AML Oceanographic

Physical conditions within the ocean

David Wilson, Regional Sales Manager EMEA

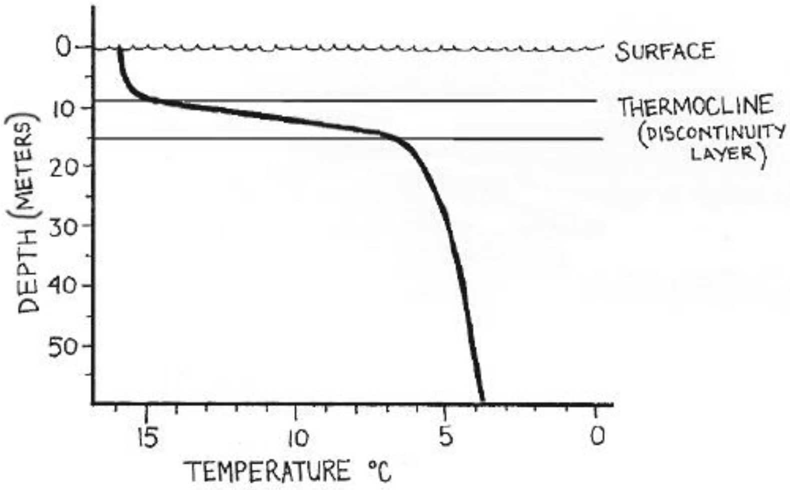
Physical Oceanography

- From Wikipedia: **Physical oceanography** is the study of physical conditions and physical processes within the ocean, especially the motions and physical properties of ocean waters.

- TEMPERATURE
- CONDUCTIVITY
- SALINITY
- DISSOLVED OXYGEN
- BIOLOGICAL

Temperature

- Air-sea interaction drives surface temperature
- Wind, waves, and turbulent mixing transport heat down below the surface into a mixed layer of similar temperature
- Below the mixed layer, at the thermocline, temperature rapidly changes with depth, stabilizing in the deep ocean (below 1000 m depth)
- Measured via remote sensing (satellite), thermistor strings, buoys, drifters, and CTD casts

