

PROVOR/ ARVOR ARGO profiling floats

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A long partnership

- **A family of floats**
 - 1st float MARVOR : multicycle Rafos float in 90-94
 - PROVOR for ARGO program in 99
 - Provor Acoustic, Provcarbon, Provbio
 - Sliding along a cable POPS , MOPS (under ice operation..)
 - Now a new generation of smaller profiler .. ARVOR
- **Reliable technology** based on
 - **flotation engine** technology enabling a capability to be deployed worldwide without ballasting,
 - **development methodology** including all phases until sea trials.
→ availability of high-performance offshore lagrangian floats.
- **Since 90 , a long and constant industrial partnership** between **IFREMER** team and Tekelek, Martec and now **KANNAD** team.

Provor range and history



**Marvor
Multi cycle
Rafos**

1990-1997



**Provor-T et
CTF**



**Optical
sensors
Iridium**



**Coastal
float**



**Rafos
Sofar
CTD**



**20g
to 50
Kg**



**Upper
sounder
Rafos /
Sofar
acoustic
modem
Iridium**

What is an ARGO float ?

Antenna

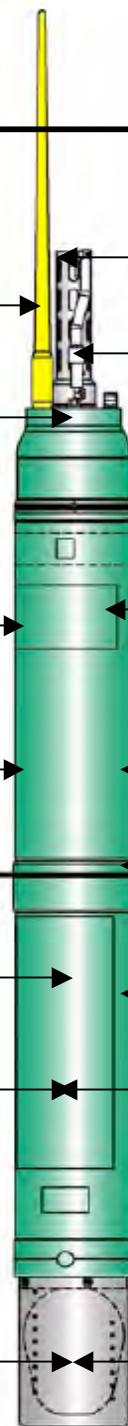
CTD sensors

Satellite transmitter

Control unit

Housing
Energy

Buoyancy engine



PROVOR CTS 3

Flexible Argos Antenna

SBE 41 CP (continuous p

ARGOS PTT

Low power controller

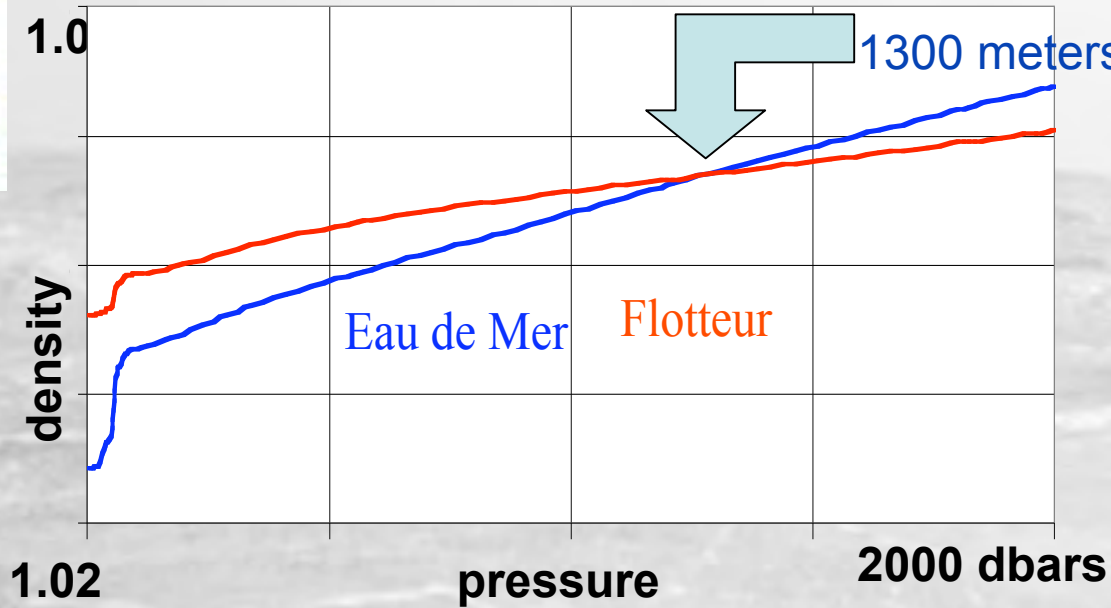
Damping disk

Hard coated anodized
aluminum tube

Lithium battery

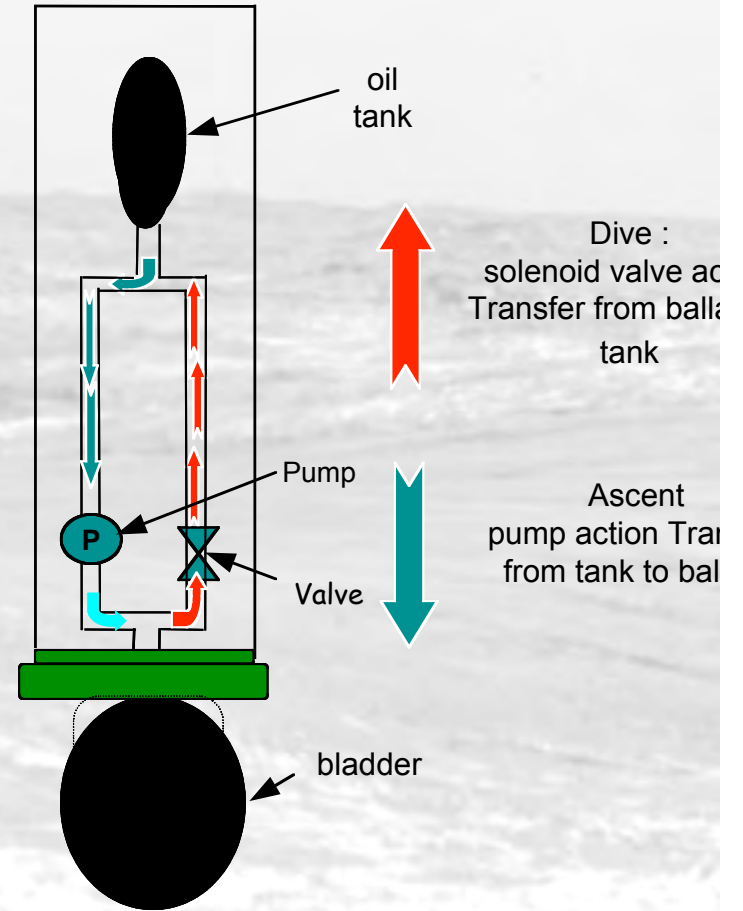
High pressure pump with large
capability of buoyancy

Buoyancy engine Provor/ Arvor



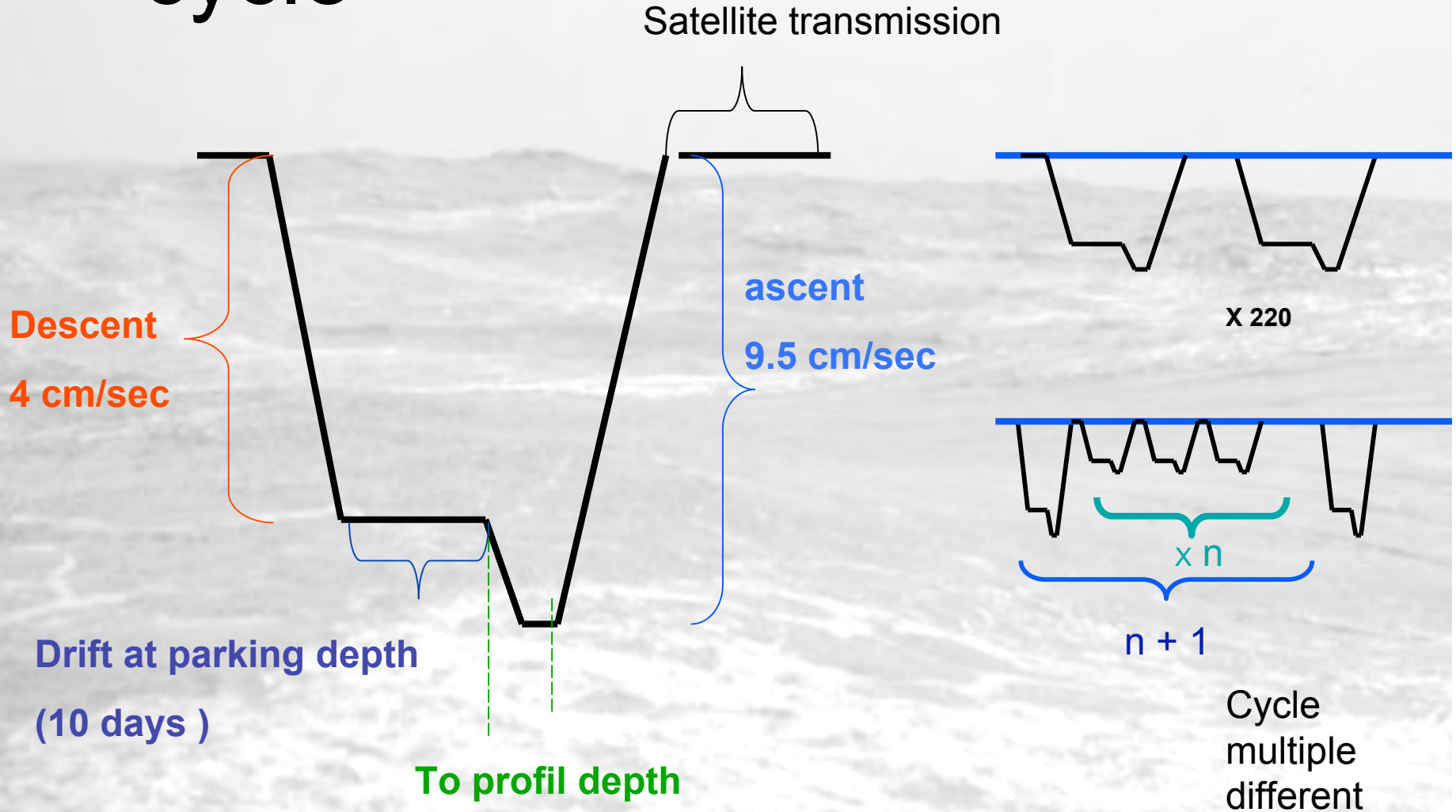
Stabilization crossing point **water** and **float** density

