European Ground Motion Service **Validation**

InSAR Big Data Analytics

Land Monitoring

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PROGRAMME
OF THE EUROPEAN UNION

Copernicus
Europe's eyes on Earth

11 - 15 SEPTEMBER 2023 UNIVERSITY OF LEEDS
FRINGE 2023

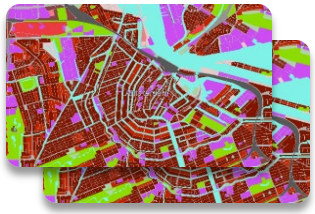
Implemented by European Environment Agency

European Commission

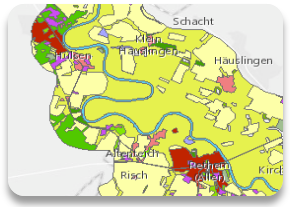
The Copernicus Land Monitoring Service – Open Geospatial data

Local

Urban Atlas
2006-12-18



Riparian Zones
2012-18



N2K
2006-12-18

Coastal Zones
2012-18

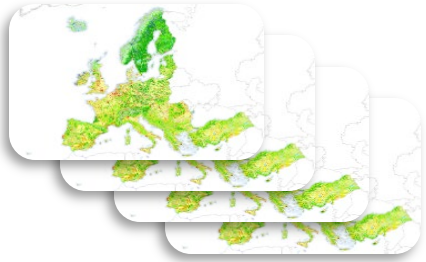
Imagery and reference data

EU-DEM

EU-Hydro

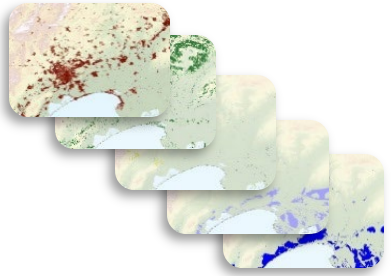
Pan-European

CLC & CLCC
1990-2000-06-12-18

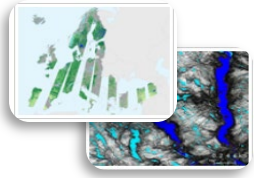


CLC+ Backbone
2018

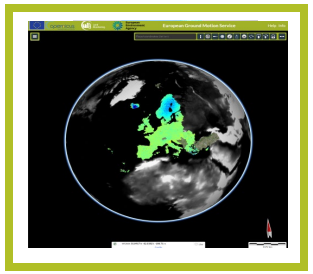
High Resolution Layers
2006-09-12-15-18



Biophysical parameters



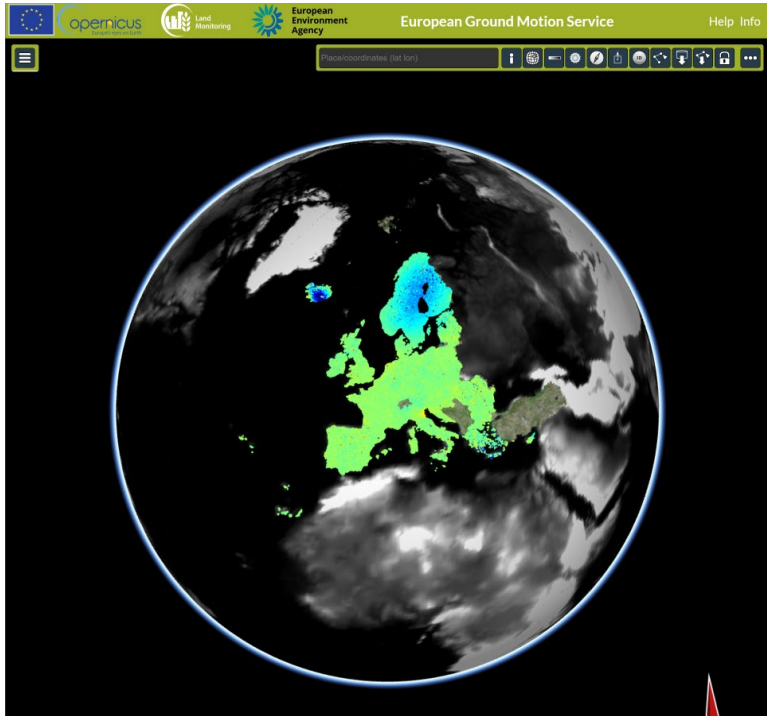
European Ground Motion Service



European Ground Motion Service (EGMS) – production and validation teams

Production Consortium

e-geos AN ASI/TELESPAZIO COMPANY · TRE TAMIRA · NORCE · GAFAG · NHAZCA · Earth Metrics a measure on the world · GEOLOGICAL SURVEY OF NORWAY · PPO.Labs · LECHNER TUTAS KOZ FONT · DLR



Validation Consortium

sixense · brgm Géosciences pour une Terre durable / SERVICE GÉOLOGIQUE NATIONAL · GeoSphere Austria · TERRASIGNA · TNO innovation for life · NGI

Validation data providers

GEO PARTNER · DTU Space National Space Institute · Instituto Geográfico Nacional · IGN INSTITUT NATIONAL DE L'INFORMATION GÉOGRAPHIQUE ET FORESTIÈRE · istituto per il rilevamento elettromagnetico dell'ambiente · 1919 CZECH GEOLOGICAL SURVEY · LNEG · Instituto Geológico y Minero de España

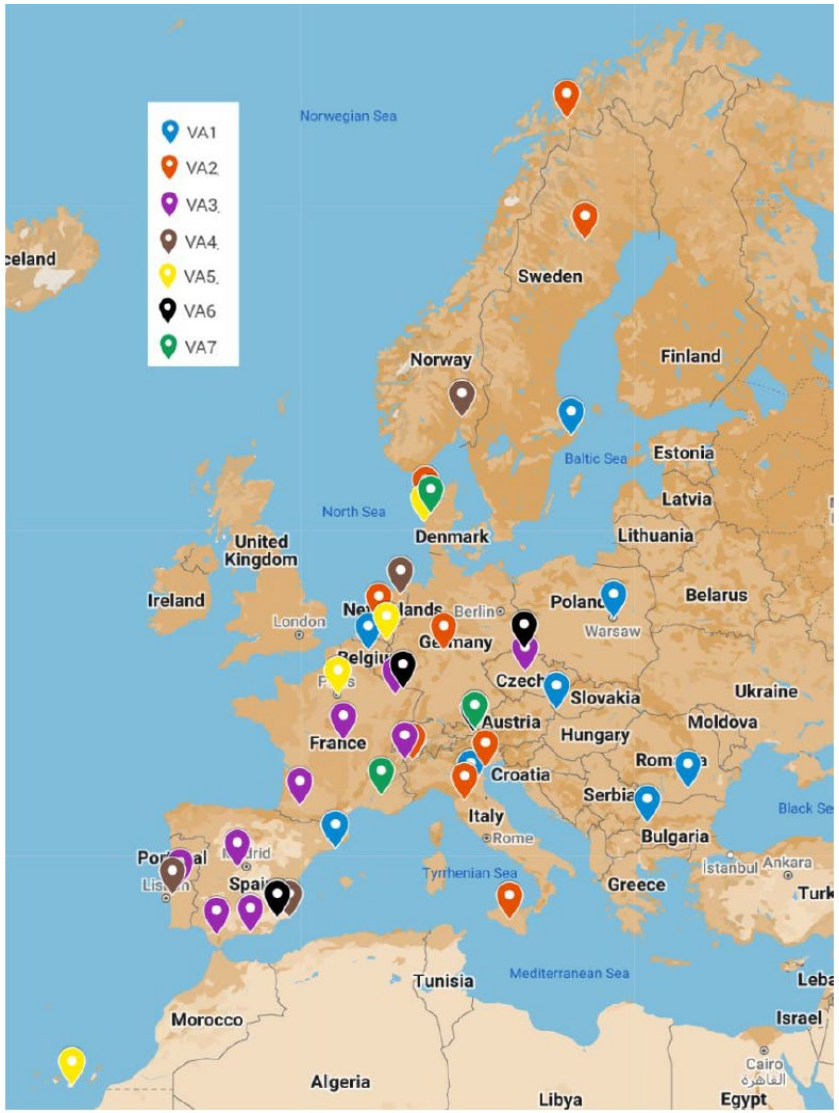
Validation general objectives

- ✓ **Validation** is perceived as a ‘strong’ concept -> our activity is closer to **verification**.
- ✓ We are measuring **agreement** with other ground motion measuring techniques -> Index of Agreement (**IoA**)
- ✓ The validation team work should be a complement to the production team -> A reproducible ***double-check***.

- *It verifies the **usability** of the data for different applications according to initial user requirements and with respect to the fields of application foreseen by the Validation of the EGMS Product Portfolio and the EGMS End User Requirements documents.*
- *It determines if the **quality** of the products is consistent with the technical specs for different areas and applications.*
- *It addresses the **completeness** and **consistency** of the data products together with their **accuracy**.*
- *It is performed **independently** from the EGMS production.*
- *It is based on the comparison of data of different nature.*
  - *Therefore, a complete agreement is most likely impossible, and differences may not be related to a quality issue.*

European Ground Motion Service (EGMS) – Validation Activities/Sites

VA1	Point Density check
VA2	Comparison with other ground motion services
VA3	Comparison with inventories of phenomena, events
VA4	Consistency check with ancillary geo-information
VA5	Comparison with GNSS data
VA6	Comparison with insitu monitoring
VA7	Evaluation of XYZ + displacements with CR



