EUREF's contribution to EPOS' GNSS Services

C. Bruyninx, R. Fernandes, M. Lidberg, W. Söhne

ROYAL OBSERVATORY OF BELGIUM

UNIVERSIDADE DA BEIRA INTERIOR
Covilhã | Portugal

LANTMÄTERIET

Bundesamt für Kartographie und Geodäsie

REFAG2022, 17-20 Oct. 2022, Thessaloniki, Greece

Outline

- Introduction
- EUREF - EPOS relation
- GNSS data
- GNSS products
- Conclusions

Environmental European Research Infrastructures

source http://envri.eu/

European Plate Observing System

EPOS is the European Research Infrastructure serving Solid Earth science

Multidisciplinary research platform to provide access to quality-controlled data from diverse Earth science disciplines, together with tools for their use in analysis and modelling

EPOS currently in Pilot Operational Phase

Start of Operational Phase in 2023

EPOS data portal

https://www.ics-c.epos-eu.org/

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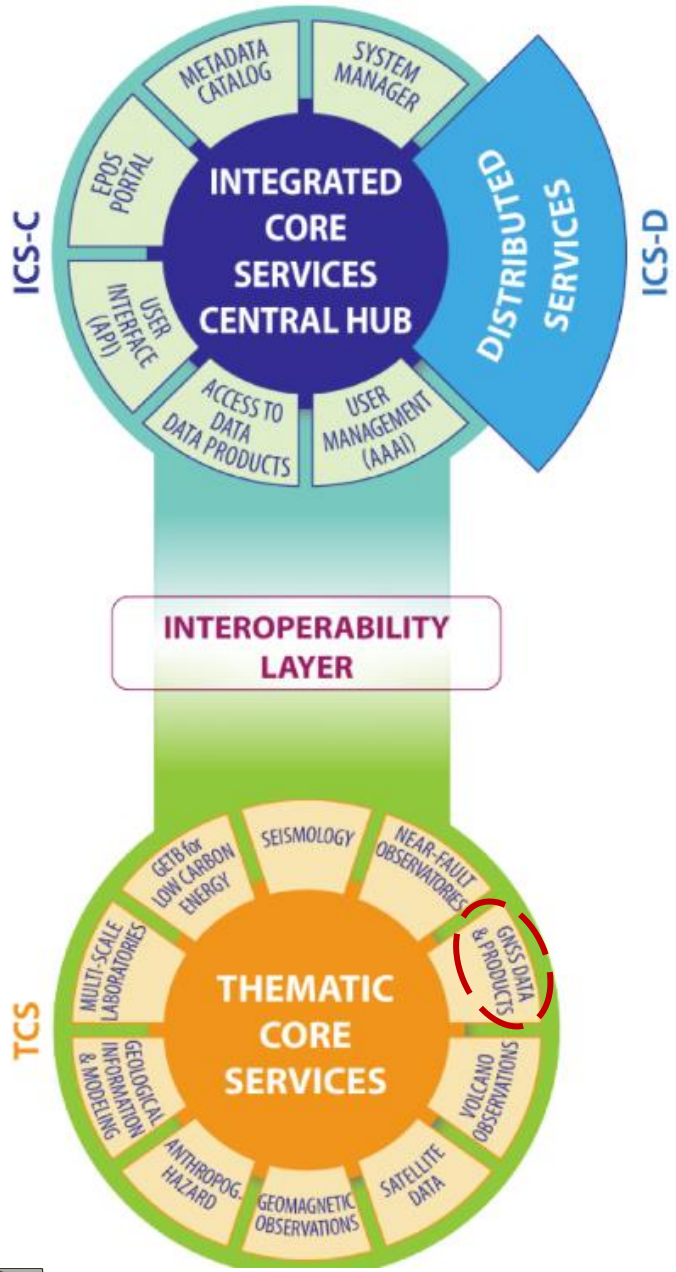
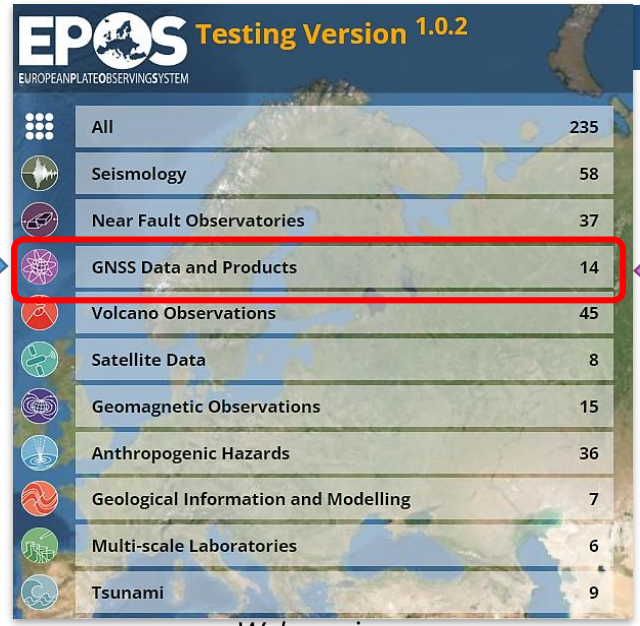
Organization of GNSS Services in EPOS

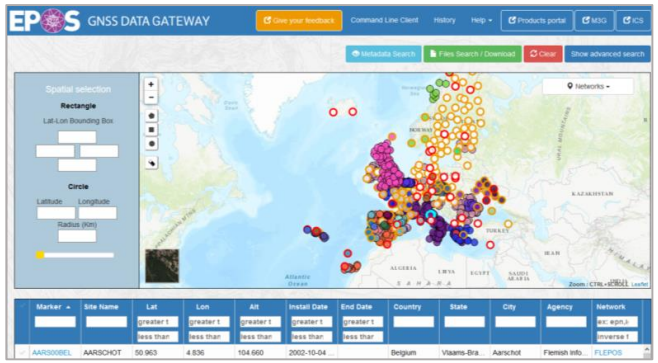




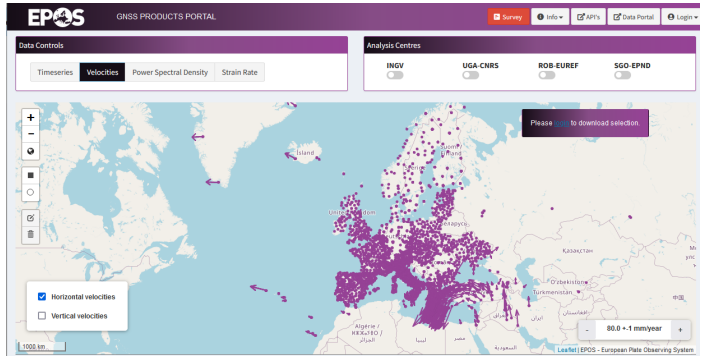
EPOS data portal

Web services

EPOS-GNSS data portal



EPOS-GNSS product portal



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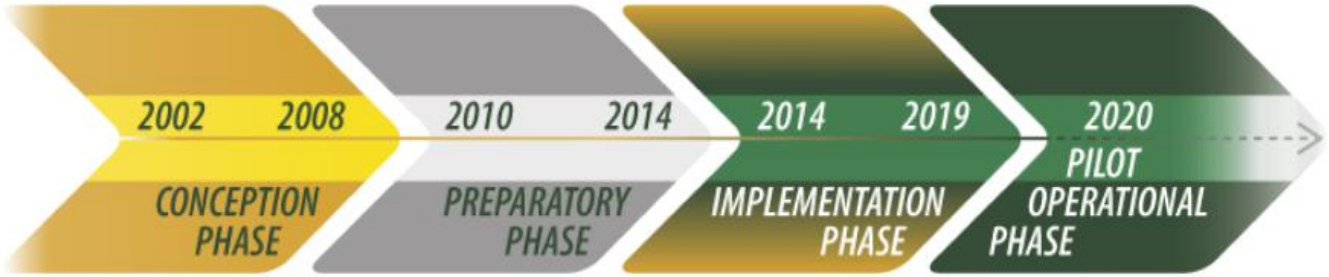
EUREF – EPOS relation



2011: EPOS reaches out to EUREF

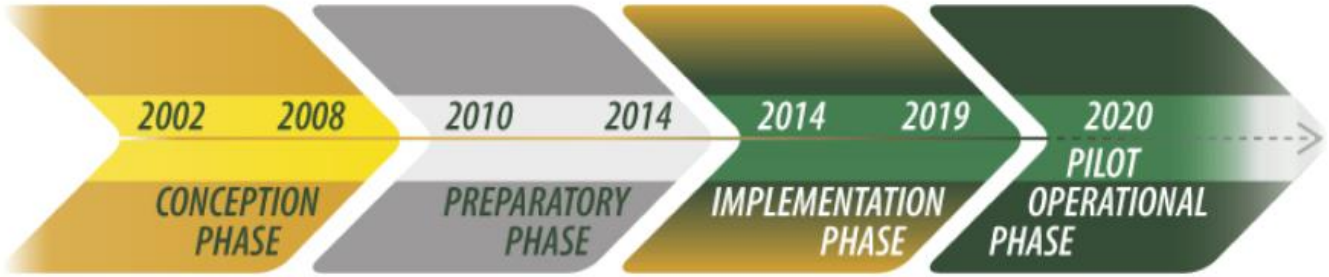
EUREF appointed person to ensure interface with EPOS.

