NOVAC

Network for Observation of Volcanic and Atmospheric Change

Specific Targeted Research Project:

Sub-Priority 1.1.6.3 Global Change and Eco-systems
IV.1 Natural Disasters
IV.1.2 Volcanic risk assessment

Project No: 18354

Delivery D1.2.o

PM from the Final Meeting.

2009-04-03

NOVAC FOURTH ANNUAL MEETING

Guatemala

25th January – 1st February 2010

Participants:

Chalmers	Bo Galle Patrik Norman Santiago Arellano Vladimir Conde Claudia Rivera
UHEI	Christoph Kern Leif Vogel Ulrich Platt
BIRA	Gaia Pinardi
UCAM	No
IFM-GEOMAR	Martin Scherwath Kristin Garofalo
IPGP	No
INGV	Mike Burton
UNAM	Hugo Delgado José Manuel Álvarez
INETER	Angélica Muñoz Julio Álvarez
OVSICORI	Eliécer Duarte
INGEOMINAS	Gustavo Garzón Zoraida Chacón Carlos Cardona
SNET	Francisco Montalvo Xóchilt
OVG	No
UMBC	No
MIT	Luisa Molina
IGEPN	Julie Bourquin Silvana Hidalgo Freddy Vásconez
INSIVUMEH	Gustavo Chigna Victoria Caceres Omar
UES	No
INGV-PA	Nicole Bobrowski Salvo Inguaggiato

Preliminary Agenda for the NOVAC Final meeting

Monday 25 January **Hotel Los Dos Mundos, Monterrico, Guatemala**			
Time	**Activity**	**Remark**	**Person in charge**
9:00 – 9:20	Welcome, practical details	Lunches Internet Transport costs	Bo, Victoria, Gustavo C.
9:20-12:00	**Agenda issues**		Bo
	Overall agenda		
	Field excursions		
	Fieldwork		
	Special reports, input		
	Special meetings	Steering committee Fiel-Volcan	
	Presentations	Input to Final Report Continuation possibilities/ambitions	
	Conference dinner		
	Training Monday	Topics Participants	
	Individual discussions	Reports Economy Audit	
12:00 – 13:00	Lunch		
13:00 – 15:00	**Reports**		
	Annual Reports		
	Final Reports		
	Deliverables and milestones		
	Audits		
15:00 – 15:30	Coffee break		
15:30 – 17:00	**Economy**		
	Overall economy (redistributions?, Management reports)		
	Audit budget		
	Equipment budget		
	Installation plan		
17:00 – 18:00	**Other issues**		
	Mid term review		
	Future of NOVAC (prepare inputs Friday)		
	Decisions on Field excursions		
	Decisions on Training workshop		
	EuroNews Film		

Tuesday 26 January **Hotel Los Dos Mundos, Monterrico, Guatemala**

09:00 – 18:00	**Scientific reports by partners** 20 - 30 min on last 15 months activities including highlights for Final Report	
09:00 - 09:20	Activities from last year, Chalmers	Bo
09:20 - 09:40	Activities from last year, UHEI	Christoph, Leif
09:40 – 10:00	Activities from last year, BIRA	Gaia Pinardi
10:20 – 10:40	Coffee break	
10:40 – 11:00	Activities from last year, IFM-GEOMAR	Martin
11:00 – 11:20	Activities from last year, IPGP	Kristin Garofalo?
11:20 – 11:40	Activities from last year, INGV-CA	Mike Burton
11:40 – 12:00	Activities from last year, UNAM	Hugo Delgado
12:00 – 13:00	Lunch	
13:00 - 13:20	Activities from last year, INETER	Angelica Muños
13:20 - 13:40	Activities from last year, OVSICORI	Eliecer Duarte
13:40 – 14:00	Activities from last year, INGEOMINAS	Gustavo Garzon
14:00 – 14:20	Activities from last year, SNET	Francisco Montalvo
14:40 – 15:00	Activities from last year, MIT	Luisa Molina
15:00 – 15:40	Coffee break	
16:00 – 16:20	Activities from last year, IGEPN	Silvana Hidalgo
16:40 – 17:00	Activities from last year, INGV-PA	Salvo Inguaggiato

