



GROUP ON  
EARTH OBSERVATIONS

Geohazard Supersites  
& Natural Laboratories

# Status of the GSNL initiative

Stefano Salvi

Chair of the Supersites Advisory Committee

CEOS WG Disasters, Bonn, March 2016



# The Geohazards Supersites & Natural Laboratories

A voluntary partnership aiming to demonstrate in specific areas of the world (the **Supersites**) the advantages of **global collaboration on geohazard research to provide visible benefits for local Risk Prevention and Response activities.**

### Specific goals:

- Promote scientific advancements** in geohazard research through easier data access and international collaboration
- Promote a more direct uptake of scientific results** in local prevention and response activities for **seismic** and **volcanic** risks
- Promote knowledge transfer** on geohazard research



## Active Supersites

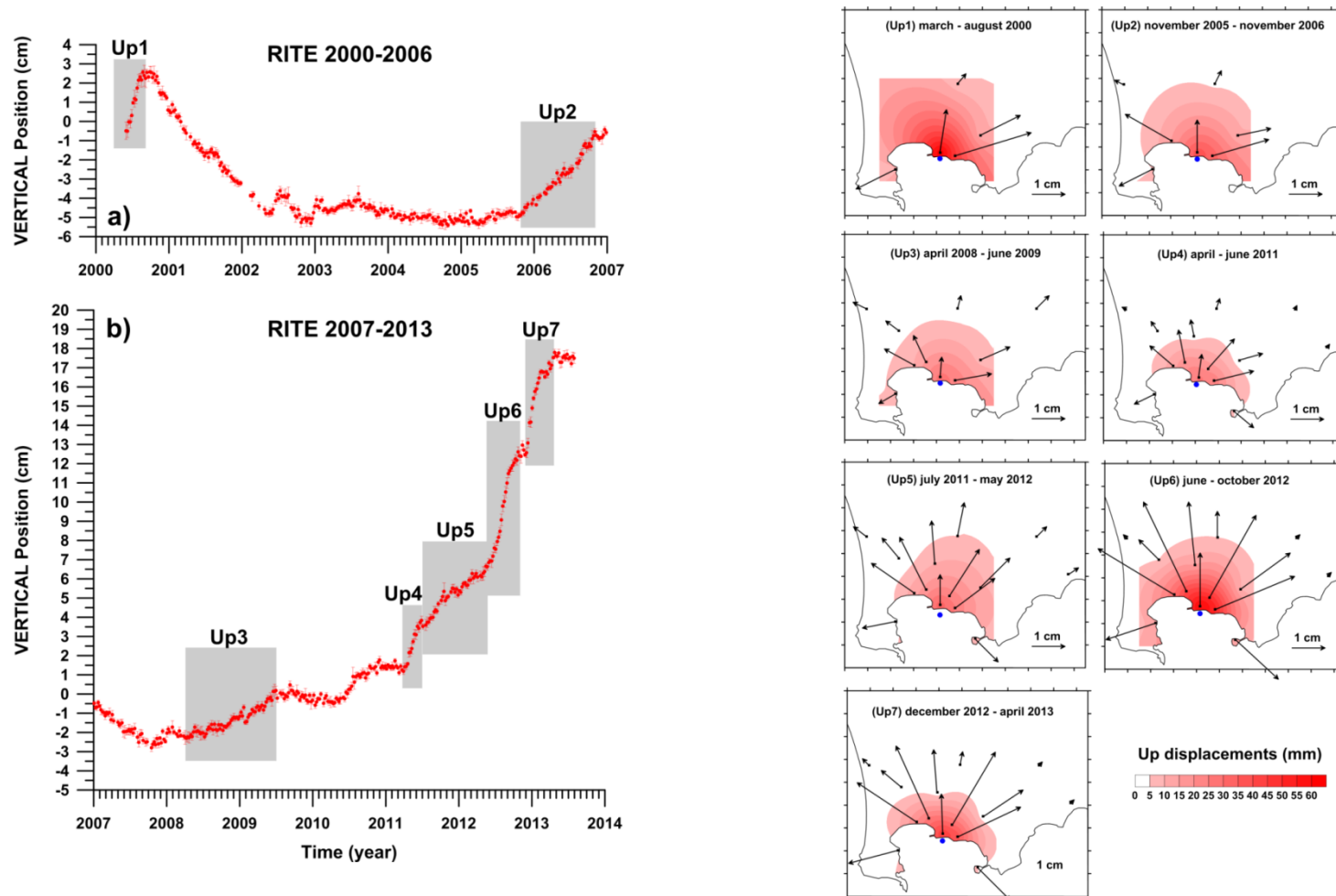
1. **Hawaiian volcanoes** – USGS
  2. **Icelandic volcanoes** – Univ. of Iceland & IMO
  3. **Etna volcano** – INGV - Catania
  4. **Campi Flegrei volcano** – INGV - Naples
  5. **Western North Anatolian Fault** – KOERI - Istanbul
  6. **Taupo Volcano** – GNS Science - Lower Hutt
  7. **Tungurahua and Cotopaxi volcanoes** – IGEPN - Quito
- Gorkha Earthquake Event Supersite (April 25, 2015)



## Supersites proposals

1. Greek Supersite – Coordinator: ITSAK, Athens: reviewed in November by three experts, revised proposal to be received in April. Some issues still pending.
2. South East Asia Natural Laboratory. It is going to be reduced to a Supersite proposal, then after 2 years the NL might be re-evaluated. To be received in April.
3. San Andreas fault Supersite – Initial draft by USGS. Should be re-submitted using new template.

