OPERATOR'S MANUAL

OBS-3A Turbidity and Temperature Monitoring System

Revision: 1/18

WARRANTY AND ASSISTANCE

This equipment is warranted by CAMPBELL SCIENTIFIC (CANADA) CORP. ("CSC") to be free from defects in materials and workmanship under normal use and service for **twelve (12) months** from date of shipment unless specified otherwise. ***** **Batteries are not warranted.** ***** CSC's obligation under this warranty is limited to repairing or replacing (at CSC's option) defective products. The customer shall assume all costs of removing, reinstalling, and shipping defective products to CSC. CSC will return such products by surface carrier prepaid. This warranty shall not apply to any CSC products which have been subjected to modification, misuse, neglect, accidents of nature, or shipping damage. This warranty is in lieu of all other warranties, expressed or implied, including warranties of merchantability or fitness for a particular purpose. CSC is not liable for special, indirect, incidental, or consequential damages.

Products may not be returned without prior authorization. To obtain a Return Merchandise Authorization (RMA), contact CAMPBELL SCIENTIFIC (CANADA) CORP., at (780) 454-2505. An RMA number will be issued in order to facilitate Repair Personnel in identifying an instrument upon arrival. Please write this number clearly on the outside of the shipping container. Include description of symptoms and all pertinent details.

CAMPBELL SCIENTIFIC (CANADA) CORP. does not accept collect calls.

Non-warranty products returned for repair should be accompanied by a purchase order to cover repair costs.

CAMPBELL SCIENTIFIC®

Campbell Scientific (Canada) Corp.
14532 131 Avenue NW | Edmonton AB T5L 4X4
780.454.2505 | fax 780.454.2655 | campbellsci.ca

Assistance

Products may not be returned without prior authorization. The following contact information is for Canadian and international clients residing in countries served by Campbell Scientific (Canada) Corp. directly. Affiliate companies handle repairs for clients within their territories. Please visit *www.campbellsci.ca* to determine which Campbell Scientific company serves your country.

To obtain a Returned Materials Authorization (RMA), contact CAMPBELL SCIENTIFIC (CANADA) CORP., phone (780) 454-2505. After a measurement consultant determines the nature of the problem, an RMA number will be issued. Please write this number clearly on the outside of the shipping container. Campbell Scientific's shipping address is:

CAMPBELL SCIENTIFIC (CANADA) CORP.
RMA#_____
14532 131 Avenue NW
Edmonton, Alberta T5L 4X4
Canada

For all returns, the client must fill out a "Statement of Product Cleanliness and Decontamination" form and comply with the requirements specified in it. The form is available from our web site at *www.campbellsci.ca/repair*. A completed form must be either emailed to *repair@campbellsci.ca* or faxed to (780) 454-2655. Campbell Scientific (Canada) Corp. is unable to process any returns until we receive this form. If the form is not received within three days of product receipt or is incomplete, the product will be returned to the client at the client's expense. Campbell Scientific (Canada) Corp.f reserves the right to refuse service on products that were exposed to contaminants that may cause health or safety concerns for our employees.

Precautions

DANGER — MANY HAZARDS ARE ASSOCIATED WITH INSTALLING, USING, MAINTAINING, AND WORKING ON OR AROUND **TRIPODS, TOWERS, AND ANY ATTACHMENTS TO TRIPODS AND TOWERS SUCH AS SENSORS, CROSSARMS, ENCLOSURES, ANTENNAS, ETC**. FAILURE TO PROPERLY AND COMPLETELY ASSEMBLE, INSTALL, OPERATE, USE, AND MAINTAIN TRIPODS, TOWERS, AND ATTACHMENTS, AND FAILURE TO HEED WARNINGS, INCREASES THE RISK OF DEATH, ACCIDENT, SERIOUS INJURY, PROPERTY DAMAGE, AND PRODUCT FAILURE. TAKE ALL REASONABLE PRECAUTIONS TO AVOID THESE HAZARDS. CHECK WITH YOUR ORGANIZATION'S SAFETY COORDINATOR (OR POLICY) FOR PROCEDURES AND REQUIRED PROTECTIVE EQUIPMENT PRIOR TO PERFORMING ANY WORK.

Use tripods, towers, and attachments to tripods and towers only for purposes for which they are designed. Do not exceed design limits. Be familiar and comply with all instructions provided in product manuals. Manuals are available at www.campbellsci.ca or by telephoning (780) 454-2505 (Canada). You are responsible for conformance with governing codes and regulations, including safety regulations, and the integrity and location of structures or land to which towers, tripods, and any attachments are attached. Installation sites should be evaluated and approved by a qualified personnel (e.g. engineer). If questions or concerns arise regarding installation, use, or maintenance of tripods, towers, attachments, or electrical connections, consult with a licensed and qualified engineer or electrician.

General

- Prior to performing site or installation work, obtain required approvals and permits.
- Use only qualified personnel for installation, use, and maintenance of tripods and towers, and any attachments to tripods and towers. The use of licensed and qualified contractors is highly recommended.
- Read all applicable instructions carefully and understand procedures thoroughly before beginning work.
- Wear a **hardhat** and **eye protection**, and take **other appropriate safety precautions** while working on or around tripods and towers.
- **Do not climb** tripods or towers at any time, and prohibit climbing by other persons. Take reasonable precautions to secure tripod and tower sites from trespassers.
- Use only manufacturer recommended parts, materials, and tools.

Utility and Electrical

- **You can be killed** or sustain serious bodily injury if the tripod, tower, or attachments you are installing, constructing, using, or maintaining, or a tool, stake, or anchor, come in **contact with overhead or underground utility lines**.
- Maintain a distance of at least one-and-one-half times structure height, 6 meters (20 feet), or the distance required by applicable law, **whichever is greater**, between overhead utility lines and the structure (tripod, tower, attachments, or tools).
- Prior to performing site or installation work, inform all utility companies and have all underground utilities marked.
- Comply with all electrical codes. Electrical equipment and related grounding devices should be installed by a licensed and qualified electrician.

Elevated Work and Weather

- Exercise extreme caution when performing elevated work.
- Use appropriate equipment and safety practices.
- During installation and maintenance, keep tower and tripod sites clear of un-trained or non-essential personnel. Take precautions to prevent elevated tools and objects from dropping.
- Do not perform any work in inclement weather, including wind, rain, snow, lightning, etc.

Maintenance

- Periodically (at least yearly) check for wear and damage, including corrosion, stress cracks, frayed cables, loose cable clamps, cable tightness, etc. and take necessary corrective actions.
- Periodically (at least yearly) check electrical ground connections.

WHILE EVERY ATTEMPT IS MADE TO EMBODY THE HIGHEST DEGREE OF SAFETY IN ALL CAMPBELL SCIENTIFIC PRODUCTS, THE CLIENT ASSUMES ALL RISK FROM ANY INJURY RESULTING FROM IMPROPER INSTALLATION, USE, OR MAINTENANCE OF TRIPODS, TOWERS, OR ATTACHMENTS TO TRIPODS AND TOWERS SUCH AS SENSORS, CROSSARMS, ENCLOSURES, ANTENNAS, ETC.

PLEASE READ FIRST

About this manual

Please note that this manual was originally produced by Campbell Scientific Inc. (CSI) primarily for the US market. Some spellings, weights and measures may reflect this origin.

Some useful conversion factors:

Area:	1 in^2 (square inch) = 645 mm^2
Length:	1 in. (inch) = 25.4 mm
	1 ft (foot) = 304.8 mm
	1 yard = 0.914 m
	1 mile = 1.609 km
Mass:	1 oz. (ounce) = 28.35 g
	1 lb (pound weight) = 0.454 kg
Pressure:	1 psi (lb/in2) = 68.95 mb
Volume:	1 US gallon = 3.785 litres

In addition, part ordering numbers may vary. For example, the CABLE5CBL is a CSI part number and known as a FIN5COND at Campbell Scientific Canada (CSC). CSC Technical Support will be pleased to assist with any questions.

About sensor wiring

Please note that certain sensor configurations may require a user supplied jumper wire. It is recommended to review the sensor configuration requirements for your application and supply the jumper wire is necessary.

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Figures

Tables

OBS-3A Turbidity and Temperature Monitoring System

1. Introduction

The OBS-3A combines our OBS® probe with pressure, temperature, and conductivity sensors in a battery-powered recording instrument. Batteries and electronics are contained in a housing capable of operating at depths of up to 300 meters—depending on the pressure sensor installed.

Before installing the OBS-3A, please study:

- Section 2, *Precautions*
- Section 3, *Initial Inspection*

2. Precautions

- Although the OBS-3A is rugged, it should be handled as precision scientific instruments.
- Maximum depth for the OBS-3A housing is 300 meters. Working depths for individual instruments are limited by the installed pressure sensor. If exceeded, the pressure sensor will rupture and the housing will flood.
- Bright sun near the surface (<2 meters) or black-colored sediments can cause erroneous OBS readings.
- The OBS sensor must be kept clean to measure sediment concentration or turbidity accurately.
- When cleaning the OBS-3A, do not use MEK, benzene, toluene, or electronic cleaners as they could damage the OBS window.
- The conductivity sensor is very fragile and is enclosed in a hole behind the OBS sensor. Do not poke it with any tool or object as the electrodes may be damaged.
- Always put the OBS-3A in sleep mode when it will not be used for a while to conserve battery capacity (see Section 6.12, *Shutdown* *(p. 40)*).

3. Initial Inspection

- Upon receipt of the OBS-3A, inspect the packaging and contents for damage. File damage claims with the shipping company.
- Check this information against the shipping documents to ensure the correct product is received (see Section 3.1, *Ships With* *(p. 2)*).

3.1 Ships With

CSI pn 21229 Accessory Kit
ResourceDVD
CSI pn 29225 HydroSci Software on DVD

4. Overview

The heart of the OBS-3A is an OBS® sensor for measuring turbidity and suspended solids concentrations by detecting near infrared (NIR) radiation scattered from suspended particles. With a unique optical design, OBS sensors perform better than most in situ turbidity sensors in the following ways:

1. Small size and sample volume,

2. Linear response and wide dynamic range,

3. Insensitivity to bubbles and organic matter,

4. Rejects effects of ambient light and temperature change.

The OBS-3A includes a temperature sensor and may be equipped with pressure and conductivity sensors. Batteries and electronics are contained in a housing capable of operating at depths of up to 300 meters, depending on which pressure sensor is installed. A survey cable may be used to tow the OBS-3A and a depressor weight by clamping a cable harness to the housing.

Depending on the number of sensors and the statistics selected, the OBS-3A can log as many as 200,000 lines of data (one per hour for 23 years) including: time, date, depth, nephelometric turbidity units (NTUs), °C, and salinity. When sampling with a full suite of sensors, the unit will run about 300 hours. When using the instrument for surveys, the data are captured by a PC running the HydroSci software in the log file created at initialization.

4.1 OBS Sensor

The OBS sensor consists of an infrared-emitting diode (IRED) with a peak wavelength of 875 nm, four photodiodes, and a linear temperature transducer. The IRED produces a conical beam with half-power points at 50° (FIGURE 4-1). The IR scattered between 140° and 160° is detected after passing through a daylight-rejection filter and is proportional to turbidity and sediment concentration. See Section 5, *Specifications* (p. 4).

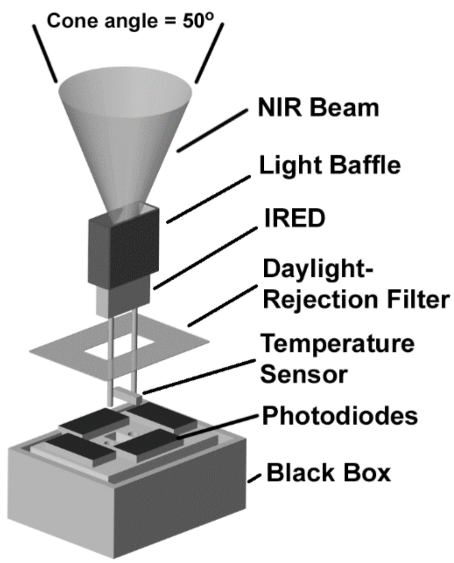


FIGURE 4-1. Anatomy of an OBS sensor

4.2 Temperature and Optional Sensors

Temperature is measured with a fast-response, stainless steel-clad thermistor. Pressure is measured with a semiconductor piezoresistive strain gage. Conductivity is measured with a four-electrode conduction-type cell. Working depths for available pressure sensors are listed in TABLE 6-1.

4.3 Optics and Turbidity Measurements

Turbidity is the cloudy appearance of a liquid produced by light scattered from suspended matter. It is an *apparent* optical property that depends on the size, color, and shape of scattering particles, and the instrument used to measure it. In accordance with standard method 2130B and ISO 7027, turbidity is usually measured with a 90°-scatterance nephelometer and reported in NTUs. Turbidity standards are discussed in Section 7, *Calibration* *(p. 42)*.

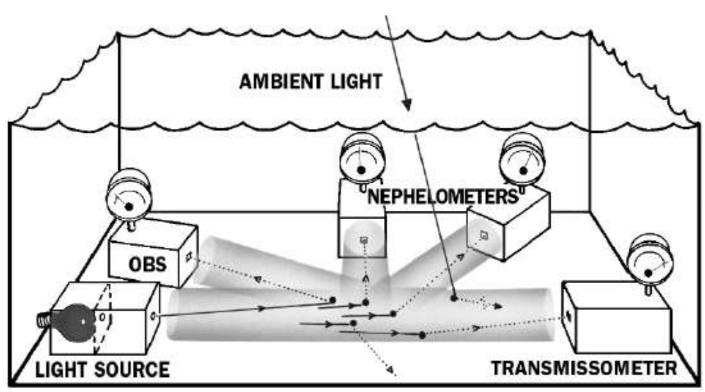


FIGURE 4-2. Optical particle detectors

Light transmission in water is attenuated by scattering (deflection by water molecules, and suspended matter) and absorption, which converts light to heat. Attenuation, absorption, and scattering are inherent properties of water that are affected only by impurities such as color and suspended organic matter. Optically pure water is not readily available; however deionized water that has passed through a 0.2 µm filter is adequate for most practical purposes.

There are dozens of turbidimeter designs, however most are configured in one of the ways shown in FIGURE 4-2. These include: forward-scatterance, 90° scatterance, and backscatterance nephelometers. Some instruments combine two or more of these configurations and blend signals to produce a useful output. The transmissometer measures attenuation, an inherent optical property, but is not approved for turbidity measurements except by ISO 7027. OBS sensors have superior linearity in turbid water but a transmissometer is more sensitive at low concentrations (<~25 mg/L). Data from turbidimeters made by different companies should be compared cautiously. Inconsistencies between instruments results from variations in light sources, detectors, optical configurations, and turbidity standards.

Can turbidity be converted to suspended solids concentrations and vise-versa?

In most situations, conversions between turbidity and suspended solids concentrations will give misleading results because the conversion equates to an apparent optical property, in relative units, with one precisely defined in terms of mass and volume; these are “apples and oranges”.

Conversion of turbidity to suspended solids concentration is recommended only when:

- Measurements are made with the same turbidimeter.
- The turbidimeter is intercalibrated with a turbidity standard and suspended matter from the waters to be monitored.
- Particle size and composition do not change over the monitoring period.

Compliance with the last condition is crucial but virtually impossible to verify in the field because it is difficult to sample particles in their natural state and preserve them for laboratory analysis in a consistent and meaningful way.

5. Specifications

Features:

- Measures turbidity with patented, field-proven OBS technology,
- Runs up to 8,000 hours on three D-cell batteries,
- Monitors sediment concentrations up to 5,000 mg/L and turbidity up to 4,000 NTUs,
- Logs depth, wave height, wave period, temperature, and salinity.

5.1 Measurement Range

Turbidity (AMCO Clear):	0.4 to 4,000 NTU[1]
Mud (D_{50}=20 µm):	0.4 to 5,000 mg/L
Sand (D_{50}=250 µm):	2 to 100,000 mg/L
Pressure[2]:	0 to 10, 20, 50, 100, or 200 m
Temperature:	0 to 35 °C
Conductivity (salinity):	0 to 65 mS/cm (40 PSU, o/oo)

[1] 0 to 100, 0 to 250, 0 to 500, 0 to 1000, 0 to 2000, and 0 to 4000 NTU ranges are available.

[2] Range depends on pressure sensor option chosen.

5.2 Accuracy

Turbidity (AMCO Clear, 0 to 2,000 NTU):	<2.0%
Mud (0.4 to 4,000 mg/L):	2.0% of reading
Sand (0.4 to 60,000 mg/L):	3.5% of reading
Pressure:	±0.5% full scale
Temperature:	±0.5 °C
Conductivity:	1%

5.3 OBS Sensor

Frequency:	5 Hz
Drift over time:	<2% per year
Drift over temperature:	0.05% per °C

5.4 Other Data

Maximum size sample:	2048
Sampling rate when connected to the PC:	1 to 25 Hz
Maximum data rate:	25 Hz (connected to PC), 5 Hz (used autonomously)
Data capacity:	8 Mbytes

Maximum number of data lines:	200,000
Battery capacity:	18 A h
Maximum battery life:	8,000 hours
Data protocols:	RS-232 / RS-485
Maximum housing depth:	300 m (984 ft)
Infrared wavelength:	850 nm
Operating temperature range:	0 to 35 °C
Storage temperature range:	–20 to 70 °C

5.5 Physcial

Length / diameter:	362 mm (14.3 in) / 76 mm (3.0 in)
Weight (w/o batteries):	1.5 kg (3.4 lb)
Weight (submerged):	0.2 kg (0.5 lb)

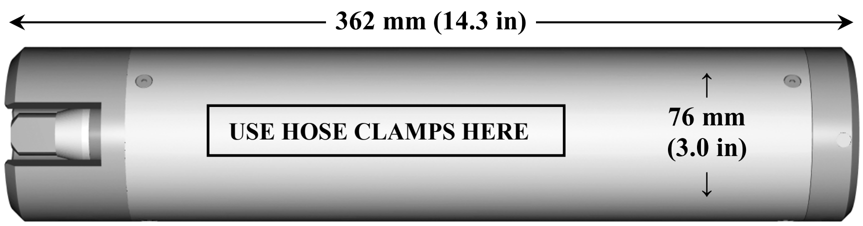


FIGURE 5-1. Dimensions

6. Operations

6.1 Instrument Setup

6.1.1 Mounting Suggestions

CAUTION Maximum depth for the OBS-3A housing is 300 meters. Working depths for individual instruments are limited by the installed pressure sensor. If exceeded, the pressure sensor will rupture and the housing will flood.

TABLE 6-1. Working and Maximum Depths		
Pressure Sensor	**Working Depth**	**Maximum Depth**
0.2 Bar	0 to 2 meters	3 meters
1 Bar	0 to 10 meters	15 meters
5 Bar	0 to 50 meters	75 meters
10 Bar	0 to 100 meters	150 meters
20 Bar	0 to 200 meters	300 meters

(1 Bar = 10 dBar ≅ 10 meters of fresh water)

Schemes for mounting the OBS-3A will vary with applications; however, the same basic precautions should be followed to ensure the unit is not lost or damaged.

