Committee on Earth Observation Satellites

# The CEOS Volcano Demonstrator

## Status of Implementation

**WGD#11, Athens**
**March 5–8, 2019**

# Why focus on volcanoes?

- Over 300,000 people have been killed by volcanoes since the 1600s
- Globally, ~30 million people live within 10 km of an active or potentially active volcano
- Volcanoes need not cause fatalities to be disruptive—losses due to the 2010 Eyjafjallajökull eruption were $200M/day, with ~100,000 cancelled flights

# What is needed?

- Large monitoring gaps exist at many hazardous volcanoes around the world
- Current EO data collection is not usually coordinated for volcano monitoring
- Need systematic observations before, during, and after volcanic events

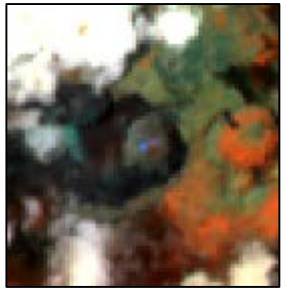
Holuhraun eruption, Iceland, 2014.
Photo credit: M Parks

# Why InSAR?

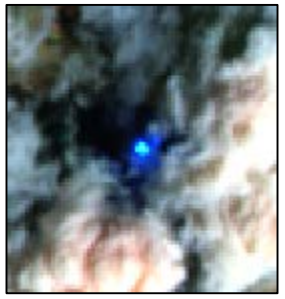
- InSAR observations are good statistical predictor for eruption within a fixed time interval of observation
- Satellite detections of deformation are dominantly in pre-eruptive periods, while thermal and gas detections generally occur during eruptions
- Allows primary measurements over large areas at high spatial resolution - > leads to detection of some processes commonly missed by ground-based measurement

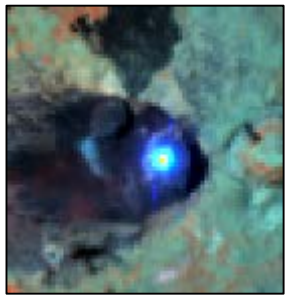
# The 2014–2017 CEOS Volcano Pilot: Achievements