	Provor	Arvor
Oil capacity	3000 cc	850 cc
from 0 to 2000 dbars	200 cc	70 cc
Emergence (initial)	500 cc (1200 cc)	350 cc (500 cc)



PROVOR and ARVOR are ready to be deployed anywhere without pre-ballasting operations

cycle



Technical information transmitted to compute precise float trajectory

Launching

**FAN TAIL READY: parameterization is done in factory
PROVOR is activated by removing a magnet .**

30 sec possible connection to modify

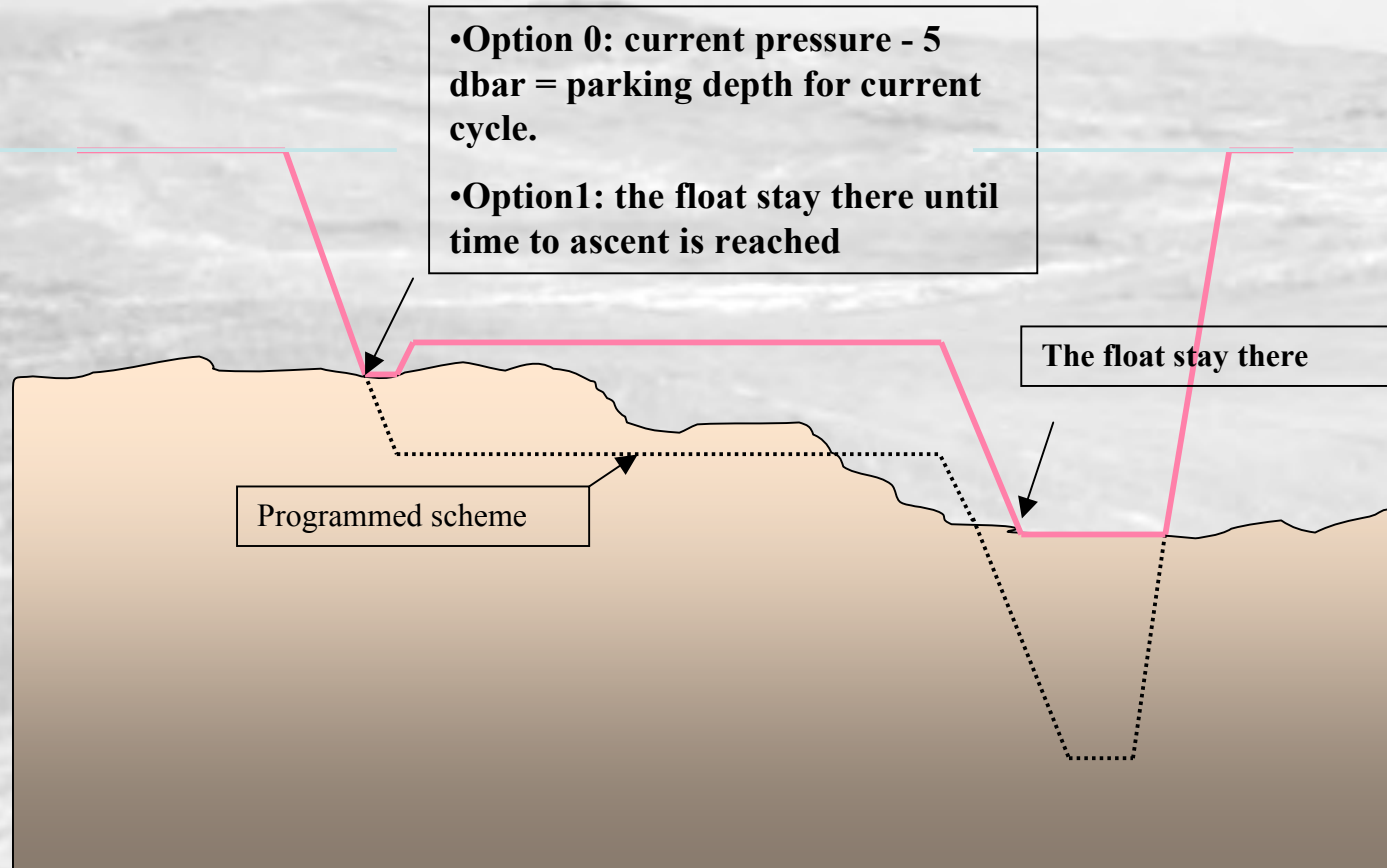
- **PROVOR parameters set could by using PC ,**
- **At the end of parameterization , PROVOR must be set in armed position,**

!AR command control validate the arm

- **When activated PROVOR tests itself and in case of success (internal pressure, sensors ,...) activate its pump during 3 seconds (to be listened)**
- **A delay of 10 minutes is programmed into the float before Flotation reduction**
- **The float waits for this time before starting its descent.**
- **A duration of about 1 hour 30 for the first dive, PROVOR “learn” sea density and buoyancy conditions to go faster for next dives 35 mn and then 20-25 mn**



