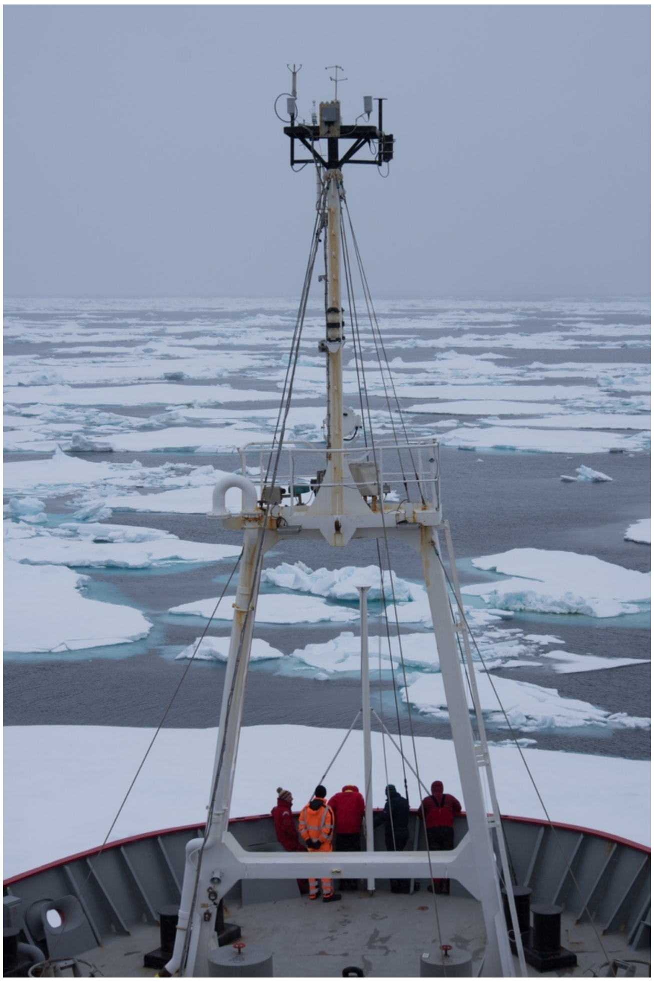
Cruise report

RRS James Clark Ross

JR18004

6th January to 17th February 2019



In the sea ice, photograph courtesy of Povl Abrahamsen

Principal Scientist: Alexander Brearley (jambre@bas.ac.uk)

British Antarctic Survey

Cambridge

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Introduction

Cruise JR18004 was completed aboard RRS James Clark Ross from 6 January to 17 February 2019. The work packages comprised three different elements from the ORCHESTRA project (Ocean Regulation of Climate by Heat and Carbon Sequestration and Transports). These were the servicing and turnaround of mooring instruments in and around Orkney Passage, a hydrographic, turbulence, glider and profiling float survey of a large seamount known as Discovery Bank, and an annual reoccupation of the A23 hydrographic section from 64° S to South Georgia. Unfortunately, an unscheduled medical evacuation from South Georgia led to the loss of 12 science days, meaning the A23 section had to be dropped from this year's science programme. The remaining work was generally very successful, although we encountered failures of two of the three gliders deployed and one of the three EM-APEX floats. The professionalism and hard work of the ship's officers and crew and the science and technical staff meant that most of the remaining goals were achieved despite the severe squeeze on the schedule.

Alexander Brearley

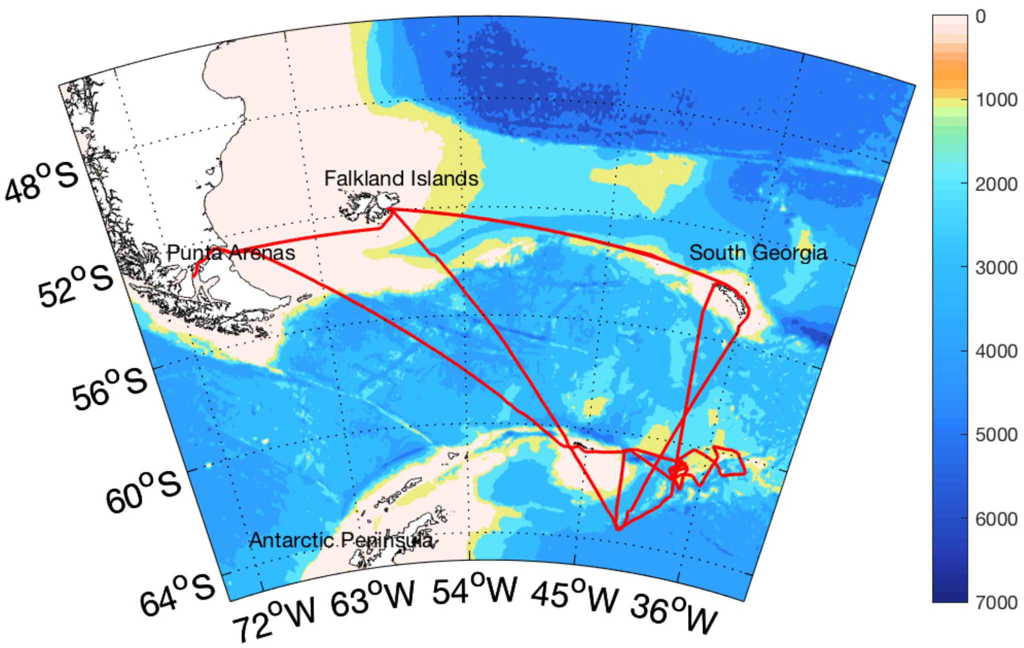


Figure 1: Figure showing overall cruise track and GEBCO bathymetry (in m) of the study region.

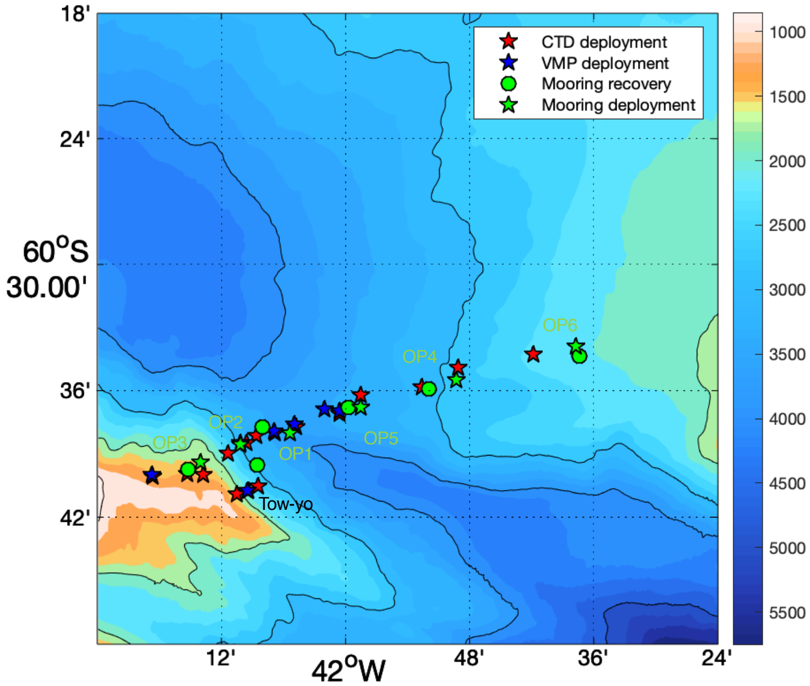


Figure 2: Map to show location of sampling stations and mooring sites around Orkney Passage. Note the figure shows mooring recovery locations and sites where deployments began, from the bridge log. Triangulated mooring positions can be found in Section 9.

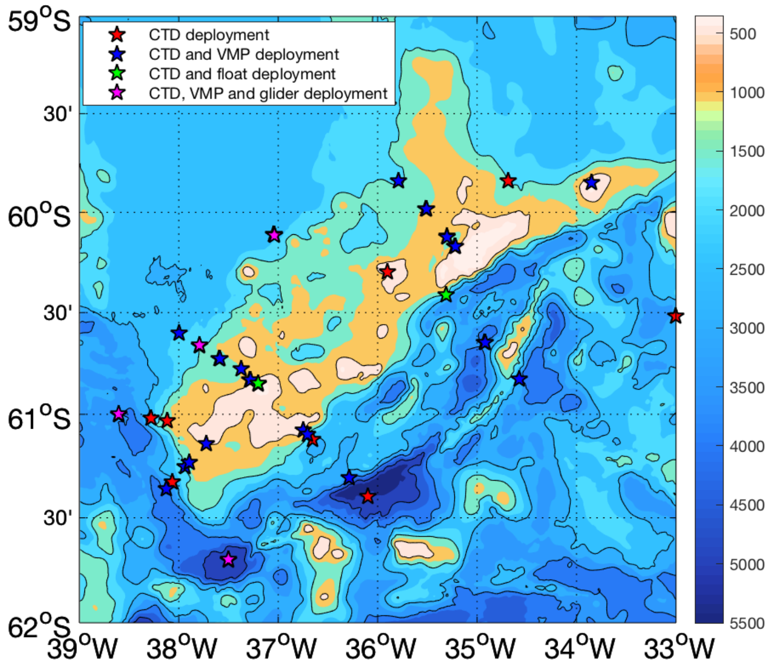


Figure 3: Map to show sampling locations and bathymetry around Discovery Bank.

Cruise personnel

Scientists

Alexander Brearley, PSO (BAS)
Povl Abrahamsen (BAS)
Russell Arnott (University of Bath)
David Bett (BAS, University of Southampton)
Rodrigo Kerr (Universidade Federal do Rio Grande)
Peter Liljegren (LDEO, Columbia University)
Leo Middleton (BAS, University of Cambridge)
Ryan Scott (BAS, University of Southampton)
Andreas Thurnherr (LDEO, Columbia University)

Technicians

Paul Provost (NMF, VMP)
William Platt (NMF, VMP)
Thomas Ballinger (NMF, VMP)
Timothy Powell (NMF, VMP)
David Hunter (BAS IT)
Sean Quirk (BAS AME)
Natalie Ensor (BAS Lab Manager)

Ship's officers and crew

Timothy Page (Master, 6 Jan to 19 Jan)
Graham Chapman (Master, 19 Jan to 17 Feb)
Christopher Naessens (Chief Officer)
Jamie Fettes (2nd Officer)
Jordan Greenhow (3rd Officer)
Michael Napier (3rd Officer)
Charles Waddicor (ETO Comms)
Gareth Lloyd (Chief Engineer)
Euan Murray (2nd Engineer)
Amanda Little (3rd Engineer)
Josh Murray (4th Engineer)
Oliver Vivian (Deck Engineer)
Stephen Amner (ETO)
John Hamilton (Purser)
Amber Chadwick (Doctor)
Albert (Martin) Bowen (Bosun Science)
George Dale (Bosun)
Gareth Wale (Motorman G1)
Christopher Walton (Chief Cook)
Zhivka Fileva (2nd Cook)
Nicholas Greenwood (Senior Steward)
Vicki Leslie (Steward)
Desislava Fileva (Steward)
Graham (Riff) Raworth (Steward)
Samuel English (SG1A)
Sheldon Smith (SG1A)
Graham Waylett (SG1A)
Alexander King (SG1A)
Colin Leslie (SG1A)
Daelyn Peck (SG1B)

Cruise narrative

For domestic purposes, the ship operated on UTC-3 hours throughout the cruise; this was the local time in Chile and the Falkland Islands; KEP was at UTC-2. All times in this section are ship's time, while UTC is used in the rest of the cruise report.

31st December: Principal Scientist Alexander Brearley and Povl Abrahamsen depart London Heathrow and fly over New Year's Eve, arriving in Punta Arenas on the afternoon of 1st January. National Marine Facilities (NMF) Technicians arrive at hotel in Punta Arenas.

1st January: Alex Brearley and Povl Abrahamsen arrive in Punta Arenas, join ship, and are welcomed by the Purser. NMF Technicians remain at hotel.

2nd January: The remaining science party arrive from New York, Cambridge and Bath at the ship. NMF Technicians transfer from hotel to the ship.

3rd January: Safety briefing at 0900 in Officers and Scientist's Lounge, including being shown the lifeboats. Laboratory safety briefing at 1100 for all science personnel carried out by the Laboratory Manager Natalie Ensor. Unpacking of break bulk cargo from Cambridge begins, but confirmation that the three containers containing the Vertical Microstructure Profiler (VMP), glider equipment and LDEO mooring cargo will not arrive in Punta Arenas from the container ship until late on 4th January.

4th January: Communication of the EM-APEX floats tested on deck. Cargo arrives at port at 2300, but we were advised that there would be no unloading overnight. Missed initial scheduled departure date.

5th January: Cargo from LDEO arrives at 1500, but we are advised that the remaining cargo will not leave the terminal that day as high winds prevented crane operations. Some issues are identified with data logging on the Plymouth Marine Laboratory (PML) flux system installed in the mail room of the ship.

6th January: Mandatory muster and lifeboat drill at 0805, followed by the remaining cargo arriving at 1100 (minus an optode for the glider, which remained missing). Tug arrives at 1300 to pull JCR off the quayside and we depart bound for Mare Harbour.

7th January: steaming to Mare Harbour for bunkering and discharge of aviation fuel. Installed VMP launch system in the morning and emptied the NOC container, securing gliders in the main lab. Underway system turned on after leaving Argentinian EEZ at 1300, and VMADCP turned on to gather bottom tracked data. Training session for watchkeeping at 1500. Most issues with the PML flux system logging are resolved, but Natalie Ensor in email contact throughout the cruise with Tom Bell and Ming-Xi Yang. Science talk held at 1900 in Officers' and Scientists' Lounge.

8th January: arrive 0800 at the West Jetty for bunkering operations. Shore leave for the science party. Move to West Jetty at 1800 in readiness for the offload of aviation fuel. Glider preparation work continues.

9th January: offload of aviation fuel at Mare Harbour, followed by departure at 1800, steaming towards test CTD site south of Burdwood Bank and M2 mooring site.

10th January: major incident training onboard at 0900 involved officers, crew and special purpose personnel (SPPs). Further glider and VMP preparation, and ADCP changed over to water track mode as we enter deeper water. Pub quiz and birthday cake for Russell Arnott in the evening.

11th January: CTD test cast, and training for the science party in CTD operations.

12th January: continue steaming towards M2 mooring site, and further practice at operating the CTD and computer given by Sean Quirk.

13th January: recover M2 mooring in gentle seas, with minimal ice. After mooring recovery, a CTD is done, followed by flotation and tethered casts of the VMPs, which both performed well. The M2 instruments were serviced and the mooring redeployed. Steamed overnight to M3 mooring.

14th January: on arrival at M3 site, science suspended due to the ship needing to undertake a medical evacuation at King Edward Point (KEP), South Georgia. Broke out of ice around 1800 GMT, proceeded to South Georgia on 4 engines.

15th January: on transit to medical evacuation in South Georgia, arrange to collect oxygen concentrators from RRS Discovery which was also on scene at the medical evacuation.

16th January: casualty plus 1 pax collected from KEP around 0600, and transit to Mare Harbour continued. Captain Page confirmed he is leaving the ship in the Falklands due to family circumstances.

17th January: steam towards Mare Harbour, arrangements made for the uplift of the patient from the ship via helicopter hi-line. Small engine room fire quickly extinguished.

18th January: helicopter evacuation of the casualty 0600. Continue steaming towards Mare Harbour.

19th January: arrive at pilot station at 0730, alongside Mare Harbour at 0800. Shore leave includes a visit to Stanley by SPPs, whilst Graham Chapman takes over as Master and bunkering operations commence. Replacement medical supplies for KEP arrive at the ship. Evening entertainment at Mount Pleasant Complex.

20th January: all aboard by 1500, depart 1545 for KEP.

21st/22nd January: steaming back to KEP to return oxygen concentrators to RRS Discovery and bottled oxygen supplies to station/Bird Island.

23rd January: visit to King Edward Point. Alongside 1100 ship's time, lunch with government officer, biosecurity brief, then science and crew party visit ashore. Following departure at 1600 bound for the M3 mooring site, a course is steered around the western side of South Georgia to avoid a large storm sitting to the southeast of the island.

24th January: continue steam towards M3 mooring. Science talks in the evening by Rodrigo Kerr, Russell Arnott and Ryan Scott. Slight diversion to the east of the direct line to avoid a band of sea ice apparent in Polarview imagery.

25th January: lifeboat drill at 1030, and brief for scientists over shifts in the coming days. Ceilidh and Burns Night celebration in the evening.

26th January: arrive 0830 at M3 mooring. Mooring recovery and turnaround, CTD at site and untethered tests of the two VMP instruments to 750 m. Ice-free conditions at the site. Complete work 1930, steam towards Orkney Passage.

27th January: arrive at OP2 at 1245 and recover mooring. Ranging using the supplied NMF deckbox to other moorings fails so mooring operations suspended whilst troubleshooting takes place. Instead, a CTD is completed at OP3, followed by OP2 (including a full-depth VMP).

28th January: Ixsea deck box continues to give problems, so mooring recoveries are suspended again. Sean and Povl eventually resolve the issue by reprogramming the ORE deckbox, with successful ranging completed by Povl on OP1 and OP3. OP2 (which had a different release) was redeployed. Several more CTDs across Orkney Passage completed. Fog overnight prevents VMP operations.

29th January: we successfully recover OP1, OP3, OP4 and OP5 moorings. Overnight CTD and VMP work.

30th January: we successfully recover OP6 mooring and steam to Discovery Bank to start CTD/VMP work at DB2 station.

31st January: damage to the CTD cable at DB3 which Sean works to fix. The station is instead completed with the old CTD wire, which has around 3950 m of usable cable left on the drum. Glider 352 is deployed, but has to be recovered after shallow dives due to a compass problem on the climbs. Correspondence with Teledyne and MARS about the failed glider. Further CTDs are completed overnight.

1st February: deploy glider 400, with initial successful dives to 150 m and 1000 m. However, contact with the glider is lost at 1200, with no further communication for the rest of the cruise. EM-APEX float 8136 deployed, initially profiling continuously to 500 m. Float 8137 fails its self test, resulting in correspondence with Hugh Fargher at Teledyne.

2md February: Glider 631 deployed successfully. High resolution section completed across central part of Discovery Bank. Attempts continue to troubleshoot the compass issue on glider 352 by Alex Brearley, Ryan Scott, Sean Quirk and Teledyne. EM-APEX 8135 deployed successfully.

3rd February: continue troubleshooting 352, but conversation with MARS and Teledyne implies that, ultimately, the compass is not fixable in the field. Further CTD and VMP operations. Both EM-APEX floats reporting successfully, with EM-APEX 8135 transitioned onto 5 day repeat cycles. NMF VMP team transitioning onto days.

4th February: we occupy a high-resolution section on the northern side of the bank with CTDs and VMPs at 2000 m, 2 x 1500 m and 1000 m depth contours, before steaming towards DB6 for another high-resolution transect. Continued efforts by Alex and Sean to get 352 working, including compass testing.

5th February: CTD and VMP survey of the southern flank of Discovery Bank between DB6 and DB5 stations. 2 CTDs and VMPs completed successfully, but damage to the CTD cable halts operations during the afternoon. The conducting cable was brought back into use, but heavy rolling pauses operations around 1730 for around two hours. Communications on the deckbox also cut out at the bottom of the 2000 m station, recovered to deck for investigation. Glider preparation continues – 330 is found to have a faulty altimeter connector, which means that swapping out the compass with 352 becomes the preferred course of action (a software upgrade on 352 is required to accommodate this change).

6th February: continues with CTD and VMP operations between DB2 and DB5. Initially we use the repaired conducting cable, but load test later carried out on the CTD wire (now around 3900 m long), which is successful. Glider preparations complete for redeployment of 352.

7th February: Redeploy glider 352, to initial success, with in-water compass calibration performed. Occupy a series of CTD/VMP stations between DB4 and DB5, using the shorter CTD cable. Two of the stations have to be moved slightly from their initial positions due to a large iceberg being present near the site.

8th February: significant difficulties talking to the science computer of glider 352. Decision made to recover around 0930, with recovery taking place at 1600. Further line of CTDs, with VMP at DB3. Transit in rough conditions overnight to Orkney Passage to begin CTDs and mooring redeployment.

9th February: re-deploy OP6, OP4 and OP5 moorings successfully. CTD and VMP at OPCTD11, followed by further CTDs overnight. Calm conditions overall, though some freshening to the east late in the day.

10th February: re-deploy OP1 and OP3 moorings in gentle seas. CTD and VMP casts are performed at OPCTD3, whilst mooring triangulation is performed at several locations within the Passage.

11th February: repeat CTD stations to the south of the Orkney Passage transect supporting work from DYNOPO. VMP stations in the day, with variable visibility. Tow-yo along the section until end of science at 0020.

12th February: steamed to Signy for limited resupply of medical items and food. Arrived 1000 with Ryan Scott winning a ballot to be the scientist ashore. Container movement whilst ship offshore of Signy. Departed for Punta Arenas around 1230, with cruise photo at 1300.

13th February: scientists work on their cruise reports as the ship steams towards Punta Arenas in roughening seas. Safety video for all scientists at 1500 followed by boat drill.

14th February: continue transit to Punta Arenas. All science data collection ceases at 1800 on entering Argentina’s Exclusive Economic Zone. Science talks 1930 by Andreas Thurnherr, Leo Middleton and David Bett.

15th February: slow progress north in rough seas, but we pass into the lee of Isla de Los Estados around 1700 and reach calmer seas. Cruise dinner and gift (film poster designed by Russell Arnott) presented.

16th February: packing glider cargo after breakfast, followed by laboratory clean-up. Submitted post-cruise assessment.

17th February: reach pilot station at Punta Delgada at 0500, alongside Punta Arenas 1200. Most science party remain on the ship overnight.

18th February: science party depart for flights/onward travel.

1. Profiling Conductivity Temperature Depth (CTD) measurements

David Bett

Introduction

A Conductivity-Temperature-Depth (CTD) unit was used to profile the water column vertically. 62 CTDs were carried out in total, with the last being a 'tow yo' of 6 profiles.

CTD instrumentation and deployment

The Sea-Bird Scientific SBE9plus CTD was mounted on a rosette with a SBE32 carousel water sampler and 24 Niskin bottles (generally 20 l, some 12 l), and was connected through the sea cable to a SBE11plus deck unit in the Underway Instrumentation Control room (UIC). The SBE9plus unit contains a Paroscientific pressure sensor and was connected to dual independent CT ducts with SBE3plus temperature and SBE4C conductivity sensors and an SBE5T submersible pump. An SBE35 Deep Ocean Standards Thermometer makes temperature measurements each time a bottle is fired, logging time, bottle position, and temperature, allowing comparison of the SBE35 readings with the CTD and bottle data. Additional sensors included a Tritech PA200 altimeter, a Chelsea Technologies Group AquaTracka Mk III fluorometer, an SBE43 dissolved oxygen sensor (plumbed into the secondary CT duct), a Biospherical QCP2350 photosynthetically active radiation (PAR) sensor, and a WET Labs C-Star transmissometer. The altimeter returns real-time accurate measurements of height off the seabed within approximately 100 m 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 500 m) 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 24 Hz and logged via the deck unit to a PC running Seasave version 7.22.3 (Sea-Bird Scientific), which allows real-time viewing of the data. The procedure was to start data logging during deployment of the CTD, then stop the winch at 10 m wire out, where the CTD package was left for at least two minutes to allow the conductivity-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 10-m soak, the CTD was raised to as close to the surface as sea conditions allowed and then lowered to within 10 m of the seabed. Bottles were fired on the upcast, where the procedure was to stop the CTD winch, hold the CTD 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 10-second gap between firings. The water sampler 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 version 7.22.3, which created four files:
JR18004_[NNN].hex hex data file
JR18004_[NNN].XMLCON ascii configuration file containing calibration information
JR18004_[NNN].hdr ascii header file containing sensor information
JR18004_[NNN].bl ascii file containing bottle fire information where NNN is the CTD number.

The SBE Data Processing module *Datcnv* 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. The cell thermal mass *(celltm)* module was then used to remove the conductivity cell thermal mass effects from the measured conductivity. This rederives 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 *JR18004_[NNN]_align_ctm.cnv*.

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. Further significant changes, mostly generalising the code to reduce the number of adjustments needed between cruises were made on JR17003a and covered in more detail in that cruise report. The scripts mentioned are setup to be non-cruise specific, however they are summarised in respect to JR18004 below:

- *ctdreadGEN* - Reads in *JR18004_ctd_align_ctd.cnv* file. Data are then stored in Matlab arrays. The output file is *JR18004_ctd_NNN.cal*.
- *editctdGEN* - reads in *JR18004_ctd_NNN.cal* and removes the 10-m soak prior to the CTD cast, through finding the minimum pressure after the soak and asking for user confirmation after displaying the full pressure plot for the cast. Data collected at the end of the upcast when the CTD was out of the water is removed graphically by selecting bad conductivities when the package is out of the water, these going wrong before pumps are switched off and at pressures either side of zero depending on pressure sensor offsets. The selected data points are set to NaN for all scientific sensors. Primary and secondary conductivity are also despiked using the interactive editor at the same time, with the option to edit the temperature profiles and T/S plots (where small conductivity spikes can be more obvious). Selected data points are set to NaN. Output is *JR18004_ctd_NNN.edt*.
- *batch_ctdGEN* - Runs a series of scripts in one go*, deriveGEN, onehzctdGEN, splitcastGEN, fallrateGEN* and *gridctdGEN. OnehzctdGEN* averages data from a 24 Hz CTD profile to 1 Hz for LADCP processing, so creates files *JR18004_ctd_NNN.1hz* and *JR18004_align_ctm_1hz.cnv*. *SplitcastGEN* splits a CTD file into an upcast and a downcast, *JR18004_ctd_NNN.var.dn* and *JR18004_ctd_NNN.var.up*. *FallrateGEN* is a matlab version of the seapath *loopedit* script. It has to be run after the initial soak is removed as it removes any data point 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 are 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 *JR18004_ctd_NNN.var.dn*. *GridctdGEN* reads in both *JR18004_ctd_NNN.var.dn* and *JR18004_ctd_NNN.var.up*, and averages the data into 2-dbar bins. Data are padded with NaNs to 5999dbar, thereby ensuring that arrays for all CTDs are the same size. Outputs are *JR18004_ctd_NNN.2db.mat* and *JR18004_ctd_NNN.2db.up.mat*.

- *batch_botGEN* – Runs a series of scripts *makebotGEN, sb35readGEN, readsalGEN, addsalGEN, salcalGEN* and *mergebotGEN. MakebotGEN* reads in *JR18004_NNN.ros* and *JR18004_NNN.bl*, 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 *JR18004_bot_NNN.1st*. Sb35readGEN loads *JR18004_NNN_sbe35.asc*, *JR18004_bot_NNN.1st* and *JR18004_ctd_NNN.cal*. The SBE35 data are saved in *JR18004_bot_NNN.sb35* and SBE35 temperature minus CTD temperature is saved in *tempcals.all.mat*.

Once this batch of scripts has been run for all CTD casts, the offset can be decided and then entered into *salcalappGEN*. This applies any temperature and conductivity offset and salinity is recalculated. The uncalibrated values are then saved with _uncal added to the variable name. All programs following salcalappGEN must then be re-run with versions including the _uncal variables. This is all done via the script *batch_calGEN.* The chosen calibrations were constant offsets for the primary and secondary temperature sensors of 0.00054004 and -0.0011 respectively. Two different piecewise linear offsets, as a function of station number, were chosen for the two conductivity sensors and the Matlab scripts are shown below. For further details on the chosen calibrations see *salcalappGEN* and *tempcond_calibration_timeseries.m.*

```
function offset=condoffset1_jr18004(press,temp,cond,stano,gtime)
   if 1<=stano && stano<=18
      offset=0.0013;
   else
      offset=0.000043954;
   end
end

function offset=condoffset2_jr18004(press,temp,cond,stano,gtime)
   if 1<=stano && stano<=15
      offset=0.0011;
   elseif 16<=stano && stano<=25
      offset=(0.0011-(stano-15)*0.00017629);
   else
      offset=-0.00066288;
   end
   offset=offset+condoffset1_jr18004(press,temp,cond,stano,gtime);
end
```

During CTD calibration calculation differences were discovered between the primary and secondary conductivity sensors, shown in Figure 4. Comparing to salinity samples this appears to be due to the secondary conductivity sensor. The offset between the two sensors changed during the course of the cruise, and it is noticeably greater at station 10, as again apparent in Figure 4.

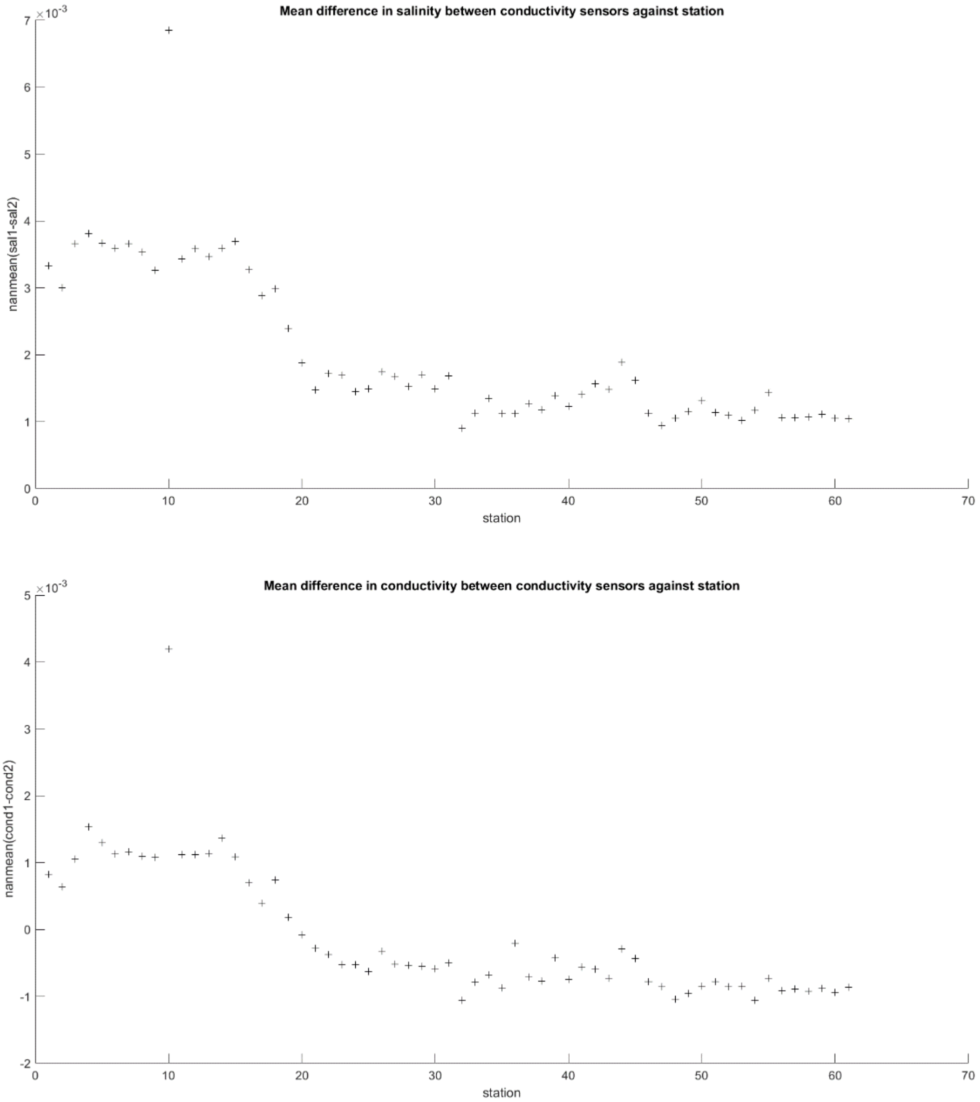


Figure 4: The difference between the primary and secondary conductivity sensors on the CTD as a function of station. The top panel shows the offset in terms of conductivity, the lower panel in terms of calculated salinity.

2. Salinity samples

Rodrigo Kerr and Povl Abrahamsen

Seawater samples were collected for salinity analysis throughout JR18004, allowing us to calibrate the measurements obtained from the underway thermosalinograph (TSG) and CTD conductivity sensors. The protocols used for discrete seawater sampling and laboratory analysis are described below. A total of 460 samples were analysed, comprising 368 for the CTD and 92 for the TSG sensor calibrations.

Seawater sampling

Seawater samples to determine the practical salinity of seawater based on electrical conductivity measurements were taken: (i) from Niskin bottles at different depths during each CTD cast and (ii) from the seawater pumped through the underway TSG in the data preparation laboratory. The depths and number of samples were defined by the CTD operator based on salinity profiles of each oceanographic station (generally 6 depths were chosen for each CTD cast); for the underway measurements, samples were collected every 4 h during the cruise. Borosilicate glass bottles of 200 ml were used to storage the samples until laboratory analysis. The glass bottles were 3-times rinsed with seawater before taking the sample aliquot. After that, the bottleneck was cleaned/dried to prevent salt crystal build up and a plastic stopper was inserted before closing the glass bottle. The glass bottle was stored upside down in the crate. Each crate has 24 glass bottles, once all bottles had been filled with sample the crate was stored in the temperature-controlled radiation laboratory, which was kept at around 20 ± 1 °C. The samples were kept in the laboratory for at least 24 h before processing to allow the samples to equilibrate to room temperature.

Laboratory analysis

A salinometer measures the conductivity ratio of a sample of seawater at a controlled temperature. The salinometer used on the JR18004 cruise was a Guildline Autosal 8400B s/n 63360 (Figure 5a), with a peristaltic pump attached to the intake tube. IAPSO standard seawater (OSIL, Figure 5b) was used to calibrate the readings obtained from the salinometer. The batch P160 (K_{15} = 0.99983, practical salinity = 34.993, and expiry date of 20th July 2019) was used for oceanographic stations from #1 to #43, while batch P162 (K_{15} = 0.99983, practical salinity = 34.993, and expiry date of 16th April 2021) was used for oceanographic stations from #44 to #57 (Table 1). Both batches were used for thermosalinograph underway samples, see Table 1 for details. The cell temperature of the salinometer was adjusted to 24°C.

A standardised protocol was applied to process the salinity samples, which consisted of the following steps to start a run of the analyses of a crate: 1) flush the internal conductivity cell with open/old batch (standard) to adjust the reading for values close to that expected to the samples, 2) run a new batch of standard seawater before starting the analysis of samples, 3) run the samples stored in the crate, and 4) run another batch at the end of the analysis. If another crate was analysed in the sequence, the last batch readings are replicated at the beginning of the next analysis worksheet. Before the samples were inserted in the internal conductivity cell they were gently inverted and any crystalized salt in the cap was removed. To obtain a reading of the sample, the internal conductivity cell was flushed three times before to be filled with the sample. At least three readings were performed for each sample. When the analyses were finished, the internal conductivity cell was cleaned and filled with Milli-Q water.

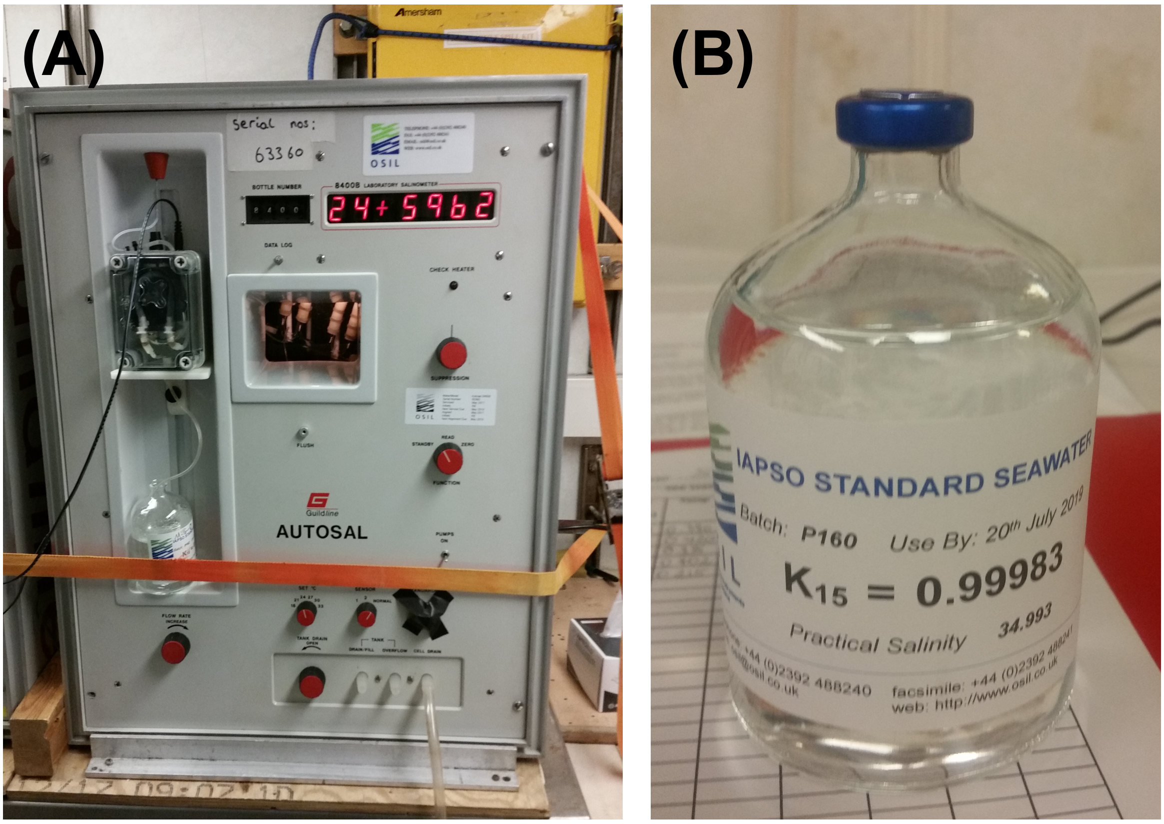


Figure 5: Salinometer Guildline Autosal 8400B s/n 63360 (a) and IAPSO standard seawater – batch P160 (b) used during the cruise JR18004.

CRATE NUMBER	CRATE COLOUR	CTD STATION	TIME (GMT) IN LAB	TIME (GMT) ANALYSED	ANALYST	BATCH USED
10	Blue/Green	#1	11/01/2019 16:53	16/01/2019 21:28	DB	P160
7	White	#2	13/01/2109 N/A	16/01/2019 23:40	EPA	P160
3	Yellow	#3 to #6	28/01/2019 08:23	01/02/2019 06:17	RA / DB	P160
5	Blue	#7 to #10	29/01/2019 04:38	02/02/2019 15:38	RK / EPA	P160
7	Blue/Black	#11 to #14	30/01/2019 13:43	02/02/2019 17:46	RK	P160
u4	Red	Underway	31/01/2019 05:10	02/02/2019 19:54	RK	P160
2	Red	#15 to #18	01/02/2019 20:23	04/02/2019 14:01	RK	P160
10	Green	#19 to #22	02/02/2019 21:48	04/02/2019 16:03	RK / EPA	P160
7	White	Underway	04/02/2019 04:48	05/02/2019 13:16	RK	P160
5	Blue	#23 to #26	04/02/2019 05:24	05/02/2019 15:20	RK / EPA	P160
7	Blue/Black	#27 to #30	04/02/2019 18:19	08/02/2019 13:41	RK	P160
2	Red	#31 to #35	06/02/2019 10:10	08/02/2019 15:26	RK / EPA	P160
5	Blue	#36 to #39	07/02/2019 00:46	08/02/2019 17:09	RK	P160
7	White	#40 to #43	07/02/2019 22:38	11/02/2019 16:37	RK	P160
3	Yellow	Underway	08/02/2019 08:34	11/02/2019 18:08	RK	P160
u4	Red	#44 to #47	09/02/2019 09:57	12/02/2019 18:05	RK	P162
10	Green	#48 to #51	10/02/2019 05:32	12/02/2019 19:33	RK	P162
5	Blue	#52 to #55	11/02/2019 07:17	13/02/2019 12:52	RK / NE	P162
2	Red	#56 & #57	11/02/2019 19:53	13/02/2019 13:45	NE	P162
u2	Blue	Underway	12/02/2019 11:31	13/02/2019 15:23	NE / RK	P162

Table 1: Raw information regarding the salinity samples stored and analysed during JR18004.

SBE35 high precision thermometer

Data from the SBE35 thermometer were uploaded after every CTD cast using the *SeaTerm* program. After starting the program, the status was checked; this step should display the current time and the number of bottles fired. After checking status, the dataset was downloaded. Once the download was completed, the file was opened and the information 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. After that, the status was checked to ensure that the memory was clear. *SeaTerm* was closed through the *Disconnect* button and the deck unit switched off. The file data was backed up onto the network folders.

3. Lowered Acoustic Doppler Profiler (LADCP)

Leo Middleton and Andreas Thurnherr

During the casts conducted on JR18004, current profiling was completed using a pair of LADCPs attached to the CTD rosette. The pair were orientated as an uplooker and a downlooker, on the side and underneath the rosette respectively. The instruments used were both 300kHz Telodyne/RDI Workhorse Monitor LADCPs, run with zero blanking distance, 8 m bins and a staggered 1.3/1.5 ping rate. In the preparation for each cast a pre-deployment script was run on both the uplooker and downlooker to check the instruments were behaving as expected. Deployment scripts were then run, first on the uplooker then the downlooker. The above-mentioned scripts are included here with a brief description to record the parameters used. Additionally, there are logs of the commands issued included with the data; these should be referred to for further information on the pre-deployment tests.

Pre-Deployment Script

PS0	Print system configuration
PA	Run pre-deployment tests (Checked in case of FAIL output)
PT200	Run built-in tests (Internal Moisture recorded)
PC2	Display sensor output (Checked to ensure sensor values were dynamically adjusting)
RS	Display memory card free/used space (Recorded)

Deployment Script

Downlooker	Uplooker	
CR1	CR1	Reset to factory settings
RN M1804	RN S1804	Set file name prefix for JR18004 (later to be renamed as recorded on the log sheet)
TS *Date *Time	TS *Date *Time	Log date and time
WM15	WM15	Water mode 15 (LADCP)
TC2		Ensembles per burst: 2
LP1	LP1	Pings per ensemble: 1
TB 00:00:02.80		Time per burst: 2.8s
TE 00:00:01.30	TE 00:00:00.00	Time per ensemble: 1.3s (0 for uplooker)
TP 00:00.00	TP 00:00:00	Time between pings: 0
LN25	LN25	Number of depth cells: 25
LS0800	LS0800	Bin size: 8m
LF0	LF0	Blank time after transmit: 0s
	WB1	Set to narrow bandwidth (redundant command)
LW1	LW1	Narrow bandwidth mode
LV400	LV400	Ambiguity velocity: 4m/s
SM1	SM2	Set as Downlooker and Uplooker respectively
SA011	SA011	Send synchronisation pulse before each ensemble
SB0	SB0	Disable hardware-break detection on Channel B
SW5500		Delay of 550ms after synchronisation pulse
SI0		Send synchronisation pulse after each ensemble
EZ0011101	EZ0011101	Sensor settings: manual speed of sound (1500m/s); manual transducer depth (0m); measured heading;

		measured pitch; measured roll; manual salinity (35psu); measured temperature
EX00100	EX00100	Use beam coordinates
CF11101	CF11101	Flow settings: enable automatic ensemble cycling; enable automatic ping cycling; enable binary data output (only functional if serial output is enabled); disable serial output; enable data recorded
CK	CK	Save as user defaults
CS	CS	Begin pinging

After each cast the binary instrument files were downloaded onto the local workstation. The LADCP files and the log files were then backed up into the legdata/LADCP directory.

On 09/02/19, between station 49 and station 50, the uplooking LADCP was switched out to check that the spare LADCP (of the same model) was working. It was found to give comparable results and was left as the uplooker for the remainder of the stations.

The LADCP serial numbers were as follows:
Downlooker: 14443
Uplooker 1: 14897 (Stations 1-49)
Uplooker 2: 15060 (Stations 50-62)

Data Processing

The LADCP horizontal velocity data were processed using version IX 13 of the Matlab-based software LDEO developed by Martin Visbeck and maintained by Andreas Thurnherr at the Lamont-Doherty Earth Observatory. This software incorporates the CTD time series (see Chapter 1) to constrain the sound speed and LADCP depth, the GPS time series to constrain the barotropic velocities and the Shipboard ADCP data (see Chapter 4) to constrain the surface layer velocities and provide a metric for LADCP data quality. The software calculates the horizontal velocities using both the shear and velocity inversion techniques.

The LADCP vertical velocity data were processed using V1.4 of the perl-based software LADCP_w developed by Andreas Thurnherr at the Lamon-Doherty Earth Observatory. This software incorporates the CTD data to calculate the measured vertical velocity based on a state-of-the-art technique outlined in Thurnherr (2011). The software also applies a finestructure parameterisation of internal waves within the spectra of the measured vertical velocity to give measurements of both Vertical Kinetic Energy (VKE) and VKE-derived turbulent kinetic energy dissipation.

The details of our cast-specific parameters are all contained within set_cast_params.m, as included with the data. The parameters are primarily file locations and data formatting. The only other adaptation made was to switch the bottom track mode within defaults.m to post-processed rather than RDI to correct the poor performance of the bottom track within certain casts.

The CTD profiles from stations 1-61 are all standard downcast-upcast profiles, however for station 62 we conducted a tow-yo whereby the rosette was brought down to the seafloor then back up to 1000m and back down 6 times whilst being towed at ~0.3 knots. While the tow-yo profiles can be processed for vertical velocity and VKE with the standard software, processing for horizontal velocity requires pre-processing of the input files and post-processing of the results; the results are thus somewhat experimental and should be used with caution. LDEO_IX version IX 14 was used for processing the tow-yo profiles for horizontal velocity and the resulting profiles are numbered 06201-06206 and provided in a separate directory, together with a README file that contains important notes regarding their interpretation. In particular, it should be noted that i) the lat/lon information of the tow-yo profiles (both horizontal and vertical velocities) are from the ship and not from the CTD package. Available USBL data can and should be used to derive corrections. ii) Just like regular profiles, the horizontal velocities from the tow-yo are averages between the down- and the corresponding upcasts (vertical velocities are never averaged). Because of the towing of the package, the tow-yo profiles therefore represent both spatial and temporal averages.

Horizontal Velocities

Data Quality

Overall, the quality of the LADCP data in both the vertical and horizontal velocities was very high. We will illustrate this with a few comparative figures within this section.

Firstly, in Figure 6, we have plotted the mismatch between the LADCP horizontal velocity data in the surface layer (processed without the SADCP data) and the SADCP derived velocities in the surface layer. The subsequent results will be using processed data that has incorporated the SADCP, however this metric has shown to be a good indicator of data quality in the past. Figure 6 shows that almost all the casts have a mismatch of less than 0.06 m/s. This is an indicator of very high-quality data.

Next, in Figure 7, we plot the LADCP range, as it varies with depth, across all of the stations. Note the range remains relatively regular, with an expected pattern of decreasing near the surface and at depth. The early Orkney Passage stations have a slightly larger decay with depth by comparison but remain well within usable levels throughout.

Results

In this section we present the primary output of the LADCP processing. We have divided up the casts into three categories: the two moorings at M2 and M3; The Orkney Passage casts and the casts at Discovery Bank. We have not included the M2 and M3 mooring data here for brevity.

Discovery Bank

Figure 8 shows the processed horizontal velocities at the stations we occupied around Discovery Bank. It is clear we have signals that are consistent with Taylor column activity, particularly on the western flank, as previously from Argo float data outlined in Meredith et al. (2015). Repeat casts do show however that there is some important variability in this signal which is cause for further analysis.

Orkney Passage

Figure 9 shows the casts at Orkney Passage. Here there is a bimodal flow at all depths, with the outflow primarily in the west and the inflow primarily in the east, consistent with previous occupations.

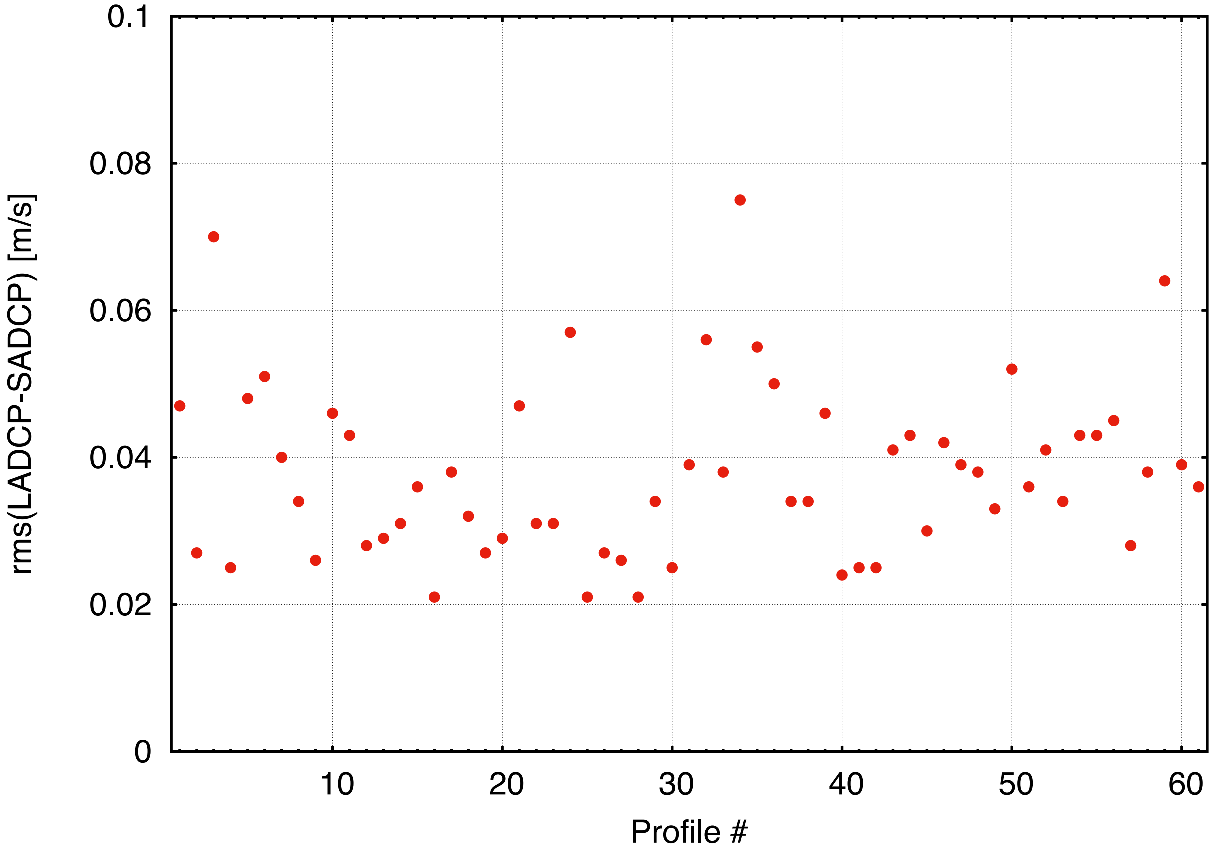


Figure 6: Root-mean-squared mismatch between LADCP velocities in the surface layer and SADCP-derived velocities, as a function of station number.

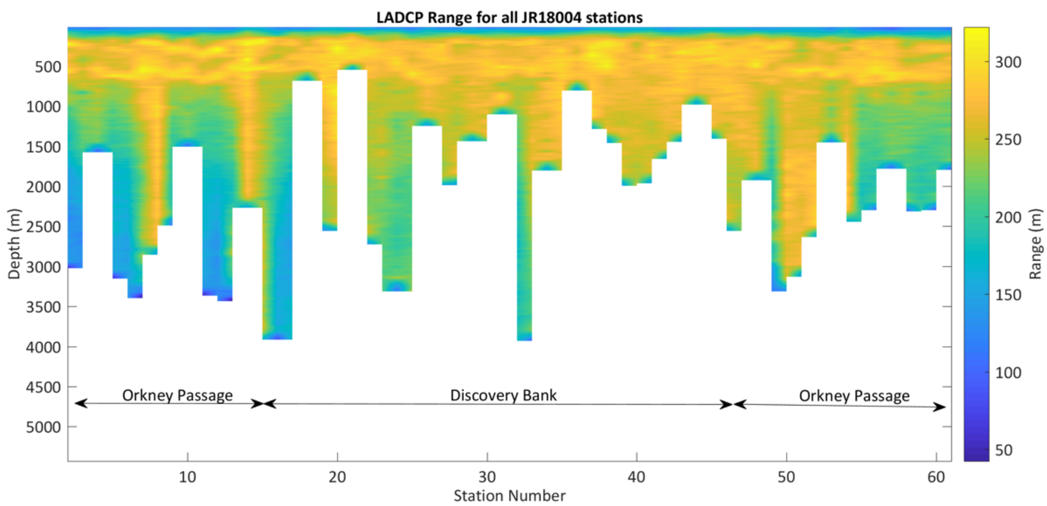


Figure 7: Plot of LADCP range (in metres) as a function of station number.

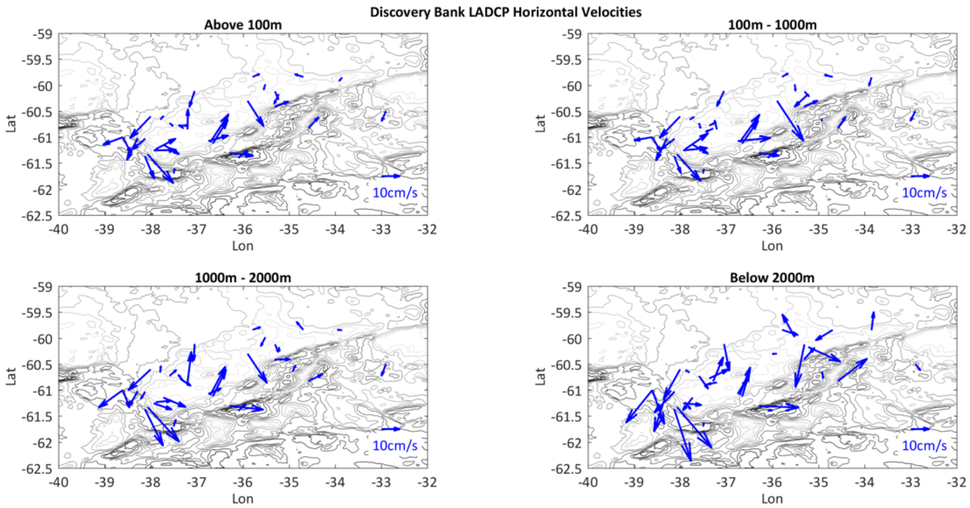


Figure 8: Processed LADCP velocities observed over Discovery Bank in a variety of depth ranges.

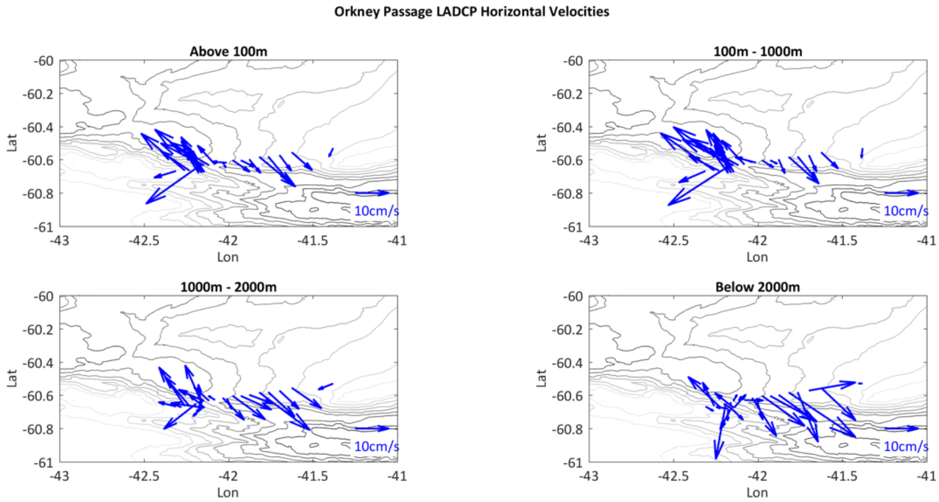


Figure 9: Processed ADCP velocities observed at Orkney Passage in a variety of depth ranges.

Vertical velocities and VKE-Finestructure Parameterization

The LADCP data from all profiles were also processed for vertical velocity and vertical kinetic energy (VKE) using the LADCP_w software version 1.4. All profiles could be processed without problems, including profile 034 where the CTD failed during the bottom bottle stop, as well as the tow-yo profiles 06201-06206. Figure 10 shows two example profiles from a station with weak and another station with strong internal waves. The agreement between the vertical velocities from the two ADCPs is excellent.

