EUREF SYMPOSIUM 2025

COVILHÃ, PORTUGAL

UNIVERSIDADE BEIRA INTERIOR

ABSTRACTS BOOK

June 25-26, 2025

PRESENTATION

EUREF is the Sub-Commission for Europe of the International Association of Geodesy (IAG) Reference Frame. Since 1990, the EUREF Symposium has been held annually, serving as a platform to present and discuss the work related to the realization, maintenance, and application of the European Terrestrial Reference System 1989 (ETRS89), the European Vertical Reference System (EVRS), and the EUREF Permanent Network (EPN).

The 2025 edition of the EUREF Symposium is hosted by the University of Beira Interior (UBI), a public university founded in 1979 and located in Covilhã, central Portugal. This year's event is co-organized by UBI and the Direção-Geral do Território (DGT), bringing together specialists in geodesy and reference frames in a collaborative and academic environment.

The scientific program of the symposium is structured around four sessions. The first focuses on the activities of the EUREF Governing Board, its coordinators, and working group chairs, offering an overview of the organization's recent initiatives. The second session highlights national and local efforts, showcasing how countries and regions implement and utilize EUREF's reference systems in their geodetic practices. The third session is dedicated to research, innovation, and future perspectives in geodesy, welcoming contributions that build upon or enhance EUREF data and products, including projects linked to broader initiatives such as the European Plate Observing System (EPOS). Finally, the poster session provides space for both national reports and individual contributions, allowing for a broader exchange of ideas and developments across the community. Altogether, the program aims to reflect the diversity, progress, and future challenges of geodetic reference systems in Europe.

PROGRAM

TUESDAY (24th)

9h00 | Registration

10h30 | Coffee Break

11h00 – 11h10 | Welcome — Rui Fernandes

11h10 – 11h30 | Reprocessing 27 Years of GNSS Data: The EPN-Repro3 Campaign and Its Challenges — Christof Völksen

11h30 – 11h50 | An update of GFZ's contribution to EPN-Repro3 — Benjamin Männel

11h50 – 12h10 | MUT AC 2025 - Status Report & Outlook — Andrzej Araszkiewicz

12h10 – 12h30 | Report from NKG EPN AC and SWE EPND AC — Lotti Jivall

12h30 | Lunch

14h00 – 14h20 | Contribution of the BKG to EPN-Repro3 and its Operational Analysis — Lin Wang

14h20 – 14h50 | Report on EPN Analysis Centres and Combined Coordinate Solutions — Tomasz Liwosz

14h50 – 15h10 | Reference Frame Coordination Report — Juliette Legrand

15h10 | Coffee Break

15h40 – 16h00 | GNSS processing at Université-Grenoble-Alpes for EPOS-GNSS — Gaël Janex

16h00 – 16h20 | INGV GNSS processing for active tectonics and geodynamics — Enrico Seperloni

16h20 – 1640 | EPN Densification – Status and future — Ambrus Kenyeres

17h00 | End of Workshop

WEDNESDAY (25th)

8h00 | Registration

9h00 | Opening Session

9h30 | Invited Speaker

9h30 – 10h30 | EUREF Meets EPOS: Boosting Visibility and Use of Geodetic Data in a European Research Ecosystem - **Lilli Freda** (EPOS ERIC Executive Director)

10h30 | Coffee Break

11h00 | Session 1 - Activities of the EUREF Governing Board

11h00 – 11h15 | Report on the Activities of the EUREF Governing Board — Wolfgang Söhne

11h15 – 11h30 | EUREF Study Group on alternatives to ETRS89. Status of work — Xavier Collilieux

11h30 – 11h45 | EPN: Current Status and Progress — Carine Bruyninx

11h45 – 12h00 | The report of the EPN Analysis Centres Coordinator — Tomasz Liwosz

12h00 – 12h15 | Report of the EPN Troposphere Coordinator — Rosa Pacione

12h15 – 12h30 | Reference Frame Coordination Status Report — Juliette Legrand

12h30 | Lunch

14h00 | Session 1 - Activities of the EUREF Governing Board (Continuation)

14h00 – 14h15 | Status and future of the European Vertical Reference Frame — Martina Sacher

14h15 – 14h30 | Status report for the EUREF Working Group "European Unified Height Reference" — Joachim Schwabe

14h30 – 14h45 | Changes regarding IAG Subcommission 2.4a "Gravity and Geoid in Europe" and the impact on the European gravimetric quasigeoid — Joachim Schwabe

14h45 – 15h00 | The use of permanent GNSS stations as GNSS/leveling points in validating the Dutch height transformation — Bas Alberts

15h00 – 15:15 | SKVRF2024 – New national realization of the EVRS height system in Slovakia — Branislav Droščák

15h15 – 15h30 | Reference Frame Validation of a Network RTK Service in Great Britain Using the Grid Check Approach — Lennard Huisman

15h30 | Coffee Break

16h00 | Poster Session – Brief Presentations

16h30 | Poster Session – National Reports

17h00 | End of EUREF Symposium day one

THURSDAY (26th)

09h00 | Session 2 - National and Local activities

09h00 – 09h10 | National Report of Austria — Anastasiia Walenta

09h10 – 09h20 | National Report of Czech Republic — Jan Reznicek

09h20 – 09h30 | National Report of Finland — Pasi Häkli

09h30 – 09h40 | National Report of Germany — Andreas Gerschwitz

09h40 – 09h50 | National Report of Slovakia — Martin Ferianc

09h50 – 10h00 | National Report of Sweden — Tina Kempe

10h00 – 10h10 | National Report of Switzerland — Arturo Villiger

10h10 – 10h20 | National Report of France — José Pinheiro

10h20 – 10h30 | National Report of Hungary — Ambrus Kenyeres

10h30 | Coffee Break

11h00 | Session 3 - Research, Innovation and Future Perspectives

11h00 – 11h15 | Advancing European GNSS Infrastructure Through EPOS-GNSS and EUREF Collaboration — Rui Fernandes

11h15 – 11h30 | raw2rin: A Unified Tool for Converting Raw GNSS Data to RINEX — Duarte Arribas

11h30 – 11h45 | A Novel Approach to GNSS Data Storage Using TileDB in the Context of EPOS — Fernando Geraldes

11h45 – 12h00 | Tracking performance analysis of multi-GNSS EPN stations — Michail Gianniou

12h00 – 12h15 | On the ITRF2020 Updates — Zuheir Altamimi

12h15 | Lunch

13h45 | Session 3 - Research, Innovation and Future Perspectives (Continuation)

13h45 – 14h00 | ETRS89 and its realizations in the EPSG Dataset — Roger Lott

14h00 – 14h15 | Extending the ETRS89 lifetime: case study for Spain — Joaquin Zurutuza

14h15 – 14h30 | EUREF Serbia 2023 campaign — Filip Kostadinović

14h30 – 14h45 | Modernised transformation between century-old national CRS and ETRS89 — Jochem Lesparre

14h45 – 15h00 | Geodesy 2026–2035: Work towards a new strategic plan for geodesy at Lantmäteriet, Sweden — Martin Lidberg

15h | Coffee Break

15h30 | Open Discussions & Resolutions

16h30 | Closing Session

17h00 | End of EUREF Symposium day two

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ABSTRACTS

ANALYSIS CENTER & REPRO 3 WORKSHOP

Reprocessing 27 Years of GNSS Data: The EPN-Repro3 Campaign and Its Challenges

Author(s)
Christof Völksen

Abstract
With the release of the new ITRF2020 as a new implementation of the International Terrestrial Reference Frame and its adoption by the IGS in GPS week 2238, this change was also imperative for the EPN analysis centres (ACs). However, it was not only necessary to modernise the ITRS reference frame, but also to make significant changes to existing standards in GNSS-Analysis. Particularly, the transition from individual to type mean corrections for the GNSS antennas played a crucial role. The transition to new standards in the current processing of GNSS data made it clear that the analyses carried out previously would lead to inconsistencies between the early, before GPS week 2238, and recent operational products. Here, we refer to the coordinate solutions with their normal equations and the hourly tropospheric zenith total delays (ZTDs) as products.
This problem can only be solved by reprocessing all data since the start of the EPN in 1996 using the same standards as the most recent operational analyses in the IGS20. This marked the launch of the EPN-Repro3 initiative, the third reprocessing campaign involving 12 EPN analysis centres (ACs). Although the idea for this initiative was conceived early on, the work has stretched over the last two years. One reason for the lengthy nature of this effort is undoubtedly the sheer volume of data that has accumulated over a period of 27 years. The presentation once again describes the approach taken for this initiative and addresses some key questions regarding the standards used. It also reports on the current status and provides an outlook on the work still to be done.

