INSEGNACI ETNA 2020

ANNUAL INTERNATIONAL WORKSHOP [ON LINE] – 2020, DECEMBER 4TH

Inflations, deflations and slip on the faults

Salvatore Consoli, INGV-OE (salvatore.consoli@ingv.it)
Francesco Carnemolla, Università di Catania (francesco.carnemolla@unict.it)
Shan Gremion, ENS Lyon (shan.gremion@ens-lyon.fr)
Pierre Briole, ENS Paris & INGV-OE (pierre.briole@ens.fr)
& un certo Daniele

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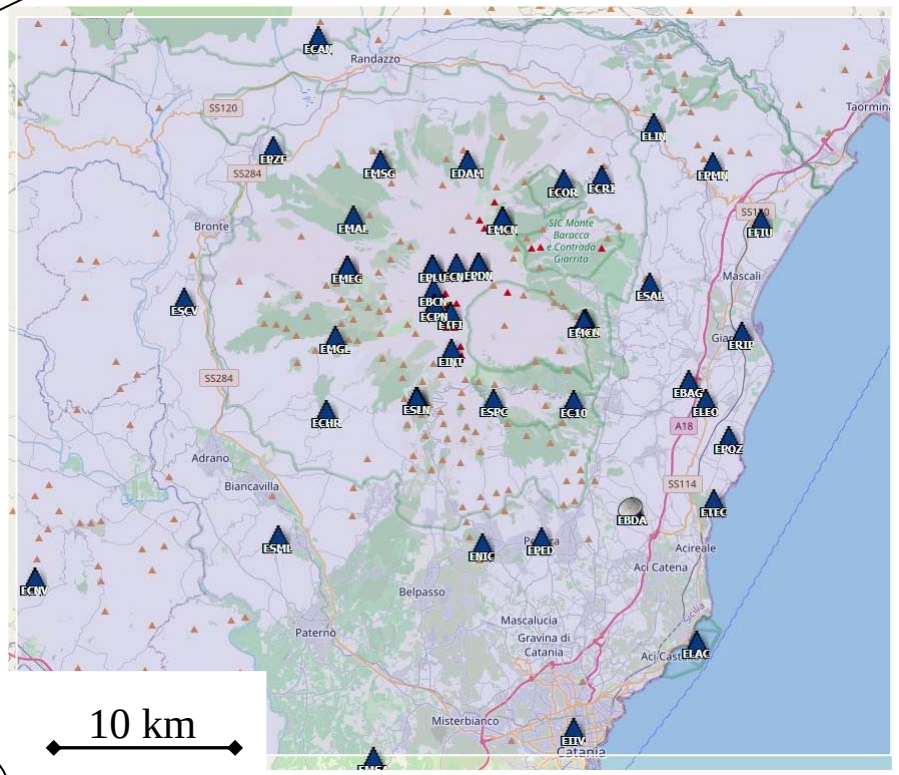
GPS measures precisely the deformations of Etna

Data transmitted in real time and processed at the INGV-OE in Catania.

Maintenance made by several technicians using dedicated equipment.

Winter maintenance at the Cratere del Piano GPS station.



More than 40 permanent GPS stations

Accuracy = 1 to 2 centimeters in real time

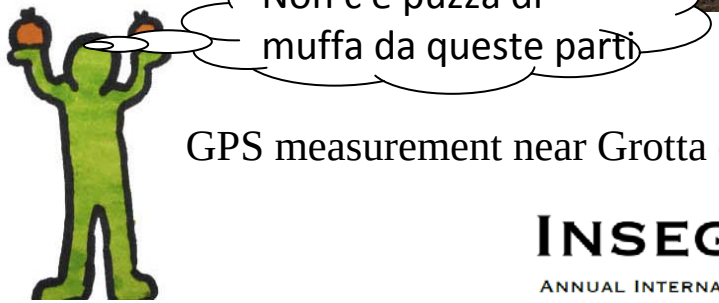
Campaign GPS measurements

During eruptions and after earthquakes, GPS measurements are made at additional (not permanent) points.

This increases of density of GPS points is needed to characterize properly the deformations and interpret them.

PERSONALE		3-giu mer	4-giu gio	5-giu ven	8-giu lun	9-giu mar	10-giu mer	11-giu gio	15-giu lun	16-giu mar	17-giu mer
Bonforte	Alessandro			SGBO-EGIA-ESGR	PDAP-PISA			MDGR		ETRP-ECDV-EMCH	
Calvagna	Francesco	MONT	EMZL-EGAL-ENUN	FOPE-ESTP-EVCL	ESNT -ESRV	EGON-MANG		EMZL-EGAL-ENUN-ETUR-EPDG	EMIR-EARS-EMSL	ECRS - R.Pignatello - EMAG	ECES - - EI
Amantia	Alfio		EGON-ETAC		ESNT -ESRV		STAZ-ETAC SGBO				ECES - - EI
Consoli	Salvatore	ECES - ERAN - ELIG	ETUR-EPDG	ECSV-EASN		ESVN - EMIS	EGIA-ESGR	ESTP-EVCL-ECSV-FOPE-EASN	EMSC-EPEL-ECNL-ETAR	ECRS - R.Pignatello - EMAG	EFAN-
Guglielmino	Francesco				PDAP-PISA			MDGR		ETRP-ECDV-EMCH	
Saraceno	Benedetto		ETUR-EPDG	ECSV-EASN			EGIA-ESGR	ESTP-EVCL-ECSV-FOPE-EASN	EMSC-EPEL-ECNL-ETAR	ECRS - R.Pignatello - EMAG	MO
Aiesi	Gianpiero		EGON-ETAC				STAZ-ETAC SGBO			ECRS - R.Pignatello - EMAG	EFAN-
Cappuccio	Lino	ECES - ERAN - ELIG		SGBO-EGIA-ESGR		ESVN - EMIS			EMIR-EARS-EMSL		MO
Laudani / Ferro		MONT	EMZL-EGAL-ENUN	FOPE-ESTP-EVCL		EGON-MANG		EMZL-EGAL-ENUN-ETUR-EPDG			

Grid with the programming of a GPS campaign.



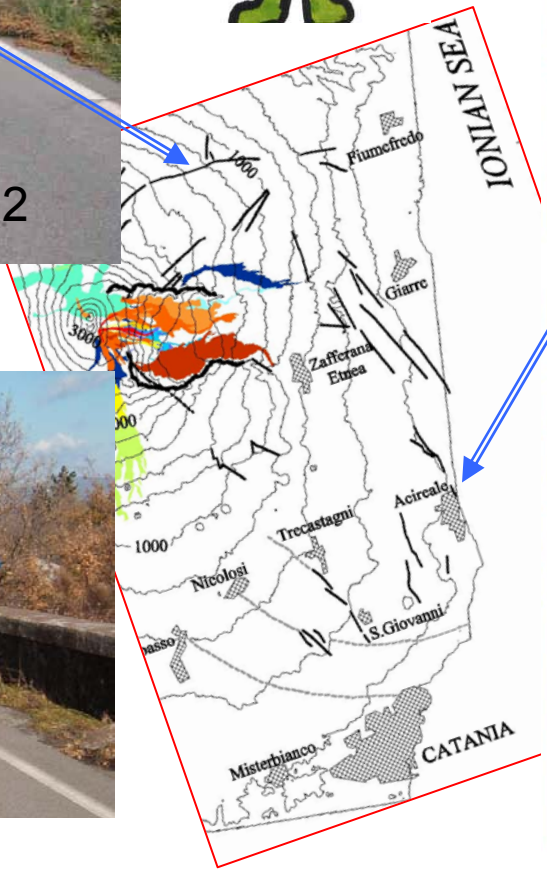
GPS measurement near Grotta dei Lamponi in July 2019

