BIO-ARGO: QUALIFICATION OF SENSORS AND EVALUATION OF THEIR FACTORY CALIBRATIONS.

Euro Argo, 2013
Southampthon, UK.

Antoine Poteau,
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Outline

1. ProvBioll. (float and sensors)
2. Why we did what we did.
3. 3 procedures for “calibration”
4. Validation
5. Conclusion Pros/Cons

1 / ProvBioII: sensors and floats.

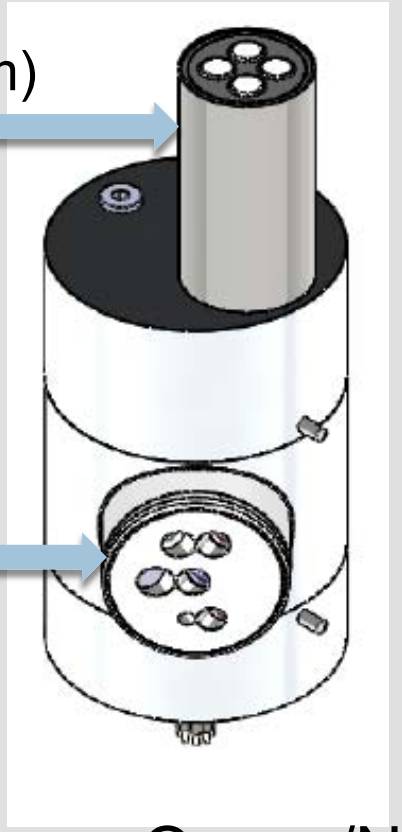
60 floats with combo of 2 standard sensors

OCR-504

- 3 Downwelling Irradiance, Ed(380,412,490nm)
- Photosynthetically active radiation (PAR)

ECO Triplet

-Chlorophyll_a (Chl_a)
-Backscatter (bb 700nm)
-Colored Dissolved Organic Matter (CDOM)



remOcean/NAOS

1 / ProvBioll: sensors and floats.

SUNA:

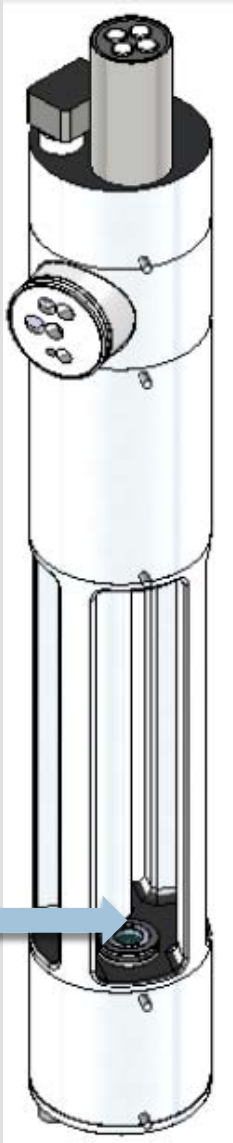
-Submersible Ultraviolet Nitrate Analyzer

Optode:

-dissolved oxygen

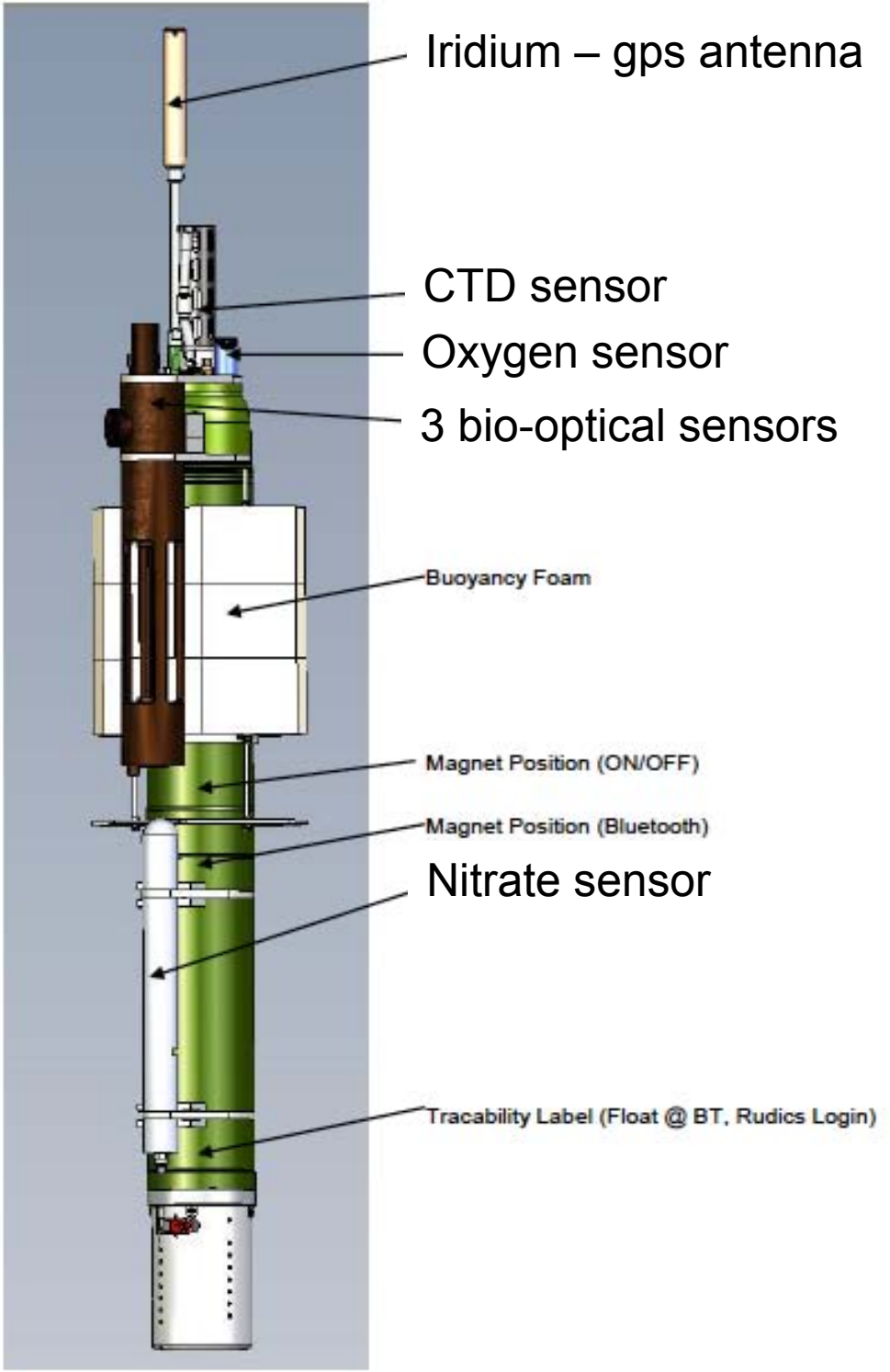
c-Rover:

-Beam Attenuation Coefficient, cp 660nm



1 / ProvBioll: sensors and floats.

