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Monitoring Dissolved Oxygen in New Jersey Coastal Waters Using Autonomous Gliders

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Notice

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Executive Summary

The coastal ocean is a highly variable system with processes that have significant implications on the hydrographic and oxygen characteristics of the water column. The spatial and temporal variability of these fields can cause dramatic changes to water quality and in turn the health of the ecosystem. While low Dissolved Oxygen (DO) concentrations are not uncommon in the coastal ocean, what is less understood is how the location and size of these low DO regions vary and what impact that variability has on ecosystem health. Therefore alternative sampling strategies are needed to continuously map these low DO areas in a way that quantifies this variability. This project applies a series of Autonomous Underwater Vehicle (AUV) deployments from Sandy Hook to Cape May, NJ to address this need by mapping the subsurface DO concentration in near real-time within the near coastal ocean.

The long endurance capability combined with the required sawtooth pattern propulsion make the glider an ideal platform for continuously mapping sub-surface ocean conditions at high resolution and in near real-time. In this project we completed 6 glider missions along the New Jersey coast in 2011 and 2012. Each glider was specifically setup to complete these nearshore missions that focus the monitoring specific to the needs defined by the Environmental Protection Agency (EPA) and the New Jersey Department of Environmental Protection (NJDEP). All the glider missions were completed in accordance to the operating procedures described in the Quality Assurance Project Plan (QAPP). The QAPP was approved by the project participants at EPA, Rutgers, and NJDEP. The document clearly states the pre- and post-deployment steps needed to ensure the quality of the data collected during each mission. By following these specifications we documented the required quality assurance steps for the AAnderra Optode, SeaBird CTD (pumped and unpumped) and the glider platform itself. The missions were carried out with a predefined path that was adjusted through consensus of the project partners (Rutgers, EPA, and NJDEP) to capture the variability in the magnitude and structure of dissolved oxygen patterns in the coastal ocean.

Consistent with previous discrete sampling, each glider mission observed DO concentrations below 5 mg/L. These lower concentrations were limited to the bottom layer. The unique sampling provided through the glider AUV showed that the DO concentrations were highly variable in the vertical, horizontal, and through time. The scales of variability of the DO concentration observed over these two seasons were on the order of 60-80 km in space and 3-4 days in time. The strongest gradients were observed across the thermocline with surface waters usually much more oxygenated than the bottom waters. These vertical gradients were weaker closer to the coast and broke down following strong wind events. Since sampling was all done in real-time, the monitoring data was immediately available to NJDEP and EPA to inform their response to these events. Based on these missions, we have begun to sample the dynamic coastal ocean environment at the scales of known variability. The results show that while there are persistent patterns in the dissolved oxygen fields off our coasts, rapid changes can occur with varied effects across the region.

Figures

Tables

Acronyms and Abbreviations

Autonomous Underwater Vehicle	AUV
Coastal Ocean Observation Lab	COOL
Colored Dissolved Organic Matter	CDOM
Conductivity Temperature Depth	CTD
Dissolved Oxygen	DO
Global Positioning System	GPS
Institute of Marine and Coastal Sciences	IMCS
Integrated Ocean Observing System	IOOS
Mid-Atlantic Regional Association Coastal Ocean Observing System	MARACOOS
New Jersey Department of Environmental Protection	NJDEP
Quality Assurance Project Plan	QAPP
Quality Assurance/ Quality Control	QA/QC

Acknowledgements

The coastal monitoring described here is built on significant leveraging and partnership. With the support of EPA we filled a critical observing gap along the inner shelf of the New Jersey coast. The presence of MARACOOS, the Mid-Atlantic Regional component of IOOS provided critical facilities and technical expertise to accelerate the adaption of the shelf-wide glider missions to near-shore missions with a specific focus on water quality monitoring. EPA Region II and NJDEP identified the need and provided the necessary resources to support these coastal missions. We would like to specifically acknowledge Michael Borst (EPA), Darvene Adams (EPA), Bruce Friedman (NJDEP), and Robert Schuster (NJDEP) for all their help with planning and logistics. The captain and crew of the R/V Clean Waters provided the deployment support and the EPA and NJDEP crews helped with the recoveries. Throughout the project there is consistent communication to both adapt the glider mission given the near-real time data and coordinate a response if needed.

1. Introduction

1.1. Motivation

The coastal ocean is a highly variable system with processes that have significant implications on the hydrographic and oxygen characteristics of the water column. The spatial and temporal variability of these fields can cause dramatic changes to water quality and in turn the health of the ecosystem. Both the U. S. Environmental Protection Agency (EPA) and the New Jersey Department of Environmental Protection (NJDEP) have prioritized monitoring the coastal waters off New Jersey in their long-term strategic plans as an essential component of the decision-making process. Of particular interest are the spatial and temporal characteristics of dissolved oxygen (DO). In response to this need to better understand the dynamics, we put together a program to augment existing monitoring with targeted deployments of glider Autonomous Underwater Vehicles (AUVs) equipped with sensors to map coastal dissolved oxygen and hydrographic conditions in near-real time along the New Jersey inner-shelf.

Hypoxic and anoxic conditions ripple through the entire ecosystem causing fish kills and potentially large disruptions to local and remote food webs. Both NJDEP and EPA have defined standards and criteria to classify the coastal ocean based on measured DO concentrations. Healthy ecosystems are typically defined as having DO concentrations above 5 mg/L. Conditions become hypoxic when DO concentrations decrease below the 5.0 mg/L limit. DO concentrations less than 2.3 mg/L fall below the limit of juvenile and adult shellfish and finfish survival and increase the risks for lethal impacts to the coastal ocean (U.S. EPA, 2000).

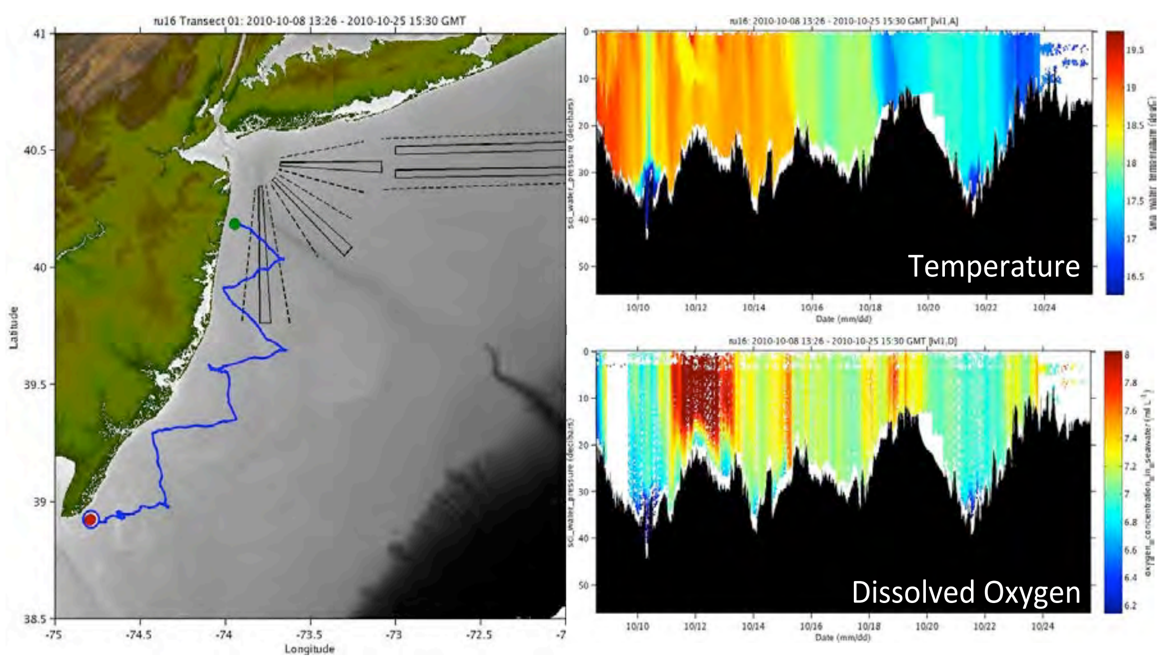

Figure 1: Temperature (upper right) and dissolved oxygen concentration (lower right) collected during a coastal run along the New Jersey coast from October 8, 2010 through October 25, 2010

Monitoring for DO in the coastal ocean has typically been done through lab analyses of discrete water samples collected from boats or helicopters. Between 1979 and 2005 this sampling identified DO concentrations below 5.0 mg/L every year off the coast of New Jersey. While these low values are not uncommon, what is less understood is how the location and size of these low DO regions vary along the New Jersey coast and the impact that variability has on ecosystem health. Therefore, alternative sampling strategies are needed to map the low DO areas in a way that quantifies this variability. This project applies a series of AUV transits from Sandy Hook to Cape May, NJ to map the subsurface DO concentration in near real-time within the near coastal ocean (Figure 1). The primary users for the data generated by this project are the EPA and the water monitoring division of the NJDEP. During each mission the real-time data was used to map dissolved oxygen and water column stratification along the New Jersey coast. The 6 missions together allow us to begin to quantify range, structure, and evolution of DO off the New Jersey coast.

1.2 Objectives

The objectives for this project were to:

- Evaluate the use of AUVs as a tool to monitor DO concentrations across a broad spatial area at high spatial and temporal resolution for the purpose of problem identification, diagnosis, and evaluation.

- Provide spatially and temporally comprehensive water quality data to be used to assess the coastal ocean as required under section 106 of the Clean Water Act.

- Produce Standard Operating Procedures, Quality Assurance procedures, validation data, and a data analysis/data management system for future AUV monitoring.

1.3 Shallow Glider AUV

The Rutgers University Institute of Marine and Coastal Sciences (RU/IMCS) in collaboration with the Mid-Atlantic Regional Association Coastal Ocean Observing System (MARACOOS), the Mid-Atlantic regional component of the Integrated Ocean Observing System (IOOS), the NJDEP Division of Water Monitoring and Standards, and the EPA (Region II and the Office of Research and Development) have demonstrated the use of the Slocum glider to observe temperature, salinity, and dissolved oxygen concentrations off the coast of New Jersey. In the summer of 2009, the first glider mission to complete the coast wide sampling of hydrography and DO served as a pilot for the missions described in this report. The glider was deployed on August 20, 2009 for 20 days covering 316 kilometers and generating 5,100 water-column profiles from the surface to near the ocean floor. This deployment provided a horizontal, vertical, and temporal resolution of DO in coastal ocean water conditions previously unavailable. The mission tracked the evolving fields of dissolved oxygen and hydrography through upwelling and coastal storm events (Ragsdale et al., 2011). This project extends these types of missions for two summers in 2011 and 2012.

The glider AUV is 1.2 m long and weighs 52 kilograms in air (Figure 2). The vehicle is designed for long duration missions (exceeding 2 weeks) with frequent connections to shore for data download and mission modifications. For our coastal missions the gliders are programmed to surface every 3 hours. At each surfacing the glider

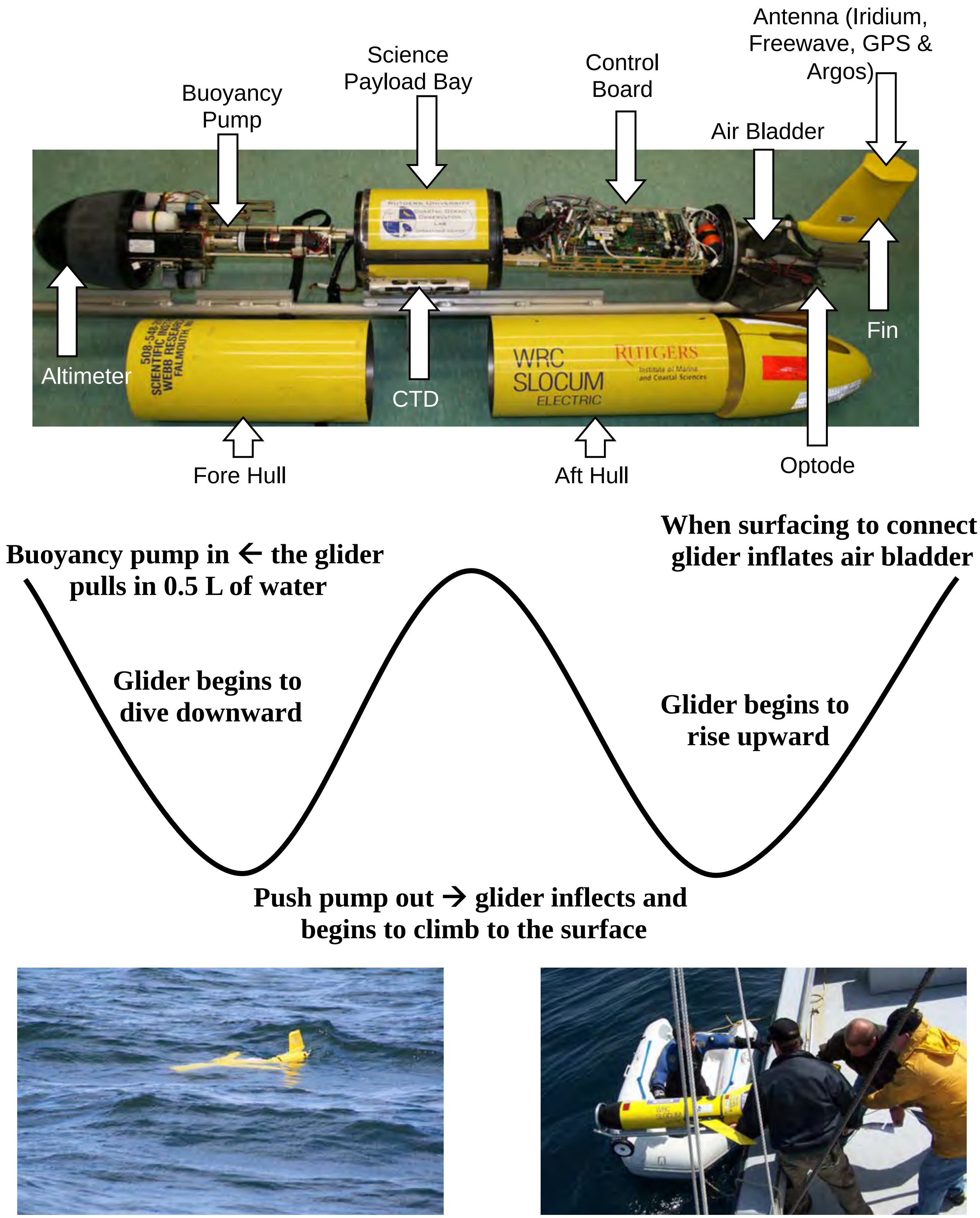

Figure 2: Slocum Electric glider including: a photo of the glider components (top); a schematic illustrating the glider flight path (middle); and two photos showing the glider on the surface following a deployment (bottom left) and a during recovery (bottom right).

determines its position via Global Positioning System (GPS) and then connects to the Coastal Ocean Observation Lab (COOL) at Rutgers via satellite. Between connections the glider is submerged and cutoff from the pilots back on shore. It is during these segments that the glider samples the sub-surface ocean (Figure 1). The AUV moves through the water by cycling a buoyancy pump to take in and extract 500 ml of seawater. Near the surface the glider pulls the seawater into the nose, reducing the internal volume of the glider, lowering its displacement. The lower displacement causes the glider to sink and it begins to dive. Using moveable battery packs as ballast, the glider maintains a dive angle of 26 degrees throughout the decent. This angle is optimal to translate the vertical sinking into forward motion. When the glider reaches the end of its dive, approximately 2 m above the seafloor, the piston extends forcing the water back into the ocean through the nose. This increases the glider's displacement, restores positive buoyancy and allows it to rise toward the surface (Figure 2). Over these coastal missions we deployed gliders with two types of buoyancy pumps. Each worked as described above, but had different cycling speeds. Glider ru07 and ru16 both had a 100 meter pump that cycled from full in to full out in approximately 10-12 seconds. A second pump installed in ru28 was specifically designed for the shallower water of the inner shelf. This pump's cycle time was faster going from full in to full out in 5-6 seconds. The fast response time allows the glider to inflect faster and therefore get closer to the seafloor. Between surfacings, the glider navigates in this sawtooth pattern using an on board attitude sensor (pitch, roll, and heading) to dead reckon its position along the path. Steering adjustments are made with a fin to ensure the glider remains on its intended heading. Once back at the surface it uses the current GPS position and that of the last surfacing to linearly interpolate its position over the time it was submerged.

The buoyancy-driven propulsion of these vehicles affords high energy efficiency allowing deployment endurance approaching 30 days with alkaline batteries needing to provide less than 1,400 amp hours (Schofield et al., 2007). This is the equivalent of running a 100 watt lightbulb for 21 hours. The buoyancy driven propulsion also puts a high demand on mission preparation to ensure it operates continuously throughout the deployment through a wide range of water density. Prior to each mission the glider is carefully ballasted so that its neutral weight matches the expected mean water density of the study site. Since the glider depends on displacement adjustments for propulsion, it is critical that this ballasting step be done precisely. The long endurance capability combined with the required sawtooth pattern propulsion make the glider an ideal platform for continuously mapping sub-surface ocean conditions at high vertical and horizontal resolution and in near real-time.

1.4 Specific Glider Setup

Each glider was specifically setup to complete these nearshore missions that focus the monitoring specific to the monitoring needs. For each coastal run, the glider was deployed near Sandy Hook, NJ. The AUV completed a zigzag track along the coast toward Cape May, NJ (Figure 3). Prior to each mission, Rutgers, NJDEP and EPA approved the path. This path, defined by a series of waypoints, lead the glider from Sandy Hook to Cape May sampling the vertical and horizontal structure of DO between 1 and 25 miles from the coast while avoiding known hazards, including fish havens and shipping lanes. This path was subject to change based on environmental conditions. For

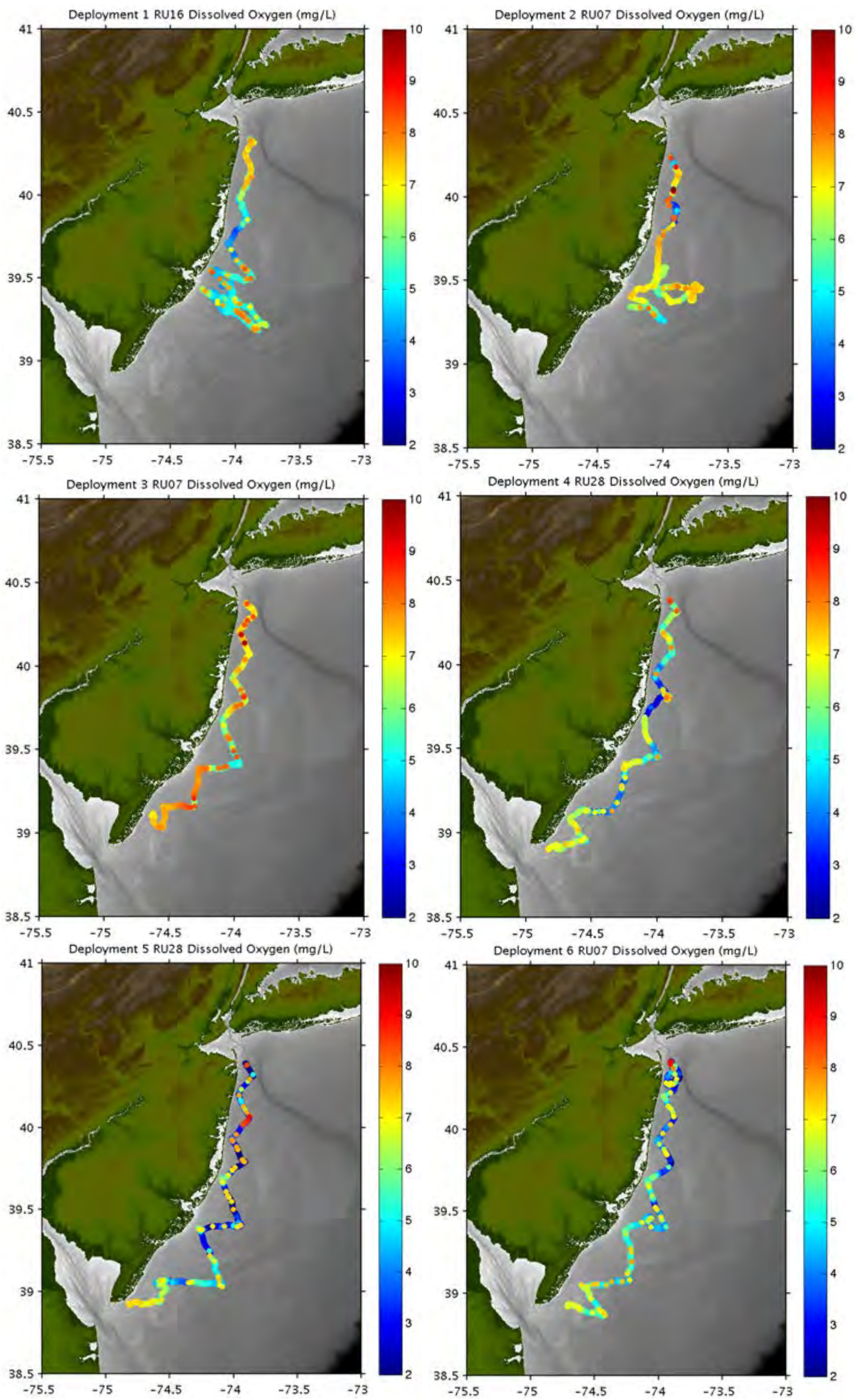

Figure 3: The path for each deployment completed in August 2011 (upper left), October 2011 (upper middle), June 2012 (upper right), July 2012 (lower left), August 2012 (lower middle), and September 2012 (lower right). The path color indicates the lowest Dissolved Oxygen concentration observed for each profile along the track.

example during the summer of 2011 the glider deployed in the first mission was redirected to focus on a large phytoplankton bloom off the central New Jersey coast. Later in August that same glider was directed offshore to deeper waters to preserve glider safety during the rough wave and current conditions during Hurricane Irene. Any modification was agreed to by the project partners to concentrate the sampling, ensure the glider was not put into unnecessary risk, or both.

Each glider was equipped with two main sensors, a Sea-Bird Conductivity Temperature Depth (CTD) (Model GPCTD) and an Aanderraa Optode (Model 3835/5014W). The CTD samples conductivity, temperature and pressure at 0.5 Hz throughout the mission. The measured water pressure is used to calculate depth. These data with the interpolated position from the GPS readings allow mapping of the ocean temperature, salinity and density along the track. The optode measures phase shifts across a calibrated foil at 1Hz that when combined with measured temperature gives the calculated DO concentration and percent saturation. In addition three of the missions were flown with an additional sensor that measured optical backscatter, Colored Dissolved Organic Matter (CDOM) fluorescence, and Chlorophyll-a fluorescence. While not a focus of this report, the Chlorophyll-a fluorescence highlighted location of the peak phytoplankton concentrations relative to the observed gradients in DO and hydrography.

For each mission the glider was deployed from the EPA Research Vessel Clean Waters out of Jersey City, NJ. The deployment location was fixed about 8 miles south of the tip of Sandy Hook 3 miles offshore. To deploy the glider it was simply lowered off the stern of the Clean Waters before a series of in water test were completed to verify the glider was working properly. Following the mission we coordinated to EPA and NJDEP to identify a boat and port closest to the glider position for recovery. On either a NJDEP or EPA small vessel (less than 30 ft) we would transit out to the glider's location. Once the glider was visually located from the boat, the glider was gently pulled from the water over the side of the vessel (Figure 2). The details of the procedures for both deployment and recovery are outlined in the Quality Assurance Project Plan (QAPP) included in this report as Annex A.

2. Data Analysis

2.1 Quality Assurance

All the glider missions were completed in accordance to the operating procedures described in the QAPP (Annex A). The QAPP was approved by the project participants at EPA, Rutgers, and NJDEP. The document clearly states the pre- and post-deployment steps needed to ensure the quality of the data collected during each mission. In addition, decision making criteria are defined to take advantage of the adaptive capabilities of the glider sampling and reduce the risk on the glider given changing ocean and atmospheric conditions. The QAPP with details of the operating procedures will be particularly useful as the government agencies move forward with incorporating AUV data into environmental decision-making. This QAPP has already informed the development of an IOOS document on Quality Assurance and Control Standards for Real-Time Dissolved Oxygen Measurements.

Over the course of the project, 5 amendments were added to the initial QAPP to add flexibility to the hardware options while maintaining the quality data standards. Amendments 1 and 2 allowed us to substitute CTD sensors provided they pass the comparability tests outlined in the QAPP. Amendment 3 was a simple replacement of a discontinued titration test kit with its updated replacement as recommend by the vendor. Amendment 4 allowed us to substitute additional gliders from the Rutgers fleet in the event of damage or loss so that we could meet the continuous sampling requirements through the summer months. The final amendment updated some of the mission documents. As the Rutgers glider program continues to evolve and expand, best practices are often refined. The specifics of all these amendments are detailed in the QAPP attached to this report as Appendix A.

As stated previously, the main purpose of these missions was to deliver quality DO data to both the EPA and NJDEP. Given that, we designed and carried out a procedure that provides specific requirements for the glider itself and the sensors it carried on board. Prior to each deployment, the glider went through an extensive check-out procedure to ensure that all systems (communications, navigation, science payloads, etc.) were working as required. The results of each check-out and check in following the deployment were documented and delivered to EPA. These mission documents are attached to this report as appendices B thru G for each of the 6 missions completed. In the following sections we detail the sensor specific quality control procedures.

The data analysis carried out for each of these missions was approved by the project participants in the QAPP. The pre-, post- and in mission planning were all carried out to ensure quality data output. The primary objective of the work was to ensure the delivery of quality DO data throughout the water column along the glider's path. In this section we describe the processing and quality assurance approach we took to ensure that this objective was met.

2.1.1 Dissolved Oxygen:

The dissolved oxygen data was sampled with an optical unit manufactured by Aanderra Instruments called the optode. Based on manufacturer specifications each optode deployed was sent to the factory for an annual calibration. In addition to these annual calibrations, we also completed pre- and post- deployment verifications. To do this we compared optode observations to concurrent Winkler titrations of a sample at both 0% and 100% saturation. Results of each comparison were documented. These specifications required that all optode measurements were within 5% saturation of the results of the Winkler titrations for both the 0% and 100% saturation samples. For the 0% saturation samples the optodes did not fail any test with saturations all measured between 0.02% and 0.012% saturation over all deployments. Similarly for the 100% tests, all optodes met the requirements specified in the QAPP with all optode measurements within 5% of the Winkler titration results (Table 1). The only test that could not be completed was the post deployment verification following mission

Table 1. Summary of DO comparability tests at100% saturation

Target: 100%	Aanderraa Optode vs. Winkler titration			
	Pre-Deployment		Post-Deployment	
Deployment	Optode	Winkler	Optode	Winkler
#1	95.1%	94.3%	Glider lost	
#2	94.6%	94.3%	91.8%	92.4%
#3	97.0%	98.8%	97.3%	98.8%
#4	97.3%	98.8%	97.6%	95.6%
#5	97.6%	95.6%	96.2%	94.0%
#6	96.2%	94.0%	95.3%	96.0%

1. This was the only mission where the glider could not be recovered due to loss. A copy of the details of each of these verification tests is included in the documentation for each mission in Appendix B through G.

Table 2. Summary of CTD comparability pre- and post- deployment tank tests.

Glider CTD vs. SBE 19 CTD (in test tank, pre/post deployment verification)								
	Pre-Deployment				Post-Deployment			
	Temperature		Conductivity		Temperature		Conductivity	
Deployment	SBE19	Glider	SBE19	Glider	SBE19	Glider	SBE19	Glider
#1	21.290	21.309	4.459	4.457	Glider lost			
#2	21.324	21.320	3.370	3.374	23.024	23.026	3.614	3.614
#3	18.470	18.430	4.210	4.229	19.580	19.580	4.302	4.299
#4	20.326	20.328	4.406	4.403	22.112	22.116	4.692	4.695
#5	22.300	22.340	4.798	4.783	22.256	22.255	4.979	4.976
#6	22.294	22.292	4.384	4.382	20.416	20.415	4.062	4.060
*Castaway CTD, not SBE19								

2.1.2 Hydrography

The hydrographic data collected on each mission was done with either a pumped or unpumped CTD specifically engineered for these gliders. Like the optode, we deployed glider CTDs that were calibrated by the factory at least once per year. With the loss of ru16 at the end of the first mission, there was an amendment drafted that would allow a CTD not factory calibrated within the last year provided it passed the remaining tests. The verification procedures required a two-tier approach to verifying the temperature and conductivity data from the glider CTD. The first tier test was a pre- and

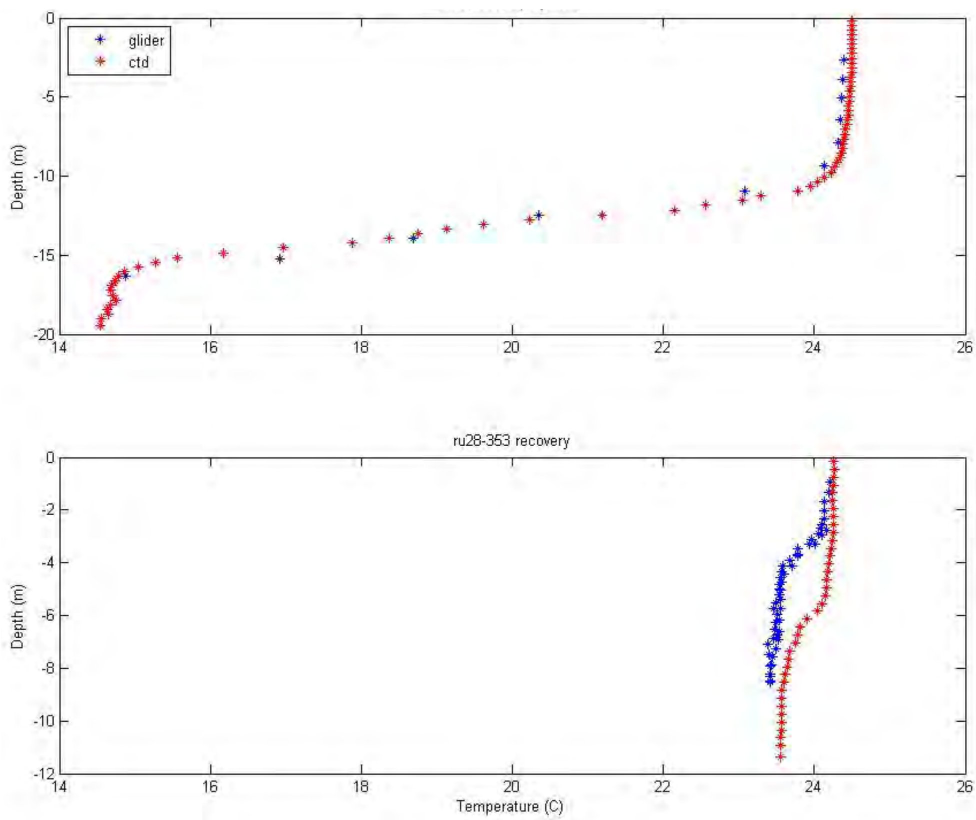

Figure 4: Comparison temperature profiles for the deployment (top) and recovery (bottom) of mission 4 in July of 2012. The glider temperature profile is blue and the stand alone CTD is red.

post- deployment verification between the glider CTD and a factory calibrated sea bird-19 CTD in our ballast tank in New Brunswick, NJ. The result of each verification for each deployment is shown in Table 2. For most missions, the glider CTD passed this test with all temperature and conductivity measurements within 0.05 C and 0.005 S/M, respectively. The only exception was the single test (pre-deployment #3) in which a castaway CTD replaced the standard SBE-19 unit. This castaway was not designed for a static tank test and therefore the results should be taken with caution. Even with this known issue, the comparability for both temperature and conductivity were within 0.08 C and 0.019 S/m, respectively. It could not be determined if this failure was a quality issue until the post deployment tank test conducted after recovery that verified the glider CTD measurements were within range of the SBE-19 (Table 2). The second tier test was an in situ verification at the deployment and recovery of the glider. For each deployment and recovery we lowered a separate CTD meeting manufacturer calibration requirements to compare to a concurrent glider profile. This second tier test gave an in situ comparison within the hydrographic conditions of the mission (Figure 4). For all the deployment tests, the structure and magnitude of the temperature and conductivity measured by the glider CTD was verified against the independent measurement (within 0.05 C for temperature and 0.005 S/m for conductivity). The same was not always possible with the recovery cast comparisons. Because of the logistics during a recovery it was not always possible to match the time and location of the CTD and glider casts. The greater the mismatch, the more influence the different environmental conditions at each cast bias the comparison. For example the CTD cast shown in (Figure 4, bottom) was taken 730 m away from and 50 minutes after the glider profile. Given this, the discrepancy between these casts is less a measure of instrument quality and more a measure of the environmental variability. Therefore we relied more on the in tank post deployment comparison tests to verify the quality of the glider CTD sensor (Table 2).

2.2 Data Post Processing

During each mission, data was stored locally on the glider and a subset of data was sent back to Rutgers via the satellite link. The transmitted subset consisted of every third data point within alternating profiles. The resulting resolution of this subset was approximately 0.9 m in the vertical and 110 m in the horizontal. After recovery of the glider, all data were run through sensor specific QA/QC verifications. The sensor specific post processing are described in the following two sub-sections.

2.2.1 Dissolved Oxygen

Raw oxygen profiles were corrected using the following criteria:

1. Aanderaa Oxygen Optodes typically exhibit a measurement time lag of ~22 seconds (Aanderra Users Manual). During the deployment, we used this stated value as the shift value. Upon recovery and download of the full resolution dataset, the following extra steps were taken.
2. Consecutive dissolved oxygen profiles were examined to determine the sensor-specific time lags by time-shifting the up and down profiles until best alignment of the vertical features determined by (insert criterion) was achieved. Each sensor

show a time-lag close to the reported time lag (Aanderra Users Manual) with some slight variation (20 – 25 seconds).
3. A mean time-lag value was selected using the entire dataset from each deployment and all profiles were then time-shifted by the observed best-result shift.

2.2.2 Hydrography

CTD: Gliders deployed during this project were configured with pumped and unpumped CTD sensors. Regardless of whether the CTD was pumped, all CTD profiles were processed in the same manner. Pumped units typically display smaller errors in raw sampling, a significant advantage in highly stratified water columns, which are typical in this area in the Spring, Summer and Fall seasons. The following methods were used to analyze and correct raw CTD profiles:

1. Raw temperature outliers were removed by comparing against climatology in this region. A temperature measurement was removed if it was < 8 degrees Celsius or > 28 degrees Celsius.
2. Individual profiles of temperature and conductivity are checked for spikes using the methods present in the Argo Data Quality Control Manual v2.8 (Argo Quality Control Manual). Spike values, defined as (insert e.g., changes of more than 100oC) are removed from further processing.
3. Temperature and conductivity profiles are corrected for thermal lag of the conductivity cell as described in Garau, et.al. (2011). The correction method aligns the raw temperature and conductivity signals, taking into account the variable speed of the glider. Four correction parameters are then calculated that minimize the area between the temperature-salinity curves of 2 consecutive vertical profiles. These parameters are then used to estimate the temperature inside the conductivity cell. This estimate of temperature inside the cell is combined with the measured temperature to calculate salinity for each profile. This method is shown to correct artificial salinity spikes with values of upto 0.3 PSU.
4. Consecutive down and up profiles are examined and used to calculate a mean profile representing the actual water column temperature, conductivity and salinity profiles. The following assumptions are made:
    a. Raw downcast profiles typically exhibit an erroneous spike in the salinity profile present as abnormally high salinity values in the region of the thermocline. Density profiles calculated using these erroneous values result in a thermodynamically unstable water column (higher density water on top of lower density water).
    b. Raw upcast profiles typically exhibit an erroneous spike in the salinity profile present as abnormally low salinity values in the region of the thermocline. Density profiles calculated using these erroneous values

result in a thermodynamically unstable water column (higher density water on top of lower density water).

c. Measured temperature and conductivity values for the true water column profile lie somewhere in between the mean of consecutive downcasts/upcasts.

d. As a rule of thumb, gliders typically travel twice the horizontal distance as they travel vertically. For this project, we agreed to provide at least one profile at 110 meter horizontal resolution. Given that the water column depth range was 0 – 30 meters, a consecutive profile pair covered 100 - 120 meters. This methodology allows us to meet the spatial resolution requirements.

5. Calculated mean profiles were then inspected for salinity spikes and any profile containing a spike > 0.3 PSU was eliminated from the post-processed dataset (Garau et.al. 2011). Across all project deployments, less than 1% of the corrected profiles were discarded.

3. Results

The six deployments sampled the variability in both the hydrography and dissolved oxygen over two summers off the coast of New Jersey. To do this we used three gliders, RU16 (Mission 1), RU07 (Missions 2, 3, & 6), and RU28 (Missions 4 & 5). Details of each mission including dates, duration, and observations are summarized in Table 3. The two deployments in 2011 were completed in August and October before, during, and after a large phytoplankton bloom, Hurricane Irene (August 28, 2011), and the remnants of Tropical Storm Lee (September 4, 2011). The four deployments in 2012 covered each month between June and September, inclusive, mapping the seasonal evolution from late spring through early fall. Within each of these missions we observed significant variability in the measured dissolved oxygen. All six missions measured DO concentrations below 5 mg/L with 4 missions observing DO concentrations below 2 mg/L.

Table 3. Summary of the 6 glider missions completed in 2011 and 2012.

					Temperature		Salinity	
Deployment	Deployment	Recovery	Length (Days)	# Profiles	Min	Max	Min	Max
#1	August 10, 2011	September 9, 2011	30	3,952	9.3	25.2	29.3	33.3
#2	October 6, 2011	October 27, 2011	21	6,757	15.5	20.1	25.5	32.8
#3	June 7, 2012	June 19, 2012	12	6,636	11.3	20.5	27.7	32.9
#4	July 10, 2012	July 30, 2012	20	14,641	12.3	26.5	29.7	33.2
#5	August 14, 2012	August 30, 2012	16	9,084	12.2	26.0	28.1	33.0
#6	September 13, 2012	October 4, 2012	21	11,577	11.0	23.8	29.3	35.1

	Dissolved Oxygen		Mean Temperature		Mean Salinity		Mean Dissolved Oxygen	
Deployment	Min	Max	Surface	Bottom	Surface	Bottom	Surface	Bottom
#1	3.07	9.23	22.6	14.2	30.5	31.7	7.70	4.81
#2	1.73	11.76	17.9	17.5	29.7	30.7	7.74	5.82
#3	4.07	12.43	19.3	16.6	31.0	31.7	8.34	6.71
#4	1.88	9.81	24.3	18.4	31.5	32.0	7.29	4.87
#5	0.94	12.70	24.5	17.4	31.7	32.1	7.42	3.87
#6	0.82	13.29	20.8	16.8	31.9	32.3	7.10	4.20

This is consistent with the historic helicopter sampling using a Kemmerer water sampler in which DO concentrations below 5 mg/L were observed in each year between 1979 and

2005 (http://www.epa.gov/region02/monitor/nybight/). The glider sections showed a persistent vertical structure with lower DO concentrations below the seasonal thermocline and higher concentrations above. This basic structure was seen to vary in time and space.

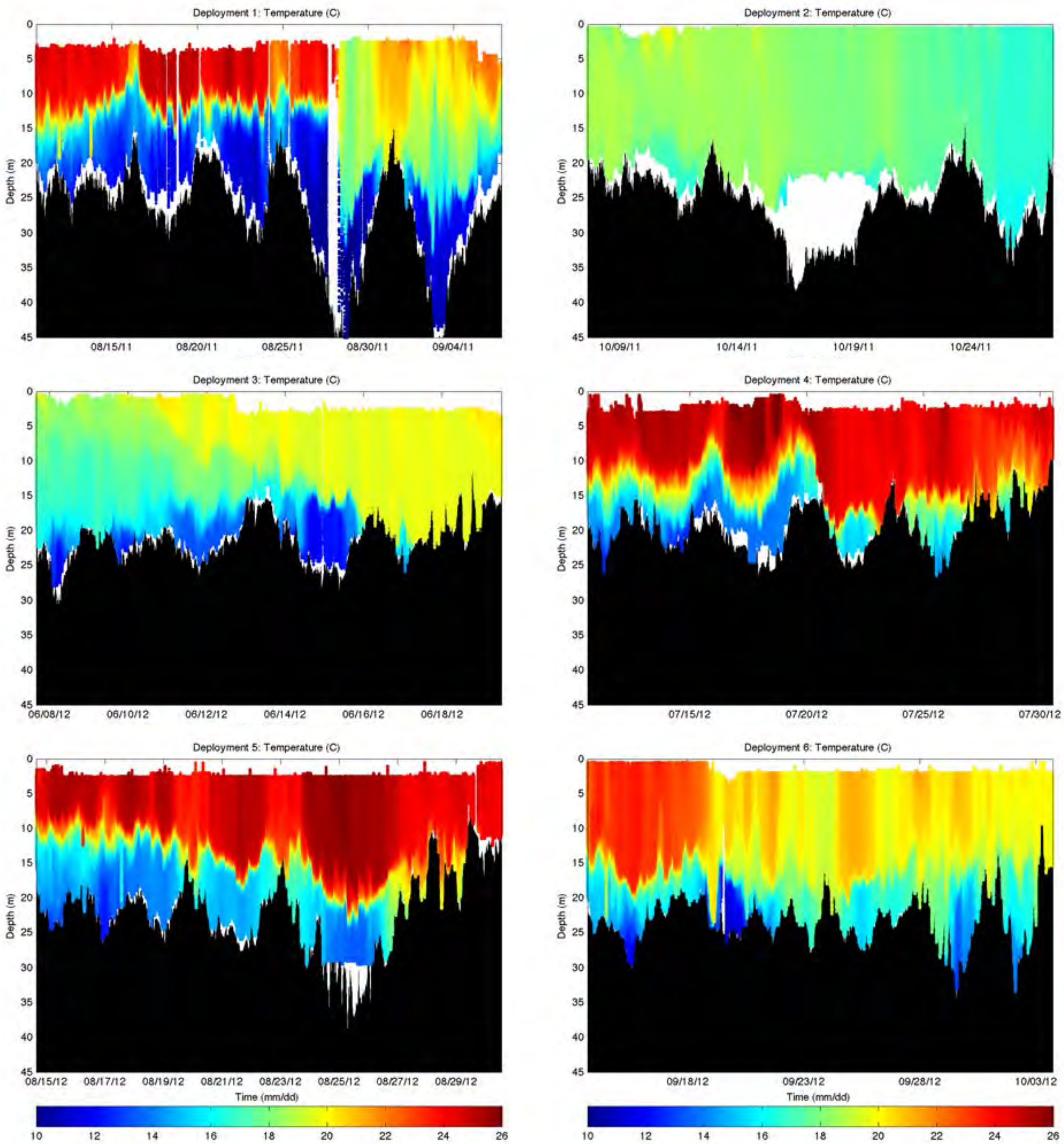

Figure 5: Cross-sections of temperature for the deployments completed in August 2011 (upper left), October 2011 (upper right), June 2012 (middle left), July 2012 (middle right), August 2012 (lower left), and September 2012 (lower right).

The objective of this project was to capture that spatial and temporal variability at a resolution not obtainable from discrete sampling. Spatially, the lowest values were seen off the Northern New Jersey coast in both the August and October missions in 2011. In

2012 the lowest DO were again within the bottom layer below the thermocline. In all missions, the DO was seen to vary significantly in the vertical profile and along the path in both space and time. Temporal changes were predominately caused by strong (Hurricane Irene) and moderate wind events that mixed the more oxygenated surface water with the deeper less oxygenated water. Spatial variability was strongly depth dependent with most of the lower concentrations within the bottom layer in waters shallower than 20 m. There were exceptions to these generalities in each deployment.

While this project focused on the observed variability of the DO fields, it is important to place these observations in the context of the simultaneously sampled seawater temperature and salinity. The remaining subsections present the results for the thermal, saline and DO variability observed through these 6 missions. We characterize the range as well as structure of these fields as they evolve within and between the summer seasons of 2011 and 2012.

3.1 Temperature

Mean surface temperatures observed across all missions were in the mid 20s °C, except in the Fall of 2011 and spring of 2012 where the temperatures were in the upper teens. For all missions the mean bottom temperatures were between 14 and 19 degree C. The summer deployments show a two layer structure previously observed off the New Jersey coast with a warmer fresher layer separated from a colder saltier layer by a very strong thermocline approximately midway through the water column (Figure 5). During the October deployment in 2011, the water column had already transitioned from summer stratified conditions to late fall/winter mixed conditions (Figure 5, upper right). During the first deployment of 2012 (June), the stratification was just beginning to strengthen (Figure 5, middle left). The two 2011 deployments show the late season transition from the strong stratified summer to the mixed fall. The strong rapid mixing due to Hurricane Irene initiated the breakdown of the thermocline at the end of August with a dramatic cooling of the surface layer of over 7 degree C (Figure 5, upper left). The temperature continues to decline throughout the water column over the course of the following October mission. The 2012 missions illustrate the seasonal transition with the onset of thermal stratification beginning in June, strengthening through July and August and beginning to breakdown in September. This breakdown is seen in the deepening of the thermocline and a cooling of the surface layer through the September mission. On average the water temperatures below the thermocline are warmer in 2012 (Table 3). In both years, the thermocline is 10 to 15 m deep.

3.2 Salinity

The mean surface salinity varied from 29.7 to 31.9 practical salinity units (psu) over all the missions. Bottom salinity was typically about 1 psu saltier (Table 3). The structure of the salinity fields again highlights the predominance of the summer two layer system with fresher water sitting above saltier water (Figure 6). Unlike the temperature sections, the salinity data also shows the influence of the Hudson River with the freshest water occurring mostly near the northern limit of the missions (left side of the panels in Figure 6). In 2011 the most significant feature is the large slug of freshwater seen near the surface and in some locations throughout the water column in October (Figure 6, upper right). This is the impact of the significant rainfall that fell in August from

Hurricane Irene and other storms that eventually made its way out into the coastal ocean. This is the freshest water we saw over the entire project. In 2012, the four deployments

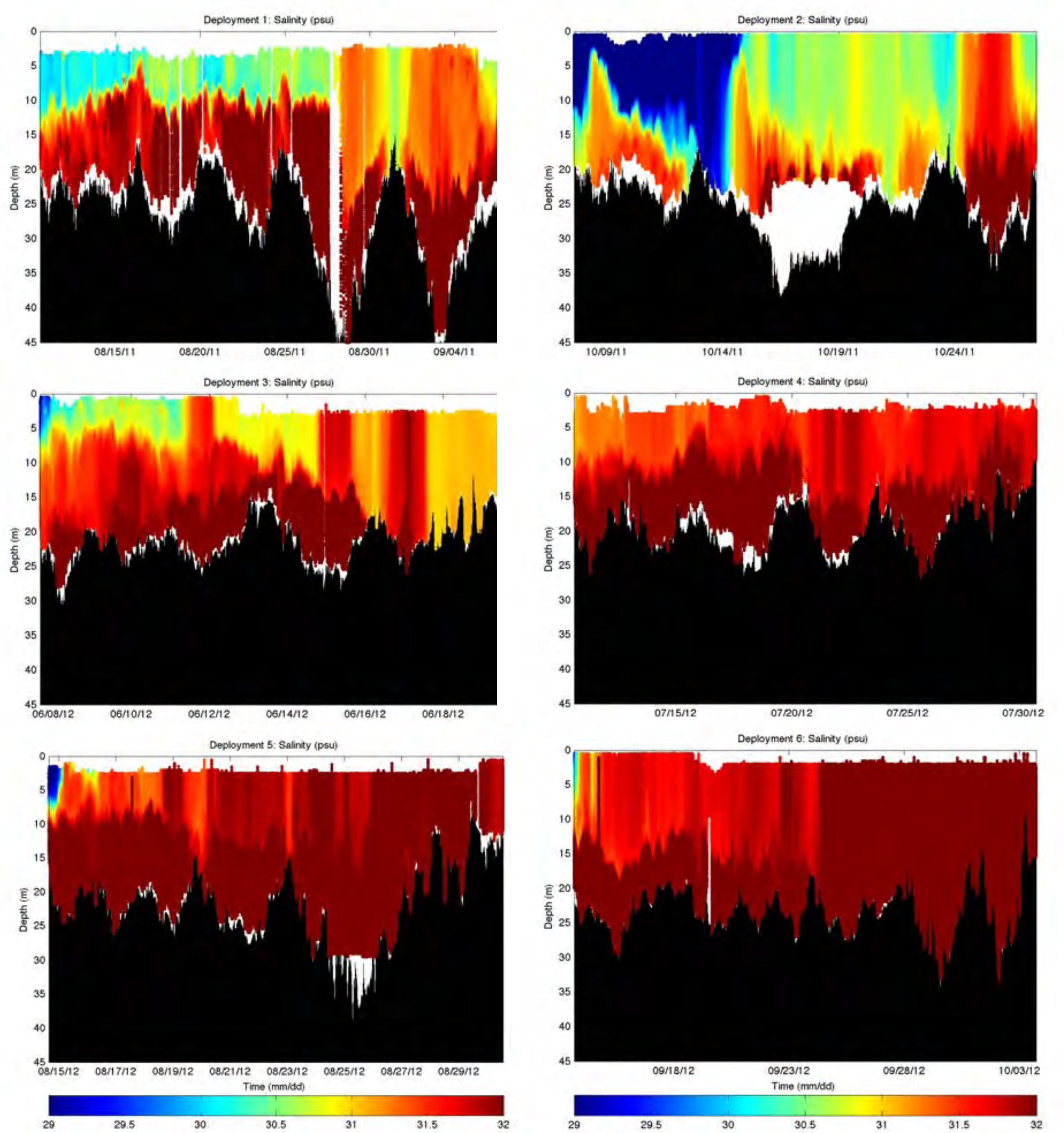

Figure 6: Cross-sections of salinity for the deployments completed in August 2011 (upper left), October 2011 (upper right), June 2012 (middle left), July 2012 (middle right), August 2012 (lower left), and September 2012 (lower right).

capture the seasonal evolution of freshwater inputs with fresher water near the surface toward the north in the late spring (June). The surface salinity gradually increases through the summer with the exception of a small slug of freshwater off Sandy Hook in

August (Figure 6, lower left). The fall of 2012 had higher salinity waters found well mixed throughout the water column.

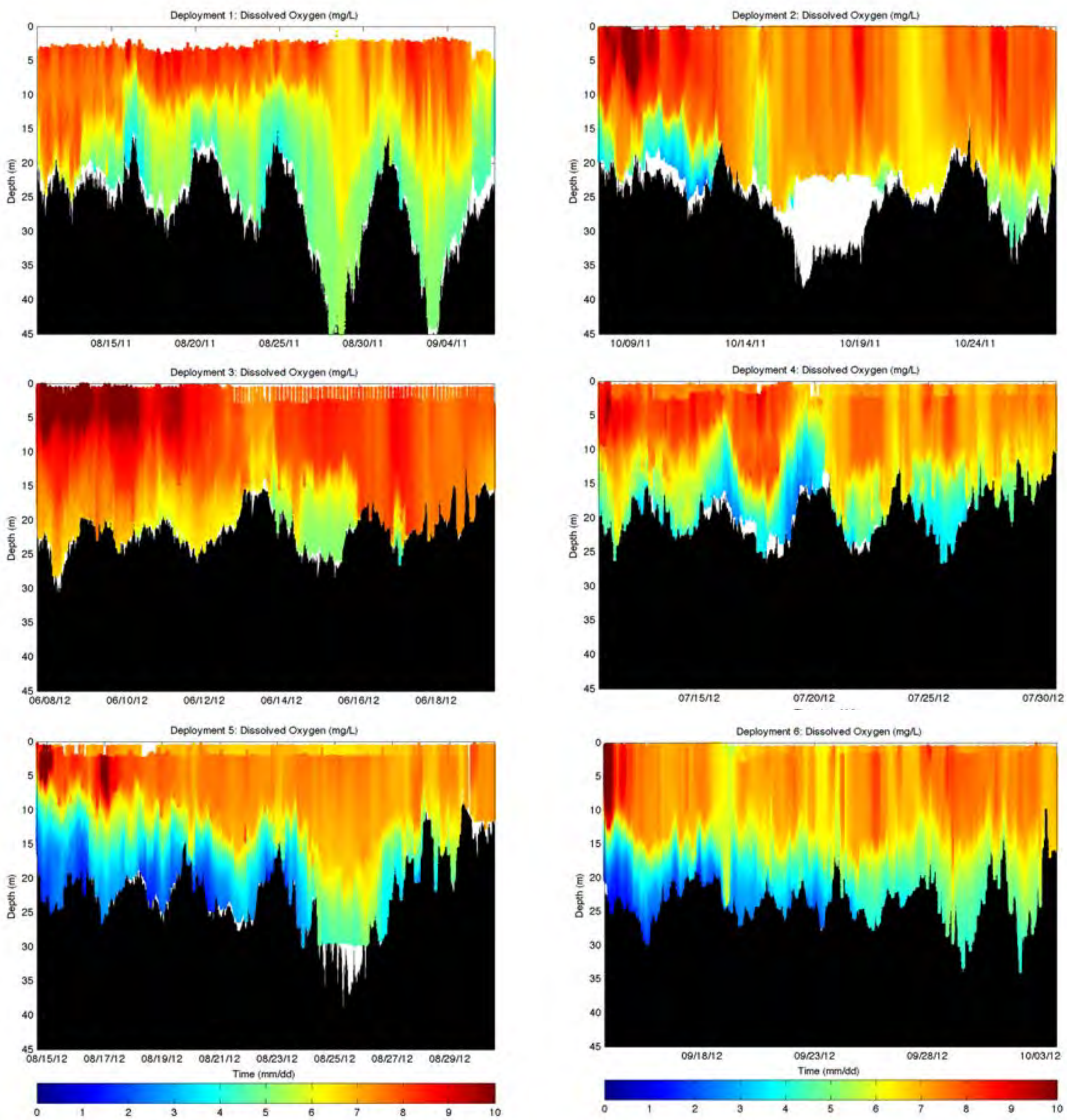

Figure 7: Cross-sections of dissolved oxygen concentration for the deployments completed in August 2011 (upper left), October 2011 (upper right), June 2012 (middle left), July 2012 (middle right), August 2012 (lower left), and September 2012 (lower right).

3.3 Dissolved Oxygen

In each mission completed over the two years, DO concentrations were observed below 5 mg/L. The lowest values were seen during the late summer in 2012 with absolute minimum values below 1.0 mg/L. In general the mean bottom concentrations were 3.0 mg/L less than the surface. In the remaining sub-sections we describe the details of the observed variability in the DO fields within and between deployments and years.

3.3.1. Spatial/Temporal Distribution

Similar to the thermal structure, the DO fields over the summer months were best characterized as a two-layer system with higher concentrations above the thermocline and lower concentrations below (Figure 7). The summer of 2011 was subject to a large phytoplankton bloom that was interrupted by two significant rain events (Hurricane Irene and the remnants of Tropical Storm Lee) while the summer of 2012 was much less eventful. The lowest values were seen in July, August and September 2012 with some

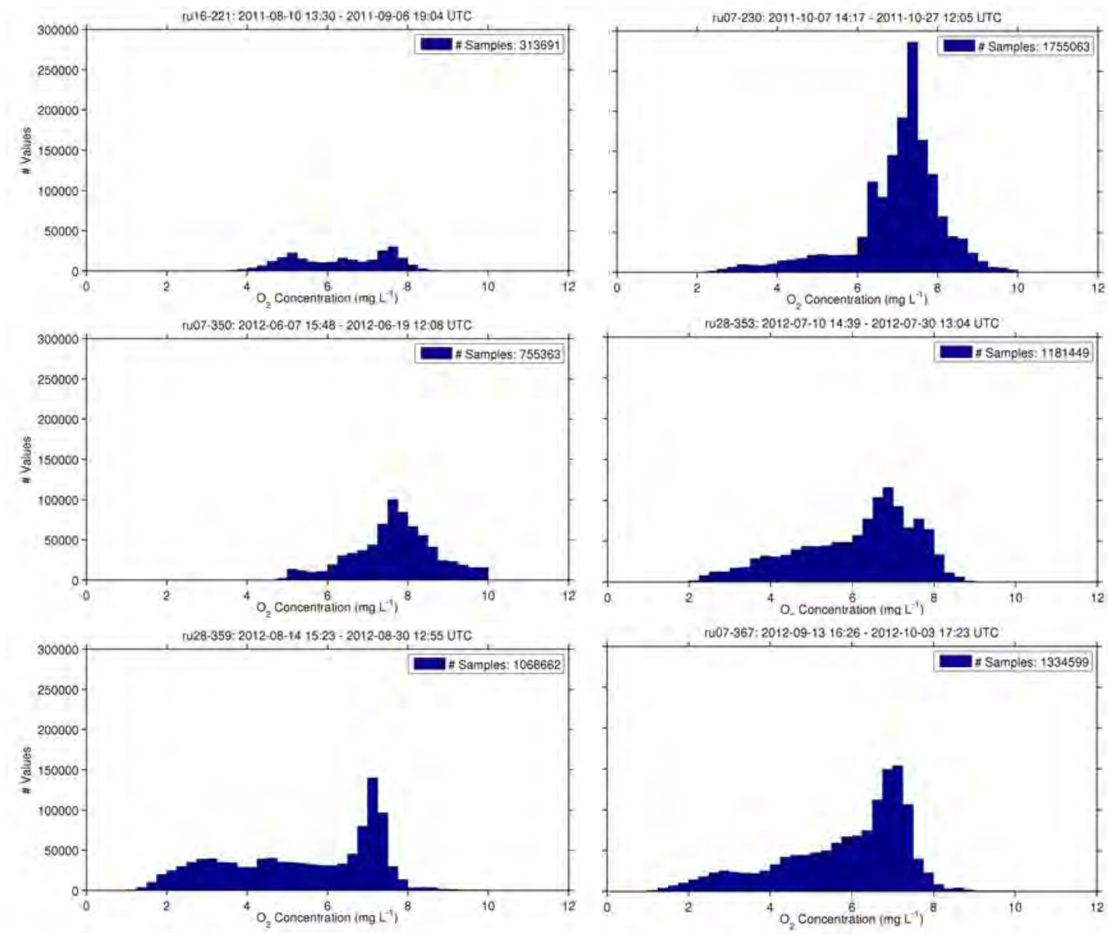

Figure 8: Histogram of dissolved oxygen for the deployments completed in August 2011 (upper left), October 2011 (upper right), June 2012 (middle left), July 2012 (middle right), August 2012 (lower left), and September 2012 (lower right).

values below 1.0 mg/L. In August of 2011, the lowest concentrations were seen near the seafloor closer to the coast. This mission coincided with a large phytoplankton bloom observed across the entire domain. Even with the large expanse of the bloom, the lowest values, all above 3.8 mg/L, were limited to waters shallower than 20 m. Following Hurricane Irene (August 28, 2011), the large salinity gradient, setup by Irene's rains, maintained the stratification into the fall. This maintained the boundary between the lower oxygen concentration of the bottom layer and the surface. As the October mission progressed, even this late stratification broke down and the lower layer readily mixed with the higher concentrations of the surface layer. Over the four missions in 2012 we see the progression from a relatively well-oxygenated water column in June with all values above 4.5 mg/L (Figure 7, middle left) to a more bimodal distribution in the late summer and early fall. The summertime lows in the bottom layer were 1.88 mg/L in July and 0.94 mg/L in August (Figure 7 and 8). In general there was a tendency for the lowest values to occur along the northern coast of NJ, within the 25-m isobath. During the last mission in September 2012, the distribution of observations transitioned toward a more oxygenated water column (Figure 8). For all missions, the DO concentration in the surface layer was never below 5 mg/L and was seen as high as 12 mg/L. For the bottom layer all DO concentrations were between 0.82 mg/L and 8.5 mg/L. From the two years of data we can see that the late summer condition in each year both show a bimodal distribution with higher concentrations in the surface layer and lower concentrations in the lower layer. While the surface peak is the same between the two years, we do see lower DO concentrations in the lower layer in 2012 (peak approximately 3 mg/L) compared to 2011 (peak approximately 5 mg/L) in 2012 (Figure 7).

3.3.2 Decorrelation scales:

Since the glider is a non-stationary platform it is important to state that it is simultaneously sampling temporal and spatial change. It is difficult to differentiate a measured change in DO concentration as a change in time or a change in space when looking at the glider data in isolation. Using autocorrelation we calculated the decorrelation time and length scales for each deployment. The decorrelation scale is defined as the scale, in time or space, in which the autocovariance coefficient falls below 0. These scales describe the time and space over which the DO variability becomes uncorrelated. For example, a decorrelation length scale of 50 km indicates that the DO observations at any point are correlated with DO observations within 50 km. Similarly, a decorrelation time scale of 5 hours indicates that the DO observations at a particular time are correlated with DO observations at that point for 5 hours before and after the measurement. These scales can be used to guide the sampling required in time and space to capture the variability of DO along the coast. For the remainder of this report, the DO concentrations of the surface layer will be represented as those sampled between 3 m and 4 m below the surface and the DO concentration of the bottom layer will be represented by those sampled between 3m and 4m above the seafloor. The average spatial decorrelation scales for all the deployments are 67 km for the surface and 92 km for the bottom (Table 4). This scale is approximately the length of a glider leg from offshore to onshore and likely reflective of the persistent difference seen between the nearshore and offshore dissolved oxygen vertical structure. The 2011 deployments showed similar scales for the surface and bottom, all within 10 km of the project mean. The 2012 data show a larger spread in the values of the length scales between surface and bottom as well as between different deployments. For each 2012 deployment the surface scale was smaller than the bottom scale. There is also a general trend toward longer length scales in the bottom layer later in the season.

The mean temporal scale across all deployments was 3.2 days for the surface and 4.6 days for the bottom layer. Similar to the space scale, the bottom layer had longer decorrelation time scales than the surface. With an average glider speed of approximately 20-24 km/day, it would take the glider about 2.8 to 3.3 days to cover the mean spatial decorrelation scale. While we feel that these temporal scales are more reflective of the time it takes for the glider to move through the variation in space rather than a measured local change over time, we do observe faster changes in time that are more episodic and predominately due to mixing induced by local winds. Given this, the data suggest that the sampling must resolve the spatial scales reported in Table 4 at a temporal resolution sufficient to capture the effects of wind forced events.

Table 4. Decorrelation scales for time and space for each deployment. The scales are calculated separately for the surface and bottom data.

	Space Scales (km)		**Time Scales (Days)**	
	Surface	**Bottom**	**Surface**	**Bottom**
Deployment 1: August 2011	62.0	70.6	3.19	3.70
Deployment 2: October 2011	76.7	77.5	3.74	3.79
Deployment 3: June 2012	77.9	74.1	3.45	3.24
Deployment 4: July 2012	49.8	62.9	2.78	3.70
Deployment 5: August 2012	97.9	107.5	4.53	5.53
Deployment 6: September 2012	38.0	162.8	1.78	7.81
Project Average	**67.1**	**92.6**	**3.2**	**4.6**

3.3.3 Influence of Water Depth

For all missions the main influence driving the spatial and temporal variation in the observed DO was water depth. As described above, the spatial decorrelation scales were on the order of a single transect taken from the glider from either deep to shallow or shallow to deep water. In order to confirm the influence of water depth on the observed vertical structure of the DO we show the DO concentration for the bottom (blue) and surface (red) data described above versus depth (Figure 9). For each mission we see again the higher DO concentrations in the surface layer compared to the bottom layer. With the exception of the first mission, we also see a consistent pattern in the vertical gradient of DO with water depth. In the shallower waters the surface and bottom layer DO concentrations are very similar usually between 6 and 8 mg/L. As the glider moves into deeper water, the surface and bottom DO values diverge. This divergence is primarily driven by increasingly lower concentrations in the bottom layer below stronger stratification further offshore. The exception to this pattern is the first mission where

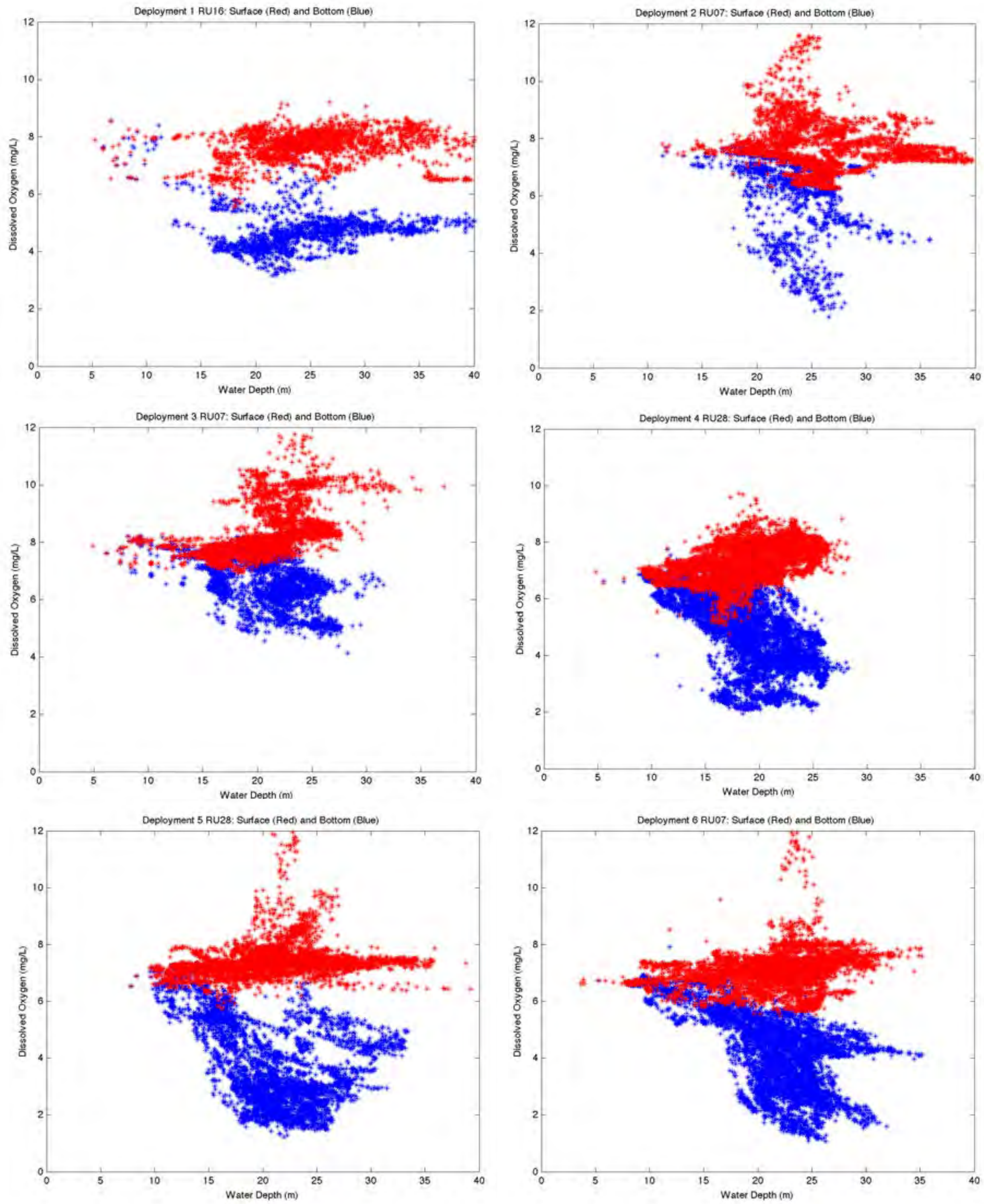

Figure 9: The dissolved oxygen concentration of the surface (red) and bottom (blue) layers vs. water depth for each deployment completed in August 2011 (upper left), October 2011 (upper middle), June 2012 (upper right), July 2012 (lower left), August 2012 (lower middle), and September 2012 (lower right).

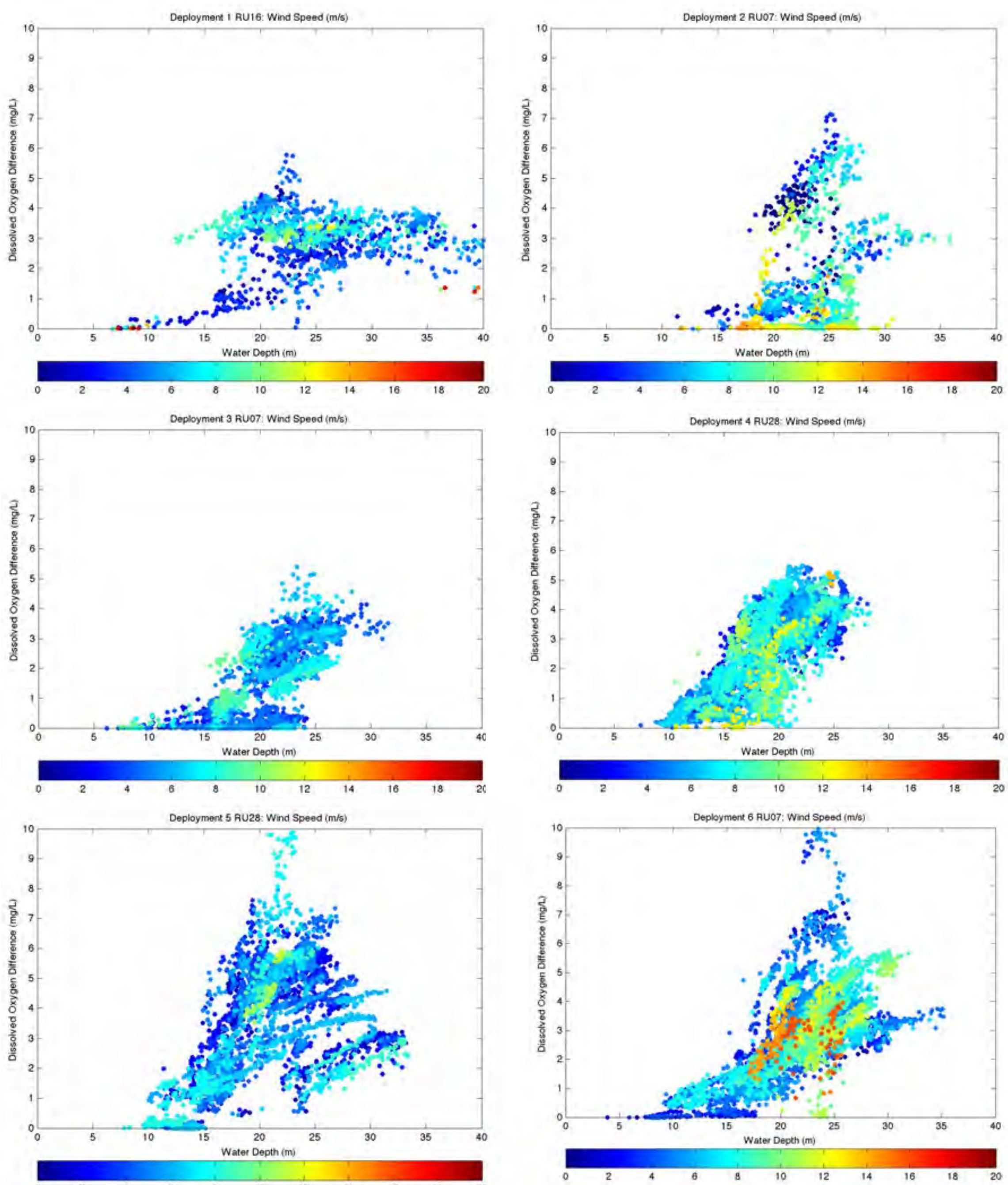

Figure 10: The difference in dissolved oxygen concentration between the surface and bottom layers vs. water depth for each deployment completed in August 2011 (upper left), October 2011 (upper middle), June 2012 (upper right), July 2012 (lower left), August 2012 (lower middle), and September 2012 (lower right). The color of the scatter is wind speed (m/s).

there is little evidence of any dependence on water depth. During this mission the conditions remained stratified from the shallow to the deep water. The specifics of this first mission will be discussed in the following two sections (3.4 and 3.5).

The influence of wind events on the structure of the DO relative to the depth dependence described above is highlighted in Figure 10. These scatter plots relate the difference between the DO concentration in the surface and bottom layers vs. water depth. The color of the scatter indicates the wind speed. Once again the lower differences (less stratified) conditions are found over the shallow water depths. The larger differences between surface and bottom are found further offshore. For each mission we also show the distribution of wind speeds relative to each observation. The blue values are weaker winds (below 5 m/s) and the stronger winds (>10 m/s) are shown in yellow to red. While there are cases in which the local winds are seen to reduce the stratification in the DO concentrations (see Irene discussion below), the water depth is seen as a much more consistent influence on the observed vertical structure. From this we can see that the decorrelation scales described above largely represent the variability observed as the glider transits from shallow to deep water or deep to shallow water. The temporal scales are representative of the time it takes the glider to complete the transit. Over this two year period we see a general structure in which the nearshore water are well mixed with DO concentrations between 6 and 8 mg/L. As the glider moves offshore, the water column tends to be more stratified resulting in a more isolated bottom layer. It is over these deeper layers that we see the largest vertical gradients between surface and bottom waters and the lowest bottom DO concentrations.

