WEBOVS: Integrated monitoring system interface for volcano observatories

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Abstract

Volcanological observatories have common needs and often common practical problems for multi disciplinary data monitoring applications. In fact, accessing to integrated data in real-time and measurements uncertainties estimation are keys for a strike interpretation, but instruments variety, data sampling and acquisition systems heterogeneity lead to difficulties that may check a crisis management.

We have developed in the last few years an operational system that attempts to answer these questions, considering our 20 different networks and more than 200 permanent sensors installed in Guadeloupe. Based on a single computer server and a Web interface, the whole raw data are processed using automatic routines presently every minute for continuous seismology, and every 20 minutes for other slower acquisitions. Graphics are defined on preset moving time intervals mostly used for interpretation: last day, month, year, 10 years, all available data, and user defined. Numerical and graphical results are presented per station (calibrated data), per monitoring network (processed data), and the system is widely open to inter disciplines real-time modeling. Moreover, computers, stations and individual sensors states are checked automatically using simple criteria (files update and signal quality), and displayed as synthetic pages for technical control.

This system leads to a real-time Internet access for integrated monitoring and becomes a strong support for scientists and technician's exchanges. It has been set up last year in Montagne Pelée observatory, and is planed to be installed in Piton de la Fournaise observatory and Azores volcanological center.

Objectives

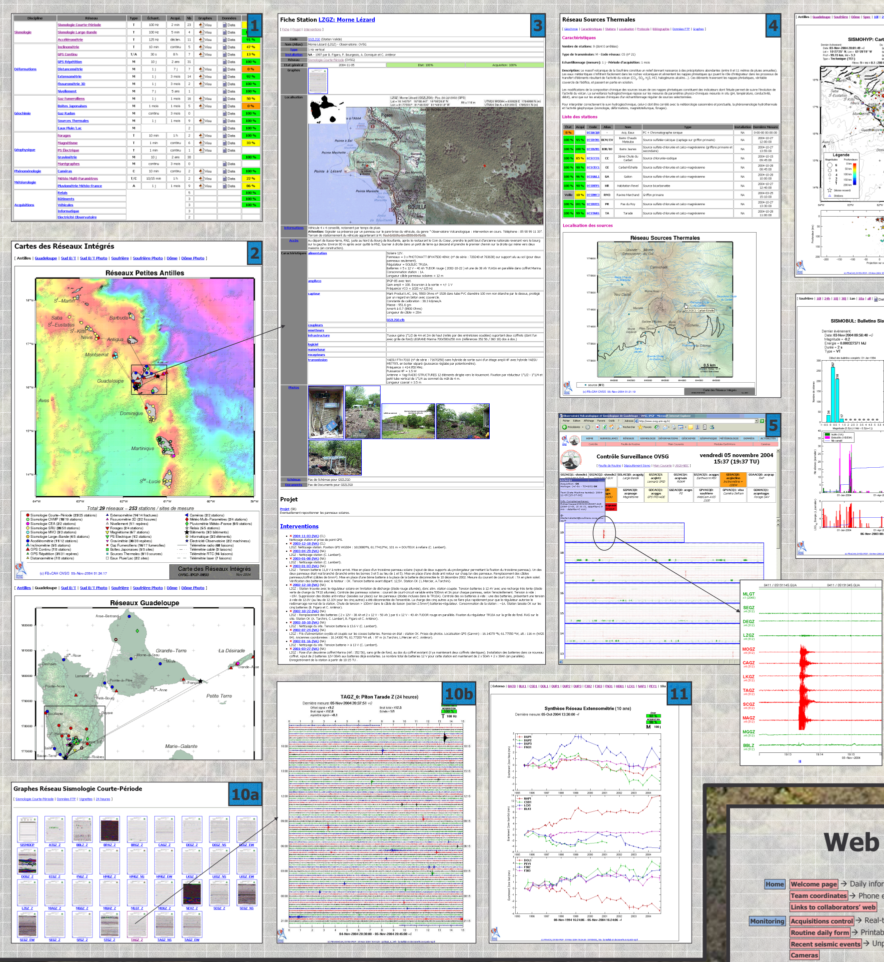
- **Access to monitoring data**
  - Real-time aspect
  - Numerical and graphical data presentation
  - Original, validated, processed and modelized data
  - Associated technical information
  - Global overview: all networks, different time scales
- **Technical networks maintenance**
  - Automatic control of acquisitions
  - Follow technical information and interventions
- **Help scientific and technical collaborations**
  - Access to a unique level of information
  - Support for discussion and data exchanges

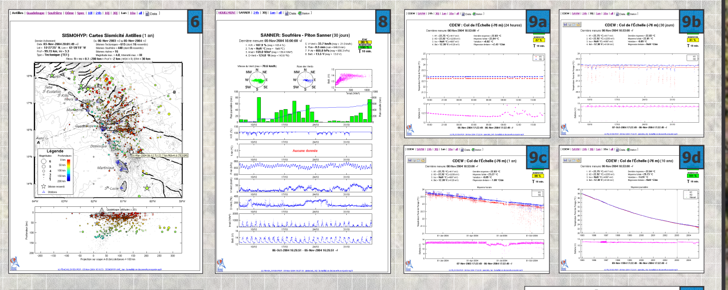
Common problems

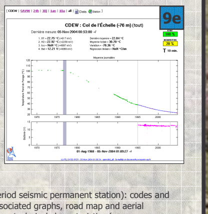
- **Diversity of monitoring networks**
  - Example of OVSG : 20 different networks
    - 13 automated networks (50 telemetred stations)
    - 7 manual networks (150 measurement sites)
  - Data sampling: from 100 Hz to 1 year
  - Acquisition system heterogeneity:
    - OS, software's, computer languages
    - Analog, digital, manual
    - Data file formats !
- **Different levels of information's**
  - Technical (sensors, data errors, ...)
  - Scientific (phenomenology, interpretations, modeling, ...)

