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Recent advances in the Lesser Antilles observatories – Part 2

WebObs - An integrated web-based system for monitoring and network management

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Abstract

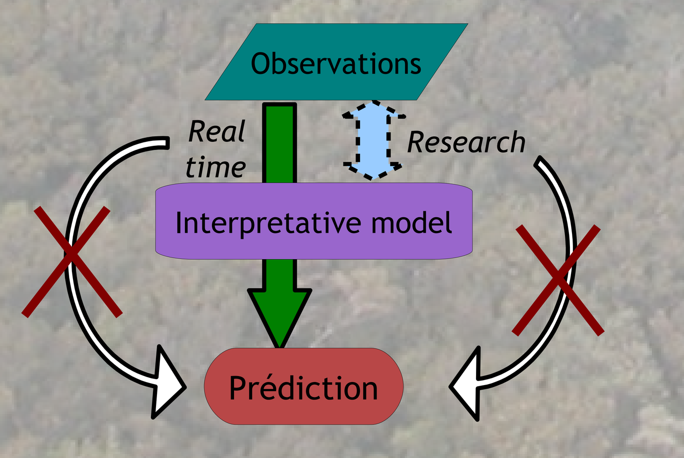
Seismological and Volcanological observatories have common needs and often common practical problems for multi disciplinary data monitoring applications. In fact, access to integrated data in real-time and estimation of measurements uncertainties are keys for an efficient interpretation, but instruments variety, heterogeneity of data sampling and acquisition systems lead to difficulties that may hinder crisis management. In Guadeloupe observatory, we have developed in the last years an operational system that attempts to answer the questions in the context of a pluri-instrumental observatory. Based on a single computer server, open source scripts (*Matlab*, *Perl*, *Bash*, *Nagios*) and a Web interface, the system proposes:

- an extended database for networks management, stations and sensors (maps, station file with log history, technical characteristics, meta-data, photos and associated documents);
- a web-form interfaces for manual data input/editing and export (like geochemical analysis, some of the deformation measurements, ...);
- routine data processing with dedicated automatic scripts for each technique, production of validated data outputs, static graphs on preset moving time intervals, and possible e-mail alarms;
- computers, acquisition processes, stations and individual sensors status automatic check with simple criteria (files update and signal quality), displayed as synthetic pages for technical control.

In the special case of seismology, WebObs includes a digital stripchart multichannel continuous seismogram associated with EarthWorm acquisition chain (see companion paper Part 1), event classification database, location scripts, automatic shakemaps and regional catalog with associated hypocenter maps accessed through a user request form.

This system leads to a real-time Internet access for integrated monitoring and becomes a strong support for scientists and technicians exchange, and is widely open to interdisciplinary real-time modeling. It has been set up at Martinique observatory and installation is planned this year at Montserrat Volcanological Observatory. It also in production at the geomagnetic observatory of Addis Abeba in Ethiopia.

