

# EUREF NEWSLETTER

## SEASON'S GREETINGS

BY THE EUREF CHAIR MARTIN LIDBERG

*Dear colleagues,*

*Summarizing the year 2023 is about as hard as summarizing the year 2022. We have a conflict in Europe since almost two years now, and a more recent conflict in the middle east. So, again my thoughts go to all the innocent victims.*

*The way forward is anyway to continue to work for a better world. And maybe follow the old saying that “no one can do everything, but everyone can do something”.*

*From the professional side, I am happy that we could again meet in Gothenburg for a physical EUREF Symposia in May! During the pandemic we did quite well using digital meetings. But after some time, we need to meet also face to face. Many items are so much better discussed at physical meetings. Saying that, I am very happy for the offer we got from ICGC to host the 2024 EUREF Symposia in Barcelona. I hope to see you there!*

*I wish you, your relatives and friends a merry Christmas and all the best for 2024!*

*Martin.*

## EUREF GOVERNING BOARD 2023

BY THE EUREF GB CHAIR WOLFGANG SÖHNE

In 2023, the EUREF Governing Board was for the first time since February 2020 able to meet again in-person. On February 09+10 we met at BKG premises in Frankfurt, Germany. Nine members joined physically, 11 plus one guest virtually. Such hybrid meetings are not optimal but much better than in former times where absent members were not able to participate at all. One main topic was the preparation of the Annual Symposium which was planned, after four years, again as an in-person meeting. For the time being, the old session structure was kept. Other topics were the introduction of ITRF2020 or IGS20 and the proper derivation of ETRF2020. The terms of EUREF chair, EUREF secretary and EUREF GB chair ended in 2023. All three declared their willingness to continue for another four-years term, and the GB members agreed.

Our second meeting was in connection to the 2023 Symposium, held in Gothenburg, Sweden, as a noon-to-noon in-person meeting. The final program of the symposium was discussed. The number of registration was smaller than in former years which may be a consequence of the long period of pandemic. The GB decided to present options for a new structure of the symposium to gain more visibility to the NMAs and to scientific contributions. Since the United Nations Global Geodetic Center of Excellence (UN-GGCE) has been recently inaugurated in Bonn, Germany, there was an invited talk about the history, status and plans of the GGCE. Concerning the switch to IGS20 and beyond (e.g. new software versions) not all Analysis Centers (ACs) were ready leading to a significant delay for the combinations and the derivation of the multi-year solutions. ACs were urged to proceed with the switch as soon as possible. Due to the delay in the operational processing the planned third reprocessing of the EPN will also be delayed. Presentations on behalf of the EUREF GB were announced for IUGG2023 and WGAAL2023. There was one major change in the GB because Elmar Brockmann left after almost 20 years of membership. As a consequence, two EUREF Working Groups (WGs) were officially closed, the important maintenance of the official national coordinates, introduced by Elmar, will be continued by the EPN Central Bureau.

The third GB meeting of the year was an online meeting, divided into two parts in October and November 2023, reporting on the status and progress of the Coordinators and WGs.

For 2024, the GB plans two in-person and one online meeting.



## EUREF SYMPOSIUM 2024

BY ERNEST BOSCH AND JOEL GRAU

We all at the Institut Cartogràfic i Geològic de Catalunya are thrilled to invite you to participate in the EUREF Symposium 2024 in Barcelona, from June 5th to June 7th, 2024. We also invite you to participate in the tutorial “**GNSS contributions to Space Weather monitoring**”, scheduled on June 4th and presented by two relevant research groups with vast experience on this topic, gAGE/UPC and UPC-IonSAT, that we are sure will be worthwhile of your time on such a relevant component of high precision GNSS computation.

We will inform you as soon as the symposium webpage is available. There you will find detailed information on the symposium program, venue, registration, and other useful information for your stay. Hotel reservation won’t be held by the organization as Barcelona offers a wide variety of options, so please save the dates as we look forward to welcoming you to Barcelona.

