Review best practices in glider operations: Glider platforms in the lab

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22 May 2012/Mallorca Groom/Jerico workshop

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Zentrum für Material- und Küstenforschung

Content

→ Platform maintenance
→ Sensor maintenance
→ Sensor calibration
→ Intercalibration for multiple gliders

Platform maintenance

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Seaglider

- → Refurbishments (battery exchange) typically done by manufacturer (iRobot)
- → Pressure from glider users: iRobot offers training to customers or companies to do refurbishments
  - In practice: not all customers can benefit (high costs for training)
  - In practice: Seaglider maintenance still involves shipping the whole glider to US (complex due to lithium batteries and long return times)
- → Upside: most vehicle maintenance not in hands of user

Slocum

- → Refurbishments (battery exchange) typically done by user
- → Theory: you buy a high-quality product and would only need to replace batteries and ballast. In practice: a lot of time is spend on repairs of all kind of sorts.
- → Upside: many things can be repaired without expensive (time and money) returns to manufacturer.

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Slocum: best practices

- → Battery change: alkaline / lithium
- → Ballasting, follow manufacturer instructions, but some calculation aids can be developed.
- → Degassing of 1000m oil-pumps
- → Repairs of various kinds?
- → O-ring maintenance?

Platform maintenance

Spray

→ ... (no feed back)

General

- → Database with info on all gliders, sensors and work done.
- → DT-INSU has implemented such a database for their glider fleet of 18 gliders.
- → Coupled to GFCP.

Web link:
https://glider83a.dt.insu.cnrs.fr/maintenance

Sensor maintenance and calibration

Commonly used sensors:

→ CTD, pumped and unpumped

→ Optical sensors

- Fluorescence
- Turbidity
- Optical backscatter
- CDOM
- Irridiance

→ Oxygen

CTD

CTD comes in two versions: unpumped (old) and pumped (new)

Maintenance important because of bio-fouling and dirt, in particular to conductivity cell. A method for CTD maintenance is given in:

Medeot et al., 2011, *Laboratory Evaluation and Control of Slocum Glider C–T Sensors,* Journal of Atmospheric and Oceanic technology.

Cleaning cell with Triton X-100, and bleach, rinse with de-ionised water.

Many, if not most, groups don't do this, however.

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CTD

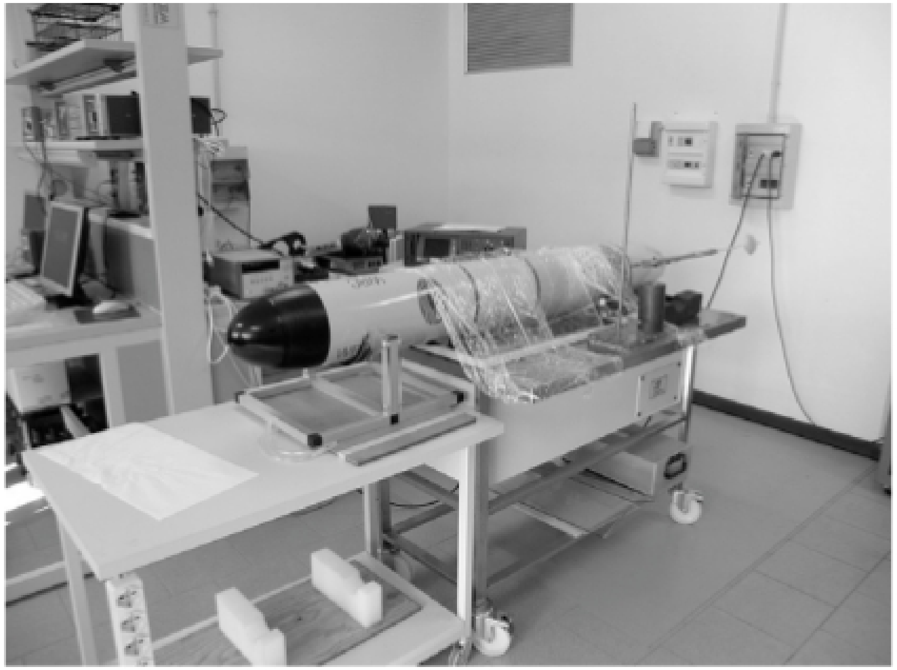
CTD comes in two versions: unpumped (old) and pumped (new)

