



Rheticus[®]

Monitoring the evolution of our Earth

Rheticus[®] Displacement Service description

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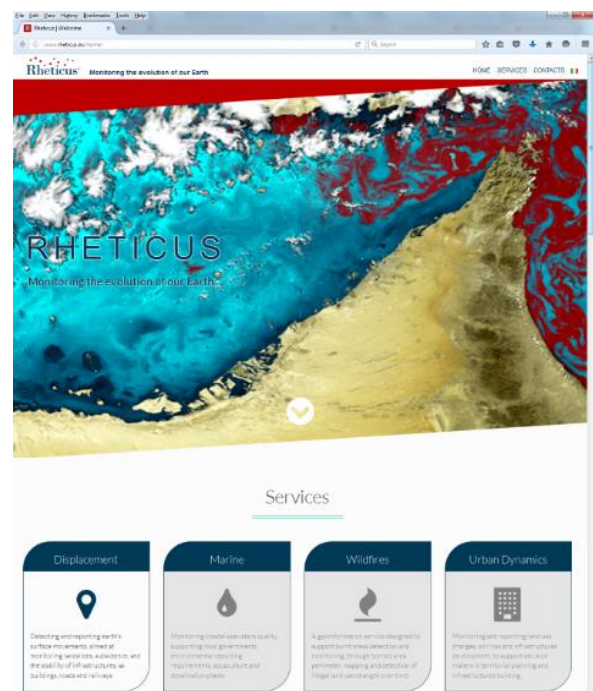
Rheticus®

Rheticus® is an **automatic cloud-based geoinformation service platform**, designed to deliver **fresh** and **accurate** data and **information** for monitoring the evolution of the earth's surface. The geoinformation services provided by the platform include services for the dynamic monitoring of the Earth's morphology, vegetation and infrastructure, or coastal seawater and are aimed both at monitoring the environmental and production aspects.

Rheticus® provides information by means of **graphic indicators**, **dynamic diagrams** and preset **reports**. The information provided allow to immediately assess the monitored areas. Moreover, the system allows the user to define **threshold levels** which, if exceeded, **trigger alarms** that are immediately sent to the user.

Rheticus® is a platform which is **accessed by subscription** and allows users to have continually updated information.

The service update is guaranteed through the use of **satellite images**, mapping data and environmental information available online as **open data**. The service **update** is done every time new data becomes available and, depending on the service, the refresh rate can range from a **monthly to daily** frequency.



Accessing to Rheticus® is cross-platform and the services are available both through the web portal or tablets and smartphones. Information is displayed by a preset dashboard, which simplifies the analysis of monitored phenomena, providing users a comprehensive overview. Services are also available in **Machine to Machine** mode (M2M) via standard sharing protocols, making the Rheticus® platform an information hub, which delivers content to other online systems. Export capabilities of data and information are also available, in order to allow users to download it in standard formats and to facilitate their use in other external application environments.

Rheticus® Key features

The service	<p>Best cost / performance ratio, thanks to the adoption of open data, to the automation of the processes and the adoption of a cloud architecture.</p> <p>Geoinformation services designed to meet the needs of users who can access the platform to activate monitoring services on any area of the globe.</p> <p>Services may only be available on specific areas or country.</p>
Data	<p>Uses geospatial information and open data available on the cloud.</p> <p>Direct access to major satellite databases available online using the best data available on the area of interest.</p>
Processing	<p>Automated processing for the entire production chain, ensuring timely and regular updating of geoinformation services provided.</p> <p>Adopts standardized processing procedures, which guarantee the high quality level of geoinformation services provided.</p>
Delivery	<p>Standardized outputs with standard specifications and quality levels of services measurable through predefined metrics.</p> <p>Geoinformation services supplied with metadata of both the service and the data used for the production of the service.</p> <p>Downloading of information and data in standard formats, which can be used in the main office automation, CAD and GIS applications.</p> <p>Accessible from PC, Tablet and Smartphone through a user interface (GUI) or through M2M access.</p>
Terms & conditions	<p>Delivers geoinformation services with a use license, which regulates the conditions of use.</p> <p>www.rheticus.eu/home/pdf/terms_and_conditions.pdf</p>

Available services

Rheticus® provides multiple geoinformation services, which are continuously growing and evolving.

