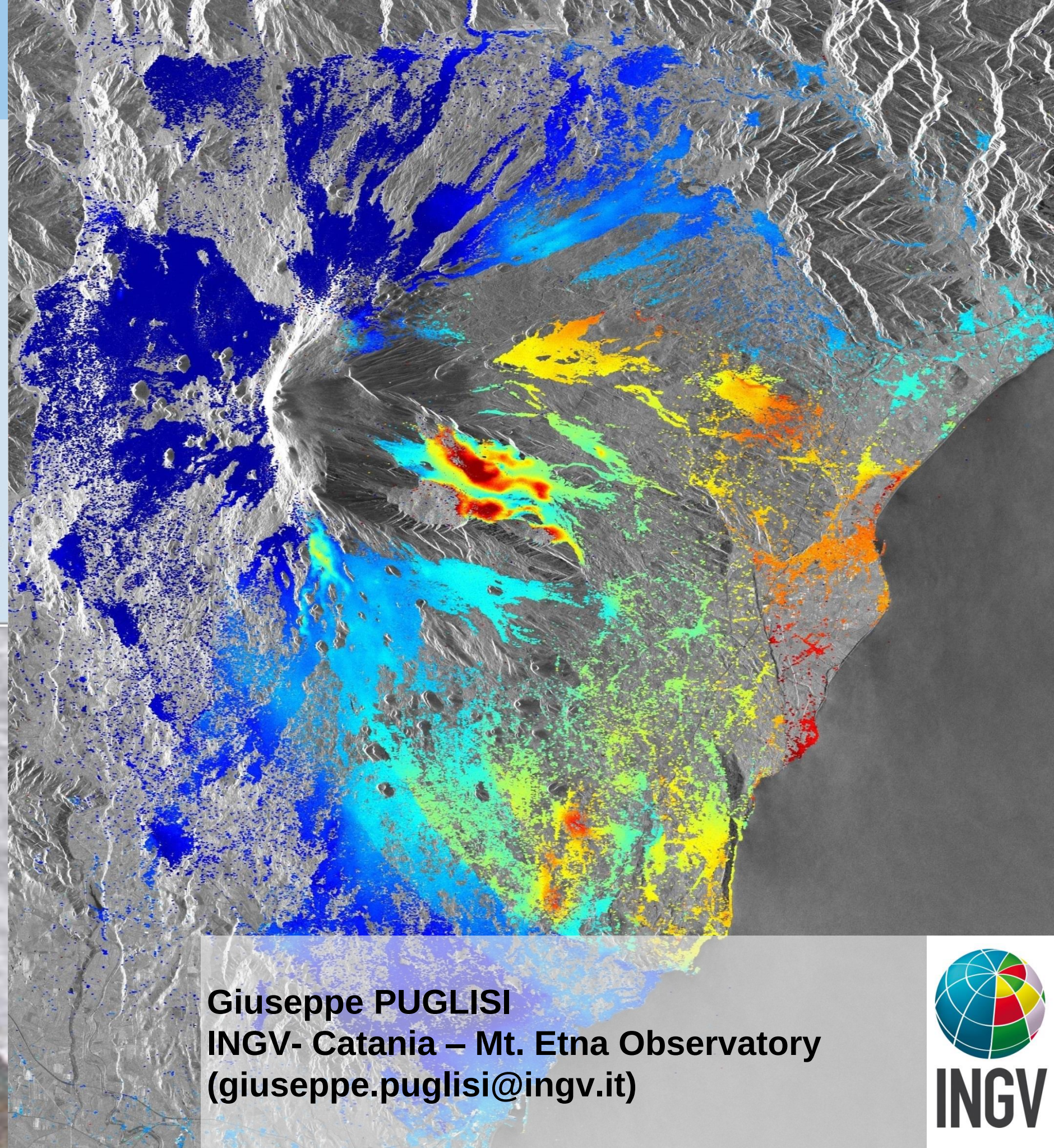
