Sentry Operations Report for the TN-365 Dick Cruise DRAFT

WHOI Sentry Operations Group
Sean Kelley, Justin Fujii, Zac Berkowitz, Stefano Suman, Mike Skowronski

Sentry Expedition Leader: Sean Kelley

R/V Thomas G. Thompson — February 21st through March 28th

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1 Summary

This document summarizes operations with the *Sentry* autonomous underwater vehicle (AUV) during the TN-365 Dick cruise. Included in this report is the vehicle configuration; basic vehicle and sensor performance; and post-dive reports (with summary statistics and narratives). This report does not attempt to describe the scientific results or conclusions. A detailed description of the data files resulting from this cruise is provided in a separate document. Individual dive summaries for Sentry dives 527-531 follow — each of these is a free-standing document summarizing the dive.

2 Cruise Log

This section provides a brief chronological summary of *Sentry* activities during the cruise. Additional information on specific dives is available in the dive reports.

21 FEB 2019 Departed Durban South Africa.

22 FEB 2019 In Transit.

23 FEB 2019 Vessel turned around and started heading towards Port Elizabeth to drop off sick science party member.

24 FEB 2019 In Transit.

25 FEB 2019 Transfered ill science party member at Port Elizabeth. Began transit to work site.

26 FEB 2019 In transit.

27 FEB 2019 In transit.

28 FEB 2019 Arrived on station site4. Severe weather once on station, started vessel multibeam survey.

01 MAR 2019 Vessel multibeam survey, dredge.

02 MAR 2019 Sentry527 deployed and recovered. 7 hour dive, called up early due to impending weather.

03 MAR 2019 Sunday No Sentry Dive due to weather.

04 MAR 2019 Monday No Sentry Dive due to weather.

05 MAR 2019 Ships Multibeam survey.

06 MAR 2019 Depoyed Sentry528 at 05:00 local. Dredged during dive. Waveglider deployed for the Sentry dive.

07 MAR 2019 Recovery of Sentry528, 06:00 local.

08 MAR 2019 Ship Multibeam surveying.

09 MAR 2019 Ship Multibeam surveying.

10 MAR 2019 Deployment of Sentry529 10:00 local. Three dredges completed during dive.

11 MAR 2019 Recovery of Sentry529, 10:00 local. Dredging followed Sentry dive, final dredge of the day had a large wuzzle and took extra time for the dredge to come on board.

12 MAR 2019 Ship multibeam surveying.

13 MAR 2019 Ship multibeam surveying and dredging.

14 MAR 2019 Deployment and recovery of Sentry530, deploying at 04:00 local, and recovery at 21:30 to avoid impending weather.

15 MAR 2019 Ships multibeam with dredging.

16 MAR 2019 Ships multibeam with dredging.

17 MAR 2019 Ships multibeam with dredging.

18 MAR 2019 Deployment of Sentry351 at 13:00. Excellent weather.

19 MAR 2019 Recovery of Sentry531. Waveglider recovery following Sentry.

20 MAR 2019 Weather still holding, ship multibeam surveying.

21 MAR 2019 Ships Multibeam survey and dredging

22 MAR 2019 Dredging Ops

23 MAR 2019 Depart Station

24 - 27 MAR 2019 In transit

28 MAR 2019 Arrive Cape Town South Africa

3 Vehicle Configuration

4 Navigation

All dives were navigated using real time Doppler Velocity Log (DVL) velocity inertial measurement unit (IMU) attitude measurements. External aiding during descent was performed with Ultra-Short Baseline (USBL) throughout the cruise. Dive specific notes on navigation are included in the dive reports. All final navigation consists of a track where the DVL/IMU track was fused with the USBL fixes in post-processing.

4.1 Coordinate origins

The vehicle's control system uses simple equidistant coordinates. This system uses an origin, defined in terms of latitude and longitude with the World Geodetic System 1984 (WGS84) datum, and a fixed scaling between meters displacement from the origin. We use the identical routines that have been used by the National Deep Submergence Facility (NDSF) assets Alvin and Jason for decades. Likewise we always used the same origin for Sentry and Alvin at each site. These simple coordinates have several advantages for realtime control of a vehicle. Unlike Universal Transverse Mercator (UTM) grid coordinates, the x and y axes intersect at right angles and align with true east and north respectively at the origin. These coordinates distort quickly as one moves away from the origin, but we solve that problem by putting the origin close to the operating area. We almost always report our results in latitude/longitude, so most users need not be aware of these details.

4.2 USBL Calibration and Performance Notes

A CASIUS calibration of the USBL system was not conducted during this cruise.

5 Items of Note

This section summarized details which are worthy of note or mention for future reference but which do not constitute problems:

N.1: Waveglider was on board for cruise and operated for roughly two weeks in the water. No major issues with the WG, everthing worked really well.

N.2: server van was located main deck, portside forward. Spares van was forward.

N.3: The 480vAC power from the ship was dirty and causing problems with our equipment. Report attached to this document.

N.4: The Sentry AC unit died, which made cooling the container very difficult. Suggest buying an AC unit or more Fans.

N.5: Charge current was limited to 3 amps due to running the chargers off of extension cords from the lab power.

N.6: We were not able to display navG on the bridge due to network restrictions, only the sonardyne display.

N.7: USBL pole requires 30min for launch and recovery.

6 Ship Specific Information

This section summarizes ship specific information factual, good, and bad and is meant primarily to facilitate more effective use of the same vessel in the future.

S.1: Sentry Nav station and personnel were stationed in "Hydrolab".

S.2: Hydrolab is extremely noisy, with an AC unit that is constantly running and makes conversations difficult. Would choose to be in different lab next time.

S.3: USBL pole takes over 30 minutes to deploy and recover.

S.4: 480VAC power to the van was very noisy and required lab power for most of the equipment inside the container.

S.5: Sentry launched and recovered starboard side.

S.6: Ships small boat was used for the single recovery of the waveglider.

7 Technical Issues

This section summarizes technical issues encountered by the *Sentry* operations group on the cruise. Issues which affected primarily individual dives are listed in the individual dive reports.

T.1: None

8 Acknowledgments

1. Thank you to NSF for funding a portion of this expedition.
2. Thank you to the Captain and crew of the R/V Thompson for safe operations and support.

9 Comments from Science

None

Sentry 527 Dive Report
DRAFT

Sean Kelley, Justin Fujii, Zac Berkowitz, Stefano Suman, Mike Skowronski

Sentry Expedition Leader: Sean Kelley

Summary

Weather: Deployment: winds 5 knts, seas 4-5ft. Recovery: winds 20 knts, seas 5-10ft.

Reason for end of dive: Weather

Important Positions

Dive Origin: -41 -4 42 45

Launch Position: sentry527 launch position: 41 0.143'S 043 0.590'E

Vehicle Configuration

The science sensing suite for this dive was:

Table 1: Sentry Sensor Configuration

Sensor
Qty(3) APS 1540 Magnetometers (stbd, center)
Edgetech 4-24kHz Sub-Bottom Profiler (SBP)
Edgetech 120kHz/410kHz Sidescan sonar
Reson 7125 Multibeam Sonar
Seabird SBE49 Conductivity-Temperature-Depth (CTD)
Anderaa optode model 4330
300kHz RDI DVL
Blue View P900-90 Forward Looking Sonar
IXEA PHINS
Reson Sound Velocity Probe
NOAA PMEL MAPR
NOAA PMEL ORP Sensor

This dive was navigated using the DVL/INS system in real time. USBL provided post-dive corrections.

Narrative

Sentry527 is the first dive of TN-365.

Sentry527 took advantage of a small weather window on Saturday. A multibeam survey 2700m north to south and 1500m wide with 155m spacing was planned. After a successful launch Sentry submerged began the descent to the seafloor. There were several issues to address during the descent. The whiffle nav LBL system was not connected to a transducer in the computer lab. This took considerable time to troubleshoot. Sonardyne SMS worked initially, but then stopped working for roughly 15 minutes, starting to work again before Sentry arrived on the bottom. The micromodem was tested with the over the side transducer to qualify the installation and operation. We were able to recieve and transmit to Sentry with the system. The transducer was not left in the water.

The dive length was very limited by weather, with conditions expected to deteriorate by 21:00. A short dredge was accomplished with the small window between deployment and recovery. Sentry was able to complete just three of the north south survey lines.

Recovery went reasonably well, with Sentry back on deck just after 19:00. All systems operated well for the first dive.

Dive Statistics

0.1 sentry527 Summary

sentry527 Summary
Origin: -41.066667 42.750000
Origin: 41 4.000'S 042 45.000'E
Launch: 2019/03/02 10:56:00
Survey start: 2019/03/02 12:09:11
Survey start: Lat:-41.002249 Lon:43.015887
Survey start: Lat:41 0.135'S Lon:043 0.953'E
Survey end: 2019/03/02 16:46:00
Survey end: Lat:-41.022778 Lon:43.009104
Survey end: Lat:41 1.367'S Lon:043 0.546'E
Ascent begins: 2019/03/02 16:46:00
On the surface: 2019/03/02 17:30:11
On deck: 2019/03/02 17:47:33
descent rate: 34.4 m/min
ascent rate: 53.4 m/min
survey time: 4.6 hours
deck-to-deck time 6.9 hours
Min survey depth: 2052m
Max survey depth: 2697m
Mean survey depth: 2426m
Mean survey height: 85m
distance travelled: 14.84km
average speed: 0.88m/s
average speed during photo runs: 0.99 m/s over 0.00 km
average speed during multibeam runs: 0.88 m/s over 14.84 km
total vertical during survey: 3866m
Battery energy at launch: 20.3 kwhr
Battery energy at survey start: 19.8 kwhr
Battery energy at survey end: 15.2 kwhr
Battery energy on surface: 15.2 kwhr
Battery energy on deck: 15.0 kwhr

UTC Time	Mission Time	Event	Notes
2019/03/02 10:56:00	+00:00:00.00	launch	launch
2019/03/02 12:08:22	+01:12:22.84	descent	end
2019/03/02 12:09:11	+01:13:11.25	onbottom	START
2019/03/02 12:19:44	+01:23:44.65	ballast-test	start
2019/03/02 12:19:44	+01:23:44.66	ballast-test	end
2019/03/02 12:24:44	+01:28:44.74	start	MB 1
2019/03/02 16:46:00	+05:50:00.08	abort	
2019/03/02 17:30:11	+06:34:11.46	surface	surface
2019/03/02 17:47:32	+06:51:32.66	recovery	autogenerated

Table 2: Summary of events during dive sentry527

Sensor Information

This is a recently added section with selected sensor metadata. This section will be expanded in coming months. Additional data is available in the sentry527/nav-sci/proc directory within the sentry527_config matlab structure as well as in ascii text logs in sentry527/metadata. At present metadata is not yet automatically collected on all sensors.

0.2 sentry527 Devices

Instrument	Model	Serial Num.	Comments	Config File
USBL	Sonardyne AvTrak2	U001AA5		`avtrak_20190302_0759.cfg`
DVL	RDI Navigator (300kHz)	727-2000-00M	CX: 1, WP: 0	`dvl300_20190302_0759.cfg`
CTD	SBE 49	222		`sbe49_20190302_0800.cfg`
SAIL	obs A/D orp A/D	13 9	A: 5, G: 1.00, O: 0 A: 3, G: 1.00, O: 0.002	`a2d2-pods_20190302_0759.cfg`

Ballast Test

```
>> sentry_plot_ballastcontroller
Mean controller buoyancy: 60.741 N (6.19 kg, 13.66 lb)
Mean thrust model buoyancy: 96.002 N (9.79 kg, 21.58 lb)
```

Special Data Processing Notes

No MAPR installed for this dive.

Plots and Images

This section contains selected images of data products and plots of vehicle navigation and selected sensors.

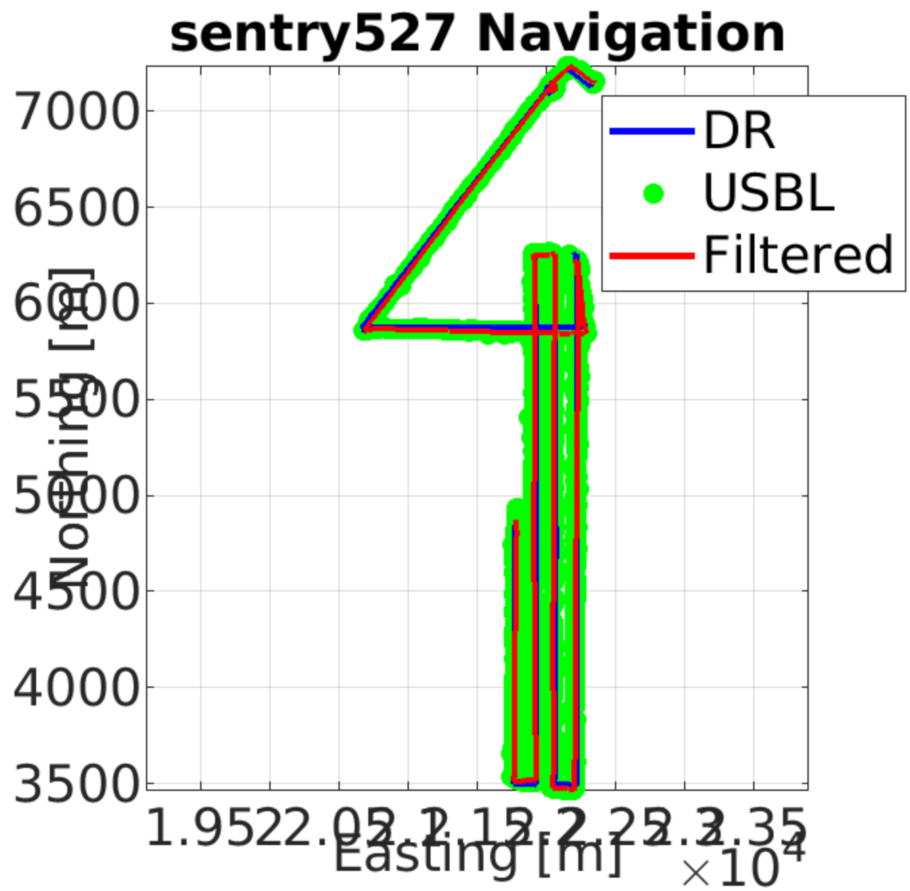


Figure 1: Latitude/Longitude plot of Sentry dive 527 based on post-processed navigation

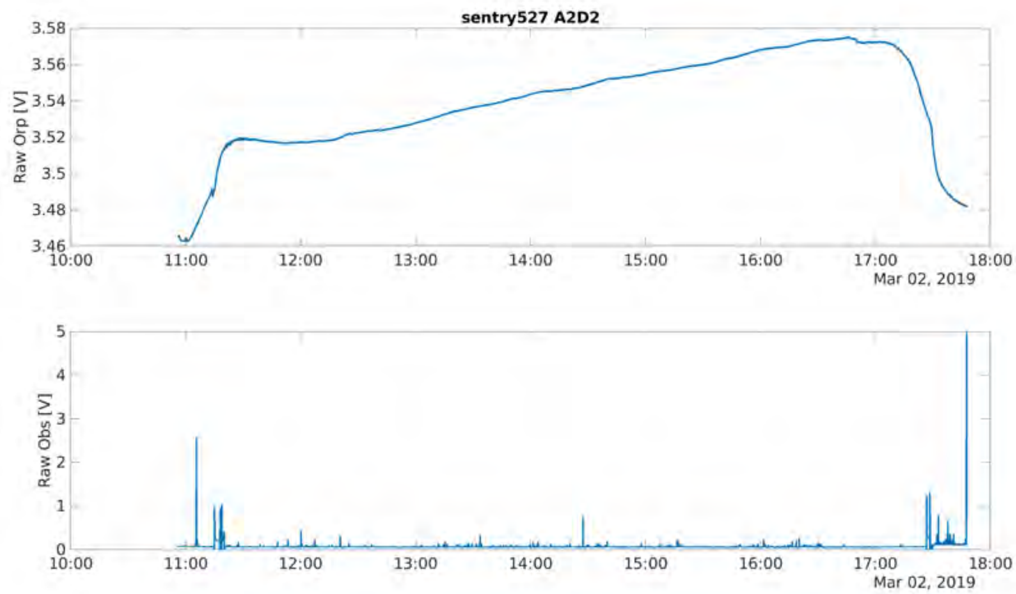


Figure 2: Raw analog Sensor Data

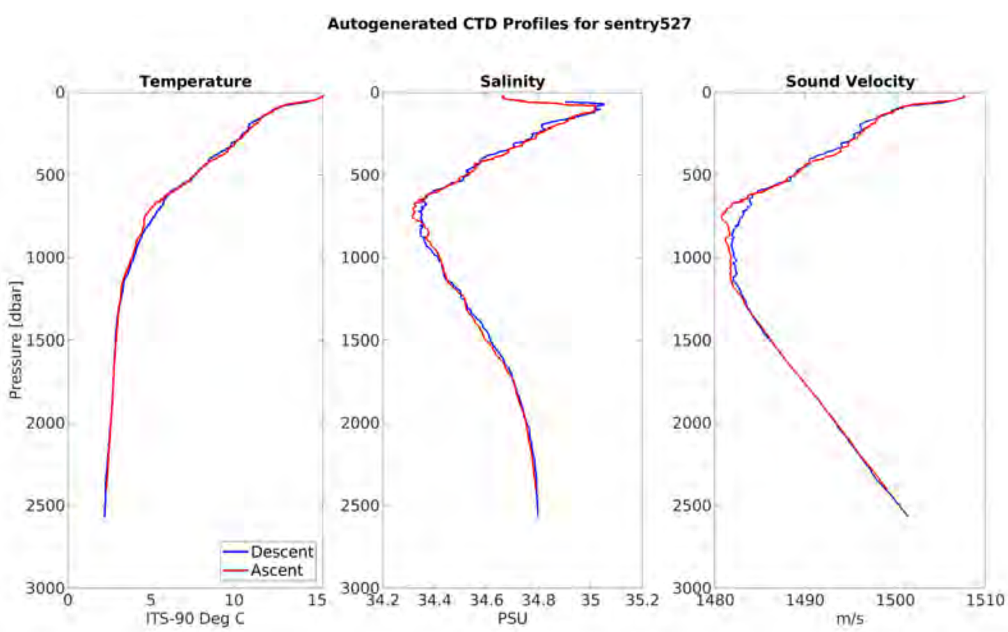


Figure 3: CTD profile sensor data

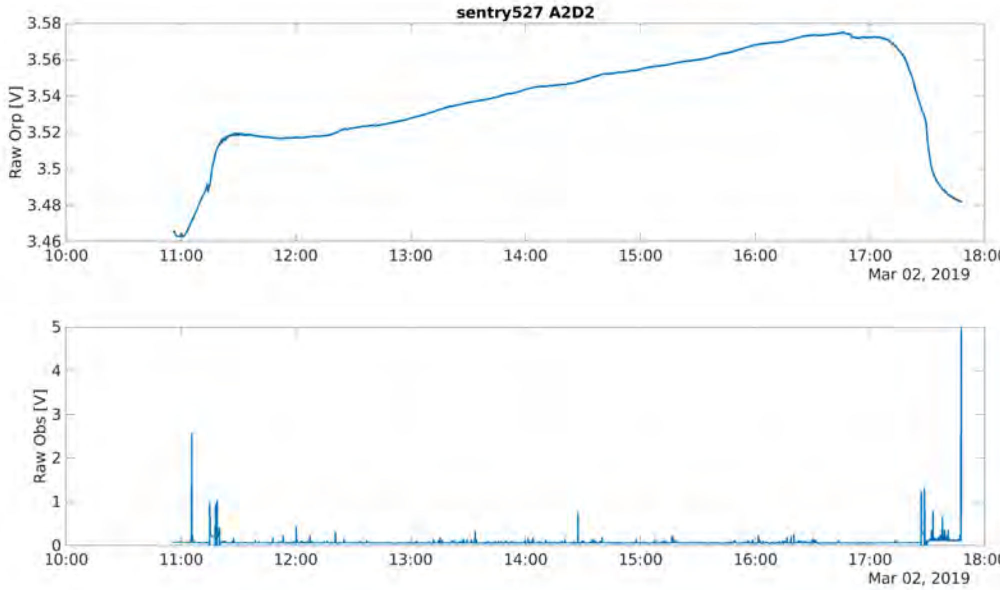


Figure 4: CTD and SVP sensor data

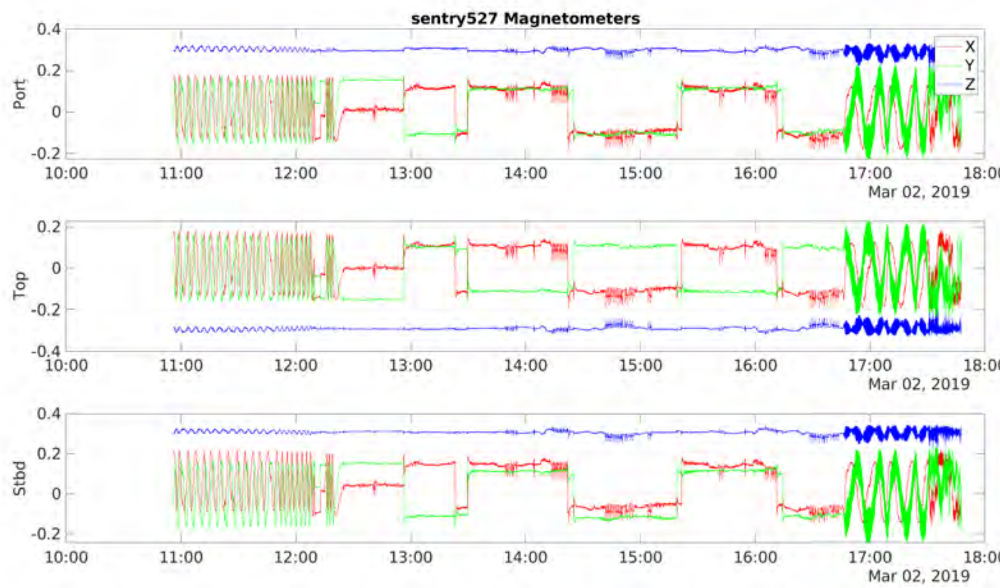


Figure 5: Magnetometer data from each of the three magnetometers on Sentry

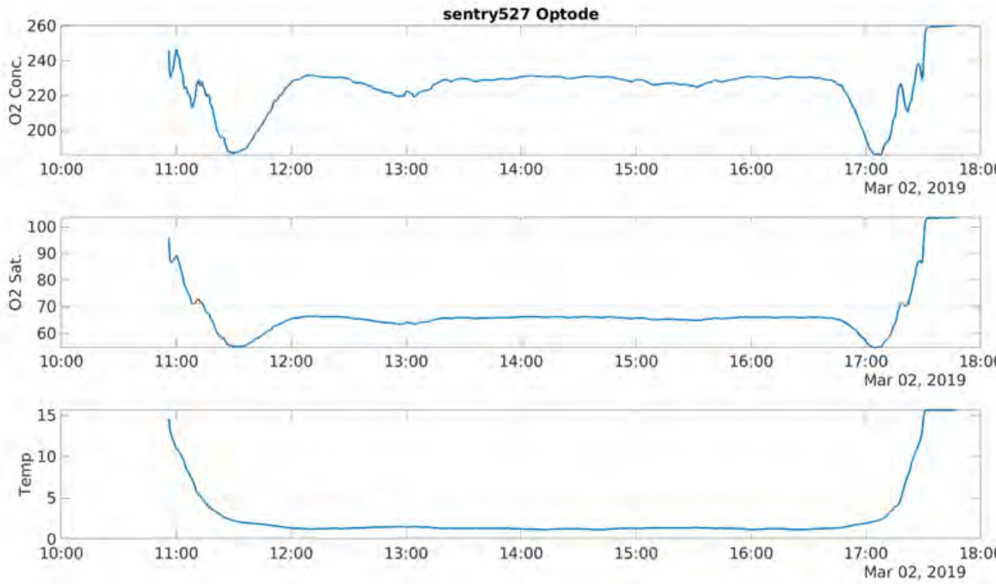


Figure 6: Optode temperature, O2 saturation, and concentration

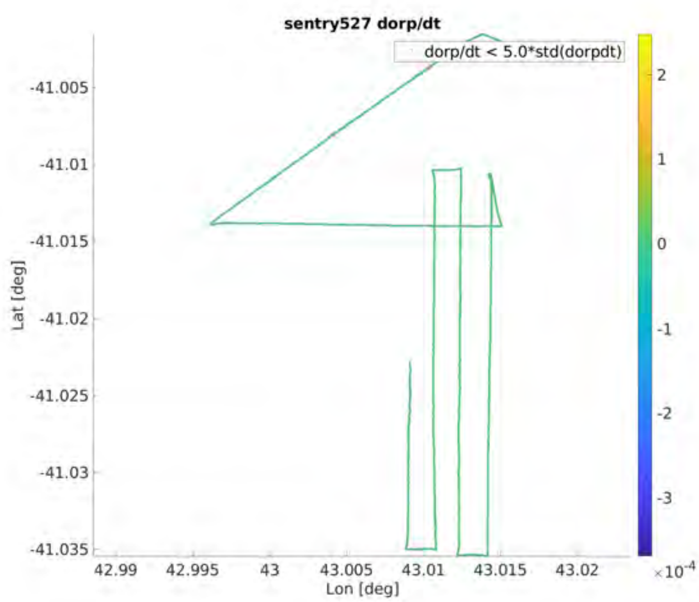


Figure 7: Navigated ORP sensor data.