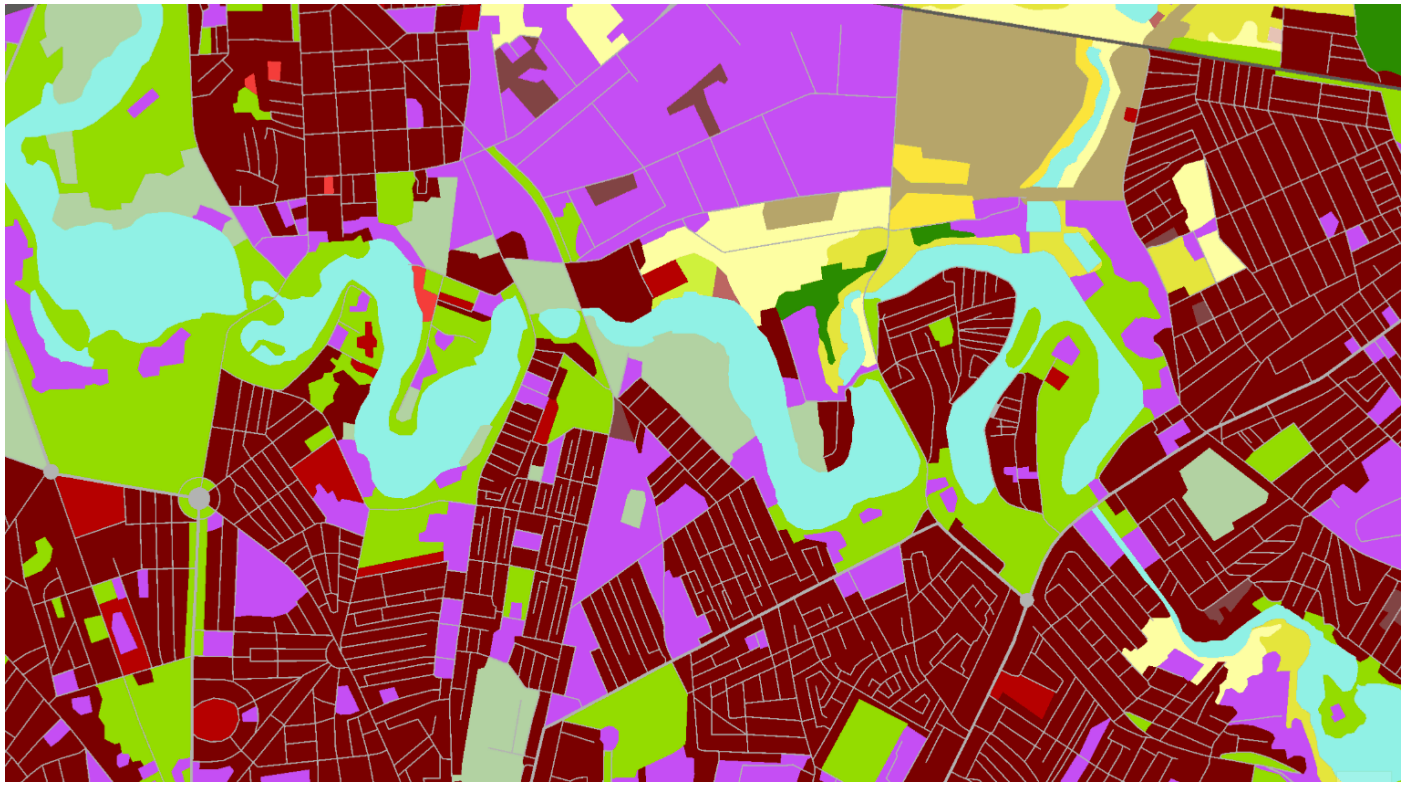
- 50 sites in Europe covering 10 EU countries have been selected to perform independent validation of the EGMS service.

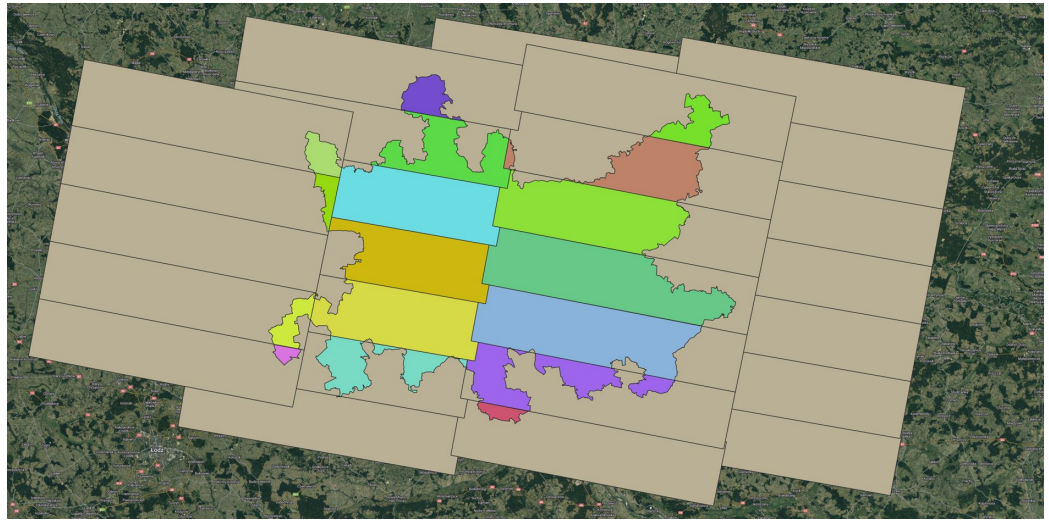
- Carefully selected to represent all thematic areas to ensure usability criteria of EGMS products is met.

Validation results will arrive in **November 2023**, stay tuned!

VA1 – Point Density Check

- **Objective**: Study the density per land cover class and its homogeneous behaviour across the EGMS service.
- **Data**: Urban atlas 2018 QC vector dataset taken as reference (12 validation sites spread across EU)
- **Considerations**: Takes into account 4 different EGMS data providers/algorithms and burst overlapping

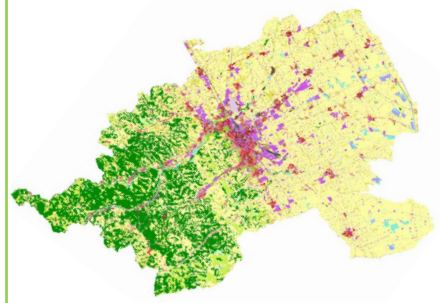




VA1 – Point Density Check (Poster)

Urban Sites

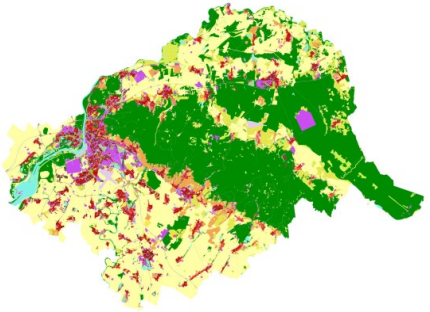
Bologna



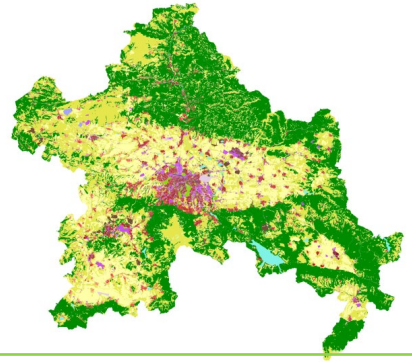
Bucarest

Stockholm

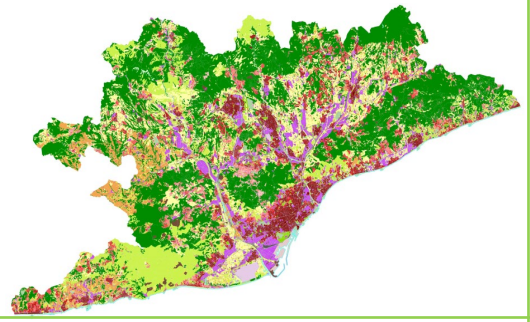
Bratislava



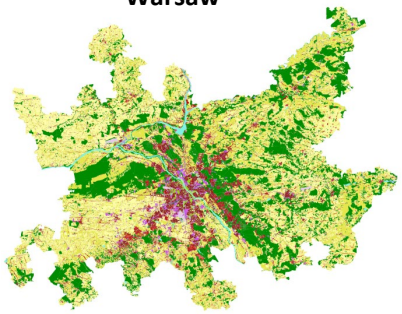
Sofia



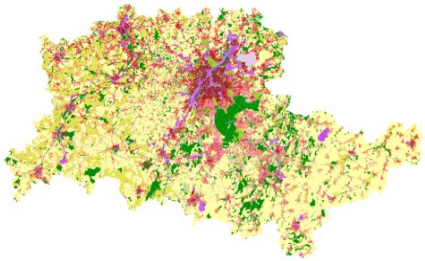
Barcelona



Warsaw

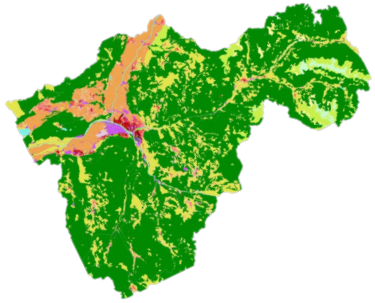


Brussels

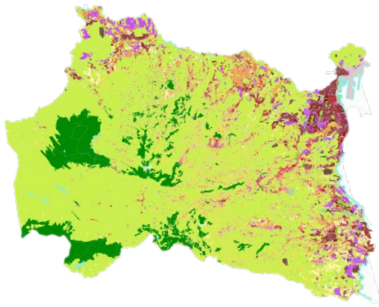


Rural & Mountainous Sites

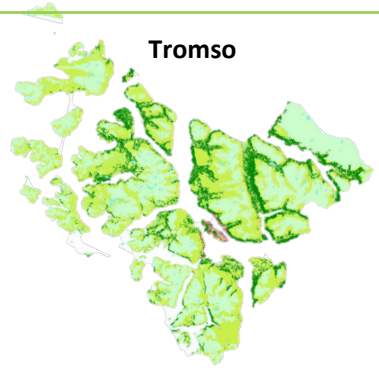
Bolzano



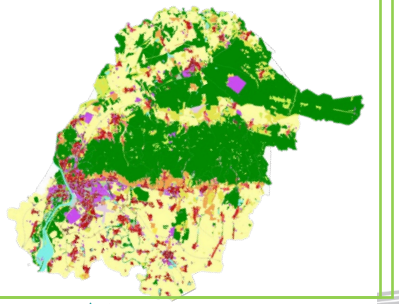
Las Palmas



Tromso

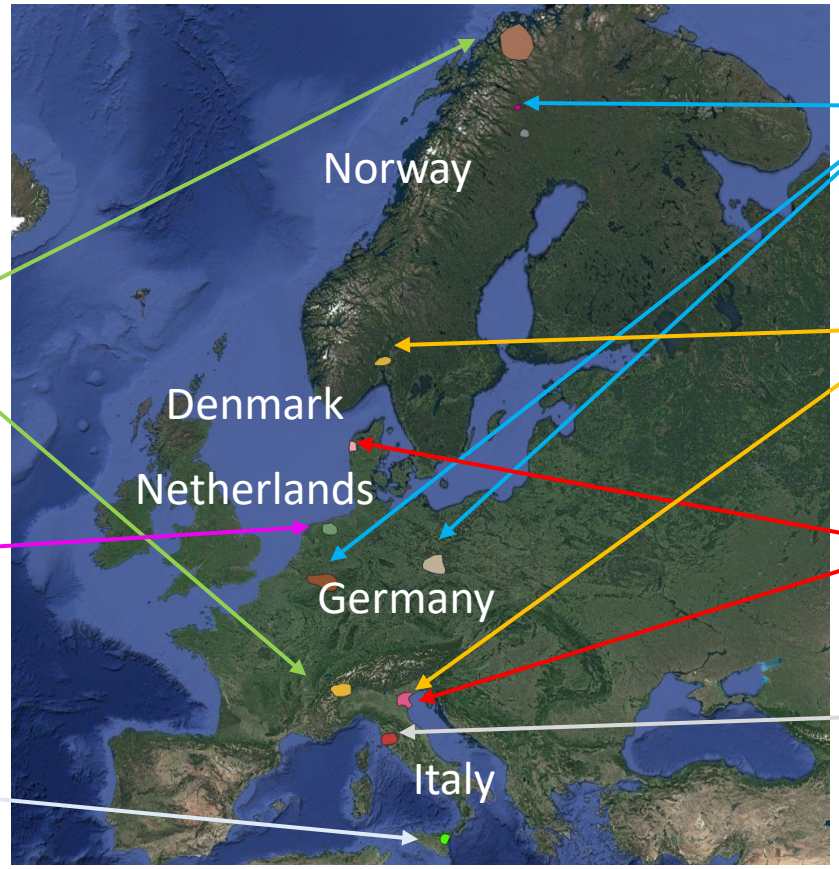


Zilina



VA2 – Comparison with other Ground Motion Services (GMS)

