Large scale ground deformation services and their potential for downstream applications

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GAF Company Introduction

- GAF provides experience-based innovation for individual geo-information solutions & high-resolution satellite data mapping services & consulting.
- 35+ years of experience
- 50+ projects for Copernicus
- 140+ countries
- 220+ employees
- 150+ elevation models of cities worldwide with 0,3m and 0,5m resolution
- 4 Mio.+ km² of 5m resolution EuroMaps 3D elevation model worldwide

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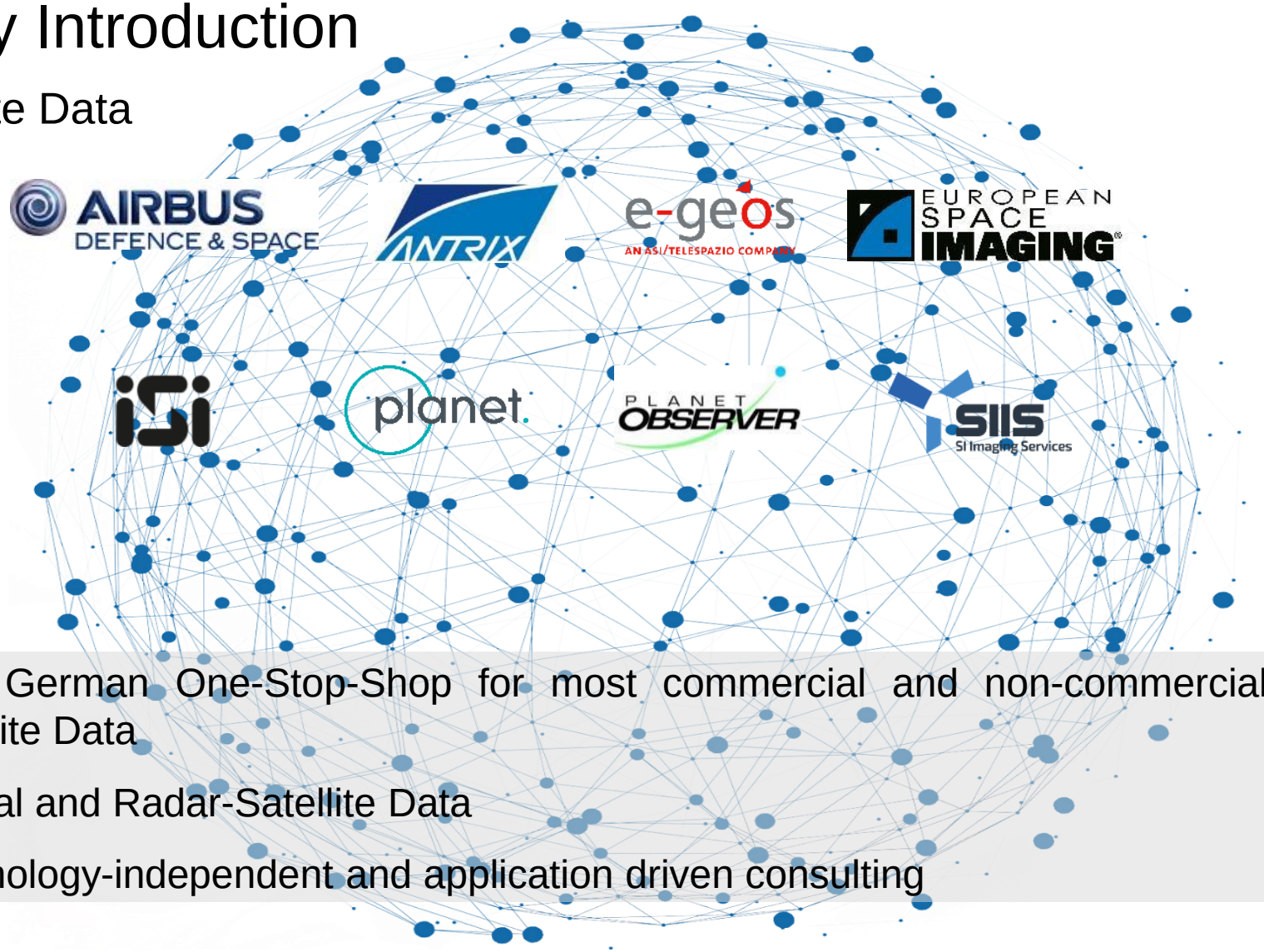
GAF Company Introduction

Multi-Source Satellite Data



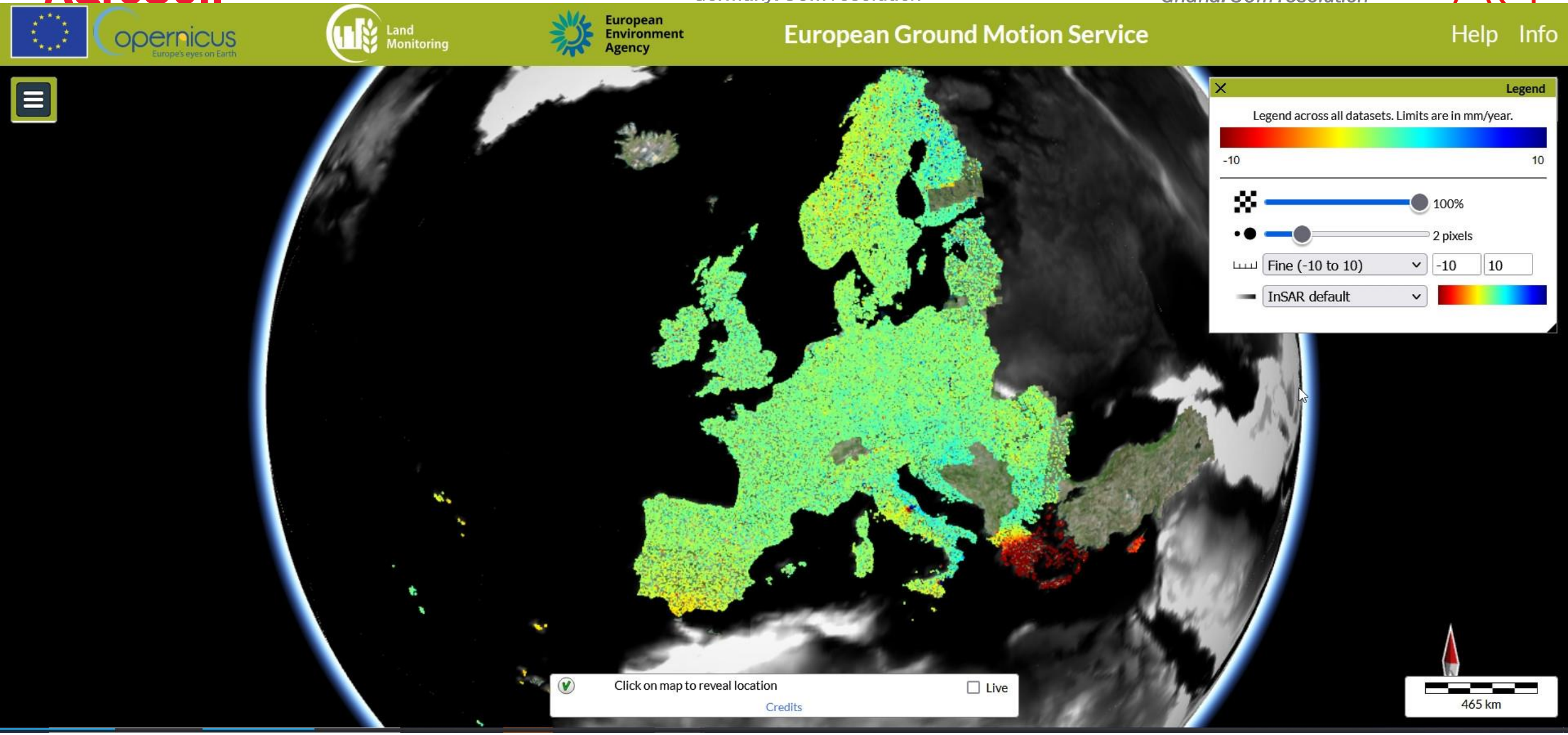
and more …

- Sole German One-Stop-Shop for most commercial and non-commercial EO-Satellite Data
- Optical and Radar-Satellite Data
- Technology-independent and application driven consulting

