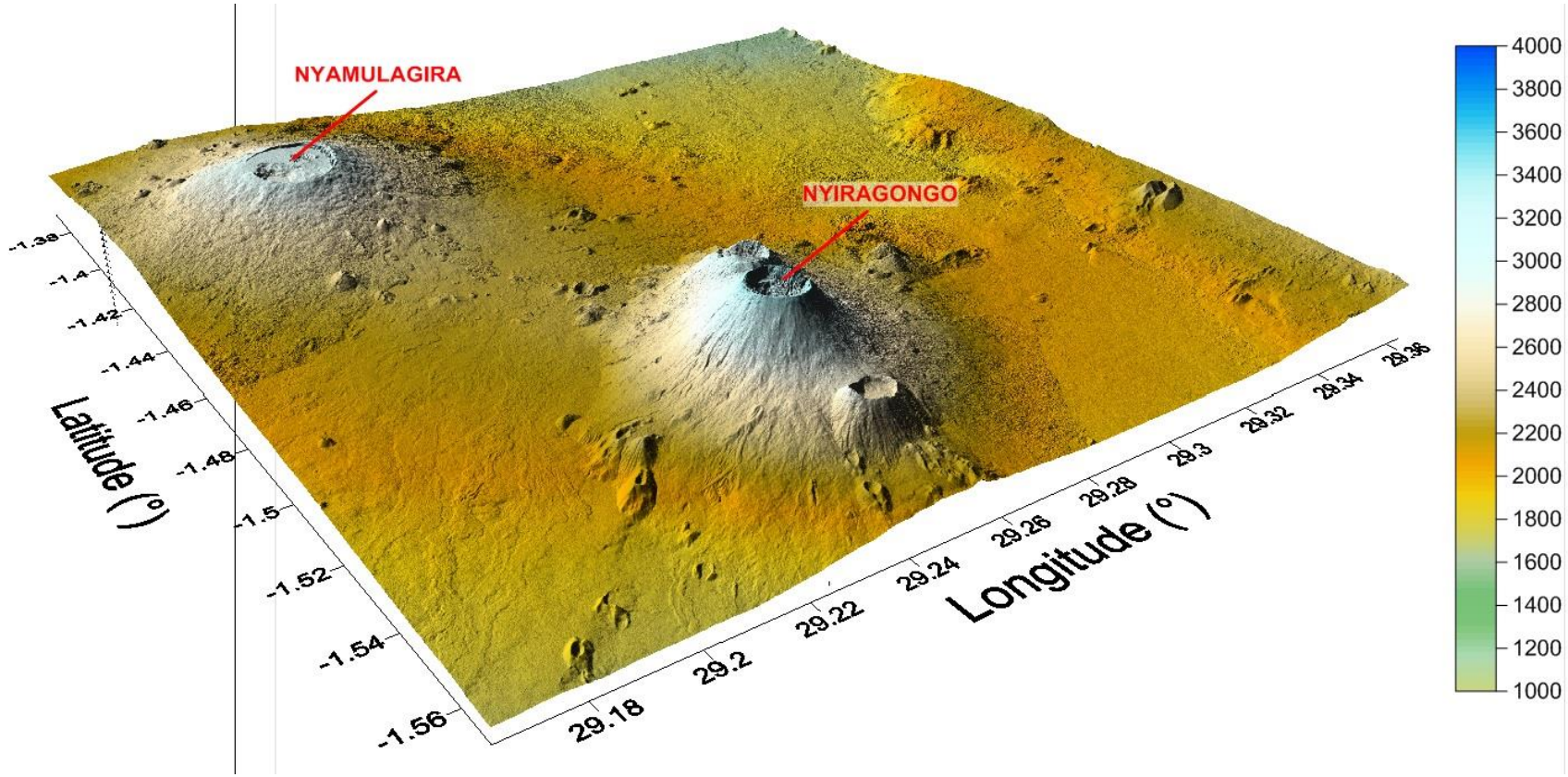
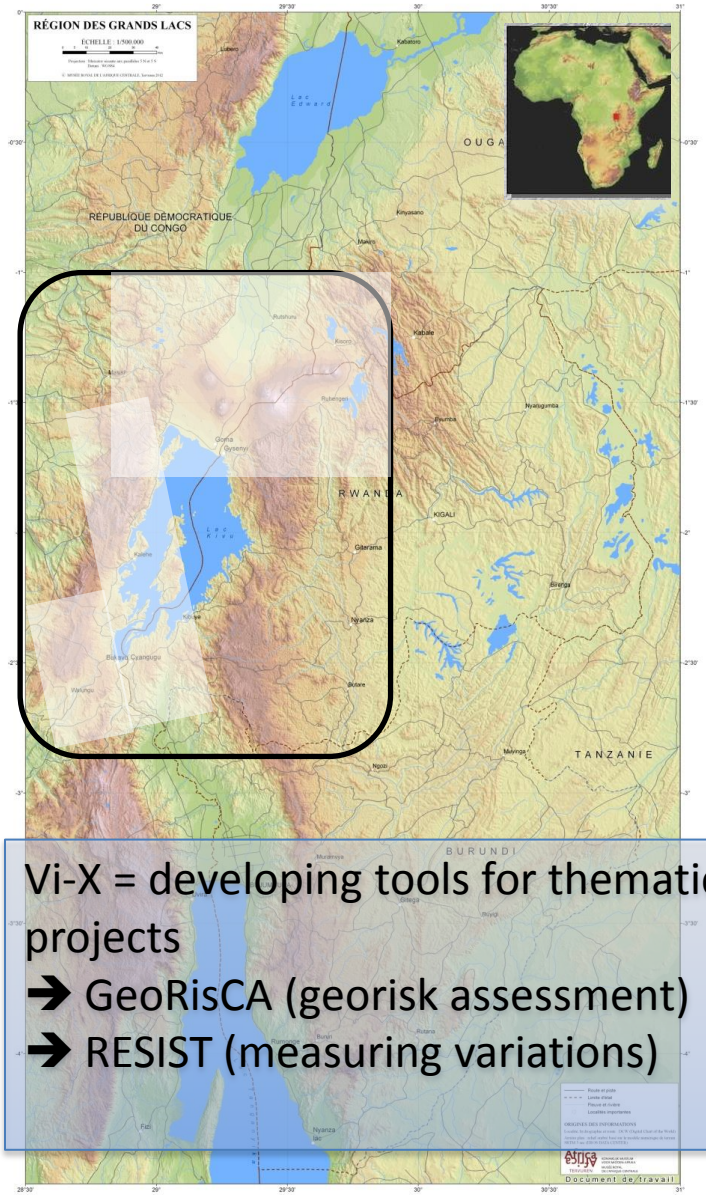
Vi-X (STEREO-II 2012 – 2014):
Study and Monitoring of Virunga volcanoes using TanDEM-X

