



Space Expertise for Infrastructure monitoring



Telespazio

A Finmeccanica/Thales Company



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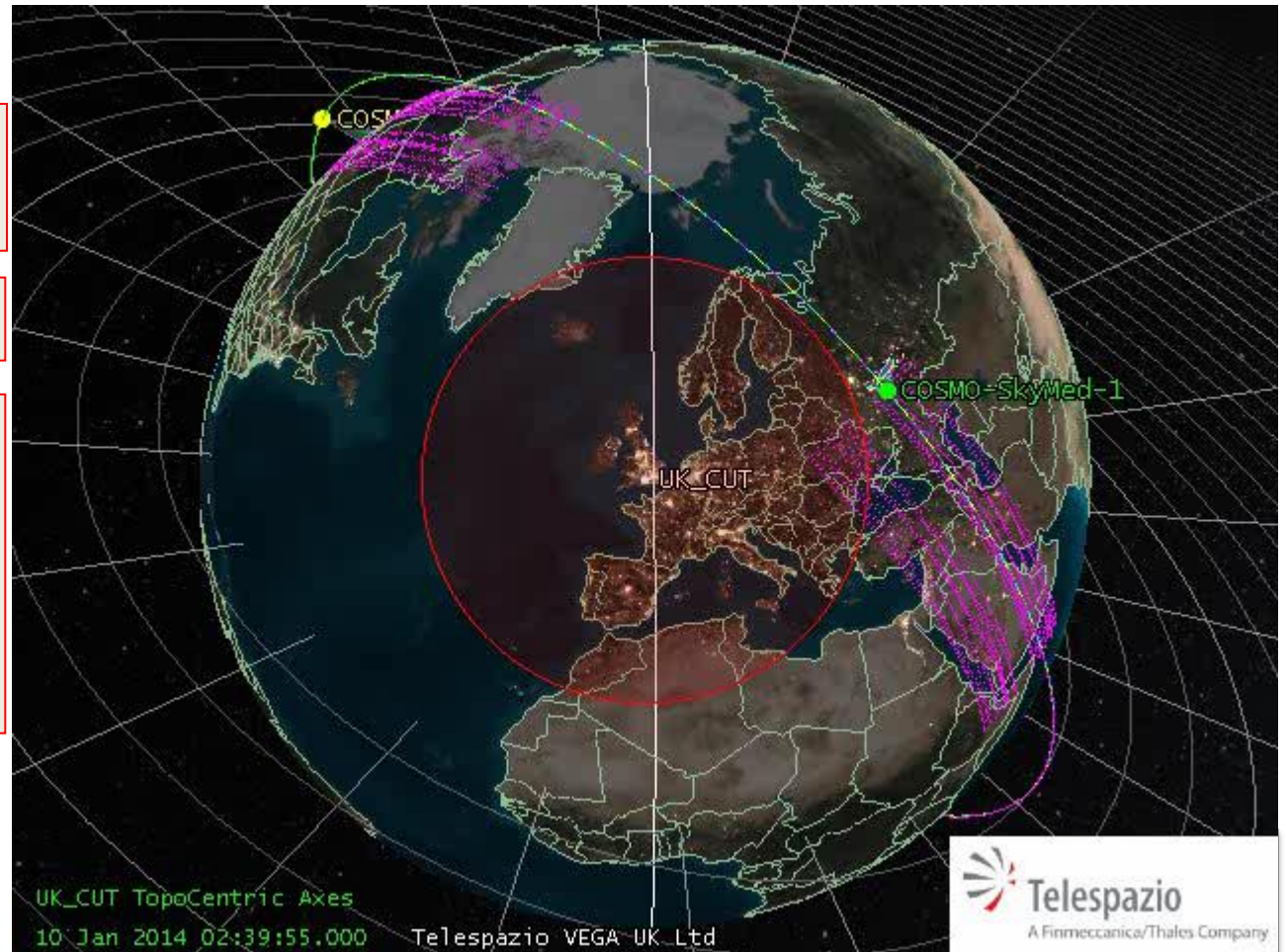
Conclusion

Radar satellites: Basic principles

Active satellites
Emit a radar signal

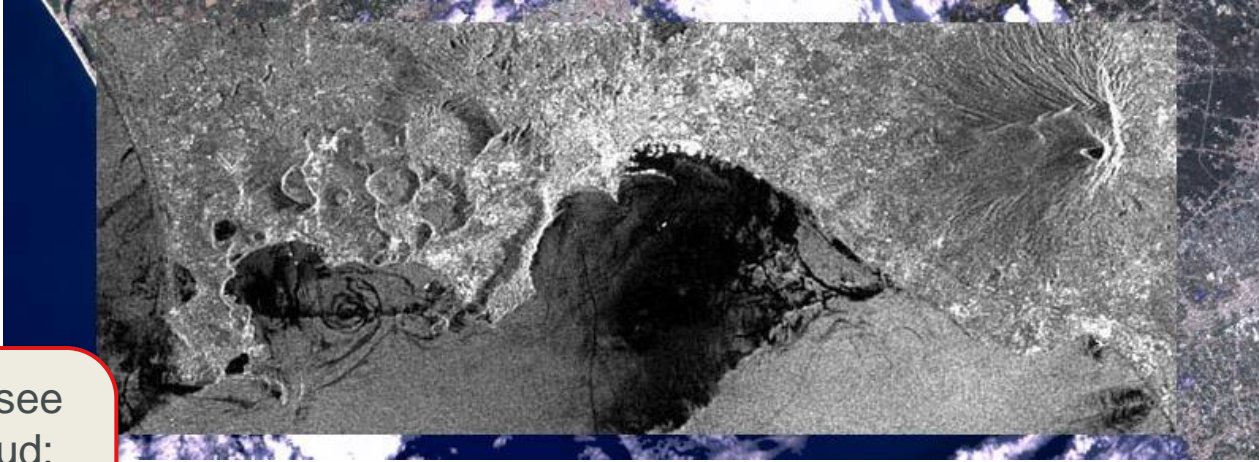
Polar orbit

Images with
resolution up to 1m
and frequency up to
4 days -
CosmoSkyMed



Radar Satellites: Basic principles

Provide guaranteed image acquisition in all weather and lighting conditions



Radar can see through cloud:
Vital in the UK,
Northern Europe
and the Tropics



Radar can see
at night:
Twice the clear
sky imaging
opportunity

BIG

Differential SAR interferometry: basic principles

Differential SAR interferometry is a powerful technique to measure from satellite slow surface deformations due to subsidence, landslides, seismic and volcanic phenomena