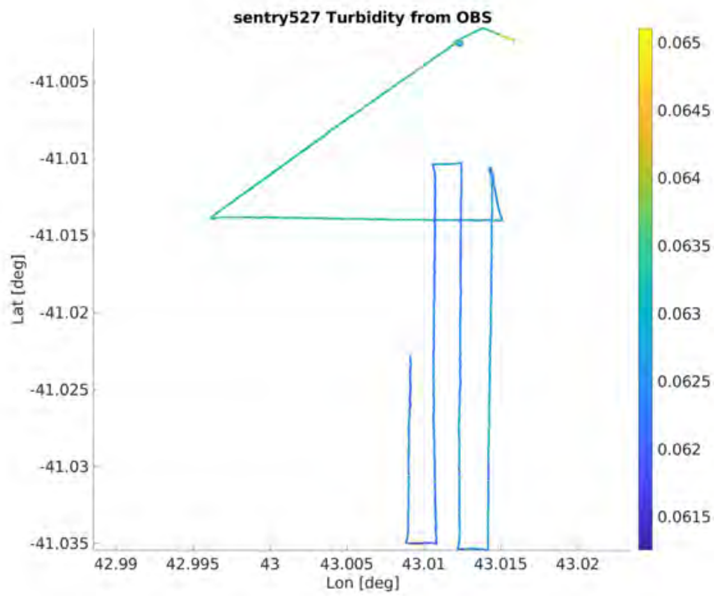


Figure 8: Navigated OBS sensor data.

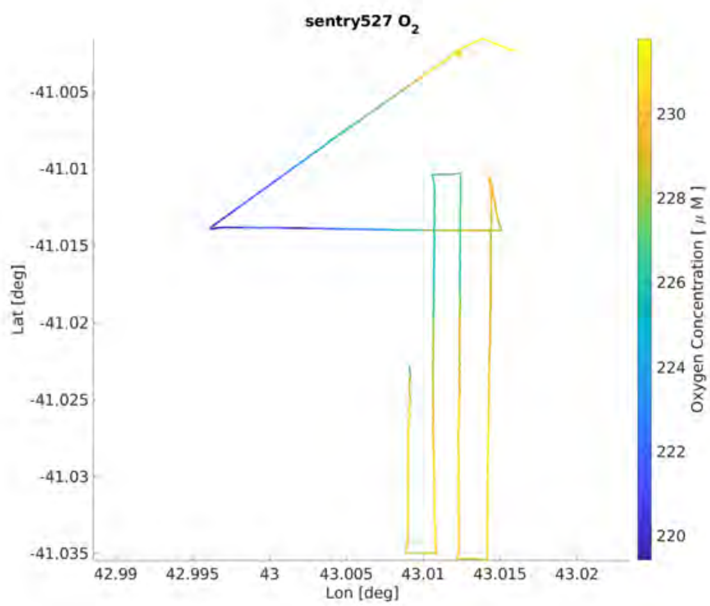
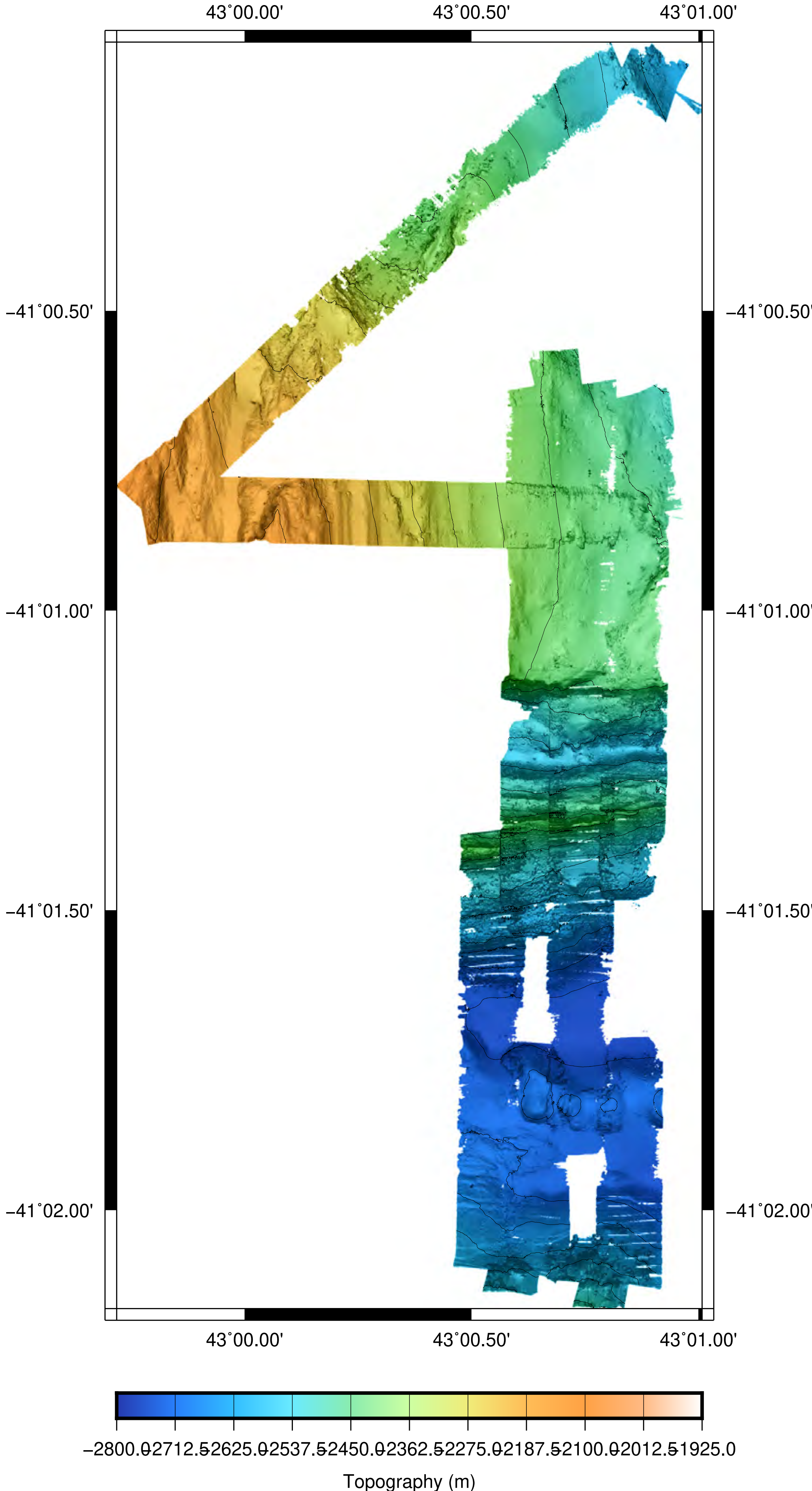


Figure 9: Navigated optode sensor data.

sentry527_20190302_1841_rnv V02 Bathy Generated at 20190304_1346



Sentry 528 Dive Report
DRAFT

Sean Kelley, Justin Fujii, Zac Berkowitz, Stefano Suman, Mike Skowronski

Sentry Expedition Leader: Sean Kelley

Summary

Weather: Deployment: winds nill, seas nill. Recovery: winds 15 knts, seas 5-10ft.

Reason for end of dive: out of battery

Important Positions

Dive Origin: -41 -1.2 43 29.7

Launch Position: sentry528 launch position: 40 59.627'S 043 27.831'E

Vehicle Configuration

The science sensing suite for this dive was:

Table 3: Sentry Sensor Configuration

Sensor
Qty(3) APS 1540 Magnetometers (stbd, center)
Edgetech 4-24kHz SBP
Edgetech 120kHz/410kHz Sidescan sonar
Reson 7125 Multibeam Sonar
Seabird SBE49 CTD
Anderaa optode model 4330
300kHz RDI DVL
Blue View P900-90 Forward Looking Sonar
IXEA PHINS
Reson Sound Velocity Probe
NOAA PMEL MAPR
NOAA PMEL ORP Sensor

This dive was navigated using the DVL/INS system in real time. USBL provided post-dive corrections.

Narrative

Sentry528 is the second dive of TN-365.

Sentry528 was a multibeam survey, covering 5km by 1.7km at 3200m depth with 155m spacing. Sentry was launched at 05:00 local with the launch of the waveglider following. There were no major issues with either vehicle, both performed well. The waveglider was limited in maneuverability due to strong currents with little to no wave action.

Two dredges were performed during the dive, one to the west of the survey and one to the east. Both roughly taking 7hours. Recovery went reasonably well, with Sentry back on deck just after 05:00. All systems operated well for the second dive.

Dive Statistics

0.3 sentry528 Summary

sentry528 Summary
Origin: -41.020000 43.495000
Origin: 41 1.200'S 043 29.700'E
Launch: 2019/03/06 03:35:57
Survey start: 2019/03/06 05:05:12
Survey start: Lat:-40.996216 Lon:43.476685
Survey start: Lat:40 59.773'S Lon:043 28.601'E
Survey end: 2019/03/07 02:13:35
Survey end: Lat:-40.986618 Lon:43.451406
Survey end: Lat:40 59.197'S Lon:043 27.084'E
Ascent begins: 2019/03/07 02:13:35
On the surface: 2019/03/07 03:14:56
On deck: 2019/03/07 03:31:55
descent rate: 36.5 m/min
ascent rate: 53.8 m/min
survey time: 21.1 hours
deck-to-deck time 23.9 hours
Min survey depth: 3134m
Max survey depth: 3483m
Mean survey depth: 3317m
Mean survey height: 73m
distance travelled: 73.99km
average speed: 0.97m/s
average speed during photo runs: NaN m/s over 0.00 km
average speed during multibeam runs: 0.97 m/s over 73.99 km
total vertical during survey: 9862m
Battery energy at launch: 20.3 kwhr
Battery energy at survey start: 19.7 kwhr
Battery energy at survey end: 1.5 kwhr
Battery energy on surface: 1.3 kwhr
Battery energy on deck: 1.2 kwhr

UTC Time	Mission Time	Event	Notes
2019/03/06 03:35:57	+00:00:00.00	launch	launch
2019/03/06 05:04:23	+01:28:26.14	descent	end
2019/03/06 05:05:11	+01:29:14.55	onbottom	START
2019/03/06 05:19:24	+01:43:27.35	ballast-test	start
2019/03/06 05:19:24	+01:43:27.36	ballast-test	end
2019/03/06 05:24:24	+01:48:27.35	start	MB 1
2019/03/06 19:32:00	+15:56:03.77	end	MB 1
2019/03/06 19:32:00	+15:56:03.77	start	MB 1
2019/03/07 02:13:34	+22:37:37.68	abort	
2019/03/07 03:14:56	+23:38:58.94	surface	surface
2019/03/07 03:31:55	+23:55:57.85	recovery	autogenerated

Table 4: Summary of events during dive sentry528

Sensor Information

This is a recently added section with selected sensor metadata. This section will be expanded in coming months. Additional data is available in the sentry528/nav-sci/proc directory within the sentry528_config matlab structure as well as in ascii text logs in sentry528/metadata. At present metadata is not yet automatically collected on all sensors.

0.4 sentry528 Devices

Instrument	Model	Serial Num.	Comments	Config File
USBL	Sonardyne AvTrak2	U001AA5		`avtrak_20190306_0146.cfg`
DVL	RDI Navigator (300kHz)	727-2000-00M	CX: 1, WP: 0	`dvl300_20190306_0146.cfg`
CTD	SBE 49	222		`sbe49_20190306_0147.cfg`
SAIL	obs A/D orp A/D	13 9	A: 5, G: 1.00, O: 0 A: 3, G: 1.00, O: 0.002	`a2d2-pods_20190306_0146.cfg`

Ballast Test

```
>> sentry_plot_ballastcontroller
Mean controller buoyancy  : 56.036 N (5.71 kg, 12.60 lb)
Mean thrust model buoyancy: 81.873 N (8.35 kg, 18.41 lb)
```

Special Data Processing Notes

None

Plots and Images

This section contains selected images of data products and plots of vehicle navigation and selected sensors.

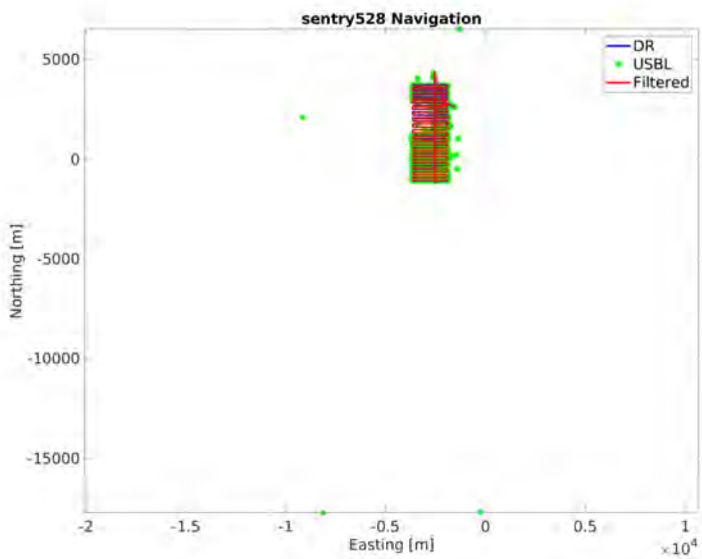


Figure 10: Latitude/Longitude plot of Sentry dive 528 based on post-processed navigation

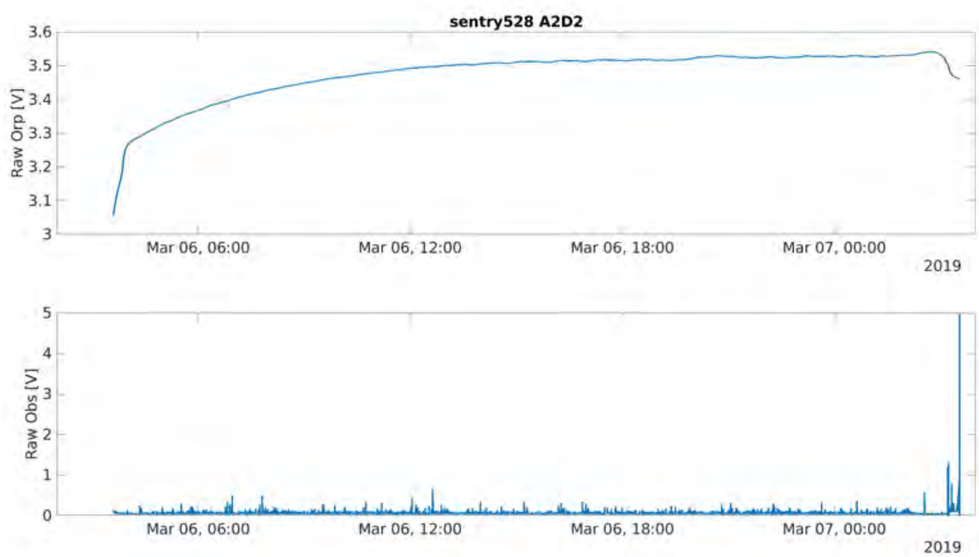


Figure 11: Raw analog Sensor Data

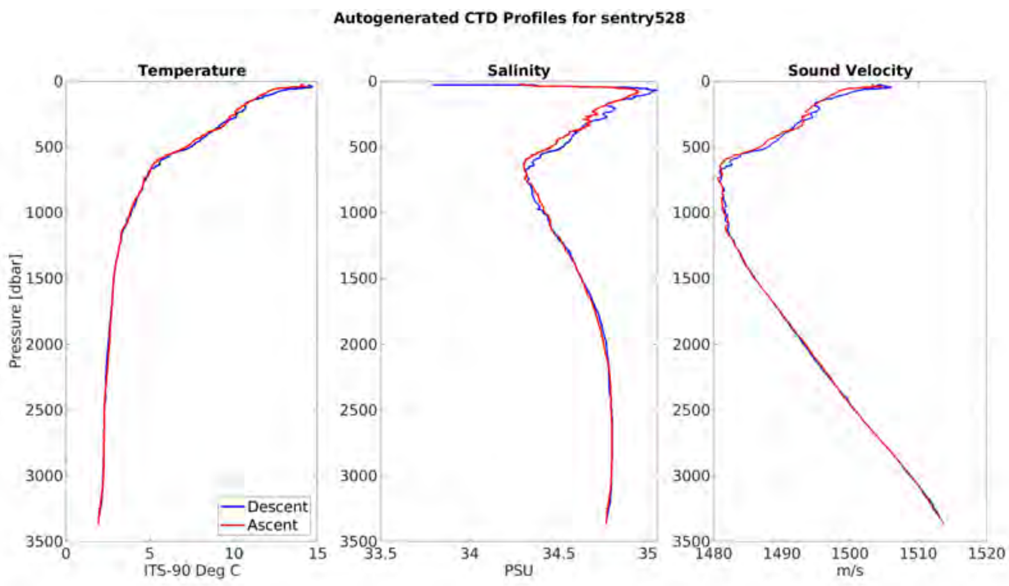


Figure 12: CTD profile sensor data

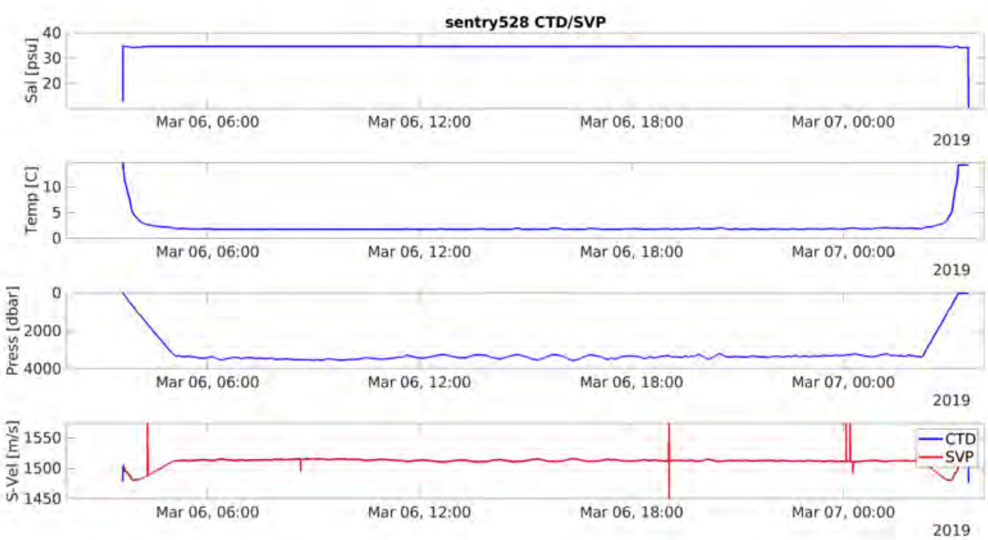


Figure 13: CTD and SVP sensor data

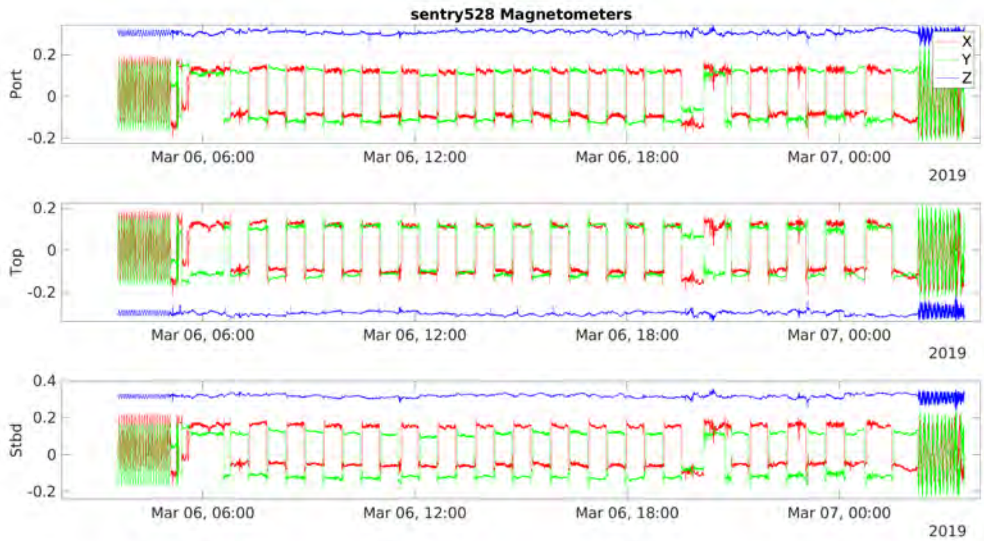


Figure 14: Magnetometer data from each of the three magnetometers on Sentry

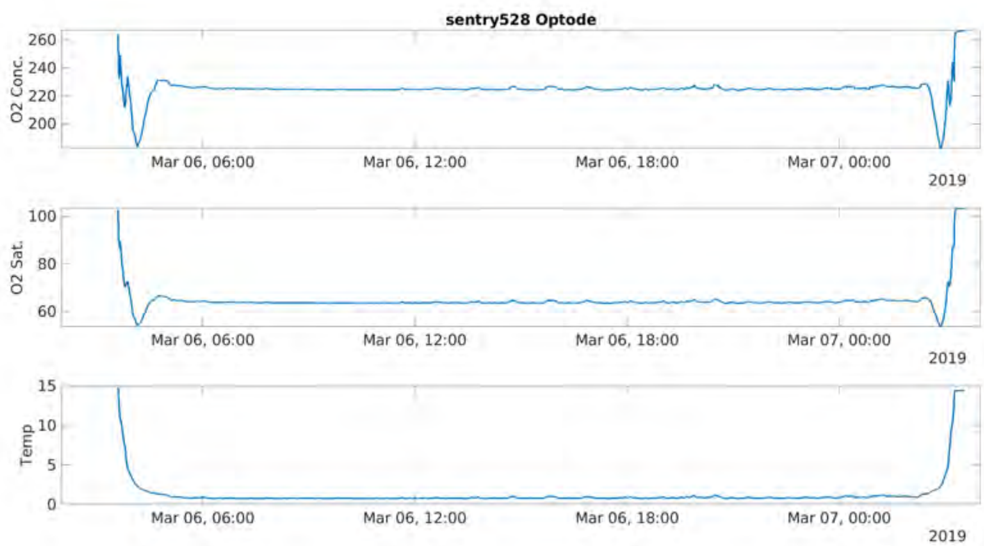


Figure 15: Optode temperature, O2 saturation, and concentration

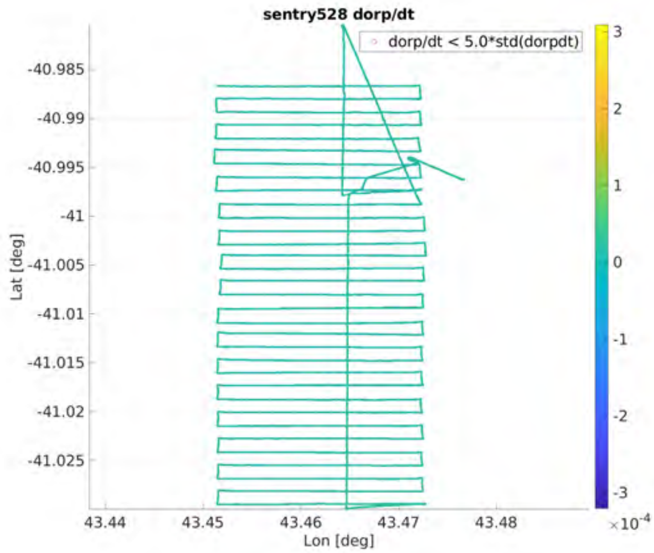


Figure 16: Navigated ORP sensor data.