- **Objective**: Study the agreement with existing national/regional ground motion services.
- **Data**: national and regional GMS initiatives and specific processings (CNR/IREA – Sicily, DTU – Denmark)



Landslides
(Subsidence)

Oil/Gas Extraction
(Subsidence)

Volcanism
(Subsidence and heave)

Mining
(Subsidence and heave)

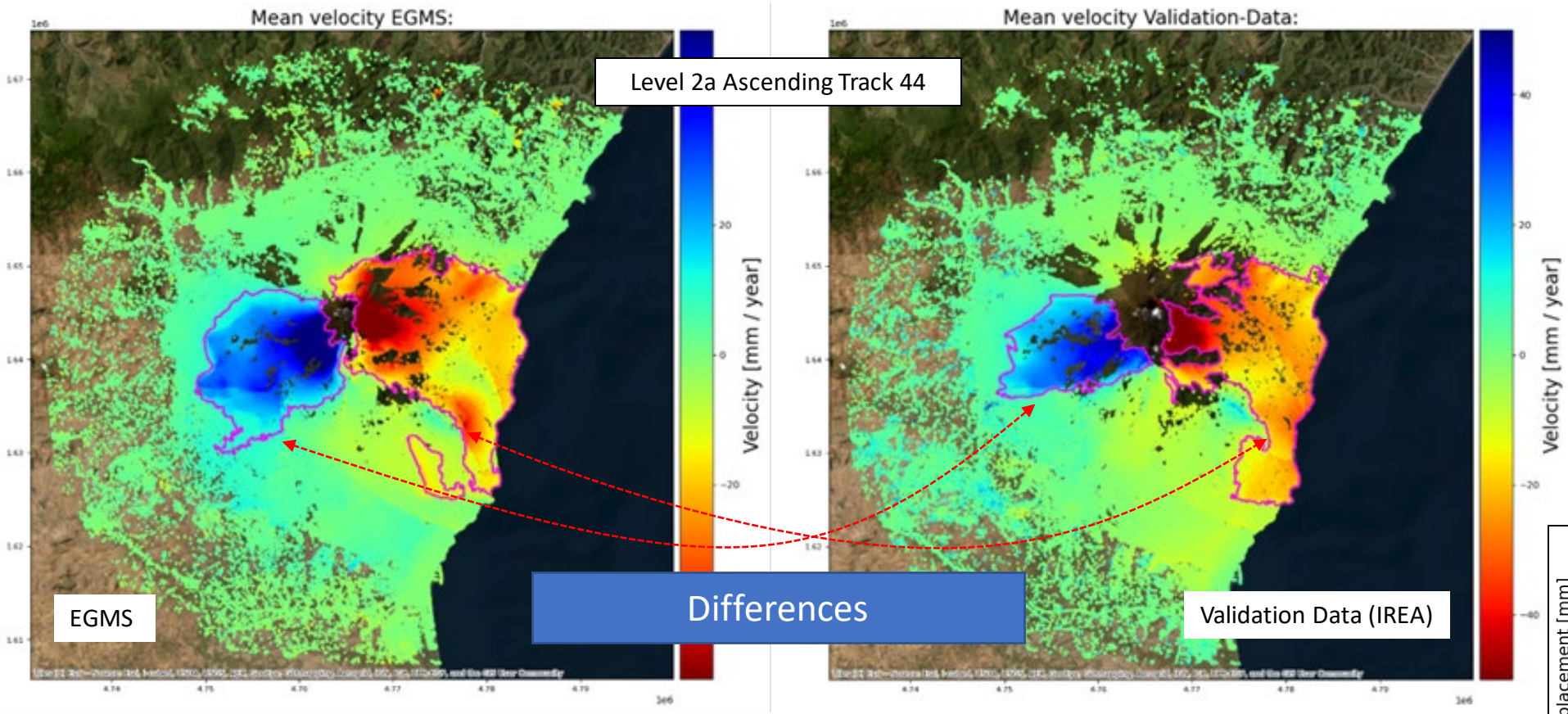
Engineering works/construction
(Subsidence)

Coastal Subsidence
(Subsidence)

Water Extraction
(Subsidence)

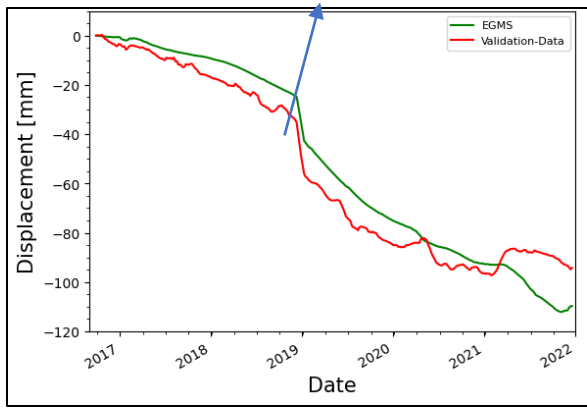
DTU Space
National Space Institute

VA2 – Comparison with other Ground Motion Services (GMS) - Poster



istituto per il rilevamento elettromagnetico dell'ambiente

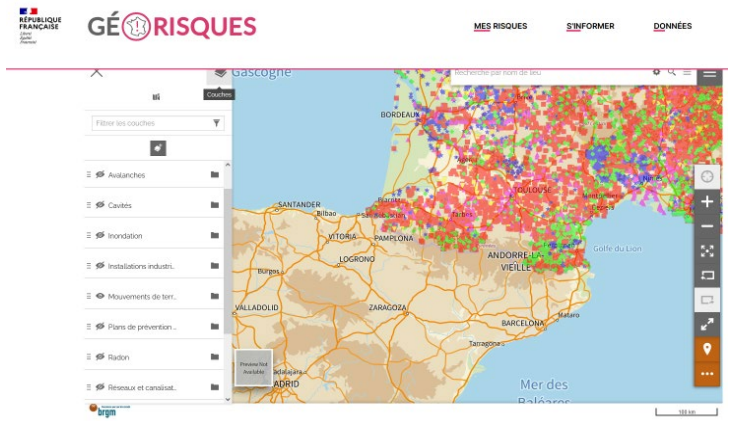
Eruption Dec. 2018

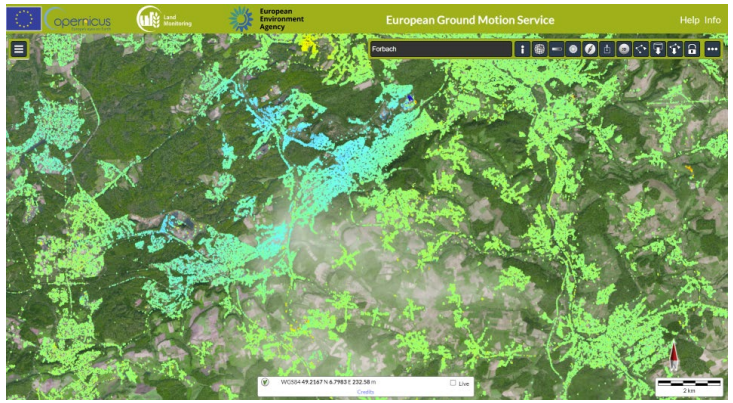


- Overall good agreement
- Only two large ADAs (as in most products)
- Some differences in point coverage and ADA extents
- Very dynamic system, some differences between datasets have to be expected

VA3 – Comparison with inventories of phenomena

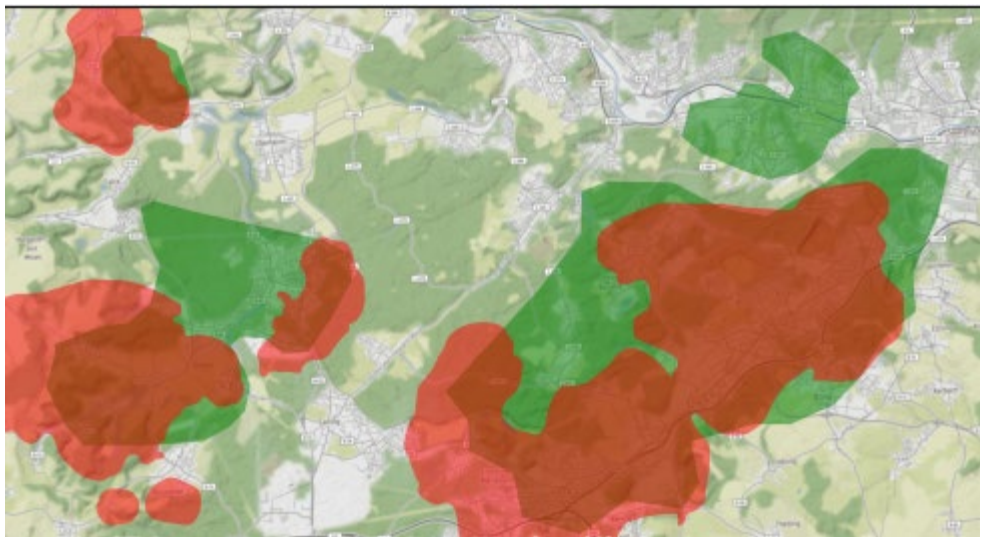
- **Objective**: comparison of EGMS derived inventories versus national initiatives.
- **Data**: national landslide inventories (Spain, France, Czech Republic)
- **Considerations**: systematic approach based on ADA (EGMS to enrich inventories).





