SPURS

Salinity Processes Upper-ocean Regional Study

KNORR 209-1 Cruise Report

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September 6 - October 9, 2012

Contents

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Cruise Narrative:

The goal of this cruise was to deploy mooring floats, gliders and drifters in the regions of the salinity maximum near 25 N 38 W and survey the hydrography and microstructure of the area. We departed Woods Hole at 0830 on Sept. 6 in fine weather but anticipating rough seas from two hurricanes predicted to be in our path. Hurricane Leslie was moving slowly south of Bermuda but predicted to cross our path. Hurricane Michael was near our study site and moving slowly. Captain Adam Seamans chose to employ an extra generator for more speed so that we could get past the path of Leslie before she arrived. This strategy worked and fortunately Michael moved out of our way as we approached the study area. We deployed two STS-APEX floats in the path of Leslie hoping to record the ambient noise generated by the wind and rain of the storm. The overall ship track is shown in Figure 1. Deviations in the path to the Azores were necessitated by later storms.

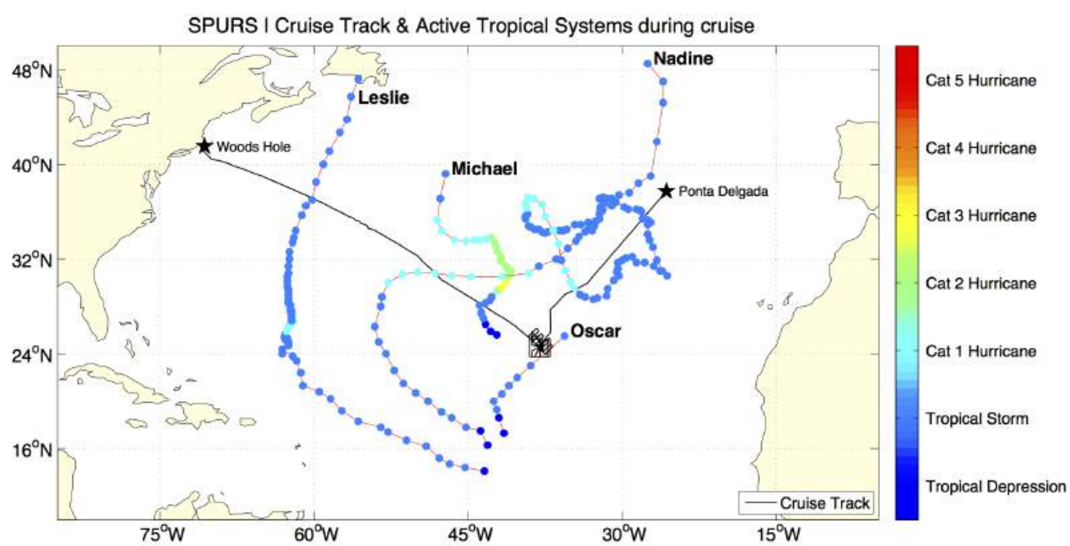


Figure 1. Overall cruise track for Knorr 209-1. Deviations from great circle routes were motivated by several hurricanes and tropical storms whose tracks are shown.

The basic plan was to spend roughly one week deploying assets, including moorings, floats and gliders, about one week doing a small “control volume” with repeat surveys around the moorings, and about one week doing a feature survey, targeting a front or eddy identified by the satellites and models.

The moorings required bathymetric surveys of the area before finalizing the sites. We used the Seabeam profiler to do the surveys for all three sites, then worked out a plan that preserved the desired right-angle geometry while providing satisfactory bottom conditions. Figure 2 shows the final mooring positions and bottom topography.

Bottom Survey

Prior to the mooring deployments, a bottom survey was conducted with the ship’s SeaBeam 2100 Multibeam Bathymetric Survey System, manufactured by L-3 Communications SeaBeam Instruments. A full-ocean-depth CTD profile was collected prior to the start of the survey to provide an accurate sound speed profile, and it was confirmed that the SeaBeam reading matched those of the sound-speed corrected Knudsen 12-kHz depth sounder and the depth estimated from the pressure and altimeter reading from the ship’s CTD. The bathymetry from the survey is displayed in Figure 2 with the actual deployment locations of the WHOI and PMEL moorings and their depths. A gridded version of these data is available as a netCDF binary file (“spurs_large_grid.grd”).

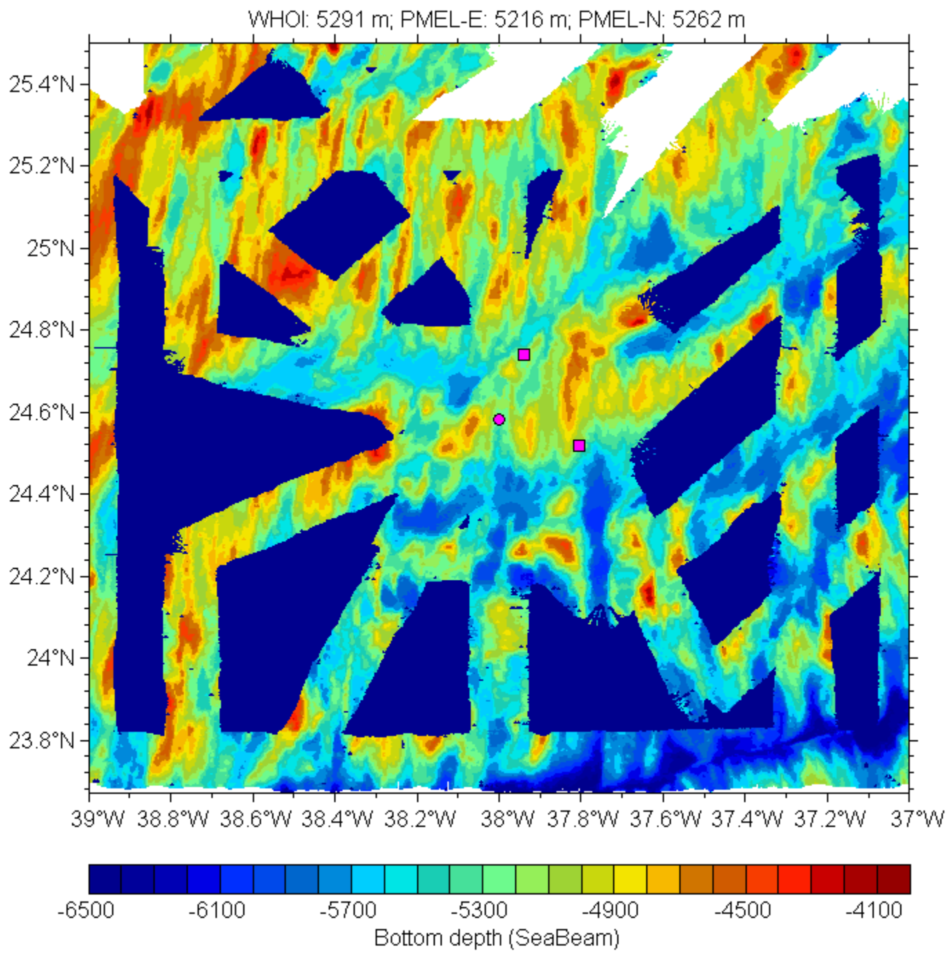


Figure 2: Bottom depth from the *Knorr's* SeaBeam 2100 multibeam bathymetry system. The pink circle indicates the anchor position of the WHOI mooring (5291-m depth), and the pink squares mark the positions of the PMEL moorings.

The WHOI mooring was deployed on September 14th in fine weather, then the PMEL Prawler North mooring the following day in similarly calm conditions. As it was necessary to evaluate the performance of the first Prawler, the second Prawler deployment was delayed for several days. The winds had come up during this time so time was spent deploying APEX floats, some of which had been deployed overnight between the first two mooring deployments.

The Apex floats were deployed in a 4x4 array 90 nm on a side. The other floats were deployed on the transits to and from the site in order to enhance far field coverage and record wind and rain events under hurricanes. Seagliders, T-Gliders and Wave gliders were deployed largely in the mooring area, as they could self navigate to where they had to be. Salinity sensing surface drifters were deployed in 4 groups of 3 (triplets) along the eastern line of the APEX float array, three at the mooring site and three during a large scale survey. Details on the deployment of each instrument type can be found in the sections to follow.

A “control volume” around the moorings was done with the Under-way CTD (UCTD) while steaming, the ships ADCP, and VMP casts for microstructure combined with CTD/LADCP casts at the 3 corners. Station positions were chosen to be outside the watch circles of the moorings, at 24°33’N, 38°02’W (WHOI), 24°47’N, 37°55’W (PMEL-N) and 24°29’N, 37° 46’W (PMEL-E).

A large-scale survey was commenced on Sept. 28th to track the high salinity water which appeared to be moving north. The UW-CTD, CTD/LADCP were used for this (VMP had consistent computer failures so was deemed not safe to deploy). Several initial sections allowed us to identify the saltiest patch for a time series study with the CTD and IVER-AUV. After that we commenced an even larger-scale radiator pattern survey to take us back toward the moorings for glider recoveries (T-Gliders and French “Tenuse” Glider) and final CTD stations. We left the SPURS area on the morning of Friday October 5 heading toward the Azores as winds picked up from tropical storm Oscar. UCTDs were performed until the last working probe was lost, and several more STS-APEX floats were deployed on the transit.

Through-out the cruise NASA Program Manger Eric Lindstrom maintained a cruise blog which featured all of the cruise activities and personnel at various times. It can be viewed and will be archived at: http://earthobservatory.nasa.gov/blogs/fromthefield/category/spurs/

SPURS information and data can be found at: http://spurs.jpl.nasa.gov

Some highlights of KNORR209-1 include finding record-breaking high salinities in the area, the generally fine weather despite ever threatening hurricanes (which we credit to Eric), the successful deployment of so many new technologies and a phone call from the International Space Station. We also found the perfect motto for SPURS in the Knorr motto “Sal sume sub sol”, which is taken as “more fun under the sun” but literally means “more salt under the sun”. The Captain and crew of the Knorr are thanked for their positive, can-do attitude and willingness to help science in all ways possible. The science party is thanked for their overall professionalism and dedication to securing the best data set possible. Well done all!

General Timeline for KNORR 209-1, Sept. 6- Oct. 9, 2012

Sept. 6 : Depart WH, Steam for ~25°N, ~38°W, water sampling for TSG every 4 hours

Sept. 6-12: Steam to avoid hurricanes, deploy APEX floats and do test CTD stations

Sept. 13: Arrive at 24° 45’N, 38° 02’W, Do deep CTD cast and begin Seabeam survey of bottom at 3 mooring sites, deploy STS-APEX floats

Sept. 14: deploy WHOI mooring at 24° 34.867'N, 38° 0.00'W.

Sept. 15: deploy North PMEL mooring at 24° 44.464' N, 37° 56.424' W. Gliders

Sept. 16: deploy STS-APEX floats, gliders.

Sept. 17: deploy STS-APEX floats, 4 triplets of SSS Drifters, CTD and UCTD.

Sept. 18: deploy East PMEL mooring at 24° 30.968' N, 37° 48.234'W . STS-APEX floats, Lagrangian float, VMP, CTD and UCTD.

Sept. 19-22: Occupy 3 CTD & VMP stations near moorings in control volume time series, deploy Wave Gliders, T-Gliders

Sept. 22-27: STS Float deployments, CTD & VMP stations in large scale survey, UCTD

Sept. 28: Steam north and survey salty patch with UCTD & CTD

Sept. 29: Time series CTD stations while holding position, IVER-AUV missions

Sept. 30: IVER-AUV surface stratification study, start large scale radiator pattern survey

Oct. 1-4: Large-scale radiator survey with U/W CTD, and CTD stations

Oct. 5: Check moorings, CTD stations at moorings, retrieve T- gliders, begin steam for Azores

Oct. 6-8: Steam, Deploy STS-APEX floats

Oct. 9: Arrive Ponta Delgada, Azores

Cruise Report – Thermosalinograph - Julius Busecke, Phil Mele

The RV Knorr has an underway measurement system that collects and logs various data including sea surface salinity (SSS) and sea surface temperature (SST). Sea water is pumped from an intake at about 5 meters depth at the front of the bow. Salinity (referred to as TSG) is measured by a SeaBird SBE45 sensor at the back of the main lab. An internal hull mounted SeaBird SBE48 at the intake point measures temperature. A comparison of the SBE45 and SBE48 temperatures suggests a lag of 4 minutes from the intake to the SBE45 (the averaging interval is 1 minute). Samples were collected for analysis with a Guildline Autosal (salinometer) from a faucet in the analytical lab between intake and the SBE45. Sampling interval was 4 hours with two replicate samples drawn. The unknown time lag between the analytical lab and the SBE45 presents an issue in determining the error between TSG data and samples. Standard water batch IAPSO P154 was used for the analysis. No obvious linear drift was detected over time except for variations in the variance possibly caused by either better/worse conditions for the salinometer or less/more variable TSG data surrounding the samples. The relevant lag from samples to the TSG can pose a great uncertainty in determining the errors relative to the salinometer. One approach was to compute a least square fit to the errors and do this for different lags to find the minimum error. It is suggested to additionally compare the samples in terms of surrounding TSG variance (see figure 2). If the variance surrounding a sample is low, the time lag becomes less important compared to a situation where the TSG is measuring a steep gradient or a very variable field. A constant line is fit in a weighted least square sense, where weights are defined as the inverse of the surrounding variance around each sample. This approach should yield an error estimate,which is somewhat less dependent on the lag time and also on variations in noting the time after sample retrieval. Another possible bias for the salt values could be the pressure within the system. The SBE45 computes the salinity for a 0 dbar surface pressure level, while there is measurable non-zero pressure in the system. A crude estimate with a pressure gauge yielded about 5-8 dbars. This might be a partial explanation for the consistent overestimation of SSS by the SBE45. The total offset of the TSG with respect to the sampled data based on the variance-weighted approach is about +0.008 PSU, which takes the pressure effect into account.

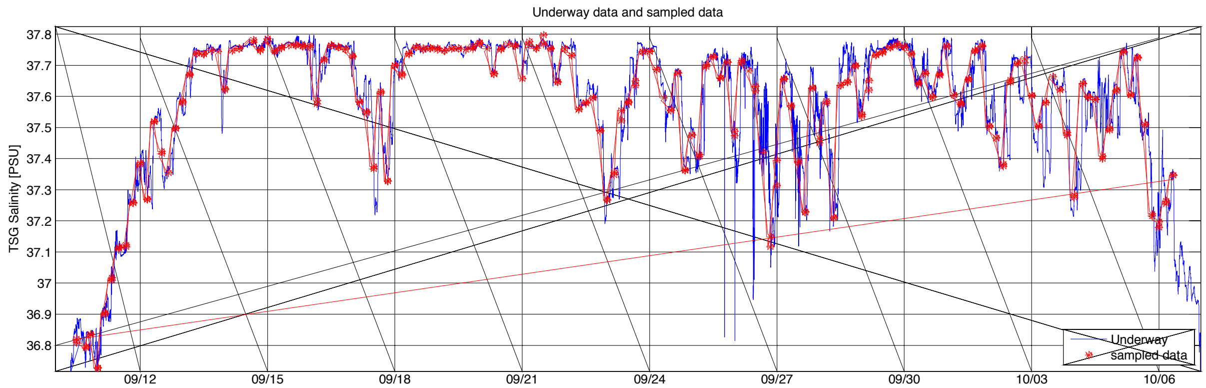


Figure 1. Time series of underway salinity measurements. The blue line marks the TSG data (sampling interval 1 minute), while the red dots denote the sampled salinity value at the first time step after the recorded sampling time. For illustration purposes only a part of the time series is shown.

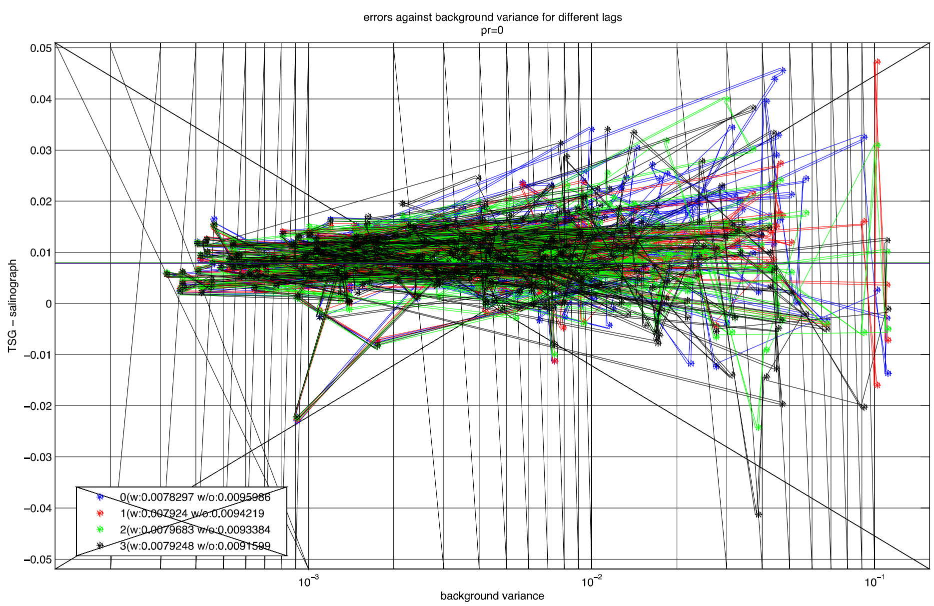


Figure 2. Error between TSG and Salinometer plotted against salinity variance | Variance is computed over 11 TSG samples centered over the sample time. Different colored dots denote different time lags (values in minutes given in the legend). The constant least square fit results are given in the legend for each lag (w denotes a value weighted by the inverse of the variance while w/o denotes a regular least square fit). Some high error values are not shown on the current axes to better show the lower variance field. They are however included in the fit.

<u>WHOI mooring - </u> Tom Fararr

The WHOI surface buoy used in this project is equipped with meteorological instrumentation for estimation of air-sea fluxes, including two Improved Meteorological (IMET) systems. The mooring line also carries current meters, and conductivity and temperature recorders.

This mooring is of an inverse-catenary design utilizing wire rope, chain, and synthetic rope and has a scope of 1.45 (scope is defined as slack length/water depth). The buoy is a 2.8-meter diameter foam buoy with an aluminum tower and rigid bridle. The watch circle is 4.2 nmi diameter.

The mooring, WHOI PO mooring #1250, was deployed 14 September 2012, at 24°34.867'N, 38° 0.00'W. The water depth was 5292 m. The anchor was released from the ship at 18:38:58 UTC and was settled on the seafloor before 20:00 UTC. The anchor position was estimated by performing an ‘acoustic anchor survey’, pinging the acoustic releases from several positions to triangulate the anchor position. The results of this survey are summarized in Figure X1.

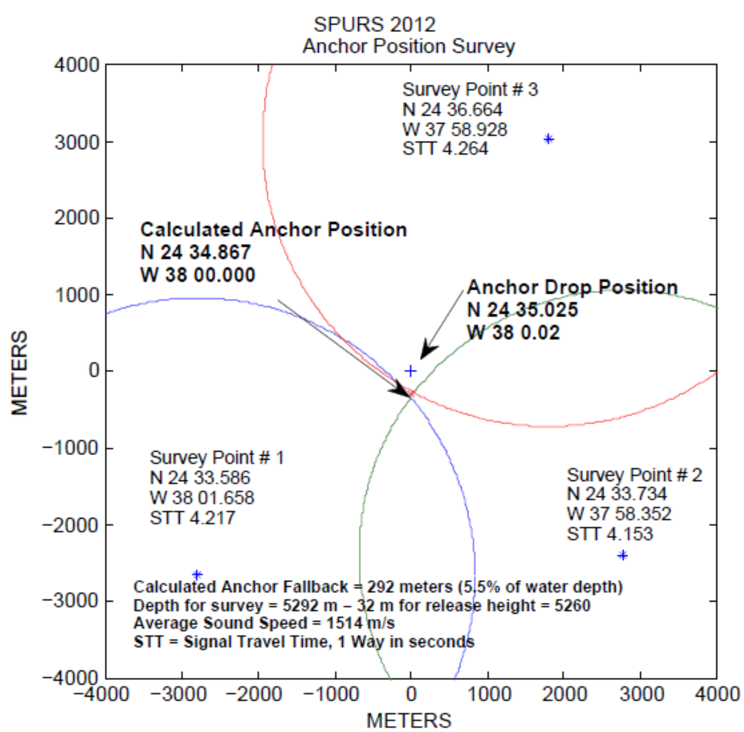


Figure 1: Summary of anchor survey, showing locations where the release was queried and the acoustic signal travel times (STT) in seconds.

Table 1: Types of measurements collected on the WHOI-SPURS air-sea interaction surface mooring.

Surface Measurements	Subsurface Measurements
Wind speed	Temperature

Wind direction	Conductivity
Air temperature	Current speed
Sea surface temperature	Current direction
Barometric pressure	
Relative humidity	
Incoming shortwave radiation	
Incoming longwave radiation	
Precipitation	
Surface wave height and direction (buoy pitch, roll, heave, and yaw)	
Turbulent fluctuations of humidity, temperature, and wind	

Surface Instruments

There are two independent IMET systems (Hosom et al., 1995; Payne and Anderson, 1999) on the buoy (Figures III-1 and III-2). These systems measure the following parameters once per minute, and transmit hourly averages via satellite:

relative humidity with air temperature
barometric pressure
precipitation
wind speed and direction
shortwave radiation
longwave radiation
near-surface ocean temperature and conductivity

All IMET modules are modified for lower power consumption so that a non-rechargeable alkaline battery pack can be used. Near-surface temperature and conductivity are measured with two SeaBird MicroCat instruments with RS-485 interfaces attached to the bottom of the buoy.

One-hour averages of data from the IMET modules are transmitted via Service Argos. Data are also logged redundantly on flash cards within the logger/controller for each system and within each meteorological module. The 1-minute data stored on the buoy are more suitable for scientific analysis; when the buoy and mooring are recovered, we will use the data from the two redundant IMET systems, as well as data from the freshly calibrated systems on the research vessels used for deployment and recovery and post-deployment calibrations, to identify any instrument performance problems and develop a "best" time series of the surface meteorology for estimation of air-sea fluxes. However, any SPURS investigators wishing to view the data in near real time may do so by visiting http://uop.whoi.edu/projects/spurs/.

In addition to the IMET measurements, the buoy also carries an instrument to measure the height and direction of surface waves (Bouchard and Farrar, 2008). This instrument was purchased from the U.S. National Data Buoy Center (NDBC) under the terms of a WHOI-NDBC Memorandum of Agreement. The processed, real-time wave data are available from the NDBC web site under Station Number 41061.

Figure X2: WHOI-SPURS surface mooring after deployment.

The buoy also carries two atmospheric turbulence packages for measuring turbulent sensible and latent heat fluxes and wind stress. Each of these packages, known as Direct Covariance Flux Systems (DCFS), comprise fast-response infrared hygrometers (LiCor 7200 model), Gill 3-axis sonic anemometers, and a motion package.

For the IMET meteorological packages and other buoy instruments, instrument types and measurement heights are given in Table III-1, along with the instrument IDs and their associated loggers. Note that IMET logger L-37 is known as “System 1” and logger L-38 is known as “System 2”, **but, with some potential for confusion**, DCFS “System 2” is attached to IMET “System 1”.

Subsurface Instruments

The mooring line is heavily instrumented for measuring temperature, conductivity, and velocity. Figure X3 shows how the instruments are configured on the mooring. The instruments will be described in more detail elsewhere.

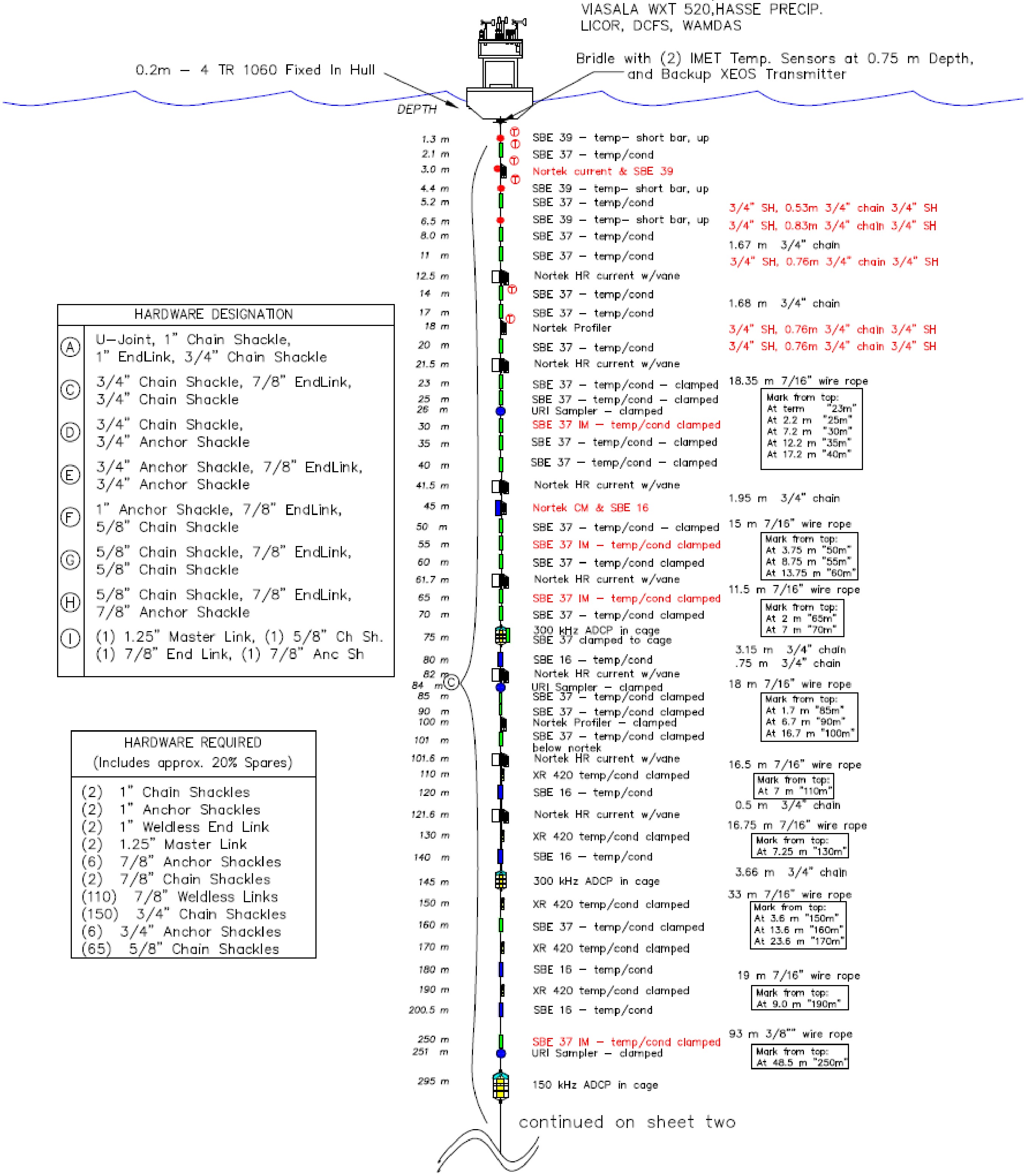
Parameter(s) measured	Sensor	Height above buoy deck (deck is ~75 cm above sea level)	Serial number and logger number
HRH/ATMP	Rotronic MP-101A	237 cm	250/L-37
BPR	Heise DXD (Dresser Instruments)	237.5 cm	225/L-37
WND	RM Young	266 cm	221/L-37
PRC	RM Young 50202 Self-siphoning rain gauge	232 cm	220/L-37
LWR	Eppley Precision Infrared Radiometer (PIR)	280.5 cm	206/L-37
SWR	Eppley Precision Spectral Pyranometer (PSP)	280.5 cm	229/L-37
SST/SSS	SeaBird Electronics SBE37-SI	-150 cm	5996/L-37
HRH/ATMP	Rotronic MP-101A	231 cm	247/L-38
BPR	Heise DXD (Dresser Instruments)	230 cm	233/L-38
WND	RM Young	266 cm	239/L-38
PRC	RM Young 50202 Self-siphoning rain gauge	233 cm	229/L-38
LWR	Eppley Precision Infrared Radiometer (PIR)	280.5 cm	503/L-38
SWR	Eppley Precision Spectral Pyranometer (PSP)	280.5 cm	223/L-38
SST/SSS	SeaBird Electronics SBE37-SI	-150 cm	5997/L-38
HRH/ATMP	LASCAR	162 cm	336/stand-alone
PRC	Hasse	228 cm	HAS001/stand-alone
ATMP	SBE 39, with external thermixtor and radiation shield	215 cm	72/stand-alone
HRH/ATMP/PRC/WND	Vaisala WXT-520	258 cm	VWX003/stand-alone
HRH/ATMP	Rotronic MP-101A	237 cm	248/stand-alone
DCFS WND			DCFS sys 2/L-37
DCFS WND			DCFS sys 1/L-37
DCFS H20	LiCor 7200		DCFS sys 2/L-37
DCFS H20	LiCor 7200		DCFS sys 1/L-38

Table III-1: Measurement heights and sensor types for buoy measurements. The buoy deck is estimated to be 75 cm above the mean water line, so add 75 cm to height above deck to obtain height above sea level.

PO Mooring # 1250

BUOY WATCH CIRCLE ~ 4 N.Miles

2.7 m Surlyn Buoy with
(2) IMET/Iridium Telemetry,
XEOS GPS, SA AT/H, LASCAR
VIASALA WXT 520,HASSE PRECIP.
LICOR, DCFS, WAMDAS



HARDWARE DESIGNATION	
(A)	U–Joint, 1" Chain Shackle, 1" EndLink, 3/4" Chain Shackle
(C)	3/4" Chain Shackle, 7/8" EndLink, 3/4" Chain Shackle
(D)	3/4" Chain Shackle, 3/4" Anchor Shackle
(E)	3/4" Anchor Shackle, 7/8" EndLink, 3/4" Anchor Shackle
(F)	1" Anchor Shackle, 7/8" EndLink, 5/8" Chain Shackle
(G)	5/8" Chain Shackle, 7/8" EndLink, 5/8" Chain Shackle
(H)	5/8" Chain Shackle, 7/8" EndLink, 7/8" Anchor Shackle
(I)	(1) 1.25" Master Link, (1) 5/8" Ch Sh. (1) 7/8" End Link, (1) 7/8" Anc Sh

HARDWARE REQUIRED (Includes approx. 20% Spares)
(2) 1" Chain Shackles
(2) 1" Anchor Shackles
(2) 1" Weldless End Link
(2) 1.25" Master Link
(6) 7/8" Anchor Shackles
(2) 7/8" Chain Shackles
(110) 7/8" Weldless Links
(150) 3/4" Chain Shackles
(6) 3/4" Anchor Shackles
(65) 5/8" Chain Shackles

continued on sheet two

SPURS MOORING

V13- Sheet 1 of 2

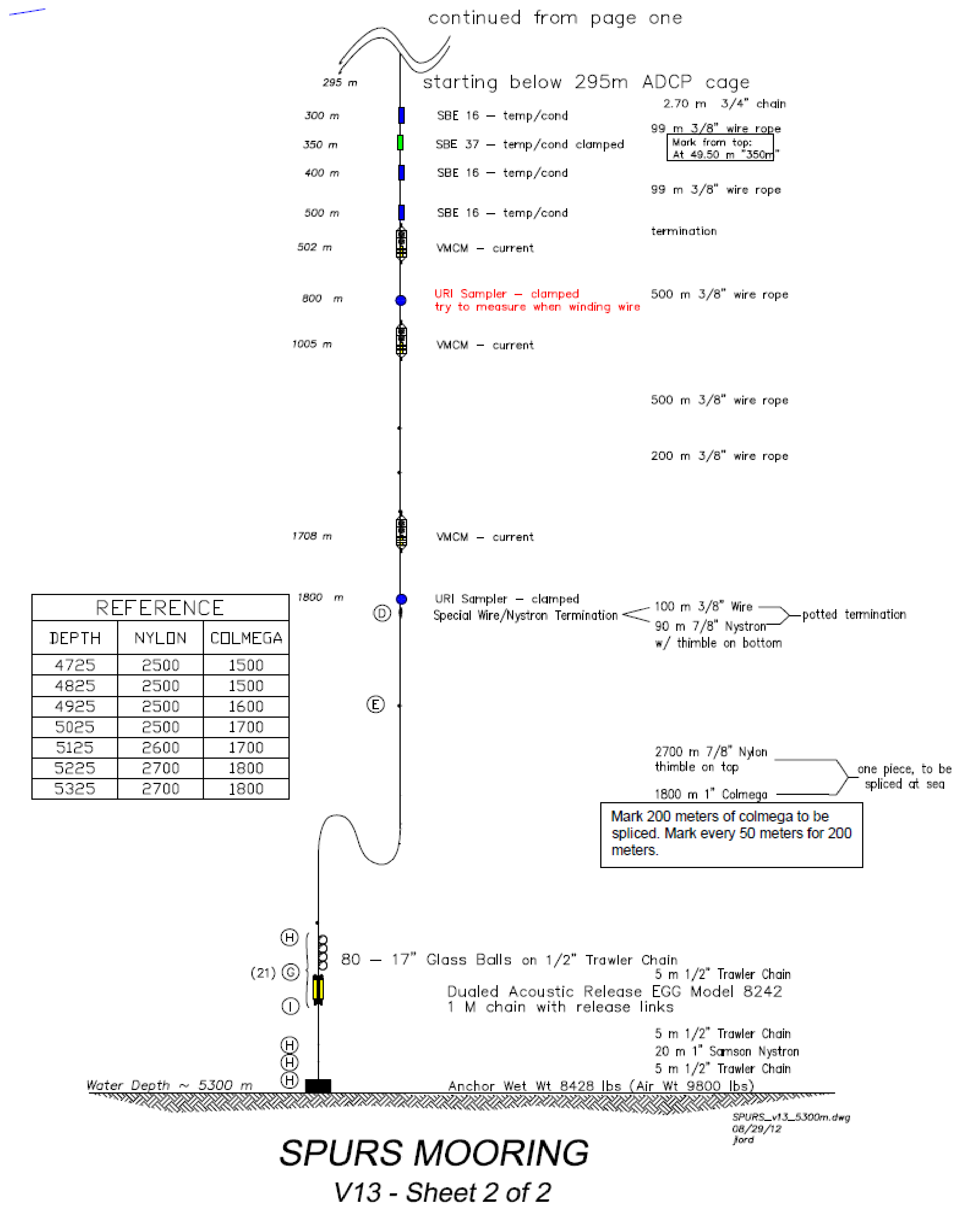


Figure X3 (continued from previous page): Diagram of WHOI-SPURS mooring, showing mooring design and subsurface instrumentation.