Grounding behaviour



PT (21) 0 for grounding option activated (default configuration)
 1 for grounding option non activated
 PT (25) 50 dBars to be adjustable

Ascent

Ascent speed is regulated at 9.5 cm / sec all along profile

computed on dP/dt with actions on pump

**PM (7) sampling period for CTD in seconds
(10 sec) 1 Hz max**

**PM (9) profil depth (dbar) initial depth
before pop up**

**PM (10) Duration before pop up profil must
be long enough to go from drift to profil
depth 4 cm /sec**

***With Provbio possibility to be at
dedicated time on surface for ie 6 and 12
AM and 6 PM GPS time affected by
longitude***

Rendez vous accuracy 15 minutes

Measurements

Parameter	Pressure	Temperature	Salinity
Range	0, 2500 dBars	-2, 35 ° Celsius	2 To 42 PSU **
Initial accuracy	2,4 dBars	0.002°C	0.003 PSU
Resolution	0.1 dBar	0.0001°C	0.0001 PSU
Drift	<5 dBar / 5years *	<0.002°C/ 5years	<0.010 PSU / 5 years
Transmitted range	0, 2500 dBars	-2, 30 ° Celsius	10 to 42 PSU
Transmitted resolution	1 dBar	0.001° C	0.001 PSU 15 bits

Informations origin : Sea bird instruments

* Pressure offset is compensated at each surfacing

** stop pumping at 5 dBar

CTD pump continuous or intermittent ?

- PROVOR CTS 3 use SBE 41 CP
- 1 Hz sampling
- Continuous pumping in order to
 - flow constant rate to the cell, forcing a fixed response time, independent of the motion of the CTD in water,
 - minimize thermal mass errors in conductivity cell
- PROVOR use continuous pumping , power consumption :

Discussed issue ...

Solution proposed is to leave choice to user and enable

- intermittent operation in deep area and ,
- Continuous operation in shallow area

Ascending profile acquisition and processing

CDT sampled every 10s

Shallow area

CTD pump continuously running

Deep area: typ 76 slices

Acquiring

Averaging P,T, S

Argos message computing: interleaving and relative coding to minimize amount of data.

Random selection for transmitting messages

- PM (11) threshold surface / bottom Pressure (dBar)
- PM (12) thickness of the surface slices (dBar)
- PM (13) thickness of the bottom slices (dBar)

ARGOS messages

4 types

- CTD during descent
- CTD during drift
- CTD during ascent
- technical messages

For a typical cycle

9 days drift (1 measure every 12 hours)

→ 18 PTS data

Ascent with a threshold surface / bottom at 200 meters

bottom zone from 2000 m to 200 m thickness slice 25 m

→ 72 PTS data

Surface zone from 200 m to 5 m thickness slice 10 m

→ 20 PTS data

total is 110 triplets data

20 ARGOS messages of 248 bits OR 4960 bits

Each message transmits 6- 7 points per message (relative coding)

Transmission duration is fixed between 6 hours to 8 hours for low latitude

For PROVOR maximum 300 PTS or 40 messages

40 messages de 248 bits or 9.92 kbits 1240 octets

It is a user choice !

Satellite data transmission Argos 1 & 2

ARGOS , half wave supple antenna very good performances of transmission time to be adjusted according latitude

Time on surface 6 hours at 45° of latitude to transmit 110 PTS

interlacement messages strategy **and** randomized repetition call are efficient to not loose a complete part of the profile

PA (0) transmission period (given by CLS) 40 seconds for float

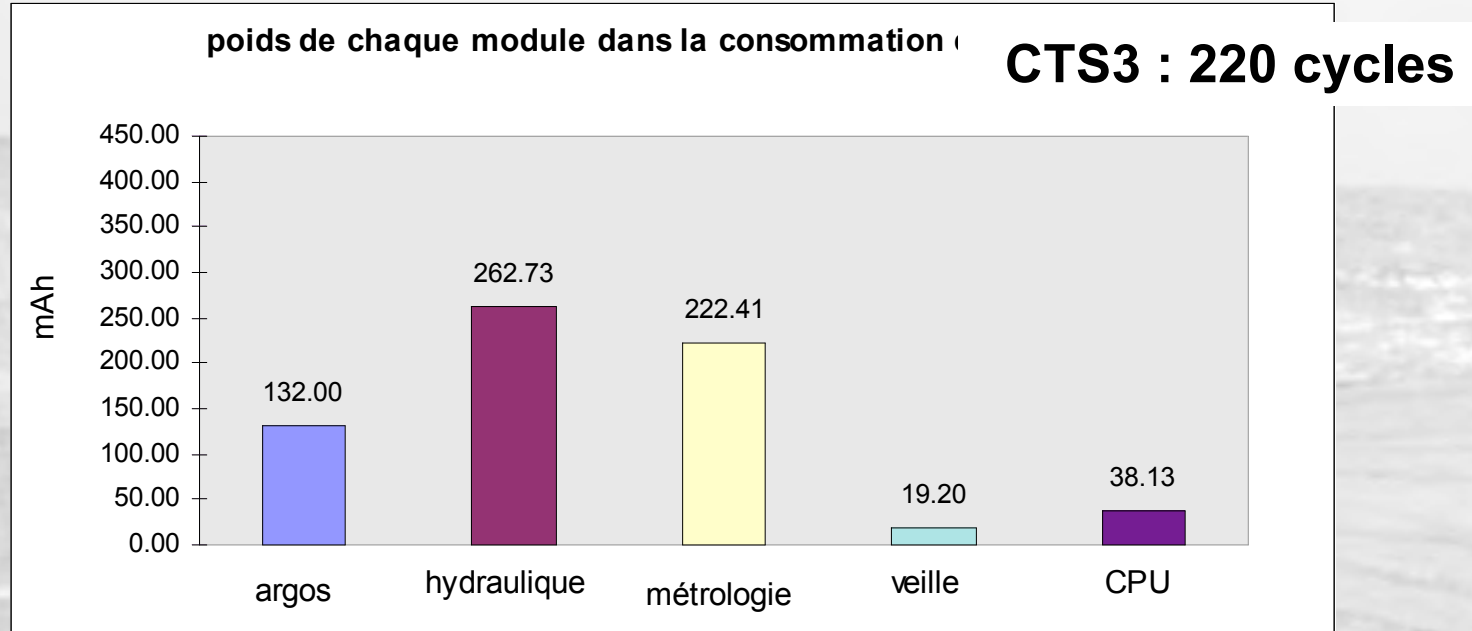
PA (1) number ARGOS messages transmission (computed according number of measurements)

