NOSS sensor, towards direct in situ absolute salinity measurement: CTD carousel observations in the Northwestern and Eastern Mediterranean

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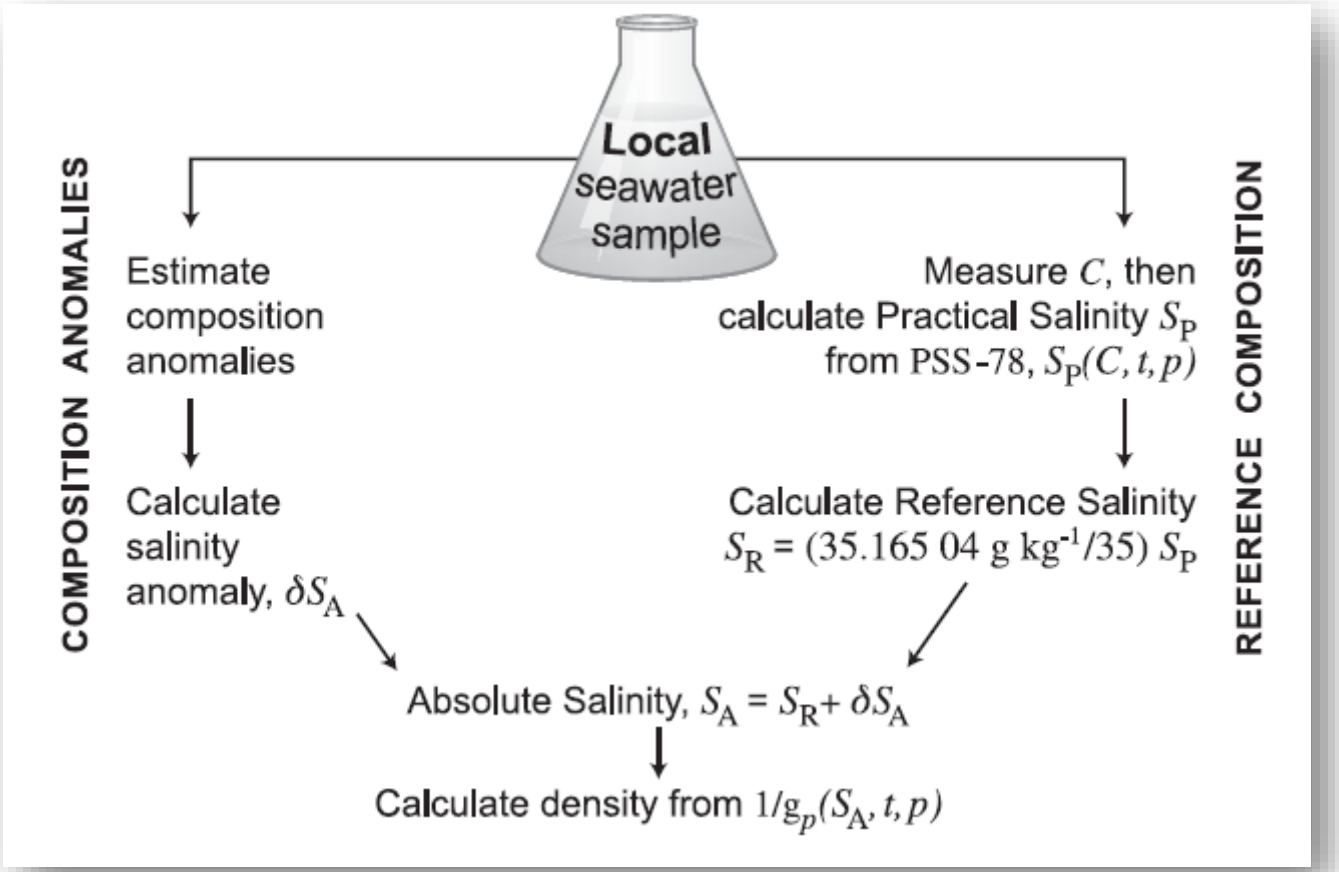
Session: Ocean Observing and Sensing

