. All offsets are stored in salcals.all.mat. Plots of temperature and conductivity offsets are output to the screen.

• calibrations reads in tempcals.all.mat and salcals.all.mat, and plots primary and secondary temperature and conductivity minus SBE35 temperature and conductivity calculated from the salinity samples. This allows determination of any offsets that should be applied to calibrate the CTD sensors.

• Once this second subset of programs has been run the offsets found in calibrations are entered into salcalapp, which is then run again. Any required temperature or conductivity offset is applied here, and salinity, θ, and σ are recalculated. Offset data are saved in jr307botNNN.cal. All programs following salcalapp must then be re-run.

Project reports for JR307:

Water column sampling

Sian Henley, Libby Jones, Jacqueline Stefels, Sabrina Heiser

Water samples were taken from 12L Niskin bottles mounted on the shipboard 24 bottle rosette, which were fired at discreet depths from the CTD computer in the UIC. Bottles were fired on the upcast, where the procedure was to stop the CTD winch, hold the package in situ for a few seconds to allow sensors to equilibrate, and then fire a bottle. Once on deck, the CTD rosette was sampled in the water bottle annex or on the open deck as dictated by sea and weather conditions and logistical requirements.

In most cases, two bottles were fired at each depth to accommodate sampling requirements and ensure sufficient water volumes were available. The first bottle was sampled for total and dissolved dimethylsulphoniopropionate (DMSP) followed by high performance liquid chromatography (HPLC) analysis of algal pigments and POC. The second bottle was sampled for CO_2 and other dissolved inorganic carbon system parameters, then macronutrients and isotopic composition of nitrate, then POC and PON or RNA, then oxygen isotopes of seawater. A record of all samples collected is presented in Table 3.

Samples for analysis of dissolved inorganic carbon system parameters were taken first immediately after the Niskin was opened to minimise gas exchange. Samples were tapped from the Niskin using Tygon tubing. Glass sample bottles were filled and overflowed by at least one half of the bottle volume to ensure all bubbles were excluded before securing the bottle top. In the laboratory, samples were fixed with mercuric chloride in the fume hood before the bottle top was made airtight with Apiezon grease and secured with a rubber holding strap. Samples were inverted to homogenise the mercuric chloride and stored in the dark. Samples were analysed for dissolved inorganic carbon (DIC) concentration and total alkalinity (TA) using a VINDTA instrument at Rothera Research Station calibrated to certified reference materials. All carbonate system parameters including CO_2 are calculated from DIC and TA using in situ temperature, salinity, nutrient concentrations and known constants.

Samples for macronutrient and nitrate isotope analysis were filtered using Acrodisc PF syringe filters with 0.2 µm Supor membranes, snap frozen at -80°C for 12 hours and then stored at -20°C for subsequent analysis in the UK. Concentration of nitrate, nitrite, phosphate and silicate will be analysed using a Technicon AAII segmented flow autoanalysis system at Plymouth Marine Laboratory, UK. Nitrate isotopic analysis will be performed at the University of Edinburgh by using bacterial denitrifiers (*Pseudomonas aureofaciens*) for the quantitative conversion of sample nitrate into N_2O for analysis by gas chromatography isotope ratio mass spectrometry (GC-IRMS).

Table 3: Water samples collected during JR307. Sampling times and locations given in Appendix 1.

