


Module 12

Getting the Highest Accuracy Data from Moored Instruments

Overview



**Getting the Highest Accuracy
Data: Moored**

- Initial Calibration Accuracy
- How to determine sensor problems
- Care of sensor in the field and how to counter fouling
- Sensor drift characteristics
- Correcting data with pre- and post-deployment calibrations
 - Example and protocol: Dissolve Oxygen
- Field validations
- Post recovery cleaning and care

In the module we will discuss the means to get the highest accuracy in your moored measurements. This includes care of sensors in the field and understanding sensor drift characteristics. Moored instruments can exhibit unexpected drift in conductivity. Topics covered include pre- and post-deployment calibrations, field calibrations, and bio-fouling.

Static Errors



Static Errors Initial Calibration Accuracy

- Initial accuracy limited by:
 - the standards
 - calibration equation
 - ability to calibrate in a controlled bath
- Standards for Salinity and Temperature
 - IAPSO Standard Seawater 0.002 psu
 - Gallium and Jarrett Cells,
 - 0.7 millidegrees (mK) (0.0007 deg C)
- Effect: You cannot report to better than the standards

Static Errors (*continued*)

SBE How to Determine if a Sensor is Drifting or is Broken

- Drifting sensors tend to stay reasonable with respect to the measured variable
 - Might exhibit an offset or linear change with time
- Broken sensors exhibit more catastrophic changes in their data
 - Readings drop to zero and never recover
 - Lots of very large spiking in the data (noise)
 - Sensor does not respond to changes in parameter it is measuring

Fouling



Instrument Malfunction

SBE
Seabird

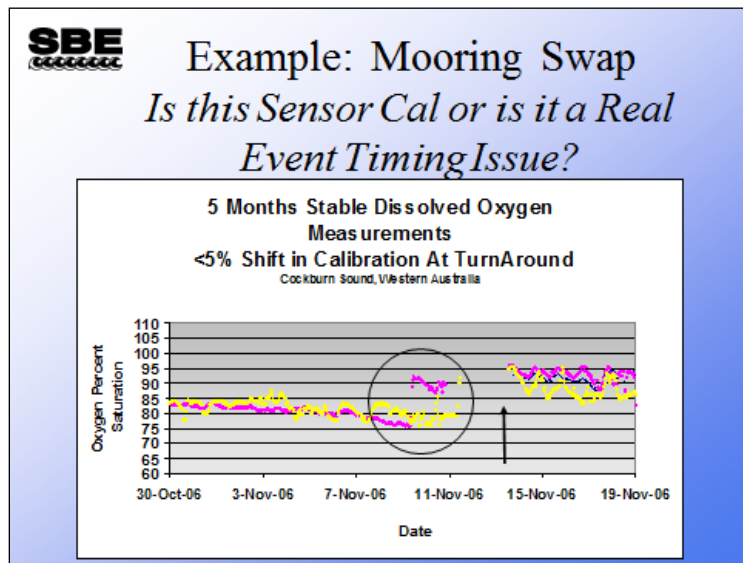
Example: Instrument malfunction

Sometimes, the Problem is Obvious

upon Recovery

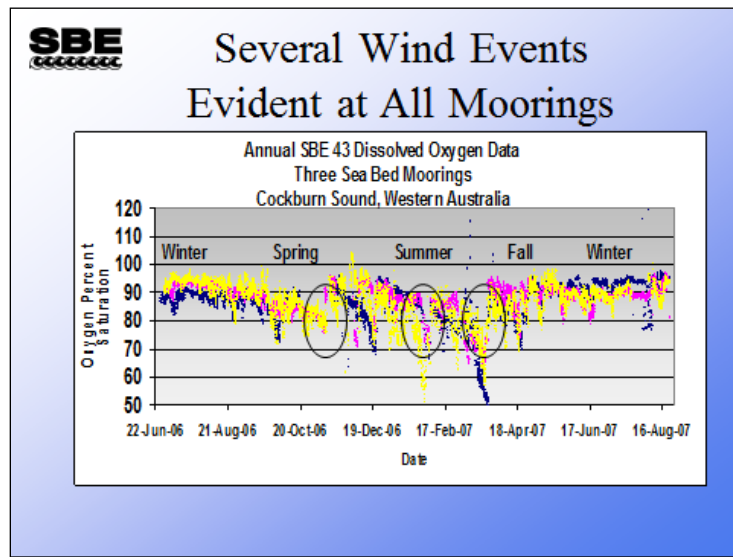


Instrument Malfunction (*continued*)



In this example, the customer saw a rapid decline in oxygen. They assumed the sensor was going bad so planned to recover it. They recovered the sensor, and swapped it a few days later with a newly calibrated sensor. They observed a large shift in oxygen (~5%) and complained that the sensors were not working.

Instrument Malfunction (*continued*)



In this example, there is an apparent slow mean drift in sensor output with time. However, the large wind-driven events in the oxygen data are not sensor related and occur on regular 2-10 day time scales. This is observed at all moorings in this bay. Furthermore, the mix-down occurs very quickly (over the course of several hours to a day), so removing without an immediate sensor replacement during an event will cause a missed natural occurrence, and mislead the data.

When all the nearby mooring data were analyzed, it became clear that the sensor swap occurred during a wind event, and that the bulk of the 5% shift observed on the previous slide was probably caused by a natural occurring event, rather than indicative of a sensor problem or drift.