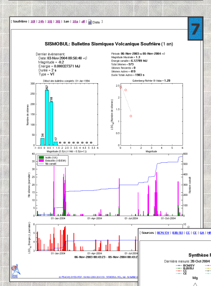
Solutions

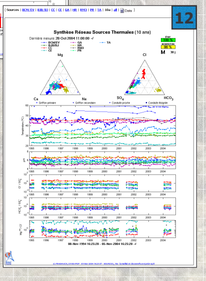
- **Web site**
  - Fixed architecture with dynamic content
  - Data forms for manual data input and configuration files
- **Data bank**
  - Native format files in directories, centralized on a single computer (also necessary for archive purpose)
  - Simple text files for manual data inputs, networks 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
  - Process of continuous seismic data (digital seismogram)
  - Process user graphic request (if any)
  - Update control screens on Web
- **Routine schedule: every 20 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, 5 years) for all networks
- **Routine schedule: every day**
  - Update some graphics (time scale "all data") and network maps
  - Burn 2 CD-ROM for seismic data archives
  - Full mirror of data on remote Paris server though Internet











Screenshots samples

1. General table of networks, sorted by disciplines, with links to associated graphs and data. Real-time percentage of operation is shown by color cells. Each discipline and monitoring technique have their own descriptive page (see example screenshot **4.**). All web pages are automatically built and updated by shell or *Matlab* scripts.

2. Example of integrated network maps, updated every day, with a link to individual station files (see example screenshot **3.**). We defined five different geographic scales: Lesser Antilles (~600-km wide), Guadeloupe archipelago (~100 km), South Basse-Terre area (~25 km), Soufrière volcanic edifice (~4 km), and Soufrière lava dome (~1 km).

3. Example of station file (here a short-period seismic permanent station): codes and general characteristics, real-time state, associated graphs, road map and aerial photograph of the site, practical information, technical characteristics (sensor, power, transmission, ...), descriptive pictures, current project and chronological agenda of intervention maintenance. All information can be edited by web forms.

4. Example of a network main page (here hot springs geochemical survey): list of stations, main characteristics, real-time state, last date and time of data acquisition, and interactive network map (with link to station files), also a detailed protocol description of the technique and associated article references.

5. Monitoring control page (automatic refresh every minute): table shows real-time state of acquisition computers, links to main routine tools, and strip-chart seismicity of selected stations (last 36 hours, example of a local event).

6. Example of seismic hypocenter map (last year, regional scale): located events displayed by magnitude (size) and depth (color) with links to detailed information and seismograms. Known faults are also drawn, and vertical projection shows the subduction zone. Four other geographic scales (Guadeloupe, volcano, lava dome, and user-defined) and five other different time scales are available for these data.

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

8. Example of a real-time meteorological station (last 30 days): wind diagrams, rain, atmospheric pressure and other weather parameters.

9. Example of preset time-scales for real-time graphs (here an automated station with two temperature sensors in a 76-m depth well, and battery voltage): **a.** Last 24 hours; **b.** last 30 days; **c.** last year; **d.** last 10 years; and **e.** all available data (1968 to present). On the last graph, the gray area indicates last eruption period (1976), and green dots stand for old manual measurements.

10. Example of short-period seismic helicorders (last 24 h): **a**. small icons of all stations, all components; **b.** full-scale helicorder for one station located on the volcano (during a recent seismic crisis).

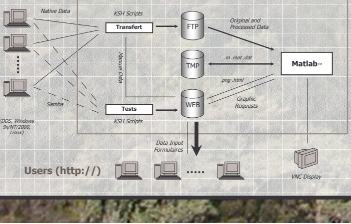
11. Example of a synthetic graph (last 10 years) of the extensometer manual network: differential displacements sorted by active areas. Note also links to individual graphs of each monitored site, station files and digital data files.

12. Example of synthetic graph (last 10 years) of the hot springs manual network: ternary plots and temporal variations of chemical parameters (ion chromatograph analyses). This shows how specific and complex can be the automatic graphs.

Web site map

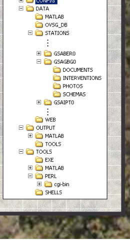
Home	Welcome page	→ Daily information, volcano image, 24h seismicity and weather
	Team coordinates	→ Phone emergency list
	Links to collaborators' web	
Monitoring	Acquisitions control	→ Real-time state of computer acquisitions
	Routine daily form	→ Printable checklist for manual controls
	Recent seismic 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 connected on Intranet. A single server makes 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. User defined graphics are also produced with the same scripts on request.

Simplified 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 editable through Linux or Windows.



Conclusions

- **Simple, efficient and dedicated tool**
  - Keep existing stations and acquisitions "as is"
  - Adapted scripts (process and display) for each specific network
  - Using of original data (no 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
  - Very fast interface independent from the number of users