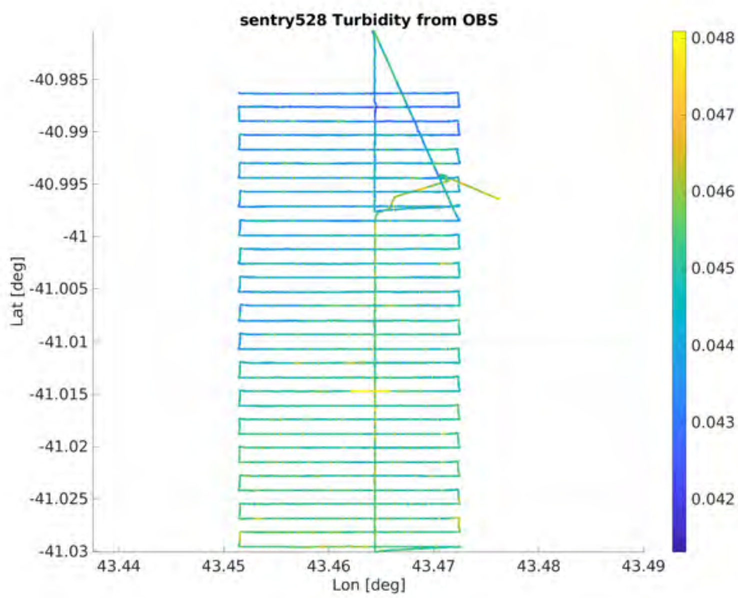


Figure 17: Navigated OBS sensor data.

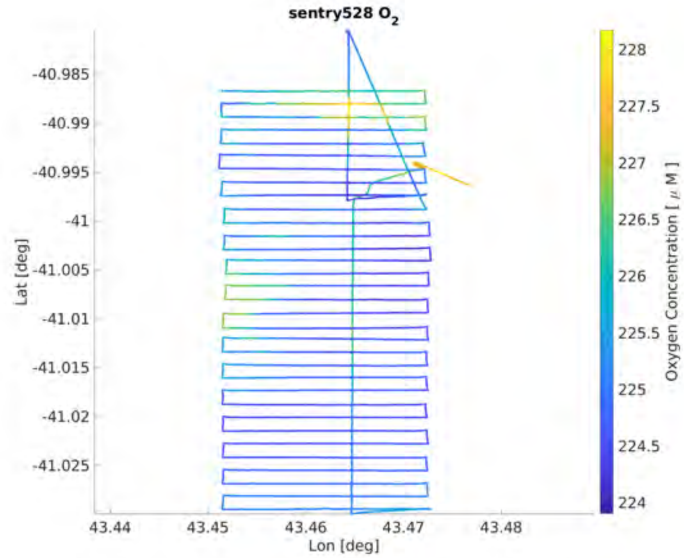


Figure 18: Navigated optode sensor data.

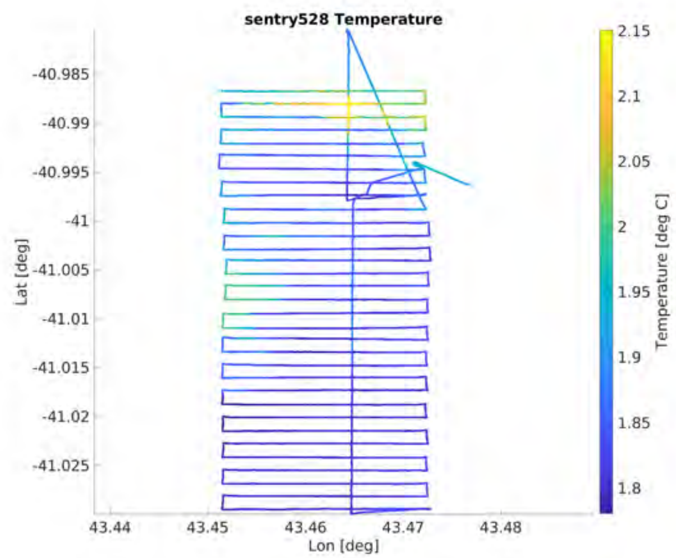


Figure 19: Navigated temperature sensor data

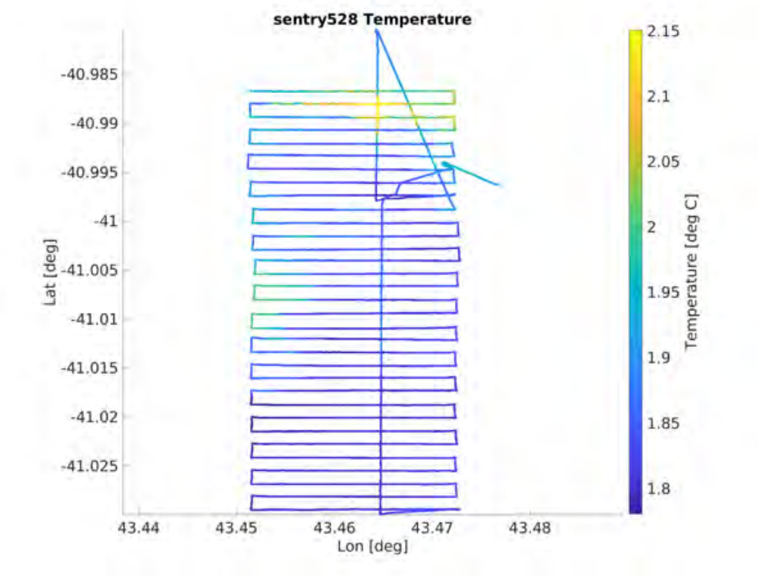
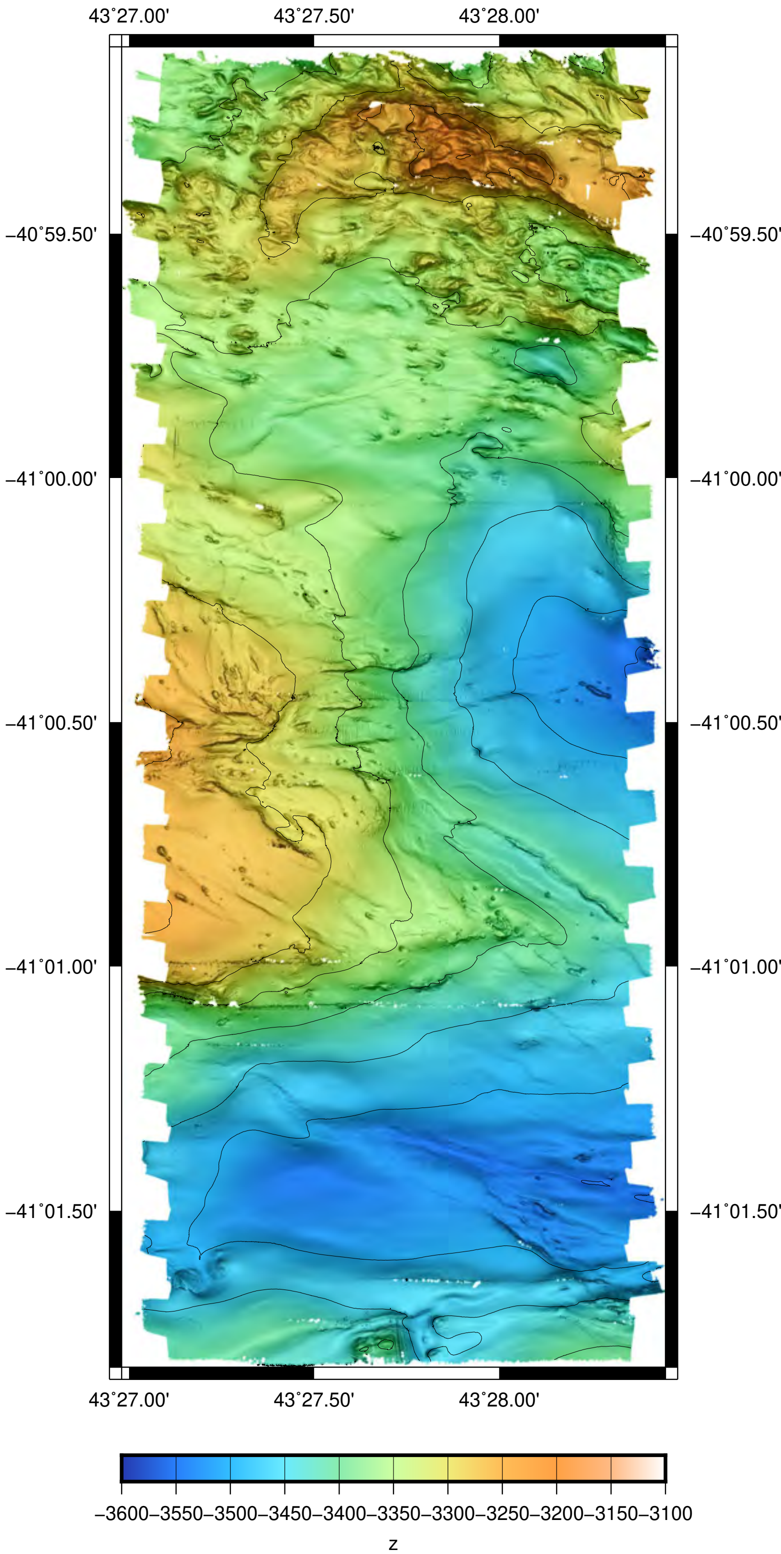


Figure 20: Navigated temperature sensor data

sentry528 (rev 02, no crossing lines)



Sentry 529 Dive Report
DRAFT

Sean Kelley, Justin Fujii, Zac Berkowitz, Stefano Suman, Mike Skowronski

Sentry Expedition Leader: Sean Kelley

Summary

Weather: Deployment: winds nill, seas nill. Recovery: winds 5-10 knts, seas 5ft.

Reason for end of dive: out of battery

Important Positions

Dive Origin: -41 -5.526 43 55.3812

Launch Position: sentry529 launch position: 41 4.803'S 043 58.984'E

Vehicle Configuration

The science sensing suite for this dive was:

Table 5: Sentry Sensor Configuration

Sensor
Qty(3) APS 1540 Magnetometers (stbd, center)
Edgetech 4-24kHz SBP
Edgetech 120kHz/410kHz Sidescan sonar
Reson 7125 Multibeam Sonar
Seabird SBE49 CTD
Anderaa optode model 4330
300kHz RDI DVL
Blue View P900-90 Forward Looking Sonar
IXEA PHINS
Reson Sound Velocity Probe
NOAA PMEL MAPR
NOAA PMEL ORP Sensor

This dive was navigated using the DVL/INS system in real time. USBL provided post-dive corrections.

Narrative

Sentry529 is the third dive of TN-365.

Sentry529 was a multibeam survey, covering 5km by 2km from 2400m depth down to 3800m depth, 155m spacing. Sentry launch and bottom approach were issue free, with significantly less drift from currents on the way down. Sentry performed a ballast test along with maggie spins once on bottom. After several hours on bottom, Sentry began to drive away from the planned survey. The vessel was not in USBL range, and the course Sentry was driving away from the survey was noticed through the waveglider status updates. The vessel was able to manouver back to the survey site, and verify through USBL that Sentry was in fact driving off the survey lines in the wrong direction. The DVL was reset acoustically to a new X/Y position, this helped Sentry get back on the planned survey line. With no issues occuring for the remainder of the dive. Three dredges were performed during the dive.

Once Sentry was back on deck, the DVL issue was debugged. The error occured from a bad string recieved by Sentry software on the serial port dedicated to the DVL. There was an error in one byte, that swapped the reported year from 2019 to 2011, causing a massive error in the dead reckoning.

Dive Statistics

0.5 sentry529 Summary

sentry529 Summary
Origin: -41.092100 43.923020
Origin: 41 5.526'S 043 55.381'E
Launch: 2019/03/10 08:05:48
Survey start: 2019/03/10 09:15:31
Survey start: Lat:-41.082256 Lon:43.988670
Survey start: Lat:41 4.935'S Lon:043 59.320'E
Survey end: 2019/03/11 07:21:38
Survey end: Lat:-41.075345 Lon:43.985538
Survey end: Lat:41 4.521'S Lon:043 59.132'E
Ascent begins: 2019/03/11 07:21:38
On the surface: 2019/03/11 08:09:41
On deck: 2019/03/11 08:19:13
descent rate: 36.4 m/min
ascent rate: 53.8 m/min
survey time: 22.1 hours
deck-to-deck time 24.2 hours
Min survey depth: 2536m
Max survey depth: 3952m
Mean survey depth: 3212m
Mean survey height: 76m
distance travelled: 71.79km
average speed: 0.89m/s
average speed during photo runs: NaN m/s over 0.00 km
average speed during multibeam runs: 0.89 m/s over 71.79 km
total vertical during survey: 10239m
Battery energy at launch: 20.7 kwhr
Battery energy at survey start: 20.1 kwhr
Battery energy at survey end: 2.8 kwhr
Battery energy on surface: 2.7 kwhr
Battery energy on deck: 2.6 kwhr

UTC Time	Mission Time	Event	Notes
2019/03/10 08:05:48	+00:00:00.00	launch	launch
2019/03/10 09:14:42	+01:08:53.84	descent	end
2019/03/10 09:15:30	+01:09:42.31	onbottom	START
2019/03/10 09:39:58	+01:34:10.75	ballast-test	start
2019/03/10 09:39:58	+01:34:10.76	ballast-test	end
2019/03/10 09:44:58	+01:39:10.75	start	MB 1
2019/03/11 07:21:38	+23:15:49.85	abort	
2019/03/11 08:09:41	+24:03:52.94	surface	surface
2019/03/11 08:19:12	+24:13:24.45	recovery	autogenerated

Table 6: Summary of events during dive sentry529

Sensor Information

This is a recently added section with selected sensor metadata. This section will be expanded in coming months. Additional data is available in the sentry529/nav-sci/proc directory within the sentry529_config matlab structure as well as in ascii text logs in sentry529/metadata. At present metadata is not yet automatically collected on all sensors.

0.6 sentry529 Devices

Instrument	Model	Serial Num.	Comments	Config File
USBL	Sonardyne AvTrak2	U001AA5		`avtrak_20190310_0547.cfg`
DVL	RDI Navigator (300kHz)	727-2000-00M	CX: 1, WP: 0	`dvl300_20190310_0547.cfg`
CTD	SBE 49	222		`sbe49_20190310_0548.cfg`
SAIL	obs A/D orp A/D	13 9	A: 5, G: 1.00, O: 0 A: 3, G: 1.00, O: 0.002	`a2d2-pods_20190310_0547.cfg`

Ballast Test

```
>> sentry_plot_ballastcontroller
Mean controller buoyancy  : 48.975 N (4.99 kg, 11.01 lb)
Mean thrust model buoyancy: 63.506 N (6.47 kg, 14.28 lb)
```

Special Data Processing Notes

None

Plots and Images

This section contains selected images of data products and plots of vehicle navigation and selected sensors.

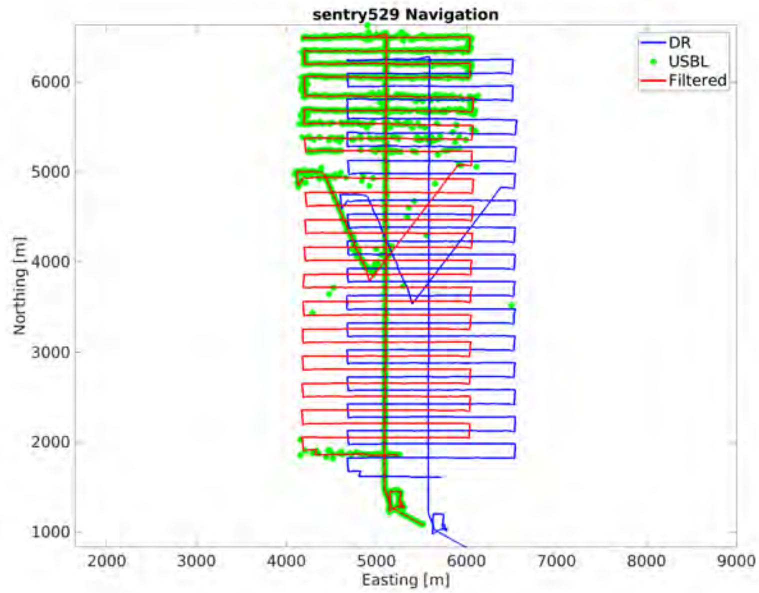


Figure 21: Latitude/Longitude plot of Sentry dive 529 based on post-processed navigation

