



InSAR – Infrastructure Monitoring

A Look Back in Time and More

Luciano Rocca
EO59

52nd Annual Southeastern Transportation Geotechnical Engineering Conference

Charlotte, North Carolina 2023



Satellite InSAR

(Interferometric Synthetic Aperture Radar)



- Detect and measure ground deformation
- Fully remote
- Assessment and monitoring
- Large areas (and local details)

Satellite InSAR

Basic principles

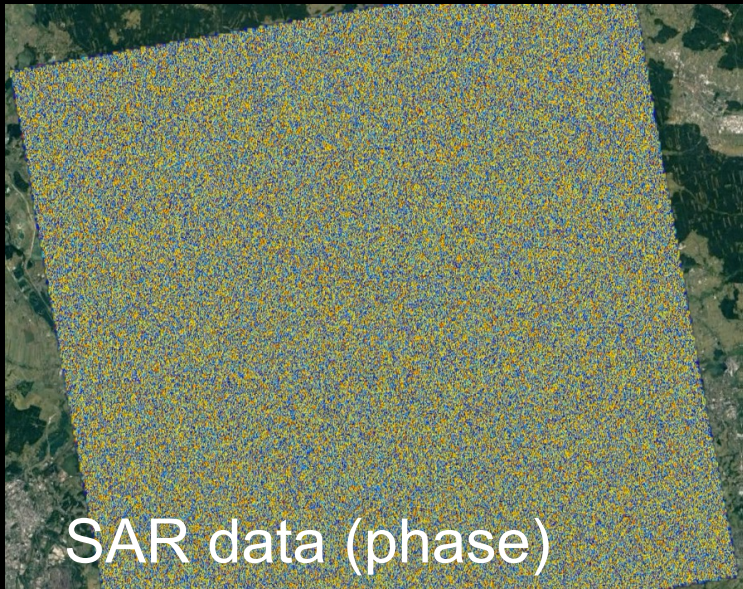


Image 1



Image 2...n



wavelength ~ 5 cm

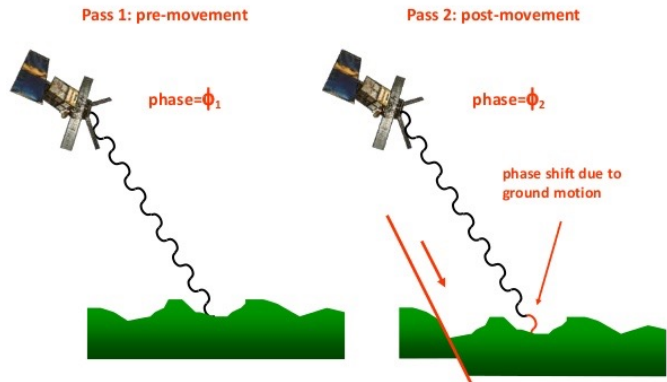


cm/mm distances can be measured through the phase

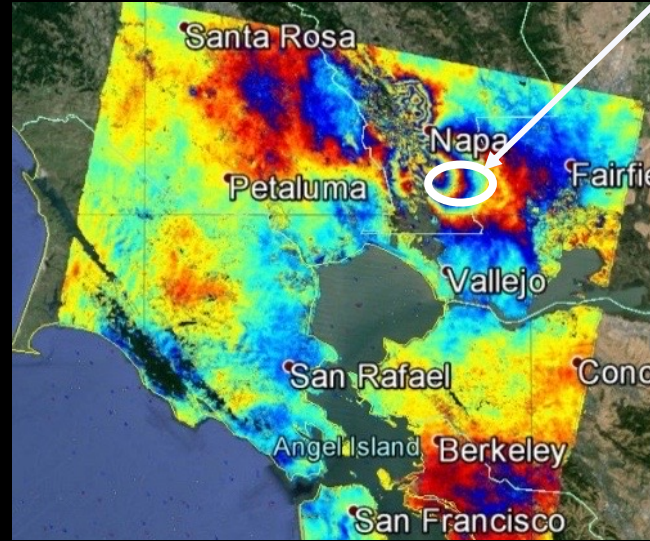
Satellite InSAR

Basic principles

InSAR: How it works



Credit: G. Funning



Displacement: 2.77
 cm (LOS)

