# Provor CTS5

## New PROVOR float dedicated to challenging sensors and complex missions: opportunities for arctic deployments.

E. Leymarie[1], C. Penkerc'h[1] , C. Marec[2], J. Lagunas-Morales[2], C. Schaeffer[3], A. David[3], P. Brault[3], H. Claustre[1], M. Babin[2], S. Le Reste[4]

(1) Laboratoire d'Océanographie de Villefranche (LOV), CNRS/UPMC, Villefranche-sur-mer, France. (2) UMI Takuvik, Québec, Canada. (3) NKE Instrumentation, Z.I. de Kerandré, Rue Gutenberg, 56700 HENNEBONT, France. (4) IFREMER, Brest, France.

## Summary:

For more than a decade, the Argo program has proved its usefulness for physical measurements within the ocean. More recently, floats developed for this program have been used independently for a large number of other applications, from biogeochemical measurements to rainfall estimation. New programs, like remOcean and NAOS projects, have already succeeded in merging a significant number of sensors on the same float named ProvBioII (NKE). This float is perfectly suitable for a large range of "BioArgo" applications, and merging of sensors provides scientific benefits and cost reductions. Now new challenging sensors, such as imaging, chemical or acoustic sensors, are already planned to be implemented on floats. These new applications will need improved capacities of the float, in particular the electronic which manages sensors, and also increased flexibility of the float missions to accommodate all the potentials scientific applications. All these new capacities make this new float well adapted for arctic deployments, which require an avoidance of sea-ice and a large storage of data.

We present here a prototype version of a new NKE float which implements the so-called "double electronic boards" architecture. This scheme is based on one navigation board to drive the float and one acquisition board to drive sensors. This architecture is used to secure vital functions of the float and allows easier and safer integration of new challenging sensors. The new float prototype is equipped with a new navigation board developed by NKE, named APMT. This board allows script-based mission and is able to exchange data and receive navigation commands from an acquisition board. This allows retroactive programming of the float's mission based on scientific measurements, which could be extremely useful for a large number of applications including arctic deployments (avoidance of sea-ice) or adapted sampling of biogeochemical events. In addition, this new APMT board has large memory capacities as well as advanced remote control options. A new acquisition board developed by the LOV and OSEAN company has been interfaced with the float. This new low power acquisition board is able to accommodate a large range of sensors (including news sensor for sea-ice detection) and perform in real time complex processing of collected data (FFT, Wavelet decomposition or statistical identification).

## New Provor CTS5:

The new Provor CTS5 uses the same mechanical (tube, ballast) features than the regular Provor. But it implements a new powerful electronic board :

**APMT board**

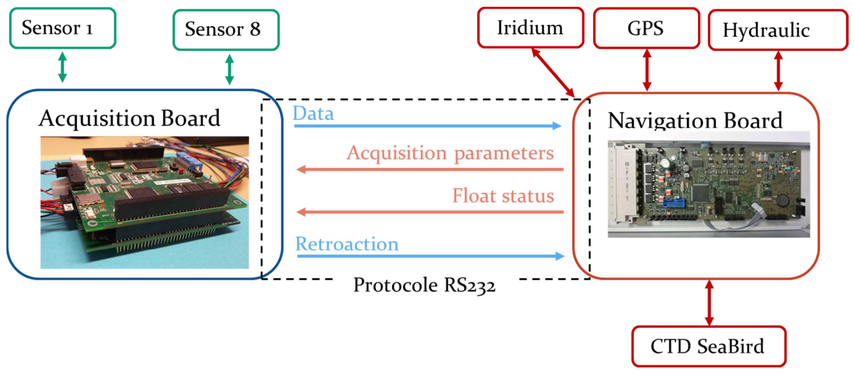
- Microcontroler 16-32 bits (48 Ko RAM, 1 Mo FLASH)
- 64 Ko de FRAM, 8 Mo de FLASH, micro-SD (32 Go)

**Provor CTS5 main features**

- ✓ Self-ballasted, navigation capabilities trough high density gradient
- ✓ High Speed Iridium RUDICS telemetry
- ✓ Highly flexible script based mission
- ✓ Large internal memory for data storage under ice
- ✓ Mission change without communication (base on date, useful for under-ice)
- ✓ +66% additional energy (compare to CTS3)

## The LOV Multi-Application acquisition board :

The new PROVOR CTS5 could be equipped with a new and powerful acquisition board developed by the LOV and OSEAN company. It allows to interface quickly a wide range of sensors, to process data in real time and to send navigation commands to the APMT navigation board (retroaction)




**LOV acquisition Board:**

- CPU ARM32 bits
- RAM CMOS de 4 Mo
- Mass memory SD 8 Go

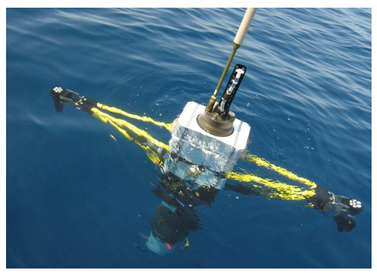
**main features:**

- ✓ up to 8 sensors
- ✓ low power high CPU capacity
- ✓ send retroactive commands to float
- ✓ easy implementation of new sensor
- ✓ data processing fully controlled by LOV
- ✓ future passive acoustic capacities

