SAR PRODUCTS (part of WP9)

M. POLCARI [ONT], M. ALBANO [ONT], A. ANTONIOLI [ONT], S. ATZORI [ONT], L. BECCARO [ONT], C. BIGNAMI [ONT], A. BONFORTE [OE], S. BORGSTROM [OV], F. DOUMAZ [ONT], N. FAMIGLIETTI [ONT], F. GUGLIELMINO [OE], M. MORO [ONT], G. PEZZO [ONT], G. PUGLISI [OE], S. SALVI [ONT], M. SAROLI [ONT], V. SINISCALCHI [OV], S. STRAMONDO [ONT], N. SVIKGAS [ONT], C. TOLOMEI [ONT], E. TRASATTI [ONT]

General Description (Objectives)

The main aim of *SAR Products* module is the generation of two class of scientific products of soil deformation measurements derived from processing of single pair or large datasets of SAR images acquired by several space mission such as Cosmo-SkyMed, TerraSAR-X, Sentinel-1, ALOS-2 etc.

Soil deformation measurements are provided by INGV GEOSAR Laboratory by exploiting single pass or multi-temporal SAR Interferometry (InSAR) techniques such as PS (Ferretti et al., 2001), SBAS (Berardino et al., 2002) and IPTA (Werner et al., 2003).

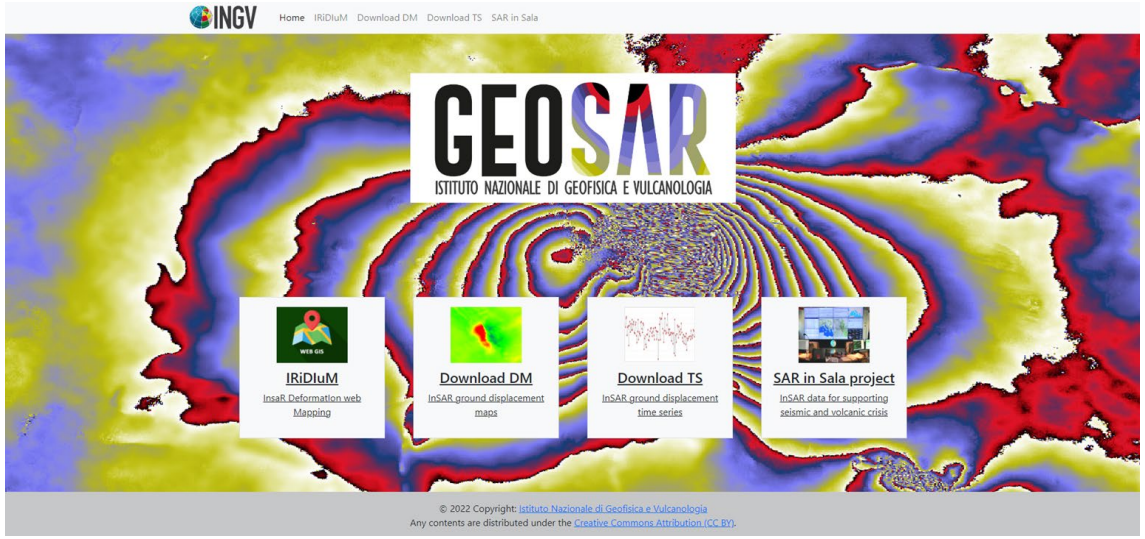
Such product can be applied in the study of ground deformation phenomena due to earthquakes, volcanoes, landslides, natural and anthropogenic subsidence etc

Currently, SAR products are generated on demand and are available for internal (INGV) and external (DPC) users via the IRIDIUM webgis (http://www.geosar-iridium.cs.ingv.it/).

Progress Description

In the last year the **webgis Iridium** has been populated with new SAR products including the ones related to the most important natural events (e.g. 2023 Turkey-Syria earthquakes).

All the products are available to be displayed and downloaded for any users



Future steps will focus on the generation of products based on the amplitude and the coherence of SAR signal to be applied for rapid mapping purposes and climate changes studies

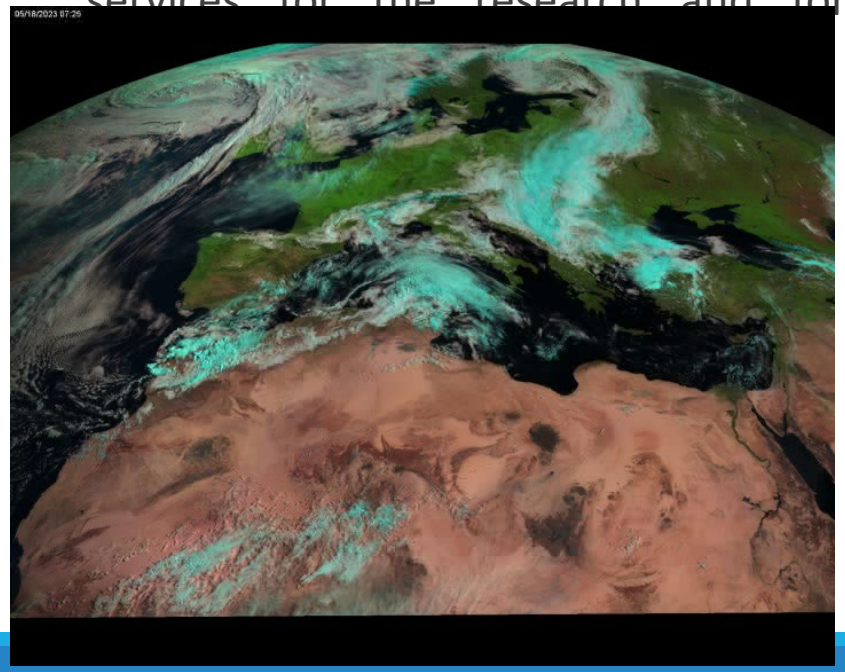
Antenna Multi Missione (AMM) (part of WP9)

