

ESA's 2025 Big Data Foundations for Earth Observation Training Course

Thematic EO Applications & use-cases I (GREEN DEAL)

Helmut Herglotz
EOX IT Services
22.09.2025



European
Commission

researchLatvia[★]
Value Through Knowledge



Ministry of
Education and Science
Republic of Latvia



11:30 – 13:00

- About EOX and me
- What is the Green Deal?
- Domains of the Green Transition
- Strategies applied to reach those goals
- EO applications and decision support with EO
- Synergy between big data methodologies and EO
- Overview of typical use cases



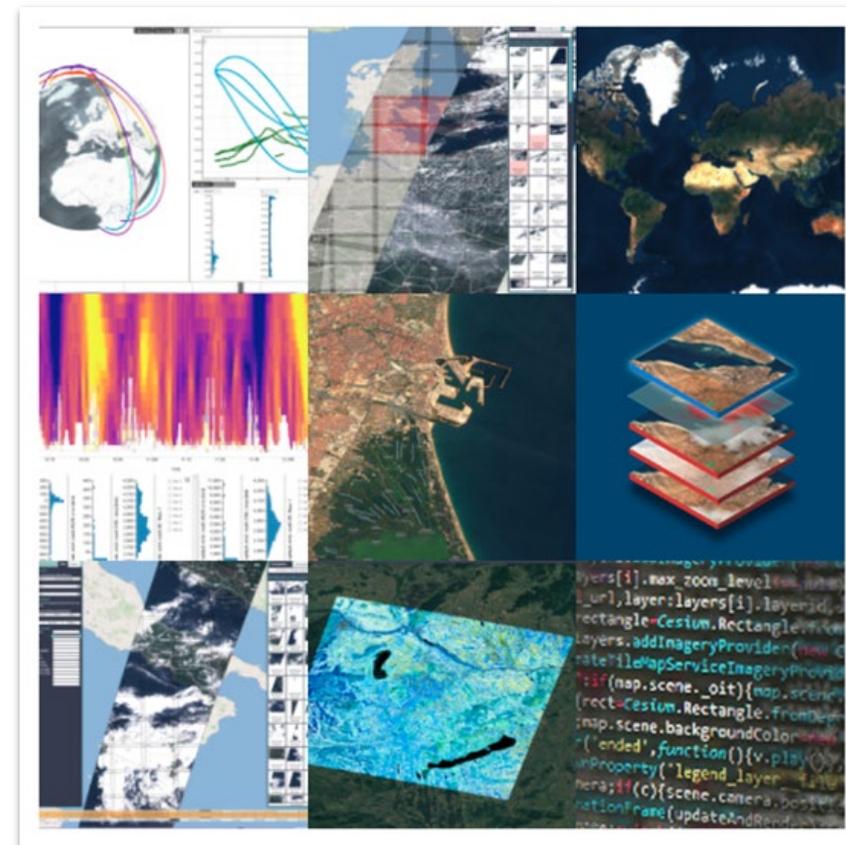
EOX IT Services GmbH, Vienna, Austria

<https://eox.at>

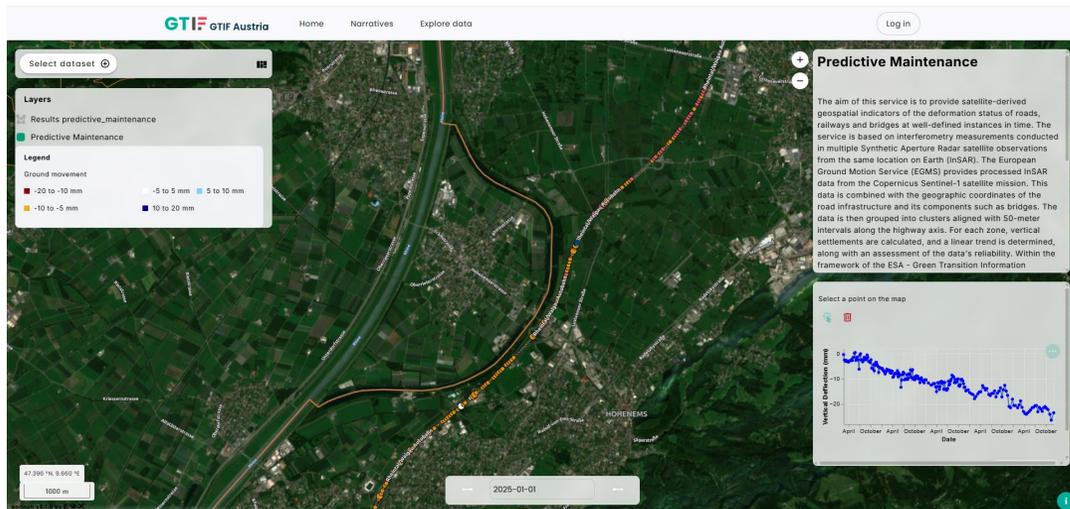
- **Geospatial IT** engineering, product and operations services
- **Cloud-based** platforms and (graphical) Web applications, EO-dashboards
- Value from **Earth observation** satellites data
- **Customers** in governments, space application industry, and geoscience
- Over **70 ESA contracts** since establishment of EOX in 2008



EOxFamily June 2024



GTIF Austria Consolidation



SatInSys (Satgras Application)



Helmut Herglotz
Project Manager
EOX IT Services GmbH

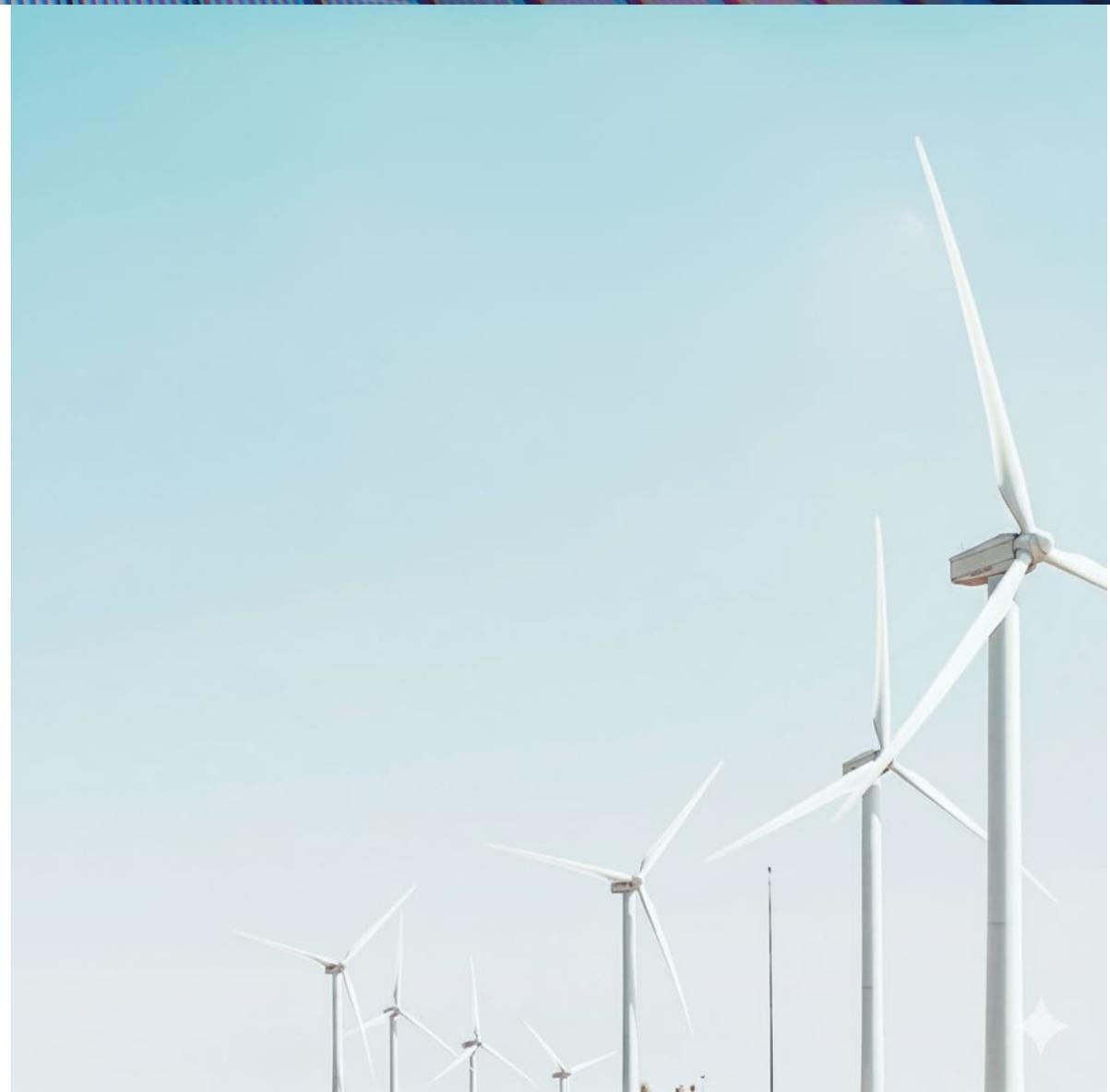
The Green Deal

Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions the European Green Deal, 2019

- *‘a new growth strategy that aims to transform the EU into a fair and prosperous society, with a modern, resource-efficient and competitive economy where there are no net emissions of greenhouse gases in 2050 and where economic growth is decoupled from resource use’ EU Commission, 2019*



- The EU Green Deal serves as a roadmap for sustainable growth and development within the European Union
- Its goal is to make Europe the world's first climate-neutral continent by 2050
- Introduced by the European Commission in December 2019
- Created to address climate change, biodiversity decline, and environmental pollution





Key Objectives

- Reduce greenhouse gas emissions by at least 55% by 2030
- Establish a clear pathway toward achieving climate neutrality by 2050
- Transition the EU economy toward greater sustainability
- Promote a circular economy that minimizes waste and encourages recycling
- Improve energy efficiency and expand the use of renewable energy
- Safeguard and restore biodiversity and natural ecosystems

Domains of the Green Deal



Domains of the Green Deal



EO Climate Adaptation

Energy Transition

Mobility Transition

Carbon Accounting

Sustainable Cities



Strategies to Reach the Key Objectives

- **Policy Framework & Legislation ("Fit for 55")**
 - Raising the 2030 climate target (cutting emissions by at least 55%).
 - Revising laws on emissions trading (ETS), renewables, energy efficiency, cars, aviation, etc.
 - Carbon Border Adjustment Mechanism (CBAM) to prevent carbon leakage.
- **Sustainable Finance & Investment**
 - EU Green Taxonomy: defining what counts as a “green” investment.
 - Sustainable Finance Strategy to guide private and public money into green projects.
 - Just Transition Mechanism: support for regions, industries, and workers most affected.
- **Research, Innovation & Digital Tools**
 - Funding through Horizon Europe for clean tech, energy storage, and climate solutions.
 - Digitalization and AI for smarter resource management.
 - Earth observation (Copernicus Programme) → monitoring emissions, land use, biodiversity, oceans, disasters.
- **Sectoral Roadmaps & Action Plans**
 - Farm to Fork Strategy → sustainable food systems.
 - Circular Economy Action Plan → product design, recycling, waste reduction.
 - Biodiversity Strategy 2030 → protect 30% of EU land and seas.
 - Renovation Wave → energy efficiency in buildings.
 - Sustainable and Smart Mobility Strategy → green transport shift.

- **Carbon Pricing & Market Mechanisms**
 - Expanding the EU Emissions Trading System (ETS).
 - Pricing carbon in aviation, shipping, and road transport.
 - Linking carbon pricing with global partners.
- **International Action & Diplomacy**
 - EU leadership in global climate negotiations (Paris Agreement, COP summits).
 - Partnerships for green energy and raw materials.
 - Green Deal diplomacy with developing countries.
- **Citizen & Business Involvement**
 - European Climate Pact: engaging citizens and organizations.
 - Support for SMEs to transition sustainably.
 - Education and skills programs for the green economy.