Campaign measurement in June 2020

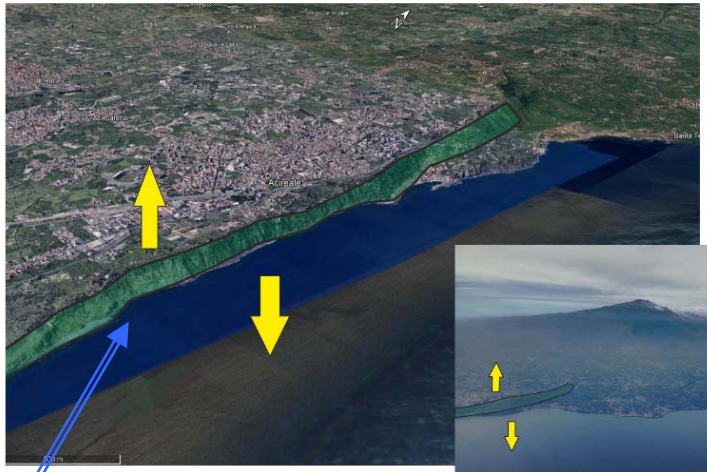
What is a fault?

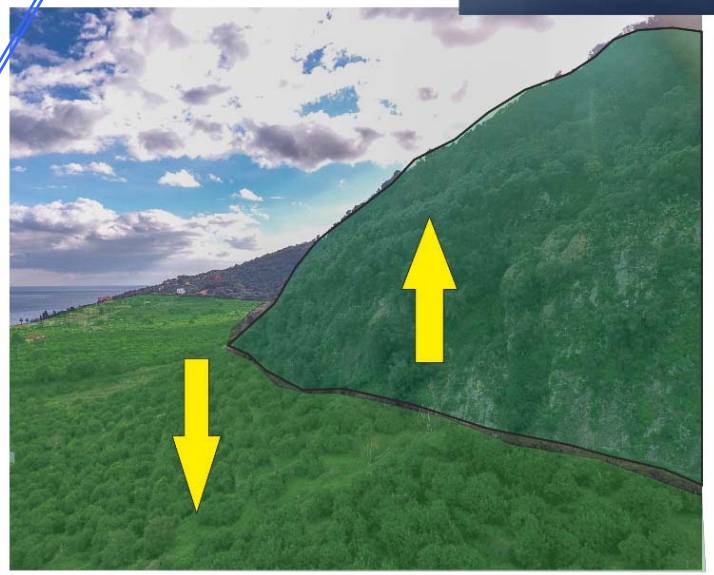
Caspita, guarda che tra cent'anni questa strada si butta nella sciara!

Pernicana Fault

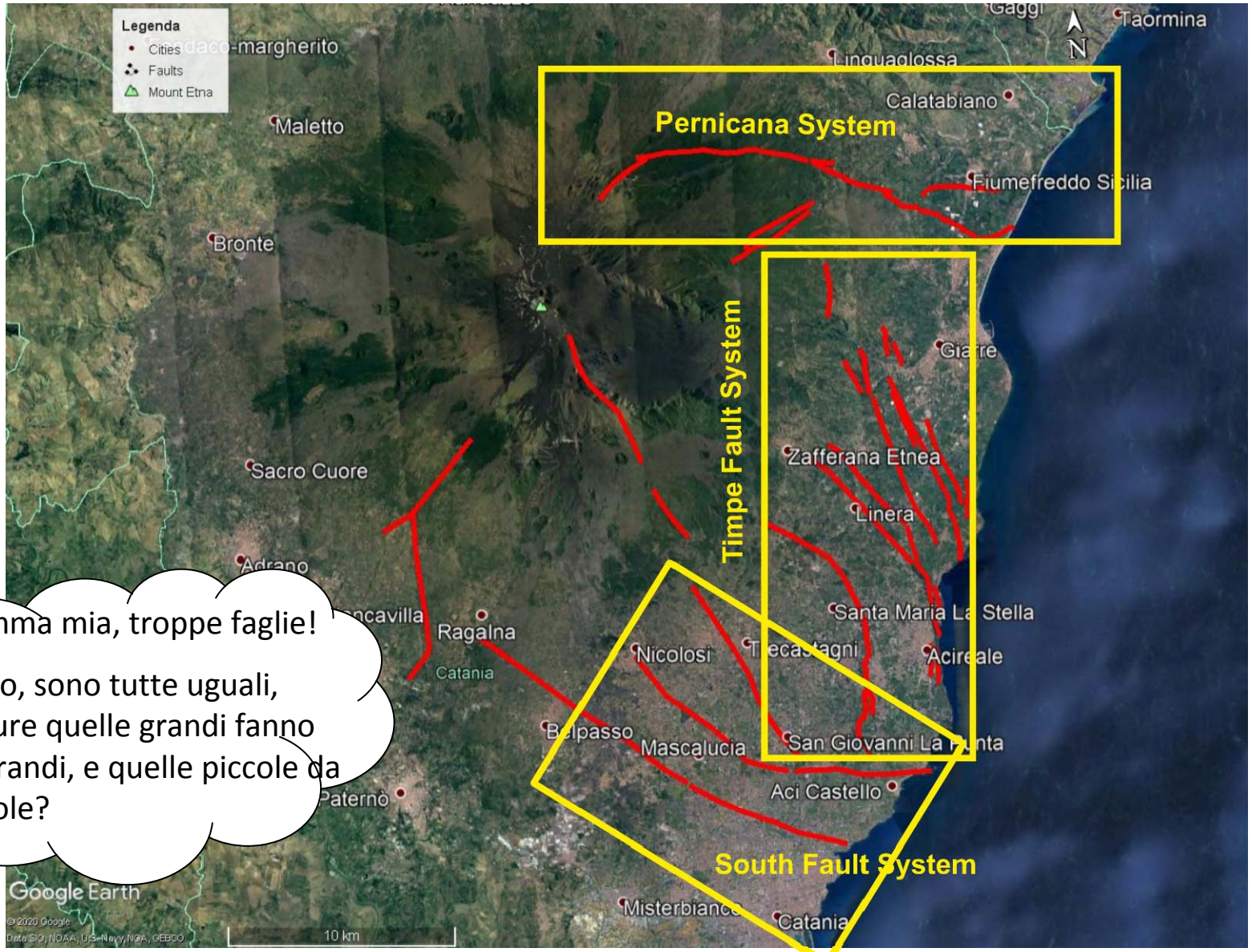


Timpa of Acireale





Where are the faults?



comu diceva u vècchiu Padron 'Ntoni

Mamma mia, troppe faglie!

Ciccio, sono tutte uguali, oppure quelle grandi fanno da grandi, e quelle piccole da piccole?

