End User Interface Manual

EGMS SERVICE DOCUMENTATION

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3.0	16/11/2023	Yngvar Larsen	Update reflecting availability of BASIC products, as well as two different datasets (2015-2021 and 2018-2022), in the Explorer.

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1 Introduction

1.1 Scope of the Document

This document introduces the EGMS Product Archive and Dissemination System (PADS, **RD4**) as the frontend of the service. It provides an overview of the EGMS Explorer for viewing the data and downloading the products. Chapter 2 outlines the main requirements considered during the design of the system. Chapter 3 describes the generic functions of the interactive EGMS Explorer. Chapter 4 described the functions for viewing and analysing the data. Chapter 5 describes the interface with the Product Archive, which provides search and download functions for registered users.

1.2 References and Related Documents

Table 1. Reference Documents

ID	Reference or Related Document	Date	ID	Source or Link/Location
RD1.	Algorithm Theoretical Basis	25/10/2023	EGMS-D3-ALG-SC1-2.0-006	EGMS ORIGINAL Consortium
RD2.	Product User Manual	17/05/2022	EGMS-D4-PUM-SC1-2.0-007	EGMS ORIGINAL Consortium
RD3.	Product Description and Format Specification	25/10/2023	EGMS-D6-PDD-SC1-2.0-009	EGMS ORIGINAL Consortium
RD4.	Product Archive and Dissemination system description	10/10/2022	EGMS-D9-PADS-SC1-2.0-011	EGMS ORIGINAL Consortium
RD5.	Quality assurance and control report	02/11/2023	EGMS-D10.7-QCR-SC2-078	EGMS ORIGINAL Consortium
RD6.	GNSS calibration report	16/11/2023	EGMS-D19.4-GCR-SC2-082	EGMS ORIGINAL Consortium

2 Key input requirements

The EGMS Product Archive and Dissemination System [**RD4**] provides access to the ground motion data produced by the service. The system comprises two main parts integrated in the end user interface: an interactive EGMS Explorer data viewer allowing all users to explore the data within a map interface and a product archive enabling registered users to search and download data for use within their systems.

The goal of the PADS is to make ground motion data findable, accessible, usable, and understandable. It has been designed to be intuitive to use, serving both casual users and professionals. EGMS provides ground motion data for tens of billions of locations, each with hundreds of individual measurement values, so the Explorer has been designed to be as efficient and responsive as possible. Users can navigate a fully three-dimensional map of the service area, view average velocities, and explore deformation histories. No user registration is required for the Explorer, except in case of data download. The Product Archive provides an interface for registered users (see Section 5.2) to find and download datasets in standard formats that are easily ingested into the users' GIS and other software.

The following subsections outline the input requirements that were considered when designing the interface.

2.1 Key requirements for visualisation

The visualisation interface is expected to be the most used interface to EGMS products. Although user needs vary, depending on the use case and user expertise, the Explorer tries to meet the needs of all users within a single intuitive interface, called the EGMS Explorer (Section 3). The primary requirement, shared by all users, is to see where ground movement occurs and how fast. A user should be able to open the service, quickly find and zoom to their area of interest, and display velocity measurements. The initial symbolisation needs to be intuitive but customisable (Section 4). The background map should allow easy identification of the ground features being measured. Users need to be able to compare and contrast individual measurements as well as different datasets. Users need to be able to see the progression of deformation over time, both for single points and areas of interest.

2.2 Key requirements for search and download

A subset of users' needs to be able to download data for use within their workflows. Copernicus services require registration and authentication for data download. Thus, a form-based web interface has been created to allow easy discovery and data download in an easily ingestible format (Section 5.2). Users primarily need to be able to search for a given geographical area of interest (AOI). They should be simple to specify, either by text-based entry or uploading a simple polygon in a standard format. As multiple datasets are available, the user should be able to filter based upon the acquisition geometry or other parameters.

3 EGMS Explorer overview

3.1 Basic elements

3.1.1 Layout

The EGMS Explorer is an interactive environment allowing the users to view and analyse data, and to download interferometric synthetic aperture radar (InSAR) products. The interface includes five basic elements: the map viewer, the North arrow, the scale, the coordinates, the map layers, and the toolbar (Figure 1A):

- **Map viewer:** The map can be viewed both in 2D or 3D by clicking on the corresponding element of the toolbar (Figure 2G). 3D-mode is especially useful when analysing mountainous areas (Figure 1C).

- **North arrow and scale:** the North arrow is always directed upwards while using the 2D-mode (Figure 1B). The arrow adjusts according to navigation when the user activates the 3D-mode (Figure 1C). The scale bar gives a distance reference in meter/kilometre that automatically adjusts when zooming in/out.

- **Coordinates and credits:** When clicking somewhere in the map viewer, coordinates and elevation information of the point are displayed at the bottom of the EGMS Explorer interface (Figure 1A). The default coordinate system is latitude/longitude in degrees (WGS84). By clicking on the coordinate display, the user can change the projection to meters (LAEA). The blue text "Credits" opens a window with further information on data and code attributions.

- **Datasets and map layers:** In the upper left corner, the users can choose which InSAR datasets (Section 4.2), the background and supplementary map layers (Section 0) to visualise in the map viewer.

- **Toolbar:** The bar in the upper right corner includes a set of tools useful for navigation, visualisation, data analysis, search and download in the Product Archive (Figure 2).

Figure 1. The overall layout of the EGMS Explorer interface (A) and detailed views in 2D (B) and 3D modes (C).

Figure 2. Toolbar elements available in the upper right corner of the EGMS Explorer interface (Figure 1A). A. Search by location or coordinates. B. Get help and information. C. Add external layers from WMS servers. D. Show the dataset legend. E. Set the light direction from the view angle (3D mode). F. Show the user location on the map. G. Generate a link to the current map view. H. Toggle between 2D/3D modes. I. Draw a polygon for averaging InSAR series. J. Tools for search and download in the Product Archive (Section 5). K. Show/hide the toolbar.

3.1.2 Navigation

The EGMS Explorer interface allows the users to pan around, zoom, tilt, and rotate the map. In 2D-mode, flying in/out, left/right and up/down is possible. To tilt and rotate, the user must first activate the 3D-mode in the toolbar (Figure 2H). The navigation can be performed using a mouse, a keyboard, or a touch screen. The possible actions are summarised in Table 2.