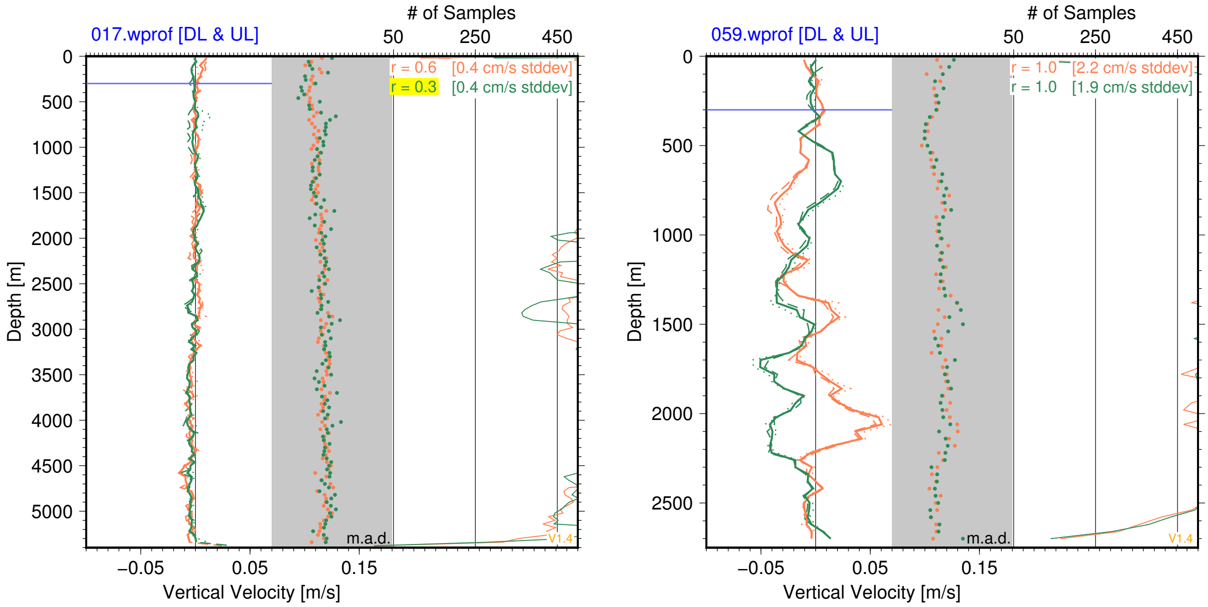


Figure 10: Example diagnostic plots showing vertical ocean velocity (leftmost profiles in each panel) from a station with weak and strong internal waves. Orange and green profiles are from down- and up-casts, respectively. Dashed, dotted and solid lines are from downlooker, uplooker and from both ADCPs combined, respectively.

The LADCP_w software also includes an implementation of a VKE-based finestructure parameterization for turbulent kinetic energy dissipation (ε). Figure 11 shows the resulting estimates, together with suitably averaged VMP-derived measurements for the same two vertical velocity profiles shown in Figure 10. Default parameters were used, except that no low-turbulence threshold was applied (this will be the default for LADCP_w version 1.5). While the agreement between the fine- and microstructure derived dissipation values in many profiles is not nearly as close as those in these example profiles, the two methods agree well on average (Figure 12) with some indications that the VKE finestructure method underestimates weak dissipation levels (ε < 1 x 10 W/kg) by about factor 2 in this data set.

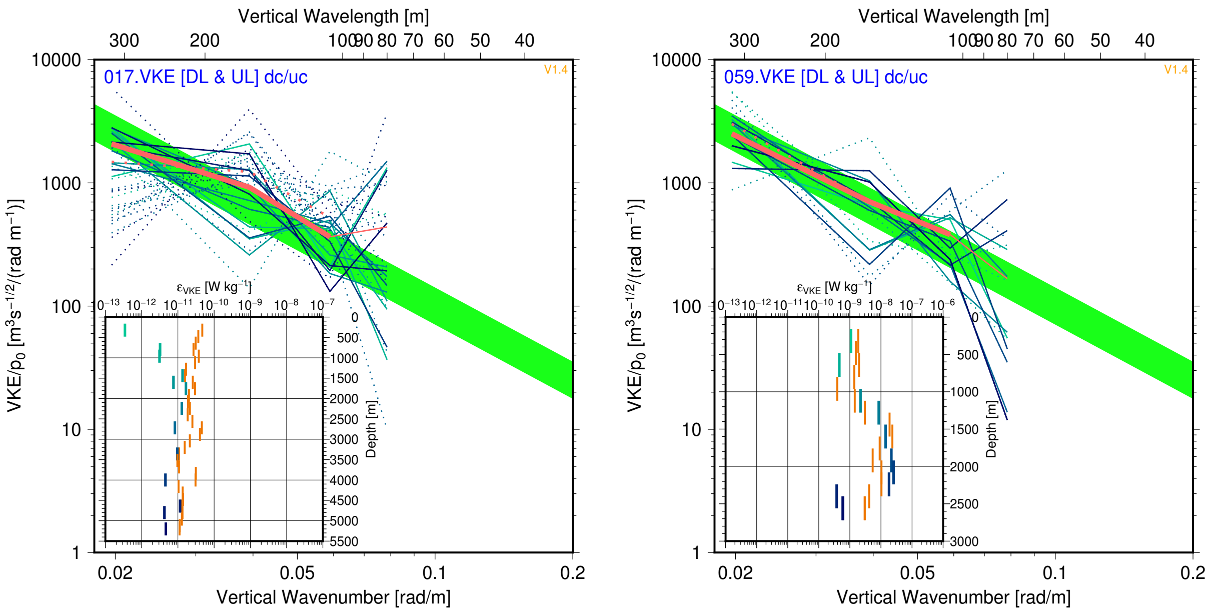


Figure 11: Example diagnostic plots showing dissipation (insets) from the vertical-velocity profiles shown in Figure 10. Both microstructure-derived dissipation (orange) and finestructure estimates (blue-green) are shown.

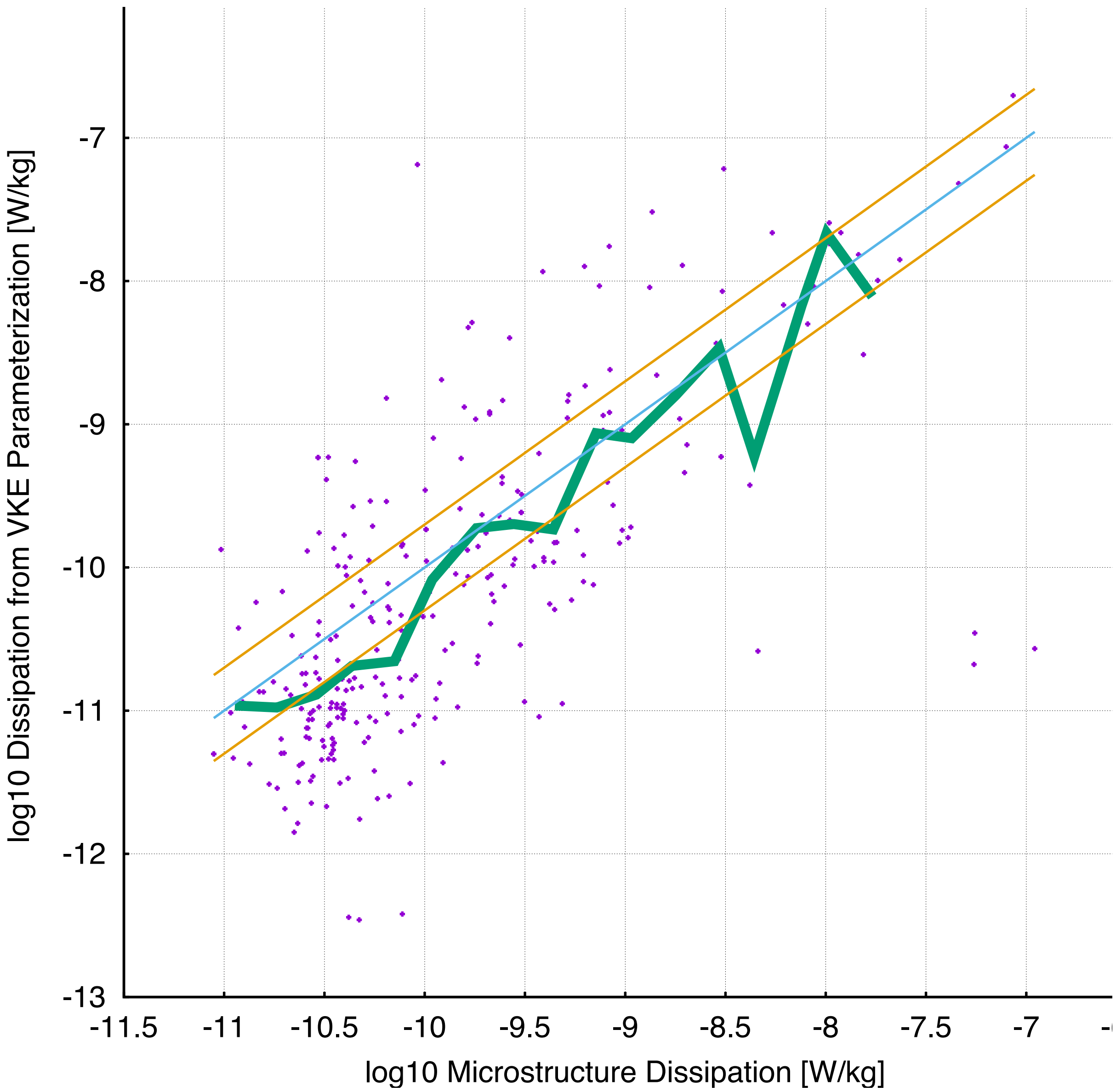


Figure 12: Finestructure- vs. microstructure-derived dissipation of kinetic energy from all profiles with both LADCP and VMP data. Purple dots: individual samples (160 m spectral windows/averages). Heavy green line: VKE-derived epsilon values averaged in 0.2 log_{10}(VMPε) bins. Thin blue and orange lines: 1-to-1 relationship with factor-2 error bands.

Reference

Meredith, M.P., Meijers, A.S., Naveira Garabato, A.C., Brown, P.J., Venables, H.J., Abrahamsen, E.P., Jullion, L. and Messias, M-J. (2015). Circulation., retention and mixing of waters within the Weddell-Scotia Confluence, Southern Ocean: The role of stratified Taylor columns. *J. Geophys. Res. Oceans,* **120(1),** 547-562.

Thurnherr, A. (2011). Vertical velocity from LADCP data. Conference proceedings from Current, Waves and Turbulence Measurements (CWTM), 2011 IEEE/OES 10th, doi: 10.1109/CWTM.2011.5759552.

4. Shipboard Acoustic Doppler Current Profiler (SADCP)

Russell Arnott and Povl Abrahamsen

Introduction

Ocean current velocities from 8 m to 1000 m depth were measured via a 75-KHz Teledyne RDI Ocean Surveyor shipboard acoustic Doppler current profiler (SADCP). Data were acquired, displayed and logged via the RDI VmDas software (version 1.42) and subsequently processed via a series of bespoke Matlab routines developed from previous cruises.

Setup

Throughout the cruise, the SADCP was set to run in narrowband mode (as opposed to broadband mode) and was run independently so as not to go through the System Synchronisation Unit (SSU). For much of the cruise, the acquisition was in *Water Tracking* (WT) mode; when the vessel was sailing in water less than 1000 m depth for a prolonged duration, the acquisition was switched to *Bottom Tracking* (BT) mode. To prevent individual file sizes from become too large (thus impeding subsequent processing), the SADCP was periodically stopped and restarted to allow a new file to start logging. On average, this was carried out at least once in a 24-hour period; the start and stop times associated with each file sequence were recorded in the SADCP log found in Appendix B. Note that it was imperative that the SADCP was always logging during CTD casts; the SADCP data were subsequently used to process data from the upward- and downward-facing lowered ADCPs (LADCPs) onboard the CTD carousel.

Data output

The VmDas software saved the data files with the file naming nomenclature of "JR18004_xxx_000nnn.aaa" where xxx = the file sequence number starting at 000, nnn = the file number within that sequence and aaa = the file type. For each sequence, 9 different file types were created:

Extension	Description	Type
*.ENR	Raw ADCP data file	Binary
*.ENS	ADCP data screened (by VmDas or user) with *.NMS navigation data added.	Binary
*.ENX	ADCP single-ping data and navigation data after bin-mapping and transform to Earth coordinates. Screened for error velocity, vertical velocity and false targets.	Binary
*.LOG	All output logging and error messages	ASCII
*.LTA	Long-time average of ADCP data (averaging time period specified in VmDas software options – in this case, 600 seconds).	Binary
*.N1R	Raw National Marine Electronics Association (NMEA) navigation data from Seatex GPS system.	ASCII
*.NMS	Navigation data after screening and pre-averaging.	Binary
*.STA	Short-time average of ADCP data (averaging time period specified in VmDas software options – in this case, 120 seconds)	Binary
*.VMO	Options settings for data collection	ASCII

Post-processing

The raw SADCP files were processed via series of Matlab scripts originally obtained from IFM Kiel but adapted accordingly for use on the JCR by various researchers, most notably Angelika Renner and Deb Shoosmith. As such, should in-depth information on the processing protocol and subroutines be required, it is recommended that you refer to cruise report JR165 from December 2007. The JR165 report provides extensive explanations of the processing flow accompanied by thorough explanation of the processing protocol.

With assistance from Povl Abrahamsen (EPA), past scripts were adapted resulting in the script 'OS75_JCR_JR18004.m'. Within this script, the following were allocated:

1. The file location of the raw SADCP output files [RAWPATH] and the location of the processed files [PATH].
2. The filename prefix 'JR18004_000_000000' and the cruise name 'JR18004'.
3. Matrices of file sequence numbers were made, initially distinguishing between files that were bottom-tracked [1,2,5,10,14,15,18:20,25,33] and water-tracked [3,4,6:9,11:13,16,17,21:24,26:32,34:50] as well as all file sequence numbers [1:50]
4. The averaging period 'superaverage' (using the default of 120 seconds) and the starting year of the cruise (2019) were assigned.
5. The upper (ref_uplim) and lower (ref_lowlim) reference depth limits for the water track calibration of 300 m and 500 m respectively. Note that the defaults for this are typically 400 m and 600 m; the shallower reference depths were decided upon from observing the stability of the SADCP profiles in VmDas over the course of the cruise in preparation for VMP deployments. Discussions with Andreas Thurnherr and EPA concluded that the shallower and more stable reference depths were to be used.
6. The narrowband misalignment angle and amplitude scaling factor corrections (misalignment_nb and amplitude_nb) were set to 0 and 1 respectively for the initial run. Note that the broadband equivalent [*_bb] can be ignored here as narrowband mode was used at all times. The alignment and amplitude offsets were calculated during the initial run. Once the actual offsets were generated, they were substituted in and the script re-ran thus applying this offset to the SADCP files. The values generated were compared to calibration values from other cruises; they were found to be comparable in magnitude but overall different as the SADCP was re-aligned while the JCR was in dry-dock during the summer of 2018. Various misalignment and amplitude values can be seen below in Table 2. The values in bold were those used in the final processing. As recommended in Cruise Report JR165, it is prudent to use median values as these are less susceptible to skewing from extreme / anomalous values when compared to the mean values.

Description	Amplitude (A) scaling factor			Angle° (α) offset		
	mean	median	std	mean	median	std
Bottom-tracking files only	1.009443	1.007989	0.08589	0.0843	0.0980	0.4872
All files	1.009877	1.008383	0.010965	0.0687	0.0993	0.5230
Water-tracking files only (300m – 500m ref limit)	1.019629	**1.018107**	0.014732	-0.1704	**-0.1689**	0.5938
Water-tracking files only (400m – 600m ref limit)	1.021893	1.019532	0.019435	-0.1693	-0.1655	0.6059

Table 2: Amplitude scaling factors and angle offsets generated using various combinations of file sequence inputs. Values in bold were those used in the post-processing.

Three SADCP file sequences were seen to crash in VmDas and had to be restarted (namely file sequences #010, #019 and #020). As a result, these files were incomplete with gaps in the navigation data preventing them from being processed using the original script. EPA added the follow line of script to line 625 of the primary processing script 'OS75_JCR_JR18004.m':

```
time_for_plot(isnan(time_for_plot))=interp1(ii,time_for_plot(ii),find(isnan(time_for_plot)),'linear','extrap');
```

which locates the missing values (manifested as NaNs) and interpolates new values into their place. Following the insertion of this line, it was possible to include the rogue files in the misalignment analysis. The final values used for the analysis were obtained from the water-tracked file sequences with reference depths of 300 m to 500 m; the median amplitude scaling factor of 1.018107 and median misalignment angle of 0.1689°. Water-tracking file sequences were used as there were 39 of these compared to the 11 bottom-tracked files; simply more data equates to a more suitable offset. If files with bottom-tracking are included, the processing scripts used these preferentially. Thus, bottom-tracking files were not included when calculating the final offset.

7. Once these values were decided on, the SADCP were reprocessed with these offsets in place changing misalignment_nb from 0 to 0.1689 and amplitude_nb from 1 to 1.018107.

Once reprocessed, these data were then used to produce vertical time profiles as well as quiver vector plots using the various mapping and figure plotting codes used on previous cruises.

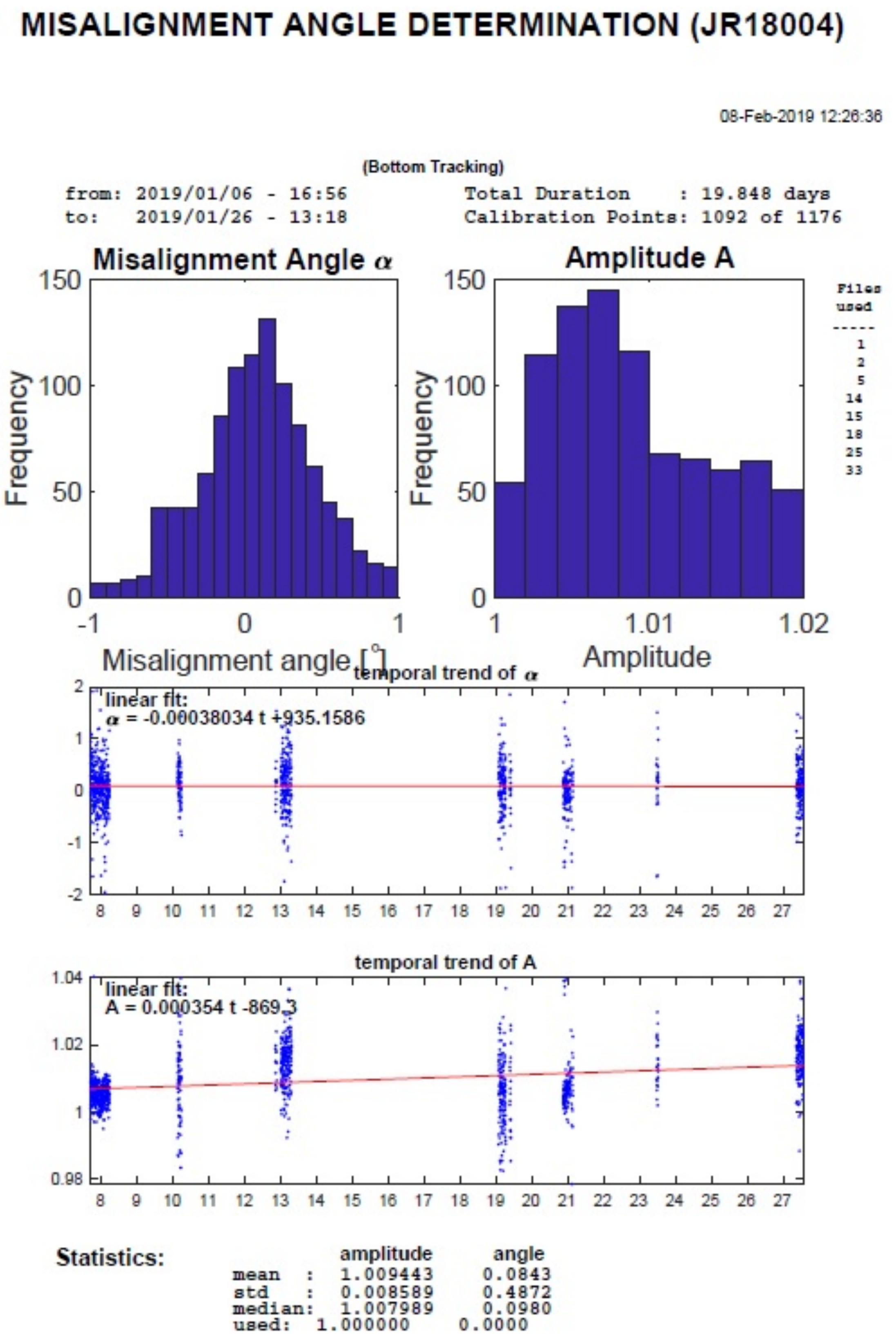


Figure 13: Misalignment angle determination: bottom-tracked file sequences only.

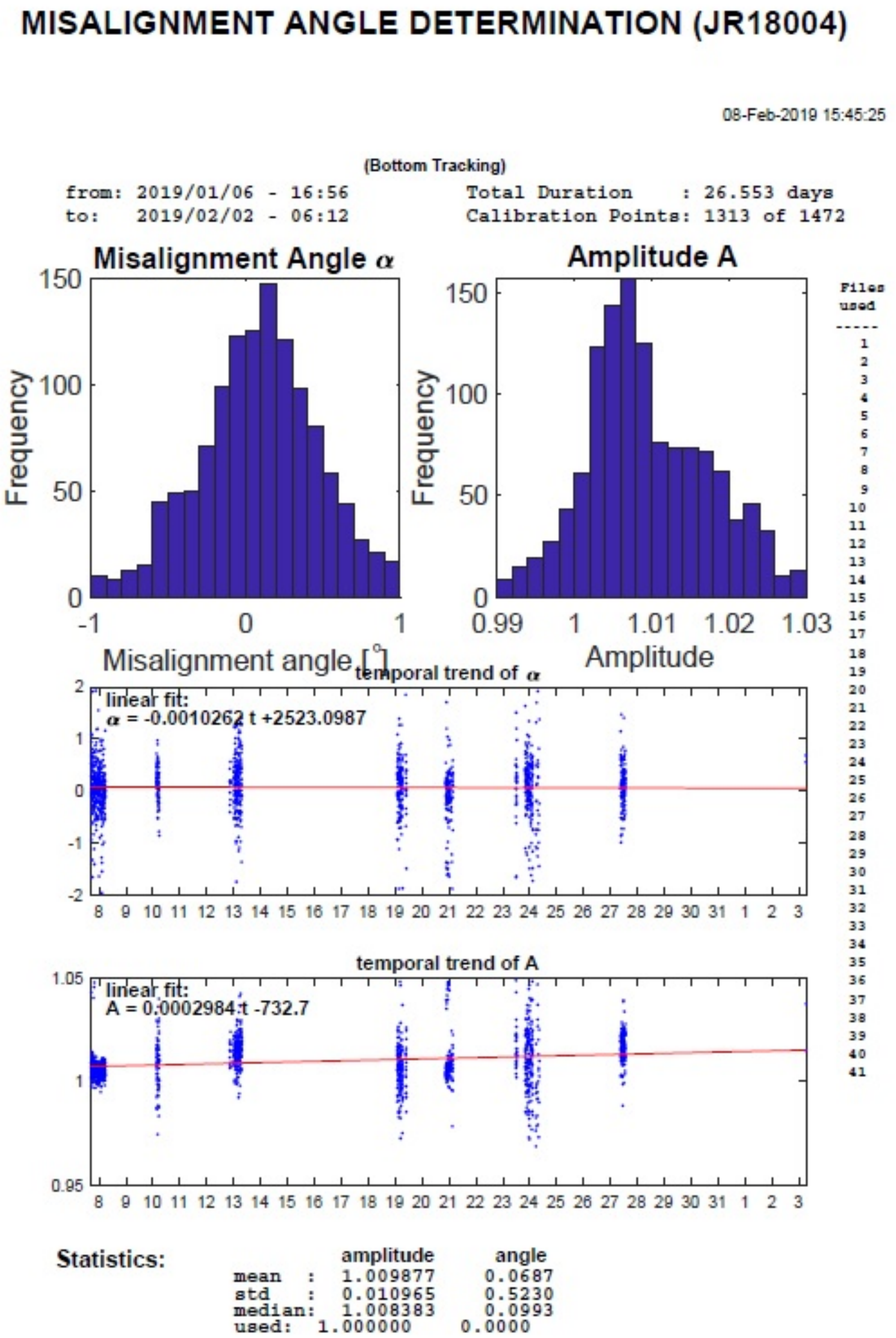


Figure 14: Misalignment angle determination: all files.

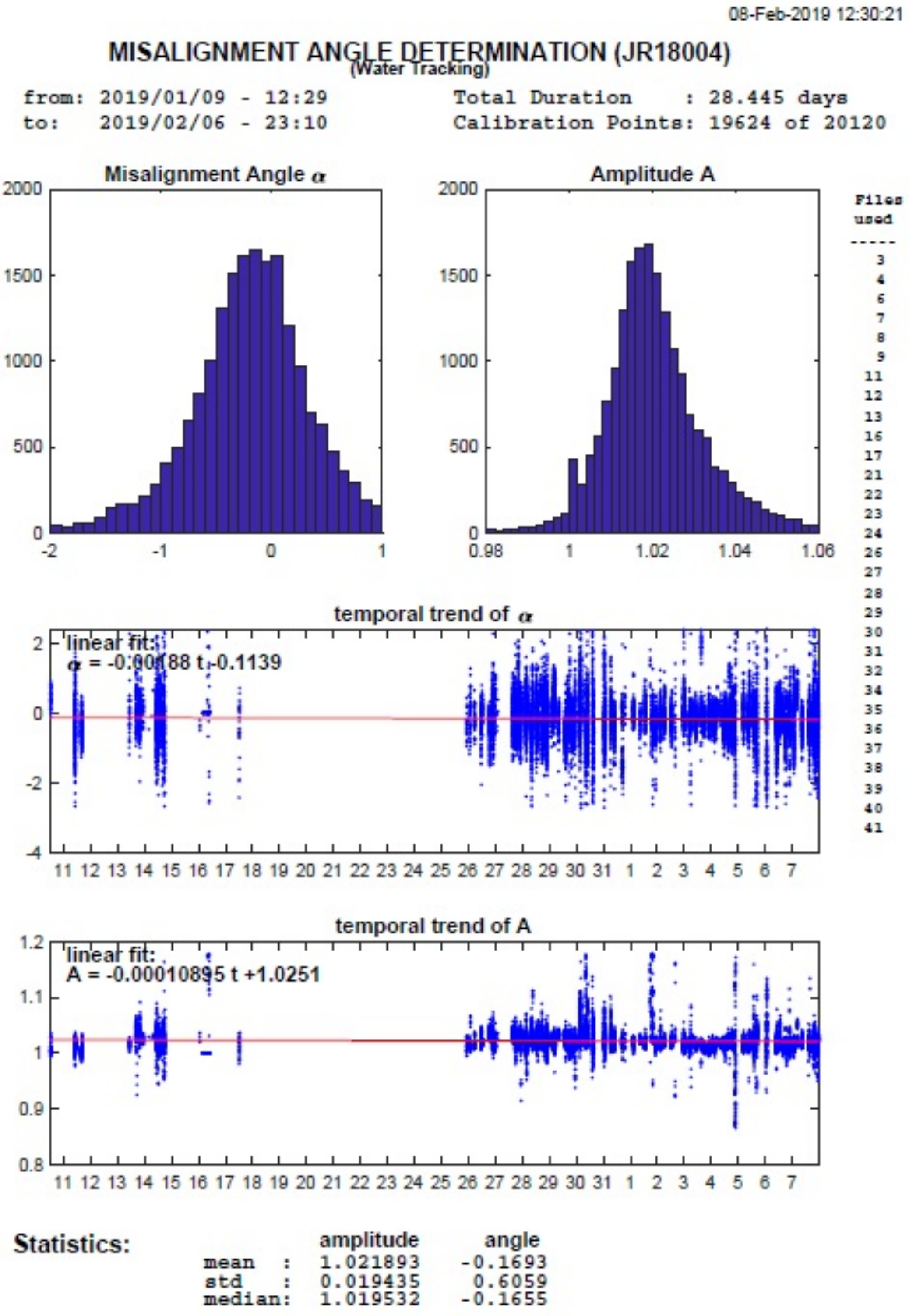


Figure 15: Misalignment angle determination: water-tracked file sequences only with default reference limits of 400 m to 600 m.

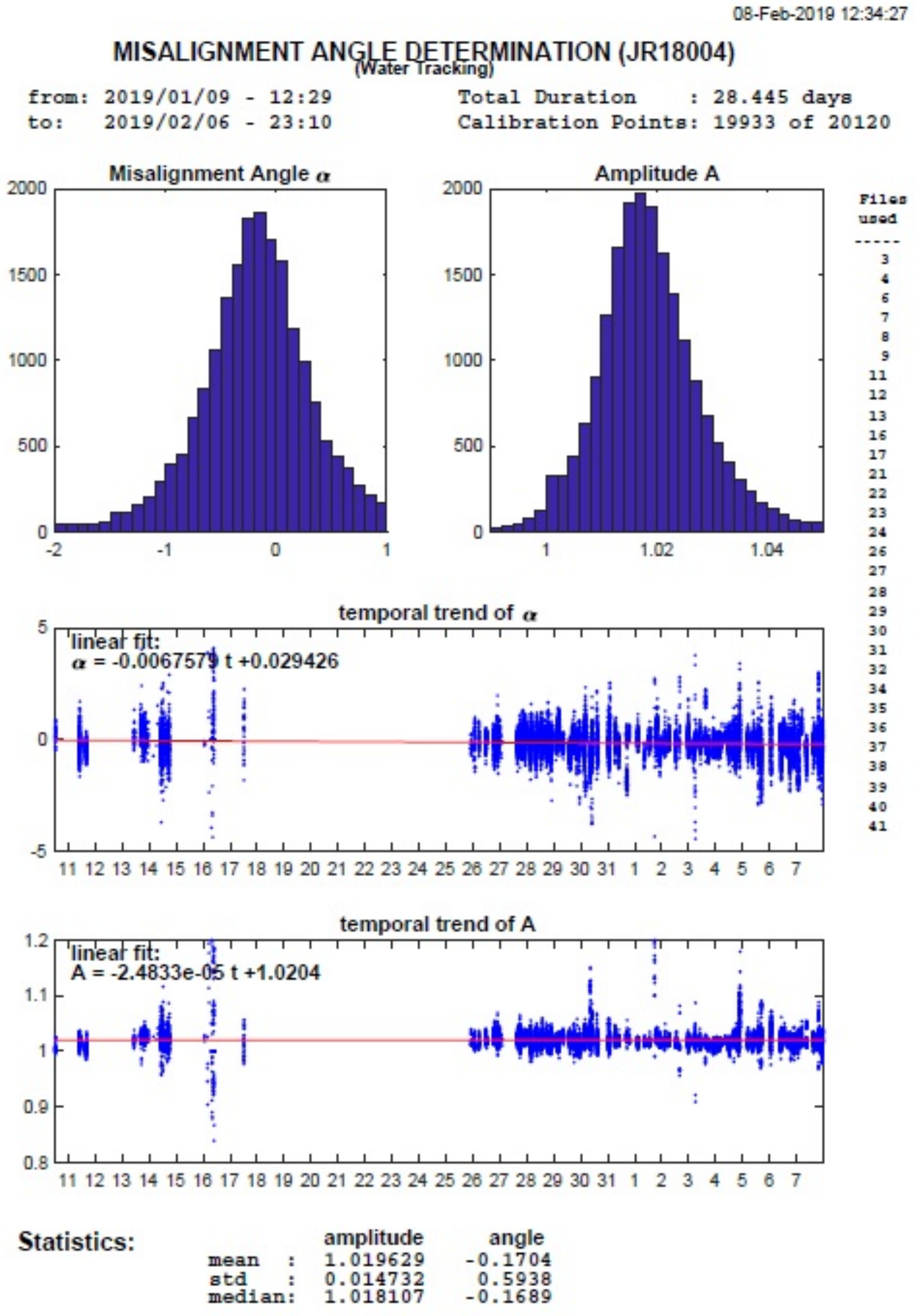


Figure 16: Misalignment angle determination: water-tracked file sequences only with default reference limits of 300 m to 500 m. It was this set-up that was used to generate the final misalignment angle and amplitude scaling factor.

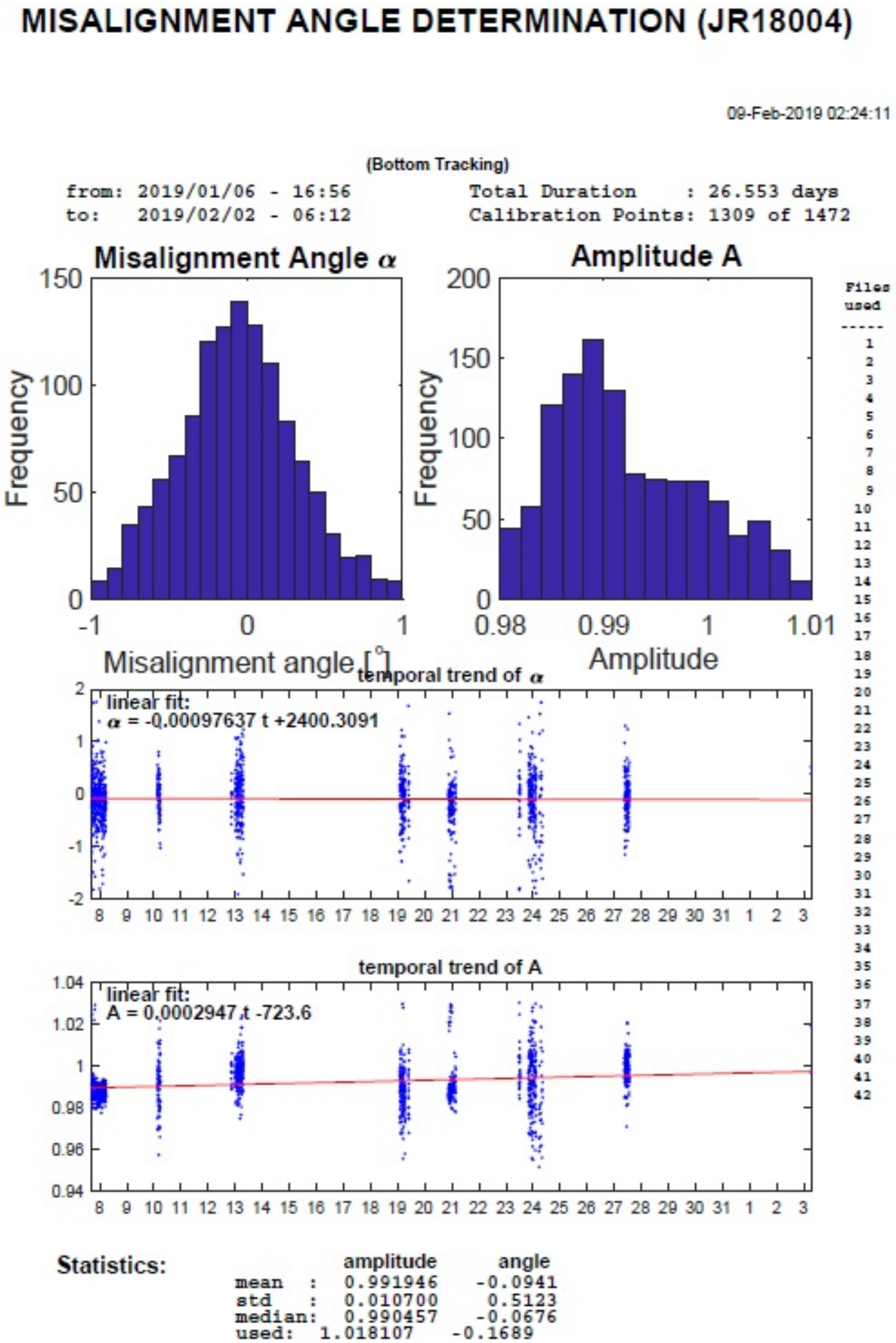


Figure 17: Misalignment angle and amplitude scaling factor distributions after applying the calculated offsets.

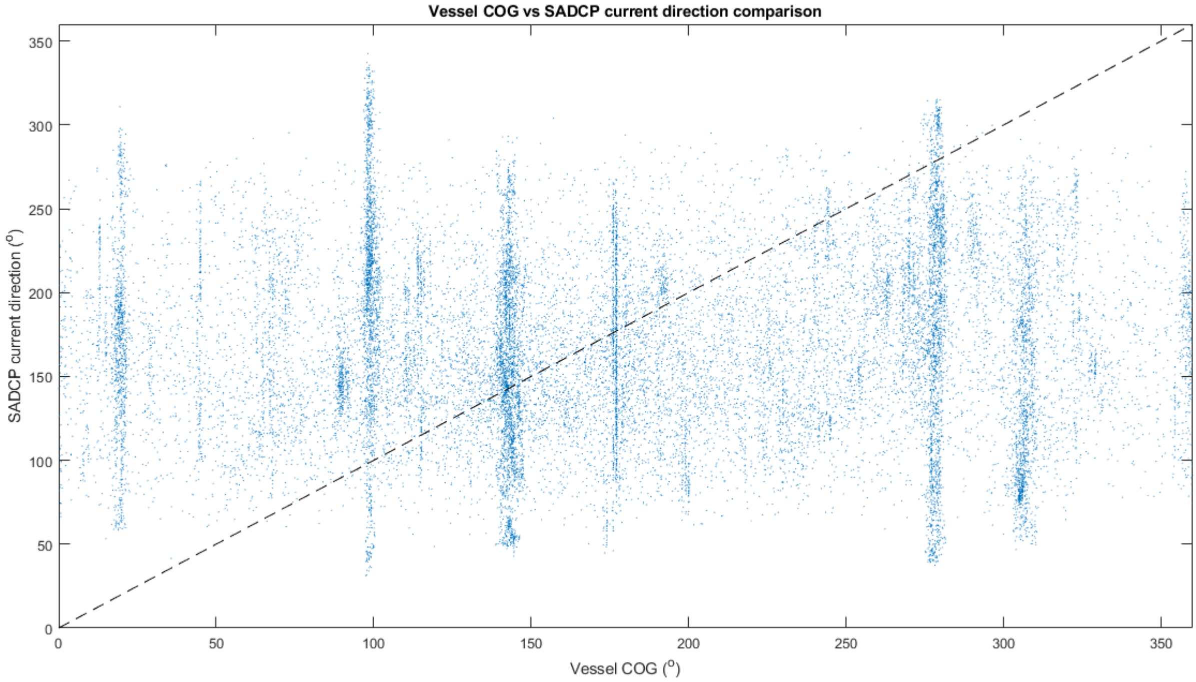


Figure 18: Comparison scatter plot for SADCP current direction and vessel course-over-ground (COG).

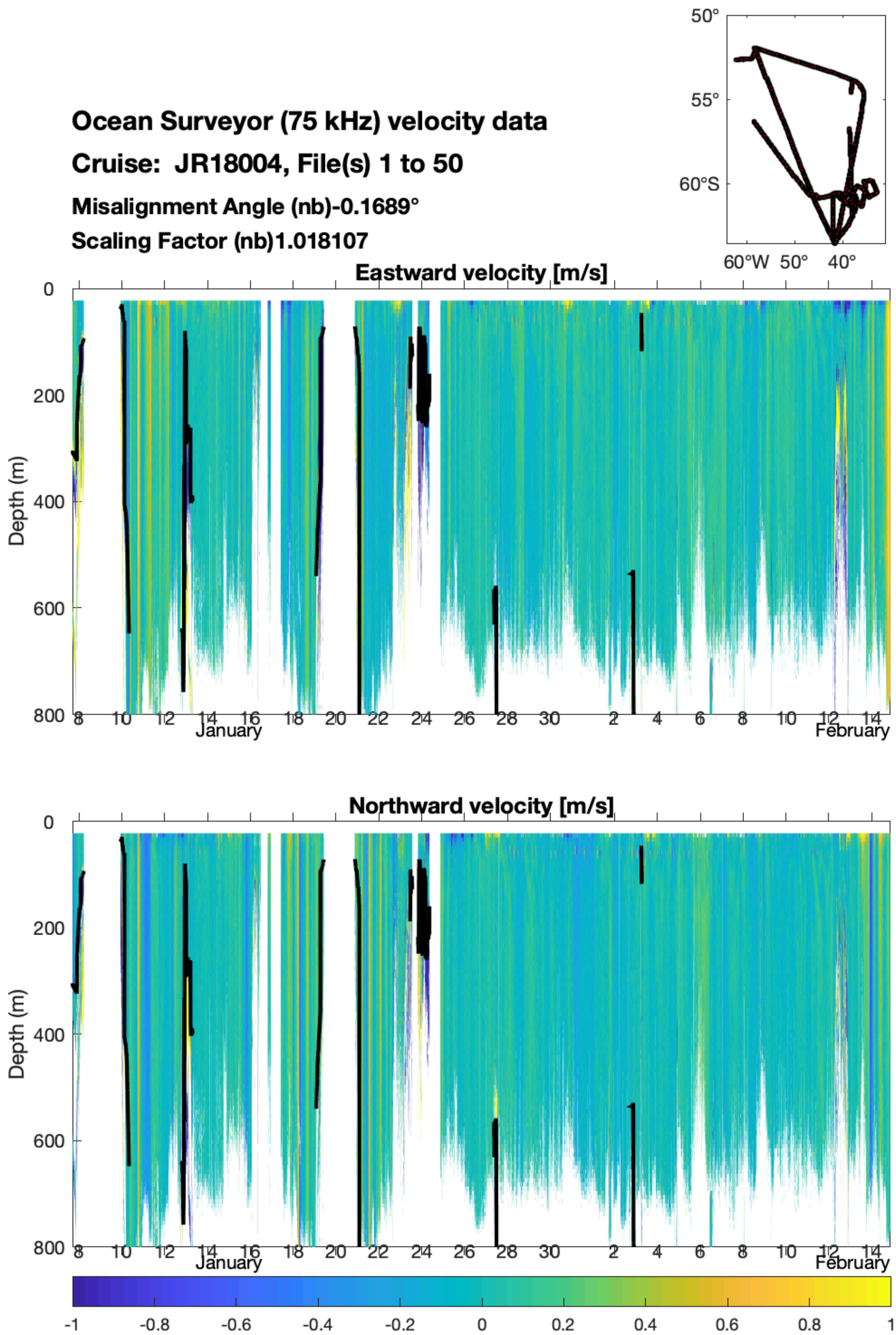


Figure 19: Eastward and northward SADCP velocities (m/s).

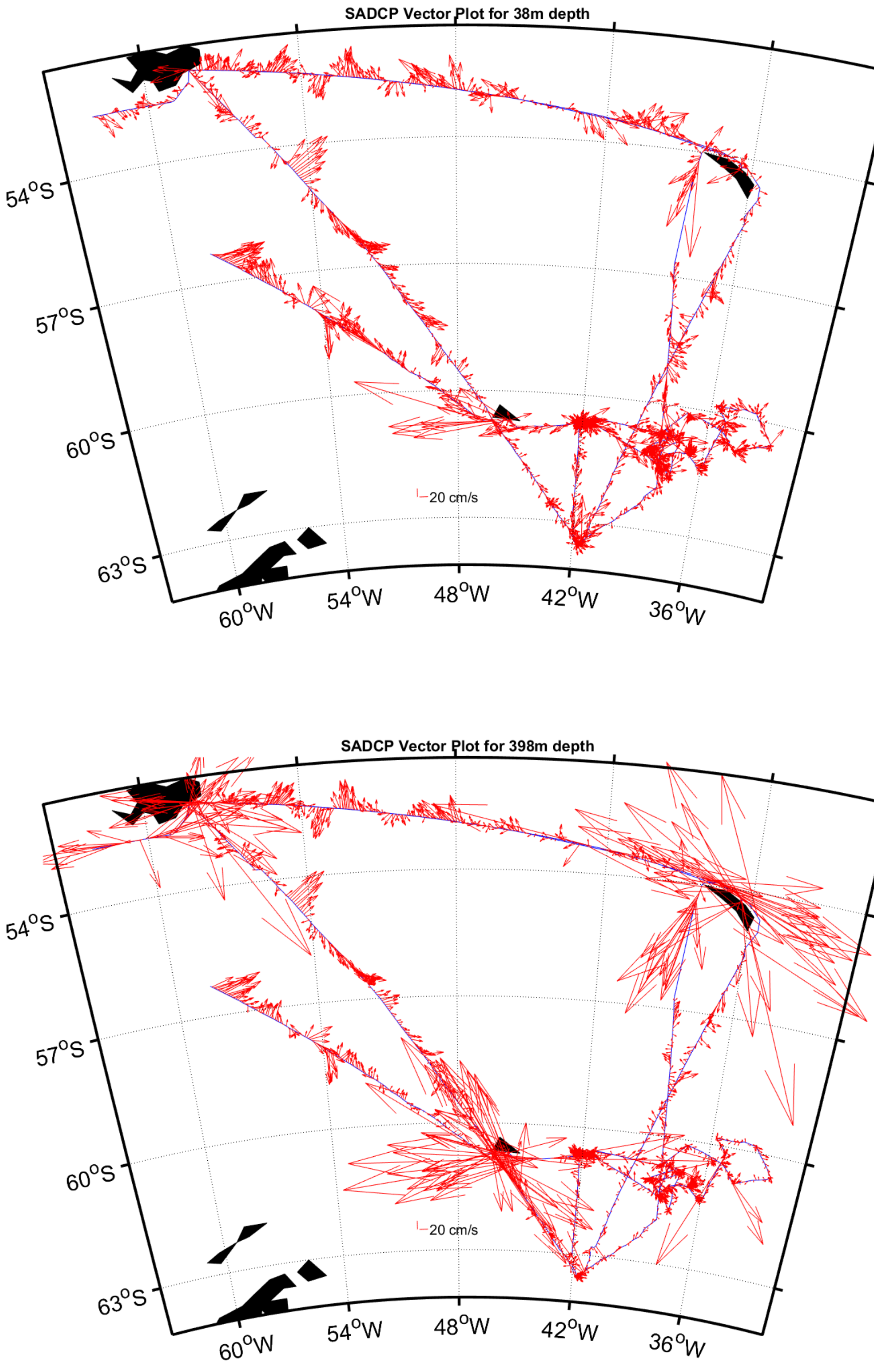


Figure 20: SADCP current velocity quiver / vector plot of all data at 38m depth (upper) and 398m depth (lower).

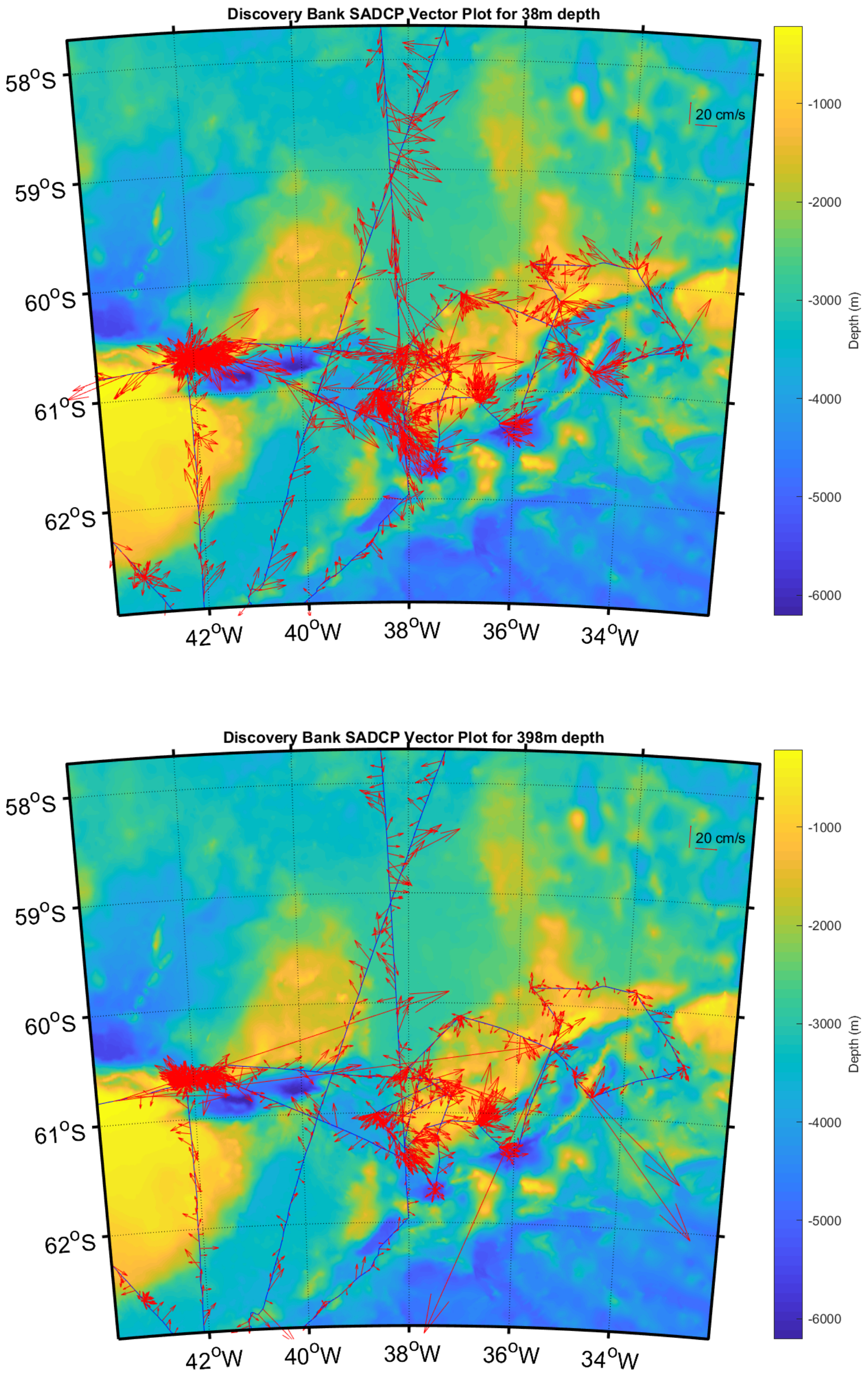


Figure 21: SADCP current velocity quiver / vector plots for Discovery Bank superimposed over GEBCO bathymetry data. Bin depth of 38m (upper) and 398m (lower).

5. Underway Collection and Data Processing

Peter Liljegren and Povl Abrahamsen

Collection

During scientific operations, underway data were collected and recorded using the SCS system on server JRLB. The following instruments were used to collect the data:

- WET Labs WSCHL Fluorometer
- WET Labs C-Star Transmissometer
- Two SBE38 Sea-Bird Sea Surface Temperature Probes placed at the inlet of the system
- SBE45 Sea-Bird Thermosalinograph
- Kongsberg Seatex Seapath 300
- EA600 Hull Mounted Kongsberg Simrad Hydrographic 12-kHz Echo Sounder

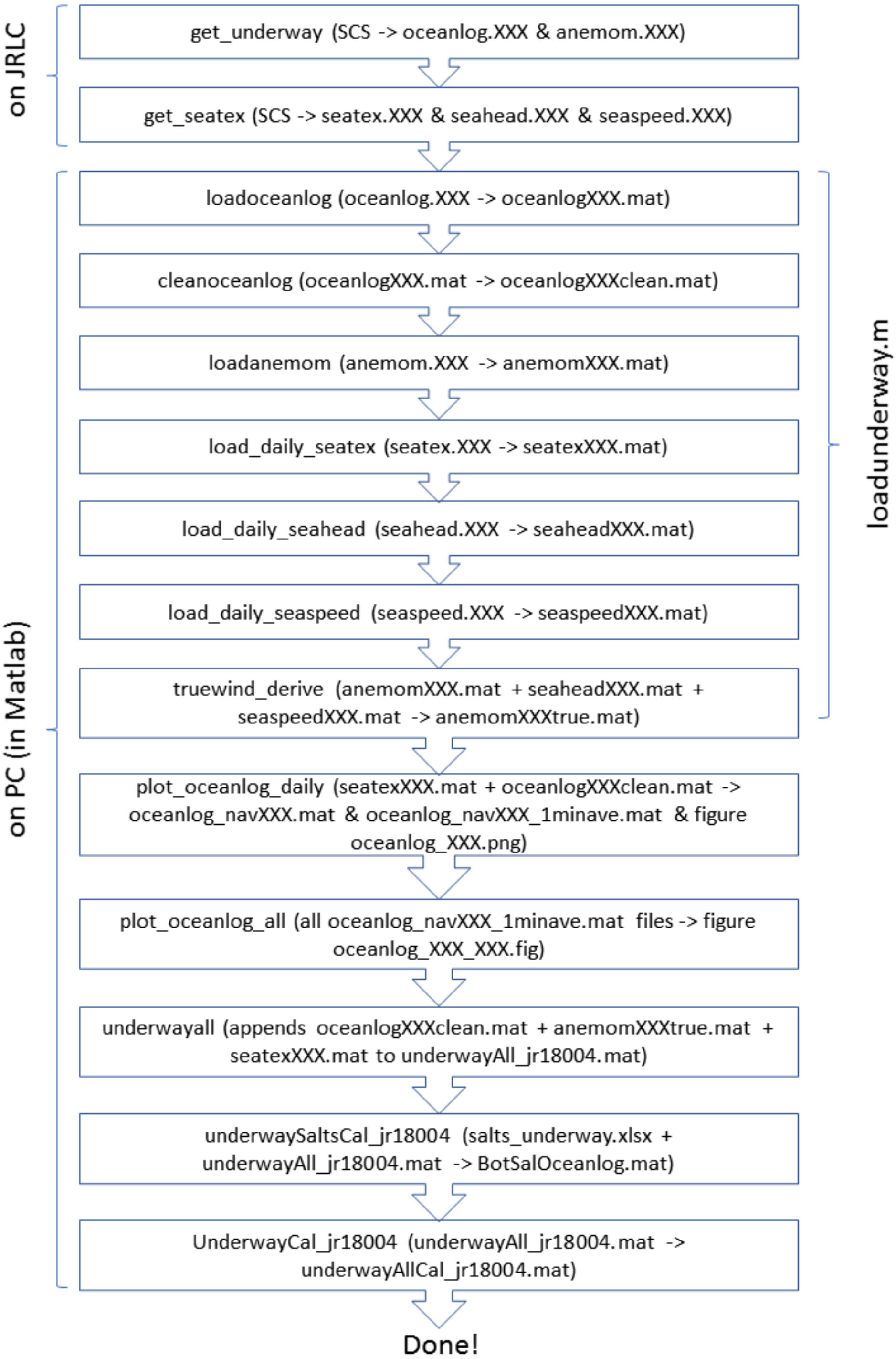
In addition, every four hours an underway water sample was taken from the uncontaminated seawater supply in the data prep lab. These samples were analyzed on the Guildine Autosal 8400B Salinometer in the Radiation Lab, as described in Chapter 2. These reference points would ultimately be used to calibrate and adjust the underway salinity data to the more exact salinometer measurements on the underway water samples.

Processing

The scripts used to process the underway data were written by Hugh Venables and others on previous cruises and modified slightly on this cruise. No cleaning of navigational data was performed. The true wind scripts were modified to use heading and speed data from the Seapath, along with the sonic anemometer data (which measures the relative wind) to calculate true wind speed and direction.

Povl Abrahamsen supplied the following flowchart to better visualize the processing of the underway data from beginning to end. The two initial steps are handled on Linux server "JRLC", where the oceanlogger and seatex (GGA, HDT and VTG) streams are downloaded into daily ASCII files. The remainder is handled in Matlab on a Windows laptop. These steps entail some cleaning, plotting, and appending of the data sets.

Note that the "time_jday" variable in the output files starts at zero on 1 Jan 2019: thus, 25.5 refers to noon on 26 Jan.



The final steps on the flowchart refer to the calibration of the underway salinity data by comparing against the more accurate data measured by the salinometer. Figure 22 shows the data points and best fit line used to calibrate the data. As we do not have regular sampling points from the start of the cruise until science was restarted after the Medevac to South Georgia, a constant offset of 0.0035 was applied from beginning of our sampling until noon on the 26th Julian day (26 Jan). From noon on Julian day 26 to the end of our data collection on Julian day 45, a near-linear decrease in the difference between the salinity recorded on the thermosalinograph and the bottles collected and measured using the salinometer was observed, and a line fitted (ignoring outliers marked in blue on the figure below). The equation used was y = -0.000886x + 0.0261. The drift of the thermosalinograph conductivity sensor may have been caused by fouling during the cruise; cleaning the conductivity cell before the next cruise may be advisable.