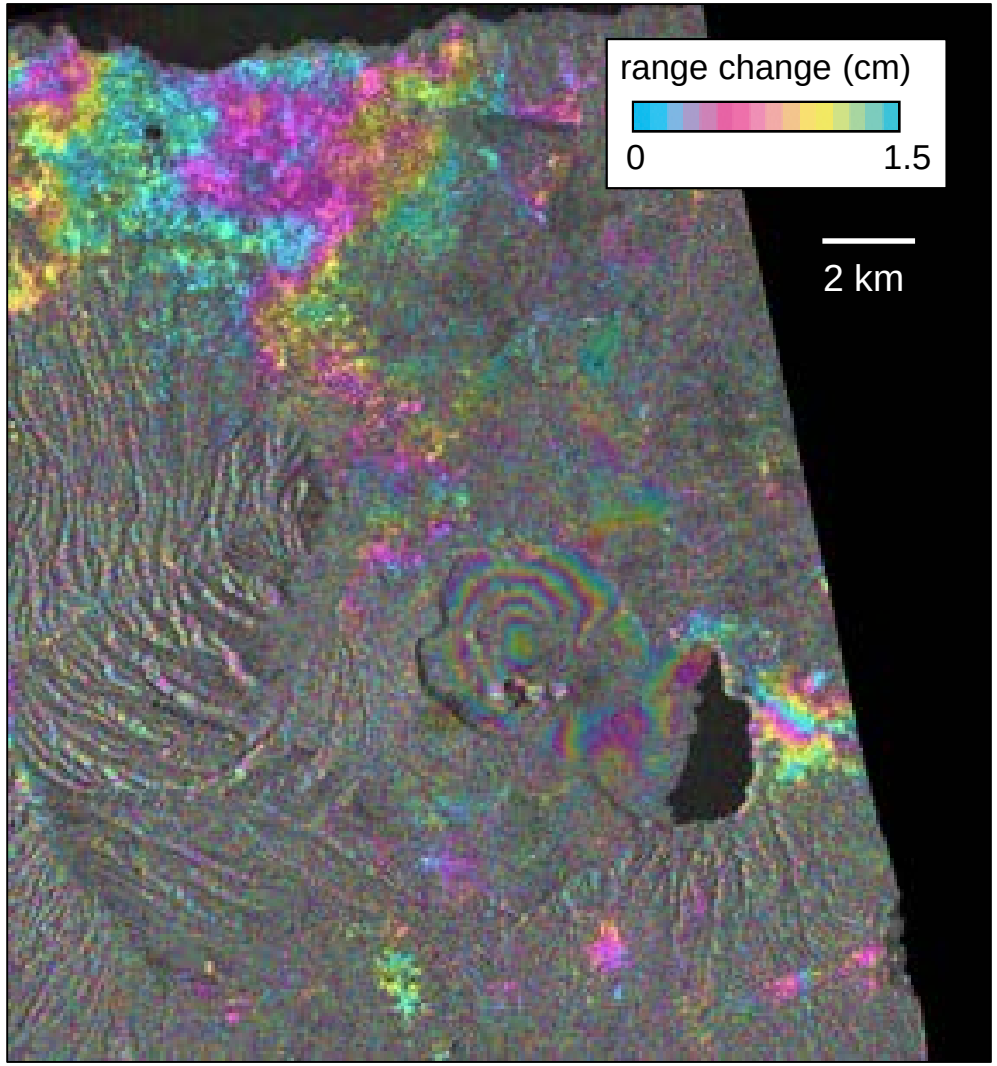
- Identified restless volcanoes that would not otherwise be known (for example, Cordón Caulle, Chile)
- Comprehensive tracking of unrest and eruptive activity
- Demonstrated need for a diverse approach (multiple satellites, multiple capabilities)
- Helped inform decisions about alert levels and response (for example, Chiles-Cerro Negro, Chile; Masaya, Nicaragua; Sabancaya, Peru)