Wednesday 27 January

Hotel Los Dos Mundos, Monterrico, Guatemala
Hotel Candelaria, Antigua, Guatemala

09:00 – 12:00	**Transport to Antigua**	
07:00 - 08:00	Breakfast, Check out	
09:00 – 11:00	Bus transport to Antigua. Bus leaves 09:00	All
11:00 – 12:00	Check in	All
12:00 – 13:00	Lunch	
13:00 – 18:00	**Special Scientific Reports**	
13:00 - 13:20		
13:20 – 13:40	Analysis of ground-based data, (temperature effects, NO2 Harestua, calibration issues)	Gaia Pinardi
14:20 – 14:40	Recent Remote Sensing results on Etna	Mike Burton
15:00 – 15:20	Coffee break	
15:20 – 15:40	Current status of radiative transfer corrections and retrieval of aerosol optical depth	Christoph
15:40 – 16:00		
16:00 – 16:20	The NOVAC Rapid Alert system, preliminary first results from Telica	Vladimir Conde
16:20 – 16:40		
16:40 – 17:00		
17:00 – 17:20	NOVAC batch program	Patrik, Santiago
17:20 – 17:30	Comparison between batchprocessed and manual evaluations of fluxes from Tungurahua	Santiago
	The “bathtub”-problem	
17:30 – 18:00	Satellite comparison issues	Gaia Pinardi
	Photoes from Goma	Santiago

Thursday 28 January

Hotel Candelaria, Antigua, Guatemala

09:00 – 13:00	**Seminars, courses**	
9:00 – 9:20	Activity from last year, INSIVUMEH	Victoria Caceres
9:20 – 9:40	BrO retrieval of plume scans – Implementation in the NOVAC Post Processing Program Special feature: Quest for the least wrong BrO fit scenario	Leif
9:40 – 10:00	Interesting news: Nyira, Etna, alternative SO2 evaluation, moonlight DOAS	Nicole
10:20 – 10:40	Phreatic activity in Costa Rica	Eliecer
10:40 – 11:00	Coffee break	
11:00 – 11:20	MobileDOAS measurements at Masaya and San Cristóbal volcanoes	Angélica
11:20 – 11:50	First results of SO2 measurements at Villarrica volcano (Chile) by stationary scanning miniDOAS	Kristin
11:50 – 12:50	General gas related volcanology Geochemistry of volcanic discharged fluids. Stromboli geochemical monitoring	Salvo
13:00 – 14:00	Lunch	
14:00 – 15:00	Volcanology (petrology and melt inclusions related to gases)	Hugo
15:00 – 16:00	Ideas for the future	Mike
16:00 – 16:30	Coffee break	
16:30 – 18:00	**Discussions on input to Final Report from the different WPs**	Possibly split on different WPs
14:00 – 14:20	Overall conclusions	
14:00 – 14:20		
14:40 – 15:00		
15:00 – 15:40	Coffee break	
19:00 -	Conference Dinner	

Friday 29 January **Hotel Candelaria, Antigua, Guatemala**		
09:00 – 12:00	**Future of NOVAC**	
09:00-09:20	Meteorology (WRF, ECMWF, NOAA), results from comparisons at Popocatepetl, implementation in observatory software	Patrik
09:20 – 10:30	Presentations by partners on their ambitions/possibilities to continue	
10:30 – 11:00	EU, GEO, ICSU, UN-ISDR	Bo
11:00 – 11:30	NOVAC Data protocol (revision)	
11:30 – 12:00		
12:00 – 13:00	Lunch	
13:00 – 15:00	**Closing session**	
13:00 - 13:20	Decisions to be made	
13:20 – 13:40	Audit budget distribution	
13:40 – 14:00	Mid term review actions	
14:00 – 14:20	Final Reports time schedule	
14:40 – 15:00	Judging quality of flux measurements	Santiago
15:00 – 15:30	Coffee break	

16:00 – 19:00	**Transport to Santiaguito**	

Saturday 30 January **Hotel Candelaria, Antigua, Guatemala**		
09:00 – 19:00	**Field excursion to Pacaya**	
09:00 – 09:20		
09:20 – 09:40		