- Profile 0 to 2000m
- Surface every day at 12 GMT
- Drift at 1000m
- Ex: 4 zones for chlorophyll_a
  - 0 – 10m : 0.20m resolution
  - 10 – 250m : 1m resolution
  - ~~250 – 1000m : 10m resolution~~
  - 250 – 1000m : 1 m resolution
  - 1000 - 2000m : 50m resolution



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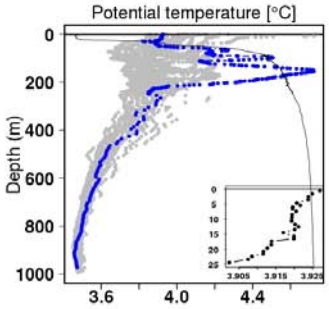

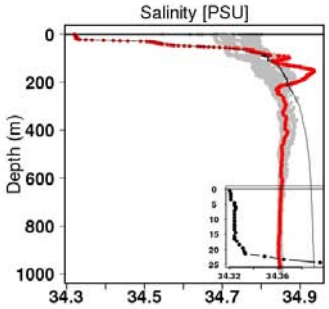

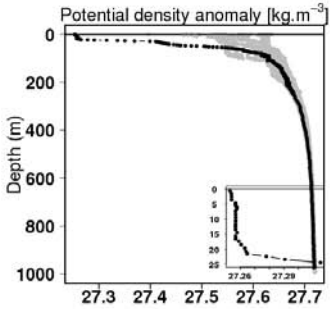

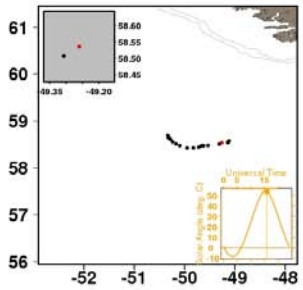

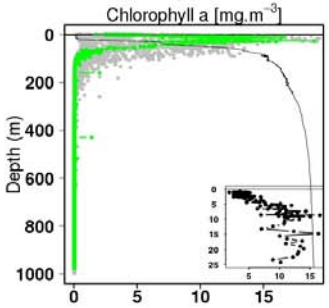

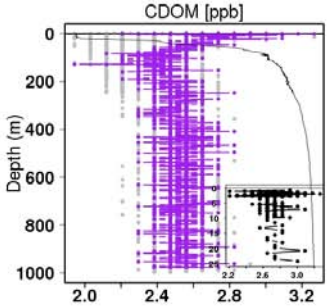

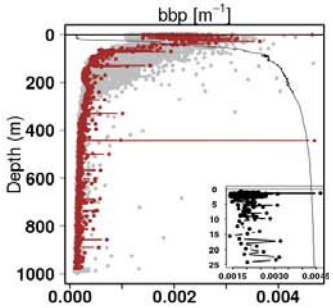

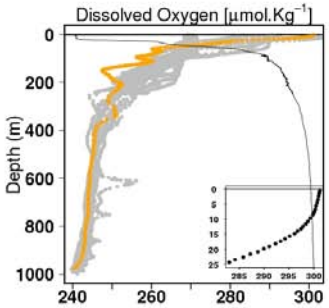

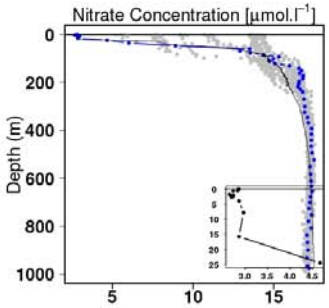

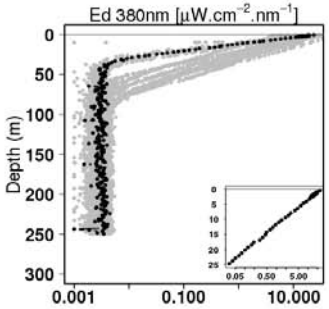

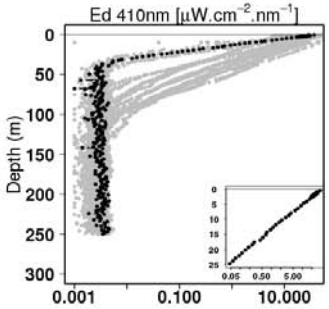

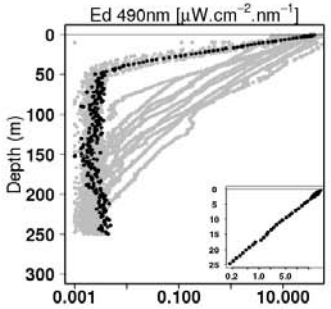

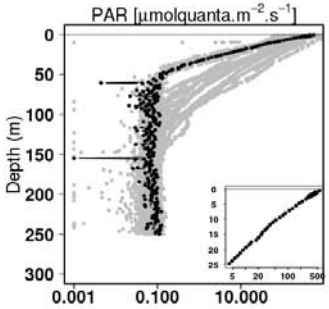

2/ Why we did what we did

We deployed two floats in 2008

-at the same time.

-and the same place,

(HOTS station, Hawaii. USA).

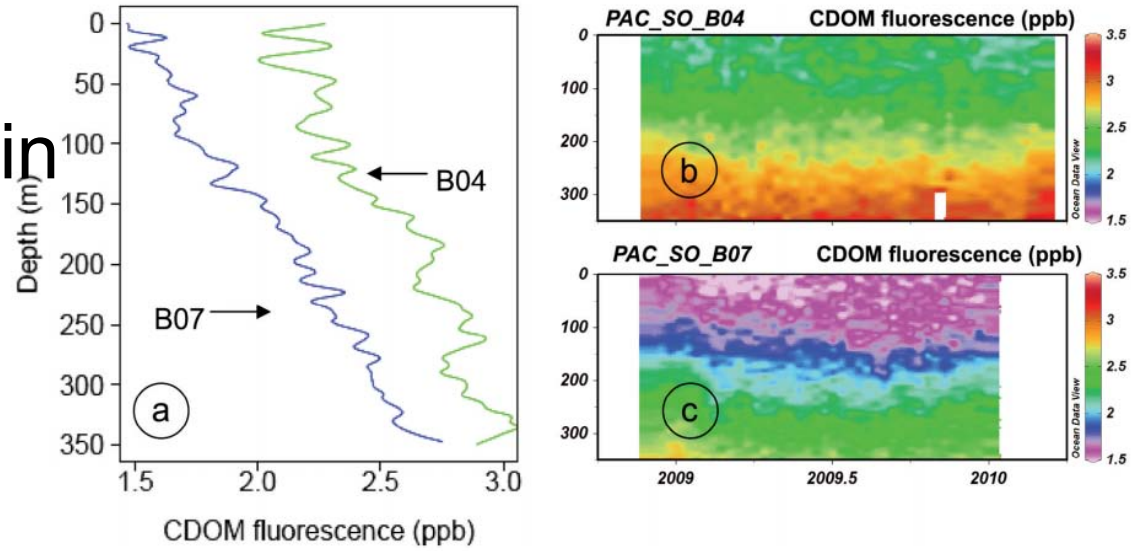

Figure 4. (a) A couple of CDOM fluorescence profiles (in parts per billion) acquired by two floats (B04 and B07) at the same location in the South Pacific (27.19°S; 109.88°W) and on the same day (3 December 2008, cycle 0 around 19:00 GMT). (b and c) Vertical sections showing the CDOM signals recorded by the two floats over their entire lifetime.

Xing et al., 2012

Offset for the Colored Dissolved Organic Matter (CDOM)

Why we did what we did

If the sensor is well calibrated
the deep value must be correct.

Equation , for this study we assume than the scale factor is good

The errors in the dark value have a more pronounced impact on the accuracy of chlorophyll retrieval when its concentration (i.e. numerical count) is low.