Care of Sensors in the Field

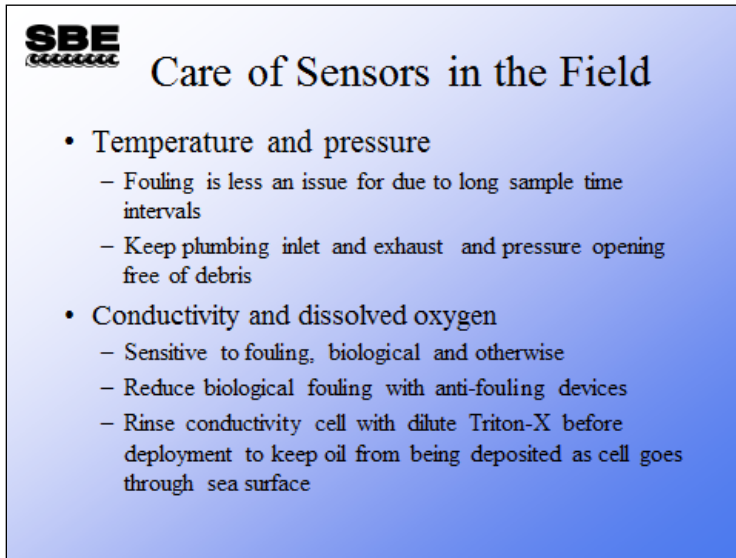
SBE
Care of Sensors in the Field
in General

- Bio-fouling is the major problem with moored instruments
- Can correct sometimes given pre and post calibration data or in situ sampling during deployments
- Conductivity and dissolved oxygen are susceptible



This SBE 37 is deployed in the tide waters of Georgia. Biological activity surges when the water temperature exceeds 20 °C. The researcher uses extra bio-fouling protection on each end of the conductivity cell and protects the pressure housing of the instrument with packing tape and silicon grease.

Care of Sensors in the Field (*continued*)

A blue rectangular slide with a black border. In the top left corner is the SBE logo, which consists of the letters 'SBE' in a bold, sans-serif font above a series of horizontal wavy lines. To the right of the logo is the title 'Care of Sensors in the Field' in a black serif font. Below the title is a bulleted list of maintenance instructions for sensors in the field.

SBE
Care of Sensors in the Field

- Temperature and pressure
 - Fouling is less an issue for due to long sample time intervals
 - Keep plumbing inlet and exhaust and pressure opening free of debris
- Conductivity and dissolved oxygen
 - Sensitive to fouling, biological and otherwise
 - Reduce biological fouling with anti-fouling devices
 - Rinse conductivity cell with dilute Triton-X before deployment to keep oil from being deposited as cell goes through sea surface

As we have discussed, thermometers are very robust. In moored applications, the sampling interval is much longer than the time constant of the thermometer, so except in extreme conditions fouling does not affect thermometers.

Occasionally, when a Sea-Bird instrument with a Druck pressure sensor is deployed in a muddy and/or biologically productive environment, the pressure port may partially fill with sediment or the pressure port plug vent hole may be covered with biological growth. Either of these occurrences can cause a delay in the pressure response, or in extreme cases can completely block the pressure signal. Sea-Bird developed a high-head pressure port plug for these types of deployments. See **Application Note 84** on our website for details.

Note: Newer pumped SBE 37 MicroCATs (SMP, IMP, SIP) and all IDO and ODO SBE 37 MicroCATs (SMP-IDO, IMP-IDO, SIP-IDO, SMP-ODO, IMP-ODO, SIP-ODO) are not compatible with the high-head pressure port plug.

We'll talk more about conductivity sensors and dissolved oxygen sensors.

Care of Sensors in the Field: Conductivity

SBE
Care of Sensors in the Field:
Conductivity

- Conductivity cells may be equipped with AF24173 Anti-Foulant Devices



On conductivity sensors, a very thin coating can change the cell geometry, having a large effect on the conductivity measurement.

Care of Sensors in the Field: Conductivity (*continued*)




Care of Sensors in the Field: Conductivity (*continued*)

SBE Advantages of Pumping on Moored Instruments

- Plumbing keeps sensors out of continuous fouling environment
 - Traps water between samples
 - Anti-foulant diffuses into trapped water to take care of any incoming biota
 - Anti-foulant protection allows longer deployments with more accurate data

Additional protection: Copper tube extends from intake of TC sensors



SBE 16+ with Ecos

Sensor Drift Characteristics



Sensor Drift Characteristics

- Biggest cause of sensor drift is fouling
 - Mainly a problem with conductivity and DO
- Electronic drift
 - SBE products have very little drift due to stable engineered electronics
- Extreme events that causes a shift in calibration
 - Thermal heating a temperature sensor
 - Movement of electrodes in conductivity cell
 - Scratches on DO membrane or fluorophor

Sensor Drift Characteristics (*continued*)

SBE Sensor Drift Characteristics

- Shelf drift similar as profiling instruments
- Pressure and temperature drift as offset
 - Typical temperature drift rates for SBE 16*plus*, 16*plus* V2, 37, and 39 are 0.0002 °C per month
 - Typical pressure drifts are linear, with rates of 0.018% - 0.05% of full scale per year
- Conductivity and oxygen drift as slope
 - Conductivity drift rates are 0.0003 Siemens/meter/month
 - SBE 43 drift rate is 1 – 2% per month
 - SBE 63 drift rate is much less once deployed
 - Shelf drift rate 1-2% per year

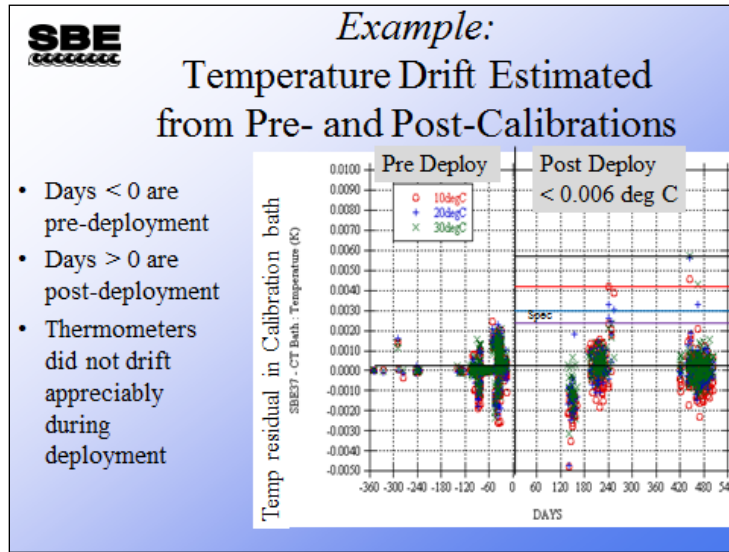
Correcting Data with Pre- and Post-Deployment Calibrations