A. Costanzo[ONT], S. Falcone [ONT],

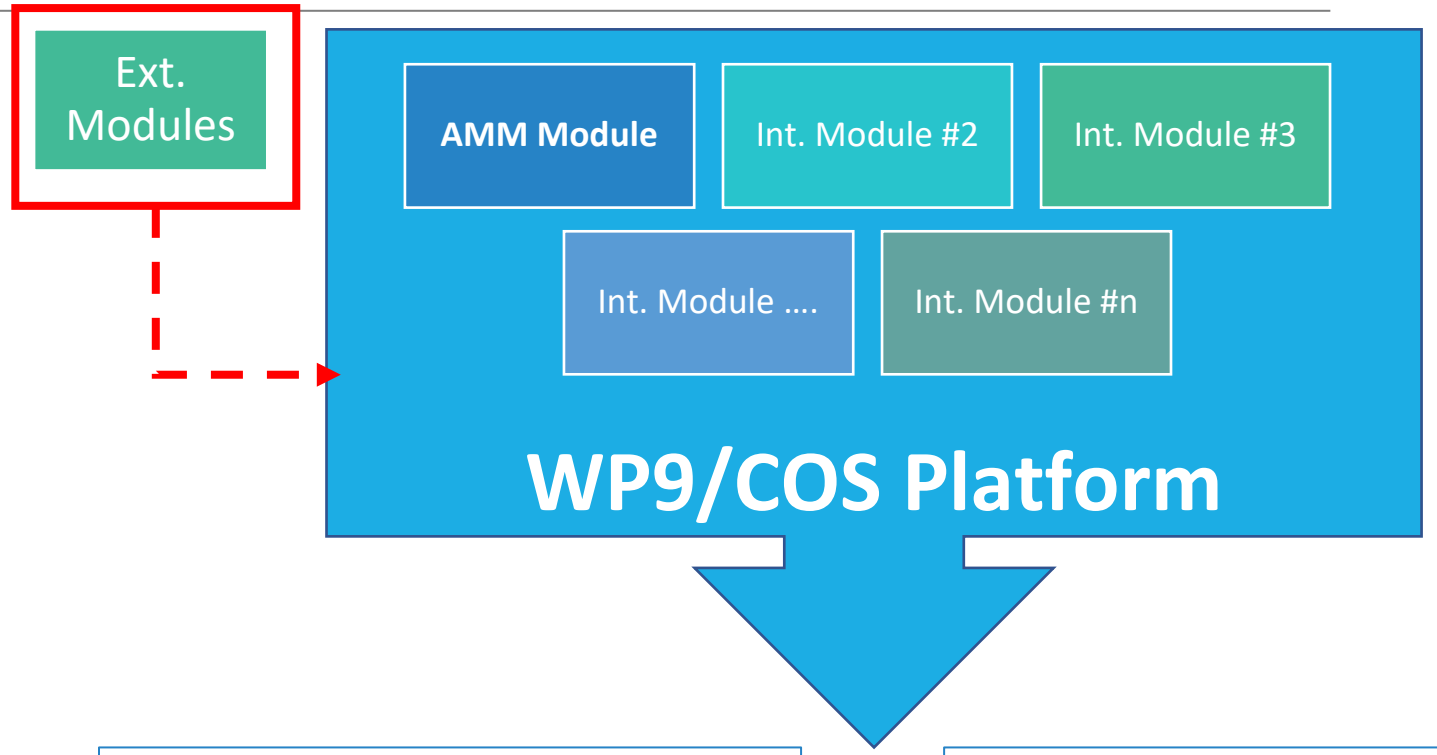
M. Musacchio [ONT] M. Silvestri [ONT], F. Rabuffi [ONT]

General Description (Objectives)

AMM will be part of the WP9 infrastructure representing the internal module dedicated to the EO data acquisition and distribution for the I/O modules which will produce services for the research and for



Example of MSG4 RSS RGB natural colors



products/services toward MEET community

products/services toward the citizen

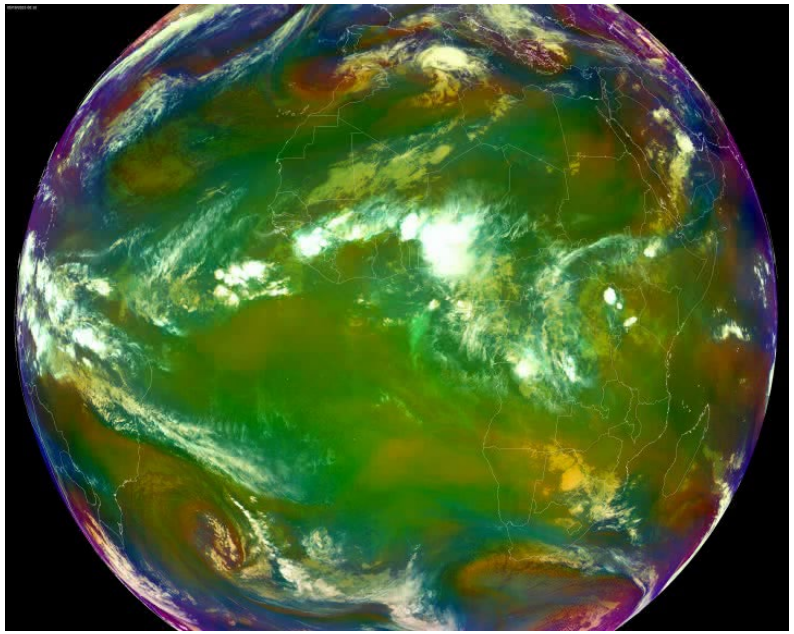
Higher education and Training

Progress Description

AMM has been acquired (2022) by using the PON-GRINT funded project, it is under the test/decomissioning phase (second quarter 2023) and it will provide data for the WP9/COS ITC platform as soon as will be ready.