Dark correction is VERY important

Why we did what we did

Biogeochemical sensors & Argo
Boss, Claustre & Johnson
Argo science team 2010
« The greatest challenge is the coordination with respect to sensor calibration, data treatment (QC) and distribution. »

Biogeochemical sensors on profiling floats
Claustre, D'ortenzio , Poteau
EuroArgo 2010
« Support regular international intercomparison exercises.
(Calibration of numerous optodes for O2-Argo at Bergen (Bittig)
Develop internationally agreed calibration centers) »
platforms »

3/3 procedures for “calibration”

Method 1 : Factory calibration

Method 2 : Cross-calibration against known reference sensors (master) (SIBO)

Method 3 : New black measurement in pool

Method 1 : Factory calibration

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620 Applegate St.
Philomath, OR 97370

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ECO Chlorophyll Fluorometer Characterization Sheet

Date: 4/28/2011 S/N: FLBBCD-2244

Chlorophyll concentration expressed in µg/l can be derived using the equation:

CHL (µg/l) = Scale Factor * (Output - Dark counts)

	Digital
Dark counts	45 counts
Scale Factor (SF)	0.0072 µg/l/count
Maximum Output	4130 counts
Resolution	1.0 counts
Ambient temperature during characterization	22.3 ℃

Dark Counts: Signal output of the meter in clean water with black tape over detector.

SF: Determined using the following equation: SF = x ÷ (output - dark counts), where x is the concentration of the solution used during instrument characterization. SF is used to derive instrument output concentration from the raw signal output of the fluorometer.

Maximum Output: Maximum signal output the fluorometer is capable of.

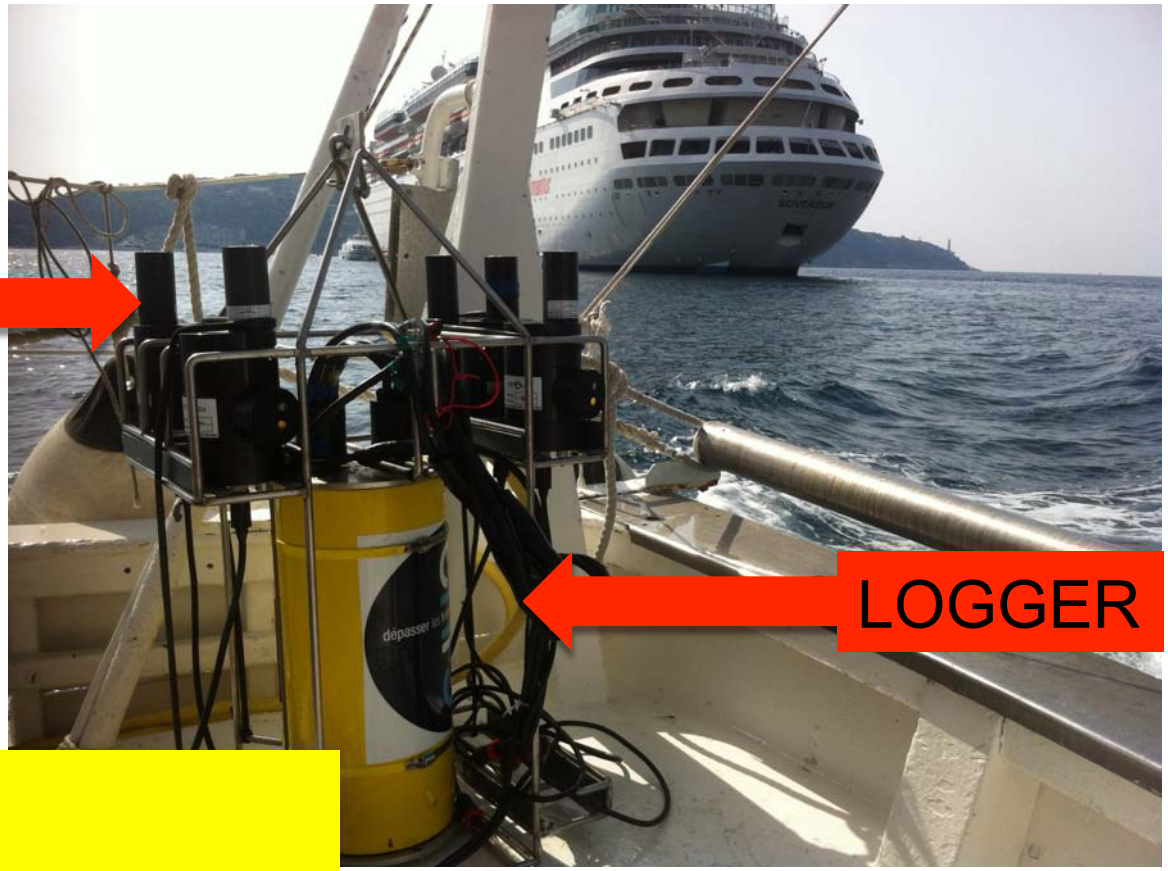
Resolution: Standard deviation of 1 minute of collected data.

The relationship between fluorescence and chlorophyll-a concentrations in-situ is highly variable. The scale factor listed on this document was determined using a mono-culture of phytoplankton (Thalassiosira weissflogii). The population was assumed to be reasonably healthy and the concentration was determined by using the absorption method. To accurately determine chlorophyll concentration using a fluorometer, you must perform secondary measurements on the populations of interest. This is typically done using extraction-based measurement techniques on discrete samples. For additional information on determining chlorophyll concentration see "Standard Methods for the Examination of Water and Wastewater" part 10200 H, published jointly by the American Public Health Association, American Water Works Association, and the Water Environment Federation.

3/ “cross-calibration ” (SIBO)

System of Inter-calibration of Bio-Optic sensors (SIBO).

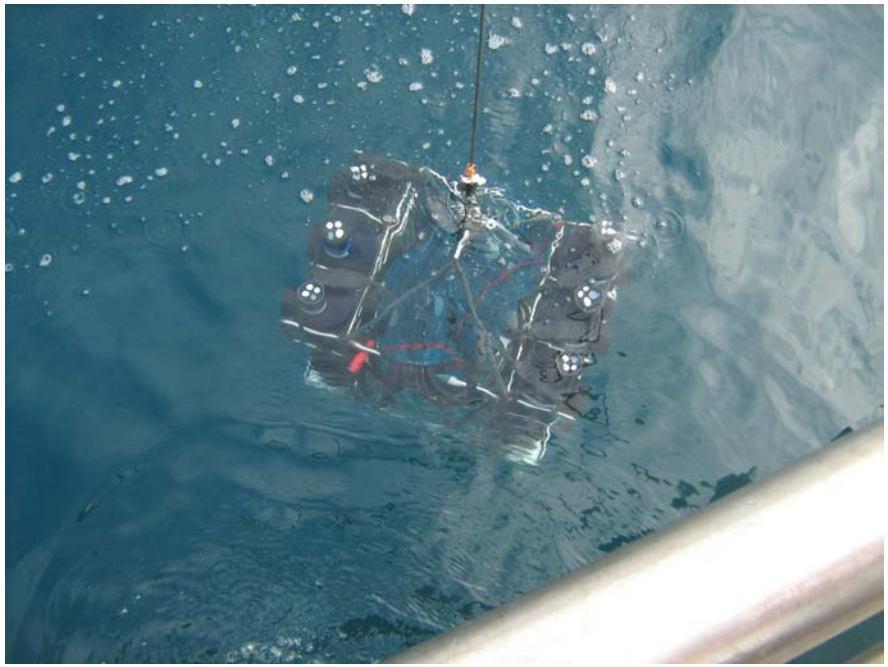
- Logger up to
  - 6 Eco3
  - 6 OCR
  - 6 transmitiometer
  - 4 suna
- 0 -200 meters profiles