- The most important general precaution is to ***orient the unit so that the OBS sensor "looks" into clear water*** without reflective surfaces.

- Nearly all exposed parts of the instrument are made of Delrin®, a strong but soft plastic. Always ***pad the parts of the OBS-3A housing that will contact metal or other hard objects*** with electrical tape or neoprene. Expanded polyethylene tubes make excellent padding.

- ***Never mount the instrument by the end-caps or attach anything to them.*** This could stress the screws holding the unit together, cracking either the end-caps or pressure housing, and cause a leak.

Moorings

The most convenient means for mounting the unit to a frame or wire is to use large high-strength nylon cable ties (7.6 mm or 0.3 in width) or stainless steel hose clamps. Use at least six cable ties or two hose clamps for redundancy. Position the clamps on the inner 2/3rds of the pressure tube, labeled "USE HOSE CLAMPS HERE", so stress is not transmitted to the ends (see FIGURE 5-1.). First cover the area(s) to be clamped with tape or 2 mm (1/16 in) neoprene sheet. Clamp the unit to the mounting frame or wire using the padded area. Do not tighten the hose clamps more than necessary to produce a firm grip. Over tightening may crack the pressure housing and cause a leak. Use spacer blocks when necessary to prevent chafing the unit with the frame or wire.

Surveys

The OBS-3A will usually be towed from a cable harness for surveys. The serial cable supplied with the unit is strong enough to tow the OBS-3A and a 5-kg depressor weight; however, the towing forces must be transmitted to the pressure housing and not to the connector. To provide strain relief for the connector, attach a cable grip about 30 cm above the SUBCONN® connector (FIGURE 6-1) and attach a short length of 3 mm (1/8 in) wire rope to the cable grip. Clamp the wire rope to the pressure housing in the clamping area with two stainless steel hose clamps. Provide a small loop of slack cable between the cable grip and connector and put chafe protection on the sensor head where it contacts the wire rope.

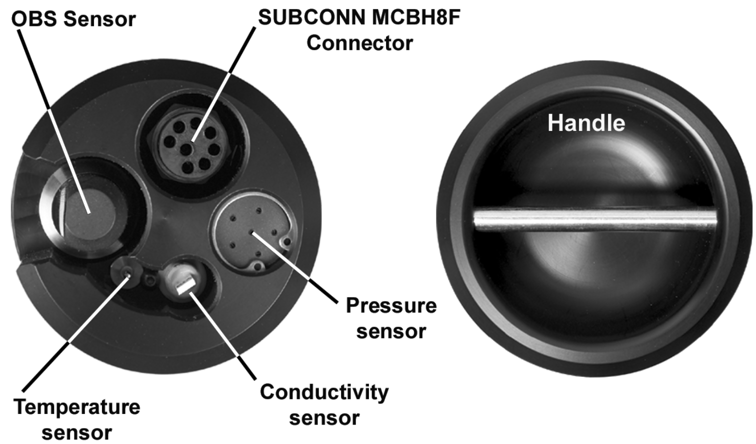


FIGURE 6-1. Components

6.1.2 Battery Installation

If unit is wet, perform the following operations with the unit held sensor end up. Remove the three hex screws from the end with the handle and pull the cap down and out of the housing.

CAUTION Use caution if you have significantly changed elevation since the OBS-3A may be under pressure and the cap could pop out.

Wipe water from inside walls of the tube with a paper towel (FIGURE 6-2). Slide the battery clip back and insert the batteries with the positive terminal (+) toward the clip. Push the batteries down and slide the clip against the housing wall to hold them in place. Inspect the O-ring in the cap and replace the cap and screws.

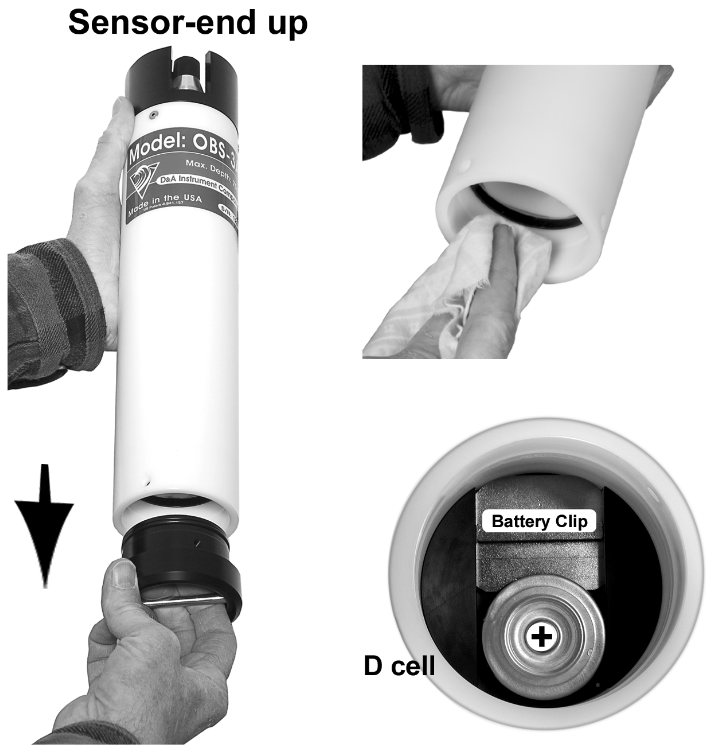


FIGURE 6-2. Battery installation

For extended deployment time, lithium batteries are a good alternative to alkaline batteries. Campbell Scientific sells a D-cell-sized battery spacer (pn 21906) that allows lithium D-cell batteries to be used with the OBS-3A. Lithium D-cell batteries have a higher voltage than their alkaline counterparts, necessitating the spacer. Campbell Scientific does not sell lithium D-cell batteries.

6.2 Software Installation

NOTE Install HydroSci before connecting the OBS-3A to the computer.

Insert the ResourceDVD and type "OBS-3A" in the product window. Install the HydroSci software. Follow the installation wizard to install the software. This utility is your interface with the OBS-3A. As part of the installation, a system-maintenance program is included. Communication drivers exist on the CD.

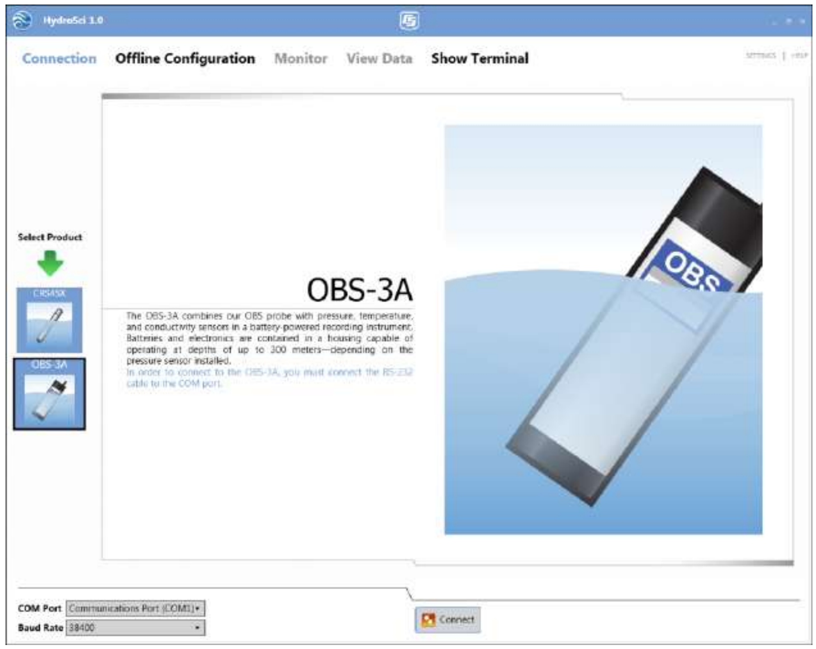
The main purpose of this section is to explain how to program and operate the OBS-3A with HydroSci. It covers: 1) turning the OBS-3A ON and testing the sensors, 2) setting it up to sample in one of its four modes, 3) recording data with a PC or uploading data from the OBS-3A, 4) importing data into a spreadsheet, 5) plotting data, and 6) turning the OBS-3A OFF.

6.3 Running HydroSci

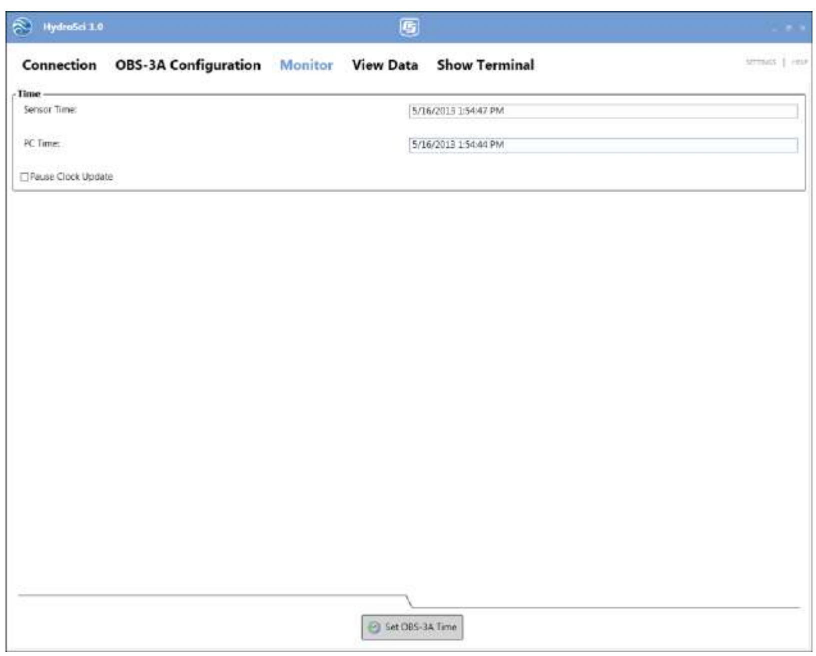
1. Select the HydroSci program to start the program.

2. Physically connect the OBS-3A to a PC with the test cable.

3. Select **OBS-3A**  on the left side of the screen and select the appropriate **COM Port** and **Baud Rate** at which to communicate. Press the **Connect** button.



4. Upon successful connection, the **Monitor** screen will appear:



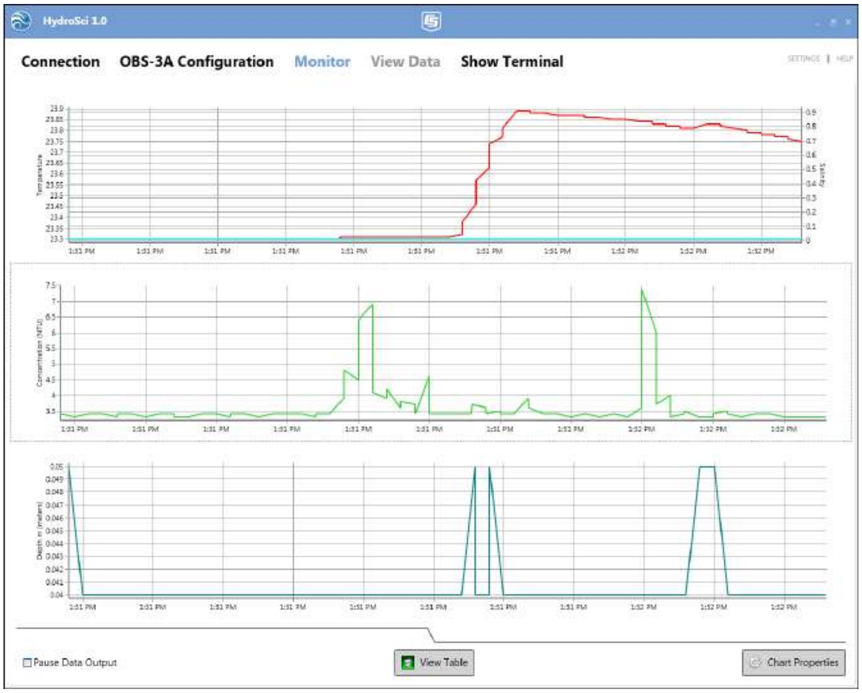
5. Synchronize the OBS-3A clock with your PC by clicking **Set OBS-3A Time.**

6. Configure your OBS-3A as desired. For more information on configuration options, see Section 6.8, *OBS-3A Configuration* *(p. 14)*.

7. After you have finished interacting with your sensor, click on the **Connection** tab and press the **Disconnect** button to disconnect from your sensor.

6.4 Testing Sensors

Before daily operations and deployments, verify the instrument works by pressing **Survey Configuration** and **Start Survey**. Then press **Monitor** to see the plot.



Blow on the temperature sensor to observe an increase in temperature (red trace line on the top plot).

Dip the sensor in salty water and conductivity will increase (aqua trace line on the top plot).

Wave your hand in from of the OBS sensor; the turbidity signal will fluctuate and data will scroll (green trace line on the middle plot).

Blow into the pressure sensor and a small elevation in the pressure signal will occur (blue trace line on bottom plot).

Click on **OBS-3A Configurations | Information** to view *Sampling, Serial Numbers, Calibration Dates, and Firmware.*

6.5 Water-Density and Barometric Corrections

Since depths are estimated from pressure measurements, it is important to set the water temperature and salinity so the OBS-3A can correct for water density and calculate depth in meters or feet (this will not affect temperature or salinity measurements). Also, the sensor measures absolute pressure so another correction must be made for barometric pressure. **Be sure to do this while the OBS-3A is at the surface.** Doing so when the instrument is submerged will result in large errors in the depth measurement. The error will be approximately equal to the instrument depth when the correction is made. Depending on the magnitude of barometric pressure fluctuations at the sampling site and the desired accuracy, you may want to correct data for atmospheric effects using barometric pressure simultaneously recorded at a nearby site.

6.6 Menus

HydroSci has five tabs: **Connection**, **OBS-3A Configuration**, **Monitor**, **View Data**, and **Show Terminal**.

Connection menu is used for connecting and disconnecting the sensor, as mentioned above.

OBS-3A Configuration tab allows you to view information about your sensor, perform operations, or set up your OBS-3A in a survey, cyclic, scheduled, or setpoint configuration. Further detail will be discussed below.

The **Monitor** screen can be used to monitor the current survey data. You can choose to view data in a graphical format or a tabular format.

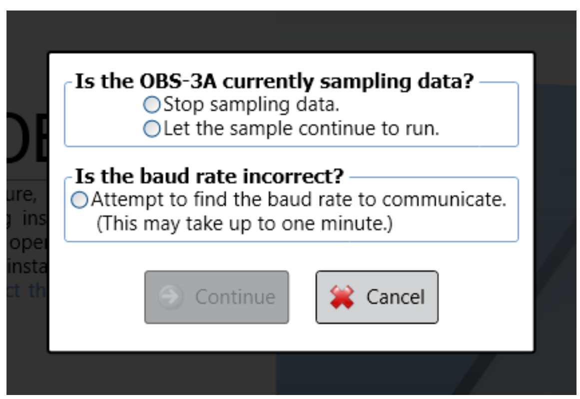
The **View Data** tab can be used to view data stored on the OBS-3A from cyclic, scheduled, and setpoint surveys. (When running in survey configuration, data is not stored to the OBS-3A.)

Show Terminal tab brings up a terminal screen that allows you to view the commands being sent to the OBS-3A and the responses that are returned.

6.7 Connection

The default communication settings are: 115 kbps, 8 data bits, no parity, no flow control. These settings will work for most applications and with most PCs.

If the OBS-3A does not connect this screen will appear:



If the OBS-3A is sampling, you have the option to stop the test. You can also choose to connect and allow the test to continue to run. If HydroSci cannot find an OBS-3A at the specified baud rate, you can have HydroSci try each baud rate until the OBS-3A responds.

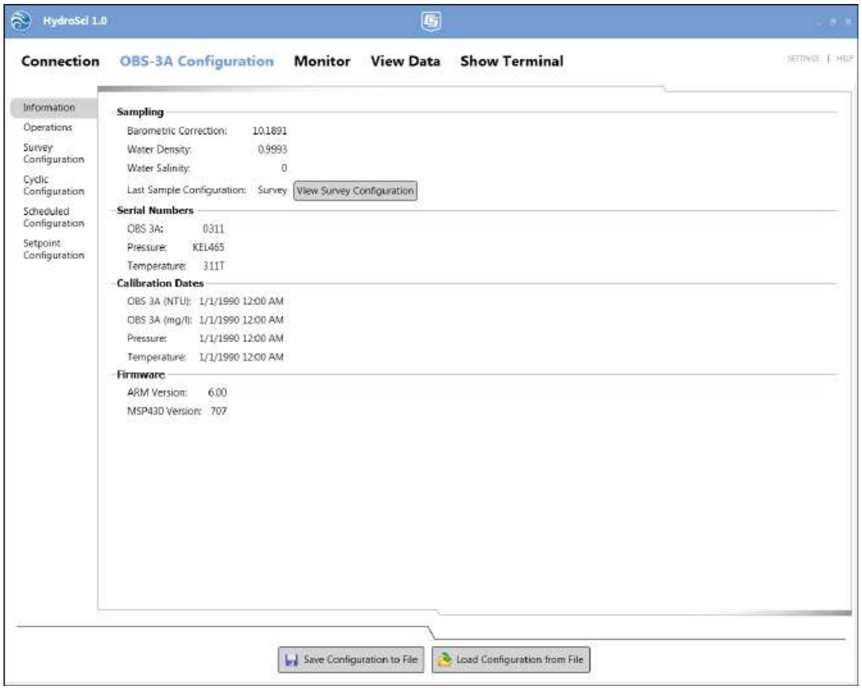
Use the radio buttons to make your selection and then press the **Continue** button.

6.8 OBS-3A Configuration

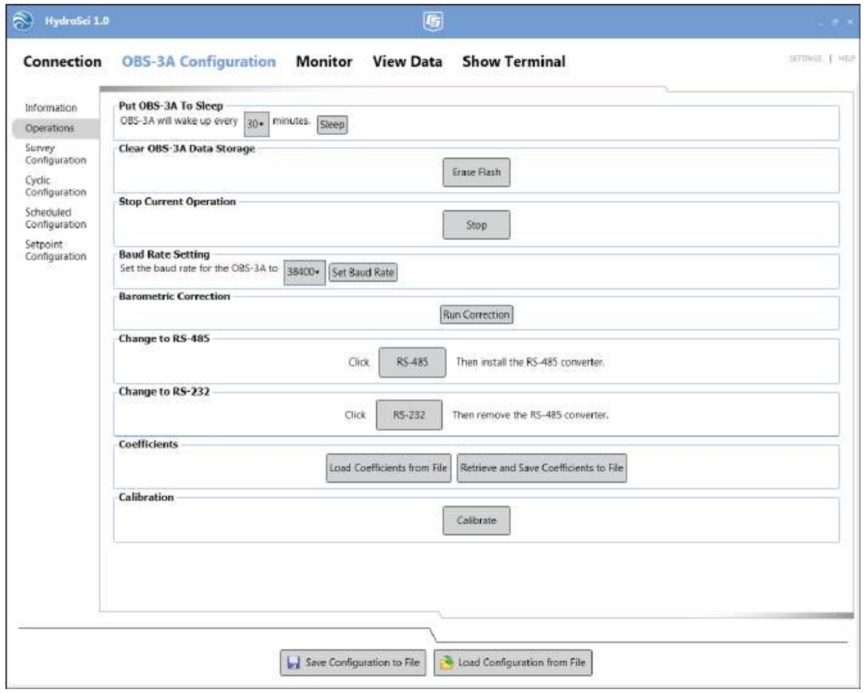
The configuration tab displays setup information, allows you to perform operations such as putting the unit to sleep or erasing the data, and allows you to set up datalogging configurations.