Monitoring = real-time observations + interpretative model



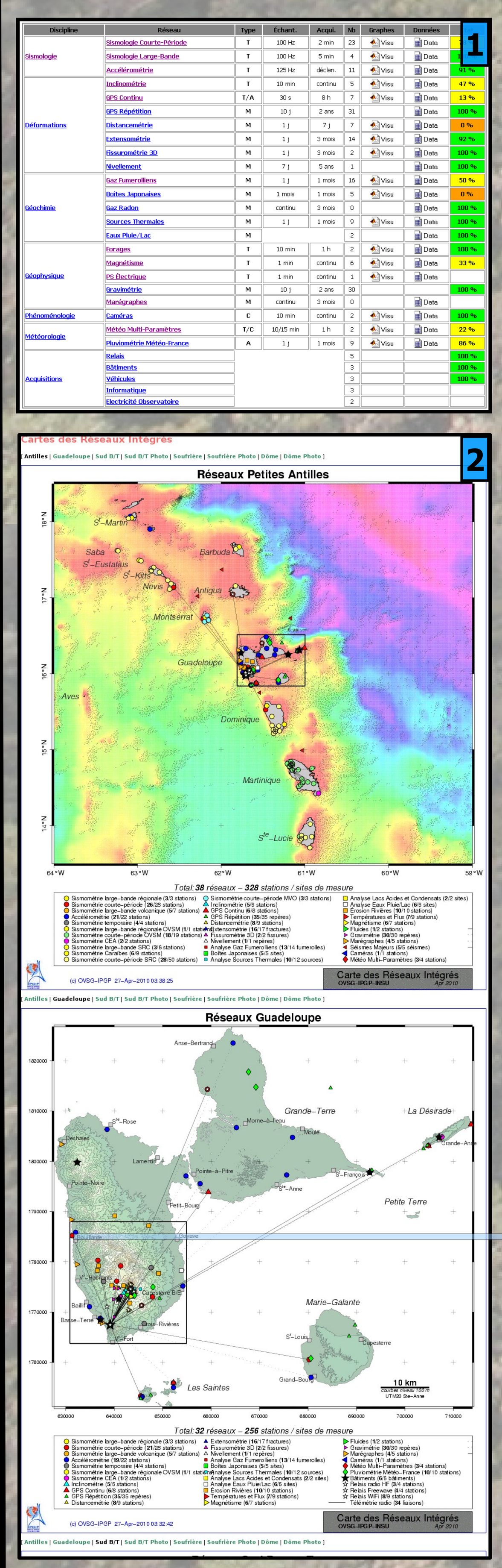
Research developments using observations of natural phenomena must lead to a gradual characterization of an interpretative model of physical and chemical processes. During a crisis management, operational scientific advisories (i.e., prediction) have to be based on the real-time observations *through* this interpretative model; there is no more time to spend in fundamental research. Thus, the main objective of tools in an observatory is to maintain up-to-date quantitative models linked to the real-time data.

