Abstract:
Over the last year, a group of like-minded marine technicians, scientists, and data managers have worked on an initiative to develop best practices related to sea-going operations on research vessels. The goal of each working group is to develop a best practice document that will ultimately result in standardized operational practices and improved data quality throughout the Academic Research Fleet. During this breakout session each active working group (EK-80, General Underway Systems, and CTD) will provide details regarding their status, share draft documentation, and request feedback from the community on the current content. Kristin Beem (OSU) and Rebecca Hudak (WHOI) will share the results of technician training cruises focused on both pier side and “underway” EK-80 calibrations on the R/V Atlantis and R/V Sikuliaq and provide a summary of the metrics for choosing an adequate calibration site. Shawn Smith (R2R, FSU, SAMOS) will provide an overview on the status of the general underway best practices working group, proposed contents and encourage community input on other content of community interest. Laura Stolp (WHOI) and Rebecca Hudak (WHOI) will introduce the session attendees to the CTD tiers, cleaning documentation, instrument list for deriving psa, decision trees, and cleaning recommendations. Leah McRaven will close out this session with a presentation on CTD Data: From Raw Collection to Science Use. This presentation will provide an overview of why this data is important, anticipated sensor accuracies and drifts, how to visualize anticipated accuracies, and how to visualize CTD contamination during acquisition.

An update on:
Developing EK80 Best Practices

RVTEC 2022
November 2, 2022

EK80 Working Leads & Working Groups Members

Rebecca Hudak
Rolling Deck to Repository
Woods Hole Oceanographic Institute
Shipboard Scientific Support Group

Kristin Beem
UNOLS Tech Training Committee
RCRV Marine Science Technical Director

Alexa Gonzalez: NOAA
Kristin Sojka: NOAA
Lynne Butler: URI
Peter Shanks: Australian Antarctic Division
Adrianne Copeland: NOAA/FFO
Mike Jech: NOAA
Jennifer Johnson: WHOI/AOPE
Shannon Hoy: NOAA/ OER
Andone Lavery: WHOI
Beth Phillips: NOAA
Liz Weidner: UNH/CCOM

Our Approach

Gather Responses to the Survey

Organize Groups and Identify Leads

Documentation of Alternative and Existing Methods

Development of Best Practice Documents

Beta test Best Practice Documents

Publish to OBPS

Current Focus- Calibration and Installation

EK-80 Fisheries Sonar Suite- 2022 Update

- Monthly Meetings - Third Thursdays @ 1300 ET
- Took a brief break during active sailing season
- About 13 active members contributing; including those from NOAA, UNH, OSU, URI, and WHOI
- R/V Atlantis EK80 first calibration Winter 2022 BP Group Members guided and assisted in calibration
- R/V Sikuliaq Calibration Cruise in February 2022 and EK80 attended calibration learned about Sikuliaq protocols and setup.
- Ocean Best Practice Document - Strong focus on calibrating an EK80 as well as what features should be running to get the best data

R/V Sikuilaq Displays during EK80 Calibration

RVTEC Community Items of Interests

- Setups for NOAA (used on the R/V Atlantis) and the R/V Sikuliaq- Automated Rigging Systems Price is around $11-15K but it's much quicker and "easier" - Calibration will still take 6-8 hours minimum

- Map of Calibration Spots- What makes a good Calibration Site?
  (deep pier facility- if available, low flow rate/ slack tide, low target counts, 50+ meter water depth, during daylight, etc.)

UAF Technicians Rigging up the Calibration Spheres

Note- Thank you to UAF Science Support Group and R/V Sikuliaq Crew- as well as the institutions who sent technicians to attend WHOI, OSU, SIO, NOAA, and USGC. Of course thank you to NSF for funding and support!

Questions/Interested?

Get involved!

- Reach out to the lead of the working group you are interested in joining
  EK-80: Rebecca Hudak rhudak@whoi.edu, Kristin Beem: kristin.beem@oregonstate.edu

- Oceans Best Practices Website (where final BP document will live):
  https://www.oceanbestpractices.org/
- Ocean Mapping Wiki- Great Resource- collaborative website includes EK80 Information! Shannon Hoy- one of the wiki leads
  https://github.com/oceanmapping/community/wiki

An update on:
General Flow-through Systems

RVTEC 2022
November 2, 2022

Group Members & Working Group Leads

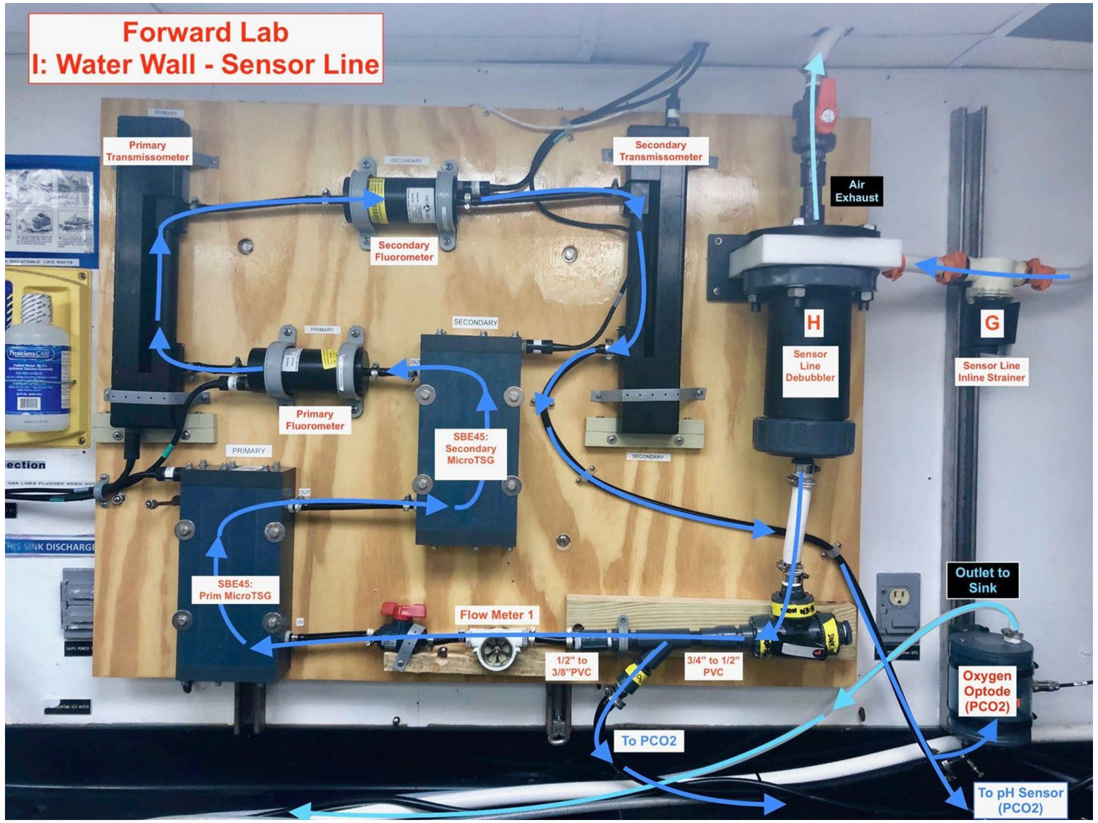
Shawn Smith
Rolling Deck to Repository
SAMOS Initiative
COAPS, Florida State University

