

Time & location:

Part I: Friday, May 16, 2025, 1300-1530 CEST (online)

Part II: Wednesday, June 18, 2025, 1400-1600 CEST (online)

PART III: Wednesday, June 25, 2025, 1700-1800 local time (in-person, Covilhã)

Excused for Part I: Alessandro Caporali, Ambrus Kenyeres, Markku Poutanen, Joao Torres

Excused for Part II: Alessandro Caporali, Rolf Dach

Excused for Part III: Alessandro Caporali, Rolf Dach, Joao Torres, Xavier Collilieux

Guest for Part III: Tobias Bauer

MINUTES**1. Opening (Söhne)**

The EUREF GB chair welcomes the GB members and guests to the GB98 meetings.

2. Approval of minutes of 97th GB meeting (Kollo)

There have been some corrections delivered to KK by CB and WS. KK will send out the final version for review asap.

Action Item to KK: *distribute the final version of the minutes of GB97 meetings to the GB members.*

3. Review of Action Items from previous GB meetings (Söhne)

WS discusses the Action Items of GB97 which are all done, in progress or on the agenda.

4. EUREF Governance**a. EUREF Symposium and AC Workshop 2025 (Fernandes, Ribeiro)**

Status as of Part I: there are 55 registrations for in-person participation to Symposium and Workshop plus 15 for on-line participation to the AC Workshop. The number of submitted abstracts is not sufficient. Some GB members indicate that they will submit their abstracts asap. The GB agrees to publish another, final call for the Symposium via EUREF mail.

TL and CV will take responsibility for the program of the AC workshop.

Question about the planned bus-transfer between Lisbon Airport and Covilhã. Currently, there is sufficient interest for the shuttle bus, so it will be arranged.

Action Item to ML and RF: *write a reminder for the symposium and AC workshop via EUREF mail to encourage participation and submission of abstracts*

Update as of Part II: Additional presentation from Italy for AC workshop about EPOS. GB Dinner on Tuesday about 730-800 PM, self-paid, reply by Friday. Email about bus shuttle today. Bus will leave 1730 on Monday afternoon from Lisbon airport.

b. Status of 2024 Resolutions (Söhne)

WS discusses the resolutions of the 2024 Symposium and evaluates all of them as "in progress". CB asks for the status of former years' resolutions.

Action item to WS: *distribute the list (xlsx) of the EUREF Symposia resolutions to the GB members, upload also to the restricted area at EUREF webpage*

c. EUREF 2025 Resolutions (All)

Part I: WS invites the GB members to consider and prepare potential resolutions for the upcoming symposium. JS indicates that a resolution on gravity database is in

preparation. CV suggests a resolution on EPN and EPOS solution comparison to get EPOS and EPN work together in the terms of products harmonization.

Part II: JL will provide a proposal for the resolution about national coordinates in ETRF.

Part III: CB proposes a resolution on the EPN stations to be automatically also EPOS stations. The visibility through EPOS Portal is already given, the outreach of the stations would be larger, and such decision would simplify the work of the EPN CB at this point.

JS proposes a resolution on building up a new gravity database, since the existing database is strongly connected to the former IAG Sub-commission 2.4a chair Heiner Denker.

JL proposes a resolution on the national ETRS89 coordinates of EPN stations. There was a resolution no. 3 of 2009 on this topic, which should be renewed. The GB discusses a possible resolution on the contributions out of the EUREF community to the EPSG registry. Although this was a topic of the EuroSDR workshops where the EUREF Chair ML participated, some GB members have concern to formulate such a resolution without more discussion on this topic. ZA proposes a short resolution on the support of the ETRS89 Study Group.

d. EUREF GB membership (Pacione, Torres, Völksen; Söhne)

Part I: BM and JZ are accepting the prolongation of their GB membership, which ends 2025, for a second term. CV explains the result of the Call for GB membership launched March this year. There was only one candidature by Lennard Huisman with support of various institutions. He is going to send the related documents to the GB. Providing the acceptance of the candidature by the GB, WS proposes to dispense with an election during the symposium but to go for an “election by applause” during the Opening Session. The GB agrees. The GB discusses changes of coordinators “in charge of specific tasks” as well as Working Group Chairs. For the reference frame on the one hand and for the height reference on the other hand WS proposes “in-house solutions”, i.e., successors coming from IGN and from BKG, resp. Proposition to create the position of a Coordinator for EPN densification, and close WG EPN Densification.

Part II: WS had video call with Lennard, he was only candidate for GB membership, will be introduced in opening session, as well continuation of Joaquin and Benjamin. ML: Question – who from LOC will be present in opening session, Vice-president of University and in closing from IGN. All “official” acts during the opening session since there is enough time.