A free-flight mode is also available and combines navigation based on keyboard and mouse. The movement is controlled using the keyboard (Table 2, key). The look direction is controlled by moving the mouse.

The toolbar includes a geographical search function that allows for quickly zooming the map view to an area of interest based on a locality name, a street address or latitude/longitude coordinates (Figure 2A). Latitude/longitude coordinates can be e.g. copied and pasted in the toolbar from Google Maps.

Table 2. Actions for EGMS Explorer navigation

Action	Mouse	Key	Touch
Fly in / out (2/3D modes)	Scroll wheel on mouse or scroll gesture on trackpad	W, S	Stretch/Pinch with two fingers
Fly left / right (2/3D modes)	Click-and-drag	A, D	Drag with one finger
Fly up / down (2/3D modes)	Click-and-drag	Q, E	Drag with one finger
Tilt (3D mode)	Click-and-drag with right mouse button or while holding Shift key	-	Move two fingers up or down
Rotate (3D mode)	Click-and-drag with right mouse button or while holding Shift key	-	Move two fingers in a circular motion
Enter / Exit free-flight mode	-	Alt + G	-

4 Data visualisation

4.1 Interaction with InSAR data

When selecting an EGMS dataset (Figure 3A), the ground deformation information is visualised in the map viewer. The colour of each point represents the mean velocity, in mm/year, according to a generic colour scale that can be adjusted by the user (Figure 3B). Each individual layer can also be modified differently in the dataset setting window (Figure 3C), further documented in Section 4.2.2. To view the entire data series and get information about the measurement properties, the user must click on an EGMS point (Figure 3D), which opens an additional window: the time series viewer (Figure 3E). The location of the active point is shown by a white circle in the map viewer.
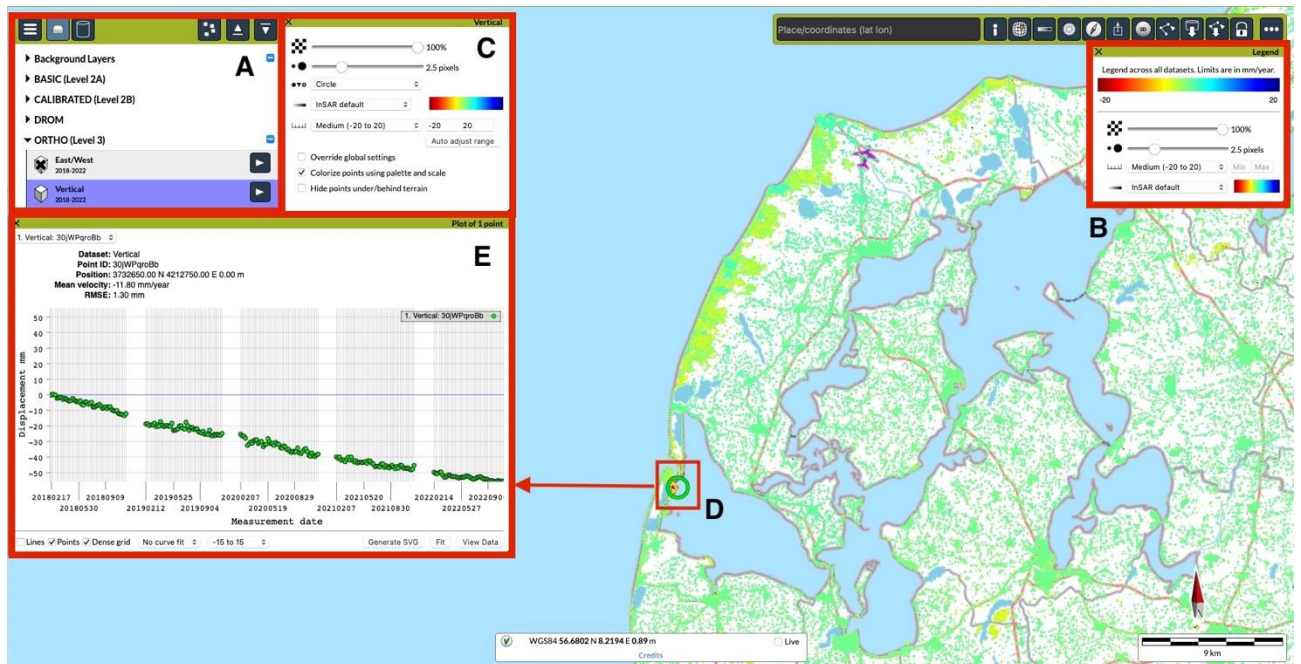

Figure 3. Interaction with EGMS data in the EGMS Explorer interface. A. Data selection window. B. Colour scale of the EGMS map. C. Configuration of the dataset visualisation. D. Selected PS point for time series visualisation. E. Time series viewer.

The time series viewer is composed of several essential elements and more advanced functions to get information about the measurement properties, view the data and plot the displacement (y-axis) against time (x-axis):

- Basic information about the point (dataset, Point ID, position, mean velocity, Root Mean Square Error RMSE) is shown in the upper left corner (Figure 4A).

- By default, the time series viewer displays the entire documented period (x-axis) and the whole range of InSAR displacements based on max.-min. values (y-axis) (Figure 4B). The viewer is interactive, which allows the user to zoom in/out the graph using the scroll wheel on the mouse or the scroll gesture on the trackpad.

- To rescale the y-axis only, zoom in/out while holding the shift key. Fixed y-axis limits can also be set by selecting specific values in a scrolling menu at the bottom of the viewer (Figure 4C). Finally, to return to the default view after zooming in/out, click on the button "Fit" (Figure 4D).

- It is possible to compare time series from different locations by clicking on two or more points on the map while holding the Shift key (Figure 4E–F). The time series window gets updated with the information related to the latest point (Figure 4G) while keeping the first displacement series plotted in the viewer (Figure 4H). The information related to first selected point can still be retrieved in the upper-left scrolling list (Figure 4I).

