Benefits of VHR X-band data for InSAR

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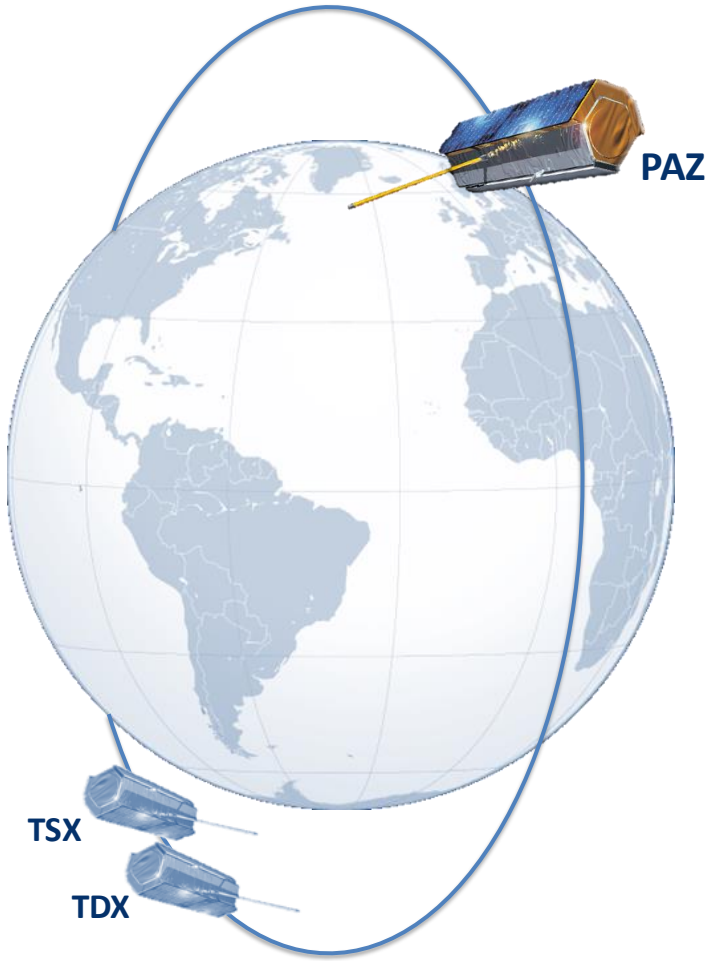
hisdeSAT DARES

Hisdesat's PAZ VHR radar satellite

- Hisdesat, the Spanish Governmental Satellite operator
- Owner and operator of PAZ satellite (launched 2018)
- Dual mission: Defense and Civilian
- Delivery of imagery and value-added services
- Support to Copernicus, ESA, EMSA, SATCEN, etc. and many commercial users worldwide
- AIS secondary payload

PAZ and the Constellation



PAZ, Premium X-band imaging:

- Very High resolution down to 25 cm
- Excellent radiometry (NESZ)
- High accuracy geolocation (< 1 m)

Agreement Hisdesat-Airbus to run the PAZ/TerraSAR-X Constellation:

- Full compatibility between satellites
- Enhanced daily imaging capacity
- 4 / 7 day interferometric revisit

From Sentinel-1 to VHR X-band

Within Sentinel-1 data, InSAR techniques have been widely used in different markets, due to:

- S1 has global blanket coverage
- Short revisit time
- Free and open data license
- Optimal operational model for InSAR purposes
- Perfectly fit for many applications commercially run worldwide

From Sentinel-1 to X-band

But in civil engineering and infrastructure monitoring, X-band **higher resolution** provides differential value:

- With higher resolution it is possible to spot more detailed features
- High density of points allow to associate measurement to specific points in the infrastructure to be monitored
- PAZ delivers sub-metric geolocation accuracy

