
PROVOR AND CORIOLIS DATA CENTER A STEP TOWARDS OPERATIONAL OCEANOGRAPHY

G rard LOAEC*, Thierry CARVAL*, Serge LE RESTE*, Gilbert MAUDIRE*

* IFREMER - Brest - Marine Technology and Information Systems Division

1 - INTRODUCTION

At the beginning of the nineties, initially within the framework of WOCE program, many tens of multicycle subsurface MARVOR floats have been launched in South Atlantic. Then, with close relationship with the Hydrographic Service of the French Navy, some others have been deployed in North Atlantic. More than 150 MARVOR floats have been running since 1994, giving a better description of the water circulation at depth. These floats typically drift at a given pressure level, being regularly located by acoustics, and come up to the surface every two or three months to achieve ARGOS data transmission. These data are then processed and results are given through scientific publications many months after raw data acquisition.

More recently, the need to get oceanic data that could be introduced in real time into prediction models of the climate evolution, or for defense applications, has been growing up (ARGO and associated programs). PROVOR profiling float has been developed for this use. PROVOR has got benefit from MARVOR improvements and technology has been demonstrated. However, it is necessary to distribute the validated data very quickly after their capture at sea. That is the aim of the CORIOLIS Data Center.

2 - PROVOR DESCRIPTION

PROVOR is a free drifting profiler which uses most of the electronic or mechanical parts which were designed for MARVOR, and takes advantage of its improvements. PROVOR is designed to drift at depth for 5 years and come up to the surface every ten days. Data are then transmitted and the float is localized, using ARGOS satellite system. During the trips between the surface and the depth, profiles of temperature and conductivity of the upper



layer of the ocean are gathered. The typical operating cycle is shown on figure 1.

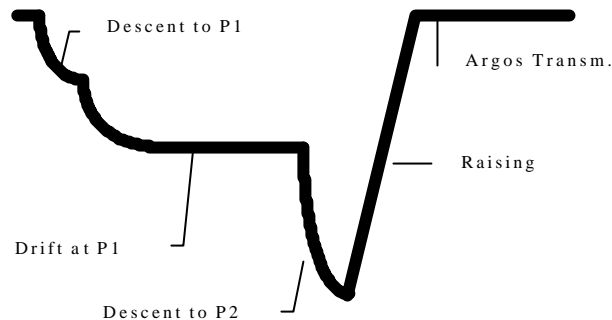


Fig. 1 - Operating cycle of PROVOR float

The float executes identical cycles which are programmed by the user before launching. During the descent phase, the float reaches the drifting level (P1) by light adjustments of the volume of the external ballast, each time the float stabilizes. There is no control of the speed which is about 2.4 cm/s. T or CT measurements can be conducted and the period of data acquisition can be as low as 10 seconds. After the float stabilizes at the desired pressure, it drifts with the surrounding water, until the date of the second descent to the profile pressure (P2), where it stays for a few hours, waiting for the hour of start of profile. The typical duration of the drifting phase is 10 days and the maximum pressure 2000 dbars. As PROVOR is able to adjust its volume, it can drift at a given pressure to identify the circulation of the water and dives to a higher depth before raising to the surface, to provide CTD informations all over the water column. The speed of the float is controlled during the raising and is typically set to 5.5 m/mn. After PROVOR reaches the surface, it transfers the necessary volume of oil to the ballast to provide a sufficient enough stability to ensure good data transmission results. The number of cycles that can be achieved is a function of the operating pressure and the volume of data that is to be transmitted. Taking into account a 24 (PROVOR-Temperature profiler fitted with SEASCAN sensors) or 26 (PROVOR-CT Conductivity/temperature profiler fitted with FSI sensors) lithium cells battery pack, the number of cycles is about 150, giving 300 T or CT profiles.

