Sentinel-1 – INSAR Performance Study with TOPS Data (A)
The Geodetical Framework of Vesuvius/Campi Flegrei test site

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INGV - Osservatorio Vesuviano (Naples, Italy)

- ***INGV-OV PRESENTATION***
- ***GEOPHYSICAL MONITORING NETWORKS***
- ***INSAR/GEODETICAL DATA COMPARISON: PREVIOUS EXPERIENCES***
- ***SENTINEL-1/GEODETICAL DATA COMPARISON: THE BEGINNING***
- ***REMARKS AND CONCLUSIONS***

The historical building of the Osservatorio Vesuviano

INGV-OV Presentation

The **Istituto Nazionale di Geofisica e Vulcanologia (INGV)**

- The largest Italian research institution in **Earth Sciences** with headquarter in Rome and offices in many cities all over Italy with about **1.000** personnel units;
- INGV runs surveillance networks, laboratories and observatories and collects, studies and disseminates data in the field of **seismology, volcanology, geodesy, geochemistry and marine sciences**;
- INGV is the **reference scientific institution** for the Italian government **in the field of geo-hazard** at national (DPC, Dipartimento della Protezione Civile) and local level.

The **Osservatorio Vesuviano (INGV-OV)**

- **Founded in 1841** by King Ferdinando II di Borbone, the Osservatorio Vesuviano, Naples branch of INGV **(INGV-OV)**, **is the oldest Volcanological Observatory in the World**;
- INGV-OV is in charge for monitoring the Neapolitan Volcanic District **(Vesuvius, Campi Flegrei and the Island of Ischia)** through geophysical, geodetical and geochemical networks located in the area.

The INGV-OV monitoring center

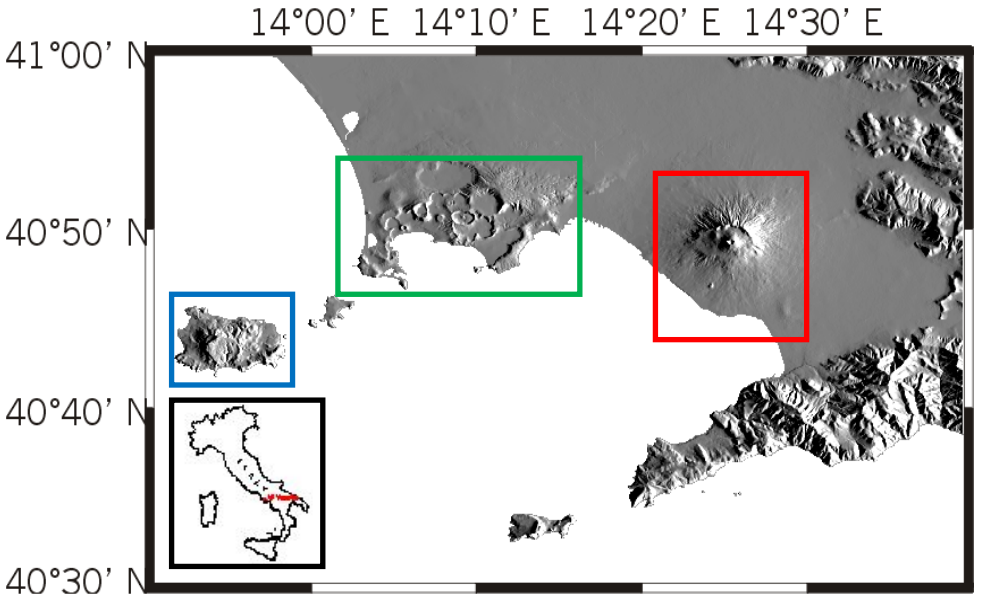
The Neapolitan Volcanic District (Southern Italy)

In the Neapolitan Volcanic District there are three active volcanoes

- Mt. Vesuvius
- Main eruptions 79 A.D., 1631
- Last eruption 1944

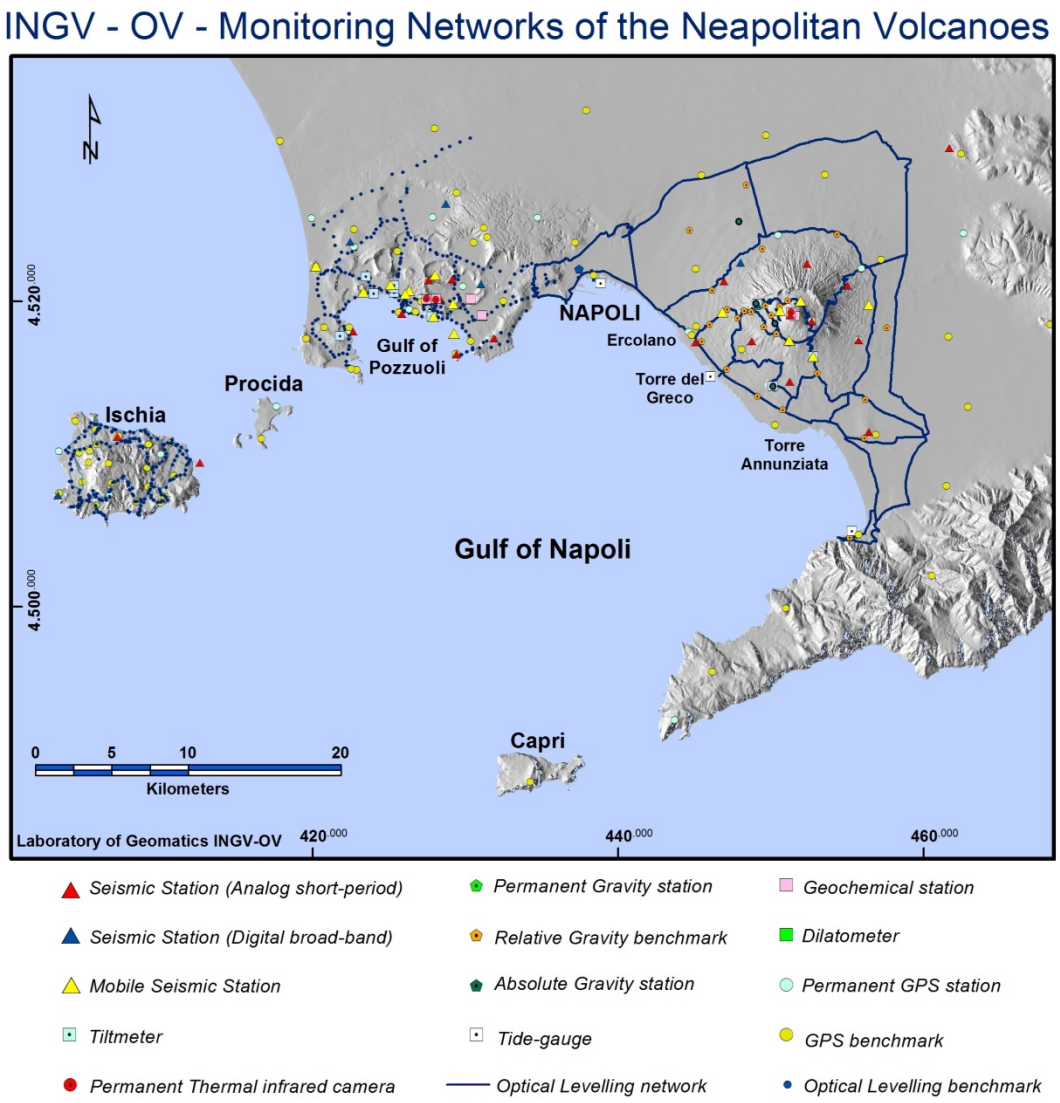
- Campi Flegrei
- Main eruptions 39.000 years ago, 15.000 years ago
- Last eruption 1538

- The Island of Ischia
- Main eruption 55.000 years ago
- Last eruption 1302

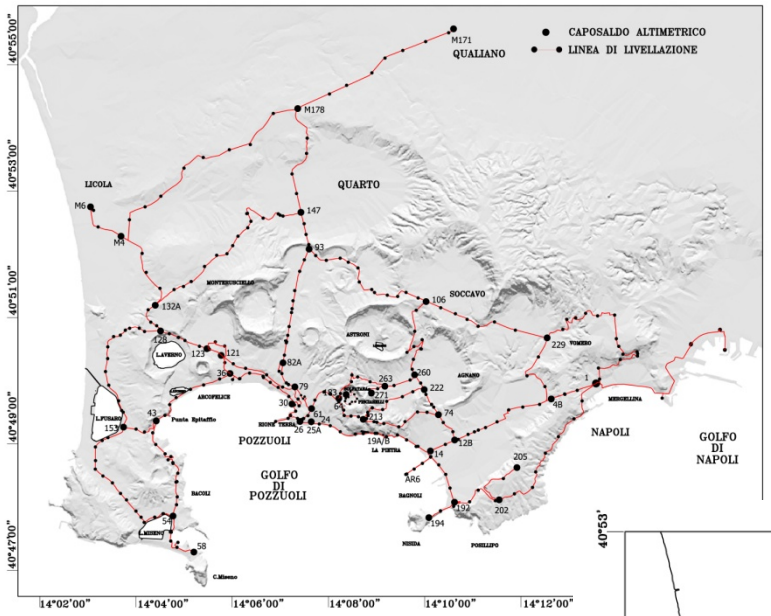


INGV-OV is in charge for monitoring the Neapolitan Volcanic District (up)

Geophysical Monitoring Networks

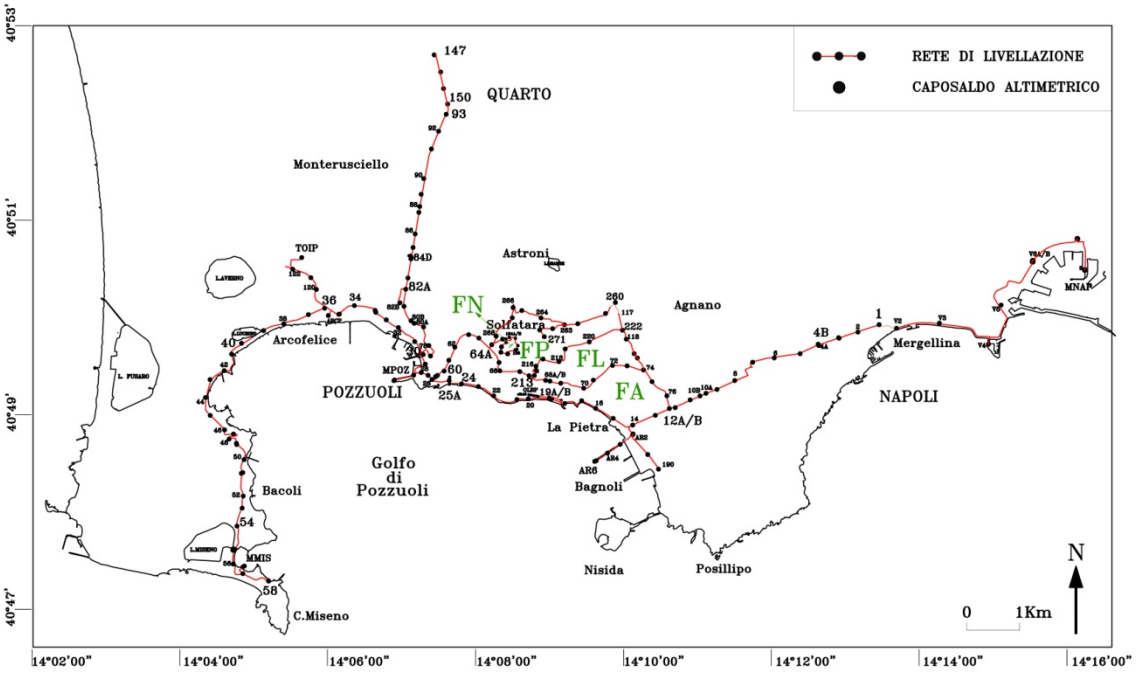


Geodetical Networks (leveling)



The Campi Flegrei leveling network

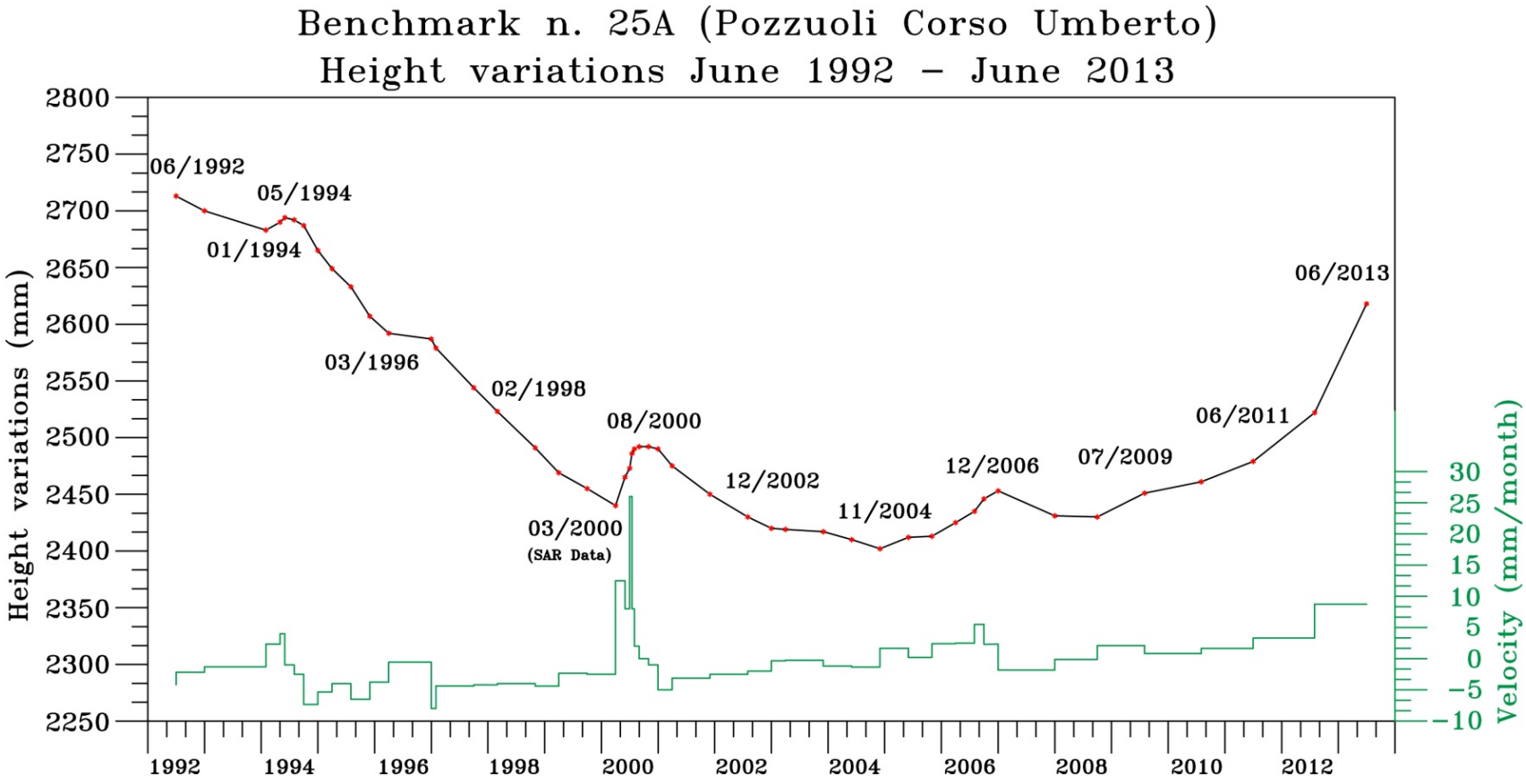
- 370 benchmarks
- 140 Kms
- 15 loops
- coverage: ~160 Km^2 - mean distance: 400ms