Space for a Green Future

EO applications and decision support systems

Space for a Green Future





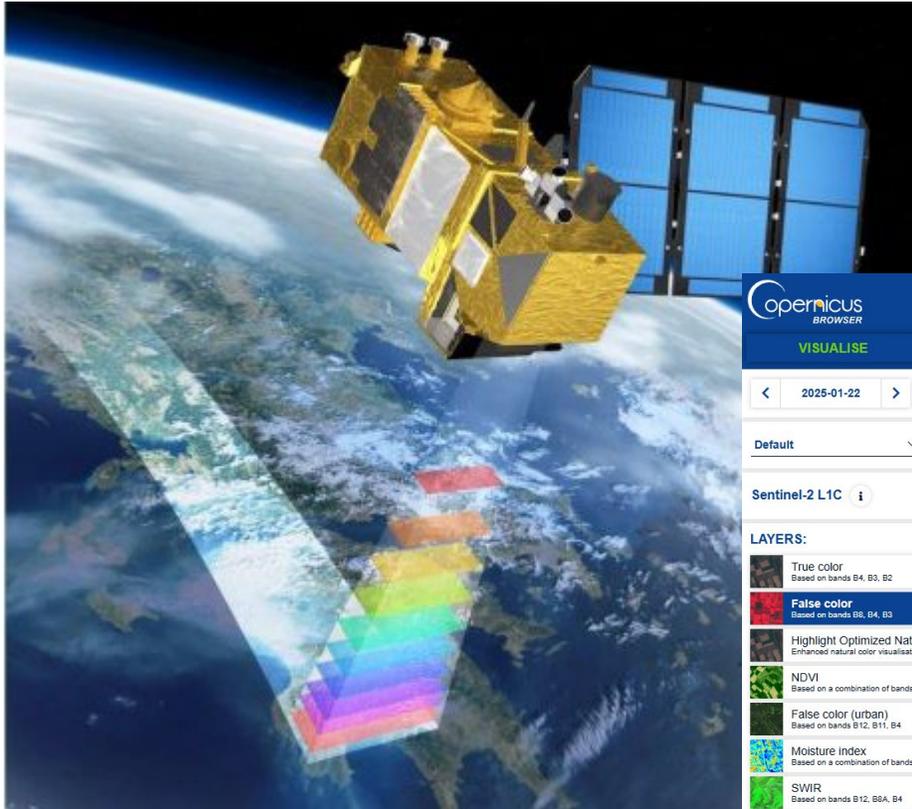
PROGRAMME OF THE
EUROPEAN UNION



co-funded with



Copernicus



Copernicus Data Space Ecosystem – EO Browser

Copernicus BROWSER

EN Login

VISUALISE SEARCH

2025-01-22 10%

Default

Sentinel-2 L1C

LAYERS:

- True color
Based on bands B4, B3, B2
- False color** + Add to </>
Based on bands B8, B4, B3
- Highlight Optimized Natural Color
Enhanced natural color visualisation
- NDVI
Based on a combination of bands (B8 - B4)/(B8 + B4)
- False color (urban)
Based on bands B12, B11, B4
- Moisture index
Based on a combination of bands (B8A - B11)/(B8A + B11)
- SWIR
Based on bands B12, B8A, B4
- NDWI
Based on a combination of bands (B3 - B8)/(B3 + B8)
- NDSI
Based on a combination of bands (B3 - B11)/(B3 + B11); values above 0.42 are regarded as snowy
- Custom
Create custom visualisation

Show effects and advanced options Hide layer Share

© Copernicus ESA About Support

Copernicus Sentinel-2 satellite:

- multispectral
- 10 m resolution on ground
- ~ weekly revisit



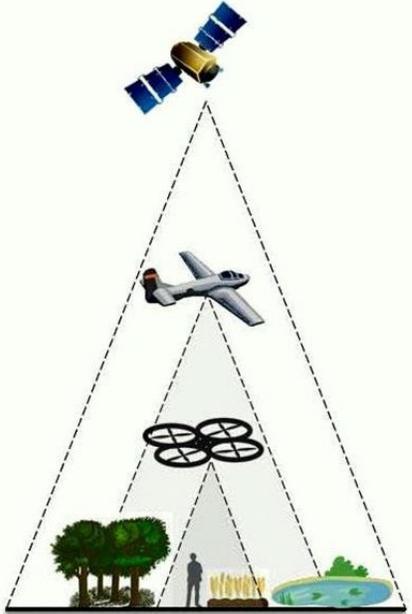
European Space Agency

Earth observation data from space was crucial to identifying climate change.

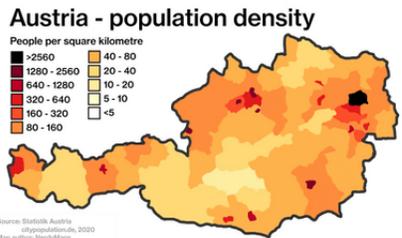
ESA is helping Europe to move from monitoring to managing, and to harness the use of space to pursue climate action, supporting national and European efforts to become carbon neutral by 2050.

Working with international partners – many of whom are from outside the space industry – ESA accelerates the use of space for a green future.

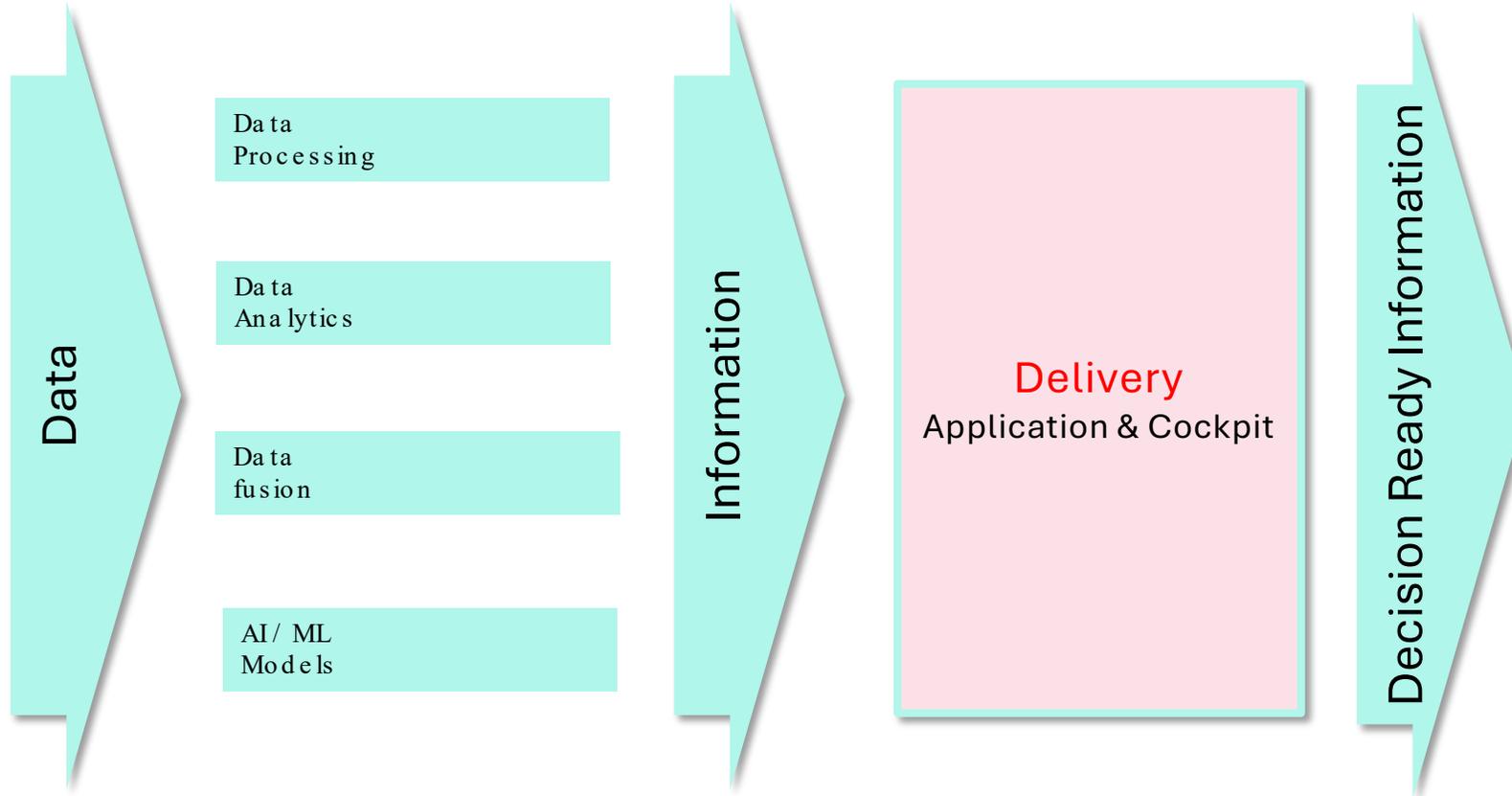
EO applications and decision support systems (Value Adding)



Earth-observation



Socio-economic



Synergy between big data methodologies and EO

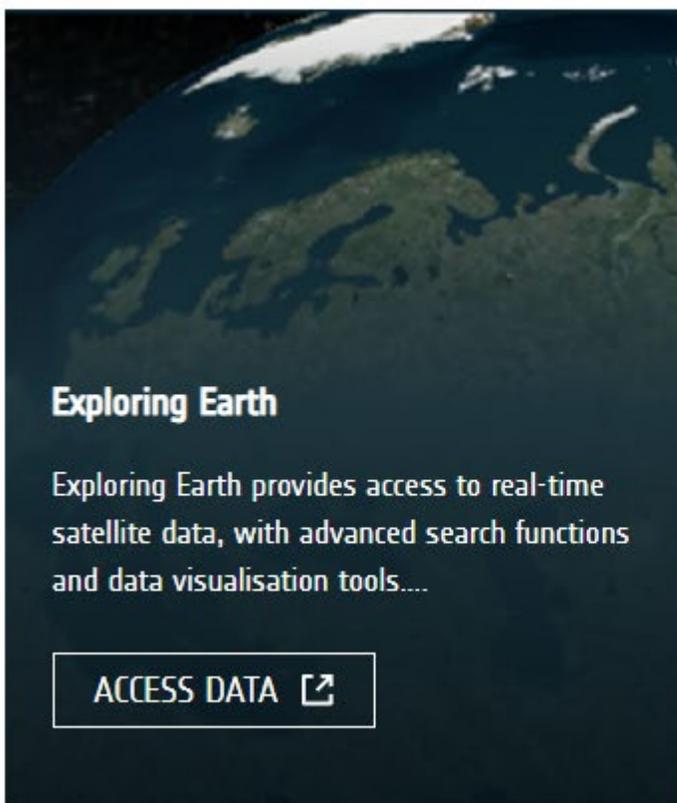
How much data does the Copernicus Data Space Ecosystem (CDSE) produce daily?

How much data does the Copernicus Data Space Ecosystem (CDSE) produce daily?

Up to 30 TB

(source: <https://sentinels.copernicus.eu/-/copernicus-data-space-ecosystem-cdse-releases-annual-report-2023>)

DATA CATALOGUES



Exploring Earth

Exploring Earth provides access to real-time satellite data, with advanced search functions and data visualisation tools....

[ACCESS DATA](#) 



Data system

Copernicus Data Space Ecosystem

The Copernicus Data Space Ecosystem provides free instant access to a wide range of data and services from the Copernicus Sentinel missions....

[ACCESS DATA](#) 



FedEO

FedEO provides a unique entry point to a number of scientific catalogues and services....