# Supersites results: unrest at Campi Flegrei

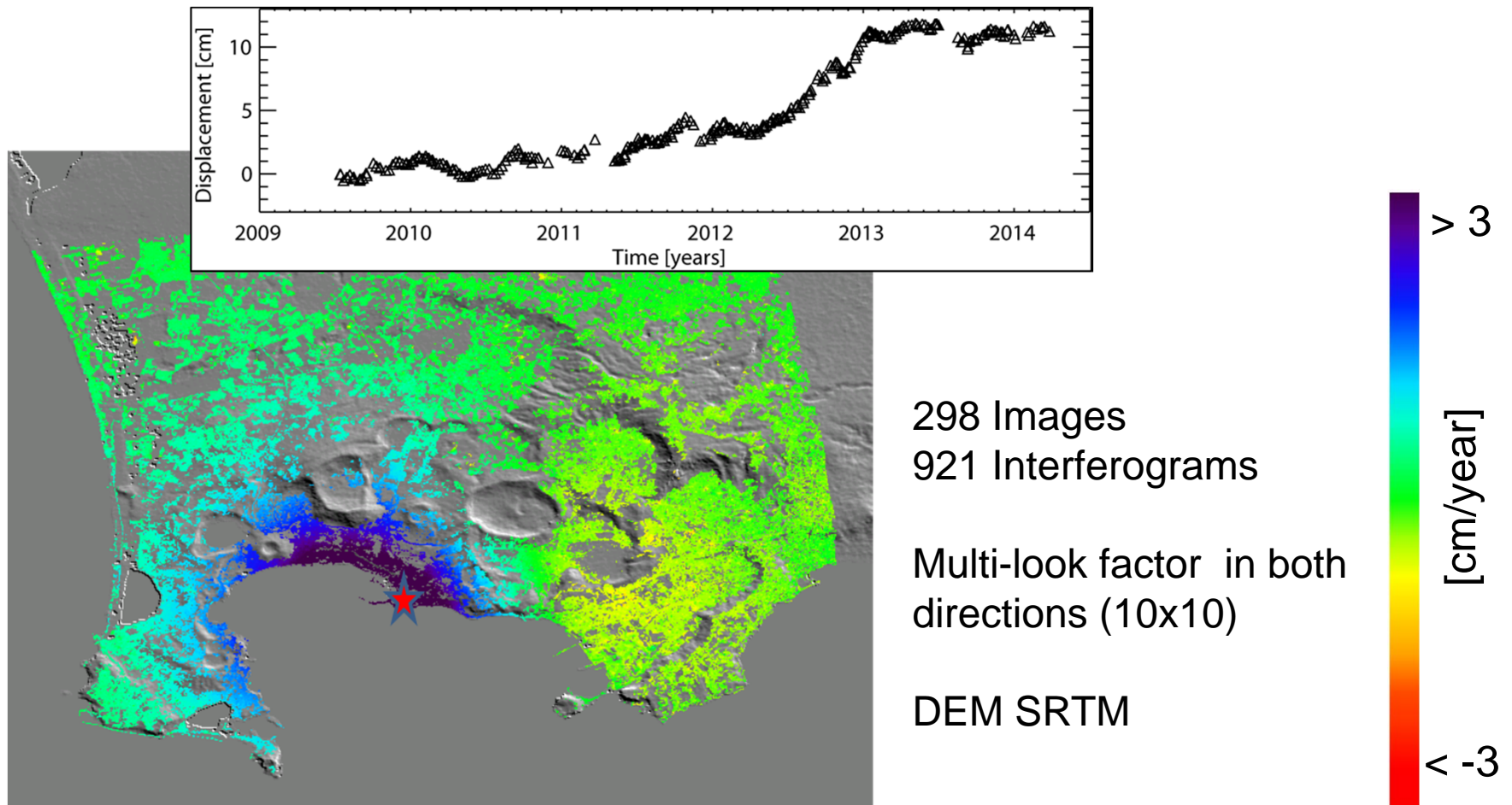


**Deformation pattern from cGPS data (2000-2013)**

P. De Martino et al., 2014

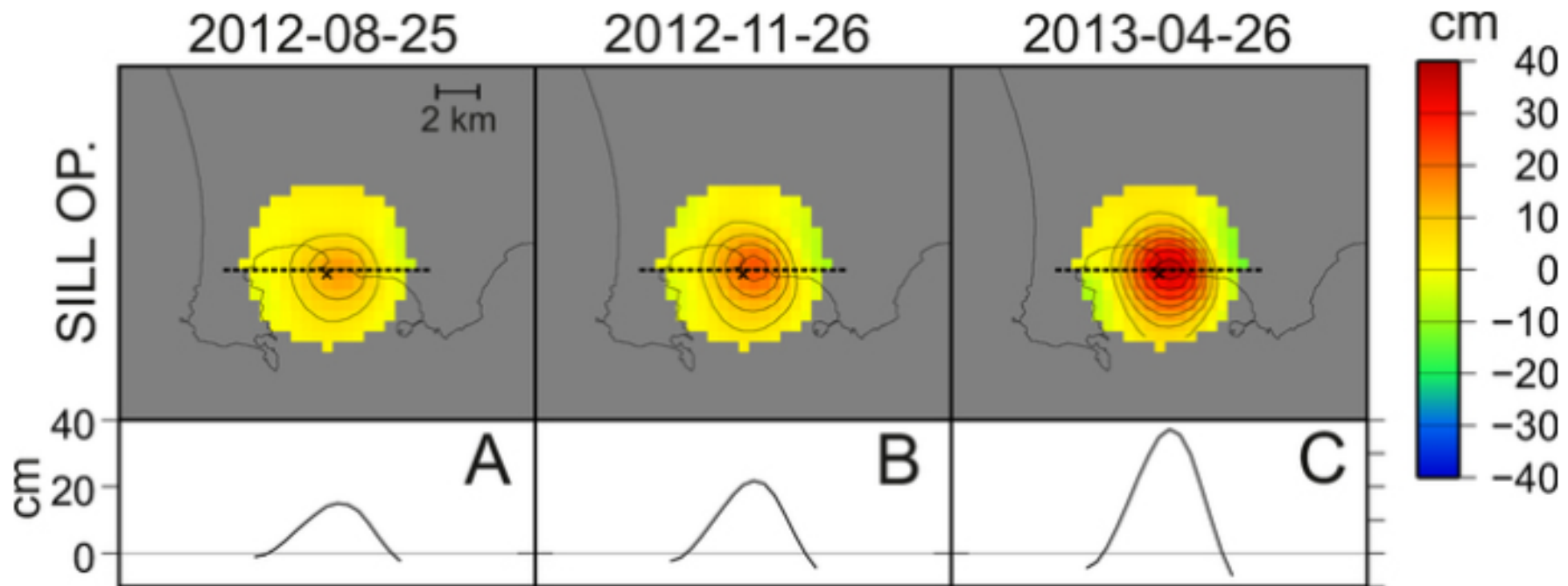


# Supersites results: unrest at Campi Flegrei



**CSK Ascending Mean Velocity Map (2009-2014)**

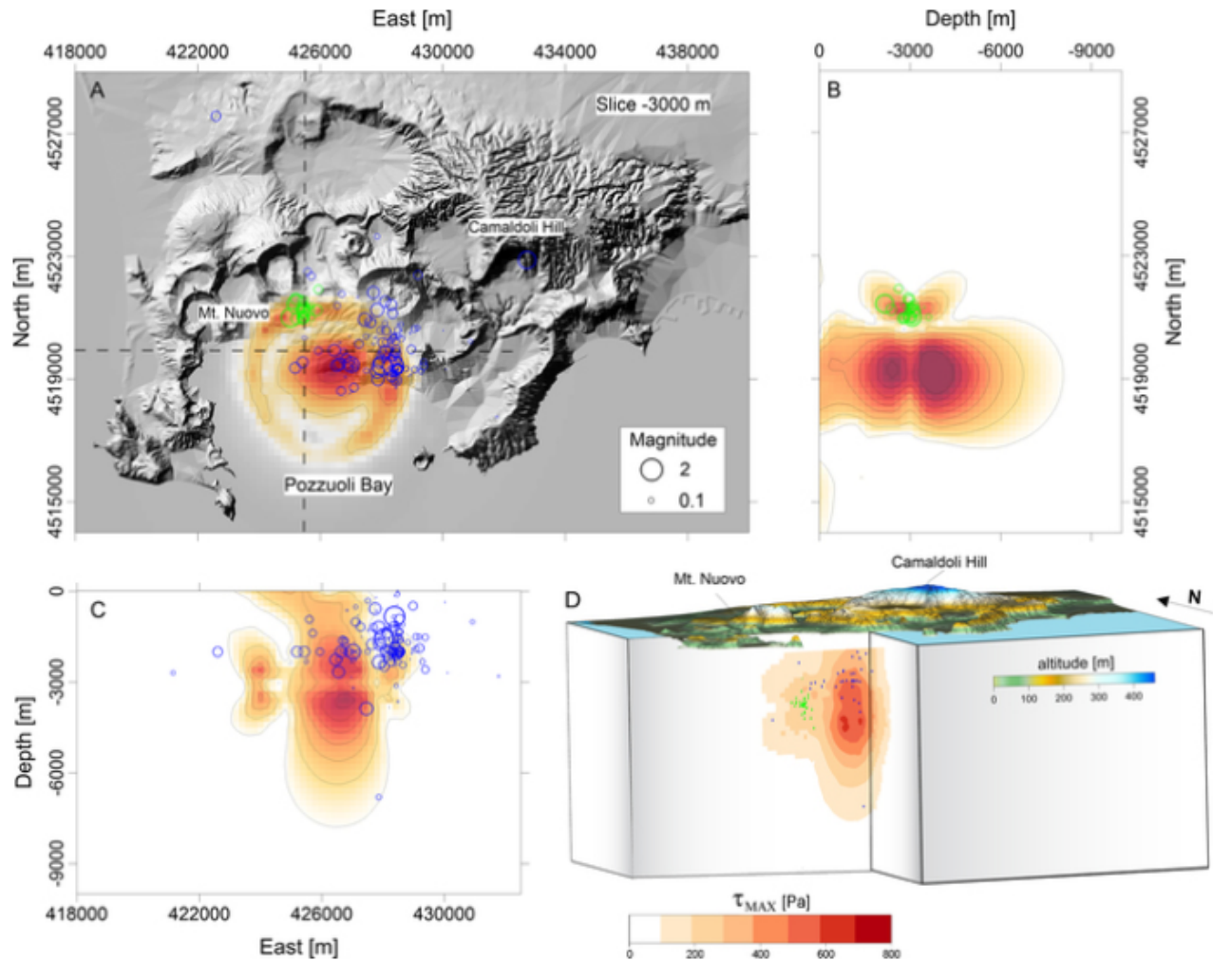
# Supersites results: unrest at Campi Flegrei



**Magma migration in a sill-like source at 3100 m depth,  
for a volume of 0.004 km<sup>3</sup>**



# Supersites results: unrest at Campi Flegrei



**Model validated by seismic data**



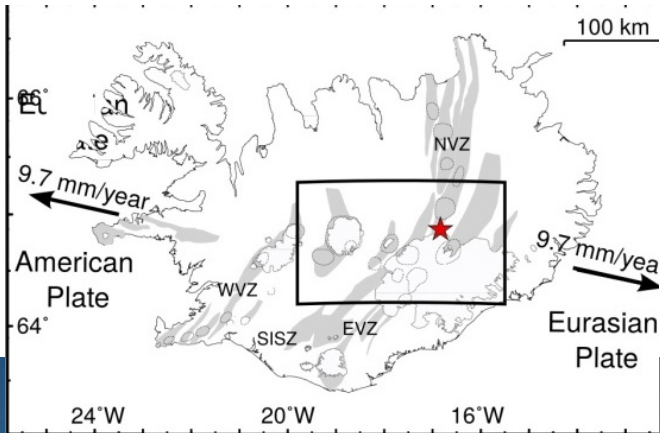


## Campi Flegrei deformation monitoring

- Main decision making agency: Dept. of Civil Protection (DPC)
- Main scientific institution in charge: INGV
- Collaborating scientists: IREA-CNR
  
- InSAR and GPS data are cross-validated and used to constrain source models (together with other in situ data).
- The 11 cm uplift recorded in the April 2012—January 2013 period ( cm with a peak of 3 cm/month) led DPC to raise the alert level of the volcano from “**background**” to “**attention**”.



