Syllabus for Sea-Bird Electronics Training for Data Collection in the Ocean

Class starts at 9:00 AM

MODULE 0: WELCOME TO SEA-BIRD

1. Introduction
2. Oceanographic basics
    - What is a profile and how is it used?
    - Oceanographic terms and commonly used parameters

MODULE 1: PROFILING PRODUCTS

1. Real-time systems
    - SBE 9/11*plus*
    - SBE 49
2. Internally recording instruments
    - SBE 19, 19*plus*, 19*plus* V2 - Physical configuration and sampling rates
    - SBE 25, 25*plus* - Physical configuration and sampling rates
3. Memory and battery endurance for internally recording instruments
    - Memory capacity related to number of sensors logged
    - Battery endurance - Power consumption of various sensors
4. Modular sensors and sensor integration with Sea-Bird CTDs
5. Real-time telemetry for internally recording instruments (SBE 19, 19*plus*, 19*plus* V2, 25, 25*plus*) and SBE 49
    - SBE 36 deck unit and PDIM
6. Water sampling equipment - SBE 32 Carousel Water Sampler and SBE 55 ECO Water Sampler
    - SBE 11*plus* deck unit for real-time control of Carousel with SBE 9*plus* CTD
    - SBE 17*plus* memory and power module for autonomous sampling with Carousel and SBE 9*plus* CTD
    - SBE 33 deck unit for real-time control of Carousel or ECO with SBE 19, 19*plus*, 19*plus* V2, 25, or 25*plus* CTD
    - Auto Fire Module (AFM) for autonomous sampling with SBE 19, 19*plus*, 19*plus* V2, 25, or 25*plus* CTD or SBE 50 Pressure Sensor
    - Autonomous sampling with ECO and SBE 19, 19*plus*, 19*plus* V2, 25, or 25*plus* CTD
7. Autonomous instruments
    - SBE 41 and 41cp
8. Activity: Install Seasoft and course data

MODULE 2: SETTING UP AND ACQUIRING DATA

1. SeatermV2, user interface for internally recording instruments
    - Selecting an instrument
    - Communications
    - Instrument status
    - Zero conductivity frequency
    - Activity: Connect computer to SBE 19*plus* V2, Set it up for data collection and collect data
    - Cast headers
    - Upload
    - Headers
    - Activity: Upload data to your computer from SBE 19*plus* V2
    - Capturing ASCII data

2. Seasave, real-time data collection for SBE 19, 19*plus*, 19*plus* V2, 25, 25*plus*, 49, and 9*plus*/11*plus*
    - Seasave and configuration *(.xmlcon* or *.con*) file - number and type of sensors, calibration coefficients
    - Activity: Create .xmlcon file for SBE 19*plus* V2
    - Seasave displays
    - Displaying archived data
    - Activity: Set up displays, and display bench cast data from SBE 19*plus* V2
    - Other Seasave configuration items
        - Serial ports
        - Real-time water sampling
        - TCP/IP ports
        - Miscellaneous
        - Serial data output
        - Shared file output
        - Mark variable selection
        - TCP/IP output
        - SBE 11*plus* alarms
        - Remote display (SBE 14)
        - PC alarms
        - Header form and prompts
    - Saving setup
    - Acquiring real-time data
    - Seasave file types
    - Using internally recording instruments for real-time applications
        - Instrument preparation for real-time data collection
        - Water sampling
    - Activity: Use Seasave to take a real-time cast from SBE 19*plus* V2
    - Setting up Auxiliary Sensors; WET Labs examples
    - Activity: Activity: Use Seasave to plot raw example data set
3. SBE Data Processing post-processing software
    - Data Conversion from raw data to engineering units
    - Sea Plot
    - Activity: Convert and plot data in SBE Data Processing

MODULE 3: DATA CONVERSION AND PLOTTING

1. Data processing introduction
    - Activity: Use Seasave to plot raw example data set
    - Data processing flow chart
    - SBE Data Processing, user interface
2. Conversion to scientific units
    - Data Conversion uses input .con file and raw data (.hex or .dat) file to convert to scientific units
    - File selection
    - Data setup and output variable selection
    - Cast header view
    - Output (.cnv) file format
    - Water sampler output (.ros) file format
    - Activity: Use Data Conversion to convert pressure, temperature, and conductivity
3. Displaying ***converted*** data: Sea Plot
    - Basic plots
    - Multiple files: overlay plots
    - Temperature – Salinity (TS) plots
    - Activity: Use Sea Plot on example data set

