Rapid Response Systems for Volcanic risk support developed for Italy and in the GMES core services

SAFER-FP7 project
ASI-SRV project

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OVERVIEW

- INGV activities overview
- GEMS Emergency Management: SAFER project overview
- Earthquakes and Volcanoes (E&V) Services
- Contributes to international E&V Emergencies
- ASI-SRV project for Italian volcanic risk management

Istituto Nazionale di Geofisica e Vulcanologia
INGV

INGV branches

• Centro Nazionale Terremoti

Roma
- *Seismology and Tectonophysics*
- *Geomagnetism, Aeronomy and Envorinment*

Napoli
- *Osservatorio Vesuviano*

Catania
- *Volcanology (Etna-Aeolian Isl.)*

Milano
- Engineering *Seismology*

Palermo
- *Geochemistry*

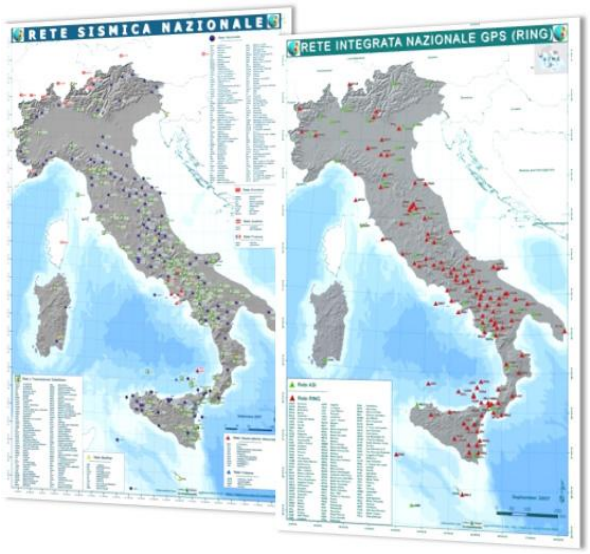
Pisa
- *Volcanology and modeling*

Bologna
- *Seismology*
- *Climatology*

Other observatories

- Rocca di Papa Roma
- L'Aquila
- Gibilmanna Palermo
- Ercolano Napoli
- Arezzo
- Ancona
- Messina
- Lipari Messina
- Stromboli Messina
- Grottaminarda Avellino
- Portovenere La Spezia
- Roma Via Nizza
- Roma Viale Pinturicchio
- Napoli Via Coroglio
- Genova Dept. Earth Sc.- University

INGV Monitoring Systems



- Seismic surveillance
- GPS network and geodesy
  - About 200 seismic stations
  - About 110 GPS stations

- Geochemistry network
- Marine (sub-marine) instruments
- **Remote Sensing (receiving antennas and laboratory)**

SAFER project rationale

- The project SAFER aim is to implement and to validate a preoperational version of the GMES Emergency Response Service, reinforcing the European capacity to respond to such challenges

- In first priority we want to validate an information service focusing on rapid mapping during the response phase and then to enrich this service with a wider set of thematic products.

- In the long term, ERCS will provide tangible benefits for all citizens, in Europe and worldwide, in terms of better quality of life, better health, and increased safety.

THEMATIC SERVICE – GEOPHYSICAL RISKS

- Earthquakes and Volcanoes (E&V) services
  - Summary of Main Objectives
    - ✓Consolidate, validate and deliver thematic information at European and Worldwide level related to the geophysical risk for ERCS activities
    - ✓Creating a permanent exchange of information with user community and other partners in order to facilitate the integration, validation and use of E&V thematic services in the ERCS system

Selected products for operational services

The proposed products for E&V services were:

- Volcanic products
  - SO2 content and flux maps
  - HTE maps
  - ASH maps (mass, loading and dispersal modelling)
  - Sin-Eruptive deformation by DInSAR
- Earthquake products
  - Damage mapping by SAR (and/or by VHR optical and SAR fusion)
  - Co-Seismic deformation by DInSAR
  - SAR time series (prevention phase product)

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EARTHQUAKES AND VOLCANOES SERVICES

Major events used to test the E&V thematic service products

- September 2009 Padang earthquake (Indonesia)
- January 2010 Port au Prince earthquake (Haiti)
- April-May 2010 Eyjafjallajökull eruption (Iceland)
- October-November 2010 Merapi eruption (Indonesia)
- May 2011 Grimsvotn eruption (Iceland)
- June 2011 Dubbi eruption
- October-November 2011 El Hierro eruption (Spain)

The ITAFACE

WP30200 Geophysical thematic services /title> - Mozilla Firefox

File Modifica Visualizza Cronologia Segnalibri Strumenti Aiuto

file:///C:/Users/Massimo/Documents/INGV/SAFER/2011/SAFER_WEB/

Più visitati Come iniziare Ultime notizie

SAFER PRELIMINARY Dissemination... | WP30200 Geophysical thematic s...

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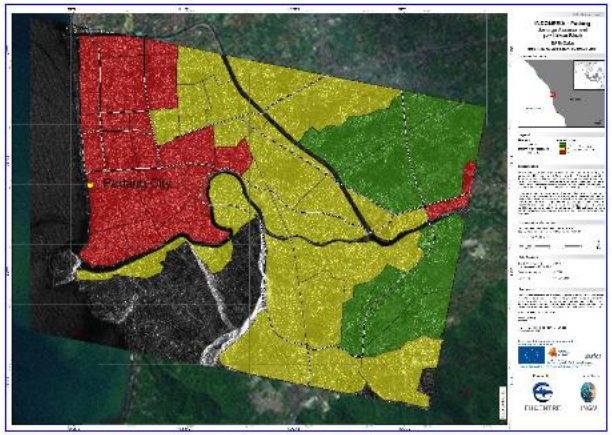
On the 30th September 2009, at 17:16:10 local time (10:16:10 UTC) an earthquake with a magnit
off the Southern coast of Sumatra, Indonesia. The epicenter was 45 kilometers west-northwest
220 kilometers Southwest of Pekanbaru, Sumatra. The map shows a post disaster damage asses
suburbs.

The map has been performed by Christian Bignami and Fabio Dell'Acqua

For furhter information please contact Christian Bignami



Padang post earthquake damage map

Completato

WP30200 Geophysical thematic services /title> - Mozilla Firefox

File Modifica Visualizza Cronologia Segnalibri Strumenti Aiuto

file:///C:/Users/Massimo/Documents/INGV/SAFER/2011/SAFER_WEB/index_merapi.html

Più visitati Come iniziare Ultime notizie

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NILU

Merapi, one of Indonesia's most active volcanoes, lies in one of the world's most densely populated areas and dominates the landscape immediately north of the major city of Yogyakarta. Merapi is the youngest and southernmost of a volcanic chain extending NNW to Ungaran volcano. Center of Volcanology and Geological Hazard Mitigation (CVGHM) Local Observatory reported that from the end of September to 20 October the rate of inflation at Merapi was 0.6 cm per day. On 21 October the rate increased to 10.5 cm per day, and incidents of incandescence from the lava dome increased. The rate of inflation increased sharply on 24 October to a rate of 42 cm per day. The next day, the alert Level has been set up to 4. An eruption began at about 17:00 (local time) on 26 October that was characterized by explosions along with pyroclastic flows that traveled WSW and SE, after an increase of the inflation starting from September 2009. CVGHM reports that multiple pyroclastic flows occurred until 18:54 (local time), when the pyroclastic flowactivity started to subside. Most of the pyroclastic flows lasted 2 to 9 minutes, except for two that lasted 33 minutes each. An ash plume was also observed rising 1.5 km above the crater.

Within the SAFER activity, INGV has produced different maps describing the volcanic ash and SO2 content. The retrievals have been performed by Stefano Corradini, Augusto Neri, Claudia Spientti and Fred Prata by using home made SW. Moreover INGV, and Gamma have produced map derived by Radar data.

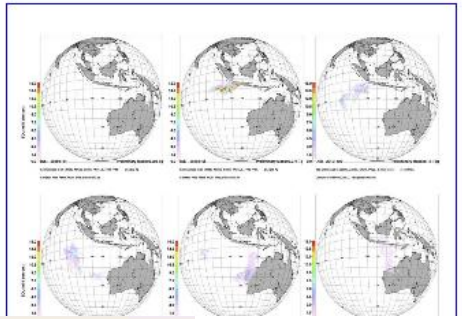
For furhter information on the SAFER project please contact Fabrizia Buongiorno or Massimo Musacchio

For furhter information on the ASH and SO2 SAFER product please contact Stefano Corradini

For furhter information on the cumulative ASH fall product please contact Augusto Neri

For furhter information on the Volacnic aerosol optical depth product please contact Claudia Spinetti

For furhter information on the product please contact Christian Bignami



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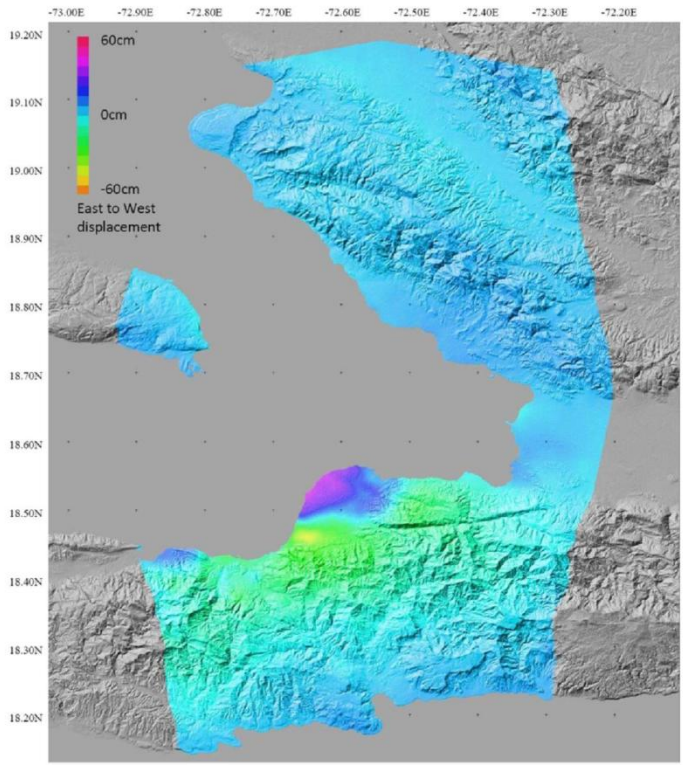
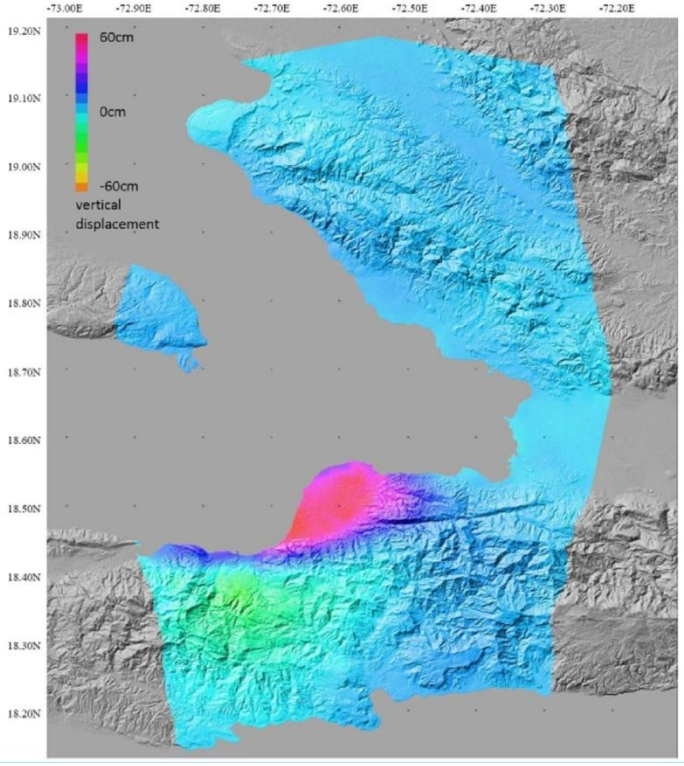
Port au Prince earthquake (Haiti)