[ACCESS DATA](#) 

1. Big Data Processing & Infrastructure

- Hadoop, Spark, Dask
- Google Earth Engine, AWS Earth on Cloud
- Kafka, Flink
- Example: Real-time flood mapping

2. Artificial Intelligence / Machine Learning

- Random Forests, SVM, Gradient Boosting
- CNNs, RNNs, Transformers
- Transfer learning, AutoML
- Example: Crop yield prediction

3. Data Fusion & Interoperability

- Combination of different remote sensing sources (Optical + Radar + LiDAR + Meteorological, etc.)
- Open Data Cube, xarray
- OGC, STAC standards
- Example: Biodiversity & climate studies

4. Visualization, Analytics & Decision Support

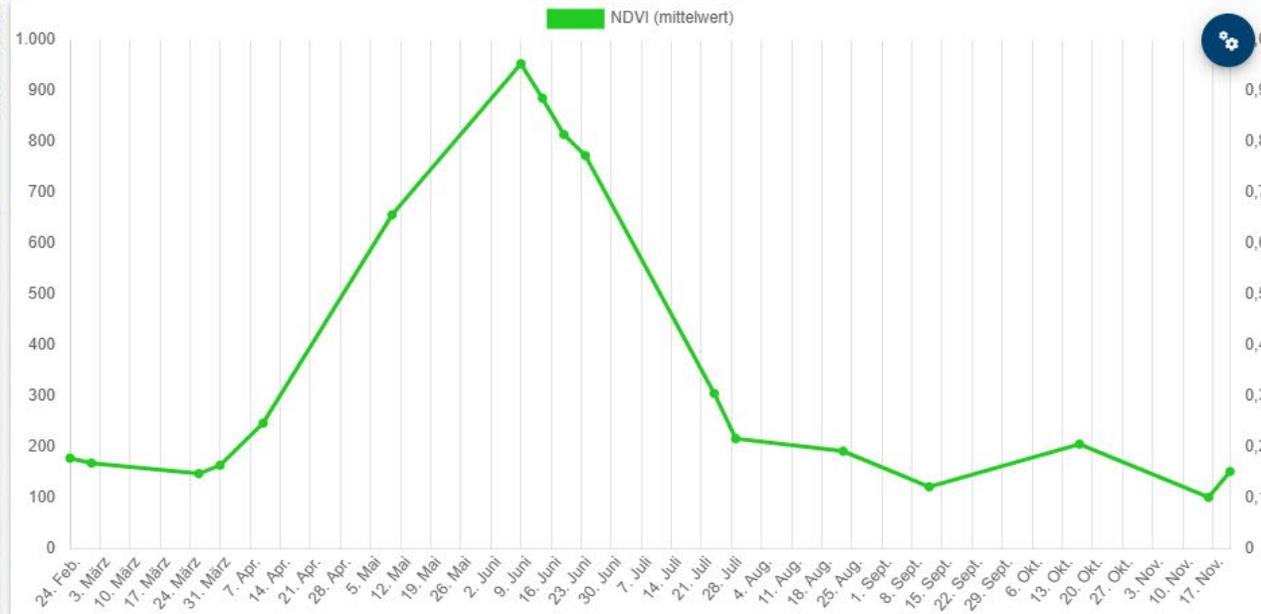
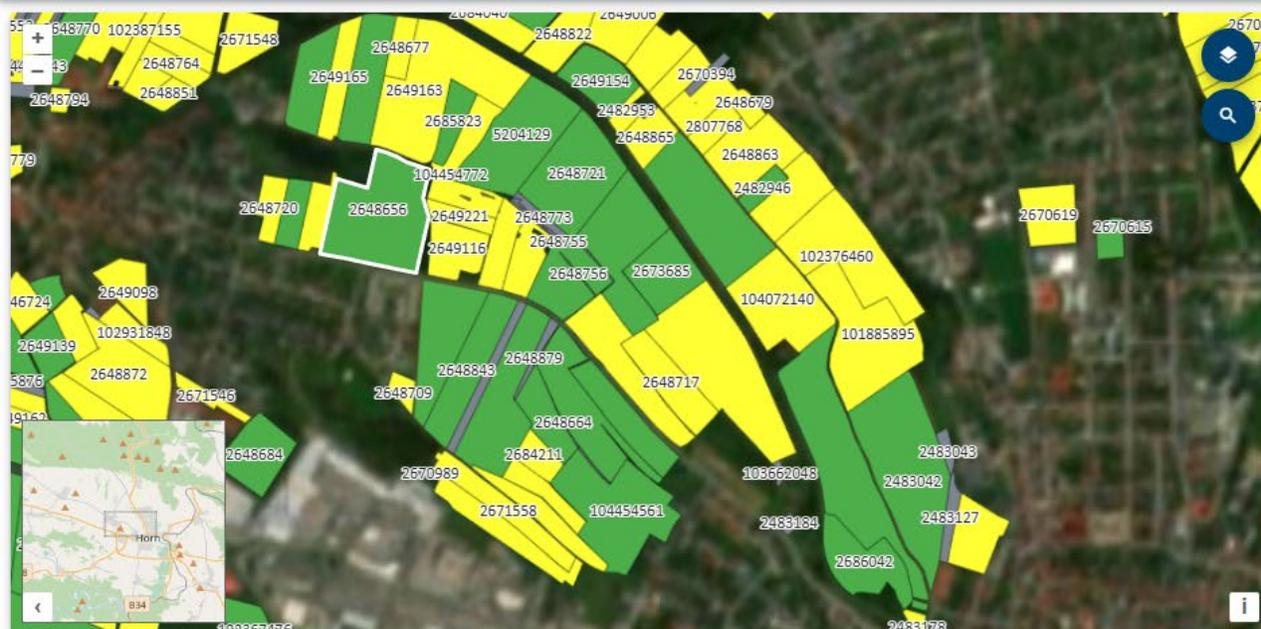
- GTIF Platform (eodash, EOxHub), ArcGIS, QGIS, PostGIS
- Dash, Kepler.gl, PowerBI
- Time-series visual analytics
- Example: Water management & carbon accounting

Overview of typical EO Usecases

Agriculture & Food Security

- Crop mapping, yield prediction, irrigation, area monitoring systems
 - E.g. Normalized difference vegetation index (NDVI) for health and density of vegetation
 - Machine Learning Models combining NDVI, meteorological data trained with in situ data for yield and quality prediction

Overview of typical EO Usecases



Schlag-ID	Schlagnutzungsarten-Code beantragt	SNAR_BEZEICHNUNG	Compliance (Crop Type)	Kulturgruppen-Code beantragt	Kulturgruppe beantragt	VHR-Daten notwendig	Kulturgruppen-Code vorhergesagt - Rang 1	Kulturgruppe vorhergesagt - Rang 1	Wahrscheinlichkeit Vorhersage - Rang 1	Kulturgruppen-Code vorhergesagt - Rang 2	Wahrscheinlichkeit Vorhersage - Rang 2	Kulturgruppe vorhergesagt - Rang 2	In-Situ-Daten vorhanden
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Keine Daten vorhanden

2021
Thu, Jul 29



Biodiversity & Ecosystem Monitoring

- Habitat mapping, species detection

Forestry

- Deforestation, fire risk, carbon stocks

Overview of typical EO Usecases



→ THE EUROPEAN SPACE AGENCY



GTIF | Green Transition Information Factory **Carbon Accounting**



DOMAINS & TOOLS

LAYERS

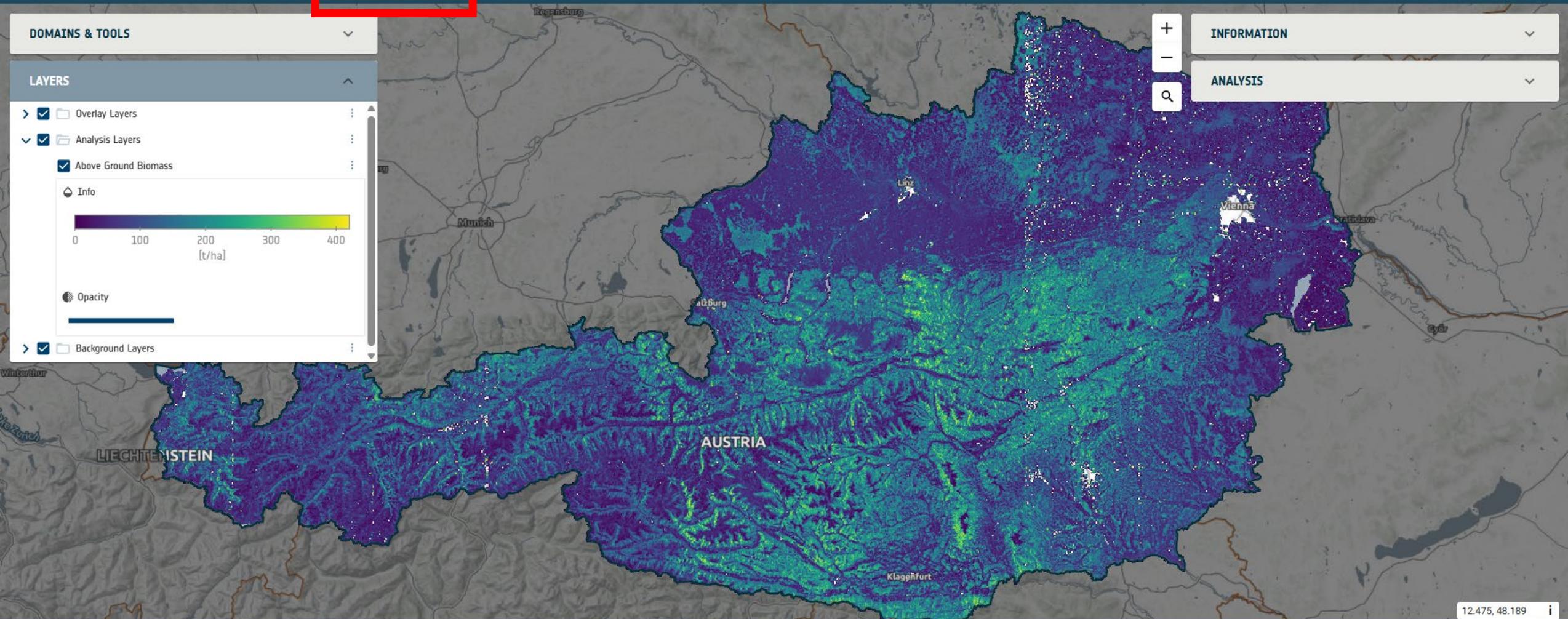
- Overlay Layers
- Analysis Layers
 - Above Ground Biomass
 - Info
 - 0 100 200 300 400 [t/ha]
 - Opacity
- Background Layers

+ -

INFORMATION

ANALYSIS

Q



12.475, 48.189

Urban Development

- Land use change, heat islands

Overview of typical EO Usecases



Select dataset



NUTS2 Austria (Gemeinden)

LULUCF Time Series

Datetime

01.01.2023 00:00



Legend

Land cover classes

- Coniferous forest
- Deciduous forest
- Unstocked forest
- Annual cropland
- Viticulture
- Orchards
- Other perennial crops
- Other woody biomass in cropland
- Grassland
- Other woody biomass in grassland
- Water
- Wetland
- Unvegetated settlements
- Trees in settlements
- Grassland in settlements
- Rocks and screes
- Glaciers
- Alpine dwarf shrub heaths

Land Use, Land Use Change and Forestry (LULUCF)

Land Use, Land Use Change and Forestry (LULUCF) status map for the years 2015 - 2023 over Austria, at the Level 3 of the LULUCF Nomenclature.

