An automatic acquisition/quality control/fast delivery software for real time follow-up of data coming from a tide gauge network

Philippe Téchiné, Bruno Buisson, Laurent Testut and Christian Le Provost,
LEGOS UMR5566 CNES/CNRS/IRD/UPS, OMP Toulouse, France

ROSAME network & Sao Tomé

ROSAME is the Réseau d'Observation Subantarctique et Antarctique du niveau de la MEr (Sea Level Subantarctic and Antarctica Observation Network). It is implanted in the Terres Australes et Antarctiques Françaises (Southern and Antarctica French Lands, figure 1).

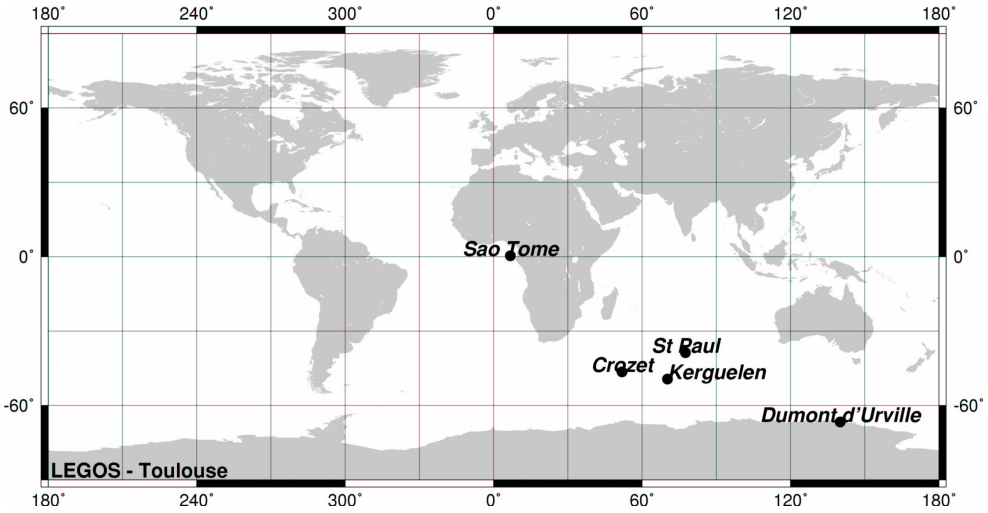

Figure 1: ROSAME network & Sao Tomé

ROSAME network consists of 4 coastal tide gauge stations situated in Indian Ocean and Antarctica:

- Kerguelen station is localized along the wharf of Port aux Français, the french scientific base in Kerguelen.
- St Paul station is situated in the crater of a partially immersed volcano which communicates with ocean.
- Crozet station is settled on the Possession Island in Crozet archipelago. Crozet bottom pressure does not exist any more. It was destroyed by a storm in july 2001. A new tide gauge station will be installed at the end of 2003.
- Dumont d'Urville station is situated near the french scientific base of Dumont d'Urville in Antarctica.

Since june 1999, LEGOS processes data from Sao Tomé station which is located on Sao Tomé island in the gulf of Guinea.

Automatic real time acquisition and transmission of data

Hourly measures of atmospheric pressure, seawater bottom pressure, temperature and conductivity are automatically performed at the same time by tide gauge station (figure 2).

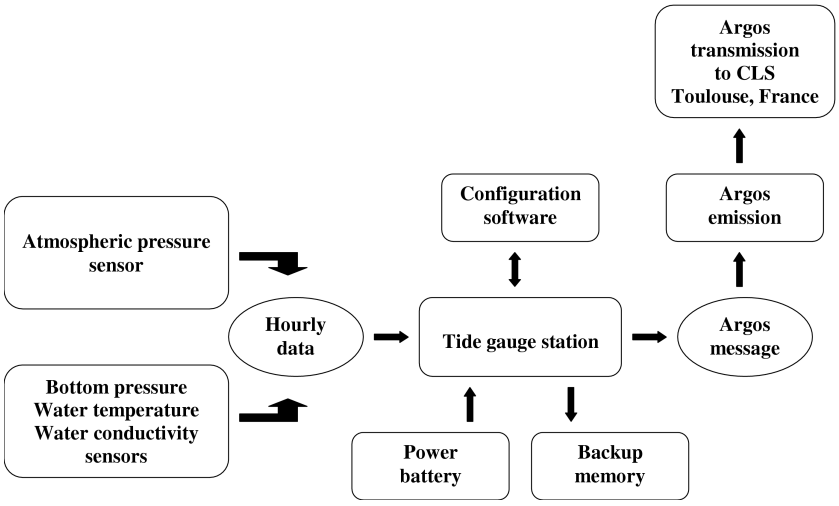

Figure 2: Automatic real time acquisition and transmission of data

Tide gauge station automatically builds an Argos message, containing real time data from last 7 hours and transmits message, every 200 seconds, via Argos system by satellite to CLS Processing Center in Toulouse.

Automatic acquisition/quality control/fast delivery software

CLS Processing Center automatically sends Argos message by email to LEGOS (figure 3). Email message is automatically processed.