Napoli - Pozzuoli - Miseno line
Pozzuoli - Quarto line

(Image courtesy C. Del Gaudio)

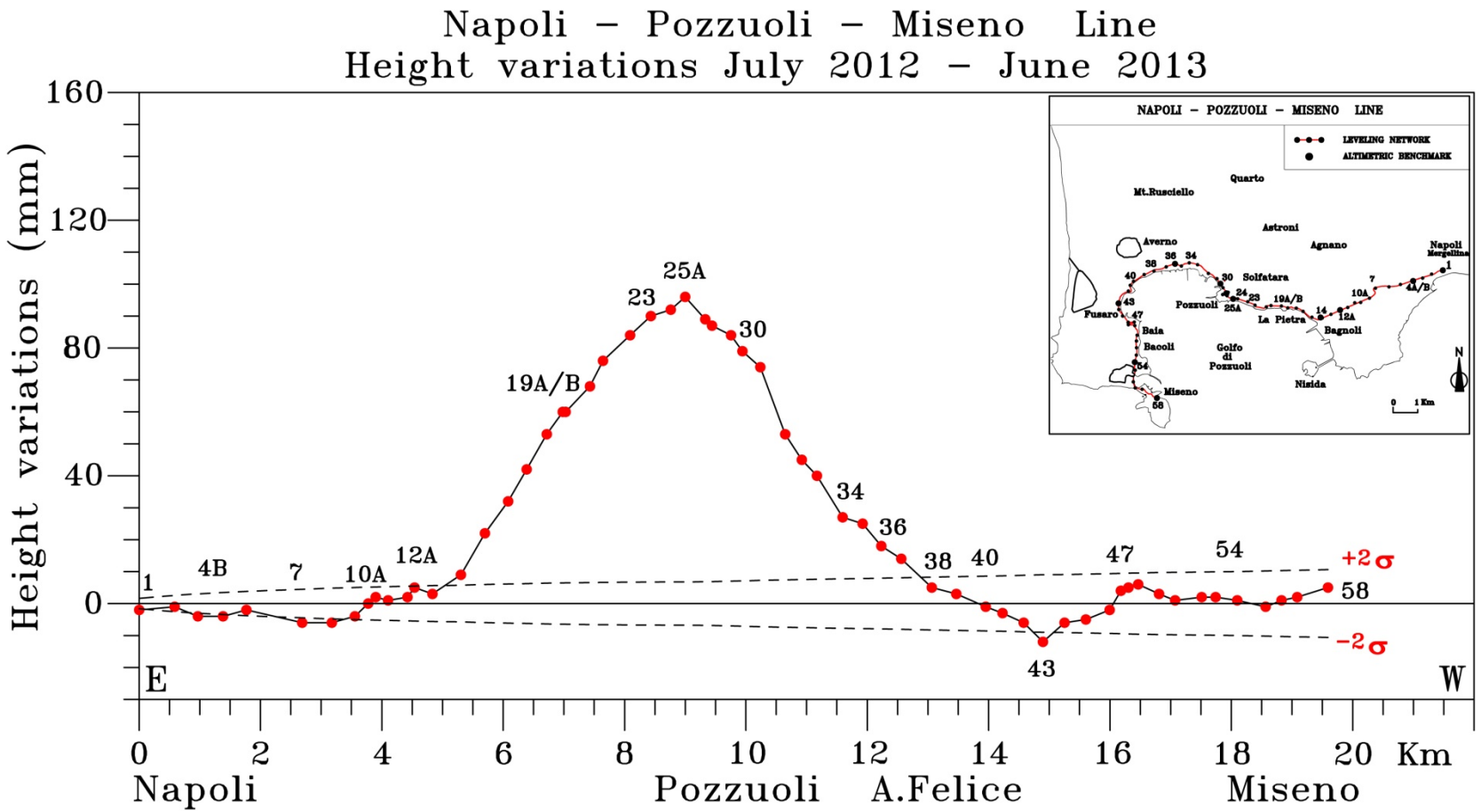
Leveling Measurements at bm 25A



For a better comparison with InSAR archive data…

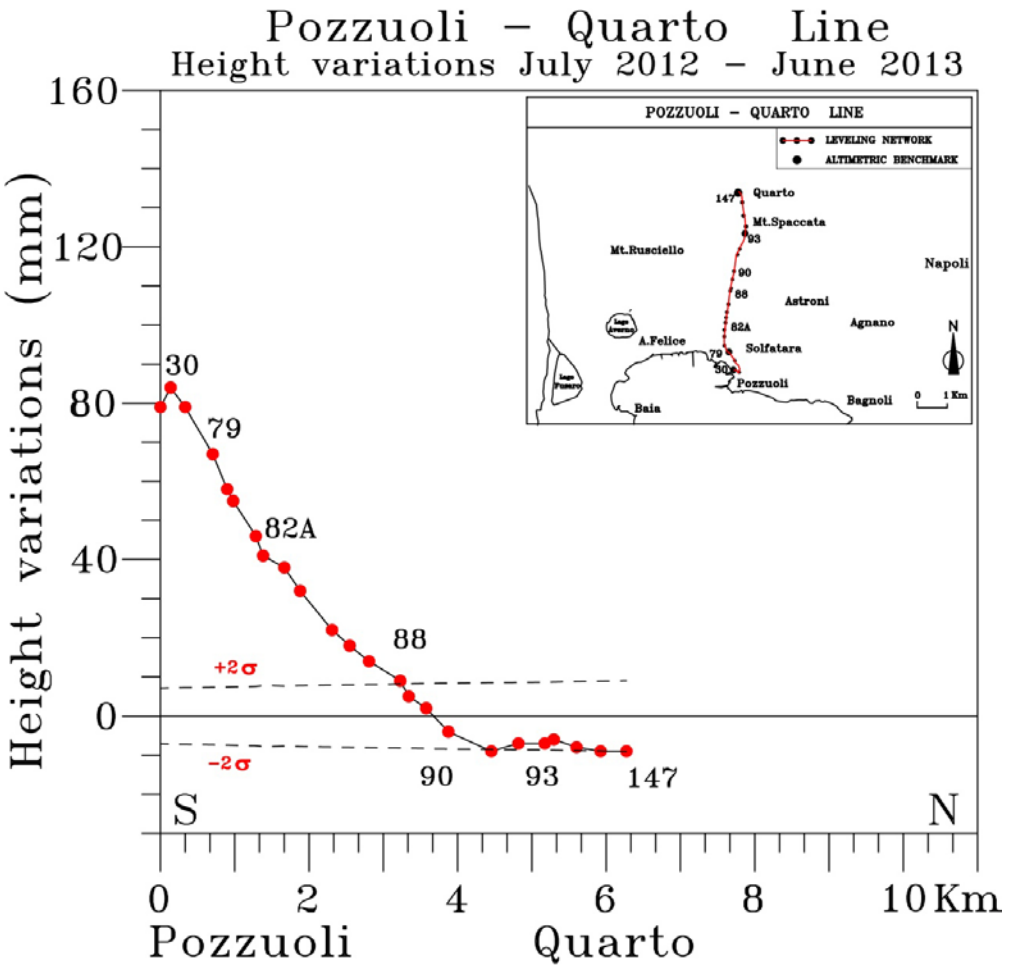
(Image courtesy C. Del Gaudio)

Recent Results from Leveling Measurements



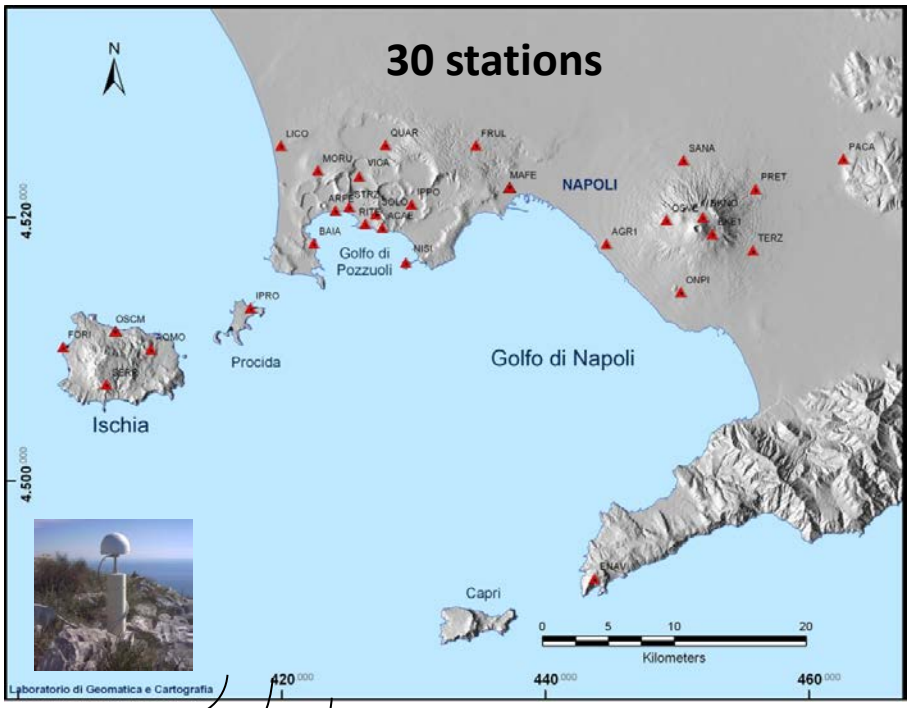
(Image courtesy C. Del Gaudio)

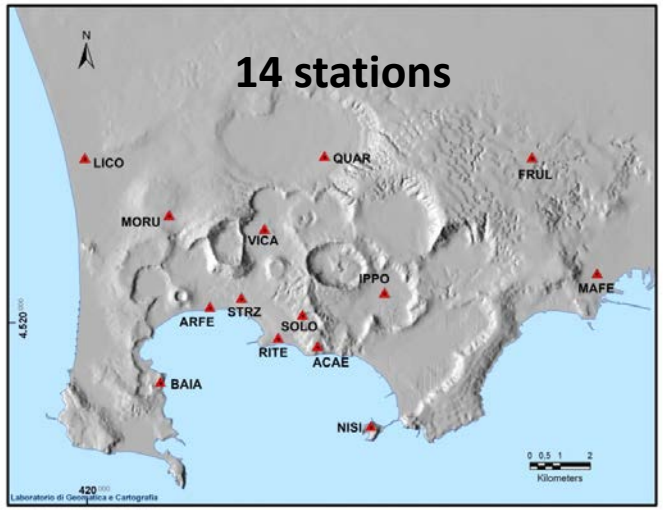
Recent Results from Leveling Measurements (2)

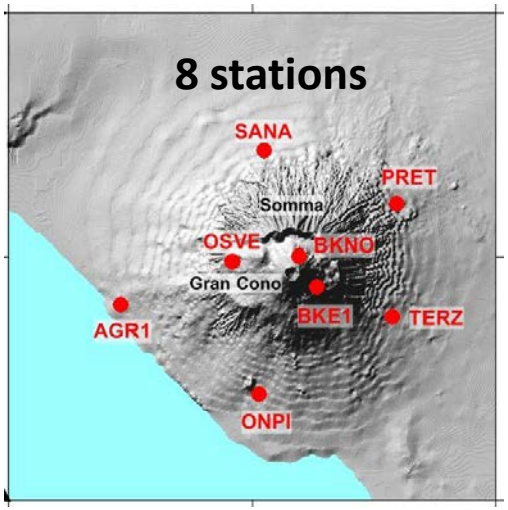


(Image courtesy C. Del Gaudio)

Geodetical Networks (CGPS, Continuos GPS)