A typical service provided by Rheticus® is made-up by one or more suitably combined geoinformation products, which are characterized by technical specifications, refresh rates, issued output.

Rheticus® Service	Products	Focus	Update
Displacement	Landslides	Landslides, subsidence, infrastructures as buildings, roads, railways	Weekly
	Subsidence		
	Infrastructures stability		
Marine	Clorophyl	Coastal seawaters quality	Daily
	Surface temperature	Mapping of marine areas with high fishing rates.	
	Turbidity		
	Fishing area		
Wildfires	Burned Area	Burned area mapping and detection of illegal land use changes	Monthly
UrbanDynamics	Urban Change	Monitoring the anthropic changes.	Monthly
	Infrastructure Building	Soil sealing	
	SoilSealing		

Demo area: www.rheticus.eu

Rheticus® Displacement

The Rheticus® Displacement is the ideal solution for the monitoring of:

- **landslide areas**
- **subsidence** in urban and suburban areas (subsidence may be induced by natural and / or man-made causes, such as the withdrawals or release of fluids into the ground, the digging of mines or tunnels)
- **stability of infrastructure** such as dams, bridges, roads or railways

Rheticus® Displacement provides information about terrain displacement by means of graphic indicators, dynamic diagrams and preset reports. The information provided allow to immediately assess the level of stability of the monitored areas. Moreover, the system allows the user to define threshold levels, related to the speed of movement which, if exceeded, trigger alarms that are immediately sent to the user.



Example of the Rheticus® Displacement user interface

Rheticus® Displacement is the ingenious evolution on the *Cloud* of a service usually provided off-line. Planetek Italia too, through its Preciso® Landslide service, has been providing in the recent years displacement analysis to a variety of public and private customers. Besides, through Rheticus® Displacement the monitoring of terrain displacement can switch, from the provision of a *one-time* service, to the offering of a continuous, subscription-based, monitoring service.

The monitoring is carried out through the processing of RADAR images acquired by SAR (Synthetic Aperture RADAR) satellites Sentinel1 launched by the European Space Agency (ESA). Thanks to the data policy of the Copernicus programme (www.copernicus.eu), all the satellite data collected by the Sentinel missions are freely available with open licenses, meaning they can be used for commercial purposes by private organization. The open and free access to Copernicus data is guaranteed until 2034, which allows Planetek to have a long-term growth strategy for IaaS based on Sentinel satellite data.

The two Sentinel 1 satellites collect, with a revisit time of up to 6 days, RADAR images on the entire Earth's surface. Through the processing of a time series of these images, with interferometric processing techniques, it is possible measuring **millimetric displacements** of the terrain or infrastructures.



Example of terrain displacement monitoring

Through the analysis of trends in movement speed, Rheticus® Displacement enables the early detection of stability problems for slopes or infrastructures, that can create damages to property and people.

How it works

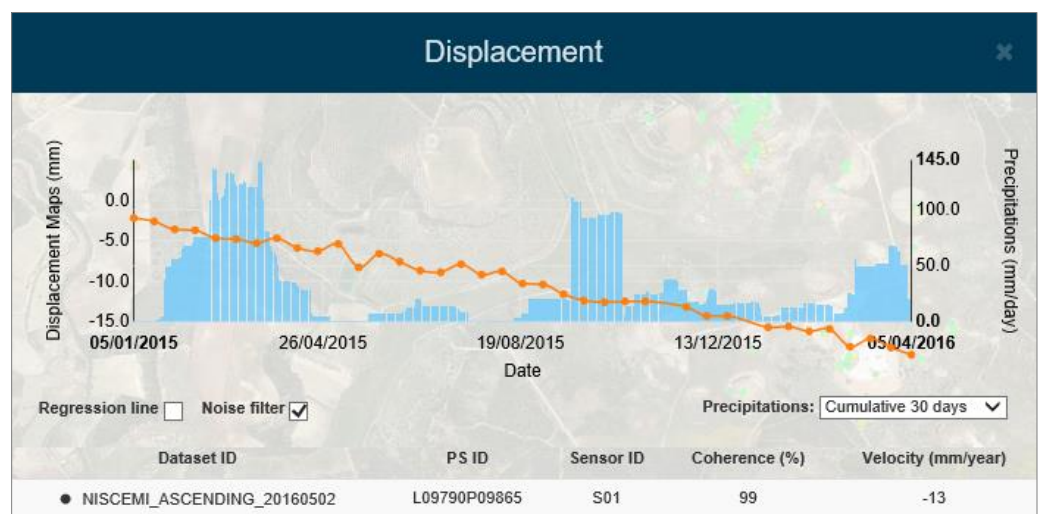
To activate the subscription to Rheticus® Displacement, the user must just provide the perimeter of his area of interest.