PA (2) Argos transmission duration (hours) 6 to 8 hours

PA (3) number of ARGOS ID (not used today)

PA (4) Argos ID 20 and 28 bits ID accepted

Provor CTS3: consumption



**@ 2000 meters , 10 days drift , 92 pts in profile 18 points during drift CTD pump always ON.
6 hours on surface**

	Ah / cycle (max)	Battery capacity Ah	Cycles number
CTS3	0.65	144	220

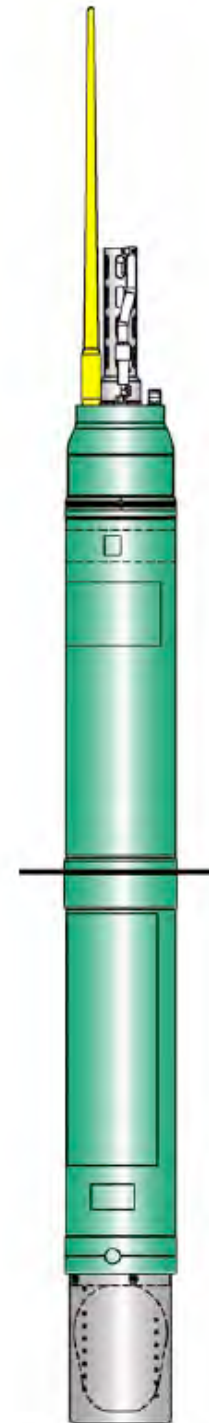
- Hydraulic more efficient (pump & valve)
- Emerged volume optimized
- Argos transceiver more efficient
- More cells
- Efficiency of CTD pump improved

1st batch of PROVOR CTS 3 deployed by JMA

WMO	Days at sea	cycle
2900584	963	194
2900583	963	194
2900575	958	193
2900574	958	193
2900579	873	176
2900587	864	174
2900586	863	174
2900580	868	175
2900588	558	112
2900585	418	84
2900576	363	73
2900578	363	73
2900577	78	16

**Launched end 05
5 days per cycle**

**125 days
to reach
220 cycles !**



Transmission mode evolution

Two ways / more data / less time in surface

Iridium & Argos 3

IRIDIUM

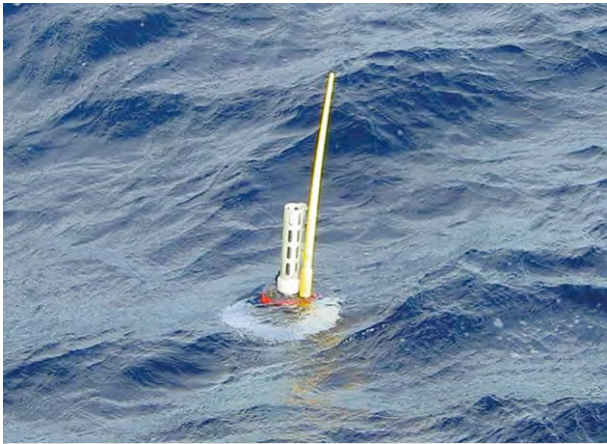
- Two type of modem 9522 and 9601
- SBD 1960 octets and 200 according modem
- Iridium with GPS positioning (Iridium position 30 km)