OI China, Wednesday, October 24, 2018

Density: Definition of TEOS-10

TEOS-10 for the International Thermodynamic Equation of Seawater 2010



Chemical composition of seawater : Salinity anomaly δS_A

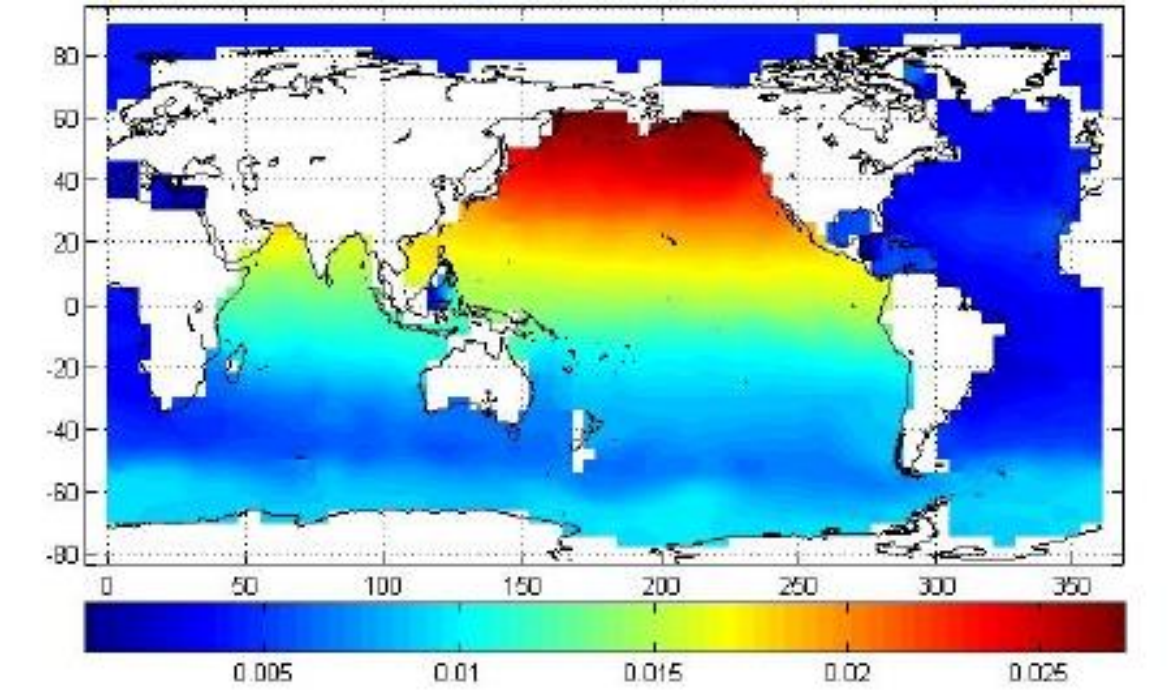
Open Ocean

- Relative chemical composition of seawater is slightly different in different geographic locations.
- Anomalies of salinity can vary from **0 to 0.025 g/kg.**

Coastal waters

- The difference between Absolute salinity and Reference salinity can be large **up to 0.1 g/kg.**

Spatial distribution of absolute Salinity Anomaly δS_A (at p=2000 dbar) around the world



T. J. McDougall et al., The international thermodynamic equation of seawater – 2010 calculation and use of thermodynamic properties, Intergovernmental Oceanographic Commission, Manuals and Guides., 20, 196, 2009

NOSS : a solution for in-situ density measurement

Multiple outputs:

- Refractive index, Density, Absolute Salinity
- Temperature, Pressure

Communication:

- RS232 Serial output, Data Format ASCII

Mechanical features:

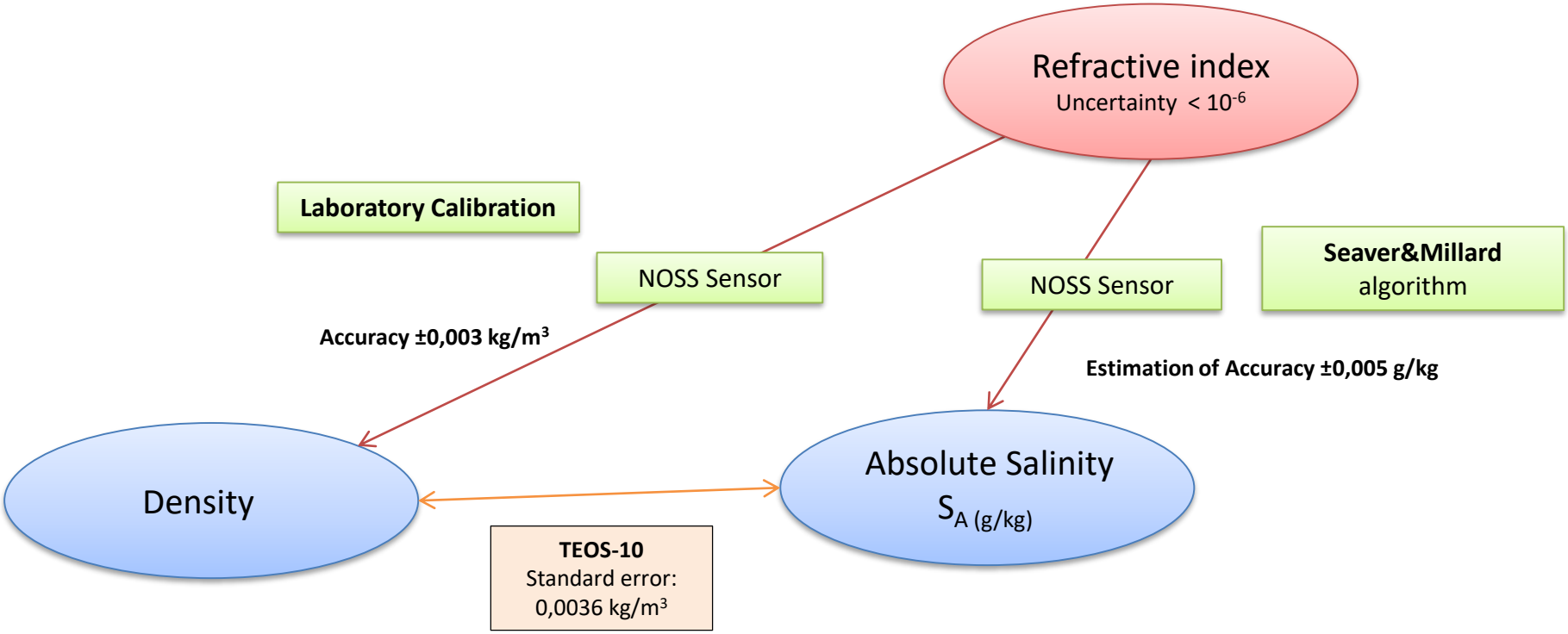
- Dimensions: diam. 100mm height 185mm
- Weight: 2.4kg (in air) 1.7kg (in water)