Rheticus® Displacement then automatically downloads, from the Collaborative Ground Segment of Copernicus all the multi-temporal satellite RADAR data available over the area of interest. The various datasets are downloaded on a cloud-based data center, and then Rheticus® Displacement activates the image processing workflow based on SPINUA. The result of this processing is a **database of geocoded points**, called *Persistent Scatterers* (PS). Each point provides information about its **displacement** (in millimeters) in different times: the date the measure is the collection date of the satellite image on which the point has been recognized by the processing system. The processing is

updated every time a new dataset is available over the area of interest, and therefore a new displacement information is available whenever the satellite collects a new dataset.

These data are processed by means of statistical models to identify temporal and spatial trends, to help the user evaluate the phenomenon of interest in the monitored area.

Rheticus® Displacement provides the user with **graphic indicators**, **dynamic diagrams** and preset **reports** that allow to immediately assess the level of stability of the monitored areas. Moreover, the system allows the user to define **threshold levels**, related to the speed of movement which, if exceeded, **trigger alarms** that are immediately sent to the user.



Displacement of a single Persistent Scatterer observed across a multi-temporal series of SAR data

Rheticus® Displacement is designed to interoperate with geodetic ground-based monitoring systems that provide real-time data. In this way the user can access, in a unique point of access to actionable knowledge, both the information coming from the satellite monitoring, with a synoptic view of the area of interest, and the detailed monitoring by means of data collected on the ground by geodetic instruments, favoring the process of analysis and understanding of the ongoing phenomenon.

Applications

Rheticus® Displacement services are usefull in several markets and applications:

Government Institutions & NGOs:

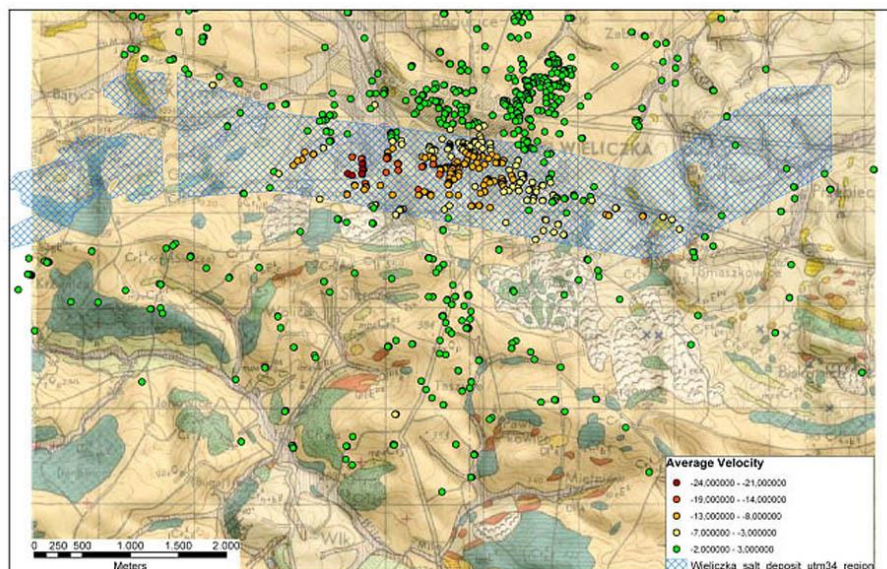
- Spatial Planning (*master plan*) and Land Management
- Public Safety to Monitoring of slope and infrastructure stability in order to prevent or mitigate the damages caused by landslides and subsidence (*civil protection*)
- Monitoring of public works and infrastructure
- Monitoring of mining activities