AgroSoil

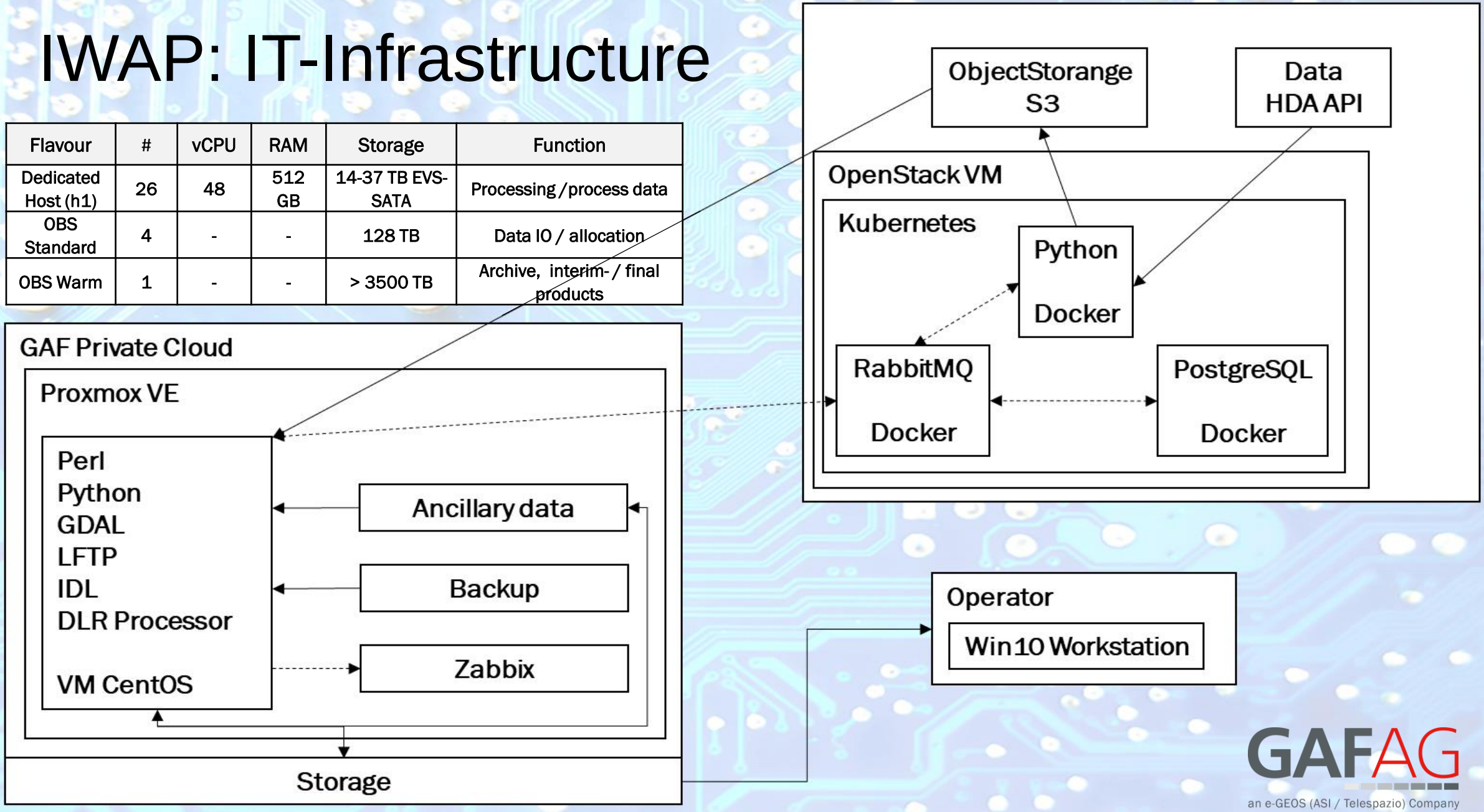
Germany: 30m resolution

Ghana: 30m resolution



IWAP: IT-Infrastructure

Flavour	#	vCPU	RAM	Storage	Function
Dedicated Host (h1)	26	48	512 GB	14-37 TB EVS-SATA	Processing /process data
OBS Standard	4	-	-	128 TB	Data IO / allocation
OBS Warm	1	-	-	> 3500 TB	Archive, interim- / final products



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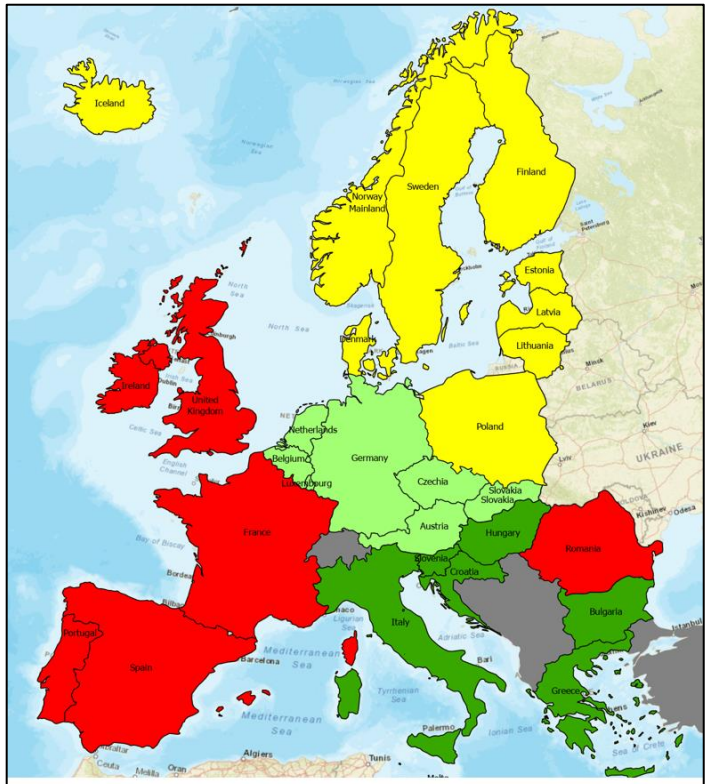
IWAP: Core Services

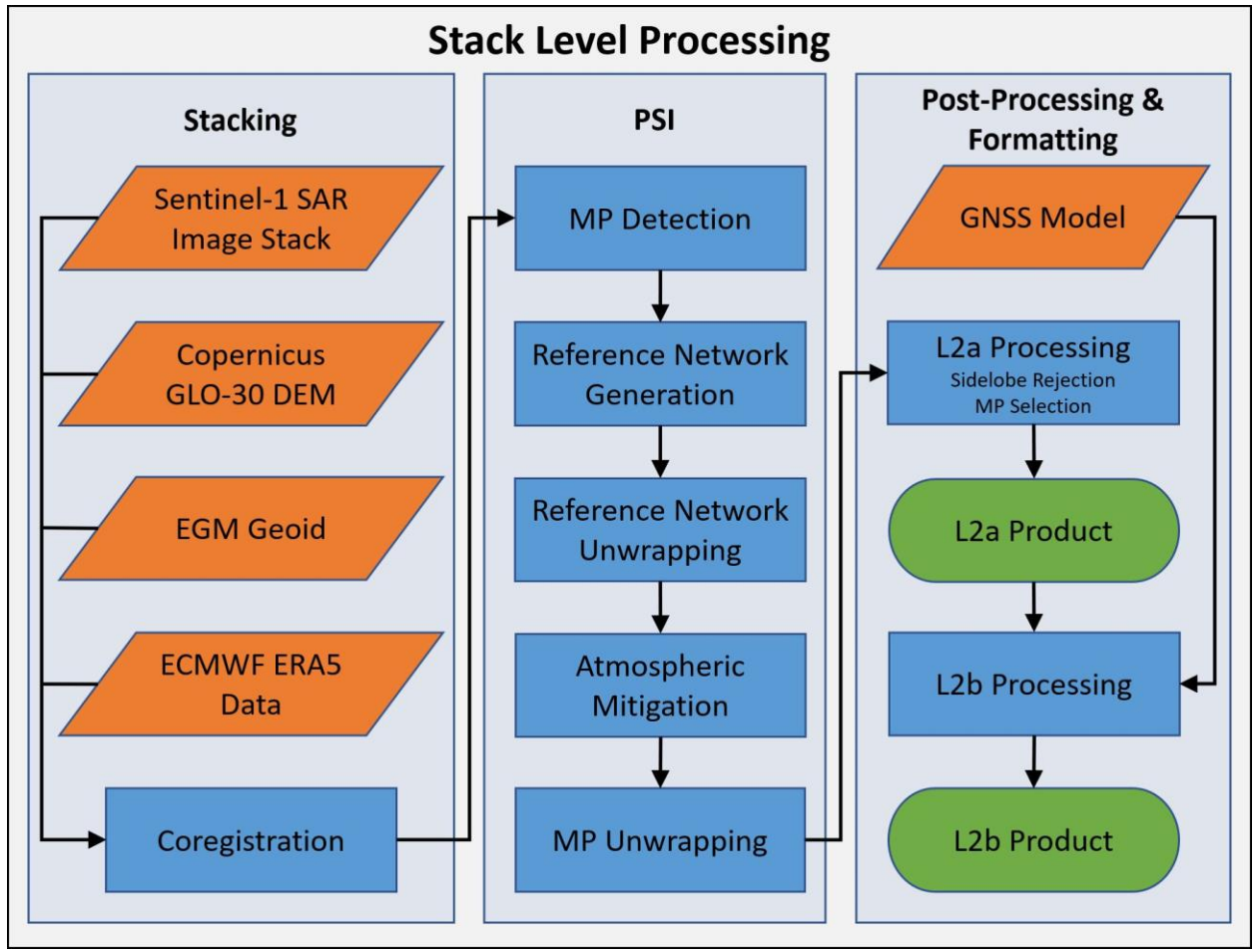
- Services utilising the extensive Sentinel-1 data base providing a global archive of interferometric stacks
- IWAP Processing technology developed by DLR and advanced in close cooperation
- Exploiting wide area InSAR core services as a fundamental information source from:
  1) Ground Motion Service Germany (Update)
  2) European Ground Motion Service
  3) Global wide area processing on request with customized product generation