Event	Site (area in Appendix 1)	Depths	Sampling
18	H1	5, 15, 25, 40, 70, 120, 200, 300, 400, 500, 549	Full depth: Nutrients, δNO_3, POCN, DIC, $\delta^{18}O$ Upper 120m: DMSP, HPLC, POC
27	T9	5, 15, 25, 40, 70, 100, 150, 200, 300, 400, 500, 700, 894	Full depth: Nutrients, δNO_3, POCN, DIC, $\delta^{18}O$ Upper 100m: DMSP, HPLC, POC
48	T2	5, 15, 25, 40, 70, 120, 200, 300, 400, 500, 640	Full depth: Nutrients, δNO_3, POCN, DIC, $\delta^{18}O$ Upper 120m: DMSP, HPLC, POC
49	T1	5, 15, 25, 40, 70, 100, 200, 300, 400, 600, 900, 1200, 1564	Full depth: Nutrients, δNO_3, RNA, DIC, $\delta^{18}O$ Upper 100m: DMSP, HPLC, POC
51	T3	5, 15, 25, 40, 70, 100, 200, 300, 400, 600, 737	Full depth: Nutrients, δNO_3, DIC, $\delta^{18}O$ Upper 100m: POCN, DMSP, HPLC, POC
53	T5	5, 15, 25, 40, 70, 100, 200, 300, 500, 800, 929	Full depth: Nutrients, δNO_3, POCN, DIC, $\delta^{18}O$ Upper 100m: DMSP, HPLC, POC
54	T4	5, 15, 25, 40, 70, 100, 150, 200, 300, 500, 700, 842	Full depth: Nutrients, δNO_3, DIC, $\delta^{18}O$ Upper 100m: DMSP, HPLC, POC
55	T6	5, 15, 25, 40, 70, 100, 150, 200, 300, 500, 700, 876	Full depth: Nutrients, δNO_3, DIC, $\delta^{18}O$ Upper 100m: POCN, DMSP, HPLC, POC
56	T7	5, 15, 25, 40, 70, 120, 200, 300, 500, 700, 819	Full depth: Nutrients, δNO_3, POCN, DIC, $\delta^{18}O$ Upper 120m: DMSP, HPLC, POC
59	T8	5, 15, 25, 40, 70, 120, 200, 300, 500, 700, 798	Full depth: Nutrients, δNO_3, DIC, $\delta^{18}O$ Upper 120m: DMSP Upper 25m: HPLC, POC
60	T10	5, 15, 25, 40, 70, 100, 150, 200, 300, 400, 503	Full depth: Nutrients, δNO_3, POCN, DIC, $\delta^{18}O$ Upper 100m: DMSP, HPLC, POC

Samples for particulate carbon and nitrogen were filtered through muffle-furnaced 25 mm ~0.7 µm GF/F filters using a custom-built overpressure system run off the ship's compressed air supply. Filters were dried overnight, snap frozen at -80°C and then stored at -20°C for subsequent analysis at the University of Edinburgh. Samples will be decarbonated by fuming

with HCl and then analysed for the concentration and isotopic composition of POC and PN using a Carlo Erba NA 2500 elemental analyser inline with a VG Prism III IRMS.

Samples for RNA sequencing were filtered through 47mm 0.2 µm nucleopore membrane filters using a threeway filtration rig under vacuum. Samples on filters were fixed with 1ml RNALater solution, sealed in polypropylene wallets, placed in the fridge overnight and frozen at -20°C for subsequent analysis.

Samples for oxygen isotopes of seawater were taken directly from the Niskin into crimp-cap bottles that were immediately sealed and stored in the dark at room temperature for transport to the UK for analysis. Samples will be analysed using the equilibrium method for oxygen isotopes, with samples run on a VG Isoprep 18 and SIRA 10 mass spectrometer.

Samples for total DMS + DMSP were immediately stored in crimp-cap vials after adding concentrated NaOH to convert all DMSP into DMS. In addition, subsamples were filtered over 47 mm Whatmann GF/F filters to remove particulate DMSP. Aliquots of the filtrate were transferred to crimp-cap vials after which NaOH was added. All vials were immediately capped gas tight and stored until analyses at Rothera Base. At base the samples were analysed for their DMS content using a Proton-Transfer Reaction TOF Mass Spectrometer (Ionicon, TOF8000).

Samples for HPLC analysis of phytoplankton pigments were filtered over 47 mm Whatmann GF/F filters. Filters were wrapped in aluminium foil and immediately frozen in LN_2, contained in a dry shipper. Afterwards, filters were transferred to -80 ºC for storage until analysis at the home laboratory. At the home laboratory, samples will be freeze dried, extracted with 90% acetone and analysed with a Waters liquid chromatography system (Model 2690), a cooled auto-sampler (4 °C) and a Waters 996 diode-array detector.

Samples for particulate organic carbon were filtered through muffle-furnaced 25 mm Whatmann GF/F filters. Filters were wrapped in aluminium foil and immediately frozen in LN2, contained in a dry shipper. Afterwards, filters were transferred to -80 ºC for storage until analysis at the home laboratory. Samples will be decarbonated by fuming with HCl, dried and then analysed for the concentration and isotopic composition of POC using a Picarro CM-CRDS.

CTD and underway data

The collection and processing of CTD data was conducted in the same way as that discussed in detail above for JR307 and JR308. The ship's underway system was also used during JR307 to take near-surface measurements of ocean temperature, salinity, fluorescence and dissolved oxygen concentrations when permitted by sea ice conditions.

Observations and preliminary results

Biogeochemistry data are not yet available due to analytical limitations in Antarctica, but will be submitted to BODC as per the data management plan for NERC Fellowship NE/K010034/1. Data obtained by Dutch scientists will be made available through appropriate channels in The Netherlands.