EPOS goals related to GNSS:

- ✓ Provide access to GNSS data, metadata, and products
- ✓ Promote best practices for GNSS station operation, data quality control and data management
- ✓ Maintain and develop GNSS products for Solid Earth sciences

From as much as possible GNSS stations all over Europe

EUREF – EPOS relation



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EUREF (Permanent Network) = EPOS GNSS component?

EPOS:

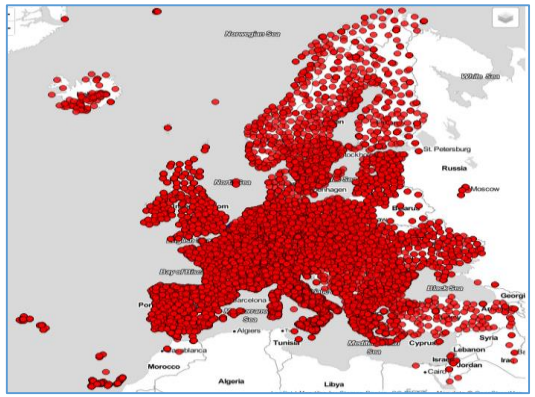
- EPOS: 3000+ GNSS stations
- Less strict guidelines: Site logs, Data availability
- Products focusing on solid earth research

EPOS ambition out of the scope of EUREF

But harmonization with EUREF must be guaranteed!

EUREF

Existing GNSS stations



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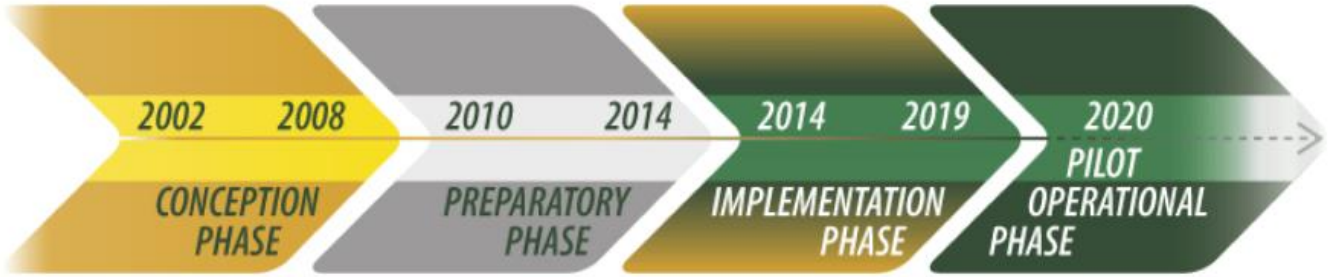

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Assure EUREF standards are transposed to EPOS.

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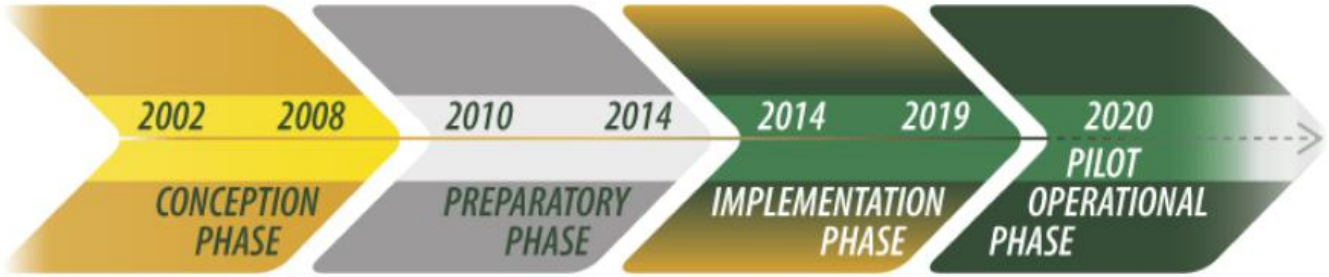

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More and more agencies involved in EUREF started to contribute also to EPOS.

EUREF 2019 Resolution No2

The IAG Reference Frame Sub-commission for Europe (EUREF)

recognising that that the European Plate Observing System (**EPOS**) will maintain a **sustainable European infrastructure for solid Earth studies** from 2020 onwards, including a GNSS infrastructure and related GNSS-based products

and noting the efforts of the EUREF community towards the derivation of a European deformation model in order to improve cross-boundary positioning

and considering that many European countries active in EUREF are a member (or planning to become a member) of the EPOS European Research Infrastructure Consortium (ERIC)

***encourages* the EUREF community to also contribute to EPOS especially to its GNSS component**

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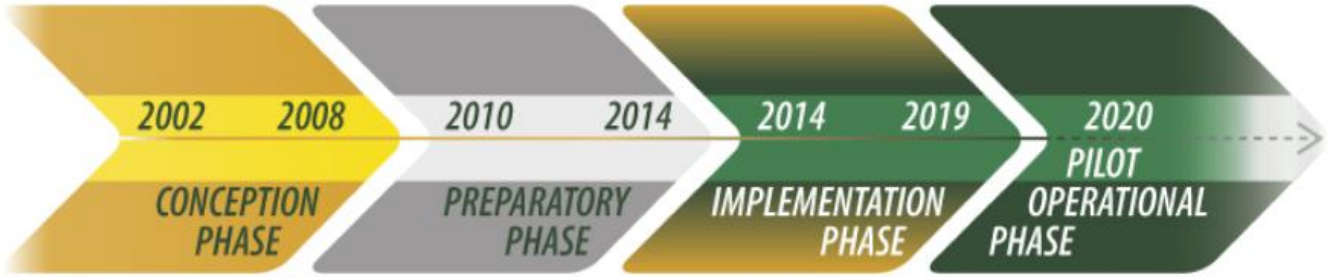

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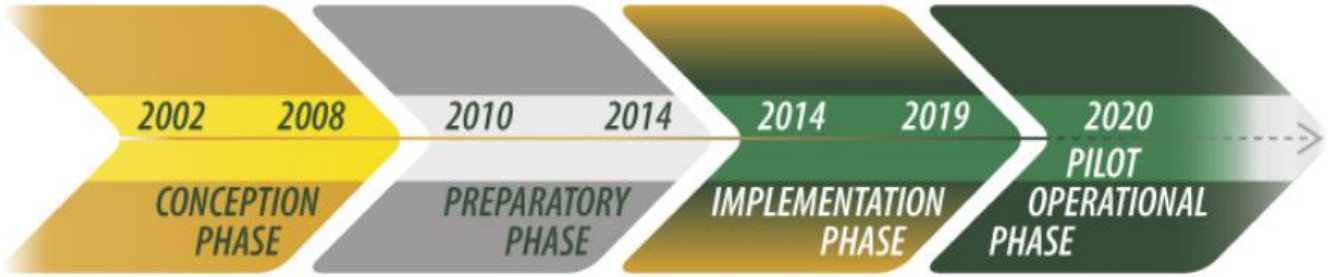

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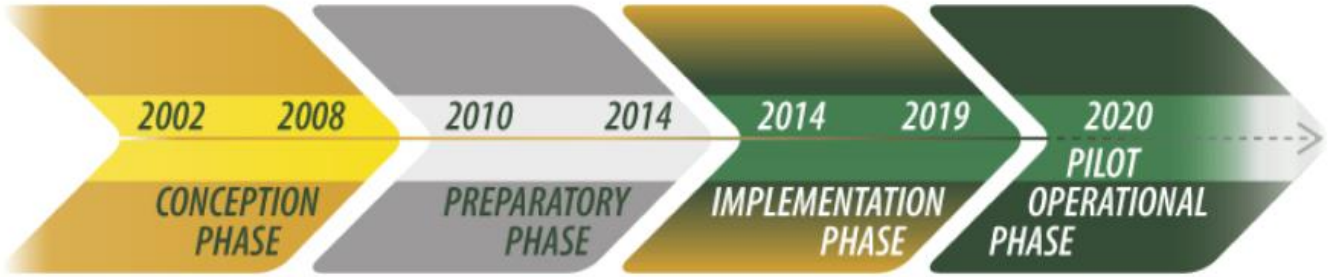

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Summer of 2022 : EPOS and EUREF sign MoU

- collaboration on standards and guidelines
- develop common components
- inform each other on progress, projects or initiatives
- raise awareness of the complementarity of the two initiatives in each of the two communities