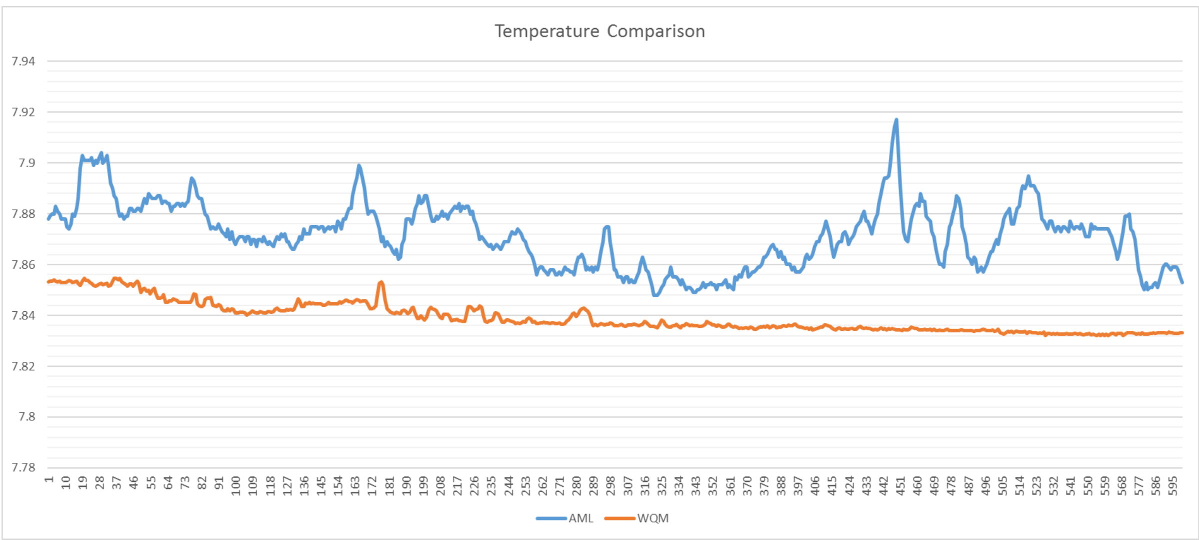


AML Xchange Sensor Concepts: T/CT•Xchange

	Specification	Notes
Maximum Depth	6000 m	
Range	-5 to 45 Degrees C	Will over-range to 60 Degrees C
Accuracy	+/- 0.005 Degrees C	
Precision	0.003 Degrees C	
Resolution	0.001 Degrees C	
Response Time	100 ms	

AML vs Sea-Bird

- Fast response aged thermistor
- Almost no averaging built into sensor
- Very good for vertical profiling applications and microstructure analysis
- Low amount of filtering can result in data that appears to be noisy compared with sensors with a lot of built in averaging



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Conductivity sensors

- Conductive
  - AML, Sea-Bird, Idronaut, Guildline
- Inductive
  - RBR, Valeport, Aanderaa, SAIV
- Refractive Index
  - NKE

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AML Xchange Sensor Concepts: C/CT•Xchange

	Specification	Notes
Maximum Depth	6000 m	
Range	0 – 90 mS/cm	Will over-range to 100 mS/cm
Accuracy	+/- 0.01 mS/cm	
Stability	+/- 0.003 mS/cm per month	When protected by UV•Xchange
Precision	0.003 mS/cm	
Resolution	0.001 mS/cm	
Response Time	25 ms	

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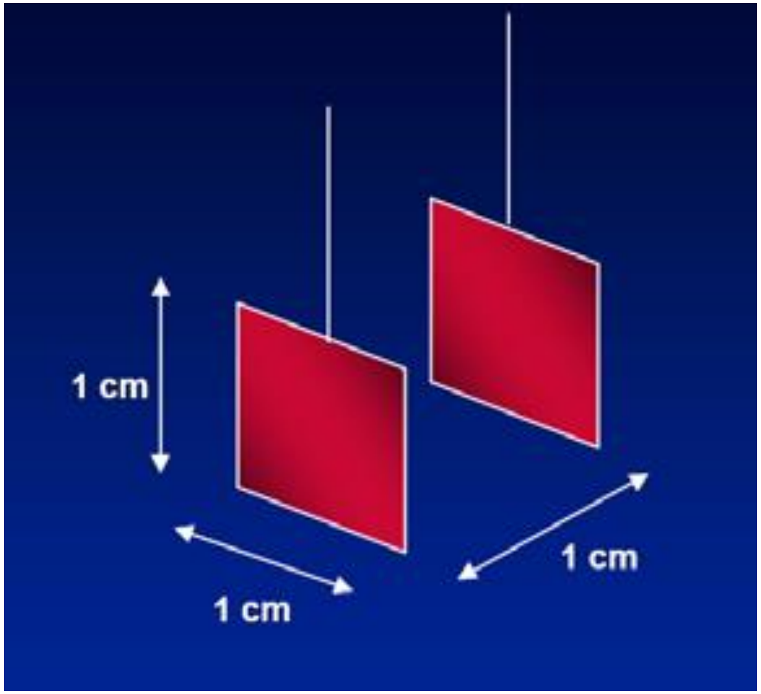
Conductivity - Principles



- Reciprocal of Resistance
- Conductance between faces of a 1cm cube of water
- Units of Siemens/m (S/m)
- Often expressed as mS/cm