Sep. 16, 2015


Nov. 19, 2015


Feb. 7, 2016

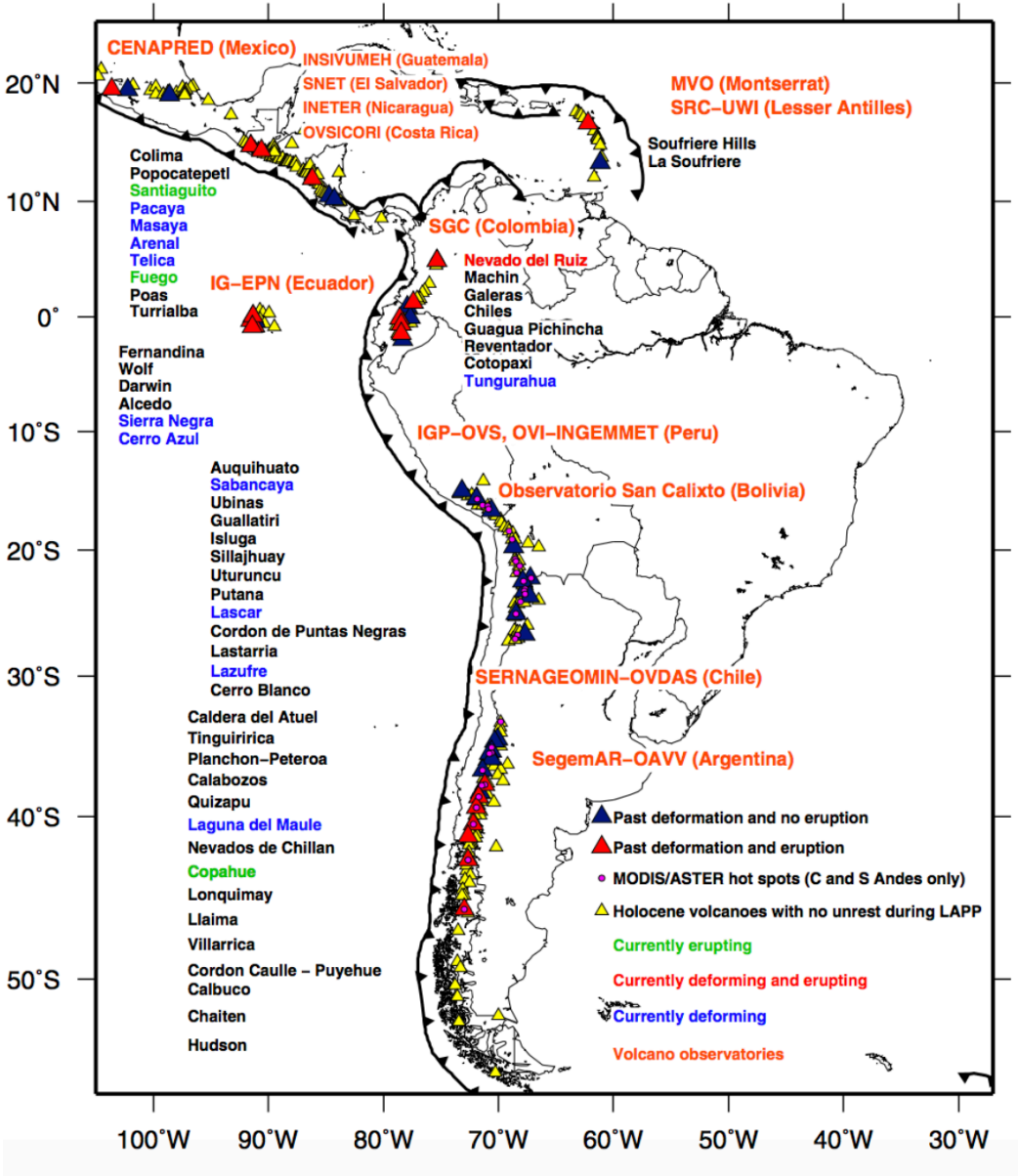

Mar. 26, 2016




Unrest at Masaya volcano, Nicaragua, during 2015-2016. (left) Growth of a thermal anomaly as a lava lake rose within the volcano's crater. (right) Inflationary deformation in a Cosmo-SkyMed interferogram spanning October 17, 2015–March 9, 2016.

# The CEOS 2014–2017 Volcano Pilot: Lessons

- Coordination between multiple space agencies yields near-daily coverage during volcanic crises
- Systematic background observations are critical
- Acquisition plans should be flexible
- Low latency is critical
- 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 extended visits and MS/PhD training are better