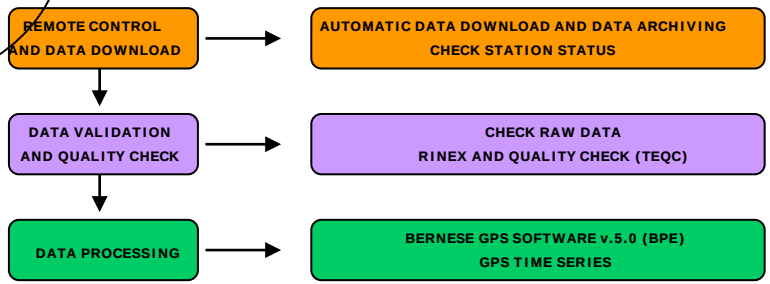




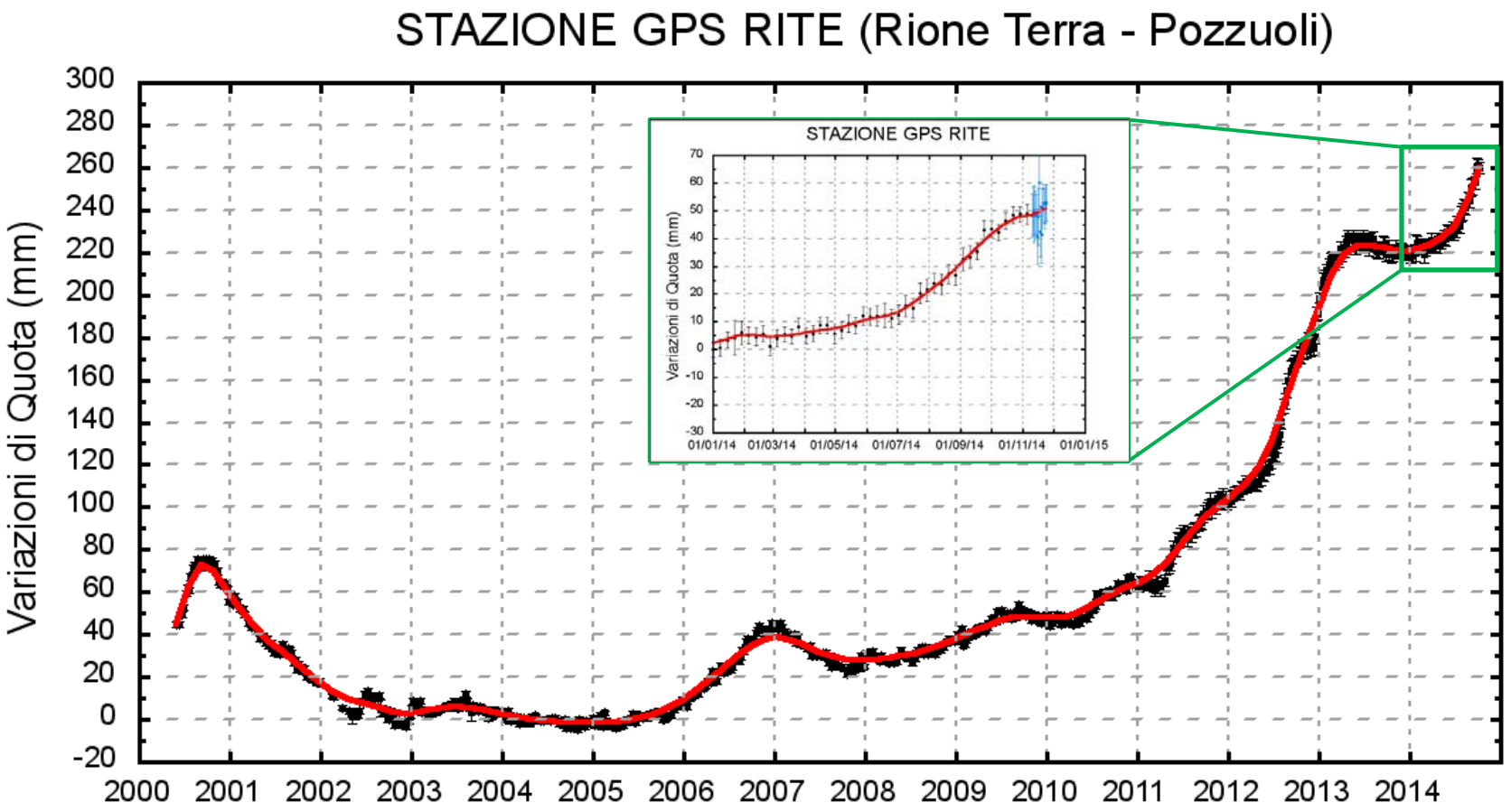


30" sampling rate

Automatic system for daily download and processing



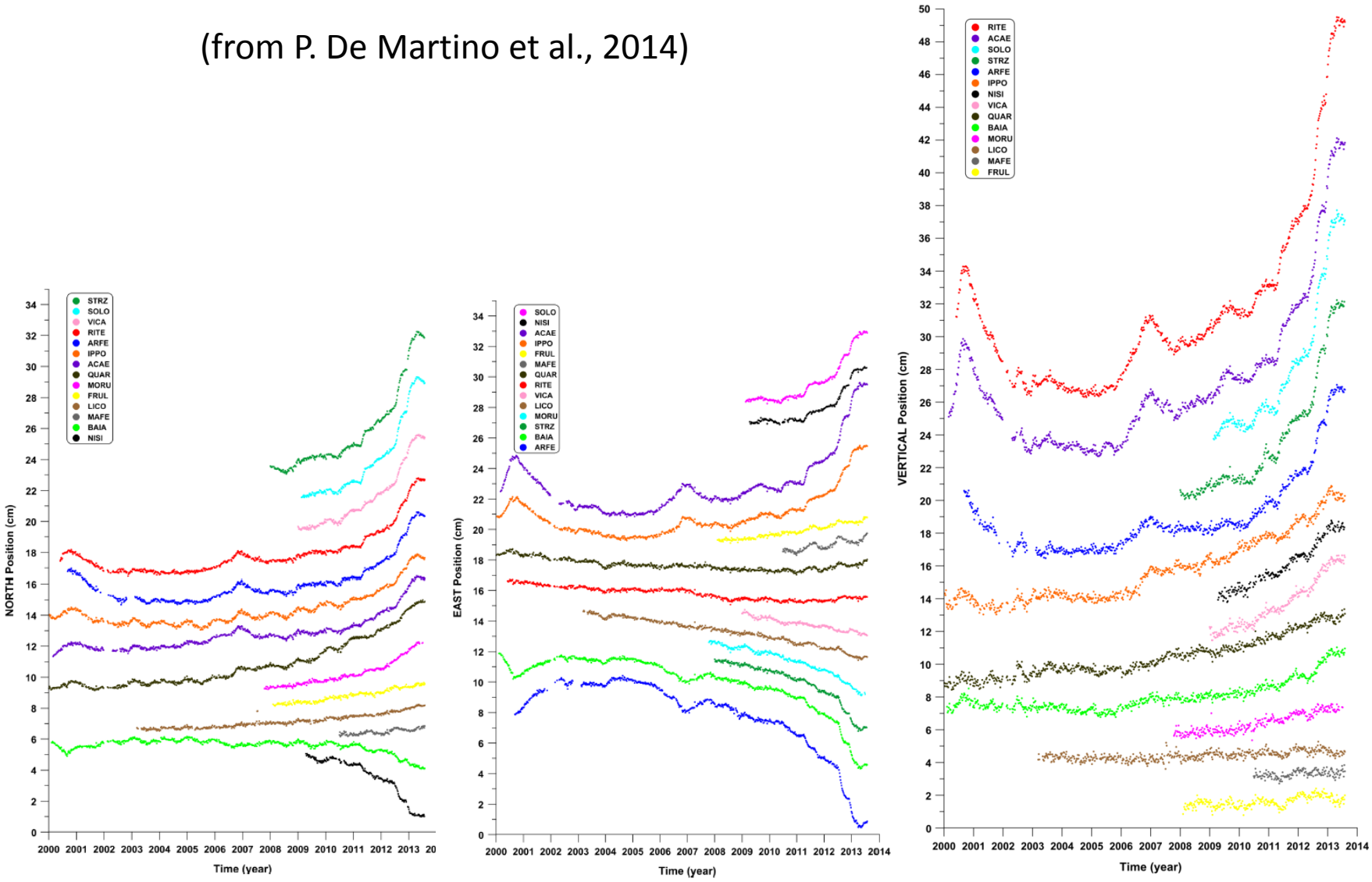
CGPS Measurements at RITE station



Vertical component of ground deformation for RITE CGPS station (2000-2014)
In the inner box : the detail from 01/01/2014 to 11/25/2014

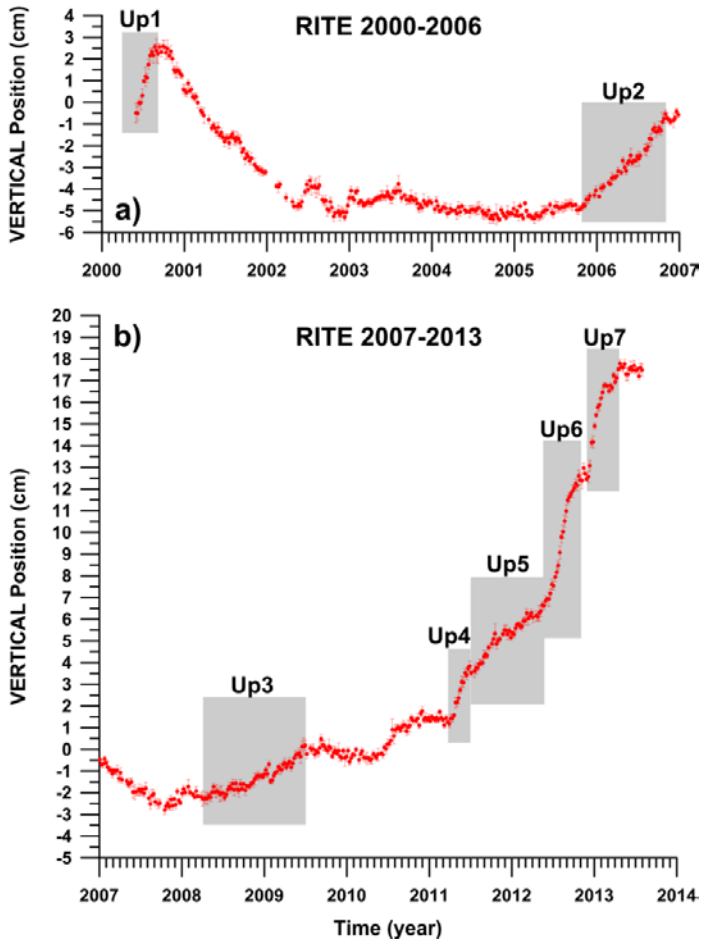
CGPS time-series at Campi Flegrei (2000-2013)

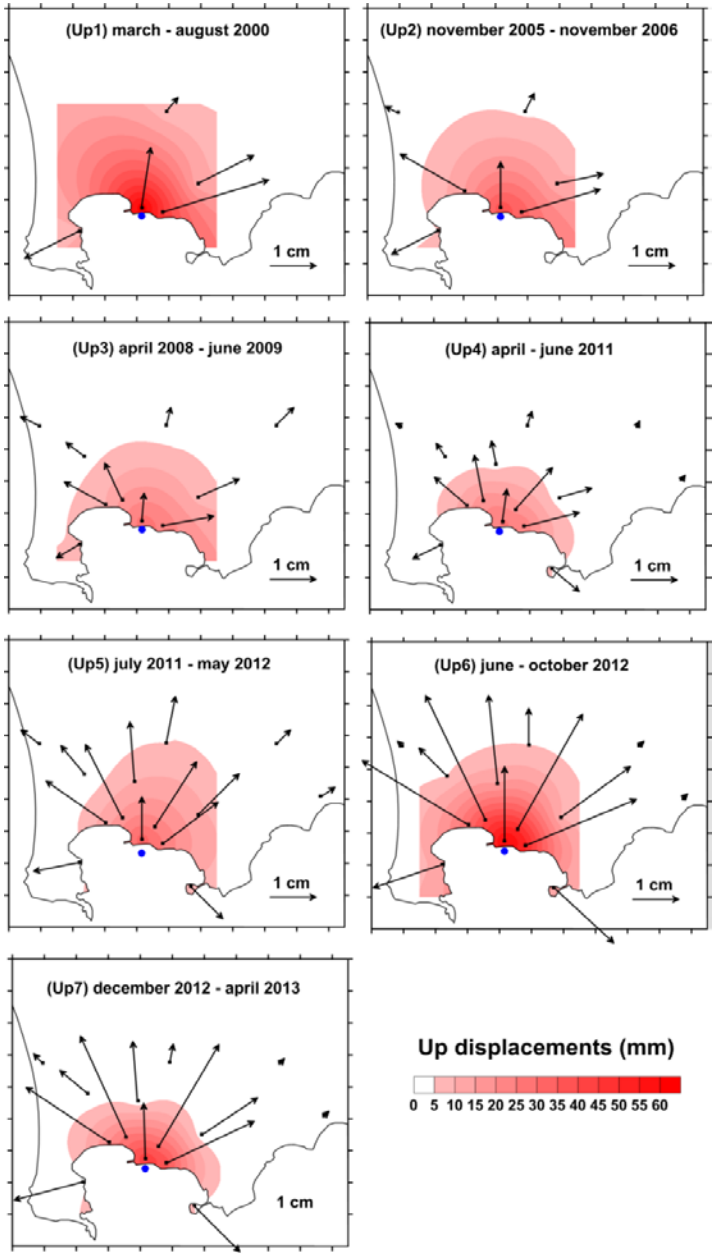
(from P. De Martino et al., 2014)



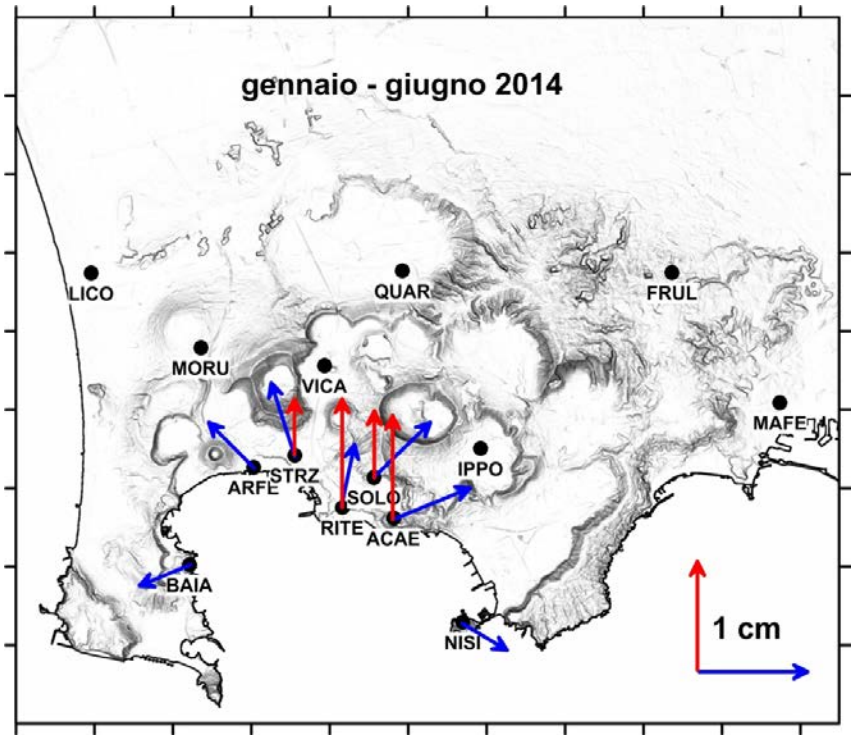
The Campi Flegrei deformation pattern inferred from CGPS data (2000-2013)