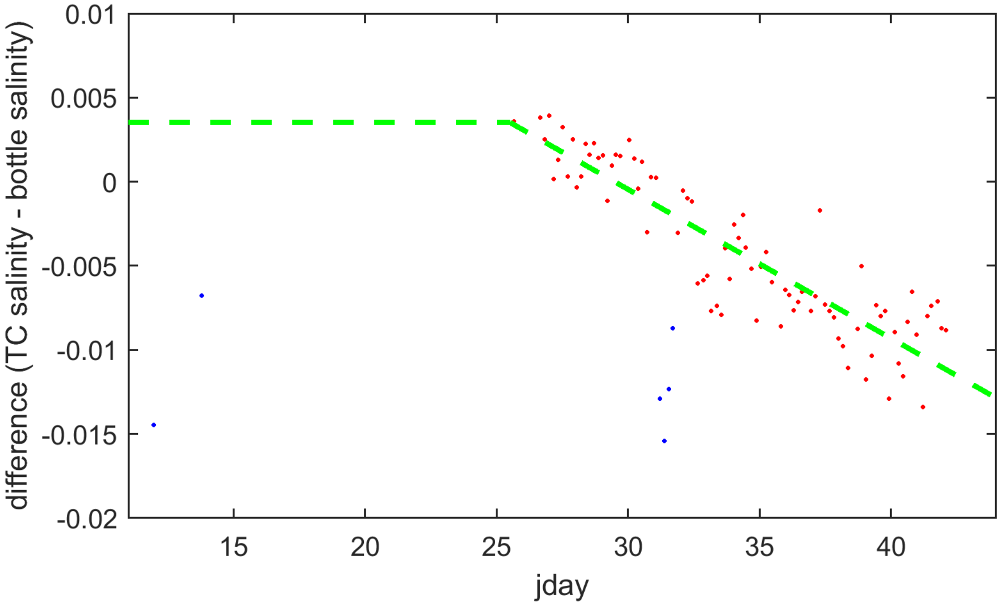


Figure 22: Difference between bottle salinity and TSG salinity, plotted by day number. The correction used is plotted with the green dashed line.

Output files

The final calibrated output file, underwayAllCal_jr18004.mat, contains two Matlab structures, anemom and oceanlogcal. The fields are listed below:

anemom	year	year	calendar year
	time_jday	days	Julian day (starting at zero on 1 Jan)
	time_secs	seconds	seconds since midnight on 1 Jan
	wind_dir	degrees	relative wind direction (zero at the bow of the ship)
	wind_spd	knots	relative wind speed
	wind_spd_ms	m/s	relative wind speed
	windvel_east	m/s	true wind speed component toward the east
	windvel_north	m/s	true wind speed component toward the north
	windspeed_true	m/s	true wind speed
	winddirection_true_TO	deg T	true wind direction that the wind blows toward
	winddirection_true_FROM	deg T	true wind direction that the wind blows from
oceanlogcal	year	year	calendar year
	time_jday	days	Julian day (starting at zero on 1 Jan)
	time_secs	seconds	seconds since midnight on 1 Jan
	atemp1	deg C	air temperature 1
	atemp2	deg C	air temperature 2

hum1	%	relative humidity 1
hum2	%	relative humidity 2
par1	μmol/s/m^2	PAR (photosynthetically available radiation) 1
par2	μmol/s/m^2	PAR (photosynthetically available radiation) 2
tir1	W/m^2	TIR (total incoming radiation) 1
tir2	W/m^2	TIR (total incoming radiation) 2
press1	hPa	atmospheric pressure 1
press2	hPa	atmospheric pressure 2
sst	deg C	sea surface temperature 1 (at inlet)
sst2	deg C	sea surface temperature 2 (at inlet)
flow	L/min	flow through thermosalinograph, transmissometer, and fluorometer
trans	%	light transmission (from transmissometer)
fluor	μg/l	Chl. A fluorescence (from fluorometer)
saltemp	deg C	temperature in thermosalinograph
sal_uncal		uncalibrated salinity from thermosalinograph
cond	S/m	uncalibrated conductivity from thermosalinograph
speed	m/s	speed of sound through water (from uncalibrated thermosalinograph T/S)
sal		calibrated salinity from thermosalinograph
offset.sal		offset applied to thermosalinograph salinities
lon	deg E	longitude (interpolated from Seapath)
lat	deg N	latitude (interpolated from Seapath)

6. Swath Bathymetry

Natalie Ensor and Povl Abrahamsen

The multi-beam sonar on the JCR, a Kongsberg Simrad EM122, was running during much of the cruise, from our departure from M3 towards King Edward Point (KEP), until entering the Argentinian EEZ. During this time, data were recorded when we were not in areas already covered by BAS multibeam data archives (e.g. Orkney Passage). The data have been split into three surveys. Note that JR18004_a does not contain any data. The first actual survey, JR18004_b covers the transit from M3 to KEP and much of the return from KEP to M3 and on to Orkney Passage. JR18004_c covers Discovery Bank, starting and ending in Orkney Passage. JR18004_d started when leaving Orkney Passage at the end of science and ended on entering the Argentinian EEZ. The division into surveys is shown in Figure 23.

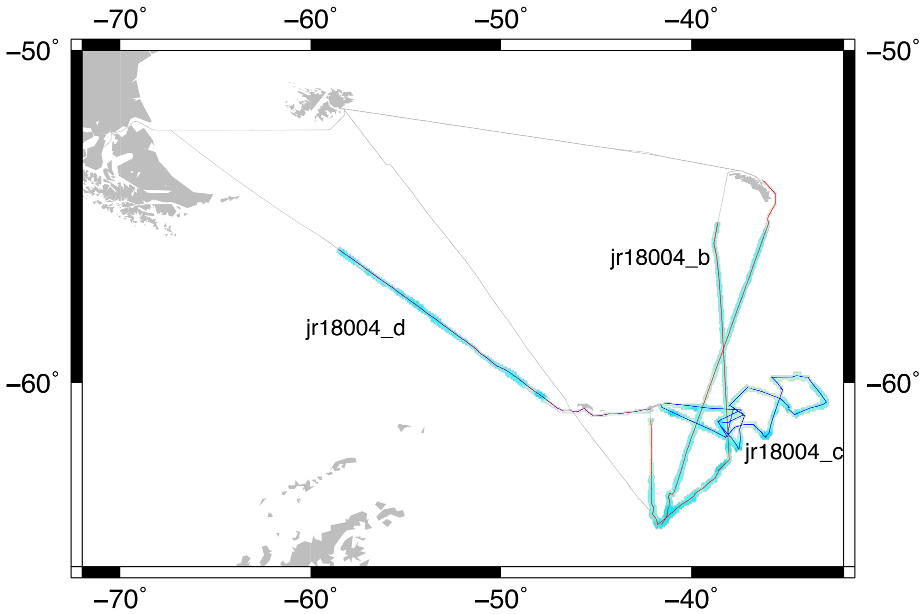


Figure 23: Overview of the swath bathymetry data from JR18004, with track colours alternating between blue and red.

Instruments and methods

Data acquisition was performed on a Windows 7 workstation, em122, running Simrad's SIS software, version 4.1.3. The default settings, as described in the notes "Using the EM122 multibeam on an opportunistic basis", by Gwen Buys and Alex Tate, version 3.0 dated 28/4/2013, were used – with varying maximum beam angles, depending on the depth and sea state. CTD casts were imported occasionally as sound velocity profiles, to represent local conditions. The details of the profiles used at different points in the cruise are in Table 3 below.

Data from this cruise have not been cleaned and processed on board. Generally, the data appear to be of good quality, though some manual cleaning will be required. When pinging, all centre-beam depths are logged to SCS (even when not logging full multibeam data). We did not log data in Orkney Passage or when on passage in well-swathed areas (or in EEZs). When the EM122 was pinging, the EA600 was in passive mode, synchronised by the KSync synchronisation system.

The EM122 workstation displayed occasional disk warnings, including warnings of bad blocks, at the start of the cruise. Because of this, the system was shut down from 17:30 on 11 Jan to 13:08 on 13 Jan to rebuild the disks. However, further warnings were still displayed later in the cruise.

Survey	Note	Lines	Date 2019	Time	Info on SVP or other events	Location/ station
JR18004_a			 11/1 11/1	 10:54 17:31	Changed SVP to JR16005 CTD 8 EM122 switched on Rebooted PC	
JR18004_b			13/1 13/1	13:09 16:41	New survey created, started pinging after disk rebuild. Changed SVP to JR18004 CTD 2	M2 (CTD 2)
		0 43	14/1 16/1	11:43 07:34		 KEP
		44 88	24/1 26/1	14:43 11:30		KEP M3 (CTD 3)
	 1	89 105	26/1 27/1	22:07 13:45		M3 (CTD 3) OP3 (CTD 4)
		106	27/1	23:00	Started logging and immediately stopped	OP3 (CTD 4)
	1		28/1 30/1	03:28 11:39	Changed SVP to CTD 5 Restarted SIS	
JR18004_c			30/1	11:41	New survey, started pinging	
		0 11	30/1 31/1	14:58 02:10		OP6 (CTD 14) DB2 (CTD 15)
			31/1	07:10	Changed SVP to JR18004 CTD 15	DB2 (CTD 15)
	2	12 111	31/1 8/2	07:10 10:44		DB2 (CTD 15) DB3 (CTD 47)
	 1	112 130	8/2 9/2	14:24 08:33		DB3 (CTD 47) OPCTD20 (CTD 48)
			9/2	09:21	Changed SVP to JR18004 CTD 5	OPCTD20 (CTD 48)
JR18004_d			12/2	00:40	New survey	
		0 9	12/2 12/2	03:28 13:12		OPS1a (CTD 62) Borge Bay
	 3	10 29 63	12/2 13/2 14/2	15:35 11:00 20:57	 Entering Argentinian waters. EM122 switched off	Borge Bay Edge of Argentinian EEZ

Notes:
1. Not logging while doing science in Orkney Passage.
2. Multiple starts and stops at Discovery Bank stations. Full details are in the version of the table on the legwork (cruise backup) drive.
3. Some bad data, especially on starboard side, probably related to the sea state and direction of waves.

Table 3: Summary of swath data and speed of sound profiles used. All times UTC. Stops for science stations have not been included; a full copy of the event log table with science stations included is available and has been saved on the legwork drive.

7. Vertical Microstructure Profiler (VMP) operations

Andreas Thurnherr

Instrumentation, Processing Software and File Naming Convention

In order to sample the turbulence, two Velocity Microstructure Profilers (VMPs) from the National Marine Facilities (NMF) pool were used during the cruise: serial number 16, which had been used extensively during previous projects, as well as serial number 107, which had not performed well during previous deployments but which had been serviced by the manufacturer (Rockland Scientific) prior to this cruise. Both profilers were equipped with dual shear and micro-temperature as well as with a single micro-conductivity sensor. Additionally, each VMP had an SBE CTD installed. Ancillary instruments to locate the profilers included USBL and RDF beacons, as well as flashers mounted to the recovery skirts of the profilers. ODAS software version 4.3.05 was used for data processing. Except for the test dips, the VMP files were named using the number of the corresponding CTD profiles. Since the VMPs were not used during all CTD profiles, the VMP file numbers are non-contiguous. The technical report from the instrument is found in Chapter 13 of this document.

VMP Cast Logistics

Except for the test casts, all VMP profiles were carried out to full depth. The weight-release pressures were calculated by subtracting either 80 m (early profiles) or 50 m (later profiles) from the observed (multibeam) water depths — the profilers drop an additional 20-30 m after weight release due to their inertia — and converting the resulting depths to pressures at the appropriate latitude of ~61°S using a routine from the TEOS-10 library. Drop times were estimated from the drop rates determined during early casts and sufficient time was added to ensure that the weight release would be fired based on pressure and not time. These calculations were logged on the log sheets, as were pre-cast upper ocean velocities to ensure that the VMPs would not drift toward shallower regions. VMP drift distances were small throughout the entire cruise (~300 m or less) and horizontal drift was never a problem. For all but two profiles (026 and 034) the VMP casts were carried out simultaneously with the corresponding CTD/LADCP profiles. First the VMP was deployed, then the ship moved a couple of hundred metres out of the way and the CTD was deployed. During the casts, the VMP was tracked with the USBL system and recovered after recovery of the CTD system. After each profile, the diagnostic plots created by the processing software were inspected and failed sensors were replaced before the following cast. Hard copies of all plots and log sheets were filed.

Test Casts and Hydrodynamic Performance

First, tethered test dips were performed with both instruments at the M2 mooring site to verify basic functionality of the electronics and the weight releases. No problems were encountered. The data were processed and inspection of the diagnostic profiles indicated no problems with any of the installed sensors. Two weeks later, at the continuation of science work at the M3 mooring site, untethered test casts to 750 dbar were carried out with both instruments, again without any problems with cast logistics or any of the sensors. Drop rates were around 65 cm/s for both instruments, which is in the optimal range. (Acceptable speeds are anywhere from 50 to 80 cm/s.) Detailed comparison of the diagnostic plots from the two instruments revealed, however, significantly greater broadband (i.e. not a vibration) horizontal instrument accelerations in both axes in VMP#16 than in #107, i.e. the hydrodynamic performance of #107 was clearly superior to the performance of #16. Consistent with this observation, the dissipation noise floor of #017 (~2 x 10^{-11} W/kg) was significantly below that of #16 (~1 x 10^{-10} W/kg). Based on available data from other projects using the same type of VMP (DIMES and DoMORE, using WHOI instruments) a noise level of 1 x 10^{-10} W/kg is not satisfactory. An inspection of VMP#16 revealed a lose drag brush which was tightened before the next deployment.

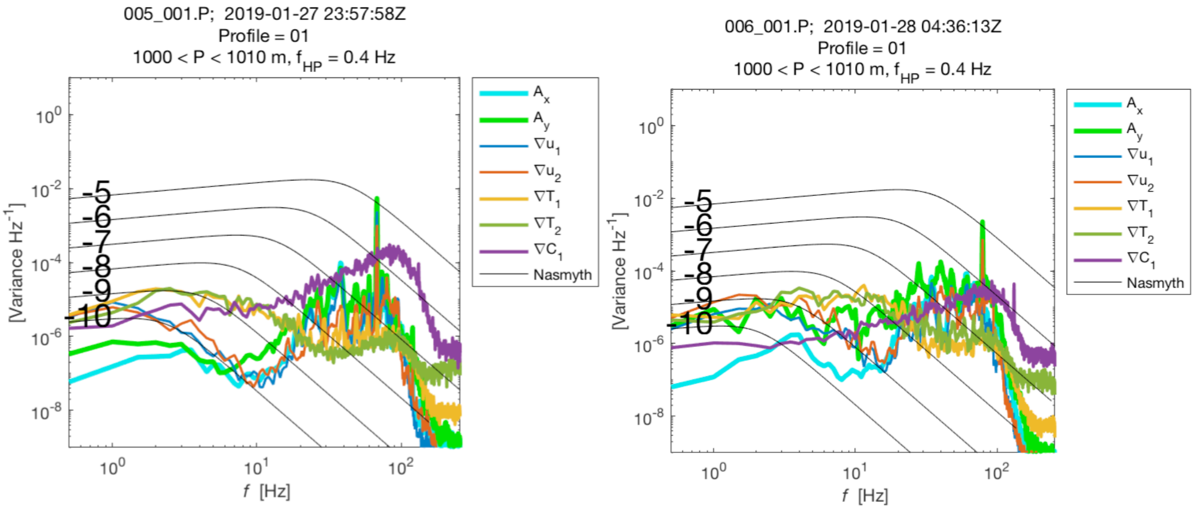


Figure 24: Diagnostic plots showing spectra of instrument acceleration (Ax and Ay) for VMP#107 (left panel) and #16 (right panel) from profiles 005 and 006, respectively. Note the broadband elevated Ay in the right panel, compared to Ax in the same panel, as well as compared to both Ax and Ay in the left panel, indicting sub-optimal hydrodynamic performance. See text for details.

The first science profile (005) was carried out at the OP2 waypoint with VMP #107 to a target depth of 3060 m. The drop rate was somewhat variable (because of significant vertical ocean velocities) but generally decreased between about 70 cm/s near the surface to ~62 cm/s near 3000 m, with a mean of 63 cm/s. The mean rise rate was 95 cm/s. Inspection of the diagnostic profiles did not reveal any problems and the noise level was again about 2 x 10^{-11} W/kg, i.e. very good. The following science profile (006) was carried out at OP1 with VMP#16 to a target depth of 3510 m. Mean drop and ascent rates were 62 and 79 cm/s, respectively. Dissipation from shear sensor 1 had a noise level of about 2 x 10^{-11} W/kg but shear sensor 2 had a much higher one, again at ~1 x 10^{-10} W/kg. Inspection of the spectra from this cast indicates that tightening of the drag brush reduced x-axis accelerations (Ax) to acceptable levels, whereas the y-axis accelerations (Ay) were still significantly elevated (Figure 24), most likely accounting for the high noise level in shear 2. Again the y-axis accelerations were broad band in nature without indications for a vibrational peak. The instrument was visually inspected again but no other problems could be found.

In order to put the hydrodynamic performance of the two VMPs of this cruise into a wider context, the diagnostic plots were compared to diagnostic plots from a WHOI profiler used during the DoMORE project, as well as to data from profiles collected with VMP#16 during the DYNOPO project. Based on these comparisons VMP#107 was seen to behave similarly to the WHOI instrument whereas VMP#16 also showed the same anomalously high broadband y-axis accelerations in several (only a few were inspected) of the profiles from DYNOPO. Since it therefore appears that the sub-optimal hydrodynamic performance of VMP#16 is a characteristic of that instrument, all remaining profiles of this cruise were collected with VMP#107.

Data Quality

A total of 31 VMP profiles were collected, corresponding to the following CTD station numbers: 005, 006, 012, 013, 015, 017, 019, 020, 023, 024, 026, 028, 029, 030, 031, 033, 034, 036, 037, 038, 039, 041, 042, 043, 044, 047, 049, 053, 058, 059, 061. The following profile-specific notes apply:

- During profile 012 the T2 micro temperature sensor flatlined.
- During profile 017 the T2 micro temperature sensor failed.
- During profile 019 the shear-2 sensor showed high levels of noise.
- During profile 020 the shear-1 sensor was bad.
- During profile 023 the shear-1 sensor was bad.
- CTD profile 026 was carried out after recovery of the VMP.
- During profile 028 the shear-1 sensor was bad
- During profile 029 both shear sensors were bad.
- During profile 030 the shear-2 sensor had many spikes.
- During profile 033 both shear sensors had some spikes.
- CTD profile 034 was carried out after recovery of the VMP. The CTD failed during the bottom bottle stop.
- During profile 037 the shear-2 sensor showed some spikes near 800dbar.
- During profile 047 shear-1 was noisy.
- During profile 049 shear-1 developed a fairly subtle problem below 2700m. Many spectra were inspected to ensure that the problem was with shear-1.

The bad sensors were changed after the profiles where the problems were detected. With the single exception of profile 029, where no good shear data are available between 635 and 1040 m and below 1150 m, there are high-quality full-depth dissipation profiles available from all sampled stations. In profiles 020, 023, 028, 047, 049, 053, 058, 059 and 061, the shear-2 sensor provided better data; for all other profiles the shear-1 sensor performed either better or equally well as the shear-2 sensor. Except for profile 033, where the ε profile from the shear-1 sensor should be de-spiked before use, and profile 029 where the ε data from the shear-1 sensor in the bad depth ranges should be removed, the ε profiles form the better sensor from each profile should be usable without further editing.

As noted above, with the exception of 026 and 034, all VMP profiles were collected simultaneously with the corresponding CTD/LADCP profiles.

8. pCO_2 and Underway Surface Fluxes

Natalie Ensor

pCO_2

The pCO_2 system that resides in the Data Prep Lab aboard the JCR belongs to Plymouth Marine Laboratory, and will continually collect data as part of the ORCHESTRA project. The laboratory managers were asked to look after it by Ian Brown for the season until he joins the ship for JR18005. The system's flow valve failed last cruise so during the daily rounds the equilibrator and pre-equilibrator were checked and small adjustments made as required (to ensure the rates were as close as possible to 1.6 and 1.2 l/min respectively).

There were several days where the equilibrator system had to be cleaned due to krill having permeated through the filter and into the chambers. As this was becoming a daily issue, the Deck Engineer Oliver Vivian has changed the system to use a smaller filter, which he checked every day.

There also seems to be a blockage in the system, between the main sensor unit and the equilibrator section. Ian Brown was informed and he is scheduled to deal with the issue when he joins the ship at beginning of JR18005.

Fluxes

Natalie Ensor took responsibility for the daily checks on the flux equipment belonging to PML, which is located in the Mail Room on the JCR. Whilst completing daily lab rounds, Natalie would go to the mail room to ensure that all the sensors were acquiring new data and that the files were of the correct size due to the macros running correctly.

At the beginning of the cruise, Alex Brearley, Povl Abrahamsen and Natalie Ensor worked on troubleshooting the system as the data being acquired was not usable. However, these problems were eventually solved (with the help of Ming-Xi Yang and Tom Bell back at PML) and from then on, Natalie took over the daily checks.

The daily checks were taken from a document supplied by PML (Appendix C). There are a few details that are not mentioned in the document that may be of use in future:

- If the Dell computer needs restarting at any point, the user name and password are:
  - Username: Ship
  - Password: orchestrapml
- If the Dell computer is restarted, the LPMS macro does NOT need setting up, it should automatically start on the hour
- The macro for the Systron system is located here:-
  - C:\users\ship\mydocuments\ORCHESTRA\Tera_Term_macros
  - And called MotionPak-send-recieve2.ipf
- The macro has to be opened through the C:\ drive, it cannot be opened in the Igor Pro program
- Remote access is possible to the system from other areas of the ship via TeamViewer for the Picarro system and either TeamViewer or through the Remote Desktop Connection program (address pmpc1266, using the above username and password) for the Dell computer. Only the Dell computer was accessed remotely during JR18004.

Over the course of the cruise, there were a few issues, but these have all been sorted and communicated to Ming and Tom.

9. Mooring operations

Povl Abrahamsen and Peter Liljegren

A total of eight previously deployed moorings were recovered and redeployed on JR18004, for recovery in 2021. The triangulated positions of the moorings are given in Table 4; the times indicate the anchor drop for deployments, or release time for recoveries.

Mooring	Deployment	Recovery	Latitude	Longitude	Depth
M2 (1719)	24/03/17 19:37	13/01/19 10:58	62° 36.854' S	043° 14.475' W	3052
M3 (1719)	24/03/17 10:30	26/01/19 11:40	63° 31.963' S	041° 46.299' W	4573
M2 (19XX)	13/01/19 19:11		62° 36.798' S	043° 14.384' W	3052
M3 (19XX)	26/01/19 20:19		63° 31.945' S	041° 46.146' W	4560
OP1 (1719)	18/04/17 15:17	29/01/19 11:27	60° 38.048' S	042° 05.090' W	3693
OP2 (1719)	18/04/17 19:19	27/01/19 15:50	60° 38.746' S	042° 10.766' W	3058
OP3 (1719)	19/04/17 12:07	29/01/19 15:19	60° 39.428' S	042° 13.766' W	1737
OP4 (1719)	21/04/17 17:20	29/01/19 18:27	60° 35.398' S	041° 49.615' W	2949
OP5 (1719)	19/04/17 17:33	29/01/19 21:20	60° 36.721' S	041° 58.517' W	3387
OP6 (1719)	20/04/17 14:13	30/01/19 13:25	60° 33.806' S	041° 38.041' W	2310
OP1 (19XX)	10/02/19 14:03		60° 37.609' S	042° 05.465' W	3645
OP2 (19XX)	28/01/19 21:19		60° 38.503' S	042° 10.247' W	3102
OP3 (19XX)	10/02/19 16:51		60° 39.365' S	042° 13.772' W	1750
OP4 (19XX)	09/02/19 16:15		60° 35.418' S	041° 49.765' W	2952
OP5 (19XX)	09/02/19 17:56		60° 36.423' S	041° 58.625' W	3408
OP6 (19XX)	09/02/19 12:28		60° 33.851' S	041° 37.994' W	2312

Table 4: Summary of mooring operations on JR18004. Depths are given in metres.

A brief description of the mooring operations is given below, with details for each mooring as required. Mooring recoveries and deployments were done using the storage drum of the BAS mooring winch, without the traction winch. All the mooring deployments were performed buoy first (anchor last).

Operations

The first three moorings, M2, M3, and OP2, all used Edgetech/ORE 8242xs releases, and were released using the ship's Teledyne Benthos UDB-9400E deck unit, mounted in the waterfall rack in the UIC, using a hull-mounted transducer. For the remaining moorings, which used Ixsea/Ixblue AR861 releases, we had two deck units: Ixsea TT-801 s/n 27, from the NMF Sensors and Moorings group, and ORE 8011M s/n 31515, from LDEO.

Initially, we attempted to use the TT-801 deck unit. However, we did not receive any responses from the moorings. After trying the deck unit with the dunking transducer, it became apparent that the amplifier circuit was not working, and the unit was not transmitting correctly. Attempts were made to repair the deck unit, but it was not possible to get the unit working reliably.

The 8011M deck unit was initially running firmware 1.392, which had a known bug affecting its ability to transmit any Ixsea codes ending with a non-numerical last hexadecimal digit (e.g., 1A6F). This was a problem for almost all of the releases on the Orkney Passage moorings. Edgetech sent us a copy of firmware 1.402, which Sean Quirk was able to flash onto the firmware EEPROM using a PIC programmer and the MPLAB software. Once this firmware was installed, the deck unit correctly transmitted Ixsea codes, and this deck unit was used for the remaining moorings. As we did not have the correct adapter to connect the (old-style) transducer connector on this 8011M to the hull-mounted transducer, a dunking transducer was used. This was lowered to 24 m below the top of the ship's railing, amidships on the starboard side. This resulted in a transducer depth of approximately 19 m. We found that the deck unit struggled to pick up received signals from the releases when the thrusters were running. Thus, most of the ranges were taken with thrusters disengaged.

M2 and M3 moorings

The first mooring we visited was M2. This was recovered on the morning of 13 Jan, and redeployed the same afternoon, after the instruments had been serviced and preliminary data quality was checked. One of the glass spheres directly above the acoustic release was shattered; this most likely occurred either during recovery or deployment in 2017, as the glass was mostly intact, indicating that it was unlikely to have imploded at depth. One additional sphere had a possible crack forming; both of these were replaced with spare BAS Benthos spheres. On 14 Jan, we arrived at the M3 mooring site, which was approx. 70% ice-covered, but with large pools of open water. Before we had a chance to release the mooring, we were diverted on a Medevac to South Georgia, and all science was placed on hold. We returned to M3 on 26 Jan to find the site free of ice. The mooring was recovered, serviced, and redeployed without incident. Strangely, the blanking plug on Aquadopp 2317 was missing on recovery. Also, the cable guides were shaken off Microcats 14764, 4119, and 14763. This could indicate fairly severe strumming of the mooring wire. Cable guides were re-attached before the instruments were redeployed.

Orkney Passage moorings

In Orkney Passage, we first recovered OP2 on 27 Jan. After we realized that the deck units were not working correctly, we redeployed OP2 on 28 Jan, while trying to repair the TT-801 and reflash the 8011M firmware. After the 8011M was confirmed to be working, the remaining moorings were recovered on 29-30 Jan, and we then steamed off to Discovery Bank.

While we were at Discovery Bank, we serviced the Orkney Passage instruments and releases. All buoyancy was also checked and found to be in good condition. One 5-m Eddygrip rope was slightly frayed and was replaced; several of the end stops are showing wear on the end surface from the shackle and should be replaced in the future.

All of the Microcats were deployed onto the CTD rosette on CTD casts 17, 18, and 19. The OP2 Microcats were calibrated on CTD cast 8. On all of these casts, the rosette was held for at least five minutes at each bottle stop. The instruments were attached to spare OTE Niskin bottle frames using hose clamps (90-110 mm size on the sensor end, 77-95 mm on the instrument housing), and installed on the rosette in empty Niskin bottle slots. They logged data at an interval of 10 s; the resulting data will be calibrated against the final CTD data, once the temperatures and salinities in these files have been corrected against salinity samples and the SBE-35 standard thermometer.

Acoustic release 562 was found to contain a small amount of water in the bottom of the instrument housing. This did not reach the electronics, and the release worked as intended. Some corrosion was visible on the non-stainless components of the release, and this release has been sent back to Cambridge for servicing/refurbishment.

The wire clamp on SBE-39 4409 was replaced, as the screw threads had been stripped during deployment on JR16005. Microcat 8267 has been returned to Cambridge to be fitted with a pressure sensor; it is the only Microcat that does not currently have one.

Before the Aquadopps were redeployed, a brief functional check was carried out in the main lab. This included testing the heading, pitch, and roll measurements. The only instrument that did not pass this test was 5424, where the compass calibration was badly out, giving a restricted range of readings. This instrument was re-batteried with two lithium batteries instead of one, which may be partially responsible for the change of calibration. A compass recalibration was performed on board, and subsequently the instrument appeared to work well in the lab. A preliminary analysis of the recovered data file shows a larger range of compass headings and believable variability in the current direction; however, the median current direction is offset about 30 degrees from the expected direction. While currents at this location are not entirely barotropic, this still does look suspect, and warrants further investigation.

The Orkney Passage moorings were successfully redeployed on 9-10 Feb. Mooring OP6 was triangulated after deployment; the remaining moorings were triangulated together on the evening of 10 Feb. The survey is shown in the figure below (with the ship's track in red). This was an efficient way to range all the moorings. If repeated in the future, it might be useful also to include ranging stops near the drop positions of OP4 and OP5.

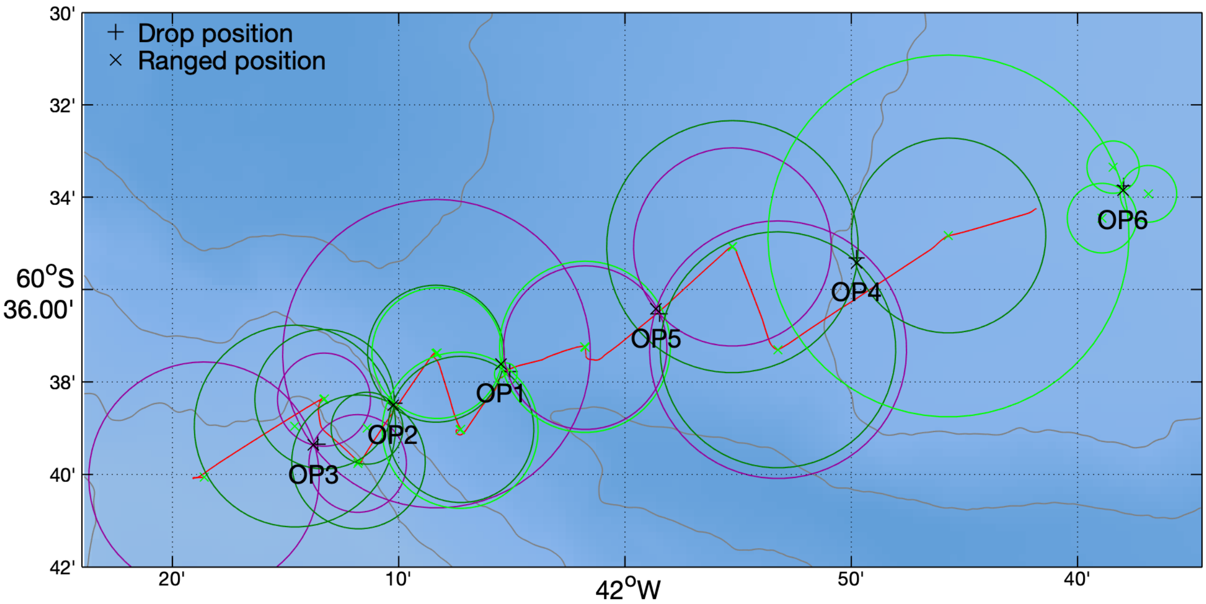


Figure 25: Map of mooring drop and ranging positions.

Hardware

The Orkney Passage and M2/M3 moorings all use 3/16" (5 mm) 3x19 plastic-jacketed galvanized wire, supplied by Mooring Systems Inc. (MSI), with an outer diameter of 6.5 mm, and swaged sockets to fit 1/2" shackles. Buoyancy on M2 and M3 consists of Benthos 17-inch glass spheres, shackled onto 3/8" galvanized chain using 5/16" screwpin shackles. Buoyancy on the OP moorings consists of Benthos and Vitrovex 17-inch glass spheres attached to Kevlar ropes using the Vitrovex's Eddygrip swivel system.

1/2" safety bolt shackles were used on the wire and Eddygrip ropes. Most of these were Van Beest Green Pin shackles; however, the eyes on some of the Eddygrip ropes are too small for these shackles, and Crosby shackles were used instead, where required. 5/8" shackles were used on the acoustic releases and anchors, with 3/4" shackles used on the tandem release rings for the Ixsea tandem releases. The (stainless) top link of the Ixsea tandem kits was wrapped in Scotch 33+ vinyl tape for insulation. For single releases, a Crosby S-643 7/8" x 5½" weldless ring was used as the release link, again, wrapped in Scotch 33+ tape for insulation. For the tandem kits, a 2-m length of 12mm long link chain was attached to Ixsea super duplex release links using 7/16" alloy screw pin shackles. This chain was led through a

Crosby S-643 1-1/8" x 6" weldless ring. The chain used on the moorings was 12mm grade 30 galvanised long link chain.

All of the instrumentation deployed on the OP and M moorings was clamped onto the mooring wire. Table 5 gives an overview of the instrument types deployed, and the tools required to remove them from the mooring wire.

Model	Parameters	Tools required	Connector	Serial nos.
SBE-39	T & P	3/8" socket	internal	All M2/M3 except 0229 (M2)
SBE-39	T only	3/8" socket	internal	0083 (OP2) and 0229 (M2)
SBE-39	T & P	3/16" Allen key	internal	1239 (OP3)
SBE-39	T only	3/16" Allen key	4-pin / internal	Remaining OP instruments
SBE-37SM	T, C, P	3/8" socket	3-pin	2956 (OP4) and 2707 (OP6)
SBE-37SM	T, C, P	3/8" socket	4-pin	Remaining instruments
Aquadopp DW (6000 m)	U, V, W, T, P	9/16" socket & spanner	Round	9380 (M2)
Aquadopp DW (6000 m)	U, V, W, T, P	9/16" socket & spanner	Square	All remaining instruments on M2/M3
Aquadopp DW (6000 m)	U, V, W, T, P	17 mm socket & spanner	Round	Instruments on OP1, OP2, and OP4
Aquadopp DW (6000 m)	U, V, W, T, P	13 mm socket & spanner	Square	5424 (OP3)
Aquadopp DW (6000 m)	U, V, W, T, P	13 mm socket & spanner	Round	8556 (OP3) and all instruments on OP5 and OP6

Table 5: List of instrument types used in mooring operations and tools/connector details.

The times in the tables below are relative to GPS time. On both the deployment and recovery cruises, clocks were synchronized with server “jrlb.jcr.nerc-bas.ac.uk”, which is accessible on the JCR’s public network. In turn, this machine is synchronized with the ship’s Galleon NTP-4000 GPS time server, which is on the data network only.

Full details of mooring recoveries and deployments are given in Appendix D, with mooring diagrams given in Appendix E.

10. Glider operations

Ryan Scott and Alexander Brearley

Introduction

This season's ORCHESTRA glider operations involved deploying three Teledyne Webb Research (TWR) Slocum gliders at Discovery Bank. Each of the gliders had different sensor configurations, found in Table 6.

Serial number / operator	Installed sensors	Sample.ma file / Initial state_to_sample	Deployment location (degrees and decimal mins)	Deployment data and time (UTC)
400 (NMF)	CTD EcoPuck Dissolved oxygen optode	Sample10.ma, 7 Sample30.ma, 15 Sample20.ma, 7	61° 41.996' S 37° 29.986' W	01/02/19 – 11:10
631 (BAS)	CTD EcoPuck Dissolved oxygen optode PAR	Sample10.ma, 7 Sample30.ma, 15 Sample20.ma, 7 Sample60.ma, 15	60° 6.967' S 37° 2.160' W	02/02/19 – 11:13
352 (NMF)	CTD MicroRider	Sample10.ma, 7 Sample40.ma, 7	61° 00.006' S 38° 36.005' W 60° 39.548' S 37° 47.115' W	31/01/19 – 16:55; 07/02/19 – 11:52
330 (NMF)	CTD EcoPuck	Sample10.ma, 7 Sample30.ma, 15	N/A	N/A

Table 6: Instrument setup/deployment details.

Pre-deployment

Setup (all gliders):

Before deployment, functional checks were conducted for each of the gliders (Functional checkout sheets are found in the Appendix F). This included:

1. Testing communications on both Freewave and Iridium. We initially encountered difficulties connecting to Unit 400, but this was quickly resolved by changing the serial number in the Freewave box.
2. Downloading the proglets.dat file to check the installed proglets on each glider.
3. Using the wiggle on command to check the battery, rudder and pump work properly.
4. Checking the voltage of the recovery nose release and the drop weight burn wire.
5. Checking the GPS and Argos are working.
6. Updating each gliders' sample files. Initial state_to_samples are found in Table 6. State_to_sample 7 means sample whilst diving, climbing, hovering. State_to_sample 15 means sample everywhere.
7. Updating each glider's SBD and TBD lists. These define the flight and science parameters that the glider sends to the Cambridge dockserver.

8. Creating a new mission file disco.mi with overtime to 1 hour for 1st dive. Two surfacing behaviours are used Surface01.ma – glider surfaces if it gets no comms after a given time; Surface03.ma – glider surfaces after a yo is complete.
9. Updated the goto_l10.ma and yo15.ma, which define the waypoints and how deep the glider goes. First dives were set to 50 m.
10. A simulation dive was completed on Unit 631, testing the mi and ma files. The simulation completed normally.

Setup (MicroRider only):

Whilst stationary at Mere Harbour, Falkland Islands, the health of MicroRider SN228 was tested prior to deployment by running a bench test with the dummy probes using following command:

odas5ir –f setup.cfg –N

Data were collected for 200 seconds and the quick_bench function from the Rockland Scientific Inc. (RSI) ODAS Toolbox was used to generate test spectra (Figure 26). The shear spectra did not look great, with a large number of spikes found above 30 Hz. RSI agreed and suggested that the spikes could be due to noise created by the MicroRider's persistor clock.

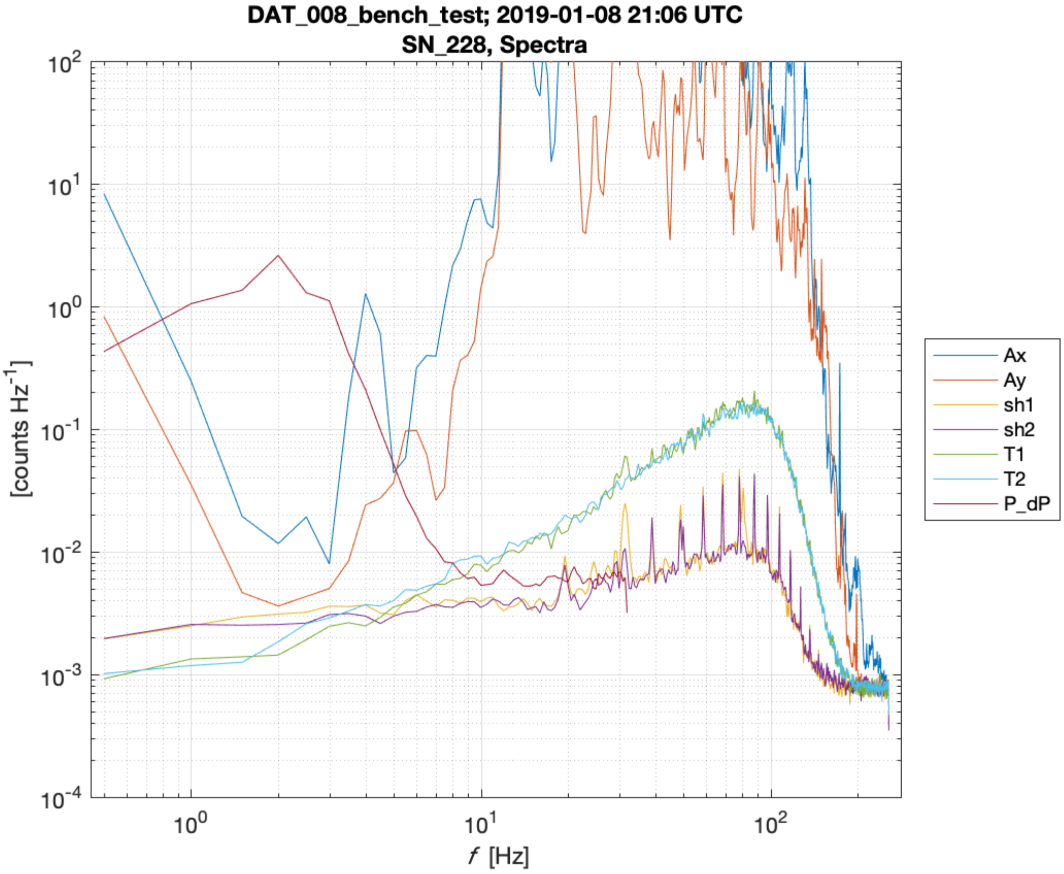


Figure 26: Frequency spectra produced from a bench test at Mare Harbour, pre-software update. Spikes are seen in the shear spectra.

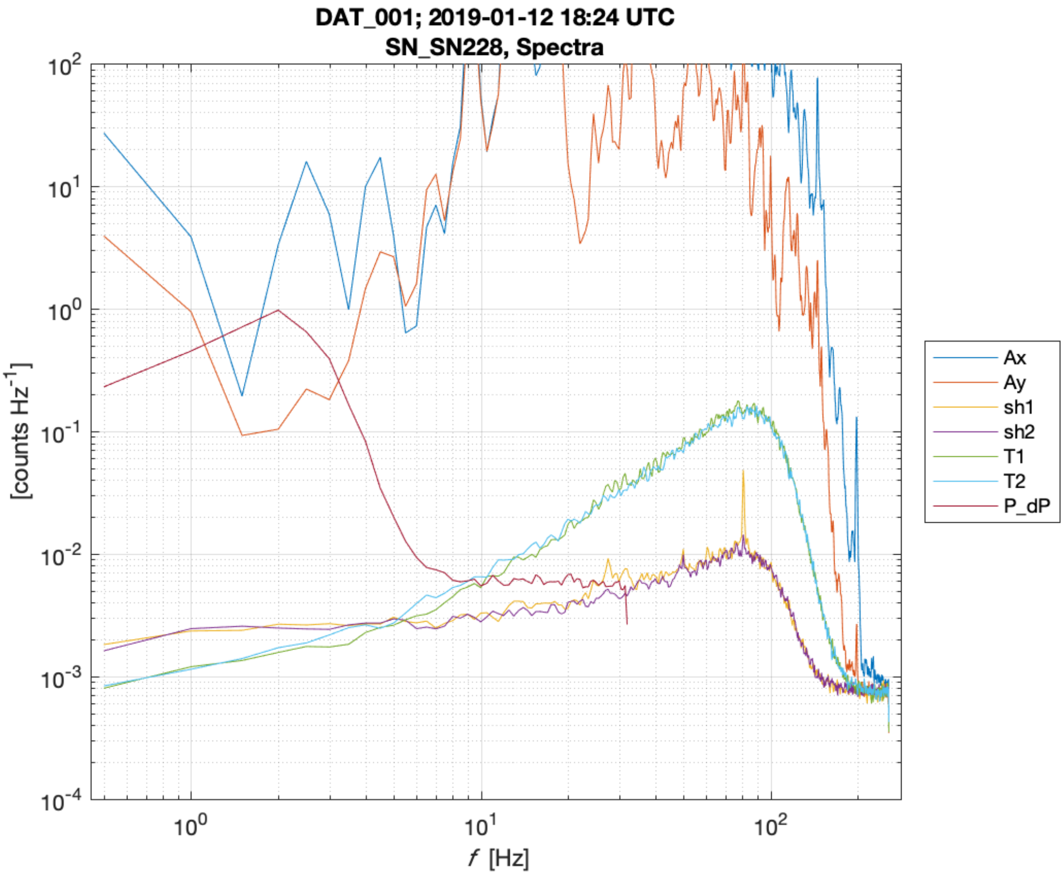


Figure 27: Frequency spectra produced from a bench test at Mare Harbour, post-software update. Very few spikes are seen in the shear spectra.

Rockland suggested that upgrading the software should produce improved results; they were correct (Figure 27). The MicroRider is now running ODAS v4.0.

The MicroRider's setup.cfg file, which contains parameters used in post-deployment processing, was edited before deployment. Cruise information and the serial numbers for the two chosen thermistor and shear probes were included. Both shear probes were cold water calibrated and the calibration coefficients were also entered into the setup.cfg file. The serial numbers are found in Table 7. Additionally, the accelerometer channels were changed to type=piezo, corresponding to the SN228's new type of accelerometer.

Glider SN	**MicroRider SN**	**Sh1**	**Sh2**	**T1**	**T2**
352	228	M1642	M1645	T611	T1429

Table 7: Microstructure probe serial numbers.

Unit 330 undeployable:

Unit 330 was meant to be shipped with a dissolved oxygen optode, but unfortunately this had to be moved as a separate consignment, which subsequently got delayed during shipment through Chile and did not arrive at the ship in time for departure.

Consequently, 1 bolt and 3 nuts weighing ~110g were glued and cable tied to the ejection weight tubing, ensuring that the ballasting of the glider was still correct. Additionally, the nose recovery system had to be replaced because a faulty burn wire meant that the nose fell off on the bench. Furthermore, during Unit 330's functional checkout it became apparent that the altimeter wasn't working correctly – the usual clicking could not be heard at all, even with a stethoscope. When trying to replace the altimeter with Unit 352's working one, the plug was stuck fast, despite being fully unscrewed. With a bit of force, the altimeter became free, but the rubber in the socket on the bulkhead had clearly been fused with that of the altimeter cable, and the end of the cable had broken off (Figure 28). This meant that no watertight seal would be made, rendering Unit 330 undeployable.

Figure 28: Rubber from the altimeter cable fused with rubber in the bulkhead socket (left). Right: A comparison between the end of the broken altimeter's cable (left; Unit 330's), and a working altimeter (right; Unit 352's).

Deployments (in order)

Unit 352 (31/01/19):

Unit 352 was the first glider to be deployed. Last minute preparations involved installing the MicroRider probes listed in Table 7. The two shear probes were oriented orthogonally, with Sh1's plate being parallel with the glider's wings (horizontal; Figure 29). Once the glider was out on deck, the wings were screwed on and the green (on) plug was taped. Initially, there was trouble talking to the glider on Iridium, but this was solved by remotely restarting the dockserver in Cambridge. A MicroRider calibration test with the probes installed was then run on deck, producing good results (relatively low thermistor and shear channel standard deviations; Figure 30, Ch 4 and 6, and Ch 8 and 9 respectively).

During all deployments, status.mi is the first mission to run, checking that all the sensors are being read. The glider was then set to dive to 50 m, but unfortunately the glider was unable to complete its first yo, aborting on the upcast with an error relating to m_pitch. Attempts were made at completing 3 50 m dives and 1 150 m dive, all with the same result (Figure 31). The glider pumped oil out to full capacity and moved its battery fully back, resulting in pitch angles up to ~50°. This caused the glider to travel faster, resulting in lower temporal resolution. Then the glider stopped reporting its GPS position for a short time, so the decision was made to recover the glider.

Figure 25: Orientation of the microstructure probes.

```
ch:   0  min:     +2  max:     +4  mean:     +3.0  stdev:    0.26
ch:   1  min:   -556  max:   +464  mean:    -28.3  stdev:  192.14
ch:   2  min:    -98  max:    +99  mean:     +2.5  stdev:   32.40
ch:   4  min: -11204  max: -11176  mean: -11193.8  stdev:    7.83
ch:   5  min: -11923  max: -10934  mean: -11197.8  stdev:  161.97
ch:   6  min:  -8117  max:  -8089  mean:  -8105.0  stdev:    7.67
ch:   7  min:  -8279  max:  -7897  mean:  -8099.3  stdev:   71.07
ch:   8  min:   -609  max:   +411  mean:     +8.3  stdev:  103.93
ch:   9  min:   -130  max:   +106  mean:     +2.5  stdev:   23.76
ch:  10  min:   +101  max:   +102  mean:   +101.6  stdev:    0.50
ch:  11  min:   +105  max:   +109  mean:   +107.0  stdev:    1.06
ch:  12  min:  -1900  max:  -1898  mean:  -1899.0  stdev:    0.25
ch:  32  min: +19058  max: +19079  mean: +19068.8  stdev:    3.84
ch:  40  min: -16491  max: -16422  mean: -16456.1  stdev:   19.85
ch:  41  min: -32763  max: -32713  mean: -32737.2  stdev:   15.05
ch:  42  min: -31446  max: -31446  mean: -31446.0  stdev:    0.00
ch: 255  min: +32752  max: +32752  mean: +32752.0  stdev:    0.00
```

Figure 30: Output from the MicroRider calibration test, conducted on deck with probes.

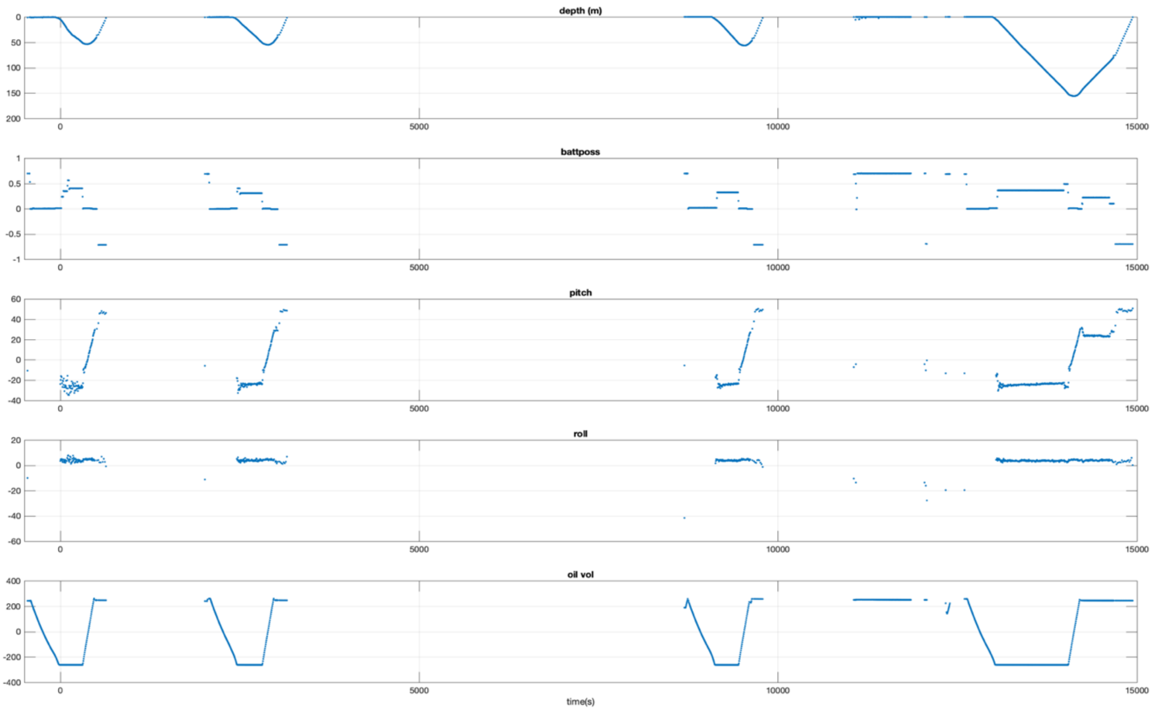


Figure 31: Unit 352 test dive flight parameters. Lower temporal resolution is seen after each abort on the upcasts.

Unit 400 (01/02/19):

Unit 400 completed its first test dive to 50 m with all science sensors recording successfully (Figure 32). The glider's yo15.ma file was altered and the glider was put on a 1000 m dive. After successfully completing the 1000 m yo the glider appeared well ballasted and was flying well (Figure 33) so the glider was put onto double yos. This involved setting num_half_cycles_to_do=4 in the yo15.ma file, as well as changing the overtime to 86400 s (1 day) in the disco.mi file and the no_comms surfacing behaviour in the surfac01.ma file to 86400 s (1 day).

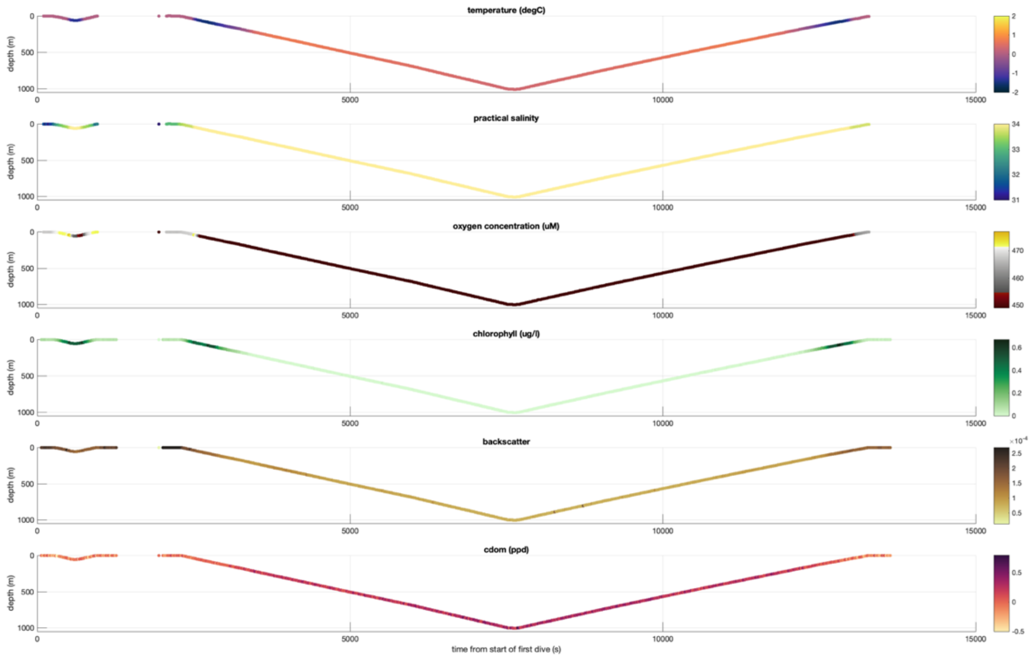


Figure 32: Unit 400 science parameters.

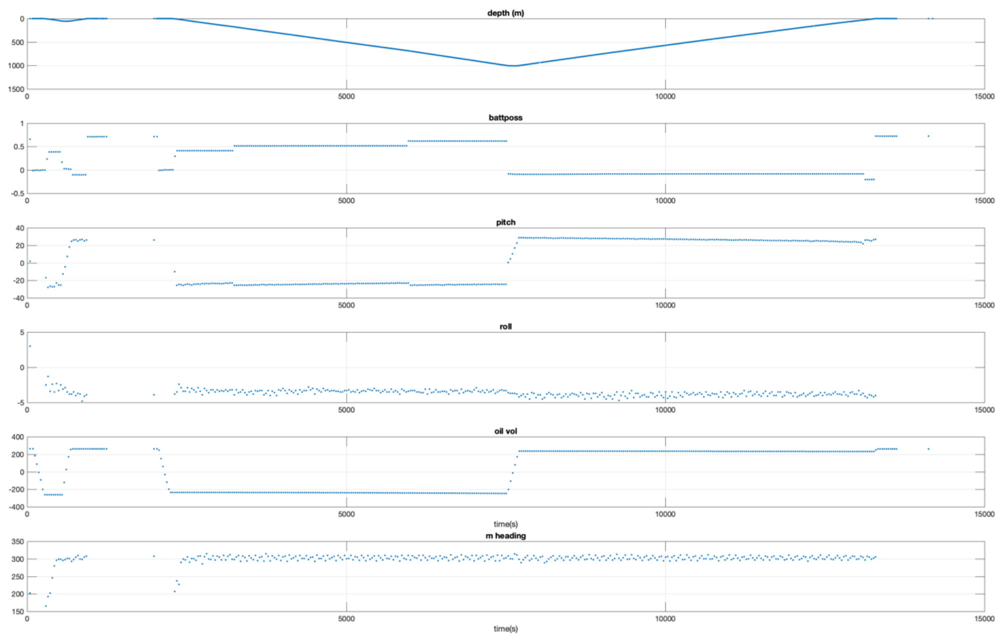


Figure 33: Unit 400 two test dive flight parameters, showing the instrument was well-ballasted.

