Borse di studio GARR
Orio Carlini

Vulcanologia & Intelligenza artificiale

L’uso del machine learning nella previsione probabilista degli eventi vulcanici dell’Etna

@casadipagliafelcerossa

Giulio Domina | Tutor: Flavio Cannavò
INGV – Catania

Consortium GARR | THE ITALIAN EDUCATION & RESEARCH NETWORK

Introduzione

- L'Etna è il vulcano **più alto e attivo** d'Europa.

- Considerando anche le **importanti infrastrutture,** un **milione di persone** che vivono alle pendenze

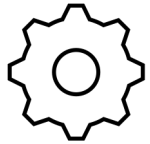
- La previsione e l'individuazione precoce dei fenomeni vulcanici è importante per salvaguardare la **sicurezza**, la **salute pubblica** e sostenere l'**attività turistica** nella regione.

Metodologia

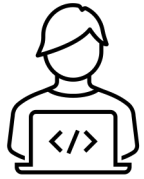
Tre fasi:

1. Analisi del contesto

2. Data engeneering

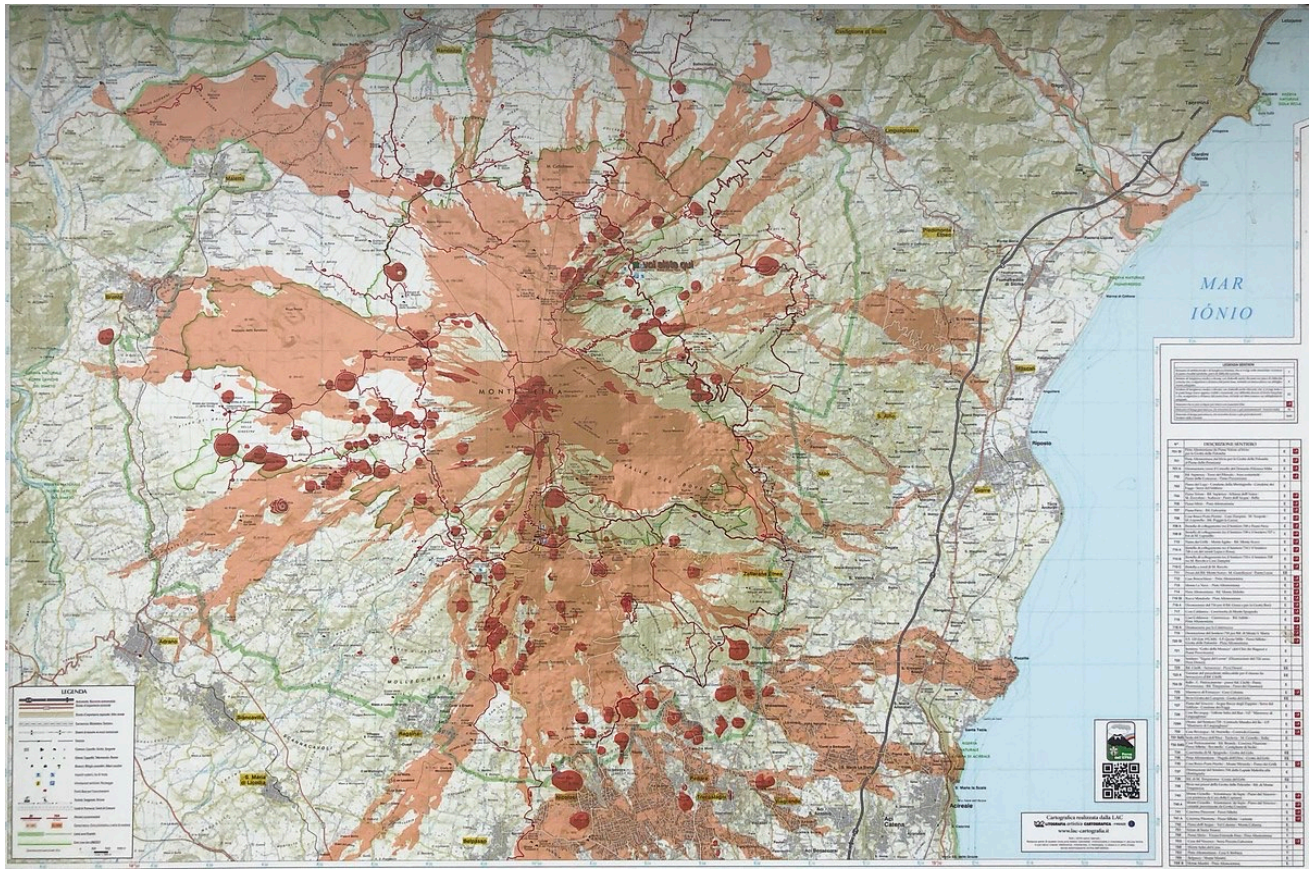


3. Costruzione del modello



1.1 Analisi del contesto

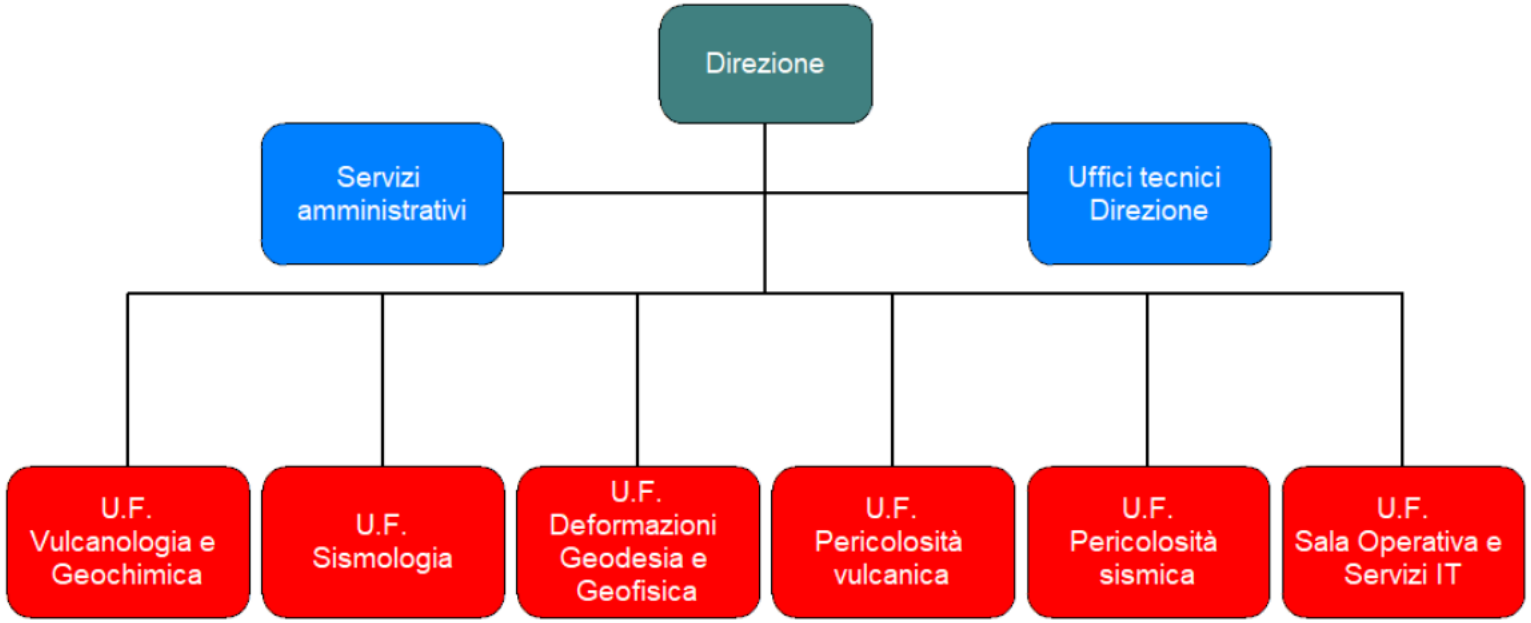
- Stato dell’arte
  - Ricerca preliminare & questionari