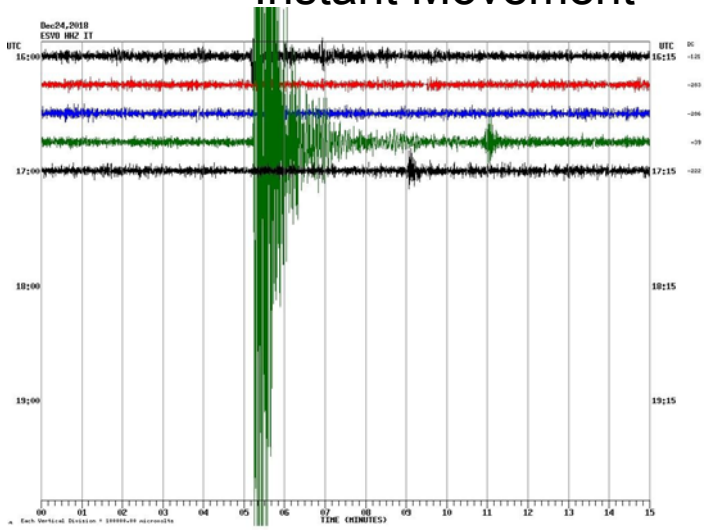
Faults on Etna

Seismic faults

Aseismic faults

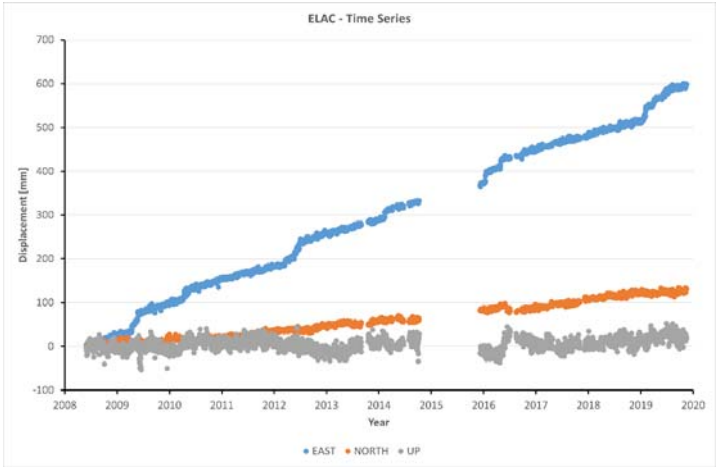
Chissà se esistono faglie alternativamente sismiche e asismiche?

Instant Movement



Seismogram of the earthquake of December 2018 at the seismic station ESVD

Slow Movement

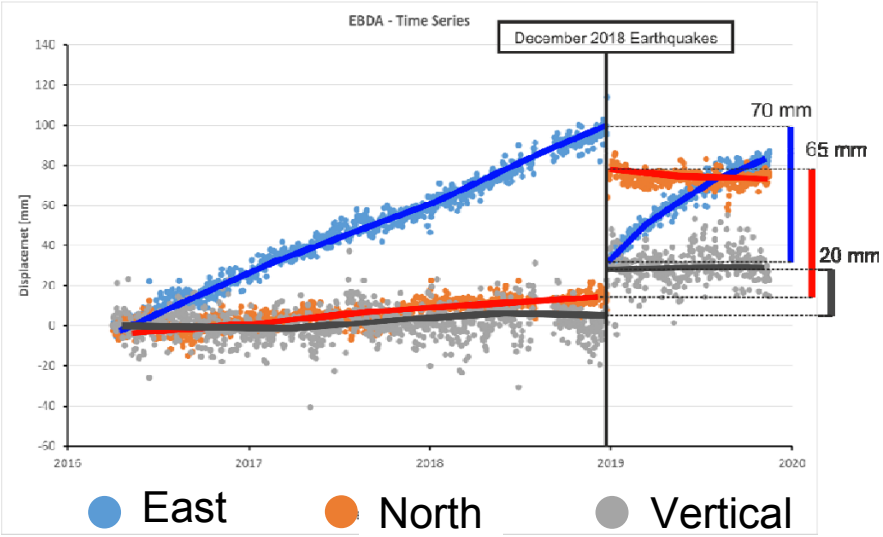


Time series of the GPS station ELAC

drawings from Pierre Bichet

The seismic fault of December 2018

The village of Fleri after the December 2018 earthquake

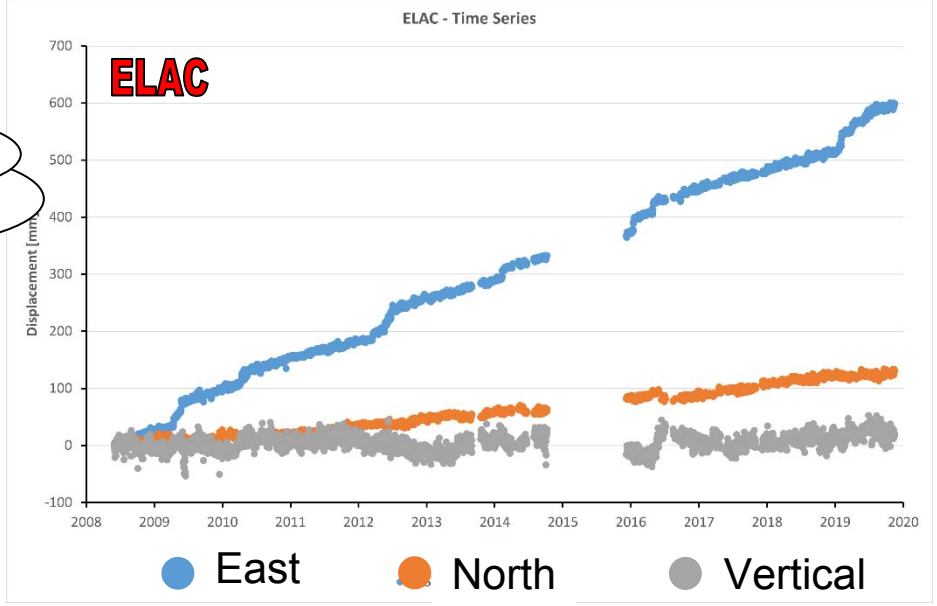


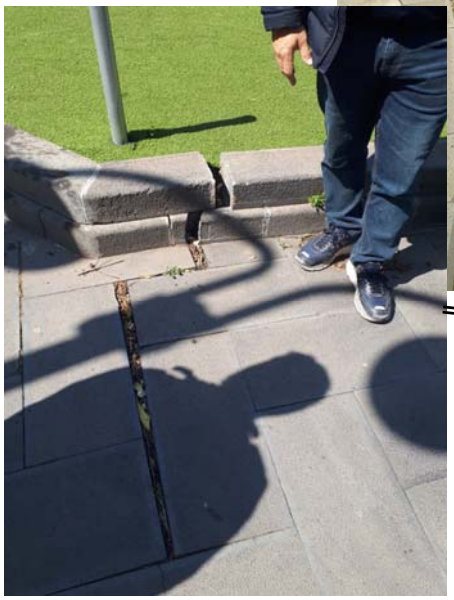
Abrupt motion at the EBDA GPS station in december 2018