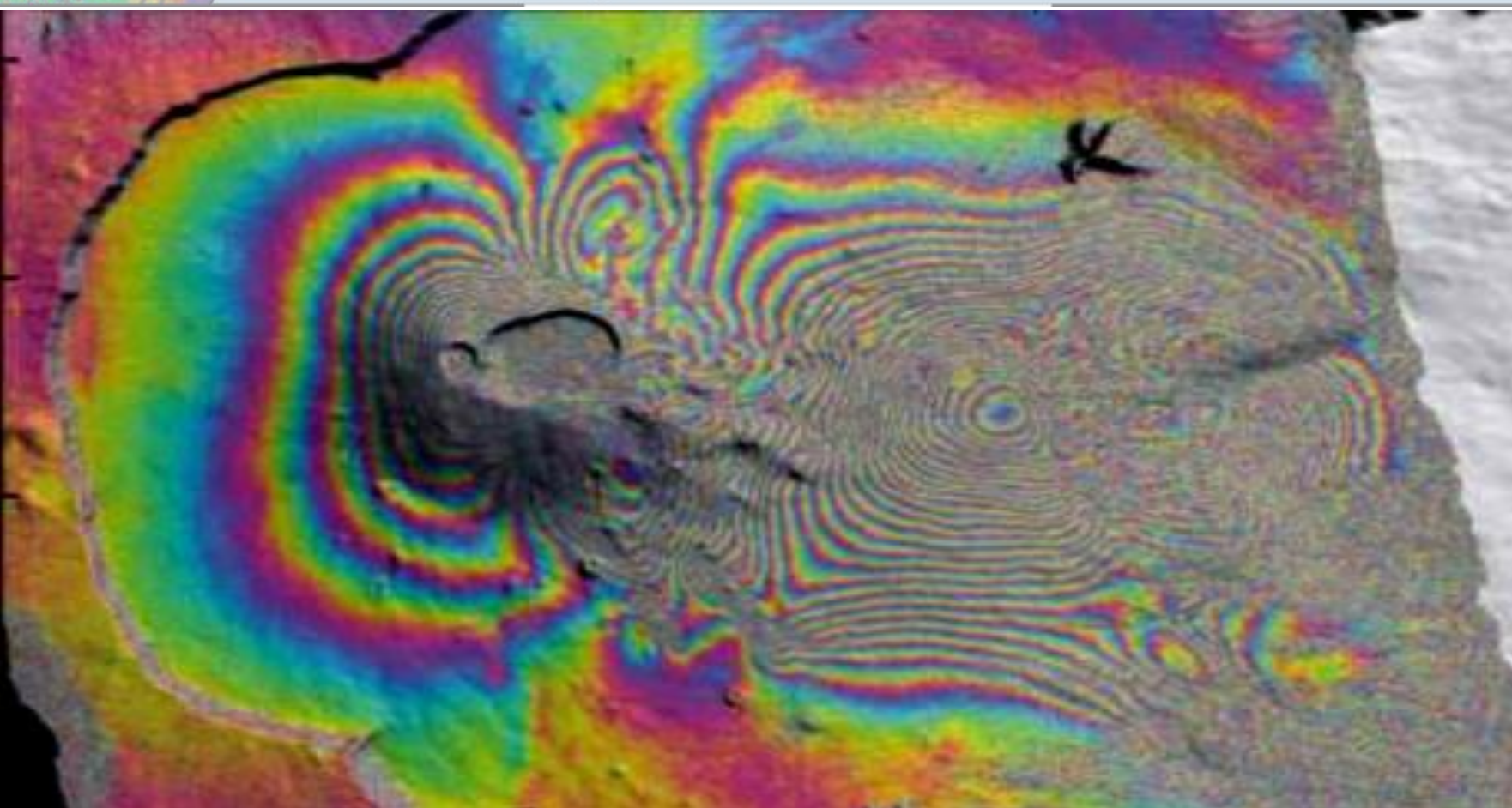
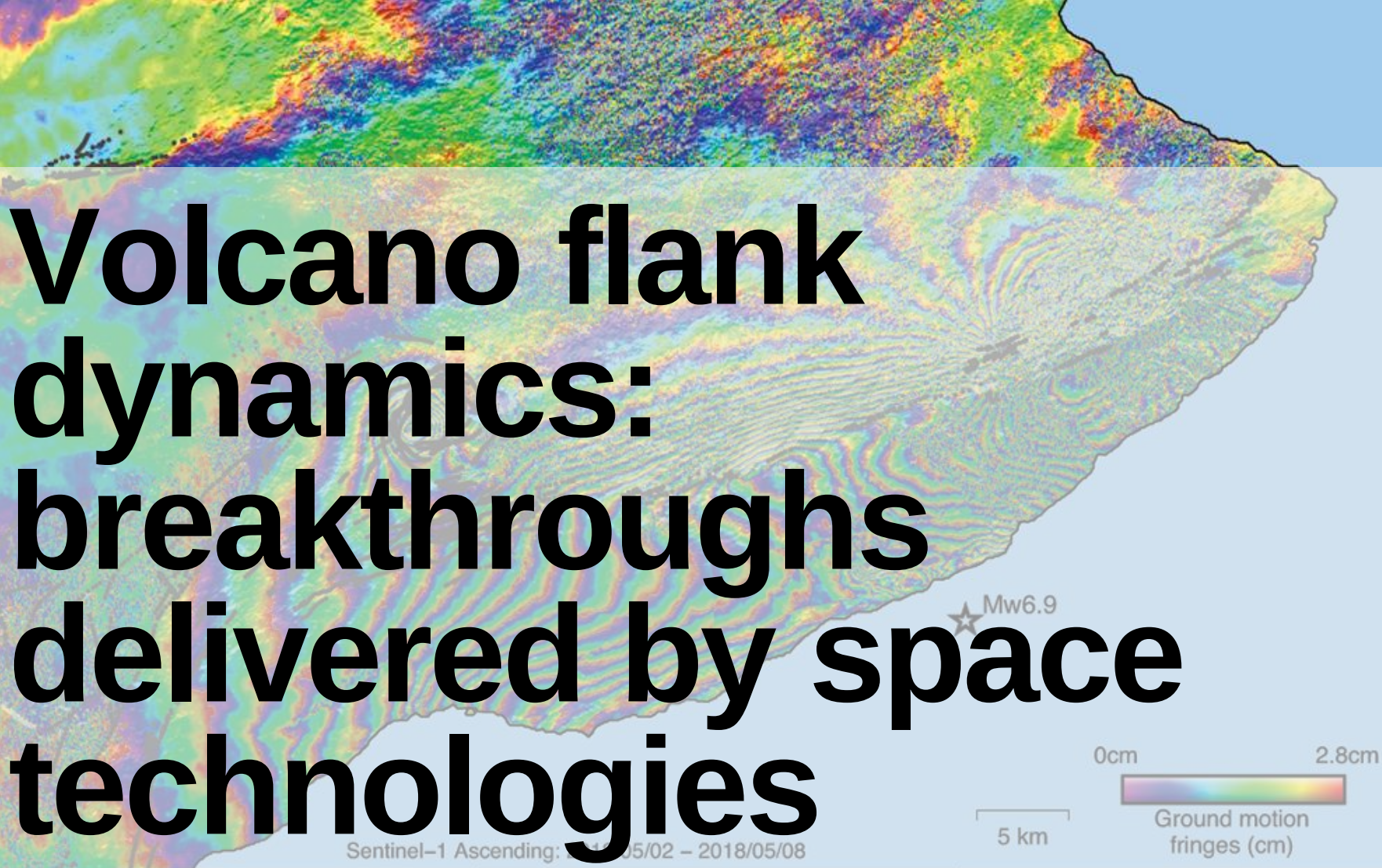