An update of GFZ’s contribution to EPN-Repro3

Author(s)
Benjamin Männel

Abstract
The EPN Reprocessing Working Group has taken the major task of reprocessing all GNSS data accumulated in the EPN from 1996 until the end of 2022. As a EUREF Analysis Center GFZ joins this effort by processing an EPN subnetwork of about 122 stations. Similar to the operation efforts, the reprocessing was performed using GFZ’s processing software EPOS.P8.
In this contribution, GFZ’s solutions for the EUREF reprocessing effort EPN-Repro3 will be discussed. Aspects of the station selection, parametrization, processing scheme, and used products are considered in the first part. The second part focuses on the results by discussing station coordinates, troposphere delays, and gradients from the first solutions.

MUT AC 2025 – Status Report & Outlook

Author(s)
Andrzej Araszkiewicz

Abstract
This presentation summarizes the current status of activities carried out at the MUT Analysis Center in the context of the EPN Repro3 project. GNSS data from 180 stations were processed using the GAMIT/GLOBK v10.71 software suite. Challenges such as antenna orientation issues is addressed. Results from ambiguity resolution and weekly repeatability analyses are presented. National GNSS re-analyses, performed in the framework of the BIFROST and EPND initiatives, are also discussed. Tools and services for ionospheric monitoring and space weather assessment are also introduced.

Report from NKG EPN AC and SWE EPND AC

Author(s)
Lotti Jivall, Tina Kempe, Tong Ning

Abstract
Lantmäteriet operates the NKG EPN AC on behalf of the Nordic Geodetic Commission (NKG). The NKG AC contributes to the operational EPN-products with final weekly and daily solutions, as well as rapid daily solutions, using the Bernese GNSS Software version 5.4. The processed network currently consists of 106 stations in the northern part of Europe. During the spring 2025, ultra-rapid solutions have been set up for the Swedish part of the NKG AC network and the hourly submission of solutions has started for validation by EPN ACC. NKG EPN AC participated in the EPN Repro3, comprising a total of 125 stations (maximum 111 at the same time) during the time period 1996-01-01 – 2022-11-30.
SWE EPND AC is the Swedish contribution to the EPN Densification project, where we contribute both to the main project (SGO-Penc) and the alternative combination (ARANZADI). The solutions are identical to the LM-solutions of the NKG GNSS AC (joint GNSS analysis centre for all Nordic and Baltic countries), except for the different format of the SINEX-files. The contribution consists of daily/weekly coordinate solutions from both operational processing and repro. The repro is performed in the same way as the EPN Repro3, but starting from 1997-01-01. It is the second repro of NKG GNSS AC and it included a total of 132 stations (maximum 126 at the same time). In addition to the coordinate solutions, there are troposphere solutions (constrained to weekly coordinates as well as directly from daily solutions) for the full period from 1997 until now, which we think could be interesting for climate studies.
The report mainly focuses on the two repros (for EPN and EPND), in which we present results and challenges.

a permanent GNSS network in Germany joins the EPN-Densification Working Group

Author(s)
Lin Wang, Tetyana Romanyuk, Christian Rentsch, Hans-Georg Dick, Irene Feldmeth, Uwe Hensel, Falko John, Martin Freitag, Ole Roggenbuck, Wolfgang Sohne, Axel Rülke

Abstract
The combined network of GREF and selected SAPOS reference station (DREF-Online) consists of 108 high-quality active IGS, EPN, GREF and SAPOS permanent GNSS stations. This GNSS network links German reference frame with the European reference system and to international reference system on behalf of the Working Committee of the Surveying Authorities of the Laender of the Federal Republic of Germany(AdV).

This network is an essential component for providing and securing the integrated geodetic spatial reference in Germany. DREF-Online products are computed with the latest Bernese GNSS development branch in BKG and it follows mainly the EPN processing standard to ensure a robustic and high quality solution.
EPN-Densification Working Group (EPN-D WG) combines the European regional GNSS normal equation and estimates the regional combination solution for the coordinate and velocity in the EUREF Terrsterial reference system. It currently includes more than 4800 GNSS stations which most locates in Europe and surrounding regions. BKG have been contributing to EPN-D WG with the GREF network which is an extended BKG AC network for EPN. With this new DREF-Online network, 45 new permanent stations are introduced into the EPN-D WG for the first time. This significantly enhance the spatial distribution in the Germany for the EPN-D WG.

Report on EPN Analysis Centres and Combined Coordinate Solutions

Author(s)
Tomasz Liwosz

Abstract
The EPN Analysis Centres Coordinator combines and analyses GNSS coordinate solutions (operational and Repro3) provided by the EPN Analysis Centres (ACs). The EPN Repro3 project, launched in 2022, aims at reanalyzing of all EPN data from 1996 to the present using a consistent methodology. This report presents the status of AC operational and Repro3 solutions, outlines the strategy used for combination of AC solutions, and presents the results from analysis of individual AC Repro3 solutions. Additionally, we discuss the results from preliminary combination of AC Repro3 solutions, and present the status of Repro3 combined solutions.

Reference Frame Coordination Report

Author(s)
Juliette Legrand

Abstract
The primary purpose of the EUREF Permanent Network (EPN) is to provide access to the European Terrestrial Reference System 89 (ETRS89) which is the standard precise GNSS coordinate system throughout Europe.
To maintain the ETRS89, the Reference Frame Coordinator computes the EUREF Reference Frame product which is one of the core products of EUREF. It consists of the precise multi-year positions and velocities of the EPN stations expressed in the latest ITRS/ETRS89 realization. Unfortunately, since the switch to IGS20/igs20.atx in November 2022, no official reference frame product has been published.
A Reference Frame hybrid test solution aligned to IGS20 and based on daily solutions coming from the EPN-repro2 and operational EPN solutions compatible with IGS14/igs14.atx completed by operational EPN solution in IGS20/igs20.atx is being tested while waiting for an EPN Reference Frame product based on EPN-repro3 daily solutions.
The presentation will present the current temporary product published and will describe which EUREF Reference Frame product is submitted to EPOS.

GNSS processing at Université-Grenoble-Alpes for EPOS-GNSS

Author(s)
Gaël Janex, Anne Socquet

Abstract
“EPOS - GNSS data and products” is one of the 10 Thematic Core Services of the European Research Infrastruture EPOS. EPOS-GNSS centralizes and distributes GNSS data and metadata from permanent stations throughout Europe. It also provides various types of products (daily solutions, position time series, position instrument and co-seismic offsets, secular velocities and deformation fields). OSUG/ISTerre hosts one of the two EPOS-GNSS data processing centers that has been producing a double-difference solution using GAMIT/GLOBK (last reprocessing in 2024, 1621 time series generated and distributed), and associated velocities generated with MIDAS. This analysis centre is committed to generating daily position solutions, and aims at providing solutions that match very closely, and with a good reactivity (a few days) the GNSS data distributed by the EPOS data nodes. For easier management and more reactivity, we are therefore currently in transition to a PPP solution, using the latest version of GipsyX.

INGV GNSS processing for active tectonics and geodynamics

Author(s)
Enrico Serpelloni, Roberto Devoti, Nicola D’Agostino, Leonardo Martelli, Letizia Elia, Grazia Pietrantonio, Adriano Cavaliere, Daniele Randazzo, Patrizia Pizzullo, Michele Proietto, Paolo Perfetti, Antonio Avallone

Abstract
INGV is currently processing the largest parts of the continuous GNSS networks that provide freely accessible data over the Euro-Mediterranean and African region (~6000 stations) with the GAMIT/GLOBK, GIPSY and BERNESE software. Three different and independent data analysis centers, each using one of the three software above mentioned, are operating in different locations using different computational resources, adopting slightly different approaches in handling the metadata and covering different regions. The position time-series in different reference frames from the three GNSS data analysis centers are provided in PBO POS format through the INGV RING web portal, although the service is still under development. Here we present the ongoing effort in developing a multi-software GNSS processing engine: a modular, scalable, and fully automated workflow designed to process thousands of GNSS stations using multiple scientific software packages (namely GAMIT/GLOBK, GIPSYX and BERNSE) within High-Performance Computing (HPC) environments. We will also discuss some key problems in comparing our geodetic products with EPOS ones.

EPN Densification – Status and future

Author(s)
Ambrus Kenyeres, Joaquín Zurutuza

Abstract

EPN Densification is a long term program of EUREF to integrate national level active networks on the product level. The participating 30 Analysis Centres contribute with daily or weekly processing results in SINEX format and the inputs, following a thorough cleaning and metadata harmonization are merged with the CATREF software. All details and results are published in the https://epnd.sgo-penc.hu portal.

The last published solution was EDD2237 including input from GPSweek 1500 to 2237 and still expressed in IGb14. In the meantime, in the frame of the EUREF-EPOS cooperation an EPOS pan-European solution, derived by University of Grenoble (UGA) was received and also integrated. The UGA solution, computed with the GAMIT software, includes more than 1600 stations, but also expressed in IGb14. Beyond the apparent network overlap it provides fresh results e.g. over UK and considered as a relevant contribution to EPND. The presentation gives also an overview of the new EPO2237 solution.

