Automation Day 2022

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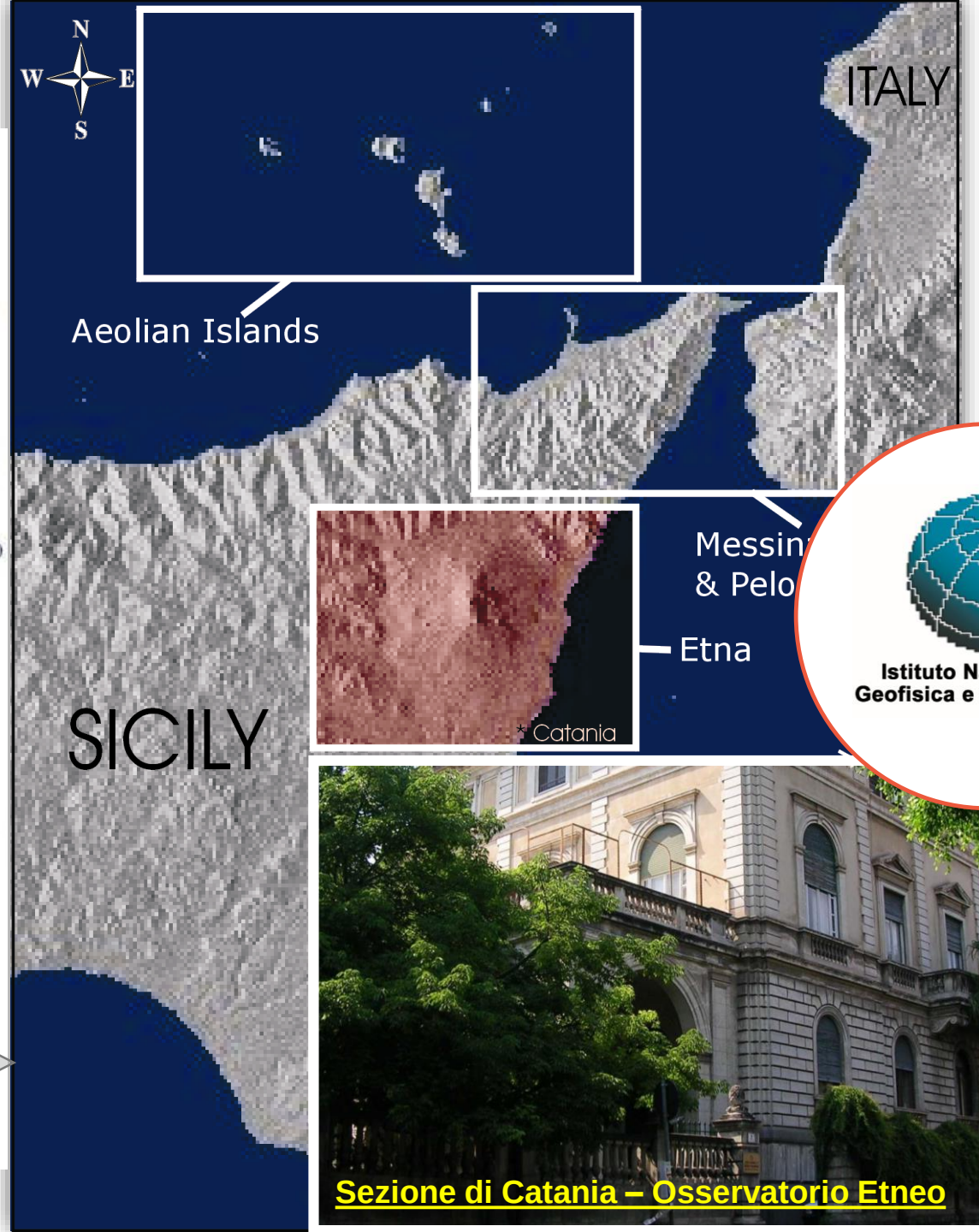
Università di Catania - 21/12/2022

INGV

Sedi distaccate

- Ancona
- Arezzo
- Ercolano Napoli
- Gibilmanna Palermo
- Grottaminarda Avellino
- L'Aquila
- Lipari Messina
- Messina
- Nicolosi Catania
- Portovenere La Spezia
- Rocca di Papa Roma
- Roma Via Nizza
- Roma Viale Pinturicchio
- Stromboli Messina
- Vulcano Messina



Sezione di Catania – Osservatorio Etneo

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Volcano Hazard Monitoring

BEFORE ERUPTION

Changes occur before an eruption starts, including:

- Ground deformation
- Gas emission
- Thermal anomalies

ERUPTION STARTS

ONGOING ERUPTION

Different kind of hazards are associated to volcanic eruptions, including:

- Lava flows
- Ash and Gas emission
- Pyroclastic deposits

ERUPTION ENDS

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Volcano hazard monitoring is referred to both following the manifestations of the eruption once it has started, as well as forecasting the areas potentially threatened.

