OVSG's instrumental networks

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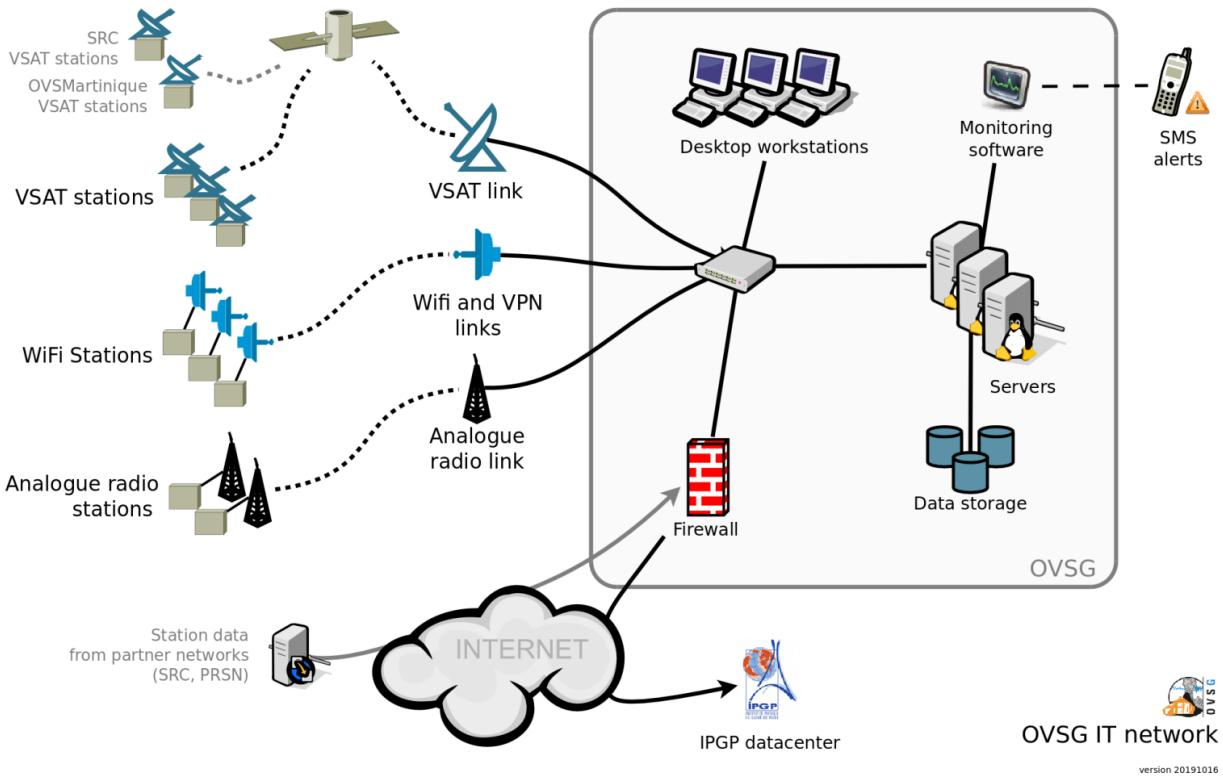
For monitoring the seismicity of the arc of the Lesser Antilles and the Soufrière de Guadeloupe volcano OVSG implements various networks of instruments. Some, such as the seismological network, have several decades of existence and others that rely on the most modern available techniques (muon telescopes, MultiGas detectors, measurement of ground temperatures through fiber-optic...) are currently being implemented at the OVSG. Their development and integration, as well as their long-term reliability represent the most strategic technical issue of he observatory, considering:
-difficulties and challenges related to the tropical climate
-logistic issues
-the broad spectrum of data collection and acquisition frequencies
Here we review existing OVSG's networks, recent developments and short- to medium-term perspectives.