X-band data is typically used @3m or @1m (**VHR**) resolution

X-band resolution advantage

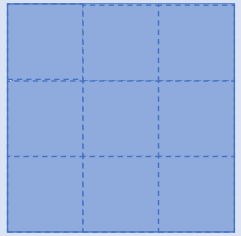
Level 1

Sentinel-1 IW mode. Resolution: **5m x 20m**

5 m x 20 m = **100 m²**

Level 2

PAZ StripMap. Resolution: **3m x 3m**



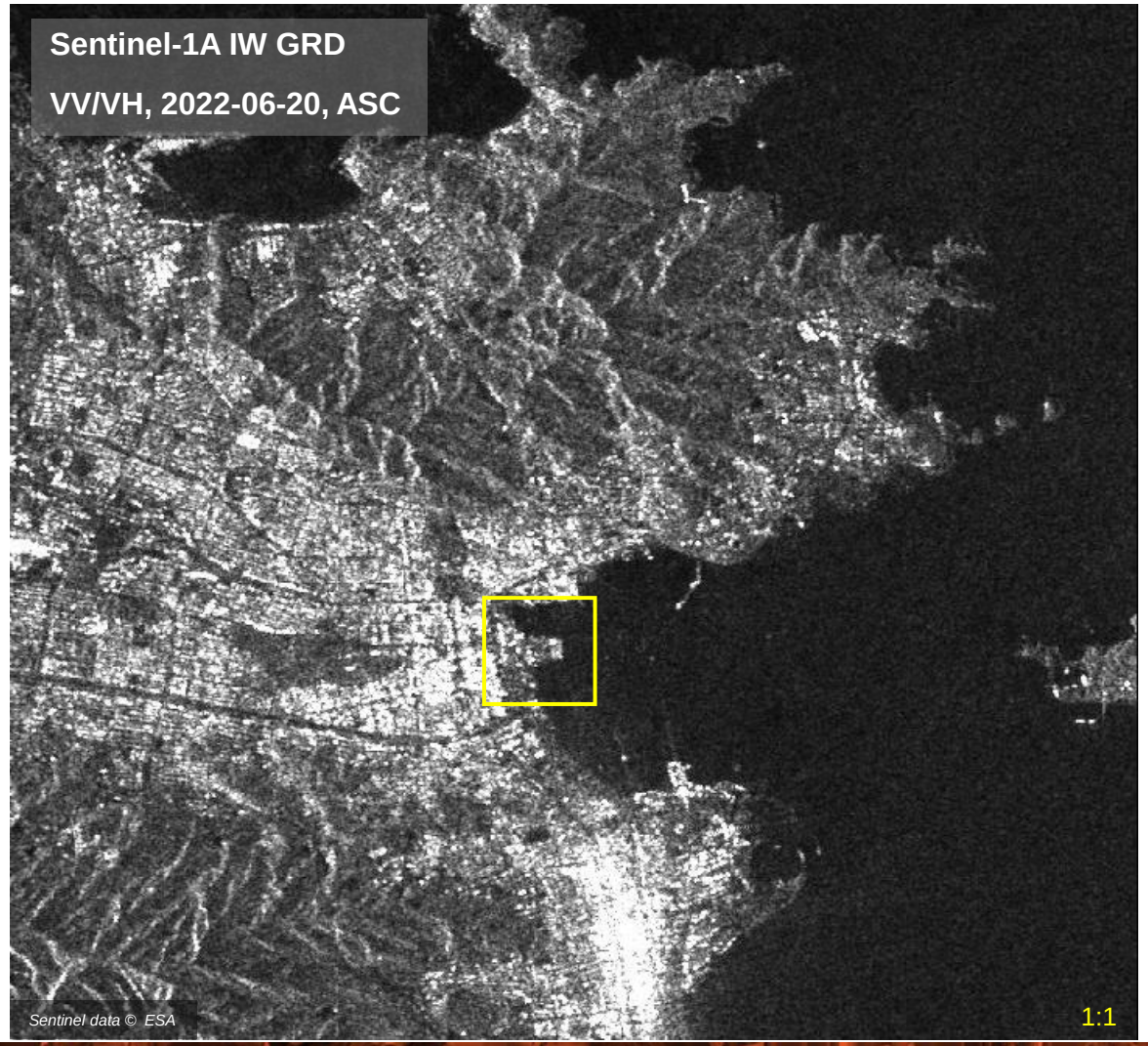
3m x 3m = **9 m²**

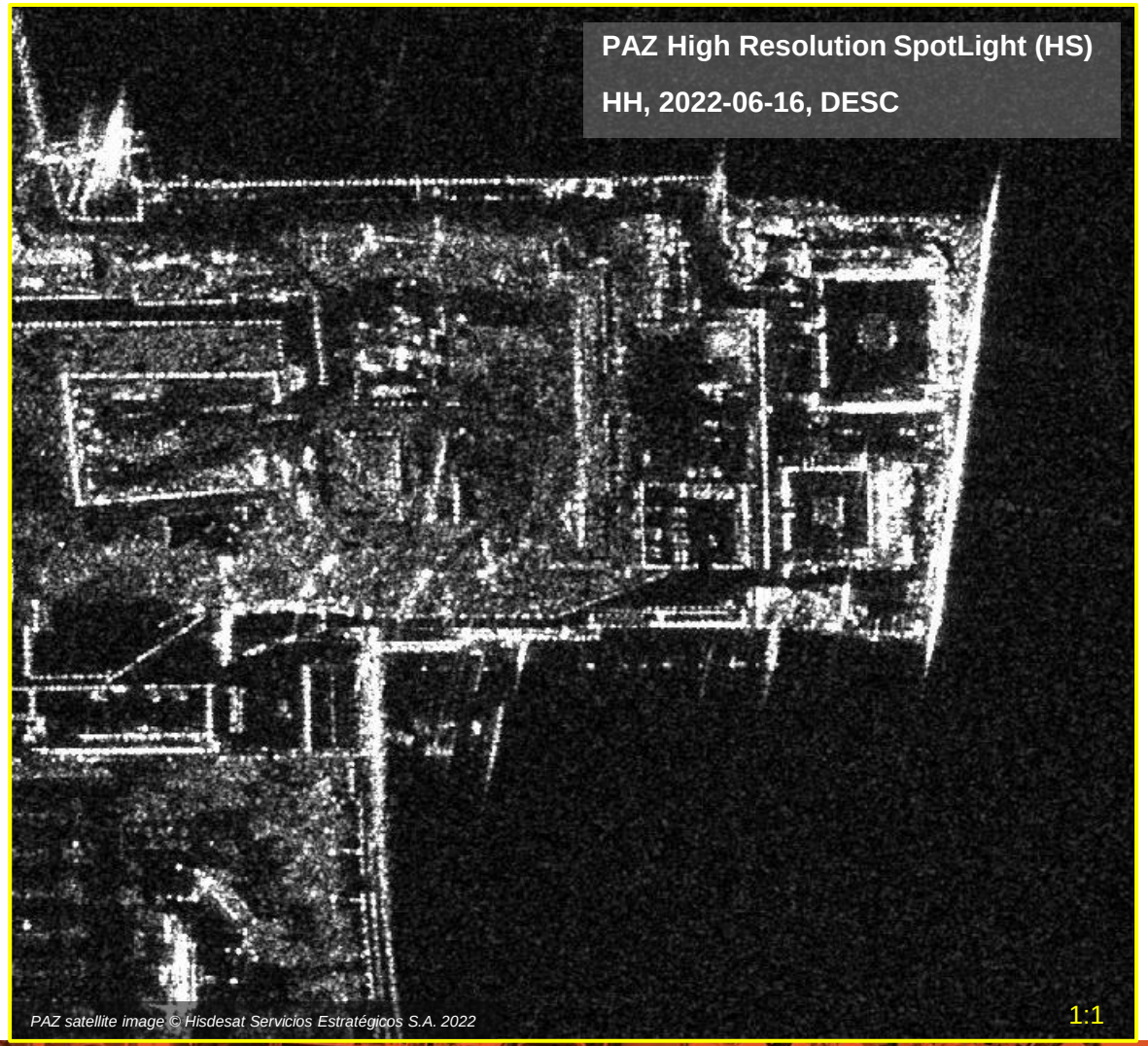
Level 3

PAZ High Resolution SpotLight. Resolution: **1m x 1m**

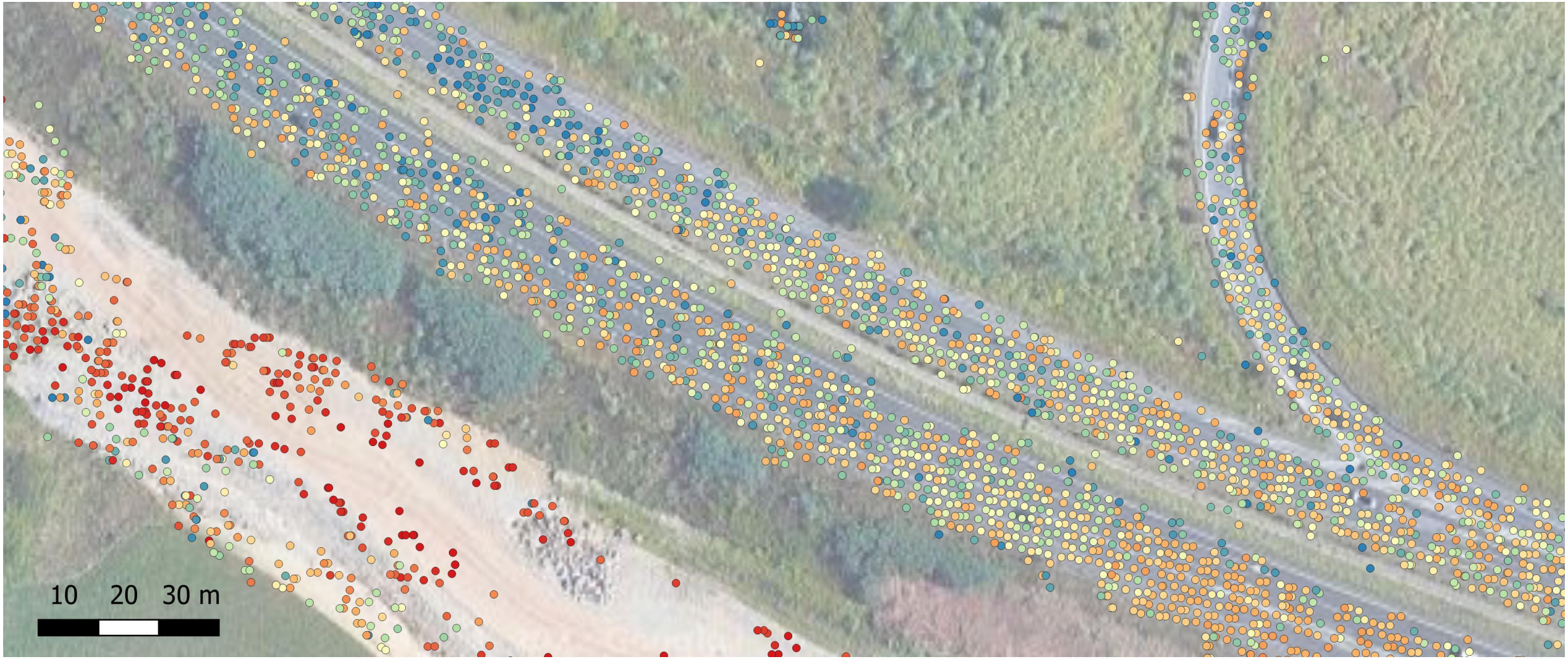
1m x 1m = **1 m²**

Sentinel-1 vs. VHR X-band data