Enterprise – Civil Engineering (roads, railways, underground, dams)

- Monitoring the infrastructures and the territory where they belong
- Monitoring, during the construction of the infrastructures, the stability of the terrain and of the infrastructure itself
- Evaluate the effectiveness of consolidation works on slopes

Enterprise – Oil&gas and Mining

- Assessing the arising of subsidence phenomena after the whitdrawal or pumping of underground fluids (water, gas, oil)
- Monitoring subsidence due either to the extraction of underground rocks and minerals or to the excavation of tunnels for roads or pipelines.



Subsidence map due to local mining in Wielitcka (Poland) using shape file downloaded from Rheticus®

References

Sentinel 1

SENTINEL-1 is an imaging radar mission providing continuous all-weather, day-and-night imagery at C-band.

The SENTINEL-1 is a two satellite constellation that provides high reliability, improved revisit time, geographical coverage and rapid data dissemination to support operational applications in the priority areas of marine monitoring, land monitoring and emergency services.

To accomplish this the satellites carry a C-SAR sensor, which offers medium and high resolution imaging in all weather conditions. The C-SAR is capable of obtaining night imagery and detecting small movement on the ground, which makes it useful for land and sea monitoring.

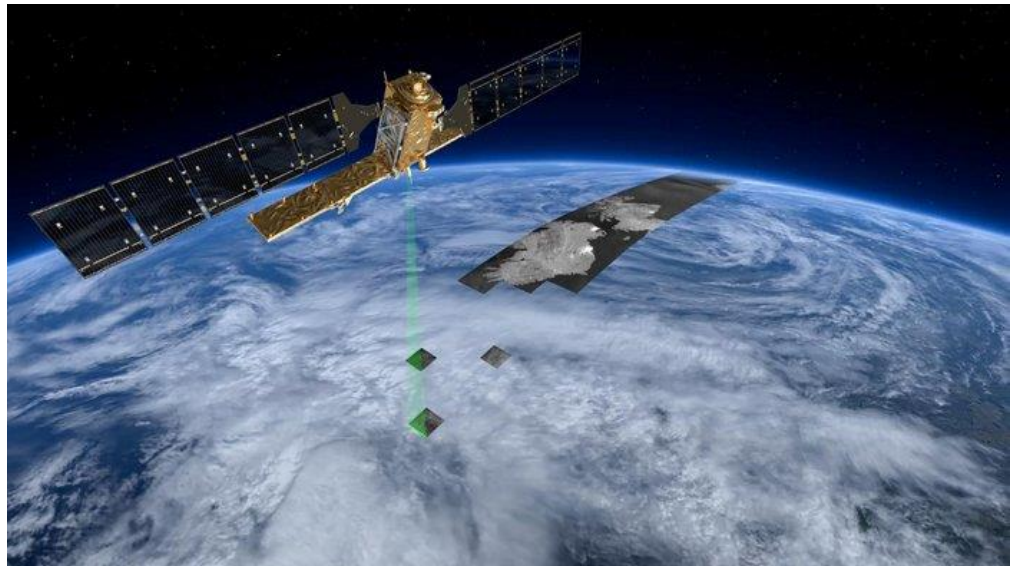


Figure 1 – The Sentinel 1a satellite

source: <https://sentinel.esa.int/web/sentinel/user-guides/sentinel-1-sar/overview>