MODULE 4: WATER SAMPLING AND DEPLOYMENT

1. Water Sampling introduction
    - SBE 32 Carousel and SBE 55 ECO Water Samplers
    - Autonomous sampling with Carousel and internally recording instruments - AFM or 17*plus* V2
        - AFM (with SBE 19, 19*plus*, 19*plus* V2, 25, or 25*plus* CTD or SBE 50 Pressure Sensor) - close on downcast, upcast, when stationary, or elapsed time
        - SBE 17*plus* V2 (with SBE 9*plus* CTD) - close on upcast
    - Autonomous sampling with ECO and internally recording instruments
2. SeatermAF V2, user interface for autonomous sampling
    - CTD communications
    - Sampling protocols - close on downcast, upcast, when stationary, or elapsed time
3. Real-time data and water sampling with internally recording instruments - SBE 33 Deck Unit
    - Cabling and capabilities of SBE 33 (use with SBE 19, 19*plus*, 19*plus* V2, 25, or 25*plus* CTD)
4. Deployment issues
    - Cabling real-time system, lab to winch to CTD
    - Grounding considerations for real-time system
    - Instrument plumbing
    - Be neat!
    - Why and how long should I soak?
    - Using CTD in cold places
5. Correlating CTD data with water samples
    - Extracting CTD data for water samples with Data Conversion - .ros file
    - Summarizing water sample data with Bottle Summary - .btl file
    - Activity: Create .ros file and .btl file

MODULE 5: MISCELLANEOUS APPLICATIONS

1. Fresh water applications - pump turn-on considerations, specific conductance
2. Sound velocity – direct measurement vs calculation from CTD data
3. Adding data to your CTD data at the deck unit
    - NMEA interface for Latitude and Longitude
    - Surface PAR
4. Supporting custom auxiliary sensors – user-defined polynomial equations
5. Adding 9600 baud data channel or RS-232 serial output interface to 911*plus*
6. Thermosalinographs
    - SBE 21 - T and C, auxiliary sensors, remote T, GPS data, memory
    - SBE 45 - T and C only, no memory, remote T and GPS data with use of optional interface box
    - Cabling and setup
    - Calibration and maintenance recommendations
    - Example installation and data

MODULE 6: MAKING MEASUREMENTS IN THE OCEAN

1. How a sensor works
2. Sensor response times
    - Temperature
    - Conductivity
    - Pressure
    - Dissolved Oxygen - SBE 43
3. Interaction of profiling rate and sampling rate on resolution
    - SBE 9/11*plus*
    - SBE 25, 25*plus*
    - SBE 19, 19*plus*, 19*plus* V2

4. Activity: Compare resolution for data from same cast for SBE 19 and SBE 25
5. Coordinating measurements in time and space
    - Salinity is function of T, C, and P, and must be calculated on measurements from same parcel of water
    - Coupling T and C measurement - TC Duct and pump
    - SBE 911*plus* measurement sequence and alignment of data
    - SBE 25 and 25*plus* measurement sequence and alignment of data
    - SBE 19, 19*plus*, and 19*plus* V2 measurement sequence and alignment of data
    - Response to step change

MODULE 7: GETTING THE HIGHEST ACCURACY DATA, PROFILING

1. Care of sensors in the field and sensor drift characteristics
    - Temperature
    - Conductivity
        - Results of cell fouling
        - Cell cleaning
        - When cells go bad
        - Zero frequency
    - Dissolved oxygen
    - pH
    - Pressure
2. Converting sensor output to engineering units
    - How calibration maps sensor response to engineering units
    - Calibration procedures - baths, primary standards, fixed point cells
        - Temperature
        - Conductivity
        - Pressure
        - Dissolved oxygen
        - pH
    - Calibration results: Calibration sheets, what is on them
3. Using calibrations to adjust data
    - Pre-deployment and post-deployment calibrations used to adjust data
        - Temperature
        - Conductivity
        - Dissolved Oxygen
4. Seawater calculator – SeaCalc III
5. Activity: Correct T and C using pre- and post-cruise calibrations

