Dissolved oxygen sensors

Calibration needs, current practices and alternatives

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2nd FCT Workshop – London, 13 march 2014

1 – Current status: needs, practices and lacks

2 – Up to date recommendations

3 – Alternatives

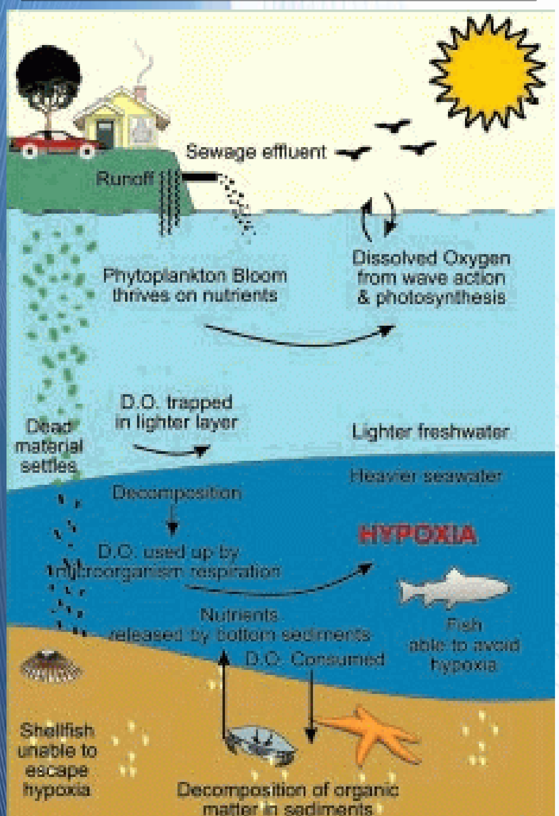
Scientific needs

Ifremer

Coastal waters

- Water quality index
- Biomass indicator

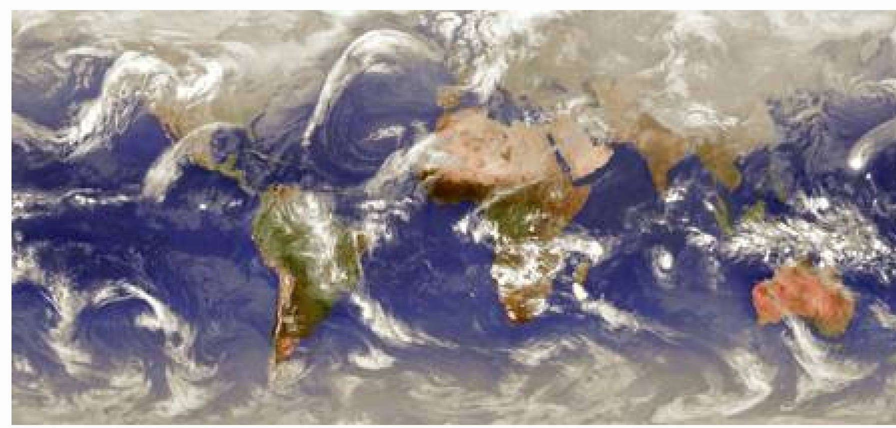
≈ 5 to 6 µmol/l



Open ocean

- Climatology
- Water masses
- Mixing processes
- Biogeochemical processes

≈ 1 µmol/l



Situation (practices and lacks)

Calibration common practices:

1- Manufacturer recommendations:

- Calibration at 100% (stirred water or humid air)
- Calibration at 0% (sodium sulphite)

2- Calibration lab recommendations:

- Winkler as reference measurement for 100%

Do not control sensor linearity

Situation (practices and lacks)

Maintenance sensor common practices:

- Membrane/foil life span (using conditions, …)

Storage common practices:

- Storage condition effects

Using conditions:

- Biofouling effects
- Chemical interferents / Influence quantities (temperature, pressure, salinity, current, … ?)