- On 12 January 2010 a strong earthquake (M 7.0) hit the city of Port Au Prince ant the surrounding areas.
  - ***Deformation map***
  - ***Damaged area (BASeDaLE)***

Deformation map





- Deformation map component by means of DInSAR (left, east-west component , right vertical component)

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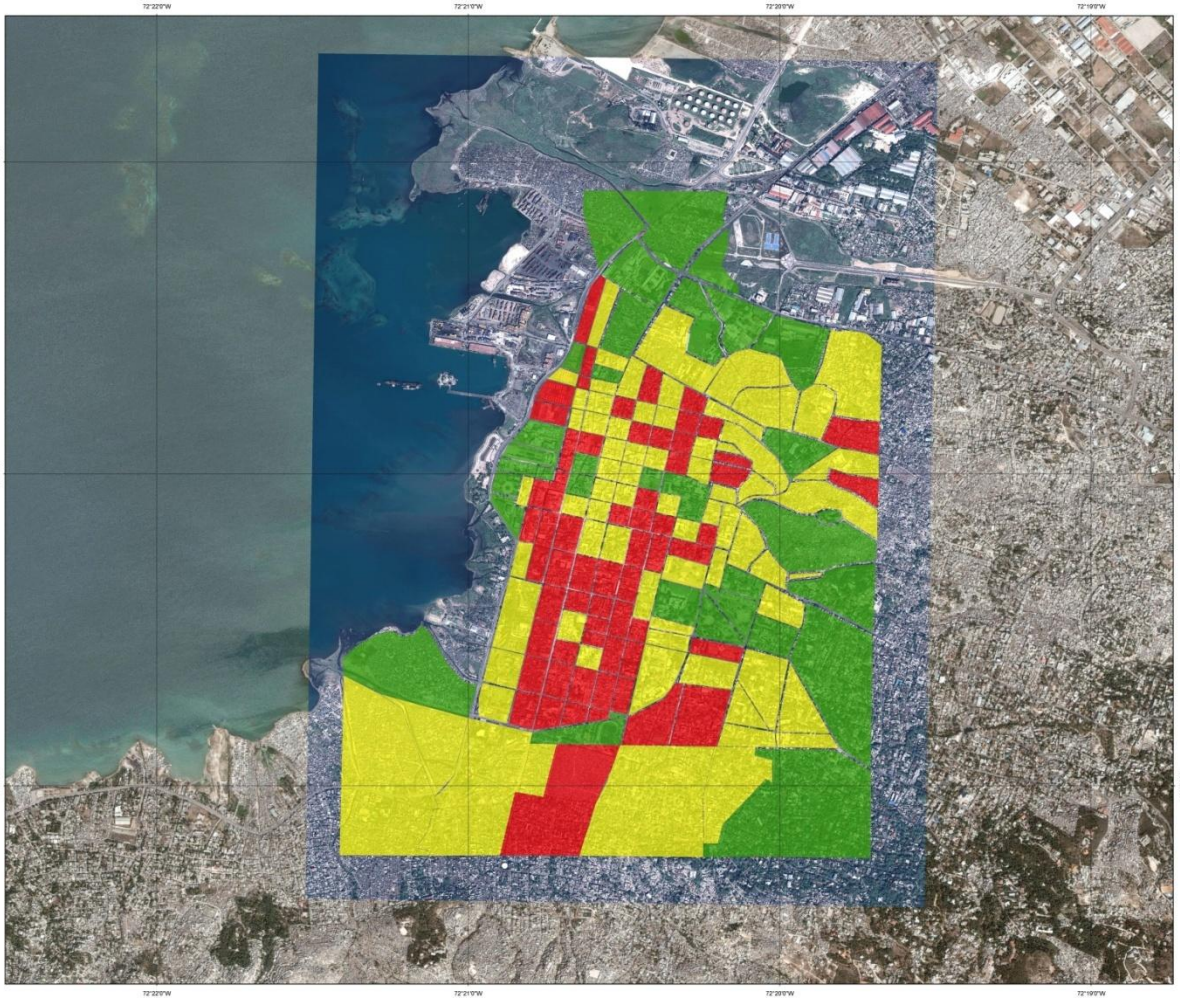
Damaged area (BASEDALE)



- Damage estimation map of Port Au Prince, Haiti. SAR damage map at block scale (Green= low level /no damage; Yellow= medium level damage; Red= high level damage)

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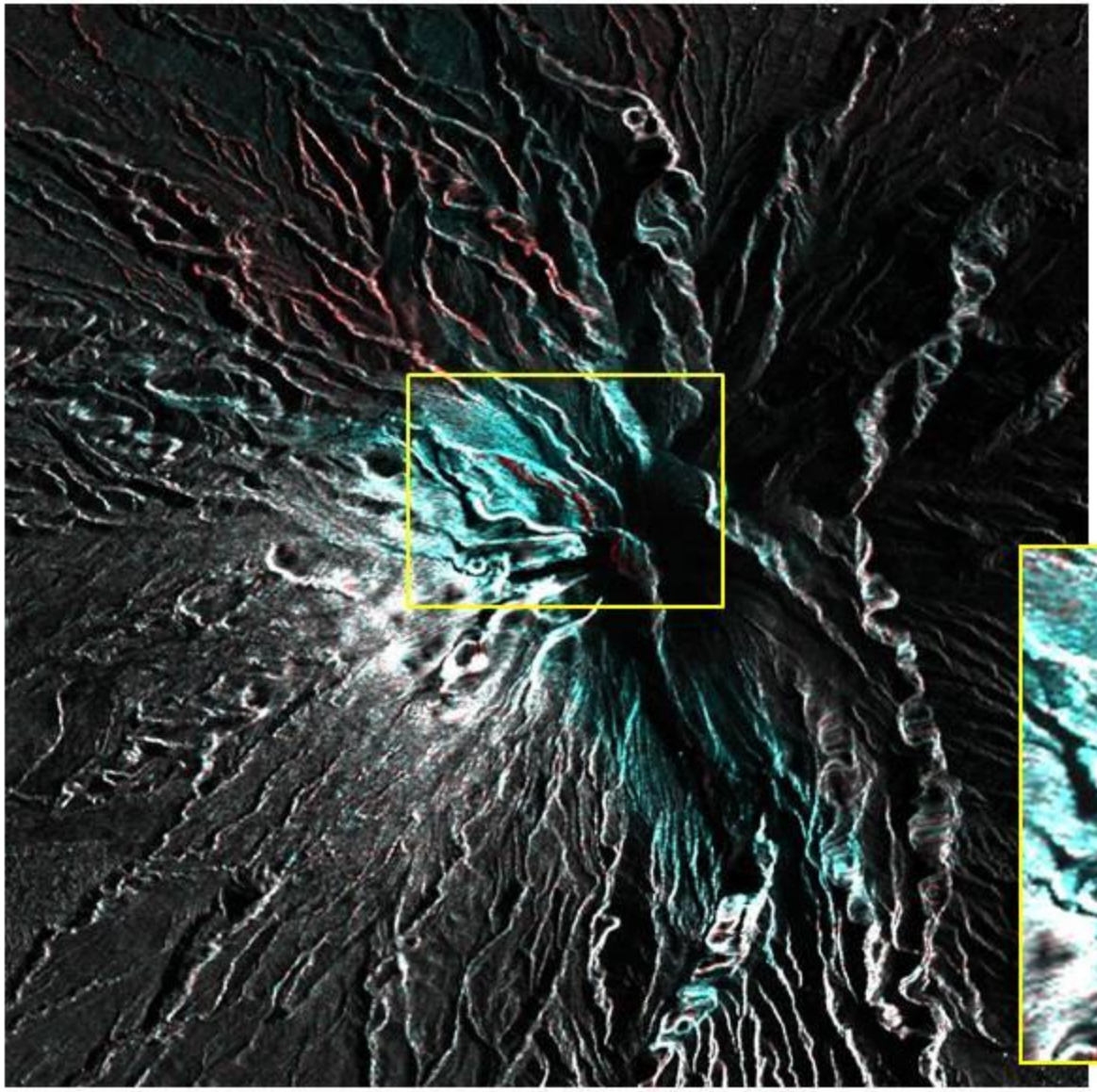
Merapi eruption (Indonesia)

- SAFER was activated by the WFP User (ID of the activation is GERS063 on October 28 2010)
- The data analysis and the accurate update of the local situation was carried out in coordination with FP7 MIA-VITA project
  - INGV, NILU, GAMMA start to produce thematic products and forecast models
  - First reports where issued towards the Center of Volcanology and Geological Hazard Mitigation (CVGHM) from the October 29th
  - First SAFER news letter was sent on November 1st

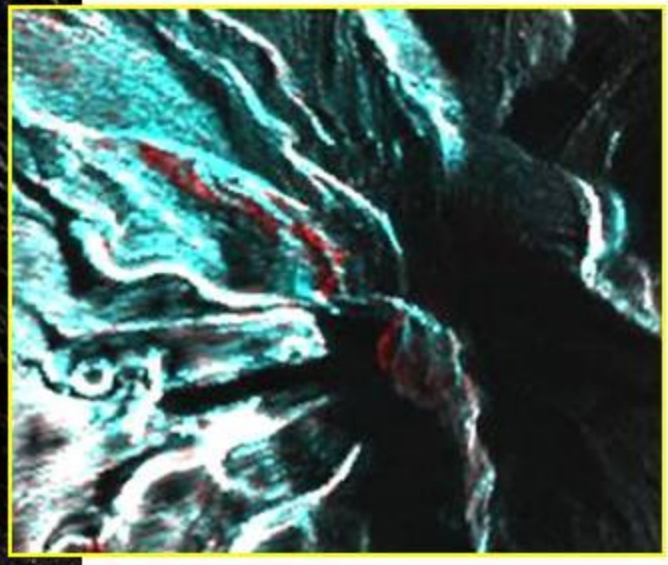
  - ***Deformation Map***
  - ***SO2 content***
  - ***Ash content***
  - ***Ash dispersion model***

COSMO-SkyMed ascending data: 5/11/2010 VS 6/11/2010

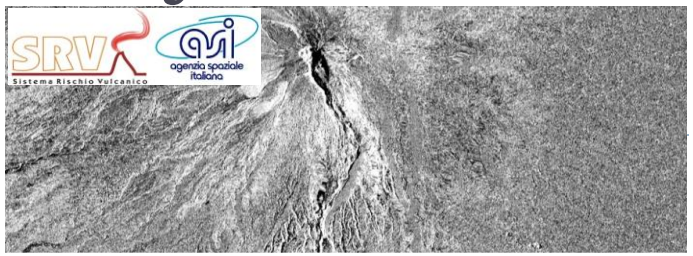


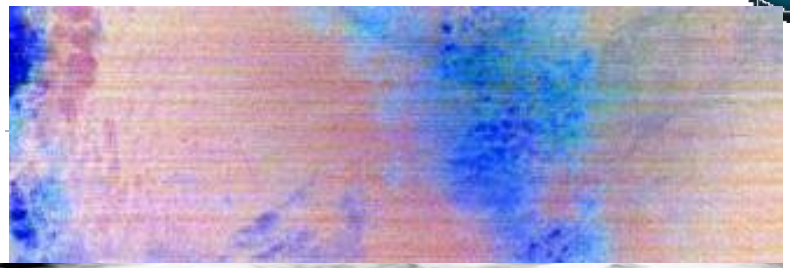
This RGB color composition reveals presence of new features in the area close to the crater (red pixels in the yellow box)