Shawn Smith: R2R/FSU
Laura Stolp: WHOI
Rebecca Hudak: WHOI
Kristin Beem: OSU/RCRV
Katie Watkins-Brandt: NOAA
Gabe Matthias: URI
Emily Shimada: Oregon State
Kate Kouba: Oregon State
John Ballard: UCSD
Sara Rivero-Calle: UGA
Suzanne H. O'Hara: LDEO/R2R
Morgan Hudgins: UGA
Jeremy Taylor: NOAA/JIMAR
Lynne Butler: URI
Peter Shanks: Australian Antarctic Division
Webb Pinner: Capable Solutions
Taylor Crockford: WHOI
Michael Tepper-Rasmussen: Oregon State

Scope

Sept. 2021 (last) meeting focused on key components

- Intake
- Seachest
- Pipes, valves, and tubing
- Pumps
- Flow meters
- Debubblers
- Sensors



Atlantic Explorer Water Wall

Discussion topics from WG

- Intake
  - How to document location and which intake is in use?
- Cleaning methods, frequency for Seachest and other system components
- Pumps
  - Impeller vs diaphragm?
  - Which are in use?
- Flow meters
  - How many needed and where?
- Debubblers
  - Sizing, cleaning, etc.
  - What sensors are sensitive to bubbles?
- Sensors
  - Recommend “order” of sensors along flow path

Logging Events for Harvest in NRT

Could event logs (R2R, ship tech, etc) be leveraged to track flow-through system events that may impact data quality

List | Find | Help

Instrument: Underway Science seawater

Summary | Threaded

-- Author -- | Underway Science seawater | -- Action -- | **6 Entries**

Event	dateTimeUTC	GPS_Time	Instrument	Action	Transect	Station	Cast	Latitude	Longitude	Seafloor	Author	Comment
20220927.1038.002	20220927.1038	2022/09/27 10:38:46	**Underway Science seawater**	service	NaN	NaN	NaN	64.171087	-51.719479		eCheung1	Freshwater flush
20220930.1314.001	20220930.1314	2022/09/30 13:14:30	**Underway Science seawater**	start	NaN	NaN	NaN	64.069989	-52.109291		eCheung1	
20221001.1537.001	20221001.1537	2022/10/01 15:38:04	**Underway Science seawater**	service	NaN	NaN	NaN	67.107425	-56.364080		eCheung1	Flow stopped due to bubbles. Cleared air from pump
20221001.2304.001	20221001.2304	2022/10/01 23:04:49	**Underway Science seawater**	service	NaN	NaN	NaN	66.993977	-57.055581		sBrugger1	Flow stopped due to bubbles. Bled air out.
20221002.0449.001	20221002.0449	2022/10/02 04:49:52	**Underway Science seawater**	stop	NaN	NaN	NaN	67.012336	-57.356250		eCheung1	Stopped while on station in poor weather
20221002.1645.001	20221002.1645	2022/10/02 16:45:22	**Underway Science seawater**	start	NaN	NaN	NaN	67.003172	-57.374717		sBrugger1	

Next steps

- Start meeting again in early 2023
  - Recruit other interested team members
- Need additional expertise on team
  - Science users
  - Marine engineers
- Build draft text in 2023
- Goal to present at RVTEC 2023
  - Get feedback, test methods, and submit to OBPS

Questions

An update on:
Developing CTD Best Practices

RVTEC 2022
November 2, 2022

Group Members & Working Group Leads

Laura Stolp
Rolling Deck to Repository
Woods Hole Oceanographic Institute
Shipboard Scientific Support Group

Rebecca Hudak
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John Ballard: UCSD
Susan Becker: UCSD
Lynne Butler: URI
Peter Shanks: Australian Antarctic Division
Taylor Crockford: WHOI
Alexa Gonzalez: NOAA
Morgan Hudgins: UGA
Mike Kovatch: UCSD
Gabe Matthias: Independant
Leah McRaven: WHOI
Fernando Santiago-Mandujano: UH
Katherine Egan: NOAA

Tier Structure

Tier 1

These practices would be the fundamental CTD best practices and incorporated in Tier2 and Tier 3. The idea being that data collected using these BP would be uniformly collected across the fleet.

- Ship technician and crew/science party for deployment

Tier 2

- Science party involved and has responsibilities
- Bottle samples - some salinity/oxygen, maybe done on ship or on shore, not all bottles nor all CTD casts

Tier 3 - Gold Standard

- CTD group (ie ODF, GoSHIP, WOCE)
- Oxygen sample taken

Tier 1 - BASIC

These practices would be the fundamental CTD best practices and incorporated in Tier 2 and Tier 3. The idea being that data collected using these BP would be uniformly collected across the fleet.

- Ship technician and crew/science party for deployment
- Minimum instrumentation on package
  - Dual temperature/conductivity
  - Oxygen sensor with backup on hand
  - Fluorometer
  - Transmissometer
- Responsible party technicians vs science .. science party should be cognizant of what needs to be done and technicians keep in mind to ask science to do what they can do.
- Data checking in realtime- what tools can be used

Tier 2 - Intermediate

- Everythin in Tier 1
- Science party involvement with responsibilities
- Bottle samples - some salinity/oxygen, maybe done on ship or on shore, not all bottles nor all CTD casts
- Compare CTD sensors w/ underway sensor data
  - TSG to CTD salinity
  - Underway O2 to SBE 43
- Second sensor on package 2 SBE43, 2 SBE3, 2 SBE4
- Data checking in realtime- differences between dual temp or dual cond.

Tier 3 - Gold Standard

- Inclusive of Tier 1 and Tier 2
- CTD group (ie ODF, GoSHIP, WOCE)
- Go Ship documentation
- Prioritize sample types
- Oxygen sample taken
  - Process on the ship - Winkler titrations
  - Process later?
- Salinities Autosal run on ship for each cast all bottles
- On board processing..
- Data checking in realtime - plotting temp/cond differences - fitting O2 and Salinity.