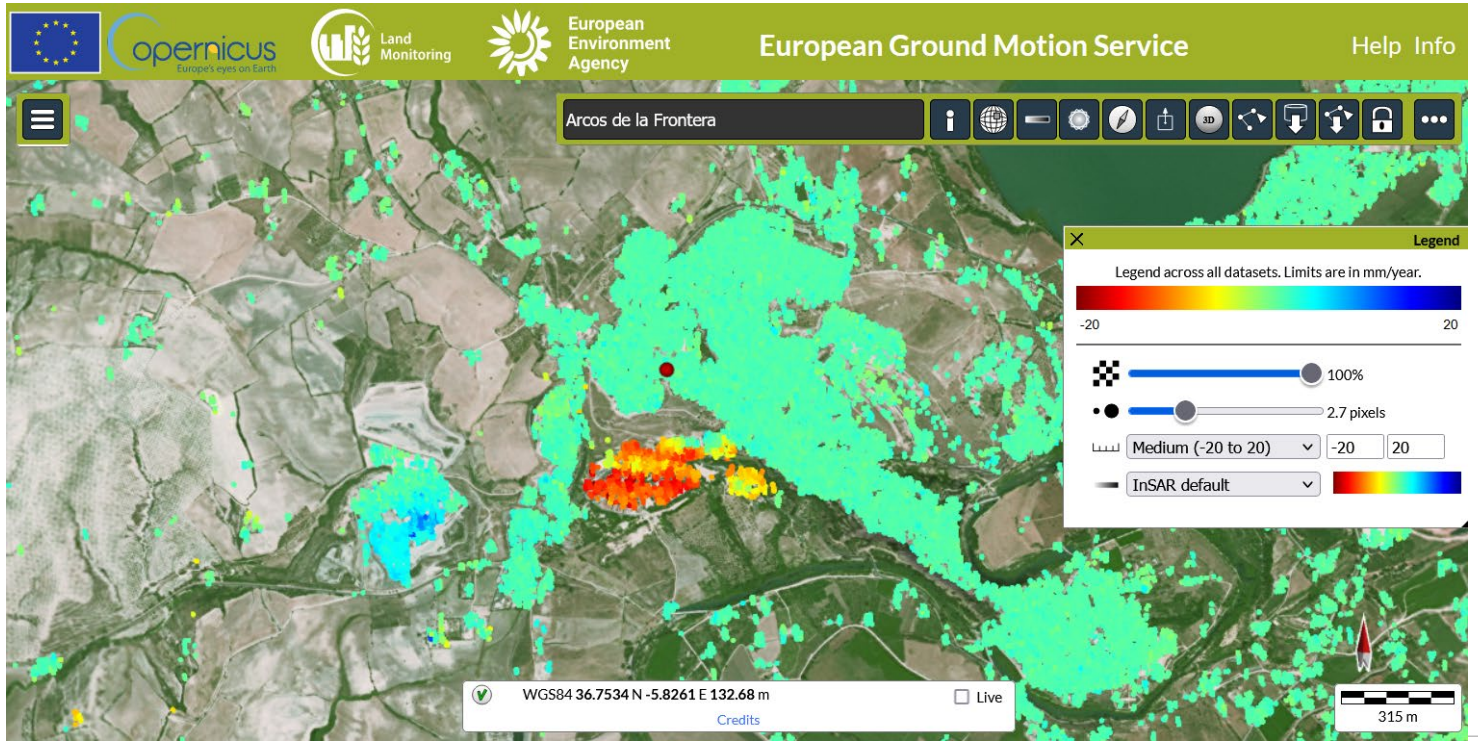
Polygons

ADA

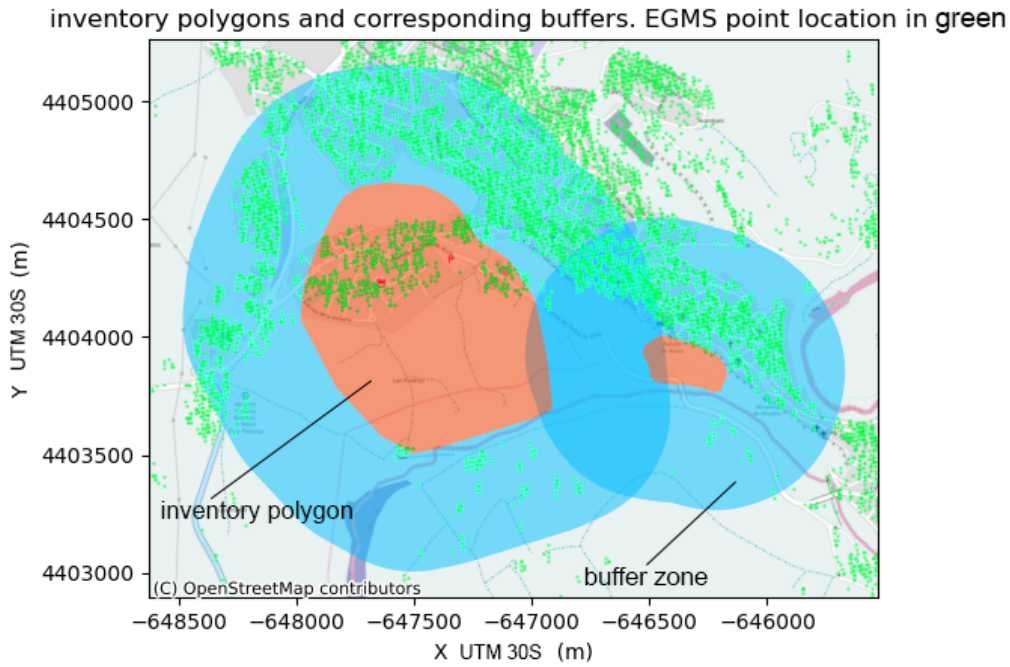


VA3 – Comparison with inventories of phenomena

1. Does EGMS detect motion within the polygons from the national inventories?
2. Are EGMS polygons similar to polygons from national inventories?
3. Does EGMS polygons contain points from national inventories?




```
Average polygon area (km²) 0.46490549126391373
Proposed buffer distance (km): 0.3409198920802047
```



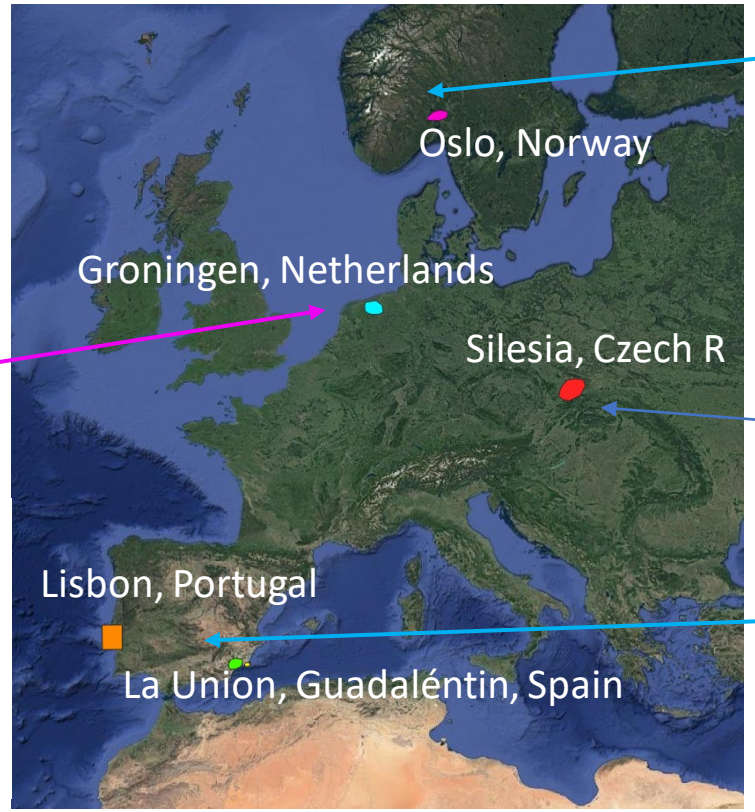

```
Average velocities for each polygon:
    outside [1.3744542  1.37364096]
    inside  [-8.64753788  1.9       ]

Estimated Indicator (absolute difference inside/outside) [10.02199208  0.52635904]
Numbers of points inside polygons [528.   4.]
Standard deviation of velocity in the polygon [4.59312249 0.14142136]
Standard deviation of velocity outside_the_polygon [1.3506873  0.55280621]

percentage of polygons with at least  3  points among polygons with points 100.0
percentage of polygons with no points 0.0
```

VA4 – Consistency check with ancilliary geodata

- **Objective**: Consistency of EGMS derived ADA inventories + expert judgement + extensive databases.
- **Data**: Geological, Lithological, Hydrogeological, Geomorphological and geotechnical maps.
- **Considerations**: Relies on expert judgement and based on the concept of radar-interpretation.