Despite the absence of quantitative biogeochemical data, we observed high fluorescence readings and biomass in the surface ocean throughout the transect. Particularly noteworthy was the observed high biomass in the outer shelf regions, similar to or perhaps greater than the inner shelf and coastal regions. This was accompanied by very high levels of DMSP. The more detailed data to come will give deeper insight into spatial variability in production and biogeochemical processes and allow us to confirm and explain, or refute these assertions.

Comments and recommendations

The scientific objectives of JR307 were met and exceeded, with all proposed stations and one additional station being sampled, and all samples processed successfully. The additional station was in the deepest cold hole of the JR308 study area, which we sampled to ascertain the biogeochemical effects of the cold oceanographic anomaly and potential consequences for the marine fauna studied during JR308. This station will also serve as a useful comparison to the transect stations as a result of the absence/presence of warm nutrient-rich CDW.

Laboratory processing of sea water samples, filtration in particular, took longer than anticipated. As such, particulates for organic carbon and nitrogen analysis were not sampled at every station, specifically site 1, site 4 and site 8 (Table 3). Particulates were sampled in the upper ocean (<120m water depth) only at site 3 and site 6. Particulates were sampled over the full water depth at sites 2, 5, 7, 9, 10 and at the cold hole site H1. Sampling of dissolved nutrients and isotopes over the full depth at each site preserved the primary scientific objective of the cruise, to trace the CDW nutrient source across the shelf. The revised sampling of particulates maintained spatial coverage of particle dynamics, particularly in the upper ocean where variability is likely to be most pronounced, albeit with slightly reduced spatial resolution. This made the workload manageable within the constraints of available ship time, and did not compromise the scientific objectives of the cruise.

For future reference, full sampling of the CTD rosette took approximately one hour from the CTD being secured in the bottle annex and sample processing took 3 to 4 hours. A further 1-2 hours was required for each station for cleaning and setting up equipment, and sorting and storing samples. As such, I would recommend that the minimum time allowed between stations for full-depth sampling (CTD on deck at station 1 to CTD on deck at station 2) be not less than 6 hours when particulate samples are required, and a maximum of 3 stations

should be sampled per day, particularly when considering Hours of Rest regulations. This scheme of work would/did allow the addition of other cruise activities that did not require use of the same equipment or personnel to run concurrently (e.g. benthic biology or glider work, in the case of JR307/8), thus enhancing the scientific program and overall output of the ship time.

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Appendices:

Appendix 1: Station details for AGT, EBS, SUCS and CTD deployments.