(from P. De Martino et al., 2014)

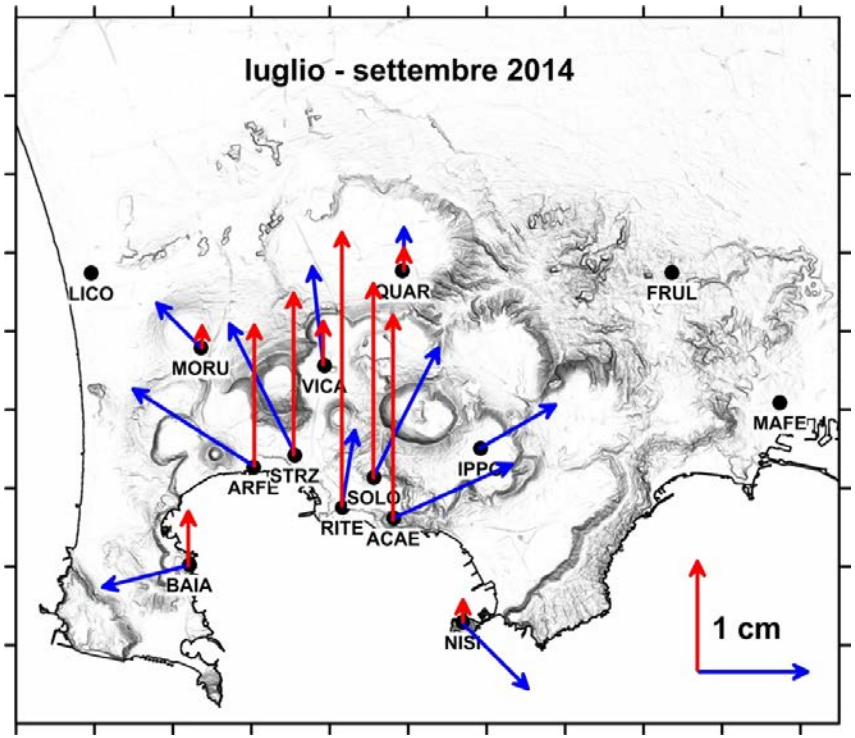




Horizontal and Vertical GPS deformation pattern at Campi Flegrei (2014)



January - June 2014

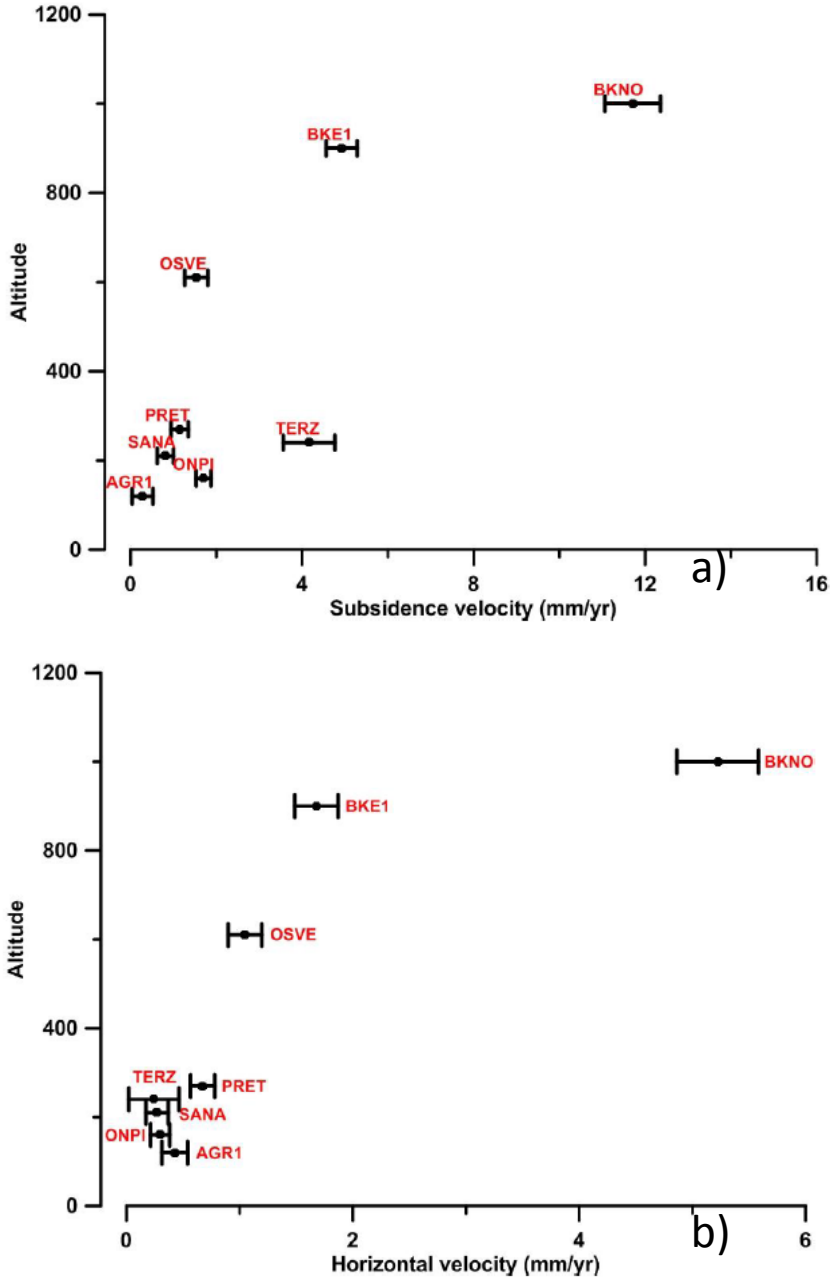


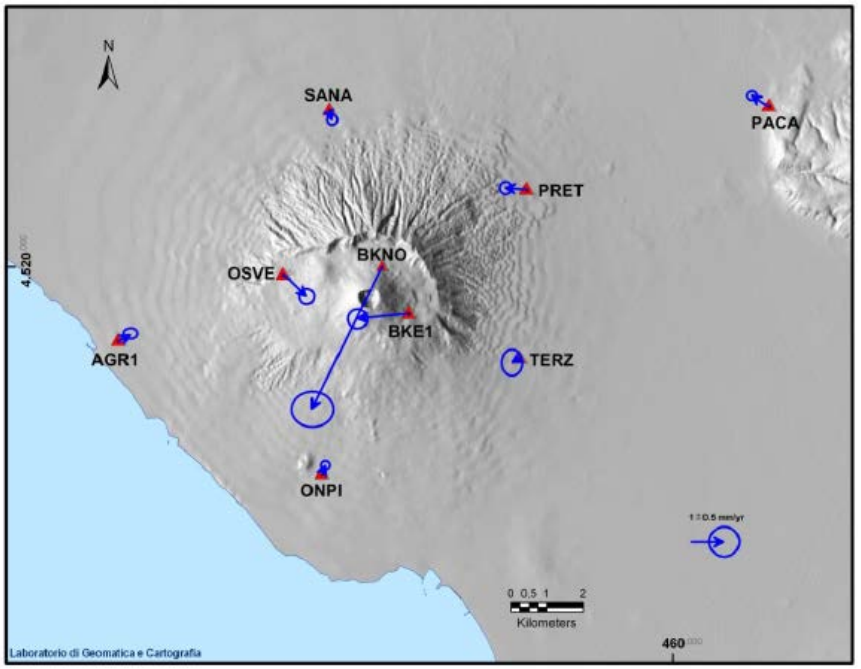
July - September 2014

Recent Results from CGPS data

Vesuvius volcano:
ground deformations from 2001 to 2012

(from U. Tammaro et al., 2013)





The horizontal GPS field c)

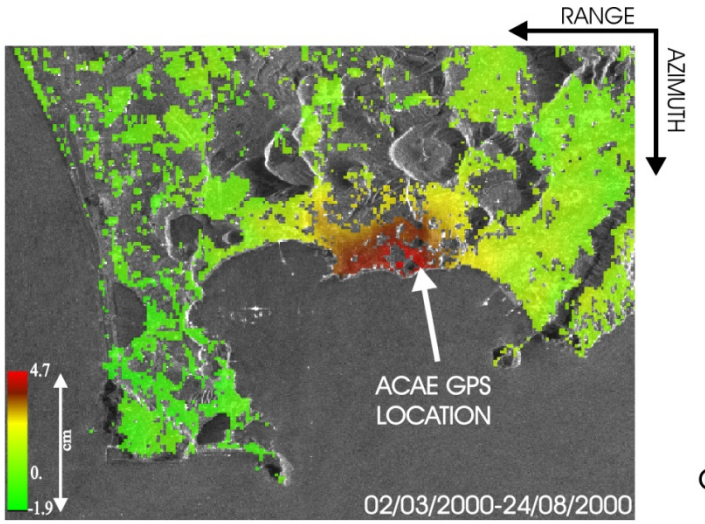
InSAR/Geodetical data comparison: previous experiences

a) deformation map (02/03/2000-24/08/2000), ERS2 descending;

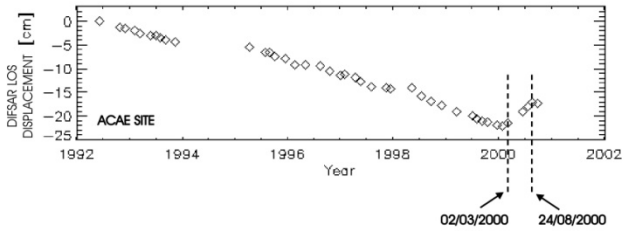
b) SBAS time-series (6/1992-9/2000) for the ACAE GPS location;

c) comparison between GPS measurements (ACAE site) projected into the radar LOS and SAR measurements (March to August 2000)

(from Lanari et al., 2004)



a



b

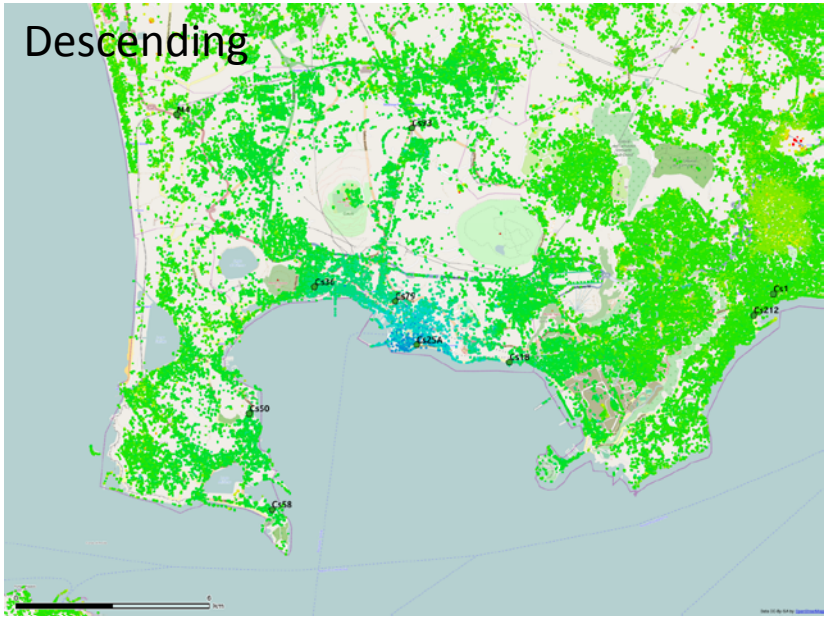
SITE	TIME INTERVAL	GPS LOS Disp.	DIFSAR LOS Disp.
ACAE	02/03/2000-24/08/2000	4.7 cm	4.4 cm

c

InSAR/Geodetical data comparison: previous experiences (2)

a) Time series (Nov. 2002 – Sep. 2010), ENVISAT ascending & descending;