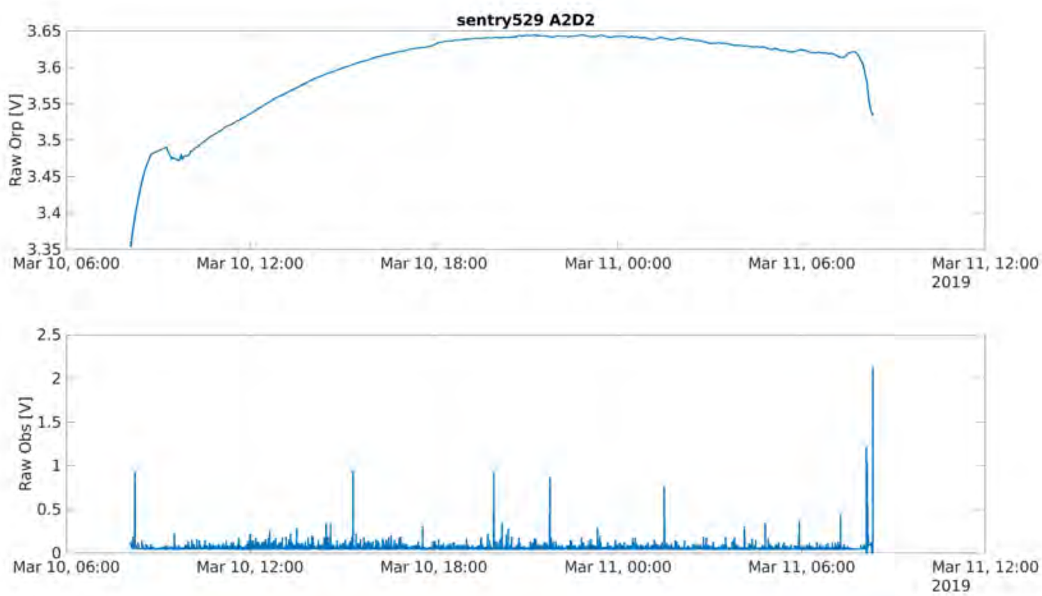


Figure 22: Raw analog Sensor Data

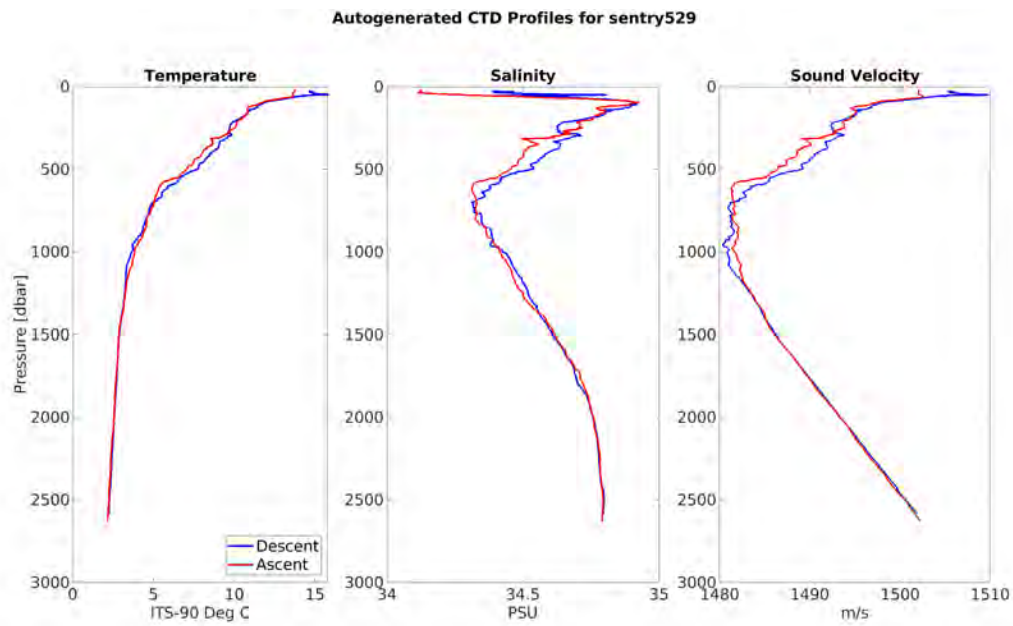


Figure 23: CTD profile sensor data

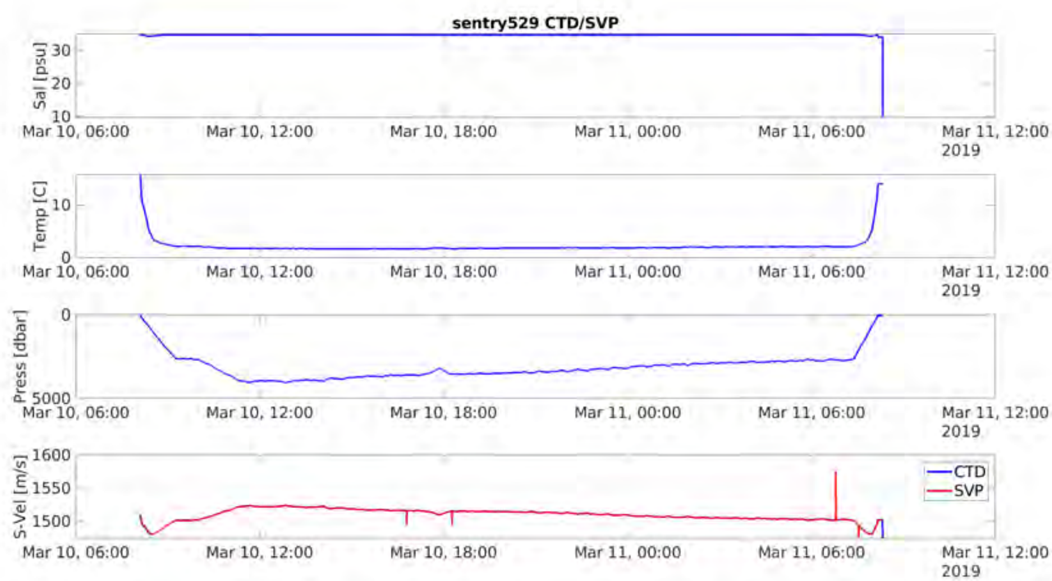


Figure 24: CTD and SVP sensor data

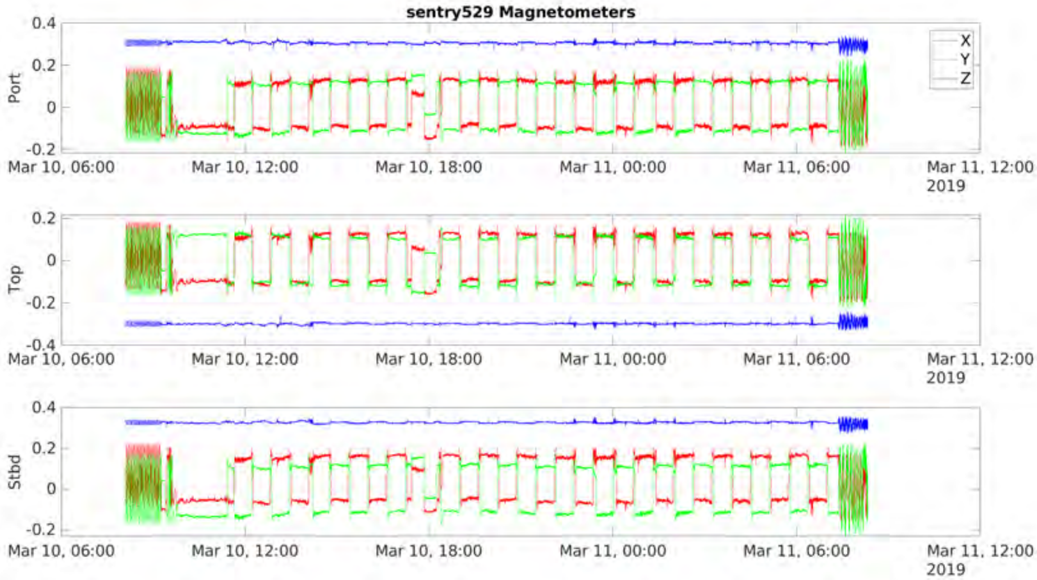


Figure 25: Magnetometer data from each of the three magnetometers on Sentry

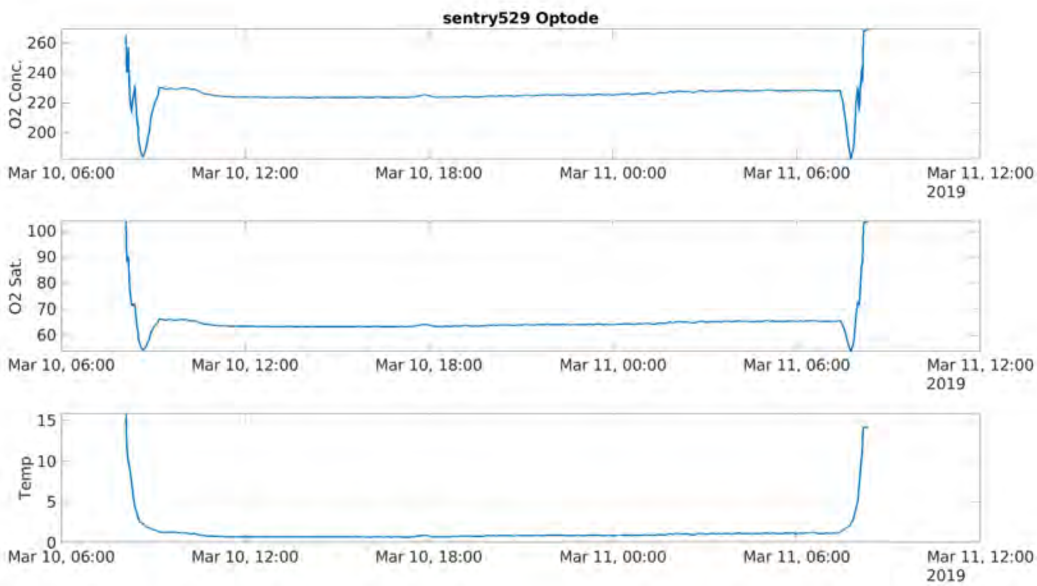


Figure 26: Optode temperature, O2 saturation, and concentration

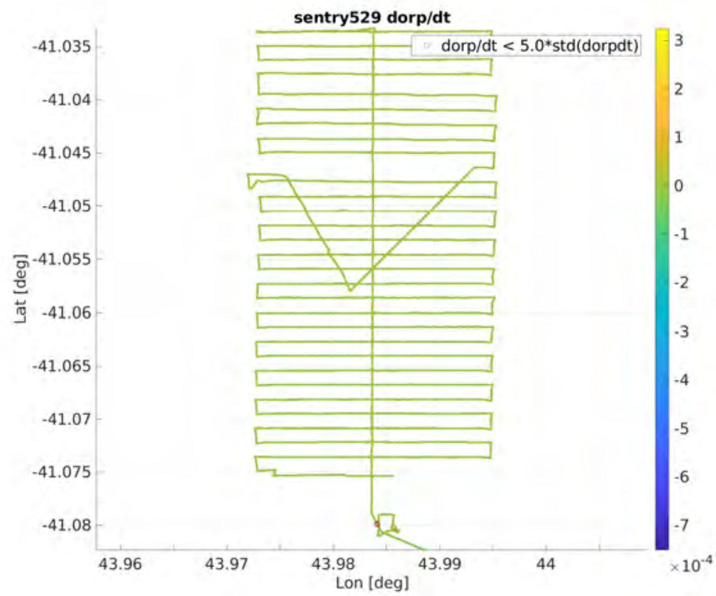


Figure 27: Navigated ORP sensor data.

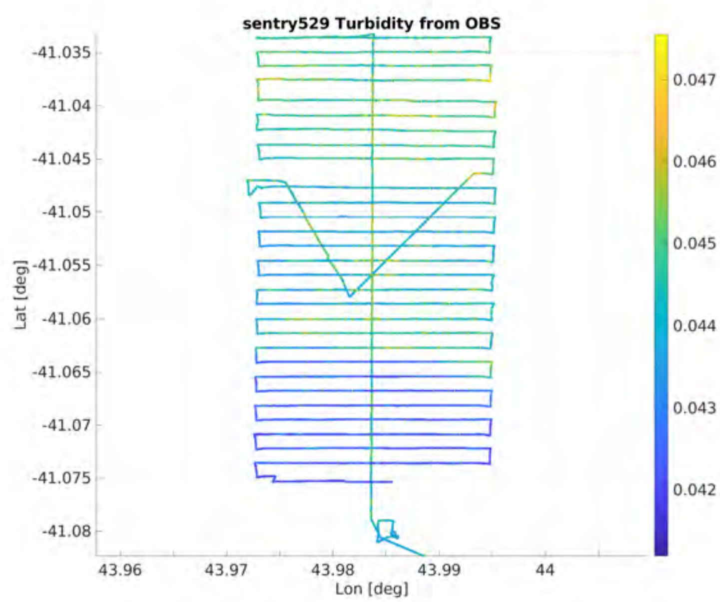


Figure 28: Navigated OBS sensor data.

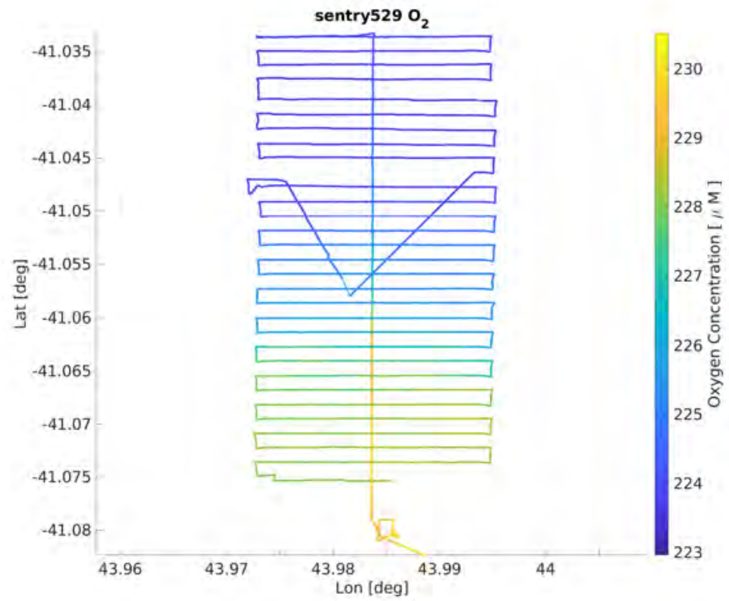


Figure 29: Navigated optode sensor data.

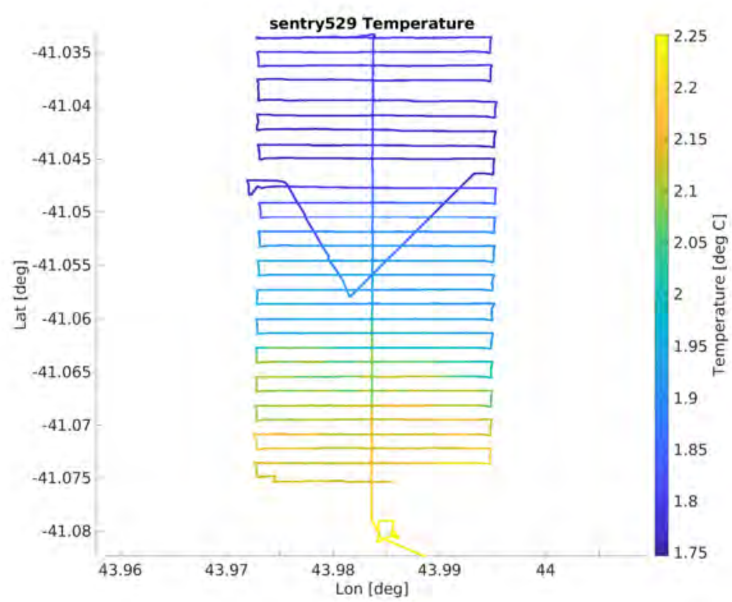


Figure 30: Navigated temperature sensor data

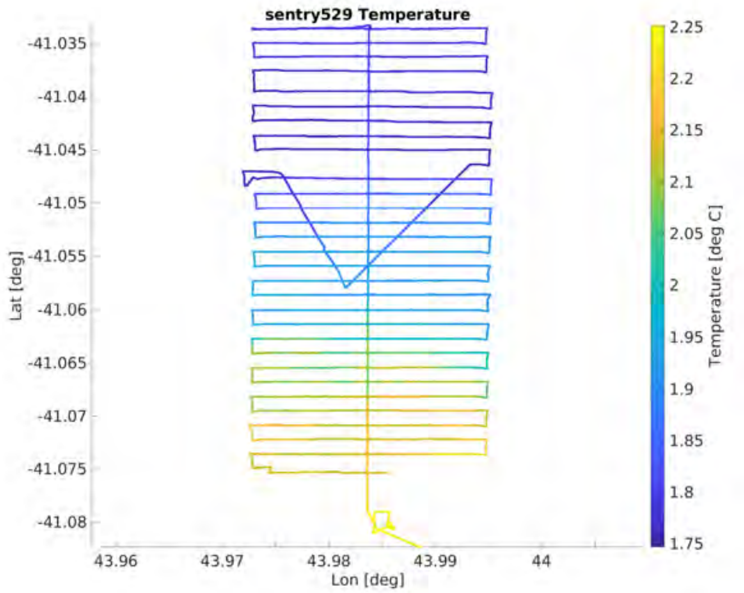
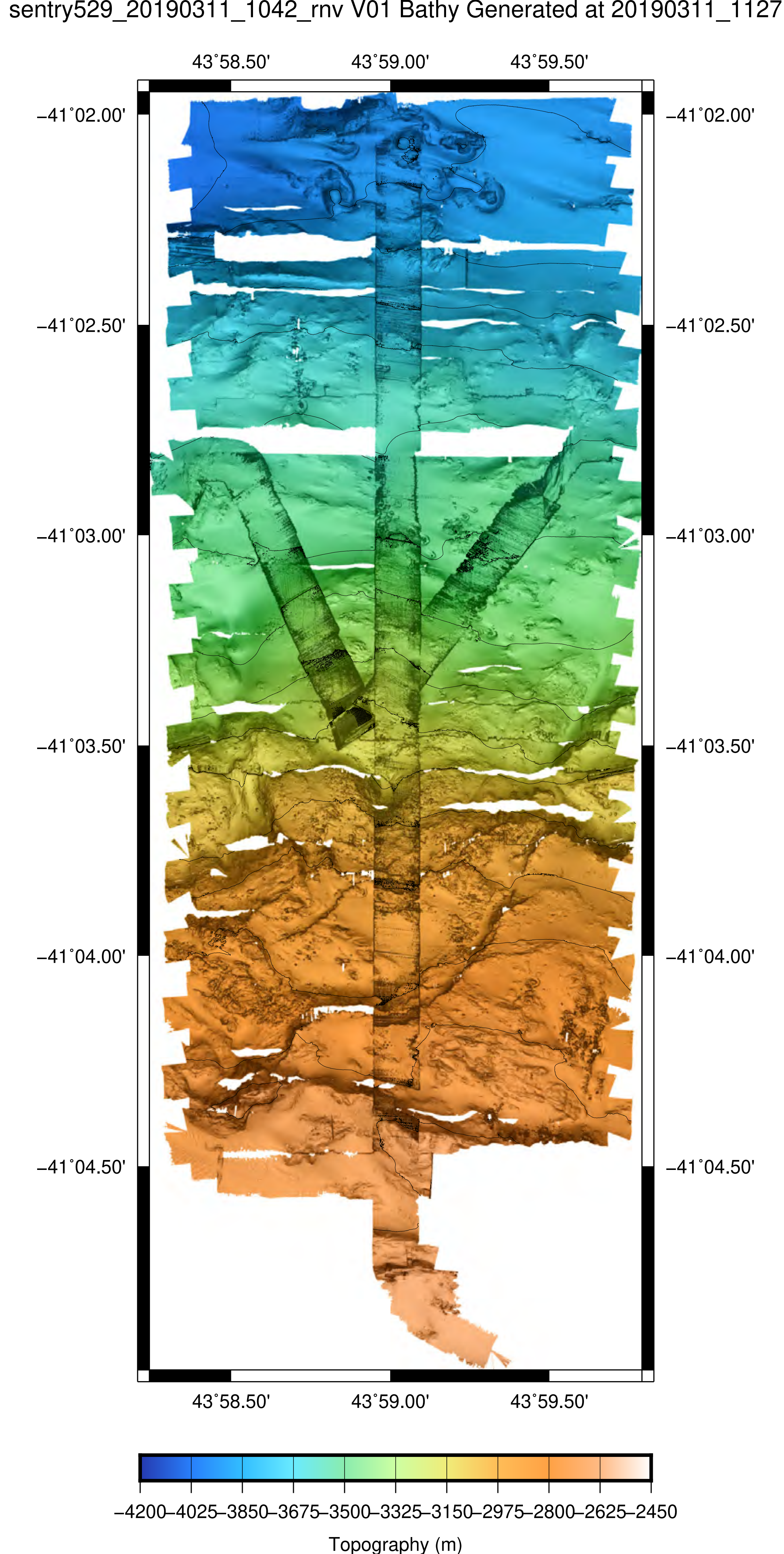


Figure 31: Navigated temperature sensor data


sentry529_20190311_1042_rnv V01 Bathy Generated at 20190311_1127
43˚58.50'
43˚59.00'
43˚59.50'
−41˚02.00'
−41˚02.50'
−41˚03.00'
−41˚03.50'
−41˚04.00'
−41˚04.50'
−4200 −4025 −3850 −3675 −3500 −3325 −3150 −2975 −2800 −2625 −2450
Topography (m)

Sentry 530 Dive Report
DRAFT

Sean Kelley, Justin Fujii, Zac Berkowitz, Stefano Suman, Mike Skowronski

Sentry Expedition Leader: Sean Kelley

Summary

Weather: Deployment: winds 5-10knots, seas 5-6 ft. Recovery: winds 15-20 knts, seas 5-8ft confused.

Reason for end of dive: Weather

Important Positions

Dive Origin: -40 -50.0 44 32

Launch Position: sentry530 launch position: 40 47.967'S 044 34.602'E

Vehicle Configuration

The science sensing suite for this dive was:

Table 7: Sentry Sensor Configuration

Sensor
Qty(3) APS 1540 Magnetometers (stbd, center)
Edgetech 4-24kHz SBP
Edgetech 120kHz/410kHz Sidescan sonar
Reson 7125 Multibeam Sonar
Seabird SBE49 CTD
Anderaa optode model 4330
300kHz RDI DVL
Blue View P900-90 Forward Looking Sonar
IXEA PHINS
Reson Sound Velocity Probe
NOAA PMEL MAPR
NOAA PMEL ORP Sensor

This dive was navigated using the DVL/INS system in real time. USBL provided post-dive corrections.

Narrative

Sentry530 is the fourth dive of TN-365.

Sentry530 was a multibeam survey, covering 5km by 2km at 3200m depth. Sentry launch and bottom approach went well, with very little drift on the descent. After several hours on bottom, weather reports indicated deteriorating conditions for the following morning when we planned to recover. Sentry was then scheduled to be recovered following the second dredge in order to avoid the impending weather. Sentry was able to complete just over half of the intended survey. Sentry was recovered and back onboard 09:30 local. Two dredges were performed during the dive.

No issues with hardware during the dive, all data looks excellent.

Dive Statistics

0.7 sentry530 Summary

sentry530 Summary
Origin: -40.833333 44.533333
Origin: 40 50.000'S 044 32.000'E
Launch: 2019/03/14 02:59:33
Survey start: 2019/03/14 04:24:16
Survey start: Lat:-40.799891 Lon:44.575427
Survey start: Lat:40 47.993'S Lon:044 34.526'E
Survey end: 2019/03/14 18:36:43
Survey end: Lat:-40.785952 Lon:44.582437
Survey end: Lat:40 47.157'S Lon:044 34.946'E
Ascent begins: 2019/03/14 18:36:43
On the surface: 2019/03/14 19:35:35
On deck: 2019/03/14 19:40:51
descent rate: 36.8 m/min
ascent rate: 53.6 m/min
survey time: 14.2 hours
deck-to-deck time 16.7 hours
Min survey depth: 2924m
Max survey depth: 3275m
Mean survey depth: 3123m
Mean survey height: 71m
distance travelled: 48.56km
average speed: 0.95m/s
average speed during photo runs: NaN m/s over 0.00 km
average speed during multibeam runs: 0.95 m/s over 48.56 km
total vertical during survey: 6313m
Battery energy at launch: 20.2 kwhr
Battery energy at survey start: 19.5 kwhr
Battery energy at survey end: 7.8 kwhr
Battery energy on surface: 7.7 kwhr
Battery energy on deck: 7.6 kwhr

UTC Time	Mission Time	Event	Notes
2019/03/14 02:59:32	+00:00:00.00	launch	launch
2019/03/14 04:23:27	+01:23:55.05	descent	end
2019/03/14 04:24:16	+01:24:43.55	onbottom	START
2019/03/14 04:43:56	+01:44:23.85	ballast-test	start
2019/03/14 04:43:56	+01:44:23.86	ballast-test	end
2019/03/14 04:48:56	+01:49:23.95	start	MB 1
2019/03/14 18:36:42	+15:37:09.95	abort	
2019/03/14 19:45:13	+16:45:40.88	surface	surface

Table 8: Summary of events during dive sentry530

Sensor Information

This is a recently added section with selected sensor metadata. This section will be expanded in coming months. Additional data is available in the sentry530/nav-sci/proc directory within the sentry530_config matlab structure as well as in ascii text logs in sentry530/metadata. At present metadata is not yet automatically collected on all sensors.

0.8 sentry530 Devices

Instrument	Model	Serial Num.	Comments	Config File
USBL	Sonardyne AvTrak2	U001AA5		`avtrak_20190314_0042.cfg`
DVL	RDI Navigator (300kHz)	727-2000-00M	CX: 1, WP: 0	`dvl300_20190314_0043.cfg`
CTD	SBE 49	222		`sbe49_20190314_0043.cfg`
SAIL	obs A/D orp A/D	13 9	A: 5, G: 1.00, O: 0 A: 3, G: 1.00, O: 0.002	`a2d2-pods_20190314_0042.cfg`

Ballast Test

```
>> sentry_plot_ballastcontroller
Mean controller buoyancy  : 48.975 N (4.99 kg, 11.01 lb)
Mean thrust model buoyancy: 63.506 N (6.47 kg, 14.28 lb)
```

Special Data Processing Notes

None

Plots and Images

This section contains selected images of data products and plots of vehicle navigation and selected sensors.

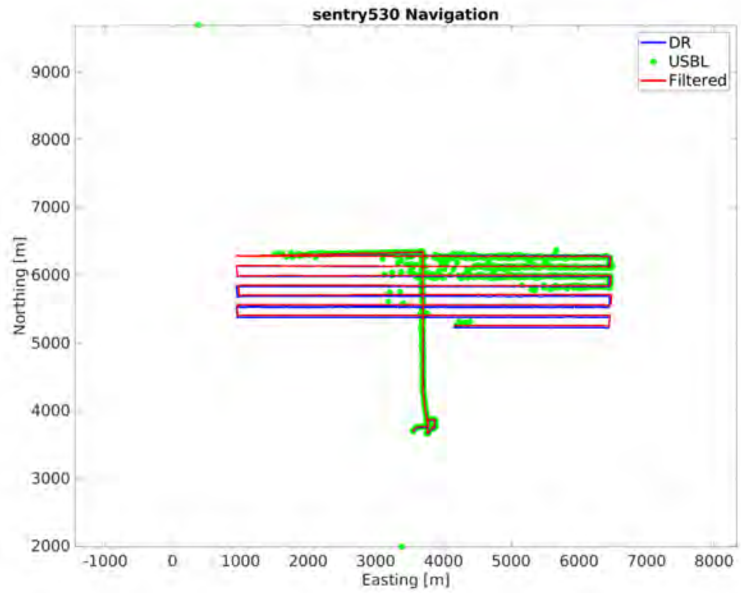


Figure 32: Latitude/Longitude plot of Sentry dive 530 based on post-processed navigation