Mappa sentieri del parco dell’Etna

1.2 Analisi del contesto

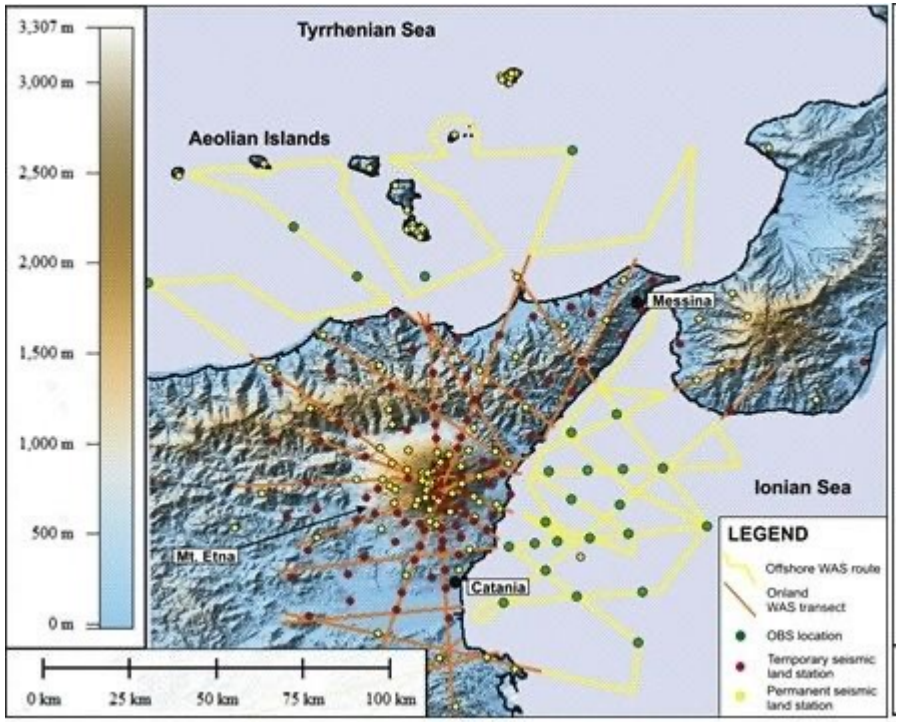
- Collaborazione interdisciplinare
  - diversi campi di ricerca