6.8.1 Information

Information provides you with the system information, including: **Sampling**; **Serial Numbers** for the OBS-3A, pressure sensor, and temperature sensor; **Calibration Dates**, and **Firmware**.



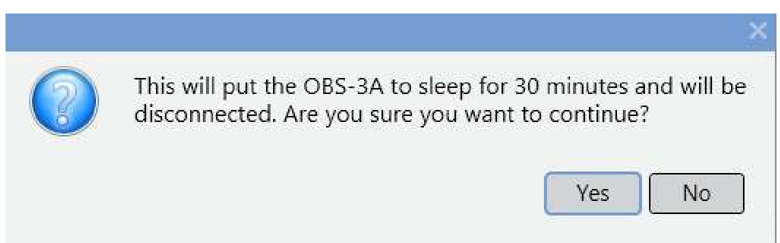
6.8.2 Operations



Put OBS-3A to Sleep

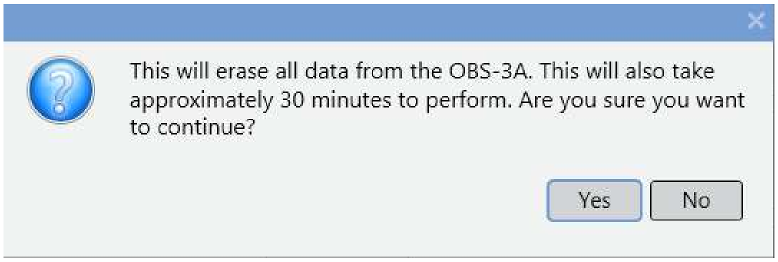
Press the **Sleep** button to put the OBS-3A in low-power, sleep mode. This should be done when the OBS-3A will not be used for an extended period of time to conserve battery capacity. Use the drop-down button to specify how often the OBS-3A will wake to check for communication.

HydroSci will confirm if you want to put the OBS-3A to sleep.



Clear OBS-3A Data Storage

Press the **Erase Flash** Button to clear all data stored in the OBS-3A. HydroSci will confirm you want to clear all the data stored.

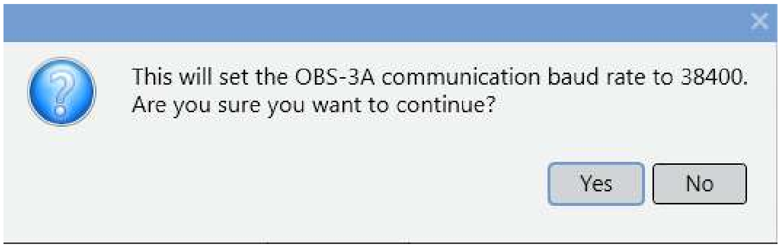


Stop Current Operation

Press the **Stop** button to end any operation currently running in the OBS-3A.

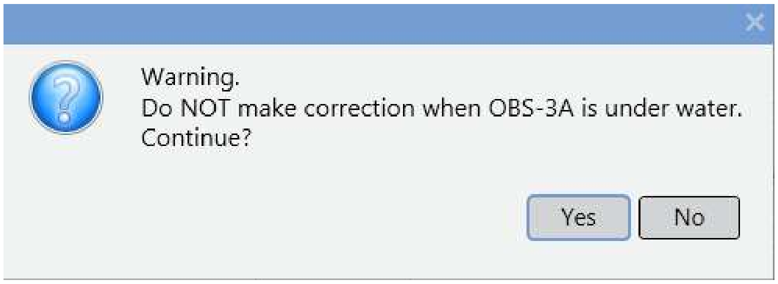
Baud Rate Setting

Specifies the baud rate at which the OBS-3A will communicate. Use the drop-down list to selct a baud rate and then press the **Set Baud Rate** button.

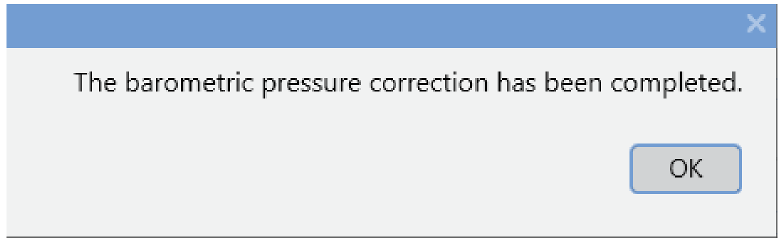


Barometric Correction

The OBS-3A measures absolute pressure so a correction must be made for barometric pressure. Press the **Run Correction** button to run a barometric pressure correction.



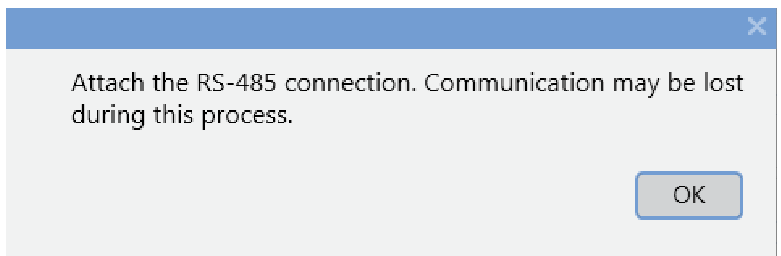
NOTE Be sure to do this while the OBS-3A is at the surface. Doing so when the instrument is submerged will result in large errors in the depth measurement.



Change to RS-485

To switch from RS-232 communication to RS-485 communication, press the **RS-485** button and install the RS-485 converter.

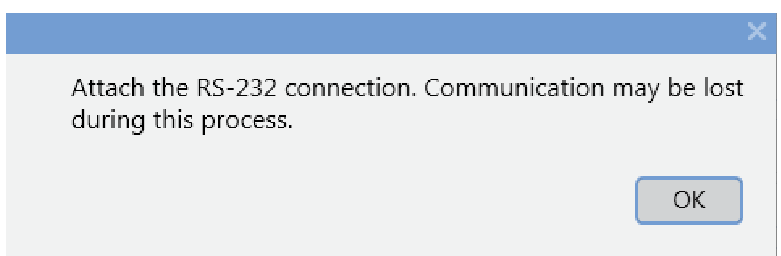
NOTE Once the button is pressed, you will no longer be able to communicate via RS-232. However, if you accidently push this button, the OBS-3A can be reset by removing and reinserting the batteries.



Change to RS-232

To switch from RS-485 communication to RS-232 communication, press the **RS-232** button and then remove the RS-485 converter.

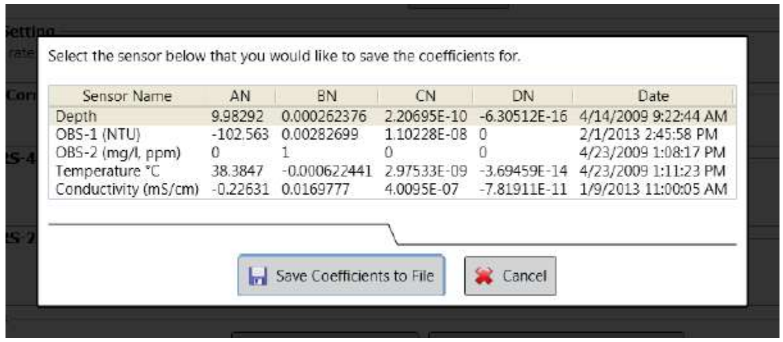
NOTE Once the button is pressed, you will no longer be able to communicate via RS-485. However, if you accidently push this button, the OBS-3A can be reset by removing and reinserting the batteries.



Coefficients

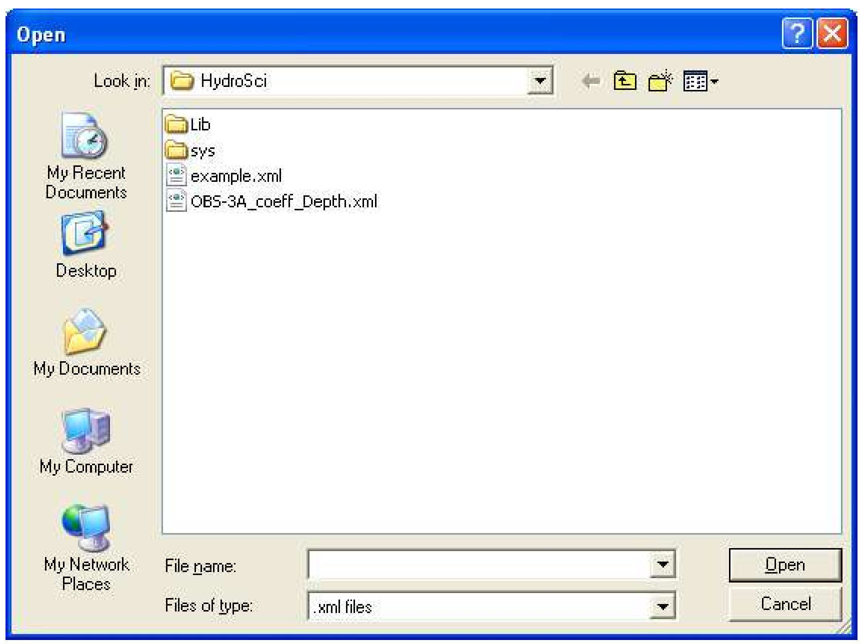
The **Coefficients** box can be used to retrieve and save the coefficients stored in the OBS-3A that are used to calculate the output values for each sensor. The saved files can be used to load the coefficients into the OBS-3A at a time later, if necessary.

Press the **Retrieve and Save Coefficients to File** button to retrieve the coefficients from the OBS-3A and save them to a file on your computer.

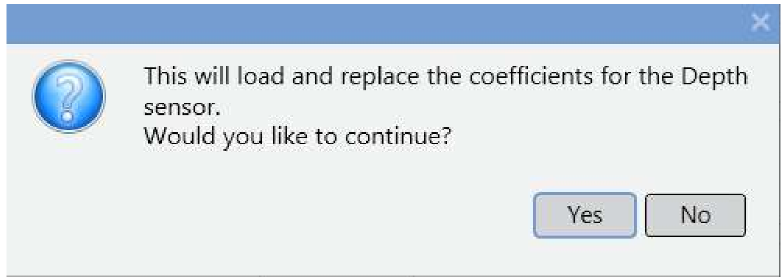


Select the desired sensor from the resulting dialog box and then press the **Save Coefficents to File** button. It is a good idea to save the coefficients for each sensor to a file.

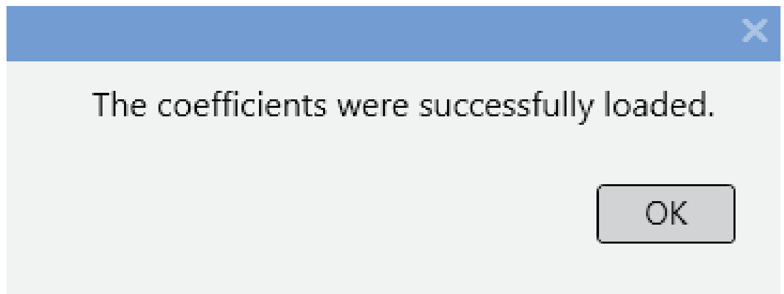
If it becomes necessary to load coefficients from a saved file, press the **Load Coefficients from File** button. Select the appropriate file from the resulting browsing window and press **Open**.



You will be asked to confirm that you really want to replace the coefficients from the corresponding sensor.



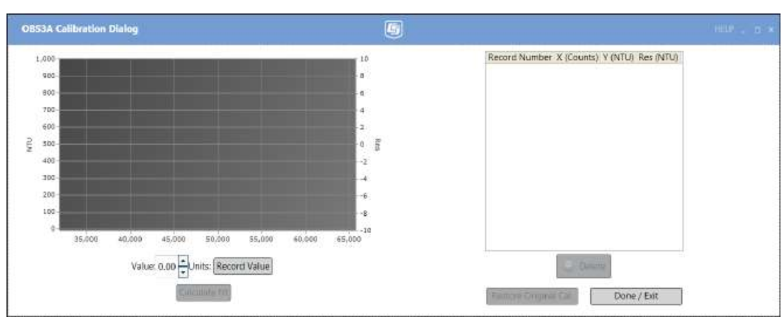
Press **Yes** and the coefficients from the file will be loaded into the OBS-3A.



Calibration

The **Calibration** box can be used to calibrate the OBS-3A for NTU or mg/L measurements. Press the **Calibrate** button. You will be asked to select NTU or mg/L.

After selecting the units, you will be taken to the calibration screen.



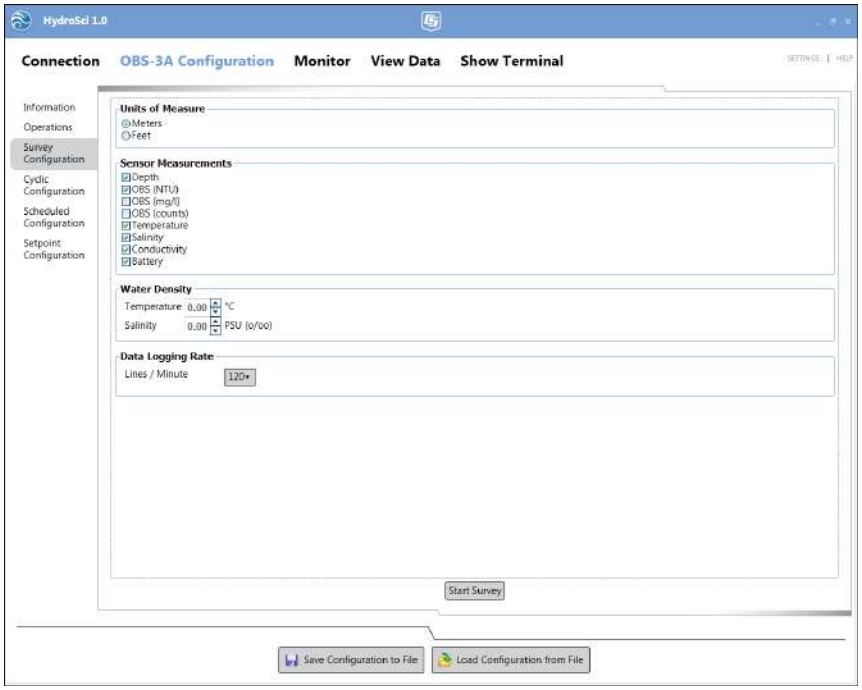
For more information on calibration, detailed procedures are found in in Section 7, *Calibration (p. 42)*.

6.8.3 Survey Configuration

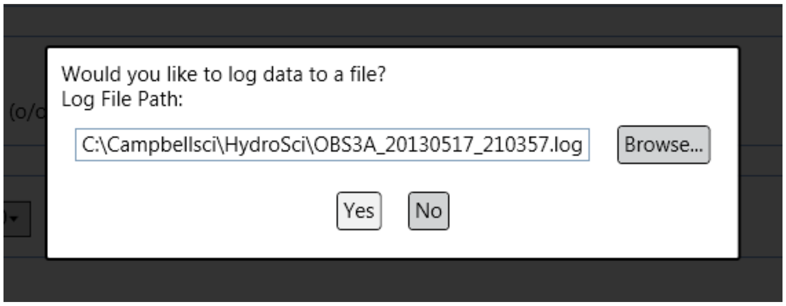
Select the **Survey Configuration** mode when operating the unit with a cable connection to a PC and when high data rates are desired.

Before setting the survey configuration, run a **Barometric Correction** from the **Options** screen. Be sure to do this while the OBS-3A is at the surface. Doing so when the instrument is submerged will result in large depth errors. See Section 6.5, *Water-Density and Barometric Corrections* *(p. 12)*, for more details.

All the parameters for a survey configuration are described below. After setting the parameters, press the **Start Survey** button to begin logging data.



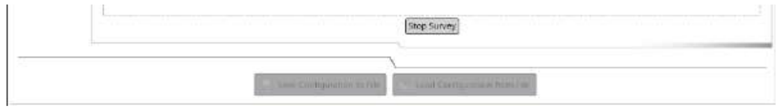
You will be asked whether or not you want to log data to a file on your computer.



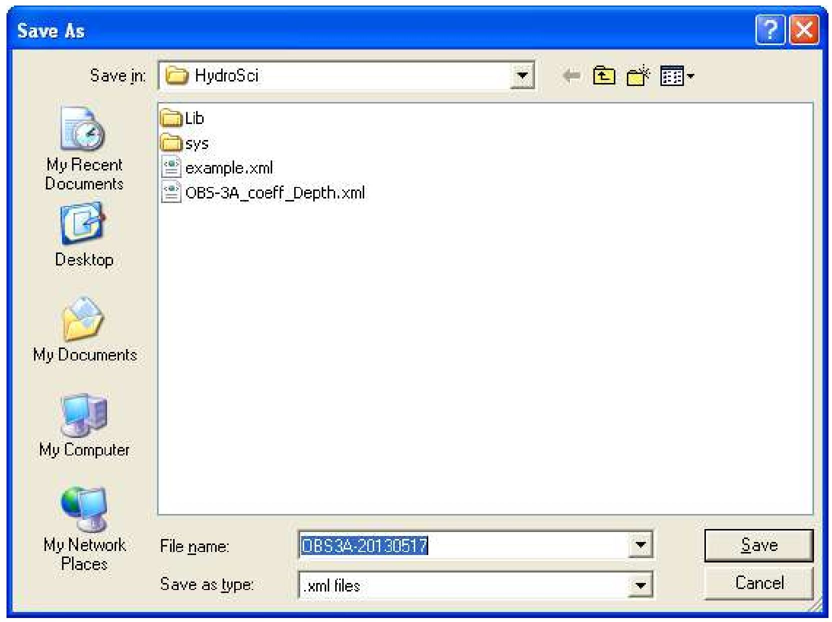
NOTE In survey mode, data is not saved to the OBS-3A. Data will not be saved if you choose not to log data to a file.

After the survey is started, you can select the **Monitor** tab to view the data.