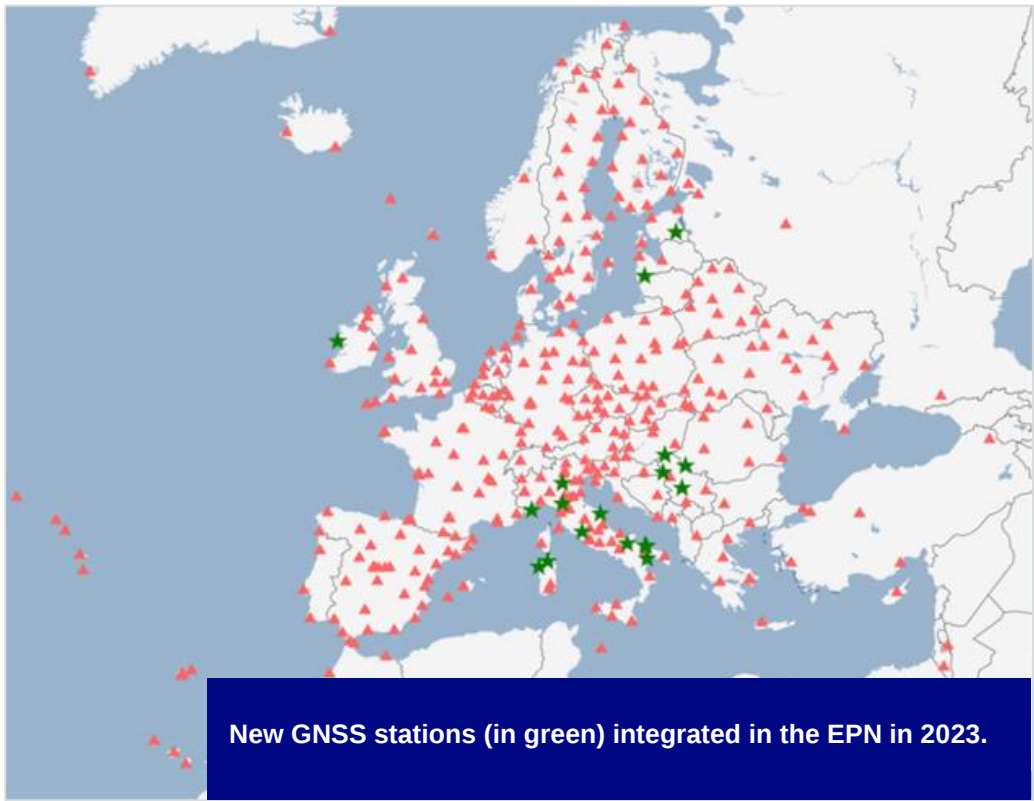


## THE EUREF PERMANENT GNSS NETWORK (EPN)

BY CARINE BRUYNINX AND JULIETTE LEGRAND

 **GNSS@ROB** @be\_GNSS

The EPN Central Bureau (CB, managed by the Royal Observatory of Belgium) continued to monitor operationally EPN station performance in terms of data availability, correctness of metadata, and data quality. In 2023, the EPN Central Bureau (CB, <https://www.epncb.oma.be/>) added 17 new stations to the EPN (indicated in green on the map on the left) and adapted its routines to process RINEX 4 data..



To move towards FAIR-aligned GNSS data (as recommended by Resolution No 2 of the 2021 EUREF symposium), the latest version of M3G (<https://gnss-metadata.eu>) allows now to insert the Digital Object Identifiers (DOI) associated with the dataset of a GNSS station. The EPN CB also offers help to assign a DOI to the dataset of EPN stations.

Encouraged by Resolution No 2 of the 2019 EUREF symposium in Tallinn, 20% additional EPN stations are sharing their daily RINEX data with the European Plate Observing System (EPOS), reaching now 87% of the EPN stations. These EPN data are available from the EPOS data portal(<https://www.epos-eu.org/dataportal>) through the ROB-EUREF EPOS data node built on top of the historical EPN data centre managed by the EPN CB.

For more news, follow [https://twitter.com/be\\_gnss](https://twitter.com/be_gnss).