b) comparison on bm 25A between leveling and SAR (asc. + desc.) data



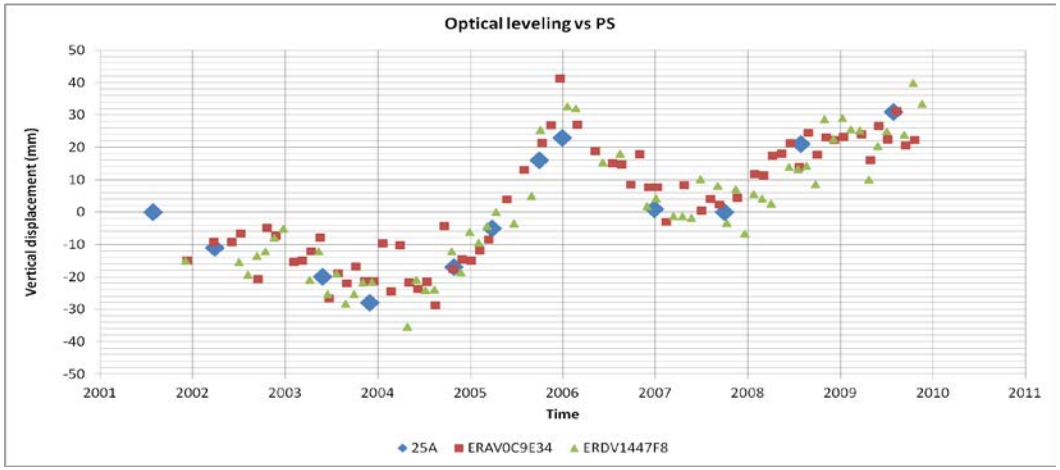
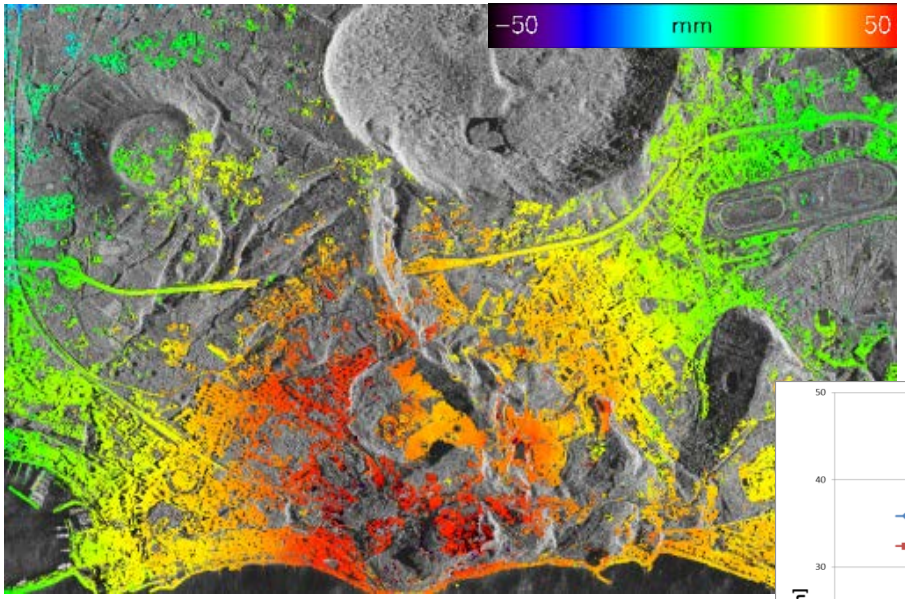
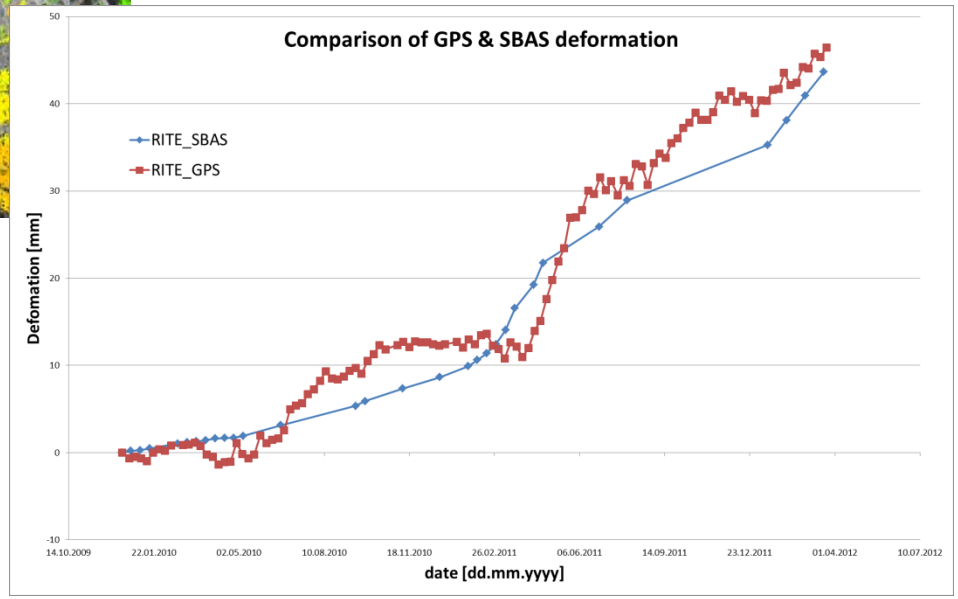


Image courtesy e-geos

InSAR/Geodetical data comparison: previous experiences (3)

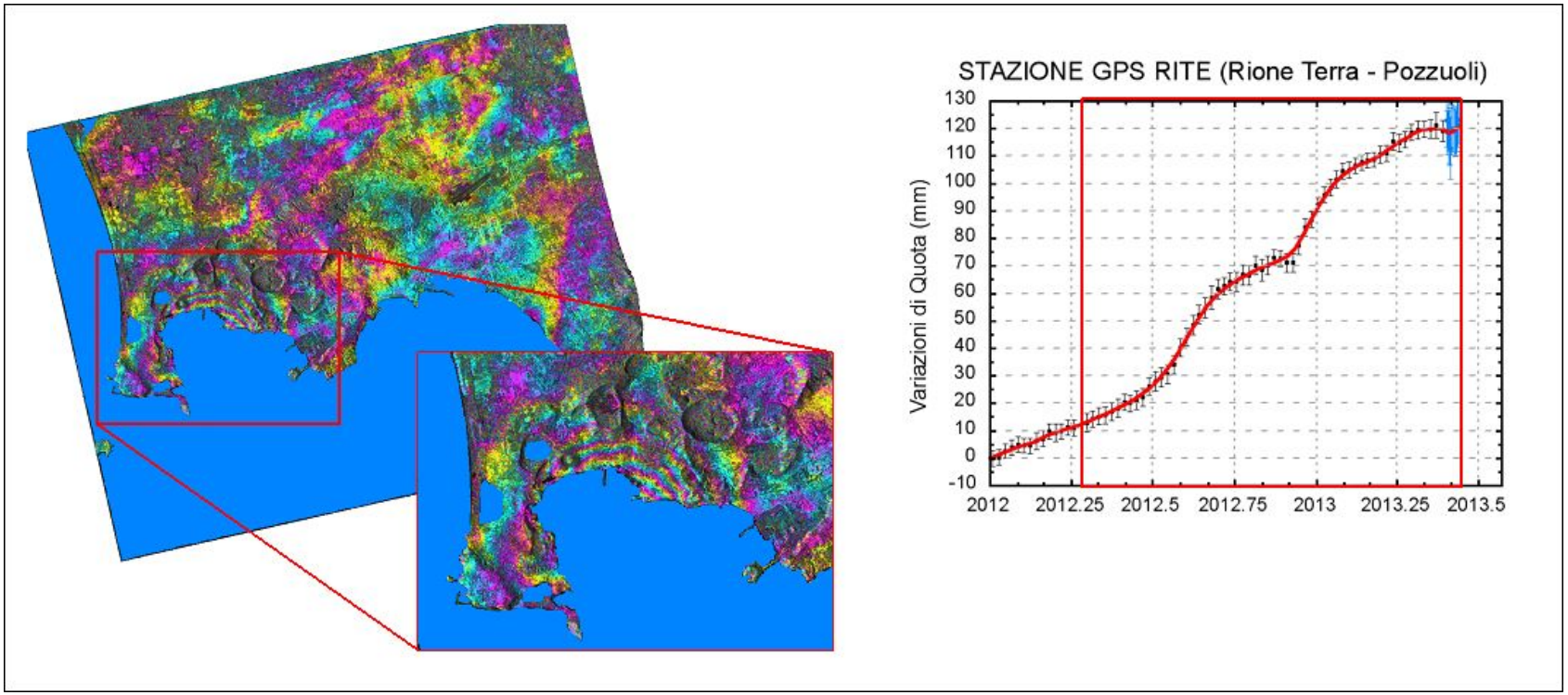


TSX SBAS processing (12/2009-3/2012)
(from Minet et al., 2012)



CGPS (LOS)/TSX SBAS comparison
RITE CGPS station
(from Minet et al., 2012)

InSAR/Geodetical data comparison: previous experiences (4)

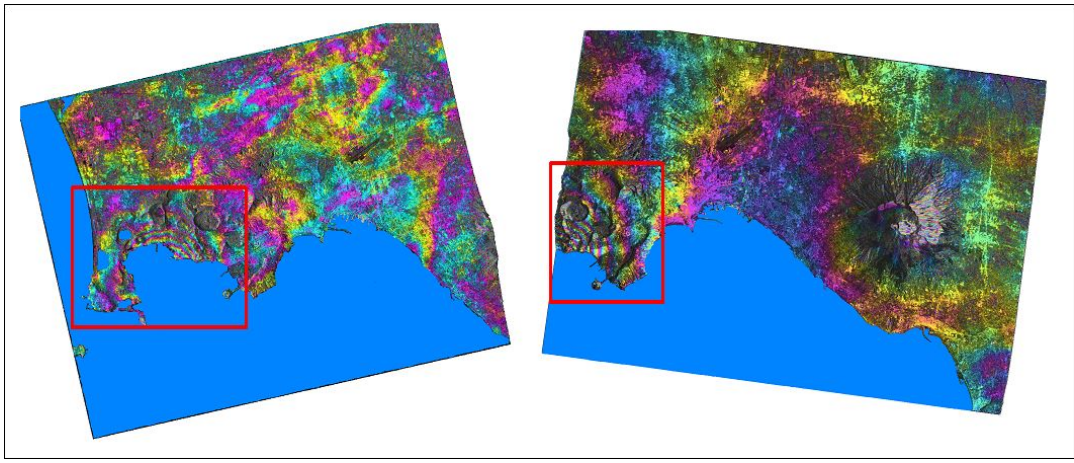


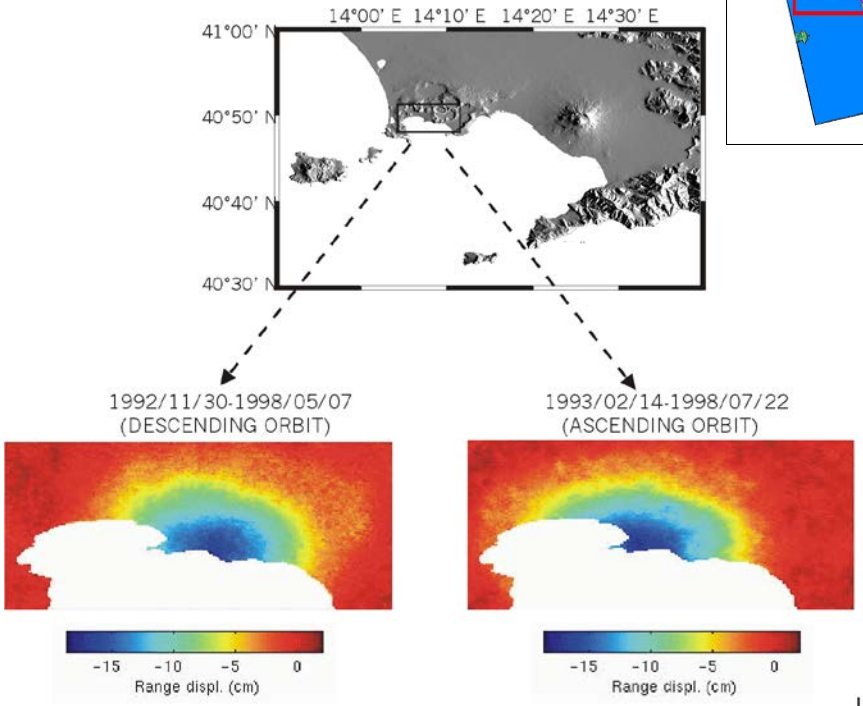
Left: TSX (Strip) interferogram (17/04/2012-09/06/2013, ascending)
Right: CGPS time-series (01/01/2012-09/06/2013) - RITE station, height variations
(Image courtesy S. Borgstrom & V. Siniscalchi, InSAR data processing,
P. De Martino, CGPS data processing, TSX data from Proposal "GEO1649")

The horizontal component of ground motion

TSX Interferograms

Left: Asc., (17/04/2012-09/06/2013)
Right: Desc., (04/04/2012-18/06/2013)





ERS deformation maps

Left: Desc., (30/11/1992-07/05/1998)
Right: Asc., (14/02/1993-22/07/1998)

(Image courtesy IREA-CNR)

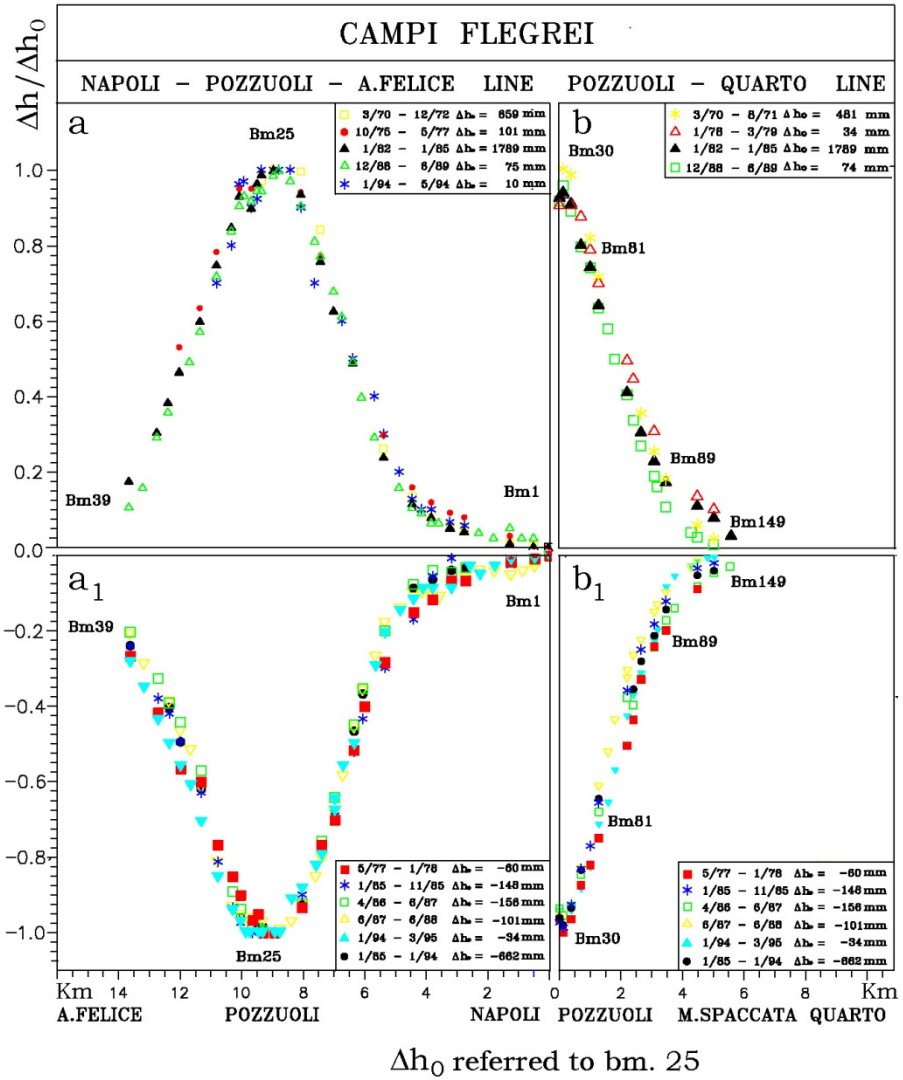
Note also the invariance in time of the deformation pattern from deflation to inflation…