Volcano Hazard Monitoring

GROUND observations

SATELLITE data

Physics-based MODELING

SCENARIOS in Real-Time

HAZARD assessment

Potential IMPACT

RISK mitigation

WEB-GIS dissemination

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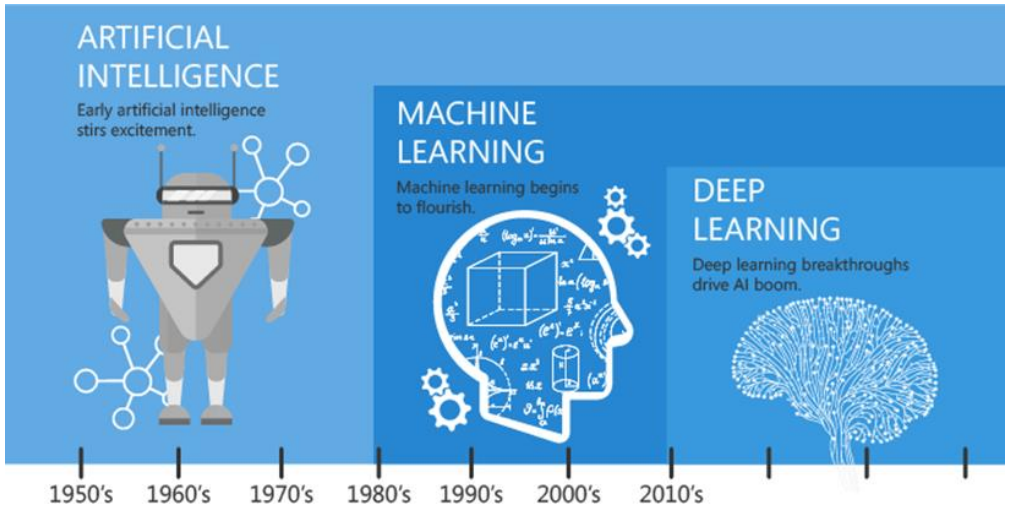
Volcano Hazard Monitoring from Space



Satellite technology makes it possible to observe changes in the Earth's surface and to monitor volcanic activity in even the most isolated corners of the globe providing spectral estimates for large areas.

The increasing availability of open-source satellite data and current developments in cloud computing and data-driven approaches have made the monitoring of volcanic hazards from space more feasible for volcano observatories.

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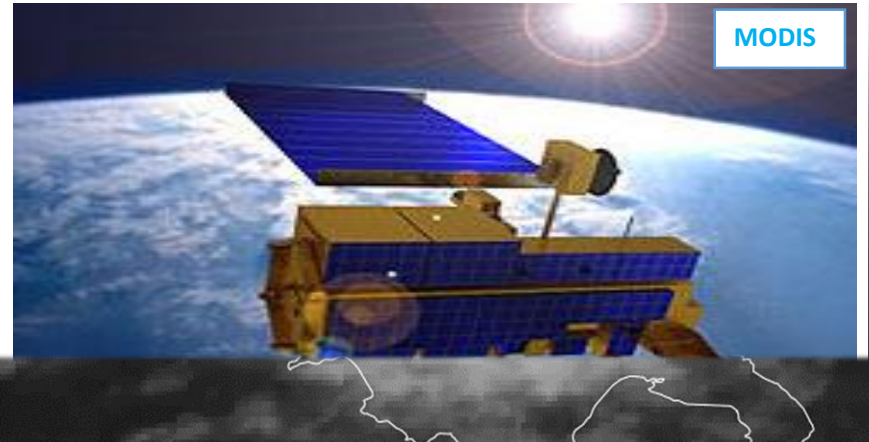
The three pillars of the monitoring of volcanic hazards from space:

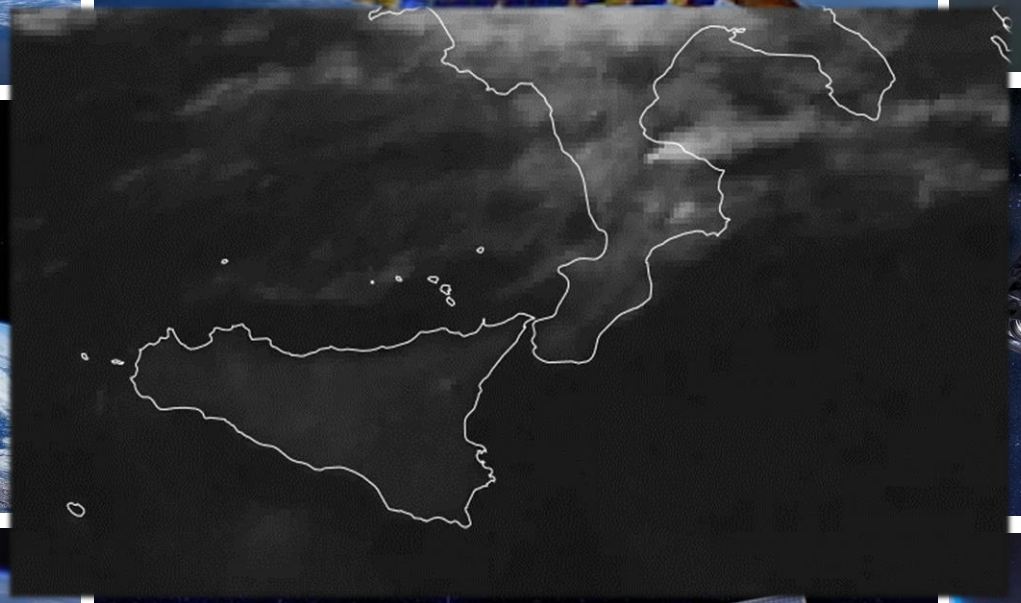
1) Open-access Satellite data streams → from Infrared to Visible and Radar

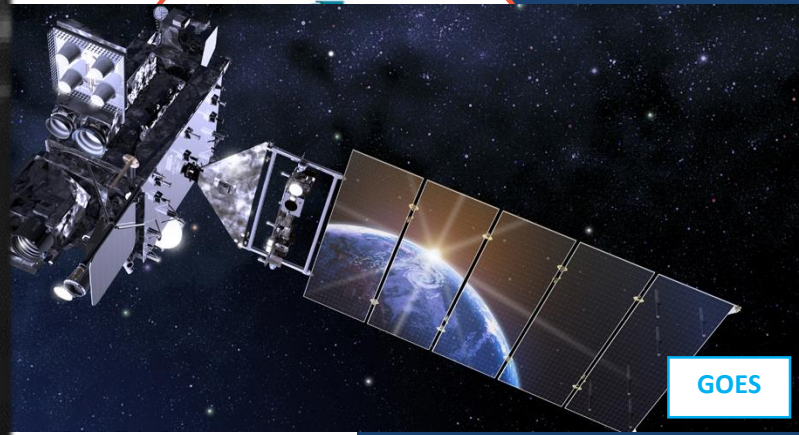
2) Data-driven approaches → Artificial Intelligence

