Journées Luxembourgeoises de la Géodynamique

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Development of an Interferometric Mass Processing Chain for Multitemporal Ground Deformation Measurements

L. Libert[1], D. Derauw[1], N. d'Oreye[2,3]

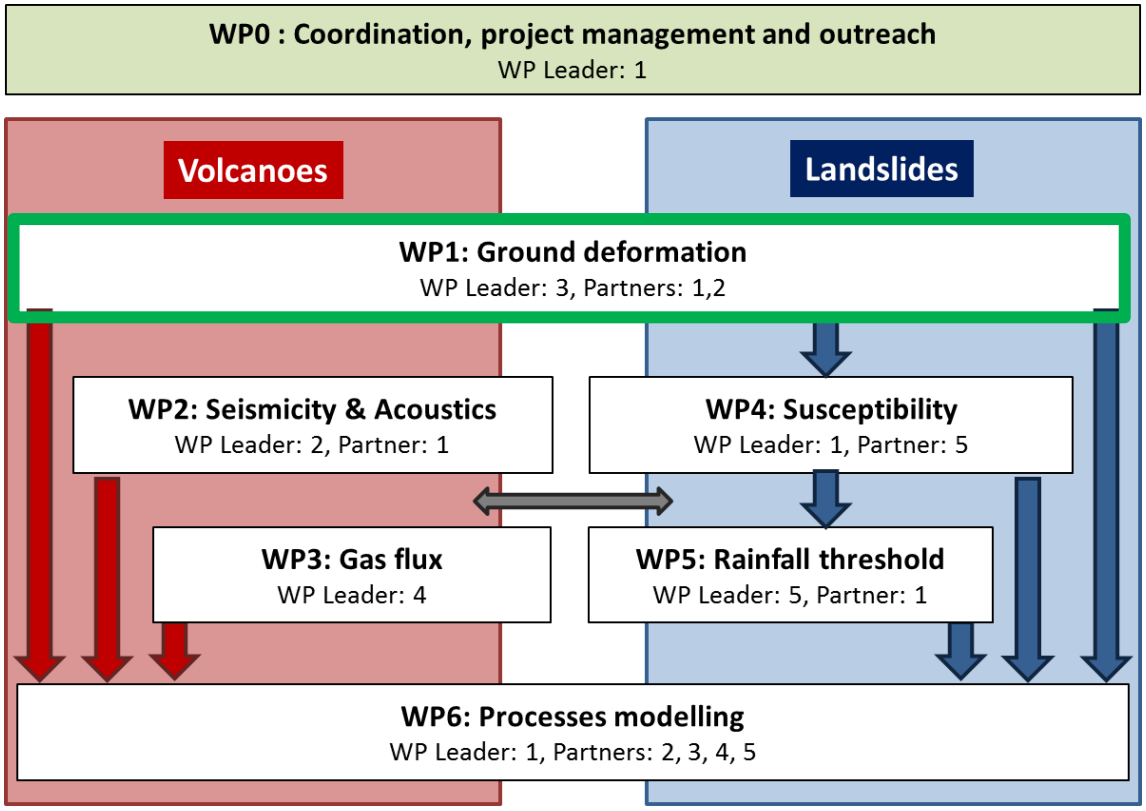
[1]*Centre Spatial de Liège, Université de Liège, Belgium*

[2]*European Center for Geodynamics and Seismology, Luxembourg*

[3]*National Museum of Natural History, Luxembourg*

RESIST : the big picture

The main goal of RESIST is to understand the mechanisms driving **volcanic eruptions** and **landslides** in the Kivu region.

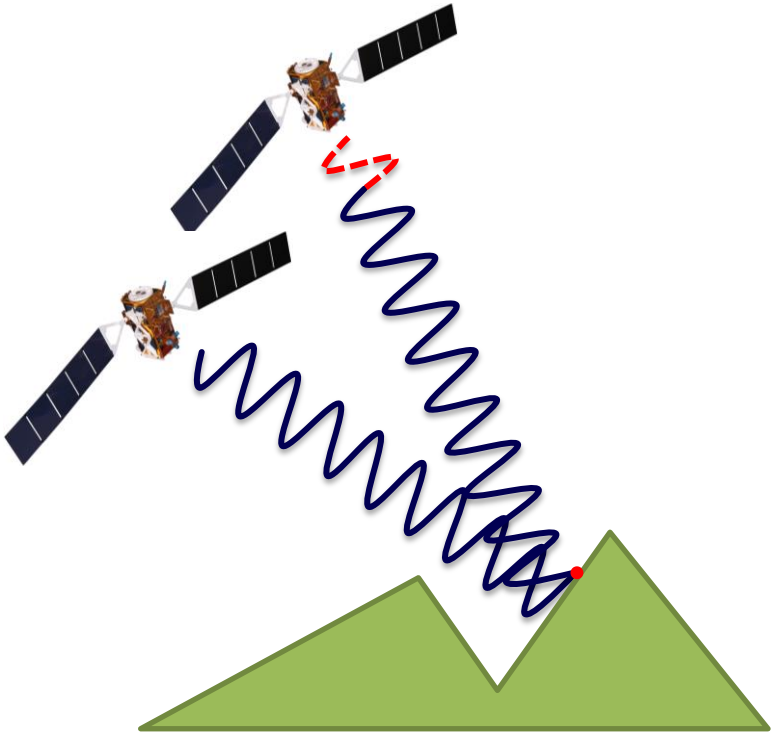


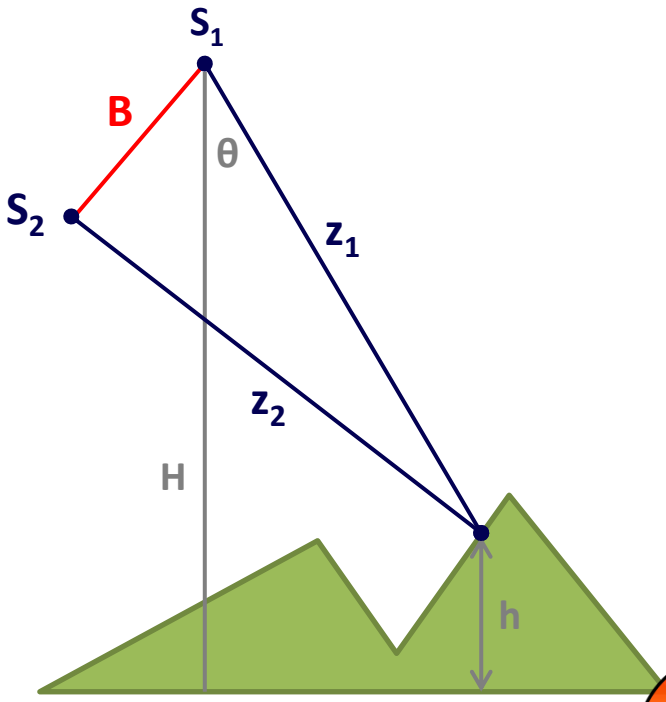
Partner 1: RMCA; Partner 2: MNHN/ECGS; Partner 3: CSL; Partner 4: BIRA-IASB; Partner 5: NASA

The Differential SAR Interferometry Approach

Interferometry measures the optical path difference related to two coherent wavefronts.

The Synthetic Aperture Radar (SAR) interferometry is used to map the **topography** and **ground deformations**.





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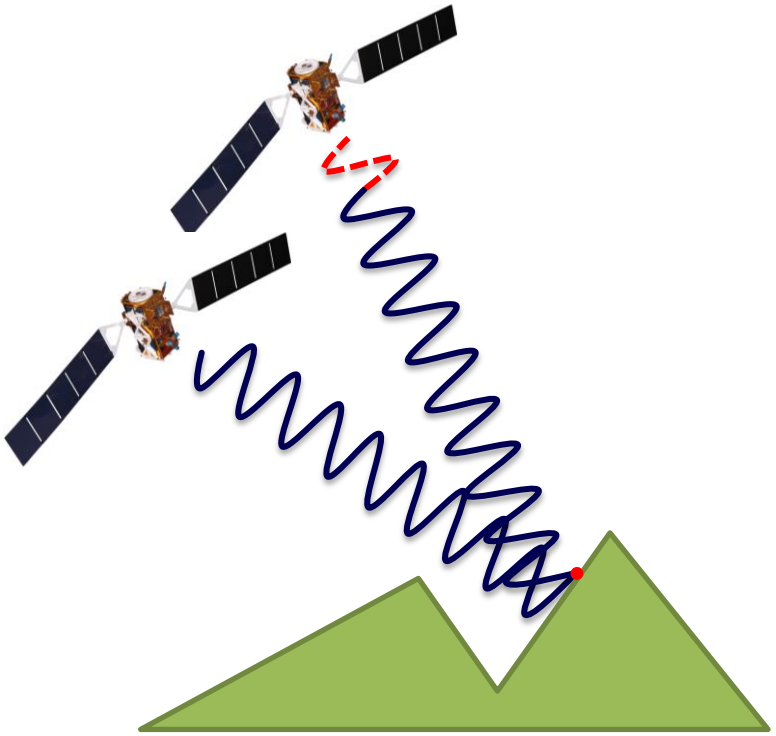
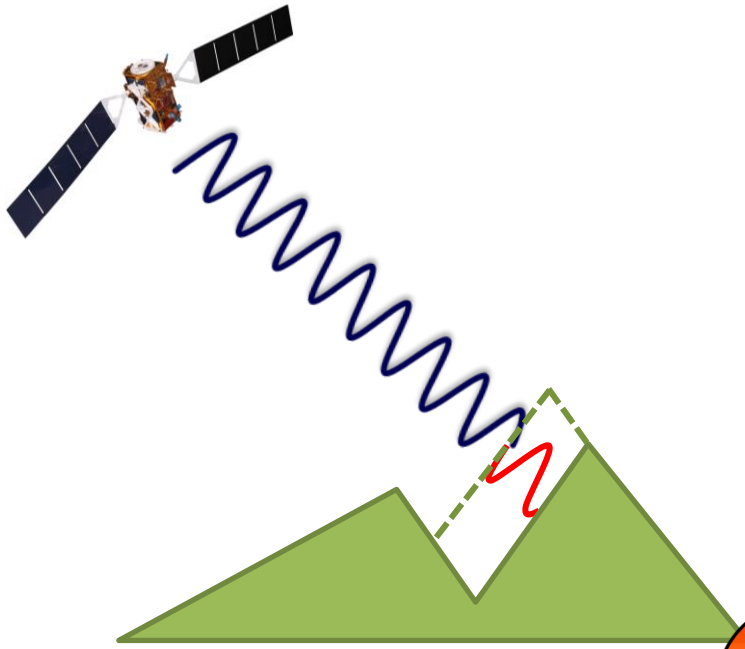
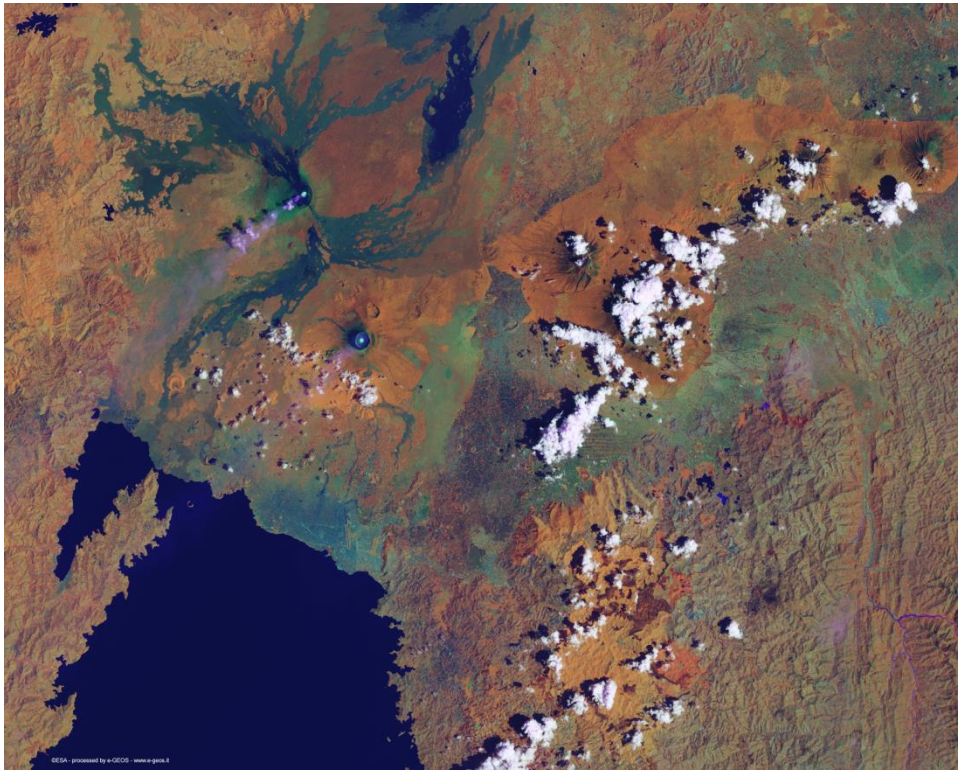