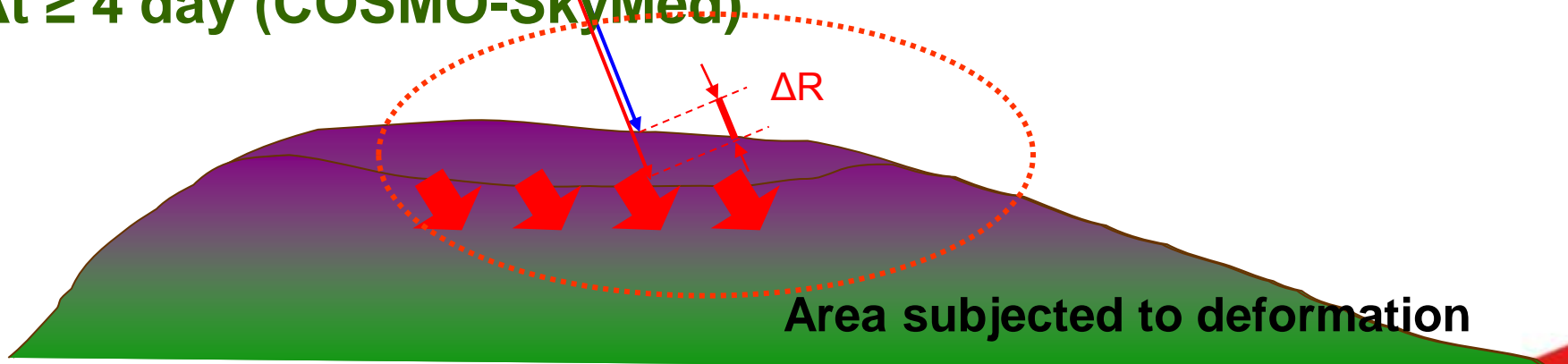
1st acquisition R_1
2nd acquisition

R_2

The phase difference between the two acquisitions provides a measurement of the terrain displacement **along line of sight**

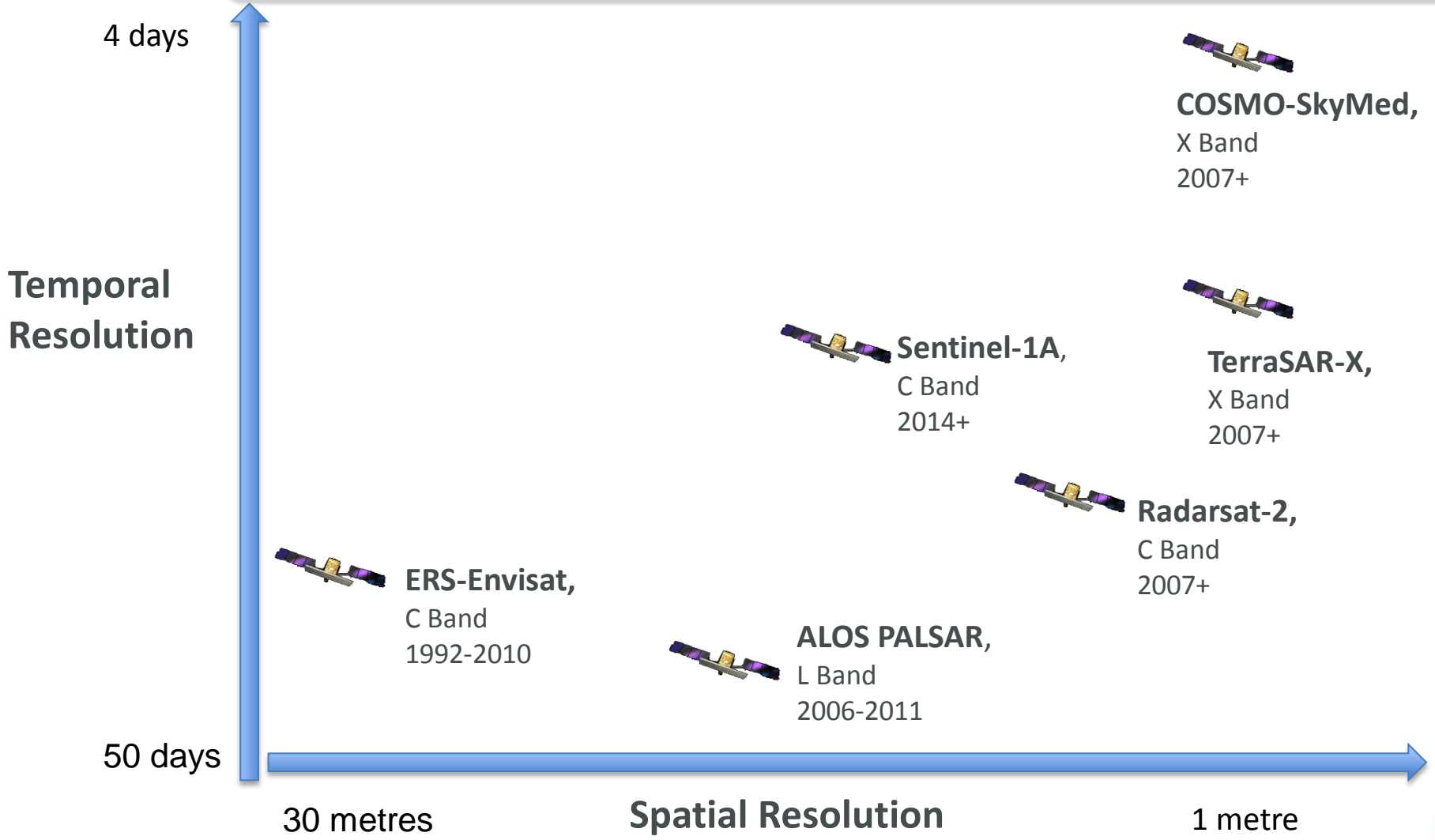
$\Delta t \geq 35$ day (ERS/ENVISAT)

$\Delta t \geq 4$ day (COSMO-SkyMed)