Earthquakes

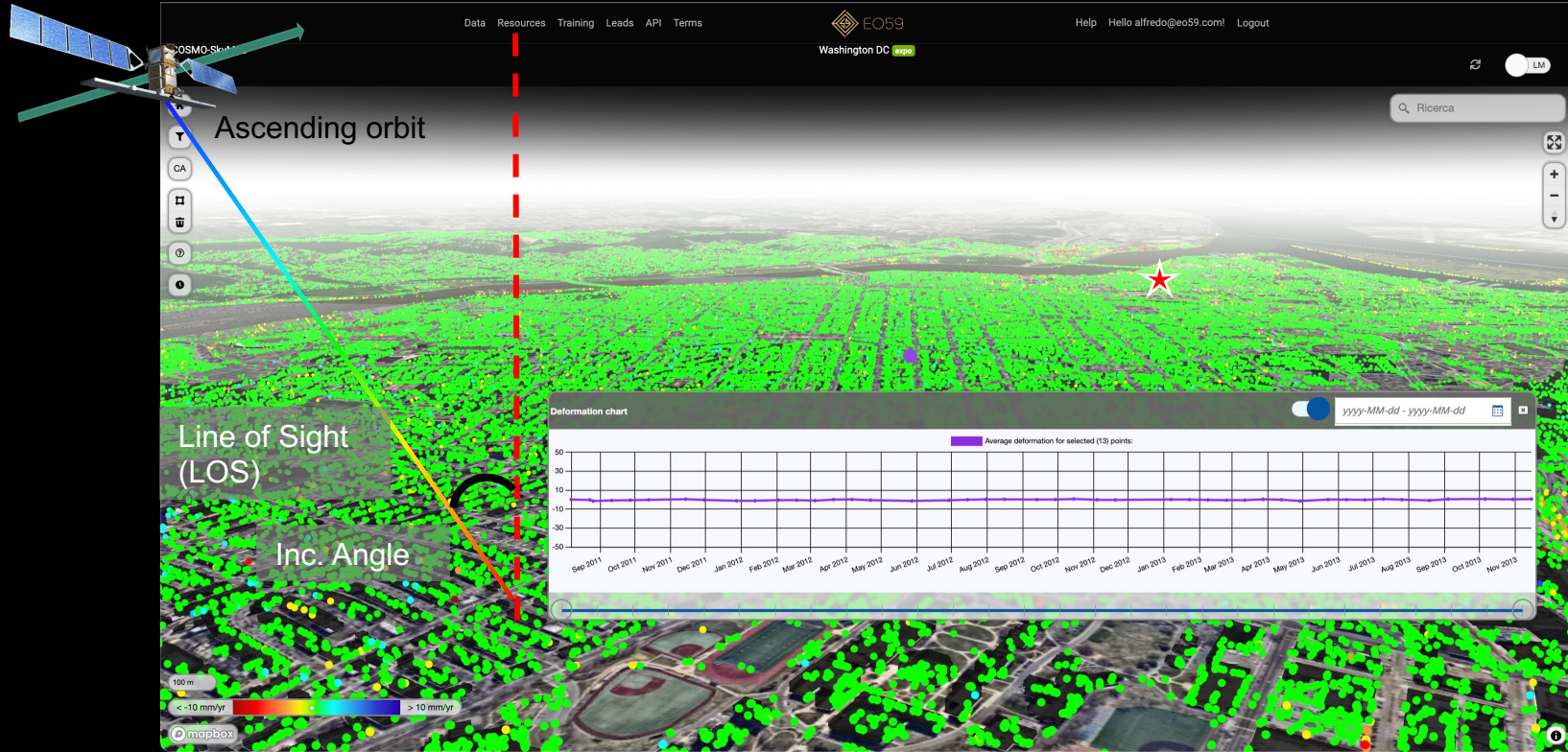
Co-seismic
 deformation

Event (24 Aug 2014)

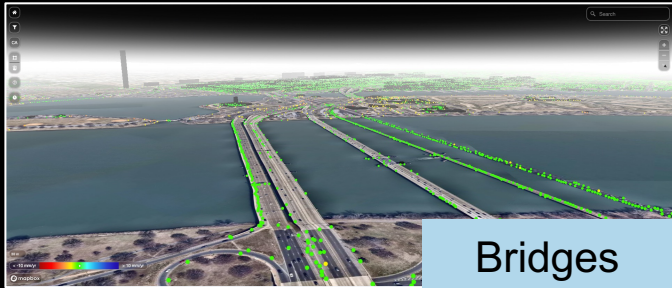


Satellite InSAR

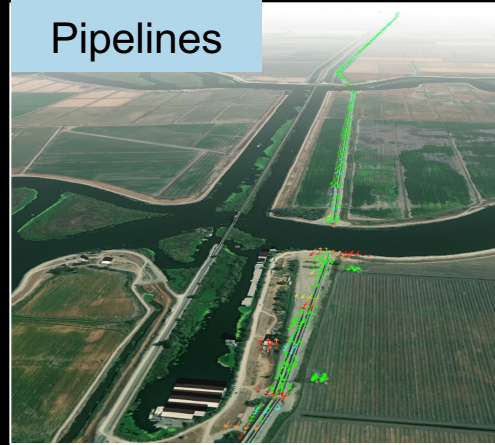
Basic principles...a step forward: A-DINSAR