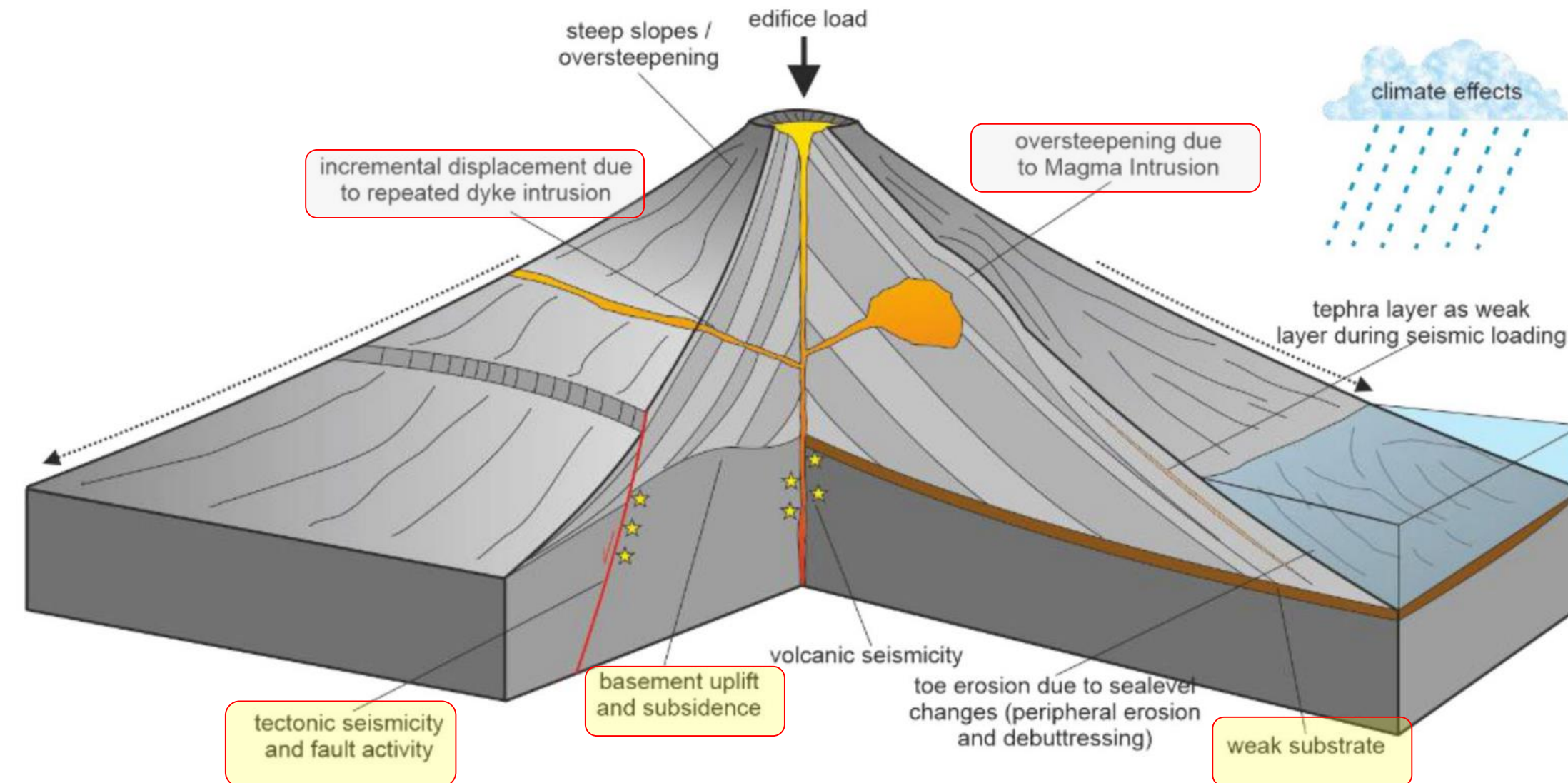