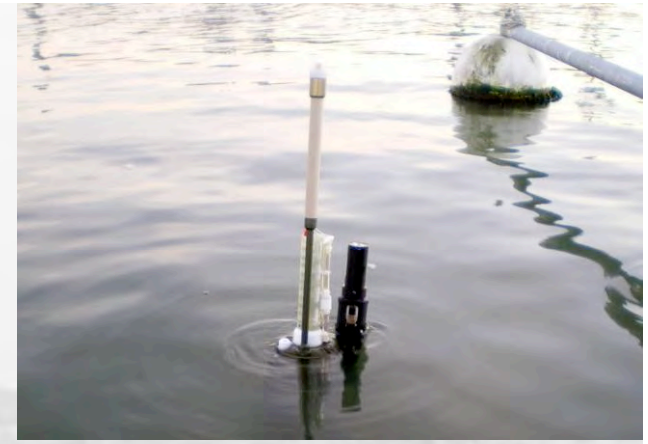
ARGOS 3

- Several operating possibilities
- one profile data transmitted in a pass
- Downlink commands
- Uplink with high data rate and low rate
- Localization by Doppler (2 pass) or GPS
- Need of "rendez vous" for optimization





GPS need ?
 Iridium & Argos 1-2 and 3
 @1 typical profile / 5 kbits



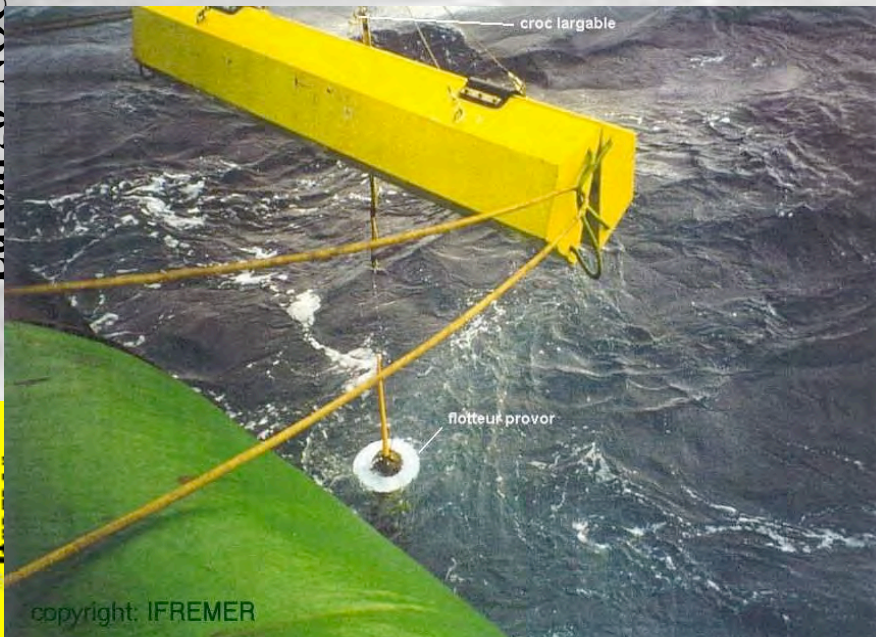
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	Fix accuracy Without GPS	Fix accuracy With GPS	Surface time	Consumption for a typical profile	Equipment cost
ARGOS 1-2	Several 100 meters	30 m Typical TTFF 5 minutes (cold start)	6 – 8 hours According latitude	130 mAh @ 7 Vdc 0.9 Wh	cheapest
ARGOS 3	Idem		<1 hour With GPS & rendez vous	Will be evaluated within Euroargo	To be checked PMT cost , multifrequency antenna cost
HD & LD			< 2 hours Without GPS		
IRIDIUM (9522)	Several kms to 10 kms		5 to 10 minutes		Antenna cost to be improved

Low speed release methods...

PROVOR CTS3 is fan tail ready
Remove the magnet to start

The rope method

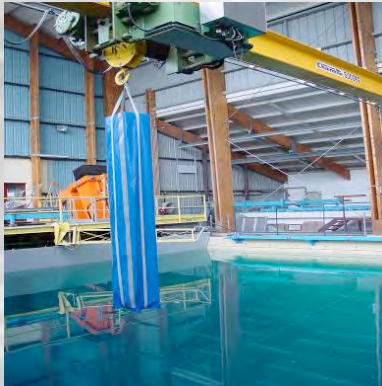


**"GRP
dropping
box"**

Deployment from opportunity ship

To facilitate deployment from opportunity ship

- PROVOR is shipped in a cardboard box itself in a wooden box
- A reusable release kit including sliding bag , padlock



Brest basin test

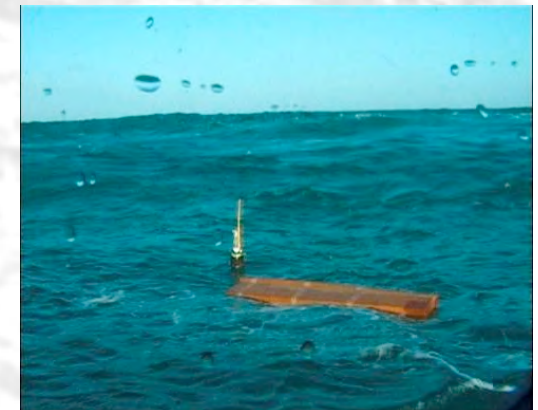
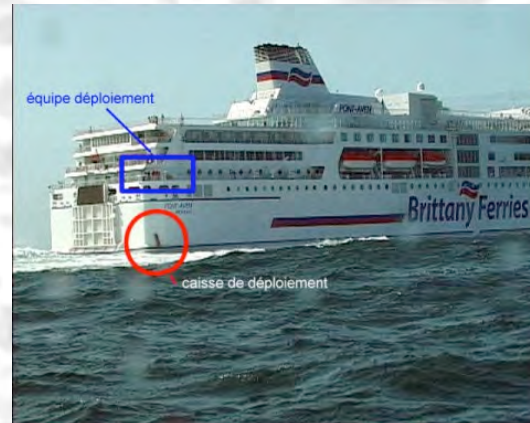
Opening using a “salt pastille” padlock