EPND's crucial product is the high quality station velocity field, contributing to the generation of the continental scale velocity model, which form the basis of other European services as EGMS and also contribute to the discussion about the modernized ETRS89 realization.

EPND's future is highly dependent on the success of the ongoing national level reprocessing activities. The actual picture is quite colorful with successfully completed repro3, with networks where the processing is in good progress or in a well prepared phase but there are also cases, where repro3 seems difficult to perform. The presentation provides an overview showing the actual status.

OPENING SESSION

EUREF Meets EPOS: Boosting Visibility and Use of Geodetic Data in a European Research Ecosystem

Author(s)
Lili Freda (EPOS ERIC Executive Director)

Abstract
The collaboration between EPOS and EUREF marks a strategic effort to enhance the visibility, accessibility, and usability of high-quality geodetic data across disciplines within the European research landscape. By integrating the EUREF Permanent Network (EPN) data and products into the EPOS infrastructure, both parties aim to foster data interoperability and promote FAIR principles. While the cooperation between EPN and the EPOS GNSS Thematic Core Service (TCS) forms a natural starting point, the partnership also envisions expanding to other domains in line with EPOS' multidisciplinary mission. Beyond advancing scientific research, these efforts are expected to generate broader societal value by enhancing the reusability of shared geospatial data and products in areas such as environmental monitoring, hazard assessment, and sustainable development. Through coordinated governance, technical exchange, and community engagement, the collaboration delivers integrated GNSS-based services and lays the groundwork for a more connected, impactful European geoscience ecosystem.

SESSION 1

Report on the Activities of the EUREF Governing Board

Author(s)
Wolfgang Soehne

Abstract
The IAG Sub-Commission for Europe, EUREF, is a joint effort of research organizations and National Mapping and Cartographic Agencies. Its main goal is the definition, realization and maintenance of the European Reference Frames (realizations of the European Terrestrial Reference System (ETRS89) and the European Vertical Reference System (EVRS). The EUREF key infrastructures are the EPN (EUREF Permanent Network) and the UELN (United European Levelling Network). Within EUREF's flat structure the EUREF activities are coordinated by the EUREF Governing Board (GB). The EUREF GB oversees and discusses EUREF activities and policy. The GB meets three times a year. Since the last EUREF symposium 2024 in Barcelona the GB had several digital meetings. The main activities and progress of the GB within this period are summarized in this presentation. More details about EUREF can be found at http://www.euref.eu/.
This presentation gives an overview about the main topics which were discussed in the EUREF GB during the past twelve months.

EUREF Study Group on alternatives to ETRS89. Status of work

Author(s)
X. Collilieux, Altamimi Z., Araszkiewicz A., Arnfinnsdatter Skaar K., Bruyninx C., Caporali A., Dach R., Danezis C., Gianniou M., Kenyeres A., Kollo K., Kotsakis C., Häkli P., Huisman L., Legrand J., Liebsch G., Lidberg M., Liwosz T., Männel B., Pacione R., Poutanen M., Prange L., Sacher, M., Schwabe J., Söhne W. , Torres J. A. , Verbeurght J., Virly B., Völksen C., Walenta A., Zurutuza J.

Abstract
The European Terrestrial Reference System 89 (ETRS89) was adopted in 1990 in Firenze, Italy, following the EUREF Resolution 1. It is defined in such a way that it coincides with ITRS at epoch 1989.0 and is fixed to the stable part of the Eurasian tectonic plate. 12 realizations have been published so far, the most recent being ETRF2020. Since then, most European countries have aligned their national reference frame with respect to an ETRS89 realization complying with the INSPIRE Directive. The objective of the “EUREF Study Group on alternatives to ETRS89” is to investigate if ETRS89 is still in line with user needs and to propose an alternative definition of the system if it is relevant. This presentation will show the status of work.

EPN: Current Status and Progress

Author(s)
Carine Bruyninx, Juliette Legrand, Andras Fabian, Anna Miglio, Fikri Bamahry, Eric Pottiaux

Abstract
The EUREF Permanent Network (EPN) provides the GNSS reference stations essential for accessing and maintaining the European Terrestrial Reference Frame. For users, it is crucial to identify, at any given epoch, which EPN stations are performing according to expectations so they can be reliably used as reference stations during data analysis.
To support this, the EPN Central Bureau (CB) continuously monitors station performance, focusing on data availability, metadata correctness, and data quality. This presentation provides an update on the current status of the EPN, highlighting major developments since the 2025 EUREF Symposium. It also outlines the progress made by the EUREF community in implementing resolutions adopted at previous symposia.

The report of the EPN Analysis Centres Coordinator

Author(s)
Tomasz Liwosz, Andrzej Araszkiewicz

Abstract
The EPN Analysis Centres Coordinator (ACC) combines and analyses GNSS coordinate solutions provided by the 17 EPN Analysis Centres (AC). The combined solutions computed by the ACC are used for the creation of the EPN cumulative solution, and also serve for rapid EPN station position monitoring.
The report presents the activities of the EPN ACC during the last year, and outlines the status of AC and combined operational solutions. In 2022, the EPN Repro3 project began which aims at reanalysis of all EPN data from 1996 to the present using a consistent methodology. This report presents also the status of 12 AC solutions contributing to the Repro3 project, outlines the combination strategy, and discusses results from analysis of individual AC solutions. We also present the status of Repro3 combined solution

Report of the EPN Troposphere Coordinator

Author(s)
Rosa Pacione

Abstract
In addition to station coordinates, the EPN ACs submit GNSS Zenith Total Delays (ZTD) and horizontal gradients on a routine basis. These ZTDs are used by the EPN Troposphere Coordinator (TC) to generate the combined EPN troposphere solution containing the combined troposphere estimates with an hourly sampling rate. The agreement among the AC solutions is evaluated in terms of weekly mean bias and standard deviation. This presentation describes the present status of the activities, concentrating on the major changes since the EUREF Symposium of 2023.

Reference Frame Coordination Status Report

Author(s)
Juliette Legrand, Carine Bruyninx

Abstract
The primary purpose of the EUREF Permanent Network (EPN) is to provide access to the European Terrestrial Reference System 89 (ETRS89) which is the standard precise GNSS coordinate system throughout Europe.
To maintain the ETRS89, the Reference Frame Coordinator computes the EUREF Reference Frame product which is one of the core products of EUREF. It consists of the precise multi-year positions and velocities of the EPN stations expressed in the latest ITRS/ETRS89 realization. Unfortunately, since the switch to IGS20/igs20.atx in November 2022, no official reference frame product has been published.
A Reference Frame hybrid test solution aligned to IGS20 and based on daily solutions coming from the EPN-repro2 and operational EPN solutions compatible with IGS14/igs14.atx completed by operational EPN solution in IGS20/igs20.atx is being tested while waiting for an EPN Reference Frame product based on EPN-repro3 daily solutions.
The presentation will present the current temporary product published.

Status and future of the European Vertical reference Frame

Author(s)
Martina Sacher, Joachim Schwabe, Cornelis Slobbe

Abstract
The first part of the presentation is related to new data in the United European Leveling Network (UELN). Since the last EUREF symposium in 2024, the data of the new national leveling network of Serbia was provided to the UELN data center. For the time being, the integration of the Serbian data in the UELN is only provisional, as the border connections to some neighbouring countries are still missing.

In the second part of the presentation, possibilities for the stabilization of the European leveling network by additional approaches are discussed. The integration of hydrodynamic levelings has already been presented in the last symposium. In this presentation, a new selection of hydrodynamic connections is used. Another possibility to reduce systematic errors is the integration of GNSS data. A set of heights, derived from GNSS observations and the European Gravimetric Quasigeoid 2015 was included in the UELN adjustment. The results are compared with the results of the adjustment of leveling data only and of leveling data with additional hydrodynamic connections.

Status report for the EUREF Working Group “European Unified Height Reference”

Author(s)
Joachim Schwabe; Martina Sacher; Gunter Liebsch; Martin Lidberg; Heiner Denker; Jonas Ågren; Anders Alfredson; Riccardo Barzaghi; Mirjam Bilker-Koivula; Artu Ellmann; Bruno Garayt; Andreas Hellerschmied; Ambrus Kenyeres; Urs Marti; Sander Varbla

Abstract
The EUREF Working Group “Unified European Height Reference” was formed by resolution in 2021 with the objective to enhance the usability of European heights, particularly for GNSS-based height determination in practical applications such as civil engineering, digital elevation models, etc. The main goal is to establish a European Height Reference Surface (EHRS) that is tailored to a consistent dataset of GNSS-leveling control points (EHRS_CP) referring to the latest ETRS89 and EVRS realizations, as presented at the EUREF Symposium 2023. Furthermore, comprehensive information about the national integrated spatial reference systems, including heights and geoid models, shall be made available through the Information and Service System for European Coordinate Reference Systems (CRS-EU).
The release of a first experimental solution for the EHRS is currently envisaged for 2026 based on the EHRS_CP dataset and the European gravimetric quasigeoid model EGG2015. Investigations into the derivation of the corrector surface have been performed and will be continued throughout the year.
Over the last three years, new GNSS-leveling data for the EHRS_CP dataset have been provided by a large number of countries. Meanwhile, the GNSS coordinates collected so far have been processed and harmonized to ETRF2020 as far as currently possible. Therefore, it is planned to publish the dataset and make it available via the EVRS website or upon request. A formal enquiry for permission has been prepared and sent to the data providers.
Finally, recent developments regarding regional geoid initiatives in Europe will be summarized. An announcement about the IAG Subcommission 2.4a „Geoid and Gravity in Europe“ will be made in a separate contribution.