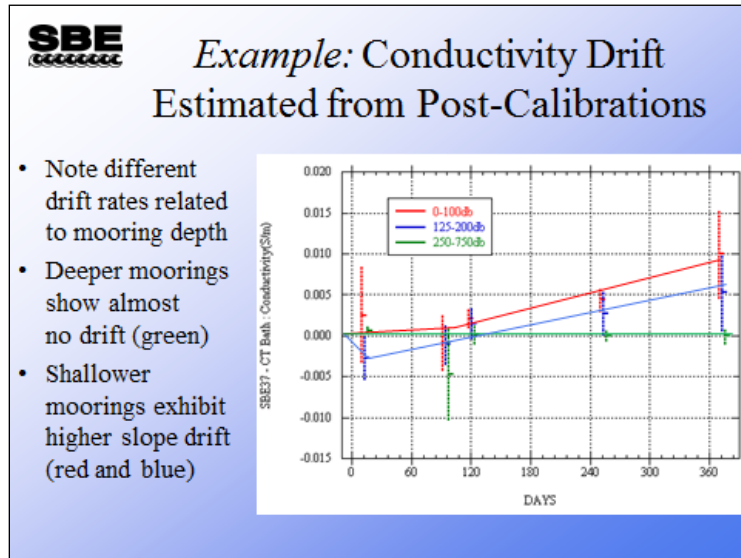
Correcting Data With Pre- and Post- Deployment Calibrations

- Temperature
 - Pre-/Post- deployment calibrations are only way for temperature
- Conductivity and Dissolved Oxygen
 - Pre-/Post-deployment calibrations
 - In-situ water samples during deployment
 - CTD profiles adjacent to mooring
 - Pre and post lab validations
- Same methods as shown in Modules 7 and 8

Correcting Data with Pre- and Post-Deployment Calibrations (*continued*)



Correcting Data with Pre- and Post-Deployment Calibrations (*continued*)



Care of Sensors in the Field: Dissolved Oxygen



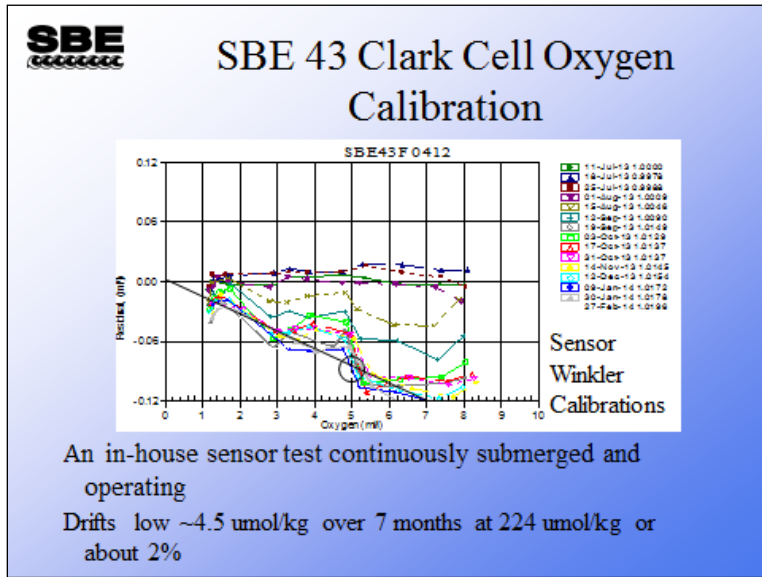
SBE
SBE Oxygen Sensor Factory Calibrations
and Frequency of Service

- SBE 43 Electrochemical DO
- 18 point calibration
 - 3 oxygen, 6 temperatures
 - 5 coefficients
- SBE 63 Optical DO
- 24 point calibration
 - 4 oxygen, 6 temperatures
 - 8 coefficients

- Factory service/calibration interval depends on use and deployment environments
- Annual to biennial factory service advised
 - Longer intervals possible if Best Practices followed and oxygen validation capability exists in your facility.

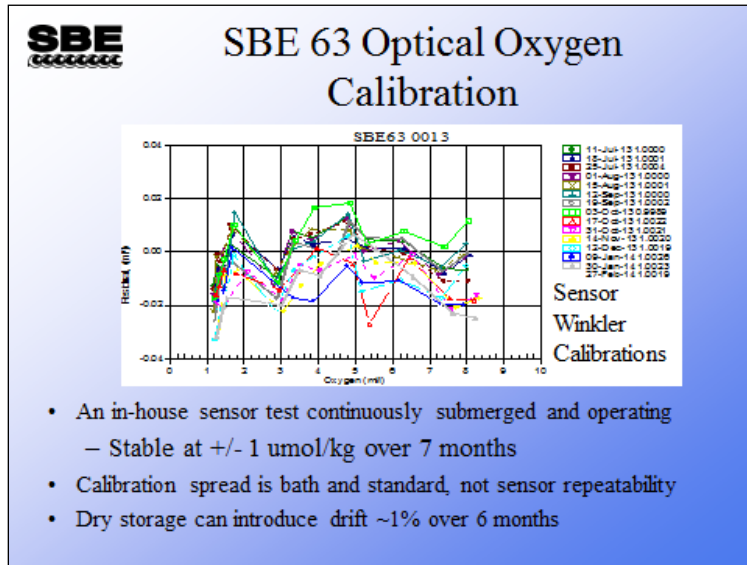
Each SBE 43 and SBE 63 is calibrated individually in a temperature-controlled bath. Bath temperatures are varied at each of 3 to 4 oxygen values, providing a comprehensive 18 to 24-point calibration. Two reference sensors in each bath are standardized against Winkler titrations weekly and monitored with high-quality controlled wet chemistry standards. Response time tests are conducted on each sensor, using gas. Salinity and pressure impacts on sensor response are each checked at two separate points.

Care of Sensors in the Field: Dissolved Oxygen (continued)



Plot indicates a slope drift of < 0.1 ml/L (~4.5 umol/kg) over seven months at saturation.