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Up to date recommendations (optical sensors)

Ifremer

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Recent oceanographic calibration lab recommendations to reach best adjustment and uncertainties

Calibration common practices:

More recently, to reach best adjustment and uncertainties:

3- Oceanographic calibration lab recommendations:

- Multi-points calibration *(linearity control, temperature effects)*

- Adjustment following "H. Uchida, T. Kawano, I. Kaneko, M. Fukasawa, J. Atmos. Oceanic Technol., 25, 2271–2281 (2008)"

Existing multipoints calibration facilities for oceano:

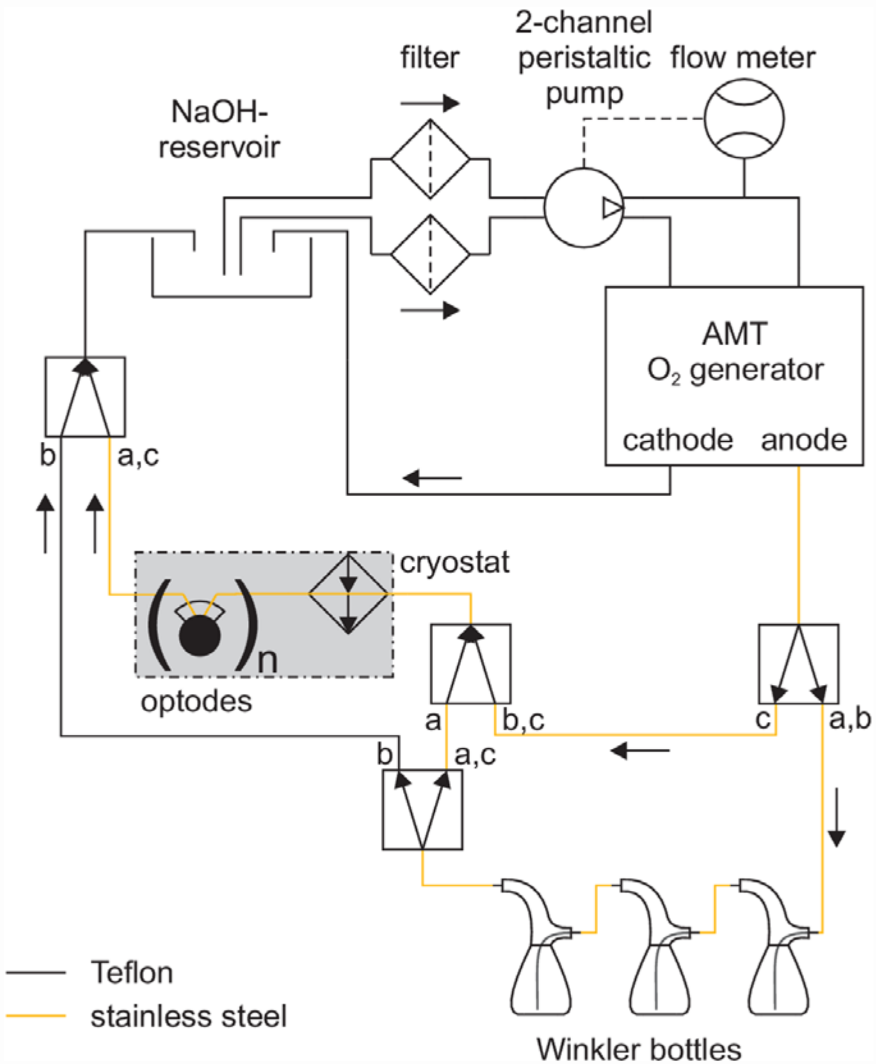
- Electrochemical systems:

GEOMAR (H. Bittig)

"A novel electrochemical calibration setup for oxygen sensors and its use for the stability assessment of Aanderaa optodes"

Henry C. Bittig, Björn Fiedler, Tobias Steinhoff, Arne Körtzinger

Limnol. Oceanogr. Methods 10:921-933 (2012)



Up to date recommendations (optical sensors)