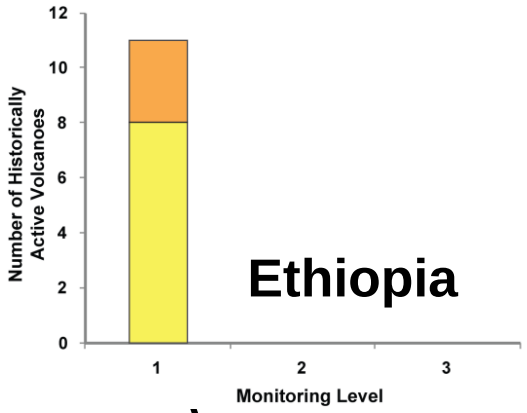


# Volcano Demonstrator: An Evolution from the Volcano Pilot

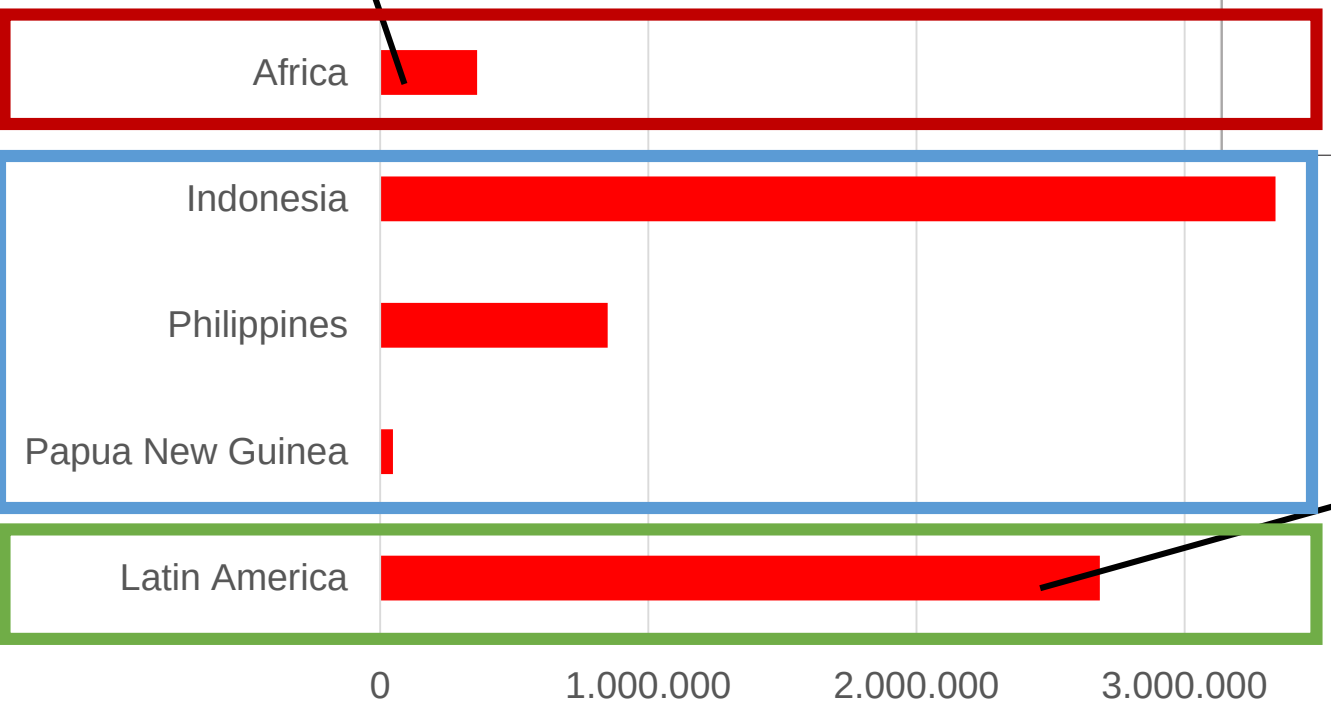
- There are ~100 volcano observatories around the world with a range of capabilities.  How can we meet their heterogeneous needs?
- More observations are needed at a diversity of volcanoes to understand the nature of precursors and manifestations of eruptive activity
- Focus on integrating SAR with IR, UV, and visible observations to develop a comprehensive approach to satellite monitoring of active volcanism.