Sunday 31 January **Hotel Candelaria, Antigua, Guatemala**			
06:00 – 20:00	**Field excursion to Santa Maria, Santiaguito, Fuego, Pacaya** Sign in for participation below		
Santa Maria	**Santiaguito**	**Fuego**	**Pacaya**
Bo			

Monday 1 February **Hotel Candelaria, Antigua, Guatemala**		
09:00 – 17:00	**NOVAC hard- and software training exercises**	

25th January 2010

The meeting starts. Bo welcomes everyone to the Fourth NOVAC Annual Meeting. Gustavo Chigna and Victoria Cáceres welcome the participants on behalf of INSIVUMEH. All the participants then present themselves.

A preliminary agenda is presented and practicalities as meals and time planning are discussed. The basic agenda will be: first administrative issues, then scientific reports, special reports, discussions about future, fieldtrips, and training course. A conference dinner will be arranged in Antigua on Thursday 28. The first 2 days of the meeting will be held in Monterrico, and the next days in Antigua.

An introductory presentation about active volcanism and its monitoring in Guatemala is presented by Gustavo Chigna from INSIVUMEH.

Gustavo Chigna (INSIVUMEH-Guatemala), *Active volcanism in Guatemala*.
The volcanic arc in Guatemala comprises 33 volcanoes, 4 of which are considered as active: Tacaná, Santiaguito, Pacaya, and Fuego. Volcanic monitoring is carried out on these volcanoes through seismic, geodetic and geochemical methodologies. Santiaguito, Fuego and Pacaya also have permanent observatories. The eruptive history of Santa María (Santiaguito), Pacaya and Fuego is summarized, as well as the ongoing activity of these volcanoes.

In the afternoon, Bo Galle spoke about the management and financial deliverables required from the participants of the project. Specific details will be sorted out during the week with each partner, but the general information about content and timing of reporting was given to everyone.

Bo Galle (Chalmers-Sweden), *Project mid-term review*.
After a thorough evaluation of the project by Gerald Ernst, from Ghent University, Belgium, many interesting points were highlighted. On his presentation, Bo summarizes the problems, achievements, suggestions, and potential collaborators given by the reviewer. The output of this review was highly positive for the project.

Bo Galle (Chalmers-Sweden), *EuroNews report about NOVAC*.
EuroNews, which broadcasts online news in many languages, featured NOVAC in connection with an installation campaign in Colombia during November 2009. The report stresses the importance of long-term and safe gas measurements to help to understand the level of activity of a volcano, using as an example the case of Nevado del Ruiz, which eruption in 1985 had catastrophic consequences for the population of Armero. The 8 minute report was projected for the participants of the Annual Meeting.

26th January 2010

This is the day for the activity reports of the different partners.

Bo Galle (Chalmers), *Activity report from Chalmers*.
Bo acts as the PI of Chalmers and Coordinator of the NOVAC project. During the 4th year of the project, Chalmers have carried out activities within the work-packages WP1.1 Scientific management, WP1.2 Administrative management, WP1.3 Dissemination of results, WP2.1 Instrument development, WP2.2 Instrument compilation, WP2.3 Instrument installation, WP2.4 Internet and network, WP3.1 Geophysical interpretation,

WP4.1 Global emissions. The main achievements include: lobbying activities, development of batch processing program, compilation of 16 ver. 1 instruments, installation of 9 instruments in 4 volcanoes, implementation of meteorological data in real-time and post-processing evaluation, evaluation and geophysical interpretation of data for 3 volcanoes.

Cristoph Kern (UHEI-Germany), *Activity report from UHEI.*
Among the activities performed by UHEI during the fourth year, Cristoph emphasizes: improvements to the ver. 2 instrument, development of robust BrO retrievals, studies of BrO chemistry in volcanic plumes, study of radiative transfer in and around volcanic plumes, evaluation of SO_2 columns in the 360-390 nm region, optimization of the NOVAC database, and research on the SO_2 camera.

Gaia Pinardi (BIRA-Belgium), *Activity report from BIRA.*
The most important achievements of BIRA during the fourth year of activities are related with ground based and satellite data retrieval. Within these, 10 spectrometers were characterised for slit function, offset, stray light levels, and temperature corrections. A comparison of stratospheric measurements in Harestua was made with the Chalmers instrument. A study of satellite measurements of SO_2 plumes is being carried out.

