The European Ground Motion Service: a continental scale map of ground deformation

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Technological background

- The launch of the Sentinel-1 constellation
- The refinement of algorithms
- The increased computational capability offered by cloud computing platforms
- The number of successful case studies
- The trust of several entities in the InSAR results

Wide area InSAR is ready for the development of national/regional Ground Motion Services

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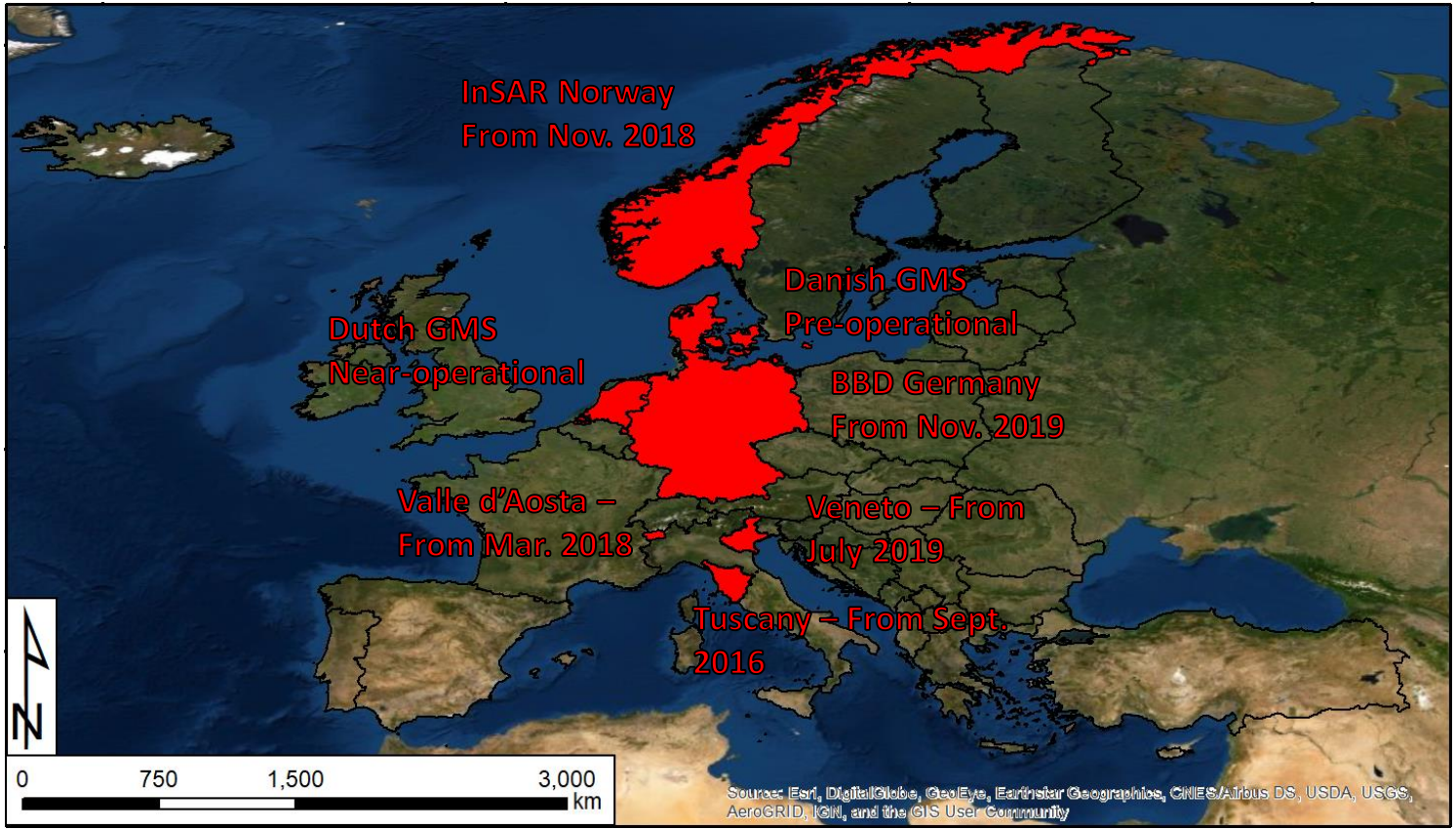
Examples of operational national and regional GMS' at EU level