Unit 631 (02/02/19):

Upon deployment, Unit 631 aborted when running disco.mi. This was easily rectified – the glider had the incorrect sample file. It was looking for sample60.ma but it only had sample40.ma, so sample40.ma was downloaded from the glider and the filename changed to sample60.ma. The glider then completed a test dive to 50 m successfully, and was subsequently put on a single 1000 m yo. The glider was flying well and its science sensors were comparable to the CTD readings, so it was put on double 1000 m yos.

Post-deployment

Unit 400

Unfortunately, despite flying well and displaying no sign of any leaks or errors, communications with Unit 400 were lost after its first 1000 m dive. Its last known location was 61° 40.724' S, 37° 33.865' W at 15:07:28 (UTC) on Friday 1st February 2019. A double yo should take approximately 12 hours, and the overtime and no_comms surfacing behaviours should have caused the glider to abort a day after its last surfacing. Typically, leaks are reported by the glider and gradually affect its flight, so the two most likely explanations are that the glider experienced a catastrophic flooding event, or that it surfaced but became trapped under an iceberg.

Unit 352

Once Unit 352 had been recovered and taken into the lab, testing was carried out to try and recreate the error the glider was getting in the water. The error was related to m_pitch, so we tested the glider's attitude sensor by reporting m_pitch, m_roll and m_heading to the screen whilst the glider was incrementally positioned to steep pitch angles of up to 50°. This was recorded in log file 07880000.mlg and although loadmission sci_on.mi was run, we were not able to recreate the error.

The next step was to open up the glider, allowing Sean Quirk, the AME technician, to take a look at the attitude sensor. Sean downloaded the software to self-test the attitude sensor but could not find any information on maximum permissible voltage and may have inadvertently blown the diode. He then replaced the diode and found a fuse that was blown, so replaced that with a length of wire and managed to get the compass talking with sensible values on the True North software on the computer. We then plugged it back into the glider, but the pump started stalling and other sensors were going out of service. After exit resetting and taking the attitude sensor out of service straight away, other sensors did not go out of service, suggesting that it was the attitude sensor somehow causing this.

With Unit 330 undeployable but seemingly having a working attitude sensor, the decision was made to install Unit 330's attitude sensor in Unit 352. This required updating Unit 352's firmware to v8.2, because the new release contains in-situ compass calibration functionality, and the sensor would need to be calibrated. The TWR instructions for upgrading the software were closely followed and can be found here: https://datahost.webbresearch.com/viewtopic.php?f=5&t=263. Upgrading the glider to v8.2 would also enable the remote transfer of snippets of microstructure data, so the instructions in RSI TN044 were followed to take advantage of this new functionality. This involved altering the glider's proglet.dat and autoexec.bat files, creating a Sample73.ma for the MicroRider, and changing the TBD list so that 60 second averaged snippets of MicroRider data were sent (using a state_to_sample of 7).

After setup was completed, two simulation dives to 150 m were conducted. The first produced a slightly strange change in pitch on the way up (at 28 m), but it did not abort or show any of the same error messages we were getting in the water. The second simulation (log file unit_352-2019-035-4-1.mlg) threw an error related to the MicroRider proglet, which was possibly connected to the number of errors the glider is allowed to accumulate. After discussions with Steve Woodward (NMF) and Ben Allsup (TWR) this error was deemed unproblematic.

Recovering Unit 352 provided the opportunity to download the full microstructure dataset and inspect the performance of the microstructure probes. All probes seemed to be functioning, however shear 2 was noisier (Figure 34) more contaminated by a 2-3 Hz peak in the accelerometer spectra than shear 1 (Figure 35). Consequently, the shear 2 probe was changed to serial number: M1535. Following a second functional checkout, the MicroRider was bench and calibration tested, producing similar spectra to those previously observed (e.g. Figure 26), albeit with slightly more roll due to being on a moving ship.

On 7th February, the probes were fitted in the same orientation as previously (Figure 29) and Unit 352 was re-deployed. Once in the water, status.mi was run successfully, so the in-situ

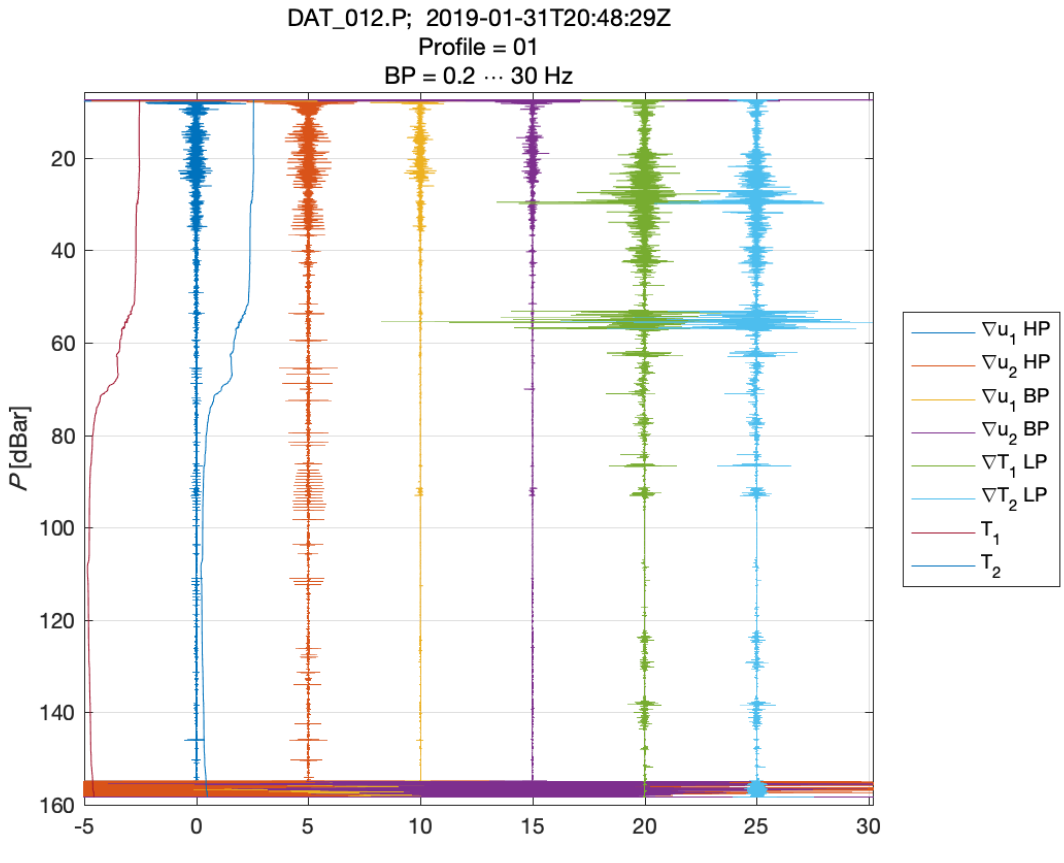


Figure 34: Unit 352 shear and temperature gradients from its 150 m test downcast. Shear 2 is nosier.

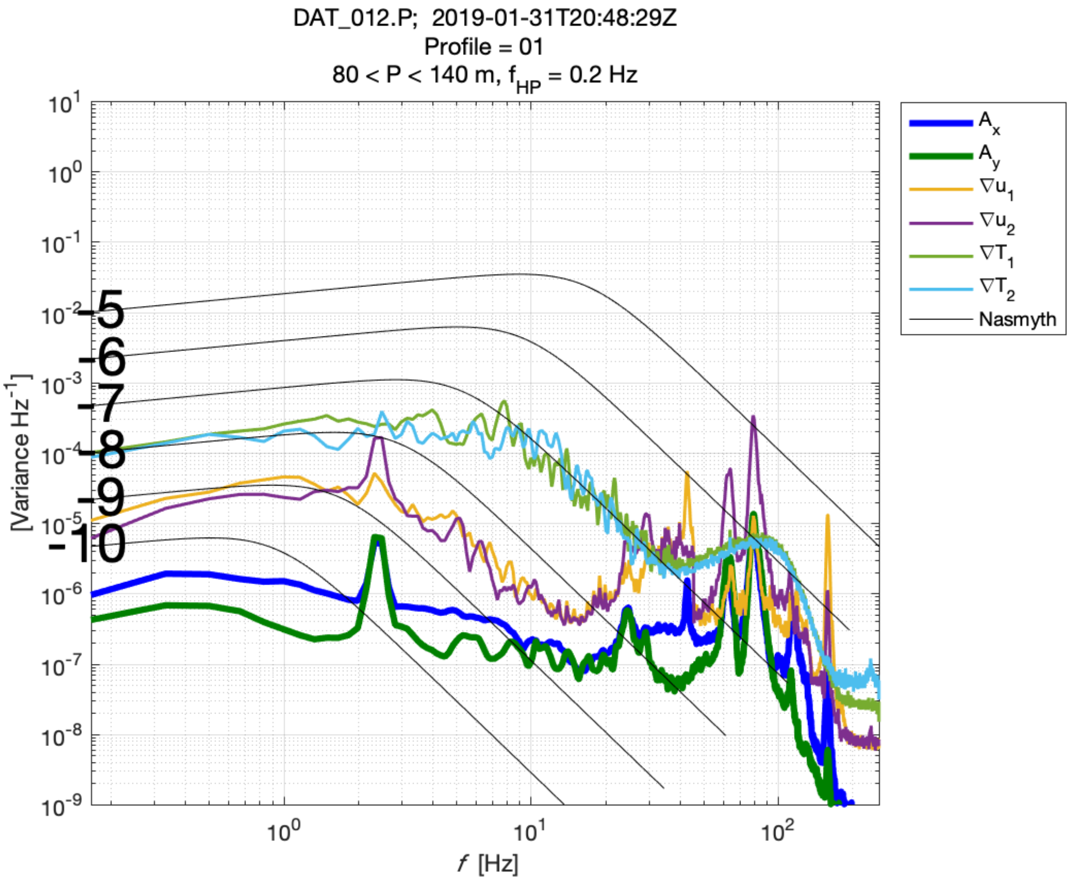


Figure 35: Unit 352 mean frequency spectra between 80-140 m. Shear 2 is contaminated by a 2-3 Hz peak in the accelerometer data.

compass calibration mission attcal.mi could be initiated. This involves the glider making a series of ~40 m dives (Figure 35), rotating in circles with varying of pitch angles. The glider recorded the 08010000.cal calibration file, which was then entered in the True North Glider Cal Program to generate a set of offsets. These offsets were then given to the glider by typing the following command:

compass_cal set_offsets XXX YYY ZZZ.

Old compass offsets could be printed to the screen using:

compass_cal get_offsets.

Old and new offsets are shown in Table 8. The new value of Mag Total 3 sigma should be lower than the original, which in this case is true.

	Original compass offsets	**New compass offsets**
X	-1620	-1209
Y	1580	1737
Z	2919	1318
Mag Total 3σ (%)	18.15	3.84

Table 8: Unit 352 old and new compass calibration offsets.

After the compass calibration, Unit 352 successfully completed a 150 m yo and was flying well (Figure 36), sending back science files (Figure 37). As a last check before setting the glider on 1000 m yos, an in-situ MicroRider calibration test was completed, producing no alarming standard deviations (Figure 38).

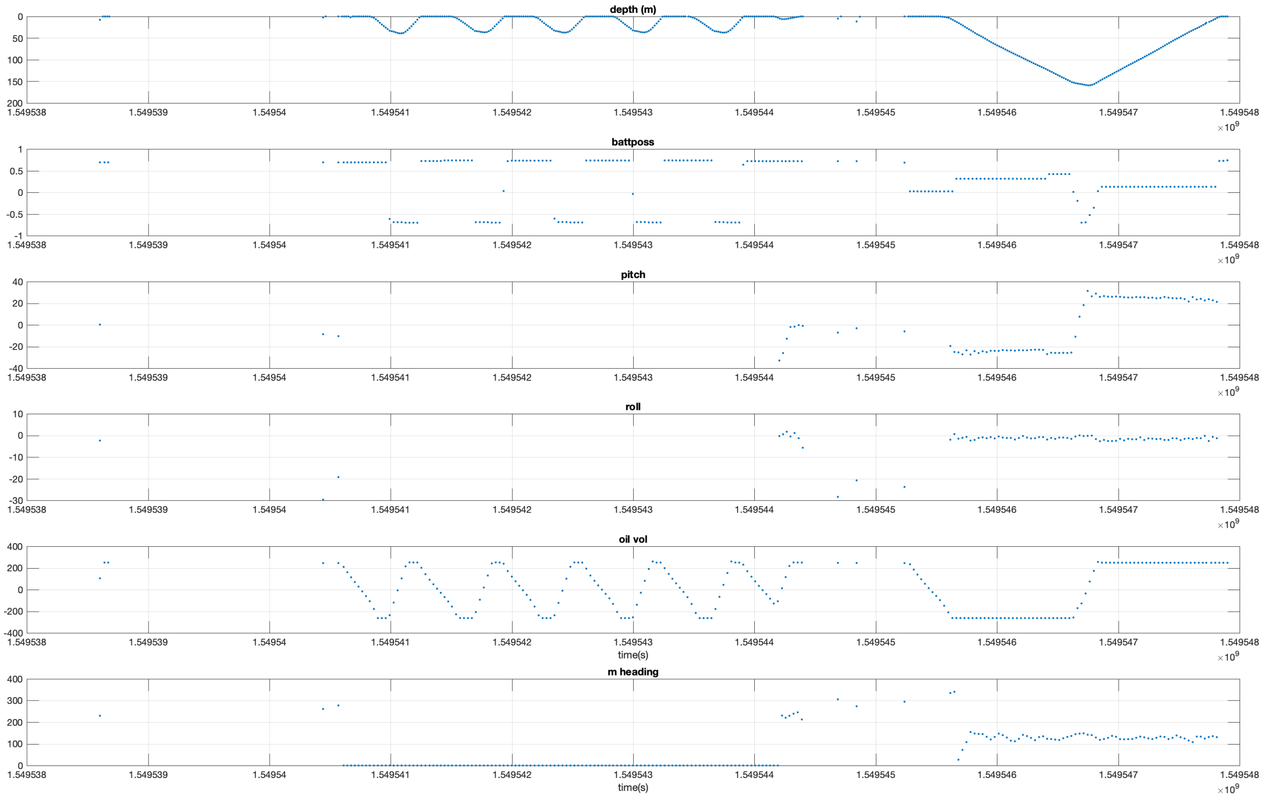


Figure 36: Unit 352 flight parameters during compass calibration and the subsequent 150 m yo.

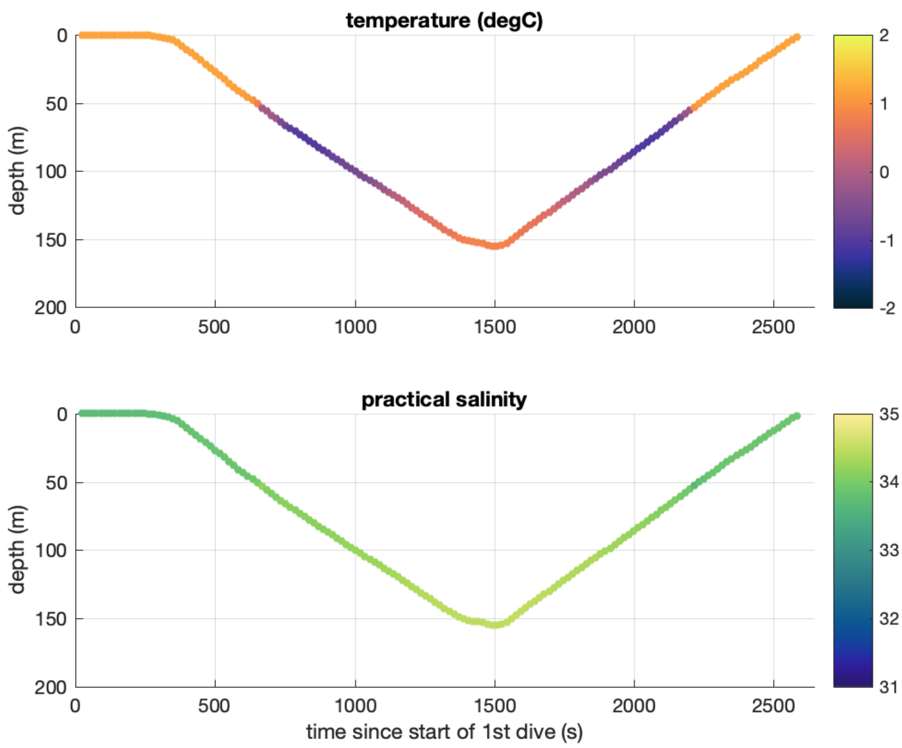


Figure 37: Unit 352 science parameters during 150 m yo after compass calibration.

```
ch:   0  min:     +2  max:     +4  mean:     +3.0  stdev:    0.24
ch:   1  min:  -2439  max:  +3216  mean:    -60.3  stdev:  557.36
ch:   2  min:   -293  max:   +314  mean:    -86.1  stdev:  112.63
ch:   4  min: -11464  max: -11385  mean: -11443.8  stdev:   28.58
ch:   5  min: -11555  max: -11390  mean: -11459.6  stdev:   28.16
ch:   6  min:  -8346  max:  -8332  mean:  -8339.9  stdev:    3.90
ch:   7  min:  -8409  max:  -8285  mean:  -8332.2  stdev:   28.04
ch:   8  min:  -3924  max:  +4778  mean:     -0.5  stdev: 1183.42
ch:   9  min:  -2810  max:  +2180  mean:    -49.8  stdev:  608.17
ch:  10  min:   +102  max:   +104  mean:   +102.6  stdev:    0.50
ch:  11  min:    +84  max:   +145  mean:   +110.2  stdev:   17.52
ch:  12  min:  -2006  max:  -2003  mean:  -2005.0  stdev:    0.24
ch:  32  min: +19061  max: +19082  mean: +19071.4  stdev:    3.94
ch:  40  min: -32532  max: -32349  mean: -32461.9  stdev:   62.15
ch:  41  min: -31655  max: -31429  mean: -31499.1  stdev:   53.59
ch:  42  min: -31439  max: -31439  mean: -31439.0  stdev:    0.00
ch: 255  min: +32752  max: +32752  mean: +32752.0  stdev:    0.00
```

Figure 38: Unit 352 in-water MicroRider calibration test.

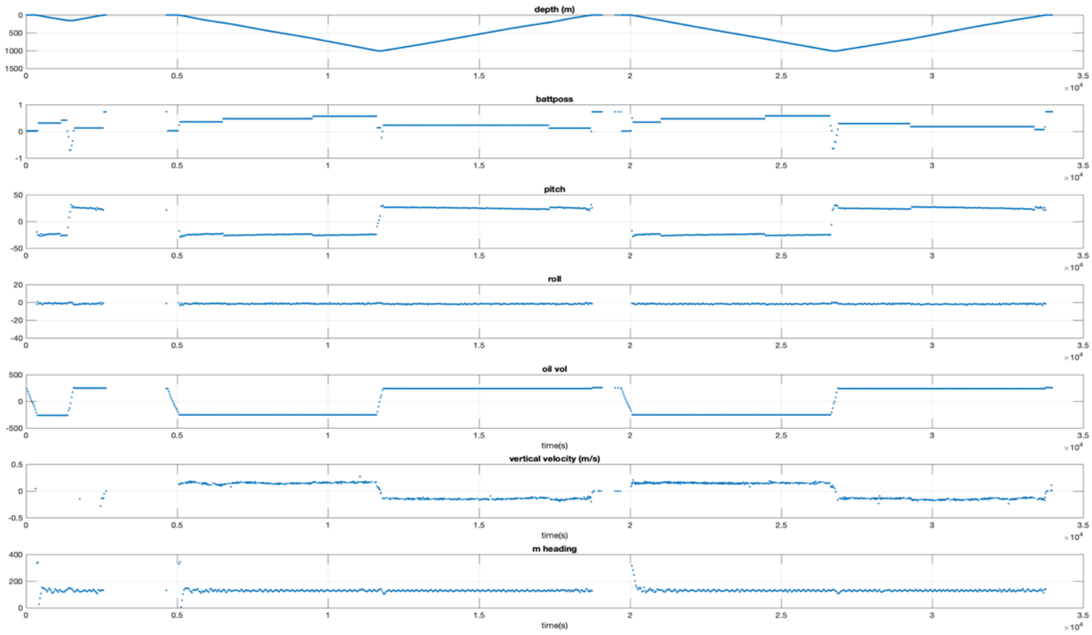


Figure 39: Unit 352 completed two 1000 m dives successfully and was well ballasted.

Subsequently, Unit 352 continued to fly nicely (Figure 39), completing two single 1000 m yos without any reported errors. The only problem was that, after both 1000 m yos, the glider failed to send any TBD science files, despite sending SBD glider files. Files can sometimes fail to send due to an Iridium comms drop-out, however it is very strange for this to repeat for two dives (and in any case, the script we were using was scheduled to send the TBD files before the SBD files).

Initially, it was thought that it could be an incompatibility issue between the script that tells the glider to send files at each surfacing (which uses the surface dialog), and the new glider firmware. After changing the surface dialog back to the old format, the files were still not sending, so an attempt was made to access the glider's science computer via consci to see if any science files were being created. This resulted in a “Failed to open data/log file error (Figure 40), and the glider science computer froze. This problem persisted, despite multiple attempts to access the science computer by restarting the glider and the Cambridge dockserver. Since it was uncertain that any science files were being created, the decision was made again to recover the glider. It is still uncertain what caused the glider’s science computer to apparently freeze, but suspicion does fall on the Mcirorider proglet.

```
        F_IRIDIUM_LEAD_ZEROS_FACTORY
        F_IRIDIUM_PHONE_NUM_FACTORY
   Iridium login script (from c:\config\loginexp.2):   empty or non-existent
SCI ERROR: timed out waiting for science to start loggingpre_mission_init(): Failed to open data/log
files
timestamp: Thu Feb  7 23:26:02 2019
Mission completed ABNORMALLY, ret = -1
Mission end: grun_mission() DISC02.MI unit_352-2019-037-7-0 (0806.0000)

SEQUENCE: DISC02.MI unit_352-2019-037-7-0 (0806.0000) aborted on try 0
SEQUENCE: Forcing use of critical devices
          Returning to GliderDos to let iridium report in.
          Setting U_MAX_TIME_IN_GLIDERDOS(s) to 900

SEQUENCE: suspended
GliderDos A -3 >consci
communications NOT ready for consci.
... because: m_science_clothesline_lag not updated since last cycle
consci
```

Figure 40: Error message that occurred while attempting to access Unit 352's science persistor.

Upon recovery, memory cards were pulled from the glider and files were transferred off the MicroRider, revealing that science files and MicroRider files were in fact being recorded. Despite this, it was not feasible to redeploy the glider on JR18004, because the source of the error was still undetermined.

Unit 631

Unit 631 aborted during its first double 1000 m yo due to an overtime value that was set too small – overtime in the disco.mi file was updated to 86400 s, however, the mission wasn’t stopped and then reran, so the new overtime wasn’t taken by the glider. This was a reminder that previous deployments had actually had overtime set to -1, so this change was made.

Unit 631 made good progress during the cruise, completing a northwest-southeast transect across Discovery Bank (Figure 41) before heading back north on a repeated transect. The change in direction is reflected by a change in heading from ~150° to ~320° (Figure 42), and the glider made several dives as shallow as ~30 m as it passed over the ridge. Since converging on an appropriate autoballast solution, the amount of oil pumped was progressively reduced in the yo15.a file, by the end of the cruise the glider was pumping ~140 cc on the upcasts and ~-120 cc on the downcasts. This reduces battery consumption, conserving energy.

The glider has successfully been transferring CTD data throughout its deployment. A Temperature-Salinity (T-S) plot created from the CTD data (Figure 43) reveals 3 water masses. A consistent layer of cold (~-1.2°C) Winter Water (WW) is observed at depths of ~100 m. Fresh (< 34) Antarctic Surface Water (AASW) spans a wide range of temperatures, with a maximum of ~1.2°C. Warm (~0.3-1°C) water with high salinity (>~34.6) is Circumpolar Deep Water (CDW), and is found at depths of 200-1000 m.

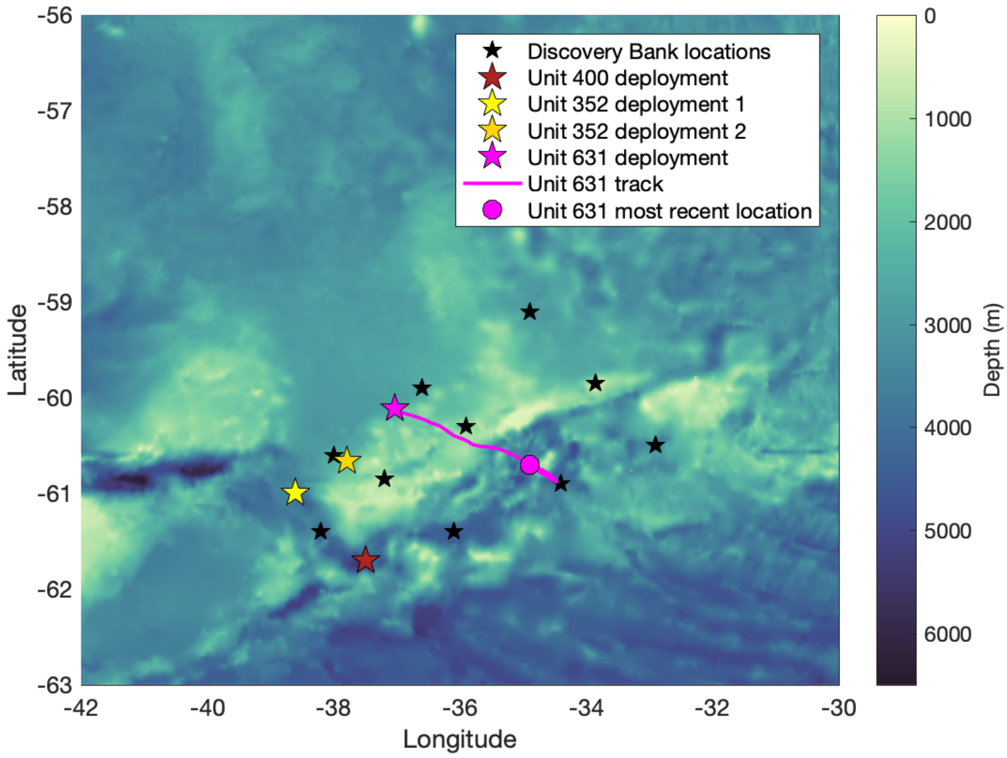


Figure 41: Map of Discovery Bank, showing locations of each glider deployment and the track of Unit 631.

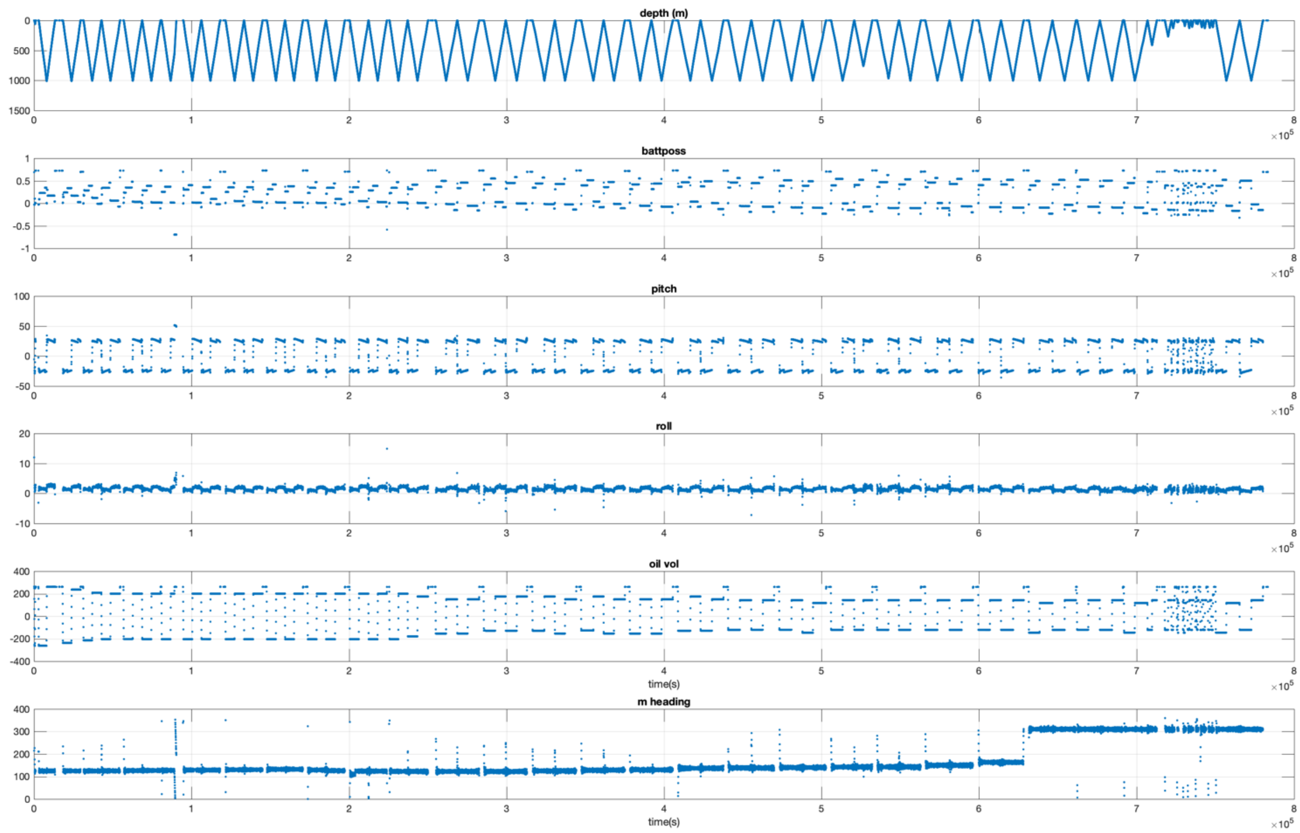


Figure 42: Unit 631's flight parameters. The glider has reduced the amount of oil pumped, conserving energy.

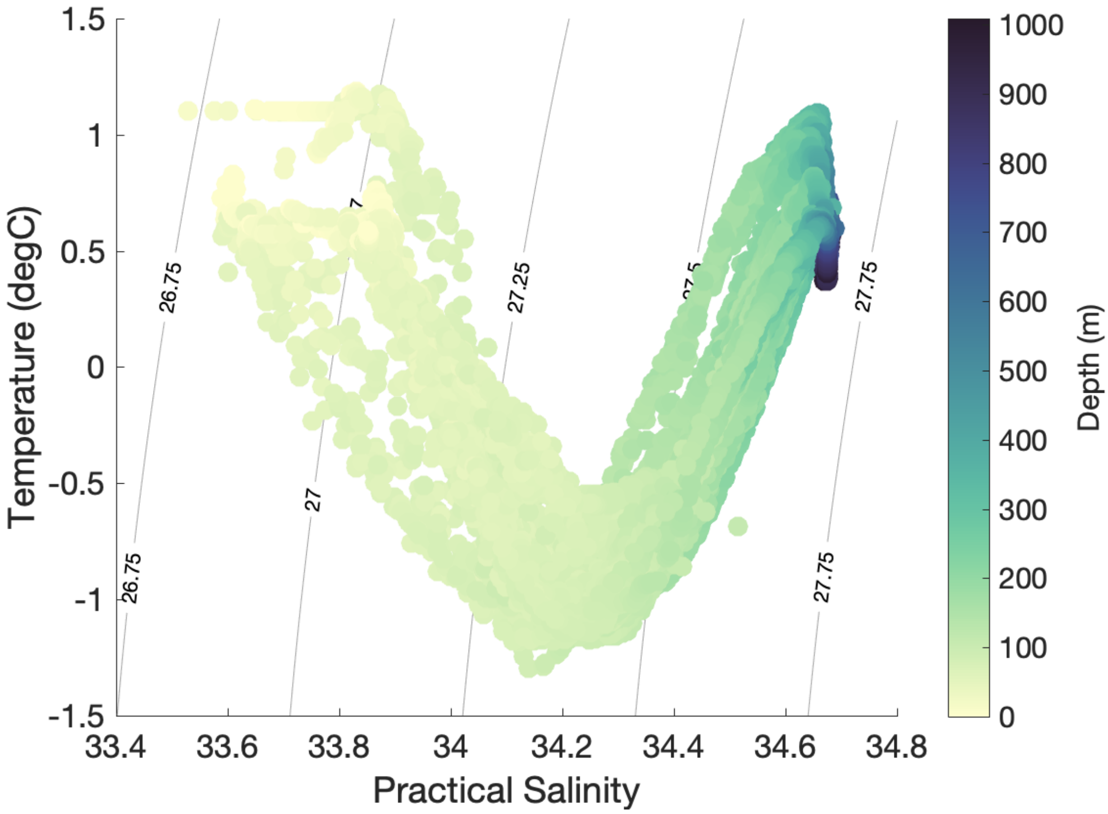


Figure 43: Temperature-Salinity plot created using Unit 631's CTD data. The axes have been chosen to show the majority of the data.

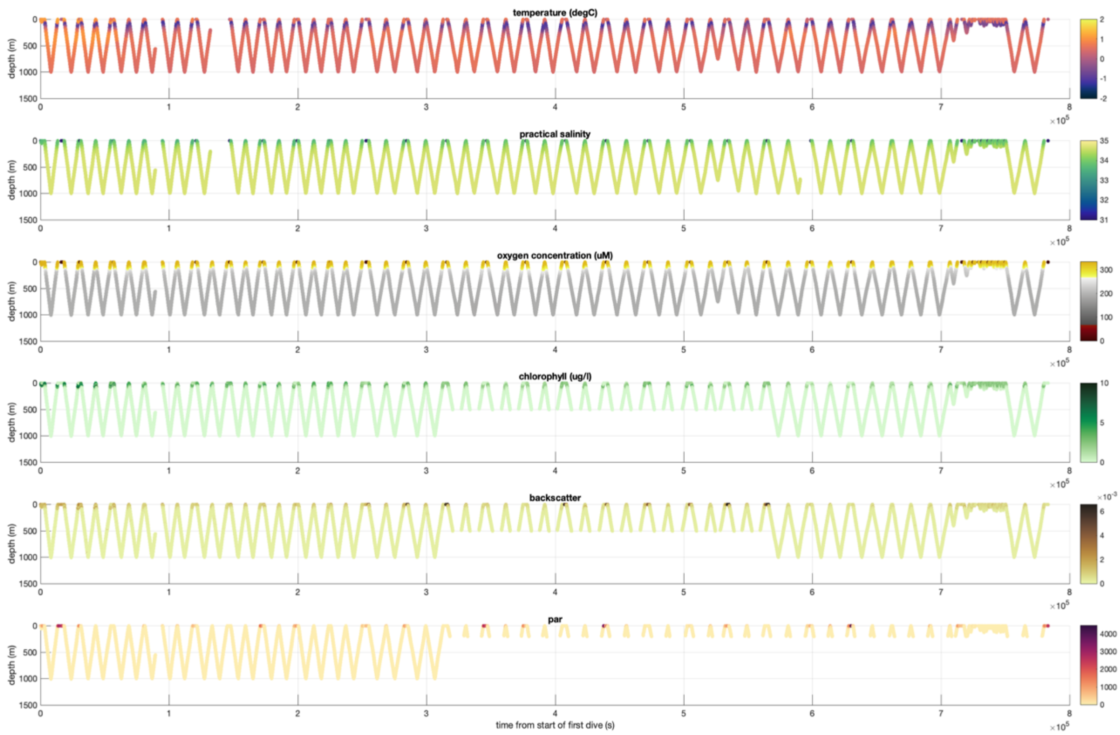


Figure 44: Unit 631's science parameters. Sensor recording behaviours were changed during deployment.

Additionally, the glider has been recording and sending data from the EcoPuck, oxygen and PAR sensors (Figure 44) to the Cambridge dockserver. Oxygen concentrations of ~300 μM are found in the top 100 m of the water column, reducing down to ~192 μM at 1000 m. Elevated chlorophyll and backscatter is found in the top 60 m, with maximum values of ~6 μg/l and ~6 x 10^{-3} respectively. PAR values are predominantly 0, but values up to ~4000 are observed in the surface layers.

Gaps in the science time series (Figure 44) can be explained. The short gap 7 yos into the mission occurred due to the aborted mission described above (due to an incorrect overtime). Later gaps at 1.3 x 10^5 s (in temperature and salinity) and 5.9 x 10^5 s (in salinity only) are likely due to a drop of Iridium whilst sending TBD science files; the data should be stored on the glider. The cut-off in chlorophyll and backscatter between 3.2 x 10^5 s to 5.6 x 10^5 s was due to a change in the maximum depth for sampling to 500 m. This decision was made to save battery consumption, but after discussions it was changed back to full depth sampling. Similarly, the maximum depth for sampling for the par sensor was changed to 200 m at the same time, however, this change has been kept for the remainder of the deployment.

Data processing

TBD science files and SBD glider files have been downloaded from the Cambridge dockserver and then backed up in the glider subfolder on the JRLB legwork drive. These files are then accessed in a virtual linux machine, where the dbd2asc script is used to convert the files into ascii format. The dbd2asc script has to be copied into the directory containing the data, and the following commands are used:

```
dir *.sbd | ./dbd2asc –s > sbdtemp.dba
dir *.tbd | ./dbd2asc –s > tbdtemp.dba
```

Matlab is then used to open these dba files, where the segment lines can manually be removed and the num_ascii_tags changed to 12. This makes the files compatible with the SOCIB Toolbox in Matlab, and the loadSlocumData function can read in the data. Matlab is then used to create the glider and science figures shown above.

11. EM-APEX float deployments

Alexander Brearley

Introduction

Two EM-APEX floats manufactured by Teledyne Webb Research were deployed as part of JR18004. In addition to standard Argo sensors (temperature, conductivity and pressure), these drifting profilers incorporate water column current velocity data. Upon surfacing, the float transmits its position and data over the Iridium satellite system to a shore-based receiver. These current velocities can be used to characterize internal wave properties, upper ocean dynamics and patterns of geostrophic shear.

Three EM-APEX floats were procured for ORCHESTRA, with the intention of using them to determine the internal wave field and velocity structure around Discovery Bank, which has previously been suggested to exhibit Taylor column dynamics. The floats were ballasted for the required ocean buoyancy by Teledyne Webb Research and delivered to Cambridge. A communications account was set up with MetOcean to manage Iridium RUDICS communications (common with BAS' glider fleet communications). All data are backed up to a Teledyne Webb server apex.webbresearch.com, and emails about surfacings were set up in the email-recipients.txt file for each float to Alex Brearley, Povl Abrahamsen, Andrew Meijers and Hugh Venables.

More information about the technical specification of the floats can be found in the APEX-EM Electromagnetic Profiling Float User manual (2014, TWR).

Setup

Prior to being shipped from Cambridge, the floats were unboxed and inspected for physical damage. The PhoneNumbers parameter was changed to ensure both RUDICS and dial-up:

PhoneNumbers = D00881600005135,0017818711053

Communication tests were also run on each of the three instruments prior to shipping.

Upon arrival in Punta Arenas, the three floats were removed from the boxes and communications once again tested. Logs of one of these tests is included in the appendix.

Deployment

It was initially intended that three floats would be deployed. However, just prior to the deployment of the first float, 8137 failed its pre-mission self-testing, on account of a fault with the EM current meter. The failed test script is displayed at the end of this section. Hugh Fargher at TWR advised that it would need to be returned to the manufacturer for repair.

The two other floats (8135 and 8136) were deployed successfully. Prior to each deployment the mission self test was run and the results saved to the cruise log. The deployment locations aimed to capture both the northern and southern flanks of the proposed anticyclonic circulation around the bank.

Details of deployment locations and times are given in Table 9. Pre-deployment checks were recorded via a custom logsheet.

Serial number	Date in water (UTC)	Time in water (UTC)	Latitude	Longitude	Teraterm log file name
8136	01/02/2019	1810	60° 50.976'S	37° 11.974'S	missionstart_8136_01022019.log
8135	02/02/2019	2140	60° 24.778'S	37° 18.903'S	missionstart_8135_02022019.log

Table 9: Deployment times and positions of EM-APEX float locations

Post-deployment checks

Following deployment of the floats, the initial behaviour of each of the instruments was continual sampling to 500 m. Once it had been verified that the instruments were performing satisfactorily (through verification of the plots sent via email for each surfacing), the floats were moved onto longer term missions. Float 8136, to the north of Discovery Bank, was initially in too shallow water for its initial intended sampling (1400 m to the surface twice within an inertial period, with parking at ~0.5 days at 1000 m). After discussion with Hugh Fargher at Teledyne, it was decided this float would initially profile from 700 m to the surface once per day, with parking at 500 m. In contrast, 8135 was set to complete two 1400 m to the surface profiles within one inertial period, then park at 1000 m for ~4.5 days.

12. AME Technical Report

Sean Quirk

Cruise Summary

Cruise	Departure	Arrival	AME Engineer(s)
JR18004	06/01/19 (Punta Chile)	17/02/19 (Punta Chile)	Sean Quirk

Table 10: Cruise summary

This cruise is part of the Orchestra Project using CTDs, VMPs and gliders to analyse ocean patterns at Orkney Passage and Discovery Bank.

Instrumentation

Systems used on cruise

Instrument	#SN if Used	Make and Model	Comments
Lab Instruments			
AutoSal	65763 and 63360	OSIL 8400B	See "autosal section"
Scintillation counter	No	PERKINELMER TRI-CARB 2910TR	Not Used, Tested for Future Cruises
XBT	No		
Acoustic			
ADCP	Yes		
EM122	Yes		
TOPAS	Yes		
EK60/80	Yes		
K-Sync	Yes		
SSU	No		
USBL	Yes	Sonardyne GPT	Used B1 and B2 beacons and 2 x NMF beacons
10kHz IOS Pinger	No		
Benthos 12kHz Pinger	No		
Benthos 14kHz Pinger	No		
Mors 10kHz Transponder	No		
EA600	Yes		Bridge Equipment but logged
Oceanlogger			
Barometer1	V145002	VAISALA PTB210B1A2B	Inside the UIC
Barometer2	V145003	VAISALA PTB210B1A2B	Inside the UIC
Air humidity & temp1	61019333	Rotronic Hygroclip 2	On Foremast
Air humidity & temp2	61019251	Rotronic Hygroclip 2	On Foremast

TIR1 sensor (pyranometer)	172882	Kipp & Zonen Sp Lite2	On Foremast
TIR2 sensor (pyranometer)	172883	Kipp & Zonen Sp Lite2	On Foremast
PAR1 sensor	160959	Kipp & Zonen PQS-1	On Foremast
PAR2 sensor	160960	Kipp & Zonen PQS-1	On Foremast
Thermosalinograph	0018	SBE45	PrepLab
Transmissometer	1497DR	CST-846DR	PrepLab
Fluorometer	1498	WSCHL-1498	PrepLab
Flow meter	05/811950	LitreMeter F112-P-HC-AP-OR-PP	PrepLab
Seawater temp 1	0765	SBE38	Sea Inlet
Seawater temp 2	0771	SBE38	Sea Inlet

Instrument	#SN if Used	Make and Model	Comments
CTD			
Deck unit 1	0548	SBE11plus	
Underwater Comms/ Depth	1225	SBE9plus	
Temp1	5645	SBE3plus	
Temp2	2191	SBE3plus	
Cond1	3248	SBE 4C	
Cond2	4126	SBE 4C	
Pump1	1807	SBE5T	
Pump2	7966	SBE5T	
Standards Thermometer	0061	SBE35	
Transmissometer	527DR	C-Star	
Oxygen sensor	0620	SBE43	
PAR sensor	70442	QCP2350	
Fluorometer	12.8513-001	CTG Aqua Tracker MkIII	
Altimeter	10127.244739	Tritech S10127 232	
CTD swivel linkage	1961018	Focal Technologies Group	
LADCP Master Down	14443	Teledyne RDI WHM300	
LADCP Slave Up	14897	Teledyne RDI WHM300	
Pylon	0636	SBE32	
Other ship's systems (non-AME)			
Anemometer	1511001	Gill Instruments Windobserver 70	Bridge Equipment, logged by Oceanlogger. On Foremast all of cruise
Ships Gyro	Yes		Bridge Equipment, logged

Table 11: Systems and instrumentation used on cruise.

Notes for Heading and Course Instruments

Seatex

Worked well for the duration of the cruise.

Notes for Lab Instruments used

AutoSal

Upon arrival repairs were made to the two faulty units to ensure a working unit. On arrival into the Falklands on the 09/01/2019, a spare autosal was delivered and installed into the rad lab. This was the preferred unit for the scientists. The autosal S/N 63360 was used for the whole cruise and worked well.

The rear heating lamp was replaced on the 19/01/2019 in AutoSal S/N 63360 and on the 16/02/2019 in S/N 65763.

Notes for Acoustic Systems used

ADCP

Used on cruise with no issues, a small number of software crashes occurred but this is not unusual for the system.

EM122

Was used on this cruise opportunistically. At the beginning of the cruise the computer required rebuilding of HDD by IT.

EA600

Worked for the duration of the cruise.

USBL

The USBL system has been working well for the duration of the cruise. Two additional NMF 6G Directional WMT beacons were provided for VMP operations and added to the Fusion system with serial numbers: 305950_002 and 312930_004. As the old fusion system is not compatible with the newer WMT beacons these required setup in 6G Terminal Lite. As the WMT beacons normally require a wakeup tone that the "USBL Big Head" cannot provide these needed to be set to always on. This was done by changing the AT value, which is located in "**Options-> Preferences**", setting to 14. This can also be manually entered in the command window to the beacon but if a reconnection is required this will change it back to the default AT so it is better to change the preferences.

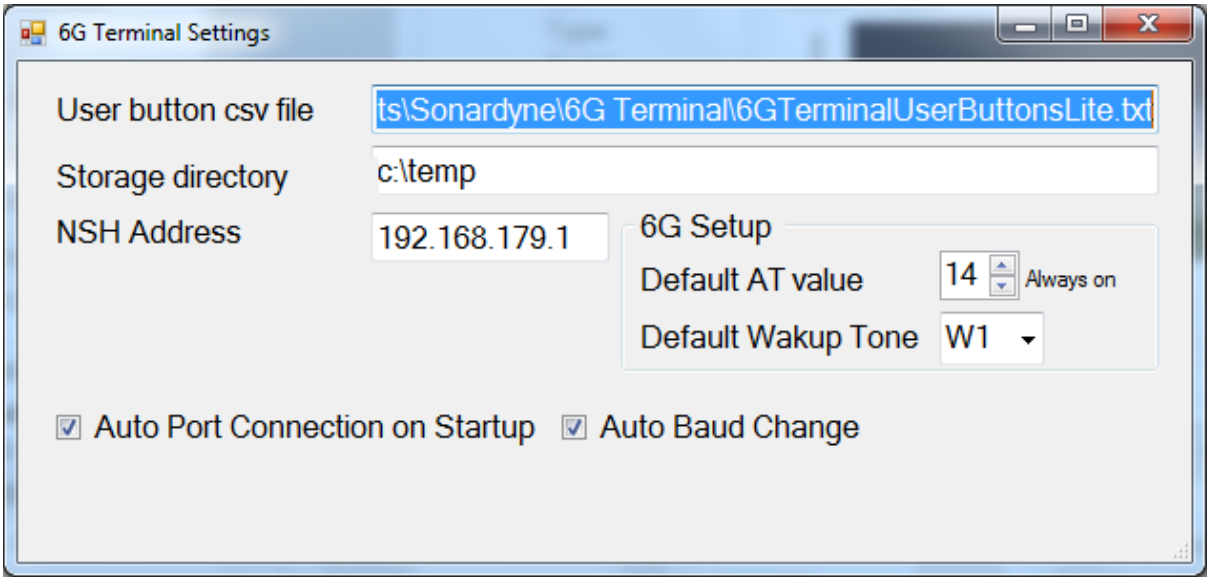


Figure 45: Default AT value.

As the Fusion program has more powerful features in term of ranging between offsets and providing range and bearings it was decided to use this over the Ranger program. This presented a problem as the WMT beacons have a different turnaround time from the options presented in the old version of Fusion when setup to use the Sonardyne wideband 1 communications. Sonardyne was contacted to ask if it was possible to set this up and they confirmed that it is not. The beacons were then set to use the HPR channels B45 and B65 which allows operation in Fusion. Both beacons performed well for the duration of the cruise. At the end of the cruise the beacons were left with the above settings.

Notes about the Oceanlogger

Transmissometer

At the start of the cruise it was noted that the Transmissometer was producing unusually low results; this was investigated. It was discovered that the lenses had a build-up of contamination: this was cleaned and the problem fixed.

Flow Rate

The flow rate of the system was checked and discovered to be running at too low. The common rate recommended rate among the 3 sensors was 1.5 l/min so this was increased. As the flow rate increase was performed it was noted that the flow rate maxed out at 1.3l/min when the flow on the display was at 1.5 l/min. A setting on the flow meter showed the maximum flow rate output at 1.3l/min this was adjusted to 2 l/min. This still led to an incorrect flow rate display in the oceanlogger system. The calibration equation was looked into and was previously:

$$\frac{\left(\left(\left(\frac{X}{124}\right)*1^{E^{-3}}\right)-4\right)}{12.3077}$$

A new infield calibration was performed on the 26/01/2019. This was performed by taking a minimum reading with no flow giving a voltage of 0.481 V. The flow meter was then set to give maximum output (setting meter to maximum flow of 1l/min and passing 1.5l/min or water through the system) this was 2.394 V. A linear flow from minimum to maximum was assumed this led to the following proportional equation being derived.

$$\frac{(\mathrm{x} - 0.481)}{1.913} * Maximum\ Flow\ rate$$

The maximum flow rate for the flow meter was set to 2 l/min thus the equation becomes:

$$\frac{(\mathrm{x} - 0.481)}{1.913} * 2$$

This was changed on the system on the 26/01/2019 and appears to be working well.

Notes about the CTD

Basic Stats			
Number Of Casts	63	Number of Successful Casts	61
Max Depth	5426	Min Depth	545
Cable Removed (m)	40	Number of Re-terminations (elect.)	2

Table 12: CTD statistics

CTD Cable

Due to the relatively short length of the spare CTD wire allowing approx. 3.9km casts and the primary CTD wire being unusable, the conducting cable (17.4mm Co-Axial cable) was used for the deeper casts on this cruise. A change has been made to the procedure for performing the mechanical load test where the bolts are tightened after the load test with just enough force to keep the wire tight.

Spare CTD cable damaged wire

On the 05/02/2019 the spare CTD wire was damaged on cast 34 as shown in Figure 46.

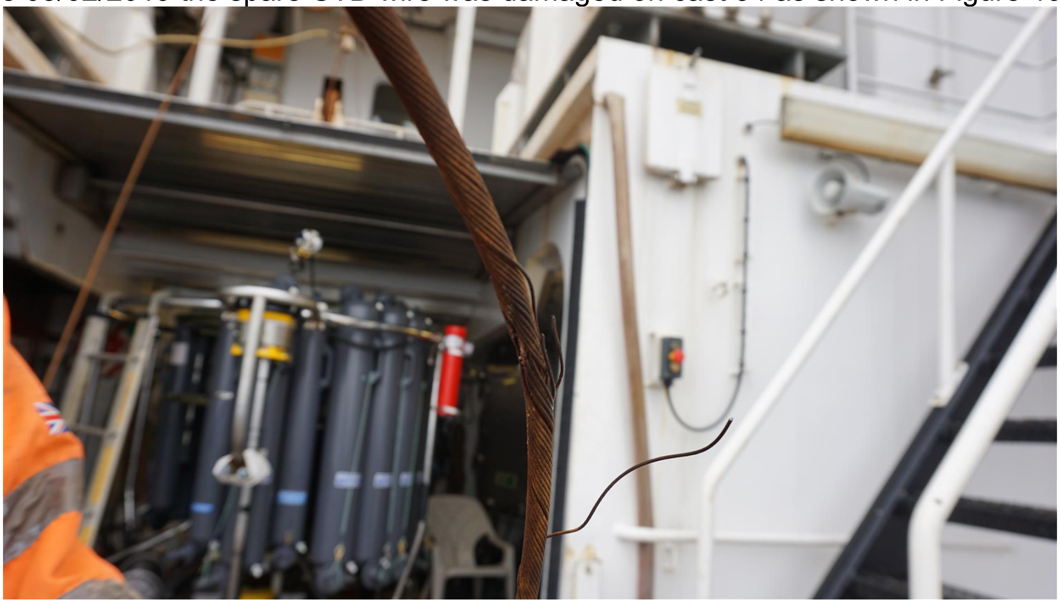


Figure 46: Spare CTD wire cable damage

It is unclear exactly what cause the damage but it is suspected that it jumped the sheave on deployment and got snagged. Approximately 40 m was removed to get past the damaged cable and was successfully re-terminated.

Conducting cable (17.4mm co-axial)

The BAS cable termination kit was collected from the Discovery while alongside in the Falklands on the 09/01/2019. The mechanical and electrical connection was completed on the 09/01/2019 with load testing completed on the 10/01/2019. It should be noted that the large mechanical termination and connection to the CTD makes deploying the CTD much more challenging. In addition to this it also a higher chance of damage to the electrical connection and a hard potting is recommended along with some form of strain relief.

Damaged Tail

On 31/01/2019, when deploying the CTD, the soft tail of the conducting cable was snagged upon the wire tag with the load testing information on the shackle as shown in Figure 47. This resulted in a short of the cable to seawater and blowing of the fuse in the deck unit due to a cut into the wires on the cable as shown in Figure 48.

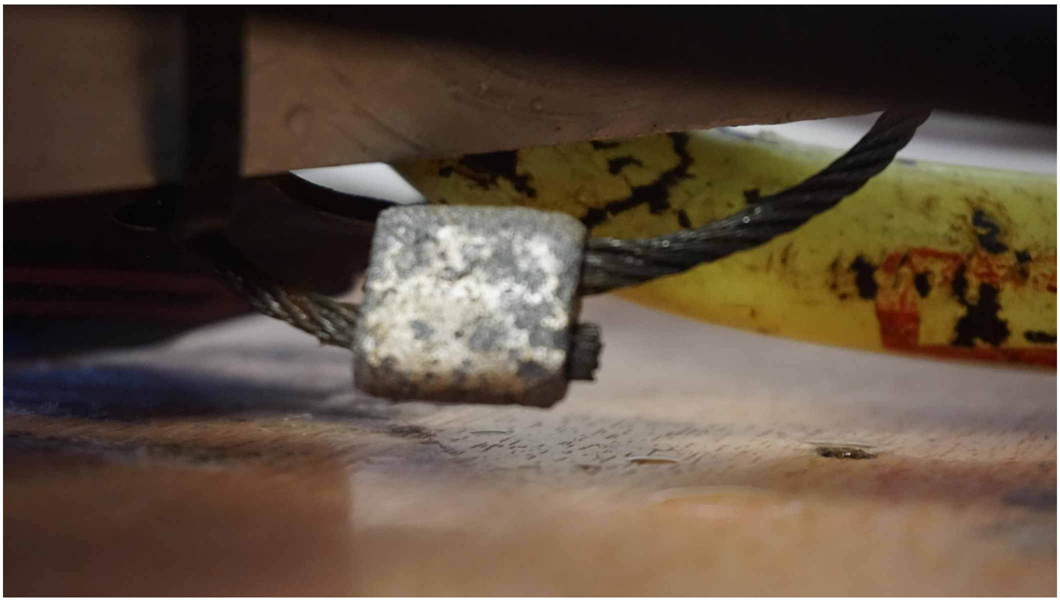


Figure 47: Wire on load testing information tag

Figure 48: Damage to tail on conducting wire

The cable was cut just below the pot and was electrically re-terminated without requiring the mechanical termination.

Damaged Pot

On 05/02/2019, the CTD cast was working well until reaching bottom depth when comms cut out and the fuse on the deck unit blew. Upon recovery of the CTD water was observed to be coming out of the end of the wire when the tail was cut. Under closer inspection it was noticed that the tail coming from the pot had become loose and a gap was seen as shown in Figure 49.

Figure 49: Conducting wire potting damage.

It is suspected that the cable was flexing substantially due to a combination of the heavy mechanical termination and rough seas that the CTD was deployed in which may have caused the compound to have become loose. In future it is recommended to use some form of bend restrictor on the flexible tail end to minimise physical movement. For the next termination spiral wrap should be added.

