Committee on Earth Observation Satellites

The CEOS Volcano Demonstrator

Rationale and Implementation

WGD#9, Brussels
March 13-15, 2018

The CEOS Volcano Pilot

JUSTIFICATION: Millions of people live within ~20 km of a potentially active volcano, but about half of these volcanoes are unmonitored by ground-based sensors.

GOALS

- Identify volcanoes in Latin America that are in a state of unrest, and track that unrest (and eruptions) using satellite data in support of hazard mitigation activities
- Assess data needs in terms of volume, repeat times, spatio-temporal resolution, wavelength, etc., and improve satellite-based monitoring techniques
- Develop a strategy for capacity-building in countries that do not currently have access to abundant EO data and/or the ability to process and interpret such data.

ACHEIVEMENTS

- Identified restless volcanoes that would not otherwise be known
- Comprehensive tracking of unrest and eruptive activity
- Demonstrated need for a diverse approach (multiple satellites, multiple capabilities)
- Helped inform decisions about alert levels and response actions (sometimes, satellites provided the only observations of unrest)

The CEOS Volcano Pilot

LESSONS

- Coordination between multiple space agencies and satellite platforms can result in near-daily coverage at most active volcanoes
- Systematic background observations are critical
- Acquisition plans should be flexible to accommodate changes in activity
- Low latency is key (automated availability of data/products?)
- Sustainability requires dedicated support from multiple agencies
- No one-size-fits-all solution for volcano observatories
  - raw data vs. interpreted data
  - no active observatories in some volcanically active areas
  - Need to include uncertainty in interpretation
  - Short courses are appreciated, but not enough—extended visits and MS/PhD training are better approaches

Towards coordinated regional multi-satellite InSAR volcano observations: Results from the Latin America pilot project

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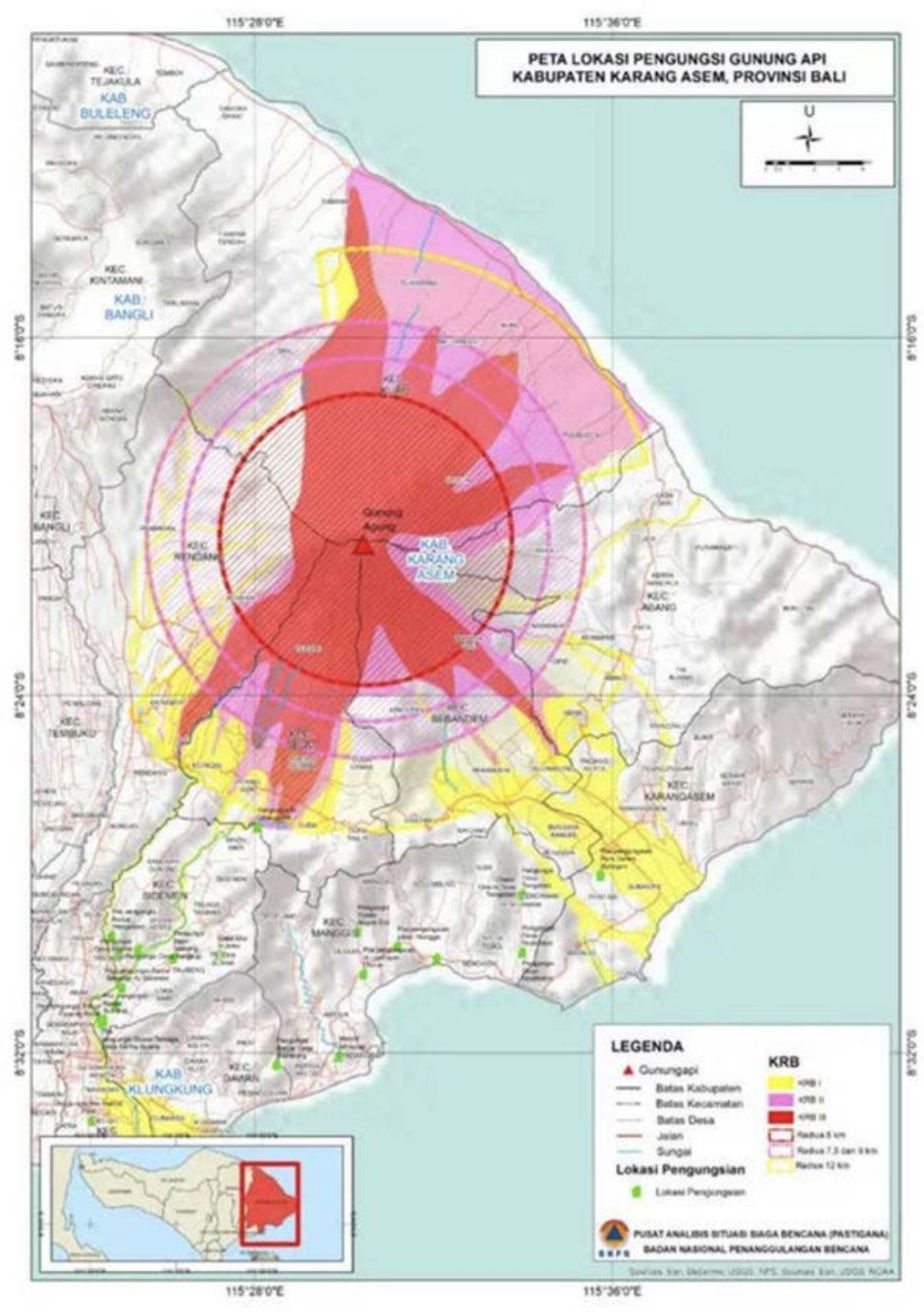
Abstract