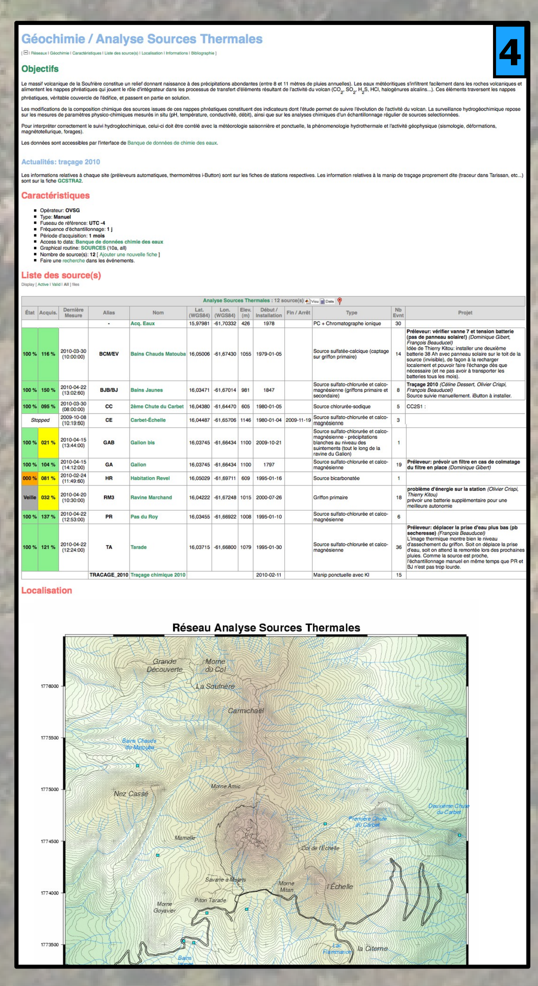
Objectives

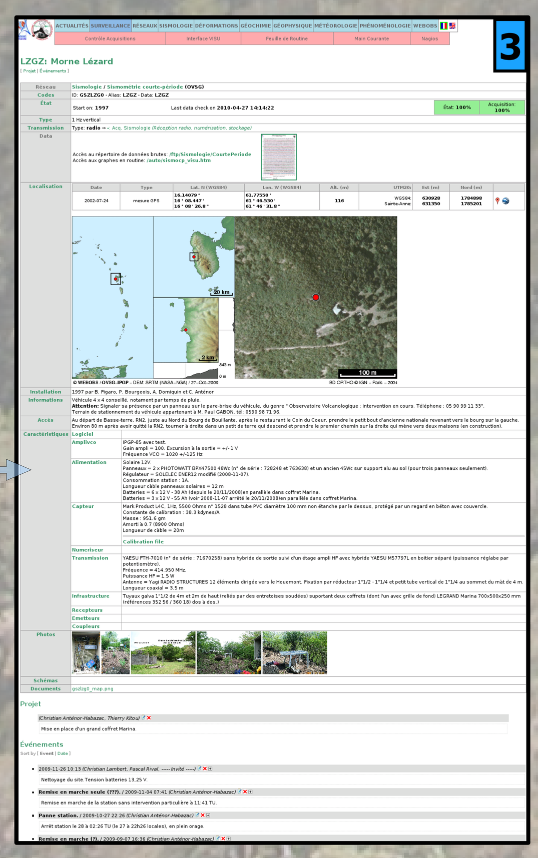
- **"Instant" access to monitoring data**
  - Real-time (or near real-time)
  - Different levels of data: original, validated, and through interpretative model (1st order)
  - Graphics available at preset timescales (moving windows) + possible manual request
  - Associated technical information (link to station and sensor)
  - Global and multidisciplinary overview: all networks
- **Technical networks maintenance**
  - Automatic control of acquisitions
  - Log of technical information and interventions
  - Shared calendar for team organization
- **Help scientific and technical collaborations**
  - Access to a unique level of information
  - Support for discussion and data exchanges (but not oriented to public data distribution)
- **Common problems**
  - Diversity of networks (automated/manual, sampling from 100 Hz to 1 year, analog/digital, data formats, OS, ...)
  - Different levels of information (technical/scientific)