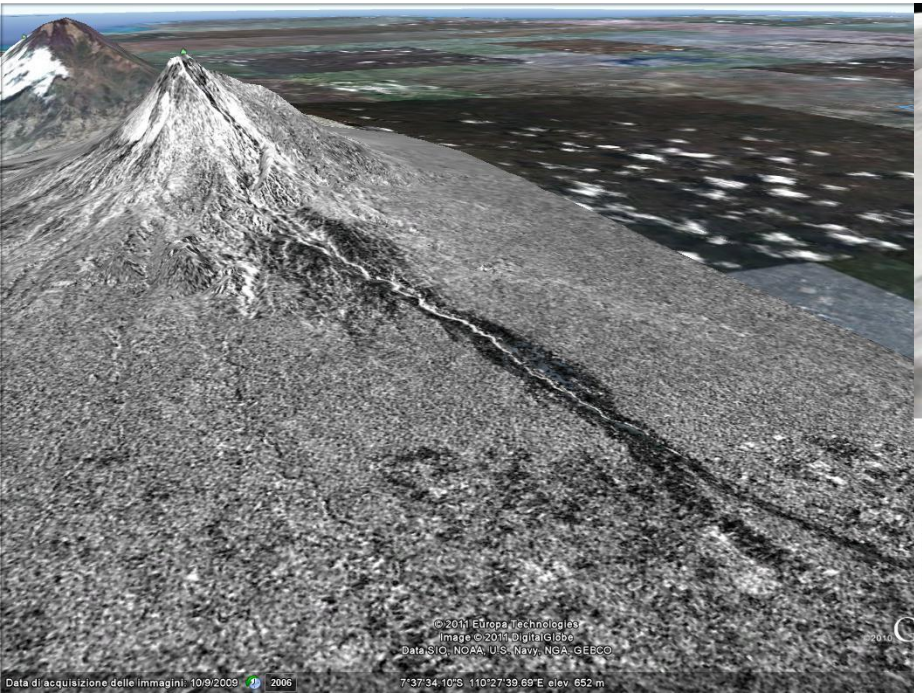
The cyan areas are representative of decrease of scattering in the 6/11 image, probably related to ash or pyroclastic deposits

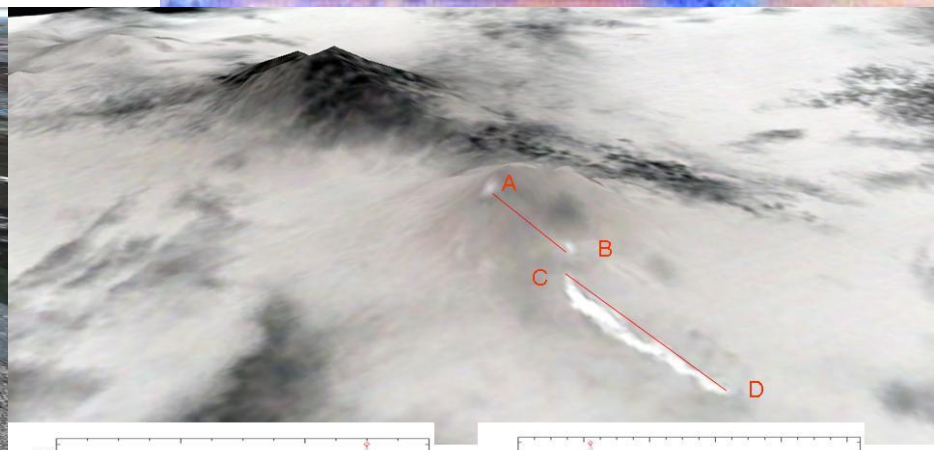


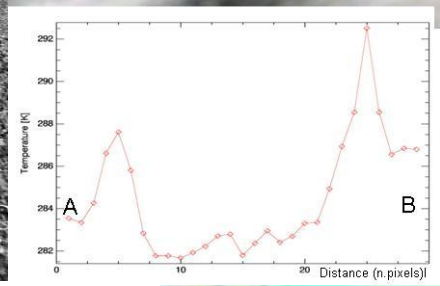
Pyroclastic flow on the southern flank

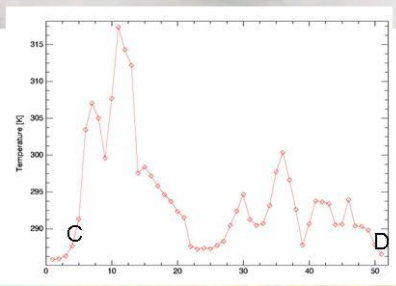












The change detection analysis on COSMO-SkyMed data acquired the 1/5/2010 e l'8/11/2010 shows the presence of the pyroclastic flow on the southern flank of Merapi, the white color detects the presence of material which has filled up the old channel, the black color detects the pyroclastic material that has covered the area around the channel.

NASA-JPL has furnished ASTER data starting from 26 of October 2010

The cloud coverage was very high, the ASTER data acquired on 11-01-2010 shows clearly the presence of hot material which has reported a pyroclastic flow

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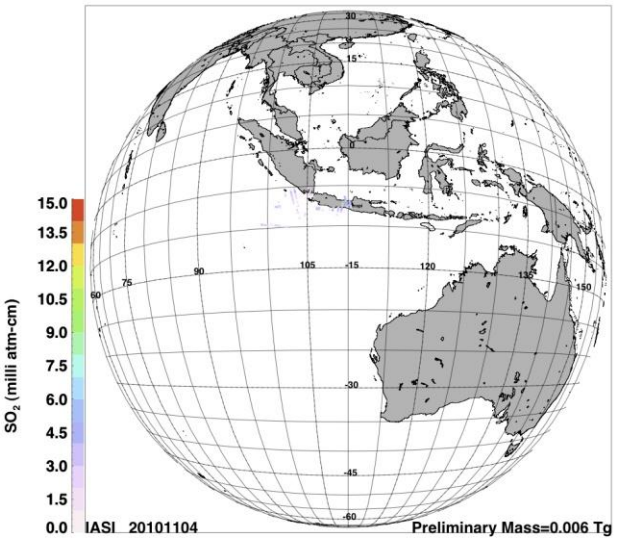
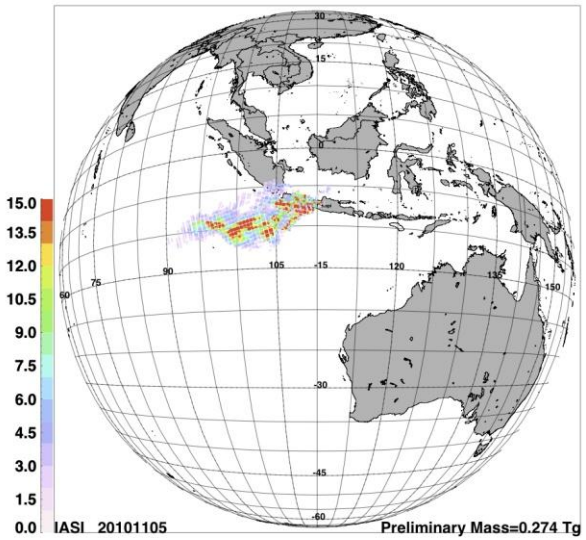
SO_2 detection and analysis (IASI)



See Clarisse et al. (2008), Atmos. Chem. Phys., 8, 7723-7734. [T_c=200 K]

Contact: Fred Prata, NILU. fred.prata@nilu.no



See Clarisse et al. (2008), Atmos. Chem. Phys., 8, 7723-7734. [T_c=200 K]

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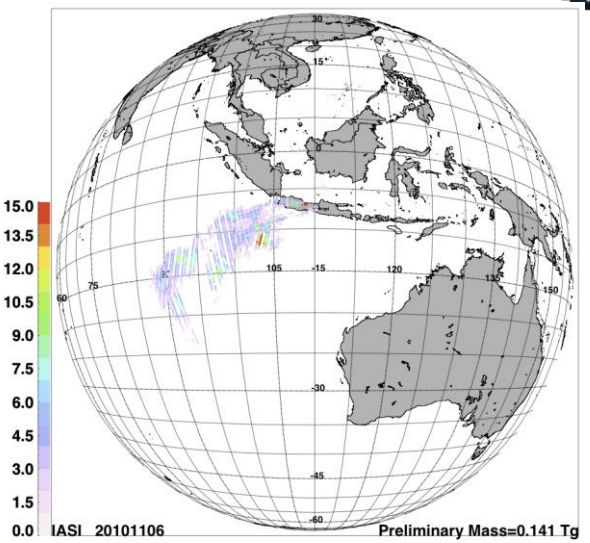

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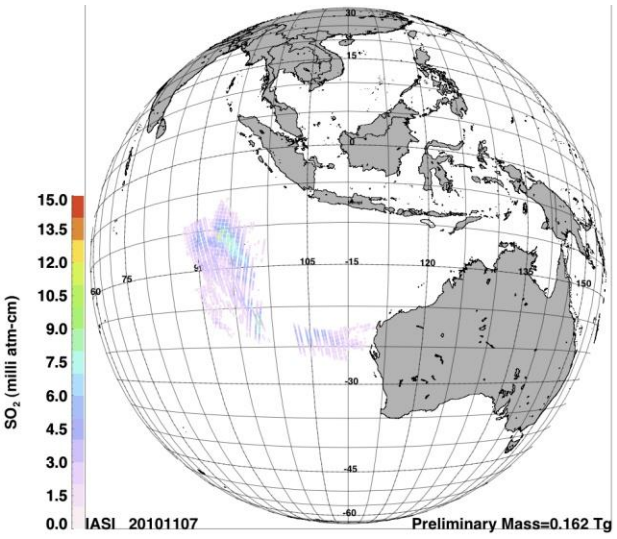

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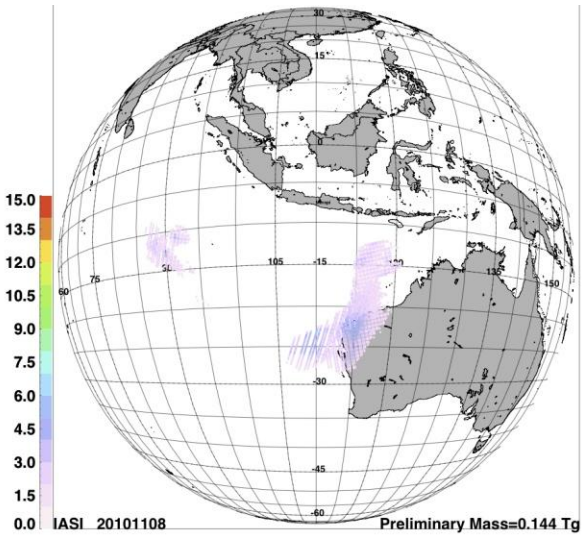

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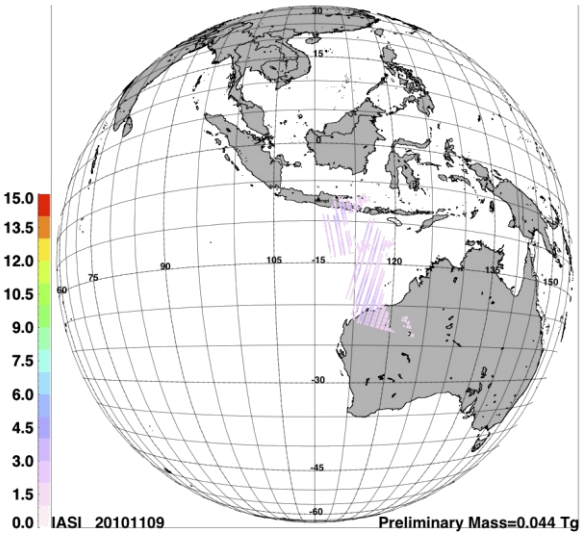