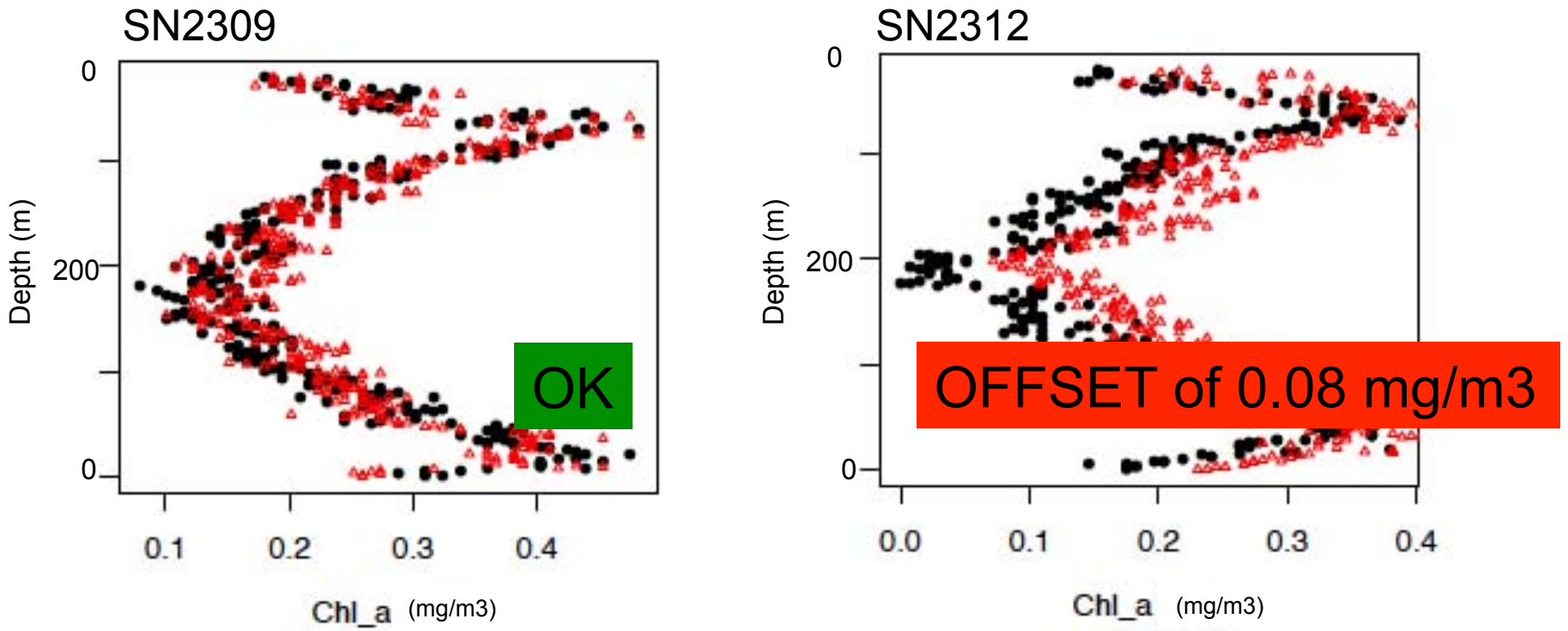
Comparison with MASTER/GOLD references

3/ “cross-calibration ” (SIBO)

Concentration of chl_a
around 0.05 to 2mg/m3



3/ “cross-calibration ” (SIBO)