Cleaning Compatibility Chart

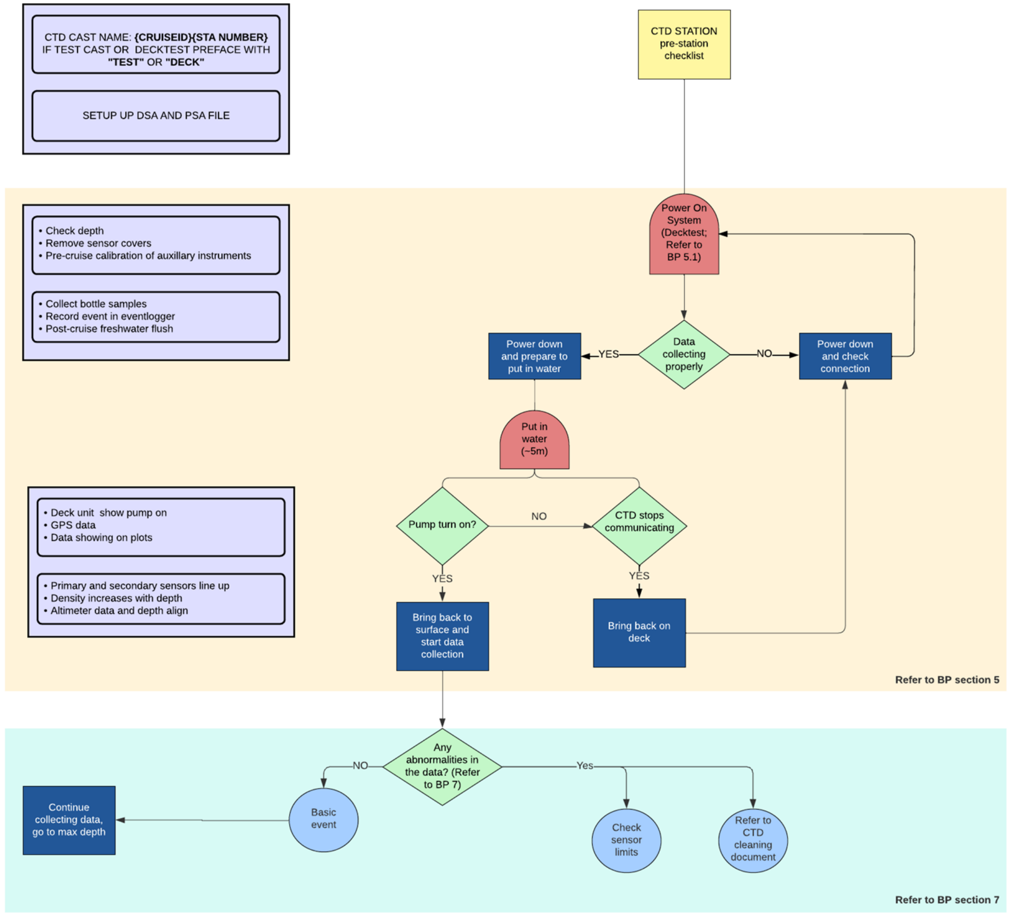
Sensors	Bleach	Tergitol/ Triton X	Vinegar	Lens Paper	High grade isopropyl Alcohol	DI H2O agitated cleaning	CLEAN Compressed air	Rinse w hose	Soapy water	HCL
Temp	Y	Y	Y			Y		Y	Y	
Cond	Y	Y	Y			Y	Y	Y	Y	Not recommended
Oxygen		N				Y		Y	N	
O2 Optode		N				Y		Y	N	
Fluorometer		Y		Y		Y		Y	Y	
SUNA				Y	Y	Y		Y		
PAR		Y				Y		Y	Y	
SBE Pumps		Y				Y		Y	Y	N

CTD Profiler Index

- Log sheet examples
- Cleaning charts
- Data/Deployment/Recovery Cheat sheets
- CTD manuals
- SeaBird Application notes
- Decision Trees

https://docs.google.com/document/d/1LZUypwV-IIP7dM2rYI_ljCDu1NrbAj3pU7TN3TDxrJI/edit

Decision Tree Discussion Points



Post Deployment

Protocol: insert link

Supplies: Kit A

Quick Guide:

Fast cast turnaround:

1. Agitate and flush warm water through cell, repeat 3x
2. Push through DI water, leave syringe in place until next cast.

>15-minute turnaround:

1. Flush cell with TERGITOL™, rinse with warm water thoroughly
2. Continue with Fast cast turnaround procedure.

30 minutes

Protocol: insert link

Supplies: Kit B

Quick Guide:

Post Deployment (>15-minute turnaround) + bleach:

1. Follow procedure for >15 minutes turnaround
2. Agitate and flush warm bleach solution through cell
3. Flush with warm water for 5 mins
4. Push through DI water, leave syringe in place until next cast.

>60 minutes

Protocol: insert link

Supplies: Kit C

Quick Guide:

Post Deployment (>15-minute turnaround) + 30 mins + soak:

1. Follow procedure for >X minutes turnaround + 30 mins.
2. Agitate and flush warm TERGITOL™ through cell for 1 min.
3. Drain, refill to closed system, and allow to soak for 1 hour.
4. Flush with warm water for 5 minutes.
5. Push through DI water, leave syringe in place until next cast.
6. Locking sleeve freshwater rinse.

Post Cruise

Protocol: insert link

Supplies: Kit D

Quick Guide:

1. Inspect and clean all bulkhead connectors, cables, and O-rings
2. Main housing maintenance
3. Inspect pressure port
4. Conductivity cell cleaning based on fouling
5. Validate frequency output for zero conductivity
6. Validate temperature sensors
7. Ancillary sensor and pump maintenance
8. Refer to proper storage recommendations

Decision Tree Discussion Points

- What do you do if it looks like something got sucked up and is throwing off your sensor readings?

Visualizing CTD Contamination

Leah McRaven

Physical Oceanography, WHOI

RVTEC Nov 2nd, 2022

Photo: Evie Fachon

Photo: Rachel Fletcher

Photo: Isabela Le Bras

Photo: Charlie Wright

UNOLS
UNIVERSITY-NATIONAL OCEANOGRAPHIC LABORATORY SYSTEM

R2R
ROLLING DECK TO REPOSITORY

Ocean best practices

WOODS HOLE OCEANOGRAPHIC INSTITUTION

Anticipated sensor accuracies and drifts

Example range of CTD end uses:

- **Hydrographic profile measurements**
  - High-accuracy calculation of in situ physical parameters, for example density, salinity, and sound speed velocity
- **Complementary profile measurements**
  - Calculation of physical values from auxiliary sensors, for example dissolved oxygen
- **Physics-dependent discrete water sample analysis**
  - Water sample analysis requiring in situ measurements, for example dissolved inorganic carbon and dissolved oxygen sample analysis
- **In situ and density-referenced sensor validation and calibration**
  - Sensors attached to CTD frame or deployed on other platforms (e.g. gliders, floats, and moorings) requiring validation or calibration
- **Matching discrete water sample measurements to water masses and physical properties**

Parameter	Initial Accuracy	Stability	Maximum anticipated drift for 1 year deployment
SBE3 Temperature	±0.001 °C	<0.001 °C over 6 months	±0.002 °C
SBE4 Conductivity	±0.0003 S/m (±0.003 mS/cm)	0.0003 S/m (0.003 mS/cm) per month	±0.0039 S/m (±0.039 mS/cm)
Derived salinity*	±0.004 psu		±0.050 psu
Derived density*	±0.002 kg/m^3		±0.041 kg/m^3

* approx. for ranges -1-10 °C and 25-35 mS/cm

Visualizing anticipated sensor accuracies: Difference plots

AR41

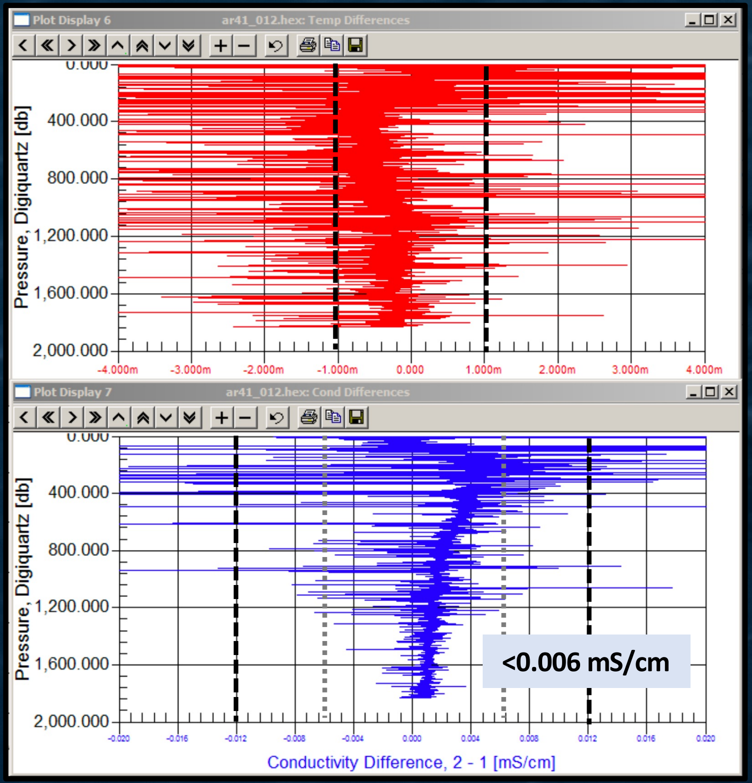
Sensor	Time between calibration and use	Anticipated accuracy
Temperature	10 months	±0.001 °C
Conductivity	4 months	±0.012 mS/cm, likely ±0.006 mS/cm