Derived by means of Artificial Intelligence, deep learning U-Net automated supervised classification algorithm and rule-based post-processing. The scope of the Austrian Space Applications Program (ASAP 18) flagship GHG-KIT project - "Prototyping an EO-enabled kit supporting greenhouse gas reporting" is to develop a scientific Proof-of-Concept (PoC) towards the first European Earth Observation (EO)-integrated CO2 and CH4 Monitoring Verification and Reporting (MVR) System using Copernicus satellite data and information products, including two prototypes:

Select administrative area on map



Invalid value ""

47.021 °N, 13.589 °E

2023-01-01

Water Resources

- Droughts, glaciers, water quality

Overview of typical EO Usecases



Skip to content



GTIF CIF - BETA

Home Dashboard Stories Editor

Select indicator +



Layers

> Overlay Layers

▼ Data Layers

Sea floor depth below geoid

Legend

Sea floor depth below geoid [m]



Opacity



> Base Layers

Sea floor depth below geoid

Aquaculture Energy

Satellite: placeholder

Sensor: placeholder

Agency: CMEMS

Extent: 2017-01-01 - 2017-01-01

> Description

> Providers 1

CANADA

GREENLAND SEA

ATLANTIC OCEAN

FINLAND

NORWAY

SWEDEN

UNITED KINGDOM

IRELAND

NETHERLANDS

BELGIUM

GERMANY

FRANCE

AUSTRIA

ITALY

POLAND

SLOVAKIA

ROMANIA

SERBIA

LATVIA

LITHUANIA

BELARUS

UKRAINE

69.293 °N, 42.949 °E

500 km

2017-01-01

Disaster Management

- Floods, landslides, wildfires

Climate & Atmosphere

- GHG, air quality, sea-level rise

Coastal & Marine Systems

- Coral reefs, oil spills, fishing

ESA's 2025 Big Data Foundations for Earth Observation Training Course

Basic EO data exploration with Green Transition Information Factory (GTIF)

Helmut Herglotz
EOX IT Services
22.09.2025



European
Commission

researchLatvia[★]
Value Through Knowledge



Ministry of
Education and Science
Republic of Latvia



14:00 – 15:30

- What is GTIF?
- Past and ongoing GTIF initiatives in Europe
- GTIF domains
- GTIF capabilities

DEMO

- Infrastructure Predictive Maintenance (AIT)
- The Austrian GTIF platform

What is GTIF?

GTIF

Green Transition Information Factory

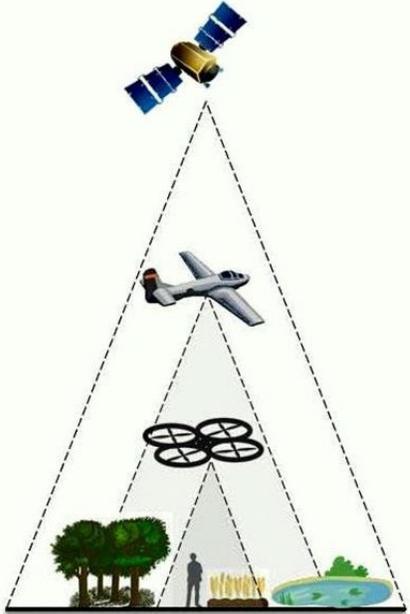
Actionable information from Earth Observation
to *accelerate* the Green Transition of society and economy



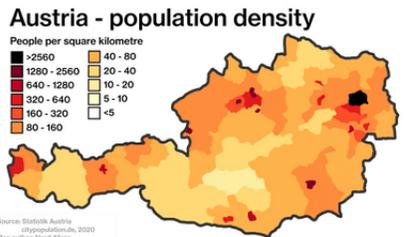
EXPLORE TOOLS

The ESA Green Transition Information Factory (GTIF) allows users to interactively discover the underlying opportunities and complexities of transitioning to carbon neutrality by 2050 using the power of

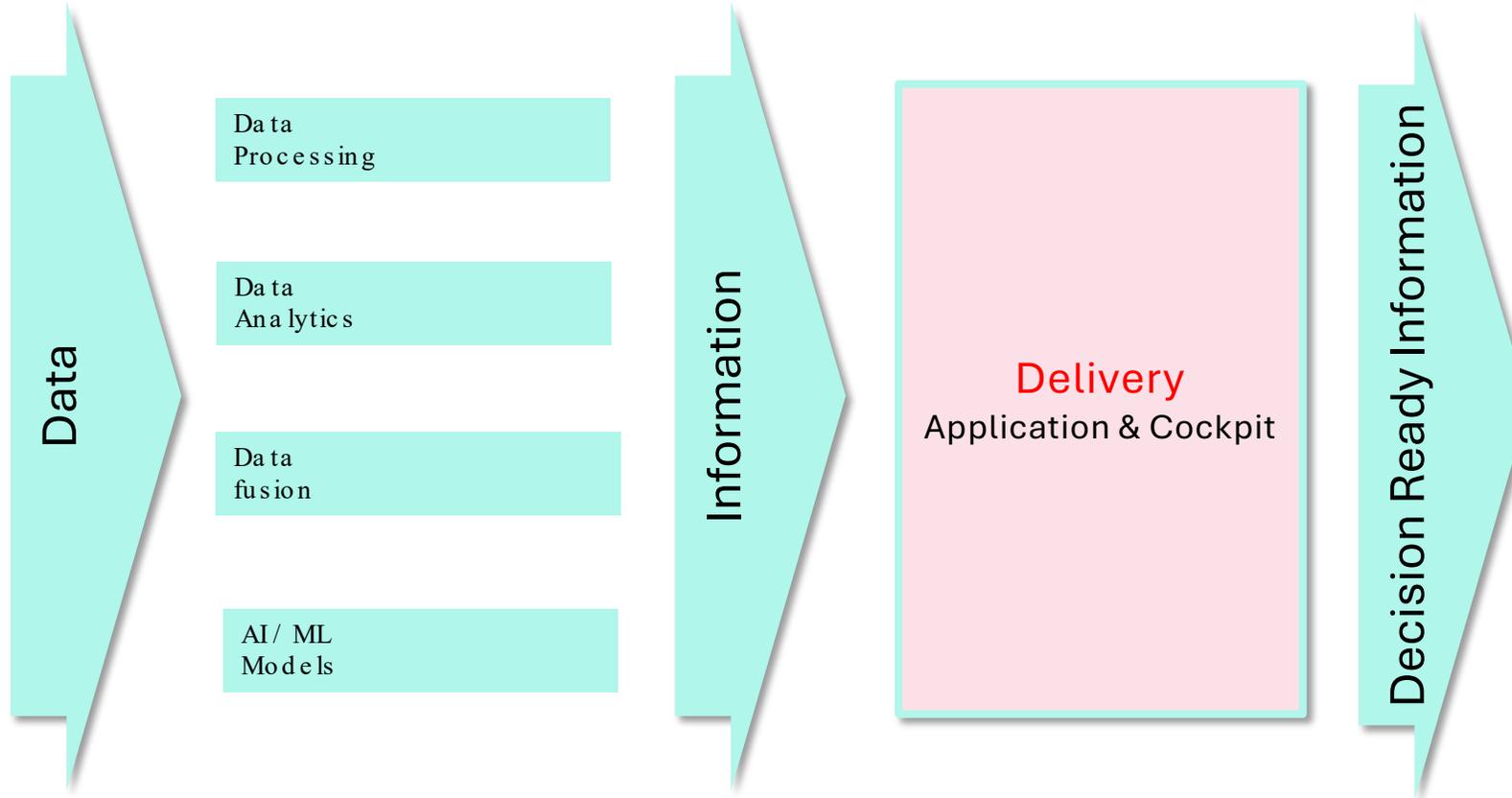
RECAP: EO applications and decision support systems



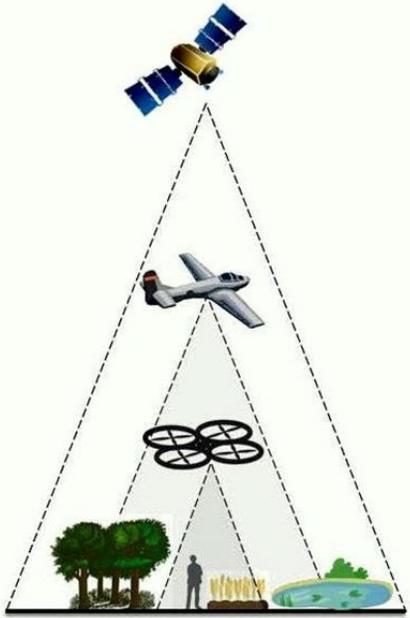
Earth-observation



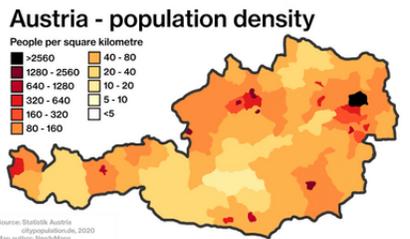
Socio-economic



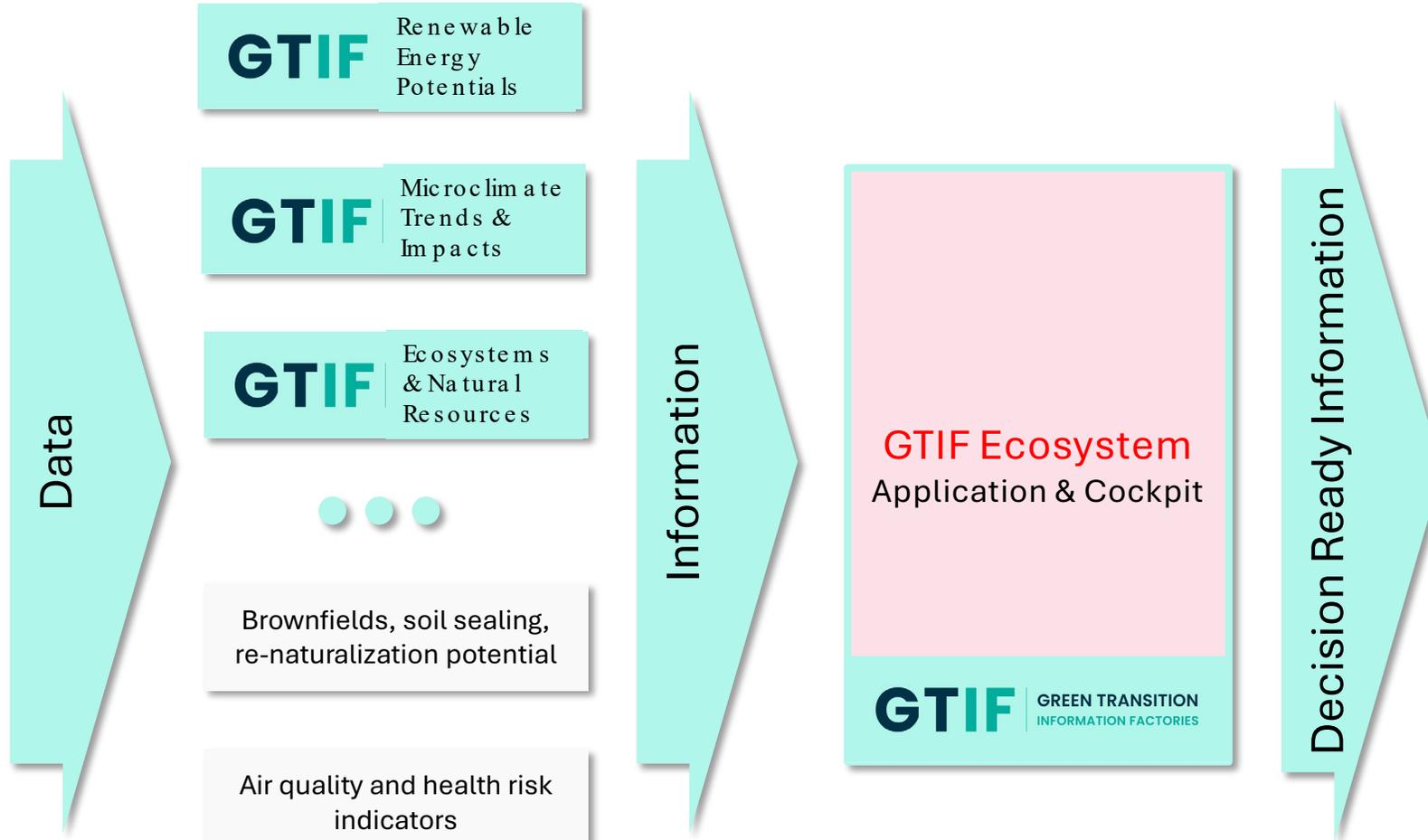
Green Transition Information Factories



Earth-observation



Socio-economic



Legend

- GTIF** GTIF Capability
- Third Party Info Source (non-GTIF)

Past and Ongoing GTIF Initiatives

Past and ongoing GTIF activities in Europe



GTIF Activity	Focus
GTIF Austria Demonstrator	Austria
GTIF Austria Consolidation	Austria
Baltic GTIF	Baltic Sea States
Cerulean GTIF	Arctic Seas
Danube Information Factory	River Ecosystems (flooding, irrigation)
UK GTIF	UK, Ireland, Canada
GTIME	Vegetation Change
NoiseSphere	Mobility (noise)
Popsicle	Population simulation (resilience against climate change and related emergencies)
SAFIR	Sentinel assisted Forestry insight and research
[AND MANY MORE!!!]	