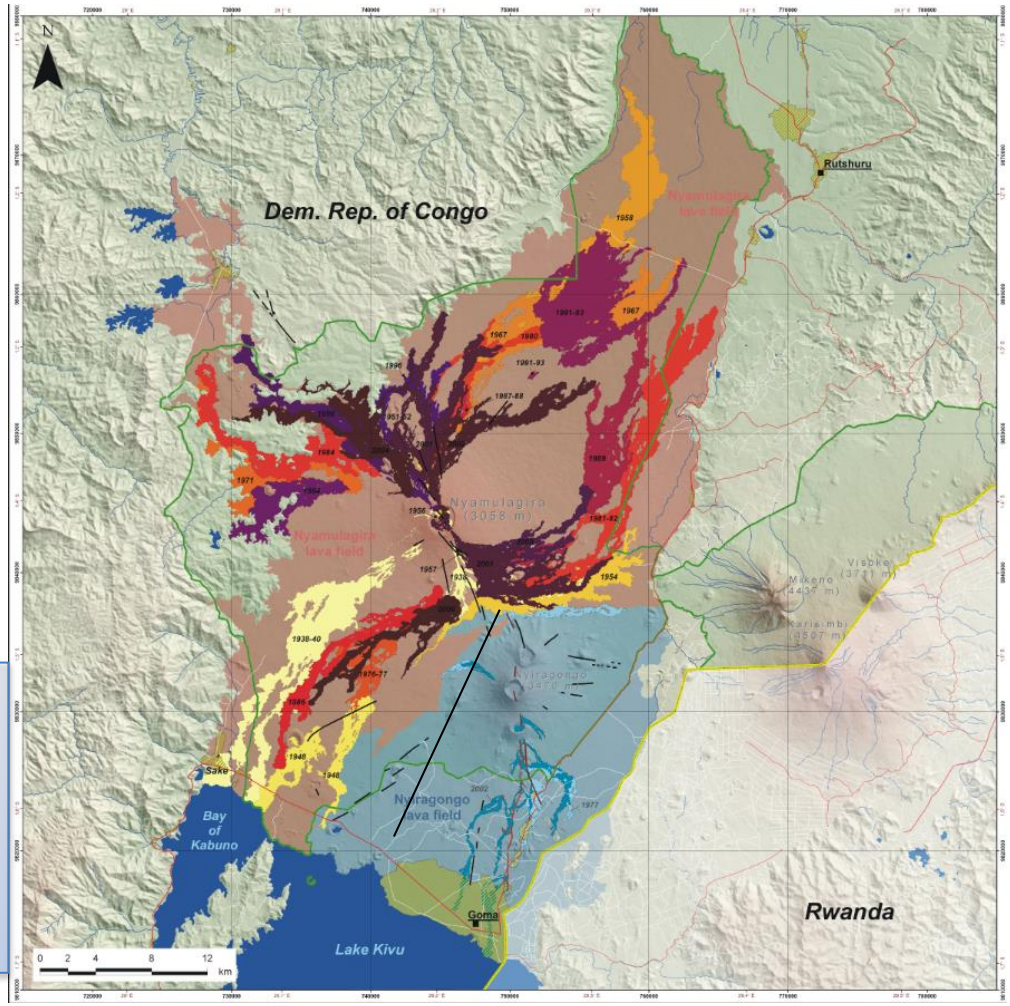
F. Kervyn[1] , N. d'Oreye[2,3], D. Derauw[5], F. Albino[1], B. Smets[1,2,4]



[1] *Royal Museum for Central Africa*
[2] *European Center for Geodynamics and Seismology*
[3] *National Museum of Natural History*
[4] *Vrije Universiteit Brussel*
[5] *Centre Spatial de Liège, University of Liège*

GEOLOGICAL SETTING





Vi-X = developing tools for thematic projects

➔ GeoRisCA (georisk assessment)

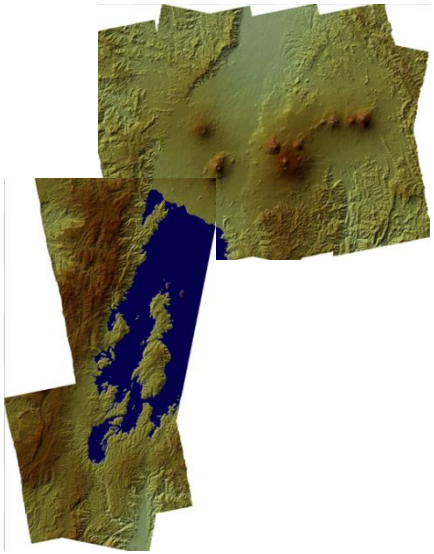
➔ RESIST (measuring variations)