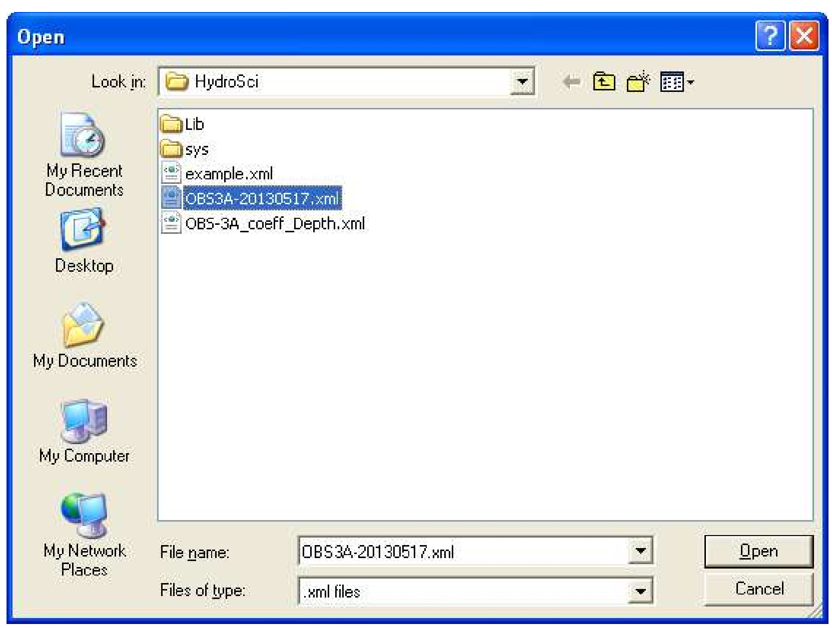
When you have finished logging data, return to the **OBS-3A Configuration** tab and press the **Stop Survey** button to stop the survey.



If desirable, save the configuration to the computer to be used at a later time by pressing **Save Configuration To File** button.



You can press the **Load Configuration From File** button to load a configuration that has previously been saved. The configuration can then be edited and/or started in the OBS-3A.



Units of Measure

Select the units for depth (Meters or Feet).

Sensor Measurements

Select the check boxes next to the sensor measurements you wish to make.

Water Density

Specify the water temperature and salinity. The specified temperature and salinity only affect the depth calculation. They do not influence temperature or salinity measurements.

Data Logging Rate

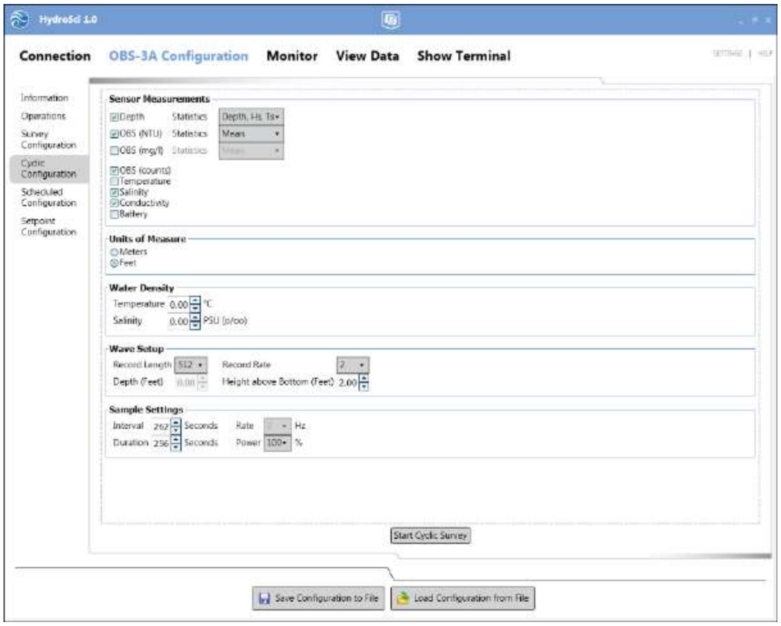
Rate is the frequency of sampling. Select 12, 30, 60, or 120 lines per minute.

6.8.4 Cyclic Configuration

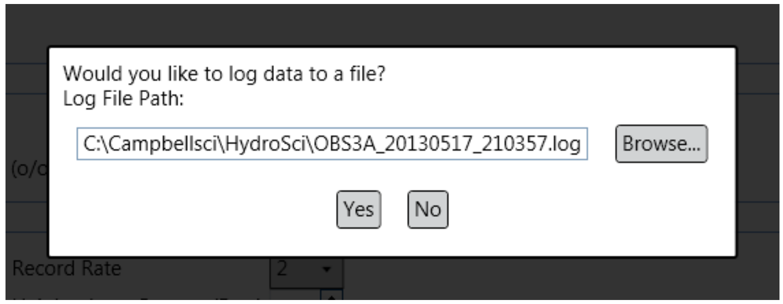
Cyclic Configuration is used to record data internally in the 8 MB, non-volatile FLASH memory at regular intervals; every 1, 5, 15, or 30 minutes. Depending on the number of sensors measured and the statistics selected, the OBS-3A can log as many as 200,000 lines of data (one per hour for 23 years) including: time, date, depth, NTUs, °C, and salinity.

Before setting the survey configuration, run a **Barometric Correction** from the **Options** screen. Be sure to do this while the OBS-3A is at the surface. Doing so when the instrument is submerged will result in large depth errors. See Section 6.5, *Water-Density and Barometric Corrections* *(p. 12)*, for more details.

All of the parameters for a cyclic configuration are described below.



You will be asked whether or not you want to log data to a file on your computer.



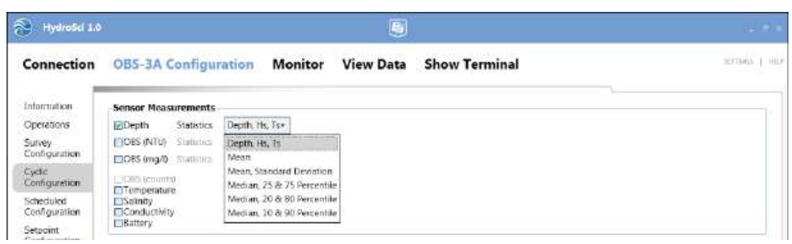
After setting the parameters, you can also press the **Save Configuration To File** button to save the configuration to be used at a later time.

You can press the **Load Configuration From File** button to load a configuration that has previously been saved. The configuration can then be edited and/or started in the OBS-3A.

After setting the parameters, press the **Start Cyclic Survey** button to begin logging data. Go to the **Connection** tab and press **Disconnect** to disconnect from the OBS-3A. Unplug the test cable. Install dummy plug and locking sleeve. The instrument is then ready for deployment.

- **Sensor Measurements**

  Select the check boxes next to the sensor measurements you wish to make. For Depth, OBS (NTU), and OBS (mg/L), use the drop-down boxes next to **Statistics** to select the desired statistics for the measurement.



- **Units of Measure**

  Select the units for depth (Meters or Feet).

- **Water Density**

  Specify the water temperature and salinity. The specified temperature and salinity only affect the depth calculation. They do not influence temperature or salinity measurements.

- **Wave Setup**

NOTE Wave Setup fields are only enabled when Depth is selected under Sensor Measurements and the Depth Statistics is set to Depth, Hs, Ts.

  - ***Record Length***

    When wave measurements are selected, this sets the time in seconds for which depth measurements are made for the wave-spectral computations.

    Use a record length of 512 seconds for inshore waters (lakes and rivers), protected bays and estuaries. For coastal waters with intermediate periods (6 to 9 seconds) use 1024 seconds. For the open ocean select a record length of 2048 seconds to record long period waves (Ts > 10 seconds).

  - ***Record Rate***

    Rate is the frequency of sampling for the duration of measurements. All sensors are sampled at the same rate, typically 2, 5, 10, or 25 times per second (Hz). For example, a rate of 25 Hz for a 60-second duration will produce a sample with 1500 measurements for each sensor.

  - ***Depth***

    This is the user's best estimate of the water depth when the OBS-3A is deployed. It is an initial value needed by the unit to compute wave heights and correct for the attenuation of dynamic pressure with depth. When depth is specified in the **Wave Setup** box, the OBS-3A automatically measures height above bottom after reaching the deployment depth.

  - ***Height Above Bottom***

    This is distance above the bottom in meters or feet where the OBS-3A will come to rest after it is deployed. It is an alternative initial value used by the unit to correct for pressure attenuation. When height above bottom is selected, depth is automatically computed once the unit has come to rest.

- **Sample Settings**

  - ***Interval***

    The time, in seconds, between the start of one sample and the beginning of the next. In cyclic mode, this is the time between samples. The interval must be longer than the duration plus some time for statistical computations. HydroSci will prompt you if too short an interval is selected.

- ***Rate***

  Rate is the frequency of sampling for the duration of measurements. All sensors are sampled at the same rate, typically 2, 5, 10, or 25 times per second (Hz). For example, a rate of 25 Hz for a 60-second duration will produce a sample with 1500 measurements for each sensor. When wave statistics are chosen, the rate must be selected in the **Wave Setup** box.

- ***Duration***

  This is the length of time in seconds that the OBS-3A is measuring its sensors. The duration must always be less than the interval. The minimum duration is five seconds and the maximum is the longer of the wave record length or the 2048 / rate.

NOTE The product of the rate and the duration cannot exceed 2048.

- ***Power***

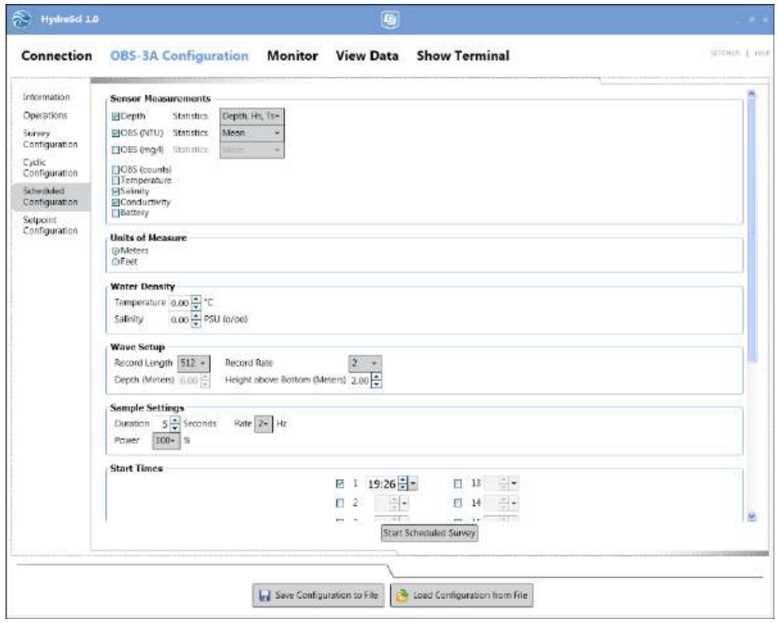
  This indicates the percentage of time over the duration of a sample that sensors are ON. Higher power levels mean larger samples, better statistics, and shorter battery life. Lower levels spare the batteries but result in more random noise in sample statistics.

6.8.5 Scheduled Configuration

Scheduled Configuration is used to sample at specific times in hours and minutes on a 24-hour clock.

Before setting the survey configuration, run a **Barometric Correction** from the **Options** screen. Be sure to do this while the OBS-3A is at the surface. Doing so when the instrument is submerged will result in large depth errors. See Section 6.5, *Water-Density and Barometric Corrections* *(p. 12)*, for more details.

All of the parameters for a scheduled configuration are described below. After setting the parameters, press the **Start Scheduled Survey** button to begin logging data.



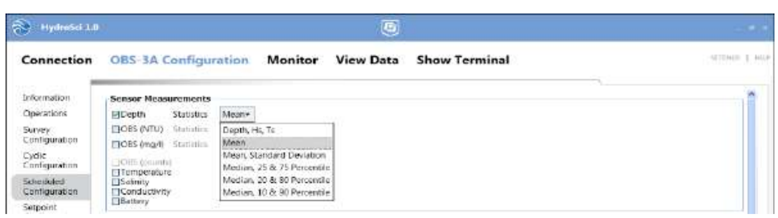
Go to the **Connection** tab and press **Disconnect** to disconnect from the OBS-3A. Unplug the test cable. Install dummy plug and locking sleeve. The instrument is then ready for deployment.

After setting the parameters, you can also press the **Save Configuration To File** button to save the configuration to be used at a later time.

You can press the **Load Configuration From File** button to load a configuration that has previously been saved. The configuration can then be edited and/or started in the OBS-3A.

- **Sensor Measurements**

  Select the check boxes next to the sensor measurements you wish to make. For Depth, OBS (NTU), and OBS (mg/L), use the drop-down boxes next to **Statistics** to select the desired statistics for the measurement.



- **Units of Measure**

  Select the units for depth (Meters or Feet).

- **Water Density**

  Specify the water temperature and salinity. The specified temperature and salinity only affect the depth calculation. They do not influence temperature or salinity measurements.

- **Wave Setup**

NOTE Wave Setup fields are only enabled when Depth is selected under Sensor Measurements and the Depth Statistics is set to Depth, Hs, Ts.

  - ***Record Length***

    When wave measurements are selected, this sets the time in seconds for which depth measurements are made for the wave-spectral computations.

    Use a record length of 512 seconds for inshore waters (lakes and rivers), protected bays and estuaries. For coastal waters with intermediate periods (6 to 9 seconds) use 1024 seconds. For the open ocean select a record length of 2048 seconds to record long period waves (Ts > 10 seconds).

  - ***Record Rate***

    Rate is the frequency of sampling for the duration of measurements. All sensors are sampled at the same rate, typically 2, 5, 10, or 25 times per second (Hz). For example, a rate of 25 Hz for a 60-second duration will produce a sample with 1500 measurements for each sensor.

  - ***Depth***

    This is the user's best estimate of the water depth when the OBS-3A is deployed. It is an initial value needed by the unit to compute wave heights and correct for the attenuation of dynamic pressure with depth. When depth is specified in the Wave Setup box, the OBS-3A automatically measures height above bottom after reaching the deployment depth.

  - ***Height Above Bottom***

    This is distance above the bottom in meters or feet where the OBS-3A will come to rest after it is deployed. It is an alternative initial value used by the unit to correct for pressure attenuation. When height above bottom is selected, depth is automatically computed once the unit has come to rest.

- **Sample Settings**
  - ***Duration***

    This is the length of time in seconds that the OBS-3A is measuring its sensors. The duration must always be less than the interval. The minimum duration is five seconds and the maximum is the longer of the wave record length or the 2048 / rate.

NOTE The product of the rate and the duration cannot exceed 2048.

  - ***Rate***

    Rate is the frequency of sampling for the duration of measurements. All sensors are sampled at the same rate, typically 2, 5, 10, or 25 times per second (Hz). For example, a rate of 25 Hz for a 60-second duration will produce a sample with 1500 measurements for each sensor. When wave statistics are chosen, the rate must be selected in the Wave Setup box.

  - ***Power***

    This indicates the percentage of time over the duration of a sample that sensors are ON. Higher power levels mean larger samples, better statistics, and shorter battery life. Lower levels spare the batteries but result in more random noise in sample statistics.

- **Start Times**

  This block is used to set up the sampling schedule. You can manually set up to 24 times in each 24 hour period to perform a sample. Select the check box for each sample time that you wish to set. The time field will then be enabled. Use the drop-down box to select the hour of the day at which to take the sample. Click on the minutes field and either use the arrow keys to set the minutes or type in a number directly.

  The buttons at the bottom can be used to simplify creating a schedule:

  Clear All – Clears all of the check boxes, but leaves the time fields as is so that the same times can be easily selected again.

  Select All – Selects all of the check boxes.

  Clear Times – Clears all of the check boxes and time fields.

  Hourly – Automatically sets the sampling schedule to the top of every hour.

  2 Hourly – Automatically sets the sampling schedule to every other hour.

  AM – Automatically sets the sampling schedule to every 30 minutes starting at midnight and ending at 11:30 a.m.

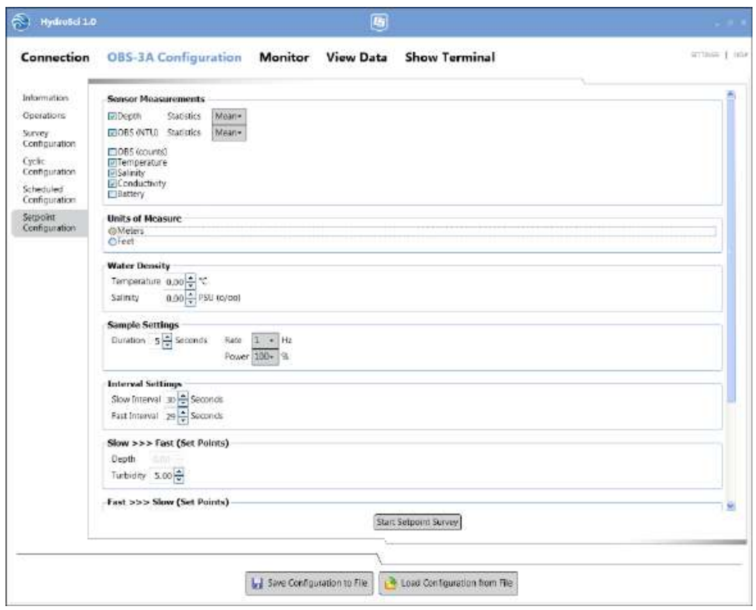
  PM – Automatically sets the sampling schedule to every 30 minutes starting at noon and ending at 11:30 p.m.

6.8.6 Setpoint Configuration

Setpoint Configuration mode is used for fast sampling of events such as storms, floods, dredging operations, and construction activities. The unit will revert to slow recording between events. Sample events two to five times faster than the rate chosen for the periods between events. For example, program the OBS-3A to sample slowly for a duration of 30 seconds every 900 seconds (15 minutes), and to sample at a fast rate every 180 seconds (three minutes), when the turbidity level exceeds a specified setpoint.

Before setting the survey configuration, run a **Barometric Correction** from the **Options** screen. Be sure to do this while the OBS-3A is at the surface. Doing so when the instrument is submerged will result in large depth errors. See Section 6.5, *Water-Density and Barometric Corrections* *(p. 12)*, for more details.

All of the parameters for a setpoint configuration are described below. After setting the parameters, press the **Start Setpoint Survey** button to begin logging data.



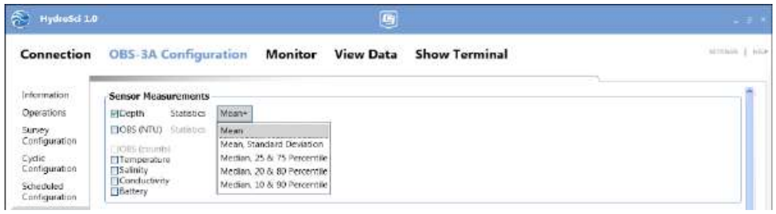
Go to the **Connection** tab and press **Disconnect** to disconnect from the OBS-3A. Unplug the test cable. Install dummy plug and locking sleeve. The instrument is then ready for deployment.

After setting the parameters, you can also press the **Save Configuration To File** button to save the configuration to be used at a later time.

You can press the **Load Configuration From File** button to load a configuration that has previously been saved. Then configuration can then be edited and/or started in the OBS-3A.

- **Sensor Measurements**

  Select the check boxes next to the sensor measurements you wish to make. For Depth and OBS (NTU) use the drop-down boxes next to **Statistics** to select the desired statistics for the measurement.



- **Units of Measure**

  Select the units for depth (Meters or Feet).

- **Water Density**

  Specify the water temperature and salinity. The specified temperature and salinity only affect the depth calculation. They do not influence temperature or salinity measurements.