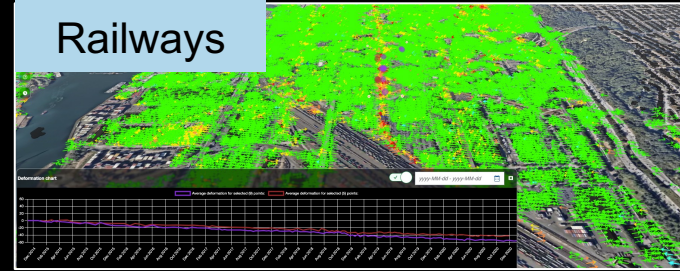
Applications



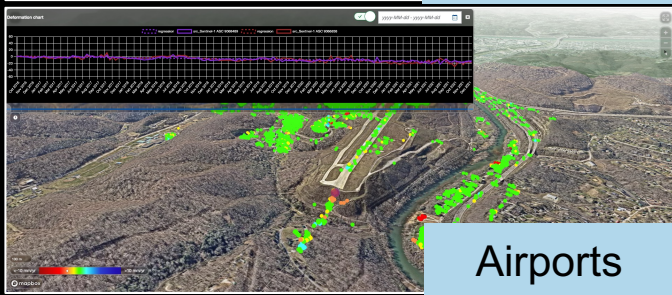
Bridges



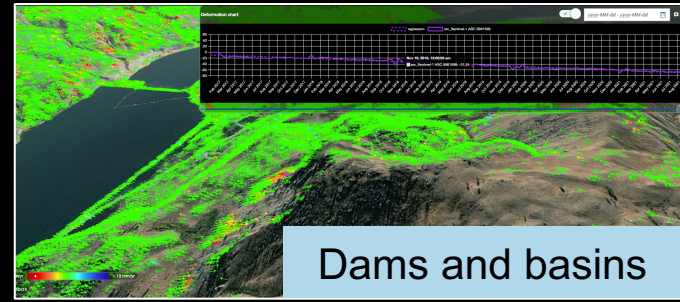
Pipelines



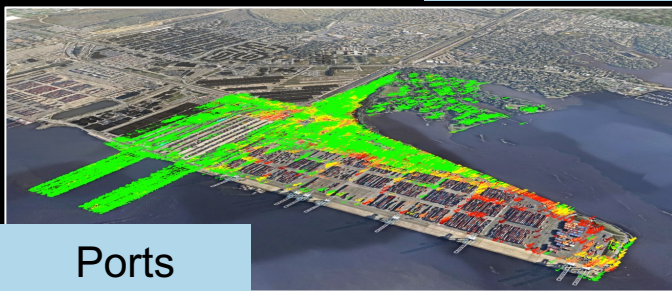
Railways



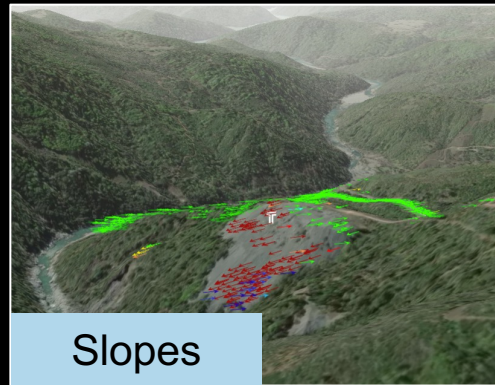
Airports



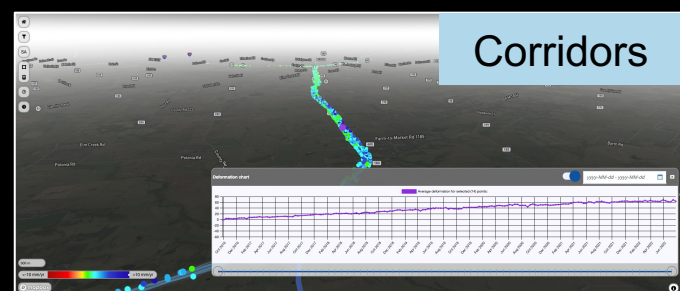
Dams and basins



Ports