Technical Concept - BBD & EGMS



After		Before	
%	Partner	%	Partner
14.7%	e-GEOS	24.2%	e-GEOS
36.5%	TREA	31.7%	TREA
35.6%	NORCE	31.1%	NORCE
13.1%	DLR|GAF	13.0%	DLR|GAF

Service Area



PSI-WAP Processing

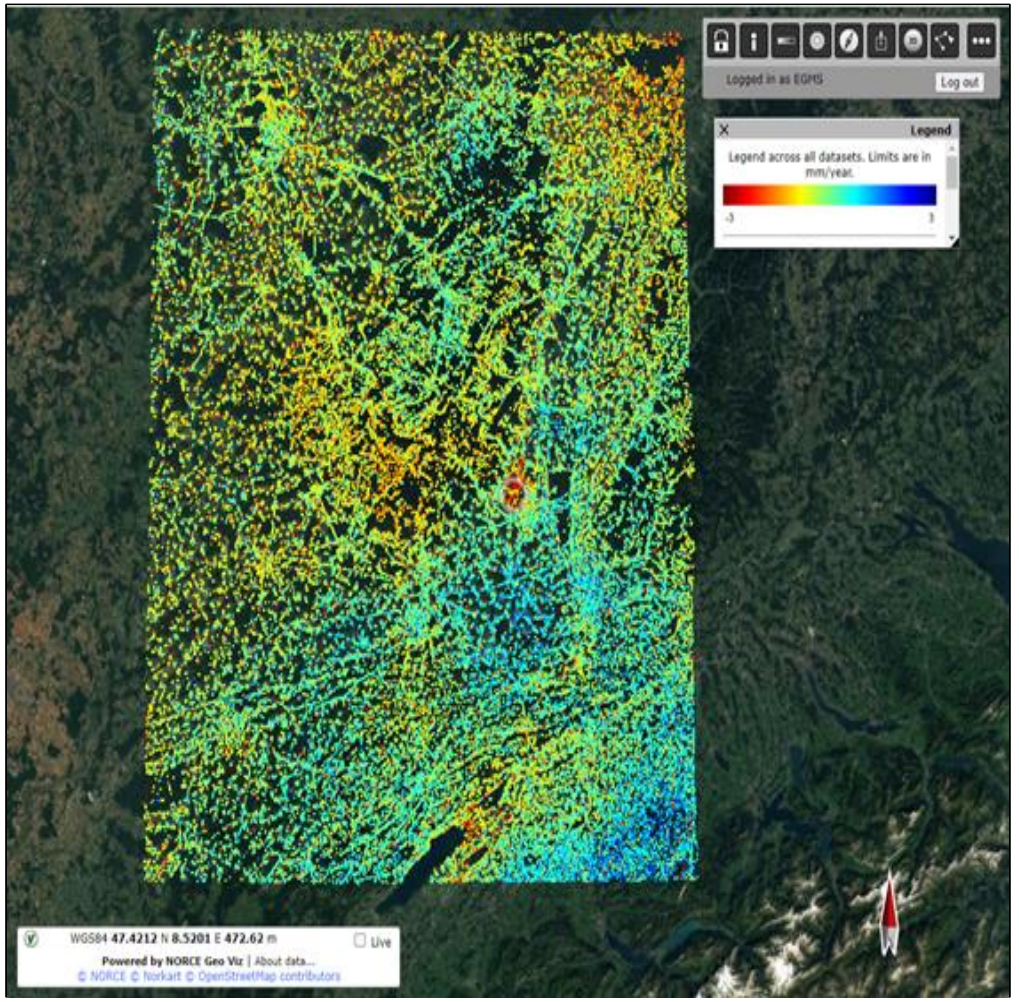
Validation and Quality Control

EGMS: harmonisation exercise

1. Product validation of all IPEs over the harmonisation test site in the area ***Nancy – Freiburg – Berne – Besancon***
2. Number of Measurement Points:

IPE	Ascending	Descending	Percent difference
EGEOS	11189114	11200706	0.1%
GAF	10937979	10611433	3.1%
NORCE	11715483	12001883	2.4%
TREA	10357149	10480132	1.2%

3. Overall number of MPs show: all 4 IPEs achieve similar values.
4. Variations result from local geometric effects of the mapped objects relative to the incidence angle and illumination direction.



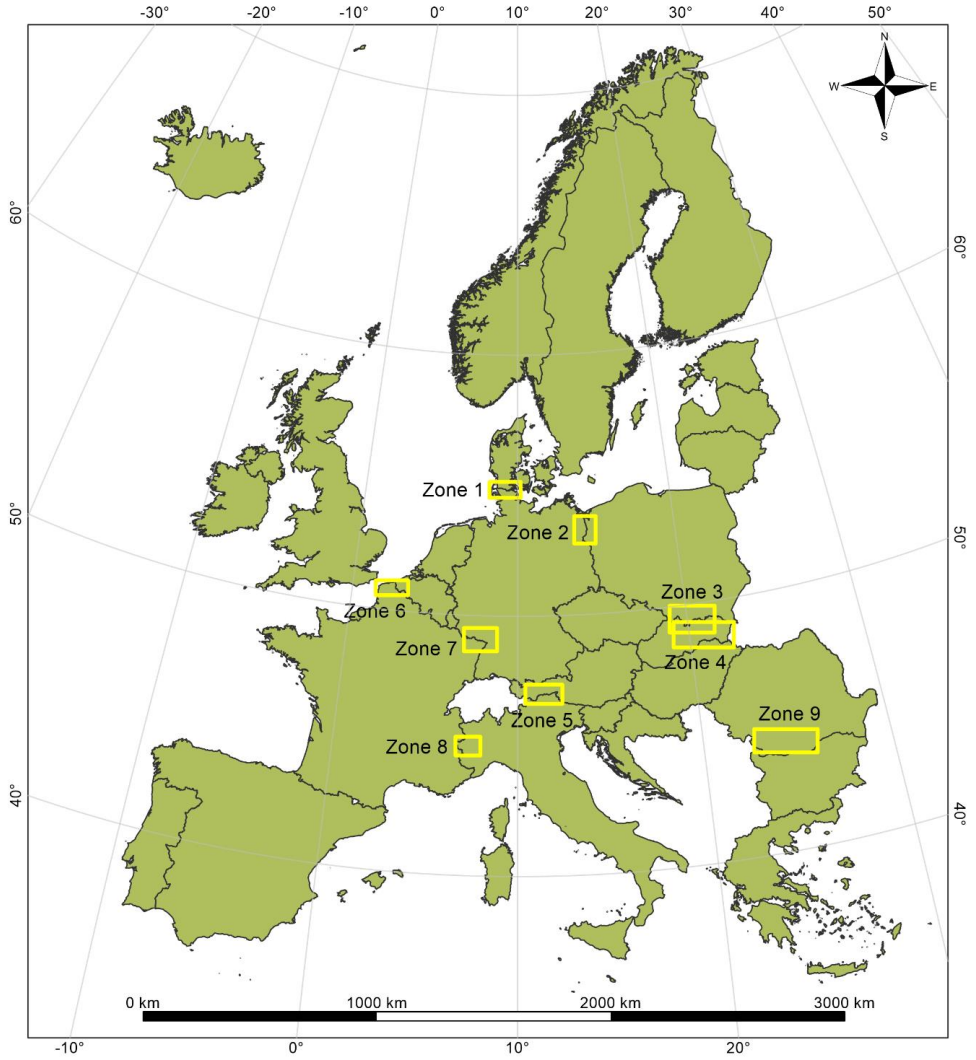
Validation and Quality Control

Production QC – pairwise IPE

1. MP densities for CLC18 of the overall area (zone 1 – 9)

CLC18-Class	Ascending	Descending
1.1.1	5808	5893
1.1.2	2374	2525
1.2.1	2603	2633
1.2.2	1953	2051
1.2.3	2343	2390
1.2.4	1127	1112
3.3.2	2383	2527
3.3.3	2010	2082

2. Results show that
   a) all minimum requirements were met and in some classes even considerably outperformed,
   b) the difference between ascending and descending data is maximally 6 % indicating a good correlation between the two directions.