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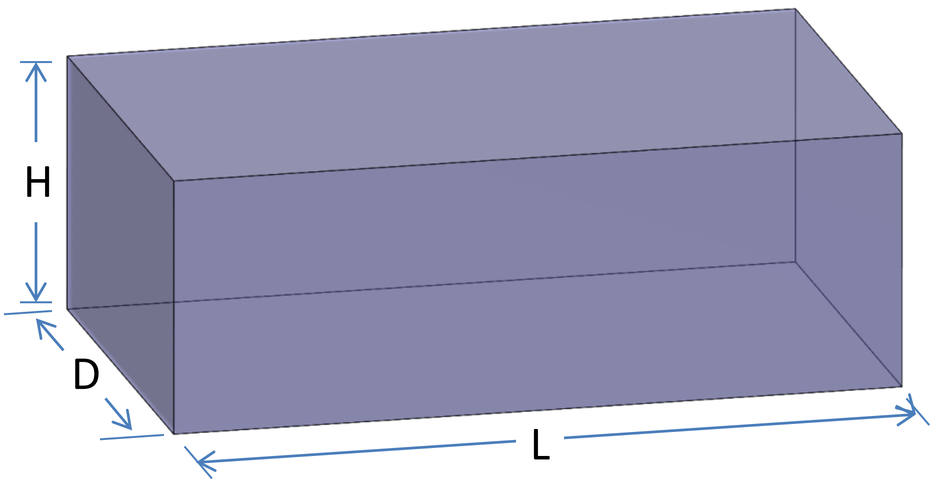
Cell Constant K_c



- Dictates sensitivity of cell

Higher K_c = Less Sensitive

- Depends on diameter and length of water volume within cell

- **K_c = Length / Area**
- **$K_c = L/(H*D)$**

K_c to Resistance

- Resistivity ρ = Reciprocal of Conductivity

$$R = \rho\ L/A$$

$$R = \rho\ K_c$$

$$\rho = R/K_c$$

Therefore:

$$\mathbf{C = K_c/R}$$

(determined from calibration) (measured)

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Resistance to Conductivity

- We measure resistance, and turn it into conductivity. Roughly, this means:

$$C = K_c/R$$

- We **calibrate** to measure K_c for each cell.

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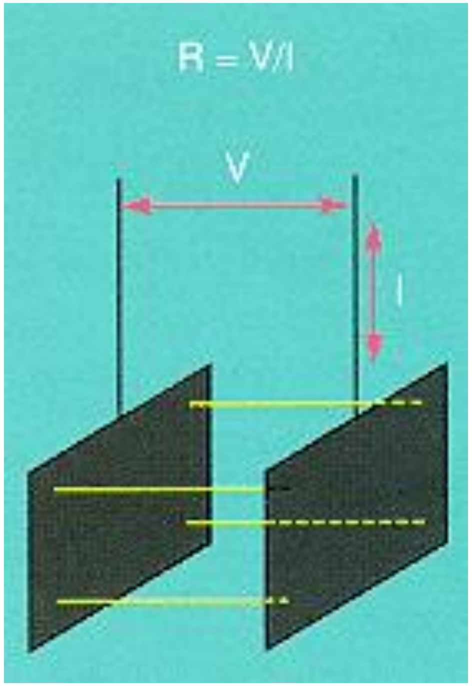
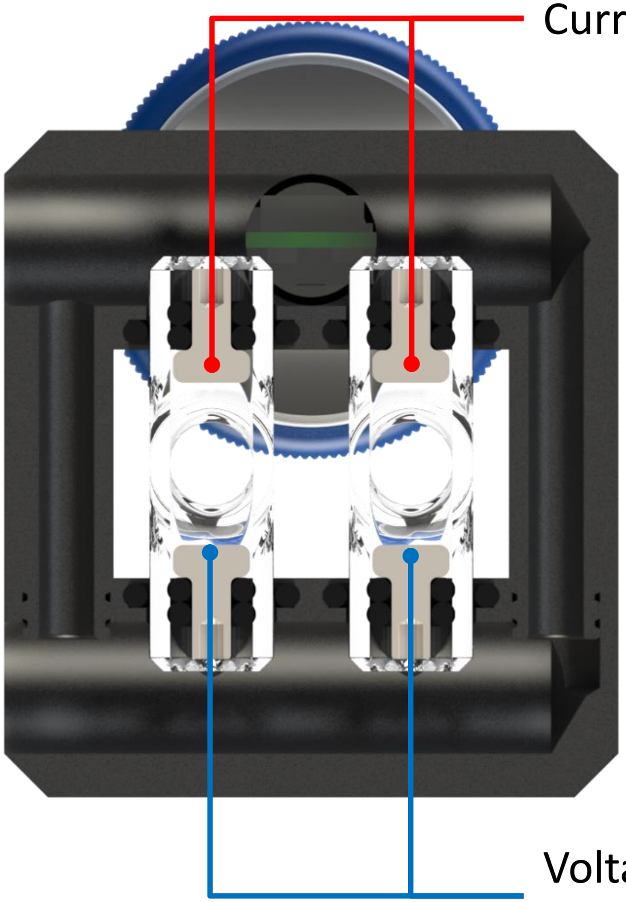
Conductivity Cell Designs