Within Latin America, about 319 volcanoes have been active in the Holocene, but 202 of these volcanoes have no seismic, deformation or gas monitoring. Following the 2012 Santorini Report on satellite Earth Observation and Geohazards, the Committee on Earth Observation Satellites (CEOS) developed a 4-year pilot project (2013-2017) to demonstrate how satellite observations can be used to monitor large numbers of volcanoes cost-effectively, particularly in areas with scarce instrumentation and/or difficult access. The pilot aims to improve

Demonstrating the Demonstrator:

Agung, Bali Indonesia



Agung Volcano, Bali, Indonesia

- Erupted in 1963–64, caused 2000 deaths and had a major impact on global climate
- Seismic swarm starting in September resulted in the evacuation of ~100,000 people
- Seismicity waned in October, but elevated levels of earthquake activity persisted
- Phreato-magmatic eruptions began in mid-late November, eruption of lava in the crater in late November with occasional discrete explosions
- Intense socio-political pressure on CVGHM
- No direct access to satellite data
- Conflicting messages on Twitter

Coordinated response effort by global geodetic community. Results, shared with CVGHM, aided with interpretation and decision making.

Bull Volcanol (1999) 60:323–334

ORIGINAL PAPER

Chris Newhall et al.

IAVCEI Subcommittee for Crisis Protocols

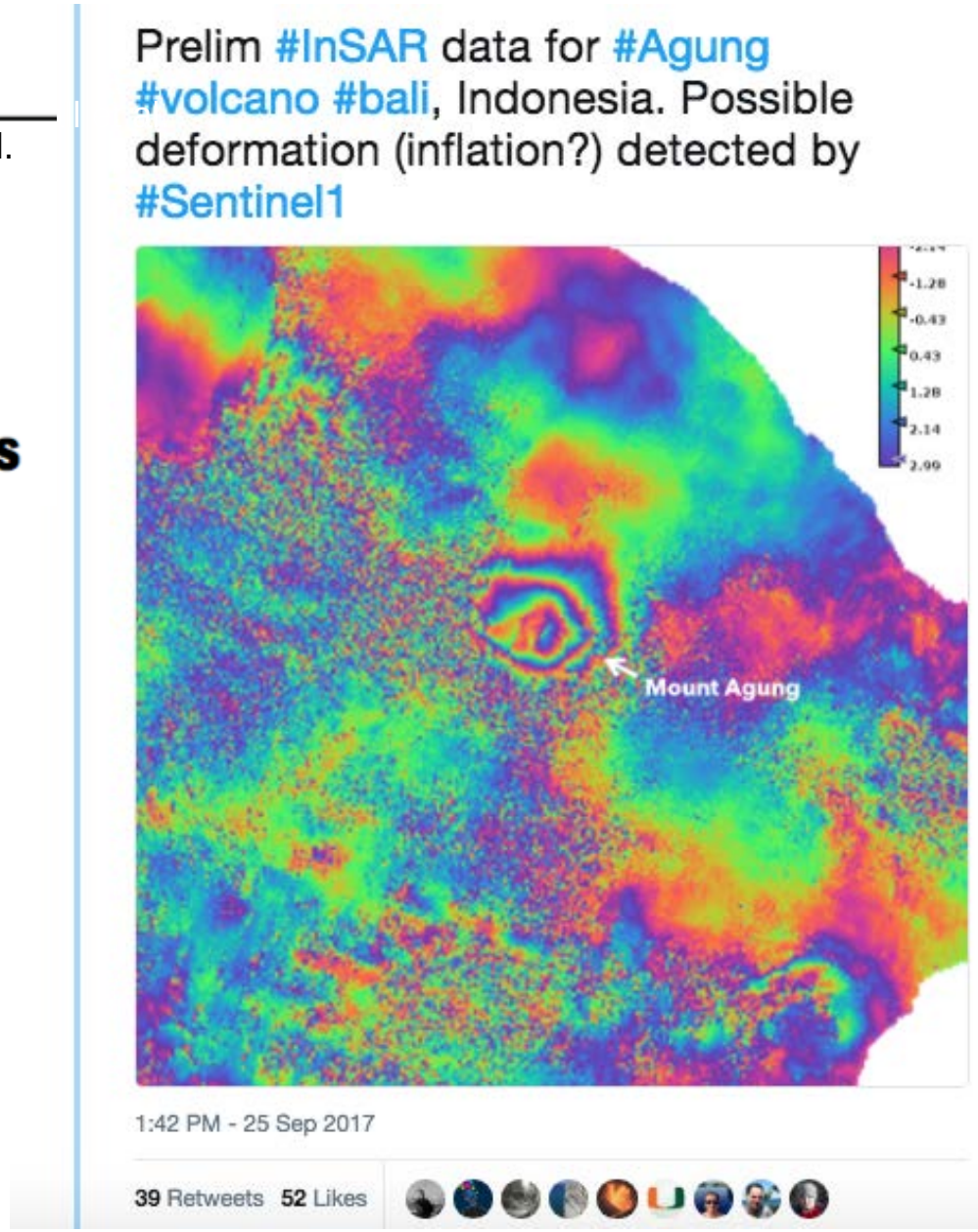
Professional conduct of scientists during volcanic crises

"Some warnings and forecasts, especially those based on remote sensing data alone, have ignored important constraints from other disciplines.

Some that were intended only for limited professional discussion "escaped" into the public domain.