Calibration important because of

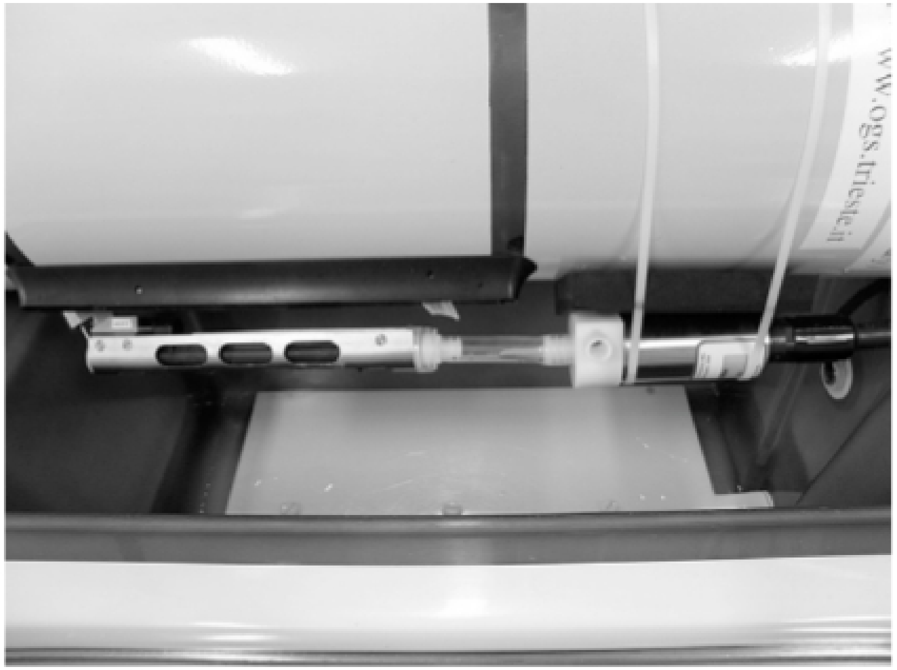
- → Sensor drift
- → Thorough cleaning may not render sensor state as original factory state.

A method for lab calibration is described in (again):

Medeot et al., 2011, *Laboratory Evaluation and Control of Slocum Glider C–T Sensors,* Journal of Atmospheric and Oceanic technology.



A view of the TWR Slocum glider testing setup.



A close-up of the glider C–T hookup with the SBE 5M submersible pump.

Figures from Medeot et al. 2011

CTD

A method for lab calibration is described in (again):

Medeot et al., 2011, *Laboratory Evaluation and Control of Slocum Glider C–T Sensors,* Journal of Atmospheric and Oceanic technology.

Only OGS does this, however.

NURC proposed CTD calibration facility at EGO meeting in Gran Canaria.

Further information lacking.