Changes regarding IAG Subcommission 2.4a „Gravity and Geoid in Europe“ and the impact on the European gravimetric quasigeoid

Author(s)
Joachim Schwabe

Abstract
For more than two decades, the IAG Subcommission 2.4a „Gravity and Geoid in Europe“ (IAG SC 2.4a) was chaired by Heiner Denker (Institute of Geodesy/IfE, Hannover). During this period, a tremendous amount of gravity and elevation data has been collected from various sources. The data were mainly used to compute gravimetric quasigeoid models covering the entire of Europe known as the „European Gravimetric Geoid“ (EGG, latest 2015).

Dr. Denker has recently resigned from the role. The sub-commission is now chaired by this author and deputy Thomas Grombein (Karlsruhe Institute of Technology). The gravity database cannot be transferred since the data were provided mostly subject to confidentiality agreements. Thus, in the coming years the foremost concern will be to rebuild the database from scratch.
This challenging task may be facilitated by using the latest and quality-controlled datasets for the national geoid models, and by building upon exchanges with the network of experts in regional geoid modeling initiatives, such as the NKG geoid, European Alps Geoid project, the Geomed project, etc.
The pan-European gravimetric quasigeoid model is a key input for computing the European Height Reference Surface (EHRS). Hence, the work within IAG SC 2.4a is closely connected with the goals and activities of the EUREF Working Group „European Unified Height Reference“ (also chaired by this author). Bundling these activities will overall benefit the different communities (gravity field vs. reference frames, science vs. mapping agencies vs. end users).
Most of the national points of contact are already known to the EUREF Working Group. As a first step, we will therefore reach out to (re-)provide the latest and official national datasets to the IAG SC 2.4a under defined terms and conditions. The organizations possessing the data are kindly encouraged to support this endeavour.

The use of permanent GNSS stations as GNSS/leveling points in validating the Dutch height transformation

Author(s)
Bas Alberts, Lennard Huisman, Huib de Ligt, Bas van Goor, Jochem Lesparre

Abstract
The current height transformation for the Netherlands between physical NAP heights and ellipsoidal ETRS89 heights is based on the quasi-geoid model NLGEO2018. This model was fit to NAP using
82 GNSS/leveling points acquired in the mid-1990s. Although this fit has a very high reported accuracy of 0.5 cm, there were a few issues limiting the quality assessment of the resulting height transformation. First, the transformation of the older GNSS heights to the current Dutch realization of ETRS89 was not straightforward. Furthermore, recent data with sufficient accuracy were not available to validate the results. A measurement campaign, carried out in 2021, showed that the current transformation procedure results in heights that on average match leveled heights better than the old procedure, but a more detailed assessment was not possible.

Instead of running a new dedicated campaign, we explored the use of permanent GNSS-stations as GNSS/leveling points. A first test was performed using a network of 20 IGRS stations in the northeastern part of the Netherlands. In 2023 the NAP heights of the GNSS antennas were measured as part of the regional leveling campaign. To investigate the effect of subsidence, these leveled NAP heights of the GNSS antennas were compared to yearly, weekly and daily GNSS solutions. The second test made use of the nationwide network of permanent GNSS stations, which are connected to NAP by local tie measurements. For these stations the time between the local tie and the regional leveling may be larger and, as most GNSS stations are located on buildings, the NAP heights of the GNSS antenna is measured using tachymetry. Both of these factors may limit the accuracy of the resulting heights. To get highly accurate GNSS heights at the time of the local tie measurement, a new processing of GNSS time series was performed for all data since 2016.

Both experiments showed that a consistent and accurate set of GNSS/leveling points can be obtained using permanent GNSS stations. In this presentation we will show the results of the analysis and discuss the potential of the large number of permanent GNSS and IGRS stations for geoid model validation in the Netherlands.

SKVRF2024 - New national realization of the EVRS height system in Slovakia

Author(s)
Miroslava Jancovicova, Branislav Droščák

Abstract
Two vertical reference systems are binding in Slovakia: the Baltic Height System after adjustment (Bpv; EPSG: 8357) and the European Vertical Reference System (EVRS). In practice, the most commonly used system in Slovakia is Bpv, although the current realization Bpv57 has been in use since 1957. The reference tide gauge of the Bpv is Kronstadt and the reference heights are normal heights according to Molodensky. Until now, all new levelling measurements are still being incorporated into the original Bpv57 realization. This realization is outdated and shows both global and local inhomogeneity. Keeping high quality heights in Bpv is difficult due to its definition. It uses Krasovsky ellipsoid, S-Gr57 or S-Gr64 gravity system, and the classical method of calculating gravity reduction. On the other side, the EVRS height system is based on geopotential numbers calculated from the latest available data defined by the parameters of the current GRS80 ellipsoid. In 2019, current realization of the EVRS system, EVRF2019, was introduced by the BKG processing center. A year later, the GKU obtained a new, more accurate quasi-geoid model called GMSQ2019 (Bucha et al., 2019) for work with EVRS using GNSS methods. GKU carried out the adjustment of geopotential numbers on the 1st order levelling points in the EVRF2019 realization. Test on the points of the National Spatial Network showed that the normal heights in the EVRS height system in the EVRF2019 realization, together with the new quasi-geoid model GMSQ2019, would allow the determination of heights anywhere in Slovakia using GNSS methods within an accuracy of 1 to 2 cm. In 2024, the final adjustment of geopotential numbers for all 1st and 2nd order levelling points in the EVRF2019 realization was performed. The new national realization of EVRS was named Slovak Vertical Reference Frame 2024 with the abbreviation SKVRF2024. It represents a national densification of the EVRS (EVRF2019) official realization. Geopotential numbers for 1st order levelling points were adjusted by connecting to the 7 reference points in the EVRF2019 realization provided by the BKG processing center with consideration of their standard deviations. Subsequently, geopotential numbers of the 2nd order levelling points were adjusted by connecting them to the already adjusted 1st order levelling points. This national realization SKVRF2024 was established in Slovakia by the novel of the ÚGKK SR Decree No. 300/2009 Z.z. from the April 1st, 2024. The advantage of the EVRS is that it uses the latest available measurements and a modern approach for the calculation of normal heights using geopotential numbers. The differences between the Bpv57 realization and the national realization SKVRF2024 range from 4 to 18 cm.

Reference Frame Validation of a Network RTK Service in Great Britain Using the Grid Check Approach

Author(s)
Lennard Husiman, Mark Greaves

Abstract
The coordinate reference frame in GNSS Real-Time Kinematic (RTK) positioning is defined by the coordinates of the GNSS base stations. In network RTK, users receive data from a virtual reference station, computed using observations and coordinates from a network of real base stations.
In Great Britain, the RTK infrastructure is managed by Ordnance Survey (OS) in collaboration with commercial partners. OS operates and monitors the GNSS base stations and provides RTK services to its own surveyors, while commercial partners offer services to external users.

To assess the consistency of the coordinate reference frame provided by one of these commercial partners, the Grid Check approach was applied. This methodology evaluates the consistency of the reference frame by comparing the coordinates provided in the metadata of virtual stations with coordinates independently computed from the observation data.
This validation effort was a collaboration between Ordnance Survey and Kadaster. Data collection and pre-validation were carried out using Kadaster's existing Grid Check implementation. Final coordinate computations in the national realization of ETRS89 for Great Britain were performed by Ordnance Survey.
As this was the first time the Grid Check was applied to a service in Great Britain, several lessons were learned. For instance, due to the larger geographic area compared to the Netherlands, the data collection and processing workflows had to be adapted to handle a significantly higher number of virtual stations.
This contribution presents the results of the validation and also differences in applying the Grid Check methodology in a small country (the Netherlands) versus a larger one (Great Britain).

SESSION 2

National Report of Austria

Author(s)
David F., Dellinger J., Eigner A., Fredriksson J., Hellerschmied A., Lercher T., Mayer D., Öhlknecht Y., Sehnal M., Titz H., Walenta A., Zahn E.