MODULE 8: GETTING THE HIGHEST ACCURACY DATA, PROFILING (*continued*)

1. Field calibrations, pressure and temperature
    - Pressure, offsets on deck
    - Temperature, reversing thermometers
2. Field calibrations, discrete water samples for conductivity and dissolved oxygen
    - Sample collection strategies, checking for leaks, what part of water column should we use
    - Conductivity, laboratory salinometer determination of discrete water samples
    - Dissolved oxygen, Winkler titration of discrete water samples
3. Activity: Correct conductivity with water samples

MODULE 9: ADVANCED DATA PROCESSING *OR* WHY DOESN'T MY DATA LOOK LIKE THE EXAMPLES IN CLASS?

1. Dynamic errors
    - Response time for temperature
    - Response time for conductivity: dependent on flow speed and thermal mass
    - Errors in salinity: not sampling same water parcel, mismatched T & C response times, thermal mass of conductivity cell, ship heave
2. Processing modules for correcting for dynamic errors
3. Activity: Convert data
4. Filtering pressure to remove digitization effects and account for conductivity time constant: Filter
    - Cause and effect of digitization noise
    - Manipulating data to compensate: Filter
5. Discussion of sensor alignment, what it means for T, C, P, DO
    - Diagrams of cause of misalignment
    - Plots showing effect of misalignment on salinity; discussion of spiking
    - Manipulating data to remove misalignment: Align CTD
    - Examples of T and C alignment
    - Activity: Correct alignment of conductivity in example data
    - Causes of misalignment of Dissolved Oxygen data
    - Examples of DO alignment
    - Activity: Correct alignment of DO in example data
6. Correcting for conductivity cell thermal mass
    - Causes and example
    - Manipulating data to compensate for cell thermal mass: Cell Thermal Mass
    - Activity: Correct for cell thermal mass in example data
7. Data artifacts induced by ship heave
    - Diagram and explanation showing error when instrument package slows or stops
    - Removing loops and wild points in data: Loop Edit and Wild Edit
    - Activity: Remove loops in example data
8. Ancillary data processing
    - Section: retrieve portion of a cast
    - Split: separate upcast from downcast
    - Window Filter: filter data with a variety of shapes
9. Bin averaging data
    - Bin Average protocols - pressure interpolated or not interpolated
    - Surface bin
    - File selection and data setup
    - Output (.cnv) file format
    - Activity: Use Bin Average on example data set
10. Data processing tips
11. Complete processing flow chart
    - 911*plus*
    - 19*plus* or 19*plus* V2
    - 25*plus*
12. Batch processing
    - Automating processing of large sets of cast data
    - Activity: Batch process example data sets

MODULE 10: MOORED INSTRUMENTS

1. Instrument types and capabilities
    - SBE 16, 16*plus*, 16*plus* V2, 16*plus*-IM, and 16*plus*-IM V2 SEACAT C-T (pressure optional) Recorder
    - SBE 37 (SM, SMP, SMP-IDO, SMP-ODO, SI, SIP, SIP-IDO, SIP-ODO, IM, IMP, IMP-IDO, IMP-ODO) MicroCAT C-T (pressure optional) Recorder
    - SBE 43 and 63 Dissolved Oxygen Sensors
    - SBE 39, 39*plus*, and 39-IM Temperature (pressure optional) Recorder and SBE 56 Temperature Logger
2. Inductive modem telemetry - mooring diagram, instrument and surface coupling, data transmission
3. Adding a modem to other manufacturer's instruments
    - SBE 44 or Underwater Inductive Modem Module (UIMM) link to instrument with serial interface
    - Sea-Bird OEM components to convert serial-output instruments to IM operation
4. Clock drift
5. Memory capacity - memory size and scan length for each instrument
6. Battery Endurance
    - Calculating current draw
    - Battery endurance issues: temperature and shelf life
    - Battery type, capacity, and endurance examples for each instrument
    - Activity: Calculate battery endurance for SBE 37-SM
7. Sampling theory: sampling rate and resolution