IREA-CNR

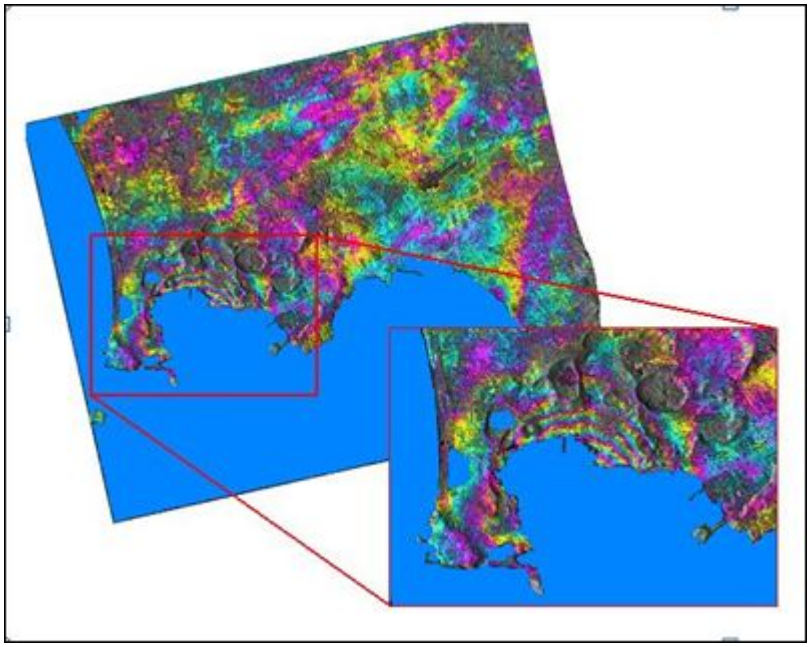
Invariance of the deformation pattern from deflation to inflation

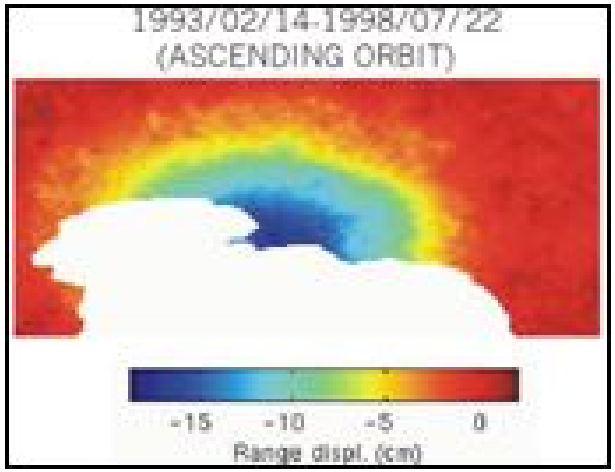
Height variations of single benchmarks along EW and NS profiles during given time intervals, normalized to the maximum deformation value in the same time interval

(from Orsi et al., 1999;
Del Gaudio et al., 2010)



Is the deformation field widening to the west of Campi Flegrei?





Left: TSX (Strip) interferogram (17/04/2012-09/06/2013, ascending)
Right: ERS deformation map (14/02/1993-22/07/1998, ascending)

Some evidences also from tiltmetric data…

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S1A - Amplitude images

20/10/2014, ascending

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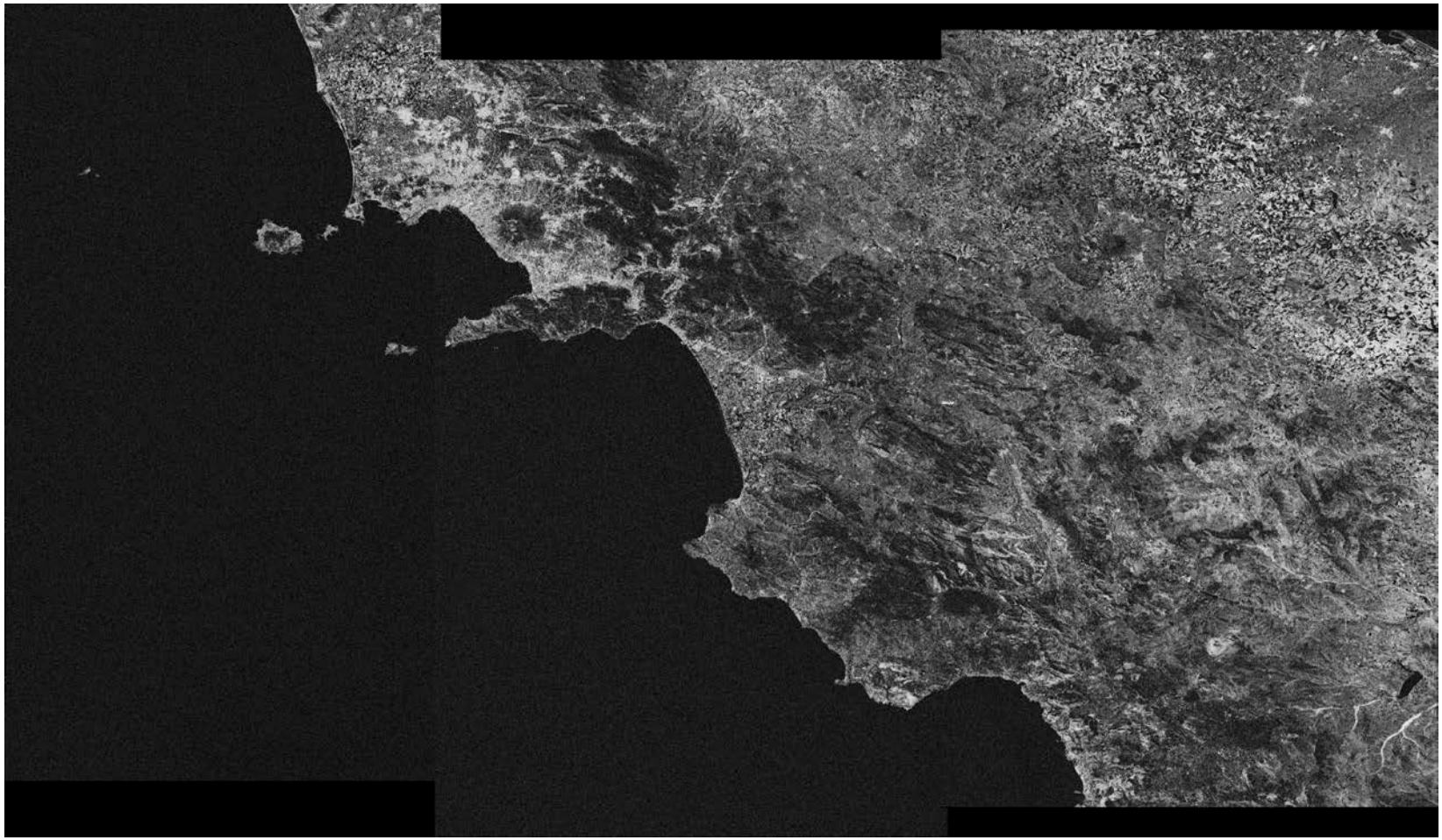
S1A - Coherence images



20/10/2014-01/11/2014, ascending

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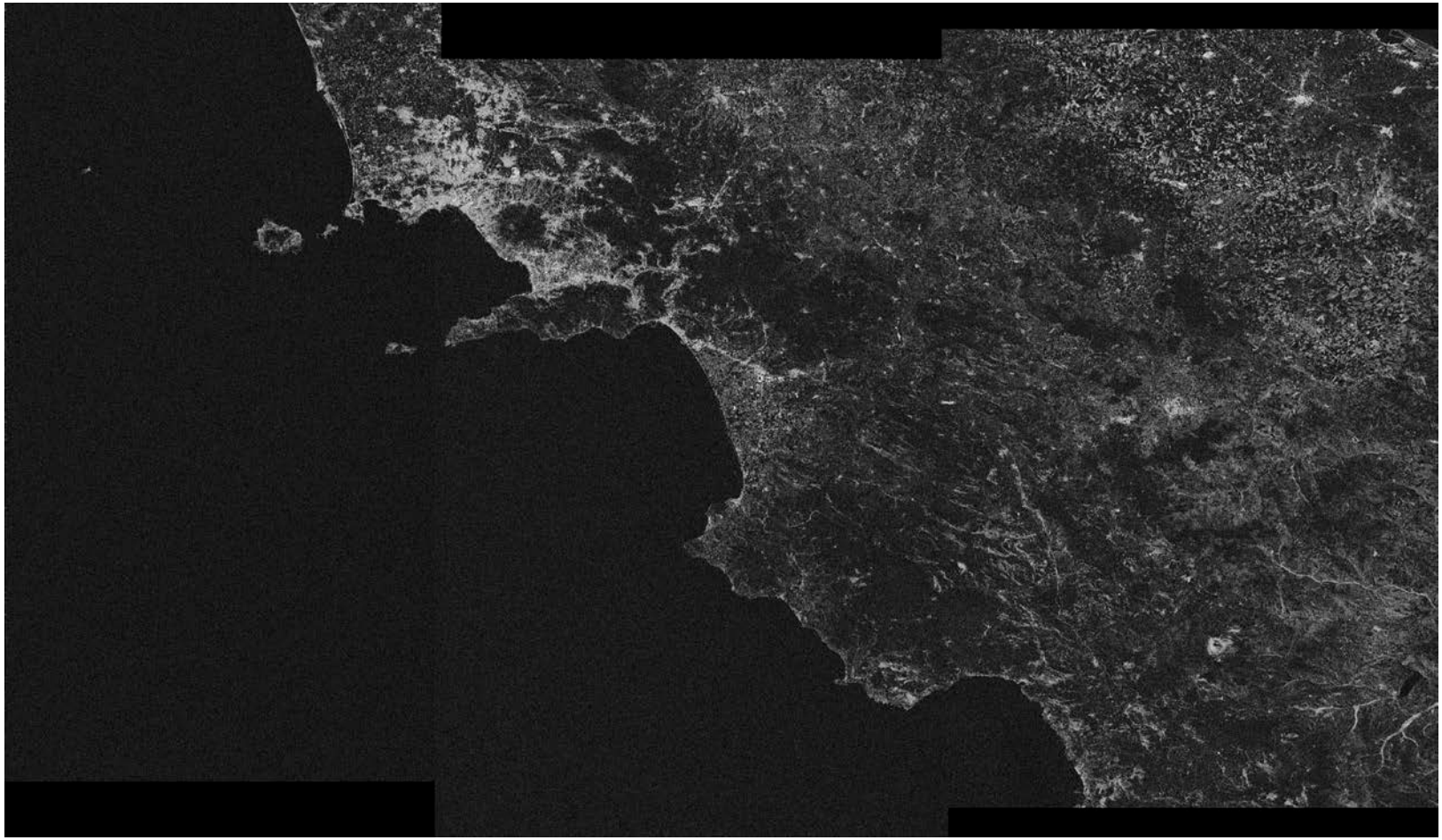
S1A - Coherence images



20/10/2014-13/11/2014, ascending

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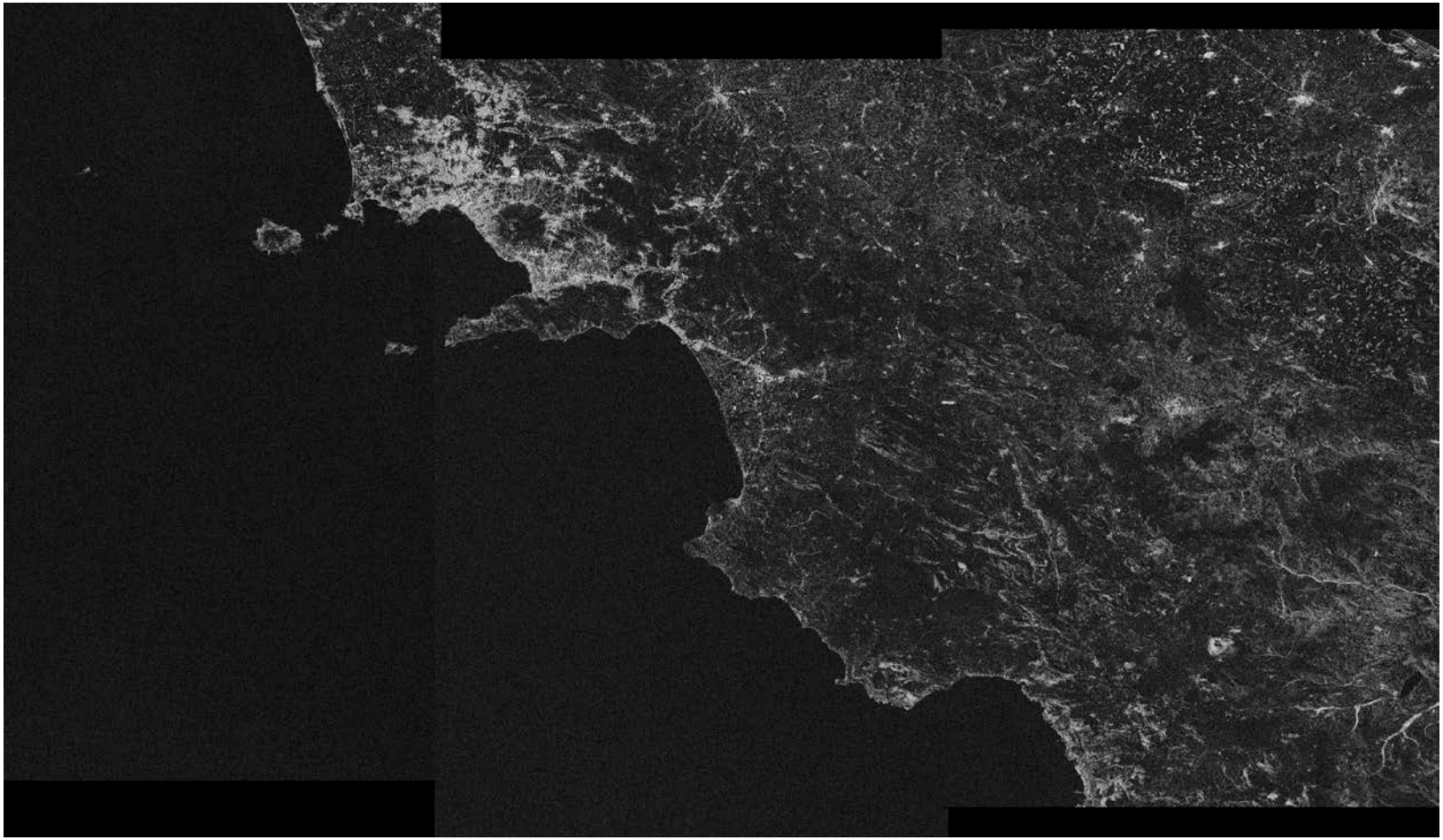
S1A - Coherence images