Abstract
Since 2024, the EPN Analysis Center (AC) has focused on an internal data processing update, resulting in a core analysis kit to support AC operations in following EPN guidelines and delivering homogeneous products. The goal is to use this kit for multiple purposes, such as processing EUREF station lists for BEV AC or re-analyzing the Austrian Positioning Service (APOS) network.
As part of ongoing system updates, the EPN Data Center at BEV will migrate the old data from the FTP to the HTTPS server and discontinue the download service on the FTP. We also plan to remove the anonymous FTP upload in a second step.
The APOS Network has been extended with six reference stations and six monitoring stations as part of a national densification plan, particularly targeting areas with extensive Real Time Kinematic (RTK) deployment. Further expansion includes two more reference and three monitoring stations. A custom monitoring system has been developed to support this growing infrastructure. To facilitate data exchange, we cooperate with the National Institute of Oceanography and Applied Geophysics – OGS in Italy, which operates the Friuli Regional Deformation Network (OGS-FReDNet).
Work on the regional geoid was expanded last year through new collaboration with the Austrian Federal Institute of Agricultural Economics, Rural and Mountain Research (BAB) and TU Graz. BEV is conducting its own gravity field surveys to support the realization of the regional geoid as well as cooperating with the Federal Agency for Cartography and Geodesy (BKG) in Germany focused on leveling in the Ehrwald test area. The regional geoid computation is part of the European Alps Geoid project (EAlpG), which aims to develop a high-accuracy geoid model for Austria.
The GGOS Coordinating Office and IAG Secretariat have launched the new IAG website (geodesy.science) to boost communications within the geodetic community and engage non-geodesists. The website features job listings and submission forms for news, events, and job opportunities.

National Report of Czech Republic

Author(s)
Jan Reznicek

Abstract
National Report of the Czech Republic presents activities of the Land Survey office and Research Institute of Geodesy, Topography and Cartography, that have taken place in the past year, including the administration of CZEPOS GNSS network, levelling measurements, GOP contributions to science & reference frames, or Gravimetry research at GOP.

National Report of Finland

Author(s)
Pasi Häkli

Abstract
National report of Finland.

National Report of Germany

Author(s)
Andreas Gerschwitz

Abstract
The short presentation gives an overview about the news and progress of the German National surveying activities, in particular on the new German-wide positioning service as a joint effort of the German Länder and the Federal State.

National Report of Slovakia

Author(s)
Martin Ferianc

Abstract
National report of Slovakia presents joint, national authority, university and research institutes contribution about present status and news focused primarily on the field of geodetic controls, geodesy, geoinformatics, metrology, InSAR and Earth sciences which have happened since the last EUREF 2024 symposium.

National Report of Sweden

Author(s)
Tina Kempe

Abstract
We will present a short national report.

National Report of Switzerland

Author(s):
Arturo Villiger, Daniel Ineichen, Simon Lutz, Lars Prange, Stefan Schaer

Abstract
Important highlights and developments at the national mapping agency swisstopo are presented. This includes aspects of the Geostation Zimmerwald, the Permanent Network Anlaysis Center PNAC, the Swiss Positioning Service swipos, as well as GNSS meteorology.

National Report of France

Author(s)
José Pinheiro, François L'Ecu

Abstract
This report outlines the advancements and ongoing projects in the field of geodesy in France, focusing on the GNSS permanent network, international activities, leveling, gravimetry, and future perspectives.
The RGP Network, coordinated by IGN with approximately 50 partners from private, public, and scientific sectors, comprises 500 permanent stations as of May 31, 2025. Of these, 454 stations are located in continental Europe, with 34 integrated into the EPN (26 active) and 261 into EPOS. The network provides hourly, daily, and weekly geodetic solutions and collaborates with Météo France for hourly Zenith Total Delay (ZTD) production. Associated services include a widely accessed website, RINEX data downloads, and an online GNSS processing service with significant monthly engagement, demonstrating its critical role in geodetic data dissemination and analysis.
IGN actively contributes to various international geodetic initiatives, thereby strengthening global geodetic infrastructures. These contributions include partnerships with organizations such as IGS, EUREF/EPN, DORIS, REGINA, and SONEL, each playing a pivotal role in advancing geodetic technologies and data management.
In the context of the NIREF scientific leveling, contributing to the EVRS, an 800 km leveling line from Strasbourg to Dunkirk is underway since 2022. By 2024, 270 km have been completed, with the goal for 2025 being to reach Dunkirk. Concerning the national leveling network, a new post-seismic leveling was conducted in La Laigne in 2024. Other leveling campains were also conducting to replace some triplet benchmarks.
The national gravimetric network was maintained in 2024, encompassing 25 relative lines, 11 gradients, and 43 absolute gravity measurements. A new Sintrex CG-6 relative gravimeter has been purchased in 2024.
Future plans include evaluating InSAR technology for geodetic networks, establishing multi-technique reference stations, devoloping cloud infrastructure for RGP and ensuring RINEX3 compatibility. These advancements aim to enhance the precision and efficiency of geodetic infrastructures.

National Report of Hungary

Author(s)
Ambrus Kenyeres, István Galambos, Bálint Magyar, Márta Varga, Gábor Virág

Abstract
The Hungarian National Report summarizes the main actions and achievements in geodetic infrastructure developments, service maintenance, new services and contributions to EPN.
We continued our efforts to install Integrated Satellite Geodetic Reference Stations (Hungarian abbreviation IMMA), which integrates a permanent GNSS station, two InSAR corner reflectors and a height benchmark. The IMMA stations gradually replace the permanent GNSS stations monumented on buildings and also serves as InSAR reference points and height primary benchmarks. In 2024 10 new stations had been installed. Thanks to the IMMA development our GNSS service has 42 stations and we could serve our RTK clients without significant service quality issues over highly disturbed ionospheric circumstances.
Great achievement that a new InSAR service had been published. It is available in the https://insar-hungary.hu website and interactively provide access to high resolution InSAR derived surface deformation.
The SGO GNSS Analysis Centre was one of the first which completed EPN repro3 and we alsocompleted the reprocessing of our national active GNSS network data. Additionally we took over theprocessing of the Austrian APOS network data processing.
SGO performs the EPN Densification combinations. As a new milestone an EPOS-EPND combined solution had been published, where the solution series of selected EPND ACs and the EPOS pan-European AC at UGA, Grenoble was integrated.

SESSION 3

Advancing European GNSS Infrastructure Through EPOS-GNSS and EUREF Collaboration

Author(s)
R. Fernandes, C. Bruyninx, L. Carvalho, P. Crocker, G. Janex, J. Legrand, J.-L. Menut, A. Socquet, M. Vergnolle

Abstract
The GNSS Thematic Core Service (TCS) of the European Plate Observing System (EPOS-GNSS) provides access to homogenized, quality-controlled GNSS data and derived products—such as coordinate time series, velocity fields, and strain rate maps—from over 2,100 stations across Europe. This infrastructure is supported by a distributed network of data and product repositories, integrated via the GLASS software suite, which facilitates standardized data access through web portals and APIs, adhering to FAIR principles.
In 2022, EPOS ERIC and EUREF signed a Memorandum of Understanding (MoU) to enhance collaboration in geodetic activities. Since 2024, this MoU has been operationalized through joint efforts focusing on harmonizing standards, exchanging data and IT solutions, and ensuring complementarity in GNSS-related services. These initiatives aim to improve interoperability and streamline the development of shared scientific products.
While the focus of EUREF remains the definition, realization, and maintenance of the European Reference Systems, EPOS-GNSS concentrates on facilitating access to GNSS data and products tailored to Solid Earth research. The collaboration enables both communities to benefit from shared infrastructure and coordinated developments, particularly in data validation, distribution frameworks, and long-term station performance monitoring. Here, we present the current status of EPOS-GNSS operations, highlight recent developments in data dissemination and service integration, and describe the planned joint activities with EUREF under the MoU framework. These coordinated efforts aim to support geodetic and geophysical research, with emphasis on Solid Earth studies that rely on consistent, high-quality GNSS observations across Europe.

raw2rin: A Unified Tool for Converting Raw GNSS Data to RINEX

Author(s)
D. Arribas, F. Geraldes, R. Fernandes

Abstract
GNSS CORS stations produce large volumes of raw observational data, typically stored in proprietary formats defined by each receiver manufacturer. These formats are not compatible with standard processing software and cannot be used directly in scientific or operational workflows. Converting raw data to the Receiver Independent Exchange (RINEX) format is therefore an essential step for data distribution, processing, and archiving in geodetic applications.
This work presents raw2rin, a software tool developed to automate the conversion of raw GNSS observation files to RINEX. It supports input from multiple receiver brands and allows users to define key conversion settings, such as sampling rate, observation span, RINEX version, and satellite systems to include. The tool also permits editing of metadata fields to ensure correct and consistent header information.
raw2rin performs the entire workflow automatically, from raw file ingestion to the generation of compressed RINEX files and accompanying processing reports. The reports include information on file format detection, decoding parameters, metadata changes, and any warnings encountered during conversion. The tool supports both individual file uploads and batch processing, and it is accessible through a simple web interface.
By fully automating the conversion of raw GNSS data to RINEX, raw2rin simplifies the preparation of consistent, standards-compliant data products for CORS operators, GNSS data centers, and the scientific community. It reduces the need for proprietary tools or manufacturer-specific expertise and ensures reproducibility and traceability in the generation of observation files ready for geodetic processing and distribution.