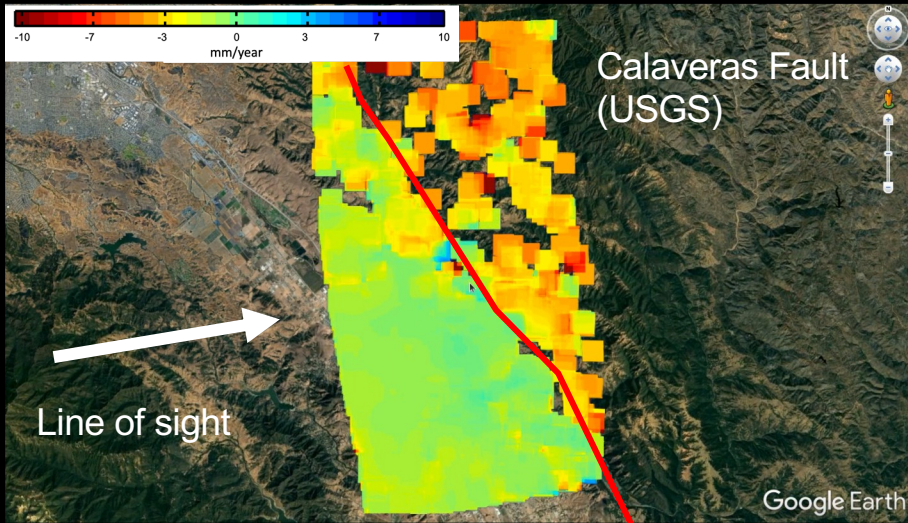
Slopes



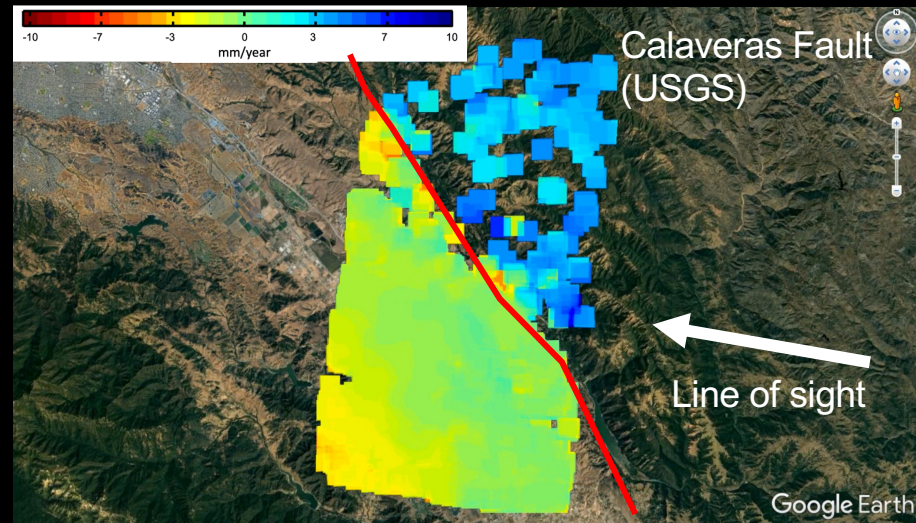
Corridors

Satellite InSAR

Geophysical information at regional scale



Ascending orbit



Descending orbit



EO59



Expanding the boundaries



Descending orbit



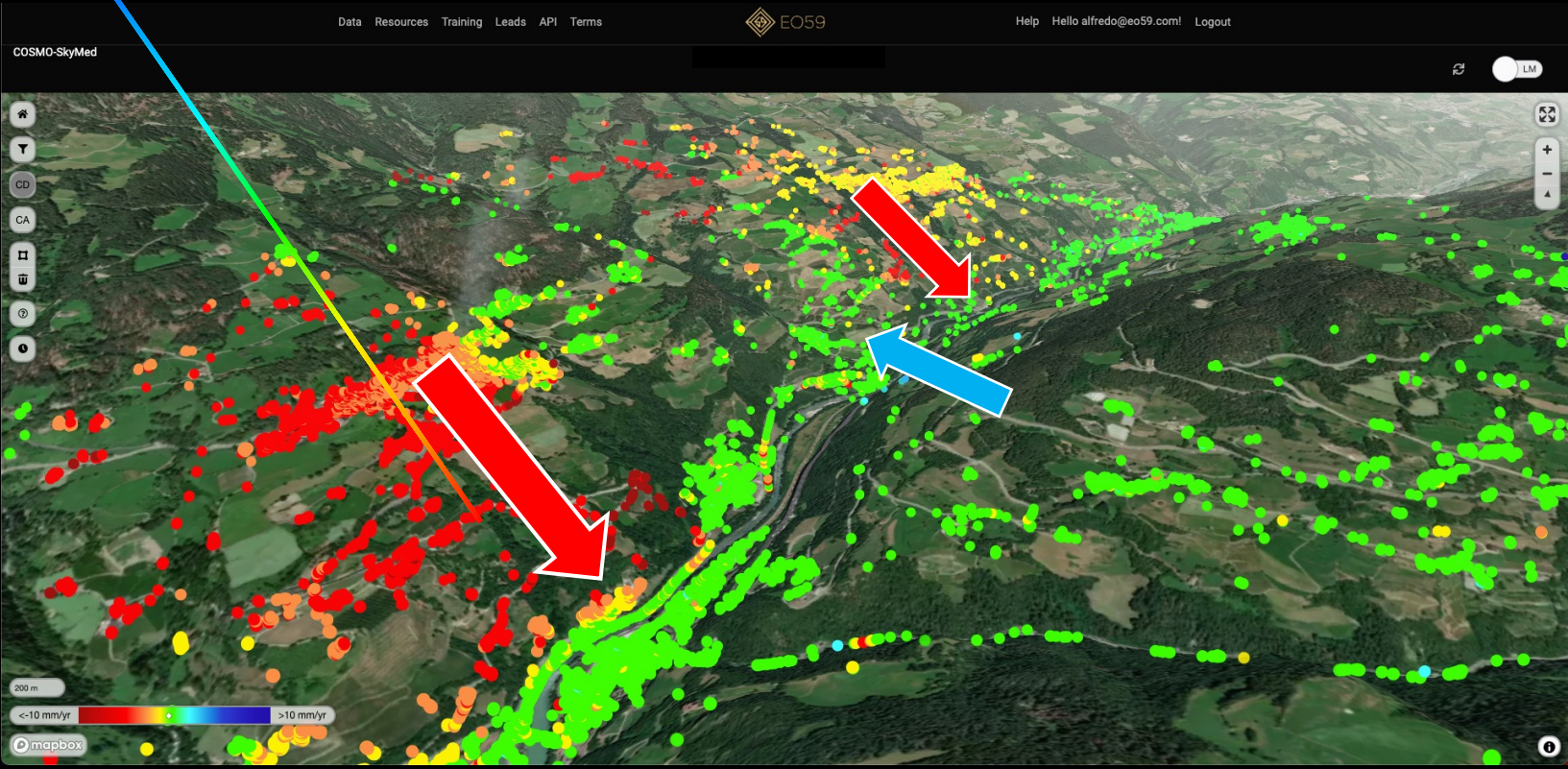
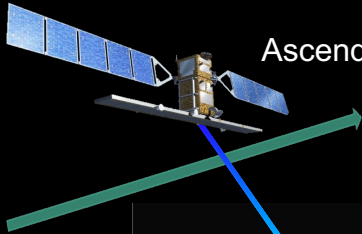
Ascending orbit