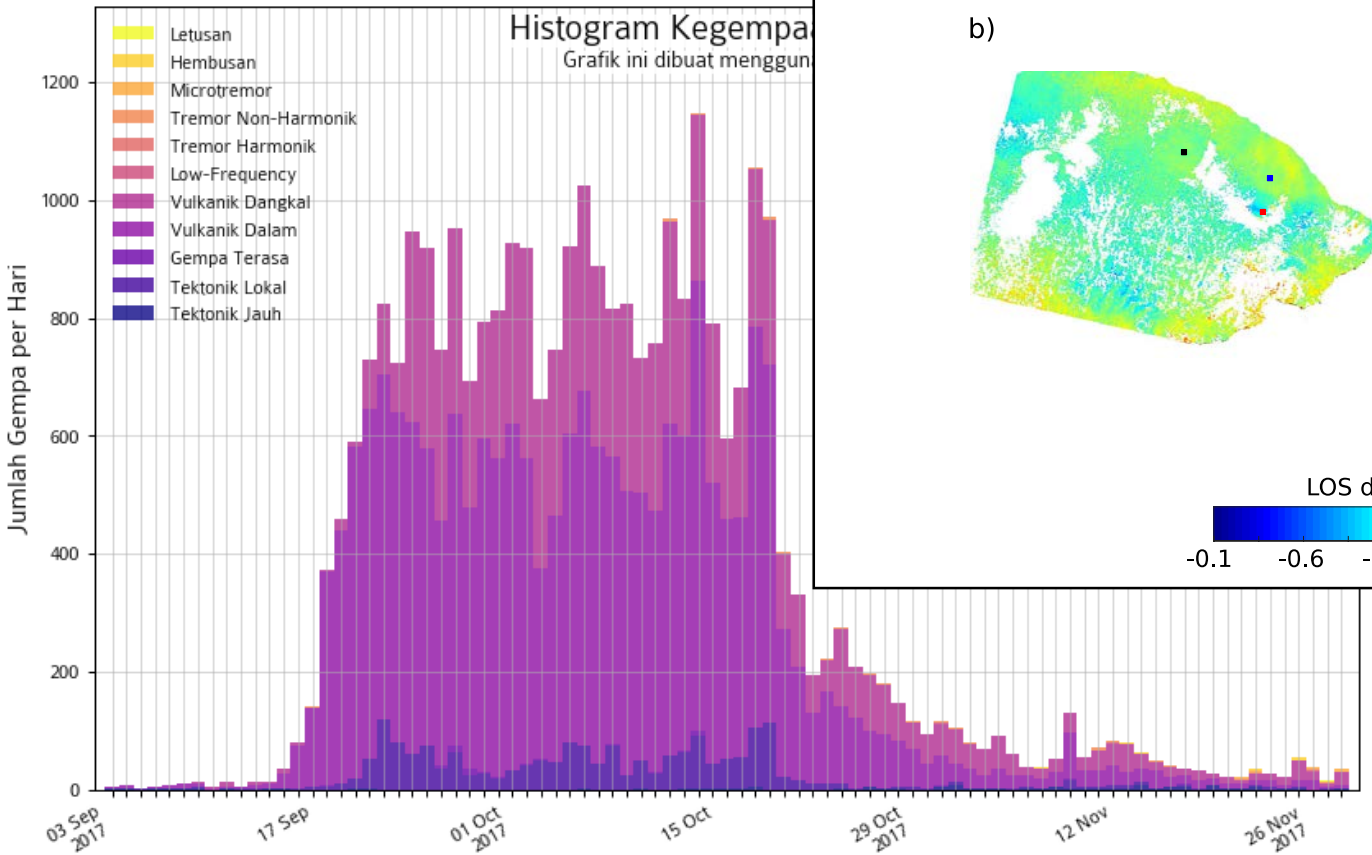
Some are from scientists unable to resist the siren call of media exposure; many are innocent, media-solicited forecast-like comments from individuals who are utterly unaware of how disruptive their comments can be for team scientists.

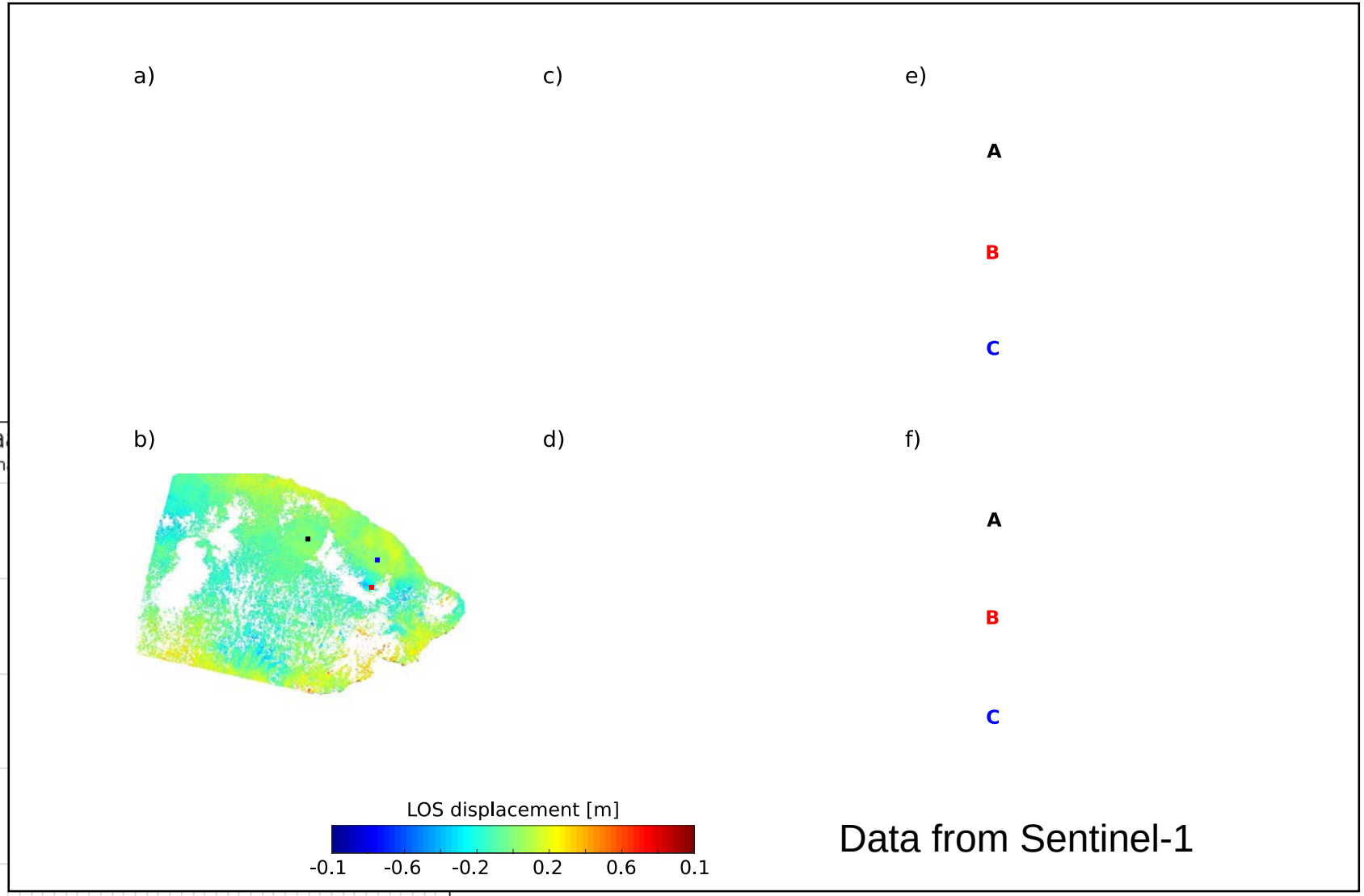
Whatever the cause, the effects are serious distraction from more pressing duties, loss of credibility for all scientists, and, usually, misguidance for public officials."