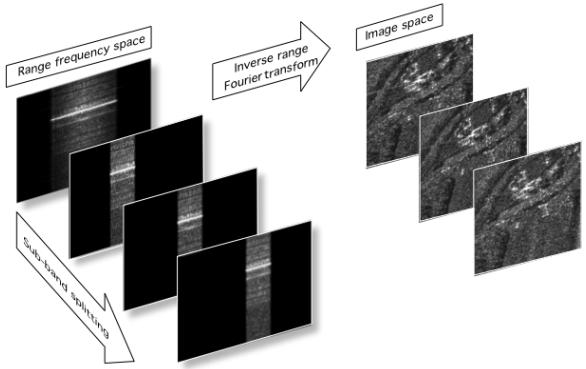
Vi-X

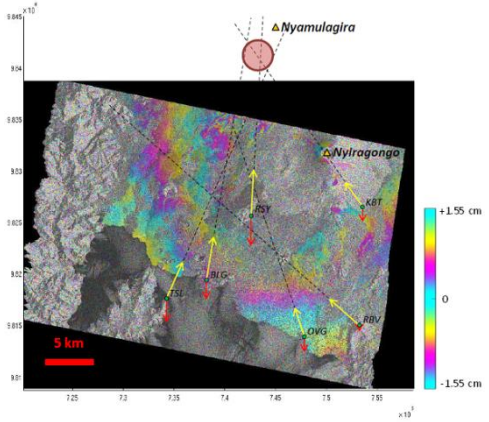
High Resolution DEM Analysis

Advanced InSAR Processing

InSAR ground deformation monitoring and modeling

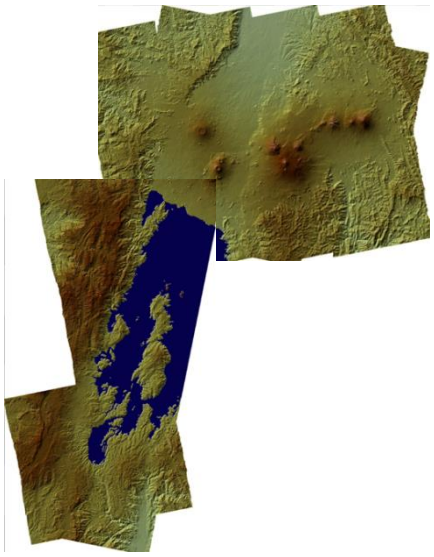






Vi-X

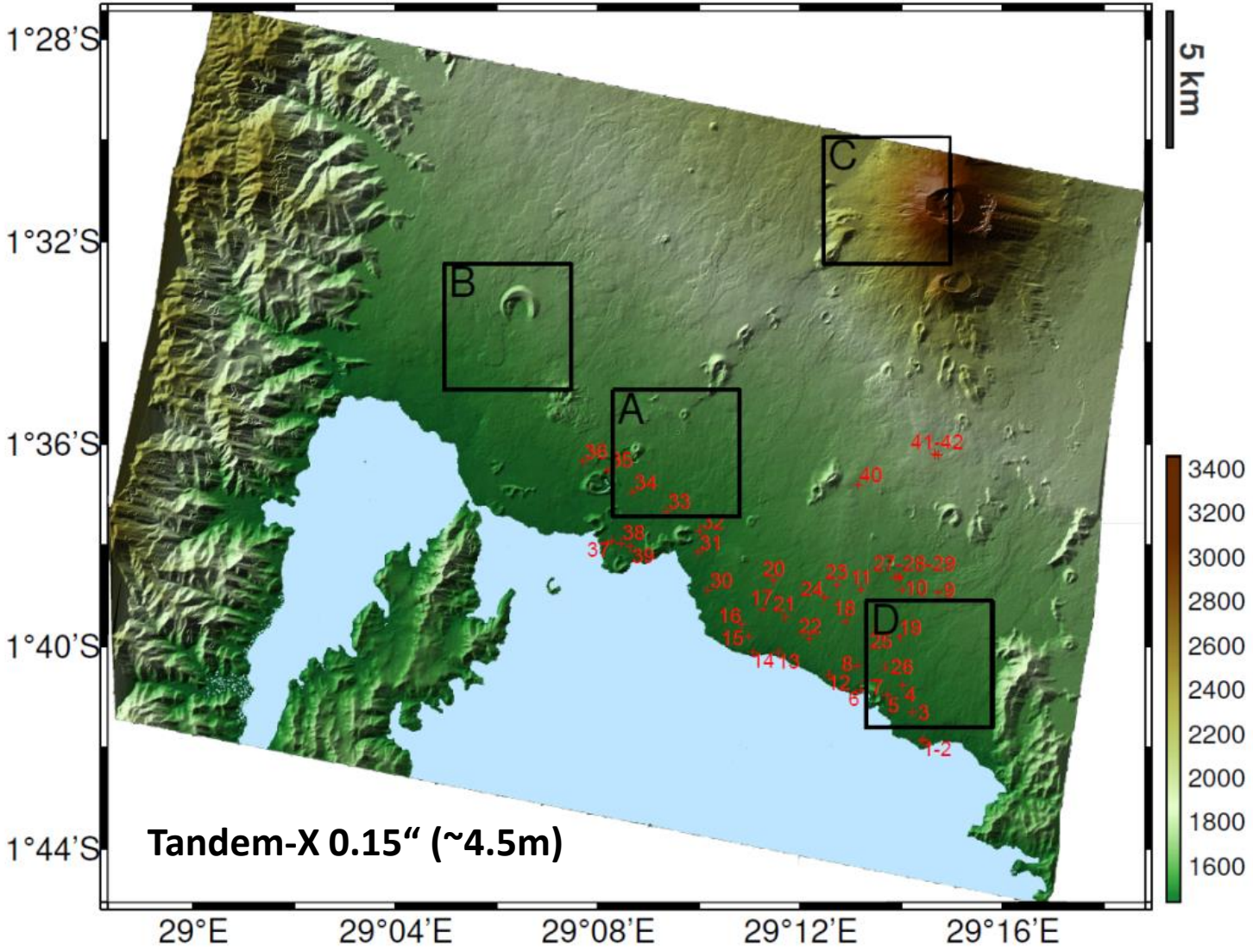
High Resolution DEM Analysis



- ✓ DEM computation from TanDEM-X data
- ✓ Lava flow simulation
- ✓ Detailed geomorphological analysis