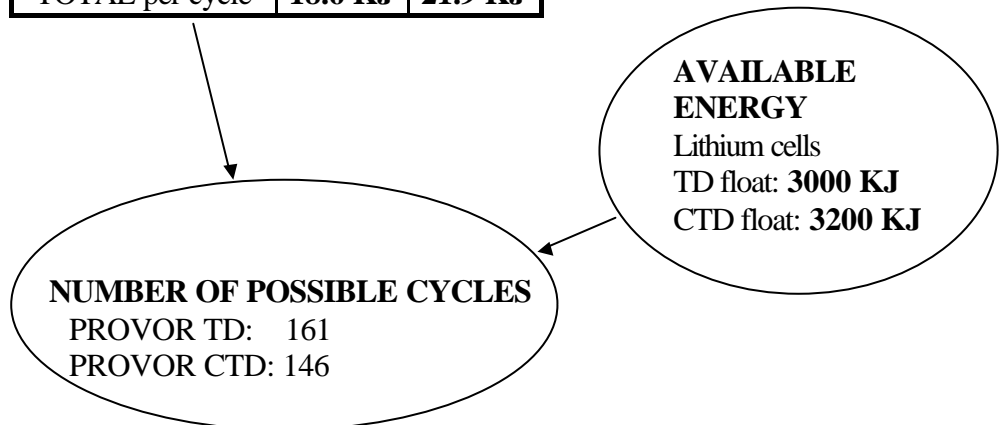
PROVOR ENERGY BUDGET

Conditions:

- Buoyancy control: 400 cm³
- 1 week cycle : descent, drifting at 1000m, descent to 2000m, rise.
- Measurements during descent and rise: T or CTD, 1 sample/m
- Measurement during drifting: 1 sample / 6 hours
- Data compression using XBT algorithms: 100 pts for descent, 100pts for rise.
- ARGOS Satellite transmission: 4 hours (PROVOR-T) or 6 hours (PROVOR-CT)

ENERGY REQUIRED PER CYCLE

PHASE	TD	CTD
Buoyancy control	13.9 KJ	13.9 KJ
Satellite transmission	2.5 KJ	3.8KJ
Electronics	2.0 KJ	2.0 KJ
Measurements	0.2 KJ	1.9 KJ
TOTAL per cycle	18.6 KJ	21.9 KJ



2 - DATA ACQUISITION

It is necessary to keep the time spent at the surface as low as possible for many reasons :

- the environment is much harsher at the surface than at depth (swell effects in rough sea, risks of collision...),
- the float aims to describe the subsurface water circulation and its drift at the surface must be low, compared with the drift at depth,
- a long stay at the surface means a great energy consumption, as the floats comes up to the surface to transmit data via ARGOS.

For all these reasons, it is necessary to reduce the volume of data to transmit and to choose correctly the most pertinent informations, according to the aims of the final user of the equipments. On PROVOR, CTD measurements are gathered function of time and then processed to extract temperature and conductivity profiles which are functions of the pressure. As the sampling period may be as low as 10 seconds, the number of measurement points over 2000 meters during the raising phase may reach 2000. The resolution of the different measurements is 0.01°C , 0.01 mS/cm and 1 dbar respectively for Temperature, Conductivity and Pressure. That means that the raw data is stored on about 6000 bytes.