Need to update Newhall et al., 1999, for the age of twitter…

Result #1: September-October seismicity was a result of a dike intrusion

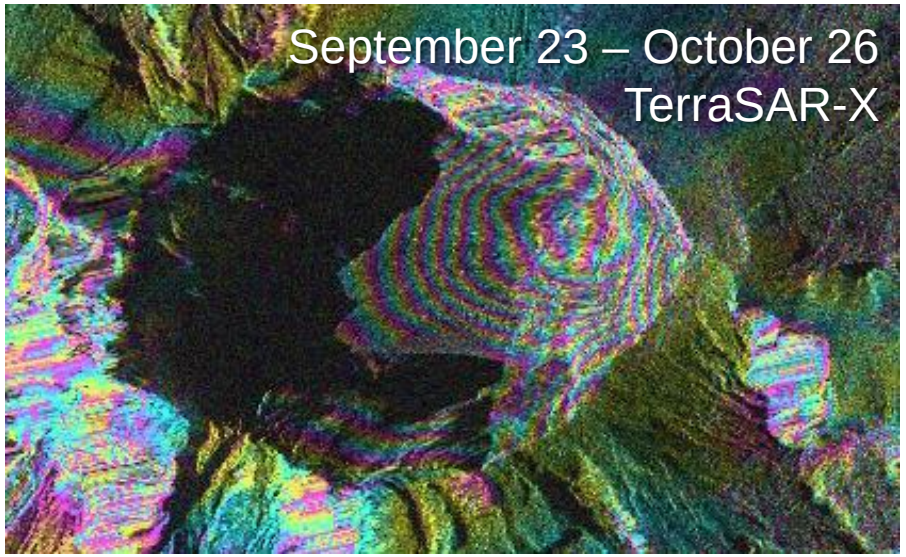




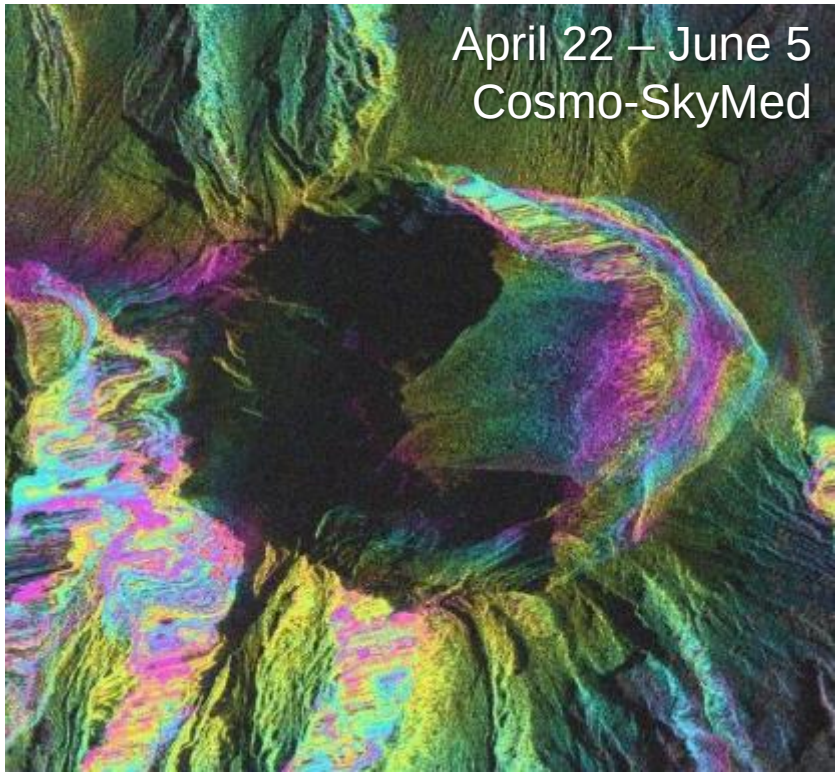
Data from Sentinel-1

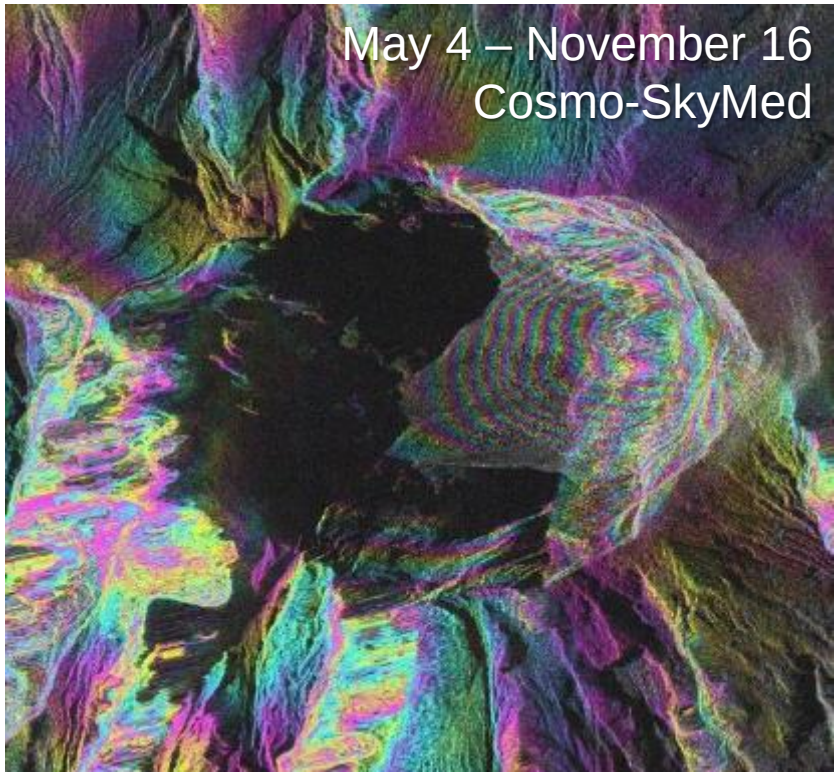