DESIGNATION		NOSS 2-2
Refractive Index	Range Initial accuracy	1.3353 to 1.3458 <1.10^{-6}
Temperature	Range Initial accuracy Response time (at 63%)	-2 +35°C < ±0.006°C < 150msec
Operational Depth	Range Initial Accuracy	0 to 2100 dbar ±1 dbar

Links between :

Refractive index and absolute salinity

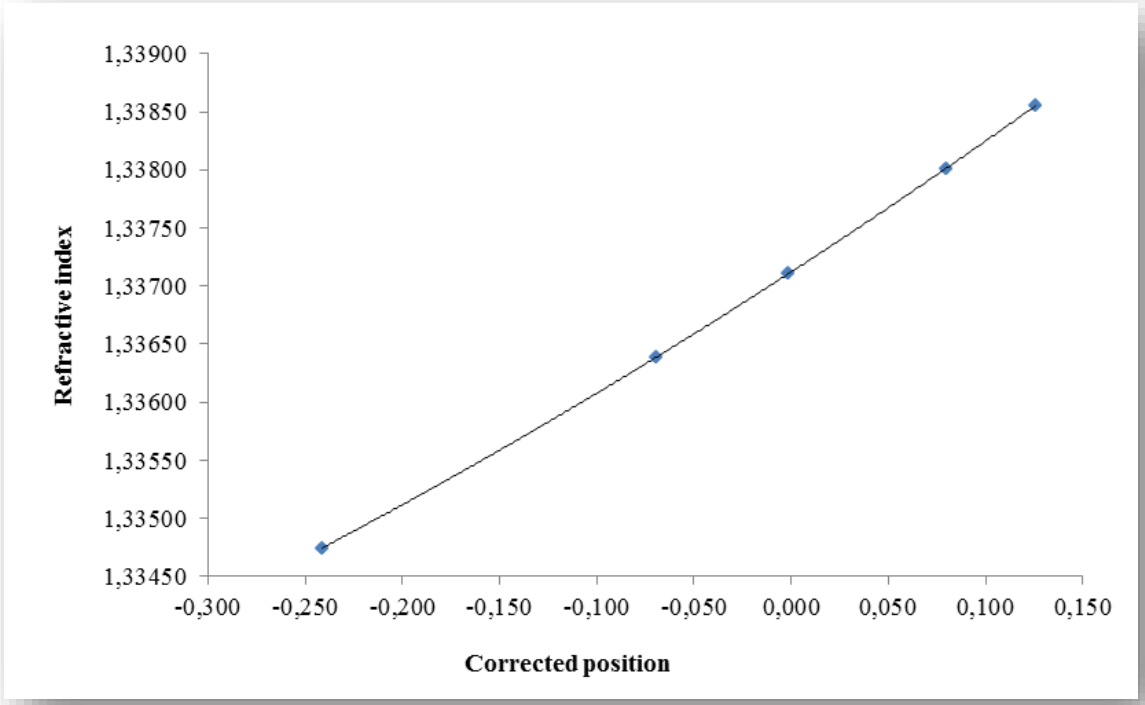
Refractive index and density



Calibration method

Calibration in reference salinity at multiple refractive index points at fixed temperature and at atmospheric pressure.

Performed in thermostated bath for several reference salinity samples (S_R from TEOS-10, 20 to 40 g/kg or lower range 0 to 27g/kg)



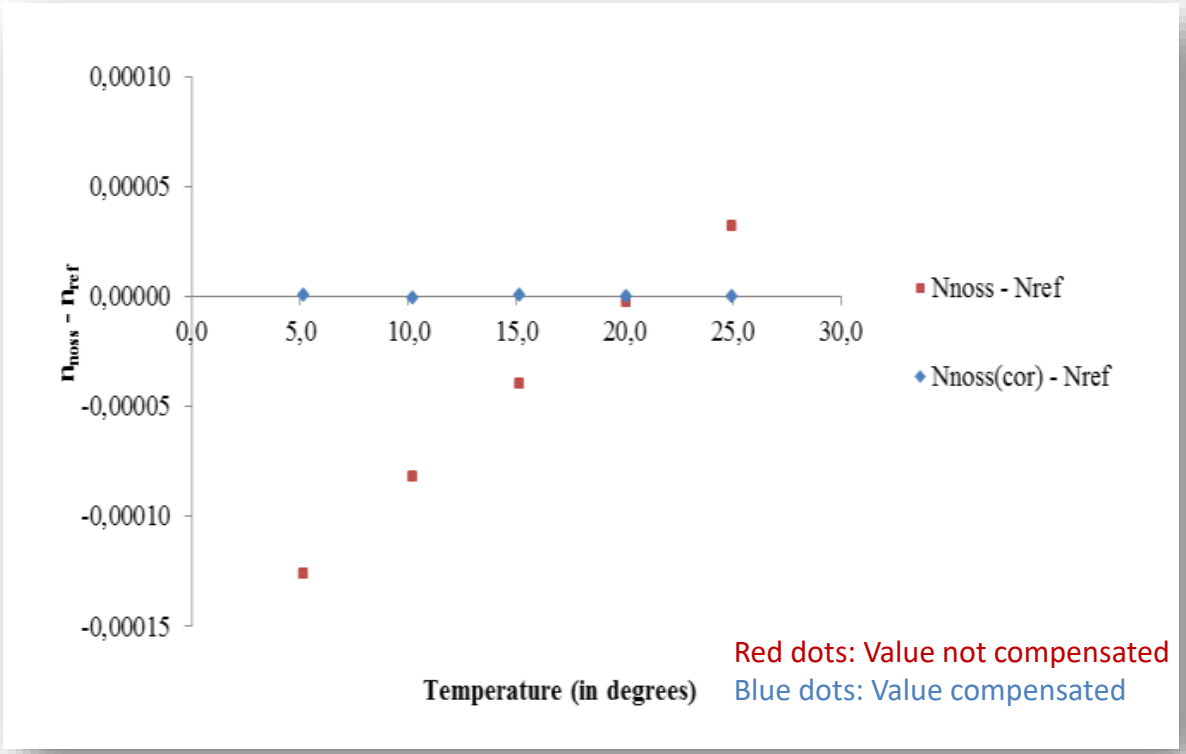
Residual error for salinity calibration: <10^{-6} in refractive index equivalent to 0.005 g/kg in salinity