AMM includes:

1. Geostationary Antenna System and Digital Receivers
   - *Antenna Ku-band dual feed con LNB and DVB S2 receivers*
   - *EUMETCast Key Units (EKUs)*
2. Hardware for system management and data processing
   - *Servers for acquisition and continuous processing*
   - *Desktops for visualization and implementation of the processing chains*
   - *NAS for temporary storage*
3. Software for satellite station management and data processing
   - *EUMETCast Client Software*
   - *Met2! (acquisition, processing and visualization of EUMETSAT data)*
   - *ESA- Toolboxes for Copernicus services*



Airmass RGB from MSG images

Available data in near RT: Sentinel 1\2, Sentinel 3, Sentinel 5, MSG/MTG, GOES-16, Himawari-8, Landsat8, METOP, MODIS, NPP, etc.

Digital Surface Models from EO data processing

(part of WP9)

C. Spinetti [ONT], M. Bisson [PI], G. Ganci [OE], R. Gianardi [PI], A. Cappello [OE], G. Bilotta [OE]
Monica Palaseanu-Lovejoy [USGS]*, M. F. Buongiorno [ONT]

*External collaboration (INGV-USGS Agreement)

General Description (Objectives)

The main aim of DSMs (Digital Surface Models) module is the generation of accurate and high spatial resolution topographies by elaborating, through relative short time workflows, stereo pairs and tristereo images acquired by Pleiades, WorldView, Skysat

The workflows are based on principles of the stereo-satellite photogrammetry performed with different processing algorithms: ASP (Beyer et al., 2018) and MicMAc (Rupnik et al., 2007).

The obtained surfaces will be able to reproduce at high spatial resolution the topographies modified by calamitous natural phenomena (volcanic events, earthquakes, landslides, etc) allowing to map the areas affected by such phenomena and quantify the morphological changes.

Currently, published DSMs products are available on line: https://doi.org/10.5066/P9IGLDYE, https://doi.org/10.3390/data4030120, https://doi.org/10.1594/PANGAEA.899176, https://doi.org/10.1594/PANGAEA.899140 https://doi.org/10.3390/rs15010198

Progress Description

In the last year the DSMs were mainly produced for the active volcanic areas, in order to update the topographies for a correct modelling of the volcanic hazard:

Volcano site	DSM year
Mt. Etna (Italy)	**July 2015*, July 2019**, July 2021***, June 2022***
Stromboli (Italy)	**July 2019****
Virunga (Congo)	**segmented areas 2019-2023****

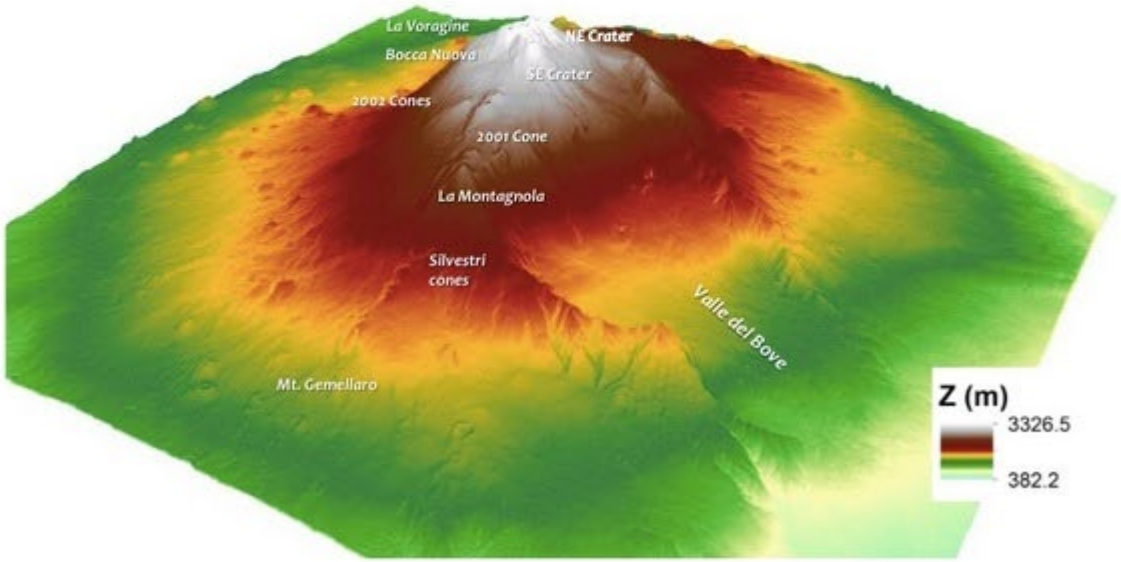
*data are provided by AIRBUS
**data are acquired under INGV-DPC Agreement
*** data are provided in the framework of Supersite Initiative
**** data are acquired under UNO Project

Future steps will focus on the generation of topographies based on new satellite data and different algorithm. In details, the Meet project will allows to prepare an infrastructure where a dedicated module will integrate in a unique way to run an alternative algorithm under the Hexagon-Erdas package to extract the DSMs.