The Differential SAR Interferometry Approach

Differential SAR Interferometry offers **large spatial coverage** and temporal sampling of the order of **one to several days**.

Contrary to PSI, MSBAS considers **distributed scatterers** and computes deformations along **two axes**.



http://www.e-geos.it

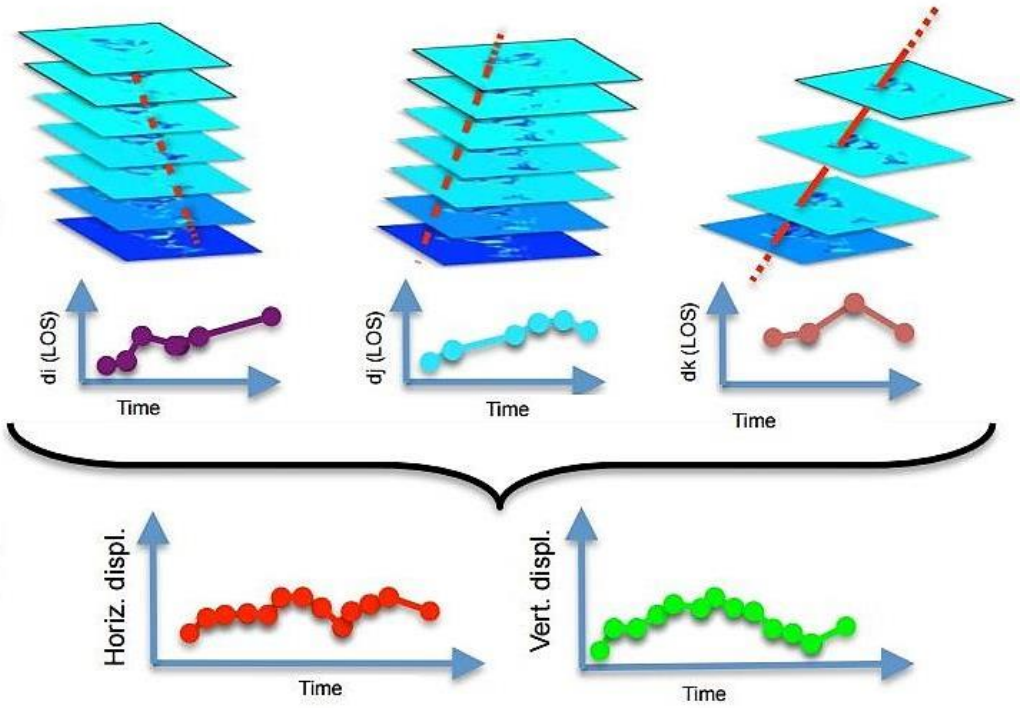
Multidimensional Small BAseline Subset (MSBAS)

Integration of DInSAR data sets

- From different sensors
- With different spatial and temporal sampling and resolution
- With different incidence angles, wavelengths, pass directions, etc.

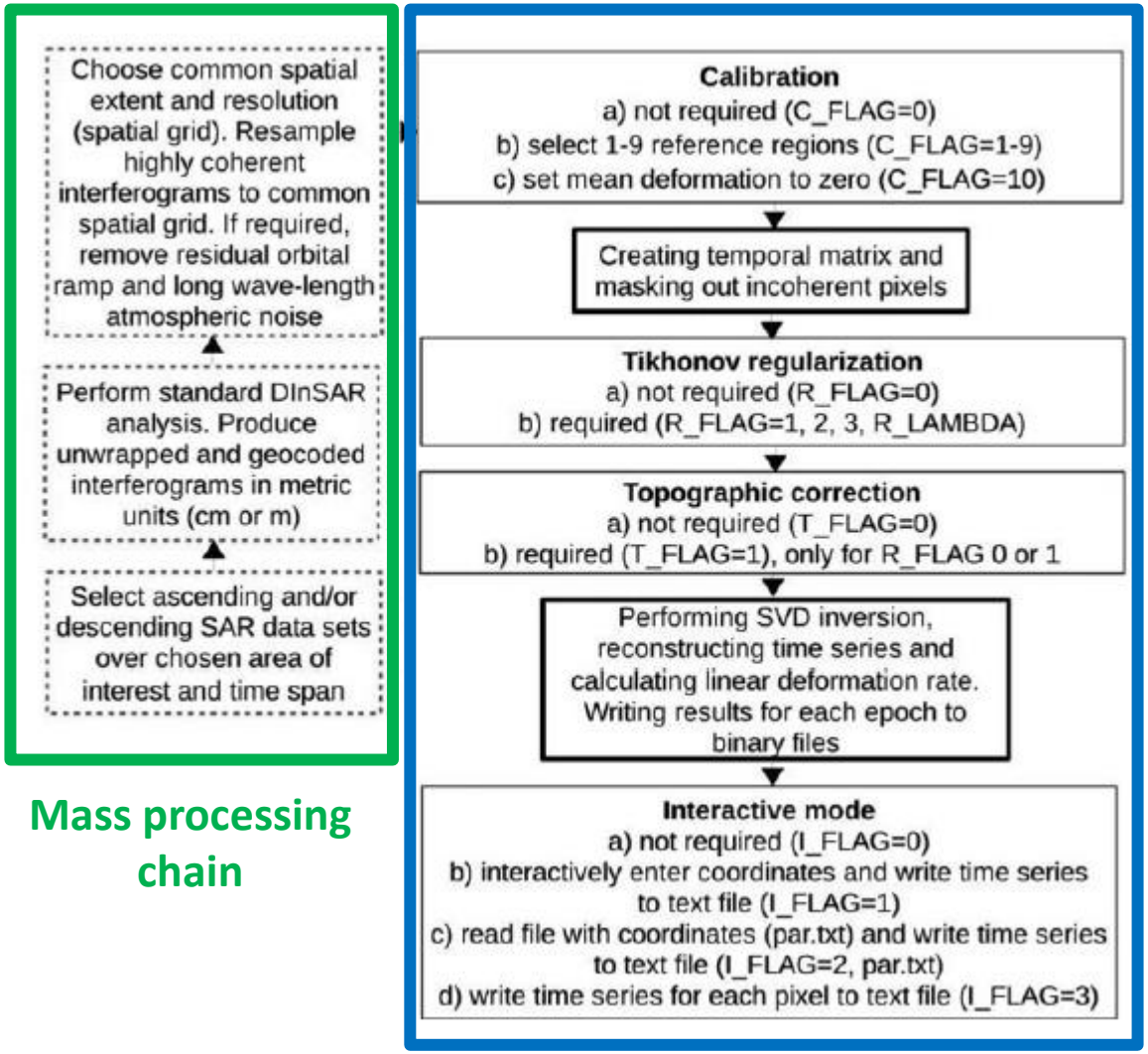
Computation of 2D time series of ground deformations, along :

- The East-West direction
- The vertical direction



MSBAS code avalaible on : *www.insar.ca*

MSBAS



S. Samsonov and N. d'Oreye, *Canadian Journal of Remote Sensing*, 2017

RESIST

Mass Processing Chain

Interferometric Mass Processing Chain

A three-step approach:

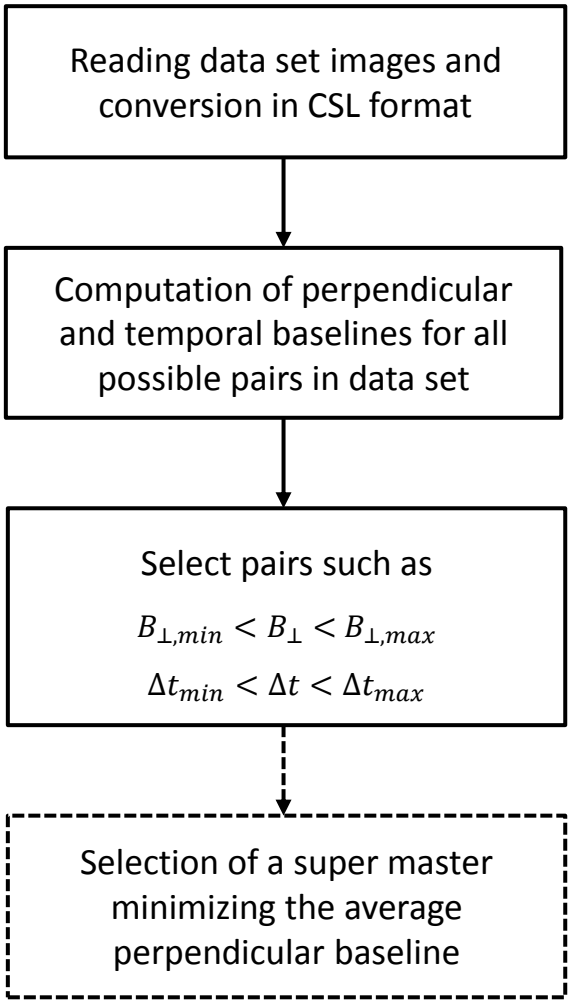
Integration of the *CSL InSAR Suite* (CIS) routines by a shell script for an automatic processing of the selected interferometric pairs