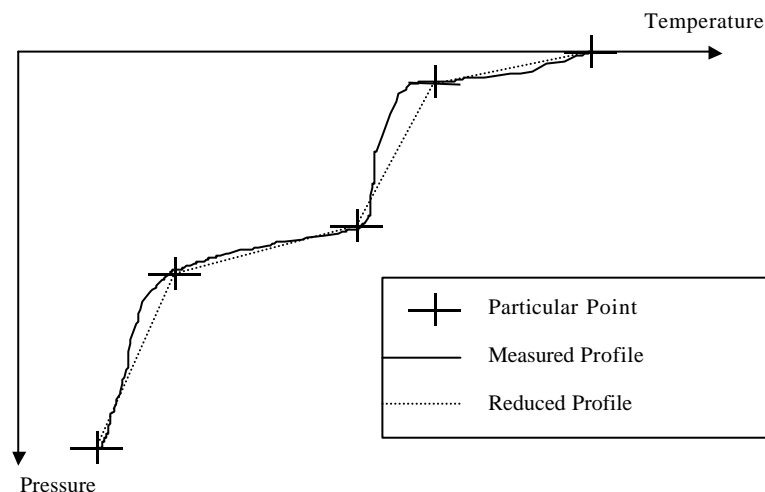


Fig 2 - illustration of the reduction method

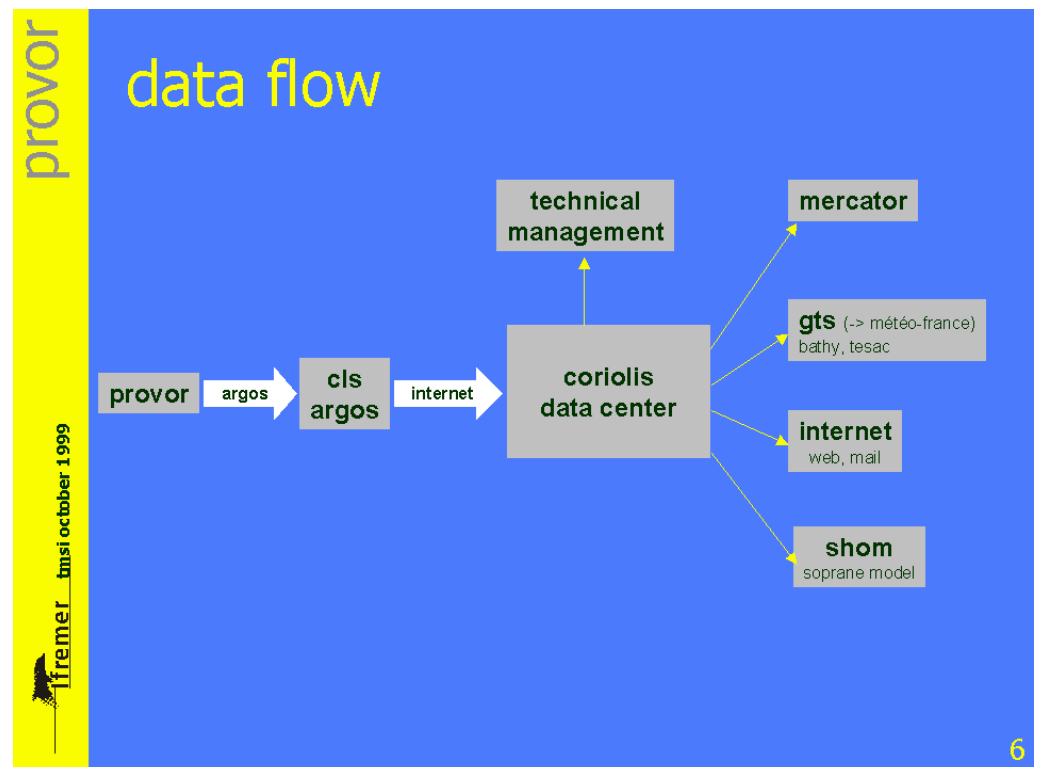
Without any treatment, 4 days would be necessary to transmit all these data. It is possible to reduce the volume of raw data by keeping only some particular points in such a way that, if a straight line is draught between 2 particular points, the difference between the real T or C measurements and the interpolated values is lower than a maximum error which is defined during the programming phase of the float.

This data processing method was already used to reduce the volume of data provided by XBT sensors and is illustrated on figure 2. As the variability of T and C is much higher in the upper layer of the water column, it is possible to define two different areas with a specific maximum error in each area, for exemple 0.1°C in the upper side and 0.03°C in the lower side.