CTD Swivel

At the start of the cruise slight damage was noted to the rubber seal on the pins upon the connector for the CTD wire side as shown in Figure 50.


Figure 50: CTD Swivel damage to rubber seal on pins

This has further manifested into very slight corrosion on the power pin of the CTD as shown in Figure 51.

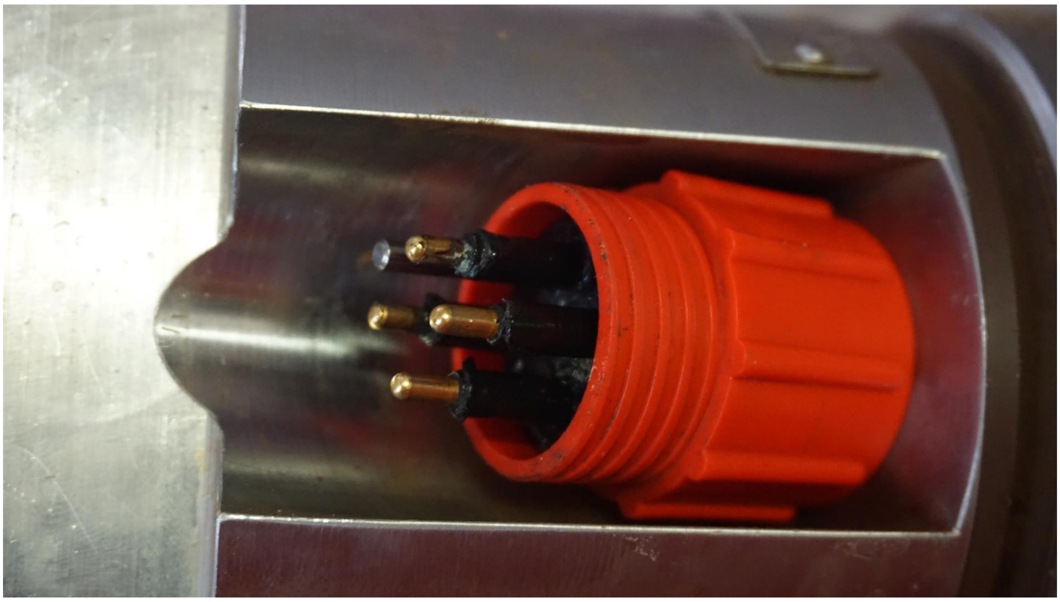


Figure 51: Slight corrosion on power pins of CTD swivel

This has currently not been changed out for the spare and should be monitored closely for further corrosion and changed out for the spare as necessary.

CTD Bottles

20 litre bottles

During the cruise several of the 20 l bottles were still slightly leaking although there was a significant improvement over JR18001. After discussions with the PSO and the oncoming PSO it was decided to move back to the 12 l bottles as these will be acceptable for the remainder of the season.

12 litre bottles

While changing over to the 12 l bottles, 2 were found to be leaking due to chips close to the bottom sealing O rings.

LADCP

All 3 LADCPs were fitted over the course of the cruise and confirmed to be working well.

LADCP Battery Housing Damage

During venting of the battery housing the head from the bolt securing the plastic cap for the venting plug snapped off. Fortunately enough of the bolt remained exposed to remove without having to drill out. This was replaced with an M4 x 12mm bolt although it is suspected that the correct size is M4 x 15mm which will need to be ordered.

LADCP Cable Damage

While looking for spare LADCP cables 2 x LADCP cables were discovered with broken charging pins. These were repaired with spare tails cut from existing cables. Spare tails have been requested for ordering.

LADCP Battery Housing Bulkhead Damage

At the start of the cruise significant corrosion was noted on the LADCP battery housing bulkhead and associated cable. This was cleaned but corrosion continued on the bulkhead and cable as shown in Figure below.

Figure 52: LADCP Battery Housing Corrosion

Figure 53: LADCP Cable Corrosion

The bulkhead was replaced on the 08/02/2019 along with the repaired cable.

LADCP Battery Housing Re-wiring

While work was being performed on the bulkhead replacement it was noted that the connector for the LADCP battery pack was quite far recessed into the housing as shown in Figure 54.

Figure 54: LADCP battery housing wiring prior to modification

It was decided to extend the ground cable, as shown in Figure , to make easier access to the connector to aid reassembly of the unit.

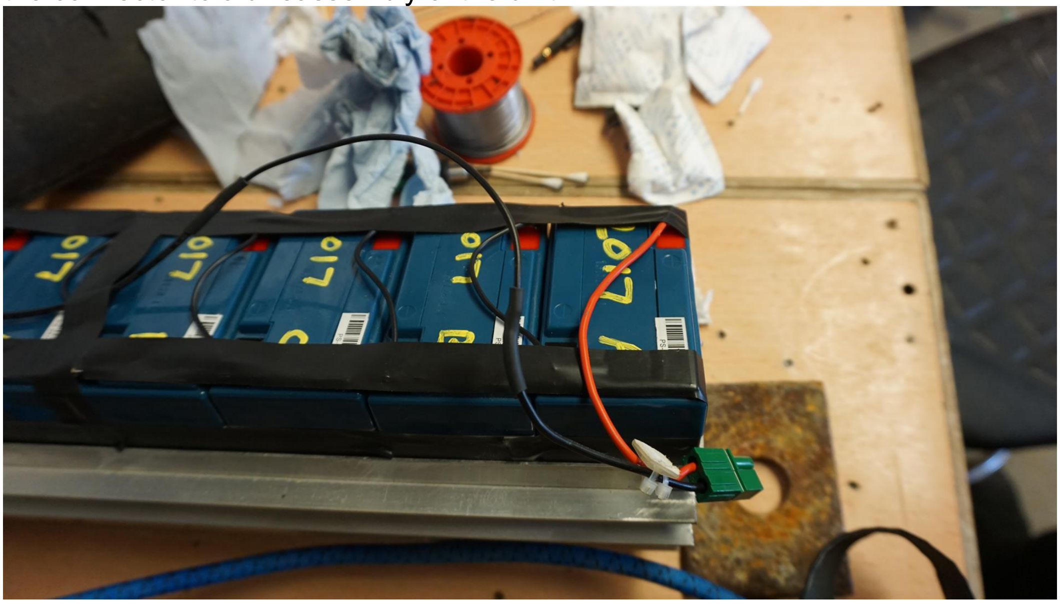


Figure 55: LADCP battery housing wiring after modification

LADCP O-ring sizes

While performing the bulkhead replacement it was suspected that the incorrect O-ring had been used for the internal sealing face (backup O-ring). The spare O-ring located in the box is size BS256 and is of the same dimensions as the currently installed one which seems to large. Although the end cap has fitted on great care was needed to ensure the O-ring did not come out the groove and get trapped. The O-ring was put in the -80° freezer to shrink in size and then quickly installed with the assistance of the deck engineer.

CTD Deployment Procedure

Prior to deployment, all bottles are cocked and the deionised water is vented from the temperature/conductivity sensors. Pre-deployment technical tests are carried out on the LADCP's and are logged. The LADCP is then activated and starts logging.

Once the Deck crew and winch operator are ready the CTD is lifted into the water and lowered to 10 m, where power is started and logging begins. It is held here until the operator sees the difference between T1 and T2 stabilize. This can take some time, especially if the air temperature and sea temperature are far apart. In some circumstances, mainly turbulent surface waters, it can be necessary to lower the CTD to 20 m or further where the temperature is more stable, this is at the operator's discretion. Once stable, the CTD is lifted to as near to the surface as the winch op deems safe then it is lowered to the required depth or bottom without stopping. The bottom depth is an approximation from the best echo sounder available, commonly the EM122. If bottom depth is required then the altimeter will start working from under 100 m of the sea bed and is used to stop approximately 10 m from the sea bed. From here some adjustment can be made to get closer, this is done at the operator's discretion. Once the down cast is complete bottles are fired at requested depths, in order, deepest first. When each bottle is fired 15 seconds are given to ensure that the independent standards thermometer has time to take a reading.

Once on the surface the CTD is returned to the vessel, the C/T sensors are filled with deionised water to avoid damage. All data is backed up as soon as possible.

Information about CTD configuration

Name	**Purpose**	**Distance from Base of Frame to sensor**
Altimeter	Distance to sea bed (max 100m)	0.04
LADCP Master	Downward Facing LADCP	0.10
LADCP Slave	Upward Facing LADCP	1.48
Temp1/Temp2	Temperature at 24Hz	0.31
Fluorimeter	Measures Florescence	0.17
9+	Communications and Pressure measurement	0.38
C1/C2	Conductivity Cells	0.35
Dissolved Oxygen	Oxygen in the Water	0.38
Bottles Bottom End Cap	Water collection (24)	0.5
Bottles Top End Cap	Water collection (24)	1.68
Transmissometer	Measure of light transmitted through water	0.30
SBE35 Top	Accurate Temperature sensor	1.46
SBE35 Bottom	Accurate Temperature sensor	1.10
Par	Radiation Sensor	1.62

Table 12: CTD configuration parameters.

Additional work completed on cruise

CLAM

While using the spare CTD cable the CLAM system would continuously alarm with max and min back tension along with the graph showing incorrectly. This was tracked down to the cable parameters and max/min tensions not being set in the system. The settings were copied from the CTD cable and entered into the auxiliary settings and worked correctly see below image in Figure 56 and Figure 57 for used settings. Note the password for the system is now saved on the wiki.

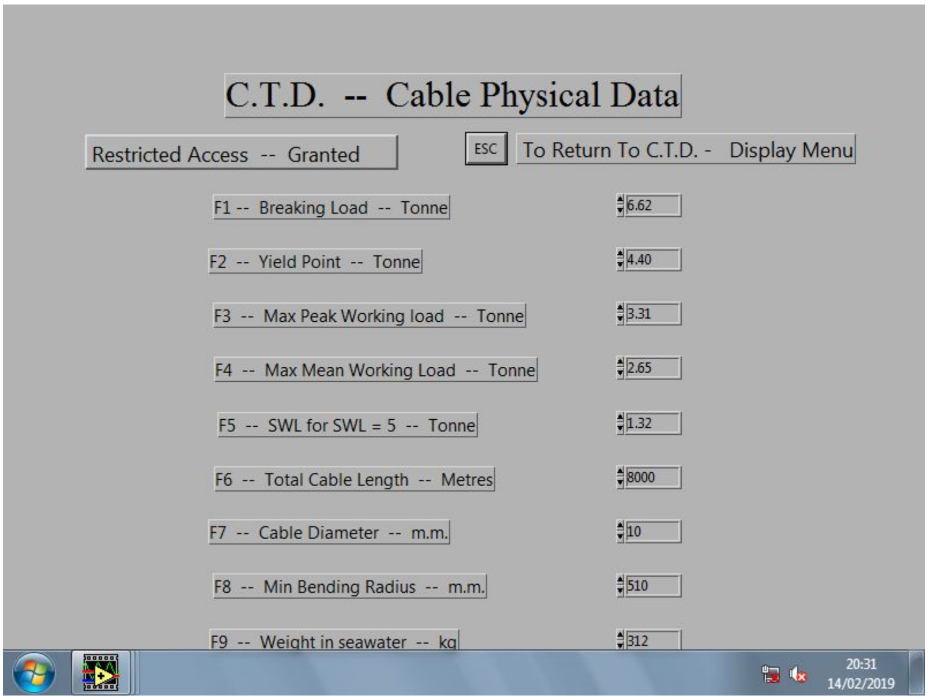


Figure 56: CLAM CTD cable physical parameters

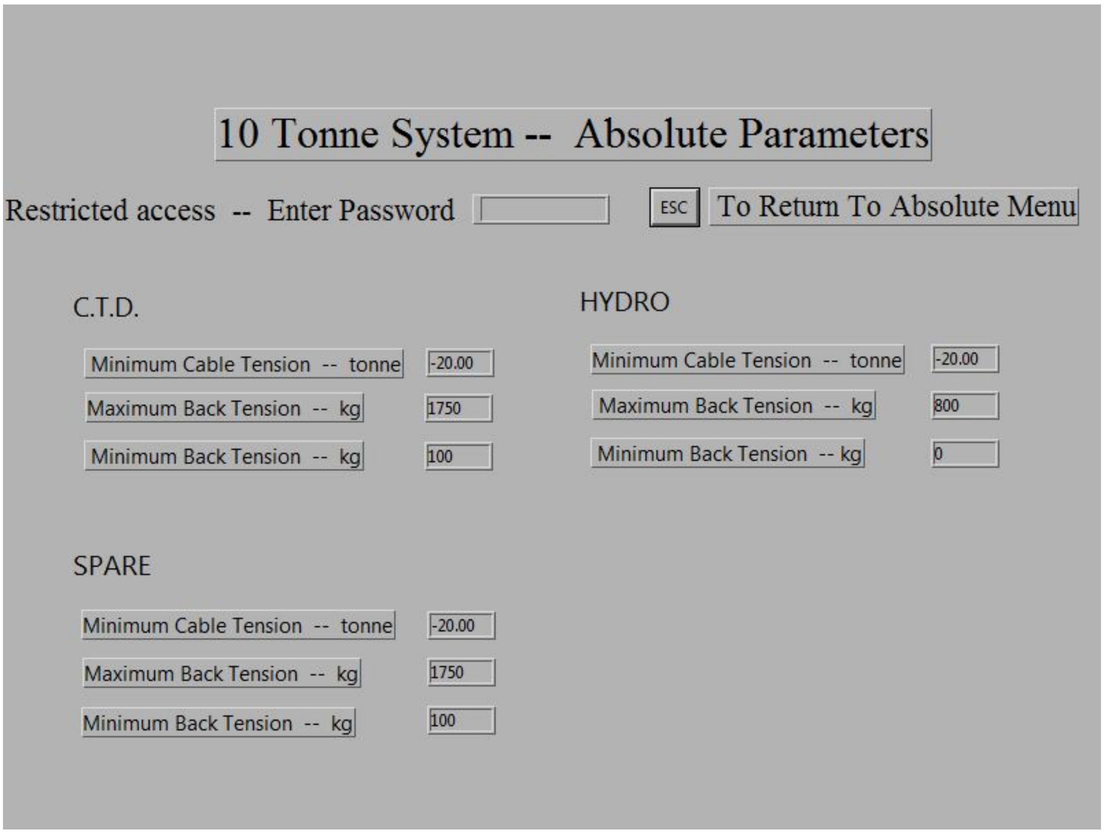


Figure 57: CLAM 10 Tonne System Absolute Parameters

In addition to this it was discovered that every time the program restarts, it wipes the spare cable settings. In future if the spare CTD cable is getting used the normal CTD cable should be selected in CLAM as it runs through the same system and has the same parameters.

Moorings Acoustic Transducers

The primary NMF Ixblue TT-801 acoustic deck unit was not functioning correctly and the spare LDEO Edgetech 8011M unit could not talk to all the releases because of a known bug in the firmware. A fix was found for the 8011M which required to upgrade the firmware on the PIC inside the unit. This was performed with the microchip PICstart plus although due to the age of the unit getting the correct software proved more difficult than necessary as it is no longer supported. It is recommended to upgrade to a newer PIC programmer that will provide better support in the future. This has been requested.

SLOCUM Glider

Slocum glider 352 was recovered due to a fault with the attitude sensor. This was investigated and a fault was found on the board, with a blown diode and fuse. A repair was attempted on the board and while it was functioning on a test program it would not read the data correctly into the glider. Slocum 330 had a faulty altimeter while attempting to disconnect the altimeter cable from the glider the rubber had amalgamated to itself and so broke on removal. A decision was made to take the attitude sensor board from this glider and place it into 352. To do this a firmware upgrade was needed to be performed to accommodate the newer attitude sensor compass calibration on glider 352. While the upgrade to the main mission worked well and the glider was physically operational remote access to the science data was not available. The glider was recovered and the fault is still being investigated.

Navmet data stream

At the start of the cruise there were issues with the Navmet display showing incorrect data. The data appears to have a time lag which builds up over time. This has been tracked to a suspected problem with the IT server. Currently this is with the IT team back in Cambridge awaiting resolution.

AME Department notes

Pre-cruise tasks

Task	Status
Download AME_Eng/Platform_Specific/JCR	N
Check cruise planning meeting notes	N
Number of days hand over with previous ships AME Engineer	5

Daily & weekly tasks

Task	Frequency	Status
Sanity check the Oceanlogger data	Daily	Y
Check the Following Fans: Oceanlogger Acoustic Rack Seapath EM122 (Tween) Topas (Tween)	Daily	Y
Mega test CTD cable	Weekly	Y
Clean Underway System	Weekly	Y

End of cruise checks

Task	Status
XBT left in cage, in a suitable state	
The salinity bottles have been cleaned, if used	
CTD left in suitable state - Ducts cleaned with Triton and deionised water, blanking plugs installed and system washed with water	
CTD Slip Ring have been cleaned	
Office is tidy, with manuals and files returned and items stowed for sea	
Clean the following fans: Oceanlogger Acoustic Rack Seapath EM122 (Tween) Topas (Tween)	
Scintillation Counter test Procedure	

Items to be purchased

Item	Supplier	Quantity	Use
RS Pro Black Nylon Cable Tie, 300mm x 4.8 mm	RS	5	Cable management
RS Pro Black Nylon Cable Tie, 150mm x 3.6 mm	RS	1	Cable management

3M Scotchcast 2131 173ml/210g	MacArtney	10	Cable potting ask expiry date on compound if only 1 season order 5
Loctite Superglue Precision 5 g Super Glue	RS	2	Used on cruise
PG164140 - In-Circuit Debugger/Programmer, MPLAB PICkit 4, PIC/dsPIC Devices	Farnell	1	PIC programmer
Dummy connector for LADCP cables both male and female (I think it's LPDC-7-MP and LPDC-7-FS)	Teledyne/Planet Ocean?	2 of each	Blanking plugs for LADCP cables on the CTD
3m length LADCP tail 7 pin male LPMIL-7-MP / CM3	Teledyne/Planet Ocean?	1	Tail for connecting into battery power for LADCP
3M 2903 Black Duct Tape, 50m x 48mm x 0.15mm	RS	4	General use
SIBA, 500mA Glass Cartridge Fuse, 6.3 x 32mm, Speed F	RS	20	CTD sea cable fuses
Chemtronics Fibre Optic Cleaning Wipe x 50 pcs for Fibre Optic Connectors, LCD Screens, Plasma Screens	RS	1 box	Cleaning wipes for underway and CTD sensors

13. NMF Cruise Report

Technical team

Paul Provost
Billy Platt
Tom Ballinger
Tim Powell

Equipment used

VMP 6000 s/n 016
VMP 6000 s/n 107

Deployments and recoveries

Both VMP 6000s were deployed and recovered the same way. Deployments were made using the hydraulic launch and recovery system (LARS), which launches the VMP from the VMP trolley. A quick release pin was inserted through a bight in the rope around the bale. Recovery was made using the same system in reverse. The LARS upright in the launch/recover position with the line paid out going over the sheave of the trolley, around the stern of the JCR and as far up the starboard deck as it would reach. The line was then attached to a hook fixed to an extendable pole. Once the VMP was 'hooked' the pole would detach from the hook and the VMP would be floated around the stern to the LARS and winched up and into the trolley.

Initial setup

Both VMP fish were fitted with the following recovery aids:
Sonardyne WMT 6G USBL beacon
Novatech Zenon strobe flasher with pressure sensor switch
Novatech RF beacon
Novatech Iridium beacon

Bright orange homemade flag

Both VMPs (s/n 016 and s/n 107) were assembled in the same fashion and with the same recovery aids. Each pressure housing was opened up to connect the release battery as it is stored disconnected. The 3.6 V Lithium battery in s/n 016 had died. This battery was replaced in both instruments as a matter of course.

The release 'Faith' was fitted to s/n 016 and release 'Hope' fitted to s/n 107. Both release units were tested by simulating a short cast of 82 seconds. This allowed a quick bench test of sensors installed, the LED and finally the release unit. Both VMPs and releases passed this test. Both releases/VMP units fired the solenoid in the release for 2 seconds, paused for 6 seconds and repeated 16 times.

A1 galvanic timed releases (GTR) were used for all deployments. Pre-burning was carried out for the first dozen or so casts by soaking 4-6 GTR's in a pot of seawater in the fridge at 6°C so as to reduce the overall lifetime of the links to approximately 18 h instead of 24 h.

Initially, both VMP's were float tested to ensure they were sufficiently buoyant. Then, an approximately 150m tethered cast was carried out to ensure the weight release worked correctly and that the units were able to float to the surface. Both tests on both VMP's were successful and they were then each deployed to 750 m. This also provided an opportunity to test the LARS, the two VMP trolleys and the recovery method for both ship crew and the technical team.

Both 750 m test casts proved successful, and the data from the shear sensors and the thermistors looked good. The level of noise in the accelerometer plot was compared between both instruments. The noise level in s/n 107 was significantly less than s/n 016. Thus, s/n 107 was used as the primary instrument. The noise levels in s/n 016 was compared to its previous noise levels on JR17005, so the instrument remains good, but s/n 107 displayed even lower noise levels. Andreas Thurnherr, who was examining the data, commented that he was used to working with two other instruments from WHOI that had noise levels on the accelerometer channel comparable to s/n 107 and therefore his preference was to use this as the main instrument.

The fall rate of the two VMPs was ~0.65 m/s for both instruments using two 6.8 kg weights and 140 mm of another weight, yielding a total of about 17kgs. The weight bracket arrangement of previous trips was used where the half weight sits slightly higher so as to allow the release strap to sit around its middle and prevent it falling out. This should be used as the standard weight configuration from now on as it has been proven to be reliable and successful on both instruments on multiple casts.

General proceedings

s/n 0107 worked very well and was used for all deployments. The Iridium system proved very reliable and was essential for relocating the instrument during the regular dense fog that occurred during JR18005.

A USBL beacon (6G) was used to track the VMP whilst it was underwater, allowing the bridge to maintain a record of where it was drifting and enabling scientists/technicians to confirm that the VMP had started its ascent after releasing its weights. The USBL beacon was set up slightly differently due to the software change on the JCR since its last refit. The software used this time was Fusion instead of Ranger2. The USBL beacons have been set to stay permanently on so that they communicate properly with the ship and its software. Note this will be different to use on NMF ships as the head on the JCR is an older version.

Whenever a noisy/suspected bad probe was identified from the Matlab plots, it was swapped for a replacement probe. The sensor list in the appendix reflects this.

Once, during recovery, the cable loop between the Iridium head and the battery pack was hooked by mistake.

No issues were encountered during any deployments other than some noisy probes. The instrument worked perfectly every dive using the correct release logic and never once hit the bottom or had any issues. The noise seen on the data channels on previous cruises appears to have been resolved and s/n 107 is now producing data with less noise than s/n 016.

Probes used
Micro conductivity – 2
Micro structure – 10
Micro temperature – 6

JR18-004 VMP-6000 Component Reference

S/N 016

Board	Part Number	Serial Number	Calibration Date	Comments
Persistor		13505	N/A	
CF2 Interface	P040R01	072	N/A	
LP-PS	P050R02	110	N/A	
Release	P031R02	024	N/A	Changed, replacing s/n 017 after issues on JC156
Pressure Sensor		87770	05/01/2016	
ASTP	P049R02	090	13/11/2015	
uC	P059R01	058	19/09/2016	
Magnetometer	P032R01	032	05/01/2016	

S/N 107

Board	Part Number	Serial Number	Calibration Date	Comments
Persistor		16095	N/A	Fitted by Rockland (RMA 1762)
CF2 Interface	P040R01	128	N/A	Fitted by Rockland (RMA 1422)
LP-PS	P050R02	183	N/A	Fitted by Rockland (RMA 1762)
Release	P031R02	019	N/A	
Pressure Sensor		143541	4/1/2016	
ASTP	P049R02	076	19/11/2013	
Magnetometer	P078R00	002	25/10/2016	Fitted by Rockland (RMA1422)
uC	P059R01	072	19/09/2017	Fitted by Rockland (RMA 1762)

JR18-004 VMP-6000 External Sensor Record

S/N 107

Date	Shear 1	Shear 2	Temp 1	Temp 2	μCond	SBE 3F	SBE 4C	Comments
26/01/19	542	543	1168	1170	100	5916	3240	1170 No data
30/01/19				1183				
01/02/19			1562					1168 noisy
02/02/19		544						
02/02/19	395							542 noisy
03/02/19	713							395 noisy
04/02/19	722							713 noisy
04/02/19	1410	1412						722 544 noisy
10/02/19	950							

S/N 016

Date	Shear 1	Shear 2	Temp 1	Temp 2	μCond	SBE 3F	SBE 4C	Comments
26/01/19	395	540	765	863	97	4969	4245	

JR18-004 Microstructure Profiler Locator Beacons

VMP-6000 Profiler S/N 016

Type	Model	Serial No.	Channel	Comment
Acoustic	Sonardyne 6G Type 8190 WMT USBL Transponder		Unit ID: 004ESE Address: 2704	Submerged only Config: 7212
Visual	Novatech ST-400A Strobe	W06-137	Double burst flash - white	Surface only in darkness
Radio DF	Novatech RF-700A1 RDF	U03-040	Ch C 160.725MhZ	**whip antenna** 2 sec on, 4 sec off
GPS Iridium	Novatech iBCN MMI-7500RH	D09 023	**IMEI 30043406013_1010**	GPS fix and Iridium update every 10 minutes

VMP-6000 Profiler S/N 107

Type	Model	Serial No.	Channel	Comment
Acoustic	Sonardyne 6G Type 8190 WMT USBL Transponder		Unit ID: 005597 Address: 3005	Submerged only Config: 7212
Visual	Novatech ST-400A Strobe	C01-021	Double burst flash - white	Surface only in darkness
Radio DF	Novatech RF-700A1 RDF	X04-061	Ch 72 156.625MhZ	**” whip antenna** 2 sec on, 4 sec off
GPS Iridium	Novatech iBCN MMI-7500RH	M00PQX	**IMEI 30043406013_4020**	GPS fix and Iridium update every 10 minutes

Appendix A: Science event log

Event numbers are taken from the bridge science log. CTD times are taken from the 1Hz data files. Glider and mooring recovery and other times are taken either from the bridge log or deck notes. Positions are taken from the Seapath GPS, and depths from the EM122 echo sounder. Missing depths reflect periods when the EM122 was not logging.

Bridge event number	**Event**	**Time (UTC)**	**Position**	**Water depth (EM122)**	**Description/notes**
1	CTD 1	11/01/2019 11:50:53 11/01/2019 11:54:20 11/01/2019 13:31:13 11/01/2019 16:03:32	56° 39.358'S 051° 47.934'W 56° 39.359'S 051° 47.936'W 56° 39.358'S 051° 47.940'W 56° 39.355'S 051° 47.935'W	5002 4998 5010 4986	Logging started Downcast started Bottom End of upcast **Test CTD using conducting cable**
2	M2 mooring recovery	13/01/2019 11:00 13/01/2019 11:30 13/01/2019 11:50 13/01/2019 12:30	62° 37.346'S 043° 13.990'W 62° 37.348'S 043° 13.989'W 62° 36.781'S 043° 14.489'W 62° 36.601'S 043° 14.677'W	---- ---- ---- ----	Mooring released Mooring at surface Mooring hooked Recovery complete
3	CTD 2	13/01/2019 13:15:41 13/01/2019 13:20:50 13/01/2019 14:28:39 13/01/2019 15:52:22	62° 36.595'S 043° 14.678'W 62° 36.595'S 043° 14.676'W 62° 36.596'S 043° 14.675'W 62° 36.598'S 043° 14.671'W	3036 3036 3036 3036	Logging started Downcast started Bottom End of upcast
4	VMP float test	13/01/2019 16:36 13/01/2019 16:38	62° 36.589’S 043° 14.674’W 62° 36.579'S 043° 14.674'W	3036 3036	VMP deployed VMP recovered
5	VMP float test	13/01/2019 16:49 13/01/2019 16:55	62° 36.576'S 043° 14.674'W 62° 36.545'S 043° 14.674'W	3037 3032	VMP deployed VMP recovered

Bridge event number	Event	Time (UTC)	Position	Water depth (EM122)	Description/notes
6	VMP test	13/01/2019 17:43 13/01/2019 17:46	62° 37.566'S 043° 14.670'W 62° 37.551'S 043° 14.662'W	3053 3052	VMP deployed VMP recovered
7	VMP test	13/01/2019 17:54 13/01/2019 18:14	62° 37.544'S 043° 14.655'W 62° 37.481'S 043° 14.629'W	3054 3053	VMP deployed VMP recovered
8	M2 mooring deployment	13/01/2019 18:25 13/01/2019 19:11	62° 37.473'S 043° 14.618'W 62° 36.900'S 043° 14.620'W	3055 3041	Deployment started Deployment complete
9	M3 mooring recovery	26/01/2019 11:40 26/01/2019 12:50 26/01/2019 13:01 26/01/2019 13:32	63° 31.640'S 041° 47.320'W 63° 31.939'S 041° 45.904'W 63° 31.950'S 041° 45.871'W 63° 32.000'S 041° 45.779'W	4562 4559 4562 ---	Mooring released Mooring at surface Mooring hooked Recovery complete
10	CTD 3	26/01/2019 13:59:13 26/01/2019 14:03:51 26/01/2019 15:46:07 26/01/2019 17:33:20	63° 31.981'S 041° 46.060'W 63° 31.981'S 041° 46.058'W 63° 31.978'S 041° 46.055'W 63° 31.980'S 041° 46.058'W	4591 4591 4590 4587	Logging started Downcast started Bottom End of upcast
11	VMP 750dbar test	26/01/2019 18:10:00 26/01/2019 18:45:00	63° 31.987'S 041° 46.063'W 63° 31.826'S 041° 46.052'W	4589 4581	VMP deployed VMP recovered
12	M3 mooring deployment	26/01/2019 19:22 26/01/2019 20:19	63° 31.285'S 041° 46.685'W 63° 32.014'S 041° 46.656'W	4579 4590	Deployment started Deployment complete
13	VMP 750dbar test	26/01/2019 20:44:00 26/01/2019 21:36:00	63° 32.279'S 041° 46.652'W 63° 32.194'S 041° 46.457'W	4590 4604	VMP deployed VMP recovered
14	OP2 mooring recovery	27/01/2019 15:54 27/01/2019 16:31 27/01/2019 16:42 27/01/2019 17:46	60° 38.399'S 042° 09.145'W 60° 38.548'S 042° 10.198'W 60° 38.554'S 042° 10.385'W 60° 38.494'S 042° 11.160'W	3120 3057 2795 ----	Mooring released Mooring at surface Mooring hooked Recovery complete
15	CTD 4	27/01/2019 21:06:22 27/01/2019 21:12:53 27/01/2019 21:49:09 27/01/2019 22:32:17	60° 39.973'S 042° 13.768'W 60° 39.973'S 042° 13.768'W 60° 39.968'S 042° 13.770'W 60° 39.973'S 042° 13.766'W	1567 1566 1569 1550	Logging started Downcast started Bottom End of upcast

Bridge event number	Event	Time (UTC)	Position	Water depth (EM122)	Description/notes
16	VMP 5	27/01/2019 23:59:00	60° 38.463'S 042° 10.205'W	3148	VMP deployed
		27/01/2019 03:35:00	60° 37.598'S 042° 04.956'W	3534	VMP recovered
17	CTD 5	28/01/2019 00:29:03	60° 38.471'S 042° 09.617'W	3178	Logging started
		28/01/2019 00:35:09	60° 38.472'S 042° 09.619'W	3178	Downcast started
		28/01/2019 01:39:45	60° 38.472'S 042° 09.623'W	3190	Bottom
		28/01/2019 02:58:17	60° 38.472'S 042° 09.622'W	3173	End of upcast
18	VMP 6	28/01/2019 04:35:00	60° 37.580'S 042° 04.957'W	3600	VMP deployed
		28/01/2019 08:40:00	60° 37.327'S 042° 05.940'W	3586	VMP recovered
19	CTD 6	28/01/2019 05:01:53	60° 37.736'S 042° 04.748'W	3628	Logging started
		28/01/2019 05:07:06	60° 37.735'S 042° 04.746'W	3629	Downcast started
		28/01/2019 06:27:52	60° 37.733'S 042° 04.748'W	3630	Bottom
		28/01/2019 07:59:35	60° 37.735'S 042° 04.746'W	3628	End of upcast
20	CTD 7	28/01/2019 09:35:19	60° 36.208'S 041° 58.504'W	3402	Logging started
		28/01/2019 09:42:33	60° 36.196'S 041° 58.516'W	----	Downcast started
		28/01/2019 10:56:06	60° 36.185'S 041° 58.523'W	3407	Bottom
		28/01/2019 12:17:40	60° 36.184'S 041° 58.523'W	3407	End of upcast
21	CTD 8	28/01/2019 14:17:14	60° 34.915'S 041° 49.100'W	----	Logging started
		28/01/2019 14:20:32	60° 34.916'S 041° 49.100'W	----	Downcast started
		28/01/2019 15:22:59	60° 34.950'S 041° 49.060'W	2879	Bottom
		28/01/2019 16:53:25	60° 35.002'S 041° 49.034'W	2876	End of upcast
22	OP2 mooring deployment	28/01/2019 19:56	60° 39.539'S 042° 08.539'W	3054	Deployment started
		28/01/2019 21:19	60° 38.452'S 042° 10.218'W	3149	Deployment complete
23	CTD 9	28/01/2019 23:48:36	60° 39.001'S 042° 11.393'W	2516	Logging started
		28/01/2019 23:54:04	60° 39.002'S 042° 11.394'W	2525	Downcast started
		29/01/2019 00:52:56	60° 39.001'S 042° 11.394'W	2530	Bottom
		29/01/2019 01:55:29	60° 39.001'S 042° 11.390'W	2515	End of upcast
24	CTD 10	29/01/2019 02:56:09	60° 39.943'S 042° 15.348'W	1512	Logging started
		29/01/2019 02:59:54	60° 39.946'S 042° 15.353'W	1510	Downcast started
		29/01/2019 03:36:16	60° 39.929'S 042° 15.415'W	1514	Bottom
		29/01/2019 04:21:10	60° 39.906'S 042° 15.564'W	1506	End of upcast

Bridge event number	Event	Time (UTC)	Position	Water depth (EM122)	Description/notes
25	CTD 11	29/01/2019 05:28:14	60° 38.141'S 042° 08.672'W	3406	Logging started
		29/01/2019 05:32:13	60° 38.138'S 042° 08.675'W	3406	Downcast started
		29/01/2019 06:45:09	60° 38.098'S 042° 08.777'W	3391	Bottom
		29/01/2019 08:11:40	60° 38.077'S 042° 08.776'W	3374	End of upcast
26	OP1 mooring recovery	29/01/2019 11:30:00	60° 38.227'S 042° 06.209'W	----	Mooring released
		29/01/2019 11:48:00	60° 38.226'S 042° 06.211'W	3680	Mooring at surface
		29/01/2019 12:31:00	60° 38.034'S 042° 05.346'W	3671	Mooring hooked
		29/01/2019 14:02:00	60° 38.102'S 042° 04.756'W	3709	Recovery complete
27	OP3 mooring recovery	29/01/2019 15:21:00	60° 38.955'S 042° 14.600'W	----	Mooring released
		29/01/2019 15:34:00	60° 38.953'S 042° 14.603'W	----	Mooring at surface
		29/01/2019 16:01:00	60° 39.383'S 042° 13.997'W	1715	Mooring hooked
		29/01/2019 16:30:00	60° 39.523'S 042° 13.767'W	1702	Recovery complete
28	OP4 mooring recovery	29/01/2019 18:30:00	60° 34.908'S 041° 49.962'W	----	Mooring released
		29/01/2019 18:49:00	60° 34.913'S 041° 50.464'W	2974	Mooring at surface
		29/01/2019 19:10:00	60° 35.478'S 041° 49.268'W	2923	Mooring hooked
		29/01/2019 20:02:00	60° 35.951'S 041° 48.969'W	2945	Recovery complete
29	OP5 mooring recovery	29/01/2019 21:19:00	60° 36.140'S 041° 58.696'W	----	Mooring released
		29/01/2019 21:54:00	60° 36.088'S 041° 58.662'W	3418	Mooring at surface
		29/01/2019 22:11:00	60° 36.787'S 041° 58.531'W	3384	Mooring hooked
		29/01/2019 22:30:00	60° 37.056'S 041° 58.627'W	3366	Recovery complete
30	VMP 12	29/01/2019 23:40:00	60° 37.927'S 042° 06.882'W	3567	VMP deployed
		30/01/2019 03:40:00	60° 36.614'S 042° 08.791'W	3561	VMP recovered
31	CTD 12	30/01/2019 00:07:51	60° 38.027'S 042° 06.844'W	3622	Logging started
		30/01/2019 00:11:49	60° 38.027'S 042° 06.845'W	3621	Downcast started
		30/01/2019 01:20:23	60° 38.023'S 042° 06.844'W	3619	Bottom
		30/01/2019 02:45:04	60° 38.024'S 042° 06.840'W	3621	End of upcast
32	VMP 13	30/01/2019 05:05:00	60° 36.982'S 042° 00.631'W	3444	VMP deployed
		30/01/2019 08:44:00	60° 36.660'S 042° 00.998'W	3468	VMP recovered
33	CTD 13	30/01/2019 05:26:56	60° 37.088'S 042° 00.584'W	3437	Logging started
		30/01/2019 05:31:46	60° 37.087'S 042° 00.587'W	3440	Downcast started
		30/01/2019 06:40:29	60° 37.082'S 042° 00.588'W	3439	Bottom
		30/01/2019 08:04:04	60° 37.081'S 042° 00.587'W	3436	End of upcast

Bridge event number	Event	Time (UTC)	Position	Water depth (EM122)	Description/notes
34	CTD 14	30/01/2019 11:15:07 30/01/2019 11:20:04 30/01/2019 12:11:12 30/01/2019 13:11:42	60° 33.313'S 041° 37.518'W 60° 33.314'S 041° 37.519'W 60° 33.316'S 041° 37.514'W 60° 33.317'S 041° 37.522'W	2286 2287 2290 2287	Logging started Downcast started Bottom End of upcast
35	VMP 15	31/01/2019 02:48:00 31/01/2019 07:04:00	61° 21.737'S 038° 07.568'W 61° 22.640'S 038° 06.618'W	3963 3932	VMP deployed VMP recovered
36	CTD 15	31/01/2019 03:10:02 31/01/2019 03:13:11 31/01/2019 04:38:02 31/01/2019 06:06:17	61° 21.756'S 038° 07.686'W 61° 21.756'S 038° 07.686'W 61° 21.773'S 038° 07.667'W 61° 21.798'S 038° 07.620'W	3986 3988 3987 3976	Logging started Downcast started Bottom End of upcast
37	CTD 16 – attempt 1	31/01/2019 10:17:00 31/01/2019 10:32:00	60° 59.976'S 038° 35.993'W 60° 59.995'S 038° 35.998'W	3919 3926	CTD deployed CTD recovered due to comms issues
38	CTD 16	31/01/2019 13:31:42 31/01/2019 13:35:45 31/01/2019 14:49:28 31/01/2019 16:10:51	60° 59.998'S 038° 36.008'W 60° 59.999'S 038° 36.006'W 60° 59.998'S 038° 36.013'W 60° 59.999'S 038° 36.006'W	3927 3925 3926 3930	Logging started Downcast started Bottom End of upcast
39	Glider 352 deployment	31/01/2019 16:55:00 31/01/2019 16:57:00 31/01/2019 21:57:00 31/01/2019 22:00:00	61° 00.004'S 038° 36.005'W 61° 00.022'S 038° 36.007'W 61° 01.430'S 038° 36.183'W 61° 01.435'S 038° 36.201'W	3931 3939 3962 3965	Glider off deck Glider deployed Glider in net Glider recovered
40	VMP 17	01/02/2019 03:40:00 01/02/2019 09:04:00	61° 42.011'S 037° 30.067'W 61° 41.467'S 037° 29.850'W	5422 5419	VMP deployed VMP recovered
41	CTD 17	01/02/2019 03:57:20 01/02/2019 04:01:06 01/02/2019 06:04:06 01/02/2019 08:27:39	61° 42.136'S 037° 30.115'W 61° 42.137'S 037° 30.115'W 61° 42.136'S 037° 30.116'W 61° 42.137'S 037° 30.116'W	5412 5419 5428 5420	Logging started Downcast started Bottom End of upcast
42	Glider 400 deployment	01/02/2019 11:10:00 01/02/2019 11:13:00	61° 41.996'S 037° 29.986'W 61° 42.012'S 037° 29.990'W	---- 5418	Glider off deck Glider deployed
43	Float 8136 deployment	01/02/2019 18:08:00 01/02/2019 18:10:00	60° 50.962'S 037° 11.971'W 60° 50.972'S 037° 11.973'W	705 707	Float off deck Float deployed

Bridge event number	Event	Time (UTC)	Position	Water depth (EM122)	Description/notes
44	CTD 18	01/02/2019 18:40:12	60° 51.121'S 037° 12.041'W	689	Logging started
		01/02/2019 18:44:00	60° 51.121'S 037° 12.038'W	689	Downcast started
		01/02/2019 19:05:45	60° 51.121'S 037° 12.043'W	690	Bottom
		01/02/2019 19:51:12	60° 51.122'S 037° 12.041'W	690	End of upcast
45	VMP 19	01/02/2019 23:45:00	60° 36.092'S 037° 59.960'W	2568	VMP deployed
		02/02/2019 03:00:00	60° 36.338'S 038° 01.111'W	2563	VMP recovered
46	CTD 19	01/02/2019 23:53:14	60° 36.110'S 037° 59.917'W	2570	Logging started
		01/02/2019 23:56:29	60° 36.109'S 037° 59.915'W	2570	Downcast started
		02/02/2019 00:49:25	60° 36.110'S 037° 59.918'W	2570	Bottom
		02/02/2019 02:13:55	60° 36.114'S 037° 59.914'W	2570	End of upcast
47	VMP 20	02/02/2019 06:52:00	60° 06.701'S 037° 02.463'W	2606	VMP deployed
		02/02/2019 09:52:00	60° 06.965'S 037° 02.152'W	----	VMP recovered
48	CTD 20	02/02/2019 07:11:11	60° 06.808'S 037° 02.714'W	2608	Logging started
		02/02/2019 07:14:22	60° 06.810'S 037° 02.732'W	2607	Downcast started
		02/02/2019 08:05:19	60° 06.790'S 037° 02.900'W	2611	Bottom
		02/02/2019 09:15:04	60° 06.746'S 037° 02.867'W	2613	End of upcast
49	Glider 631 deployment	02/02/2019 11:07:00	60° 06.965'S 037° 02.156'W	----	Glider off deck
		02/02/2019 11:09:00	60° 06.964'S 037° 02.157'W	----	Glider deployed
50	CTD 21	02/02/2019 16:22:16	60° 17.990'S 035° 54.001'W	----	Logging started
		02/02/2019 16:27:01	60° 17.990'S 035° 54.002'W	----	Downcast started
		02/02/2019 16:48:18	60° 17.990'S 035° 54.001'W	----	Bottom
		02/02/2019 17:16:27	60° 17.989'S 035° 53.977'W	556	End of upcast
51	CTD 22	02/02/2019 19:20:02	60° 24.764'S 035° 18.889'W	2738	Logging started
		02/02/2019 19:25:06	60° 24.776'S 035° 18.904'W	2747	Downcast started
		02/02/2019 20:24:57	60° 24.775'S 035° 18.904'W	----	Bottom
		02/02/2019 21:28:36	60° 24.775'S 035° 18.906'W	2756	End of upcast
52	Float 8135 deployment	02/02/2019 21:42:00	60° 24.785'S 035° 18.913'W	2744	Float off deck
		02/02/2019 21:50:00	60° 24.874'S 035° 19.049'W	2746	Float deployed
53	VMP 23	03/02/2019 00:28:00	60° 38.786'S 034° 55.240'W	4443	VMP deployed
		03/02/2019 04:57:00	60° 39.015'S 034° 54.580'W	4349	VMP recovered

Bridge event number	Event	Time (UTC)	Position	Water depth (EM122)	Description/notes
54	CTD 23	03/02/2019 00:48:09	60° 38.906'S 034° 55.456'W	4832	Logging started
		03/02/2019 00:53:03	60° 38.906'S 034° 55.458'W	4508	Downcast started
		03/02/2019 02:23:43	60° 38.905'S 034° 55.460'W	4460	Bottom
		03/02/2019 04:04:38	60° 38.882'S 034° 55.427'W	4502	End of upcast
55	VMP 24	03/02/2019 07:14:00	60° 49.709'S 034° 34.529'W	3421	VMP deployed
		03/02/2019 10:28:00	60° 49.100'S 034° 33.274'W	3764	VMP recovered
56	CTD 24	03/02/2019 07:28:34	60° 49.764'S 034° 34.696'W	3294	Logging started
		03/02/2019 07:31:38	60° 49.766'S 034° 34.705'W	3276	Downcast started
		03/02/2019 08:38:39	60° 49.764'S 034° 34.685'W	3304	Bottom
		03/02/2019 09:51:06	60° 49.770'S 034° 34.700'W	3278	End of upcast
57	CTD 25	03/02/2019 15:15:07	60° 30.016'S 032° 53.995'W	3535	Logging started
		03/02/2019 15:19:12	60° 30.014'S 032° 53.995'W	3542	Downcast started
		03/02/2019 16:29:28	60° 30.018'S 032° 53.999'W	3527	Bottom
		03/02/2019 17:51:56	60° 30.017'S 032° 54.000'W	3528	End of upcast
58	CTD 26	03/02/2019 22:29:32	59° 51.004'S 033° 51.010'W	1262	Logging started
		03/02/2019 22:33:22	59° 51.004'S 033° 51.010'W	1262	Downcast started
		03/02/2019 23:02:06	59° 51.004'S 033° 51.011'W	1265	Bottom
		03/02/2019 23:39:15	59° 51.004'S 033° 51.011'W	1265	End of upcast
59	VMP 26	03/02/2019 23:48:00	59° 50.995'S 033° 50.994'W	1299	VMP deployed
		04/02/2019 00:58:00	59° 50.904'S 033° 51.118'W	1276	VMP recovered
60	CTD 27	04/02/2019 03:42:20	59° 50.543'S 034° 41.453'W	2048	Logging started
		04/02/2019 03:45:39	59° 50.542'S 034° 41.453'W	2046	Downcast started
		04/02/2019 04:27:15	59° 50.552'S 034° 41.455'W	2047	Bottom
		04/02/2019 05:16:39	59° 50.557'S 034° 41.458'W	2043	End of upcast
61	VMP 28	04/02/2019 09:17:00	59° 50.440'S 035° 47.287'W	2007	VMP deployed
		04/02/2019 11:28:00	59° 51.429'S 035° 44.726'W	1976	VMP recovered
62	CTD 28	04/02/2019 09:30:52	59° 50.426'S 035° 47.430'W	2011	Logging started
		04/02/2019 09:34:14	59° 50.426'S 035° 47.429'W	2008	Downcast started
		04/02/2019 10:18:40	59° 50.446'S 035° 47.434'W	2008	Bottom
		04/02/2019 11:06:38	59° 50.455'S 035° 47.426'W	2007	End of upcast
63	VMP 29	04/02/2019 13:19:00	59° 58.925'S 035° 30.742'W	1457	VMP deployed
		04/02/2019 15:09:00	59° 58.793'S 035° 30.927'W	1474	VMP recovered

Bridge event number	Event	Time (UTC)	Position	Water depth (EM122)	Description/notes
64	CTD 29	04/02/2019 13:36:18 04/02/2019 13:40:25 04/02/2019 14:13:02 04/02/2019 14:48:10	59° 58.927'S 035° 30.852'W 59° 58.928'S 035° 30.852'W 59° 58.927'S 035° 30.852'W 59° 59.005'S 035° 30.956'W	1459 1459 1458 1457	Logging started Downcast started Bottom End of upcast
65	VMP 30	04/02/2019 16:40:00 04/02/2019	60° 07.357'S 035° 18.207'W Not recorded	1551 ----	VMP deployed VMP recovered
66	CTD 30	04/02/2019 16:51:12 04/02/2019 16:54:27 04/02/2019 17:26:01 04/02/2019 18:06:08	60° 07.266'S 035° 18.268'W 60° 07.266'S 035° 18.268'W 60° 07.265'S 035° 18.269'W 60° 07.261'S 035° 18.269'W	1511 1518 1517 1513	Logging started Downcast started Bottom End of upcast
67	VMP 31	04/02/2019 19:42:00 04/02/2019 21:38:00	60° 10.318'S 035° 13.214'W 60° 10.672'S 035° 12.025'W	1090 601	VMP deployed VMP recovered
68	CTD 31	04/02/2019 20:00:05 04/02/2019 20:04:05 04/02/2019 20:32:25 04/02/2019 21:04:45	60° 10.292'S 035° 13.381'W 60° 10.298'S 035° 13.381'W 60° 10.300'S 035° 13.381'W 60° 10.391'S 035° 13.254'W	1122 1121 1119 1050	Logging started Downcast started Bottom End of upcast
69	CTD 32	05/02/2019 05:10:06 05/02/2019 05:13:23 05/02/2019 07:06:53 05/02/2019 09:05:40	61° 23.996'S 036° 05.988'W 61° 23.995'S 036° 05.986'W 61° 23.998'S 036° 05.988'W 61° 23.995'S 036° 05.990'W	5492 5482 5442 5458	Logging started Downcast started Bottom End of upcast
70	VMP 33	05/02/2019 10:35:00 05/02/2019 14:20:00	61° 18.450'S 036° 17.231'W 61° 18.298'S 036° 15.207'W	4016 4012	VMP deployed VMP recovered
71	CTD 33	05/02/2019 10:48:13 05/02/2019 10:51:05 05/02/2019 12:11:37 05/02/2019 13:38:36	61° 18.450'S 036° 17.245'W 61° 18.451'S 036° 17.244'W 61° 18.431'S 036° 17.047'W 61° 18.434'S 036° 17.042'W	4017 4014 3996 4000	Logging started Downcast started Bottom End of upcast
72	CTD 34 - attempt 1	05/02/2019 17:18:00 05/02/2019 17:27:00	61° 05.854'S 036° 42.289'W 61° 05.856'S 036° 42.283'W	1870 1871	CTD off deck CTD recovered to deck, wire damaged
73	VMP 34	05/02/2019 18:11:00 05/02/2019 19:56:00	61° 05.857'S 036° 42.310'W 61° 05.267'S 036° 41.366'W	1866 1771	VMP deployed VMP recovered

Bridge event number	Event	Time (UTC)	Position	Water depth (EM122)	Description/notes
74	CTD 34	05/02/2019 22:25:46	61° 05.903'S 036° 42.494'W	1835	Logging started
		05/02/2019 22:28:36	61° 05.903'S 036° 42.492'W	1830	Downcast started*
		05/02/2019 23:10:55	61° 05.904'S 036° 42.494'W	1835	Bottom
		06/02/2019 00:02:15	61° 05.890'S 036° 42.500'W	1834	End of upcast
75	CTD 35	06/02/2019 07:27:04	61° 07.433'S 036° 39.278'W	3052	Logging started
		06/02/2019 07:30:09	61° 07.434'S 036° 39.277'W	3042	Downcast started
		06/02/2019 08:35:48	61° 07.436'S 036° 39.276'W	3047	Bottom
		06/02/2019 09:53:31	61° 07.436'S 036° 39.277'W	3051	End of upcast
76	VMP 36	06/02/2019 10:53:00	61° 04.514'S 036° 45.064'W	819	VMP deployed
		06/02/2019 11:38:00	61° 04.471'S 036° 44.864'W	821	VMP recovered
77	CTD 36	06/02/2019 11:59:53	61° 04.519'S 036° 45.083'W	819	Logging started
		06/02/2019 12:01:54	61° 04.524'S 036° 45.078'W	818	Downcast started*
		06/02/2019 12:20:49	61° 04.524'S 036° 45.078'W	818	Bottom
		06/02/2019 12:52:21	61° 04.523'S 036° 45.085'W	819	End of upcast
78	VMP 37	06/02/2019 16:16:00	61° 08.644'S 037° 43.347'W	1213	VMP deployed
		06/02/2019 18:27:00	61° 08.888'S 037° 42.814'W	1258	VMP recovered
79	CTD 37	06/02/2019 16:30:08	61° 08.642'S 037° 43.589'W	1296	Logging started
		06/02/2019 16:32:01	61° 08.642'S 037° 43.590'W	1296	Downcast started*
		06/02/2019 17:02:42	61° 08.642'S 037° 43.591'W	1296	Bottom
		06/02/2019 17:39:56	61° 08.642'S 037° 43.590'W	1295	End of upcast
80	VMP 38	06/02/2019 19:50:00	61° 13.987'S 037° 53.647'W	1472	VMP deployed
		06/02/2019 21:50:00	61° 14.201'S 037° 52.494'W	1420	VMP recovered
81	CTD 38	06/02/2019 20:09:02	61° 13.985'S 037° 53.649'W	1474	Logging started
		06/02/2019 20:11:48	61° 13.986'S 037° 53.648'W	1471	Downcast started*
		06/02/2019 20:39:02	61° 13.986'S 037° 53.648'W	1471	Bottom
		06/02/2019 21:16:52	61° 14.029'S 037° 53.384'W	1477	End of upcast
82	VMP 39	06/02/2019 22:38:00	61° 15.278'S 037° 56.050'W	2016	VMP deployed
		07/02/2019 00:57:00	61° 15.436'S 037° 54.966'W	1774	VMP recovered

* CTD not brought to surface before start of downcast

Bridge event number	Event	Time (UTC)	Position	Water depth (EM122)	Description/notes
83	CTD 39	06/02/2019 22:48:41	61° 15.272'S 037° 56.047'W	2015	Logging started
		06/02/2019 22:53:23	61° 15.272'S 037° 56.047'W	2016	Downcast started
		06/02/2019 23:31:32	61° 15.362'S 037° 56.090'W	2014	Bottom
		07/02/2019 00:24:28	61° 15.361'S 037° 56.089'W	2010	End of upcast
84	CTD 40	07/02/2019 02:07:18	61° 19.654'S 038° 04.164'W	3121	Logging started
		07/02/2019 02:11:23	61° 19.654'S 038° 04.165'W	3118	Downcast started
		07/02/2019 03:09:56	61° 19.721'S 038° 04.116'W	3149	Bottom
		07/02/2019 04:18:49	61° 19.902'S 038° 03.826'W	3147	End of upcast
85	VMP 41	07/02/2019 09:26:00	60° 39.865'S 037° 47.617'W	1969	VMP deployed
		07/02/2019 11:42:00	60° 39.569'S 037° 47.069'W	1954	VMP recovered
86	CTD 41	07/02/2019 09:42:30	60° 39.870'S 037° 47.672'W	1970	Logging started
		07/02/2019 09:46:16	60° 39.872'S 037° 47.674'W	1971	Downcast started
		07/02/2019 10:22:20	60° 39.869'S 037° 47.674'W	1970	Bottom
		07/02/2019 11:12:42	60° 39.881'S 037° 47.428'W	1956	End of upcast
87	Glider 352 deployment	07/02/2019 11:50:00	60° 39.545'S 037° 47.079'W	1956	Glider off deck
		07/02/2019 11:53:00	60° 39.549'S 037° 47.134'W	1961	Glider deployed
88	VMP 42	07/02/2019 16:19:00	60° 43.658'S 037° 35.356'W	1675	VMP deployed
		07/02/2019 18:59:00	60° 43.817'S 037° 33.967'W	1644	VMP recovered
89	CTD 42	07/02/2019 16:47:59	60° 43.669'S 037° 35.527'W	1673	Logging started
		07/02/2019 16:50:41	60° 43.669'S 037° 35.526'W	1672	Downcast started*
		07/02/2019 17:36:12	60° 43.669'S 037° 35.521'W	1674	Bottom
		07/02/2019 18:23:33	60° 43.694'S 037° 35.344'W	1685	End of upcast
90	VMP 43	07/02/2019 20:52:00	60° 46.635'S 037° 22.097'W	1462	VMP deployed
		07/02/2019 22:39:00	60° 46.645'S 037° 21.168'W	1419	VMP recovered
91	CTD 43	07/02/2019 21:06:32	60° 46.631'S 037° 22.140'W	1474	Logging started
		07/02/2019 21:10:37	60° 46.637'S 037° 22.135'W	1464	Downcast started
		07/02/2019 21:37:21	60° 46.637'S 037° 22.139'W	1466	Bottom
		07/02/2019 22:15:58	60° 46.669'S 037° 21.974'W	1449	End of upcast
92	VMP 44	07/02/2019 23:34:00	60° 49.988'S 037° 16.921'W	997	VMP deployed
		08/02/2019 01:25:00	60° 49.699'S 037° 15.932'W	987	VMP recovered