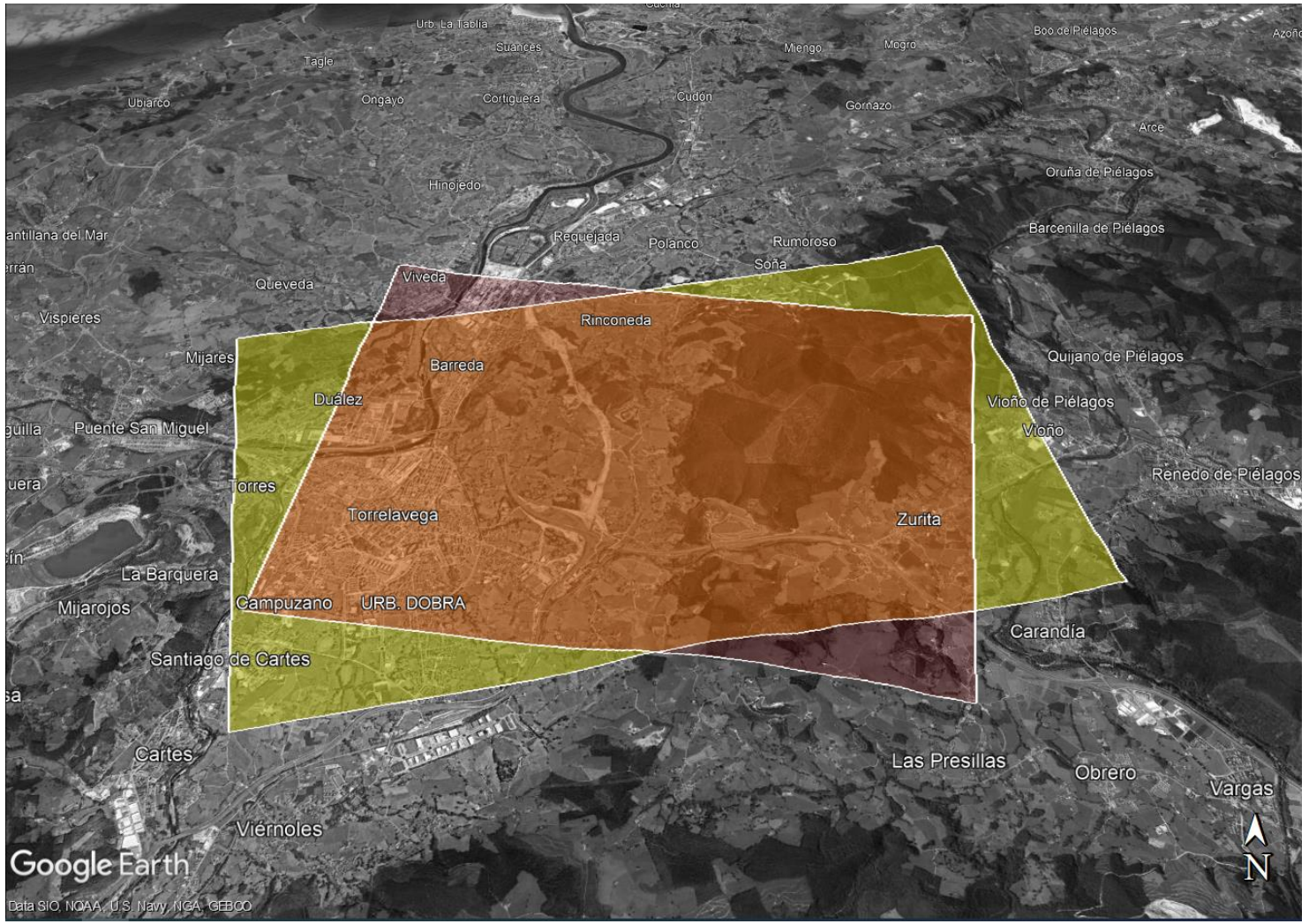
Measurement points density with VHR



InSAR Case Study with PAZ VHR

- **Goal:** monitoring of infrastructure in urban area
- **Input data:** PAZ HS 300 MHz stack. 1m resolution. Total 50 images. ASC/DESC
- **Time span:** 9 months