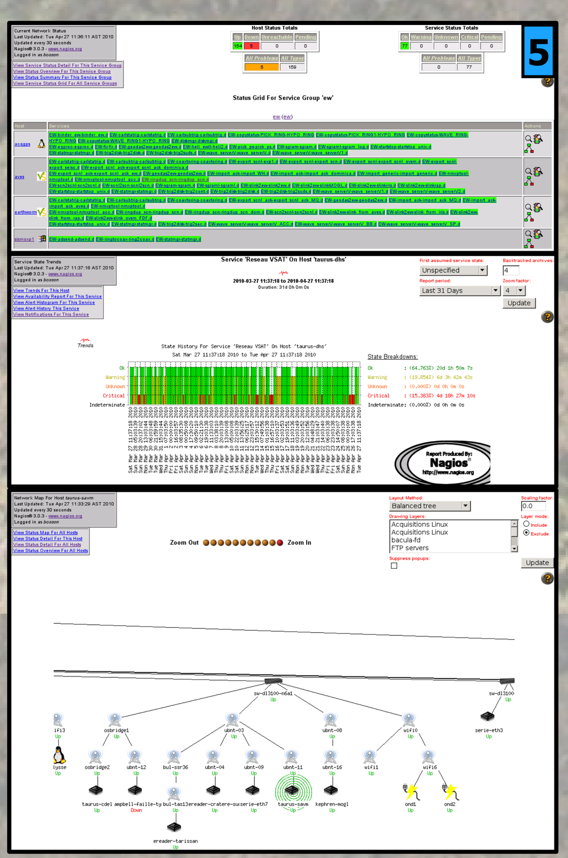
Adopted solutions

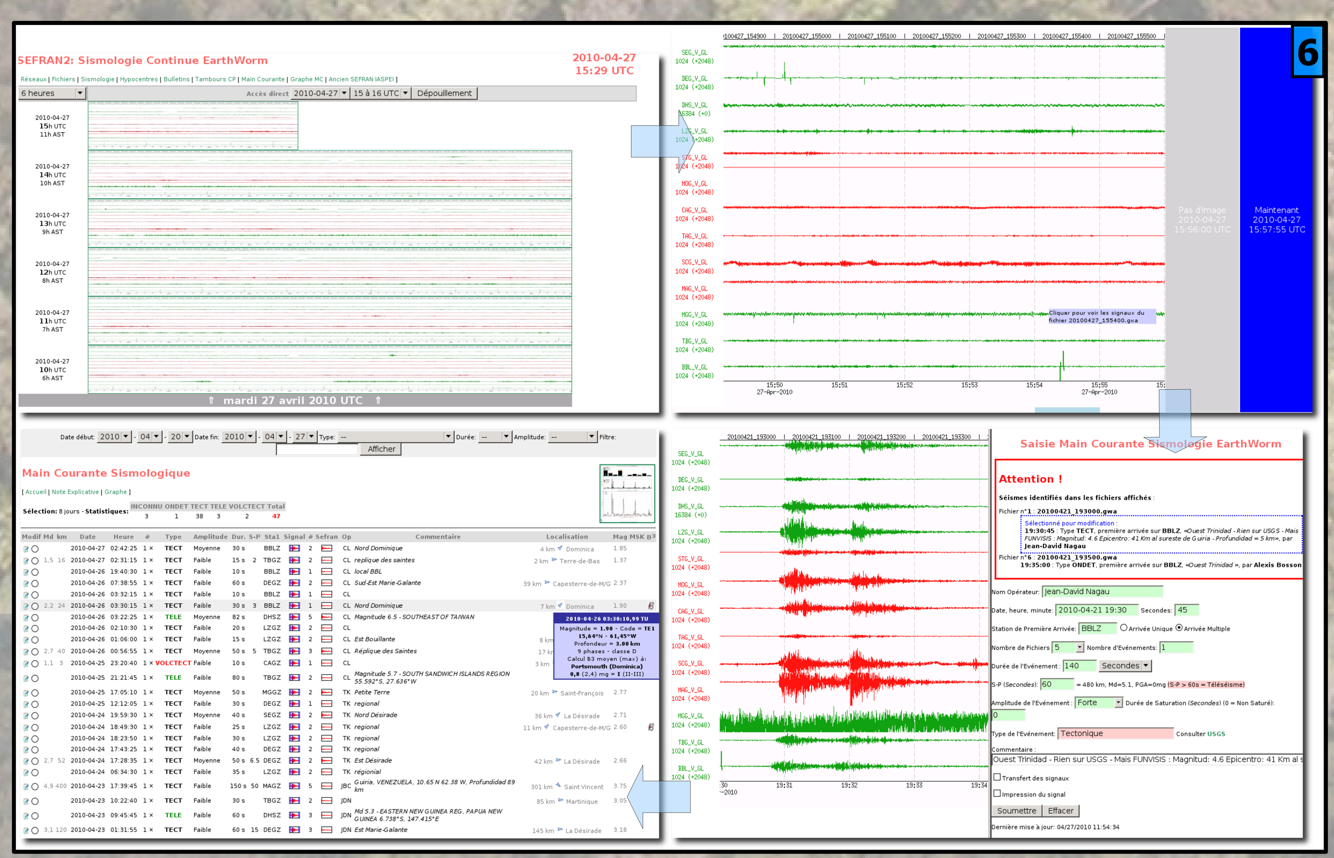
- **Web site**
  - Fixed architecture with mixed static/dynamic content
  - Data forms for manual data input and configuration files
- **Data bank**
  - Native format files in directories, centralized on a single computer (also necessary for archive purpose)
  - Simple text files for manual data inputs, networks characteristics and station interventions archives
- **Data processing: *Matlab* scripts**
  - Specific for each network ⇔ homogeneous matrices (t,d)
  - Preset usual moving time scales (day, month, year...) to anticipate the most common requests
  - Graphs per station (original data), per network (processed/validated data), per discipline (modelized data)
- **Routine schedule: every minute**
  - Test of acquisition computers (clock, disk, date and time of last data file) by *Linux* shell scripts and *Nagios* (for Ethernet-based stations)
  - Process of continuous seismic data (digital seismogram)
  - Process user graphic request (if any)
  - Update control screens on Web
- **Routine schedule: every 30 minutes**
  - Transfer of new data files from acquisitions to server (mirroring)
  - Launch the *Matlab* routines to make preset graphics (24 h, 30 days, 1 year, 10 years) for all networks
- **Routine schedule: every day**
  - Update some graphics (time scale "all data") and network maps
  - Full mirror of data on remote Paris server though Internet