3.4. Event Response: Summer Bloom 2011

During the summer of 2011, there was a large summer phytoplankton bloom that formed in mid-July and continued through August. Based on satellite imagery the phytoplankton concentrations were highest along the southern coast of New Jersey and extended well offshore and upcoast (Figure 11). Our August 2011 deployment targeted this bloom as we adapted the mission plan to cover the entire coastal area to one that would sample in and outside of the largest phytoplankton concentrations (upper left, Figure 5, 6, and 7). We redirected the glider along cross-bloom transects through the highest concentrations observed off the central coast of New Jersey. As the glider moved south, the DO concentrations of the bottom layer dropped from 7 mg/L to around 4 mg/L. While the surface layer concentration remained above 6 mg/L along the entire path. Beneath the bloom the ocean was clearly stratified with DO concentrations of 7 to 8 mg/L in the surface and 4 to 5 mg/L in the bottom layers, respectively. Based on the samples taken by whomever 6 and 12 miles off the coast

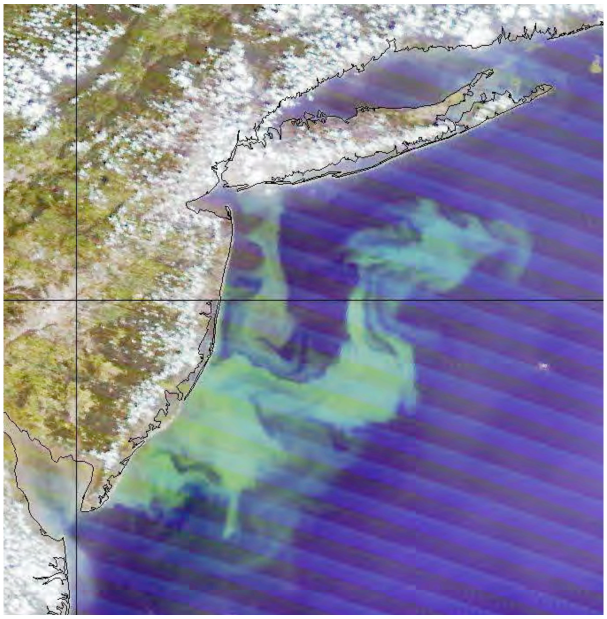

Figure 11: True color image of the summer 2011 phytoplankton bloom. Image courtesy of the Mid Atlantic Regional Association Coastal Ocean Observing System (MARACOOS).

of Beach Haven on August 20, 2011, the bloom consisted of *nannochloris oculata* (>200,000 cells/ml) and *heterosigma akashiwo* (8,000 cells/ml) (Based on laboratory analysis of water samples taken by NJDEP, Robert Schuster, personal communications). Based on Satellite imagery (not shown), the passing of Hurricane Irene pushed the bloom up against the coast in late August before it broke up in mid September. Our deployment in October, following the break up of the bloom, measured DO concentrations below 4.0 mg/L in the bottom layer. These lower concentrations, initially isolated from the surface layer by the freshwater input resulting from Irene's rains, were mixed away by the end of the October mission.

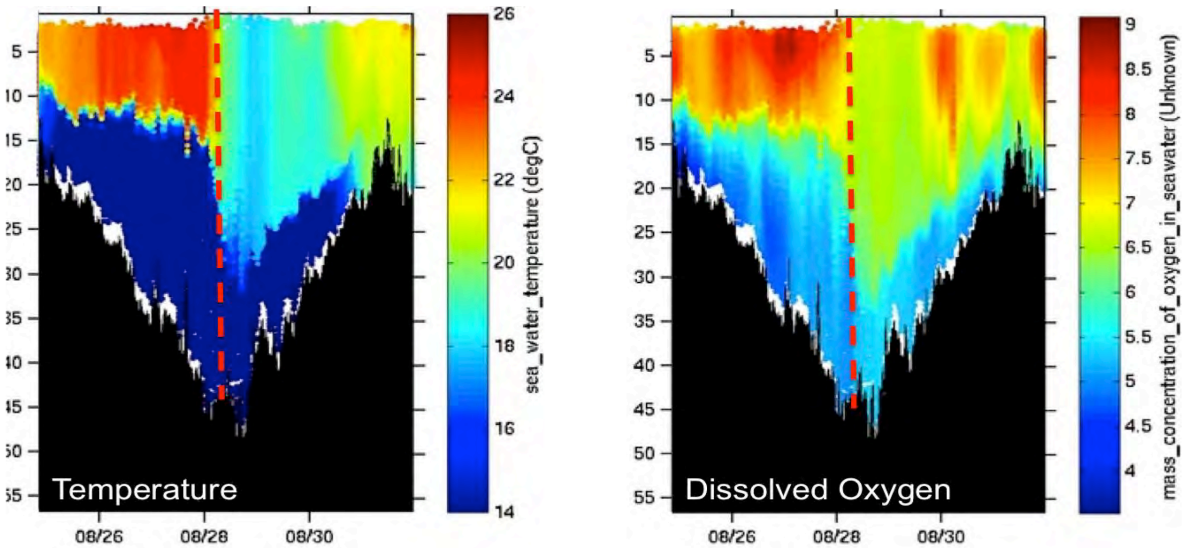

Figure 12: Glider path during August 2011. The temperature (C) (left) and dissolved oxygen concentration (mg/L) (right) collected during Hurricane Irene along the cross-shelf line at the southern end of the path. The timing of the storm is shown as a red dashed line in each cross-section.

3.5 Event Response: Hurricane Irene

In late August 2011 Hurricane Irene tracked directly over the inner New Jersey Shelf. The first deployment of this project captured this significant forcing event. Prior to the storm passing, we modified the glider mission from the zigzag path toward Cape May to one that maintained a cross-shelf line (Figure 3, upper left). The cross-shelf line was timed so that the glider was in deeper water at the peak of the storm. In so doing we were able to capture the evolution of the hydrographic (Figure 5 & 6, upper left) and dissolved oxygen (Figure 7, upper left) fields before, during and after the storm. A subsection of these data centered on the storm are shown in (Figure 12). A dramatic impact of Hurricane Irene is seen in the temperature data. This section shows how quickly the storm mixed the water column, transitioning from strongly stratified before the storm to a deeper and weaker thermocline following the storm. This section gave us our first look at how quickly the inner-shelf was impacted by a hurricane at this spatial resolution. The impact of this rapid mixing and subsequent cooling of the ocean surface, rapidly reduced Irene's intensity.

Similarly, the structure of the dissolved oxygen fields underwent a significant transformation through the storm. Before the storm, there was a large gradient through the water column with higher concentrations near the surface separated from lower oxygen values below the thermocline. The bimodal distribution illustrates this stratification with the lower DO values of the bottom layer in the highest peak on the left and the higher DO values in the small, more broad peak on the right (Figure 13). Following the storm, the intense mixing weakened the strong DO gradient allowing higher oxygen concentrations to penetrate deeper toward the seafloor. The distribution of oxygen values in the pre-storm and post-storm sections shows a shift toward the middle of the range (Figure 13). After the storm there are no observed concentrations below 4 mg/L or above 8 mg/L. There is still a bimodal distribution but it has shifted from the pre-storm peaks of 5 mg/L and 7.5 mg/L to about 5.2 mg/L and 6.5 mg/L for the bottom (left peak) and surface (right peak) layers respectively. The largest peak in the distribution has also shifted from the lower concentrations of the bottom layer to the higher concentrations of the surface layer.

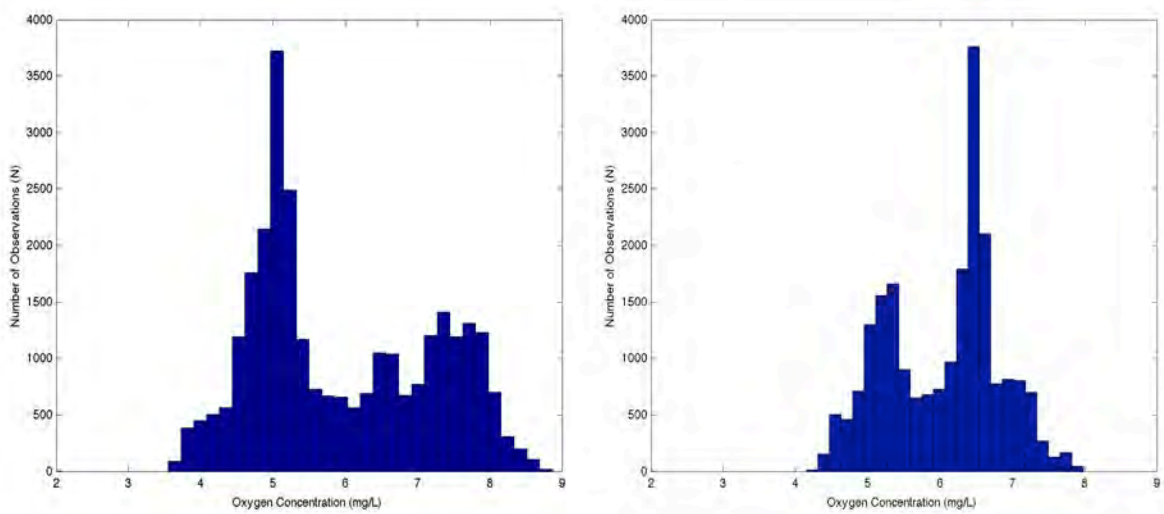

Figure 13: Distribution of dissolved oxygen measurements collected in the above cross-sections before (left) and after (right) the passing of Hurricane Irene.

4. Conclusions

With the effort of all on the team were able to successfully map the dissolved oxygen concentration off the New Jersey coasts through 6 glider missions completed in 2011 and 2012. Each mission was carried out as prescribed in the QAPP document to ensure the quality of the data collected. By following these specifications we documented the required quality assurance steps for the AAnderra Optode, SeaBird CTD (pumped and unpumped) and the glider platform itself. The missions were carried out with a predefined path that was adjusted through consensus of the project partners to capture the variability in the magnitude and structure of dissolved oxygen. Across all six missions, we observed DO concentrations below 5 mg/L within the bottom layer, two of those saw concentrations below 1 mg/L. The stratification setup by warm summer days was seen to trap this less oxygenated bottom layer until wind events (both moderate and severe) mixed more oxygenated water across this boundary. The sampling provided through the glider AUV showed that the concentrations of dissolved oxygen were highly variable in the vertical, horizontal, and through time.

The strongest gradients were observed across the thermocline with surface waters usually much more oxygenated than the bottom waters. These gradients were weaker closer to the coast and significantly weakened following several strong wind events. Spatial variability explained most of the variability with more mixed conditions in the shallow waters near the coast and more stratified conditions in the deeper water offshore. It was in the deeper waters offshore that most of the lower DO concentrations were found below the thermocline. The scales of this variability observed over these two seasons was on the order of 60-80 km in space and 3-4 days in time. We conclude that these decorrelation scales are representative of the distance over which the water depth varied. The time scale is more an indicator of the time it takes the glider to cover this distance rather than a change across all space in time.

There were observed changes in time, predominately caused by strong (Hurricane Irene) and moderate wind events that mixed the more oxygenated surface water with the deeper less oxygenated water. During Hurricane Irene we saw rapid mixing of the more oxygenated surface waters across the thermocline and into the bottom waters. In addition, events like Irene and the coastal bloom in 2011 highlighted the capability to adapt pre-determined missions to respond to these events. This allowed us to ensure that observations were taken relative to the bloom throughout the storm. Since this was all done in real-time the monitoring data was immediately available to NJDEP and EPA to inform their response to these events. In the case of the bloom, the monitoring data guided NJDEP boat sampling to further study the details of the bloom.

Based on these missions, we have begun to sample the dynamic coastal ocean environment at the scales of known variability. The results show that while there are persistent patterns in the dissolved oxygen fields associated with water depth and stratification off our coasts, rapid changes can occur with varied responses across the region. These results highlight the need to coordinate the high-resolution data sampled along the gliders path with strategic point measurements in time. Based on these missions, a line of at least two moored bottom DO time series stations oriented across the shelf would help to distinguish the variability observed by the glider in space and time. These point observations combined with the coast wide coverage of the glider would be able to identify regions of low DO and characterize how they evolve through time. With these glider missions we have begun to characterize the scales of variability. These scales can inform State and Federal agencies as they refine criteria to assess the impact of low DO in the coastal ocean in a way that accounts for its observed variability.

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Appendix A

QAPP

Spatial and Temporal Monitoring of Dissolved Oxygen (DO) in New Jersey Coastal Waters Using AUVS

Data Quality Assurance Project Plan

Prepared by: ________________ 7/12/2011
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Rutgers, The State University of New Jersey
New Brunswick, NJ 08901

Approved by: ________________
Michael Borst, EPA project officer, date

Approved by: ________________ 6/17/11
Darvene Adams, EPA Region 2 project technical lead, date

Approved by: ________________ 6/17/11
Carol Lynes, EPA Quality Assurance Officer, date

Approved by: ________________ 6/23/11
Robert Schuster, NJDEP technical point of contact, date

Approved by: ________________ 7/12/2011
John Kerfoot, Rutgers data management lead, date

Approved by: ________________ 7/12/2011
Chip Haldeman, Rutgers glider logistics lead, date

Revision Log

Revision Date	Reason for Revision

2.0 Table of Contents:

Appendix

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4.0 Project Organization:

Josh Kohut – Rutgers University: Josh Kohut will serve as the lead manager of the Rutgers component of the project. He will serve as the Rutgers point of contact and ensure that all objectives as outlined in the contract are met. Josh Kohut will also be responsible for overall project QA.

John Kerfoot – Rutgers University: John Kerfoot will be responsible for the data management and quality control for each glider deployment.

Chip Haldeman - Rutgers University: Chip Haldeman will direct all logistics related to glider deployment and recovery.

Michael Borst – EPA ORD: Michael Borst will serve as the EPA project officer. He is a member of the project team and will act as the primary point of contact for EPA, oversee operations.

Darvene Adams – EPA Region 2: Darvene Adams will serve as the EPA Region 2 project technical lead.

Robert Schuster – NJDEP: Will serve as the technical point of contact for the New Jersey Department of Environmental Protection.

All individuals listed above are part the project team.

5.0 Special Training Needs/Certification

All glider related tasks and data management will be carried out by the experienced team at Rutgers. As of the award of this contract from EPA to Rutgers University, the Rutgers AUV team has completed 259 deployments and delivered quality data to local, state, research and federal agencies. Each member of the Rutgers team has been trained both in the lab and in the field. At sea experience specific to glider operation will be required for each deployment and recovery. At least one individual on the vessel must be certified by the lead PI to complete the deployment/recovery as described in appendix C and D. This certification will be documented in the deployment checklist. Additionally experience with oceanographic sensors and sensor care of at least one year or equivalent manufacturer training is required. Operation of the glider and all calibration procedures require no specific certification beyond the experience described here.

6.0 Problem Definition/Background

6.1 Problem Definition

The coastal ocean is a highly variable system with processes that have significant implications on the hydrographic and oxygen characteristics of the water column. The spatial and temporal variability of these fields can cause dramatic changes to water quality and in turn the health of the entire ecosystem. Both the New Jersey Department of Environmental Protection (NJDEP) and the Environmental Protection Agency (EPA) – Region II have prioritized monitoring the coastal waters off New Jersey in their long-term strategic plans as an essential component of the decision-making process. Of particular interest are the spatial and temporal characteristics of dissolved oxygen (DO). Hypoxic and anoxic conditions ripple through the entire ecosystem causing fish kills and potentially large disruptions to local and remote food webs. In response to this need, we have put together a program to augment existing monitoring with targeted deployments of glider Autonomous Underwater Vehicles (AUVS) equipped with sensors to map coastal hydrography and dissolved oxygen conditions in near-real time along the New Jersey inner-shelf.

The study area for this project will be the coastal waters off the New Jersey coast between Sandy Hook and Cape May. The glider will be tasked on a zig-zag pattern to cover the waters within the 3 nm NJ jurisdiction (Figure 1). The objectives of this project are to monitor the hydrography and dissolved oxygen of these coastal waters. We will deploy a Slocum-electric glider 6 times (three per year) during the stratified summer season. The primary users for the data generated by this project will be the EPA and the water monitoring division of the NJDEP. During each mission the real-time data will be used to map dissolved oxygen and water column stratification along the New Jersey coast. Following each deployment the full quality controlled dataset will be delivered to the EPA for inclusion in their coastal data archive.

Dissolved oxygen thresholds developed by EPA, NJDEP and Rutgers are based on the state standard of 5.0 mg/l and the EPA criteria of 2.3 mg/l and 4.8 mg/l (U.S. EPA, 2000). These thresholds will guide the use of the data throughout the project. If the glider observes values below the state standard of 5.0 mg/l, the EPA and NJDEP will determine the course of action including possible re-task of the glider and deployment of additional assets to sample the region. In addition NJDEP will use these data to evaluate the adoption of the EPA criteria of 4.8 mg/l and 2.3 mg/l as a state standard. The high-resolution sampling approach of the glider will also be able to bound these areas of low oxygen in time and space to guide both the response to significant events and the adoption of potential new standards.

Based on these thresholds, a healthy marine environment will be defined as having dissolved oxygen values higher than the State standard and EPA criteria (>5 mg/l). Conditions become hypoxic when these levels decrease below the 5.0 mg/l limit (State) and 4.8 mg/l limit (EPA). More extreme events defined by dissolved oxygen values below 2.3 mg/l (EPA) fall below the limit of juvenile and adult survival (U.S. EPA, 2000). For this project and fact sheet describing these conditions in more detail will be developed and made available to those interested in accessing the data.

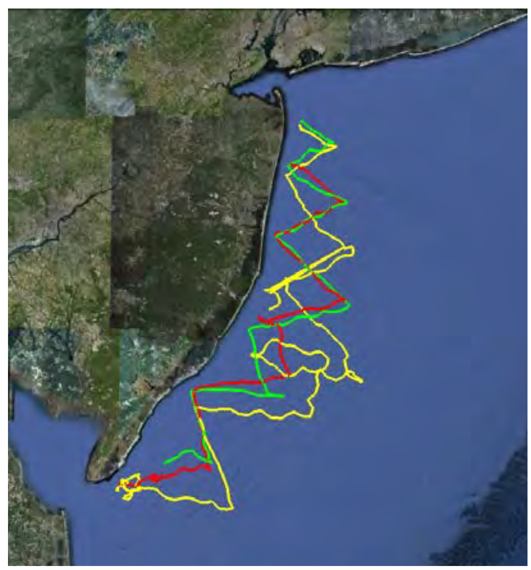

Figure 1: Glider tracks for the three coastal runs completed in 2010.

6.2 Background

The Rutgers University Institute of Marine and Coastal Sciences (RU/IMCS) in collaboration with the NJDEP Division of Water Monitoring and Standards and the EPA Region II demonstrated the use of the IMCS Slocum glider to observe temperature, salinity, and dissolved oxygen concentrations off the coast of New Jersey. These near-shore missions provide continuous measures of ocean temperature, salinity, and dissolved oxygen. In the summer of 2009, a single deployment was completed to serve as a pilot. A glider was deployed on August 20, 2009 for 20 days covering 316 kilometers and generating 5,100 water-column profiles from the surface to near the ocean floor. This deployment provided an increased horizontal, vertical, and temporal resolution for dissolved oxygen in coastal ocean water conditions previously unavailable. We tracked the evolving fields of dissolved oxygen and hydrography through upwelling and coastal storm events (Ragsdale et al., 2011). In 2010, three missions were run from late summer into fall. From late August through mid-November over 1,200 km of data were collected in the waters just off the New Jersey coast (Figure 1). Procedures were implemented to service the glider so that it could be redeployed in Sandy Hook, NJ within one week of recovery in Cape May, NJ. Real-time hydrographic and oxygen data was collected and posted to our public website and shared with Stevens Institute of Technology for assimilation into their operational ocean forecast model. The experience gained during these series of deployments has enabled us to customize glider hardware and mission planning to operate in this challenging region of our coastal ocean.

7.0 Project/Task Description:

Glider AUVs: The research will use continuous ocean observations from a series of glider deployments along the inner-shelf of the waters off the New Jersey coast. The buoyancy-driven propulsion of these vehicles affords high efficiency and deployment endurance approaching 30 days with alkaline batteries (Schofield et al., 2007). These particular gliders have been operated jointly by Rutgers University Coastal Ocean Observation Lab (RU COOL) scientists and Teledyne Webb Research Corporation engineers in science experiments since 1999, transitioning to sustained deployments by the COOL Operations Center in 2003.

The vehicle preparation and deployments will leverage the significant federal investment in the Rutgers University glider center. Initial glider preparation and ballasting will be completed at the Rutgers center before each deployment. Throughout the missions, the gliders will surface and connect via an onboard satellite modem to the

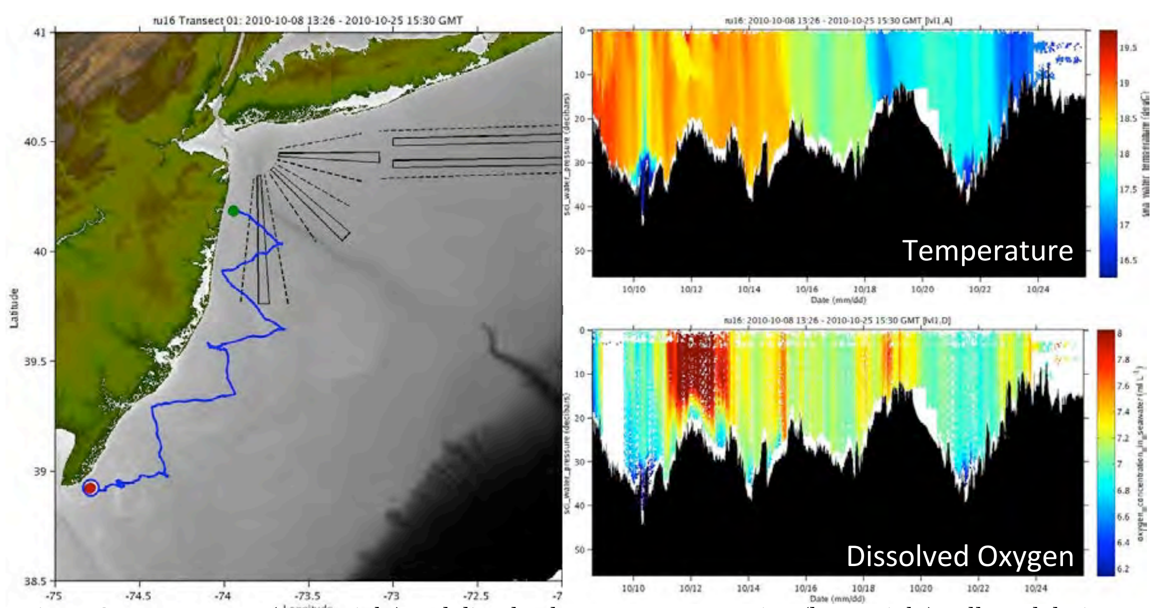

Figure 2: Temperature (upper right) and dissolved oxygen concentration (lower right) collected during a coastal run along the New Jersey coast from October 8, 2010 through October 25, 2010

glider center at regular intervals, typically 3 hours. These surfacings provide an opportunity to download the most recent data segment from the glider and send new mission commands as needed to the glider. The most recent data transferred back from the gliders will be automatically processed in real-time and visualized on the lab website (http://rucool.marine.rutgers.edu/).

Through this work we will run three (3) deployments per year between July and September (inclusive) in both 2011 and 2012. Based on prior experience it is anticipated that each deployment will take about 21 days to complete. For each coastal run, the glider will be deployed off Sandy Hook, NJ and run a zigzag track down the coast toward Cape May, NJ (Figure 1). The precise location of the track will be dependent on environmental conditions and accessible water depths. Prior to each deployment we will meet with NJDEP and EPA to ensure that the planned mission path meets their monitoring interests. Along this track the glider will sample temperature, salinity, and density from the CTD and dissolved oxygen concentration and percent saturation from the optode (Figure 2). Data will be stored locally on the glider and a subset of science data will be sent back to Rutgers in real-time via the satellite link. The subset will consist of every third data point within every third up and down profile. The resulting resolution of this subset will be approximately 0.9m in the vertical and 110m in the horizontal. After recovery of the glider, all data will be run through sensor specific QA/QC verifications outlined in sections 10, 13-16 of this document before delivery to NJDEP and EPA.

For each deployment the glider will be equipped with two main sensors, a pumped Sea-Bird CTD (Model GPCTD_and an Aanderraa Optode (Model 3835/5014W). The CTD will sample conductivity, temperature and pressure a rate of 0.5 Hz throughout the mission. The pressure will be used to calculate depth. These data will be used to map ocean temperature, salinity and density along the track. The optode will measure raw phase shifts across a calibrated foil that when combined with measured temperature from the CTD will give measures of dissolved oxygen concentration and percent saturation at a rate of 1 Hz.

Project Timeline

	June 2011	**July through October 2011**	**November 2011 thru May 2012**	**July through October 2012**	**April 2013**
Glider Delivery	X				
Glider Deployments (6)		XX XX XX		XX XX XX	
Factory Calibration: CTD and Optode			XX XX		
Deployment Reports (6)		X X X		X X X	
Final Report					X

8.0 Quality Objectives and Criteria for Measurement Data

The quality objectives for this project will be categorized as real-time and post processed. The real-time data are those subset of data that are sent back to Rutgers during the mission via the satellite link. The transmission is a data subset to reduce file size that will 1) reduce time on the surface when the glider is most vulnerable to damage and 2) reduce the airtime on the expensive satellite link. During each deployment the data will be logged locally on the glider with the glider manufacturer software on 2 Silicon Systems 2.0 GB flash drives powered by the glider batteries. The glider engineering data will be logged every 4 seconds and the science data will be logged at the sample rate for each sensor (CTD: 2 seconds, Optode: 1 second). Following recovery of the glider the entire dataset logged locally on the glider will be recovered and used to construct the post-processed dataset.

Geo-location for all glider collected data will be determined with an on board GPS, three-dimensional attitude sensor (heading, pitch, and roll), two pressure sensors (redundant depth) and an altimeter (height above the seabed). All sensors will be checked for accuracy prior to and following each deployment as described and documented in the pre- and post-deployment worksheets (Appendix A and E). If any values are found out of the acceptable range reported by the component manufacturers, they will be recalibrated and documented in the worksheets.

	CTD Real Time	**CTD Post Processed**	**Optode Real-Time**	**Optode Post Processed**
Precision *based on manufacturer claims*	Temp.: ±0.05 °C Cond.: ±0.0001 S/M Pres.: ±0.03 dbar	Temp.: ±0.05 °C Cond.: ±0.0001 S/M Pres.: ±0.03 dbar	Conc.: ±8µM Sat: ±1%	Conc.: ±8µM Sat: ±1%
Bias	Bias will be determined through the direct comparisons with simultaneous in situ CTD data.	Bias will be determined through the direct comparisons with simultaneous in situ CTD data.	Bias will be determined through the two-point calibration described in this document.	Bias will be determined through the two-point calibration described in this document.
Representativeness	Data will represent the vertical and horizontal structure with resolution of 0.9 m and 120m in the vertical and horizontal, respectively	Data will represent the vertical and horizontal structure with resolution of 0.5 m and 120m in the vertical and horizontal, respectively	Data will represent the vertical and horizontal structure with resolution of 0.9 m and 120m in the vertical and horizontal, respectively	Data will represent the vertical and horizontal structure with resolution of 0.5 m and 120m in the vertical and horizontal, respectively
Comparability *based on manufacturer claims*	Temp.: ±0.05 °C Cond.: ±0.005 S/M Pres: ±0.1 dbar	Temp.: ±0.05 °C Cond.: ±0.005 S/M Pres: ±0.1dbar	Sat.: ±5%	Sat.: ±5%
Completeness*	70% for all measurements	95% for all measurements	70% for all measurements	95% for all measurements
Sensitivity *based on manufacturer claims*	Temp.: 0.001 °C Cond.: 0.00001 S/M Pres.: 0.001 dbar	Temp.: 0.001 °C Cond.: 0.00001 S/M Pres.: 0.001 dbar	Conc.: <1µM Sat: 0.4%	Conc.: <1µM Sat: 0.4%

*100 % completeness is based on user specification of a measurement resolution of 0.5 m in the vertical and 120 m in the horizontal.

9.0 Non-Direct Measurements

Secondary data will provide context for data collected and be used to guide the mission planning for each deployment. These data include satellite and HF radar measurements from the Mid-Atlantic Regional Coastal Ocean Observing System (MARCOOS) and aircraft remote sensing from the the NJDEP. Both the MARACOOS and

NJDEP data are hosted on local machines at Rutgers as part of other projects. These data will be accessed directly from these machines using OPeNDAP protocols. The remote sensed data will provide maps of currents and other sea-surface conditions to guide the specific piloting decisions related to these missions. These data meet the quality criteria required to guide the glider missions along the New Jersey coast based on assessments generated by the data providers.

10.0 Field Monitoring Requirements

10.1 Monitoring Process Design

This plan is based on manufacturers recommendations, the scientific literature, and our own experience collecting data from autonomous gliders off the coast of New Jersey since 2003.

Deployment description: We will focus these sections on the coastal waters from Sandy Hook to Cape May between the 5 and 30 meter isobaths. The Slocum glider that we will use in this project transfers vertical motion generated by changing buoyancy into horizontal motion on the order of 20-30 cm/s. The result is a saw-toothed pattern that allows the vehicle to sample the water column from the surface to the bottom along its glide path with high spatial resolution (on the order of 100m). This particular glider has the shallow water capabilities and sensor payload required for this work. It is equipped with a pumped Sea-bird CTD for hydrographic measurements and an Aanderraa Optode for dissolved oxygen measurements. In addition to this sensor payload, the glider will be a next generation G2 model from Teledyne Webb Research with significant durability upgrades. The buoyancy drive configuration for this vehicle will allow it to operate in waters from 5 to 30 meters deep. This shallower operating range will allow us to extend the glider lines closer to the coast than in previous missions. The location and time of the data collected by the glider will be recorded on board and transmitted periodically to shore via the satellite link at each surfacing. The geo-location of these data will be determined based on an on board GPS, attitude sensor (compass, pitch and roll), pressure (depth) and altimeter (height above the bottom). Horizontal location will be determined through a linear interpolation based on time of the data points between the known GPS positions recorded at each surfacing event. GPS locations will be determined with an onboard Garmin GPS (model: GPS15L-W) with a standard accuracy of <15m. This unit has been flown on glider missions around the world including those operated by Rutgers and The U.S. Navy. Time will be recorded on two separate onboard processors and maintained through automatic synchronization with the GPS clock at each surfacing. The pressure sensor incorporated into the pumped CTD will be used to determine the depth of the measurement. These methods reduce the uncertainty on the sub-surface data location and are consistent with those carried out on the previous 259 deployments completed by the Rutgers glider team.

10.2 Monitoring Methods

All data related to this project will be collected using a G2 glider purchased from Teledyne Webb Research customized for shallow water application. This glider will be equipped with a Sea-Bird pumped CTD and Aanderra Optode. Prior to each deployment the preferred path will be determined through a meeting between Rutgers, EPA, and NJDEP.

The glider will be tasked along this path and programmed to sample the CTD at 0.5 Hz and the optode at 1.0 Hz throughout the mission. A detailed description of the deployment and recovery procedures and required equipment can be found in Appendix H, I, and J of this document.

The primary mission of each deployment will be to sample the coastal waters between Sandy Hook and Cape May. Two possible scenarios could modify this initial plan.

1) Weather-related mission modifications: In the event of a significant coastal storm or high current event, the experienced Rutgers pilots will make modifications to the path to ensure that the glider will not be put in danger and can continue its primary mission to monitor the waters between Cape May and Sandy Hook. In each case, Rutgers will forward mission changes to the EPA project officer via email with copies to the project team.
2) Significant Hypoxic Event: If the glider identifies a region of low oxygen (concentration < 2ppm), it could be retasked to temporarily suspend the mission and survey the low oxygen area. Based on battery estimates this sampling could be carried out for approximately 3 to 4 days without affecting the mission duration. In this case, EPA will notify Josh Kohut at Rutgers of the interest to suspend the primary mission and modify the mission waypoints. Rutgers will then respond with an email to the EPA Project Officer with copies to the project team outlining the details on the new mission path.

In the event of equipment malfunction or damage that will not allow the glider to continue its mission, it will be tasked to remain at the surface until a vessel can be arranged for recovery. Depending on the severity of the issue, the glider will be repaired and returned to operation starting at either the recovery location to continue its previous mission or at Sandy Hook to start a new mission. The starting location will be determined through a meeting between Rutgers, EPA, and NJDEP and will be dependent on the length of the time the glider is under repair.

Throughout the missions glider engineering and science data will be logged on two 2.0 GB flash drives. These data will be stored locally until the conclusion of the mission. During the mission a subset of these data will be downloaded to a server on the Rutgers network every 3 hours coinciding with a surface event. These data will be subset to meet the criteria outlined in the table in section 8.0.

10.3 Field Quality Control

Before and after a given deployment:

Sea-bird CTD: The CTD will be referenced to a second, factory calibrated CTD in a seawater tank before each deployment as part of the ballasting procedure. A second reference will be generated with a full water column cast using the same calibrated CTD at the deployment and recovery location. These reference profiles will be compared with CTD profiles recorded by the glider. Using the satellite link, data collected on the glider will be uploaded to the lab and compared with the in situ data. If the data comparisons fall within the comparability criteria outlined in section 8 of this document, the glider data will be distributed to project partners and users identified above. Following each mission the glider

CTD will be cleaned as recommended from the manufacturer. Reference CTD profiles taken at the recovery site will be compared to glider profiles recorded just before recovery to ensure data consistency. All steps will be documented as shown in Appendix (A and B).

Aanderraa Optode: Before each deployment the we will confirm the DO sensor factory calibration with the two point test (0% and 100% saturation) described in the owners manual. The results of these tests will confirm the most recent factory calibration. Any drift observed between the pre- and post-deployment tests will be used to linearly correct the data in time throughout the mission. All steps will be documented in pre- and post-deployment sheets as shown in Appendix B.

Analyte	DQI	Field QC Check	Frequency of Collection	Acceptance Criteria	Corrective Actions
CTD	Comparability and bias	In tank CTD	Before and After each deployment	Within range listed in table in Section 8	Suspect values are flagged as described in section 16.2 of this document.
CTD	Comparability and bias	SBE-19 CTD cast	Before and after each deployment	Within range listed in table in Section 8	Suspect values are flagged as described in section 16.2 of this document.
CTD	All	Manufacturer Factory Calibration	Annually	Within range listed in table in Section 8	Recalibrate until data quality meets criteria listed in table in Section 8.
Optode	Comparability and bias	Manufacturer defined 2-point test	Before and After each deployment	Within range listed in table in Section 8	Correct data based on test results.
Optode	All	Manufacturer Factory Calibration	Annually	Within range listed in table in Section 8	Recalibrate until data quality meets criteria listed in table in Section 8.

Data post-processing following each deployment:

Prior to data delivery to NJDEP and EPA, all sensor specific QA/QC will be applied including time offsets and thermal corrections. These techniques will be followed based on the scientific literature and manufacturer recommendations. All processing will be based on the extensive infrastructure already in place at Rutgers to support the 259 missions already flown from the command center.

Sea-bird CTD: During the mission, 2 corrections will be applied to the real-time CTD dataset: 1) The temperature and conductivity sensors on the instrument have different measurement response times, thus the 2 independent measurements are aligned with respect to time so that each CTD record represents a measurement on a single parcel of water. This time shift is accounted for by the known flow rate of the pump on the CTD. 2) The second correction results from the thermal mass of the conductivity cell and this effect on the resulting salinity calculation. The CTD temperature is measured outside of the conductivity cell while the conductivity is measured inside the cell. In addition, the conductivity cell is made of borosilicate glass and is capable of storing heat from the surrounding water inside the wall of the cell, resulting in a heating or cooling of new water parcels as they pass through the cell. The result of this configuration is that the measured conductivity and temperature used to calculate salinity will result in erroneous salinity values, especially across strong thermoclines. A method has been developed which allows us to correct for this heating inside the cell, resulting in more accurate salinity profiles (Morison, J.R., et. al., 1994). A description of the method with glider specific examples can be found in Garau, B., et. al., 2011).

Aanderraa Optode: The calculation of oxygen concentration and saturation is based on the measured phase shifts from optode and the concurrent temperature values from the CTD. We will align these two measurements based on manufacturer suggestions and combine them to get the observed dissolved oxygen data. This will be done in accordance with the manufacturers manual section titled : 'External calculation of Oxygen'. The description is attached as appendix G.

11.0 Analytical Requirements

The analytical requirements for this project are restricted to the Winkler titrations used in the 2-point oxygen tests to confirm the calibration of the optode. The analytical methods and quality control for these titrations will be carried out as described in EPA Method 360.2 attached as Appendix F.

12.0 Sample Handling and Custody Requirements

The samples collected in the lab as part of the optode two point tests will be immediately transferred for the titration method described in EPA method 360.2 (Appendix F).

13.0 Testing, Inspection, Maintenance, and Calibration Requirements

13.1 Instrument/Equipment Testing, Inspection and Maintenance

Sea-bird CTD: The CTD will be inspected and tested as outlined in Appendix A. This includes a visual inspection, instrument cleaning before and after each deployment and comparisons with additional CTD data both in the tank and in situ during deployment and recovery. These procedures as followed are outlined in the manual drafted by the manufacturer.

Aanderaa Optode: The Aanderra Optode will be inspected and tested before and after the deployment as described in Appendix B. This includes visual inspection of the membrane to detect degradation, and 2 point calibration testing before and after each deployment. These procedures will be conducted in accordance with those outlined in the manufacturers manual.

Glider Vehicle: The glider itself will be inspected and tested before and after each deployment as described in Appendix A and E. This includes confirmation of proper operation of the gliders position (GPS), time of measurement (onboard processors), heading (Compass), and depth (pressure).

13.2 Instrument/Equipment Calibration and Frequency

Sea-bird CTD: The CTD will be calibrated by the factory annually prior to each set of summer deployments. This is in accordance with recommended annual factory calibrations from the manufacturer. In addition to these factory calibrations, comparisons will be made with in situ CTD measurements from another Sea-Bird CTD in the ballast tank and with a concurrent profile in the field both before and following each deployment. These will be used to confirm the factory calibration.

Aanderaa Optode: The optode will be calibrated by the factory prior to each set of summer deployments. This is in accordance with recommended annual factory calibrations from the manufacturer. In addition to these factory calibrations, a 2 point calibration will be conducted at Rutgers both before and after each deployment. This test will be conducted as outlined in the manufactures manual. These will be used to confirm the factory calibration.

Glider Vehicle: The three-dimensional attitude sensor will be calibrated as required to ensure accurate measures of heading, pitch, and roll. These calibrations will be no more than one year apart.

13.3 Inspection/Acceptance of Supplies and Consumables

Reagents used for the dissolved oxygen titrations will be purchased for each test. All reagents will be purchased and utilized as prescribed in the test-kit manufacturer manual.

14.0 Data Management

The data management for this project will be based on the considerable infrastructure already in place at Rutgers to support glider operations. For each deployment the complete dataset will be stored locally on the glider. In addition a subset of the data files recorded by the glider in real-time is transferred back to shore via the satellite communication system. Once the binary encoded files arrive on shore, they are converted to ascii text using a set of unix utilities. These files are then archived to a fileserver at the Institute of Marine and Coastal Sciences, where they are backed up daily.

The Matlab programming language will be used to process the raw data stream. Scientific (i.e., temperature, conductivity, depth) parameters are merged with the glider navigational parameters (i.e., GPS, timestamps) and are stored in organized data structures, which are saved to the IMCS fileserver in near real-time. The following quality control checks are then performed:

1. Duplicate timestamps are removed.
2. Invalid GPS fixes are removed using an algorithm that eliminates fixes that result in impossible surface drift velocities (>10 m/s).
3. Invalid temperature and salinity values are removed based upon expected hydrographic values that occur at the time of deployment (summer conditions). Values more than 2 standard deviations outside these ranges will be removed.
4. Differences in the temperature and conductivity sampling are corrected by aligning the measurements in the time domain based on successive profiles.
5. The aligned temperature and conductivity values are used to calculate ocean salinity values and these values are then corrected for thermal inertia to get rid of artificial salinity spiking (Garau, B., et. al., 2011; Morison, J.R., et. al., 1994).
6. Oxygen values from the optode are aligned by shifting them in the time domain by a pre-determined number of seconds based on manufacturer recommendations and confirmed by comparing successive profiles.

Real-time glider health and deployment status will also be available on the internet at:

http://marine.rutgers.edu/cool/auvs

This webpage will include plots of relevant scientific parameters (temperature, salinity, density, oxygen concentration, etc.) and maps showing the gliders path and intended waypoints. These processed datasets will be made available in near real-time in the NetCDF file format via the Thematic Real-time Environmental Data Distribution System (**THREDDS**). While the glider is in its mission the real-time distributed data will be considered provisional until the complete dataset is quality controlled after recovery. During the deployment, if any of these provisional data fall outside the criteria listed in section 8 of this document under 'real-time', they will be flagged and removed from the data stream.

Once the glider has been recovered, files containing the full datasets are downloaded and the previous steps are repeated, providing the end user with the complete scientific and navigational data streams. All levels of these processing will be stored on the file server and backed-up daily throughout the project. Upon completion of a given deployment a copy of all data will be delivered to the EPA project officer with the documentation described in section 15 of this document.

15.0 Assessments/Oversight

The calibration, testing, maintenance for each deployment will be documented. This documentation includes:

1) a pre-deployment check out (Appendix A)
2) a pre-deployment check out for the optode (Appendix B)
3) a deployment checklist (Appendix C)
4) a recovery checklist (Appendix D)
5) a post-deployment checklist (Appendix E)
6) manufacturer calibration documentation

A deployment packet will be made up of all the above documents and a hardcopy of the data. For each deployment the Rutgers team will ensure that all are filled out completely and accurately. Throughout the deployments, EPA will be permitted to field audit the project.

16.0 Data Review, Verification, and Usability

16.1 Data Review, Verification, and Validation

Josh Kohut and Chip Haldeman will ensure that all testing, maintenance and inspection is completed before and after each deployment. These steps will be documented and complied in the deployment reports described in section 15 of this document. The checkout and checklist documents listed in the appendix of this document will ensure that all steps are included. Josh Kohut and John Kerfoot will ensure that all quality control processing and assessment is carried out on all real-time and post-processed data prior to delivery to EPA. Any deviations from the QAPP/SOPs will be documented.

16.2 Reconciliation with User Requirements

Following each deployment, the final quality controlled data will be within the criteria described in section 8 of this document. If a value is found outside these criteria, it will be flagged in the final dataset. Each data point will be treated independently so that any one point flagged will not restrict use of the other quality data from the same deployment.

17.0 Reporting, Documents, and Records

The project will generate deployment reports and a final report. The deployment report will document all glider and sensor preparation, maintenance, calibration, and inspection. These reports will be labeled with glider name, deployment number, and deployments dates. These reports will include all components described in section 15 of this document. Two copies will be generated for each of the 6 deployments. The first copy will be sent to the EPA project officer in both hard copy and PDF forms. The second copy will remain at Rutgers with Josh Kohut the Rutgers project lead.

Rutgers will also prepare and submit a final report to the EPA project officer documenting the results of the data collection, the validation/verification of the results, and the final standard operating procedures conducted for all 6 deployments. This report will summarize the information contained in the deployment reports described above. Additional documents resulting from this work could include public and scientific presentations and articles submitted to the peer review literature. The real-time and post processed data for each mission will be maintained on the Rutgers file server described in Section 14.0 of this document for at least 7 years following the conclusion of each deployment. The documentation will also be retained in electronic and hardcopy forms for at least 7 years following the each deployment. The 7 year time horizon in consistent with NJDEP standards.

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U.S. EPA, 2000. *Ambient Aquatic Life Water Quality Criteria for Dissolved Oxygen (Saltwater): Cape Cod to Cape Hatteras.* EPA-822-R-00-012.

GLIDER	
PREPARER	
PREP DATE	
LOCATION	

PRE-SEAL

FORE CHECK

Check pump threaded rod (grease) ________

Check pitch battery threaded rod (grease) ________

Leak detect in place, batteries secure, white guides free,
no metal shavings, bottles installed, grounded? ________

PAYLOAD CHECK

Science Bay Instrument Serial Numbers

1 ____________________

2 ____________________

3 ____________________

4 ____________________

5 ____________________

CTD cable clear, no leak at CTD joint, no leak at pucks
Grounded? ________

Science Bay Weight Configuration

____

AFT CHECK

Iridium Card Installed (SIM #)

1 ______________

Flash card old files removed?

Inspect strain on connectors (damaged connectors as well),
Persistor power supply cable secure, battery secured,
ballast bottle in place, aft cap clear of leak, grounded? ________

Battery check (using load?)

1. Attach aft battery pack, verify voltage at J13 ________
2. Disconnect aft battery
3. Screw in aft connector
4. Connect pitch battery, verify voltage at J13 ________
5. Disconnect pitch battery
6. Screw in fore connector, verify voltage at J13 ________
7. Attach pitch battery
8. Attach aft battery
9. Verify voltage at J31 (simple probe)

____

POST-SEAL

GENERAL

Pick Point Present? ______
Special Instruments Present? ______

HARDWARE

Nose Cone and pump bladder inspection ______
put c_alt_time 0, verify alt chirping ______
Corrosion Prevention & Anode Check
Anode Style/Weight ______
Glider Parts Grounded (stickers) ______
Ejection weight assembly OK and unseized? ______
Pressure Sensor Check (corrosion, clear) ______
Aft sensor ______
Payload sensor ______

POWERED

Verify Argos ping ______
Wiggle for 5 minutes ______
Record m_battery once stabilized ______
Record m_vacuum @ temperature @ ballast ______

OUTSIDE

Record compass reading ______
GPS check? (40 28.75, 74 26.25) ______
Iridium connect ______
zero_ocean_pressure, get m_pressure ______
let air bladder inflate, does it shut off? ______

SOFTWARE

GENERAL

Version ______
Date ok, delete old logs ______
Re-burn latest software image
mdblist.dat, mi, ma, science! ______

\CONFIG

simul.sim deleted ______
if ver < 7.0 configure sbdlist.dat ______

\MAFILES ______

goto_l10.ma (set x_last_...) ______

AUTOEXEC.MI

Phone Number
Main is RUDIC, alt is TWR ______
u_iridium_failover_retries = 10 ______
c_ctd41cp_num_fields_to_send 4 ______
Calibration coefficients ______

In Gliderdos, reset glider to test settings
get f_max_working_depth (102 m) ______
f_ballast_pumped_deadz_width = 30? ______

CACHE MANAGEMENT (DONE ON DOCKSERVER!)
(this step is very important!)

del ..\state\cache*.*
after *bdlist.dat are set (exit reset):
logging on; logging off
send ..\state\cache*.cac ______

send *.mbd *.sbd *.tbd ______________ ______________

*** Software Burning Tips :** if using Procomm or local folder, copy all the files from the software image locally. Then proceed to edit them for the glider and do a mass freewave transfer of the files. Save these files or prepare the to-glider with these f

SCIENCE

SENSOR RETURN

put c_science_send_all 1
put c_science_all_on 8
put c_science_on 3
All sensors reporting values? ______________

CTD

Tank static comparison OK? ______________

OPTODE

Check in completed? ______________
Remove any shielding ______________

PUCK 1

Puck Type ______________

Verify Darkcounts ______________________

PUCK 2

Puck Type ______________

Verify Darkcounts ______________________

PUCK 3

Puck Type ______________

Verify Darkcounts ______________________

Slocu   Glide Aanderaa Optode Chec IN/OUT
  Poin Calibration & Calibratio Coeffcient Record

OPTODE MODEL SN: ______________________ **IN OUT** ______________________

Calibration Record

PERFORMED BY: ______________________

CALIBRATION DATE: ______________________

Previous: | *Current:*

C0Coef	5.3E+03	-1.9E+02	4.1E+00	-3.8E-02	**C0Coef**	5.3E+03	-1.9E+02	4.1E+00	-3.8E-02
C1Coef	-2.9E+02	9.7E+00	-2.1E-01	2.0E-03	**C1Coef**	-2.9E+02	9.7E+00	-2.1E-01	2.0E-03
C2Coef	6.5E+00	-2.0E-01	4.5E-03	-4.3E-05	**C2Coef**	6.5E+00	-2.0E-01	4.5E-03	-4.3E-05
C3Coef	-6.7E-02	1.9E-03	-4.4E-05	4.3E-07	**C3Coef**	-6.7E-02	1.9E-03	-4.4E-05	4.3E-07
C4Coef	2.7E-04	-6.8E-06	1.7E-07	-1.6E-09	**C4Coef**	2.7E-04	-6.8E-06	1.7E-07	-1.6E-09

Delta: 0.0

point Calibration

0% Point	*100 Point*
Solution: ________ **Na_2SO_3**	*Solution:* ________ **Na_2SO_3**
________ **H_2O**	________ **H_2O**
________ **Temperature**	________ **Temperature**
________ **Air Pressure**	________ **Air Pressure**
________ **Winkler Label**	________ **Winkler Label**
________ **Winkler Source**	________ **Winkler Source**
Results:	*Results:*
OPTODE: ________ **Wphase**	**OPTODE:** ________ **Wphase**
________ **% Saturation**	________ **% Saturation**
________ **Temperature**	________ **Temperature**
________ **Calculated Concentration**	________ **Calculated Concentration**
________ **Calculated % Saturation**	________ **Calculated % Saturation**
WINKLER: ________ **% Saturation**	**WINKLER:** ________ **% Saturation**
________ **Concentration**	________ **Concentration**

In-Ai Saturatio Check

SATURATION: ________ **TEMP** ________ **PRESS** ________

Paste Sample Report

Protect	3830	1024	0			
PhaseCoef	3830	1024	1.915733	1.090776	0	0
TempCoef	3830	1024	21.16457	-0.030634	2.89E-06	-4.18E-09
FoilNo	3830	1024	1707			
C0Coef	3830	1024	5326.502	-192.1173	4.143571	-0.037869
C1Coef	3830	1024	-292.0675	9.719927	-0.214295	0.0020078
C2Coef	3830	1024	6.475949	-0.19808	0.0044994	-4.31E-05
C3Coef	3830	1024	-0.066929	0.0018807	-4.42E-05	4.284E-07
C4Coef	3830	1024	0.000265	-6.83E-06	1.671E-07	-1.62E-09
Salinity	3830	1024	35			
CalAirPhase	3830	1024	31.09332			
CalAirTemp	3830	1024	9.937991			
CalAirPress	3830	1024	1005.22			
CalZeroPha	3830	1024	65.60457			
CalZeroTem	3830	1024	19.1812			
Interval	3830	1024	2			
AnCoef	3830	1024	0	1		
Output	3830	1024	100			
SR10Delay	3830	1024	-1			
SoftwareVe	3830	1024	3			
SoftwareBu	3830	1024	11			

Glider ____________ Date ____________

Pilots ____________ Where ____________

Laptop ____________ Vehicle Powerup: CTRL ^ C (until you get to prompt)!!!

On boat
(Remember after 10 min glider will go into mission, as well as on powerup!)

Battery Voltage	______	get m_battery
Vacuum Pressure	______	get m_vacuum, should be > 7 for bladder inflation
Iridium Connection	______	look for connect dialog & surface dialog, let it dial at prompt
boot app	☐	boot app
boot (should report application)	☐	reports boot application
run status.mi	☐	mission completed normally?
		(this can be run the night before or at dock)

In Water

zero_ocean_pressure	☐	while glider in water
run odctd.mi (with or without float, ask RU)	☐	glider should dive and surface, type why? Should say overdepth, if not call (would say don't need float for ru06, ru07 use it the first deployment) (can skip this if you want for multiple deployments)
send *.dbd *.mlg *.sbd	☐	"send *.sbd" is most important
		(this applies moreso to when handoff'ed to iridium)
run 100_tn.mi	☐	sequence 100_tn.mi(5)
Verify dive; **disconnect freewave** Report to Rutgers		
Perform CTD Comparison CAST	☐	typically done with RU provided SB19 or Cast Away CTD
LAT: **LON**		

Glider ____________ Date ____________

Pilots ____________ Where ____________

Laptop ____________

Recovery	get Lat/Lon from email or shore support	☐
	obtain freewave comms obtain lat/lon with where command	☐
	Perform CTD Comparison CAST	☐
	LAT: **LON:**	
	(note instrument type!)	

RUTGERS Coastal Ocean Observation Lab

Slocum Glider Check-IN

DATE: ____________

GLIDER: ____________ **SB:** _____________

Power on vehicle in order to fully retract pump, and/or to deflate air bladder.

Vehicle Cleaning (hose down with pressure)

Nose cone

1. Remove nose cone
2. Loosen altimeter screws, and remove altimeter or leave temporarily attached
3. Retract pump
4. Remove altimeter and hose diaphragm removing all sand, sediment, bio oils
5. Clean nose cone and altimeter

Tail cone

1. Remove tail cone
2. Hose and clean anode and air bladder making sure air bladder is completely clean
3. Clean cowling

Wing rails

1. Remove wing rails and hose down

Tail plug cleaning

1. Dip red plug in alcohol and clean plug if especially dirty
2. Re-dip red plug and repeatedly insert and remove to clean the glider plug
3. Compress air glider female connector
4. Lightly silicon red plug and replace in glider once silicon has been dispersed evenly in the plugs.

CTD Comparison Check

1. Inspect CTD sensor for any sediment buildup, take pictures of anything suspicious or make note.

Static Tank Test

SB19
Temperature: ________________

Conductivity: ________________

Glider (SB41CP or pumped unit)
Temperature: ________________

Conductivity: ________________

CTD Maintenance (reference SeaBird Application Note 2D)

1. Perform CTD backward/forward flush with 1% Triton X-100 solution
2. Perform CTD backward/forward flush with 500 – 1000 ppm bleach solution
3. Perform the same on a pumped unit, just different approach
4. Repeat comparison test if results not within T < .01 C, C < .005 S/m

Static Tank Test

SB19
Temperature: ________________

Conductivity: ________________

Glider (SB41CP or pumped unit)
Temperature: ________________

Conductivity: ________________

METHOD #: 360.2 Approved for NPDES (Issued 1971)

TITLE: Oxygen, Dissolved (Modified Winkler, Full-Bottle Technique)

ANALYTE: CAS # O Oxygen 7782-44-7

INSTRUMENTATION: Titration, Probe

STORET No. 00300

1.0 Scope and Application

1.1 This method is applicable for use with most wastewaters and streams that contain nitrate nitrogen and not more than 1 mg/L of ferrous iron. Other reducing or oxidizing materials should be absent. If 1 mL of fluoride solution is added before acidifying the sample and there is no delay in titration, the method is also applicable in the presence of 100 200 mg/L ferric iron.

1.2 The Dissolved Oxygen (DO) Probe technique gives comparable results on all samples types.

1.3 The azide modification is not applicable under the following conditions: (a) samples containing sulfite, thiosulfate, polythionate, appreciable quantities of free chlorine or hypochlorite; (b) samples high in suspended solids; (c) samples containing organic substances which are readily oxidized in a highly alkaline solution, or which are oxidized by free iodine in an acid solution; (d) untreated domestic sewage; (e) biological flocs; and (f) where sample color interferes with endpoint detection. In instances where the azide modification is not applicable, the DO probe should be used.

2.0 Summary of Method

2.1 The sample is treated with manganous sulfate, potassium hydroxide, and potassium iodide (the latter two reagents combined in one solution) and finally sulfuric acid. The initial precipitate of manganous hydroxide, $Mn(OH)_2$, combines with the dissolved oxygen in the sample to form a brown precipitate, manganic hydroxide, $MnO(OH)_2$,. Upon acidification, the manganic hydroxide forms manganic sulfate which acts as an oxidizing agent to release free iodine from the potassium iodide. The iodine, which is stoichiometrically equivalent to the dissolved oxygen in the sample is then titrated with sodium thiosulfate or phenylarsine oxide (PAO).

3.0 Interferences

3.1 There are a number of interferences to the dissolved oxygen test, including oxidizing and reducing agents, nitrate ion, ferrous iron, and organic matter.

3.2 Various modifications of the original Winkler procedure for dissolved oxygen have been developed to compensate for or eliminate interferences. The Alsterberg modification is commonly used to successfully eliminate the nitrite interference, the Rideal-Stewart modification is designed to eliminate ferrous iron interference, and the Theriault procedure is used to compensate for high concentration of organic materials.

3.3 Most of the common interferences in the Winkler procedure may be overcome by use of the dissolved oxygen probe.

4.0 Sample Handling and Preservation

4.1 Where possible, collect the sample in a 300 mL BOD incubation bottle. Special precautions are required to avoid entertainment or solution of atmospheric oxygen or loss of dissolved oxygen.

4.2 Where samples are collected from shallow depths (less than 5 feet), use of an APHA-type sampler is recommended. Use of a Kemmerer type sampler is recommended for samples collected from depths of greater than 5 feet.

4.3 When a Kemmerer sampler is used, the BOD sample bottle should be filled to overflowing. (overflow for approximately 10 seconds). Outlet tube of Kemmerer should be inserted to bottom of BOD bottle. Care must be taken to prevent turbulence and the formation of bubbles when filling bottle.

4.4 At time of sampling, the sample temperature should be recorded as precisely as required.

4.5 Do not delay the determination of dissolved oxygen in samples having an appreciable iodine demand or containing ferrous iron. If samples must be preserved either method (4.5.1) or (4.5.2) below, may be employed.

4.5.1 Add 2 mL of manganous sulfate solution (6.1) and then 2 mL of alkaline iodide-azide solution (6.2) to the sample contained in the BOD bottle. Both reagents must be added well below the surface of the liquid. Stopper the bottle immediately and mix the contents thoroughly. The sample should be stored at the temperature of the collection water, or water sealed and kept at a temperature of 10 to 20°C, in the dark. Complete the procedure by adding 2 mL H_2SO_4 (see 7.1) at time of analysis.

4.5.2 Add 0.7 mL of conc. H_2SO_4 (6.3) and 1 mL sodium azide solution (2 g NaN3 in 100 mL distilled water) to sample in the BOD bottle. Store sample as in (4.5.1). Complete the procedure using 2 mL of manganous sulfate solution (6.1), 3 mL alkaline iodide-azide solution (6.2), and 2 mL of conc. H_2SO_4 (6.3) at time of analysis.

4.6 If either preservation technique is employed, complete the analysis within 4-8 hours after sampling.

5.0 Apparatus

5.1 Sample bottles-300 mL ±3 mL capacity BOD incubation bottles with tapered ground glass pointed stoppers and flared mouths.

5.2 Pipets-with elongated tips capable of delivering 2.0 mL ±0.10 mL of reagent.

6.0 Reagents

6.1 Manganous sulfate solution: Dissolve 480 g manganous sulfate ($MnSO_4 \cdot 4H_2O$) in distilled water and dilute to 1 liter.

6.1.1 Alternatively, use 400 g of $MnSO_4 \cdot 4H_2O$ or 364 g of $MnSO_4 \cdot 4H_2O$ per liter. When uncertainty exists regarding the water of crystallization, a solution of equivalent strength may be obtained by adjusting the specific gravity of the solution to 1.270 at 20°C.

6.2 Alkaline iodide-azide solution: Dissolve 500 g of sodium hydroxide (NaOH) or 700 g of potassium hydroxide (KOH) and 135 g of sodium iodide (Nai) or 150 g of potassium iodide (KI) in distilled water and dilute to 1 liter. To this solution add 10 g of solution azide (NaN3) dissolved in 40 mL of distilled water.

6.3 Sulfuric acid: concentrated.

6.4 Starch solution: Prepare an emulsion of 10 g soluble starch in a mortar or beaker with a small quantity of distilled water. Pour this emulsion into 1 liter of boiling water, allow to boil a few minutes, and let settle overnight. Use the clear supernate. This solution may be preserved by the addition of 5 mL per liter of chloroform and storage in a 10°C refrigerator.

6.4.1 Dry, powdered starch indicators such as "thyodene" may be used in place of starch solution.

6.5 Potassium fluoride solution: Dissolve 40 g KF $2H_2O$ in distilled water and dilute to 100 mL.

6.6 Sodium thiosulfate, stock solution, 0.75 N: Dissolve 186.15 g $Na_2S_2O_3$•$5H_2O$ in boiled and cooled distilled water and dilute to 1 liter. Preserve by adding 5 mL chloroform.

6.7 Sodium thiosulfate standard titrant, 0.0375 N: Prepare by diluting 50.0 mL of stock solution to 1 liter. Preserve by adding 5 mL of chloroform. Standard sodium thiosulfate, exactly 0.0375 N is equivalent to 0.300 mg of DO per 1.00 mL. Standardize with 0.0375 N potassium biiodate.

6.8 Potassium biiodate standard, 0.0375 N: For stock solution, dissolve 4.873 g of potassium, biiodate, previously dried 2 hours at 103°C, in 1000 mL of distilled water. To prepare working standard, dilute 250 mL to 1000 mL for 0.0375 N biiodate solution.

6.9 Standardization of 0.0375 N sodium thiosulfate: Dissolve approximately 2 g (±1.0 g) KI in 100 to 150 mL distilled water; add 10 mL of 10% H_2SO_4 followed by 20.0 mL standard potassium biiodate (6.8). Place in dark for 5 minutes, dilute to 300 ml, and titrate with the standard sodium thiosulfate (6.7) to a pale straw color. Add 1-2 mL starch solution and continue the titration drop by drop until the blue color disappears. Run in duplicate. Duplicate determinations should agree within ± 0.05 mL.

6.10 As an alternative to the sodium thiosulfate, phenylarsine oxide (PAO) may be used. This is available, already standardized, from commercial sources.

7.0 Procedure

7.1 To the sample collected in the BOD incubation bottle, add 2 mL of the manganous sulfate solution (6.1) followed by 2 mL of the alkaline iodide-azide solution (6.2), well below the surface of the liquid; stopper with care to exclude air bubbles, and mix well by inverting the bottle several times. When the precipitate settles, leaving a clear supernatant above the manganese hydroxide floc, shake again. When settling has produced at least 200 mL of clear supernatant, carefully remove the stopper and immediately add 2 mL of conc. H_2SO_4 (6.3) (sulfamic acid packets, 3 g may be substituted for H_2SO_4)[1] by allowing the acid to run down the neck of the bottle, re-stopper, and mix by gentle inversion until the iodine is uniformly distributed throughout the bottle. Complete the analysis within 45 minutes.

7.2 Transfer the entire bottle contents by inversion into a 500 mL wide mouth flask and titrate with 0.0375 N thiosulfate solution (6.7) (0.0375 N phenyarsine oxide (PAO) may be substituted as titrant) to pale straw color. Add 1-2 mL of starch solution (6.4) or 0.1 g of powdered indicator and continue to titrate to the first disappearance of the blue color.

7.3 If ferric iron is present (100 to 200 mg/L), add 1.0 mL of KF (6.5) solution before acidification.

7.4 Occasionally, a dark brown or black precipitate persists in the bottle after acidification. This precipitate will dissolve if the solution is kept for a few minutes longer than usual or, if particularly persistent, a few more drops of H_2SO_4 will effect dissolution.

8.0 Calculation

8.1 Each mL of 0.0375N sodium thiosulfate (or PAO) titrant is equivalent to 1 mg DO when the entire bottle contents are titrated.

8.2 If the results are desired in milliliters of oxygen gas per liter at 0°C and 760 mm pressure multiply mg/L DO by 0.698.

8.3 To express the results as percent saturation at 760 mm atmospheric pressure, the solubility data in Table 422:1 (Whipple & Whipple, p 446-447, Standard Methods, 14th Edition) may be used. Equations for correcting the solubilities to barometric pressures other than mean sea level are given below the table.

8.4 The solubility of DO in distilled water at any barometric pressure, p (mm Hg), temperature, T °C, and saturated vapor pressure, μ (mm Hg), for the given T, may be calculated between the temperature of 0° and 30°C by:

$$\text{ml/L DO} = \frac{(P - \mu) \times 0.678}{35 + T}$$

and between 30° and 50°C by:

$$\text{ml/L DO} = \frac{(P - \mu) \times 0.827}{49 + T}$$

9.0 Precision and Accuracy

9.1 Exact data are unavailable on the precision and accuracy of this technique; however, reproducibility is approximately 0.2 mg/L of DO at the 7.5 mg/L level due to equipment tolerances and uncompensated displacement errors.

Bibliography

1. Kroner, R. C., Longbottom, J. E., Gorman, R.A., "A Comparison of Various Reagents Proposed for Use in the Winkler Procedure for Dissolved Oxygen", PHS Water

Pollution Surveillance System Applications and Development, Report #12, Water Quality Section, Basic Data Branch, July 1964.

2. Annual Book of ASTM Standards, Part 31, "Water", Standard D1589-60, Method A, p 373 (1976).
3. Standard Methods for the Examination of Water and Wastewater, 14th Edition, p 443, method 422 B (1975).

Appendix 8 Calculate the Oxygen Externally

If the Optode is mounted on a CTD and the CTD is equipped with a fast responding temperature sensor it might be desirable to do the temperature compensation externally. This will improve the accuracy when subjected to fast temperature changes (when going through a gradient). The Optode must then be configured to output differential phase shift information (DPhase). Based on this data and the temperature data from the CTD, the oxygen concentration can be calculated by use of the following formula:

$$[\mathrm{O}_2] = C0Coef + C1Coef \cdot P + C2Coef \cdot P^2 + C3Coef \cdot P^3 + C4Coef \cdot P^4$$

P is the measured phase shift (DPhase) and the *C0Coef* to *C4Coef* are temperature dependent coefficients calculated as:

$$CxCoef = CxCoef_0 + CxCoef_1 \cdot t + CxCoef_2 \cdot t^2 + CxCoef \cdot t^3$$

The $CxCoef_{0\text{-}3}$ are the foil characterizing coefficients found in the Calibration Certificate for the Sensing Foil 3853, and *t* is external temperature in °C.

An Excel sheet that includes these calculations is available by contacting the factory.

If the CTD is not able to receive the RS232 output, the Oxygen Optode 3975 with analogue output can be used. The two channel “intelligent” digital to analogue converter supplied with this sensor is able to output two channels of your selection (including DPhase). By setting the Output property to –103 the Optode 3975 will output phase (10 to 70°) at analogue output 1 (refer to Table 3-4 at page 23).

Glider Deployment

- Make sure you have Glider Deployment Checklist
- Glider equipment
- Spare wings!

THIS GUIDE FOLLOWS THE GLIDER DEPLOYMENT CHECKLIST AND SHOULD BE USED AS A 2ND HAND REFERENCE WHEN DEPLOYING

1. **Obtain control of the glider** – do as so in class and the general communications sheet. The *enter* button pressed repeatedly will let you know if you are at a prompt.
2. **Allow glider to call Rutgers** – Once you have the following dialog, it is OK to type *callback xx* to obtain better control of the glider.

```
18631    Iridium modem matched: CONNECT 4800
18631    Iridium connected...
18631    Iridium console active and ready...
Vehicle Name: ru16
```

3. ***boot app*** – this is a crucial double check, entering the command should report (if the vehicle resets, it was NOT in *boot app* mode, obtain control after reset and continue):
   `Boots Application at 0xE40000`
4. **confirm boot app** – type *boot*
5. ***consci*** – This should switch the terminal control over to the science computer, your prompt will change to sci_dos. If this does not occur, call Rutgers or supervisor for further instruction.
6. **on boat – *run status.mi***:
   a. **What is this mission doing?**
      i. This mission is checking general mission parsing, input sensors, and GPS position.
   b. **What is end result of mission?**
      i. Glider should attempt GPS hits:

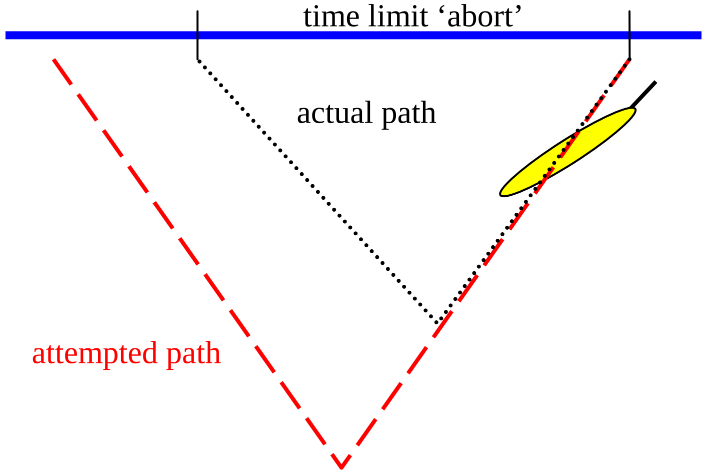
```
185.76 14 behavior surface_2: SUBSTATE 2 ->3 : waiting for GPS fix
185.84    init_gps_input()
186.15    sensor: m_gps_lat = 1754.2646 lat
186.21    sensor: m_gps_lon = -6701.6409 lon
186.31    sensor: m_gps_status = 0 enum
```

      ii. Mission should complete with following information:

```
201.29 16 behavior surface_2: STATE Active -> Mission Complete
201.39    behavior ?_-1: layered_control(): Mission completed normally
201.46    behavior ?_-1: run_mission(): Mission completed:
MS_COMPLETED_NORMALLY(-1)
```


REMINDER : GLIDER'S WILL SIT IDLE 1O MINUTES BY DEFAULT, ISSUE A CARRIAGE RETURN TO KEEP CONTROL WHILE YOU DEPLOY

7. **Place glider in water**
8. **zero_ocean_pressure**
   a. glider should report that the pressure sensor has been re-calibrated. This step is very important, and could be a solution to problems down the line with pressure sensors being out of calibration. This must be done with glider in the water.
9. **run overtime.mi: (SEE DEPLOYMENT CHECKLIST IF NECESSARY TO RUN!) (Rutgers no longer runs this mission during deployments)**
   a. **What is mission doing?**
      i. This mission tests an abort capability of glider detecting time, and responding to a time limit.
      ii. Tests buoyancy of vehicle, because it will dive



   b. **What is end result of mission?**
      i. Glider will dive but a time limit will expire and glider will 'abort' the overtime mission.
      ii. Glider will submerge for several minutes, witness it surface by monitoring Freewave or computer terminal.
      iii. Mission will end with an abort, if you have glider on terminal, hit enter to see if you are at a command line. You should either witness the following:

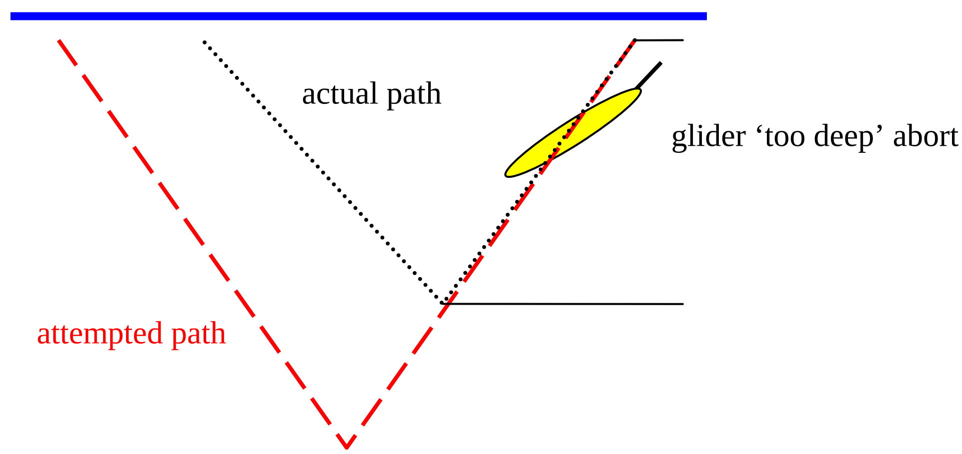
```
233.32    ERROR behavior ?_-1: we_are_done(): At the surface, return (-
2)MS_COMPLETED_ABNORMALLY

233.40    behavior ?_-1: we_are_done(): Restoring U_CYCLE_TIME from
15.000000 to 4.000000
233.50    restore_sensors()....
          Restored u_depth_rate_filter_factor from -1 to 4
233.59    behavior ?_-1:    ABOVE WORKING DEPTH
233.64    behavior ?_-1:    drop_the_weight = 0
234.87    behavior ?_-1: run_mission(): Mission completed:
MS_COMPLETED_ABNORMALLY(-2)
```

      iv. ***why?*** – That should indicate the reason for abort, in this case, ms_abort_overtime in case you missed the

REMINDER : GLIDER'S WILL SIT IDLE 1O MINUTES BY DEFAULT, ISSUE A CARRIAGE RETURN TO KEEP CONTROL WHILE YOU DEPLOY above messages.

```
ABORT HISTORY: total since reset: 1
ABORT HISTORY: last abort cause: MS_ABORT_OVERDEPTH
ABORT HISTORY: last abort time: 1987-09-16T12:27:14
ABORT HISTORY: last abort segment: ru17_ghost_deep-
1987-258-0-0 (0150.0000)
ABORT HISTORY: last abort mission: ODCTD7.MI
```

10. **run odctd.mi:**
    a. **What is this mission testing?**
        i. This mission tests the ability of the glider to detect depth and abort for being in water deeper than it thinks it should be in. The operator's task is to witness the glider submerge and surface. This verifies proper ballast of the vehicle. Occasionally for certain deployments a float will be used on the tail until ballast is confirmed.
    b. **What is end result of this mission?**
        i. Glider should dive and surface, this time aborting just as in overtime.mi but for overdepth.



        ii. Attempt to witness the following at mission completion:

```
172.03    ERROR behavior ?_-1: we_are_done(): At the surface, return (-
2)MS_COMPLETED_ABNORMALLY

172.09    behavior ?_-1: we_are_done(): Restoring U_CYCLE_TIME from
15.000000 to 4.000000
172.16    restore_sensors()....
          Restored u_depth_rate_filter_factor from -1 to 4
172.23    behavior ?_-1:    ABOVE WORKING DEPTH
172.27    behavior ?_-1:    drop_the_weight = 0
173.46    behavior ?_-1: run_mission(): Mission completed:
MS_COMPLETED_ABNORMALLY(-2)
```

        iii. If you do not see above, type ***why?*** and this should indicate reason for aborting, overdepth. Note abort count is now at 1-2 aborts.

11. **Receiving data files from test missions:**

a. If you are on a terminal equipped with Z-modem protocol you can transfer the files from the test missions to the laptop.
b. **send *.sbd *.mlg** *.**dbd *.tbd**

12. Run the following missions:
    a. **sequence 100_tn.mi(5)**
    b. **Ctrl-P** – will hasten the process of running the mission.

ONCE THE GLIDER DIVES FROM THIS MISSION, RUTGERS WILL OBTAIN CONTROL FROM THE NEXT SURFACING. DO THE FOLLOWING ITEMS:

1. ONCE GLIDER DIVES, UNPLUG FREEWAVE MODEM POWER
2. NOTIFY/CALL RUTGERS ALERTING THEM YOU PLACED THE GLIDER ON A 15 MINUTE MISSION
3. WEATHER CONDITIONS PENDING, TAKE A CTD CAST
4. WEATHER CONDITIONS PENDING, SLOWLY START STEAMING HOME
5. CONTACT RUTGERS IN 20-30 MINUTES FOR A STATUS, RUTGERS WILL CONTACT YOU EARLIER IF A SITUATION ARISES

RUTGERS UNIVERSITY
COASTAL OCEAN OBSERVATION LAB
OPERATIONS CENTER

Glider Recovery

IMPORTANT NOTE:
GPS and Iridium antennas are shared. You must issue a **callback xx** command to insure a timely GPS once glider communications are established.

