Rolling Deck to Repository (R2R)

Best Practices for Underway Transmissometers

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The Challenge

- The R2R team envisioned starting near-real time (NRT) quality evaluation of underway parameters from flow-water systems
- Determined that present data acquisition methods are not sufficiently standardized and metadata too inconsistent/hard to locate to facilitate NRT evaluation QC

Recommendations from R2R Advisory:

- Identify flow-water parameters in physical units desired by science
- R2R to work with operators [of underway systems] to establish procedures required to derive and distribute parameters in physical units to meet user requirements
- R2R to work with operators to further document flow-water instrumentation

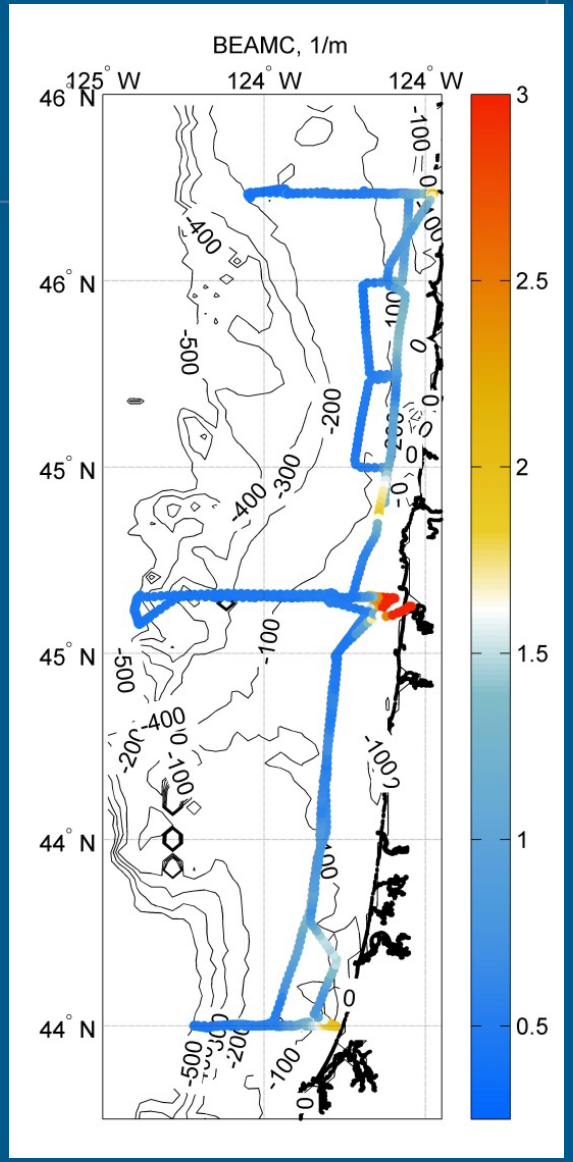
Working Group

- Established in 2018
- Started with underway transmissometers (all C-Star type in UNOLS)
- Drafted best practices that include
  - Data to record and provide to users
  - Basic C-Star Calculations
  - Metadata to document devices
  - Cleaning and in-situ calibration
  - Installation
  - Storage between cruises

Seabird
C-Star
Transmissometers
(source: datasheet_cstar.pdf)

Data to Record

- What do science users want?
  - Signal voltage (Vsig) or raw counts
    - contingent upon device configuration
  - Used by science to calculate
    - Transmittance Ratio (Tr)
    - Beam Attenuation (c)



Calculated beam-c from an underway transmissometer for a cruise off the Oregon coast.

C-Star Calculations

Transmittance Ratio (Tr) =

$$[(V_{sig} - V_{darkS})/(\mathbf{V_{ref}} - \mathbf{V_d})]^*[(\mathbf{V_{air}} - \mathbf{V_d})/(V_{airS} - V_{darkS})]$$

V_{sig} = recorded signal from instrument (in volts or counts)

V_{darkS} = dark (closed path) value from the Ship in-situ calibration

$\mathbf{V_{ref}}$ = clean water signal measured during Factory calibration

$\mathbf{V_d}$ = dark (closed path) value from the Factory calibration

$\mathbf{V_{air}}$ = air (open path, no water) value from the Factory calibration

V_{airS} = air (open path, no water) value from the Ship in-situ calibration

C-Star Calculations

Beam Attenuation (c) = -1/z * ln (Tr)

Tr = Transmittance Ratio

z = instrument path length in meters (0.10 or 0.25)

- Tr typically reported in % rather than decimal
- Tr entered as a decimal to calculate c in units of m^{-1}

Metadata Recommendations

- The following need to be provided to properly calculate transmittance ratio and beam attenuation from the signal voltage
  - Reference voltage (Vref) - From factory sensor calibration
  - Dark voltage (Vd) - From factory sensor calibration
  - Open-air voltage (Vair) - From factory sensor calibration
  - Dark voltage (VdarkS) and Open-air voltage (VairS)
    - From routine shipboard in-situ cleaning and calibration
  - Beam path length (z in meters)

Metadata Recommendations

- Also useful to properly quality evaluate or apply observations to scientific activities are
  - Wavelength of light used: e.g., 650nm (red), 530nm (green), 470nm (blue), 715nm (infrared)
  - Instrument number (serial number from manufacturer) - Traces the individual device to essential metadata
  - Technician name - Who did the ship in-situ calibration?
  - A technician/engineering log - Noting problems, cleanings, repairs, etc.