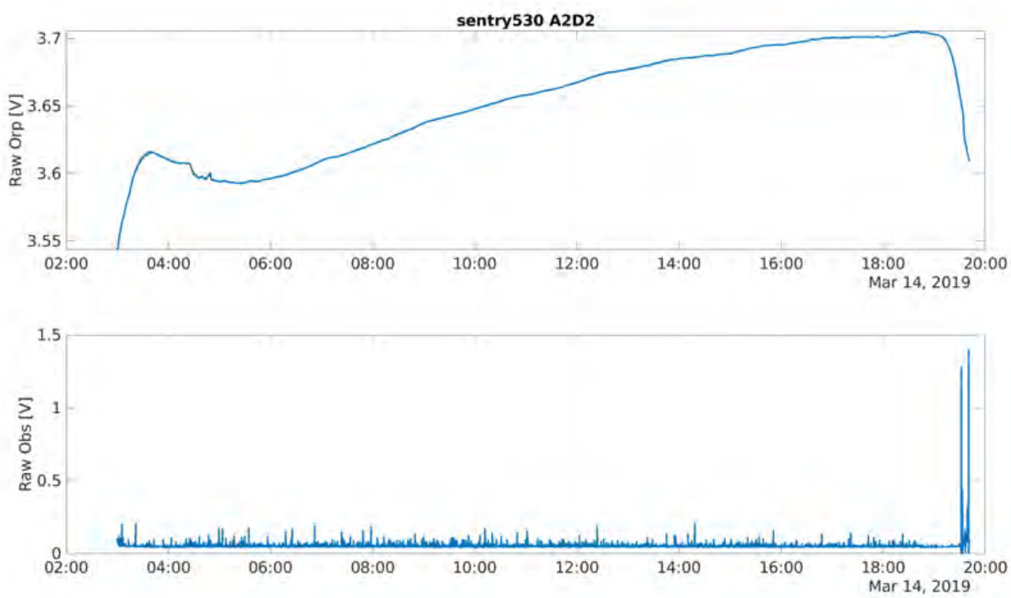


Figure 33: Raw analog Sensor Data

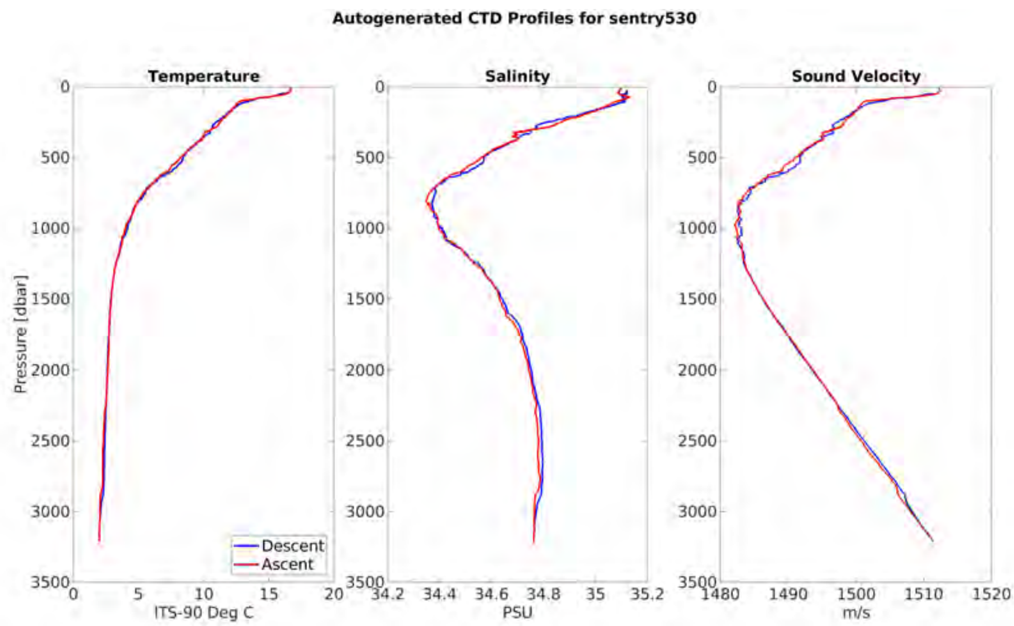


Figure 34: CTD profile sensor data

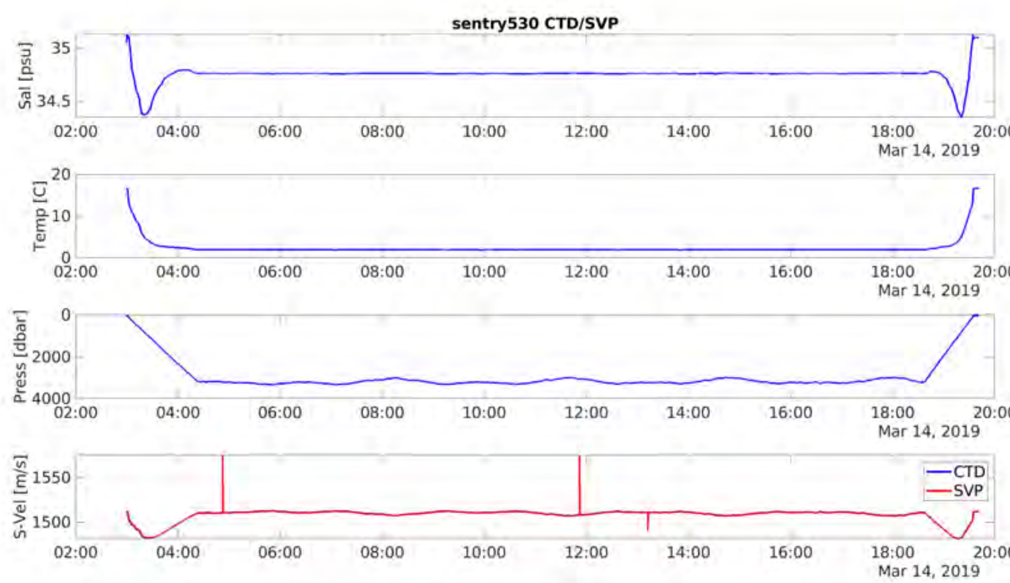


Figure 35: CTD and SVP sensor data

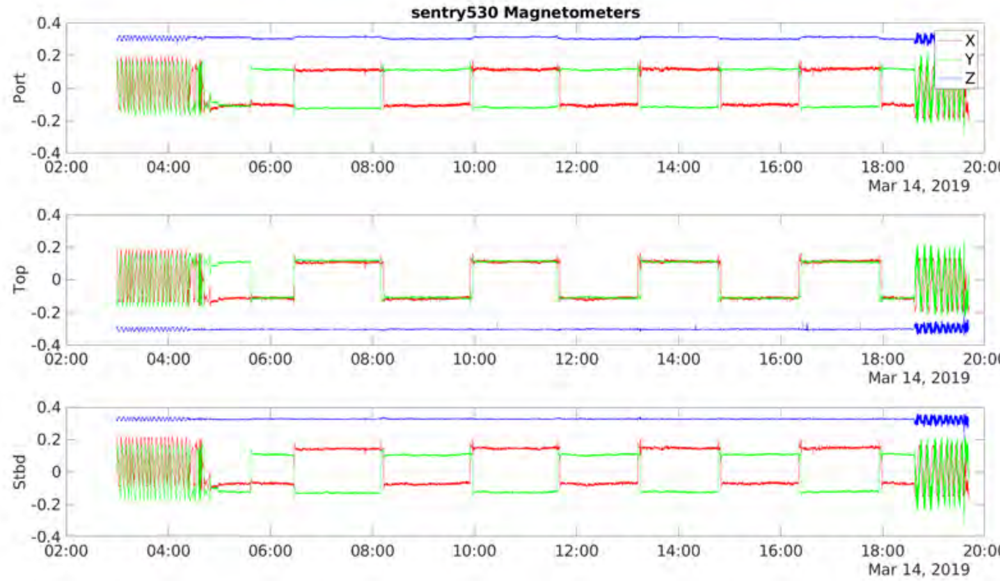


Figure 36: Magnetometer data from each of the three magnetometers on Sentry

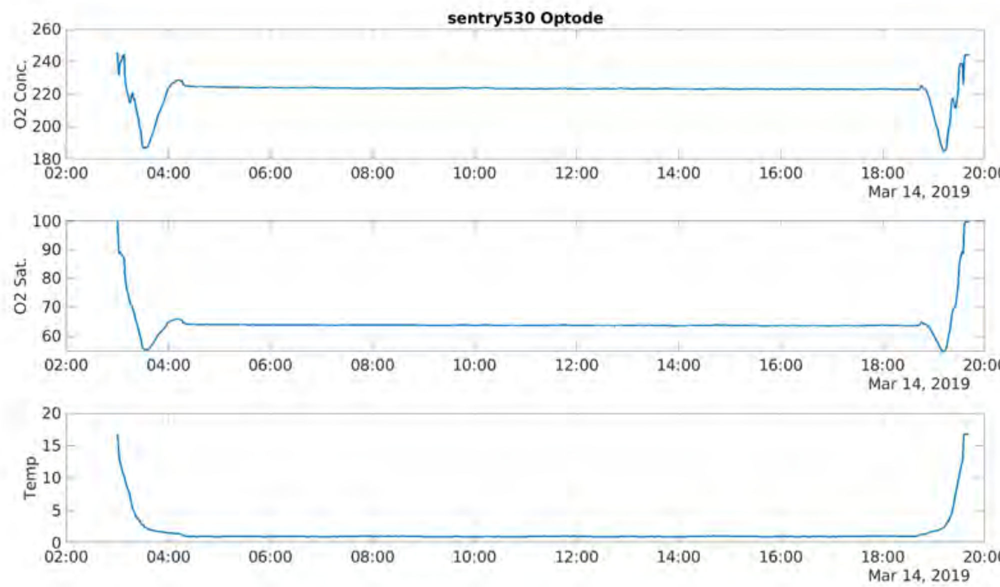


Figure 37: Optode temperature, O2 saturation, and concentration

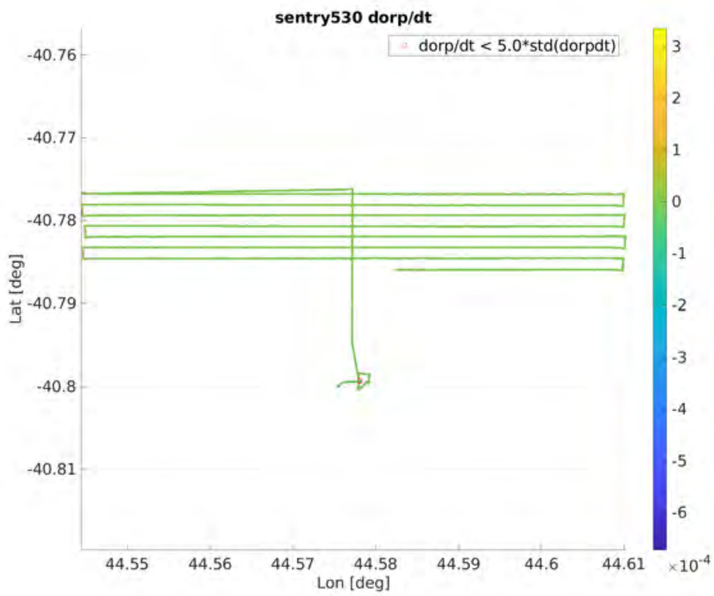


Figure 38: Navigated ORP sensor data.

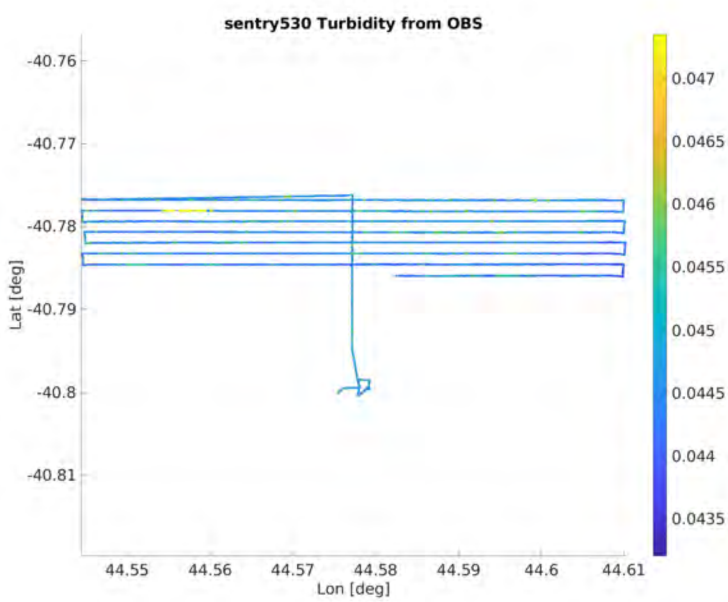


Figure 39: Navigated OBS sensor data.

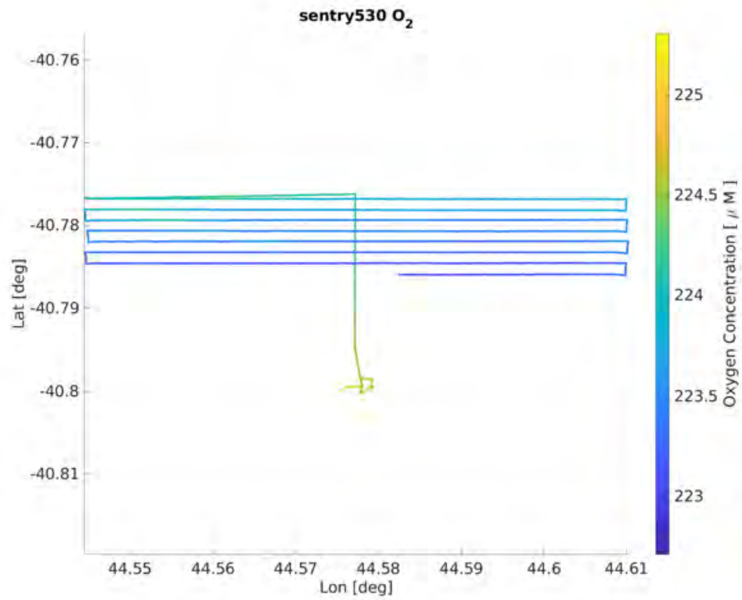


Figure 40: Navigated optode sensor data.

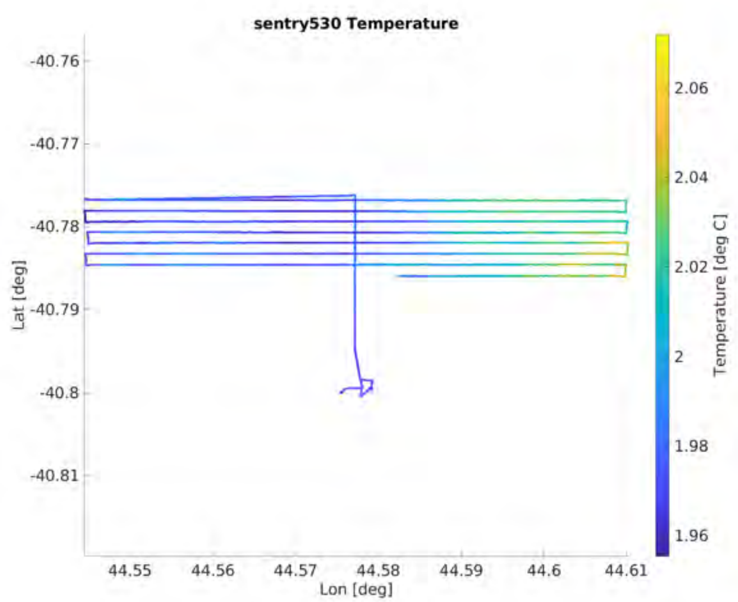


Figure 41: Navigated temperature sensor data

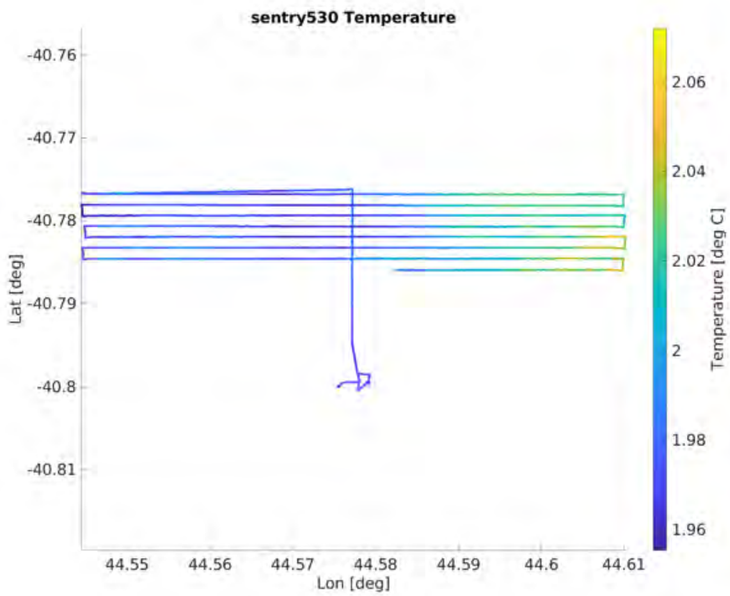
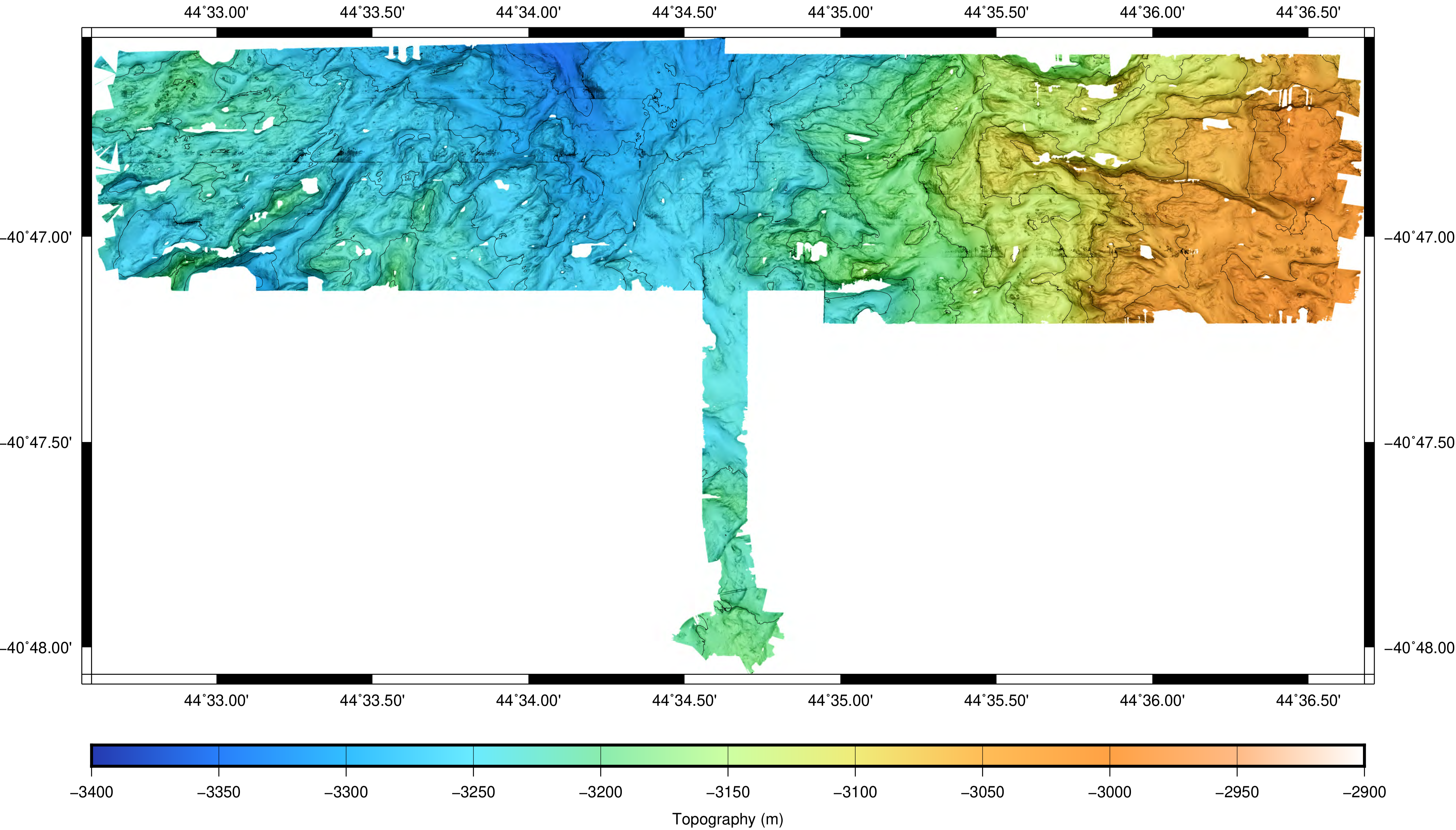


Figure 42: Navigated temperature sensor data

sentry530_20190314_2114_rnv V02 Bathy Generated at 20190315_0039



Sentry 531 Dive Report
DRAFT

Sean Kelley, Justin Fujii, Zac Berkowitz, Stefano Suman, Mike Skowronski

Sentry Expedition Leader: Sean Kelley

Summary

Weather: Deployment: winds Nill, seas Nill. Recovery: winds Nill, seas Nill.

Reason for end of dive: Out of Power

Important Positions

Dive Origin: -40 -28.4 44 53.2

Launch Position: sentry531 launch position: 40 25.255'S 044 55.627'E

Vehicle Configuration

The science sensing suite for this dive was:

Table 9: Sentry Sensor Configuration

Sensor
Qty(3) APS 1540 Magnetometers (stbd, center)
Edgetech 4-24kHz SBP
Edgetech 120kHz/410kHz Sidescan sonar
Reson 7125 Multibeam Sonar
Seabird SBE49 CTD
Anderaa optode model 4330
300kHz RDI DVL
Blue View P900-90 Forward Looking Sonar
IXEA PHINS
Reson Sound Velocity Probe
NOAA PMEL MAPR
NOAA PMEL ORP Sensor

This dive was navigated using the DVL/INS system in real time. USBL provided post-dive corrections.

Narrative

Sentry531 is the fifth dive of TN-365.

Sentry531 was a multibeam survey, covering 5km by 1.6km at 3200m depth with a tighter 150m line spacing. Sentry launch and bottom approach went well, with very little drift on the descent. Sentry performed a ballast test along with maggie spins once on bottom. Overall the mission went well in the difficult terrain. Sentry was recovered and back onboard 13:00 local. Three dredges were performed during the dive.

No issues with hardware during the dive, all data looks excellent.

Dive Statistics

0.9 sentry531 Summary

sentry531 Summary
Origin: -40.473333 44.886667
Origin: 40 28.400'S 044 53.200'E
Launch: 2019/03/18 12:51:24
Survey start: 2019/03/18 14:24:11
Survey start: Lat:-40.423914 Lon:44.930813
Survey start: Lat:40 25.435'S Lon:044 55.849'E
Survey end: 2019/03/19 10:38:56
Survey end: Lat:-40.431345 Lon:44.929984
Survey end: Lat:40 25.881'S Lon:044 55.799'E
Ascent begins: 2019/03/19 10:38:56
On the surface: 2019/03/19 11:41:19
On deck: 2019/03/19 11:50:59
descent rate: 35.8 m/min
ascent rate: 52.9 m/min
survey time: 20.2 hours
deck-to-deck time 23.0 hours
Min survey depth: 3034m
Max survey depth: 3489m
Mean survey depth: 3267m
Mean survey height: 80m
distance travelled: 63.90km
average speed: 0.87m/s
average speed during photo runs: NaN m/s over 0.00 km
average speed during multibeam runs: 0.87 m/s over 63.90 km
total vertical during survey: 13776m
Battery energy at launch: 20.0 kwhr
Battery energy at survey start: 19.3 kwhr
Battery energy at survey end: 1.7 kwhr
Battery energy on surface: 1.6 kwhr
Battery energy on deck: 1.5 kwhr

UTC Time	Mission Time	Event	Notes
2019/03/18 12:51:23	+00:00:00.00	launch	launch
2019/03/18 14:23:22	+01:31:58.55	descent	end
2019/03/18 14:24:11	+01:32:47.15	onbottom	START
2019/03/18 14:47:07	+01:55:44.06	ballast-test	start
2019/03/18 14:47:07	+01:55:44.07	ballast-test	end
2019/03/18 14:52:08	+02:00:44.16	start	MB 1
2019/03/19 10:38:56	+21:47:32.21	abort	
2019/03/19 11:41:18	+22:49:54.97	surface	surface
2019/03/19 11:50:58	+22:59:34.67	recovery	autogenerated

Table 10: Summary of events during dive sentry531

Sensor Information

This is a recently added section with selected sensor metadata. This section will be expanded in coming months. Additional data is available in the sentry531/nav-sci/proc directory within the sentry531_config matlab structure as well as in ascii text logs in sentry531/metadata. At present metadata is not yet automatically collected on all sensors.

0.10 sentry531 Devices

Instrument	Model	Serial Num.	Comments	Config File
USBL	Sonardyne AvTrak2	U001AA5		`avtrak_20190318_1053.cfg`
DVL	RDI Navigator (300kHz)	727-2000-00M	CX: 1, WP: 0	`dvl300_20190318_1054.cfg`
CTD	SBE 49	222		`sbe49_20190318_1054.cfg`
SAIL	obs A/D orp A/D	13 9	A: 5, G: 1.00, O: 0 A: 3, G: 1.00, O: 0.002	`a2d2-pods_20190318_1054.cfg`

Ballast Test

```
>> sentry_plot_ballastcontroller
Mean controller buoyancy  : 61.475 N (6.27 kg, 13.82 lb)
Mean thrust model buoyancy: 88.962 N (9.07 kg, 20.00 lb)
```

Special Data Processing Notes

None

Plots and Images

This section contains selected images of data products and plots of vehicle navigation and selected sensors.