- **Sample Settings**

  - ***Duration***

    This is the length of time in seconds that the OBS-3A is measuring its sensors. The duration must always be less than the interval. The minimum duration is five seconds and the maximum is 2048 / rate.

NOTE The product of the rate and the duration cannot exceed 2048.

  - ***Rate***

    Rate is the frequency of sampling for the duration of measurements. All sensors are sampled at the same rate, typically 2, 5, 10, or 25 times per second (Hz). For example, a rate of 25 Hz for a 60-second duration will produce a sample with 1500 measurements for each sensor.

  - ***Power***

    This indicates the percentage of time over the duration of a sample that sensors are ON. Higher power levels mean larger samples, better statistics, and shorter battery life. Lower levels spare the batteries but result in more random noise in sample statistics.

- **Interval Settings**

    - ***Slow Interval***

      The time, in seconds, between the start of one sample and the beginning of the next, when an event is not occurring. The interval must be longer than the duration plus some time for statistical computations. HydroSci will prompt you if too short an interval is selected.

    - ***Fast Interval***

      The time, in seconds, between the start of one sample and the beginning of the next, when an event is occurring. The interval must be longer than the duration plus some time for statistical computations. HydroSci will prompt you if too short an interval is selected.

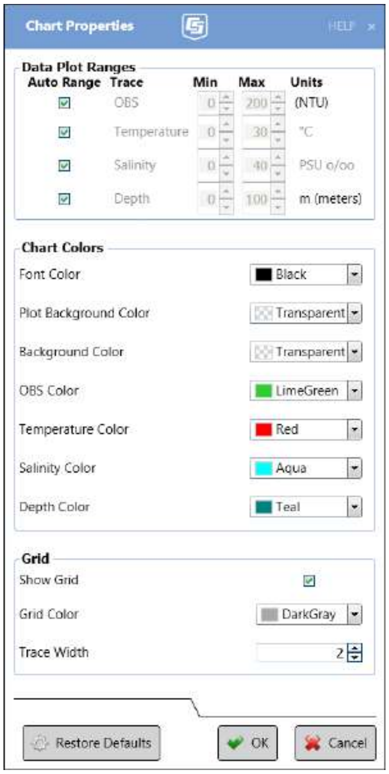
- **Switches**

  Determines when the OBS-3A will switch from slow to fast and from fast to slow logging. Use the radio buttons to select one of the logic criteria.

6.9 Monitor

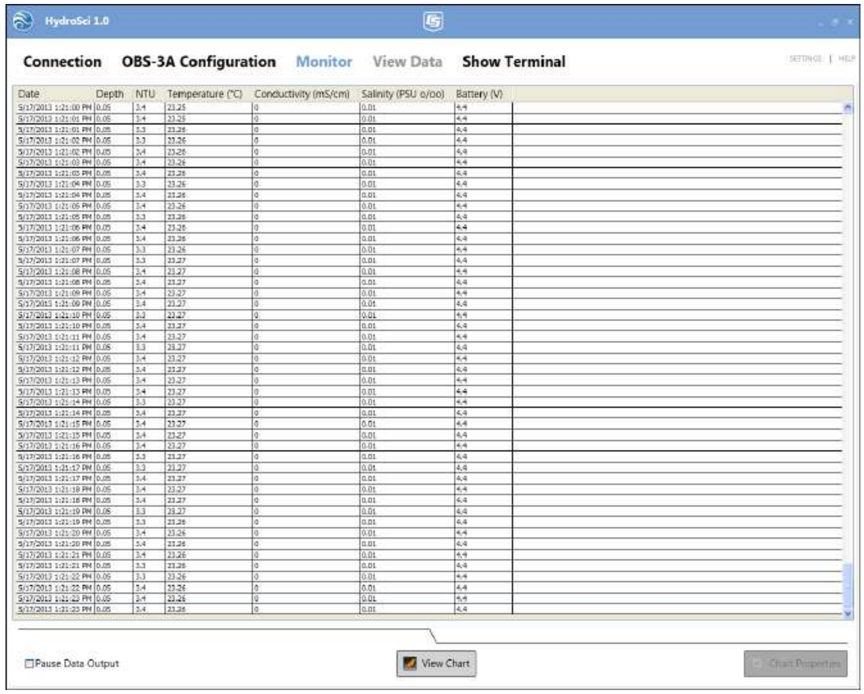
The **Monitor** screen can be used to monitor the current survey data. You can choose to view data in a graphical format or a tabular format. Use the **View Chart/View Table** button at the bottom of the screen to toggle between these two formats.

Temperature, Salinity, Concentration, and Depth are shown on the charts. Only the sensor measurements that were chosen in the configuration will be shown. (Temperature and Salinity are shown as different traces on the same chart. The temperature scale is on the left axis, and the salinity scale is on the right axis.) You can change chart properties by pressing the **Chart Properties** button.

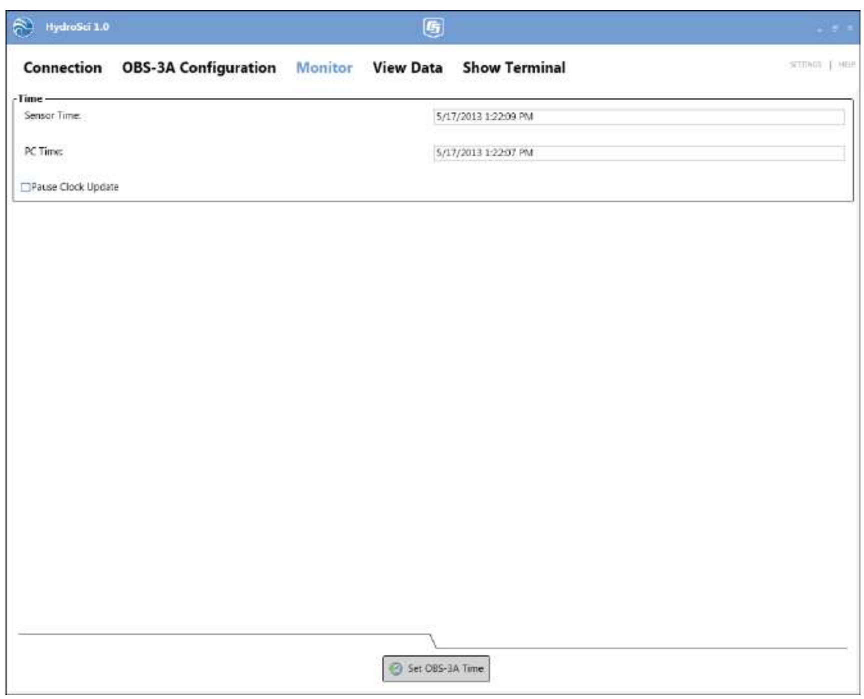


Hold the right mouse button and use the mouse to pan through the data. Zoom in on a graph by holding the left mouse button and dragging the mouse from top-left to bottom-right over the area to be zoomed. Undo the zoom by holding the left mouse button and dragging the mouse from bottom-right to top-left. Select the **Pause Data Output** check box to temporarily pause the charts from updating.

All sensor measurements selected in the configuration will be shown in the table view. Use the scroll bar to scroll through the data. Select the **Pause Data Output** check box to temporarily pause the table from updating.



If a survey is not currently running, the **Monitor** screen shows the current Sensor Time and PC Time. Press the **Set OBS-3A Time** button to set the OBS-3A time to the current PC time. Select the **Pause Clock Update** check box to disable the clock updates.



6.10 View Data

The **View Data** screen can be used to view data stored on the OBS-3A from cyclic, scheduled and setpoint surveys. (When running in survey configuration, data is not stored to the OBS-3A.)

All of the available files will be shown in the **List of Data Files**. Click on a file in the list to have its contents displayed in **Data File Contents**.

Use the radio buttons to choose whether to view the data file contents in CSI TOA5 Data Format or OBS Data Format.

TOA5 – Data is stored in a comma separated format. Header information for each of the columns is included, along with units of measure and output processing used.

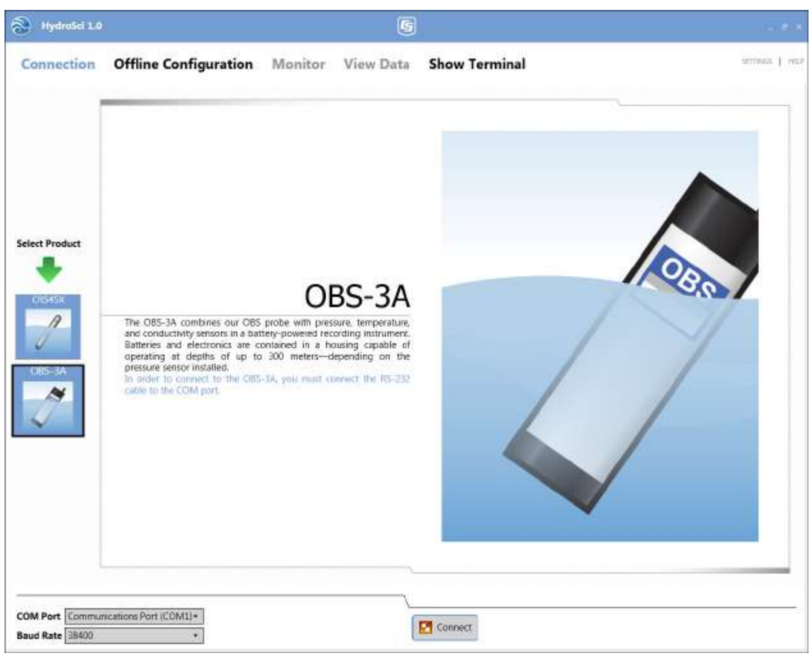
OBS – Data is stored separated by spaces. Header information includes the OBS-3A serial number and firmware version, and the data columns contained in the file.

Press the **Save Data File** to save the data file contents to a file on your computer in the format chosen by the radio buttons. Press the **View Data File** button to view the data file contents in **View**. In **View**, you can choose to graph the data, if desired.

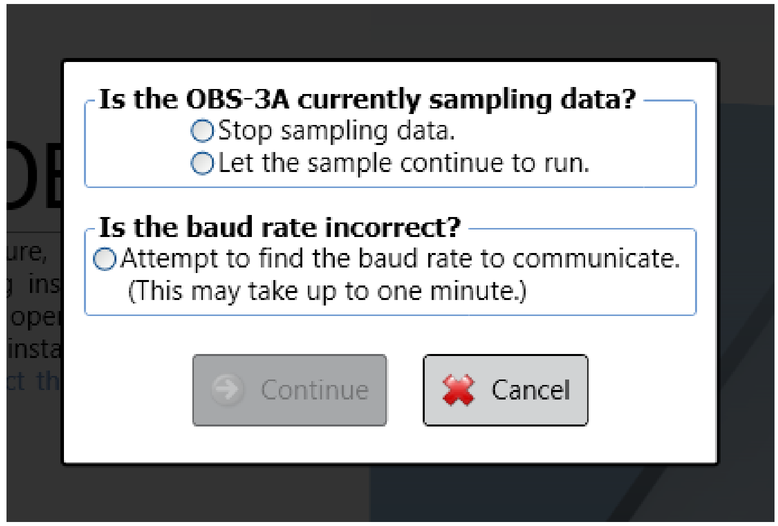
6.10.1 Data Retrieval

1. Remove dummy plug and connect OBS-3A to PC with test cable.

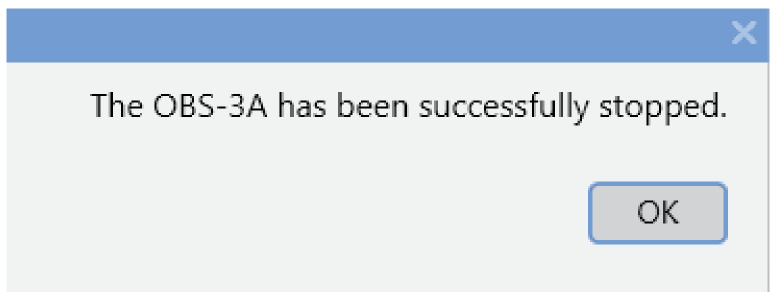
2. Run the **HydroSci Program** and connect to OBS-3A.



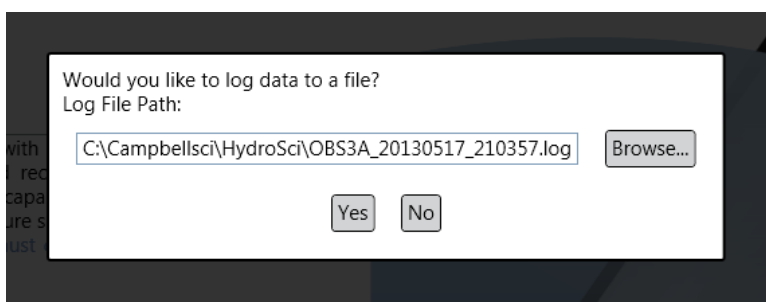
3. A screen asking if the OBS-3A is currently sampling will appear. If you are ready to stop sampling, select radio button **Stop sampling data**. If you are not ready to stop, select **Let the sample continue to run**.



If you selected **Stop sampling data**, a screen will appear saying **The OBS-3A has been successfully stopped**. Press **OK**.



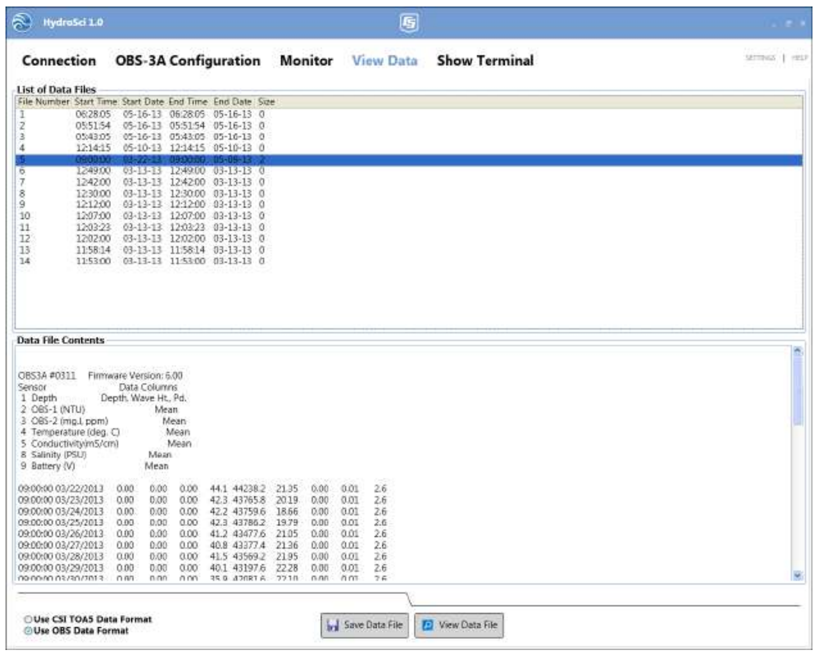
Otherwise, **Let the sample continue to run** will ask you if you would like to log data to a file? Select **Yes** or **No**.



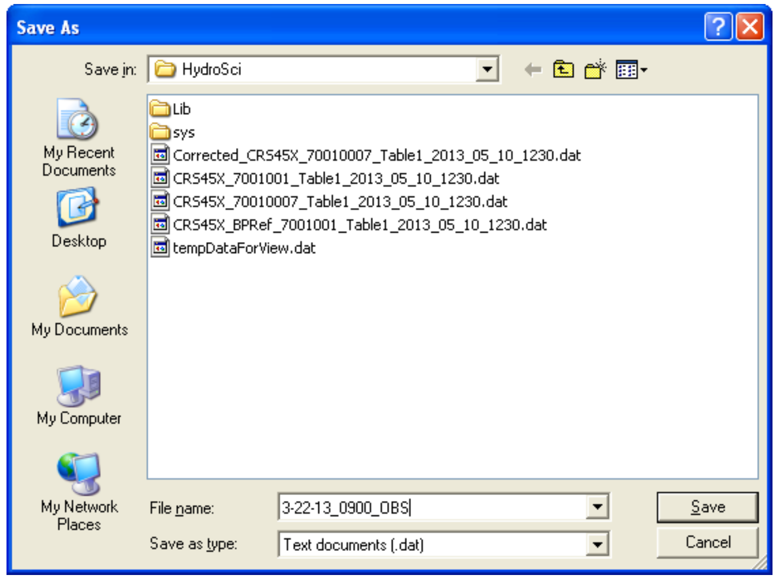
When you are ready to stop, go to **OBS-3A Configuration | Operations** press **Stop** under **Stop Current Operation** to end data collection.

4. Go to **View Data** to save data in a file.

5. Highlight the data with the start and end times you want. The **Data File Contents** shows a preview of the data you have selected. You can also click **View Data File** to view the complete data file.



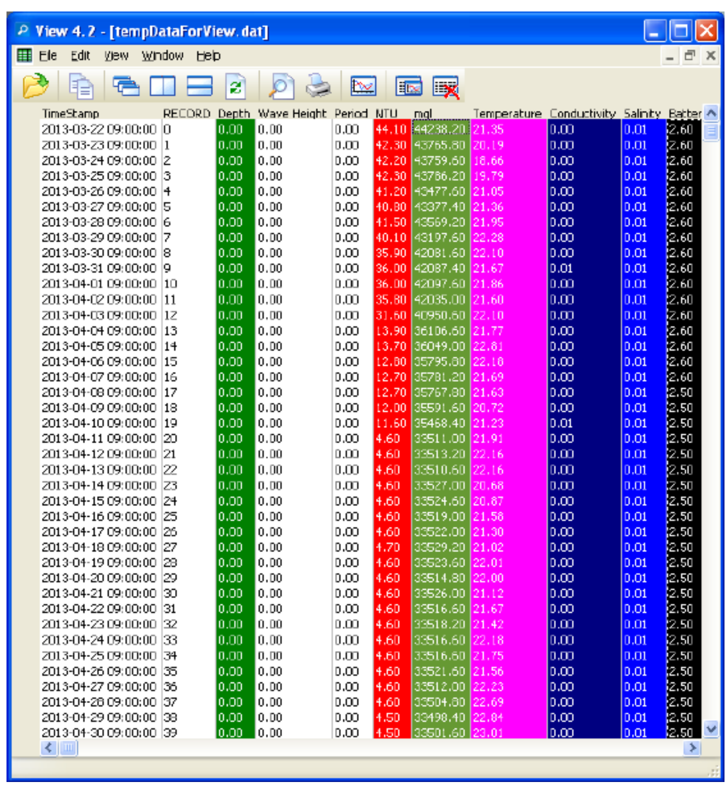
6. Once the correct data is selected, press **Save Data File**. The **Save As** screen will appear, name your file and press **Save**.