Ground Motion Service (BBD)

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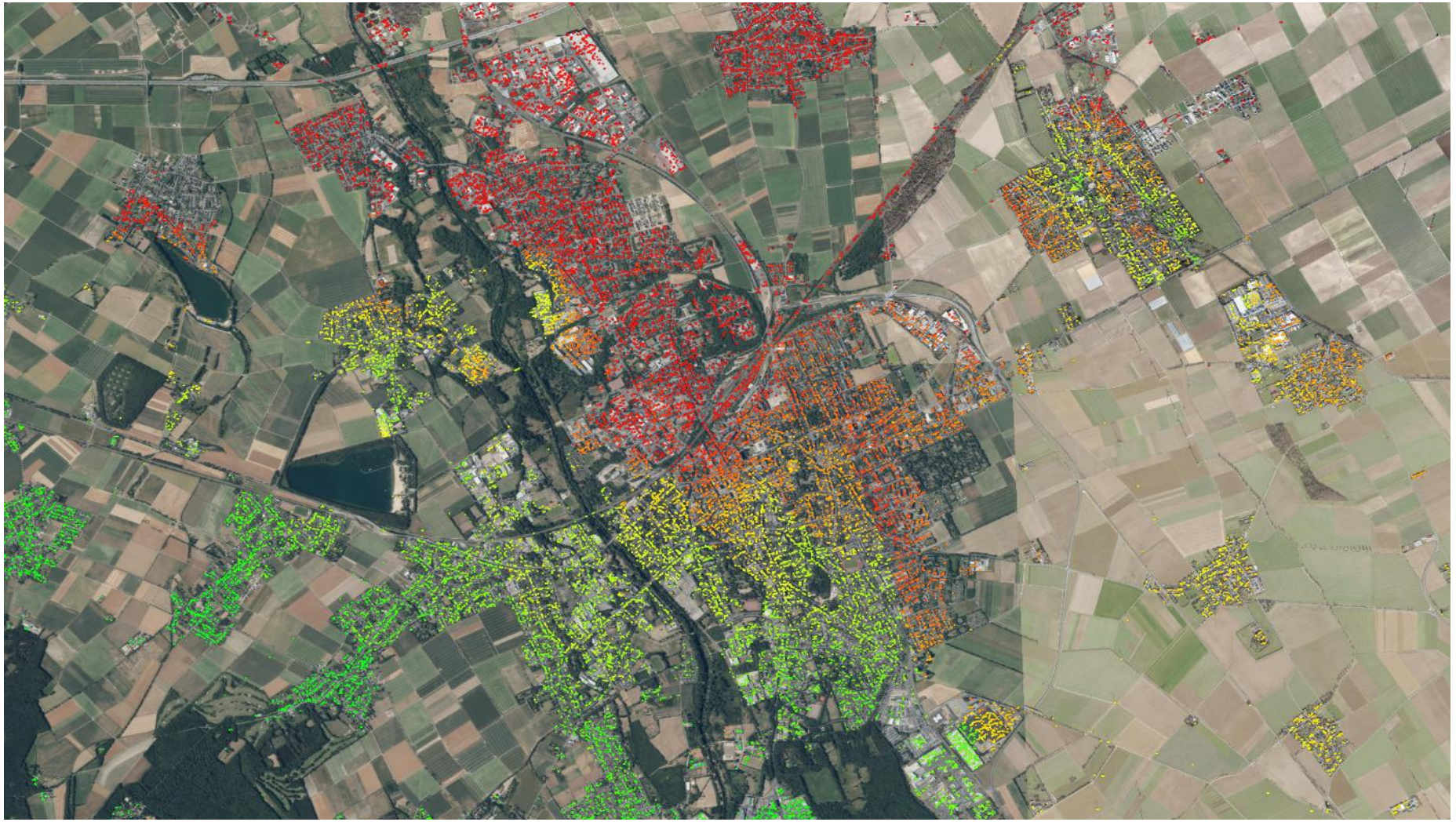
BGR



Product Visualisation in Alpine Terrain

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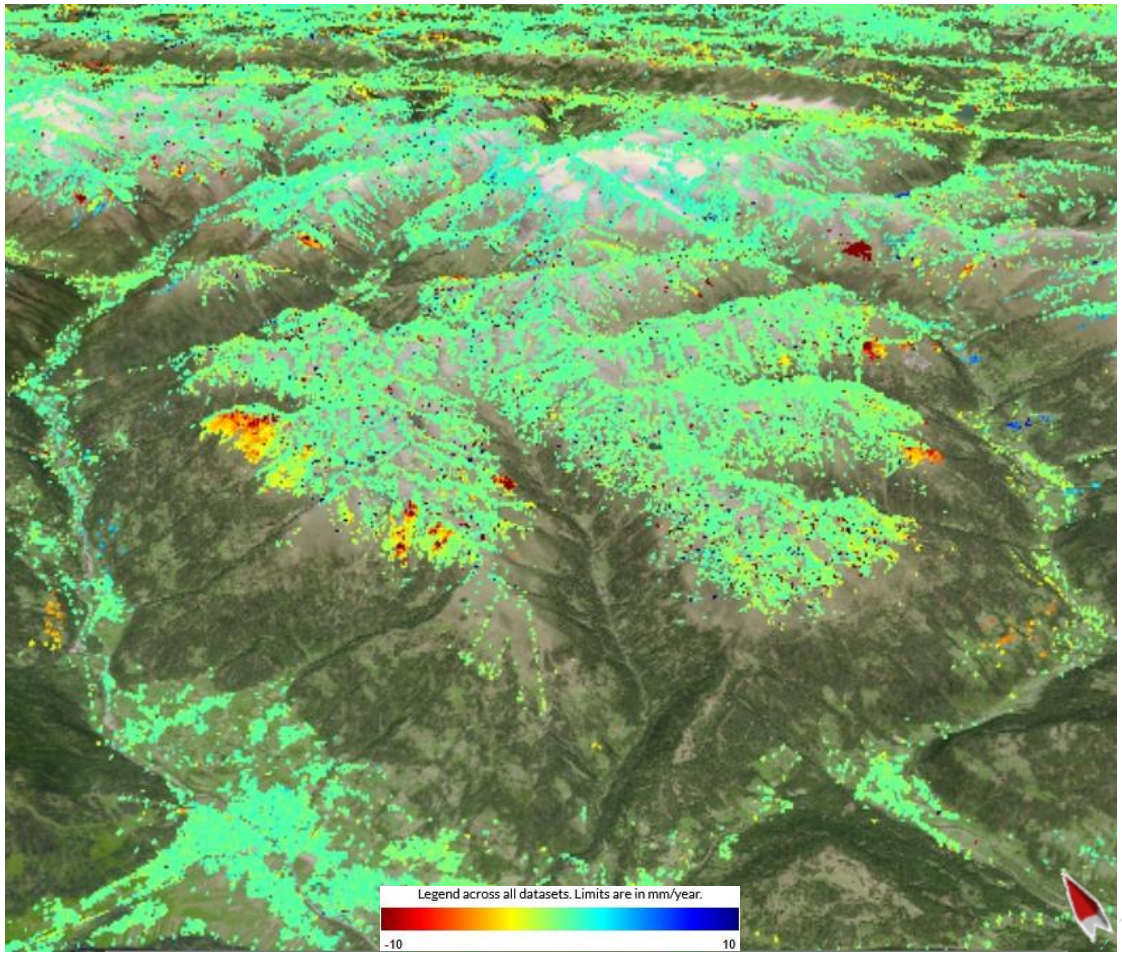
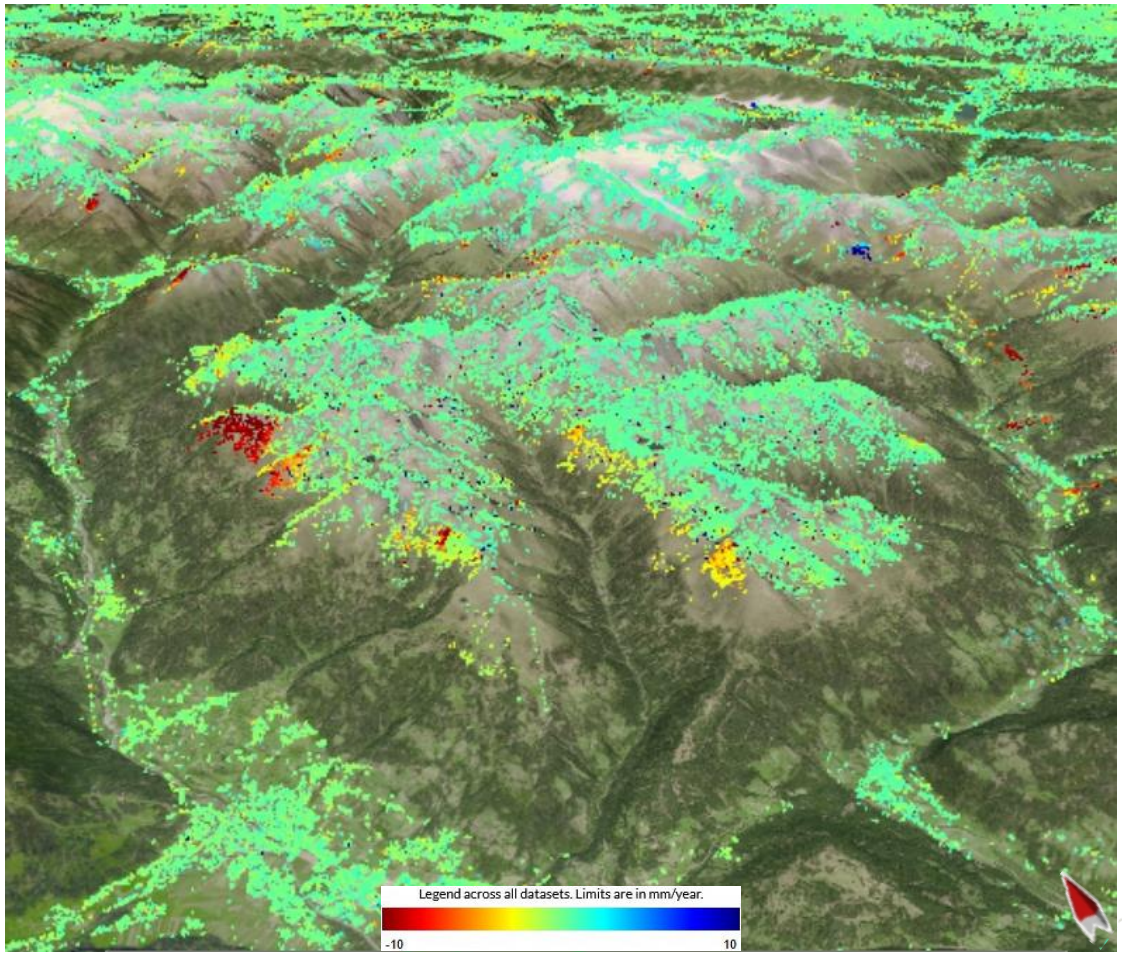
MP density in alpine terrain, Lienz (Austria)