Urban subsidence, Engineering works/ construction
(Subsidence)

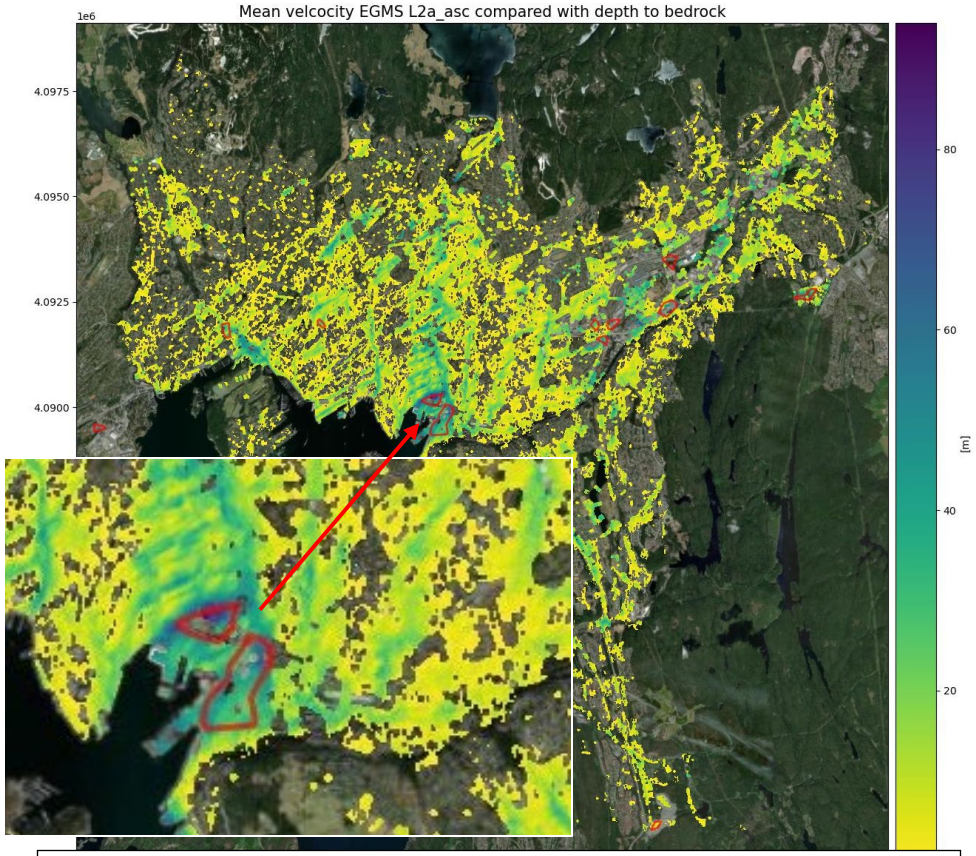
Oil/Gas Extraction
(Subsidence)

Ground water extraction
(Subsidence)

VA4 – Consistency check with ancilliary geodata - Poster

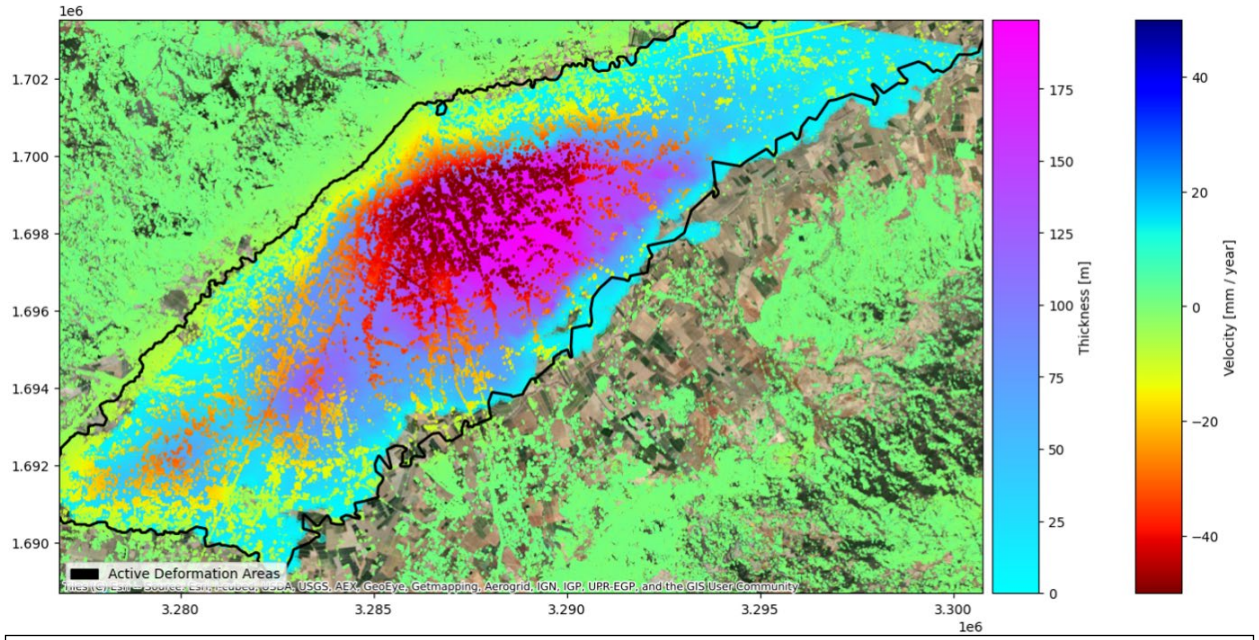
Comparison with soft soil thickness/depth to bedrock maps.

Depth to bedrock map with ADAs (red)



Most ADAs correlate with areas of thicker overburden

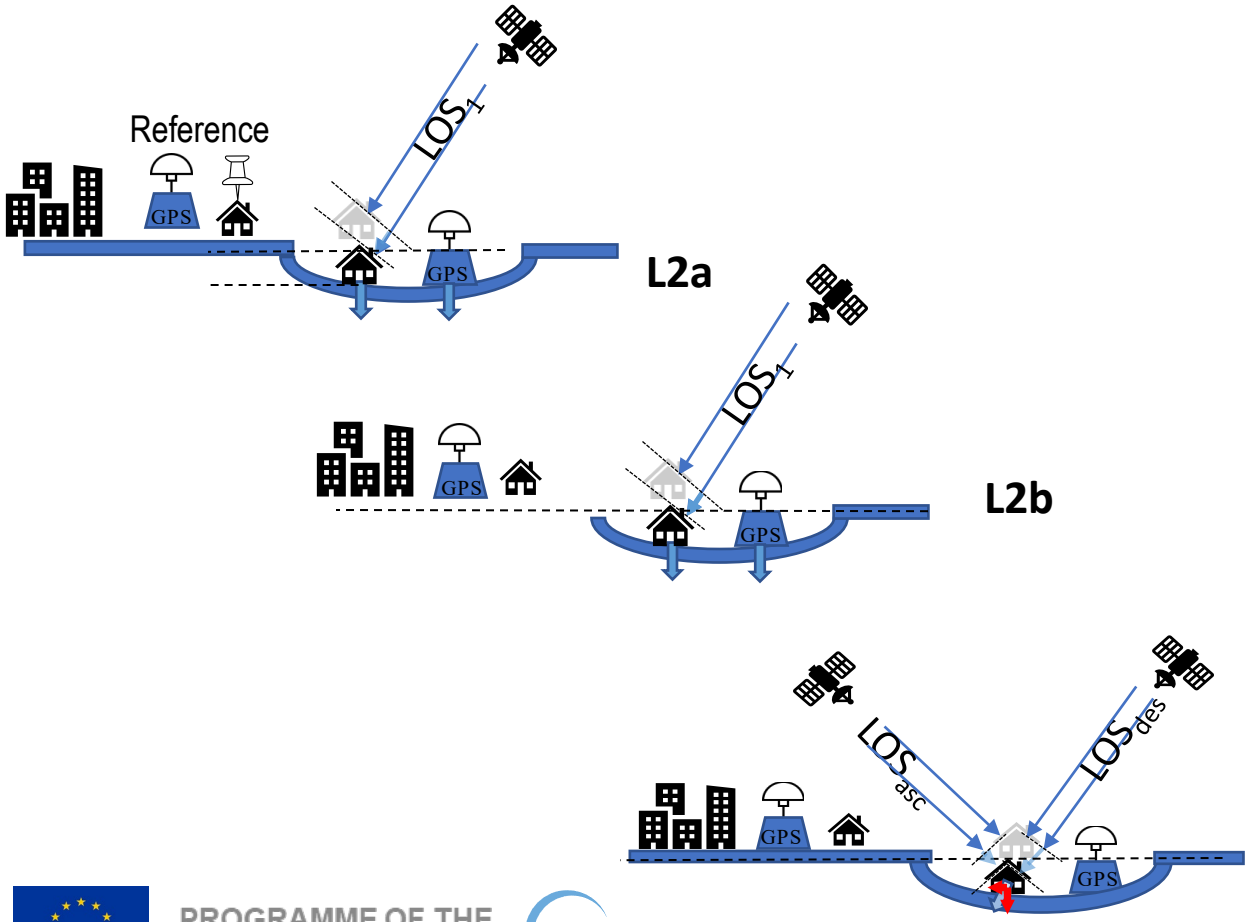
Soft soil thickness with ADA (black) and subsidence velocity

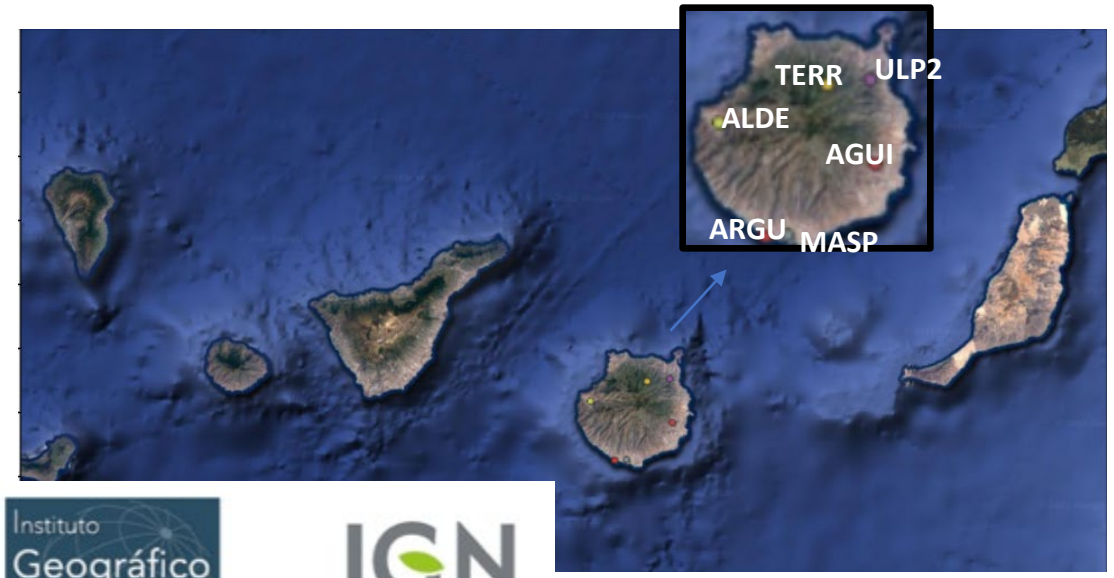


Very good correlation in location and extent with soft soil thickness deeper than 5m (areas with soft soil thickness smaller than 5 m have been masked out for better visibility). Good correlation of area with highest thickness and highest subsidence area.

VA5 – Comparison with GNSS data

- **Objective**: validate the geocoding of EGMS products and timeseries intercomparison.
- **Data**: GNSS quality controlled data coming from stations in ES, FR, DK.
- **Considerations**: obviously none of the stations used to produce the Calibrated/L2b have been used.