CTD – Calibration in the field

Calibration against shipborne CTD casts

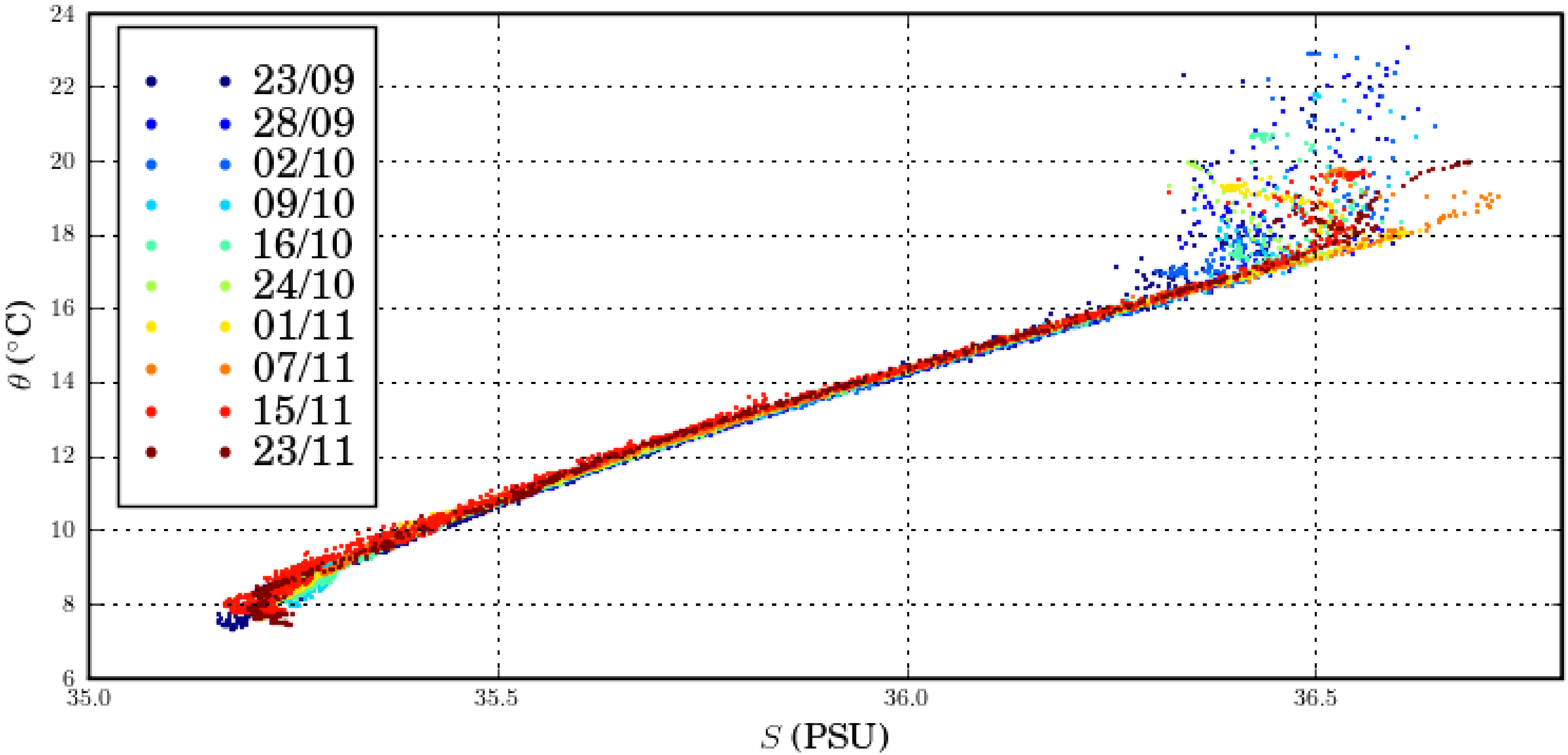
→ Directly: glider(s) mounted in CTD frame
→ Indirectly: gliders in waters near CTD casts

Indirect method works if water is deep enough so that S-T properties are well-defined and stable, but problematic In shallow or coastal waters.

Figures from Medeot et al. 2011

CTD – Calibration in the field

Indirectly: gliders in waters near CTD casts: example from Rapid array (2008), NOC data.