Ifremer

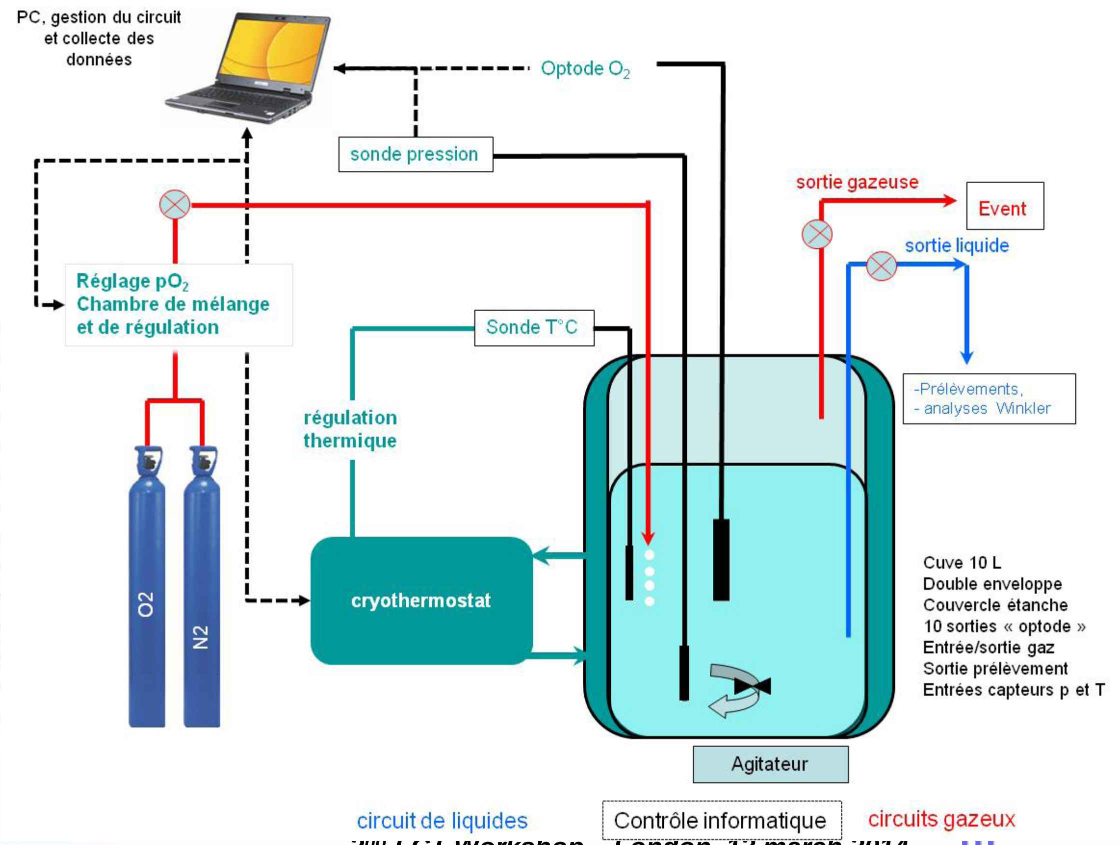
Existing multipoints calibration facilities for oceano:

- Bubbling systems:

- CSIRO (C. Neill) and AADI (J. Hovdenes)

  Specific bench designed for optodes

- MIO (D. Lefèvre)

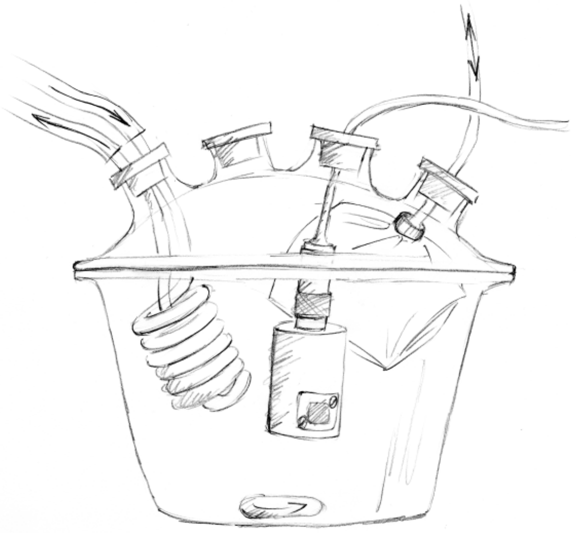


Up to date recommendations (optical sensors)

Existing multipoints calibration facilities for oceano:

- Bubbling systems:

- MPI (F. Janssen)



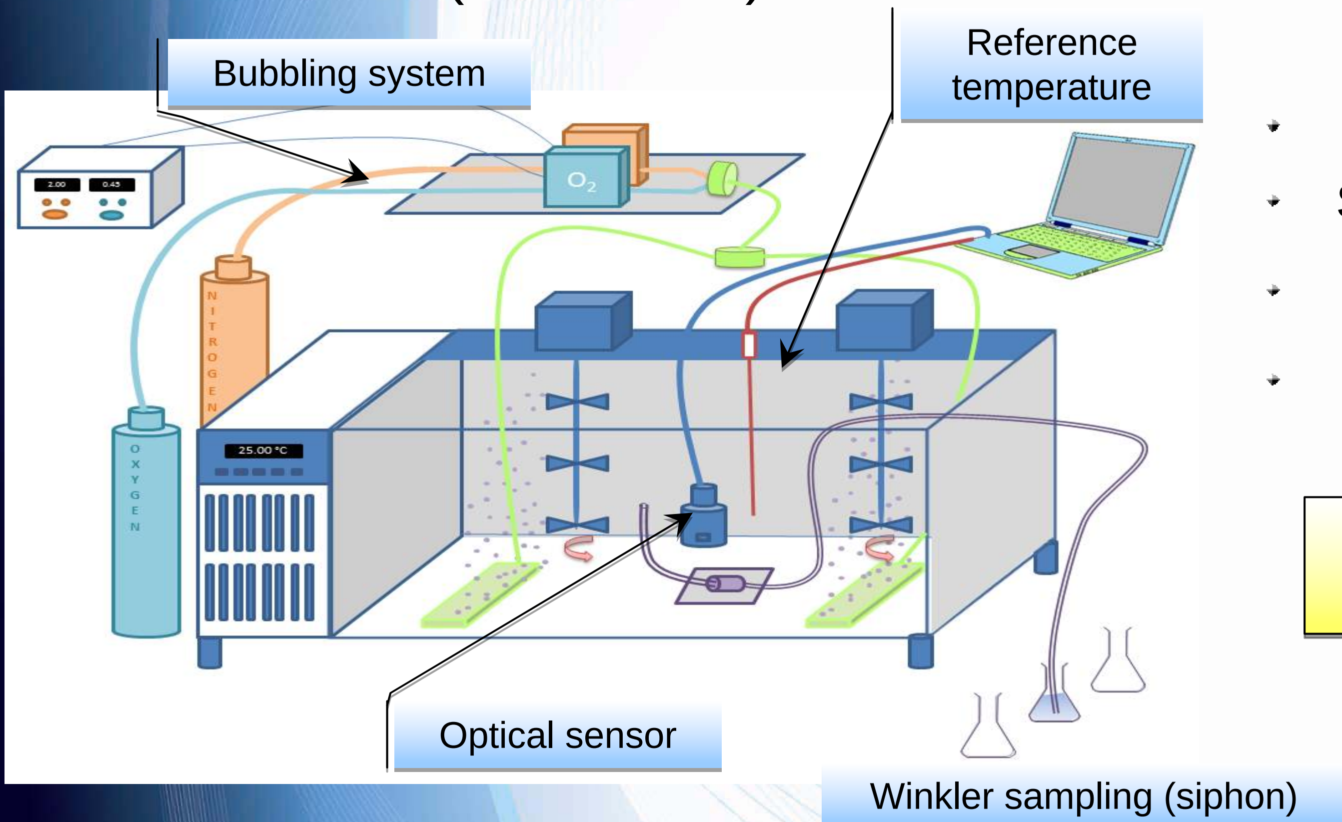
- JAMSTEC (H. Uchida)

Up to date recommendations (optical sensors)

Existing multipoints calibration facilities for oceano:

- Bubbling systems:

- Ifremer (F. Salvetat)