The aseismic fault of Aci Trezza

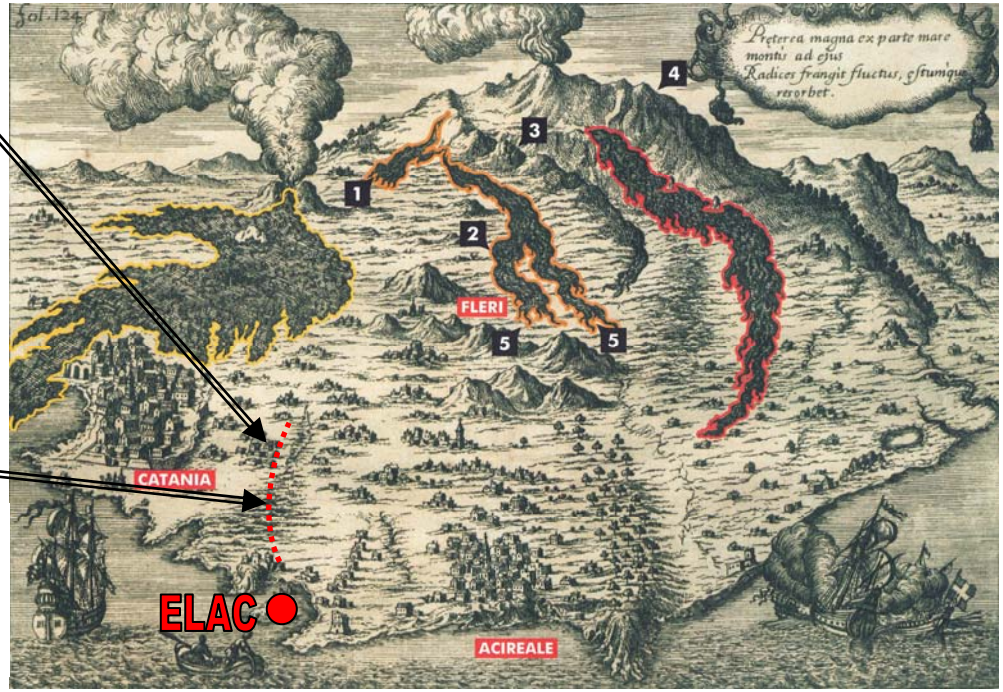
La faglia è mobile, qual piuma al vento, ...