3) Cloud computing → Google Earth Engine (GEE), Google Colab

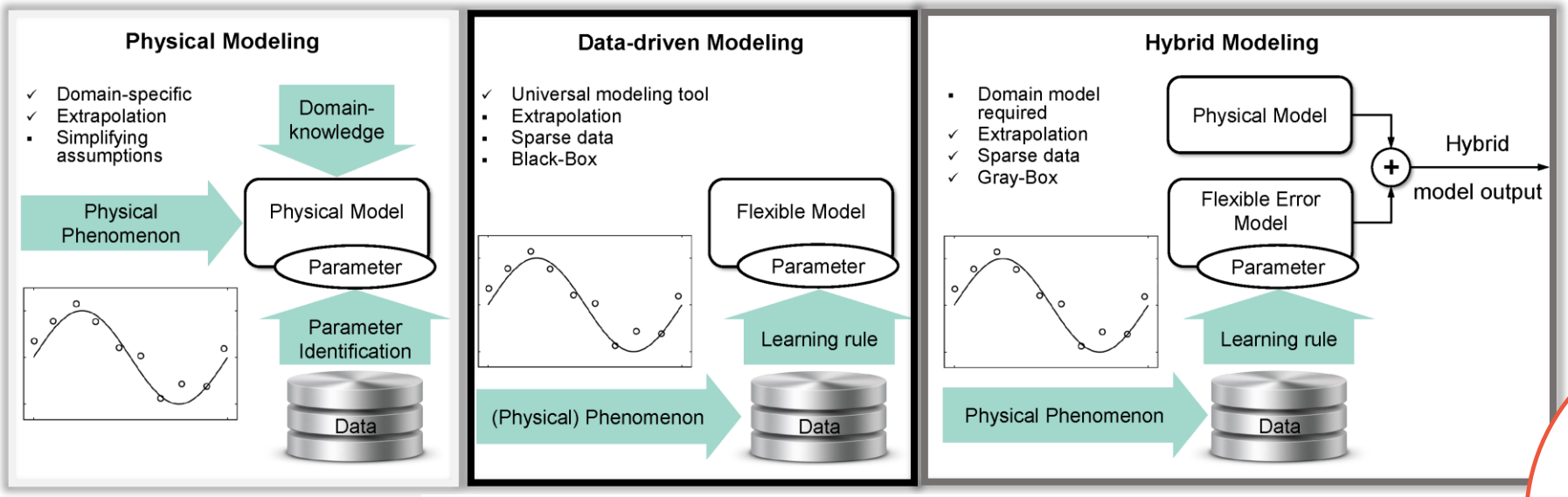
Open-access Satellite data streams

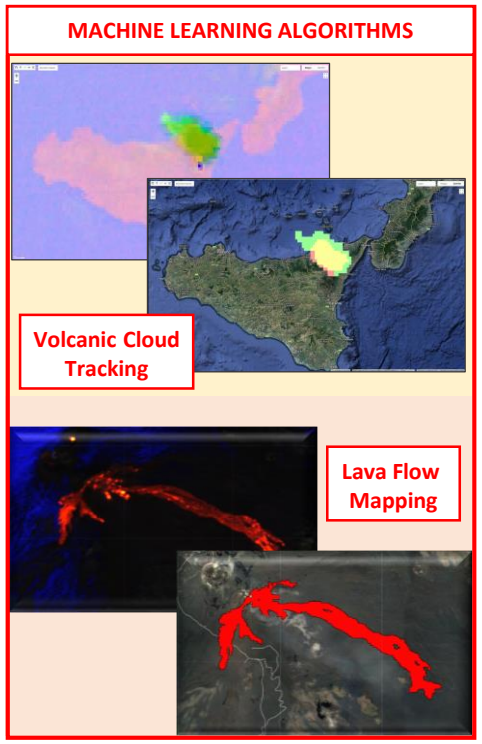






Modeling approaches





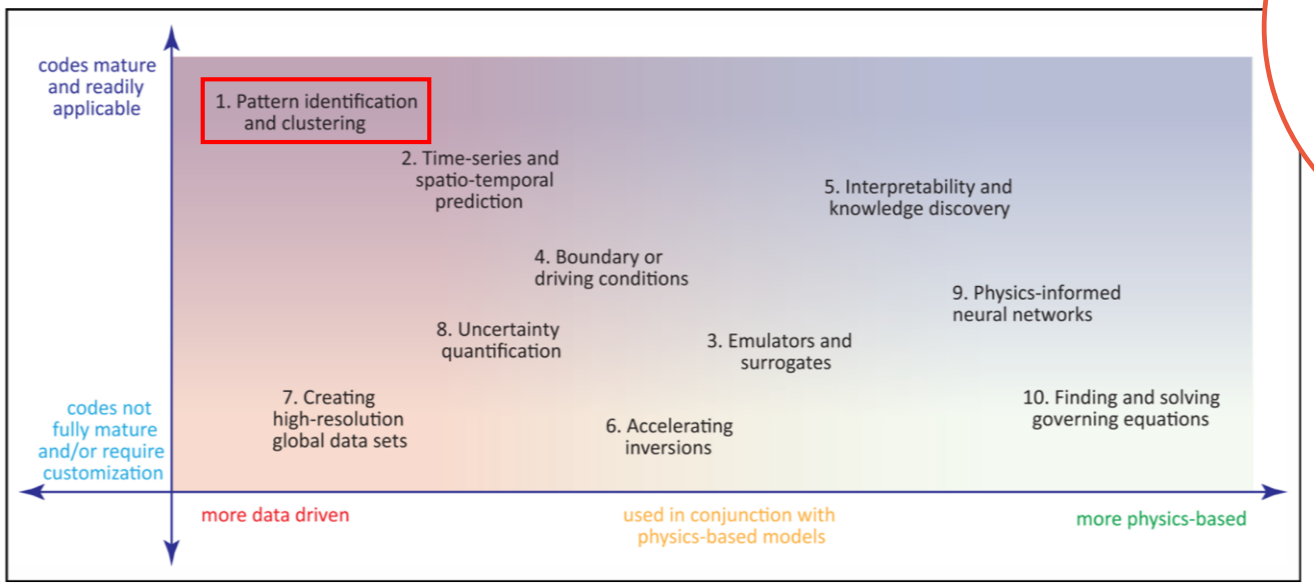


Fig. 1. Ten ideas for applying machine learning (ML) in the Earth and space sciences, roughly organized by the degree of involvement of physics-based models (horizontal scale) and the degree to which ML codes are available and readily applicable versus being in development and requiring significant customization (vertical scale). Credit: Jacob Bortnik