**Goals**:

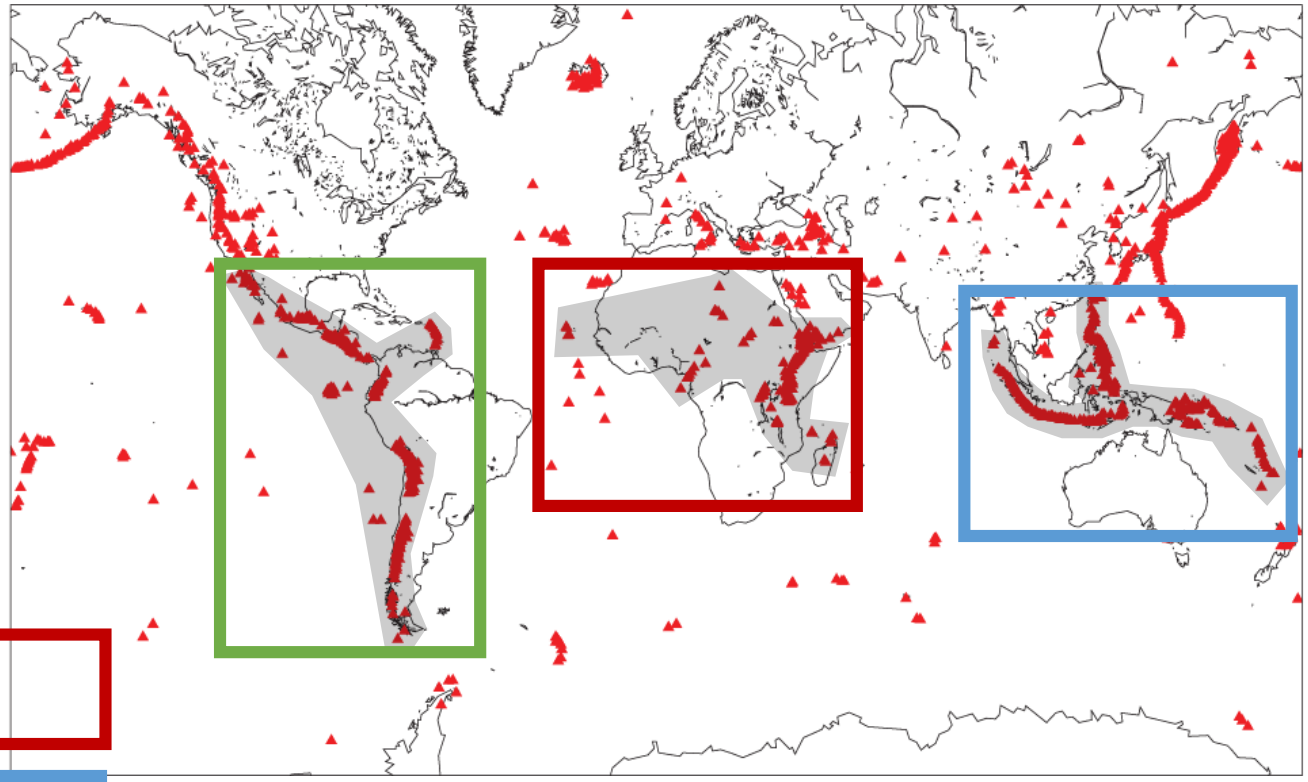
1) Fill gaps where satellite observations are not being fully exploited
2) Learn more about volcanoes to aid forecasting and risk reduction
3) Aid with crisis responses
4) Build capacity in developing nations
5) Demonstrate a sustainable volcano monitoring system



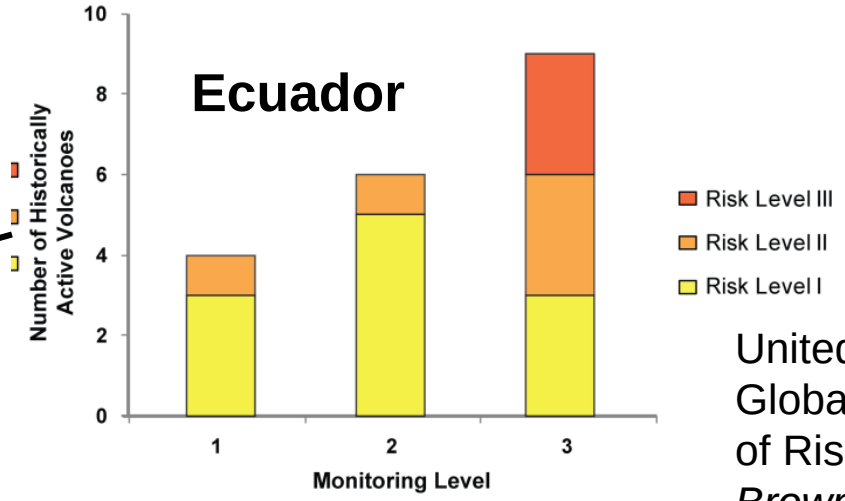

**Ethiopia**




**Population within 10 km of a historically active volcano**



monitoring network in the Galapagos Islands is due to be installed.