Results from Fabien Albino and Juliet Biggs, University of Bristol

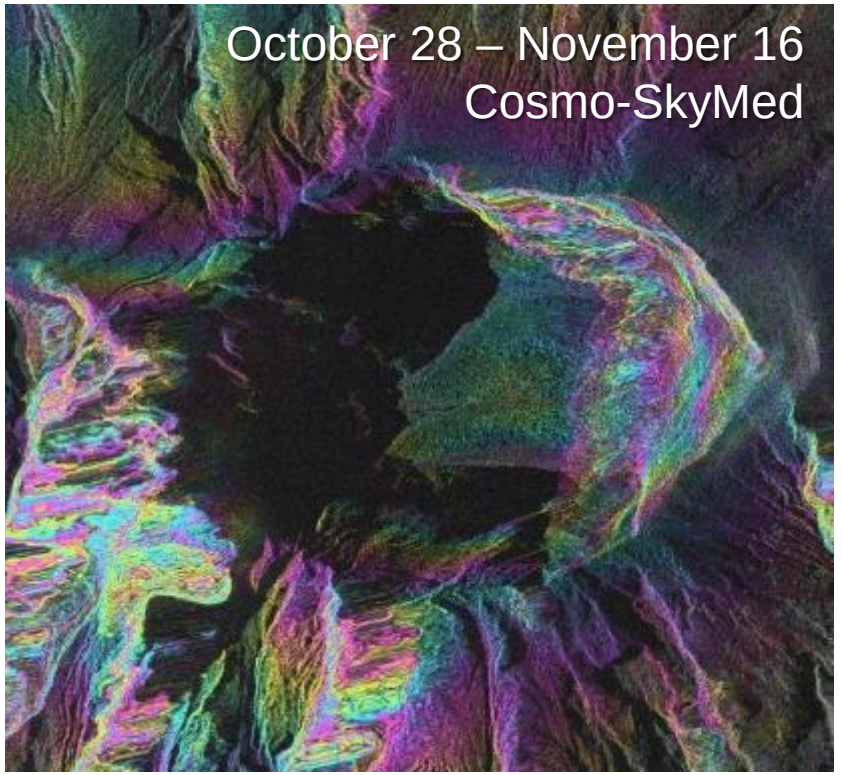
<u>Result #2</u>: No volcano-wide deformation was observed prior to the eruption, but intra-crater deformation did occur in September-October