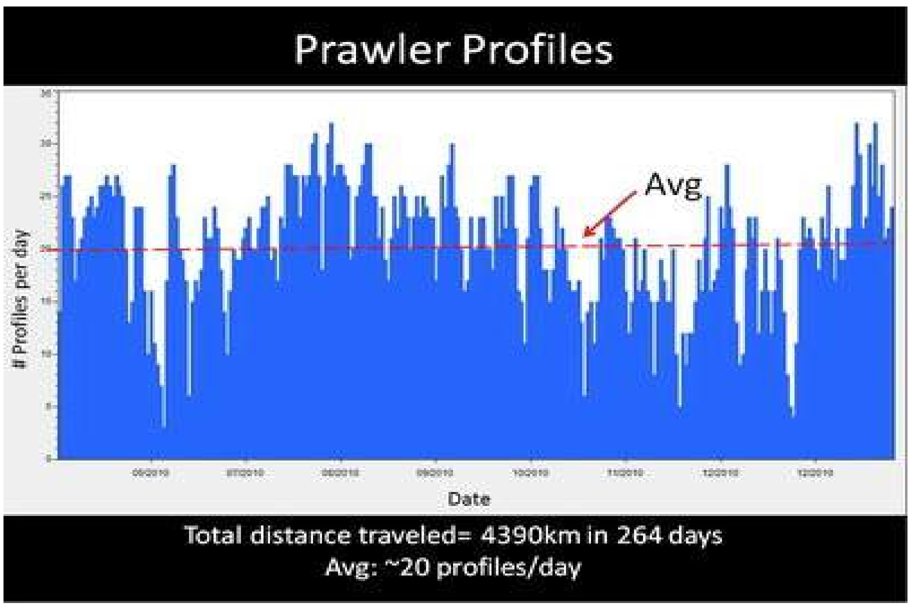
PMEL Moorings -John Shanley, Andrew Meyer

Anchor locations :

The North mooring anchor position is 24 44.464 N 37 56.424 W

The East mooring anchor position is 24 30.968 N 37.48.234W

The Prawler instrument on the NOAA moorings will make 5-30 profiles per day, the average is about 20 profiles per day.



Prawler: The Prawler (Profiler + Crawler) is a wave-powered subsea instrument that eliminates the need for multiple sensors on the mooring line. During descent, it makes a CTD profile and communicates those via inductive modem to the surface buoy. Once reaching the pre-determined bottom depth (~500m) a micro-processor activates a ratcheting mechanism and harnesses the wave motion to crawl up the mooring line.

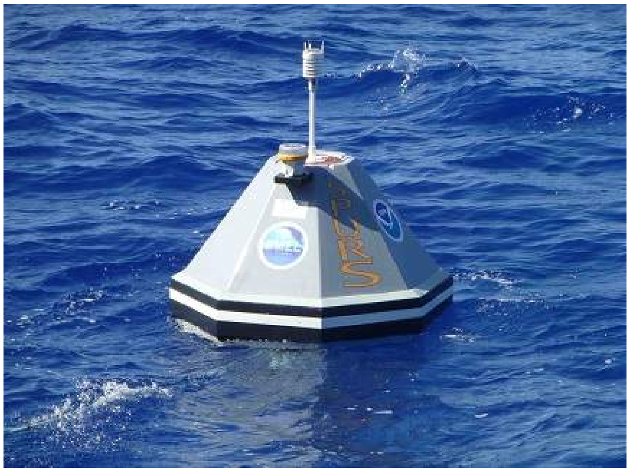


Figure 2.a. (left) Surfae float for Prawler mooring. Figure 2.b. (right) Prawler unit on jacketed cable. It contains the CTD, inductive modem and ratchetting mechanism.

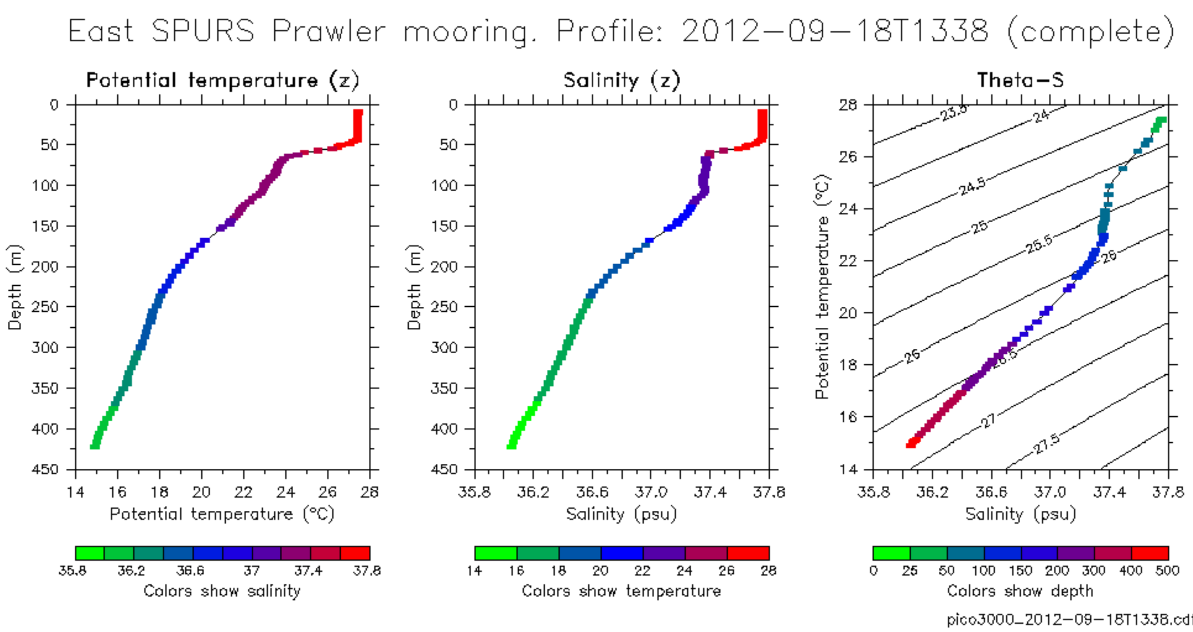


Figure 3. Potential temperature and salinity against depth for an early profile from the Prawler East mooring. The right panel shows the Temperature – Salinity relationship

Hydrography: Ship CTD Operations -Chris Rea

SPURS ship-based CTD operations were undertaken in a series of components as follows:

• Initial test casts were made to familiarize participants with the vessels CTD equipment and SOP for CTD operations, and to establish a sampling routine. On the first cast all 23 bottles on the rosette were tripped at 1000 m, providing an initial check for salinity sampling and the salinometer analyses.

• A full depth CTD cast was made near the proposed site of the WHOI mooring to calibrate the vessel's depth sounders (Sea-Beam and Knudsen) for determining the WHOI deployment depth. A 2000 m cast for comparison with the mooring instruments was made after the mooring deployment.

• A series of 300 m casts were made at glider deployments. This was the nominal depth of the initial glider descent.

• A control volume was sampled over a week where CTD casts to 1000 m were made to characterize the variability around the mooring sites. A 'radiator', or 'butterfly', grid of stations was occupied around the mooring positions, followed by more circuits of the control volume stations.

• A high salinity spot was chosen and a series of hourly CTD casts was made while the vessel held station in the same spot by dynamic positioning for eighteen hours.

• A large-scale survey of 24 stations was conducted to characterize a surface high salinity feature to the north-west and through the study area.

The *Knorr* s on-board Sea-Bird SBE 9/11 CTD and 24-bottle rosette sampler were used on the cruise. An independently recording LADCP was attached to the rosette. Twenty-three 10 L Niskin bottles were mounted on the rosette; position 15 on the rosette was reserved for mounting the LADCP (Section ?). After the full depth and first 2000 m casts, the number of samples required per cast was reduced, and twenty-three bottles on the rosette was deemed excessive for rapid turn-around of the rosette between stations. The outer ring of eleven Niskin bottles was removed from the rosette for cast number 12 and thereafter.

Data Processing

All ship CTD data were processed with the Seasoft software from Sea-Bird Electronics. The vessel's data collection system used Seasave Version 7.21k. The CTD configuration, sensor serial numbers and calibration constants used during the cruise are tabled in the Appendix. Data processing was done using SBE Data Processing Version 7.22.0. Files were created containing the complete 24 Hz data converted to ASCII and engineering units. Data were reduced to 1 m bins using the following sequence of modules from the SBE Data Processing suite:

1. datcnv: convert current and voltage values to engineering units. The first valid good data scan was identified and scans prior to this were excluded from further processing.

2. bottlesum: determine parameter values at bottle trip positions.

3. alignctd: compensate for the different positions of temperature, conductivity and oxygen sensors in the pumped flow through the TC duct, and differences in time constant of the sensors.

4. wildedit: remove extreme wild points.

5. celltm: compensate for conductivity cell thermal mass.

6. filter: filter spikes.

7. loopedit: remove pressure reversals.
8. derive: derive dependent variable oxygen.

9. binavg: average into 1 m depth bins.

10. derive: derive dependent variable salinity.

11. split: split into down and up casts.

For the use of LADCP group, additional files providing 1 s binned data were produced, using the datcnv, wildedit, celltm, filter, binavg time, derive salinity, and derive depth modules.

File types, indicated by file extensions, produced during data collection were:

• .bl: Information about bottle trips

• .con: ASCII configuration files

• .hdr: Header file

• .hex: Raw binary data

• .nav: NMEA positions and times at mark events

• .xmlcon: Configuration information

Files types produced during data processing were:

• .btl: Final bottle data file

• .cdn: Final 1 m binned downcast

• .cnv: Final 1 m binned data, both up and down casts

• .cup: Final 1 m binned up cast

• .hdr: Header file

• .ros: Scan numbers during bottle trip events

• .xmlcon: Configuration information for the cast

CTD Sampling Protocol

The following abbreviated sampling protocol was observed on the cruise.

1. Bottles were cocked in the hangar no more than 15 min prior to on-station.

2. The LADCP data collection was started and the LADCP data download and recharge cable was disconnected.

3. The CTD was moved out on deck.

4. Taps closed and caps open (top and bottom) were checked.

5. Soaking tubes were removed.

6. CTD powered on and logging started.

7. CTD deployed over the side.

8. CTD down to 10 m to ensure exclusion of air bubbles from the TC-duct and for the conductivity sensors to equilibrate to ocean temperature.
9. The CTD brought back to the surface, the winch wire-out meter zeroed and the cast proper begun.

10. Choosing bottle depths:
(a) Bottom of cast.
(b) Within surface mixed layer (usu. about 30m).
(c) Thick stads (isohaline and isothermal layers > ~ 20 m).
(d) Smax and Smin , however, avoid maxima and minima in very thin layers.
(e) Standard depths, choosing from 1000, 900, 800, 750, 700, 600, 500, 400, 300, 250, 200, 150, 100, 75. Space bottles evenly, but switch them around from cast to cast to get a good coverage over the range of salinities.
Allow 45 to 60 s soak before bottle trips.

Avoid strong thermoclines or haloclines. These often also occur around thin local maxima and minima. Clines are intensified around thin stads, so avoid them. Any movement of the sensors or bottles into surrounding clines will increase the variability between bottle samples and CTD readings.

11. After the cast and the CTD back on deck, the data collection was terminated and power to the underwater unit turned off.
12. CTD returned to the hangar.
13. TC duct tubes attached and filled with deionized water.
14. Salt samples were taken.
15. The trigger unit and LADCP were rinsed with freshwater.

CTD Calibration

Sensors on the CTD were freshly calibrated before the Line W cruise, immediately prior to SPURS. This was considered sufficiently recent and those calibration coefficients were accepted for this cruise.

Samples were taken from the rosette to check the calibration of the conductivity sensors. These samples were analyzed on a Guildline Salinometer 8400-B in the laboratory at sea (See Section ?). To monitor the sensors' response and drift during the cruise, the conductivity delta between the two sensors was observed. During the cruise the difference between the two sensors remained constant (see Figures). The difference between salinity determinations and sensor salinities was also monitored and found to remain constant during the cruise within the confidence interval. The primary sensor was found to be closest to the salinometer salinity values (Figure 1) and was thereafter used to provide salinity values. Some of the variability appeared to be related to the samplers or operators on watch. This was addressed by emphasizing standardized sampling techniques and consistent choice of sampling depths. Improvement in later stations was observed. It should be noted that errors and differences in salinity determinations were within WOCE standards.

Since the conductivity measurement and salinity calculation is temperature dependent, the response of the temperature sensors was monitored by observing the difference between the primary and secondary temperature channels on the CTD. This difference was not distinguishable from zero ($\Delta T = 1.4 \pm 3 \times 10^{-4}$ at bottle depths) given the accuracy of the sensors (0.001° C), and no significant trend was observed during the cruise ($T1 = 0.99997 T2 + 0.00032$).

Oxygen titrations were not done on the cruise, and no calibration checks could be done. Fluorometer and turbidimeter readings were also collected without calibration checks.

Figure 1: (Top) Difference between salinity from the primary and secondary conductivity channels of the CTD, plotted against station number. (Bottom) Difference between salinity from the primary conductivity channel and the salinometer, plotted against station number. In each case, the dashed lines indicate one standard deviation from the mean at each station. The dot-dashed line indicates the mean of all differences. The solid line is a regression line indicating the trend over all differences. Data points are color coded with the watch on which the samples were taken.

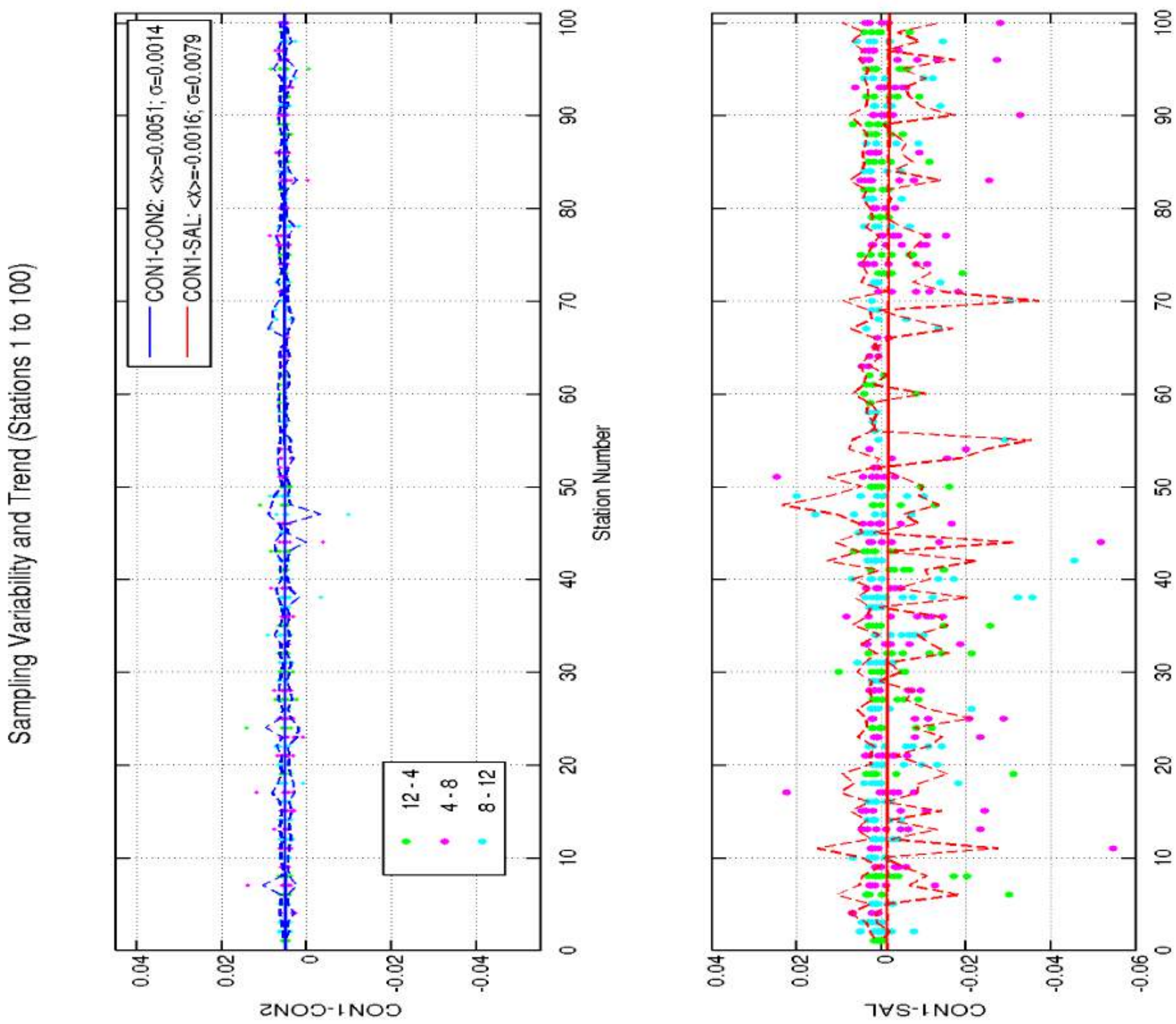


Figure 2: Variability indicated by box-and-whisker plots of the difference between salinity derived from the primary conductivity channel and the salinometer samples, grouped by the watch sampling the Niskin bottles. The variances of the samples drawn by the 12–4 and 8–12 watches are not significantly different; the variances of the samples drawn by the 4–8 watch are significantly different from both the other two watches (95%). The variability in the sampling was addressed by emphasizing the sampling procedure and choice of bottle depths. There was subsequent improvement in the variability in salinity difference between CTD and bottle samples.

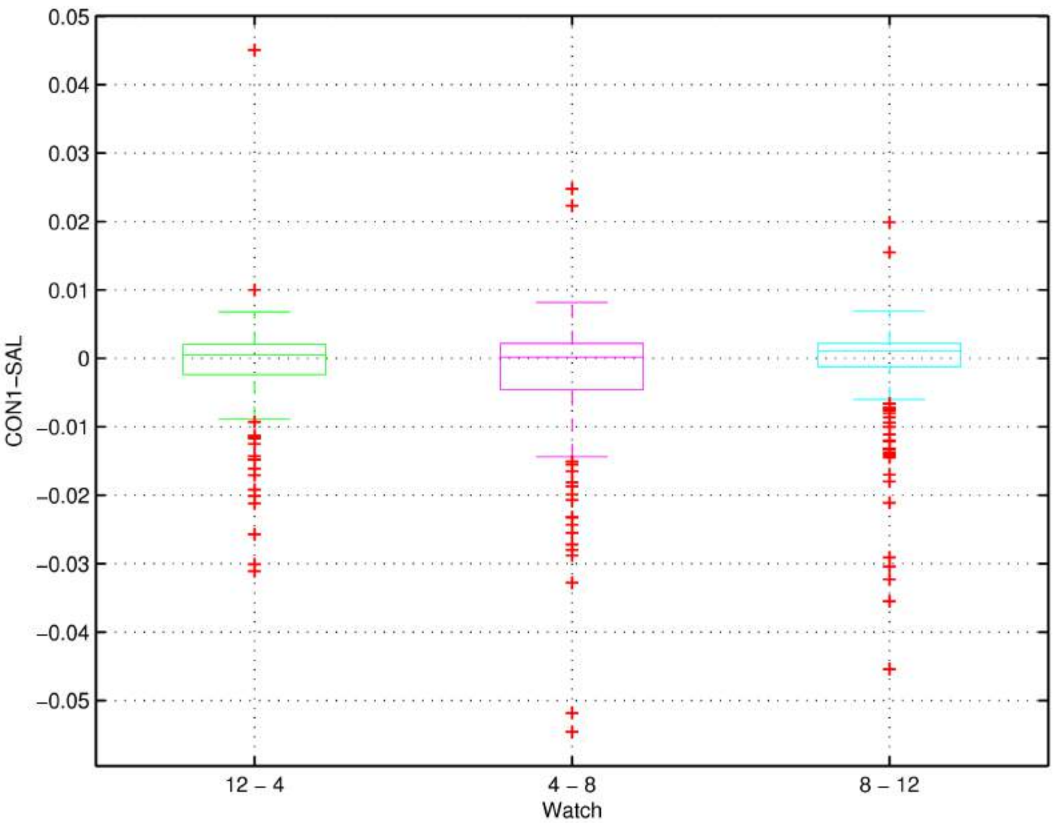


Figure 3: The regression between CTD salinity and salinometer values from Niskin samples for primary and secondary sensors.

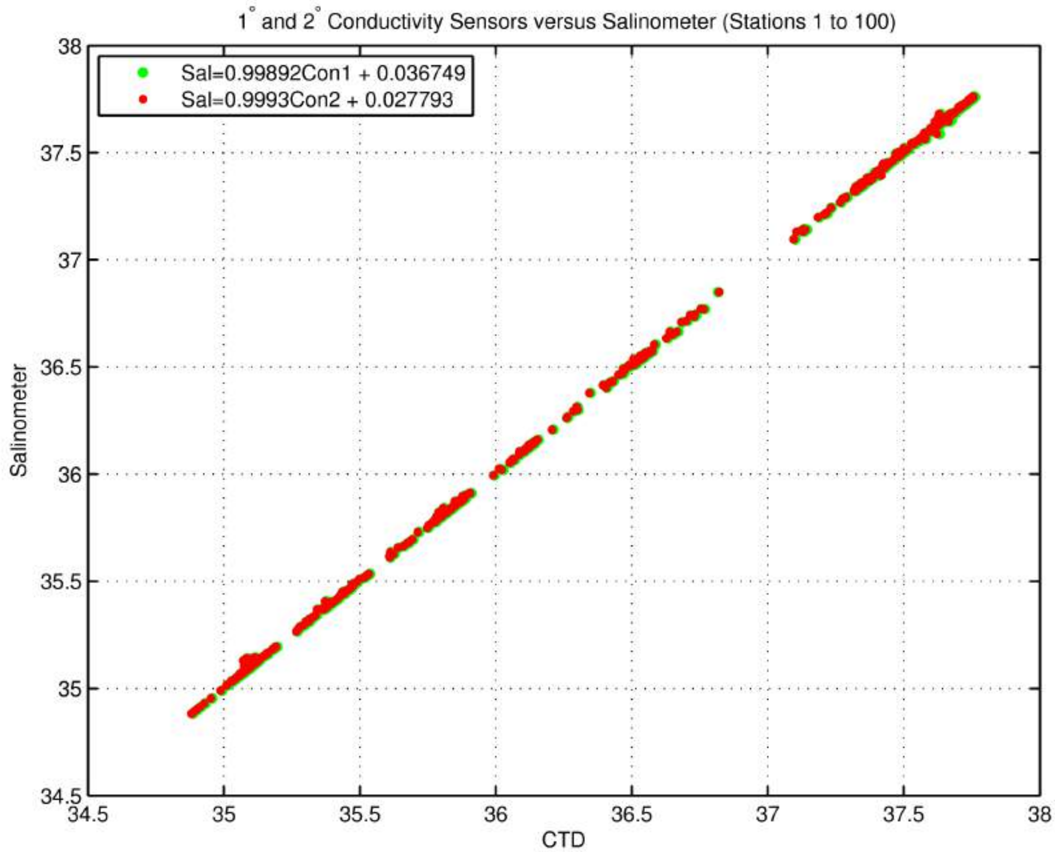


Figure 4: Difference between salinity from Niskin samples and primary conductivity sensor salinities plotted against Niskin bottle number. No consistently leaking Niskin bottles were observed.

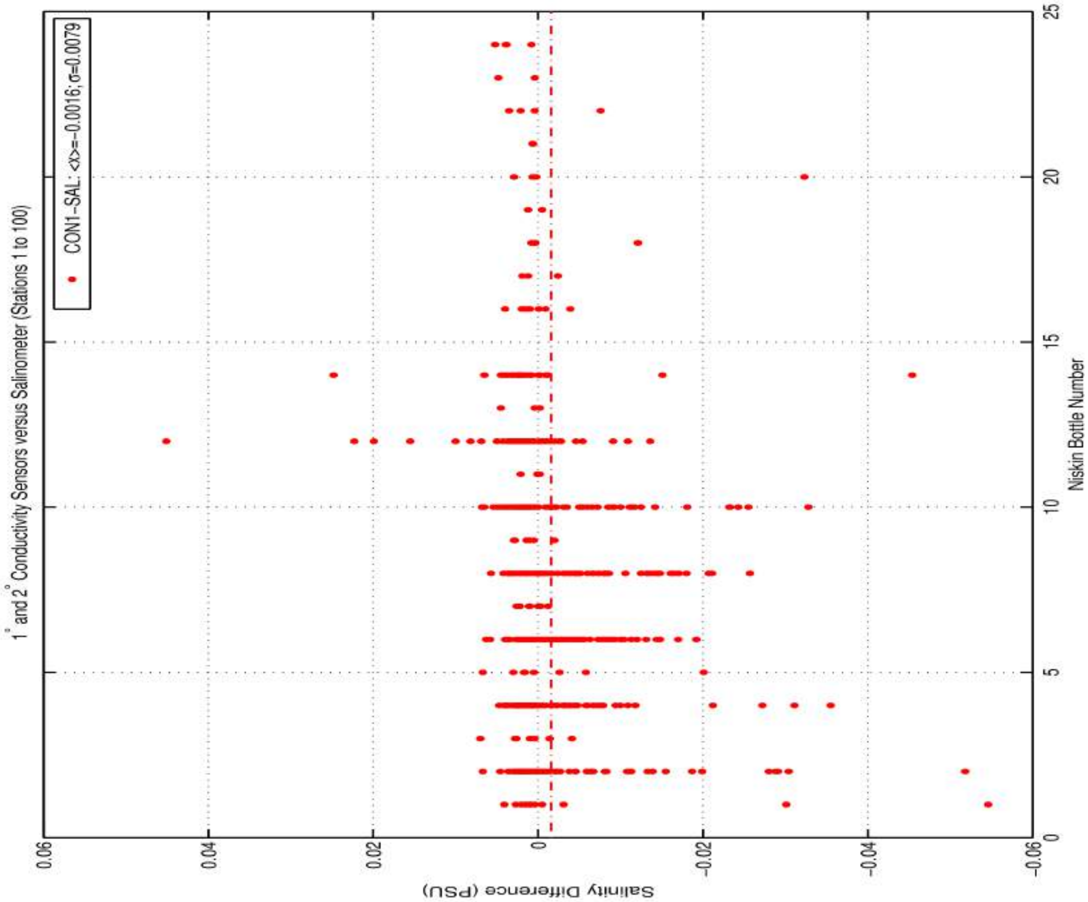
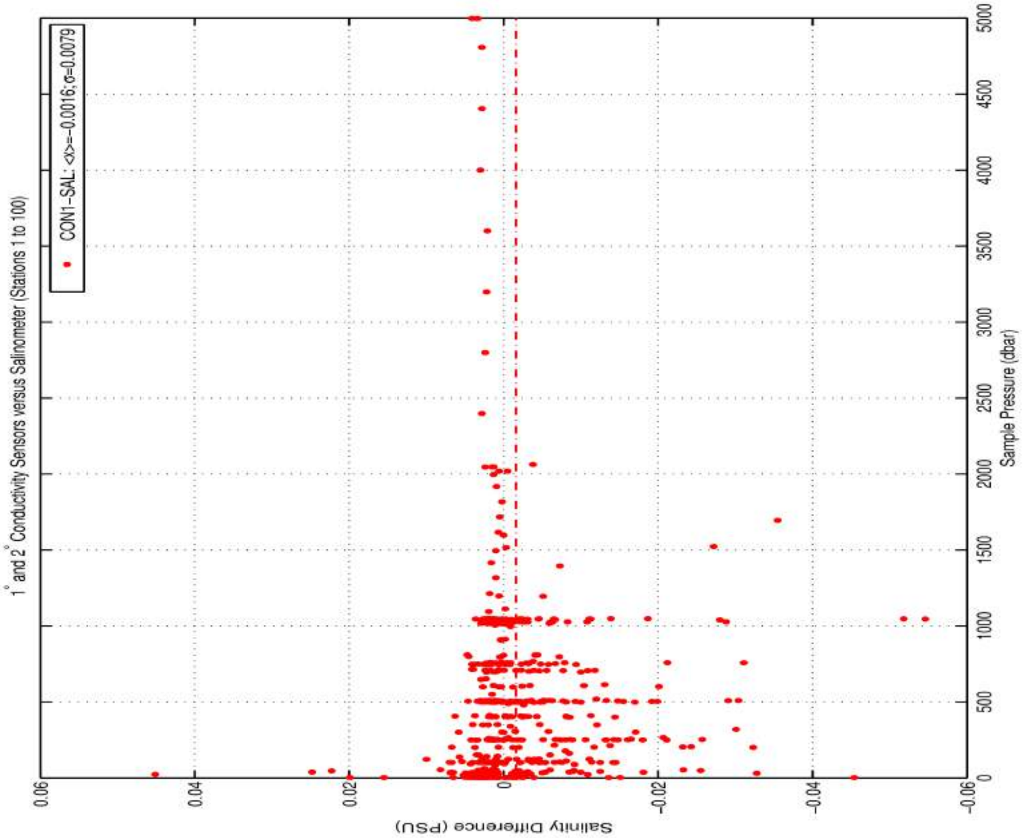


Figure 5: Difference between salinity from Niskin samples and primary conductivity sensor salinities plotted against pressure.



CTD Stations

The CTD casts with times, positions, depths and samples are listed in Tables in the Appendix.

Stations 1 and 2 were test casts. All bottles were tripped at 1000 m on Station 1 to provide a check for salinity sampling and the salinometer. Two of the underway CTD probes were attached to the rosette at Station 1 in an attempt to calibrate the probes against the CTD profile. This was not successful because of the difference in optimal descent rates of the UCTD and CTD, and turbulence and interference created by the rosette. The free descent rate of the UCTD probe is 4 $m \cdot s^{-1}$ while the descent rate of the CTD rosette is $\leq 1.0\ m \cdot s^{-1}$. The resulting excessive spiking in the UCTD record rendered it essentially unusable.

Station 3 was a full depth cast done to check the offset of the Knudsen 12 kHz echo sounder. It was found that the bathymetric depth calculated from the CTD pressure and rosette altimeter reading was within 1 m of the reading from the echo sounder. After Station 11, eleven bottles were removed from the rosette because relatively few salinity samples were required for checking the drift of the conductivity sensors.

On Station 15 the 'fire' button on the deck unit was used to trigger some bottles instead of using the interrupt in software, causing the bottles to close out of sequence. This did not affect any of the bottles required for salinity samples, which had already been correctly closed.

At Station 16, during flat calm conditions, a UCTD probe was lowered into the surface while on CTD station in an attempt to sample the surface layer, unreliably sampled by the CTD on the rosette.

Some variability had been noticed in the Salinometer versus CTD readings, and during Station 21 additional bottle samples were taken at 1000 m to investigate this variability.

After some overnight rainfall, air bubbles in the TC ducts created the impression of very low surface salinities in the CTD data at Station 38. Additional bucket salinity samples were taken before the problem was finally diagnosed. The TC ducts were back-flushed with fresh water and the air-release valves in the TC ducts reamed out. There was a recurrence of the problem on the following cast, Station 39, and the back-flushing was repeated, this time with success.

On Station 40 heavy rainfall began as the CTD was being recovered after the cast, which may have affected salinity sampling as a possible source of fresh water to dilute samples.

On Station 46, the underwater unit power was turned on after the CTD was already in the water. There were no pre-cast air data obtained for this station.

On Station 50, a tangled line required recovery of the rosette before redeployment.

On Station 55, another air bubble problem occurred which was cleared by descending to 30 m before returning to the surface to begin the cast. The TC ducts were again back-flushed after this station.

During the 18-hour stations (Casts 52–70), a UCTD probe was mounted on the rosette at Stations 52–57 and 60–65. The UCTD probe was mounted with the sensors pointing up, and the rosette was raised through the surface then lowered again for a final bottle sample before recovery in an attempt to sample the surface layer, a feat which is difficult with the usual configuration of the rosette-mounted CTD.

Some large spikes were observed on Stations 65 and 66. The cause was diagnosed as looping (pressure reversals) of the CTD rosette during ship rolls.

The Seasave software failed to connect to the NMEA string during Station 67 and data collection was restarted while the CTD package was already in the water. Pre-cast air data for this cast was lost. After this cast the CTD data-capture computer was rebooted and a new instance of Seasave was started.

After Station 72 some doubts were expressed about apparent corrosion affecting the integrity of the conducting cable and termination of the CTD, and the chinese finger termination was replaced.

Data

The data are available in the directories data_on_memory/ctd (raw data) and science_on_memory/processed_ctd (processed data). Station log sheets have been scanned and are in science_on_memory/processed_ctd/logsheets/ctdlogsheets.pdf. Salinity sample sheets are scanned in science_on_memory/Salinometer/logsheets/salinometerlogsheets.pdf.

Data from the CTD casts taken near the mooring sites and on the dynamic positioning stations are shown in the following figures.

Figure 6: CTD casts obtained during the 18-hour dynamic positioning stations.