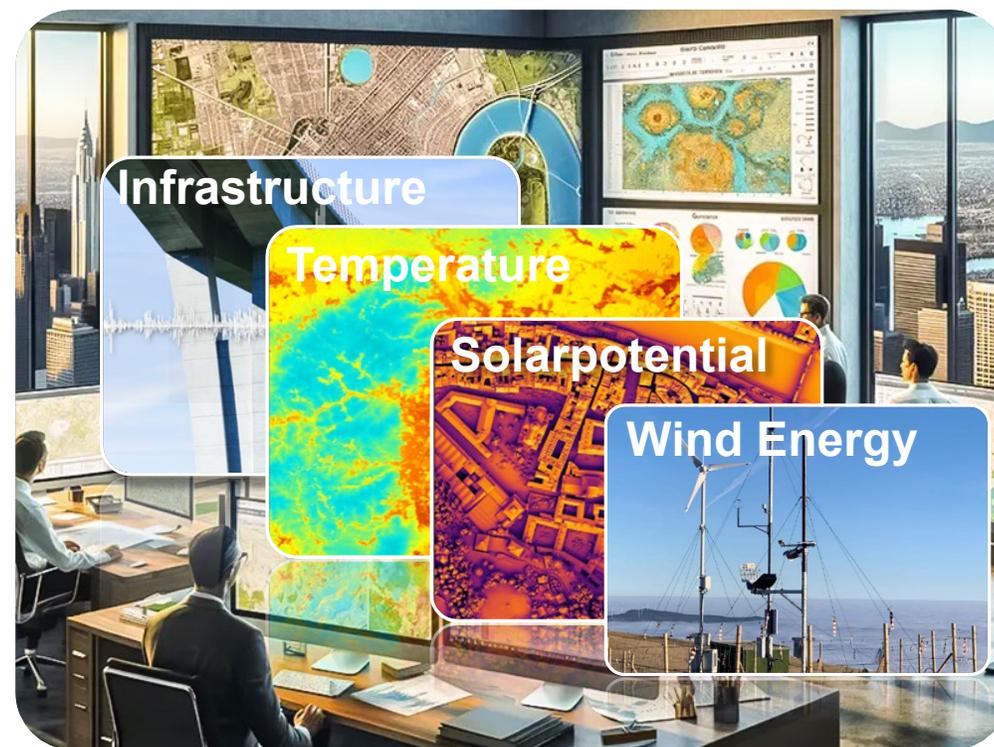
Past and ongoing GTIF activities in Europe



National Stakeholders

GTIF-AT Demonstrator

<https://gtif.esa.int/explore>



GTIF domains

Domains of the Green Deal



EO Climate Adaptation

Energy Transition

Mobility Transition

Carbon Accounting

Sustainable Cities



The screenshot displays the Energy Transition tool interface. The central map shows a topographic view with wind power density overlaid in a color scale from blue (low) to red (high). The map includes labels for various locations and elevation points, such as 'Lehrstadel 1766m' and 'Müzzuschlag'. On the left, the 'DOMAINS & TOOLS' panel lists categories like Energy Transition, Mobility Transition, Sustainable Cities, Carbon Accounting, and EO Adaptation Services. Below this, the 'Tools' section shows counts for 'Hydropower Assessment' (5), 'Micro Hydropower Tools' (1), 'Solar Energy Assessment' (5), and 'Wind Energy Assessment' (4). The 'LAYERS' panel on the left shows 'Overlay Layers' and 'Analysis Layers', with 'Protected areas (Natura 2000)' selected. On the right, the 'INFORMATION' panel provides 'TIPS ON USING THIS TOOL' and 'WHY THIS DATA'. The 'ANALYSIS' panel contains filters for 'Filter for elevation [m]' (0 to 4000), 'Filter for slope [°]' (0 to 50), 'Distance to settlements WSF [m]' (0 to 540), and a checked option for 'Exclude protected areas'. An 'Add constraint' button is also present.

DOMAINS & TOOLS

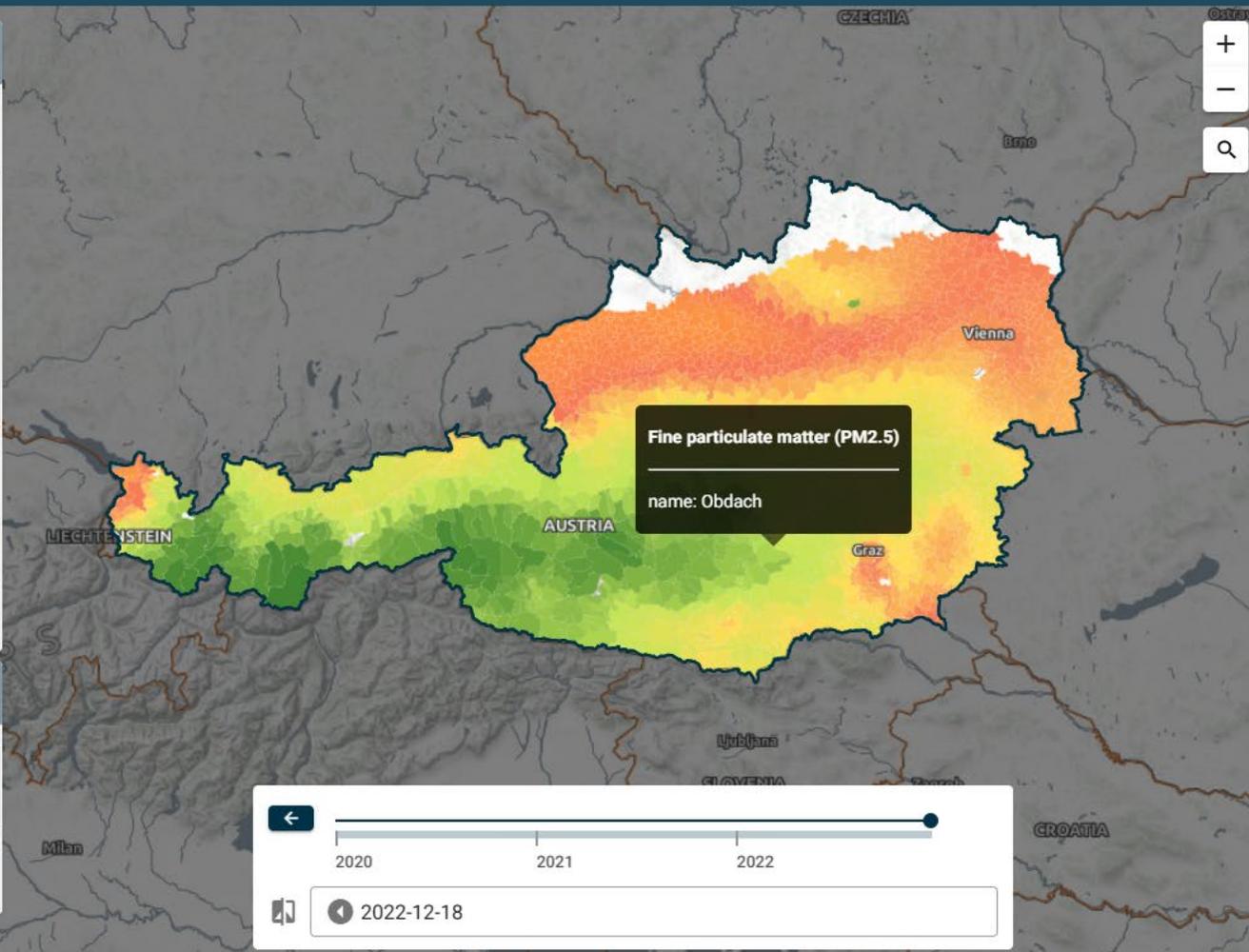
- Sustainable Cities
- Carbon Accounting
- EO Adaptation Services

Tools

- Air Quality Health **3**
 - Coarse particulate matter (PM10)
 - Fine particulate matter (PM2.5)**
 - Health Risk Index (ARI)
- Dynamic Human Presence **2**
 - Dynamic human presence count
 - Dynamic human presence density
- Human Mobility Patterns **6**

LAYERS

- Overlay Layers
- Analysis Layers
 - Fine particulate matter (PM2.5)**



INFORMATION

HOW TO USE THIS TOOL

Selecting the single LAU it is possible to visualize in the "ANALYSIS" box the respective time series of PM2.5.

WHY THIS DATA

Particulate Matter with diameters less than 2.5µm - mass concentration in µg/m³ obtained daily from the Copernicus Atmosphere Monitoring Service (CAMS) European air quality forecasts dataset. The value displayed on the platform represents the geographical mean and maxima values of the daily average pollutant concentration for each Local Administrative Unit (LAU).