1. Glider will call Dockserver and issue its GPS location. These should be used prior to leaving dock. Communication from Rutgers personnel or an email/text message to Sat phone from a Dockserver email can facilitate this.
2. Setup equipment, notably an antenna as high as possible on boat.
3. Standby equipment waiting for connection as you proceed to given GPS location. Shore-side personnel can be called for latest GPS locations as well if need be.
4. Once glider is within range of the Freewave modem, issue immediately a ***callback xx*** command.
5. type ***where***, glider will respond with the following:

```
GliderLAB I -3 >where
Vehicle Name: ru01
Curr Time: Tue Jan  8 20:48:17 2008 MT:   13931
DR  Location:  3928.824 N -7412.074 E measured    13930.6 secs ago
GPS TooFar:   69697000.000 N 69697000.000 E measured     1e+308 secs
ago
GPS Invalid :  3929.233 N -7418.050 E measured      1.667 secs ago
GPS Location: 69697000.000 N 69697000.000 E measured     1e+308 secs
ago
   sensor:m_final_water_vx(m/s)=0                       1e+308 secs ago
   sensor:m_final_water_vy(m/s)=0                       1e+308 secs ago
   sensor:c_wpt_lat(lat)=0                              1e+308 secs ago
   sensor:c_wpt_lon(lon)=0                              1e+308 secs ago
   sensor:x_last_wpt_lat(lat)=3927.492                   13931 secs ago
   sensor:x_last_wpt_lon(lon)=-7413.635                  13931 secs ago
   sensor:m_battery(volts)=11.5033497532925              1.933 secs ago
   sensor:m_vacuum(inHg)=0.0990272592008097              2.014 secs ago
   sensor:m_leakdetect_voltage(volts)=2.49575702100992      1.886 secs
ago
   sensor:sci_water_cond(S/m)=3                         1e+308 secs ago
   sensor:sci_water_temp(degC)=10                       1e+308 secs ago
```

   a. Note the highlighted region, this is the glider's GPS location

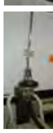
IMPORTANT: note seconds at end of line, this is the age of the GPS hit. It is important this be something reasonable, on the order of minutes or seconds. OR ELSE YOU ARE USING AN OLD HIT OR A NON-EXISTENT ONE. If there is no new hit, try issuing a ***callback 5*** command, and repeat the ***where*** command until a hit is received.
Proceed to wrangle glider, report 'The bear is in the igloo…' to shore.

Glider Equipment Checklist

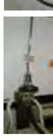
General (ALWAYS):

1.  Freewave modem configured for that glider (see Freewave modem configuration guide)
2.  Serial DB-9 Cable
3.  12 V DC power supply for Freewave (or battery for freewave with proper connector)
4. Computer with terminal software
5. DC → AC converter (if needed/available)?

Recovery:

1.  N-terminated coax cable for Freewave modem
2.  900 MHz antenna for quick-securing to boat
3. Satellite Phone
4. Animal control pole, boat hook, or some controlling device (most boats possess a boat hook for worst case scenarios)
5. Empty glider cart
6. Recent email or phone call to someone with access for GPS location
7. Red plug for glider power-down

Deployment:

1. Glider Deployment Checklist
2.  N-terminated coax cable for Freewave modem
3.  900 MHz antenna for quick-securing to boat
4. Satellite Phone
5. Glider Toolbox(s) (if available)
6. Animal control pole, boat hook, or some controlling device (most boats possess a boat hook for worst case scenarios)
7. Designated glider wings + spares!
8. Buoy with line (if Rutgers/operators feel is necessary)
9. SeaBird 19 for comparison cast at deploy location (along with SeaBird software)

Amendment 1: Use of YSI CastAway CTD

The YSI CastAway CTD is a small self-contained lightweight CTD that is GPS enabled. The flow through cell houses a suite of instruments that measure water temperature, conductivity and pressure. The manufacturer specifications for each parameter are listed in the table below. For more detailed information on the CastAway please visit the YSI website at: www.ysi.com.

	Range	Accuracy	Resolution
Conductivity	0 – 100,000 µS/cm	0.25% ±5 µS/cm	1 µS/cm
Temperature	-5° - 45° C	0.05° C	0.01° C
Pressure	0 – 100 dBar	0.25% of FS	0.01 dBar
Salinity (Derived)	Up to 42 (PSS-78)	0.1 (PSS-78)	0.01 (PSS-78)
Sound Speed (Derived)	1400 – 1730 m/s	0.15 m/s	0.01 m/s
GPS		10m	

The purpose of this amendment is to authorize the substitution of the SBE-19 described in the QAPP with the CastAway. Both CTDs will be used for side-by-side comparison profiles with the glider at the deployment and recovery of the vehicle. The small size of the CastAway permits a safer deployment/recovery in rough weather or from a small vessel. In addition, the self-contained data collection eliminates the need for a laptop and the required external power.

It will be the judgment of Josh Kohut the Rutgers lead on this project to determine weather conditions require the use of the CastAway instead of the SBE-19. The decision will be based on forecasted sea-state and vessel characteristics at the time of recovery or deployment. The decision will be communicated to each signatory of the QAPP in via email.

Amendment 2: Use of non-factory calibrated Glider CTD

The purpose of this amendment is to authorize the use of a glider installed SeaBird CTD that has not met the annual factory calibration criteria. In the case that equipment loss and project deployment timeline does not permit the delay of a lengthy factory calibration, a CTD that has not been calibrated within the last year could be substituted given the following:

1) The substituted CT was factory calibrated no more than five years prior to deployment.

2) The substituted CTD meets the requirements outlined in the table listed in Section 8 of this QAPP relative to the SeaBird-19 (calibrated within the last year).

If a CTD meeting these requirements is used in a given deployment, a statement will be included with the deployment documentation. The statement will specify that the CTD was not factory calibrated in the last year, calibration checks were preformed, and the data meets the QC criteria specified in the QAPP.

Amendment 3: Use of manufacturer-suggested replacement for dissolved oxygen field titration kit

Verification of AAnderaa oxygen optode calibration is conducted via the azide modification of the Winkler titration method, pursuant to EPA method # 360.2. This test involved the usage of EPA compliant field kits manufactured by Lamotte Company, purchased from Fisher Scientific. This kit (item # S45088) has been discontinued, but the manufacturer has issued a replacement kit (item # S94979) that uses a liquid sulfamic acid instead of a powdered version. This kit will be used to verify oxygen optode calibrations for the remainder of this project. Methodology will remain the same.

Amendment 4: Use of multiple gliders to complete remaining coastal glider flights

Losses incurred throughout the duration of this project have led to the usage of Slocum gliders other than the glider initially purchased by the NJ DEP. The glider used for the second coastal monitoring run, RU07, will be used again for this project, starting with a coastal flight in June 2012. The glider purchased by the NJ DEP, RU28, was struck and sunk by a cargo ship and later recovered. This glider has been rebuilt by the manufacturer and is scheduled to be delivered to Rutgers by the end of May 2012. The ability to use these two gliders interchangeably provides some flexibility in the project while adhering to the standards in the QAPP. Glider RU07 can carry one of 3 payload bays that will meet the standards set forth in this document for CTD calibration criteria. Bay 1 is CTD and oxygen only. In addition to these sensors, Bay 2 carries one optical puck (Wetlabs EcoPuck BBFL2-599, calibration date 29Jan2009), with two channels of fluorometry (chl a and CDOM) and one channel of backscatter at 470 nm. Bay 3 carries CTD, oxygen, and two optical pucks (BB3-796, calibration date 16Dec2010; BBFL2-338, calibration date 11May2011) measuring backscatter at 470, 532, 650, and 880 nm and fluorescence for chl a and CDOM. Data from the EcoPucks would be provisional as calibration dates fall outside of the limits set forth in this document, but can provide a qualitative understanding of the physical and biological coupling present during the coastal monitoring flights.

Amendment 5: Updated glider check-out lists

As the Rutgers glider program continues to expand, best practices and procedures are often refined, pursuant to operational experience. As such, preparatory checklists are updated to include new or more thorough procedures, as well as accounting for changes from the manufacturer, such as software updates internal to the glider.

Attached are three documents that have been updated since the fall coastal monitoring run has been completed. They are:

1.) Pre-deployment check-out (Appendix A)
2.) Deployment checklist (Appendix C)
3.) Post-Deployment checklist (Appendix E)

Appendix A has been updated with checks to avoid issues that we have recently seen in the field, including uncalibrated compasses resulting in the inability to attain specified headings and therefore necessitating recovery vs. continuing flight.

Appendix C has been modified slightly to include new preliminary test mission names, aimed at reducing confusion on the part of the deployment technician, which can often be students or those otherwise unfamiliar with the intricacies of glider operations.

Appendix D has been modified with the intent of streamlining the data backup process, thereby removing single point failures.

GLIDER	
PREPARER	
PREP DATE	
LOCATION	

SCIENCE BAY SERIAL NUMBERS
1) ____
2) ____
3) ____
4) ____

PRE-SEAL

FORE CHECK

Check pump & pitch threaded rod (grease & clean if necessary) ____
Grounded Nose? ____

Leak detect in place, batteries secure, white guides free, no metal shavings, bottles installed ____

PAYLOAD CHECK

Special Sensors / Additional Sensors
1) ____
2) ____

CTD cable clear, no leak at CTD joint, no leak at pucks ____

Grounded Parts: Fore Sci Ring ____
Aft Sci Ring ____
CTD ____
Other? ____

Science Bay Weight Configuration ____

AFT CHECK

Iridium Card Installed (SIM #) (if not standard) ____
Flash Card: old data removed? ____
Inspect strain on connectors (worn connectors), battery secured, ballast bottle present, aft cap clean/clear of leak ____
Aft cap grounded? ____

Battery check
Aft Pack - J13 Voltage ____
Pitch Pack - J13 Voltage ____
Nose Packs - J13 Voltage ____
Aft Emer - J31 Voltage ____

POST-SEAL

GENERAL

Pick Point Present? ____
Special Instruments? ____

HARDWARE

put c_alt_time 0, verify alt chirp ____
Nose Cone and pump bladder inspection ____
Anode grounded? ____
Anode size / remainder (est) ____
Pressure Sensor Check (corrosion, clear)
Aft sensor ____
Payload sensor ____
Ejection weight assembly OK and unseized? ____

POWERED

Verify Argos ping ____
Wiggle for 5 minutes ____
Stabilized m_battery ____
m_vacuum @ T @ ballast ____

OUTSIDE

Compass Check (reading @ compass)
1) ____
2) ____
3) ____
4) ____
logging on; rotate slowly 360, logging off, plot data: 360 test ____

GPS check
(lat) ____ (lon) ____
Iridium connect ____ Alt ____
zero_ocean_pressure, get m_pressure ____
let air bladder inflate, does it shut off? ____

SOFTWARE

GENERAL

Version ________ Re-burn latest software image ________

Date OK? ________ configure TBDlist ________

delete old logs ________ NBDlist ________

\CONFIG

simul.sim deleted ________

\MAFILES

goto_l10.ma (set x_last_...) ________

AUTOEXEC.MI

Irid Main: 88160000592 ________ c_ctd41cp_num_fields_to_send 4 ________

Irid Alt: 15085482446 ________ Calibration coefficients ________

u_iridium_failover_retries = 10 ________ f_ballast_pumped_deadz_width = 30? ________

Reset the glider, observe any errors get f_max_working_depth (102 m) ________

CACHE MANAGEMENT

del ..\state\cache*.*

after *bdlist.dat are set (exit reset):

logging on; logging off

send ..\state\cache*.cac ________

send *.mbd *.sbd *.tbd ________

*** Software Burning Tips :** if using Procomm or local folder, copy all the files from the software image locally. Then proceed to edit them for the glider and do a mass freewave transfer of the files. Save these files or prepare the to-glider with these files

SCIENCE

SENSOR RETURN

put c_science_send_all 1

put c_science_all_on 8

put c_science_on 3

All sensors reporting values? ________

CTD

Tank static comparison OK? ________

OPTODE

Check in completed? ________

Glider ____________ Date ____________

Pilots ____________ Where ____________

Laptop ____________ Vehicle Powerup: CTRL ^ C (until you get to prompt)!!!

On boat **(Remember after 10 min glider will go into mission, as well as on powerup!)**	Battery Voltage	____	get m_battery
	Vacuum Pressure	____	get m_vacuum, should be > 7 for bladder inflation
	Iridium Connection	____	look for connect dialog & surface dialog, let it dial at prompt
	boot app	☐	boot app
	boot (should report application)	☐	reports boot application
	run status.mi	☐	mission completed normally?
In Water	zero_ocean_pressure	☐	while glider in water
	run od.mi (with or without float, ask RU)	☐	glider should dive and surface, type why? Should say overdepth, if not call
	send *.dbd *.mlg *.sbd	☐	"send *.sbd" is most important (this applies moreso to when handed off to iridium)
	run shallow.mi or deep.mi	☐	(glider should dive and not reappear) (report to Rutgers or steam out slowly once it dives)
	Verify dive; **disconnect freewave** Report to Rutgers		
	Perform CTD Comparison CAST	☐	typically done with RU provided SBE19 or Cast Away CTD
	LAT: **LON**		

Slocum Glider Check-IN

DATE: ____________

GLIDER: ____________ **SB:** _____________

Vehicle Powered

Power on vehicle in order to fully retract pump, and/or to deflate air bladder.

Vehicle Cleaning (hose down with pressure)

Nose cone

1. Remove nose cone
2. Loosen altimeter screws, and remove altimeter or leave temporarily attached
3. Retract pump
4. Remove altimeter and hose diaphragm removing all sand, sediment, bio oils
5. Clean nose cone and altimeter

Tail cone

1. Remove tail cone
2. Hose and clean anode and air bladder making sure air bladder is completely clean
3. Clean cowling

Wing rails

1. Remove wing rails and hose down

Tail plug cleaning

1. Dip red plug in alcohol and clean plug if especially dirty
2. Re-dip red plug and repeatedly insert and remove to clean the glider plug
3. Compress air glider female connector
4. Lightly silicon red plug and replace in glider once silicon has been dispersed evenly in the plugs

CTD Comparison Check

1. Inspect CTD sensor for any sediment buildup, take pictures of anything suspicious or make note.

Static Tank Test

SBE19
Temperature: ________________

Conductivity: ________________

Glider (SBE41CP or pumped unit)
Temperature: ________________

Conductivity: ________________

CTD Maintenance if comparison is not acceptable (reference SeaBird Application Note 2D)

1. Perform CTD backward/forward flush with 1% Triton X-100 solution
2. Perform CTD backward/forward flush with 500 – 1000 ppm bleach solution
3. Perform the same on a pumped unit, just different approach
4. Repeat comparison test if above results not within T < .01 C, C < .005 S/m

SB19
Temperature: ________________

Conductivity: ________________

Glider (SB41CP or pumped unit)
Temperature: ________________

Conductivity: ________________

Vehicle Disassembled

1. Check leak points for water or salt buildup
2. **BACKUP FLASH CARDS** in /coolgroup/gliderData/glider_OS_backups/<glider>/<glider-deploymentID>/<from glider>,<from sb_0xxx>

   ____

   DO NOT DELETE DATA OFF CARDS
3. Change permissions on <glider-deploymentID> folder to read, write, execute for owner and group, and read, execute for everyone
4. Remove used batteries and place in return crate

   ____
5. Re-assemble glider with a vacuum

Appendix B

Deployment 1
8/10/2011 – 9/9/2011

RUTGERS UNIVERSITY
COASTAL OCEAN OBSERVATION LAB
OPERATIONS CENTER

GLIDER RU16

MISSION EPA - DEP 1

DATE

8/10/2011 - TBD

GLIDER DENSITY (in target water)

1021.50 kg/m^3

LOCATION

Coastal NJ - EPA/DEP kg/m^3

RU COOL GLIDER BALLAST RECORD

O:\coolgroup\Gliders\Glider Ballasting\ru16\2011_07_27 ru16 NJDEP run 1_ru28replacement (SH to Cape May).xls

			MASS (g)	COMMENTS
Deployment	GLIDER	FORE STEM	7315.7	*New optode (sn 1024) is 57.3 g heavier
EPA-DEP 1		FORE HULL	4369.4	pulled 70g out of aft bottle
Glider		AFT STEM (red plug, card)	6429.2	
RU16		AFT HULL	4378.4	
		COWLING	1147.2	
Date		SCREWS (vacuum,cowling,aft battery)	18.7	
7/27/2011	PAYLOAD	PAYLOAD BAY (no rails!)	8002.6	should be around 8.4 kg
		WINGS	492.6	
Preparer		WING RAILS (screws)	0	on bay
Chip		PICK POINT	0	n/a
	BATTERIES	AFT BATTERY	7627	
		PITCH BATTERY	9465	
Air Temperature		FORE BATTERY 1 (starboard)	744.8	
20		FORE BATTERY 2 (port)	744.4	
	WEIGHT BOTTLES	AFT BOTTLE	377.7	447.9-70.2=377.7
		FORE BOTTLE 1 (starboard)	351.7	
		FORE BOTTLE 2 (port)	305.4	

Tank Specifics		Glider Specifics		H MOMENT (rad)		(deg)
Tank Density (g/mL)	1021.6100	Glider Volume (mL)	50771	Angle of Rotation (before)		0.0
Tank Temperature (C)	21.29	Total Mass (g)	51769.8	Angle of Rotation (after)		0.0
Weight in Tank (g)	-10.00	Glider Density 1 (air) (g/mL)	1.0197	Angle of Rotation	0	0.0
Target Specifics		**Volume Change (temperature induced)**		Weight on Spring (after)		
Target Density (g/mL)	1.0215	Volume Change (tank) (mL)	5	Weight added		
Target Temperature ©	15.00	Volume Change (target) (mL)	-22	Radius of Hull		
				H-distance	#DIV/0!	

Should Hang (in tank) (g)	-51821005.26	**Adjust Glider Mass (Dunk Volume) (g)**	-51740.87	volume 1:
Adjust by: (g)	-51820995.26	**Adjust Glider Mass (entered volume) (g)**	69.94	volume 2:

^ Ballasting Alternative (known VOLUME)

Calculated Glider Volume (calculated from scales) (mL)	50.68	average =	#DIV/0!
Glider Density 2 (in target water, using calculated volume above) (kg / m³)	1827677.3	PICK POINT MASSES	107 g air / 66 g Water
Glider Density 3 (in target water, using entered volume) (kg / m³)	1020.1	PICK POINT VOLUME	40.4 mL

Ballast Sheet

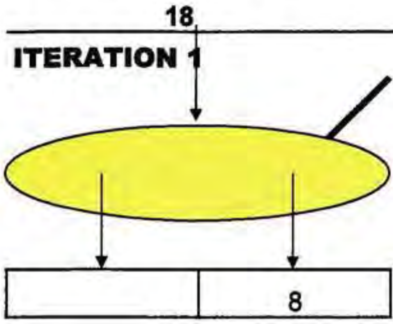
Glider Density 4 (in target water, using entered volume) (kg / m³)	1022152.11

	Ballast Pump Size	Glider Reported pump_volume		Resultant Volume (in air/tank)	
Full Retract Scale Weight				50.6747193	
Full Extend Scale Weight				50.6747193	
	432			50.2518574	
Original Volume	50771				
			% Matched	Max Density Range	
Pump Size	0		#DIV/0!	0.00	+- sigma
Pump Size (retracted)	50720.32528		#DIV/0!	1020.12	Max Density (in target)
Pump Size (extended)	50720.32528		#DIV/0!	1020.12	Min Density (in target)

DISCLAIMER = make sure all values are correct, and accurate, dependencies are exact dunk weights, tank density and temperature, as well as units

BALLAST ITERATIONS **GLIDER:** RU16 **DATE:** 7/27/2011

ITERATION 1



BALLAST

FORE 1	
FORE 2	
AFT	

NOTES

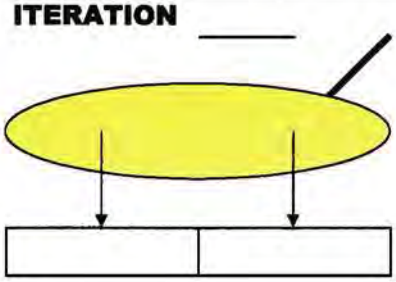
Roll - 0.007 radians

Ballasted: 1021.5

TANK: C - 4.4592
(SB19) T - 21.29
D - 1021.61

TANK: C - 4.4565
(Glider) T - 21.309
D - 1021.59

ITERATION ______



BALLAST

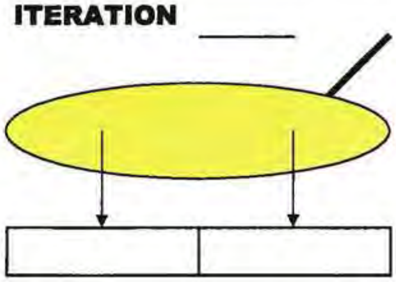
FORE 1	
FORE 2	
AFT	

NOTES

TANK:
(SB19)

TANK:
(Glider)

ITERATION ______



BALLAST

FORE 1	
FORE 2	
AFT	

NOTES

TANK:
(SB19)

TANK:
(Glider)

Pre-Deployment Check Out

GLIDER	RU16
PREPARER	Chip
PREP DATE	27 July 2011
LOCATION	Coastal NJ - EPA - DEP

PRE-SEAL

FORE CHECK

Check pump threaded rod (grease) ✓
Check pitch battery threaded rod (grease) ✓
Leak detect in place, batteries secure, white guides free, no metal shavings, bottles installed, grounded? ✓

PAYLOAD CHECK

Science Bay Instrument Serial Numbers

1 CTD 0055
2 Optode SN [redacted] 972
3 *Optode leaked,
4 Changed to SN 2024
5

CTD cable clear, no leak at CTD joint, no leak at pucks
Grounded? ✓

Science Bay Weight Configuration

Banana fore + aft bottom, Weight bar w/ one large + one small

AFT CHECK

Iridium Card Installed (SIM #)

1 89881-69414-00015-5174

Flash card old files removed?

Inspect strain on connectors (damaged connectors as well), Persistor power supply cable secure, battery secured, ballast bottle in place, aft cap clear of leak, grounded? ✓

Battery check (using load?)

1. Attach aft battery pack, verify voltage at J13 15.92
2. Disconnect aft battery
3. Screw in aft connector
4. Connect pitch battery, verify voltage at J13 15.93
5. Disconnect pitch battery
6. Screw in fore connector, verify voltage at J13 ✓
7. Attach pitch battery
8. Attach aft battery
9. Verify voltage at J31 (simple probe) ✓

POST-SEAL

GENERAL

Pick Point Present? No
Special Instruments Present? No

HARDWARE

Nose Cone and pump bladder inspection	✓
put c_alt_time 0, verify alt chirping	✓
Corrosion Prevention & Anode Check	
Anode Style/Weight	Small, used but OK
Glider Parts Grounded (stickers)	✓
Ejection weight assembly OK and unseized?	✓
Pressure Sensor Check (corrosion, clear)	✓
Aft sensor	✓
Payload sensor	✓

POWERED

Verify Argos ping	✓
Wiggle for 5 minutes	✓
Record m_battery once stabilized	15.78
Record m_vacuum @ temperature @ ballast	5.84 @ ballast

OUTSIDE

Record compass reading	.382 radians (~20 deg.)
GPS check? (40 28.75, 74 26.25)	✓
Iridium connect	✓
zero_ocean_pressure, get m_pressure	0.002
let air bladder inflate, does it shut off?	✓

SOFTWARE

GENERAL

Version	7.6
Date ok, delete old logs	✓
Re-burn latest software image	
mdblist.dat, mi, ma, science!	✓

\CONFIG

simul.sim deleted	✓
if ver < 7.0 configure sbdlist.dat	✓ N/A

\MAFILES

	✓
goto_l10.ma (set x_last_...)	✓

AUTOEXEC.MI

Phone Number	
Main is RUDIC, alt is TWR	✓
u_iridium_failover_retries = 10	✓
c_ctd41cp_num_fields_to_send 4	✓
Calibration coefficients	✓

In Gliderdos, reset glider to test settings

get f_max_working_depth (102 m)	✓
f_ballast_pumped_deadz_width = 30?	✓

CACHE MANAGEMENT (DONE ON DOCKSERVER!)
(this step is very important!)

del ..\state\cache*.*	
after *bdlist.dat are set (exit reset):	
logging on; logging off	
send ..\state\cache*.cac	✓
send *.mbd *.sbd *.tbd	✓

*** Software Burning Tips :** if using Procomm or local folder, copy all the files from the software

Software Burning Tips : If using Procomm or local folder, copy all the files from the software image locally. Then proceed to edit them for the glider and do a mass freewave transfer of the files. Save these files or prepare the to-glider with these f

SCIENCE

SENSOR RETURN

put c_science_send_all 1
put c_science_all_on 8
put c_science_on 3
All sensors reporting values? ✓

CTD

Tank static comparison OK? ✓ - see ballast iteration 1

OPTODE

Check in completed? ✓
Remove any shielding ✓

PUCK 1

Puck Type N/A

Verify Darkcounts —

PUCK 2

Puck Type N/A

Verify Darkcounts —

PUCK 3

Puck Type N/A

Verify Darkcounts —

Pre-Deployment Check Out
For
Aanderaa Oxygen Optode

RUTGERS Coastal Ocean Observation Lab

:locum Glider Aanderaa Optode Check IN/OUT
: Point Calibration & Calibration Coeffcient Record

OPTODE MODEL, SN: MN# 5014W SN# 1024 **IN / OUT** OUT

Calibration Record
CALIBRATION DATE: 8/9/2011 **PERFORMED BY:** Chip Haldeman, Kaycee Coleman

Previous:					Current:				
C0Coef	4.3E+03	-1.3E+02	2.2E+00	-1.4E-02	**C0Coef**	4.3E+03	-1.3E+02	2.2E+00	-1.4E-02
C1Coef	-2.3E+02	5.7E+00	-6.9E-02	1.9E-04	**C1Coef**	-2.3E+02	5.7E+00	-6.9E-02	1.9E-04
C2Coef	5.1E+00	-9.6E-02	5.2E-04	7.7E-06	**C2Coef**	5.1E+00	-9.6E-02	5.2E-04	7.7E-06
C3Coef	-5.3E-02	7.2E-04	3.3E-06	-1.9E-07	**C3Coef**	-5.3E-02	7.2E-04	3.3E-06	-1.9E-07
C4Coef	2.1E-04	-1.8E-06	-4.3E-08	1.1E-09	**C4Coef**	2.1E-04	-1.8E-06	-4.3E-08	1.1E-09

Delta: 0.0

*** Sodium Thiosulfate verified by Kaycee Coleman**

2 point Calibration

0% Point		*100% Point*	
Solution: 15.0 g	**Na_2SO_3**	*Solution:* 0	**Na_2SO_3**
Pasport device	**Cross reference**	Pasport device	**Cross reference**
26.94	**Temperature**	10	**Temperature**
995.15	**Air Pressure (hPa)**	995.145	**Air Pressure (hPa)**
Sample A	**Winkler Label**	Sample B	**Winkler Label**
LaMotte 7414 - Azide mod	**Winkler Source**	LaMotte 7414 - Azide mod	**Winkler Source**
Results:		*Results:*	
OPTODE: 71.93	**Dphase**	**OPTODE:** 34.31	**Dphase**
0.16 µM		335 µM	
0.06	**% Saturation**	95.09	**% Saturation**
26.93	**Temperature**	9.93	**Temperature**
0.16	**Conc (calculated) (µM)**	330.78	**Calculated Concentration**
0.07	**% Saturation (calculated)**	95.52	**Calculated % Saturation**
WINKLER 0.2	**Concentration (µM)**	**WINKLER:** 326.56	**Concentration**
< .2	**(Titrations) (ppm)**	-10.45	**(Titrations) (ppm)**
0.07	**% Saturation**	94.3	**% Saturation**
DELTAS:		**DELTAS:**	
-0.04 **Conc Δ** 0 **% Δ**		4.22 **Conc Δ** 1.22 **% Δ**	
0.01 **Temp Δ**		0.07 **Temp Δ**	

In-Air Saturation Check

SATURATION: 96.3 **@ TEMP** 24.44 **@ PRESS** 995.15

Paste Sample Report

Protect	3830	1024	0			
PhaseCoe	3830	1024	-1.51E+00	1.14E+00	0.00E+00	0.00E+00
TempCoe	3830	1024	2.12E+01	-3.06E-02	2.89E-06	-4.18E-09
FoilNo	3830	1024	1023			
C0Coef	3830	1024	4.27E+03	-1.33E+02	2.16E+00	-1.40E-02
C1Coef	3830	1024	-2.30E+02	5.74E+00	-6.85E-02	1.89E-04
C2Coef	3830	1024	5.06E+00	-9.62E-02	5.22E-04	7.71E-06
C3Coef	3830	1024	-5.26E-02	7.15E-04	3.31E-06	-1.86E-07
C4Coef	3830	1024	2.11E-04	-1.84E-06	-4.29E-08	1.11E-09
Salinity	3830	1024	0.00E+00			
CalAirPha	3830	1024	3.12E+01			
CalAirTen	3830	1024	9.73E+00			
CalAirPre:	3830	1024	9.81E+02			
CalZeroPl	3830	1024	6.56E+01			
CalZeroTε	3830	1024	2.26E+01			
Interval	3830	1024	2			
AnCoef	3830	1024	0.00E+00	1.00E+00		
Output	3830	1024	1			
SR10Dela	3830	1024	-1			
Software\	3830	1024	3			
SoftwareI	3830	1024	11			

Deployment Checklist

Glider RU16 Date 8/10

Pilots Josh + Kaycee Where Atlantic Highlands

Laptop Field-mini Vehicle Powerup: CTRL ^ C (until you get to prompt)!!!

On boat (Remember after 10 min glider will go into mission, as well as on powerup!)	Battery Voltage	14.797	get m_battery
	Vacuum Pressure	8.538	get m_vacuum, should be > 7 for bladder inflation
	Iridium Connection	✓	look for connect dialog & surface dialog, let it dial at prompt
	boot app	✓	boot app
	boot (should report application)	✓	reports boot application
	run status.mi	✓	mission completed normally?
In Water	zero_ocean_pressure	✓	while glider in water
	run odctd.mi (with or without float, ask RU) why?	✓	glider should dive and surface, type why? Should say overdepth, if not call (would say don't need float for ru06, ru07 use it the first deployment) (can skip this if you want for multiple deployments)
	send *.dbd *.mlg *.sbd	✓	"send *.sbd" is most important 9 (this applies moreso to when handoff'ed to iridium)
	run 100_tn.mi	✓	sequence 100_tn.mi(5)
	Verify dive; **disconnect freewave** Report to Rutgers		
	Perform CTD Comparison CAST	✓	typically done with RU provided SB19 or Cast Away CTD
	LAT: 73°52'45.789 LON 40°21'4.365		

Recovery Checklist

Glider RU16 Date TBD

Pilots ______ Where ______

Laptop ______

Recovery	get Lat/Lon from email or shore support	☐
	obtain freewave comms obtain lat/lon with where command	☐
	Perform CTD Comparison CAST	☐
	LAT: **LON:**	
	(note instrument type!)	

***As of date of submission, RU16 has not been recovered**

Post-Deployment Checklist

RUTGERS
Coastal Ocean
Observation Lab

Slocum Glider Check-IN

DATE: _TBD______

GLIDER: _RU16__SB: __0055__

Power on vehicle in order to fully retract pump, and/or to deflate air bladder.

Vehicle Cleaning (hose down with pressure)

Nose cone

1. Remove nose cone
2. Loosen altimeter screws, and remove altimeter or leave temporarily attached
3. Retract pump
4. Remove altimeter and hose diaphragm removing all sand, sediment, bio oils
5. Clean nose cone and altimeter

Tail cone

1. Remove tail cone
2. Hose and clean anode and air bladder making sure air bladder is completely clean
3. Clean cowling

☐

Wing rails

1. Remove wing rails and hose down

Tail plug cleaning

1. Dip red plug in alcohol and clean plug if especially dirty
2. Re-dip red plug and repeatedly insert and remove to clean the glider plug
3. Compress air glider female connector
4. Lightly silicon red plug and replace in glider once silicon has been dispersed evenly in the plugs.

N/A

CTD Comparison Check

1. Inspect CTD sensor for any sediment buildup, take pictures of anything suspicious or make note.

Static Tank Test

SB19	*Glider (SB41CP or pumped unit)*
Temperature: ______________	Temperature: ______________
Conductivity: ______________	Conductivity: ______________

CTD Maintenance (reference SeaBird Application Note 2D)

1. Perform CTD backward/forward flush with 1% Triton X-100 solution
2. Perform CTD backward/forward flush with 500 – 1000 ppm bleach solution
3. Perform the same on a pumped unit, just different approach
4. Repeat comparison test if results not within T < .01 C, C < .005 S/m

Static Tank Test

SB19	*Glider (SB41CP or pumped unit)*
Temperature: ______________	Temperature: ______________
Conductivity: ______________	Conductivity: ______________

Manufacturer Calibration Documentation

Aanderaa Optode and Seabird CTD

TEST & SPECIFICATIONS

AANDERAA DATA INSTRUMENTS

Layout No:		**Product:**	3830
Circuit Diagram No:		**Serial No:**	1024
Program Version:			

---

1. Visual and Mechanical Checks:	
1.1. O-ring surface	N/A
1.2. Soldering quality	N/A
1.3. Visual surface	OK
1.4. Pressure test (60MPa)	N/A
1.5. Galvanic isolation between housing and electronics	OK
2. Current Drain and Voltages:	
2.1. Average current drain at 0.5Hz sampling (Max: 38mA)	31.1 mA
2.2. Current drain in sleep (Max: 300uA)	192 uA
3. Performance Test in Air, 20°C Temperature:	
3.1. Amplitude measurement (Blue: 290 – 470mV)	378.42 mV
3.2. Phase measurement (Blue: 27 ±5°)	29.78 °
3.3 Temperature Measurement (100 ± 300mV)	-27.42 mV
4. Firmware:	
4.1. Firmware upgrade	3.11

Date:
August 5, 2011

Sign: Shawn A. Sneddon

Service and Calibration Engineer

Aanderaa Data Instruments, Inc.
182 East Street Attleboro, MA 02703 Tel. +1 (508) 226-9300 email: infoUSA@aadi.no
an ITT Analytics Company

CALIBRATION CERTIFICATE

AANDERAA DATA INSTRUMENTS

Sensing Foil Batch No:	1023	**Product:**	3830
Certificate No:	3830 1024 2000	**Serial No:**	1024
		Calibration Date:	August 5, 2011

This is to certify that this product has been calibrated using the following instruments:

Fluke CHUB E-4	Serial No. A7C677
Fluke 5615 PRT	Serial No. 849155
Fluke 5615 PRT	Serial No. 802054
Honeywell PPT	Serial No. 44074
Calibration Bath model FNT 321-1-40	1

Parameter: Internal Temperature:

Calibration points and readings:

Temperature (°C)	-	-	-	-
Reading (mV)	-	-	-	-

Giving these coefficients

Index	0	1	2	3
TempCoef	2.11646E+01	-3.06342E-02	2.88984E-06	-4.17900E-09

Parameter: Oxygen:

	O2 Concentration	Air Saturation
Range:	0-500 µM [1]	0 - 120%
Accuracy[1]:	< ±8µM or ±5%(whichever is greater)	±5%
Resolution:	< 1 µM	< 0.4%
Settling Time (63%):	< 25 seconds	

Calibration points and readings[2]:

	Air Saturated Water	Zero Solution (Na_2SO_3)
Phase reading (°)	3.12009E+01	6.55748E+01
Temperature reading (°C)	9.72549E+00	2.25779E+01
Air Pressure (hPa)	9.81020E+02	

Giving these coefficients

Index	0	1	2	3
PhaseCoef	-1.50632E+00	1.14205E+00	0.00000E+00	0.00000E+00

[1] *Valid for 0 to 2000m (6562ft) depth, salinity 33 - 37ppt*

[2] *The calibration is performed in fresh water and the salinity setting is set to: 0*

Date:
August 5, 2011

Sign: Shawn A. Sneddon

Service and Calibration Engineer

Aanderaa Data Instruments, Inc.
182 East Street Attleboro, MA 02703 Tel. +1 (508) 226-9300 email: infoUSA@aadi.no

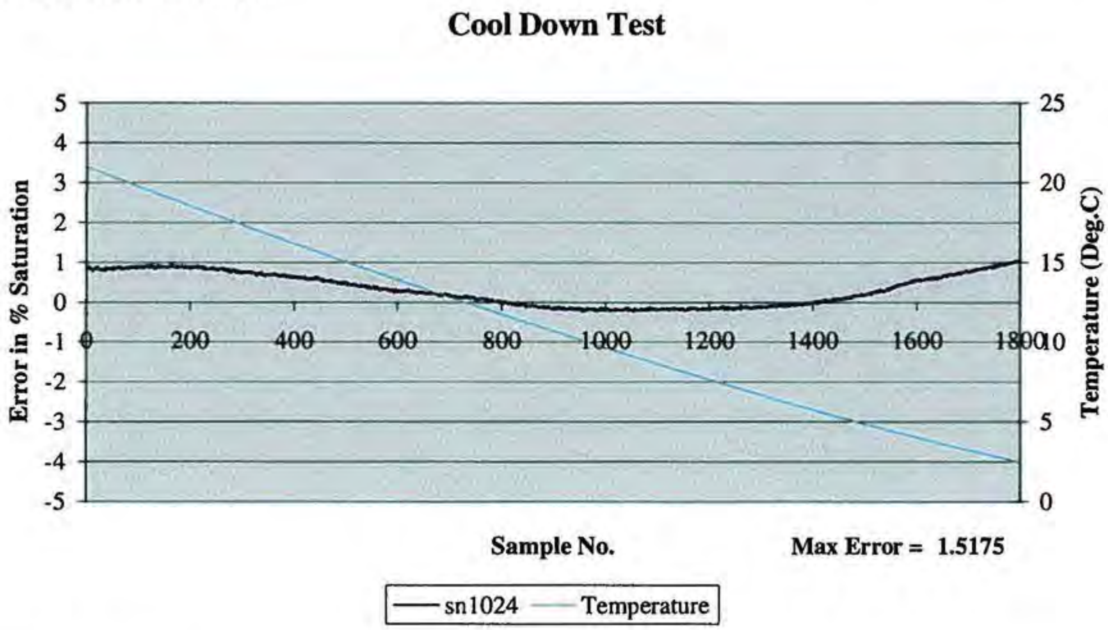
AANDERAA DATA INSTRUMENTS

CALIBRATION CERTIFICATE

Sensing Foil Batch No: 1023
Certificate No: 3830 1024 2000

Product: 3830
Serial No: 1024
Calibration Date: August 5, 2011

Data from Cool Down Test:



SR10 Scaling Coefficients:

At the SR10 output the Oxygen Optode 3830 can give either absolute oxygen concentration in μM or air saturation in %. The setting of the internal property "Output" [3], controls the selection of the unit. The coefficients for converting SR10 raw data to engineering units are fixed.

Output = -1	Output = -2
A = 0	A = 0
B = 4.883E-01	B = 1.465E-01
C = 0	C= 0
D = 0	D = 0
Oxygen (uM) = A + BN + CN2 + DN3	Oxygen (%) = A + BN + CN2 + DN3

[3] *The default output setting is set to -1*

Date:
August 5, 2011

Sign: Shawn A. Sneddon

Service and Calibration Engineer

Aanderaa Data Instruments, Inc.
182 East Street Attleboro, MA 02703 Tel. +1 (508) 226-9300 email: infoUSA@aadi.no
an ITT Analytics Company

CALIBRATION CERTIFICATE

AANDERAA DATA INSTRUMENTS

Form No. 621. Dec 2005

Certificate No: 3853_1023_40408
Batch No: 1023

Product: O2 Sensing Foil PSt3 3853
Calibration Date: 18 August 2010

Calibration points and phase readings (degrees)

Temperature (°C)		3.81	10.40	19.94	29.39	38.67
Pressure (hPa)		970.25	970.25	970.25	970.25	970.25
O2 in % of O2+N2	0.00	72.97	72.50	71.81	71.02	70.09
	1.00	68.13	67.16	65.72	64.27	62.70
	2.00	64.72	63.48	61.63	59.79	57.95
	5.00	56.48	54.75	52.40	50.16	48.05
	10.00	47.08	45.17	42.67	40.36	38.33
	20.90	35.87	34.01	31.74	29.73	28.04
	30.00	30.48	28.83	26.79	25.03	23.56

Giving these coefficients [1)]

Index	0	1	2	3
C0 Coefficient	4.27019E+03	-1.32724E+02	2.15630E+00	-1.40276E-02
C1 Coefficient	-2.29730E+02	5.74242E+00	-6.85358E-02	1.88612E-04
C2 Coefficient	5.06402E+00	-9.62085E-02	5.22181E-04	7.70890E-06
C3 Coefficient	-5.26332E-02	7.15467E-04	3.31185E-06	-1.86124E-07
C4 Coefficient	2.10917E-04	-1.84088E-06	-4.28646E-08	1.11120E-09

[1)] Ask for Form No 621S when this O2 Sensing Foil is used in Oxygen Sensor 3830 with Serial Numbers lower than 184.

Date: 3/4/2011

Sign:

Tor-Ove Kvalvaag

Tor-Ove Kvalvaag, Calibration Engineer

AANDERAA DATA INSTRUMENTS AS

5851 BERGEN, NORWAY Tel. +47 55 60 48 00 Fax. +47 55 60 48 01 E-mail: info@aadi.no Web: http://www.aadi.no

SBE SEA-BIRD ELECTRONICS, INC.
13431 NE 20th St. Bellevue, Washington 98005 USA
Phone: (425) 643-9866 Fax: (425) 643-9954 www.seabird.com

Service Report

RMA Number 63738

Customer Information:

Company	WEBB RESEARCH CORPORATION	**Date**	4/28/2011
Contact	Peter Collins		
PO Number	TWR4570		

Serial Number	WEBB Glider-0055
Model Number	WEBB Glider

Services Requested:

1. Evaluate/Repair Instrumentation.
2. Perform Routine Calibration Service.

Problems Found:

1. The conductivity cell was found to require cleaning and re-platinization.
2. Antifoulant devices were found to be dirty.

Services Performed:

1. Performed initial diagnostic evaluation.
2. Performed "Post Cruise" calibration of the temperature & conductivity sensors.
3. Cleaned and replatinized the conductivity cell.
4. Performed "Final" calibration of the temperature & conductivity sensors.
5. Calibrated the pressure sensor.
6. Installed NEW AF24173 Anti-foulant cylinder(s).
7. Performed complete system check and full diagnostic evaluation.

Special Notes:

SEA-BIRD ELECTRONICS, INC.
13431 NE 20th St. Bellevue, Washington 98005 USA
Phone: (425) 643-9866 Fax: (425) 643-9954 www.seabird.com

Temperature Calibration Report

Customer:	WEBB RESEARCH CORPORATION		
Job Number:	63738	**Date of Report:**	4/21/2011
Model Number	WEBB Glider	**Serial Number:**	WEBB Glider-0055

Temperature sensors are normally calibrated 'as received', without adjustments, allowing a determination sensor drift. If the calibration identifies a problem, then a second calibration is performed after work is completed. The 'as received' calibration is not performed if the sensor is damaged or non-functional, or by customer request.

An 'as received' calibration certificate is provided, listing coefficients to convert sensor frequency to temperature. Users must choose whether the 'as received' calibration or the previous calibration better represents the sensor condition during deployment. In SEASOFT enter the chosen coefficients using the program SEACON. The coefficient 'offset' allows a small correction for drift between calibrations (consult the SEASOFT manual). Calibration coefficients obtained after a repair apply only to subsequent data.

'AS RECEIVED CALIBRATION' ☑ Performed ☐ Not Performed

Date: 4/12/2011 **Drift since last cal:** +0.00012 Degrees Celsius/year

Comments:

'FINAL CALIBRATION' ☑ Performed ☐ Not Performed

Date: 4/21/2011 **Drift since 16 Sep 06** +0.00049 Degrees Celsius/year

Comments:

SEA-BIRD ELECTRONICS, INC.

13431 NE 20th Street, Bellevue, Washington, 98005-2010 USA

Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0055
CALIBRATION DATE: 21-Apr-11

WEBB GLIDER TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

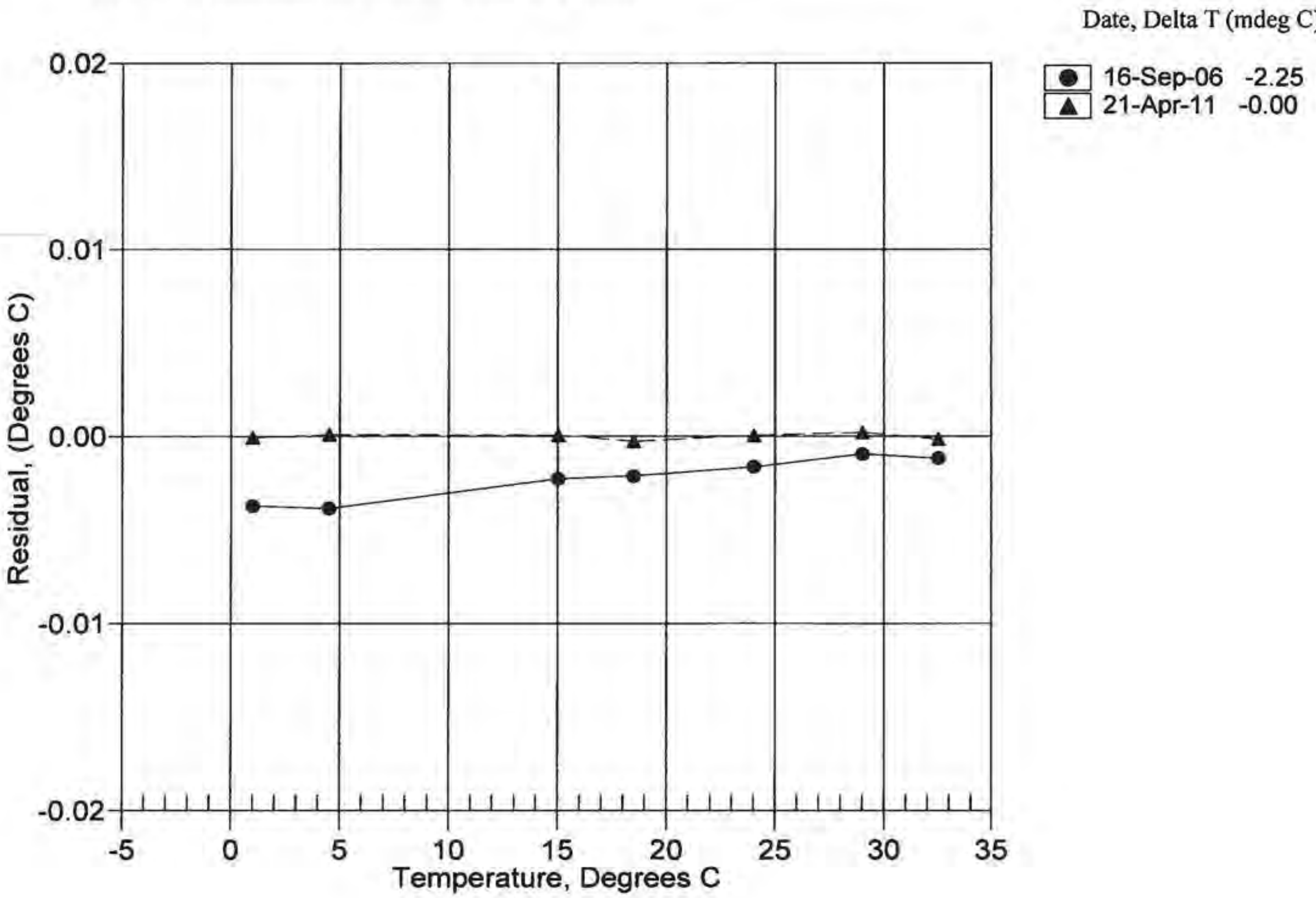
ITS-90 COEFFICIENTS

a0 = 3.207743e-005
a1 = 2.722827e-004
a2 = -2.066693e-006
a3 = 1.499035e-007

BATH TEMP (ITS-90)	INSTRUMENT OUTPUT	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	611669.0	0.9999	-0.0001
4.5000	523780.4	4.5001	0.0001
14.9999	335258.3	15.0000	0.0001
18.5000	290693.0	18.4997	-0.0003
24.0000	233673.5	24.0001	0.0001
29.0000	192748.1	29.0002	0.0002
32.5000	168994.5	32.4999	-0.0001

Temperature ITS-90 = $1/\{a0 + a1[ln(n)] + a2[ln^2(n)] + a3[ln^3(n)]\} - 273.15$ (°C)

Residual = instrument temperature - bath temperature



SEA-BIRD ELECTRONICS, INC.

13431 NE 20th Street, Bellevue, Washington, 98005-2010 USA

Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0055
CALIBRATION DATE: 12-Apr-11

WEBB GLIDER TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

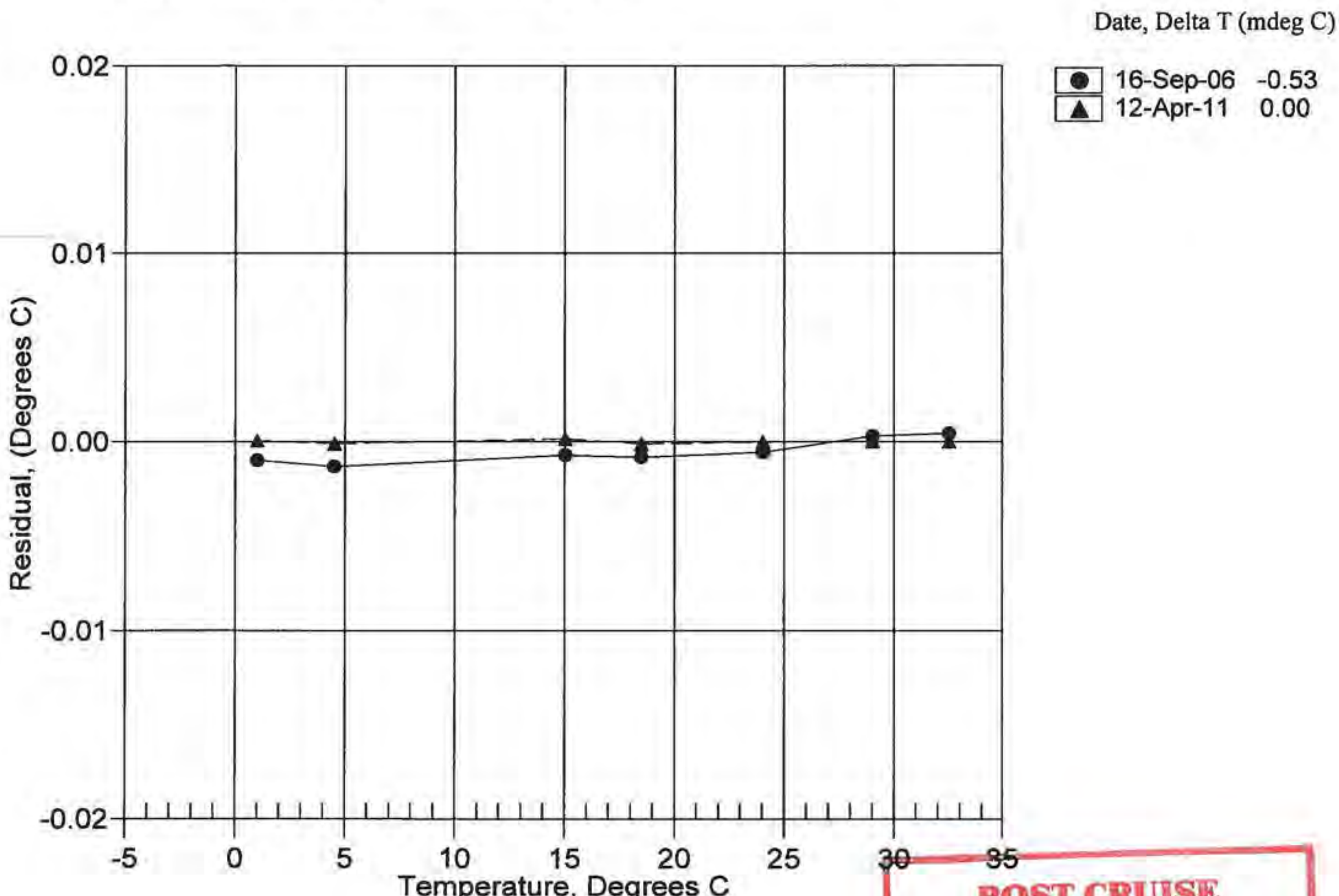
ITS-90 COEFFICIENTS

a0 = -3.406049e-005
a1 = 2.876925e-004
a2 = -3.261384e-006
a3 = 1.807112e-007

BATH TEMP (ITS-90)	INSTRUMENT OUTPUT	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	611741.0	1.0000	0.0000
4.5000	523843.0	4.4999	-0.0001
15.0000	335277.2	15.0002	0.0002
18.5000	290706.5	18.4999	-0.0001
24.0000	233684.1	24.0000	-0.0000
29.0000	192758.5	29.0000	0.0000
32.5001	169003.2	32.5001	0.0000

Temperature ITS-90 = $1/\{a0 + a1[ln(n)] + a2[ln^2(n)] + a3[ln^3(n)]\} - 273.15$ (°C)

Residual = instrument temperature - bath temperature



POST CRUISE CALIBRATION

SEA-BIRD ELECTRONICS, INC.
13431 NE 20th Street Bellevue, Washington 98005 USA
Phone: (425) 643-9866 Fax: (425) 643-9954 www.seabird.com

Conductivity Calibration Report

Customer:	WEBB RESEARCH CORPORATION		
Job Number:	63738	**Date of Report:**	4/21/2011
Model Number	WEBB Glider	**Serial Number:**	WEBB Glider-0055

Conductivity sensors are normally calibrated 'as received', without cleaning or adjustments, allowing a determination of sensor drift. If the calibration identifies a problem or indicates cell cleaning is necessary, then a second calibration is performed after work is completed. The 'as received' calibration is not performed if the sensor is damaged or non-functional, or by customer request.

An 'as received' calibration certificate is provided, listing the coefficients used to convert sensor frequency to conductivity. Users must choose whether the 'as received' calibration or the previous calibration better represents the sensor condition during deployment. In SEASOFT enter the chosen coefficients using the program SEACON. The coefficient 'slope' allows small corrections for drift between calibrations (consult the SEASOFT manual). Calibration coefficients obtained after a repair or cleaning apply only to subsequent data.

'AS RECEIVED CALIBRATION' ☑ **Performed** ☐ **Not Performed**

Date: 4/12/2011 **Drift since last cal:** -0.00030 **PSU/month***

Comments:

'CALIBRATION AFTER CLEANING & REPLATINIZING' ☑ **Performed** ☐ **Not Performed**

Date: 4/21/2011 **Drift since 16 Sep 06** +0.00010 **PSU/month***

Comments:

Measured at 3.0 S/m

Cell cleaning and electrode replatinizing tend to 'reset' the conductivity sensor to its original condition. Lack of drift in post-cleaning-calibration indicates geometric stability of the cell and electrical stability of the sensor circuit.

SEA-BIRD ELECTRONICS, INC.

13431 NE 20th Street, Bellevue, Washington, 98005-2010 USA

Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0055
CALIBRATION DATE: 12-Apr-11

WEBB GLIDER CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

COEFFICIENTS:

g = -9.922178e-001
h = 1.277352e-001
i = -1.768050e-004
j = 2.937973e-005

CPcor = -9.5700e-008
CTcor = 3.2500e-006
WBOTC = -1.2360e-005

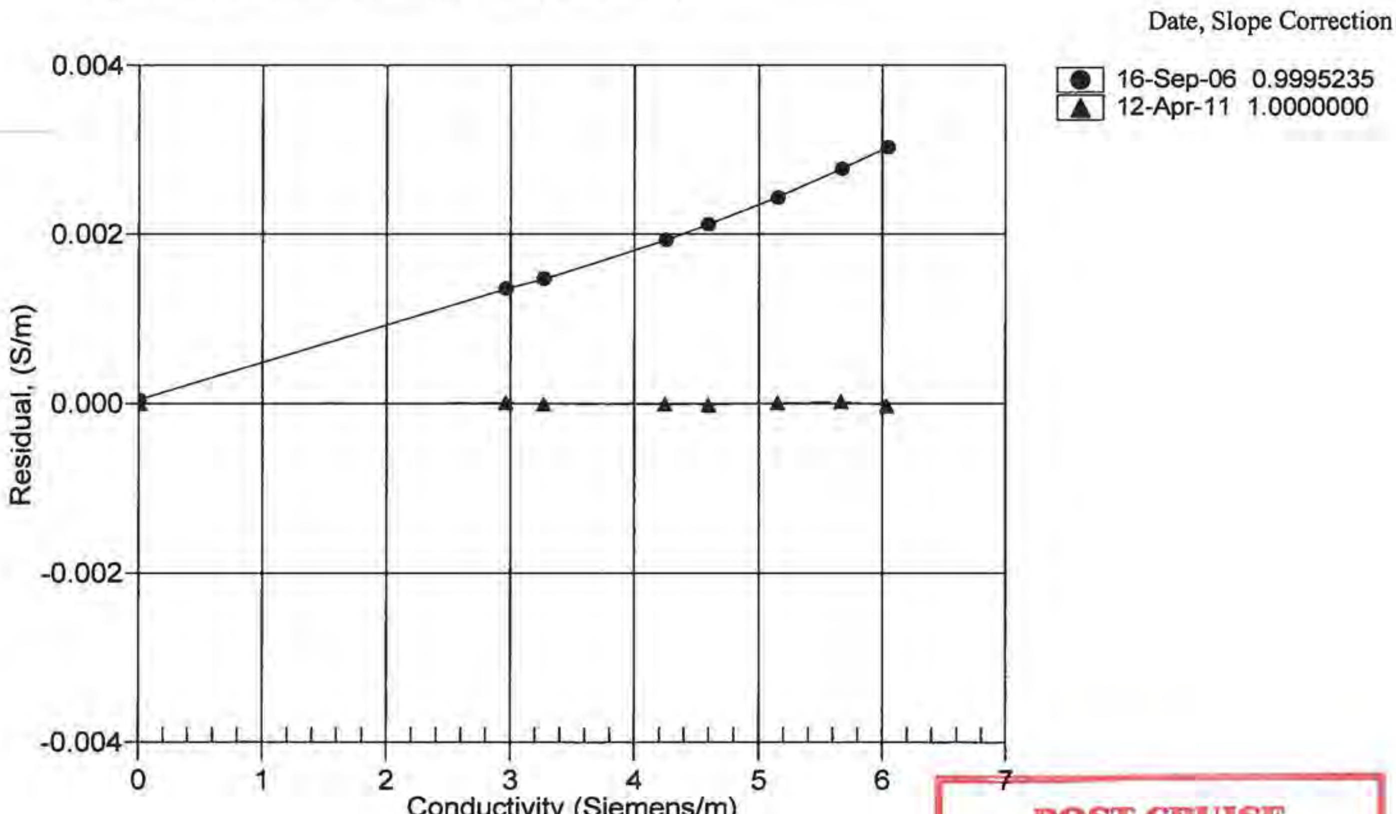
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (Hz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2790.34	0.00000	0.00000
1.0000	34.6460	2.96279	5566.06	2.96280	0.00001
4.5000	34.6257	3.26851	5776.57	3.26850	-0.00001
15.0000	34.5827	4.24598	6402.67	4.24597	-0.00001
18.5000	34.5732	4.58959	6608.42	4.58957	-0.00001
24.0000	34.5624	5.14502	6927.81	5.14503	0.00001
29.0000	34.5545	5.66424	7213.28	5.66427	0.00003
32.5001	34.5481	6.03450	7409.92	6.03448	-0.00002

f = INST FREQ * sqrt(1.0 + WBOTC * t) / 1000.0

Conductivity = $(g + hf^2 + if^3 + jf^4) / (1 + \delta t + \varepsilon p)$ Siemens/meter

t = temperature[°C)]; p = pressure[decibars]; δ = CTcor; ε = CPcor;

Residual = instrument conductivity - bath conductivity



POST CRUISE CALIBRATION

SEA-BIRD ELECTRONICS, INC.

13431 NE 20th Street, Bellevue, Washington, 98005-2010 USA
Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0055
CALIBRATION DATE: 21-Apr-11

WEBB GLIDER CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

COEFFICIENTS:

```
g = -9.902156e-001
h =  1.272303e-001
i = -6.633333e-005
j =  2.154632e-005
```

```
CPcor = -9.5700e-008
CTcor =  3.2500e-006
WBOTC = -1.2360e-005
```

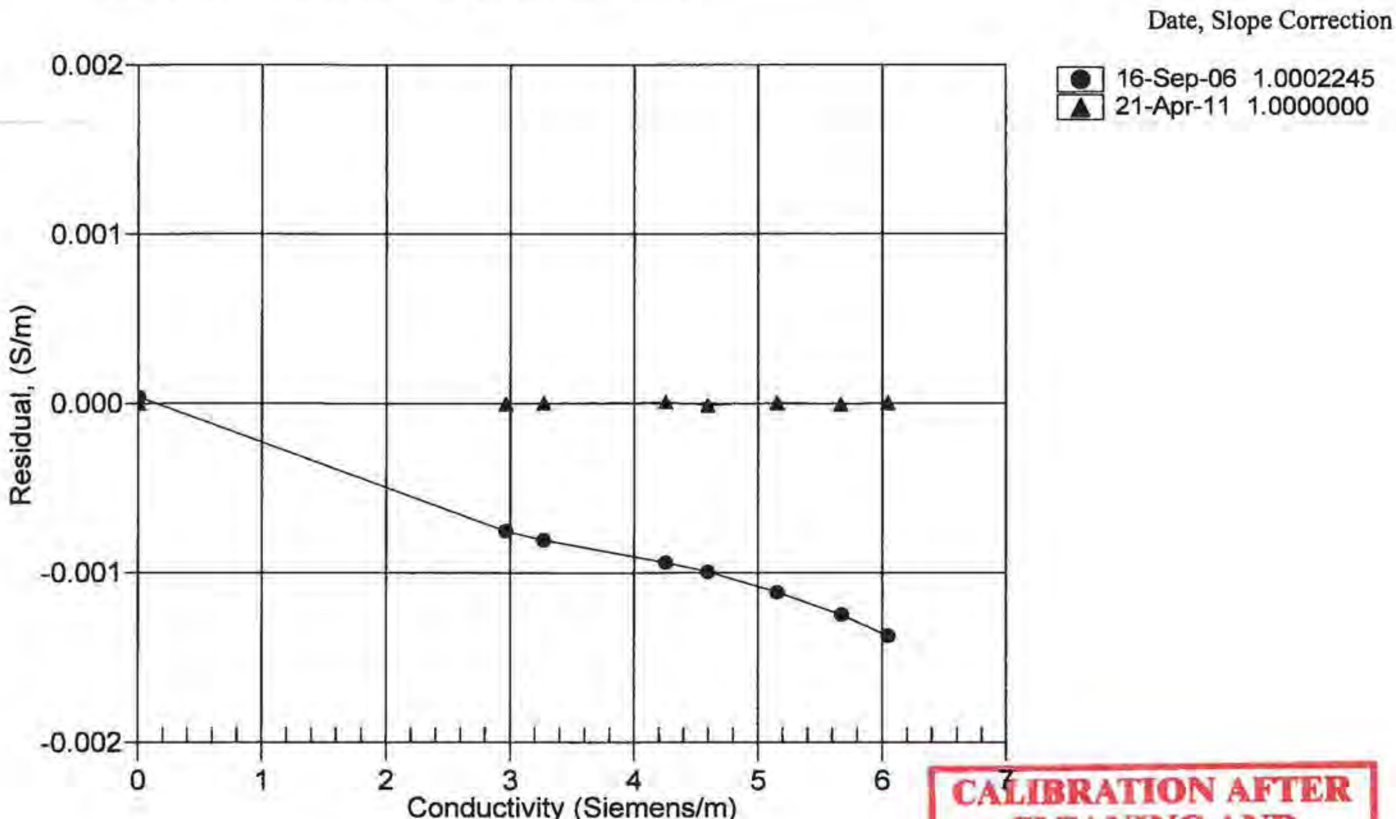
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (Hz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2790.35	0.00000	0.00000
1.0000	34.6758	2.96510	5569.15	2.96509	-0.00000
4.5000	34.6552	3.27102	5779.81	3.27102	0.00000
14.9999	34.6115	4.24913	6406.34	4.24914	0.00001
18.5000	34.6016	4.59295	6612.23	4.59294	-0.00001
24.0000	34.5899	5.14866	6931.84	5.14866	0.00000
29.0000	34.5806	5.66804	7217.47	5.66804	-0.00001
32.5000	34.5732	6.03837	7414.26	6.03838	0.00000

f = INST FREQ * sqrt(1.0 + WBOTC * t) / 1000.0

Conductivity = $(g + hf^2 + if^3 + jf^4) / (1 + \delta t + \varepsilon p)$ Siemens/meter

t = temperature[°C)]; p = pressure[decibars]; δ = CTcor; ε = CPcor;

Residual = instrument conductivity - bath conductivity



CALIBRATION AFTER CLEANING AND REPLATINIZING CELL

SEA-BIRD ELECTRONICS, INC.