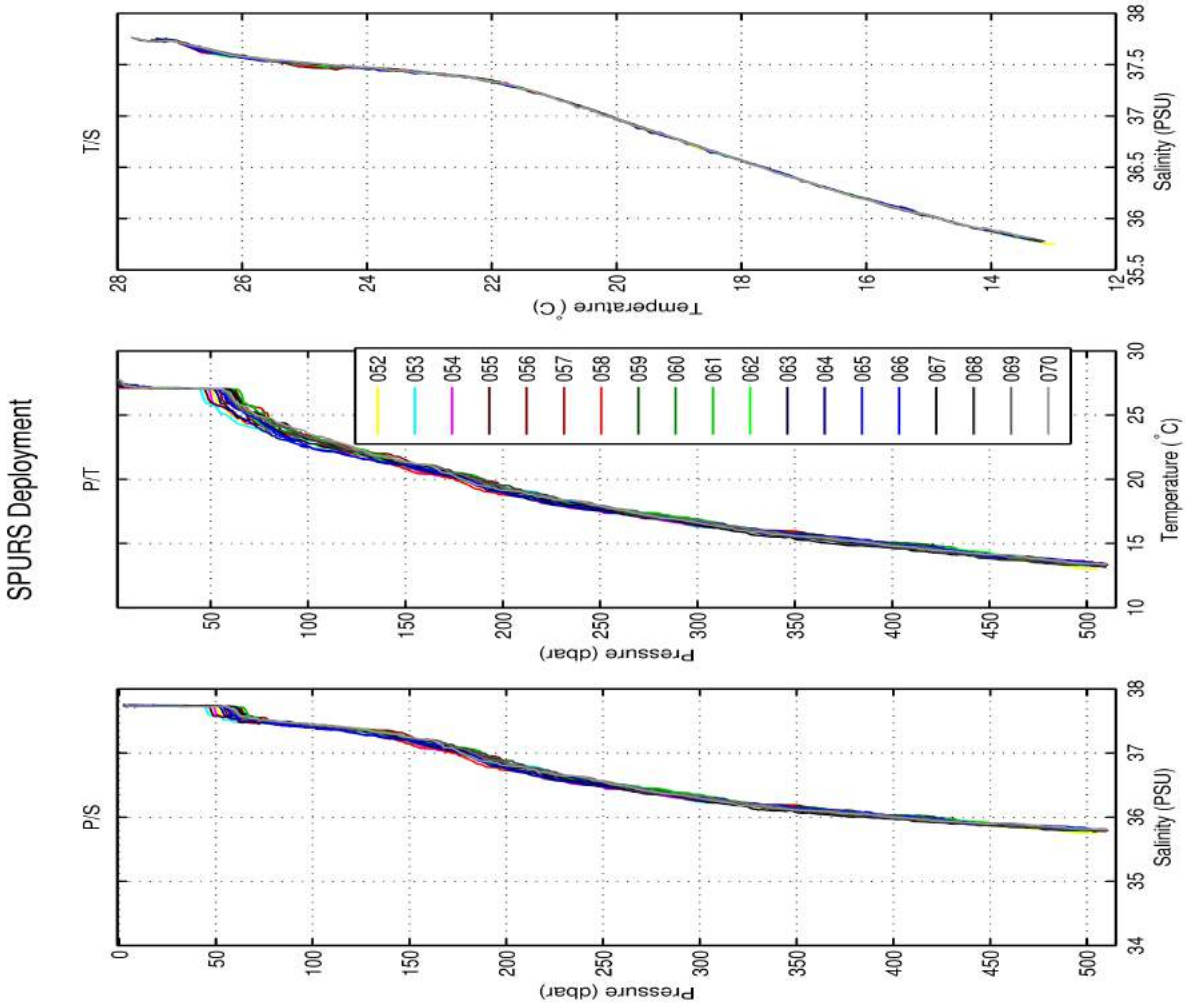


Figure 7: CTD casts obtained in the vicinity of the PICO-E mooring.

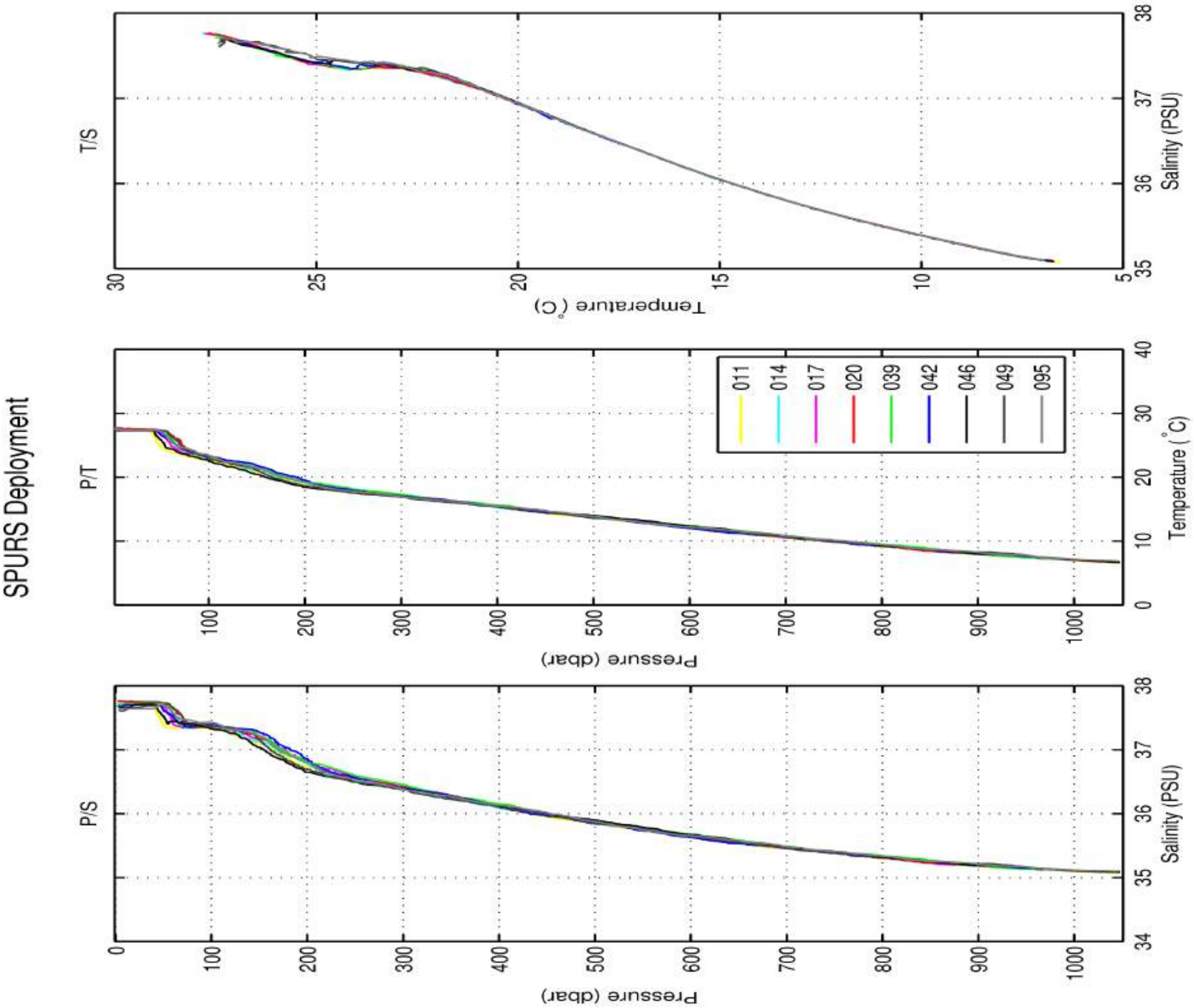


Figure 8: CTD casts obtained in the vicinity of the PICO-N mooring.

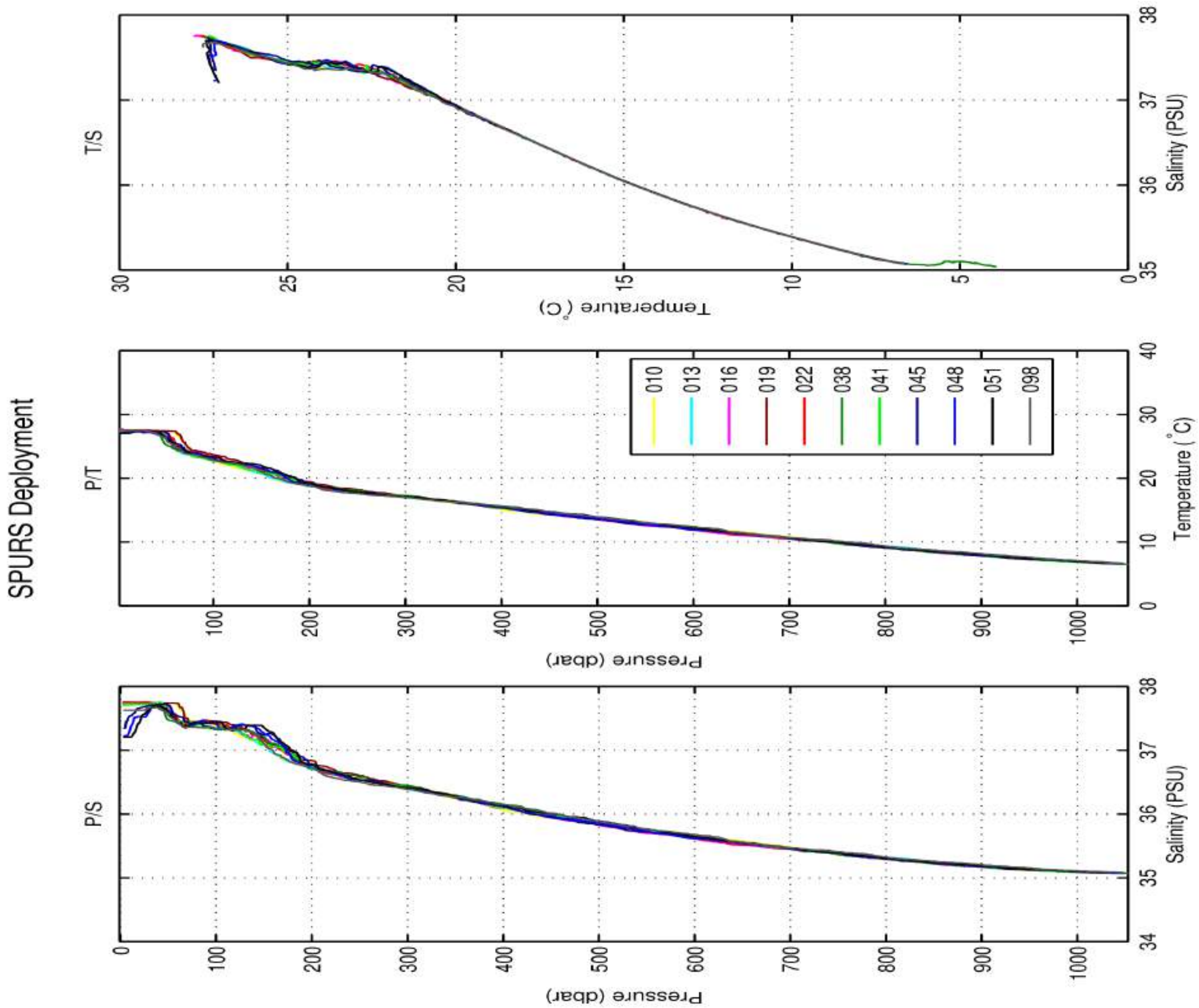
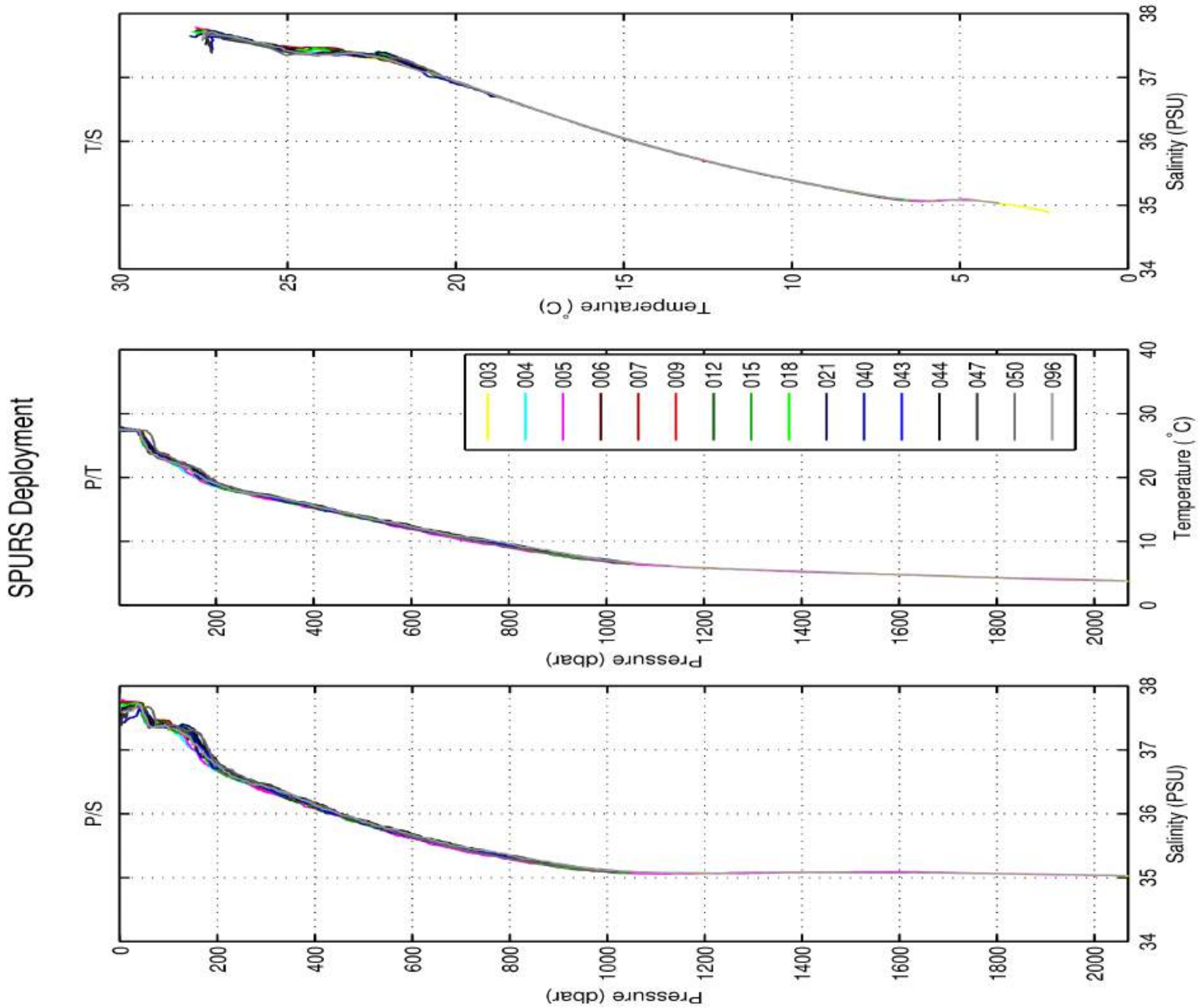


Figure 9: CTD casts obtained in the vicinity of the WHOI mooring.



Appendix

PSA file: C:\Users\tomf\Application Data\Sea-Bird\Seasave\Seasave.psa

Date: 10/02/2012

Instrument configuration file: C:\data\Cruise\KN209\raw\KN209_01_001.XMLCON

Configuration report for SBE 911plus/917plus CTD

Frequency channels suppressed : 0
Voltage words suppressed : 0
Computer interface : RS-232C
Deck unit : SBE11plus Firmware Version >= 5.0
Scans to average : 1
NMEA position data added : Yes
NMEA depth data added : No
NMEA time added : No
NMEA device connected to : deck unit
Surface PAR voltage added : Yes
Scan time added : No

1) Frequency 0, Temperature

Serial number : 4360
Calibrated on : 17-Feb-12
G : 4.36270311e-003
H : 6.49904712e-004
I : 2.31365566e-005
J : 1.86535914e-006
F0 : 1000.000
Slope : 1.00000000
Offset : 0.0000

2) Frequency 1, Conductivity

Serial number : 3042
Calibrated on : 17-Feb-12
G : -1.06511827e+001
H : 1.45091541e+000
I : -7.64624338e-005
J : 8.07436667e-005
CTcor : 3.2500e-006
CPcor : -9.57000000e-008
Slope : 1.00000000
Offset : 0.00000

3) Frequency 2, Pressure, Digiquartz with TC

Serial number : 0462
Calibrated on : 15-Mar-12
C1 : -4.872453e+004
C2 : 2.143123e-002
C3 : 1.347220e-002
D1 : 3.959500e-002
D2 : 0.000000e+000
T1 : 2.994567e+001
T2 : -2.488396e-004
T3 : 3.985300e-006
T4 : 7.998620e-010
T5 : 0.000000e+000
Slope : 0.99988587
Offset : -1.74580
AD590M : 1.282050e-002
AD590B : -9.111540e+000

4) Frequency 3, Temperature, 2

Serial number : 2774
Calibrated on : 08-Mar-12
G : 4.32562685e-003
H : 6.47085041e-004
I : 2.42677157e-005
J : 2.50146798e-006
F0 : 1000.000
Slope : 1.00000000
Offset : 0.0000

5) Frequency 4, Conductivity, 2

Serial number : 3089
Calibrated on : 09-Mar-12
G : -1.03616200e+001
H : 1.39324960e+000
I : 2.45586836e-004
J : 4.42430584e-005
CTcor : 3.2500e-006
CPcor : -9.57000000e-008
Slope : 1.00000000
Offset : 0.00000

6) A/D voltage 0, Fluorometer, WET Labs ECO-AFL/FL

Serial number : FLNTURTD-304
Calibrated on : 2008-03-10
Dark output : 0.0710
Scale factor : 1.00000000e+001

7) A/D voltage 1, Turbidity Meter, WET Labs, ECO-NTU

Serial number : FLNTURTD-304
Calibrated on : 20080310
ScaleFactor : 5.000000
Dark output : 0.048000

8) A/D voltage 2, Transmissometer, WET Labs C-Star

Serial number : CST-1117DR
Calibrated on : 2008-04-30
M : 21.7014
B : -1.3672
Path length : 0.250

9) A/D voltage 3, Free

10) A/D voltage 4, Altimeter

Serial number : 1192
Calibrated on :
Scale factor : 15.000
Offset : 0.000

11) A/D voltage 5, Oxygen, SBE 43

Serial number : 0113
Calibrated on : 11-Feb-12
Equation : Sea-Bird
Soc : 3.62900e-001
Offset : -5.83700e-001
A : -3.07280e-003
B : 1.94560e-004
C : -2.91830e-006
E : 3.60000e-002
Tau20 : 1.19000e+000
D1 : 1.92634e-004
D2 : -4.64803e-002
H1 : -3.30000e-002
H2 : 5.00000e+003

H3 : 1.45000e+003

12) A/D voltage 6, Free

13) A/D voltage 7, Free

14) SPAR voltage, Unavailable

15) SPAR voltage, SPAR/Surface Irradiance

Serial number :
Calibrated on :
Conversion factor : 0.00000000
Ratio multiplier : 0.00000000

Scan length : 40

Pump Control
This setting is only applicable to a custom build of the SBE 9plus.
Enable pump on / pump off commands: NO

Data Acquisition:
Archive data: YES
Delay archiving: NO
Data archive: <none selected>
Timeout (seconds) at startup: 60
Timeout (seconds) between scans: 10

Instrument port configuration:
Port = COM1
Baud rate = 9600
Parity = N
Data bits = 8
Stop bits = 1

Water Sampler Data:
Water Sampler Type: None

Header information:
Header Choice = Prompt for Header Information
prompt 0 = Ship:
prompt 1 = Station:
prompt 2 = Operator:

TCP/IP - port numbers:
Data acquisition:
Data port: 49163
Status port: 49165
Command port: 49164
Remote bottle firing:
Command port: 49167
Status port: 49168
Remote data publishing:
Converted data port: 49161
Raw data port: 49160

Miscellaneous data for calculations
Depth and Average Sound Velocity
Latitude when NMEA is not available: 0.00000000
Average Sound Velocity
Minimum pressure [db]: 20.00000000
Minimum salinity [psu]: 20.00000000
Pressure window size [db]: 20.00000000
Time window size [s]: 60.00000000
Descent and Acceleration
Window size [s]: 2.00000000
Plume Anomaly
Theta-B: 0.00000000
Salinity-B 0.00000000
Theta-Z / Salinity-Z 0.00000000

```
    Reference pressure [db]            0.00000000
  Oxygen
    Window size [s]:                   2.00000000
    Apply hysteresis correction:       1
    Apply Tau correction:              1
  Potential Temperature Anomaly
    A0:                                0.00000000
    A1:                                0.00000000
    A1 Multiplier:                     Salinity
---------------------------------------------
Serial Data Output:
  Output data to serial port: NO
---------------------------------------------
Mark Variables:
  Variables:
  Digits   Variable Name [units]
  ------   ---------------------
  0        Scan Count
  4        Depth [salt water, m]
  7        Conductivity [S/m]
  5        Salinity, Practical [PSU]
---------------------------------------------
Shared File Output:
  Output data to shared file: NO
---------------------------------------------
TCP/IP Output:
  Raw data:
    Output raw data to socket:            NO
    XML wrapper and settings:             NO
    Seconds between raw data updates:     0.00000000
  Converted data:
    Output converted data to socket:      NO
    XML format:                           NO
---------------------------------------------
SBE 11plus Deck Unit Alarms
  Enable minimum pressure alarm:    NO
  Enable maximum pressure alarm:    NO
  Enable altimeter alarm:           NO
---------------------------------------------
SBE 14 Remote Display
  Enable SBE 14 Remote Display:     NO
---------------------------------------------
PC Alarms
  Enable minimum pressure alarm:    NO
  Enable maximum pressure alarm:    NO
  Enable altimeter alarm:           NO
  Enable bottom contact alarm:      NO
  Alarm uses PC sound card.
---------------------------------------------
Options:
  Prompt to save program setup changes: YES
  Automatically save program setup changes on exit: NO
  Confirm instrument configuration change: YES
  Confirm display setup changes: YES
  Confirm output file overwrite: YES
  Check scan length: NO
  Compare serial numbers: NO
  Maximized plot may cover Seasave: NO
```

Table 1: All CTD stations occupied on SPURS-1 cruise

CTD Station	Start Date Time	Start Lat	Start Long	End Date Time	End Lat	End Long	Bathy Depth	Duration	Cast Depth	Bottle Samples
1	Sep 10 2012 17:51:54	31.33870	-48.83368	Sep 10 2012 18:39:19	31.33682	-48.83818	5573	50	1009	23
2	Sep 11 2012 13:06:06	29.11952	-45.45027	Sep 11 2012 14:52:52	29.12198	-45.44772	3809	111	1997	23
3	Sep 13 2012 09:24:16	24.56580	-38.03152	Sep 13 2012 12:53:02	24.58340	-38.03873	4902	210	4911	16
4	Sep 13 2012 19:33:29	24.57297	-38.03832	Sep 13 2012 20:06:23	24.57307	-38.03830	4885	35	349	4
5	Sep 14 2012 23:02:54	24.49750	-38.00030	Sep 15 2012 00:27:29	24.49663	-38.00157	5508	88	2025	7
6	Sep 16 2012 17:18:35	24.57997	-38.06238	Sep 16 2012 17:48:07	24.57997	-38.06240	4628	31	319	5
7	Sep 16 2012 19:14:02	24.58088	-38.05607	Sep 16 2012 19:59:44	24.58387	-38.04880	4663	46	348	6
8	Sep 18 2012 05:06:43	24.59208	-37.96752	Sep 18 2012 06:03:56	24.59673	-37.96470	5103	58	1000	12
9	Sep 18 2012 19:54:45	24.55072	-38.03337	Sep 18 2012 20:50:07	24.54730	-38.03768	5074	57	1037	6
10	Sep 19 2012 01:38:50	24.78287	-37.91667	Sep 19 2012 02:30:57	24.78287	-37.91923	5330	53	1037	7
11	Sep 19 2012 08:14:26	24.48333	-37.76668	Sep 19 2012 09:08:34	24.48307	-37.76773	5830	54	1037	7
12	Sep 19 2012 13:25:01	24.54990	-38.03283	Sep 19 2012 14:16:51	24.54773	-38.03520	5113	53	1037	7
13	Sep 19 2012 18:59:51	24.78182	-37.91760	Sep 19 2012 19:53:37	24.77878	-37.91813	5462	56	1018	7
14	Sep 20 2012 01:33:58	24.48287	-37.76740	Sep 20 2012 02:27:07	24.48153	-37.76860	5769	55	1037	7
15	Sep 20 2012 07:05:08	24.55033	-38.03312	Sep 20 2012 08:07:44	24.54892	-38.03450	5110	63	1021	8
16	Sep 20 2012 12:27:38	24.78392	-37.91688	Sep 20 2012 13:20:37	24.78680	-37.92140	5446	53	1039	7
17	Sep 20 2012 19:54:59	24.48300	-37.76760	Sep 20 2012 20:53:50	24.48180	-37.76748	5779	59	1018	8
18	Sep 21 2012 01:10:31	24.54973	-38.03287	Sep 21 2012 02:03:06	24.54983	-38.03382	5033	53	1038	7
19	Sep 21 2012 06:09:18	24.78318	-37.91780	Sep 21 2012 06:59:10	24.78168	-37.91817	5319	51	1008	7
20	Sep 21 2012 14:01:45	24.48342	-37.76773	Sep 21 2012 14:53:02	24.48202	-37.76857	5771	53	1039	7
21	Sep 21 2012 19:24:00	24.54997	-38.03278	Sep 21 2012 20:24:41	24.54847	-38.03277	5104	62	1018	12
22	Sep 22 2012 00:50:28	24.78292	-37.91813	Sep 22 2012 01:43:22	24.78013	-37.91842	5339	54	1038	7
23	Sep 22 2012 10:02:22	25.24797	-37.00202	Sep 22 2012 10:58:02	25.24692	-37.00152	5915	57	1020	6
24	Sep 22 2012 14:25:54	24.74988	-37.00150	Sep 22 2012 15:19:26	24.74787	-37.00388	5645	54	1039	7
25	Sep 22 2012 19:29:12	24.24253	-37.00190	Sep 22 2012 20:25:29	24.24100	-37.00233	5468	56	1020	7
26	Sep 22 2012 23:54:29	23.75008	-37.00267	Sep 23 2012 00:45:52	23.74843	-37.00503	5594	53	1038	7
27	Sep 23 2012 04:12:52	23.74988	-37.50033	Sep 23 2012 05:04:41	23.74880	-37.50048	5795	51	1040	7
28	Sep 23 2012 08:25:02	23.75023	-38.00128	Sep 23 2012 09:23:42	23.75007	-38.00248	5730	60	1020	7
29	Sep 23 2012 13:09:17	24.25067	-38.00140	Sep 23 2012 13:59:09	24.24940	-38.00372	5764	51	1039	7
30	Sep 23 2012 17:46:25	24.75222	-38.00538	Sep 23 2012 18:39:08	24.75373	-38.00680	5460	55	1039	7
31	Sep 23 2012 22:28:06	25.25038	-38.00123	Sep 23 2012 23:17:57	25.25202	-38.00382	5086	49	1020	6
32	Sep 24 2012 02:43:46	25.25043	-38.49997	Sep 24 2012 03:35:16	25.25270	-38.50162	5337	52	1039	7
33	Sep 24 2012 06:31:25	25.25007	-38.99993	Sep 24 2012 07:24:22	25.24973	-38.99998	5083	53	1041	6
34	Sep 24 2012 10:35:47	24.75610	-39.00208	Sep 24 2012 11:31:44	24.75502	-39.00313	5195	57	1019	7
35	Sep 24 2012 15:06:59	24.24908	-39.00230	Sep 24 2012 15:59:46	24.24813	-39.00330	5070	53	1042	7
36	Sep 24 2012 19:32:02	23.75353	-39.00132	Sep 24 2012 20:27:34	23.75202	-39.00290	5550	56	1019	7
37	Sep 24 2012 23:44:29	23.74970	-38.50147	Sep 25 2012 00:35:27	23.74800	-38.50547	5585	52	1037	7
38	Sep 25 2012	24.78340	-37.91540	Sep 25 2012	24.78340	-37.91540	5287	102	2025	12

	11:21:58			13:03:51						
39	Sep 25 2012 18:05:44	24.48453	-37.76872	Sep 25 2012 19:10:13	24.48457	-37.76877	4395	64	1019	6
40	Sep 25 2012 23:03:09	24.55027	-38.03343	Sep 25 2012 23:57:24	24.55018	-38.03342	5081	55	1041	7
41	Sep 26 2012 03:56:18	24.78550	-37.91622	Sep 26 2012 04:53:20	24.78658	-37.91740	5390	57	1038	7
42	Sep 26 2012 10:15:21	24.48363	-37.76503	Sep 26 2012 11:11:48	24.48377	-37.76502	5770	57	1038	7
43	Sep 26 2012 16:38:45	24.54787	-38.03240	Sep 26 2012 17:37:35	24.54777	-38.03447	5128	61	1038	7
44	Sep 26 2012 18:00:56	24.55060	-38.03290	Sep 26 2012 18:56:11	24.55340	-38.03520	5051	56	1039	6
45	Sep 26 2012 23:07:53	24.78323	-37.91738	Sep 27 2012 00:01:34	24.78218	-37.91837	5344	54	1039	6
46	Sep 27 2012 05:27:29	24.48403	-37.76773	Sep 27 2012 06:23:32	24.48280	-37.76987	5728	56	1039	7
47	Sep 27 2012 10:32:11	24.55120	-38.03403	Sep 27 2012 11:26:52	24.54950	-38.03473	5098	56	1039	6
48	Sep 27 2012 15:37:44	24.78207	-37.91832	Sep 27 2012 16:35:17	24.78077	-37.91897	5461	57	1039	7
49	Sep 27 2012 21:51:34	24.48308	-37.76717	Sep 27 2012 22:45:23	24.48192	-37.76858	5777	55	1019	6
50	Sep 28 2012 03:00:08	24.55100	-38.03377	Sep 28 2012 04:03:54	24.54992	-38.03420	5103	64	1036	7
51	Sep 28 2012 08:03:21	24.78298	-37.91867	Sep 28 2012 09:01:29	24.78320	-37.91983	5461	59	1019	8
52	Sep 29 2012 07:03:42	25.50000	-38.49990	Sep 29 2012 07:34:33	25.50000	-38.50007	5252	29	502	2
53	Sep 29 2012 08:08:56	25.49998	-38.50003	Sep 29 2012 08:36:19	25.49998	-38.50007	4992	26	501	2
54	Sep 29 2012 09:04:33	25.50000	-38.50007	Sep 29 2012 09:32:07	25.50000	-38.50007	4989	27	501	2
55	Sep 29 2012 10:04:53	25.50000	-38.50003	Sep 29 2012 10:37:31	25.49998	-38.50007	4991	31	507	2
56	Sep 29 2012 11:02:25	25.49998	-38.50007	Sep 29 2012 11:29:37	25.50008	-38.49937	4985	26	506	2
57	Sep 29 2012 12:04:24	25.49998	-38.49998	Sep 29 2012 12:33:41	25.49997	-38.50007	4986	29	506	2
58	Sep 29 2012 12:58:04	25.50003	-38.49988	Sep 29 2012 13:30:32	25.49998	-38.50003	4982	29	507	2
59	Sep 29 2012 14:00:31	25.49997	-38.50003	Sep 29 2012 14:26:59	25.49998	-38.50007	4987	27	497	2
60	Sep 29 2012 15:07:48	25.49997	-38.50003	Sep 29 2012 15:35:06	25.49997	-38.50003	4982	25	497	2
61	Sep 29 2012 16:01:46	25.49997	-38.50003	Sep 29 2012 16:29:22	25.49997	-38.50003	4982	25	497	2
62	Sep 29 2012 17:02:22	25.49997	-38.50007	Sep 29 2012 17:28:55	25.49997	-38.50003	4981	25	497	2
63	Sep 29 2012 18:03:38	25.49998	-38.50007	Sep 29 2012 18:32:14	25.49998	-38.50003	4990	28	502	2
64	Sep 29 2012 19:02:59	25.49997	-38.50007	Sep 29 2012 19:30:47	25.49997	-38.50007	4993	26	500	2
65	Sep 29 2012 20:02:33	25.49997	-38.50003	Sep 29 2012 20:30:02	25.49997	-38.50007	4982	26	506	2
66	Sep 29 2012 21:02:57	25.49998	-38.50003	Sep 29 2012 21:33:22	25.49997	-38.50007	4989	31	506	2
67	Sep 29 2012 22:04:34	25.49997	-38.50007	Sep 29 2012 22:34:20	25.49997	-38.50003	4981	32	506	2
68	Sep 29 2012 23:01:53	25.49997	-38.50003	Sep 29 2012 23:32:17	25.49997	-38.50007	4998	31	506	2
69	Sep 30 2012 00:01:20	25.49997	-38.50003	Sep 30 2012 00:31:58	25.49997	-38.50007	4988	31	506	2
70	Sep 30 2012 00:58:07	25.49997	-38.50007	Sep 30 2012 01:28:15	25.49998	-38.50003	4989	31	506	2
71	Sep 30 2012 07:28:53	25.45777	-39.15338	Sep 30 2012 08:21:32	25.45810	-39.15570	4969	54	1018	6
72	Sep 30 2012 11:35:52	25.80352	-38.74832	Sep 30 2012 12:27:42	25.80377	-38.74858	5023	53	1039	6
73	Sep 30 2012 15:58:51	26.15033	-38.33742	Sep 30 2012 16:52:08	26.15198	-38.34318	5271	54	1036	6
74	Sep 30 2012 19:33:27	25.92612	-38.11010	Sep 30 2012 20:28:17	25.92717	-38.11923	4626	55	1011	6
75	Oct 01 2012 01:06:33	25.58387	-38.50393	Oct 01 2012 02:02:37	25.58787	-38.50523	4804	57	1039	6
76	Oct 01 2012 05:15:13	25.23873	-38.91672	Oct 01 2012 06:07:59	25.24412	-38.92052	4536	53	1036	7
77	Oct 01 2012 08:07:16	25.02218	-38.67987	Oct 01 2012 08:59:52	25.03188	-38.68077	5211	53	1003	7
78	Oct 01 2012	25.36330	-38.28537	Oct 01 2012	25.36600	-38.28678	5104	54	1040	5