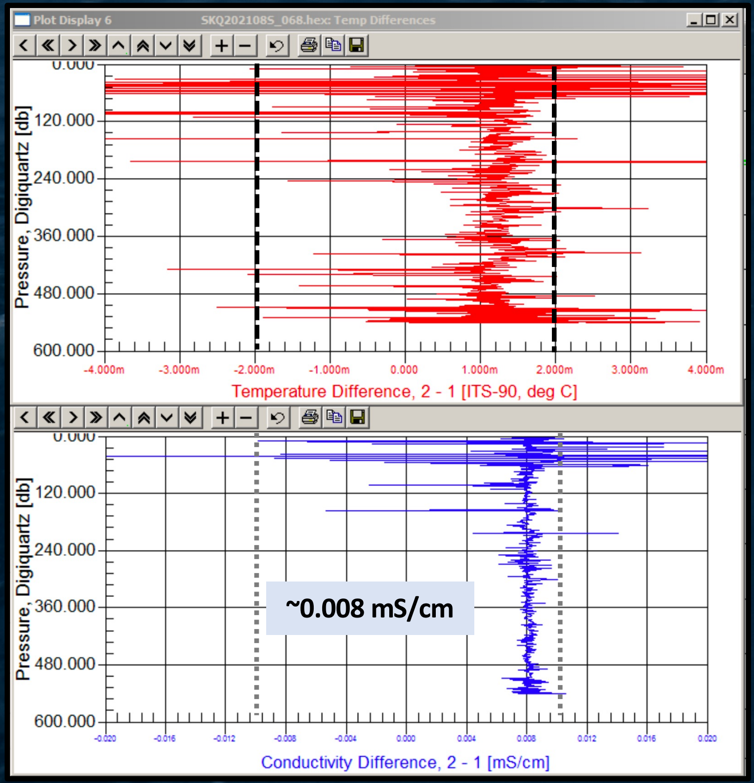
SKQ2021-08s

Sensor	Time between calibration and use	Anticipated accuracy
Temperature	16 months	±0.002 °C
Conductivity	15 months	±0.045 mS/cm, likely ±0.01 mS/cm

These plots provide a relative comparison, making them suitable for detecting changes that occur suddenly or at a rate faster than anticipated sensor drifts

On average, sensor differences and their drifts should fall within 2× the anticipated accuracy





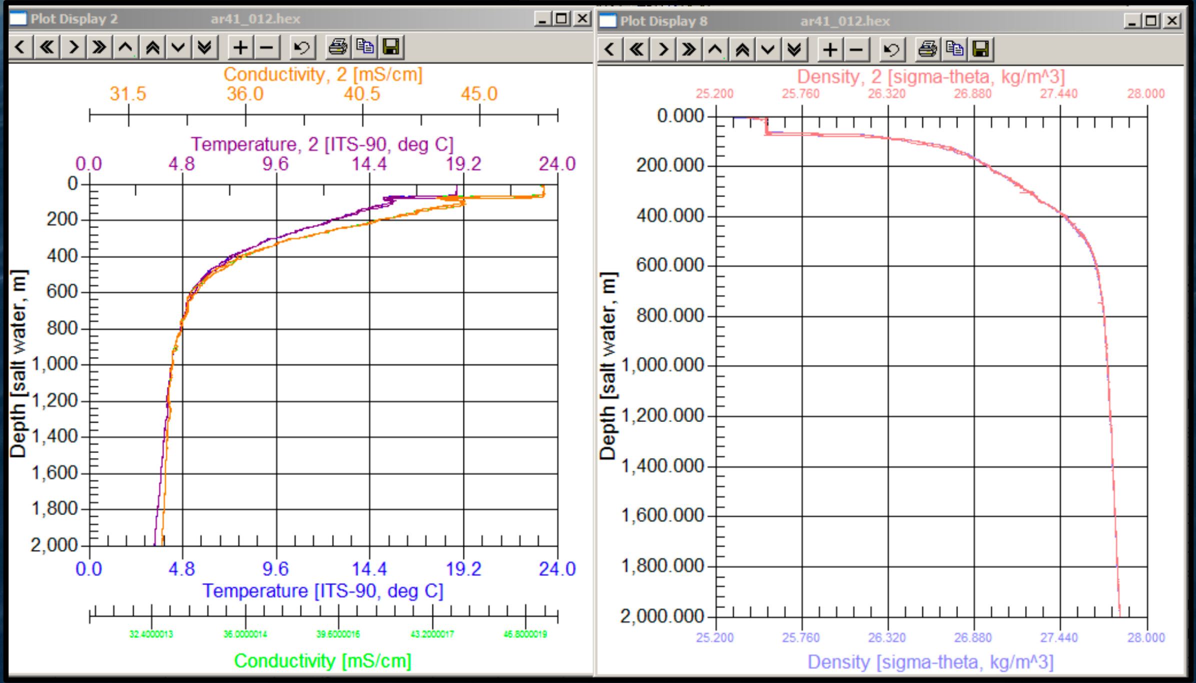
Visualizing anticipated sensor accuracies: Density plots

Calculated seawater density, in general, increases as a function of depth

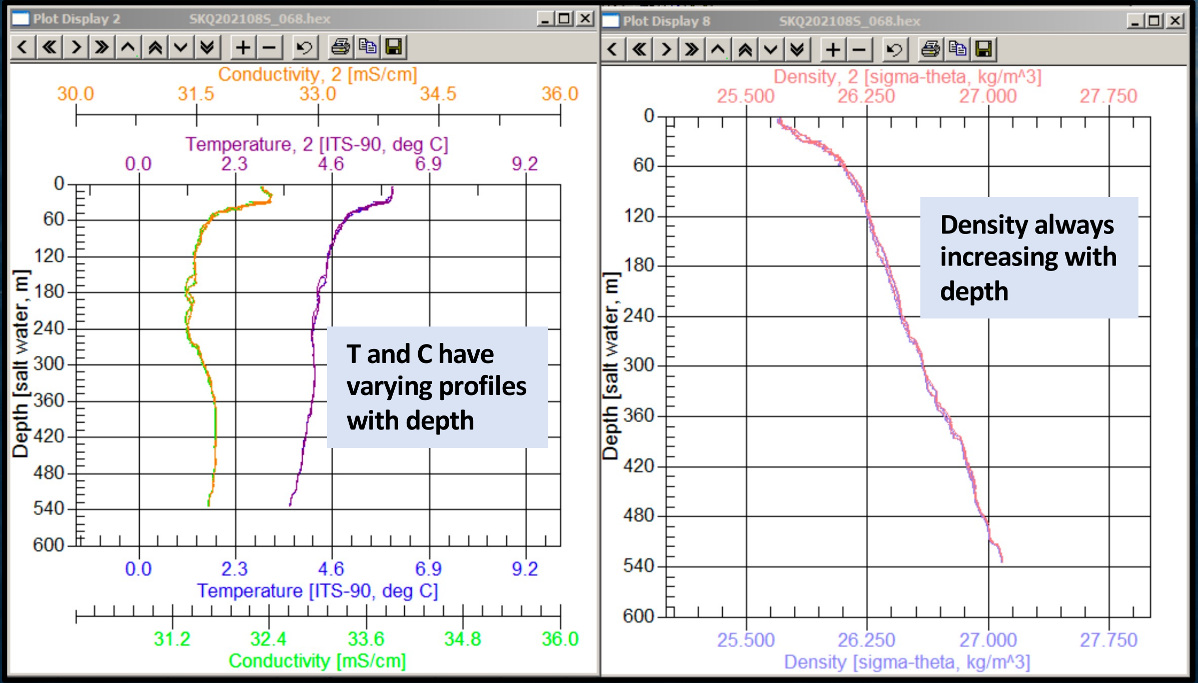
Parameter	Initial Accuracy	Maximum anticipated drift for 1 year deployment
Derived density*	±0.002 kg/m³	±0.041 kg/m³