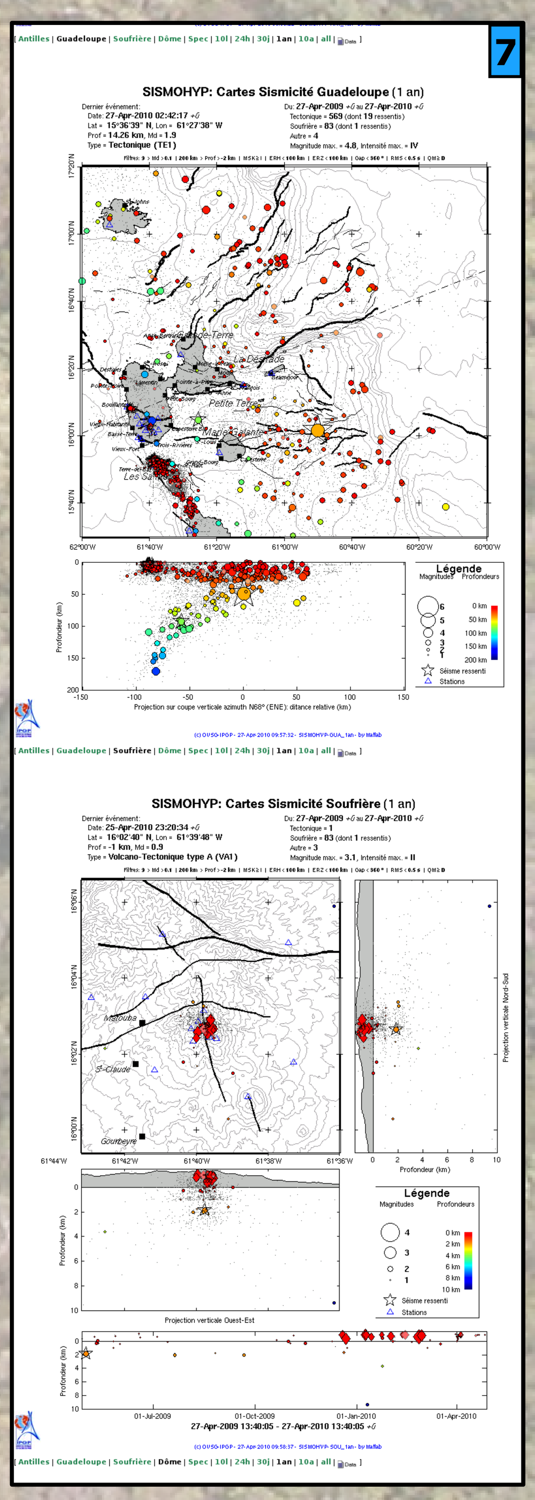












Screenshots selection

1. General table of networks, sorted by disciplines, with links to associated graphs and data. Real-time percentage of function is shown by color cells.

2. Network maps (five different geographic scales), updated every day, with a link to each station files (see example screenshot **3.**).