# The Coordinators

## Analysis Center Coordinator

BY TOMASZ LIWOSZ AND ANDRZEJ ARASZKIEWICZ

In 2023 the EPN Analysis Centres Coordinator (ACC) worked on operational combinations of Analysis Centres (AC) solutions provided in the IGS20 framework. After the introduction of IGS20 reference frame (November 27, 2023; GPS week 2238), the creation of EPN combined coordinate solutions was stopped, because most of the EPN AC solutions could not provide their solutions according to IGS20 standards on time (e.g., due to necessary transition to the new version of the Bernese GNSS Software, lack of manpower). Finally, the combined solutions for past weeks (since 2238 to present) were completed in October and November, and the regular creation of operational combined solutions resumed in December. The comparisons of AC solutions can be found at the ACC website: [www.epnacc.wat.edu.pl/epnacc/final/](http://www.epnacc.wat.edu.pl/epnacc/final/).

In addition, the strategy for a combination of AC solutions was slightly enhanced. It now includes also the preliminary stacking of AC solutions into long-term solutions. This additional step allows to detect potential issues in individual AC solutions. Also, the outliers found in the resulting position time series are excluded from AC solutions before the final combination.

In 2023, ACC and ACs worked on the new Guidelines for EPN Analysis Centres. The new guidelines describe the present strategy for GNSS observations processing in EPN within the IGS20 framework. The guidelines are available at the EPN Central Bureau website: [http://www.epncb.eu/documentation/guidelines/guidelines\\_analysis\\_centres.pdf](http://www.epncb.eu/documentation/guidelines/guidelines_analysis_centres.pdf). The new guidelines are consistent with the IGS20 standards. The main changes in the EPN analysis include the usage of the new EPN antenna model (based almost exclusively on the IGS type-mean model), the correction of antennas not oriented to true north, exclusion of GNSS observations without receiver antenna calibrations, the usage of new ocean tide model, and the new long filenames for the EPN products.

## Troposphere Coordinator

BY ROSA PACIONE

Due to the transition to IGS20 standards occurred on November 27th, 2022 (GPS week 2238) tropospheric final operational combination stopped because of the lack of input solutions from the EPN ACs. As of today 15 EPN ACs are providing final tropospheric operational products conformed to IGS20 standards and the final tropospheric operational combination from GPS week 2238 till today is ongoing. In addition, in 2023 it was recommended to the EPN ACs to submit rapid operational tropospheric estimates (namely ZTDs and horizontal gradients) obtained as a by-product of the rapid analysis for the EPN stations included in their sub-network. As of today 9 ACs are providing these rapid products with a deadline for the submission of 22 hours after the end of observations of the analyzed day. This allowed a rapid operational combination that is currently under evaluation.

## Reference Frame Coordinator

BY JULIETTE LEGRAND

Since the release of IGS20 in Nov. 2022 (GPS week 2238), EUREF started to produce operational solutions in the new IGS20 using also updated modelling. Consequently, in January 2023, the last Reference Frame Solution C2235 in IGB14 was published (<https://doi.org/10.24414/ROB-EUREF-C2235>). It provides the positions and velocities for 389 EPN stations and covers the period from January 1, 1996 to November 12, 2022. All the necessary information can be found at <https://epncb.oma.be/productsservices/coordinates/#product>.

The next release of the Reference Frame Product will be a cumulative solution consistently expressed in IGS20 based on the Repro 3 solutions (currently being processed) and the final daily solutions produced since GPS week 2238. In the meantime, for monitoring purposes, the EPN position time series continue to be updated daily based on a mix of daily operational solutions in IGB14 and IGS20, for example <https://epncb.oma.be/productsservices/timeseries/index.php?station=ADAR00GBR&update>.