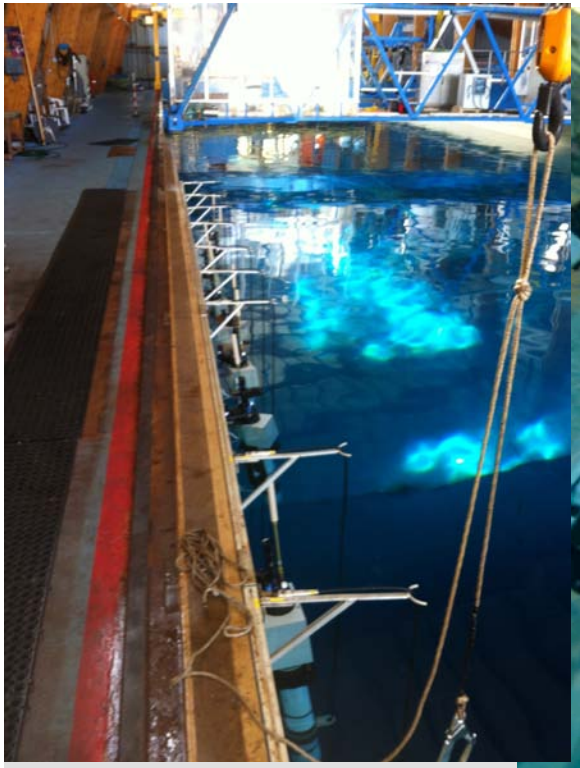


Adjust the black if necessary to account for this offset

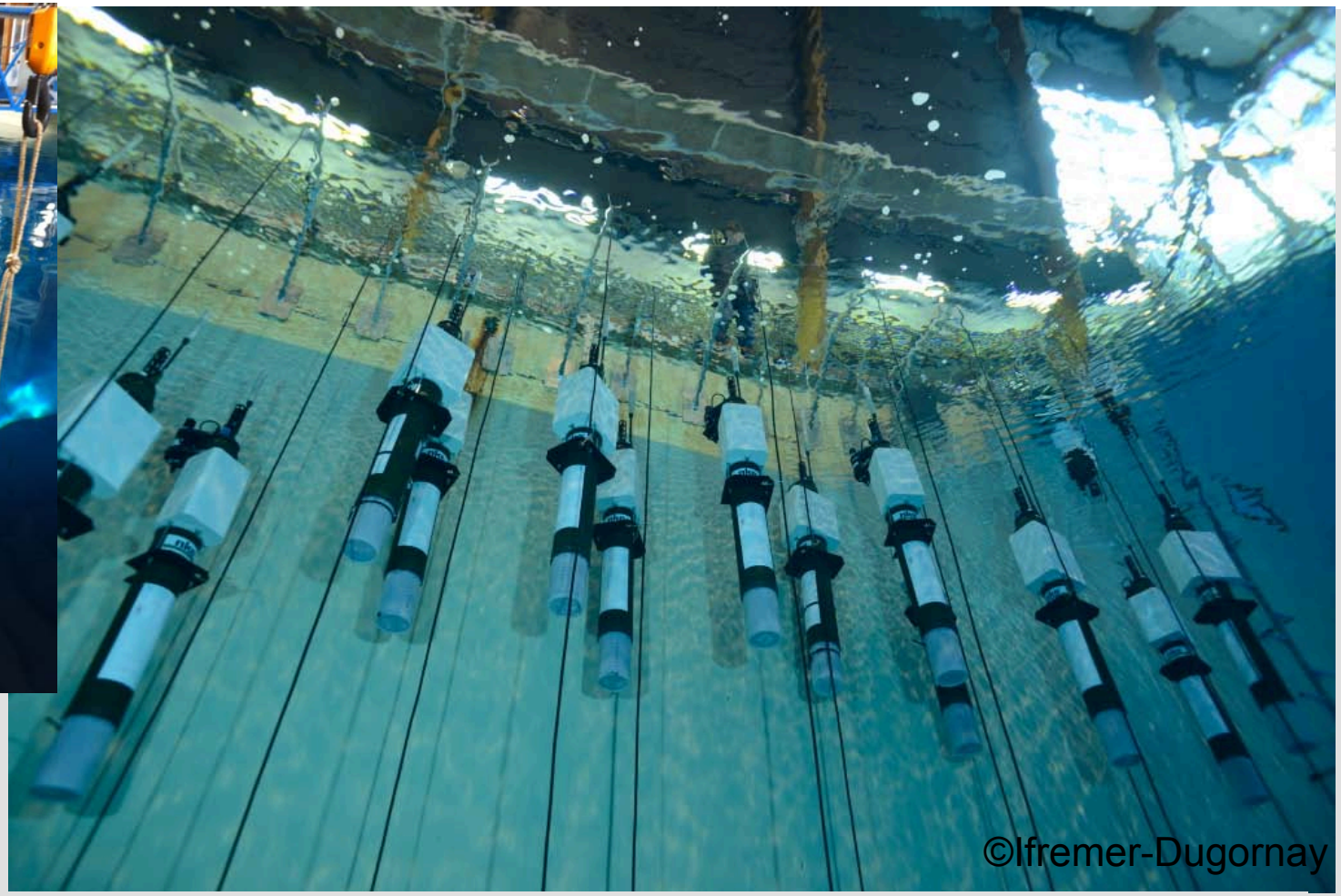
Black : tested sensor

Red : Master/Gold

3/ “black in pool”



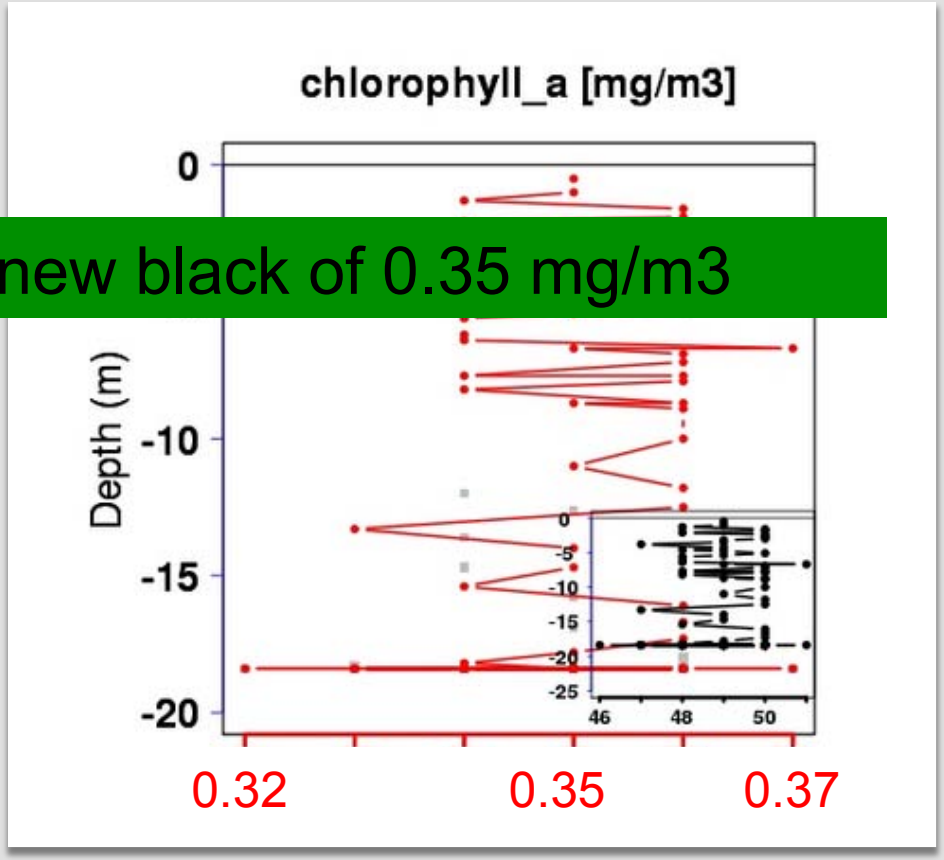
Tests conducted in pool.



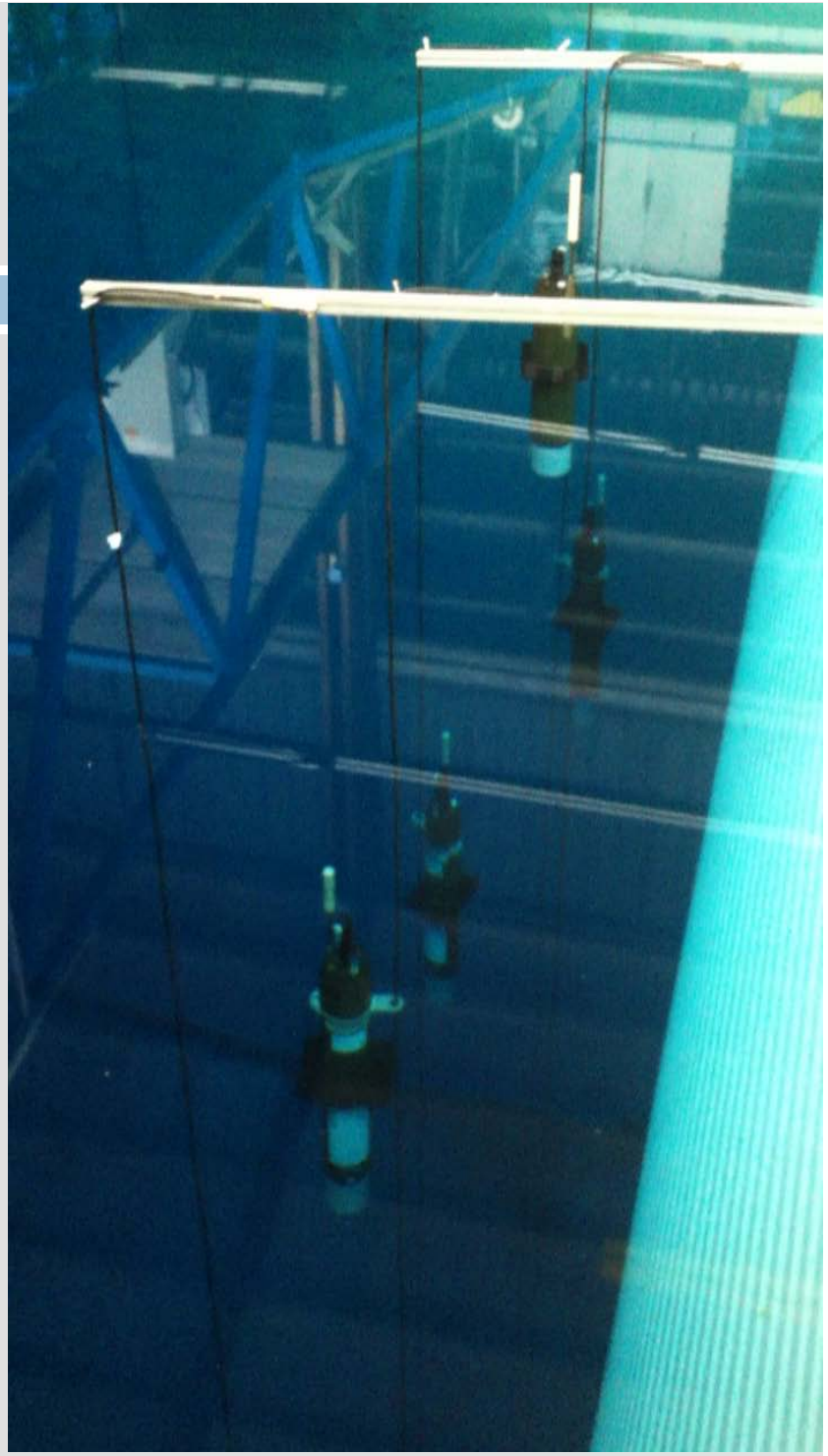
Up to 20 floats at the same time in the pool in Ifremer, Brest 20 meters depth

3/ “black in pool”

Dark profile during the test.



new black of 0.35 mg/m3



4/ Validation

For the validation we assume that for several floats deployed :

- at the same time,
- at the same place (1 mile off),
- and at the same depth (1000 meters),

-> We would have the same value at depth.