MODULE 11: SETUP OF MOORED INSTRUMENTS

1. Setting up a moored instrument: Seaterm and SeatermV2 user interface
    - Setting communication parameters
    - Checking calibration coefficients and instrument status
    - Setting date and time
    - Setting pump operation parameters
    - Upload file types and upload choices
2. Activity: Set up SBE 37-SM, collect data, upload, and check data
3. Converting sensor output to scientific units
    - How each instrument stores and reports data
    - Conversion utilities for SBE 37 and 39
4. Headers and data formats
5. Activity: Convert data, derive salinity and sigma-t, and plot results with Sea Plot
6. Setting up Auxiliary Sensors; WET Labs examples
7. Preparing for deployment
    - Anti-foulant paints
    - Install fresh batteries
    - Check connectors and cables
    - Clear memory of old data and set up instrument
    - Check list example
    - Verify functionality
    - SBE 16*plus* and 16*plus* V2 : pump operation and dissolved oxygen sensors
    - Clean data collection
    - Plumbing
    - Start logging: now or later?
    - Deploying in cold places
    - Inductive modem systems:
        - Set instrument ID
        - Set up entire system: buoy, buoy computer, communication link to shore
        - Review commands for requesting data
        - Troubleshooting

MODULE 12: GETTING THE HIGHEST ACCURACY DATA, MOORED

1. Care of sensors in field
    - Temperature
    - Conductivity
        - Results of cell fouling
        - AF24173 Anti-Foulant Devices: TBTO
        - Pumping
    - Dissolved Oxygen
        - Results of fouling
        - Membrane rinsing
2. Pre-deployment and post-deployment calibrations used to adjust conductivity calibration
    - Example
3. Temperature and conductivity drift
    - Conductivity positive drift
4. Correcting data with field comparisons – conductivity example
5. Correcting Dissolved Oxygen data for fouling
6. Post recovery maintenance
        - Cleaning
        - Checking zero frequency
        - Storage

MODULE 13: WAVES AND TIDES - SBE 26 AND 26*PLUS* SETUP AND DEPLOYMENT WITH SEASOFT FOR WAVES (REFERENCE ONLY; NOT COVERED IN CLASS)

MODULE 14: WAVES AND TIDES - DATA PROCESSING WITH SEASOFT FOR WAVES (REFERENCE ONLY; NOT COVERED IN CLASS)

MODULE 15: TROUBLESHOOTING

1. Real-time systems
    - 911*plus*
2. Deployment problems – pump, sensors with long turn-on transients, wet end termination, slip ring
3. Data problems
    - .xmlcon or .con file doesn't match instrument setup
    - Incorrect calibration coefficients
    - Data scan mismatch
4. NMEA problems
    - NMEA standard format
    - Communication parameters
    - Sea-Bird NMEA simulation program
5. SBE 32 Carousel Water Sampler
6. SBE 33 or 36 Deck Unit
7. Opto / NMEA Box
8. Internally recording instruments
    - Communication problems – batteries, cable, comm port
    - Reset switch
9. Auto Fire Module (AFM)
10. Activity: Diagnose cause of an instrument's damage, Use Seasave to look at and diagnose data problems

MODULE 16: THE CRUISE – BEFORE, DURING, AND AFTER

1. Pre-cruise equipment checks
2. Verify functionality
3. Shipping precautions
4. Moored instruments and anti-foul paint
5. Tools and spare parts
6. Care and Maintenance during cruise
7. Flooded instruments
8. Care and maintenance after cruise
9. Care and maintenance after moored instrument recovery
10. Storage after recovery

MODULE 17: BASIC MAINTENANCE OF SEA-BIRD EQUIPMENT

1. Annual maintenance
2. Lubricating hardware
3. Electrostatic discharge precautions
4. Replacing O-rings and seals
5. Pump maintenance
6. Replacing bulkhead connectors

MODULE 18: RETURNING INSTRUMENTS TO SEA-BIRD FOR SERVICE

1. Sea-Bird contact information
2. Information needed by Sea-Bird
3. Battery shipping regulations
4. Service scheduling and authorization
5. Service package
6. Service turn-around times