Products

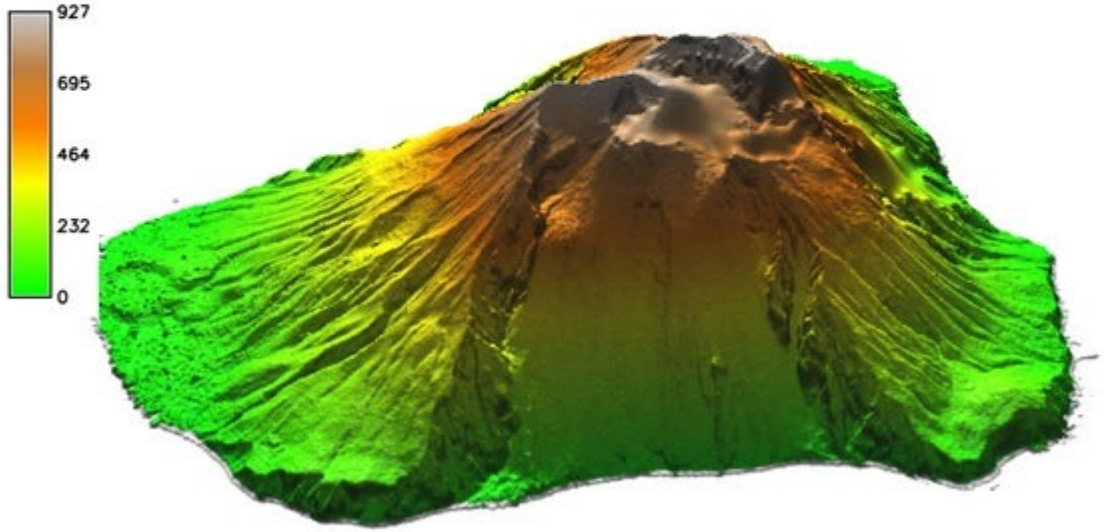
Mt. Etna DSM

spatial resolution: 2 m
planimetric accuracy: 2 m
vertical accuracy: +/- 0.8 m



Stromboli DSM

spatial resolution: 1 m
planimetric accuracy:1-2 m
vertical accuracy: +/- 1.6 m



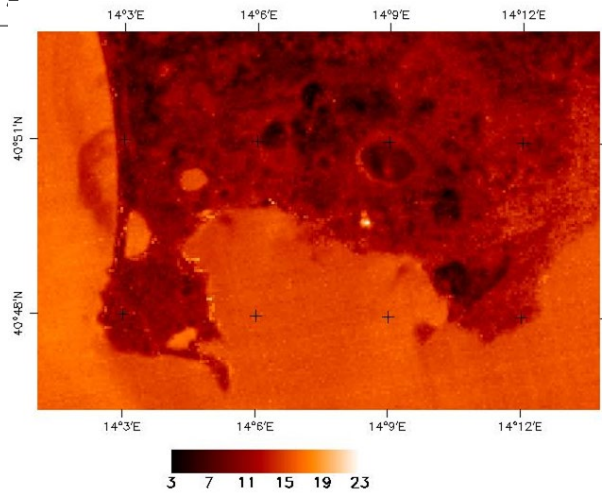
Multi/Hyper-spectral observations for volcanoes and environmental applications (part of WP9)

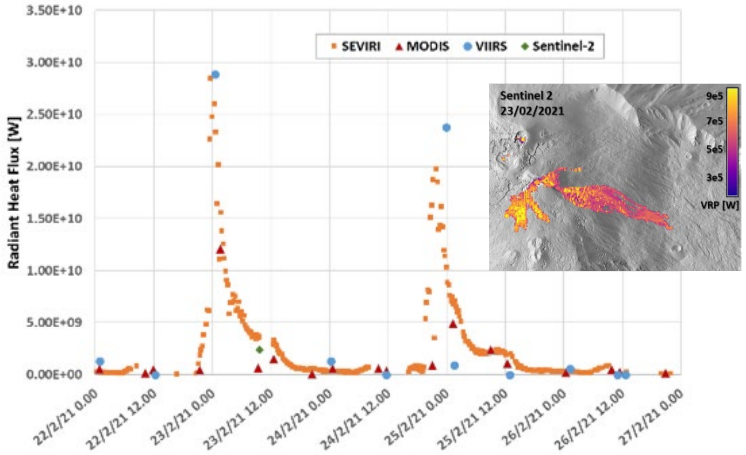
G. GANCI [OE], M. SILVESTRI [ONT], G. BILOTTA [OE], V. ROMANIELLO [ONT], A. CAPPELLO [OE], M. MUSACCHIO [ONT], F. ZUCCARELLO [OE], F. RABUFFI [ONT], R. GUARDO [OE]

General Description (Objectives)

Estimation of ***land surface temperature*** (LST) using Thermal InfraRed (TIR) remote sensing data to estimate reliable parameters of land surface physical processes on different scales with a positive cost–benefit ratio.

The productions of temperature surface map and hot spot location on maps are delivered as product to the Civil Protection Department (external user) and for specific users' needs involved in the G-TEP platform (https://geohazards-tep.eu/). The products are delivered by report, email, FTP and if available web services.



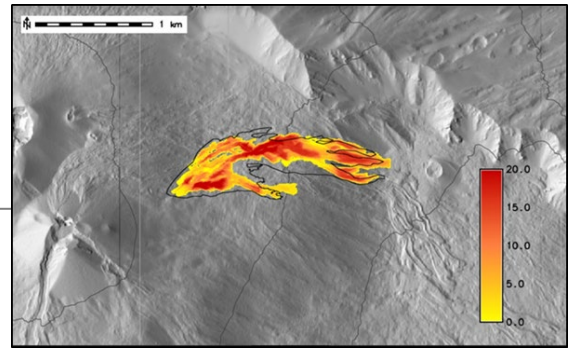


Quantification of HTE anomalies via the estimation of the radiant heat flux.