RESIST

Interferometric Mass Processing Chain

Interferometric pairs selection

- Small perpendicular baselines to prevent geometric decorrelation
- Small temporal baselines to prevent temporal decorrelation

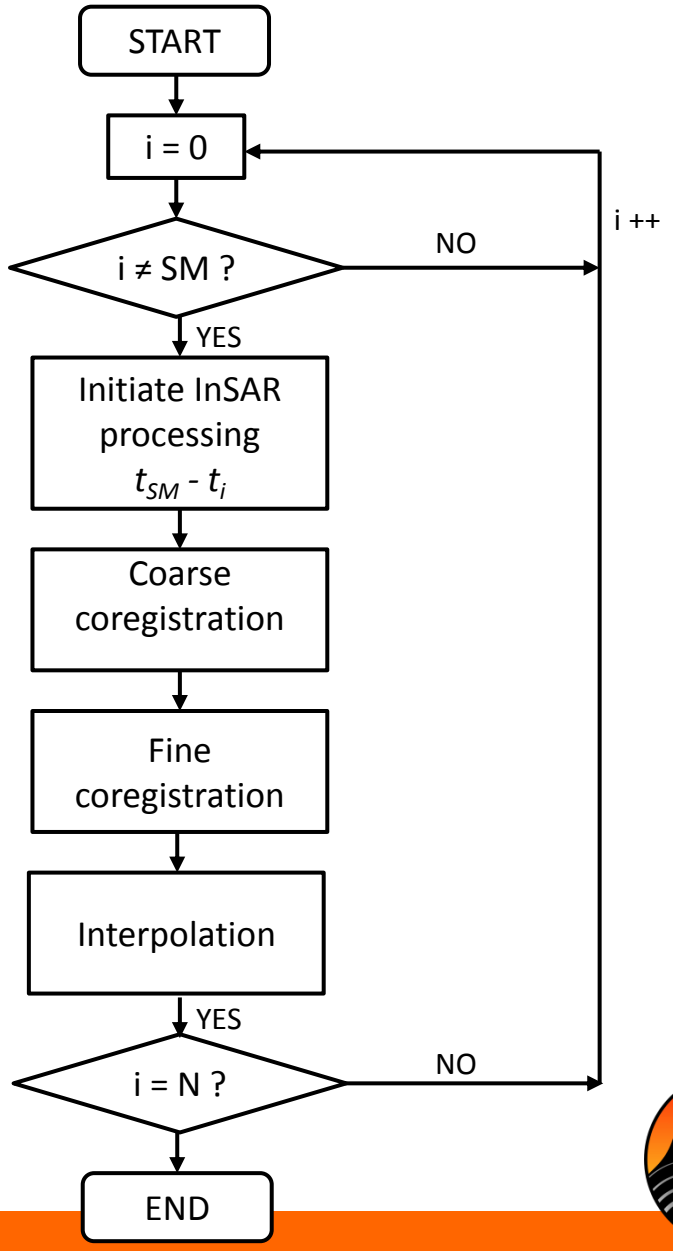


Interferometric Mass Processing Chain

Coregistration on super master

Let us consider a data set composed of $N + 1$ SAR images acquired at times $t_0, t_1, \ldots, t_N$.

Super master image is acquired at time t_{SM}.



Interferometric Mass Processing Chain

What is the CIS added-value ?

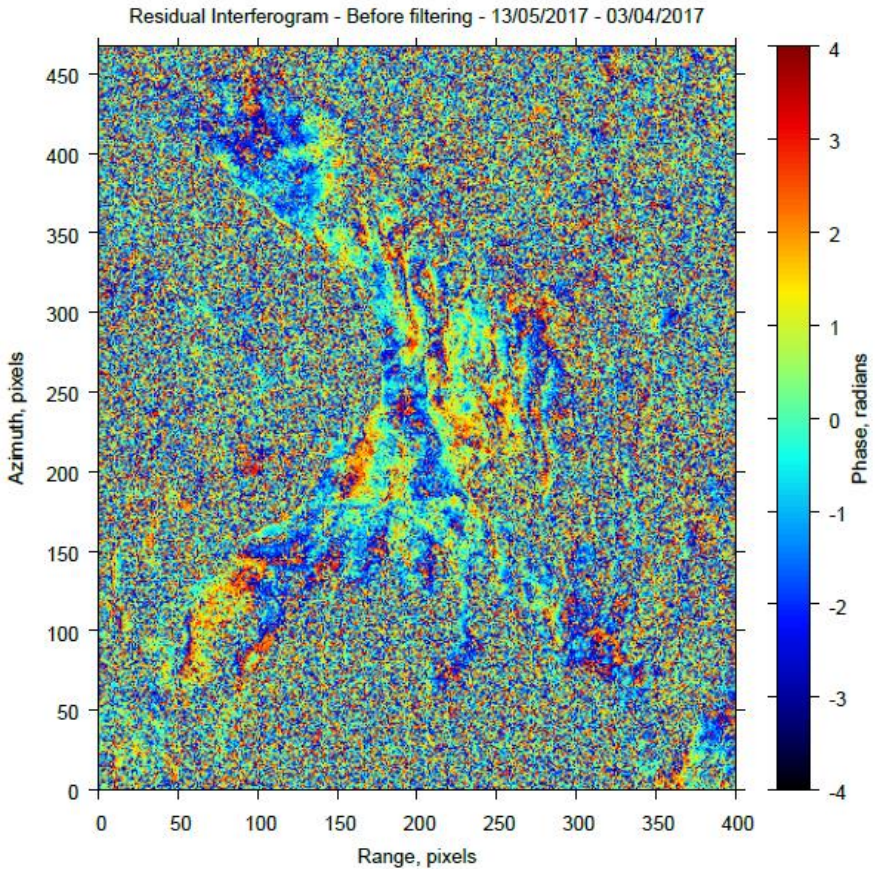
- Fully adaptable and flexible
- A user/developer co-construction
- Saving memory and time in the long-term

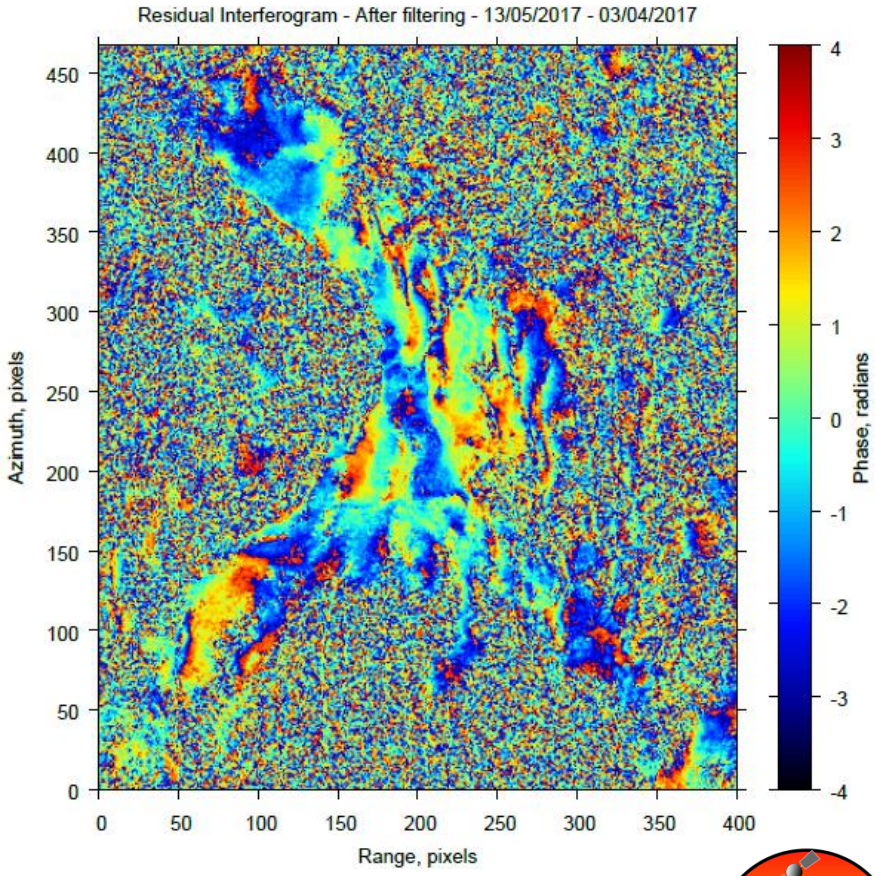
What is now possible with CIS ?

- Supporting ERS, Envisat, Radarsat, TerraSAR-X/TanDEM-X, ALOS, Cosmo-SkyMed and Sentinel-1 data
- Adaptive filtering
- Phase unwrapping: branch-cut or snaphu
- Image/data set interpolation
- Sentinel-1 interferometry

What is now possible with CIS ?