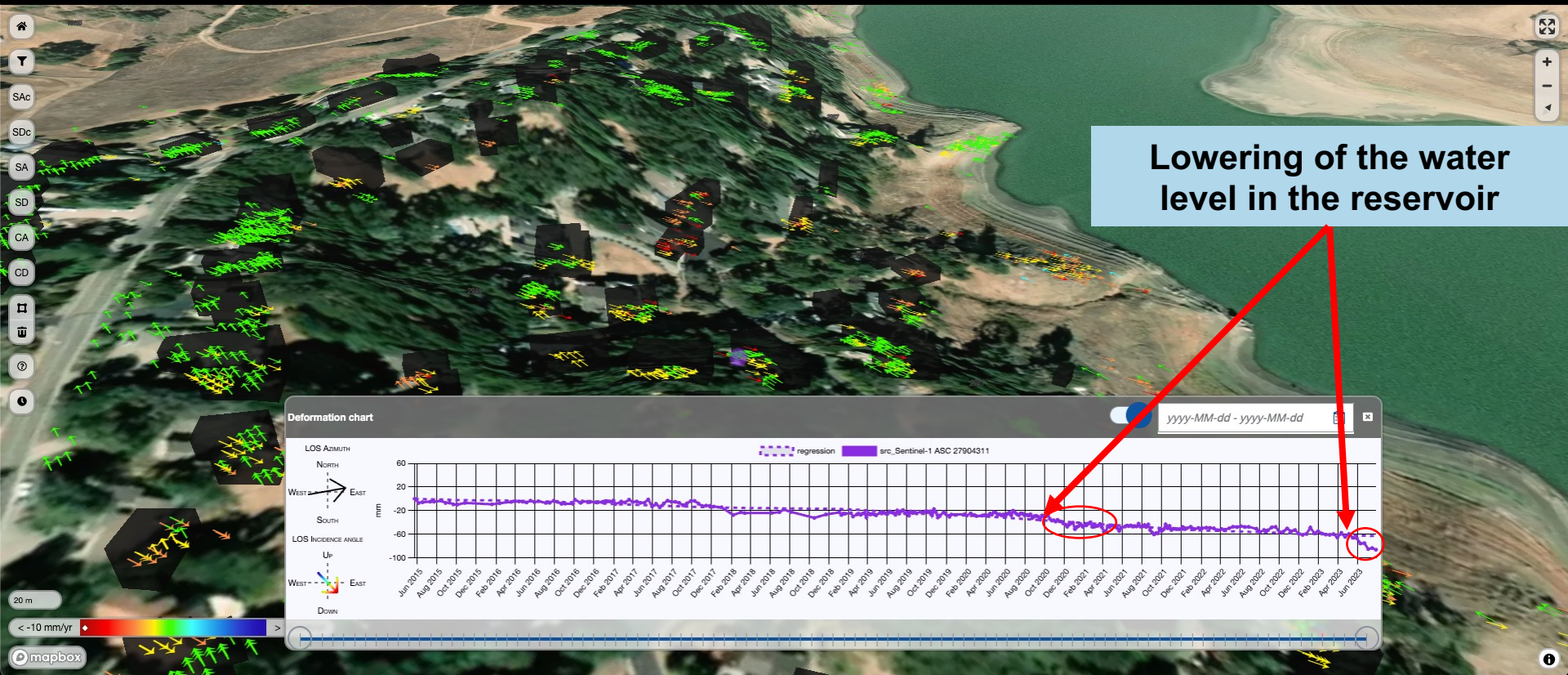
EO59



Expanding the boundaries

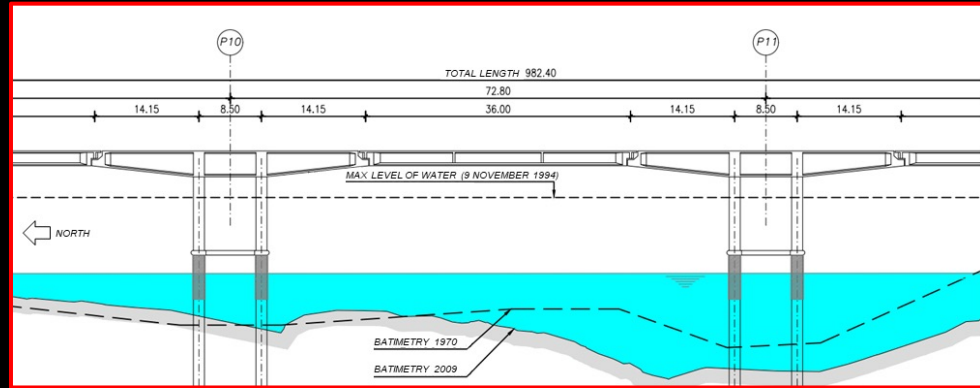
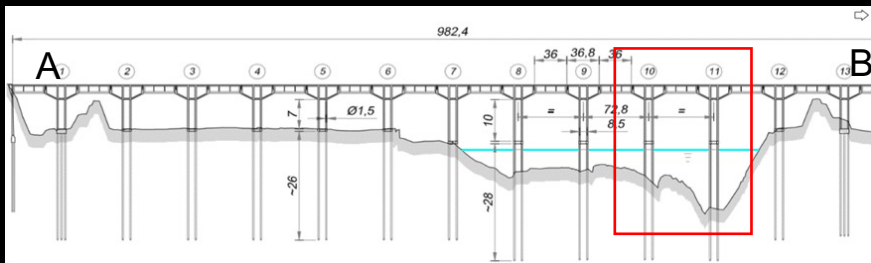