[https://eos.org/opinions/ten-ways-to-apply-machine-learning-in-earth-and-space-sciences]

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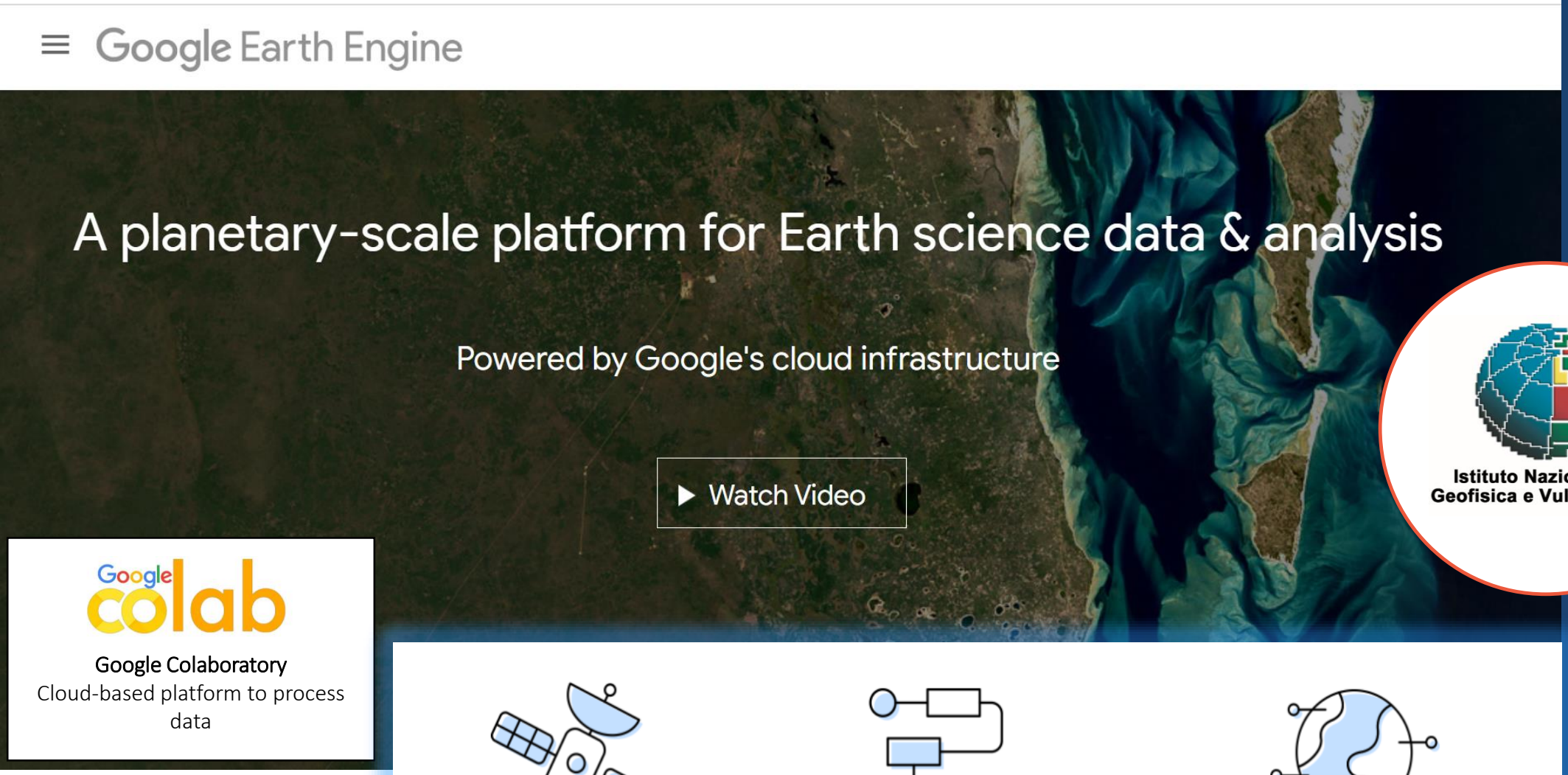
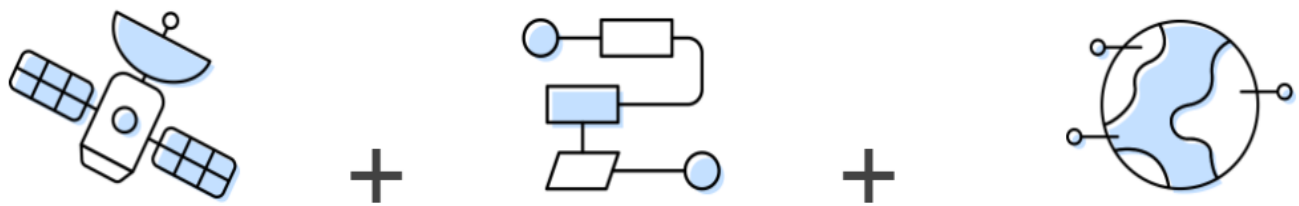
Cloud computing