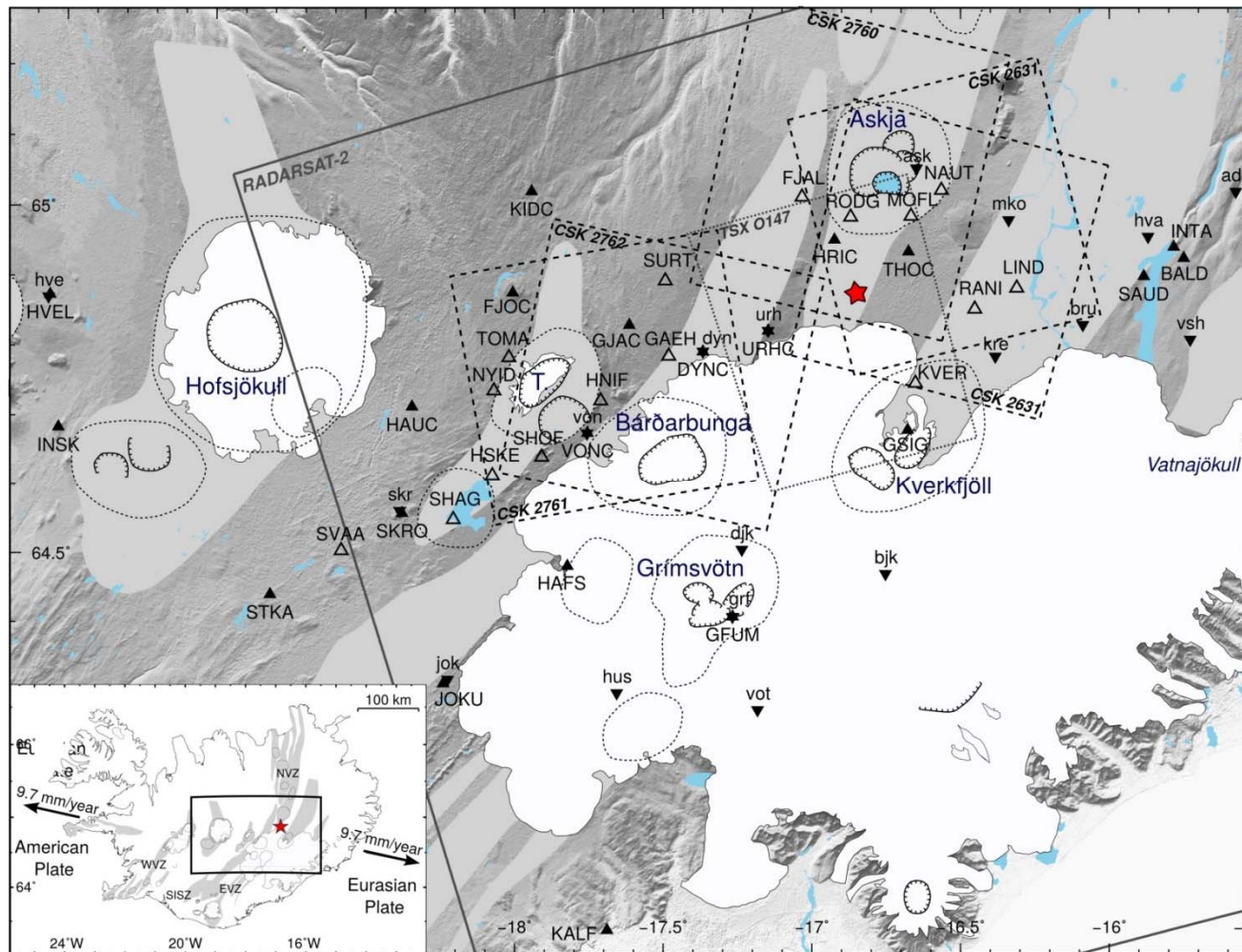
# Supersites results: the Bardabunga eruption



Eruption starts August 16, 2014 under a 800 m - thick ice cap. Worst scenario was magma/water interaction, causing strong explosions, 10-km high volcanic ash/gas plume, subglacial floods.



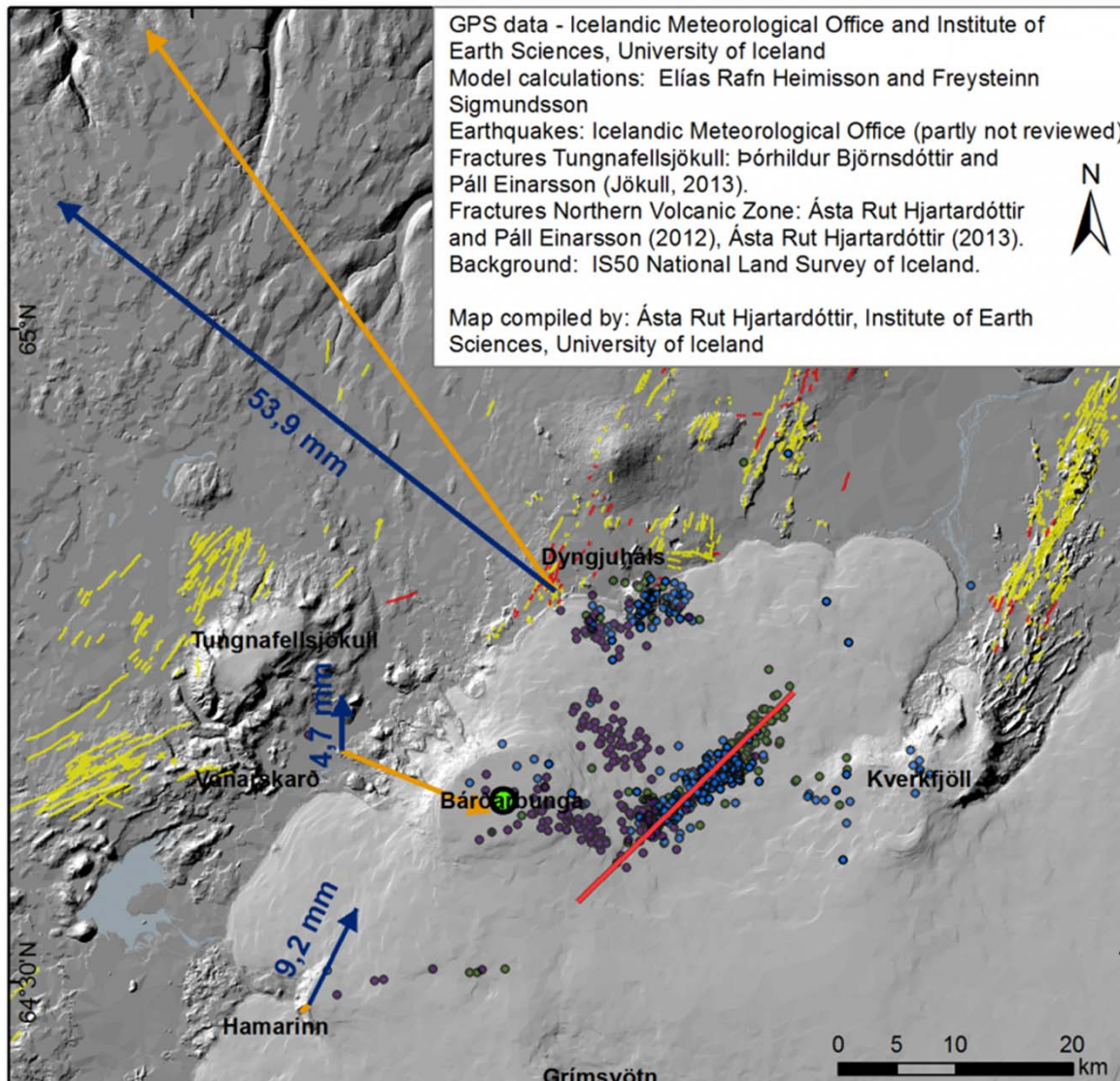
# Supersites results: the Bardabunga eruption



**Very good EO data coverage through the Supersite**



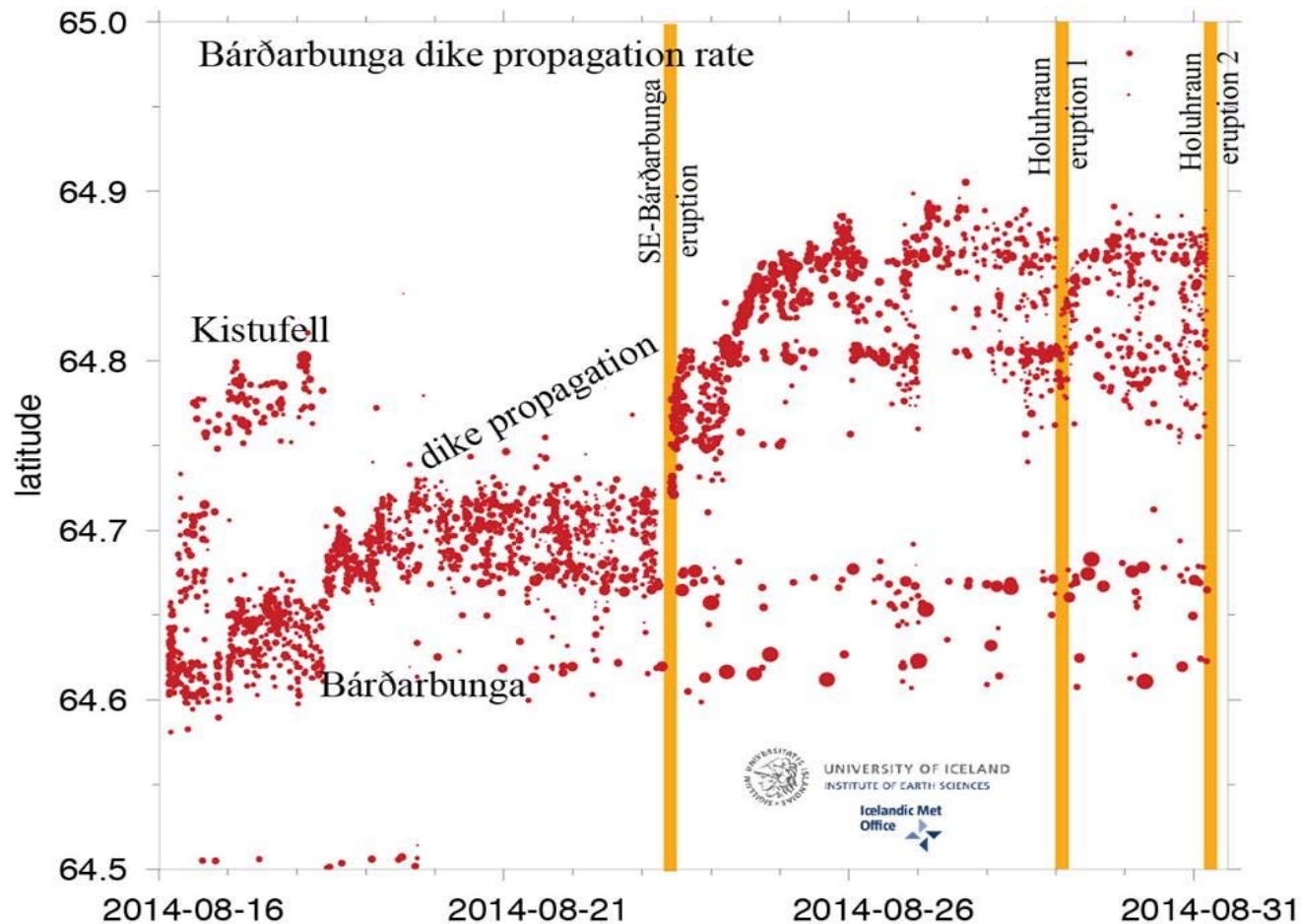
# Supersites results: the Bardabunga eruption