CTD – Calibration in the field

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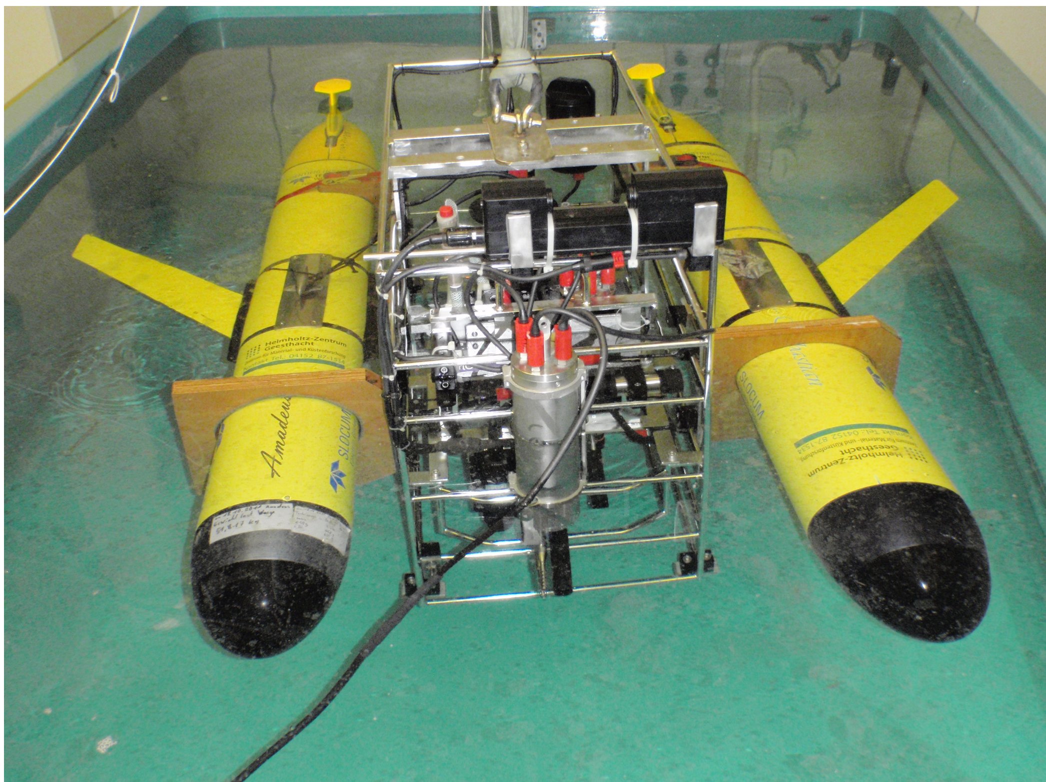