20/10/2014-25/11/2014, ascending

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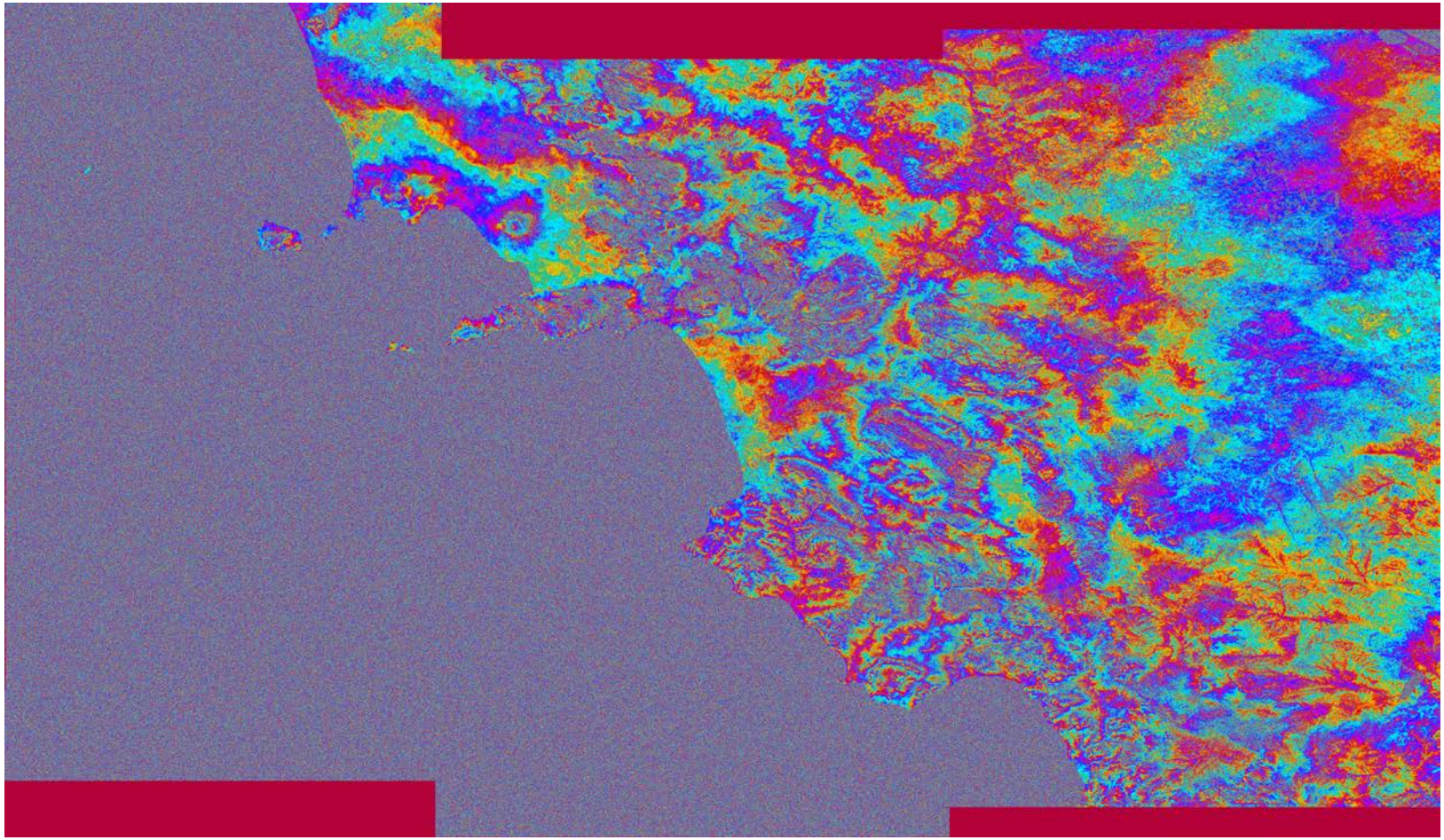
S1A - Interferograms



20/10/2014-01/11/2014, ascending

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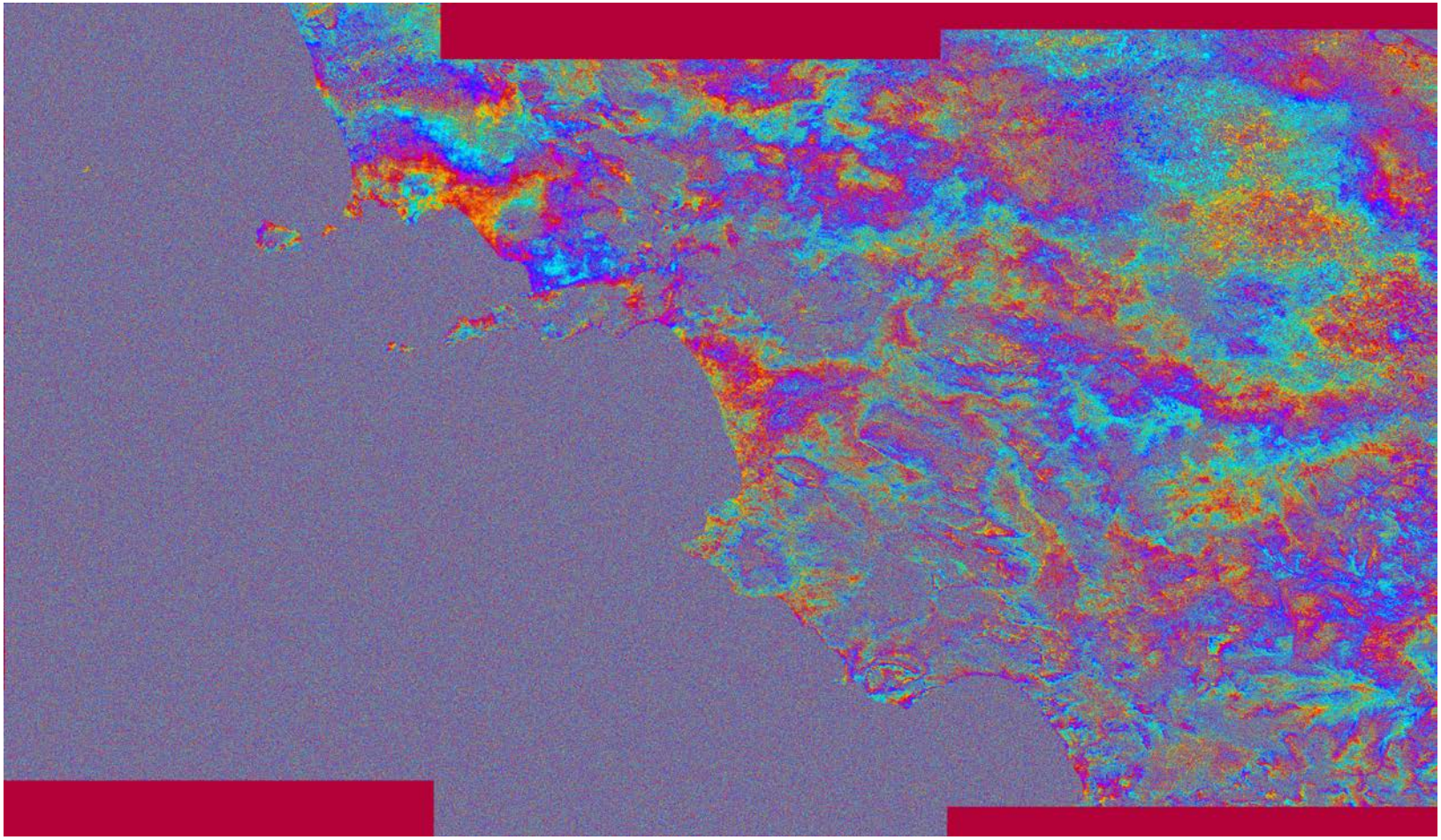
S1A - Interferograms



20/10/2014-13/11/2014, ascending

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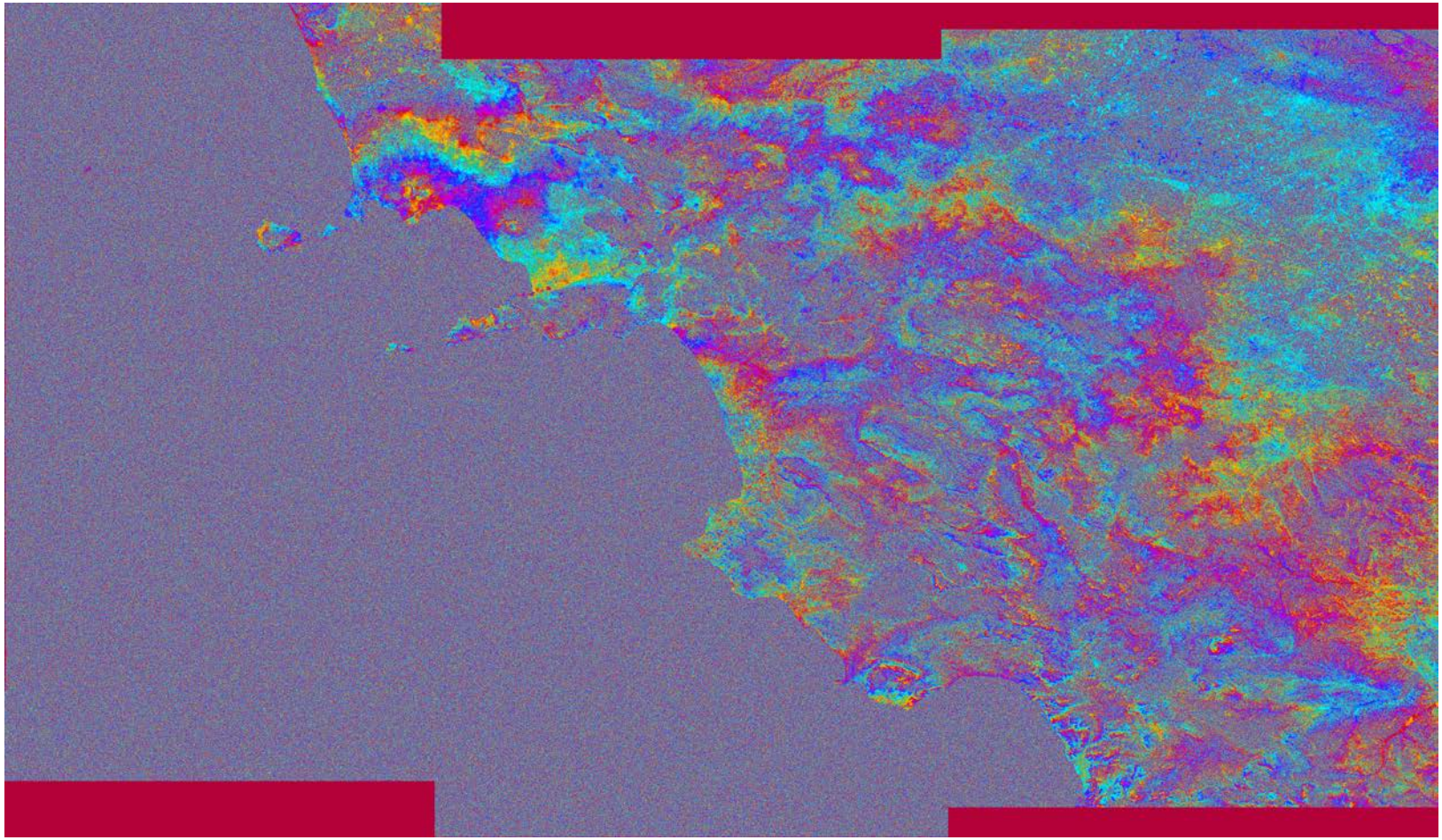
S1A - Interferograms



20/10/2014-25/11/2014, ascending

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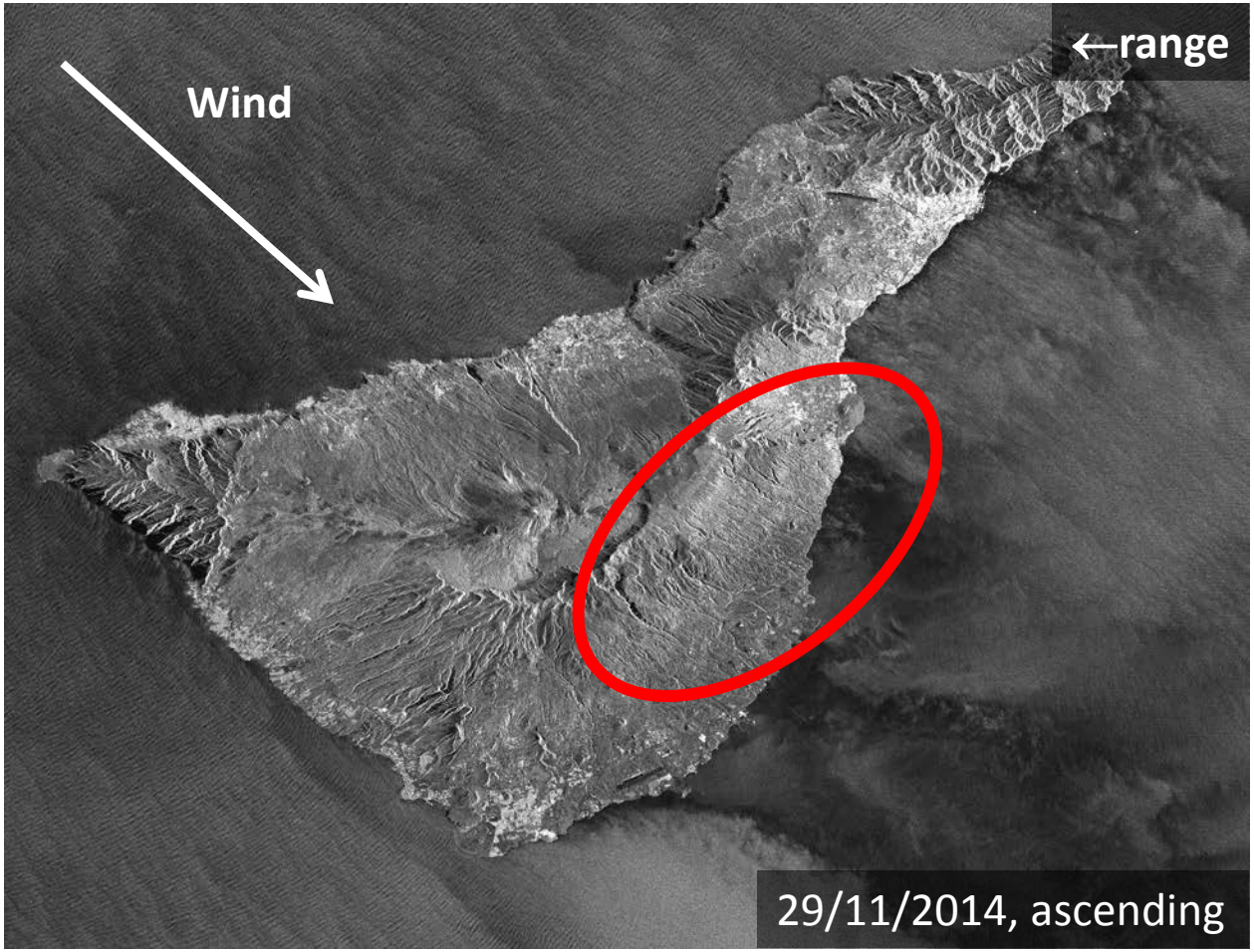
Monitoring of «Unusual» Atmospheric Artifacts with Sentinel-1

- Strong atmospheric artefact observed over Tenerife (Canary islands, Spain).