**August 20th:  
seismicity starts to  
migrate north**



# Supersites results: the Bardabunga eruption

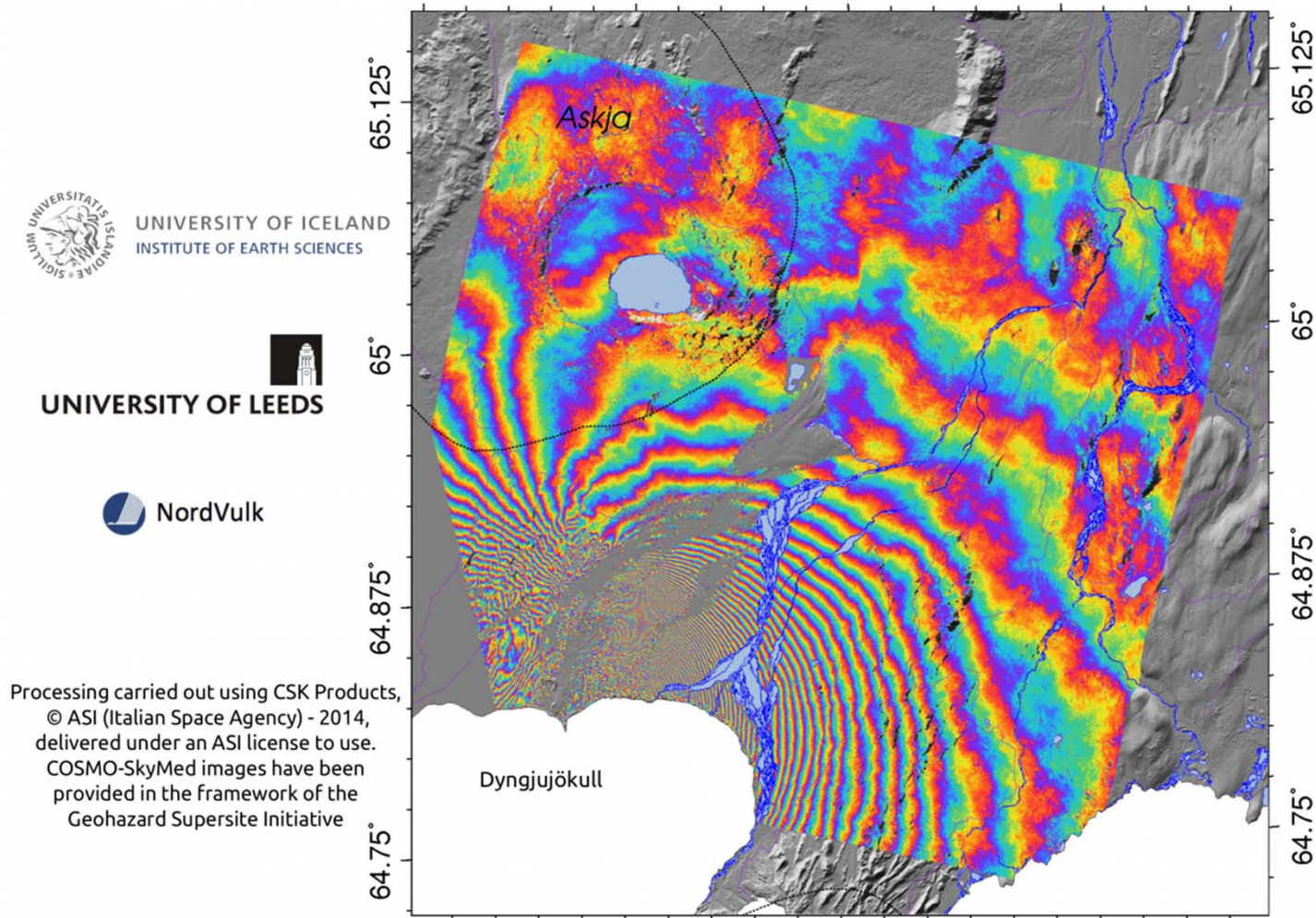


**Magma migrates 40 km to the north, outside of the ice cap**

Bryndís Brandsdóttir, Univ. of Iceland



# Supersites results: the Bardabunga eruption



**CSK interferograms used to model the dyke evolution**



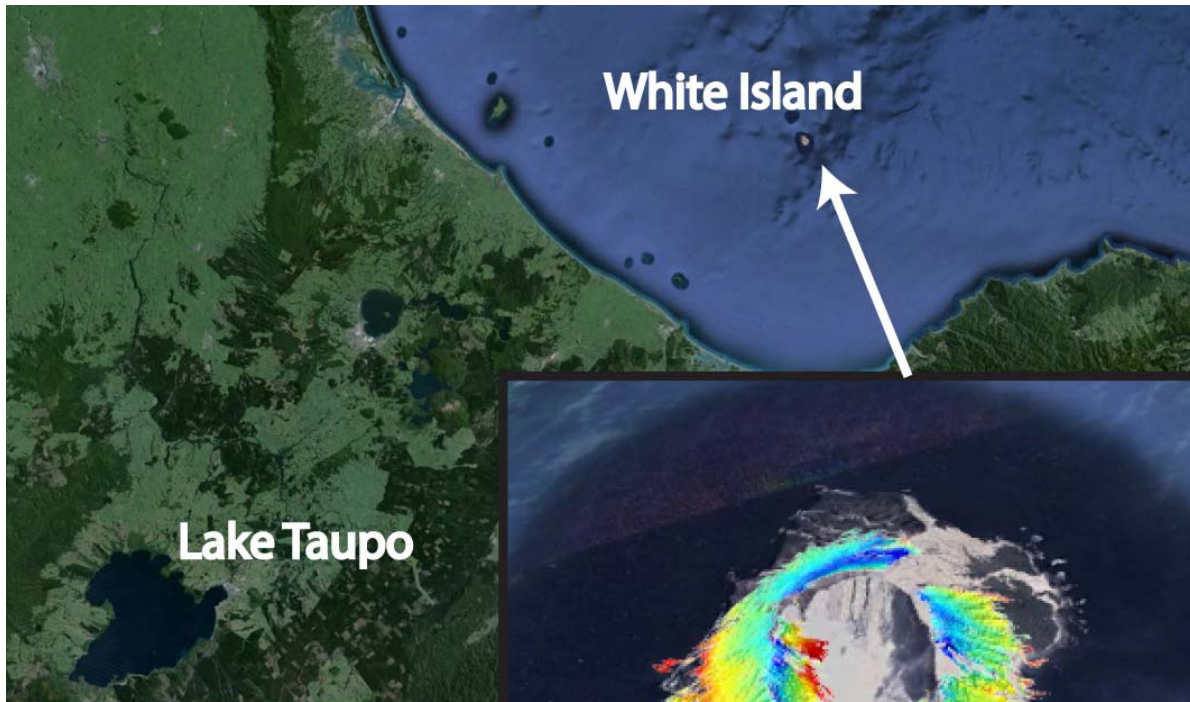
## Bardabunga eruption monitoring

- Main decision making agency: Iceland Police, Dept. of Civil Protection
- Main scientific institutions in charge: University of Iceland, Iceland Meteorological Office
- Collaborating scientists: University of Leeds, NordVulk
  
- The EO data allowed to model the magma migration outside of the ice cap, providing invaluable information for the situational awareness.
- Constant monitoring was ensured through international collaboration.
- Scientific results were used [to take decisions](#), and were disseminated on the [Univ. of Iceland website](#).