MoU larger than cooperation on GNSS-related issues

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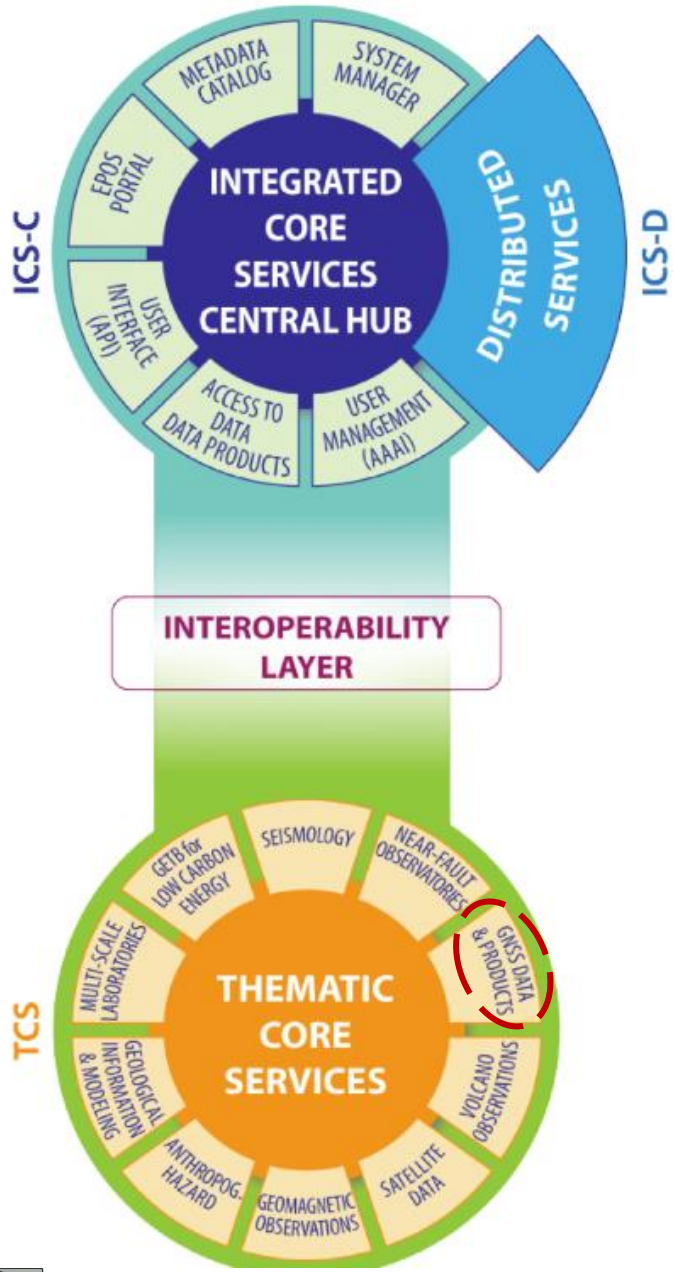
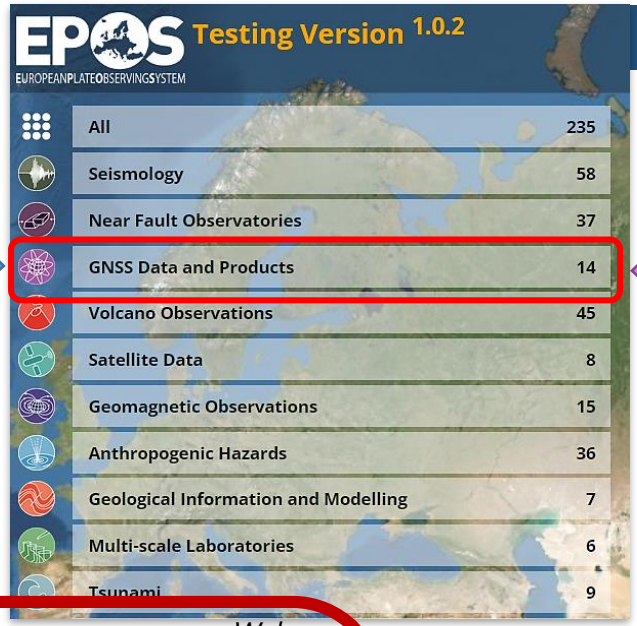
Organization of GNSS Services in EPOS

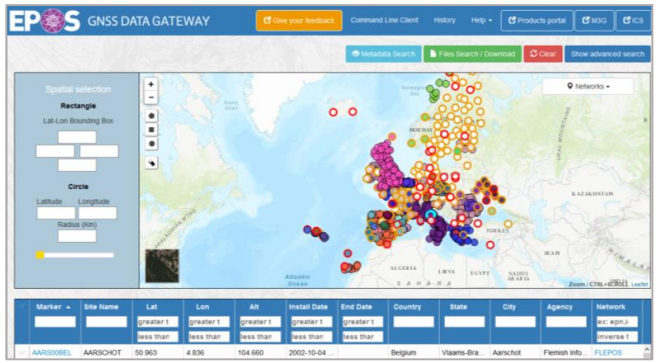




EPOS data portal

Web services

EPOS-GNSS data portal



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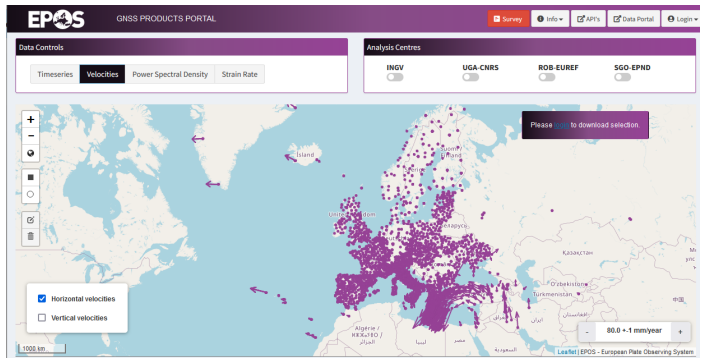

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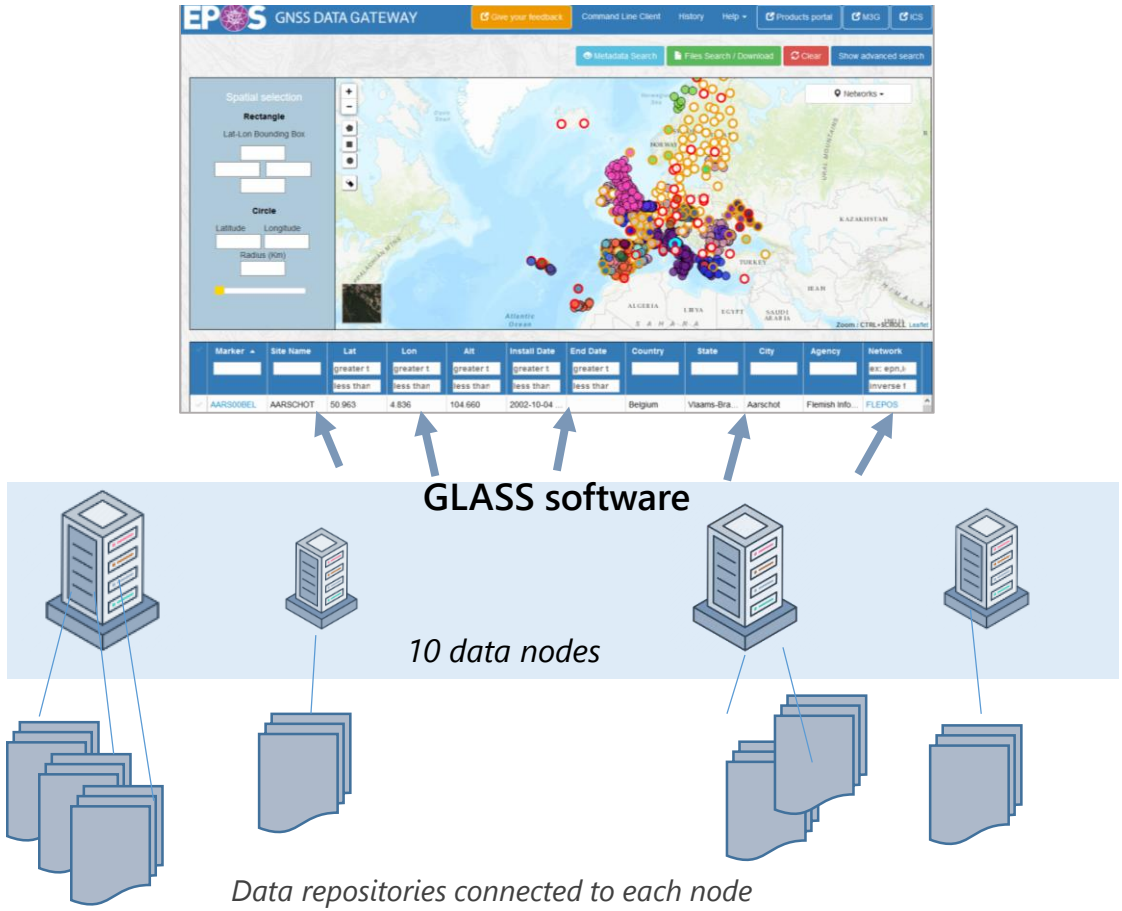
EPOS-GNSS data dissemination

- Suitable to distribute data from 1000's of GNSS stations
  - Centralized access through one portal
  - But: RINEX data stay distributed at several local nodes (who can then still monitor data usage) →distribute load

- Learn from previous experiences within EUREF
  - Centralized portal should not offer access to RINEX data files with 'significant' metadata errors
  - Possibility to identify 'heavily' degraded daily RINEX data before download

EPOS-GNSS data dissemination concept

EPOS GNSS Data Gateway: http://gnssdata-epos.oca.eu



Distributed Data Access:

Station operators upload their GNSS observation data to a data repository (or data center).