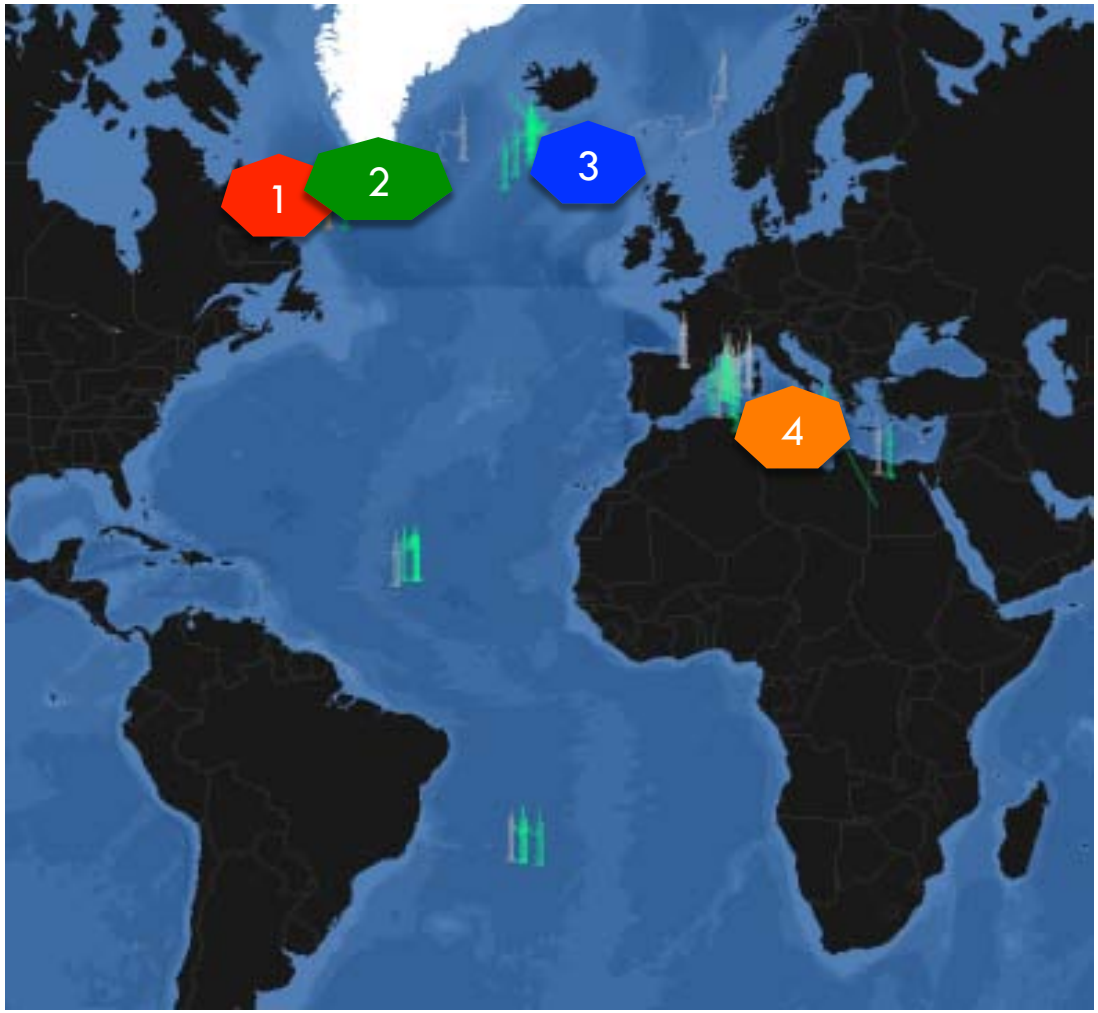
4/ Validation

-Zone 1 : labrador sea
4 ProvBioII

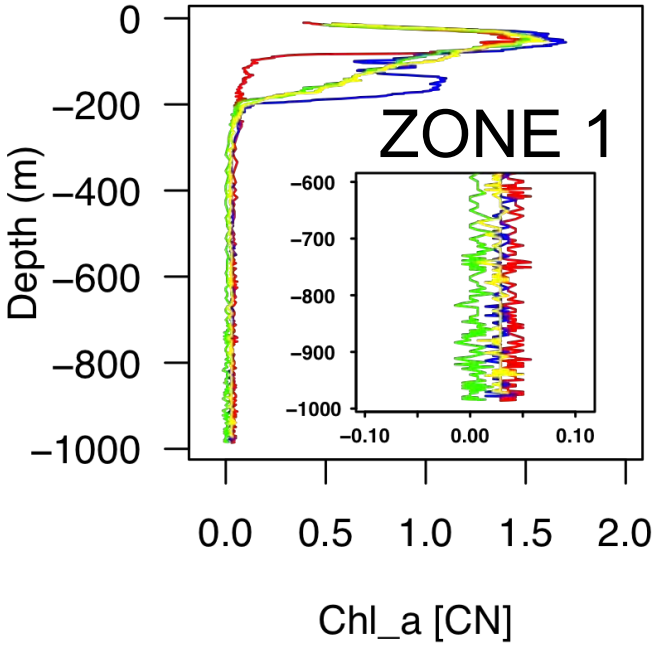
-Zone 2 : labrador sea
3 ProvBioII I& 1 Navis