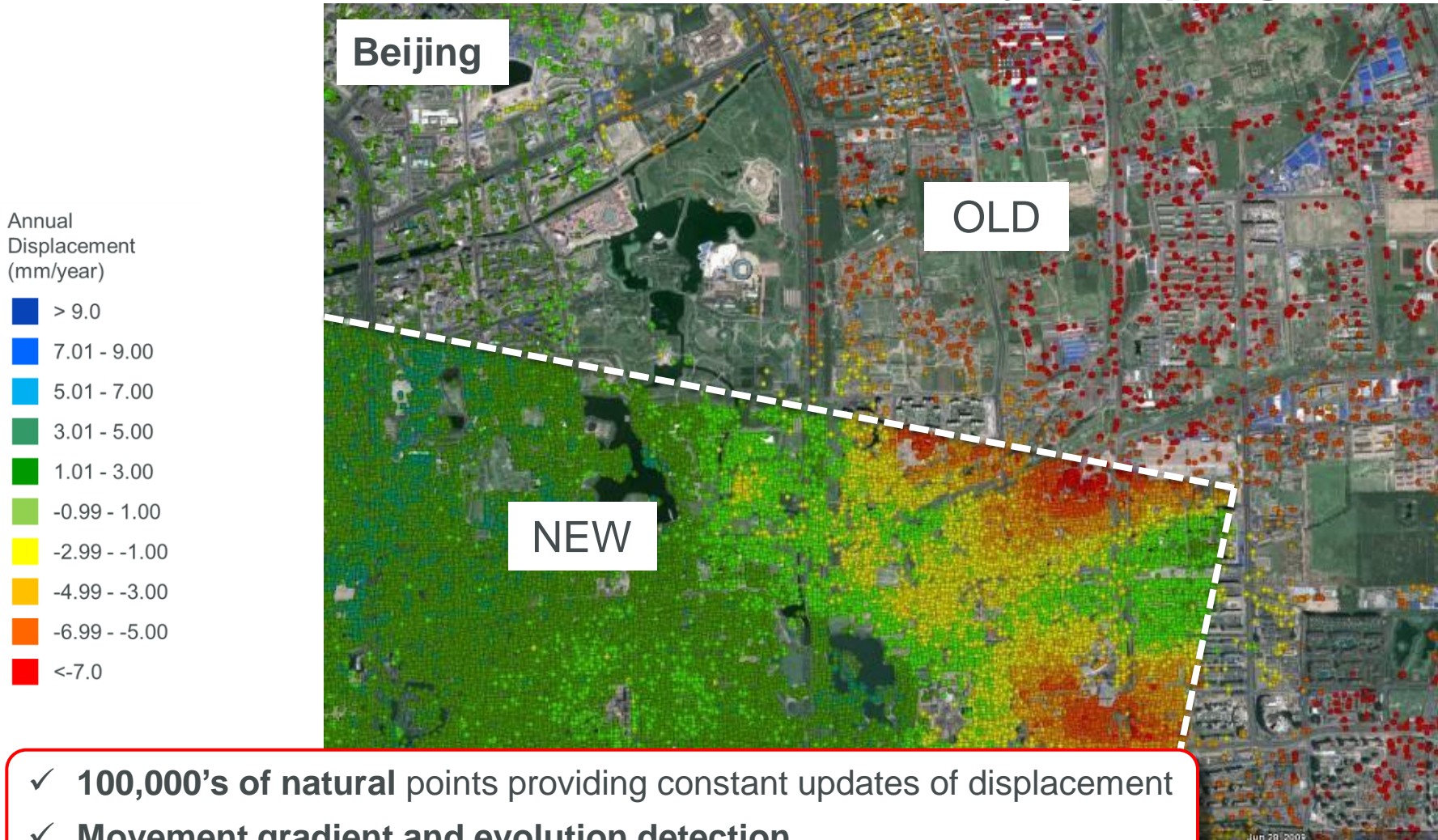
Radar satellite history

“Improvements to Radar Systems and large image data archives”



BIG DATA The Art of the Possible, CSIC, Cambridge 2015

Improvements of radar systems InSAR interferometry becomes Solid Surveying Mapping Service

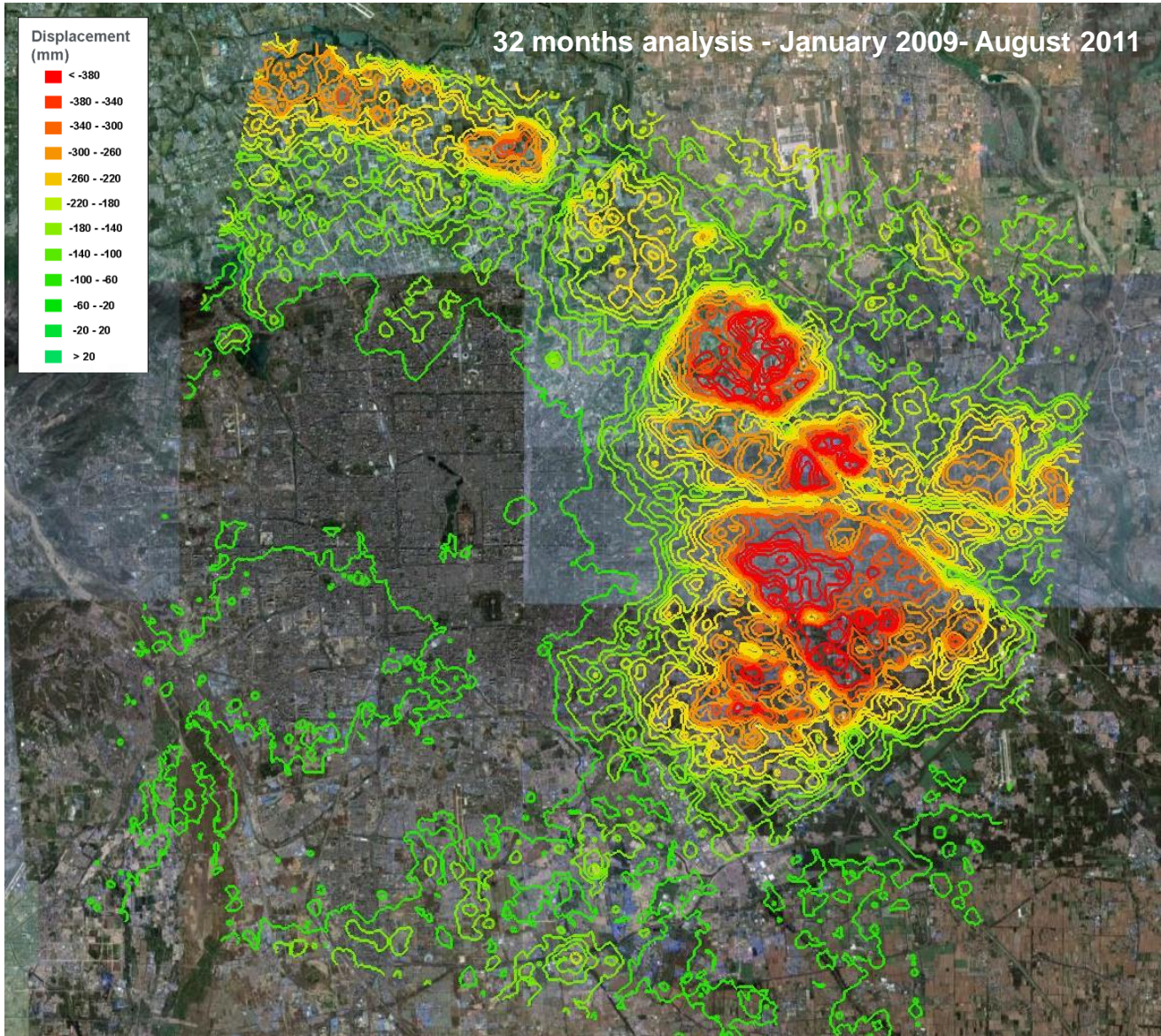


- ✓ **100,000's of natural points** providing constant updates of displacement
- ✓ **Movement gradient and evolution detection**

Improvements of radar systems



**InSAR interferometry becomes
Solid Surveying Mapping Service**



The Civil Engineering Sector

✓ **Satellite ground motion measurements: InSAR**



Solid Surveying Tool



✓ **Linear Infrastructures:** railways and highways, embankments, tunnels & bridges