Volcano flank dynamics: breakthroughs delivered by space technologies



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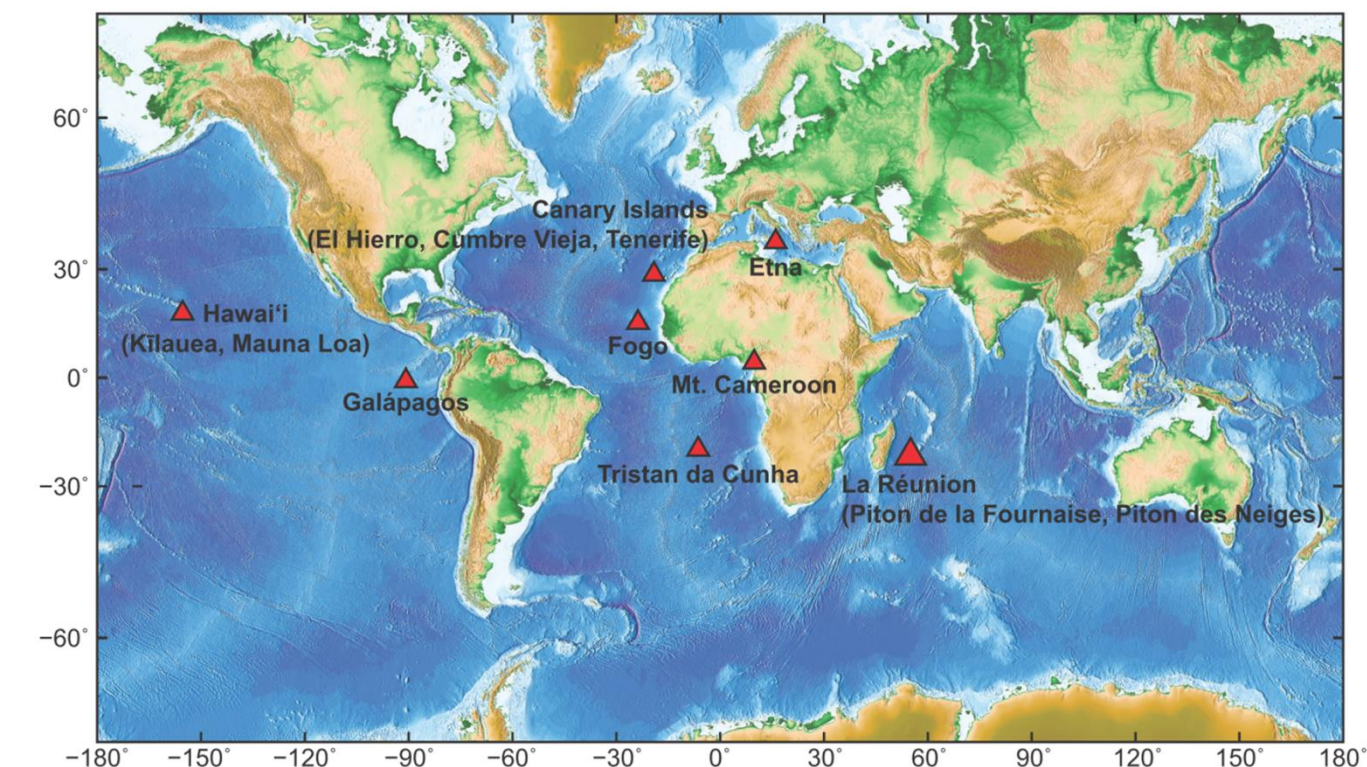
Volcano flank movements originate from ...



From Di Traglia et al., *Int. J. Earth Sc.* (2020) DOI: 10.1007/s00531-020-01930-9

We focus our attention to:

- **Persistent flank motion**, typically deep-seated, steady-state movement of large sectors of a volcano edifice due to interaction between gravity and magma dynamics (*Poland et al. 2017*), sometimes referred to as “volcanic spreading” (*Borgia et al. 1992; Merle and Borgia 1996*);
- **Transient flank motion** (i.e. flank “unrest”), considered the precursor to catastrophic collapses, associated with intrusive processes, co-eruptive deformation, seismic shaking, or other relatively rapid increases in shear stress (*de Vries and Davies 2015*);



From Poland et al., *J. Volcanol. Geoth. Res.* (2017) DOI: 10.1016/j.jvolgeores.2017.05.004

Persistent flank motion may trigger Transient flank motion with severe impacts in the society

- Flank Eruptions
- Lateral Blasts
- Sector collapses
- Landslides
- Tsunamis

State of the art at the end of '80th



Main questions

- **Extension:** how wide are the areas affected by persistent flank motions?
- **Structure:** how is the tectonic setting of the areas affected by persistent flank motion ?
- **Rate:** how fast / steady is the motion ?