Landslide activation and water level of the reservoir



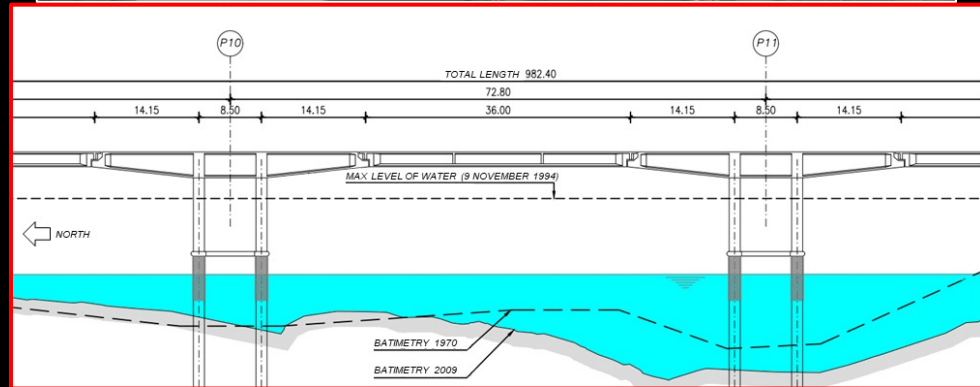
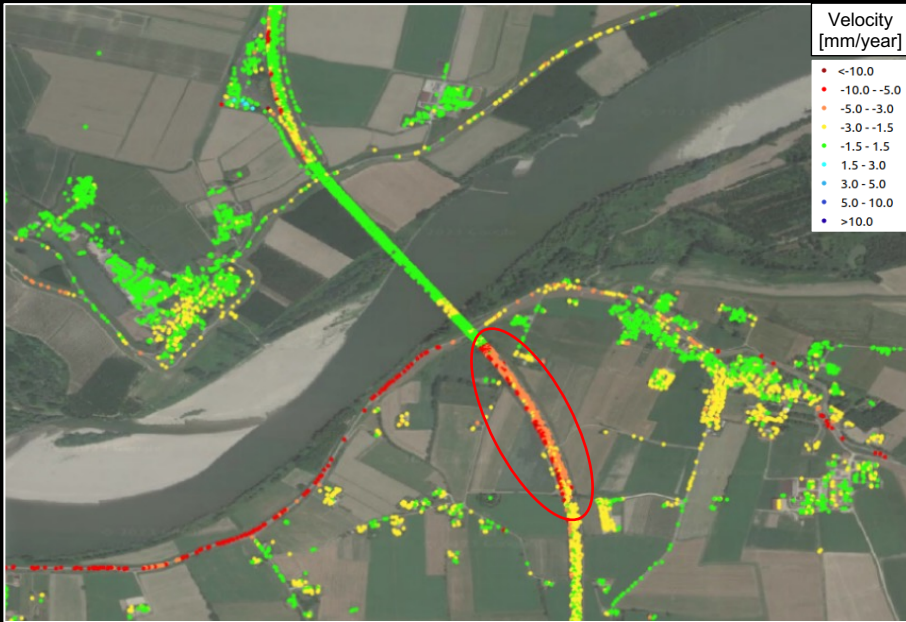


Bridge affected by geotechnical issues...





Bridge affected by geotechnical issues...

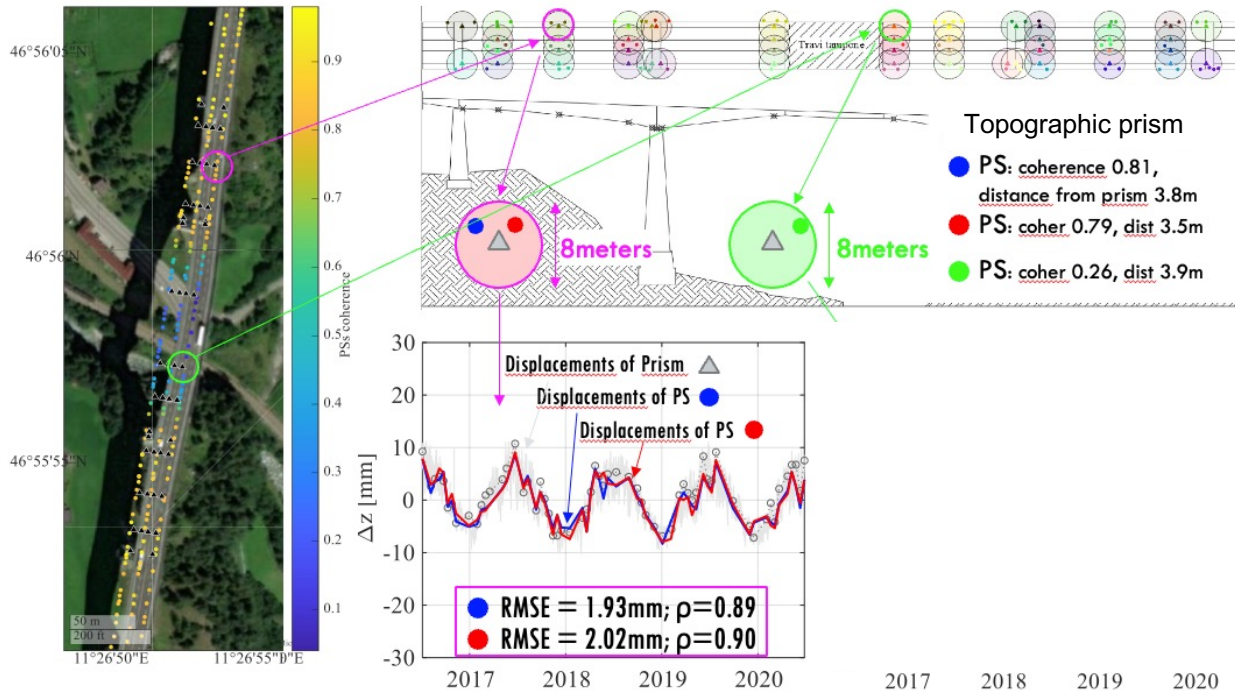


Comparison InSAR – total station

Objective: to study the uncertainties in bridge displacements measured with InSAR

Method: to compare displacement time series of PSs extracted with InSAR and of optical prisms measured with topographic monitoring. Distance between prism and PS < 4m

Result: RMSE=[1.9-6.2mm] depending on vertical displacement of bridge section, PS coherence, distance between the PS and prism compared



InSAR...a “new” technology?