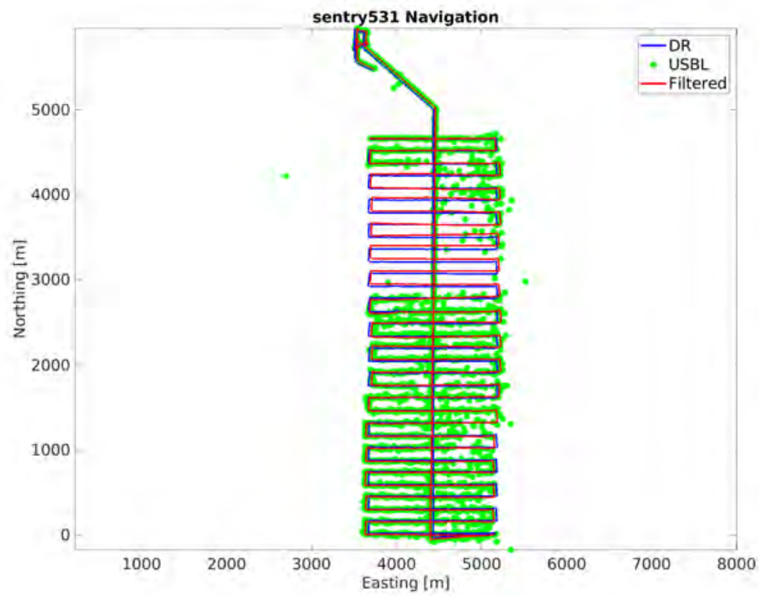


Figure 43: Latitude/Longitude plot of Sentry dive 531 based on post-processed navigation

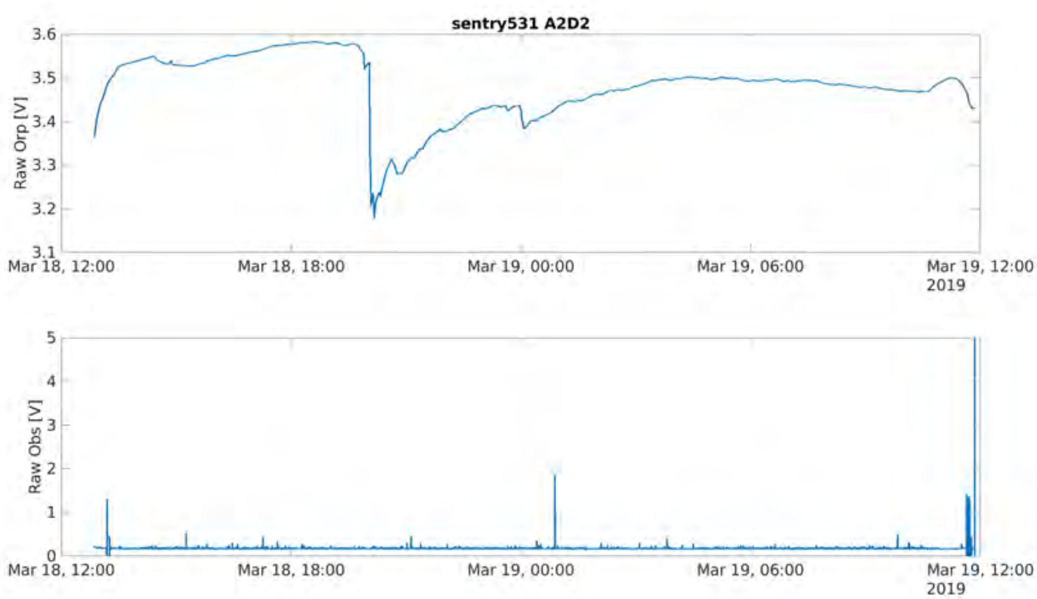


Figure 44: Raw analog Sensor Data

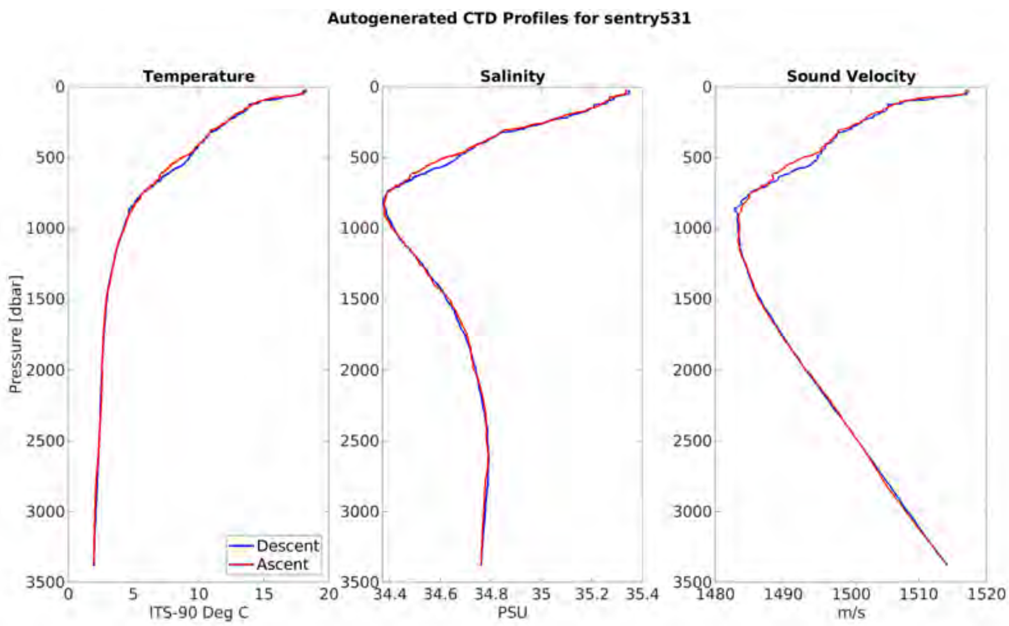


Figure 45: CTD profile sensor data

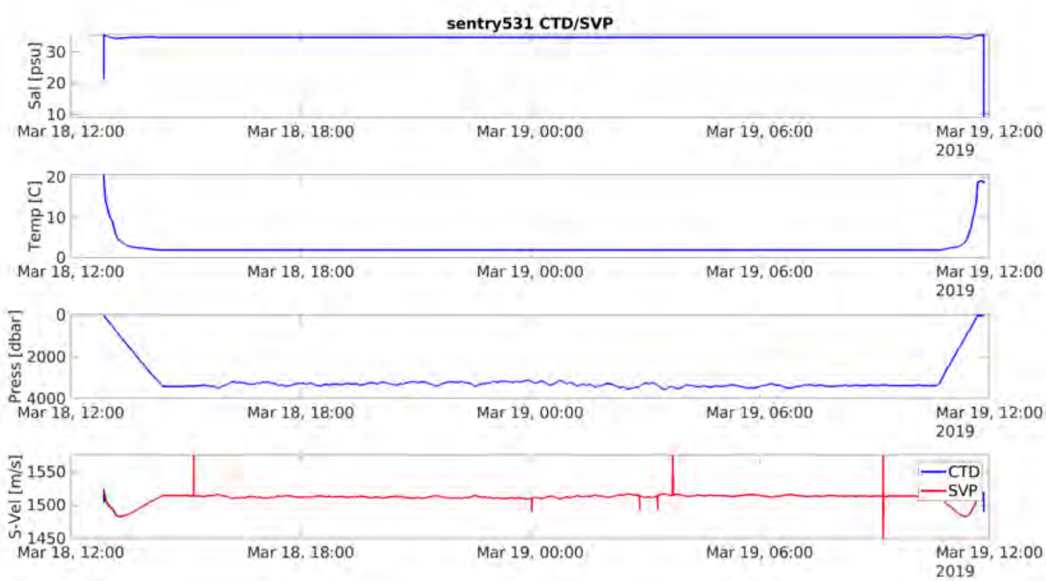


Figure 46: CTD and SVP sensor data

Figure 47: Magnetometer data from each of the three magnetometers on Sentry

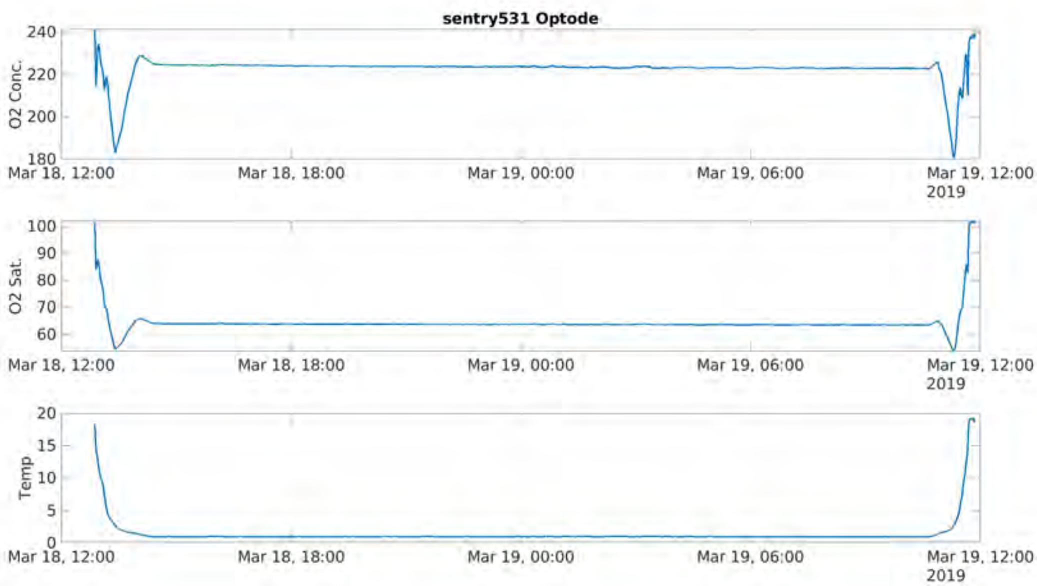


Figure 48: Optode temperature, O2 saturation, and concentration

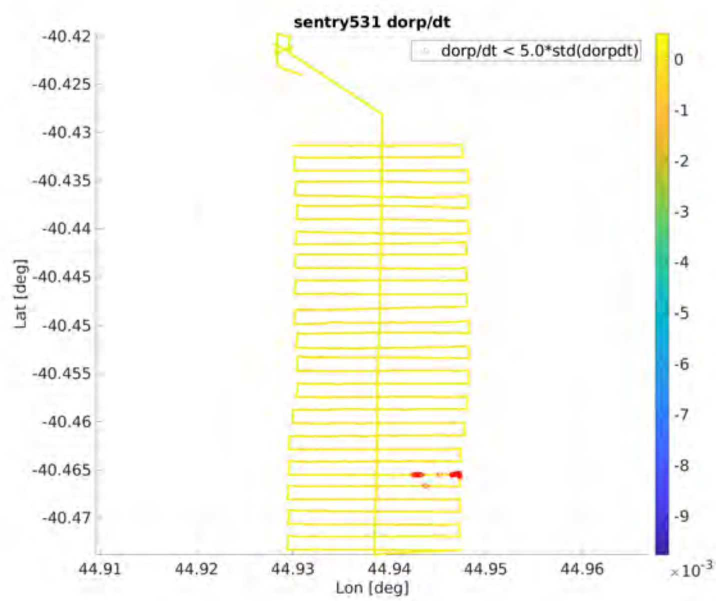


Figure 49: Navigated ORP sensor data.

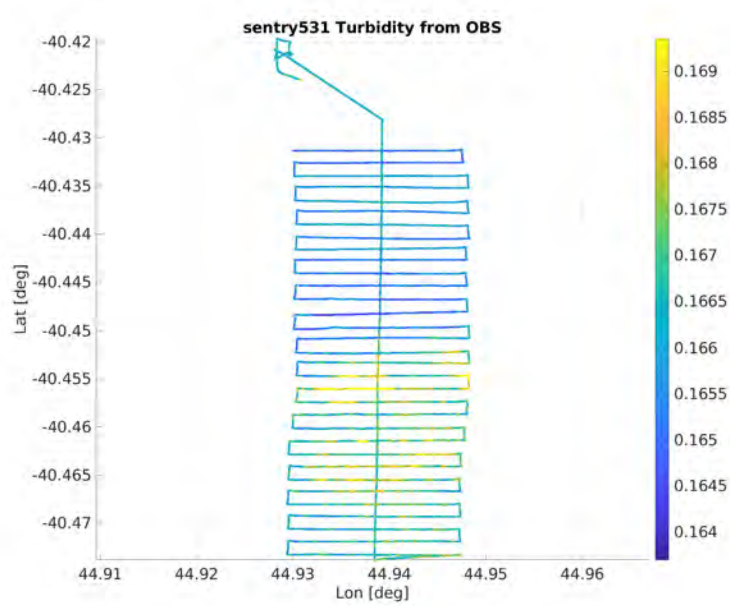


Figure 50: Navigated OBS sensor data.

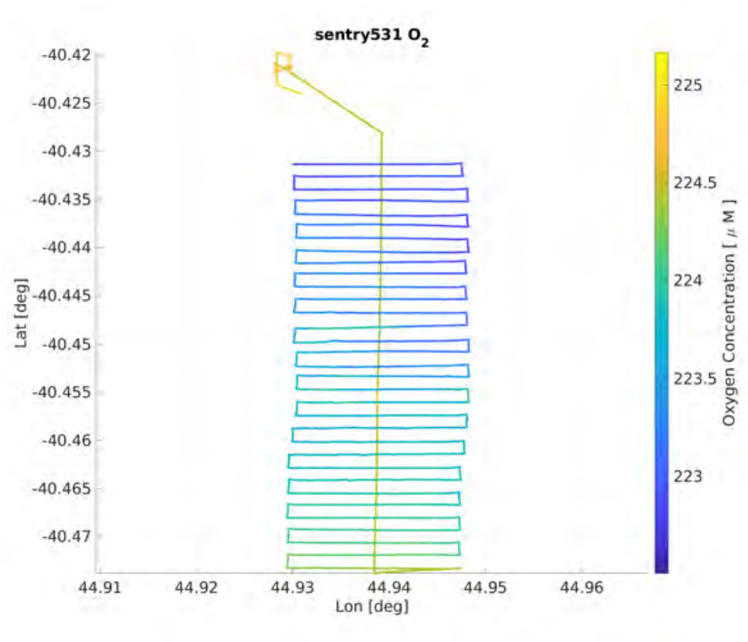


Figure 51: Navigated optode sensor data.

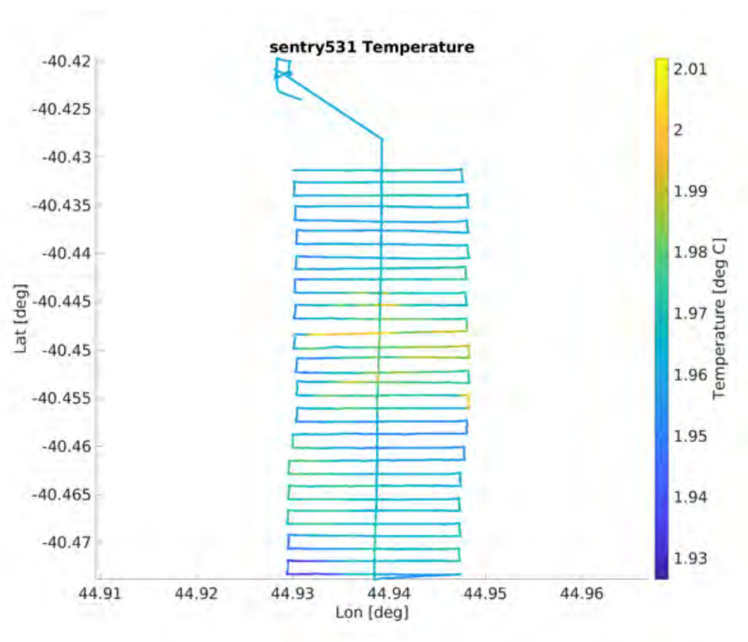


Figure 52: Navigated temperature sensor data

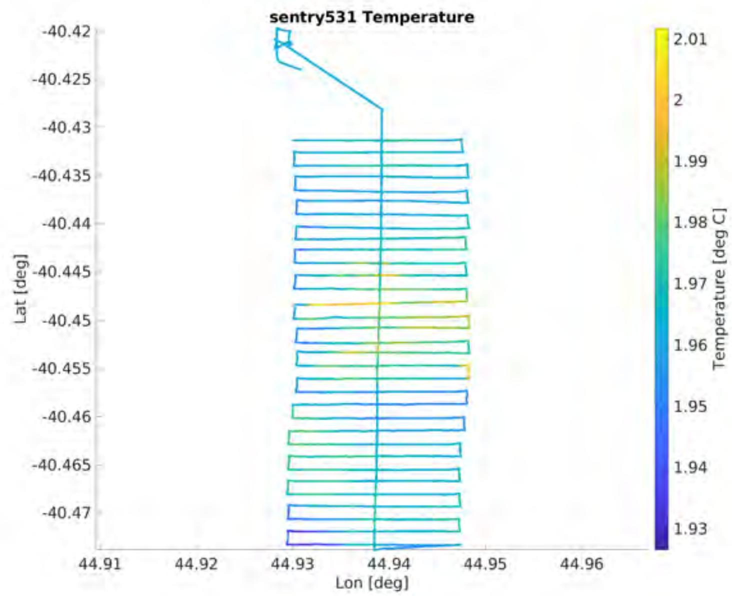
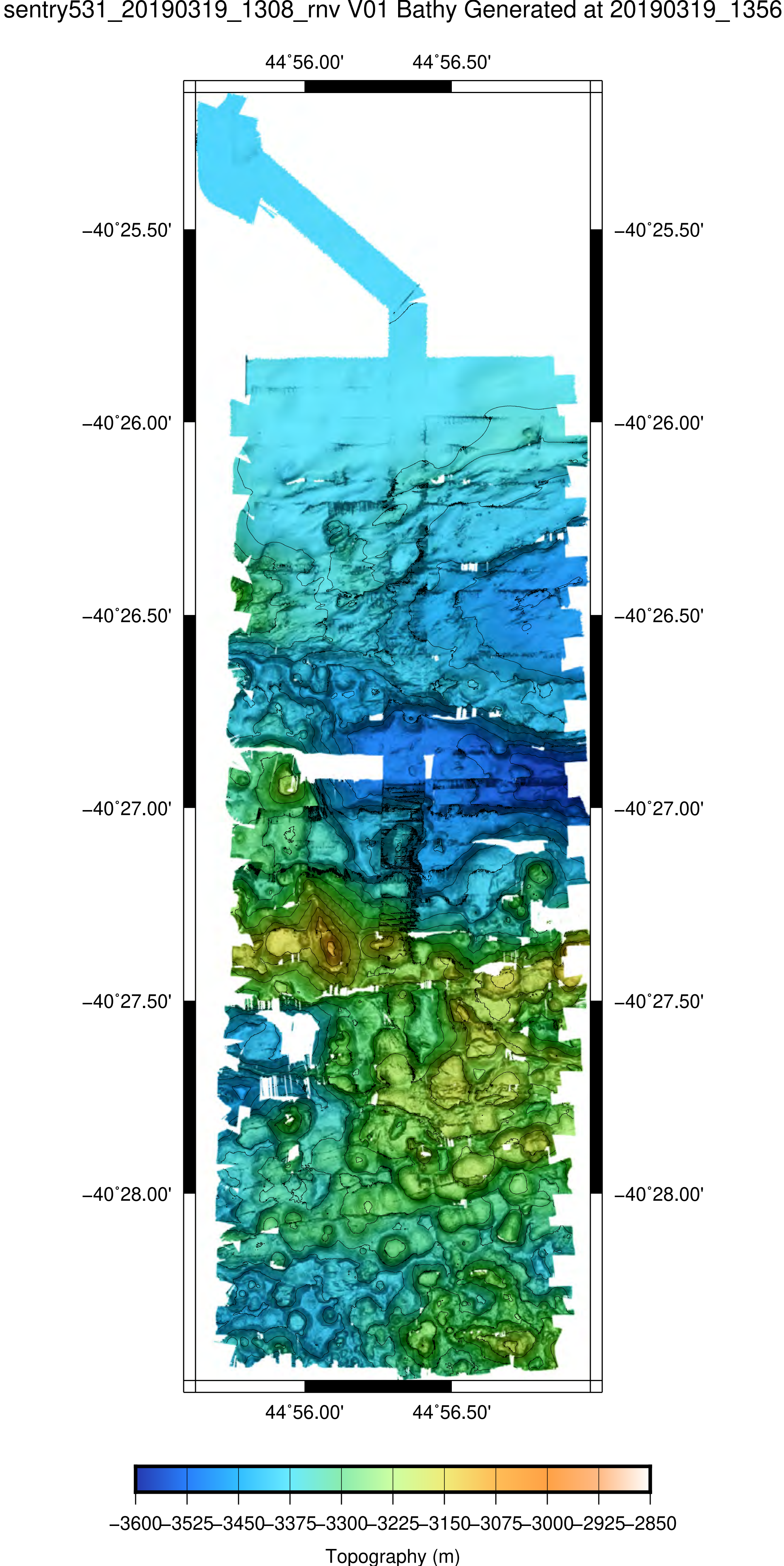


Figure 53: Navigated temperature sensor data


sentry531_20190319_1308_rnv V01 Bathy Generated at 20190319_1356
44˚56.00'
44˚56.50'
−40˚25.50'
−40˚26.00'
−40˚26.50'
−40˚27.00'
−40˚27.50'
−40˚28.00'
−3600
−3525
−3450
−3375
−3300
−3225
−3150
−3075
−3000
−2925
−2850
Topography (m)

WHOI/NDSF

Thompson 480VAC Power Report

Cruise : 2019 Henry Dick
Cruise ID : TN365
Date : March 20, 2019
Prepared By : skelley@whoi.edu / zberkowitz@whoi.edu

Summary

This document summarizes Sentry Operations use of the 480VAC power onboard the Thompson during the 2019 Henry Dick cruise. The Sentry system was mobilized in Durban South Africa with one container requiring 480VAC from ships power. The Sentry container converts 480VAC to 220VAC/120VAC. The container current draw is minimal with most of the draw from charging Sentry batteries (roughly 2.5kw). The Sentry container was initially fed from Circuit P413. With no issues or problems while tied up to the pier, equipment and computers appeared to work as expected. Several days into the transit we began to see issues with the van power.

Sentry Van Configuration

The Sentry container converts 480VAC down to 220VAC/120VAC through a dry type power transformer located inside the Sentry container. Power is routed to the transformer through a fused knife switch with 30A fuses on each phase.

Table 1: Dry Type Power Transformer nameplate specs
Cat. No. 4111-1166-304

kVA	15
Phase	1
Hz	50/60
Rise	135 deg C
Ins. Class	180 deg C
Weight	250lbs
Class	AA
Wire	AI

The transformer outputs 120VAC and 220VAC that is routed to a breaker box. Attached to the breaker box is a line filtering box installed in 2016 to help with dirty power. The line filtering box has three circuits each with an EMI and surge protection device. These three circuits are designated as DPA, DPB, and NAV. The EMI and surge protection devices have been in use for several years with no issues thus far. Following the protection devices is a UPS on each circuit.

Table 2: Noise and surge suppression hardware

(a) Mean Well Surge Suppression

Descscription	Spec
Model	SPD-240P
Max Cont. Voltage	300VAC
Voltage Protect Rating	1500V
Nominal Discharge Current	5kA
Max Surge Current	20kA
Max Discharge Current	20kA
Response Time	less than 25ns

(b) TDK-Lambda EMI Filter

Descscription	Spec
Model	RSMN-2030L
Rated current	30A
Withstand Voltage	2500VAC 1 min
Isolation Resistance	100 M-ohm
Leakage Current	10uA
Rated Voltage	250VAC
DC Resistance	12m-Ohms

Timeline

- During the transit to the work site issues started popping up with the container equipment. The first thing we noticed out of place was a high pitched audible wine noise coming from the line filter box. Opening the cover of the box confirmed this was the source of the noise, likely coming from the line filters on the each circuit.

- The main processing computer (DPA) for data processing is located on the DPA circuit inside the container. DPA started to randomly reboot itself for no obivous reason several days into the transit. On the front of the computer a dash light was flashing, indicating the computer was unhappy with the input power. At this point we were not sure if the issue was the computer itself or an issue with the input power. In order to test if the van power was causing the issue, an extension cord was routed to the van from the ships lab. Connecting the computer to the hydrolab 120VAC power immediately caused the front dash light to stop flashing as well as the computer to stop rebooting itself. The AC cable from the lab to the computer was left in place, with no symptoms of the same behaviour.

- Sentry requires a submersible pump to deliver chilled water from the container to the vehicle. The pump was unable to deliver the required pressure for circulating the water to Sentry. Again, suspecting an issue with the power inside the container, an AC cable was routed from the lab to the pump. After connecting the pump to the lab's 120VAC power the pump operated normally with the necessary pressure to move the water to the vehicle. The pump was left on lab power.

- Cordless chargers for the BOSCH power tools were unable to charge the batteries installed in each of them. The chargers and batteries were moved into the lab to charge. Even after moving these into the lab, the batteries will no longer take a charge and need to be replaced.

- Several extension cords were routed to the container to move most of the equipment to lab 120VAC power as we were now suspecting issues with the power. This included, processing computers, data RAIDS, GPS clock, chargers, KVM, fiber switch, chiller and chiller pump, and the Sentry sailbox. Once the equipment was moved over to lab power we started looking into what the supplied signal looked like inside the container. Trying to understand what was actually happening. Line notching and line distortion seem to be the common theme with the supplied power. The oscilloscope only tapped power on the 120VAC side of the transformer. The direct 480VAC power is outside the limit of the oscilloscope and much to dangerous to work with. The line notching was very apparent while the vessel was at transit speed, 11knots. The relationship between the speed at which the vessel was moving was directly related to the voltage drop outs we were seeing.

