Float technology progress. PROVOR / ARVOR floats.

AST 13, March 2012

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Context and plan

- The work started within the Euro-Argo preparatory phase, then continued within the NAOS (Novel Argo Ocean observing System) project. Developments are made in collaboration with our industrial partner NKE.

- Status for :
  - ✓ Argo float improvements
  - ✓ Sensors: oxygen, nitrate, density
  - ✓ Deep float
  - ✓ Satellite transmission: Argos 3
  - ✓ Electronic architecture in floats
  - ✓ Bio Argo floats

Argo float improvements

- ✓ One specific task of NAOS is dedicated to improve float reliability and lifetime by:
  - enhancing the buoyancy engine manufacturing process,
  - completing rugged self tests before deployment,
  - simplifying the deployment procedure,
  - Adding technical information to transmitted data
  - …
- ✓ One other task is to reduce costs of sub-assemblies. The work is focused on:
  - Hydraulic engine,
  - The glass or carbon epoxy hull,
  - The antenna.
- ✓ The new needs of the scientific community is also taken into account to make the floats more efficient

Oxygen sensors

The recommendations of oxygen meeting (Brest, may 2011) has suggested:

a) to transmit phase raw data of the Aanderaa optode,

b) If possible to do a multipoint calibration to better adjust the conversion parameters phase / concentration. This method should result in a better accuracy (~1uMol/kg)

c) If multipoint calibration is not possible, to do 0-100% calibration at 2 different temperatures

d) To use the 7 parameters equation (Uchida et al) rather than Aanderaa polynomial to calculate O2 concentration.

Test of Provor-DO at Ifremer pool.

Oxygen sensors on float

→ Applications on Provor

a) For float without any satellite transmission limitation (Iridium): transmission of the phases C1 and C2 with 0.002° resolution and 16 bits range (+ temperature).

b) For floats with Argos transmission: to limit the amount of data, transmission of the difference of phases with resolution limitation of 0.008° and 13 bits range 10° to 75° (+ temperature)

In 2012:

10 Provor (Argos transmission) will be equipped with phase transmission. The optodes have been multipoints calibrated in 2011.

6 Provor will be fitted with Iridium transmission.

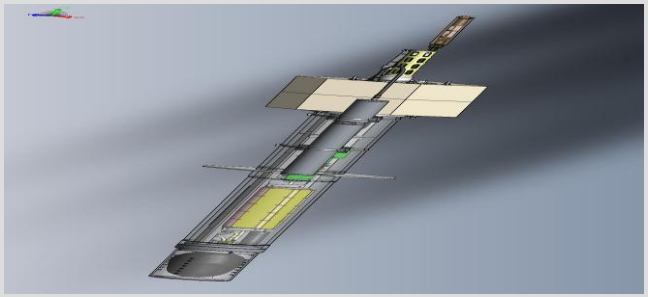
Nitrate sensors

SUNA (Submersible Ultraviolet Nitrate analyser) and ISUS (In Situ Ultraviolet Spectrophotometer) sensors, from Satlantics manufacturer, have been embedded on 2 Provor floats (Collaboration CNRS-UPMC-Ifremer) and tested at sea in the Moose project framework (Mediterranean sea, June 2011).

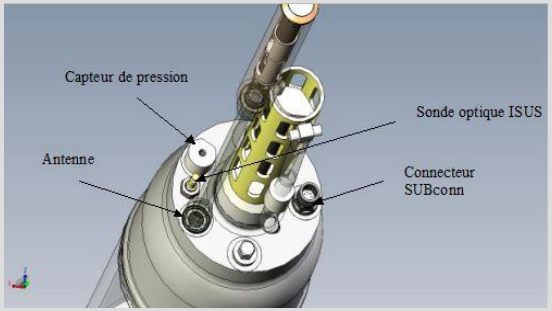
The Isus was dismantled and integrated into the Provor, the sensor was mounted on the upper end cap.The Suna was mounted along the Provor hull (with additionnal flotation foam).

~72 levels of pressure (from 1000m depth to surface) were sampled with 7 samples at each level.

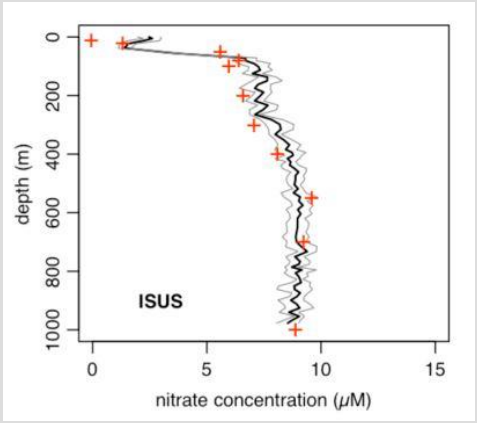
This experiment was useful to validate nutrients measurements on Provor floats for next NAOS Bio floats.