An automatic system is currently operational on Etna and Stromboli volcanoes in order to process Middle and Thermal InfraRed bands acquired by Low-to-Medium spatial resolution satellite sensors.

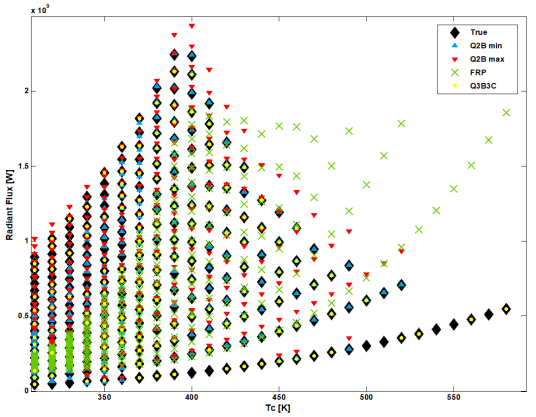
The CL-HOTSAT system provides **hotspot** maps**, radiant heat flux** time series and maps and, in case of an eruption, an estimation of the effusion rate (Time-Averaged Discharge Rate TADR). The TADR is obtained as proportional to the radiant heat flux. Whether very high resolution optical data are available, the conversion from radiant heat flux to TADR is obtained from successive DSM difference. The products are delivered by email, FTP, WEB-GIS and are used to produce weekly report on volcanic activity for DPC purposes.

Progress Description

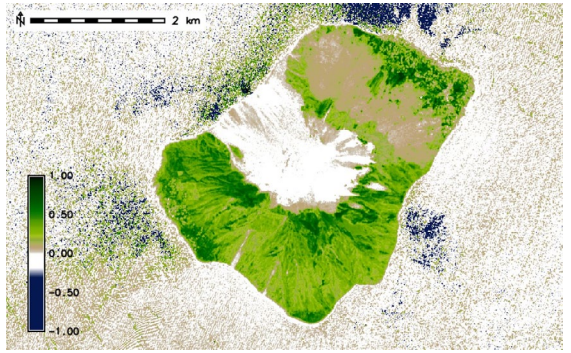


- Automatic multi-sensors multi-temporal chain optimization for LST and Heat Flux time series and maps (***PNRR MEET - WP9 Action 9.4***)

-Exploitation and support of the new SBG-TIR mission including the development of a new hotspot detection algorithm and a new approach for LST estimation by using sharpening algorithms and NDVI computations (***ASI - THERESA***)



- Development of machine learning techniques for volcanic state characterization from heat flux and LST time series (***VT SAFARI Pianeta Dinamico 2023-25***)



- Land use, NDVI and NDWI dynamic update through Landsat, Sentinel2 and PRISMA data for fire ignition maps at Stromboli island (***DPC ALL B – WP4.2***)

HERMES

- HEmera Returning MESsenger -

drones

MDPI

Technical Note

HERMES: A Data and Specimens Transporter from the Stratosphere to the Ground—The First Experimental Flight

Giovanni Romeo [1,*], Pasquale Adobbato [2], Simone Bacci [2], Giuseppe Di Stefano [1], Alessandro Iarocci [1], Amedeo Lepore [1], Massimo Mari [1], Silvia Masi [3], Francesco Pongetti [1], Giuseppe Spinelli [1] and Massimiliano Vallocchia [1]

Istituto Nazionale di Geofisica e Vulcanologia

Sapienza Università di Roma

Gruppo ABACHOS

Agenzia Spaziale Italiana

HERMES is a “physical method” of transferring data from a high altitude experiments, carried by stratospheric balloon, to the ground using a little unmanned UAV. The aircraft (glider) carries a copy of the on-board computer disk and can transport it to the ground under request. The mission control can command the releasing after uploading the landing point coordinates