3. Example of station file (here a short-period seismograph): codes and general characteristics, real-time state, associated graphs,geographical coordinates (and links to *GoogleMaps* & *GoogleEarth*), DEM maps and topography, aerial photograph, practical information, technical characteristics (sensor, power, transmission, …), photos, project and chronological log of maintenance.

4. Example of a network main page (here hot springs geochimical survey): list of stations and real-time state, last date and time of acquisition files, specific interactive map (link to station files).

5. Control of acquisitions is carried on by the *Nagios* system (www.nagios.org), an open-source package specifically dedicated to infrastructure monitoring. All computers, radio link, station and sensors using Ethernet protocol (wired or wireless) are monitored permanently, with specific state levels and possible alarms.

6. Main steps of real-time continuous seismic processing: (1) stripchart of selected stations, (2) zoom of hourly graph to select an event, (3) semi-automatic form of detected event, (4) seismic event database with detailed information for each event, including automatic shakemaps.

7. Example of seismic hypocenter map (last year, regional and volcano scales): located events displayed by magnitude (size) and depth (color) with links to detailed information and seismograms. Known faults are also shown.

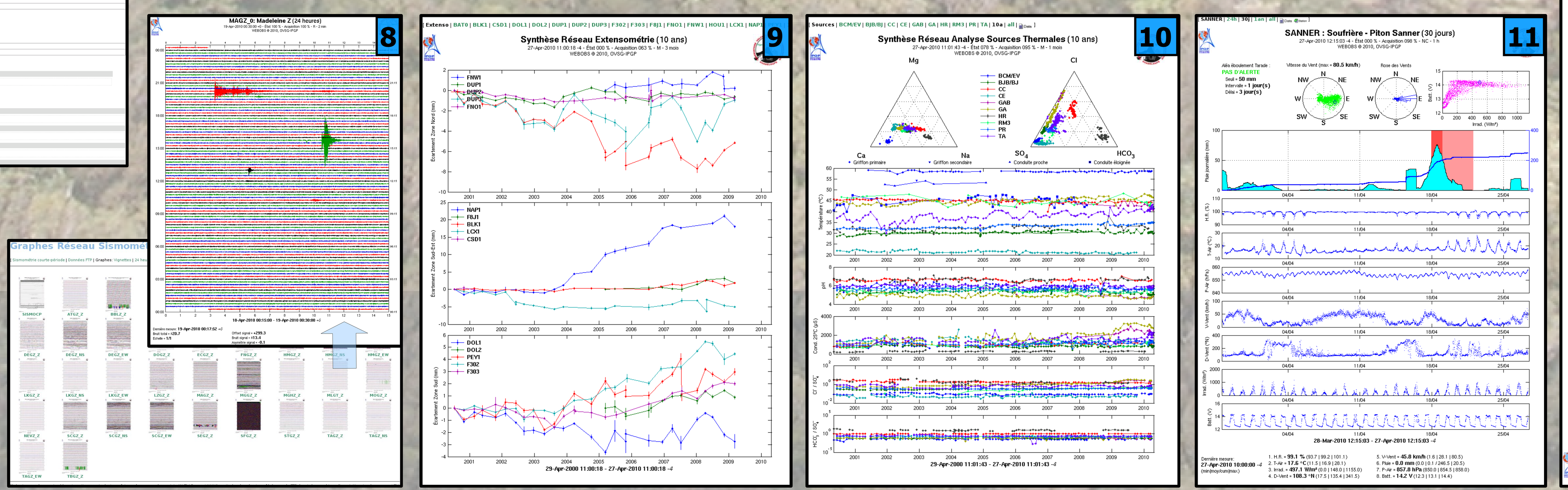
8. Short-period seismic helicorders (last 24 h), all stations, all components. The process includes an estimation of noise level and offset interval, in order to detect sensors problem.