TSX processing by Jackie Salzer
GFZ Potsdam

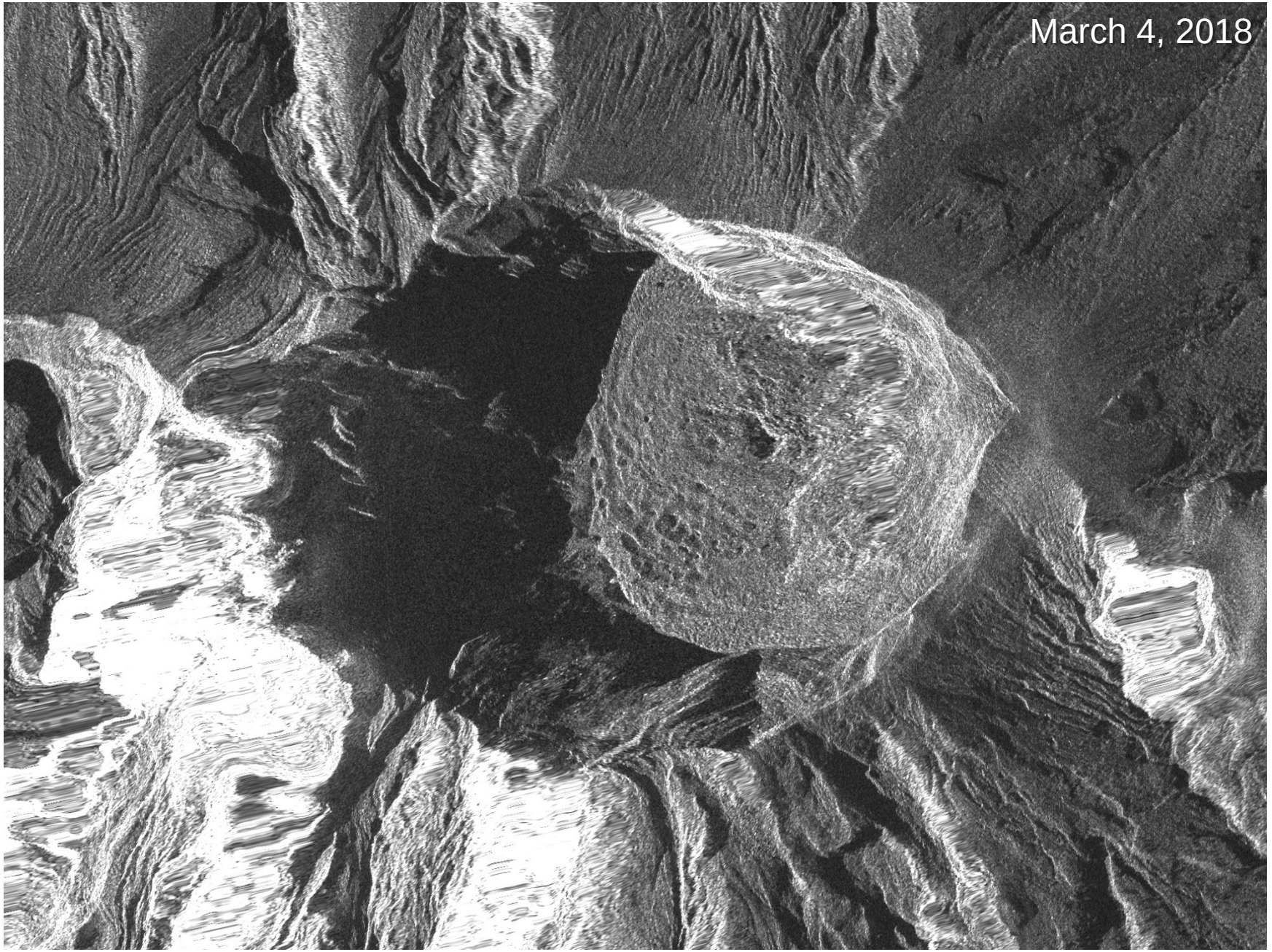






<u>Result #3</u>: High-resolution views of lava accumulation and degradation

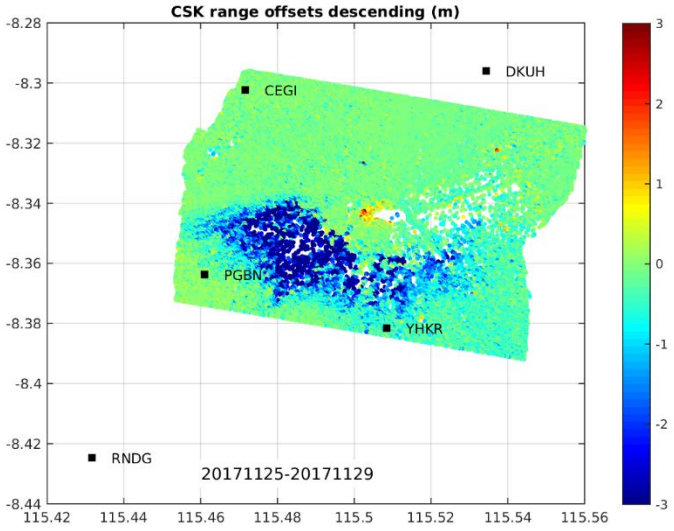
Cosmo-SkyMed spotlight data

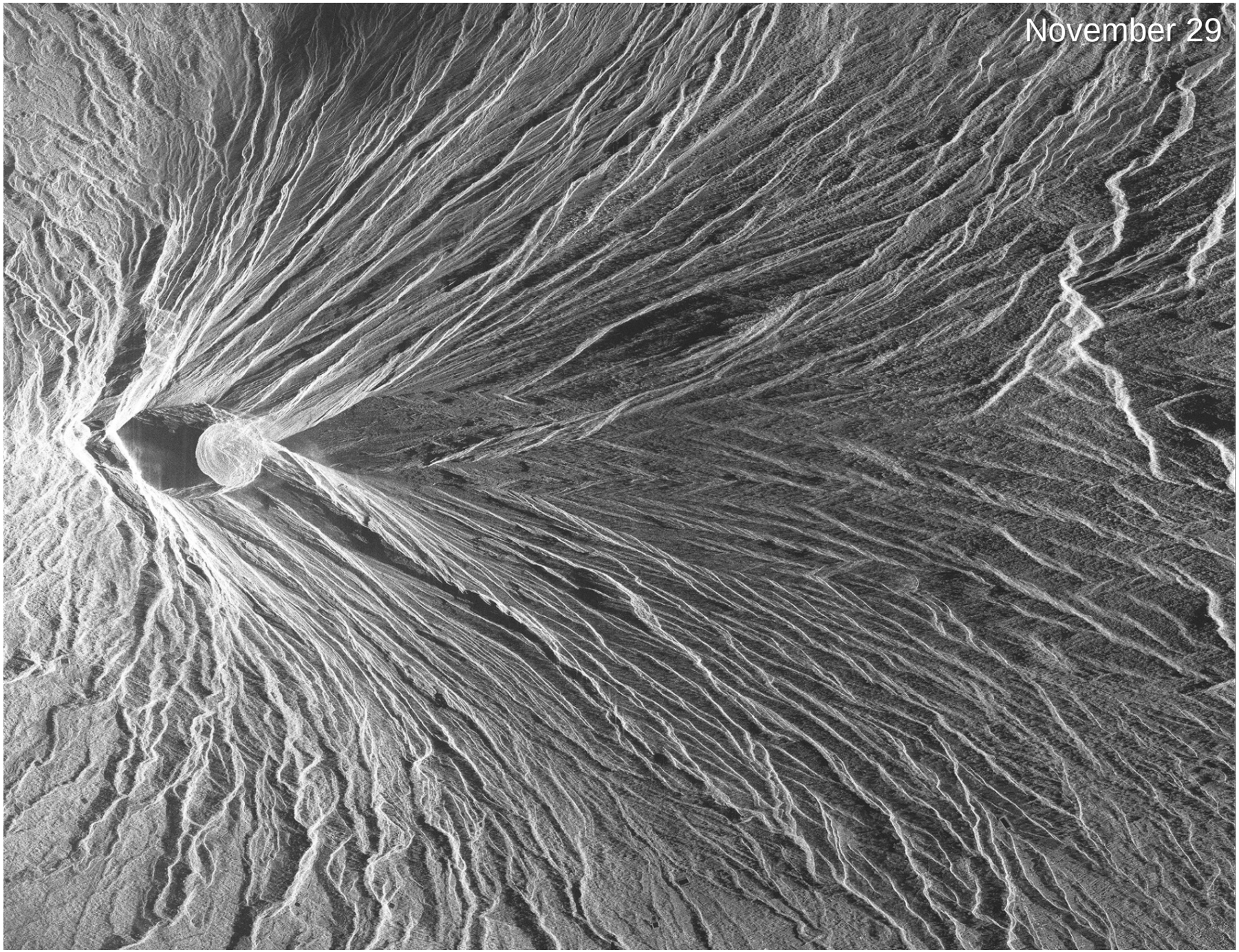


Result #4: Major deformation of the volcano's SE flank

Data from Cosmo-SkyMed and Sentinel-1

Data processed by Teng Wang, Earth Observatory Singapore

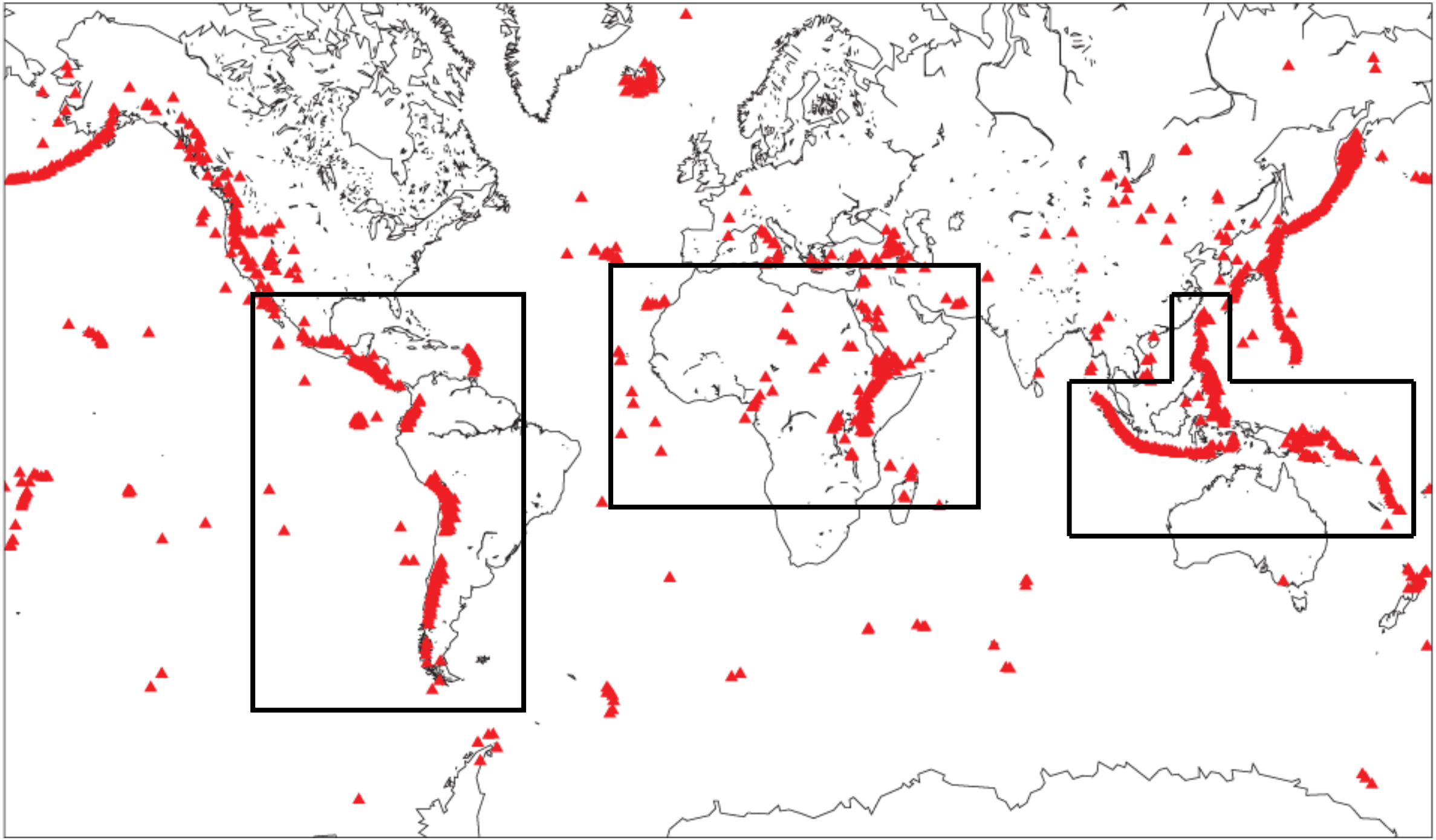




Volcano Demonstrator: An Evolution from the Volcano Pilot

- Many volcano observatories in Latin American are relatively mature. How can the lessons of the pilot be expanded to lesser-developed areas? There are ~100 volcano observatories around the world with a range of capabilities. How can we meet their heterogeneous needs?
- Observations are needed at a diversity of volcanoes to understand the nature of precursors and manifestations of eruptive activity, and the best methods for tracking unrest and eruptions. Latin America provided a start, but more examples are needed.
- The Volcano Pilot focused heavily on SAR, which is often the most difficult data to obtain. Future efforts should focus on integrating SAR with IR, UV, and visible observations to develop a comprehensive approach to satellite monitoring of active volcanism.