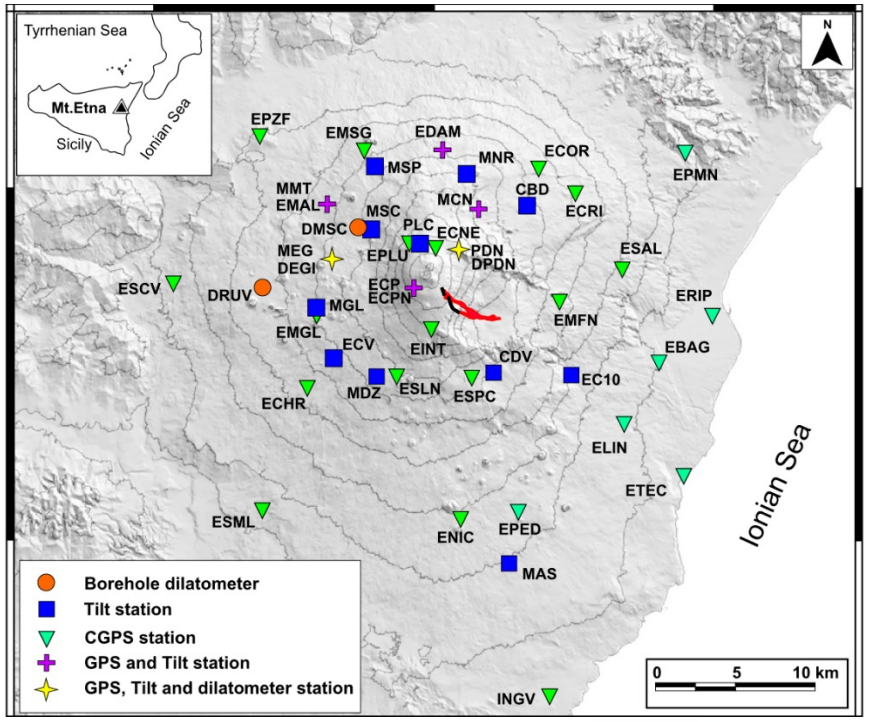


Organigramma INGV

1.3 Analisi del contesto

- Vincoli teorici e pratici
  - limiti del modello e dei dati rilevati





2. Data engineering

Esplorazione dei dati

↓

Feature engineering

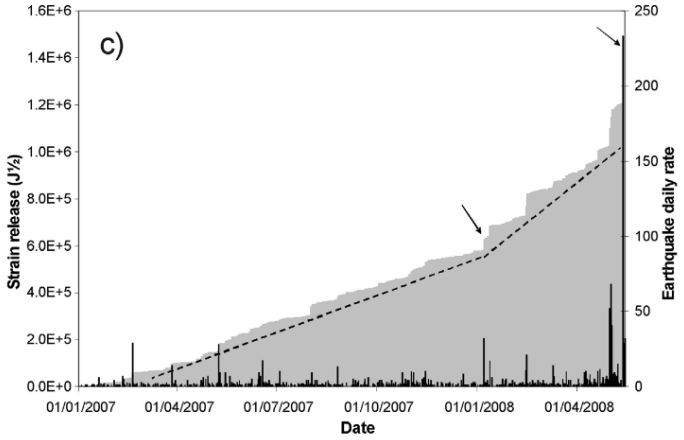
↓

Differenti tipi di dati possono essere usati:

- *Sismografi*