United Nations Global Assessment of Risk Report
*Brown et al., 2015*

# Volcano Demonstrator Leads:

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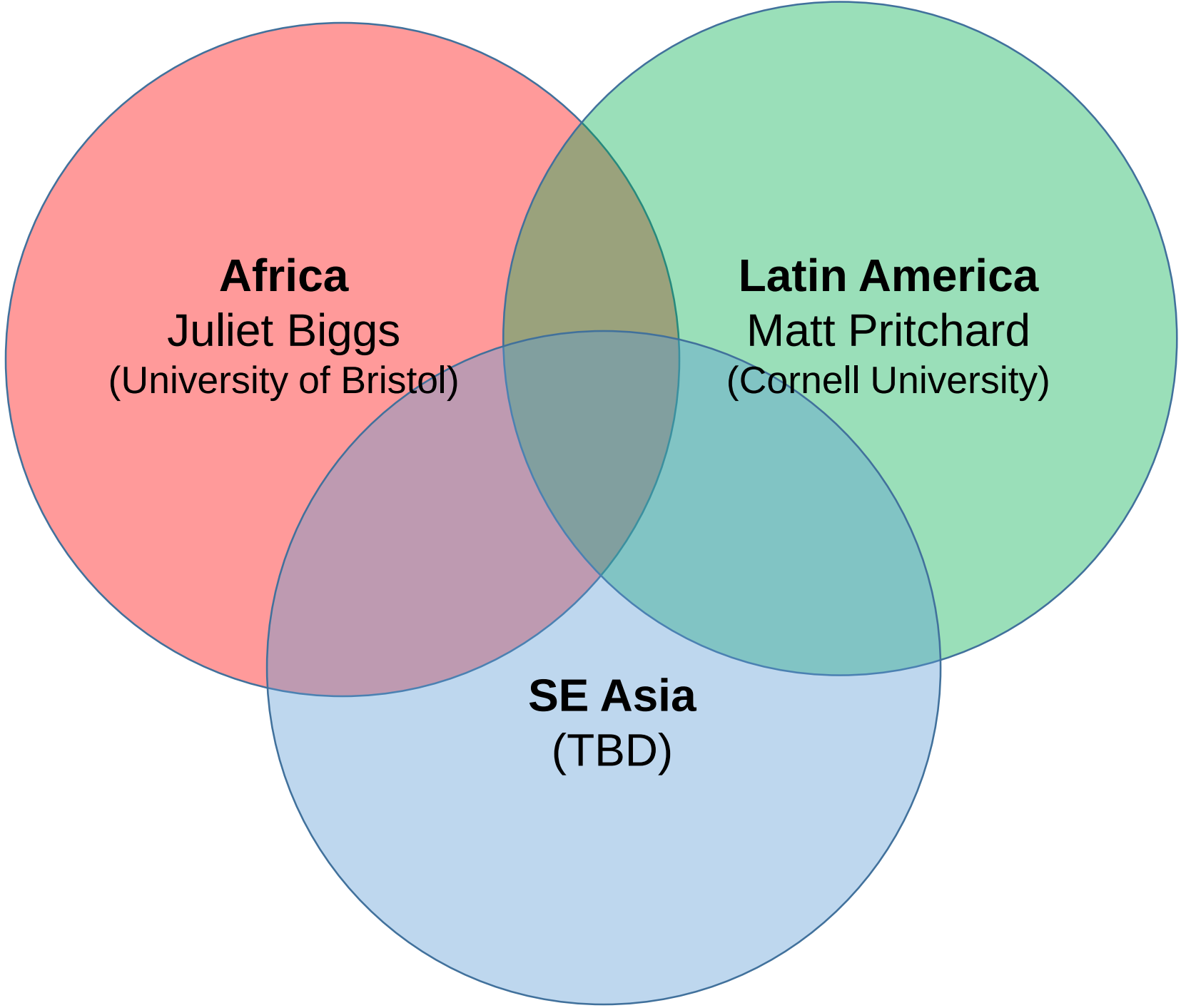
(University of Leeds)