Martin Scherwath (IFM-GEOMAR-Germany), *Seismologic study of San Cristóbal and Masaya volcanoes.*
An exercise of comparison between NOVAC gas measurements and seismicity is being carried out by IFM-GEOMAR in Nicaraguan volcanoes. Martin presented some preliminary results of this study, including a description of the available data, the frequency distributions, and inference of some source mechanisms like cracking-related seismicity.

Kristin Garofalo (IFM-GEOMAR-Germany), *Activity report from IPGP*.
On behalf of IPGP, Kristin presented a summary of the activities developed in Piton de la Fournaise volcano. After presenting generalities about the volcano and the monitoring network, a correlation between seismic energy output (as measured by the RSAM), gas emission (from NOVAC stations), and precipitation rate was presented.

Mike Burton (INGV/Ca-Italy), *Activity report from INGV/Ca*.
Mt. Etna's gas monitoring network comprises a locally-developed scanning network, FLAME, and three sites for NOVAC instruments. In this presentation, Mike described the components, transmission, and technical problems found during the last 6 years of operation. Then, a comparison of the results obtained by the two networks is presented. Finally, plans for a more in-depth comparison, as well as specific studies such as gas chemistry in the plume and environmental impact were presented.

Hugo Delgado (UNAM-Mexico), *Activity report from UNAM*.
Popocatépetl and Colima are the Mexican volcanoes monitored by NOVAC. On his presentation, Hugo described the instrumental networks deployed at these volcanoes, a thorough validation of the acquired data, and some preliminary results about the gas emissions for volcanology and environmental impact, particularly within other related projects in Mexico City. Finally, some ideas about the future beyond the scope of NOVAC and other ongoing projects were presented.

Angélica Muñoz (INETER-Nicaragua), *Activity report from INETER.*
On her presentation, Angélica listed the problems, solutions, and future endeavours to keep operational the NOVAC stations around Masaya and San Cristóbal volcanoes. The group in INETER had made a considerable effort to solve technical problems of the systems. Among the activities reported is the participation of Julio Álvarez in a training course in Sweden, and visits of personnel of Chalmers to help solving instrumental problems.

Eliécer Duarte (OVSICORI-Costa Rica), *Activity report from OVSICORI.*
The activity of Turrialba volcano has increased dramatically during the last year, after 142 years of quiescence. The environmental impact of the ongoing activity is tremendous, as it was shown by Eliécer on his presentation.

Gustavo Garzón (INGEOMINAS-Colombia), *Activity report from INGEOMINAS.*

The volcanoes Galeras, Nevado del Ruiz and Nevado del Huila are constantly monitored by the group in INGEOMINAS within NOVAC. Gustavo presented the details of the networks and a large number of results obtained by his group in Colombia. The main activities during the fourth year were done on instrument installation, exploitation of data for volcanology, risk assessment and environmental impact, as well as on dissemination of results. Data is used for the observatories to better interpret the level of volcanic activity and transmitted to local authorities. Interesting observations were discussed during his presentation.

Francisco Montalvo (SNET-El Salvador), *Activity report from SNET*.
Santa Ana and San Miguel volcanoes are currently being monitored by NOVAC stations. Francisco presented the general features of these two active volcanoes, the ongoing eruptive processes, the monitoring network, and a study of the gas emission measurements in relation with the observed seismic energy output.

Luisa Molina (Molina Center for Energy and Environment-USA), *Activity report from MIT*.
Luisa presented the main results of the ongoing campaigns carried out by her group on Megacity air pollution. Past and present projects have been performed around Mexico City, were in cooperation with UNAM, it has been possible to estimate the contribution of SO_2 from volcanoes, based on NOVAC measurements. This is an important step towards identifying the emission budget of the main sources of pollution in the highly populated area. Future work will continue exploiting NOVAC data in the context of urban air quality assessment.