See Clarisse et al. (2008), Atmos. Chem. Phys., 8, 7723-7734. [T_c=200 K]

Contact: Fred Prata, NILU. fred.prata@nilu.no

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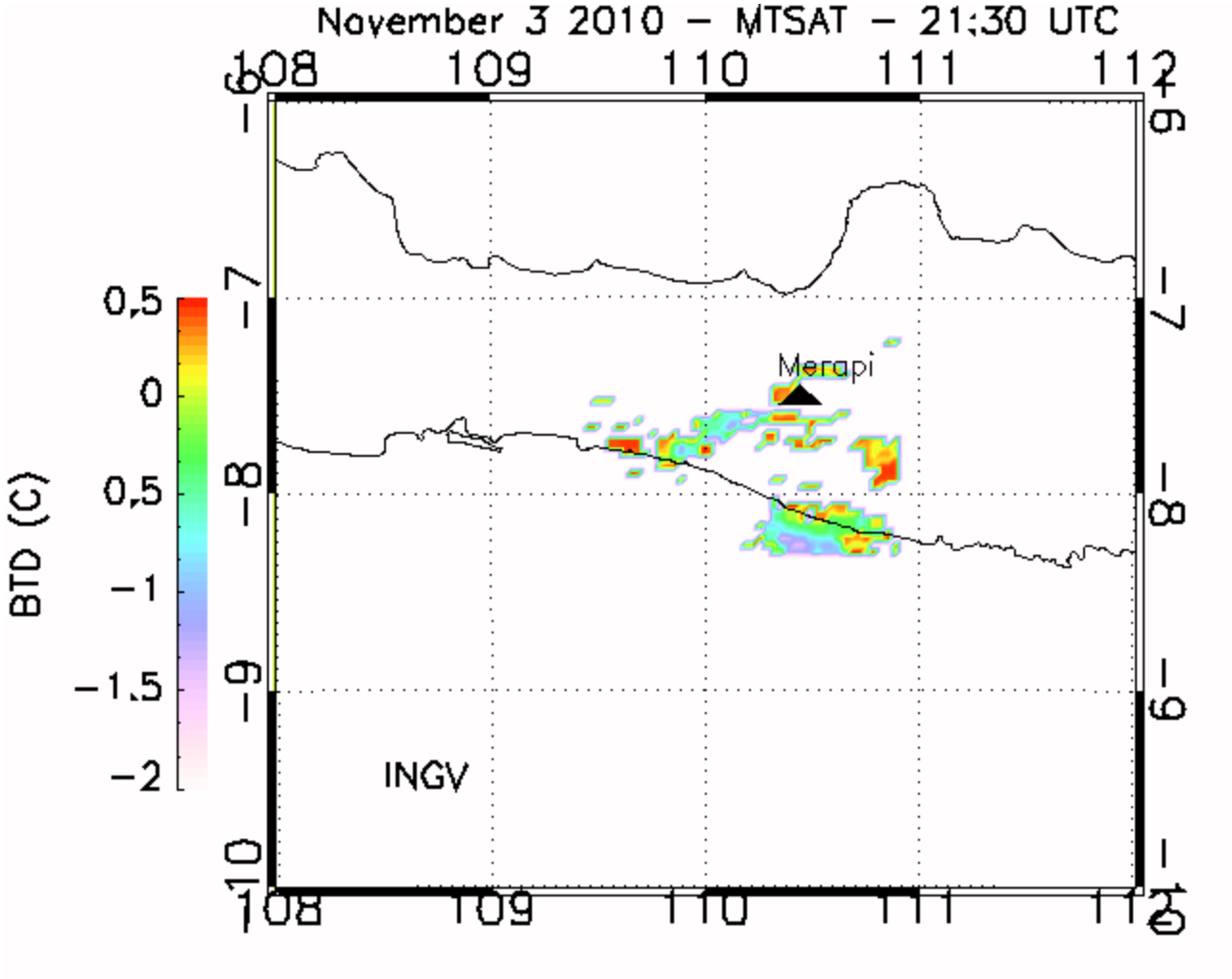
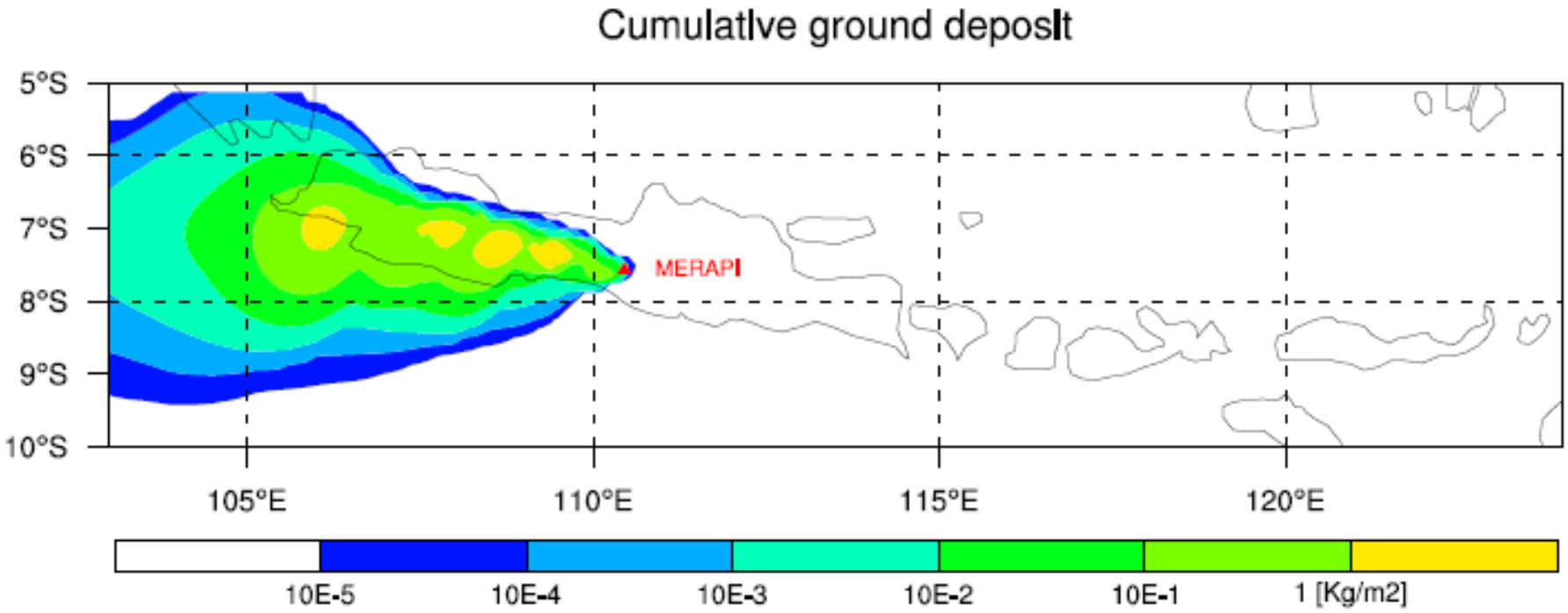
ASH detection from MTSAT



Ash cumulative ground deposit modelled



El Hierro eruption (Spain)

- During the still on going el Hierro volcanic crisis INGV has been activated in order to deliver services available for supporting the re-action of the Spanish authorities. INGV was able to publish in less then 12 hour the following web based service for the RT analysis of surface thermal state of El Hierro island.

http://labtel2.rm.ingv.it/rapidresp/hierro/index.html

- ***Surface thermal analysis***
- ***SO2 and ASH preliminary detection (for sub aerial eruption)***

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MSG-SEVIRI: MS2RWS: El Hierro - Mozilla Firefox

File Modifica Visualizza Cronologia Segnalibri Strumenti Ajuto

http://labtel2.rm.ingv.it/rapidresp/hierro/index.html

MSG-SEVIRI: MS2RWS: El Hierro

INGV CNT Istituto Nazionale di Geofisica e Vulcanologia — Remote Sensing Group

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Rapid Response Web Service (MS2RWS)

El Hierro: Lon: 18° 03' W; Lat: 27° 74' N; , Height: 1500 m A.S.L..

INLAND RT monitoring activity of Hierro Volcano

GMT

The following graphics show the radiance values and brightness temperature values derived from MSG-SEVIRI data. Each curve represents the values derived from the pixel overlapping El Hierro island according the two following red boxes:

Red box

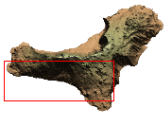
Upper Left corner: lat. 27.823275°, lon. -18.160537

Lower Right corner: lat. 27.73307°, lon. -17.96699

Red box

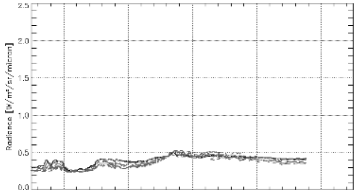
Upper Left corner: lat. 27.73307°, lon. -18.160537

Lower Right corner: lat. 27.650834°, lon. -17.96699



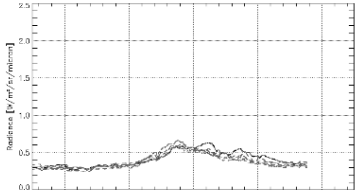
Radiance daily variation analysis by means of 4th channel

(3.9 micron, MSG-SEVIRI, time in the figures is UTC)



Radiance daily variation analysis by means of 4th channel

(3.9 micron, MSG-SEVIRI, time in the figures is UTC)



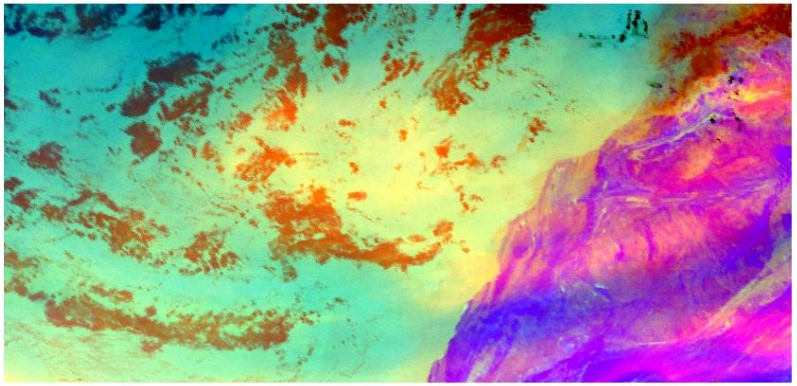
MSG-SEVIRI: MS2RWS: El Hierro - Mozilla Firefox

File Modifica Visualizza Cronologia Segnalibri Strumenti Ajuto

http://labtel2.rm.ingv.it/rapidresp/hierro/index.html

MSG-SEVIRI: MS2RWS: El Hierro

NRT channel combination enabling the ASH and SO2 detection.