*approx. for ranges -1-10 °C and 25-35 mS/cm

AR41



SKQ2021-08s

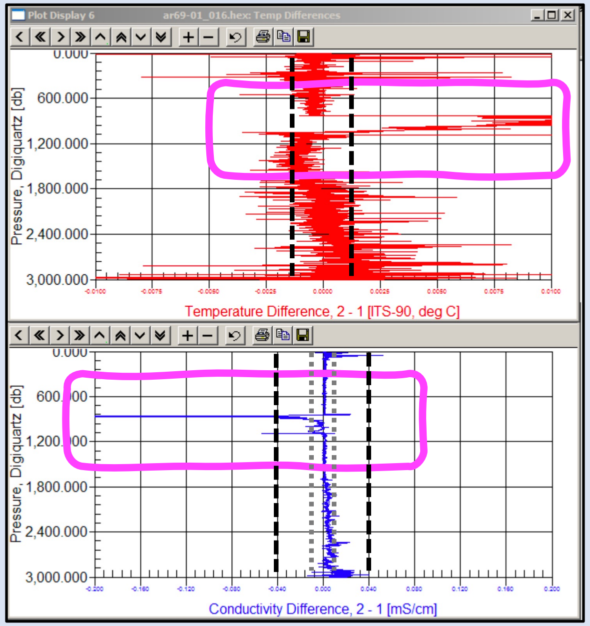


Visualizing CTD contamination during acquisition: Sudden contamination

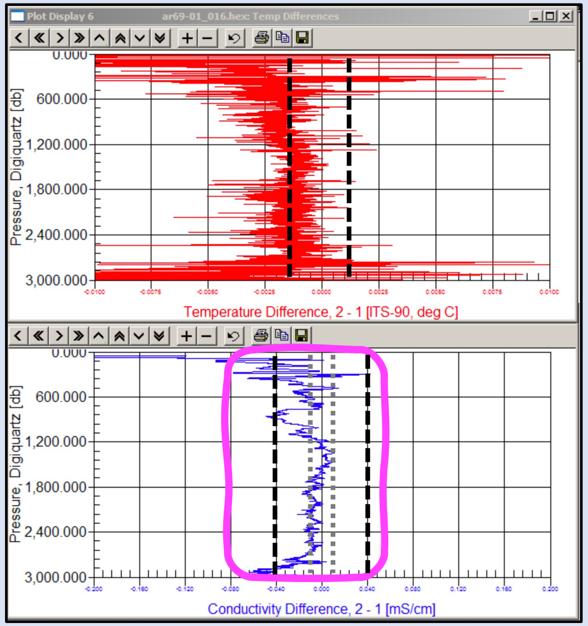
AR30-03 OOI Irminger 5

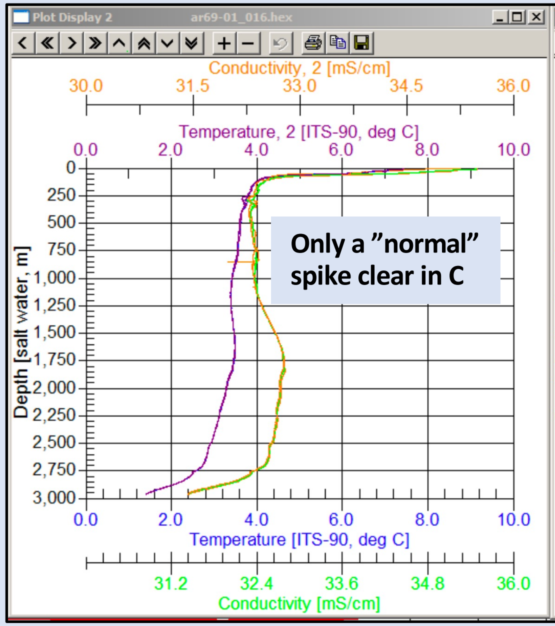
Sensor	Time between calibration and use	Anticipated accuracy
Temperature	<12 months	±0.001 °C
Conductivity	<12 months	±0.039 mS/cm, likely ±0.006 mS/cm

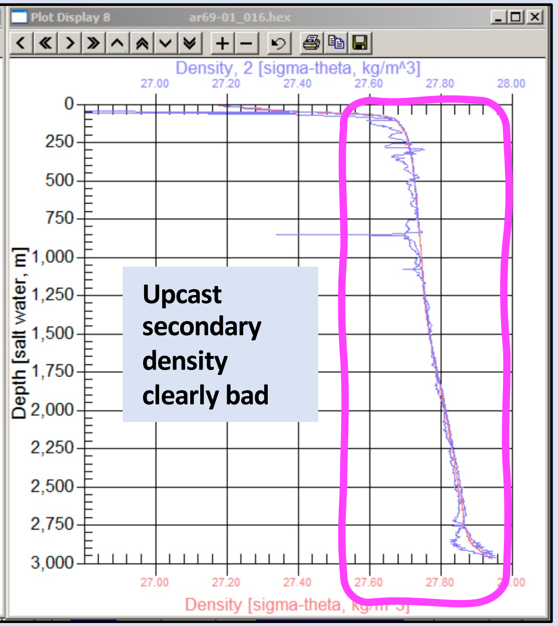
Downcast



Upcast







- The downcast plots show a sudden and large change
- The period appears brief and as though the contaminant may have flushed through the unit around 800 m
- However, during the upcast, conductivity differences were larger than 0.04 mS/cm (about an order of magnitude larger than expected)

- The upcast density clearly highlights the secondary sensor suite as being impacted by the contamination event.

<u>Impacted end users: All end users should be notified that secondary data may not be appropriate for use in any application</u>

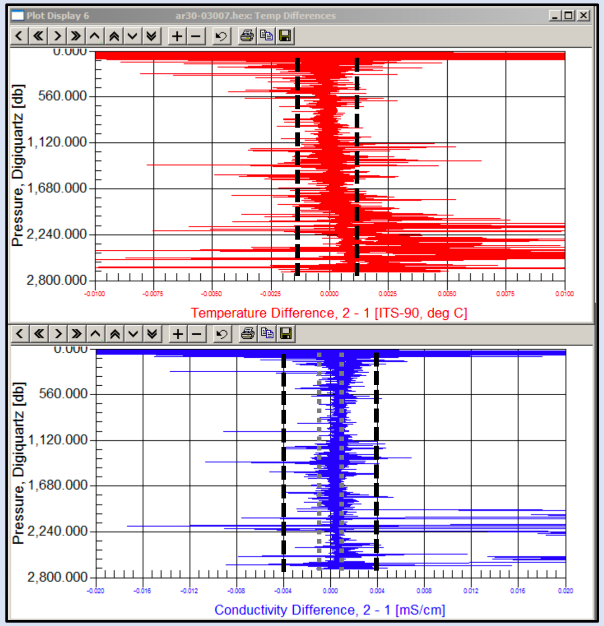
- ➢ **Direct communication with CTD POC/Chief Sci**
- ➢ **Elog event created**