To make these RINEX data visible to EPOS:

1. The GLASS software (developed by GNSS group in EPOS) is used to index the RINEX observation files in the repository
2. Nodes send https://... (or ftp://...) location of the RINEX data in the repository to the EPOS-GNSS Data Gateway

When users connect to Data Gateway, they will be redirected to nodes → data repositories

Data Gateway offers centralized access to RINEX data via
- Web interface
- APIs

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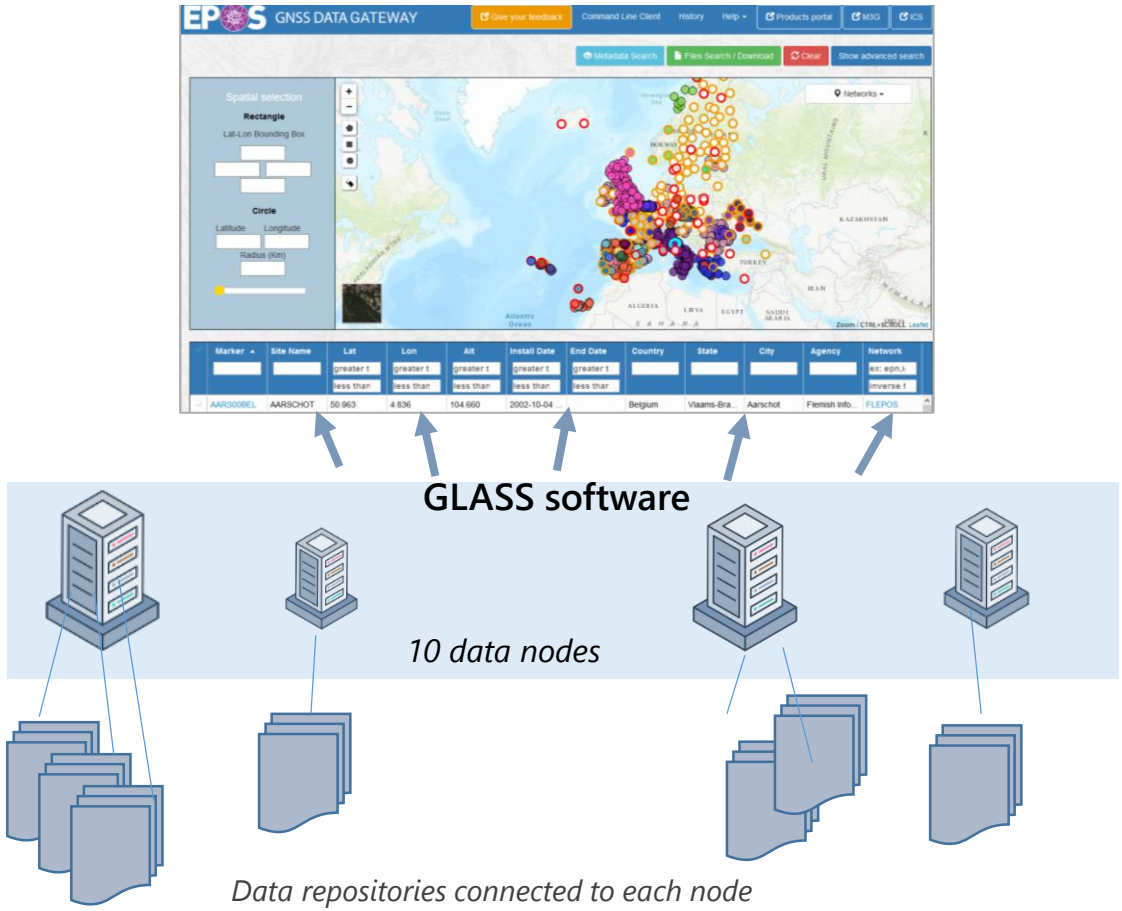

GLASS software ensures harmonization:

All nodes perform same 'processing' on RINEX data

A. Crosscheck of site log and RINEX headers

B. Check data quality of RINEX observation files (G-nut/Anubis)

C. Decide what to do with RINEX

- If 'critical' RINEX header error, do not inform Data Gateway of new data
- If RINEX header OK, inform Data Gateway on new data + provide info on data quality

A lot of geo-scientists rely on the correctness of RINEX headers

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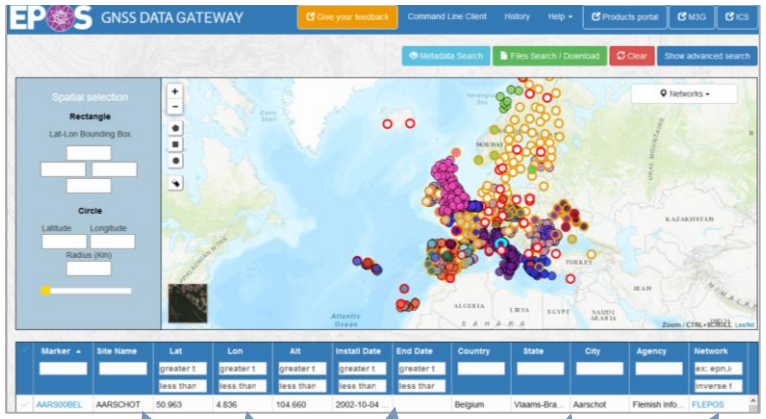
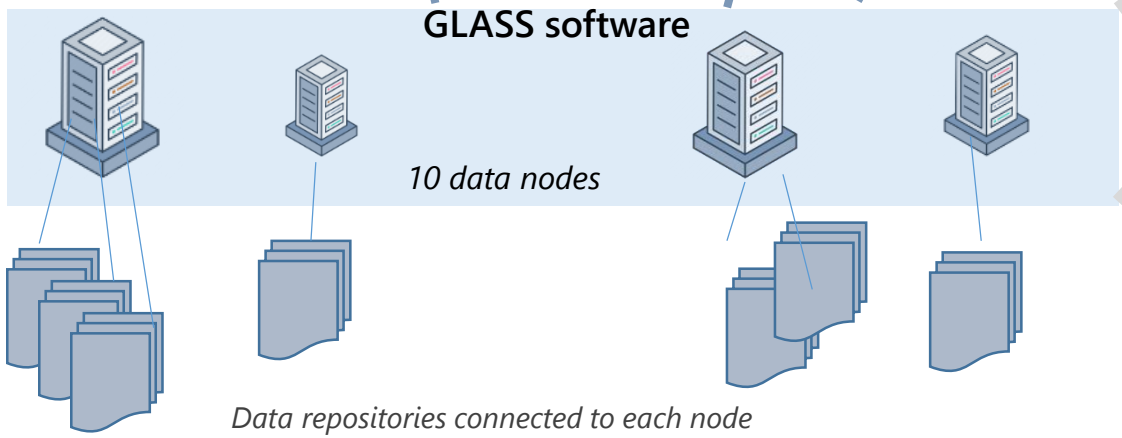
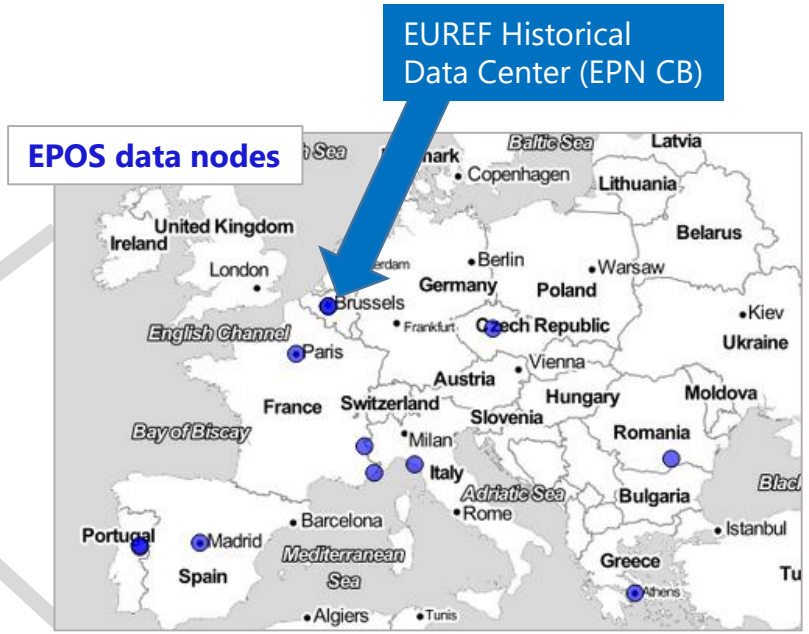