Some early milestones...

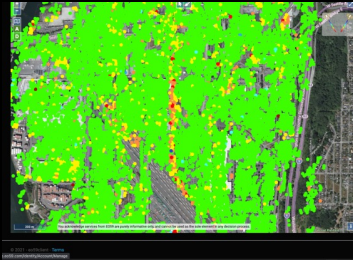
First SAR
satellites



InSAR



MT-InSAR



Hi resolution satellites



Sentinel-1



1991

1992

2000

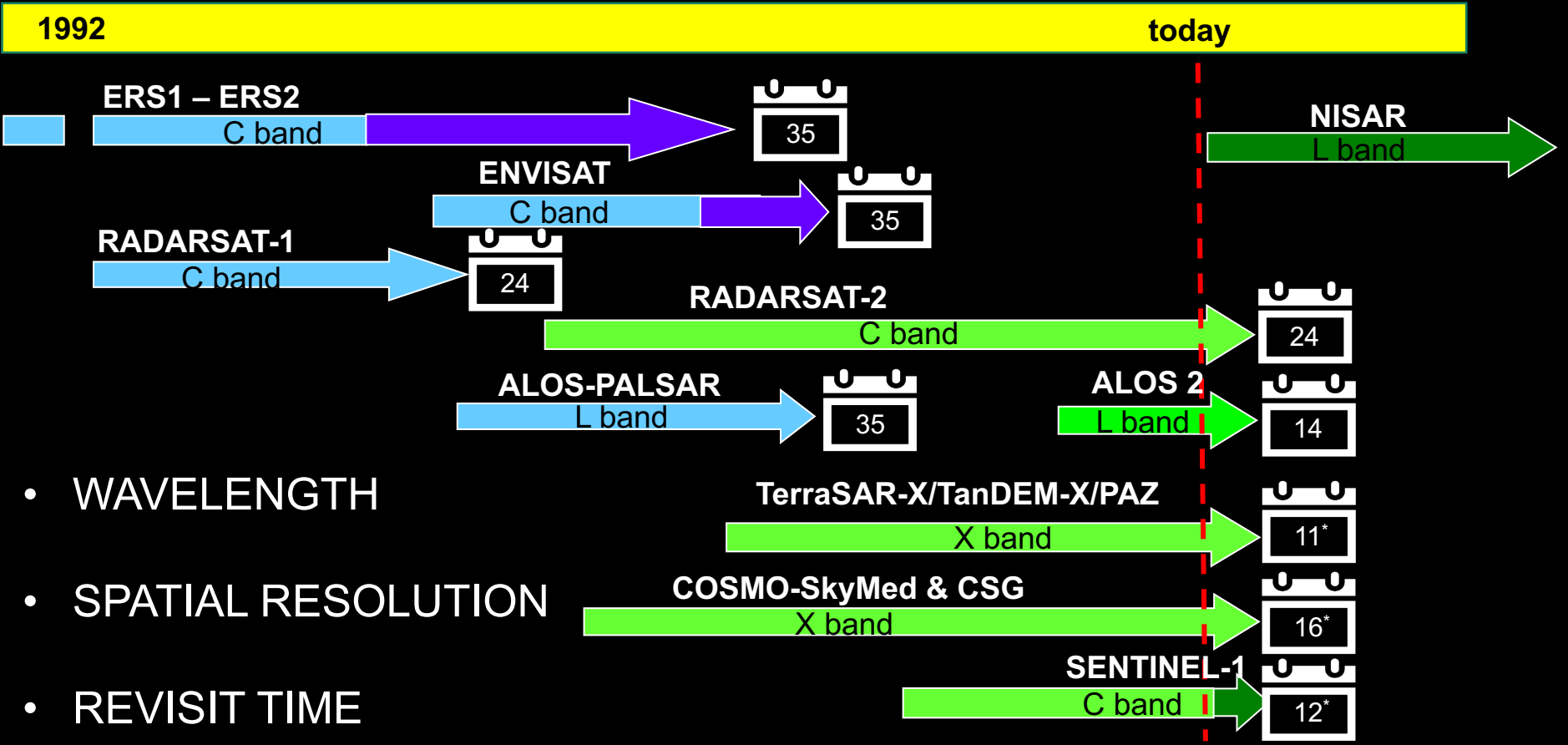
2007

2014

...