UL coordinates: Lat 32.730569° N, Long. 30.54320° W

LR coordinates: Lat 22.293986° N, Long. 5.361757° W

Preliminary SO2 detection analysis:
pseudo color image generated by means of decorrelation stretch procedure using the MSG-SEVIRI channel 6, 7 and 9 centered respectively at 7.3, 8.7 and 10.8 mi

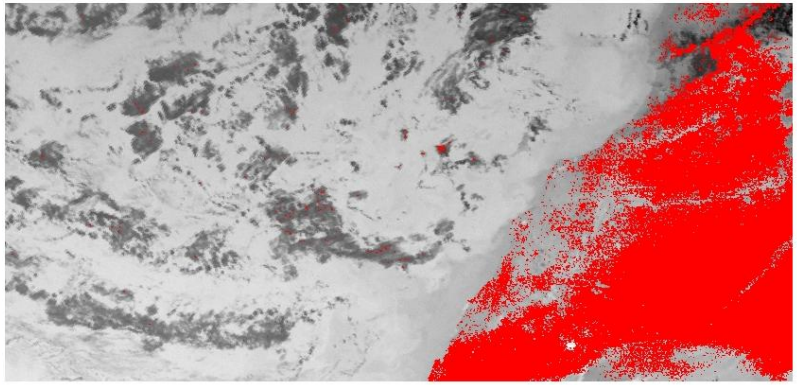
Due to the strong SO2 absorption in channels 6 and 7, the technique can be used to identify the volcanic SO2 clouds.

MSG-SEVIRI: MS2RWS: El Hierro - Mozilla Firefox

File Modifica Visualizza Cronologia Segnalibri Strumenti Ajuto

http://labtel2.rm.ingv.it/rapidresp/hierro/index.html

MSG-SEVIRI: MS2RWS: El Hierro



UL coordinates: Lat 32.730569° N, Long. 30.54320° W

LR coordinates: Lat 22.293986° N, Long. 5.361757° W

Preliminary ASH detection analysis:
brightness temperature difference (BTD) image obtained by using the MSG-SEVIRI channels 9 and 10 centered around 10.8 and 12 micr

Negative BTD values (red pixels) may be indicative of a volcanic ash clouds presence.

MSG-SEVIRI: MS2RWS: El Hierro - Mozilla Firefox

File Modifica Visualizza Cronologia Segnalibri Strumenti Ajuto

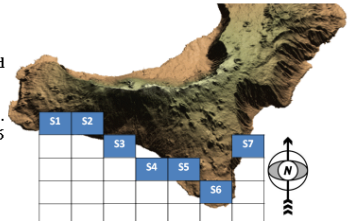
http://labtel2.rm.ingv.it/rapidresp/hierro/index.html

MSG-SEVIRI: MS2RWS: El Hierro

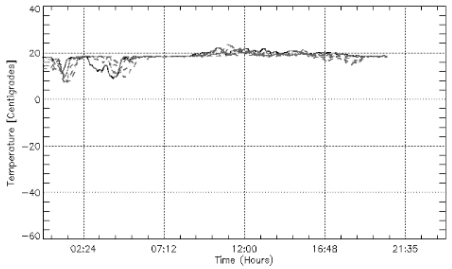
OFF SHORE South El Hierro surface thermal analysis.

The following graphics show the brightness temperature values derived from MSG-SEVIRI data measured on South El Hierro off shore.

Each graphic includes the values derived from seven different N-S trasects. Transects S1and S2 are composed by 7 pixels, transects S3 and S7 by 6 pixels, trasects S4, S5 and S7 by 5 pixels and transect S6 by 4 pixels.



Transect	Lat. N Start	Long. W Start	Lat. N End	Long. W End
S1	27.686413	-18.123192	27.482819	-18.117573
S2	27.686413	-18.102939	27.482819	-18.097357
S3	27.669516	-18.072055	27.482819	-18.062073
S4	27.624463	-18.041147	27.482819	-18.036706
S5	27.625553	-18.010006	27.482819	-18.006378
S6	27.626211	-17.989844	27.482819	-17.986165
S7	27.635879	-17.959701	27.482819	-17.965941



Transect S1

ASI-SRV

FUNDING
AGENZIA SPAZIALE ITALIANA
Project Managers;Simona Zoffoli, Lugi Dini

CONSORTIUM:
INGV, ACS, G-PLUS,CNR-IREA,UNIV-MODENA-REGGIO EMILIA

REFERENCE USERS
Italian Department of Civil Protection

Chiara Cardaci, Pierluigi Soddu, Chiara Christiani, Antonio Ricciardi, Domenico Mangione

ASI-SRV TEAM CREDITS

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ASI-SRV Project Main Objectives:

1. Development of demonstrative system with pre-operational capability to integrate EO data and ground measured data to support the decision system of Italian Civil Protection Department (DPC) for Volcanic Risk management

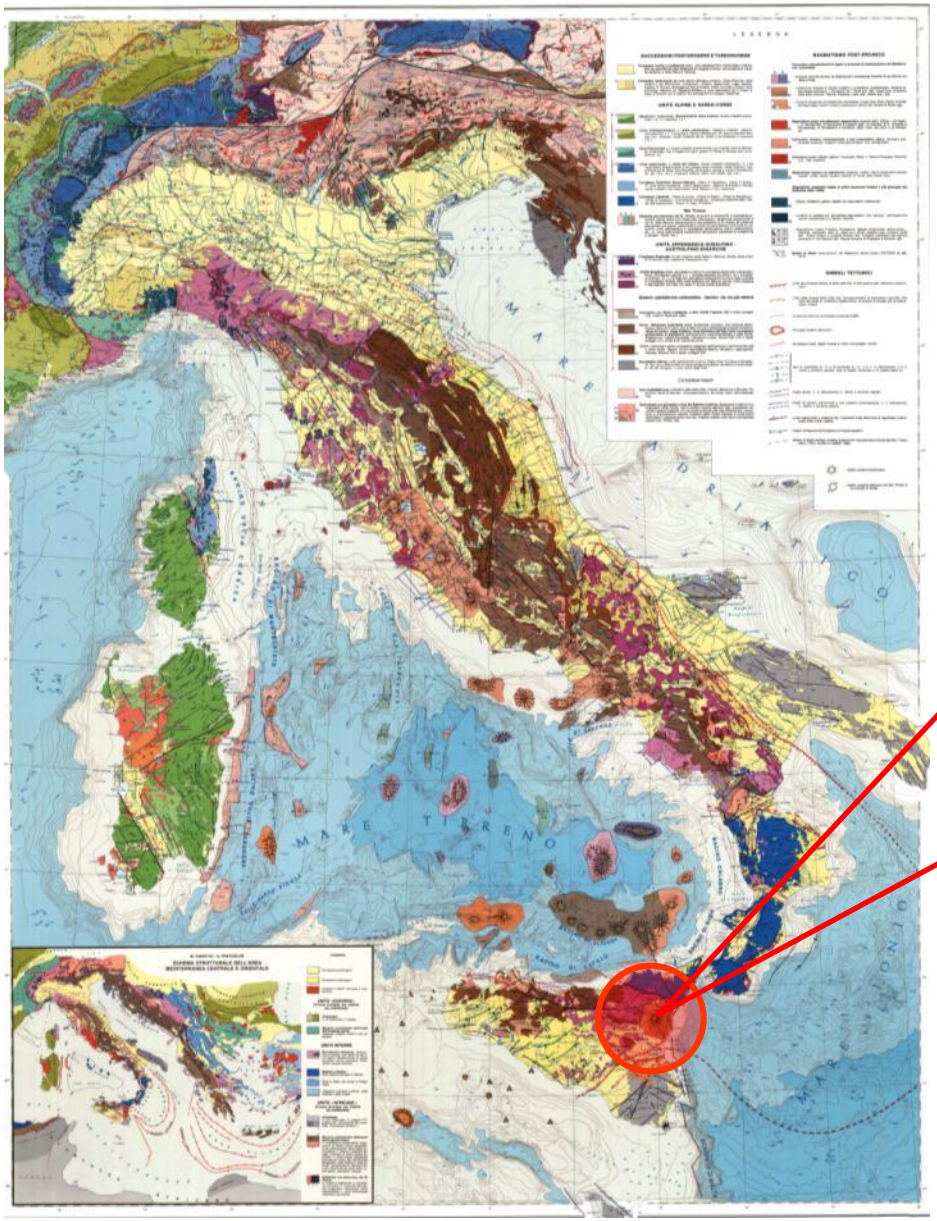
2. Support the scientific research to develop specific product procedures based on Remote Sensing data processing and analysis based on User Requirements

3. Develop specific User Interfaces that could be integrated with the already existent DPC Volcano Surveillance System

ASI-SRV TEST AREA

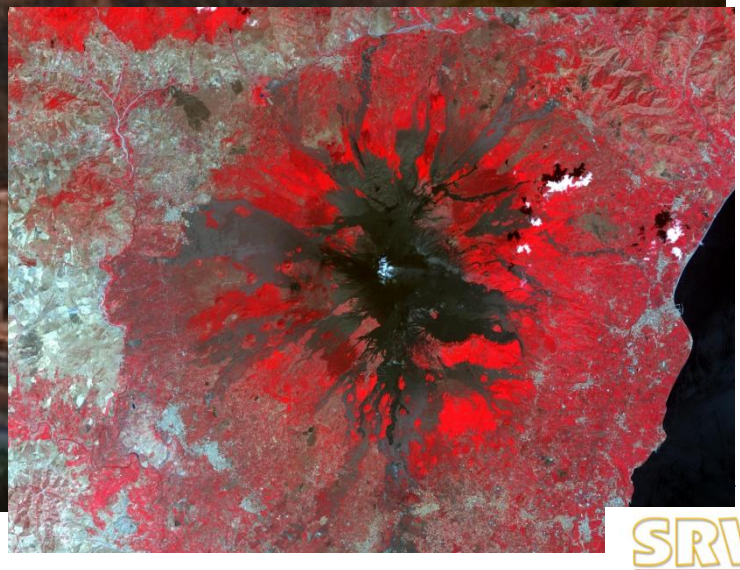
SRV
Sistema Rischio Vulcanico

ETNA



Etna is characterized by a persistent volcanic activity with frequent effusive episodes, in the last decade has shown an increase of explosive episodes. Etna is one of the most important natural laboratory to develop and test EO product