Drones **2023**, *7*, 308. https://doi.org/10.3390/drones7050308

HERMES

Zero pressure Balloon

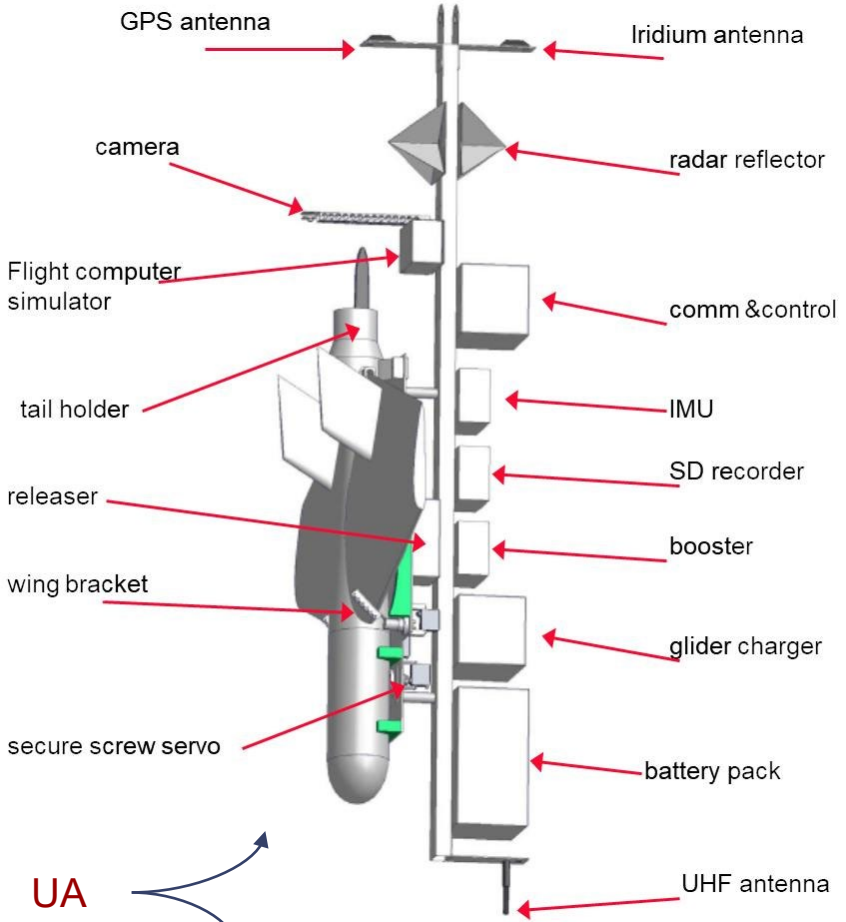
Flight ladder

Flight Termination

Parachute

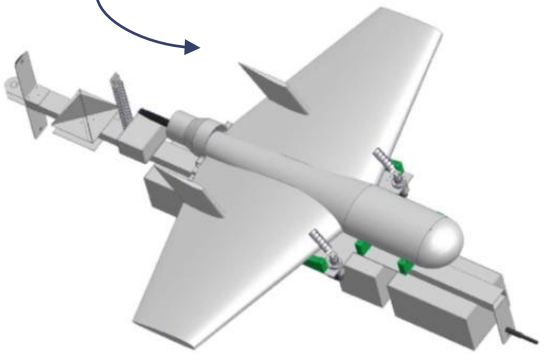
Empire (Iridium TM + ATC)