*J. Legrand has taken over the responsibility of the project “Monitoring of official national ETRF coordinates on EPNCB” previously managed by E. Brockmann. National mapping agencies are now invited to send the official ETRS89 coordinates used in their countries to J. Legrand (J.Legrand@oma.be).*

# The Working Groups

## WG on Reprocessing

BY CHRISTOF VÖLKSEN

At the EUREF symposium in Gothenburg, it was decided to complete the reprocessing for the entire EPN, called EPN-Repro3, starting from the foundation of the EPN in 1996 until the end of 2022 according to the latest IGS20 standards by the end of 2023. This decision was adopted as Resolution #3 at the end of the symposium. The urgency of providing the reprocessed products becomes clear when one realizes that they are of great importance for the creation of updated Reference Frame Products that are required by numerous users. There were and are a few hurdles to overcome along the way. It turned out that some ACs needed more time to implement the new software for the analysis of the GNSS data and also for the provision of computer resources. After all, more than 25 years of data from well over 300 stations have to be reprocessed, which will tie up considerable resources at the individual analysis centres. In addition, a number of software problems were uncovered that had to be eliminated one by one and delayed the entire process. Some reprocessed products were also missing for several days in 2021 and 2022.

In view of these facts, it is no longer possible to finalize EPN-Repro3 by the end of 2023. In the meantime, the ACs involved in EPN-Repro3 are hard at work and it is hoped that the first part of the work will be completed as quickly as possible.

## WG on Deformation Modeling

BY REBEKKA STEFFEN AND MARTIN LIDBERG

The new velocity model for Europe was released just before the EUREF Symposia in May under the name EuVeM2022. It is based on the EPND2150 velocities. The gridded horizontal and vertical velocities are derived using Extended Least Squares Collocation (LSC) methodology, and provided in several well known file formats. DOI: <https://doi.org/10.23701/euvem2022>

## WG on European Unified Height Reference

BY MARTINA SACHER AND JOACHIM SCHWABE

The WG was established through Resolution No. 1 at the EUREF 2021 Symposium (see EUREF Newsletter 2021). One of the long-term goals is to complement EVRS and ETRS89 with an official European height reference surface (EHRS, to be realized by a combined quasigeoid model). A main building stone for this will be a new European GNSS/leveling dataset “European Height Reference Surface – Control Points” (EHRS\_CP) as a successor to the previous EUVN\_DA dataset.

Since the launch of the WG, updated GNSS/leveling data from a significant number of countries have been received. Normal heights are referenced to EVRF2019, and ellipsoidal heights are reported with precise information about their reference to either ETRF2000, ETRF2014 or the national ETRS89 realizations, including reference epoch. This will facilitate the task to largely homogenize the data and reduce systematic differences between the countries as far as possible. First results of preliminary comparisons with available gravimetric quasigeoid models were reported at the EUREF Symposium 2023 in Gothenburg. There are plans to intensify the analysis in 2024, including the impact of vertical velocity models not only for Scandinavia but also for the whole European continent (e.g. EuVeM2022, Steffen et al. 2023). Furthermore, the update and enlargement of the United European Leveling Network (UELN) will result in an update of the EVRF2019 in 2025, which will also contribute to the final version of the EHRS\_CP dataset.

Another aspect of the WG is the synergy with regional activities to compute the gravimetric (quasi)geoid, not only on continental level with the European Gravimetric Geoid (EGG, Denker/IAG SC 2.4a), but also in, e.g., Scandinavia (NKG geoid, FAMOS/BSCD2000, see below), the Alps (European Alps Geoid Project), or the Mediterranean region (Geomed, Barzaghi et al.). In this context, a milestone has been reached recently for the Baltic Sea region. The first release for the Baltic Sea Chart Datum 2000 (BSCD2000) height transformation grid was published in November 2023 (<https://doi.org/10.58440/iho-bscd2000>) alongside with a release note in the International Hydrographic Review (<https://doi.org/10.58440/ihr-29-2-n11>). The transformation grid is meant for use in hydrography and navigation, however, the download also includes the gravimetric quasigeoid solution for scientific purposes. Compared to the NKG 2015 geoid, the new model exploits a vast number of new precise shipborne gravity data for most areas of the Baltic Sea. These data were measured over a timespan of almost ten years and were partly co-financed by the EU under the scope of the "Finalizing Surveys for the Baltic Motorways of the Sea" (FAMOS). They will also contribute to the upcoming next version of the NKG geoid, envisaged for 2025/2026. Thus, it can be expected that both BSCD2000 geoid and NKG geoid will form the cornerstone of the EHRS for Scandinavia and the Baltic Sea.