13431 NE 20th Street, Bellevue, Washington, 98005-2010 USA

Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0055
CALIBRATION DATE: 11-Apr-11

WEBB GLIDER PRESSURE CALIBRATION DATA
508 psia S/N 8731

COEFFICIENTS:

PA0 =	-4.923020e-002	PTCA0 =	-6.138614e+002
PA1 =	2.347635e-002	PTCA1 =	-3.687158e-003
PA2 =	2.022392e-009	PTCA2 =	-3.964818e-003
PTHA0 =	-7.057100e+001	PTCB0 =	2.495538e+001
PTHA1 =	5.142905e-002	PTCB1 =	-1.250000e-004
PTHA2 =	-2.077328e-007	PTCB2 =	0.000000e+000

PRESSURE SPAN CALIBRATION

PRESSURE PSIA	INST OUTPUT	THERMISTOR OUTPUT	COMPUTED PRESSURE	ERROR %FSR
14.72	13.8	1824.0	14.74	0.00
104.97	3853.3	1824.0	104.92	-0.01
204.96	8108.1	1824.0	204.94	-0.00
304.98	12359.5	1926.0	304.97	-0.00
404.97	16608.7	1823.0	404.97	0.00
504.98	20852.8	1826.0	504.95	-0.01
404.95	16609.4	1824.0	404.99	0.01
304.94	12361.3	1822.0	304.98	0.01
204.96	8109.3	1822.0	204.96	0.00
104.97	3854.7	1824.0	104.96	-0.00
14.72	13.6	1825.0	14.73	0.00

THERMAL CORRECTION

TEMP ITS90	PRESS TEMP	INST OUTPUT
32.50	2020.60	26.99
29.00	1951.90	27.80
24.00	1852.20	28.83
18.50	1743.40	29.53
15.00	1676.30	30.62
4.50	1468.30	31.16
1.00	1399.50	31.19

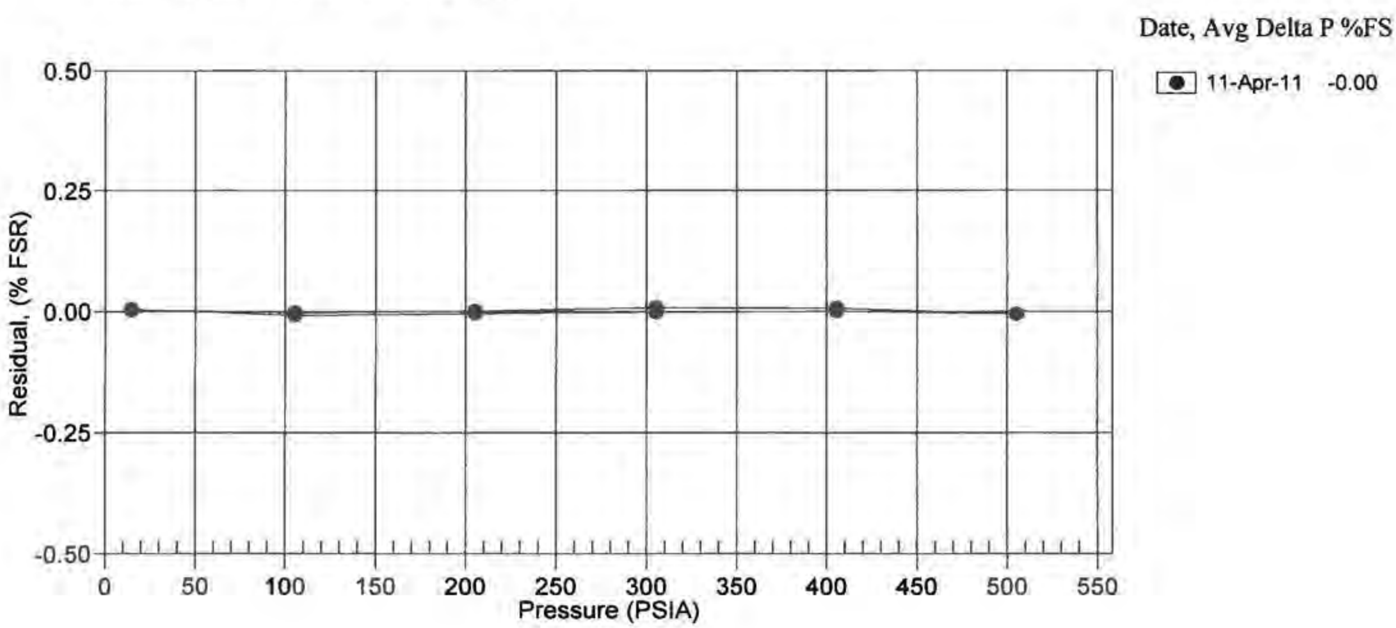
TEMP(ITS90)	SPAN(mV)
-5.00	24.96
35.00	24.95

y = thermistor output; t = PTEMPA0 + PTEMPA1 * y + PTEMPA2 * y^2

x = pressure output - PTCA0 - PTCA1 * t - PTCA2 * t^2

n = x * PTCB0 / (PTCB0 + PTCB1 * t + PTCB2 * t^2)

pressure (psia) = PA0 + PA1 * n + PA2 * n^2



Appendix C

Deployment 2
10/6/2011 – 10/27/2011

RUTGERS UNIVERSITY

COASTAL OCEAN
OBSERVATION
LAB
OPERATIONS CENTER

GLIDER RU07

MISSION EPA - DEP 2

DATE

10/6/ - 10/27/2011

GLIDER DENSITY (in target water)

1019.60	kg/m^3

LOCATION

Coastal NJ - EPA/DEP	kg/m^3

RU COOL GLIDER BALLAST RECORD

O:\coolgroup\Gliders\Glider Ballasting\ru07\2011_09_28 ru07 NJDEP.xls

final w/ heavy wings

1019.6

			MASS (g)	
Deployment	GLIDER	FORE STEM	14503.9	
		FORE HULL		
		AFT STEM (red plug, card)	6733.9	
Glider		AFT HULL	12209	
		COWLING	1151.5	
		SCREWS (vacuum,cowling,aft battery)		
Date	PAYLOAD	PAYLOAD BAY (no rails!)	7514.3	
		WINGS	496	
		WING RAILS (screws)		
Preparer		PICK POINT		
	BATTERIES	AFT BATTERY		
		PITCH BATTERY	9405	
		FORE BATTERY 1 (starboard)		
Air Temperature		FORE BATTERY 2 (port)		
20	WEIGHT BOTTLES	AFT BOTTLE	-113	tossed in there for final dunk to get vol right for ballast section
		FORE BOTTLE 1 (starboard)		
		FORE BOTTLE 2 (port)		

Tank Specifics		Glider Specifics		H MOMENT (rad)		(deg)
Tank Density (g/mL)	1.0155	Glider Volume (mL)	50926.429	Angle of Rotation (before)	-0.05	-2.9
Tank Temperature (C)	21.21	Total Mass (g)	51900.6	Angle of Rotation (after)	-0.29	-16.6
Weight in Tank (g)	180.00	Glider Density 1 (air) (g/mL)	1.0191	Angle of Rotation	0.24	13.8
Target Specifics		**Volume Change (temperature induced)**		Weight on Spring (after)	538	
Target Density (g/mL)	1.0190	Volume Change (tank) (mL)	4	Weight added	290	
Target Temperature ©	15.00	Volume Change (target) (mL)	-22	Radius of Hull	107	
				H-distance	**7.1**	

Should Hang (in tank) (g)	151.30	**Adjust Glider Mass (Dunk Volume) (g)**	-28.70	volume 1:	50926.43
Adjust by: (g)	-28.70	**Adjust Glider Mass (entered volume) (g)**	-29.13	volume 2:	

^ Ballasting Alternative (known VOLUME)

Calculated Glider Volume (calculated from scales) (mL)	**50926.853**	average =	50926.43	
Glider Density 2 (in target water, using calculated volume above) (kg / m³)	**1019.6**	PICK POINT MASSES	107 g air / 66 g Water	
Glider Density 3 (in target water, using entered volume) (kg / m³)	**1019.6**	PICK POINT VOLUME	40.4 mL	Ballast Sheet
Glider Density 4 (in target water, using entered volume) (kg / m³)	**1019.56**	G1 Volume	50.9 L	

Ballast Pump Size

		Glider Reported pump_volume	Resultant Volume (in air/tank)
Full Retract Scale Weight	376	-207	50733.861
Full Extend Scale Weight	-16	209	51119.8451
	432		50683.0133
Original Volume	50926.429		

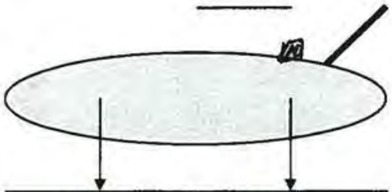
C-4

		% Matched	Max Density Range	
Pump Size	385.984045	107.8%	3.87	+- sigma
Pump Size (retracted)	-193.41607	96.5%	1023.45	Max Density (in target)
Pump Size (extended)	192.567979	4.5%	1015.72	Min Density (in target)

DISCLAIMER = make sure all values are correct, and accurate, dependencies are exact dunk weights, tank density and temperature, as well as units

BALLAST ITERATIONS **GLIDER:** ______ **DATE:** ______

ITERATION ______



186	36

BALLAST

FORE 1	
FORE 2	100.3g
AFT	~~[illegible]~~ 86g

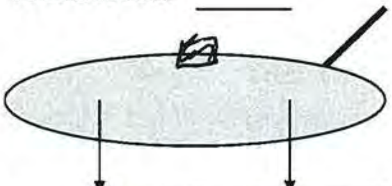
NOTES

16672 wont -141 w/ heavy wings
-100 potential to add 100.g to aft
-20 -20
-20 -120
-140

▨ = 42g
roll = ~~440~~ -1010

TANK: T= 21.210 **TANK:**
(SB19) C=3.401 (Glider)
D=1015.50

ITERATION ______



226	98

BALLAST

FORE 1	
FORE 2	
AFT	

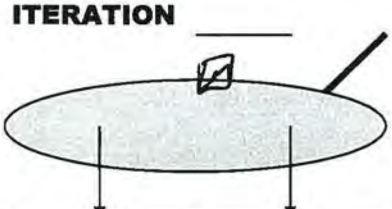
NOTES

steel nuts: 40g, 70g
lead sheets 25, 50g

▨ = 340g
pump = 209 cc

TANK: **TANK:**
(SB19) (Glider)

ITERATION ______



626	90

BALLAST

FORE 1	
FORE 2	
AFT	

NOTES

▨ = 340g
pump = -207 cc

map = ±213

TANK: **TANK:**
(SB19) (Glider)

206.3

10/4/2011

RUOT NJDEP #3 ballast

SH NYHOPS : 1014.35
19°C

↓

Tuckerton 1019.0
19°C

·1017 3 → 4.5 σ

~ 1020 – 1021.5

BALLAST ITERATIONS **GLIDER:** ____ **DATE:** ____

ITERATION ____

BALLAST

FORE 1	
FORE 2	
AFT	

NOTES ~~remove 8g~~ add 22g

116 62
+200
+54
116 116
+254 want +22 ⇒ −232
−116 −116
−116 +138 lets make it tail light
~~+56 −56~~
$\boxed{\cancel{+66} \; \cancel{+88}}$

TANK: ____ **TANK:** ____
(SB19) ____ (Glider) ____

ITERATION ____

BALLAST

FORE 1	~~142~~.5
FORE 2	
AFT	

NOTES −116 +138
+25 −25
−91 113 ⇒ +23

TANK: ____ **TANK:** ____
(SB19) ____ (Glider) ____

ITERATION 3

166	72

BALLAST

FORE 1	98.0g
FORE 2	119.8g
AFT	NC

NOTES weighted dunk
H:
roll w/ weight = −.29
roll = −.05
weight = 290g
scale = 538 g

TANK: T= 20.961 **TANK:** ____
(SB19) C=3.409 (Glider) ____
D=1015.72

2nd SB dunk
T= 20.975
C=3.370
D=1015.48

SB Glider
T= 20.962
C= 3.374
D=

O:\coolgroup\Gliders\Glider Ballasting\ru07\2011_09_28 ru07 NJDEP.xls

			MASS (g)	COMMENTS
Deployment	GLIDER	FORE STEM	14503.9	
		FORE HULL		
		AFT STEM (red plug, card)	6733.9	
Glider		AFT HULL	12209	
		COWLING	1151.5	
		SCREWS (vacuum,cowling,aft battery)		
Date	PAYLOAD	PAYLOAD BAY (no rails!)	7514.3	
		WINGS	438.7	
		WING RAILS (screws)		
Preparer		PICK POINT		
	BATTERIES	AFT BATTERY		
		PITCH BATTERY	9405	
		FORE BATTERY 1 (starboard)		
Air Temperature		FORE BATTERY 2 (port)		
20	WEIGHT BOTTLES	AFT BOTTLE		
3		FORE BOTTLE 1 (starboard)		
		FORE BOTTLE 2 (port)		

C-8

Tank Specifics		Glider Specifics		H MOMENT (rad)		(deg)
Tank Density (g/mL)	1.0155	Glider Volume (mL)	50926.429	Angle of Rotation (before)		0.0
Tank Temperature (C)	20.98	Total Mass (g)	51956.3	Angle of Rotation (after)		0.0
Weight in Tank (g)	238.00	Glider Density 1 (air) (g/mL)	1.0202	Angle of Rotation	0	0.0
Target Specifics		**Volume Change (temperature induced)**		Weight on Spring (after)		
Target Density (g/mL)	1.0205	Volume Change (tank) (mL)	3	Weight added		
Target Temperature ©	15.00	Volume Change (target) (mL)	-21	Radius of Hull	107	
				H-distance	**#DIV/0!**	

Should Hang (in tank) (g)	230.38	**Adjust Glider Mass (Dunk Volume) (g)**	-7.62	volume 1:	50926.43
Adjust by: (g)	-7.62	**Adjust Glider Mass (entered volume) (g)**	-7.62	volume 2:	

^ Ballasting Alternative (known VOLUME)

Calculated Glider Volume (calculated from scales) (mL)	**50926.429**	average =	50926.43
Glider Density 2 (in target water, using calculated volume above) (kg / m³)	**1020.6**	PICK POINT MASSES	107 g air / 66 g Water
Glider Density 3 (in target water, using entered volume) (kg / m³)	**1020.6**	PICK POINT VOLUME	40.4 mL
Glider Density 4 (in target water, using entered volume) (kg / m³)	**1020.65**	G1 Volume	50.9 L

Ballast Sheet

O:\coolgroup\Gliders\Glider Ballasting\ru07\2011_09_28 ru07 NJDEP.xls

			MASS (g)	COMMENTS
Deployment	GLIDER	FORE STEM	14503.9	
		FORE HULL	—	
		AFT STEM (red plug, card)	6733.9	+ bottle
Glider		AFT HULL	12209.0	
		COWLING	1151.5	
		SCREWS (vacuum,cowling,aft battery)		
Date	PAYLOAD	PAYLOAD BAY (no rails!)	7514.3	
		WINGS	438.7	
		WING RAILS (screws)	—	
Preparer		PICK POINT	—	
	BATTERIES	AFT BATTERY	—	
		PITCH BATTERY	9405.0	
		FORE BATTERY 1 (starboard)	—	
Air Temperature		FORE BATTERY 2 (port)	—	
20	WEIGHT BOTTLES	AFT BOTTLE	—	
		FORE BOTTLE 1 (starboard)	—	
		FORE BOTTLE 2 (port)	—	

Tank Specifics		**Glider Specifics**		**H MOMENT (rad)**		**(deg)**
Tank Density (g/mL)	1.0200	Glider Volume (mL)	50900	Angle of Rotation (before)		0.0
Tank Temperature (C)	21.64	Total Mass (g)	0	Angle of Rotation (after)		0.0
Weight in Tank (g)	-22.00	Glider Density 1 (air) (g/mL)	0.0000	Angle of Rotation	0	0.0
Target Specifics		**Volume Change (temperature induced)**		Weight on Spring (after)		
Target Density (g/mL)	1.0205	Volume Change (tank) (mL)	6	Weight added		
Target Temperature ©	15.00	Volume Change (target) (mL)	-24	Radius of Hull	107	
				H-distance	**#DIV/0!**	

Should Hang (in tank) (g)	-4.62	**Adjust Glider Mass (Dunk Volume) (g)**	-2.12	volume 1:
Adjust by: (g)	17.38	**Adjust Glider Mass (entered volume) (g)**	51919.32	volume 2:

^ Ballasting Alternative (known VOLUME)

Calculated Glider Volume (calculated from scales) (mL)	**21.566**	average =	#DIV/0!
Glider Density 2 (in target water, using calculated volume above) (kg / m³)	**0.0**	PICK POINT MASSES	107 g air / 66 g Water
Glider Density 3 (in target water, using entered volume) (kg / m³)	**0.0**	PICK POINT VOLUME	40.4 mL
Glider Density 4 (in target water, using entered volume) (kg / m³)	**1020.16**	G1 Volume	50.9 L

Ballast Sheet

C-10

Ballast Pump Size

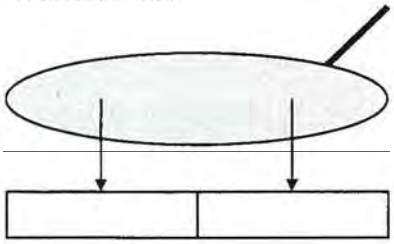
		Glider Reported pump_volume	Resultant Volume (in air/tank)
Full Retract Scale Weight			0
Full Extend Scale Weight			0
	432		-423.52941
Original Volume	50900		

		% Matched	Max Density Range	
Pump Size	0	#DIV/0!	0.00	+- sigma
Pump Size (retracted)	50900	#DIV/0!	0.00	Max Density (in target)
Pump Size (extended)	50900	#DIV/0!	0.00	Min Density (in target)

DISCLAIMER = make sure all values are correct, and accurate, dependencies are exact dunk weights, tank density and temperature, as well as units

BALLAST ITERATIONS **GLIDER:** RU07 SB 101 **DATE:**

ITERATION



BALLAST

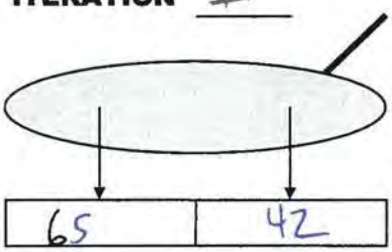
FORE 1	
FORE 2	
AFT	

NOTES

TANK: (SB19) C=4.1945 T=21.324

TANK: (Glider) C=4.195 T=21.320

ITERATION 1



BALLAST

FORE 1	
FORE 2	
AFT	

NOTES
FBBan = 112g
A BanB = 338g

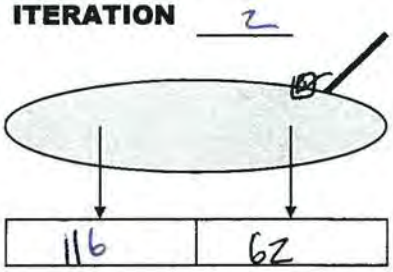
SBWB Top = 964g

AftBattW= 412g
ABB = 0g

TANK: C=4.233 (SB19) T=21.636 D=1020.00

TANK: (Glider)

ITERATION 2



BALLAST

FORE 1	142.5
FORE 2	164.4
AFT	

NOTES
SS says add 1688.9g
added 1826g => only add 137.1 less

Ⓐ = 200g

TANK: (SB19)

TANK: (Glider)

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		Component	MASS (g)	COMMENTS
Deployment	GLIDER	FORE STEM	8196.4	
		FORE HULL	4639.2	
		AFT STEM (red plug, card)	65286	
Glider		AFT HULL	4257.2	
		COWLING	1151.7	
		SCREWS (vacuum,cowling,aft battery)		
Date	PAYLOAD	PAYLOAD BAY (~~no rails!~~)	60390.1	6040
		WINGS	438	
		WING RAILS (screws)		
Preparer		PICK POINT		
	BATTERIES	AFT BATTERY	7624.5	
		PITCH BATTERY	9406.8	
		FORE BATTERY 1 (starboard)		
Air Temperature 20		FORE BATTERY 2 (port)	14527.6.8	
	WEIGHT BOTTLES	AFT BOTTLE	2000	
		FORE BOTTLE 1 (starboard)	142.4	
		FORE BOTTLE 2 (port)	164.33	

C-12

Tank Specifics		Glider Specifics		H MOMENT (rad)		(deg)
Tank Density (g/mL)		Glider Volume (mL)	50900	Angle of Rotation (before)		0.0
Tank Temperature (C)		Total Mass (g)	0	Angle of Rotation (after)		0.0
Weight in Tank (g)		Glider Density 1 (air) (g/mL)	0.0000	Angle of Rotation	0	0.0
Target Specifics		**Volume Change (temperature induced)**		Weight on Spring (after)		
Target Density (g/mL)		Volume Change (tank) (mL)	-71	Weight added		
Target Temperature ©		Volume Change (target) (mL)	0	Radius of Hull	107	
				H-distance	**#DIV/0!**	

Should Hang (in tank) (g)	0.00	**Adjust Glider Mass (Dunk Volume) (g)**	#DIV/0!	volume 1:	
Adjust by: (g)	0.00	**Adjust Glider Mass (entered volume) (g)**	0.00	volume 2:	

^ Ballasting Alternative (known VOLUME)

Calculated Glider Volume (calculated from scales) (mL)	**#DIV/0!**	average =	#DIV/0!
Glider Density 2 (in target water, using calculated volume above) (kg / m³)	**#DIV/0!**	PICK POINT MASSES	107 g air / 66 g Water
Glider Density 3 (in target water, using entered volume) (kg / m³)	**0.0**	PICK POINT VOLUME	40.4 mL
Glider Density 4 (in target water, using entered volume) (kg / m³)	**0.00**	G1 Volume	50.9 L

Ballast Sheet

Pre-Deployment Check Out

GLIDER	RU07
PREPARER	Dave A.
PREP DATE	10/3/11
LOCATION	NJ DEP

PRE-SEAL

FORE CHECK

Check pump threaded rod (grease) ✓
Check pitch battery threaded rod (grease) ✓
Leak detect in place, batteries secure, white guides free, no metal shavings, bottles installed, grounded? ✓

PAYLOAD CHECK

Science Bay Instrument Serial Numbers

1 CTD 0101
2 BBFL2 600
3 OPTODE 1504
4
5

CTD cable clear, no leak at CTD joint, no leak at pucks Grounded? ✓

Science Bay Weight Configuration

—

AFT CHECK

Iridium Card Installed (SIM #)

1 —

Flash card old files removed?

Inspect strain on connectors (damaged connectors as well), Persistor power supply cable secure, battery secured, ballast bottle in place, aft cap clear of leak, grounded? ✓

Battery check (using load?)

1. Attach aft battery pack, verify voltage at J13 15.9
2. Disconnect aft battery
3. Screw in aft connector
4. Connect pitch battery, verify voltage at J13 15.94
5. Disconnect pitch battery
6. Screw in fore connector, verify voltage at J13 15.91
7. Attach pitch battery
8. Attach aft battery
9. Verify voltage at J31 (simple probe) 15.97

POST-SEAL

GENERAL

Pick Point Present? N
Special Instruments Present? N

HARDWARE

Nose Cone and pump bladder inspection ✓

put c_alt_time 0, verify alt chirping
Corrosion Prevention & Anode Check
Anode Style/Weight: New
Glider Parts Grounded (stickers)
Ejection weight assembly OK and unseized?
Pressure Sensor Check (corrosion, clear)
Aft sensor
Payload sensor

POWERED

Verify Argos ping
Wiggle for 5 minutes
Record m_battery once stabilized: 15.43
Record m_vacuum @ temperature @ ballast: 6.35@20.5

OUTSIDE

Record compass reading: 212.3@202, 274.6@285°
GPS check? (40 28.75, 74 26.25)
Iridium connect
zero_ocean_pressure, get m_pressure
let air bladder inflate, does it shut off?

SOFTWARE

GENERAL

Version: 7.6
Date ok, delete old logs
Re-burn latest software image
mdblist.dat, mi, ma, science!

\CONFIG

simul.sim deleted
if ver < 7.0 configure sbdlist.dat

\MAFILES

goto_l10.ma (set x_last_...)

AUTOEXEC.MI

Phone Number
Main is RUDIC, alt is TWR
u_iridium_failover_retries = 10
c_ctd41cp_num_fields_to_send 4
Calibration coefficients

In Gliderdos, reset glider to test settings
get f_max_working_depth (102 m)
f_ballast_pumped_deadz_width = 30?

CACHE MANAGEMENT (DONE ON DOCKSERVER!)
(this step is very important!)

del ..\state\cache*.*
after *bdlist.dat are set (exit reset):
logging on; logging off
send ..\state\cache*.cac
send *.mbd *.sbd *.tbd

*** Software Burning Tips :** if using Procomm or local folder, copy all the files from the software image locally. Then proceed to edit them for the glider and do a mass freewave transfer of the files. Save these files or prepare the to-glider with these f

Pre-Deployment Check Out
For
Aanderaa Oxygen Optode

RUTGERS
Coastal Ocean
Observation Lab

Slocum Glider Aanderaa Optode Check IN/OUT
2 Point Calibration & Calibration Coeffcient Record

OPTODE MODEL, SN: 1504 on ru28/ru07 **IN / OUT** IN/OUT

Calibration Record
CALIBRATION DATE: 9/6/2011

PERFORMED BY: Chip Haldeman, Rachel Plunkett

Previous:

C0Coef				
C1Coef				
C2Coef				
C3Coef				
C4Coef				

Current:

C0Coef	4.5E+03	-1.6E+02	3.3E+00	-2.8E-02
C1Coef	-2.5E+02	8.0E+00	-1.6E-01	1.3E-03
C2Coef	5.7E+00	-1.6E-01	3.1E-03	-2.5E-05
C3Coef	-6.0E-02	1.5E-03	-2.8E-05	2.2E-07
C4Coef	2.4E-04	-5.3E-06	1.0E-07	-7.1E-10

Delta: -4141.0

2 point Calibration

	0% Point	*100% Point*
Solution: (Na_2SO_3)	15.0 g	0
Cross reference	PasPort Device	PasPort Device
Temperature	24.5	10.22
Air Pressure (hPa)	1011.06	1012.41
Winkler Label	Sample A	Sample B
Winkler Source	LaMotte 7414 - Azide mod	LaMotte 7414 - Azide mod
Results: **OPTODE:** Dphase	71.19	34.2
% Saturation	0.07	94.61
Temperature	24.5	9.83
Conc (calculated) (µM)	0.2	334.55
% Saturation (calculated)	0.08	95.46
WINKLER: Concentration (µM)	0.2	326.56
(Titrations) (ppm)	(0, 0, 0) (< 2 µM)	(10.4, 10.4, 10.4)
% Saturation	0.018 (worst case @ 2 µM)	94.3
DELTAS: Conc Δ	0	7.99
% Δ	0.062	1.16
Temp Δ	0	0.39
Temp avg	24.5	10.025

In-Air Saturation Check

SATURATION: 96.3 **@ TEMP** 24.44 **@ PRESS** 995.15

Sodium Thiosulate Normalization

Normalization (mL) 1.99 (2.0 ± .1) (EPA Compliance)

Paste config report all from optode

Protect	5014	1504	0			
PhaseCoef	5014	1504	-3.33906	1.13833	0	0
TempCoef	5014	1504	23.7279	-0.0306	2.83E-06	-4.2E-09
FoilNo	5014	1504	5009			
C0Coef	5014	1504	4537.931	-162.595	3.29574	-0.02793
C1Coef	5014	1504	-250.953	8.02322	-0.1584	0.001311
C2Coef	5014	1504	5.664169	-0.15965	0.003079	-2.5E-05
C3Coef	5014	1504	-0.05994	0.001483	-2.8E-05	2.15E-07
C4Coef	5014	1504	0.000244	-5.3E-06	1E-07	-7.1E-10
Salinity	5014	1504	0			
CalAirPhas	5014	1504	32.38397			
CalAirTemp	5014	1504	9.906067			
CalAirPress	5014	1504	1004.483			
CalZeroPha	5014	1504	66.21377			
CalZeroTen	5014	1504	20.49095			
Interval	5014	1504	4			
AnCoef	5014	1504	0	1		
Output	5014	1504	1			
SR10Delay	5014	1504	-1			
SoftwareVe	5014	1504	3			
SoftwareBu	5014	1504	24			

Deployment Checklist

Glider RU07 Date 10/6/11

Pilots Dave A. Where Sandy Hook

Laptop Glider Mini Vehicle Powerup: **CTRL ^ C (until you get to prompt)!!!**

On boat (Remember after 10 min glider will go into mission, as well as on powerup!)	Battery Voltage	15.3	get m_battery
	Vacuum Pressure	6.8	get m_vacuum, should be > 7 for bladder inflation
	Iridium Connection	✓	look for connect dialog & surface dialog, let it dial at prompt
	boot app	✓	boot app
	boot (should report application)	✓	reports boot application
	run status.mi	✓	mission completed normally? (this can be run the night before or at dock)
In Water	zero_ocean_pressure	✓	while glider in water
	run odctd.mi (with or without float, ask RU)	✓	glider should dive and surface, type why? Should say overdepth, if not call (would say don't need float for ru06, ru07 use it the first deployment) (can skip this if you want for multiple deployments)
	send *.dbd *.mlg *.sbd	✓	"send *.sbd" is most important (this applies moreso to when handoffed to iridium)
	run 100_tn.mi	✓	sequence 100_tn.mi(5)
	Verify dive; **disconnect freewave** Report to Rutgers		
	Perform CTD Comparison CAST	✓	typically done with RU provided SB19 or Cast Away CTD
	LAT: 40 20.559 **LON** 73 51.949		

glider deployed w/ light wings + lead estimated density 1019.0

C-20

Recovery Checklist

Glider RU07

Date 10/27/2011

Pilots Chip

Where Off Atlantic City

Laptop Chip

Recovery	get Lat/Lon from email or shore support	X
	obtain freewave comms obtain lat/lon with where command	n/a
	Perform CTD Comparison CAST	x
	LAT: 39 20.990 LON: 74 15.115	
	(note instrument type!)	Castaway

Post-Deployment Checklist

RUTGERS
Coastal Ocean Observation Lab

Slocum Glider Check-IN

DATE: 10/28/11

GLIDER: RU07 **SB:** 101

Power on vehicle in order to fully retract pump, and/or to deflate air bladder.

Checkin batt volts
aft 12.8
pitch 12.6
fore 12.6 + 12.0

Vehicle Cleaning (hose down with pressure)

Nose cone

1. ~~1.~~ Remove nose cone
2. ~~2.~~ Loosen altimeter screws, and remove altimeter or leave temporarily attached
3. ~~3.~~ Retract pump
4. ~~4.~~ Remove altimeter and hose diaphragm removing all sand, sediment, bio oils
5. ~~5.~~ Clean nose cone and altimeter

Tail cone

1. ~~1.~~ Remove tail cone
2. ~~2.~~ Hose and clean anode and air bladder making sure air bladder is completely clean
3. ~~3.~~ Clean cowling

Wing rails

1. Remove wing rails and hose down

Tail plug cleaning

1. Dip red plug in alcohol and clean plug if especially dirty
2. Re-dip red plug and repeatedly insert and remove to clean the glider plug
3. Compress air glider female connector
4. Lightly silicon red plug and replace in glider once silicon has been dispersed evenly in the plugs.

CTD Comparison Check

1. Inspect CTD sensor for any sediment buildup, take pictures of anything suspicious or make note.

Static Tank Test

SB19		*Glider (SB41CP or pumped unit)*	
Temperature:	23.024 °C	Temperature:	23.026
Conductivity:	3.614	Conductivity:	3.614

CTD Maintenance (reference SeaBird Application Note 2D)

1. Perform CTD backward/forward flush with 1% Triton X-100 solution
2. Perform CTD backward/forward flush with 500 – 1000 ppm bleach solution
3. Perform the same on a pumped unit, just different approach
4. Repeat comparison test if results not within T < .01 C, C < .005 S/m

Static Tank Test

SB19		*Glider (SB41CP or pumped unit)*	
Temperature:		Temperature:	
Conductivity:		Conductivity:	

RUTGERS Coastal Ocean Observation Lab

Slocum Glider Aanderaa Optode Check IN/OUT
2 Point Calibration & Calibration Coeffcient Record

OPTODE MODEL, SN: 1504 on ru07 NJDEP # 3 **IN / OUT** IN

Calibration Record **PERFORMED BY:** David Aragon

CALIBRATION DATE: 11/14/2011

Previous:

C0Coef				
C1Coef				
C2Coef				
C3Coef				
C4Coef				

Current:

C0Coef	4.5E+03	-1.6E+02	3.3E+00	-2.8E-02
C1Coef	-2.5E+02	8.0E+00	-1.6E-01	1.3E-03
C2Coef	5.7E+00	-1.6E-01	3.1E-03	-2.5E-05
C3Coef	-6.0E-02	1.5E-03	-2.8E-05	2.2E-07
C4Coef	2.4E-04	-5.3E-06	1.0E-07	-7.1E-10

Delta: -4141.0

2 point Calibration

	0% Point		*100% Point*
Solution:	10.0 g	Na_2SO_3	NA
Cross reference	PasPort Device		PasPort Device
Temperature	23.08		9.68
Air Pressure (hPa)	1002.709684		1002.709684
Winkler Label	(unlabeled)		Sample C
Winkler Source	LaMotte 7414 - Azide mod		LaMotte 7414 - Azide mod
Results: OPTODE: Dphase	70.9		34.68
% Saturation	0.17		91.76
Temperature	21.11		9.68
Conc (calculated) (µM)	0.6		325.91
% Saturation (calculated)	0.22		92.7
WINKLER: Concentration (µM)	2		325
(Titrations) (ppm)	(0, 0, 0) (< 2 µM)		(10.4, 10.4, 10.4)
% Saturation	0.57 (worst case @ 2 µM)		92.44
DELTAS: Conc Δ	-1.4		0.91
% Δ	-0.35		0.26
Temp Δ	1.97		0
Temp avg	22.095		9.68

In-Air Saturation Check

SATURATION: 91.15 **@ TEMP** 20.04 **@ PRESS** 1002.371

Sodium Thiosulate Normalization

Normalization (mL) 1.99 (2.0 ± .1) (EPA Compliance)

Paste config report all from optode

Protect	5014	1504	0			
PhaseCoef	5014	1504	-3.33906	1.13833	0	0
TempCoef	5014	1504	23.7279	-0.0306	2.83E-06	-4.2E-09
FoilNo	5014	1504	5009			
C0Coef	5014	1504	4537.931	-162.595	3.29574	-0.02793
C1Coef	5014	1504	-250.953	8.02322	-0.1584	0.001311
C2Coef	5014	1504	5.664169	-0.15965	0.003079	-2.5E-05
C3Coef	5014	1504	-0.05994	0.001483	-2.8E-05	2.15E-07
C4Coef	5014	1504	0.000244	-5.3E-06	1E-07	-7.1E-10
Salinity	5014	1504	0			
CalAirPhas	5014	1504	32.38397			
CalAirTem|	5014	1504	9.906067			
CalAirPres:	5014	1504	1004.483			
CalZeroPh:	5014	1504	66.21377			
CalZeroTer	5014	1504	20.49095			
Interval	5014	1504	4			
AnCoef	5014	1504	0	1		
Output	5014	1504	1			
SR10Delay	5014	1504	-1			
SoftwareV	5014	1504	3			
SoftwareB	5014	1504	24			

2011/11/10 RU07 NT DEP #7
OPTODE 1504 0% test

~~NaSO~~
sodium sulfite = 10.0 g
9.0 L tap water

1.99 sod thio ✓

0% test start
$T_o = 22.78$
$T_p = 22.70$

add solution 9:24 GMT

$T_o = 23.11$
$T_p = 23.08$

$C = 0.40$ µM
$S = 0.17$ %
$D_p = 70.90$

2011/11/11 SN 1504
100% test

T_o = ~~9.82~~ 9.74
T_p = 9.74

sample taken @ 3:40 pm GMT
sal = ?

T_o = 9.68   O = 272.22 (check sal)
T_p = 9.58   S = 91.76   sal = ?
D_p = 34.68
sample C

Sample A
3:52pm GMT
T_o = 9.65   O = 326.27
T_p = 9.64   S = 91.91   sal = 0 ?
D_p = 34.68

air pressure = 29.61 in Hg

Sample C

~~Ap~~ → 36

D_p = 34.68, T = 9.68 ⇒ O_c = 325.91 μM

Sample C set room temp ~~for~~
7:45 to → 8:53

titration #1
~~#1~~ 1.0 + .04 = 1.04
⇒ 10.4
#2 1.0 + .04 = 1.04
⇒ 10.4
#3 1.0 + .04 ⇒ 10.4

SAmple A still particulate

11/14/2011
in air check: ref sensor
D = 31.96   AP = 29.60
T = 20.04
c = 258.18
% = 91.15

Manufacturer Calibration Documentation

Aanderaa Optode, Seabird 19 CTD, and YSI Castaway CTD

AANDERAA DATA INSTRUMENTS

TEST & SPECIFICATIONS

Form No. 712, Feb2006

Layout No: 1308E, 1299G
Circuit Diagram No:
Program Version: 3, Build: 22

Product: Oxygen Optode 5014W
Serial No: 1504

---

1. **Visual and Mechanical Checks:**
   - 1.1. O-ring surface
   - 1.2. Soldering quality
   - 1.3. Visual surface
   - 1.4. Pressure test (60MPa)
   - 1.5. Galvanic isolation between housing and electronics

2. Current Drain and Voltages:	
2.1. Average current drain at 0.5Hz sampling (Max: 38mA)	31 mA
2.2. Current drain in sleep (Max: 300µA)	250 µA
2.3. DSP voltage, IC5.1 (3.3 ±0.15V)	3.31 V
2.4. Excitation driver voltage, IC1.1 (3.3 ±0.15V)	3.30 V
2.5. Flash/RS232 driver voltage, IC7.4 (5 ±0.2V)	5.09 V
3. Receiver test:	
3.1. Average of Receiver readings (0 ±50mV)	-6 mV
3.2. Standard Deviation of Receiver readings (Max: 10mV)	2.56 mV
4. Performance Test in Air, 0°C Temperature:	
4.1. Amplitude measurement (Blue: 220 – 470mV)	362.42 mV
4.2. Phase measurement (Blue: 30 ±5)	34.0 °
4.3. Standard deviation of Phase measurement: (Max: 0.02°)	0.006 °
4.4. Temperature measurement: (700 ±300mV)	727.31 mV
5. Performance Test in Air, 20°C Temperature:	
5.1. Amplitude measurement (Blue: 290 – 470mV)	378.56 mV
5.2. Phase measurement (Blue: 25 ±5°)	28.6 °
5.3. Standard deviation of Phase measurement: (Max: 0.02°)	0.016 °
5.4. Temperature measurement: (100 ±300mV)	-174.34 mV
6. Performance Test in Air, 40°C Temperature:	
6.1. Amplitude measurement (Blue: 320 – 500mV)	365.66 mV
6.2. Phase measurement (Blue: 22 ±5°)	25.9 °
6.3. Standard deviation of Phase measurement: (Max: 0.02°)	0.003 °
6.4. Temperature measurement: (-500 ±300mV)	-510.77 mV

Date: 4 February 2011

Sign:

Vidar Selsvik

Vidar Selsvik, Production Engineer

CALIBRATION CERTIFICATE

AANDERAA DATA INSTRUMENTS

Form No. 710. Dec 2005

Sensing Foil Batch No: 5009
Certificate No:

Product: Oxygen Optode 5014W
Serial No: 1504
Calibration Date: 29 January 2011

This is to certify that this product has been calibrated using the following instruments:

Parameter: Internal Temperature:

Calibration points and readings:

Temperature (°C)	0.98	11.90	23.85	35.87
Reading (mV)	738.73	392.58	-3.97	-376.36

Giving these coefficients

Index	0	1	2	3
TempCoef	2.37279E01	-3.05951E-02	2.83023E-06	-4.19785E-09

Parameter: Oxygen:

	O2 Concentration	Air Saturation
Range:	0-500 μM [1]	0 - 120%
Accuracy[1]:	< ±8μM or ±5% (whichever is greater)	±5%
Resolution:	< 1 μM	< 0.4%
Settling Time (63%):	< 25 seconds	

Calibration points and readings[2]:

	Air Saturated Water	Zero Solution (Na_2SO_3)
Phase reading (°)	3.23840E+01	6.62138E+01
Temperature reading (°C)	9.90607E+00	2.04910E+01
Air Pressure (hPa)	1.00448E+03	

Giving these coefficients

Index	0	1	2	3
PhaseCoef	-3.33906E00	1.13833E00	0.00000E00	0.00000E00

[1] *Valid for 0 to 2000m (6562ft) depth, salinity 33 - 37ppt*

[2] *The calibration is performed in fresh water and the salinity setting is set to: 0*

Date: 31 January 2011

Sign:

Tor-Ove Kvalvaag

Tor-Ove Kvalvaag, Calibration Engineer

AANDERAA DATA INSTRUMENTS AS

5851 BERGEN, NORWAY Tel. +47 55 60 48 00 Fax. +47 55 60 48 01 E-mail: info@aadi.no Web: http://www.aadi.no

CALIBRATION CERTIFICATE

AANDERAA DATA INSTRUMENTS

Form No. 621, Dec 2005

Certificate No: 3853_5009_40331
Batch No: 5009

Product: O2 Sensing Foil PSt3 3853
Calibration Date: 2 June 2010

Calibration points and phase readings (degrees)

Temperature (°C)		3.97	10.93	20.15	29.32	38.39
Pressure (hPa)		977.00	977.00	977.00	977.00	977.00
O2 in % of O2+N2	0.00	73.18	72.63	71.62	70.72	69.77
	1.00	68.01	67.02	65.42	63.92	62.31
	2.00	64.39	63.16	61.20	59.44	57.57
	5.00	55.80	54.16	51.76	49.56	47.45
	10.00	46.27	44.47	41.97	39.75	37.69
	20.90	35.09	33.38	31.14	29.24	27.56
	30.00	29.85	28.30	26.31	24.64	23.19

Giving these coefficients [1)]

Index	0	1	2	3
C0 Coefficient	4.53793E+03	-1.62595E+02	3.29574E+00	-2.79285E-02
C1 Coefficient	-2.50953E+02	8.02322E+00	-1.58398E-01	1.31141E-03
C2 Coefficient	5.66417E+00	-1.59647E-01	3.07910E-03	-2.46265E-05
C3 Coefficient	-5.99449E-02	1.48326E-03	-2.82110E-05	2.15156E-07
C4 Coefficient	2.43614E-04	-5.26759E-06	1.00064E-07	-7.14320E-10

[1)] Ask for Form No 621S when this O2 Sensing Foil is used in Oxygen Sensor 3830 with Serial Numbers lower than 184.

Date: 2/24/2011

Sign:

Tor-Ove Kvalvaag

Tor-Ove Kvalvaag, Calibration Engineer

AANDERAA DATA INSTRUMENTS AS

5851 BERGEN, NORWAY Tel. +47 55 60 48 00 Fax. +47 55 60 48 01 E-mail: info@aadi.no Web: http://www.aadi.no

SBE **SEA-BIRD ELECTRONICS, INC.**
13431 NE 20th St. Bellevue, Washington 98005 USA
Phone: (425) 643-9866 Fax: (425) 643-9954 www.seabird.com

Service Report

RMA Number 63738

Customer Information:

Company	WEBB RESEARCH CORPORATION	**Date**	4/28/2011
Contact	Peter Collins		
PO Number	TWR4570		

Serial Number	WEBB Glider-0055
Model Number	WEBB Glider

Services Requested:

1. Evaluate/Repair Instrumentation.
2. Perform Routine Calibration Service.

Problems Found:

1. The conductivity cell was found to require cleaning and re-platinization.
2. Antifoulant devices were found to be dirty.

Services Performed:

1. Performed initial diagnostic evaluation.
2. Performed "Post Cruise" calibration of the temperature & conductivity sensors.
3. Cleaned and replatinized the conductivity cell.
4. Performed "Final" calibration of the temperature & conductivity sensors.
5. Calibrated the pressure sensor.
6. Installed NEW AF24173 Anti-foulant cylinder(s).
7. Performed complete system check and full diagnostic evaluation.

Special Notes:

SBE SEA-BIRD ELECTRONICS, INC.
13431 NE 20th St. Bellevue, Washington 98005 USA
Phone: (425) 643-9866 Fax: (425) 643-9954 www.seabird.com

Temperature Calibration Report

Customer:	WEBB RESEARCH CORPORATION		
Job Number:	63738	**Date of Report:**	4/21/2011
Model Number	WEBB Glider	**Serial Number:**	WEBB Glider-0055

Temperature sensors are normally calibrated 'as received', without adjustments, allowing a determination sensor drift. If the calibration identifies a problem, then a second calibration is performed after work is completed. The 'as received' calibration is not performed if the sensor is damaged or non-functional, or by customer request.

An 'as received' calibration certificate is provided, listing coefficients to convert sensor frequency to temperature. Users must choose whether the 'as received' calibration or the previous calibration better represents the sensor condition during deployment. In SEASOFT enter the chosen coefficients using the program SEACON. The coefficient 'offset' allows a small correction for drift between calibrations (consult the SEASOFT manual). Calibration coefficients obtained after a repair apply only to subsequent data.

'AS RECEIVED CALIBRATION' ☑ **Performed** ☐ **Not Performed**

Date: 4/12/2011 **Drift since last cal:** +0.00012 **Degrees Celsius/year**

Comments:

'FINAL CALIBRATION' ☑ **Performed** ☐ **Not Performed**

Date: 4/21/2011 **Drift since 16 Sep 06** +0.00049 **Degrees Celsius/year**

Comments:

SEA-BIRD ELECTRONICS, INC.
13431 NE 20th Street, Bellevue, Washington, 98005-2010 USA
Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0055
CALIBRATION DATE: 21-Apr-11

WEBB GLIDER TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

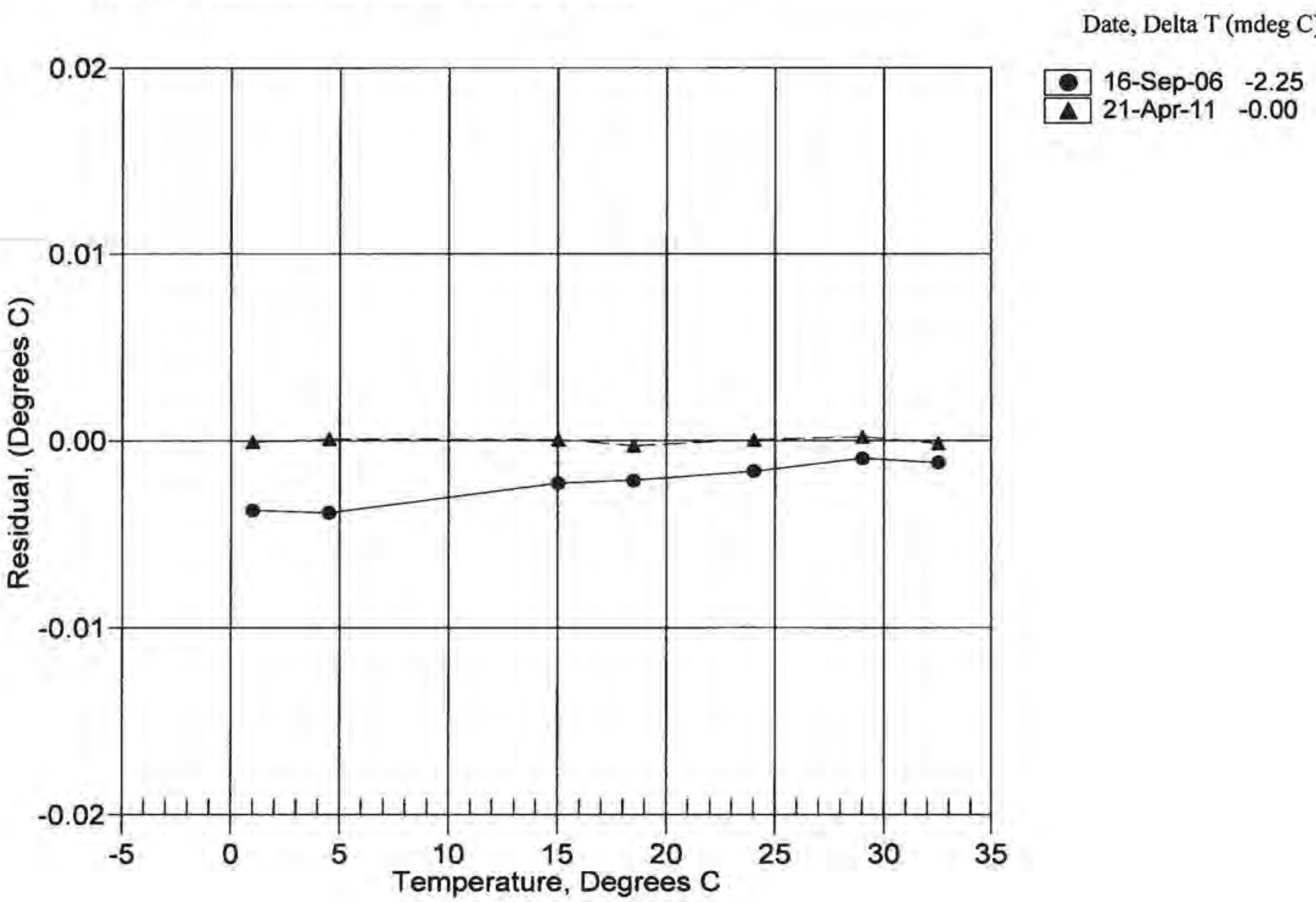
ITS-90 COEFFICIENTS

a0 = 3.207743e-005
a1 = 2.722827e-004
a2 = -2.066693e-006
a3 = 1.499035e-007

BATH TEMP (ITS-90)	INSTRUMENT OUTPUT	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	611669.0	0.9999	-0.0001
4.5000	523780.4	4.5001	0.0001
14.9999	335258.3	15.0000	0.0001
18.5000	290693.0	18.4997	-0.0003
24.0000	233673.5	24.0001	0.0001
29.0000	192748.1	29.0002	0.0002
32.5000	168994.5	32.4999	-0.0001

Temperature ITS-90 = $1/\{a0 + a1[ln(n)] + a2[ln^2(n)] + a3[ln^3(n)]\} - 273.15$ (°C)

Residual = instrument temperature - bath temperature



SEA-BIRD ELECTRONICS, INC.

13431 NE 20th Street, Bellevue, Washington, 98005-2010 USA

Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0055
CALIBRATION DATE: 12-Apr-11

WEBB GLIDER TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

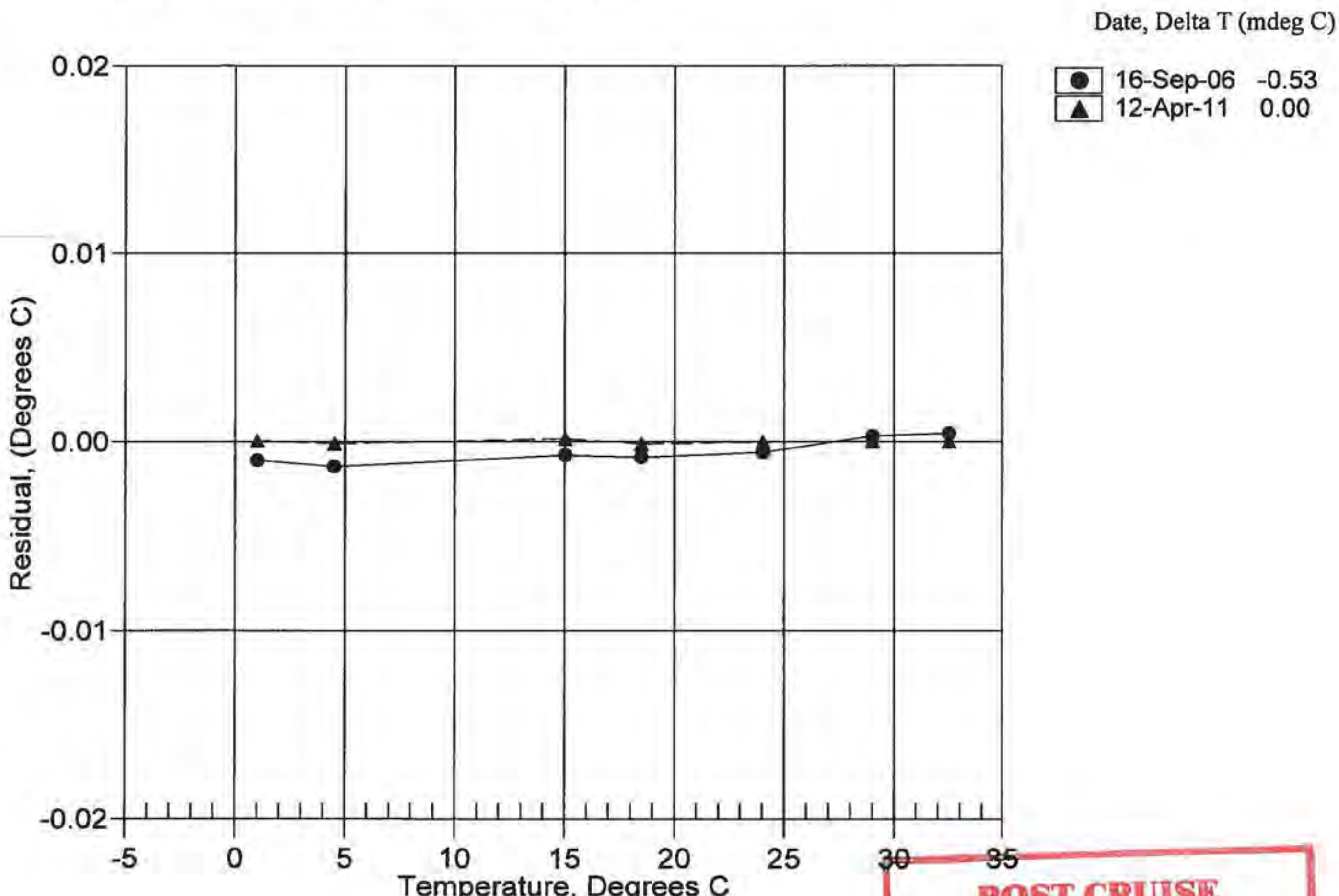
ITS-90 COEFFICIENTS

a0 = -3.406049e-005
a1 = 2.876925e-004
a2 = -3.261384e-006
a3 = 1.807112e-007

BATH TEMP (ITS-90)	INSTRUMENT OUTPUT	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	611741.0	1.0000	0.0000
4.5000	523843.0	4.4999	-0.0001
15.0000	335277.2	15.0002	0.0002
18.5000	290706.5	18.4999	-0.0001
24.0000	233684.1	24.0000	-0.0000
29.0000	192758.5	29.0000	0.0000
32.5001	169003.2	32.5001	0.0000

Temperature ITS-90 = $1/\{a0 + a1[ln(n)] + a2[ln^2(n)] + a3[ln^3(n)]\} - 273.15$ (°C)

Residual = instrument temperature - bath temperature



POST CRUISE CALIBRATION

SEA-BIRD ELECTRONICS, INC.
13431 NE 20th Street Bellevue, Washington 98005 USA
Phone: (425) 643-9866 Fax: (425) 643-9954 www.seabird.com

Conductivity Calibration Report

Customer:	WEBB RESEARCH CORPORATION		
Job Number:	63738	**Date of Report:**	4/21/2011
Model Number	WEBB Glider	**Serial Number:**	WEBB Glider-0055

Conductivity sensors are normally calibrated 'as received', without cleaning or adjustments, allowing a determination of sensor drift. If the calibration identifies a problem or indicates cell cleaning is necessary, then a second calibration is performed after work is completed. The 'as received' calibration is not performed if the sensor is damaged or non-functional, or by customer request.

An 'as received' calibration certificate is provided, listing the coefficients used to convert sensor frequency to conductivity. Users must choose whether the 'as received' calibration or the previous calibration better represents the sensor condition during deployment. In SEASOFT enter the chosen coefficients using the program SEACON. The coefficient 'slope' allows small corrections for drift between calibrations (consult the SEASOFT manual). Calibration coefficients obtained after a repair or cleaning apply only to subsequent data.

'AS RECEIVED CALIBRATION' ☑ **Performed** ☐ **Not Performed**

Date: 4/12/2011 **Drift since last cal:** -0.00030 **PSU/month***

Comments:

'CALIBRATION AFTER CLEANING & REPLATINIZING' ☑ **Performed** ☐ **Not Performed**

Date: 4/21/2011 **Drift since 16 Sep 06** +0.00010 **PSU/month***

Comments:

****Measured at 3.0 S/m***

Cell cleaning and electrode replatinizing tend to 'reset' the conductivity sensor to its original condition. Lack of drift in post-cleaning-calibration indicates geometric stability of the cell and electrical stability of the sensor circuit.

SEA-BIRD ELECTRONICS, INC.

13431 NE 20th Street, Bellevue, Washington, 98005-2010 USA

Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0055
CALIBRATION DATE: 12-Apr-11

WEBB GLIDER CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

COEFFICIENTS:

g = -9.922178e-001
h = 1.277352e-001
i = -1.768050e-004
j = 2.937973e-005

CPcor = -9.5700e-008
CTcor = 3.2500e-006
WBOTC = -1.2360e-005

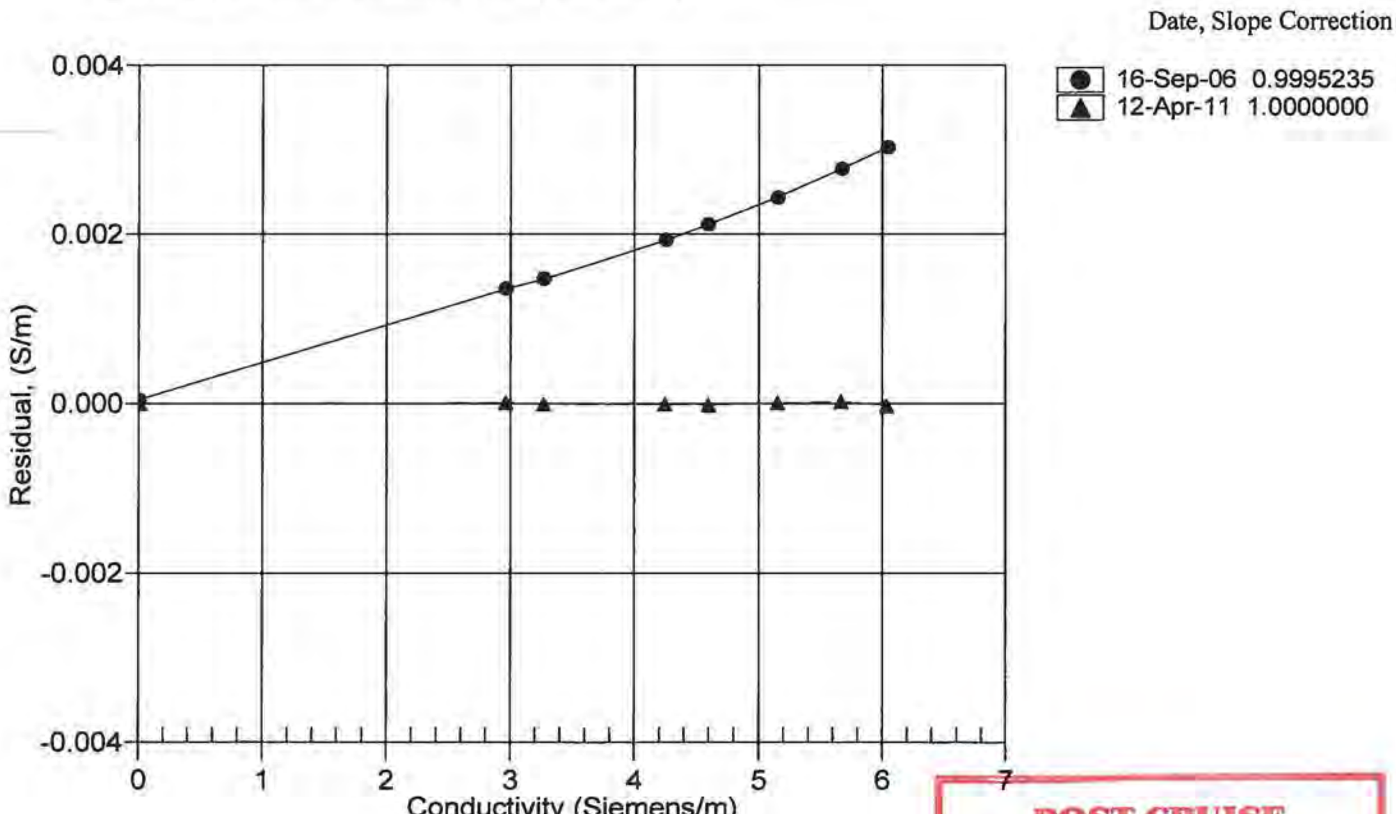
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (Hz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2790.34	0.00000	0.00000
1.0000	34.6460	2.96279	5566.06	2.96280	0.00001
4.5000	34.6257	3.26851	5776.57	3.26850	-0.00001
15.0000	34.5827	4.24598	6402.67	4.24597	-0.00001
18.5000	34.5732	4.58959	6608.42	4.58957	-0.00001
24.0000	34.5624	5.14502	6927.81	5.14503	0.00001
29.0000	34.5545	5.66424	7213.28	5.66427	0.00003
32.5001	34.5481	6.03450	7409.92	6.03448	-0.00002

f = INST FREQ * sqrt(1.0 + WBOTC * t) / 1000.0

Conductivity = $(g + hf^2 + if^3 + jf^4) / (1 + \delta t + \varepsilon p)$ Siemens/meter

t = temperature[°C)]; p = pressure[decibars]; δ = CTcor; ε = CPcor;

Residual = instrument conductivity - bath conductivity



POST CRUISE CALIBRATION

SEA-BIRD ELECTRONICS, INC.

13431 NE 20th Street, Bellevue, Washington, 98005-2010 USA
Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0055
CALIBRATION DATE: 21-Apr-11

WEBB GLIDER CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

COEFFICIENTS:

g = -9.902156e-001
h = 1.272303e-001
i = -6.633333e-005
j = 2.154632e-005

CPcor = -9.5700e-008
CTcor = 3.2500e-006
WBOTC = -1.2360e-005

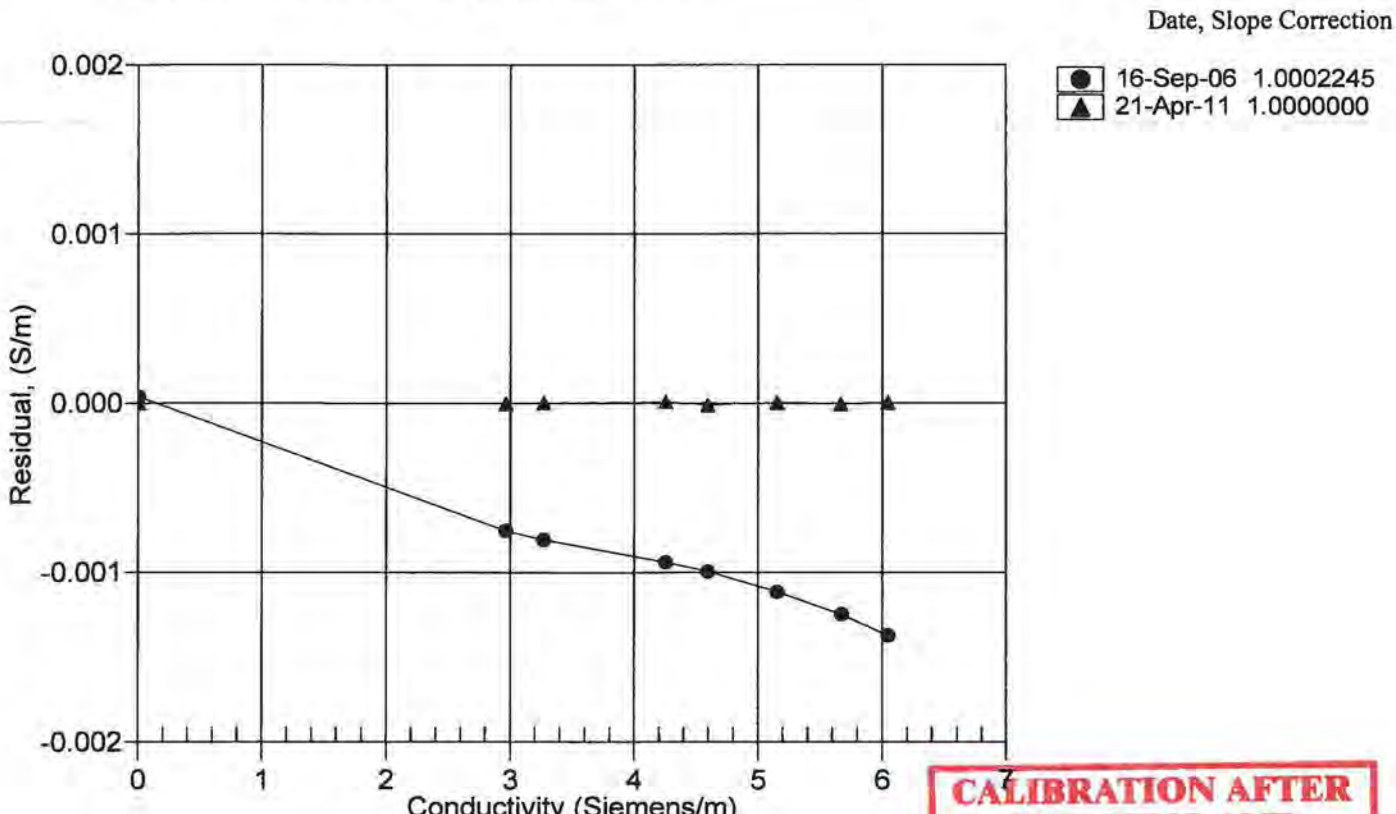
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (Hz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2790.35	0.00000	0.00000
1.0000	34.6758	2.96510	5569.15	2.96509	-0.00000
4.5000	34.6552	3.27102	5779.81	3.27102	0.00000
14.9999	34.6115	4.24913	6406.34	4.24914	0.00001
18.5000	34.6016	4.59295	6612.23	4.59294	-0.00001
24.0000	34.5899	5.14866	6931.84	5.14866	0.00000
29.0000	34.5806	5.66804	7217.47	5.66804	-0.00001
32.5000	34.5732	6.03837	7414.26	6.03838	0.00000

f = INST FREQ * sqrt(1.0 + WBOTC * t) / 1000.0

Conductivity = $(g + hf^2 + if^3 + jf^4) / (1 + \delta t + \varepsilon p)$ Siemens/meter

t = temperature[°C)]; p = pressure[decibars]; δ = CTcor; ε = CPcor;

Residual = instrument conductivity - bath conductivity



CALIBRATION AFTER CLEANING AND REPLATINIZING CELL

SEA-BIRD ELECTRONICS, INC.

13431 NE 20th Street, Bellevue, Washington, 98005-2010 USA
Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0055
CALIBRATION DATE: 11-Apr-11

WEBB GLIDER PRESSURE CALIBRATION DATA
508 psia S/N 8731

COEFFICIENTS:

PA0 = -4.923020e-002	PTCA0 = -6.138614e+002
PA1 = 2.347635e-002	PTCA1 = -3.687158e-003
PA2 = 2.022392e-009	PTCA2 = -3.964818e-003
PTHA0 = -7.057100e+001	PTCB0 = 2.495538e+001
PTHA1 = 5.142905e-002	PTCB1 = -1.250000e-004
PTHA2 = -2.077328e-007	PTCB2 = 0.000000e+000

PRESSURE SPAN CALIBRATION

PRESSURE PSIA	INST OUTPUT	THERMISTOR OUTPUT	COMPUTED PRESSURE	ERROR %FSR
14.72	13.8	1824.0	14.74	0.00
104.97	3853.3	1824.0	104.92	-0.01
204.96	8108.1	1824.0	204.94	-0.00
304.98	12359.5	1926.0	304.97	-0.00
404.97	16608.7	1823.0	404.97	0.00
504.98	20852.8	1826.0	504.95	-0.01
404.95	16609.4	1824.0	404.99	0.01
304.94	12361.3	1822.0	304.98	0.01
204.96	8109.3	1822.0	204.96	0.00
104.97	3854.7	1824.0	104.96	-0.00
14.72	13.6	1825.0	14.73	0.00

THERMAL CORRECTION

TEMP ITS90	PRESS TEMP	INST OUTPUT
32.50	2020.60	26.99
29.00	1951.90	27.80
24.00	1852.20	28.83
18.50	1743.40	29.53
15.00	1676.30	30.62
4.50	1468.30	31.16
1.00	1399.50	31.19

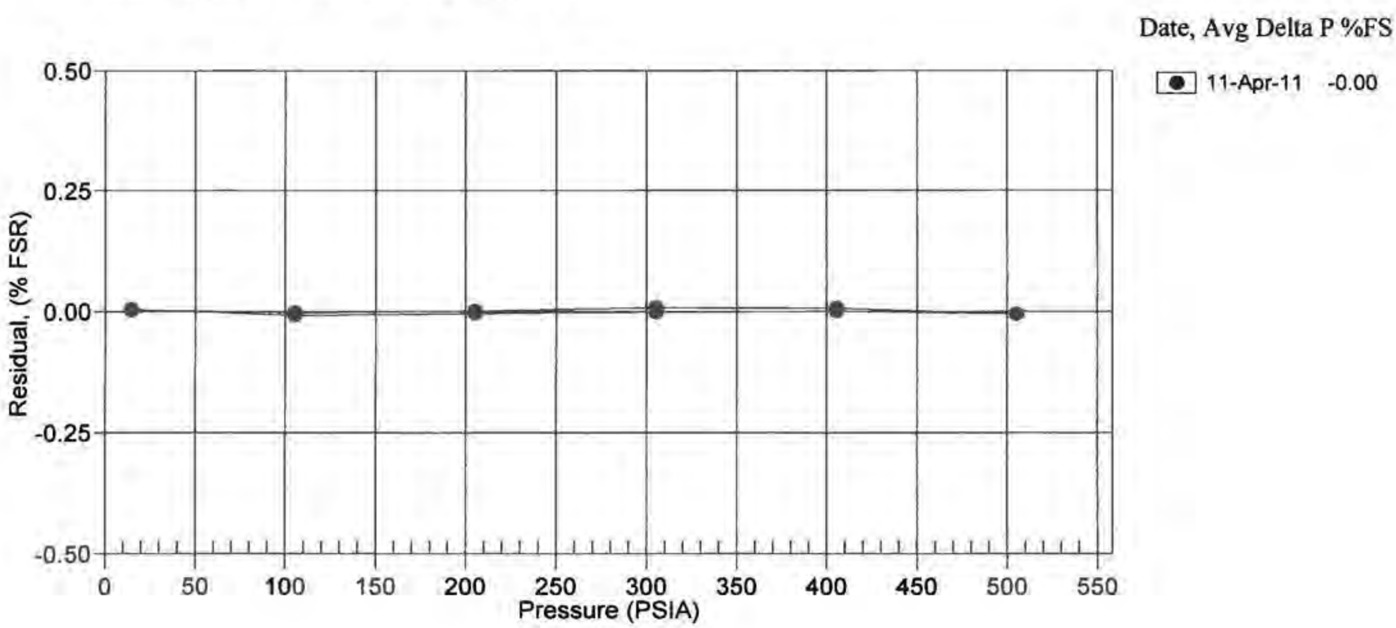
TEMP(ITS90)	SPAN(mV)
-5.00	24.96
35.00	24.95

y = thermistor output; $t = PTEMPA0 + PTEMPA1 * y + PTEMPA2 * y^2$

$x = \text{pressure output} - PTCA0 - PTCA1 * t - PTCA2 * t^2$

$n = x * PTCB0 / (PTCB0 + PTCB1 * t + PTCB2 * t^2)$

$\text{pressure (psia)} = PA0 + PA1 * n + PA2 * n^2$



9940 Summers Ridge Road
San Diego, CA 92121
Tel: (858) 546-8327
support@sontek.com

CALIBRATION CERTIFICATE

System Info

System Type	CastAway-CTD
Serial Number	11D101493
Firmware Version	1.0
Calibration Date	4/26/2011

Power

Standby Mode (A)	
Supply Voltage	2.9V

Calibration

Pressure	Passed
Conductivity	Passed
Temperature	Passed
GPS	Passed

Verified by: Jennifer Patterson

Date: 11/22/2011

9940 Summers Ridge Road
San Diego, CA 92121
Tel: (858) 546-8327
support@sontek.com

CALIBRATION CERTIFICATE

System Info

System Type	CastAway-CTD
Serial Number	11D101494
Firmware Version	1.0
Calibration Date	4/26/2011

Power

Standby Mode (A)	
Supply Voltage	2.9V

Calibration

Pressure	Passed
Conductivity	Passed
Temperature	Passed
GPS	Passed

Verified by: Jennifer Patterson

Date: 11/22/2011

Appendix D

Deployment 3
6/7/2012 – 6/19/2012

RUTGERS UNIVERSITY

COASTAL OCEAN OBSERVATION LAB

OPERATIONS CENTER

GLIDER RU07

MISSION EPA-DEP 3

DATE

6/7/2012

GLIDER DENSITY (in target water)

1021.70 kg/m^3

LOCATION

Coastal NJ kg/m^3

RU COOL GLIDER BALLAST RECORD

C:\Documents and Settings\haldeman\Desktop\Copy of 2012_06_06 ru07 NJDEP.xls

Deployment	NJDEP
Glider	RU07
Date	5.30.12
Preparer	Tina

Air Temperature
20

		MASS (g)	COMMENTS
GLIDER	FORE STEM		
	FORE HULL		
	AFT STEM (red plug, card)		
	AFT HULL		
	COWLING		
	SCREWS (vacuum,cowling,aft battery)		
PAYLOAD	PAYLOAD BAY (no rails!)		no wt. bar 6250.9, with wt. bar 7172.9
	WINGS		port 275.8 star 276.9
	WING RAILS (screws)		on payload
	PICK POINT		no pickpoint
BATTERIES	AFT BATTERY		
	PITCH BATTERY		
	FORE BATTERY 1 (starboard)		
	FORE BATTERY 2 (port)		
WEIGHT BOTTLES	AFT BOTTLE		
	FORE BOTTLE 1 (starboard)		
	FORE BOTTLE 2 (port)		

Tank Specifics		Glider Specifics		H MOMENT (rad)		(deg)
Tank Density (g/mL)	1.0220	Glider Volume (mL)	50976.357	Angle of Rotation (before)		0.0
Tank Temperature (C)	19.08	Total Mass (g)		Angle of Rotation (after)		0.0
Weight in Tank (g)	-6.00	Glider Density 1 (air) (g/mL)	0.0000	Angle of Rotation	0	0.0
Target Specifics		**Volume Change (temperature induced)**		Weight on Spring (after)		
Target Density (g/mL)	1.0220	Volume Change (tank) (mL)	-3	Weight added		
Target Temperature ©	11.00	Volume Change (target) (mL)	-29	Radius of Hull	107	
				H-distance	**#DIV/0!**	

Should Hang (in tank) (g)	-27.62	**Adjust Glider Mass (Dunk Volume) (g)**	-23.46	volume 1:	50976.36
Adjust by: (g)	-21.62	**Adjust Glider Mass (entered volume) (g)**	52068.38	volume 2:	

^ Ballasting Alternative (known VOLUME)

Calculated Glider Volume (calculated from scales) (mL)	5.871	average =	50976.36
Glider Density 2 (in target water, using calculated volume above) (kg / m³)	0.0	PICK POINT MASSES	107 g air / 66 g Water
Glider Density 3 (in target water, using entered volume) (kg / m³)	0.0	PICK POINT VOLUME	40.4 mL

Ballast Sheet (Dunk 5)

Glider Density 4 (in target water, using entered volume) (kg / m³)	**1022.42**	G1 Volume	50.9 L

Ballast Pump Size

	Ballast Pump Size	Glider Reported pump_volume	Resultant Volume (in air/tank)	
Full Retract Scale Weight			0	
Full Extend Scale Weight			0	
	432		-422.68818	
Original Volume	50976.357			
		% Matched	Max Density Range	
Pump Size	0	#DIV/0!	**0.00**	+- sigma
Pump Size (retracted)	50976.357	#DIV/0!	**0.00**	Max Density (in target)
Pump Size (extended)	50976.357	#DIV/0!	**0.00**	Min Density (in target)

DISCLAIMER = make sure all values are correct, and accurate, dependencies are exact dunk weights, tank density and temperature, as well as units

Pre-Deployment Check Out

GLIDER	RU07	**SCIENCE BAY SERIAL NUMBERS**	1) CTD 0080
PREPARER	Chip, Tina, Students		2) BBFL2S 599
PREP DATE	21 June 2012		3) Optode 1504
LOCATION	NJ Coast		4)

PRE-SEAL

FORE CHECK

Check pump & pitch threaded rod (grease & clean if necessary) ✓

Grounded Nose? ✓

Leak detect in place, batteries secure, white guides free, no metal shavings, bottles installed ✓

PAYLOAD CHECK

Special Sensors / Additional Sensors

1) —

2) —

CTD cable clear, no leak at CTD joint, no leak at pucks —

Grounded Parts: Fore Sci Ring ✓

Aft Sci Ring ✓

CTD No

Other?

Science Bay Weight Configuration Bar - 2 wts on top bottle - Aft bottom

AFT CHECK

Iridium Card Installed (SIM #) (if not standard) —✓ 89881 69514 00012 6404

Flash Card: old data removed?