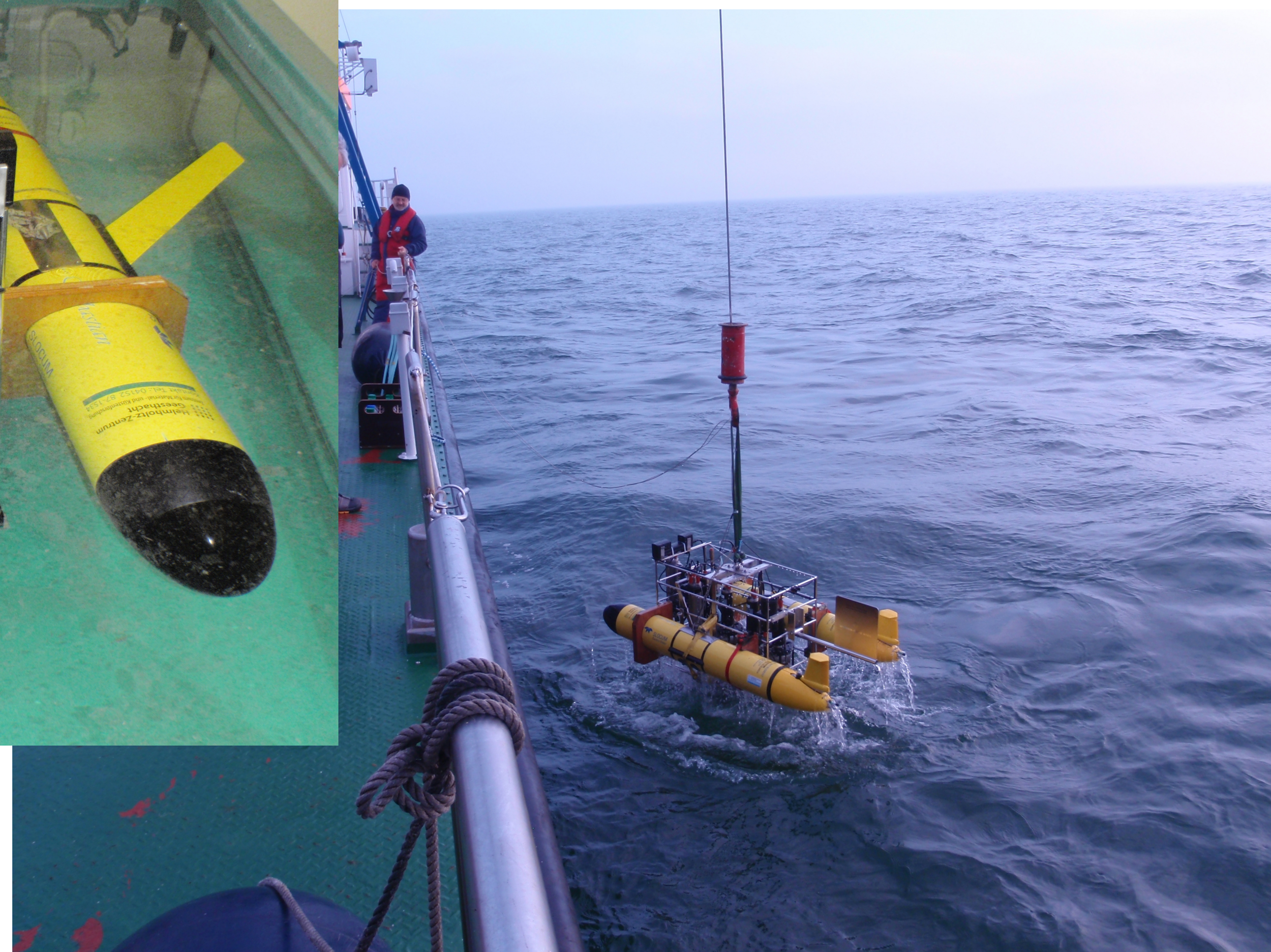
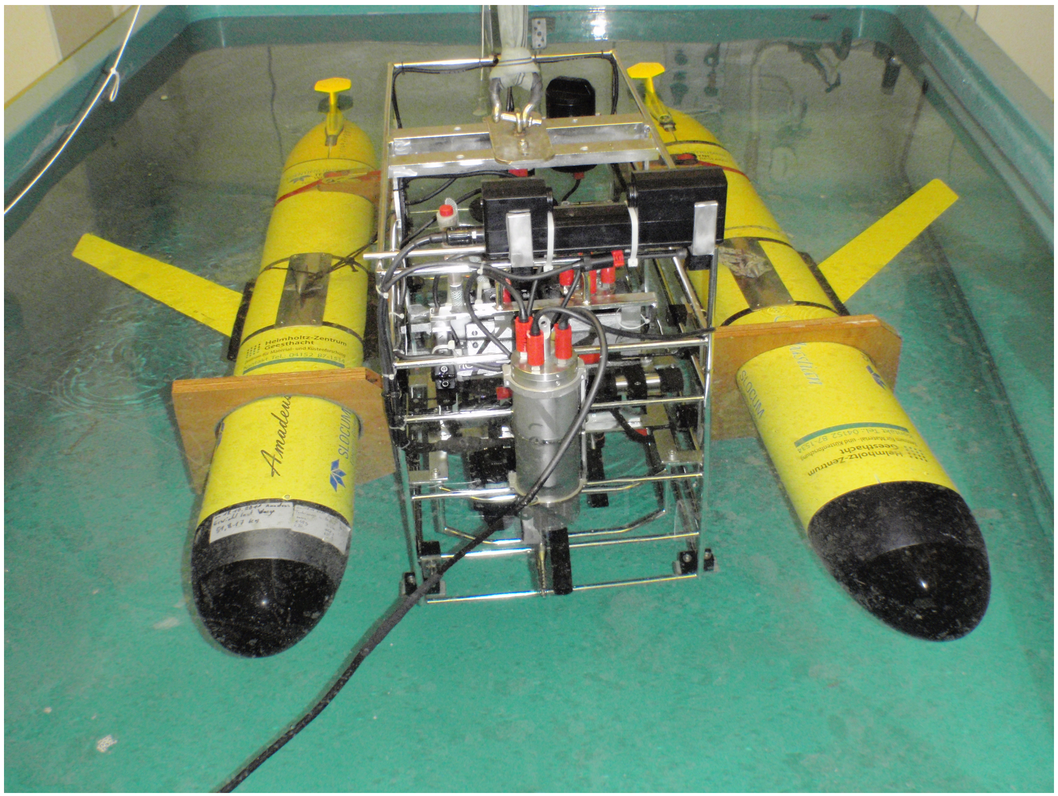
Directly: gliders in frame with reference sensors: (HZG)