Calibration Recommendations

- In-situ V_{darkS} and V_{airS}
  - Before and after each cruise
  - Or weekly as needed for science
- V_{airS} and V_{darkS} in-situ calibration and optics cleaning should occur whenever a device is installed/swapped
- Factory Calibration
  - Yearly as a minimum
  - This resets Vref
  - Operator should routinely provide factory calibration sheet with dataset

Cleaning Recommendations

- Cleaning optics
  - Before each cruise, prior to in-situ calibration for cruise
  - Or weekly as needed for science or environmental conditions
  - If dockside for more than 1 week, the optics should be cleaned and left dry until the next cruise
- Cleaning tubing
  - After each cruise, or for long duration cruises, every two weeks
  - Or as soon as biofouling is suspected
  - Never bleach sensors, bypass when ”pickling” underway system

Cleaning & In-situ Calibration Methods

- Best practice document provides
  - A list of recommended cleaning supplies
  - Step-by-step instructions for
    - optics cleaning
    - cleaning flow tubing
    - in-situ sensor calibration to determine V_{airS} and V_{darkS}

- A second set of tubing helps with both turnaround and ensuring tubing has ample cleaning time prior to installation

Installation Recommendations

- Install a debubbler upstream of the transmissometer to reduce bubbles in the system.
- The flow-tube offered by SeaBird is recommended in conjunction with black tubing to decrease biofouling.
- Water should flow from bottom to top