ETNA

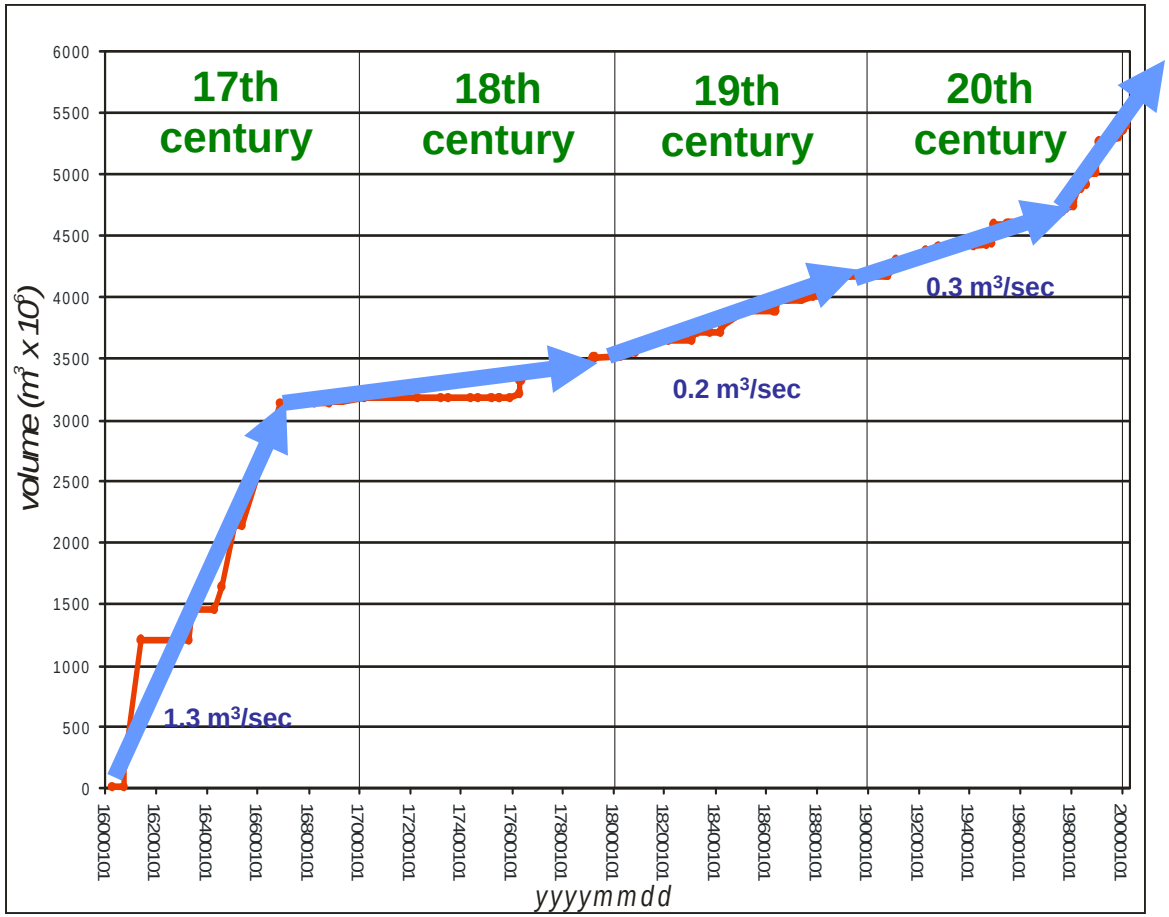


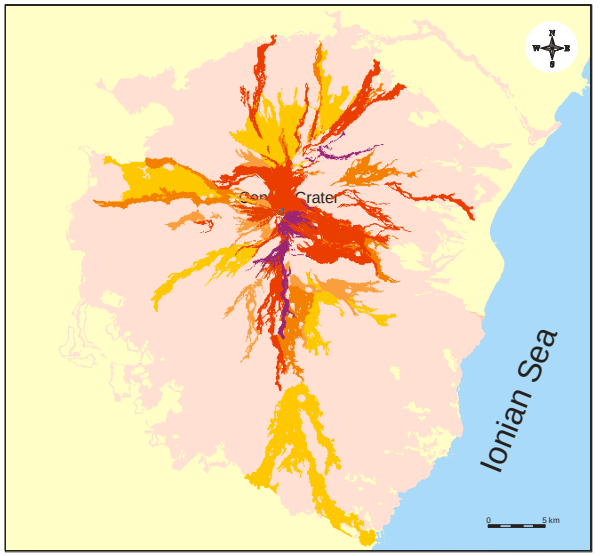
Sistema Rischio Vulcanico

Mt. Etna –Volcanic activity (INGV-CT)

volume vs time

21st Century



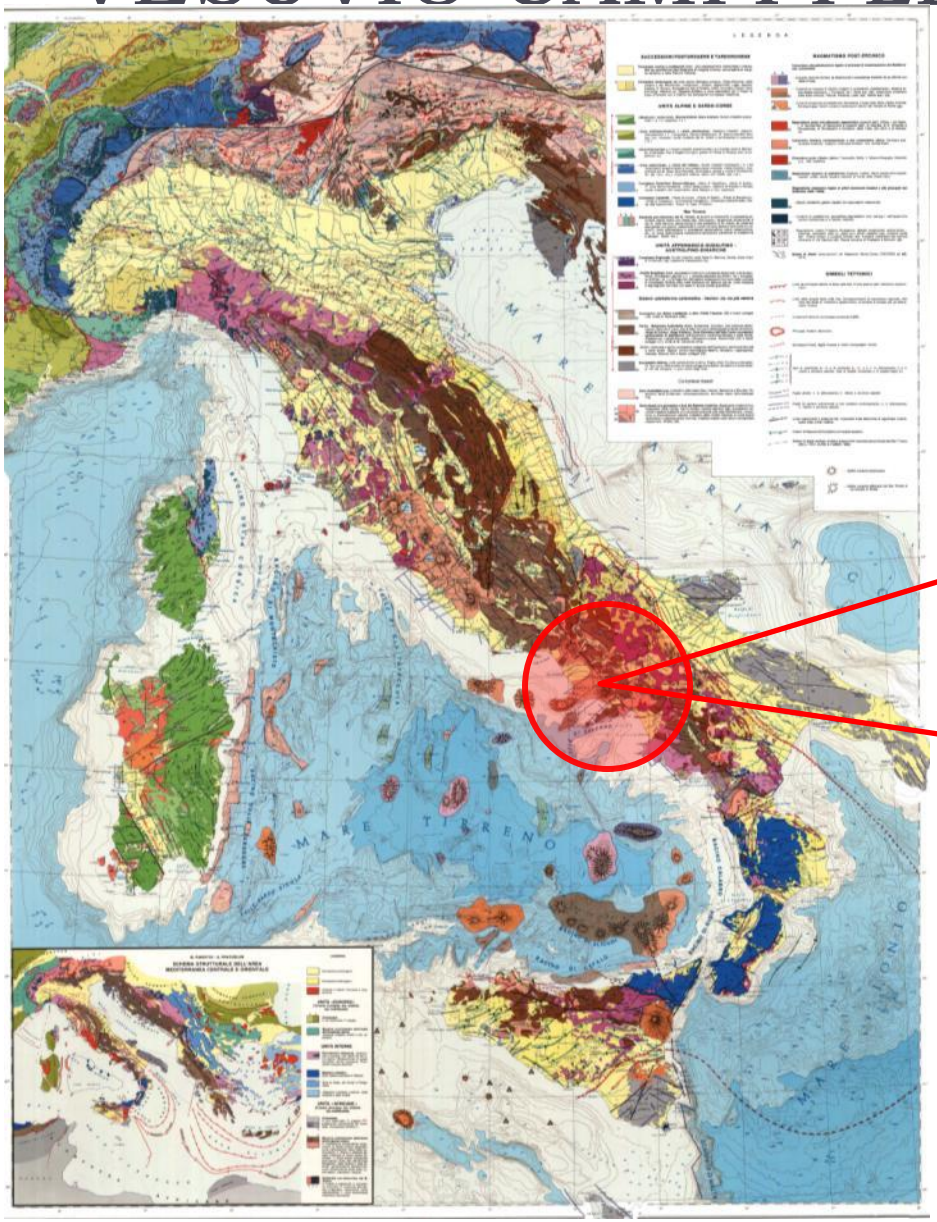


The volume of erupted products was very high during the 17th century, followed by a period of low activity lasted about 100 years.

Etna increased his effusive rate progressively between 18th and 19th centuries, culminating since 1950 in an significant increase of the volume of erupted products.

SRV Sistema Rischio Vulcanico

VESUVIO CAMPI FLEGREI

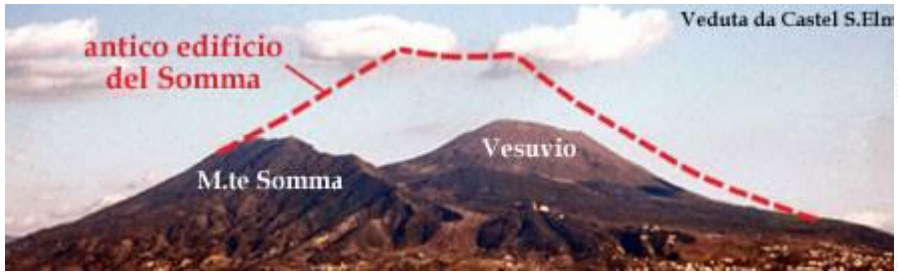


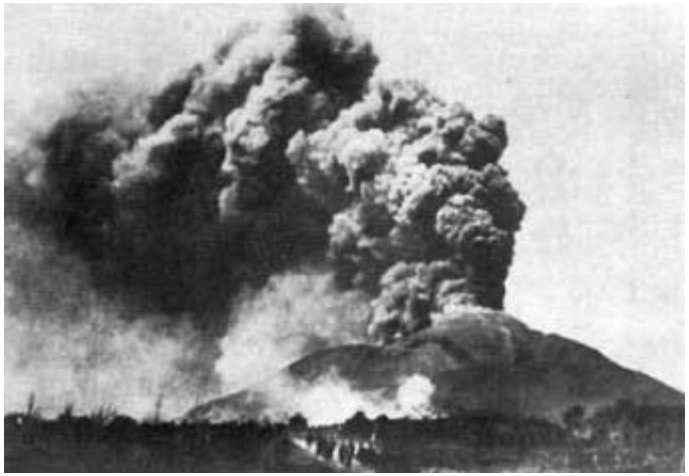
Vesuvio and Campi Flegrei area

Vesuvio is a quiescent volcano and it is constantly monitored due its very high risk.

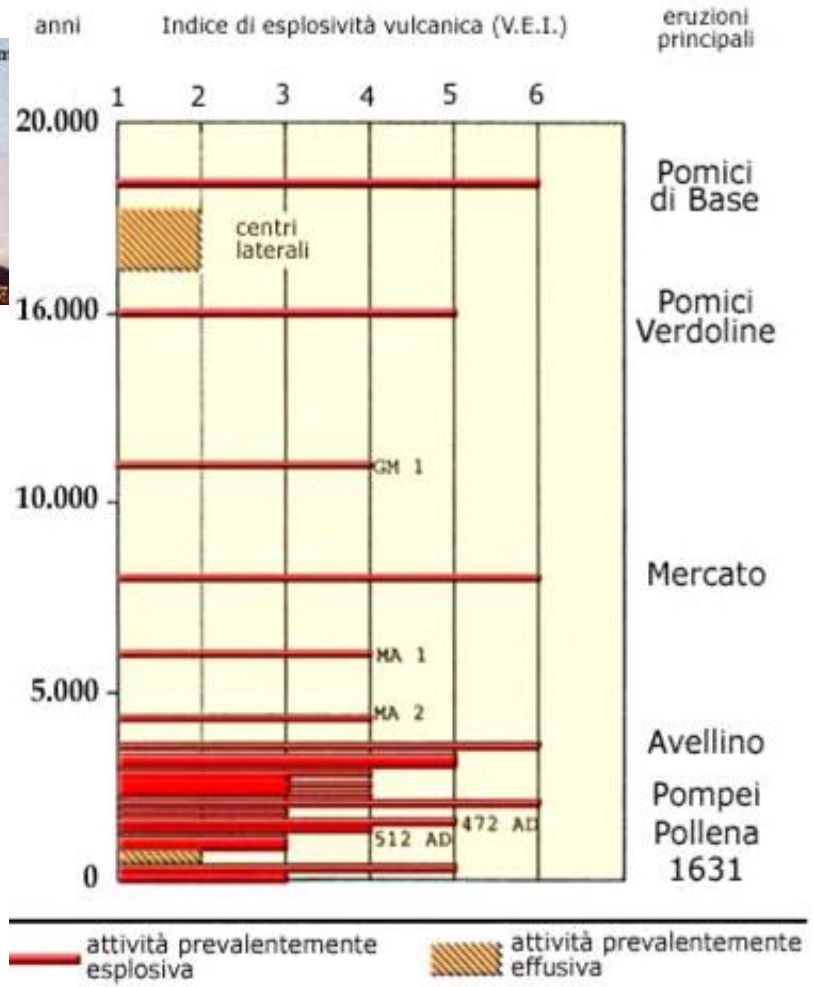
Campi Flegrei volcanic system is thermally active and presents an high surface deformation