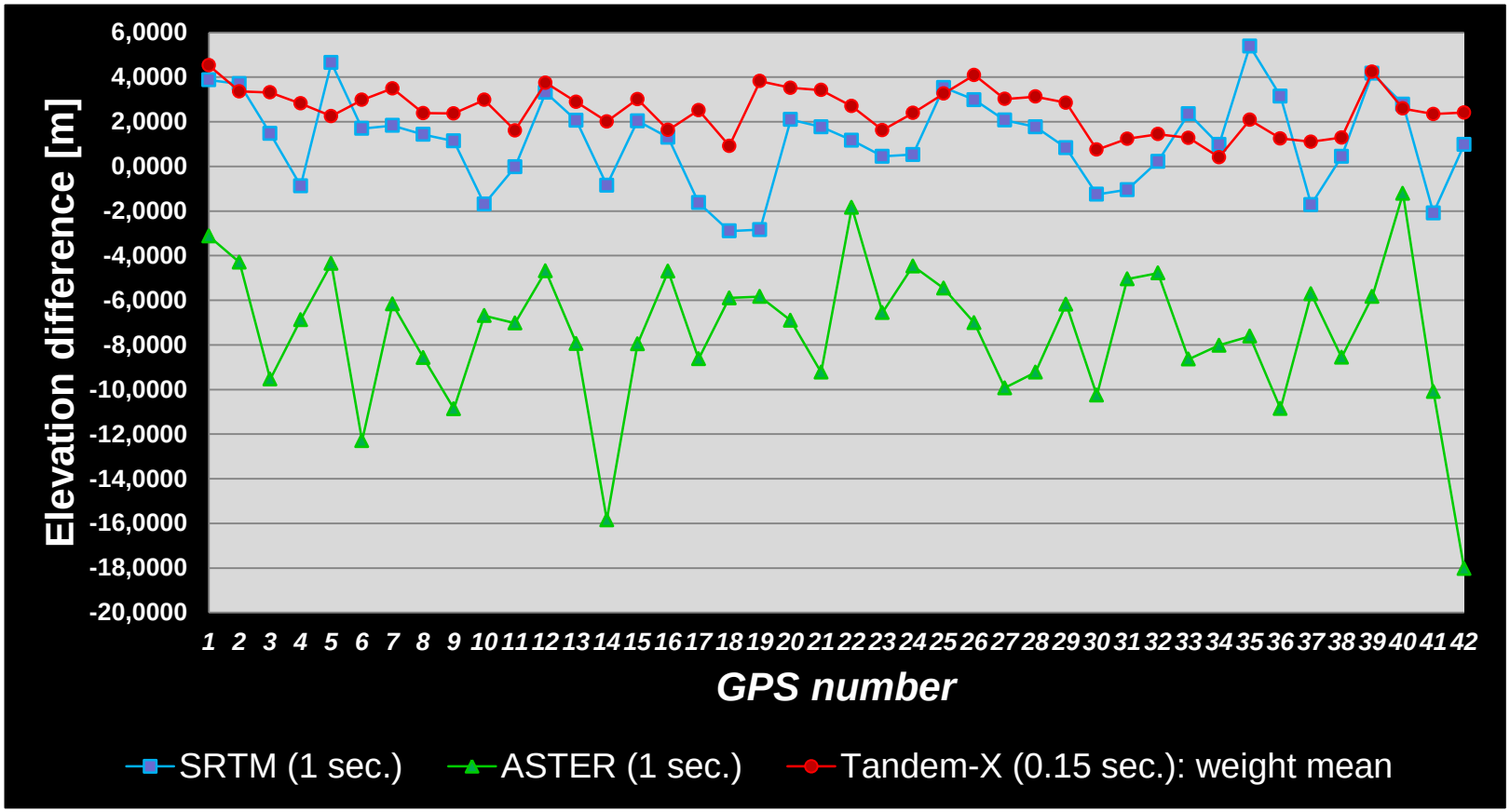
High-resolution DEM

55 DEM's were generated over the study area.



High-resolution DEM

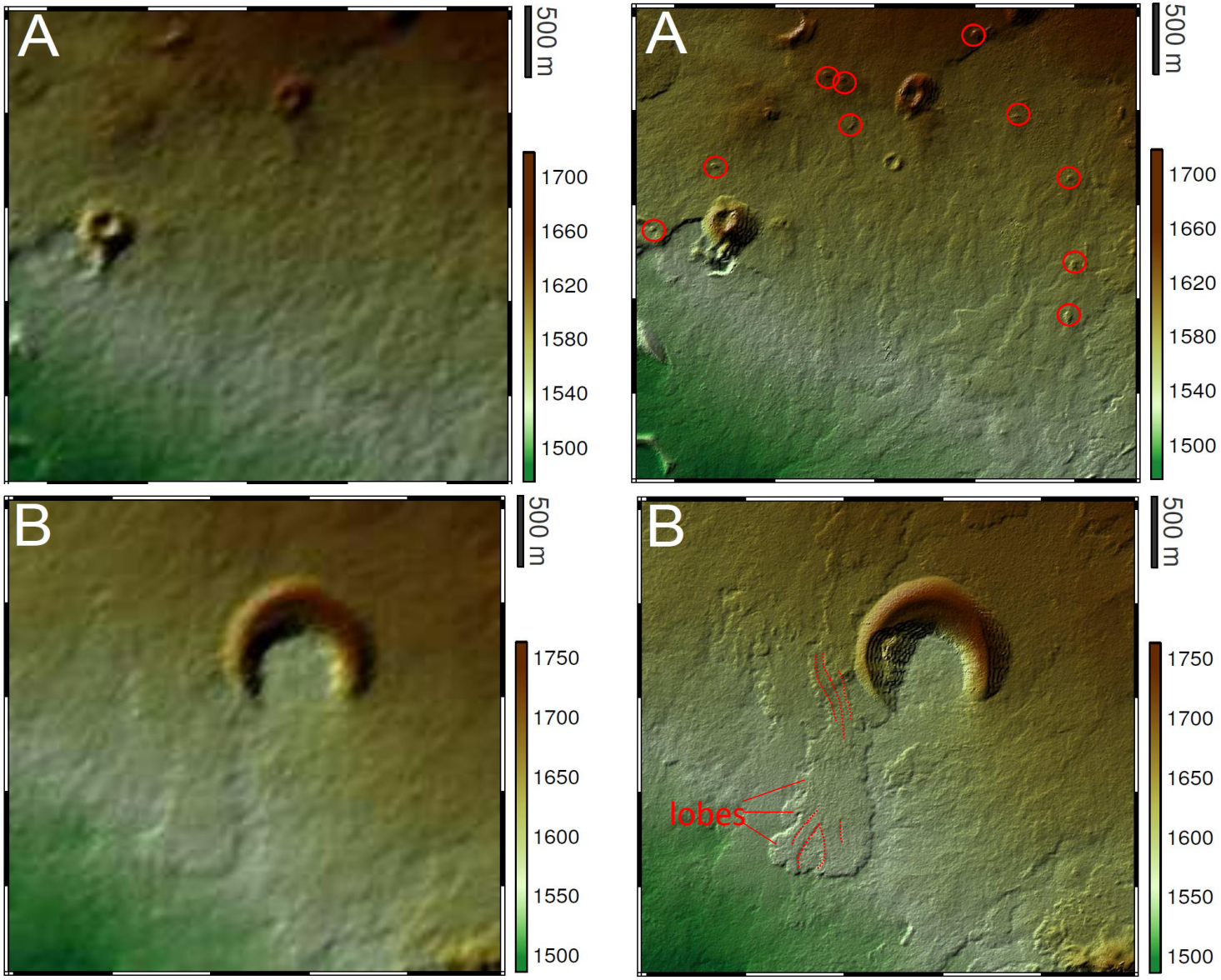
Validation of elevation data



Mean = 2.0	Mean = -7.5	Mean = 2.5
Stdev = 2.0	Stdev = 3.3	**Stdev = 1.0**
Rmse = 2.3	Rmse = 8.1	Rmse = 2.7

High Resolution DEM Analysis: geomorphology

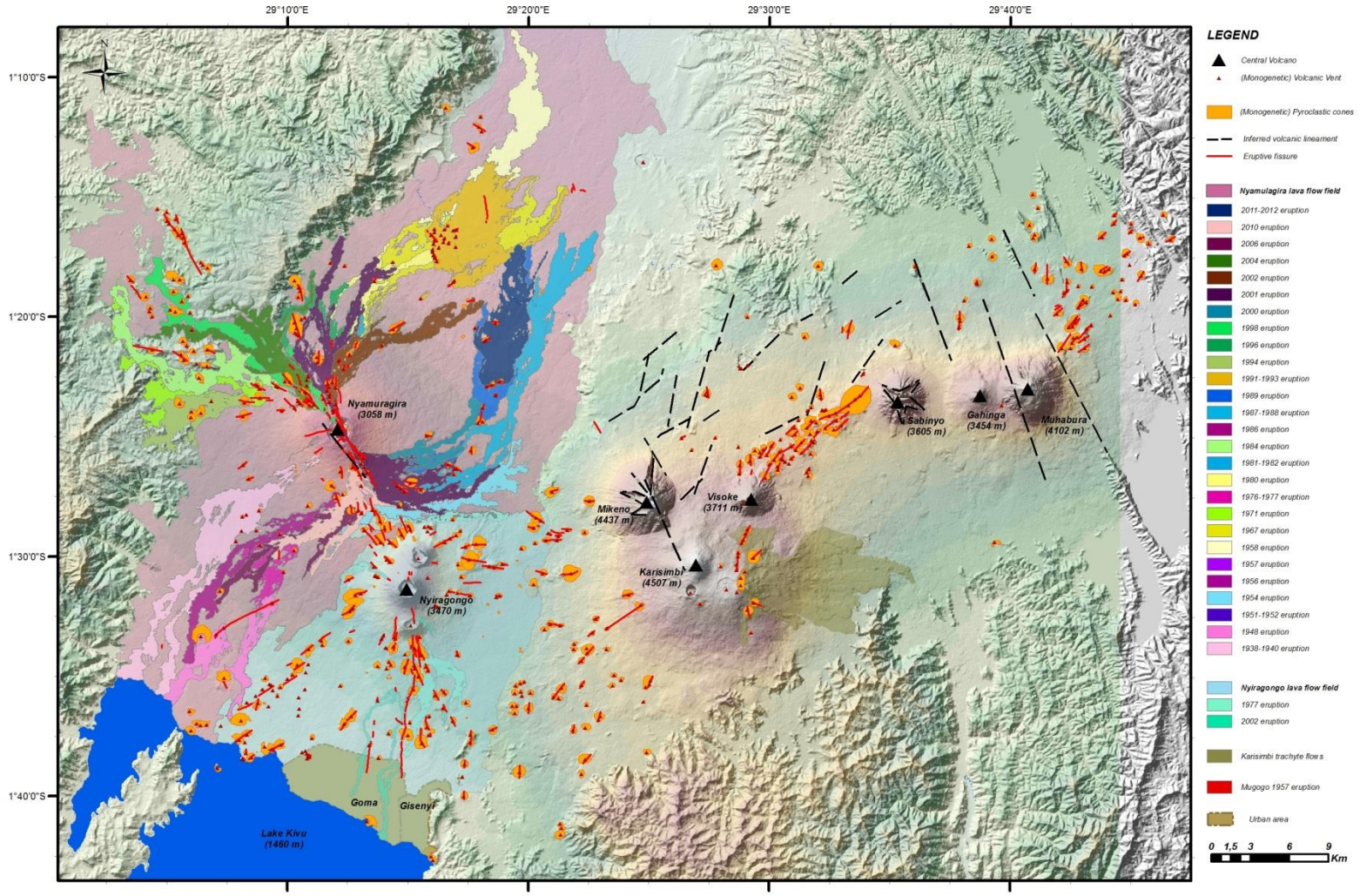
Comparison SRTM (30m) & Tandem-X DEM (4.5m)



High Resolution DEM Analysis: geomorphology

Vi-X products used as input to other projects:

Ex: GeoRisCA: production of Volcano-structural map & interpretation



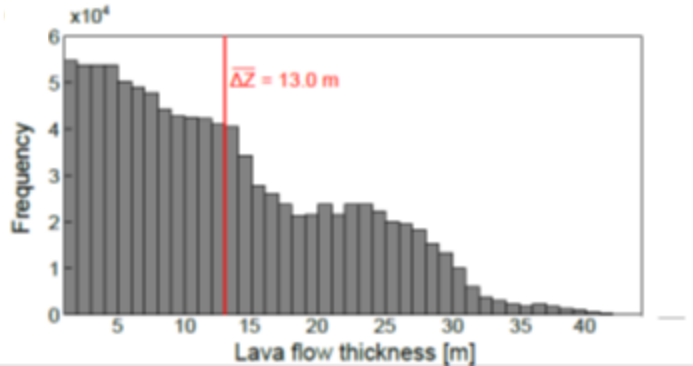
High Resolution DEM Analysis: geomorphology

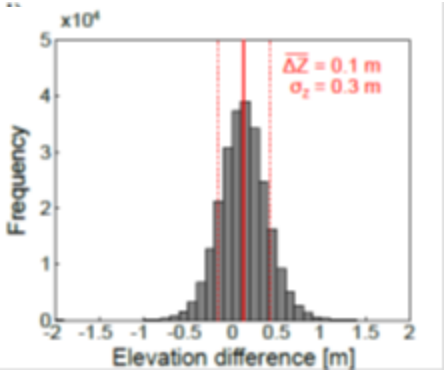
➔ Quantification of the 2011 eruptive volume

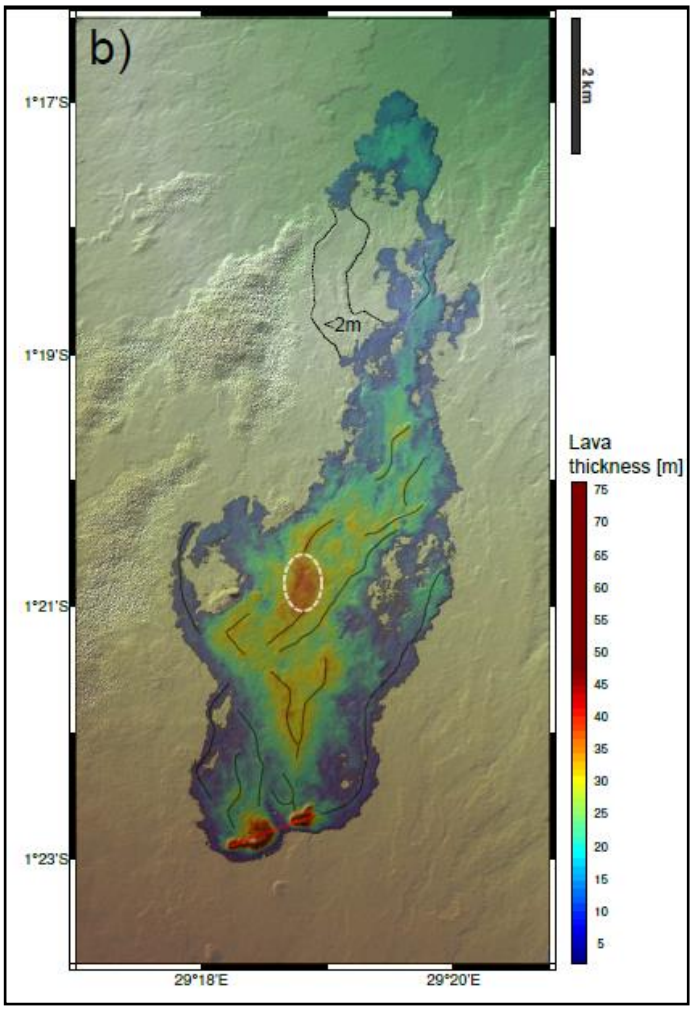
Flow length = 10 km
Eruption Area = 20 km^2

Thickness:
- Scoria cones: 50-70 m
- Flow thickness: ~ 14m

Erupted Volume: 300.10^6 m^3

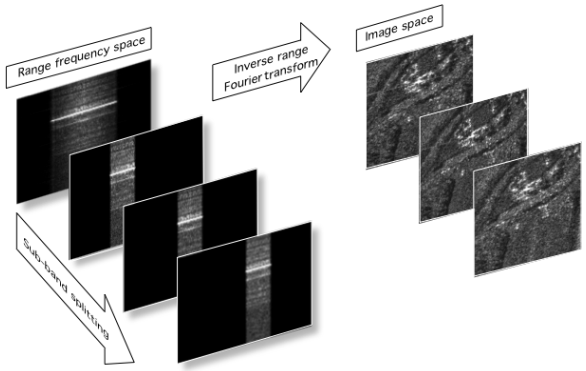






Vi-X

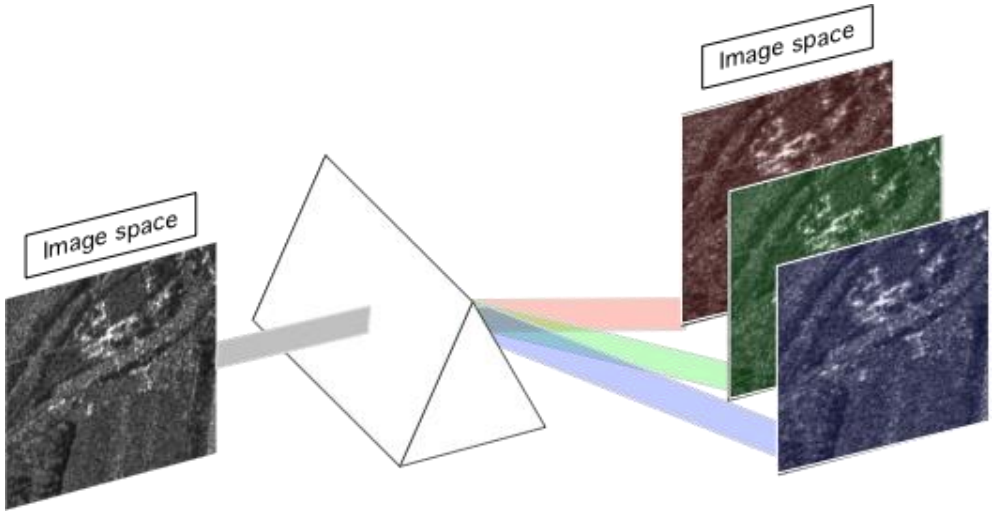
Advanced InSAR Processing



Split band SAR interferometry

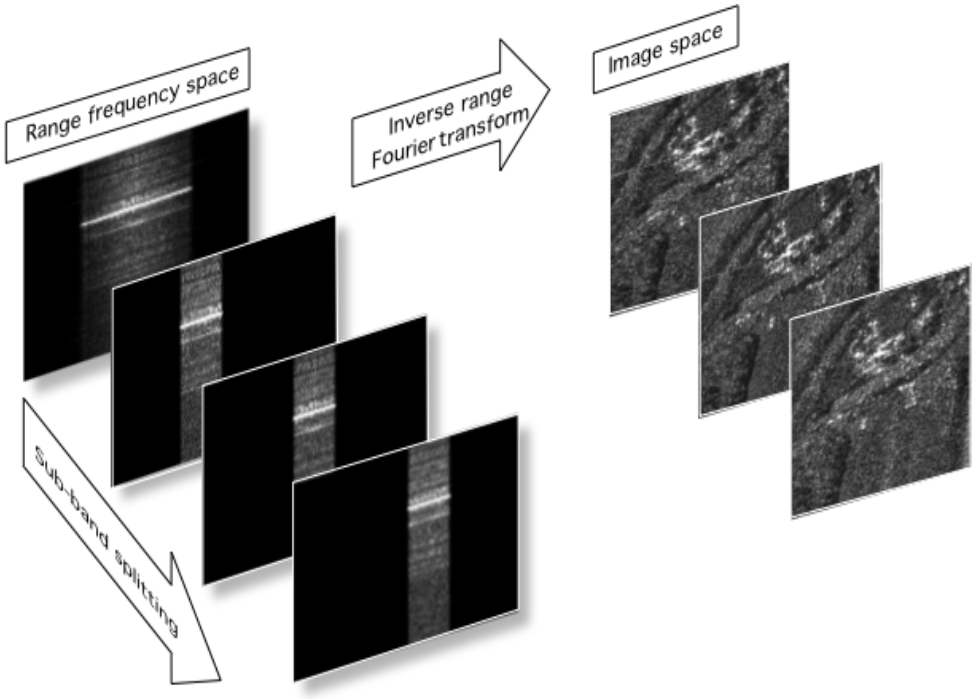
Advanced InSAR techniques: Split Band InSAR (SBInSAR)