- Vessel Engineers offered to switch the 480VAC feed to a 'cleaner' line on March 9th, about two weeks into the cruise. We opted to switch over to the cleaner source as we really had nothing to lose. Following the switch, the difference in line performance was noticeable but not significant. The apparent difference between the two 480VAC sources appears to be a Lineator Harmonic Filter (P/N AUHF-60-480-60-D). The lineator appears to improve line notching as seen in the figures below.
- Outdoor AC unit failed on March 10th. Either compressor or cooling fan motor appears to have died. Only equipment left on AC power in the container is the interior lights.

Oscilloscope Screenshots

A Tektronix TDS 3012B oscilloscope was used for analysis of the power. The blue channel is the line voltage, red is an FFT of the line voltage.

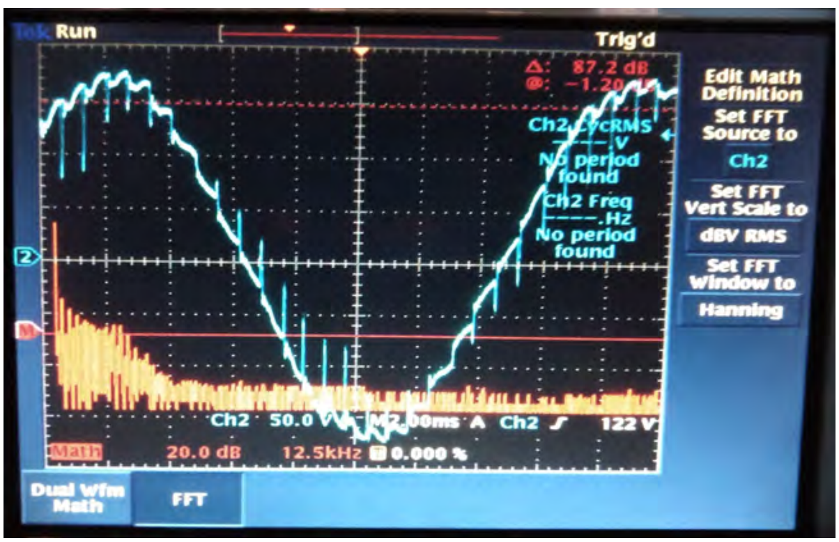


Fig1: Container 120VAC power. Harmonics and line notching can be seen on the waveform, line notching magnitude is proportional to propeller RPM. Vessel speed 12knots during this capture.

Power Source: Ships power 480VAC Circuit P413.

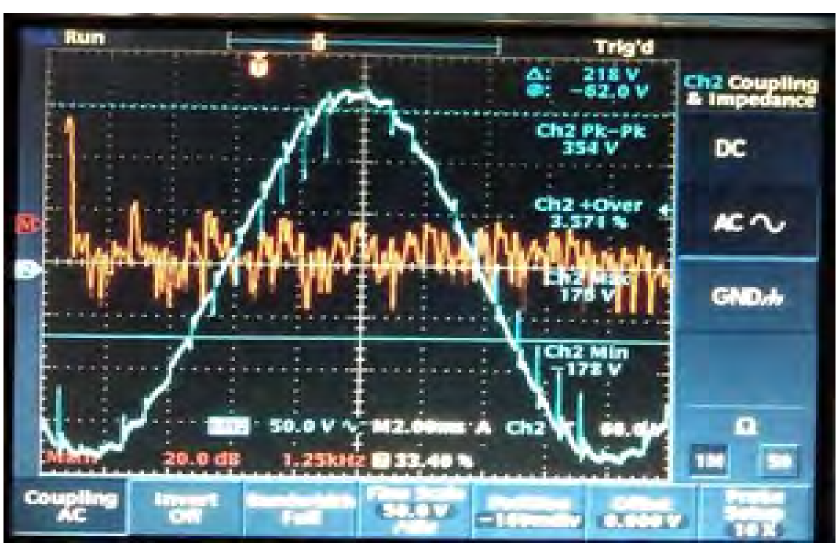


Fig2: Container 120VAC power. Harmonics and line notching can still be seen, with some attenuation on the notching. Vessel speed 12 knots.

Power Source: Ships power 480VAC Circuit P414 (w/ Lineator).

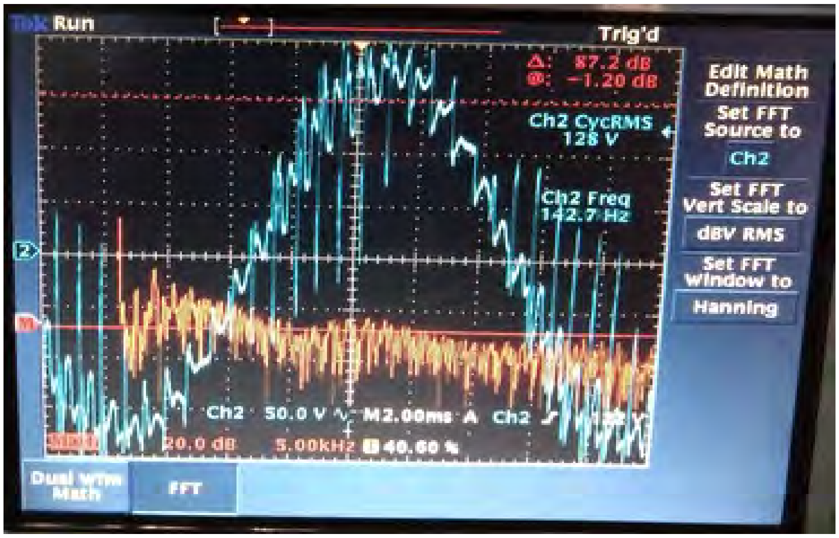


Fig3: Container 120VAC power AFTER sentry line filters. Extreme waveform distortion, noisy, harmonics, line notching. Vessel speed 12knots.

Power Source: Ships power 480VAC Circuit P413.

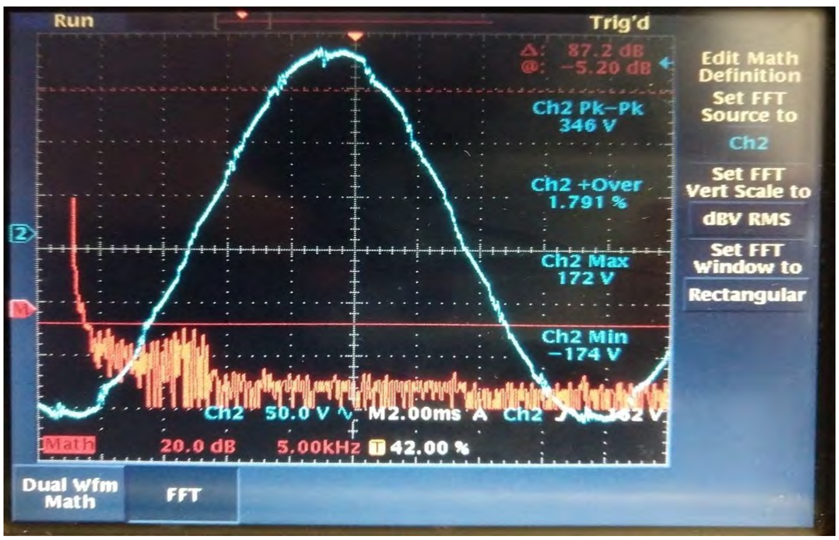


Fig4: Vessel holding station in DP. AC signal is improved from 12knot speed. Harmonics still present as indicated by the FFT as well as minimal waveform distortion.

Ships power 480VAC Circuit P414 (w/ Lineator).

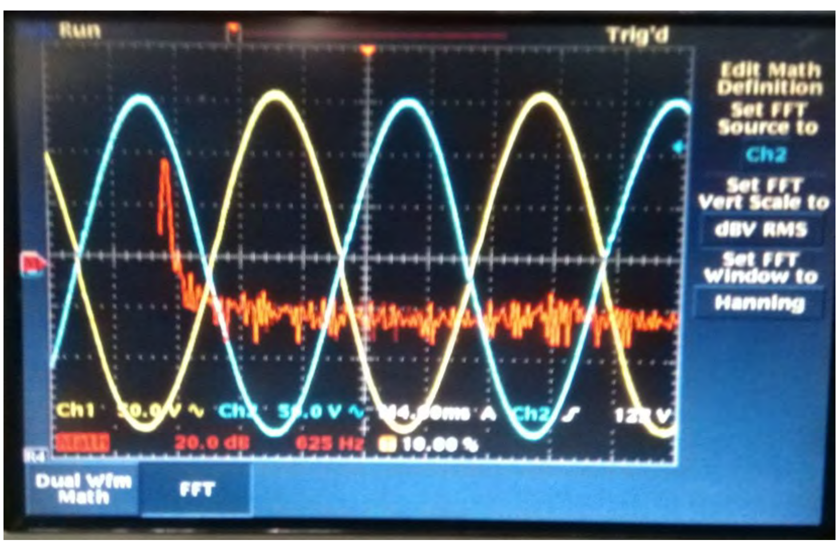


Fig5: Container UPS power output on battery, NO connection to vessel power.

Power Source: Sentry UPS on battery.

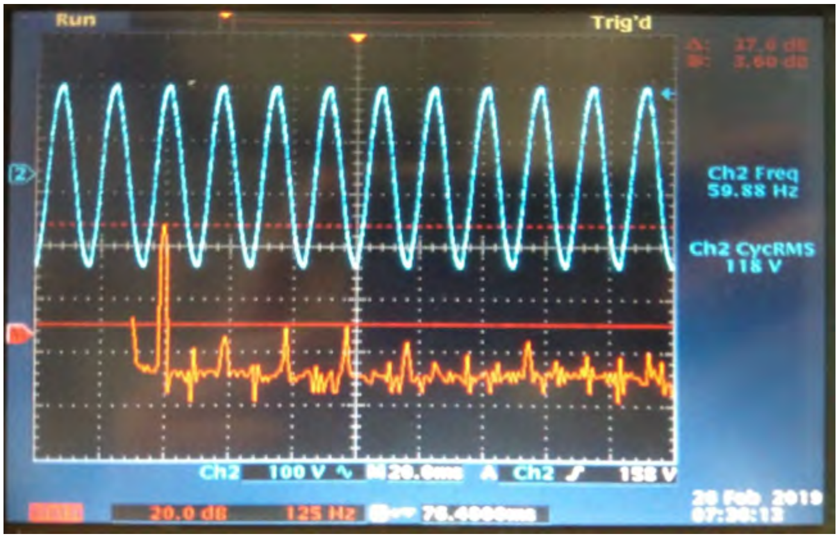


Fig6: Hydrolab 120VAC power, clean power.

Power Source: Ships power 120VAC Circuit SP208-4

WHOI/NDSF USBL REPORT

Vessel :	R/V Thomas Thompson
Vehicle :	AUV Sentry
Cruise :	2019 Henry Dick
Cruise ID :	TN365
Date :	March 7, 2019
System :	Ranger2
Owner of System :	Vessel
CASIUS Performed :	No
Contact :	skelley@whoi.edu / zberkowitz@whoi.edu / ssuman@whoi.edu

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Summary

AUV Sentry operations ultilized the onboard R/V Thomas Thompson sonardyne system during the Feb/Mar 2019 cruise for PI Henry Dick. Sentry operations were the primary users of the system, tracking Sentry during Sentry dives and SMS communications with the vehicle. During the mobilization a large effort from the Sentry group was required to bring the Ranger system online. The vessel operator and technicians have very little experiance with the system.

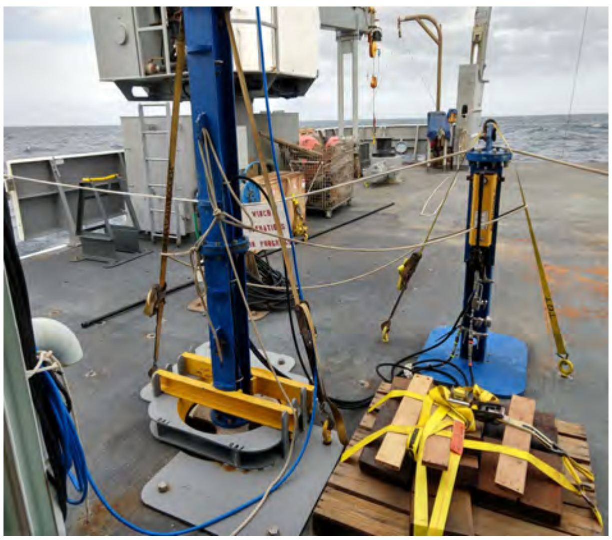
The USBL pole located on the aft deck, just aft of the hanger requires a minimum of 30 minutes to deploy and recover and three to four crew members. The pole is deployed using the ships crane, stepping the system down and up, with a 'top' flange that needs to be bolted to the top of the stem. A hand hydraulic pump is used to secure the pole in place along with the top plate.

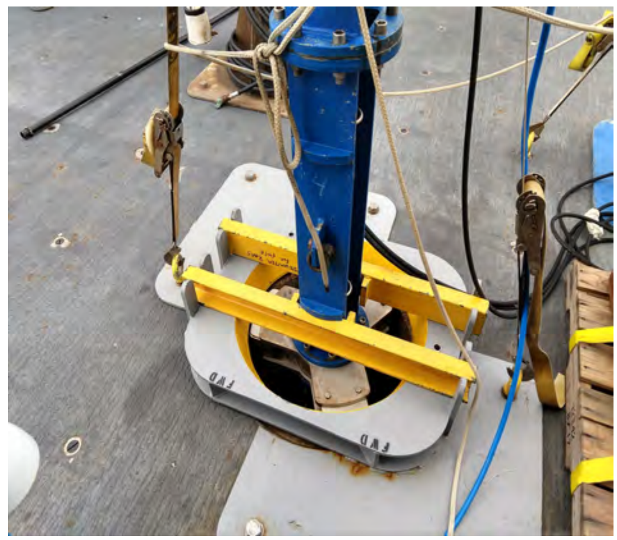
Installation Notes

- Cables to the head were routed during the mob by the ships tech. the system was completely dissasembled since last used by Jason ops.
- We donated MCIL8M/F and MCIL4M/F pairs to the TGT to make it easier to deploy/recover the USBL pole. The electrical connection to the USBL/GYRO at the end of the pole must be broken each time the pole is launched or recovered to pass the cable through an eye hole in the top-most section. The original TGT setup ran the bitter end of the USBL cable to screw terminal block within a temporary deck box. When we arrived these terminal ends were already falling apart, and the prospect of having them rewire each contact individually *each deployment* was a recipie for lost time and system failures (there wasn't even a wiring diagram inside the deck junction box). With the new connectors intalled the USBL cable can be broken/rejoined quickly for each deployment and recovery.

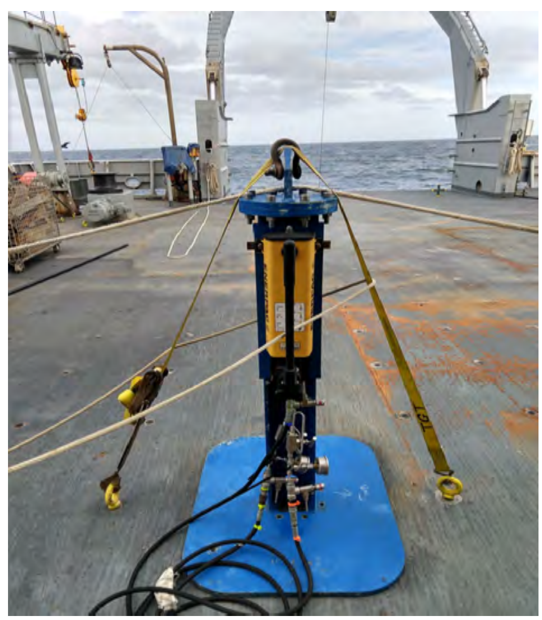
- We had asked the TGT for ships gyro over the network for input into topside navest. We had originally set up an Atlantis-like moxa bridge to get GPS/Gyro data from the ship science network. However, this data feed was cut off multiple times for unknown reasons. The assumption is that ships techs would turn our feeds off inadvertently. To prevent this we tapped the POSMV gyro feed going into Ranger2 (for some reason they've set up their USBL with TWO gyro inputs). The EM3000_to_prdid_tcp.py program converts the 100Hz EM3000 gyro datagram into 10Hz $PRDID NMEA datagrams for navest. This program was created on the transit by Sentry in order to accomidate our operations.
- During the mobilization, a system test was performed using a WSM beacon, hung over the starboard side of the ship.

System Pictures


(a) stem and tophat retracted


(b) retracted stem


(c) Full view of retracted stem


(d) Hydraulic hand pump mounted on tophat

(a) Computer setup in hydrolab


(b) junction box and wet mate connectors

(c) tophat and hydraulic pump

(d) USBL Pole model and serial number

CRP and offsets

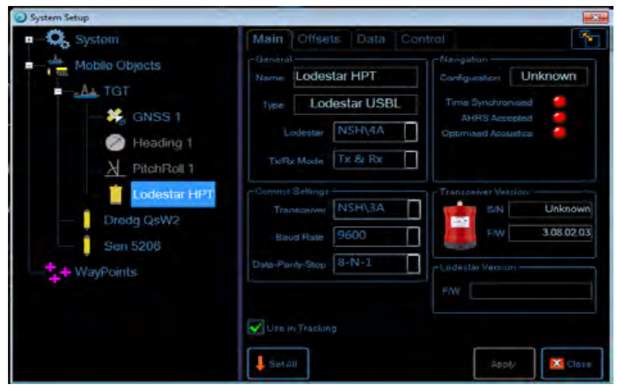
Table 1: lodestar HPT XYZ Offsets

	Lodestart to Tcvr	Ship CRP to lodestar	Ship CRP to Tcvr
Starboard	0.000m	4.875m	4.875m
Forward	0.000m	-29.562m	-29.562m
Down	0.208m	6.835m	7.043m

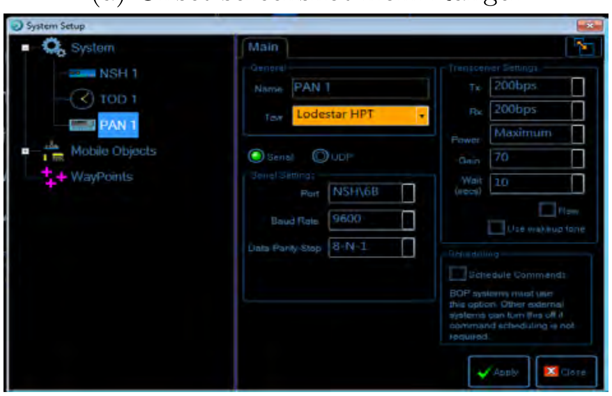
Table 2: lodestar HPT Orientation Offsets

	Lodestart to Tcvr	Ship to Lodestar	Tcvr to Ship
Pitch	-0.177°	-0.533°	0.710°
Roll	0.044°	0.018°	-0.070°
Heading	0.243°	-1.114°	0.870°

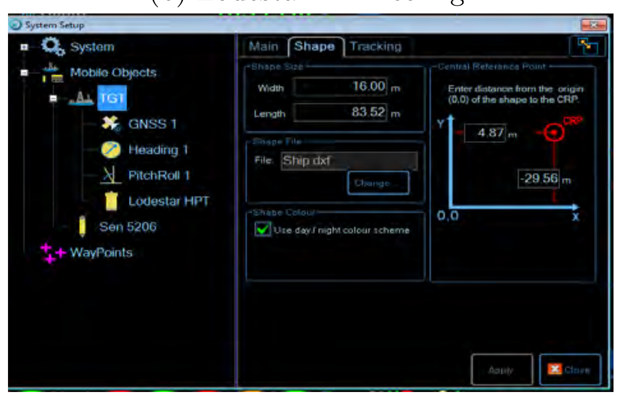
(a) Offset screenshot from Ranger



(b) Lodestar HPT config.



(c) PAN port setup



(d) Lodestar HPT config.

Figure 3: Ranger Setup

Items of Note

1. Ranger2 can only have a single job file, license does not support multiple job files.

2. The USBL cable only runs the HPT comms line. No secondary console terminal line is run like we do for Sentry. What this means is there is no easy way to get at raw gyro data from the USBL head without making a second split inside the lab and attempting to parse out valid gyro data amongst the interleaved HPT traffic.

3. With Sentry we typically select the vessel CRP (Common Reference Point or datum) to be in the same position as the transceiver. This is because when simulating with the Sonardyne, the ATS ASCII output by the Sonardyne is referenced to the transceiver, while when running real tracking, the ATS ASCII output is referenced to the CRP. Having the CRP=transceiver ensures consistency between simulated and real tracking. The Thompson Sonardyne system does not seem to be set this way though.

Sonardyne XYZ Definition from Ranger manual

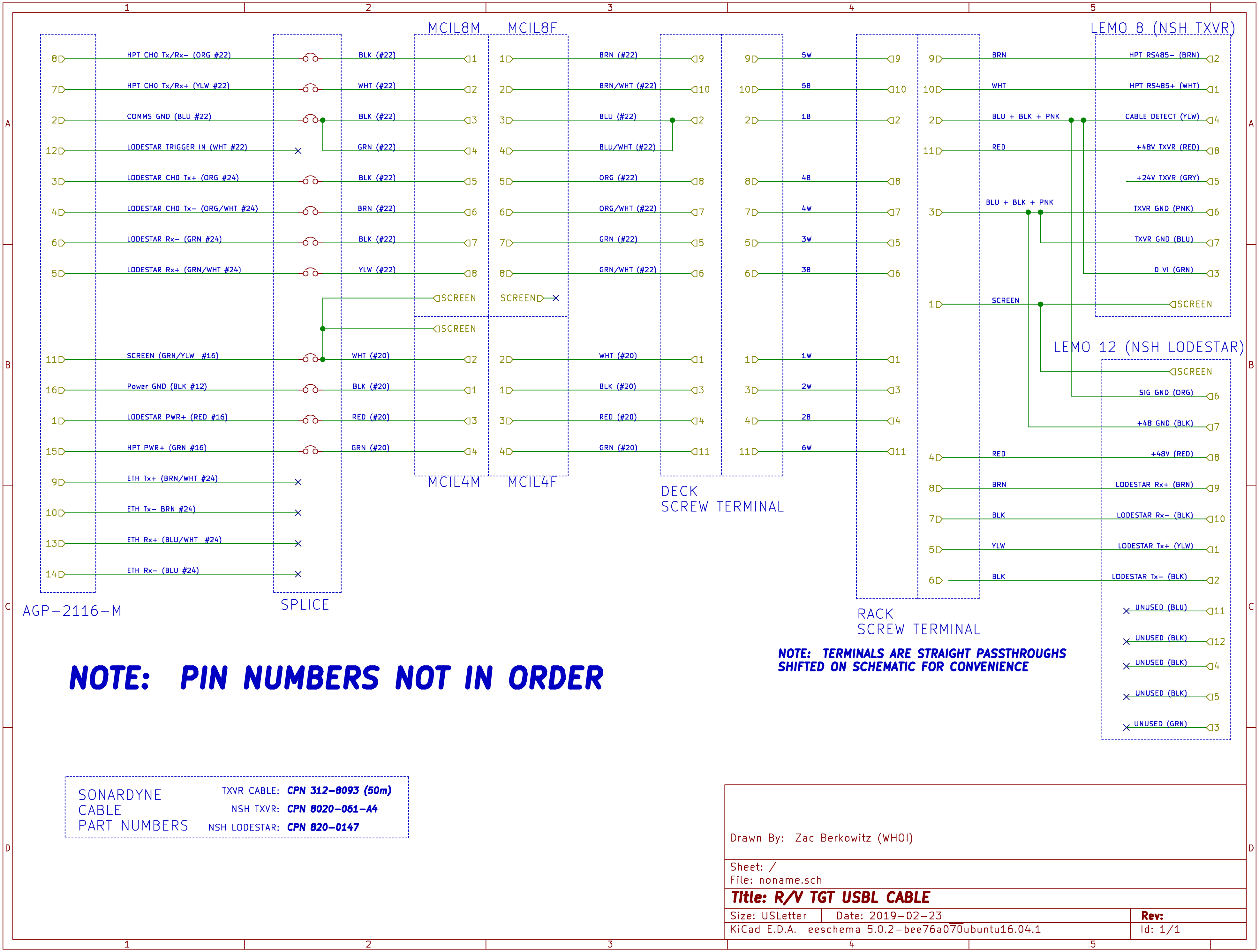
The X axis aligns with the vessels port-starboard direction, with positive co-ordinates being to starboard of the axis origin. The Y axis aligns with the vessels fore-aft direction, with positive co-ordinates being forward of the axis origin. The Z axis aligns with the vessels vertical, with positive co-ordinates being above the axis origin. Under positive Pitch rotation the Y axis rotates towards the current +Z direction. Under positive Roll rotation the Z axis rotates towards the current +X direction. Under positive Heading rotation the Y axis rotates towards the current +X direction.