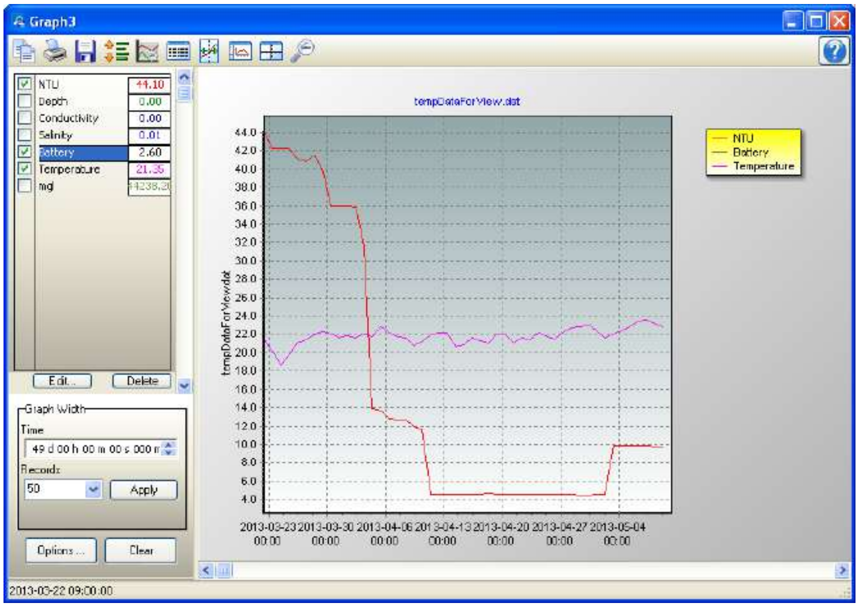
When viewing data within **View** you have the ability to view, graph and print the data from the file.

6.10.2 Graphing and Printing

To graph the data, select which columns you wish to display. They will be highlighted when selected.

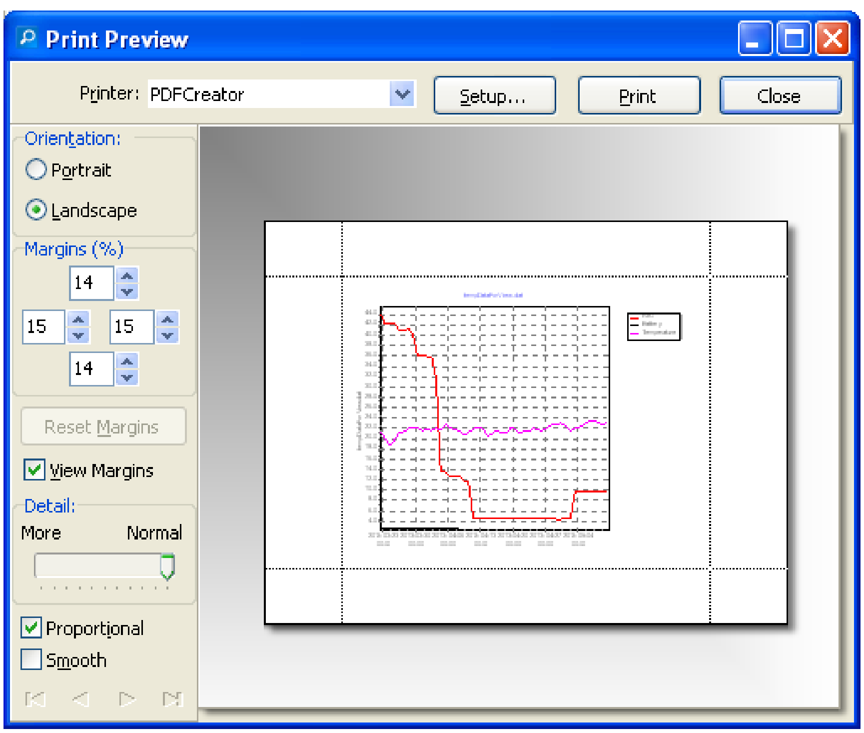


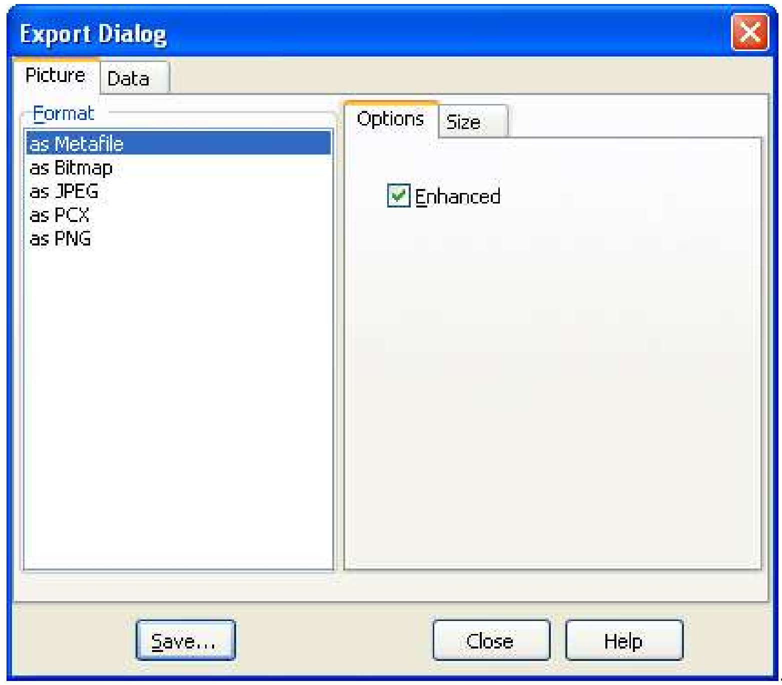
Then press the **New Line Graph**  button and a new screen will appear with various graphing options.



Categories can be selected and unselected to appear in the graph. **Graph Width** allows you to select the period the graph is showing and adjust how many data points show at once.

Printing  and **Export**ing  are done through pressing their respective buttons.

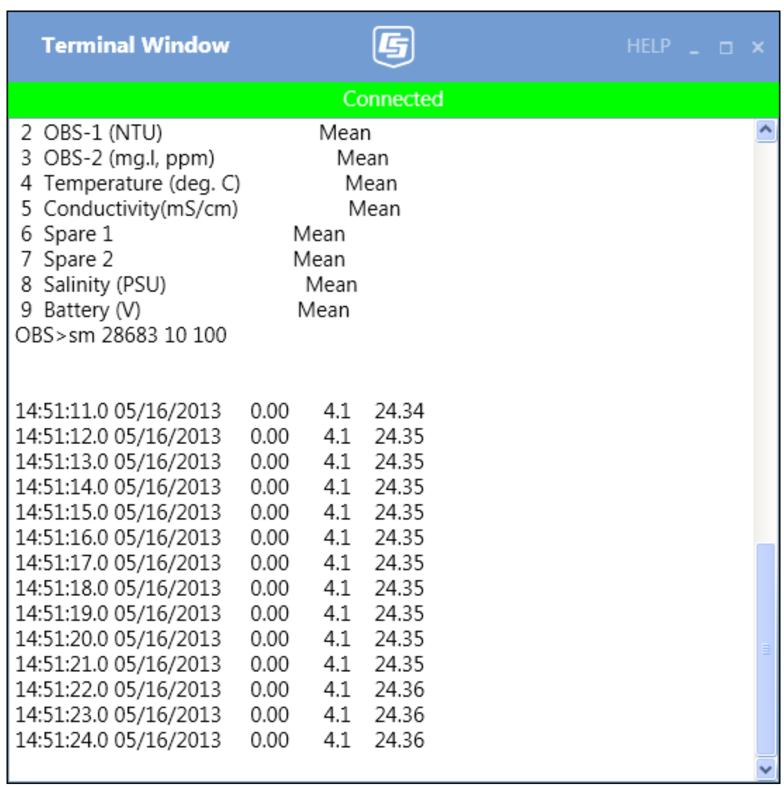




The spreadsheet of data can also be printed.

6.11 Show Terminal

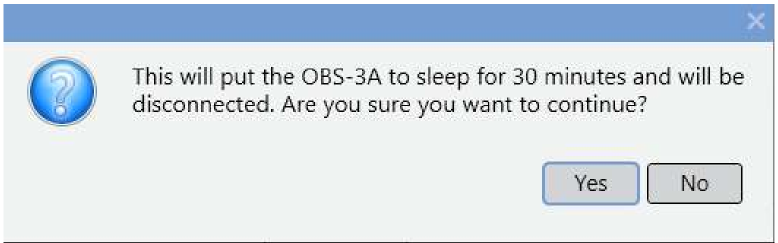
The **Show Terminal** tab brings up a terminal screen that allows you to view the commands being sent to the OBS-3A and the responses that are returned.



6.12 Shutdown

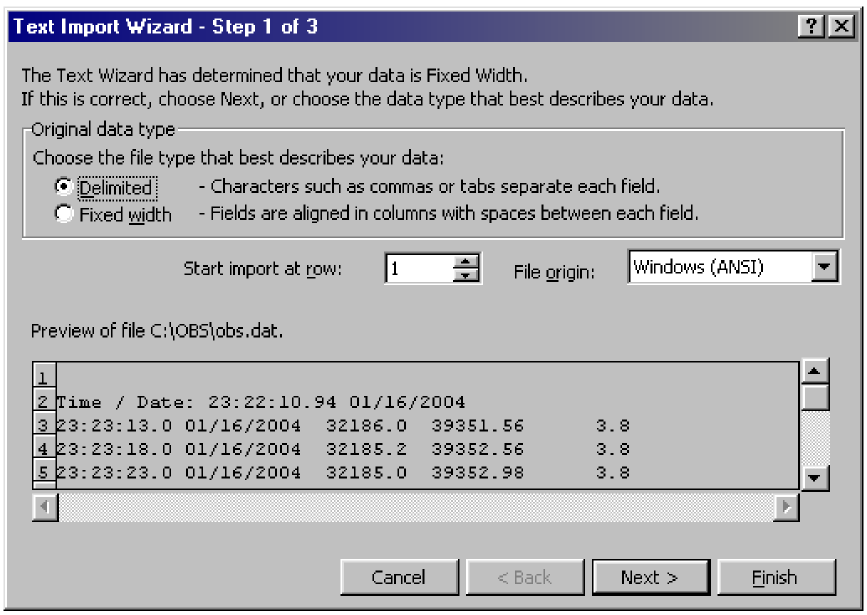
From the **OBS-3A Configuration | Operations** tab, select **Put OBS-3A To Sleep**.

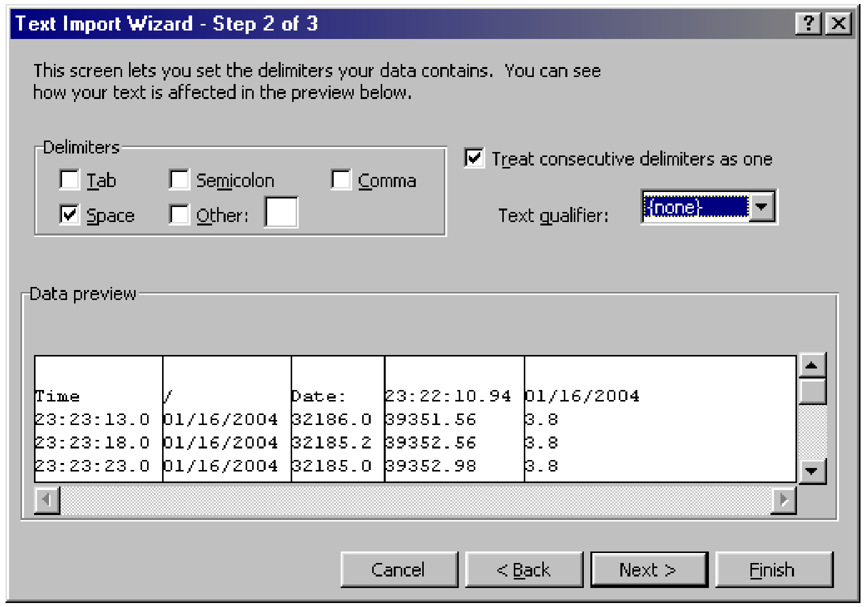
It will ask you to confirm your request. Press **Yes** and the OBS-3A will disconnect from HydroSci. You are then able to unplug your sensor.

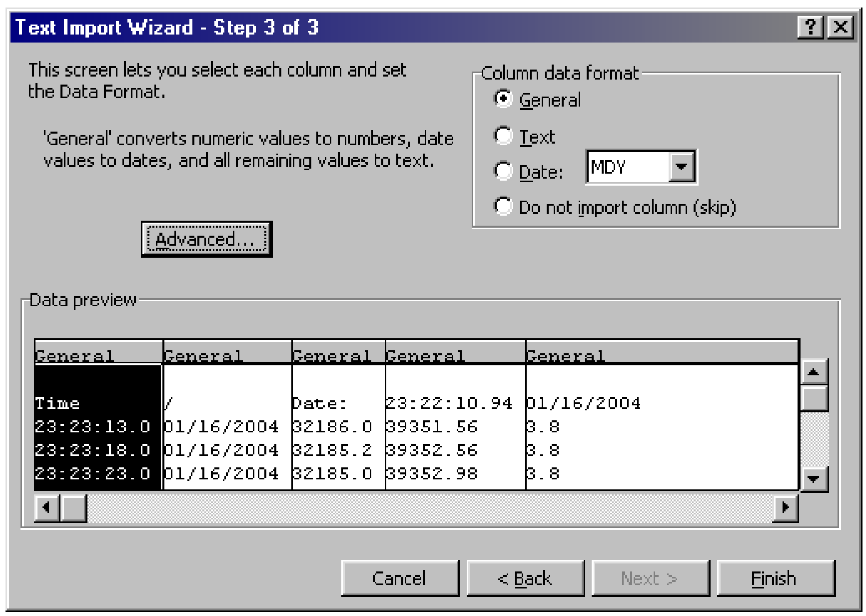


6.13 Excel Spreadsheets

To make an Excel spreadsheet from OBS-3A data, start Excel and set file type to **All**. Open a data file and select **Delimited** in Step 1 of 3 of the Text Import Wizard. Click **Next >** and select the delimiter **Space**; **Treat consecutive delimiters as one**; and {none} for **Text qualifier**. In Step 3 of 3, select the **General Column data format** and click **Finish**.

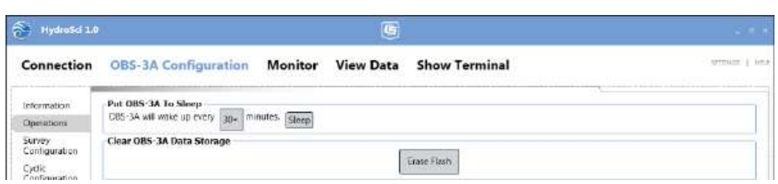




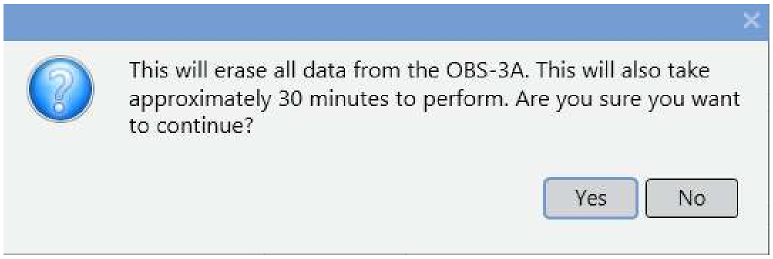


6.14 Erasing Memory Data

To erase the memory data on the OBS-3A, go to **OBS-3A Configuration | Operations | Clear OBS-3A Data Storage | Erase Flash**.



It will have you confirm that you wish to erase all the data from the OBS-3A. By following this procedure, data in the Flash memory is erased, so **be careful!**



7. Calibration

It is a good idea to use the **Retrieve and Save Coefficients to File** button (under **Operations** on the **OBS-3A Configuration** screen) to save the original coefficients before performing a calibration.

7.1 Turbidity

This section briefly describes the materials and equipment you will need and the basic procedures for calibrating OBS sensors with AMCO Clear and sediment. All sensors are factory calibrated with AMCO Clear and include a calibration certificate expressed in NTUs. AMCO Clear is available from GFS Chemicals Inc. (800-858-9682; *www.gfschemicals.com*). It is approximately three times more expensive than formazin per NTU-liter, however: 1) it is guaranteed to be stable for one year and has <1% initial lot-to-lot accuracy; 2) AMCO particles are small and uniform in size and shape (0.31 ±0.1 µm versus 1.3 ±0.6 µm for formazin); and 3) it does not flocculate or settle so stirring is not required. AMCO Clear must be made specifically for the OBS sensor.

Formazin can be purchased from the Hach Company (800-227-4224; *www.hach.com*); request the certificate of analysis when ordering it. Hach also supplies premixed, StablCal which is like formazin except that it can be stored for two years while maintaining ±5% of its nominal NTU value.

We strongly advise that the same turbidity standard be used throughout a study; do not switch between AMCO and formazin standards. Also, AMCO is premixed by the manufacturer and must be used in the container it was shipped in.

Turbidity calibration is organized into steps for Preparation; recording values with OBS-3A Utility; and Production of Standards. After completing the preparations and starting HydroSci software, you must alternate between the HydroSci and standard-production procedures.

7.1.1 Equipment and Materials

- 4000 NTU AMCO Clear, StablCal, or formazin
- 4 inch and 6 inch diameter black polyethylene containers. Concrete sample containers (Cat. # TC-4, Deslauriers Inc., 800-743-4106; *www.deslinc.com*) work well for this.
- 2 L, Class A volumetric flask

- 100 ml to deliver (TD) volumetric pipette
- 25 ml TD measuring pipette
- 2 gallons filtered distilled water (purified water from the super market works fine)
- Slotted stainless steel stirring spoon

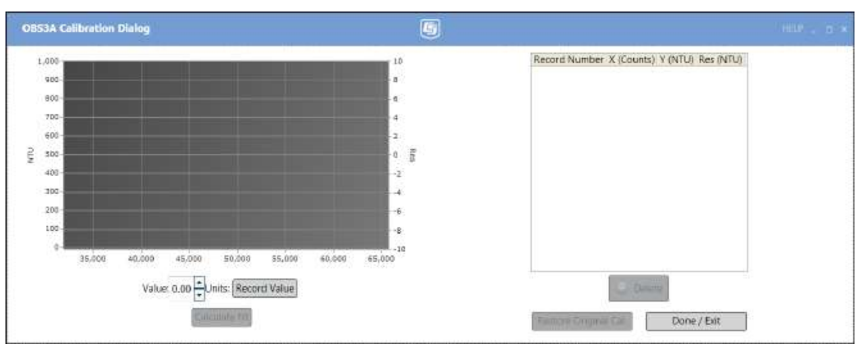
7.1.2 Preparation

1. Experience has shown that only three calibration points are needed to get sub-1% accuracy. It is recommended to do one for clean filtered water, a midrange value (125, 250, 500 or 1000 NTU) and one at the high end of the desired measurement range (250, 500, 1000, or 2000 NTU).
2. Scrub the sensor, container, spoon, and glassware with detergent and water and rinse everything twice with filtered water.
3. To avoid interference from incandescent and solar IR, perform calibrations under fluorescent lighting and make field checks in the shade.
4. Start the OBS-3A Utility Software and wake the OBS-3A.