✓ **Ports:** commercial and recreational



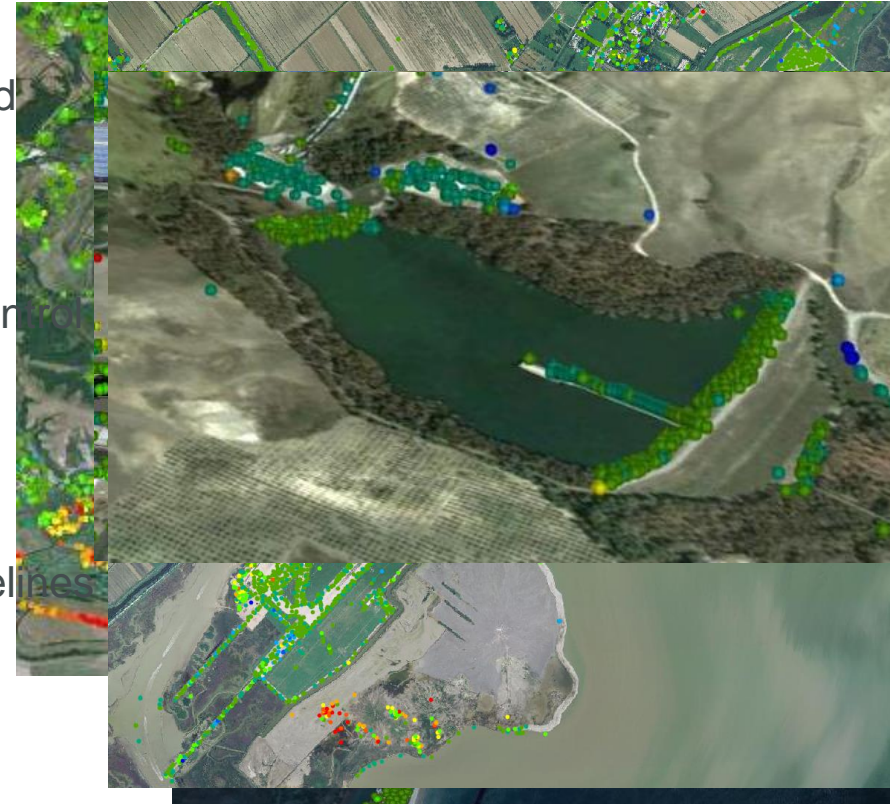
✓ **Airports:** runways, control tower and facilities



✓ **Water Management:** dams, canals and pipelines



✓ **Cities:** buildings



BIG DATA TI

ambridge 2015

Infrastructure Lifecycle

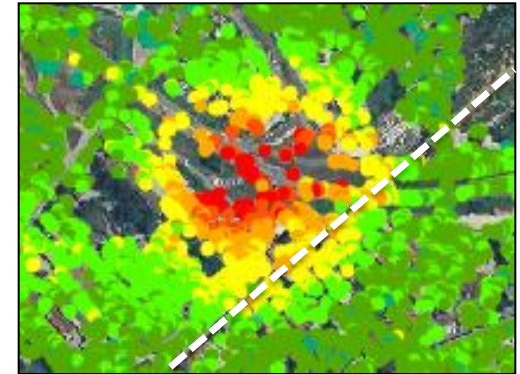
✓ *Planning & Design Phase:*

- Detection of areas of prior movement to clarify liabilities in case of construction induced movement
- Risk planning management: identification of sensitive areas



✓ *Construction Phase:*

- Measuring beyond the reach of in-situ instrumentation along track
- Complementary and independent measurements



✓ *Operations & Maintenance:*

- Long term monitoring after in-situ instrumentation has been removed
- Planning of surveying campaigns for maintenance