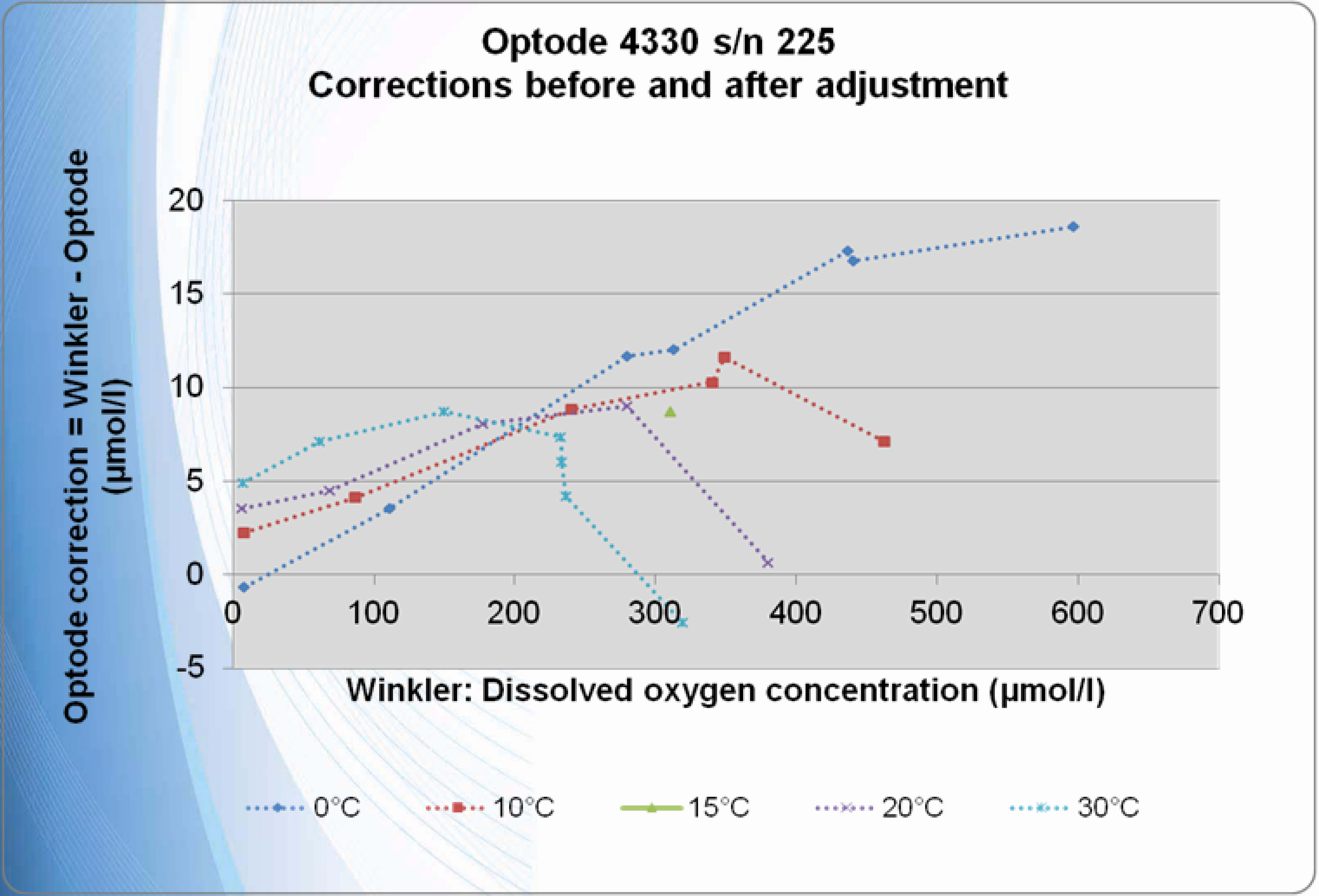


- Stability < 0.5 µmol/l
- Several hours stability
- Lowest level: nearly 0%
- 0_2 homogeneity < 2µmol/l

Fulfill requirement:
a few µmol/l

Up to date recommendations (optical sensors)