Time	Event #	Gear	Area	Action	Latitude	Longitude	Depth
07/01/2015 15:20	63	SUCS	S7	Recovered	-67.5846	-68.3045	112.7
07/01/2015 14:48	63	SUCS	S7	Deployed	-67.5853	-68.3033	141.32
07/01/2015 14:19	62	SUCS	S7	Recovered	-67.6035	-68.2851	235.2
07/01/2015 13:42	62	SUCS	S7	Deployed	-67.6037	-68.2871	250.56
07/01/2015 12:55	61	SUCS	S7	Recovered	-67.5693	-68.228	528.58
07/01/2015 12:04	61	SUCS	S7	Deployed	-67.57	-68.2273	528.32
07/01/2015 11:04	60	CTD	T10	Physics + Chemistry	-67.5703	-68.227	523.2
06/01/2015 21:02	59	CTD	T8	Physics + Chemistry	-67.9408	-68.4856	819.46
06/01/2015 20:08	58	SUCS	S6	Recovered	-67.8742	-68.4573	
06/01/2015 19:36	58	SUCS	S6	Deployed	-67.8746	-68.4591	157.44
06/01/2015 19:14	57	SUCS	S6	Recovered	-67.8852	-68.4459	476.93
06/01/2015 18:19	57	SUCS	S6	Deployed	-67.8857	-68.4481	
06/01/2015 15:04	56	CTD	T7	Physics + Chemistry	-68.238	-68.5722	851.71
06/01/2015 10:06	55	CTD	T6	Physics + Chemistry	-68.1835	-69.6794	902.4
06/01/2015 00:32	54	CTD	T4	Physics + Chemistry	-67.9382	-70.2993	809.47
05/01/2015 20:41	53	CTD	T5	Physics + Chemistry	-67.9889	-69.6521	956.16
05/01/2015 13:25	52	Glider	T2	Recovered glider 409	-66.8641	-70.36	630.53
05/01/2015 07:04	51	CTD	T3	Physics + Chemistry	-67.4611	-70.5676	768
04/01/2015 20:04	50	Glider	T2	Deployed glider 409	-66.9404	-70.3689	652.8
04/01/2015 12:28	49	CTD	T1	Physics + Chemistry	-66.4872	-71.2451	1570
04/01/2015 07:46	48	CTD	T2	Physics + Chemistry	-66.9421	-70.3605	656.64
03/01/2015 20:02	47	AGT	S5	Recovered	-67.7581	-68.1549	456.96
03/01/2015 19:21	47	AGT	s5	Deployed	-67.7541	-68.161	526.85
03/01/2015 17:42	46	AGT	S5	Deployed	-67.7548	-68.1689	454.66
03/01/2015 17:06	45	AGT	S5	Recovered	-67.7588	-68.1659	445.44
03/01/2015 16:22	45	AGT	S5	Deployed	-67.7525	-68.1754	396.25
03/01/2015 16:12	44	AGT	S5	Recovered	-67.7514	-68.1771	388.61
03/01/2015 16:01	44	AGT	S5	Deployed	-67.7483	-68.1817	451.58
03/01/2015 15:04	43	EBS	S5	Recovered	-67.7631	-68.1603	391.06
03/01/2015 14:19	43	EBS	S5	Deployed	-67.758	-68.168	471.55
03/01/2015 13:34	42	EBS	S4	Recovered	-67.7635	-68.3756	217.34
03/01/2015 13:05	42	EBS	S4	Deployed	-67.7621	-68.3643	185.72
03/01/2015 12:32	41	AGT	S4	Recovered	-67.761	-68.3638	186.58
03/01/2015 12:08	41	AGT	S4	Deployed	-67.7601	-68.3562	175.64
03/01/2015 11:39	40	AGT	S4	Recovered	-67.761	-68.3729	270.34
03/01/2015 11:12	40	AGT	S4	Deployed	-67.7608	-68.3641	188.04
03/01/2015 07:05	39	CTD	H13	Physics only	-67.8449	-69.1216	39.17
03/01/2015 02:08	38	CTD	H12	Physics only	-67.8435	-68.8676	382.46
03/01/2015 01:09	37	CTD	H11	Physics only	-67.8459	-69.1295	40.7