Presentation on options for fieldtrips.
An short presentation by personal from INSIVUMEH was done to give a better idea of the possibilities for hiking activities in Pacaya, Santiaguito and Fuego volcanoes over the weekend. Practicalities about time, transport, costs, etc., were discussed for a later decision of the interested participants.

Julie Bourquin (IGEPN-Ecuador), *Activity report from IGEPN*.
Within the NOVAC project, Cotopaxi and Tungurahua volcanoes are permanently monitored by scanning systems. However, mobile-NOVAC campaigns have been successfully performed during volcanic crisis at El Reventador and Fernandina (Galápagos) volcanoes. Julie described in her presentation the current permanent networks and presented the statistics of the data collected during the last 3 years. An interesting comparison between scanning and mobile measurements at Tungurahua revealed some considerations to take into account about the 2 methodologies. The importance of using reliable wind information was highlighted by an example of two methods of estimate of this parameter.

Salvo Inguaggiato (INGV/Pa-Italy), *Activity report from INGV/Pa*.
INGV/Palermo is in charge of geochemical monitoring of the Aeolian Islands volcanoes. During his presentation, Salvo described the existing gas monitoring network, including the NOVAC stations, and depicted the most important results and their implication for the eruptive activity. Interesting considerations were presented about complementary methodologies like fumarole- or hot-spring-sampling were also discussed.

27th January 2010

Gaia Pinardi (BIRA-Belgium), *BIRA-IASB report ground-based activities*.
In this presentation, Gaia presented the results of the work done on spectroscopy on two main different topics: spectrometric characterization of NOVAC instruments and data retrievals and comparison of NOVAC and BIRA ground-based measurements of stratospheric NO_2. On the first topic, two approaches to temperature-driven spectrometer shift correction were presented, one based on empirical factor correction after laboratory characterization of some spectrometers, and one based on the so-called “Fraunhofer calibration scheme”, which uses the known lines of the solar spectrum to derive shift/squeeze of the measured spectra. An exercise of determination of the optimal spectral range for SO_2 evaluation was also presented. On the second part of the talk, the results of side-by-side operation of a standard NOVAC instrument and a BIRA instrument on Harestua, Norway were shown. A remarkable good agreement between the two systems was found for the measurement of

NO_2, demonstrating the capability of the simpler NOVAC instrument to perform well under difficult environmental conditions.

Mike Burton (INGV/Ca-Italy), *Etna's degassing*.
The eruptive activity of Mt. Etna volcano presents different modalities. Although passive degassing predominates, active phases are also common, and for risk assessment the key question is how to identify the transitions between these two modes of activity. By using a combined petrological-remote sensing (DOAS+FTIR) approach and geochemical modelling, Mike presented a complete model of degassing for this volcano in which he concludes that quasi-steady state degassing is the most common mechanism. He also stressed the importance of measuring bulk degassing of the volcano, because fractional degassing can be modulated by different and uncontrollable parameters.

Cristoph Kern (UHEI-Germany), *Radiative transfer retrievals for accurate UV-spectroscopic measurements of volcanic SO_2 emissions*.
Radiative transfer issues are a known source of uncertainty in the type of plume measurements performed in NOVAC since the 1970s, however a serious attempt to quantify this problem has not been carried out until now. Cristoph and his group at UHEI have tackled this complication by using a 3D Monte-Carlo Radiative Transfer Model called MCARTIM, which allows computation of measurement scenarios to take into account the effect of aerosols and absorbers on the radiative transport within and around volcanic plumes. His findings demonstrate the importance of performing this analysis for accurate estimates of the gas burden of the measured plumes, and his group is working on the implementation of the developed routines in the batch-processing NOVAC software. The fact that DOAS allows quantification of absorbers and scatterers was nicely demonstrated by Cristoph during his presentation.

Vladimir Conde (Chalmers-Sweden), *NOVAC-Rapid Alert System*.
With the aim of providing the volcanological community with a NOVAC instrument capable of rapid deployment during volcanic crisis, Vladimir and his group at Chalmers have been working on the development of the Rapid-Alert NOVAC System. This is a scanning DOAS system of easy and rapid installation, high portability and potential of satellite communication in remote areas. The technical details of the system as well as the preliminary results of a field test in Nicaragua were presented during his presentation.