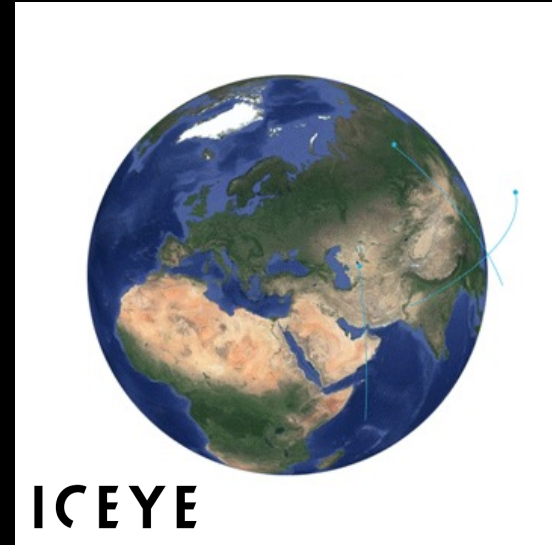
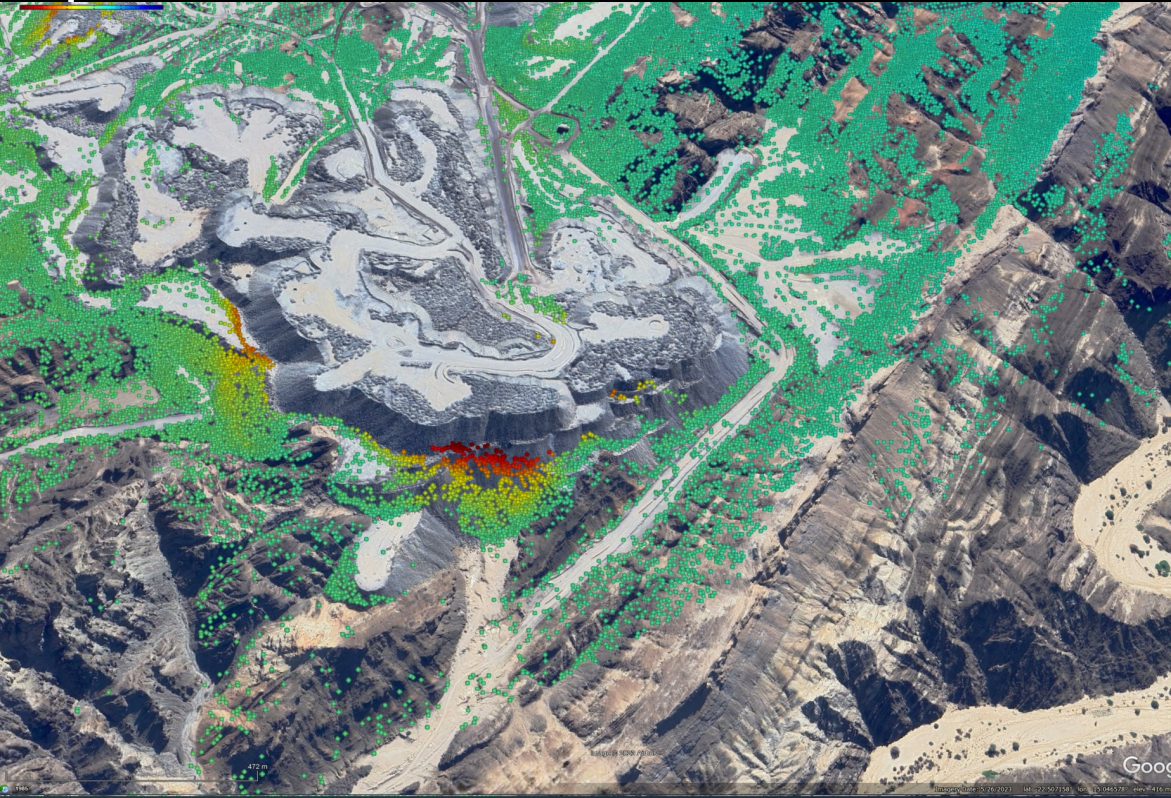


Primary civilian SAR Satellites



InSAR...a “new” technology?

...present and future

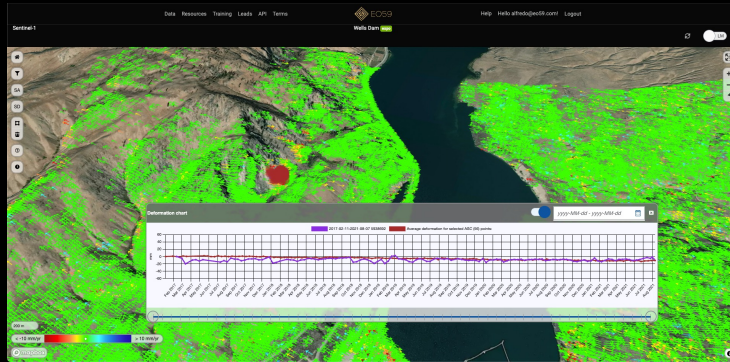


Rosing Uranium mine (Africa)

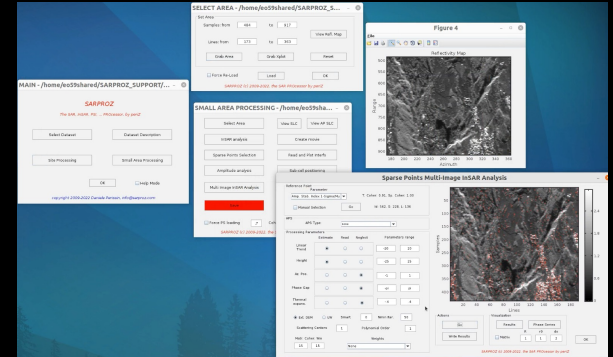
How you can have access to the “data”



Interpretation of the InSAR data



InSAR results through web-portal



Software (and training)

Conclusions

- InSAR as a bridge between past and future.
- InSAR is opportunistic, no need to install sensors, it can't be effective everywhere.
- InSAR allow us to achieve information about large areas and local details.
- InSAR is a mature technology you can use today, together with your usual monitoring techniques (surface information).



Thank you!

luciano@eo59.com

eo59.com

Virginia Beach, VA, USA
Rapla, Estonia, EU