

Evaluation of a lifetime-based optode to measure oxygen in aquatic systems

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Web Appendix 1

Salinity compensation of oxygen readings from optode and calculation of % saturation at a given salinity and temperature (Garcia and Gordon, 1992).

Input variables:

$[O_2]$ = O_2 concentration in μM , from the optode

t = temperature in degrees Celsius, from the optode temperature sensor

S = salinity in ppt, from a parallel salinity measurement

Empirical constants:

$$A_0 = 2.00856$$

$$A_1 = 3.22400$$

$$A_2 = 3.99063$$

$$A_3 = 4.80299$$

$$A_4 = 9.78188 \times 10^{-1}$$

$$A_5 = 1.71069$$

$$B_0 = -6.24097 \times 10^{-3}$$

$$B_1 = -6.93498 \times 10^{-3}$$

$$B_2 = -6.90358 \times 10^{-3}$$

$$B_3 = -4.29155 \times 10^{-3}$$

$$C_0 = -3.11680 \times 10^{-7}$$

Intermediate calculations:

$$T_s = \text{scaled temperature} = \ln[(298.15 - t)/(273.15 + t)]$$

$$\alpha = S(B_0 + B_1 \cdot T_s + B_2 \cdot T_s^2 + B_3 \cdot T_s^3) + C_0 S^2$$

$$\beta = A_0 + A_1 T_s + A_2 T_s^2 + A_3 T_s^3 + A_4 T_s^4 + A_5 T_s^5$$

Final results:

Salinity compensated oxygen concentration

$$O_2 [\mu M] = [O_2] \cdot e^\alpha$$

100% oxygen saturation with air at a pressure of 1013 mbar:

$$O_{2,100\% \text{ sat}} [\mu M] = e^{(\alpha + \beta)} / 2.2414$$

percent saturation in the given water

$$O_{2,\text{sat}} [\%] = O_2 [\mu M] / O_{2,100\% \text{ sat}} [\mu M]$$