Basic (L2B) --- ascending



Basic (L2B) --- descending

Product Visualisation in Alpine Terrain

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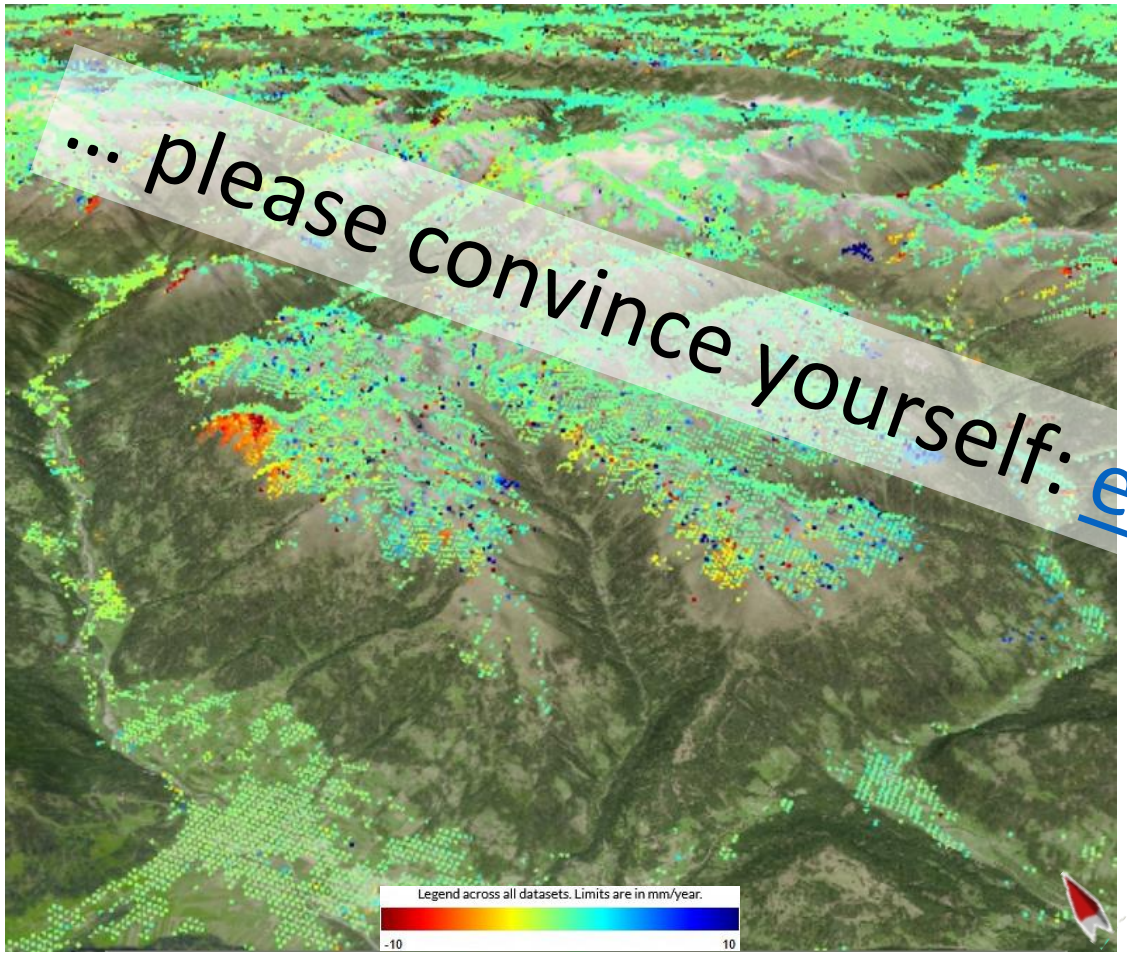
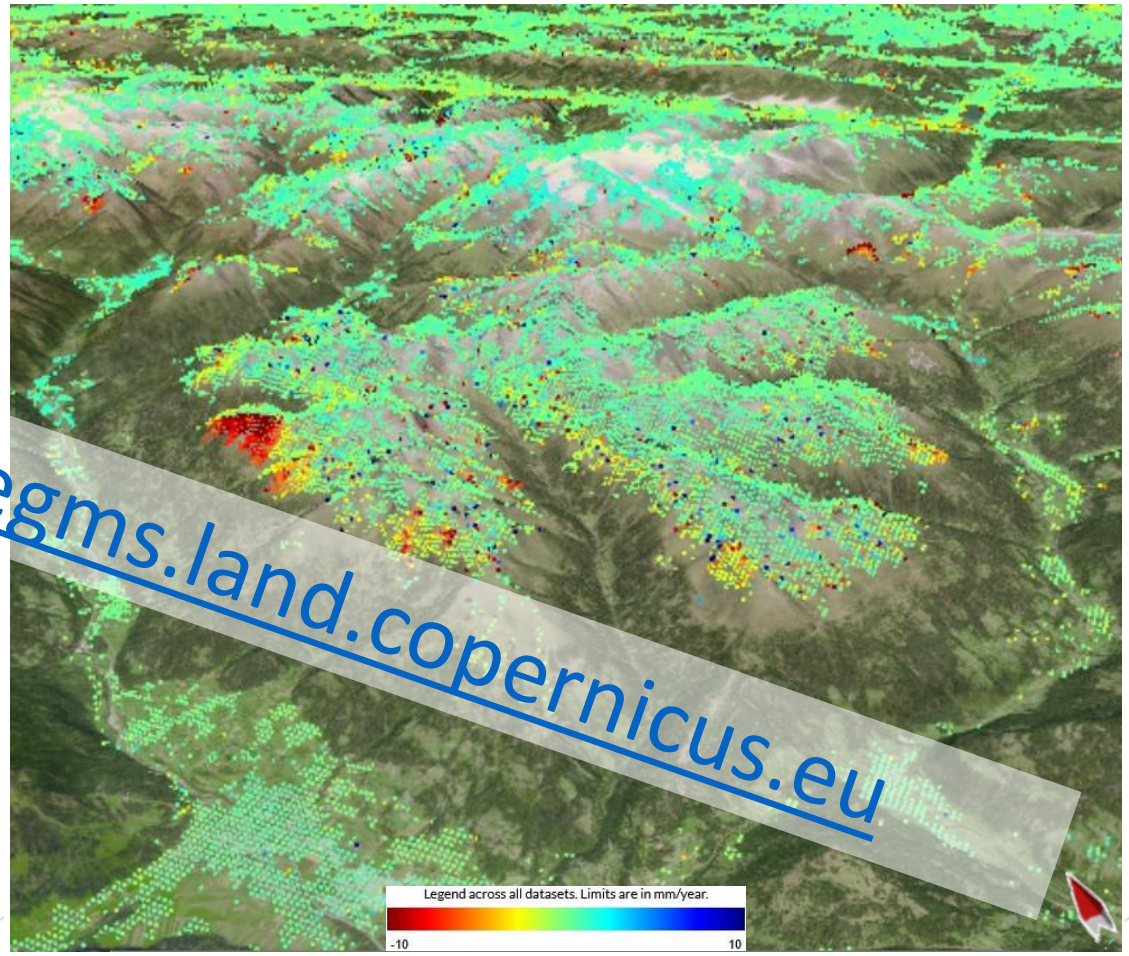
MP density in alpine terrain, Lienz (Austria)