2 electrode Conductivity Cell

- Measures voltage and current between two electrodes
- Calculates resistance of water between electrodes
- Conductivity derived from Resistance

How Our Sensor Works



- Voltage measurement kept constant
- Current adjusted higher or lower to maintain constant voltage

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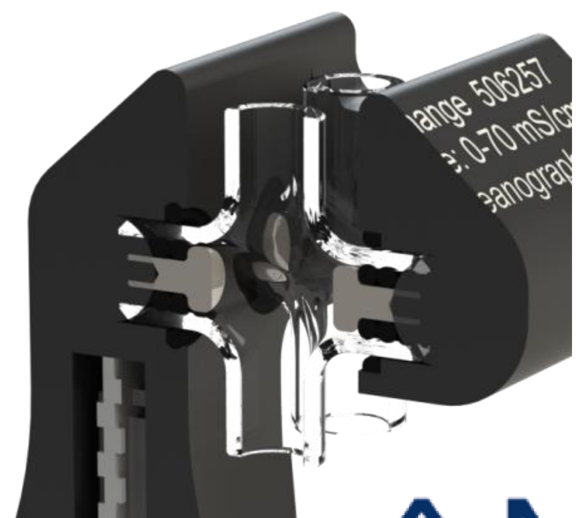
Stable Water Volume