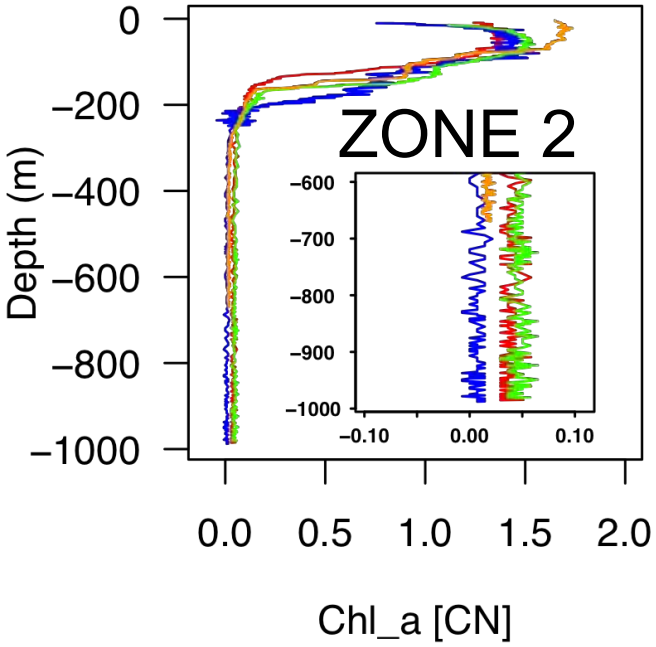
-Zone 3 : Island Basin
7 ProvBIoII

-Zone 4 :Med sea
2 ProvBioII

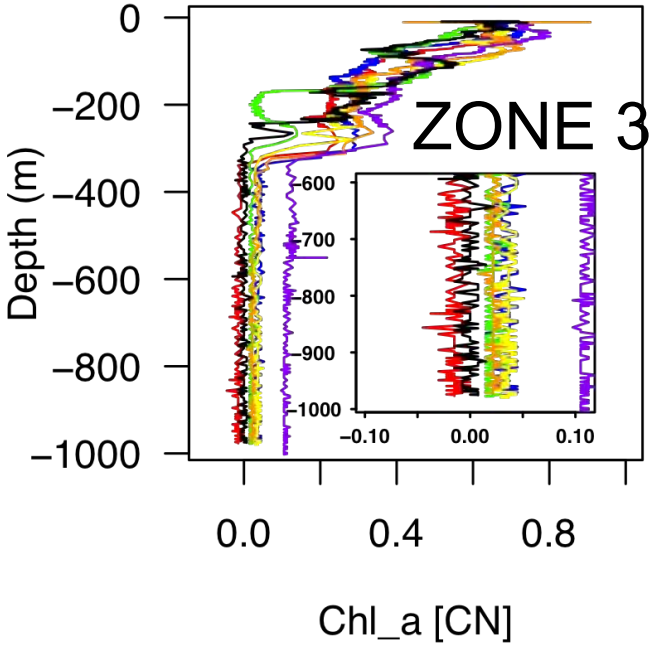


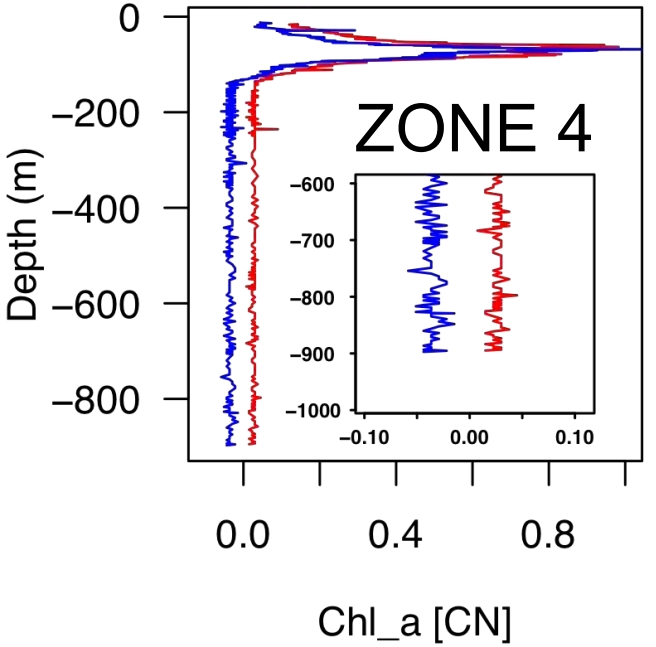
So we can test the 3 methods :
Method 1 : factory calibration
Method 2 : inter calibration
Method 3 : black in pool