Inspect strain on connectors (worn connectors), battery secured, ballast bottle present, aft cap clean/clear of leak ✓

Aft cap grounded? ✓

Battery check

Aft Pack - J13 Voltage 15.83

Pitch Pack - J13 Voltage 15.83

Nose Packs - J13 Voltage 15.84

Aft Emer - J31 Voltage 15.94

POST-SEAL

GENERAL

Pick Point Present? No

Special Instruments? No

HARDWARE

put c_alt_time 0, verify alt chirp ✓

Nose Cone and pump bladder inspection ✓

Anode grounded? ✓ ~~no~~

Anode size / remainder (est) O

Pressure Sensor Check (corrosion, clear)

Aft sensor ✓

Payload sensor ✓

Ejection weight assembly OK and unseized? ✓

POWERED

Verify Argos ping

Wiggle for 5 minutes ✓

Stabilized m_battery 15.26

m_vacuum @ T @ ballast ~~6.28~~ 6.22 @ ballast

OUTSIDE

Compass Check (reading @ compass)

1)

2) See Attached

3)

4)

logging on; rotate slowly 360, logging off, plot data: 360 test ✓

GPS check

(lat) — (lon) —

Iridium connect — Alt

zero_ocean_pressure, get m_pressure —

let air bladder inflate, does it shut off? —

SOFTWARE

GENERAL

Version 7.06 ______ Re-burn latest software image ✓

Date OK? ✓ ______ configure TBDlist default

delete old logs ✓ ______ NBDlist default

\CONFIG

simul.sim deleted ✓

\MAFILES

goto_l10.ma (set x_last_...) ✓

AUTOEXEC.MI

Irid Main: 88160000592 ✓ c_ctd41cp_num_fields_to_send 4 ✓

Irid Alt: 15085482446 ✓ Calibration coefficients ✓

u_iridium_failover_retries = 10 ✓ f_ballast_pumped_deadz_width = 30? ✓

Reset the glider, observe any errors get f_max_working_depth (102 m) ✓

CACHE MANAGEMENT

del ..\state\cache*.*

after *bdlist.dat are set (exit reset):

logging on; logging off

send ..\state\cache*.cac ✓

send *.mbd *.sbd *.tbd ✓

* **Software Burning Tips :** if using Procomm or local folder, copy all the files from the software image locally. Then proceed to edit them for the glider and do a mass freewave transfer of the files. Save these files or prepare the to-glider with these files

SCIENCE

SENSOR RETURN

put c_science_send_all 1

put c_science_all_on 8

put c_science_on 3

All sensors reporting values? ✓

CTD

Tank static comparison OK? ✓

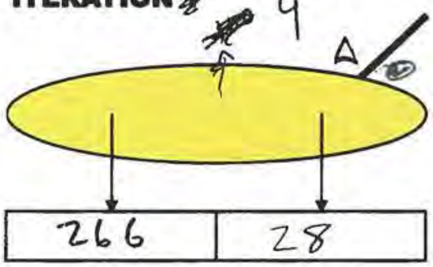
OPTODE

Check in completed? —

Compass	Glide	Diff
0	1°	+1
48	47°	-1
90	95°	+5
135	142	+7
~~180~~ 181	180	-1
229	225	-4
270	272	+2
318	322	+4

BALLAST ITERATIONS **GLIDER:** **DATE:**

ITERATION ~~#~~ ~~#~~ 4



BALLAST

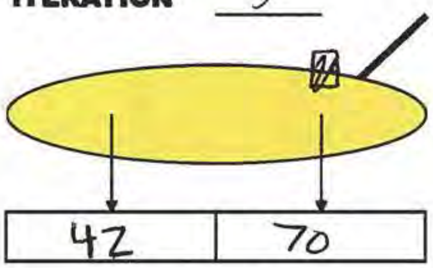
FORE 1	246.3
FORE 2	241.2
AFT	244.9

NOTES
M=52.0kg
Δ = 390g
CW 1: T=19.19 C=42100
CTD#493
CW2: T=19.18 C=41870
CTD#002
= 20g

TANK: (SB19)

TANK: (Glider)
T= 19.077
C = 4.2285
D = 1022.03

ITERATION 5



Δ = 118g

BALLAST

FORE 1	124.6
FORE 2	119.4
AFT	389

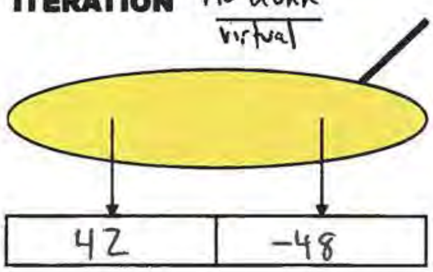
Aft batt ~~[illegible]~~ 170.0g

NOTES
266 28 want +68
+390
-238 +152
~~[illegible]~~
~~[illegible]~~ ~~[illegible]~~
~~[illegible]~~
-20
~~[illegible]~~ 42
-42 ~~62~~

TANK: (SB19)

TANK: (Glider)

ITERATION no dunk virtual



BALLAST

FORE 1	
FORE 2	
AFT	

NOTES
~~28~~ ~~48~~
28 28
~~[illegible]~~
-20 +132
~~[illegible]~~
-32 -32
-270 +338
$\boxed{-242 + 310}$

TANK: (SB19)

TANK: (Glider)

T	T
19.16	19.14
47722	47683
S	
30.93	30.90

dunk 4 castaway CTD readings

(5)

Macintosh HD:Users:haskins:Desktop:RU07_2012_5_31.xls

Deployment	Section	Component	MASS (g)	COMMENTS
NJDEP	GLIDER	FORE STEM	8195	
	GLIDER	FORE HULL	4257	now in aft
Glider	GLIDER	AFT STEM (red plug, card)	6500.2	
RU07	GLIDER	AFT HULL	4638.4	
	GLIDER	COWLING	1151.2	
	GLIDER	SCREWS (vacuum,cowling,aft battery)	16.8	
Date	PAYLOAD	PAYLOAD BAY (no rails!)	7172.9	no wt. bar 6250.9, with wt. bar 7172.9
5.30.12	PAYLOAD	WINGS	552.7	port 275.8 star 276.9
	PAYLOAD	WING RAILS (screws)	0	on payload
Preparer	PAYLOAD	PICK POINT	0	no pickpoint
Tina	BATTERIES	AFT BATTERY	7613.8	
	BATTERIES	PITCH BATTERY	9329.8	
	BATTERIES	FORE BATTERY 1 (starboard)	727.85	
Air Temperature	BATTERIES	FORE BATTERY 2 (port)	727.85	
20	WEIGHT BOTTLES	AFT BOTTLE	265.4	
	WEIGHT BOTTLES	FORE BOTTLE 1 (starboard)	246.4	
	WEIGHT BOTTLES	FORE BOTTLE 2 (port)	241.3	

D-11

Tank Specifics		Glider Specifics		H MOMENT (rad)		(deg)
Tank Density (g/mL)	1.0221	Glider Volume (mL)	50644.15	Angle of Rotation (before)		0.0
Tank Temperature (C)	18.43	Total Mass (g)	51636.6	Angle of Rotation (after)		0.0
Weight in Tank (g)	-8.00	Glider Density 1 (air) (g/mL)	1.0196	Angle of Rotation	0	0.0
Target Specifics		**Volume Change (temperature induced)**		Weight on Spring (after)		
Target Density (g/mL)	1.0223	Volume Change (tank) (mL)	-6	Weight added		
Target Temperature ©	11.00	Volume Change (target) (mL)	-26	Radius of Hull	107	
				H-distance	**#DIV/0!**	

Should Hang (in tank) (g)	-14.15	**Adjust Glider Mass (Dunk Volume) (g)**	-6.18	volume 1:	50886.221
Adjust by: (g)	-6.15	**Adjust Glider Mass (entered volume) (g)**	107.46	volume 2:	50513.226
					50532.991

^ **Ballasting Alternative (known VOLUME)**

Calculated Glider Volume (calculated from scales) (mL)	50532.991	average =	50644.146
Glider Density 2 (in target water, using calculated volume above) (kg / m³)	1022.4	PICK POINT MASSES	107 g air / 66 g Water
Glider Density 3 (in target water, using entered volume) (kg / m³)	1020.1	PICK POINT VOLUME	40.4 mL

Ballast Sheet

4

Macintosh HD:Users:haskins:Desktop:RU07_2012_5_31.xls

Deployment	NJDEP
Glider	RU07
Date	5.30.12
Preparer	Tina

Air Temperature
20

		MASS (g)	**COMMENTS**
GLIDER	FORE STEM	8195	
	FORE HULL	4257	
	AFT STEM (red plug, card) 6500.2	6488	New Zinc 25.3 vs 13.1 old
	AFT HULL	4638.4	
	COWLING	1151.2	
	SCREWS (vacuum,cowling,aft battery)	16.8	
PAYLOAD	PAYLOAD BAY (no rails!)	7172.9	no wt. bar 6250.9, with wt. bar 7172.9
	WINGS	552.7	port 275.8 star 276.9
	WING RAILS (screws)	0	on payload
	PICK POINT	0	no pickpoint
BATTERIES	AFT BATTERY	7613.8	
	PITCH BATTERY	9329.8	
	FORE BATTERY 1 (starboard)	727.85	
	FORE BATTERY 2 (port)	727.85	
WEIGHT BOTTLES	AFT BOTTLE	345.4	-34 = 311.4 311.0 - ~~40~~ 46 $\boxed{265.4}$
	FORE BOTTLE 1 (starboard)	223.4	+23 $\boxed{246.4}$
	FORE BOTTLE 2 (port)	218.3	+23 $\boxed{241.3}$

Tank Specifics		Glider Specifics		H MOMENT (rad)		(deg)
Tank Density (g/mL)	1.0221	Glider Volume (mL)	50699.72	Angle of Rotation (before)		0.0
Tank Temperature (C)	18.43	Total Mass (g)	51658.4	Angle of Rotation (after)		0.0
Weight in Tank (g)	34.00	Glider Density 1 (air) (g/mL)	1.0189	Angle of Rotation	0	0.0
Target Specifics		**Volume Change (temperature induced)**		Weight on Spring (after)		
Target Density (g/mL)	1.0223	Volume Change (tank) (mL)	-6	Weight added		
Target Temperature ©	11.00	Volume Change (target) (mL)	-26	Radius of Hull	107	
				H-distance	**#DIV/0!**	

Should Hang (in tank) (g)	-14.16	**Adjust Glider Mass (Dunk Volume) (g)**	-48.21	volume 1:	50886.221
Adjust by: (g)	-48.16	**Adjust Glider Mass (entered volume) (g)**	142.43	volume 2:	50513.226

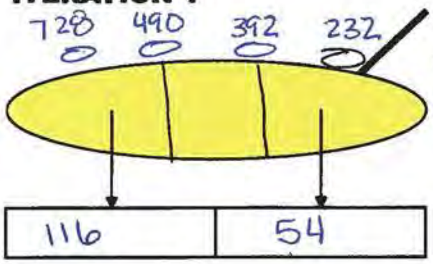
^ Ballasting Alternative (known VOLUME)

Calculated Glider Volume (calculated from scales) (mL)	50513.226	average =	50699.724
Glider Density 2 (in target water, using calculated volume above) (kg / m³)	1023.2	PICK POINT MASSES	107 g air / 66 g water Ballast Sheet
Glider Density 3 (in target water, using entered volume) (kg / m³)	1019.4	PICK POINT VOLUME	40.4 mL

BALLAST ITERATIONS **GLIDER:** RU07 **DATE:** 1 Jun 2012

n

ITERATION 1



= 1842

= 170

BALLAST

FORE 1	
FORE 2	
AFT	

1842
− 170
−1672

NOTES glider is light

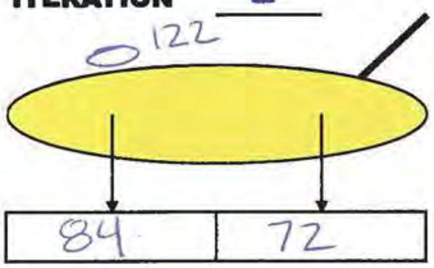
4.190
4.152

TANK: T 18.47
~~(SB19)~~ salinity C ~~aa~~ 31.25
castaway D 1022.28

TANK: T 18.43
(Glider) C 4.1527
D 1022.11

on ballast sheet

ITERATION 2



=156
−122
+34

BALLAST

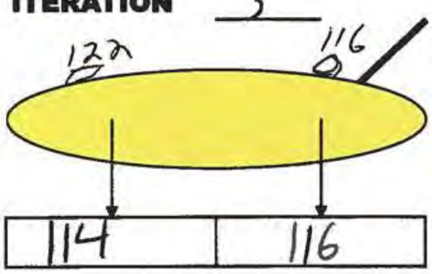
FORE 1	
FORE 2	
AFT	

NOTES dunk on same day

TANK:
(SB19)

TANK:
(Glider)

ITERATION 3



= 238

= 230

BALLAST

FORE 1	
FORE 2	
AFT	

−8g

NOTES Took 34 out of aft

- Move 40 from aft forward

New zinc added 12g
- Move ~~45~~ 46

TANK:
(SB19)

TANK:
(Glider)

3

Macintosh HD:Users:haskins:Desktop:RU07_2012_5_31.xls

			MASS (g)	COMMENTS
Deployment	GLIDER	FORE STEM	8195	
NJDEP		FORE HULL	4257	
		AFT STEM (red plug, card)	6488	
Glider		AFT HULL	4638.4	
RU07		COWLING	1151.2	
		SCREWS (vacuum,cowling,aft battery)	16.8	
Date	PAYLOAD	PAYLOAD BAY (no rails!)	7172.9	no wt. bar 6250.9, with wt. bar 7172.9
5.30.12		WINGS	552.7	port 275.8 star 276.9
		WING RAILS (screws)	0	on payload
Preparer		PICK POINT	0	no pickpoint
Tina	BATTERIES	AFT BATTERY	7613.8	
		PITCH BATTERY	9329.8	
		FORE BATTERY 1 (starboard)	727.85	
Air Temperature		FORE BATTERY 2 (port)	727.85	
20	WEIGHT BOTTLES	AFT BOTTLE	345.4	
		FORE BOTTLE 1 (starboard)	223.4	
1022.25 @ 11°C		FORE BOTTLE 2 (port)	218.3	

Tank Specifics		Glider Specifics		H MOMENT (rad)		(deg)
Tank Density (g/mL)	1.0221	Glider Volume (mL)	50900	Angle of Rotation (before)		0.0
Tank Temperature (C)	18.43	Total Mass (g)	51658.4	Angle of Rotation (after)		0.0
Weight in Tank (g)	-1672.00	Glider Density 1 (air) (g/mL)	1.0149	Angle of Rotation	0	0.0
Target Specifics		**Volume Change (temperature induced)**		Weight on Spring (after)		
Target Density (g/mL)	1.0223	Volume Change (tank) (mL)	-6	Weight added		
Target Temperature ©	11.00	Volume Change (target) (mL)	-26	Radius of Hull	107	
				H-distance	**#DIV/0!**	

Should Hang (in tank) (g)	-14.22	**Adjust Glider Mass (Dunk Volume) (g)**	1658.10	volume 1: 50886.221
Adjust by: (g)	1657.78	**Adjust Glider Mass (entered volume) (g)**	347.06	volume 2:

^ Ballasting Alternative (known VOLUME)

Calculated Glider Volume (calculated from scales) (mL)	**52182.506**	average =	#DIV/0!
Glider Density 2 (in target water, using calculated volume above) (kg / m³)	**990.5**	PICK POINT MASSES	107 g air/-66 g water Ballast Sheet
Glider Density 3 (in target water, using entered volume) (kg / m³)	**1015.4**	PICK POINT VOLUME	40.4 mL

2

Macintosh HD:Users:haskins:Desktop:RU07_2012_5_31.xls

				MASS (g)	COMMENTS
Deployment	GLIDER	FORE STEM		8195	
NJDEP		FORE HULL		4257	
		AFT STEM (red plug, card)		6488	
Glider		AFT HULL		4638.4	
RU07		COWLING		1151.2	
		SCREWS (vacuum,cowling,aft battery)		16.8	6250.9 no weight
Date	PAYLOAD	PAYLOAD BAY (no rails!)		~~8088.5~~	~~6250.9~~ wing rails on payload — with weight bar 7172.9
5.30.12		WINGS	552.7	~~552.4~~	p 275.8 s 276.9 ✓
		WING RAILS (screws)		~~[illegible]~~ 0	on payload
Preparer		PICK POINT		0	no pickpoint — payload fore plate
Tina	BATTERIES	AFT BATTERY		7613.8	
		PITCH BATTERY		9329.8	361.1
		FORE BATTERY 1 (starboard)		727.85	
Air Temperature		FORE BATTERY 2 (port)		727.85	
20	WEIGHT BOTTLES	AFT BOTTLE		~~285~~	345.4 ✓
		FORE BOTTLE 1 (starboard)		~~511~~	223.4 ✓
1022.25 @ 11°C		FORE BOTTLE 2 (port)		~~522~~	218.3 ✓

Tank Specifics		Glider Specifics		H MOMENT (rad)		(deg)
Tank Density (g/mL)	1.0221	Glider Volume (mL)	50900	Angle of Rotation (before)		0.0
Tank Temperature (C)	18.43	Total Mass (g)	50333.6	Angle of Rotation (after)		0.0
Weight in Tank (g)	-1672.00	Glider Density 1 (air) (g/mL)	0.9889	Angle of Rotation	0	0.0
Target Specifics		**Volume Change (temperature induced)**		Weight on Spring (after)		
Target Density (g/mL)	1.0223	Volume Change (tank) (mL)	-6	Weight added		
Target Temperature ©	11.00	Volume Change (target) (mL)	-26	Radius of Hull	107	
				H-distance	**#DIV/0!**	

Should Hang (in tank) (g)	-14.22	**Adjust Glider Mass (Dunk Volume) (g)**	1657.78	volume 1: 50886.221
Adjust by: (g)	1657.78	**Adjust Glider Mass (entered volume) (g)**	1671.86	volume 2:

^ **Ballasting Alternative (known VOLUME)**

Calculated Glider Volume (calculated from scales) (mL)	**50886.221**	average =	#DIV/0!
Glider Density 2 (in target water, using calculated volume above) (kg / m³)	**989.7**	PICK POINT MASSES	107 g air / 66 g Water Ballast Sheet
Glider Density 3 (in target water, using entered volume) (kg / m³)	**989.4**	PICK POINT VOLUME	40.4 mL

(1)

optode = 214.2

Macintosh HD:All My Stuff:RUCOOL:Forms:Glider Ballasting Template.xls

			MASS (g)	COMMENTS
Deployment	GLIDER	FORE STEM (altimeter bottle)	8195.0	
NJDEP		FORE HULL	4257.0	
Glider		AFT STEM (red plug, card)	6273.8	6488.0 w/optode
RU07		AFT HULL	4638.~~3~~4	
		COWLING	1151.2	
		SCREWS (vacuum, cowling, aft battery)	16.8	
Date	PAYLOAD	PAYLOAD BAY	6008.5	
5.21.12		WINGS	552.4	pick point? Fish finder?
Preparer		OTHER	228.7	rails
Tina/Austin	BATTERIES	AFT BATTERY	7613.8	
		PITCH BATTERY	9329.0	
Air temp		FORE BATTERY 1, 2	1455.7	727.85
20	WEIGHT BOTTLES	AFT BOTTLE	285.0	
		FORE BOTTLE 1 (starboard)	511.9	
		FORE BOTTLE 2 (port)	622.2	
		OTHER		

Tank Specifics		Glider Specifics		H MOMENT (rad)		(deg)
Tank Density (g/mL)		Glider Volume (mL)	50800	Angle of Rotation (before)		0.0
Tank Temperature (C)		Total Mass (g)	0	Angle of Rotation (after)		0.0
Weight in Tank (g)		Glider Density 1 (air) (g/mL)	0.0000	Angle of Rotation	0	0.0
Target Specifics		**Volume Change (temperature induced)**		Weight on Spring (after)		
Target Density (g/mL)		Volume Change (tank) (mL)	-71	Weight added	290	
Target Temperature ©		Volume Change (target) (mL)	0	Radius of Hull	107	
		(note use 53.5 E -6 in above for DE (carbon)) ^		**H-distance**	**#DIV/0!**	

(note use 70 E -6 in above for Aluminum hull)

Should Hang (in tank) (g)	0.00	**Adjust Glider Mass (Dunk Volume) (g)**	#DIV/0!
Adjust by: (g)	0.00	**Adjust Glider Mass (entered volume) (g)**	0.00

^ Ballasting Alternative (known VOLUME) (don't have to weight parts!)

Calculated Glider Volume (calculated from scales) (mL)	**#DIV/0!**
Glider Density 2 (in target water, using calculated volume above) (kg / m³)	**#DIV/0!**
Glider Density 3 (in target water, using entered volume) (kg / m³)	**0.0**
Glider Density 4 (in target water, using entered volume) (kg / m³)	**0.00**

Average Glider Volume

volume 1:

volume 2:

volume 3:

average = #DIV/0!

MISC Items Masses/Volumes

PICK POINT VOLUME 40.4 mL Ballast Sheet 107g air /

G1 Volume 50.9 L

Pre-Deployment Check Out
For
Aanderaa Oxygen Optode

RUTGERS
Coastal Ocean
Observation Lab

Slocum Glider Aanderaa Optode Check IN/OUT
2 Point Calibration & Calibration Coeffcient Record

OPTODE MODEL, SN: 1504 **IN / OUT** IN

Calibration Record **PERFORMED BY:** Amanda, Austin, David

CALIBRATION DATE: 3/23/2012

Previous:

C0Coef	4.5E+03	-1.6E+02	3.3E+00	-2.8E-02
C1Coef	-2.5E+02	8.0E+00	-1.6E-01	1.3E-03
C2Coef	5.7E+00	-1.6E-01	3.1E-03	-2.5E-05
C3Coef	-6.0E-02	1.5E-03	-2.8E-05	2.2E-07
C4Coef	2.4E-04	-5.3E-06	1.0E-07	-7.1E-10

Current:

C0Coef	4.5E+03	-1.6E+02	3.3E+00	-2.8E-02
C1Coef	-2.5E+02	8.0E+00	-1.6E-01	1.3E-03
C2Coef	5.7E+00	-1.6E-01	3.1E-03	-2.5E-05
C3Coef	-6.0E-02	1.5E-03	-2.8E-05	2.2E-07
C4Coef	2.4E-04	-5.3E-06	1.0E-07	-7.1E-10

Delta: 0.0

2 point Calibration

	0% Point		*100% Point*
Solution: Na_2SO_3	10.2 g / 900 mL	*Solution:* Na_2SO_3	NA
Cross reference	Spark Unuit 4 T Probe	**Cross reference**	Spark Unit 4 T probe
Temperature	22.22	**Temperature**	9.93
Air Pressure (hPa)	997.968	**Air Pressure (hPa)**	997.968
Winkler Label	Sample Bottle C	**Winkler Label**	Sample A, Sample B
Winkler Source	LaMotte 7414 - Azide mod	**Winkler Source**	LaMotte 7414 - Azide mod

	Results:		*Results:*
OPTODE: Dphase	71.32	**OPTODE: Dphase**	33.5
% Saturation	0.12	**% Saturation**	97.04
Temperature	21.4	**Temperature**	9.76
Conc (calculated) (µM)	0.32	**Conc (calculated) (µM)**	350.64
% Saturation (calculated)	0.12	**% Saturation (calculated)**	100.73
WINKLER: Concentration (µM)	0	**WINKLER: Concentration**	343.75
(Titrations) (ppm)	(0, 0, 0) (0 - 2 µM)	**(Titrations) (ppm)**	(11,10.8,11.2)
% Saturation	0	**% Saturation**	98.75

(worst case @ 2 µM = .04 % or 0%)

DELTAS:

0.32	**Conc Δ**	0.12	**% Δ**
0.82	**Temp Δ**	21.81	**Temp avg**

DELTAS:

6.89	**Conc Δ**	1.98	**% Δ**
0.17	**Temp Δ**	9.845	**Temp avg**

In-Air Saturation Check

SATURATION: 98.42 **@ TEMP** 25.42 **@ PRESS** 997.968

Sodium Thiosulate Normalization

Normalization (mL) 2 (2.0 ± .1) (EPA Compliance)

Paste config report all from optode

Protect	5014	1504	0			
PhaseCoef	5014	1504	-6.62372	1.204068	0	0
TempCoef	5014	1504	23.7279	-0.0306	2.83E-06	-4.2E-09
FoilNo	5014	1504	5009			
C0Coef	5014	1504	4537.931	-162.595	3.29574	-0.02793
C1Coef	5014	1504	-250.953	8.02322	-0.1584	0.001311
C2Coef	5014	1504	5.664169	-0.15965	0.003079	-2.5E-05
C3Coef	5014	1504	-0.05994	0.001483	-2.8E-05	2.15E-07
C4Coef	5014	1504	0.000244	-5.3E-06	1E-07	-7.1E-10
Salinity	5014	1504	30			
CalAirPhas	5014	1504	32.99431			
CalAirTemp	5014	1504	10.29875			
CalAirPress	5014	1504	1026.47			
CalZeroPha	5014	1504	65.21005			
CalZeroTen	5014	1504	24.86774			
Interval	5014	1504	2			
AnCoef	5014	1504	0	1		
Output	5014	1504	101			
SR10Delay	5014	1504	-1			
SoftwareVe	5014	1504	3			
SoftwareBu	5014	1504	24			

Deployment Checklist

Glider RU07 Date 6/7/12

Pilots Shannon Dave Navy Where Sandy Hook

Laptop ______ Vehicle Powerup: CTRL ^ C (until you get to prompt)!!!

On boat (Remember after 10 min glider will go into mission, as well as on powerup!)	Battery Voltage	~~15.192503~~ 15.096038	get m_battery
	Vacuum Pressure	7.750877	get m_vacuum, should be > 7 for bladder inflation
	Iridium Connection		look for connect dialog & surface dialog, let it dial at prompt
	boot app	✓	boot app
	boot (should report application)	✓	reports boot application
	run status.mi	✓	mission completed normally?
In Water	zero_ocean_pressure	✓	while glider in water
	run od.mi (with or without float, ask RU)	✓	glider should dive and surface, type why? Should say overdepth, if not call
	send *.dbd *.mlg *.sbd	✓	"send *.sbd" is most important
			(this applies moreso to when handed off to iridium)
	run shallow.mi ~~or deep.mi~~		(glider should dive and not reappear) (report to Rutgers or steam out slowly once it di
	Verify dive; **disconnect freewave** Report to Rutgers		40° 22.9~~06~~'N 73° 53.984'W → CTD Location
	Perform CTD Comparison CAST		typically done with RU provided SBE19 or Cast Away CTD
	LAT: LON		

Recovery Checklist

Glider RU07 Date 6-19-12

Pilots Dave / Tina Where Sea isle NJ

Laptop Lipman-Stn9

Recovery	get Lat/Lon from email or shore support 39' 07.123 74° 37.442	✓
	obtain freewave comms obtain lat/lon with where command	✓
	Perform CTD Comparison CAST	✓
	LAT: 39° 07.150 **LON:** 74° 37.472	
	(note instrument type!) castaway	

Post-Deployment Checklist

RUTGERS
Coastal Ocean
Observation Lab

Slocum Glider Check-IN

DATE: 6/20/12

GLIDER: RU07 **SB:** 0080

Vehicle Powered

Power on vehicle in order to fully retract pump, and/or to deflate air bladder.

Vehicle Cleaning (hose down with pressure)

Nose cone

1. Remove nose cone
2. Loosen altimeter screws, and remove altimeter or leave temporarily attached
3. Retract pump
4. Remove altimeter and hose diaphragm removing all sand, sediment, bio oils
5. Clean nose cone and altimeter

Tail cone

1. Remove tail cone
2. Hose and clean anode and air bladder making sure air bladder is completely clean
3. Clean cowling

Wing rails

1. Remove wing rails and hose down

Tail plug cleaning

1. Dip red plug in alcohol and clean plug if especially dirty
2. Re-dip red plug and repeatedly insert and remove to clean the glider plug
3. Compress air glider female connector
4. Lightly silicon red plug and replace in glider once silicon has been dispersed evenly in the plugs

CTD Comparison Check

1. Inspect CTD sensor for any sediment buildup, take pictures of anything suspicious or make note.

Static Tank Test

SB19		*Glider (SB41CP or pumped unit)*	
Temperature:	19.58°C	Temperature:	19.58°C
Conductivity:	4.302	Conductivity:	4.299

CTD Maintenance (reference SeaBird Application Note 2D)

1. Perform CTD backward/forward flush with 1% Triton X-100 solution
2. Perform CTD backward/forward flush with 500 – 1000 ppm bleach solution
3. Perform the same on a pumped unit, just different approach
4. Repeat comparison test if above results not within T < .01 C, C < .005 S/m

SB19		*Glider (SB41CP or pumped unit)*	
Temperature:	______	Temperature:	______
Conductivity:	______	Conductivity:	______

Vehicle Disassembled

1. Check leak points for water or salt buildup
2. **BACKUP FLASH CARDS** in /coolgroup/glider_OS_backups/<glider>/<from glider>,<from sb_0xxx>

   DO NOT DELETE DATA OFF CARDS
3. Give cards to John Kerfoot (if available)
4. Remove used batteries and place in return crate
5. Re-assemble glider with a vacuum

Manufacturer Calibration Documentation

Aanderaa Optode, Seabird 41CP CTD, and YSI Castaway CTD

AADI **CALIBRATION CERTIFICATE**
Form No. 622, Dec 2005

a xylem brand

Sensing Foil Batch No:	5009	**Product:**	5014
Certificate No:	5014W 1504 1129	**Serial No:**	1504
		Calibration Date:	March 23, 2012

This is to certify that this product has been calibrated using the following instruments:

Fluke CHUB E-4	Serial No. A7C677
Fluke 5615 PRT	Serial No. 849155
Fluke 5615 PRT	Serial No. 802054
Honeywell PPT	Serial No. 44074
Calibration Bath model FNT 321-1-40	1

Parameter: Internal Temperature:

Calibration points and readings:

Temperature (°C)	-	-	-	-
Reading (mV)	-	-	-	-

Giving these coefficients

Index	0	1	2	3
TempCoef	2.37279E+01	-3.05951E-02	2.83023E-06	-4.19785E-09

*Note: Temperature calibration NOT performed

Parameter: Oxygen:

	O2 Concentration	Air Saturation
Range:	0-500 µM [1]	0 - 120%
Accuracy[1]:	< ±8µM or ±5%(whichever is greater)	±5%
Resolution:	< 1 µM	< 0.4%
Settling Time (63%):	< 25 seconds	

Calibration points and readings[2]:

	Air Saturated Water	Zero Solution (Na_2SO_3)
Phase reading (°)	3.29943E+01	6.52101E+01
Temperature reading (°C)	1.02988E+01	2.48677E+01
Air Pressure (hPa)	1.02647E+03	

Giving these coefficients

Index	0	1	2	3
PhaseCoef	-6.62372E+00	1.20407E+00	0.00000E+00	0.00000E+00

[1] *Valid for 0 to 2000m (6562ft) depth, salinity 33 - 37ppt*

[2] *The calibration is performed in fresh water and the salinity setting is set to: 0*

Date:
March 23, 2012

Sign: Shawn A. Sneddon

Shawn A. Sneddon

Service and Calibration Engineer

Aanderaa Data Instruments, Inc.
182 East Street, Suite B Attleboro, MA 02703 Tel. +1 (508) 226-9300 email: infoUSA@xyleminc.com

CALIBRATION CERTIFICATE

Form No. 621, Dec 2005

a xylem brand

Sensing Foil Batch No: 5009
Certificate No: 3853 5009 40217

Product: O2 Sensing Foil PSt3 3853
Calibration Date: 8 February 2010

Calibration points and phase readings (degrees)

Temperature (°C)		3.97	10.93	20.15	29.32	38.39
Pressure (hPa)		977.00	977.00	977.00	977.00	977.00
O2 in % of O2+N2	0.00	73.18	72.63	71.62	70.72	69.77
	1.00	68.01	67.02	65.42	63.92	62.31
	2.00	64.39	63.19	61.20	59.44	57.57
	5.00	55.80	54.16	51.76	49.56	47.45
	10.00	46.27	44.47	41.97	39.75	37.69
	20.90	35.09	33.38	31.14	29.24	27.56
	30.00	29.85	28.30	28.30	24.64	23.19

Giving these coefficients [1)]

Index	0	1	2	3
C0 Coefficient	4.53793E+03	-1.62595E+02	3.29574E+00	-2.79285E-02
C1 Coefficient	-2.50953E+02	8.02322E+00	-1.58398E-01	1.31141E-03
C2 Coefficient	5.66417E+00	-1.59647E-01	3.07910E-03	-2.46265E-05
C3 Coefficient	-5.99449E-02	1.48326E-03	-2.82110E-05	2.15156E-07
C4 Coefficient	2.43614E-04	-5.26759E-06	1.00064E-07	-7.14320E-10

[1)] *Ask for Form No 621S when this O2 Sensing Foil is used in Oxygen Sensor 3830 with Serial Numbers lower than 184.*

Date:
February 8, 2010

Aanderaa Data Instruments, Inc.

182 East Street, Suite B **Attleboro, MA 02703** **Tel. +1 (508) 226-9300** **email: infoUSA@xyleminc.com**

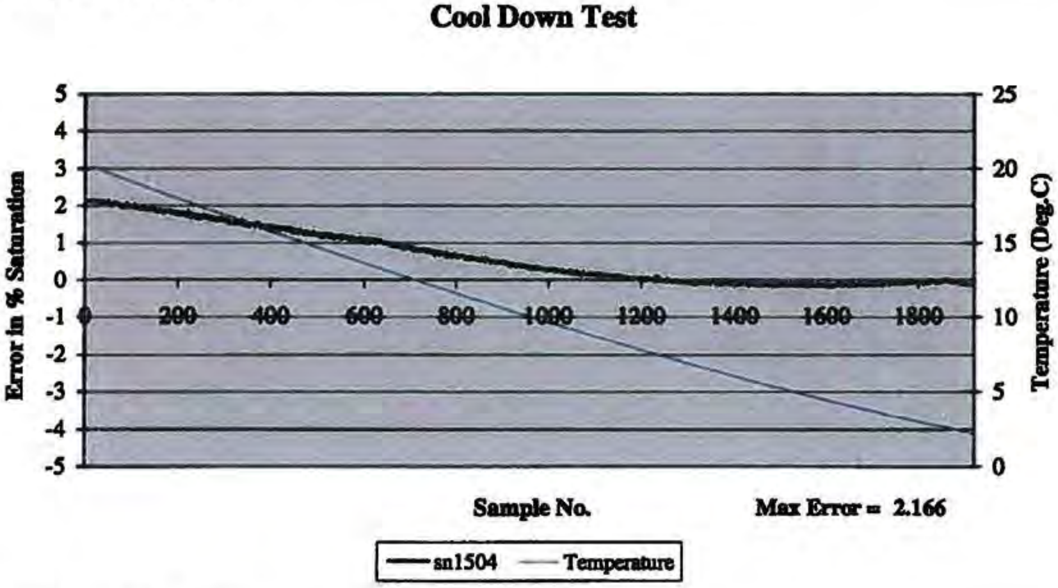
AADI CALIBRATION CERTIFICATE

Form No. 622, Dec 2005

a xylem brand

Sensing Foil Batch No:	5009	**Product:**	5014
Certificate No:	5014W 1504 1129	**Serial No:**	1504
		Calibration Date:	March 23, 2012

Data from Cool Down Test:



SR10 Scaling Coefficients:

At the SR10 output the Oxygen Optode 3830 can give either absolute oxygen concentration in µM or air saturation in %. The setting of the internal property "Output" [3)], controls the selection of the unit. The coefficients for converting SR10 raw data to engineering units are fixed.

Output = -1	Output = -2
A = 0	A = 0
B = 4.883E-01	B = 1.465E-01
C = 0	C= 0
D = 0	D = 0
Oxygen (uM) = A + BN + CN2 + DN3	Oxygen (%) = A + BN + CN2 + DN3

[3)] *The default output setting is set to -1*

Date:
March 23, 2012

Sign: Shawn A. Sneddon

Service and Calibration Engineer

Aanderaa Data Instruments, Inc.
182 East Street, Suite B Attleboro, MA 02703 Tel. +1 (508) 226-9300 email: infoUSA@xyleminc.com

SBE SEA-BIRD ELECTRONICS, INC.
13431 NE 20th St. Bellevue, Washington 98005 USA
Phone: (425) 643-9866 Fax: (425) 643-9954 www.seabird.com

Service Report

RMA Number 66958

Customer Information:

Company	WEBB RESEARCH CORPORATION	**Date**	1/12/2012
Contact	Beth Rizzo		
PO Number	TWR5740		

Serial Number	WEBB Glider-0080
Model Number	WEBB Glider

Services Requested:

1. Evaluate/Repair Instrumentation.
2. Perform Routine Calibration Service.

Problems Found:

1. The anti-foulant devices appeared "dirty".
2. Conductivity cell was found to have been cracked.

Services Performed:

1. Performed initial diagnostic evaluation.
2. Performed "Post Cruise" calibration of the temperature & conductivity sensors.
3. Replaced the conductivity cell.
4. Performed "Final" calibration of the temperature & conductivity sensors.
5. Calibrated the pressure sensor.
6. Installed NEW AF24173 Anti-foulant cylinder(s).
7. Performed complete system check and full diagnostic evaluation.

Special Notes:

SBE **SEA-BIRD ELECTRONICS, INC.**
13431 NE 20th St. Bellevue, Washington 98005 USA
Phone: (425) 643-9866 Fax: (425) 643-9954 www.seabird.com

Temperature Calibration Report

Customer:	WEBB RESEARCH CORPORATION		
Job Number:	66958	**Date of Report:**	12/28/2011
Model Number:	WEBB Glider	**Serial Number:**	WEBB Glider-0080

Temperature sensors are normally calibrated 'as received', without adjustments, allowing a determination sensor drift. If the calibration identifies a problem, then a second calibration is performed after work is completed. The 'as received' calibration is not performed if the sensor is damaged or non-functional, or by customer request.

An 'as received' calibration certificate is provided, listing coefficients to convert sensor frequency to temperature. Users must choose whether the 'as received' calibration or the previous calibration better represents the sensor condition during deployment. In SEASOFT enter the chosen coefficients. The coefficient 'offset' allows a small correction for drift between calibrations (consult the SEASOFT manual). Calibration coefficients obtained after a repair apply only to subsequent data.

'AS RECEIVED CALIBRATION' ☑ Performed ☐ Not Performed

Date: 12/13/2011 Drift since last cal: 0.0000 Degrees Celsius/year

Comments:

'FINAL CALIBRATION' ☑ Performed ☐ Not Performed

Date: 12/28/2011 Drift since 03 Apr 06 0.0000 Degrees Celsius/year

Comments:

SEA-BIRD ELECTRONICS, INC.

13431 NE 20th Street Bellevue, Washington 98005 USA
Phone: (425) 643-9866 Fax: (425) 643-9954 www.seabird.com

Conductivity Calibration Report

Customer:	WEBB RESEARCH CORPORATION		
Job Number:	66958	Date of Report:	12/28/2011
Model Number:	WEBB Glider	Serial Number:	WEBB Glider-0080

Conductivity sensors are normally calibrated 'as received', without cleaning or adjustments, allowing a determination of sensor drift. If the calibration identifies a problem or indicates cell cleaning is necessary, then a second calibration is performed after work is completed. The 'as received' calibration is not performed if the sensor is damaged or non-functional, or by customer request.

An 'as received' calibration certificate is provided, listing the coefficients used to convert sensor frequency to conductivity. Users must choose whether the 'as received' calibration or the previous calibration better represents the sensor condition during deployment. In SEASOFT enter the chosen coefficients. The coefficient 'slope' allows small corrections for drift between calibrations (consult the SEASOFT manual). Calibration coefficients obtained after a repair or cleaning apply only to subsequent data.

'AS RECEIVED CALIBRATION' ☑ Performed ☐ Not Performed

Date: 12/13/2011 Drift since last cal: 0.0000 PSU/month*

Comments:

'CALIBRATION AFTER REPAIR' ☑ Performed ☐ Not Performed

Date: 12/28/2011 Drift since Last Cal: N/A PSU/month*

Comments:
The conductivity cell was replaced.

***Measured at 3.0 S/m**

Cell cleaning and electrode replatinizing tend to 'reset' the conductivity sensor to its original condition. Lack of drift in post-cleaning-calibration indicates geometric stability of the cell and electrical stability of the sensor circuit.

Sea-Bird Electronics, Inc.

13431 NE 20th Street, Bellevue, WA 98005-2010 USA

Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0080
CALIBRATION DATE: 28-Dec-11

WEBB GLIDER TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

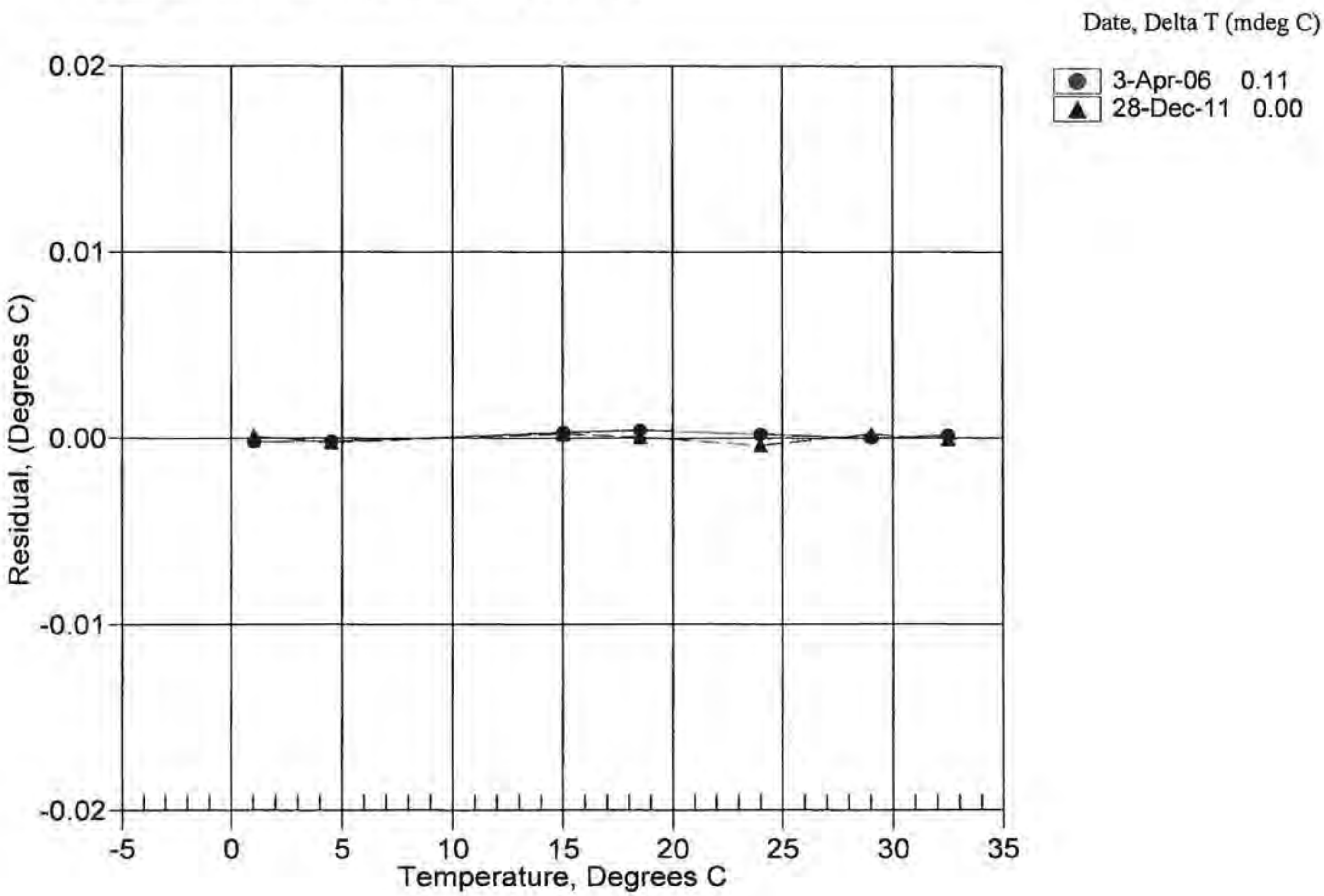
ITS-90 COEFFICIENTS

a0 = 7.461652e-005
a1 = 2.626778e-004
a2 = -1.359031e-006
a3 = 1.315501e-007

BATH TEMP (ITS-90)	INSTRUMENT OUTPUT	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	618337.9	1.0001	0.0001
4.5000	529382.2	4.4998	-0.0002
15.0000	338612.3	15.0002	0.0002
18.5000	293537.2	18.5001	0.0001
24.0000	235887.3	23.9996	-0.0004
29.0000	194510.3	29.0002	0.0002
32.5000	170501.8	32.5000	-0.0000

Temperature ITS-90 = $1/\{a0 + a1[ln(n)] + a2[ln^2(n)] + a3[ln^3(n)]\} - 273.15$ (°C)

Residual = instrument temperature - bath temperature



Sea-Bird Electronics, Inc.

13431 NE 20th Street, Bellevue, WA 98005-2010 USA

Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0080
CALIBRATION DATE: 13-Dec-11

WEBB GLIDER TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

a0 = 1.611751e-005

a1 = 2.763191e-004

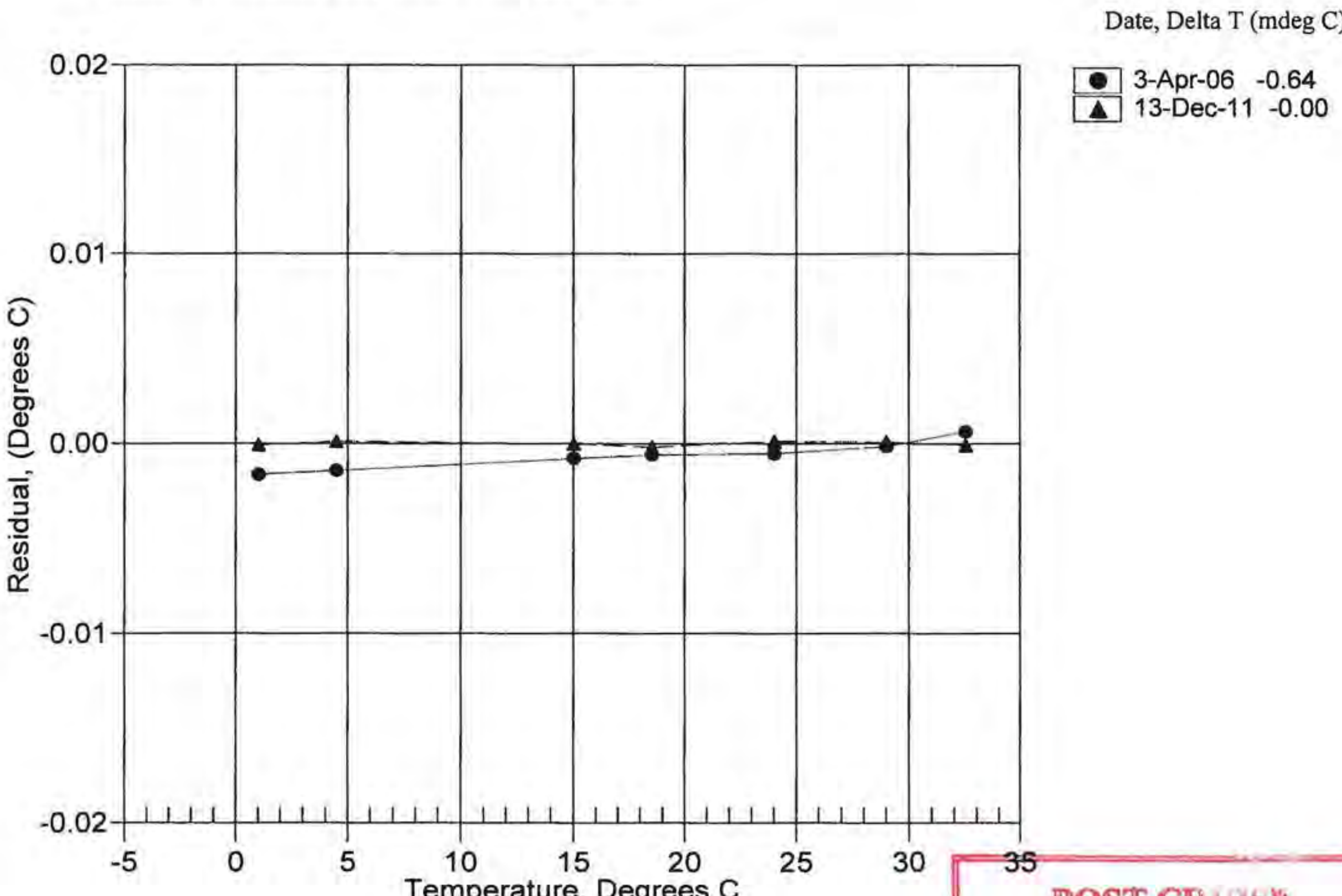
a2 = -2.419495e-006

a3 = 1.590400e-007

BATH TEMP (ITS-90)	INSTRUMENT OUTPUT	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	618303.2	0.9999	-0.0001
4.4999	529347.2	4.5000	0.0001
15.0000	338600.3	15.0000	0.0000
18.5000	293528.2	18.4998	-0.0002
24.0000	235875.9	24.0001	0.0001
29.0000	194510.0	29.0001	0.0001
32.5000	170505.0	32.4999	-0.0001

Temperature ITS-90 = $1/\{a0 + a1[ln(n)] + a2[ln^2(n)] + a3[ln^3(n)]\} - 273.15$ (°C)

Residual = instrument temperature - bath temperature



POST CRUISE CALIBRATION

Sea-Bird Electronics, Inc.

13431 NE 20th Street, Bellevue, WA 98005-2010 USA

Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0080
CALIBRATION DATE: 28-Dec-11

WEBB GLIDER CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

COEFFICIENTS:

g = -9.716705e-001
h = 1.504938e-001
i = -4.127854e-004
j = 5.350662e-005

CPcor = -9.5700e-008
CTcor = 3.2500e-006
WBOTC = -2.6171e-007

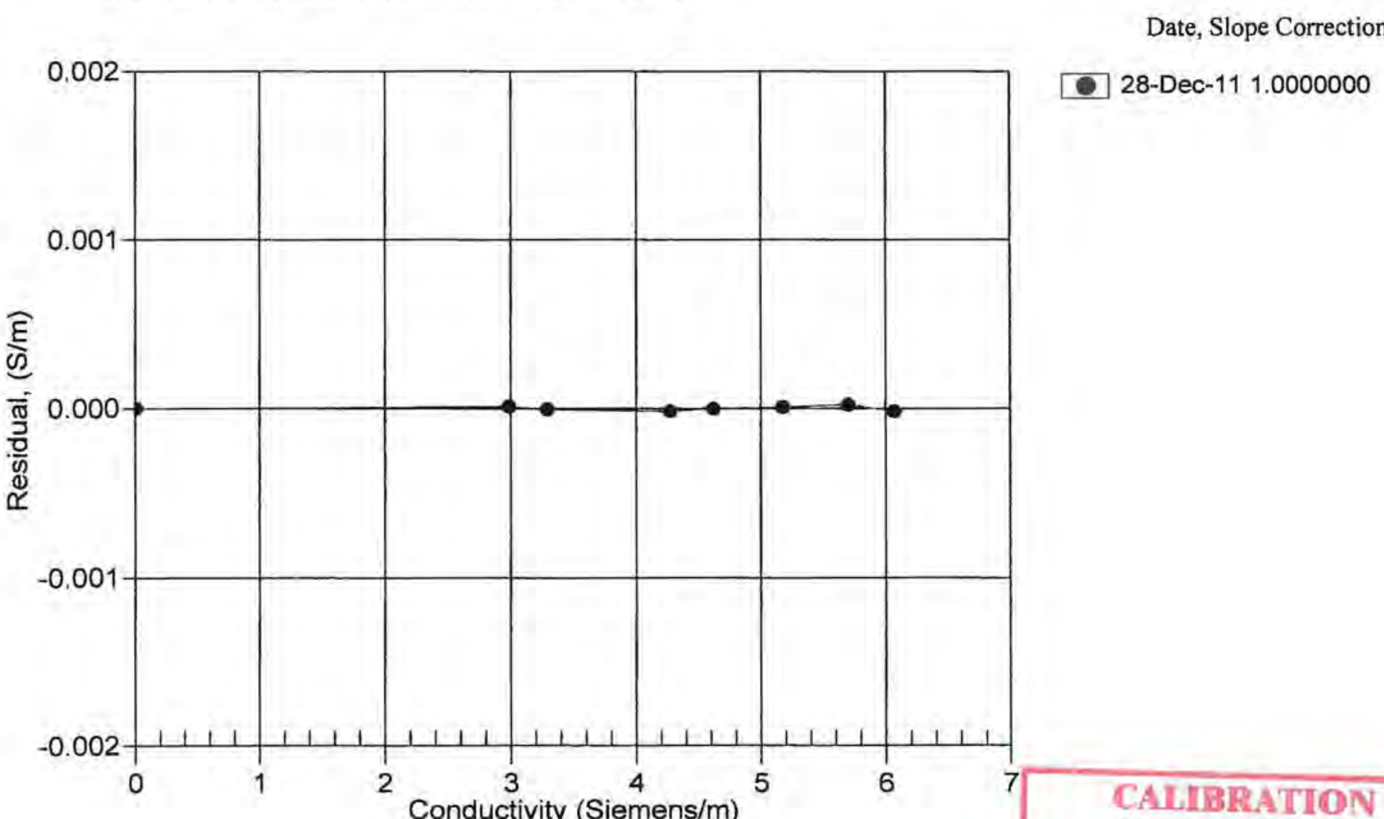
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (Hz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2546.95	0.00000	0.00000
1.0000	34.8719	2.98026	5136.55	2.98027	0.00001
4.5000	34.8512	3.28769	5332.10	3.28769	-0.00001
15.0000	34.8064	4.27053	5913.30	4.27051	-0.00002
18.5000	34.7960	4.61597	6104.17	4.61597	-0.00000
24.0000	34.7843	5.17439	6400.38	5.17440	0.00001
29.0000	34.7763	5.69650	6665.07	5.69653	0.00002
32.5000	34.7690	6.06867	6847.27	6.06866	-0.00002

f = INST FREQ * sqrt(1.0 + WBOTC * t) / 1000.0

Conductivity = $(g + hf^2 + if^3 + jf^4) / (1 + \delta t + \epsilon p)$ Siemens/meter

t = temperature[°C)]; p = pressure[decibars]; δ = CTcor; ϵ = CPcor;

Residual = instrument conductivity - bath conductivity



CALIBRATION AFTER MODIFICATIONS

Sea-Bird Electronics, Inc.

13431 NE 20th Street, Bellevue, WA 98005-2010 USA

Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0080
CALIBRATION DATE: 13-Dec-11

WEBB GLIDER CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

COEFFICIENTS:

g = -1.008199e+000
h = 1.584943e-001
i = -1.616097e-003
j = 1.562222e-004

CPcor = -9.5700e-008
CTcor = 3.2500e-006
WBOTC = -2.6171e-007

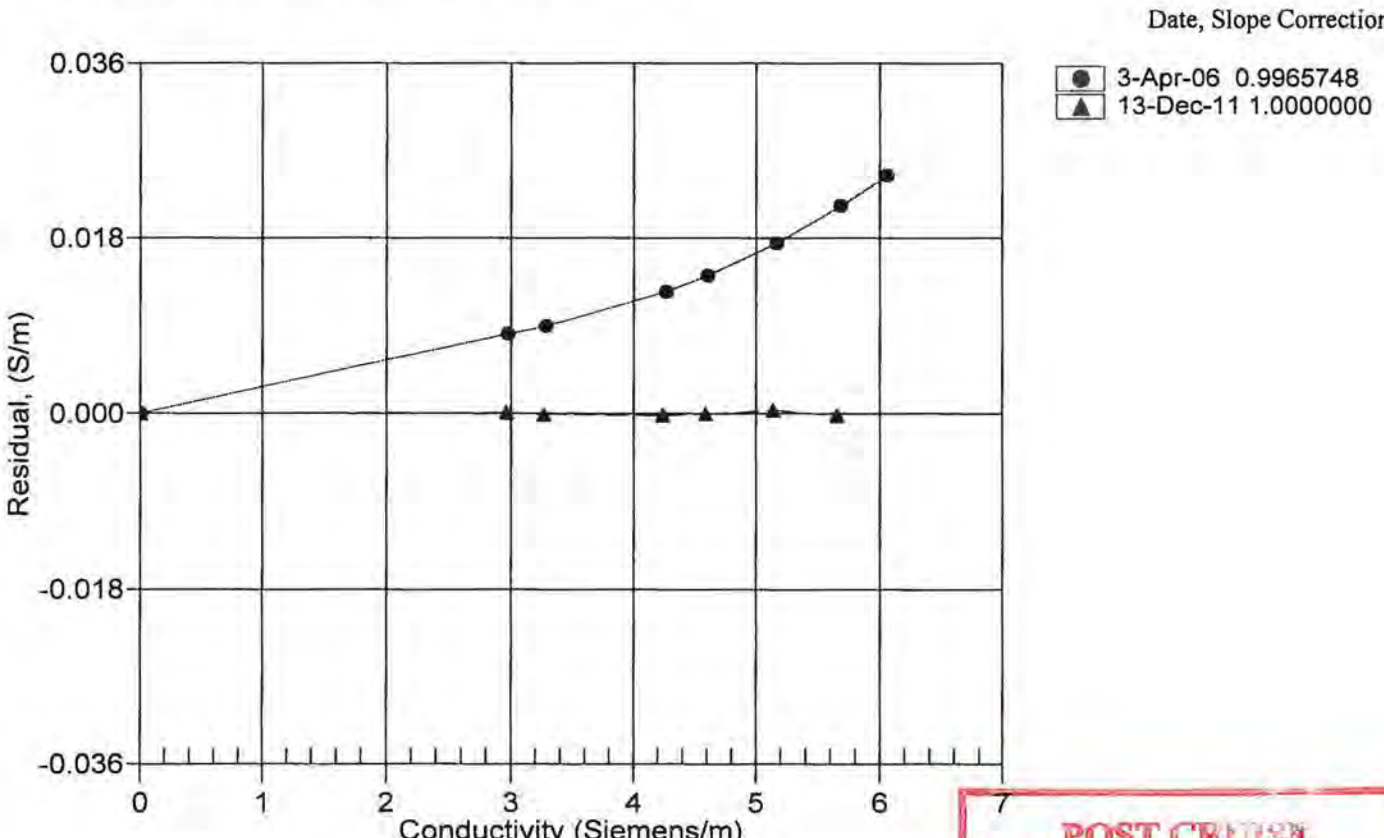
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (Hz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2547.18	0.00000	0.00000
1.0000	34.5773	2.95748	5069.44	2.95760	0.00013
4.4999	34.5570	3.26265	5260.77	3.26256	-0.00009
15.0000	34.5129	4.23831	5829.60	4.23814	-0.00017
18.5000	34.5026	4.58122	6016.35	4.58118	-0.00004
24.0000	34.4905	5.13549	6306.04	5.13585	0.00036
29.0000	34.4809	5.65353	6564.14	5.65336	-0.00017

f = INST FREQ * sqrt(1.0 + WBOTC * t) / 1000.0

Conductivity = $(g + hf^2 + if^3 + jf^4) / (1 + \delta t + \varepsilon p)$ Siemens/meter

t = temperature[°C)]; p = pressure[decibars]; δ = CTcor; ε = CPcor;

Residual = instrument conductivity - bath conductivity



POST CRUISE CALIBRATION

Sea-Bird Electronics, Inc.

13431 NE 20th Street, Bellevue, WA 98005-2010 USA

Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0080
CALIBRATION DATE: 12-Dec-11

WEBB GLIDER PRESSURE CALIBRATION DATA
508 psia S/N 9546

COEFFICIENTS:

PA0 =	4.913720e-002	PTCA0 =	-1.328415e+001
PA1 =	2.405753e-002	PTCA1 =	2.795218e-001
PA2 =	2.642862e-009	PTCA2 =	-8.601787e-003
PTHA0 =	-7.096023e+001	PTCB0 =	2.495812e+001
PTHA1 =	4.952305e-002	PTCB1 =	8.250000e-004
PTHA2 =	-2.968101e-007	PTCB2 =	0.000000e+000

PRESSURE SPAN CALIBRATION

PRESSURE PSIA	INST OUTPUT	THERMISTOR OUTPUT	COMPUTED PRESSURE	ERROR %FSR
14.74	600.1	1886.0	14.75	0.00
105.00	4352.0	1887.0	104.99	-0.00
205.01	8505.7	1891.0	204.99	-0.00
305.00	12656.0	1890.0	305.00	0.00
404.99	16802.1	1891.0	404.99	-0.00
505.00	20944.1	1890.0	504.98	-0.00
405.00	16803.2	1891.0	405.02	0.00
305.01	12657.2	1891.0	305.03	0.00
205.03	8507.1	1890.0	205.03	-0.00
105.04	4353.5	1892.0	105.03	-0.00
14.74	600.0	1893.0	14.75	0.00

THERMAL CORRECTION

TEMP ITS90	PRESS TEMP	INST OUTPUT
32.50	2116.20	612.24
29.00	2042.80	613.19
24.00	1940.70	614.20
18.50	1826.20	614.38
15.00	1754.40	614.57
4.50	1537.40	613.38
1.00	1466.30	612.58

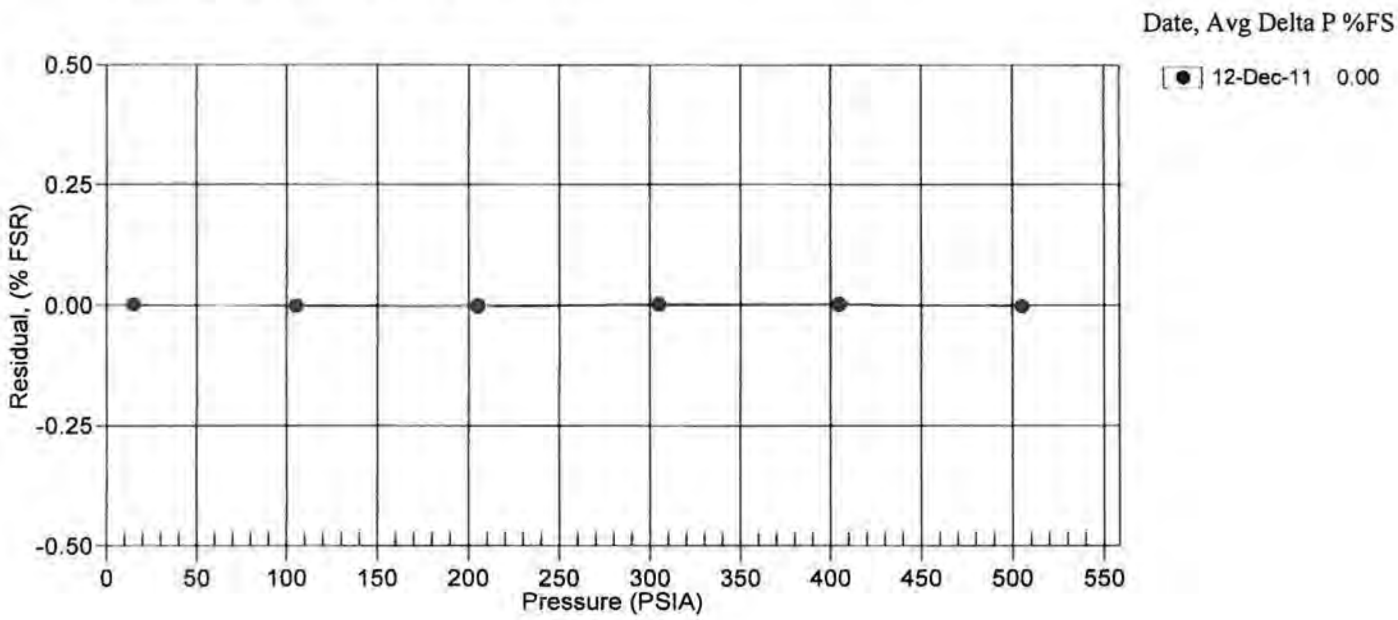
TEMP(ITS90)	SPAN(mV)
-5.00	24.95
35.00	24.99

y = thermistor output; $t = PTEMPA0 + PTEMPA1 * y + PTEMPA2 * y^2$

$x =$ pressure output $- PTCA0 - PTCA1 * t - PTCA2 * t^2$

$n = x * PTCB0 / (PTCB0 + PTCB1 * t + PTCB2 * t^2)$

pressure (psia) $= PA0 + PA1 * n + PA2 * n^2$



SonTek
a xylem brand

9940 Summers Ridge Road
San Diego, CA 92121
Tel: (858) 546-8327
support@sontek.com

CALIBRATION CERTIFICATE

System Info

System Type	CastAway-CTD
Serial Number	CC1218002
Firmware Version	0.26
Calibration Date	5/21/2012

Power

Standby Mode (A)	0.2067 / PASS
Supply Voltage	2.9V

Calibration

Pressure	Passed
Conductivity	Passed
Temperature	Passed
GPS	Passed

Verified by: nvnguyen

Date: 5/22/2012

SonTek
a xylem brand

9940 Summers Ridge Road
San Diego, CA 92121
Tel: (858) 546-8327
support@sontek.com

CALIBRATION CERTIFICATE

System Info

System Type	CastAway-CTD
Serial Number	11D101493
Firmware Version	0.26
Calibration Date	5/30/2012

Power

Standby Mode (A)	0.2094 / PASS
Supply Voltage	2.9V

Calibration

Pressure	Passed
Conductivity	Passed
Temperature	Passed
GPS	Passed

Verified by: dshumway

Date: 6/1/2012

Appendix E

Deployment 4
7/10/2012 – 7/30/2012

Pre-Deployment Check Out

GLIDER	RU28
PREPARER	Dave A + interns
PREP DATE	7/9/2012
LOCATION	NJDEP #2 Sandy Hook

SCIENCE BAY SERIAL NUMBERS	
1)	MA 20512 (0103P)
2)	1504 (RU28ORI)
3)	
4)	

PRE-SEAL

FORE CHECK

Check pump & pitch threaded rod (grease & clean if necessary) ✓

Grounded Nose? —

Leak detect in place, batteries secure, white guides free, no metal shavings, bottles installed ✓

PAYLOAD CHECK

Special Sensors / Additional Sensors

1) —

2) —

CTD cable clear, no leak at CTD joint, no leak at pucks ✓

Grounded Parts: Fore Sci Ring — Aft Sci Ring —

CTD — Other? —

Science Bay Weight Configuration —

AFT CHECK

Iridium Card Installed (SIM #) (if not standard) ✓

Flash Card: old data removed? —

Inspect strain on connectors (worn connectors), battery secured, ballast bottle present, aft cap clean/clear of leak ✓

Aft cap grounded? ✓

Battery check

Aft Pack - J13 Voltage 15.84

Pitch Pack - J13 Voltage 15.89

Nose Packs - J13 Voltage 15.75

Aft Emer - J31 Voltage 15.91

POST-SEAL

GENERAL

Pick Point Present? N

Special Instruments? N

HARDWARE

put c_alt_time 0, verify alt chirp ✓

Nose Cone and pump bladder inspection ✓

Anode grounded? ✓

Anode size / remainder (est) —

Pressure Sensor Check (corrosion, clear)

Aft sensor —

Payload sensor —

Ejection weight assembly OK and unseized? ✓

POWERED

Verify Argos ping ✓

Wiggle for 5 minutes ✓

Stabilized m_battery 15.3

m_vacuum @ T @ ballast 6.12

OUTSIDE

Compass Check (reading @ compass)

1) see attached

2)

3)

4)

GPS check

(lat) ✓ (lon) ✓

Iridium connect ✓ Alt ✓

zero_ocean_pressure, get m_pressure 0

logging on; rotate slowly 360, logging off, plot data: 360 test ✓

let air bladder inflate, does it shut off? ✓

SOFTWARE

GENERAL

Version 7.9
Date OK?
delete old logs

Re-burn latest software image
configure TBDlist
NBDlist

\CONFIG

simul.sim deleted

\MAFILES

goto_l10.ma (set x_last_...)

AUTOEXEC.MI

Irid Main: 88160000592
Irid Alt: 15085482446
u_iridium_failover_retries = 10
Reset the glider, observe any errors

c_ctd41cp_num_fields_to_send 4
Calibration coefficients
f_ballast_pumped_deadz_width = 30?
get f_max_working_depth (102 m) 31 m

CACHE MANAGEMENT

del ..\state\cache*.*
after *bdlist.dat are set (exit reset):
logging on; logging off
send ..\state\cache*.cac
send *.mbd *.sbd *.tbd

* **Software Burning Tips :** if using Procomm or local folder, copy all the files from the software image locally. Then proceed to edit them for the glider and do a mass freewave transfer of the files. Save these files or prepare the to-glider with these files

SCIENCE

SENSOR RETURN

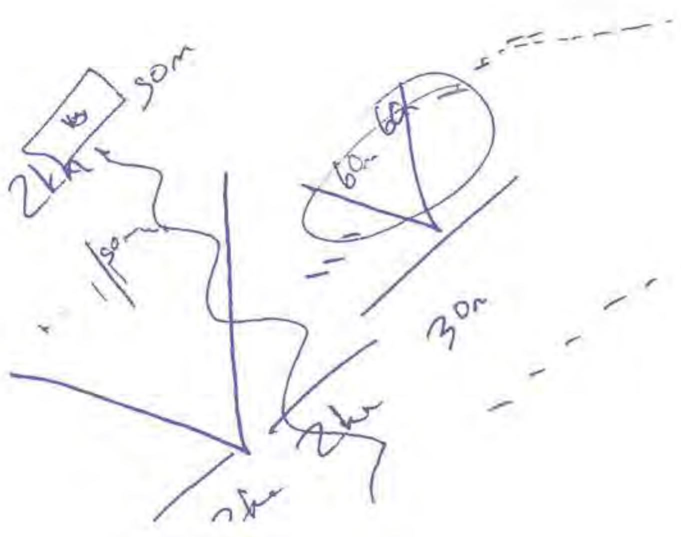
put c_science_send_all 1
put c_science_all_on 8
put c_science_on 3
All sensors reporting values?

CTD

Tank static comparison OK?

OPTODE

Check in completed?



7/5/2012

RU28 compass check

00070000.f

1) 204° → 3.59

5.32 5.32

2) 4.52 241° → 4.55

3) 5.80 333° → 5.81

4) 3.423 20° → ~~319~~ 24

5) 1.58 87° → 1.518

4) 2.79 162° → 159.6

⇓

C	G
1) 206°	202.3
2) 261	259
3) 333	332.4
4) 20	24.24
5) 87	90.54
6) 162	159.9

sting\ru28 (permission denied)\2012_07_03 ru28 NJDEP # 2.xls

			MASS (g)	COMMENTS
Deployment	GLIDER	FORE STEM (altimeter bottle)	9345.8	
2012 NJDEP # 2		FORE HULL	4905.2	
		AFT STEM (red plug, card)	6443	w/o bottle, w/ fish finder, w/optode
Glider		AFT HULL	4868.7	
ru28		COWLING	1154.5	
		SCREWS (vacuum, cowling, aft battery)	17.1	
Date	PAYLOAD	PAYLOAD BAY	11924.3	wing rails, w/o aft cable plate, w/ VMC
7/9/2012		WINGS		1 CF, 1 regular, did not weigh in air
Preparer		OTHER		
David Aragon	BATTERIES	AFT BATTERY	9069.6	
		PITCH BATTERY	9340.8	
Air temp		FORE BATTERY 1, 2	1451.4	727.5 and 728.9
20	WEIGHT BOTTLES	AFT BOTTLE	78	
		FORE BOTTLE 1 (starboard)	305	
VMC ADDED LAST MINUTE		FORE BOTTLE 2 (port)	396.8	
		OTHER		

Final but added +30g wings during deployment

E-6

Tank Specifics		**Glider Specifics**		**H MOMENT (rad)**		**(deg)**
Tank Density (g/mL)	1.0214	Glider Volume (mL)	58495	Angle of Rotation (before)	0.025	1.4
Tank Temperature (C)	21.81	Total Mass (g)	59300.2	Angle of Rotation (after)	-0.151	-8.7
Weight in Tank (g)	30.00	Glider Density 1 (air) (g/mL)	1.0138	Angle of Rotation	0.176	10.1
Target Specifics		**Volume Change (temperature induced)**		Weight on Spring (after)	382	
Target Density (g/mL)	1.0218	Volume Change (tank) (mL)	7	Weight added	290	
Target Temperature ©	24.00	Volume Change (target) (mL)	7	Radius of Hull	107	
		(note use 53.5 E -6 in above for DE (carbon)) ^		**H-distance**	**6.9**	

(note use 70 E -6 in above for Aluminum hull)

Should Hang (in tank) (g)	18.71	**Adjust Glider Mass (Dunk Volume) (g)**	-11.38
Adjust by: (g)	-11.29	**Adjust Glider Mass (entered volume) (g)**	474.06

^ Ballasting Alternative (known VOLUME) (don't have to weight parts!)

Average Glider Volume	
volume 1:	
volume 2:	
volume 3:	
average =	#DIV/0!

Calculated Glider Volume (calculated from scales) (mL)	**58019.892**
Glider Density 2 (in target water, using calculated volume above) (kg / m³)	**1021.9**
Glider Density 3 (in target water, using entered volume) (kg / m³)	**1013.6**
Glider Density 4 (in target water, using entered volume) (kg / m³)	**1021.94**

MISC Items Masses/Volumes		
PICK POINT VOLUME	40.4 mL	107 g air / 66 g Water
G1 Volume	50.9 L	
VMT35 Transceiver (w/ mount)	161 mL	148 g weight in water

1019.56

2.38

Ballast Sheet (6)

BALLAST ITERATIONS **GLIDER:** RU 28 **DATE:** 7/9/12

ITERATION 5

F	SB	A

~~90~~ 54 ~~48~~ 76

Ballast Bottles

FORE 1	305
FORE 2	
AFT	78.0

v/VMT mounted

TANK: T = 18.66
(SB19) C = 4.242
D = 1022

TANK: T = 18.664
(Glider) C = 4.239

NOTES

F A
40 -7.4
+90 -57
130 49.6
-20 +20
-73.5 -73.5
want -147
-93.5 -53.5
-147
= 70g

ITERATION

F	SB	A

Ballast Bottles

FORE 1	
FORE 2	
AFT	

TANK: T =
(SB19) C =
D =

TANK: T =
(Glider) C =

NOTES

roll = .02
T = 22.956
C = 4.6595
-40

ITERATION

F	SB	A

Ballast Bottles

FORE 1	
FORE 2	
AFT	

TANK: T =
(SB19) C =
D =

TANK: T =
(Glider) C =

NOTES

0,29

BALLAST ITERATIONS **GLIDER:** RU28 **DATE:** 7/9/12

ITERATION 4

F	SB	A

~~80~~ 40 ~~58~~ 48

Ballast Bottles

FORE 1	377.4
FORE 2	396.8
AFT	72.2

TANK: T = ~~18.66~~ **TANK:** T = ~~18.664~~
(SB19) C = ~~4.242~~ (Glider) C = ~~4.239~~
D = ~~1022~~

NOTES

F A
94 182
+178 want -122g
+44 -44
-89 -89
-61 -61
$\boxed{+72 \quad -194}$ => -122

SB19: T = 21.813
C = 4.55
D = 1021.728
roll = -.02

= 116g

ITERATION

F	SB	A

Ballast Bottles

FORE 1	
FORE 2	
AFT	

BW = 127
YO = 122g
CF = 92g

TANK: T = **TANK:** T =
(SB19) C = (Glider) C =
D =

NOTES
yellow original wings = 244gr
black wings = 254g
carbon fiber = 184g

F A
40 -68

1 YO, 1CF => 214 => -30g

ITERATION

F	SB	A

Ballast Bottles

FORE 1	
FORE 2	
AFT	132.8

TANK: T = **TANK:** T =
(SB19) C = (Glider) C =
D =

NOTES
VMT ballast 7/9/2012
F A

40 -68
+60.6
40 -7.4 (1021.8) + UMT
+90 +57 VMT adds proportions
130 49.6
-20 +20
+70 +77 => +147 want +0

+70 +77
+50 +97 → +147

BALLAST ITERATIONS **GLIDER:** RU28 **DATE:** 7/3/12

ITERATION 1

F | SB | A

110 144

Ballast Bottles

FORE 1	428.3
FORE 2	417.9
AFT	417.5

NOTES

-276.29

TANK: T = 20.326
(SB19) C = 4.406
D = 1022.1

TANK: T = 20.328
(Glider) C = 4.403

ITERATION 2

112 120

F | SB | A

94 96

Ballast Bottles

FORE 1	367.7
FORE 2	357.2
AFT	259.1

NOTES

+19.71

F A
-18 -24 want +17
-3 +3 actually add +25
-21 -21
+25 -25
+25
-4 -4
add ~ 25g to tail

TANK: T =
(SB19) C =
D =

TANK: T =
(Glider) C =

ITERATION 3

Ø

F | SB | A

94 182

Ballast Bottles

FORE 1	
FORE 2	
AFT	267.3

NOTES

roll = .025
@ = 178g

scale = 382
roll w/weight = -.151
weight ≤ 290

TANK: T =
(SB19) C =
D =

TANK: T =
(Glider) C =

Ballast pump
F A B = 227cc weight 480
124 234

F A -224.7 cc
558 226

			MASS (g)	COMMENTS
Deployment	GLIDER	FORE STEM (altimeter bottle)	9345.8	
NJDEP #2		FORE HULL	4905.2	
		AFT STEM (red plug, card)	6443	w/o bottle, w/ fish finder, w/optode
Glider		AFT HULL	4868.7	
RU28		COWLING	1154.5	
		SCREWS (vacuum, cowling, aft battery)	17.1	
Date	PAYLOAD	PAYLOAD BAY	11604.3	wing rails, w/o aft cable plate
7/9/12		WINGS	485.8	262.5 port side, 253.3 starboard side
Preparer		OTHER		
	BATTERIES	AFT BATTERY	9069.6	
		PITCH BATTERY	9340.8	
Air temp		FORE BATTERY 1, 2	1451.4	727.5 and 728.9
20	WEIGHT BOTTLES	AFT BOTTLE	132.8	
		FORE BOTTLE 1 (starboard)	397.4	
final		FORE BOTTLE 2 (port)	396.8	
		OTHER		

E-10

Tank Specifics		Glider Specifics		H MOMENT (rad)		(deg)
Tank Density (g/mL)		Glider Volume (mL)	58335	Angle of Rotation (before)	0.025	1.4
Tank Temperature (C)	21.81	Total Mass (g)	59613.2	Angle of Rotation (after)	-0.151	-8.7
Weight in Tank (g)		Glider Density 1 (air) (g/mL)	1.0219	Angle of Rotation	0.176	10.1
Target Specifics		**Volume Change (temperature induced)**		Weight on Spring (after)	382	
Target Density (g/mL)	1.0218	Volume Change (tank) (mL)	7	Weight added	290	
Target Temperature ©	24.00	Volume Change (target) (mL)	7	Radius of Hull	107	
		(note use 53.5 E -6 in above for DE (carbon)) ^		**H-distance**	**6.9**	

(note use 70 E -6 in above for Aluminum hull)

Should Hang (in tank) (g)	59610.76	**Adjust Glider Mass (Dunk Volume) (g)**	#DIV/0!
Adjust by: (g)	59610.76	**Adjust Glider Mass (entered volume) (g)**	-2.44

^ Ballasting Alternative (known VOLUME) (don't have to weight parts!)