A Novel Approach to GNSS Data Storage Using TileDB in the Context of EPOS

Author(s)
Fernando Geraldes, Duarte Arribas, Paul Crocker, Luís Carvalho, Rui Fernandes

Abstract
RINEX is the standard format for archiving and distributing GNSS observation data. However, its static, file-based nature presents limitations in scalability, efficiency, and interoperability, especially as the volume of data from permanent GNSS stations continues to grow. To address these challenges, modern database solutions such as TileDB are being explored as alternatives for GNSS data management.
TileDB is an array-based data format and storage engine designed for large, multidimensional datasets. In the GNSS context, it allows observations to be organized in arrays with dimensions such as time, satellite constellation, satellite identifier, and observation type. This structure supports efficient data access, advanced compression, and parallel operations, making it suitable for modern geodetic repositories, including cloud-based platforms.
Organizations like the EarthScope Consortium and GFZ have already adopted TileDB for archiving GNSS data, typically using one array per station. In our work, we test different strategies for optimizing data organization in TileDB. In particular, we focus on the impact of database granularity—how observations are grouped—by comparing three configurations: one array per station, one per station[1]year, and one per station-year-month.

Using real GNSS datasets and representative query types, we analyze the effect of these configurations on import times, storage requirements, and query performance. Results show that finer-grained grouping improves query speed and reduces memory and CPU usage. Among the tested approaches, the station-year configuration offers a favorable balance between performance and manageability.
This study contributes to the evaluation of database structuring strategies for GNSS data storage using TileDB. The findings support the development of more efficient and scalable data access solutions for long-term management of GNSS observations in both EPOS and other geodetic data infrastructures.

Tracking performance analysis of multi-GNSS EPN stations

Author(s)
M. Gianniou, A. Iliodromitis

Abstract
Satellite surveying has entered a new era where four Global Navigation Satellite Systems (GNSS) are available. Multi-GNSS surveying is for quite a few years a standard measurement method in the daily surveying practice. The available satellites are often much more than the minimum required, and the question which arises is which of them should be used to obtain optimal results. One key factor for this question is the superior tracking performance offered by the modern design of Galileo and BeiDou signals as well as by the modernized signals of GPS and GLONASS. However, the tracking quality depends not only on the signal's characteristics, but also on the signal processing techniques used by each particular receiver model. In this study we analyze the tracking quality of different GNSS signals using data from the EPN (EUREF Permanent Network). EPN offers ideal conditions to investigate the receivers' dependencies, as it consists of many different receiver models from all major manufacturers. For our analysis we use quantitative indexes like the number of cycle slips and the multipath level. The analysis showed that the tracking performance varies strongly in dependence on the receiver's model. Moreover, the firmware version proved to play a critical role, as the tracking performance ranking among the different GNSSs observed at a station often changes after a firmware upgrade.

On the ITRF2020 Update

Author(s)
Zuheir Altamimi, Paul Rebischung, Xavier Collilieux, Laurent Métivier, Kristel Chanard, Julien Barnéoud

Abstract
During the past more than three decades, substantial improvements have been constantly made in the data analysis strategy, at the level of both individual techniques, as well as the ITRF combination, with the aim to improve the ITRF accuracy and reliability. The ITRF2020 marked considerable innovations compared with previous versions of the ITRF, by modeling nonlinear station motions (seasonal signals and Post-Seismic Deformation –PSD– for sites subject to major earthquakes). It also demonstrated that the accuracy and stability of the CM-based frame origin, as sensed by SLR, is at the level of or better than 5 mm at epoch 2015.0 and 0.5 mm/yr. Moreover, for the first time of the ITRF history, the scale agreement between SLR and VLBI input solutions is at the level of 0.15 ppb (1 mm at the equator) at epoch 2015.0, with no drift. Motivated by these results, and for a number of reasons that will be exposed in this paper, the ITRS Center decided to regularly (yearly) update the ITRF2020. Results of the first ITRF2020 update, called ITRF2020-u2023, will be presented and discussed, with a special focus on the evaluation of the stability of the frame physical parameters when adding 3 years of extended data from the four techniques. Consequences to the ITRS a and ETRS89 relationship will be summarized.

ETRS89 and its realizations in the EPSG Dataset

Author(s)
Roger Lott

Abstract
At the EUREF Symposium in Barcelona in 2024, Olav Vestøl's presentation "EPSG codes – a blessing or a curse?" [1] described challenges with national realizations of ETRS89 using information which is included in the EPSG Dataset [2]. Since then the EUREF European Unified Height Reference working group have published "Overview of national realizations of the integrated geodetic reference in Europe" [3]. The IOGP Geodesy Subcommittee has developed a plan for integrating the EUREF overview information, together with the Nordic Geodetic Commissions NKG2020 transformations, into the EPSG Dataset in a way that will better document ETRS89 data and permit national realizations to be related, should that be required. Practical solutions for both geodetic and GIS communities are included. This presentation will describe the scheme being implemented.
Reference [3] also includes an "Overview of national height reference surfaces (geoid models) for transformation between ellipsoidal heights and leveling heights". This includes information on geoid models currently not included in the EPSG Dataset. From an IOGP perspective this tabulation is missing some information that prevents the data from being included in the EPSG Dataset. The presentation will encourage EUREF to include this information in future updates to the document.

Extending the ETRS89 lifetime: case study for Spain

Author(s)
Joaquin Zurutuza

Abstract
As of April 25th 2007, Directive 2007/2/EC of the European Parliament and of the Council of March 14th 2007 establishing the INSPIRE (Infraestructure for Spatial InfoRmation in Europe) Directive was published in the Official Journal of the European Union. One of the most relevant implications of the INSPIRE Directive is that ETRS89 (European Terrestrial Reference System) or any of its ETRF (European Terrestrial Reference Frame) realizations – ITRS (International Terrestrial Reference System) or any of its ITRF (International Terrestrial Reference Frame) in areas outside the scope of the ETRS89 – is adopted as the horizontal reference frame to refer the coordinates. As a consequence, most European countries adopted ETRF realizations as their national reference frame.
The advantage of using ETRS89/ETRF coordinates, fixed to the stable EURASIA plate and aligned to the ITRS at epoch 1989.0, is mainly their small variations over time, which makes them very suitable for legal and practical issues. However, in certain areas, such as the Eurasia south-western borders, the ETRS89 departs from the EURASIA plate and the coordinates may change rapidly over time. To maintain the ETRS89 coordinates without considering the velocities, 10 mm can be considered as a threshold to update the sites' coordinates.
This case study is focused on the Southern Iberian Peninsula, where we find a clockwise rotation of all the stations of up to some 3 to 4 mm/year related to the ETRF2000 (National reference frame). We show how the lifetime of the ETRF2000 coordinates can be extended by including coordinate variations in Southern Iberian Peninsula modeled by an auxiliary Euler pole and rotation rate. The lifetime can be lengthened from 3-4 years to around 13-15 years by applying this additional rotation to the original ETRF coordinates.

EUREF Serbia 2023 campaign

Author(s)
Filip Kostadinović, Dragana Popović

Abstract
The EUREF densification campaign, EUREF Serbia 2023, was conducted with the main objectives of maintaining and monitoring the densification of the European Terrestrial Reference Frame (ETRF) on the territory of the Republic of Serbia, controlling the integrity and stability of the existing national ETRS89 realization established by previous EUREF densification campaigns, computing the coordinates of points in the ITRF2020/IGS20 reference frame, and strengthening Serbia's European geodetic integration. The campaign lasted from July 16 to August 19, 2023, and included 118 stations, comprising EPN stations, national and regional GNSS stations, Vekom private network stations, and field survey points. Permanent stations were observed continuously, while field stations were observed during a dedicated 5-day session. ITRF2020/IGS20 coordinates and velocities were used for processing, as the cumulative EPN solution in ITRF2020/IGS20 did not exist at the time of processing. The internal quality of the solution showed high precision, with typical repeatabilities of 1–2 mm in horizontal components and 3–5 mm in vertical components. Comparison with the EUREF Serbia 2010 campaign revealed an RMS agreement of 10 mm in the horizontal and 15 mm in the vertical components at epoch 2010.63, ensuring consistency over the years. An additional alternative transformation approach, proposed by Dr. Martin Lidberg, EUREF Chair, during the EUREF Symposium 2024, was also applied to the campaign points. Comparison with the EUREF 2010 campaign showed an RMS agreement of 10 mm horizontally and 15 mm vertically at epoch 2010.63, matching the results from the standard ETRF2000 transformation. The EUREF Serbia 2023 campaign, excluding private network stations, meets Class B validation criteria and represents a reliable densification of Serbia's geodetic network in line with the latest European and global reference frames.