Visualizing CTD contamination during acquisition: Subtle contamination

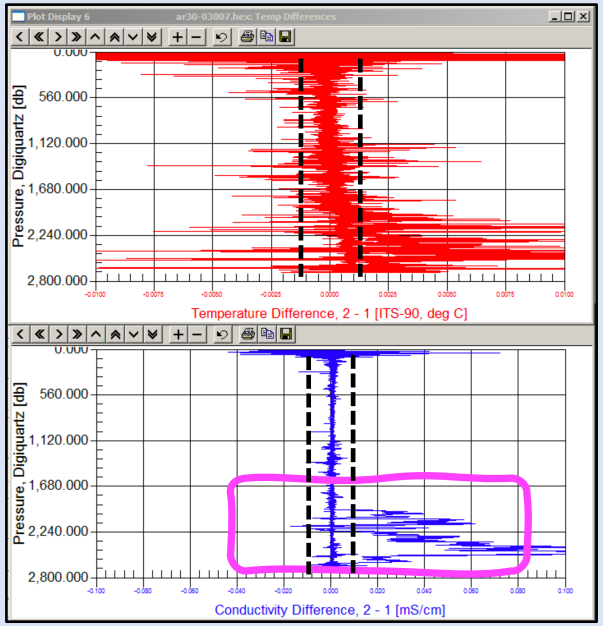
AR69-01 OOI Irminger 9

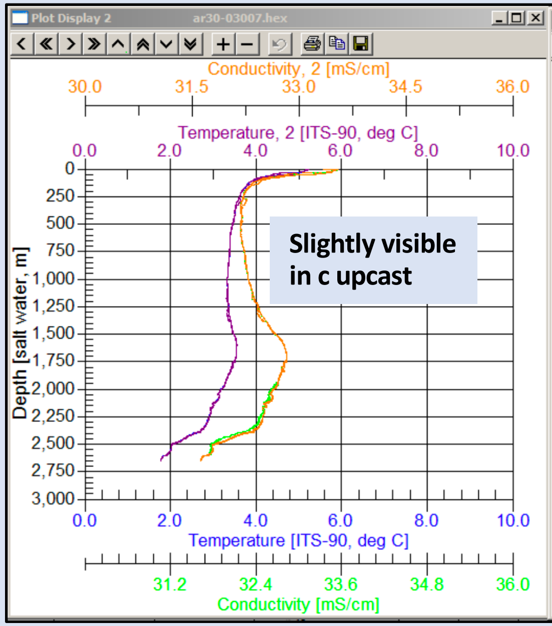
Sensor	Time between calibration and use	Anticipated accuracy
Temperature	<12 months	±0.001 °C
Conductivity	<12 months	±0.039 mS/cm, likely ±0.006 mS/cm

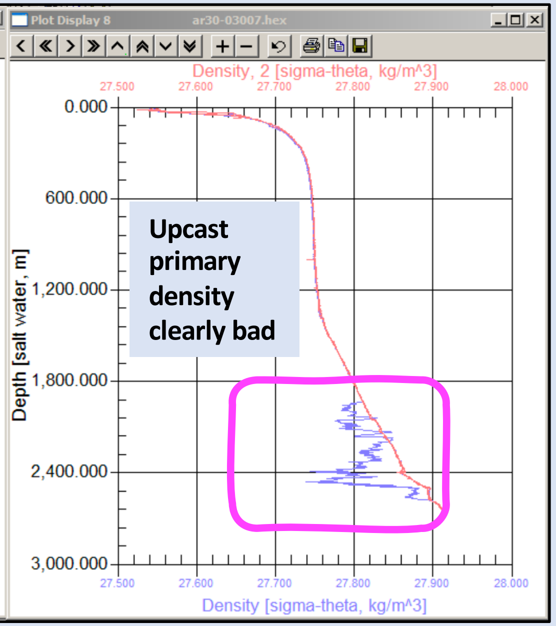
Zoomed in



Zoomed out







- Check for differences that creep off the screen as it's easy to miss larger differences
- The upcast plots near the bottom show a sudden and large change
- Conductivity differences were larger than 0.08 mS/cm (about an order of magnitude larger than expected)
- The large offset occurs only on the upcast. This was the case for 6/23 casts for the cruise.

Impacted end users: users with high accuracy needs and those requiring upcast data (any discrete water samples, sensor validation/calibration) may not be appropriate for use

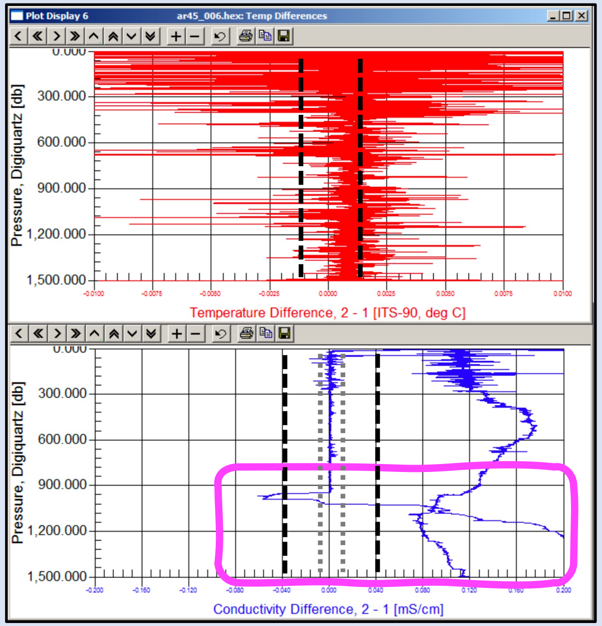
- ➢ **Direct communication with CTD POC/Chief Sci**
- ➢ **Elog event created**

Visualizing CTD contamination during acquisition: Assessing the need for cleaning

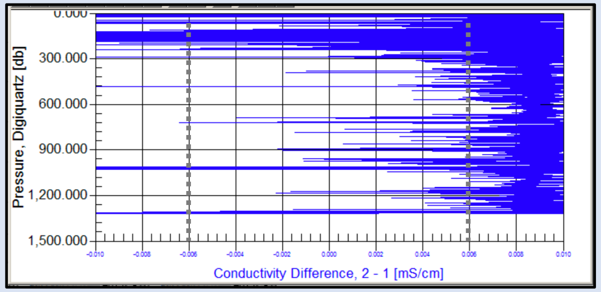
AR45 OSNAP

Sensor	Time between calibration and use	Anticipated accuracy
Temperature	<12 months	±0.001 °C
Conductivity	<12 months	±0.039 mS/cm, likely ±0.006 mS/cm