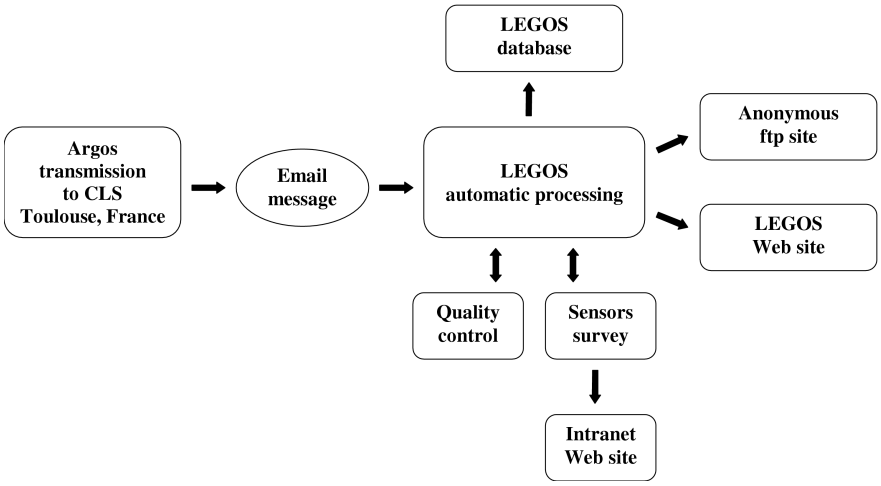

Figure 3: Automatic acquisition/quality control/fast delivery software

Sensors survey is already operational on the LEGOS intranet Web site. Quality control will soon be applied on the data. At the end of the data processing sequence, an anonymous ftp site will be updated as well as LEGOS Web site where everyone will be able to follow the evolution of the data.

Software characteristics

Processing program is based on modules written in Perl language. It gives the possibility to add new tide gauges or new sensors, or to integrate a new transmission system without having to modify the core program.

Graphics are done with GD::Graph Perl module. Visualization of the data is generated by a Perl CGI module and done on dynamic Web pages.

Perl language is used in all processing steps to give homogeneity in the program code.

Automatic acquisition

Argos messages are collected by CLS Processing Center in Toulouse, then sent towards a dedicated email address to the "Service d'Observation" of LEGOS. Processing is automatically activated by email containing Argos messages.

About 60 emails are received a day from 4 tide gauge stations: Kerguelen, St Paul, Dumont d'Urville and Sao Tomé. As one email can contain several Argos messages from different tide gauges, at least 60 processings are done each day.

Automatic processing steps

Processing decodes Argos telemetry and computes raw data.

Multi transmission of values by Argos system is used to control quality: In figure 4, two Argos messages were sent at different times from same tide gauge by two different satellites (K and L). Some data appear in first message and are repeated in second message.

```
01009 14719 9 32 K          01009 14719 9 32 L
2003-10-02 22:10:17 1       2003-10-02 23:08:21 1
B0 BA 81 80                 B8 BA 80 81
83 80 7C 7F                 80 83 80 7C
8B 66 C7 B5                 8B 72 F7 CF
9E 70 78 8D                 5E D6 79 C1
EE 07 F4 A0                 E2 37 B8 1F
F7 4F 60 7D                 D2 4F 60 7D
B2 49 49 48                 AB 47 49 49
CA C7 40 80                 48 CA C7 10
```

Figure 4: Example of Argos telemetry

For each sensor, the number of times these data appear in various Argos messages is computed. Value repeated the biggest number of times is kept. This computation will be soon operational and automatically realized in the processing.

Physical values are computed from raw data using sensors calibration values. As we have simultaneous measures triggered by tide gauge station, seawater salinity and density are computed using UNESCO algorithms. If there is not conductivity sensor, we suppose salinity as a constant.

Finally sea level is computed before database update:

$$h = (Pbottom – Patmos) / (rho * g)$$

Use of chronograms

Use of chronograms allows to describe the state of parameters and follow their evolutions according to time. Chronograms describe the type of tide gauge stations and sensors where model and serial number are represented as well as measured

parameters. Chronograms describe also the state of tide gauge stations and sensors (inactive, operational or in test), sensors calibration sheet with sensors calibration date and acquisition time step of the data.

When we decided to change tide gauge sensor, we write new calibration values in chronogram (figure 5) when they should be taken into account. That allows to follow in real time hardware evolution.

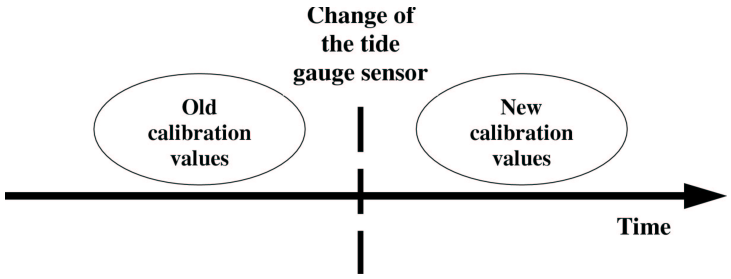

Figure 5: Practical use of a chronogram

As we have all hardware modifications or changes in calibration values written in chronograms, it is very easy to (re)compute historical data to evaluate quality of data and for example see sensors drifts.