PAZ Data collection



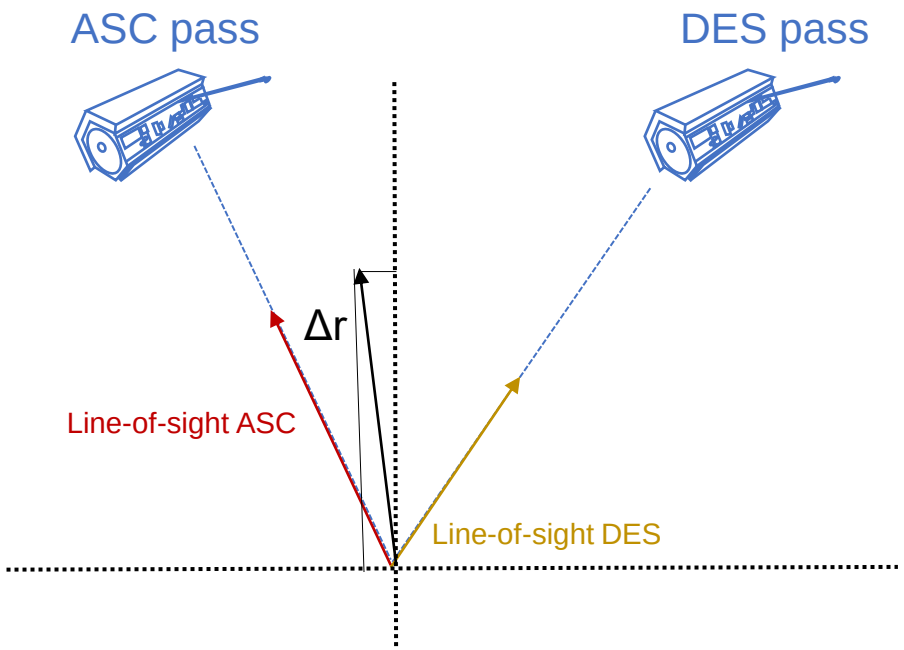
1 PAZ HS-300 series in ASC

1 PAZ HS-300 series in DESC

Data processing

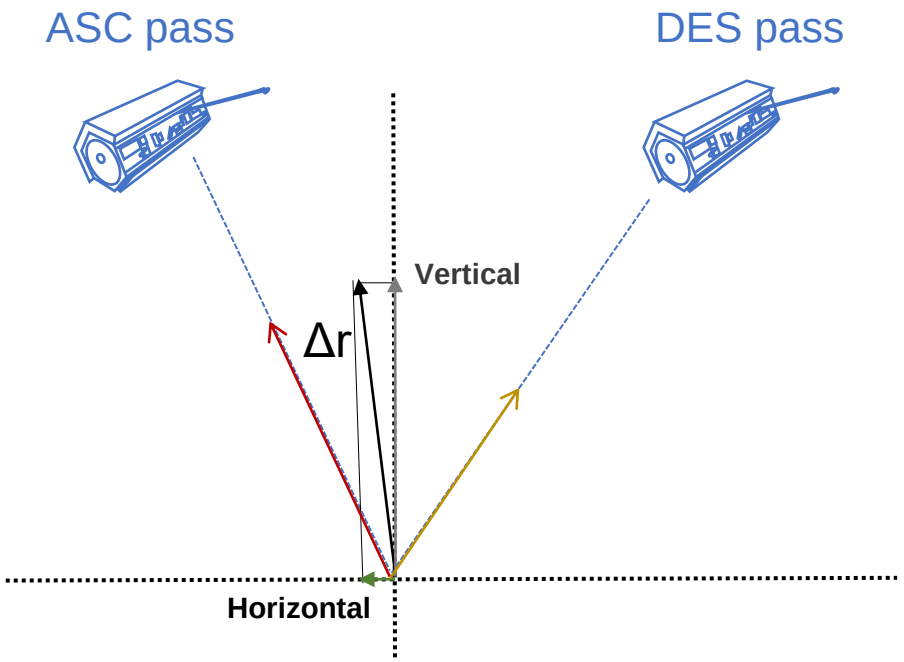
- Processing by DARES
- Advanced InSAR processing chain to maximize the number of persistent scatterers
- Atmospheric correction
- ASC / DESC combination

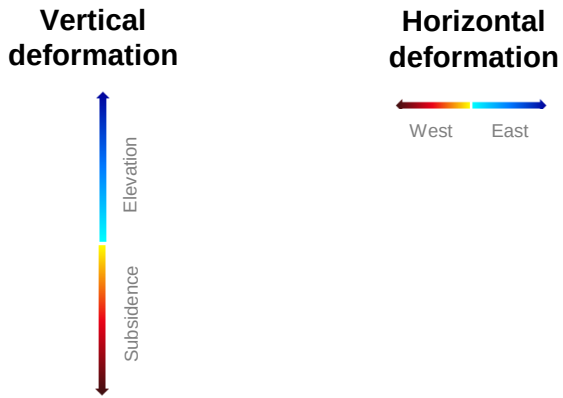
Deformation analysis



- Better estimation of the vector movement combining ASC and DES passes
- ASC (29/08/2019 – 30/05/2020), 24 images
- DES (01/09/2019 – 02/06/2020), 26 images