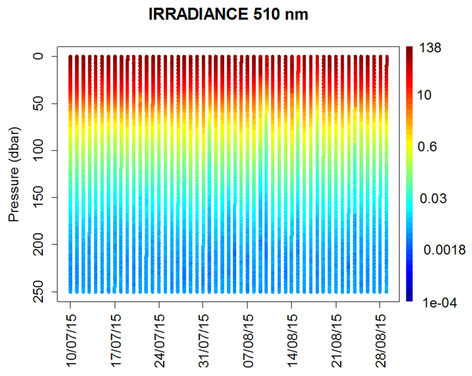
## ProVal

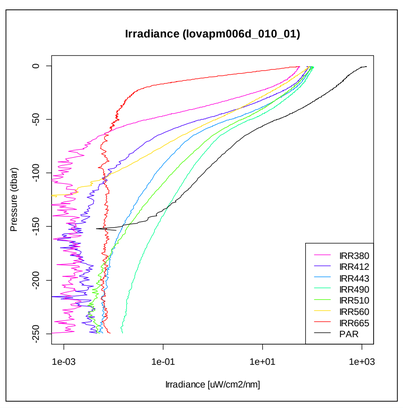
ProVal is a PROVOR CTS5 dedicated to Ocean Color Validation, it is instrumented with

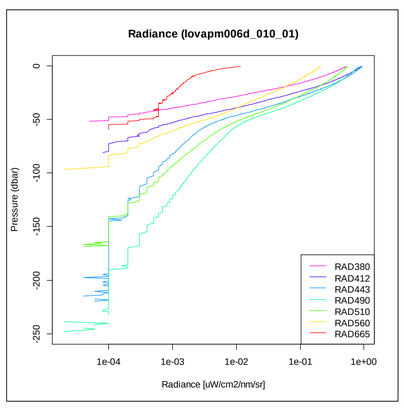
- ✓ 2 $E_d$ 7λ (*380*, *412*, 443, 490, 510, 560, 665 nm + PAR)
- ✓ 2 $L_u$ 7λ (380, 412, 443, 490, 510, 560, 665 nm)
- ✓ Fluorimeter (Chla and CDOM) and backscattering
- ✓ Compass and tilt

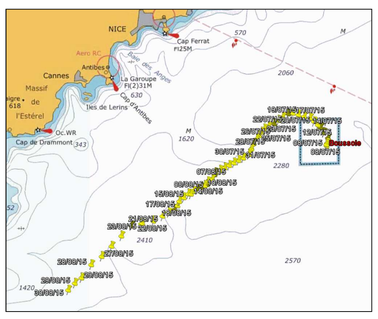


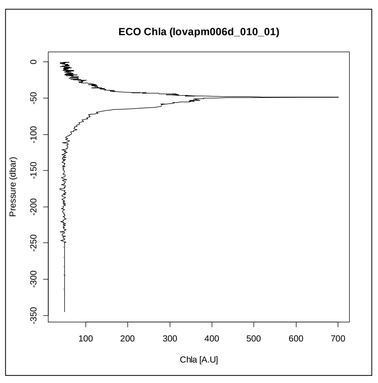
A ProVal has been deployed for two months close to the BOUSSOLE site. Around 50 profiles was acquired.



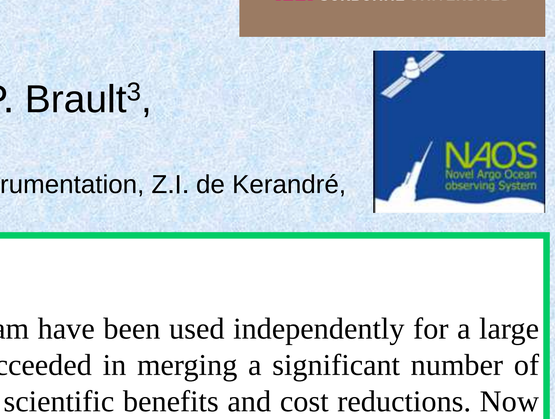



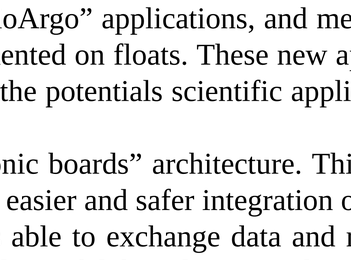



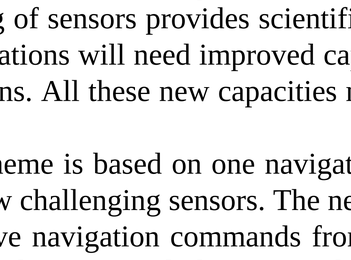

## ProIce test in Mediterranean sea:

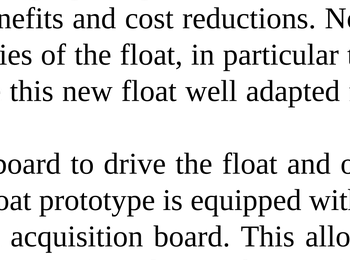
A ProIce fully equipped with sensors has been deployed from the BOUSSOLE area in February and July. Around 100 profiles have been recorded. These tests were used to validate the ability of the float to modify its ascent speed and breaks in prevision of the navigation under ice.