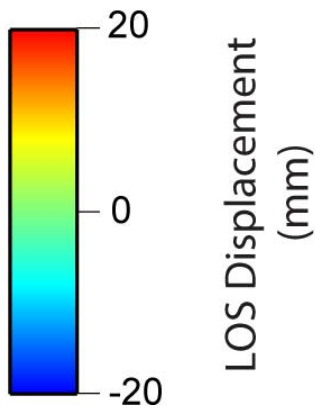
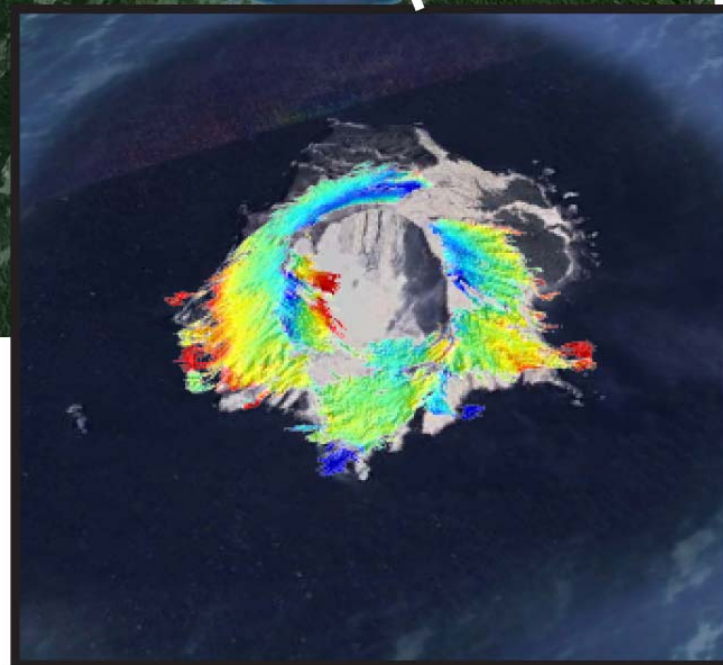




# Supersites results: White Island monitoring



Preliminary TSK  
interferogram





## New Zealand volcano monitoring

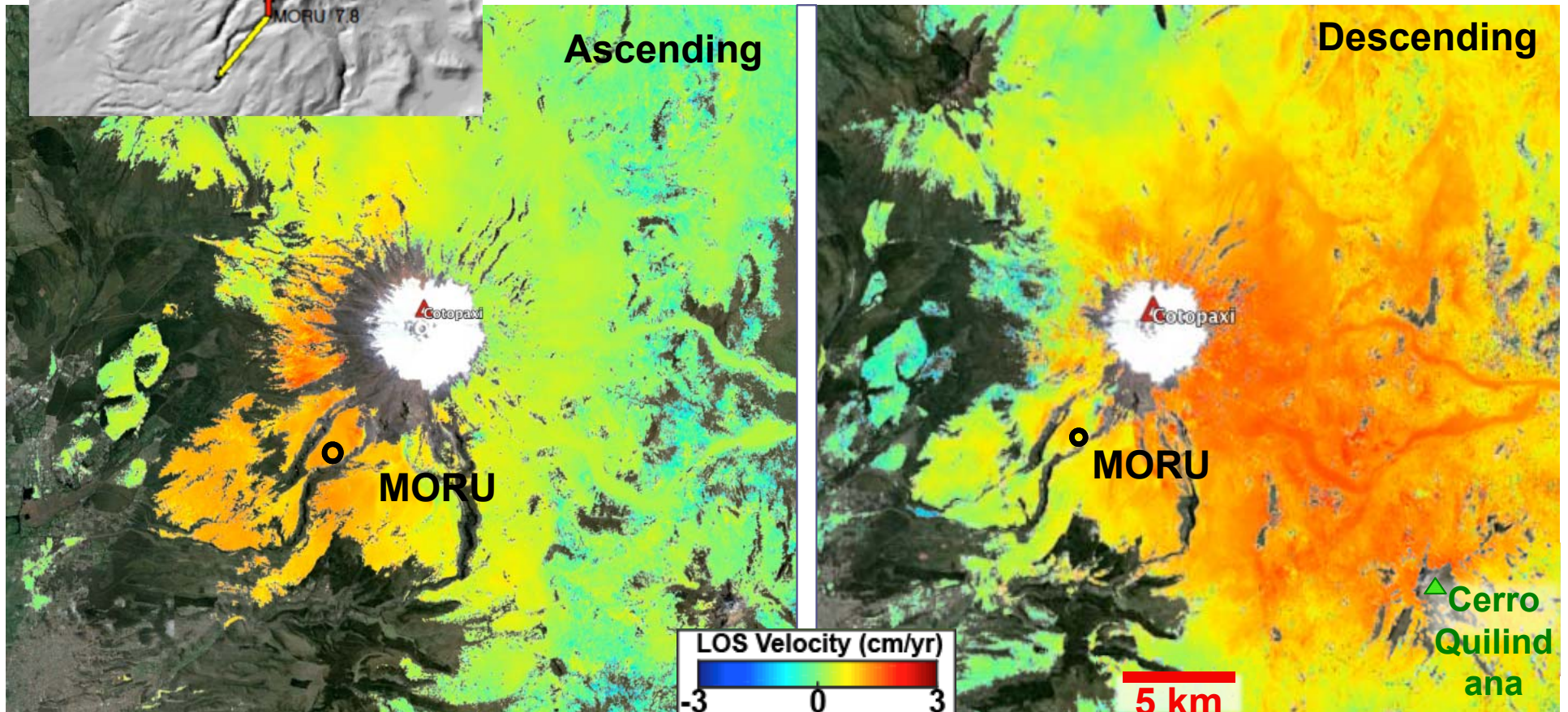
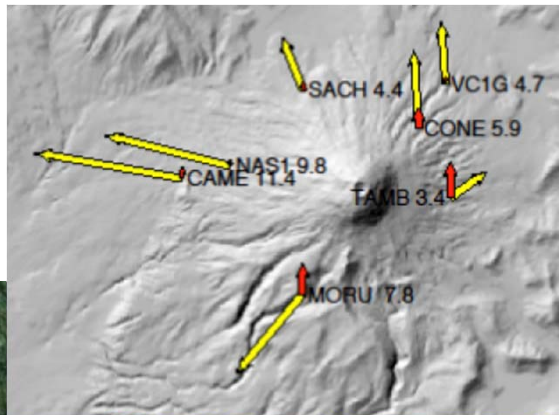
- Main decision making agency: Civil Defense Emergency Management Groups (CDEM) at national and local scale
- Main scientific institutions in charge: GNS Science
- Collaborating scientists:
- Supersite started to receive data few months ago. No results yet.



# Supersites results: Cotopaxi unrest

Initial 2015 CSK data analysis seems to show inflation (longer time-series required)