CTD – Calibration in the field

Directly: gliders in frame with reference sensors: (HZG)



Characteristics:

→ CTD
→ Turbidity
→ Transmission
→ (Oxygen)
→ Water samples (3 x 2 litres)
→ Operated using A-frame or or crane from fairly large ship.
→ About 150 kg.

DT- INSU schedules similar setup but smaller (CTD only?) for use on rubber boats.

CTD – Calibration in the field

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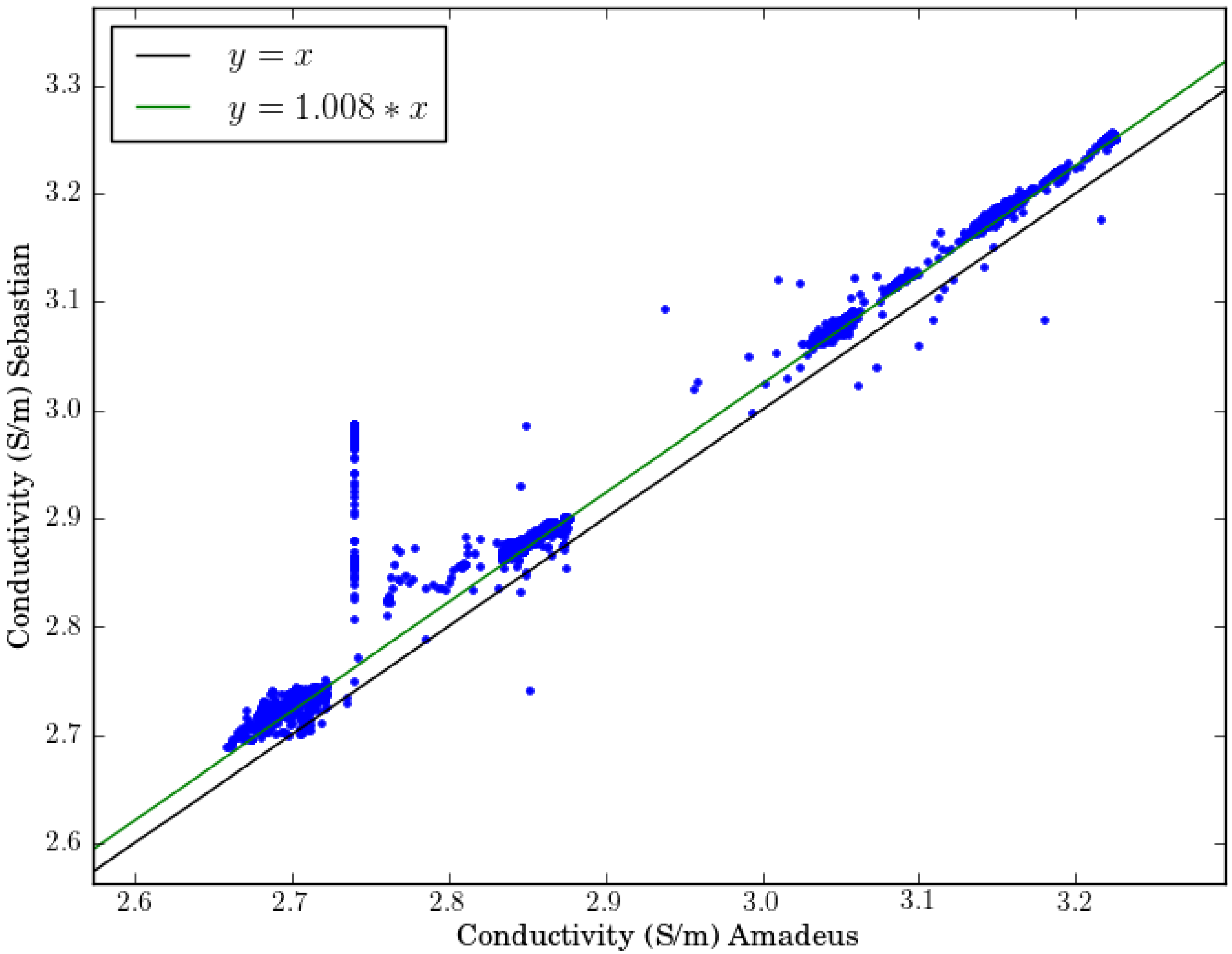
Directly: gliders in frame with reference sensors: (HZG)