Dataset metadata

ANALYSIS

Geographic Selection

Selected Units
No features in the selection

Visual Analysis Add-Ons

Save as custom layer to layers panel
Custom layer name

DOMAINS & TOOLS

- Carbon Accounting
- EO Adaptation Services

Tools

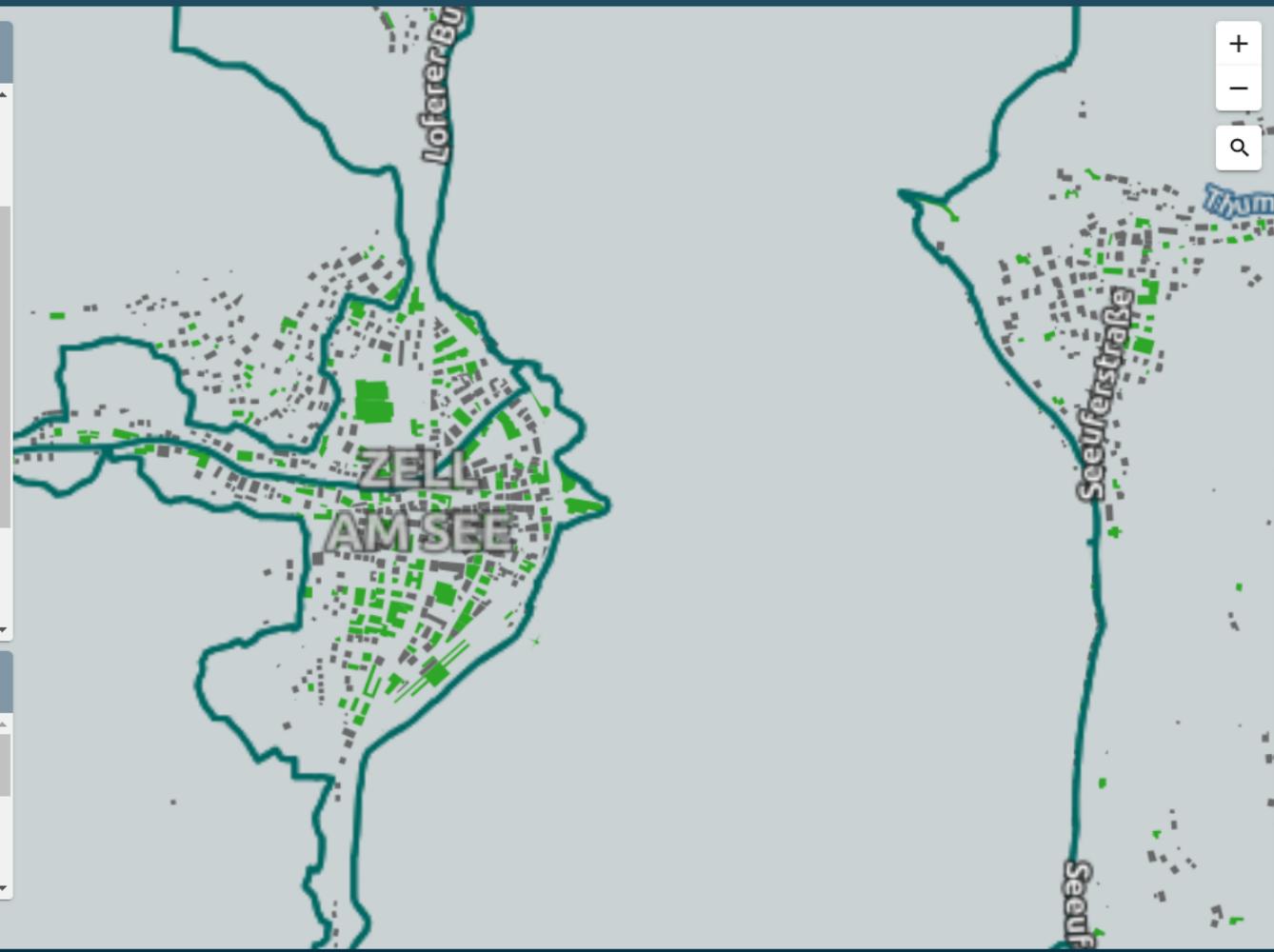
Green Roofs 8

- Existing Green Roofs
- Green Roof Impact Score
- Max Land Surface Temperature
- Percentage GR-Potential Area in relation to Total Roof Area
- Potential CO2 reduction from green roof slope < 20°
- Potential CO2 reduction from green roof slope < 45°
- Potential CO2 reduction from green roof slope < 5°
- Roofs Suitable for Greening**

Solar Roofs 4

LAYERS

- Overlay Layers
- Analysis Layers
 - Census Track (Zählsprenzel)



+
-
Q

INFORMATION

HOT TO USE THIS TOOL

Visualise all roofs that are suited for a green roof retrofitting solely looking at the slope of the roof.

Use this tool to visualise the scatterplot of Green roof potential [km²] in relation to existing Green roofs [km²] for a selected administrative unit (it currently applies to Zählsprenzel level).

WHY THIS DATA

Green Roofs (GR) products are a cutting-edge solution for mapping and quantifying the presence of green roofs on buildings. These products are based on the latest available airborne imagery with a spatial resolution of 20 cm, providing a high degree of detail and precision. Green roofs are an effective measure in reducing

ANALYSIS

Geographic Selection

Select an administrative unit in order to start analysis

Selected Units

No features in the selection

Visual Analysis Add-Ons

DOMAINS & TOOLS

- Energy Transition
- Mobility Transition
- Sustainable Cities
- Carbon Accounting
- EO Adaptation Services

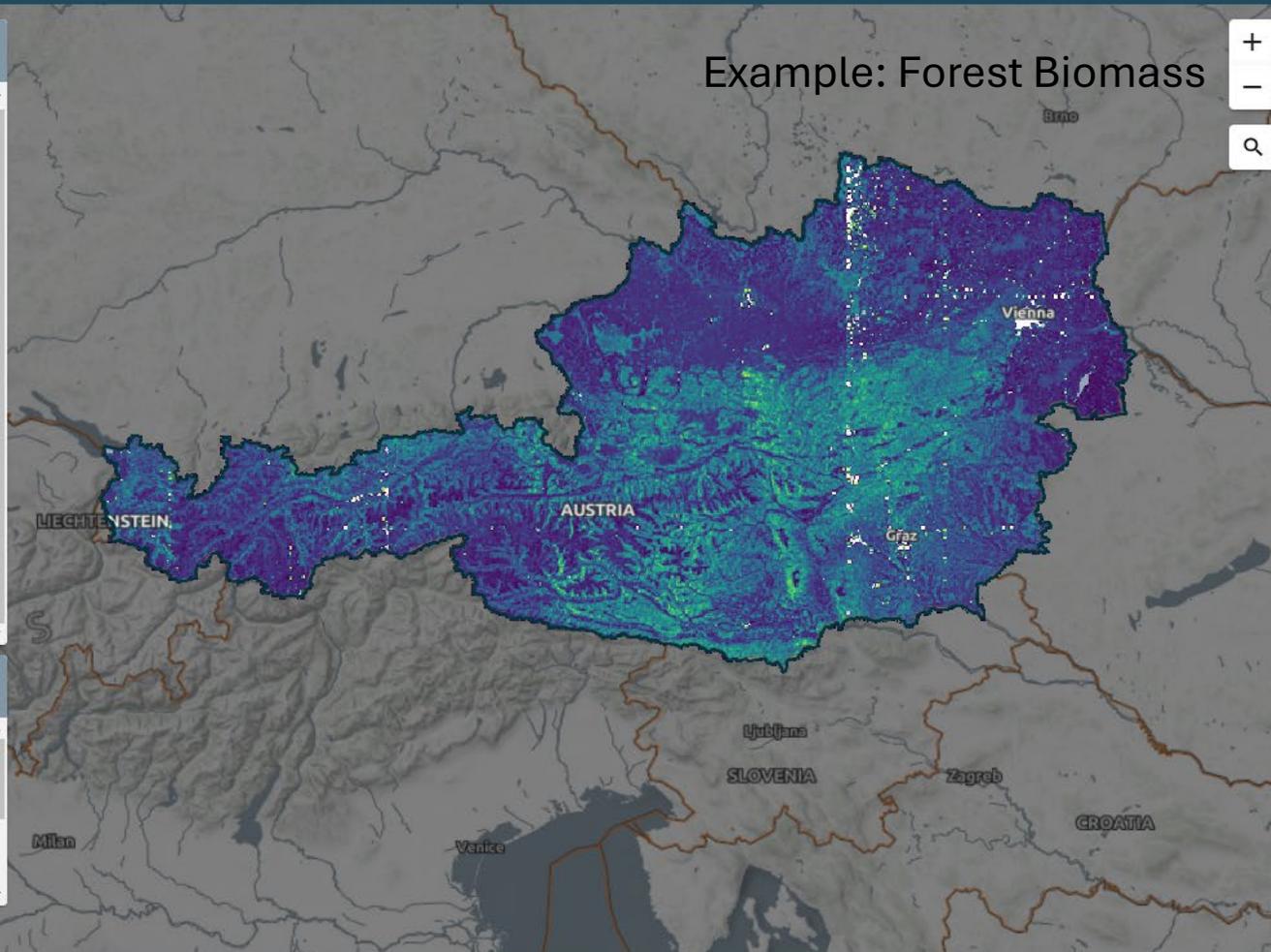
Tools

- Forest Analysis 4
 - Above Ground Biomass
 - Annual forest mask
 - Forest change detections
 - Forest disturbance type

LAYERS

- Overlay Layers
- Analysis Layers
 - Above Ground Biomass

Example: Forest Biomass



+
-
Q

INFORMATION

TIPS ON USING THIS TOOL

Use this tool to identify areas with higher or lower biomass, or more generally characterised by a specific range of biomass values.

WHY THIS DATA

Humans have exploited forest biomass as a material and energy source for millennia, but population growth and increasing demand for resources have diminished the extent and condition of forests, including the amount of carbon they store and exchange with the atmosphere. The Global Climate Observing System considers above-ground biomass (AGB) an Essential Climate Variable due to its functions as both a source of atmospheric CO₂ (and other greenhouse

ANALYSIS

Filters

Biomass [t/ha]



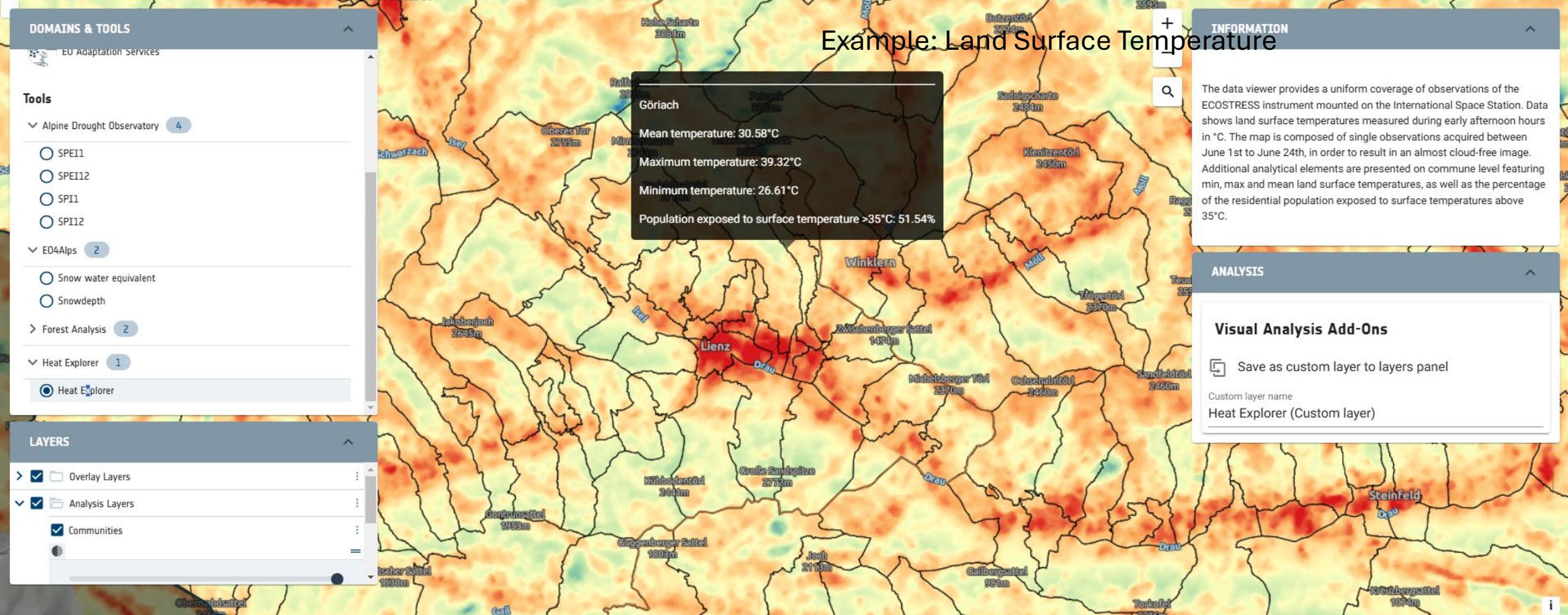
Visual Analysis Add-Ons

Save as custom layer to layers panel

Custom layer name

Above Ground Biomass (Custom layer)