Ortho (L3) --- East-West



Ortho (L3) --- Up-Down

… please convince yourself: egms.land.copernicus.eu

Value Added Services

Integrating various information sources on different levels to optimally meet user needs and requirements:

- Adaption of interferometric (Sentinel-1) base products
- Generation of information integrating multiple data sources:
  - client data
  - in-situ data
  - optical EO
  - modelling
- Assimilation of local knowledge via partner network
- WebGIS, visualisation, consulting and analysis

Value Added Services

Increasing the level of detail applying „*zoom services*“:

- triggered by indication of ground motion from core services
- using VHR and SVHR SAR systems
- optimising acquisition geometries
- increasing sampling rates using SAR-constellations for
  - densification of acquisition time series
  - higher agility and reduction of response time

Application – Sumo4Rail

Risk management on a national level (Sumo4Rail)

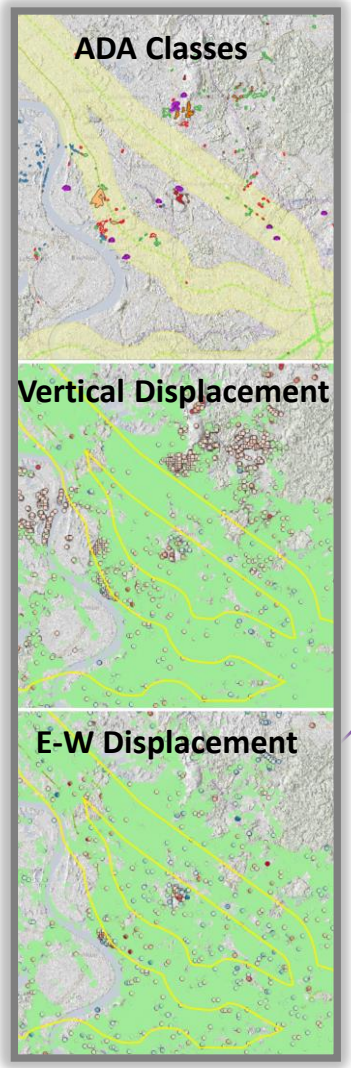
User:

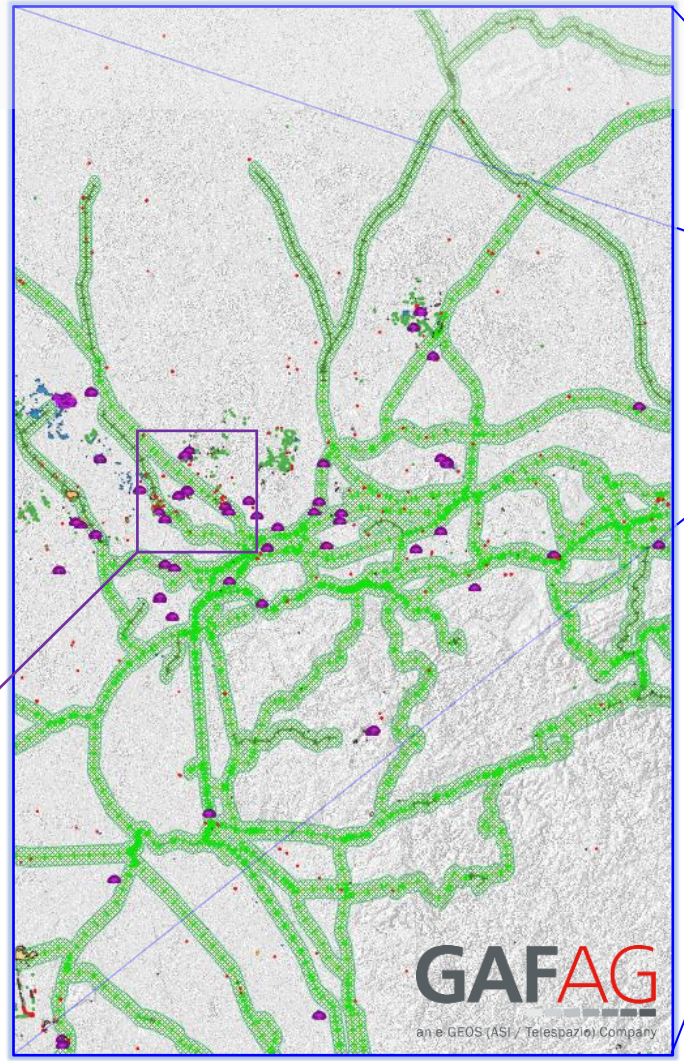
German Federal Railway Authority

Duisburger Hafen AG

- Utilisation of the German Ground Motion Service (2015-2017)
- Assessing risks along rail tracks affecting the logistics chain
- Long-term monitoring of geological, climatological and hydrological induced deformations for route planning and life-cycle management
- Port of Duisburg as terminal of the New Silk Road
- Logistics chain of special interest
- Rail tracks and highways cross mining territory of the Ruhr Basin