Bridge event number	Event	Time (UTC)	Position	Water depth (EM122)	Description/notes
93	CTD 44	07/02/2019 23:47:24	60° 49.993'S 037° 16.986'W	997	Logging started
		07/02/2019 23:51:15	60° 49.996'S 037° 16.987'W	995	Downcast started
		08/02/2019 00:11:01	60° 50.035'S 037° 16.991'W	991	Bottom
		08/02/2019 00:43:28	60° 50.071'S 037° 16.926'W	984	End of upcast
94	CTD 45	08/02/2019 05:31:45	61° 01.816'S 038° 06.883'W	1440	Logging started
		08/02/2019 05:35:36	61° 01.818'S 038° 06.904'W	1434	Downcast started
		08/02/2019 06:02:41	61° 01.838'S 038° 07.004'W	1411	Bottom
		08/02/2019 06:39:45	61° 01.864'S 038° 07.124'W	1402	End of upcast
95	CTD 46	08/02/2019 07:39:57	61° 01.226'S 038° 16.819'W	2586	Logging started
		08/02/2019 07:43:30	61° 01.219'S 038° 16.834'W	2589	Downcast started
		08/02/2019 08:30:42	61° 01.220'S 038° 16.837'W	2591	Bottom
		08/02/2019 09:28:32	61° 01.212'S 038° 16.830'W	2594	End of upcast
96	VMP 47	08/02/2019 11:16:00	61° 00.019'S 038° 36.014'W	3936	VMP deployed
		08/02/2019 14:44:00	61° 00.160'S 038° 36.665'W	3933	VMP recovered
97	CTD 47	08/02/2019 11:34:56	61° 00.019'S 038° 36.121'W	3935	Logging started
		08/02/2019 11:38:27	61° 00.018'S 038° 36.119'W	3935	Downcast started
		08/02/2019 12:56:25	61° 00.097'S 038° 36.018'W	3942	Bottom
		08/02/2019 14:20:43	61° 00.061'S 038° 36.206'W	3940	End of upcast
98	Glider 352 recovery	08/02/2019 19:03:00	60° 42.200'S 037° 22.160'W	1110	Streaming astern
		08/02/2019 19:10:00	60° 42.161'S 037° 22.304'W	1108	Glider on deck
99	CTD 48	09/02/2019 08:34:08	60° 31.780'S 041° 22.757'W	1937	Logging started
		09/02/2019 08:37:39	60° 31.783'S 041° 22.763'W	1937	Downcast started
		09/02/2019 09:14:28	60° 31.800'S 041° 22.792'W	1937	Bottom
		09/02/2019 10:01:04	60° 31.800'S 041° 22.798'W	1937	End of upcast
100	OP6 mooring deployment	09/02/2019 11:46:00	60° 34.393'S 041° 37.362'W	2356	Deployment started
		09/02/2019 12:28:00	60° 33.724'S 041° 38.078'W	2308	Deployment complete
101	OP4 mooring deployment	09/02/2019 15:10:00	60° 35.932'S 041° 51.992'W	3083	Deployment started
		09/02/2019 16:03:00	60° 35.492'S 041° 50.207'W	2970	Deployment complete
102	OP5 mooring deployment	09/02/2019 17:14:00	60° 36.802'S 041° 59.713'W	3414	Deployment started
		09/02/2019 17:45:00	60° 36.633'S 041° 58.855'W	3397	Deployment complete
103	VMP 49	09/02/2019 19:38:00	60° 36.877'S 042° 02.036'W	3496	VMP deployed
		09/02/2019 22:53:00	60° 36.987'S 042° 02.465'W	3513	VMP recovered

Bridge event number	Event	Time (UTC)	Position	Water depth (EM122)	Description/notes
104†	CTD 49	09/02/2019 19:58:10	60° 36.878'S 042° 02.051'W	3497	Logging started
		09/02/2019 20:01:24	60° 36.877'S 042° 02.051'W	3500	Downcast started
		09/02/2019 21:05:01	60° 36.881'S 042° 02.232'W	3506	Bottom
		09/02/2019 22:16:19	60° 36.972'S 042° 01.986'W	3495	End of upcast
104†	CTD 50	09/02/2019 23:38:49	60° 36.224'S 041° 55.603'W	3323	Logging started
		09/02/2019 23:42:26	60° 36.223'S 041° 55.606'W	3320	Downcast started
		10/02/2019 00:41:33	60° 36.222'S 041° 55.642'W	3321	Bottom
		10/02/2019 01:54:02	60° 36.216'S 041° 55.660'W	3323	End of upcast
105	CTD 51	10/02/2019 03:12:08	60° 35.842'S 041° 52.616'W	3139	Logging started
		10/02/2019 03:15:59	60° 35.842'S 041° 52.615'W	3134	Downcast started
		10/02/2019 04:10:09	60° 35.851'S 041° 52.613'W	3164	Bottom
		10/02/2019 05:18:08	60° 35.857'S 041° 52.612'W	3137	End of upcast
106	CTD 52	10/02/2019 06:14:32	60° 34.826'S 041° 45.870'W	2646	Logging started
		10/02/2019 06:18:08	60° 34.826'S 041° 45.872'W	2647	Downcast started
		10/02/2019 07:06:08	60° 34.826'S 041° 45.871'W	2647	Bottom
		10/02/2019 08:04:30	60° 34.829'S 041° 45.872'W	2645	End of upcast
107	OP1 mooring deployment	10/02/2019 12:27:00	60° 37.732'S 042° 08.064'W	3499	Deployment started
		10/02/2019 14:03:00	60° 37.773'S 042° 05.074'W	3649	Deployment complete
108	OP3 mooring deployment	10/02/2019 15:56:00	60° 39.721'S 042° 15.242'W	1600	Deployment started
		10/02/2019 16:51:00	60° 39.341'S 042° 13.558'W	1774	Deployment complete
109	VMP 53	10/02/2019 18:09:00	60° 39.976'S 042° 18.730'W	1492	VMP deployed
		10/02/2019 20:04:00	60° 40.081'S 042° 19.046'W	1411	VMP recovered
110	CTD 53	10/02/2019 18:29:50	60° 40.061'S 042° 18.607'W	1486	Logging started
		10/02/2019 18:33:16	60° 40.062'S 042° 18.606'W	1481	Downcast started
		10/02/2019 19:02:12	60° 40.063'S 042° 18.610'W	1482	Bottom
		10/02/2019 19:42:11	60° 40.062'S 042° 18.612'W	1484	End of upcast
111	CTD 54	11/02/2019 01:24:17	60° 34.259'S 041° 41.822'W	2453	Logging started
		11/02/2019 01:27:55	60° 34.258'S 041° 41.824'W	2452	Downcast started
		11/02/2019 02:10:40	60° 34.316'S 041° 41.881'W	2457	Bottom
		11/02/2019 03:06:48	60° 34.387'S 041° 41.942'W	2460	End of upcast

† Duplicate number on bridge event log

Bridge event number	Event	Time (UTC)	Position	Water depth (EM122)	Description/notes
112	CTD 55	11/02/2019 05:13:58	60° 40.553'S 042° 08.494'W	2700	Logging started
		11/02/2019 05:16:54	60° 40.552'S 042° 08.492'W	2700	Downcast started
		11/02/2019 06:03:48	60° 40.531'S 042° 08.512'W	2704	Bottom
		11/02/2019 07:03:39	60° 40.452'S 042° 08.750'W	2670	End of upcast
113	CTD 56	11/02/2019 07:40:02	60° 40.742'S 042° 09.512'W	2313	Logging started
		11/02/2019 07:43:12	60° 40.741'S 042° 09.514'W	2330	Downcast started
		11/02/2019 08:26:58	60° 40.742'S 042° 09.515'W	2038	Bottom
		11/02/2019 09:16:31	60° 40.742'S 042° 09.511'W	2319	End of upcast
114	CTD 57	11/02/2019 09:50:40	60° 40.915'S 042° 10.558'W	1779	Logging started
		11/02/2019 09:53:48	60° 40.916'S 042° 10.558'W	1787	Downcast started
		11/02/2019 10:26:54	60° 40.918'S 042° 10.556'W	1785	Bottom
		11/02/2019 11:05:56	60° 40.916'S 042° 10.558'W	1788	End of upcast
115	VMP 58	11/02/2019 12:06:00	60° 40.732'S 042° 09.488'W	2332	VMP deployed
		11/02/2019 14:10:00	60° 40.568'S 042° 09.797'W	2294	VMP recovered
116	CTD 58	11/02/2019 12:21:49	60° 40.727'S 042° 09.407'W	2366	Logging started
		11/02/2019 12:25:04	60° 40.727'S 042° 09.406'W	2368	Downcast started
		11/02/2019 13:06:50	60° 40.753'S 042° 09.454'W	2336	Bottom
		11/02/2019 13:47:08	60° 40.752'S 042° 09.452'W	2336	End of upcast
117	VMP 59	11/02/2019 14:47:00	60° 40.556'S 042° 08.492'W	2696	VMP deployed
		11/02/2019 17:24:00	60° 40.056'S 042° 09.024'W	2606	VMP recovered
118	CTD 59	11/02/2019 15:09:39	60° 40.549'S 042° 08.338'W	2727	Logging started
		11/02/2019 15:12:49	60° 40.548'S 042° 08.339'W	2703	Downcast started
		11/02/2019 15:59:54	60° 40.549'S 042° 08.360'W	2722	Bottom
		11/02/2019 16:47:12	60° 40.511'S 042° 08.652'W	2609	End of upcast
119	CTD 60	11/02/2019 17:54:18	60° 40.738'S 042° 09.527'W	2325	Logging started
		11/02/2019 17:57:21	60° 40.738'S 042° 09.526'W	2322	Downcast started
		11/02/2019 18:38:49	60° 40.738'S 042° 09.512'W	2310	Bottom
		11/02/2019 19:24:21	60° 40.716'S 042° 09.467'W	2338	End of upcast
120	VMP 61	11/02/2019 20:08:00	60° 40.897'S 042° 10.495'W	1803	VMP deployed
		11/02/2019 21:59:00	60° 40.485'S 042° 10.734'W	1925	VMP recovered

Bridge event number	Event	Time (UTC)	Position	Water depth (EM122)	Description/notes
121	CTD 61	11/02/2019 20:25:17	60° 40.936'S 042° 10.526'W	1758	Logging started
		11/02/2019 20:27:58	60° 40.936'S 042° 10.525'W	1772	Downcast started
		11/02/2019 21:00:41	60° 40.880'S 042° 10.471'W	1809	Bottom
		11/02/2019 21:31:56	60° 40.720'S 042° 10.510'W	1923	End of upcast
122	CTD62 (tow-yo)	11/02/2019 22:29:18	60° 40.893'S 042° 10.494'W	1804	Logging started 06201
		11/02/2019 23:03:36	60° 40.919'S 042° 10.539'W	1786	At bottom
		11/02/2019 23:21:03	60° 40.892'S 042° 10.389'W	1827	At 1000 m
		11/02/2019 23:35:41	60° 40.865'S 042° 10.252'W	1916	At bottom 06202
		11/02/2019 23:58:50	60° 40.825'S 042° 10.030'W	2034	At 1000 m
		12/02/2019 00:09:41	60° 40.805'S 042° 09.929'W	2106	At bottom 06203
		12/02/2019 00:28:42	60° 40.771'S 042° 09.748'W	2211	At 1000 m
		12/02/2019 00:49:11	60° 40.733'S 042° 09.553'W	2295	At bottom 06204
		12/02/2019 01:11:25	60° 40.694'S 042° 09.342'W	2373	At 1000 m
		12/02/2019 01:35:00	60° 40.653'S 042° 09.119'W	2457	At bottom 06205
		12/02/2019 02:00:35	60° 40.607'S 042° 08.876'W	2557	At 1000 m
		12/02/2019 02:27:30	60° 40.563'S 042° 08.617'W	2654	At bottom 06206
		12/02/2019 03:17:20	60° 40.500'S 042° 08.260'W	2762	End of upcast
					Times etc. from logsheets

Appendix B: SADCP log

Configuration note: 800 m depth with 8m bins. BT = bottom-tracking; WT = water-tracking.

Seq.	Times	Configuration	Comment
001	07/01/2019 16:53	BT	Logging started
001	08/01/2019 05:34	BT	Logging stopped
002	09/01/2019 22:31	BT	Logging started
002	10/01/2019 11:59	BT	Logging stopped
003	10/01/2019 12:00	WT	Logging started
003	11/01/2019 17:33	WT	Logging stopped
004	11/01/2019 17:34	WT	Logging started
004	12/01/2019 19:24	WT	Logging stopped
005	12/01/2019 19:25	BT	Logging started
005	13/01/2019 07:18	BT	Logging stopped
006	13/01/2019 07:19	WT	Logging started
006	13/01/2019 20:30	WT	Logging stopped
007	13/01/2019 20:31	WT	Logging started
007	14/01/2019 21:54	WT	Logging stopped
008	14/01/2019 21:56	WT	Logging started
008	15/01/2019 14:41	WT	Logging stopped
009	15/01/2019 14:42	WT	Logging started
009	16/01/2019 10:05	WT	Logging stopped
010	16/01/2019 10:06	WT	Logging started
010	16/01/2019 19:21	WT	ADCP appears to have frozen at 11:39:46. Restarting VMDAS.
011	16/01/2019 19:23	WT	Logging started
011	17/01/2019 10:01	WT	ADCP froze at 23:00:08.
012	17/01/2019 10:02	WT	Logging started
012	18/01/2019 09:28	WT	Logging stopped
013	18/01/2019 09:30	WT	Logging started
013	19/01/2019 01:43	WT	Logging stopped
014	19/01/2019 01:44	BT	Logging started
014	19/01/2019 10:21	BT	Logging stopped - switched off ADCP
015	20/01/2019 20:58	BT	Logging started
015	21/01/2019 10:58	BT	Logging stopped
016	21/01/2019 10:59	WT	Logging started
016	22/01/2019 17:41	WT	Logging stopped
017	22/01/2019 17:42	WT	Logging started
017	23/01/2019 10:51	WT	Logging stopped
018	23/01/2019 10:52	BT	Logging started
018	23/01/2019 13:25	BT	Logging stopped. At King Edward Point
019	23/01/2019 19:42	BT	Logging started
019	24/01/2019 08:40	BT	ADCP froze at 08:40:13.77.

Seq.	Times	Configuration	Comment
020	24/01/2019 10:12	WT	Logging started. Approaching South Georgia shelf break
020	24/01/2019 10:14	WT	ADCP froze. U drive (JRLB) down.
021	24/01/2019 20:52	WT	Logging started (to D drive only).
021	25/01/2019 10:53	WT	Logging stopped
022	25/01/2019 10:54	WT	Logging stopped
022	25/01/2019 17:55	WT	Logging stopped. Switching back to U drive.
023	25/01/2019 17:56	WT	Logging started (to U drive).
023	26/01/2019 17:19	WT	Logging stopped
024	26/01/2019 17:19	WT	Logging started
024	27/01/2019 08:47	WT	Logging stopped
025	27/01/2019 08:50	BT	Logging started
025	27/01/2019 13:42	BT	Logging stopped
026	27/01/2019 13:43	WT	Logging started
026	28/01/2019 10:43	WT	Logging stopped
027	28/01/2019 10:44	WT	Logging started
027	29/01/2019 02:27	WT	Logging stopped
028	29/01/2019 02:28	WT	Logging started
028	29/01/2019 23:36	WT	Logging stopped
029	29/01/2019 23:37	WT	Logging started
029	30/01/2019 23:01	WT	Logging stopped
030	30/01/2019 23:02	WT	Logging started
030	01/02/2019 11:17	WT	Logging stopped
031	01/02/2019 11:18	WT	Logging started
031	02/02/2019 04:40	WT	Logging stopped
032	02/02/2019 04:41	WT	Logging started
032	02/02/2019 16:13	WT	Logging stopped
033	02/02/2019 16:13	BT	Logging started
033	02/02/2019 22:51	BT	Logging stopped
034	02/02/2019 22:51	WT	Logging started
034	03/02/2019 05:54	WT	Logging stopped
035	03/02/2019 05:55	BT	Logging started
035	03/02/2019 06:33	BT	Logging stopped
036	03/02/2019 06:35	BT	Logging started
036	03/02/2019 06:35	BT	Logging stopped - accidentally restarted on BT mode.
037	03/02/2019 06:37	WT	Logging started
037	04/02/2019 02:14	WT	Logging stopped
038	04/02/2019 02:15	WT	Logging started
038	04/02/2019 23:54	WT	Logging stopped
039	04/02/2019 23:55	WT	Logging started
039	06/02/2019 01:17	WT	Logging stopped
040	06/02/2019 01:18	WT	Logging started
040	07/02/2019 00:58	WT	Logging stopped

Seq.	Times	Configuration	Comment
041	07/02/2019 00:59	WT	Logging started
041	08/02/2019 01:05	WT	Logging stopped
042	08/02/2019 01:07	WT	Logging started
042	08/02/2019 22:20	WT	Logging stopped
043	08/02/2019 22:21	WT	Logging started
043	09/02/2019 10:55	WT	Logging stopped
044	09/02/2019 10:56	WT	Logging started
044	10/02/2019 05:56	WT	Logging stopped
045	10/02/2019 05:57	WT	Logging started
045	10/02/2019 23:49	WT	Logging stopped
046	10/02/2019 23:50	WT	Logging started
046	12/02/2019 03:37	WT	Logging stopped
047	12/02/2019 03:38	WT	Logging started
047	12/02/2019 16:19	WT	Logging stopped
048	12/02/2019 16:20	WT	Logging started
048	13/02/2019 20:13	WT	Logging stopped
049	13/02/2019 20:14	WT	Logging started
049	14/02/2019 17:34	WT	Logging stopped
050	14/02/2019 17:35	WT	Logging started
050	14/02/2019 20:58	WT	Logging stopped. ADCP switched off. Entering Argentinian EEZ.

Appendix C: Air-sea CO_2/heat flux system on the JCR

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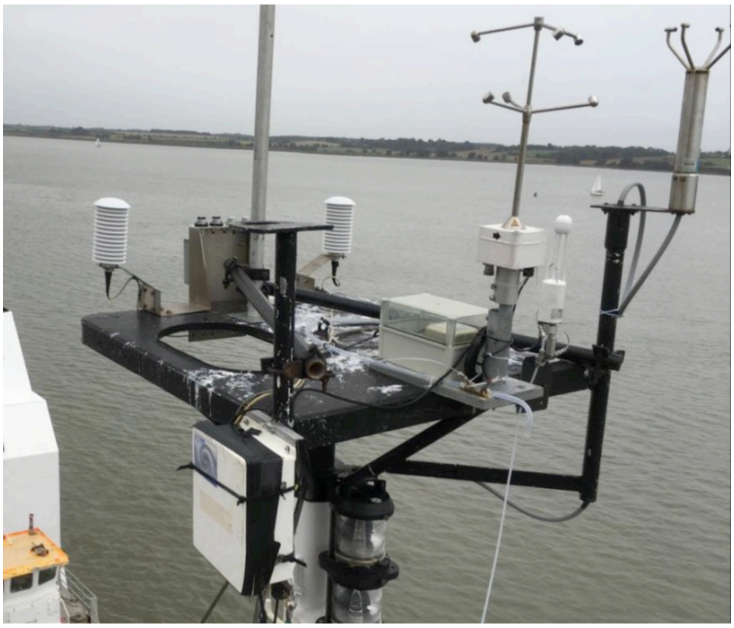
Section 1: General description
We are continuously measuring air-sea fluxes of CO2, sensible heat, latent heat (H2O) and momentum on the JCR using the eddy covariance method. This method requires rapid (>= 10 Hz) sampling of the following:
- 3-dimensional wind velocities and air temperature using a Metek sonic anemometer
- 3-dimensional acceleration and rotation using two separate instruments (a LPMS motion sensor and a Systron Donner Motionpak II, also referred to as 'Sysdon' or 'MP2')
- CO2 mixing ratio in the atmosphere (Picarro instrument)
- H2O mixing ratio in the atmosphere (Licor 7500 instrument)

All of the instruments except the Picarro are mounted on the bird table on top of the ship's foremast. The Picarro is rack mounted in the mail room. The Picarro sub-samples from a ½ inch teflon inlet tube that runs from the mail room up to the bird table. A Gast vacuum pump (just behind the instrument rack in the mail room) is used to rapidly draw air from the foremast into the mail room. A flow diagram of the setup is provided in the Appendix. Data cables also run between the mail room and the bird table and a data collection Dell PC is housed inside the instrument rack in the mail room.

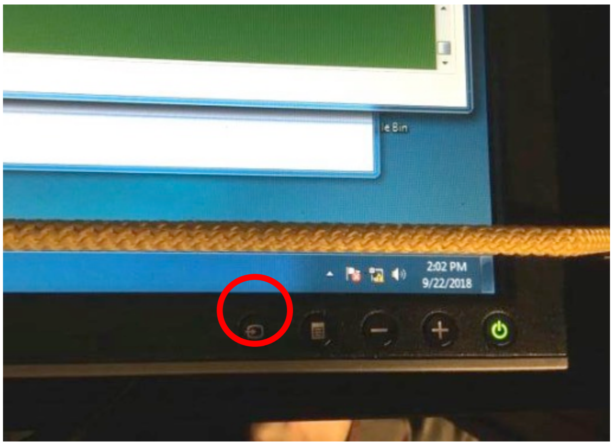
Note: the Picarro detects H2O, but a Nafion dryer (metal tube mounted vertically above the instrument rack in the mail room) is used to remove water vapor from its sampling line. The Licor also measures CO2, but at a lower accuracy/precision.




Bird table setup (left photo): Metek sonic anemometer, motion sensors, and inlet tube in the middle, with Licor on the port side of the Metek (in between the Metek and ship's sonic anemometer).
Mail room setup (right photo): Monitor (for the Dell PC and the Picarro internal PC) on the top shelf, Dell PC & UPS on the shelf below, and the Picarro on the lowest shelf (above two boxes of spares on the floor).

Section 2: Data acquisition

Two separate computers are used for data acquisition, a Dell desktop PC and the Picarro's internal PC. All data streams are logged continuously and saved in hourly files. Both PCs are synced to ship time via Ethernet (IP address: 10.104.2.250) using the Tardis2000 program.



Both PCs share the same monitor. Press the left-most button on the monitor (see photo) to switch the display. There is a mouse and a keyboard at the bottom of the enclosure. These need plugging into whichever PC needs to be controlled.

Data logging summary:

Dell PC:

- Metek: COM 12, baud 38400, logged via Teraterm software, typical file size ~5 mb
- Picarro (backup): COM 3, baud 19200, logged via Teraterm software, typical file size ~5 mb
- LPMS: COM 9, baud 19200, logged via C software, typical file size ~2 mb
- Systron Donner Motionpak II: COM 1, baud 9600, logged via Igor software, typical file size ~2 mb

All data saved onto F drive (Maxtor external hard drive), synced continuously onto E drive (Transcend external hard drive)

Picarro PC:

- Picarro: logged via Picarro software, typical file size ~20 mb

Picarro data is saved onto the C drive and synced continuously onto E drive (Transcend external hard drive). Note that the internal PC of the Picarro is fairly small, such that old data on the C drive are wiped to make room for new data (FIFO: First in first out).

- Licor: COM 3, baud 38400, logged via Teraterm software, typical file size ~7 mb
- Metek (backup): COM 2, baud 38400, logged via Teraterm software, typical file size ~5 mb

The Licor and Metek data are saved directly onto the E drive (Transcend external hard drive)

Section 3: How to start/restart data acquisition

If a Teraterm macro has crashed (reporting an error), close the windows associated with that COM port (should be three, one with data flashing across, one with the macro error, and one that says 'log…'). Then restart data acquisition:

1. All Teraterm data, i.e. Metek (on both PCs), Licor 7500 (on Picarro PC), and Picarro backup (on Dell PC) are restarted using the same general procedure for each data stream:
- open Teraterm, click serial, and find correct COM port (see info in Section 2 above)
- go to Setup, Serial port, and choose the correct baud rate (see info in Section 2 above)
- go to Control, Macro, and double click on the corresponding Macro to start data acquisition (a different one is available for each of these 3 instruments)

2. Systron Donner Motionpak II (SysDon MP2):
- open MotionPak_Send_Receive2.ipf with Igor Pro
- compile the function
- go to 'Macros' and then hit 'MotionPak Data Acquisition'
- choose the right directory for saving data (F:Data:Sysdon) and hit ok/do it

- should see a little spinning wheel on the bottom corner that indicates active data acquisition

Section 4: Daily checks (see detail below)
i. Are new data being acquired?
ii. Are the PC clocks synchronized?
iii. Are the Picarro temperature and pressure readouts normal?
iv. Is there water in the ½ inch teflon inlet tube?

i. Are new data being acquired?

Verify that there is data saved within the last hour, and that each file is the expected size (see info in Section 2). On the *Picarro PC*, data are saved in the following directories:

Picarro data (temporary)	C:\UserData\DataLog_User_Sync\Year\Month\Day
Picarro data storage	E:\Picarro backup\Picarro
Licor data	E:\Picarro backup\Licor
Metek backup data	E:\Picarro backup\Winds

On the *Dell PC*, data are saved in the following directories:

LPMS data	F:\Data\LPMS
Picarro data backup	F:\Data\Picarro
MPII data	F:\Data\SysDon
Metek data	F:\Data\Wind

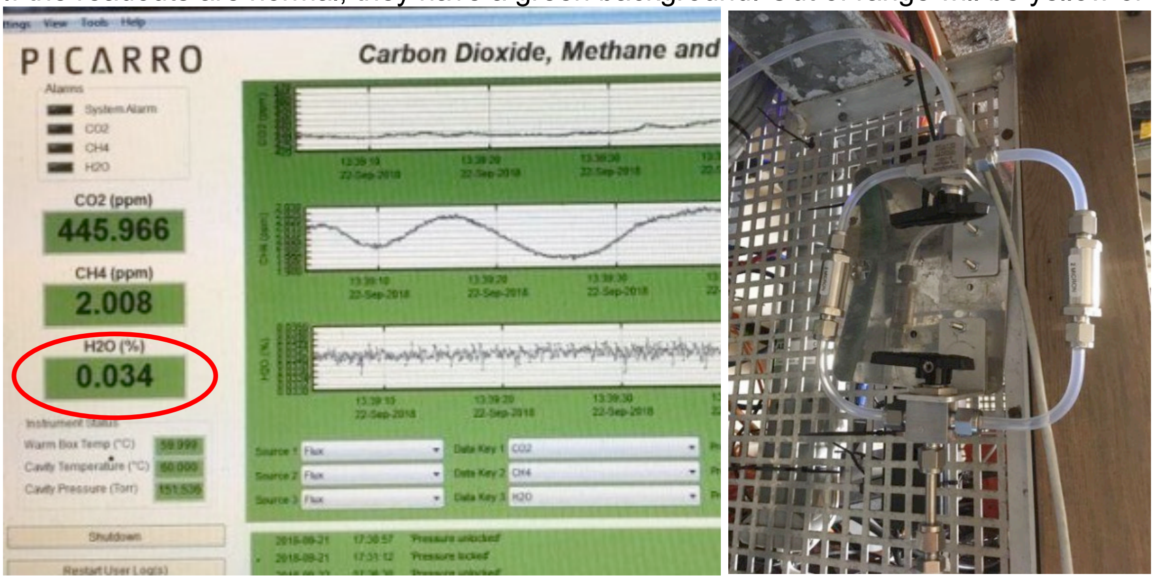
Sometimes an error occurs in the Teraterm logging program, such that a new file is not created and data are continuously logged into a single, giant file. See instructions in Section 3 for fixing this bug.

ii. Are the PC clocks synchronized? (to within 1 second).

Switch between displaying the clocks of both PCs. If there is a large difference in time (> 5s), please note down the difference.

iii. Are the Picarro temperature and pressure readouts normal?

If the readouts are normal, they have a green background. Out of range will be yellow or red.



Picarro screen (left photo) -cavity temperature and pressure should be 60°C and 151.5 Torr, respectively. If the pressure is low, the stainless steel Swagelok particle filter (right photo) needs to be switched. ***See Section 5 for details on how to do this.***

iv. Is there water in the ½ inch teflon inlet tube?

This should be most easily-observed in the tubing hanging above the instrument rack on the right hand side (before the HEPA filter). Some water droplets are fine but a large puddle of water is not!

If the ship is in a sizable storm and the Gast vacuum pump is pulling in a lot of water droplets, please turn the Gast pump off!

You can turn this pump off by unplugging the leftmost power plug (white plug, black cable) from the power strip on the bottom left of the enclosure near the floor (see photo).

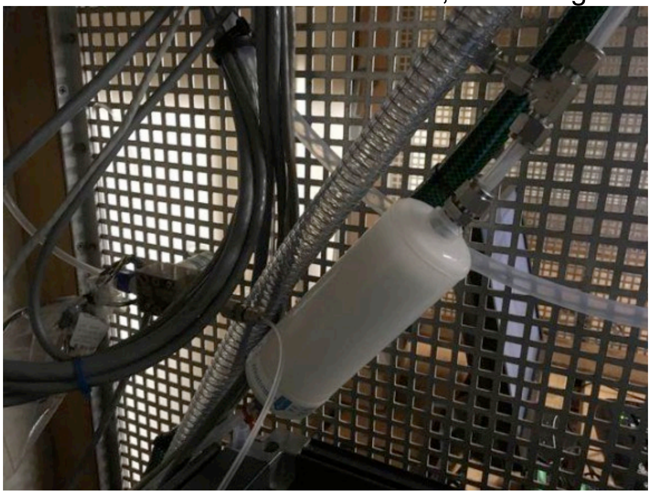
If the Picarro pressure readout is normal (see Check *iii* above), please turn the Gast pump back on again after the storm has passed. If it is not, you will need to switch the stainless steel Swagelok particle filter (see Section 5).

Section 5: Filter changes

Please email us the date and time when any filter changes are made.

HEPA filter:

The large, white, plastic HEPA particle filter (see photo) is connected to the ½ inch teflon inlet tube (see Appendix for location in setup). After ingestion of a lot of water or particles, the HEPA filter will need replacing. The filter should be ok for the duration of AMT, but a large storm event could be a problem. Replacing the HEPA filter requires the measurements to be interrupted:



a. Disconnect ½ inch Swagelok compression fittings on both ends.
b. Unscrew the Swagelok-to-NPT fittings from the plastic body of the HEPA filter.
c. Screw the Swagelok-to-NPT fittings into a new HEPA filter (available from one of the cardboard boxes in the instrument rack).
d. Re-install the HEPA filter onto the ½ inch teflon tube. There is an arrow on the filter body. Make sure this is pointing toward the floor when re-installing it.

Stainless steel Swagelok particle filters:

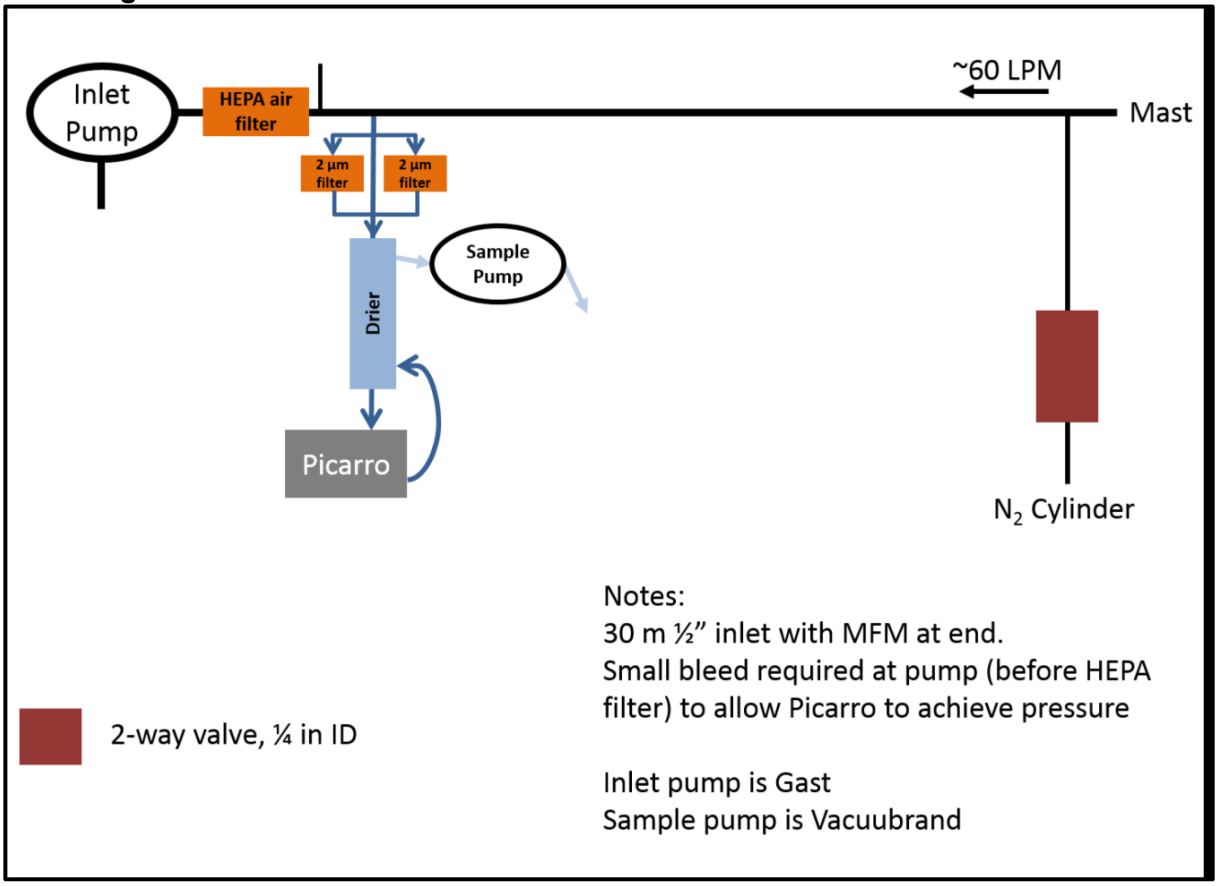
This procedure will not interrupt the measurements:
a. Turn both 3-way valves toward the direction that is opposite to their current direction. Turn **both** at the **same time** using the black plastic handles and hold the valve body to avoid damaging the tubing. Air will be re-directed towards the other (clean) filter, while flow through the previous path (dirty filter) is blocked.
b. Remove the dirty filter from the filter set with a pair of spanners.
c. Open the filter body with a pair of spanners and replace the dirty filter element with a new, 2 micron particle filter element (available from one of the cardboard boxes in the instrument rack).
d. Close the filter body and re-install into the setup. There is an arrow on the filter body. Make sure this is pointing toward the floor when re-installing. This filter is now ready for use in the future.

Section 6: What to do at end of AMT

Please change the HEPA filter (see Section 5 above).

We will communicate any other changes via email. These will likely depend on how the instrument runs during the cruise! Thanks a lot and hope all goes well!

Flow diagram



Appendix D: Mooring deployment and recovery details

Recoveries:

M2 (2017-2019)

Height above bottom (m)	**Nominal Depth** (m)	**Instrument/sn**	**Parameters measured**	**Sample interval** (min)	**Start/stop time, UTC** (dd/mm/yyyy hh:mm:ss)	**Clock drift** (hh:mm:ss)	**First good/Last good record/comments** (times are instrument times – uncorrected for drift)
532	2520	Novatech RF-700A1 W08-050 VHF radio beacon (159.480 MHz)					On triangular McLane top float
532	2520	Novatech ST-400A U08-059 Xenon flash beacon (daylight off disabled)					
511	2541	Aquadopp 2807	U, V, W, T, P	30	24/03/2017 00:00:00 13/01/2019 13:21:15	+00:02:22	24/03/2017 20:30:00 13/01/2019 11:00:00
466	2586	SBE-37SM 2708	T, C, P	15	24/03/2017 00:00:00 13/01/2019 14:05:45	+00:03:01	24/03/2017 20:15:01 13/01/2019 11:00:02
341	2711	SBE-39 1311	T, P	15	24/03/2017 00:00:00 13/01/2019 13:54:00	+00:02:47	24/03/2017 20:15:00 13/01/2019 11:00:00
239	2813	SBE-39 1232	T, P	15	24/03/2017 00:00:00 13/01/2019 13:49:25	-00:00:37	24/03/2017 20:15:00 13/01/2019 10:45:00
164	2888	SBE-39 0229	T	15	24/03/2017 00:00:00 13/01/2019 13:43:35	-00:01:48	24/03/2017 20:15:00 13/01/2019 10:44:59
19	3033	SBE-37SMP 14765	T, C, P	15	24/03/2017 00:00:00 13/01/2019 14:13:46	+00:00:06	24/03/2017 20:15:01 13/01/2019 10:45:01
16	3036	Aquadopp 9380	U, V, W, T, P	30	24/03/2017 00:00:00 13/01/2019 13:26:30	+00:02:20	24/03/2017 20:30:00 13/01/2019 11:00:00
8	3044	Releases: Edgetech 8242xs 31512 & 33152					

M3 (2017-2019)

Height above bottom (m)	**Nominal Depth** (m)	**Instrument/sn**	**Parameters measured**	**Sample interval** (min)	**Start/stop time, UTC** (dd/mm/yyyy hh:mm:ss)	**Clock drift** (hh:mm:ss)	**First good/Last good record/comments** (times are instrument times – uncorrected for drift)
532	4041	Novatech RF-700A1 W08-053 VHF radio beacon (159.480 MHz)					On triangular McLane top float
532	4041	Novatech ST-400A V08-057 Xenon flash beacon					
513	4060	Aquadopp 2317	U, V, W, T, P	30	24/03/2017 00:00:00 26/01/2019 13:54:45	+00:01:53	24/03/2017 11:30:00 26/01/2019 11:30:00
468	4105	SBE-37SM 1351	T, C, P	15	24/03/2017 00:00:00 26/01/2019 20:39:52	+00:04:02	24/03/2017 11:30:00 26/01/2019 11:30:03
393	4180	SBE-39 1247	T, P	15	24/03/2017 00:00:00 26/01/2019 14:28:22	-00:02:14	24/03/2017 11:30:00 26/01/2019 11:30:02
318	4255	SBE-39 1310	T, P	15	24/03/2017 00:00:00 26/01/201914:31:50	+00:02:53	24/03/2017 11:30:00 26/01/2019 11:30:00
241	4332	SBE-37SMP 14764	T, C, P	15	24/03/2017 00:00:00 26/01/2019 14:15:15	-00:00:11	24/03/2017 11:30:01 26/01/2019 11:30:01
116	4457	SBE-37SM 4119	T, C, P	15	24/03/2017 00:00:00 26/01/2019 20:47:30	+00:01:59	24/03/2017 11:30:00 26/01/2019 11:30:01
66	4507	SBE-39 1826	T, P	15	24/03/2017 00:00:00 26/01/2019 14:23:45	+00:01:30	24/03/2017 11:30:00 26/01/2019 11:30:00
21	4552	SBE-37SMP 14763	T, C, P	15	24/03/2017 00:00:00 26/01/2019 14:47:00	+00:00:01	24/03/2017 11:30:01 26/01/2019 11:30:01
18	4555	Aquadopp 1752	U, V, W, T, P	30	24/03/2017 00:00:00 26/01/2019 14:03:54	+00:03:05	24/03/2017 11:30:00 26/01/2019 11:30:00
9	4564	Releases: ORE 8242xs 32131 & 49027					

OP1 (2017-2019)

Height above bottom (m)	**Nominal Depth** (m)	**Instrument/sn**	**Parameters measured**	**Sample interval** (min)	**Start/stop time, UTC** (dd/mm/yyyy hh:mm:ss)	**Clock drift** (hh:mm:ss)	**First good/Last good record/comments** (times are instrument times – uncorrected for drift)
1839	1854	Novatech RF-700A1 Y07-009 VHF radio beacon (160.725 MHz)					On top float with Trimsyn TS2 syntactic foam float
1839	1854	Novatech ST-400A Y07-011 Xenon flash beacon (daylight off disabled)					
1823	1870	Six orange Vitrovex floats on 5-m Eddygrip rope					
1817	1876	Aquadopp 5993	U, V, W, T, P	10	18/04/2017 10:00:00 30/01/2019 20:16:10	+00:00:47	18/04/2017 16:00:00 29/01/2019 11:20:00
1816	1877	SBE-39 4409	T	10	18/04/2017 10:00:00 30/01/2019 17:15:53	+00:01:54	18/04/2017 16:00:00 29/01/2019 11:20:00 Thread stripped on clamp, secured with hose clamp
1483	2210	Aquadopp 6000	U, V, W, T, P	10	18/04/2017 10:00:00 30/01/2019 20:25:06	+00:01:18	18/04/2017 16:00:00 29/01/2019 11:20:00
1482	2211	SBE-37SM 7380	T, C, P	10	18/04/2017 10:00:00 30/01/2019 16:28:35	+00:00:52	18/04/2017 16:00:01 29/01/2019 11:20:01
1467	2226	Four yellow Benthos floats on 5-m Eddygrip rope					
1114	2579	Three orange Vitrovex floats on 3-m Eddygrip rope					
1064	2630	SBE-39 4413	T	10	18/04/2017 10:00:00 30/01/2019 17:22:50	+00:02:16	18/04/2017 16:00:00 29/01/2019 11:20:00
760	2933	Three yellow Benthos floats on 3-m Eddygrip rope					
710	2983	Aquadopp 6112	U, V, W, T, P	10	18/04/2017 10:00:00 30/01/2019 20:14:35	+00:01:09	18/04/2017 16:00:00 29/01/2019 11:20:00
709	2984	SBE-37SM 7381	T, C, P	10	18/04/2017 10:00:00 30/01/2019 16:32:20	+00:00:51	18/04/2017 16:00:01 29/01/2019 11:20:01
407	3286	Three orange Vitrovex floats on 3-m Eddygrip rope					
53	3640	Three orange Vitrovex floats on 3-m Eddygrip rope					
47	3646	Aquadopp 6180	U, V, W, T, P	10	18/04/2017 10:00:00 30/01/2019 20:27:20	+00:01:01	18/04/2017 16:00:00 29/01/2019 11:20:00

19	3674	SBE-37SM 7382	T, C, P	10	18/04/2017 10:00:00 30/01/2019 16:36:45	+00:00:33	18/04/2017 16:00:01 29/01/2019 11:20:01
9	3684	Three orange Vitrovex floats on 3-m Eddygrip rope					
7	3686	Releases: Ixsea AR861 564 & 1616					

OP2 (2017-2019)

Height above bottom (m)	**Nominal Depth** (m)	**Instrument/sn**	**Parameters measured**	**Sample interval** (min)	**Start/stop time, UTC** (dd/mm/yyyy hh:mm:ss)	**Clock drift** (hh:mm:ss)	**First good/Last good record/comments** (times are instrument times – uncorrected for drift)
1542	1516	Novatech RF-700A1 Y07-010 VHF radio beacon (160.725 MHz)					On rectangular McLane top float
1542	1516	Novatech ST-400A Y07-012 Xenon flash beacon (daylight off disabled)					
1526	1532	Six orange Vitrovex floats on 5-m Eddygrip rope (labelled iStar 6B)					
1520	1538	SBE-37SM 7383	T, C, P	10	18/04/2017 10:00:00 28/01/2019 12:57:00	+00:00:16	18/04/2017 19:50:01 27/01/2019 15:50:01
1421	1637	Six yellow Benthos floats on 5-m Eddygrip rope (dated 2004-2005)					
1415	1643	Aquadopp 6198	U, V, W, T, P	10	18/04/2017 10:00:00 28/01/2019 12:01:50	+00:00:51	18/04/2017 19:50:00 27/01/2019 15:50:00
1121	1937	SBE-39 0083	T	10	18/04/2017 10:00:00 28/01/2019 13:52:55	-00:01:47	18/04/2017 19:50:00 27/01/2019 15:50:00
726	2332	Aquadopp 6226	U, V, W, T, P	10	18/04/2017 10:00:00 28/01/2019 13:58:52	+00:01:39	18/04/2017 19:50:00 27/01/2019 15:50:00
725	2333	SBE-37SM 7385	T, C, P	10	18/04/2017 10:00:00 28/01/2019 13:07:30	+00:00:22	18/04/2017 19:50:01 27/01/2019 15:50:01
715	2343	Six orange Vitrovex floats on 5-m Eddygrip rope (labelled iStar 6A)					
65	2993	Aquadopp 6236	U, V, W, T, P	10	18/04/2017 10:00:00 28/01/2019 13:46:55	+00:00:52	18/04/2017 19:50:00 27/01/2019 15:50:00
21	3037	SBE-37SM 7386	T, C, P	10	18/04/2017 10:00:00 28/01/2019 13:15:55	+00:00:22	18/04/2017 19:50:01 27/01/2019 15:50:01
10	3048	Four yellow Benthos floats on 5-m Eddygrip rope					
7	3050	Releases: Edgetech 8242XS 33147 & 33614					

OP3 (2017-2019)

Height above bottom (m)	**Nominal Depth** (m)	**Instrument/sn**	**Parameters measured**	**Sample interval** (min)	**Start/stop time, UTC** (dd/mm/yyyy hh:mm:ss)	**Clock drift** (hh:mm:ss)	**First good/Last good record/comments** (times are instrument times – uncorrected for drift)
530	1207	Novatech RF-700A1 W02-086 VHF radio beacon (160.725 MHz)					On triangular McLane top float
530	1207	Novatech ST-400A W02-087 Xenon flash beacon (daylight off disabled)					
514	1223	Four orange Vitrovex floats on 5-m Eddygrip rope					
508	1229	SBE-37SM 8540	T, C, P	10	18/04/2017 10:00:00 30/01/2019 16:40:10	+00:00:50	19/04/2017 12:30:01 29/01/2019 15:20:01
308	1429	Four orange Vitrovex floats on 5-m Eddygrip rope					
300	1437	Aquadopp 5424	U, V, W, T, P	20	18/04/2017 10:00:00 30/01/2019 20:44:45	+00:01:20	19/04/2017 12:40:00 29/01/2019 15:20:00 Current directions might be suspect
53	1684	Four orange Vitrovex floats on 5-m Eddygrip rope					
47	1690	Aquadopp 8556	U, V, W, T, P	20	18/04/2017 10:00:00 30/01/2019 20:04:15	+00:02:00	19/04/2017 12:40:00 29/01/2019 15:20:00
19	1718	SBE-37SM 8541	T, C, P	10	18/04/2017 10:00:00 30/01/2019 16:43:45	+00:00:19	19/04/2017 12:30:01 29/01/2019 15:20:01
9	1728	Two orange Vitrovex floats on 3-m Eddygrip rope					
7	1730	Release: Ixsea AR861 565					

OP4 (2017-2019)

Height above bottom (m)	**Nominal Depth** (m)	**Instrument/sn**	**Parameters measured**	**Sample interval** (min)	**Start/stop time, UTC** (dd/mm/yyyy hh:mm:ss)	**Clock drift** (hh:mm:ss)	**First good/Last good record/comments** (times are instrument times – uncorrected for drift)
1130	1819	Novatech RF-700A1 W02-084 VHF radio beacon (154.585 MHz)					On top float with Trimsyn TS2 syntactic foam float
1130	1819	Novatech ST-400A W02-088 Xenon flash beacon (daylight off disabled)					
1114	1835	Four orange Vitrovex floats on 5-m Eddygrip rope (labelled iStar 4F)					
1108	1841	Aquadopp 6263	U, V, W, T, P	10	18/04/2017 10:00:00 30/01/2019 20:01:30	+00:00:22	21/04/2017 18:00:00 29/01/2019 18:20:00
1107	1842	SBE-39 4418	T, C, P	10	18/04/2017 10:00:00 30/01/2019 17:30:30	+00:01:00	21/04/2017 18:00:00 29/01/2019 18:20:00
759	2190	Four orange Vitrovex floats on 5-m white Kevlar rope (labelled iStar 2C)					
750	2199	Aquadopp 9250	U, V, W, T, P	10	18/04/2017 10:00:00 30/01/2019 19:48:30	+00:01:37	21/04/2017 18:00:00 29/01/2019 18:20:00
749	2200	SBE-39 4713	T, C, P	10	18/04/2017 10:00:00 30/01/2019 17:38:00	+00:02:52	21/04/2017 18:00:00 29/01/2019 18:20:00
53	2896	Four orange Vitrovex floats on 5-m Eddygrip rope					
47	2902	Aquadopp 9264	U, V, W, T, P	10	18/04/2017 10:00:00 30/01/2019 19:51:25	+00:01:15	21/04/2017 18:00:00 29/01/2019 18:20:00
19	2930	SBE-37SM 2678	T, C, P	10	18/04/2017 10:00:00 30/01/2019 16:50:40	+00:05:16	21/04/2017 18:00:00 29/01/2019 18:30:02
10	2939	Three orange Vitrovex floats on 3-m Eddygrip rope (labelled iStar 3B)					
7	2942	Release: Ixsea AR861 562 & 1615					Release 562 leaked slightly!