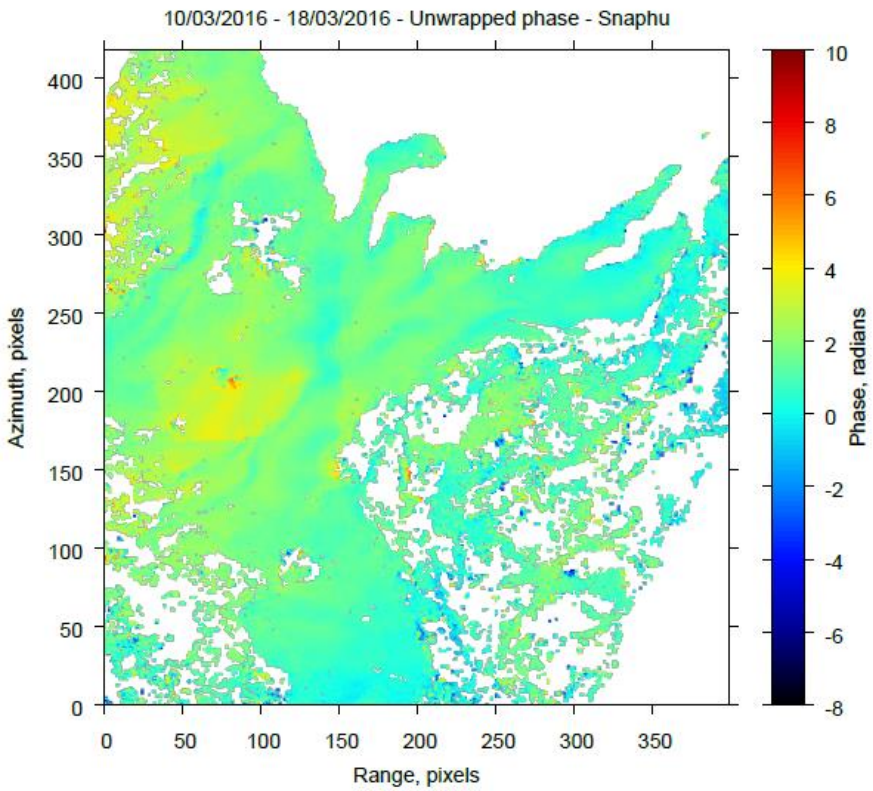
Adaptive filtering

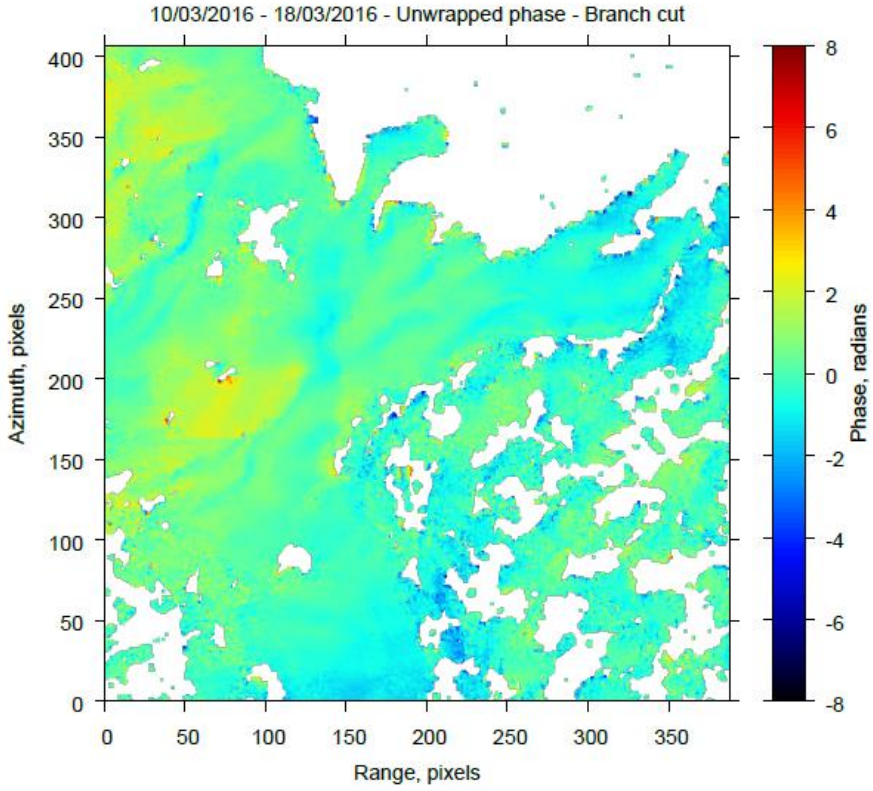




What is now possible with CIS ?

Phase unwrapping : snaphu or branch-cut algorithm

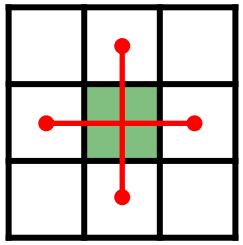




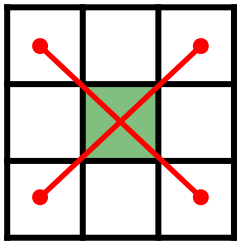
What is now possible with CIS ?

Interpolation

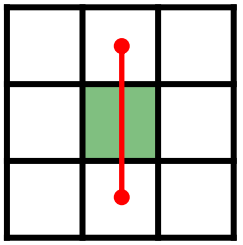
1st CASE



2nd CASE



3rd CASE



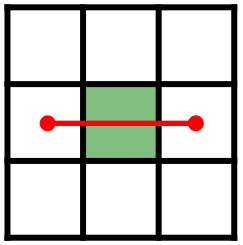
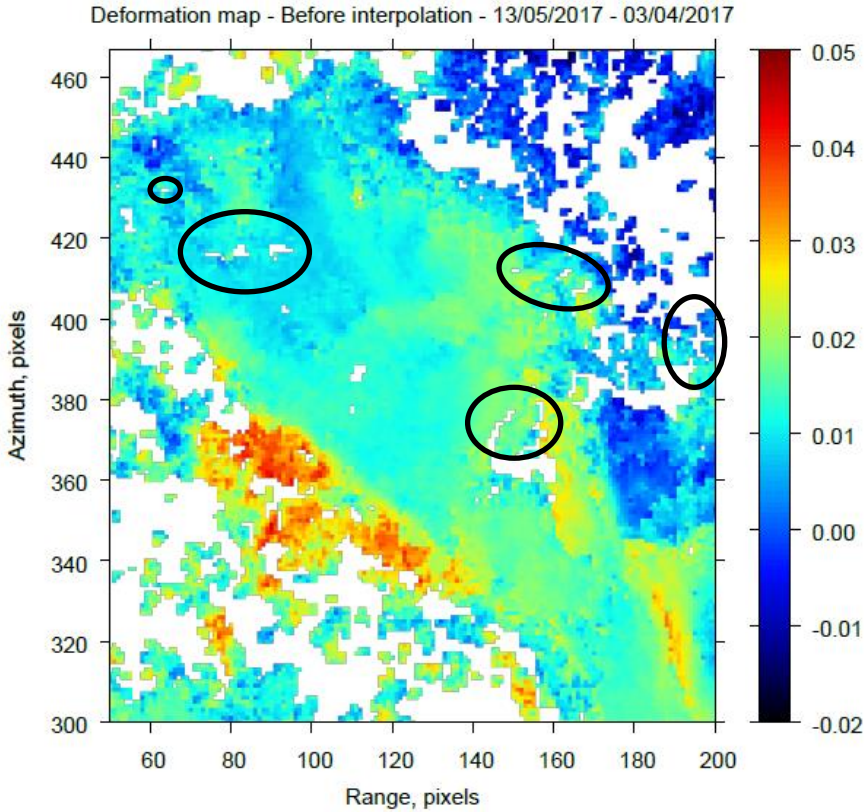
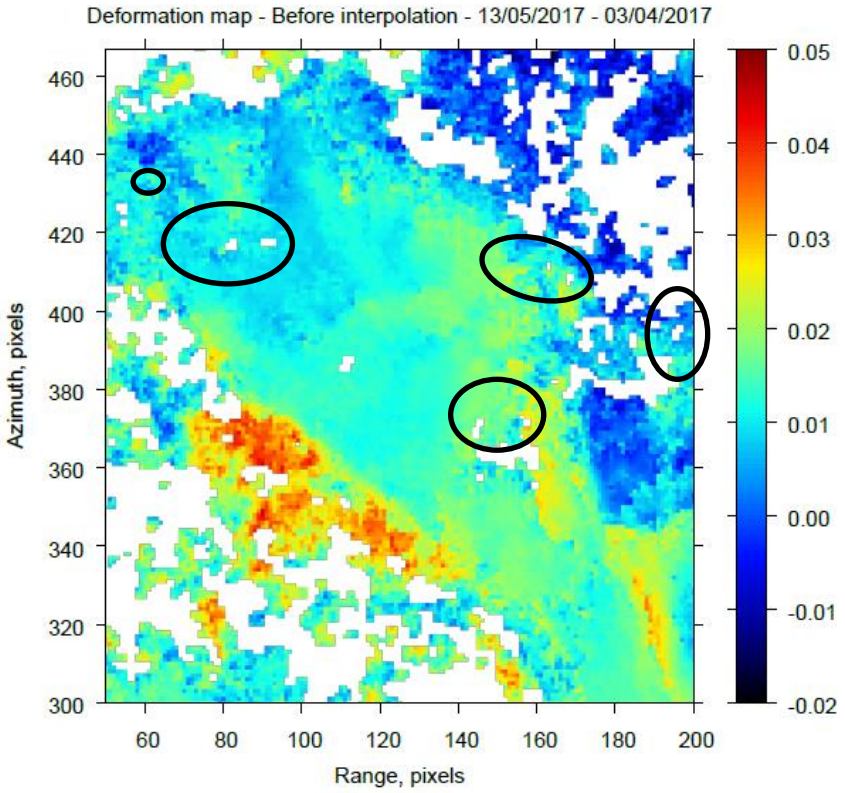


Image interpolation based on a simple bilinear/linear interpolation of nearest neighours value

What is now possible with CIS ?