EPN contribution to EPOS

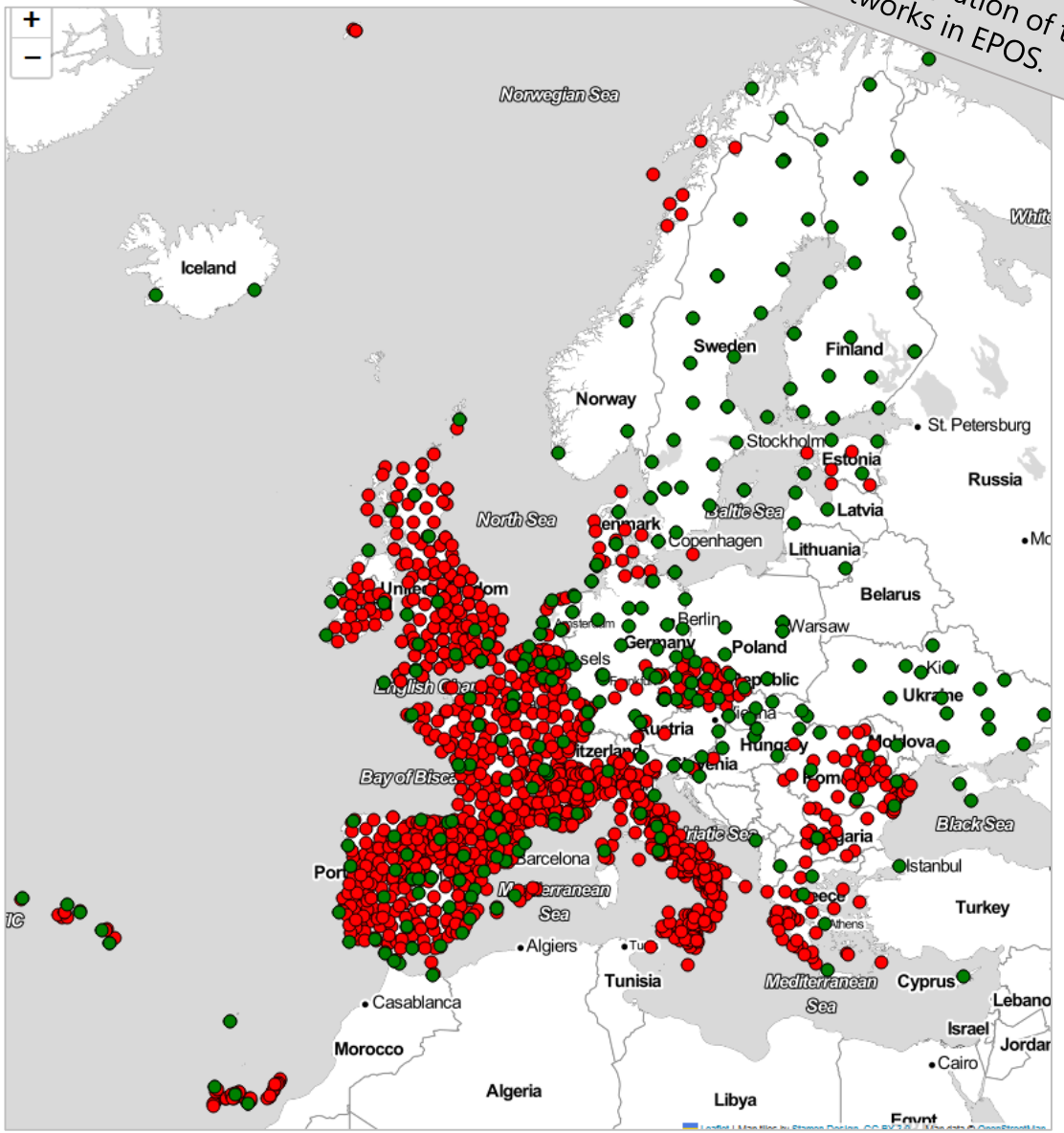
Several countries are preparing the integration of their dense networks in EPOS.

Slowly growing

1655 EPOS-GNSS stations

- ✓ **318 EPN stations**
- ✓ 1033 EPN densification stations
- ✓ 304 other GNSS stations

Site logs are mandatory for EPOS stations

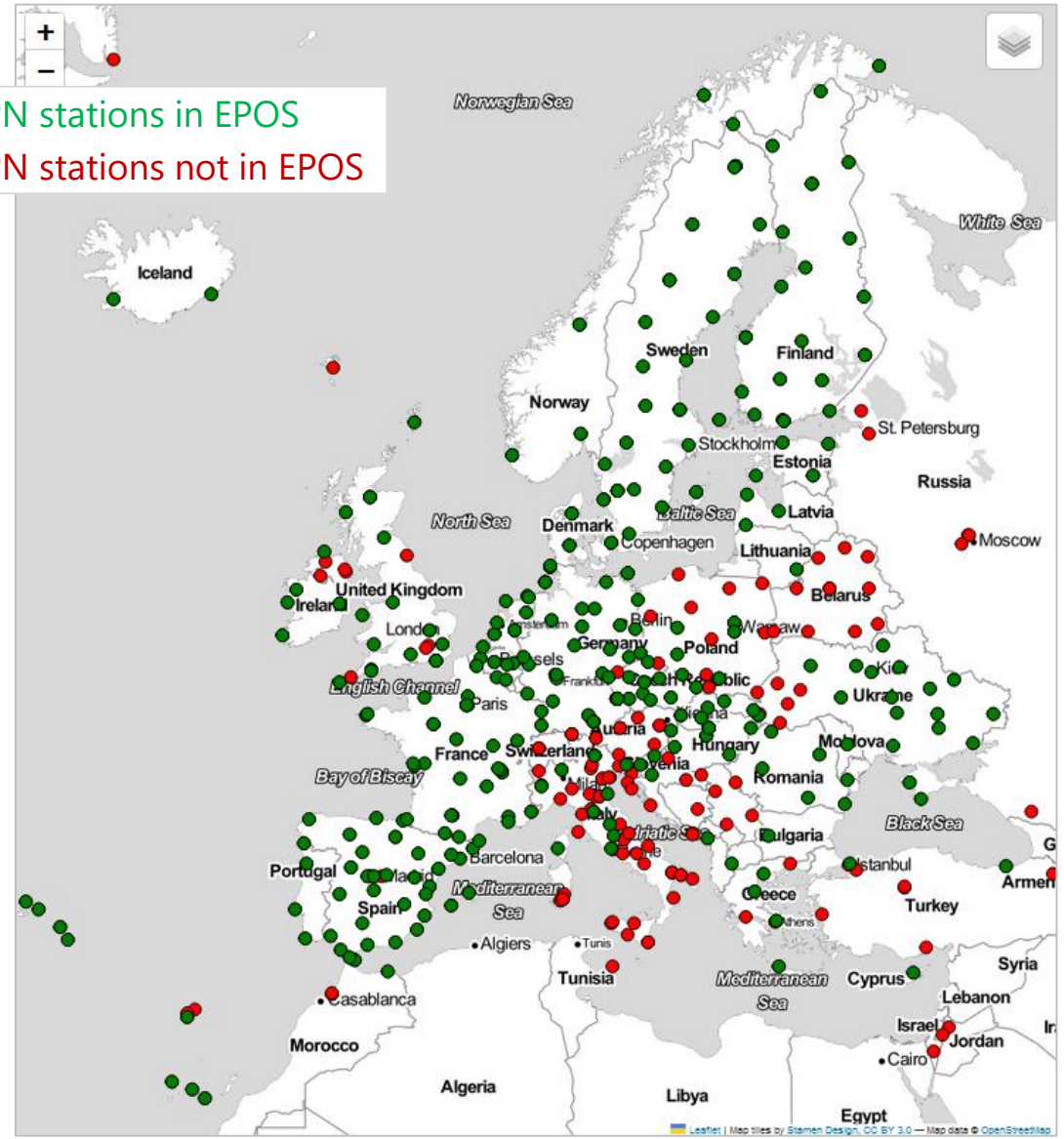


EPN stations integrated in EPOS

Redistribution of EPN station data by EPOS must be done with explicit permission of station manager