Modernised transformation between century old national CRS and ETRS89

Author(s)
Jochem Lesparre

Abstract
Some National Coordinate Reference Systems (CRS) lack a precise transformation in the EPSG geodetic parameter dataset, which complicates the use of ETRS89 for users of geo-data. The problem is often not the complexity of the national CRS. For example, the over a century old national CRS of the Netherlands used to be included in EPSG with an approximate transformation, causing inaccuracies up to 0.25 metre in GIS software. It was suggested to switch to ETRS89 to solve this problem. However, many users prefer a single national projection. The projections for ETRS89 recommended by INSPIRE were evaluated but found unsuitable. So a new national projected CRS based on ETRS89 seemed necessary. To enable users to migrate their data to a new national CRS, a precise transformation from the old national CRS to ETRS89 is needed in GIS software. Therefore, we developed a new official transformation to ETRS89 that is conform the ISO standard used by EPSG, and gives within 0.01 metre the same results as the old official transformation. The new official transformation is now included in EPSG and supported by GIS software. As a result, the desire for a new national CRS has dissipated, because a transition to a new national CRS would be costly and take years. With the modernised transformation, the existing national CRS can effectively function as a projection of ETRS89, since users can transform back and forth in GIS software without losing accuracy. This demonstrates that modernising a national CRS doesn't necessarily require a transition to a new CRS.

Geodesy 2026 – 2035, work towards a new strategic plan for geodesy at Lantmäteriet, Sweden

Author(s)
Martin Lidberg

Abstract
Building geodetic infrastructure do take time. It also effects the everyday work of our stake holders (at least we hope so!). Combined with limited resources, we think it is beneficial to t have some long-term plans for how to develop geodesy at national level.
The purpose of the geodetic infrastructure is basically to serve its users and to support user needs. This can be the end users like the traditional surveying community. But it has also extended to include “machine guidance building and construction projects (e.g. Network RTK on the excavators), and further extended to “precision farming” that also widely use Network RTK. Next step is “GNSS cm-level mass market” for the support of autonomous vehicles and drones. We have believed in this for some time but has not developed as rapid as we thought some years ago. A question is also what the role national geodetic authorities should and will have in this development.
An important role for national geodesy is also to serve global geodetic infrastructure and the “Global Geodesy Supply Chain” (GGSC). This is close but not necessarily identical to the scientific needs (e.g. GGOS strategic Plan 2024-2034).
On the reference frames, we think that the current national realizations of ETSR89 and EVRS in Sweden will serve our users well for the next decade. However, some new user groups will prefer global or regional positioning services together with “the Global Geodetic Reference Frame” (ITRF in current epoch). Good relations between national static frame and ITRF is therefore important.
Our current professional users do ask for lower uncertainty in the vertical while accessing the national height system (RH 2000) through Network RTK service. We therefore need to focus on improving the geoid model. We think that this will also be good base for a possible shift to the International Height Reference System and Frame some time in the future.
We also need to improve our scientific knowledge base for the (network) RTK technology, in order to have a scientific base for how to improve the performance of our real time RTK service.
The ambition is to present an example on how to think and plan for develop geodesy in a country in northern Europe, and maybe inspire others on considerations for the future. And feedback is of course welcomed!

POSTERS - NATIONAL REPORTS

National Report of Great Britain 2025

Author(s)
Mark Greaves

Abstract
Activities of Ordnance Survey, the national mapping agency of Great Britain and of other agencies and institutions in GB, of interest to the EUREF community.

National Report of Portugal 2025

Author(s)
Helena Ribeiro, Ana Bernardes, Ana Medeiro

Abstract
Ativities of Directorate-General for Territory (DGT), the national mapping agency of Portugal, responsible for establishing and maintaining the National Geodetic Infrastructure.
In this presentation, we will make a short summary of the geodetic activities developed by Portugal within the scope of EUREF.

National Report - Belgium

Author(s)
Jeffrey Verbeurgt, Carine Bruyninx, Filip De Doncker, Juliette Legrand, Robson Nascimento, Fikri Bamahry, Martin Vandenbroeck, Andras Fabian, Anna Miglio, Eric Pottiaux, Jean-Marie Chevalier

Abstract
This national report summarizes recent geodetic activities in Belgium relevant to the EUREF community. The poster combines the contributions of both the National Geographic Institute (NGI) and the Royal Observatory of Belgium (ROB), two Belgian federal institutions working on reference frame related activities.
The NGI continues to coordinate the maintenance of BEREF -the realization of ETRS89 on Belgian territory- in accordance with EUREF guidelines. Since the 2024 EUREF plenary, several research projects have been undertaken to enhance robustness of the realisation of BEREF. The poster introduces first results on the inclusion of a combination of Galileo and additional fiducial stations in the realization procedure. Next to information on the finalization of the 3D project, where 2258 new geodetic markers were realized using both GNSS and precise levelling, an update on the regional RTK GNSS networks is given.
The ROB continues to operate, with the help of NGI, a Belgian GNSS data node. It also links with international organisations and takes up several international services. In that frame, an update on the contributions of both ROB and NGI to international organizations such as EUREF, UN-GGIM: Europe, EPOS and EUPOS is given.

National Report of Spain

Author(s)
Miguel González Hidalgo, Esther Azcue Infanzón, José Antonio Sánchez Sobrino

Abstract
National Report of Spain in the form of poster.

National report of Serbia

Author(s)
Jelena Matić Varenica, Filip Kostadinović

Abstract
This national report highlights key geodetic activities and advancements in Serbia, focusing on the national leveling and gravimetric networks, quasi-geoid modeling, and the progress of the AGROS Control Centre and the RGA Analysis Centre. These activities, implemented in the last decade, contribute significantly to Serbia's integration into the European geodetic networks and the continuous development of its national geodetic infrastructure.

National report of Estonia

Author(s)
Karin Kollo, Jaanus Metsar

Abstract
National report gives an overview about geodetic activities in 2024-2025

National Report of Poland

Author(s)
Katarzyna Kalinczuk-Stanałowska, Aneta Mielczarczyk

Abstract
Head Office of Geodesy and Cartography in Poland (GUGiK) since 2024 has been carrying out measurements of the basic levelling network. The work in 2024 covered the north-western part of the country, and this year the work is continuing in the eastern part of Poland. Since 2024, work is also underway to measure the gravimetric basic control points. After measurements in the northern part of the country, work is being carried out in the southern part, using the A10 instrument.
The ASG-EUPOS system's station network has expanded by 13 new locations. In 2024, the GUGiK, in consortium with the National Institute of Telecommunications, applied to the European Space Agency in the NAVISP-Element 3 programme for funding for a pilot project to build a real-time GNSS band interference monitoring system. The project was approved by the ESA, started in November 2024 and is scheduled for completion in May 2026.

National Report of Romania

Author(s)
Miluță Flueraș

Abstract
This presentation provides an overview of recent developments and ongoing projects in Romania relevant to the EUREF community, focusing on the national GNSS infrastructure, geoid determination, and signal quality monitoring.
We present the current status and modernization efforts of ROMPOS System, which serves as the national CORS infrastructure supporting geodetic, surveying, and real-time positioning applications. Key upgrades in hardware, software, and network densification will be discussed, along with performance metrics and user engagement trends.
The presentation also highlights progress in the national quasi-geoid modeling, aimed at refining the transformation between GNSS-derived ellipsoidal heights and national orthometric heights. Methodological improvements, campaign data, and integration with European height systems will be briefly described.
Additionally, we introduce recent developments in our GNSS interference mitigation application, a tool designed to detect, classify, and visualize spectrum anomalies impacting GNSS signal quality. This tool plays a pivotal role in ensuring the integrity of ROMPOS services, particularly in urban and critical infrastructure zones.
An important focus of the report is a set of studies correlating interference data with VADASE (Velocity and Displacement Estimation using Standalone Engine) output from Leica GNSS receivers. VADASE is a real-time algorithm that computes high-rate displacements and velocities from standalone GNSS observations without relying on external corrections. By analyzing VADASE time series under varying interference conditions, we assess the sensitivity of displacement estimation to spectrum disruptions and explore the potential of using VADASE as an interference diagnostic indicator.
These initiatives underscore Romania's commitment to maintaining a robust geodetic infrastructure and contributing actively to the European reference frame initiatives.

National Report of Lithuania

Author(s)
Jokūbas Ogintas, Eimuntas Paršeliūnas, Saulius Urbanas, et al.