Patrik Norman (Chalmers-Sweden), *The NOVAC Post-Processing Program: novacP3*.
The novacP3 is a batch program intended to be used for re-evaluation of large amounts of data collected by the NOVAC instruments in a standardized way. This allows for trying and using different configurations and the best available data for wind, spectrometric calibration, etc. Currently the program is running on Chalmers using data from the FTP server. Patrik explain the structure of the program and some of the logics behind the most important algorithms.

Santiago Arellano (Chalmers-Sweden), *novacP3 vs. novacP: an exercise of comparison*.
To validate the performance of the batch-processing NOVAC program, detailed comparisons with the NOVAC (observatory) software is required. Such an exercise was performed for Tungurahua volcano and the main results of it presented by Santiago during his presentation. The agreement in the column amounts obtained by the 2 programs is encouraging, but the different wind and geometrical parameters used in the detailed post-processing in comparison with the typically simpler but faster approach of the observatories ranges between 30-60%. This was a good indication of the general performance of the novacP3 software and the importance of considering the most accurate possible available information to get meaningful results.

Santiago Arellano (Chalmers-Sweden), *The problem of the "bathtubs"*.
The "bath-tubes" problem refers to the typical U-shaped daily time series of SO2 fluxes calculated with the NOVAC program that has been observed in certain locations, especially when no fluxes are expected to be retrieved from the scans. An analysis of the causes of this artifact was presented in this talk. It seems that the reason is the method of calculation of the column offset in the scan, which is linearly related with the measurement error, which is usually higher at higher solar angles when the radiance levels are lower. The possibility of using a synthetic reference performs well but does not correct for this effect, but the analysis is a

good indication of the quality of the measurement for which corrections can be implemented in the future. The presentation also showed some anomalies in the results of simultaneous measurements made by the 2 versions of NOVAC instruments, which may have been caused by different exposure times or methods of plume integration that will be analyzed in the future.

Gaia Pinardi (BIRA-Belgium), *BIRA-IASB report satellite activities*.
A comparison between total SO_2 burden obtained by OMI, GOME-2 or ASTER satellite sensors and SO_2 flux obtained by NOVAC instruments at selected volcanoes was presented by Gaia in this talk. Different complications arise to make these measurements comparable, like the time/spatial resolution of the techniques, the uncertainty on wind/altitude information, different times or portions of the plume observed, data reduction procedures, etc. For these reasons, this preliminary study show little correspondence between the compared data series but highlighted the availability of data and the mentioned considerations to consider for a future study.

Bo Galle (Chalmers-Sweden), *Some slides from the Goma Volcanological Observatory*.
Unfortunately, it was impossible to arrange the participation of Matthiew Yalire from the Goma Volcanological Observatory in this meeting due to complications with visa and work. However, he sent some slides about the monitoring network around Nyiragongo volcano and some impressive pictures of the activity observed at Nyiamuragira volcano, which started a flank eruption in January 2010 that continued at the time of the meeting. Bo presented the pictures on behalf of Matthiew.

Carlos Cardona (INGEOMINAS-Colombia), *Installation of two NOVAC ScanDOAS systems at Nevado del Huila volcano (Colombia)*.
Nevado del Huila has shown intense phreatomagmatic activity during the last months, which motivated the installation of additional NOVAC instruments around this dangerous volcano. In this presentation the technical details of the two installed stations were exposed. Limited accessibility to the proximities of the volcano have determined a non optimal location of these systems, but plans exist to relocate them in the future to a more proximal position.

Zoraida Chacón (INGEOMINAS-Colombia), *Installation of two NOVAC scan DOAS systems at Nevado del Ruiz volcano*.
A quick overview of the current eruptive activity of Nevado del Ruiz volcano, the location and characteristics of 2 NOVAC systems installed on its surroundings, and some results of the measurements performed with them was presented by Zoraida in this talk. The fieldwork related with such installations was featured in a report of EuroNews which show the excellent work done by this group.

28th January 2010

Victoria Cáceres (INSIVUMEH-Guatemala), *A preliminary review of the results of NOVAC data in Guatemala*.
In this presentation, Victoria summarized the present status of the NOVAC stations in Guatemala. The talk also included slides about the observed activity of Santiaguito and Fuego volcanoes and some correlations of the measured gas fluxes with seismic energy output.