→ EPN stations data will not be automatically findable through EPOS

→ 318 from 479 EPN stations in EPOS



GNSS guidelines and metadata

Make link between EUREF and EPOS as smoothly as possible

- EPOS-GNSS station guidelines inspired from EPN station operation guidelines
  - EPOS guidelines allow more flexibility (more GNSS stations…):
    - Embargo periods on data are allowed in EPOS
  - EPN stations will satisfy EPOS station requirements

M3G Metadata Management and Distribution System for Multiple GNSS Networks

- EUREF and EPOS developed together a new site log manager: M^{3}G
  - Since 2018 M^{3}G is replacing the old EPN Central Bureau site log manager
  - Served EPOS from the beginning
  - Stations common to EPOS and EUREF: One login, one site log submission
  - M^{3}G under permanent development: both EUREF and EPOS share a common desire to evolve towards FAIR data principles

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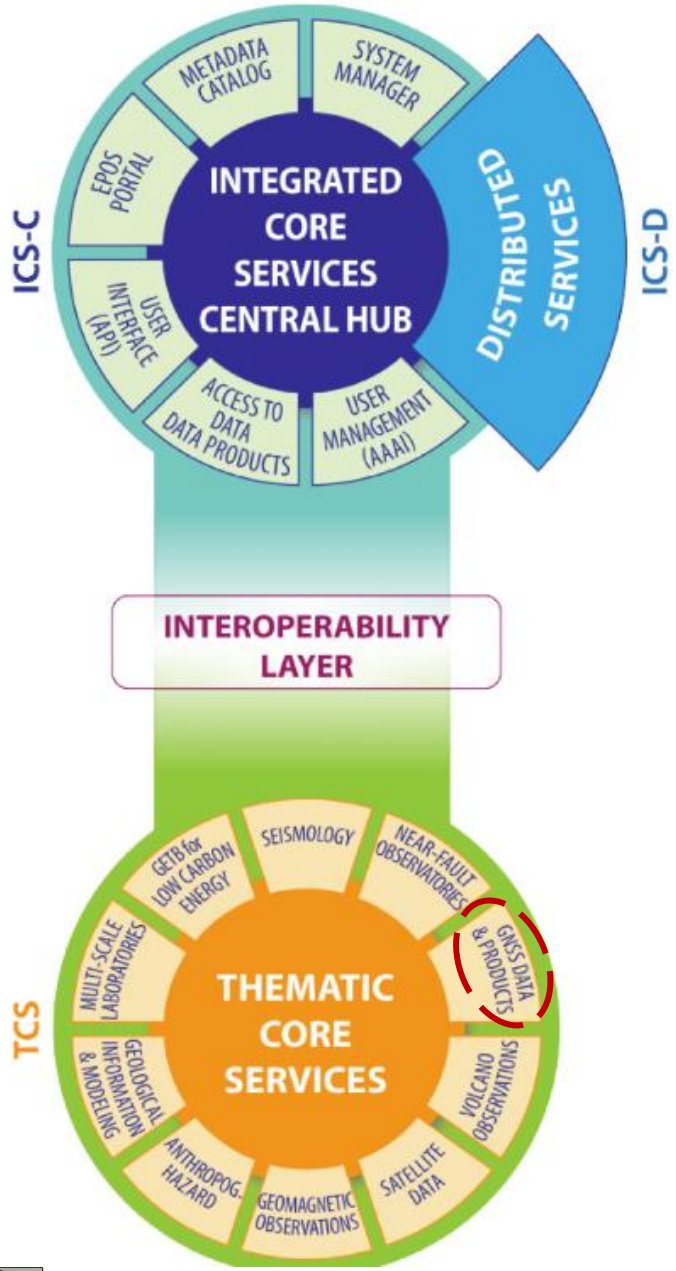

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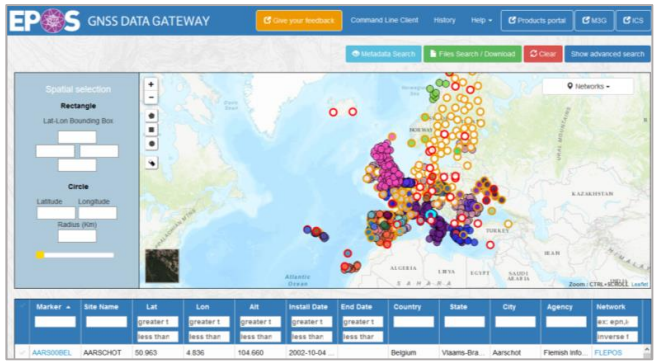
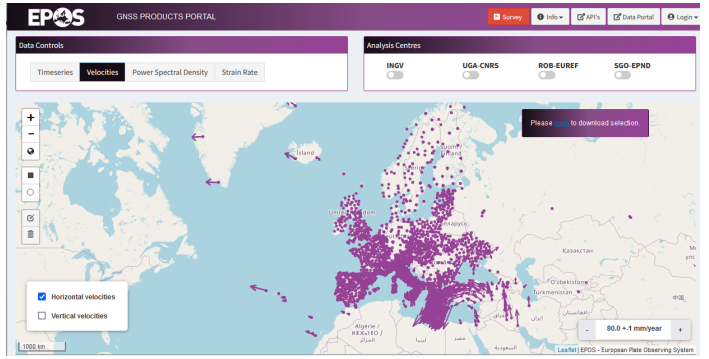


EPOS-GNSS product portal



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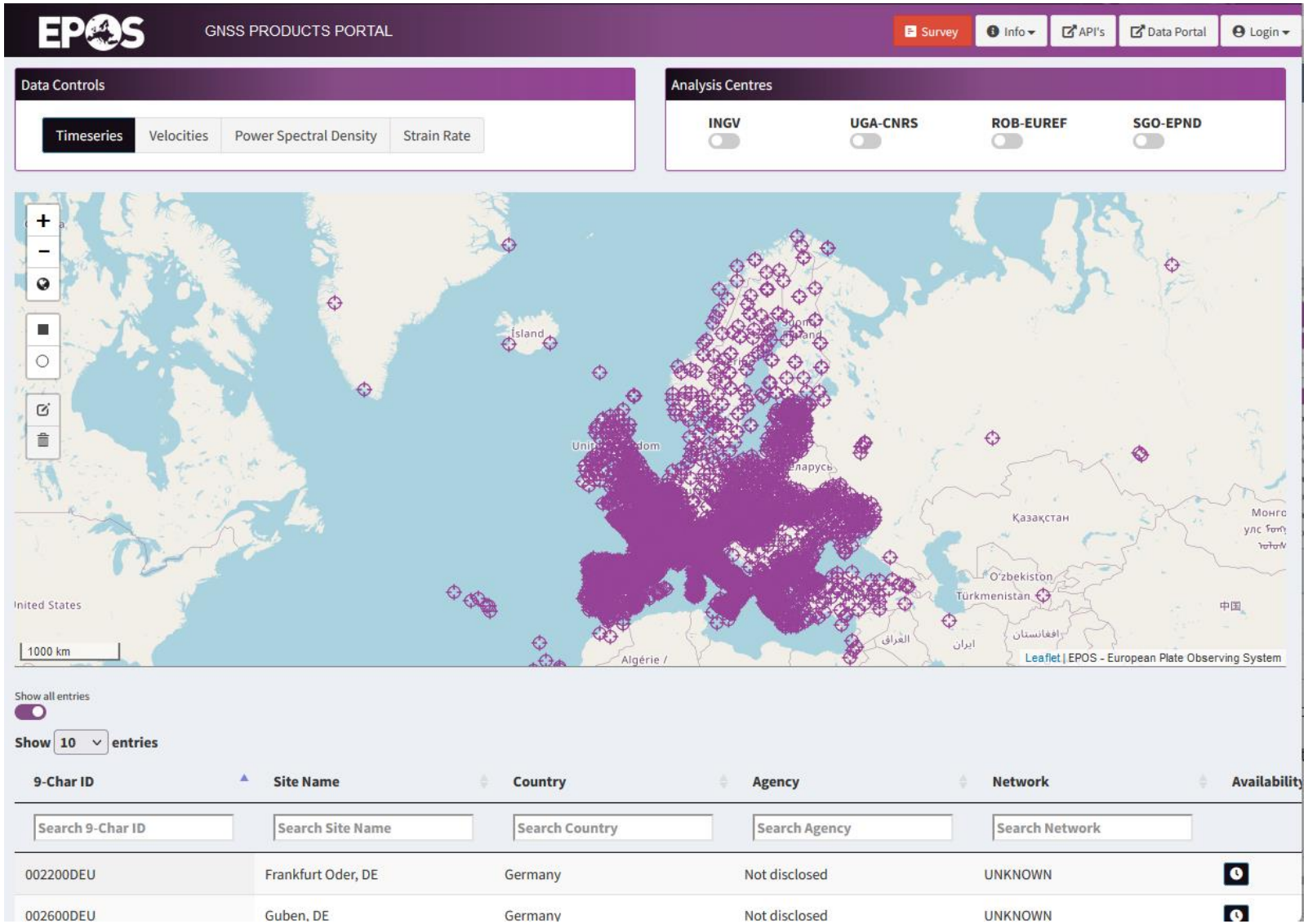
GNSS Products