Characterization in temperature

5 temperature stage have been performed between 5 and 25°C.

Objectives: Determine some corrections to compensate the effect of temperature on the refractive index measured by NOSS sensor at fixed reference salinity and at atmospheric pressure.

Allow to maintain the accuracy of NOSS sensor better than 10^{-6} at different temperature.



Red dots: Value not compensated
Blue dots: Value compensated

Laboratory equipment:
Thermostated bath

Characterization in temperature

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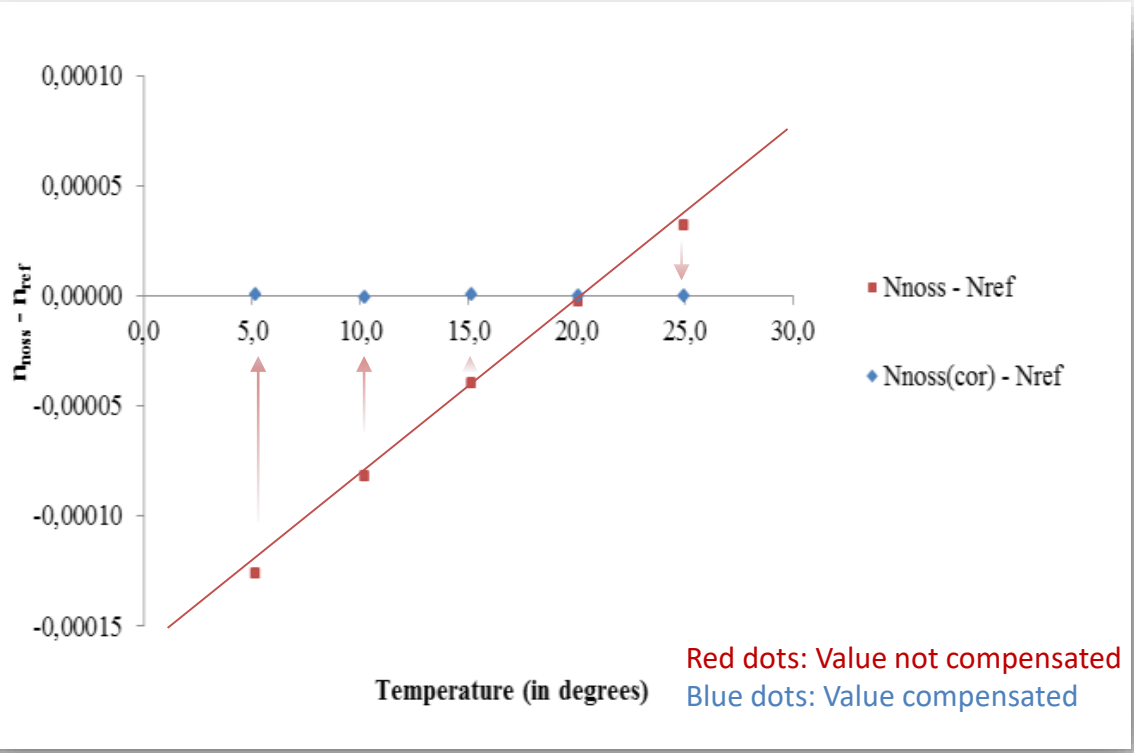