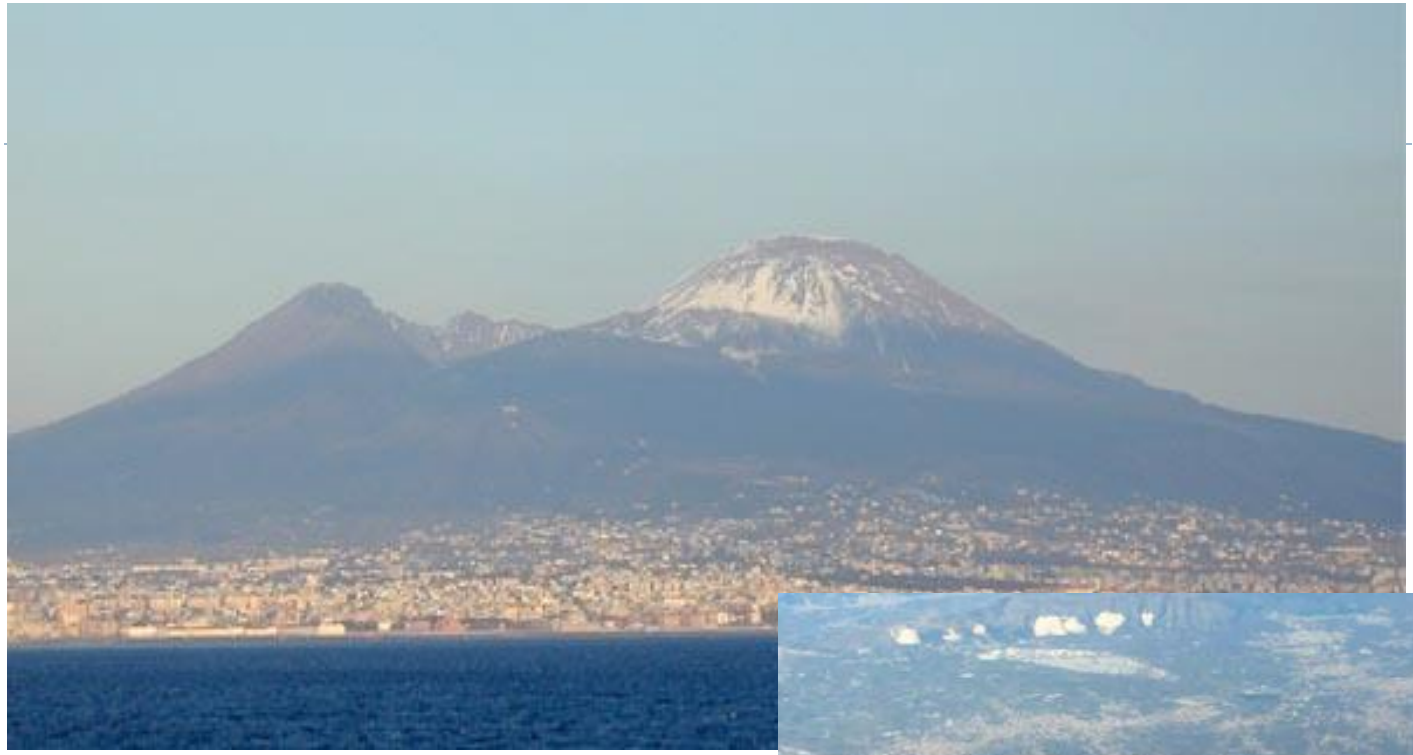
Vesuvio (INGV-OV)





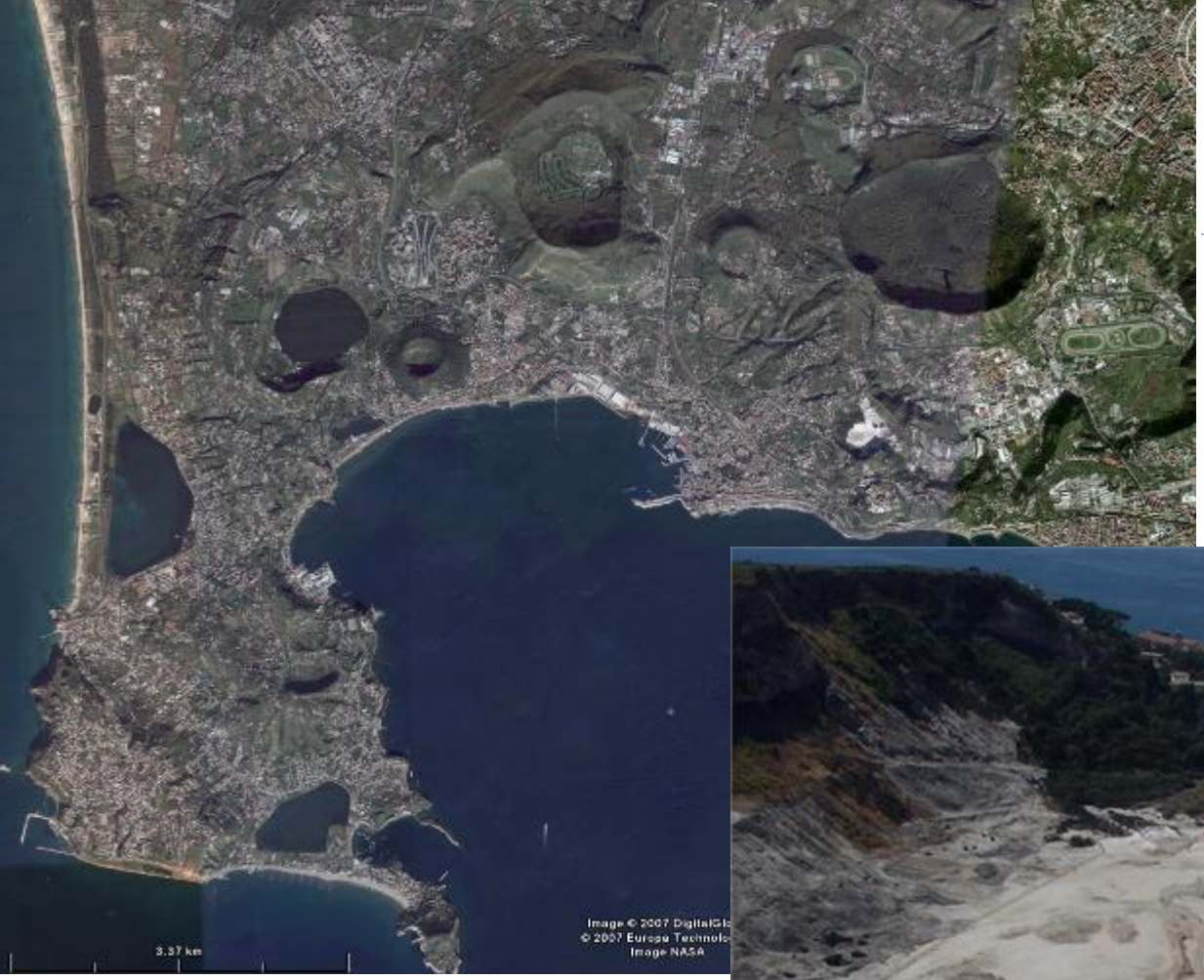
Eruption of 1906





Vesuvio

Campi Flegrei



Sistema Rischio Vulcanico

ASI-SRV DEVELOPMENT

SRV
Sistema Rischio Vulcanico

ASI-SRV LOGIC SCHEME

Sources Level

EO Raw data

Processing chains

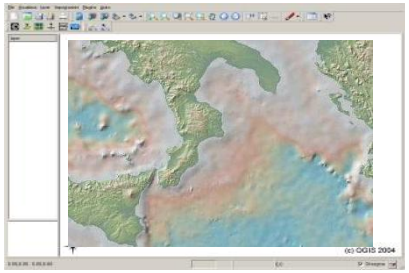
Non-EOdata

Product Archive and validation

DATA REPOSITORY

WMS Server

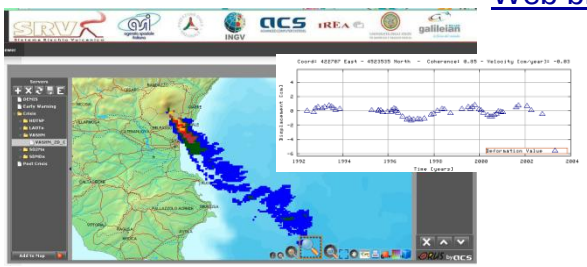
Gis desktop



Scientific Operators

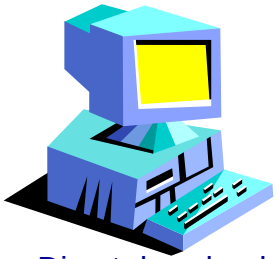
User Level

Web browser



Products publication

End user



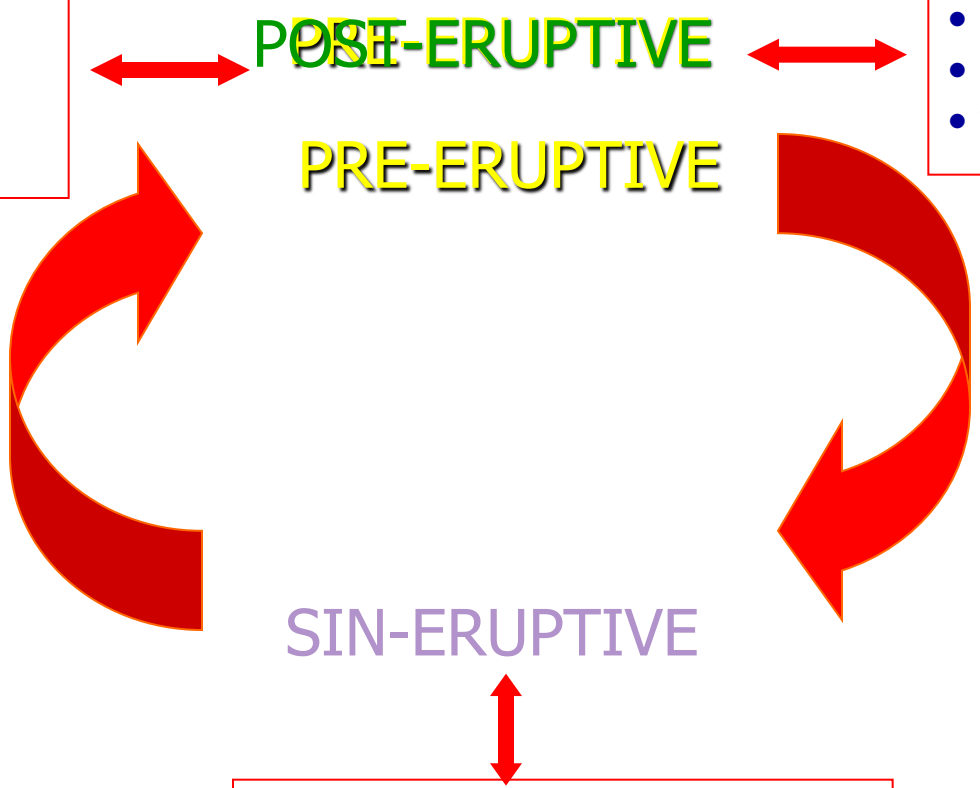
Direct download

ASI-SRV data processing algorithms have been selected during the feasibility study on the following characteristics :

- ✓ Cosolidated Scientific background and robust procedures
- ✓ Portability for different EO data
- ✓ Integration with ground measurements
- ✓ The algorithms implemented in the ASI-SRV have been developed within the scientific and industrial team in order to permit modifications and upgrades
- ✓ Choerence between the ASI-SRV products and GMES services for Volcanic and Earthquake Risks

ASI-SRV products related to Volcanic Risk Phases

- lava flows mapping
- lava flows thikness
- Ash depostis
- surface deformation



- thermal anomalies
- surface deformation
- gas emissions
- volcanic aerosols

- Lava flow T flux effusion rate
- sin-eruptive deformation
- ash clouds
- So2 eruptive plumes