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Main characteristics of the services (1)

Nation	Product portfolio	Processing characteristics
Denmark	• LOS deformation map calibrated on GNSS data and time series • E/W and vertical components • Vertical deformations calibrated on GNSS data and uplift model • Anomalous point database	• Sentinel-1 A &D images • PSI+DSI processing. • Full resolution for the deformation maps and 80x80 m resolution for the projected datasets
Germany	GNSS-calibrated LOS deformation map and time series	• Sentinel-1 A& D images • PSI full resolution processing
Italy (Tuscany Region)	• LOS deformation maps and time series • Anomalous point database and maps	• Sentinel-1 A & D images • PSI+DSI processing • Full resolution processing with time series data mining algorithm
Netherlands	• LOS deformation map calibrated on GNSS-data and time series • E/W and vertical components map • Object-based deformation monitoring with vertical and E/W decomposition	• Sentinel-1 A & D images • PSI+DSI processing • Full resolution for the deformation map and 200 m for the raster product
Norway	LOS deformation map and time series	• Sentinel-1 A & D images • PSI full resolution processing

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Main characteristics of the services (2)

Nation	Data dissemination	Validation
Denmark	• Full and open policy. Distributed through a WebGIS under request • The whole product portfolio will be available for the download, including time series • Guidelines and a data disclaimer are available	Through ground surveys and ancillary data comparison
Germany	• Full and open policy. Distributed through a WebGIS • Data download for fixed extent & upon request for larger areas • Guidelines and a data disclaimer are available	• Supported by GNSS data and based on three key concepts: estimation of the precision of the mean velocity, accuracy of the geocoding and accuracy of the mean velocity. • Pilot studies carried out at federal/national level
Italy (Tuscany Region)	• Full and open policy for the deformation maps (WebGIS), restricted for the anomalous point database • The user can download the whole deformation map at regional scale together with data guidelines	• Ground surveys, supported by ancillary data comparison, are performed to validate the highest deformation rates • A survey procedure was designed in accordance with regional entities
Netherlands	• Full and open policy • Data is going to be distributed through a dissemination platform under development	GNSS, levelling and corner reflectors
Norway	• Full and open policy. Distributed through a WebGIS • The user can download single or averaged time series	Ground surveys, periodical GNSS measurements, permanent GNSS stations collocated with artificial corner reflectors

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Features in common & unique characteristics

Features in common	• Base level: deformation map + time series • Full resolution processing of Sentinel-1 images (A&D orbits) • Free distribution policy • Data available through dissemination platforms • Users can download the time series of a single point or part of the deformation map within a bounding box • Data disclaimer and guidelines are available • Validation is a key part of the services
Unique characteristics	• Different product portfolios (except for the base level) • Selection of coherent points: PSI vs PSI+DSI • Update frequency: some GMS are updated every year (e.g. Germany, Denmark or Norway) other are updated every 12 days (Italian regions) • Different validation approaches