Google Colaboratory
Cloud-based platform to process data



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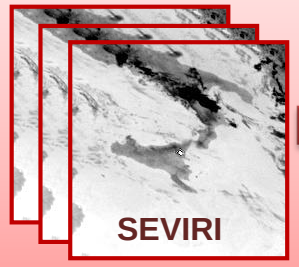
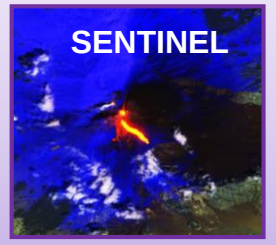
Volc@Hazard: volcano hazard monitoring from space

High Spatial Resolution Optical Images in Stereo-Tristereo

Low Spatial High Temporal Resolution Multispectral Images

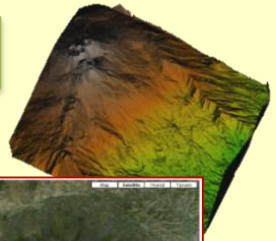


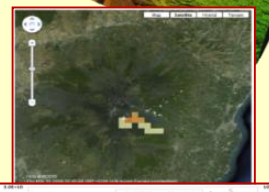
Low Temporal High Spatial Resolution Multispectral Images

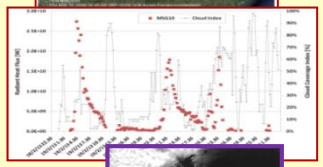


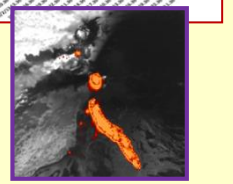
Volc@Hazard

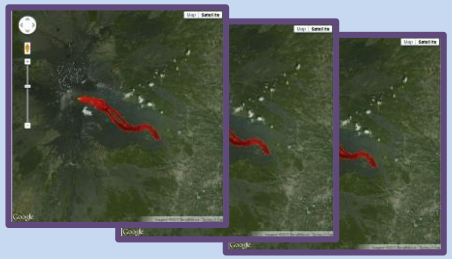
1. Digital Elevation Model
2. Hotspot Detection
3. Radiant Heat Flux
4. TADR Estimation
5. Active Lava Flow Area
6. Eruptive scenarios











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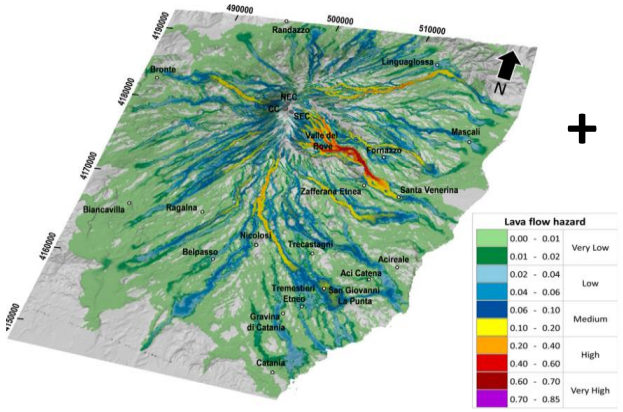
Volc@Hazard shows how free access to a diversity of remote sensing data over volcanoes can benefit hazards monitoring efforts.