The process is similar to light decomposition into spectral bands by a prism. Split-band process of SAR images is also known as Multi-Chromatic Analysis (MCA):



Advanced InSAR techniques: Split Band InSAR (SBInSAR)

Take advantage of larger bandwith (e.g. ENVISAT 15MHz / TanDEM-X 150 MHz)



1 image is splitted into sub-images, centered on its own central frequency (or wavelength) and with a lower range resolution.

Advanced InSAR techniques: Split Band InSAR (SBInSAR)

Main advantage:

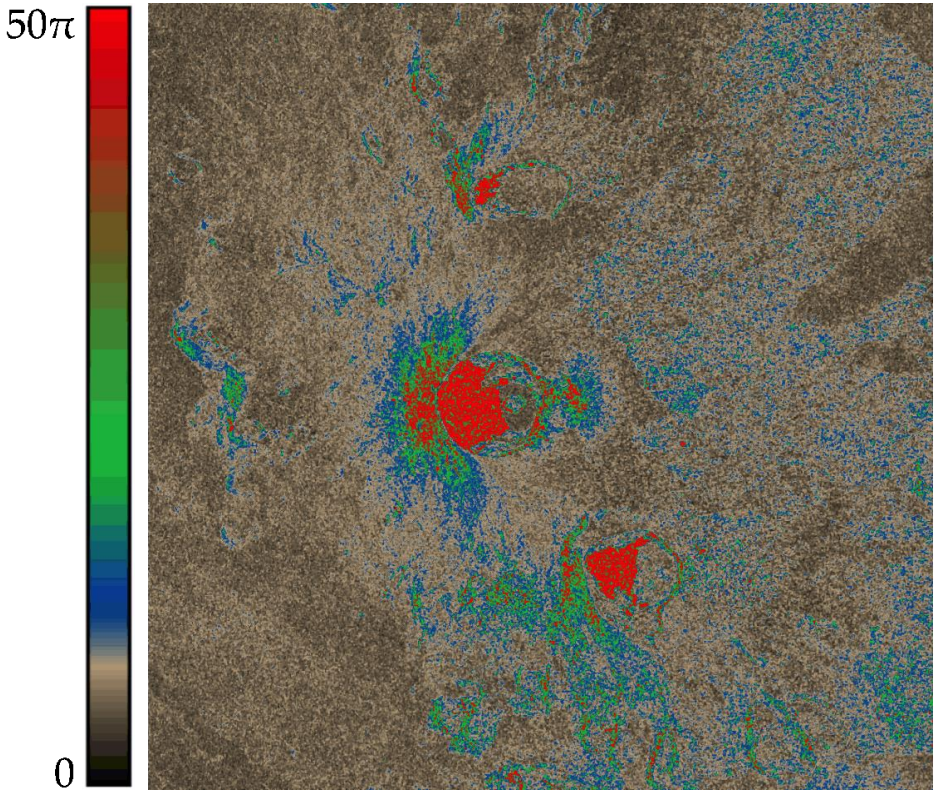
⇨ SBInSAR allows measuring the absolute interferometric phase.

⇨ SBInSAR allows unwrapping the interferometric phase on a point by point basis.

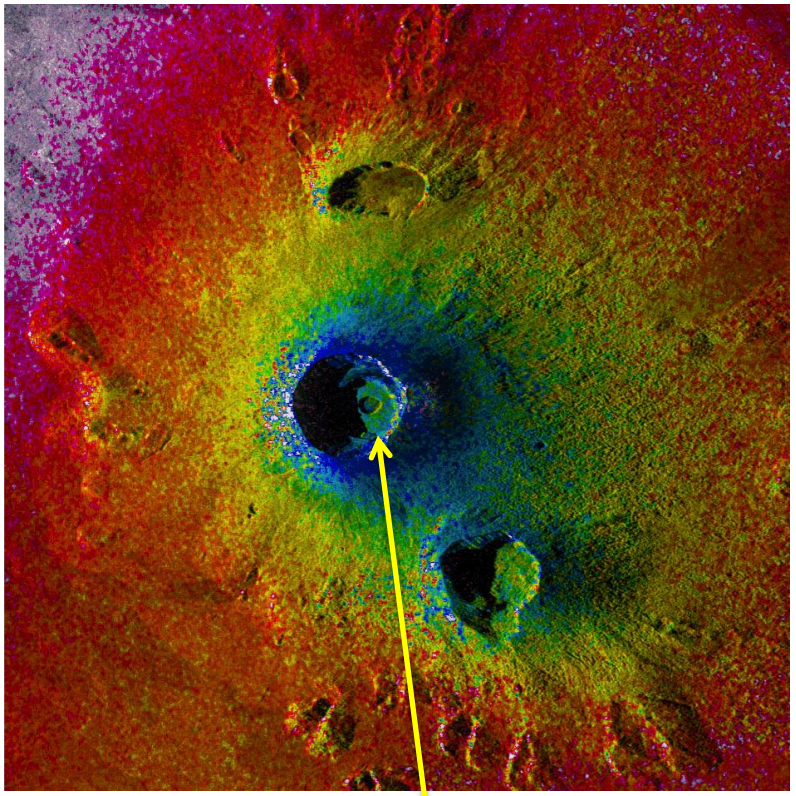
➔ Unconnected areas (water or vegetated areas) may be connected since the measurement is absolute.

SBInSAR: Nyiragongo volcano crater

TanDEM-X 21/07/2012



RMS error



Absolute phase

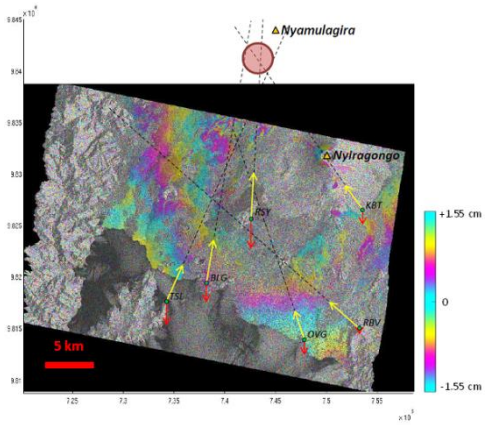
Phase corresponds to lower elevation
=> Phase unwrapping despite phase discontinuity with crater rim

Method works but requires larger bandwith (TSX – pursuite mode, SAOCOM)