3 - CORIOLIS DATA CENTER

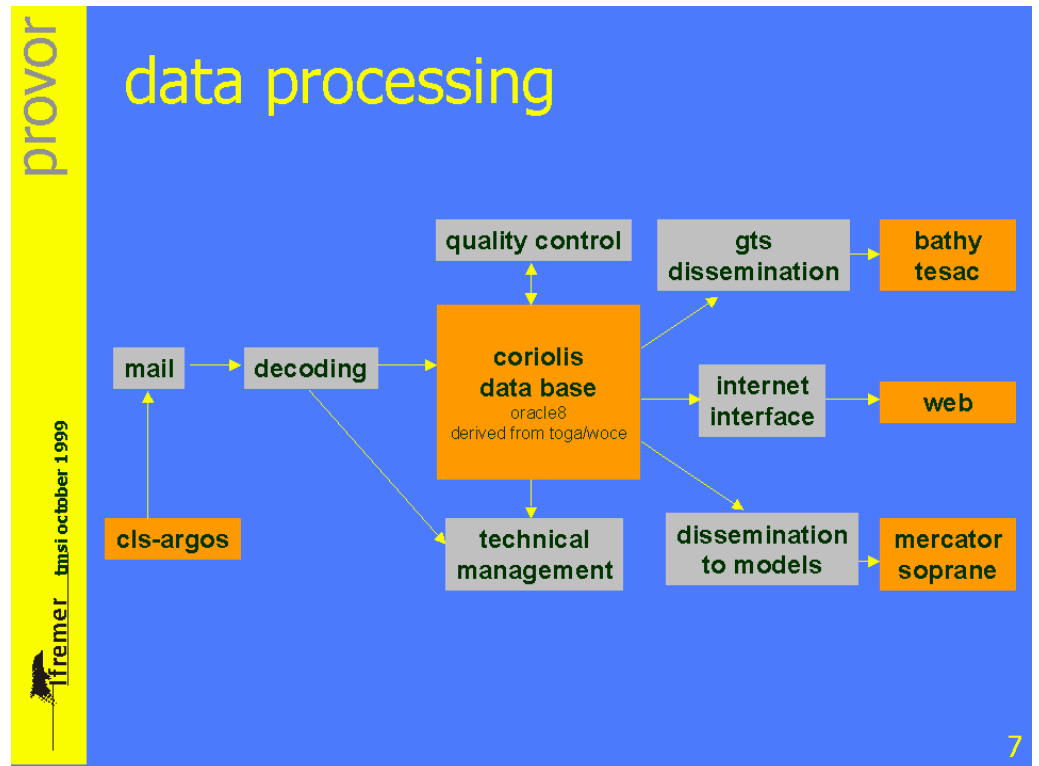
CORIOLIS is the data center for operational oceanography in IFREMER. Data issued from all PROVOR floats are processed by the CORIOLIS data center. CORIOLIS performs the following features :

- Real time acquisition of PROVOR data
- Decoding and uploading of the data in the CORIOLIS database
- Quality control
- Dissemination of the data on GTS, INTERNET (web, mail) for insertion into models



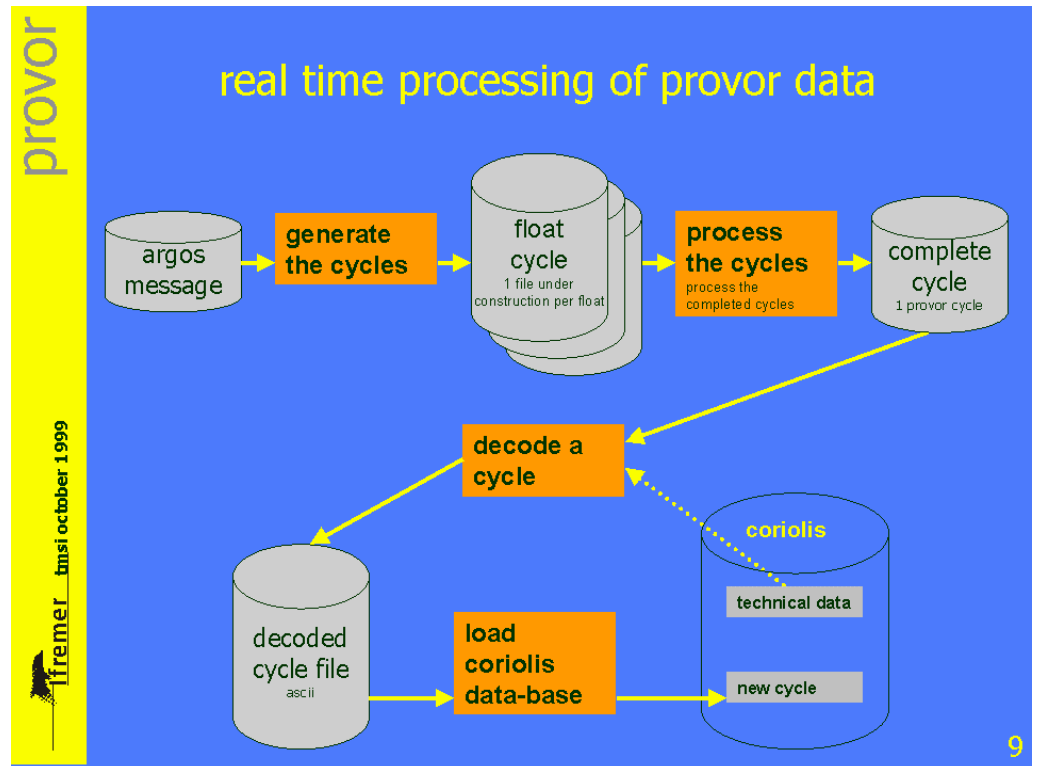
The CORIOLIS data center is an evolution of the TOGA/WOCE database (14 years of data collection, 600000 profiles) . CORIOLIS is based on three major infrastructures :