- *Tiltimetri*
- *Gas vulcanici*
- *Deformazione del suolo*
- *Sonde acustiche*
- *Satelliti e immagini*
- *Gravimetria*
- *Magnetometria*

Sala operativa INGV

2.1 segnali sismici



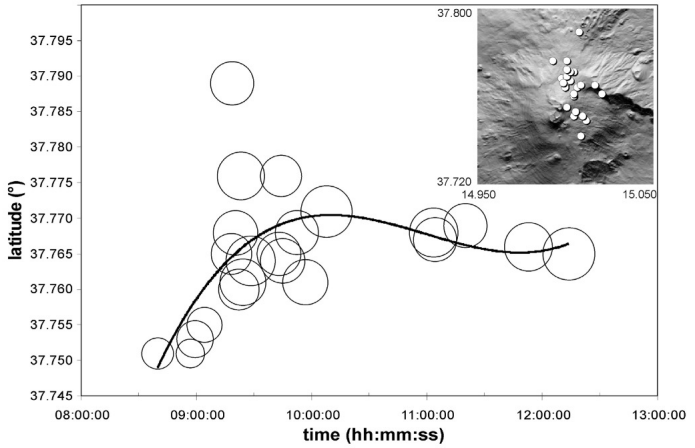
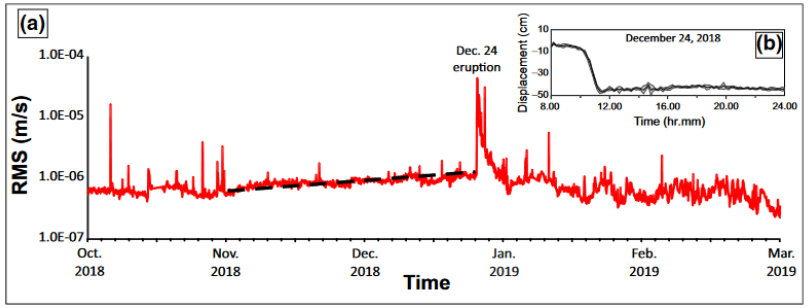
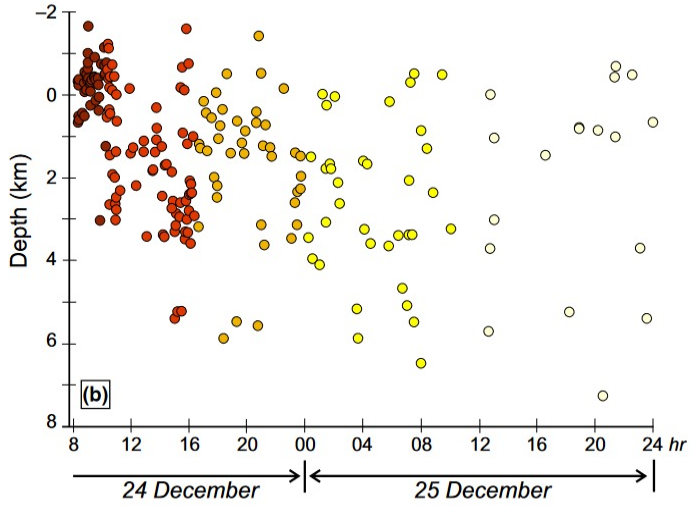
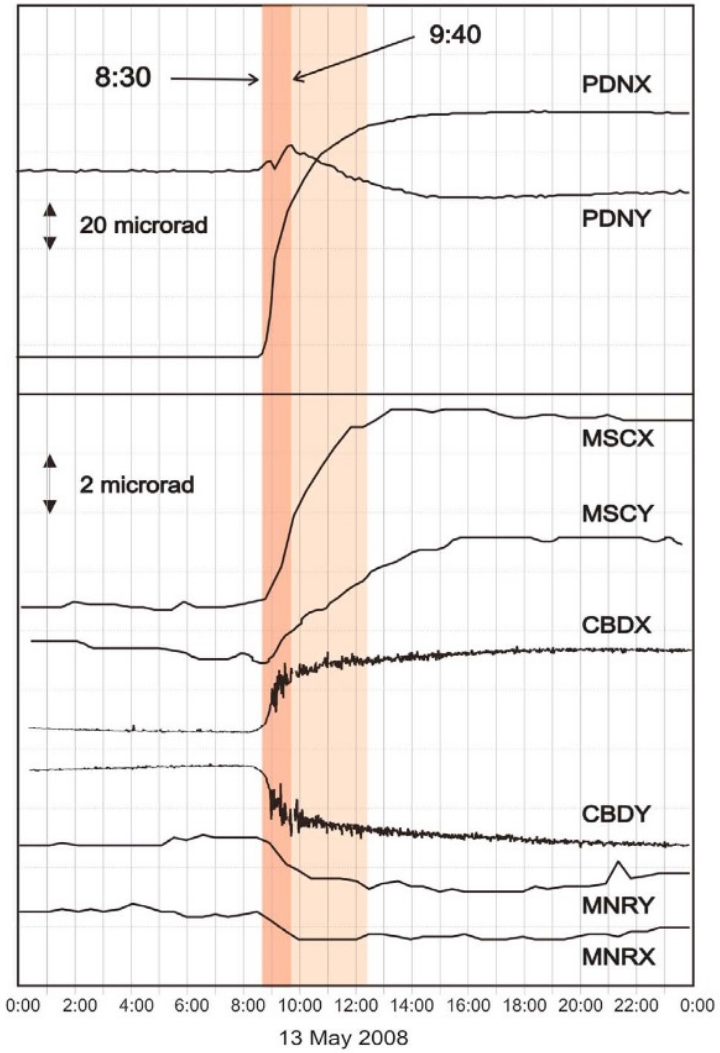