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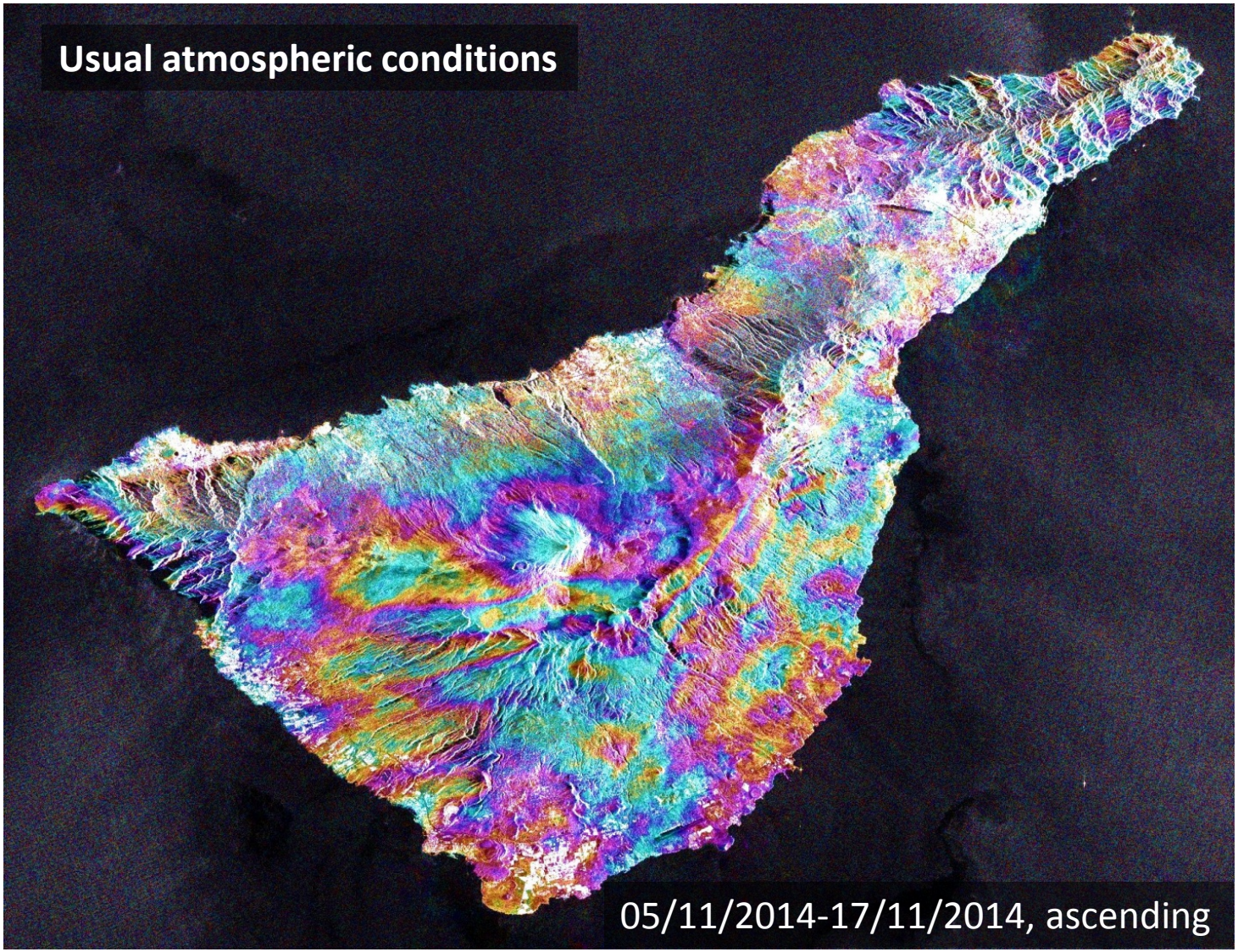
S1A - Interferograms (Tenerife)



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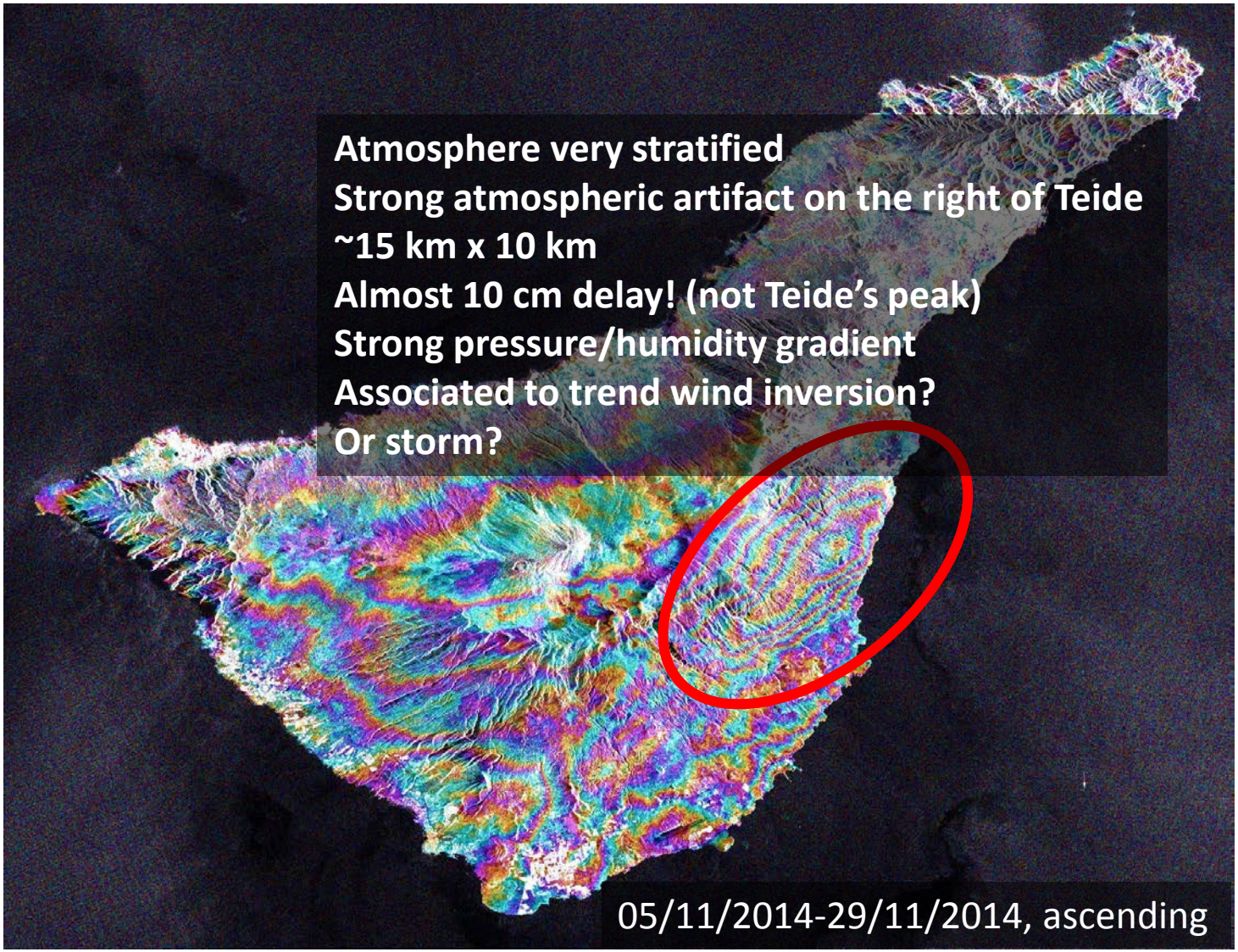
S1A - Interferograms (Tenerife)



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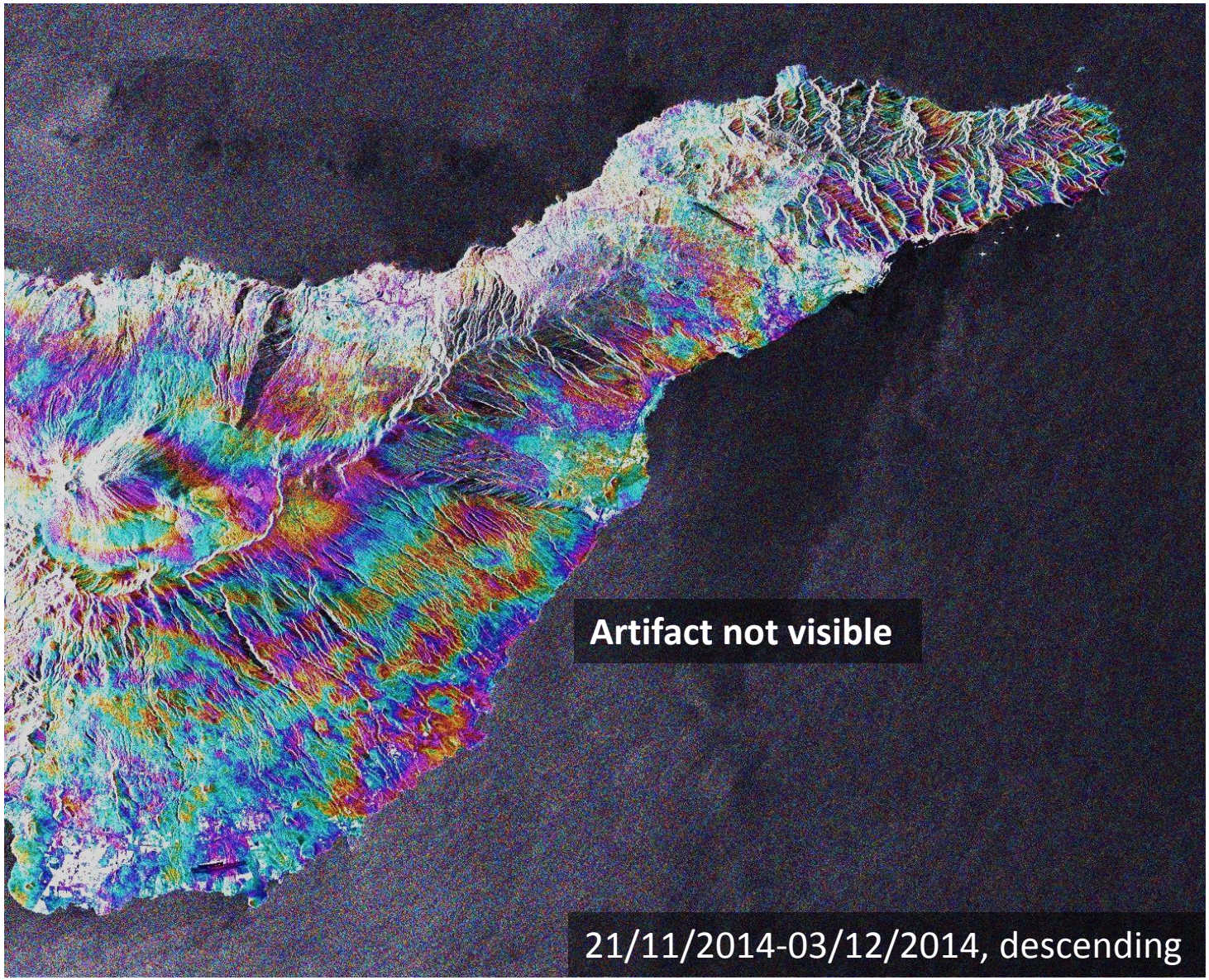
S1A - Interferograms (Tenerife)



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Remarks and Conclusions

Lessons learnt

- We observed the presence of horizontal components of ground motion: in order to get a precise comparison with leveling (vertical) results, it is crucial to get InSAR data from both ascending and descending tracks, to split them;
- The invariance in time of the deformation pattern from deflation to inflation events;
- Is the deformation field widening to the west of Campi Flegrei? And what about east (some evidences…)?

Suggestion for the next future

- While waiting for leveling results, we can exploit CGPS time-series to be projected into the radar LOS;

Supersites initiative (for interested people)

- InSAR data from different Space Agencies for Vesuvius/Campi Flegrei and Etna are now available through the Supersites initiative;
- Interested people can get in touch with the two Points of Contact at:
sven.borgstrom@ingv.it giuseppe.puglisi@ingv.it