Tremestieri



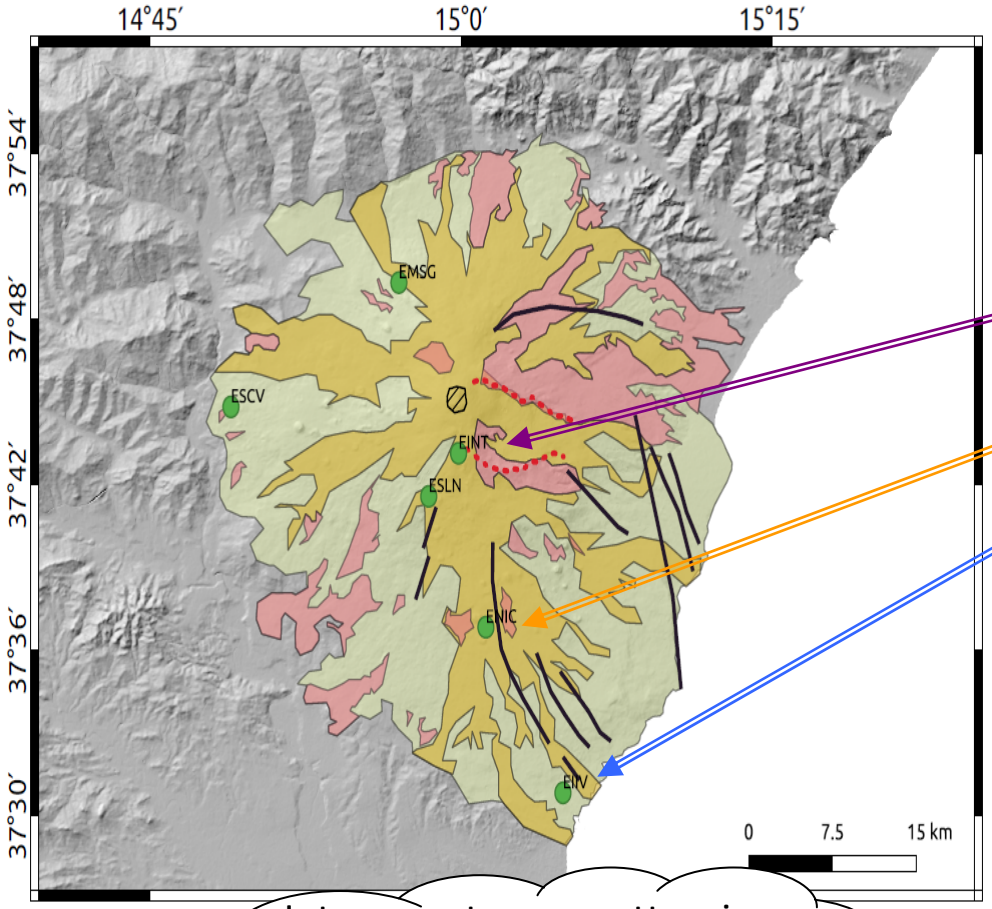


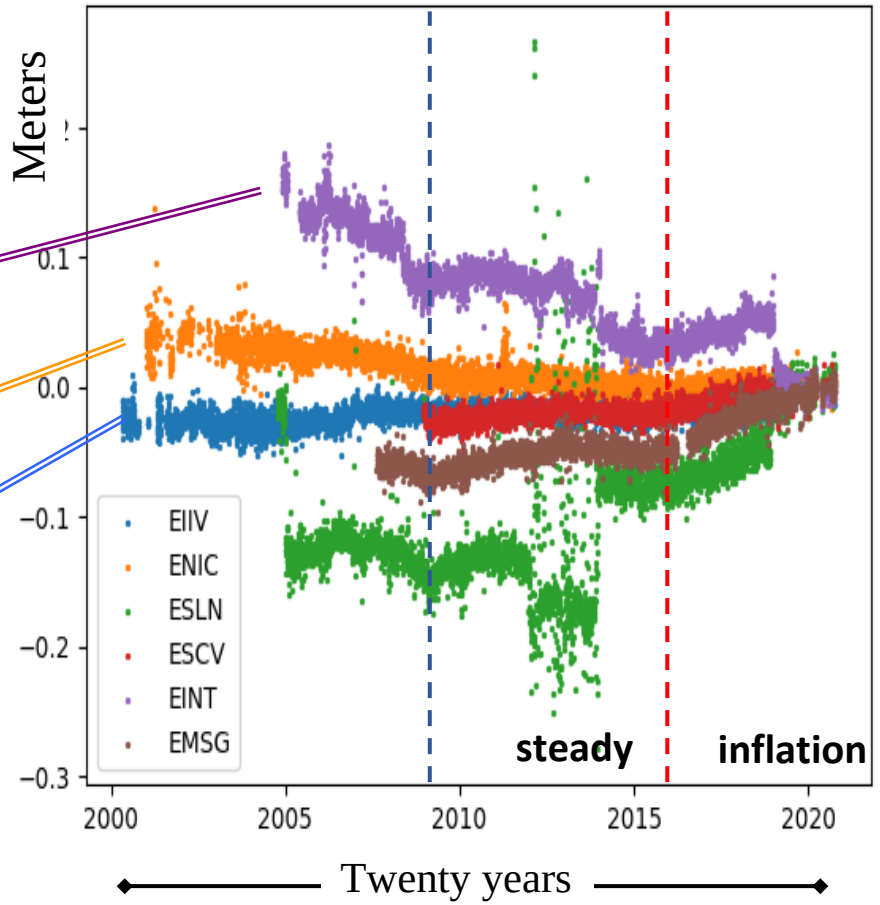
San Gregorio



Aseismic cracks along the Aci Trezza – San Gregorio fault zone

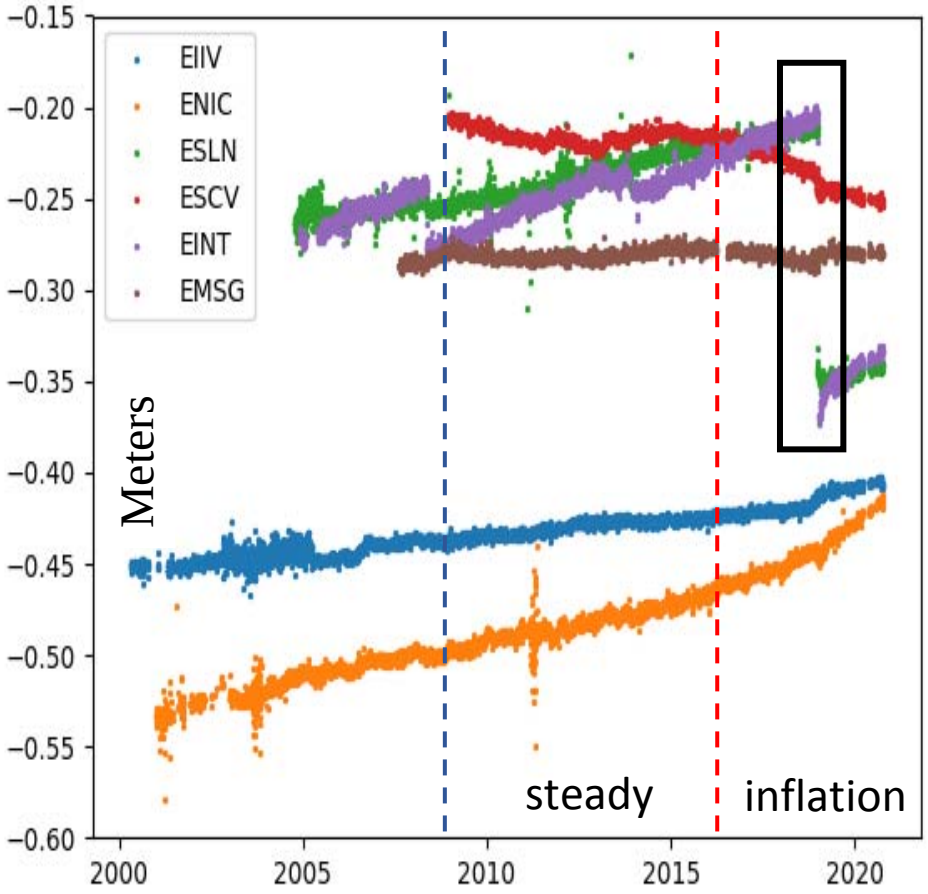
Vertical movement of the GPS stations





Horizontal movement of the GPS stations

East component

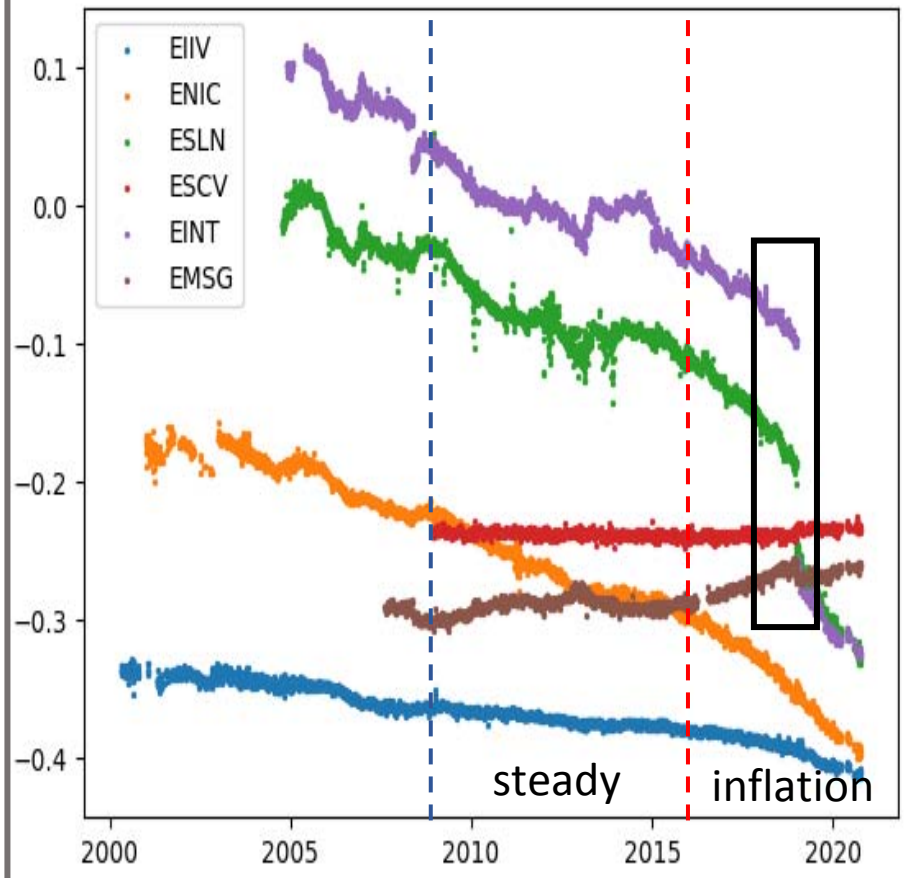


Increasing position towards East

EINT break of position during 2018 eruption

ESLN break of position during 2018 eruption

North component

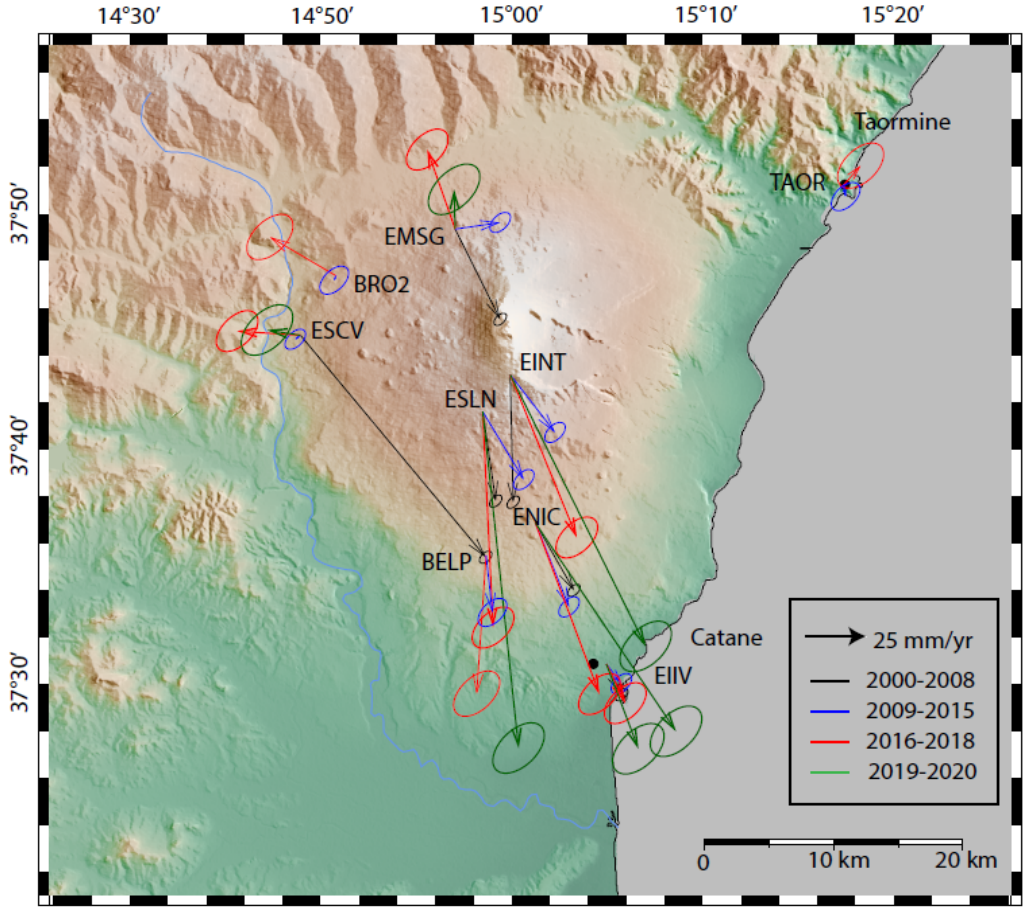


Increasing position towards South

EINT break of position during 2018 eruption

ESLN break of position during 2018 eruption

Horizontal velocities of the GPS stations