7.1.3 HydroSci Software Steps

Open the calibration dialog box under **OBS-3A Configuation | Operations | Calibration** and click the **Calibrate** button. Choose the units of calibration you would like to use: **NTU** or **mg/L** and then select **OK**. Follow the instructions to place the OBS-3A in a turbidity standard.

WARNING **You cannot change the OBS-3A calibration after exiting the calibration dialog box.**



1. Place the OBS-3A in a turbidity standard for NTU calibration or sediment standard for mg/L calibration.
2. Enter the standard value in the **Value** box of the calibration screen and press the **Record Value** button. After the sample has been logged, the plot and table of calibration data will be updated. Verify that the calibration value is what you intended it to be. If it is not correct, select the value in the table and press **Delete**.

3. Prepare the next NTU standard and put the OBS-3A in it. Repeat steps 1 and 2 for all calibration values.

4. After all calibration values have been recorded, click the **Calculate Fit** button.

5. Look at the plot of residuals (blue line) which shows the differences between the standard and computed NTU values. The average residual magnitude should be less than 1% of calibration range of 2000 NTU (maximum minus minimum NTU values) should produce an average residual less than 20 NTU. Residuals higher than 1% of the calibration range indicate that errors were made in the procedure. By inspecting the plot of residuals, you can decide which values to repeat or delete. Repeat values using the procedures described above.

6. Once satisfied with the calibration, click the **Calculate Fit** button and make a final quality check.

7. Use the **Done/Exit** button to keep the new calibration and leave the Calibration screen. Press the **Restore Original Cal** button to restore the original calibration and leave the calibration screen. This restores the calibration before you entered the Calibration screen. There is no way to restore the original factory calibration.

WARNING **Once you leave the Calibration screen, you will not be able to restore the original calibration.**

7.1.4 Making Turbidity Standards

1. For the zero NTU calibration point you will need a black 20 x 14 x 16 in. container filled with clean tap water. A Rubbermaid® plastic storage box makes a suitable container.

2. For calibrations from 50-250 NTU use a 6 in. diameter container with 2 liters of filtered water or a premixed standard. Hold the sensor in the container so the beam looks down and across the diameter to prevent the beam from reflecting off the wall.

3. A 4 in. diameter container can be used for solutions of $\geq$250 NTUs. Add one liter of filtered water and the necessary amount of formazin. See TABLE 7-1 or the formula below for the preparation of standards.

4. Stir the formazin solution with the spoon and position the OBS-3A in the standard.

5. Go to Step 2 of HydroSci Software Steps (Section 7.1.3, *HydroSci Software Steps* (p. 43)).

The formula for preparing turbidity standards other than shown in TABLE 7-1 is:

$$T_{std} = T_{stk}\left[\frac{V_{stk}}{V_{dw} + V_{stk}}\right] \qquad \text{or} \qquad V_{stk} = \left[\frac{T_{std} \times V_{dw}}{T_{stk} - T_{std}}\right]$$

Where:

T_{std} = Turbidity of the standard solution;

T_{stk} = Turbidity of the stock solution, usually 4000 NTU;

V_{stk} = Cumulative volume of stock solution at each calibration point;

V_{dw} = Initial volume.

TABLE 7-1. Mixing Volumes for Formazin Standards

Formazin Volume V_{stk} (ml)	**Solution Turbidity** T_{std} (NTU)
12.7	50
32.3	125
66.7	250
143	500
333	1000
1000	2000

7.2 Sediment

The procedure for sediment calibration is more involved than for turbidity. For a modest charge we will pre-calibrate OBS sensors with sediment provided by users. Call us for a quotation to perform this service.

CAUTION The most common cause of errors in OBS data is improper calibration.

Before proceeding with a sediment calibration, review Section 10, *Factors Affecting OBS Response* *(p. 55)*, to learn about factors that can influence the quality of your results. The most difficult part of the procedure is maintaining a stable sediment concentration while the OBS logs calibration values. This is straightforward when the material is dry, completely disaggregated mud with particles smaller than ~20 µm. It becomes more difficult the larger the sediment gets and special calibration equipment may become necessary (see Section 11, *References* *(p. 61)*).

7.2.1 Equipment and Materials

- Dry, completely disaggregated bottom sediment or suspended matter from the monitoring site,
- 1-gallon (4 L) brown Nalgene polypropylene bottle with top cut off,
- 1-liter, Class A volumetric flask,
- 2 gallons filtered distilled water (purified water from the super market works fine),
- Hand-drill motor,
- Paint stirrer.

7.2.2 Sediment Preparation

Sediment preparation is a critical factor in calibration quality. It is most convenient to use dry material because it can be accurately weighed with an electronic balance. However, this only works well for clean sand because disaggregation produces a sediment size different than existed in the field. For example, deep harbors with weak currents often have cohesive (sticky) mud with high organic-rich flocculation. Disaggregation of the flocs will reduce the particle size and change the OBS response. Sediment or suspended solids concentration is the dry weight of sediment divided by the weight of the sample (expressed in ppm) or by the volume of sample in liters (expressed as mg/L). Usually the disaggregated particles will be finer than untreated sediment. When dried sediment is used, verify that field estimates are accurate by comparing the OBS results with direct samples of suspended matter. (See Section 11, *References* **(p. 61)**.)

FIGURE 7-1 shows how different methods of disaggregating sediment can change the relationship between turbidity and the concentration of suspended material. This occurs because vigorous disaggregation produces more small particles than less vigorous methods as well as more OBS signal per unit of mass concentration. The result is higher signal levels for a given concentration.

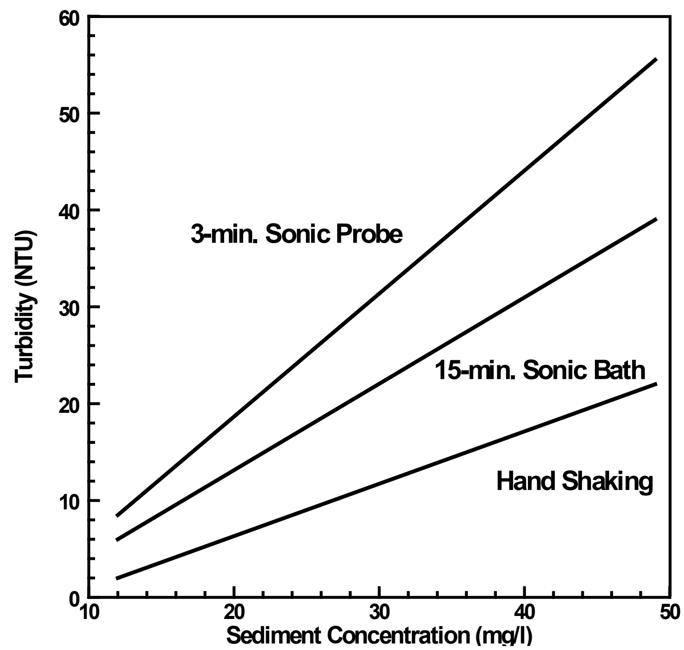


FIGURE 7-1. Effects of disaggregation

Preparation

1. Clean containers and glassware with detergent and rinse with filtered water.

2. Perform the calibration under fluorescent lighting.

3. Based on the material, select the appropriate sample duration from TABLE 7-2.

TABLE 7-2. Sample Durations for Sediment Calibrations

Sediment	Seconds
Clay	10
Silt	20
Fine Sand	40

4. Open the calibration the screen under **OBS-3A Configuration | Operation | Calibration | Calibrate** and select mg/L.

5. Enter sediment concentration values.

6. After each addition of sediment, compute mg/L or ppm with the equations given below.

Sediment concentrations are calculated with the following equations:

$$\frac{M_s}{V_i + \left[\frac{M_s}{\rho_s}\right]} = mg/l \qquad ; \qquad \frac{M_s}{M_i + M_s} = ppm$$

Where:

M_s = Mass (mg) of sediment in suspension

M_i = Initial water mass, $1 \times V_i(kg)$

V_i = Initial volume (L)

ρ_s = Sediment density (usually $2.65 \times 10^3 mg / l$)

7. For the zero calibration point you will need a clean black 20 x 14 x 16 inch container filled with clean tap water. A Rubbermaid® plastic storage box is suitable.

8. Add 2 L of filtered water to the 1 gallon container submerging the sensor at least 5 cm; tap bubbles off container walls.

9. Weigh 5 to l0 equal increments of the sediment so that the total dry weight will produce the maximum concentration expected at the monitoring site.

10. For each sediment standard, repeat Steps 2 and 3 of Section 7.1.3, *HydroSci Software Steps (p. 43)*.

11. After all sediment values have been logged, follow Steps 4 through 7 of Section 7.1.3, *HydroSci Software Steps (p. 43)*, to complete the calibration.

7.3 Salinity, Pressure and Temperature Calibrations

Due to the specialized equipment involved for salinity, pressure and temperature calibration, it is recommended that the instrument be returned to Campbell Scientific, Inc. if any of these sensors are not operating with specified accuracy. Products may not be returned without prior authorization. Refer to the Assistance section at the beginning of this manual for the proper procedure for returning products to Campbell Scientific.

8. Troubleshooting

This section will help you isolate problems that can be easily fixed such as cable-continuity, processor reset, and battery replacement from serious ones such as sensor, computer and electronic malfunctions, and damaged mechanical parts that will require our help. The problem symptoms are shown with underlined, bold text.

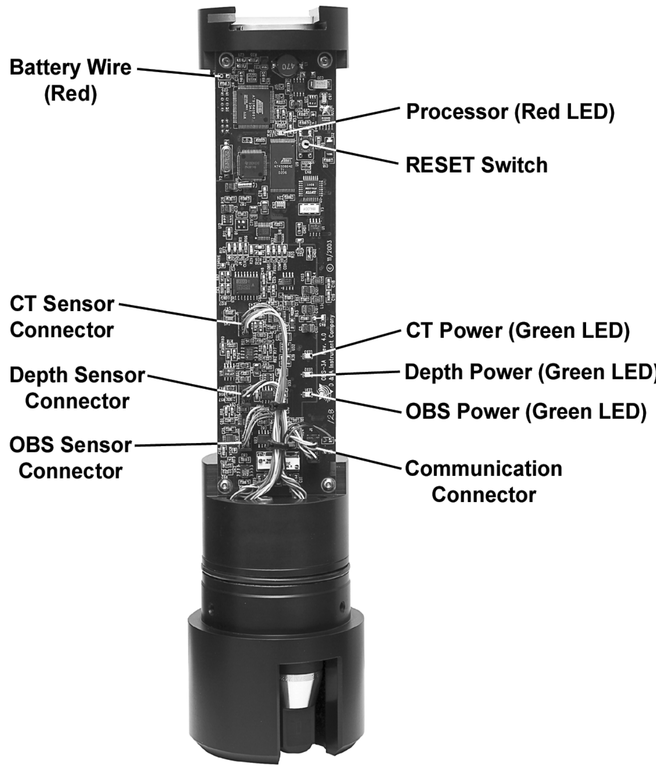


FIGURE 8-1. Component locations

Unit does not communicate with PC.

There are several possible causes for this symptom.

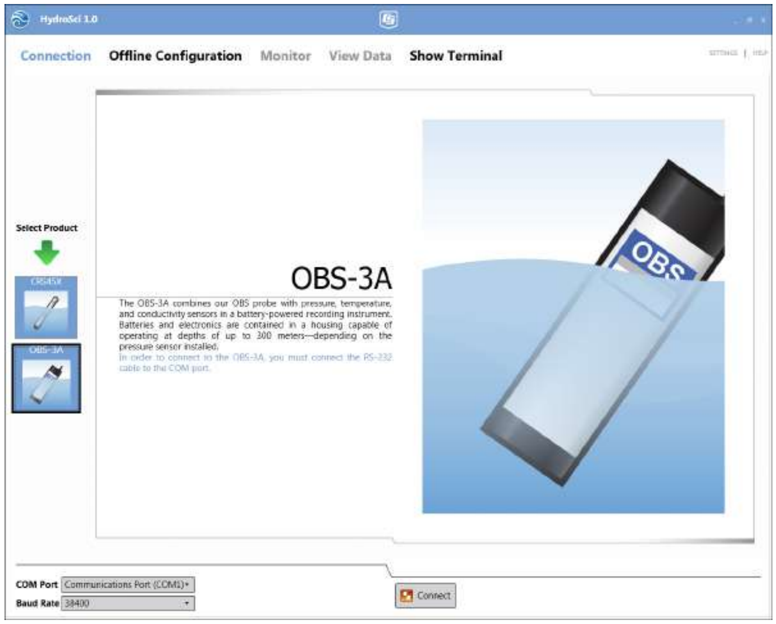
1. The test/umbilical cable is damaged or improperly connected.

2. The OBS-3A is sleeping and will not wake up.

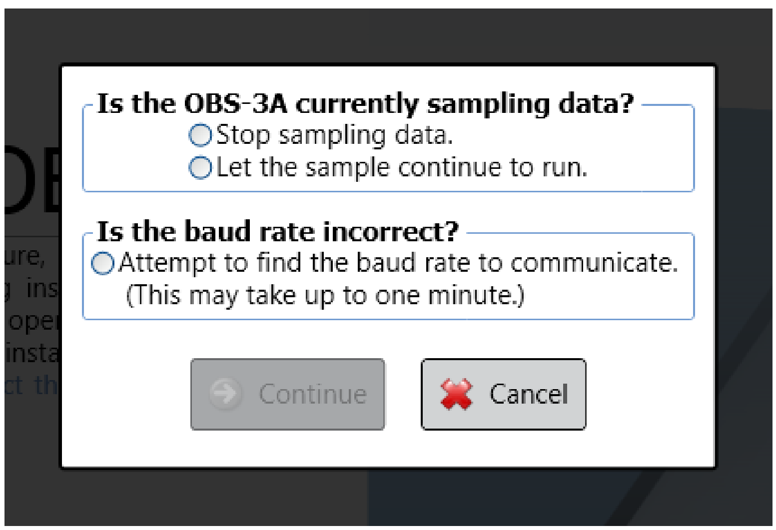
3. The batteries are dead.

4. The OBS-3A and PC are not set to the same baud rate or communication protocol (RS-232 or RS-485).

    a. Click and check COM port settings on the **Connection** tab. The default baud rate is 115.2 kB. If the PC is not set to this speed, follow the steps in Section 6.7, *Connection* *(p. 13)*, to set it.



b. If the OBS-3A still fails to respond, try changing baud rate speeds by selecting *Attempt to find the baud rate to communicate*. If this fails, switch the PC back to 115.2 kB and go to the next step.



c. Reconnect the cable and try to connect again.

d. Replace the main batteries; see Section 6.1.2, *Battery Installation* (p. 8), and try to connect again.

e. If you have a survey cable, connect instrument to external power and try to connect again.

f. Remove the unit from the pressure housing and press and release the RESET button. Try to connect again.

Power failed due to battery clip corrosion or a broken power wire.

Check for a broken red wire connecting the battery tube and circuit board. Green powder or tarnish on the battery contact parts indicates salt-water corrosion. Remove the electronics from the pressure housing. Pull battery-clip-retainer pin out with needle-nose pliers and slide the clip from its track. Clean the corroded surfaces of clip and track with a Scotch-brite® pad and reassemble unit.

OBS or other sensor malfunction.

- Inspect for physical damage such as a broken or bent thermistor, a dirty conductivity sensor, or an OBS sensor fouled with marine growth.
- Open unit and inspect for broken sensor and communication wires and loose connectors (FIGURE 8-1).
- Check sensor power by starting **OBS-3A Configuration | Survey Configuration** and selecting **All Sensors**. Green LEDs should illuminate for installed sensor.
- If the depth sensor reads high and does not change, it may need to be cleaned (see Section 9.2, *Pressure Sensor* (p. 52)).
- If the sensors appear to be in working order, the digitizer or microcontroller may be damaged. Such problems usually require factory service.

Bright sun near the surface (<2 meters) or black-colored sediments cause erroneous OBS readings.

Do not survey in shallow water between 10:00 and 14:00 local time and avoid areas with suspended black mud.

Changing the water temperature in the setup dialog box does not change the temperature measurement.

This is normal. Temperature inputs only change the water density correction used to convert pressure to depth.

OBS-3A indicates different NTU values in the field than other turbidimeters.

Not all turbidity meters read the same! OBS sensors are checked with a Hach 2100N laboratory instrument, using U.S. EPA-approved, formazin turbidity standards before leaving our factory. Turbidimeters other than the 2100N will read different NTU values on natural water samples.

OBS-3A indicates different suspended sediment levels in the field than in the laboratory.

This results from a change in sediment size or color (see Section 10, *Factors Affecting OBS Response* (p. 55)). You may have to perform a field calibration with water samples.

9. Maintenance

9.1 OBS Sensor

The OBS sensor must be kept clean to measure sediment concentration or turbidity accurately. A gradual decline in sensitivity over a period of time indicates fouling with mud, oil, or biological material. Regular cleaning with a water jet, mild detergent and warm water, or a Scotch-brite® abrasive pad will remove most contaminants encountered in the field. Solvent or mineral spirits on cloth can be used to remove oil or grease.

CAUTION Do not use MEK, benzene, toluene, or electronic cleaners as they could damage the OBS window.

At the conclusion of each survey or deployment, clean the OBS. If thick bio-fouling has developed:

1. Scrape the material off the window with a flexible knife, taking care not to scratch it.

2. Tape a strip of 400 to 600-grit wet/dry sandpaper on the edge of a bench top.

3. Add a few drops of water and rub the sensor window on the wet sandpaper, using the counter edge for a guide.

4. Continue until the sensor is smooth and pit-free.

If needed, carefully polish using abrasives until approximately 1 mm of epoxy has been removed. Deeper polishing may damage the IR source.

Although polishing may restore some clarity to the optical window, it will likely not restore the earlier calibration. A new calibration is usually required after polishing the sensor window. As clarity is lost over time, the upper range of the sensor will diminish.

Check the calibration of the sensor after cleaning with abrasives; see Section 7, *Calibration* *(p. 42)*.

9.2 Pressure Sensor

The strain gage sensor is located under a perforated disk and spring-clip (FIGURE 6-1) that protects the Hastelloy diaphragm isolating it from water. Do not touch the diaphragm with tools or pointed objects, as the instrument will leak if it is pierced. Clean the sensor with a water jet directed at the disk after each survey or deployment to flush sediment from between the disk and the sensor. Do not allow sediment to dry on the sensor diaphragm, as it is difficult to clean and will influence accuracy. If this occurs, remove the spring clip and disk with plastic tweezers then gently wipe sediment off the diaphragm with a cotton-tipped swab. Replace the disk and spring clip then flush with a water jet.

9.3 Conductivity Sensor

The conductivity sensor is very fragile and is enclosed in a hole behind the OBS sensor. Do not poke it with any tool or object as the electrodes may be damaged. Routine cleaning should only be done with a water jet directed alternately from the side and top of the sensor well. This should be done daily during surveys or after each deployment. A sensor that has been stored dry should be soaked in water for 15 minutes prior to use.

If the sensor becomes fouled with sediment, oil, or biological material, conductivity will decline over a period of time indicating cleaning is necessary. If a water jet fails to remove contaminants, the sensor can be flushed with hot soapy water or warm alcohol. Do not use solvents. The last step in the cleaning process should always be to flush with clean water.