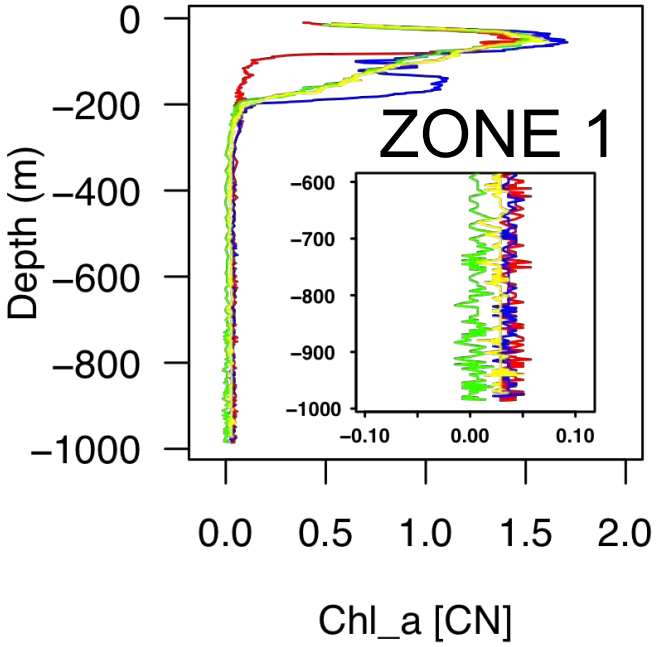


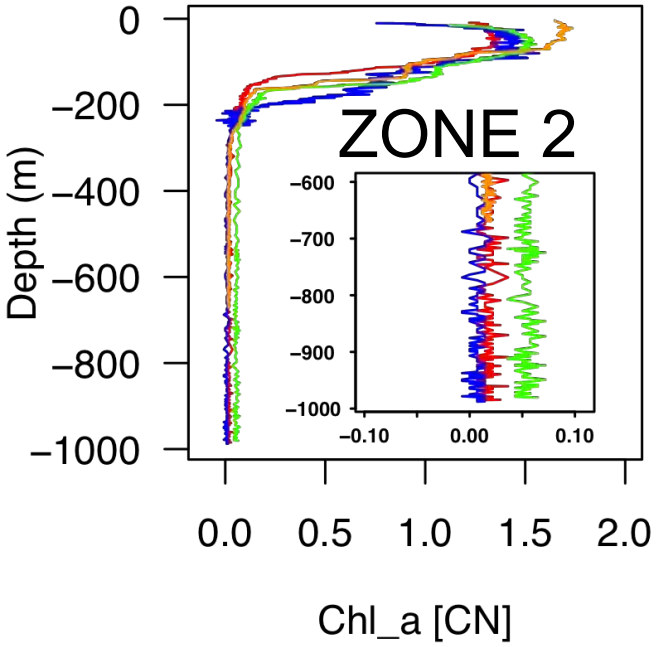


Method 1 : Factory calibration

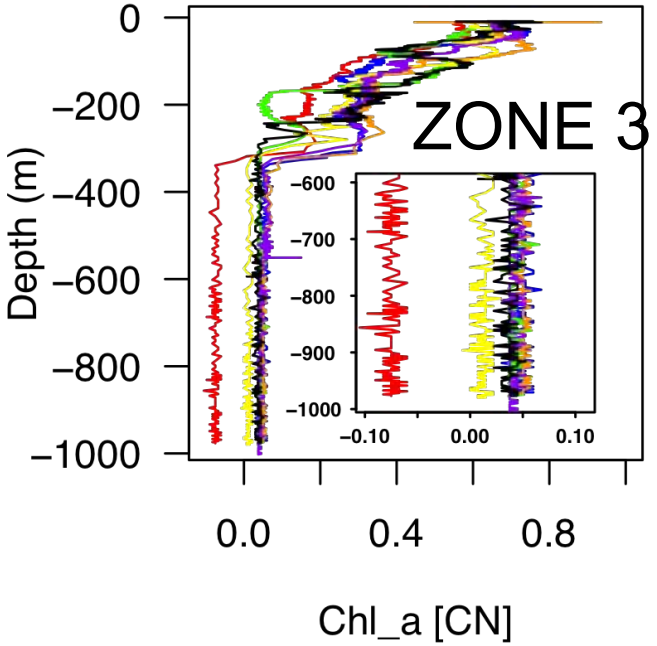


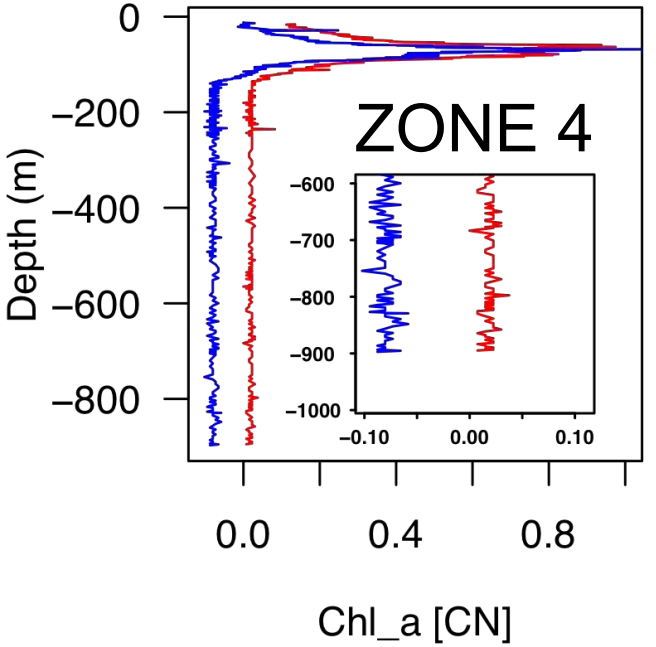


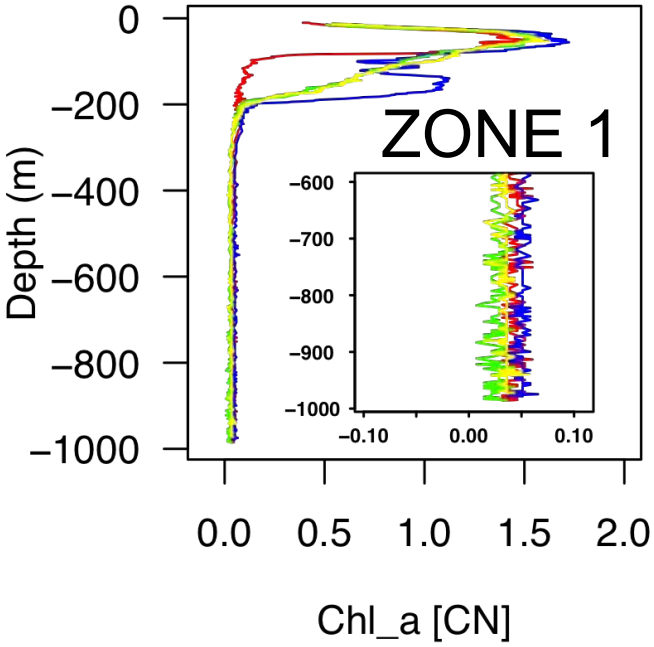


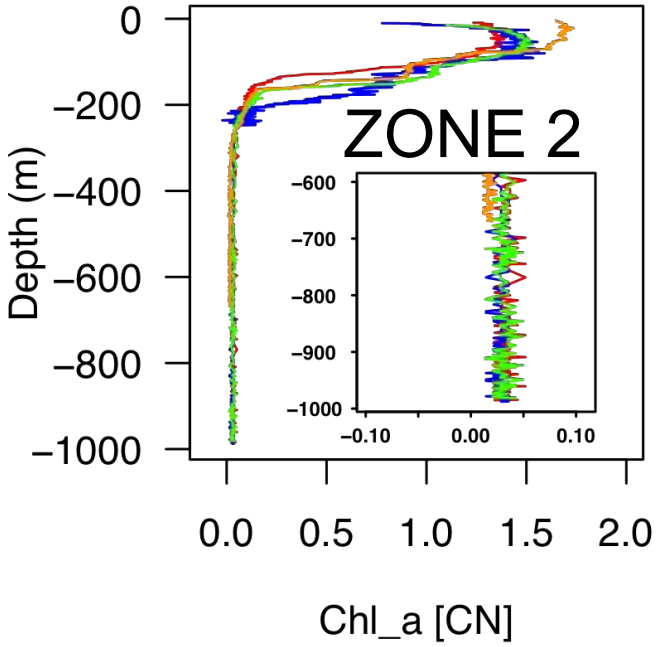


Method 2 : cross-calibration

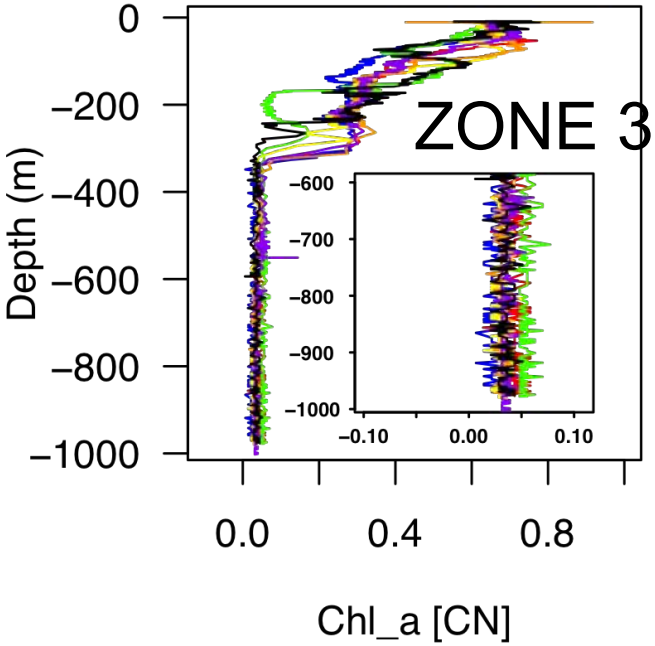


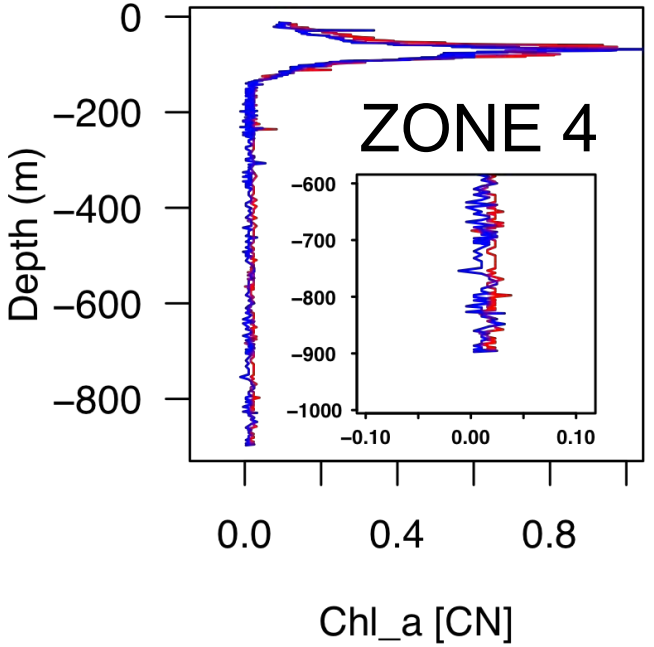






Method 3 : Black in pool





5/ Conclusion Pros/Cons

	Pros	Cons
Factory calibration	-Nothing to do	-Still need a control to identify sensor issue (one shoot mission) -No inter-calibration
Cross-calibration	-Adjustment with a MASTER -Real profile of chlorophyll_a -Quickly identify sensor issue	-No direct black measurement -Black correction no better than the factory calibration (through a MASTER) (need improvement to the method)
Black in pool	-Black measurement (float + sensor) -Good validation on the deployment	- Not a real signal

What should we do now ?
-> ask the manufacturer of float to do a black measurement
-> should we ask to the PI to do it ?
-> automatic black measurement the day of deployment (action ADMT)

The validation of the scale factor is also important
-> should we set up a European inter calibration for sensor (European master) ?

Thank you