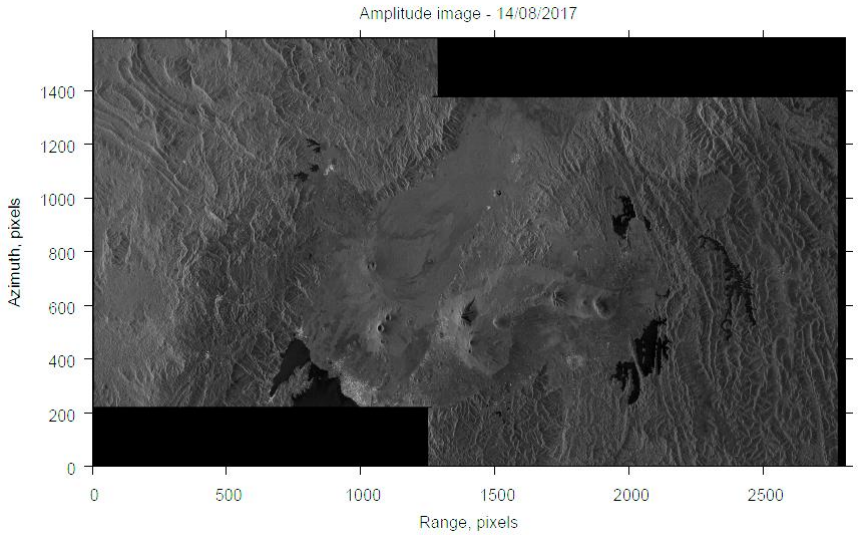
Interpolation

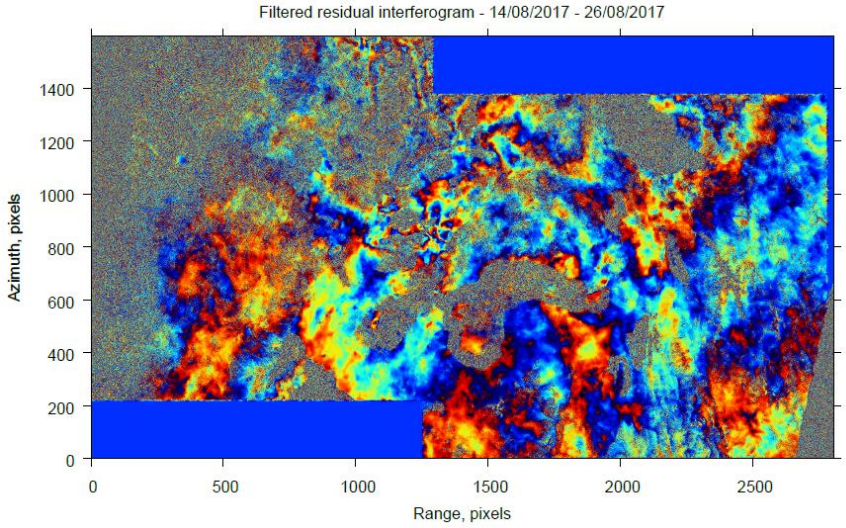


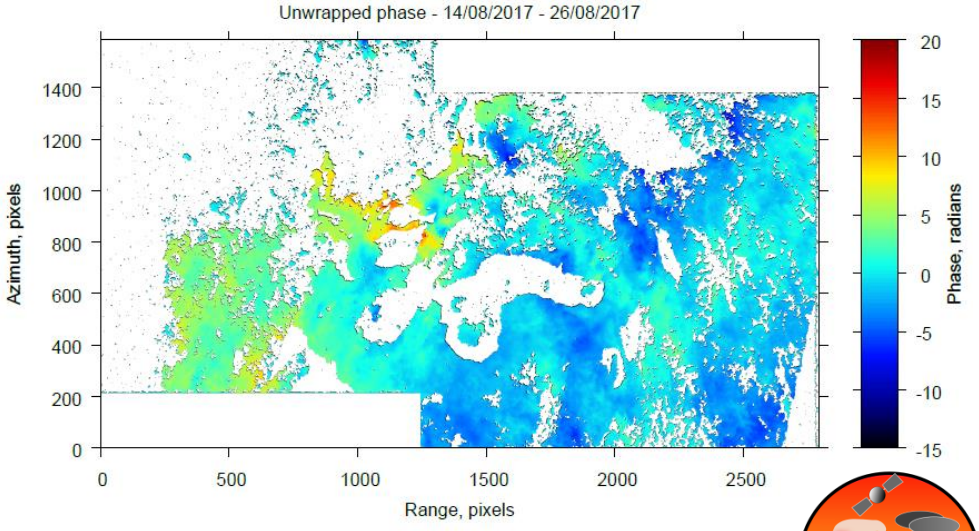


What is now possible with CIS ?

Sentinel-1 interferometry

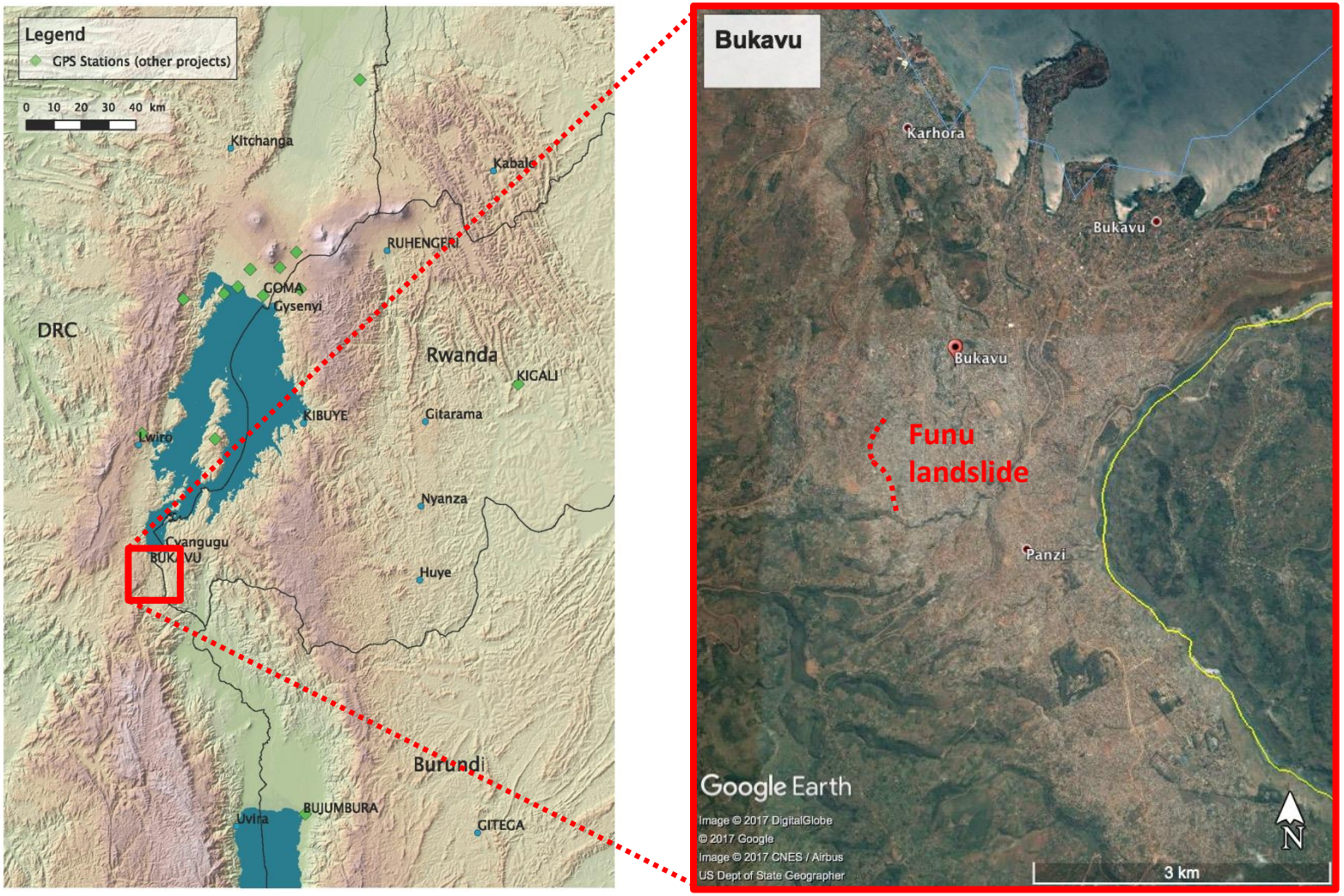






MSBAS preliminary results on Bukavu

Test site : Funu landslide, Bukavu



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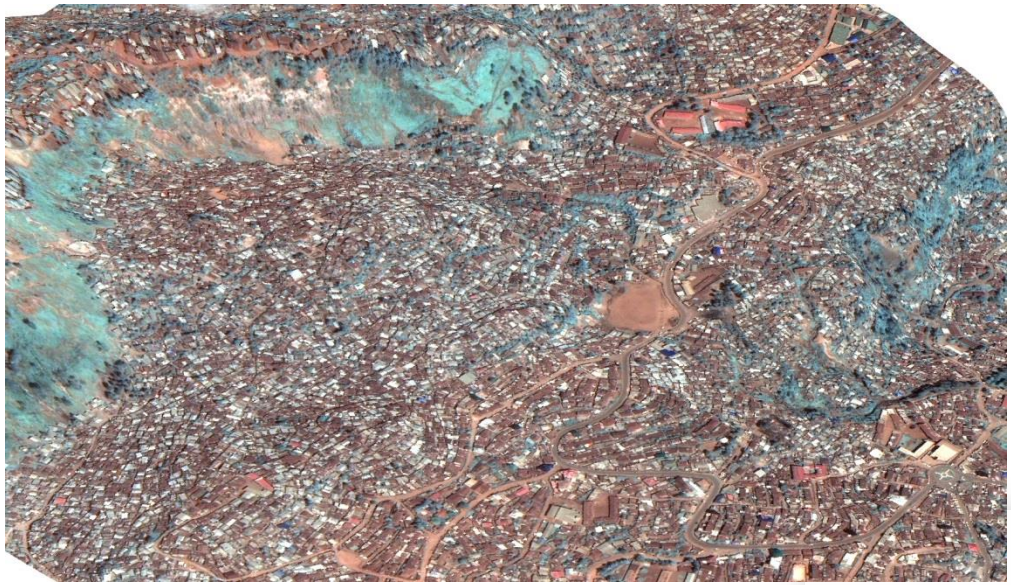
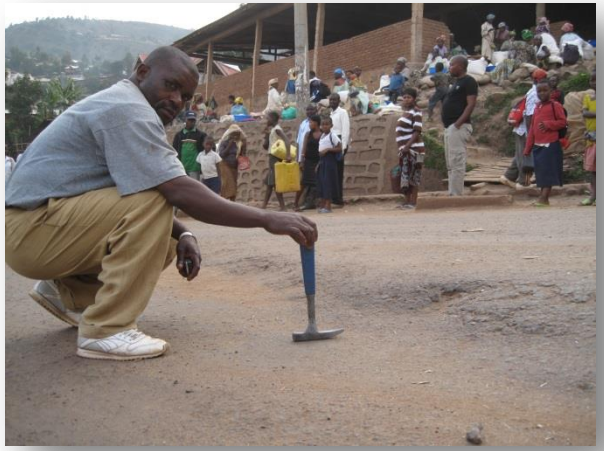
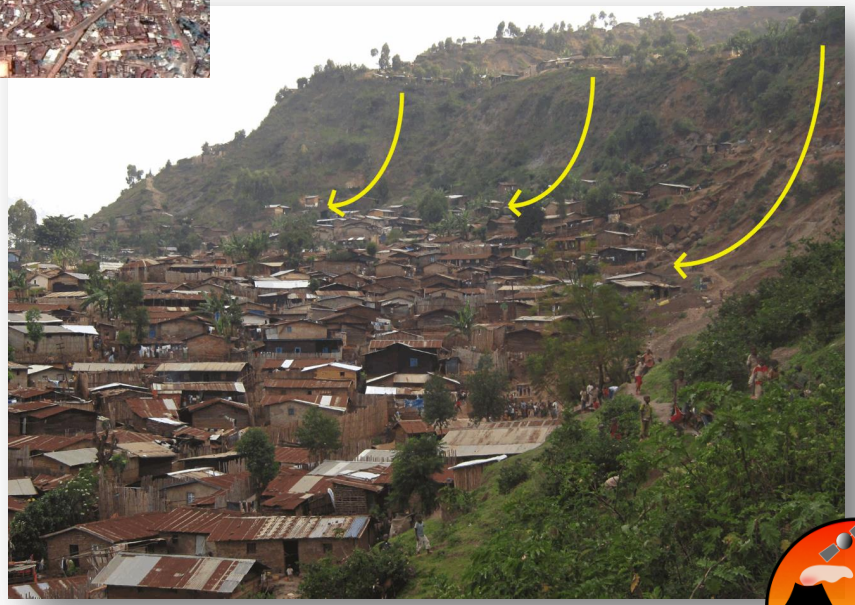