Origin Definitions from Ranger manual

The origin of a co-ordinate frame is the point where the X, Y and Z offsets are all zero (0, 0, 0). The origin of the vessel frame is called the vessels common reference point (CRP). The position of the vessels CRP is arbitrary and can be at any convenient location on the vessel. The origin of the vertical reference unit is usually at the centre of the internal inclinometer, at a location inside the VRU defined by the VRU manufacturer. The origin of the gyrocompass is at the centre of the gyro, with the foreaft direction defined by the compass lubber line.

- All positions are reported relative to the CRP.

- Simulated positions are relative to the transceiver, not to the CRP.



AGP-2116-M
SPLICE
MCIL8M
MCIL8F
MCIL4M
MCIL4F
DECK SCREW TERMINAL
RACK SCREW TERMINAL
LEMO 8 (NSH TXVR)
LEMO 12 (NSH LODESTAR)
HPT CH0 Tx/Rx- (ORG #22)
HPT CH0 Tx/Rx+ (YLW #22)
COMMS GND (BLU #22)
LODESTAR TRIGGER IN (WHT #22)
LODESTAR CH0 Tx+ (ORG #24)
LODESTAR CH0 Tx- (ORG/WHT #24)
LODESTAR Rx- (GRN #24)
LODESTAR Rx+ (GRN/WHT #24)
SCREEN (GRN/YLW #16)
Power GND (BLK #12)
LODESTAR PWR+ (RED #16)
HPT PWR+ (GRN #16)
ETH Tx+ (BRN/WHT #24)
ETH Tx- BRN #24)
ETH Rx+ (BLU/WHT #24)
ETH Rx- (BLU #24)
HPT RS485- (BRN)
HPT RS485+ (WHT)
CABLE DETECT (YLW)
+48V TXVR (RED)
+24V TXVR (GRY)
TXVR GND (PNK)
TXVR GND (BLU)
0 VI (GRN)
SIG GND (ORG)
+48 GND (BLK)
+48V (RED)
LODESTAR Rx+ (BRN)
LODESTAR Rx- (BLK)
LODESTAR Tx+ (YLW)
LODESTAR Tx- (BLK)
UNUSED (BLU)
UNUSED (BLK)
UNUSED (GRN)
BLU + BLK + PNK
NOTE: PIN NUMBERS NOT IN ORDER
NOTE: TERMINALS ARE STRAIGHT PASSTHROUGHS SHIFTED ON SCHEMATIC FOR CONVENIENCE
SONARDYNE CABLE PART NUMBERS
TXVR CABLE: CPN 312-8093 (50m)
NSH TXVR: CPN 8020-061-A4
NSH LODESTAR: CPN 820-0147
Drawn By: Zac Berkowitz (WHOI)
Sheet: /
File: noname.sch
Title: R/V TGT USBL CABLE
Size: USLetter
Date: 2019-02-23
Rev:
KiCad E.D.A. eeschema 5.0.2-bee76a070ubuntu16.04.1
Id: 1/1

CASIUS Calibration Report

Vessel: TGT

Date/Time: 05 February 2018 21:44:49

Transceiver Settings:

Name	Device No	X/Y Offset Error	Depth Offset Error
Lodestar HPT	00478B	1.0m	0.5m

GNSS Settings:

Name	Forward Offset	Starboard Offset	Height Offset
GNSS 1	29.562m	-4.875m	7.043m

Pitch, Roll & Heading Settings:

Name	Usage	Pitch Offset	Roll Offset	Heading Offset
Lodestar HPT	Pitch, Roll & Heading	0.00º	0.00º	0.00º

Beacon Settings:

Name	Received Signal	X/Y Error	Depth Error
2701	IRS 2701	30.0m	5.0m

Sound Speed:

	Surface	Average (Initial)	Average (Computed)
Sound Speed	1510.0m/s	1514.5m/s	1454.4m/s
Error	15.0m/s	15.0m/s	0.1m/s

Beacon 2701 Result:

	Beacon Latitude	Beacon Longitude	Beacon Depth	Beacon Eastings	Beacon Northings
Before	47.73620858º	-122.41686639º	209.981m	543720.364m	5287146.234m
Calculated	47.73620906º	-122.41686535º	209.070m	543720.441m	5287146.288m
Calculated Accuracy			0.022m	0.006m	0.006m

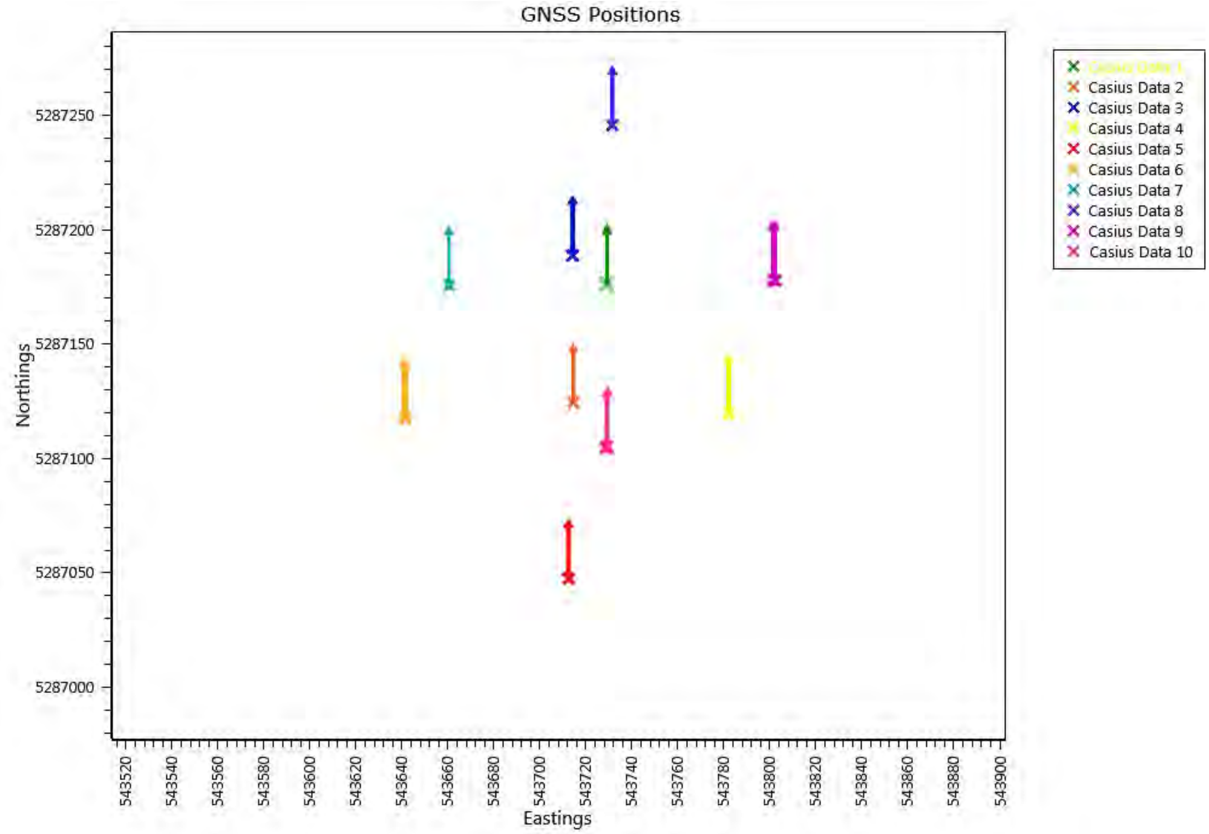
	Before CASIUS (distance)	After CASIUS (distance)	Before CASIUS (% depth)	After CASIUS (% depth)
39.4% Beacon Positions (1 sigma)	2.64m	0.18m	1.26	0.09
50.0% Beacon Positions (CEP)	3.11m	0.21m	1.49	0.10
63.2% Beacon Positions (1 Drms)	3.23m	0.25m	1.54	0.12
86.5% Beacon Positions (2 sigma)	3.72m	0.35m	1.78	0.17
98.2% Beacon Positions (2 Drms)	3.87m	0.46m	1.85	0.22

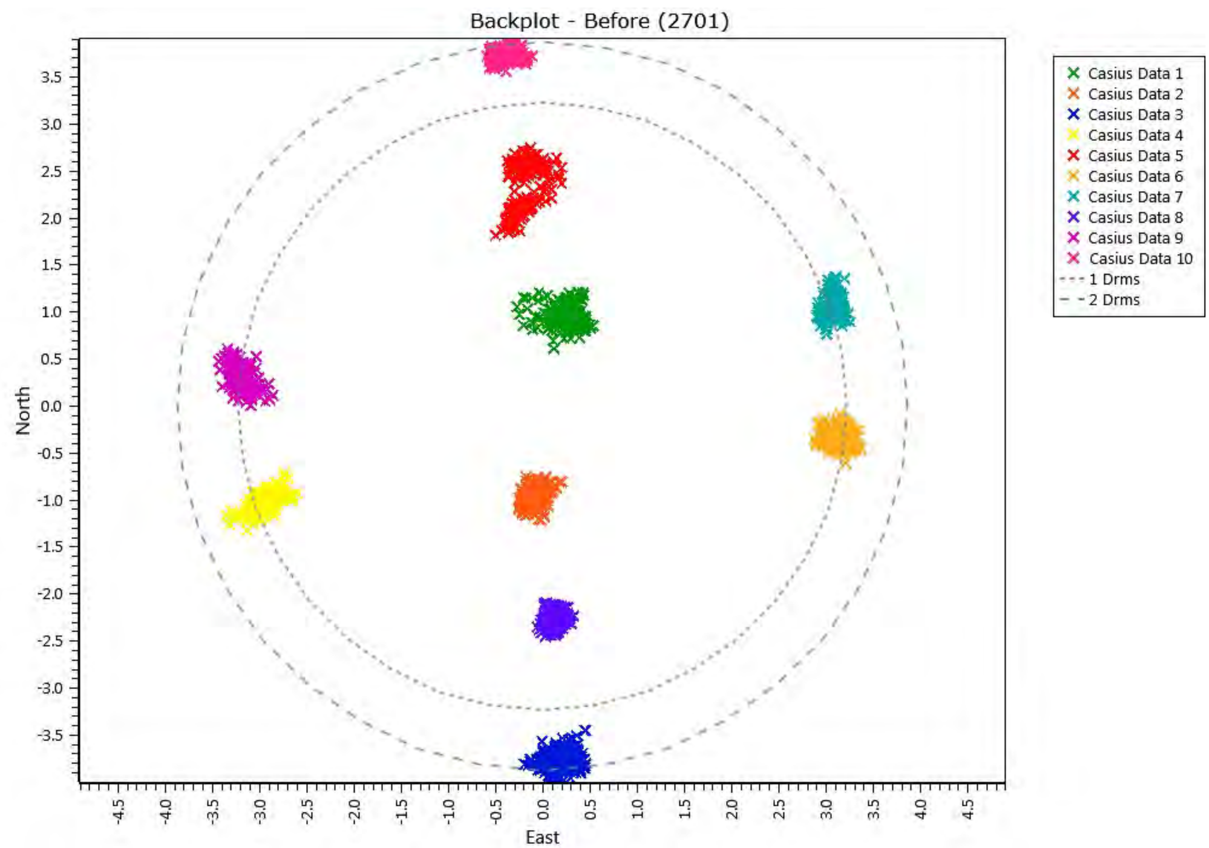
Transceiver Lodestar HPT Result:

	Transceiver Starboard Offset	Transceiver Forward Offset	Transceiver Depth Offset	Transceiver Pitch Offset	Transceiver Roll Offset	Transceiver Heading Offset
Before	0.000m	0.000m	7.043m	0.53º	-0.03º	1.11º
Calculated	0.439m	-0.023m	7.043m	**0.71º**	**-0.07º**	**0.87º**
Calculated Accuracy	0.015m	0.014m	0.000m	0.00º	0.00º	0.01º

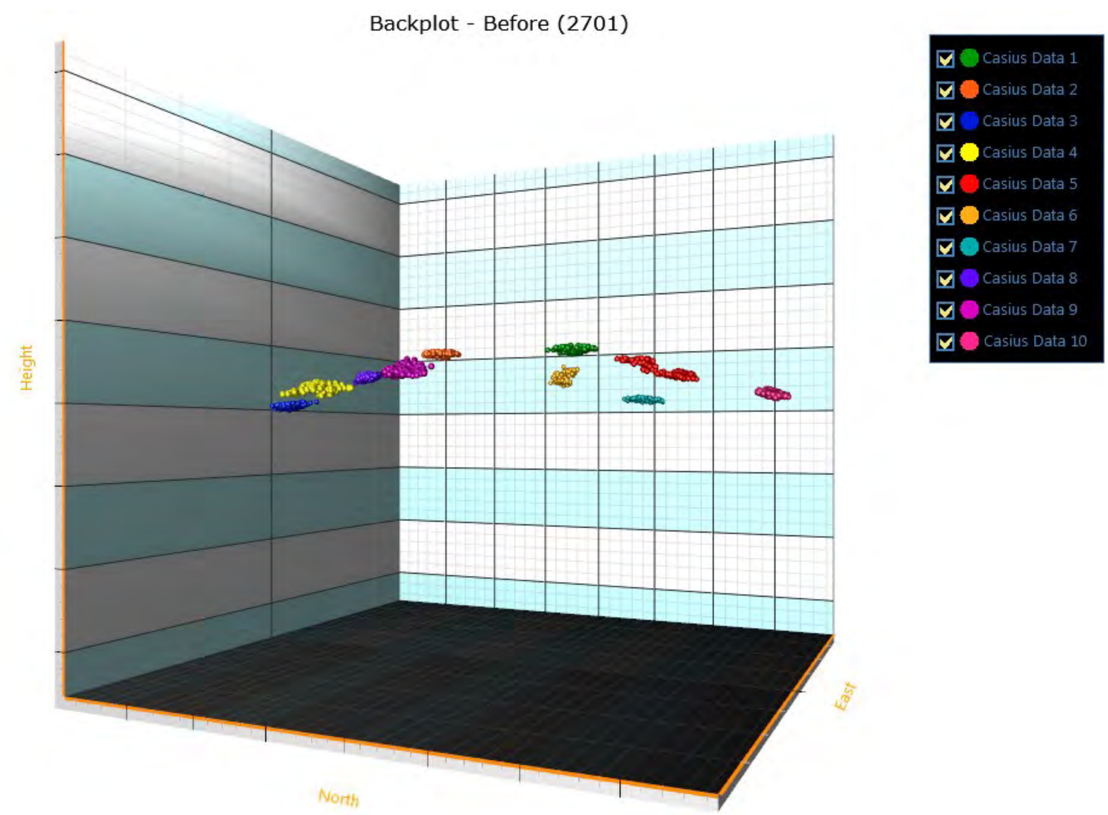
Range RMS	Direction Cosine RMS	Observations	Excluded	Iterations
0.188m	0.0009	5988	0	4

Name	Start Time	End Time	GNSS 1	Lodestar HPT	2701
Casius Data 1	2018-02-05 21:44:49Z	2018-02-05 21:48:04Z	392	204	204
Casius Data 2	2018-02-05 22:46:05Z	2018-02-05 22:49:16Z	381	202	202
Casius Data 3	2018-02-05 23:02:00Z	2018-02-05 23:05:12Z	383	200	200
Casius Data 4	2018-02-05 23:16:59Z	2018-02-05 23:20:10Z	381	200	200
Casius Data 5	2018-02-05 23:31:32Z	2018-02-05 23:34:46Z	386	202	202
Casius Data 6	2018-02-05 23:44:58Z	2018-02-05 23:48:14Z	391	201	201
Casius Data 7	2018-02-06 00:16:05Z	2018-02-06 00:19:18Z	387	202	202
Casius Data 8	2018-02-06 00:31:28Z	2018-02-06 00:34:52Z	408	200	200
Casius Data 9	2018-02-06 00:45:53Z	2018-02-06 00:49:07Z	386	201	201
Casius Data 10	2018-02-06 00:59:15Z	2018-02-06 01:02:33Z	396	203	203

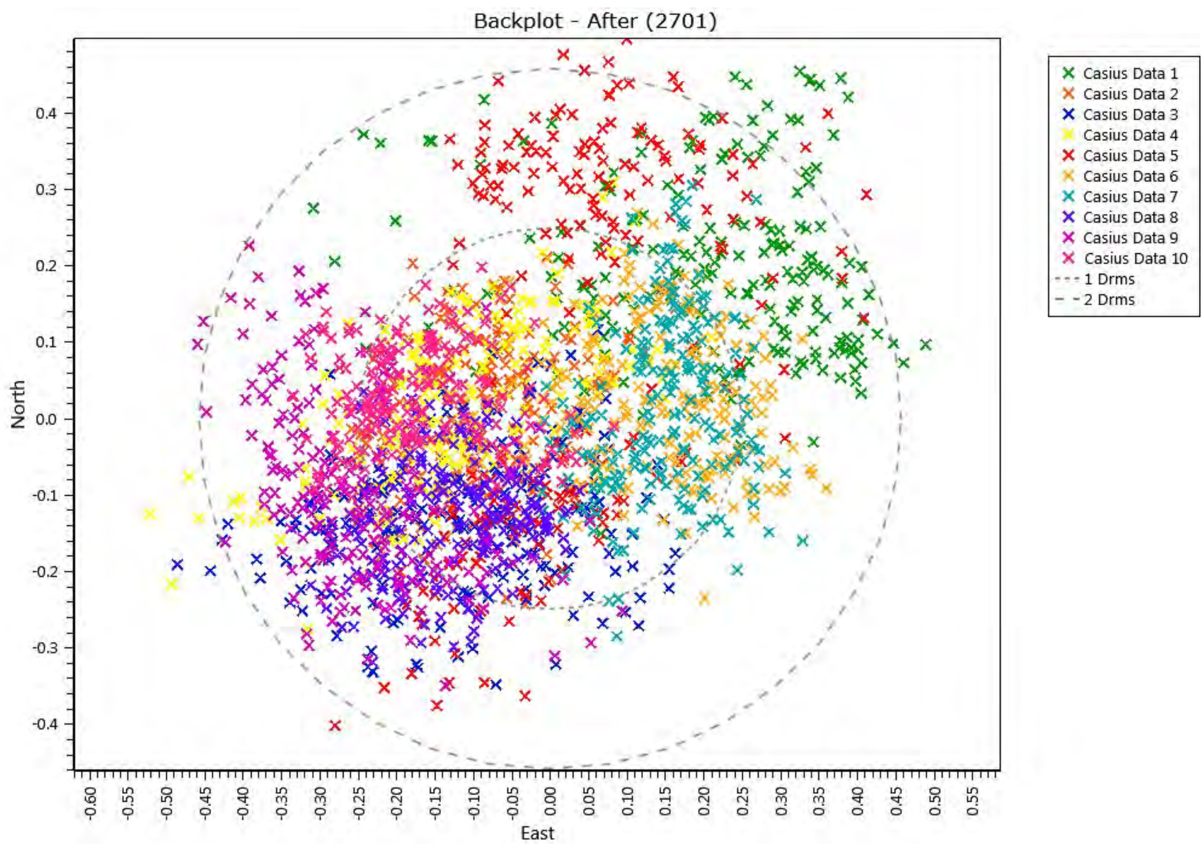


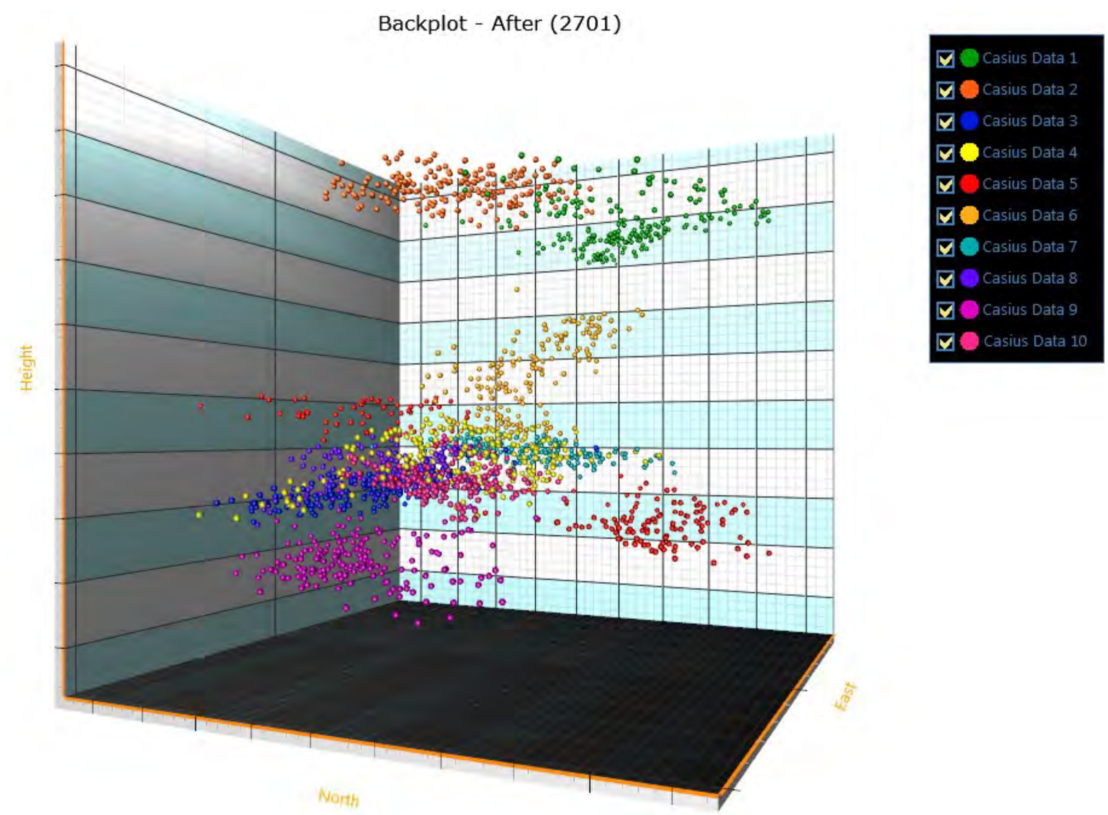


Backplot - Before (2701)
North
East
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
-3.5
-4.5
-4.0
-3.5
-3.0
-2.5
-2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
Casius Data 1
Casius Data 2
Casius Data 3
Casius Data 4
Casius Data 5
Casius Data 6
Casius Data 7
Casius Data 8
Casius Data 9
Casius Data 10
1 Drms
2 Drms



Backplot - Before (2701)
Height
North
East
Casius Data 1
Casius Data 2
Casius Data 3
Casius Data 4
Casius Data 5
Casius Data 6
Casius Data 7
Casius Data 8
Casius Data 9
Casius Data 10


Backplot - After (2701)
North
East
-0.60
-0.55
-0.50
-0.45
-0.40
-0.35
-0.30
-0.25
-0.20
-0.15
-0.10
-0.05
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
0.55
0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
Casius Data 1
Casius Data 2
Casius Data 3
Casius Data 4
Casius Data 5
Casius Data 6
Casius Data 7
Casius Data 8
Casius Data 9
Casius Data 10
1 Drms
2 Drms


Backplot - After (2701)
Height
North
East
Casius Data 1
Casius Data 2
Casius Data 3
Casius Data 4
Casius Data 5
Casius Data 6
Casius Data 7
Casius Data 8
Casius Data 9
Casius Data 10