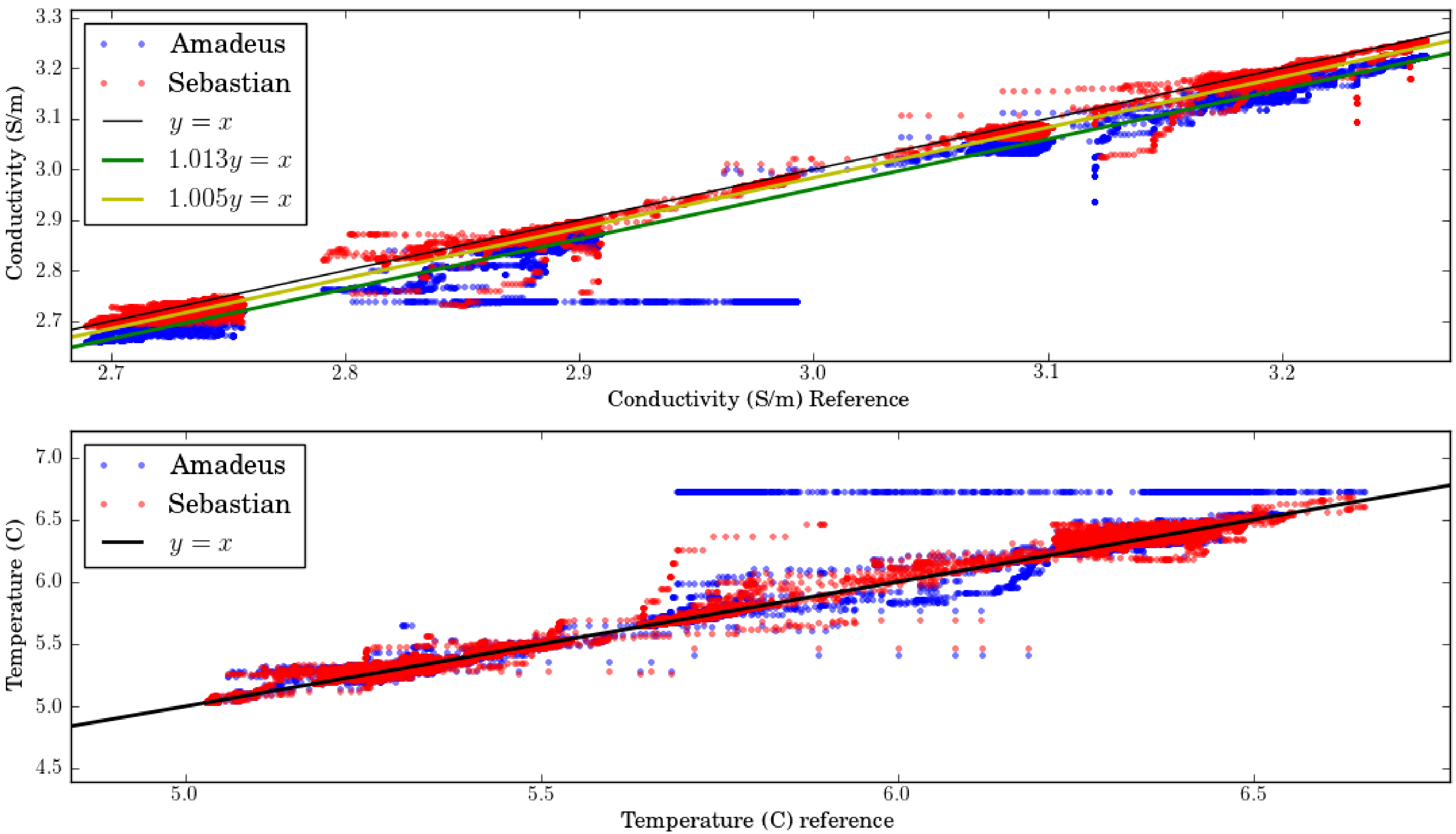


Issues with time base and interpolation

Issues with flow rate through unpumped CTD.

CTD – Calibration in the field

Directly: gliders in frame with reference sensors: (HZG)



CTD – Slocum glider

General also necessary: thermal lag correction. Not covered here.

On Slocum at least, the timestamps of the data acquisition procedures CANNOT be relied upon.

Solution is to log the timestamps of the measurements for each sensor.

NOTE: default setting on Slocum gliders is that the measurement timestamp is NOT logged.

Oxygen – Aanderaa Optodes

Maintenance:

- Replacing foils
- Keeping foils hydrated
- Cover to protect from UV

Oxygen – Aanderaa Optodes

Calibration:

- Remove from glider and add to regular CTD frame (Geomar)
- Calibrate sensors using a 2-point calibration (0-100%) saturation. (DT-INSU) Aanderaa is to provide multi-point calibrations, as is a lab in Marseille.
- Winkler titrations on several replicates from samples (NOCL and UEA). Important to have reasonably homogeneous water masses.