Vi-X

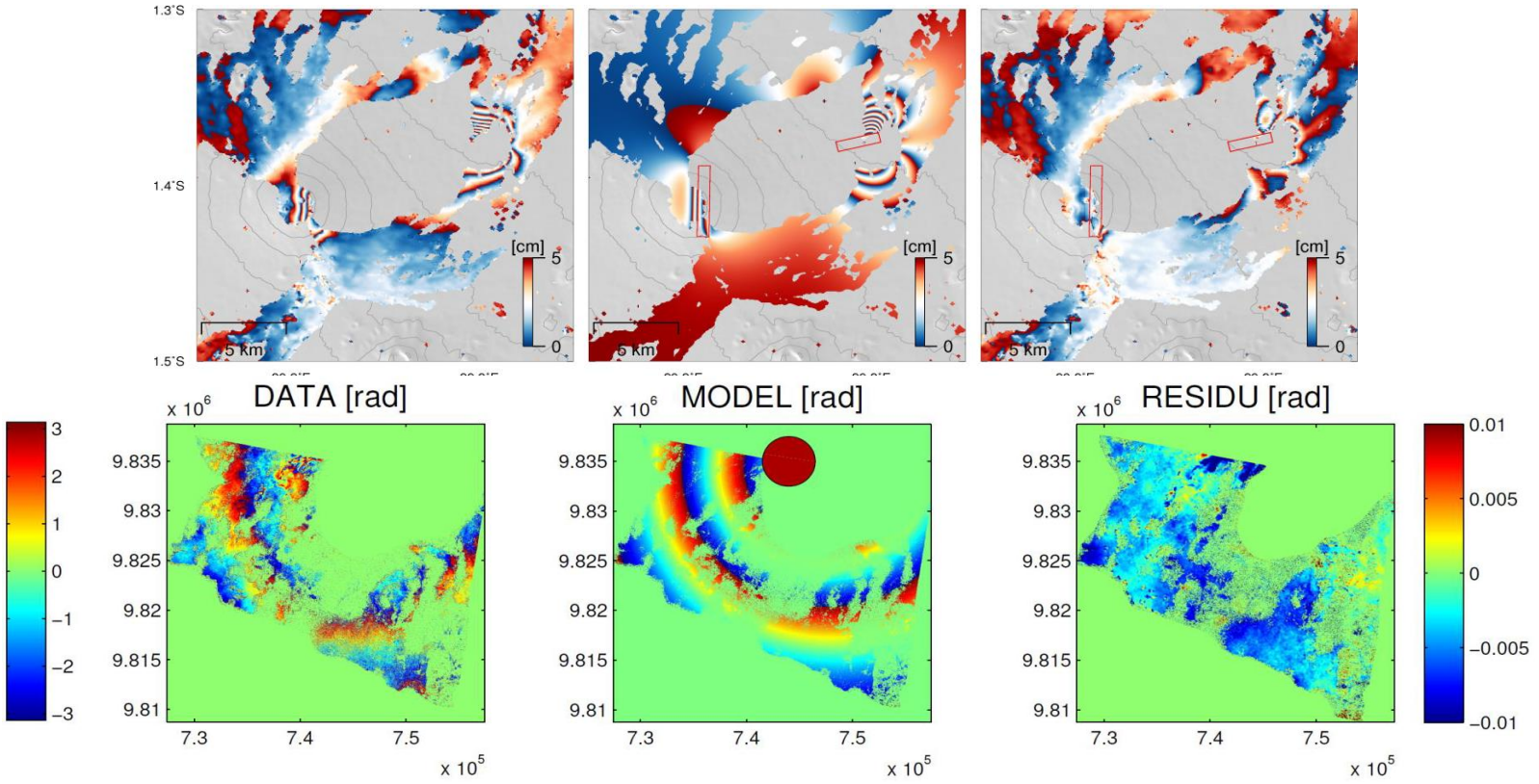
InSAR ground deformation monitoring and modeling

- ✓ Processing InSAR archives
- ✓ Processing new data

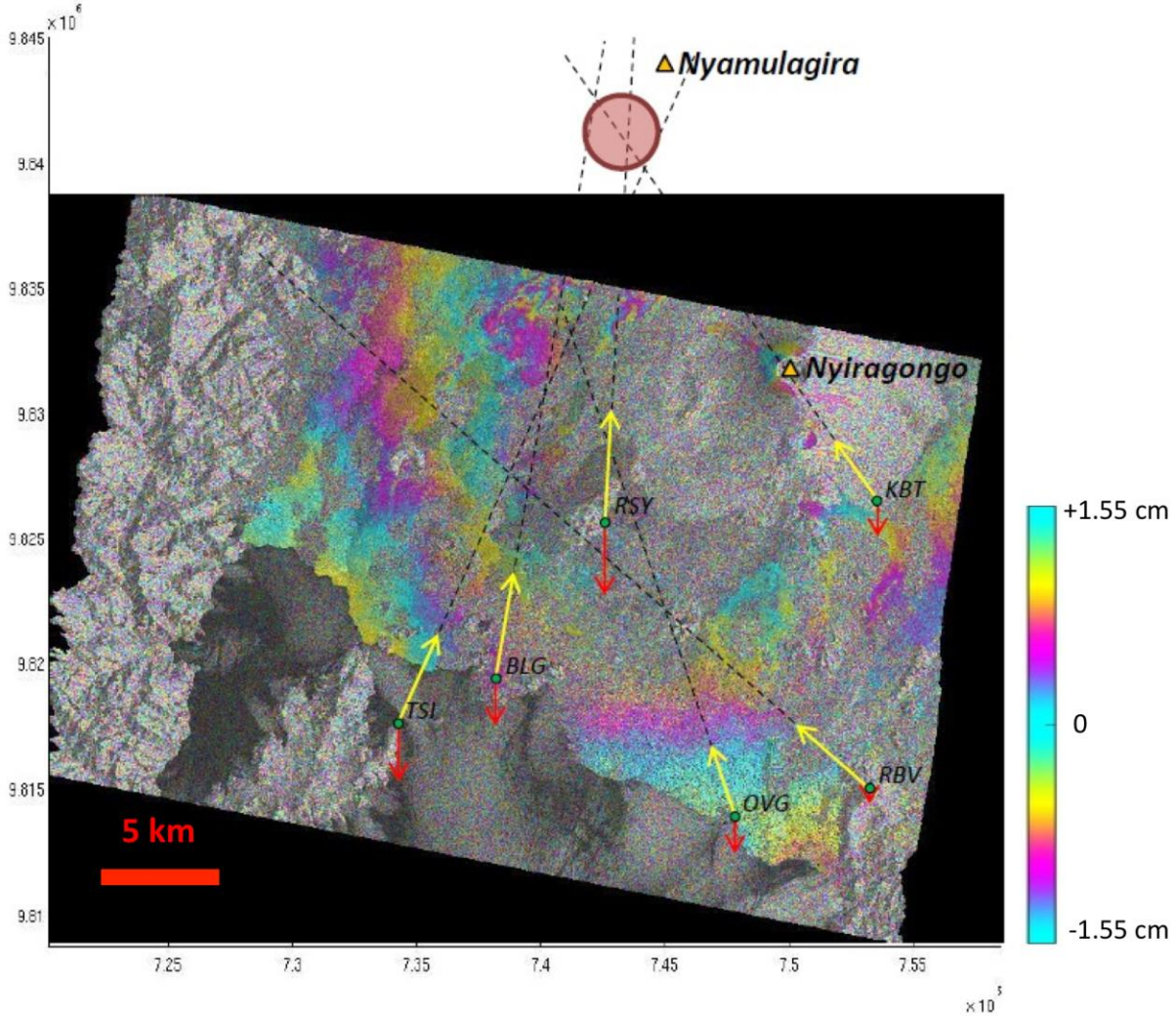


Nyamulagira eruption 2011 – 2012:

- Modeling suggest deep magma source at 20 Km
- Such deep source could explain the high frequency of eruption at Nyamulagira (~2-3 years)
- Also consistent with large erupted volume in last eruption (0.3 Km^3)



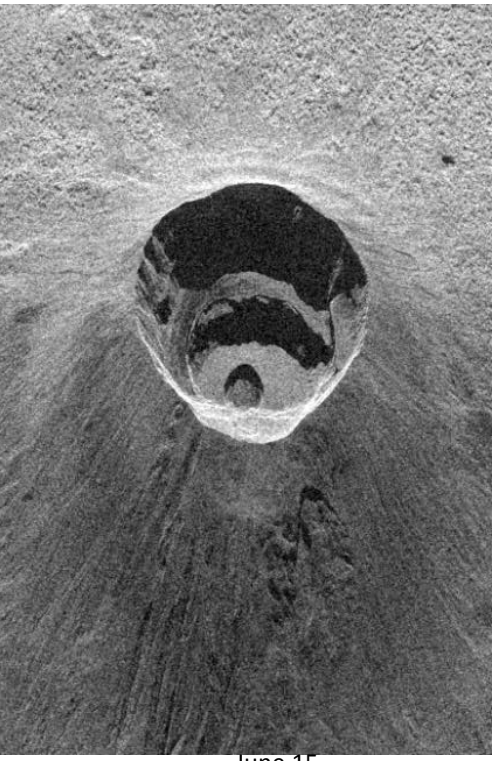
Nyamulagira eruption 2011 – 2012:



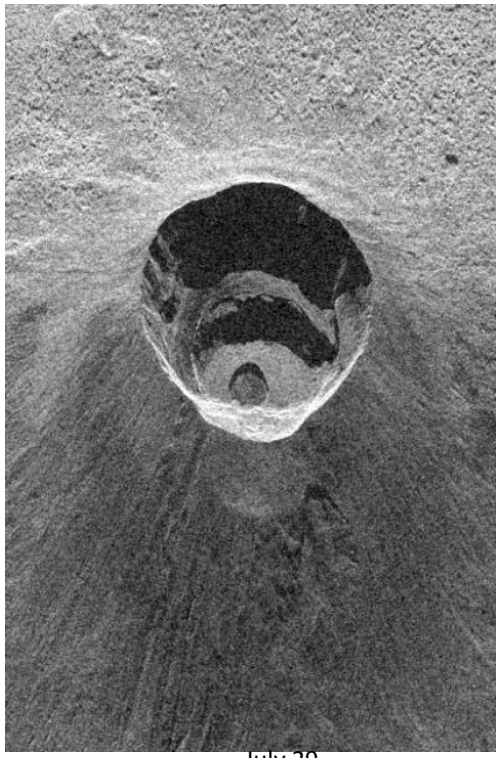
For the first time in the region, ground deformation detected simultaneously by both InSAR AND ground based system (GPS)

Other application: lava lake measurements ==> GeoRisCA

Shadows in intensity images can be used as a simple indicator of platforms height differences.

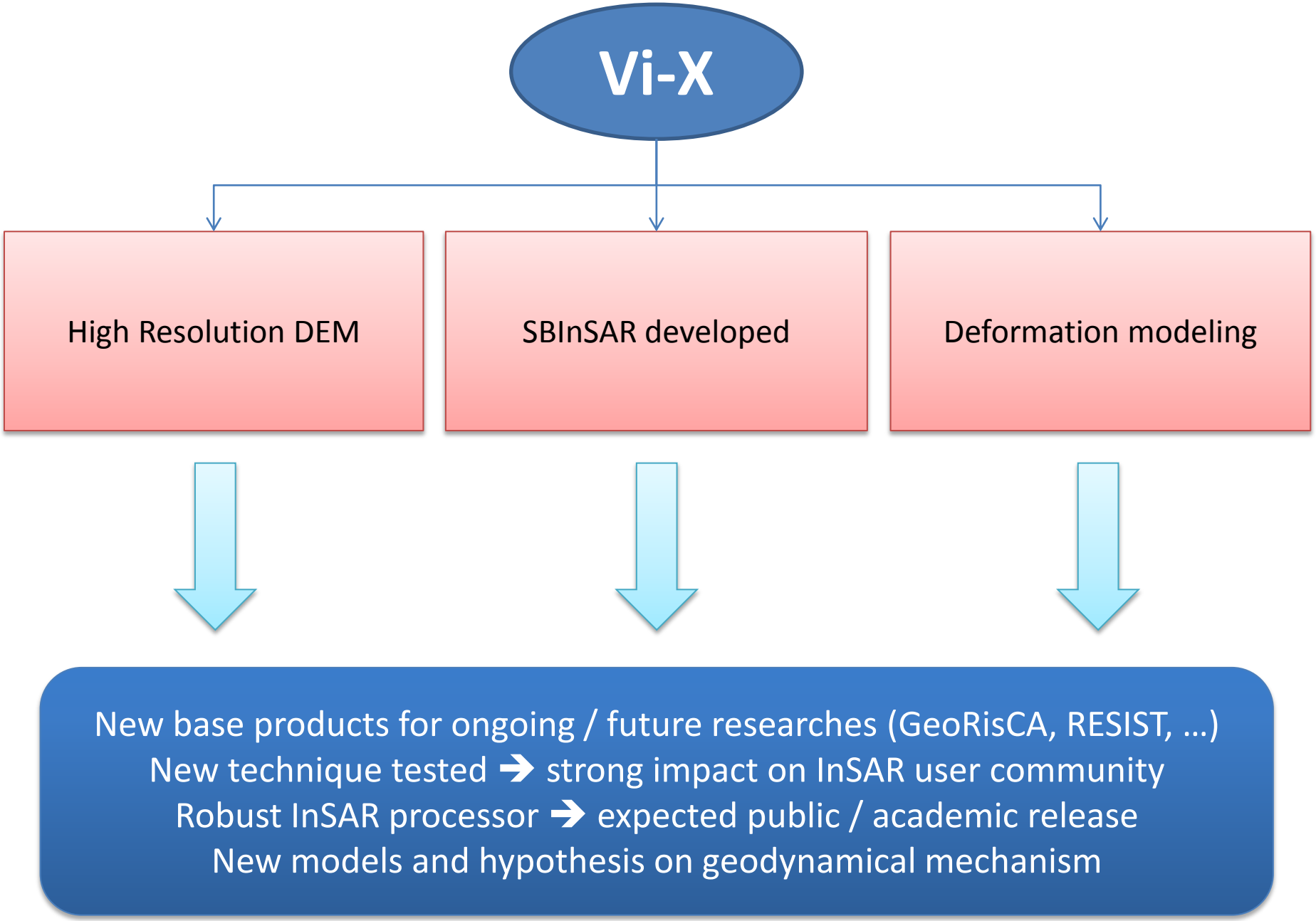


June 15, 2012



July 29, 2012

- Lava lake level with respect to P3:
  - -46m on June 15, 2012
  - -27,5m on July 29, 2012
- P3 with respect to P2:
  - -110m
- P2 with respect to crater border:
  - -235m


Vi-X
High Resolution DEM
SBInSAR developed
Deformation modeling
New base products for ongoing / future researches (GeoRisCA, RESIST, …)
New technique tested ➔ strong impact on InSAR user community
Robust InSAR processor ➔ expected public / academic release
New models and hypothesis on geodynamical mechanism