Leif Vogel (UHEI-Germany), *BrO retrieval from plume scans - Implementation in the novacPPP / Special feature: Quest for the least wrong BrO fit scenario*.
The formation of BrO in volcanic plumes is a topic of high interest because of the atmospheric impacts and the volcanological implications of this species, which is accessible to DOAS observation. The retrieval of BrO is not straightforward, however, and some open questions exist about the mechanism of formation and evolution of this gas in time. A serious analysis of these problems is being carried out by UHEI, and the most important achievements of it were presented by Leif in this presentation.

Nicole Bobrowski (UHEI-Germany), *Some case studies: (1) Nyiragongo, (2) Etna (3) alternative SO_2 evaluation, (4) moonlight-DOAS*.

This presentation by Nicole showed interesting results on the significance of BrO measurements in volcanic plumes at Nyiragongo and Etna volcanoes, the potential of an alternative spectral region for SO_2 retrieval near to the visible and on the capability of the NOVAC ver. 2 instrument to perform solar and lunar measurements. On BrO, Nicole proposed a model of degassing for Etna volcano that accounts for the observed BrO/SO_2 molar ratios measured by UV spectroscopy. The alternative SO_2 evaluation is interesting due to the fact of less problems with stray light and scattering principally, while the direct measurements with the sun or the moon as radiation sources allows studies of atmospheric chemistry processes and plume observations/radiative transfer for 24 hours, if the conditions are adequate.

Eliécer Duarte (OVSICORI-Costa Rica), *Phreatic eruptions from Turrialba Volcano. The reawakening after 142 years of quietness*.
This presentation showed photographic and remote sensing evidence of dramatic environmental impact caused by the recent awakening of Turrialba volcano in Costa Rica. Eliécer explained the main observations and hypothesis about the present level of activity and the importance of strengthening the surveillance of this volcano, also by NOVAC instruments that were deployed in the surroundings.

Angélica Muñoz (INETER-Nicaragua), *Algunos resultados de mediciones de dióxido de azufre - Proyecto NOVAC*.
Interesting results have been obtained by the group of INETER from stationary and mobile DOAS measurements of the gas plumes of Masaya and San Cristóbal volcanoes. These have been the result of efforts done during the last year to keep the network operational. The measurements help to define baseline levels and anomalies of degassing and are being currently used by INETER as a tool for a better risk assessment. This was presented and explained by Angélica during her talk.

Kristin Garofalo (IPGP-France), *First results of SO2 measurements at Villarrica volcano (Chile) by stationary scanning miniDOAS.*
This presentation dealt with the correlation of gas emission measurements and seismic measurements at Villarica in Chile. Two scanning miniDOAS instruments have been installed at Villarica and the co-variation of the degassing and the seismic activity.

Salvo Inguaggiato (INGV/Pa-Italy), *Volcanic gases: sampling and analysis*.
This was a plenary talk on volcanic gas geochemistry by direct sampling techniques. The presentation included an introduction of magmatic volatiles, the measurement techniques, isotopes (N, He), an overview of volcanism in the Aeolian Archipelago, the Stromboli's geochemical monitoring network, the Stromboli's eruptions in 2002 and 2007, a design of a dissolved CO_2 measuring system, and general conclusions. The presentation also showed the most used approaches and models of field geochemists and some data series that reveal the complexities of the plumbing systems of the studied volcanoes.

Hugo Delgado (UNAM-Mexico), *Integrating geological data for the interpretation of degassing processes*.
This presentation showed the importance of multidisciplinary studies for understanding a volcanic eruption. The example was the long-lasting eruption of Popocatépetl volcano, which is an excellent case of a well-documented eruption. Hugo's main point was that the plethora of data coming from monitoring has meaning in the context of a model which should consider all the available information, from geological history to high-sampling rate observations. As not all the volcanoes can be monitored in detail, international cooperation is needed, something that has been well shown with NOVAC.