Opitcal sensors – Wetlabs and Satlantic

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Calibration:

- Remove sensors from glider and return to manufacturer. Drawback is long turn-around times (about 6 weeks or more).
- Do in-house calibration or field calibration
  - Satlantic irridiance sensors are calibrated in dedicated dark-room at NURC. Sensors appear to deteriorate by about 5% yearly.
  - Wetlabs sensors are calibrated in the field.

Opitcal sensors – Wetlabs and Satlantic

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Calibration of Wetlabs sensors:

- Suspended particulate matter (SPM)
- Chlorophyll_a
- CDOM

NOCL has a detailed protocol to determine Chl_a and CDOM quantities from samples, against which glider data are compared.

- Chl_a using a fluormetric method
- CDOM using a spectrophotometer

Opitcal sensors – Wetlabs and Satlantic

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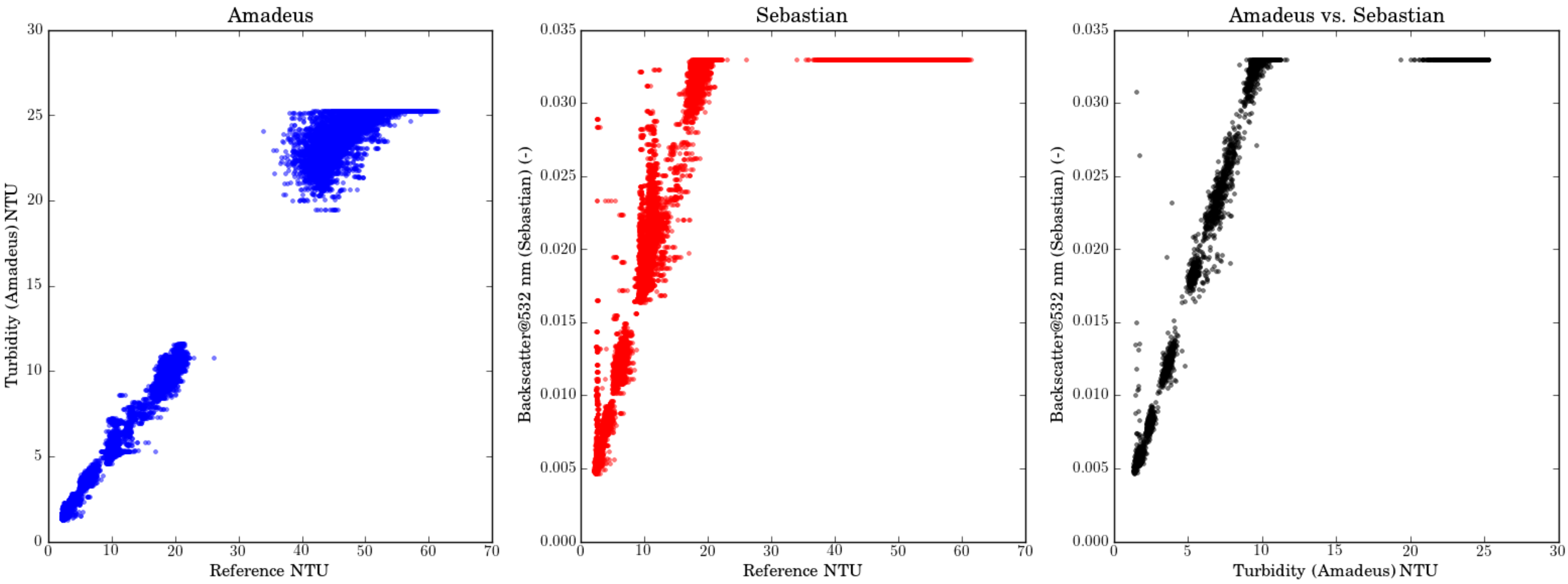
Calibration of Wetlabs sensors SPM: Example of two different sensors. (Preliminary results and not compared with water samples yet.)



Opitcal sensors – Wetlabs and Satlantic

Things to determine/investigate:

- ➔How various sensors relate,
- ➔How sensors drift due to aging,
- ➔How sensor sensitivity changes in time due to change in the environment

Not sure how much work on this is done by or known to Groom partners, but careful to avoid re-inventing the wheel.