	12:09:38			13:02:20						
79	Oct 01 2012 16:13:22	25.71427	-37.88028	Oct 01 2012 17:08:02	25.71977	-37.88878	4638	55	1030	6
80	Oct 01 2012 19:14:59	25.49070	-37.65033	Oct 01 2012 20:05:40	25.49507	-37.65300	5469	52	1007	6
81	Oct 01 2012 23:23:36	25.13858	-38.05037	Oct 02 2012 00:14:49	25.14087	-38.05040	5102	52	1038	5
82	Oct 02 2012 03:32:30	24.79673	-38.44668	Oct 02 2012 04:24:58	24.80510	-38.44693	5299	53	1031	6
83	Oct 02 2012 06:29:29	24.58213	-38.20717	Oct 02 2012 07:23:37	24.58840	-38.20803	5432	55	1012	7
84	Oct 02 2012 10:32:05	24.92392	-37.80472	Oct 02 2012 11:24:37	24.92668	-37.80508	5628	53	1039	5
85	Oct 02 2012 14:34:10	25.27028	-37.40307	Oct 02 2012 15:27:48	25.27757	-37.40178	5143	54	1038	5
86	Oct 02 2012 17:33:26	25.05060	-37.16792	Oct 02 2012 18:23:41	25.05470	-37.16953	5656	51	1038	6
87	Oct 02 2012 21:44:03	24.69837	-37.56802	Oct 02 2012 22:36:10	24.69973	-37.56838	5101	53	1009	5
88	Oct 03 2012 01:48:06	24.35512	-37.96688	Oct 03 2012 02:42:08	24.35870	-37.96753	5829	54	1039	6
89	Oct 03 2012 04:38:40	24.13747	-37.74828	Oct 03 2012 05:33:25	24.13717	-37.74813	6177	55	1039	6
90	Oct 03 2012 08:43:15	24.48552	-37.34902	Oct 03 2012 09:34:42	24.49032	-37.35237	5873	52	1005	7
91	Oct 03 2012 12:55:15	24.83337	-36.93693	Oct 03 2012 13:45:39	24.83498	-36.93802	5224	51	1040	5
92	Oct 03 2012 15:48:06	24.61502	-36.71793	Oct 03 2012 16:40:01	24.62010	-36.72072	6420	52	1027	5
93	Oct 03 2012 19:57:32	24.26348	-37.11892	Oct 03 2012 20:49:09	24.26600	-37.11888	4605	52	1009	6
94	Oct 04 2012 00:07:04	23.91242	-37.50457	Oct 04 2012 00:59:12	23.91987	-37.50023	5467	53	1034	5
95	Oct 04 2012 04:52:49	24.48428	-37.76637	Oct 04 2012 05:46:41	24.48897	-37.76818	5762	55	1037	7
96	Oct 04 2012 07:29:05	24.55010	-38.03272	Oct 04 2012 08:58:50	24.55758	-38.03187	5049	90	2041	7
97	Oct 04 2012 20:27:23	24.59027	-37.80337	Oct 04 2012 21:26:53	24.59028	-37.80328	5008	60	1040	6
98	Oct 04 2012 22:50:23	24.78353	-37.91660	Oct 04 2012 23:44:54	24.78360	-37.91697	5316	55	1039	5
99	Oct 05 2012 02:58:57	25.21737	-37.53267	Oct 05 2012 03:50:22	25.21832	-37.52282	4899	52	1034	5
100	Oct 05 2012 06:54:34	25.63288	-37.13040	Oct 05 2012 07:47:56	25.62772	-37.12183	5568	54	1034	7

Table 2: CTD stations occupied within 3 mile of WHOI mooring position

CTD Station	Start Date Time	Start Lat	Start Long	End Date Time	End Lat	End Long	Bathy Depth	Duration	Cast Depth	Bottle Samples
3	Sep 13 2012 09:24:16	24.56580	-38.03152	Sep 13 2012 12:53:02	24.58340	-38.03873	4902	210	4911	16
4	Sep 13 2012 19:33:29	24.57297	-38.03832	Sep 13 2012 20:06:23	24.57307	-38.03830	4885	35	349	4
5	Sep 14 2012 23:02:54	24.49750	-38.00030	Sep 15 2012 00:27:29	24.49663	-38.00157	5508	88	2025	7
6	Sep 16 2012 17:18:35	24.57997	-38.06238	Sep 16 2012 17:48:07	24.57997	-38.06240	4628	31	319	5
7	Sep 16 2012 19:14:02	24.58088	-38.05607	Sep 16 2012 19:59:44	24.58387	-38.04880	4663	46	348	6
9	Sep 18 2012 19:54:45	24.55072	-38.03337	Sep 18 2012 20:50:07	24.54730	-38.03768	5074	57	1037	6
12	Sep 19 2012 13:25:01	24.54990	-38.03283	Sep 19 2012 14:16:51	24.54773	-38.03520	5113	53	1037	7
15	Sep 20 2012 07:05:08	24.55033	-38.03312	Sep 20 2012 08:07:44	24.54892	-38.03450	5110	63	1021	8
18	Sep 21 2012 01:10:31	24.54973	-38.03287	Sep 21 2012 02:03:06	24.54983	-38.03382	5033	53	1038	7
21	Sep 21 2012 19:24:00	24.54997	-38.03278	Sep 21 2012 20:24:41	24.54847	-38.03277	5104	62	1018	12
40	Sep 25 2012 23:03:09	24.55027	-38.03343	Sep 25 2012 23:57:24	24.55018	-38.03342	5081	55	1041	7
43	Sep 26 2012 16:38:45	24.54787	-38.03240	Sep 26 2012 17:37:35	24.54777	-38.03447	5128	61	1038	7
44	Sep 26 2012 18:00:56	24.55060	-38.03290	Sep 26 2012 18:56:11	24.55340	-38.03520	5051	56	1039	6
47	Sep 27 2012 10:32:11	24.55120	-38.03403	Sep 27 2012 11:26:52	24.54950	-38.03473	5098	56	1039	6
50	Sep 28 2012 03:00:08	24.55100	-38.03377	Sep 28 2012 04:03:54	24.54992	-38.03420	5103	64	1036	7
96	Oct 04 2012 07:29:05	24.55010	-38.03272	Oct 04 2012 08:58:50	24.55758	-38.03187	5049	90	2041	7

Table 3: CTD stations occupied within 3 mile of PICO-E mooring position

CTD Station	Start Date Time	Start Lat	Start Long	End Date Time	End Lat	End Long	Bathy Depth	Duration	Cast Depth	Bottle Samples
11	Sep 19 2012 08:14:26	24.48333	-37.76668	Sep 19 2012 09:08:34	24.48307	-37.76773	5830	54	1037	7
14	Sep 20 2012 01:33:58	24.48287	-37.76740	Sep 20 2012 02:27:07	24.48153	-37.76860	5769	55	1037	7
17	Sep 20 2012 19:54:59	24.48300	-37.76760	Sep 20 2012 20:53:50	24.48180	-37.76748	5779	59	1018	8
20	Sep 21 2012 14:01:45	24.48342	-37.76773	Sep 21 2012 14:53:02	24.48202	-37.76857	5771	53	1039	7
39	Sep 25 2012 18:05:44	24.48453	-37.76872	Sep 25 2012 19:10:13	24.48457	-37.76877	4395	64	1019	6
42	Sep 26 2012 10:15:21	24.48363	-37.76503	Sep 26 2012 11:11:48	24.48377	-37.76502	5770	57	1038	7
46	Sep 27 2012 05:27:29	24.48403	-37.76773	Sep 27 2012 06:23:32	24.48280	-37.76987	5728	56	1039	7
49	Sep 27 2012 21:51:34	24.48308	-37.76717	Sep 27 2012 22:45:23	24.48192	-37.76858	5777	55	1019	6
95	Oct 04 2012 04:52:49	24.48428	-37.76637	Oct 04 2012 05:46:41	24.48897	-37.76818	5762	55	1037	7

Table 4: CTD stations occupied within 3 mile of PICO-N mooring position

CTD Station	Start Date Time	Start Lat	Start Long	End Date Time	End Lat	End Long	Bathy Depth	Duration	Cast Depth	Bottle Samples
10	Sep 19 2012 01:38:50	24.78287	-37.91667	Sep 19 2012 02:30:57	24.78287	-37.91923	5330	53	1037	7

13	Sep 19 2012 18:59:51	24.78182	-37.91760	Sep 19 2012 19:53:37	24.77878	-37.91813	5462	56	1018	7
16	Sep 20 2012 12:27:38	24.78392	-37.91688	Sep 20 2012 13:20:37	24.78680	-37.92140	5446	53	1039	7
19	Sep 21 2012 06:09:18	24.78318	-37.91780	Sep 21 2012 06:59:10	24.78168	-37.91817	5319	51	1008	7
22	Sep 22 2012 00:50:28	24.78292	-37.91813	Sep 22 2012 01:43:22	24.78013	-37.91842	5339	54	1038	7
38	Sep 25 2012 11:21:58	24.78340	-37.91540	Sep 25 2012 13:03:51	24.78340	-37.91540	5287	102	2025	12
41	Sep 26 2012 03:56:18	24.78550	-37.91622	Sep 26 2012 04:53:20	24.78658	-37.91740	5390	57	1038	7
45	Sep 26 2012 23:07:53	24.78323	-37.91738	Sep 27 2012 00:01:34	24.78218	-37.91837	5344	54	1039	6
48	Sep 27 2012 15:37:44	24.78207	-37.91832	Sep 27 2012 16:35:17	24.78077	-37.91897	5461	57	1039	7
51	Sep 28 2012 08:03:21	24.78298	-37.91867	Sep 28 2012 09:01:29	24.78320	-37.91983	5461	59	1019	8
98	Oct 04 2012 22:50:23	24.78353	-37.91660	Oct 04 2012 23:44:54	24.78360	-37.91697	5316	55	1039	5

Table 5: CTD casts taken during the 18-hour dynamic positioning station

CTD Station	Start Date Time	Start Lat	Start Long	End Date Time	End Lat	End Long	Bathy Depth	Duration	Cast Depth	Bottle Samples
52	Sep 29 2012 07:03:42	25.50000	-38.49990	Sep 29 2012 07:34:33	25.50000	-38.50007	5252	29	502	2
53	Sep 29 2012 08:08:56	25.49998	-38.50003	Sep 29 2012 08:36:19	25.49998	-38.50007	4992	26	501	2
54	Sep 29 2012 09:04:33	25.50000	-38.50007	Sep 29 2012 09:32:07	25.50000	-38.50007	4989	27	501	2
55	Sep 29 2012 10:04:53	25.50000	-38.50003	Sep 29 2012 10:37:31	25.49998	-38.50007	4991	31	507	2
56	Sep 29 2012 11:02:25	25.49998	-38.50007	Sep 29 2012 11:29:37	25.50008	-38.49937	4985	26	506	2
57	Sep 29 2012 12:04:24	25.49998	-38.49998	Sep 29 2012 12:33:41	25.49997	-38.50007	4986	29	506	2
58	Sep 29 2012 12:58:04	25.50003	-38.49988	Sep 29 2012 13:30:32	25.49998	-38.50003	4982	29	507	2
59	Sep 29 2012 14:00:31	25.49997	-38.50003	Sep 29 2012 14:26:59	25.49998	-38.50007	4987	27	497	2
60	Sep 29 2012 15:07:48	25.49997	-38.50003	Sep 29 2012 15:35:06	25.49997	-38.50003	4982	25	497	2
61	Sep 29 2012 16:01:46	25.49997	-38.50003	Sep 29 2012 16:29:22	25.49997	-38.50003	4982	25	497	2
62	Sep 29 2012 17:02:22	25.49997	-38.50007	Sep 29 2012 17:28:55	25.49997	-38.50003	4981	25	497	2
63	Sep 29 2012 18:03:38	25.49998	-38.50007	Sep 29 2012 18:32:14	25.49998	-38.50003	4990	28	502	2
64	Sep 29 2012 19:02:59	25.49997	-38.50007	Sep 29 2012 19:30:47	25.49997	-38.50007	4993	26	500	2
65	Sep 29 2012 20:02:33	25.49997	-38.50003	Sep 29 2012 20:30:02	25.49997	-38.50007	4982	26	506	2
66	Sep 29 2012 21:02:57	25.49998	-38.50003	Sep 29 2012 21:33:22	25.49997	-38.50007	4989	31	506	2
67	Sep 29 2012 22:04:34	25.49997	-38.50007	Sep 29 2012 22:34:20	25.49997	-38.50003	4981	32	506	2
68	Sep 29 2012 23:01:53	25.49997	-38.50003	Sep 29 2012 23:32:17	25.49997	-38.50007	4998	31	506	2
69	Sep 30 2012 00:01:20	25.49997	-38.50003	Sep 30 2012 00:31:58	25.49997	-38.50007	4988	31	506	2
70	Sep 30 2012 00:58:07	25.49997	-38.50007	Sep 30 2012 01:28:15	25.49998	-38.50003	4989	31	506	2

Table 6: CTD stations occupied during large grid survey

CTD Station	Start Date Time	Start Lat	Start Long	End Date Time	End Lat	End Long	Bathy Depth	Duration	Cast Depth	Bottle Samples
71	Sep 30 2012	25.45777	-39.15338	Sep 30 2012	25.45810	-39.15570	4969	54	1018	6

	07:28:53			08:21:32						
72	Sep 30 2012 11:35:52	25.80352	-38.74832	Sep 30 2012 12:27:42	25.80377	-38.74858	5023	53	1039	6
73	Sep 30 2012 15:58:51	26.15033	-38.33742	Sep 30 2012 16:52:08	26.15198	-38.34318	5271	54	1036	6
74	Sep 30 2012 19:33:27	25.92612	-38.11010	Sep 30 2012 20:28:17	25.92717	-38.11923	4626	55	1011	6
75	Oct 01 2012 01:06:33	25.58387	-38.50393	Oct 01 2012 02:02:37	25.58787	-38.50523	4804	57	1039	6
76	Oct 01 2012 05:15:13	25.23873	-38.91672	Oct 01 2012 06:07:59	25.24412	-38.92052	4536	53	1036	7
77	Oct 01 2012 08:07:16	25.02218	-38.67987	Oct 01 2012 08:59:52	25.03188	-38.68077	5211	53	1003	7
78	Oct 01 2012 12:09:38	25.36330	-38.28537	Oct 01 2012 13:02:20	25.36600	-38.28678	5104	54	1040	5
79	Oct 01 2012 16:13:22	25.71427	-37.88028	Oct 01 2012 17:08:02	25.71977	-37.88878	4638	55	1030	6
80	Oct 01 2012 19:14:59	25.49070	-37.65033	Oct 01 2012 20:05:40	25.49507	-37.65300	5469	52	1007	6
81	Oct 01 2012 23:23:36	25.13858	-38.05037	Oct 02 2012 00:14:49	25.14087	-38.05040	5102	52	1038	5
82	Oct 02 2012 03:32:30	24.79673	-38.44668	Oct 02 2012 04:24:58	24.80510	-38.44693	5299	53	1031	6
83	Oct 02 2012 06:29:29	24.58213	-38.20717	Oct 02 2012 07:23:37	24.58840	-38.20803	5432	55	1012	7
84	Oct 02 2012 10:32:05	24.92392	-37.80472	Oct 02 2012 11:24:37	24.92668	-37.80508	5628	53	1039	5
85	Oct 02 2012 14:34:10	25.27028	-37.40307	Oct 02 2012 15:27:48	25.27757	-37.40178	5143	54	1038	5
86	Oct 02 2012 17:33:26	25.05060	-37.16792	Oct 02 2012 18:23:41	25.05470	-37.16953	5656	51	1038	6
87	Oct 02 2012 21:44:03	24.69837	-37.56802	Oct 02 2012 22:36:10	24.69973	-37.56838	5101	53	1009	5
88	Oct 03 2012 01:48:06	24.35512	-37.96688	Oct 03 2012 02:42:08	24.35870	-37.96753	5829	54	1039	6
89	Oct 03 2012 04:38:40	24.13747	-37.74828	Oct 03 2012 05:33:25	24.13717	-37.74813	6177	55	1039	6
90	Oct 03 2012 08:43:15	24.48552	-37.34902	Oct 03 2012 09:34:42	24.49032	-37.35237	5873	52	1005	7
91	Oct 03 2012 12:55:15	24.83337	-36.93693	Oct 03 2012 13:45:39	24.83498	-36.93802	5224	51	1040	5
92	Oct 03 2012 15:48:06	24.61502	-36.71793	Oct 03 2012 16:40:01	24.62010	-36.72072	6420	52	1027	5
93	Oct 03 2012 19:57:32	24.26348	-37.11892	Oct 03 2012 20:49:09	24.26600	-37.11888	4605	52	1009	6
94	Oct 04 2012 00:07:04	23.91242	-37.50457	Oct 04 2012 00:59:12	23.91987	-37.50023	5467	53	1034	5

Table 7: CTD stations occupied during ‘butterfly’ grid survey

CTD Station	Start Date Time	Start Lat	Start Long	End Date Time	End Lat	End Long	Bathy Depth	Duration	Cast Depth	Bottle Samples
23	Sep 22 2012 10:02:22	25.24797	-37.00202	Sep 22 2012 10:58:02	25.24692	-37.00152	5915	57	1020	6
24	Sep 22 2012 14:25:54	24.74988	-37.00150	Sep 22 2012 15:19:26	24.74787	-37.00388	5645	54	1039	7
25	Sep 22 2012 19:29:12	24.24253	-37.00190	Sep 22 2012 20:25:29	24.24100	-37.00233	5468	56	1020	7
26	Sep 22 2012 23:54:29	23.75008	-37.00267	Sep 23 2012 00:45:52	23.74843	-37.00503	5594	53	1038	7
27	Sep 23 2012 04:12:52	23.74988	-37.50033	Sep 23 2012 05:04:41	23.74880	-37.50048	5795	51	1040	7
28	Sep 23 2012 08:25:02	23.75023	-38.00128	Sep 23 2012 09:23:42	23.75007	-38.00248	5730	60	1020	7
29	Sep 23 2012 13:09:17	24.25067	-38.00140	Sep 23 2012 13:59:09	24.24940	-38.00372	5764	51	1039	7
30	Sep 23 2012	24.75222	-38.00538	Sep 23 2012	24.75373	-38.00680	5460	55	1039	7

	17:46:25			18:39:08						
31	Sep 23 2012 22:28:06	25.25038	-38.00123	Sep 23 2012 23:17:57	25.25202	-38.00382	5086	49	1020	6
32	Sep 24 2012 02:43:46	25.25043	-38.49997	Sep 24 2012 03:35:16	25.25270	-38.50162	5337	52	1039	7
33	Sep 24 2012 06:31:25	25.25007	-38.99993	Sep 24 2012 07:24:22	25.24973	-38.99998	5083	53	1041	6
34	Sep 24 2012 10:35:47	24.75610	-39.00208	Sep 24 2012 11:31:44	24.75502	-39.00313	5195	57	1019	7
35	Sep 24 2012 15:06:59	24.24908	-39.00230	Sep 24 2012 15:59:46	24.24813	-39.00330	5070	53	1042	7
36	Sep 24 2012 19:32:02	23.75353	-39.00132	Sep 24 2012 20:27:34	23.75202	-39.00290	5550	56	1019	7
37	Sep 24 2012 23:44:29	23.74970	-38.50147	Sep 25 2012 00:35:27	23.74800	-38.50547	5585	52	1037	7

**Salinometry - ** Jason Smith

The salinometer used on the SPURS (KN209) cruise was an Autosal model 8400B (WHOI #11). It was set up in the analytical lab of the *R/V Knorr*, with the intent of maintaining a stable room temperature. This salinometer was also used on the preceding cruise (Line-W, Woods Hole to Woods Hole). As the ship was initially having some trouble with the air conditioning system, the Autosal bath temp was raised from 24°C to 27°C for the duration of the cruise. Every attempt was then made to keep the room temperature near 25°C.

Once the temperatures were stabilized, the salinometer was standardized. OSIL IAPSO standard seawater, batch # P-154, was used for all standardizations. A few trial runs were then conducted to check the Autosal for stability. It quickly became apparent that when running a series of bottles, there would occasionally be an errant value. A well mixed bottle would produce a couple of reasonably stable readings and then the conductivity ratio would quickly climb over 100 units, and then start to drift back down. Shutting down the unit and doing a visual inspection of the interior yielded no obvious major problems, although the venting fan appeared to be partially blocked. The method of securing the salinometer to the bulkhead was changed to improve the flow of the venting fan. Drain tube routing was also changed to ensure that there was no way for the tube to contact the container being used to collect the flushed sample water. Running more test bottles showed that while most readings were stable, a noisy unstable reading might still crop up. It was then noticed that occasionally the barbed plastic drain hose fitting would not fully clear itself after sample flushing. Readings taken under this condition seemed to be less stable than those taken while the drain was completely clear. The fix was to make 3 modifications to the setup. The salinometer was tilted slightly towards the operator, the flow rate of the sample was increased, and the plastic barbed fitting was ovaled vertically. Further test runs showed the readings to be repeatable and acceptably quiet.

Over the next several weeks samples collected were analyzed daily. Standard procedure was to allow the samples to sit overnight so that they were at the controlled room temperature at the time of testing. For the first few days, the Autosal was standardized prior to that day's run of bottles, and then again afterward to verify that there was no drift. Seeing a lack of drift, standardizations were limited to the beginning of each daily testing session. All samples were carefully mixed prior to analysis.

In all, 1034 samples were analyzed. 635 were drawn from Niskin bottles on the CTD rosette following casts of various depths. 352 bottles were filled with seawater leading to one of R/V *Knorr*'s thermosalinographs. 40 samples were collected from a bucket thrown over the side hourly during the 24 hour single-station time series. 7 bottles were filled by submerging them directly at the surface. Only 1 surface sample was not analyzed, because it exhibited excessive bio-contamination. Fortunately, it was 1 of 2 samples taken from the same source and the second bottle was much cleaner.

LADCP Data and Data Processing **-**Julian Schanze

LADCP data were acquired on all CTD stations using a RDI Workhorse 150kHz Acoustic Doppler Current Profiler, which was mounted downward looking on the CTD frame. The ambiguity velocity was set to 3.0 m/s for stations 001 through 007 and was reduced to 2.5 m/s due to operation in a low-current area with low scatterers to minimize the influence of erroneous bins. The WH150 was charged to full voltage (48VDC nominal, usually around 50V) as determined by a charging current of less than 0.2A at 58V charging voltage. Data were downloaded and erased from the recorder after each cast with the exception of casts 038 and 039 in which time was insufficient to download data. The data for cast 038 and 039 is thus identical. In processing the data, however, the timestamp from the CTD data ensures that only the appropriate portion of the data is used in processing, thus ensuring that both stations are processed correctly.

All data were stored on both LADCP acquisition PCs, LADCP5 and LADCP3 and were backed up on 2 USB drives that are being carried to Woods Hole by Julian Schanze. The data was furthermore duplicated to the shipboard server in the share science_on_memory, including both raw and processed data. All data acquisition was done on LADCP-3 using LADCP_acquire (http://www.ldeo.columbia.edu/cgi-bin/ladcp-cgi-bin/hgwebdir.cgi) with parameters as listed below. All processing was completed on LADCP-5 using the LDEO_IX software package maintained by Andreas M Thurnherr (http://www.ldeo.columbia.edu/cgi-bin/ladcp-cgi-bin/hgwebdir.cgi). Version IX_8 was used for all processing.

The data is provided relative to the LADCP root directory for cruise KN209-01, which is uploaded to science_on_memory and will be referred to as (LADCP root).

The directory structure is as follows

```
(LADCP root)
    -kn209-01_xxx           (directory for each station using leading zeros and 3 digits, 001-100)
        -pro                (processed data)
        -updn               (raw data and settings)
    -checkpoints            (checkpoints written by LDEO_IX software)
    -ctdladcp               (CTD data in time-format (1s resolution), needed by LDEO_IX)
    -SADCP_IN               (directory containing Shipboard ADCP data)
        -wh300              (Workhorse 300kHz data)
          -contour          (actual MATLAB data file folder)
        -os75nb             (Ocean Surveyor 75kHz data, narrow band)
          -contour          (actual MATLAB data file folder)
        -os75bb             (Ocean Surveyor 75kHz data, broad band)
          -contour          (actual MATLAB data file folder)
    -matlab                 (directory of MATLAB scripts and functions as found on the
                            LADCP-5 computer)
```

The only relevant folder in the MATLAB directory is (LADCP root)/matlab/wh/m.

There are also some files directly in (LADCP root):
kn209_01_sadcp.mat (interpolated shipboard LADCP data using both WH300 and OS75BB data for shallow and deep depths, respectively).
Set_casts_params.m (main settings file used by LDEO_IX

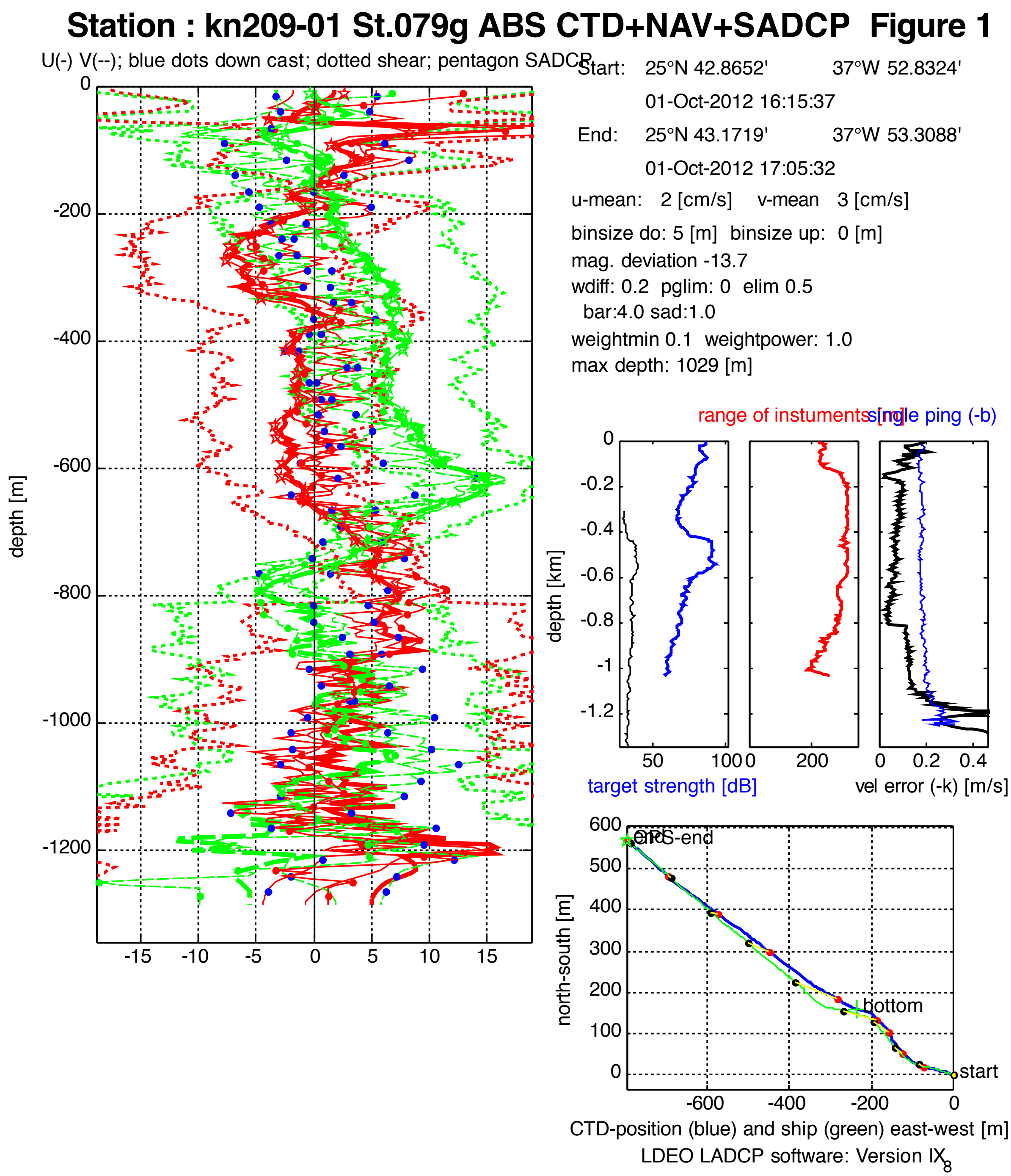
The shipboard NMEA string has occasional drop-outs in both latitude and longitude. This was addressed by a simple (conservative) fix in the LDEO_IX software, which is supplied in the LADCP data directory under (LADCP root)/matlab/wh/m/loadnav_DT_IX.m

```
% Addded linear interpolation for drop-outs in navigation
% Julian Schanze jschanze@whoi.edu 11-Sep-2012
slat=data(:,1);
slon=data(:,2);
llhalf=floor(length(slat)/2);

slatmu = median(slat);
slonmu = median(slon);
slatmu1 = median(slat(1:llhalf));
slonmu1 = median(slon(1:llhalf));
slatmu2 = median(slat(llhalf+1:end));
slonmu2 = median(slon(llhalf+1:end));
slatmudiff=abs(slatmu1-slatmu2);
slonmudiff=abs(slonmu1-slonmu2);
% This should be about half the total ship drift (if it is linear, which it
% may not be)
% For safety, multiply this result by 5 rather than 2.

slatoutliers = abs(slat - slatmu) > 10*slatmudiff;
slonoutliers = abs(slon - slonmu) > 10*slonmudiff;

slat(slatoutliers)=NaN;
slon(slonoutliers)=NaN;

slat(isnan(slat)) = interp1(find(~isnan(slat)),...
   slat(~isnan(slat)), find(isnan(slat)),'cubic');
slon(isnan(slon)) = interp1(find(~isnan(slon)),...
   slon(~isnan(slon)), find(isnan(slon)),'cubic');

d.slat=slat;
d.slon=slon;
```

The code should be self-explanatory.

Other modifications were done to loadrdi.m, process_cast.m, edit_data.m, battery.m and plotinv.m and a new function “mkSADCPjjs.m” was added to merge SADCP data. All of these files may be found in (LADCP root)/matlab/wh/m/

Most of these changes are minor and deal with issues that were encountered in data processing, such as navigational dropouts, low scatter below approximately 900m depth and interference from other instruments (possibly the shipboard ADCP?).
A typical output of LDEO_IX looks as follows:

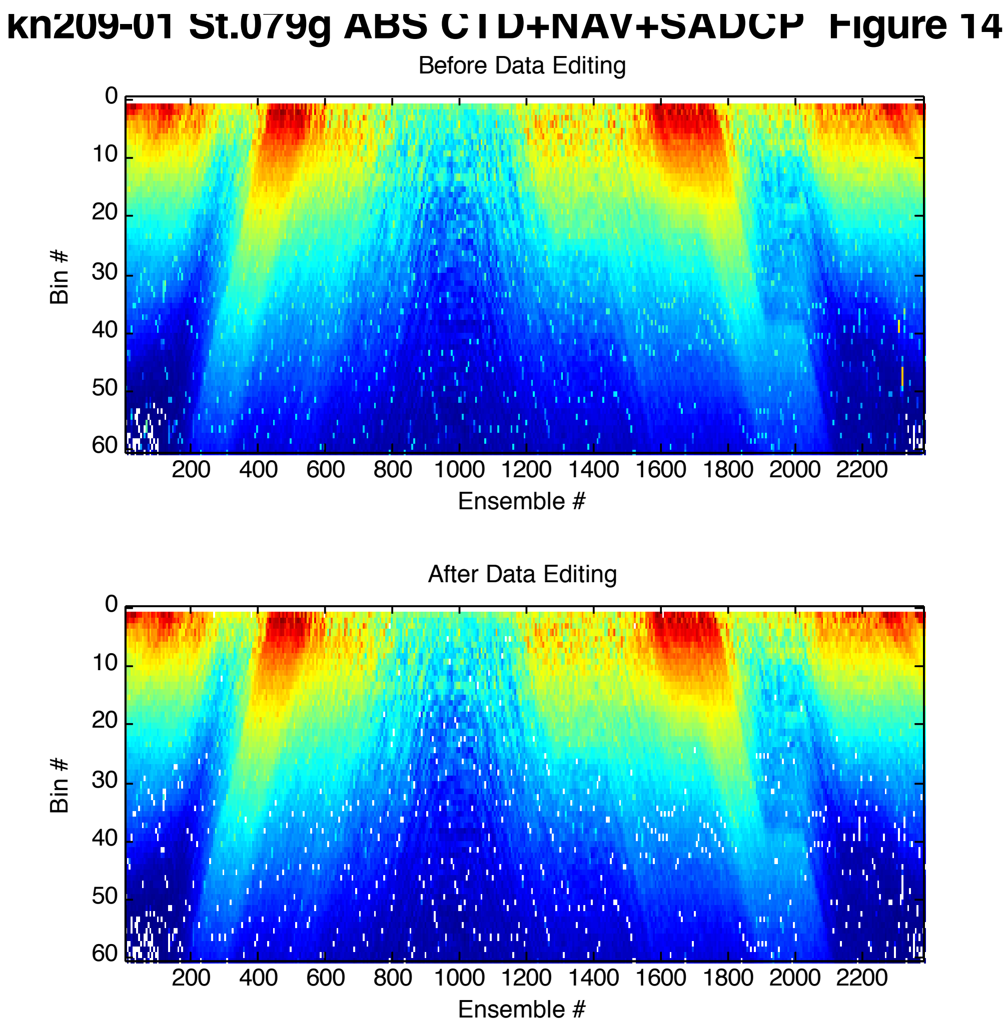


The left side panel shows u and v velocities estimated using shear-only, SADCP constraints and the ‘best estimate’. Metadata (Time, latitude, longitude, mean velocities, magnetic deviations, maximum depth…) are shown in the upper left hand column. The station number is prominently printed at the top of the page. The units are in cm/s, which is cut off as there is no bottom plot in this processing mode.

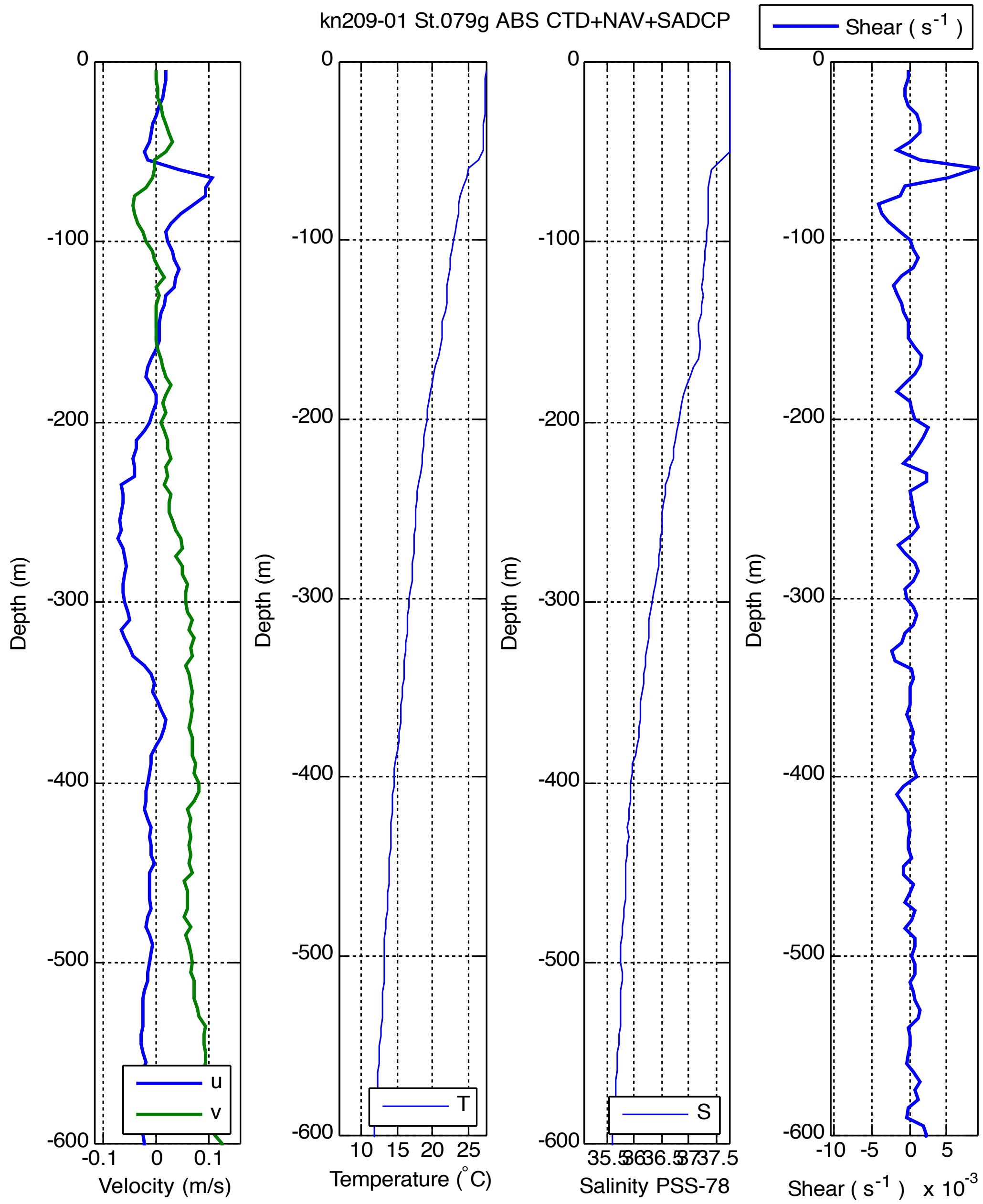
The horizontal resolution is 5m for this. This may be adjusted in set_cast_param.m.