Mike Burton (INGV/Ca-Italy), *Future of NOVAC, What's next?*
As a final contribution to the meeting, Mike presented some ideas about the strategy to follow for keeping NOVAC operational and expand it in the future. His main points included to convert NOVAC data in actionable information by collaborating with other groups/disciplines, expand the network with more instruments like OP-FTIR and SO_2 cameras; establish closer cooperation with satellite scientists; and, the willing to continue cooperation in the future. Similar contributions were added by the other partners at the end of the meeting.

29th January 2010

Patrik Norman (Chalmers-Sweden), *NOVAC wind data – meteorological update*
In this presentation Patrik showed the latest developments on the implementation of routines to get the best available wind information to calculate gas fluxes for NOVAC measurements. The main effort has been done in implementing a Weather Research and Forecasting (WRF) model, which is a mesoscale meteorological model based on analyzed wind information from NOAA and ECMWF, to get 3D wind fields around the volcanic areas with unprecedented spatial and temporal resolution. The model has been implemented and is being tested for higher reliability.

Bo Galle (Chalmers-Sweden), *Administrative aspects for general discussion*.
As one of the closing presentations, Bo leaded a discussion on the main topics to consider for the final months of the project. Among these were the possibilities to continue with NOVAC that have been looked for by the coordination of the project during the last months, details about the audit process, actions to take respect to the outputs of the mid-term review of the project, time schedule for submitting the final reports, and request of interests or ideas from the partners for the future of the project.

All partners, *Ideas for the future of NOVAC*.
The session part of the meeting concluded with a lively discussion about the ideas and expectations of the partners about the continuation of NOVAC after ending of the project. Here is a summary of the main ideas:

- UNAM: establish clear data exploitation rules, form high level human resources, conduct climate studies, establish lines of study for each partner, activities to be done by UNAM and possible sources of funding.
- IFM-GEOMAR: will continue working in Chile in cooperation with SERNAGEOMIN. The project in Nicaragua is ending but data analysis will be completed in 2 months.
- SNET: Keep the instruments operational and possibly add San Salvador volcano to the network.
- INETER: Keep the network functioning, add Concepción volcano, build 2 mobile DOAS instruments, extend collaboration with Mexican and Central American partners for training and support in crisis, and exploit data in cooperation with interested partners.
- INGEOMINAS: Keep the network in operation and look for collaboration with other partners
- BIRA: Continue data analysis of satellite data in cooperation with other partners and involvement in projects EVOSS and SAVAA, aimed at satellite-based volcanic surveillance.
- UHEI: Continue in close collaboration with Chalmers supporting the NOVAC partners on data evaluations and maintenance of instruments, especially the ver. 2 NOVAC systems. Documenting the implemented algorithms and continue doing fieldwork in volcanoes.
- IGEPN: Keep and expand the network, include CO_2 gas chambers, secure funding from local sources, establish lines of research in petrology that can be related with NOVAC information, open to collaboration with other partners.
- OVSICORI: Keep the network in operation, acquire mobileDOAS instruments, conduct studies on urban air pollution and global warming, and acquire early-warning geochemical systems.
- INSIVUMEH: Look for funding to continue operating the network.

1st February 2010

Training activities.

	Teacher	Not participating	Instrument hardware	Observatory software	DOASIS course	Windoas course	MobileDOAS	Radiative transfer
			17:00	**15-16**	**9:30 -12:00**	**13-15**	**16:00**	
			Axis box...	meteorology				
Name			Manne box	new features				

			Vladimir	*Patrik, Vladimir*	*Christoph*	*Gaia*	*Bo*	*Christoph*
Omar					x	x	x	x
Gustavo Chigna								
Victoria			x	x			x	
Gustavo Garzón				x				
Hugo		x						
José Manuel				x	x	x	x	
Nicole			x	x		x	x	x
Xóchilt			x	x				
Gaia	x							
Claudia		x						
Vladimir	x							
Patrik	x							
Eliécer							x	
Francisco			x		x		x	
Julio			x	x	x	x	x	x
Angélica							x	
Zoraida					x			
Carlos						x		
Silvana		x						
Julie		x						
Kristin				x	x	x	x	
Martin		x						
Freddy		x						
Leif	x					x		x
Cristoph	x			x			x	
Bo	x							
Santiago	x							
Ulrich	x							