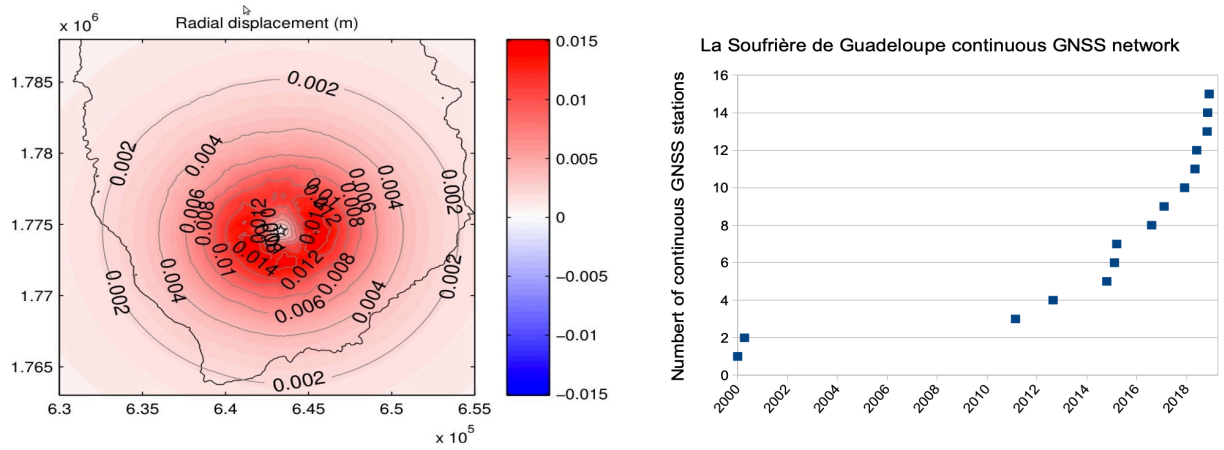
Guadeloupe and northern Lesser Antilles scale :
At regional scale most of the measurements of OVSG are done for regional tectonic dynamic studies. It include mainly seismic (10), accelerometrics26) and GNSS (12) stations.
7 of these sites are equipped with a broad band seismometer, an accelerometer and a GNSS instrument. Data are sent in real time to OVSM, SRC and PTWC thought Vsat technology and are part of the tsunami early warning system.
OVSG also participate to the Caribbean Tsunami Early Warning System (CTWS) with two tide gauges transmitting data on Global Communication System (GTS) thought GOES13 satellite.

On and around la Soufrière de Guadeloupe volcano :
Several networks continuously measuring are used to monitor la Soufrière de Guadeloupe including seismic (up to 100Hz acquisition), gaz analysis, deformations (15 continuous GNSS, 1 radar distance-meter), temperatures and now muons telescopes..
These continuous measurements are completed with sites witch are measured punctually (gaz and spring sampled for chemical analysis, GNSS, manual distance-meters(15), temperature of ground and fluids, gravity...).



Processing, archiving, visualization, communication...The computer network is the center of OVSG's data acquisition system.

Soufrière GNSS network evolution :
During the last 8 years the continuous GNSS stations dedicated to volcano survey increased from 2 to 15 stations. Numerical simulation of ground deformation using Mogi[1] solutions where performed in order to determine the best geometry of the network.



Left : *Awaited radial displacement due to intrusion of 1*10^6 m^3 of material at 3km depth below Soufrière de Guadeloupe dome. Right : Evolution of the number of cGNSS stations dedicated to la Soufrière*

Gaz composition analysis
In 2017 we installed 3 multigaz systems in order to analysis CO2, H2S, and SO2 composition of fumaroles. Unfortunately these equipments didn't resist to the hard conditions of the summit of la Soufrière.
We have now developed a new multigaz design to face the hard atmospheric conditions at the summit of la Soufrière de Guadeloupe.

Projects for the nearly future :
Distributed temperature Sensors (DTS) :
One of the most challenging and important parameters to acquire for better understanding and monitoring the volcano is the total heat flux released by the volcano. In order to better estimate the heat flux we plan to install a DTS at the summit of the volcano in the early 2020. This equipment send laser pulses into an optical fiber and analyses the time of returns of these pulses leading to an equivalent of 4 temperature sensors per meters of optical fiber. The electrical part of the system will be connected to 1.7 km of optical fiber buried in the ground inside and in the vicinity of the fumarole area. This system will be equivalent of 68000 temperature sensors distributed all along the optical fiber.

Muon telescopes :
In 2008 Domoscan team in collaboration with OVSG installed for the first time a muon telescope down the dome of la Soufrière. After several years of collaboration with Domoscan, and after with Diaphane project, OVSG is now involved in MegaMu project. In this frame 3 muon telescopes will be integrated to OVSG's networks in order to detect and localize the steam bursts with a time-resolution of several days. The addition of gravity data to muon tomograpgy allow a better determination of the density structure of the volcano[2]. A relative gravity-meter will be installed during 2020 at the summit of the dome in order to compare temporals variation of density seen from the gravity-meter and muon tomography

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2. Rosas-Carbajal et al. (2017). Three-dimensional density structure of La Soufrière de Guadeloupe lava dome from simultaneous muon radiographies and gravity data. Geophysical Research Letters, 44.