Average Glider Volume	
volume 1:	58320
volume 2:	58335
volume 3:	
average =	58327.5

Calculated Glider Volume (calculated from scales) (mL)	#DIV/0!
Glider Density 2 (in target water, using calculated volume above) (kg / m³)	#DIV/0!
Glider Density 3 (in target water, using entered volume) (kg / m³)	1021.8
Glider Density 4 (in target water, using entered volume) (kg / m³)	0.00

MISC Items Masses/Volumes

PICK POINT VOLUME	40.4 mL	107 g air / 66 g Water
G1 Volume	50.9 L	
VMT35 Transceiver (w/ mount)	161 mL	

Ballast Pump Size

Glider Density	1.0218
Glider Mass	59708
Tank Density	1.0221

		Glider Reported pump_volume	Resultant Volume (in air/tank)
Full Retract Scale Weight	304	-224.7	58119.95
Full Extend Scale Weight	-122	227	58536.74

Original Volume	58320		

		% Matched	Max Density Range	
Pump Size	416.789	108.4%	**3.65**	+- sigma
Pump Size (retracted)	-216.738	98.1%	**1025.72**	Max Density (in target)
Pump Size (extended)	200.0509	106.5%	**1018.42**	Min Density (in target)

DISCLAIMER – make sure all values are correct, and accurate, dependencies are exact dunk weights, tank density and temperature, as well as units

Iter 3

58335
59613.2

Deployment	2012 NJDEP # 2
Glider	ru28
Date	7/9/2012
Preparer	David Aragon
Air temp	20

4

		MASS (g)	COMMENTS
GLIDER	FORE STEM (altimeter bottle)	9345.8	
	FORE HULL	4905.2	
	AFT STEM (red plug, card)	6443	w/o bottle, w/ fish finder, w/optode
	AFT HULL	4868.7	
	COWLING	1154.5	
	SCREWS (vacuum, cowling, aft battery)	17.1	
PAYLOAD	PAYLOAD BAY	11604.3	wing rails, w/o aft cable plate
	WINGS	515.8	262.5 port side, 253.3 starboard side
	OTHER		
BATTERIES	AFT BATTERY	9069.6	
	PITCH BATTERY	9340.8	
	FORE BATTERY 1, 2	1451.4	727.5 and 728.9
WEIGHT BOTTLES	AFT BOTTLE	72.2	
	FORE BOTTLE 1 (starboard)	397.4	
	FORE BOTTLE 2 (port)	396.8	
	OTHER		

Tank Specifics		Glider Specifics		H MOMENT (rad)		(deg)
Tank Density (g/mL)	1.0217	Glider Volume (mL)	58335	Angle of Rotation (before)	0.025	1.4
Tank Temperature (C)	21.81	Total Mass (g)	59582.6	Angle of Rotation (after)	-0.151	-8.7
Weight in Tank (g)	-28.00	Glider Density 1 (air) (g/mL)	1.0214	Angle of Rotation	0.176	10.1
Target Specifics		**Volume Change (temperature induced)**		Weight on Spring (after)	382	
Target Density (g/mL)	1.0218	Volume Change (tank) (mL)	7	Weight added	290	
Target Temperature ©	24.00	Volume Change (target) (mL)	7	Radius of Hull	107	
		(note use 53.5 E -6 in above for DE (carbon)) ^		**H-distance**	**6.9**	
		(note use 70 E -6 in above for Aluminum hull)				

Should Hang (in tank) (g)	0.69	**Adjust Glider Mass (Dunk Volume) (g)**	28.69
Adjust by: (g)	28.69	**Adjust Glider Mass (entered volume) (g)**	28.16

^ Ballasting Alternative (known VOLUME) (don't have to weight parts!)

Calculated Glider Volume (calculated from scales) (mL)	**58335.521**
Glider Density 2 (in target water, using calculated volume above) (kg / m³)	**1021.3**
Glider Density 3 (in target water, using entered volume) (kg / m³)	**1021.3**
Glider Density 4 (in target water, using entered volume) (kg / m³)	**1021.26**

Average Glider Volume

volume 1:	58320
volume 2:	58335
volume 3:	
average =	58327.5

MISC Items Masses/Volumes

PICK POINT VOLUME	40.4 mL	107 g air / 66 g Water
G1 Volume	50.9 L	
VMT35 Transceiver (w/ mount)	161 mL	

Deployment			MASS (g)	COMMENTS
2012 NJDEP # 2	GLIDER	FORE STEM (altimeter bottle)	9345.8	
		FORE HULL	4905.2	
		AFT STEM (red plug, card)	6443	w/o bottle, w/ fish finder, w/optode
Glider		AFT HULL	4868.7	
ru28		COWLING	1154.5	
		SCREWS (vacuum, cowling, aft battery)	17.1	
Date	PAYLOAD	PAYLOAD BAY	11604.3	wing rails, w/o aft cable plate
7/9/2012		WINGS	515.8	262.5 port side, 253.3 starboard side
Preparer		OTHER		
David Aragon	BATTERIES	AFT BATTERY	9069.6	
		PITCH BATTERY	9340.8	
Air temp		FORE BATTERY 1, 2	1451.4	727.5 and 728.9
20	WEIGHT BOTTLES	AFT BOTTLE	267.3	
		FORE BOTTLE 1 (starboard)	367.7	
3		FORE BOTTLE 2 (port)	357.2	
		OTHER		

Tank Specifics		Glider Specifics		H MOMENT (rad)		(deg)
Tank Density (g/mL)	1.0221	Glider Volume (mL)	58320	Angle of Rotation (before)	0.025	1.4
Tank Temperature (C)	20.33	Total Mass (g)	59708.4	Angle of Rotation (after)	-0.151	-8.7
Weight in Tank (g)	98.00	Glider Density 1 (air) (g/mL)	1.0238	Angle of Rotation	0.176	10.1
Target Specifics		**Volume Change (temperature induced)**		Weight on Spring (after)	382	
Target Density (g/mL)	1.0215	Volume Change (tank) (mL)	1	Weight added	290	
Target Temperature ©	24.00	Volume Change (target) (mL)	11	Radius of Hull	107	
		(note use 53.5 E -6 in above for DE (carbon)) ^		**H-distance**	**6.9**	
		(note use 70 E -6 in above for Aluminum hull)				

Should Hang (in tank) (g)	-24.64	**Adjust Glider Mass (Dunk Volume) (g)**	-122.64
Adjust by: (g)	-122.64	**Adjust Glider Mass (entered volume) (g)**	-122.81

^ Ballasting Alternative (known VOLUME) (don't have to weight parts!)

Calculated Glider Volume (calculated from scales) (mL)	**58320.164**
Glider Density 2 (in target water, using calculated volume above) (kg / m³)	**1023.6**
Glider Density 3 (in target water, using entered volume) (kg / m³)	**1023.6**
Glider Density 4 (in target water, using entered volume) (kg / m³)	**1023.60**

Average Glider Volume

volume 1:	58320
volume 2:	
volume 3:	
average =	58320

MISC Items Masses/Volumes

PICK POINT VOLUME 40.4 mL 107 g air / 66 g Water

G1 Volume 50.9 L

VMT35 Transceiver (w/ mount) 161 mL

Deployment			MASS (g)	COMMENTS
2012 NJDEP # 2	GLIDER	FORE STEM (altimeter bottle)	9345.8	
		FORE HULL	4905.2	
Glider		AFT STEM (red plug, card)	6180.2	w/o bottle
ru28		AFT HULL	4868.7	
		COWLING	1154.5	
		SCREWS (vacuum, cowling, aft battery)	17.1	
Date	PAYLOAD	PAYLOAD BAY	11611.3	wing rails
7/9/2012		WINGS	515.8	262.5 port side, 253.3 starboard side
Preparer		OTHER		
David Aragon	BATTERIES	AFT BATTERY	9069.6	
		PITCH BATTERY	9340.8	
Air temp		FORE BATTERY 1, 2	1451.4	727.5 and 728.9
20	WEIGHT BOTTLES	AFT BOTTLE	259.1	
		FORE BOTTLE 1 (starboard)	367.7	
Z		FORE BOTTLE 2 (port)	357.2	
		OTHER		

Tank Specifics		Glider Specifics		H MOMENT (rad)		(deg)
Tank Density (g/mL)	1.0221	Glider Volume (mL)	58190.9	Angle of Rotation (before)		0.0
Tank Temperature (C)	20.33	Total Mass (g)	59444.4	Angle of Rotation (after)		0.0
Weight in Tank (g)	-42.00	Glider Density 1 (air) (g/mL)	1.0215	Angle of Rotation	0	0.0
Target Specifics		**Volume Change (temperature induced)**		Weight on Spring (after)		
Target Density (g/mL)	1.0215	Volume Change (tank) (mL)	1	Weight added	290	
Target Temperature ©	24.00	Volume Change (target) (mL)	11	Radius of Hull	107	
		(note use 53.5 E -6 in above for DE (carbon)) ^		**H-distance**	**#DIV/0!**	
		(note use 70 E -6 in above for Aluminum hull)				

Should Hang (in tank) (g)	-24.59	**Adjust Glider Mass (Dunk Volume) (g)**	17.41
Adjust by: (g)	17.41	**Adjust Glider Mass (entered volume) (g)**	9.29

^ Ballasting Alternative (known VOLUME) (don't have to weight parts!)

Calculated Glider Volume (calculated from scales) (mL)	**58198.848**
Glider Density 2 (in target water, using calculated volume above) (kg / m³)	**1021.2**
Glider Density 3 (in target water, using entered volume) (kg / m³)	**1021.3**
Glider Density 4 (in target water, using entered volume) (kg / m³)	**1021.20**

Average Glider Volume

volume 1:	58182.9
volume 2:	58198.85
volume 3:	
average =	58190.88

MISC Items Masses/Volumes

PICK POINT VOLUME 40.4 mL — 107 g air / 66 g Water

G1 Volume 50.9 L

VMT35 Transceiver (w/ mount) 161 mL

O:\coolgroup\Gliders\Check Out Sheets, Ballasting, Labels, Forms, etc\Glider Ballas... (permission den... 03 ru28 NJDEP # 2.xls

Deployment			MASS (g)	COMMENTS
2012 NJDEP # 2	GLIDER	FORE STEM (altimeter bottle)	9345.8	
		FORE HULL	4905.2	
Glider		AFT STEM (red plug, card)	6180.2	w/o bottle
ru28		AFT HULL	4868.7	
		COWLING	1154.5	
		SCREWS (vacuum, cowling, aft battery)	17.1	
Date	PAYLOAD	PAYLOAD BAY	11611.3	wing rails
7/9/2012		WINGS	515.8	262.5 port side, 253.3 starboard side
Preparer		OTHER		
David Aragon	BATTERIES	AFT BATTERY	9069.6	
		PITCH BATTERY	9340.8	
Air temp		FORE BATTERY 1, 2	1451.4	727.5 and 728.9
20	WEIGHT BOTTLES	AFT BOTTLE	417.5	
		FORE BOTTLE 1 (starboard)	428.3	
		FORE BOTTLE 2 (port)	417.9	
		OTHER		

Tank Specifics		Glider Specifics		H MOMENT (rad)		(deg)
Tank Density (g/mL)	1.0221	Glider Volume (mL)	58182.9	Angle of Rotation (before)		0.0
Tank Temperature (C)	20.33	Total Mass (g)	59724.1	Angle of Rotation (after)		0.0
Weight in Tank (g)	254.00	Glider Density 1 (air) (g/mL)	1.0265	Angle of Rotation	0	0.0
Target Specifics		**Volume Change (temperature induced)**		Weight on Spring (after)		
Target Density (g/mL)	1.0220	Volume Change (tank) (mL)	1	Weight added	290	
Target Temperature ©	15.00	Volume Change (target) (mL)	-17	Radius of Hull	107	
		(note use 53.5 E -6 in above for DE (carbon)) ^		**H-distance**	#DIV/0!	
		(note use 70 E -6 in above for Aluminum hull)				

Should Hang (in tank) (g)	-24.12	**Adjust Glider Mass (Dunk Volume) (g)**	-278.12
Adjust by: (g)	-278.12	**Adjust Glider Mass (entered volume) (g)**	-278.12

^ Ballasting Alternative (known VOLUME) (don't have to weight parts!)

Calculated Glider Volume (calculated from scales) (mL)	**58182.901**
Glider Density 2 (in target water, using calculated volume above) (kg / m³)	**1026.8**
Glider Density 3 (in target water, using entered volume) (kg / m³)	**1026.8**
Glider Density 4 (in target water, using entered volume) (kg / m³)	**1026.78**

Average Glider Volume

volume 1:	58182.9
volume 2:	
volume 3:	
average =	

MISC Items Masses/Volumes

PICK POINT VOLUME	40.4 mL	107 g air / 66 g Water
G1 Volume	50.9 L	
VMT35 Transceiver (w/ mount)	161 mL	148 g ...

Ballast Sheet

Deployment			MASS (g)	COMMENTS
NJDEP	GLIDER	FORE STEM (altimeter bottle)	9345.8	
		FORE HULL	4905.2	
Glider		AFT STEM (red plug, card)	6180.2	w/o bottle
RU28		AFT HULL	4868.7	
		COWLING	1154.5	
		SCREWS (vacuum, cowling, aft battery)	17.1	
Date	PAYLOAD	PAYLOAD BAY	11611.3	
7/2/12		WINGS	515.8	253.3 262.5 pick point? Fish finder?
Preparer		OTHER		
Shannon Josue	BATTERIES	AFT BATTERY	9069.6	
		PITCH BATTERY	9340.8	
Air temp		FORE BATTERY 1, 2	1451.4	725.0 726.4
20	WEIGHT BOTTLES	AFT BOTTLE	~~417.5~~	259.1
		FORE BOTTLE 1 (starboard)	~~428.3~~	367.7
		FORE BOTTLE 2 (port)	~~417.9~~	357.2
		OTHER		

E-16

Tank Specifics		Glider Specifics		H MOMENT (rad)		(deg)
Tank Density (g/mL)	1.022	Glider Volume (mL)	50800	Angle of Rotation (before)		0.0
Tank Temperature (C)	20.33	Total Mass (g)	0	Angle of Rotation (after)		0.0
Weight in Tank (g)	254.00	Glider Density 1 (air) (g/mL)	0.0000	Angle of Rotation	0	0.0
Target Specifics		**Volume Change (temperature induced)**		Weight on Spring (after)		
Target Density (g/mL)	1.022	Volume Change (tank) (mL)	-71	Weight added	290	
Target Temperature ©	15.00	Volume Change (target) (mL)	0	Radius of Hull	107	
		(note use 53.5 E -6 in above for DE (carbon)) ^		**H-distance**	**#DIV/0!**	

(note use 70 E -6 in above for Aluminum hull)

Should Hang (in tank) (g)	0.00	**Adjust Glider Mass (Dunk Volume) (g)**	#DIV/0!
Adjust by: (g)	0.00	**Adjust Glider Mass (entered volume) (g)**	0.00

^ Ballasting Alternative (known VOLUME) (don't have to weight parts!)

Average Glider Volume

volume 1:

volume 2:

volume 3:

average = #DIV/0!

Calculated Glider Volume (calculated from scales) (mL)	**#DIV/0!**
Glider Density 2 (in target water, using calculated volume above) (kg / m³)	**#DIV/0!**
Glider Density 3 (in target water, using entered volume) (kg / m³)	**0.0**
Glider Density 4 (in target water, using entered volume) (kg / m³)	**0.00**

MISC Items Masses/Volumes

PICK POINT VOLUME	40.4 mL	107 g air / 66 g Water
G1 Volume	50.9 L	Ballast Sheet
VMT35 Transceiver (w/ mount)	161 mL	148 g weight in water

Pre-Deployment Check Out
For
Aanderaa Oxygen Optode

RUTGERS Coastal Ocean Observation Lab

Slocum Glider Aanderaa Optode Check IN/OUT
2 Point Calibration & Calibration Coeffcient Record

OPTODE MODEL, SN: 1504 **IN / OUT** OUT

Calibration Record **PERFORMED BY:** Amanda

CALIBRATION DATE: 3/23/2012

Previous: / *Current:*

C0Coef	4.5E+03	-1.6E+02	3.3E+00	-2.8E-02	**C0Coef**	4.5E+03	-1.6E+02	3.3E+00	-2.8E-02
C1Coef	-2.5E+02	8.0E+00	-1.6E-01	1.3E-03	**C1Coef**	-2.5E+02	8.0E+00	-1.6E-01	1.3E-03
C2Coef	5.7E+00	-1.6E-01	3.1E-03	-2.5E-05	**C2Coef**	5.7E+00	-1.6E-01	3.1E-03	-2.5E-05
C3Coef	-6.0E-02	1.5E-03	-2.8E-05	2.2E-07	**C3Coef**	-6.0E-02	1.5E-03	-2.8E-05	2.2E-07
C4Coef	2.4E-04	-5.3E-06	1.0E-07	-7.1E-10	**C4Coef**	2.4E-04	-5.3E-06	1.0E-07	-7.1E-10

Delta: 0.0

2 point Calibration

0% Point		*100% Point*	
Solution: 15.0 g/ 1500 ml	**Na_2SO_3**	*Solution:* NA	**Na_2SO_3**
Spark Unuit 4 T Probe	**Cross reference**	Castaway	**Cross reference**
23.391	**Temperature**	10.07	**Temperature**
1006.434	**Air Pressure (hPa)**	1006.095	**Air Pressure (hPa)**
Sample Bottle C	**Winkler Label**	Sample A, Sample B	**Winkler Label**
LaMotte 7414 - Azide mod	**Winkler Source**	LaMotte 7414 - Azide mod	**Winkler Source**

Results:		*Results:*	
OPTODE: 71.12	**Dphase**	**OPTODE:** 33.9	**Dphase**
0.02	**% Saturation**	97.34	**% Saturation**
23.03	**Temperature**	10.09	**Temperature**
0.07	**Conc (calculated) (µM)**	338.13	**Conc (calculated) (µM)**
0.03	**% Saturation (calculated)**	96.76	**% Saturation (calculated)**
WINKLER: 0	**Concentration (µM)**	**WINKLER:** 343.75	**Concentration**
(0, 0, 0) (0 - 2 µM)	**(Titrations) (ppm)**	(10.20,10.20)	**(Titrations) (ppm)**
0	**% Saturation**	98.75	**% Saturation**
(worst case @ 2 µM = .04 % or 0%)			

DELTAS:

0.07	**Conc Δ**	0.03	**% Δ**	-5.62	**Conc Δ**	-1.99	**% Δ**
0.361	**Temp Δ**	23.2105	**Temp avg**	-0.02	**Temp Δ**	10.08	**Temp avg**

In-Air Saturation Check

SATURATION: 98.42 **@ TEMP** 25.42 **@ PRESS** 997.968

Sodium Thiosulate Normalization

Normalization (mL) 2 (2.0 ± .1) (EPA Compliance)

Paste config report all from optode

FoilNo	5014	1504	5009			
C0Coef	5014	1504	4537.931	-162.595	3.29574	-0.02793
C1Coef	5014	1504	-250.953	8.02322	-0.1584	0.001311
C2Coef	5014	1504	5.664169	-0.15965	0.003079	-2.5E-05
C3Coef	5014	1504	-0.05994	0.001483	-2.8E-05	2.15E-07
C4Coef	5014	1504	0.000244	-5.3E-06	1E-07	-7.1E-10
Salinity	5014	1504	0			
CalAirPhas	5014	1504	32.99431			
CalAirTem	5014	1504	10.29875			
CalAirPres	5014	1504	1026.47			
CalZeroPh	5014	1504	65.21005			
CalZeroTe	5014	1504	24.86774			
Interval	5014	1504	2			
AnCoef	5014	1504	0	1		
Output	5014	1504	1			
SR10Delay	5014	1504	-1			
SoftwareV	5014	1504	3			
SoftwareB	5014	1504	24			
SR10Delay	5014	1504	-1			
SoftwareV	5014	1504	3			
SoftwareB	5014	1504	24			

Deployment Checklist

Glider RU28 Date 7/10/2012

Pilots Dave, Tina Where SH

Laptop Tina EEpc Vehicle Powerup: **CTRL ^ C (until you get to prompt)!!!**

40 23. 09.5

73 54 12.0

On boat (Remember after 10 min glider will go into mission, as well as on powerup!)	Battery Voltage	15.3	get m_battery
	Vacuum Pressure	8.1	get m_vacuum, should be > 7 for bladder inflation
	Iridium Connection	✓	look for connect dialog & surface dialog, let it dial at prompt
	boot app	✓	boot app
	boot (should report application)	✓	reports boot application
	run status.mi	✓	mission completed normally?
In Water	zero_ocean_pressure	✓	while glider in water
	run od.mi (with or without float, ask RU)	✓	glider should dive and surface, type why? Should say overdepth, if not call
	send *.dbd *.mlg *.sbd	—	"send *.sbd" is most important (this applies moreso to when handed off to iridium)
	run shallow.mi or deep.mi	✓	(glider should dive and not reappear) (report to Rutgers or steam out slowly once it di
	Verify dive; **disconnect freewave** Report to Rutgers		
	Perform CTD Comparison CAST	✓	typically done with RU provided SBE19 or Cast Away CTD
	LAT: 40° 23' 9.5" **LON** 73° 54' 12"		w/ castaway & SB19

Recovery Checklist

Glider RU28

Date 7/30/2012

Pilots Dave

Where EeZee Bree Marina Cape May, NJ NJDEP

Laptop Tina EEPC laptop (not used)

Recovery	get Lat/Lon from email or shore support	☑
	obtain freewave comms obtain lat/lon with where command	☑
	Perform CTD Comparison CAST	☑ castaway
	LAT: 38 54 .1869 LON: 74 48.763 (note instrument type!)	

Post-Deployment Checklist

RUTGERS
Coastal Ocean
Observation Lab

Slocum Glider Check-IN

DATE: 7/30/12

GLIDER: RU28 **SB:** 0057P

Vehicle Powered

1. *Power on vehicle in order to fully retract pump, and/or to deflate air bladder.*
2. *Wiggle vehicle for 5 minutes.*

Vehicle Cleaning (hose down with pressure)

Nose cone

1. Remove nose cone ✓
2. Loosen altimeter screws, and remove altimeter or leave temporarily attached ✓
3. Retract pump ✓
4. Remove altimeter and hose diaphragm removing all sand, sediment, bio oils ✓
5. Clean nose cone and altimeter ✓

Tail cone

1. Remove tail cone ✓
2. Hose and clean anode and air bladder making sure air bladder is completely clean ✓
3. Clean cowling ✓

Wing rails

1. Remove wing rails and hose down ✓

Tail plug cleaning

1. Dip red plug in alcohol and clean plug if especially dirty ✓
2. Re-dip red plug and repeatedly insert and remove to clean the glider plug ✓
3. Compress air glider female connector
4. Lightly silicon red plug and replace in glider once silicon has been dispersed evenly in the plugs ✓

CTD Comparison Check

1. Inspect CTD sensor for any sediment buildup, take pictures of anything suspicious or make note.

Static Tank Test

SBE19		*Glider (SBE41CP or pumped unit)*	
Temperature:	22.112 °C	Temperature:	22.116 °C
Conductivity:	4.692 S/m	Conductivity:	4.695 S/m

CTD Maintenance if comparison is not acceptable (reference SeaBird Application Note 2D)

1. Perform CTD backward/forward flush with 1% Triton X-100 solution
2. Perform CTD backward/forward flush with 500 – 1000 ppm bleach solution
3. Perform the same on a pumped unit, just different approach
4. Repeat comparison test if above results not within T < .01 C, C < .005 S/m

SB19		*Glider (SB41CP or pumped unit)*	
Temperature:		Temperature:	
Conductivity:		Conductivity:	

Vehicle Disassembled

1. Check leak points for water or salt buildup ✓
2. **BACKUP FLASH CARDS** in /coolgroup/gliderData/glider_OS_backups/<glider>/<glider-deploymentID>/<from glider>,<from sb_0xxx>

   DO NOT DELETE DATA OFF CARDS
3. Change permissions on <glider-deploymentID> folder to read, write, execute for owner and group, and read, execute for everyone
4. Remove used batteries and place in return crate ✓
   12.6, 12.62, 12.56, 12.58
5. Re-assemble glider with a vacuum

Manufacturer Calibration Documentation

Aanderaa Optode, Seabird Slocum Payload CTD, YSI Castaway CTD, and Seabird 19 CTD

AADI **CALIBRATION CERTIFICATE**
Form No. 622, Dec 2005

a xylem brand

Sensing Foil Batch No:	5009	**Product:**	5014
Certificate No:	5014W 1504 1129	**Serial No:**	1504
		Calibration Date:	March 23, 2012

This is to certify that this product has been calibrated using the following instruments:

Fluke CHUB E-4	Serial No. A7C677
Fluke 5615 PRT	Serial No. 849155
Fluke 5615 PRT	Serial No. 802054
Honeywell PPT	Serial No. 44074
Calibration Bath model FNT 321-1-40	1

Parameter: Internal Temperature:

Calibration points and readings:

Temperature (°C)	-	-	-	-
Reading (mV)	-	-	-	-

Giving these coefficients

Index	0	1	2	3
TempCoef	2.37279E+01	-3.05951E-02	2.83023E-06	-4.19785E-09

*Note: Temperature calibration NOT performed

Parameter: Oxygen:

	O2 Concentration	Air Saturation
Range:	0-500 μM [1]	0 - 120%
Accuracy[1]:	< ±8μM or ±5%(whichever is greater)	±5%
Resolution:	< 1 μM	< 0.4%
Settling Time (63%):	< 25 seconds	

Calibration points and readings[2]:

	Air Saturated Water	Zero Solution (Na_2SO_3)
Phase reading (°)	3.29943E+01	6.52101E+01
Temperature reading (°C)	1.02988E+01	2.48677E+01
Air Pressure (hPa)	1.02647E+03	

Giving these coefficients

Index	0	1	2	3
PhaseCoef	-6.62372E+00	1.20407E+00	0.00000E+00	0.00000E+00

[1] *Valid for 0 to 2000m (6562ft) depth, salinity 33 - 37ppt*

[2] *The calibration is performed in fresh water and the salinity setting is set to: 0*

Date:
March 23, 2012

Sign: Shawn A. Sneddon

Shawn A. Sneddon

Service and Calibration Engineer

Aanderaa Data Instruments, Inc.
182 East Street, Suite B Attleboro, MA 02703 Tel. +1 (508) 226-9300 email: infoUSA@xyleminc.com

AADI **CALIBRATION CERTIFICATE**

Form No. 621, Dec 2005

a xylem brand

Sensing Foil Batch No: 5009
Certificate No: 3853 5009 40217

Product: O2 Sensing Foil PSt3 3853
Calibration Date: 8 February 2010

Calibration points and phase readings (degrees)

Temperature (°C)		3.97	10.93	20.15	29.32	38.39
Pressure (hPa)		977.00	977.00	977.00	977.00	977.00
O2 in % of O2+N2	0.00	73.18	72.63	71.62	70.72	69.77
	1.00	68.01	67.02	65.42	63.92	62.31
	2.00	64.39	63.19	61.20	59.44	57.57
	5.00	55.80	54.16	51.76	49.56	47.45
	10.00	46.27	44.47	41.97	39.75	37.69
	20.90	35.09	33.38	31.14	29.24	27.56
	30.00	29.85	28.30	28.30	24.64	23.19

Giving these coefficients [1)]

Index	0	1	2	3
C0 Coefficient	4.53793E+03	-1.62595E+02	3.29574E+00	-2.79285E-02
C1 Coefficient	-2.50953E+02	8.02322E+00	-1.58398E-01	1.31141E-03
C2 Coefficient	5.66417E+00	-1.59647E-01	3.07910E-03	-2.46265E-05
C3 Coefficient	-5.99449E-02	1.48326E-03	-2.82110E-05	2.15156E-07
C4 Coefficient	2.43614E-04	-5.26759E-06	1.00064E-07	-7.14320E-10

[1)] *Ask for Form No 621S when this O2 Sensing Foil is used in Oxygen Sensor 3830 with Serial Numbers lower than 184.*

Date:
February 8, 2010

Aanderaa Data Instruments, Inc.
182 East Street, Suite B **Attleboro, MA 02703** **Tel. +1 (508) 226-9300** **email: infoUSA@xyleminc.com**

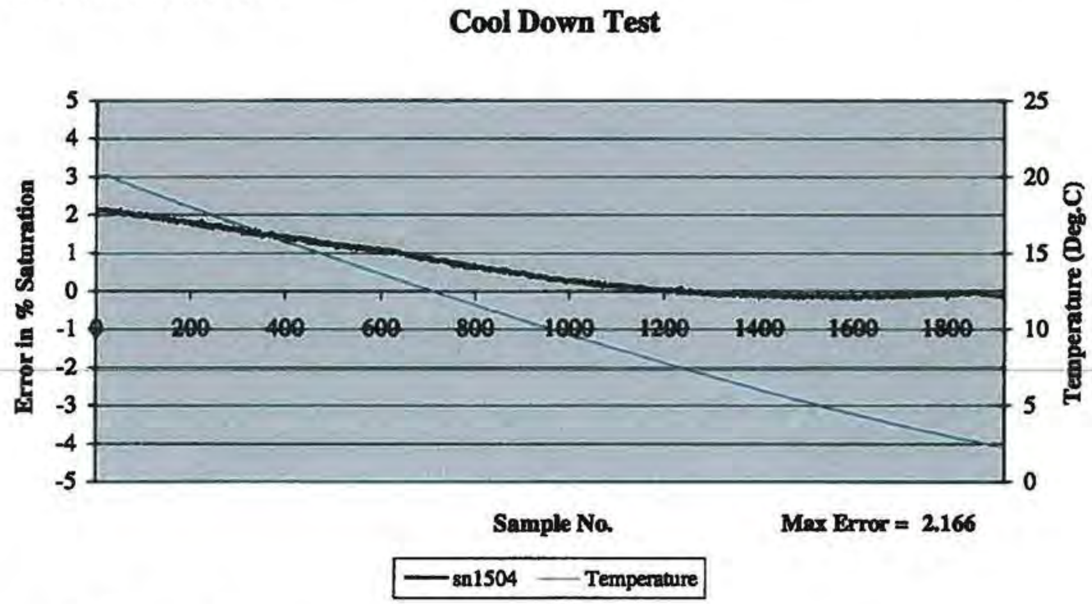
AADI CALIBRATION CERTIFICATE

Form No. 622, Dec 2005

a xylem brand

Sensing Foil Batch No:	5009	**Product:**	5014
Certificate No:	5014W 1504 1129	**Serial No:**	1504
		Calibration Date:	March 23, 2012

Data from Cool Down Test:



SR10 Scaling Coefficients:

At the SR10 output the Oxygen Optode 3830 can give either absolute oxygen concentration in µM or air saturation in %. The setting of the internal property "Output" [3], controls the selection of the unit. The coefficients for converting SR10 raw data to engineering units are fixed.

Output = -1	Output = -2
A = 0	A = 0
B = 4.883E-01	B = 1.465E-01
C = 0	C= 0
D = 0	D = 0
Oxygen (uM) = A + BN + CN2 + DN3	Oxygen (%) = A + BN + CN2 + DN3

[3] *The default output setting is set to -1*

Date:
March 23, 2012

Sign: Shawn A. Sneddon

Service and Calibration Engineer

Aanderaa Data Instruments, Inc.
182 East Street, Suite B Attleboro, MA 02703 Tel. +1 (508) 226-9300 email: infoUSA@xyleminc.com

Sea-Bird Electronics, Inc.

13431 NE 20th Street, Bellevue, WA 98005-2010 USA

Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0103
CALIBRATION DATE: 11-Dec-11

SLOCUM PAYLOAD CTD
TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

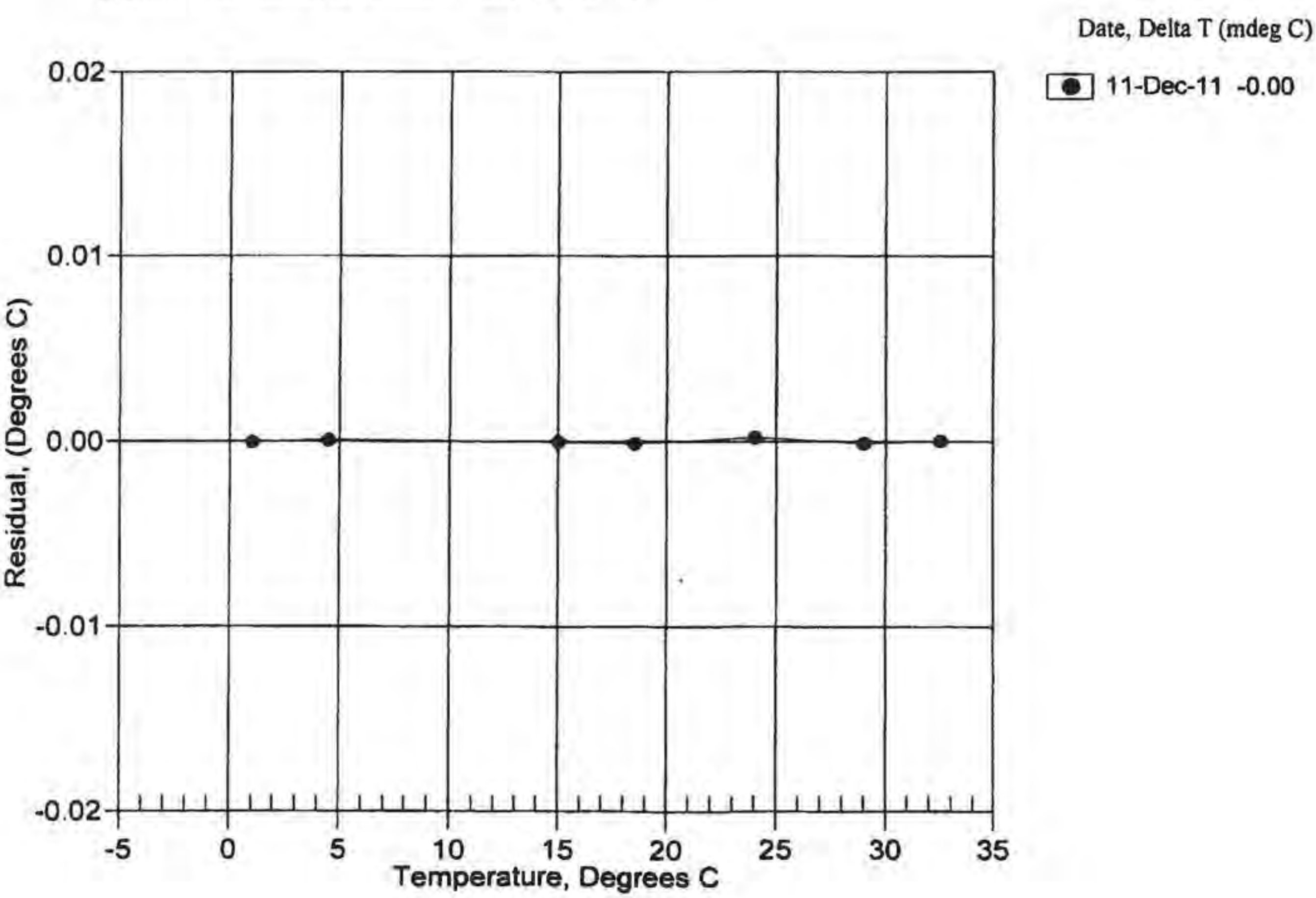
ITS-90 COEFFICIENTS

a0 = -8.443070e-005
a1 = 3.069531e-004
a2 = -4.655974e-006
a3 = 2.044800e-007

BATH TEMP (ITS-90)	INSTRUMENT OUTPUT	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	581271.2	1.0000	-0.0000
4.5000	496277.6	4.5001	0.0001
15.0001	315060.0	15.0001	-0.0000
18.5002	272494.8	18.5001	-0.0001
24.0000	218238.0	24.0002	0.0002
29.0000	179458.2	28.9999	-0.0001
32.5000	157017.6	32.5000	0.0000

Temperature ITS-90 = $1/\{a0 + a1[ln(n)] + a2[ln^2(n)] + a3[ln^3(n)]\} - 273.15$ (°C)

Residual = instrument temperature - bath temperature



Sea-Bird Electronics, Inc.

13431 NE 20th Street, Bellevue, WA 98005-2010 USA

Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0103
CALIBRATION DATE: 11-Dec-11

SLOCUM PAYLOAD CTD
CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

COEFFICIENTS:

g = -9.716254e-001
h = 1.434026e-001
i = -4.364055e-004
j = 5.287390e-005

CPcor = -9.5700e-008
CTcor = 3.2500e-006
WBOTC = 2.5540e-007

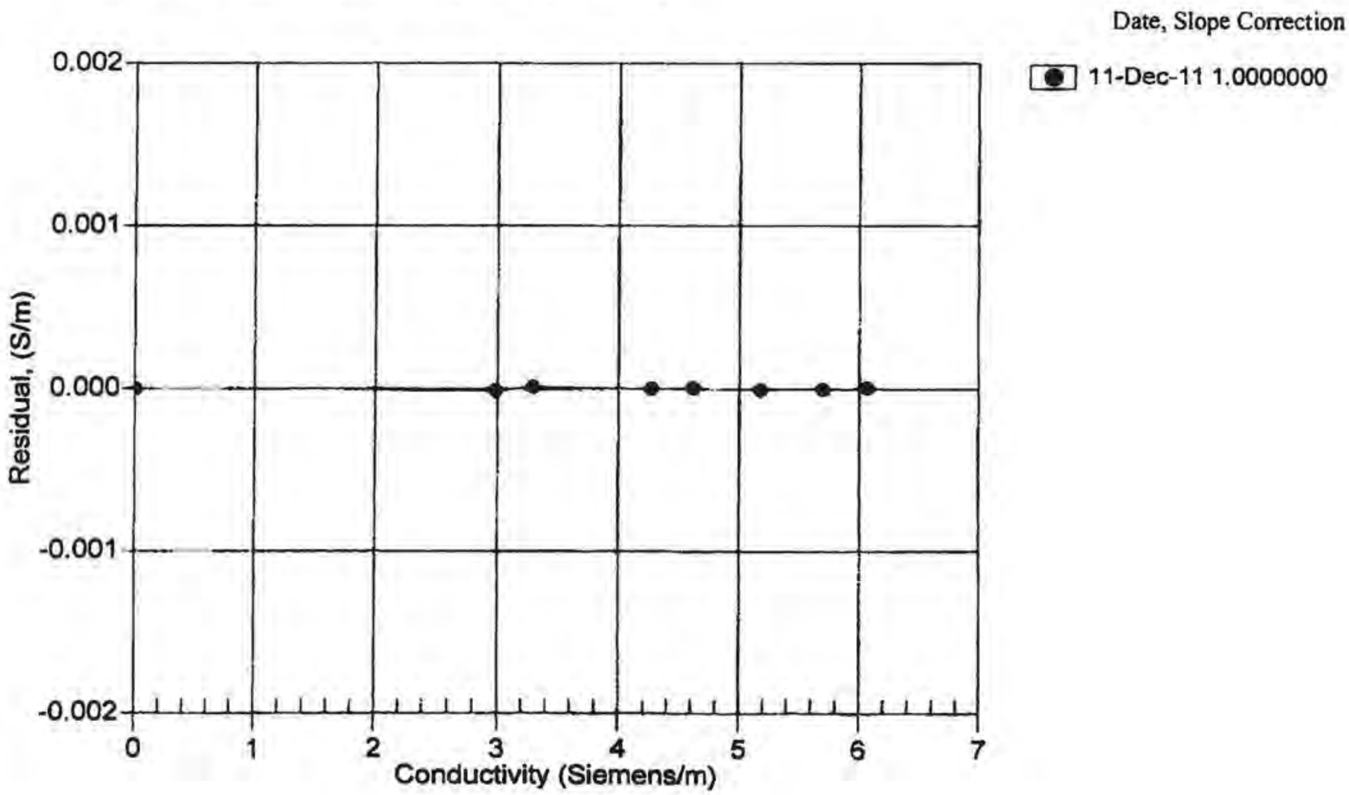
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (Hz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2610.07	0.00000	0.00000
1.0000	34.8264	2.97675	5262.53	2.97673	-0.00001
4.5000	34.8059	3.28384	5462.88	3.28385	0.00001
15.0001	34.7625	4.26572	6058.32	4.26572	-0.00000
18.5002	34.7533	4.61093	6253.91	4.61094	0.00000
24.0000	34.7433	5.16897	6557.40	5.16896	-0.00001
~~29.0000~~	~~34.7373~~	~~5.69083~~	~~6828.65~~	~~5.69083~~	~~-0.00001~~
32.5000	34.7337	6.06321	7015.57	6.06322	0.00001

f = INST FREQ * sqrt(1.0 + WBOTC * t) / 1000.0

Conductivity = $(g + hf^2 + if^3 + jf^4) / (1 + \delta t + \varepsilon p)$ Siemens/meter

t = temperature[°C)]; p = pressure[decibars]; δ = CTcor; ε = CPcor;

Residual = instrument conductivity - bath conductivity



Sea-Bird Electronics, Inc.

13431 NE 20th Street, Bellevue, WA 98005-2010 USA
Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0103
CALIBRATION DATE: 09-Dec-11

SLOCUM PAYLOAD CTD
PRESSURE CALIBRATION DATA
1450 psia S/N 3459007

COEFFICIENTS:

PA0 =	1.808852e-001	PTCA0 =	5.250272e+005
PA1 =	4.795118e-003	PTCA1 =	5.270342e-002
PA2 =	-2.529450e-011	PTCA2 =	7.433101e-002
PTEMPA0 =	-7.404472e+001	PTCB0 =	2.538938e+001
PTEMPA1 =	4.758229e-002	PTCB1 =	2.750000e-004
PTEMPA2 =	-1.458957e-007	PTCB2 =	0.000000e+000

PRESSURE SPAN CALIBRATION

PRESSURE PSIA	INST OUTPUT	THERMISTOR OUTPUT	COMPUTED PRESSURE	ERROR %FSR
14.75	528113.0	2035.0	14.79	0.00
315.06	590761.0	2036.0	315.02	-0.00
615.08	653406.0	2036.0	615.03	-0.00
915.08	716094.0	2037.0	915.04	-0.00
1215.11	778833.0	2037.0	1215.11	-0.00
1465.09	831126.0	2037.0	1465.06	-0.00
1215.07	778837.0	2036.0	1215.13	0.00
915.03	716102.0	2037.0	915.08	0.00
615.03	653412.0	2036.0	615.05	0.00
315.03	590766.0	2036.0	315.04	0.00
14.75	528101.0	2035.0	14.74	-0.00

THERMAL CORRECTION

TEMP ITS90	THERMISTOR OUTPUT	INST OUTPUT
32.50	2255	528186.00
29.00	2180	528173.80
24.00	2074	528155.80
18.50	1957	528134.20
15.00	1882	528122.60
4.50	1659	528110.00
1.00	1585	528109.00

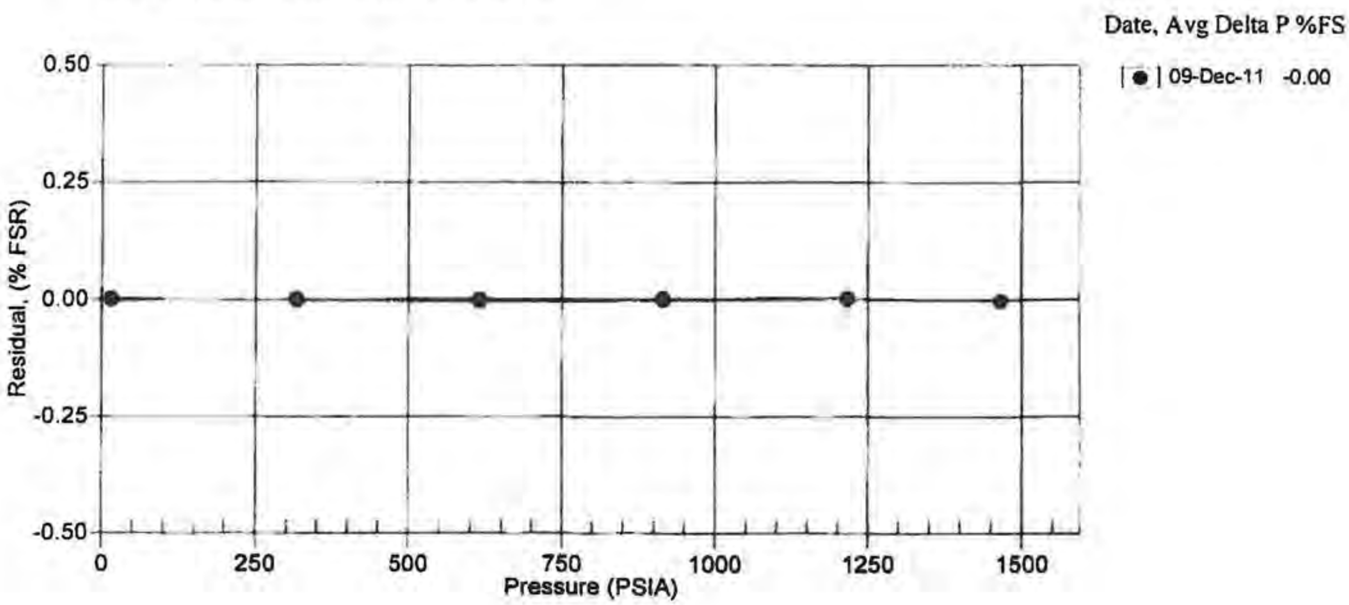
TEMP(ITS90)	SPAN(mV)
-5.00	25.39
35.00	25.40

y = thermistor output; $t = PTEMPA0 + PTEMPA1 * y + PTEMPA2 * y^2$

x = pressure output - $PTCA0 - PTCA1 * t - PTCA2 * t^2$

$n = x * PTCB0 / (PTCB0 + PTCB1 * t + PTCB2 * t^2)$

pressure (psia) = $PA0 + PA1 * n + PA2 * n^2$



SonTek
a xylem brand

9940 Summers Ridge Road
San Diego, CA 92121
Tel: (858) 546-8327
support@sontek.com

CALIBRATION CERTIFICATE

System Info

System Type	CastAway-CTD
Serial Number	11D101493
Firmware Version	0.26
Calibration Date	5/30/2012

Power

Standby Mode (A)	0.2094 / PASS
Supply Voltage	2.9V

Calibration

Pressure	Passed
Conductivity	Passed
Temperature	Passed
GPS	Passed

Verified by: dshumway

Date: 6/1/2012

SBE SEA-BIRD ELECTRONICS, INC.

13431 NE 20th St. Bellevue, Washington 98005 USA
Phone: (425) 643-9866 Fax: (425) 643-9954 www.seabird.com

Service Report

RMA Number: 69172

Customer Information:

Company	Rutgers
Date	6/14/2012
Contact	David Aragon
PO Number	S1665726

Serial Number	051018
Model Number	SBE 05T

Services Requested:

1. Evaluate/Repair Instrumentation.

Problems Found:

Services Performed:

1. Performed initial diagnostic evaluation.

Special Notes:

SBE SEA-BIRD ELECTRONICS, INC.
13431 NE 20th St. Bellevue, Washington 98005 USA
Phone: (425) 643-9866 Fax: (425) 643-9954 www.seabird.com

Service Report

RMA Number 69172

Customer Information:

Company	Rutgers	Date	6/14/2012
Contact	David Aragon		
PO Number	S1665726		

Serial Number	199618-1645
Model Number	SBE 19-03

Services Requested:

1. Evaluate/Repair Instrumentation.
2. Perform Routine Calibration Service.

Problems Found:

1. The Y-cable had some corrosion damage on pins and had previously been repaired by customer. Will be replaced with PN 17709 Y-cable.

Services Performed:

1. Performed initial diagnostic evaluation.
2. Performed "Post Cruise" calibration of the temperature & conductivity sensors.
3. Calibrated the pressure sensor.
4. Installed NEW pump / data Y-cable.
5. Performed complete system check and full diagnostic evaluation.

Special Notes:

Sea-Bird Electronics, Inc.

13431 NE 20th Street, Bellevue, WA 98005-2010 USA

Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 1645
CALIBRATION DATE: 17-May-12

SBE19 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

g = 4.20453005e-003
h = 5.97712451e-004
i = 5.15077996e-006
j = -1.52678800e-006
f0 = 1000.0

IPTS-68 COEFFICIENTS

a = 3.64763497e-003
b = 5.84092998e-004
c = 9.48775778e-006
d = -1.52627797e-006
f0 = 2563.761

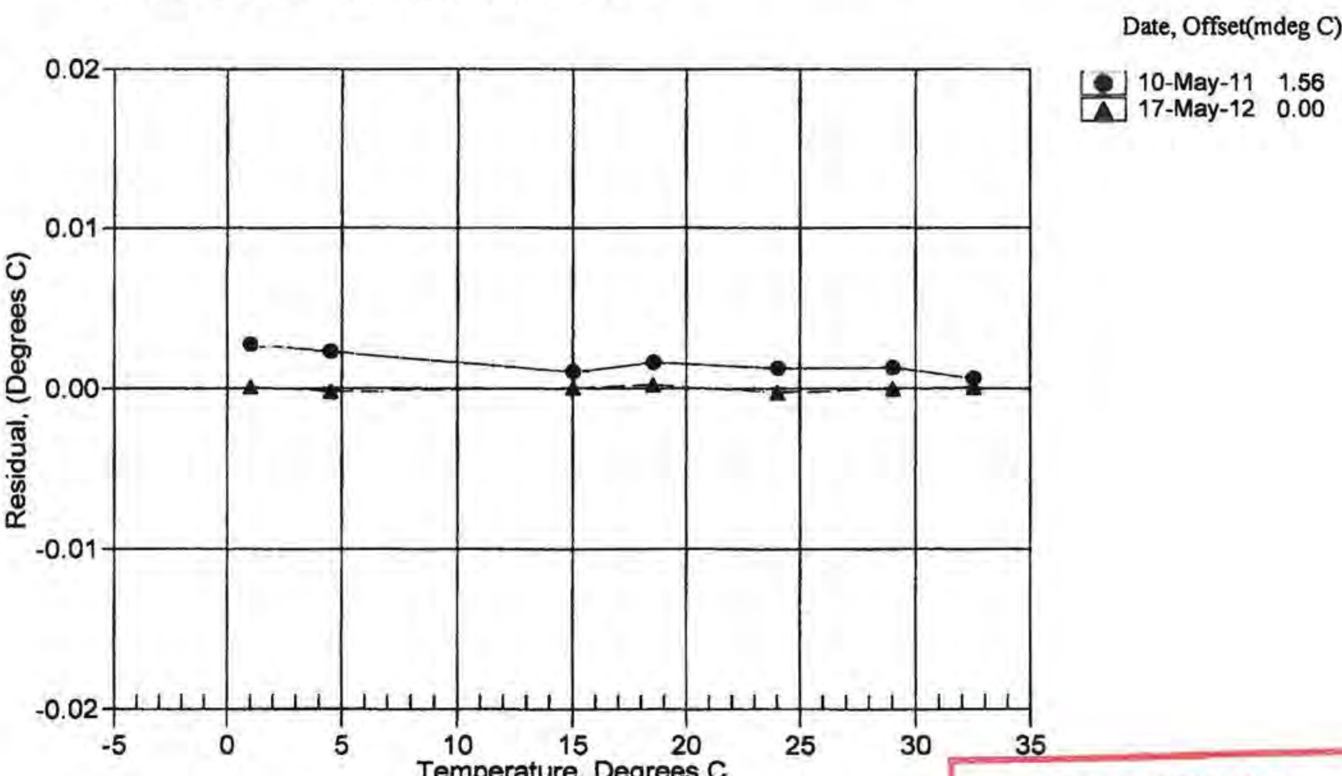
BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
0.9999	2563.761	1.0000	0.00010
4.4999	2774.062	4.4997	-0.00018
15.0000	3478.313	15.0000	0.00004
18.5000	3738.690	18.5002	0.00024
24.0000	4175.001	23.9997	-0.00026
29.0000	4601.563	29.0000	-0.00002
~~32.5000~~	~~4917.634~~	~~32.5001~~	~~0.00007~~

Temperature ITS-90 = $1/\{g + h[ln(f_0/f)] + i[ln^2(f_0/f)] + j[ln^3(f_0/f)]\} - 273.15$ (°C)

Temperature IPTS-68 = $1/\{a + b[ln(f_0/f)] + c[ln^2(f_0/f)] + d[ln^3(f_0/f)]\} - 273.15$ (°C)

Following the recommendation of JPOTS: T_{68} is assumed to be 1.00024 * T_{90} (-2 to 35 °C)

Residual = instrument temperature - bath temperature



POST CRUISE CALIBRATION

SBE **SEA-BIRD ELECTRONICS, INC.**
13431 NE 20th St. Bellevue, Washington 98005 USA
Phone: (425) 643-9866 Fax: (425) 643-9954 www.seabird.com

Temperature Calibration Report

Customer:	Rutgers		
Job Number:	69172	**Date of Report:**	5/21/2012
Model Number:	SBE 19-03	**Serial Number:**	199618-1645

Temperature sensors are normally calibrated 'as received', without adjustments, allowing a determination sensor drift. If the calibration identifies a problem, then a second calibration is performed after work is completed. The 'as received' calibration is not performed if the sensor is damaged or non-functional, or by customer request.

An 'as received' calibration certificate is provided, listing coefficients to convert sensor frequency to temperature. Users must choose whether the 'as received' calibration or the previous calibration better represents the sensor condition during deployment. In SEASOFT enter the chosen coefficients. The coefficient 'offset' allows a small correction for drift between calibrations (consult the SEASOFT manual). Calibration coefficients obtained after a repair apply only to subsequent data.

'AS RECEIVED CALIBRATION' ✔ **Performed** **Not Performed**

Date: 5/17/2012 **Drift since last cal:** -0.00153 **Degrees Celsius/year**

Comments:

'CALIBRATION AFTER REPAIR' **Performed** ✔ **Not Performed**

Date: **Drift since Last cal:** **Degrees Celsius/year**

Comments:

Sea-Bird Electronics, Inc.
13431 NE 20th Street, Bellevue, WA 98005-2010 USA
Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 1645
CALIBRATION DATE: 17-May-12

SBE19 CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Seimens/meter

GHIJ COEFFICIENTS

```
g = -4.04794553e+000
h =  4.82841506e-001
i =  1.24162353e-003
j = -3.13086509e-005
CPcor = -9.5700e-008 (nominal)
CTcor =  3.2500e-006 (nominal)
```

ABCDM COEFFICIENTS

```
a =  5.10588664e-002
b =  4.27666673e-001
c = -4.03166139e+000
d = -1.19643464e-004
m =  2.1
CPcor = -9.5700e-008 (nominal)
```

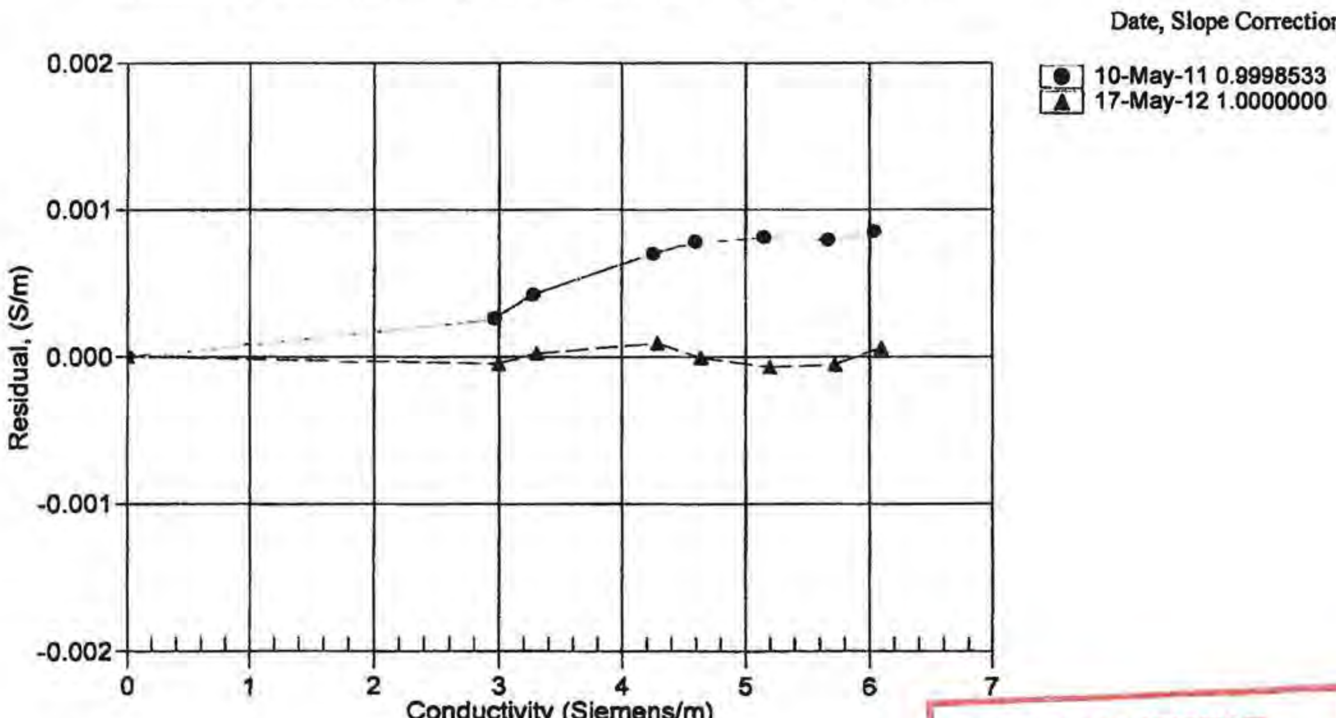
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2.88554	0.00000	0.00000
0.9999	35.0146	2.99128	8.31658	2.99124	-0.00005
4.4999	34.9937	3.29980	8.68395	3.29982	0.00002
15.0000	34.9505	4.28633	9.76514	4.28642	0.00009
18.5000	34.9406	4.63307	10.11731	4.63307	-0.00001
24.0000	34.9285	5.19347	10.66172	5.19340	-0.00000
29.0000	34.9182	5.71712	11.14627	5.71707	-0.00005
32.5000	34.9078	6.09014	11.47892	6.09020	0.00006

Conductivity = $(g + hf^2 + if^3 + jf^4)/10(1 + \delta t + \varepsilon p)$ Siemens/meter

Conductivity = $(af^m + bf^2 + c + dt)/[10(1 + \varepsilon p)$ Siemens/meter

t = temperature[°C)]; p = pressure[decibars]; δ = CTcor; ε = CPcor;

Residual = (instrument conductivity - bath conductivity) using g, h, i, j coefficients



POST CRUISE CALIBRATION

SEA-BIRD ELECTRONICS, INC.
13431 NE 20th Street Bellevue, Washington 98005 USA
Phone: (425) 643-9866 Fax: (425) 643-9954 www.seabird.com

Conductivity Calibration Report

Customer:	Rutgers		
Job Number:	69172	Date of Report:	5/21/2012
Model Number:	SBE 19-03	Serial Number:	199618-1645

Conductivity sensors are normally calibrated 'as received', without cleaning or adjustments, allowing a determination of sensor drift. If the calibration identifies a problem or indicates cell cleaning is necessary, then a second calibration is performed after work is completed. The 'as received' calibration is not performed if the sensor is damaged or non-functional, or by customer request.

An 'as received' calibration certificate is provided, listing the coefficients used to convert sensor frequency to conductivity. Users must choose whether the 'as received' calibration or the previous calibration better represents the sensor condition during deployment. In SEASOFT enter the chosen coefficients. The coefficient 'slope' allows small corrections for drift between calibrations (consult the SEASOFT manual). Calibration coefficients obtained after a repair or cleaning apply only to subsequent data.

'AS RECEIVED CALIBRATION' ✔ Performed ☐ Not Performed

Date: 5/17/2012 **Drift since last cal:** -0.00040 **PSU/month***

Comments:

'CALIBRATION AFTER CLEANING & REPLATINIZING' Performed ✔ Not Performed

Date: **Drift since Last cal:** **PSU/month***

Comments:

**Measured at 3.0 S/m*

Cell cleaning and electrode replatinizing tend to 'reset' the conductivity sensor to its original condition. Lack of drift in post-cleaning-calibration indicates geometric stability of the cell and electrical stability of the sensor circuit.

Sea-Bird Electronics, Inc.

13431 NE 20th Street, Bellevue, WA 98005-2010 USA

Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 1645
CALIBRATION DATE: 22-May-12

SBE19 PRESSURE CALIBRATION DATA
150 psia S/N 169585 TCV: -105

QUADRATIC COEFFICIENTS:

PA0 = 7.374722e+001
PA1 = -1.962260e-002
PA2 = 7.626656e-008

STRAIGHT LINE FIT:

M = -1.964407e-002
B = 7.416500e+001

PRESSURE PSIA	INST OUTPUT(N)	COMPUTED PSIA	ERROR %FS	LINEAR PSIA	ERROR %FS
14.57	3050.0	14.61	0.02	14.25	-0.21
29.80	2265.0	29.69	-0.07	29.67	-0.09
59.69	728.0	59.50	-0.13	59.86	0.12
94.83	-1068.0	94.79	-0.03	95.14	0.21
124.81	-2578.0	124.84	0.02	124.81	0.00
149.79	-3812.0	149.66	-0.09	149.05	-0.49
124.82	-2584.0	124.96	0.09	124.93	0.07
94.85	-1078.0	94.99	0.10	95.34	0.33
59.83	711.0	59.83	0.00	60.20	0.24
29.86	2255.0	29.89	0.02	29.87	0.01
14.58	3047.0	14.67	0.06	14.31	-0.18

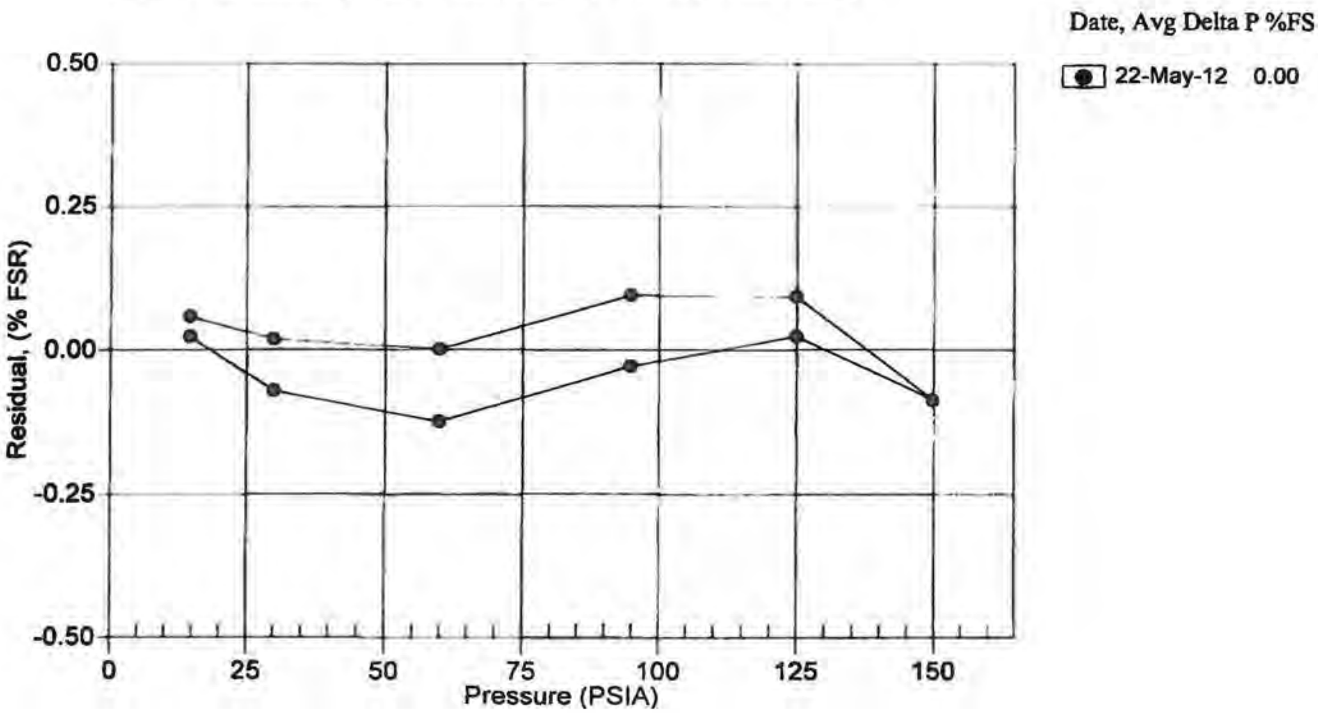
Straight Line Fit:

Pressure (psia) = M * N + B (N = binary output)

Quadratic Fit:

pressure (psia) = PA0 + PA1 * N + PA2 * N^2

Residual = (instrument pressure - true pressure) * 100 / Full Scale Range



Appendix F

Deployment 5
8/14/2012 – 8/30/2012

Pre-Deployment Check Out

GLIDER	RU28
PREPARER	Dave R. Shannon
PREP DATE	8/10/12 8/13/12
LOCATION	NJDEP Sandy Hook

SCIENCE BAY SERIAL NUMBERS	
1)	0057P
2)	Optode SN 1504
3)	
4)	

PRE-SEAL

FORE CHECK

Check pump & pitch threaded rod (grease & clean if necessary) ✓
Grounded Nose? ✓

Leak detect in place, batteries secure, white guides free, no metal shavings, bottles installed ✓

PAYLOAD CHECK

Special Sensors / Additional Sensors
1) UDEL VEMCO
2)

CTD cable clear, no leak at CTD joint, no leak at pucks ✓

Grounded Parts: Fore Sci Ring ✓ CTD ✓
Aft Sci Ring ✓ Other?

Science Bay Weight Configuration

AFT CHECK

Iridium Card Installed (SIM #) (if not standard) —
Flash Card: old data removed? No

Inspect strain on connectors (worn connectors), battery secured, ballast bottle present, aft cap clean/clear of leak ✓
Aft cap grounded? ✓

Battery check
Aft Pack - J13 Voltage 15.89
Pitch Pack - J13 Voltage 15.89
Nose Packs - J13 Voltage 15.89, 15.86
Aft Emer - J31 Voltage 15.91

After
~16
~16
~16
15.91
emer circuit power

POST-SEAL

GENERAL

Pick Point Present? No (vemco)
Special Instruments? vemco, fish finder

HARDWARE

put c_alt_time 0, verify alt chirp ✓
Anode grounded? ✓
Pressure Sensor Check (corrosion, clear)
Aft sensor ✓
Payload sensor ✓

Nose Cone and pump bladder inspection ✓
Anode size / remainder (est) ✓
Ejection weight assembly OK and unseized? ✓

POWERED

Verify Argos ping ✓
Wiggle for 5 minutes ✓
Stabilized m_battery 15.455 v
m_vacuum @ T @ ballast 6.17

OUTSIDE

Compass Check (reading @ compass)

1) 204	2.787	= 159
2) 246	3.490	= 199
3) 310	6.277	= 359
4) 20	0.968	= 53

logging on; rotate slowly 360, logging off, plot data: 360 test —

GPS check
(lat) 4028.75 (lon) 7426.22
Iridium connect ✓ Alt ✓
zero_ocean_pressure, get m_pressure
-6.000 bar 0m
let air bladder inflate, does it shut off? ✓ 8.59

5) 82	1.593	= 91
6) 170	2.298	= 131

check #2 over?

SOFTWARE

GENERAL

Version	7.9	Re-burn latest software image	✓
Date OK?	✓	configure TBDlist	—
delete old logs	—	NBDlist	—

\CONFIG

simul.sim deleted ✓

\MAFILES

goto_l10.ma (set x_last_...) ✓

AUTOEXEC.MI

Irid Main: 88160000592	✓	c_ctd41cp_num_fields_to_send 4	✓
Irid Alt: 15085482446	✓	Calibration coefficients	✓
u_iridium_failover_retries = 10	✓	f_ballast_pumped_deadz_width = ~~30?~~	10
Reset the glider, observe any errors		get f_max_working_depth ~~(102 m)~~	31m

CACHE MANAGEMENT

del ..\state\cache*.*
after *bdlist.dat are set (exit reset):
logging on; logging off
send ..\state\cache*.cac —
send *.mbd *.sbd *.tbd —

* **Software Burning Tips :** if using Procomm or local folder, copy all the files from the software image locally. Then proceed to edit them for the glider and do a mass freewave transfer of the files. Save these files or prepare the to-glider with these files

SCIENCE

SENSOR RETURN

put c_science_send_all 1
put c_science_all_on 8
put c_science_on 3
All sensors reporting values? ✓

CTD

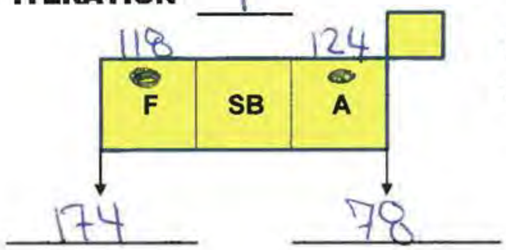
Tank static comparison OK? ✓

OPTODE

Check in completed? ✓

BALLAST ITERATIONS **GLIDER:** RU28 **DATE:** 8/13/12

ITERATION 1



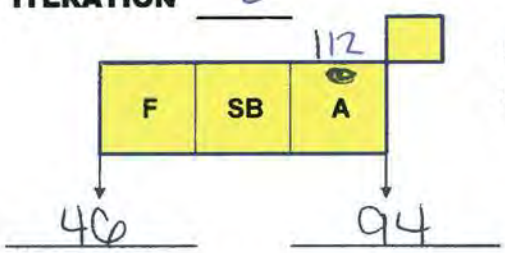
Ballast Bottles

FORE 1	397.4
FORE 2	396.8
AFT	132.8

NOTES roll ≈ 0.066 rad

TANK: T = 22.3 | **TANK:** T = 22.34
(SB19) C = 4.79 | (Glider) C = 4.78
D = 1022.72

ITERATION 2



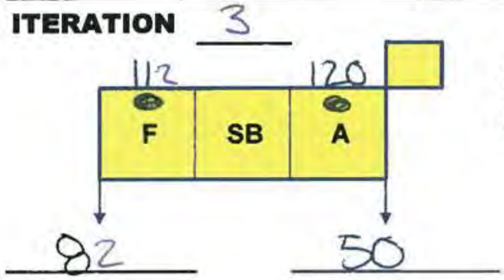
Ballast Bottles

FORE 1	
FORE 2	
AFT	

NOTES roll ≈ -0.0925

TANK: T = | **TANK:** T =
(SB19) C = | (Glider) C =
D =

ITERATION 3



Ballast Bottles

FORE 1	241.4
FORE 2	33.4
AFT	10.7

NOTES

TANK: T = | **TANK:** T =
(SB19) C = | (Glider) C =
D =

Deployment			MASS (g)	COMMENTS
2012 NJDEP # 3	GLIDER	FORE STEM (altimeter bottle)		
		FORE HULL		
Glider		AFT STEM (red plug, card)		w/o bottle, w/ fish finder, w/optode
ru28		AFT HULL		
		COWLING		
		SCREWS (vacuum, cowling, aft battery)		
Date	PAYLOAD	PAYLOAD BAY		wing rails, w/o aft cable plate, w/ VMC
8/13/12		WINGS		1 CF, 1 regular, did not weigh in air
Preparer		OTHER		
Dave K & Shannon	BATTERIES	AFT BATTERY	9100.4	
		PITCH BATTERY	9378.4	
Air temp		FORE BATTERY 1, 2	1464	
~~20~~	WEIGHT BOTTLES	AFT BOTTLE	10.7	
FINAL		FORE BOTTLE 1 (starboard)	241.4	
		FORE BOTTLE 2 (port)	333.4	
		OTHER		

F-6

Tank Specifics		Glider Specifics		H MOMENT (rad)		(deg)
Tank Density (g/mL)	1.0227	Glider Volume (mL)	58495	Angle of Rotation (before)	0.066	3.8
Tank Temperature (C)	22.33	Total Mass (g)	n/a	Angle of Rotation (after)	-0.0925	-5.3
Weight in Tank (g)	-100.00	Glider Density 1 (air) (g/mL)	#VALUE!	Angle of Rotation	0.1585	9.1
Target Specifics		**Volume Change (temperature induced)**		Weight on Spring (after)	358	
Target Density (g/mL)	1.0213	Volume Change (tank) (mL)	10	Weight added	286	
Target Temperature ©	25.00	Volume Change (target) (mL)	8	Radius of Hull	114	
		(note use 53.5 E -6 in above for DE (carbon)) ^		**H-distance**	7.9	

(note use 70 E -6 in above for Aluminum hull)

Should Hang (in tank) (g)	-87.21	Adjust Glider Mass (Dunk Volume) (g)	#VALUE!
Adjust by: (g)	12.79	Adjust Glider Mass (entered volume) (g)	#VALUE!

^ Ballasting Alternative (known VOLUME) (don't have to weight parts!)

Calculated Glider Volume (calculated from scales) (mL)	#VALUE!
Glider Density 2 (in target water, using calculated volume above) (kg / m³)	#VALUE!
Glider Density 3 (in target water, using entered volume) (kg / m³)	#VALUE!
Glider Density 4 (in target water, using entered volume) (kg / m³)	1021.03

1019.56
1.47

Average Glider Volume

volume 1:
volume 2:
volume 3:
average = #DIV/0!