OP5 (2017-2019)

Height above bottom (m)	**Nominal Depth** (m)	**Instrument/sn**	**Parameters measured**	**Sample interval** (min)	**Start/stop time, UTC** (dd/mm/yyyy hh:mm:ss)	**Clock drift** (hh:mm:ss)	**First good/Last good record/comments** (times are instrument times – uncorrected for drift)
424	2963	Novatech RF-700A1 W02-085 VHF radio beacon (159.480 MHz)					On rectangular McLane top float
424	2963	Novatech ST-400A W02-089 Xenon flash beacon (daylight off disabled)					
408	2979	Four yellow Benthos floats on 5-m Eddygrip rope					
400	2987	Aquadopp 12010	U, V, W, T, P	10	18/04/2017 10:00:00 30/01/2019 19:37:10	+00:01:19	19/04/2017 18:20:00 29/01/2019 21:20:00
399	2988	SBE-39 4716	T	10	18/04/2017 10:00:00 30/01/2019 17:45:50	+00:01:50	19/04/2017 18:20:00 29/01/2019 21:20:00
53	3334	Four yellow Benthos floats on 5-m Eddygrip rope					
46	3341	Aquadopp 12016	U, V, W, T, P	10	18/04/2017 10:00:00 30/01/2019 19:40:05	+00:00:41	19/04/2017 18:20:00 29/01/2019 21:20:00
18	3369	SBE-37SM 7387	T, C, P	10	18/04/2017 10:00:00 30/01/2019 16:55:25	+00:00:10	19/04/2017 18:20:01 29/01/2019 21:20:01
9	3378	Two orange Vitrovex floats on 3-m Eddygrip rope (labelled iStar 2A)					
7	3380	Release: Ixsea AR861 1618					

OP6 (2017-2019)

Height above bottom (m)	**Nominal Depth** (m)	**Instrument/sn**	**Parameters measured**	**Sample interval** (min)	**Start/stop time, UTC** (dd/mm/yyyy hh:mm:ss)	**Clock drift** (hh:mm:ss)	**First good/Last good record/comments** (times are instrument times – uncorrected for drift)
424	1886	Novatech RF-700A1 V08-056 VHF radio beacon (159.480 MHz)					On triangular McLane top float
408	1902	Four orange Vitrovex floats on 5-m Eddygrip rope					
400	1910	Aquadopp 12020	U, V, W, T, P	10	18/04/2017 10:00:00 30/01/2019 20:35:05	+00:01:33	20/04/2017 14:40:00 30/01/2019 13:20:00
53	2257	Four yellow Benthos floats on 5-m Eddygrip rope					
46	2264	Aquadopp 12053	U, V, W, T, P	10	18/04/2017 10:00:00 30/01/2019 20:37:00	+00:01:56	20/04/2017 14:40:00 30/01/2019 13:20:00
18	2292	SBE-37SM 8267	T, C	10	18/04/2017 10:00:00 30/01/2019 17:05:35	+00:00:31	20/04/2017 14:40:01 30/01/2019 13:20:01
9	2301	Two orange Vitrovex floats on 3-m Eddygrip rope (labelled iStar 2C)					
7	2303	Release: Ixsea AR861 1356					

Deployments:

M2 (2019-)

Height above bottom (m)	**Nominal Depth** (m)	**Instrument/sn**	**Parameters measured**	**Sample interval** (min)	**Start time, UTC** (dd/mm/yyyy hh:mm:ss)	**Comments**
532	2520	Novatech RF-700A1 U08-058 VHF radio beacon (159.480 MHz)				On triangular McLane top float
532	2520	Novatech ST-400A V08-057 Xenon flash beacon				
511	2541	Aquadopp 2807	U, V, W, T, P	30	13/01/2019 17:00:00	
466	2586	SBE-37SM 6557	T, C, P	15	13/01/2019 17:00:00	
341	2711	SBE-39 1311	T, P	15	13/01/2019 17:00:00	
239	2813	SBE-39 1232	T, P	15	13/01/2019 17:00:00	
164	2888	SBE-39 0229	T	15	13/01/2019 17:00:00	
19	3033	SBE-37SMP 14765	T, C, P	15	13/01/2019 17:00:00	
16	3036	Aquadopp 9380	U, V, W, T, P	30	13/01/2019 17:00:00	
8	3044	Releases: Edgetech 8242xs 31512 & 33152				

M3 (2019-)

Height above bottom (m)	**Nominal Depth** (m)	**Instrument/sn**	**Parameters measured**	**Sample interval** (min)	**Start time, UTC** (dd/mm/yyyy hh:mm:ss)	**Comments**
532	4028	Novatech RF-700A1 W08-053 VHF radio beacon (159.480 MHz)				On triangular McLane top float
532	4028	Novatech ST-400A V08-057 Xenon flash beacon				
511	4049	Aquadopp 2317	U, V, W, T, P	30	26/01/2019 18:00:00	
466	4094	SBE-37SMP 10172	T, C, P	15	26/01/2019 18:00:00	
391	4169	SBE-39 1247	T, P	15	26/01/2019 18:00:00	
316	4244	SBE-39 1310	T, P	15	26/01/2019 18:00:00	
239	4321	SBE-37SMP 14764	T, C, P	15	26/01/2019 18:00:00	
114	4446	SBE-37SMP 16961	T, C, P	15	26/01/2019 18:00:00	
64	4496	SBE-39 1826	T, P	15	26/01/2019 18:00:00	
19	4541	SBE-37SMP 14763	T, C, P	15	26/01/2019 18:00:00	
16	4544	Aquadopp 1752	U, V, W, T, P	30	26/01/2019 18:00:00	
8	4552	Releases: ORE 8242xs 32131 & 49027				

OP1 (2019-)

Height above bottom (m)	**Nominal Depth** (m)	**Instrument/sn**	**Parameters measured**	**Sample interval** (min)	**Start time, UTC** (dd/mm/yyyy hh:mm:ss)	**Comments**
1839	1806	Novatech RF-700A1 Y07-009 VHF radio beacon (160.725 MHz)				On top float with Trimsyn TS2 syntactic foam float
1839	1806	Novatech ST-400A Y07-011 Xenon flash beacon (daylight off disabled)				
1823	1822	Six orange Vitrovex floats on 5-m Eddygrip rope				
1817	1828	Aquadopp 5993	U, V, W, T, P	10	08/02/2019 00:00:00	
1816	1829	SBE-39 4409	T	10	08/02/2019 00:00:00	
1483	2162	Aquadopp 6000	U, V, W, T, P	10	08/02/2019 00:00:00	
1482	2163	SBE-37SM 7380	T, C, P	10	08/02/2019 00:00:00	
1467	2178	Four orange Vitrovex floats on 5-m Eddygrip rope				
1114	2531	Three orange Vitrovex floats on 3-m Eddygrip rope				
1064	2681	SBE-39 4413	T	10	08/02/2019 00:00:00	
760	2885	Three yellow Benthos floats on 3-m Eddygrip rope				
710	2935	Aquadopp 6112	U, V, W, T, P	10	08/02/2019 00:00:00	
709	2936	SBE-37SM 7381	T, C, P	10	08/02/2019 00:00:00	
407	3238	Three orange Vitrovex floats on 3-m Eddygrip rope				
53	3592	Three orange Vitrovex floats on 3-m Eddygrip rope				
47	3598	Aquadopp 6180	U, V, W, T, P	10	08/02/2019 00:00:00	
19	3626	SBE-37SM 7382	T, C, P	10	08/02/2019 00:00:00	
9	3636	Three orange Vitrovex floats on 3-m Eddygrip rope				
7	3638	Releases: Ixsea AR861 564 & 1616				

OP2 (2019-)

Height above bottom (m)	**Nominal Depth** (m)	**Instrument/sn**	**Parameters measured**	**Sample interval** (min)	**Start time, UTC** (dd/mm/yyyy hh:mm:ss)	**Comments**
1543	1559	Novatech RF-700A1 Y07-010 VHF radio beacon (160.725 MHz)				On rectangular McLane top float
1543	1559	Novatech ST-400A Y07-012 Xenon flash beacon (daylight off disabled)				
1527	1575	Six yellow Benthos floats on 5-m Eddygrip rope				
1520	1582	SBE-37SM 7383	T, C, P	10	28/01/2019 19:30:00	
1421	1681	Six orange Vitrovex floats on 5-m Eddygrip rope				
1415	1687	Aquadopp 6198	U, V, W, T, P	10	28/01/2019 19:30:00	
1121	1981	SBE-39 0083	T	10	28/01/2019 19:30:00	
727	2375	Aquadopp 6226	U, V, W, T, P	10	28/01/2019 19:30:00	
726	2376	SBE-37SM 7385	T, C, P	10	28/01/2019 19:30:00	
715	2387	Six orange Vitrovex floats on 5-m Eddygrip rope				
65	3037	Aquadopp 6236	U, V, W, T, P	10	28/01/2019 19:30:00	
21	3081	SBE-37SM 7386	T, C, P	10	28/01/2019 19:30:00	
10	3092	Four yellow Benthos floats on 5-m Eddygrip rope				
7	3095	Releases: Edgetech 8242XS 33147 & 33614				

OP3 (2019-)

Height above bottom (m)	Nominal Depth (m)	Instrument/sn	Parameters measured	Sample interval (min)	Start time, UTC (dd/mm/yyyy hh:mm:ss)	Comments
530	1236	Novatech RF-700A1 W02-086 VHF radio beacon (160.725 MHz)				On triangular McLane top float
530	1236	Novatech ST-400A W02-087 Xenon flash beacon (daylight off disabled)				
514	1243	Four yellow Benthos floats on 5-m Eddygrip rope				
508	1243	SBE-39 1239	T, P	10	08/02/2019 00:00:00	
308	1442	Four orange Vitrovex floats on 5-m Eddygrip rope				
300	1450	Aquadopp 5424	U, V, W, T, P	10	08/02/2019 00:00:00	Has 13mm clamp; 2 batteries
299	1451	SBE-37SM 8540	T, C, P	10	08/02/2019 00:00:00	
53	1697	Four yellow Benthos floats on 5-m Eddygrip rope				
47	1704	Aquadopp 8556	U, V, W, T, P	20	08/02/2019 00:00:00	Has 13mm clamp; 1 battery
19	1732	SBE-37SM 8541	T, C, P	10	08/02/2019 00:00:00	
9	1741	Two yellow Benthos floats on 3-m Eddygrip rope				
7	1743	Release: Ixsea AR861 1942				

OP4 (2019-)

Height above bottom (m)	**Nominal Depth** (m)	**Instrument/sn**	**Parameters measured**	**Sample interval** (min)	**Start time, UTC** (dd/mm/yyyy hh:mm:ss)	**Comments**
1130	1822	Novatech RF-700A1 W02-084 VHF radio beacon (154.585 MHz)				On top float with Trimsyn TS2 syntactic foam float
1130	1822	Novatech ST-400A W02-088 Xenon flash beacon (daylight off disabled)				
1114	1838	Four orange Vitrovex floats on 5-m Eddygrip rope				
1108	1844	Aquadopp 6263	U, V, W, T, P	10	08/02/2019 00:00:00	
1107	1845	SBE-39 4418	T, C, P	10	08/02/2019 00:00:00	
759	2193	Four yellow Benthos floats on 5-m Eddygrip rope				
750	2202	Aquadopp 9250	U, V, W, T, P	10	08/02/2019 00:00:00	
749	2203	SBE-39 4713	T, C, P	10	08/02/2019 00:00:00	
53	2899	Four yellow Benthos floats on 5-m Eddygrip rope				
47	2905	Aquadopp 9264	U, V, W, T, P	10	08/02/2019 00:00:00	
19	2933	SBE-37SM 2956	T, C, P	10	08/02/2019 00:00:00	
9	2943	Three yellow Benthos floats on 3-m Eddygrip rope				
7	2945	Releases: Ixsea AR861 565 & 1615				

OP5 (2019-)

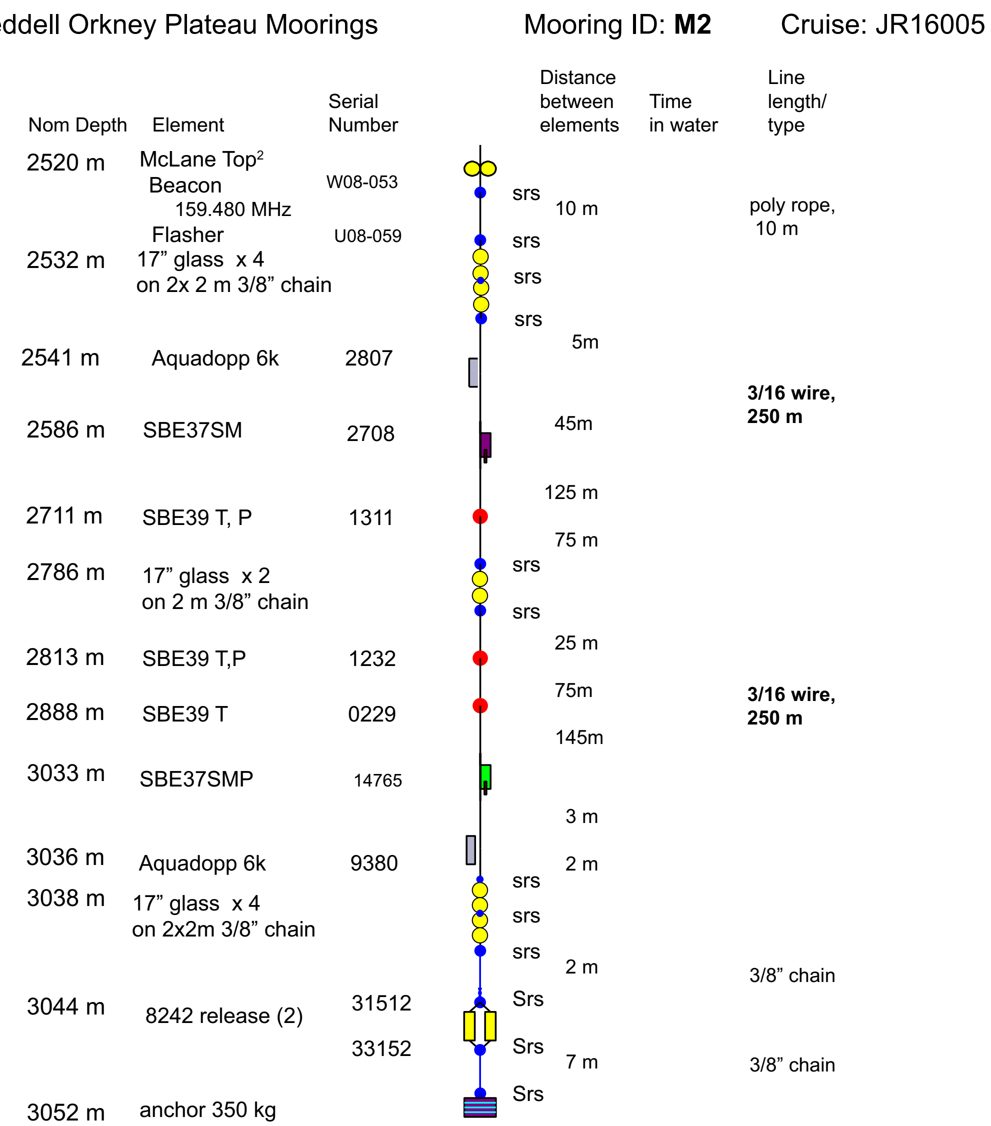
Height above bottom (m)	**Nominal Depth** (m)	**Instrument/sn**	**Parameters measured**	**Sample interval** (min)	**Start time, UTC** (dd/mm/yyyy hh:mm:ss)	**Comments**
424	2984	Novatech RF-700A1 W02-085 VHF radio beacon (159.480 MHz)				On triangular McLane top float
424	2984	Novatech ST-400A W02-089 Xenon flash beacon (daylight off disabled)				
408	3000	Four orange Vitrovex floats on 5-m Eddygrip rope				
400	3008	Aquadopp 12010	U, V, W, T, P	10	08/02/2019 00:00:00	
399	3009	SBE-39 4716	T	10	08/02/2019 00:00:00	
53	3355	Four orange Vitrovex floats on 5-m Eddygrip rope				
46	3362	Aquadopp 12016	U, V, W, T, P	10	08/02/2019 00:00:00	
18	3390	SBE-37SM 7387	T, C, P	10	08/02/2019 00:00:00	
9	3399	Two orange Vitrovex floats on 3-m Eddygrip rope (labelled iStar 2A)				
7	3401	Release: Ixsea AR861 1618				

OP6 (2019-)

Height above bottom (m)	Nominal Depth (m)	Instrument/sn	Parameters measured	Sample interval (min)	Start time, UTC (dd/mm/yyyy hh:mm:ss)	Comments
424	1888	Novatech RF-700A1 V08-056 VHF radio beacon (159.480 MHz)				On triangular McLane top float
408	1904	Four floats on 5-m Eddygrip rope				
400	1912	Aquadopp 12020	U, V, W, T, P	10	08/02/2019 00:00:00	
53	2259	Four floats on 5-m Eddygrip rope				
46	2266	Aquadopp 12053	U, V, W, T, P	10	08/02/2019 00:00:00	
18	2294	SBE-37SM 2707	T, C, P	10	08/02/2019 00:00:00	
9	2303	Two floats on 3-m Eddygrip rope				
7	2305	Release: Ixsea AR861 1356				

Appendix E: Mooring diagrams

Recovered moorings:



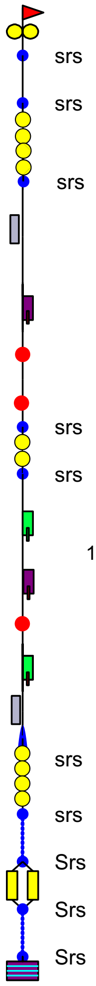
Target Position: Lat S 62 36.924’ Lon W 043 14.618’ Target Depth 3049m

Anchor Drop: Lat S 62 36.942’ Lon W 043 14.709’ 24 Mar 2017 19:37:14

Triangulated Pos: Lat S 62 36.854’ Lon W 043 14.475’ Depth 3052 m

Weddell Orkney Plateau Moorings   Mooring ID: M3   Cruise: JR16005

Depth	Element	Serial Number	Distance between elements	Wire marker	Line length/ type
4041 m	McLane Top w/ radio + strobe 159.48 MHz	W08-050 V08-057	10 m		poly rope, 10 m
4051 m	17" glass x 4 on 2x 2 m 3/8" chain		5 m		
4060 m	Aquadopp 6k	2317	45 m	**5**	**3/16 wire, 250 m**
4105 m	SBE37SM	1351	75 m	**50**	
4180 m	SBE39 T,P	1247	75 m	**125**	
4255 m	SBE39 T,P	1310	50 m	**200**	
4305 m	17" glass x 2 on 2 m 3/8" chain		25 m		
4332 m	SBE37SMP	14764	125 m	**25**	**3/16 wire, 250 m**
4457 m	SBE37SM	4119	50 m	**150**	
4507 m	SBE39 T,P	1826	45 m	**200**	
4552 m	SBE37SMP	14763	3 m	**245**	
4555 m	Aquadopp 6k	1752	2 m	**248**	
4557 m	17" glass x 4 on 2x2m 3/8" chain		2 m		3/8" chain
4564 m	8242 release(2)	32131 49027	7 m		3/8" chain
4573 m	anchor 350 kg wet				



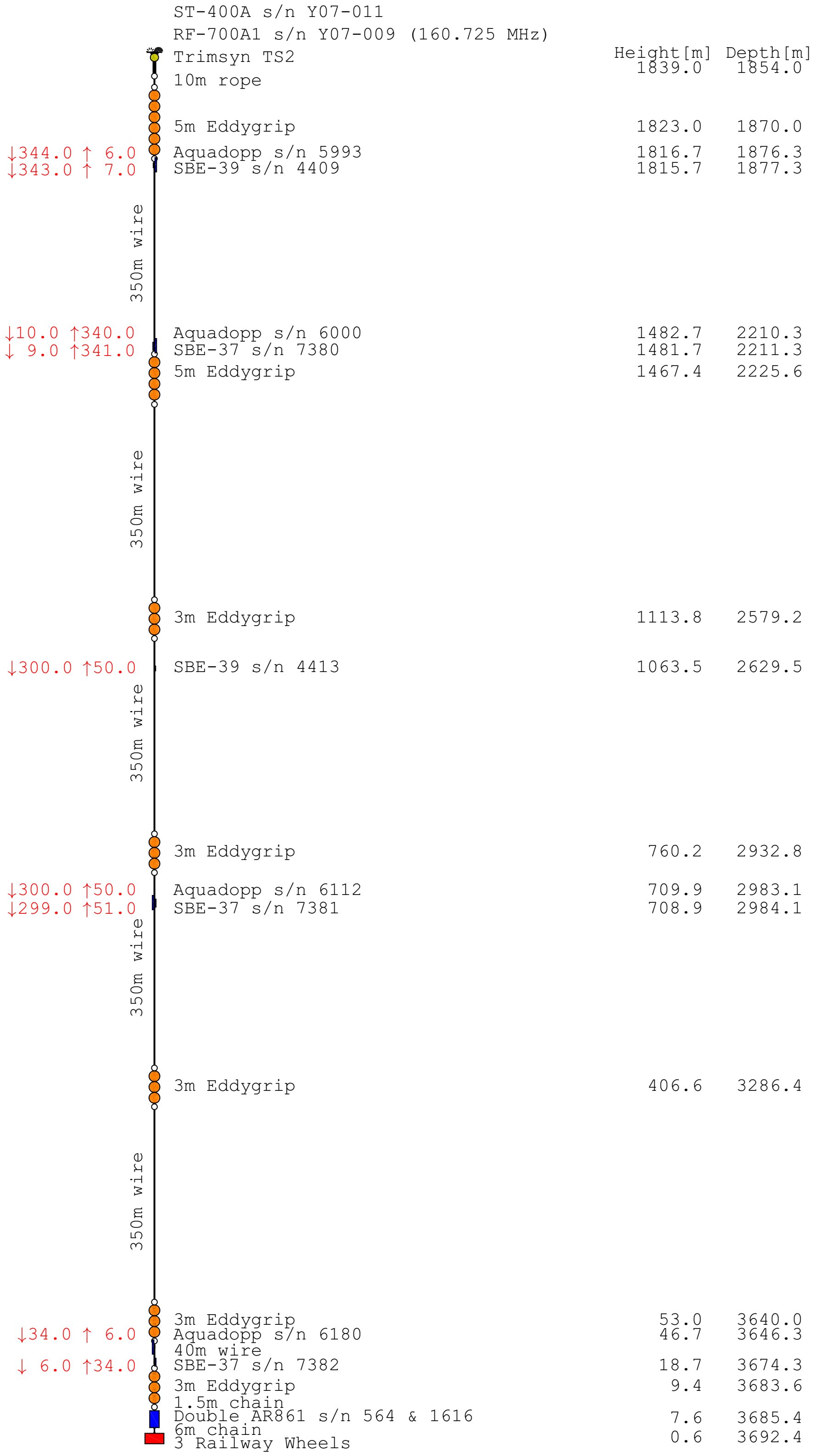
Target Position: Lat S 63 31.998 ' Lon W 041 46.656' Target Depth 4622 m

Anchor Drop: Lat S 63 32.030' Lon W 041 46.726' 24 Mar 2017 10:30:48

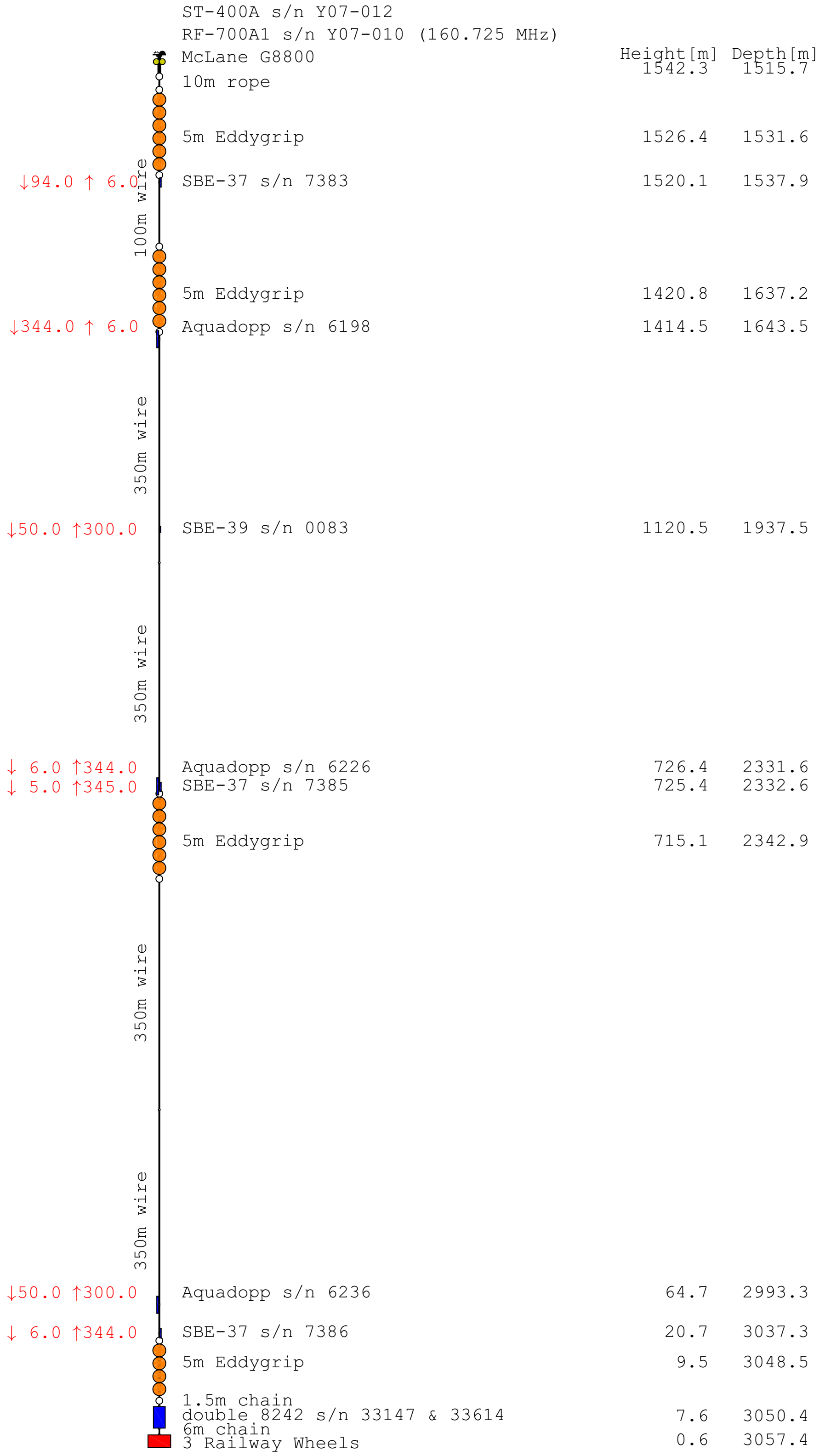
Triangulated Pos: Lat S 63 31.963' Lon W 041 46.299' Depth 4573 m

notes: radio duty cycle: 2 s on, 4 off

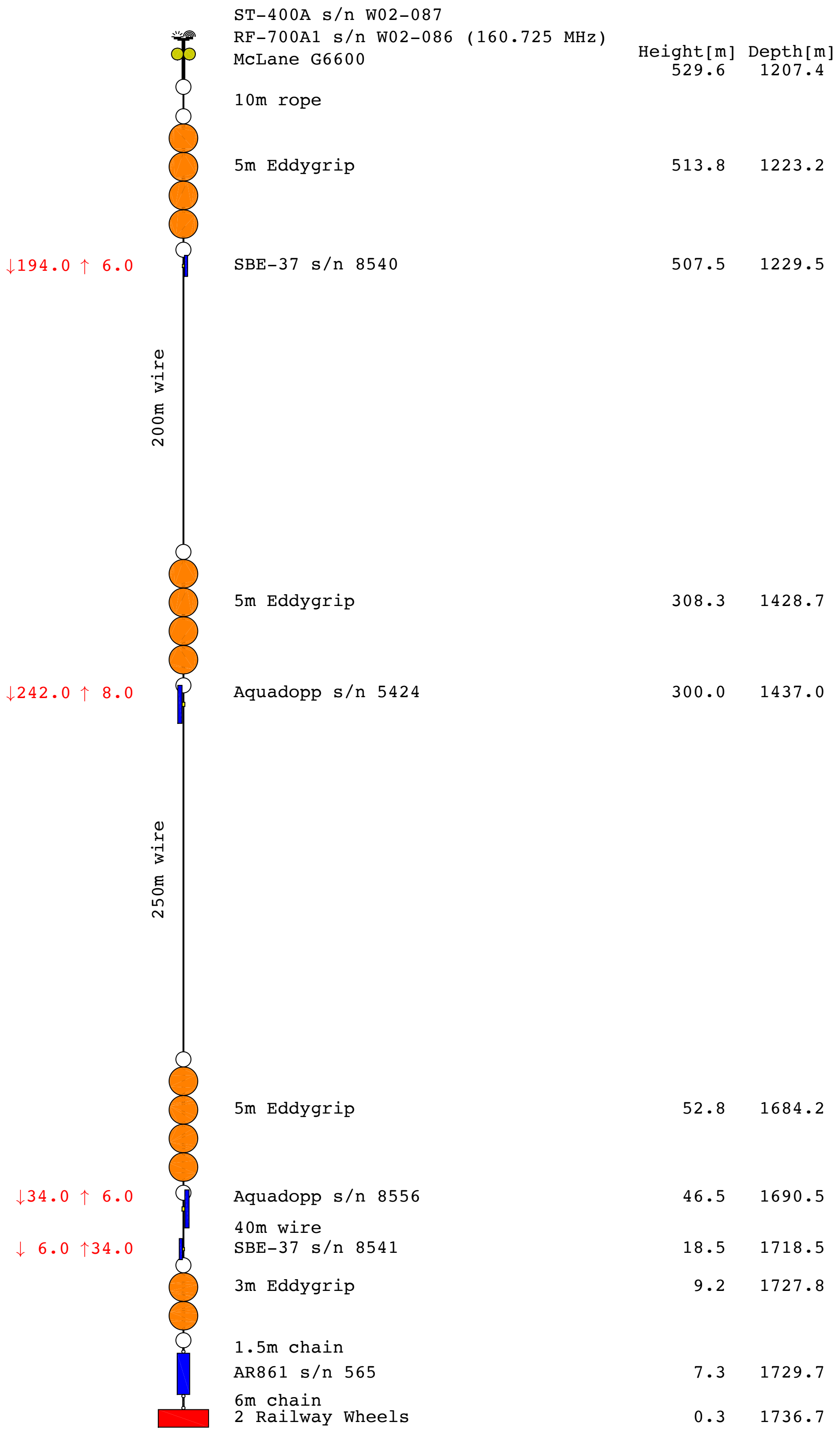
Mooring OP1 - as deployed in 2017



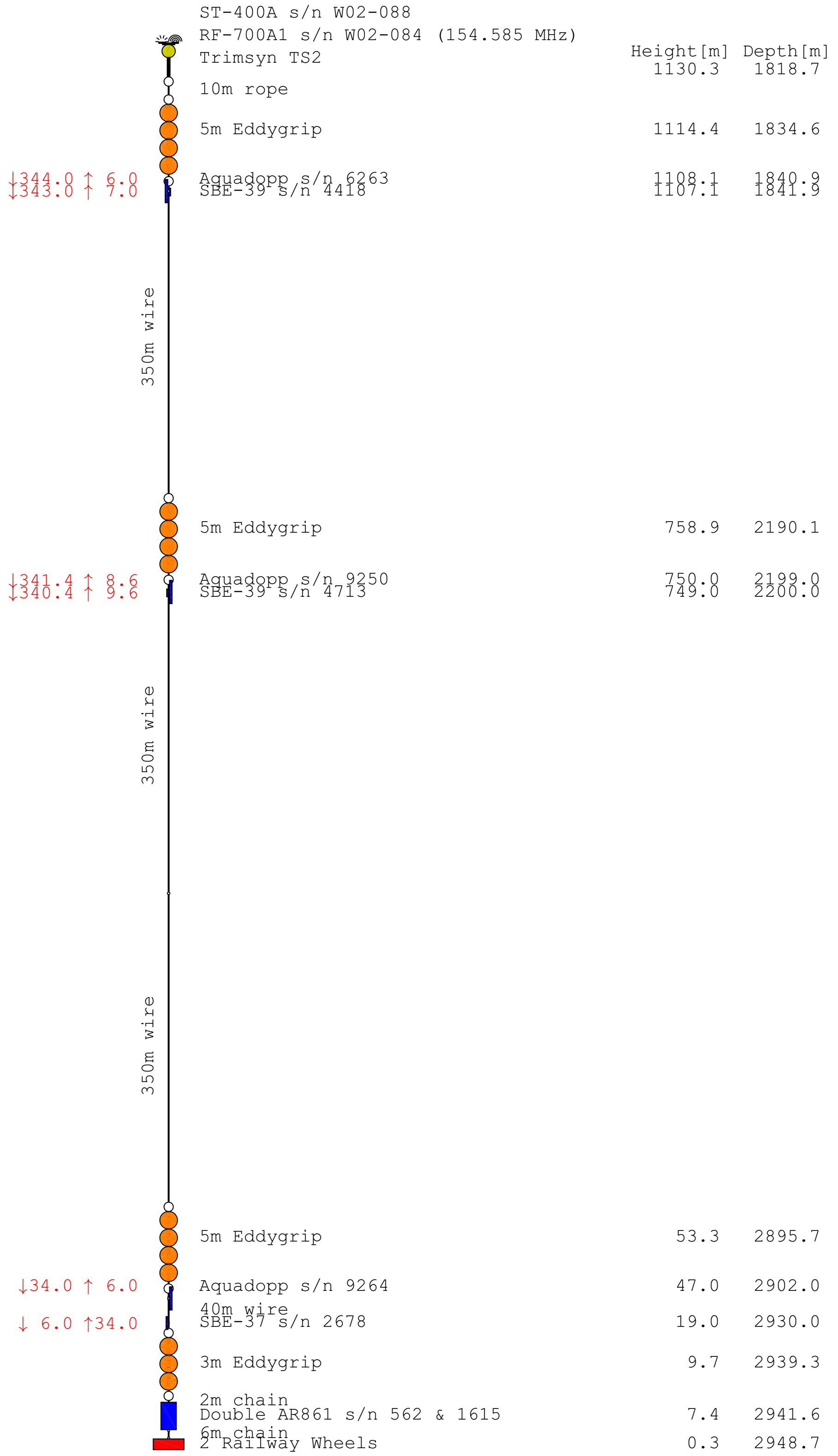
Mooring OP2 - as deployed in 2017



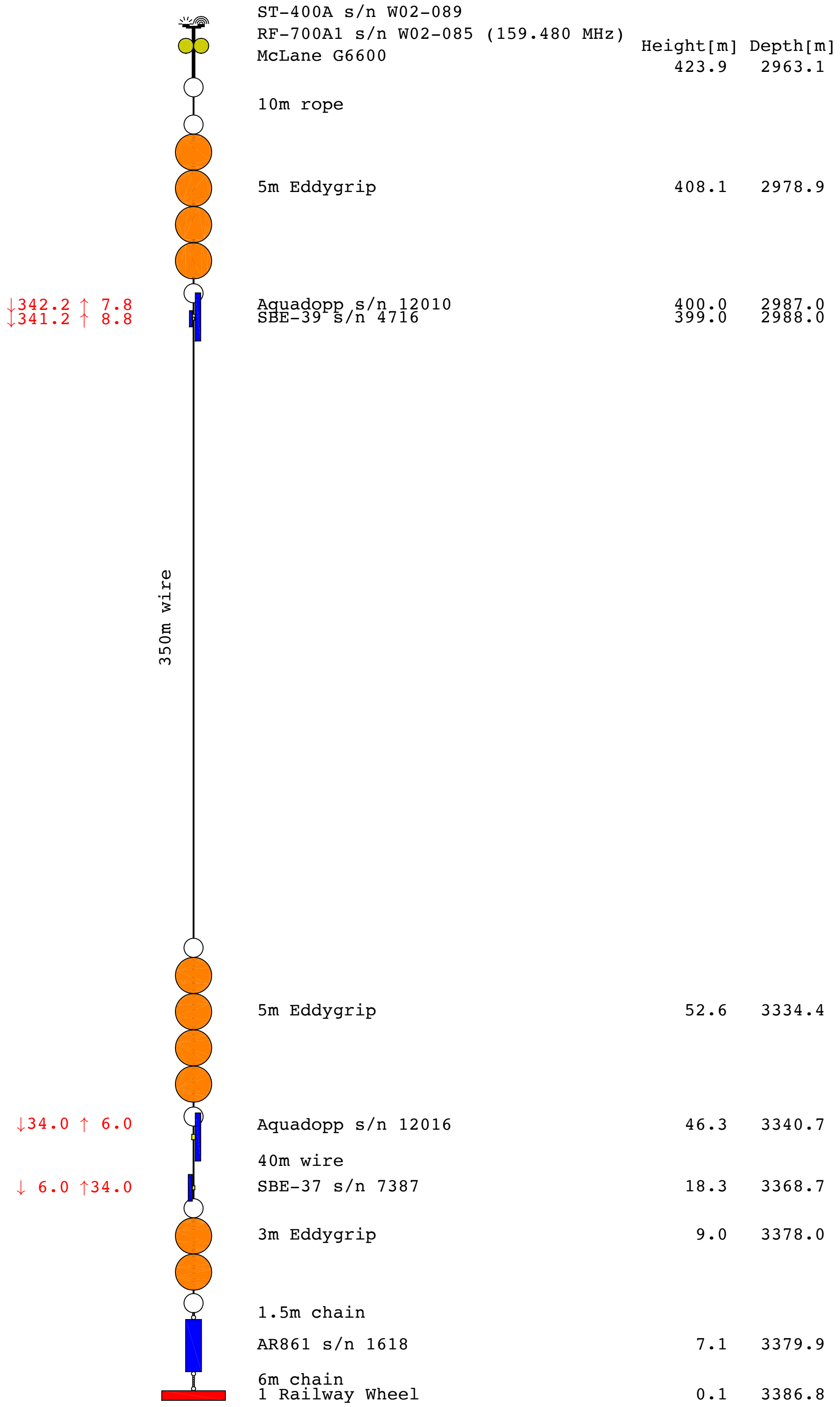
Mooring OP3 - as deployed in 2017



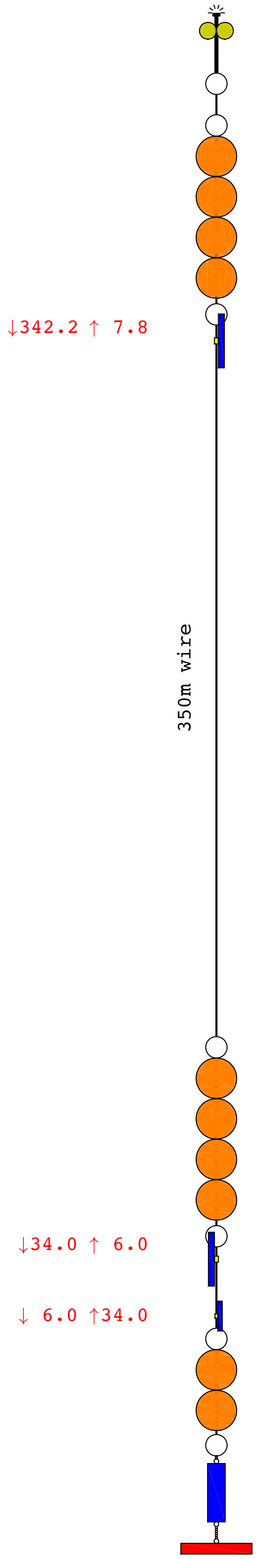
Mooring OP4 - as deployed in 2017



Mooring OP5 - as deployed in 2017



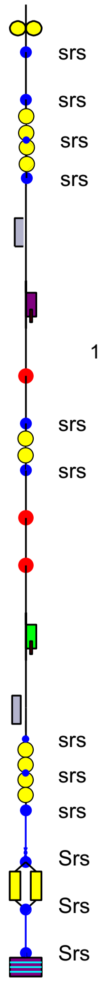
Mooring OP6 - as deployed in 2017



	Height[m]	Depth[m]
RF-700A1 s/n V08-056 (159.480 MHz) McLane G6600	423.9	1886.1
10m rope		
5m Eddygrip	408.1	1901.9
Aquadopp s/n 12020	400.0	1910.0
5m Eddygrip	52.6	2257.4
Aquadopp s/n 12053	46.3	2263.7
40m wire		
SBE-37 s/n 8267	18.3	2291.7
3m Eddygrip	9.0	2301.0
1.5m chain		
AR861 s/n 1356	7.1	2302.9
6m chain		
1 Railway Wheel	0.1	2309.8

Deployed moorings:

Weddell Orkney Plateau Moorings   Mooring ID: **M2**   Cruise: JR18004



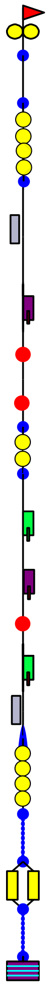
Nom Depth	Element	Serial Number	Distance between elements	**Wire marker**	Line length/ type
2520 m	McLane Top^2 Beacon 159.480 MHz Flasher	U08-058 V08-057	10 m		poly rope, 10 m
2532 m	17" glass x 4 on 2x 2 m 3/8" chain		5 m		
2541 m	Aquadopp 6k	2807		**5**	**3/16 wire, 250 m**
2586 m	SBE37SM	6557	45m	**50**	
2711 m	SBE39 T, P	1311	125 m	**175**	
2786 m	17" glass x 2 on 2 m 3/8" chain		75 m		
2813 m	SBE39 T,P	1232	25 m	**25**	
2888 m	SBE39 T,P	0229	75 m	**100**	**3/16 wire, 250 m**
3033 m	SBE37SMP	14765	145 m	**245**	
3036 m	Aquadopp 6k	9380	3 m	**248**	
3038 m	17" glass x 4 on 2x2m 3/8" chain		2 m		
3044 m	8242 release (2)	31512 33152	2 m		3/8" chain
3052 m	anchor 350 kg		7 m		3/8" chain

Target Position: Lat S 62 36.924' Lon W 043 14.618' Target Depth 3049m

Anchor Drop: Lat S 62 36.924' Lon W 043 14.618' 13 Jan 2019 19:11:30

Triangulated Pos: Lat S 62 36.798' Lon W 043 14.384' Depth 3052 m

Weddell Orkney Plateau Moorings Mooring ID: M3 Cruise: JR18004

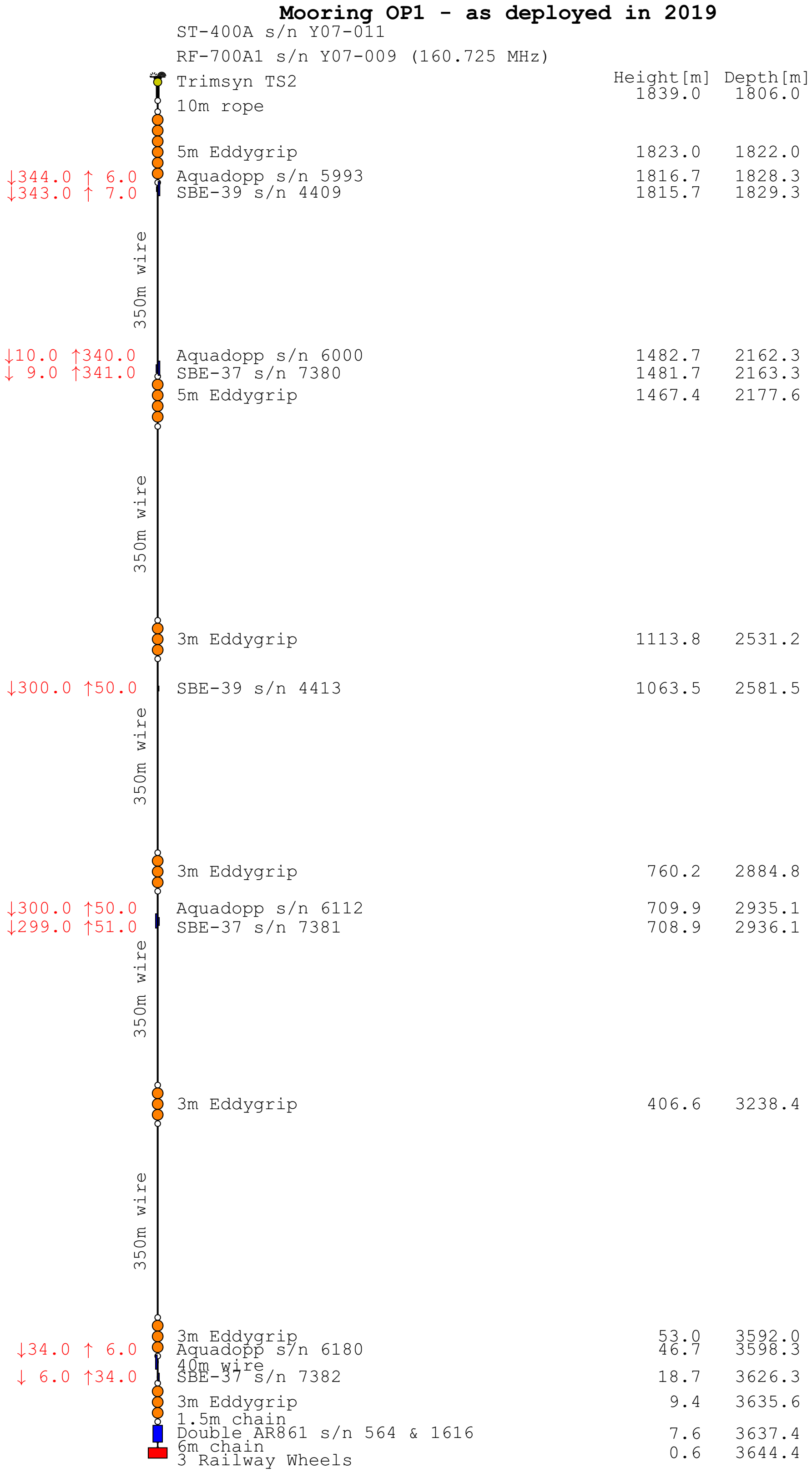


Depth	Element	Serial Number		Distance between elements	Wire marker	Line length/ type
4028 m	McLane Top w/ radio + strobe 159.48 MHz	W08-053 V08-057	srs	10 m		poly rope, 10 m
4042 m	17" glass x 4 on 2x 2 m 3/8" chain		srs, srs	5 m		
4049 m	Aquadopp 6k	2317		45 m	5	**3/16 wire, 250 m**
4094 m	SBE37SMP	10172		75 m	50	
4169 m	SBE39 T,P	1247		75 m	125	
4244 m	SBE39 T,P	1310		50 m	200	
4294 m	17" glass x 2 on 2 m 3/8" chain		srs, srs	25 m		
4321 m	SBE37SMP	14764		125 m	25	**3/16 wire, 250 m**
4446 m	SBE37SMP	16961		50 m	150	
4496 m	SBE39 T,P	1826		45 m	200	
4541 m	SBE37SMP	14763		3 m	245	
4544 m	Aquadopp 6k	1752		2 m	248	
4548 m	17" glass x 4 on 2x2m 3/8" chain		srs, srs	2 m		3/8" chain
4552 m	8242 release(2)	32131 49027	Srs, Srs	6 m		3/8" chain
4560 m	anchor 350 kg wet		Srs			

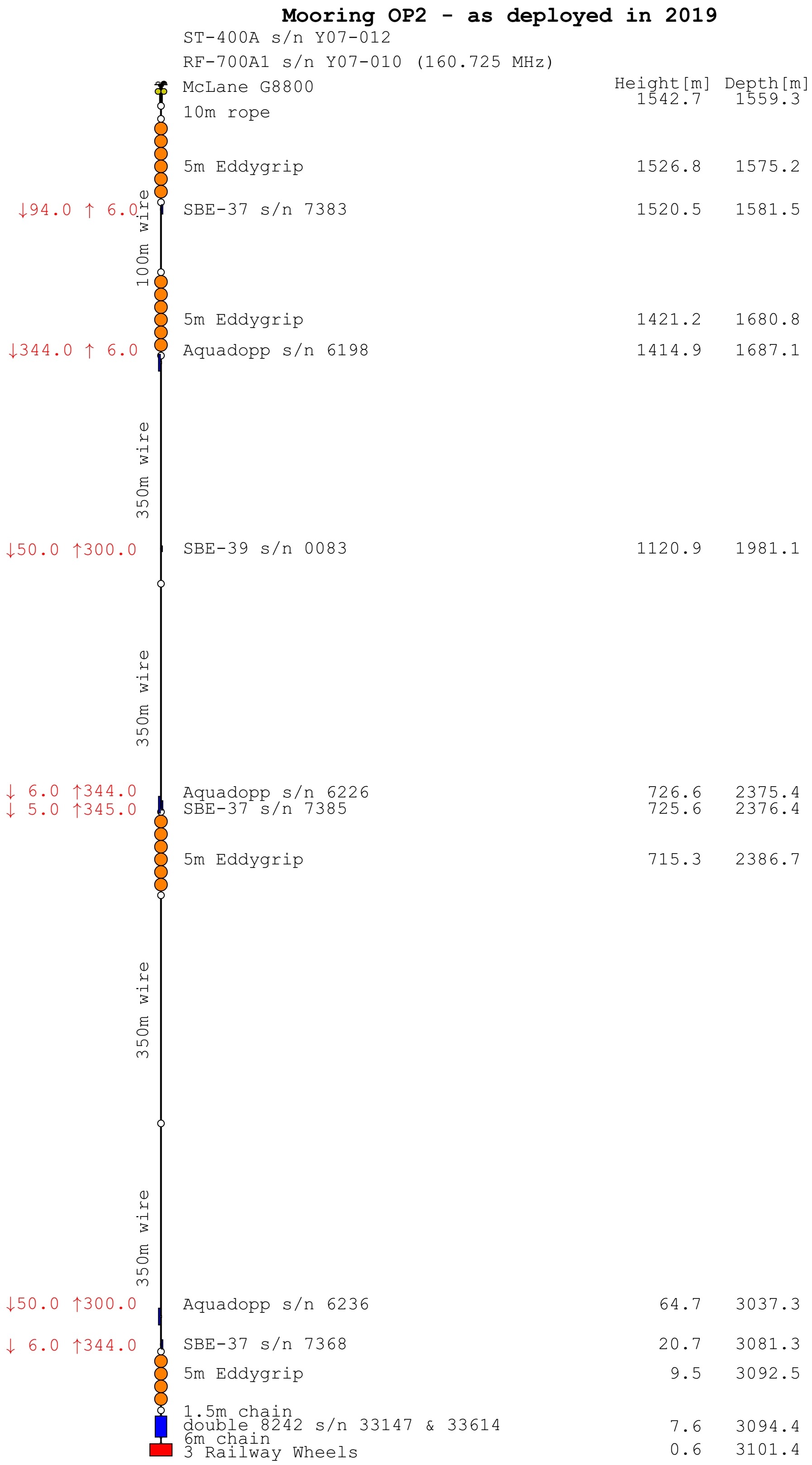
Target Position: Lat S 63° 31.998' Lon W 041° 46.656' Depth: 4622 m

Anchor Drop: Lat S 63° 32.014' Lon W 041° 46.656' 26 Jan 2019 20:19:26

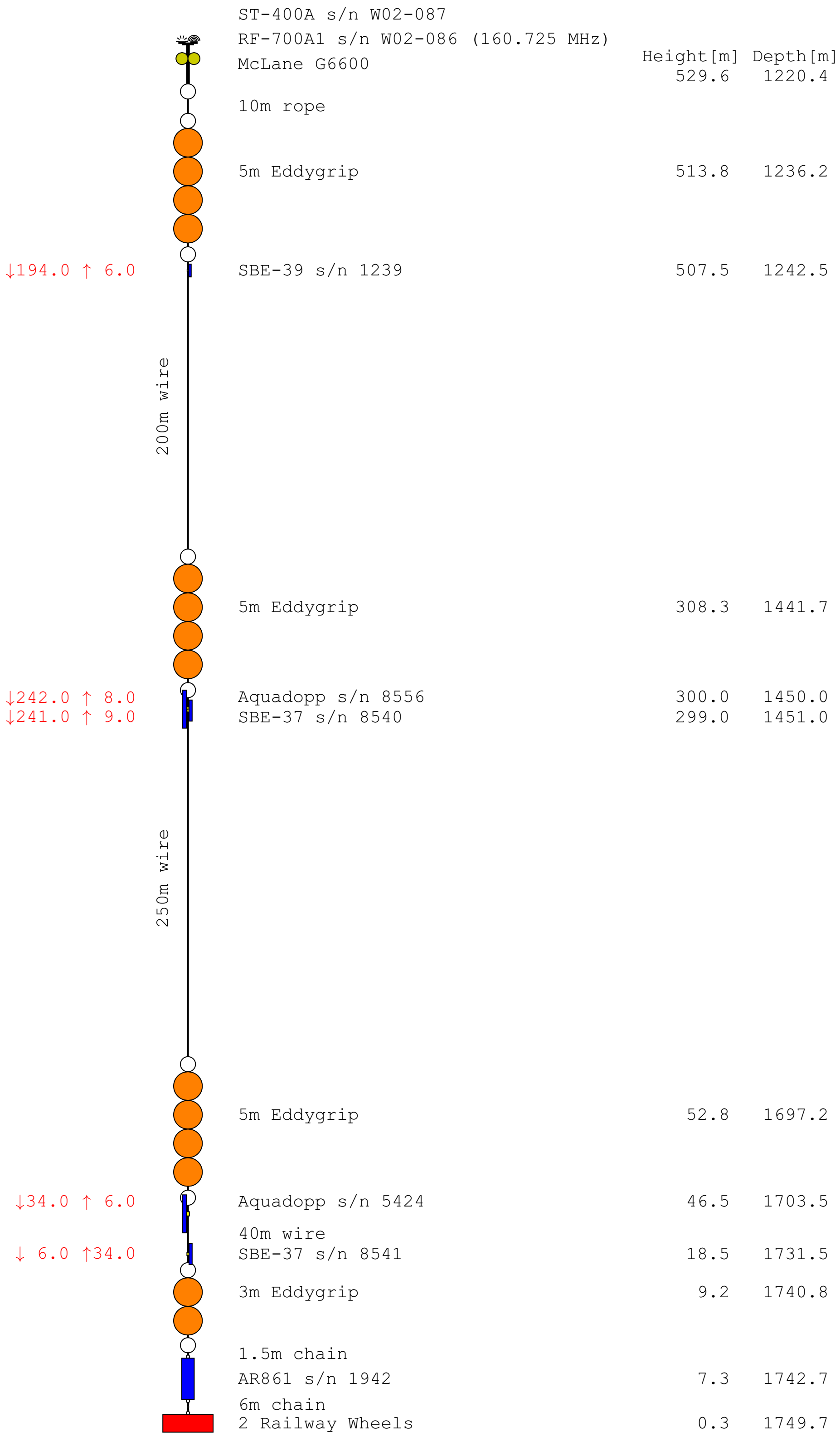
Triangulated Pos:Lat S 63° 31.945' Lon W 041° 46.146' Depth 4560 m



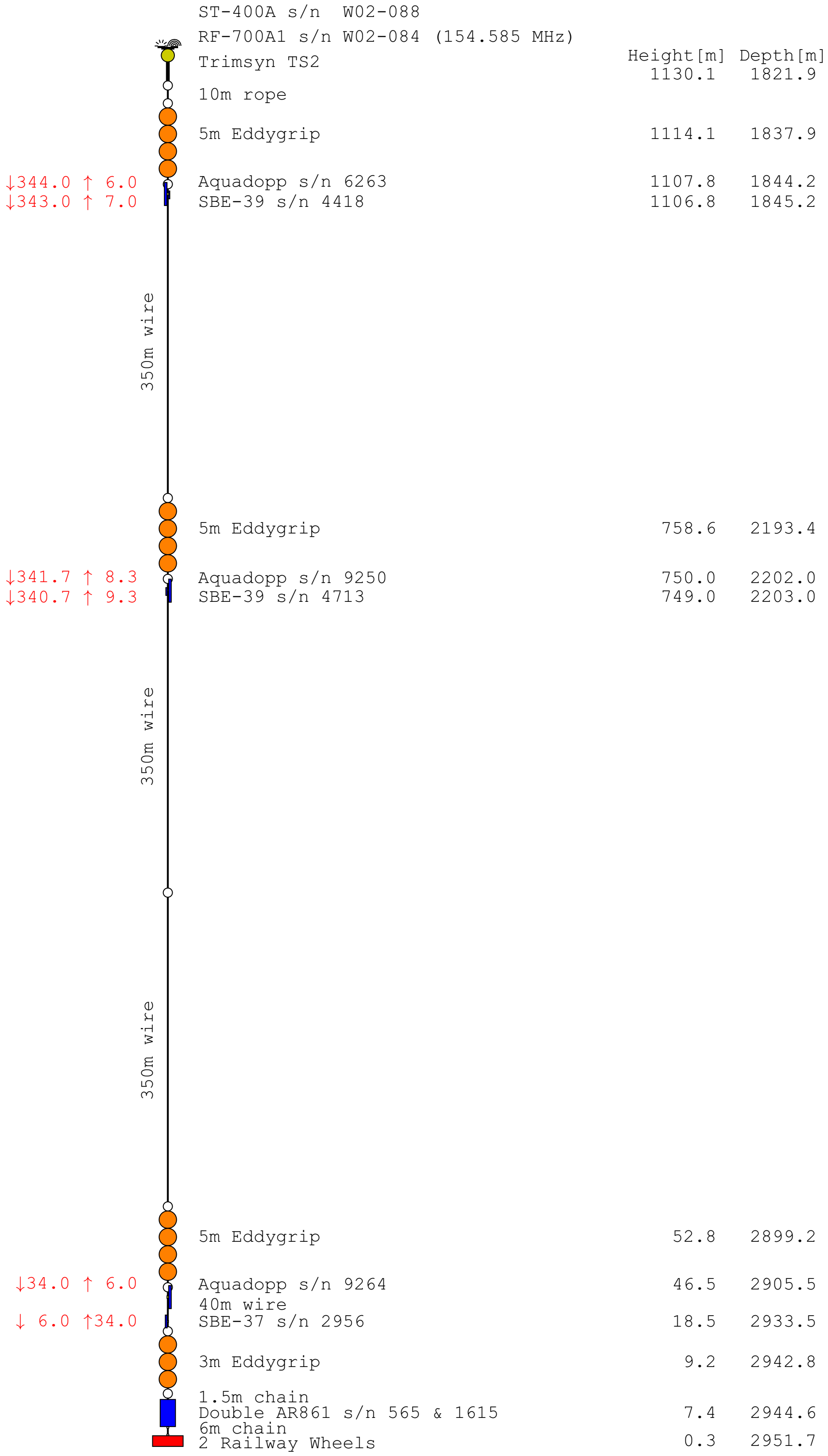
Mooring OP1 - as deployed in 2019
ST-400A s/n Y07-011
RF-700A1 s/n Y07-009 (160.725 MHz)
Trimsyn TS2
Height[m] Depth[m]
1839.0 1806.0
10m rope
5m Eddygrip 1823.0 1822.0
↓344.0 ↑ 6.0 Aquadopp s/n 5993 1816.7 1828.3
↓343.0 ↑ 7.0 SBE-39 s/n 4409 1815.7 1829.3
350m wire
↓10.0 ↑340.0 Aquadopp s/n 6000 1482.7 2162.3
↓ 9.0 ↑341.0 SBE-37 s/n 7380 1481.7 2163.3
5m Eddygrip 1467.4 2177.6
350m wire
3m Eddygrip 1113.8 2531.2
↓300.0 ↑50.0 SBE-39 s/n 4413 1063.5 2581.5
350m wire
3m Eddygrip 760.2 2884.8
↓300.0 ↑50.0 Aquadopp s/n 6112 709.9 2935.1
↓299.0 ↑51.0 SBE-37 s/n 7381 708.9 2936.1
350m wire
3m Eddygrip 406.6 3238.4
350m wire
3m Eddygrip 53.0 3592.0
↓34.0 ↑ 6.0 Aquadopp s/n 6180 46.7 3598.3
40m wire
↓ 6.0 ↑34.0 SBE-37 s/n 7382 18.7 3626.3
3m Eddygrip 9.4 3635.6
1.5m chain
Double AR861 s/n 564 & 1616 7.6 3637.4
6m chain
3 Railway Wheels 0.6 3644.4


Mooring OP2 - as deployed in 2019
ST-400A s/n Y07-012
RF-700A1 s/n Y07-010 (160.725 MHz)
McLane G8800
Height[m] Depth[m]
1542.7 1559.3
10m rope
5m Eddygrip 1526.8 1575.2
↓94.0 ↑ 6.0
SBE-37 s/n 7383 1520.5 1581.5
100m wire
5m Eddygrip 1421.2 1680.8
↓344.0 ↑ 6.0
Aquadopp s/n 6198 1414.9 1687.1
350m wire
↓50.0 ↑300.0
SBE-39 s/n 0083 1120.9 1981.1
350m wire
↓ 6.0 ↑344.0
Aquadopp s/n 6226 726.6 2375.4
↓ 5.0 ↑345.0
SBE-37 s/n 7385 725.6 2376.4
5m Eddygrip 715.3 2386.7
350m wire
350m wire
↓50.0 ↑300.0
Aquadopp s/n 6236 64.7 3037.3
↓ 6.0 ↑344.0
SBE-37 s/n 7368 20.7 3081.3
5m Eddygrip 9.5 3092.5
1.5m chain
double 8242 s/n 33147 & 33614 7.6 3094.4
6m chain
3 Railway Wheels 0.6 3101.4

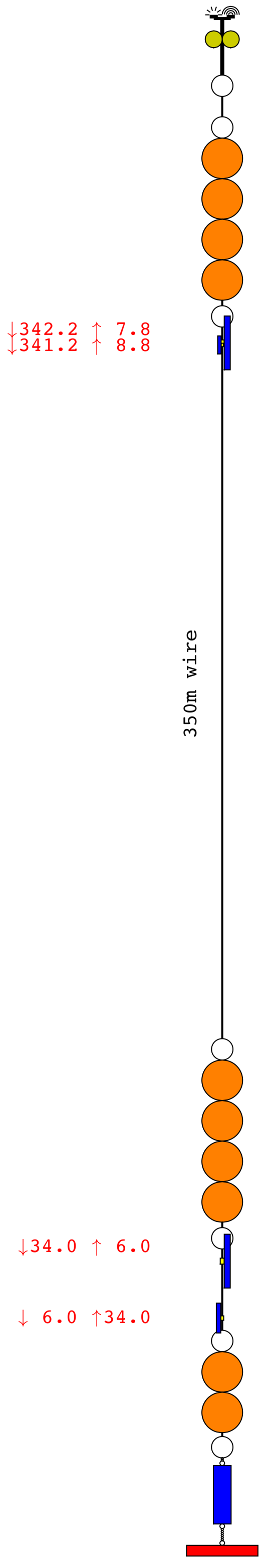
Mooring OP3 - as deployed in 2019



Mooring OP4 - as deployed in 2019

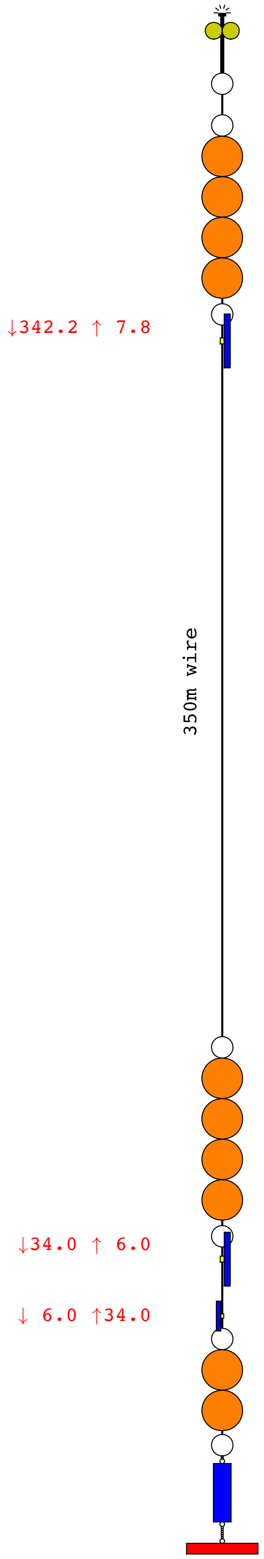


Mooring OP5 - as deployed in 2019



	Height[m]	Depth[m]
ST-400A s/n W02-089		
RF-700A1 s/n W02-085 (159.480 MHz)		
McLane G6600	423.9	2984.1
10m rope		
5m Eddygrip	408.1	2999.9
Aquadopp s/n 12010	400.0	3008.0
SBE-39 s/n 4716	399.0	3009.0
5m Eddygrip	52.6	3355.4
Aquadopp s/n 12016	46.3	3361.7
40m wire		
SBE-37 s/n 7387	18.3	3389.7
3m Eddygrip	9.0	3399.0
1.5m chain		
AR861 s/n 1618	7.1	3400.9
6m chain		
1 Railway Wheel	0.1	3407.8

Mooring OP6 - as deployed in 2019



	Height[m]	Depth[m]
RF-700A1 s/n V08-56 (159.480 MHz) McLane G6600	423.9	1888.1
10m rope		
5m Eddygrip	408.1	1903.9
Aquadopp s/n 12020	400.0	1912.0
5m Eddygrip	52.6	2259.4
Aquadopp s/n 12053	46.3	2265.7
40m wire		
SBE-37 s/n 2707	18.3	2293.7
3m Eddygrip	9.0	2303.0
1.5m chain		
AR861 s/n 1356	7.1	2304.9
6m chain		
1 Railway Wheel	0.1	2311.8

Appendix F: Glider functional checkout sheets

Unit 330

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Document #:	4095-FCP
Rev:	
Date:	10/01/2019
ECO #:	

Glider Functional Checkout (Estimated Time To Complete: 90 minutes)

Glider Serial Number:	Unit 330
Tested By:	Ryan Scott
Reason For Test:	Pre-deployment checkout
Date:	10/01/2019

CAUTION

1. The CTD should not be run dry for more than 30 seconds at a time.
2. The glider must not be in simulation. If glider is in simulation, follow the instructions in step 1.02 to delete the simul.sim file

NOTES
If any test results in a failure, the FCP must be restarted after the failure is corrected.