Red dots: Value not compensated
Blue dots: Value compensated

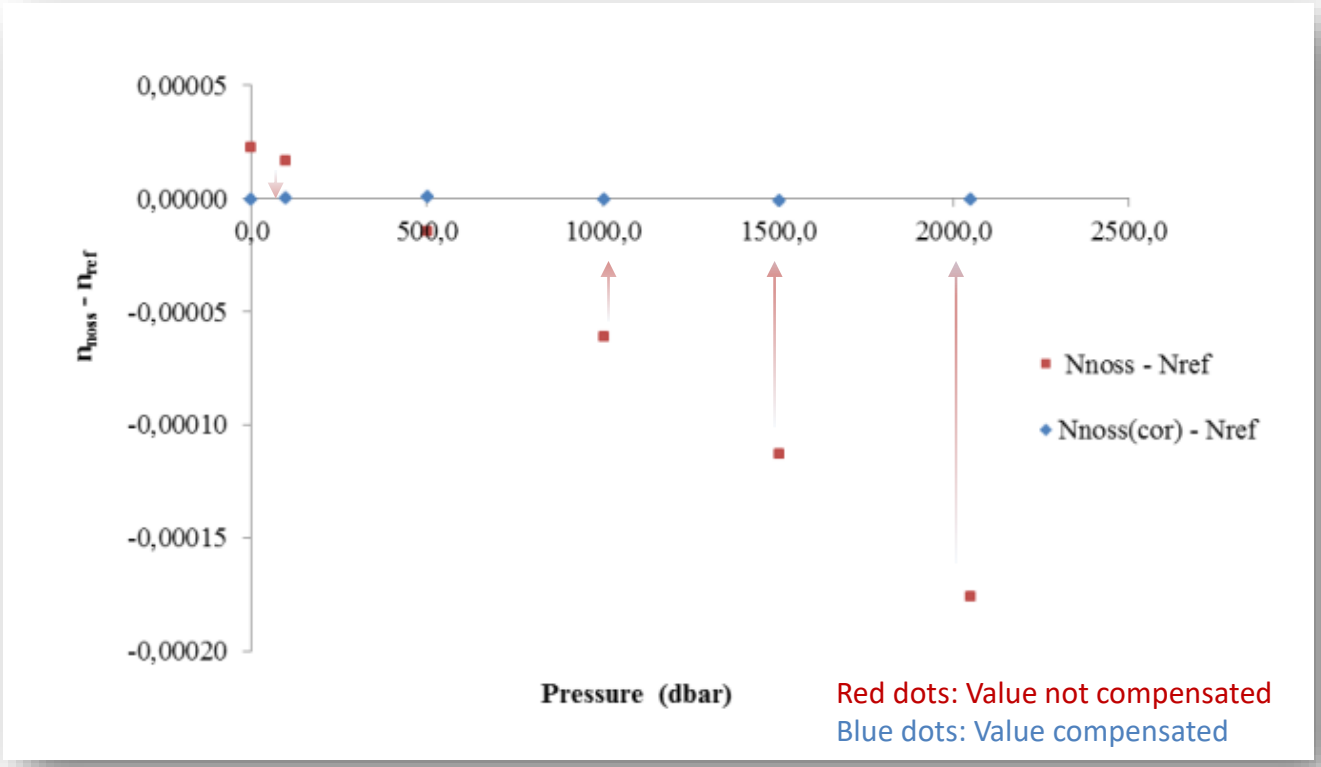
Laboratory equipment:
Thermostated bath

Characterization in pressure

7-8 pressure stages have been performed between 0 and 2000 dbar.

Objectives: Determine some corrections to compensate the effect of pressure on the refractive index measured by NOSS sensor at fixed reference salinity with a low level of variability in temperature.

Allow to maintain the accuracy of NOSS sensor better than 10^{-6} at different pressure.



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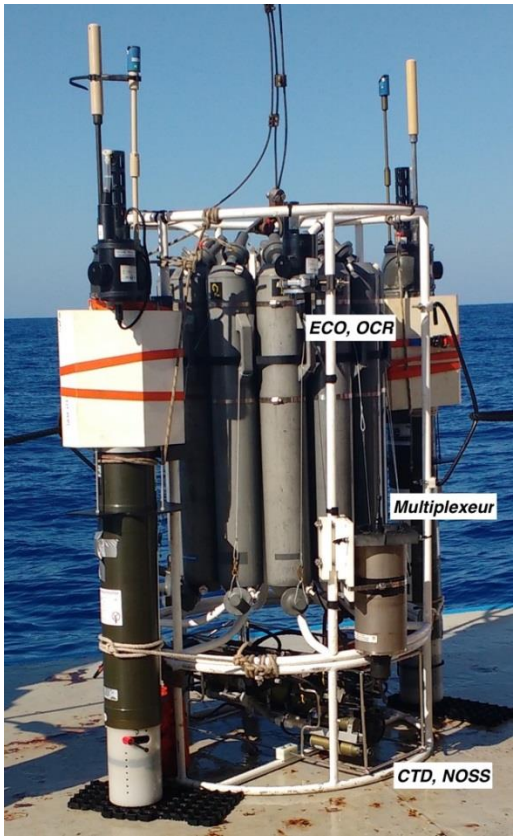
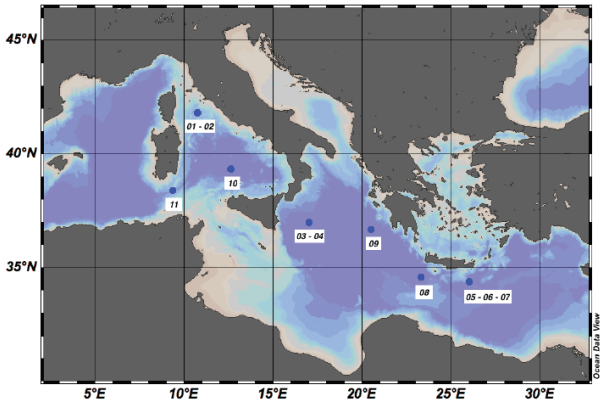
Deployment of NOSS on a Carousel CTD, in the Mediterranean Sea : BioArgoMed cruise