(See The poster "The challenge of deploying biogeochemical ARGO floats at the Arctic ice-edge: the need for an efficient sea-ice detection system" to have more information about this program.)



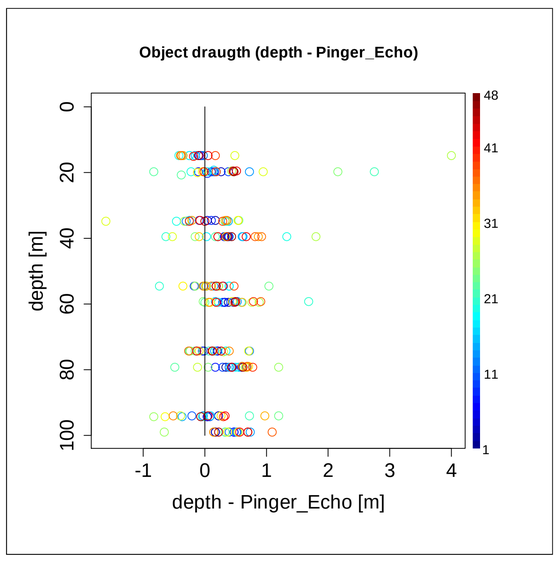




## Sea Ice detection : Altimeter

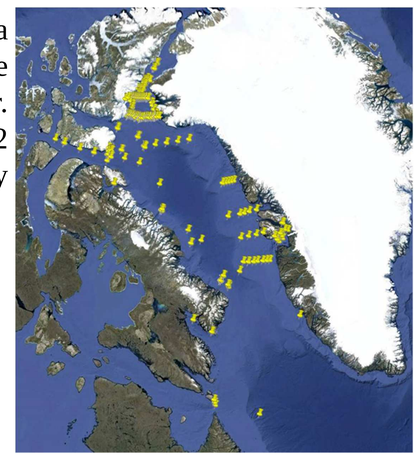
An altimeter is used to detect Icebergs. Results obtained in the med sea show that the draught (depth – Pinger_Echo) has an average value close to 0 (0.28) and a deviation of 0.6m.

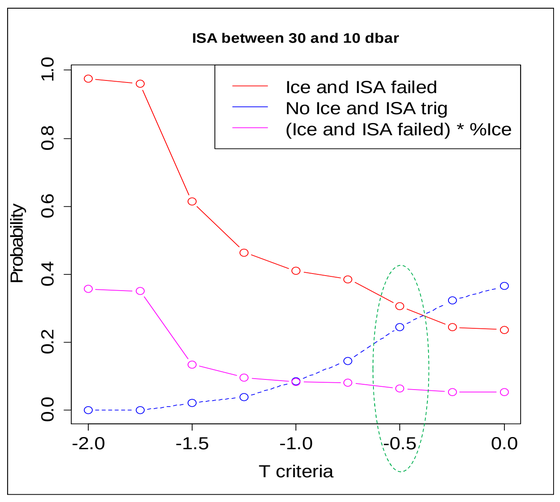
Some points appears with measured draught up to 4m while we can presume that no real object was above the float. This technic will be used to detect Icebergs with draught typically bigger than 10m.

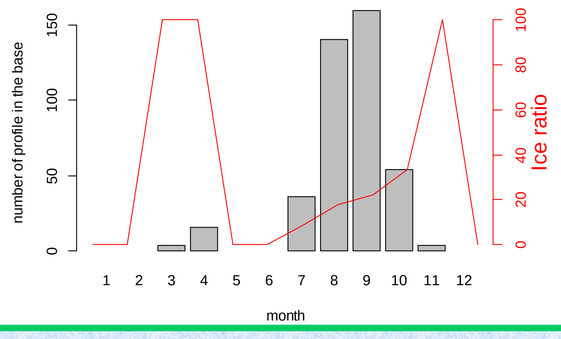



## Sea Ice detection : ISA

The Ice Sensing Algorithm (ISA) was introduced in Weddell Sea by Klatt *et al.* (JAOT 2007) to estimate the presence of sea-ice based on the median of the temperature between 50 and 20 dbar. This method was adapted to the Baffin bay thanks to the 392 CTD profiles with sea-ice information brought together by Takuvik. A critical temperature of -0.5°c was chosen in the bay.






***Acknowledgements***: These developments are funded thanks to the project ProVal (CNES-TOSCA), the project remOcean (ERC advanced grant N°246777) and finally the project NAOS ("Investissements d'avenir" ANR-10-EQPX-40).