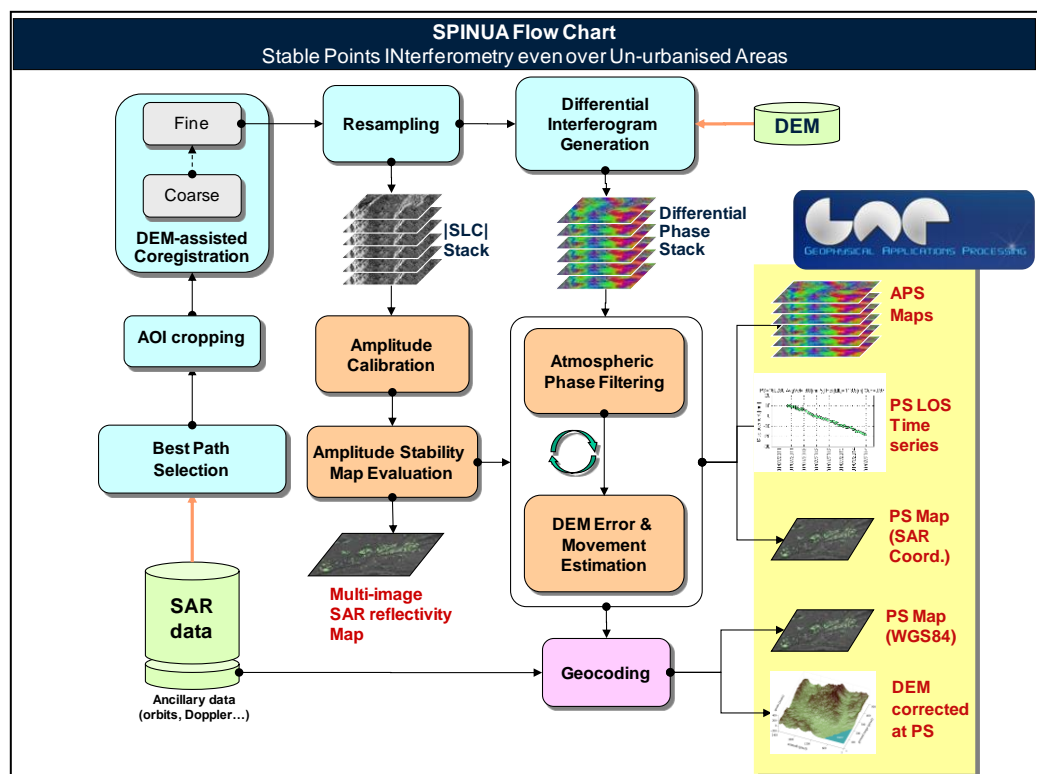
SENTINEL-1 potentially images all global landmasses, coastal zones and shipping routes in European waters in high resolution and covers the global oceans at regular intervals. Having a primary operational mode over land and another over open ocean allows for a pre-programmed conflict-free operation. The main operational mode features a wide swath (250 km) with high geometric (typically 20 m Level-1 product resolution) and radiometric resolutions, suitable for most applications.

SPINUA® - Persistent Scatterers processing chain

Rheticus® Displacement is based on **SPINUA®** (“Stable Points Identification in Non Urbanized Area”) provided by GAP S.r.l.

SPINUA® algorithm has been applied and tested on both large urban areas and scarcely urbanized regions for monitoring both **instable areas** (affected by subsidences, landslides, post-seismic deformations), and **instable infrastructures** (dams, bridges, railways, pipelines, etc.).

SPINUA® implements a DInSAR algorithm to measure topography, exploiting the phase difference between the backscattered microwave signals of two images received from slightly different satellite orbits. If the two SAR acquisitions are also displaced in time, and a priori information about terrain topography is available, displacements occurred between the two acquisitions with respect to the known topography can be detected with **millimetric accuracy**. When a series of SAR acquisitions is available over a site, it is possible to combine them into several differential interferograms, which allow to follow displacement trends through time (multi-temporal DInSAR).



SPINUA® overcomes the limitations of conventional InSAR and extends the applicability of radar interferometry from regional to local-scale geology investigations of ground instability. SPINUA® delivers highly accurate measurements of ground displacements over long time periods. Atmospheric effects and topographic influence can be removed using 25 or more SAR images. The high-level of error compensation allows the generation of time series charts, visualizing the **evolution of the displacement** of each stable point. Ground deformation is measured with a precision of **1.5 mm/year** along

the line of sight of the satellite. Horizontal localization precision of measurement points is 10 m.

SPINUA® can also detect millimetric ground motion in areas utilized for oil & gas extraction, storage, pipelines and can be used also for monitoring the surface uplift in Steam Assisted Gravity Drainage production, ground motion due to changes in underground CO storage pressure for CO emission control and the stability of offshore anchored platforms.