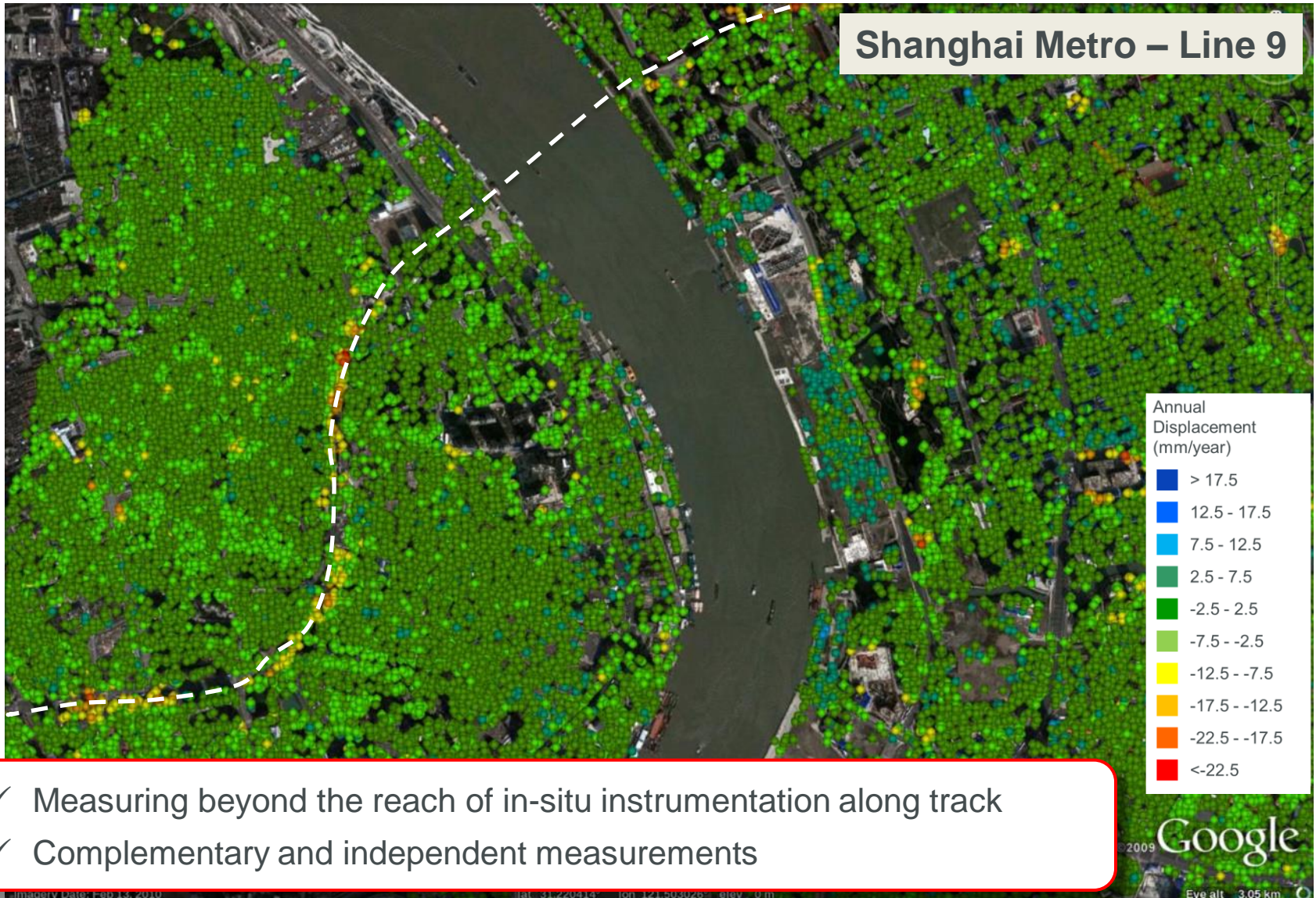
Highway

Ground motion results CosmoSkyMed



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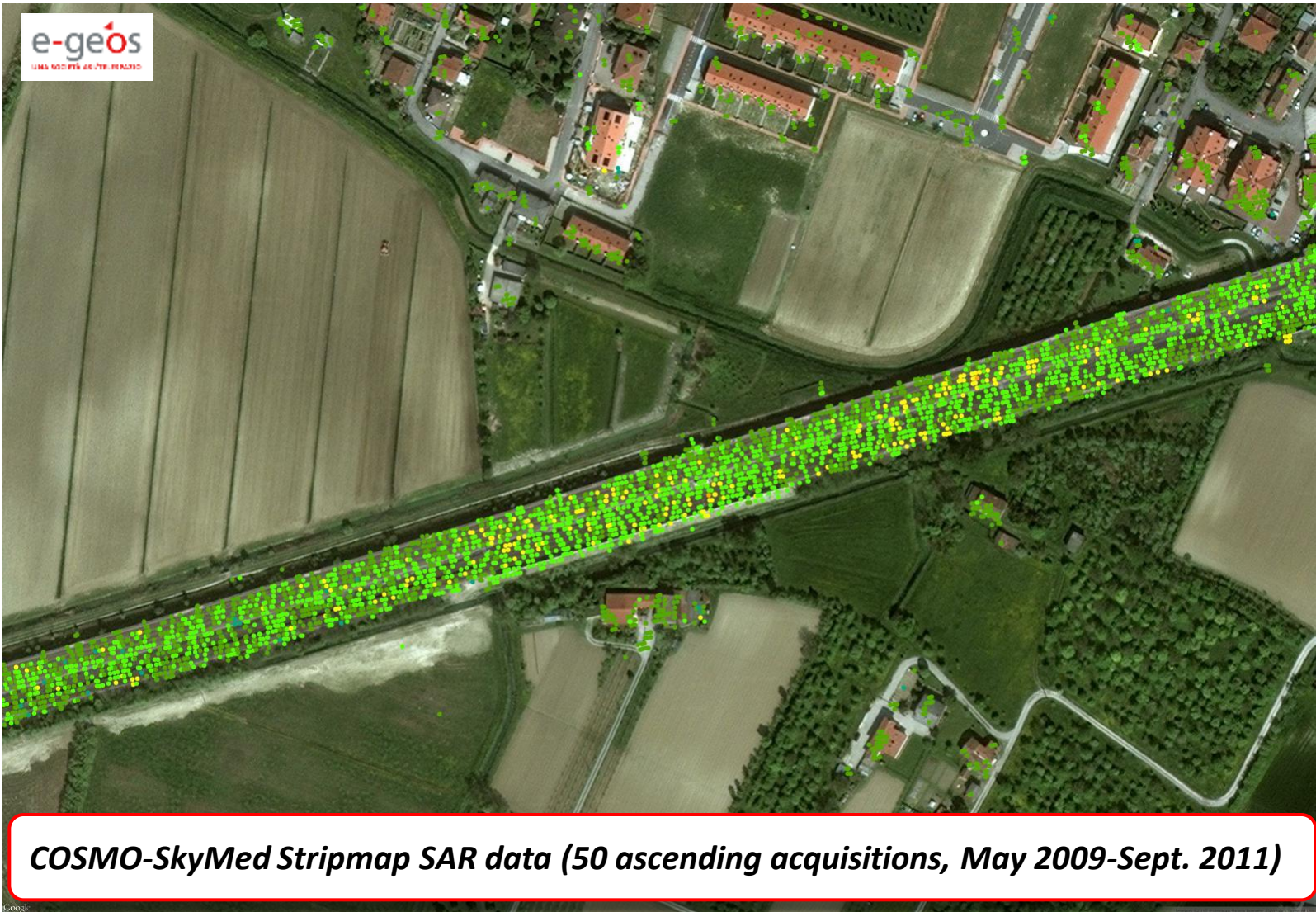
Tunnel Construction Phase



- ✓ Measuring beyond the reach of in-situ instrumentation along track
- ✓ Complementary and independent measurements