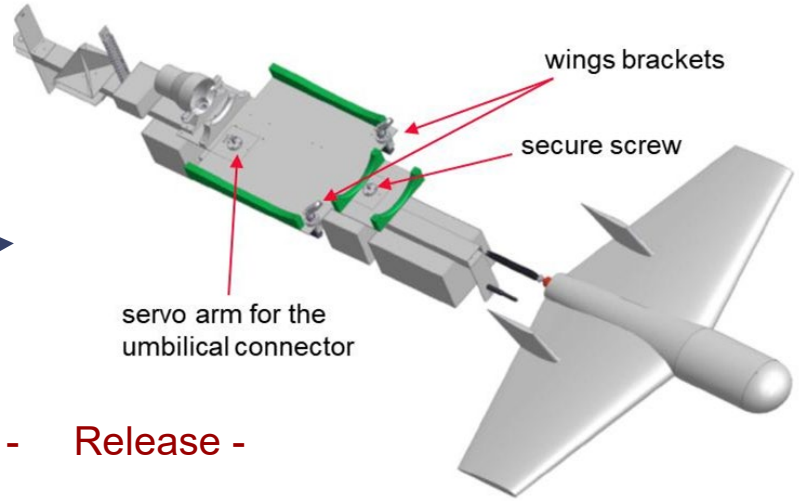
Scientific Payload + Gondola + UAV



Gondola + UAV

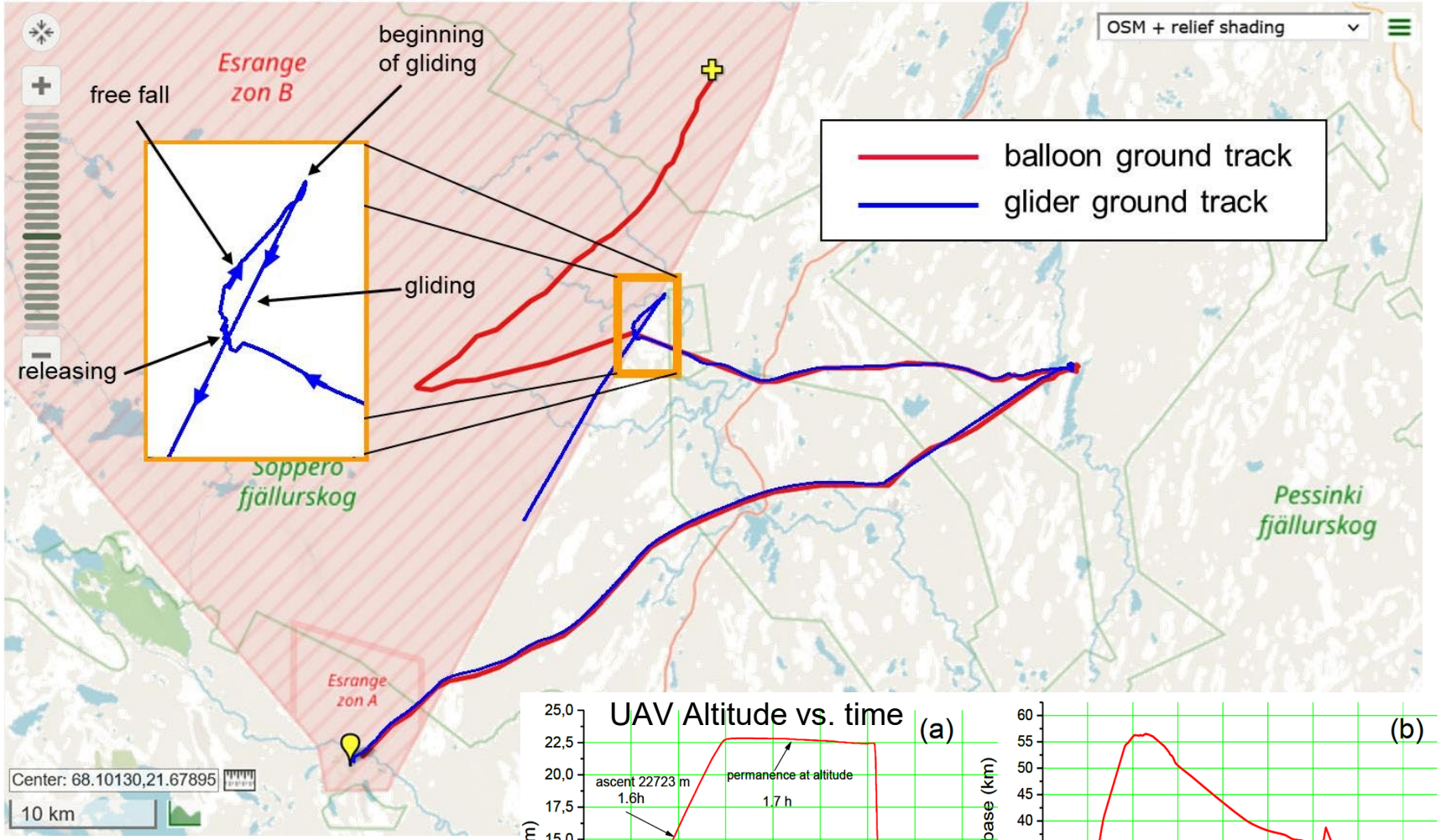
UAV

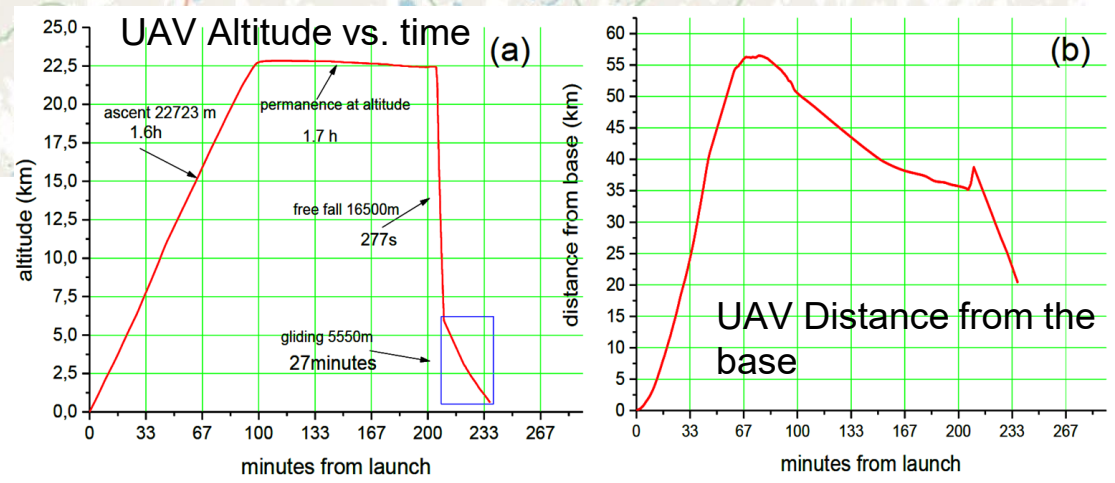




- Release -

HERMES





Integrazione, test e lancio di HERMES il 22 Luglio 2022 presso la base della SS Corporation a Kiruna

UAS Based CAL/VAL ACTIVITIES (part of WP9)

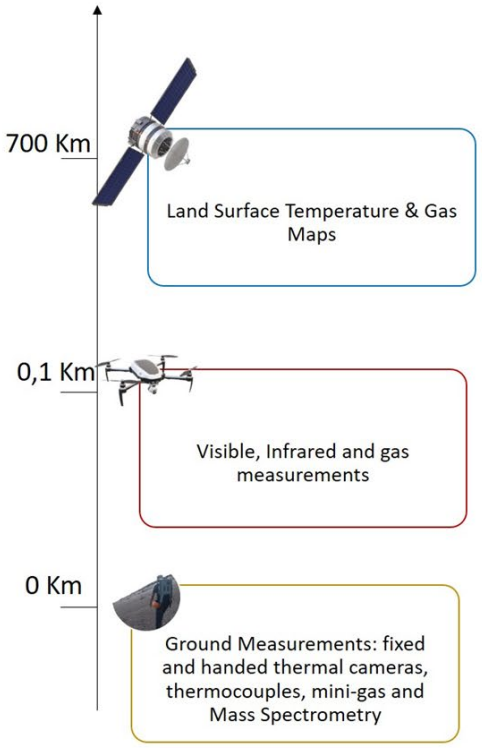
E. Marotta [OV], M. Silvestri [ONT], P.Belviso [Ov], r. avino [OV], F. Rabuffi [ONT], E.B. Sessa [OV], T. Caputo [OV], R. Peluso [Ov], F. Sansivero [OV], a. Vicari [Irpinia], N.a. Famiglietti [Irpinia]