Sumo4Rail


ADA Classes
Vertical Displacement
E-W Displacement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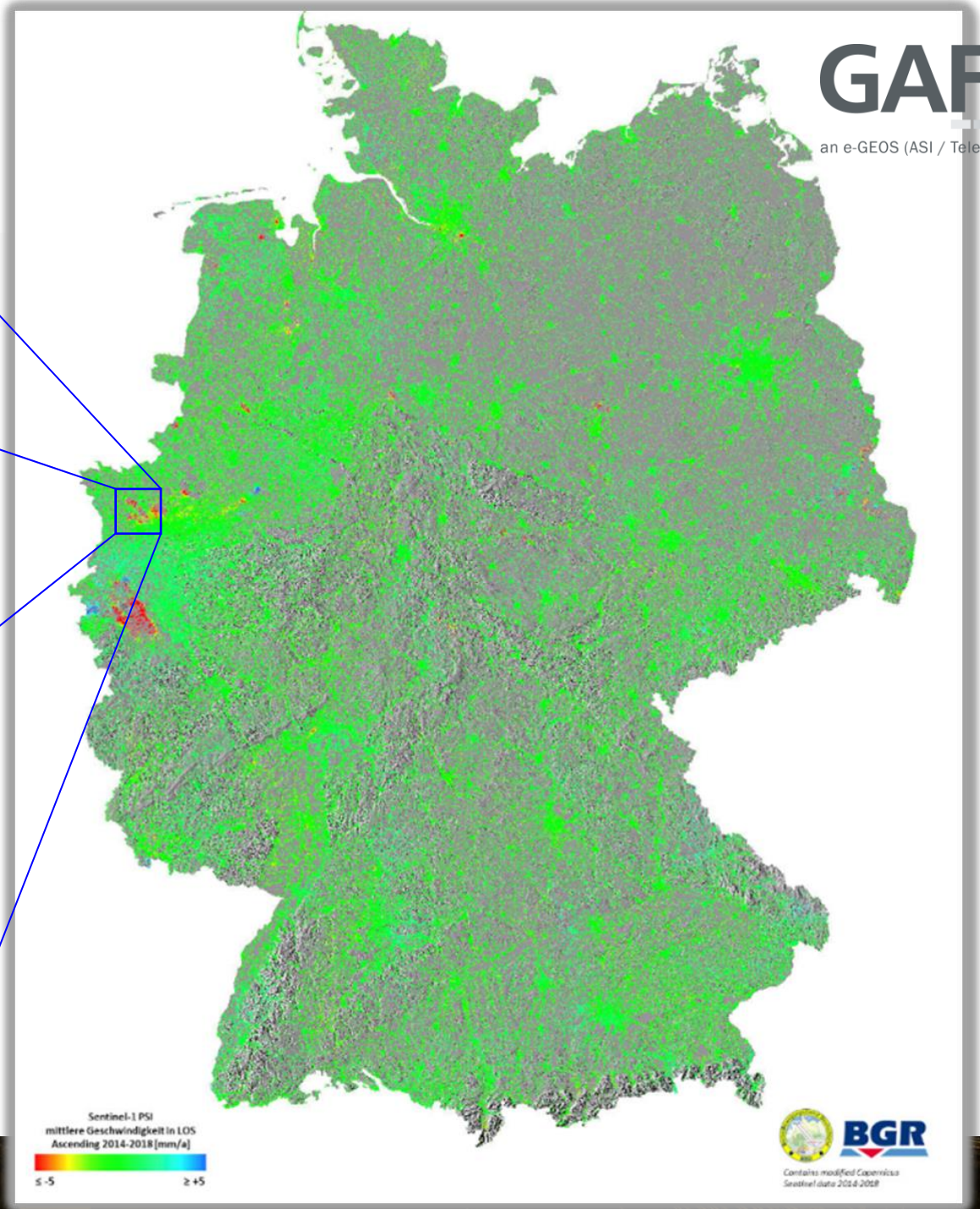
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Sentinel-1 PSI
mittlere Geschwindigkeit in LOS
Ascending 2014-2018 [mm/a]
≤ -5
≥ +5
BGR

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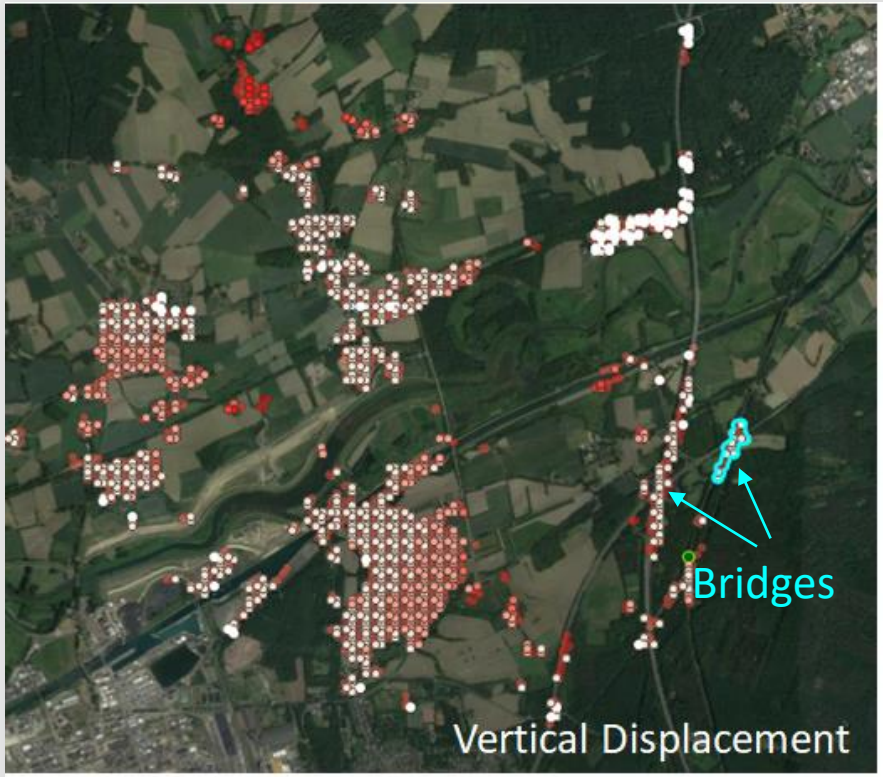
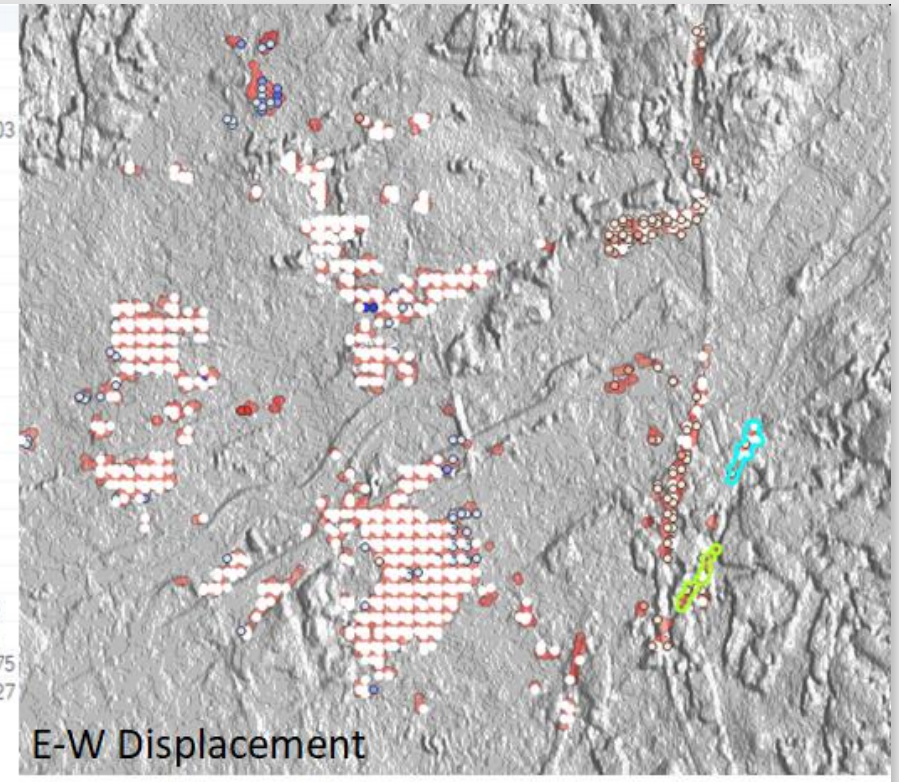
Ground Motion Along Rail Tracks

Ground motion due to mining activities affecting infrastructure elements (rail tracks, highways, bridges, buildings…)



Attribute	
FID	157
ADA_ID	340
N_APS	3
X_MEAN	372244.43700000003
Y_MEAN	5729336.71
VEL_MIN	7.413975
VEL_MEAN	9.846456
VEL_MAX	11.749563
VEL_CLASS	1
DEF_MEAN	-43.682568
TNI_CLASS	1
SNI_CLASS	1
QI_CLASS	1
CORRIDOR	2
FAULT	0
V_HOR_MIN	-7.54158740243
V_HOR_MAX	-4.33749323143
V_HOR_MEAN	-5.792847735872
V_VER_MIN	-13.03966941634
V_VER_MAX	-5.05865272747
V_VER_MEAN	-8.25116114876375
SLOPE_SDEV	8.54033112219403
SLOPE_MAX	40.510589599609375
SLOPE_MEAN	9.6393326030918427