EQUIPMENT REQUIRED:	
Maintenance Laptop (including Freewave transceiver)	Green "go" plug
Clock with UTC time	Hand tools to remove / replace nose cone and tail cowling.
Thermometer	RF Chirp (TWR P/N E-710) - optional if glider is tested through satellite or with local receiver
Digital multimeter	

Indoor Tests:				Pass/Fail/ Result/Note
1.00	1. Verify Connection of Glider O&M Communications Kit (dockserver).			yes
	2. Start up and sign into the Dockserver or Maintenance Laptop.			yes
	3. Start glider terminal *From a linux terminal session:* *type "start-glider-terminal" to start glider terminal* *type "inspect-dockserver" to monitor Dock Server activity (optional)*			yes
	4. If a script.xml is running, click the stop button and make sure it stays off (red) during the procedure.			
	5. Place a "RF Chirp" beeper near the fin. During the test, verify that the RF Chirp beeps approximately every 90 seconds (or use alternative method to confirm Argos transmissions)			yes
	6. Insert Green Plug or Bench Power Supply to power up the Glider. *NOTE: The Strobe Light will flash when power is applied to the Glider.*			yes
	7. Verify the Air Pump has turned on and record time.	start time =	08:51	yes
	8. Verify that the Freewave Master indicates carrier detect (CD light turns green) within 30 seconds of applying Glider power.			yes
1.01	1. For LBS Gliders with software version 1.9 and higher, type `ctrl-Q` to initialize the start up sequence			
	2. Type `ctrl-C` on the Glider Terminal to prevent the glider from sequencing into a mission.			yes
	NOTE: If the Glider begins to run the mission "initial.mi" before accepting a ctrl-c, you must type `exit reset` *to restart the process. Failure to do so may result in test errors due to some sensors being disabled.*			
1.02	1. At the first GliderDOS prompt, type the following commands:			yes
	`lab_mode on`			yes
	`callback 30`			yes
	`logging on` (wait for response `LOG FILE OPENED`)			yes
	2. Note the name of the log file *NOTE: It will take 1-2 minutes for the log file to open.*	Log file name:	0247.0000	
	3. Type `simul?` If no response, then the glider is not in simulation. If the glider is in simulation, type `del \config\simul.sim` then type `exit reset` and restart the FCP			yes
	4. Type `time` and verify that the time matches the current UTC time (+/- 5 minutes).			yes
	1. Remove the nose dome.			replaced recovery system
	2. Type `put c_alt_time 0`			yes

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1.03	3. Verify that a regular clicking sound is heard from the Altimeter Transducer. *NOTE: Close proximity or direct physical contact between the transducer and your ear will be required.*			NO!
	4. Type `report ++ m_altimeter_voltage`			yes
	5. Verify that the voltage reading updates every 10-12 seconds and changes.			yes
	6. Type `put c_alt_time -1` to stop altimeter from pinging.			yes
	7. Type `report clearall`			yes
1.04	1. Type `get m_leakdetect_voltage` and verify that the reading is greater than 2.3 V	m_leakdetect_voltage=	2.47	yes
	2. Type `get m_leakdetect_voltage_forward` (G2 only) and verify that the reading is greater than 2.3 V	m_leakdetect_voltage forward =	2.47	yes
CAUTION: Only perform step 1.05 if a new battery pack has been installed. Otherwise, proceed to step 1.06.				
1.05	Type `put m_coulomb_amphr_total 0` (only for new batteries)			
1.06	1. Type `get m_coulomb_amphr_total` and note the value *(applies to all G2 gliders and G1 gliders with add-on coulomb counters)* Note: For gliders with new batteries, verify that total count is less than 5 amp-hrs. For gliders with partially used batteries, verify that total count makes sense.	m_coulomb_amphr_total =	1.52	yes
	2. Refer to mission endurance calculator to determine if enough energy is available for desired mission.			yes
1.07	1. Type `consci`			yes
	2. Verify that the science prompt `SciDos>` is displayed.			yes
	3. Type `dir app`			yes
	4. Verify that the result contains the file SUPERSCI.APP.			yes
	5. Type `zs \config\proglets.dat`			yes
	6. Type `quit`			yes
	7. Verify that control returns to the Glider Processor (`GliderLAB>` is displayed)			yes
1.08	1. Review proglets.dat to determine which science sensors are installed in the glider.			yes
	2. List each of these sensors in step 1.11a-f			yes
	3. Locate the glider sensor information sheet (GSI) for each sensor:			yes
1.08a	Sensor name:			CTD41CP UART 3 BIT 30
	Sensor checkout sheet & revision:			
1.08b	Sensor name:			FLBBCD UART 0 BIT 29
	Sensor checkout sheet & revision:			
1.08c	Sensor name:			COMMENTED OUT OXY4
	Sensor checkout sheet & revision:			
1.08d	Sensor name:			
	Sensor checkout sheet & revision:			
1.08e	Sensor name:			
	Sensor checkout sheet & revision:			
1.08f	Sensor name:			
	Sensor checkout sheet & revision:			
1.09	1. Type `report ++ m_depth`			yes
	2. Verify m_depth is ±0.5m (if m_depth is greater than ±0.5 m, type `zero_ocean_pressure` and try again)			yes
	3. Type `report clearall`			yes
1.10	1. Type `strobe on` (if Installed)			yes
	2. Verify that the strobe light flashes periodically.			yes
	3. Type `strobe off`			yes
1.11	Verify that the Air Pump shuts off between 3 and 10 minutes	elapsed time =	?	yes

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Tested By:	Ryan Scott
Reason For Test:	Pre-deployment checkout
Date:	10/01/2019

1.11	*NOTE: After the Air Pump turns off, it should not turn back on until the glider is reset.*	elapsed time =	?	yes
1.12	1. Type `get m_vacuum` (vacuum will increase when the air bladder is inflated)			yes
	2. Verify that the vacuum reading is greater than 7"Hg (1000m) or 6"Hg (200m)	`m_vacuum` =	10.3	yes
1.13	1. Type `ballast` and wait for the response "`The Air Pump is off`" (this may take several minutes for a deep glider)			yes
	2. Type `report clearall`			yes
	3. Type `get m_vacuum`			yes
	4. Confirm that the value has decreased by ~2.5 from step 1.04 and that the value is either above 5.5"Hg (1000m gliders) or 4.5"Hg (200m gliders)	`m_vacuum` =	7.67	yes
NOTE: Crusty residue may need to be removed from annode to get a good connection.				
1.14	1. Remove the tail cowling.			yes
	2. Probe between the forward Anode and Pump Flange Screws using a Digital Multimeter on ohms setting.			yes
	3. Note the resistance.	resistance =	0.04	yes
	4. Probe between the aft anode and Ejection Weight Tube using a Digital Multimeter on ohms setting.			yes
	5. Verify that resistance is less than 10 ohms.	resistance =	0.02	yes
1.15	1. For Gliders equipped with digifin			yes
	2. Type get m_digifin_leakdetect_reading.	reading=	1022	yes
	3. If reading is less than 1019, the digifin needs factory service. Take digifin out of service (use - digifin) and continue FCP.			
1.16	1. At the prompt type `wiggle on` and let the glider wiggle for 10 minutes *NOTE: It is not unusual for the Pitch Motor to produce warnings on startup after being idle or after transportation. If this happens, stop the wiggle, put the device back into service if necessary, and restart the wiggle.*			yes
	2. Verify that no motor driver warnings or errors are displayed on the Glider Terminal.			yes
	3. Verify that the Digifin moves from Port to Starboard.			yes
	4. Listen to verify that Motors are not binding or stalling. (optional)			yes
1.17	1. Type `get m_tot_num_inflections`			yes
	2. Verify that total is less than 20,000 inflections, and meets next mission requirements.	`m_tot_num_inflections` =	6,688	yes
1.18	After wiggling for 10 minutes, type `wiggle off`			yes
NOTE: only perform step 1.18 if thruster is installed. Note that thruster should not be operated in air for more than 30 seconds to prevent overheating.				
1.19	1. Make sure that thruster blades are not obstructed.			N/A
	2. Type `report ++ m_thruster_current`			N/A
	3. Type `put c_thruster_on 20`			N/A
	4. Verify that thruster spins clockwise when viewed from the aft end and that `m_thruster_current` updates regularly.			N/A
	5. Type `put c_thruster_on 0` to turn off the thruster.			N/A
	5. Type `report clearall`			N/A
CAUTION: Ensure Glider is dry prior to performing step 1.19 and 1.20. The presence of salt water during these steps increases the potential for accidental initiation of the recovery system release and glider weight release.				
NOTE: only perform step 1.19 if nose release recovery system is installed				
1.20	1. Disconnect the supply lead to the recovery system at the Mecca connector.			yes
	2. Connect the Digital Voltmeter between the Supply Lead and the forward Anode.			yes
	3. Type `put c_recovery_on 1`			yes
	4. Verify that the voltage is at least 5 volts.	voltage =	10.7	yes
	5. Type `put c_recovery_on 0` and wait for verification that the glider has accepted this command.			yes
	6. Verify that the voltage in the supply lead is zero and reconnect the Recovery System Supply Lead.			yes
	1. Type `lab_mode off`			yes
	2. Disconnect the Supply Lead to the Drop Weight at the Mecca Connector.			yes
	3. Connect the Digital Voltmeter between the supply lead and the ejection weight tube or aft anode assembly.			yes

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1.20	4. Type `put c_weight_drop 1`			yes
	5. Verify that the voltage is at least 5 volts.	voltage =	10.8	yes
	6. Type `put c_weight_drop 0` (Glider Software Release 7.15 and higher)			yes
	7. Type `put m_weight_drop 0` (Glider Software Release 7.15 and higher)			yes
	8. Type `logging off` and wait for response "`LOG FILE CLOSED`"			yes
	9. Type `exit pico`			yes
	10. Verify that the voltage is 0, and reconnect the Drop Weight Supply Lead.			yes
1.22	Install the Nose Cone and Tail Cover.			

Outdoor Tests:				**Pass/Fail/ Result/Note**
2.01	1. Place the Glider outdoors on a level surface with an unobstructed view of the sky.			yes
	2. Insert the green Power Plug.			yes
2.02	1. For LBS Gliders with software version 1.9 and higher, type `ctrl-Q` to initialize the start up sequence			
	2. Type `ctrl-C` on the Glider Terminal.			yes
	3. At the Gliderdos prompt, Type the following commands:			yes
	`lab_mode on`			yes
	`callback 30`			yes
	`logging on` (wait for response `LOG FILE OPENED`)			yes
	4. Note the name of the log file *NOTE: It will take 1-2 minutes for the log file to open.*	Log file name:	0249.0000	
2.03	1. Type `report ++ m_heading m_pitch m_roll`			yes
	2. Verify that the sensor updates periodically and `m_pitch` and `m_roll` are 0 (+/- 0.18 radian).			yes
	3. Rotate the glider cart and verify that `m_heading` changes (Rotate glider 90° at four different points)			yes
	4. Type `report clearall`			yes
2.04	1. Type `put c_gps_on 3`			yes
	2. Verify that the GPS gets fixes within 2 minutes.			yes
	In the following example string, the highlighted A should turn from a V to an A.			
	gps_diag(2)cyc#:538|GPRMC,161908,**A**,5958.3032,N, 7000.5568,W,0.000,343.9,190808,0.3,W|			
	3. Type `put c_gps_on 1`			yes
2.05	1. On the Glider Terminal, type `callback 0 0`			yes
	2. Verify that the Iridium call completes successfully on primary number			yes
	3. Type `callback 1 1`			yes
	4. Verify that the Iridium call completes successfully on alternate number			yes
	5. Type `callback 30`			yes
2.06	1. Type `get m_battery`			
	2. Verify that the reading is 9.7-12 volts (lithium) and 12-16 volts (alkaline).	`m_battery =`	14.84	no
2.07	1. Ensure that motors are not moving, and the air pump is off.			yes
	2. Type `put c_argos_on 0`			yes
	3. Type `get m_coulomb_current`			yes
	4. Verify that the reading is between 0.086 and 0.288 amps.	`m_coulomb_current =`	0.169	yes
2.08	Type `logging off`. Wait for response "`LOG FILE CLOSED`"			yes
2.09	Type `run status.mi`. Wait for normal completion			yes
2.10	1. Type `send *.*`			yes
	2. Save the Data Files and Dock Server Log Files as a part of the Test Record.			

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Date:	10/01/2019

	3. If desired, type `dellog all` to delete all sent logs.	yes
2.11	1. For 1000m gliders, type `put c_de_oil_vol -1000` to fully retract oil to inside reservoir. *NOTE: Oil volume should retract to -260cc*	yes
	2. Type `report ++ m_de_oil_vol` to monitor retraction.	yes
	3. Type `put c_air_pump 0` to deflate the air bladder for storage	yes
2.12	Type `exit` and remove power when prompted.	yes

Signature: RYAN SCOTT **Date:** 12/01/2019

REV	DESCRIPTION	ECO#	BY	DATE
A	Initial release	---	---	---
B	Format changes, science sensor testing moved to standalone GSI docs, several tolerances tightened, wording clarified, added notice	449	BH, BS, CD, BA	27/03/2012
C	Added steps for confirmation of BAM calibration values	624	BS	01/08/2012
D	Removed steps for confirmation of BAM calibration values; minor edits for accuracy; added fields for noted values	624	BS	01/08/2012
E	Added compass four point check.	773	CS	02/05/2013
F	Added coulomb count verification; inserted put c_alt_time -1 to stop altimeter from pinging	791	CS	18/06/2013
G	Rearranged steps to streamline process, added steps 1.18, 1.20.6, 1.20.7	12698	BS	19/06/2014

Unit 352

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Date:	09/01/2019
ECO #:	

Glider Functional Checkout (Estimated Time To Complete: 90 minutes)

Glider Serial Number:	Unit 352
Tested By:	Ryan Scott
Reason For Test:	Pre-deployment checkout
Date:	09/01/2019

CAUTION

1. The CTD should not be run dry for more than 30 seconds at a time.
2. The glider must not be in simulation. If glider is in simulation, follow the instructions in step 1.02 to delete the simul.sim file

NOTES

If any test results in a failure, the FCP must be restarted after the failure is corrected.

EQUIPMENT REQUIRED:	
Maintenance Laptop (including Freewave transceiver)	Green "go" plug
Clock with UTC time	Hand tools to remove / replace nose cone and tail cowling.
Thermometer	RF Chirp (TWR P/N E-710) - optional if glider is tested through satellite or with local receiver
Digital multimeter	

Indoor Tests:		Pass/Fail/ Result/Note
1.00	1. Verify Connection of Glider O&M Communications Kit (dockserver).	yes
	2. Start up and sign into the Dockserver or Maintenance Laptop.	yes
	3. Start glider terminal *From a linux terminal session:* *type "start-glider-terminal" to start glider terminal* *type "inspect-dockserver" to monitor Dock Server activity (optional)*	yes
	4. If a script.xml is running, click the stop button and make sure it stays off (red) during the procedure.	
	5. Place a "RF Chirp" beeper near the fin. During the test, verify that the RF Chirp beeps approximately every 90 seconds (or use alternative method to confirm Argos transmissions)	yes
	6. Insert Green Plug or Bench Power Supply to power up the Glider. *NOTE: The Strobe Light will flash when power is applied to the Glider.*	yes
	7. Verify the Air Pump has turned on and record time. — start time = 11:08	yes
	8. Verify that the Freewave Master indicates carrier detect (CD light turns green) within 30 seconds of applying Glider power.	yes
1.01	1. For LBS Gliders with software version 1.9 and higher, type `ctrl-Q` to initialize the start up sequence	
	2. Type `ctrl-C` on the Glider Terminal to prevent the glider from sequencing into a mission.	yes
	NOTE: If the Glider begins to run the mission "initial.mi" before accepting a ctrl-c, you must type `exit reset` *to restart the process. Failure to do so may result in test errors due to some sensors being disabled.*	
1.02	1. At the first GliderDOS prompt, type the following commands:	yes
	`lab_mode on`	yes
	`callback 30`	yes
	`logging on` (wait for response `LOG FILE OPENED`)	yes
	2. Note the name of the log file *NOTE: It will take 1-2 minutes for the log file to open.* — Log file name: 0766.0000	
	3. Type `simul?` If no response, then the glider is not in simulation. If the glider is in simulation, type `del \config\simul.sim` then type `exit reset` and restart the FCP	yes
	4. Type `time` and verify that the time matches the current UTC time (+/- 5 minutes).	yes
	1. Remove the nose dome.	yes

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1.03	2. Type `put c_alt_time 0`			yes
	3. Verify that a regular clicking sound is heard from the Altimeter Transducer. *NOTE: Close proximity or direct physical contact between the transducer and your ear will be required.*			yes
	4. Type `report ++ m_altimeter_voltage`			yes
	5. Verify that the voltage reading updates every 10-12 seconds and changes.			yes
	6. Type `put c_alt_time -1` to stop altimeter from pinging.			yes
	7. Type `report clearall`			yes
1.04	1. Type `get m_leakdetect_voltage` and verify that the reading is greater than 2.3 V	m_leakdetect_voltage=	2.47	yes
	2. Type `get m_leakdetect_voltage_forward` (G2 only) and verify that the reading is greater than 2.3 V	m_leakdetect_voltage forward =	2.47	yes
CAUTION: Only perform step 1.05 if a new battery pack has been installed. Otherwise, proceed to step 1.06.				
1.05	Type `put m_coulomb_amphr_total 0` (only for new batteries)			
1.06	1. Type `get m_coulomb_amphr_total` and note the value *(applies to all G2 gliders and G1 gliders with add-on coulomb counters)* Note: For gliders with new batteries, verify that total count is less than 5 amp-hrs. For gliders with partially used batteries, verify that total count makes sense.	m_coulomb_amphr_total =	2.1	yes
	2. Refer to mission endurance calculator to determine if enough energy is available for desired mission.			yes
1.07	1. Type `consci`			yes
	2. Verify that the science prompt `SciDos>` is displayed.			yes
	3. Type `dir app`			yes
	4. Verify that the result contains the file SUPERSCI.APP.			yes
	5. Type `zs \config\proglets.dat`			yes
	6. Type `quit`			yes
	7. Verify that control returns to the Glider Processor (`GliderLAB>` is displayed)			yes
1.08	1. Review proglets.dat to determine which science sensors are installed in the glider.			yes
	2. List each of these sensors in step 1.11a-f			yes
	3. Locate the glider sensor information sheet (GSI) for each sensor:			
1.08a	Sensor name:			CTD41CP UART 2 BIT 27
	Sensor checkout sheet & revision:			
1.08b	Sensor name:			LOGGER UART 0 BIT 29
	Sensor checkout sheet & revision:			
1.08c	Sensor name:			
	Sensor checkout sheet & revision:			
1.08d	Sensor name:			
	Sensor checkout sheet & revision:			
1.08e	Sensor name:			
	Sensor checkout sheet & revision:			
1.08f	Sensor name:			
	Sensor checkout sheet & revision:			
1.09	1. Type `report ++ m_depth`			yes
	2. Verify m_depth is ±0.5m (if m_depth is greater than ±0.5 m, type `zero_ocean_pressure` and try again)			yes
	3. Type `report clearall`			yes
1.10	1. Type `strobe on` (if Installed)			N/A
	2. Verify that the strobe light flashes periodically.			N/A
	3. Type `strobe off`			N/A

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1.11	Verify that the Air Pump shuts off between 3 and 10 minutes *NOTE: After the Air Pump turns off, it should not turn back on until the glider is reset.*	elapsed time =	5	yes
1.12	1. Type `get m_vacuum` (vacuum will increase when the air bladder is inflated)			yes
	2. Verify that the vacuum reading is greater than 7"Hg (1000m) or 6"Hg (200m)	`m_vacuum` =	10.38	yes
1.13	1. Type `ballast` and wait for the response "`The Air Pump is off`" (this may take several minutes for a deep glider)			yes
	2. Type `report clearall`			yes
	3. Type `get m_vacuum`			yes
	4. Confirm that the value has decreased by ~2.5 from step 1.04 and that the value is either above 5.5"Hg (1000m gliders) or 4.5"Hg (200m gliders)	`m_vacuum` =	7.87	yes
NOTE: Crusty residue may need to be removed from annode to get a good connection.				
1.14	1. Remove the tail cowling.			yes
	2. Probe between the forward Anode and Pump Flange Screws using a Digital Multimeter on ohms setting.			yes
	3. Note the resistance.	resistance =	?	
	4. Probe between the aft anode and Ejection Weight Tube using a Digital Multimeter on ohms setting.			yes
	5. Verify that resistance is less than 10 ohms.	resistance =	?	
1.15	1. For Gliders equipped with digifin			
	2. Type get m_digifin_leakdetect_reading.	reading=	1023	yes
	3. If reading is less than 1019, the digifin needs factory service. Take digifin out of service (use - digifin) and continue FCP.			
1.16	1. At the prompt type `wiggle on` and let the glider wiggle for 10 minutes *NOTE: It is not unusual for the Pitch Motor to produce warnings on startup after being idle or after transportation. If this happens, stop the wiggle, put the device back into service if necessary, and restart the wiggle.*			yes
	2. Verify that no motor driver warnings or errors are displayed on the Glider Terminal.			yes
	3. Verify that the Digifin moves from Port to Starboard.			yes
	4. Listen to verify that Motors are not binding or stalling. (optional)			yes
1.17	1. Type `get m_tot_num_inflections`			yes
	2. Verify that total is less than 20,000 inflections, and meets next mission requirements.	`m_tot_num_inflections` =	22,377	yes
1.18	After wiggling for 10 minutes, type `wiggle off`			yes
NOTE: only perform step 1.18 if thruster is installed. Note that thruster should not be operated in air for more than 30 seconds to prevent overheating.				
1.19	1. Make sure that thruster blades are not obstructed.			N/A
	2. Type `report ++ m_thruster_current`			N/A
	3. Type `put c_thruster_on 20`			N/A
	4. Verify that thruster spins clockwise when viewed from the aft end and that `m_thruster_current` updates regularly.			N/A
	5. Type `put c_thruster_on 0` to turn off the thruster.			N/A
	5. Type `report clearall`			N/A
CAUTION: Ensure Glider is dry prior to performing step 1.19 and 1.20. The presence of salt water during these steps increases the potential for accidental initiation of the recovery system release and glider weight release.				
NOTE: only perform step 1.19 if nose release recovery system is installed				
1.20	1. Disconnect the supply lead to the recovery system at the Mecca connector.			yes
	2. Connect the Digital Voltmeter between the Supply Lead and the forward Anode.			yes
	3. Type `put c_recovery_on 1`			yes
	4. Verify that the voltage is at least 5 volts.	voltage =	10.5	yes
	5. Type `put c_recovery_on 0` and wait for verification that the glider has accepted this command.			yes
	6. Verify that the voltage in the supply lead is zero and reconnect the Recovery System Supply Lead.			yes
	1. Type `lab_mode off`			yes

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1.20	2. Disconnect the Supply Lead to the Drop Weight at the Mecca Connector.			yes
	3. Connect the Digital Voltmeter between the supply lead and the ejection weight tube or aft anode assembly.			yes
	4. Type `put c_weight_drop 1`			yes
	5. Verify that the voltage is at least 5 volts.	voltage =	10.8	yes
	6. Type `put c_weight_drop 0` (Glider Software Release 7.15 and higher)			yes
	7. Type `put m_weight_drop 0` (Glider Software Release 7.15 and higher)			yes
	8. Type `logging off` and wait for response "`LOG FILE CLOSED`"			yes
	9. Type `exit pico`			yes
	10. Verify that the voltage is 0, and reconnect the Drop Weight Supply Lead.			yes
1.22	Install the Nose Cone and Tail Cover.			yes

	Outdoor Tests:			**Pass/Fail/ Result/Note**
2.01	1. Place the Glider outdoors on a level surface with an unobstructed view of the sky.			yes
	2. Insert the green Power Plug.			yes
2.02	1. For LBS Gliders with software version 1.9 and higher, type `ctrl-Q` to initialize the start up sequence			
	2. Type `ctrl-C` on the Glider Terminal.			yes
	3. At the Gliderdos prompt, Type the following commands:			yes
	`lab_mode on`			yes
	`callback 30`			yes
	`logging on` (wait for response `LOG FILE OPENED`)			yes
	4. Note the name of the log file *NOTE: It will take 1-2 minutes for the log file to open.*	Log file name:	0767.0000	
2.03	1. Type `report ++ m_heading m_pitch m_roll`			yes
	2. Verify that the sensor updates periodically and `m_pitch` and `m_roll` are 0 (+/- 0.18 radian).			yes
	3. Rotate the glider cart and verify that `m_heading` changes (Rotate glider 90° at four different points)			yes
	4. Type `report clearall`			yes
2.04	1. Type `put c_gps_on 3`			yes
	2. Verify that the GPS gets fixes within 2 minutes. In the following example string, the highlighted A should turn from a V to an A. gps_diag(2)cyc#:538|GPRMC,161908,**A**,5958.3032,N, 7000.5568,W,0.000,343.9,190808,0.3,W|			yes
	3. Type `put c_gps_on 1`			yes
2.05	1. On the Glider Terminal, type `callback 0 0`			yes
	2. Verify that the Iridium call completes successfully on primary number			yes
	3. Type `callback 1 1`			yes
	4. Verify that the Iridium call completes successfully on alternate number			yes
	5. Type `callback 30`			yes
2.06	1. Type `get m_battery`			yes
	2. Verify that the reading is 9.7-12 volts (lithium) and 12-16 volts (alkaline).	`m_battery =`	11.0075	yes
2.07	1. Ensure that motors are not moving, and the air pump is off.			yes
	2. Type `put c_argos_on 0`			yes
	3. Type `get m_coulomb_current`			yes
	4. Verify that the reading is between 0.086 and 0.288 amps.	`m_coulomb_current =`	0.144	yes
2.08	Type `logging off`. Wait for response "`LOG FILE CLOSED`"			yes

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2.09	Type `run status.mi`. Wait for normal completion	yes
2.10	1. Type `send *.*`	yes
	2. Save the Data Files and Dock Server Log Files as a part of the Test Record.	
	3. If desired, type `dellog all` to delete all sent logs.	yes
2.11	1. For 1000m gliders, type `put c_de_oil_vol -1000` to fully retract oil to inside reservoir. *NOTE: Oil volume should retract to -260cc*	yes
	2. Type `report ++ m_de_oil_vol` to monitor retraction.	yes
	3. Type `put c_air_pump 0` to deflate the air bladder for storage	yes
2.12	Type `exit` and remove power when prompted.	yes

Signature: RYAN SCOTT **Date:** 11/01/2019

REV	DESCRIPTION	ECO#	BY	DATE
A	Initial release	---	---	---
B	Format changes, science sensor testing moved to standalone GSI docs, several tolerances tightened, wording clarified, added notice	449	BH, BS, CD, BA	27/03/2012
C	Added steps for confirmation of BAM calibration values	624	BS	01/08/2012
D	Removed steps for confirmation of BAM calibration values; minor edits for accuracy; added fields for noted values	624	BS	01/08/2012
E	Added compass four point check.	773	CS	02/05/2013
F	Added coulomb count verification; inserted put c_alt_time -1 to stop altimeter from pinging	791	CS	18/06/2013
G	Rearranged steps to streamline process, added steps 1.18, 1.20.6, 1.20.7	12698	BS	19/06/2014

Unit 400

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Glider Functional Checkout (Estimated Time To Complete: 90 minutes)

Glider Serial Number:	24/09/1901
Tested By:	Alex Brearley
Reason For Test:	Functional checkout prior to Discovery Bank deployment
Date:	09/01/2019

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CAUTION

1. The CTD should not be run dry for more than 30 seconds at a time.
2. The glider must not be in simulation. If glider is in simulation, follow the instructions in step 1.02 to delete the simul.sim file

NOTES

If any test results in a failure, the FCP must be restarted after the failure is corrected.

EQUIPMENT REQUIRED:	
Maintenance Laptop (including Freewave transceiver)	Green "go" plug
Clock with UTC time	Hand tools to remove / replace nose cone and tail cowling.
Thermometer	RF Chirp (TWR P/N E-710) - optional if glider is tested through satellite or with local receiver
Digital multimeter	

Indoor Tests:		Pass/Fail/ Result/Note
1.00	1. Verify Connection of Glider O&M Communications Kit (dockserver).	yes
	2. Start up and sign into the Dockserver or Maintenance Laptop.	yes
	3. Start glider terminal *From a linux terminal session:* *type "start-glider-terminal" to start glider terminal* *type "inspect-dockserver" to monitor Dock Server activity (optional)*	yes
	4. If a script.xml is running, click the stop button and make sure it stays off (red) during the procedure.	yes
	5. Place a "RF Chirp" beeper near the fin. During the test, verify that the RF Chirp beeps approximately every 90 seconds (or use alternative method to confirm Argos transmissions)	yes
	6. Insert Green Plug or Bench Power Supply to power up the Glider. *NOTE: The Strobe Light will flash when power is applied to the Glider.*	yes
	7. Verify the Air Pump has turned on and record time. — start time = 1148UTC	yes
	8. Verify that the Freewave Master indicates carrier detect (CD light turns green) within 30 seconds of applying Glider power.	yes
1.01	1. For LBS Gliders with software version 1.9 and higher, type `ctrl-Q` to initialize the start up sequence	N/A
	2. Type `ctrl-C` on the Glider Terminal to prevent the glider from sequencing into a mission.	yes
	NOTE: If the Glider begins to run the mission "initial.mi" before accepting a ctrl-c, you must type `exit reset` *to restart the process. Failure to do so may result in test errors due to some sensors being disabled.*	
1.02	1. At the first GliderDOS prompt, type the following commands:	
	`lab_mode on`	yes
	`callback 30`	yes
	`logging on` (wait for response `LOG FILE OPENED`)	yes
	2. Note the name of the log file *NOTE: It will take 1-2 minutes for the log file to open.* — Log file name:	02560000.mlg
	3. Type `simul?` If no response, then the glider is not in simulation. If the glider is in simulation, type `del \config\simul.sim` then type `exit reset` and restart the FCP	no response
	4. Type `time` and verify that the time matches the current UTC time (+/- 5 minutes).	yes
1.03	1. Remove the nose dome.	yes
	2. Type `put c_alt_time 0`	yes
	3. Verify that a regular clicking sound is heard from the Altimeter Transducer. *NOTE: Close proximity or direct physical contact between the transducer and your ear will be required.*	yes
	4. Type `report ++ m_altimeter_voltage`	yes

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Tested By:	Alex Brearley
Reason For Test:	Functional checkout prior to Discovery Bank deployment
Date:	09/01/2019

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	5. Verify that the voltage reading updates every 10-12 seconds and changes.			yes
	6. Type `put c_alt_time -1` to stop altimeter from pinging.			yes
	7. Type `report clearall`			yes
1.04	1. Type `get m_leakdetect_voltage` and verify that the reading is greater than 2.3 V	m_leakdetect_voltage=	2.49	yes
	2. Type `get m_leakdetect_voltage_forward` (G2 only) and verify that the reading is greater than 2.3 V	m_leakdetect_voltage forward =	2.48	yes
CAUTION: Only perform step 1.05 if a new battery pack has been installed. Otherwise, proceed to step 1.06.				
1.05	Type `put m_coulomb_amphr_total 0` (only for new batteries)			N/A
1.06	1. Type `get m_coulomb_amphr_total` and note the value *(applies to all G2 gliders and G1 gliders with add-on coulomb counters)* Note: For gliders with new batteries, verify that total count is less than 5 amp-hrs. For gliders with partially used batteries, verify that total count makes sense.	m_coulomb_amphr_total =	0.92	yes
	2. Refer to mission endurance calculator to determine if enough energy is available for desired mission.			yes
1.07	1. Type `consci`			yes
	2. Verify that the science prompt `SciDos>` is displayed.			yes
	3. Type `dir app`			yes
	4. Verify that the result contains the file SUPERSCI.APP.			yes
	5. Type `zs \config\proglets.dat`			yes
	6. Type `quit`			yes
	7. Verify that control returns to the Glider Processor (`GliderLAB>` is displayed)			yes
1.08	1. Review proglets.dat to determine which science sensors are installed in the glider.			yes
	2. List each of these sensors in step 1.11a-f			yes
	3. Locate the glider sensor information sheet (GSI) for each sensor:			
1.08a	Sensor name: Sensor checkout sheet & revision:			CTD41CP UART 2 BIT 27
1.08b	Sensor name: Sensor checkout sheet & revision:			FLBBCD UART 0 BIT 29
1.08c	Sensor name: Sensor checkout sheet & revision:			OXY4 UART 3 BIT 30
1.08d	Sensor name: Sensor checkout sheet & revision:			N/A
1.08e	Sensor name: Sensor checkout sheet & revision:			N/A
1.08f	Sensor name: Sensor checkout sheet & revision:			N/A
1.09	1. Type `report ++ m_depth`			yes
	2. Verify m_depth is ±0.5m (if m_depth is greater than ±0.5 m, type `zero_ocean_pressure` and try again)			yes
	3. Type `report clearall`			yes
1.10	1. Type `strobe on` (if Installed)			yes
	2. Verify that the strobe light flashes periodically.			yes
	3. Type `strobe off`			yes
1.11	Verify that the Air Pump shuts off between 3 and 10 minutes *NOTE: After the Air Pump turns off, it should not turn back on until the glider is reset.*	elapsed time =		yes
1.12	1. Type `get m_vacuum` (vacuum will increase when the air bladder is inflated)			yes
	2. Verify that the vacuum reading is greater than 7"Hg (1000m) or 6"Hg (200m)	m_vacuum =	9.95	yes
1.13	1. Type `ballast` and wait for the response "`The Air Pump is off`" (this may take several minutes for a deep glider)			yes
	2. Type `report clearall`			yes
	3. Type `get m_vacuum`			yes

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	4. Confirm that the value has decreased by ~2.5 from step 1.04 and that the value is either above 5.5"Hg (1000m gliders) or 4.5"Hg (200m gliders)	`m_vacuum =`	7.5	yes
NOTE: Crusty residue may need to be removed from annode to get a good connection.				
1.14	1. Remove the tail cowling.			yes
	2. Probe between the forward Anode and Pump Flange Screws using a Digital Multimeter on ohms setting.			yes
	3. Note the resistance.	resistance =	?	
	4. Probe between the aft anode and Ejection Weight Tube using a Digital Multimeter on ohms setting.			yes
	5. Verify that resistance is less than 10 ohms.	resistance =	?	
1.15	1. For Gliders equipped with digifin			
	2. Type get m_digifin_leakdetect_reading.	reading=	1023	yes
	3. If reading is less than 1019, the digifin needs factory service. Take digifin out of service (use - digifin) and continue FCP.			
1.16	1. At the prompt type `wiggle on` and let the glider wiggle for 10 minutes *NOTE: It is not unusual for the Pitch Motor to produce warnings on startup after being idle or after transportation. If this happens, stop the wiggle, put the device back into service if necessary, and restart the wiggle.*			yes
	2. Verify that no motor driver warnings or errors are displayed on the Glider Terminal.			yes
	3. Verify that the Digifin moves from Port to Starboard.			yes
	4. Listen to verify that Motors are not binding or stalling. (optional)			yes
1.17	1. Type `get m_tot_num_inflections`			yes
	2. Verify that total is less than 20,000 inflections, and meets next mission requirements.	`m_tot_num_inflections =`	0	
1.18	After wiggling for 10 minutes, type `wiggle off`			yes
NOTE: only perform step 1.18 if thruster is installed. Note that thruster should not be operated in air for more than 30 seconds to prevent overheating.				
1.19	1. Make sure that thruster blades are not obstructed.			N/A
	2. Type `report ++ m_thruster_current`			N/A
	3. Type `put c_thruster_on 20`			N/A
	4. Verify that thruster spins clockwise when viewed from the aft end and that `m_thruster_current` updates regularly.			N/A
	5. Type `put c_thruster_on 0` to turn off the thruster.			N/A
	5. Type `report clearall`			N/A
CAUTION: Ensure Glider is dry prior to performing step 1.19 and 1.20. The presence of salt water during these steps increases the potential for accidental initiation of the recovery system release and glider weight release.				
NOTE: only perform step 1.19 if nose release recovery system is installed				
1.20	1. Disconnect the supply lead to the recovery system at the Mecca connector.			yes
	2. Connect the Digital Voltmeter between the Supply Lead and the forward Anode.			yes
	3. Type `put c_recovery_on 1`			yes
	4. Verify that the voltage is at least 5 volts.	voltage =	10.2	
	5. Type `put c_recovery_on 0` and wait for verification that the glider has accepted this command.			yes
	6. Verify that the voltage in the supply lead is zero and reconnect the Recovery System Supply Lead.			yes
1.20	1. Type `lab_mode off`			yes
	2. Disconnect the Supply Lead to the Drop Weight at the Mecca Connector.			yes
	3. Connect the Digital Voltmeter between the supply lead and the ejection weight tube or aft anode assembly.			yes
	4. Type `put c_weight_drop 1`			yes
	5. Verify that the voltage is at least 5 volts.	voltage =	10.7	yes
	6. Type `put c_weight_drop 0` (Glider Software Release 7.15 and higher)			yes
	7. Type `put m_weight_drop 0` (Glider Software Release 7.15 and higher)			yes
	8. Type `logging off` and wait for response "`LOG FILE CLOSED`"			
	9. Type `exit pico`			yes
	10. Verify that the voltage is 0, and reconnect the Drop Weight Supply Lead.			yes
1.22	Install the Nose Cone and Tail Cover.			

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Document #:	4095-FCP
Rev:	
Date:	22/11/2017
ECO #:	

Glider Functional Checkout (Estimated Time To Complete: 90 minutes)

Glider Serial Number:	24/09/1901
Tested By:	Alex Brearley
Reason For Test:	Functional checkout prior to Discovery Bank deployment
Date:	09/01/2019

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Outdoor Tests:				Pass/Fail/ Result/Note
2.01	1. Place the Glider outdoors on a level surface with an unobstructed view of the sky.			yes
	2. Insert the green Power Plug.			yes
2.02	1. For LBS Gliders with software version 1.9 and higher, type `ctrl-Q` to initialize the start up sequence			yes
	2. Type `ctrl-C` on the Glider Terminal.			yes
	3. At the Gliderdos prompt, Type the following commands:			yes
	`lab_mode on`			yes
	`callback 30`			yes
	`logging on` (wait for response `LOG FILE OPENED`)			yes
	4. Note the name of the log file *NOTE: It will take 1-2 minutes for the log file to open.*	Log file name:	0258.0000	
2.03	1. Type `report ++ m_heading m_pitch m_roll`			yes
	2. Verify that the sensor updates periodically and `m_pitch` and `m_roll` are 0 (+/- 0.18 radian).			yes
	3. Rotate the glider cart and verify that `m_heading` changes (Rotate glider 90° at four different points)			yes
	4. Type `report clearall`			yes
2.04	1. Type `put c_gps_on 3`			yes
	2. Verify that the GPS gets fixes within 2 minutes.			yes
	In the following example string, the highlighted A should turn from a V to an A.			
	gps_diag(2)cyc#:538|GPRMC,161908,**A**,5958.3032,N, 7000.5568,W,0.000,343.9,190808,0.3,W|			
	3. Type `put c_gps_on 1`			yes
2.05	1. On the Glider Terminal, type `callback 0 0`			yes
	2. Verify that the Iridium call completes successfully on primary number			yes
	3. Type `callback 1 1`			yes
	4. Verify that the Iridium call completes successfully on alternate number			yes
	5. Type `callback 30`			yes
2.06	1. Type `get m_battery`			yes
	2. Verify that the reading is 9.7-12 volts (lithium) and 12-16 volts (alkaline).	`m_battery` =	14.9	new lithum pack therfore higher?
2.07	1. Ensure that motors are not moving, and the air pump is off.			yes
	2. Type `put c_argos_on 0`			yes
	3. Type `get m_coulomb_current`			yes
	4. Verify that the reading is between 0.086 and 0.288 amps.	`m_coulomb_current` =	0.11	yes
2.08	Type `logging off`. Wait for response "`LOG FILE CLOSED`"			yes
2.09	Type `run status.mi`. Wait for normal completion			yes
2.10	1. Type `send *.*`			yes
	2. Save the Data Files and Dock Server Log Files as a part of the Test Record.			yes
	3. If desired, type `dellog all` to delete all sent logs.			yes
2.11	1. For 1000m gliders, type `put c_de_oil_vol -1000` to fully retract oil to inside reservoir. *NOTE: Oil volume should retract to -260cc*			yes
	2. Type `report ++ m_de_oil_vol` to monitor retraction.			yes
	3. Type `put c_air_pump 0` to deflate the air bladder for storage			yes
2.12	Type `exit` and remove power when prompted.			yes

Signature: ______________________________ Date: ______________

REV	DESCRIPTION	ECO#	BY	DATE

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Tested By:	Alex Brearley
Reason For Test:	Functional checkout prior to Discovery Bank deployment
Date:	09/01/2019

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A	Initial release	---	---	---
B	Format changes, science sensor testing moved to standalone GSI docs, several tolerances tightened, wording clarified, added notice	449	BH, BS, CD, BA	27/03/2012
C	Added steps for confirmation of BAM calibration values	624	BS	01/08/2012
D	Removed steps for confirmation of BAM calibration values; minor edits for accuracy; added fields for noted values	624	BS	01/08/2012
E	Added compass four point check.	773	CS	02/05/2013
F	Added coulomb count verification; inserted put c_alt_time -1 to stop altimeter from pinging	791	CS	18/06/2013
G	Rearranged steps to streamline process, added steps 1.18, 1.20.6, 1.20.7	12698	BS	19/06/2014

Unit 631

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Document #:	4095-FCP
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Date:	09/01/2019
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Glider Functional Checkout (Estimated Time To Complete: 90 minutes)

Glider Serial Number:	Unit 631
Tested By:	Ryan Scott
Reason For Test:	Pre-deployment checkout
Date:	09/01/2019

CAUTION

1. The CTD should not be run dry for more than 30 seconds at a time.
2. The glider must not be in simulation. If glider is in simulation, follow the instructions in step 1.02 to delete the simul.sim file

NOTES
If any test results in a failure, the FCP must be restarted after the failure is corrected.

EQUIPMENT REQUIRED:	
Maintenance Laptop (including Freewave transceiver)	Green "go" plug
Clock with UTC time	Hand tools to remove / replace nose cone and tail cowling.
Thermometer	RF Chirp (TWR P/N E-710) - optional if glider is tested through satellite or with local receiver
Digital multimeter	

Indoor Tests:				Pass/Fail/ Result/Note
1.00	1. Verify Connection of Glider O&M Communications Kit (dockserver).			yes
	2. Start up and sign into the Dockserver or Maintenance Laptop.			yes
	3. Start glider terminal *From a linux terminal session:* *type "start-glider-terminal" to start glider terminal* *type "inspect-dockserver" to monitor Dock Server activity (optional)*			yes
	4. If a script.xml is running, click the stop button and make sure it stays off (red) during the procedure.			
	5. Place a "RF Chirp" beeper near the fin. During the test, verify that the RF Chirp beeps approximately every 90 seconds (or use alternative method to confirm Argos transmissions)			yes
	6. Insert Green Plug or Bench Power Supply to power up the Glider. *NOTE: The Strobe Light will flash when power is applied to the Glider.*			yes
	7. Verify the Air Pump has turned on and record time.	start time =	13:13 (local)	yes
	8. Verify that the Freewave Master indicates carrier detect (CD light turns green) within 30 seconds of applying Glider power.			yes
1.01	1. For LBS Gliders with software version 1.9 and higher, type `ctrl-Q` to initialize the start up sequence			
	2. Type `ctrl-C` on the Glider Terminal to prevent the glider from sequencing into a mission.			yes
	NOTE: If the Glider begins to run the mission "initial.mi" before accepting a ctrl-c, you must type `exit reset` *to restart the process. Failure to do so may result in test errors due to some sensors being disabled.*			
1.02	1. At the first GliderDOS prompt, type the following commands:			yes
	`lab_mode on`			yes
	`callback 30`			yes
	`logging on` (wait for response `LOG FILE OPENED`)			yes
	2. Note the name of the log file *NOTE: It will take 1-2 minutes for the log file to open.*	Log file name:	0049.0000	
	3. Type `simul?` If no response, then the glider is not in simulation. If the glider is in simulation, type `del \config\simul.sim` then type `exit reset` and restart the FCP			yes
	4. Type `time` and verify that the time matches the current UTC time (+/- 5 minutes).			yes
	1. Remove the nose dome.			yes

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Date:	09/01/2019

1.03	2. Type `put c_alt_time 0`			yes
	3. Verify that a regular clicking sound is heard from the Altimeter Transducer. *NOTE: Close proximity or direct physical contact between the transducer and your ear will be required.*			yes
	4. Type `report ++ m_altimeter_voltage`			yes
	5. Verify that the voltage reading updates every 10-12 seconds and changes.			yes
	6. Type `put c_alt_time -1` to stop altimeter from pinging.			yes
	7. Type `report clearall`			yes
1.04	1. Type `get m_leakdetect_voltage` and verify that the reading is greater than 2.3 V	m_leakdetect_voltage=	2.47	yes
	2. Type `get m_leakdetect_voltage_forward` (G2 only) and verify that the reading is greater than 2.3 V	m_leakdetect_voltage forward =	2.47	yes
CAUTION: Only perform step 1.05 if a new battery pack has been installed. Otherwise, proceed to step 1.06.				
1.05	Type `put m_coulomb_amphr_total 0` (only for new batteries)			
1.06	1. Type `get m_coulomb_amphr_total` and note the value *(applies to all G2 gliders and G1 gliders with add-on coulomb counters)* Note: For gliders with new batteries, verify that total count is less than 5 amp-hrs. For gliders with partially used batteries, verify that total count makes sense.	m_coulomb_amphr_total =	10.17	yes
	2. Refer to mission endurance calculator to determine if enough energy is available for desired mission.			yes
1.07	1. Type `consci`			yes
	2. Verify that the science prompt `SciDos>` is displayed.			yes
	3. Type `dir app`			yes
	4. Verify that the result contains the file SUPERSCI.APP.			SMB2SCI
	5. Type `zs \config\proglets.dat`			yes
	6. Type `quit`			yes
	7. Verify that control returns to the Glider Processor (`GliderLAB>` is displayed)			yes
1.08	1. Review proglets.dat to determine which science sensors are installed in the glider.			yes
	2. List each of these sensors in step 1.11a-f			yes
	3. Locate the glider sensor information sheet (GSI) for each sensor:			
1.08a	Sensor name: Sensor checkout sheet & revision:			CTD41CP UART 0 BIT 0
1.08b	Sensor name: Sensor checkout sheet & revision:			BSIPAR UART 3 BIT 0
1.08c	Sensor name: Sensor checkout sheet & revision:			FLBB UART 2 BIT 0
1.08d	Sensor name: Sensor checkout sheet & revision:			OXY4 UART 1 BIT 2
1.08e	Sensor name: Sensor checkout sheet & revision:			
1.08f	Sensor name: Sensor checkout sheet & revision:			
1.09	1. Type `report ++ m_depth`			yes
	2. Verify m_depth is ±0.5m (if m_depth is greater than ±0.5 m, type `zero_ocean_pressure` and try again)			yes
	3. Type `report clearall`			yes
1.10	1. Type `strobe on` (if Installed)			yes
	2. Verify that the strobe light flashes periodically.			yes
	3. Type `strobe off`			yes

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1.11	Verify that the Air Pump shuts off between 3 and 10 minutes *NOTE: After the Air Pump turns off, it should not turn back on until the glider is reset.*	elapsed time =		yes
1.12	1. Type `get m_vacuum` (vacuum will increase when the air bladder is inflated)			yes
	2. Verify that the vacuum reading is greater than 7"Hg (1000m) or 6"Hg (200m)	`m_vacuum` =	9.82	yes
1.13	1. Type `ballast` and wait for the response "`The Air Pump is off`" (this may take several minutes for a deep glider)			yes
	2. Type `report clearall`			yes
	3. Type `get m_vacuum`			yes
	4. Confirm that the value has decreased by ~2.5 from step 1.04 and that the value is either above 5.5"Hg (1000m gliders) or 4.5"Hg (200m gliders)	`m_vacuum` =	7.76	yes
NOTE: Crusty residue may need to be removed from annode to get a good connection.				
1.14	1. Remove the tail cowling.			yes
	2. Probe between the forward Anode and Pump Flange Screws using a Digital Multimeter on ohms setting.			yes
	3. Note the resistance.	resistance =	?	
	4. Probe between the aft anode and Ejection Weight Tube using a Digital Multimeter on ohms setting.			yes
	5. Verify that resistance is less than 10 ohms.	resistance =	?	
1.15	1. For Gliders equipped with digifin			yes
	2. Type get m_digifin_leakdetect_reading.	reading=	1023	yes
	3. If reading is less than 1019, the digifin needs factory service. Take digifin out of service (use - digifin) and continue FCP.			
1.16	1. At the prompt type `wiggle on` and let the glider wiggle for 10 minutes *NOTE: It is not unusual for the Pitch Motor to produce warnings on startup after being idle or after transportation. If this happens, stop the wiggle, put the device back into service if necessary, and restart the wiggle.*			yes
	2. Verify that no motor driver warnings or errors are displayed on the Glider Terminal.			yes
	3. Verify that the Digifin moves from Port to Starboard.			yes
	4. Listen to verify that Motors are not binding or stalling. (optional)			yes
1.17	1. Type `get m_tot_num_inflections`			yes
	2. Verify that total is less than 20,000 inflections, and meets next mission requirements.	`m_tot_num_inflections` =	48	yes
1.18	After wiggling for 10 minutes, type `wiggle off`			yes
NOTE: only perform step 1.18 if thruster is installed. Note that thruster should not be operated in air for more than 30 seconds to prevent overheating.				
1.19	1. Make sure that thruster blades are not obstructed.			yes
	2. Type `report ++ m_thruster_current`			yes
	3. Type `put c_thruster_on 20`			yes
	4. Verify that thruster spins clockwise when viewed from the aft end and that `m_thruster_current` updates regularly.			yes
	5. Type `put c_thruster_on 0` to turn off the thruster.			yes
	5. Type `report clearall`			yes
CAUTION: Ensure Glider is dry prior to performing step 1.19 and 1.20. The presence of salt water during these steps increases the potential for accidental initiation of the recovery system release and glider weight release.				
NOTE: only perform step 1.19 if nose release recovery system is installed				
1.20	1. Disconnect the supply lead to the recovery system at the Mecca connector.			yes
	2. Connect the Digital Voltmeter between the Supply Lead and the forward Anode.			yes
	3. Type `put c_recovery_on 1`			yes
	4. Verify that the voltage is at least 5 volts.	voltage =	10.9	yes
	5. Type `put c_recovery_on 0` and wait for verification that the glider has accepted this command.			yes
	6. Verify that the voltage in the supply lead is zero and reconnect the Recovery System Supply Lead.			yes
	1. Type `lab_mode off`			yes

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1.20	2. Disconnect the Supply Lead to the Drop Weight at the Mecca Connector.			yes
	3. Connect the Digital Voltmeter between the supply lead and the ejection weight tube or aft anode assembly.			yes
	4. Type `put c_weight_drop 1`			yes
	5. Verify that the voltage is at least 5 volts.	voltage =	10.8	yes
	6. Type `put c_weight_drop 0` (Glider Software Release 7.15 and higher)			yes
	7. Type `put m_weight_drop 0` (Glider Software Release 7.15 and higher)			yes
	8. Type `logging off` and wait for response "`LOG FILE CLOSED`"			yes
	9. Type `exit pico`			yes
	10. Verify that the voltage is 0, and reconnect the Drop Weight Supply Lead.			yes
1.22	Install the Nose Cone and Tail Cover.			yes

Outdoor Tests:				**Pass/Fail/ Result/Note**
2.01	1. Place the Glider outdoors on a level surface with an unobstructed view of the sky.			yes
	2. Insert the green Power Plug.			yes
2.02	1. For LBS Gliders with software version 1.9 and higher, type `ctrl-Q` to initialize the start up sequence			
	2. Type `ctrl-C` on the Glider Terminal.			yes
	3. At the Gliderdos prompt, Type the following commands:			yes
	`lab_mode on`			yes
	`callback 30`			yes
	`logging on` (wait for response `LOG FILE OPENED`)			yes
	4. Note the name of the log file *NOTE: It will take 1-2 minutes for the log file to open.*	Log file name:	0051.0000	
2.03	1. Type `report ++ m_heading m_pitch m_roll`			yes
	2. Verify that the sensor updates periodically and `m_pitch` and `m_roll` are 0 (+/- 0.18 radian).			yes
	3. Rotate the glider cart and verify that `m_heading` changes (Rotate glider 90° at four different points)			yes
	4. Type `report clearall`			yes
2.04	1. Type `put c_gps_on 3`			yes
	2. Verify that the GPS gets fixes within 2 minutes. In the following example string, the highlighted A should turn from a V to an A. gps_diag(2)cyc#:538|GPRMC,161908,**A**,5958.3032,N, 7000.5568,W,0.000,343.9,190808,0.3,W|			yes
	3. Type `put c_gps_on 1`			yes
2.05	1. On the Glider Terminal, type `callback 0 0`			yes
	2. Verify that the Iridium call completes successfully on primary number			yes
	3. Type `callback 1 1`			yes
	4. Verify that the Iridium call completes successfully on alternate number			yes
	5. Type `callback 30`			yes
2.06	1. Type `get m_battery`			yes
	2. Verify that the reading is 9.7-12 volts (lithium) and 12-16 volts (alkaline).	`m_battery =`	10.98	yes
2.07	1. Ensure that motors are not moving, and the air pump is off.			yes
	2. Type `put c_argos_on 0`			yes
	3. Type `get m_coulomb_current`			yes
	4. Verify that the reading is between 0.086 and 0.288 amps.	`m_coulomb_current =`	0.175	yes
2.08	Type `logging off`. Wait for response "`LOG FILE CLOSED`"			yes

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2.09	Type `run status.mi`. Wait for normal completion	yes
2.10	1. Type `send *.*`	yes
	2. Save the Data Files and Dock Server Log Files as a part of the Test Record.	yes
	3. If desired, type `dellog all` to delete all sent logs.	yes
2.11	1. For 1000m gliders, type `put c_de_oil_vol -1000` to fully retract oil to inside reservoir. *NOTE: Oil volume should retract to -260cc*	yes
	2. Type `report ++ m_de_oil_vol` to monitor retraction.	yes
	3. Type `put c_air_pump 0` to deflate the air bladder for storage	yes
2.12	Type `exit` and remove power when prompted.	yes

Signature: ______________________________ **Date:** ______________

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