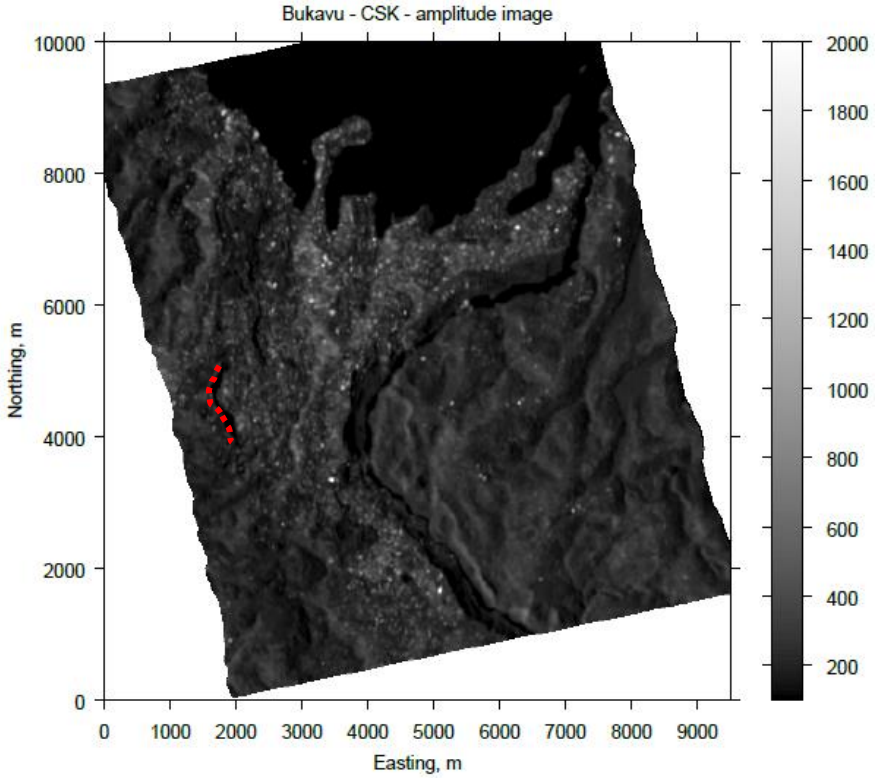


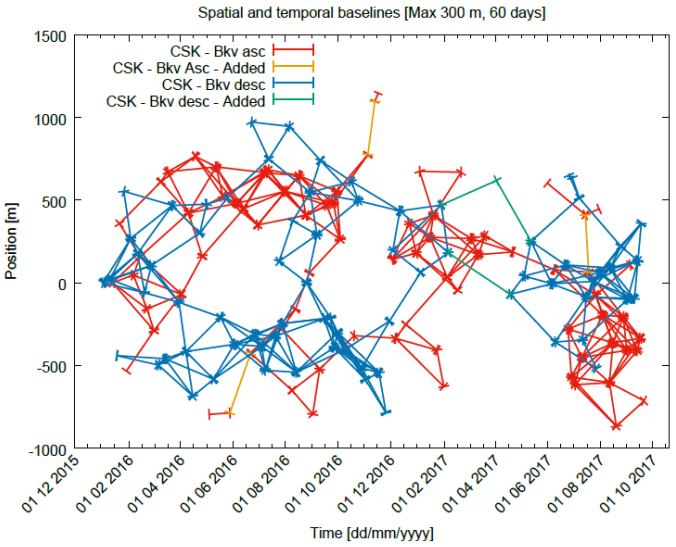


Funu landslide : data sets

Two data sets spanning 2016 - 2017:

- Cosmo-SkyMed ascending pass : 77 acquisitions / 188 interferograms $B_{\perp} < 300$ m
- Cosmo-SkyMed descending pass : 75 acquisitions / 193 interferograms $\Delta t < 56$ days





RESIST

Funu landslide : data sets

Two data sets spanning 2016 - 2017:

- Cosmo-SkyMed ascending pass : 77 acquisitions / 188 interferograms
- Cosmo-SkyMed descending pass : 75 acquisitions / 193 interferograms

Computing performances ?

Crop centered on Bukavu + ML 10x10

Adpative filtering

Snaphu + mask

Coregistration on super master :

~ 1h40 (two processes in parallel)

14 Go + 16 Go

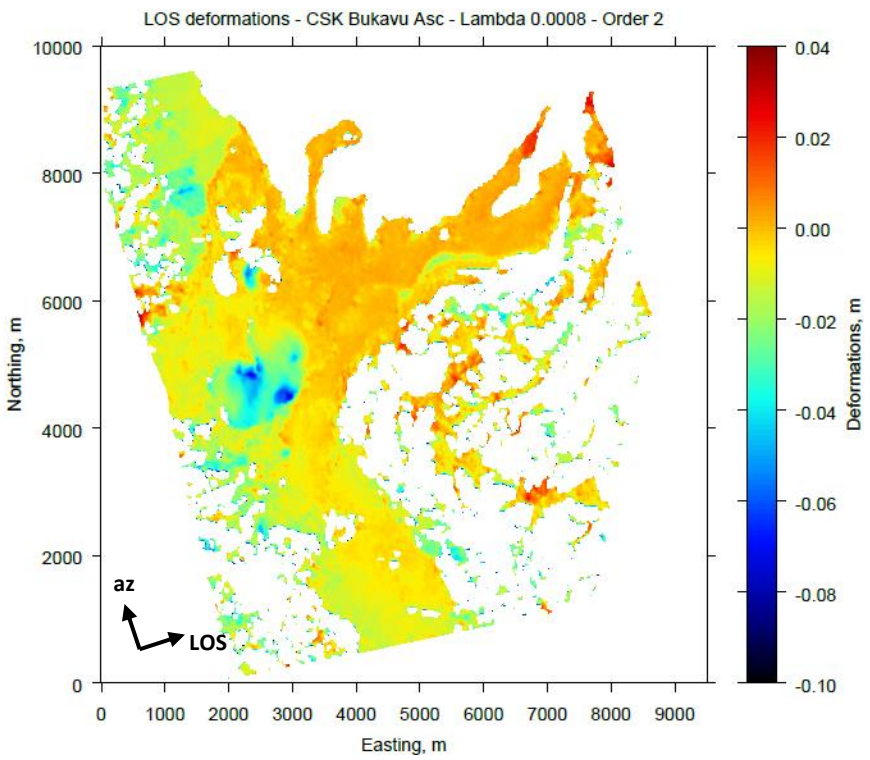
Interferometric processing and geoprojection :

~ 6h40 (two processes in parallel)