SRV Sistema Rischio Vulcanico

Products for phases and test areas

PHASE	EO PRODUCTS	GEOGRAPHICAL AREA
Knowledge and Prevention	Multiparametric Analysis product	Etna and Vesuvio – Campi Flegrei
	Deformation Map from DinSAR product (time series)	Etna and Vesuvio – Campi Flegrei
	Surface temperature and Thermal flux	Etna, Campi Flegrei, Vesuvio
	Degassing Plumes analysis product	Etna
Crisis Phase	Deformation Map from InSAR product (sin eruptive)	Etna
	Deformation Map from DinSAR produsc (time series)	Etna
	Thermal Flux, Effusion Rate	Etna
	Volcanic Plumes and Clouds analysis product	Etna
Post Crisis Phase	Deformation Map from DinSAR product (time series)	Etna
	Volcanic thickness product	Etna
	Ash and lava distribution map product	Etna

Ground monitoring data and atmospheric profiles acquired in the ASI-SRV system

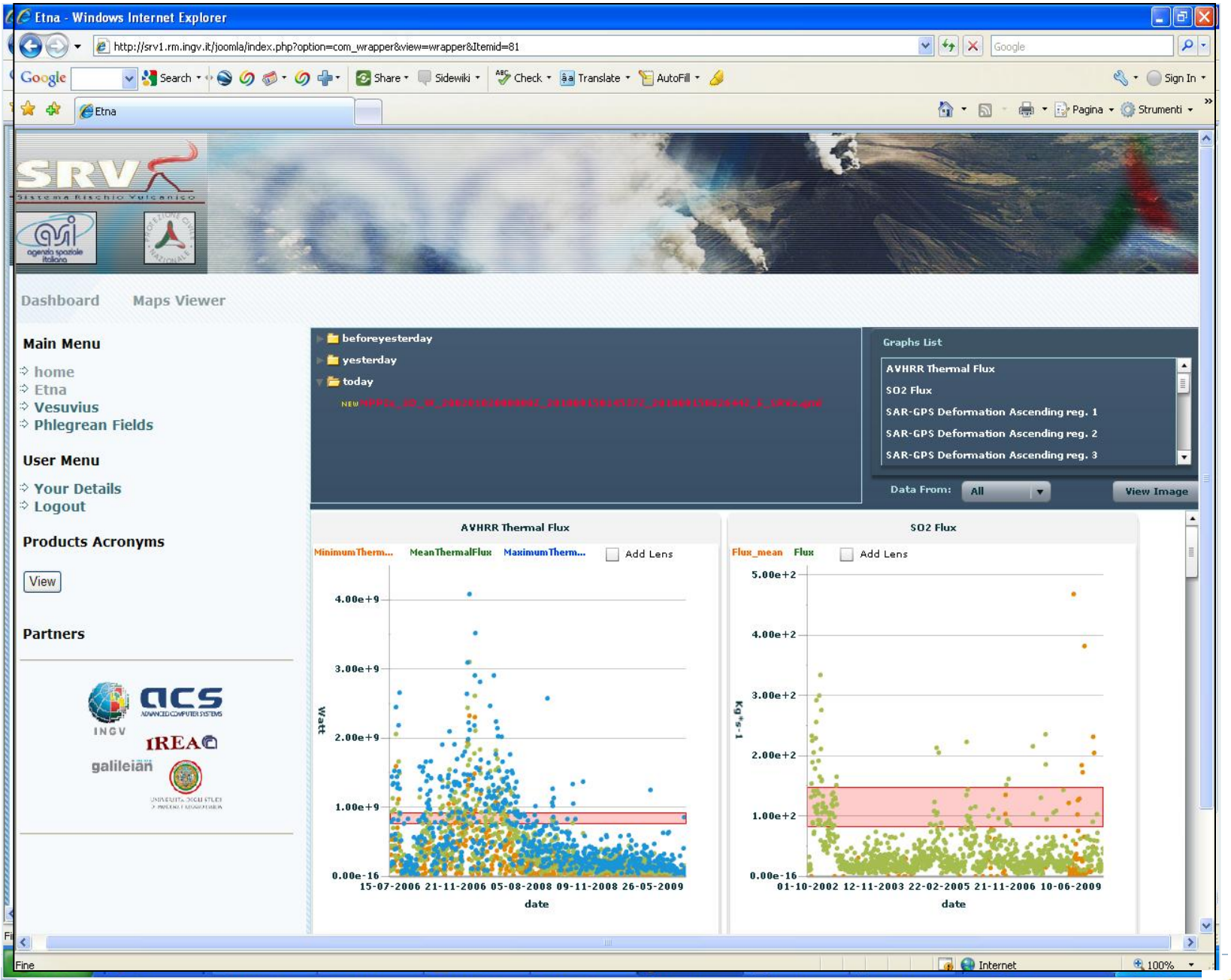
DATA TYPE	SCHEDULING	ETNA	VESUVIO	CAMPI FLEGREI
GPS	Weekly (satellite passages)	X	X	X
Leveling	On availability base		X	X
SO2 (doas/cospec)	Continuosly	X		
Video Cameras	Every 15 minutes	X		
Geological observations	Periodically	X	X	X
Temperature	Based on Satellite passages			X
Geochemical (CO2)	Daily			X
Atmospheric profiles	Daily (3 times)	X	X	X

ASI-SRV Gateway

The dissemination module (DIS) has been develop for the User access to ASI-SRV with two objectives:

1. User evaluation of the implemented products during the volcanic activity phases (Etna)
2. Test on the data formats and assimilation procedures in the USER environment

User access to the DIS is made by a web link where the products could be visualized and downloaded in ESRI "shape file formats

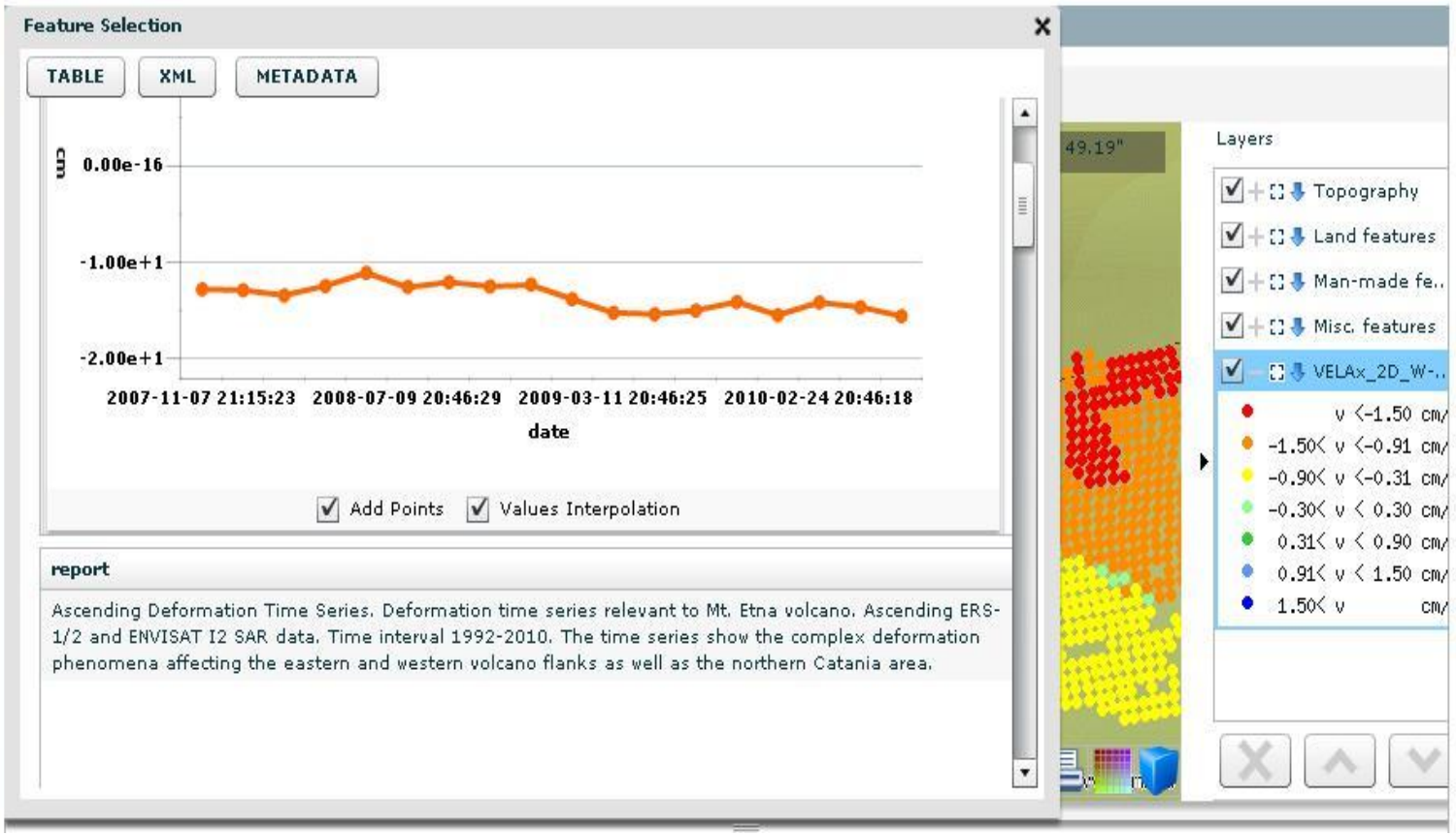

Etna - Windows Internet Explorer
http://srv1.rm.ingv.it/joomla/index.php?option=com_wrapper&view=wrapper&Itemid=81
Etna
SRV
Sistema Rischio Vulcanico
Dashboard
Maps Viewer
Main Menu
home
Etna
Vesuvius
Phlegrean Fields
User Menu
Your Details
Logout
Products Acronyms
View
Partners
INGV
ACS
IREA
galileian
beforeyesterday
yesterday
today
Graphs List
AVHRR Thermal Flux
SO2 Flux
SAR-GPS Deformation Ascending reg. 1
SAR-GPS Deformation Ascending reg. 2
SAR-GPS Deformation Ascending reg. 3
Data From:
All
View Image
AVHRR Thermal Flux
MinimumTherm...
MeanThermalFlux
MaximumTherm...
Add Lens
4.00e+9
3.00e+9
2.00e+9
1.00e+9
0.00e-16
Watt
15-07-2006 21-11-2006 05-08-2008 09-11-2008 26-05-2009
date
SO2 Flux
Flux_mean
Flux
Add Lens
5.00e+2
4.00e+2
3.00e+2
2.00e+2
1.00e+2
0.00e-16
Kg*s-1
01-10-2002 12-11-2003 22-02-2005 21-11-2006 10-06-2009
date
Fine
Internet
100%

DIS tool: Map Viewer

Map Viewer: Display Area

Example of ASI-SRV product: SAR velocity map on ETNA

Map Viewer: Toolbar Get Feature Info



CONCLUSIONs

- Since SAFER was started the INGV and partners had produced (when activated by Users or by SAFER) information following the products proposed in the Volcanic and Earthquake service to demonstrate their use.
- The SAFER thematic products by means newsletters web or ftp have been delivered both to USER and local Authorities receiving positive feedbacks
- The collaboration with other projects such as FP7 project MIA-VITA (under Environment) and ASI-SRV (for volcanic service) has demonstrated the importance of integration of procedures and results
- These events allowed to test the use of the products almost in real time.
- They were a very nice examples of coordination between GMES service SAFER, which has demonstrated the very effective tools to provide satellite products, specific research activities carried out in other FP7 projects and effective local requests and needs.
- The ASI-SRV has been fully tested and could be implemented for operational use

Thank You