Figure 6. Location of the seismic swarm preceding and accompanying the onset of eruption on 13 May 2008 plotted as function of latitude versus time. The size of the circles is proportional to the duration magnitude (M_{Dmin} = 1.0, M_{Dmax} = 3.3). The line is a fourth-order polynomial curve fitting the data set. inset shows the map of the summit area with the position of the epicenters.





2.2 Segnali Tilt



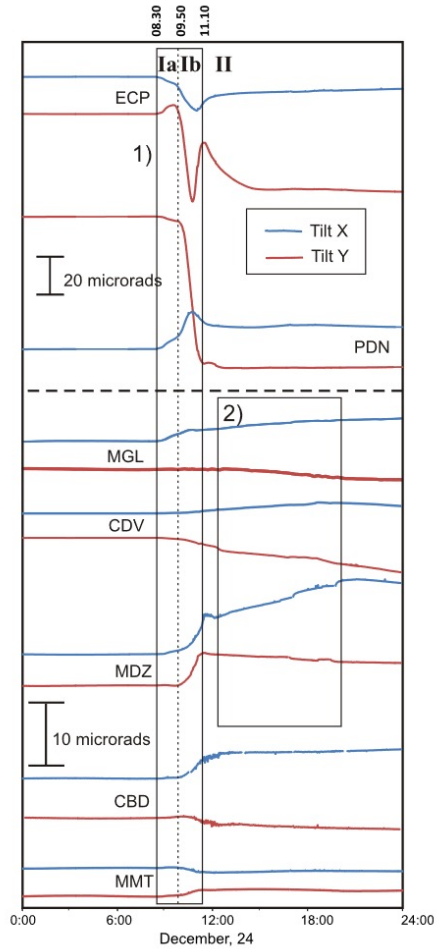
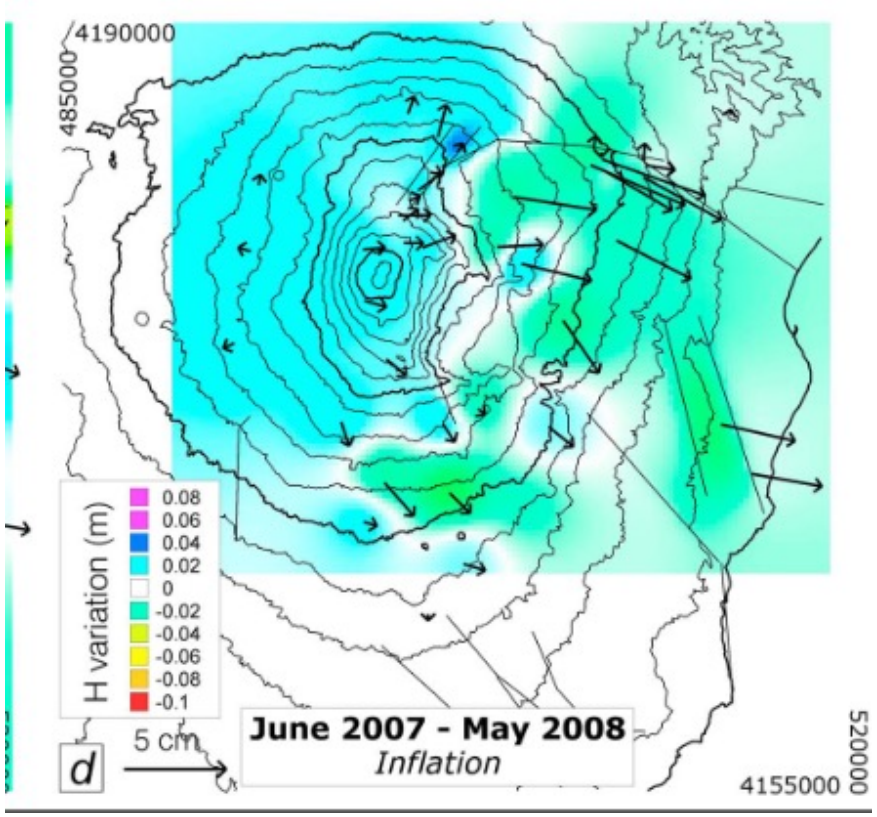


Figure 3. Tilt components recorded on 24 December 2018 at selected stations. (1) 8:20 and 11:10 UT interval where ECP and PDN recorded the strongest variations; (2) period after the 12:00 UT when significant tilt changes were recorded at the southern stations.