Care of Sensors in the Field: Dissolved Oxygen (continued)



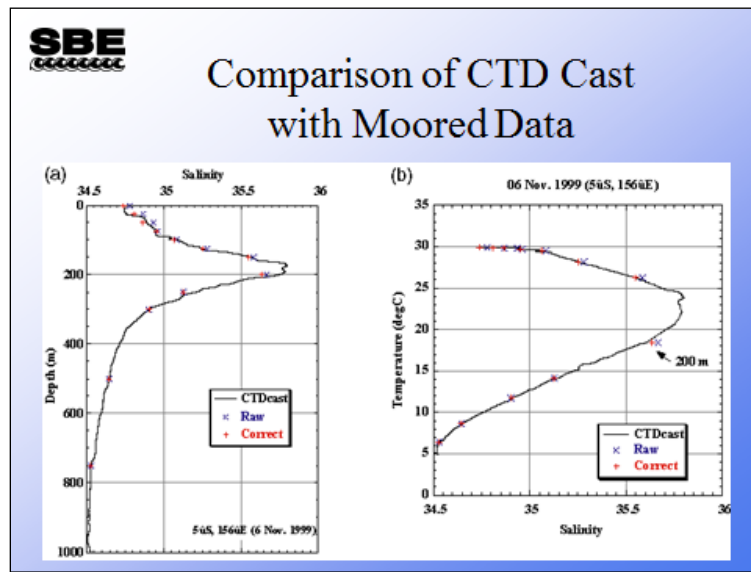
Field Validation



Field Validation of Moored Conductivity and Oxygen Sensors

- Best Practice: Validate Sensors against water samples
- Same protocol as with profiling CTD
- Secondary Standard: Can also use reference sensor to check *in situ* performance
 - For example, making CTD profiles next to mooring at deployment/recovery and during

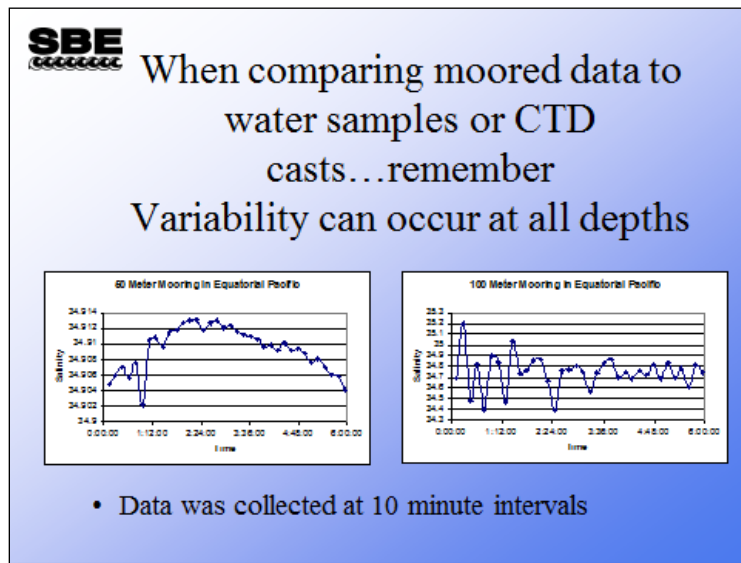
Correcting Conductivity and Temperature Data: Example



Here is a plot of a CTD cast with the mooring data overplotted on it. Raw and corrected values are shown. Although the scale is rather coarse, the correction improved the agreement between the instruments.

When choosing locations to make corrections, consider the position of the thermocline and other variables that can add error to reference samples (Winklers or CTD comparisons). Also, be aware that pressure sensors on moored instruments need to be checked, as pressure is an important variable in the salinity calculation. Large errors in pressure can create large errors in salinity.

Correcting Conductivity and Temperature Data: Example



When comparing data collected by moored instruments with data collected in a CTD profile, it is important to keep in mind that even though the mooring is fixed in place, the ocean moves around it. There can be substantial variability over a fairly small time interval. Most of the time there is little hope of having the CTD in place at the moment the moored instrument is taking a measurement.

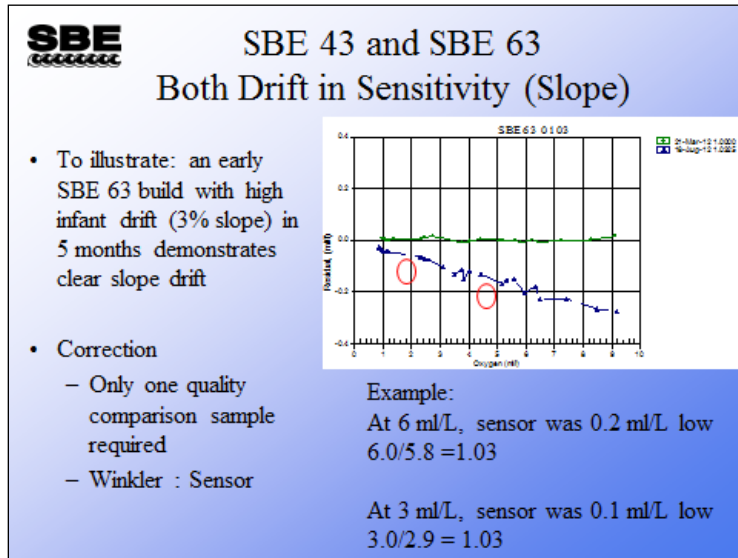
Correcting Oxygen Data



Sample Validation Procedure for Dissolved Oxygen Sensors

- Fouling correction is not a fixed quantity as in offset
- SBE 43: Only 1 term in calibration equation needs modification due to fouling, slope scaling term *Soc*
 - All other terms in calibration equation deal with temperature, salinity, and pressure effects on sensor
- SBE 63: Can also use a slope correction to data, but not via the calibration equation

Correcting Oxygen Data (*continued*)



Correcting Oxygen Data (*continued*)

SBE
seawater

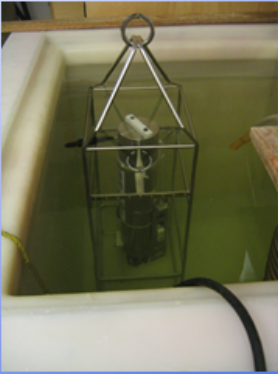
Correcting Oxygen Data for Drift

- Because normal sensor calibrations change only in slope, you **only need 1 sample to validate**
 - It is always better to have a few samples for reference standard deviation or to get an average slope correction
- Compute correction only if necessary
 - for example: if reference samples indicate the sensor is drifting beyond sensor accuracy specification (2%)


Correcting Oxygen Data (*continued*)

SBE Laboratory Bath Validation
Before and After Deployment

- Bath tests
 - Confirm functionality
 - Collect reference sample for slope correction in calibration equation
- Uniform bath with stable temperature
- Equilibrate instrument for a few hours prior to sampling
- Turn off aerators 20 min prior to sampling
- Synchronize water sample and sensor data



Correcting Oxygen Data: Lab Validation



Example:
SBE 43 Winkler Lab Validation

- Turn on CTD, verify SBE 43 is flushing (pump on)
 - If using fresh water, may need to set minimum conductivity frequency to 0, so pump will turn on
- Record data with Seasave, or upload later from CTD
- Collect Winkler water samples, fix, hold for < 36 hours, titrate
 - Replicate water samples for QA on Winkler method

Note for SBE *9plus* CTD -

Minimum conductivity frequency cannot be set by the user for an SBE *9plus* CTD. It is factory set (hard wired) to approximately 3500 Hz. An SBE *9plus* with custom modifications allows you to manually turn the pump on and off, which can be useful for fresh water applications (or for testing in the lab).