60 Go + 66 Go

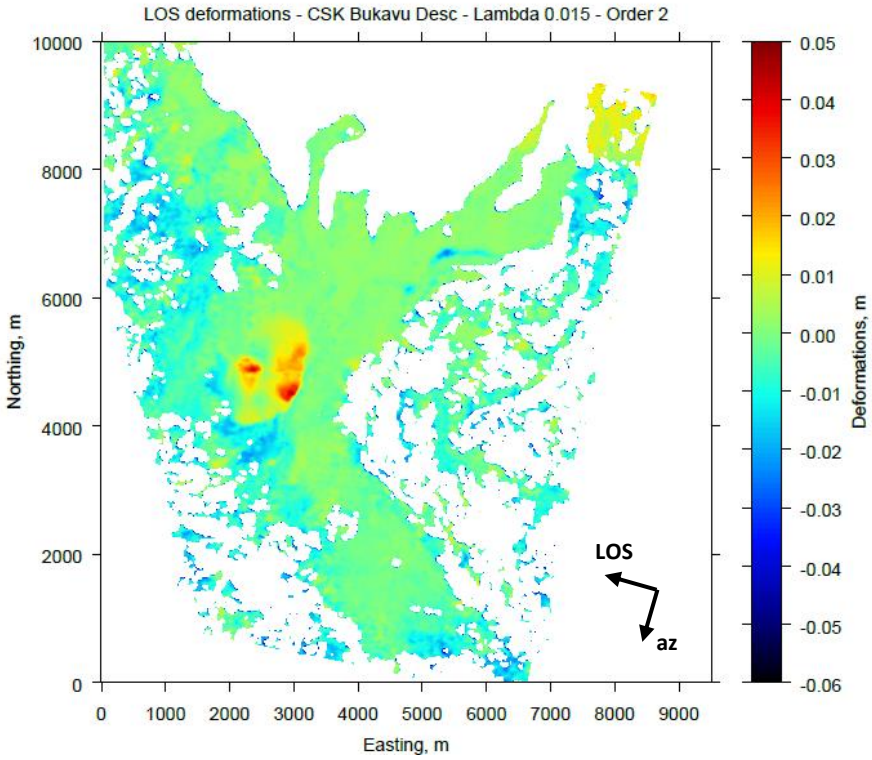
Funu landslide : SBAS

Cosmo-SkyMed – Ascending pass



Linear rate
~ max -7 cm/yr

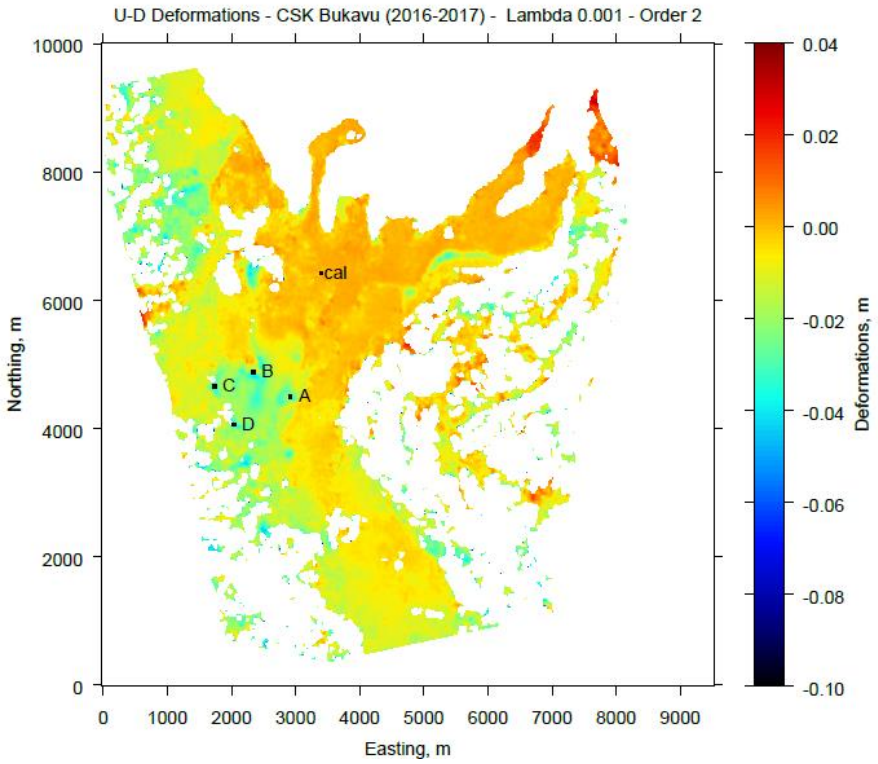
Cosmo-SkyMed – Descending pass



Linear rate
~ max 4 cm/yr

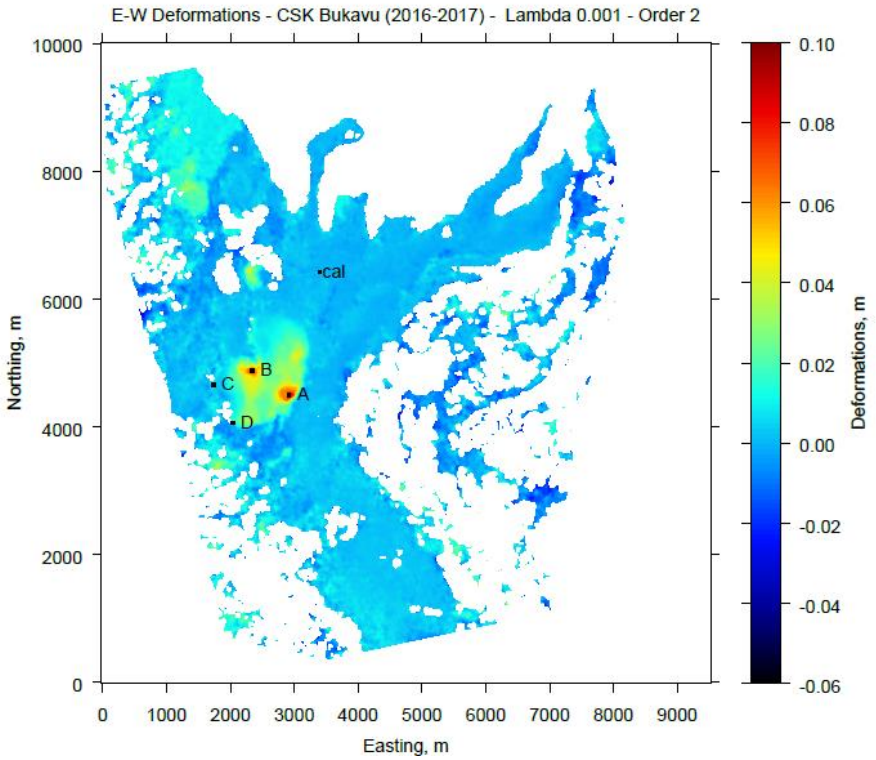
Funu landslide : MSBAS

Vertical deformation
Linear rate



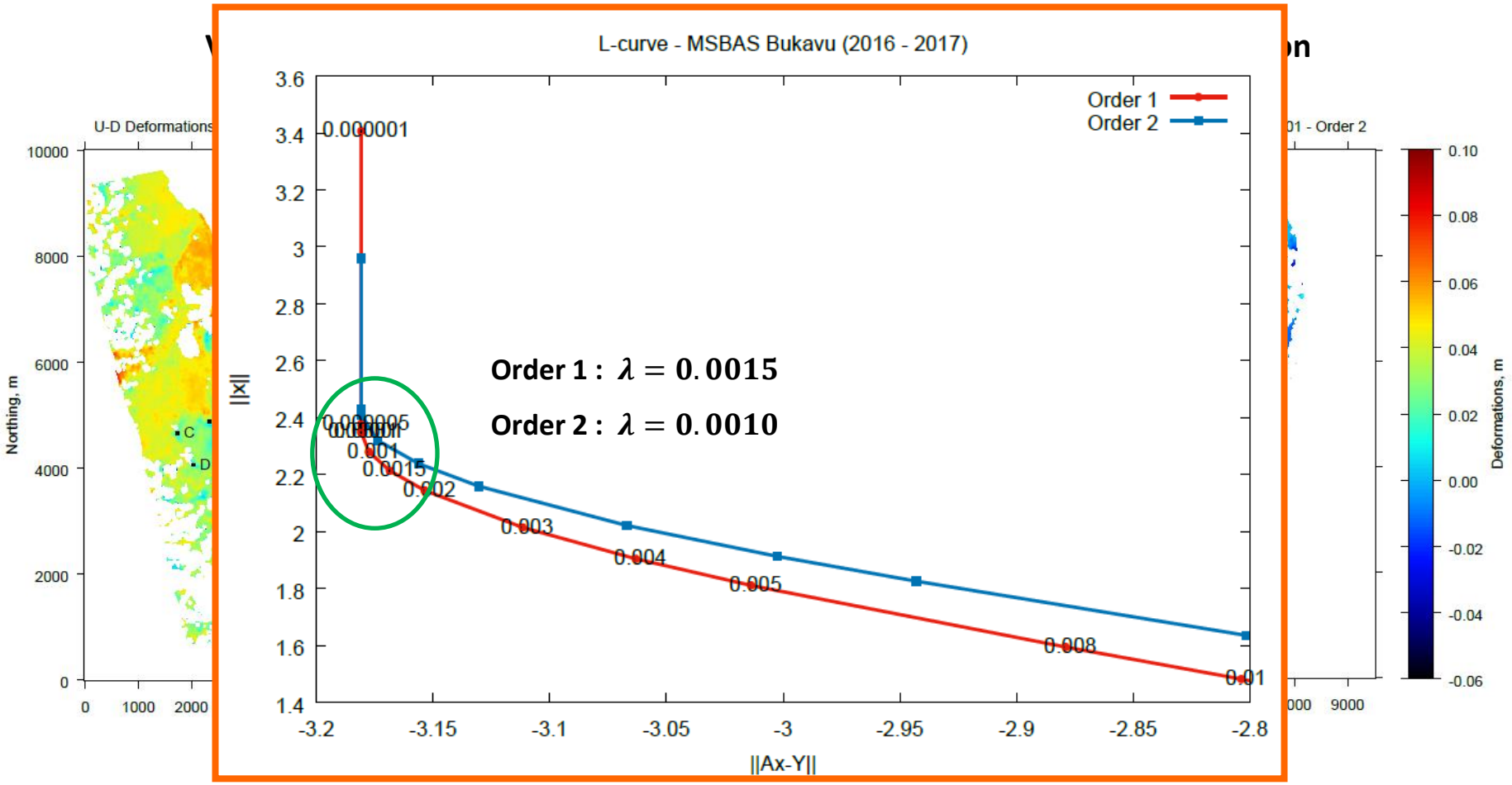
~ -4 cm/yr

West-East deformation
Linear rate

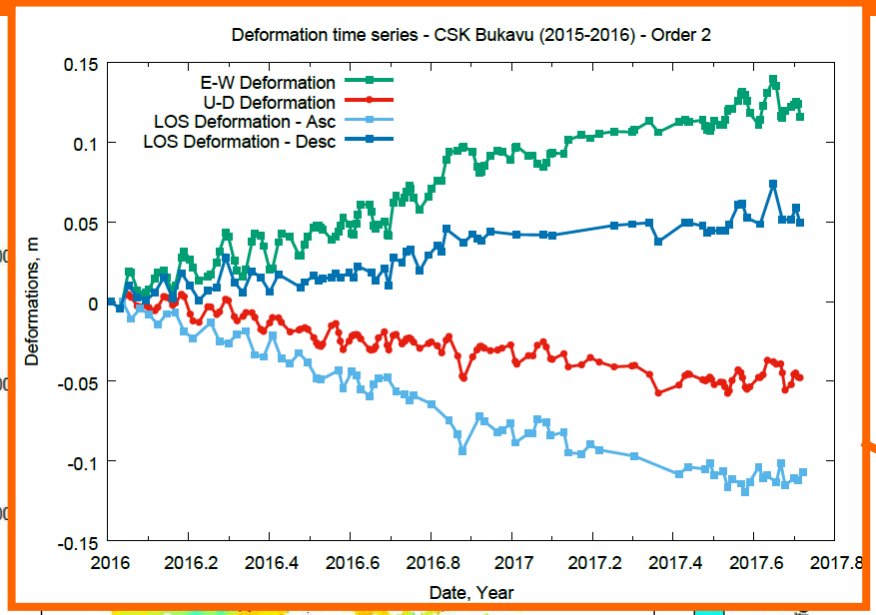


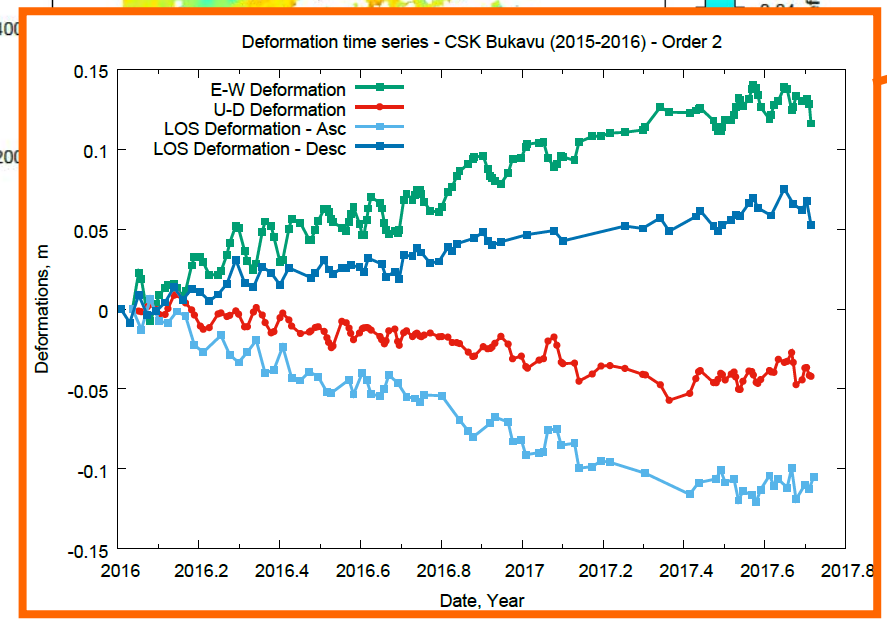