- The Glass Cross
  - UV compatible quartz
- Very low CTE
- Pressure balanced



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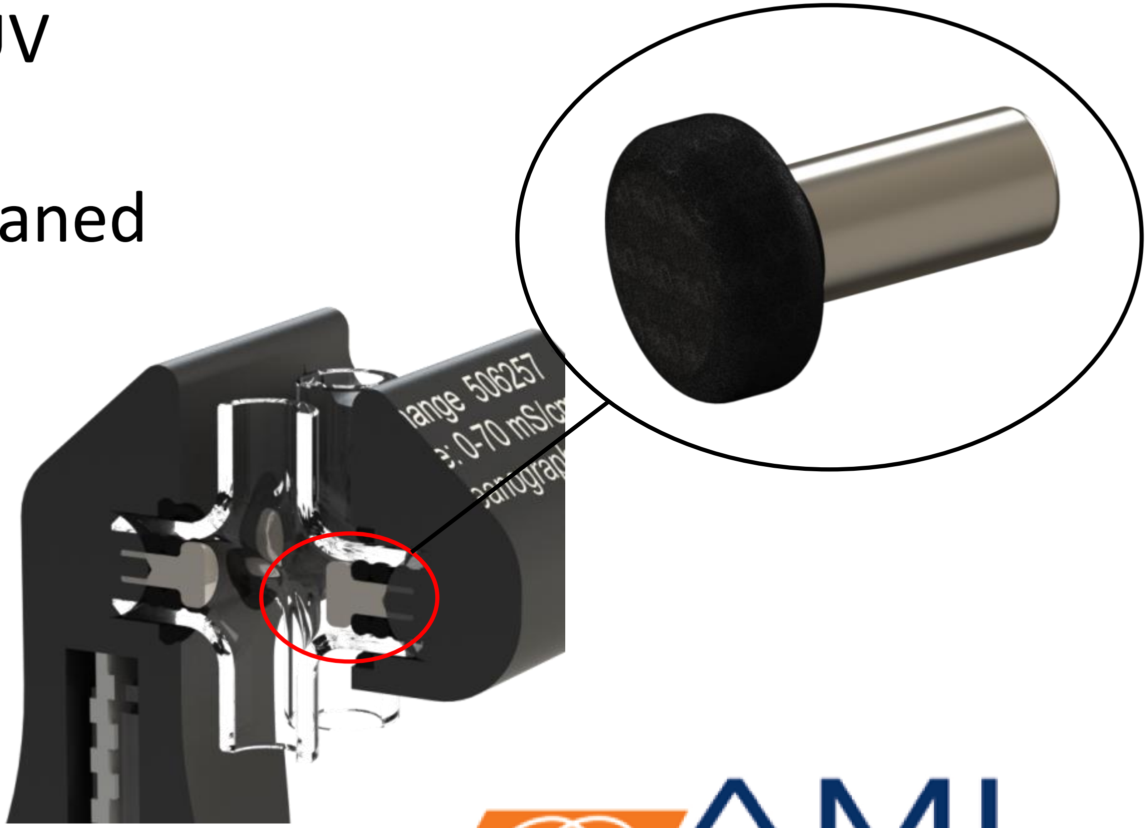
Stable Electrodes

- Platinum plated electrode
  - Compatible with UV
  - Solid and durable
  - Can be contact cleaned



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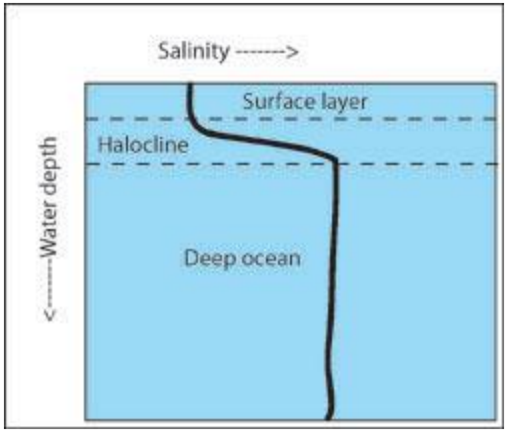
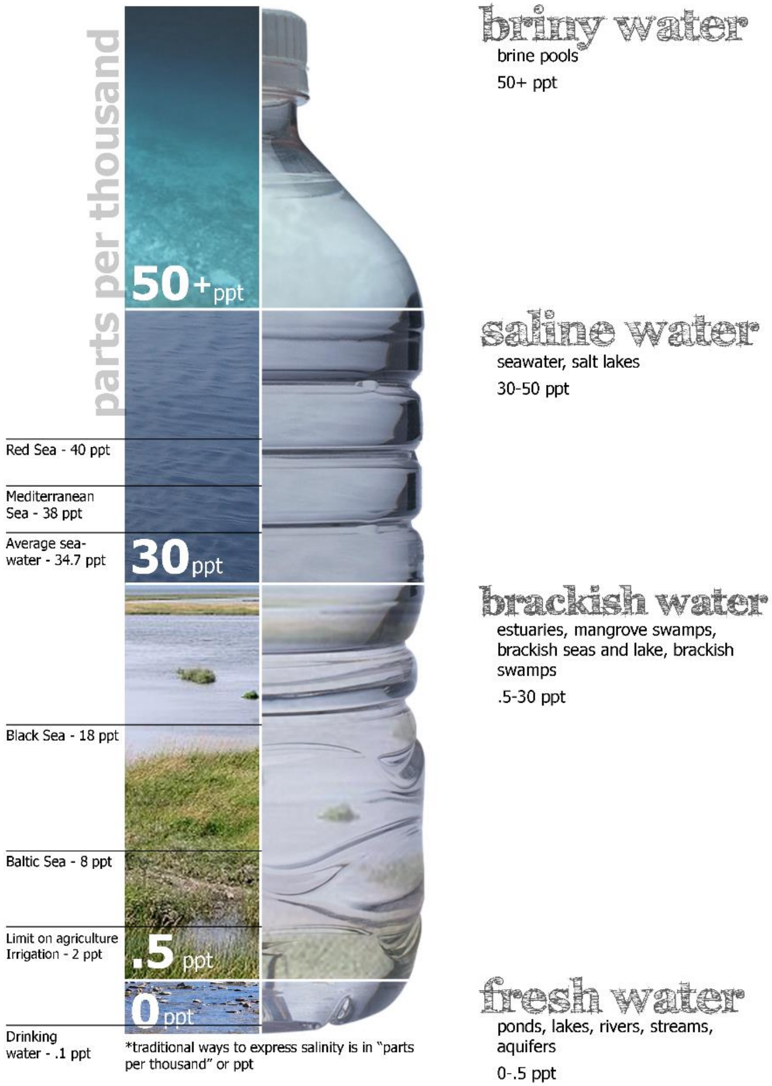
Salinity