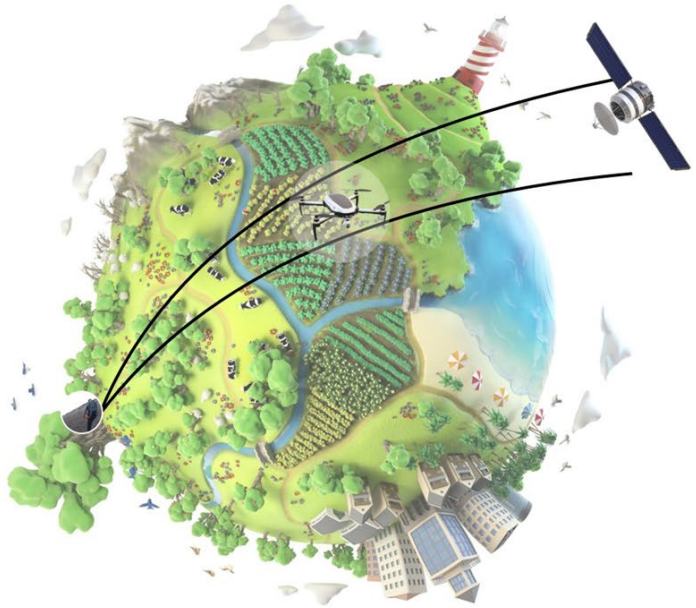
General Description (Objectives)

UAS equipped with **Thermal camera** are used to perform flights at the same time of nightly satellite passages, in order to carry out calibration and validation of satellite data. During the flight missions **thermal ground targets** are positioned while ground thermal measurements are performed with hand-held camera or permanent infrared stations to execute additional calibration of the infrared images acquired by UAS. A set of **thermal gradiometers** can also be used to evaluate the evolution of ground temperatures in a target area. A thermal gradiometer consists of a series of N temperature sensors arranged along a sensitive rod that can be inserted into the ground and to acquire a vertical thermal profile of one site.

In addition, drones equipped with a **camera integrated with RTK** system and ground base station, make it possible to develop morphological models with high detail and resolution (DTM and DSM).

Furthermore, UAS equipped with **volcanic gas sensors** are in development and design phase in order to calibrate satellites data. Geochemical measurements are performed using different payloads of gas analysers on the volcanic summit area in order to carry out: i) reconstruction of the composition of the plume and its vertical gas distribution; ii) reconstruction of the gas concentration of the plum in time and space; iii) calibration/validation of satellite data.

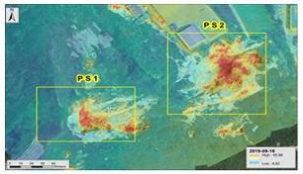




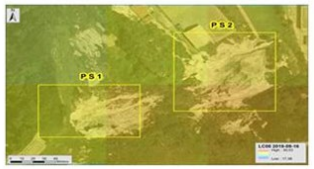
Some Progress Description

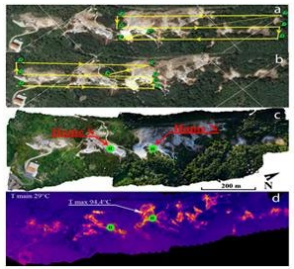
UAS

SATELLITE



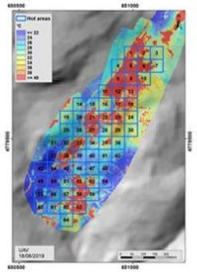
Pisciarelli (CF)



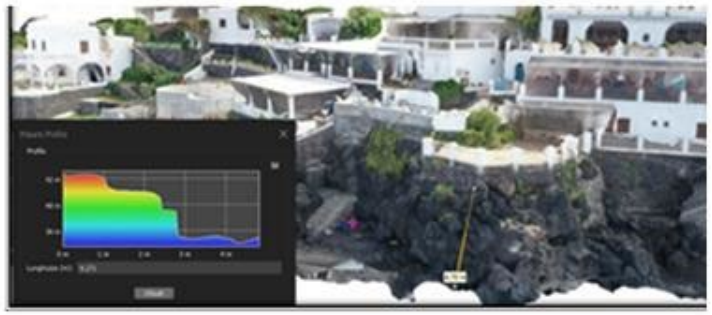


Biancane

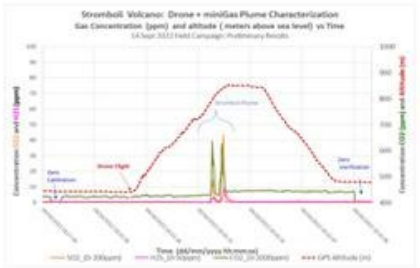
(Grosseto)



Comparison between **thermal maps** obtained by drone in the volcanic area of Pisciarelli (CampiFlegrei, NA, Campania) and those acquired by satellite. Thermal satellite images (from ASTER and Landsat 8/9) were analysed and compared to the thermal frames by both UAS and ground camera, acquired at the same time of satellite passages for several years.
The calibration tests show encouraging results.
We also obtained encouraging results at the Parco delle Biancane thermal park (GR, Tuscany).



3D high detail **morphological reconstruction** of the S. Bartolo lava flow in Stromboli which allows us to carry out precision measurements of altimetric profiles and calculation of volumes, hich will be useful for satellite acquisitions.



Geochemical composition of the Stromboli plume obtained using a miniGas sensor integrated in a UAS quadcopter. The flight was carried out at different heights in the plume. CO_2, SO_2, H_2S and H_2O concentrations were measured, also with GPS georeferencing. Preliminary results show the presence of CO_2 (maximum measured concentration 635ppm) and SO_2 (maximum measured concentration 43ppm) in the active plume.

Silvestri et al. 2020 – *Monitoring of Surface Temperature on Parco delle Biancane (Italian Geothermal Area) Using Optical Satellite Data, UAV and Field Campaigns.* – Remote Sensing, Technical Note, doi: 10.3390/rs12122018.

THANK YOU!