Potential Impact

Hazard Map



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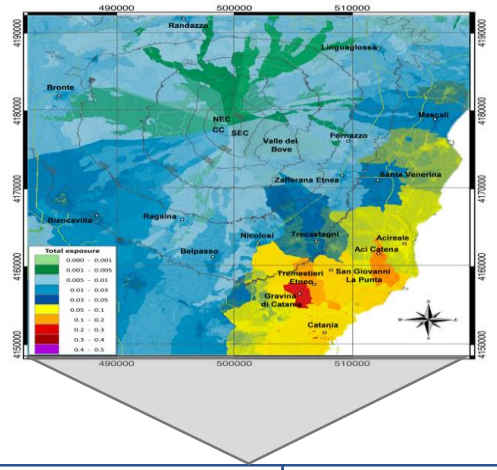
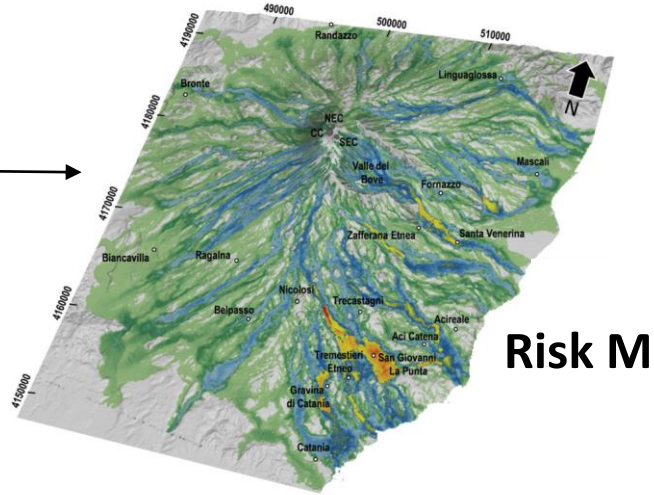
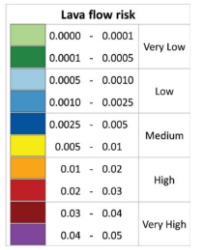
Exposure Map







Risk Map

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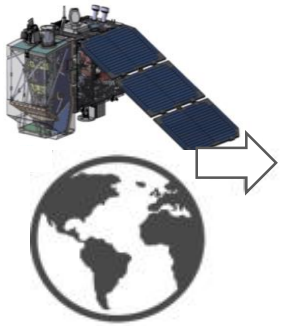
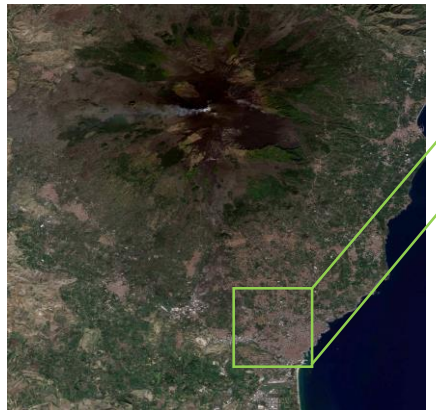
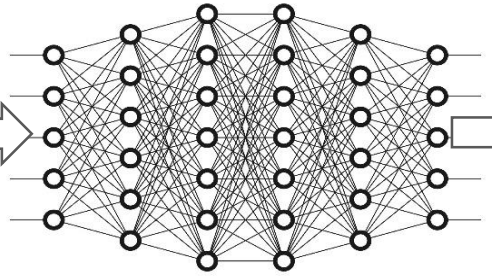
SENTINEL-2 SATELLITE IMAGERY → CROP 64X64 IMAGE PATCHES → VOLCANIC DATASET RGB → VGG-16 CNN CLASSIFIER → CLASS PATCHES → MERGE 64X64 CLASS PATCHES