- INTERNET mail for the real time processing of incoming PROVOR data.
- ORACLE 8 for the data and quality controls
- INTERNET (web, ftp) for the data dissemination.



Information and data messages transmitted by PROVOR are collected by CLS-ARGOS. Through ADS (Automatic Distribution Service), ARGOS messages are immediately forwarded to CORIOLIS Data Center in IFREMER, by INTERNET mail. The mail address used by CLS-ARGOS is associated with an automatic processing performed at every message delivery and messages are automatically processed as soon as they arrive. There is no need to maintain a system that will regularly check a new arrival of data. This function is naturally performed; it is a robust solution. Mail service is probably the most critical information infrastructure at IFREMER. The maintenance of the service is therefore a priority for the exploitation team. In case of trouble with one component of the transmission (server, network or electrical failure), the mail protocol will naturally perform the needed retransmission. The mail protocol also guaranty that the received mails are complete.

A PROVOR cycle contains four profiles (descending, ascending, immersion and surface) and technical data. The data of a PROVOR cycle are transmitted in small messages to CLS-ARGOS. For each PROVOR float, messages are gathered to create a complete cycle data file. The cycle data file is then decoded. The four profiles and the technical datas of the cycle are uploaded into the CORIOLIS database.



With conformity with international standards (IOC, MAST), each profile of the CORIOLIS database is carefully checked, automatically and visually in a three steps process :

