HIGH RESOLUTION MONITORING OF CAMPI FLEGREI (NAPLES, ITALY) BY EXPLOITING TERRASAR-X DATA: AN APPLICATION TO SOLFATARA CRATER

Christian Minet (1), Kanika Goel (1), Ida Aquino (2), Rosario Avino (2), Giovanna Berrino (2), Stefano Caliro (2), Giovanni Chiodini (2), Prospero De Martino (2), Carlo Del Gaudio (2), Ciro Ricco (2), Valeria Siniscalchi (2), Sven Borgstrom (2)

(1) Deutsches Zentrum für Luft- und Raumfahrt, Remote Sensing Technology Institute, Wessling (Germany)
(2) INGV - Sezione di Napoli "Osservatorio Vesuviano", Via Diocleziano 328 - Napoli (Italia)
The end of 2009 deformation event as the trigger for the long-term monitoring using TSX Spotlight Data

- 15.12.09 ⇔ 26.12.09
- 11 days temporal baseline
  very high coherence
- 16.5 m perp. baseline
  very low sensitivity to topography

Pisciarelli Site:
- very clear signal
- affected area 30m x 20m
- ~1 cm uplift
Campi Flegrei – a densely monitored volcanic area

- Levelling: 350 benchmarks
- GPS: 13 continuous stations
- Tiltmeter: 8 continuous stations
  6 surface + 2 borehole
- Gravity: 28 stations
- ...
Levelling Networks of Campi Flegrei

- Levelling performed 1-2 times per year
- Increase during bradyseismic crisis
- Time series for 350 benchmarks
13 continuous GPS Stations

GPS time series of weekly coordinate changes, from December 2009 to March 2011, (along North, East and Up directions) for the stations located within the selected TerraSAR-X frame.
Tilt- & Gravimeter

- Detailed information on these measurements in the paper
Geochemical analysis

- Temperature of fluids steadily increasing over the last years
TerraSAR-X Data

- High Resolution Spotlight
  300 MHz PRF
  1.1 m x 0.6m resolution
  10km x 5km covered
- descending orbit
- ~39° inc. angle
- polarization VV

- 24 acquisitions
  (15.12.2009 – 22.03.2011)
SBAS-Processing of Solfatara Subset

- 24 acquisitions
- 84 small baseline interferograms
- Topo & APS removal
- Estimate deformation using SVD

- 30% usable pixels

cropped footprint

4.8 km

Solfatara Crater  Pisciarelli Site

Reference Point (IPPO)

DLR’s SBAS Processor integrated by Kanika Goel
Correcting for reference point deformation using IPPO GPS time series

- The whole area is deforming, ➔ no stable reference point
- Reference Point IPPO with known continuous GPS Time series
- Projection of measured IPPO deformation into Line of Sight
- Correction of results for Ref. Point motion
Animated LOS deformation time series

15.12.2009 - 22.03.2011
Time series
Verification and Comparison

- GPS time series of SOLO and ACAE of acquisition time projected into LOS

- Good agreement
  - Deformation trend correct
  - Only a few mm difference between GPS (LOS) and SBAS (LOS), likely due to correction data of IPPO
    - Smoothing
    - Projection
    - … cont.

![SOLO Deformation Time Series](image)
**Interpretation**

- Starting from the end of 2004, the Campi Flegrei caldera exhibits an uplift phase where the vertical component of the ground displacement reached +77 mm (November 2004 – June 2011) on benchmark 25A.

- InSAR results (12/2009-3/2011) confirm the general uplift of the whole region of approximately 5mm/y.

- Conversely, the south–eastern part inside the Solfatara crater shows a different behaviour compared with general trend of the Campi Flegrei area, likely related to soil compaction phenomena (degassing).

- As a general comment, we must point out that, in the absence of a strong deformation signal affecting the whole area, very local and shallow deformation events mostly prevail.
Outlook & ongoing works

- X-Band time-series of Campi Flegrei
  - X-Band resolution is key-point for monitoring low deformation-rates of Campi Flegrei

- TSX data acquisition continues until end of 2011 (for now!)
  - Extension of SBAS processing using new scenes
  - Fast single interferograms in crisis situations possible

- Getting a grip of horizontal motions

- Campi Flegre is a test site in the Supersites initiative

- The data used here, is available in EOWEB archive
Thank you!

Questions?