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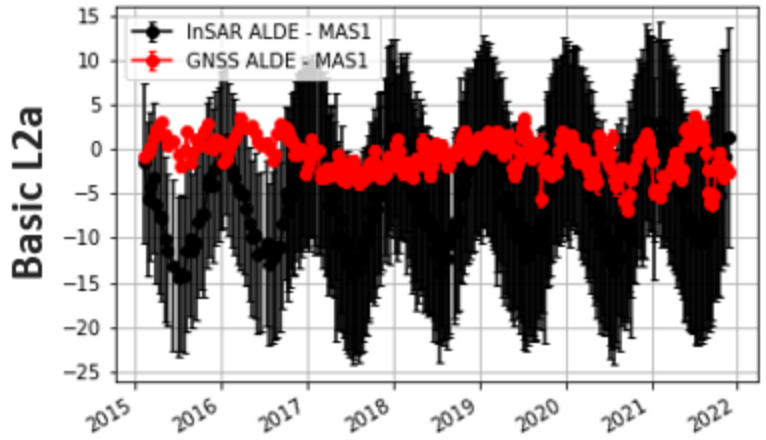
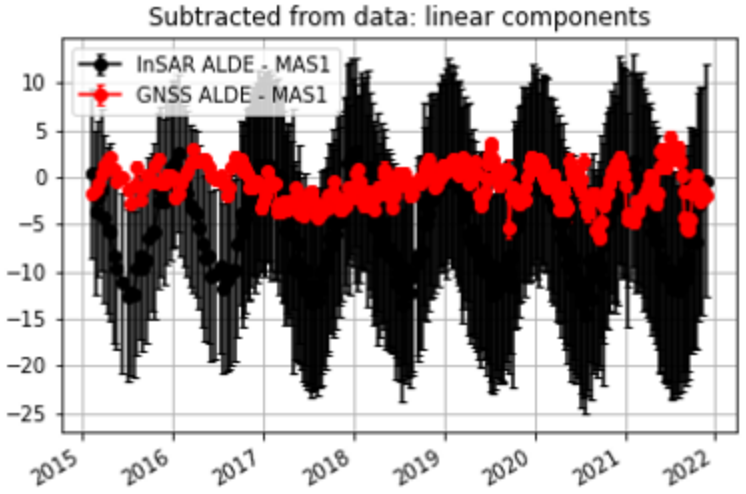
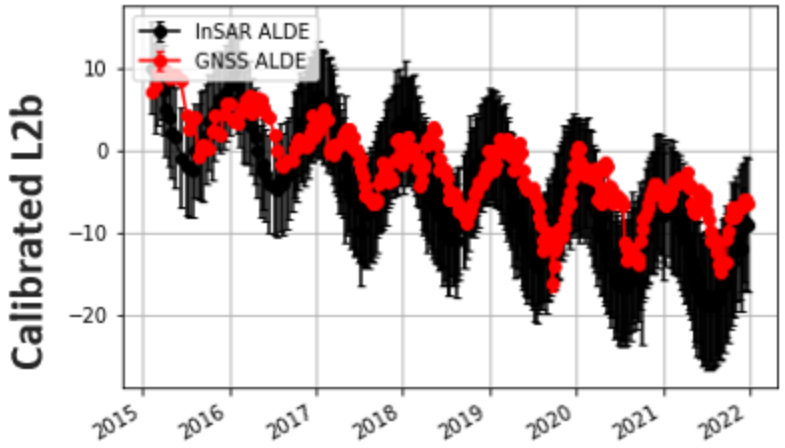
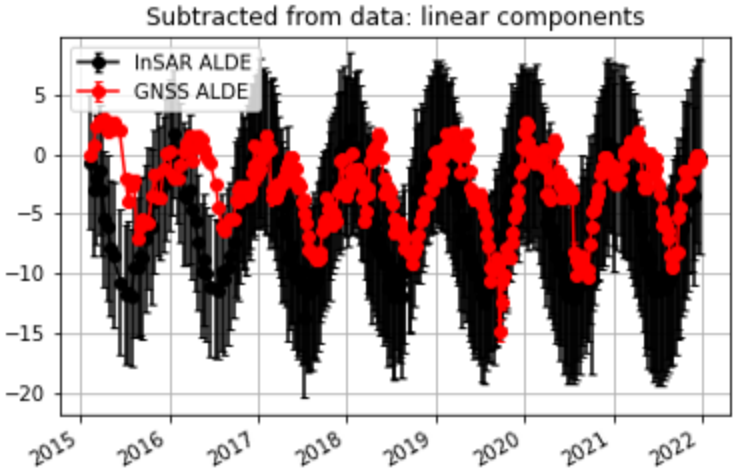
IGN INSTITUT NATIONAL DE L'INFORMATION GÉOGRAPHIQUE ET FORESTIÈRE

VA5 – Comparison with GNSS data - Poster



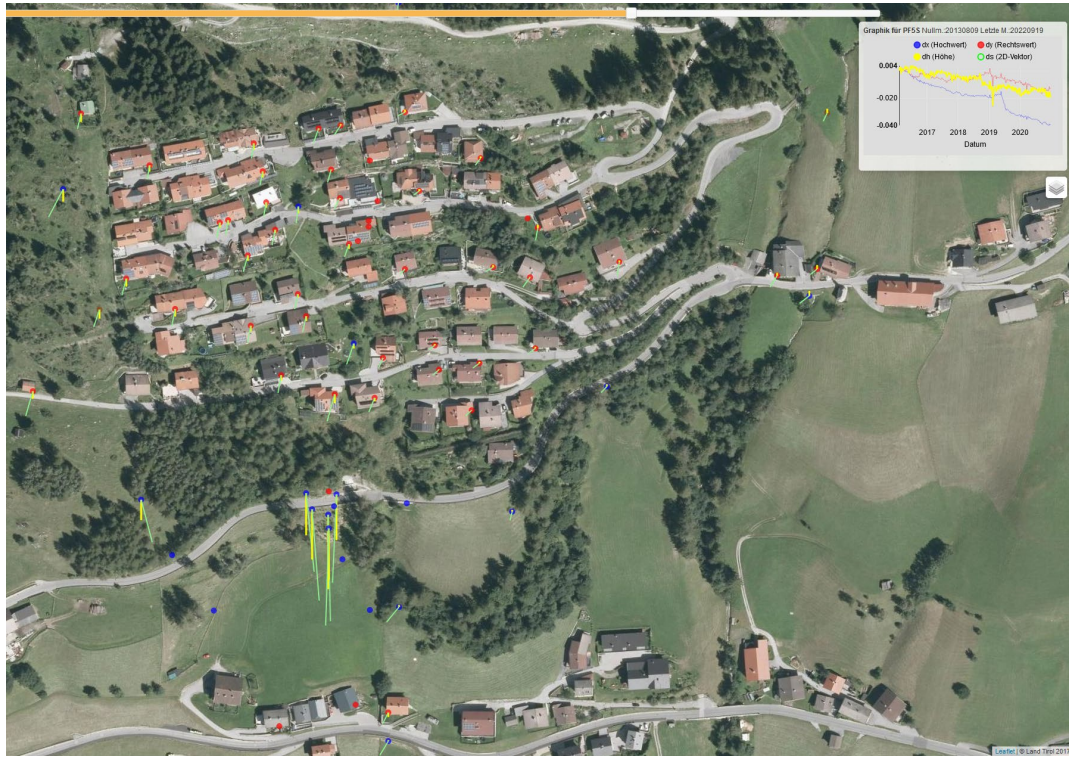


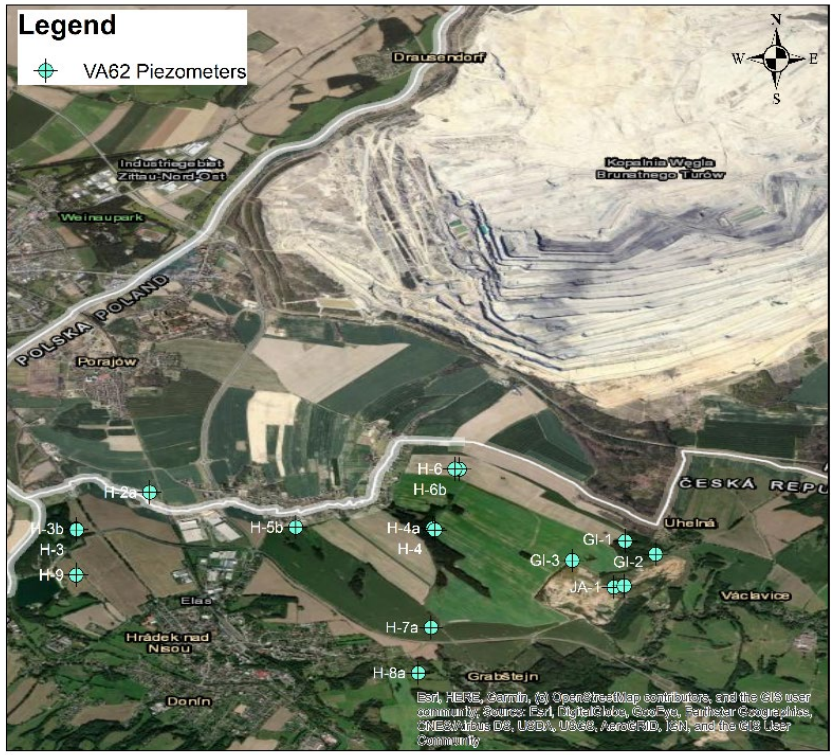




VA6 – Comparison with insitu monitoring

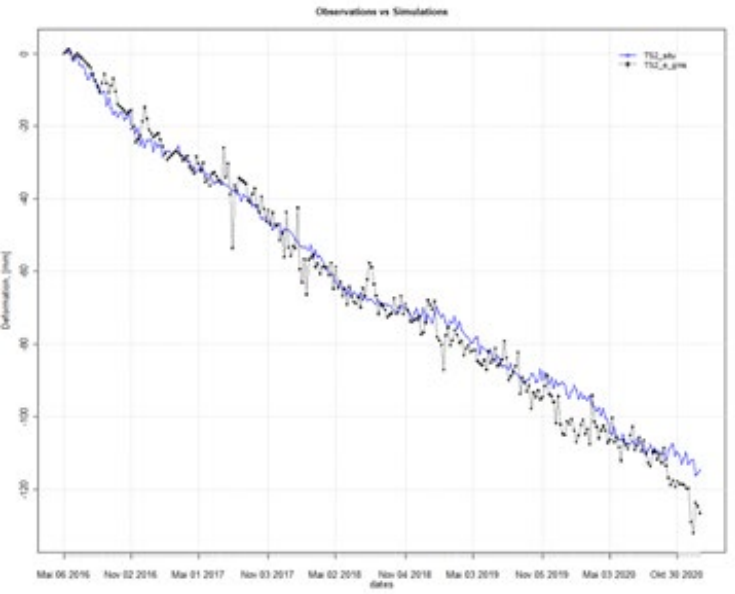
- **Objective**: evaluation of the EGMS timeseries and its velocity versus insitu data.
- **Data**: quality-controlled data coming from GPS campaigns, levelling, piezometers and geodetic monitoring.
- **Considerations**: Different temporal resolutions, precisions. We are looking for an agreement.