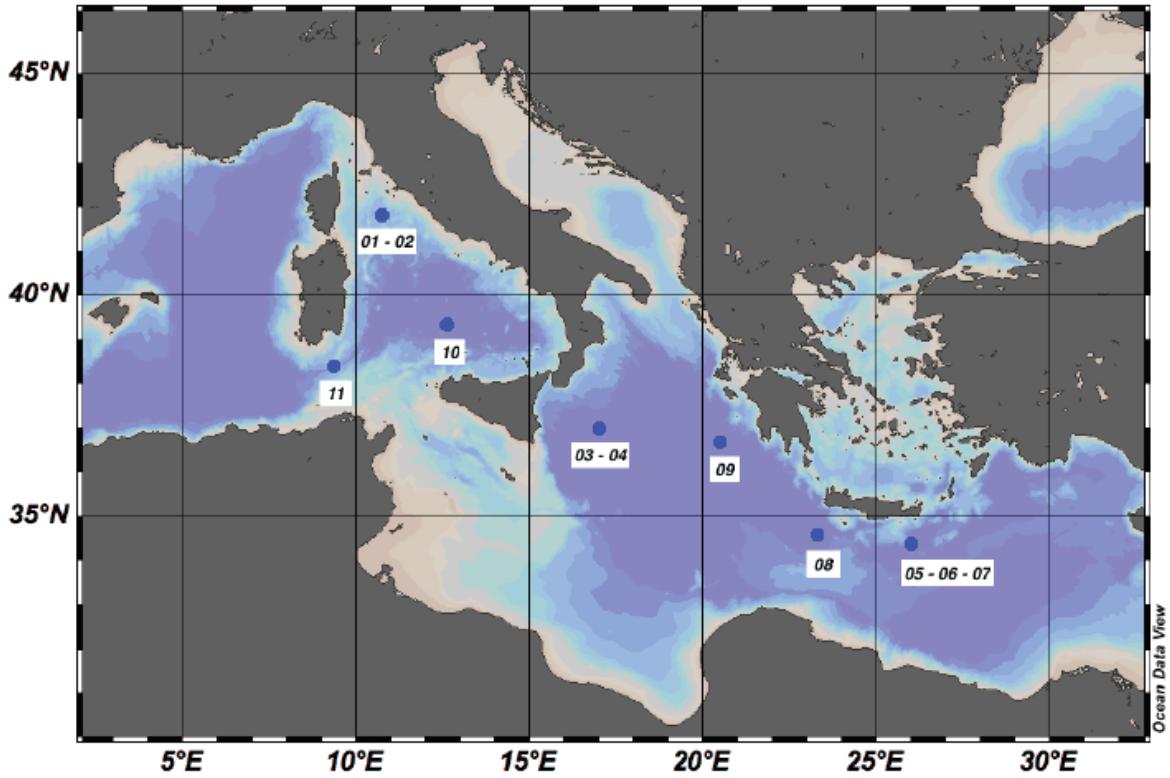




Measuring Salinity:

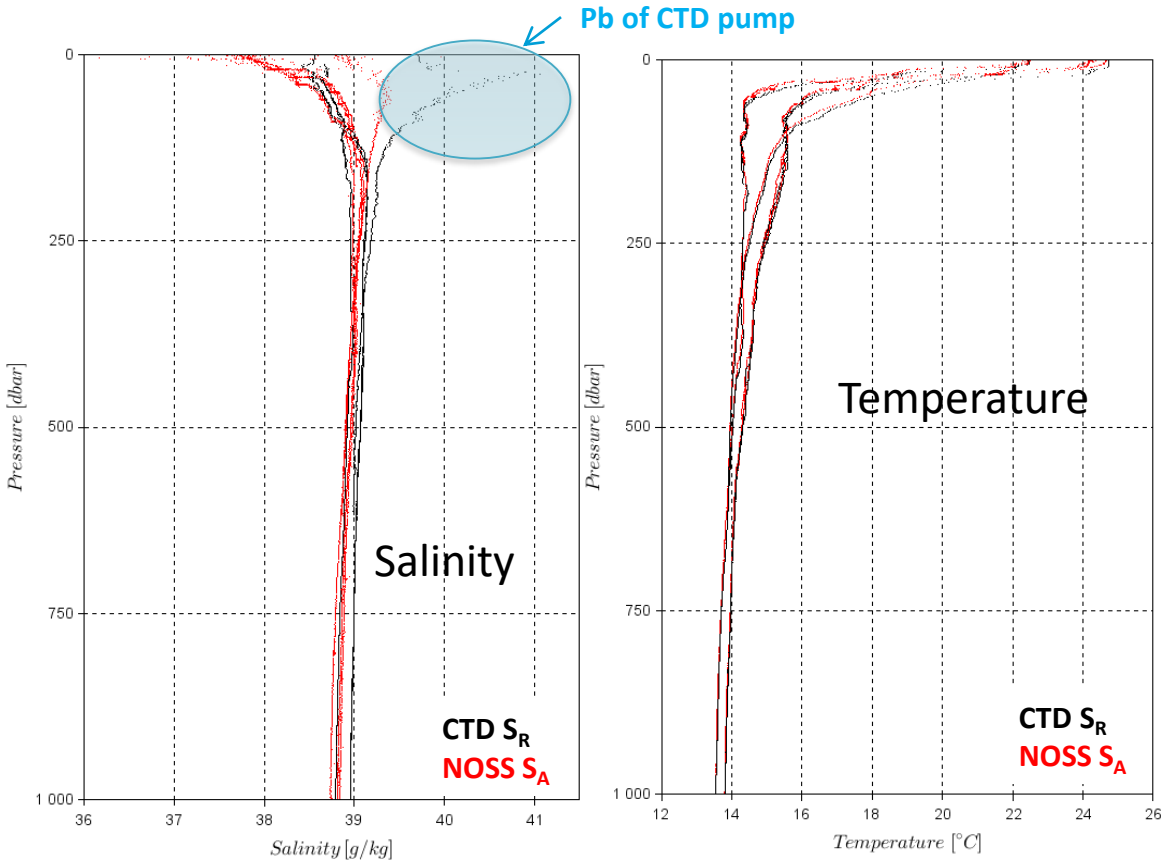
- ✓ CTD → Practical Salinity S_P
- ✓ NOSS → Absolute Salinity S_A
- ✓ Nutrient → δS_A