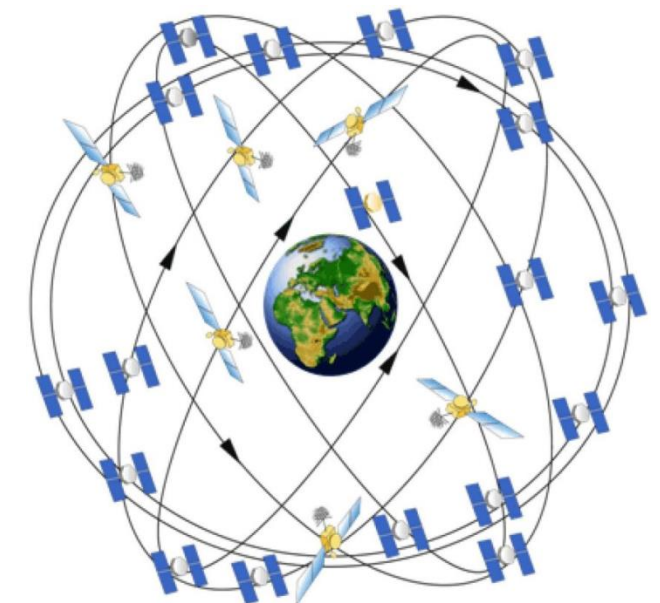
Limits of the measurements / observations

- **Time/efforts consuming:** all geodetic techniques are accurate enough, but require surveys for weeks/months, involving quite large crews;
- **“Point-wise”:** geodetic technique measure the coordinate of a specific point / network of points; **it is hard to define the extension of the moving area**
- **Discontinuous:** It is impossible to have continuous measurements
- **Qualitative:** geological observations are good to define the areas, but they do not provide information about the actual (now) movements.

The emergence of the space-based techniques for Earth Observations (GPS, SAR) on '90th years allow to overcome the limits of the previous geodetic techniques



For the first time we were able to cover the entire volcano edifice with a “single” measurement. Thus we gain, time, efforts and quantity/quality of data.



More information produces:

- New knowledge & new multidisciplinary studies
- Better models
- Increased capacity to assess the hazard