- Time series can be visualised with single points at the time of each Sentinel-1 acquisition (Figure 5A) or by connecting the acquisitions with lines (Figure 5B). The density of the x-axis grid can also be modified.

- By clicking on "View data" in the bottom-right of the time series viewer (Figure 6A), an additional window opens to view the data at the location of the point selected in the upper-left scrollable list (Figure 6B). The list includes information regarding the geographical point position, the measurement quality/reliability, and the entire series of displacement values for each exploitable Sentinel-1 acquisition (Figure 6C).

- Various best fit functions can be applied to analyse the general displacement trend over the entire documented period. The best-fit line is plotted when selecting a "Linear" function at the bottom of the time series viewer (Figure 7A). When the displacement series display a non-linear pattern, other functions can be applied, such as "Polynomial" (Figure 7B).

- An element of the toolbar allows the user to draw a polygon in the map viewer (Figure 2I, Figure 8A). Then, the EGMS measurements within the selected area are averaged and plotted in the time series viewer. The data information in the upper-left corner of the viewer indicates the number of measurement points used to plot the averaged series (Figure 8B).
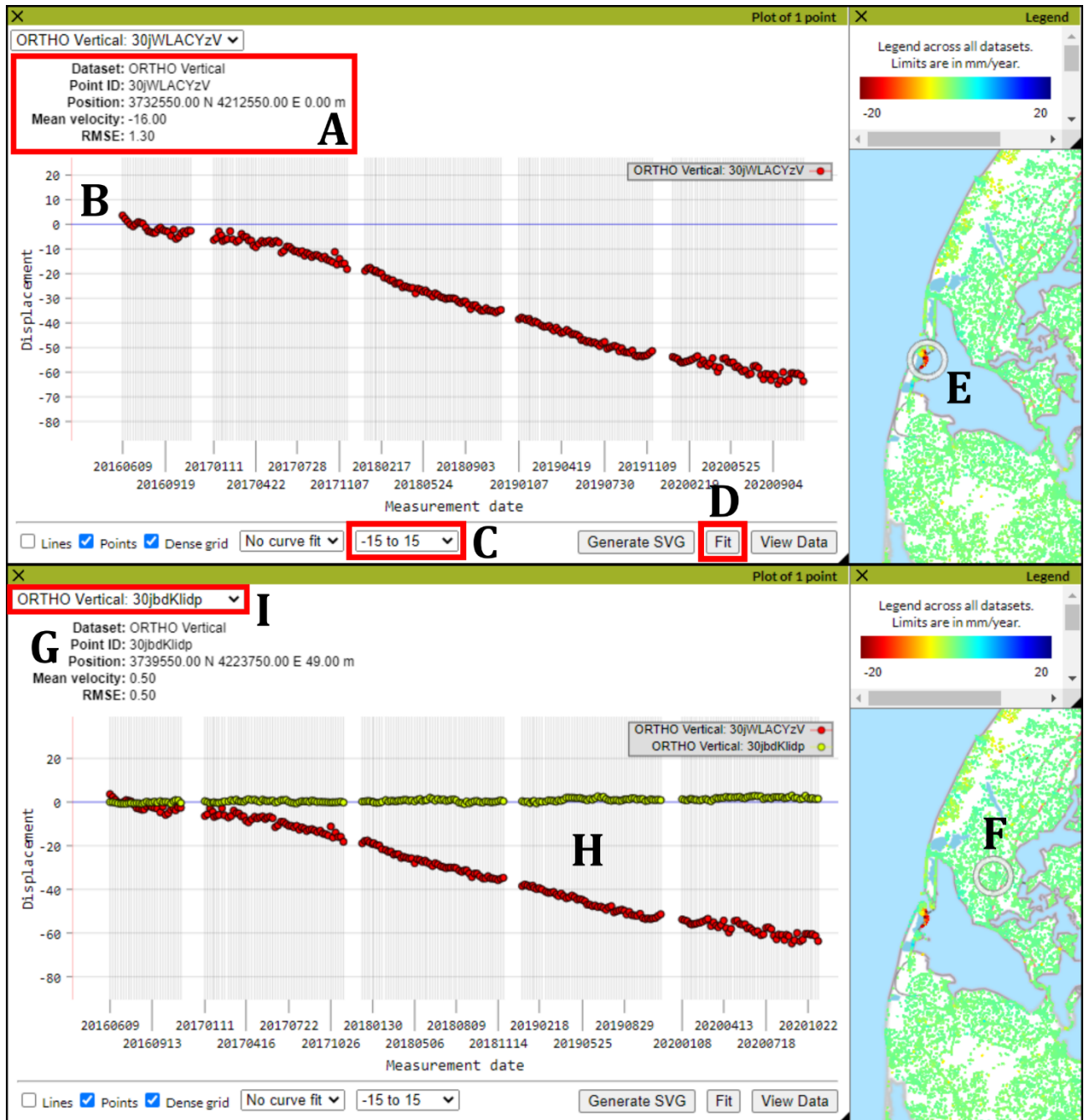
Figure 4. Time series viewer. A. General information of the selected point. **B.** Displacement plotted against time. **C.** Fixed y-axis scale. **D.** Fit to rescale the time series view to the default view (entire documented period and y-axis scaled according to max.-min. displacements). **E.** Location of the selected point. **F.** Location of a second selected point while holding the Shift key. **G.** Information of the second point. **H.** Comparison of displacement against time for the two selected points. **I.** Scrollable list to choose for which point the general information is displayed.
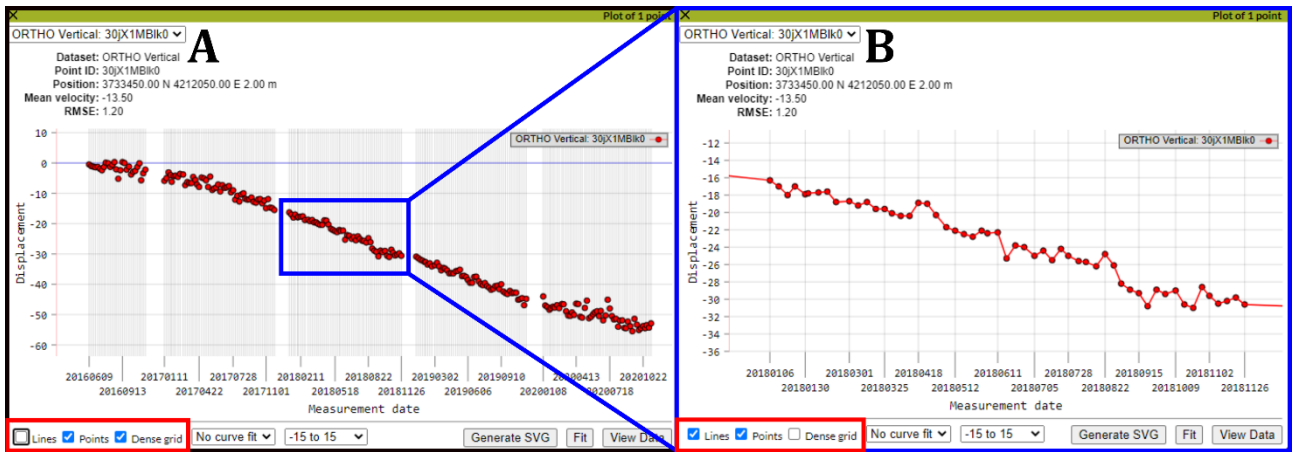
Figure 5. User option for visualisation of the time series. A. Single points at acquisition dates during the entire documented period. B. Points connected by lines during one period of interest after having zoomed in the graph.
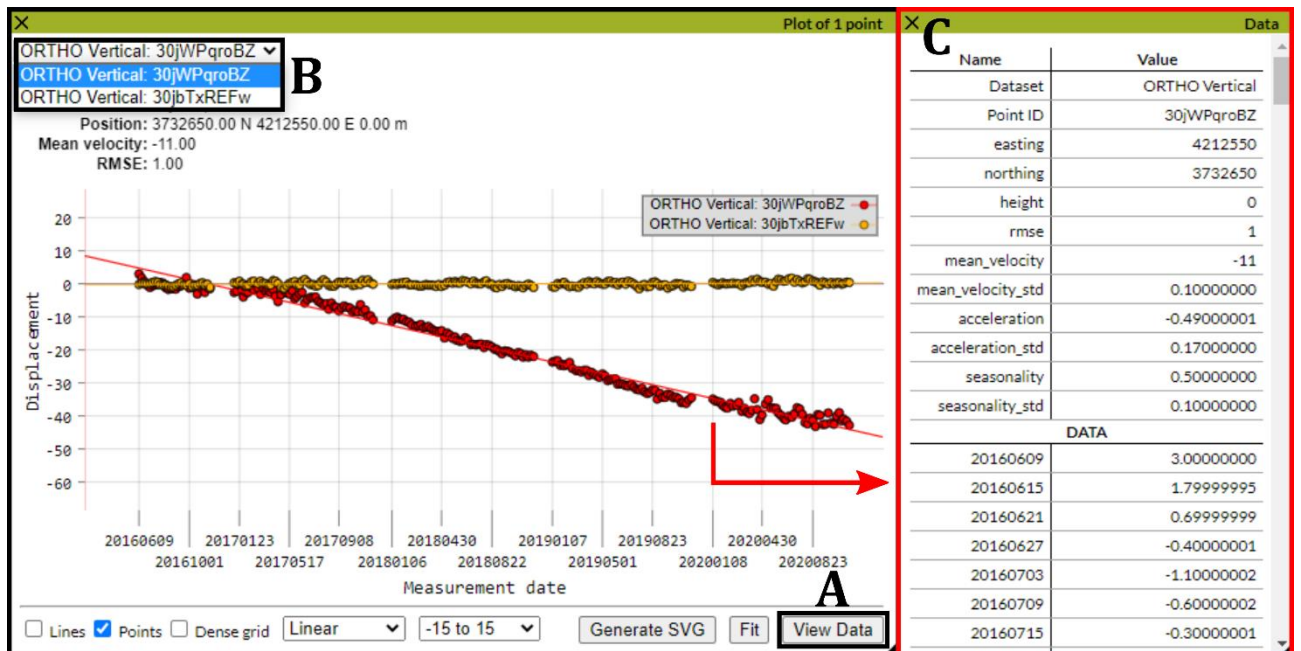