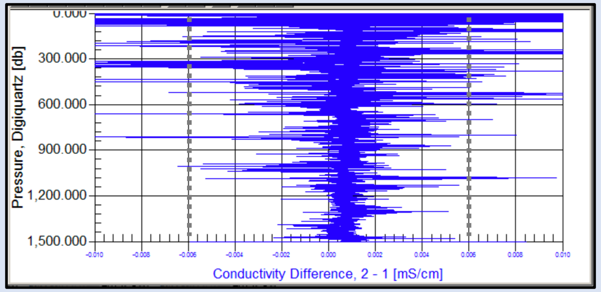
Initial event

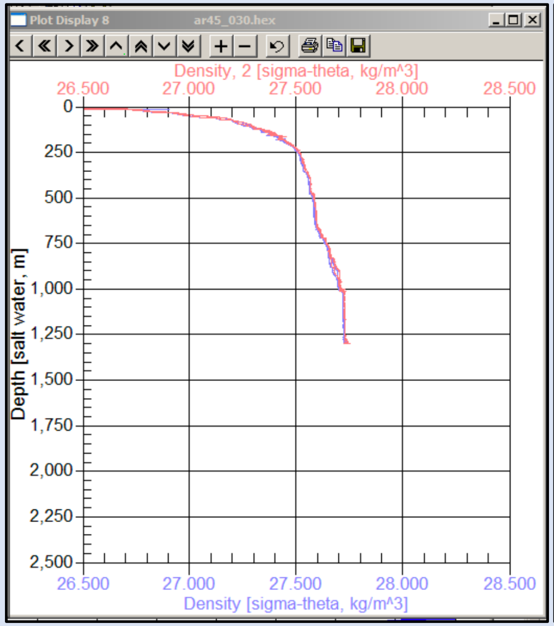


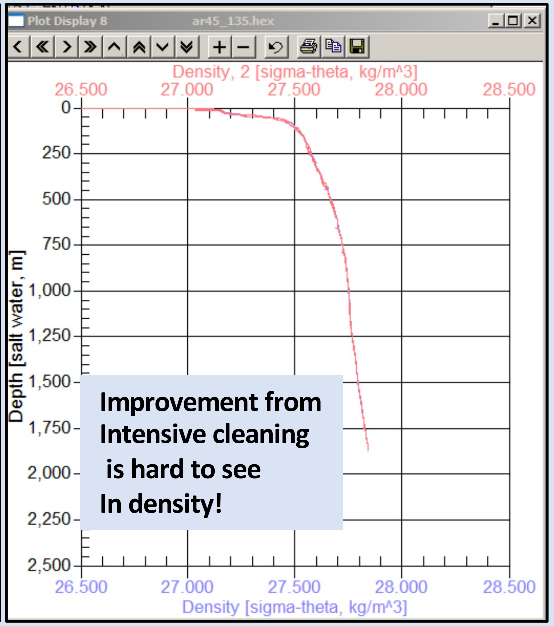
After first flushing



After intensive duct cleaning





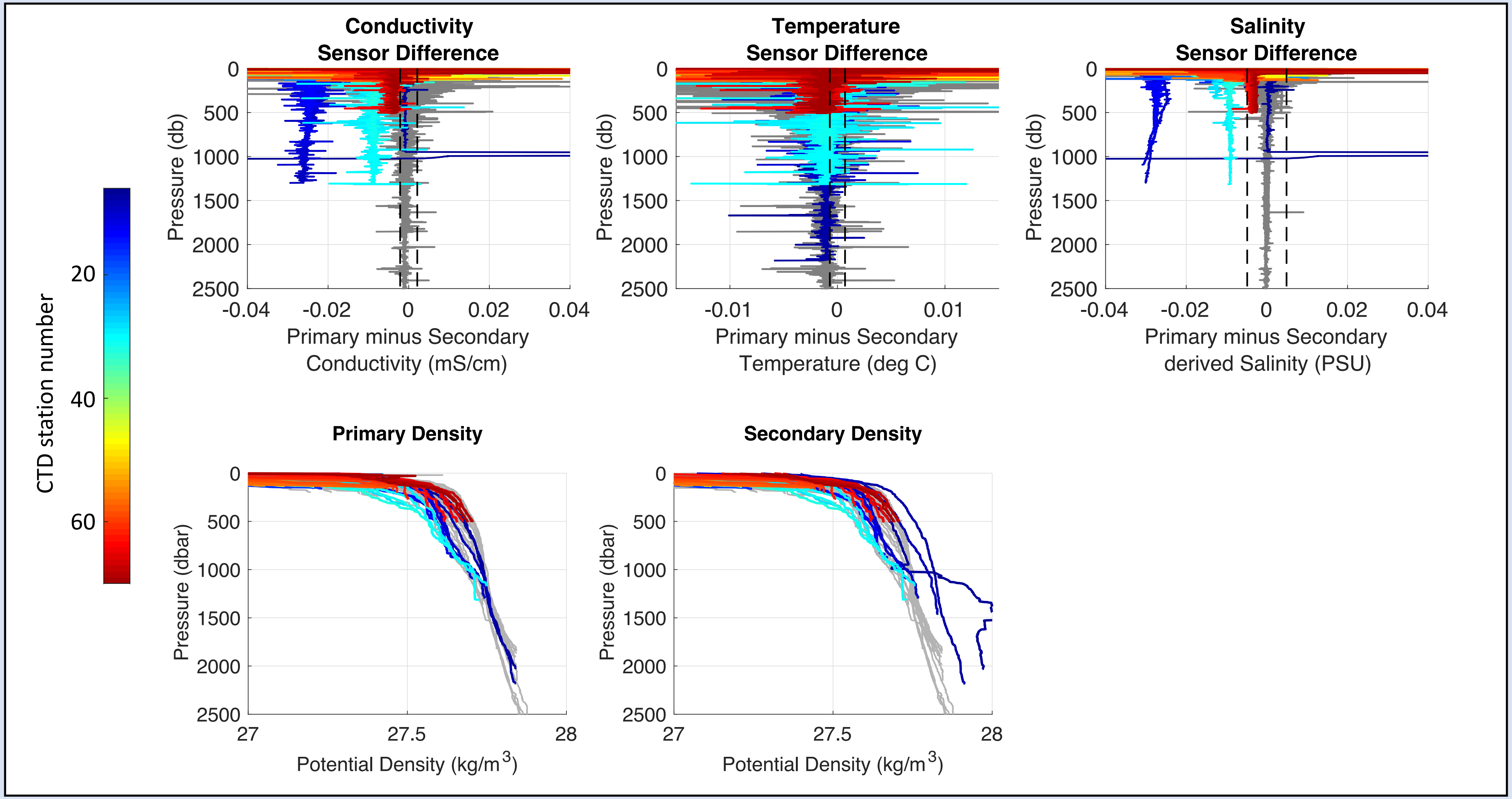


- During station 6 a sudden contamination event occurred
- After sensor flushing, conductivity differences shown in the middle upper panel are on the order of 0.01 mS/cm and within an acceptable range based on anticipated values.
- However, prior to station 6, differences were consistently lower by an order of magnitude (less than ~0.002 mS/cm).
- Additionally, subtle density inversions continued to persist in the secondary data
- The SSSGs cleaned all CTD lines more thoroughly, including rigorous flushing of the ducting and clearing the capillary hole
- This fixed all conductivity offset issues as well as the density inversions

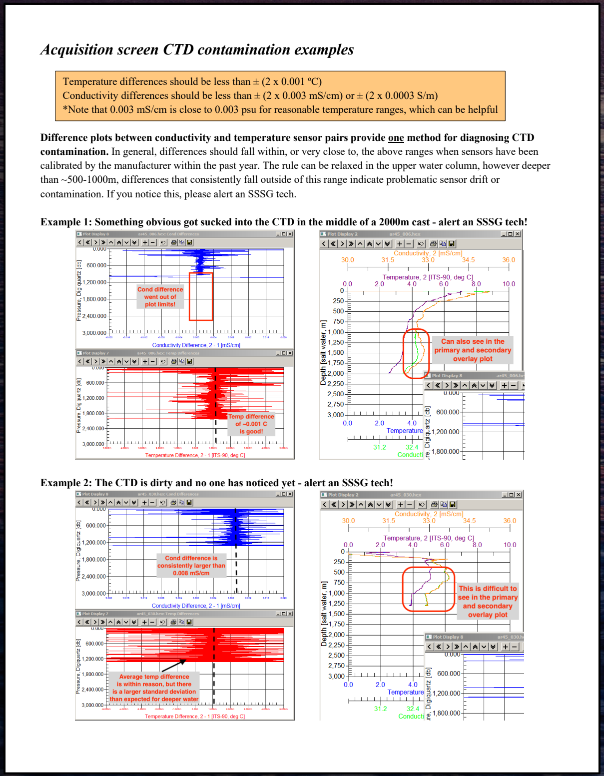
Visualizing CTD contamination during acquisition: Overlaying profiles

AR45 OSNAP

Sensor	Time between calibration and use	Anticipated accuracy
Temperature	<12 months	±0.001 °C
Conductivity	<12 months	±0.039 mS/cm, likely ±0.006 mS/cm



Resources that I am happy to share…
And I would love to hear what others have!