Provnuts (Suna sensor)



Provnuts (Embedding ISUS sensor)



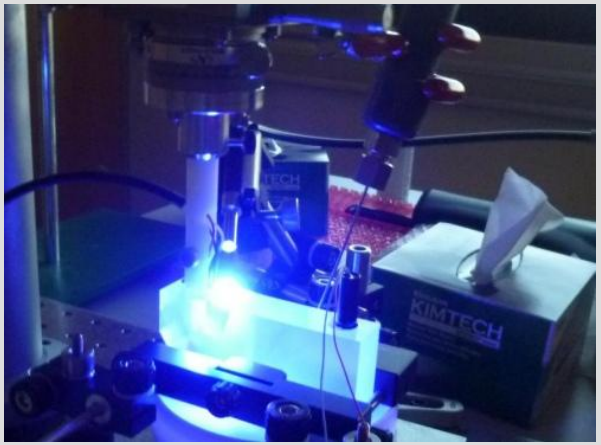
Density sensors

- The “NOSS” sensor is dedicated to get density and salinity of sea water, by measuring the refractive index (from a position sensing detector) of a laser beam passing through the water sample to analyze. The refractive index allows to compute absolute salinity.

- Improvements of first version of the sensor have been done by the end of 2011 and early 2012. This should improve long term withstanding in sea water, light influence, accuracy.

- At spring, tests will be achieved: metrology control, pressure assessment. After that, tests at sea will be done by coupling it on a CTD from a vessel.

- Depending on the results, the sensor will be embedded on a Provor float.



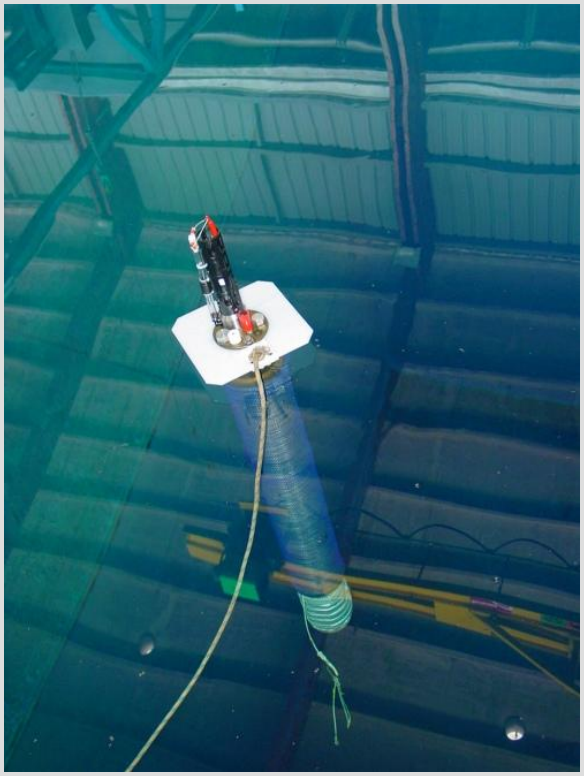
Sticking bench of
NOSS prototype

NOSS sensor:
142*100mm size, ~

Deep Arvor

The objective is to reach 3500m depth. The float is fitted with CTD and oxygen sensors. Up to 1000 points will be transmitted (more in test conditions).

- ✓ Work has been done to size the subsystems: the CTD SBE41CP endcap, the hydraulic engine (extension of 2000m model), the pressure hull, the antenna.
- ✓The tests of 2 hydraulic endcaps and several hull samples have been done.
- ✓ CTD encap has been tested in our metrology laboratory.
- ✓The first prototype have been assembled and first tests have started in march.