- Amount of dissolved matter in seawater
- Defined as the total mass in grams of matter that dissolve in 1 kg of seawater
- has no units and sometimes labeled as ppt or parts per thousand, psu or practical salinity units (relative to standard seawater with a specific chemical content), g/kg
- Difficult to measure directly, salinity is calculated from CTD sensors instead, using **TEOS-10 (Thermodynamic Equation of Seawater, 2010)**
- Like temperature, salinity is dynamic at the surface, affected by precipitation, evaporation, and freshwater inputs from rivers
- Below the surface layer there is a layer of rapid change called the halocline, and below the salinity is relatively constant at about 35





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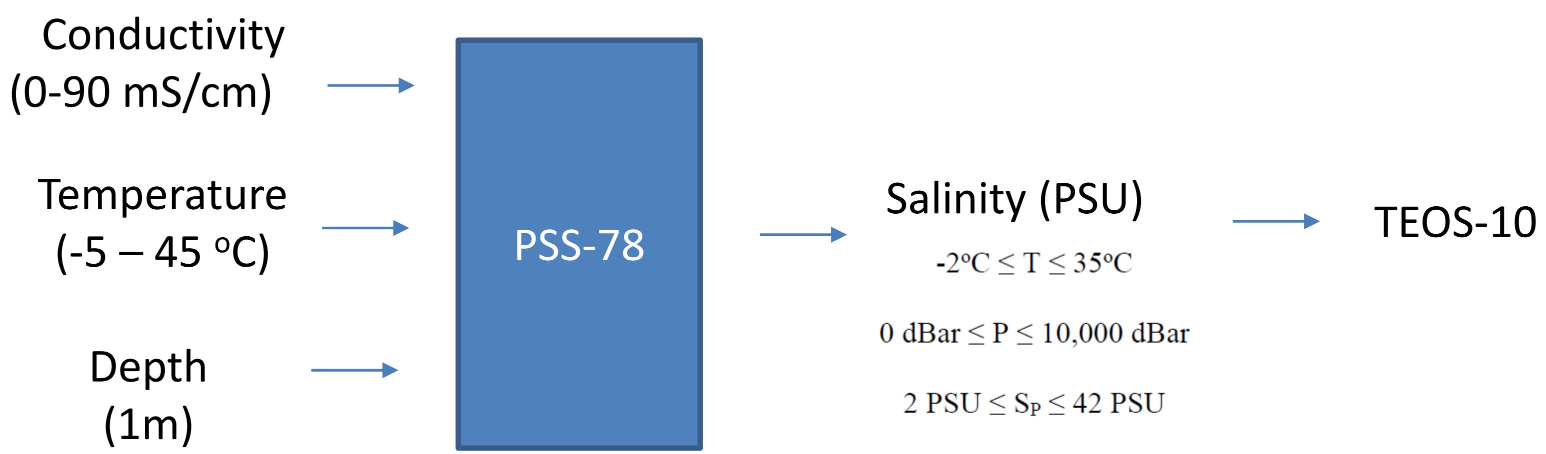
How salinity is reported:



-PSS = Practical Salinity Scale. It's a ratio of conductivity to that of a reference KCL solution at 15oC and 1 atm.

-Has been in place since 1980; universal scientific way of calculating salinity.

-The range limitations are NOT related to sensor performance

-AML instruments will over-range Salinity calculations.

Dissolved Oxygen

The vast majority of marine life depends upon oxygen to survive and measuring DO (sometimes called DO2) is fundamental to oceanographic research

- Optical sensors are the most commonly used in oceanography
- Desired output is usually mg/L or mL/L
- Sensor outputs percent saturation which must be converted to the desired output after compensating for salinity and depth
- Electrode based sensors also exist but are less reliable

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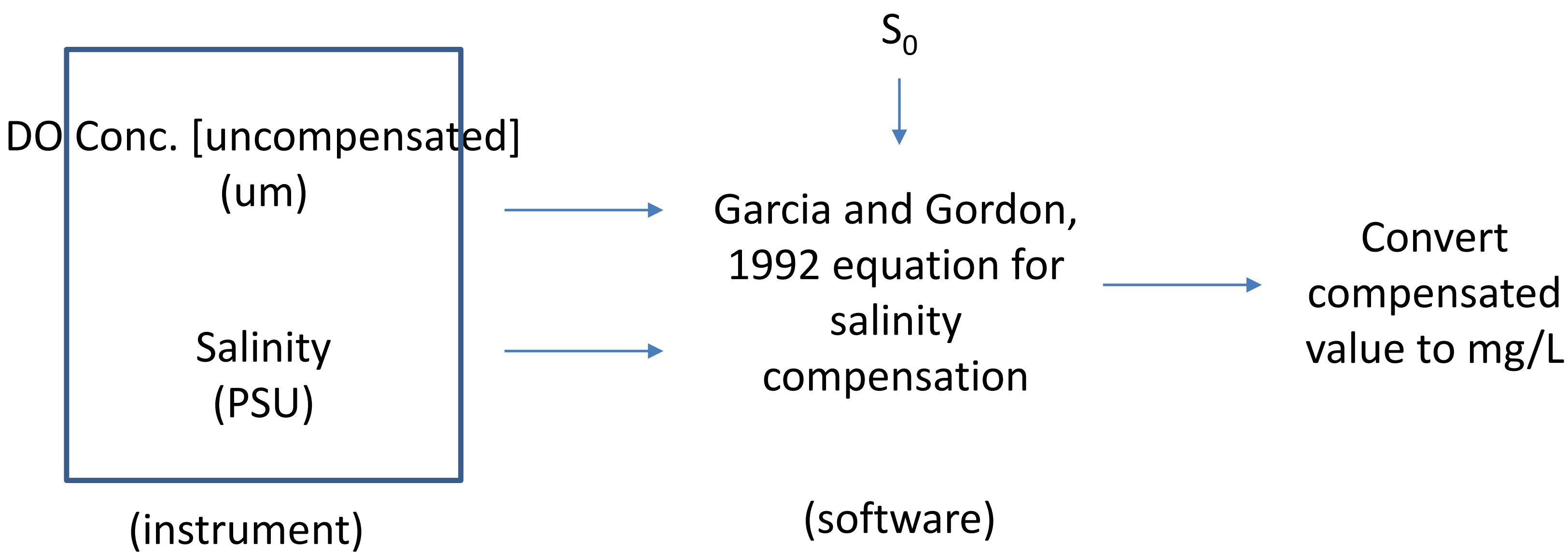
How DO is reported:



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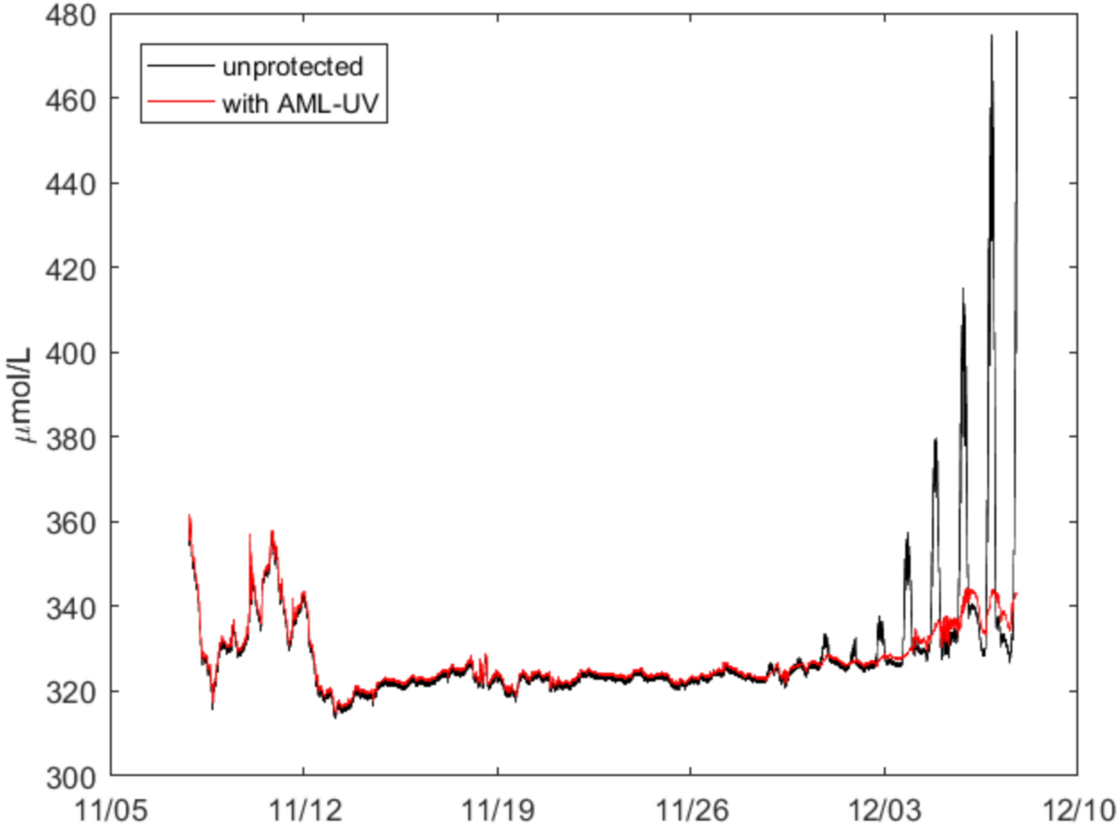
What happens to a DO sensor when it fouls?



Example deployment off the Pacific Northwest coast of United States

Biological Oceanography

The study of how organisms affect and are affected by the oceanographic system

- Mainly focused on microorganisms compared with marine biology which focuses on the larger organisms
- Sensors we commonly see:
    - Chlorophyll
        - Measured with a fluorometer to approximate numbers of phytoplankton and other microorganisms that have photosynthetic pigments
        - Fluorometer outputs RFU, relative fluorescence units that must be converted to the real concentration in ug/L
        - Gives an idea of the amount of energy there is in the food chain to support life in the ocean
    - Blue-Green Algae or BGA (phycocyanin or phycoerythrin)
        - Same measurement principle as chlorophyll only a different colour of light is used by the sensor

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