Correcting Oxygen Data: Lab Validation (*continued*)

SBE
sevens

Example: SBE 43 Winkler Lab Validation

- Output time series of CTD data:
temperature, conductivity, salinity, oxygen
voltage, OxSat, oxygen concentration (same
units as Winkler values you are generating)
- Pull data from CTD time series that corresponds
with time of Winkler samples
 - Enter CTD data and Winkler data in a spreadsheet
 - Compute correction ratio


Correcting Oxygen Data: Lab Validation (*continued*)

SBE
ocean

Example: SBE 43 Winkler Lab Validation

- Repeat procedure at different temperatures or saturations if desired
 - Correction ratio should be similar for different DO values
 - Make an average slope correction to remove noise from water sampling method

Correcting Oxygen Data: Field Validation



Example:
SBE 43 Winkler Field Validation


- Follow similar procedure for validation in field
- Choose depth of CTD and Winkler water sample comparisons where D.O. is not changing much
 - Collect replicate field samples if possible, and use average or “best of”
- If replication not possible, collect samples at multiple locations to get idea of sampling variability and to be sure you do not have a bad sample

Field validations must be carefully executed!

For additional information on SBE 43 data and corrections, see **Application Notes 64, 64-1, and 64-2** on our website.

Correcting Oxygen Data: Field Validation (*continued*)

SBE Validation in the Field at Deployment and Recovery and Routinely During Deployment



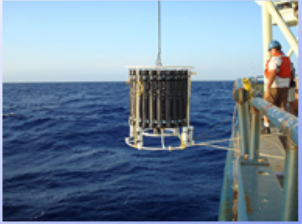

• Validation in the field allows calibration adjustments and data correction without removing instruments

- Water samples for Winkler Titrations
- CTD-DO profile adjacent to mooring

The image shows two men on the deck of a boat. One man is kneeling and working with a piece of equipment, while the other is standing and looking on. There are various pieces of gear, including a red and white cooler, and ropes visible on the deck.

Correcting Oxygen Data: Field Validation (*continued*)

SBE Validation: Use Appropriate and Quality Controlled References



- Winkler water samples
 - Requires some spin-up but **only true standard**
 - Replicate samples, blanks and QA/QC
 - Thiosulfate standardization
- Reference Sensors
 - Requires they are clean and calibrated
 - Use reference sensor correctly
 - respect response time (profiling)
 - Do not use less accurate spec'd sensor

Correcting Oxygen Data

SBE
seabird

Example:
SBE 43 Procedure Overview for
Correcting Data

- Compare a Winkler value and corresponding SBE 43 value (or known reference sensor)
- Compute correction ratio =
$$\text{(Known value / SBE 43 Value)}$$
- Multiply factory *Soc* by ratio to get *newSoc*
 - Replace factory *Soc* in .con or .xmlcon file with *newSoc*
 - Process data from time of correction forward with *newSoc*

OR Multiply the SBE 43 values by the correction ratio

The correction ratio is typically greater than 1.0 if the sensor is fouling.

See **Application Note 64-2** (www.seabird.com/application_notes/AN64-2.htm).

Activity: Compute Correction Factor for Soc

SBE Activity:
Compute Correction Factor for *Soc*

Winkler (ml/l)	SBE 43 (ml/l)	Offset = Difference (SBE 43 – Winkler)	Correction Factor (Winkler/SBE 43)
6.8	5.8		
4.2	3.6		
1.2	1.0		

- If factory *Soc* was 0.4109, calculate *newSoc*

Note that the Offset (difference between SBE 43 readings and Winkler readings) is not constant, indicating that the SBE 43 is drifting by slope, not offset.

The new *Soc* (*newSoc*) is entered in the configuration (.con or .xmlcon) file in SBE Data Processing. The modified configuration file is used for processing measurements made after the date corresponding to the Winkler water samples.

Computing Rate of Change for Soc



Computing Rate of Change for Soc

- Correction factor you just computed should yield $newSoc = 0.4931$ (using correction factor of 1.2)
- You could also apply a constant slope correction per day (or week or month) by computing a rate of change in *Soc* and processing data accordingly
- For example, let's assume fouling over mooring period was linear per day. Computing daily rate of change assuming sensor was moored for 244 days:
Rate of change = $(NewSoc - Soc) / \# \text{ of days}$
 $= (0.4931 - 0.4109) / 244 = 0.0003368/\text{day}$

Activity: Compute Rate of Change for *Soc*



Activity:

Compute Rate of Change for *Soc*

- With $Soc = 0.4109$ and $newSoc = 0.4931$:
 - Assume fouling was linear **per day**, and sensor was moored for 1 year (365 days).
What is rate of change in *Soc* per day?
 - Assume fouling was linear **per week**, and sensor was moored for 8 months (35 weeks).
What is rate of change in *Soc* per week?

Correcting Oxygen Data: Example

SBE Example: Shilshole Marina					
Date (2007)	Winkler 1	Winkler 2	Winkler 3	Average	Standard Dev
3/12	(Calibration date)				
3/23 17:10	6.123	6.165	6.239	6.176	0.059
3/30 11:10	7.077	7.084	7.111	7.091	0.018
4/19 12:20	7.324	7.328	Dud	7.326	0.003
5/04 13:10	7.552	7.579	7.569	7.567	0.014
5/04 14:10	7.643	7.742	7.765	7.717	0.065
5/17 13:10	8.239	8.250	8.248	8.246	0.006
5/30 12:40	9.025	9.184	9.146	9.118	0.083
6/05 15:20	8.517	8.509	8.488	8.505	0.015

Sea-Bird deployed an SBE 43 on a CTD at Shilshole Marina in Seattle from March 23 to June 5, 2007, and performed periodic water sampling at various times during the deployment period. The table above summarizes the Winkler results from the water samples.