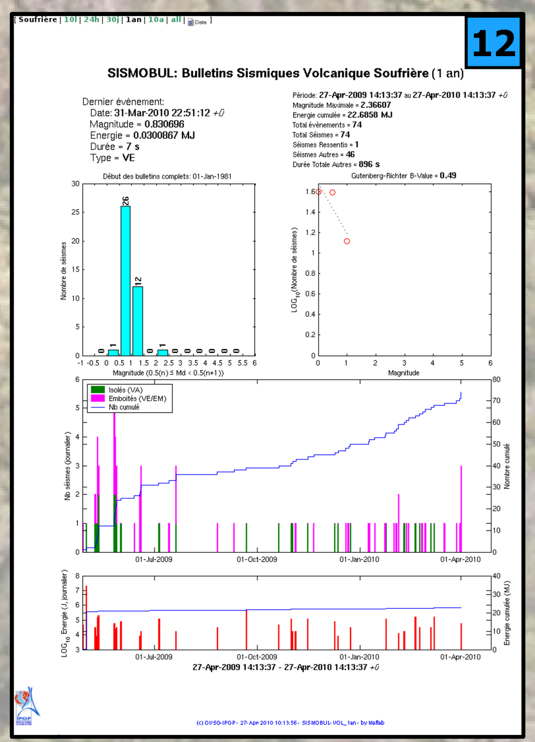
9. Example of a synthetic graph (last 10 years) of the extensometer manual network: differential displacements sorted by active areas. Note also links to individual graphs of each monitored site, station files and data.

10. Example of synthetic graph (last 10 years) of the hot springs manual network: ternary plots and temporal variations of chemical parameters (ion chromatograph analyses).

11. Example of a real-time meteorological station (last 30 days). This particular process includes an alarm with rainfall threshold linked to a local landslide hazard (see red area).

12. Example of seismic bulletin statistics (last year): histogram of magnitudes, Gutenberg-Richter B-value, number of events, energy.