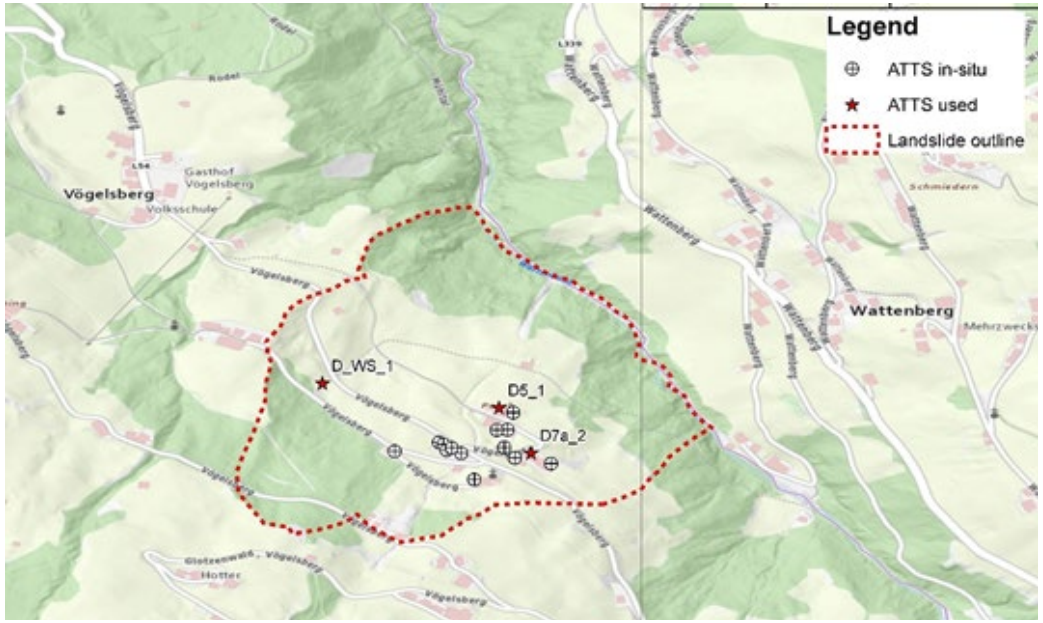


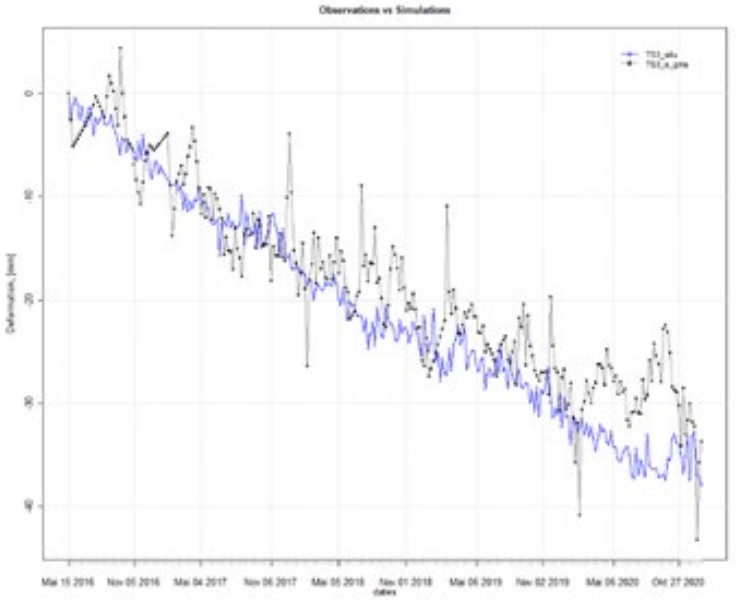


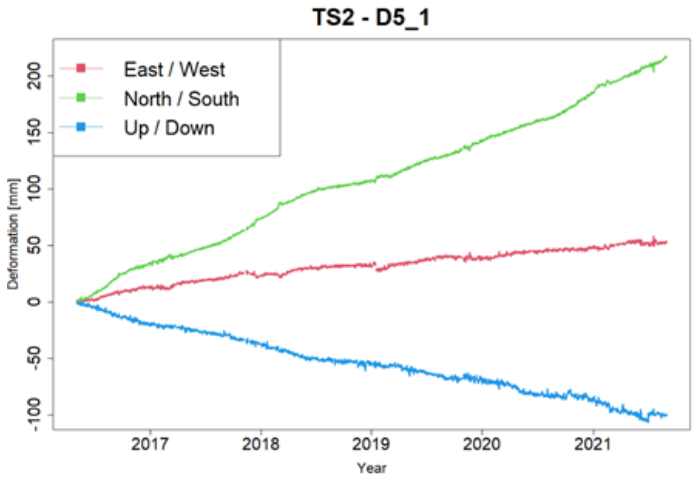
VA6 – Comparison with insitu monitoring - Poster

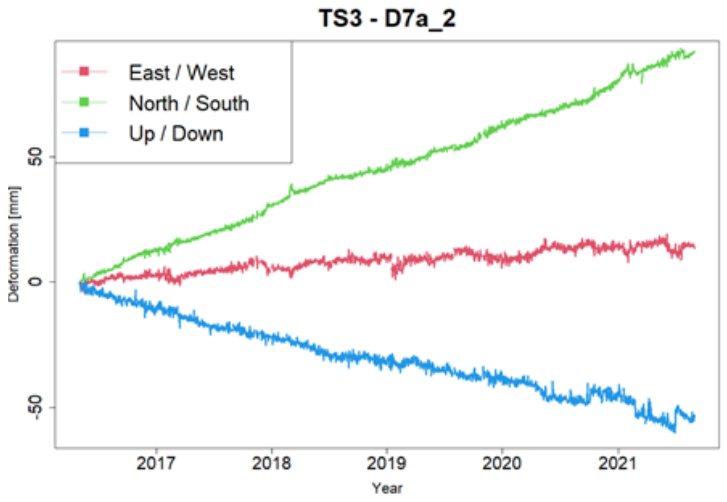
Result Examples: Geodetic 3D Automatic Total Tracking System









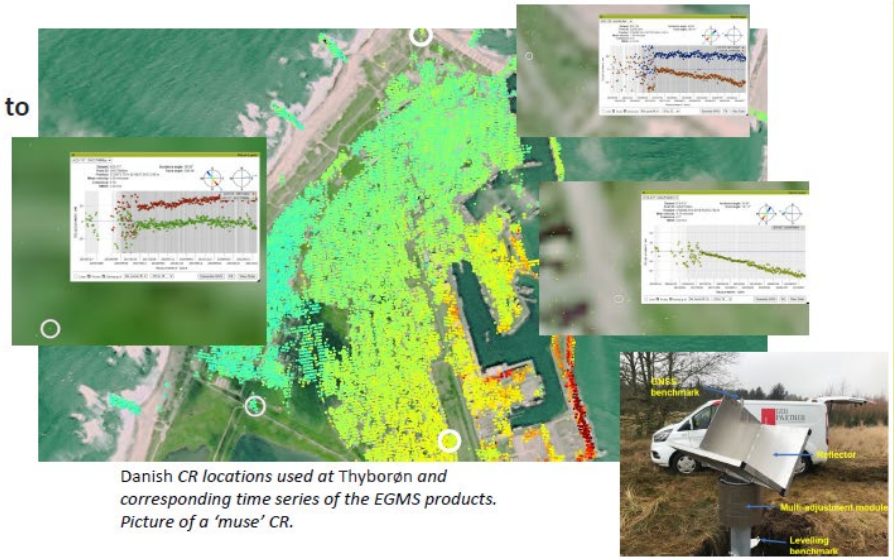


VA7 – Evaluation of XYZ with Artificial Corner Reflectors

- **Objective**: aimed to evaluate the precision XYZ of the EGMS timeseries with ACR data.
- **Data**: Quality-controlled artificial corner reflectors locations with precise measurements.
- **Considerations**: Limitations of the technique are taken into account (general agreement).

Denmark

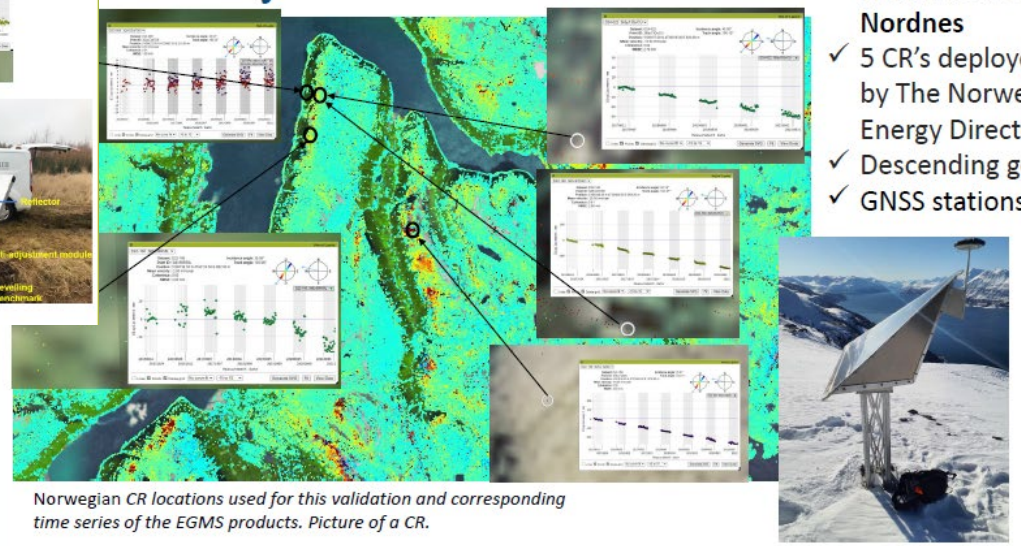
- ✓ **Thematic area: Subsidence due to consolidation – Thyborøn**
- ✓ 8 CR's deployed for C-band 3 CR's deployed in 2017 by Geopartner.
- ✓ → visible in the time series
- ✓ 5 CR's deployed in 2020 → not visible in the time series
- ✓ All reflectors are of the type 'Double geometry muse'
- ✓ Levelling in 2019, 2021, 2022