Trials on board

‘Pont Aven’

(Brittany ferries)

20 knots, 15 meters high



New model for ARGO ARVOR



Provor CTS 3	Arvor	
SBE 41 CTD with pump		No change
Identical high hydraulic pressure pump		Improved efficiency
34 Kg	20 Kg	Deployable by one person
Φ 17 cm	Φ 11 cm	Hull
L 170 cm	L 120 cm	

- Easier to deploy
- Radio link BT link for parameterization
- Technical status transmitted just after deployment
- Surface time programmable
- Cheaper

ARVOR performances ARGO

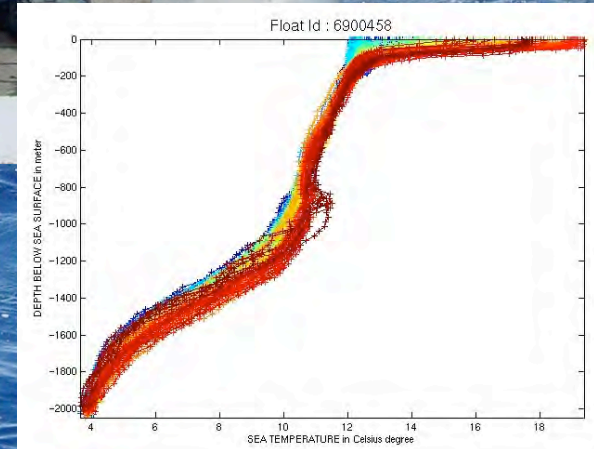
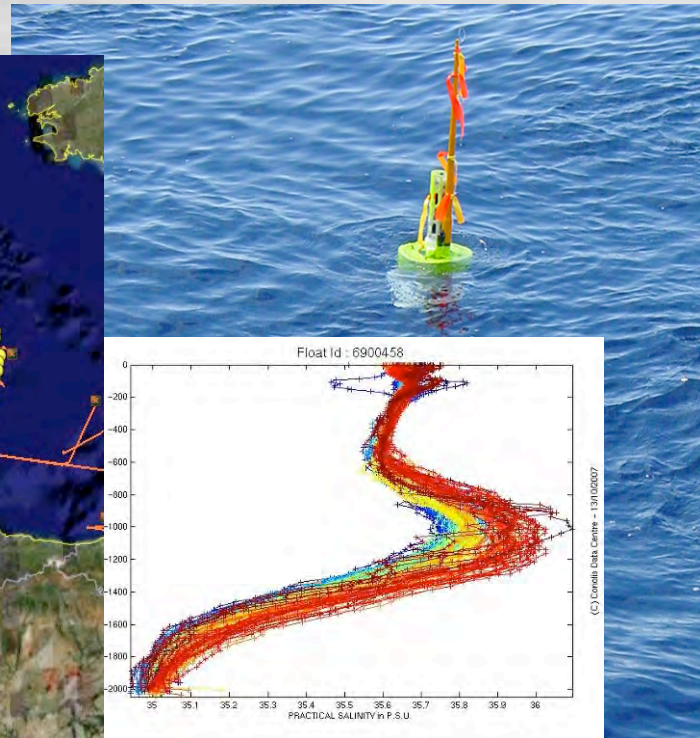


Provor CTS 3	Arvor	
Energy balance computed for potential number of cycles @2000 m, 10 days drift , Argos telemetry, 92 points in profile (70) and 18 in during drift transmitted		
220	200 *	CTD pump in continuous action
270	250 *	CTD pump is switched mode
200 cc	70cc	<i>Oil volume to move to go from surface to 2000 meters</i>
32 D cells	24 D cells	<i>Less battery</i>