Results by F. Amelung

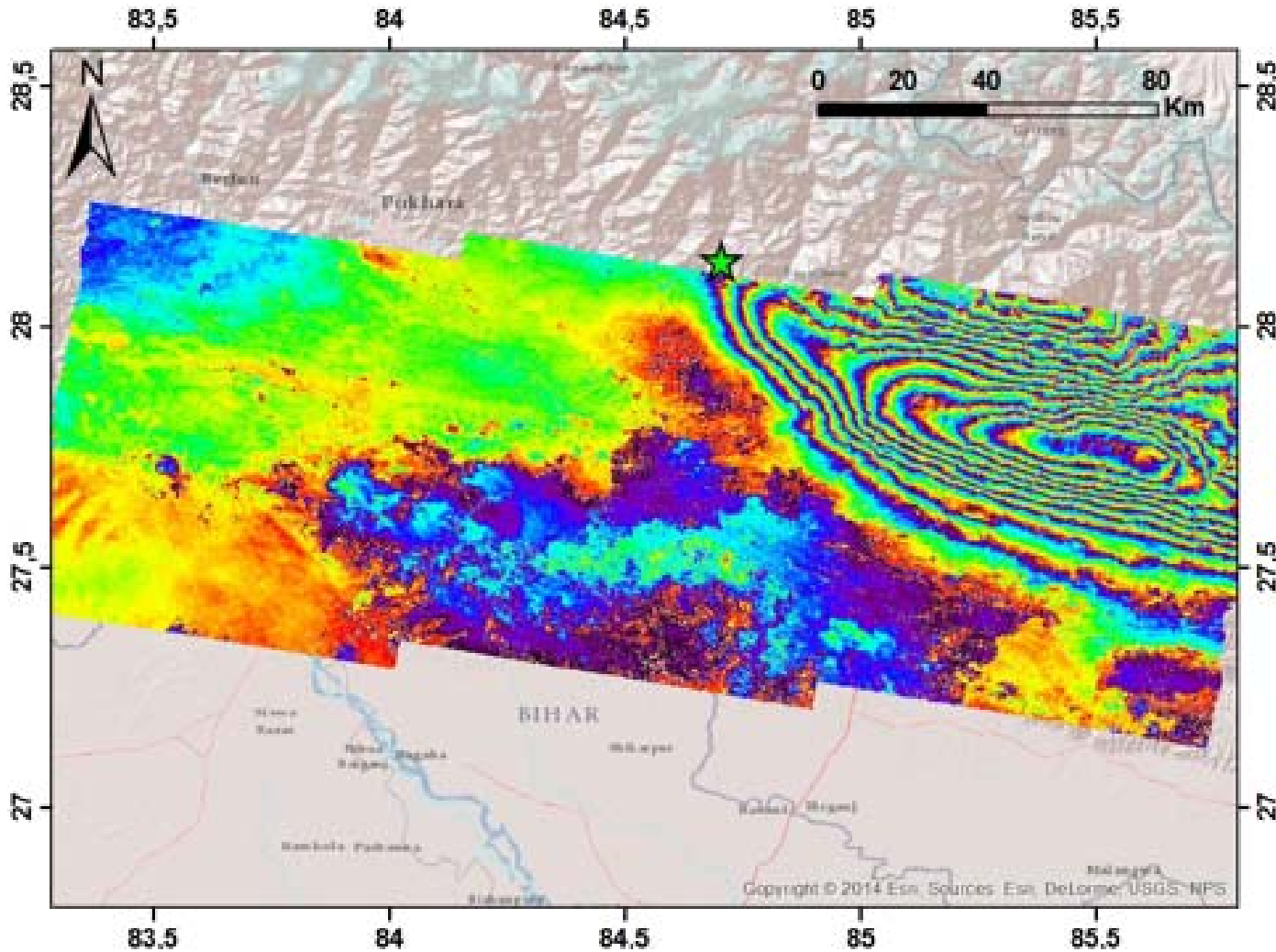




## Ecuador volcano monitoring

- Main decision making agency: National Office of Civil Defense
- Main scientific institutions in charge: Instituto Geofisico, Escuela Politecnica Nacional
- Collaborating scientists: University of Miami
- Monitoring of unrest at Cotopaxi is under way.

# Supersites results: Gorkha event ss



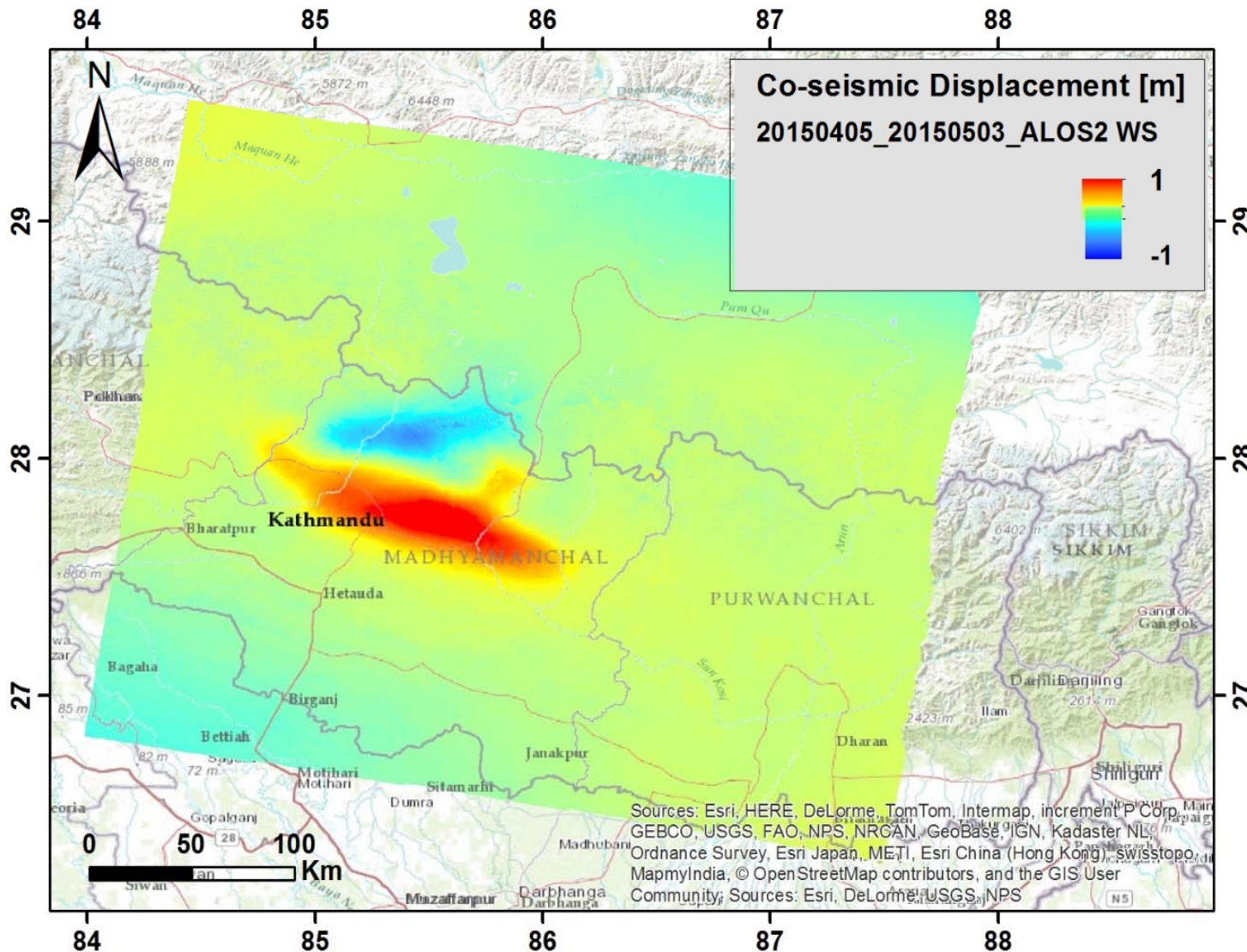
Sentinel 1  
interferogram  
(3 scenes)

C. Tolomei, INGV  
Paper in preparation





# Supersites results: Gorkha event ss



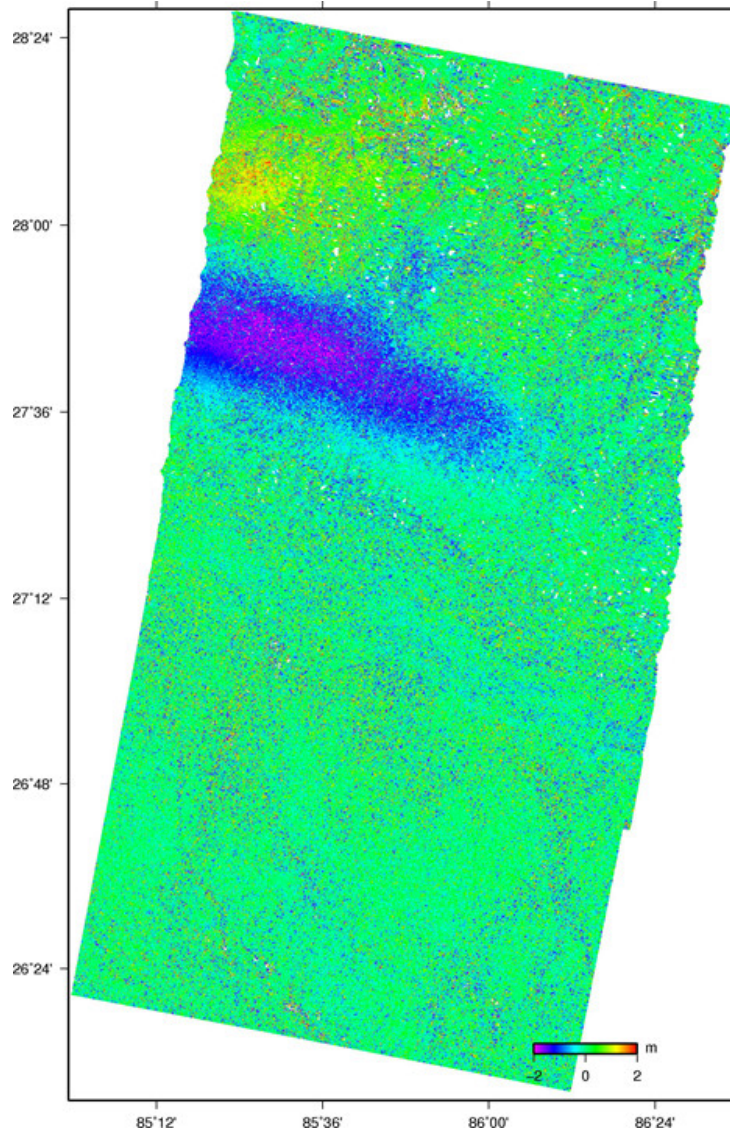
ALOS 2 WS  
interferogram  
(1 scene, 50 Gb)

Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp, GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), Swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community; Sources: Esri, DeLorme, USGS, NPS