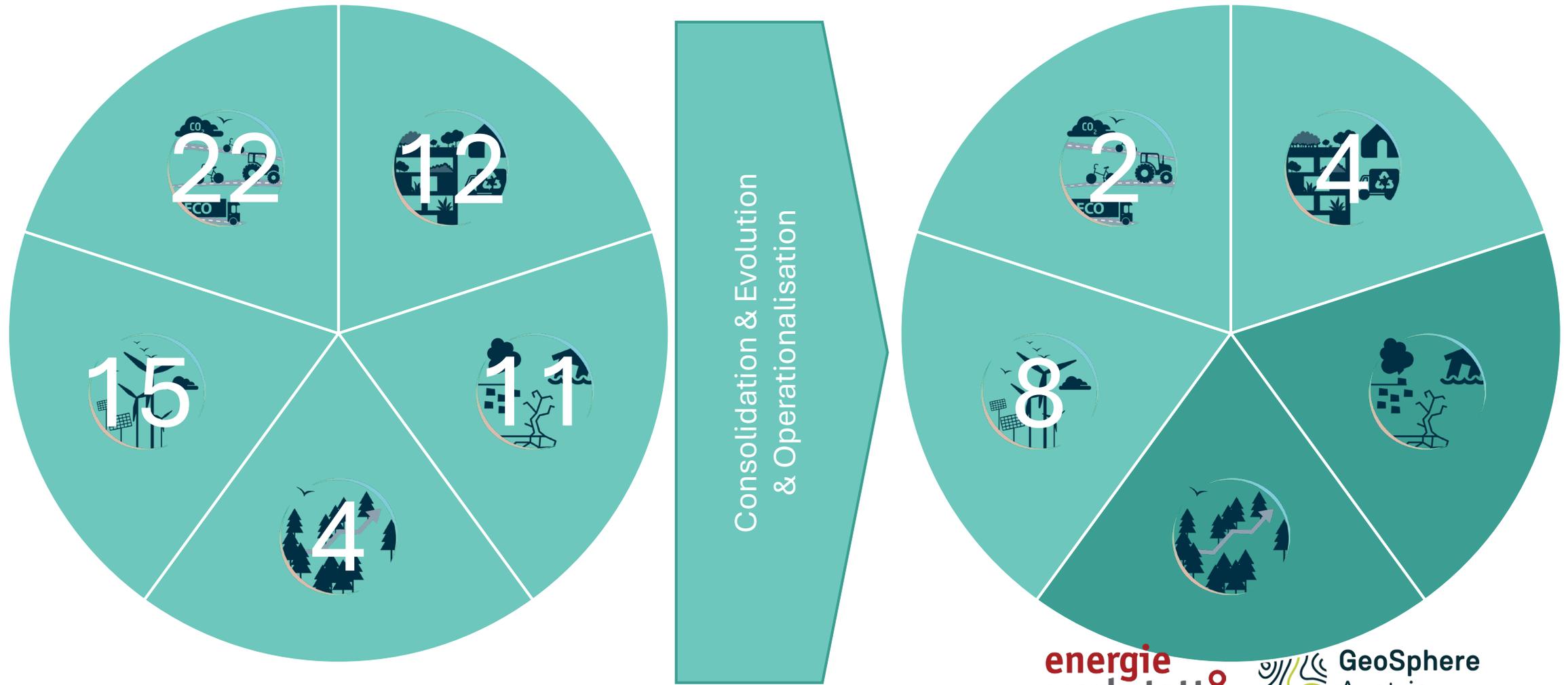
GTIF capabilities

Internal tracking of GTIF Capabilities

Currently ca. 170 Capabilities

- AI/ML based capabilities (e.g. Windpower Assessment) – ENERGY DOMAIN
- Capabilities based on big data processing (Predictive Mobility Maintenance) – MOBILITY DOMAIN
- Capabilities based on Data Fusion (Renewable Energy Site Identification) – ENERGY DOMAIN
- ...

Supported domains & GTIF capabilities (Austria)



+ consolidation and assessment of remaining GTIF-capabilities



Current GTIF enhancement implementations



GTIF Consolidation (ESA Work Requirements)		
Energy Transition	WR-01	WPD-as-a-service & update AT Wind Atlas
	WR-02	Evolve site identification capabilities for renewable energy expansion to support the identification of acceleration areas of the RED-III regulation
	WR-03	Energy nowcasting for solar- and wind energy
	WR-04	Support for energy supply and demand planning
	WR-05	Support the creation of "energy plans" for every community
	WR-06	Integration of energy grid capacity information
	WR-07	Explore support for geothermal energy potential assessment
	WR-08	Integrate BMK energy dashboard
Mobility Transition	WR-09	Assessment and integration of human mobility data sources
	WR-10	Transport Infrastructure Predictive maintenance
Sustainable Cities	WR-11	Rooftop characterisation as a service
	WR-12	Develop comparison feature for cities/regions as part of GTIF UI
	WR-13	Urban Vegetation monitoring
	WR-14	Fallow land and soil sealing identification and assessment capability

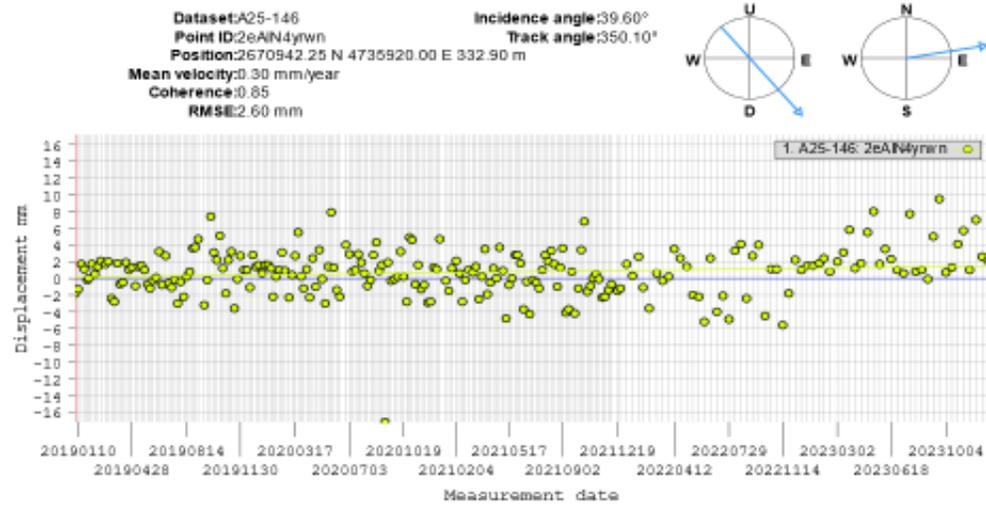


TRANSPORT INFRASTRUCTURE PREDICTIVE MAINTENANCE

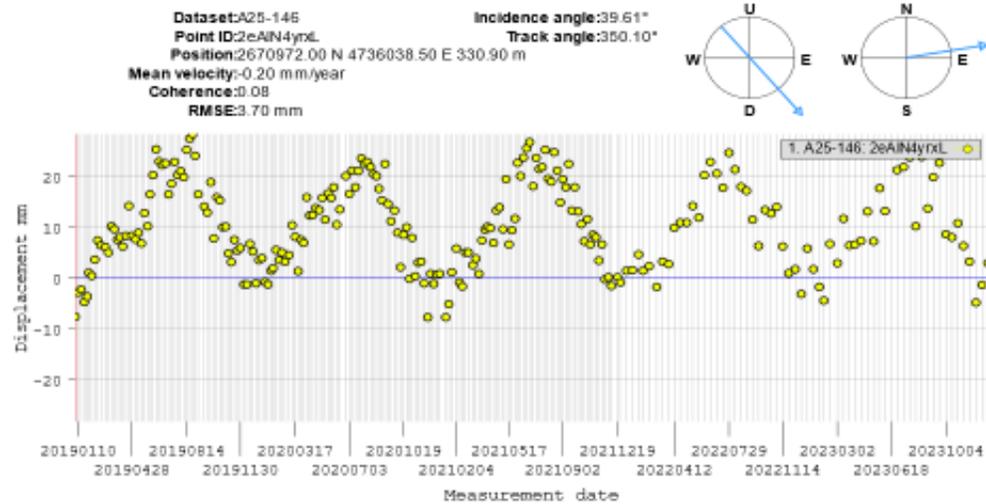
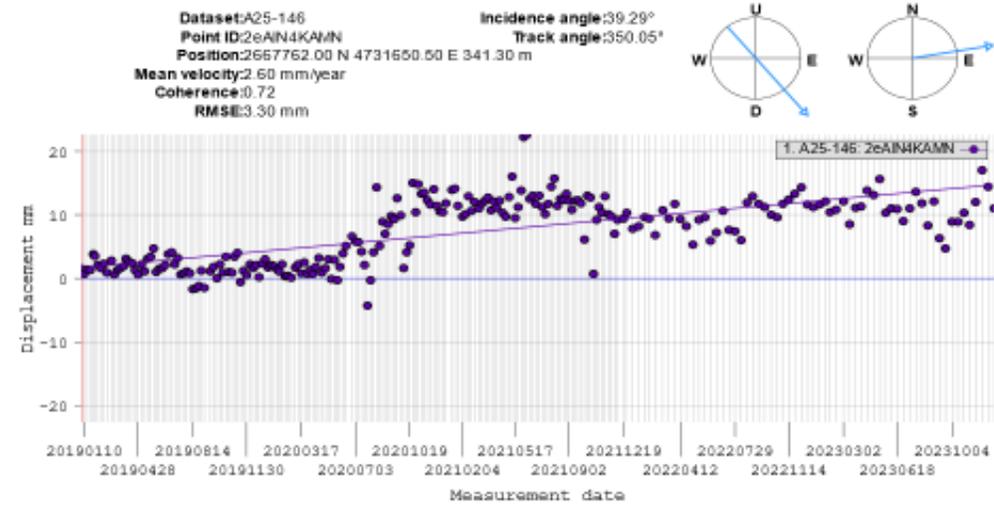


- Deformation monitoring of important infrastructure structures provides an early warning system for these structures
- Excessive settlements, washouts or structural deterioration, are often accompanied by early deformation, which can indicate upcoming damage or, in extreme cases, even failure.
- A demonstrator on a 45 km-long highway in Austria was prepared