2000 – 2020 DEFORMATION PATTERNS

2000 - 2008

Mainly towards East flank of Etna

Secular flank collapse

2009 - 2015

Mainly towards East flank of Etna

Steady velocities

2016 - 2018

Change of orientation

Radial inflation

Increasing velocities

2019 - 2020

High velocities close to summit

Radial inflation

Increasing velocities

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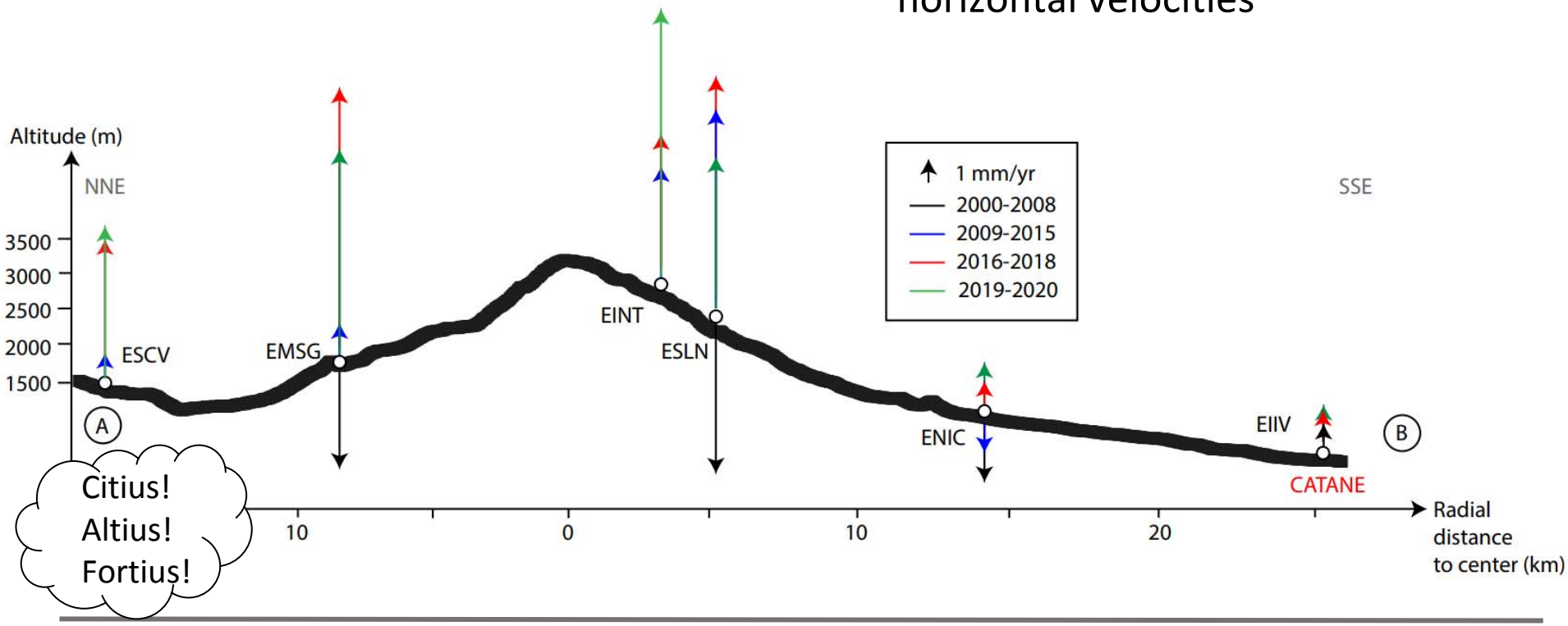
Vertical velocities of the GPS stations

NB: smaller amplitude than horizontal velocities



2000 - 2008

2009 - 2015

2016 - 2018

2019 - 2020

Deflation

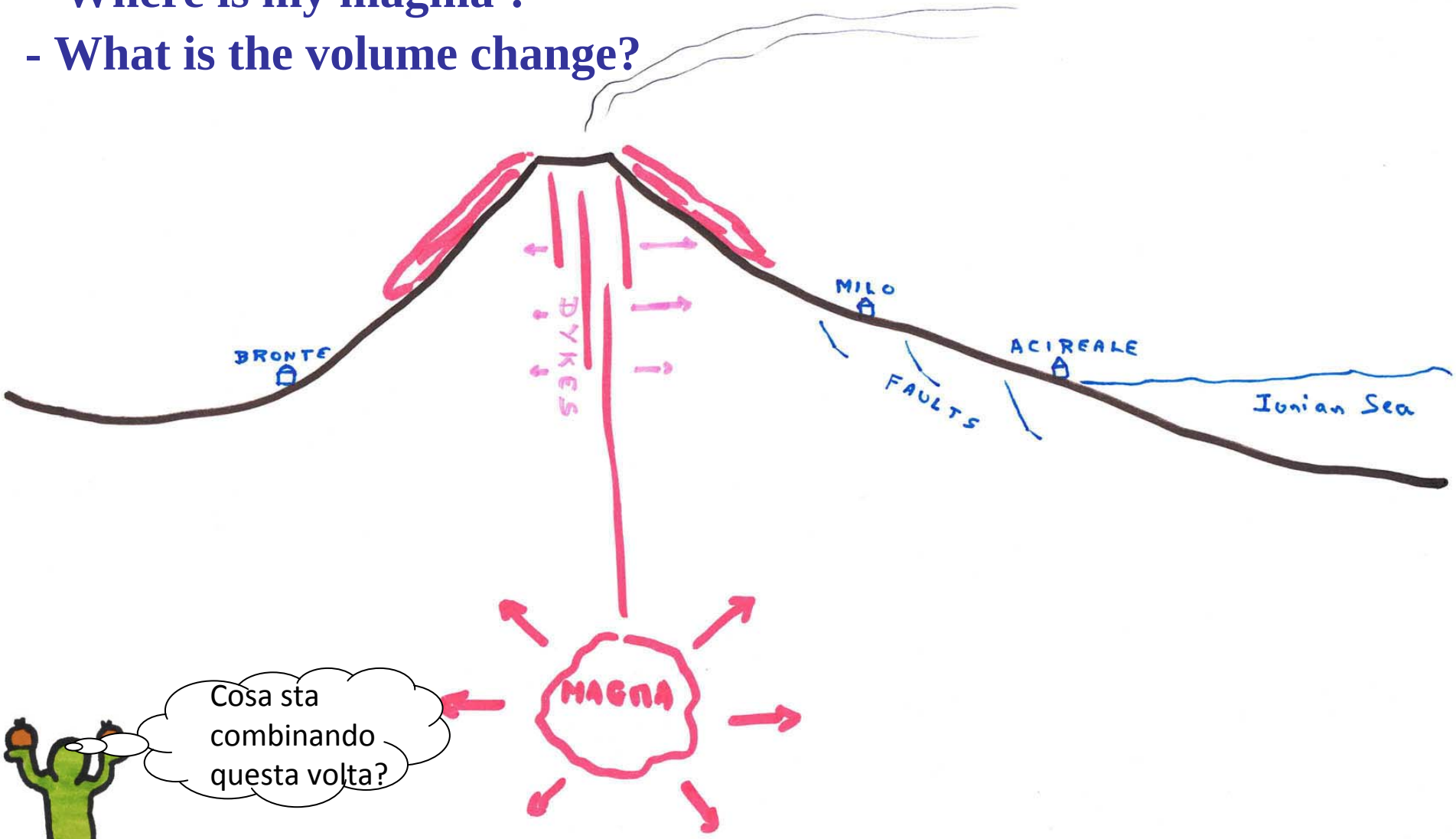
Gradual inflation

Higher velocities close to summit

The questions:

- Where is my magma ?
- What is the volume change?