End goal: develop a global volcano monitoring strategy for satellites (what volcanoes should be targeted with what data and how often?)



Volcano Demonstrator: Implementation Challenges

Organizing the global community to maximize research output and support of VOs

- Partner with established agencies, like the IAVCEI Commission on Volcano Geodesy, the Association of Latin American Association of Volcanology, etc.

Who is allowed to access data, and where will those data be stored?

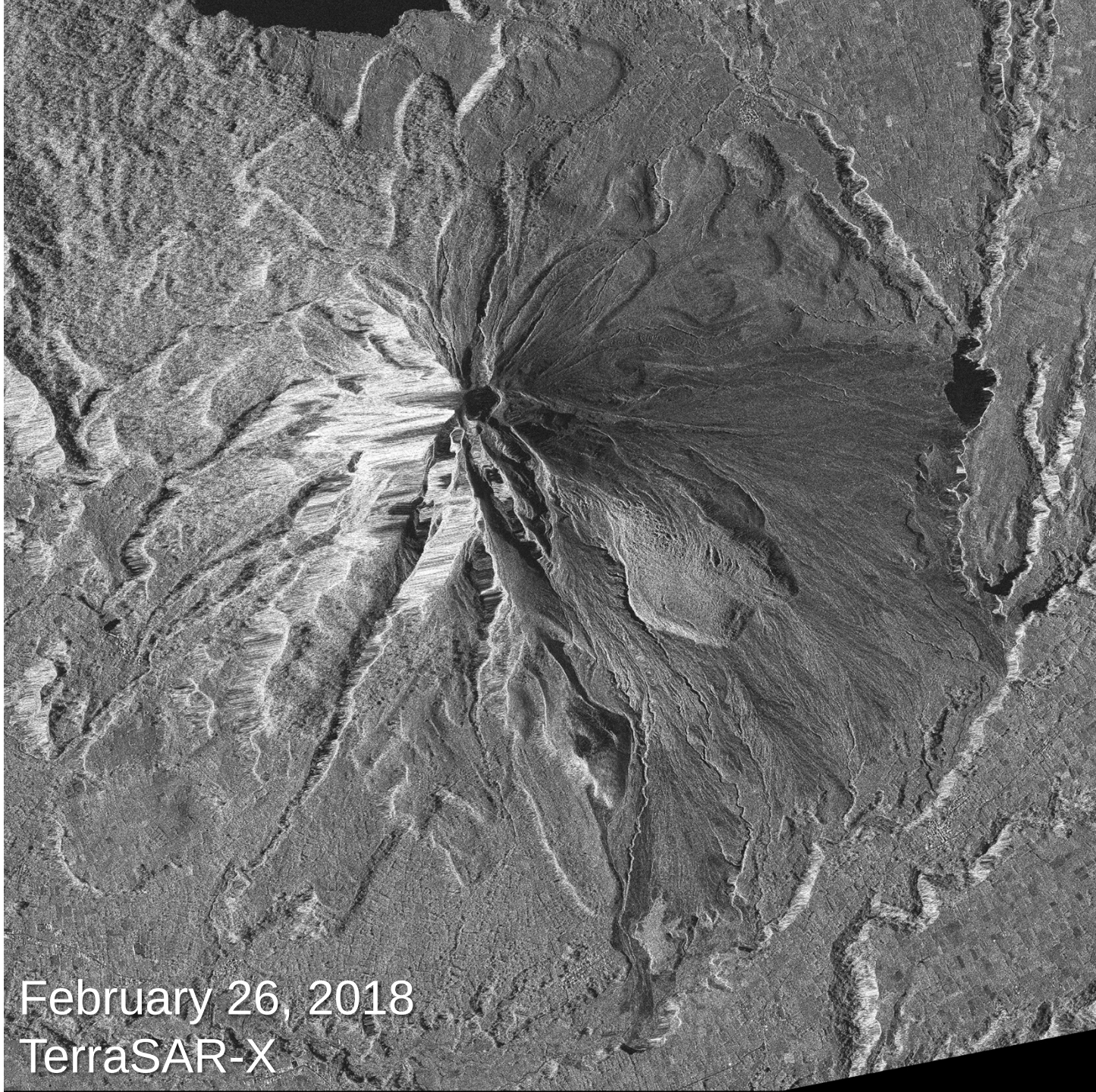
- There are already established archives for “free” data; for contributed data, there is potential for using existing archives (Volcano HDDS, GEP, DLR Supersites, etc.)
- Access could be open as long as users sign established license agreements

What is the relationship between the Demonstrator and GSNL Event Supersites?

- Perhaps no more volcano event Supersites?
  - Volcano surveillance should not be limited in time
  - Event Supersites are typically set up in the aftermath of the event
  - Long-term observations are needed where no “events” are occurring
  - Some “events” last for years (like Sinabung)

Sinabung (Indonesia) eruption: March 2013–???

- Large lava flow and repeated pyroclastic flows
- Lava dome growth
- Largest explosion to date on February 19, 2018




Thank you