Danish *CR locations used at* Thyborøn *and corresponding time series of the EGMS products. Picture of a 'muse' CR.*

Norway

- ✓ **Thematic area: Landslides, Indre Nordnes**
- ✓ 5 CR's deployed for C-band in 2014-2015 by The Norwegian Water Resources and Energy Directorate (NVE)
- ✓ Descending geometry
- ✓ GNSS stations close to the CR's



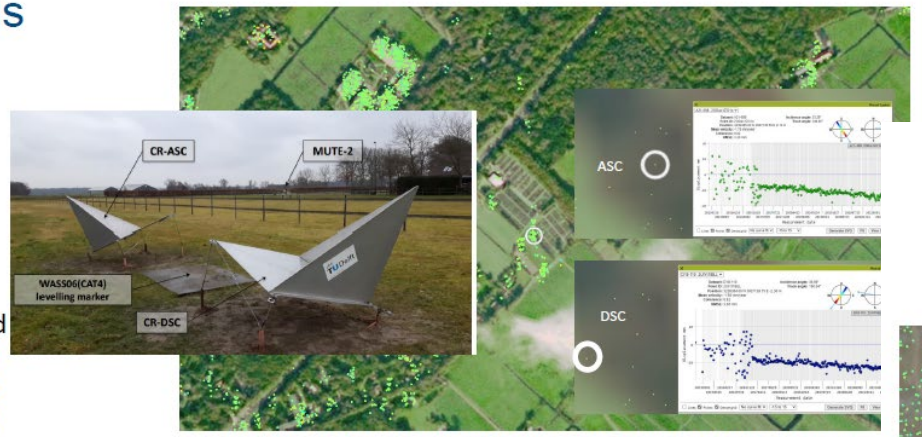
Norwegian *CR locations used for this validation and corresponding time series of the EGMS products. Picture of a CR.*

VA7 – Evaluation of XYZ with Artificial Corner Reflectors

- **Objective**: aimed to evaluate the precision XYZ of the EGMS timeseries with ACR data.
- **Data**: Quality-controlled ACR locations with precise measurements.
- **Considerations**: Limitations of the technique are taken into account (general agreement).

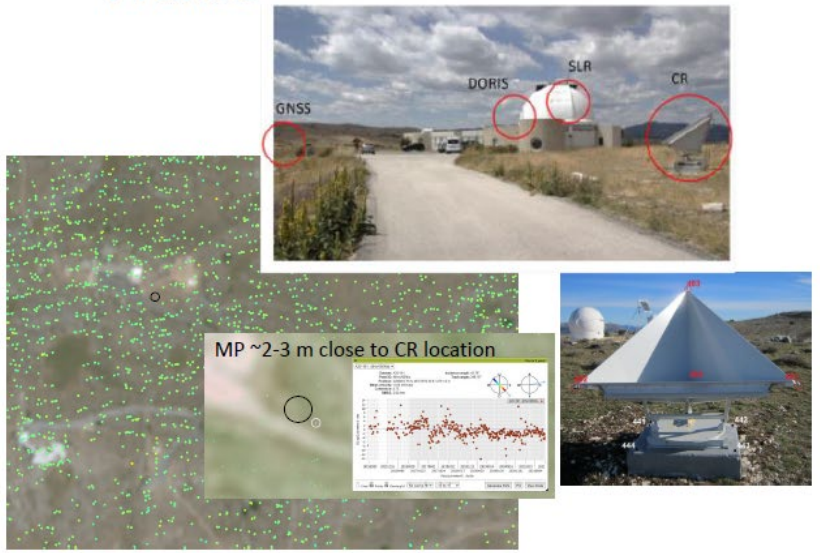
Netherlands

- ✓ Thematic area: none, relatively stable environment
- ✓ 2 CR deployed in Feb 2017
- ✓ One CR ascending geometry, one CR descending geometry
- ✓ Coordinates, heights and corresponding accuracy kindly provided by Hans van der Marel (TUDelft)



CRs location and the corresponding EGMS time series. The picture of the ascending and descending CRs.

France

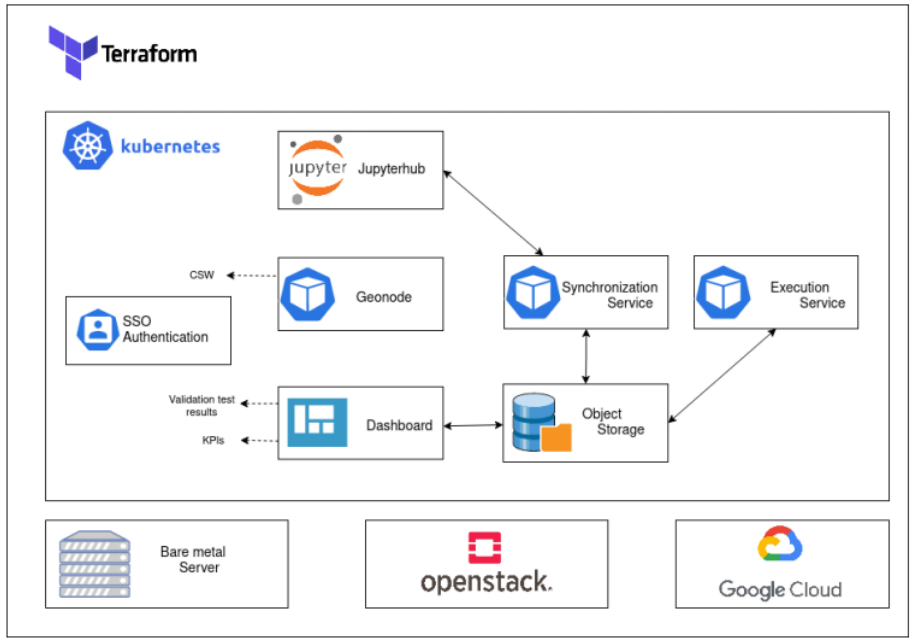


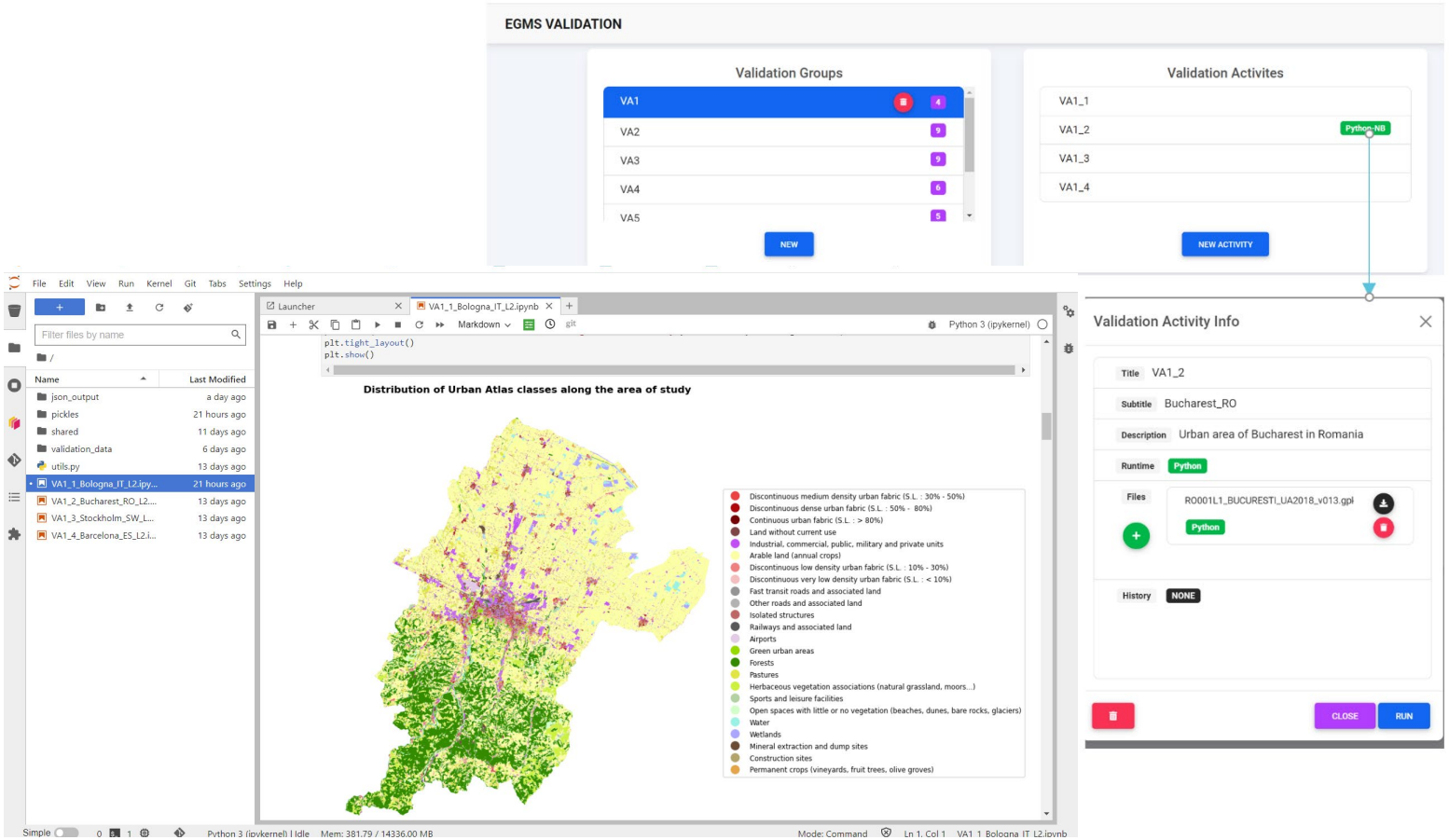
- ✓ Thematic area: **Seasonal hydraulic load/ water extraction, Calern Calern's multitechnical geodetic observatory**
- ✓ 1 CR deployed deployed for C-band in December 2018
- ✓ Ascending geometry
- ✓ Two GNSS stations, levelling in 2018, 2019, 2021, 2022

European Ground Motion Service (EGMS) – Validation Environment

A framework designed for **reproducible** research:

- Data Upload (custom dashboard)
- GeoNode validation data catalogue
- Jupyter Notebooks





Land Monitoring

Contact:

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