2.3 Segnali GPS



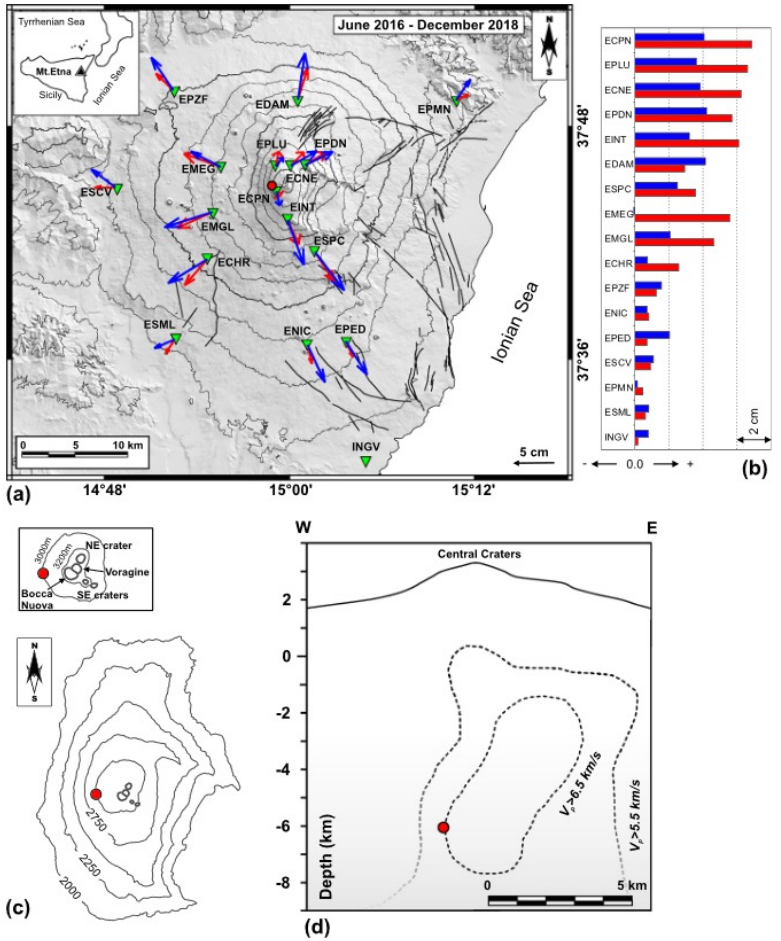


Figure 1. (a) Recorded (blue) and modeled (red) deformation pattern at Mount Etna during the recharge phase before the December 2018 eruption (June 2016 to December 2018). The histogram (b) reports the recorded (blue bars) and modeled (red bars) vertical dislocations. The vertical variations are plotted according to the CGPS station elevations. Horizontal and vertical projections (c, d) of the modeled inflation source are reported.

2.4 Data engineering

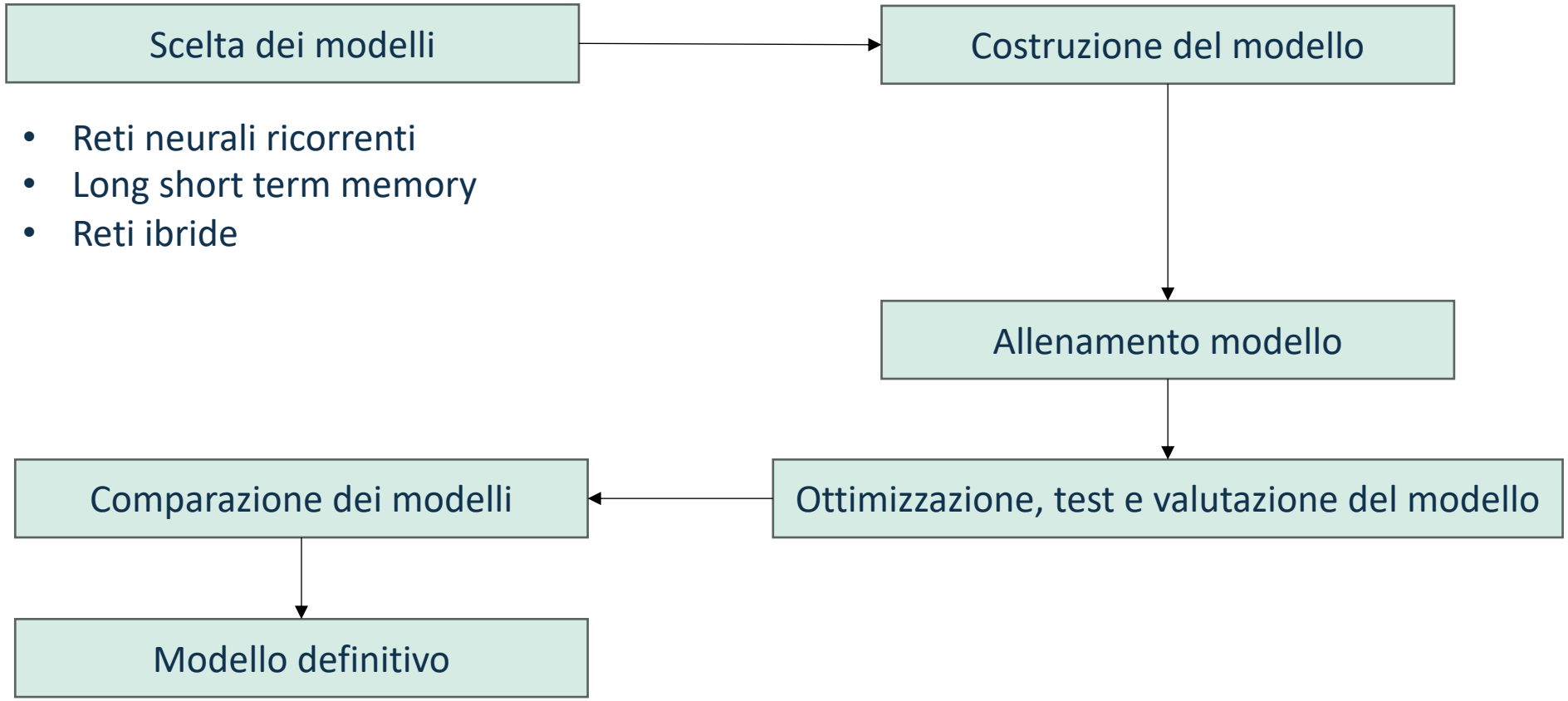
- *Sismografi*
- *Tiltimetri*
- *Gas vulcanici*
- *Deformazione del suolo*
- *Sonde acustiche*
- *Satelliti e immagini*
- *Gravimetria*
- *Magnetometria*