The reality

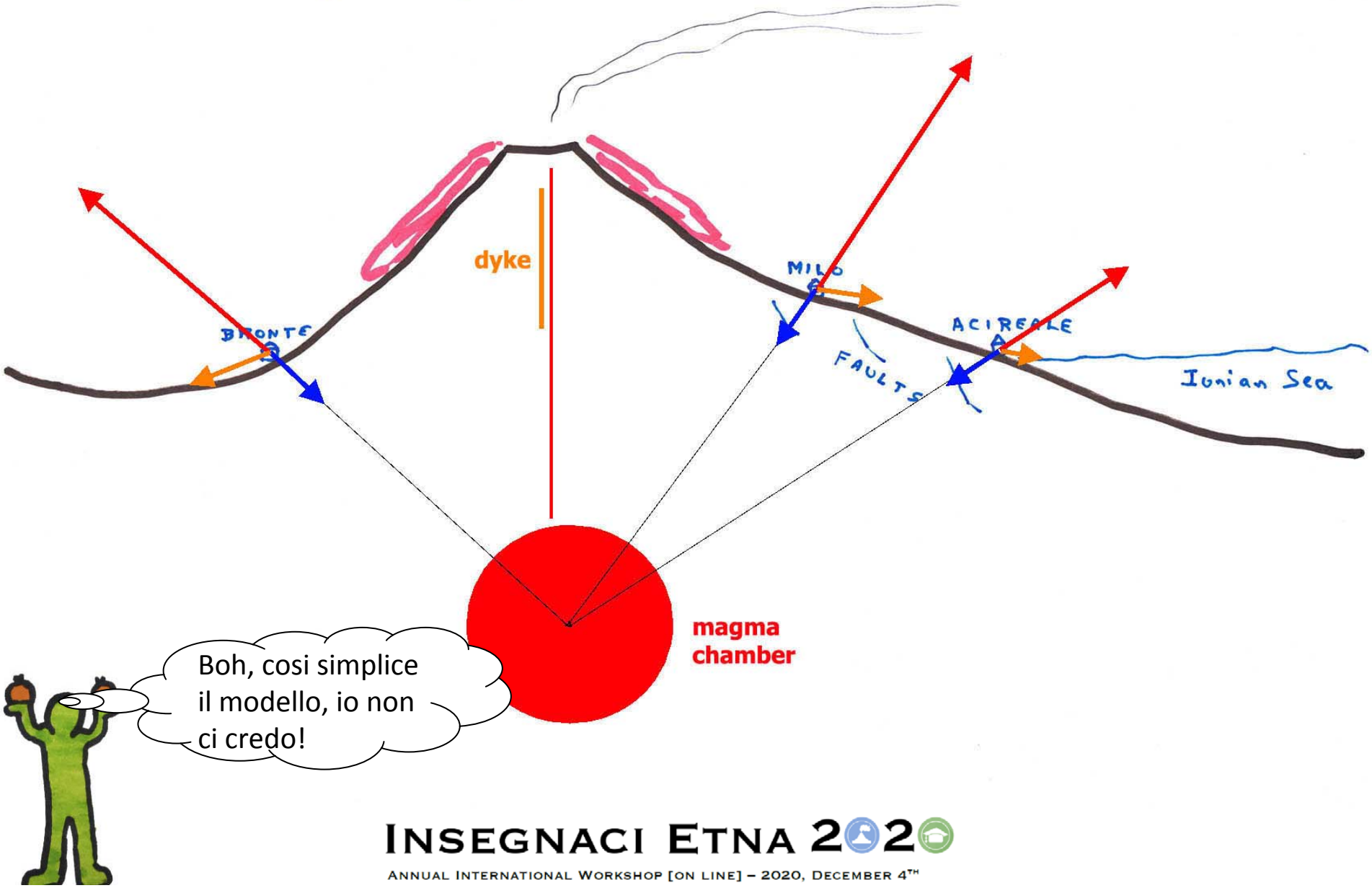


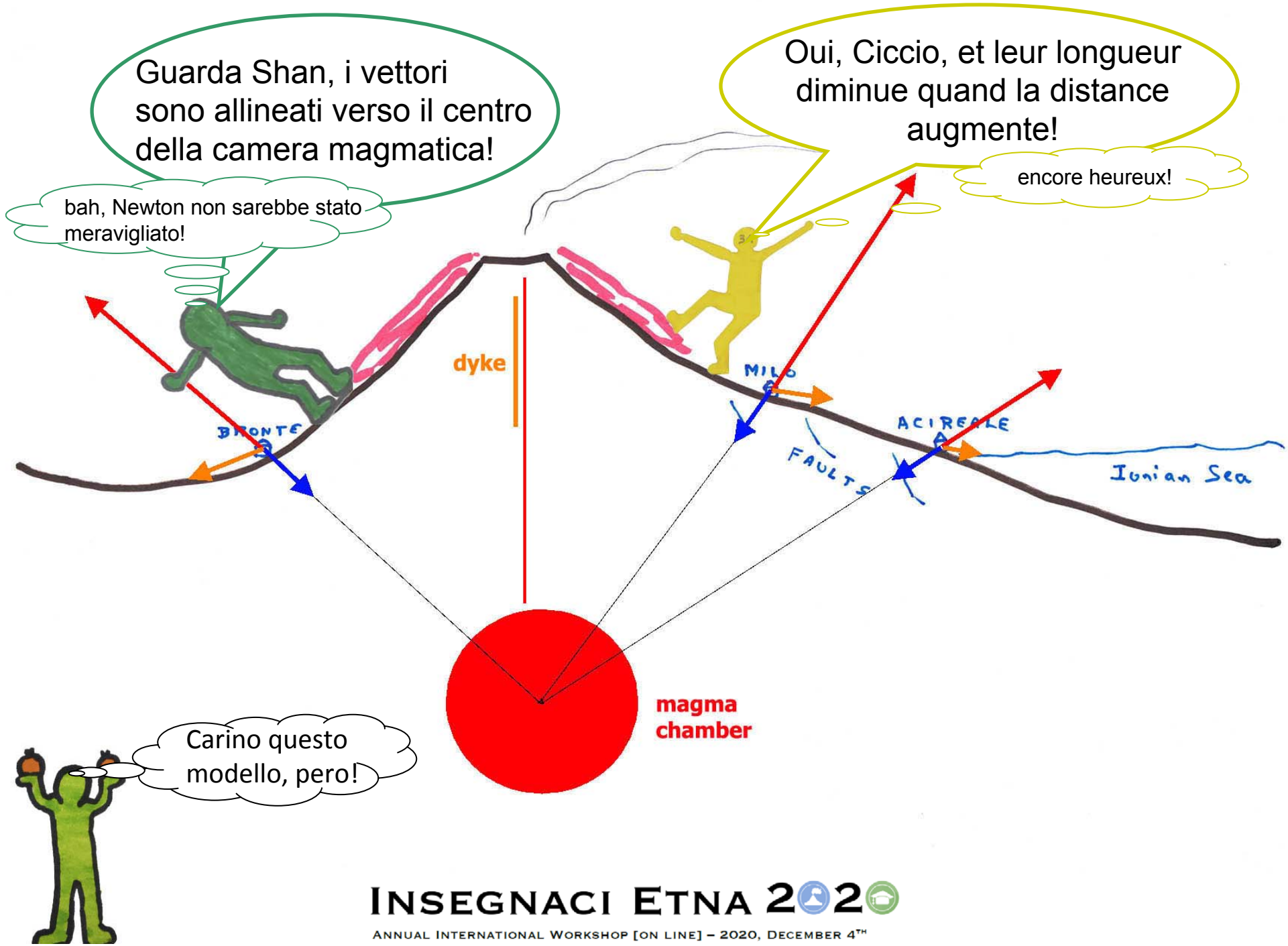
Ground deformation produced by a inflation of the magma chamber