Figure 6. Data properties and displacement values at the location of the last selected InSAR measurement point (here red time series). A. Button for opening the data viewer. B. Scrollable list to select the time series. C. Data viewer.
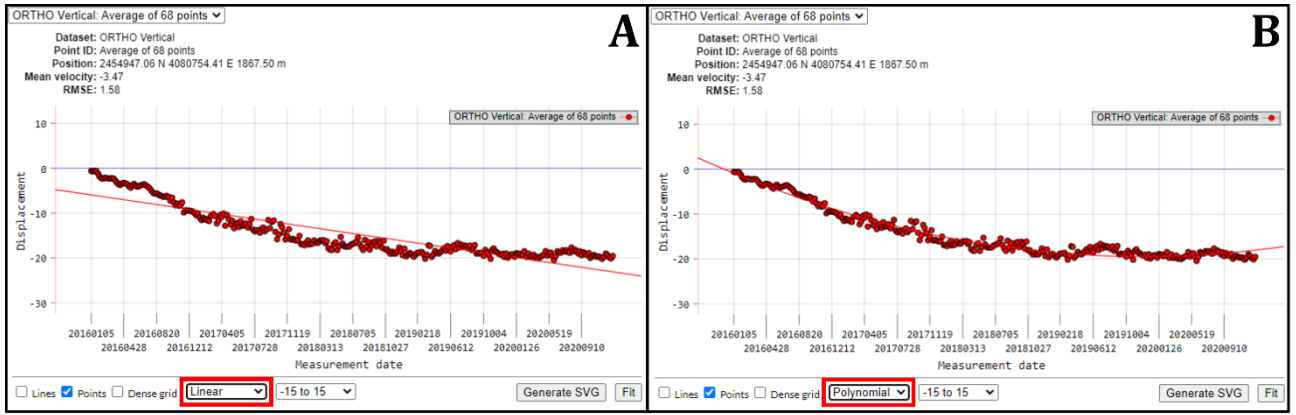
Figure 7. A. Time series with a best-fit line. B. Time series with a best-fit polynomial function.
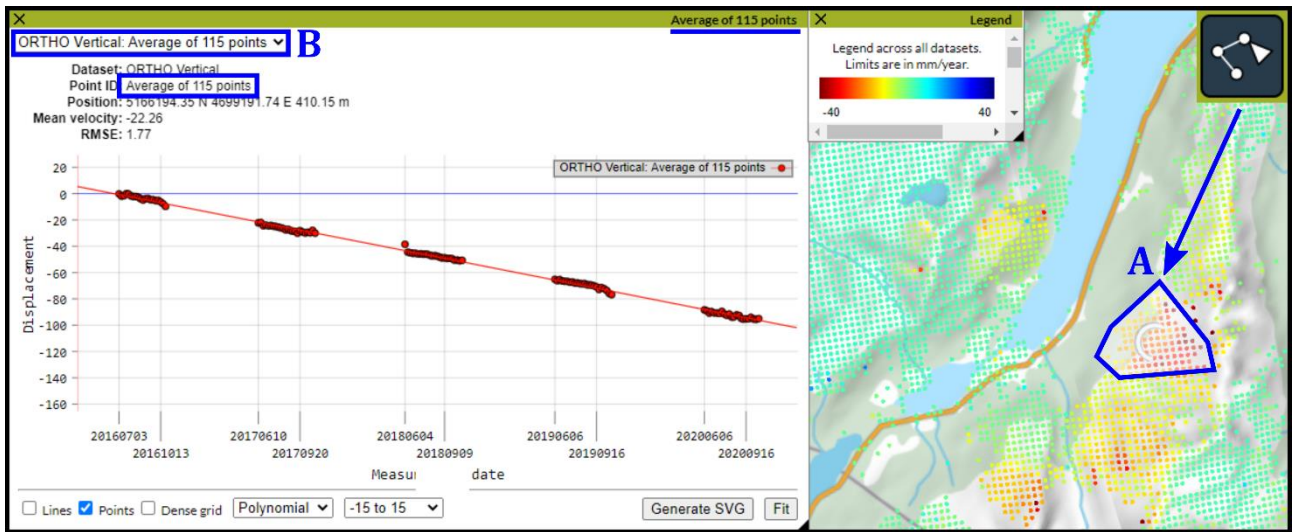