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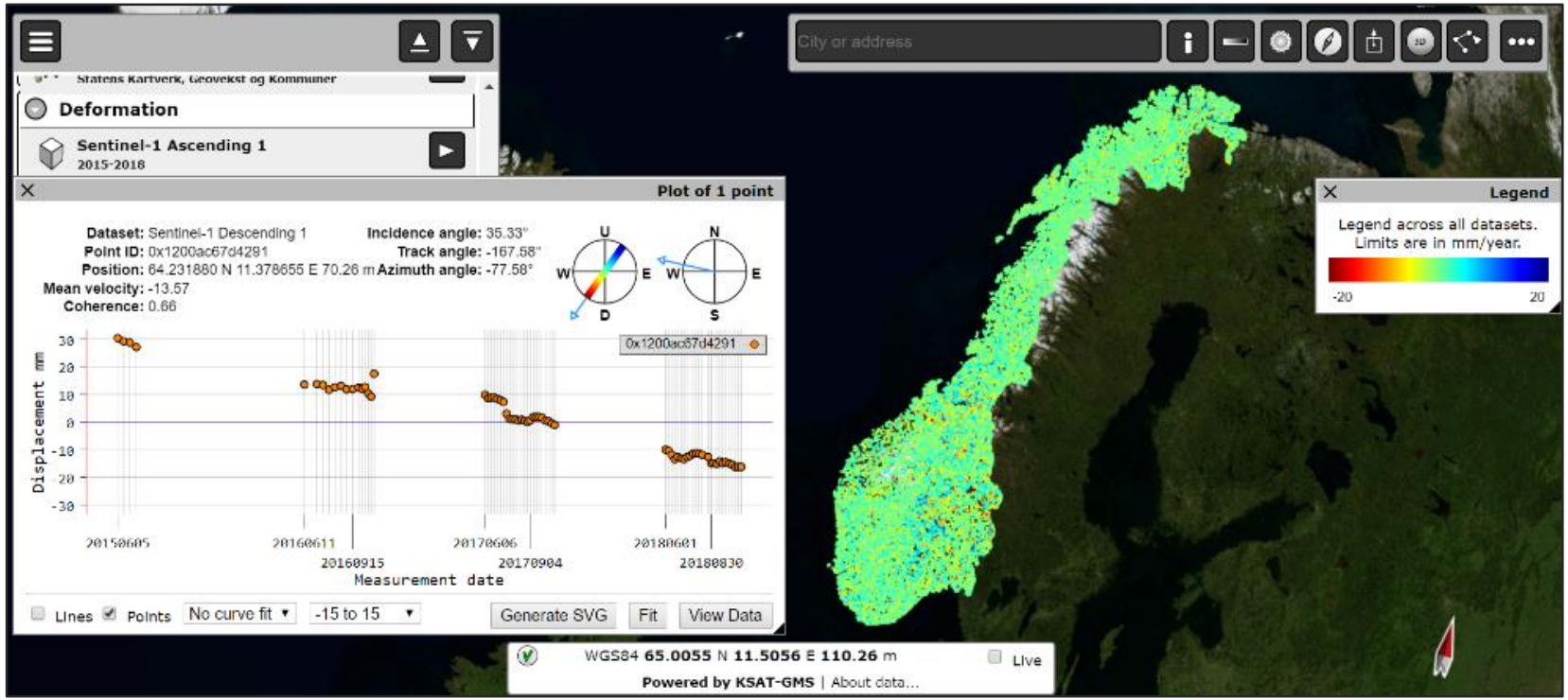
InSAR Norway – Dissemination platform



