

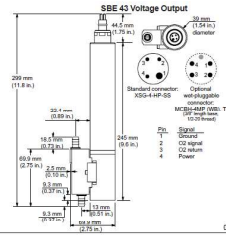


SBE43 Dissolved Oxygen sensor

SBE43 ship-based data: issues and recommendations

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Specifications
 Measurement range: 120% of surface saturation in all natural waters, fresh and salt
 Initial accuracy: 2% of saturation
 Typical stability: 0.5% per 1000 hours (clean membrane)



Clark-cell sensor (electrochemical)
 Most common sensor used to measure DO concentrations during CTD profiles (fast response)

Known issues with SB43 sensor

Advantages:

- automatic measuring system
- generating continuously data
- acceptable resolution/accuracy

Disadvantages:

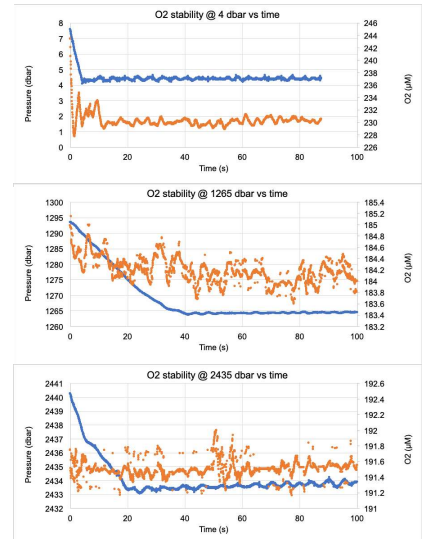
- extensive calibration/maintenance work before installation necessary
- long-term stability is limited to the reaction of the electrolytical liquid
- susceptible to bio-fouling

Need to use Winkler measurements as reference values to correct SBE43 drift during the cruise

Follow SBE cleaning procedure and respect SBE43 response time during CTD cast (closing Niskin bottle after 30s)

Example of SBE43 response time in ANTARES site (NW MED)

Pressure (dbar)
 Dissolved oxygen ($\mu\text{mol/L}$)



Care of SBE 43 Oxygen Sensors in the Field

- Oxygen sensitivity may be **maintained** by briefly rinsing the sensor with 0.1% Triton X, and then rinsing thoroughly with distilled water
- Oxygen sensitivity may be **restored** by:
 1. Briefly (1 minute) rinsing with 0.1% Triton X,
 2. Rinsing thoroughly (5 minutes) with distilled water,
 3. Soaking (1 minute) in dilute chlorine bleach,
 4. Rinsing thoroughly (5 minutes) in distilled water.



Dissolved Oxygen best with moist sponge instead of water

WINKLER measurements cautions

- **Careful when using reagents** : one bubble of 50 mm³ (50 μL) represents an input of 1.5 μmol of O₂ which corresponds to an error of 4 μM on O₂ concentrations !
- **Need to calibrate the volume of Winkler bottles**: for 150 ml bottles, an error of 50 mg induces an uncertainty of O₂ concentrations around 0.15 μM



SBE43 – Winkler adjustment method

- Choose depth for CTD and Winkler water sample comparisons where DO is not changing much but collect all water column area
- Follow SBE data processing to correct deep hysteresis

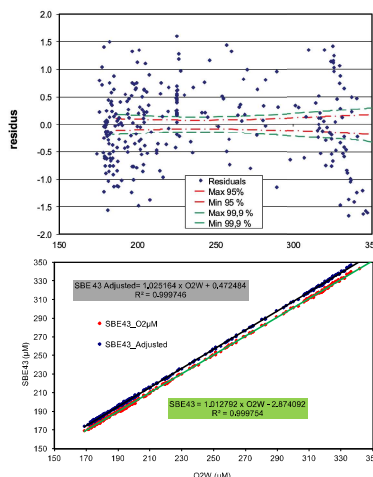
Least square fitting method:

- Compare upcast bottle files and Winkler values (pressure or density level)
- Remove bad Winkler data (QF = bad). Near surface higher standard deviation
- Group values by Winkler / SBE43 ratio (homogenous)
- Adjust SBE43 calibration coefficients (SOC, offset, E) to minimize residuals $R = (\text{SBE43 adjusted} - \text{Winkler})^2$
- Remove values with $R > 2.8 \times \text{stdev} [R]$
- Re-process coefficients adjustment until all $R < 2.8 \times \text{stdev} [R]$
- Reprocess CTD downcast files with new SBE43 coefficients

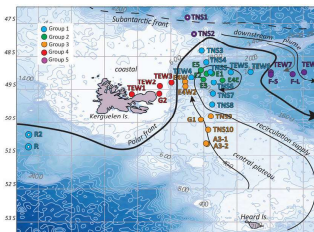
$$\text{Oxygen (ml/l)} = \left\{ \text{Soc} * \left(V + \text{Voffset} + \text{tau}(T, P) * \frac{\partial V}{\partial t} \right) \right\} * \text{Oxsol}(T, S) * (1.0 + A*T + B*T^2 + C*T^3) * e^{\frac{E*P}{K}}$$

$$\text{Oxygen (ml/l)} - \text{Soc} * (V + \text{Voffset}) * \phi$$

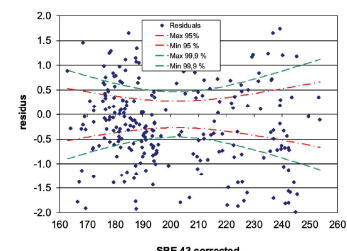
Example with KEOPS2 cruise (Southern Ocean)



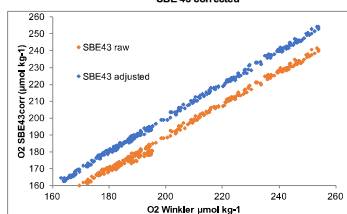
- Perform Winkler measurements from surface to bottom on 25 stations (1 profile per day = 320 data)
- SBE43raw - Winkler = 9-16 µmol/kg
- After fitting $R = \pm 2$ µmol/kg
- SBE43adj - Winkler < 1 µmol/kg



Example with PEACETIME cruise (MED SEA)



- Perform Winkler measurements from surface to bottom on 34 stations (1 profile per day = 365 data)
- SBE43raw - Winkler = 10-15 µmol/kg
- After fitting $R = \pm 2$ µmol/kg
- SBE43adj - Winkler < 1.5 µmol/kg



Final recommendations

- Clean regularly the SBE43 sensor after CTD casts
- Use Winkler titration as reference values: careful with the use of reagents and require calibrated volume vials
- Collect seawater samples outside DO gradients from surface to deep layers and respect some time before closing the Niskin bottles
- One Winkler profile per day should be enough to correct SBE43 drift
- Use the least square fitting method after verify the Winkler/SBE43 ratio: remove bad values and outsiders residual
- Use this method to adjust SOC, Offset and E coefficients
- Re-process the SBE43 values with new coefficients
- Perform a SBE43 calibration every year (depends on the use of the sensor)