Figure 8. Averaging time series within a manually drawn polygon. A. Polygon drawn with the corresponding toolbar element (Figure 2I). B. Averaged time series, here based on 115 EGMS measurement points.

4.2 Datasets

Multiple datasets are available within the EGMS Explorer. Level 2A (BASIC), Level 2B (CALIBRATED) and Level-3 (ORTHO) data "Vertical" and "East/West" are available for the European continent and the French overseas departments (DROM).

Read the Product User Manual for more information about the products (https://land.copernicus.eu/pan-european/european-ground-motion-service).

The "ORTHO (Level 3) Vertical" layer is displayed by default. The other datasets can be easily selected for viewing.

4.2.1 Selecting datasets

The data selection window (Figure 3A) lists all EGMS data and background layers available for visualisation in the Explorer interface. The buttons on the upper-right of the data selection window allows for hiding layers outside the current view (Figure 9A), and sending a selected layer to the front or the back of the map viewer (Figure 9B). A cross is shown when the dataset is unselected (Figure 9C). To select one or several datasets, click on the logo on the left side of the dataset name (Figure 9D). To see the full extent of the layer in the map viewer, click on the right-looking arrow (Figure 9E).

4.2.2 Configuring the visual appearance of an EGMS dataset

Clicking on the dataset name brings up the Dataset Settings window. In this window, the symbolisation can be fine-tuned. The layers can be displayed with a variable level of opacity (Figure 9F) and the size of the measurement points can be modified (Figure 9G). Multiple colour palettes are available and can be visualised with previously defined stretch scales (very fine, fine, medium, coarse) or manually adjusted by the user (custom) (Figure 9H). A colour-blind scalebar is available.

The colour of the points is based on the mean velocity of the entire data series expressed in mm/year. Modifications of the default visualisation parameters in the Dataset Setting window will override the global settings for the selected dataset (Figure 9I). Additional options allow for displaying all points in black (Figure 9J) or hide points located under the reference terrain model (Figure 9K).

Figure 9. Level-3 EGMS deformation layers. A. Hide layers outside the current view. B. Send selected layer to the front or the back of the view. C. Unselected layer. D. Selected layer displayed in the map viewer. E. Show the full extent of the dataset. F. Set the opacity of the layer. G. Set the point size. H. Choose the colour palette and the scale (in mm/year). I–K. Additional visualisation parameters. L. Toggle between data layers and archive search results.

4.3   Background layers

Various options for background layers are available, such as the Blue Marble NASA optical mosaic, the Euro Regional Map, high-resolution Copernicus optical imagery and the Corine Land Cover map of Europe and the DROMs (Figure 10). For further information about these datasets, the user must access the websites of the data sources, listed in the information displayed when clicking on "Credits" at the bottom of the map viewer.

Figure 10. Available background layers.

4.4   Sharing map views and downloading graphs

To share the location of the current map view, a link can be generated by clicking on the corresponding element of the toolbar (Figure 2G). A link can be sent by email or copied by (control-)clicking on the related blue texts (Figure 11A). Displacement plotted against time can be exported as .svg file by clicking on "Generate SVG" in the bottom of the time series window (Figure 11B).