From http://www.insar.ngu.no/

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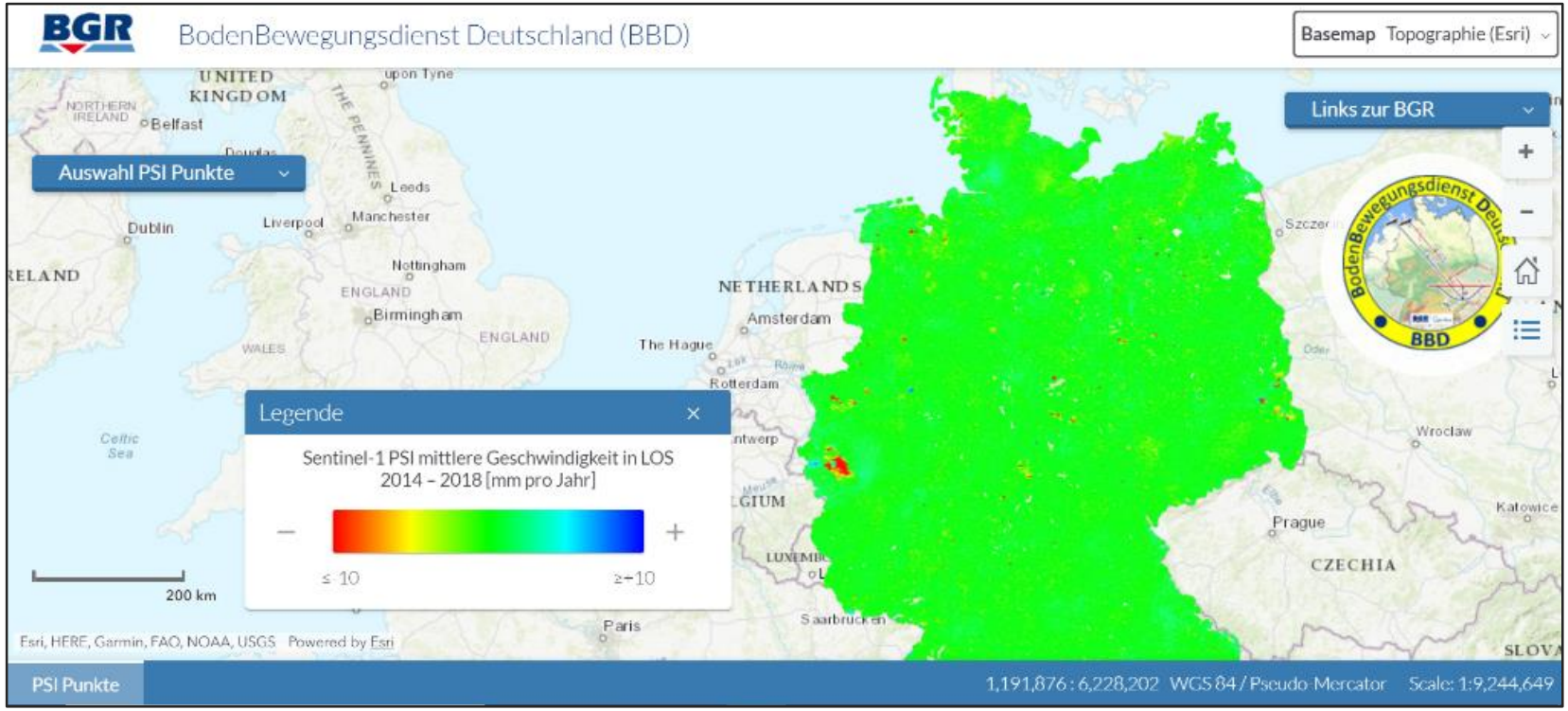
BodenBewegungsdienst Deutschland (BBD) – Dissemination platform