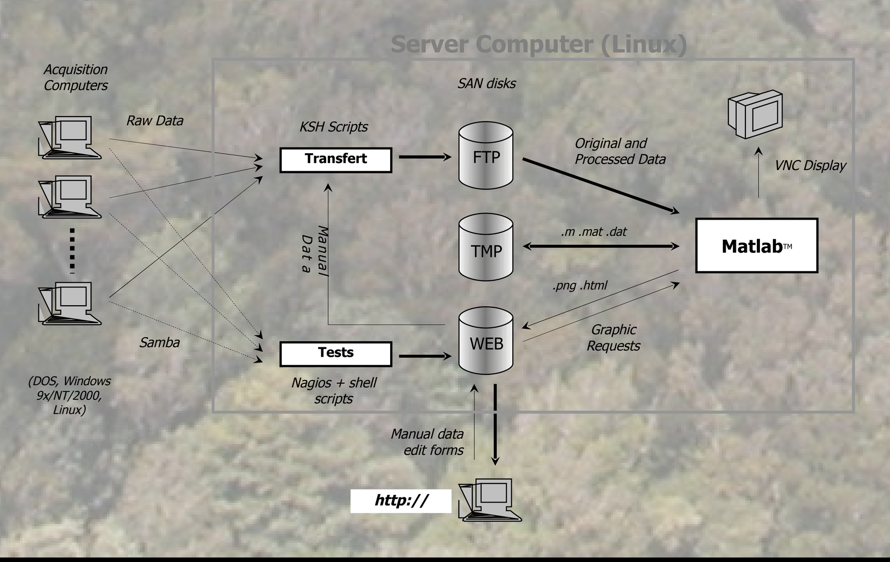




Web structure

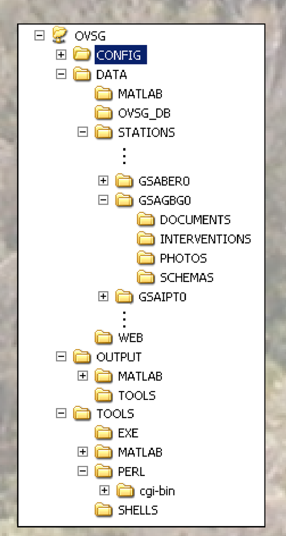
Home	**Welcome page**	→ Daily information, volcano image, 24h seismicity and weather
	Team coordinates	→ Phone emergency list
	Links to collaborators' web	
Monitoring	**Acquisitions control**	→ Real-time state of computer acquisitions
	Routine daily form	→ Printable checklist for manual controls
	Recent seismic events	→ Unprocessed bulletin and seismograms
	Cameras	
Networks	**Networks summary**	→ All networks sorted by discipline and techniques
	Network maps	→ Interactive maps with links to station files (5 different scales)
	Stations list	→ Table of all stations with current state and projects
Seismology	**Bulletins**	→ Graphs of statistics (24 h, 30 d, 1 yr, 10 yr)
	Hypocenters	→ Maps of events with links to seismograms (24 h, 30 d, 1 yr, 10 yr)
	RSAM	→ Graphs of amplitudes for selected stations (24 h, 30 d, 1 yr, 10 yr)
	Stripchart paper	→ Continuous seismograms for selected stations (36 h)
	Short-period	→ Helicorders per component (24 h)
	Broad-band	→ Helicorders per component (24 h)
	Accelerometers	→ Bulletin, maps and seismograms (per event)
Deformations	**GPS**	→ Graphs of relative displacements (30 d, 1 yr, 10 yr)
	Tiltmetry	→ Graphs of tilt signals (24 h, 30 d, 1 yr, 10 yr)
	EDM	→ Graphs of relative displacements (24 h, 30 d, 1 yr, 10 yr)
	Extensometry	→ Graphs of displacements (10 yr)
Geochimia	**Fumarolles gaz**	→ Graphs of gas components and isotopes (10 yr)
	Hot springs	→ Graphs of water components (10 yr)
	Japanese boxes	→ Graphs of gas concentrations (10 yr)
Geophysics	**Boreholes**	→ Graphs of temperature (24 h, 30 d, 1 yr, 10 yr)
	Magnetic field	→ Graphs of absolute and differential values (24 h, 30 d, 1 yr, 10 yr)
	Electric potential	→ Graphs of potentials (24 h, 30 d, 1 yr, 10 yr)
Meteorology	**Weather**	→ Graphs of weather monitor (24 h, 30 d, 1 yr, 10 yr)
	Rainmeters	→ Graphs of rain fall (1 yr, 10 yr)
Data	**User defined graphic form**	→ Allows time interval and network selection
	Manual data input forms	→ Input field data for database update
	Access to data files	→ Link to disks

Architecture



← All acquisition computers are Ethernet-connected (wired or wireless). A single server carries regular data transfers and machine controls for automatic acquisitions. *Matlab* scripts load the new data, process them and produce dedicated graphs for all networks. Manual measurements are updated through web data forms, then processed as other automatic acquisitions. User defined graphics can also be produced with the same scripts on request.

→ Simplified WEBOBS directories structure for configuration files (CONFIG), miscellaneous data files (DATA), network characteristics (STATIONS), temporary output files (OUTPUT) and scripts (TOOLS). All are in text file format and easily editable through any operating system.



Conclusions

- **Simple and adapted tool**
  - Keep existing stations and acquisitions "as is"
  - Adapted scripts (process and display) for each specific network
  - Using of original data (no need for database layer)
  - Light hardware and software, allowing easy maintenance
  - High adaptability to networks evolution
- **Sharing multidisciplinary data to users**
  - Inside the observatory or from far Internet access
  - Access to all data, including technical information, to all involved community
  - Not system-dependent or software-dependent (like GIS)
- **Real-time access for crisis management**
  - All graphs (all disciplines, all time-scales) are instantaneously accessible for preset timescales
  - Very fast interface independent from the number of users