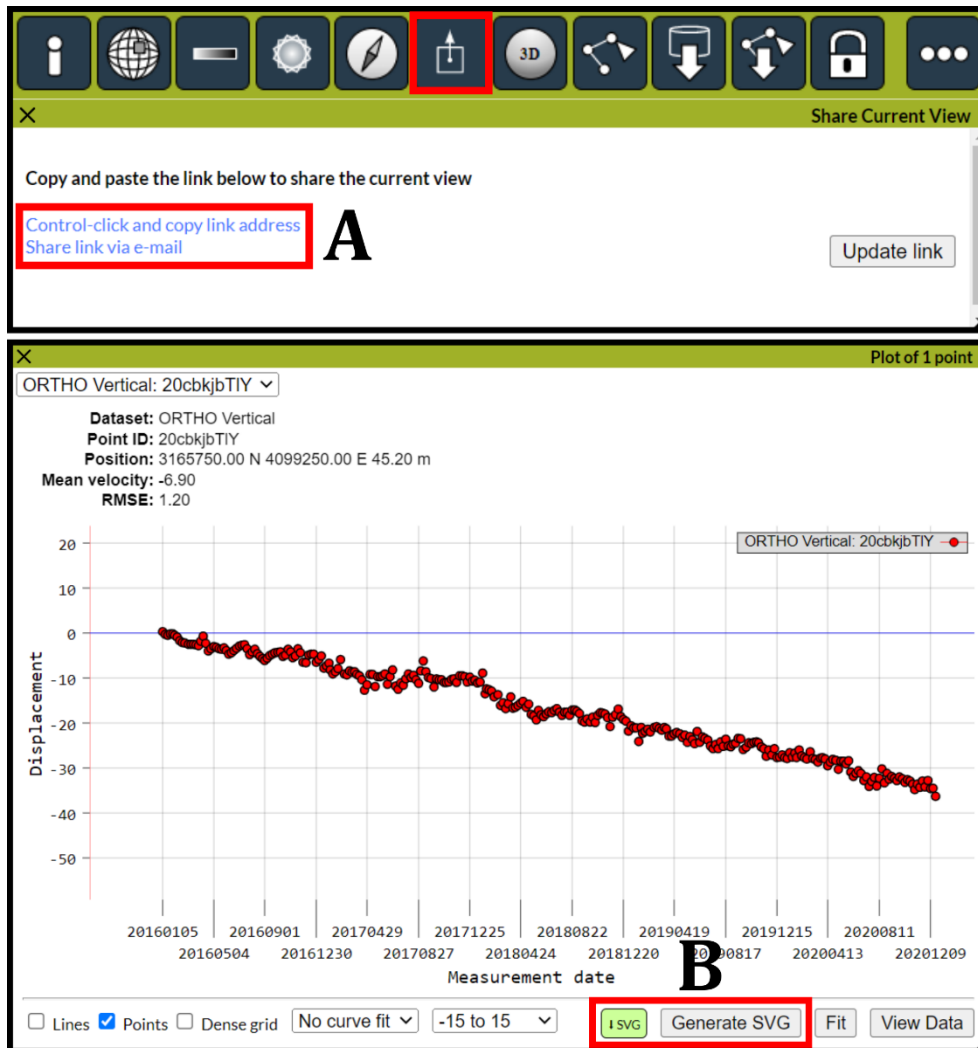**Figure 11. Sharing the current view and exporting figures. A. The sharing element of the toolbar allows for copying and sharing a URL of the current map view. B. The "Generate SVG" function in the time series viewer provides for downloading a graph figure.**

4.5 Adding external WMS/WMTS layers

The EGMS Explorer includes limited support for adding WMS/WMTS layers from external sources to the visualization, subject to certain requirements, see Figure 12. The WMS/WMTS layer will then appear in the data selection window (Figure 9) and can be toggled on/off in the same way as the EGMS data layers.

The added WMS/WMTS layers are ephemeral and will disappear if the user closes the browser window, or the page is reloaded.

Add WMS or WMTS layers

Enter the URL for a WMS or WMTS server below and click Add WMS or Add WMTS depending on the server type. Note that any custom WMS/WMTS servers added here will disappear when the page is reloaded.

WMS or WMTS server URL   Add WMS   Add WMTS

⚠ No servers added yet.

Requirements

To use an external WMS or WMTS server, the server must meet the following requirements:

- Support the necessary CORS-headers
- Support secure HTTP
- Support delivering imagery in Web Mercator projection (EPSG:3857, EPSG:900913)

The visualization's support for WMS and WTMS servers has some shortcomings, some of which may result in a given server not working even if it meets the requirements above. If you experience problems, simply reload this page.

Figure 12 Adding layers from external WMS/WMTS servers. The requirements a WMS/WMTS layer must respect to be visualised on the Explorer are indicated.

5 Product Archive

5.1 Design

Functionality for downloading EGMS products is completely and seamlessly integrated into the EGMS Explorer system, described in the previous sections. The logic and design choices are the same for the archive as for the map viewer component, and interfacing and obtaining the EGMS products should be a very intuitive process. The archive functionality will allow search and download of all released versions of the EGMS products.

This chapter outlines only the additional functions and features for finding and downloading the EGMS products.