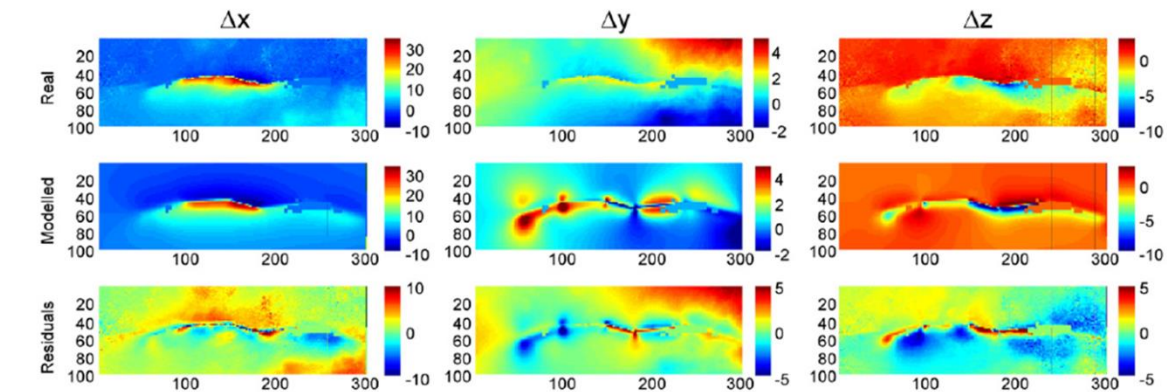
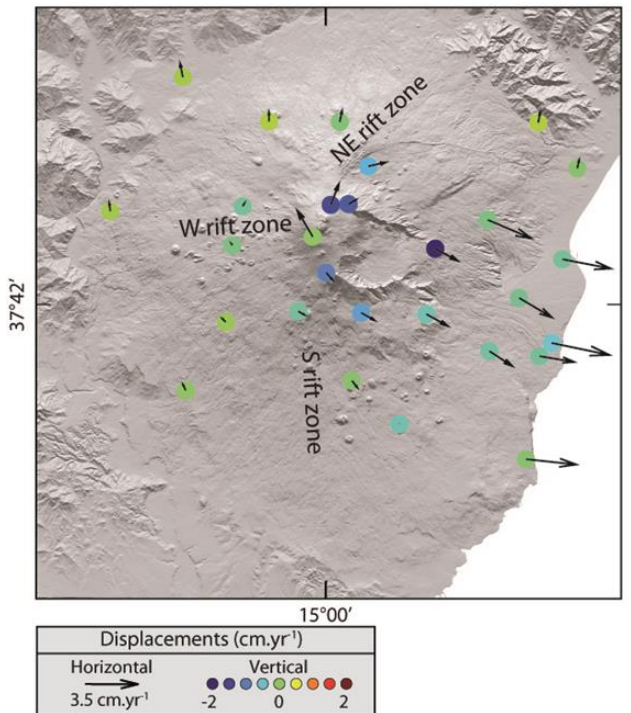
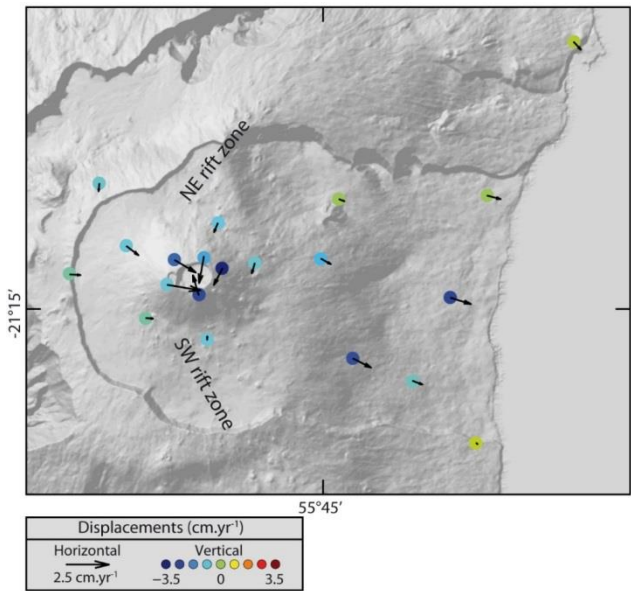
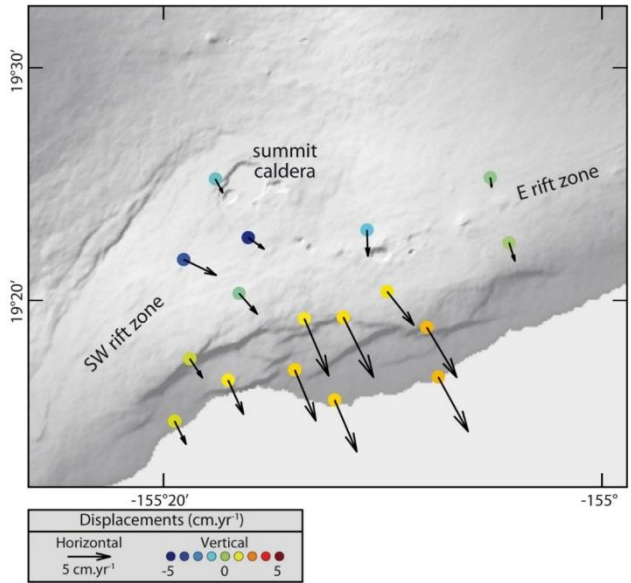
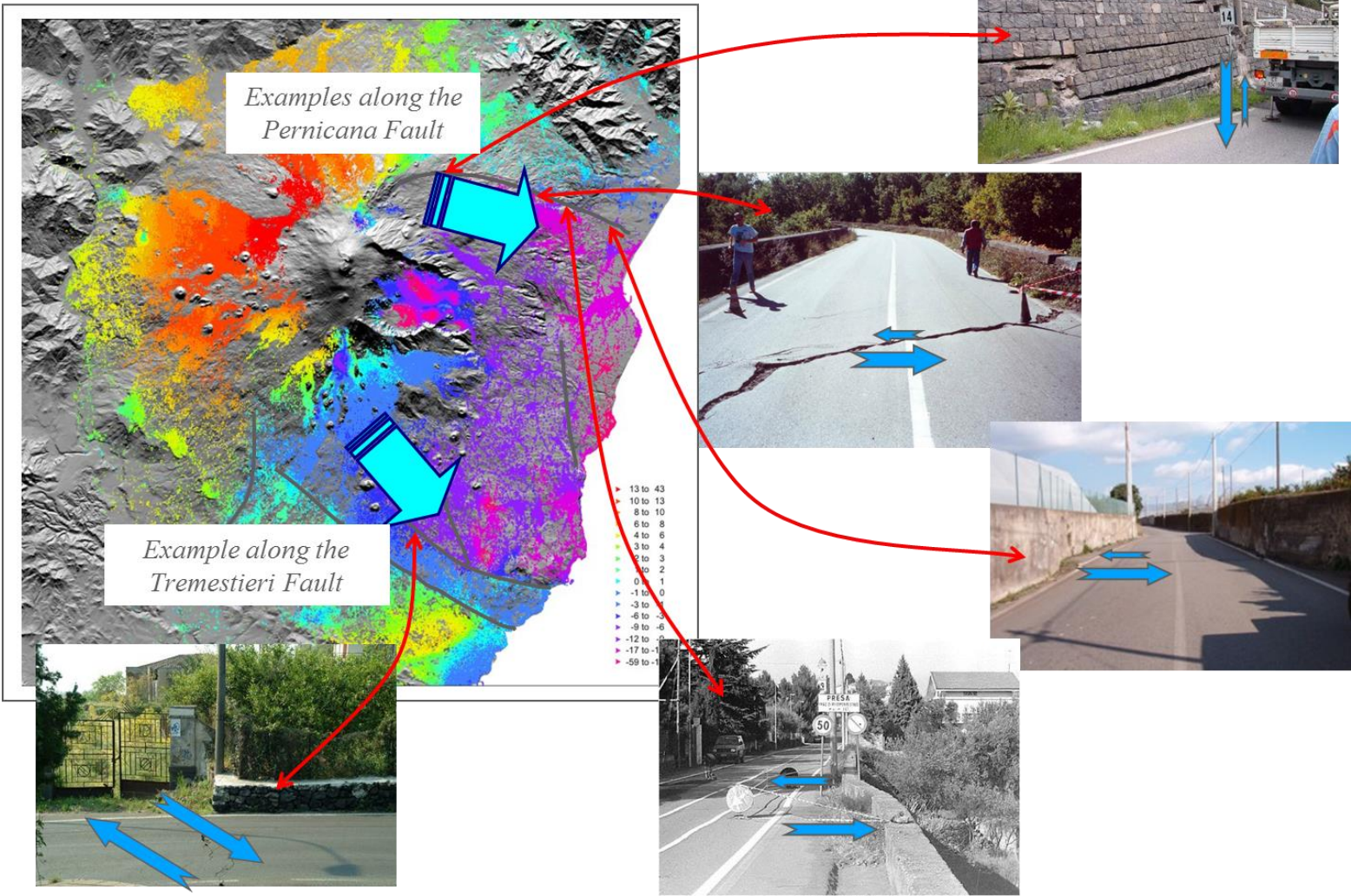
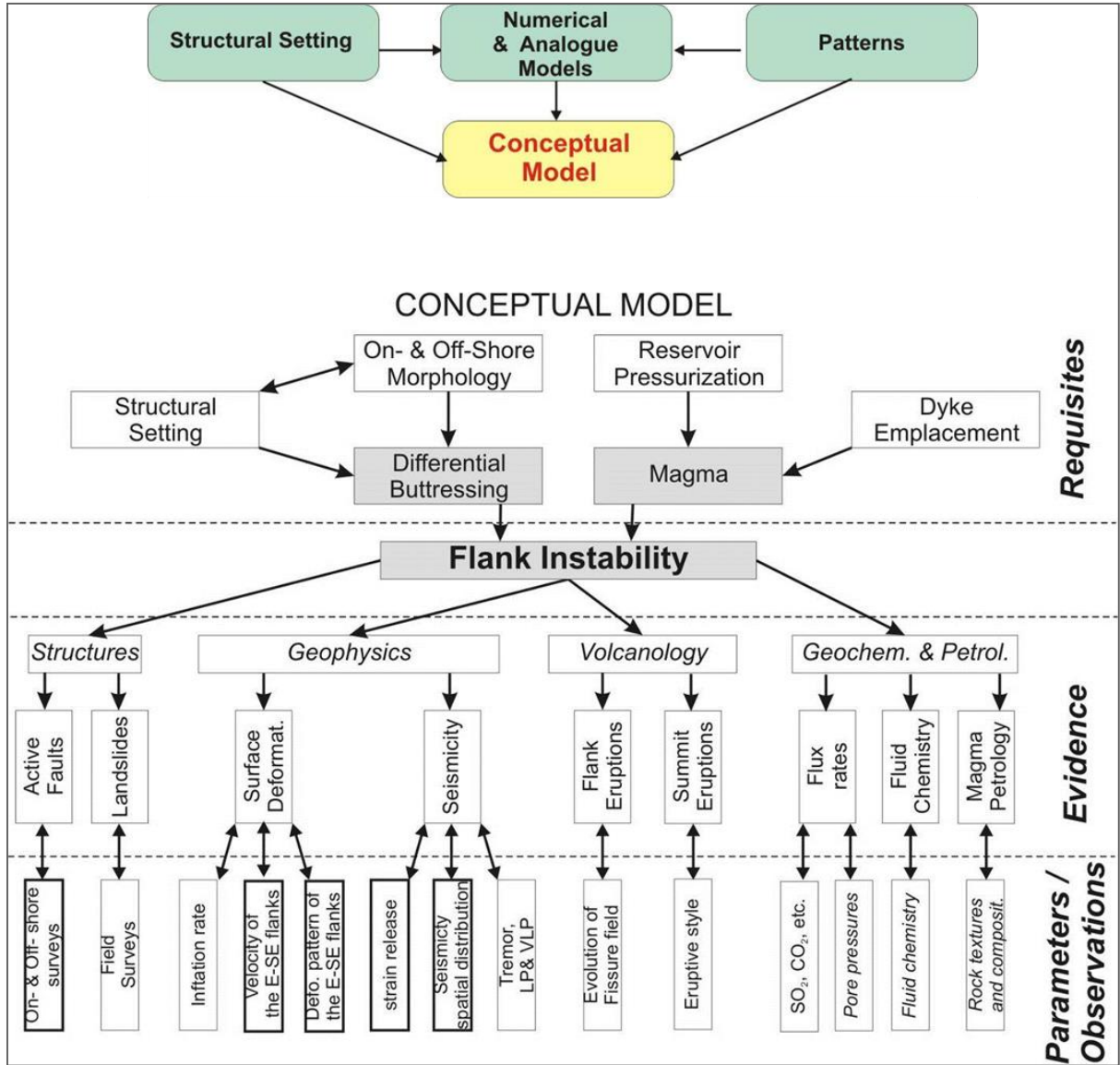
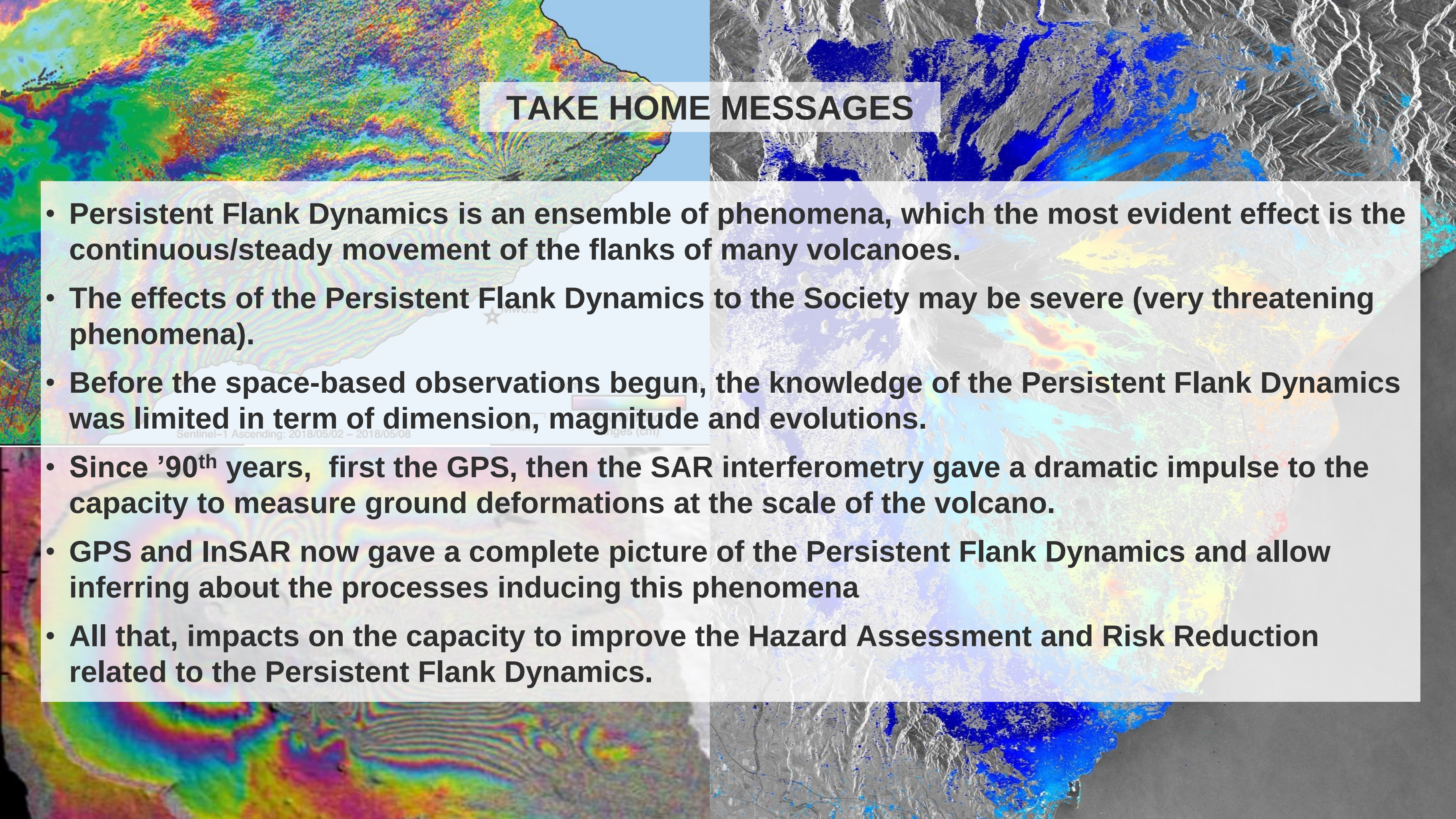


Fig. 9. Inversion results. In the first row are reported the measured Δx , Δy , and Δz components of the displacement field; in the second and third rows the corresponding calculated components, and the residual between measured and modeled displacement values are reported respectively. The values are in cm.

From Guglielmino et al. EPSL (2011)



From Acocella and Puglisi, J. Volcanol. Geoth. Res. (2013) DOI: 10.1016/j.jvolgeores.2012.06.016



TAKE HOME MESSAGES

- Persistent Flank Dynamics is an ensemble of phenomena, which the most evident effect is the continuous/steady movement of the flanks of many volcanoes.
- The effects of the Persistent Flank Dynamics to the Society may be severe (very threatening phenomena).
- Before the space-based observations begun, the knowledge of the Persistent Flank Dynamics was limited in term of dimension, magnitude and evolutions.
- Since '90th years, first the GPS, then the SAR interferometry gave a dramatic impulse to the capacity to measure ground deformations at the scale of the volcano.
- GPS and InSAR now gave a complete picture of the Persistent Flank Dynamics and allow inferring about the processes inducing this phenomena
- All that, impacts on the capacity to improve the Hazard Assessment and Risk Reduction related to the Persistent Flank Dynamics.