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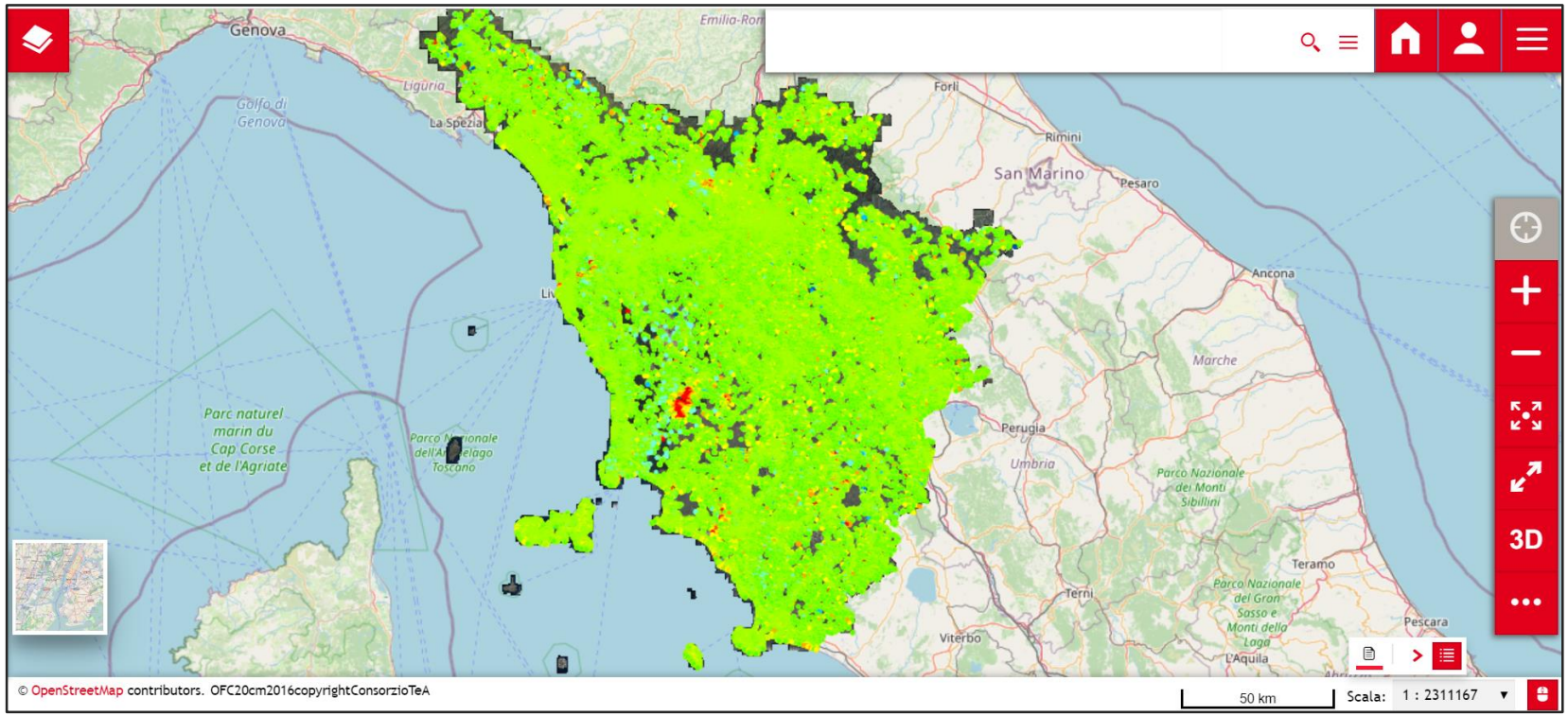
Tuscany Region monitoring service – Dissemination platform



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European Ground Motion Service - Background

- The concept of the EGMS was defined by the EU-GMS Task force, composed of 75 members of entities from all over Europe
- The work of the Task Force produced the "EGMS White Paper", i.e. conceptual framework for the EGMS
- The Copernicus User Forum and the Copernicus Committee approved the addition of the EGMS to the Copernicus Land Monitoring Service
- The EGMS is managed by the European Environment Agency (EEA)

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European Ground Motion Service – Current status

- The EEA commissioned to a group of InSAR processing experts the definition of the Product Specification Document and the Service Implementation Plan (PSD-SIP) – published in January 2020
- The work of the EEA is supported by the EGMS Advisory Board (AB) composed of 6 experts of InSAR data analysis, interpretation and dissemination
- The AB e.g. oversaw the development of the PSD-SIP and will oversee the production and validation of the EGMS
- The tender for the production of the EGMS is being finalized by the EEA and will be published soon

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European Ground Motion Service – Concept

- The Service aims to provide consistent, regular, standardized, harmonized and reliable information at pan European scale.
- The EGMS will be produced using a wide area time series InSAR approach
- Both ascending and descending orbits will be processed
- The EGMS will be updated every 12 months after the baseline
- All the data produced will be free and open for all the users, following the Copernicus data policy.
- A dissemination platform will allow for data access, visualization and download