5.1.1 Interface layout

For interfacing with the EGMS Product Archive, there are several functions accessible via the toolbar (upper right) and dataset and map layers tab (upper left) (Figures Figure 13 and Figure 14).
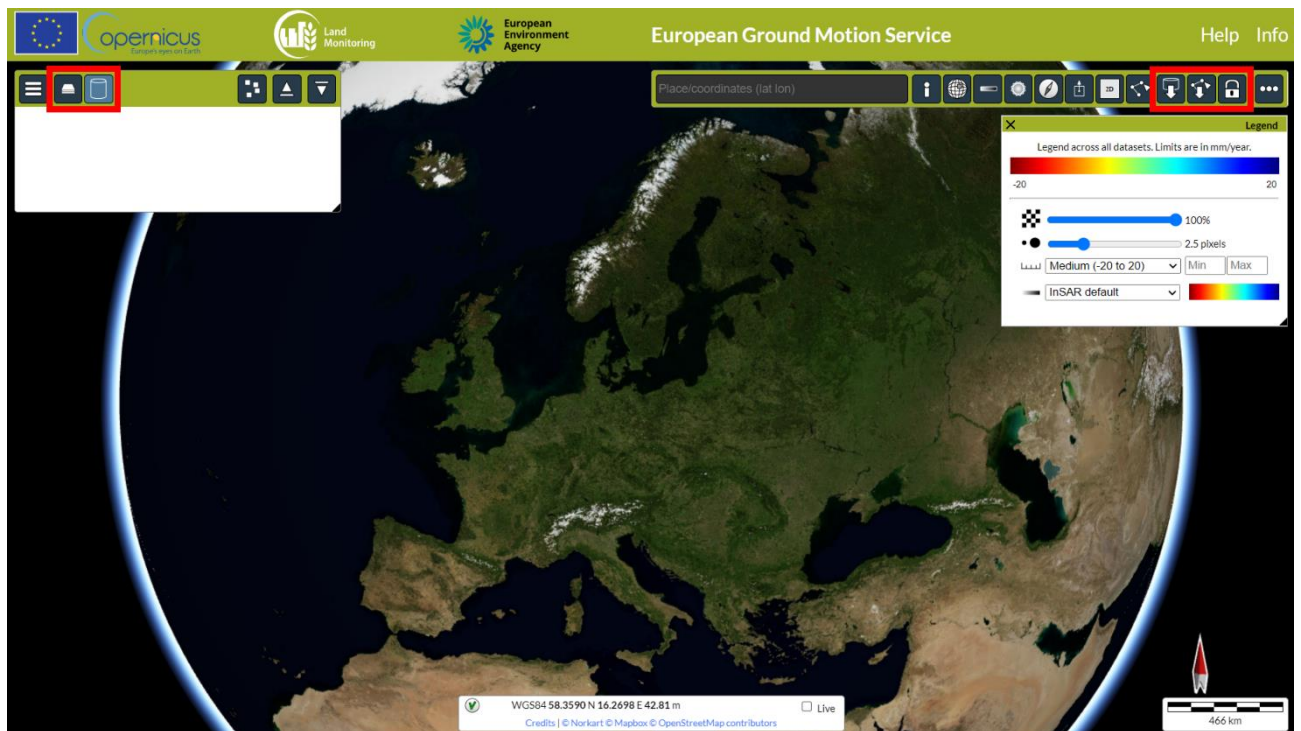

Figure 13. Tools for querying and downloading EGMS products.

Figure 14. Additional toolbar elements for interfacing with EGMS Product Archive. A. Product Archive tab. B. Geographical search of the Product Archive. C. Log in to access the archive.

5.1.2 User Authentication (EU Login)

Importantly, for searching and downloading EGMS products from the Product Archive user must be registered and logged in. This is a requirement of the European Commission for downloading and obtaining any types of Copernicus products.

For user authentication, the European Commission's "EU Login" service is used. For more details and creating the "EU Login" account please refer to: https://webgate.ec.europa.eu/cas/login.

Note:

- If user is already logged in with any of the EU web services, separate authorisation for EGMS Product Archive shall not be required. Authentication from other EU services will be automatically accepted by the EGMS Explorer.

- Log out from the EGMS Explorer is not explicitly supported. This is a recommendation from "EU Commission" to encourage users to remain continuously authorised for accessing EU web services. To log out or authorise with different credentials, please follow this link:

    o https://webgate.ec.europa.eu/tracesnt/logout

5.2 Search and download of EGMS products

5.2.1 Workflow

The starting point is to login to get access to the archive (Figure 14C).

Basic usage:

- Click the new "polygon with download" button (Figure 14B) to activate the "Product Archive" mode (Figure 15).

- Click around the map to configure a search area. Double-click to close the polygon. The Product Archive window opens under the toolbar (Figure 15). Perform the query or click on the "Clear search" button.

    o Note that the size of the "bounding box" is currently limited to maximum 3 degrees latitude/longitude.

- The "Download" button to the left of the "polygon with download" button will either be marked up with a number (indicating the number of results, Figure 15A) or a triangle (indicating an error).

- Click "View results" to bring up the list of results in a new browser tab, or review results in the "Maps and Dataset Layers" tab on the left of the Explorer (Figure 16). Outlines of any datasets in the viewer itself shall be also visible if you did not query too big an area.

- The results page is self-explanatory (Figure 16).

    o Note that you can hover over items in the results set to see the corresponding region light up in the viewer.

- If you perform a new search, the existing search results window will update with the new result set. This persists until either window is closed, or the connection between the two windows is otherwise broken.

- Download a zip file and enjoy your CSV with a cup of TIFF and XML.