The middle-right hand side has plots of target strength, showing a typical profile of high scattering in the upper 150m and a layer of deep scatterers concentrated around 600m. The range in the first 200m is limited due to the high attenuation due to scatters. Below 800m, the range also decreases due to lower abundance of scatterers. An estimate of the velocity error is shown in the right hand figure in black.
The GPS navigation (i.e. the ship's motion, green) and the shear-integrated velocity of the CTD package (CTD position, blue) are shown in the lower right hand corner.

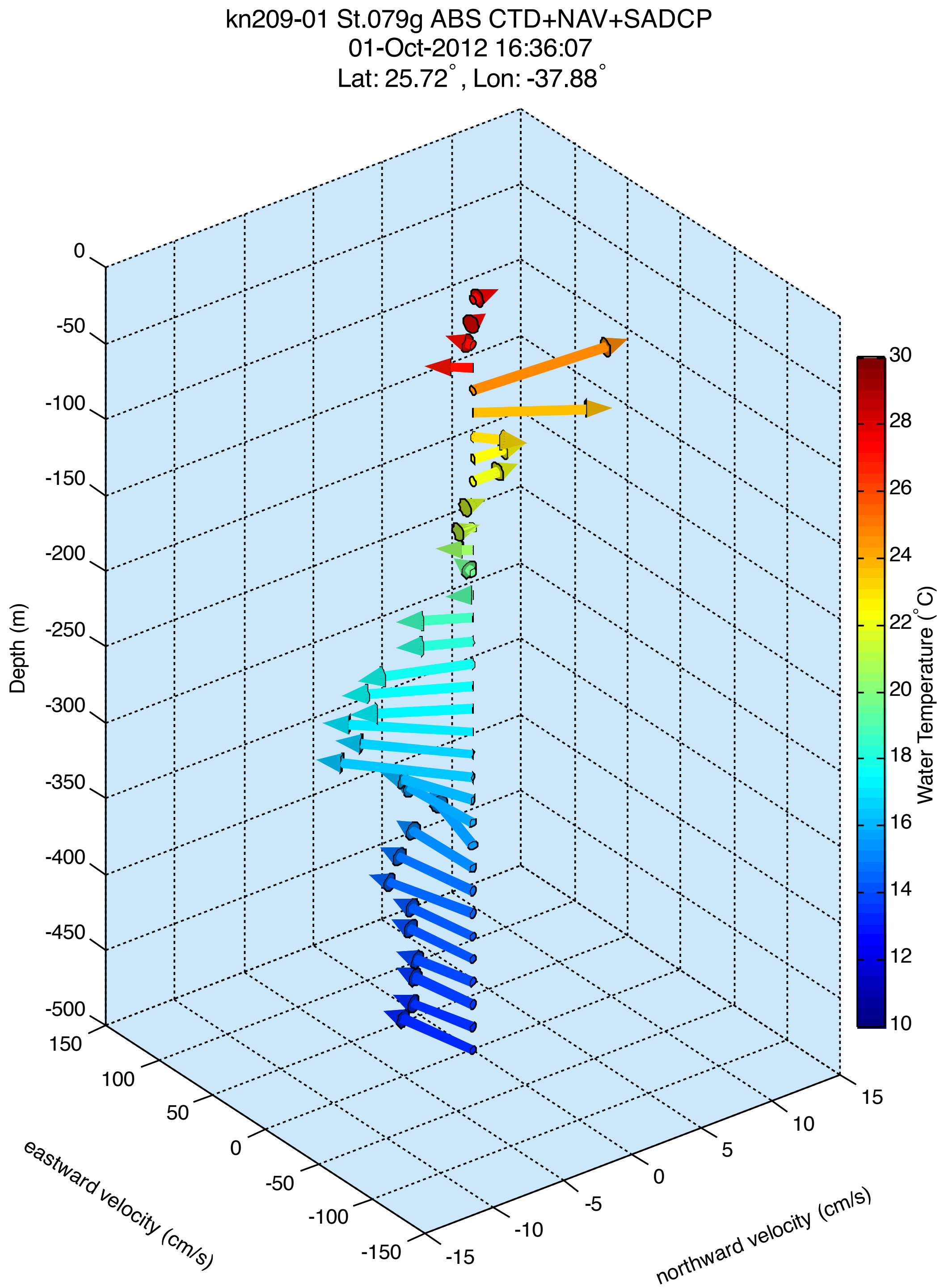
A typical image of Figure 14 is shown below:



This indicates the transition of the LADCP through the water column, starting at first ensemble (at the surface), where maximum scatter is found. One can see the artifacts and the removal of the artifacts, being mindful not to accidentally remove any good data (see documentation and code comments in LDEO_IX Software). This data may be used to produce plots of velocities and shear. It appears that on this cruise, shear was often associated with a relatively sharp thermocline found around 60m or so. This is shown below in an image generated by the code provided in (LADCP root)/matlab/wh/m, in which some lines have been added to process_cast.m to produce a figure as shown below:



This Figure shows u,v (left) Temperature, Salinity and Shear, but should only be treated as a preliminary estimate.



The length of the vector indicates speed, the orientation indicates direction and color-coding indicates temperature.

Additional information about procedure used to deploy LADCP:

The LADCP was deployed using the LADCP_acquire package using the following setup variables:

CR1
WM15
TC2
TB 00:00:02.00
TE 00:00:00.80
TP 00:00.00
WP 1
WN60
WS0500
WF0500
WV250
EZ0011101
EX00100
CF11101
RN _RDI_

This specifies 2s pings with 0.8s 'waits', 60 bins of 5 meters each and an ambiguity velocity of 2.5 m/s. The original setup of the 150kHz down-looking LADCP was an ambiguity velocity of 3 m/s and 8m bin sizes, but bin sized were adjusted by Daniel Torres (dtorres@whoi.edu) to 5m for higher resolution and ambiguity velocity was reduced by Julian Schanze (jschanze@whoi.edu) to reduce spurious returns below 900m.

The instrument was then disconnected from the cable, the connector was lubed with silicone grease and dummied off. After recovery, the instrument was hosed down with freshwater, the connector was dried and un-dummied and connected to the cable. Charging was done simultaneously with the data download, which worked flawlessly at 115200 kbit/s. The 4x12V sealed lead acid battery pack was charged using a current-limited and voltage-limited power supply at 1.6A and 58V until the charging current dropped to approximately 0.2A. The pack was then vented. After verifying a successful download, the recorder was erased to be ready for the next deployment.

Cautions:

Values of u and v below 900m should not be trusted at most stations. Please look carefully at the estimated errors.

Most paper plots have an erroneous factor of 50 for shear (as shown in the previous plot). Please divide these numbers by 50 if you want to estimate the shear. This has been fixed in the MATLAB script and re-processed.

Underway CTD -PI: Farrar; (watch standers: Lord, Hodges, Faluotico, Shanley, Meyer, Anderson, Whitely, Ngoima, Smith)

Two Oceanscience UCTD Underway Profiling Systems (or Underway CTD systems) were used heavily during the cruise, with about 740 underway CTD casts being collected between 17 September and 5 October. Each UCTD system consists of a battery-powered, internally recording CTD with a tail spool, a tail-spool winder, and a winch (Figure X1). In "free cast" mode, a length of line is wound on the tail spool with the winder, and the probe is dropped over the stern while underway; the probe falls nearly vertically through the water as the tail spool unwinds and the winch, set to free spool, pays out line to compensate for the ship's forward motion. We used, in various combinations, winches WI1029 and WI1031, winders RW1000 and RW1005, and probes 70200010, 70200023, 70200027, 70200029. All four probes had been freshly calibrated by the manufacturer (SeaBird).

With about 764 good casts taken, the UCTD systems saw very heavy use and proved to be mechanically robust given the duty cycle to which they were subjected (often performing up to 4 casts/hour). 24-hour operations were carried out from about 2200 UTC on 16 September 2012. The heavy duty cycle led to overheating of the winches; there were several winch failures, but repairs were made, typically by cleaning/repairing the brushes of the electric winch motors. By the end of the cruise, we had rigged a water cooling system by wrapping tygon tubing around the winch motor and continuously running seawater through it. We also tried propping the winch enclosure open slightly to allow air cooling and wiping the winch enclosure down with fresh water (for evaporative cooling). All three approaches had merits.

An electronic log was kept, with an entry made each time the data were offloaded from the instrument. Each cast has a separate data file, and the header of these files is the authoritative record of the cast time. The header gives the time the instrument was turned on, and the time the cast actually starts is determined by counting the number of 16 Hz scans until the instrument pressure exceeds 1 dbar. The position of each cast can be determined by matching this time with the 1-minute records of ship's GPS positions (from \\192.168.11.30\data_on_memory\athena*.csv files on the *Knorr's* network). A map of the positions of the casts is shown in Figure X2. Instrument clocks were checked against the ship's GPS time periodically over the cruise, and no clock drift was detected.

Data format and processing: The data record for each cast is stored in an ascii (text) file and contains the pressure, temperature, and conductivity output by the instrument. The file names are based on the date, approximate time, and the probe serial number; for example, file "092712_092910.SN10.asc" was collected on 27 September 2012, at approximately 09:29:10 UTC, using probe number 10. The header of each file contains the time the instrument was turned on (i.e., when the magnet was removed), and the scan number stored in the file can be used to precisely determine the time the cast actually started. The data processing done so far has been only cursory; conductivity has been lagged by one scan (1/16 second) in an attempt to better align it with the slower temperature measurement for estimation of salinity from temperature and conductivity. While this does a reasonably good job of reducing the salinity spiking that results from the mismatch of the temperature/conductivity time responses, this lag-alignment procedure needs to be revisited.

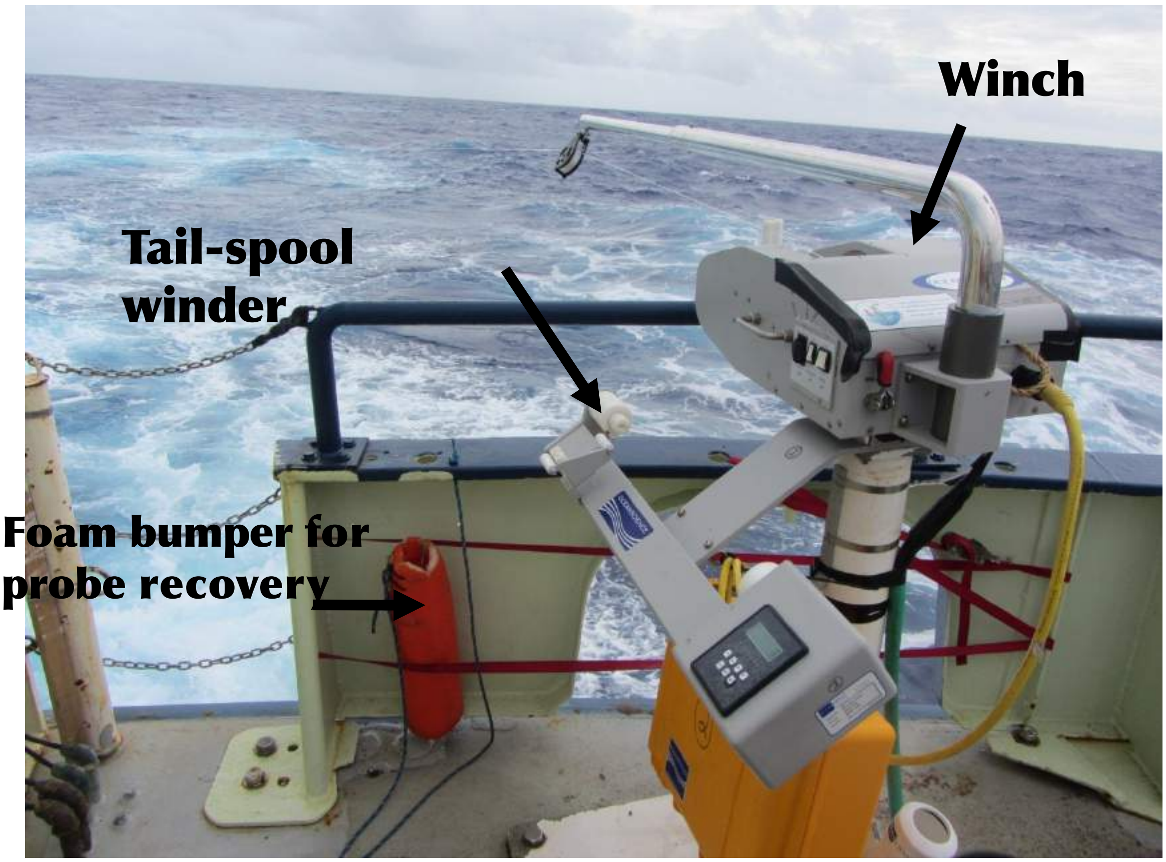


Figure X1: UCTD system during deployment on the port side of the *Knorr's* fantail.

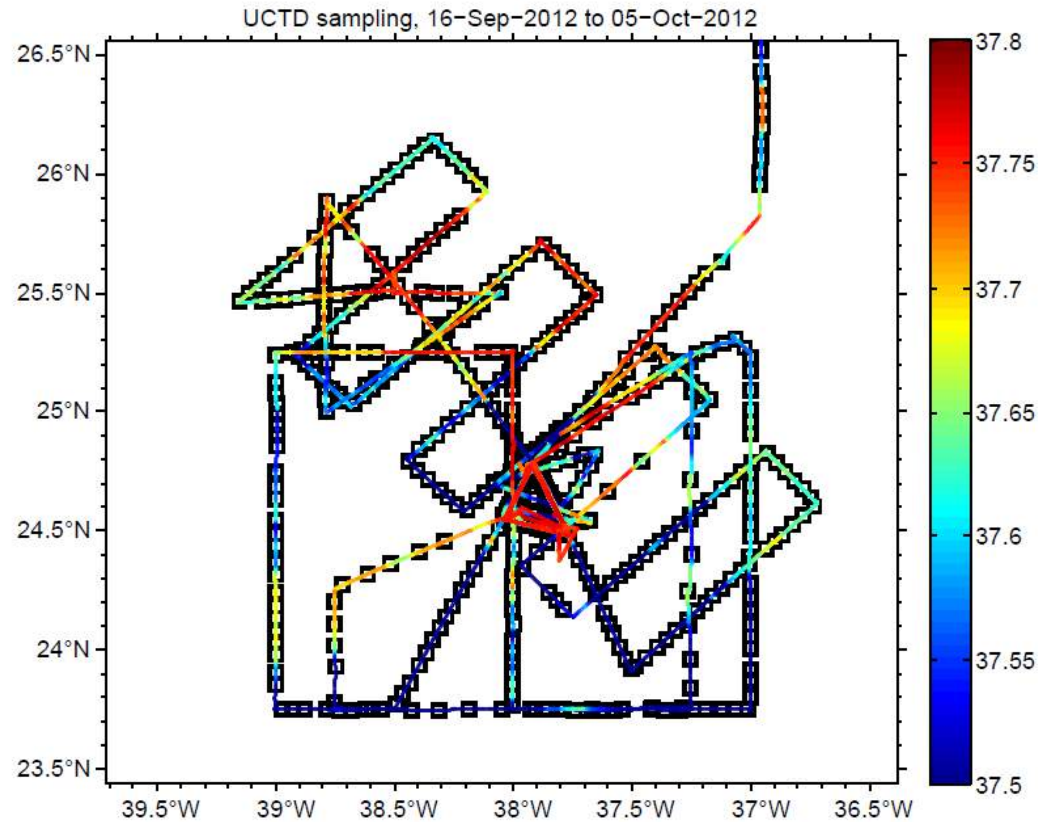


Figure X2: Positions of UCTD casts (black squares). The colored field is surface salinity from the TSG (uncorrected). The track of UCTD samples extending off the northern edge of the map extends to about 27.5°N. The inner triangle near 24.5°N, 38°W was sampled repeatedly. Typical station spacing ranged from 2-6 km.

The probes are designed to fall through the water at approximately 4 m/s, and the target depth for all casts was 400 m (100-120 s fall time). The fall speed was found to depend on various factors, including which winch was used and the direction of the windings on the tail spool. (The winder alternates the direction of the windings on the tail spool for each cast.) There is also some slight variation in the fall rate as the windings come off of the tail spool (Figure X3). Some casts were shallower than the target depth (e.g., because of tangled line or aborted casts) and some were deeper than the target depth (e.g., if the operator let the probe fall for 120 s or more).

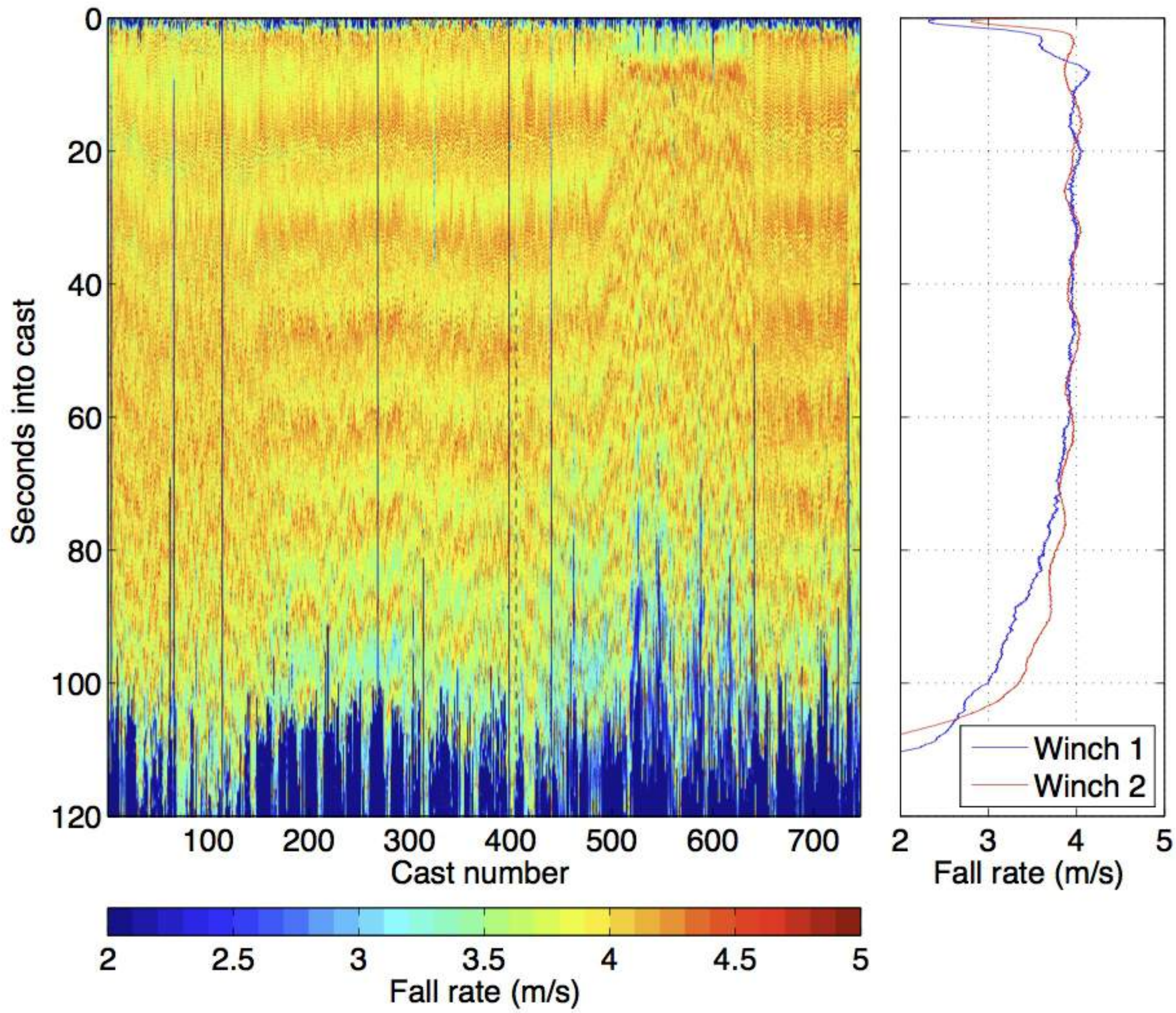


Figure X3: UCTD fall rates computed from rate of change of pressure. The nearly periodic signal in the number of seconds for which fall rates over 2 m/s are seen is due to the change of watches, with different watches letting the probe fall for 100-120 seconds before beginning retrieval. There were also systematic differences between winches, as seen in the composite fall rates in the right panel for the two winches.

Data quality monitoring: Data quality was monitored continuously during UCTD operations, primarily by use of an automated script that compares a near-surface value of salinity from each cast to the shipboard thermosalinograph (TSG; 5-m intake) and compares T-S profiles of nearly co-located UCTD and shipboard CTD casts. The TSG and shipboard CTD were regularly compared to water samples run on the salinometer, and they are more trustworthy than the UCTD. Special efforts were made to time UCTD casts to occur as nearly as possible to CTD stations. Examples of these quality-control measures are shown in Figures X4-X5. Probes were rotated out of service on the basis of these comparisons.

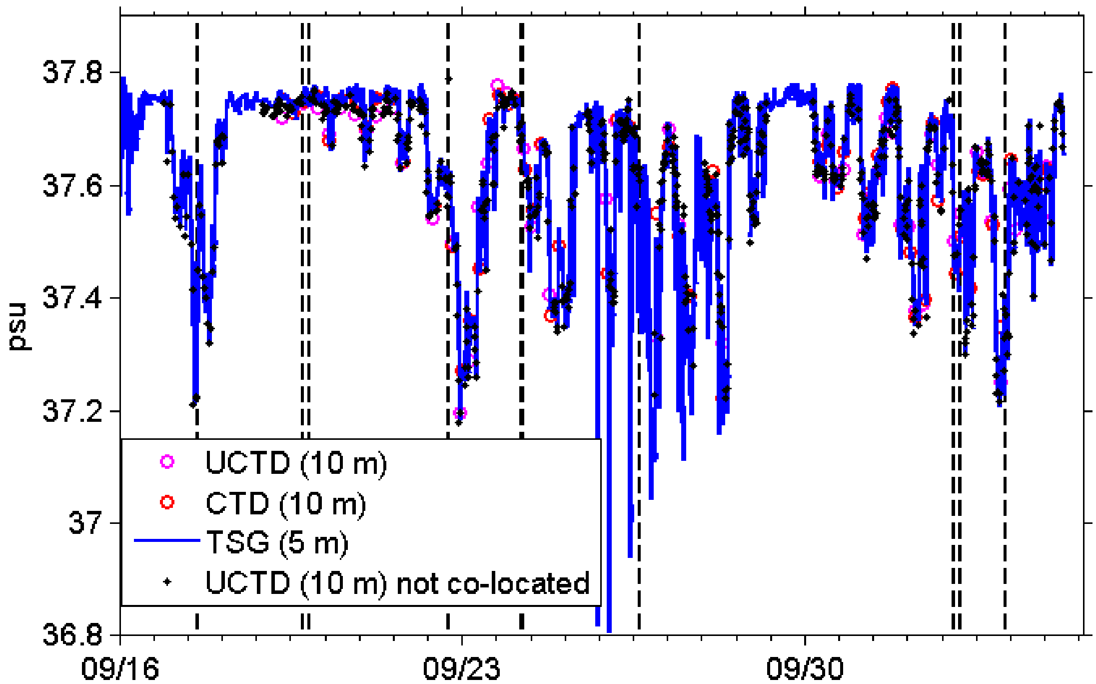


Figure X4: Comparison of UCTD data at 10 m (black dots and pink circles) to underway TSG data at 5 m (blue line; with a preliminary estimated bias of 0.007 psu removed) and shipboard CTD at 10 m (red circles). The dashed, vertical lines indicate times when UCTD probes were switched (see also Fig. X5). This was one of the measures undertaken to monitor performance of the UCTD probes.

Two probes (10 and 27) were taken out of service after their glass conductivity cells were broken in collisions with the stern during recovery. Probe 29 had a faulty battery connection. We attempted to repair it but could not reliably collect data while the probe was deployed; it could, however, reliably collect data on the bench. Probe 23 was taken out of service on 26 September because its salinity appeared to be biased high based on comparisons of its measured T-S relationship to that of the shipboard CTD (e.g., Figure X5). It re-entered service on 3 October 2012 after the only other functioning probe (SN10) was damaged during recovery (broken conductivity cell). On 5 October 2012 at 19:15 UTC, probe 23 was lost at sea when the bail on the tail spool apparently vibrated loose. The ship speed was 11.2 knots.

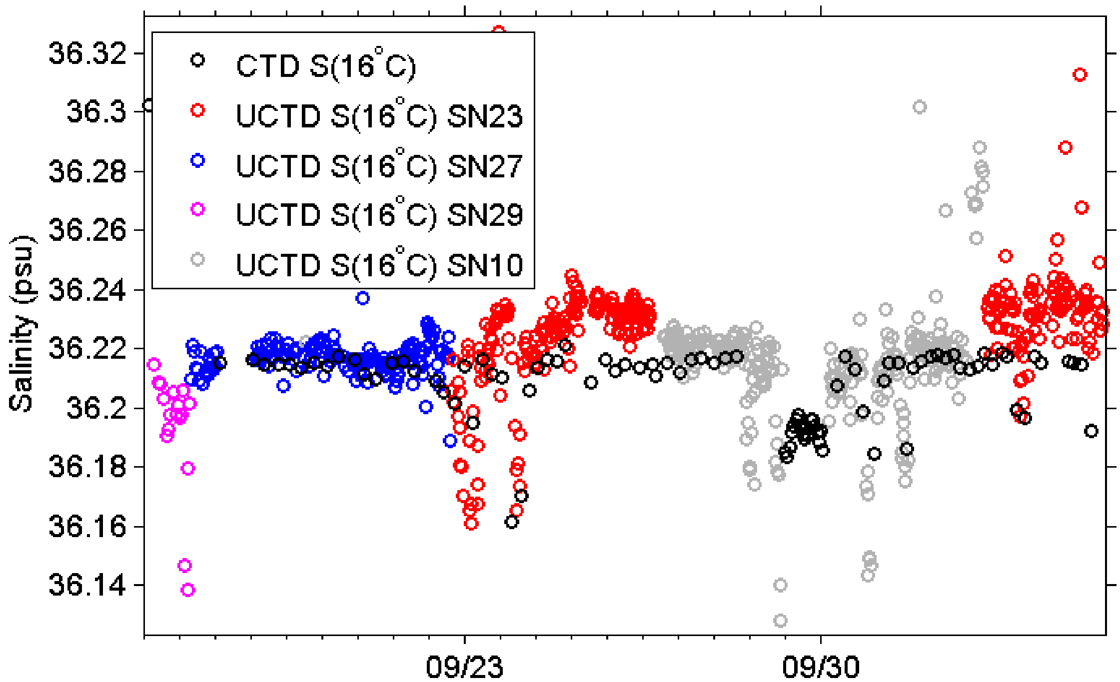


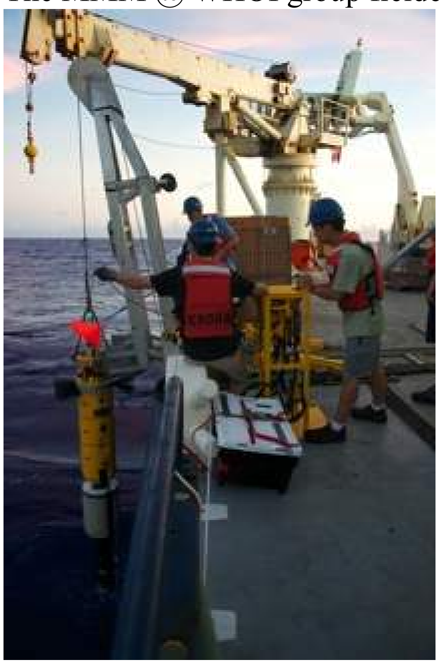
Figure X5: Salinity (uncorrected) on the 16°C isotherm for the shipboard CTD (black circles) and the UCTD (colored circles, with color indicating probe number). The T-S relationship is relatively stable at 16°C, and this was used as a metric of probe performance during UCTD operations. Probe 23 was re-entered into service after all of the other probes ceased to function.

Prospects for in situ calibration: Since one probe was lost, two have damaged conductivity cells, and the fourth saw only limited use because it ceased to function, post-cruise calibration will be of limited utility. The salinities shown in Figures X4-X5 are uncorrected, but it may be possible to use the coincident CTD and UCTD casts or other information, such as the relatively stable deep T-S relations, to correct biases in the data from individual probes. The best way to do this is not clear; one possibility would be to attempt separate regressions of temperature and conductivity against the nearly coincident CTD casts. Internal-wave heaving or other variability on short temporal or spatial scales is apparent from the fact that the CTD-UCTD T-S relations agree better than the T and S do individually, so the success of this approach would require an adequate statistical sample. Another approach might be to assume that the temperatures measured by the UCTD probes were accurate and regress conductivities or salinities as a function of measured temperature. This approach would be akin to performing a calibration in T-S space under the assumption that T was measured accurately. These possibilities and others need further evaluation prior to preparation of a final version of the data.

SPURS Microstructure –Ken Decoteau,Alec Bogdanoff, Oliver Sun and James Riley

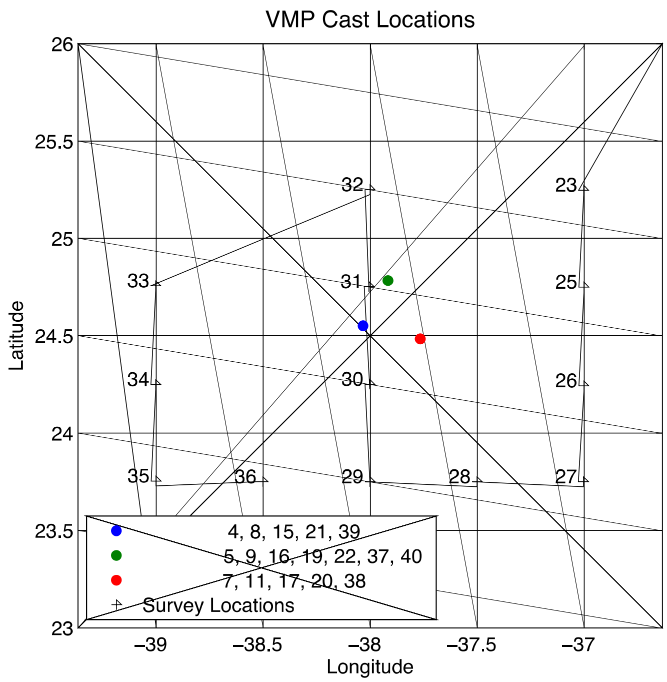
The microstructure effort of the SPURS I cruise was led by the Mixing, Measurement, and Modeling (MMM) group at the Woods Hole Oceanographic Institution (WHOI) under Principal Investigators Raymond Schmitt, Louis St. Laurent and Carol Anne Clayson. Engineer Ken Decoteau led the shipboard microstructure operations for SPURS with the team listed above.

The MMM @ WHOI group fielded eight instruments for the SPURS I cruise: two Rockland Scientific VMP5500 Vertical Microstructure Profilers, three Slocum Electric Gliders, and three Rockland MicroRider turbulence packages. The VMPs were equipped with microstructure temperature and shear probes, along with standard Seabird CTDs in pumped operation. Each Slocum Glider was deployed with a MicroRider attached. The combined platforms, which became known as a "T-Gliders," collected turbulence data similar to that of the VMPs, in addition to standard CTD and navigational data.



Pictured: Ken and Oliver on a VMP recovery (left) and initial deployment of Helo using the rake (below).

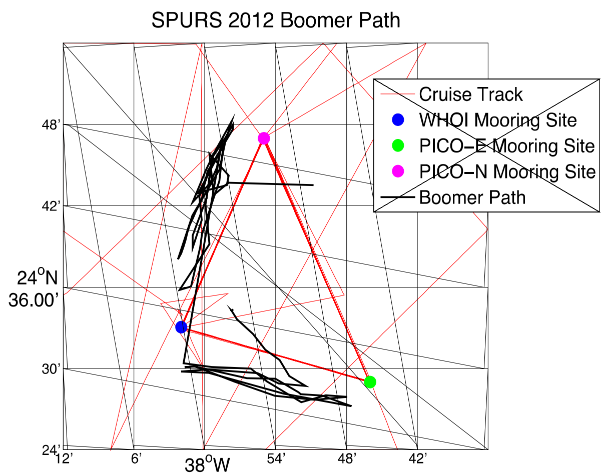
VMP missions were planned for each CTD station during SPURS. The VMP was typically released a few minutes before the ship's CTD was lowered into the water and recovered immediately after the CTD rosette was secured on deck. The microstructure and CTD profiles were taken nearly concurrently. Due to flooding of the primary VMP at an early test station, the backup VMP was used for all measurements during the cruise. A total of 31 VMP casts were attempted, with the first 13 rotating between the 3 mooring locations, another 13 during the wide-area survey (Butterfly pattern), and 5 upon return to the mooring triangle. A recurring electrical malfunction affected about 1/4 of the casts during the initial mooring survey and wide-area survey stages, with partially recoverable data. The malfunction worsened with repeated use, eventually rendering the VMP inoperable for the remainder of the cruise. We are currently working on recovering data from the final 3 casts.