MISC Items Masses/Volumes

PICK POINT VOLUME 40.4 mL — 107 g air / 66 g Water
G1 Volume 50.9 L
VMT35 Transceiver (w/ mount) 161 mL — 148 g weight in water

Ballast Sheet (6)

			MASS (g)	COMMENTS
Deployment	GLIDER	FORE STEM (altimeter bottle)	9345.8	
2012 NJDEP # 2		FORE HULL	4905.2	
		AFT STEM (red plug, card)	6443	w/o bottle, w/ fish finder, w/optode
Glider		AFT HULL	4868.7	
ru28		COWLING	1154.5	
		SCREWS (vacuum, cowling, aft battery)	17.1	
Date	PAYLOAD	PAYLOAD BAY	11604.3	wing rails, w/o aft cable plate
7/9/12		WINGS	485.8	262.5 port side, 253.3 starboard side
Preparer		OTHER		
David Aragon	BATTERIES	AFT BATTERY	9069.6	
		PITCH BATTERY	9340.8	
Air temp		FORE BATTERY 1, 2	1451.4	727.5 and 728.9
20	WEIGHT BOTTLES	AFT BOTTLE	132.8	
		FORE BOTTLE 1 (starboard)	397.4	
		FORE BOTTLE 2 (port)	396.8	
		OTHER		

F-7

Tank Specifics		Glider Specifics		H MOMENT (rad)		(deg)
Tank Density (g/mL)		Glider Volume (mL)	58335	Angle of Rotation (before)	0.025	1.4
Tank Temperature (C)	21.81	Total Mass (g)	59613.2	Angle of Rotation (after)	-0.151	-8.7
Weight in Tank (g)		Glider Density 1 (air) (g/mL)	1.0219	Angle of Rotation	0.176	10.1
Target Specifics		**Volume Change (temperature induced)**		Weight on Spring (after)	382	
Target Density (g/mL)	1.0218	Volume Change (tank) (mL)	7	Weight added	290	
Target Temperature ©	24.00	Volume Change (target) (mL)	7	Radius of Hull	107	
		(note use 53.5 E -6 in above for DE (carbon)) ^		**H-distance**	6.9	
		(note use 70 E -6 in above for Aluminum hull)				

Should Hang (in tank) (g)	59610.76	**Adjust Glider Mass (Dunk Volume) (g)**	#DIV/0!
Adjust by: (g)	59610.76	**Adjust Glider Mass (entered volume) (g)**	-2.44

^ Ballasting Alternative (known VOLUME) (don't have to weight parts!)

Calculated Glider Volume (calculated from scales) (mL)	#DIV/0!
Glider Density 2 (in target water, using calculated volume above) (kg / m³)	#DIV/0!
Glider Density 3 (in target water, using entered volume) (kg / m³)	1021.8
Glider Density 4 (in target water, using entered volume) (kg / m³)	0.00

Average Glider Volume

volume 1:	58320
volume 2:	58335
volume 3:	
average =	58327.5

MISC Items Masses/Volumes

PICK POINT VOLUME 40.4 mL — 107 g air / 66 g Water

G1 Volume 50.9 L

VMT35 Transceiver (w/ mount) 161 mL — 148 g weight in water

Ballast Sheet (5)

```
RU28 OPTODE SN1504

BEFORE

Protect   5014     1504        0
PhaseCoef          5014     1504   -6.623718E+00    1.204068E+00    0.000000E+00
0.000000E+00
TempCoef           5014     1504    2.372790E+01   -3.059506E-02    2.830229E-06
-4.197852E-09
FoilNo    5014     1504     5009
C0Coef    5014     1504     4.537931E+03   -1.625950E+02    3.295740E+00
-2.792849E-02
C1Coef    5014     1504    -2.509530E+02    8.023220E+00   -1.583980E-01
1.311410E-03
C2Coef    5014     1504     5.664169E+00   -1.596469E-01    3.079099E-03
-2.462650E-05
C3Coef    5014     1504    -5.994490E-02    1.483260E-03   -2.821099E-05
2.151560E-07
C4Coef    5014     1504     2.436140E-04   -5.267590E-06    1.000640E-07
-7.143200E-10
Salinity           5014     1504    0.000000E+00
CalAirPhase        5014     1504    3.299431E+01
CalAirTemp         5014     1504    1.029875E+01
CalAirPressure     5014     1504    1.026470E+03
CalZeroPhase       5014     1504    6.521005E+01
CalZeroTemp        5014     1504    2.486774E+01
Interval           5014     1504        2
AnCoef    5014     1504     0.000000E+00    1.000000E+00
Output    5014     1504        1
SR10Delay          5014     1504       -1
SoftwareVersion    5014     1504        3
SoftwareBuild      5014     1504       24


AFTER

Protect   5014     1504        0
PhaseCoef          5014     1504   -6.623718E+00    1.204068E+00    0.000000E+00
0.000000E+00
TempCoef           5014     1504    2.372790E+01   -3.059506E-02    2.830229E-06
-4.197852E-09
FoilNo    5014     1504     5009
C0Coef    5014     1504     4.537931E+03   -1.625950E+02    3.295740E+00
-2.792849E-02
C1Coef    5014     1504    -2.509530E+02    8.023220E+00   -1.583980E-01
1.311410E-03
C2Coef    5014     1504     5.664169E+00   -1.596469E-01    3.079099E-03
-2.462650E-05
C3Coef    5014     1504    -5.994490E-02    1.483260E-03   -2.821099E-05
2.151560E-07
C4Coef    5014     1504     2.436140E-04   -5.267590E-06    1.000640E-07
-7.143200E-10
Salinity           5014     1504    3.200000E+01
CalAirPhase        5014     1504    3.299431E+01
CalAirTemp         5014     1504    1.029875E+01
CalAirPressure     5014     1504    1.026470E+03
CalZeroPhase       5014     1504    6.521005E+01
CalZeroTemp        5014     1504    2.486774E+01
Interval           5014     1504        2
AnCoef    5014     1504     0.000000E+00    1.000000E+00
Output    5014     1504      101
```

SR10Delay	5014	1504	-1
SoftwareVersion	5014	1504	3
SoftwareBuild	5014	1504	24

8/13 after removing may fish tags

1)	3.58	210	205.11
2)	4.64	262	265
3)	5.42	305	310.54
4)	6.09	343	348
5)	.712	39	40.8
6)	1.57	92	90

final check

352 @ 354.1

Pre-Deployment Check Out
For
Aanderaa Oxygen Optode

RUTGERS
Coastal Ocean
Observation Lab

Slocum Glider Aanderaa Optode Check IN/OUT
2 Point Calibration & Calibration Coeffcient Record

OPTODE MODEL, SN: 1504 **IN / OUT** IN 7/31/2012

Calibration Record **PERFORMED BY:** Amanda

CALIBRATION DATE: 3/23/2012

Previous:					*Current:*				
C0Coef	4.5E+03	-1.6E+02	3.3E+00	-2.8E-02	**C0Coef**	4.5E+03	-1.6E+02	3.3E+00	-2.8E-02
C1Coef	-2.5E+02	8.0E+00	-1.6E-01	1.3E-03	**C1Coef**	-2.5E+02	8.0E+00	-1.6E-01	1.3E-03
C2Coef	5.7E+00	-1.6E-01	3.1E-03	-2.5E-05	**C2Coef**	5.7E+00	-1.6E-01	3.1E-03	-2.5E-05
C3Coef	-6.0E-02	1.5E-03	-2.8E-05	2.2E-07	**C3Coef**	-6.0E-02	1.5E-03	-2.8E-05	2.2E-07
C4Coef	2.4E-04	-5.3E-06	1.0E-07	-7.1E-10	**C4Coef**	2.4E-04	-5.3E-06	1.0E-07	-7.1E-10

Delta: 0.0

2 point Calibration

0% Point		*100% Point*	
Solution: 15.0 g/ 1500 ml	**Na_2SO_3**	*Solution:* NA	**Na_2SO_3**
Castaway CTD	**Cross reference**	Castaway CTD	**Cross reference**
38.38	**Temperature**	10.75	**Temperature**
1009.82	**Air Pressure (hPa)**	1010.16	**Air Pressure (hPa)**
Sample C, Sample D	**Winkler Label**	Sample A, Sample B	**Winkler Label**
LaMotte 7414 - Azide mod	**Winkler Source**	LaMotte 7414 - Azide mod	**Winkler Source**
Results:		*Results:*	
OPTODE: 70.04	**Dphase**	**OPTODE:** 33.57	**Dphase**
0.099	**% Saturation**	97.63	**% Saturation**
38.3	**Temperature**	10.68	**Temperature**
0.31	**Conc (calculated) (µM)**	336.2	**Conc (calculated) (µM)**
0.15	**% Saturation (calculated)**	97.34	**% Saturation (calculated)**
WINKLER: 0	**Concentration (µM)**	**WINKLER:** 331.25	**Concentration**
(0, 0) (0 - 2 µM)	**(Titrations) (ppm)**	(10.8,10.4)	**(Titrations) (ppm)**
0	**% Saturation**	95.57	**% Saturation**
(worst case @ 2 µM = .04 % or 0%)			

DELTAS:

0% Point				100% Point			
0.31	**Conc Δ**	0.15	**% Δ**	4.95	**Conc Δ**	1.77	**% Δ**
0.08	**Temp Δ**	38.34	**Temp avg**	0.07	**Temp Δ**	10.715	**Temp avg**

In-Air Saturation Check

SATURATION: 97.38 **@ TEMP** 23 **@ PRESS** 1005.4

Sodium Thiosulate Normalization

Normalization (mL) 2.05 (2.0 ± .1) (EPA Compliance)

Paste config report all from optode

Protect	5014	1504	0			
PhaseCoef	5014	1504	-6.62372	1.204068	0	0
TempCoef	5014	1504	23.7279	-0.0306	2.83E-06	-4.2E-09
FoilNo	5014	1504	5009			
C0Coef	5014	1504	4537.931	-162.595	3.29574	-0.02793
C1Coef	5014	1504	-250.953	8.02322	-0.1584	0.001311
C2Coef	5014	1504	5.664169	-0.15965	0.003079	-2.5E-05
C3Coef	5014	1504	-0.05994	0.001483	-2.8E-05	2.15E-07
C4Coef	5014	1504	0.000244	-5.3E-06	1E-07	-7.1E-10
Salinity	5014	1504	0			
CalAirPhas	5014	1504	32.99431			
CalAirTem|	5014	1504	10.29875			
CalAirPres:	5014	1504	1026.47			
CalZeroPh:	5014	1504	65.21005			
CalZeroTer	5014	1504	24.86774			
Interval	5014	1504	2			
AnCoef	5014	1504	0	1		
Output	5014	1504	1			
SR10Delay	5014	1504	-1			
SoftwareV	5014	1504	3			
SoftwareB	5014	1504	24			

Optode Titrations	
Optode SN	1504 (S014)
100%	
Spark:	
Air Pressure	29.83 → 1010.16
Temperature 1	51.51
Temperature 2	50.87
Temperature 3	50.87
Temperature 4	51.16
Castaway Temperature	10.75
Optode:	
Concentration	339.92
Saturation	97.630
Temperature	10.68
D Phase	33.57
Titration 1	~~[illegible]~~ 10.4 ppm
Titration 2	10.8 ppm
Titration 3	
0%	
Spark:	
Air Pressure	29.82
Temperature 1	99.94
Temperature 2	99.20
Temperature 3	124.79
Temperature 4	100.80
Castaway Temperature	38.38
Optode:	
Concentration	.100
Saturation	.099
Temperature	38.300
D Phase	70.04
Water (L)	1500 mL (1.5L)
Na2SO3 (g)	15.0 g
Sample A	no precip
Sample B	no precip
Sample C	

Thiosulfate Test (mL)
2.05

Logging ✓

Filename
2012-07-31-RU28-
optode-checkout

Oxyview Settings	
Salinity set to 0	✓
Interval set to 2	✓
Output set to 1	✓

look at log of data to check Dphase & Conc

1. SB

1.) in air check
2.) castaway, optode T @10°C

2. cf
3. optod–

log/copy entire get-all output
S=0

Deployment Checklist

Glider RU28 Date 8/14/12

Pilots DaveK Shannon Where Jersey City NJDEP

Laptop ____ Vehicle Powerup: CTRL ^ C (until you get to prompt)!!!

On boat (Remember after 10 min glider will go into mission, as well as on powerup!)	Battery Voltage	15.29	get m_battery
	Vacuum Pressure	8.326	get m_vacuum, should be > 7 for bladder inflation
	Iridium Connection	✓	look for connect dialog & surface dialog, let it dial at prompt
	boot app	✓	boot app
	boot (should report application)	✓	reports boot application
	run status.mi	✓	mission completed normally?
In Water	zero_ocean_pressure	✓	while glider in water
	run od.mi (with or without float, ask RU)	✓	glider should dive and surface, type why? Should say overdepth, if not call
	send *.dbd *.mlg *.sbd	✓	"send *.sbd" is most important (this applies moreso to when handed off to iridium)
	run shallow.mi or deep.mi	✓	(glider should dive and not reappear) (report to Rutgers or steam out slowly once it dives)
	Verify dive; **disconnect freewave** Report to Rutgers		
	Perform CTD Comparison CAST		typically done with RU provided SBE19 or Cast Away CTD
	LAT: **LON**		

F-16

Recovery Checklist

Glider RU28 Date 8/29/12

Pilots Shannon & Dave K Where Cape May

Laptop Field

Recovery		
	get Lat/Lon from email or shore support	✓
	obtain freewave comms obtain lat/lon with where command	✓
	Perform CTD Comparison CAST	✓
	LAT: 39 55.888 **LON:** 74 49.167	
	(note instrument type!) castaway	

39 55.888
74 49.167

Post-Deployment Checklist

RUTGERS
Coastal Ocean
Observation Lab

Slocum Glider Check-IN

DATE: 9/4/12

GLIDER: RU28 **SB:** 00570

Vehicle Powered

1. *Power on vehicle in order to fully retract pump, and/or to deflate air bladder.*
2. *Wiggle vehicle for 5 minutes.*

Vehicle Cleaning (hose down with pressure)

Nose cone

1. Remove nose cone ✓
2. Loosen altimeter screws, and remove altimeter or leave temporarily attached ✓
3. Retract pump ✓
4. Remove altimeter and hose diaphragm removing all sand, sediment, bio oils ✓
5. Clean nose cone and altimeter ✓

Tail cone

1. Remove tail cone ✓
2. Hose and clean anode and air bladder making sure air bladder is completely clean ✓
3. Clean cowling ✓

Wing rails

1. Remove wing rails and hose down ✓

Tail plug cleaning

1. Dip red plug in alcohol and clean plug if especially dirty ✓
2. Re-dip red plug and repeatedly insert and remove to clean the glider plug ✓
3. Compress air glider female connector ✓
4. Lightly silicon red plug and replace in glider once silicon has been dispersed evenly in the plugs ✓

CTD Comparison Check

1. Inspect CTD sensor for any sediment buildup, take pictures of anything suspicious or make note.

Static Tank Test

SBE19		*Glider (SBE41CP or pumped unit)*	
Temperature:	22.256	Temperature:	22.255
Conductivity:	4.979	Conductivity:	4.976

CTD Maintenance if comparison is not acceptable (reference SeaBird Application Note 2D)

1. Perform CTD backward/forward flush with 1% Triton X-100 solution
2. Perform CTD backward/forward flush with 500 – 1000 ppm bleach solution
3. Perform the same on a pumped unit, just different approach
4. Repeat comparison test if above results not within T < .01 C, C < .005 S/m

SB19		*Glider (SB41CP or pumped unit)*	
Temperature:		Temperature:	
Conductivity:		Conductivity:	

Vehicle Disassembled

1. Check leak points for water or salt buildup ✓
2. **BACKUP FLASH CARDS** in /coolgroup/gliderData/glider_OS_backups/<glider>/<glider-deploymentID>/<from glider>,<from sb_0xxx>

   DO NOT DELETE DATA OFF CARDS
3. Change permissions on <glider-deploymentID> folder to read, write, execute for owner and group, and read, execute for everyone
4. Remove used batteries and place in return crate ✓
5. Re-assemble glider with a vacuum ✓

*metal shavings on pitch battery screw

Manufacturer Calibration Documentation

Aanderaa Optode, Seabird Slocum Payload CTD, YSI Castaway CTD, and Seabird 19 CTD

AADI CALIBRATION CERTIFICATE

Form No. 622, Dec 2005

a xylem brand

Sensing Foil Batch No:	5009	**Product:**	5014
Certificate No:	5014W 1504 1129	**Serial No:**	1504
		Calibration Date:	March 23, 2012

This is to certify that this product has been calibrated using the following instruments:

Fluke CHUB E-4	Serial No. A7C677
Fluke 5615 PRT	Serial No. 849155
Fluke 5615 PRT	Serial No. 802054
Honeywell PPT	Serial No. 44074
Calibration Bath model FNT 321-1-40	1

Parameter: Internal Temperature:

Calibration points and readings:

Temperature (°C)	-	-	-	-
Reading (mV)	-	-	-	-

Giving these coefficients

Index	0	1	2	3
TempCoef	2.37279E+01	-3.05951E-02	2.83023E-06	-4.19785E-09

*Note: Temperature calibration NOT performed

Parameter: Oxygen:

	O2 Concentration	Air Saturation
Range:	0-500 µM [1]	0 - 120%
Accuracy[1]:	< ±8µM or ±5%(whichever is greater)	±5%
Resolution:	< 1 µM	< 0.4%
Settling Time (63%):	< 25 seconds	

Calibration points and readings[2]:

	Air Saturated Water	Zero Solution (Na_2SO_3)
Phase reading (°)	3.29943E+01	6.52101E+01
Temperature reading (°C)	1.02988E+01	2.48677E+01
Air Pressure (hPa)	1.02647E+03	

Giving these coefficients

Index	0	1	2	3
PhaseCoef	-6.62372E+00	1.20407E+00	0.00000E+00	0.00000E+00

[1] *Valid for 0 to 2000m (6562ft) depth, salinity 33 - 37ppt*

[2] *The calibration is performed in fresh water and the salinity setting is set to: 0*

Date:
March 23, 2012

Sign: Shawn A. Sneddon

Shawn A. Sneddon

Service and Calibration Engineer

Aanderaa Data Instruments, Inc.

182 East Street, Suite B Attleboro, MA 02703 Tel. +1 (508) 226-9300 email: infoUSA@xyleminc.com

AADI CALIBRATION CERTIFICATE

Form No. 621, Dec 2005

a xylem brand

Sensing Foil Batch No: 5009
Certificate No: 3853 5009 40217

Product: O2 Sensing Foil PSt3 3853
Calibration Date: 8 February 2010

Calibration points and phase readings (degrees)

Temperature (°C)		3.97	10.93	20.15	29.32	38.39
Pressure (hPa)		977.00	977.00	977.00	977.00	977.00
O2 in % of O2+N2	0.00	73.18	72.63	71.62	70.72	69.77
	1.00	68.01	67.02	65.42	63.92	62.31
	2.00	64.39	63.19	61.20	59.44	57.57
	5.00	55.80	54.16	51.76	49.56	47.45
	10.00	46.27	44.47	41.97	39.75	37.69
	20.90	35.09	33.38	31.14	29.24	27.56
	30.00	29.85	28.30	28.30	24.64	23.19

Giving these coefficients [1]

Index	0	1	2	3
C0 Coefficient	4.53793E+03	-1.62595E+02	3.29574E+00	-2.79285E-02
C1 Coefficient	-2.50953E+02	8.02322E+00	-1.58398E-01	1.31141E-03
C2 Coefficient	5.66417E+00	-1.59647E-01	3.07910E-03	-2.46265E-05
C3 Coefficient	-5.99449E-02	1.48326E-03	-2.82110E-05	2.15156E-07
C4 Coefficient	2.43614E-04	-5.26759E-06	1.00064E-07	-7.14320E-10

[1] *Ask for Form No 621S when this O2 Sensing Foil is used in Oxygen Sensor 3830 with Serial Numbers lower than 184.*

Date:
February 8, 2010

Aanderaa Data Instruments, Inc.
182 East Street, Suite B   Attleboro, MA 02703   Tel. +1 (508) 226-9300   email: infoUSA@xyleminc.com

CALIBRATION CERTIFICATE

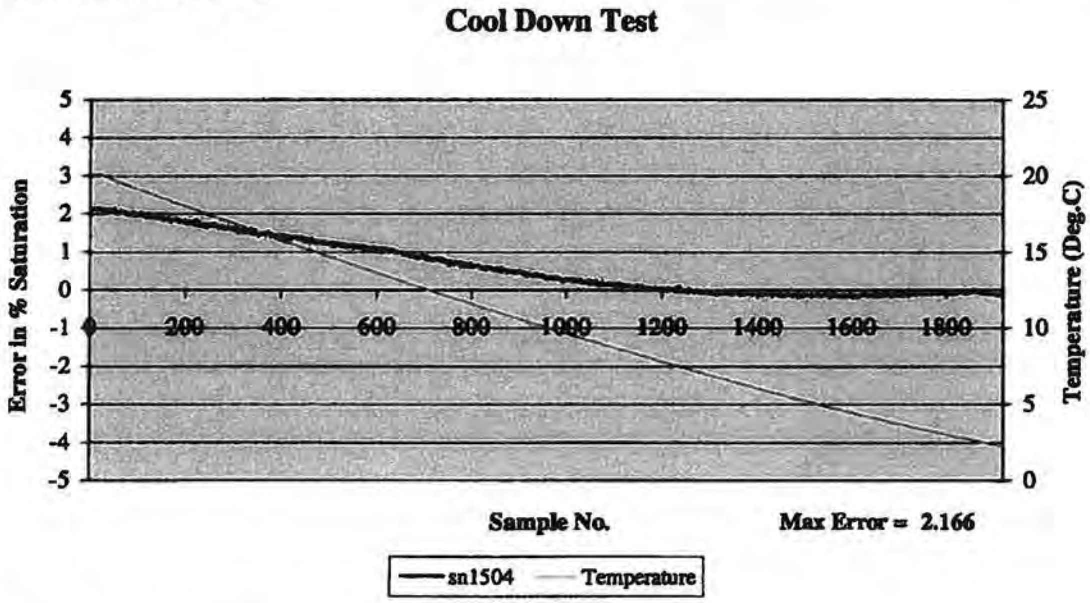
Form No. 622, Dec 2005

a xylem brand

Sensing Foil Batch No: 5009
Certificate No: 5014W 1504 1129

Product: 5014
Serial No: 1504
Calibration Date: March 23, 2012

Data from Cool Down Test:



SR10 Scaling Coefficients:

At the SR10 output the Oxygen Optode 3830 can give either absolute oxygen concentration in µM or air saturation in %. The setting of the internal property "Output" [3], controls the selection of the unit. The coefficients for converting SR10 raw data to engineering units are fixed.

Output = -1	Output = -2
A = 0	A = 0
B = 4.883E-01	B = 1.465E-01
C = 0	C= 0
D = 0	D = 0
Oxygen (uM) = A + BN + CN2 + DN3	Oxygen (%) = A + BN + CN2 + DN3

[3] *The default output setting is set to -1*

Date:
March 23, 2012

Sign: Shawn A. Sneddon

Service and Calibration Engineer

Aanderaa Data Instruments, Inc.
182 East Street, Suite B   Attleboro, MA 02703   Tel. +1 (508) 226-9300   email: infoUSA@xyleminc.com

Sea-Bird Electronics, Inc.

13431 NE 20th Street, Bellevue, WA 98005-2010 USA
Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0103
CALIBRATION DATE: 11-Dec-11

SLOCUM PAYLOAD CTD
TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

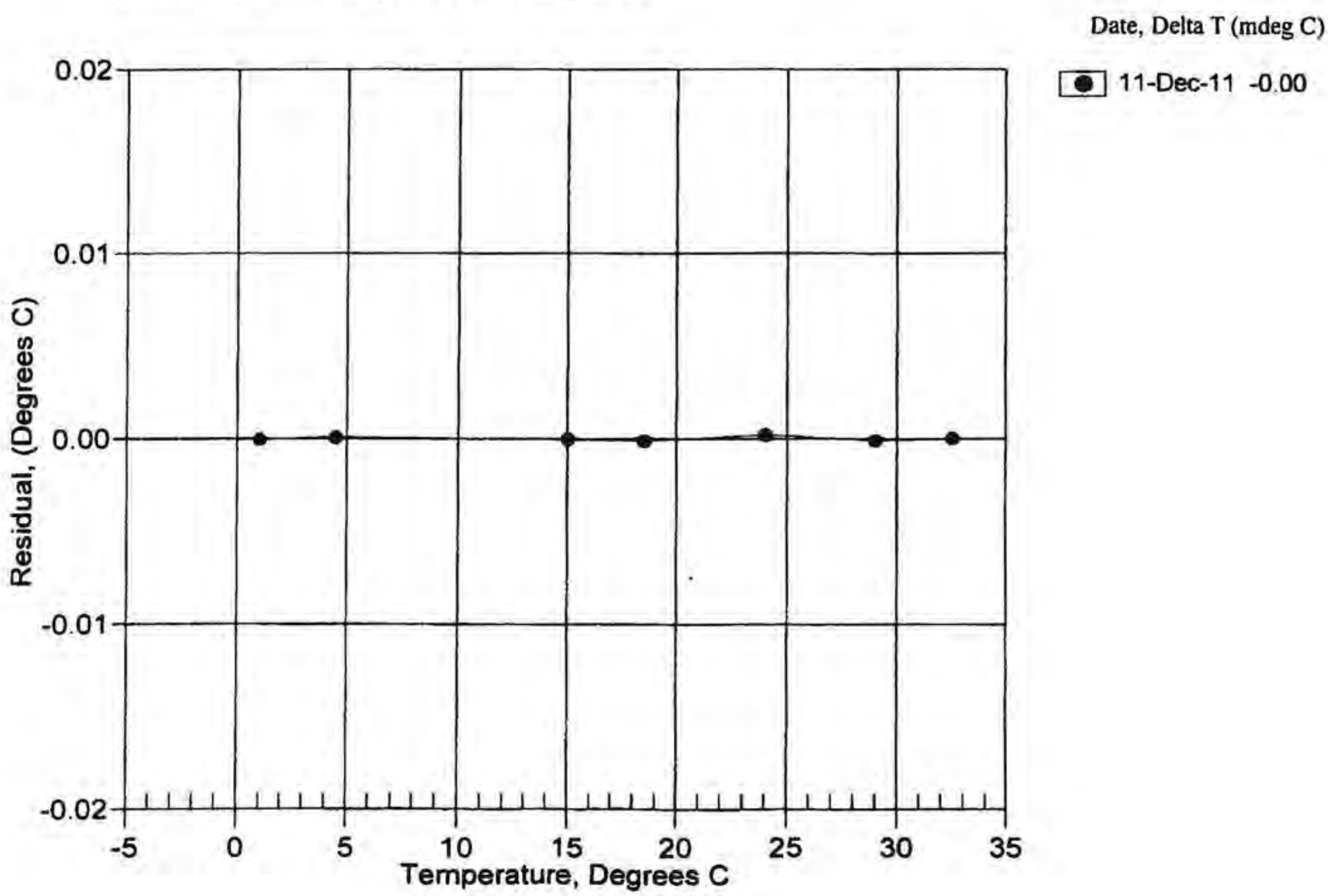
ITS-90 COEFFICIENTS

a0 = -8.443070e-005
a1 = 3.069531e-004
a2 = -4.655974e-006
a3 = 2.044800e-007

BATH TEMP (ITS-90)	INSTRUMENT OUTPUT	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	581271.2	1.0000	-0.0000
4.5000	496277.6	4.5001	0.0001
15.0001	315060.0	15.0001	-0.0000
18.5002	272494.8	18.5001	-0.0001
24.0000	218238.0	24.0002	0.0002
29.0000	179458.2	28.9999	-0.0001
2.5000	157017.6	32.5000	0.0000

Temperature ITS-90 = $1/\{a0 + a1[ln(n)] + a2[ln^2(n)] + a3[ln^3(n)]\} - 273.15$ (°C)

Residual = instrument temperature - bath temperature



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SENSOR SERIAL NUMBER: 0103
CALIBRATION DATE: 11-Dec-11

SLOCUM PAYLOAD CTD
CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

COEFFICIENTS:

g = -9.716254e-001
h = 1.434026e-001
i = -4.364055e-004
j = 5.287390e-005

CPcor = -9.5700e-008
CTcor = 3.2500e-006
WBOTC = 2.5540e-007

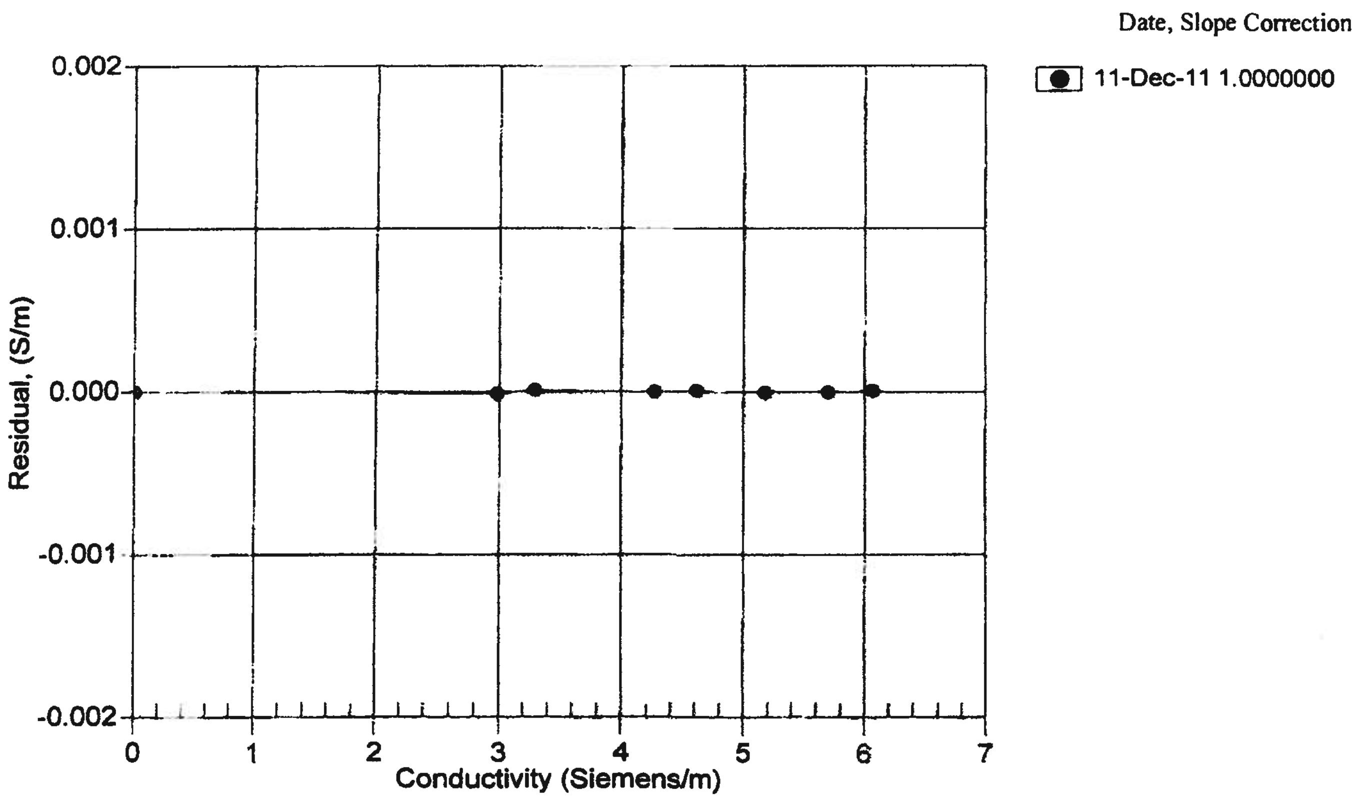
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (Hz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2610.07	0.00000	0.00000
1.0000	34.8264	2.97675	5262.53	2.97673	-0.00001
4.5000	34.8059	3.28384	5462.88	3.28385	0.00001
15.0001	34.7625	4.26572	6058.32	4.26572	-0.00000
18.5002	34.7533	4.61093	6253.91	4.61094	0.00000
24.0000	34.7433	5.16897	6557.40	5.16896	-0.00001
29.0000	34.7373	5.69083	6828.65	5.69083	-0.00001
32.5000	34.7337	6.06321	7015.57	6.06322	0.00001

f = INST FREQ * sqrt(1.0 + WBOTC * t) / 1000.0

Conductivity = $(g + hf^2 + if^3 + jf^4) / (1 + \delta t + \varepsilon p)$ Siemens/meter

t = temperature[°C)]; p = pressure[decibars]; δ = CTcor; ε = CPcor;

Residual = instrument conductivity - bath conductivity



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SENSOR SERIAL NUMBER: 0103
CALIBRATION DATE: 09-Dec-11

SLOCUM PAYLOAD CTD
PRESSURE CALIBRATION DATA
1450 psia S/N 3459007

COEFFICIENTS:

PA0 =	1.808852e-001	PTCA0 =	5.250272e+005
PA1 =	4.795118e-003	PTCA1 =	5.270342e-002
PA2 =	-2.529450e-011	PTCA2 =	7.433101e-002
PTEMPA0 =	-7.404472e+001	PTCB0 =	2.538938e+001
PTEMPA1 =	4.758229e-002	PTCB1 =	2.750000e-004
PTEMPA2 =	-1.458957e-007	PTCB2 =	0.000000e+000

PRESSURE SPAN CALIBRATION

PRESSURE PSIA	INST OUTPUT	THERMISTOR OUTPUT	COMPUTED PRESSURE	ERROR %FSR
14.75	528113.0	2035.0	14.79	0.00
315.06	590761.0	2036.0	315.02	-0.00
615.08	653406.0	2036.0	615.03	-0.00
~~915.08~~	~~716094.0~~	~~2037.0~~	~~915.04~~	~~-0.00~~
1215.11	778833.0	2037.0	1215.11	-0.00
1465.09	831126.0	2037.0	1465.06	-0.00
1215.07	778837.0	2036.0	1215.13	0.00
915.03	716102.0	2037.0	915.08	0.00
615.03	653412.0	2036.0	615.05	0.00
315.03	590766.0	2036.0	315.04	0.00
14.75	528101.0	2035.0	14.74	-0.00

THERMAL CORRECTION

TEMP ITS90	THERMISTOR OUTPUT	INST OUTPUT
32.50	2255	528186.00
29.00	2180	528173.80
24.00	2074	528155.80
~~18.50~~	~~1957~~	~~528134.20~~
15.00	1882	528122.60
4.50	1659	528110.00
1.00	1585	528109.00

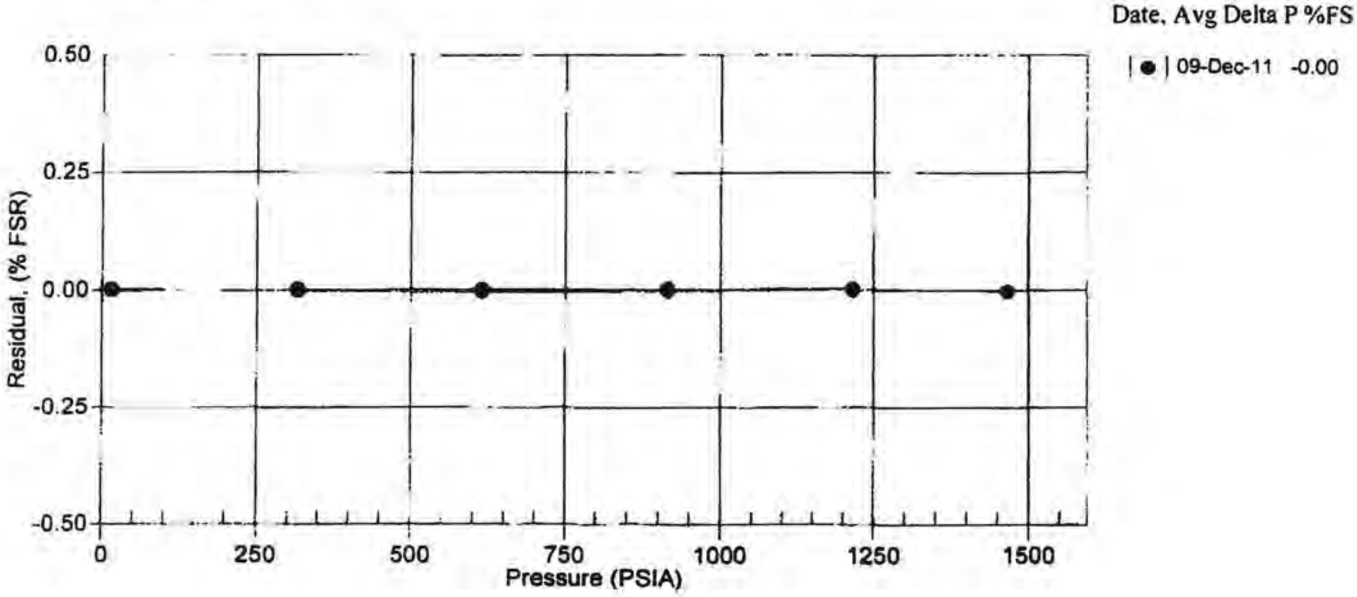
TEMP(ITS90)	SPAN(mV)
-5.00	25.39
35.00	25.40

y = thermistor output; $t = PTEMPA0 + PTEMPA1 * y + PTEMPA2 * y^2$

$x =$ pressure output $- PTCA0 - PTCA1 * t - PTCA2 * t^2$

$n = x * PTCB0 / (PTCB0 + PTCB1 * t + PTCB2 * t^2)$

pressure (psia) $= PA0 + PA1 * n + PA2 * n^2$



SonTek
a xylem brand

9940 Summers Ridge Road
San Diego, CA 92121
Tel: (858) 546-8327
support@sontek.com

CALIBRATION CERTIFICATE

System Info

System Type	CastAway-CTD
Serial Number	11D101493
Firmware Version	0.26
Calibration Date	5/30/2012

Power

Standby Mode (A)	0.2094 / PASS
Supply Voltage	2.9V

Calibration

Pressure	Passed
Conductivity	Passed
Temperature	Passed
GPS	Passed

Verified by: dshumway

Date: 6/1/2012

SBE

SEA-BIRD ELECTRONICS, INC.

13431 NE 20th St. Bellevue, Washington 98005 USA

Phone: (425) 643-9866 Fax: (425) 643-9954 www.seabird.com

Service Report

RMA Number 69172

Customer Information:

Company	Rutgers	Date	6/14/2012
Contact	David Aragon		
PO Number	S1665726		

Serial Number	051018
Model Number	SBE 05T

Services Requested:

1. Evaluate/Repair Instrumentation.

Problems Found:

Services Performed:

1. Performed initial diagnostic evaluation.

Special Notes:

SBE SEA-BIRD ELECTRONICS, INC.
13431 NE 20th St. Bellevue, Washington 98005 USA
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Service Report

RMA Number: 69172

Customer Information:

Company	Rutgers	Date	6/14/2012
Contact	David Aragon		
PO Number	S1665726		

Serial Number	199618-1645
Model Number	SBE 19-03

Services Requested:

1. Evaluate/Repair Instrumentation.
2. Perform Routine Calibration Service.

Problems Found:

1. The Y-cable had some corrosion damage on pins and had previously been repaired by customer. Will be replaced with PN 17709 Y-cable.

Services Performed:

1. Performed initial diagnostic evaluation.
2. Performed "Post Cruise" calibration of the temperature & conductivity sensors.
3. Calibrated the pressure sensor.
4. Installed NEW pump / data Y-cable.
5. Performed complete system check and full diagnostic evaluation.

Special Notes:

Sea-Bird Electronics, Inc.

13431 NE 20th Street, Bellevue, WA 98005-2010 USA

Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 1645
CALIBRATION DATE: 17-May-12

SBE19 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

g = 4.20453005e-003
h = 5.97712451e-004
i = 5.15077996e-006
j = -1.52678800e-006
f0 = 1000.0

IPTS-68 COEFFICIENTS

a = 3.64763497e-003
b = 5.84092998e-004
c = 9.48775778e-006
d = -1.52627797e-006
f0 = 2563.761

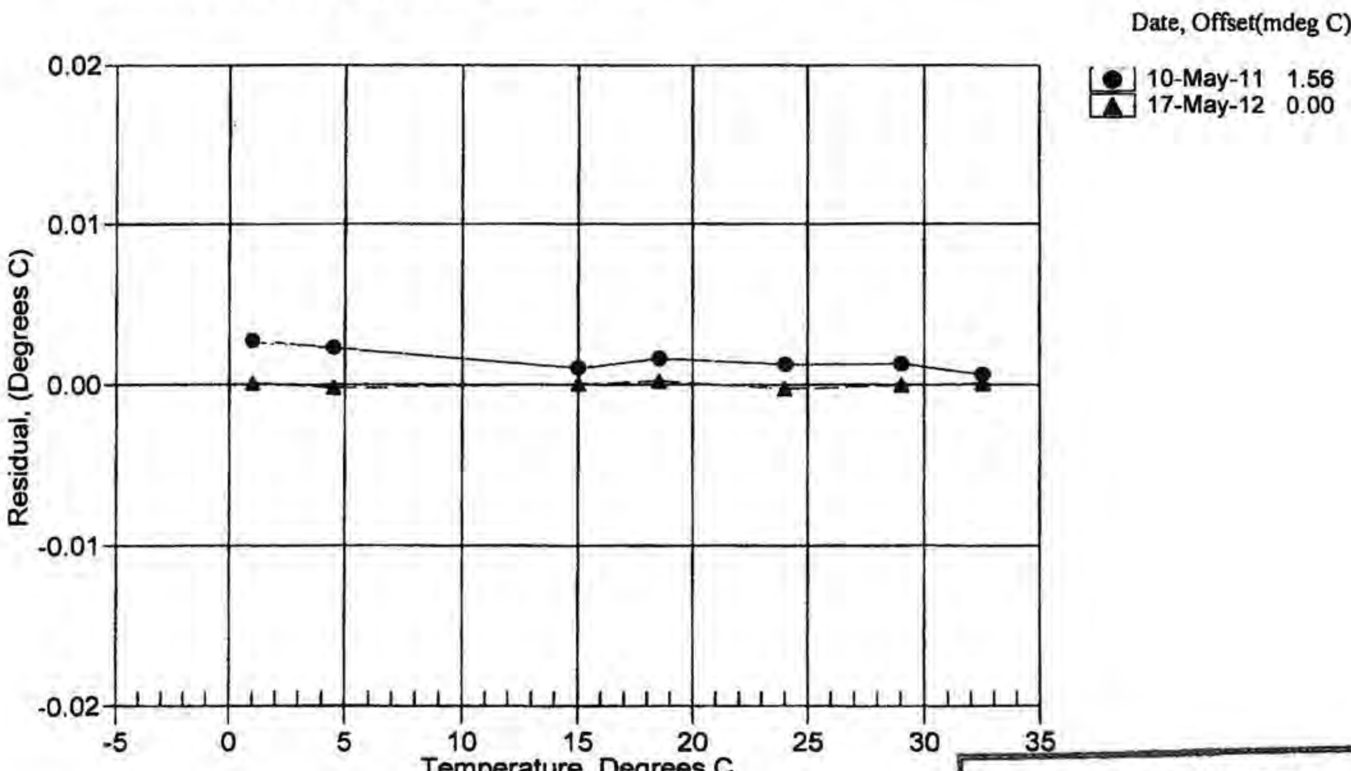
BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
0.9999	2563.761	1.0000	0.00010
4.4999	2774.062	4.4997	-0.00018
15.0000	3478.313	15.0000	0.00004
18.5000	3738.690	18.5002	0.00024
24.0000	4175.001	23.9997	-0.00026
29.0000	4601.563	29.0000	-0.00002
~~32.5000~~	~~4917.634~~	~~32.5001~~	~~0.00007~~

Temperature ITS-90 = $1/\{g + h[ln(f_0/f)] + i[ln^2(f_0/f)] + j[ln^3(f_0/f)]\} - 273.15$ (°C)

Temperature IPTS-68 = $1/\{a + b[ln(f_0/f)] + c[ln^2(f_0/f)] + d[ln^3(f_0/f)]\} - 273.15$ (°C)

Following the recommendation of JPOTS: T_{68} is assumed to be 1.00024 * T_{90} (-2 to 35 °C)

Residual = instrument temperature - bath temperature



POST CRUISE CALIBRATION

SBE
SEA-BIRD ELECTRONICS, INC.
13431 NE 20th St. Bellevue, Washington 98005 USA
Phone: (425) 643-9866 Fax: (425) 643-9954 www.seabird.com

Temperature Calibration Report

Customer:	Rutgers		
Job Number:	69172	**Date of Report:**	5/21/2012
Model Number:	SBE 19-03	**Serial Number:**	199618-1645

Temperature sensors are normally calibrated 'as received', without adjustments, allowing a determination sensor drift. If the calibration identifies a problem, then a second calibration is performed after work is completed. The 'as received' calibration is not performed if the sensor is damaged or non-functional, or by customer request.

An 'as received' calibration certificate is provided, listing coefficients to convert sensor frequency to temperature. Users must choose whether the 'as received' calibration or the previous calibration better represents the sensor condition during deployment. In SEASOFT enter the chosen coefficients. The coefficient 'offset' allows a small correction for drift between calibrations (consult the SEASOFT manual). Calibration coefficients obtained after a repair apply only to subsequent data.

'AS RECEIVED CALIBRATION' ✔ **Performed** **Not Performed**

Date: 5/17/2012 **Drift since last cal:** -0.00153 **Degrees Celsius/year**

Comments:

'CALIBRATION AFTER REPAIR' **Performed** ✔ **Not Performed**

Date: **Drift since Last cal:** **Degrees Celsius/year**

Comments:

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SENSOR SERIAL NUMBER: 1645
CALIBRATION DATE: 17-May-12

SBE19 CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Seimens/meter

GHIJ COEFFICIENTS

```
g = -4.04794553e+000
h =  4.82841506e-001
i =  1.24162353e-003
j = -3.13086509e-005
CPcor = -9.5700e-008 (nominal)
CTcor =  3.2500e-006 (nominal)
```

ABCDM COEFFICIENTS

```
a =  5.10588664e-002
b =  4.27666673e-001
c = -4.03166139e+000
d = -1.19643464e-004
m =  2.1
CPcor = -9.5700e-008 (nominal)
```

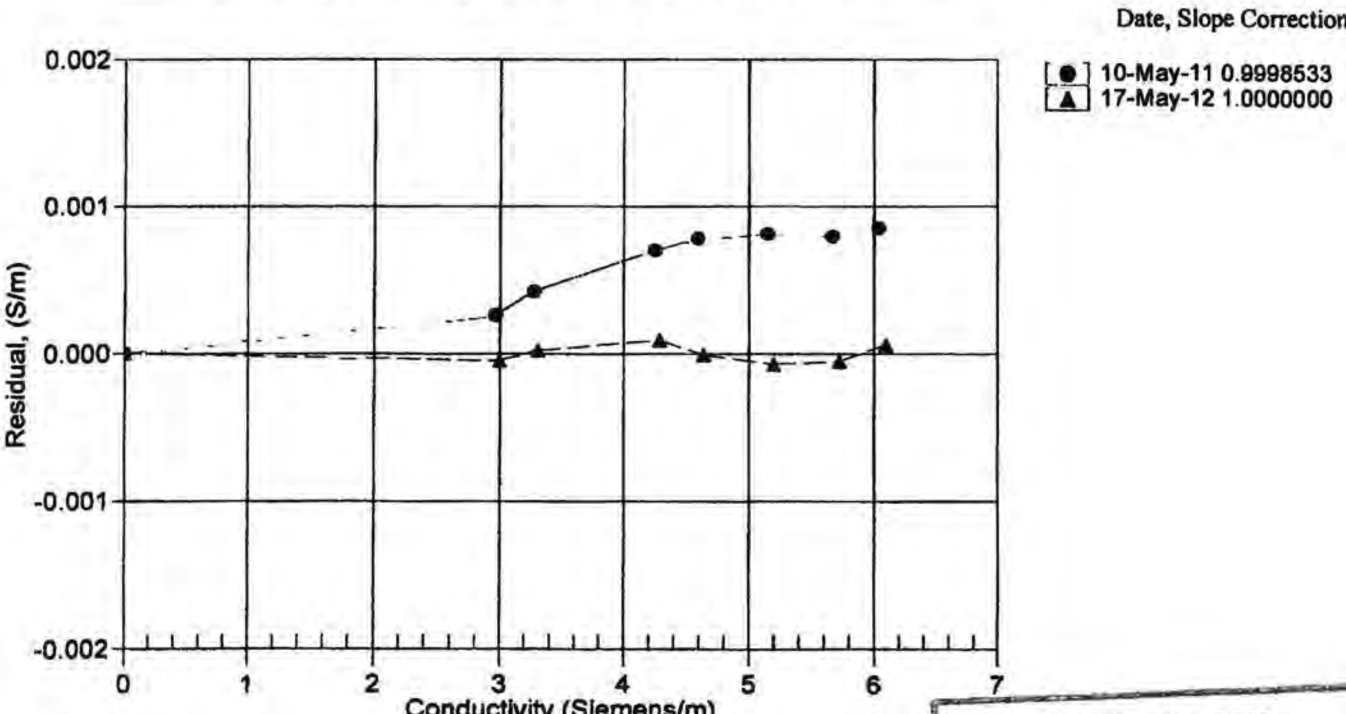
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2.88554	0.00000	0.00000
0.9999	35.0146	2.99128	8.31658	2.99124	-0.00005
4.4999	34.9937	3.29980	8.68395	3.29982	0.00002
15.0000	34.9505	4.28633	9.76514	4.28642	0.00009
18.5000	34.9406	4.63307	10.11731	4.63307	-0.00001
24.0000	34.9285	5.19347	10.66172	5.19340	-0.0000
29.0000	34.9182	5.71712	11.14627	5.71707	-0.00005
32.5000	34.9078	6.09014	11.47892	6.09020	0.00006

Conductivity = $(g + hf^2 + if^3 + jf^4) / 10(1 + \delta t + \varepsilon p)$ Siemens/meter

Conductivity = $(af^m + bf^2 + c + dt) / [10 (1 + \varepsilon p)$ Siemens/meter

t = temperature[°C)]; p = pressure[decibars]; δ = CTcor; ε = CPcor;

Residual = (instrument conductivity - bath conductivity) using g, h, i, j coefficients



POST CRUISE CALIBRATION

SBE **SEA-BIRD ELECTRONICS, INC.**
13431 NE 20th Street Bellevue, Washington 98005 USA
Phone: (425) 643-9866 Fax: (425) 643-9954 www.seabird.com

Conductivity Calibration Report

Customer:	Rutgers		
Job Number:	69172	**Date of Report:**	5/21/2012
Model Number:	SBE 19-03	**Serial Number:**	199618-1645

Conductivity sensors are normally calibrated 'as received', without cleaning or adjustments, allowing a determination of sensor drift. If the calibration identifies a problem or indicates cell cleaning is necessary, then a second calibration is performed after work is completed. The 'as received' calibration is not performed if the sensor is damaged or non-functional, or by customer request.

An 'as received' calibration certificate is provided, listing the coefficients used to convert sensor frequency to conductivity. Users must choose whether the 'as received' calibration or the previous calibration better represents the sensor condition during deployment. In SEASOFT enter the chosen coefficients. The coefficient 'slope' allows small corrections for drift between calibrations (consult the SEASOFT manual). Calibration coefficients obtained after a repair or cleaning apply only to subsequent data.

'AS RECEIVED CALIBRATION' ✔ **Performed** **Not Performed**

Date: 5/17/2012 **Drift since last cal:** -0.00040 **PSU/month***

Comments:

'CALIBRATION AFTER CLEANING & REPLATINIZING' **Performed** ✔ **Not Performed**

Date: **Drift since Last cal:** **PSU/month***

Comments:

Measured at 3.0 S/m

Cell cleaning and electrode replatinizing tend to 'reset' the conductivity sensor to its original condition. Lack of drift in post-cleaning-calibration indicates geometric stability of the cell and electrical stability of the sensor circuit.

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SENSOR SERIAL NUMBER: 1645
CALIBRATION DATE: 22-May-12

SBE19 PRESSURE CALIBRATION DATA
150 psia S/N 169585 TCV: -105

QUADRATIC COEFFICIENTS:

PA0 = 7.374722e+001
PA1 = -1.962260e-002
PA2 = 7.626656e-008

STRAIGHT LINE FIT:

M = -1.964407e-002
B = 7.416500e+001

PRESSURE PSIA	INST OUTPUT(N)	COMPUTED PSIA	ERROR %FS	LINEAR PSIA	ERROR %FS
14.57	3050.0	14.61	0.02	14.25	-0.21
29.80	2265.0	29.69	-0.07	29.67	-0.09
59.69	728.0	59.50	-0.13	59.86	0.12
94.83	-1068.0	94.79	-0.03	95.14	0.21
124.81	-2578.0	124.84	0.02	124.81	0.00
149.79	-3812.0	149.66	-0.09	149.05	-0.49
124.82	-2584.0	124.96	0.09	124.93	0.07
94.85	-1078.0	94.99	0.10	95.34	0.33
59.83	711.0	59.83	0.00	60.20	0.24
29.86	2255.0	29.89	0.02	29.87	0.01
14.58	3047.0	14.67	0.06	14.31	-0.18

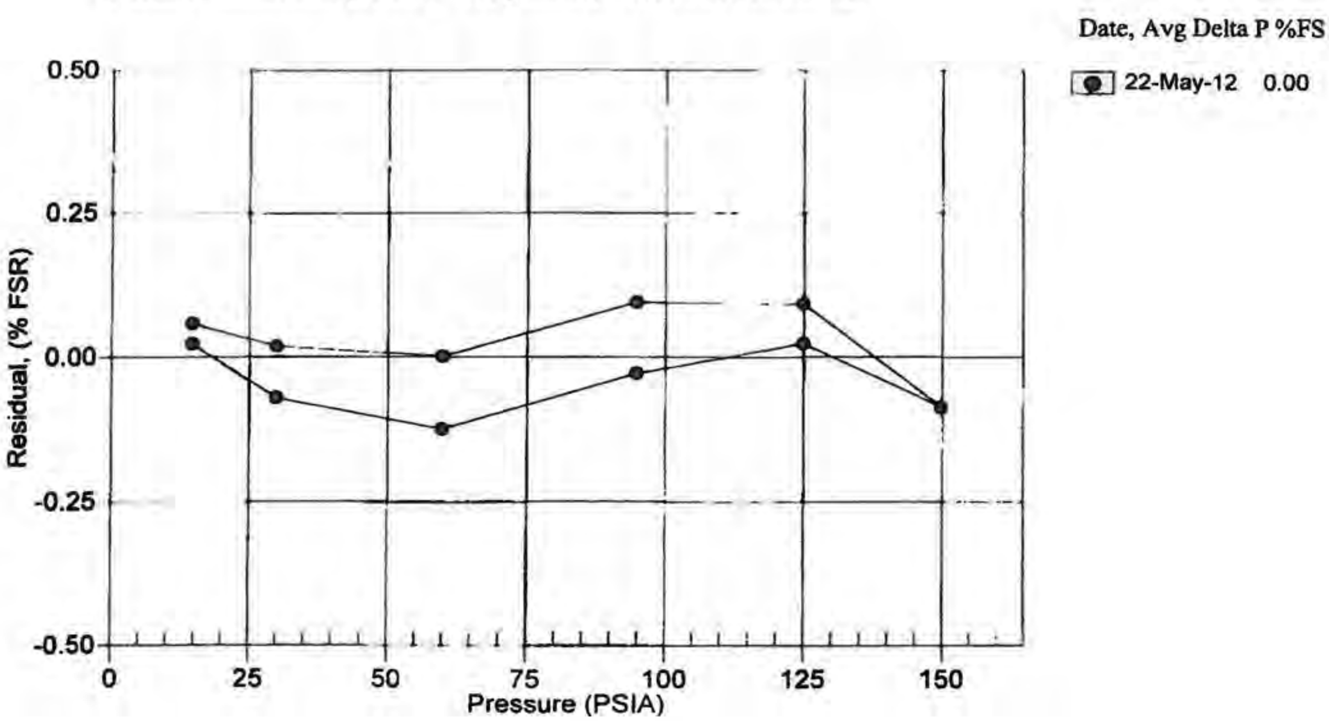
Straight Line Fit:

Pressure (psia) = M * N + B (N = binary output)

Quadratic Fit:

pressure (psia) = PA0 + PA1 * N + PA2 * N^2

Residual = (instrument pressure - true pressure) * 100 / Full Scale Range



Appendix G

Deployment 6
9/13/2012 – 10/04/2012

Pre-Deployment Check Out

GLIDER	RU07
PREPARER	Dave A., Chip, Dave K.
PREP DATE	9/7/12
LOCATION	NJDEP: NJ Coastal

SCIENCE BAY SERIAL NUMBERS	
1)	0080 - CTD/Bay
2)	~~BBFL2SLO~~ 599
3)	BBFL2 -337
4)	BB3 - 335

optode SN 1504

PRE-SEAL

FORE CHECK

Check pump & pitch threaded rod (grease & clean if necessary) ✓
Grounded Nose? ✓
Leak detect in place, batteries secure, white guides free, no metal shavings, bottles installed ✓

PAYLOAD CHECK

Special Sensors / Additional Sensors
1) Vemco 112/770/30525
2)
CTD cable clear, no leak at CTD joint, no leak at pucks ____
Grounded Parts: Fore Sci Ring ✓ CTD N
Aft Sci Ring ✓ Other? —
Science Bay Weight Configuration ____

AFT CHECK

Iridium Card Installed (SIM #) (if not standard) —
Flash Card: old data removed? ✓
Inspect strain on connectors (worn connectors), battery aft? secured, ballast bottle present, aft cap clean/clear of leak ✓
Aft cap grounded? ✓

Battery check
Aft Pack - J13 Voltage 15.80
Pitch Pack - J13 Voltage 15.80
Nose Packs - J13 Voltage 15.77
Aft Emer - J31 Voltage 15.83

POST-SEAL

GENERAL

Pick Point Present? N
Special Instruments? VEMCO

HARDWARE

put c_alt_time 0, verify alt chirp ✓
Nose Cone and pump bladder inspection ✓
Anode grounded? ✓
Anode size / remainder (est) 25%
Pressure Sensor Check (corrosion, clear)
Aft sensor ✓
Payload sensor ✓
Ejection weight assembly OK and unseized? ✓

POWERED

Verify Argos ping ✓
Wiggle for 5 minutes
Stabilized m_battery 15.26
m_vacuum @ T @ ballast 5.90

OUTSIDE

Compass Check (reading @ compass)
1)
2) over
3)
4)
logging on; rotate slowly 360, logging off, plot data: 360 test ____
GPS check
(lat) 4028.75 (lon) 74 26.22
Iridium connect — Alt —
zero_ocean_pressure, get m_pressure 0M
let air bladder inflate, does it shut off? ____

SOFTWARE

GENERAL

Version	7.9	Re-burn latest software image	✓
Date OK?	✓	configure TBDlist	✓
delete old logs	✓	NBDlist	✓

\CONFIG

simul.sim deleted ✓

\MAFILES

goto_l10.ma (set x_last_...) ______

AUTOEXEC MI

Irid Main: 88160000592	✓	c_ctd41cp_num_fields_to_send 4	✓
Irid Alt: 15085482446	✓	Calibration coefficients	✓
u_iridium_failover_retries = 10	✓	f_ballast_pumped_deadz_width = 30?	✓
Reset the glider, observe any errors		get f_max_working_depth (102 m)	✓

CACHE MANAGEMENT

del ..\state\cache*.*

after *bdlist.dat are set (exit reset):

logging on; logging off

send ..\state\cache*.cac ✓

send *.mbd *.sbd *.tbd ✓

* **Software Burning Tips :** if using Procomm or local folder, copy all the files from the software image locally. Then proceed to edit them for the glider and do a mass freewave transfer of the files. Save these files or prepare the to-glider with these files

SCIENCE

SENSOR RETURN

put c_science_send_all 1

put c_science_all_on 8

put c_science_on 3

All sensors reporting values? ✓

CTD

Tank static comparison OK? ✓

OPTODE

Check in completed? ✓

BALLAST ITERATIONS **GLIDER:** ______ **DATE:** ______

ITERATION 4

F | SB | A

112 68

Ballast Bottles

FORE 1

FORE 2

AFT

NOTES .011 = -.005

TANK: T = 22.918
(SB19) C = 4.0815
D = 1018.1.65

TANK: T =
(Glider) C =

ITERATION ______

F | SB | A

Ballast Bottles

FORE 1

FORE 2

AFT

NOTES

TANK: T =
(SB19) C =
D =

TANK: T =
(Glider) C =

ITERATION ______

F | SB | A

Ballast Bottles

FORE 1

FORE 2

AFT

NOTES

TANK: T =
(SB19) C =
D =

TANK: T =
(Glider) C =

Deployment			MASS (g)	COMMENTS
NJDEP # 4	GLIDER	FORE STEM (altimeter bottle)	8137.6	
		FORE HULL	4648.1	
Glider		AFT STEM (red plug, card)	6315	w/o optode
ru07		AFT HULL	4258.6	
		COWLING	1180.2	
		SCREWS (vacuum, cowling, aft battery)	20.4	
Date	PAYLOAD	PAYLOAD BAY	7811.9	w/o VMT but w/mount
9/10/2012		WINGS	438.9	
Preparer		OTHER		
Dave A	BATTERIES	AFT BATTERY	7660.8	
		PITCH BATTERY	9387.7	
Air temp		FORE BATTERY 1, 2	1450.1	
20	WEIGHT BOTTLES	AFT BOTTLE	389.1	DNC
final, medium wings		FORE BOTTLE 1 (starboard)	124.7	DNC
		FORE BOTTLE 2 (port)	119.5	DNC
		OTHER		

Tank Specifics		Glider Specifics		H MOMENT (rad)		(deg)
Tank Density (g/mL)	1.0182	Glider Volume (mL)	50976.357	Angle of Rotation (before)	0	0.0
Tank Temperature (C)	22.92	Total Mass (g)	NA	Angle of Rotation (after)	-0.2	-11.5
Weight in Tank (g)	180.00	Glider Density 1 (air) (g/mL)	#VALUE!	Angle of Rotation	0.2	11.5
Target Specifics		**Volume Change (temperature induced)**		Weight on Spring (after)	325	
Target Density (g/mL)	1.0223	Volume Change (tank) (mL)	10	Weight added	292	
Target Temperature ©	20.00	Volume Change (target) (mL)	-10	Radius of Hull	107	
		(note use 53.5 E -6 in above for DE (carbon)) ^		**H-distance**	**6.4**	
		(note use 70 E -6 in above for Aluminum hull)				

Should Hang (in tank) (g)	186.99	**Adjust Glider Mass (Dunk Volume) (g)**	#VALUE!
Adjust by: (g)	6.99	**Adjust Glider Mass (entered volume) (g)**	#VALUE!

^ Ballasting Alternative (known VOLUME) (don't have to weight parts!)

Calculated Glider Volume (calculated from scales) (mL)	**#VALUE!**
Glider Density 2 (in target water, using calculated volume above) (kg / m³)	**#VALUE!**
Glider Density 3 (in target water, using entered volume) (kg / m³)	**#VALUE!**
Glider Density 4 (in target water, using entered volume) (kg / m³)	**1022.11**

Average Glider Volume

volume 1:
volume 2:
volume 3:
average = #DIV/0!

MISC Items Masses/Volumes

PICK POINT VOLUME 40.4 mL 107 g air / 66 g Water
G1 Volume 50.9 L
VMT35 Transceiver (w/ mount) 161 mL

BALLAST ITERATIONS **GLIDER:** RU07 **DATE:** 9/7/12

ITERATION 1

± (above F)

F | SB | A

156 48

Ballast Bottles

FORE 1	124.6
FORE 2	119.4
AFT	389.0

NOTES
± = 144

roll = -.03

TANK: T = 22 ~~9~~ 2 9410 **TANK:** T = 22.2924
(SB19) C = ~~4~~.384 (Glider) C = 4.382
D =

ITERATION 2

112 (above F)

F | SB | A

116 ~~[illegible]~~ 60

Ballast Bottles

FORE 1	60.7
FORE 2	53.9
AFT	339.2

NOTES
want -150g
F A
156 48
-108
48 48
-21 -21
~~-129 -21~~
-129 -21
-25g (additional for 25g bolt on aft)

TANK: T = **TANK:** T = 22.314
(SB19) C = (Glider) C = 4.355
D =

heavy port roll

ITERATION 3

~~[illegible]~~ (above A)

F | SB | A

32 44

Ballast Bottles

FORE 1	71.2
FORE 2	53.9
AFT	298.7

NOTES
116 60
+112 +60 want -30
~~116 60~~
116 120 ~~[illegible]~~ +172
~~-131 -131~~
~~-14~~
~~-86 -86~~
~~+26 +26~~
-101 -101
+11 -41

TANK: T = **TANK:** T =
(SB19) C = (Glider) C =
D =

[illegible] = 46g
roll = 0.00

scale w/ weight = 325
weight = 292
roll w/ weight = -.2

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Deployment			MASS (g)	COMMENTS
	GLIDER	FORE STEM (altimeter bottle)	8137.6	
		FORE HULL	4648.1	
Glider		AFT STEM (red plug, card)	6315	w/o optode (not accurate)
		AFT HULL	4258.6	
		COWLING	1180.2	
		SCREWS (vacuum, cowling, aft battery)	20.4	
Date	PAYLOAD	PAYLOAD BAY	7811.9	w/o VMT but w/mount
		WINGS	438.9	
Preparer		OTHER		
	BATTERIES	AFT BATTERY	7660.8	
		PITCH BATTERY	9387.7	
Air temp		FORE BATTERY 1, 2	1450.1	
20	WEIGHT BOTTLES	AFT BOTTLE	389.1	DNC
		FORE BOTTLE 1 (starboard)	124.7	DNC
		FORE BOTTLE 2 (port)	119.5	DNC
		OTHER		

Tank Specifics		Glider Specifics		H MOMENT (rad)		(deg)
Tank Density (g/mL)	1.0204	Glider Volume (mL)	50976.357	Angle of Rotation (before)	0	0.0
Tank Temperature (C)	22.29	Total Mass (g)	NA	Angle of Rotation (after)	-0.2	-11.5
Weight in Tank (g)	20.00	Glider Density 1 (air) (g/mL)	#VALUE!	Angle of Rotation	0.2	11.5
Target Specifics		**Volume Change (temperature induced)**		Weight on Spring (after)	325	
Target Density (g/mL)	1.0213	Volume Change (tank) (mL)	8	Weight added	292	
Target Temperature ©	22.00	Volume Change (target) (mL)	-1	Radius of Hull	107	
		(note use 53.5 E -6 in above for DE (carbon)) ^		**H-distance**	6.4	
		(note use 70 E -6 in above for Aluminum hull)				

Should Hang (in tank) (g)	35.87	**Adjust Glider Mass (Dunk Volume) (g)**	#VALUE!
Adjust by: (g)	15.87	**Adjust Glider Mass (entered volume) (g)**	#VALUE!

^ Ballasting Alternative (known VOLUME) (don't have to weight parts!)

Calculated Glider Volume (calculated from scales) (mL)	#VALUE!
Glider Density 2 (in target water, using calculated volume above) (kg / m³)	#VALUE!
Glider Density 3 (in target water, using entered volume) (kg / m³)	#VALUE!
Glider Density 4 (in target water, using entered volume) (kg / m³)	1020.94

Average Glider Volume

volume 1:
volume 2:
volume 3:
average = #DIV/0!

MISC Items Masses/Volumes

PICK POINT VOLUME	40.4 mL	107 g air / 66 g Water
G1 Volume	50.9 L	
VMT35 Transceiver (w/ mount)	161 mL	

			MASS (g)	COMMENTS
Deployment	GLIDER	FORE STEM (altimeter bottle)	8137.6	
		FORE HULL	4648.1	
		AFT STEM (red plug, card)	6315	w/o optode (not accurate)
Glider		AFT HULL	4258.6	
		COWLING	1180.2	
		SCREWS (vacuum, cowling, aft battery)	20.4	
Date	PAYLOAD	PAYLOAD BAY	7811.9	w/o VMT but w/mount
		WINGS	438.9	
Preparer		OTHER		
	BATTERIES	AFT BATTERY	7660.8	
		PITCH BATTERY	9387.7	
Air temp		FORE BATTERY 1, 2	1450.1	
20	WEIGHT BOTTLES	AFT BOTTLE	389.1	DNC
		FORE BOTTLE 1 (starboard)	124.7	DNC
		FORE BOTTLE 2 (port)	119.5	DNC
		OTHER		

Tank Specifics		**Glider Specifics**		**H MOMENT (rad)**		**(deg)**	
Tank Density (g/mL)	1.0204	Glider Volume (mL)	50976.357	Angle of Rotation (before)		0.0	
Tank Temperature (C)	22.29	Total Mass (g)	51942.6	Angle of Rotation (after)		0.0	50976.4
Weight in Tank (g)	64.00	Glider Density 1 (air) (g/mL)	1.0190	Angle of Rotation	0	0.0	
Target Specifics		**Volume Change (temperature induced)**		Weight on Spring (after)			
Target Density (g/mL)	1.0213	Volume Change (tank) (mL)	8	Weight added	290		
Target Temperature ©	22.00	Volume Change (target) (mL)	-1	Radius of Hull	107		
		(note use 53.5 E -6 in above for DE (carbon)) ^		**H-distance**	**#DIV/0!**		
		(note use 70 E -6 in above for Aluminum hull)					

Should Hang (in tank) (g)	35.87	**Adjust Glider Mass (Dunk Volume) (g)**	-28.24
Adjust by: (g)	-28.13	**Adjust Glider Mass (entered volume) (g)**	116.19

^ Ballasting Alternative (known VOLUME) (don't have to weight parts!)

Calculated Glider Volume (calculated from scales) (mL)	**50834.941**
Glider Density 2 (in target water, using calculated volume above) (kg / m³)	**1021.8**
Glider Density 3 (in target water, using entered volume) (kg / m³)	**1019.0**
Glider Density 4 (in target water, using entered volume) (kg / m³)	**1021.80**

Average Glider Volume

volume 1:	
volume 2:	
volume 3:	
average =	#DIV/0!

MISC Items Masses/Volumes

PICK POINT VOLUME	40.4 mL	107 g air / 66 g Water
G1 Volume	50.9 L	
VMT35 Transceiver (w/ mount)	161 mL	148 g w

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			MASS (g)	COMMENTS
Deployment	GLIDER	FORE STEM (altimeter bottle)	8137.6	
		FORE HULL	4648.1	
		AFT STEM (red plug, card)	6315	w/o optode (not accurate)
Glider		AFT HULL	4258.6	
		COWLING	1180.2	
		SCREWS (vacuum, cowling, aft battery)	20.4	
Date	PAYLOAD	PAYLOAD BAY	7811.9	w/o VMT but w/mount
		WINGS	438.9	
Preparer		OTHER		
	BATTERIES	AFT BATTERY	7660.8	
		PITCH BATTERY	9387.7	
Air temp		FORE BATTERY 1, 2	1450.1	
20	WEIGHT BOTTLES	AFT BOTTLE	389.1	DNC
		FORE BOTTLE 1 (starboard)	124.7	DNC
		FORE BOTTLE 2 (port)	119.5	DNC
		OTHER		

Tank Specifics		**Glider Specifics**		**H MOMENT (rad)**		**(deg)**
Tank Density (g/mL)	1.0204	Glider Volume (mL)	50976.357	Angle of Rotation (before)		0.0
Tank Temperature (C)	22.29	Total Mass (g)	51942.6	Angle of Rotation (after)		0.0
Weight in Tank (g)	186.00	Glider Density 1 (air) (g/mL)	1.0190	Angle of Rotation	0	0.0
Target Specifics		**Volume Change (temperature induced)**		Weight on Spring (after)		
Target Density (g/mL)	1.0213	Volume Change (tank) (mL)	8	Weight added	290	
Target Temperature ©	22.00	Volume Change (target) (mL)	-1	Radius of Hull	107	
		(note use 53.5 E -6 in above for DE (carbon)) ^		**H-distance**	**#DIV/0!**	
		(note use 70 E -6 in above for Aluminum hull)				

Should Hang (in tank) (g)	35.87	**Adjust Glider Mass (Dunk Volume) (g)**	-150.32
Adjust by: (g)	-150.13	**Adjust Glider Mass (entered volume) (g)**	116.19

^ Ballasting Alternative (known VOLUME) (don't have to weight parts!)

Calculated Glider Volume (calculated from scales) (mL)	**50715.395**
Glider Density 2 (in target water, using calculated volume above) (kg / m³)	**1024.2**
Glider Density 3 (in target water, using entered volume) (kg / m³)	**1019.0**
Glider Density 4 (in target water, using entered volume) (kg / m³)	**1024.20**

Average Glider Volume

volume 1:	
volume 2:	
volume 3:	
average =	#DIV/0!

MISC Items Masses/Volumes

PICK POINT VOLUME	40.4 mL	107 g air / 66 g Water
G1 Volume	50.9 L	
VMT35 Transceiver (w/ mount)	161 mL	148 g

*Aft - Optode setup/mount not attached

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			MASS (g)	COMMENTS
Deployment	GLIDER	FORE STEM	8195	8137.6
NJDEP		FORE HULL	4257	4648.1
		AFT STEM (red plug, card)	6500.2	6315.0
Glider		AFT HULL	4638.4	4258.6
RU07		COWLING	1151.2	1180.2
		SCREWS (vacuum,cowling,aft battery)	16.8	20.4
Date	PAYLOAD	PAYLOAD BAY ~~(no rails!)~~	~~7172.9~~	no wt. bar 6250.9, with wt. bar 7172.9 ~~7120.7~~ 7811.9 (w/ the VMT)
5.30.12		WINGS	552.7	438.9 port 275.8 star 276.9
		WING RAILS (screws)	~~0~~	on payload
Preparer		PICK POINT	~~0~~	no pickpoint SB0080
Tina	BATTERIES	AFT BATTERY	7613.8	7660.8
		PITCH BATTERY	9329.8	9387.7
Air Temperature		FORE BATTERY 1 (starboard)	727.85	725.6
20		FORE BATTERY 2 (port)	727.85	724.5
	WEIGHT BOTTLES	AFT BOTTLE	265.4	389.1
		FORE BOTTLE 1 (starboard)	246.4	124.7
		FORE BOTTLE 2 (port)	241.3	119.5

Tank Specifics		Glider Specifics		H MOMENT (rad)		(deg)
Tank Density (g/mL)	1.0221	Glider Volume (mL)	50900	Angle of Rotation (before)		0.0
Tank Temperature (C)	18.43	Total Mass (g)	52000	Angle of Rotation (after)		0.0
Weight in Tank (g)	~~8.00~~	Glider Density 1 (air) (g/mL)	1.0216	Angle of Rotation	0	0.0
Target Specifics	1.02125	**Volume Change (temperature induced)**		Weight on Spring (after)		
Target Density (g/mL)	~~1.0220~~	Volume Change (tank) (mL)	-6	Weight added		
Target Temperature ©	~~11.00~~ 22.00	Volume Change (target) (mL)	-26	Radius of Hull	107	
				H-distance	#DIV/0!	