02/01/2015 22:33	36	SUCS	S5	Recovered	-67.7677	-68.1552	457.73
02/01/2015 21:26	36	SUCS	S5	Deployed	-67.7678	-68.1519	488.45
02/01/2015 20:25	35	SUCS	S5	Recovered	-67.7644	-68.1444	456.58
02/01/2015 19:40	35	SUCS	S5	Deployed	-67.7645	-68.1423	501.89
02/01/2015 19:15	34	SUCS	S5	Recovered	-67.7564	-68.1451	568.7
02/01/2015 18:17	34	SUCS	S5	Deployed	-67.7565	-68.1431	607.87
02/01/2015 17:00	33	AGT	S4	Recovered	-67.7607	-68.3643	183.94
02/01/2015 17:00	33	AGT	S4	Recovered	-67.7607	-68.3643	183.94
02/01/2015 16:37	33	AGT	S4	Deployed	-67.7604	-68.3579	170.11
02/01/2015 16:25	32	AGT	S4	Recovered	-67.7603	-68.3654	193.92
02/01/2015 15:55	32	AGT	S4	Deployed	-67.7604	-68.3581	171.65
02/01/2015 15:25	31	AGT	S4	Recovered	-67.7657	-68.4136	181.25
02/01/2015 15:05	31	AGT	S4	Deployed	-67.7652	-68.4084	161.66
02/01/2015 13:54	30	SUCS	S4	Recovered	-67.7602	-68.353	160.9
02/01/2015 13:06	30	SUCS	S4	Deployed	-67.7602	-68.3562	168.96
02/01/2015 12:51	29	SUCS	S4	Recovered	-67.7606	-68.3606	183.94
02/01/2015 12:16	29	SUCS	S4	Deployed	-67.7605	-68.3627	180.1
02/01/2015 11:51	28	SUCS	S4	Recovered	-67.7633	-68.3946	122.5
02/01/2015 11:19	28	SUCS	S4	Deployed	-67.7633	-68.3967	
02/01/2015 08:38	27	CTD	T9	Physics + Chemistry	-67.8	-68.167	10.75
02/01/2015 06:29	26	CTD	H9	Physics only	-67.7767	-68.2678	463.1
02/01/2015 05:43	25	CTD	H8	Physics only	-67.7566	-68.268	352.13
02/01/2015 04:56	24	CTD	H7	Physics only	-67.7601	-68.3785	277.63
02/01/2015 04:30	23	CTD	H6	Physics only	-67.7631	-68.3967	139.01
02/01/2015 03:58	22	CTD	H5	Physics only	-67.7692	-68.4206	252.29
02/01/2015 03:25	21	CTD	H4	Physics only	-67.7745	-68.4357	325.63
02/01/2015 02:32	20	CTD	H3	Physics only	-67.7884	-68.5185	501.12
02/01/2015 01:38	19	CTD	H2	Physics only	-67.7967	-68.605	514.18
01/01/2015 23:05	18	CTD	H1	Physics + Chemistry	-67.8236	-68.569	573.7
01/01/2015 22:37	17	SUCS	S3	Recovered	-67.8122	-68.6354	179.71
01/01/2015 22:02	17	SUCS	S3	Deployed	-67.8114	-68.6328	193.15
01/01/2015 21:47	16	SUCS	S3	Recovered	-67.8099	-68.6249	281.86
01/01/2015 21:07	16	SUCS	S3	Deployed	-67.7606	-68.3639	183.55
01/01/2015 19:40	15	EBS	S3	Deployed	-67.8238	-68.568	566.02
01/01/2015 19:14	14	AGT	S3	Recovered	-67.8238	-68.5681	566.02
01/01/2015 18:20	14	AGT	S3	Deployed	-67.8282	-68.5589	542.59
01/01/2015 17:40	13	EBS	S2	Recovered	-67.7956	-68.5959	509.18
01/01/2015 16:50	13	EBS	S2	Deployed	-67.8	-68.608	518.02
01/01/2015 16:26	12	AGT	S2	Recovered	-67.8002	-68.6083	513.41
01/01/2015 15:38	12	AGT	S2	Deployed	-67.8041	-68.6153	411.65
01/01/2015 14:53	11	SUCS	S2	Recovered	-67.7829	-68.6066	122.11
01/01/2015 14:53	11	SUCS	S2	Recovered	-67.7829	-68.6066	122.11
01/01/2015 14:08	11	SUCS	S2	Deployed	-67.7837	-68.6067	173.18
01/01/2015 13:48	10	SUCS	S2	Recovered	-67.7825	-68.6082	110.59

01/01/2015 13:08	10	SUCS	S2	Deployed	-67.7833	-68.6082	154.37
01/01/2015 12:55	9	SUCS	S2	Recovered	-67.788	-68.6053	298.37
01/01/2015 12:39	9	SUCS	S2	Deployed	-67.7879	-68.6053	304.51
01/01/2015 12:12	8	SUCS	S2	Recovered	-67.7961	-68.602	513.79
01/01/2015 11:21	8	SUCS	S2	Deployed	-67.7966	-68.6019	509.95
31/12/2014 22:48	7	EBS	S1	Recovered	-67.7832	-68.4956	533.76
31/12/2014 21:58	7	EBS	S1	Deployed	-67.7785	-68.4883	524.54
31/12/2014 21:25	6	AGT	S1	Recovered	-67.7922	-68.519	547.2
31/12/2014 20:35	6	AGT	S1	Deployed	-67.7879	-68.5094	534.91
31/12/2014 20:17	5	AGT	S1	Recovered	-67.7879	-68.5093	534.91
31/12/2014 19:27	5	AGT	S1	Deployed	-67.7837	-68.5	512.64
31/12/2014 19:09	4	AGT	S1	Recovered	-67.7842	-68.5011	507.26
31/12/2014 18:18	4	AGT	S1	Deployed	-67.7837	-68.5	512.64
31/12/2014 18:18	4	AGT	S1	Deployed	-67.7786	-68.4883	526.46
31/12/2014 17:53	3	SUCS	S1	Recovered	-67.7863	-68.5066	518.02
31/12/2014 16:51	3	SUCS	S1	Deployed	-67.7858	-68.5048	516.1
31/12/2014 16:31	2	SUCS	S1	Recovered	-67.7869	-68.5058	528.77
31/12/2014 15:24	2	SUCS	S1	Deployed	-67.7863	-68.5041	528
31/12/2014 14:55	1	SUCS	S1	Recovered	-67.7863	-68.5041	528.38
31/12/2014 13:12	1	SUCS	S1	Deployed	-67.7867	-68.5036	516.86