9.4 Batteries

The unit runs on three D-size alkaline batteries. Buy the expensive ones with the most distant pull date ("use before May 2012"). With all sensors installed, the OBS-3A will run 400 hours in survey mode and for as long as 8000 hours in one of the logging modes.

CAUTION Always put OBS-3A to sleep when it will not be used for a while to conserve battery capacity (see Section 6.12, *Shutdown* *(p. 40)*).

Refer to FIGURE 6-2 for installing batteries. Put the unit on a padded surface and remove the three screws from the end with the handlebar using the 5/64 in. hex wrench provided in the spares kit. Grasp the handlebar, turn the sensor end up and pull the cap straight out of the pressure-housing tube. Immediately wipe up any water from inside the tube. Stand the unit up on the sensor end and remove the desiccant bags. Slide the clip away from the batteries until the spent cells pop up and can be slid out of the tube. Insert fresh batteries in the tube with the positive terminal (+) up. Press them down and slide the clip over the batteries until it contacts the tube wall. Replenish the desiccant bags and clean and regrease the O-ring. Replace the end cap.

CAUTION Do not over tighten the screws.

Battery life will depend on the percentage of time the unit is sampling. TABLE 9-1 shows battery life as a function of sample duration and interval to assist with planning your setup. Pick a power-efficient sampling schedule that meets your scientific objectives.

TABLE 9-1. Battery Life (Hours)

Interval (Sec.)	Duration in seconds (% Power) 10[1] 100%	60[2] 50%	60[1] 100%	120[2] 50%	120[1] 100%	256[3] 10%	256[1] 100%	1024[3] 10%
60	1300	NO	NO	NO	NO	NO	NO	NO
600	> 8000	5450	2080	3150	1100	1460	530	NO
900	> 8000	> 8000	2970	5450	1600	2110	785	NO
1800	> 8000	> 8000	5160	> 8000	2950	3815	1510	1120
3600	> 8000	> 8000	> 8000	> 8000	5150	6400	2810	2110

NO = Not possible; 1 = All sensors; 2 = OBS & depth sensors; 3 = Wave calculations.

9.5 Pressure Housing

The pressure housing and O-ring seals require little maintenance unless the housing has been opened since the last service. However, it should be carefully inspected every six months and serviced before all deployments longer than one month.

1. Disassemble O-ring seals and inspect mating surfaces for pits and scratches.

2. Inspect O-rings for cuts and nicks; replace if necessary using spares provided.

3. Clean O-rings and mating surfaces with a cotton swab and alcohol. Remove fibers from groove and mating surfaces then grease O-rings with DOW Compound 55 and reassemble.

9.6 Antifoulant Coatings

Clear TBTA antifoulant coating or toxin-impregnated collars can be used for monitoring in biologically active waters. TBTA prevents most marine algae and encrusting animals from growing on optical surfaces for up to two months with minimal loss of IR transmission. It is illegal to use TBTA in many places so check applicable water quality regulations in your area before using TBTA coated OBS sensors. Use of TBTA is the sole responsibility of the user.

9.7 User-serviceable Parts

Alkaline D cells and the components of the 21229 Accessory Kit can be purchased as replacement parts. Campbell Scientific model numbers and product descriptions follow:

CSI pn 20990 End Cap O-ring
CSI pn 21145 Pressure Sensor Spring Clip
CSI pn 21135 End Cap Screws, 8-32 x 3/8 in, socket (5/64 in)
CSI pn 21120 Dummy Plug
CSI pn 21122 Plug Locking Sleeve, Subconn® MCDLSF
CSI pn 425 Alkaline D-Cells Batteries
CSI pn 21136 Screws, #4-40 x 1/4 in, socket
CSI pn 20792 OBS-3A Test Cable, 2 m (6.5 ft)
CSI pn 21149 Hex Driver, 5/64 in

9.8 Connector Handling, Greasing, and Cleaning

9.8.1 Handling

- Always apply grease before reattaching connectors (Section 9.8.2, *Greasing Connectors* *(p. 55)*).

- To disconnect cables, pull on connectors and not the cable. Avoid pulling at an angle.

- Avoid sharp bends at cable entry.

- Avoid angular loads on the bulkhead connector.

- Do not over tighten bulkhead nuts.
- Do not expose connectors to extended periods of heat or direct sunlight.
- If connector gets very dry, soak it in fresh water before use.

9.8.2 Greasing Connectors

9.8.2.1 Above-Water Connections (Dry Mate)

- Use a high temperature bearing grease such as Molykote® 44 Medium.
- Apply grease to the female connector so that at least a tenth of the socket's depth is filled with grease.
- Completely cover the inner edge of all sockets with a thin layer of grease that is visible on the connector face.
- After greasing, connect the male and female connectors to optimally distribute the grease on the pins and in the sockets.
- Disconnect the connectors and ensure that the grease is on every male pin. Reapply grease if needed.

9.8.2.2 Underwater Connections (Wet Mate)

- Use a high temperature bearing grease such as Molykote® 44 Medium.
- Apply grease to the female connector so that at least a third of the socket's depth is filled with grease.
- Completely seal the sockets with a thin layer of grease that is visible on the connector face.
- After greasing, connect the male and female connectors.
- Remove excess grease from the connector joint.

9.8.3 Connector Cleaning

- Use spray-based contact cleaner (isopropyl alcohol) to clean and remove any sand or mud on the connector.
- Reapply grease before reattaching connectors (Section 9.8.2, *Greasing Connectors* *(p. 55)*).

10. Factors Affecting OBS Response

This section summarizes some of the important factors that affect OBS-3A measurements and shows how ignoring them can lead to erroneous data. If you are certain that the characteristics of suspended matter will not change during your survey and that your OBS was factory calibrated with sediment from your survey site, you only need to skim this section to confirm that no problems have been overlooked.

10.1 Particle Size

The size of suspended sediment particles typically ranges from about 0.2 to 500 µm in surface water (streams, estuaries and the ocean). Everything else being equal (size, shape, and color), particle area normal to a light beam will determine the intensity of light scattered by a volume of suspended matter. Results from laboratory experiments and natural material support this and indicate a wide range of backscatter associated with very fine mud and coarse sand (about two orders of magnitude). Laboratory tests with coarse silt to medium sand material show that sensitivity changes by a factor of about 3.5 (see FIGURE 10-1). The significance is that size variations between the field and laboratory and within in a survey area cannot be ignored.

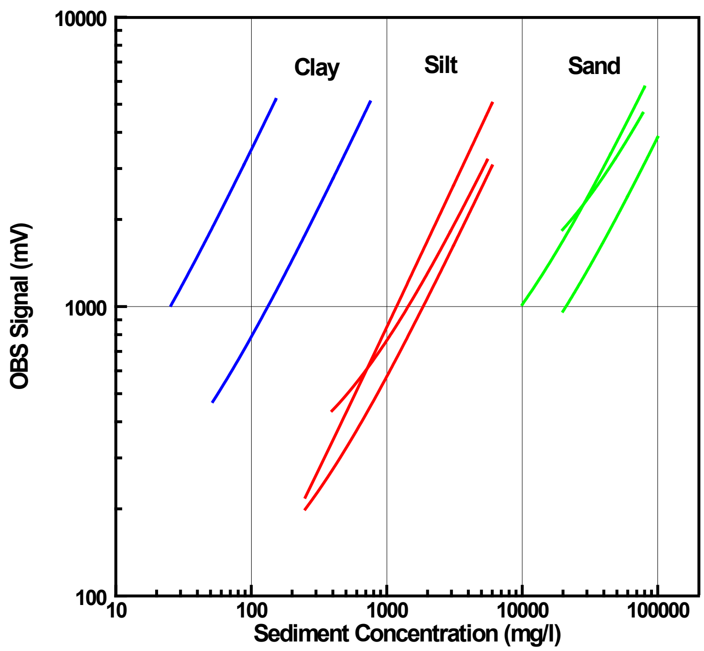


FIGURE 10-1. Response to sand, silt and clay

10.2 Suspensions with Mud and Sand

As mentioned earlier, backscattering from particles is inversely related to particle size on a mass concentration basis (see FIGURE 10-2). This can lead to serious difficulties in flow regimes where particle size varies with time. For example, when sandy mud goes through a cycle of suspension and deposition during a storm, the ratio of sand to mud in suspension will change. An OBS sensor calibrated for a fixed ratio of sand to mud will therefore indicate the correct concentration only part of the time. There are no simple remedies for this problem. The obvious thing to do is to take a lot of water samples and analyze them in the laboratory. This is not always practical during storms when the errors are likely to be largest. Do not rely solely on OBS sensors to monitor suspended sediments when particle size or composition are expected to change with time at a monitoring site.

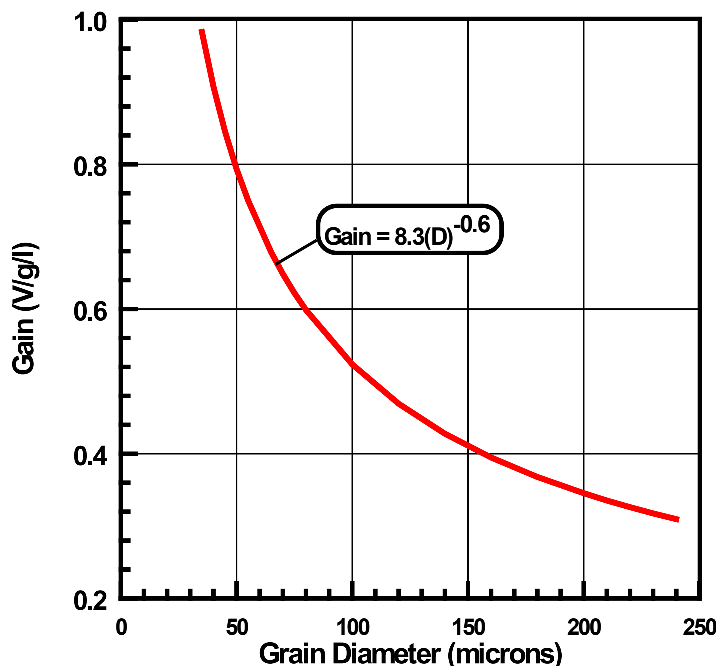


FIGURE 10-2. Effects of particle size

10.3 High Sediment Concentrations

At high sediment concentrations, particularly in suspensions of high clay and silt, the infrared radiation from the emitter can be so strongly attenuated along the path connecting the emitter, the particle, and the detector, that backscatter decreases with increasing sediment concentration. For mud, this occurs at concentrations greater than about 5,000 mg/L. FIGURE 10-3 shows a calibration in which sediment concentrations exceed 6 g/l cause the output signal to decrease. It is recommended not to exceed the specified turbidity or suspended sediment ranges unless calibrations extend over range “A” on FIGURE 10-3.

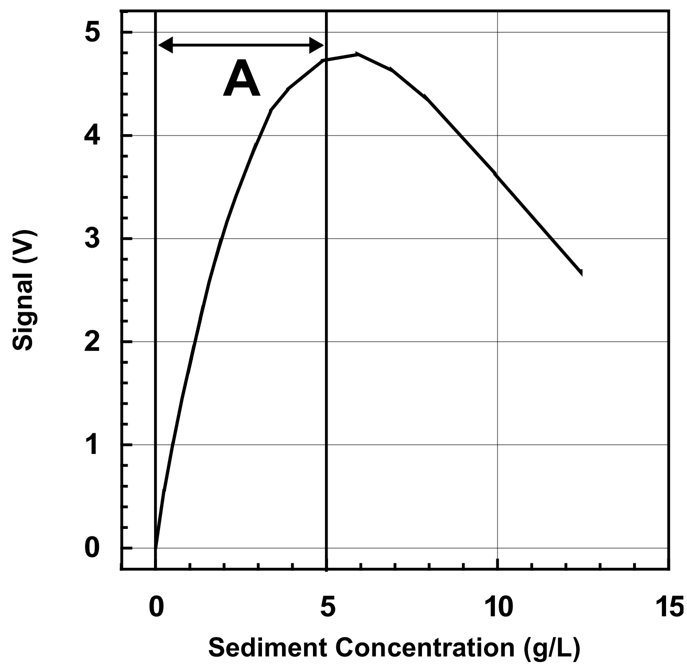


FIGURE 10-3. Response at high sediment concentrations

10.4 Sediment Color

Sediment color, after particle size, has a major effect on OBS sensitivity, and if it changes, it can degrade the accuracy of measurements. Although OBS sensors are "color blind", "whiteness", color, and IR reflectivity (measured by an OBS sensor) are well correlated. Calcite, which is highly reflective and white in color, will produce a much stronger OBS signal on a mass-concentration basis than magnetite, which is black and IR absorbing. Sensitivity to colored silt particles varies from a low of about one for dark sediment to a high of about ten for light gray sediment; see FIGURE 10-4. In areas where sediment color is changing with time, a single calibration curve may not work. Resulting errors will depend on the relative concentrations of colored sediments.

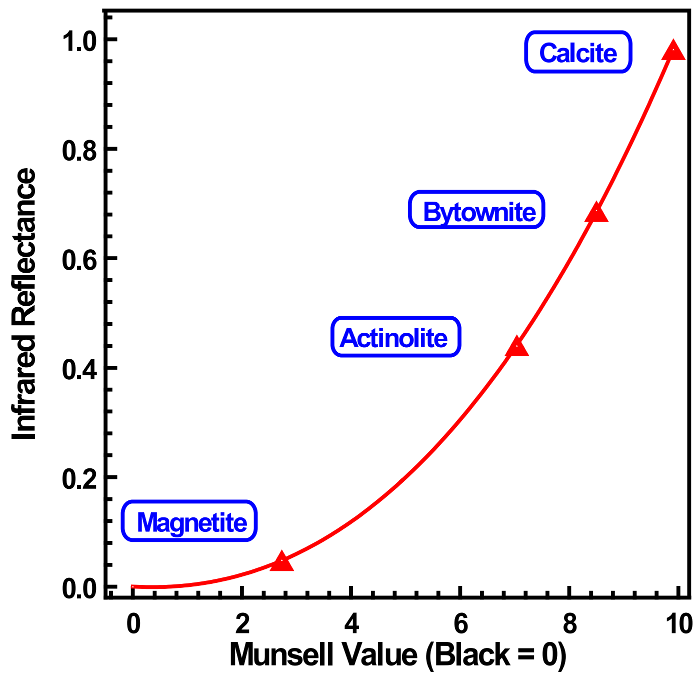


FIGURE 10-4. IR reflectance of minerals

10.5 Water Color

Several OBS users have been concerned that color from dissolved substances in water samples (not colored particles discussed in the previous section) produces erroneously low turbidity measurements. Although organic and inorganic IR-absorbing dissolved matter has visible color, its effect on OBS measurements is small unless the colored compounds are strongly absorbing at the OBS wavelength (875 nm) and are present in very high concentrations. Only effluents from mine-tailings appear to produce enough color to absorb measurable IR. In river, estuary, and ocean environments concentrations of colored materials are too low by at least a factor of ten to produce significant errors.

10.6 Bubbles

Although bubbles efficiently scatter IR, monitoring in most natural environments shows that OBS signals are not strongly affected by bubbles. Bubbles and quartz particles backscatter nearly the same amount of light to within a factor of approximately four, but most of the time bubble concentrations are at least two orders of magnitude less than sand concentrations in most environments. This means that sand will produce much more backscatter than bubbles in most situations and bubble interference will not be significant.

The scattering intensity of mineral particles, bubbles, and suspended organic material are shown in FIGURE 10-5. OBS sensors detect IR backscattered between 140° and 160°, and where the scattering intensities are nearly constant with the scattering angle. Particle concentration has the most important effect in this region. OBS sensors are also more sensitive to mineral particles than either bubbles or particulate organic matter by factors of four to six. In most environments, interference from these materials can therefore be ignored. One notable exception is where biological productivity is high and sediment production from rivers and resuspension is low. In such an environment, OBS signals can come predominately from plankton. Prop wash from ships and small, clear mountain streams where aeration produces high bubble concentrations are another probable source of erroneous turbidity readings.

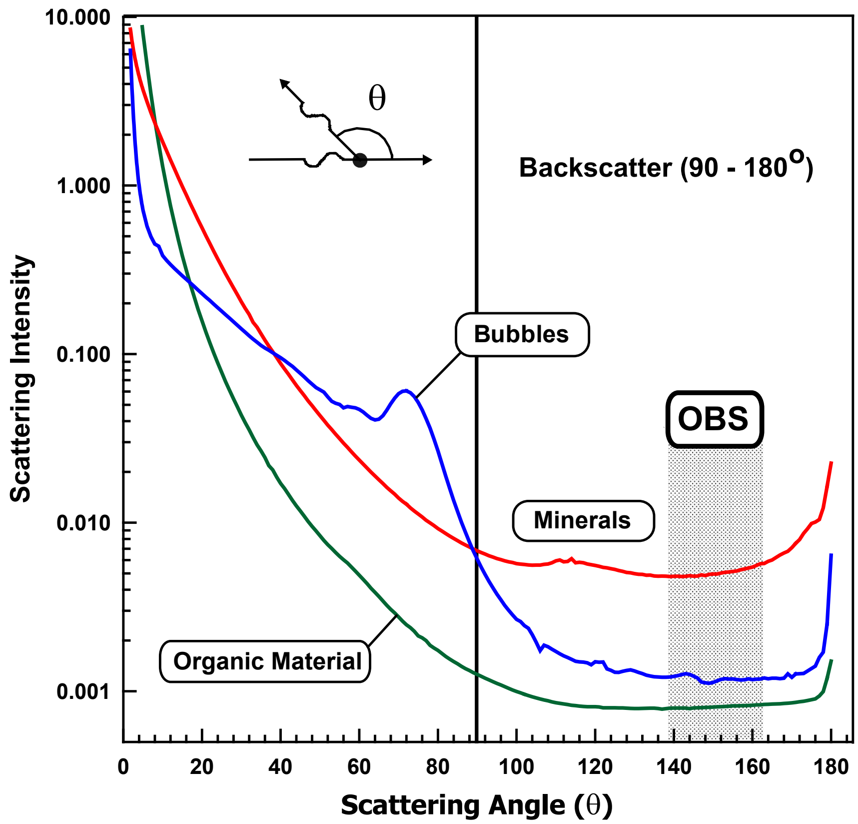


FIGURE 10-5. Scattering intensity vs. angle

10.7 Biological and Chemical Fouling

Sensor cleaning is essential during extended deployments. In salt water, barnacle growth on an OBS sensor can obscure the IR emitter and/or detectors and produce an apparent decline in turbidity. Algal growth in marine and fresh waters has caused spurious scatter and apparent increases of OBS output. The reverse has also been noted in fresh water where the signal increases after cleaning the sensor window.

Prolonged operation in freshwater with high tannin levels can cause a varnish-like coatings to develop on an OBS sensor that obscure the IR emitter and caused an apparent decline in turbidity. Cleaning algal and tannin accumulation off OBS sensors is required more often during the summer because warm water and bright sunlight increase biological and chemical activity. See Section 9.6, *Antifoulant Coatings* *(p. 54)*, for alternatives to cleaning.

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