Acquisition screen CTD contamination examples

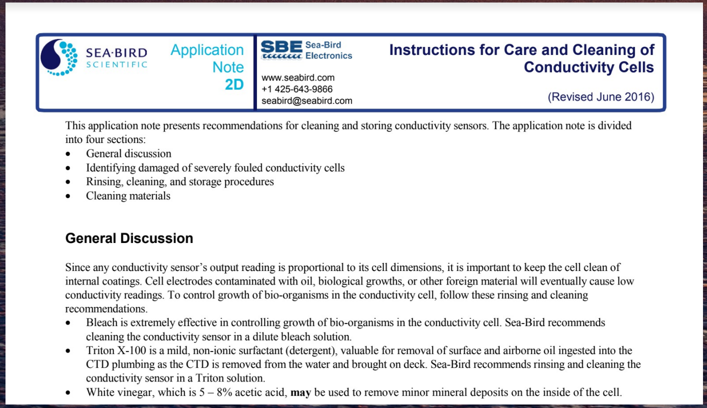
Temperature differences should be less than ± (2 x 0.001 °C)
Conductivity differences should be less than ± (2 x 0.003 mS/cm) or ± (2 x 0.0003 S/m)
*Note that 0.003 mS/cm is close to 0.003 psu for reasonable temperature ranges, which can be helpful

Difference plots between conductivity and temperature sensor pairs provide one method for diagnosing CTD contamination. In general, differences should fall within, or very close to, the above ranges when sensors have been calibrated by the manufacturer within the past year. The rule can be relaxed in the upper water column, however deeper than ~500-1000m, differences that consistently fall outside of this range indicate problematic sensor drift or contamination. If you notice this, please alert an SSSG tech.

Example 1: Something obvious got sucked into the CTD in the middle of a 2000m cast - alert an SSSG tech!

Example 2: The CTD is dirty and no one has noticed yet - alert an SSSG tech!

Quick references for acquisition screens


SEA-BIRD SCIENTIFIC Application Note 2D

SBE Sea-Bird Electronics
www.seabird.com
+1 425-643-9866
seabird@seabird.com

Instructions for Care and Cleaning of Conductivity Cells

(Revised June 2016)

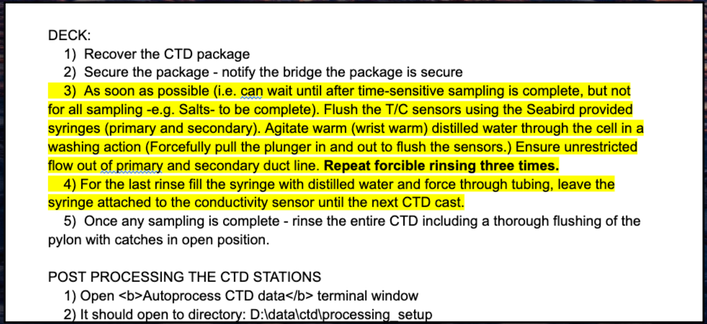
This application note presents recommendations for cleaning and storing conductivity sensors. The application note is divided into four sections:

- General discussion
- Identifying damaged of severely fouled conductivity cells
- Rinsing, cleaning, and storage procedures
- Cleaning materials

General Discussion

Since any conductivity sensor's output reading is proportional to its cell dimensions, it is important to keep the cell clean of internal coatings. Cell electrodes contaminated with oil, biological growths, or other foreign material will eventually cause low conductivity readings. To control growth of bio-organisms in the conductivity cell, follow these rinsing and cleaning recommendations.

- Bleach is extremely effective in controlling growth of bio-organisms in the conductivity cell. Sea-Bird recommends cleaning the conductivity sensor in a dilute bleach solution.
- Triton X-100 is a mild, non-ionic surfactant (detergent), valuable for removal of surface and airborne oil ingested into the CTD plumbing as the CTD is removed from the water and brought on deck. Sea-Bird recommends rinsing and cleaning the conductivity sensor in a Triton solution.
- White vinegar, which is 5 – 8% acetic acid, **may** be used to remove minor mineral deposits on the inside of the cell.

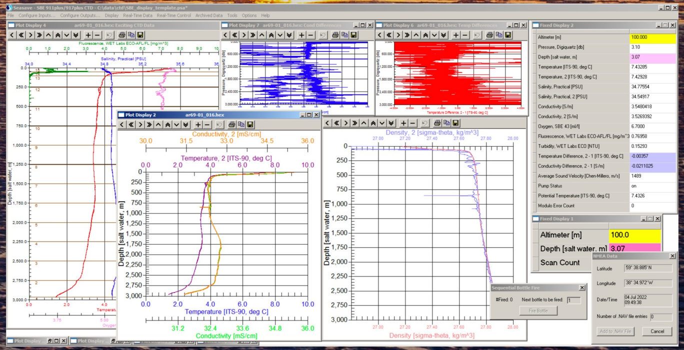

DECK:

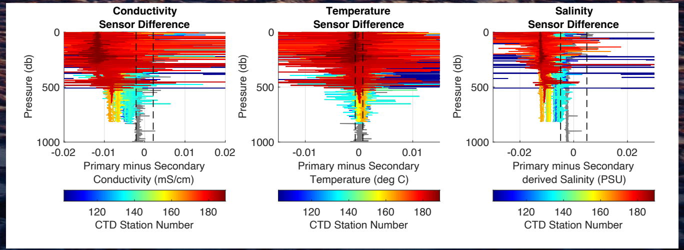
1) Recover the CTD package
2) Secure the package - notify the bridge the package is secure
3) As soon as possible (i.e. can wait until after time-sensitive sampling is complete, but not for all sampling -e.g. Salts- to be complete). Flush the T/C sensors using the Seabird provided syringes (primary and secondary). Agitate warm (wrist warm) distilled water through the cell in a washing action (Forcefully pull the plunger in and out to flush the sensors.) Ensure unrestricted flow out of primary and secondary duct line. **Repeat forcible rinsing three times.**
4) For the last rinse fill the syringe with distilled water and force through tubing, leave the syringe attached to the conductivity sensor until the next CTD cast.
5) Once any sampling is complete - rinse the entire CTD including a thorough flushing of the pylon with catches in open position.

POST PROCESSING THE CTD STATIONS

1) Open Autoprocess CTD data terminal window
2) It should open to directory: D:\data\ctd\processing_setup

Manuals and protocols for CTD sensor and duct cleaning





SBE .psa display templates and Matlab code for plotting multiple stations together

Photo: Laurie Juranek