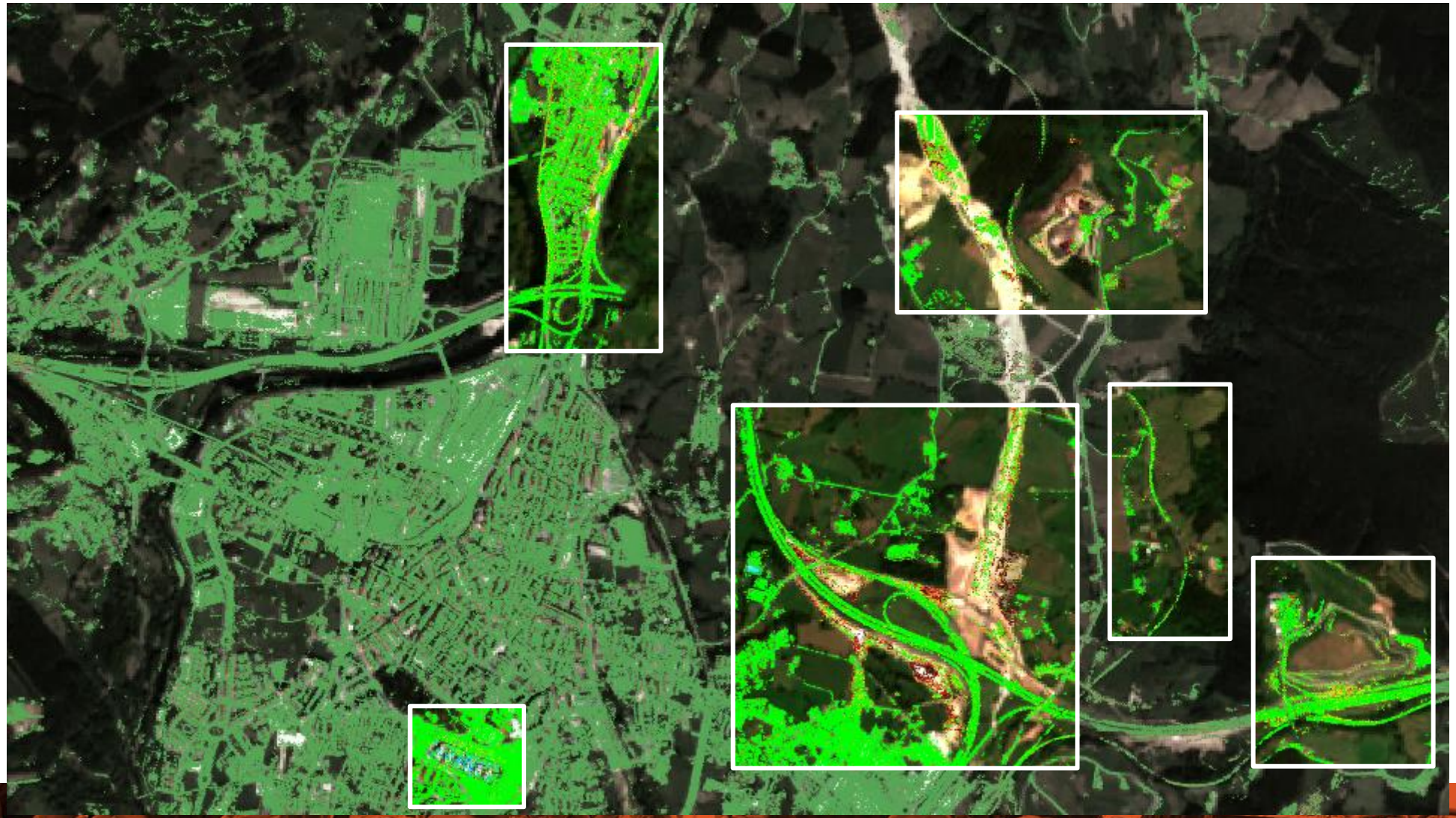
Deformation analysis





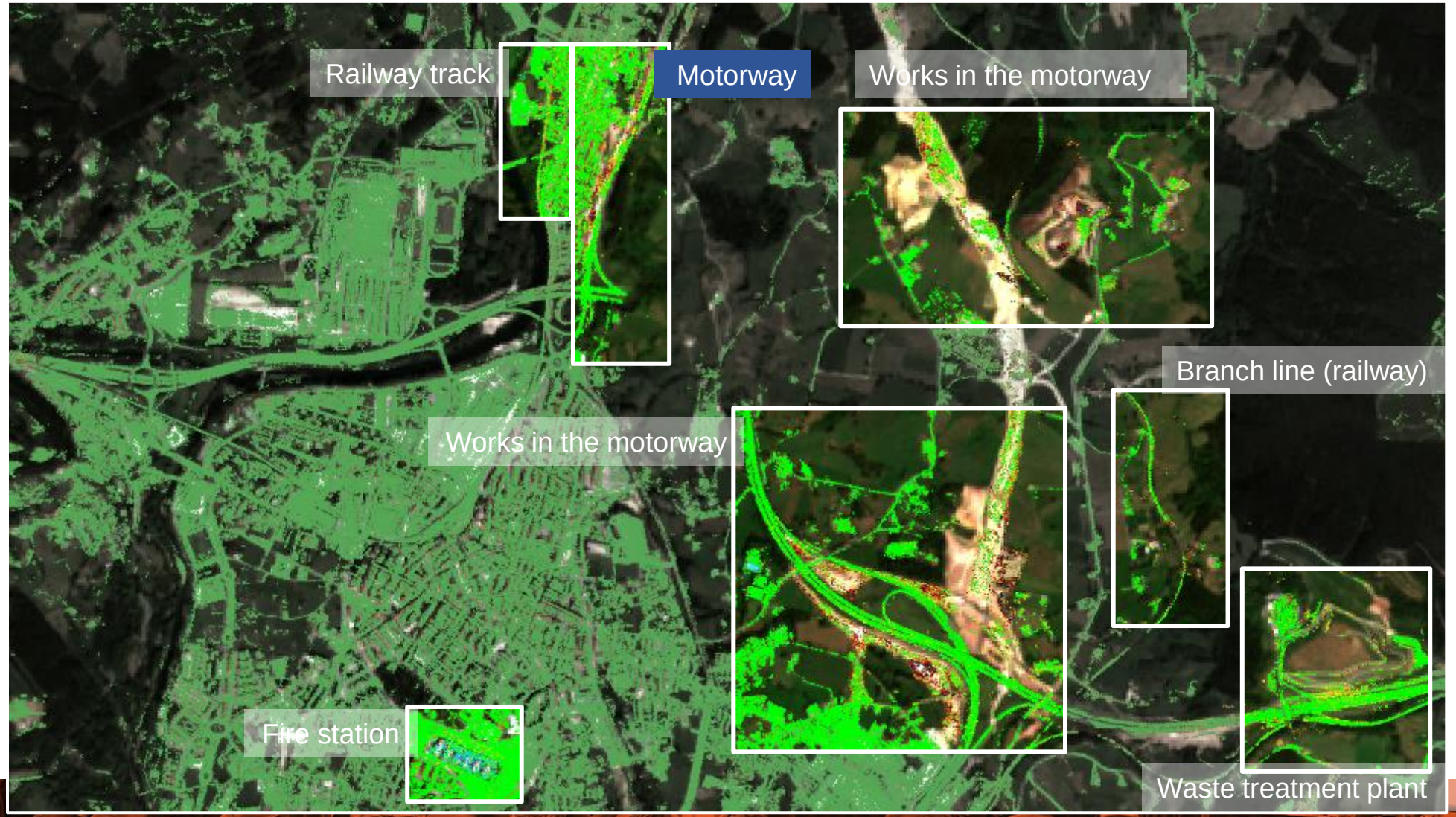
- Vertical deformation: elevation in blue and subsidence in red
- Horizontal deformation: western displacement in red and eastern displacement in blue
- Total deformation: total magnitude of the displacement vector Δr