Mike Poland
(USGS)



# Volcano Demonstrator: Plans, Partners, Benefits

- Provide support for volcano monitoring and eruption response

  - Among space-based datasets, deformation has been shown to be the most common eruption precursor
  - Optical and thermal imagery, are key for monitoring during eruptions. Measurements of topographic change derived from SAR or optical imagery are also critical for some eruptions.
  - Requires development of strong working relationships with volcano observatories through regional leads

# Volcano Demonstrator: Plans, Partners, Benefits

- Partner with established efforts:
  - **For volcano research/monitoring**: Powell Center, GSNL, Volcano observatories
  - **For data distribution/analysis**: GEP, Smithsonian, COMET, ARIA, WOVO
  - **For capacity building**: IAVCEI, GCRF Hub-Innovation projects

| Issue | Explanation |
|---|---|
| Awareness | Some observatories are not fully aware of the types of remote sensing available or where to access the data. |
| Reliability | The internet and particularly social media means the world is more connected than ever before. Data are frequently posted online, especially during eruption crises, but observatories must ensure they are from a reliable source. |
| Data Cost | Some remotely-sensed data and software for analysis is prohibitively expensive |
| Human resources: | Training in specialist areas such as satellite data retrieval is costly. There may be no redundancy within a country, with one expert and no back-up. |
| Computing resources: | Processing data can require significant computing resources, including (often costly) specialist software, fast computers with powerful processors, large amounts of data storage space. |
| Power supply and internet | Power can be unreliable in many countries, and particularly at remote observatories. Internet access and speed may be insufficient to download large data files. |
| Timeliness | In rapidly-developing unrest or eruption situations, timely access to data is crucial. Some data cannot be accessed in real-time or near real-time. The download and processing time of other data renders this inappropriate. |
| Background knowledge: | To understand the unrest at a volcano some knowledge of background activity is required. |
| Ground truth | Ground-truthing can be required to verify what is seen through remote-sensing. This requires on-the-ground expertise, human and economic resources. |

*Table 1: Barriers to the uptake of satellite monitoring in ODA countries. Summarised from the responses from a range of ODA countries to a questionnaire.*

# Build capacity among volcano observatories in Africa, Latin America, and SE Asia

- Support and contribute to efforts of partners:

e.g.,

- workshops co-located with Cities on Volcanoes conference 2020 (Greece) and IAVCEI supported by research projects

- PhD studentships for volcano observatory scientists supported by partner projects

Courtesy of Juliet Biggs, University of Bristol, NERC Innovation Proposal, 2019

# EO Data commitments

- ASI: 900 CSK scenes/year
- DLR: 450 TSX scenes/year (plus tasking)
- CNES: Pleiades as needed (?)

# Plans and Evaluation

- Need to formalize teams and establish priorities for monitoring/research (top priority is identifying SE Asia lead and communicating data quotas to teams)
- Development of guidance notes for making data requests
- Plan workshops (Cities on Volcanoes in 2020, IAVCEI in 2021)
- Work with regional leads to identify longer-term capacity building opportunities
- Submit annual written reports to CEOS WG Disasters

# Discussion Points

- What about non-X-band datasets (CSA/JAXA)?
- How will large, diverse teams be managed? (routes of communication)
- To what extent should we aim to integrate different EO datasets?
- All participants are volunteers!