Deployment of NOSS on a Carousel CTD, in the Mediterranean Sea : BioArgoMed cruise



- ✓ NOSS sensor integrated on the chassis of Carousel CTD close to the CTD pump
- ✓ Data multiplexed with other sensors and recovered (re-board) in real time
- ✓ 11 casts performed in the Mediterranean Sea

Deployment of NOSS on a Carousel CTD, in the Mediterranean Sea : BioArgoMed cruise



S_A (NOSS) → Not post-calibrated (in progress)

Nutrient → Ok

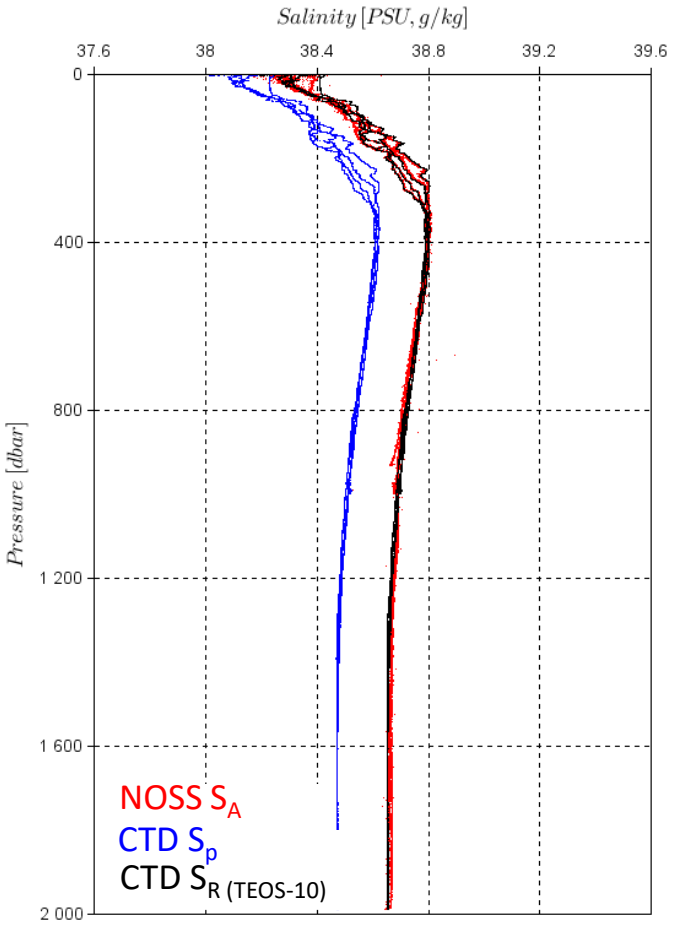
T, S_P (CTD, in progress)→ Ok

To be done: synchronisation of data in pressure

- ✓ NOSS sensor integrated on the chassis of Carousel CTD close to the CTD pump
- ✓ Data multiplexed with other sensors and recovered (re-board) in real time
- ✓ 11 casts performed in the Mediterranean Sea

Previous deployment of NOSS on a drifting float, in the Mediterranean Sea : Corrected Salinity profiles after post-processing