EPOS-GNSS Product Portal:

https://gnssproducts.epos.ubi.pt/

Analysis Centers UPLOAD products to product portal



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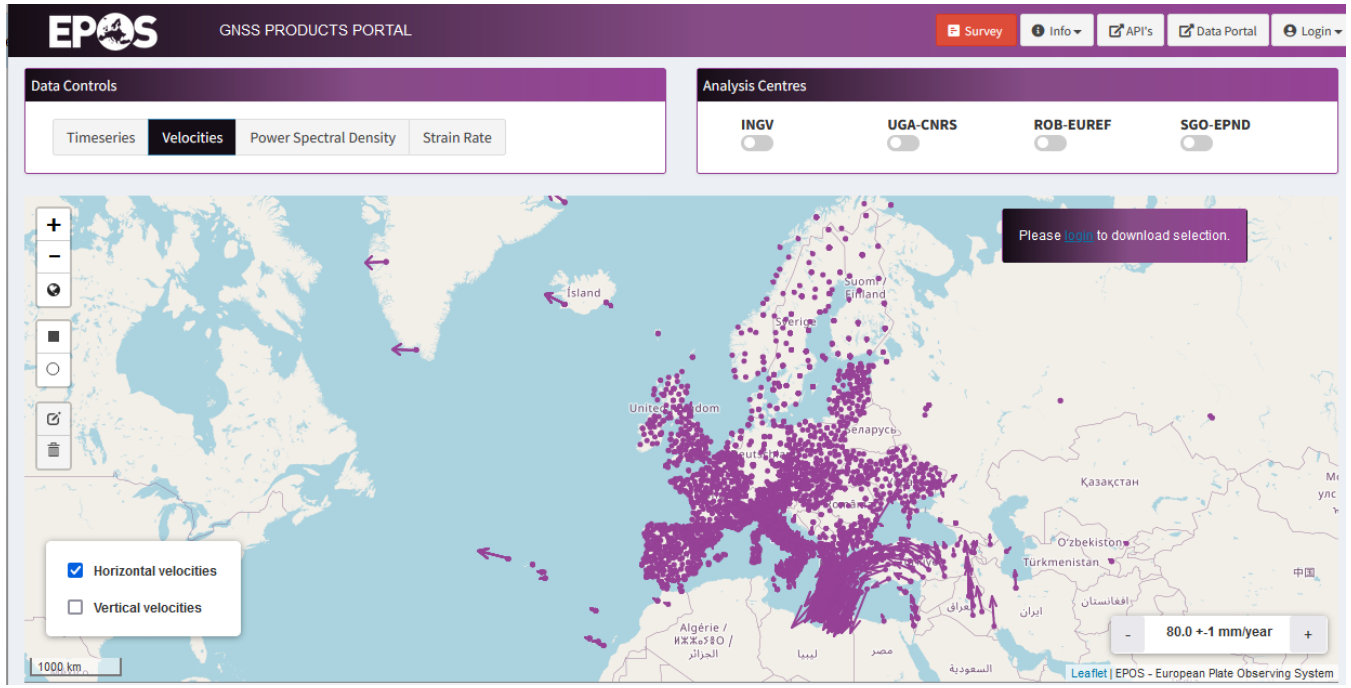

Uploaded GNSS Products

A. EPOS-specific solutions (only using EPOS station data)
   1. Double difference solution (UGA-CNRS)
   2. PPP solution (INGV)

B. EUREF solutions
   1. EPN daily combined solution (WUT-EUREF)
   2. EPN reference frame solution (ROB-EUREF)
   3. EPN densification solution (SGO-EPND)

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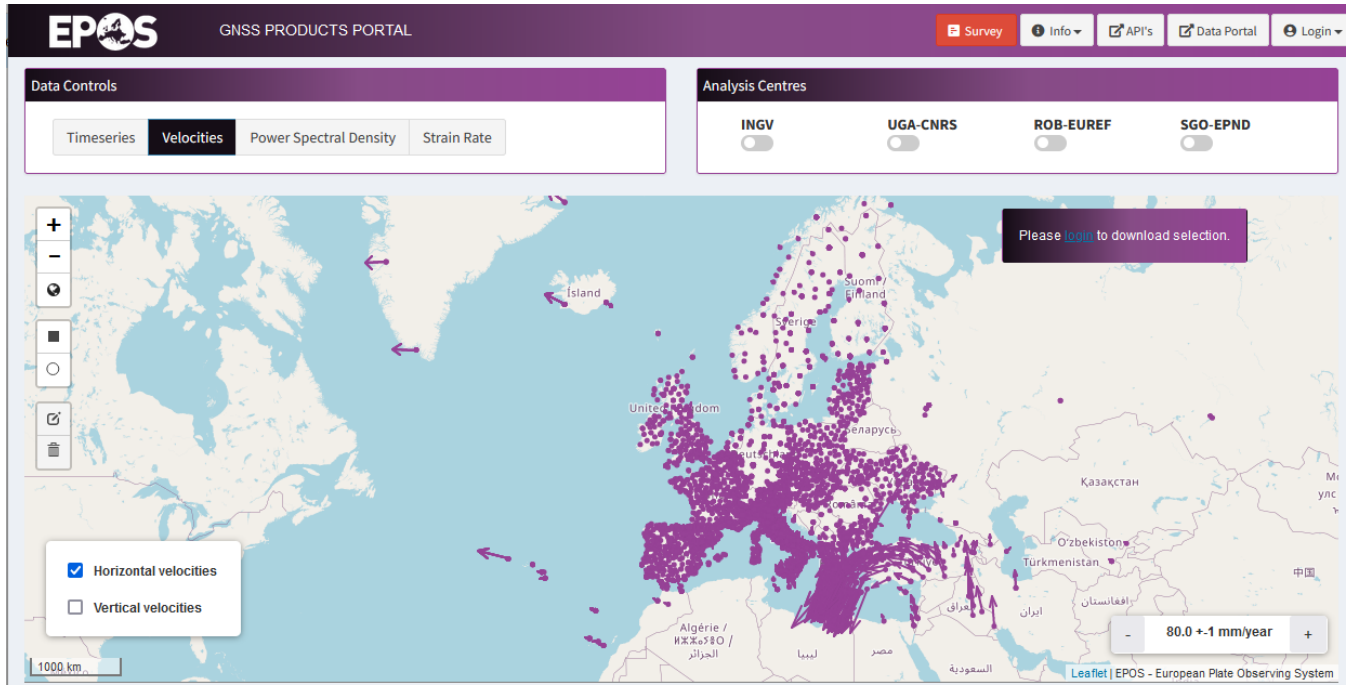

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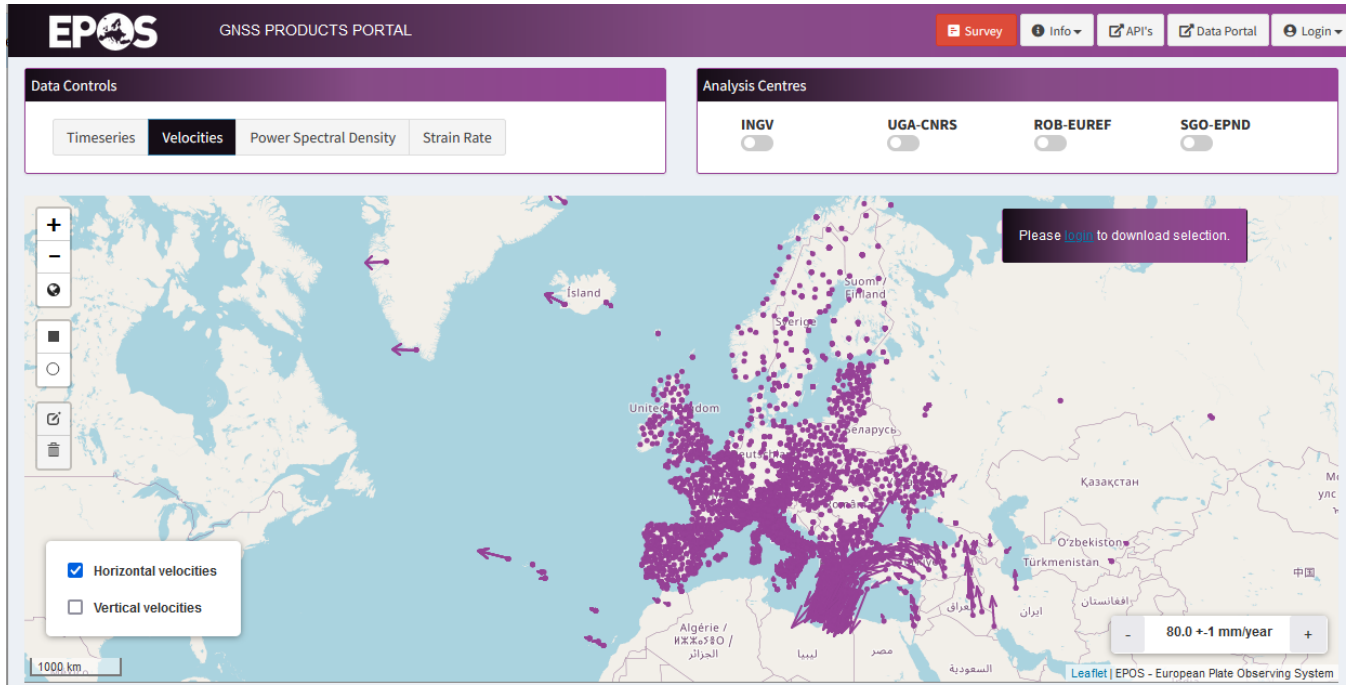