Deformation map: vertical component

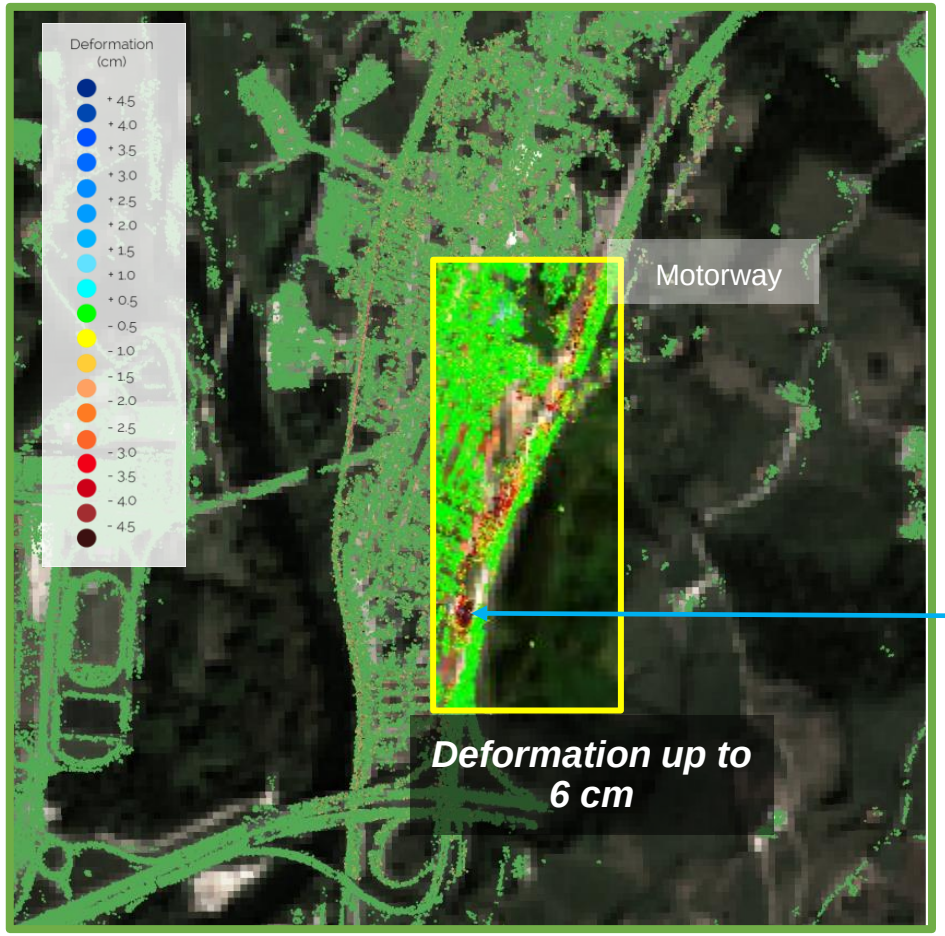


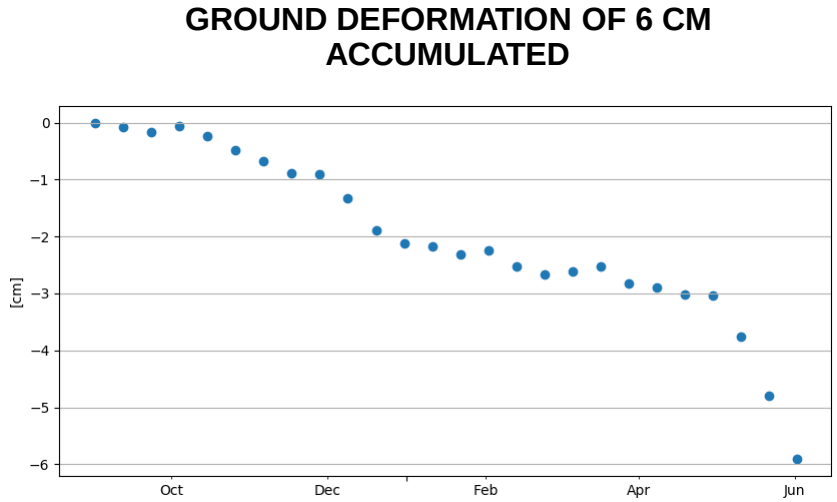
Deformation map: horizontal component

Deformation map: total component



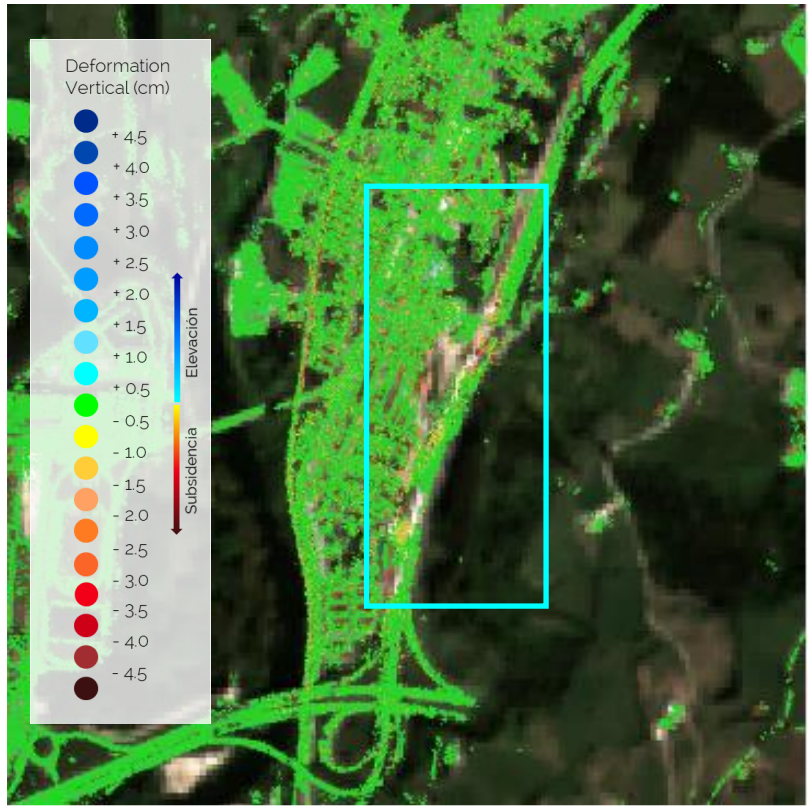
Total deformation map



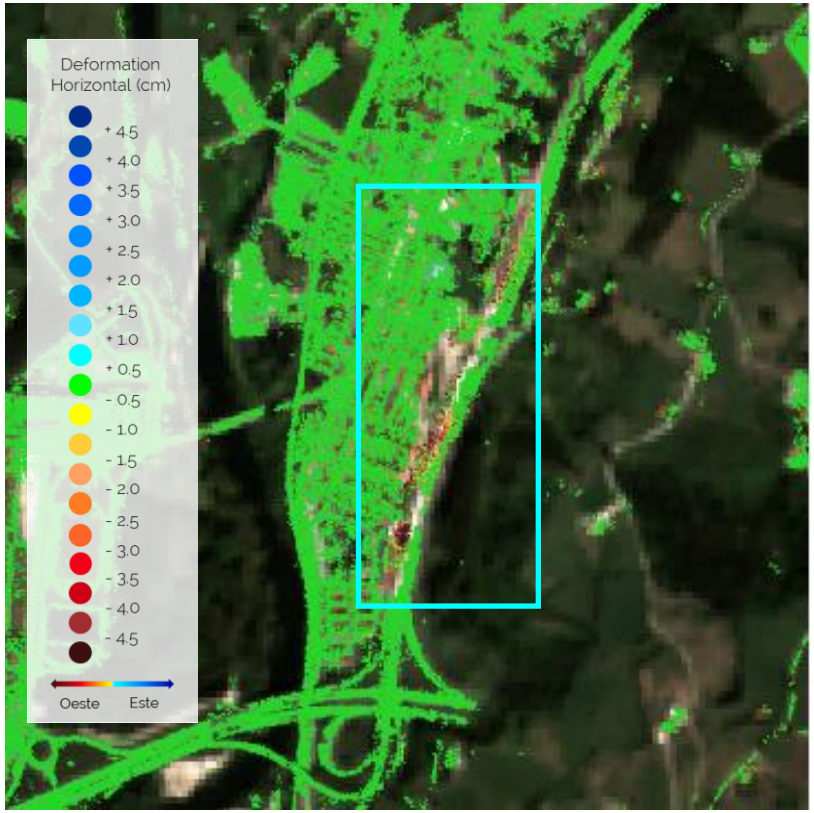


Vertical and horizontal deformation map

VERTICAL GROUND DEFORMATION



HORIZONTAL GROUND DEFORMATION



VHR X-band benefits summary

- A very high density of sampling points makes possible a more detailed measurement (spatially wise)
- The points can be associated with actual infrastructure features to be monitored
- Specially fitted to monitor infrastructures, including linear ones which are surrounded by vegetation
- Results can be even better with ST mode (25 cm x 1 m resolution)
- Of course, combining ASC and DESC passes, it is possible to extract 2D movement
- Actually in usage for infrastructure monitoring services worldwide

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