Note that 3 water samples were drawn and analyzed from the bottle collected on each water sampling date. We will use the average Winkler value on each date to perform the corrections. The standard deviation in the Winklers gives an estimate on method draw and lab errors. It does not account for co-sampling (location/timing) errors with respect to the oxygen sensor.

Correcting Oxygen Data: Example (*continued*)

SBE <small>Seabird</small>		Example: Shilshole Marina			
Date (2007)	SBE 43 **	Difference (Winkler - SBE 43)	Ratio (Winkler / SBE 43)	newSoc	Corrected SBE 43
3/12	Calibration Date, Soc = 0.00012913				
3/23 17:10	6.028	0.148	1.024	0.00013223	6.176
3/30 11:10	6.789	0.302	1.044	0.00013481	7.091
4/19 12:20	6.885	0.441	1.064	0.00013739	7.326
5/04 13:10	7.236	0.331	1.045	0.00013494	7.567
5/04 14:10	7.319	0.398	1.054	0.00013610	7.717
5/17 13:10	7.740	0.506	1.065	0.00013752	8.246
5/30 12:40	8.470	0.648	1.077	0.00013907	9.118
6/05 15:20	7.789	0.716	1.092	0.00014101	8.505

** Using original Soc (= 0.00012913)

Looking at these data, the percent change in *Soc* from beginning of deployment to end of deployment (3/23 to 6/5, approximately 2.5 months) is 7%.

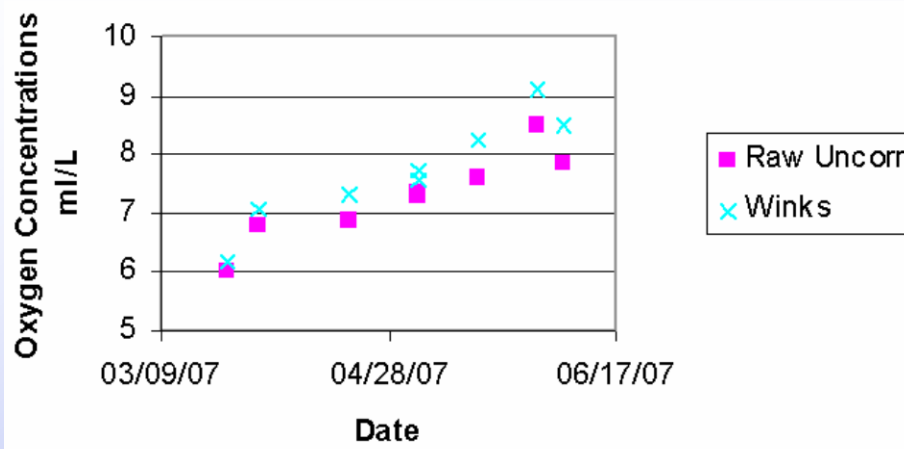
Note the following:

- The corrections would be small (< 4%) through 5/17.
- Have an idea what level of data accuracy you expect.
- Look for outliers - they could indicate a problem in your calculations, or that the sensor and water samples do not agree (for example, co-sampling errors and time of sample with sensor mismatches).
- There are many ways to implement corrections. For examples, see our website.
- Tracking data can help identify instrument or coefficient problems.
- It is not normal for the ratios and resulting *Soc* values to decrease with time.
 - 1) Verify calibration coefficients are entered in the configuration (.con) file correctly.
 - 2) Contact customer service with a sample of the problem you are seeing.
 - 3) Return the SBE 43 to the factory for assessment if the problem is not resolved.
- Sea-Bird recommends factory servicing when the *Soc* correction ratio factor ~ 1.2 (equivalent to 15 - 20% drift from factory calibration), **and** it is not corrected by sensor cleaning.

Correcting Oxygen Data: Example (*continued*)

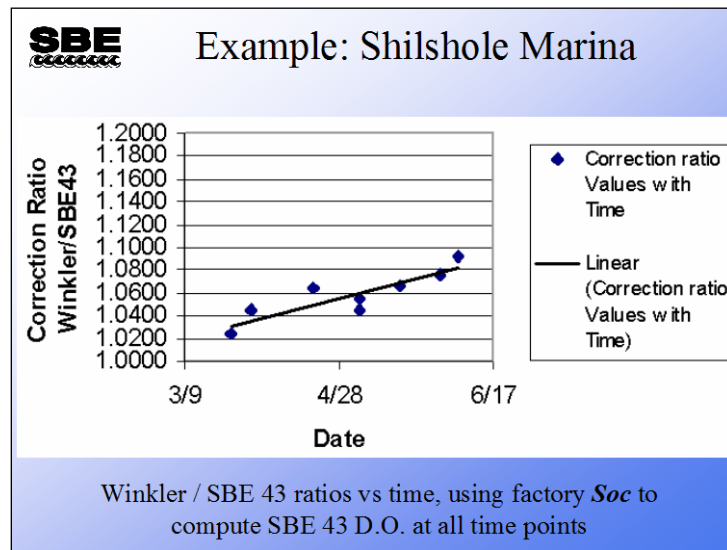


Example: Shilshole Marina



Uncorrected SBE 43 values using factory *Soc*, and corresponding Winkler titration samples over time of deployment

Correcting Oxygen Data: Example (*continued*)



This plot shows the Winkler / SBE 43 ratios versus time, using the original factory calibration value to compute the SBE 43 D.O. at all time points.

Notice the small positive trend in the correction with time. Sea-Bird recommends a factory service when the correction ratio reaches 1.2 and is not corrected with cleaning.