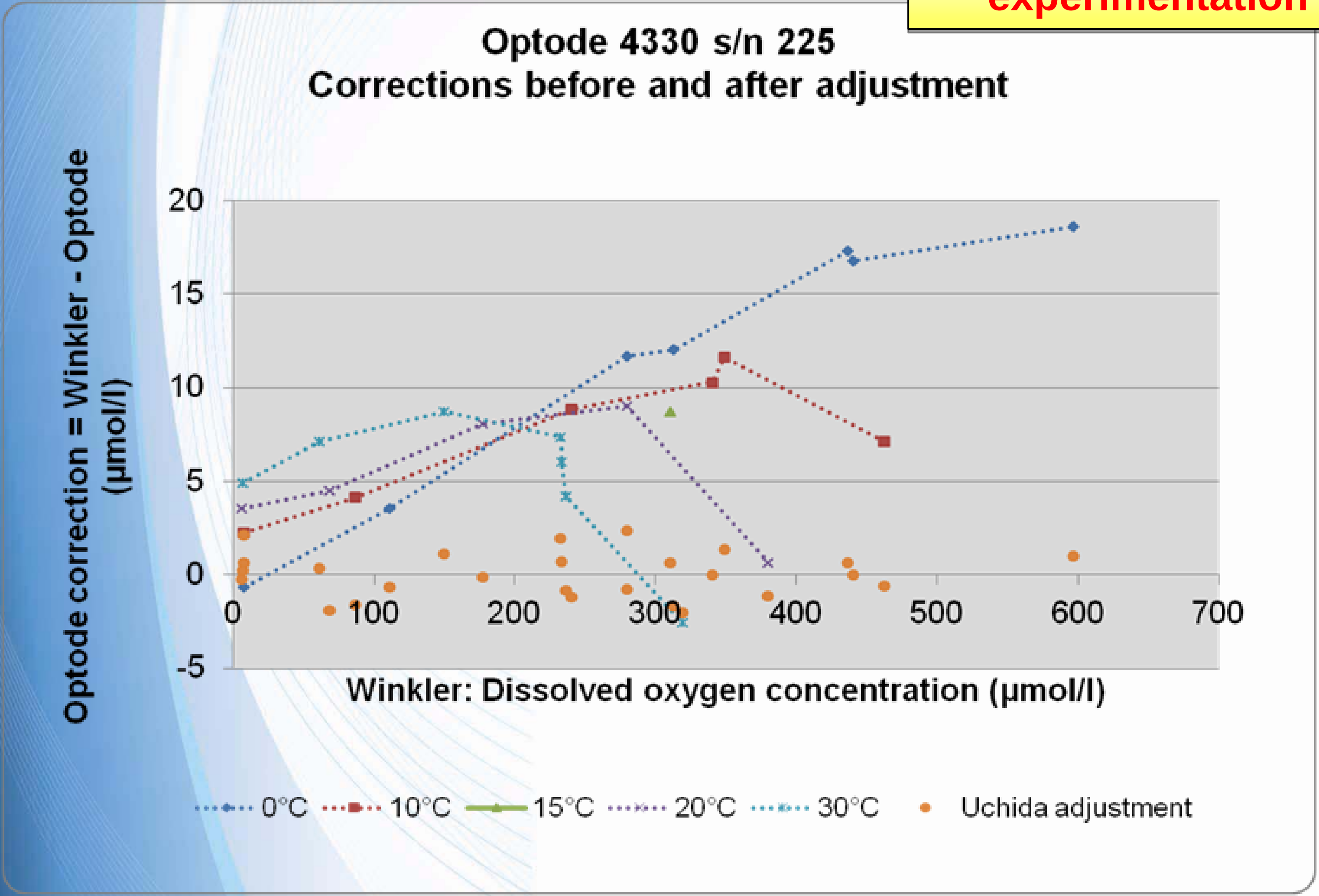
Results of a multipoints calibration



Up to date recommendations (optical sensors)