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   1. EPND+EPOS velocities (SGO-EPND)

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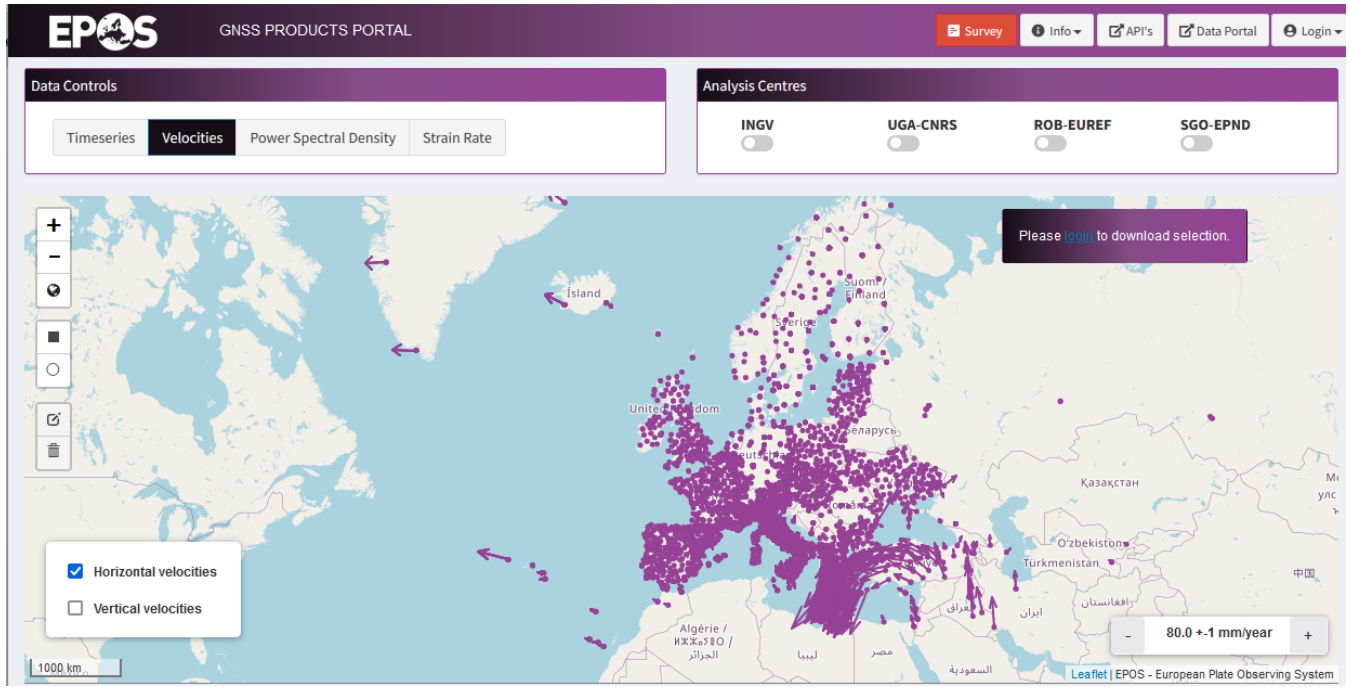

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C. EUREF-EPOS solutions
   1. EPND+EPOS velocities (SGO-EPND)
   2. Strain rates (LM)

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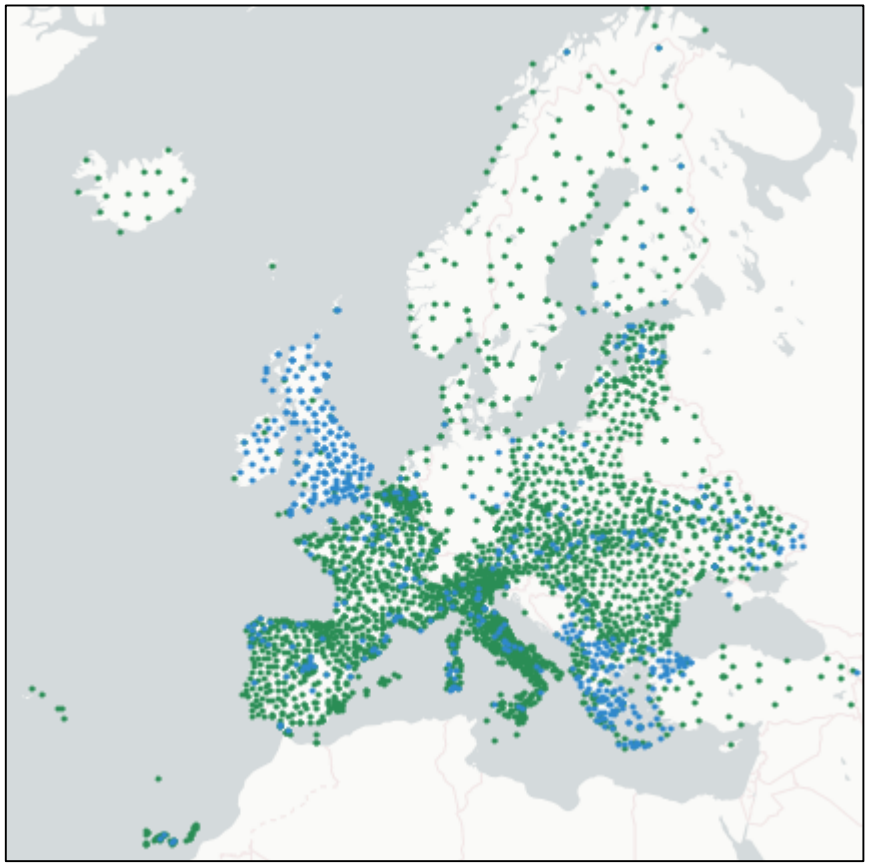
Common EUREF-EPOS products

EPND+EPOS velocities (SGO-EPND)

- Originating from EUREF working group "EPN densification"
- https://epnd.sgo-penc.hu/
- Preliminary version includes only EPND stations
- Future versions using EPND and EPOS stations → EPND-EPOS velocities



Strain rates (LM)

- Originating from EUREF Deformation Models Working Group in collaboration with EPOS
- https://www.lantmateriet.se/doi/10.23701/sr.0001
- Preliminary version calculated from EPND velocities
- Future versions calculated from EPND-EPOS velocities

ROYAL OBSERVATORY OF BELGIUM

Conclusions

EPOS Ambition: Provide data and information on ground motions based on permanent GNSS stations in Europe

Collaboration between agencies involved in EUREF and geophysicists from all over Europe from the start

Data Services

- Centralized access to daily RINEX data through EPOS-GNSS Data Gateway 1600+ stations (318 EPN stations)
- Access to EUREF data through ROB-EUREF data node (EPN HDC)
- Common EUREF-EPOS system (M^3G) for collection of, and access to, station metadata

Contributions from
- EPN station managers
- EPN data centers
- EPN Central Bureau

Product Services

- Centralized access to GNSS products through EPOS-GNSS Product Portal
  - EPOS-specific products
  - EUREF products
  - Common EUREF-EPOS products

Contributions from
- EPN analysis coordinator
- EPN reference frame coordinator
- EPN densification WG
- EPN deformation modeling WG

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Talk presented at REFAG 2022 symposium, Thessaloniki, Greece, on 18/10/2022

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the Solar-terrestrial Centre of Excellence

Contact
C.Bruyninx@oma.be
Royal Observatory of Belgium
Brussels
BELGIUM
Twitter: @be_GNSS