Motorway, Maintenance Phase

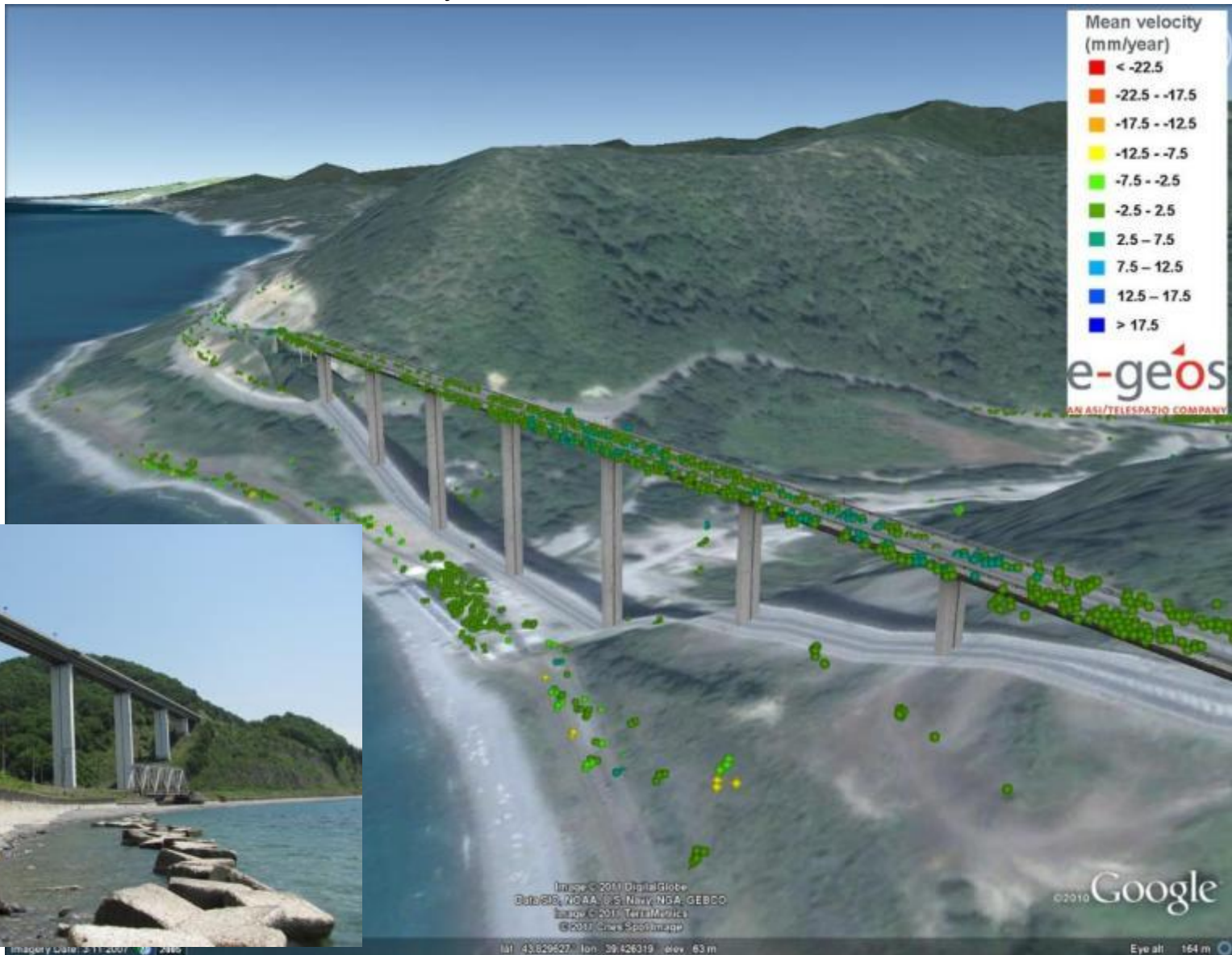


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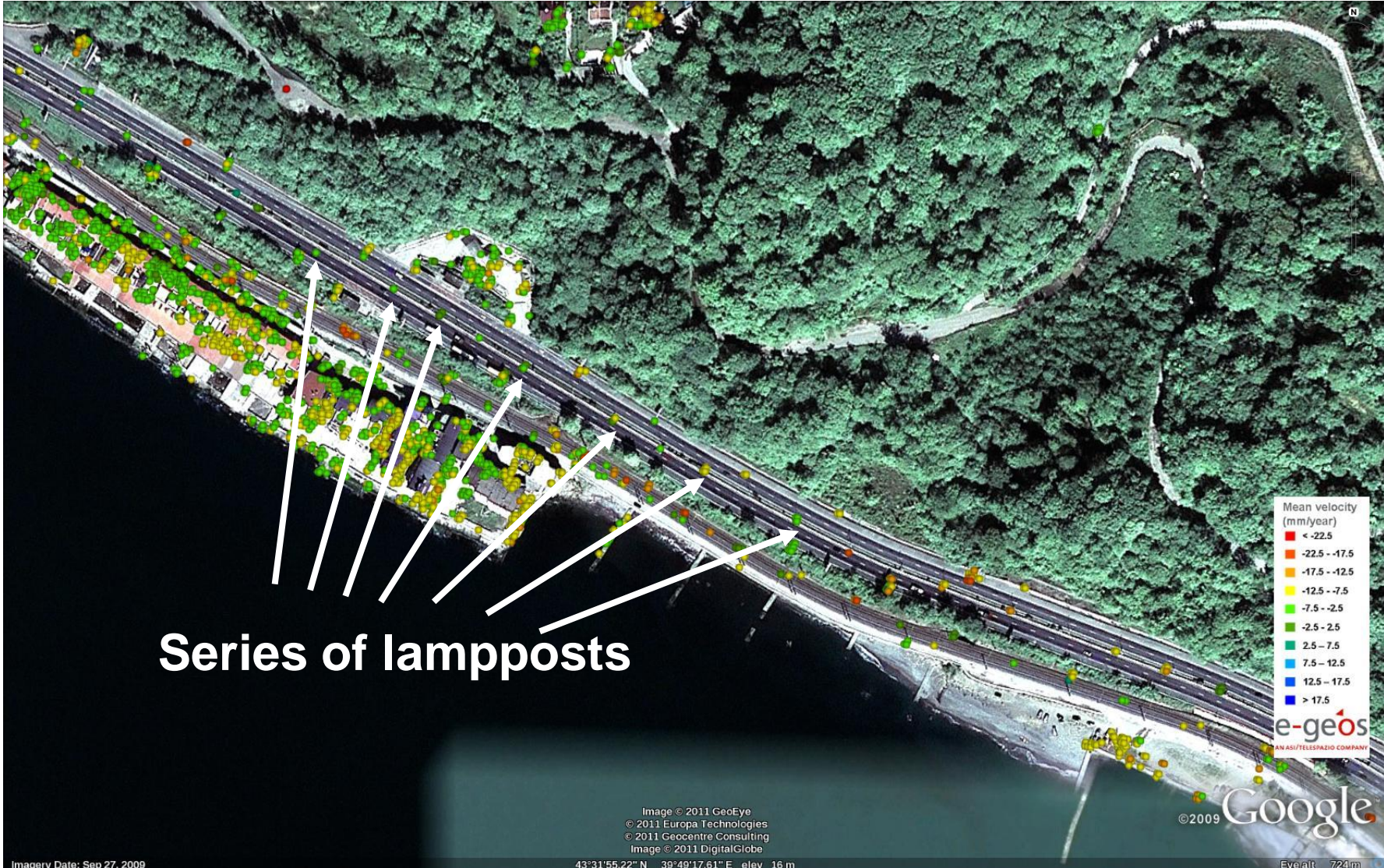
BRIDGES Maintenance phase