C. Tolomei, INGV  
Paper in preparation



# Supersites results: Gorkha event ss

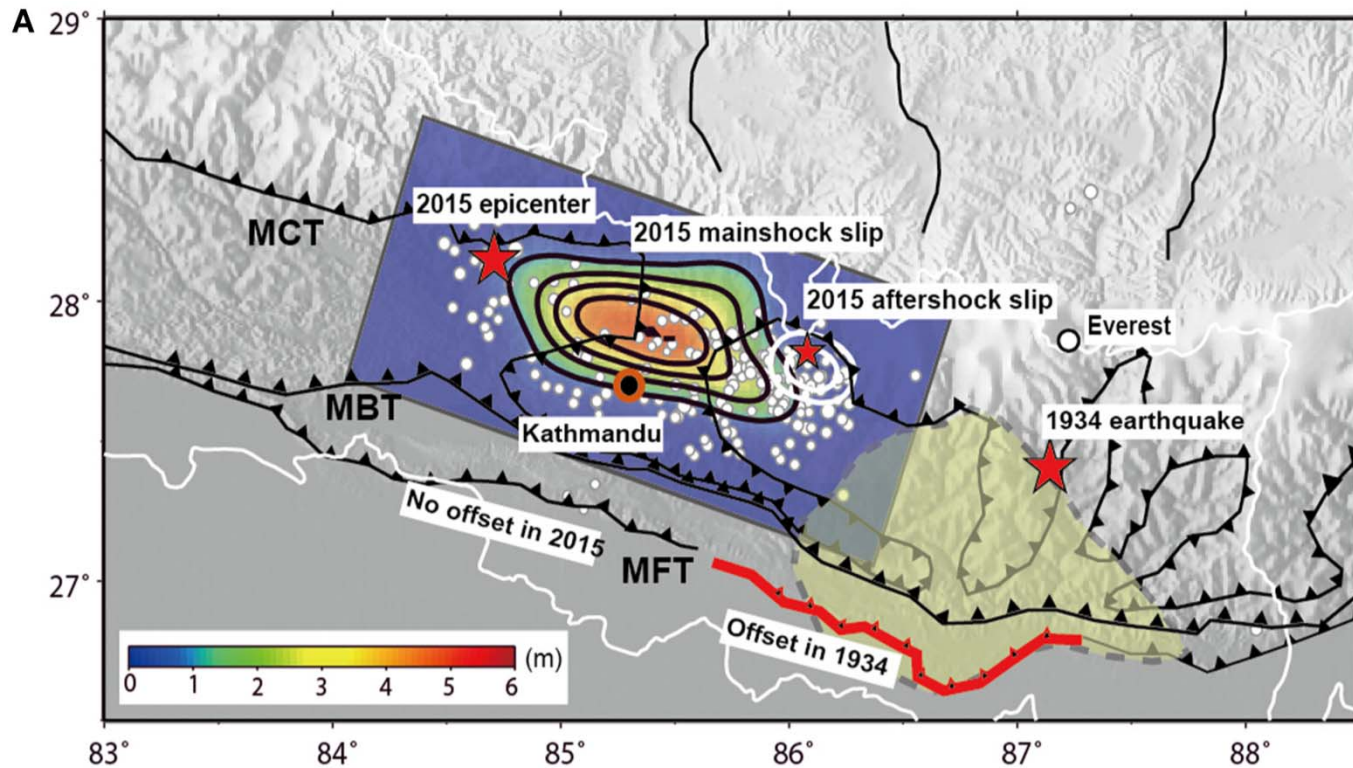


Radarsat 2  
interferogram  
(2 scenes)

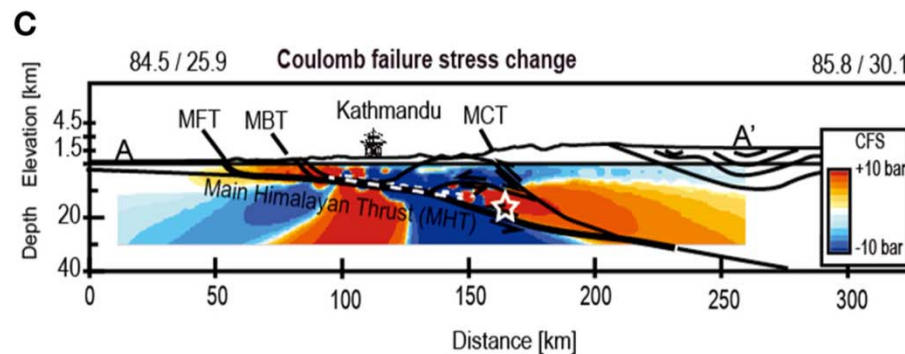
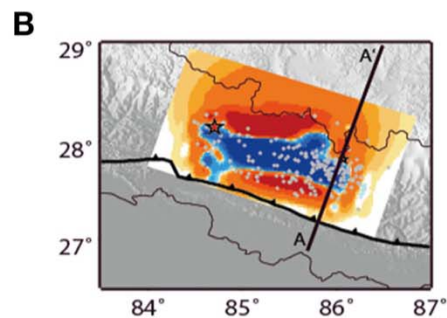
S. Samsonov



# Supersites results: Gorkha event ss



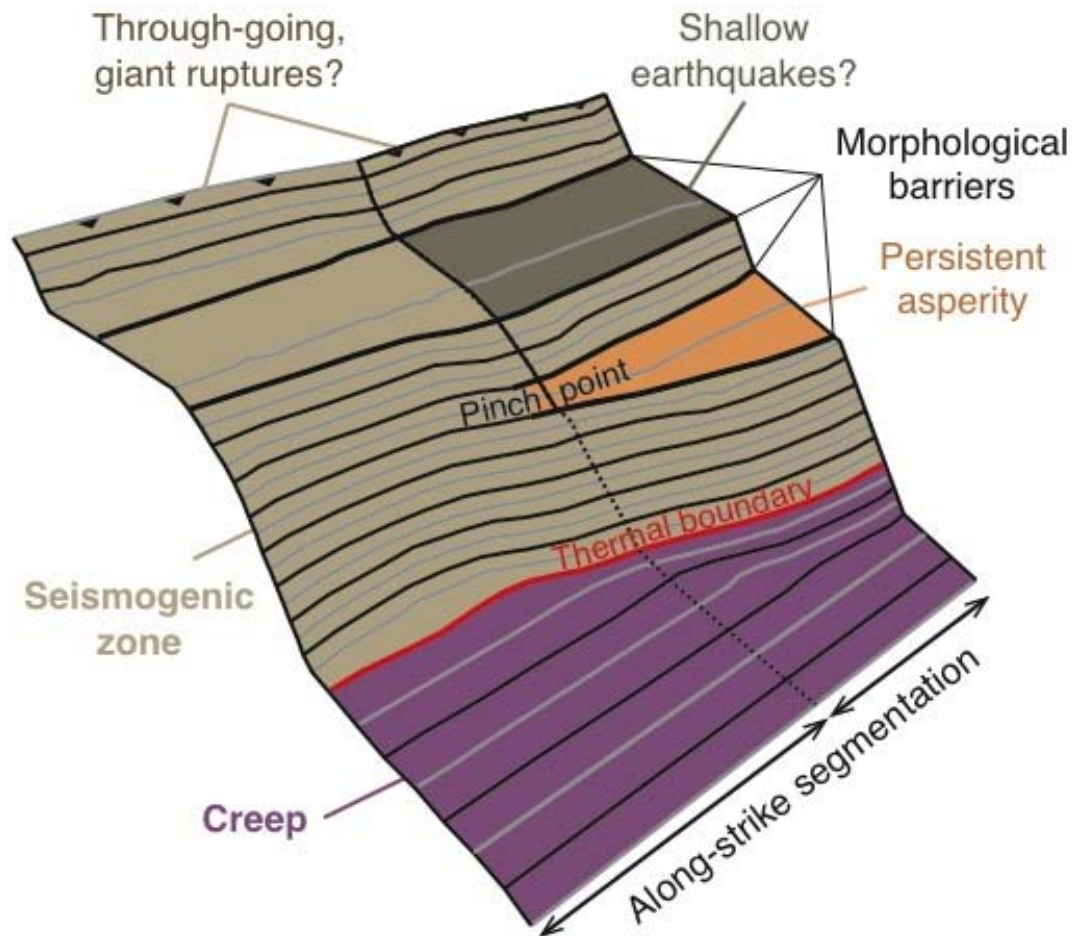
Results based on  
Radarsat 2 data



Diao et al (2015)



## Supersites results: Gorkha event ss



Using EO and geological data the precise shape of the fault surface could be mapped. It appears that the upward propagation of the 2015 eq. rupture was inhibited by asperities possibly caused by changes of dip. Possible implications for seismic hazard (future rupture of upper fault).



# Users for the Gorkha earthquake results

- Main decision making agency: National Disaster Management Authority (NDMA), National Emergency Operation Center (NEOC)
- Main scientific institutions in charge: National Society for Earthquake Technology (NSET), academic institutions
- Published science: a lot!

The screenshot shows a Google Scholar search interface. At the top, the Google logo is on the left, and a search bar contains the text "gorkha earthquake" with a search button on the right. Below the search bar, the word "Scholar" is displayed in red, followed by the text "About 787 results (0.05 sec)", where "787" is circled in blue. On the left side, there is a vertical navigation menu with the following items: "Articles" (highlighted in red), "Case law", "My library", "Any time", "Since 2016", "Since 2015", "Since 2012", and "Custom range...". The main content area displays two search results. The first result is titled "Rapid Characterization of the 2015 Mw 7.8 Gorkha, Nepal, Earthquake Sequence and Its Seismotectonic Context" and lists authors GP Hayes, RW Briggs, and WD Barnhart. The second result is titled "Slip pulse and resonance of the Kathmandu basin during the 2015 Gorkha earthquake, Nepal" and lists authors J Galetzka, D Melgar, JF Genrich, and J Geng.



## Status of EO data access

- There is a nearly routine data flow for all Permanent Supersites, some data were not requested probably because other sensors were used.
- GSNL EO data can now be easily accessed through various infrastructures: [SSARA/UNAVCO](#), [SS-Portal/DLR](#), [Data Gateway/ASI](#), [GEP&VA/ESA](#).