Sala operativa INGV

- Pulizia dei dati
- Dati mancanti
- Trasformazione
- Riduzione

→ Dataset

3. Costruzione del modello



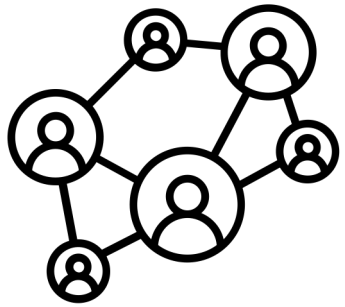
3.1 Output del modello

Evento sommitale	Evento intrusivo
ERUZIONE IMMINENTE	
ALLERTA	
RIPOSO	

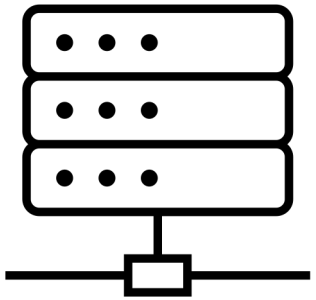
@casadipagliafelcerossa

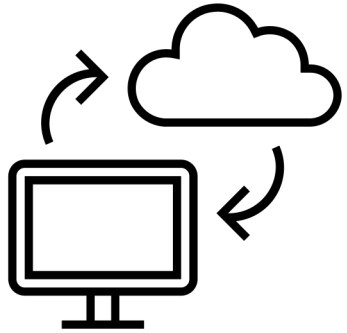
4 Aiuto della rete GARR

Network per eventuali suggerimenti e spunti di ricerca



Sfruttare la **rete GARR** per l'uso di un nuovo servizio di **cloud computing** per l'allenamento del modello





Grazie per l'attenzione

giuliodomina@gmail.com
flavio.cannavo@ingv.it

Bibliografia

Borse di studio GARR
Orio Carlini

- Aloisi, Marco, et al. "The 24 December 2018 eruptive intrusion at Etna volcano as revealed by multidisciplinary continuous deformation networks (CGPS, borehole strainmeters and tiltmeters)." *Journal of Geophysical Research: Solid Earth* 125.8 (2020): e2019JB019117.
- Aloisi, M., Bonaccorso, A. and Gambino, S., 2006. Imaging composite dike propagation (Etna 2002, case). *J. Geophys. Res.*, 111, B06404. Doi: DOI: 10.1029/2005JB003908.
- Bonaccorso, Alessandro, et al. "The initial phases of the 2008–2009 Mount Etna eruption: A multidisciplinary approach for hazard assessment." *Journal of Geophysical Research: Solid Earth* 116.B3 (2011).
- Bonaccorso, Alessandro, et al. "Mt. Etna: volcano laboratory." _Washington DC American Geophysical Union Geophysical Monograph Series_ 143 (2004).
- Carniel, Roberto, and Silvina Guzman. "Machine learning in volcanology: a review." _Volcanoes-Updates in Volcanology_ (2021).
- Hesham, Mostafa. *Enhancing Volcanology Prediction Capabilities Through Machine Learning and Data Analysis*. No. 10432. EasyChair, 2023.
- Hajian, Alireza, Giuseppe Nunnari, and Roohollah Kimiaefar. *Intelligent methods with applications in volcanology and seismology*. Springer Nature, 2023.
- Foto dell'INGV, Parco dell'etna, e di @Casadipagliafelcerossa

Giulio Domina - INGV - Catania

Consortium GARR | THE ITALIAN EDUCATION & RESEARCH NETWORK