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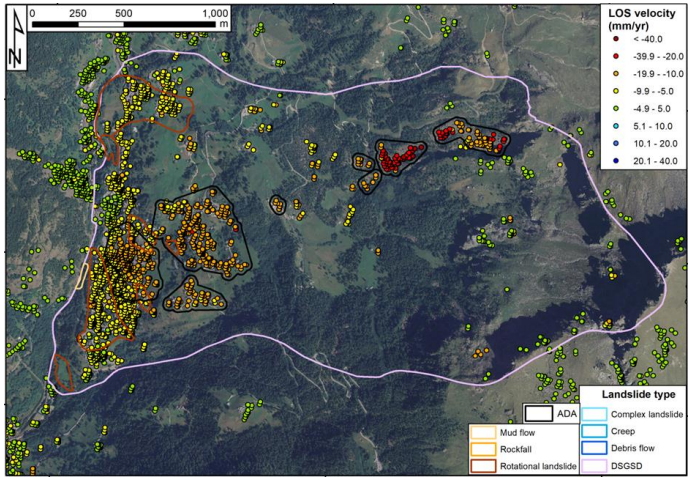
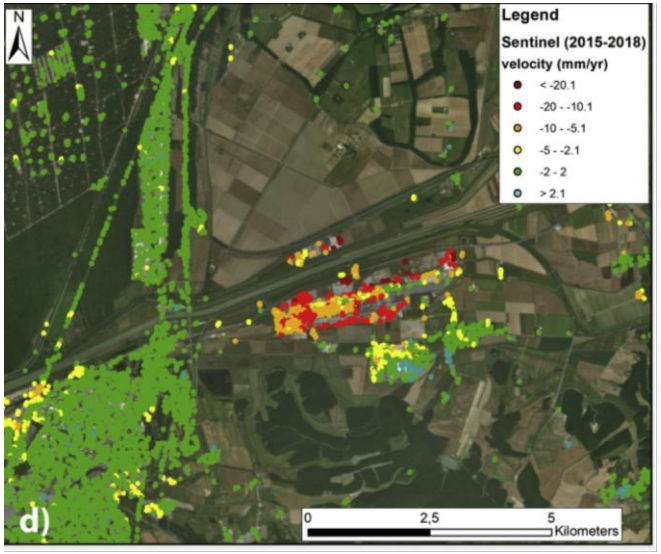
EGMS – Application areas

- Natural and man-induced geohazard risk assessment
- Geodesy
- Land management, urban and rural planning
- Climate services
- Infrastructure development and management
- Mining and other natural resources extraction



From Solari et al. "Satellite interferometric data for landslide intensity evaluation in mountainous regions"



From Ciampalini et al. "Evaluation of subsidence induced by long-lasting buildings load using InSAR technique and geotechnical data: The case study of a Freight Terminal (Tuscany, Italy)"

- Dam and groundwater monitoring
- Insurance topics and litigations
- Structural and civil engineering
- Cultural heritage
- The property market
- Railway and road management

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EGMS – Target user groups

- Geological and geodetic surveys
- Road, railway and mining administrations
- Regulators and planners
- Public authorities at European, national, regional and municipal levels
- Citizens of Copernicus participating states
- Industry (infrastructure management, engineering, oil and gas, mining, insurance, etc.)
- Energy sector
- Academia

Have a look to the "EGMS Service Implementation Plan and Product Specification Document" for use cases and requirements for each group

https://land.copernicus.eu/user-corner/technical-library/egms-specification-and-implementation-plan