Arvor3500 during buoyancy tests

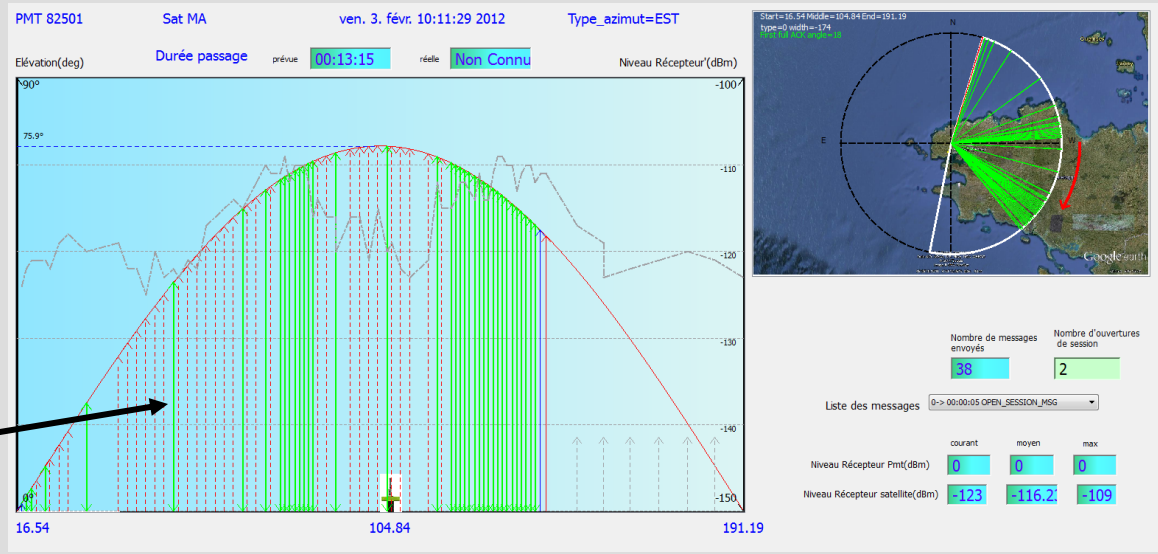
Argos 3 tests in 2011

- Argos 3 satellite transmission has been embedded on Arvor float in 2011. It uses the interactive mode capability (low data rate) of the MetopA satellite, using its prediction pass tables to make a « rendez-vous » at surface. The objective is to send all the profile data during the MetopA pass.
- The system is designed to accept the next satellites (Saral, MetopB)
- First tests in the bay of Brest were successfull. 2 floats were deployed in Mediterranean sea in early 2011.
- Results: the transmission duration was longer than expected (with high variability). The noise configuration or the downlink were suspected. However, the profile data was transmitted correctly and the remote control of the float works well.

Arvor A3

Argos 3 tests in 2012

- 2 new floats have been fitted with a new version of modem (V0.5), allowing « full ack » mode (ie transmission session is opened for the full satellite pass)
- A monitoring software has been developped to control the transmission quality during lab tests.



- News tests were done at sea in february 2012 with successfull results : 38 messages were transmitted in 5 minutes (1 Argo profile from 2000m depth represents ~20 messages). One float has been deployed in Mediterranean sea last week.
- A new 2 bands antenna is being designed
- The high data rate mode development is on going and first transmission tests have been done in lab. It should give better performance.