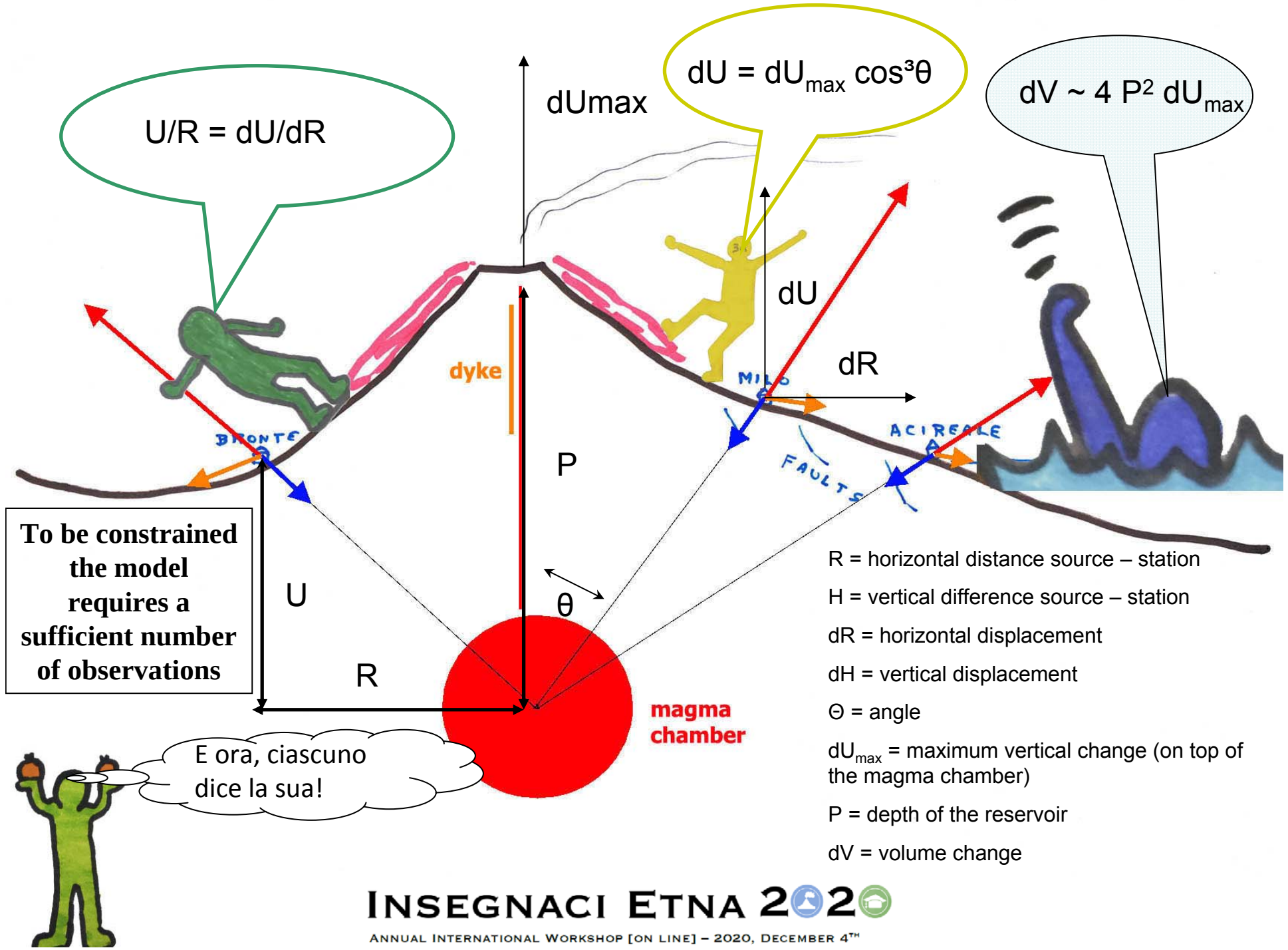
Ground deformation produced by a deflation of the magma chamber

Ground deformation produced by a dyke intrusion at shallow depth

The model !




Guarda Shan, i vettori sono allineati verso il centro della camera magmatica!
bah, Newton non sarebbe stato meravigliato!
Oui, Ciccio, et leur longueur diminue quand la distance augmente!
encore heureux!
dyke
BRONTE
MILO
ACIREALE
FAULTS
Ionian Sea
magma chamber
Carino questo modello, pero!

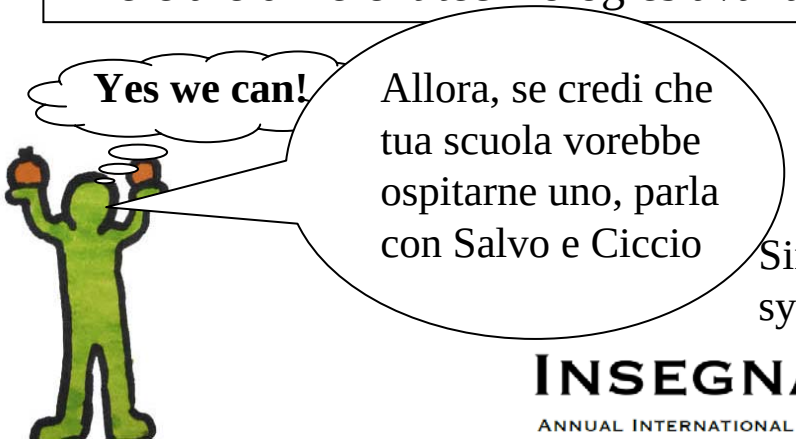

U/R = dU/dR
dUmax
dU = dU$_{max}$ cos^{3}θ
dV ~ 4 P^2 dU$_{max}$
dU
dR
dyke
P
U
R
θ
magma chamber
BRONTE
MILO
ACIREALE
FAULTS
To be constrained the model requires a sufficient number of observations
E ora, ciascuno dice la sua!
R = horizontal distance source – station
H = vertical difference source – station
dR = horizontal displacement
dH = vertical displacement
Θ = angle
dU$_{max}$ = maximum vertical change (on top of the magma chamber)
P = depth of the reservoir
dV = volume change

Tomorrow GPS in the schools of InsegnaciEtna ?

There is already one at the IISS Benedetto Radice, Bronte (here with Ugo Modica on the roof last year)!

Low cost GPS instruments could be installed in several school. This might be interesting for the students and their teachers and would make the GPS monitoring network of Etna denser.

There are different technologies available.



Simple and light mobile GPS system developed by INGV-OE

The Geocube light GPS experimented in 2017

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E tutto per oggi, ciao a tutti!
Ci vediamo sull'Etna (quello vero!) l'anno prossimo, per
InsegnaciEtna2021!