## Status of in situ data access

- Most of the older Supersites have now developed a data sharing infrastructure: [Hawaii](#), [Iceland](#), [Etna](#), Campi Flegrei.
- For other Supersites we request to put in place an initial infrastructure within the two-year term. They can build their own web platform or use other infrastructures (e.g. UNAVCO or EPOS web services).





## Issues with data access

- CSA does not provide a web interface to access Radarsat data. US scientists place Radarsat data on the SSARA/UNAVCO platform. Could we use also the GEP&VA/ESA for data sharing?
- Will CNES provide a web interface for GSNL data sharing?
- For some “old” Supersites (Marmara) the in situ data are still not easily accessible (ftp access or email requests).
- For some in situ data types (e.g. gravity, geochemical data) the access is not provided or is not straightforward.



## Status of scientific product sharing

GSNL 2.0 rules require scientists to provide their scientific results in digital format ([Supersite review procedures](#))

- Precondition #1: a data (product) policy. A schematic DP is being drafted and will be approved by SAC in April. It could be adapted to comply to local restrictions (e.g. Indonesia).
- Precondition #2: a proper attribution of IP and a licensing policy. Open data licenses will be proposed, possibly with limitations for commercial use (e.g. [CC BY-NC-SA 4.0](#)).
- Product sharing issues: agree on standard metadata, provide proper management (also for DOI attribution) and infrastructure for web access.





## A Virtual Research Environment for GSNL

- The Supersite community is now involved in a project called EVER-EST which has been funded by the EC under a Research Infrastructure call.
- The project is led by ESA and will end in October 2018.
- EVER-EST will build a Virtual Research Environment, providing a variety of services to the Supersite community, to improve the way scientists interact on each Supersite.
- Three more communities will be using this infrastructure, marine environment, hydromet hazards, land use and security.
- The VRE will help researchers to share or access data, disseminate or access scientific products, maintain long term archives for the Supersite, provide and share common tools for data processing/modeling, document scientific work, cross compare scientific results, manage IPRs (DOI attribution, licensing), facilitate remote collaboration, etc.



## The new Supersite evaluation procedure

The new procedure has been approved in November and is now enforced for all new proposals.

It has introduced new requirements to ensure that the Supersites are more efficient in providing data and promoting scientific advancements, that their scientific products can reach the decision makers and support DRM activities, and that the entire initiative is aligned with the GEO Flagship concept.

We also request formal commitments from the in situ data providers.



## GSNL as a GEO Flagship

- [First document](#), describing the initiative and proposing the Flagship status, has been integrated into the 2016 work programme.
- GEO Flagship should develop and implement pilot or pre-operational services.
- Most Supersites already provide services to their respective end-users, and experiment methods to improve these services integrating EO data into their value-adding chain
- GSNL is a global network of “projects” with the objective to promote better science and practices adapted to local needs for DRR, so there is strong benefit from the exchange of scientific knowledge, technology, practices for supporting DRM agencies.
- Better coordination with other initiatives is required.



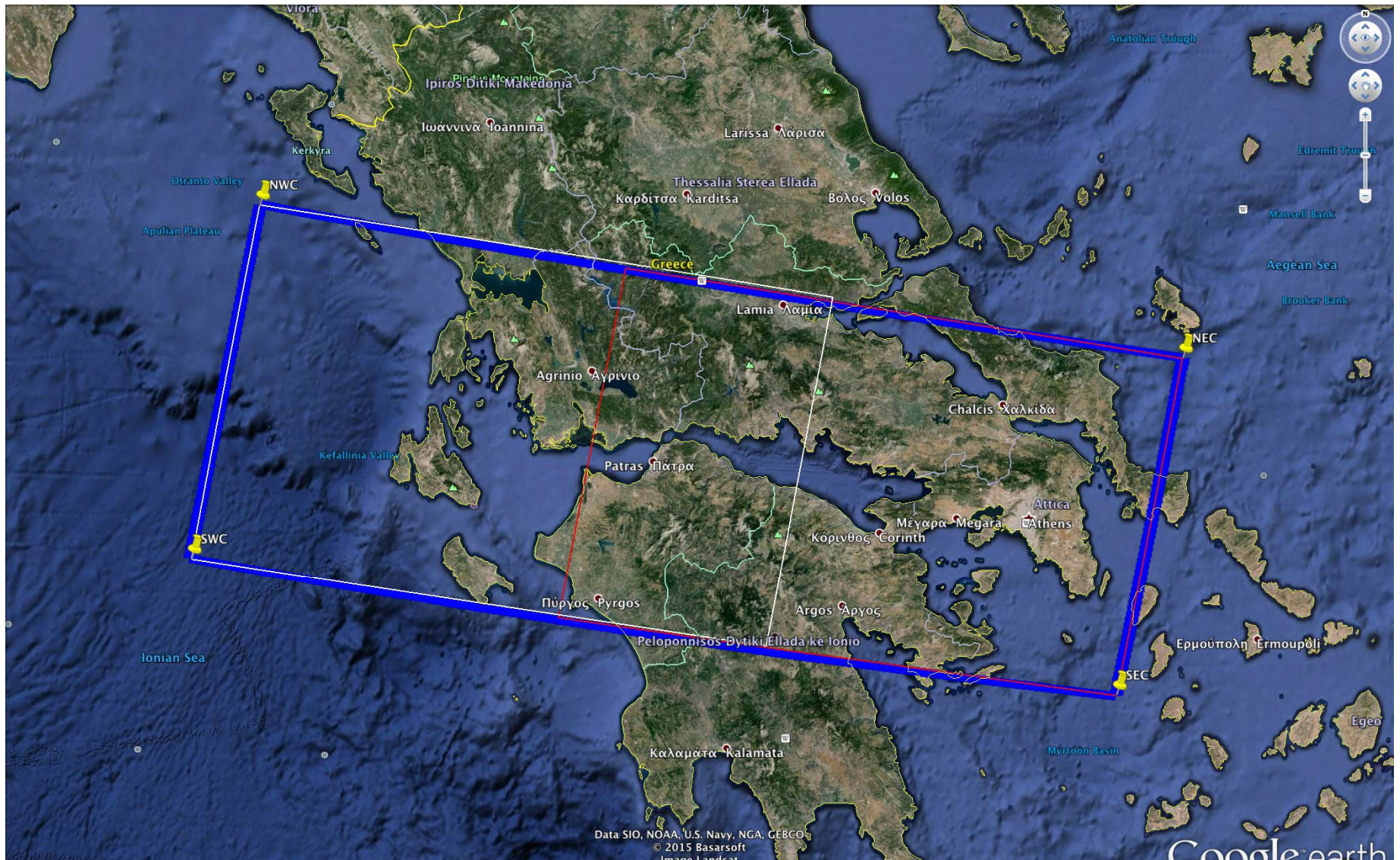
# Status of the South East Asia Natural Laboratory

- The DCT was concerned about the large data requests in the NL proposal. The Agencies requested that the concept be demonstrated on a smaller area with a more focused approach.
- At a meeting in Indonesia in February 2016 it was agreed that the Indonesians will submit a proposal for a Supersite, including probably 5-8 volcanoes with different activity type, eruption frequencies, and ground monitoring conditions, to test a variety of situations.
- The proposal will be jointly coordinated by the Institute of Technology of Bandung (ITB, a University), and the Centre for Volcanology and GeoHazard Monitoring (CVGHM).
- CVGHM is a monitoring agency, a research institute, but also a decision maker during emergencies, issuing evacuation orders.
- The University of Manila was also present but a Supersite proposal from the Philippines requires an internal process to build the partnership.





# Status of the Greek Supersite proposal





## Objectives of Greek Supersite

- Long term monitoring of the area for mapping the crustal deformation and stress-strain regime, including time-varying patterns.
- Perform updated seismicity relocations for the areas of interest, using calibrated crustal/upper models.
- Exploitation of the available datasets (existing and new) to obtain reliable empirical estimates of source, path and site effects for seismic motions in the Supersite area
- Efficient fusion of the acquired earth and space observations in order to better monitor and understand the hazard sources.
- Exploitation of ground and satellite information to assess the risk in the Supersite area and achieve Disaster Risk Reduction and Resilience.



## The partnership of the Greek Supersite

- Coordinator: Institute of Engineering Seismology & Earthquake Engineering – ITSAK, part of the Earthquake Planning and Protection Organisation (EPPO). EPPO is a government agency in charge of Prevention, Mitigation, and Emergency activities
- Core team: five more Universities in Athens, Patras and Thessaloniki





## In situ data for the Greek Supersite

- Mostly broadband and short period seismic data and GPS data



## EO data requested by the Greek Supersite

- Sentinel-1 will be used for wide area monitoring
- COSMO-SkyMed will be used for *“Periodical monitoring in order to maintain a good coherence over preselected active tectonically areas (active faults in urban or rural areas). “* (~100 images)
- Same for TerraSAR X. (~100 images)
- Same for Radarsat 2. (~50 images)
- An undefined number of ALOS 2 images
- An undefined number of optical scenes (SPOT and Pleiades)
- EMS products will be requested by EPPO and used in case of emergency.



## Side issues

- What is the status of RSAT2 for Ecuador Supersite?
- Can Tandem X DEM be made available for GSNL?
- UNAVCO is available to maintain Supersite data into SSARA, but to justify resources a formal request could be needed.
- A clear procedure should be defined for SPOT/Pleiades image requests
- Can Radarsat 2 Supersite data be hosted on the GEP?