    o Note that "Download links" (Figure 15B) will download a list of products for bulk download. This is explained in the next section.
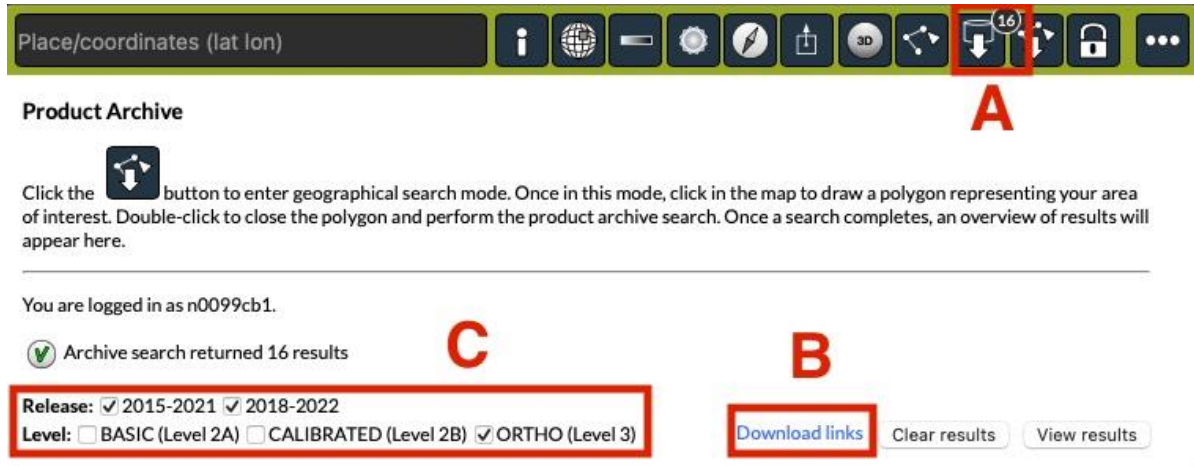
Figure 15. Product Archive mode. It enables a geographical search of the product database and preselection of the product level that is queried. Note that multiple product levels can be selected. A. Download button with the number of results from a query. B. Download a list of hyperlinks corresponding to all results of a query. C. Dataset search options.
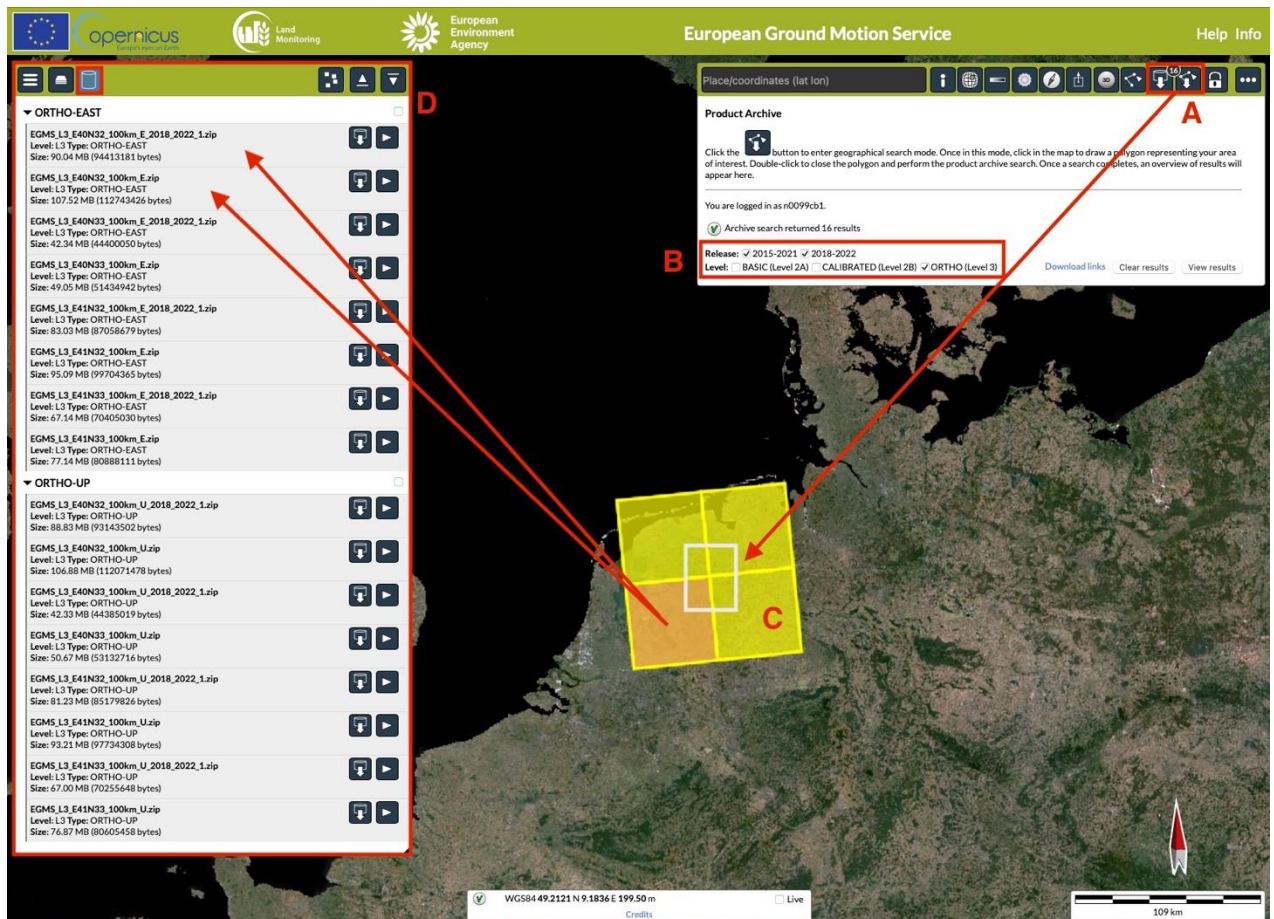

Figure 16. Overview of the workflow to search and download EGMS products. A. Archive search tools. B. Dataset options. C. Geographical outline of search results. D. list of archive search results.

5.2.2 Download of multiple products

Downloading *all* products resulting from a search query is possible by clicking on the "Download links" in the Product Archive tab (Figure 16B). Clicking on this link will download the plain ascii file containing hyperlinks to download data that can be easily scriptable (Figure 17).

Notes:

- All hyperlinks are generated with a security token that expires after one hour.

- The token is refreshed as long as a download using the token is in progress – so it remains valid for one more hour after a given download finishes.

- If the token expires, the following error message is reported:

  "You need a valid download token to download data. Rerun your search to obtain new links with valid download tokens."

```
https://dev.insar.no/insar-
api/archive/download/EGMS_L2b_146_0369_IW2_VV.zip?id=ec955301c7e749d1a3a886907e28021c

https://dev.insar.no/insar-
api/archive/download/EGMS_L2b_146_0370_IW2_VV.zip?id=ec955301c7e749d1a3a886907e28021c

https://dev.insar.no/insar-
api/archive/download/EGMS_L3_E42N43_100km_E.zip?id=ec955301c7e749d1a3a886907e28021c
```

Figure 17. Example of the list of hyperlinks for downloading EGMS products in the bulk.

List of abbreviations

Abbreviation	Name	Reference
AOI	Area of Interest	
ATS	Average Time Serie	
ATSd	Detrended Average Time Series	
CLC	CORINE Land Cover	
CLMS	Copernicus Land Monitoring Service	
DEM	Digital Elevation Model	
DS	Distributed Scatterer	
EEA	European Environment Agency	www.eea.europa.eu
EGMS	European Ground Motion Service	https://land.copernicus.eu/en/products/european-ground-motion-service
EPN	EUREF Permanent Network	
GNSS	Global Navigation Satellite Systems	
InSAR	Interferometric Synthetic Aperture Radar	
IPE	InSAR Processing Entity	
IPR	Intellectual Properties Rights	
KPI	Key Performance Indicators	
LAEA	Lambert Azimuthal Equal Area	
MP	Measurement Point	
ORIGINAL	OpeRatIonal Ground motion INsar Alliance	
ORR	Operational Readiness Review	
PS	Persistent Scatterer	
QC	Quality control	
RD	Related Documents	
SCR	Signal to Clutter Ratio	
stddev	Standard deviation	
TS	Time Series	

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