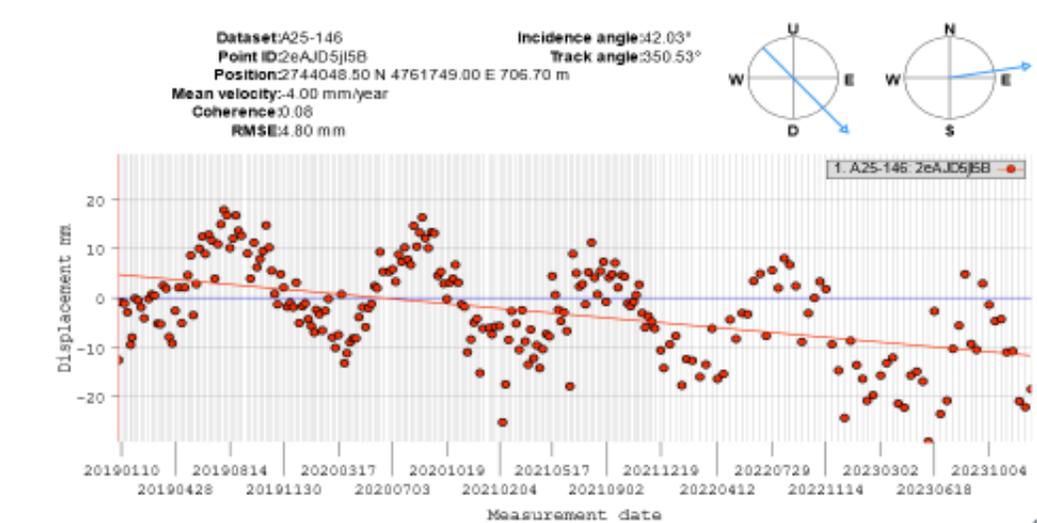
TRANSPORT INFRASTRUCTURE PREDICTIVE MAINTENANCE



Highway

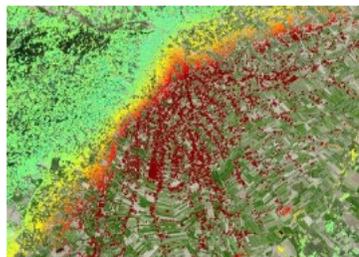


Bridge





European Ground Motion Service



Overview

Technical summary

Documentation

Datasets

Applications & use cases

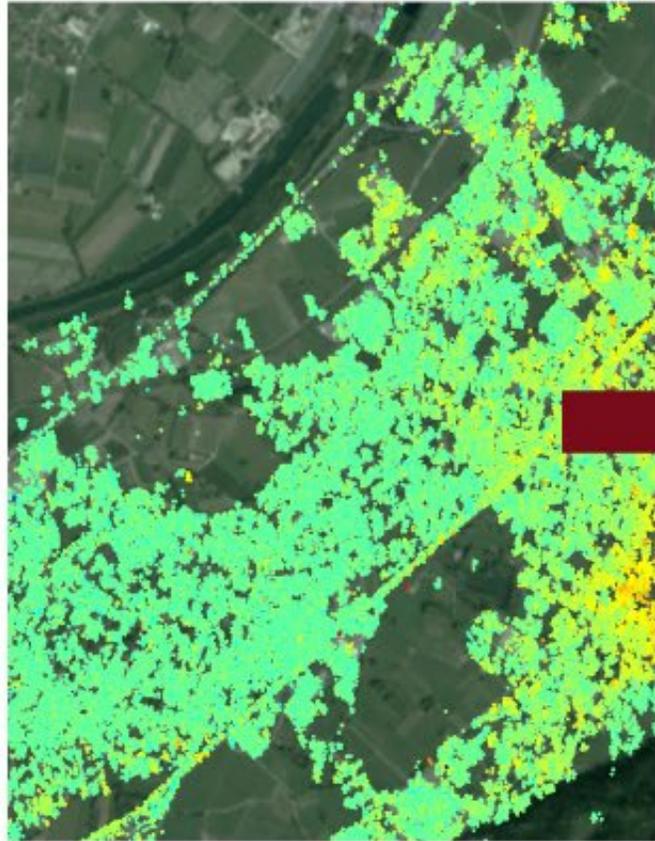
The Earth's surface is in constant motion. Whether due to natural phenomena such as tectonic activity or volcanism, or because of human activities such as groundwater extraction or mining, the dynamism of the surface can have significant impacts on infrastructure and natural ecosystems. In recent years, increasing awareness of the potential risks related to ground motion has led to a demand for comprehensive and reliable information on these movements.

The European Ground Motion Service (EGMS) was created in response to user needs voiced at the Copernicus User Forum. This product represents the bleeding edge of space-based remote sensing technology, using Synthetic Aperture Radar Interferometry (InSAR) data derived from Sentinel-1 to detect and measure ground movements across Europe with millimetre precision. The product is updated annually and can be used for a variety of applications; city, regional, or state authorities can use it to monitor the structural integrities of dams, bridges, railways, and buildings. It allows urban planners to make data-driven decisions about where to build new infrastructure by assessing the likelihood of natural hazards such as landslides or subsidence. Researchers can also use EGMS data to study the impacts of climate change, such as thawing permafrost and coastal subsidence.

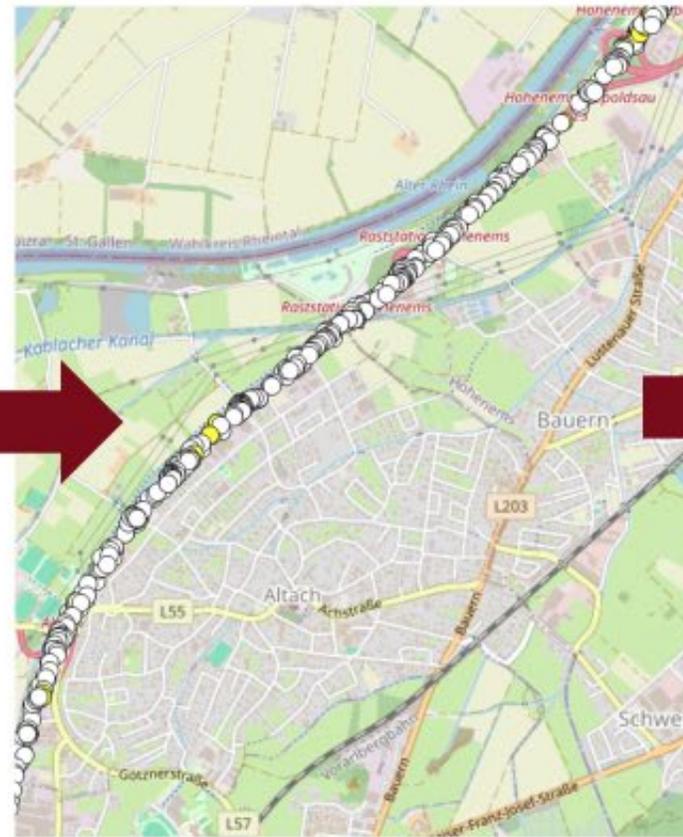
Datasets

You can only view and download the data in the EGMS Explorer (external site).

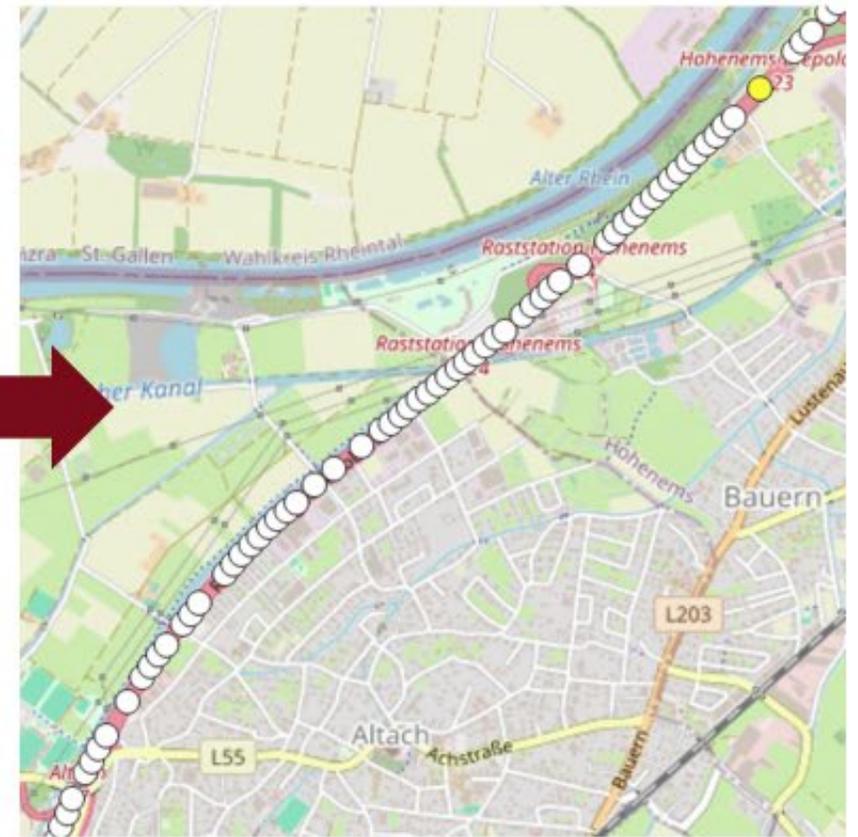
TRANSPORT INFRASTRUCTURE PREDICTIVE MAINTENANCE



EGMS



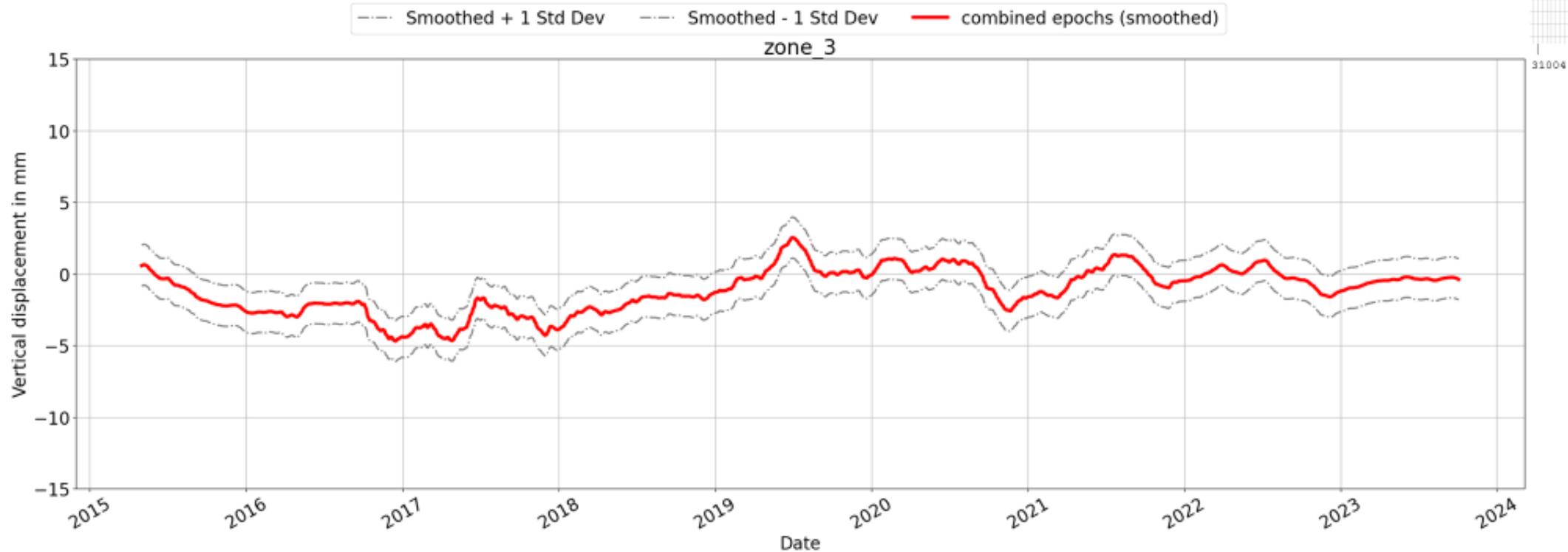
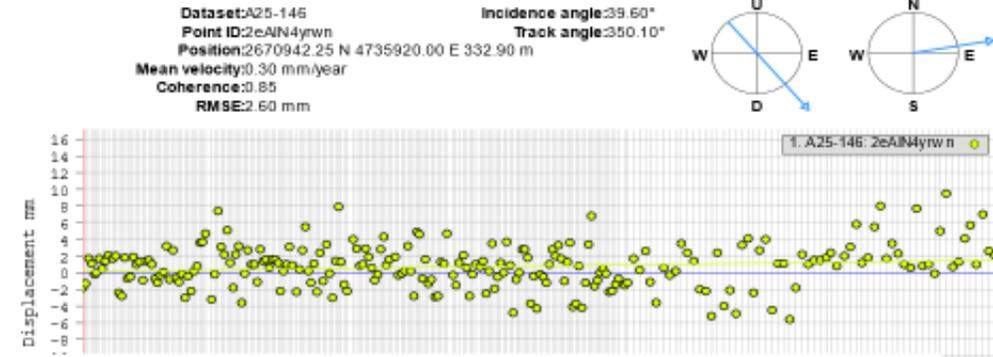
Reselected points



Clustered and decomposed

TRANSPORT INFRASTRUCTURE PREDICTIVE MAINTENANCE

- Recalculation to vertical deformation for each zone
- Combine EGMS Epochs





Ground Movement Data
(Sentinel-1 pre-processed by EGMS)

Motorway Geometry
(OpenStreetMap)



Data

Selection of PS points
on the motorway,
subtraction of bridges
above the motorway

Clustering of points in
50m sections

Determination of vertical
deformation from LoS,
combination of different
EGMS epochs

Information



Integration into the
EOX Dashboard

Decision ready information

Bundesministerium
Innovation, Mobilität
und Infrastruktur



DEMO

Storytelling / Narratives

Explore

Repository

Workspace

<https://gtif-austria.info>

Thank you



Thank you for your attention.



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Find out more about GTIF Austria at

<https://gtif-austria.info>

<https://github.com/GTIF-Austria>