Abstract
Results in Geodesy and Cartography journal

•CORS Network (LitPOS):

- 35 stations (Lithuania) + 6 LatPOS (Latvia) + 3 ASG-PL (Poland)
- Trimble R9 receivers, choke ring antennas, BERNESE 5.4 software
- ~2,200 users, ~6,000 rovers

•Vertical Network:

- Second levelling of first-order network (~2,000 km) • 2024 updates shown in blue

•Gravity Survey:

- 2024 campaign: ~5,000 km coverage
- NZ55 & ZLS D13 equipment

National Report of The Netherlands

Author(s)
Bas Alberts

Abstract
The National Report highlights the various activities of the Dutch Partnership for Geodetic Infrastructure (NSGI) for the period 2024 – 2025. The activities include the survey campaign of 2025 as well as several new developments and experiments.

POSTERS - SCIENTIFIC &TECHNICAL SESSIONS

Estimation of GNSS Station Coordinates in the Hitechniques Network in Ireland

Author(s)
Andrzej Araszkiewicz, Dariusz Liszka

Abstract
This study presents the results of a 10-day GNSS data processing campaign conducted on a dense network of stations operated by Hitechniques Ltd. in Ireland. The observations were processed using the GAMIT/GLOBK software suite, with GPS and Galileo signals and precise products from the IGS20 reference frame. The quality of the estimated coordinates was evaluated through residual analysis and comparison with a set of reference and control stations from the SmartNet Ireland network. The results confirm the consistency and reliability of the Hitechniques network for precise geodetic applications. Analyses have also shown that the coordinates align with the Irish realization, which, however, deviates from the latest EUREF solutions.

The new Portuguese National Geodetic Network adjustment

Author(s)
Carolina Brito, Ana Navarro, João Catalão, Ana Bernardes, Ana Medeiro, Helena Ribeiro

Abstract
The Portuguese National Geodetic Network (RGN) is a fundamental infrastructure that supports national cartography, consisting of approximately 8600 geodetic vertices, 7973 located in mainland Portugal, 523 in the Azores, and 108 in Madeira, mostly materialized by geodetic pillars. As part of the European Terrestrial Reference System 1989 (ETRS89) implementation, 127 first-order and 520 second-order vertices in mainland Portugal were observed between 1997 and 2005. In 2025, 130 geodetic landmarks are being re-observed. Given the use of different equipment, technologies, and satellite constellations, initially GPS, and later GPS, GLONASS, Galileo, and BeiDou, as well as the progressive deployment of permanent GNSS stations from the National CORS Network (ReNEP), the adjustment of the RGN was carried out separately for the two observation periods: 1997–2005 and 2025. ReNEP is a geodetic network of 47 permanent GNSS stations distributed across the national territory, supporting the definition of the national reference frame.

The methodology adopted for the RGN analysis consists of a two-stage network adjustment using Leica Infinity software (version 4.2.0): (1) a minimally constrained adjustment, where coordinate corrections are minimized to identify gross errors, detect significant residuals, and evaluate the network's internal consistency; and (2) a constrained adjustment, fixing at least three control points to official coordinates provided by the National Directorate-General for Territory (DGT). The adjustment of GPS observations from 1997 to 2005 posed several challenges, including the need to convert all observation files to the standard RINEX format, the presence of low-quality data, and missing or uncertain antenna height information. After identifying network inconsistencies, potentially problematic baselines were excluded from the adjustment. Even so, the resulting F-test value was 4.74, substantially higher than the critical threshold of 0.97, indicating that some issues remain in the network. Nevertheless, the adjusted PT-TM06/ETRS89 coordinates showed average planimetric differences below 2 mm, and vertical discrepancies of ~3 mm (orthometric) and ~6 mm (ellipsoidal), within acceptable tolerances. The 2025 observations, still in progress, will be adjusted using ReNEP stations as fixed control points, enhancing network stability and accuracy through high-quality, continuously operating GNSS data.

A permanent GNSS network in Germany joins the EPN-Densification Working Group

Author(s)
Lin Wang, Tetyana Romanyuk, Christian Rentsch, Hans-Georg Dick, Irene Feldmeth, Uwe Hensel, Falko John, Martin Freitag, Ole Roggenbuck, Wolfgang Sohne, Axel Rülke

Abstract
The combined network of GREF and selected SAPOS reference station (DREF-Online) consists of 108 high-quality active IGS, EPN, GREF and SAPOS permanent GNSS stations. This GNSS network links German reference frame with the European reference system and to international reference system on behalf of the Working Committee of the Surveying Authorities of the Laender of the Federal Republic of Germany(AdV). This network is an essential component for providing and securing the integrated geodetic spatial reference in Germany. DREF-Online products are computed with the latest Bernese GNSS development branch in BKG and it follows mainly the EPN processing standard to ensure a robustic and high quality solution.
EPN-Densification Working Group (EPN-D WG) combines the European regional GNSS normal equation and estimates the regional combination solution for the coordinate and velocity in the EUREF Terrsterial reference system. It currently includes more than 4800 GNSS stations which most locates in Europe and surrounding regions. BKG have been contributing to EPN-D WG with the GREF network which is an extended BKG AC network for EPN. With this new DREF-Online network, 45 new permanent stations are introduced into the EPN-D WG for the first time. This significantly enhance the spatial distribution in the Germany for the EPN-D WG.

Towards a 4D National Spatial Reference System (National Report of Slovenia)

Author(s)
Sandi Berk, Niko Fabiani, Klemen Medved, Natalija Novak, Polona Pavlovčič Prešeren, Peter Prešeren, Klemen Ritlop, Oskar Sterle, Bojan Stopar

Abstract
The territory of Slovenia with its western part situated at the Adriatic microplate is tectonically active. Surface deformation reaches few millimeters per year which has an impact on the quality of the national spatial reference system. Static realizations of the system become out of date in a decade, and we are facing the challenge of how to introduce the fourth dimension (time) of the national spatial reference system.

The main aspects to be considered are the quality of reference system itself and the impact of the proposed solution on various spatial databases and services. In order to provide a conceptual framework of the future realization of the spatial reference system in Slovenia, we started the so-called SLO4D Project.

Assessing small-scale Surface Deformation zones in Europe

Author(s)
Benjamin Männel, Jens Wickert

Abstract
Dense GNSS station networks and derived highly accurate 3D velocities offer the potential to image small-scale surface deformation fields. The robustness and sensitivity of the applied algorithm are crucial for the reliable detection of local and potentially small horizontal or vertical deformation zones. Based on a multivariate median estimation of strain rate and plate rotation, the imaging approach R3DI (Robust 3D Imaging) enables robust estimation, with the achieved spatial resolution dependent solely on the density of the station network and the local strain rate.
The contribution will discuss (1) the achievable spatial resolutions using checkerboard tests with real station locations in Europe and (2) the impact of applied station velocity solutions on the detectable small-scale horizontal and vertical surface deformation zones. For the latter, NGL and EPND solutions will be compared, with a focus on surface deformations in Italy and Central Europe.

The stability of ETRS89 – comparison between recent observations and earlier national realisations in Serbia and Sweden using different ETRFs and the EuVeM2022 velocity model

Author(s)
Lotti Jivall, Filip Kostadinović, Dragana Popović, Rebekka Steffen

Abstract
The common European reference frame ETRS89, with its ETRFyyyy realisations, has provided a stable geodetic system over recent decades. Most national realisations agree within a few centimeters in the horizontal components, especially those based on the “conventional frame” ETRF2000.
However, the time-dependent translation in the transformation from ITRS to ETRF2000 and earlier realisations introduced a bias in vertical velocities. Starting with ETRF2014, this translation was removed, leaving only the plate rotation. As a result, a horizontal offset of approximately 7 cm was introduced compared to previous ETRFs.
To improve consistency with older realisations, Dr. Martin Lidberg proposed adding a static rotation to the ITRF–ETRF transformation. This method, tested here as ETRF2020rot, preserves horizontal agreement with ETRF2000 while retaining vertical components from ITRF2020. Parameters for this approach are presented in Lidberg (2024).
Two national case studies are presented—Serbia and Sweden—to assess the impact of using different ETRS89 realisations (ETRFyyyy) based on ITRF2020 of a recent epoch, in comparison with the original national reference frames. The tested frames include ETRF2020, ETRF2020rot, ETRF2000, and ETRF97 (for Sweden). The European velocity model EuVeM2022 was used to correct for tectonic movements since the national realisation epoch.
The EUREF Serbia 2023 campaign was processed in ITRF2020 (epoch 2023-08-02) and compared to the national realisation based on ITRF2000 (epoch 2010-08-18). For Sweden, a recent weekly EPND solution (week 2365, epoch 2025-05-07) was compared to SWEREF 99, based on ETRF97 (epoch 1999-07-01).