- Moose mission in the Dyfamed/Boussole site

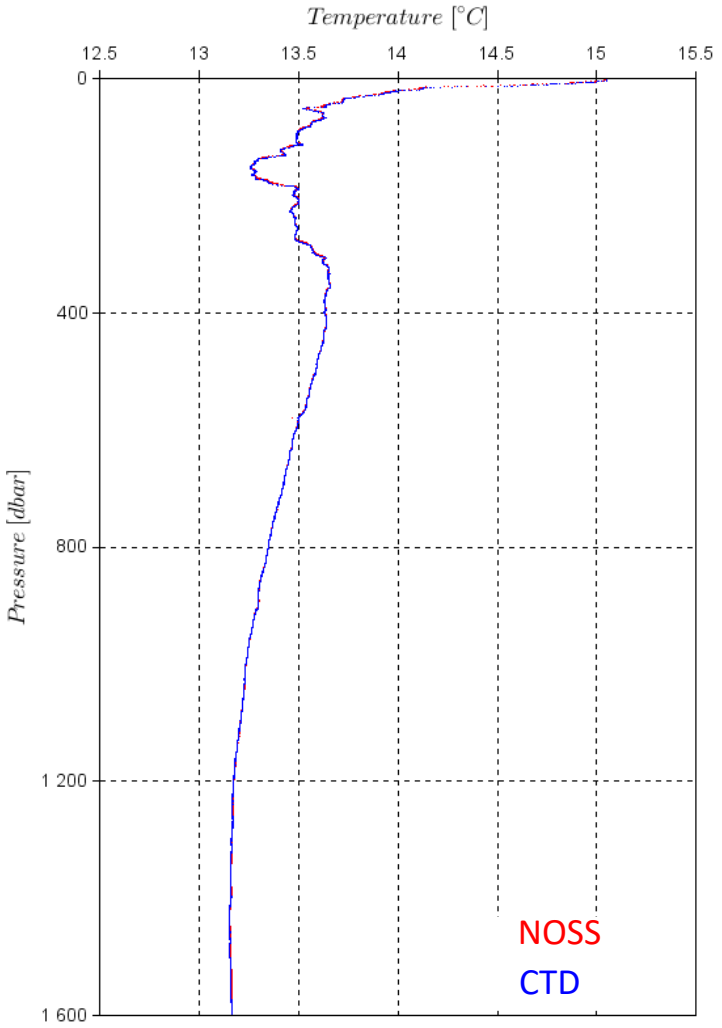


Salinity time series have similar shapes for both NOSS (S_{noss}) and CTD sensors (S_R) with a very slight deviation ($\delta S_A \leq 0.02$ g/kg) from 0 to 2000 dbar.

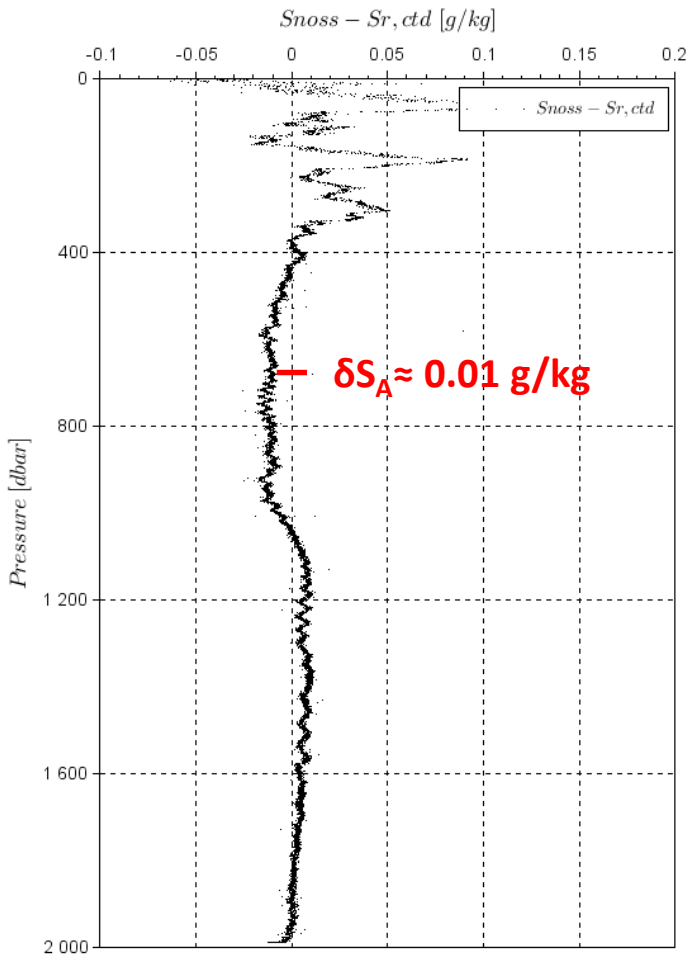
Previous deployment of NOSS on a drifting float, in the Mediterranean Sea : Temperature profiles

- Moose mission in the Dyfamed/Boussole site

Temperature time series have similar shapes for both NOSS and CTD sensors from 0 to 2000 dbar.



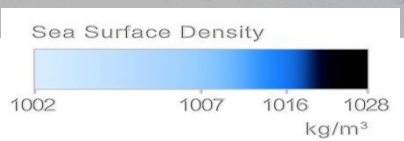
Salinity difference distributions in the NW Mediterranean Sea



$$\delta S_A = S_{A\,(NOSS)} - S_{R\,(CTD)}$$

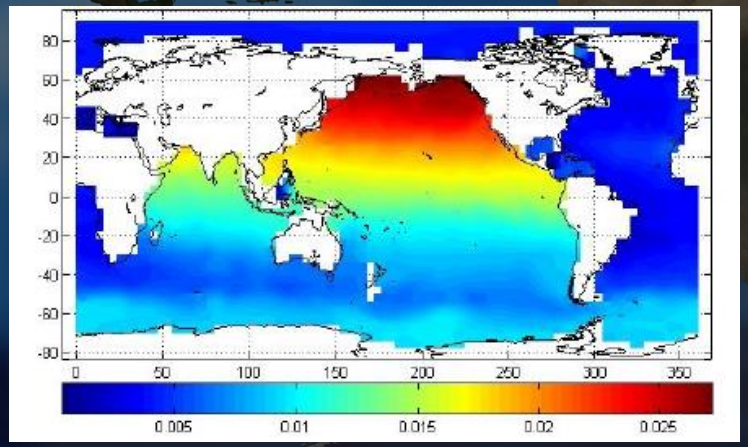
Conclusions : what NOSS will offer …

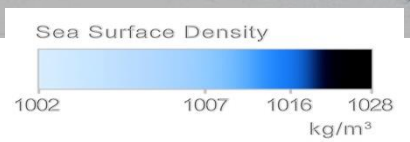
- New tool for monitoring *in situ* absolute salinity S_A and density ρ of seawater in parallel of current measurement instrument (CTD).
- Alternative solution for classical CTD
- Better knowledge of traceability of salinity anomalies (density and absolute salinity)



Next objectives…

- To target deployments in waters such as Indian and Pacific Ocean where water salinity anomalies are more likely to be present





Thank you for your attention

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