Quality control

Quality control is the step which we are working on presently.

Electronic mail is used as an alarm system to detect problems: When a tide gauge station is switched on, we receive first an initialisation message. By comparing Argos messages received, an alarm email is sent if a new initialisation message is received from tide gauge station whereas no maintenance operation is in hand.

In the same way, processing sends an alarm email if the same Argos message is always received, if there is not Argos message received any more or if an error arises during automatic processing steps.

For each sensor, values exceeding sensors thresholds are removed.

Gaps between successive acquisitions are computed and compared to detection thresholds of measure error: An alarm email is sent when such a problem occurs.

Finally, a visual control of the data is realized every day on the “Service d’Observation” of LEGOS intranet Web site to see evolution of the data and make a sensors survey.

Intranet Web site

On the intranet Web site, we have gathered important informations for an operational follow-up of tide gauge stations and in situ interventions. In figure 6, real time follow-up of Kerguelen data is presented for 10 days for atmospheric pressure, seawater temperature and bottom pressure.

Last updated processing date allows to know when last Argos message was received. Dates of first and last measures are printed above graphics for each sensor. We can compare last updated processing date with last received value date: There is only a difference of 1 hour and 10 minutes.

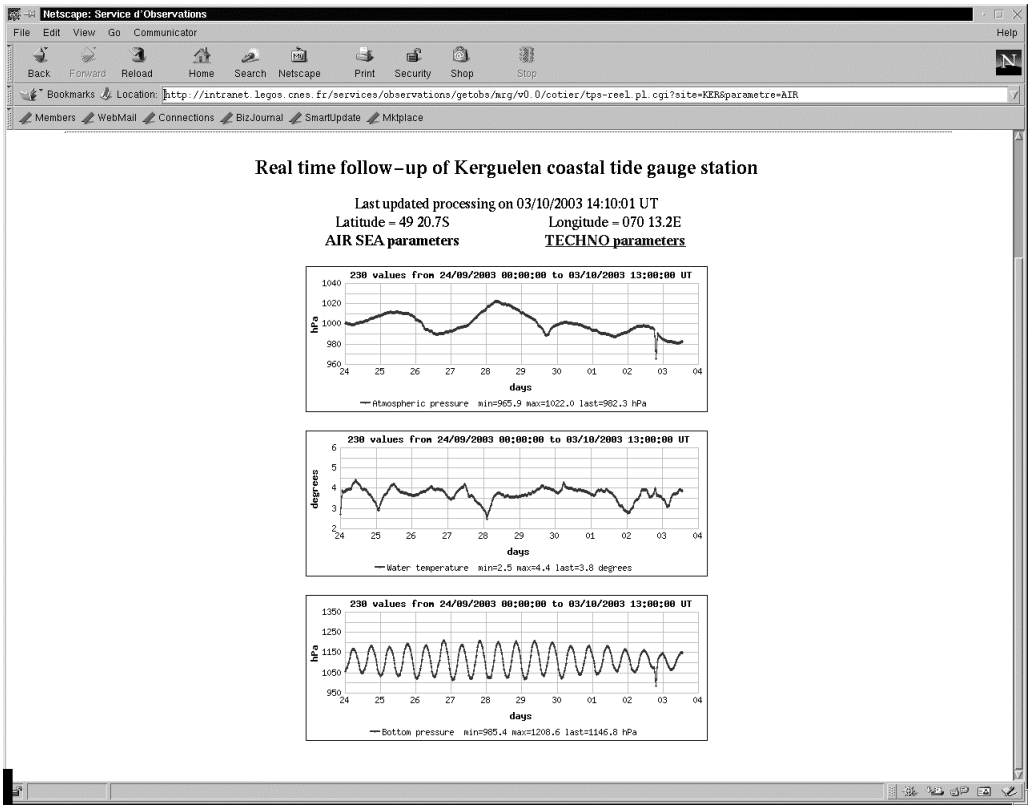

Figure 6: Intranet Web site

Minimum, maximum and last values are printed below each graphic.

When multi transmission of values by Argos system and control quality will be taken into account, wrong data at the end of atmospheric pressure and bottom pressure will disappear. For each sensor, a second curve will be printed to represent how many times values are repeated in Argos messages, as a quality indicator.

TECHNO parameters link allows to access to a similar web page with graphics for used memory percentage, battery voltage, etc.

Fast delivery

Presently, data are processed with a processing sequence which takes time and sea level data are sent to Hawaii Sea Level Center on a monthly basis.

In 2004, with this new automatic processing, ROSAME & Sao Tomé database will be weekly updated on an anonymous ftp site. We will expect to deliver our data on a daily basis when all steps of the software will have been optimized.

In the future

Same algorithm as real time processing will allow, if we need, to recompute historical data using chronograms.

Sea level data from ROSAME network & Sao Tomé will be accessible in real time on LEGOS Web site.

This automatic acquisition/quality control/fast delivery software for real time follow-up can be extended to new tide gauges or new transmission systems.