Active Deformation Areas

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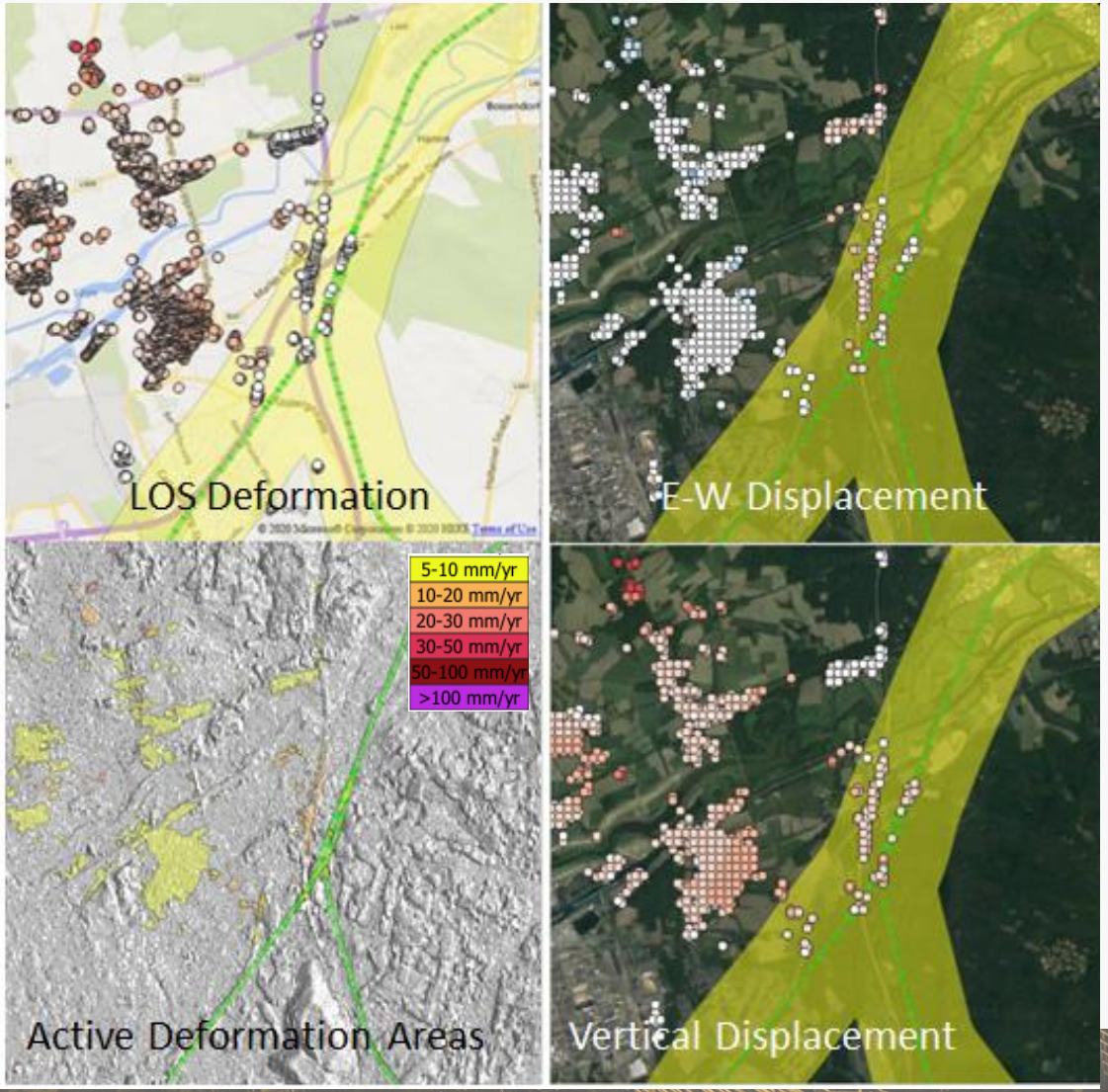
Active deformation areas (ADA) as relevant information for the user

- detection and aggregation of ADAs
- classification of ADAs considering
  - horizontal and vertical displacement
  - geology – tectonics - seismic
  - terrain based information extracted from DEM, e.g. slope, aspect, sink drainage …
  - hydrology
  - infrastructure elements



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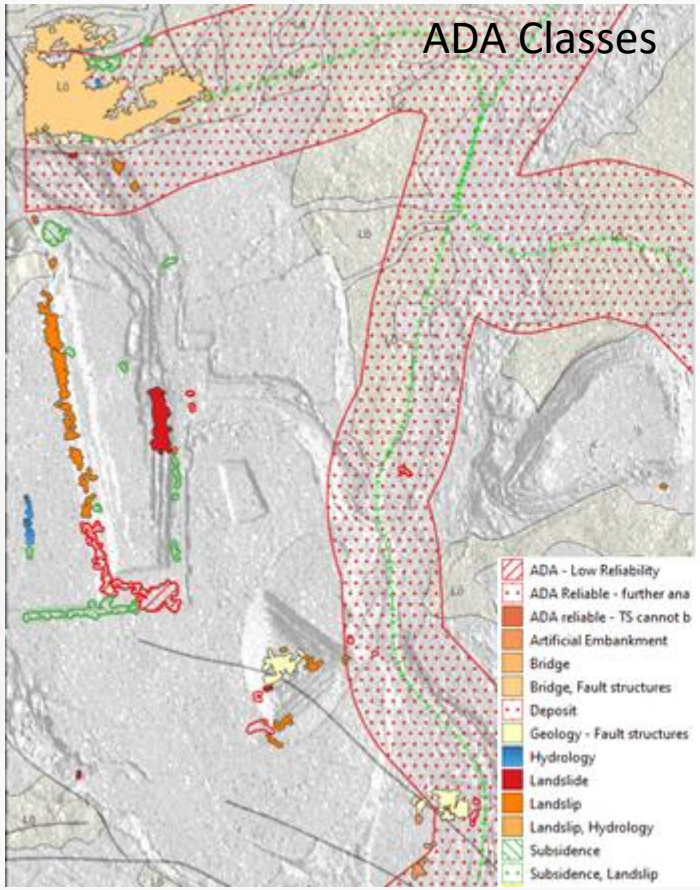
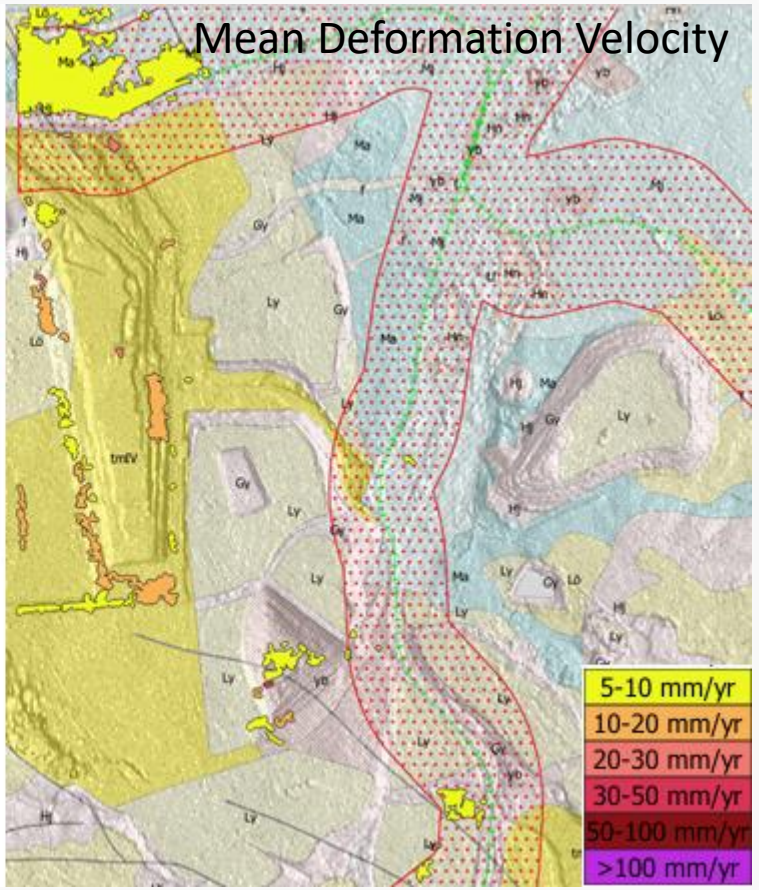
Ground Motion at Mining Sites

Monitoring of dynamics and stability

- geological maps as main information source for soil type, fault systems, mining areas and hydrology
- calculated slope for potentially instable areas (landslides, landslips, etc.)





Application – EO4Infrastructure

Risk management on a European level

Users:

Partners:

- Conceptualisation of a service meeting EGMS specifications
- Risk management approaches for railway operators in a European context
- Monitoring of critical infrastructure
- Integration of varying user requirements and multisource information

Application – EO4Infrastructure

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Use Cases

Monitoring of Soundproof Walls

Monitoring of Bridges

Geologically induced Movements

Ground motion due Groundwater fluctuations

Slope and embankment Monitoring

Long-term monitoring of climate changes

Monitoring of slow moving points

Vegetation monitoring

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Our Way Forward

GAF currently intensifies all application and service development efforts on a national, European and global level to serve customers / users in the market segments:

- Civil engineering
- Infrastructure operators
- Geothermal energy
- Defence and intelligence
- (Geo)Risk and insurance
- Oil & Gas industry
- Mining