~ max 8 cm/yr towards East

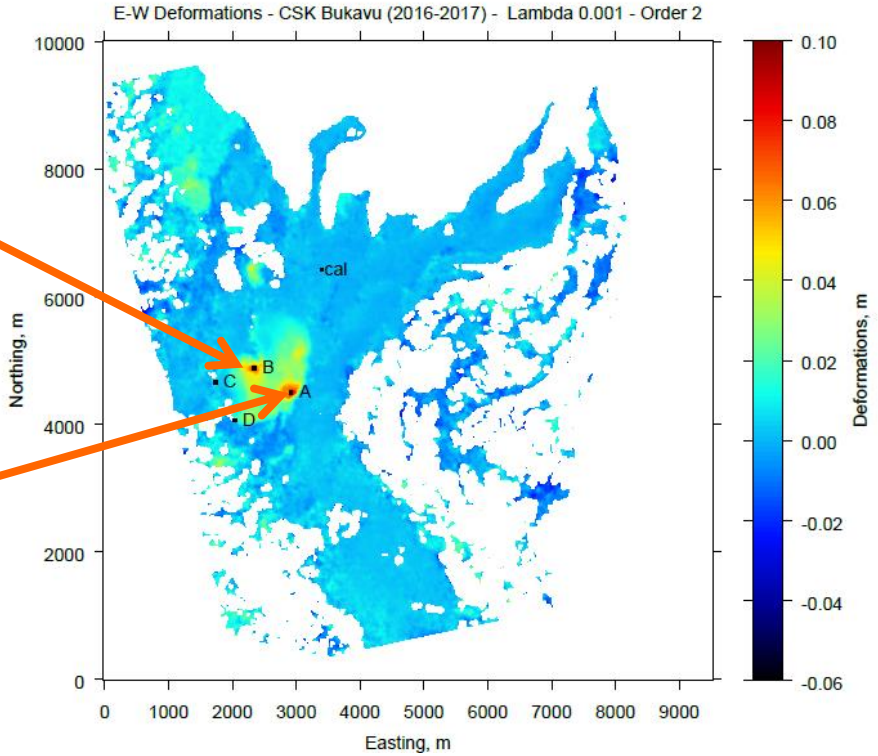
Funu landslide : MSBAS



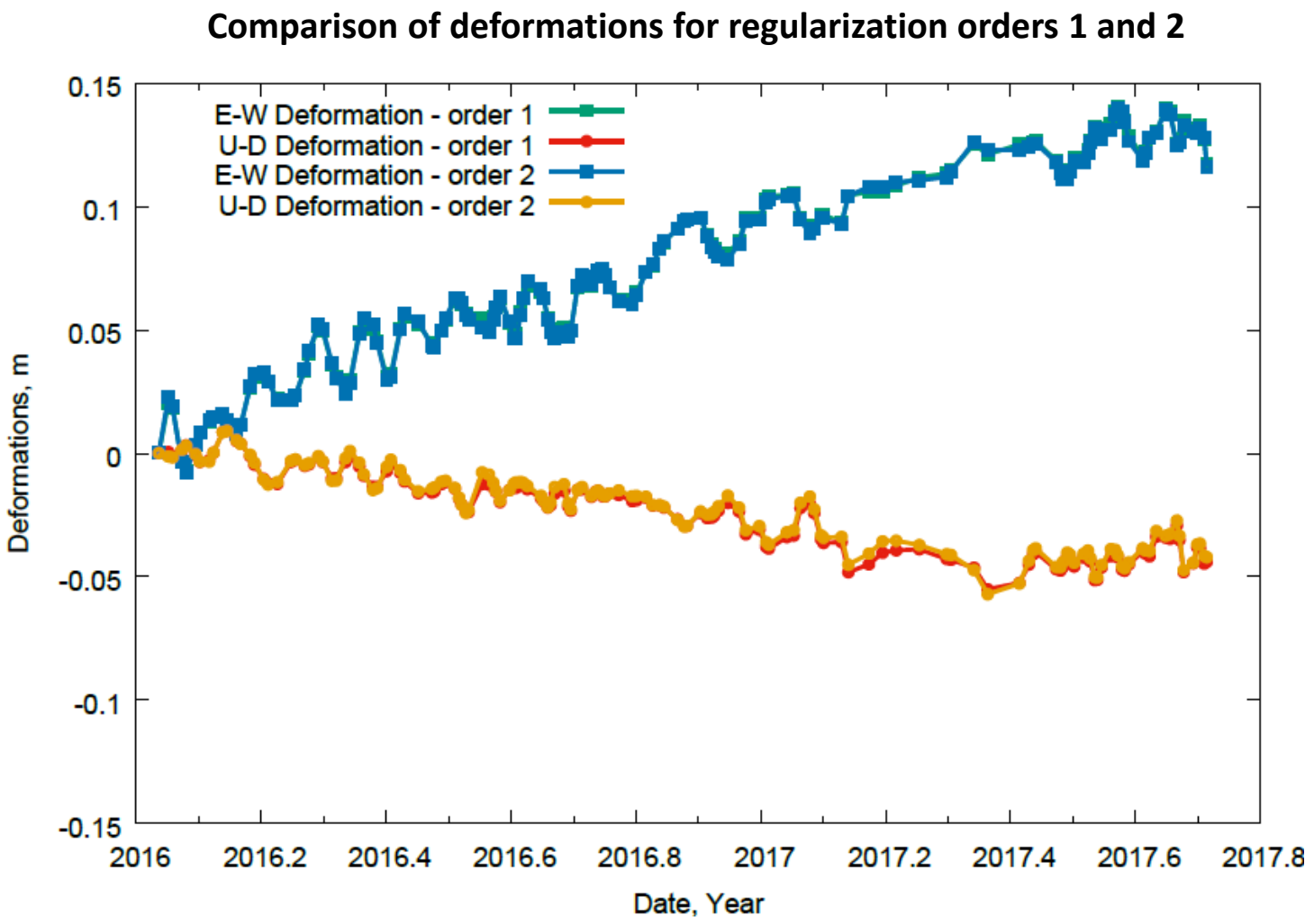
Funu landslide : MSBAS



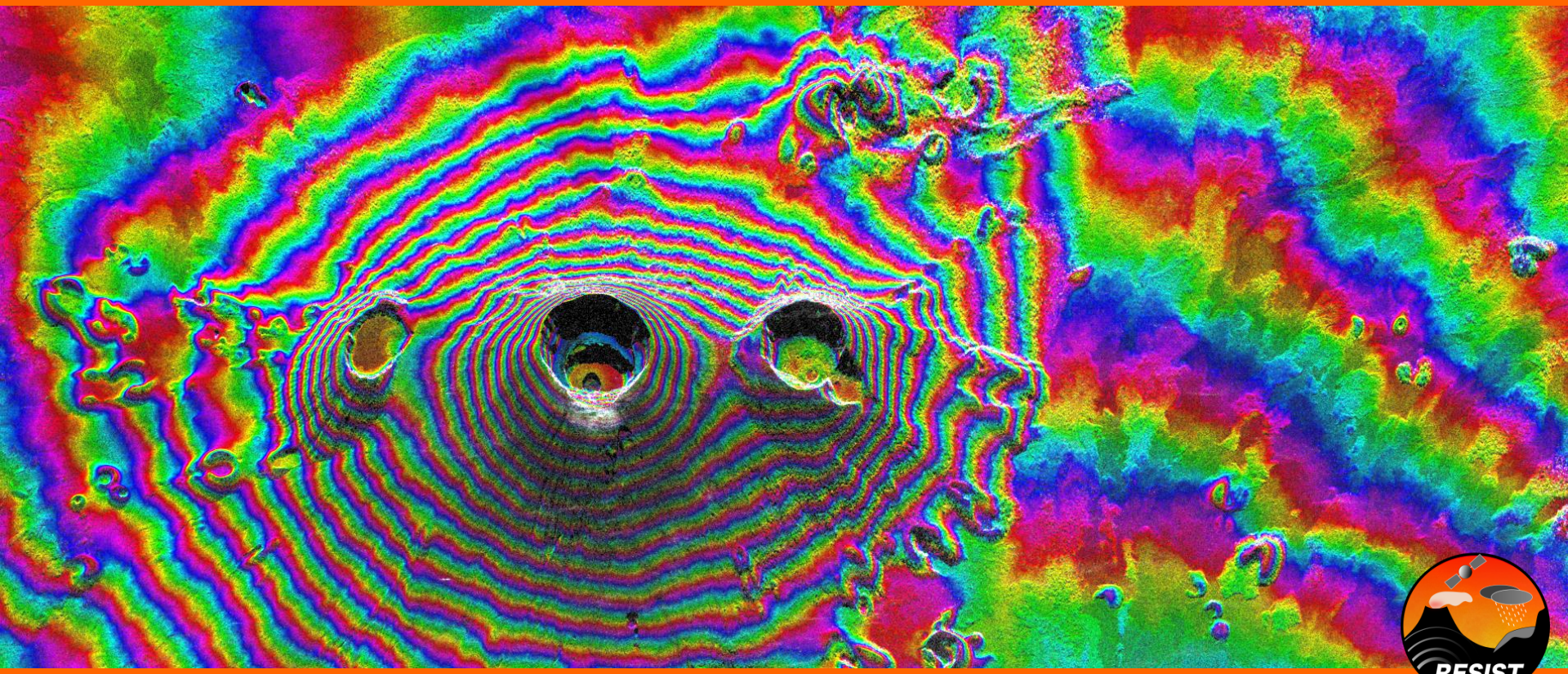




Funu landslide : MSBAS



Conclusions

- Numerous improvements made and options integrated in CIS
- An end-to-end working interferometric processing chain
- Preliminary results on Bukavu, for the 2016 – 2017 period, consistent with previous analysis

Thank you for your attention