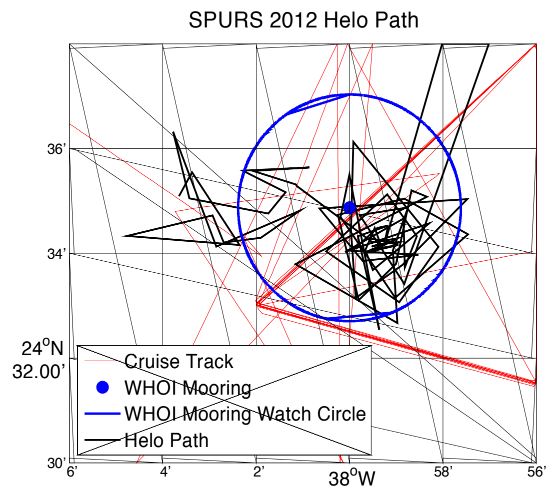


Two T-Gliders were deployed shortly upon arrival in the SPURS sampling area. Except for a brief, ~1 day check-up period for each instrument, the gliders remained in the water for the duration of SPURS operations, or about two weeks. During the check-ups, each glider's MicroRider was found to have sustained minor flooding through its nose cone. Glider "Boomer," profiled to 200 m along lines between the PICO-N and WHOI moorings for the first half of the cruise, and the WHOI and PICO-E moorings during the second half. Glider "Helo" stayed within 2 km of the WHOI mooring throughout its mission and profiled to an initial depth of 50m, which was soon extended to 70m. A third T-glider, "Saul," was deployed for about a day during the dynamic positioning stations. Together the three gliders recorded 2235 successful microstructure casts, with 1668 from Helo and 567 from Boomer.

Deployment & Recovery

The primary method of deployment and recovery of the VMP is the HRP LARS system; a hydraulic valve spool controlling a set of forks and a winch perform most of the active movements for the system. On deployment, the line is attached to the bail of the VMP via a pin through a loop in the line. The VMP is released when the pin is pulled. To recover, the VMP is hooked forward of the LARS system and brought to the main hook where the winch line is attached to the bail. The VMP is raised out of the water and brought back on board.





The gliders were deployed using a newly designed "rake" that holds the glider as it is lowered into the water using a crane and can be pull away once the glider is floating in the water. A small boat is required as a buoy is tethered to the gliders for the first few dives. Once the go-ahead is given the buoy is removed from the glider and the glider is set on its mission. To recover a glider, a small boat is driven to the glider and it is taken on board and brought back to the ship. Due to the sensitive nature of the probes, great care is taken when deploying and recovering the T-Gliders.

Instrument Details

The initial VMP deployed was SN008 "Vito". This instrument was seriously damaged due to failure of the aft bulkhead seal. Approximately half a cup of seawater entered the pressure case while the instrument was held at surface for its initial ballast checks. The electronics were stripped off the chassis, and the instrument parts were cleaned and investigated for signs of damage. The cause of the bulkhead failure was evident, though a main face seal failure seems likely.

The second VMP, SN010 "Vader," was assembled to replace of the flooded instrument. Initial ballast checks with SN010 were successful. After a few casts, however, a failed o-ring was found on one of the new cables. Although there were no signs of further o-ring failures, the instrument continued to experience intermittent electrical malfunctions, or "glitches," on subsequent casts.

The deep G2 glider, Boomer was prepared with MicroRider MR036, a high power MR with two shear, and two micro-temperature probes. Boomer initially sampled on upcast only, from a depth of 200m to surface. It was first deployed on September 14, 2012 in a triangle pattern west of the PMEL-North buoy. After the mooring deployments, Boomer was moved in closer to the moorings, and then spent roughly 10 days moving along a 20km North-South line just West of the PMEL-N/WHOI moorings. After being recovered due to a problem with sensors, it was found that the nose cone had flooded due to a pinched o-ring. The instrument was repaired and redeployed on September 25, 2012 along an East-West line South of the moorings. This glider profiled for an additional 175 upcast and downcasts to 200m.

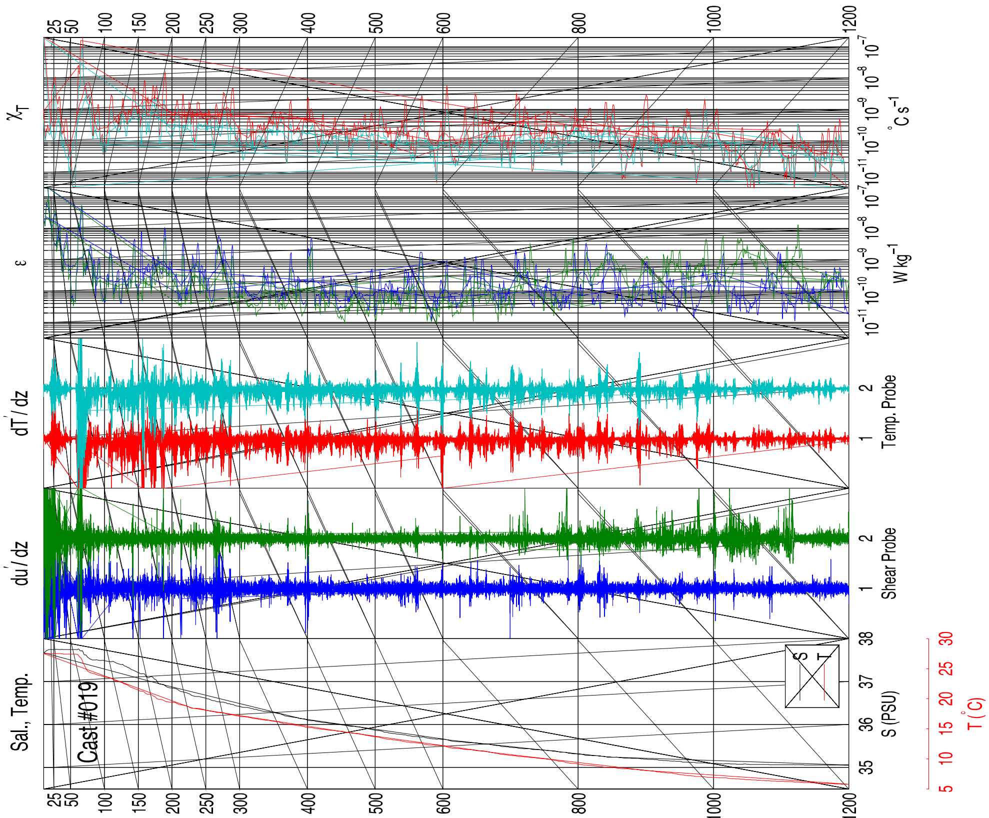
The shallow G1 glider, Helo was prepared with MicroRider MR065, a low power MR with micro-conductivity, two shear, and one micro-temperature probe. Helo initially sampled to 50 meters holding station near the WHOI mooring. This depth target was quickly adjusted to 70 meters after analyzing the CTD data from Boomer. Initial concerns about the light ballasting of Helo were still relevant, and the 70m target was probably the maximum depth capable of this glider. After six days, with some questionable results keeping the glider on-station, the waypoint behavior was transitioned to a more normal line a few kilometers long, roughly East-West, but still near the WHOI mooring.

On September 18, Helo was recovered due to signs of sensor failure. Like with Boomer, the nose cone had flooded. Of the 411 profiles in this first segment, the first half appear fair, however, the last half exhibit clear issues as the single micro-temperature and one of the two shear channels succumbed to seawater. Also, a six-hour chunk of CTD data was missing due to a science motherboard error. Helo was repaired and redeployed on September 18, 2012. A total of 961 profiles were obtained during this second set. The same mission parameters were used for the remainder of its time in water until it was recovered on October 4, 2012. Helo looked to have encountered something in its travels, which “chewed off” the tips of both shear probes, and bent one of the prongs off the micro-conductivity.

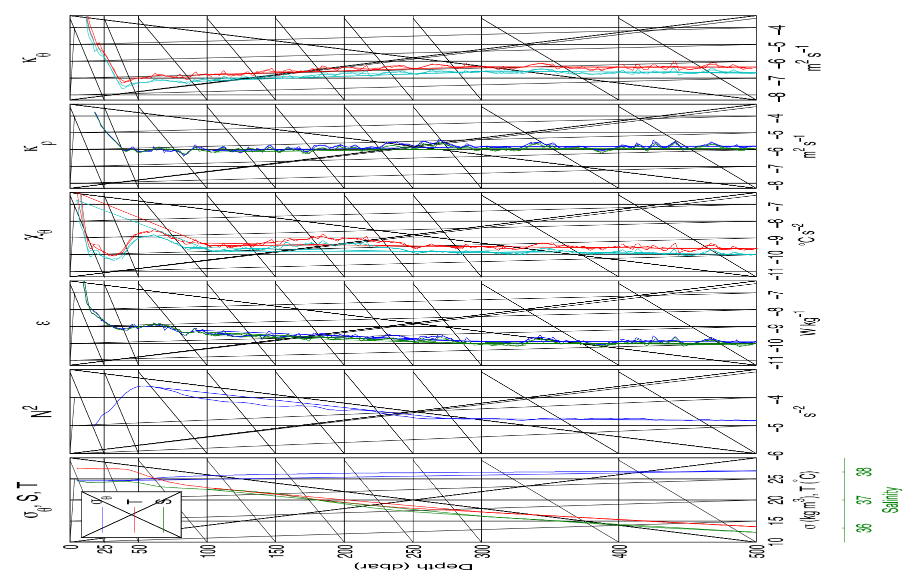
The shallow G1 glider, Saul (u064) was prepared for a deployment of up to 24 hours off-site at a salinity maximum. The glider was prepared with MicroRider MR049. Ballasting was performed in the water, alongside the small boat. It was determined that the glider flew well enough to release for mission, although some electrical issues with the science motherboard, coupled with flight and mission parameter issues resulted in no useful data from this deployment. It was useful in that we now know a bit more about two failure modes for both our MicroRider triggering method, and with the mission we had been relying on with our other gliders.

Data & Preliminary Results

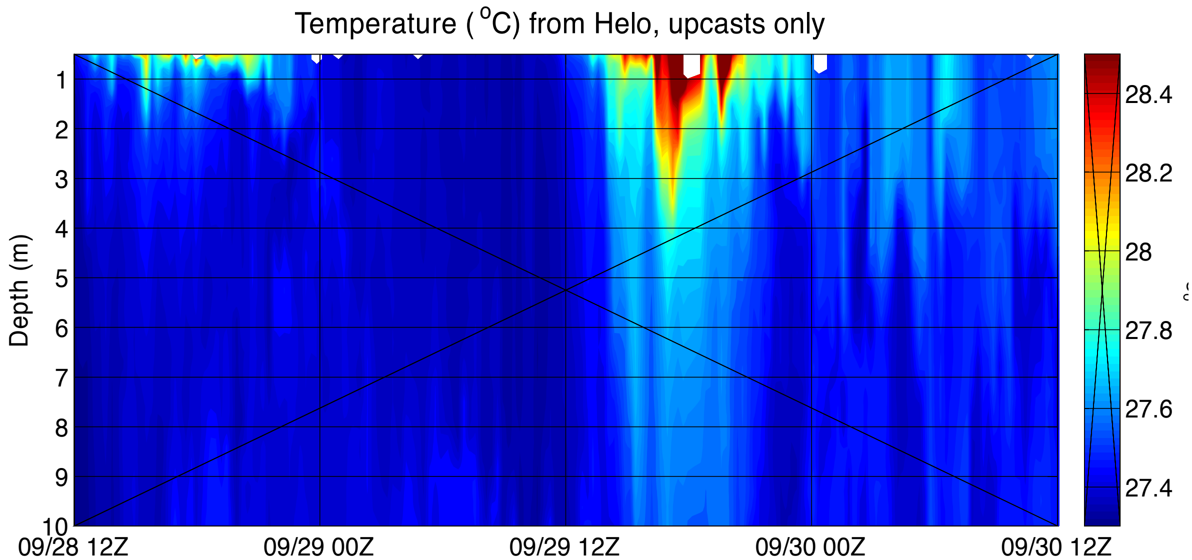
The MicroRider internally records the microstructure data and CTD data from the glider is record on the science bay of the glider. The VMP internally records all microstructure and CTD data to one file. The glider records of microstructure and CTD must be matched up in time and depth. This requires carefully investigation of each cast, and thus only a few casts were processed on board the Knorr.



The figure above is an example of the type of data collected by the VMP after our initial shipboard processing. This particular figure is for cast #019, which was done at the PICO-N buoy. From left to right the first profile is of salinity and temperature, the shear from the two shear probes, the temperature gradient from the micro-temperature probes, an estimate of dissipation from the two, and estimate of χ_T. Based on the data collected from the cruise, we created a composite of the microstructure of the region. The figure to below includes potential density, salinity, and temperature; buoyancy frequency; dissipation; χ_T; K_ρ; and K_θ.



Initial review of the data collected from the gliders is promising. The plot below shows the days in which the diurnal warming was the largest during the cruise. The data is from Helo's upcasts only. The diurnal warming is very clear in the profiles and corresponding microstructure is available for those dives.



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Data web page: **http://iop.apl.washington.edu/seaglider/index.php**

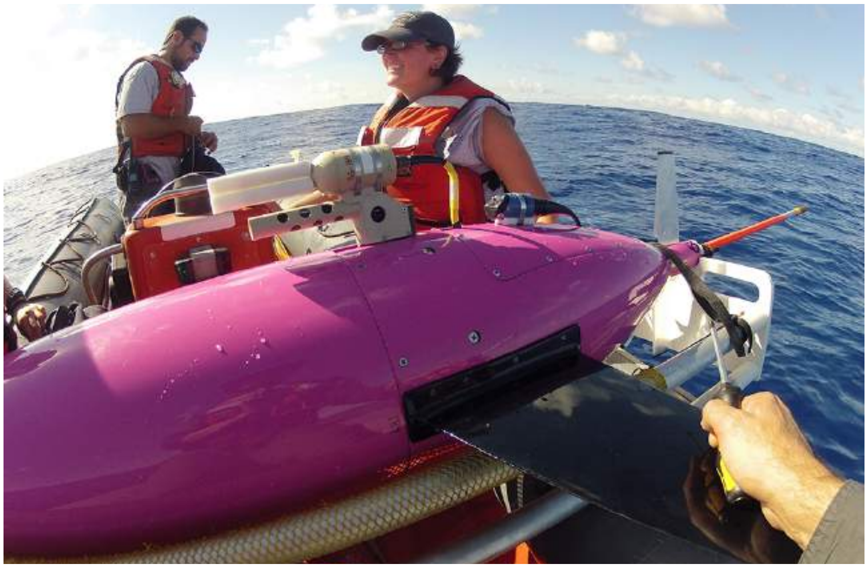


Fig. 1 SG189 during the "attitude adjustment" procedure.

Instrumentation
Each of the three wavegliders contains:
- CTD,
- Oxygen Optode,
- Fluorometer/scatterometer,
- Dual micro-T probes

Deployment

SG#	Deployment time (UTC)	Deployment location	Notes
189 (pink)	2012-09-13 18:01	24° 34.162′ N, 38° 01.845′ W	
190 (yellow)	2012-09-15 17:58	24° 44.922′ N, 37° 55.505′ W	
190 (yellow)	2012-09-16 16:33	24° 34.757′ N, 38° 03.970′ W	Redeployment
191 (yellow)	2012-09-16 18:11	24° 34.690′ N, 38° 03.785′ W	

SG189
SG189 was deployed on September 13, 2012. During the first dives it became clear that the glider is out of trim (40° roll to STBD). Misaligned forward fairing (which has a keel weight) was hypothesized as the likely cause of the problem.

On September 14, 2012, SG189 was recovered into a RHIB. Fairing misalignment was confirmed and corrected (Fig. 1), and the glider was redeployed.

SG190
SG190 was deployed September 15, 2012. The first dives were unsuccessful due to the excessive buoyancy of the glider. It was determined that extra 200g of lead weight needed to be added.

The same day, the glider was recovered with a RHIB. An attempt to add weight while in the RHIB failed (a piece of lead lost in the fairing), so the glider was brought on board Knorr.

Overnight, 200g (50+50+100g) of lead was affixed in the inside of the aft fairing (at 3,9, and 6 o'clock positions, respectively, see photo.)

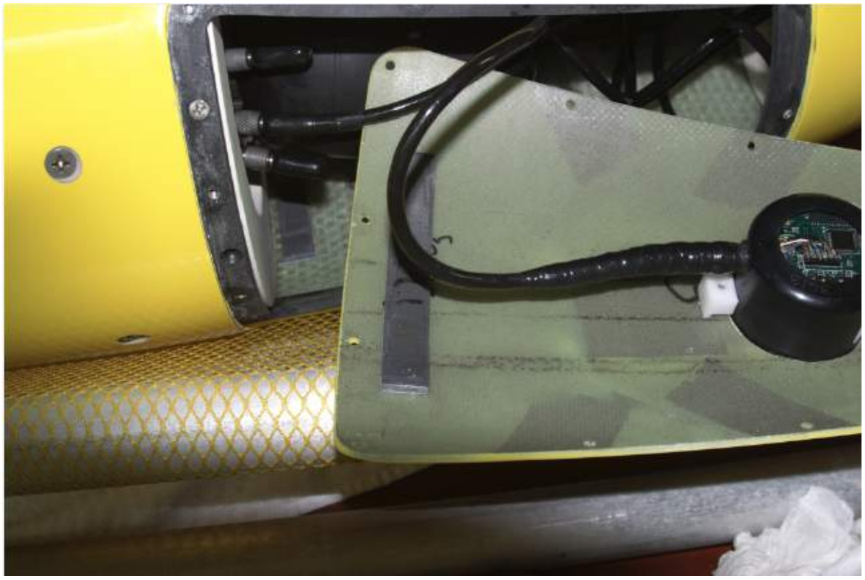


Fig. 2 Added weight placement in SG190 (50- and 100-g lead strips visible).

The glider was re-deployed the following day (September 16, 2012) without further complications.

SG191
Prior to the deployment, it was determined that SG191 may suffer the same ballasting issue as SG190. To correct that, 100g of lead was added (50+50g, inside the aft fairing at 4 and 8 o'clock positions).

SG191 was deployed on September 16, 2012 without an incident.

Navigation patterns

Seagliders 190 and 191 navigate the 140×140km box racetrack pattern (Fig. 3). SG189 navigates the smaller 50×50 km bowtie pattern. All the patterns are centered approximately at (24°34'N, 38°02'W), just S of WHOI mooring.

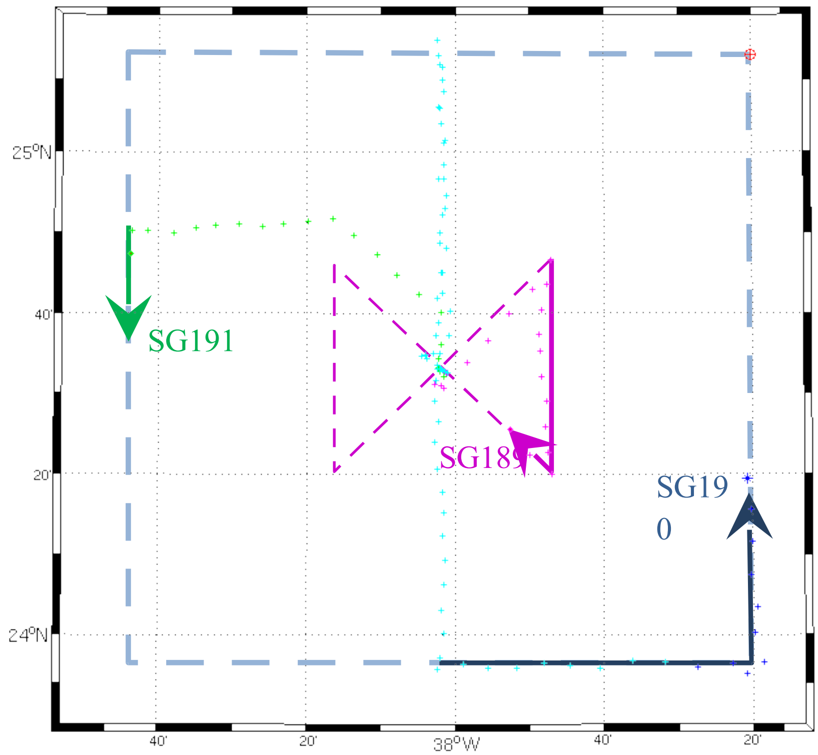


Fig. 3 Seaglider positions as of October 7, 2012 and their navigation patterns.

Cross-calibration with Rosette CTD

SG#	Dive #	CTD cast	Time
189	76	97	Oct. 4 20:34Z
190	41	44	Sep. 26 18:05Z
191	38	43	Sep. 26 16:44Z

CTD casts were started simultaneously with the gliders' dives, but there were much faster (30' vs. $1^h45'$). Naturally, profiles diverged due to internal wave activity (Fig. 4). Agreement between Seagliders and Rosette CTD becomes much tighter in TS space (Fig. 5), with mean salinity offsets of O(0.01) (assuming accurate temperatures). Careful calibration will follow.

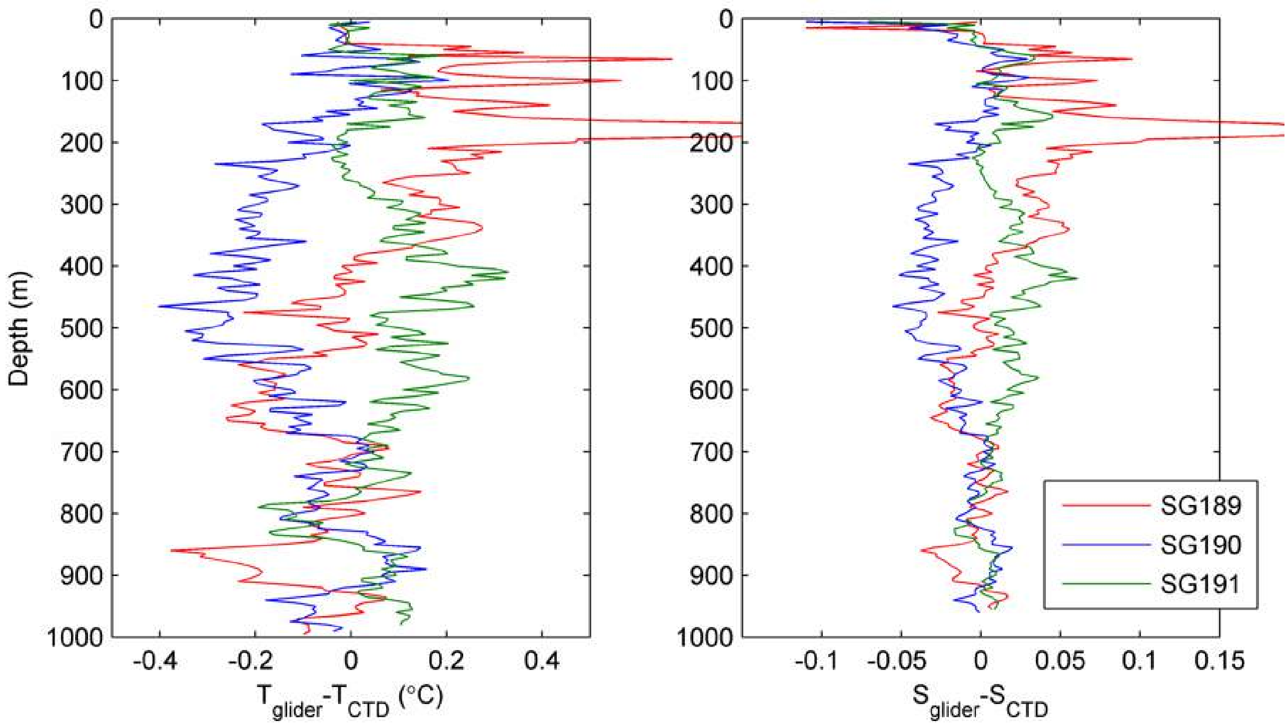


Fig. 4 Differences between Seaglider and Rosette CTD temperature (left) and salinity (right) during simulcasts.

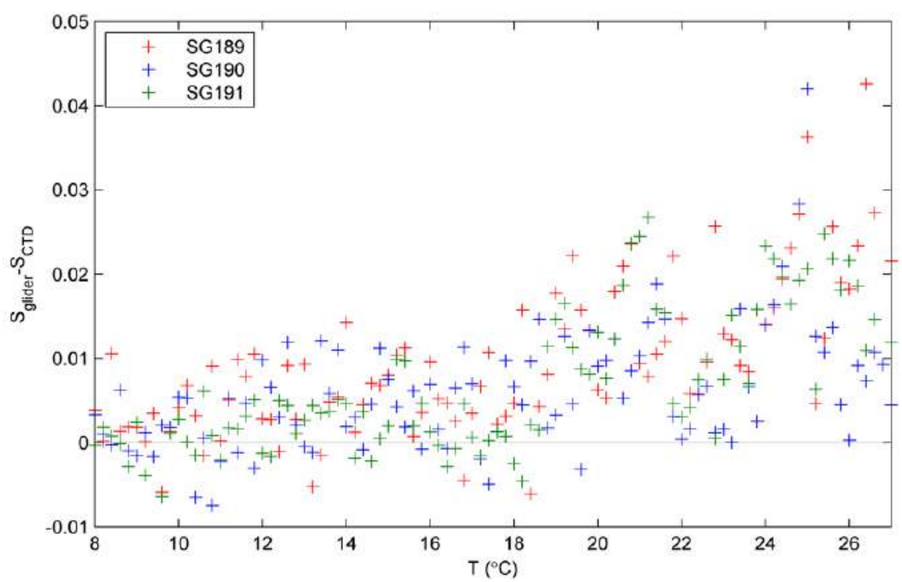
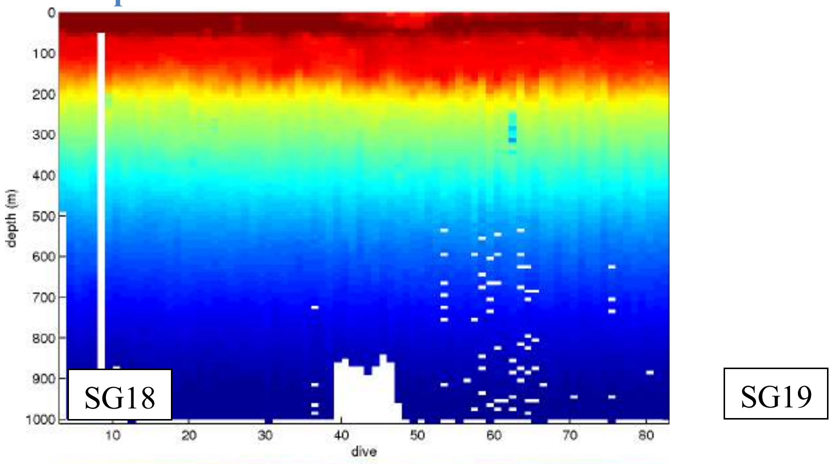
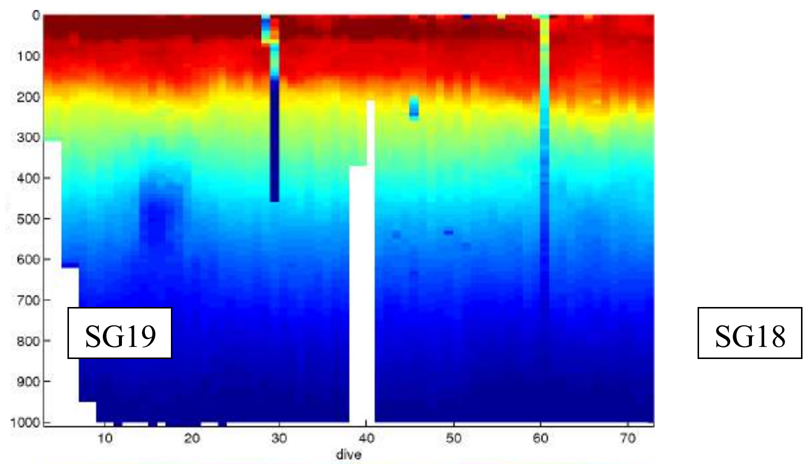
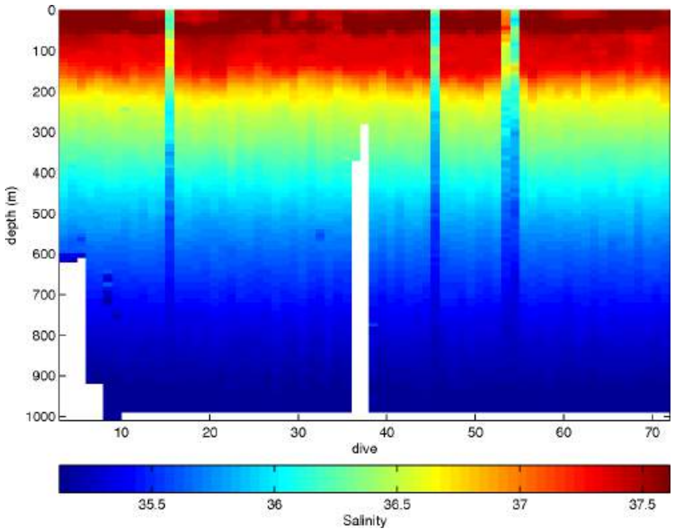


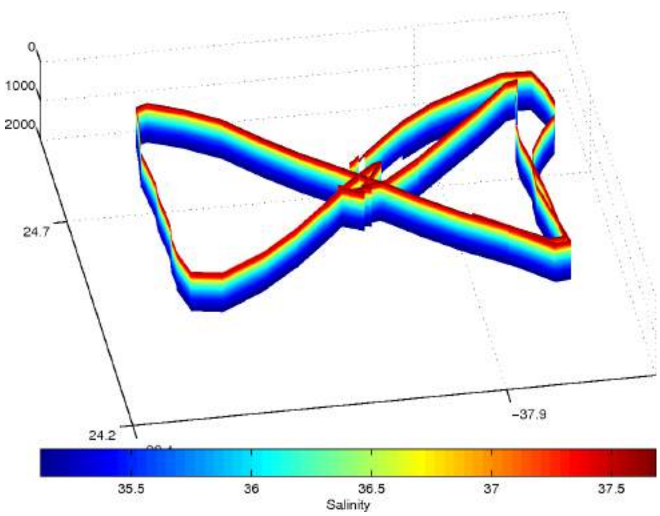
Fig. 5 Differences in salinity measured by Seagliders and Rosette CTD during simulcasts as a function of temperature.

Sample sections






depth (m)
0
100
200
300
400
500
600
700
800
900
1000
dive
10
20
30
40
50
60
70
35.5
36
36.5
37
37.5
Salinity


0
1000
2000
24.7
24.2
−37.9
35.5
36
36.5
37
37.5
Salinity

STS/PAL APEX Floats **Jessica Anderson**

During the SPURS R/V Knorr cruise, 26 Argo-type profiling floats were deployed for Dr. Stephen Riser from the University of Washington. Two (2) additional floats were damaged during shipment to the Knorr and were sent back to Seattle prior to departing Woods Hole. All floats deployed were equipped with Surface Temperature and Salinity (STS) and Passive Acoustic Listener (PAL) sensor packages in addition to the primary SBE41 CTD. The unpumped SBE STS sensor makes high vertical resolution (~10cm) temperature and salinity measurements from 30m all the way to the sea surface, operating in tandem with the primary SBE41 from 4-30m. The PAL uses a broad-band hydrophone to measure wind speed and rainfall acoustically while the float is drifting at a depth of 1000m between profiles. Additionally, the use of Iridium satellite telemetry allows for 2-way communication with the floats so that the float mission (depth, frequency, etc.) can be changed after deployment.

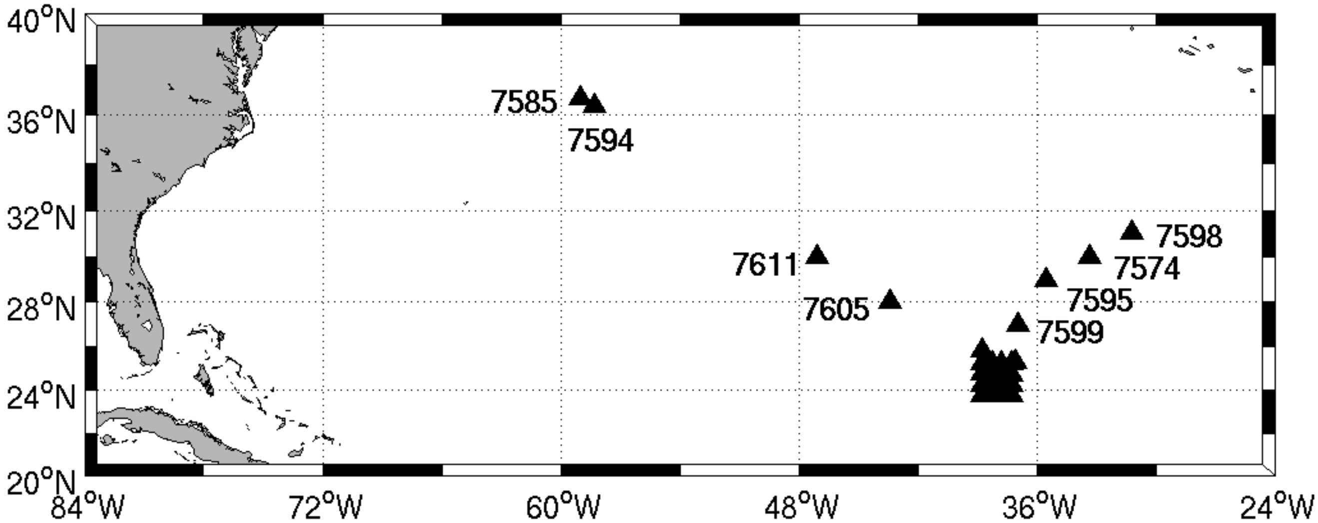
Eight (8) floats were deployed during the transit to/from the SPURS region from Woods Hole/Ponta Delgada, respectively. An active hurricane season provided the opportunity for 2 of these floats to be deployed in the projected path of Hurricane Leslie. The remaining floats were deployed in a 4 by 4 grid surrounding the SPURS central mooring. Float spacing was approximately 0.5 degrees. All floats were deployed by lowering them on a line from the stern of the ship while moving at approximately 1 knot. Three (3) deployed floats failed for unknown reasons. One of these floats was recovered on 9/22/2012 and will be shipped back to Seattle for diagnosis.

All deployed floats are part of the Argo program (www.argo.ucsd.edu) with support for the STS/PAL sensors provided by NASA in conjunction with SPURS. Data from the primary SBE41 CTD can be accessed in real-time via www.coriolis.eu.org. Additionally, raw data from the SBE41, SBE STS, and PAL sensors can be accessed at http://runt.ocean.washington.edu/. Deployment locations and sample profiles are provided below.