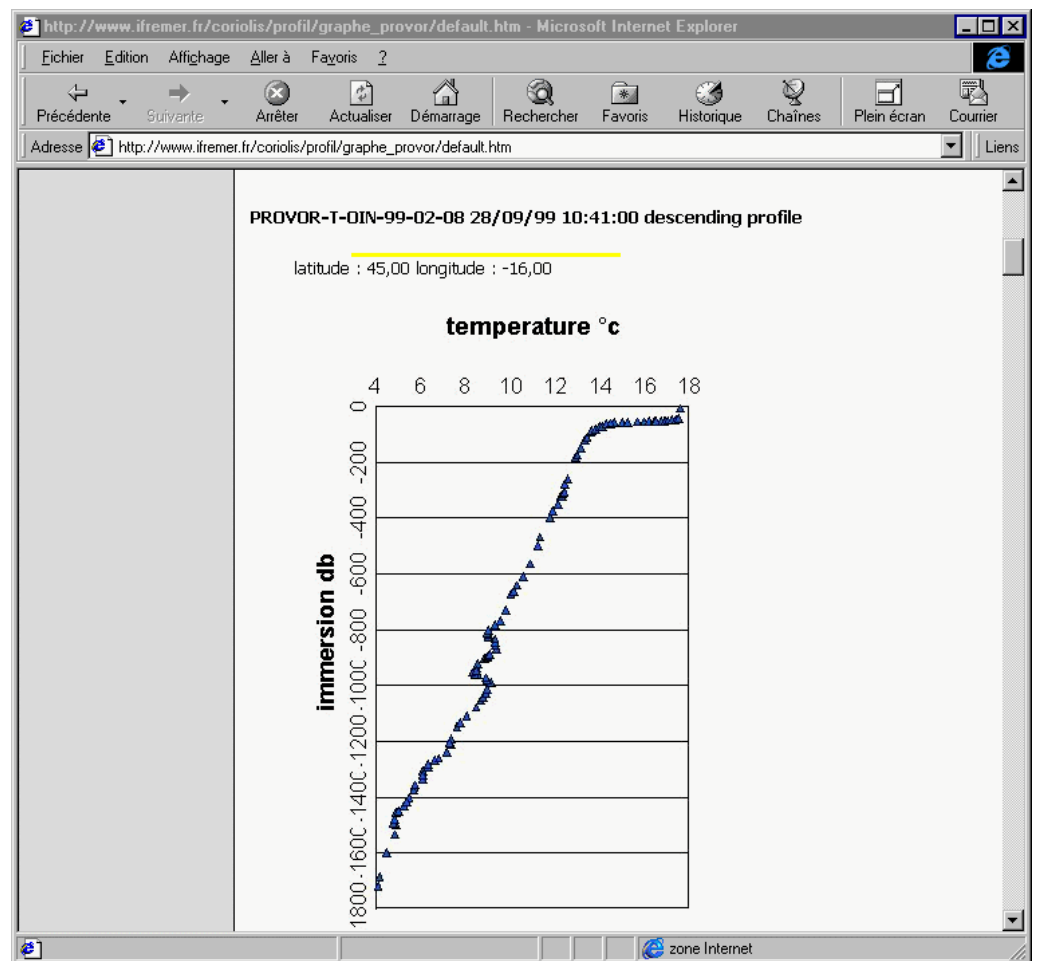
- QC0: control of the format
- QC1: control of the date and location of the station
- QC2: control of the observations : search for constant value, local broad range and narrow range, spikes, vertical stability.

As a result of these checks, a quality flag is added on each numerical value. The flag value complies to the IGOSS scale from the international GTSP program. The good data are flagged to 1, and the flag value increases with the severity level of the detected anomalies.

IGOSS scale	
1	: good value
2	: probably good value
3	: probably bad value
4	: bad value
5	: interpolated or corrected value
9	: lack of value

Following the Quality Control, the PROVOR profiles are disseminated on two main channels which are INTERNET and GTS.

The CORIOLIS web server address is www.ifremer.fr/coriolis .



All PROVOR profiles are available

- in ascii format
- in medatlas format
- in graphic charts

The drift of each PROVOR float is available on a geographic (and soon interactive) map.

The PROVOR profiles, after the quality control procedure are transmitted to a mailing list. All users people registered on the mailing list receive in their personal mailbox the new profiles available.

After the quality control procedure, all new PROVOR profiles are gathered in a file, using TESAC format. This file is then transmitted by way of FTP to our GTS operator, METEO-FRANCE. GTS is the Global Telecommunication Service of the World Meteorological Organisation (WMO).

4 –CONCLUSION

PROVOR-T is now produced by series, by MARTEC company and the PROVOR-CT will be ready at the beginning of 1999. The first operationnal floats are cycling every week or every two weeks through POMMIER experiment which is conducted by the Hydrographic Service of the French Navy. Raw data are collected every monday morning and validated data are available on tuesday. This experiment aims to validate equipments and data processing software which will be used in next operational programs like CORIOLIS-Atlantic which represents the French contribution to ARGO program.

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To contact the authors :

G. Loaëc : Gerard.Loac@ifremer.fr

S. Le Reste: Serge.Le.Reste@ifremer.fr

G.Maudire: Gilbert.Maudire@ifremer.fr

T.Carval: Thierry.Carval@ifremer.fr