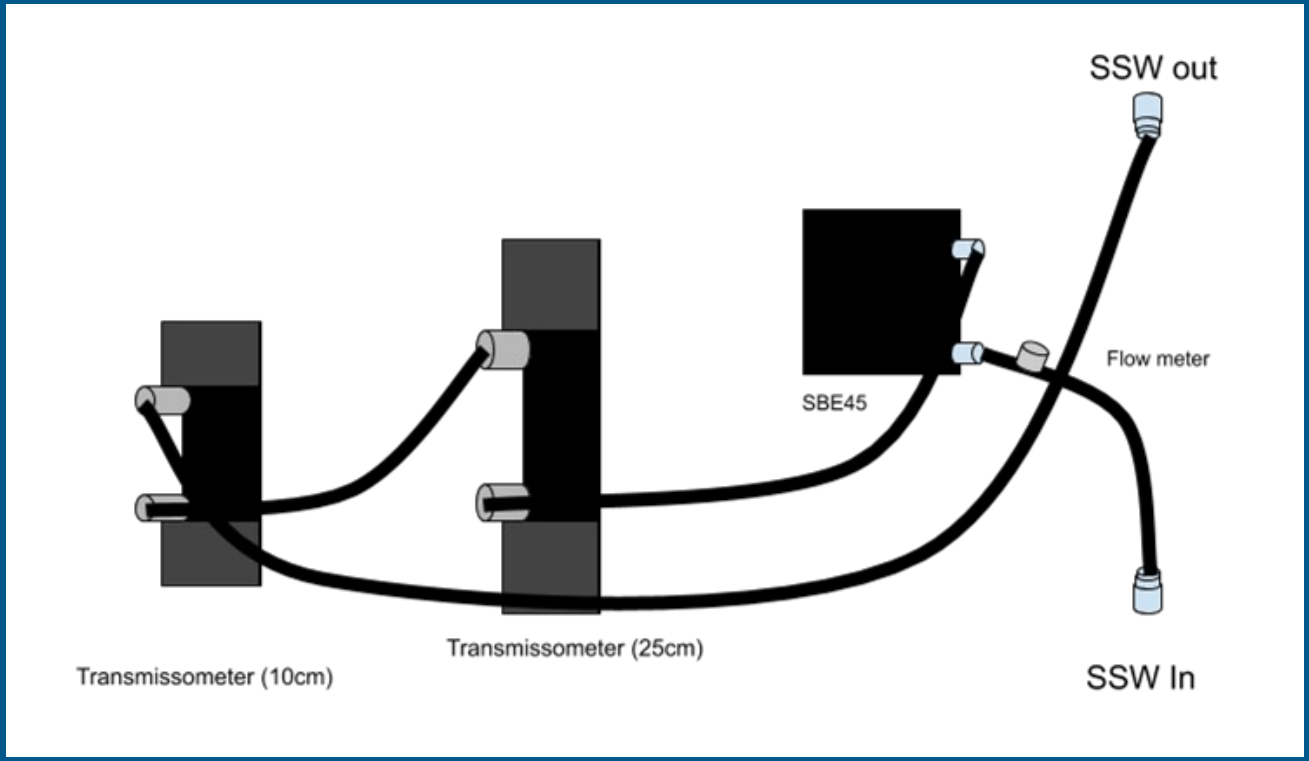


Diagram of science sea-water system on R/V Armstrong

Storage Recommendations

- Conduct a fresh-water flush of the entire underway system to remove any seawater.
- Drain the system of all water.
- Follow the Cleaning Procedures as outlined.
- Re-assemble the system, clean and dry.

Summary

- Working group created draft Best Practices document for Underway Transmissometers
  - https://www.rvdata.us/files/Transmissometer_Best_Practices_v2_final.pdf
- Seeking input from RVTEC
  - Send feedback to srsmith@fsu.edu by 30 November 2019
- Once revised:
  - Encourage adoption of practices on U.S. research vessels
  - Document will be submitted to International Ocean Data Exchange best practices repository (https://www.oceanbestpractices.org/).

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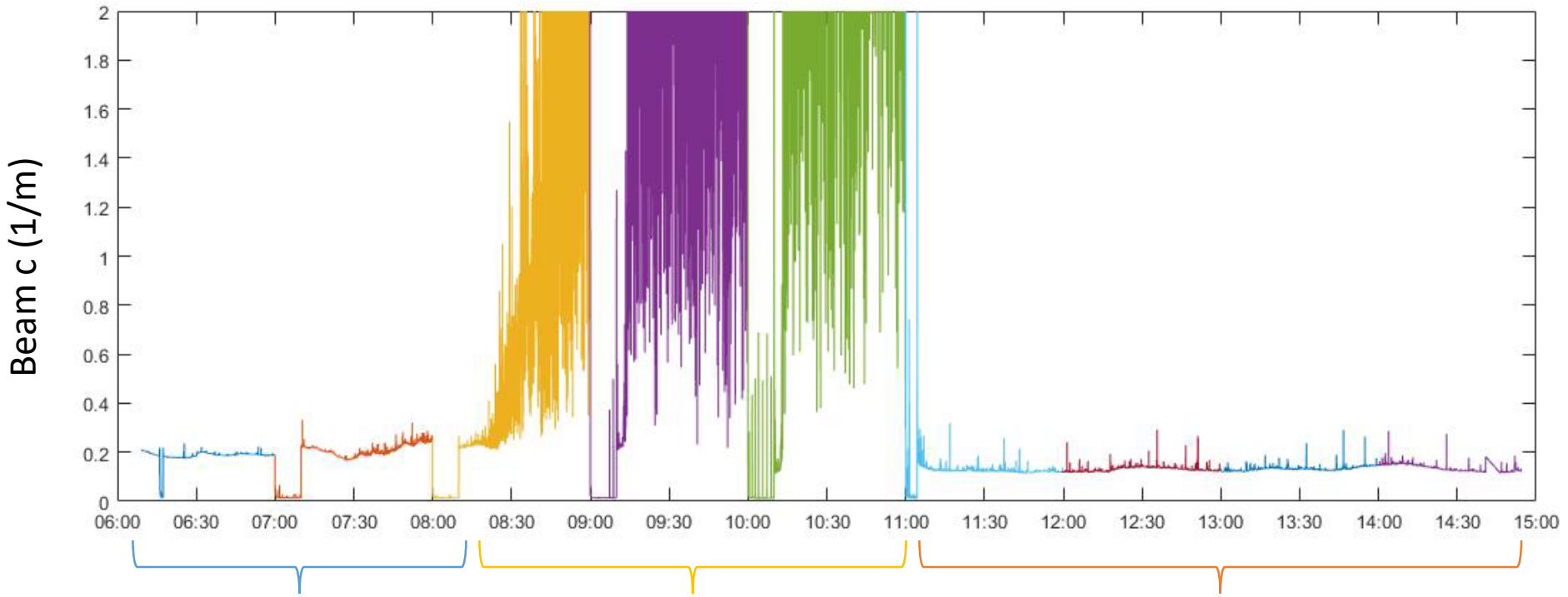
Trouble with the Bubble & a good example of when a little bit of everything goes right and wrong…



Good data, a few bubbles but fine, steady, reasonable total (0.12- 0.4) and filtered (0.05 – 0.1 values

Bad data, bubble city, noisy, unreasonable total (any value >1) values; filtered values not unreasonable but bubbles are still apparent spikes=bubble trouble

Good data, a few bubbles but fine, steady, reasonable total (~0.2); filtered values non-existent meaning issues with the filter, in this case no filter on the hour every hour