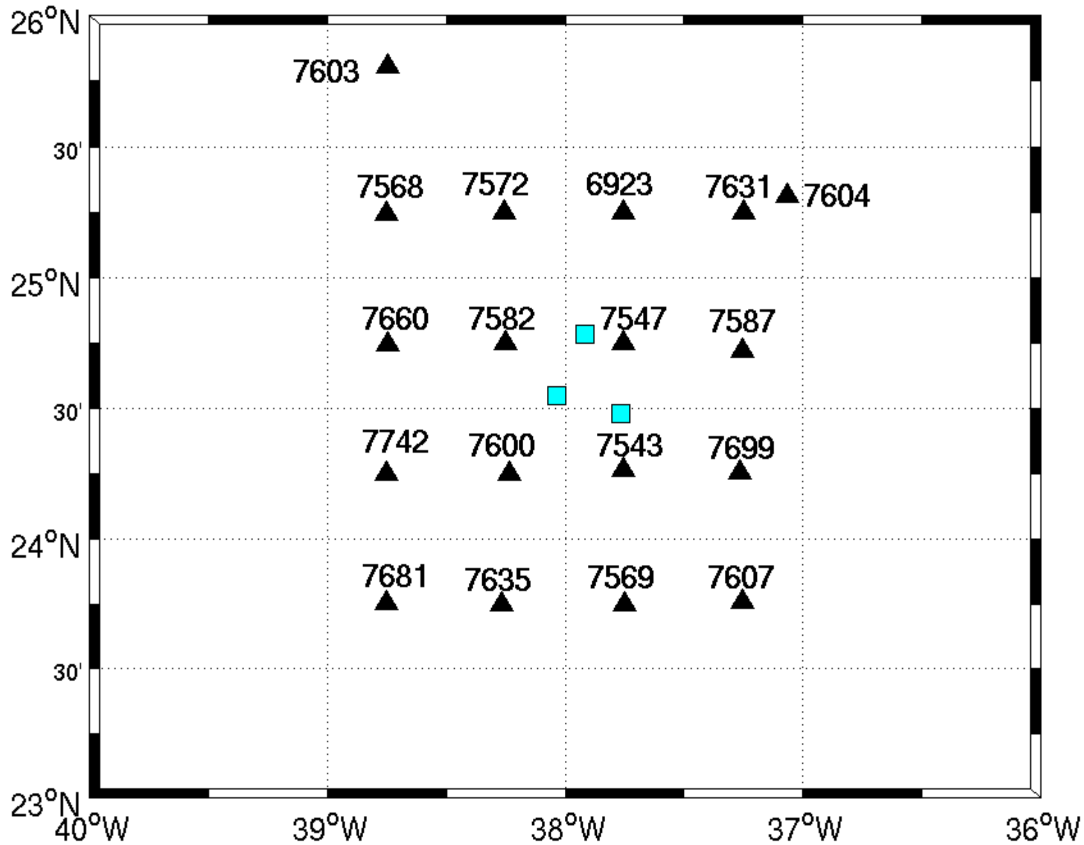
←Argo Float Endcap with

SBE41, STS, & PAL Sensors

Transit Argo Float Deployment Locations



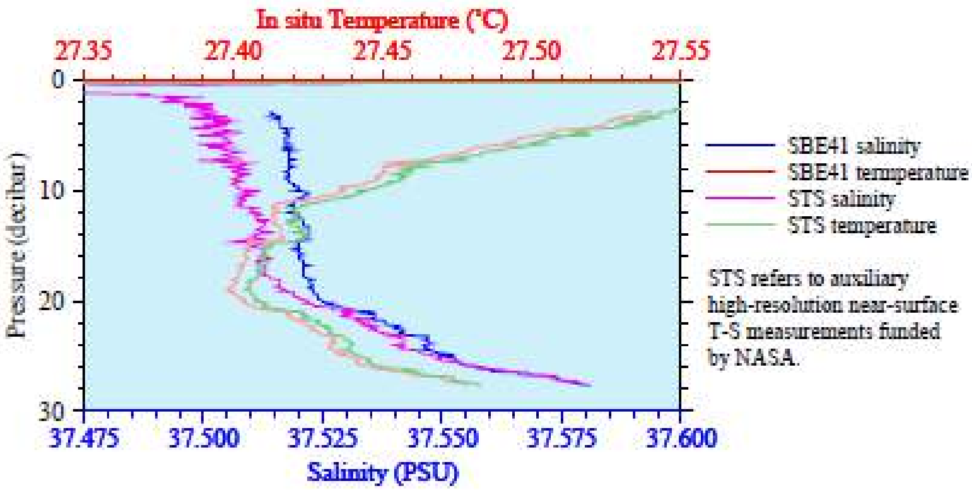
SPURS Grid Argo Float Deployment Locations

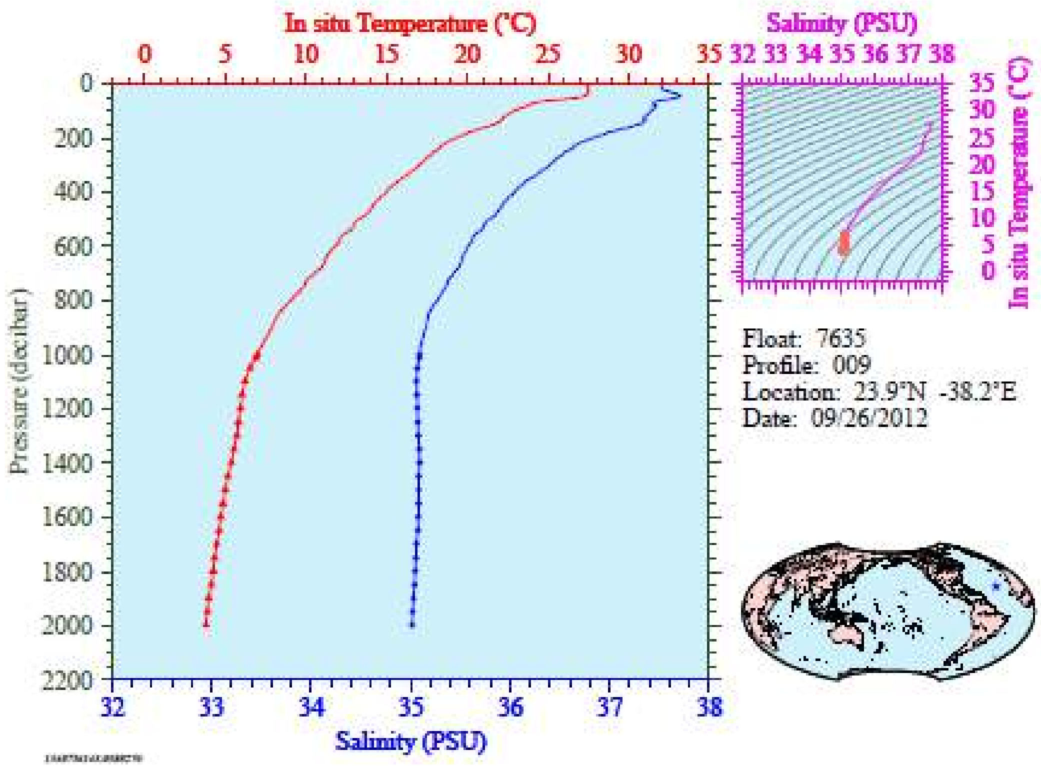


SPURS Argo Float Deployment Details

Date	Float ID	Latitude	Longitude	Comments
09/08/2012 17:14	7585	36.6545	-58.9871	Hurricane Leslie
09/08/2012 20:12	7594	36.3432	-58.3153	Hurricane Leslie
09/11/2012 04:50	7611	29.9949	-47.0929	
09/12/2012 01:44	7605	28.0006	-43.3840	
09/13/2012 22:20	7600	24.2520	-38.2340	SPURS Grid
09/14/2012 00:59	7543	24.2669	-37.7548	SPURS Grid
09/15/2012 02:55	7547	24.7528	-37.7558	SPURS Grid
09/15/2012 05:24	7582	24.7505	-38.2516	SPURS Grid
09/16/2012 00:42	6923	25.2514	-37.7529	SPURS Grid
09/16/2012 03:11	7572	25.2492	-38.2546	SPURS Grid
09/16/2012 05:41	7568	25.2426	-38.7511	SPURS Grid. Failed.
09/16/2012 08:27	7660	24.7473	-38.7449	SPURS Grid
09/17/2012 03:15	7631	25.2480	-37.2490	SPURS Grid. Failed. Recovered 9/22.
09/17/2012 07:00	7587	24.7212	-37.2524	SPURS Grid
09/17/2012 10:02	7699	24.2551	-37.2651	SPURS Grid
09/17/2012 13:10	7607	23.7579	-37.2541	SPURS Grid
09/17/2012 16:04	7569	23.7504	-37.7508	SPURS Grid
09/17/2012 19:01	7635	23.7491	-38.2654	SPURS Grid
09/17/2012 21:47	7681	23.7525	-38.7522	SPURS Grid
09/18/2012 00:42	7742	24.2519	-38.7518	SPURS Grid
09/22/2012 09:07	7604	25.3143	-37.0677	SPURS Grid. Replacement for Float 7631.
09/30/2012 11:34	7603	25.8030	-38.7486	SPURS Grid. Replacement for Float 7568. Failed.
10/05/2012 15:48	7599	26.9957	-36.9675	
10/06/2012 05:17	7595	28.9981	-35.5422	
10/06/2012 16:29	7574	29.9939	-33.3164	
10/07/2012 03:26	7598	31.0184	-31.1957	

SBE41 & STS Sensor Profile





Wave Gliders –Dave Fratantoni and Ben Hodges

Three Liquid Robotics, Inc. Wave Gliders were deployed from R/V Knorr (see Table). Each Wave Glider (WG) was equipped with two Sea-Bird GPCTD's , one at nominally 22 cm depth beneath the surface float and a second at approximately 660 cm depth on the sub. Additionally, each WG carried an Airmar PB200 Weather Station on a one-meter mast, and an Airmar CS4500 ultrasonic water speed sensor. On initial deployment each vehicle carried a small radar reflector on the met mast – these were subsequently removed when it became clear they were completely ineffective as radar targets yet likely contributors to mast breakage.

Vehicle	Flag Color	Deploy Time	Deploy Position	
WHOI-ASL2	Red	15-Sep 1705Z	37 56.50 W	24 44.70 N
WHOI-ASL3	Yellow	16-Sep 1340Z	38 04.04 W	24 34.68 N
WHOI-ASL4	Green	16-Sep 1335Z	38 04.00 W	24.34.70 N

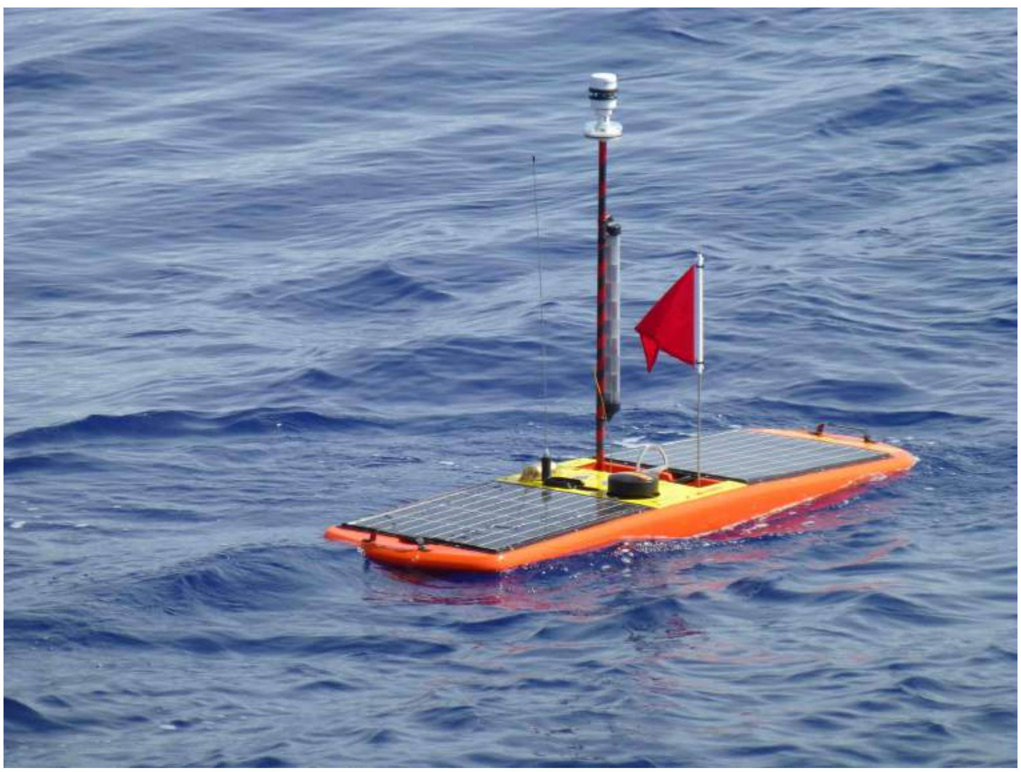


FIGURE: Wave Glider WHOI-ASL2 (Red) prior to removal of radar reflector (seen on mast). Red's met mast was broken during heavy seas several days later and was repaired onboard. Two of three vehicles lost their flag staffs early in the mission.

Notable Events:

15 September: deployed WHOI-ASL2 (red)

16 September: deployed WHOI-ASL3 (yellow) and WHOI-ASL4 (green)

19 September: untwisted WHOI-ASL4 (green) and removed radar reflector

20 September: recovered red to repair broken met mast, remove radar reflector

21 September: re-deployed red

24 September, 0400Z: sent yellow and green to park at wpts 13,11 near PICO-N mooring

for maintenance tomorrow morning

25 September, 1000Z: untwisted WHOI-ASL4 (green). flag pole gone.

removed radar reflector from WHOI-ASL3 (yellow).

took two salinity samples (X26, X28) at 20 cm near green and yellow:

1000Z (37.7017, 37.7079)

26 September: very rainy this morning. lowest salinities seen so far, near 37.0.

5 October: likely mast breakage on WHOI-ASL4 (green) noted at 1100Z.

strong wind and large (5m+) waves from TS Oscar

changed all vehicles to 10 minute telemetry interval -- first month's iridium

bill was wicked large.

Red completely stopped while heading west in TS Oscar -- back on course next morning but almost certainly twisted.

6 October: shut off weather station on green -- mast down.

red experiencing some GPS acquisition problems. Seemed to recover OK.

Sampling Plan

The three WG are following pre-determined tracklines within a 100 km box surrounding the SPURS moored array. The tracklines pass just outside the watch circles of the moorings. Several crossover points will allow occasional comparison between sensors during the mission.

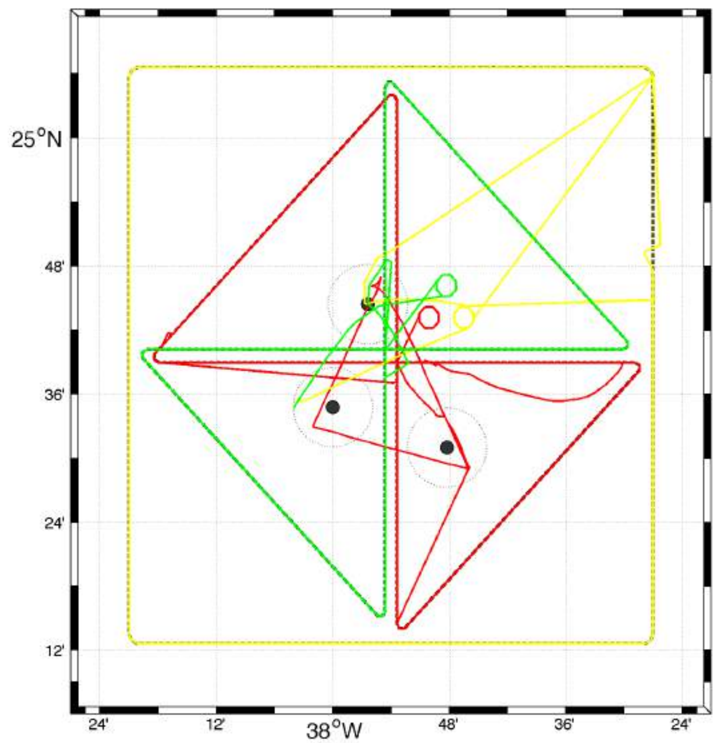


FIGURE: WG trajectories from 16 Sep – 6 Oct. Note that Red's positions while aboard the R/V Knorr for met mast repair have not been removed from this figure.

Initial Results

The Wave Gliders measure salinity just below the surface (nominally 22 cm) and at a depth of about 6 m. Under light wind and wave conditions we observed substantial warming, and small but measurable salinification, of the upper 20 cm relative to the 6 m measurements. Rain events were also particularly notable in the near-surface salinity record. In higher wind and wave conditions measurements from the two depths were generally indistinguishable.

WG CTD and meteorological observations have thus far shown excellent agreement with moored and shipboard measurements. WG CTD cross-calibration and inter-platform comparison will continue during the planned one-year deployment period.

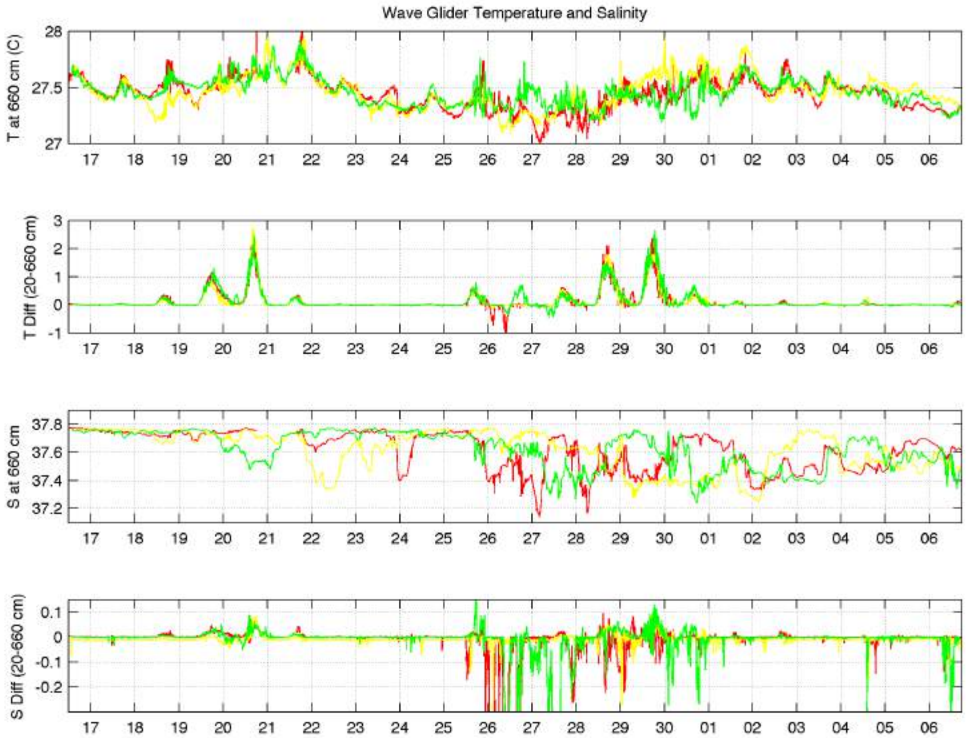


FIGURE: Time-series of temperature, salinity, and float-sub differences for the first 20 days of WG deployment. (a) Temperature at 6 m, (b) Temperature difference between 20 cm and 6 m – positive = warm surface. (c) Salinity at 6 m. (d) Salinity difference between 20 cm and 6 m – positive = salty surface.

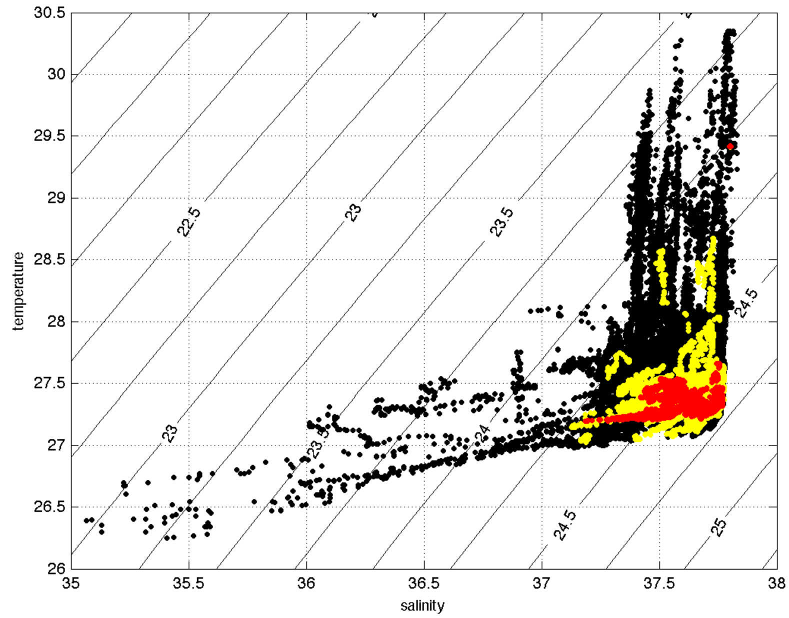


FIGURE: T-S plot for all WG data collected prior to 6 October. Colors correspond to WG-inferred wave height (yellow > 2.5 m, red > 4 m).

<u>Data Access</u>

All WG data is transmitted via Iridium SBD messages, archived at LRI, and retransmitted to WHOI/ASL for initial processing and QC. Hourly-averaged scientific data and relevant supporting measurements are generated several times per hour and forwarded to JPL for assimilation and general access by SPURS participants. Raw data is available on request (dfratantoni@whoi.edu).

Ecomappers -Ben Hodges and Dave Fratantoni

OceanServer Technology, Inc. manufactures a small (~30 kg) propeller-driven AUV called the Iver2. YSI Incorporated, together with SonTek, outfits these vehicles with a suite of their sensors, and sells them under a new name: Ecomappers. They are capable of operating at depths of up to 200 meters; at a maximum underwater speed of 3.5 knots, they have an endurance of approximately 5 hours. Navigation is done by GPS at the surface and by compass and Doppler Velocity Log (DVL) when submerged.

Two Ecomappers (serial numbers 106 and 107) completed a total of 34 science missions over 2 days as well as several test missions during the cruise. Each vehicle was equipped with a YSI CTD, a YSI oxygen sensor, a YSI chlorophyll fluorometer and turbidity sensor, a Neil Brown Ocean Sensors Inc. CTD, and a 5-beam SonTek DVL. Their acoustic modems and sidescan sonars were not used.

Figure: Ecomappers on deck, just prior to deployment from the fantail of R/V Knorr.

Early in the cruise, both Ecomappers were lowered into the water as a rough ballast check. During this test, one of them (107) detected a leak. Approximately 50 cc of water was found inside the pressure case, but no damage was immediately apparent. Shortly thereafter, OceanServer announced by email that the propeller shaft seals they had just installed were a leak risk and needed to be repaired. Detailed instructions for the repair procedure, which consisted of adding a small spacer to the propeller shaft to prevent it from moving longitudinally, were obtained. A suitable spacer was located and installed in Ecomapper 107, which then passed leak tests in the lab and on deck in a bucket, where its propeller could be spun without risking damage.

Initial results presented here are limited to temperature, as the salinity data still require some quality control, in addition to conductivity calibration and thermal lag correction, as of this writing. Underwater positions shown in the following differ from those recorded in the raw data —they have been corrected using the difference between the expected and actual surfacing locations, assuming a uniform drift while submerged due to current and DVL bias. Direct requests for data to dfratantoni@whoi.edu or bhodges@whoi.edu.

Diurnal Stratification Experiment, 29-30 September

Early on the morning of September 29, R/V Knorr began holding station at 25° 30’ N, 38° 30’ W. At dawn, Ecomapper 106 was deployed, starting its first mission at 0820Z. Over the next 18.5 hours, Ecomapper 106 completed a total of 23 missions, and Ecomapper 107 completed 10. Each mission consisted of an outward leg to a distance of 600-700 meters from the ship, and a return leg following nearly the same track. The outbound legs were run either at the surface, at a constant depth of 1 meter, or undulating between depths of 0 and 5 meters. All of the return legs were undulating, either between 0 and 5 or 0 and 10 meters. 28 of the missions ran to the south from the Knorr’s position; the remaining 5 ran to the east.

In the morning, the surface layer of was well mixed, but in the calm sunny conditions, significant stratification developed in the upper meter by midday. This stratification strengthened and deepened during the afternoon. Toward sunset, it began to decay, and by 0200 local time, it had nearly vanished. To capture the evolution of this diurnal stratification, it is important to sample undisturbed water, far enough from the ship to avoid the churning of its screws and the mixing it causes as it bobs in the waves. The homogenizing influence of the ship on the upper meter or two is obvious out to a radius of over 2 shiplengths.

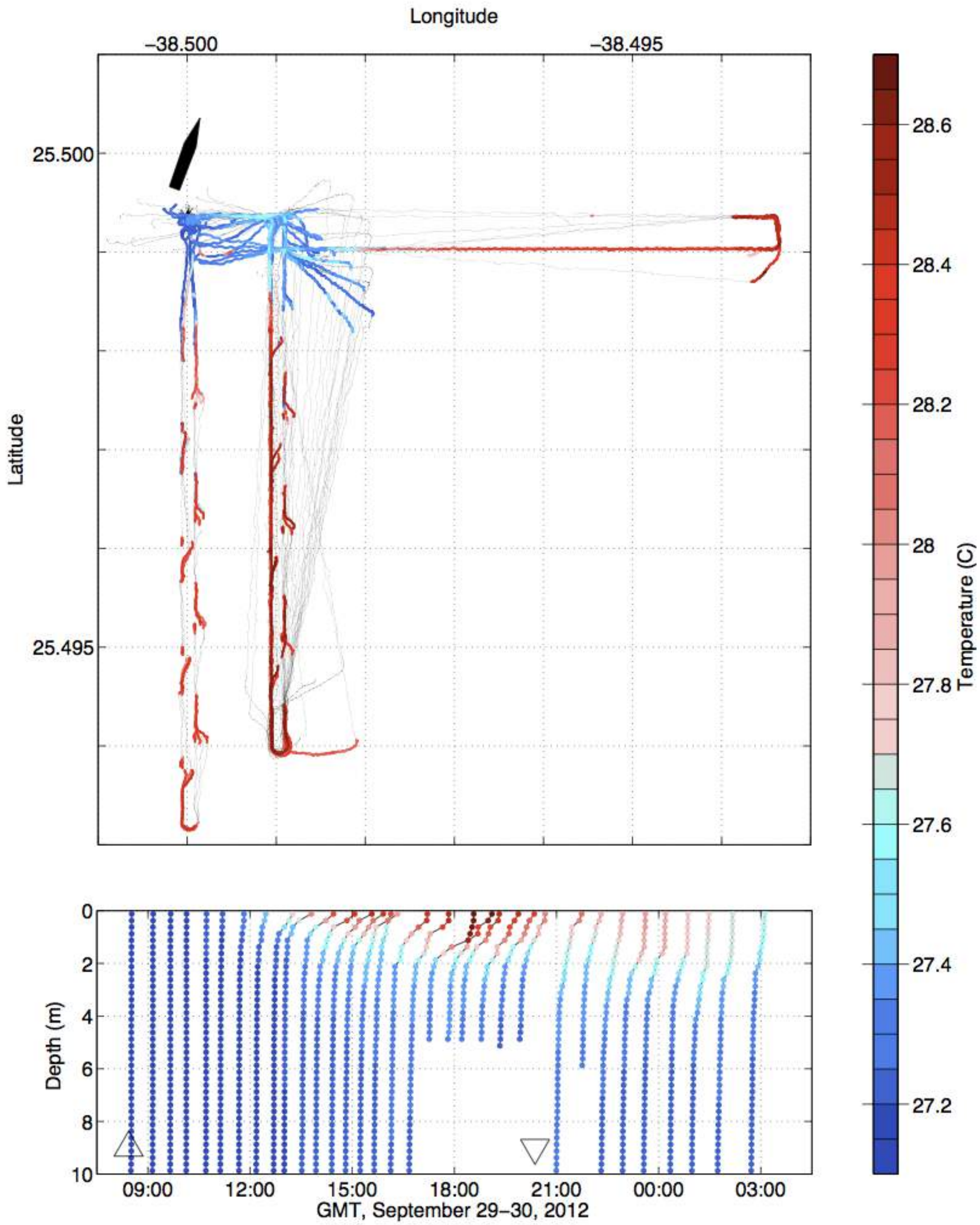
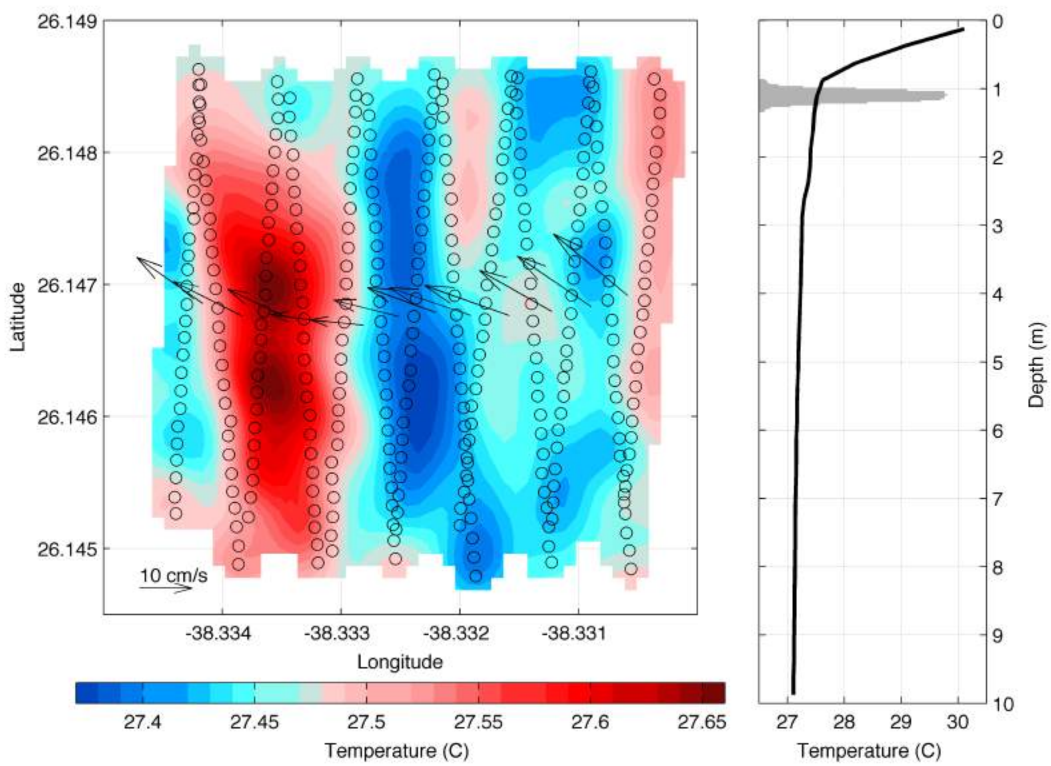


Figure: Temperature measured during the diurnal stratification experiment. Upper panel: tracks from all 33 missions; temperatures of the upper 30 cm made between 1300Z and 2000Z (the period of maximum stratification) are indicated by color. Segments of the tracks from other time periods and deeper layers are drawn lightly. Lower panel: average temperature profile, excluding contaminated measurements near the ship, for each of the 33 missions. Each profile is plotted at the time it was measured. The horizontal scaling of temperature is 1 degree C = 1 hour. Sunrise and sunset are indicated but upward and downward triangles, respectively.

Small Scale Horizontal Survey, 30 September

At 0400Z on 30 September, Ecomapper 106 was deployed for the final time. The first leg of its mission was an undulation between the surface and 10 meters, which took it well into undisturbed water. It then began a lawnmower-type survey of a 450-meter square at a nominal depth of 1 meter. 13 meridional transects 1 meter below the surface were connected by short turnaround segments at the surface, allowing for periodic GPS fixes and profiles of the upper meter.

The calm, sunny conditions produced an average stratification over the survey area of 3° C (with surface temperatures in some locations reaching 30.8° C) and approximately 0.1 psu over the upper 10 meters, most of it in the upper meter. This stratified layer supports internal waves, which were visible from the ship as surface slicks, and show up clearly in the plan view of 1-meter temperature.



Left panel: Objective map of temperature at 1.1 meters below the surface. The vehicle deviated from this surface by 6 cm RMS, and the effect of these deviations is corrected for using the local vertical temperature gradient prior to mapping. Circles mark the locations of measurements used in the map, and arrows the average current inferred from each north-south round trip. Note the internal wave crest and trough. Right panel: Average temperature profile from the entire mission. The gray histogram represents the depths at which the measurements used in constructing the map were made. Note the extreme stratification in the upper meter.

Lagrangian float (MLF) Andrey Shcherbina ashcherbina@apl.uw.edu

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Andrey Shcherbina ashcherbina@apl.washington.edu
Data web page: http://mlf2data.apl.uw.edu:5984/mlf2db/...

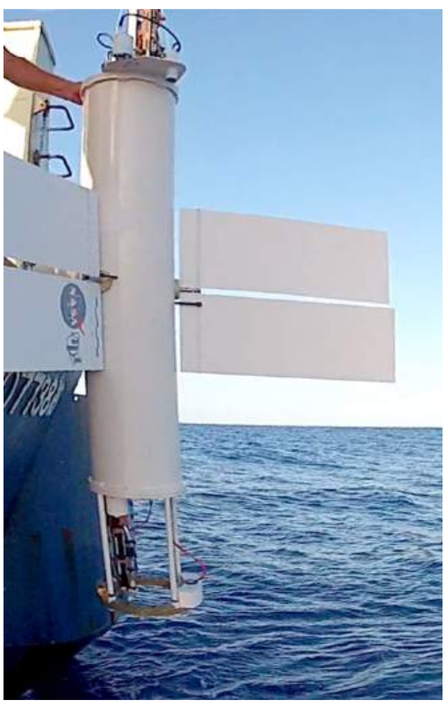
Instrumentation

An autonomous Lagrangian float (MLF, 1) was deployed at the WHOI mooring site and is expected to drift through the experiment area during the year of measurements. The float will alternate between 6-hourly profiles to about 100m and truly-Lagrangian (water-following) drifts within the mixed layer during which the vertical kinetic energy and fluxes will be measured. The floats carry redundant conductivity, temperature and pressure sensors (2x SBE 41 + SBE STS), for the estimation of tracer fluxes and turbulence structure, as well as pressure gradient and ambient noise sensors, for the estimation of scalar surface wave spectra, rain rate and wind forcing. All data is relayed in nearly real-time over the Iridium satellite uplink.