Post-Recovery Maintenance




Post-Recovery Maintenance for Moored Instruments

- Manually remove as much bio-fouling as possible
 - Scotch-bright pads work well for this
 - A **short** soak in white vinegar will make this easier
 - Plug the cell ends or install a loop of Tygon®
 - Be careful not to damage conductivity cell if you remove cell guard
- Clean and inspect any installed cables
- Finally, soak these instruments in same way as profiling instruments to remove / dilute any trapped saltwater

Post-Recovery Maintenance (*continued*)

SBE
SCIENTIFIC

After Recovery



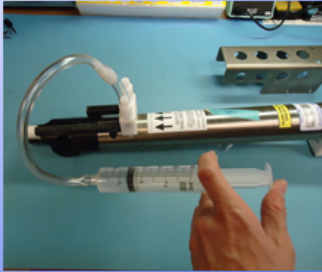
- Rinse equipment thoroughly with fresh water
- Rinse and store conductivity cell as described in Application Note 2D
- Rinse and store SBE 43 dissolved oxygen sensor as described in Application Note 64
 - SBE 63 follows similar protocol, as described in the SBE 63 manual
- Remove fouling away from pressure sensor port
- If you want to post-calibrate sensors, **do not rinse** sensors prior to calibration or validation
 - Clean outside of instrument and loop Tygon to help protect sensors from getting rinsed

Post-Recovery Maintenance (*continued*)

SBE


Routine Cleaning of Conductivity Sensors

- Agitate warm 50:1 chlorine bleach solution through the cell
- Follow with warm 1% - 2% Triton X solution
- In rare instances, coatings may be inorganic in nature
 - These may be removed with a 10% HCl solution



Never run a brush through a cell to clean it

Post-Recovery Maintenance (*continued*)



Care of Conductivity Sensors in the Field

- How to tell when cell has sustained physical damage or is dirty
 - Clean and rinse cell thoroughly with distilled or de-ionized water
 - Check sensor frequency (*zero frequency*) against calibration certificate
 - Numbers should agree to within a few tenths of a Hz
 - Noisy readings indicate a dirty cell

SENSOR SERIAL NUMBER: 4000		SBE 1961a: CONDUCTIVITY CALIBRATION DATA			
CALIBRATION DATE: 06-Aug-10		PSS 1978, C(35,15(f)) = 4.2914 Siemens/meter			
COEFFICIENTS:					
g =	-9.750395e-001	C _{Temp} =	+9.5100e-008		
h =	1.633805e-001	C _{Pres} =	3.2500e-006		
i =	-1.569986e-004				
j =	6.525413e-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	2448.38	0.0000	0.00000
1.0000	34.6362	2.36668	4927.91	2.9667	0.00000
4.5000	34.6766	3.27284	5108.92	3.2728	-0.00000
15.0000	34.6339	4.25160	5664.72	4.2516	-0.00000
18.5000	34.6244	4.33965	5847.26	4.3397	0.00000
24.0000	34.6134	5.15177	6230.50	5.1518	0.00000
29.0000	34.6065	5.67182	6383.64	5.6718	0.00000
32.5000	34.6019	6.04282	6558.06	6.0428	-0.00000
f = INST FREQ / 1000.0					
Conductivity = (g + hf ² + if ³ + jf ⁴) / (1 + (k + pf) Siemens/meter					
t = temperature[°C]; p = pressure[decibar]; k = C _{Temp} ; e = C _{Pres}					
Residual = instrument conductivity - bath conductivity					

Activity: Validations

SBE Activity: How to Enable Real-Time
Output for both Zero Conductivity
Checks and Validations

In SeatermV2 Command window, type:

TxRealTime=y

(Output real-time data while sampling autonomously or in serial line sync mode. **Note, you cannot sample faster than 10 seconds for real time output.**)

OR

In Send Commands window, under General Setup, click *Enable Output of Real-Time data*, select *Yes* as the argument, and click Execute button.

Activity: Validations (*continued*)



Activity: Reset Sample Interval to ≥ 10 seconds for Testing

In Command window, type: **SampleInterval=x**
where x= interval (seconds) between samples.

OR

In Send Commands window, under Autonomous Sampling (logging), click *Set Interval (secs) between Samples*, enter interval as the argument, and click Execute button.

Activity: Validations (*continued*)

SBE Activity: How to Setup for Zero Conductivity Frequency Testing

In SeatermV2: Example for SBE 37-SM

OutputFormat=0: raw decimal data, intended for diagnostic use

Example: Column Headings as follows:

Temp A/D **Cond Freq** Press A/D Pres sensor temp Comp A/D Date and Time

Now type StartNow at S> prompt to start the realtime output

S>StartNow

<!--start logging at = 15 May 2012 17:10:03, sample interval = 15 seconds-->

S>

#224970, 2545.383, 534298, 1557, 15 May 2012, 17:10:04

#224952, 2545.371, 534298, 1556, 15 May 2012, 17:10:19

#224928, 2545.375, 534299, 1556, 15 May 2012, 17:10:34

Activity: Validations (*continued*)



Activity: How to Check T and C against Reference Standards

- In SeatermV2 for an SBE 37-SM
- **OutputFormat=1** (default): converted decimal data
- Type **Startnow** to look at output
- Example of data for a CTD where salinity as an output (**OutputSal=Y**)

Temp deg C	Cond S/m	Press dbar	Salinity	Date Time
8.5796,	0.15269,	531.316,	1.1348,	20 Aug 2011, 09:01:44

Dissolved Oxygen Sensor Field Care



Cleaning SBE 43 and SBE 63 Oxygen Sensors in the Field

- Oxygen sensitivity may be maintained by briefly rinsing sensor with 0.1% Triton X, and then rinsing thoroughly with distilled water
- Oxygen sensitivity may be restored:
 1. Briefly (1 minute) rinse with 0.1% Triton X,
 2. Rinse thoroughly (several volumes) with distilled water
 3. Soak (1 minute) in dilute chlorine bleach
 4. Rinse thoroughly (several volumes) in distilled water

Dissolved Oxygen Sensor Field Care (*continued*)

SBE SBE 43 Dissolved Oxygen
Field Care

- If plenum is filled with mud, oil, sand, or instrument has been moored, might need to remove plenum for cleaning



Dissolved Oxygen Sensor Field Care (*continued*)

SBE To Remove Plenum on SBE 43

Locate set screws on Plastic Plenum (there should be two).