Results of a multipoints calibration

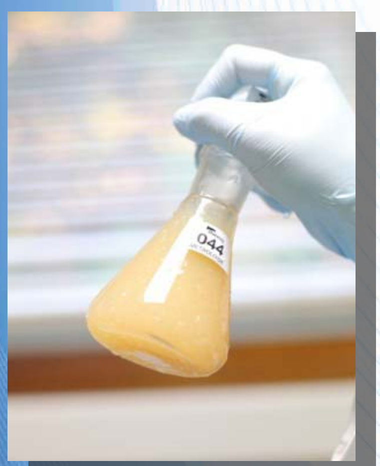
2 to 3 weeks experimentation

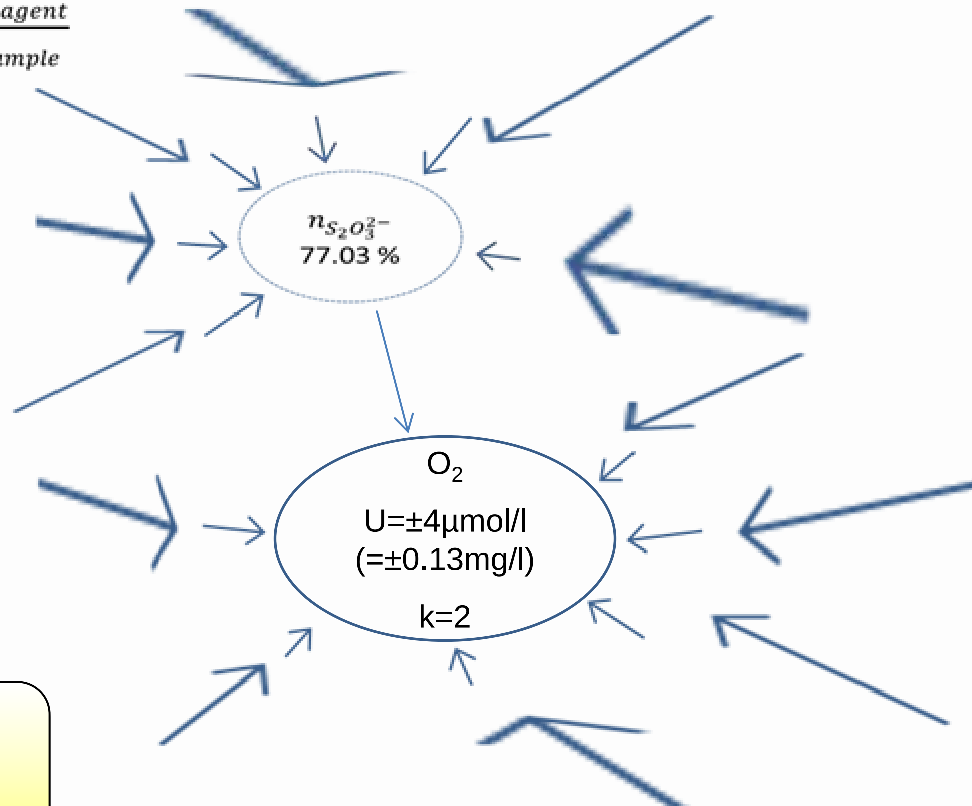


Results of a multipoint calibration

- Uncertainty calibration budget: U ≈ ± 7 µmol/l (at 440 µmol/l) with U (Winkler) = 4 µmol/l

$$[O_2]\ \mu mol/l = \left[\frac{n_{KIO_3} V_{KIO_3}}{\left(V_{S_2O_3^{2-}Cal} - V_{S_2O_3^{2-}CalBlank}\right)} \times \frac{\left(V_{S_2O_3^{2-}Sample} - V_{S_2O_3^{2-}SampleBlank}\right)}{4} \times \frac{1000000}{\left(V_{Sample} - V_{Reagents}\right)} \right] - 38 \times \frac{V_{Reagent}}{V_{Sample}}$$





Gravimetric Winkler: U/2
I.Helm, L.Jalukse, I. Leito, Anal. Chim. Acta. 741 (2012) 21-31.

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Alternatives…

How to adapt metrology to needs ?

- Simplest to more complete calibration protocols

→ Define the needs !

- *In situ* calibration
- Use of several non calibrated sensors and statistical post-processing the data → …low cost sensors ?

How to be more efficient in metrology ?

- Rethink the roles or activities of oceano institutes, NMI, consultancy companies and manufacturers (! SME)
- Build collaborations, find ways/structures to exchange
- Propose trainings, audits, ILC, transfer of know-how

Thanks for your attention