Deployment

Deployed: 18 September 2012, 19:20 UTC

Location: [24°34.41 N, 37°48.43W]



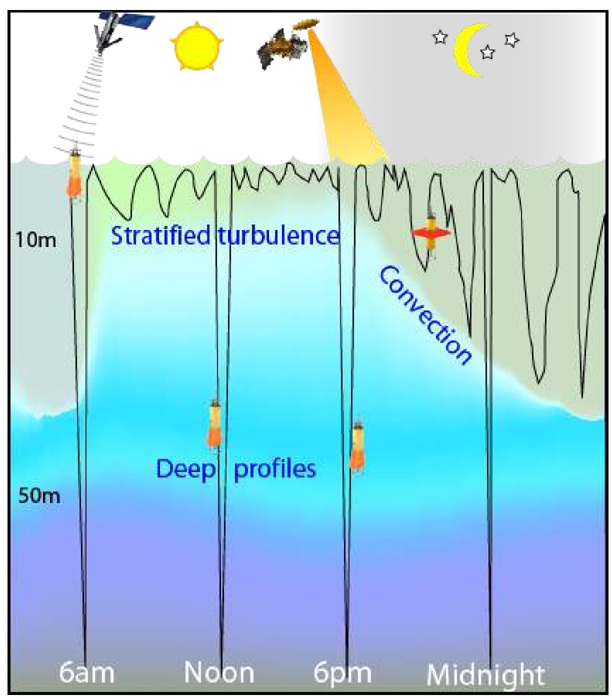


Fig. 1 (left) MLF prior to the deployment. (right) planned MLF mission

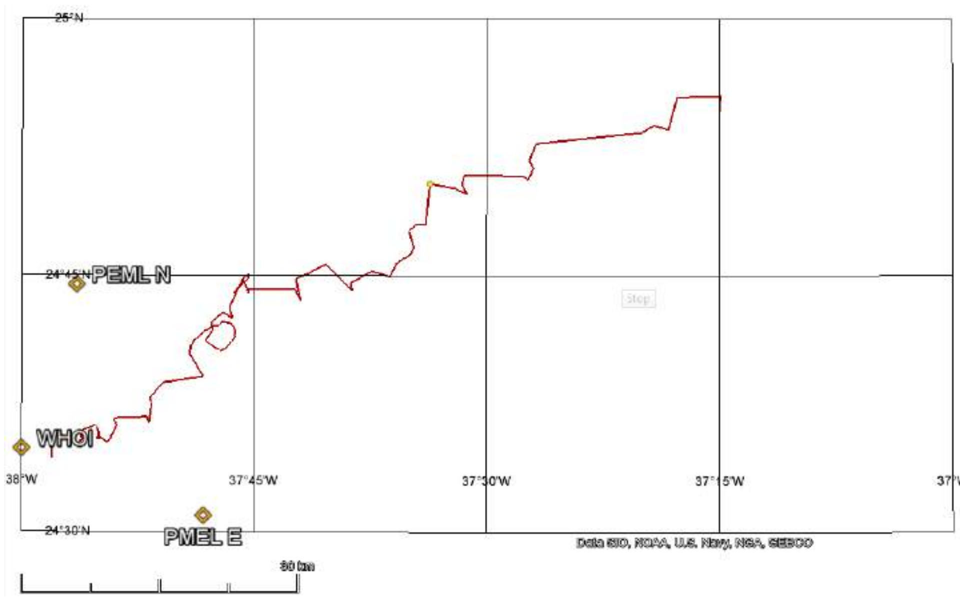


Figure 2. MLF drift map (as of October 7, 2012)

Calibration
All three CTDs on the float are new and factory-calibrated.

In-situ comparison of top and bottom SBE 41s show salinity difference of 0.003 (preliminary result).

Surface salinity measurements are routinely compared with one of the reference CTDs to monitor STS calibration (Figure 3). Presently, it shows drift of -0.0044/day or ≈-1.6/year.

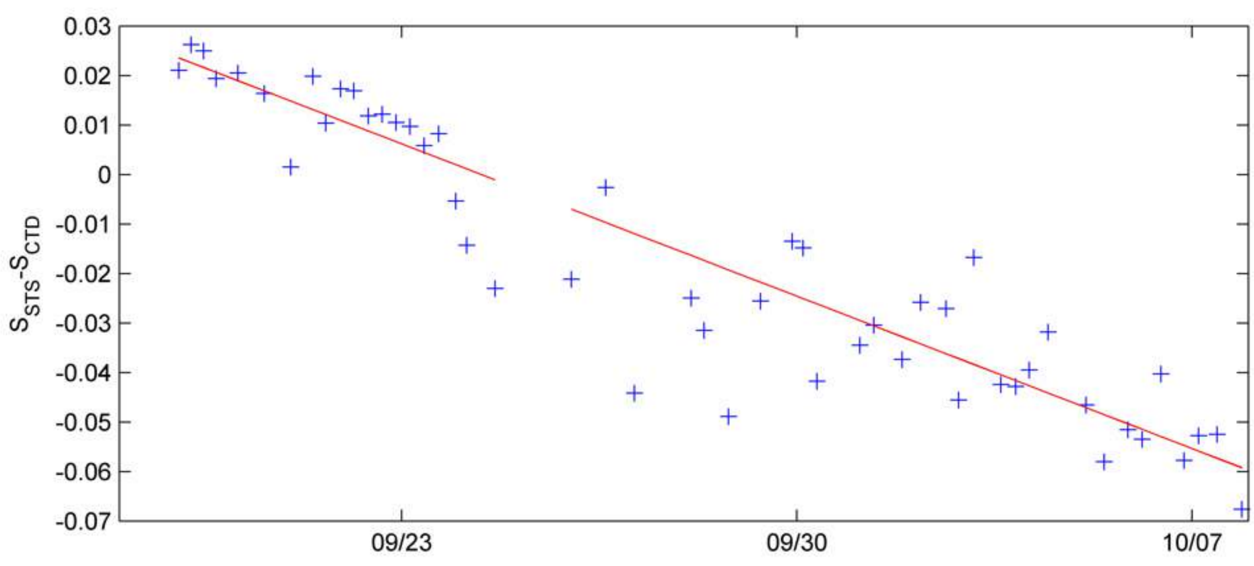


Figure 3. Surface salinity sensor offset relative to SBE 41.

Sample Sections

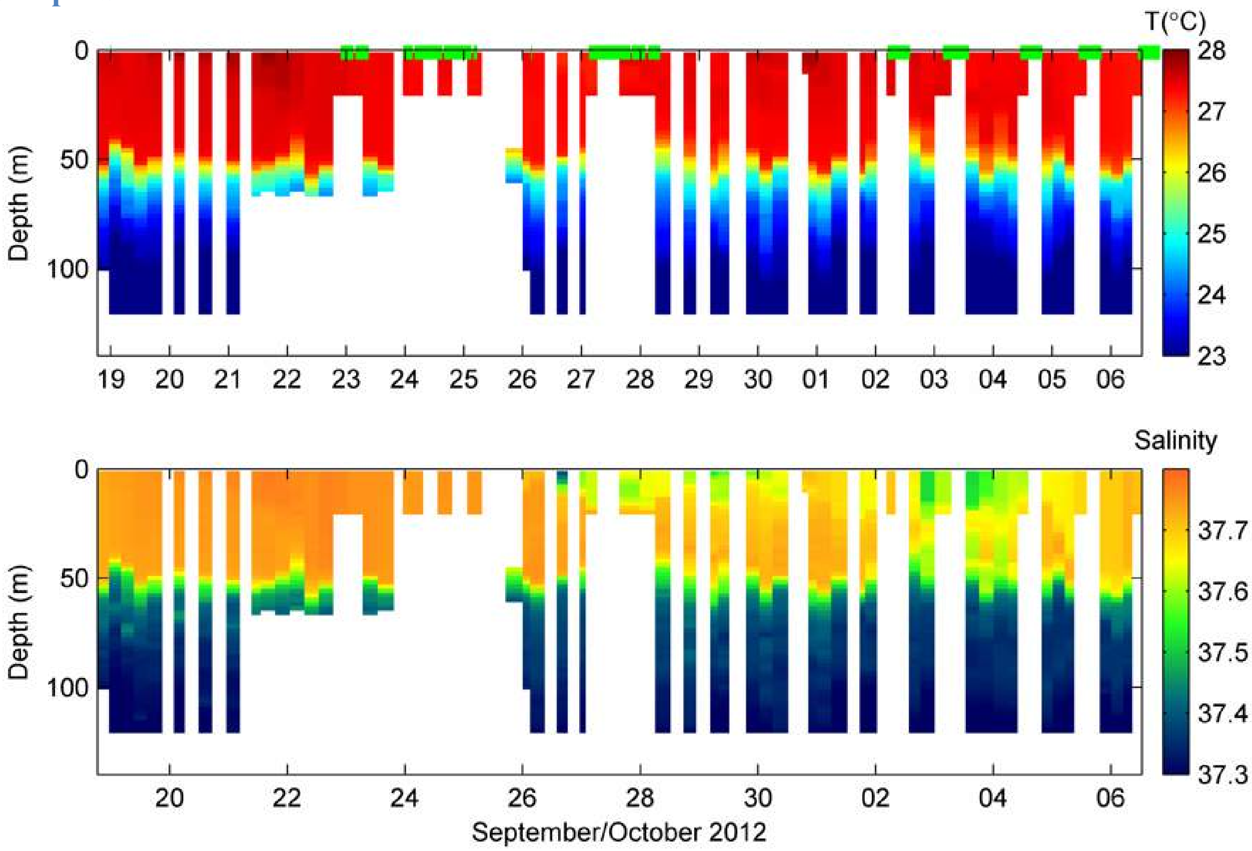


Figure 4. Evolution of temperature (top) and salinity (bottom) based on MLF profiles. Lagrangian drift periods are marked with green bars in top plot.

Cruise Report: Meteorological Mast -Steve Faluotico

A suite of meteorological instruments were installed on the *Knorr* while the ship was docked in Woods Hole (PIs: Farrar and Edson). The bow mast carried a freshly calibrated, modified VOS (Volunteer Observing Ship) IMET package, measuring short- and long-wave radiation, vector winds, humidity, and air temperature. The sensors are identical to those on the WHOI buoy, but the electronics are housed in fiberglass cases. The VOS IMET package recorded data at one-minute intervals, and the winds were corrected for the ship's motion and heading.

Other instruments were installed for the purpose of making direct covariance flux measurements for the cruise. A custom data logger made at WHOI known as a mini node recorded the data. Below is a list of the instruments, their quantity and their sample rate.

Vaisala PTU200 1Hz : - pressure, temperature and humidity

Radiometers 1Hz : Kipp & Zonen solar and infrared

Rain Gauges (2) 1Hz: - Young Model 50202

Sea Snake 1Hz: sea surface temperature

Licor 7500 Infrared Gas Analyzer (2) 20Hz: CO2/H2O

GPS 1Hz: - Hemisphere Crescent VS100

DCFS (Direct Covariance Flux System, WHOI Custom) 20 Hz:

Consists of :

- Gill R3-50 Sonic Anemometer
- Systron Donner Accelerometer
- PNI Compass
-

All of the data, but especially the atmospheric turbulence data, require careful shore-side processing to be made fit for scientific analysis (e.g., turbulent wind fluctuations cannot be estimated until a correction is applied for the ship's motion using the motion-package data). This will be completed in the coming months, and the data will be made available then.

For data and questions contact:

Tom Farrar (jfarrar@whoi.edu)

Jim Edson (james.Edson@uconn.edu)

Cruise Report: SSS Drifters -Ray Schmitt

Eighteen Pacific Gyre Surface drifters were deployed equipped with SeaBird Seacat CT sensors. They were generally deployed in their cardboard boxes, which are designed to release the float when wet and start automatically. In one instance a float was unpacked and started immediately so there was no delay in data reporting (time series station). The drifters were released in 4 groups of 3 (triplets) for dispersion studies and the remaining six were deployed individually, with three of them at the three mooring sites, another at the time-series station and the remaining two during the large-scale survey. Their drift tracks and salinity values can be seen in maps of the Data Management section.

YearMoDaTime	Note	Latitude	Longitude	Drifter numbers
20120917.0334	Triplet	25.227515	-37.251950	SSS Drifters 36300 36648 36301
20120917.0705	Triplet	24.708161	-37.254434	SSS Drifters 37658 37662 37661
20120917.1001	Triplet	24.254765	-37.262389	SSS Drifters 36653 36322 36654
20120917.1249	Triplet	23.768323	-37.249288	SSS Drifters 36718 36659 36658
20120920.1340	PMEL–N Mooring	24.783670	-37.921735	SSS Drifter # 36719
20120920.2114	PMEL-E Mooring	24.484435	-37.767927	SSS Drifter # 36726
20120921.0212	WHOI Mooring	24.550653	-38.033828	SSS Drifter # 36727
20120929.0604	Survey	25.501416	-38.498227	SSS Drifter # 36632
20121001.2313	Survey	25.142102	-38.045952	SSS Drifter #. 37300
20121003.0947	Survey	24.490648	-37.349338	SSS Drifter # 36472

Cruise Report: Data Management Component

Frederick Bingham, Yi Chao, Peggy Li, Zhijin Li and Quoc Vu

This document constitutes a report of the activities of the data management team for the SPURS project for the Knorr cruise, Sept. 6 - Oct. 9, 2012.

The data management team's (DMT) primary activity on the cruise was situational awareness. That is making the chief scientist and science party cognizant of the continuously evolving fleet of observing assets deployed during SPURS, and providing them with model output and satellite images to help plan the activities. There were several categories of activities carried out as a result.

1. Providing weather information. The cruise was very fortunate in that it dodged three hurricanes, Leslie, Michael and Nadine, and one proto-tropical storm. Hurricane Nadine was one of the longest-lived Atlantic named storm on record at 24 days of existence. We received daily weather model forecasts from ECMWF courtesy of Brian Ward. These forecasts were viewed by the chief scientist and members of the science party.

2. Providing model output. Gene Li ran the ROMS model every day during the cruise and downloaded HYCOM output. The ROMS assimilated data collected on the cruise, CTDs, underway data, etc. Model output in the form of images and model data were available through the SPURS web page and through the SPURS daily download ("daily tarball"). These model runs could be visualized along with observing assets (Figure 1). A couple of the students played around with the model data.

3. Visualizing observing assets. Positions of observing assets were constantly tracked. The assets tracked were salinity drifters, GTS (no salinity) drifters, Argo floats, STS floats, seagliders, wavegliders, underway data from the Knorr, underway TSG data from the French tenuse glider and CTD data from the Knorr. These assets could be viewed from the SPURS web page using a simple interface (Figs. 2 and 3).

4. Downloading and visualizing observing assets. The daily tarball contains a series of images and KML and KMZ files that can be visualized using Google Earth (GE). Figure 1 shows and example of this. GE is a much more sophisticated geobrowser than is available through the web interface (Fig. 2). GE gives one the ability to zoom in and out, animate, turn layers on and off, change colors, turn parts of elements on and off, etc. One can bring other assets into the visualization than are visible in the web interface. This is done through image overlays and network links. We were able to download and visualize various satellite products through these techniques. With GE one can create custom KML files to display data in many sophisticated (or not) ways. For example, the addition of the tenuse glider data was accommodated by the creation of its own set of KML files. An example of some more sophisticated visualization is provided in

Fig. 4. Finally, it should be noted that most observations were made available to the visualization system on the SPURS website within a couple of hours.

5. Collecting and organizing datasets. As the cruise was proceeding, the DMT collected and organized many of the various data streams that came in (see item 3 above). Some of these were provided to other members of the science party in the form of MATLAB .mat files. They will also be available after the cruise either from the PI involved, by contacting the DMT or by going to a web interface or ftp site (Table 1). The data were also made available to the modeling team for assimilation.

6. Data access and archive. Although not strictly a cruise activity, the DMT is committed to providing continuing access to SPURS data to all SPURS PIs. We are also committed to making sure the SPURS dataset is archived and preserved in a way that allows continued access to the data well into the future for anyone who is interested.

For everyone's convenience, I have created a combined SSS dataset and a profile T/S dataset for your convenience. It is available by contacting me. The SSS dataset combines all the datasets I had access to, including gliders, underway, floats, drifters, etc. The various instruments measure SSS at somewhat different depths, so combine them together with caution.

The profile data include floats, CTD casts and seaglider dives, but *do not* include UCTD data. However Tom Farrar has provided a nice gridded product for those interested in using the UCTD data as well. Contact him for details.

These are all put together in two .mat files that you should be able to load up and use immediately.

Julian Schanze has created a couple of very useful gridded velocity products from the LADCP and shipboard ADCP instruments. Contact him for access.

Of course, none of the datasets included here are yet ready for scientific publication. They are all preliminary and should be treated as such. Also they should not be shared with anyone outside of SPURS without permission of the PI involved.

Table 1 A summary of the availability of different datasets. Note, please do not share data outside of SPURS investigators without the permission of the PI involved. Datasets are considered preliminary until finalized by the PI.

Dataset Name	How do I get it?
Knorr Underway including TSG and shipboard ADCP	Contact the DMT
Lowered ADCP	Contact the DMT or Julian Schanze
Knorr CTD	Contact the DMT
Underway CTD	Contact the DMT or Tom Farrar
Waveglider	Contact the DMT or Dave Fratantoni
Seaglider	Contact the DMT or Craig Lee
STS Floats	http://runt.ocean.washington.edu/argo/data/ Float ID's for SPURS floats are shown in Table 2.
Salinity Drifter	ftp://spurs.ucsd.edu/ (username: spurs, password: ftp4uspur)
Tenuse glider data	Contact Gilles Reverdin
VMP and T-gliders	Contact Lou St. Laurent
Thalassa underway data	http://www.coriolis.eu.org/Data-Services-Products/View-Download/Data-selection Use platform "FNFP" for the Thalassa
WHOI Mooring	http://uop.whoi.edu/projects/SPURS/spurs.html
Aquarius data	http://podaac.jpl.nasa.gov/datasetlist?ids=Platform&values=AQUARIUS_SAC-D+&search=
Neutrally Buoyant Floats	Contact Andrey Scherbina
Model Results	Contact the DMT
Prawler Mooring Data	Contact Billy Kessler

Table 2. A list of ID numbers for floats deployed in the SPURS central area. The table layout reflects where in the 4X4 grid each float was put out. These IDs do not include floats deployed in transit to or from the SPURS site. Note, float 7568 apparently died soon after deployment and was replaced late in the cruise by 7603. For float 7543, the STS data have been deemed to be poor quality, though the regular profile data are fine.

7603 (7568)	7572	6923	7604
7660	7582	7547	7587
7742	7600	7543	7699
7681	7635	7569	7607

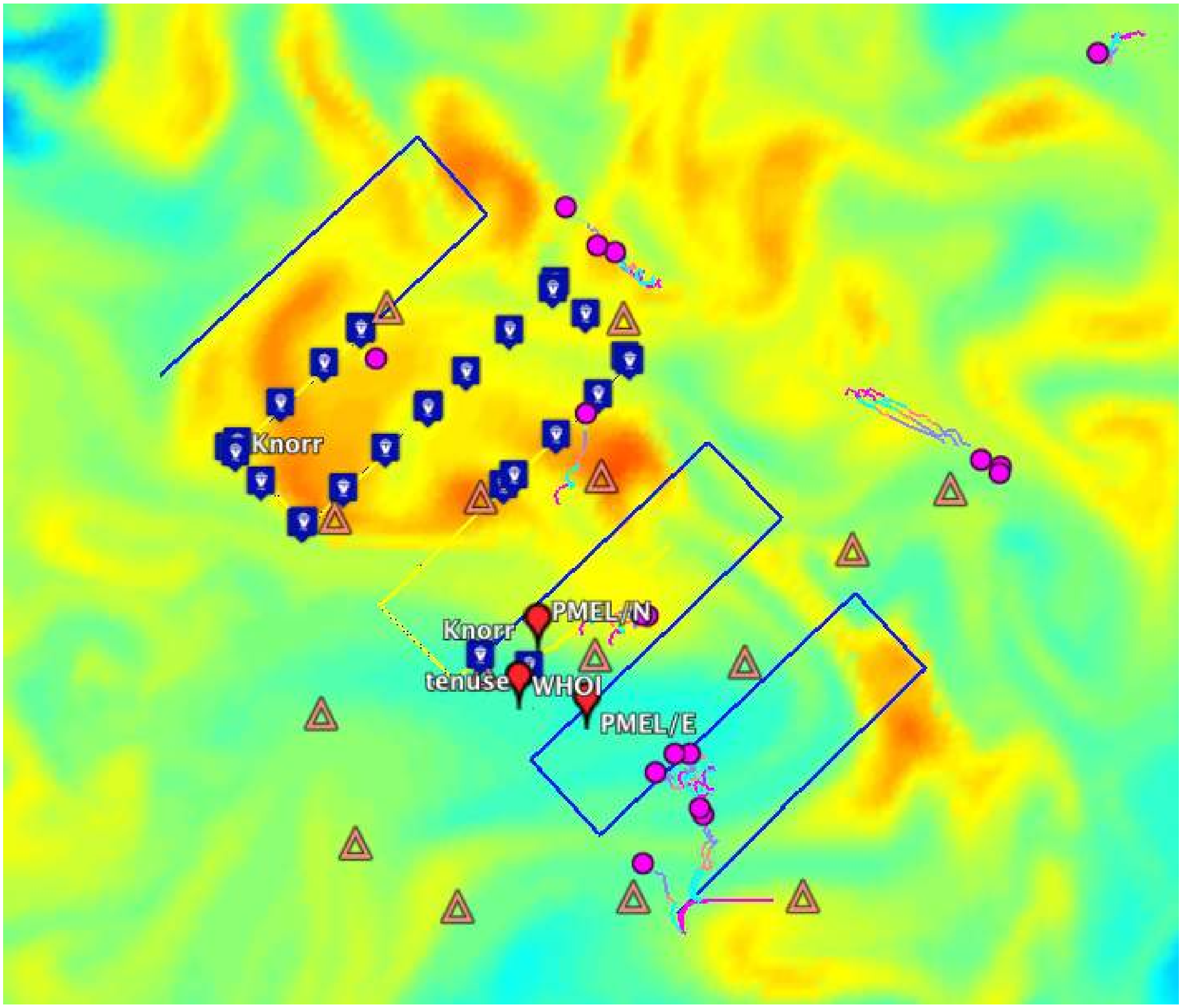


Figure 1. An example of the SPURS data display in GE. The background colors depict levels of salinity from the ROMS model. Arrayed on top are some observing assets, drifters (pink circles with 5 day tails), moorings (red markers), STS floats (brown triangles), the Knorr cruise track (blue markers), the tenuse glider (another blue marker partially hidden by the WHOI mooring marker) and a radiator pattern (blue line) the ship did the last 4 days of observation.

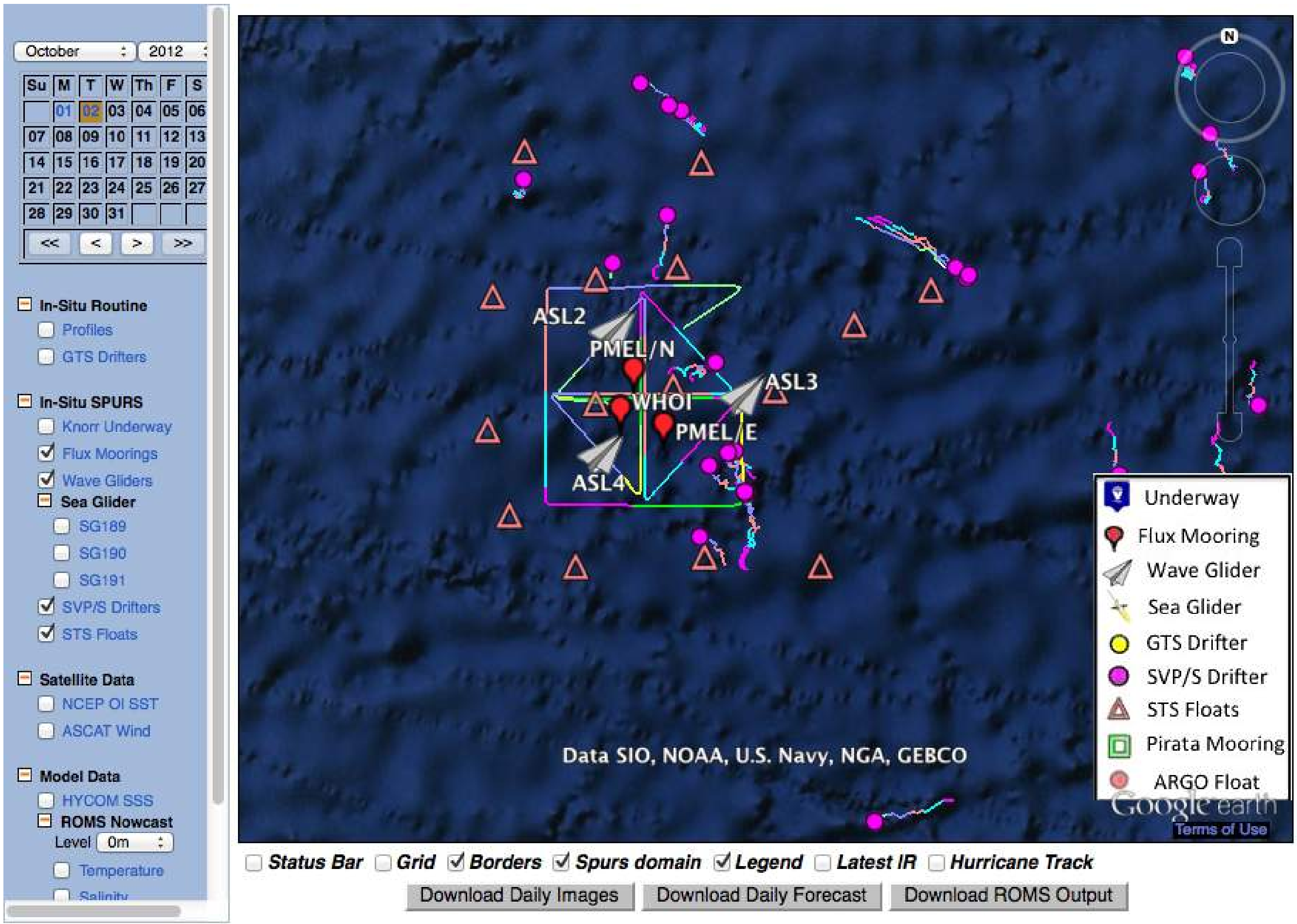


Figure 2. Visualization page from the SPURS website. This page is available at the SPURS web page (http://spurs.jpl.nasa.gov), by clicking on "SPURS Data" and "Visualization". The interface is based on the Google Earth API with a browser interface. It can be moved around and zoomed in and out of using a mouse and scroll wheel. The menu down the left hand side allows users to select from various datasets for display and to choose the specific dates they are interested in. Note the "Download Daily Images" , "Download ROMS Output" and "Download Daily Forecast" buttons. The first gives access to the daily tarball, the second to the ROMS output for the day and the third allows one to see the ECMWF forecast. The "Latest IR" button brings up the most recent IR cloud image for the Atlantic. The "Hurricane Track" button kept scientists informed of the tracks of the hurricanes we dodged during the cruise. The symbols in the image are described in the legend at the bottom right. Each symbol can be clicked on to get a pop-up window with more information about the asset (Fig. 3).

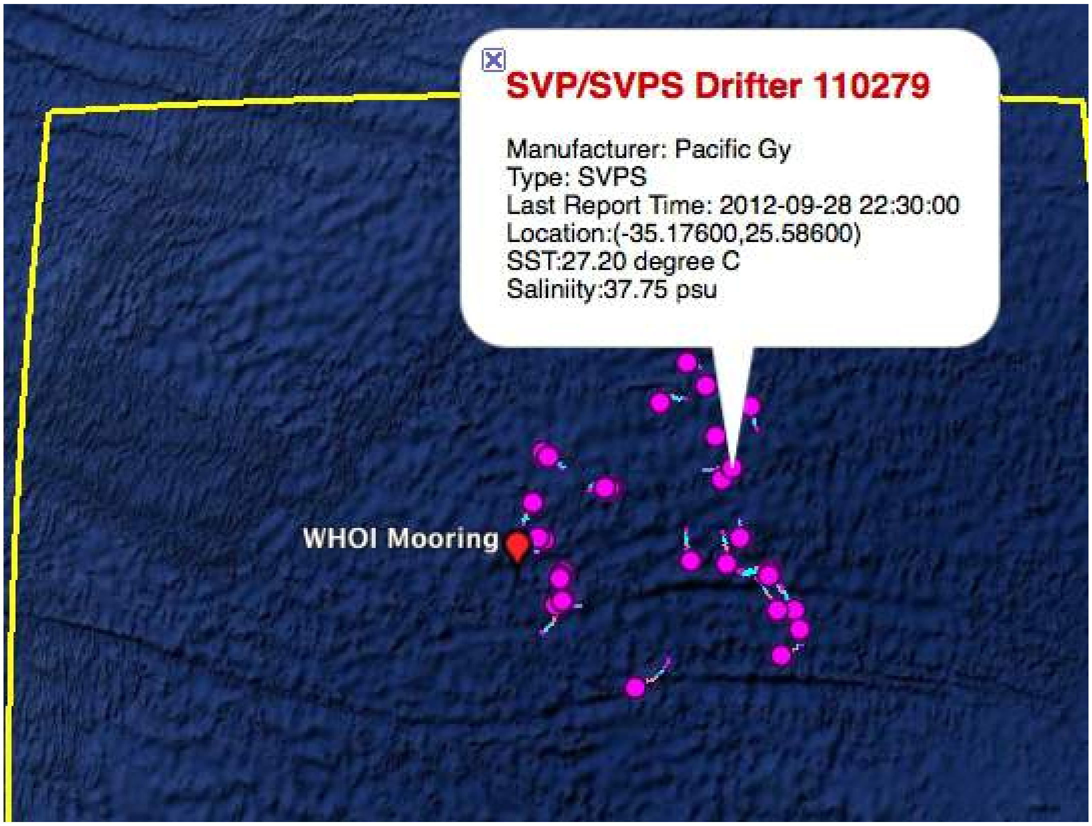

SVP/SVPS Drifter 110279
Manufacturer: Pacific Gy
Type: SVPS
Last Report Time: 2012-09-28 22:30:00
Location:(-35.17600,25.58600)
SST:27.20 degree C
Saliniity:37.75 psu
WHOI Mooring

Figure 3. A partial screen shot of the SPURS visualization page showing an example of a pop-up window with information about one of the SVP/S drifters.

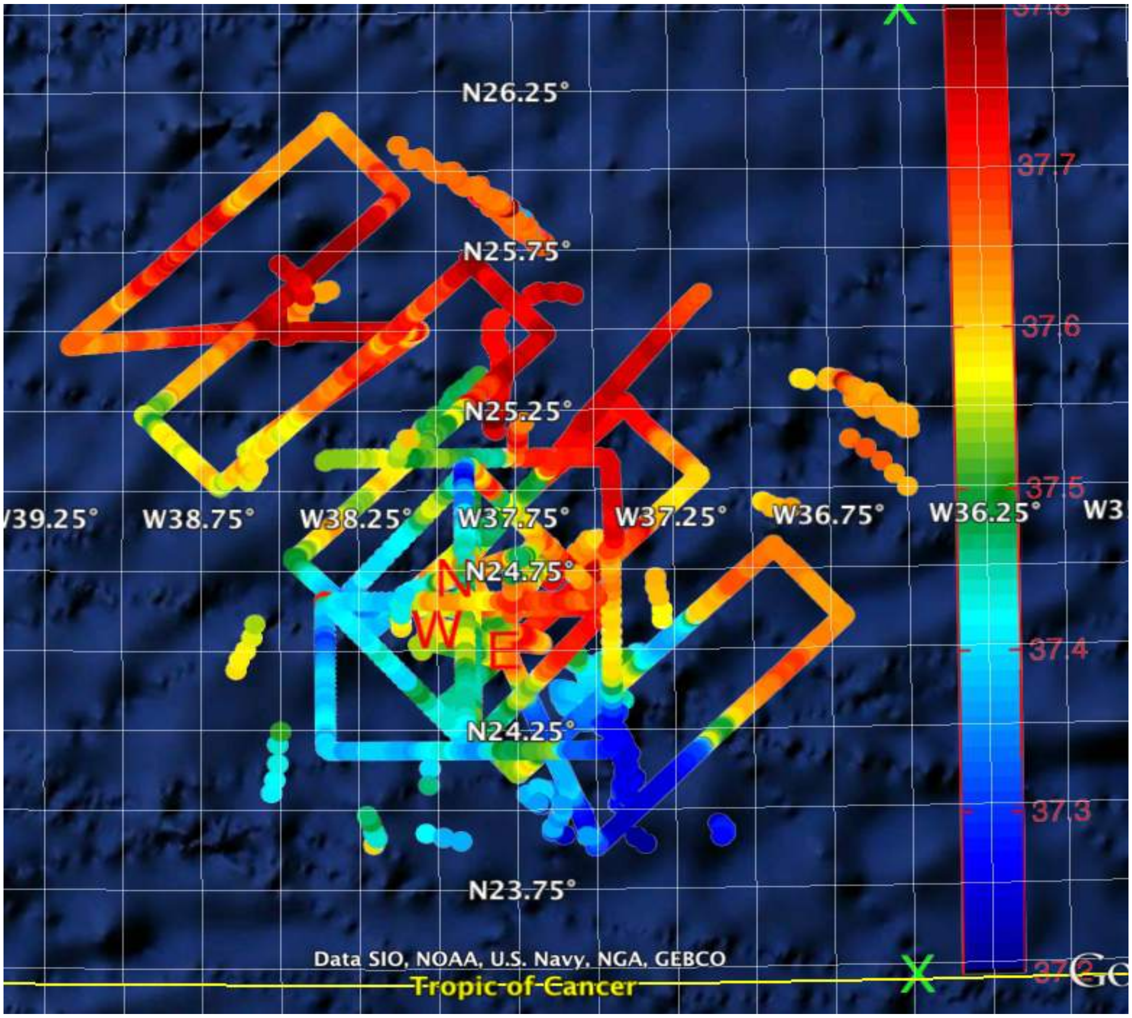


Figure 4. Visualization of the surface salinity for Sept. 29- Oct. 4. Color scale is displayed at right. This display includes all data available.