* User choice

Arvor

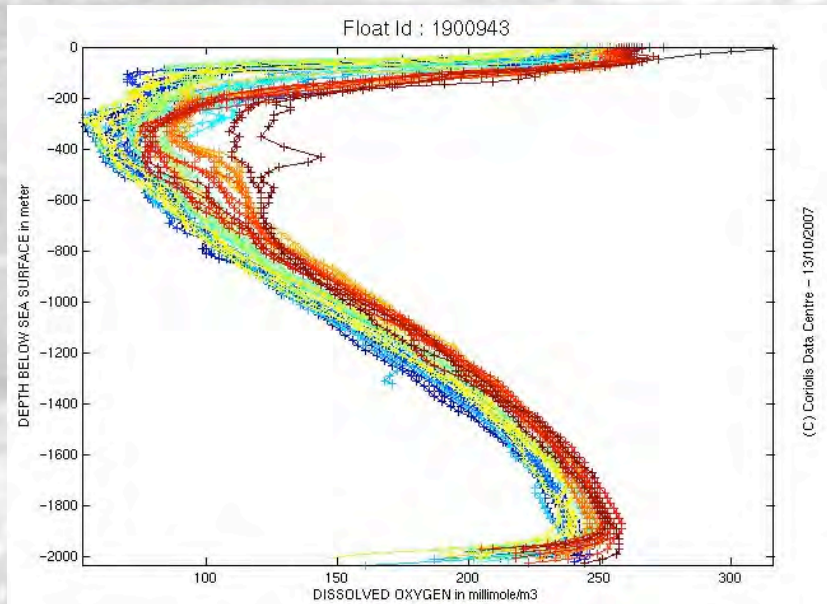
- **Qualification at sea** (end dec 07)
186 cycles performed
@ 2000 m / 2 days cycle
Data on Coriolis site (WMO 6900458).
- **10 units in production**
for first operational deployments
Some in accelerated cycles (2 days)



Contribution for marine carbon sources and sinks assessment :
ProvDO

CTD and dissolved oxygen sensor (Aanderaa optode)

- 1 prototype deployed in February 2007, : contribution to Carbooccean EU project (data on Coriolis web site, <http://www.coriolis.eu.org/WMO1900943>)



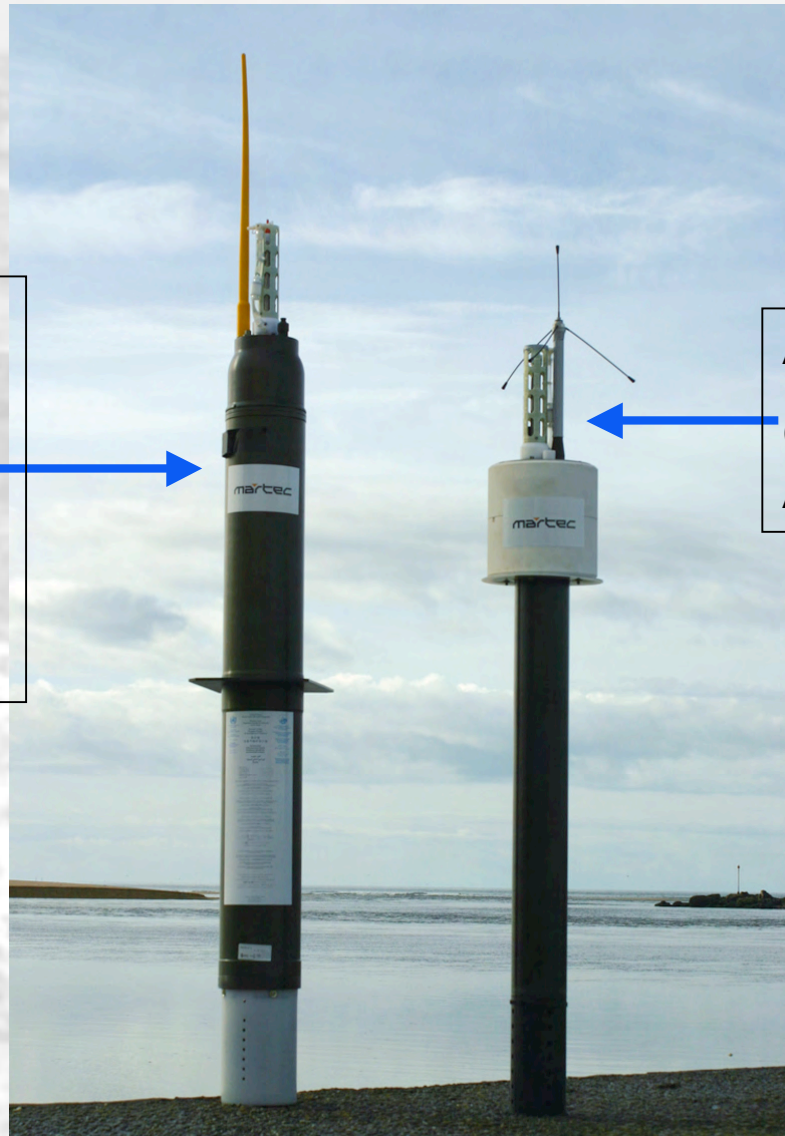
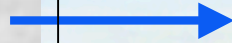
- 8 other ProvDO to be deployed end of 2007 (Chile)

PROVOR range

2 self ballasting floats for 2 purposes

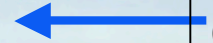
Provor:

ARGO basis and dedicated for multi-sensors embedded with good payload capacity



Arvor:

CTD optimized float for Argo applications



As conclusion

- PROVOR CTS 3 is a stabilized model in production since 2005
- Continuous monitoring and performances improvement
- We are listening euroargo users
- Market remains highly competitive, French and European markets are small regarding US.

USD / € !!!

Merçi



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