Should Hang (in tank) (g)	-26.94	**Adjust Glider Mass (Dunk Volume) (g)**	-18.94	volume 1:	50886.22
Adjust by: (g)	-18.94	**Adjust Glider Mass (entered volume) (g)**	-7.26	volume 2:	50513.23
					50532.99

^ Ballasting Alternative (known VOLUME)

Calculated Glider Volume (calculated from scales) (mL)	**50888.569**	average =	50644.15
Glider Density 2 (in target water, using calculated volume above) (kg / m³)	**1022.4**	PICK POINT MASSES	107 g air / 66 g Water
Glider Density 3 (in target water, using entered volume) (kg / m³)	**1022.1**	PICK POINT VOLUME	40.4 mL

Pre-Deployment Check Out
For
Aanderaa Oxygen Optode

RUTGERS
Coastal Ocean
Observation Lab

Slocum Glider Aanderaa Optode Check IN/OUT
2 Point Calibration & Calibration Coeffcient Record

OPTODE MODEL, SN: 1504 **IN / OUT** IN

Calibration Record

PERFORMED BY: Amanda

CALIBRATION DATE: 3/23/2012

Previous:

C0Coef	4.5E+03	-1.6E+02	3.3E+00	-2.8E-02
C1Coef	-2.5E+02	8.0E+00	-1.6E-01	1.3E-03
C2Coef	5.7E+00	-1.6E-01	3.1E-03	-2.5E-05
C3Coef	-6.0E-02	1.5E-03	-2.8E-05	2.2E-07
C4Coef	2.4E-04	-5.3E-06	1.0E-07	-7.1E-10

Current:

C0Coef	4.5E+03	-1.6E+02	3.3E+00	-2.8E-02
C1Coef	-2.5E+02	8.0E+00	-1.6E-01	1.3E-03
C2Coef	5.7E+00	-1.6E-01	3.1E-03	-2.5E-05
C3Coef	-6.0E-02	1.5E-03	-2.8E-05	2.2E-07
C4Coef	2.4E-04	-5.3E-06	1.0E-07	-7.1E-10

Delta: 0.0

2 point Calibration

0% Point

Solution: 15.2 g/ 1500 ml **Na_2SO_3**

Castaway **Cross reference**

25.89 **Temperature**

1002.709 **Air Pressure (hPa)**

Sample Bottle C **Winkler Label**

LaMotte 7414 - Azide mod **Winkler Source**

Results:

OPTODE: 71.02 **Dphase**

0.07 **% Saturation**

25.98 **Temperature**

0.21 **Conc (calculated) (µM)**

0.08 **% Saturation (calculated)**

WINKLER: 0 **Concentration (µM)**

(0, 0, 0) (0 - 2 µM) **(Titrations) (ppm)**

0 **% Saturation**

(worst case @ 2 µM = .04 % or 0%)

DELTAS:

0.21	**Conc Δ**	0.08	**% Δ**
-0.09	**Temp Δ**	25.935	**Temp avg**

100% Point

Solution: NA **Na_2SO_3**

Castaway **Cross reference**

10.54 **Temperature**

1002.709 **Air Pressure (hPa)**

Sample A, Sample B **Winkler Label**

LaMotte 7414 - Azide mod **Winkler Source**

Results:

OPTODE: 33.78 **Dphase**

96.21 **% Saturation**

10.47 **Temperature**

335.3 **Conc (calculated) (µM)**

97.16 **% Saturation (calculated)**

WINKLER: 325 **Concentration**

(10.2,10.6) **(Titrations) (ppm)**

94.02 **% Saturation**

DELTAS:

10.3	**Conc Δ**	3.14	**% Δ**
0.07	**Temp Δ**	10.505	**Temp avg**

In-Air Saturation Check

SATURATION: 95.62 **@ TEMP** 17.55 **@ PRESS** 1002.709

Sodium Thiosulate Normalization

Normalization (mL) 2 (2.0 ± .1) (EPA Compliance)

Paste config report all from optode

Protect	5014	1504	0			
PhaseCoef	5014	1504	-6.62372	1.204068	0	0
TempCoef	5014	1504	23.7279	-0.0306	2.83E-06	-4.2E-09
FoilNo	5014	1504	5009			
C0Coef	5014	1504	4537.931	-162.595	3.29574	-0.02793
C1Coef	5014	1504	-250.953	8.02322	-0.1584	0.001311
C2Coef	5014	1504	5.664169	-0.15965	0.003079	-2.5E-05
C3Coef	5014	1504	-0.05994	0.001483	-2.8E-05	2.15E-07
C4Coef	5014	1504	0.000244	-5.3E-06	1E-07	-7.1E-10
Salinity	5014	1504	0			
CalAirPhas	5014	1504	32.99431			
CalAirTemp	5014	1504	10.29875			
CalAirPress	5014	1504	1026.47			
CalZeroPha	5014	1504	65.21005			
CalZeroTen	5014	1504	24.86774			
Interval	5014	1504	2			
AnCoef	5014	1504	0	1		
Output	5014	1504	1			
SR10Delay	5014	1504	-1			
SoftwareV	5014	1504	3			
SoftwareBu	5014	1504	24			

Deployment Checklist

Glider 1,307 Date 9/13/2012

Pilots Dave/Josh/Tina Where NJDEP SH

40 23.5
73 54.4

Laptop Dave & Glider Lab 1 Vehicle Powerup: CTRL ^ C (until you get to prompt)!!!

On boat (Remember after 10 min glider will go into mission, as well as on powerup!)	Battery Voltage	15.2	get m_battery
	Vacuum Pressure	8.5	get m_vacuum, should be > 7 for bladder inflation
	Iridium Connection		look for connect dialog & surface dialog, let it dial at prompt
	boot app		boot app
	boot (should report application)		reports boot application
	run status.mi		mission completed normally?
In Water	zero_ocean_pressure		while glider in water
	run od.mi (with or without float, ask RU)		glider should dive and surface, type why? Should say overdepth, if not call
	send *.dbd *.mlg *.sbd		"send *.sbd" is most important
			(this applies moreso to when handed off to iridium)
	run shallow.mi or deep.mi		(glider should dive and not reappear) (report to Rutgers or steam out slowly once it dives)
	Verify dive; **disconnect freewave** Report to Rutgers		
	Perform CTD Comparison CAST		typically done with RU provided SBE19 or Cast Away CTD
	LAT: 4023 .557 **LON** 73 54. ~~40~~ 395		

G-16

Recovery Checklist

Glider RU07

Date 10/09/2012

Pilots Colin

Where Cape May

Laptop Asus Mini

Recovery	get Lat/Lon from email or shore support	☐
	obtain freewave comms obtain lat/lon with where command	☐
	Perform CTD Comparison CAST	✓
	LAT: 38.9131 N **LON:** 74.8100 E	
	(note instrument type!) CastAway CTD	

908 614 6190

Post-Deployment Checklist

RUTGERS
Coastal Ocean
Observation Lab

Slocum Glider Check-IN

DATE: 10/9/12

GLIDER: RU07 **SB:** 0080

Vehicle Powered

1. *Power on vehicle in order to fully retract pump, and/or to deflate air bladder.*
2. *Wiggle vehicle for 5 minutes.*

Austin and Shannon

Vehicle Cleaning (hose down with pressure)

Nose cone

1. Remove nose cone
2. Loosen altimeter screws, and remove altimeter or leave temporarily attached
3. Retract pump
4. Remove altimeter and hose diaphragm removing all sand, sediment, bio oils
5. Clean nose cone and altimeter

Tail cone

1. Remove tail cone
2. Hose and clean anode and air bladder making sure air bladder is completely clean
3. Clean cowling

Wing rails

1. Remove wing rails and hose down

Tail plug cleaning

1. Dip red plug in alcohol and clean plug if especially dirty
2. Re-dip red plug and repeatedly insert and remove to clean the glider plug
3. Compress air glider female connector
4. Lightly silicon red plug and replace in glider once silicon has been dispersed evenly in the plugs

CTD Comparison Check

1. Inspect CTD sensor for any sediment buildup, take pictures of anything suspicious or make note.

Static Tank Test

SBE19		*Glider (SBE41CP or pumped unit)*	
Temperature:	20.416	Temperature:	20.415
Conductivity:	4.062	Conductivity:	4.060

TH

CTD Maintenance if comparison is not acceptable (reference SeaBird Application Note 2D)

1. Perform CTD backward/forward flush with 1% Triton X-100 solution
2. Perform CTD backward/forward flush with 500 – 1000 ppm bleach solution
3. Perform the same on a pumped unit, just different approach
4. Repeat comparison test if above results not within T < .01 C, C < .005 S/m

SB19		*Glider (SB41CP or pumped unit)*	
Temperature:		Temperature:	
Conductivity:		Conductivity:	

Vehicle Disassembled

✓ 1. Check leak points for water or salt buildup
✓ 2. **BACKUP FLASH CARDS** in /coolgroup/gliderData/glider_OS_backups/<glider>/<glider-deploymentID>/<from glider>,<from sb_0xxx>
Dave Aragon
DO NOT DELETE DATA OFF CARDS
✓ 3. Change permissions on <glider-deploymentID> folder to read, write, execute for owner and group, and read, execute for everyone
✓ 4. Remove used batteries and place in return crate
Shannon/Amanda
✓ 5. Re-assemble glider with a vacuum

Manufacturer Calibration Documentation

Aanderaa Optode, Seabird 41 CP CTD, Seabird 19 CTD, Wetlabs ECO-pucks, YSI Castaway CTD

SBE SEA-BIRD ELECTRONICS, INC.
13431 NE 20th St. Bellevue, Washington 98005 USA
Phone: (425) 643-9866 Fax: (425) 643-9954 www.seabird.com

Service Report

RMA Number: 66958

Customer Information:

Company	WEBB RESEARCH CORPORATION	Date	1/12/2012
Contact	Beth Rizzo		
PO Number	TWR5740		

Serial Number	WEBB Glider-0080
Model Number	WEBB Glider

Services Requested:

1. Evaluate/Repair Instrumentation.
2. Perform Routine Calibration Service.

Problems Found:

1. The anti-foulant devices appeared "dirty".
2. Conductivity cell was found to have been cracked.

Services Performed:

1. Performed initial diagnostic evaluation.
2. Performed "Post Cruise" calibration of the temperature & conductivity sensors.
3. Replaced the conductivity cell.
4. Performed "Final" calibration of the temperature & conductivity sensors.
5. Calibrated the pressure sensor.
6. Installed NEW AF24173 Anti-foulant cylinder(s).
7. Performed complete system check and full diagnostic evaluation.

Special Notes:

SBE **SEA-BIRD ELECTRONICS, INC.**
13431 NE 20th St. Bellevue, Washington 98005 USA
Phone: (425) 643-9866 Fax: (425) 643-9954 www.seabird.com

Temperature Calibration Report

Customer:	WEBB RESEARCH CORPORATION		
Job Number:	66958	**Date of Report:**	12/28/2011
Model Number:	WEBB Glider	**Serial Number:**	WEBB Glider-0080

Temperature sensors are normally calibrated 'as received', without adjustments, allowing a determination sensor drift. If the calibration identifies a problem, then a second calibration is performed after work is completed. The 'as received' calibration is not performed if the sensor is damaged or non-functional, or by customer request.

An 'as received' calibration certificate is provided, listing coefficients to convert sensor frequency to temperature. Users must choose whether the 'as received' calibration or the previous calibration better represents the sensor condition during deployment. In SEASOFT enter the chosen coefficients. The coefficient 'offset' allows a small correction for drift between calibrations (consult the SEASOFT manual). Calibration coefficients obtained after a repair apply only to subsequent data.

'AS RECEIVED CALIBRATION' ✔ **Performed** **Not Performed**

Date: 12/13/2011 **Drift since last cal:** 0.0000 **Degrees Celsius/year**

Comments:

'FINAL CALIBRATION' ✔ **Performed** **Not Performed**

Date: 12/28/2011 **Drift since 03 Apr 06** 0.0000 **Degrees Celsius/year**

Comments:

SBE **SEA-BIRD ELECTRONICS, INC.**
13431 NE 20th Street Bellevue, Washington 98005 USA
Phone: (425) 643-9866 Fax: (425) 643-9954 www.seabird.com

Conductivity Calibration Report

Customer:	WEBB RESEARCH CORPORATION		
Job Number:	66958	**Date of Report:**	12/28/2011
Model Number:	WEBB Glider	**Serial Number:**	WEBB Glider-0080

Conductivity sensors are normally calibrated 'as received', without cleaning or adjustments, allowing a determination of sensor drift. If the calibration identifies a problem or indicates cell cleaning is necessary, then a second calibration is performed after work is completed. The 'as received' calibration is not performed if the sensor is damaged or non-functional, or by customer request.

An 'as received' calibration certificate is provided, listing the coefficients used to convert sensor frequency to conductivity. Users must choose whether the 'as received' calibration or the previous calibration better represents the sensor condition during deployment. In SEASOFT enter the chosen coefficients. The coefficient 'slope' allows small corrections for drift between calibrations (consult the SEASOFT manual). Calibration coefficients obtained after a repair or cleaning apply only to subsequent data.

'AS RECEIVED CALIBRATION' ✔ **Performed** **Not Performed**

Date: 12/13/2011 **Drift since last cal:** 0.0000 **PSU/month***

Comments:

'CALIBRATION AFTER REPAIR' ✔ **Performed** **Not Performed**

Date: 12/28/2011 **Drift since Last Cal:** N/A **PSU/month***

Comments:
The conductivity cell was replaced.

Measured at 3.0 S/m

Cell cleaning and electrode replatinizing tend to 'reset' the conductivity sensor to its original condition. Lack of drift in post-cleaning-calibration indicates geometric stability of the cell and electrical stability of the sensor circuit.

Sea-Bird Electronics, Inc.
13431 NE 20th Street, Bellevue, WA 98005-2010 USA
Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0080
CALIBRATION DATE: 28-Dec-11

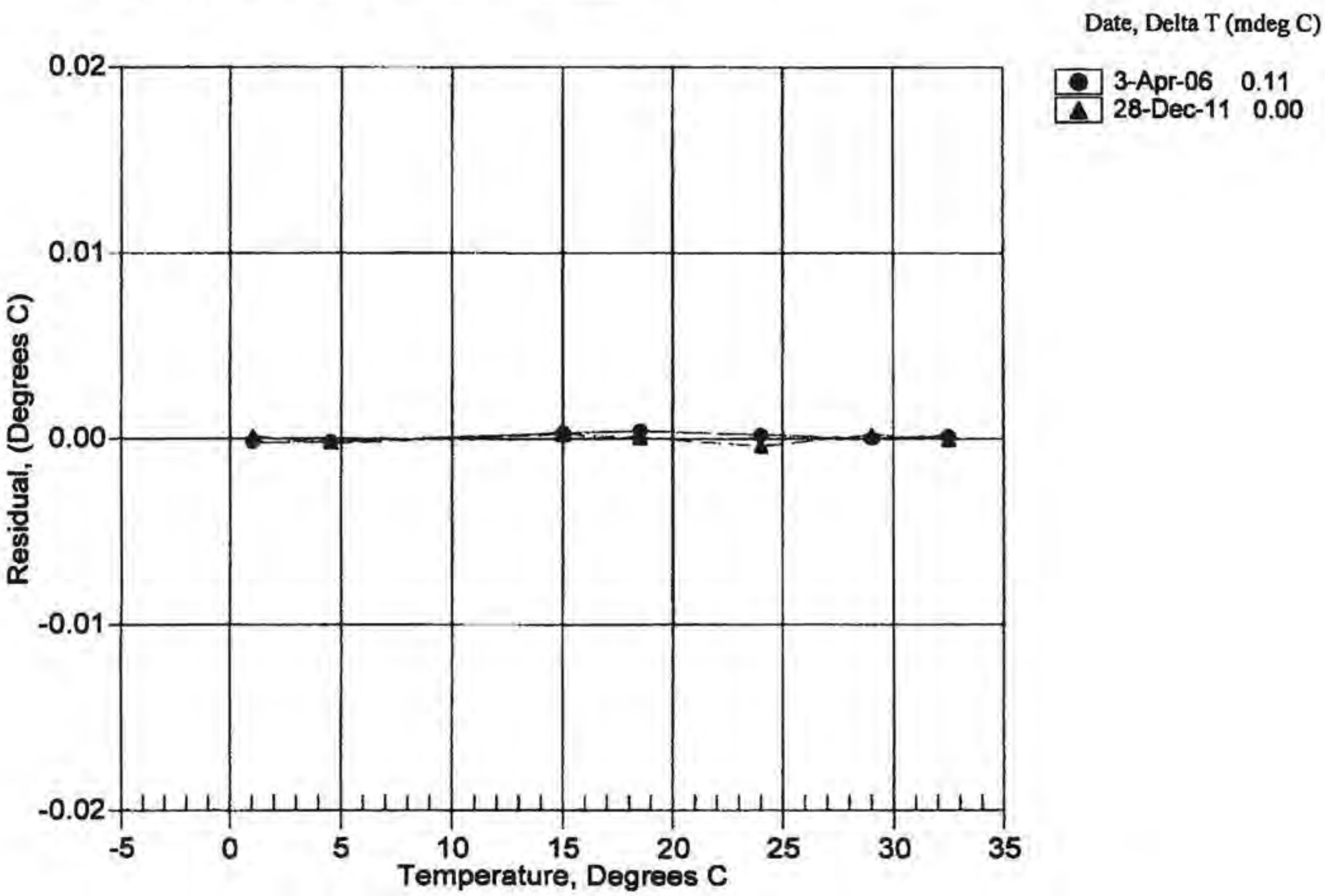
WEBB GLIDER TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS
a0 = 7.461652e-005
a1 = 2.626778e-004
a2 = -1.359031e-006
a3 = 1.315501e-007

BATH TEMP (ITS-90)	INSTRUMENT OUTPUT	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	618337.9	1.0001	0.0001
4.5000	529382.2	4.4998	-0.0002
15.0000	338612.3	15.0002	0.0002
18.5000	293537.2	18.5001	0.0001
24.0000	235887.3	23.9996	-0.0004
29.0000	194510.3	29.0002	0.0002
32.5000	170501.8	32.5000	-0.0000

Temperature ITS-90 = $1/\{a0 + a1[ln(n)] + a2[ln^2(n)] + a3[ln^3(n)]\} - 273.15$ (°C)

Residual = instrument temperature - bath temperature



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SENSOR SERIAL NUMBER: 0080
CALIBRATION DATE: 13-Dec-11

WEBB GLIDER TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

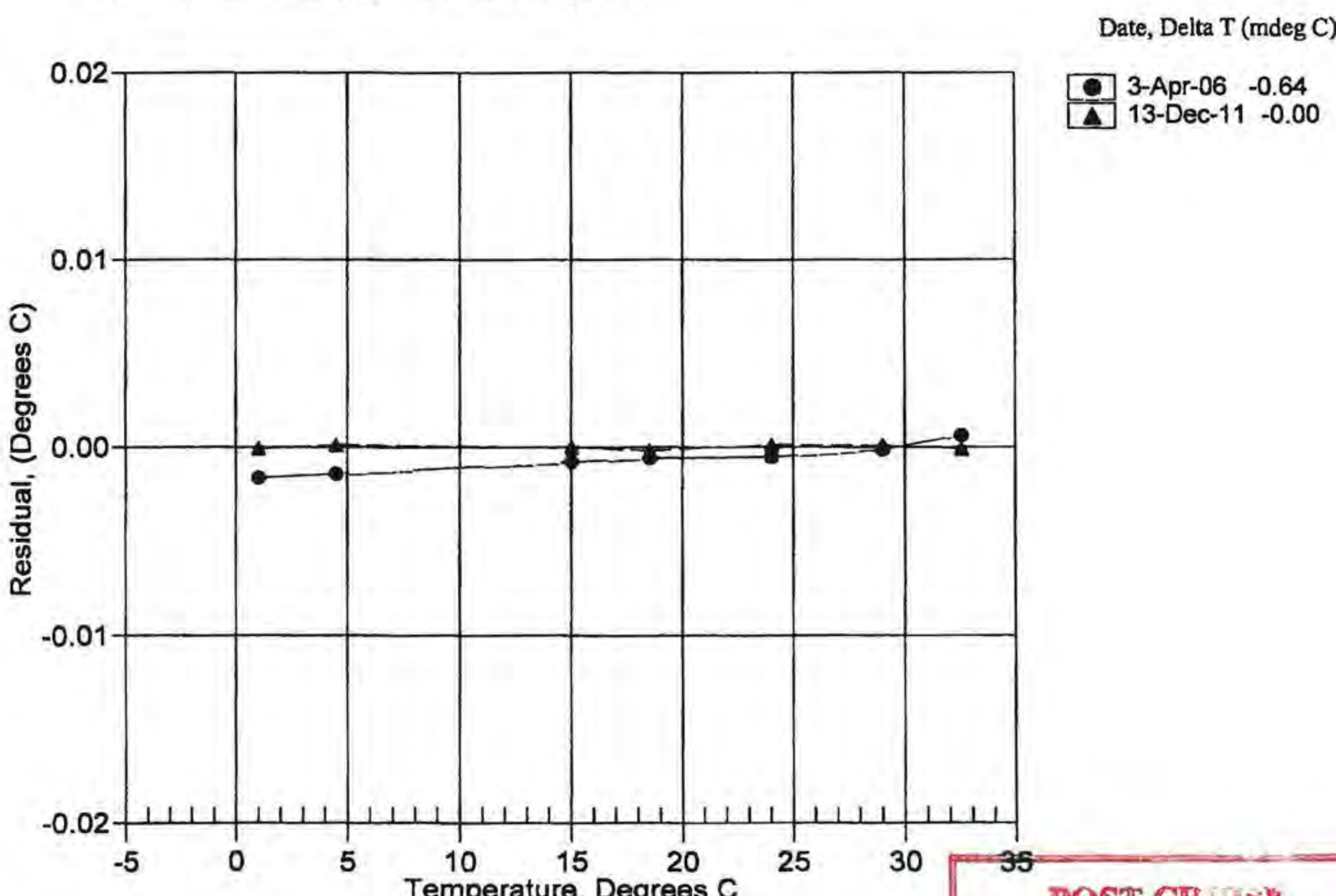
ITS-90 COEFFICIENTS

a0 = 1.611751e-005
a1 = 2.763191e-004
a2 = -2.419495e-006
a3 = 1.590400e-007

BATH TEMP (ITS-90)	INSTRUMENT OUTPUT	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	618303.2	0.9999	-0.0001
4.4999	529347.2	4.5000	0.0001
15.0000	338600.3	15.0000	0.0000
18.5000	293528.2	18.4998	-0.0002
24.0000	235875.9	24.0001	0.0001
29.0000	194510.0	29.0001	0.0001
32.5000	170505.0	32.4999	-0.0001

Temperature ITS-90 = $1/\{a0 + a1[ln(n)] + a2[ln^2(n)] + a3[ln^3(n)]\} - 273.15$ (°C)

Residual = instrument temperature - bath temperature



POST CRUISE CALIBRATION

Sea-Bird Electronics, Inc.

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SENSOR SERIAL NUMBER: 0080
CALIBRATION DATE: 28-Dec-11

WEBB GLIDER CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

COEFFICIENTS:

```
g = -9.716705e-001
h =  1.504938e-001
i = -4.127854e-004
j =  5.350662e-005

CPcor = -9.5700e-008
CTcor =  3.2500e-006
WBOTC = -2.6171e-007
```

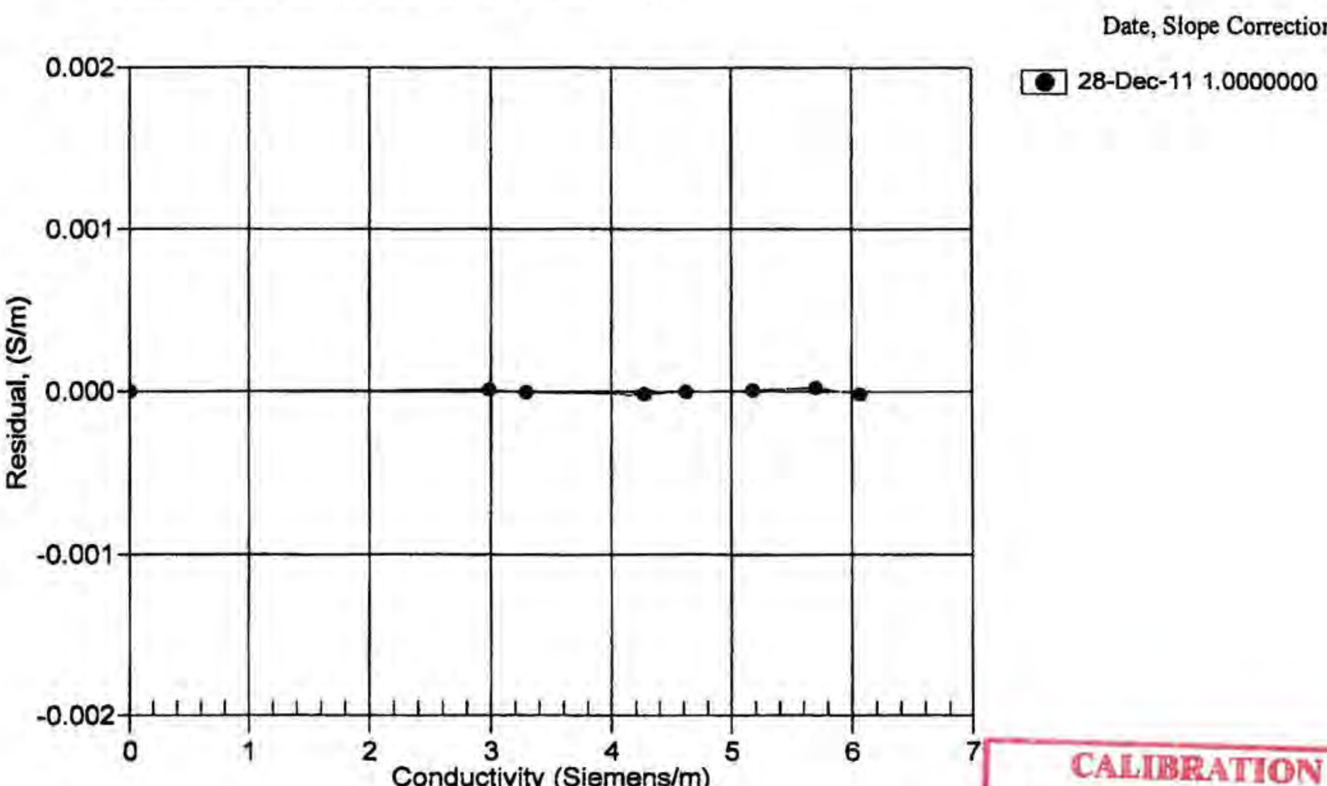
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (Hz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2546.95	0.00000	0.00000
1.0000	34.8719	2.98026	5136.55	2.98027	0.00001
4.5000	34.8512	3.28769	5332.10	3.28769	-0.00001
15.0000	34.8064	4.27053	5913.30	4.27051	-0.00002
18.5000	34.7960	4.61597	6104.17	4.61597	-0.00000
24.0000	34.7843	5.17439	6400.38	5.17440	0.00001
29.0000	34.7763	5.69650	6665.07	5.69653	0.00002
32.5000	34.7690	6.06867	6847.27	6.06866	-0.00002

f = INST FREQ * sqrt(1.0 + WBOTC * t) / 1000.0

Conductivity = $(g + hf^2 + if^3 + jf^4) / (1 + \delta t + \varepsilon p)$ Siemens/meter

t = temperature[°C)]; p = pressure[decibars]; δ = CTcor; ε = CPcor;

Residual = instrument conductivity - bath conductivity



CALIBRATION AFTER MODIFICATIONS

Sea-Bird Electronics, Inc.

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SENSOR SERIAL NUMBER: 0080
CALIBRATION DATE: 13-Dec-11

WEBB GLIDER CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

COEFFICIENTS:

g = -1.008199e+000
h = 1.584943e-001
i = -1.616097e-003
j = 1.562222e-004

CPcor = -9.5700e-008
CTcor = 3.2500e-006
WBOTC = -2.6171e-007

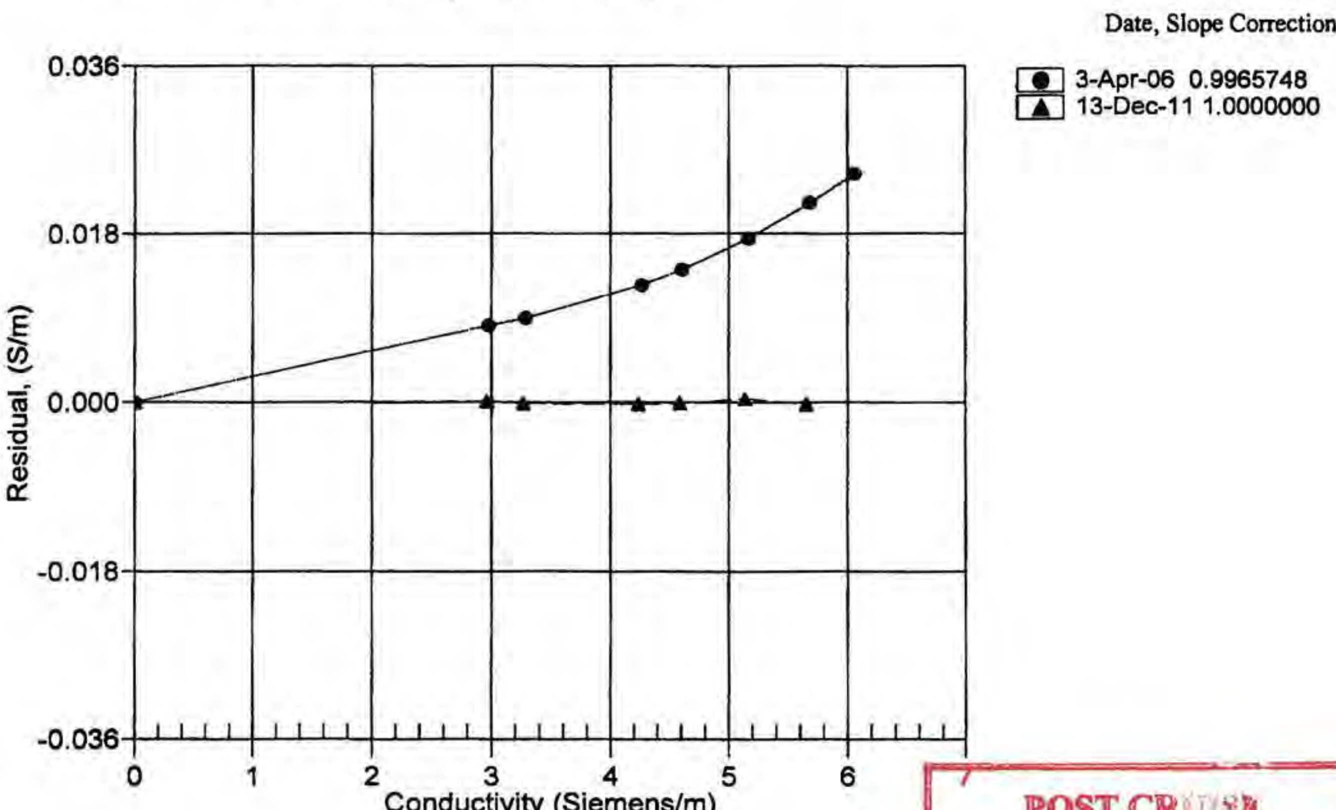
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (Hz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2547.18	0.00000	0.00000
1.0000	34.5773	2.95748	5069.44	2.95760	0.00013
4.4999	34.5570	3.26265	5260.77	3.26256	-0.00009
15.0000	34.5129	4.23831	5829.60	4.23814	-0.00017
18.5000	34.5026	4.58122	6016.35	4.58118	-0.00004
24.0000	34.4905	5.13549	6306.04	5.13585	0.00036
29.0000	34.4809	5.65353	6564.14	5.65336	-0.00017

f = INST FREQ * sqrt(1.0 + WBOTC * t) / 1000.0

Conductivity = $(g + hf^2 + if^3 + jf^4) / (1 + \delta t + \varepsilon p)$ Siemens/meter

t = temperature[°C)]; p = pressure[decibars]; δ = CTcor; ε = CPcor;

Residual = instrument conductivity - bath conductivity



POST CRUISE
CALIBRATION

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SENSOR SERIAL NUMBER: 0080
CALIBRATION DATE: 12-Dec-11

WEBB GLIDER PRESSURE CALIBRATION DATA
508 psia S/N 9546

COEFFICIENTS:

PA0 =	4.913720e-002	PTCA0 =	-1.328415e+001
PA1 =	2.405753e-002	PTCA1 =	2.795218e-001
PA2 =	2.642862e-009	PTCA2 =	-8.601787e-003
PTHA0 =	-7.096023e+001	PTCB0 =	2.495812e+001
PTHA1 =	4.952305e-002	PTCB1 =	8.250000e-004
PTHA2 =	-2.968101e-007	PTCB2 =	0.000000e+000

PRESSURE SPAN CALIBRATION

PRESSURE PSIA	INST OUTPUT	THERMISTOR OUTPUT	COMPUTED PRESSURE	ERROR %FSR
14.74	600.1	1886.0	14.75	0.00
105.00	4352.0	1887.0	104.99	-0.00
205.01	8505.7	1891.0	204.99	-0.00
305.00	12656.0	1890.0	305.00	0.00
404.99	16802.1	1891.0	404.99	-0.00
505.00	20944.1	1890.0	504.98	-0.00
405.00	16803.2	1891.0	405.02	0.00
305.01	12657.2	1891.0	305.03	0.00
205.03	8507.1	1890.0	205.03	-0.00
105.04	4353.5	1892.0	105.03	-0.00
14.74	600.0	1893.0	14.75	0.00

THERMAL CORRECTION

TEMP ITS90	PRESS TEMP	INST OUTPUT
32.50	2116.20	612.24
29.00	2042.80	613.19
24.00	1940.70	614.20
18.50	1826.20	614.38
15.00	1754.40	614.57
4.50	1537.40	613.38
1.00	1466.30	612.58

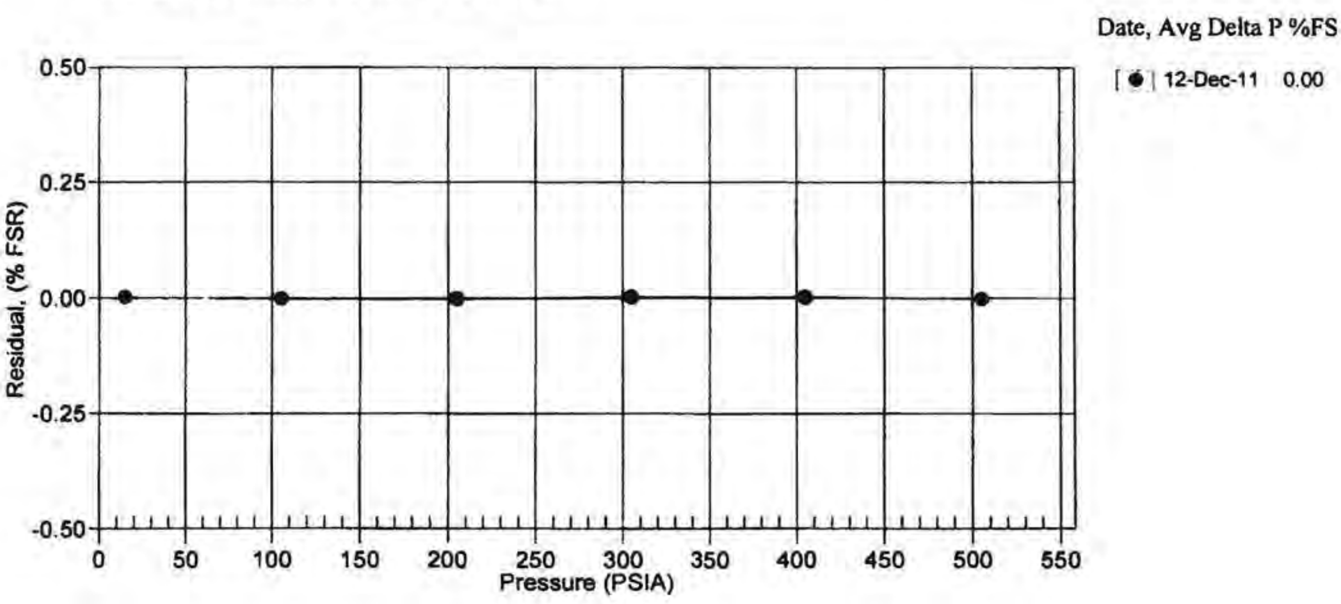
TEMP(ITS90)	SPAN(mV)
-5.00	24.95
35.00	24.99

y = thermistor output; t = PTEMPA0 + PTEMPA1 * y + PTEMPA2 * y^2

x = pressure output - PTCA0 - PTCA1 * t - PTCA2 * t^2

n = x * PTCB0 / (PTCB0 + PTCB1 * t + PTCB2 * t^2)

pressure (psia) = PA0 + PA1 * n + PA2 * n^2



PO Box 518
620 Applegate St.
Philomath, OR 97370

(541) 929-5650
Fax (541) 929-5277
www.wetlabs.com

Scattering Meter Calibration Sheet

1/10/2007 Customer: Rutgers University SO #: 459
Wavelength: 470 S/N#: BB3SLO-335 Job #: 612002 Tech: cw

Use the following equation to obtain "scaled" output values:

$$\beta(\theta c)\ m^{-1}\ sr^{-1} = \text{Scale Factor} \times (\text{Output} - \text{Dark Counts})$$

- **Scale Factor for 470 nm** = 1.158E-05 (counts)
- **Output** = meter reading (counts)
- **Dark Counts** = 50 (counts)

Instrument Resolution = 0.8847 (counts) 1.02E-05 ($m^{-1}\ sr^{-1}$)

Definitions:

- **Scale Factor**: Calibration scale factor, β(θc)/counts. Refer to User's Guide for derivation.
- **Output**: Measured signal output of the scattering meter.
- **Dark Counts**: Signal obtained by covering detector with black tape and submersing sensor in water.

Instrument Resolution: Standard deviation of 1 minute of collected data.

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Scattering Meter Calibration Sheet

1/10/2007	Customer: Rutgers University		SO #: 459
Wavelength: 532	S/N#: BB3SLO-335	Job #: 612002	Tech: cw

Use the following equation to obtain "scaled" output values:

$$\beta(\theta c)\ m^{-1}\ sr^{-1} = \text{Scale Factor} \times (\text{Output} - \text{Dark Counts})$$

- **Scale Factor for 532 nm** = 7.078E-06 (counts)
- **Output** = meter reading (counts)
- **Dark Counts** = 54 (counts)

Instrument Resolution = 0.9654 (counts) 6.83E-06 ($m^{-1}\ sr^{-1}$)

Definitions:

- **Scale Factor**: Calibration scale factor, $\beta(\theta c)$/counts. Refer to User's Guide for derivation.
- **Output**: Measured signal output of the scattering meter.
- **Dark Counts**: Signal obtained by covering detector with black tape and submersing sensor in water.

Instrument Resolution: Standard deviation of 1 minute of collected data.

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Scattering Meter Calibration Sheet

1/10/2007	Customer: Rutgers University		SO #: 459
Wavelength:660	S/N#: BB3SLO-335	Job #: 612002	Tech: cw

Use the following equation to obtain "scaled" output values:

$$\beta(\theta c)\ m^{-1}\ sr^{-1} = \text{Scale Factor} \times (\text{Output} - \text{Dark Counts})$$

- **Scale Factor for 660 nm** = 3.521E-06 (counts)
- **Output** = meter reading (counts)
- **Dark Counts** = 53 (counts)

Instrument Resolution = 0.7431 (counts) 2.62E-06 ($m^{-1}\ sr^{-1}$)

Definitions:

- **Scale Factor**: Calibration scale factor, $\beta(\theta c)$/counts. Refer to User's Guide for derivation.
- **Output**: Measured signal output of the scattering meter.
- **Dark Counts**: Signal obtained by covering detector with black tape and submersing sensor in water.

Instrument Resolution: Standard deviation of 1 minute of collected data.

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WET Labs

Scattering Meter Calibration Sheet

1/10/2007	Customer: Rutgers University		SO #: 459
Wavelength: 880	S/N#: BBFL2SLO-337	Job #: 612002	Tech: cw

Use the following equation to obtain "scaled" output values:

$$\beta(\theta c)\ m^{-1}\ sr^{-1} = \text{Scale Factor} \times (\text{Output} - \text{Dark Counts})$$

• **Scale Factor for 880 nm**	=	2.369E-06	(counts)	
• **Output**	=	meter reading	(counts)	
• **Dark Counts**	=	49	(counts)	
Instrument Resolution	=	0.7955	(counts)	1.88E-06 ($m^{-1}\ sr^{-1}$)

Definitions:

- **Scale Factor**: Calibration scale factor, β(θc)/counts. Refer to User's Guide for derivation.
- **Output**: Measured signal output of the scattering meter.
- **Dark Counts**: Signal obtained by covering detector with black tape and submersing sensor in water.

Instrument Resolution: Standard deviation of 1 minute of collected data.

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ECO CDOM Fluorometer Characterization Sheet

Date: 1/11/2007 Customer: Rutgers University

Job #: 612002 SO #: 459 S/N:# BBFL2SLO-337

CDOM concentration expressed in ppb can be derived using the equation:

CDOM (ppb) = Scale Factor * (Output - Dark Counts)

	Digital
Dark Counts	46 counts
Scale Factor (SF)	0.0874 ppb/count
Maximum Output	4120 counts
Resolution	1.0 counts
Ambient temperature during characterization	19.8 °C

Dark Counts: Signal output of the meter in clean water with black tape over detector.

SF: Determined using the following equation: SF = *x* ÷ (output - dark counts), where *x* is the concentration of the solution used during instrument characterization. SF is used to derive instrument output concentration from the raw signal output of the fluorometer.

Maximum Output: Maximum signal output the fluorometer is capable of.

Resolution: Standard deviation of 1 minute of collected data.

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ECO Chlorophyll Fluorometer Characterization Sheet

Date: 1/11/2007 Customer: Rutgers University

Job #: 612002 SO #: 459 S/N:# BBFL2SLO-337

Chlorophyll concentration expressed in µg/l can be derived using the equation:

CHL (µg/l) = Scale Factor * (Output - Dark counts)

	Digital
Dark counts	50 counts
Scale Factor (SF)	0.0121 µg/l/count
Maximum Output	4120 counts
Resolution	1.0 counts
Ambient temperature during characterization	19.8 °C

Dark Counts: Signal output of the meter in clean water with black tape over detector.

SF: Determined using the following equation: SF = x ÷ (output - dark counts), where x is the concentration of the solution used during instrument characterization. SF is used to derive instrument output concentration from the raw signal output of the fluorometer.

Maximum Output: Maximum signal output the fluorometer is capable of.

Resolution: Standard deviation of 1 minute of collected data.

The relationship between fluorescence and chlorophyll-a concentrations in-situ is highly variable. The scale factor listed on this document was determined using a mono-culture of phytoplankton (Thalassiosira weissflogii). The population was assumed to be reasonably healthy and the concentration was determined by using the absorption method. To accurately determine chlorophyll concentration using a fluorometer, you must perform secondary measurements on the populations of interest. This is typically done using extraction-based measurement techniques on discrete samples. For additional information on determining chlorophyll concentration see "Standard Methods for the Examination of Water and Wastewater" part 10200 H, published jointly by the American Public Health Association, American Water Works Association, and the Water Environment Federation.

a xylem brand

DATE: March 8, 2012
Prepared by Shawn Sneddon
Service Order 2768
Customer: Rutgers

US SERVICE & CALIBRATION DEPARTMENT

Service Report

Oxygen Optode 5014W sn1504

1. Performed visual inspection
    a. OK.
2. Checked for isolation between housing and electronics
    a. Isolation OK.
3. Checked current consumption
    a. Operating = 31.3 mA; OK.
    b. Quiescent = 205uA; OK.
4. Performed test in air checking BAmp, BPhase, and RawTemp
    a. All OK.
5. Inspected foil visually
    a. Looks OK.
6. Checked firmware version
    a. 3.24; OK.
7. Checked temperature in 10 deg.C bath with reference
    a. Sn1504 = 10.28, Reference =10.288; OK.
8. Checked saturation in 100% saturated bath with reference optode
    a. Sn1504 = 92.34%, sn338 = 100.236%; Needs to be recalibrated.
9. Performed saturation calibration at 100% and 0% saturation
    a. PASSED.
10. Checked saturation in 100% saturated bath with reference optode
    a. Sn1504 = 100.03%, sn338 = 100.433%; OK.
11. Checked saturation in 20 deg.C bath with reference optode
    b. Sn1504 = 97.40%, sn338 = 98.947%; OK.
12. Performed cool down test from 20 to 1 deg.C
    a. PASSED.
13. Returned to customer settings

Next Calibration Date: March 23, 2014
Next Service Date: March 23, 2014

TEST & SPECIFICATIONS

Form No. 620, Nov 2005

a xylem brand

Layout No:		**Product:**	5014
Circuit Diagram No:		**Serial No:**	1504
Program Version:			

---

1. Visual and Mechanical Checks:	
1.1. O-ring surface	OK
1.2. Soldering quality	N/A
1.3. Visual surface	OK
1.4. Pressure test (60MPa)	N/A
1.5. Galvanic isolation between housing and electronics	OK
2. Current Drain and Voltages:	
2.1. Average current drain at 0.5Hz sampling (Max: 38mA)	31.3 mA
2.2. Current drain in sleep (Max: 300uA)	205 uA
3. Performance Test in Air, 20°C Temperature:	
3.1. Amplitude measurement (Blue: 290 – 470mV)	377.3 mV
3.2. Phase measurement (Blue: 27 ±5°)	30.49 °
3.3 Temperature Measurement (100 ± 300mV)	29.59 mV
4. Firmware:	
4.1. Firmware upgrade	3.24

Date:
March 23, 2012

Sign: Shawn A. Sneddon

Service and Calibration Engineer

Aanderaa Data Instruments, Inc.

182 East Street, Suite B Attleboro, MA 02703 Tel. +1 (508) 226-9300 email: infoUSA@xyleminc.com

AADI CALIBRATION CERTIFICATE
Form No. 622, Dec 2005

a xylem brand

Sensing Foil Batch No:	5009	**Product:**	5014
Certificate No:	5014W 1504 1129	**Serial No:**	1504
		Calibration Date:	March 23, 2012

This is to certify that this product has been calibrated using the following instruments:

Fluke CHUB E-4	Serial No. A7C677
Fluke 5615 PRT	Serial No. 849155
Fluke 5615 PRT	Serial No. 802054
Honeywell PPT	Serial No. 44074
Calibration Bath model FNT 321-1-40	1

Parameter: Internal Temperature:

Calibration points and readings:

Temperature (°C)	-	-	-	-
Reading (mV)	-	-	-	-

Giving these coefficients

Index	0	1	2	3
TempCoef	2.37279E+01	-3.05951E-02	2.83023E-06	-4.19785E-09

*Note: Temperature calibration NOT performed

Parameter: Oxygen:

	O2 Concentration	Air Saturation
Range:	0-500 μM [1)]	0 - 120%
Accuracy[1)]:	< ±8μM or ±5%(whichever is greater)	±5%
Resolution:	< 1 μM	< 0.4%
Settling Time (63%):	< 25 seconds	

Calibration points and readings[2)]:

	Air Saturated Water	Zero Solution (Na_2SO_3)
Phase reading (°)	3.29943E+01	6.52101E+01
Temperature reading (°C)	1.02988E+01	2.48677E+01
Air Pressure (hPa)	1.02647E+03	

Giving these coefficients

Index	0	1	2	3
PhaseCoef	-6.62372E+00	1.20407E+00	0.00000E+00	0.00000E+00

1) Valid for 0 to 2000m (6562ft) depth, salinity 33 - 37ppt

2)The calibration is performed in fresh water and the salinity setting is set to: 0

Date:
March 23, 2012

Sign: Shawn A. Sneddon

Service and Calibration Engineer

Aanderaa Data Instruments, Inc.
182 East Street, Suite B   Attleboro, MA 02703   Tel. +1 (508) 226-9300   email: infoUSA@xyleminc.com

AADI **CALIBRATION CERTIFICATE**

Form No. 621, Dec 2005

a xylem brand

Sensing Foil Batch No: 5009
Certificate No: 3853 5009 40217

Product: O2 Sensing Foil PSt3 3853
Calibration Date: 8 February 2010

Calibration points and phase readings (degrees)

Temperature (°C)		3.97	10.93	20.15	29.32	38.39
Pressure (hPa)		977.00	977.00	977.00	977.00	977.00
O2 in % of O2+N2	0.00	73.18	72.63	71.62	70.72	69.77
	1.00	68.01	67.02	65.42	63.92	62.31
	2.00	64.39	63.19	61.20	59.44	57.57
	5.00	55.80	54.16	51.76	49.56	47.45
	10.00	46.27	44.47	41.97	39.75	37.69
	20.90	35.09	33.38	31.14	29.24	27.56
	30.00	29.85	28.30	28.30	24.64	23.19

Giving these coefficients [1)]

Index	0	1	2	3
C0 Coefficient	4.53793E+03	-1.62595E+02	3.29574E+00	-2.79285E-02
C1 Coefficient	-2.50953E+02	8.02322E+00	-1.58398E-01	1.31141E-03
C2 Coefficient	5.66417E+00	-1.59647E-01	3.07910E-03	-2.46265E-05
C3 Coefficient	-5.99449E-02	1.48326E-03	-2.82110E-05	2.15156E-07
C4 Coefficient	2.43614E-04	-5.26759E-06	1.00064E-07	-7.14320E-10

[1)] *Ask for Form No 621S when this O2 Sensing Foil is used in Oxygen Sensor 3830 with Serial Numbers lower than 184.*

Date:
February 8, 2010

Aanderaa Data Instruments, Inc.
182 East Street, Suite B **Attleboro, MA 02703** **Tel. +1 (508) 226-9300** **email: infoUSA@xyleminc.com**

CALIBRATION CERTIFICATE

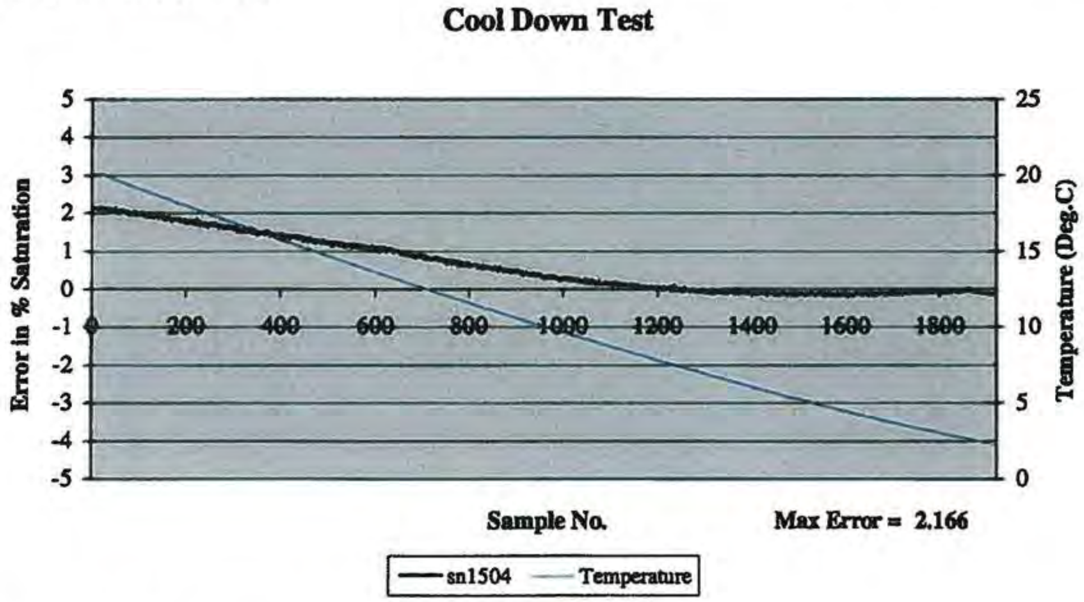
Form No. 622, Dec 2005

a xylem brand

Sensing Foil Batch No: 5009
Certificate No: 5014W 1504 1129

Product: 5014
Serial No: 1504
Calibration Date: March 23, 2012

Data from Cool Down Test:



SR10 Scaling Coefficients:

At the SR10 output the Oxygen Optode 3830 can give either absolute oxygen concentration in µM or air saturation in %. The setting of the internal property "Output" [3], controls the selection of the unit. The coefficients for converting SR10 raw data to engineering units are fixed.

Output = -1	Output = -2
A = 0	A = 0
B = 4.883E-01	B = 1.465E-01
C = 0	C= 0
D = 0	D = 0
Oxygen (uM) = A + BN + CN2 + DN3	Oxygen (%) = A + BN + CN2 + DN3

[3] *The default output setting is set to -1*

Date:
March 23, 2012

Sign: Shawn A. Sneddon

Service and Calibration Engineer

Aanderaa Data Instruments, Inc.
182 East Street, Suite B Attleboro, MA 02703 Tel. +1 (508) 226-9300 email: infoUSA@xyleminc.com

SonTek

a xylem brand

9940 Summers Ridge Road
San Diego, CA 92121
Tel: (858) 546-8327
support@sontek.com

CALIBRATION CERTIFICATE

System Info

System Type	CastAway-CTD
Serial Number	11D101493
Firmware Version	0.26
Calibration Date	5/30/2012

Power

Standby Mode (A)	0.2094 / PASS
Supply Voltage	2.9V

Calibration

Pressure	Passed
Conductivity	Passed
Temperature	Passed
GPS	Passed

Verified by: dshumway

Date: 6/1/2012

SonTek
a xylem brand

9940 Summers Ridge Road
San Diego, CA 92121
Tel: (858) 546-8327
support@sontek.com

CALIBRATION CERTIFICATE

System Info

System Type	CastAway-CTD
Serial Number	11D101494
Firmware Version	1.50
Calibration Date	8/9/2012

Power

Standby Mode (A)	0.2463 / PASS
Supply Voltage	2.9V

Calibration

Pressure	Passed
Conductivity	Passed
Temperature	Passed
GPS	Passed

Verified by: dshumway

Date: 8/13/2012

SonTek YSI incorporated
9940 Summers Ridge Road
San Diego CA USA 92121-3091
Tel: 858-546-8327 Fax: 858-546-8150
support@sontek.com FEIN: 31-1778604

PLEASE FILL IN THE INFORMATION ON THIS PAGE, AND THEN PLACE THIS PAGE INSIDE THE SHIPPING BOX.

RE[illegible]
JUN 13
BY [illegible]

Service Request #: 292472

ADDRESS INFORMATION

Ship To:	Bill To:
Chip Haldeman	Purchasing Department
IMCS Rutgers University	Rutgers, The State University of NJ
71 Dudley Rd	ASB III, 3 Rutgers Plaza, 2nd Floor
New Brunswick, NJ 08901	New Brunswick, NJ 08901-8559
Tel: 848-932-3295	E-mail: http://purchasing.rutgers.edu

INSTRUMENT INFORMATION

Serial Number: 11D101494*

Briefly describe reason for return (if applicable, include events leading to problem):

Temperature and Conductivity Recalibration ($460)
Pressure Sensor Recalibration ($220)

List contents of shipping box:
This serves as your packing list to us. List each separated item (e.g., system, cables, plugs, ...). We use this list to ensure we return the correct items to you.

Castaway CTD in Storm case w/ instructions, 2 styli, maintenance kit, usb drive w/ software, usb bluetooth adapter,

and small stainless clip

Items Received:
CTD (S/N# 11D101494*)
lanyard w/ stylus pens 3 Quick Start guides
Maintenance Kit
Carabiner clip
Splash proof case 16x12x5 with USB Drive Bluetooth modem, + 4 AA Batteries
Random Box 16 x 16 x 16

SonTek YSI incorporated
9940 Summers Ridge Road
San Diego CA USA 92121-3091
Tel: 858-546-8327 Fax: 858-546-8150
support@sontek.com FEIN: 31-1779604

Service Request Instructions

Please follow these instructions to assure prompt attention to your instrument.

1. Please package the instrument in the original box in which the instrument was shipped to you. If it is not possible to use the original box, please package it securely in a sturdy container with substantial packing to prevent possible damage during shipping. If the instrument is shipped to SonTek without such precautions, we reserve the right to refuse the shipment and/or charge for proper packaging upon return to you.

2. Please address the shipping box as follows:

SonTek/YSI
ATTN: SR# 292472
9940 Summers Ridge Road
San Diego, CA 92121-3091
United States
Tel: +1 858-546-8327

3. If the instrument is being returned from outside the United States, please be sure to state clearly on all paperwork (commercial invoice and SLI): "U.S. GOODS RETURNING FOR REPAIR". Please ship all instruments "D.D.P. SAN DIEGO". If these instructions are not followed, SonTek reserves the right to bill any charges incurred for duties and taxes to you.

4. SonTek will not accept shipments sent "FREIGHT COLLECT." All returned items must be shipped freight prepaid unless otherwise authorized.

5. We suggest you remove used battery packs before shipping. If you return an instrument to us with a used battery pack, and you wish to have the pack replaced, we must charge an additional $20·U.S. to cover the cost of government-required battery disposal.

5. Instruments returned outside of the warranty period are subject to an evaluation fee of $400. Additional charges for parts and labor may be necessary.

6. If your system has an internal recorder, please be sure to download all files before returning the system. We are not responsible for lost data.

7. Please fill in the second page of this form and place it in the returning shipping box. Keep this first page for your records.

IF YOU HAVE ANY QUESTIONS REGARDING THESE INSTRUCTIONS, PLEASE CONTACT US BEFORE RETURNING THE INSTRUMENT.

SBE

SEA-BIRD ELECTRONICS, INC.
13431 NE 20th St. Bellevue, Washington 98005 USA
Phone: (425) 643-9866 Fax: (425) 643-9954 www.seabird.com

Service Report

RMA Number 69172

Customer Information:

Company	Rutgers	Date	6/14/2012
Contact	David Aragon		
PO Number	S1665726		

Serial Number	051018
Model Number	SBE 05T

Services Requested:

1. Evaluate/Repair Instrumentation.

Problems Found:

Services Performed:

1. Performed initial diagnostic evaluation.

Special Notes:

SBE SEA-BIRD ELECTRONICS, INC.
13431 NE 20th St. Bellevue, Washington 98005 USA
Phone: (425) 643-9866 Fax: (425) 643-9954 www.seabird.com

Service Report

RMA Number 69172

Customer Information:

Company	Rutgers	Date	6/14/2012
Contact	David Aragon		
PO Number	S1665726		

Serial Number	199618-1645
Model Number	SBE 19-03

Services Requested:

1. Evaluate/Repair Instrumentation.
2. Perform Routine Calibration Service.

Problems Found:

1. The Y-cable had some corrosion damage on pins and had previously been repaired by customer. Will be replaced with PN 17709 Y-cable.

Services Performed:

1. Performed initial diagnostic evaluation.
2. Performed "Post Cruise" calibration of the temperature & conductivity sensors.
3. Calibrated the pressure sensor.
4. Installed NEW pump / data Y-cable.
5. Performed complete system check and full diagnostic evaluation.

Special Notes:

Sea-Bird Electronics, Inc.

13431 NE 20th Street, Bellevue, WA 98005-2010 USA

Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 1645
CALIBRATION DATE: 17-May-12

SBE19 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS

```
g =  4.20453005e-003
h =  5.97712451e-004
i =  5.15077996e-006
j = -1.52678800e-006
f0 = 1000.0
```

IPTS-68 COEFFICIENTS

```
a =  3.64763497e-003
b =  5.84092998e-004
c =  9.48775778e-006
d = -1.52627797e-006
f0 = 2563.761
```

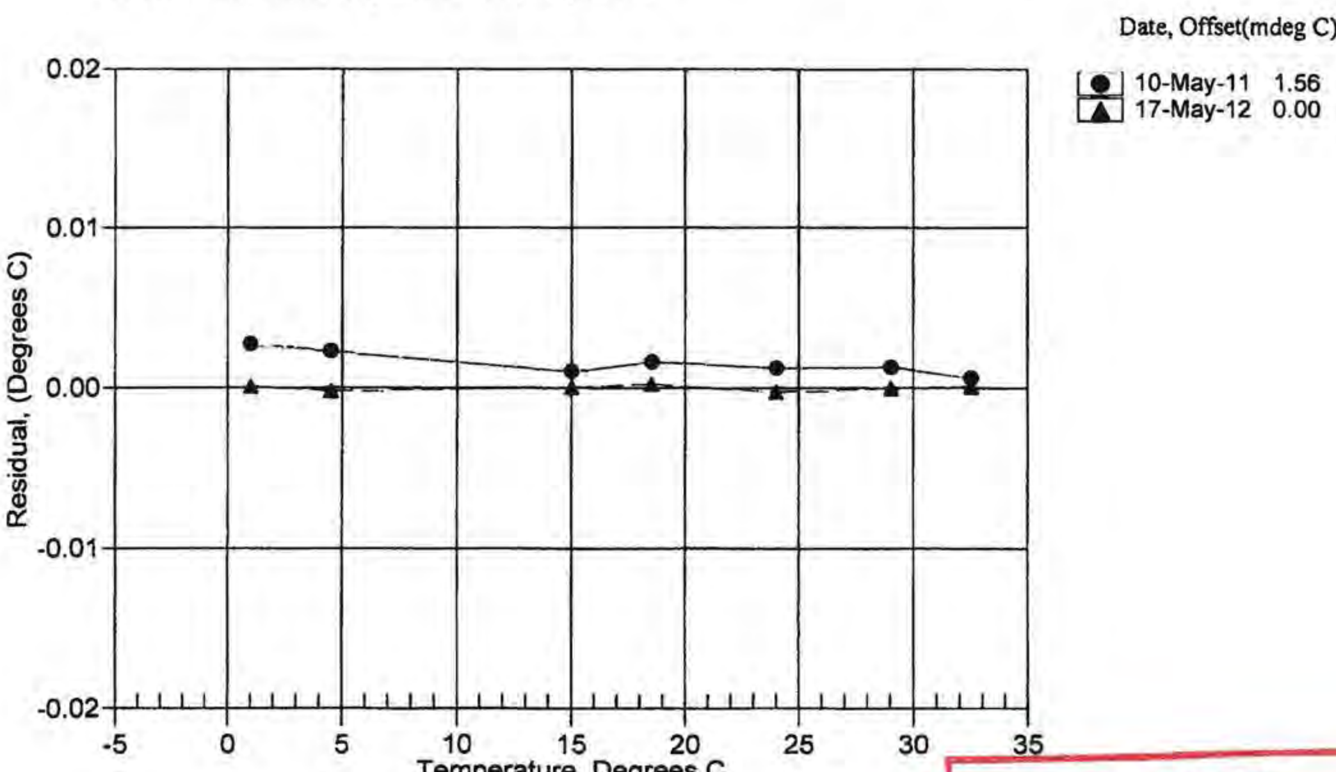
BATH TEMP (ITS-90)	INSTRUMENT FREQ (Hz)	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
0.9999	2563.761	1.0000	0.00010
4.4999	2774.062	4.4997	-0.00018
15.0000	3478.313	15.0000	0.00004
18.5000	3738.690	18.5002	0.00024
24.0000	4175.001	23.9997	-0.00026
29.0000	4601.563	29.0000	-0.00002
32.5000	4917.634	32.5001	0.00007

Temperature ITS-90 = $1/\{g + h[ln(f_0/f)] + i[ln^2(f_0/f)] + j[ln^3(f_0/f)]\} - 273.15$ (°C)

Temperature IPTS-68 = $1/\{a + b[ln(f_0/f)] + c[ln^2(f_0/f)] + d[ln^3(f_0/f)]\} - 273.15$ (°C)

Following the recommendation of JPOTS: T_{68} is assumed to be 1.00024 * T_{90} (-2 to 35 °C)

Residual = instrument temperature - bath temperature



POST CRUISE CALIBRATION

SBE SEA-BIRD ELECTRONICS, INC.
13431 NE 20th St. Bellevue, Washington 98005 USA
Phone: (425) 643-9866 Fax: (425) 643-9954 www.seabird.com

Temperature Calibration Report

Customer:	Rutgers		
Job Number:	69172	**Date of Report:**	5/21/2012
Model Number:	SBE 19-03	**Serial Number:**	199618-1645

Temperature sensors are normally calibrated 'as received', without adjustments, allowing a determination sensor drift. If the calibration identifies a problem, then a second calibration is performed after work is completed. The 'as received' calibration is not performed if the sensor is damaged or non-functional, or by customer request.

An 'as received' calibration certificate is provided, listing coefficients to convert sensor frequency to temperature. Users must choose whether the 'as received' calibration or the previous calibration better represents the sensor condition during deployment. In SEASOFT enter the chosen coefficients. The coefficient 'offset' allows a small correction for drift between calibrations (consult the SEASOFT manual). Calibration coefficients obtained after a repair apply only to subsequent data.

'AS RECEIVED CALIBRATION' ✔ **Performed** **Not Performed**

Date: 5/17/2012 **Drift since last cal:** -0.00153 **Degrees Celsius/year**

Comments:

'CALIBRATION AFTER REPAIR' **Performed** ✔ **Not Performed**

Date: **Drift since Last cal:** **Degrees Celsius/year**

Comments:

Sea-Bird Electronics, Inc.

13431 NE 20th Street, Bellevue, WA 98005-2010 USA
Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 1645
CALIBRATION DATE: 17-May-12

SBE19 CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Seimens/meter

GHIJ COEFFICIENTS

```
g = -4.04794553e+000
h =  4.82841506e-001
i =  1.24162353e-003
j = -3.13086509e-005
CPcor = -9.5700e-008 (nominal)
CTcor =  3.2500e-006 (nominal)
```

ABCDM COEFFICIENTS

```
a =  5.10588664e-002
b =  4.27666673e-001
c = -4.03166139e+000
d = -1.19643464e-004
m =  2.1
CPcor = -9.5700e-008 (nominal)
```

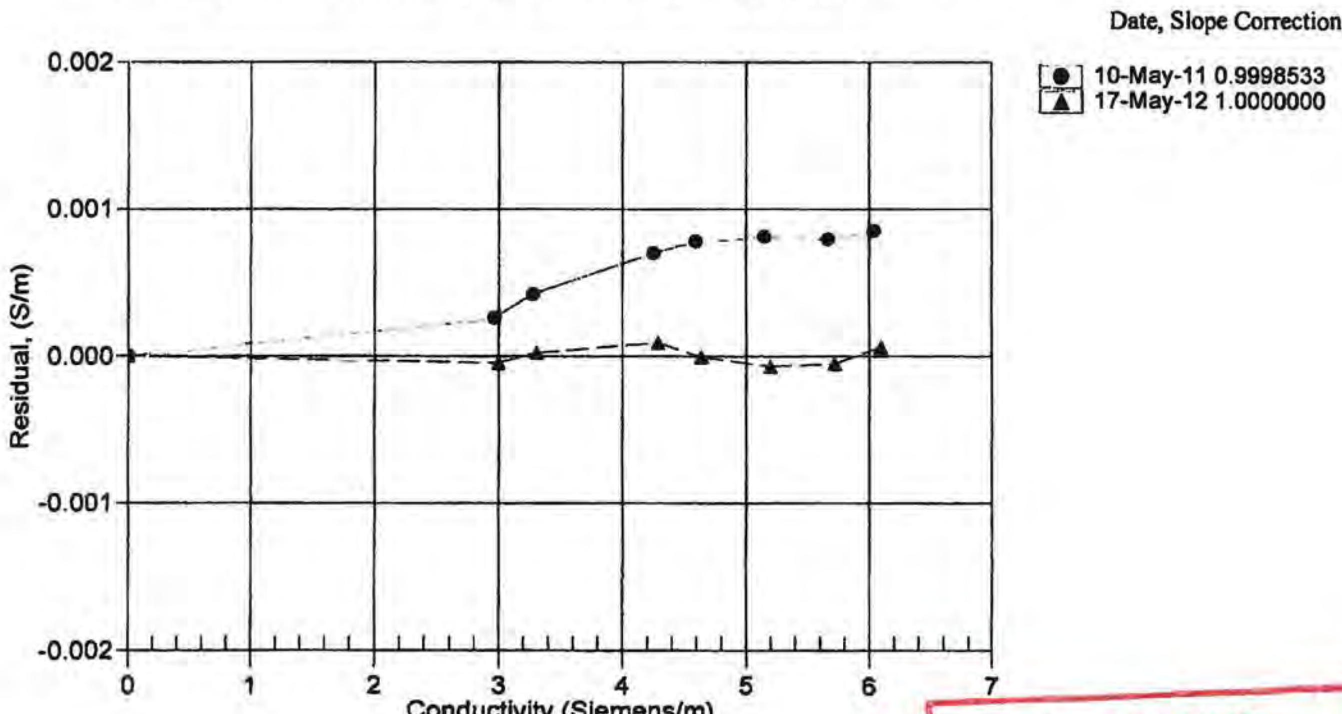
BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (kHz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2.88554	0.00000	0.00000
0.9999	35.0146	2.99128	8.31658	2.99124	-0.00005
4.4999	34.9937	3.29980	8.68395	3.29982	0.00002
15.0000	34.9505	4.28633	9.76514	4.28642	0.00009
18.5000	34.9406	4.63307	10.11731	4.63307	-0.00001
24.0000	34.9285	5.19347	10.66172	5.19340	-0.00007
29.0000	34.9182	5.71712	11.14627	5.71707	-0.00005
32.5000	34.9078	6.09014	11.47892	6.09020	0.00006

Conductivity = $(g + hf^2 + if^3 + jf^4) / 10(1 + \delta t + \varepsilon p)$ Siemens/meter

Conductivity = $(af^m + bf^2 + c + dt) / [10 (1 + \varepsilon p)$ Siemens/meter

t = temperature[°C)]; p = pressure[decibars]; δ = CTcor; ε = CPcor;

Residual = (instrument conductivity - bath conductivity) using g, h, i, j coefficients



POST CRUISE CALIBRATION

SBE **SEA-BIRD ELECTRONICS, INC.**
13431 NE 20th Street Bellevue, Washington 98005 USA
Phone: (425) 643-9866 Fax: (425) 643-9954 www.seabird.com

Conductivity Calibration Report

Customer:	Rutgers		
Job Number:	69172	**Date of Report:**	5/21/2012
Model Number:	SBE 19-03	**Serial Number:**	199618-1645

Conductivity sensors are normally calibrated 'as received', without cleaning or adjustments, allowing a determination of sensor drift. If the calibration identifies a problem or indicates cell cleaning is necessary, then a second calibration is performed after work is completed. The 'as received' calibration is not performed if the sensor is damaged or non-functional, or by customer request.

An 'as received' calibration certificate is provided, listing the coefficients used to convert sensor frequency to conductivity. Users must choose whether the 'as received' calibration or the previous calibration better represents the sensor condition during deployment. In SEASOFT enter the chosen coefficients. The coefficient 'slope' allows small corrections for drift between calibrations (consult the SEASOFT manual). Calibration coefficients obtained after a repair or cleaning apply only to subsequent data.

'AS RECEIVED CALIBRATION' ✔ **Performed** **Not Performed**

Date: 5/17/2012 **Drift since last cal:** -0.00040 **PSU/month***

Comments:

'CALIBRATION AFTER CLEANING & REPLATINIZING' **Performed** ✔ **Not Performed**

Date: **Drift since Last cal:** **PSU/month***

Comments:

****Measured at 3.0 S/m***

Cell cleaning and electrode replatinizing tend to 'reset' the conductivity sensor to its original condition. Lack of drift in post-cleaning-calibration indicates geometric stability of the cell and electrical stability of the sensor circuit.

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13431 NE 20th Street, Bellevue, WA 98005-2010 USA

Phone: (+1) 425-643-9866 Fax (+1) 425-643-9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 1645
CALIBRATION DATE: 22-May-12

SBE19 PRESSURE CALIBRATION DATA
150 psia S/N 169585 TCV: -105

QUADRATIC COEFFICIENTS:

PA0 = 7.374722e+001
PA1 = -1.962260e-002
PA2 = 7.626656e-008

STRAIGHT LINE FIT:

M = -1.964407e-002
B = 7.416500e+001

PRESSURE PSIA	INST OUTPUT(N)	COMPUTED PSIA	ERROR %FS	LINEAR PSIA	ERROR %FS
14.57	3050.0	14.61	0.02	14.25	-0.21
29.80	2265.0	29.69	-0.07	29.67	-0.09
59.69	728.0	59.50	-0.13	59.86	0.12
94.83	-1068.0	94.79	-0.03	95.14	0.21
124.81	-2578.0	124.84	0.02	124.81	0.00
149.79	-3812.0	149.66	-0.09	149.05	-0.49
124.82	-2584.0	124.96	0.09	124.93	0.07
94.85	-1078.0	94.99	0.10	95.34	0.33
59.83	711.0	59.83	0.00	60.20	0.24
29.86	2255.0	29.89	0.02	29.87	0.01
14.58	3047.0	14.67	0.06	14.31	-0.18

Straight Line Fit:

Pressure (psia) = M * N + B (N = binary output)

Quadratic Fit:

pressure (psia) = PA0 + PA1 * N + PA2 * N^2

Residual = (instrument pressure - true pressure) * 100 / Full Scale Range