Find 7/64 Allen Wrench



If you need to inspect SBE 43 Membrane

Dissolved Oxygen Sensor Field Care (*continued*)

SBE To Remove Plenum on SBE 43



Remove both set screws with
Allen Wrench

Put screws in a safe place

The image shows a close-up of a person's hand holding a white plastic plenum component of an SBE 43 sensor. The plenum has a blue and black cylindrical sensor element attached to its top. A hand is using a silver Allen wrench to turn a set screw on the side of the plenum. The background is black.

Dissolved Oxygen Sensor Field Care (*continued*)

SBE To Remove Plenum on SBE 43

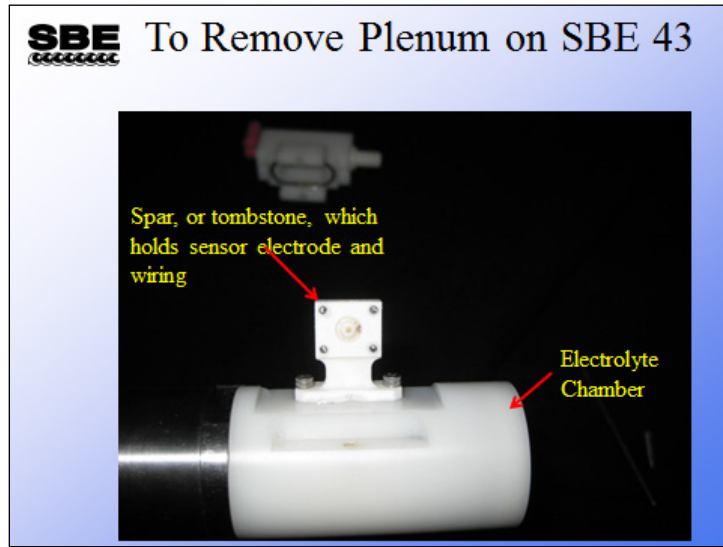
Locate set screws on Plastic Plenum (there should be two).

Find 7/64 Allen Wrench



If you need to inspect SBE 43 Membrane

Dissolved Oxygen Sensor Field Care (*continued*)



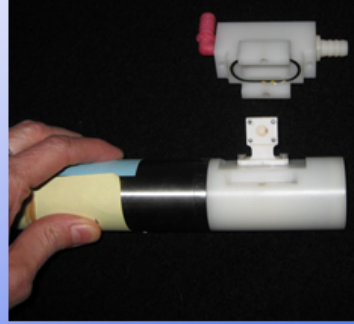
Dissolved Oxygen Sensor Field Care (*continued*)




To Remove Plenum on SBE 43

Lay plenum down. You will see an O-ring and interior housing that holds DO sensor when it is put together.

Inspect sensor face.
Do not handle membrane.
Light rinse with DI is OK.
**DO NOT TOUCH
MEMBRANE. DO NOT
WIPE MEMBRANE.**




Sensor Storage



After Cleaning

- Allow instrument to dry
- Open battery compartment and remove any exhausted batteries
 - If instrument is going to be stored for an extended period, do not replace batteries
- Follow all storage guidelines for any installed sensors and for conductivity cell
- Store instrument in a clean, dry environment

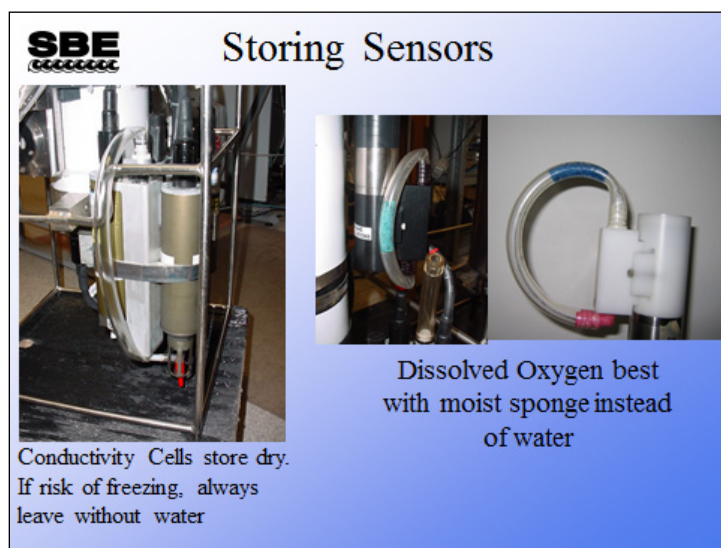
Sensor Storage (*continued*)



Sensor Storage

- Conductivity cell storage between retrieval and calibration:
 - If stored in seawater, further bio-fouling may occur
 - Short-term (< 1 day): fill with distilled or DI water if no danger of freezing
 - Long-term (> 1 day): rinse with distilled or DI water, store dry, close ends
- Oxygen sensor storage between retrieval and calibration:
 - If stored with seawater, further bio-fouling may occur
 - Because electrode is polarized, sensor will drift in storage
 - Short-term (< 1 day): place small, water-saturated sponge or piece of foam in a Tygon tube looped from inlet to outlet
 - Long-term (> 1 day): store dry, with Tygon tube looped from inlet to outlet

Sensor Storage (*continued*)



Conductivity cell (See **Application Note 2D** for details.):

- Short-term storage: If there is no danger of freezing, store the conductivity cell with distilled or de-ionized water in Tygon tubing looped around the cell. If there is danger of freezing, store the conductivity cell dry, with Tygon tubing looped around the cell.
- Long-term storage: Since conditions of transport and long-term storage are not always under the control of the user, we recommend storing the conductivity cell dry, with Tygon tubing looped around the cell ends. Dry storage eliminates the possibility of damage due to unforeseen freezing, as well as the possibility of bio-organism growth inside the cell.

Oxygen sensor (See **Application Note 64** for details.):

- Short-term storage: If there is no danger of freezing, place a small piece of clean sponge, *slightly dampened* with fresh, clean water, in the center of the tubing (not near the membrane). If there is danger of freezing, store the oxygen sensor dry, with Tygon tubing looped from inlet to outlet.
- Long-term storage: Since conditions of transport and long-term storage are not always under the control of the user, we recommend storing the oxygen sensor dry, with Tygon tubing looped from inlet to outlet. Dry storage eliminates the possibility of damage due to unforeseen freezing, as well as the possibility of bio-organism growth inside the cell.