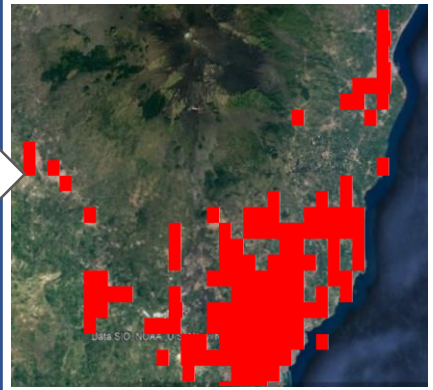
Sentinel-2A MultiSpectral Instrument



Google Earth Engine



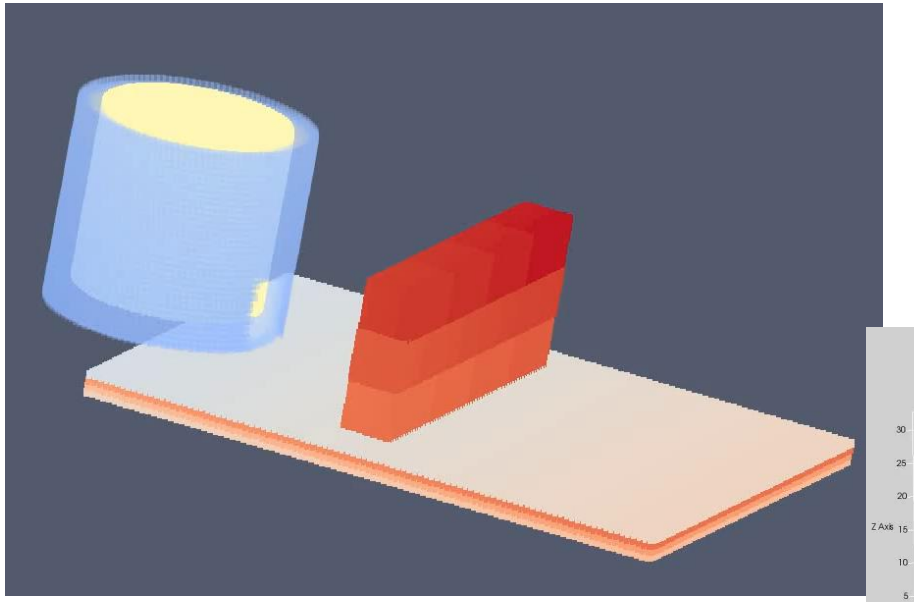
CONVOLUTIONAL NEURAL NETWORK: VGG16



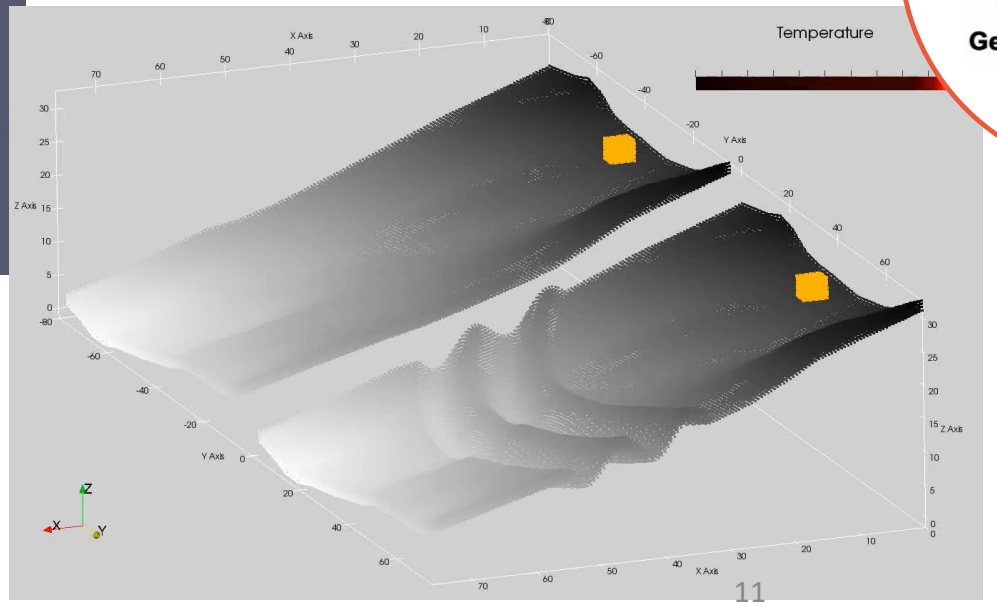
INPUT ***MODEL*** ***OUTPUT***

Evaluation and mitigation of risk

The model can be used for risk evaluation of structures, and for action planning against lava flow invasion: the action should have all and only the desired effects.



Lava flow destroying a wall of bricks.



Effect of a series of bump on a lava flow.

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Laboratory of Technologies for Volcanology

The Laboratory of Technologies for Volcanology (called ***TechnoLab***) was established in 2001 at INGV-Catania in agreement with the Department of Engineering of the University of Catania.

INTUITION –
The idea is to bring together the experience of volcanologists with the knowledge of engineers. The aim of the ***TechnoLab*** is to become the scientific and technical training center for young researchers in volcano monitoring.

Since foundation of the TechnoLab over 50 degree theses in different topics have been completed, as well as 10 PhD in Engineering have been activated on the development of methodologies for forecasting volcanic hazards.

SUGGESTED MSc FINAL PROJECTS BY **INGV-CT**

TOPICS

- Volcano Hazard monitoring from Space using Artificial Intelligence
- Volcano Activity recognition from Space using Deep Learning
- Volcanic Hazard Modelling
- Decision-making and risk mitigation measures

METHODOLOGY

- MatLab
- Cloud Computing (Google Earth Engine, Colab)
- CNN, Cellular Automata, SPH
- Machine Learning Techniques
- High-Performance Parallel Computing

SEND YOUR CV BY EMAIL TO:

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