COSMO-SkyMed StripMap

February 2009- December 2010



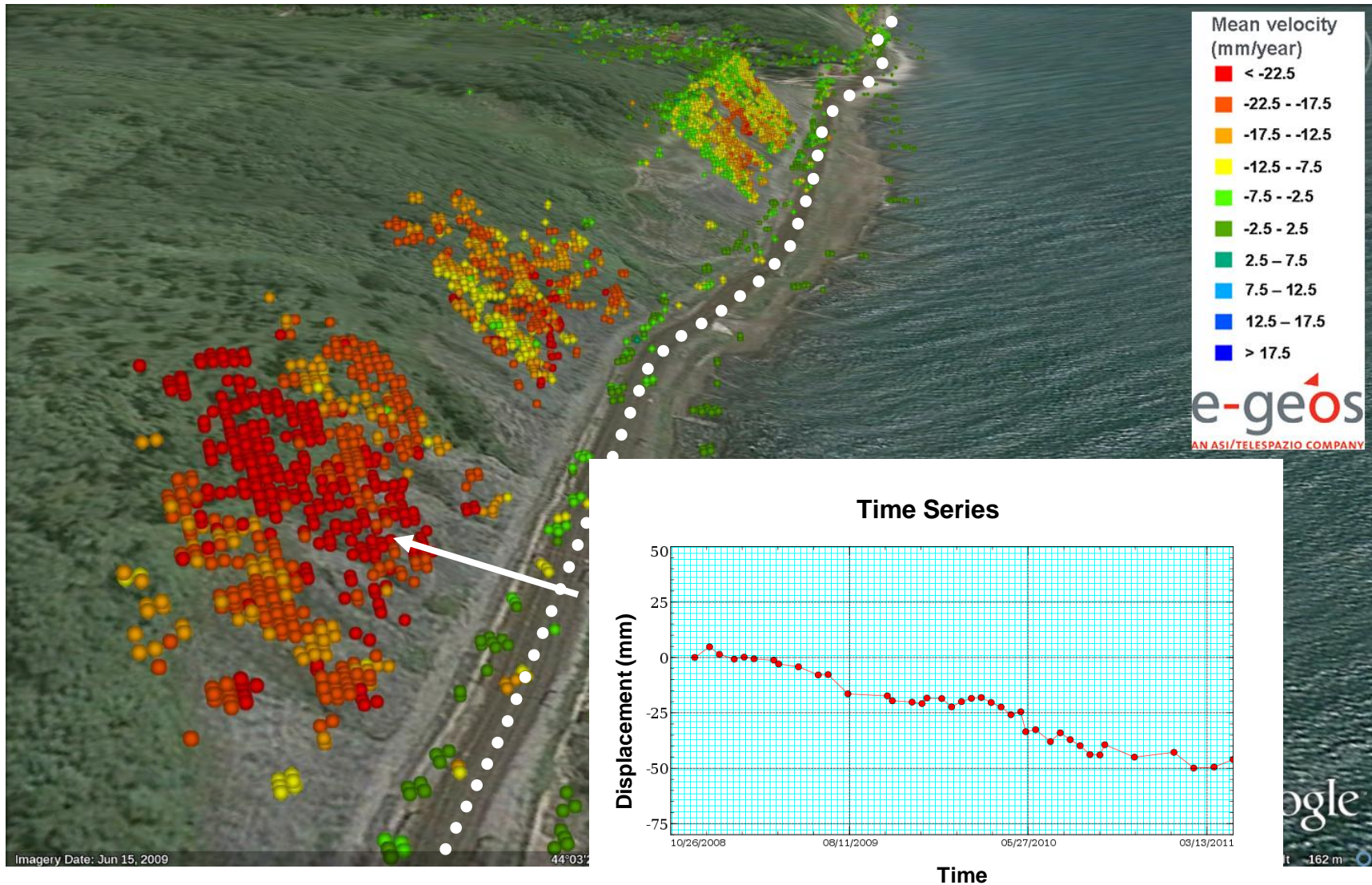
ROADS Maintenance phase



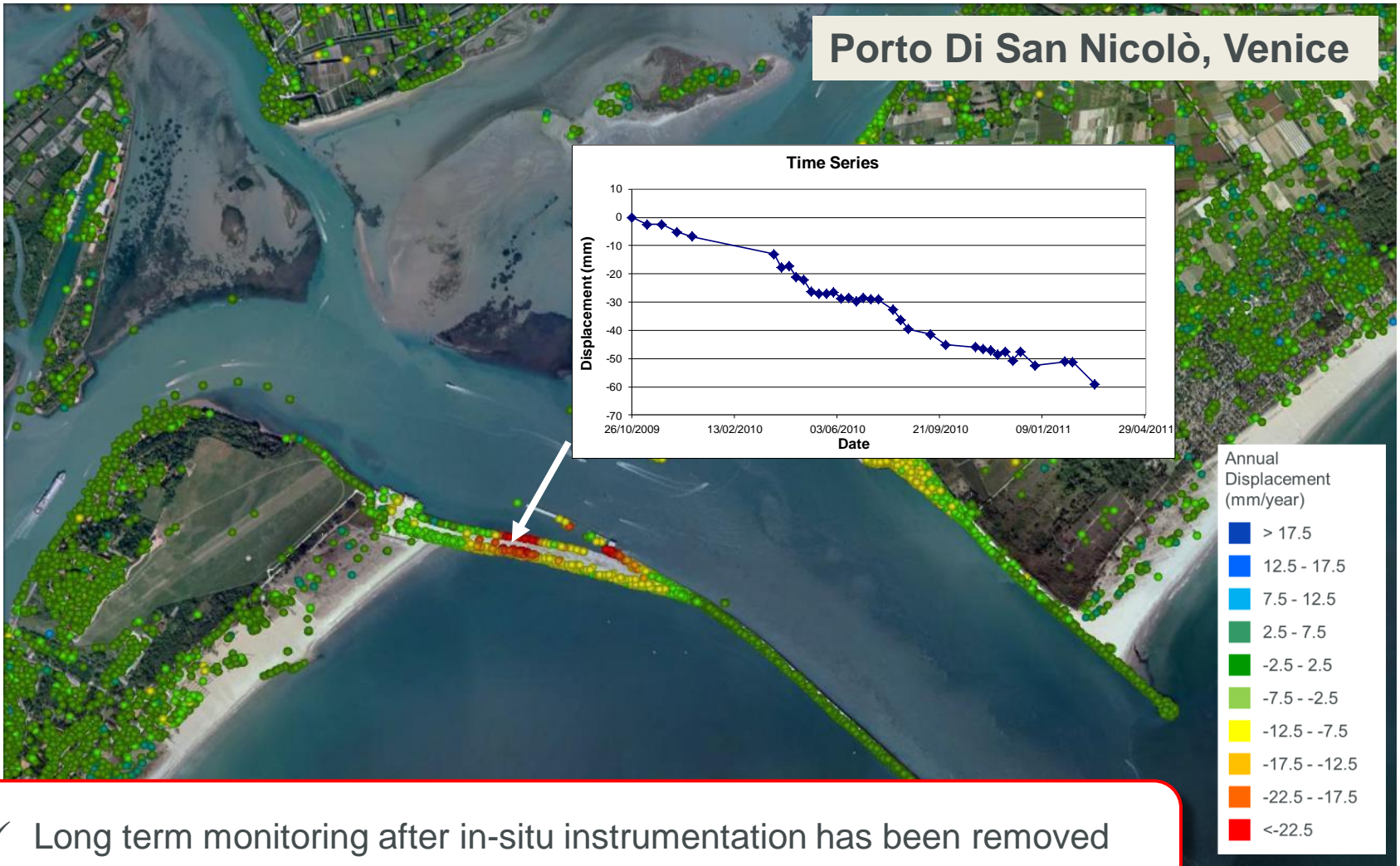
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RAILWAYS Maintenance phase

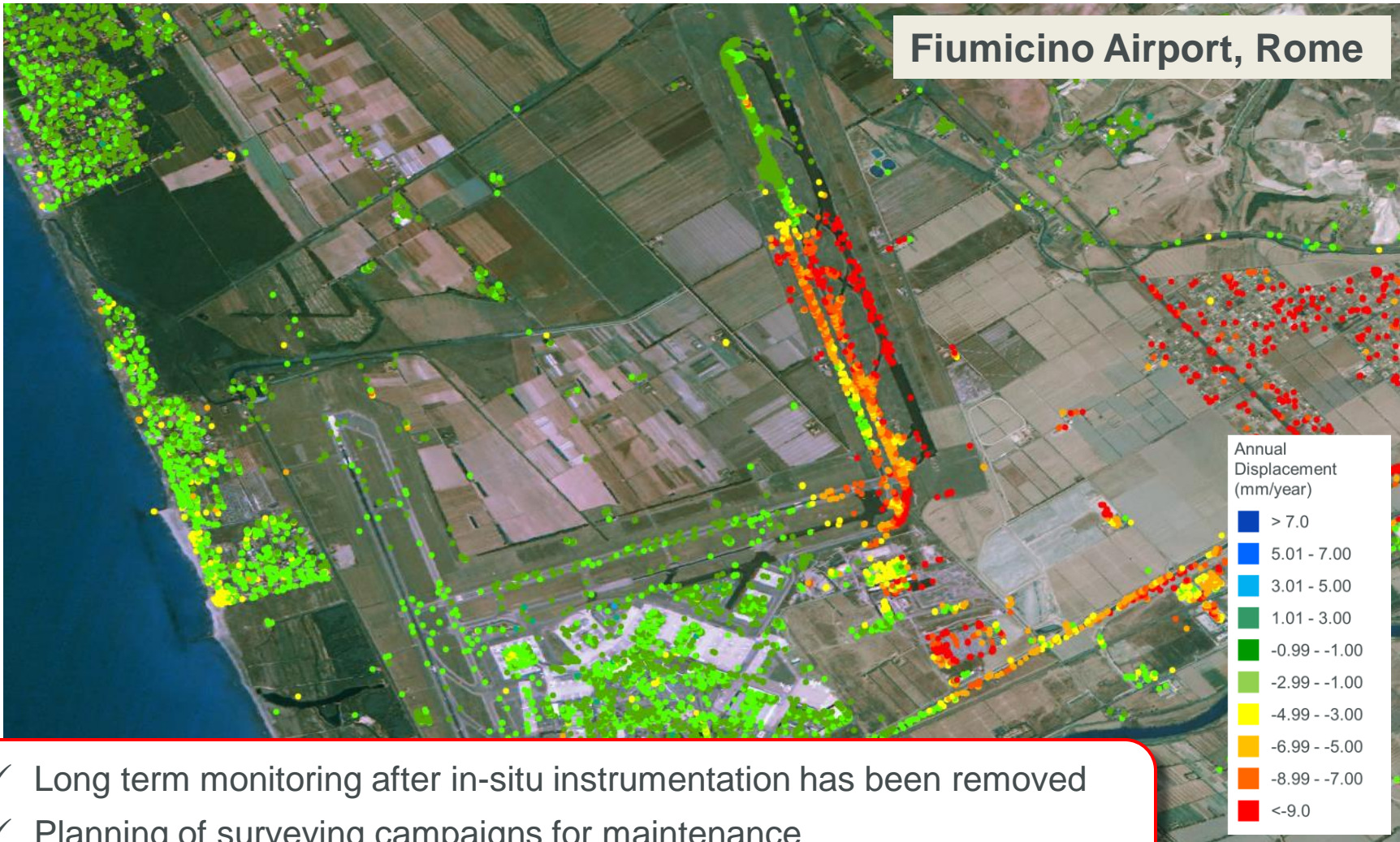
COSMO-Skymed PSP-IFSAR Analysis 2008-2011