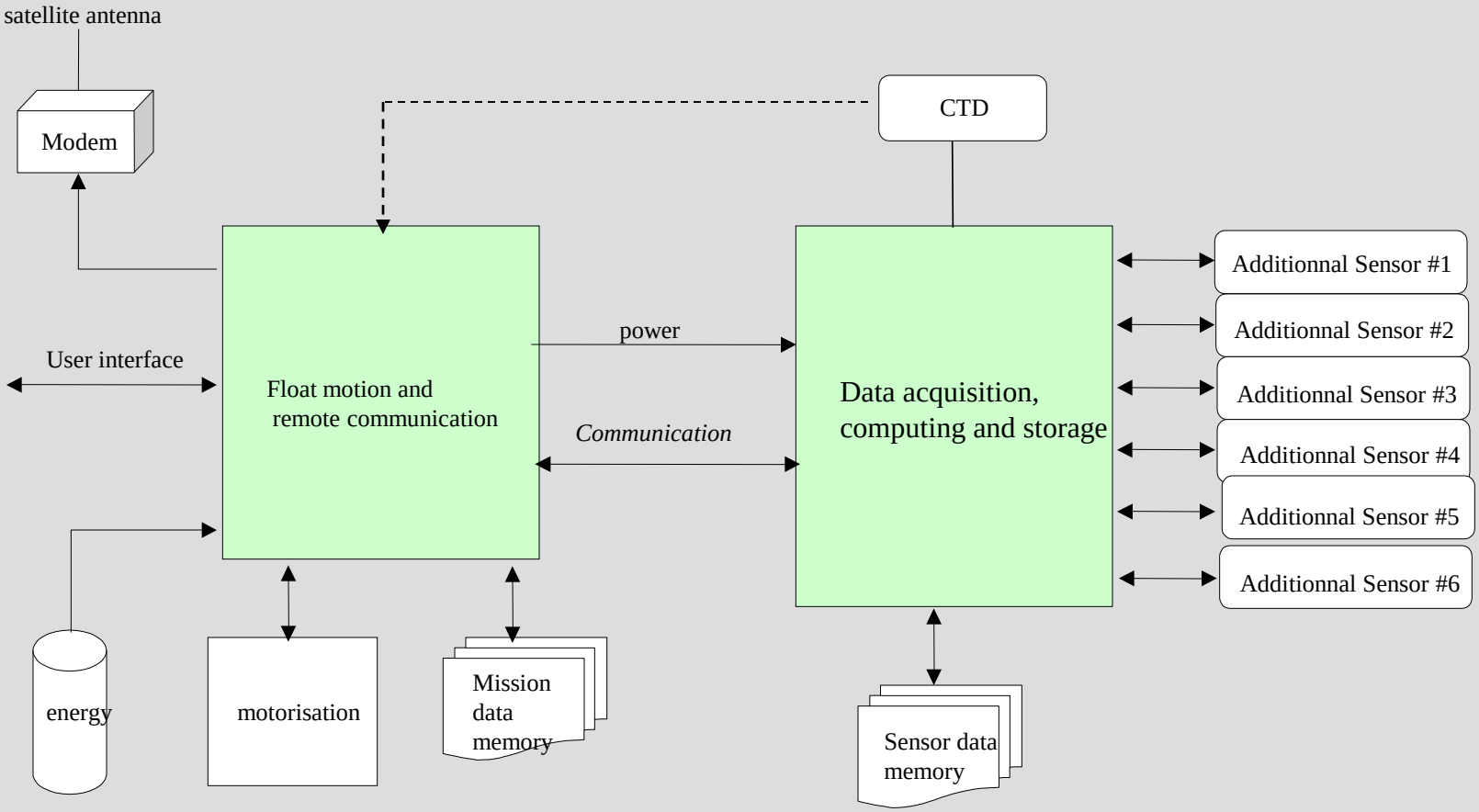
Arvor A3, transmission tests, february 2012

Evolution of Electronic architecture

A two separate units electronics have been designed: it gives more flexibility to add sensors (hardware and software).

The 1st unit manages float displacement and remote communication, the 2nd is dedicated to connect several sensors and to compute data before sending them to 1st unit.

This architecture is dedicated to multi-sensor floats (coastal applications, Bio floats)



Evolution of float behaviour

a)In case of special event detections (eg ice sensing or others), feedback from the sensor unit could be done to the motion unit to change float behaviour (profile cancelled or postponed, mission cancelled to rise to the surface, waiting,…)

b) The sequence of the float mission will be flexible to allow special schemes. The mission will be set by a « graphical user interface » software.

Exemple of mission scheme

Provor Float with Bio sensors

Bio-Argo float developments (Remocean project) are managed by the « Laboratoire d'Oceanographie de Villefranche », H.claustre, (CNRS-UPMC).

The Provor can embed additionnal optical sensors:

-dissolved oxygen (4330 Aanderaa optode)

- CHLA & CDOM fluorometer, backscatterring (Wetlab Ecopuck sensor)

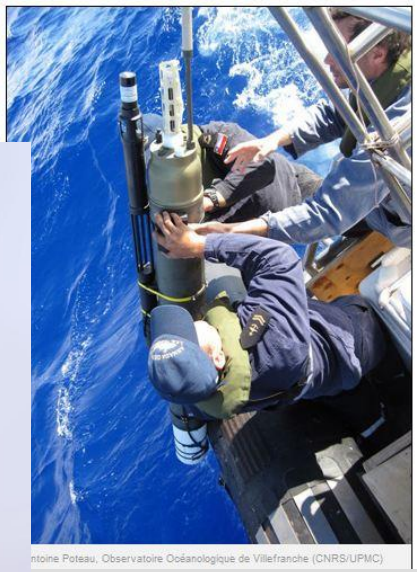
-3 wave lenght radiometer (OCR4) + PAR (400-700nm)

Optionnally, other sensors could be embedded:

-Crover transmissometer (Wetlabs)

-Nitrate (Suna sensor),

-For Arctic applications: Ice sensor (developement ongoing)



Deployment of Current ProvBio model

Exemple of next ProvBio in « Remocean A » + suna configuration

Main work for the next months…

- ✓ Improve manufacturing process to increase lifetime of floats, simplify deployment procedure,..
- ✓ Conclude on Argos3 satellite transmission performance,
- ✓ Test the deep Arvor at sea.

Thank you for your attention.