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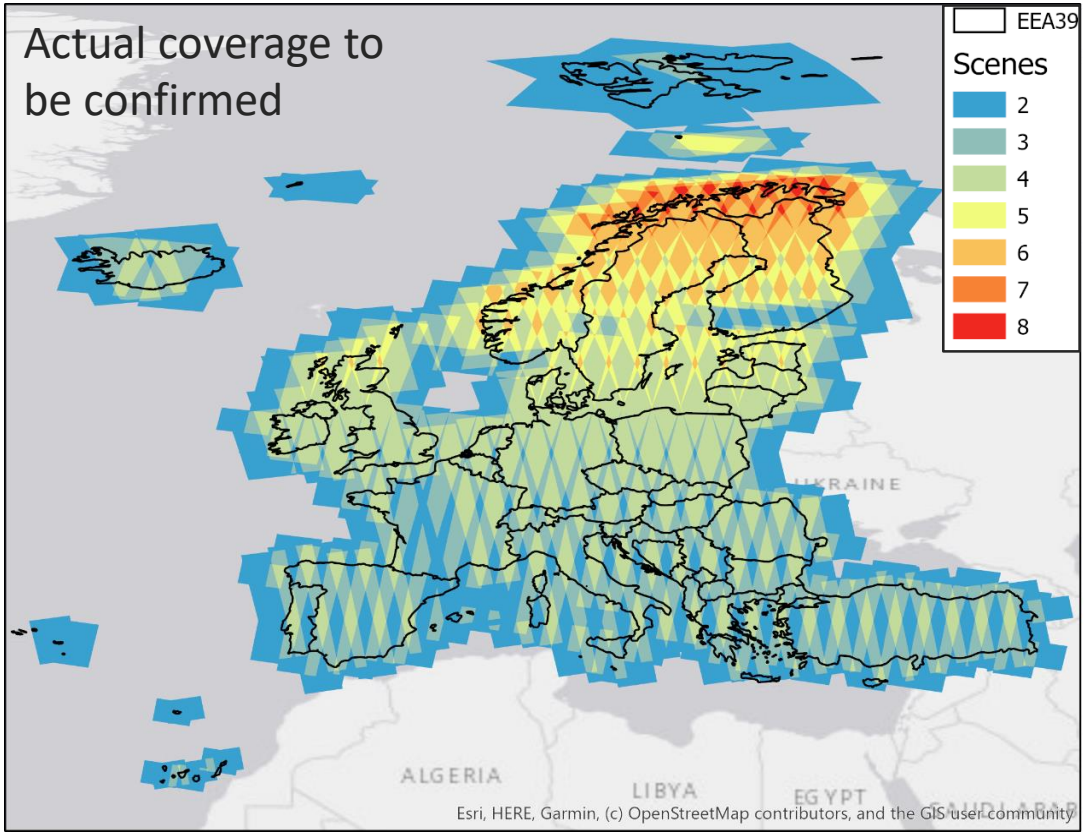
Data volume & coverage



- ~20000 individual bursts = ~750 SLC
- On average 200 scenes for any stack (at the moment)
- 60 new scenes for stack per year
- 1.5 PB (uncompressed) for the baseline
- 350 TB per year

From https://land.copernicus.eu/user-corner/technical-library/egms-specification-and-implementation-plan

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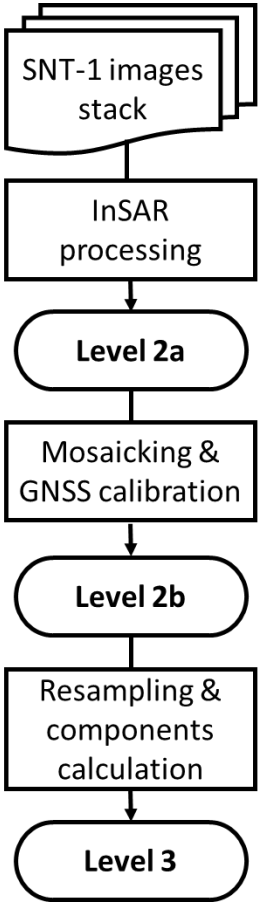
EGMS - Product levels



- Level 2a

Basic displacement information provided in satellite LOS in the original radar geometry grid, with annotated geolocalisation and quality measures per measurement point. Full resolution product.

- Level 2b (core product)

Based on Level 2a products, integrated into a standardised reference frame using external information such as GNSS data. Full resolution product.

- Level 3

East-West and Up-Down deformation rates produced by combining Level 2b data from ascending and descending orbits. Resampled product, 100 by 100 m grid.

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EGMS – Production & validation

- Specific quality requirements will be set for each product level, according to the technical capability and limitations of wide area InSAR
- The EGMS production will be quality controlled through the entire process
- Independent validation will be performed by an external validation team at the end of the production phase

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EGMS – Benefits

- For the first time European countries will have access to free InSAR results
- Huge opportunity to increase the knowledge and use of InSAR results in countries where availability and use of such data is limited or null.
- The EGMS will allow the nations/regions running a GMS to diversify their activities (e.g. processing VHR radar images or increasing the temporal frequency)
- It is expected that the EGMS is going to stimulate the development of downstream activities and of new tools and procedures to exploit the EGMS results
- User uptake activities related to the EGMS will contribute to a wider diffusion and distribution of InSAR results
- The success of the service will strengthen the role of InSAR as a reliable ground monitoring technique

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For any question

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