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- ✓ Long term monitoring after in-situ instrumentation has been removed
- ✓ **Frequent updates** with one image every 4 days



- ✓ Long term monitoring after in-situ instrumentation has been removed
- ✓ Planning of surveying campaigns for maintenance
- ✓ **Fast surveys** of proposed development areas

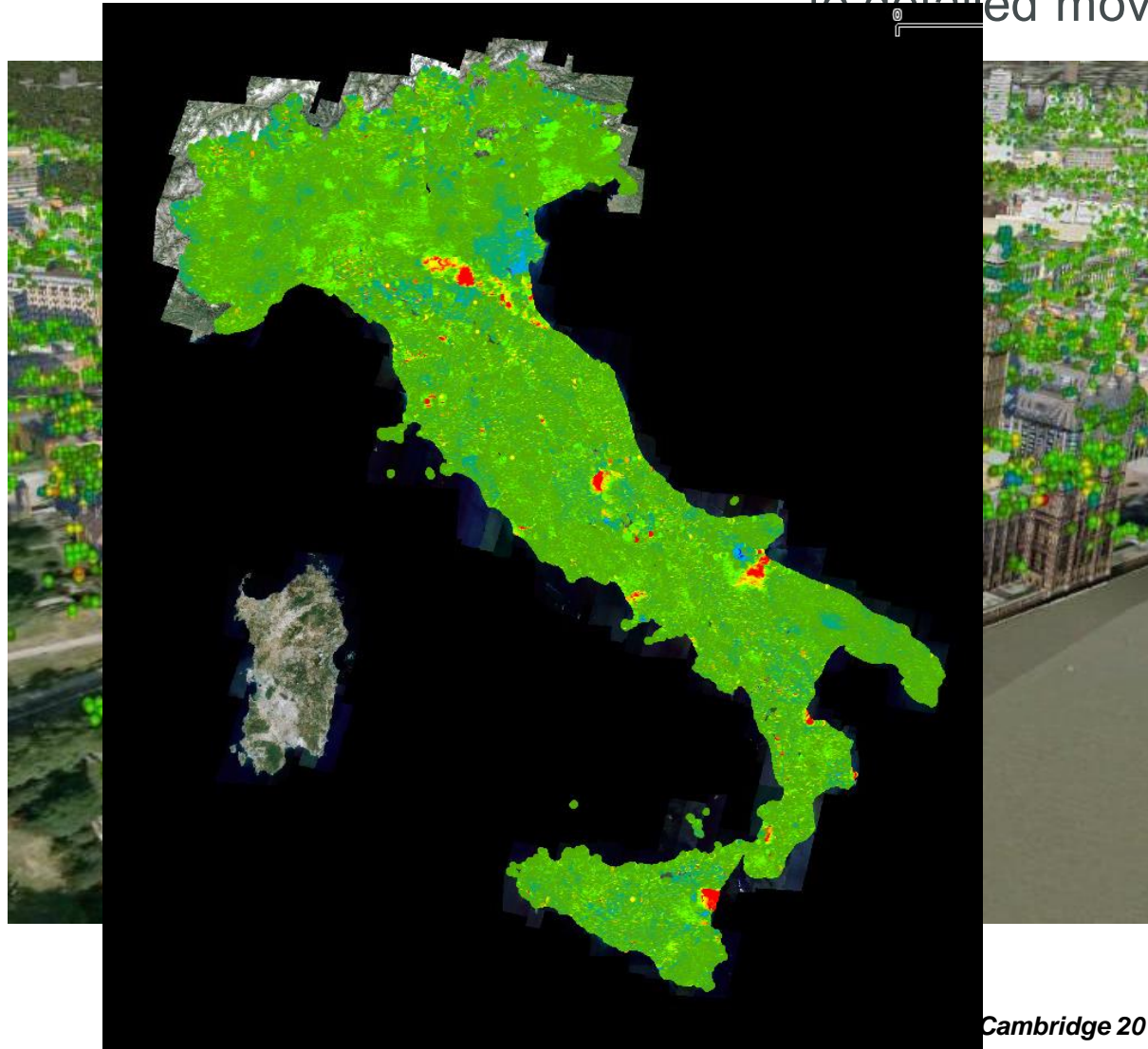
WHY TO USE InSAR for Monitoring?

- ✓ Cover **very large areas**
- ✓ Surface movement with **mm precision**
- ✓ **No need to install devices** in situ in urban areas or good reflective areas.
- ✓ The **ONLY** surveying technique able to provide with **historical movement data** for the AOI.
- ✓ Provides surface movement **beyond in situ instrumentation**.
- ✓ Can detect movement **gradient and evolution in time**.
- ✓ Near real time: up one image every 4 days for movement detection.
- ✓ **Hundreds of thousands of natural points** providing with constant updates of displacement.
- ✓ **Infrastructures maintenance**: best tool to quickly survey an asset and detect the areas already sensitive to movement to plan in situ surveying campaigns.
- ✓ **Economical** in comparison with in-situ survey campaigns.

Conclusion

From macro-scale surface movement studies of countries and major infrastructures...

to detailed movements of buildings



Annual
Displacement
(mm/year)



Legend:

Blue: Uplift

Green: Terrain Stability

Red: Subsidence

Cambridge 2015



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