Part III: The GB chair WS welcomes LH as new member of the EUREF Governing Board. He states that the Call for Nomination launched March 06, 2025, via EUREF mail was not fully successful. Various countries he talked during the symposium so far were not aware of the Call because of missing the EUREF mail, for different reasons. Any new Call in future must be provided by more than one medium, e.g. putting it in News sections, sending it to participants of past Symposia directly, etc.

5. Height Reference & Working Group on “European Unified Height Reference” (Sacher, Schwabe)

MS reports on the progress of the levelling database. Some border connections between Czech Republic and Germany (Saxony) will be re-measured. New measurements from Serbia are available. Border connections prepared with Bulgaria, North Macedonia, and Hungary. Discussions ongoing for connections with Croatia, Bosnia-Herzegovina, and Romania. New strategies for EVRS realization. We have considered hydrodynamic levelling and GNSS levelling

data integration. Next EVRS realization is not expected before early 2027 to ensure optimal accuracy and methodology. Poland is conducting new levelling measurements, but completion is not expected within the next five years. The integration of emerging technologies like optical clocks could revolutionize geodetic height systems in the coming decades. Continued collaboration, testing, and strategic planning are essential to prepare for this future.

JS gives an update of the Working Group on European Unified Height Reference. New geoid models are in progress in Germany and NKG area. A first version of the EHRS is envisaged to be released by symposium 2026. Open question: shall EHRS/EHRS_CP become an official product of EUREF? JS is now successor of Heiner Denker as chair of IAG. The gravity database cannot be simply transferred to him because of the confidential agreements for the provisioning of the data. Therefore, JS proposes to formulate a resolution for the symposium on the delivery of gravity data.

6. EPN

a. EPN CB webpage

Part III: CB announces that a rebuild of the EPN CB's webpage is planned. She invites everyone to submit ideas and wishes concerning the content.

b. Request for validation of EUREF Serbia 2023 Densification Campaign (Kostadinovic)

Part II: WS introduces that the GB received the report from Serbia at the end of May. Usually we were contacted earlier, so we had time to ask some clarifications. This time we don't have this possibility, some of us volunteered to read this report. Overview given by Filip Kostadinović, Republic Geodetic Authority of Serbia.

The purpose was to maintain and monitor the densification of the ETRS89 reference frame in Serbia, ensure integrity and stability of the national realization and compute coordinates in IGS20 and further integrate Serbia into the European geodetic framework.

Campaign Details. Observation Period: July 16 – August 19, 2023. Stations Involved: 118 total (25 EPN stations, 18 from neighbouring countries, 7 from 2010 EUREF campaign, 5 from Serbia's geodetic base network (SREF), 27 AGROS (national permanent network), 36 VECOM (private network)).

Technical Aspects. Data Processing: July–November 2024 using Bernese GPS software v5.4. Reference Frame: IGS20 and ETRF 2020. Datum Definition: Minimum constraint solution with non-net translation. Ambiguity Resolution: 75.3% average across constellations.

Coordinate Repeatability: 1–2 mm (North/East), 3–5 mm (Up), higher for field stations near roads or lakes.

Challenges and Observations. Site-dependent effects observed at stations on metal roofs. Station PENSCORE showed a jump in data after day 215. Station KASK excluded due to a 5 cm jump in the up component. Station BUJA had a 20 cm anomaly due to equipment failure.

Alternative Transformation to ETRS89. Proposed by Dr. Martin Lidberg at the 2024 symposium. Uses a static Euler pole rotation to align with ETRF 2000. Developed in-house using Python. RMS agreement: ~10 mm (horizontal) and ~15 mm (vertical). Comparable to standard transformation.

Conclusion. Internal quality of the 2023 solution: ~1–2 mm (horizontal), ~3–5 mm (vertical). Comparison with 2010 campaign: RMS agreement: 10 mm (horizontal), 15 mm (vertical)

Questions from GB.

ZA: Cutoff test – why you have RMS for height component about 2 cm? JK: Because these stations, SIDO, KLAD, IVAN and VGRAD are mounted on the metal roofs. So, I

think that is side-dependent effects for these stations and so the RMS in up component increases. ZA: Question regarding no-net-translation. You did use Bernese, the translation was done with respect of what? Why you distinguish between ITRF2020 and IGS20? JK: Yes, Bernese ADDNEQ. We translated respect to reference stations. There is no distinction, I just listed coordinates and velocities what I used. ZA: Transformation to ETRS89. You said that you applied the model from Lantmäteriet. Did you apply this model to ITRF2020-like coordinates or to ETRF-something coordinates? JK: we don't have velocities to these stations, we applied ITRF2000 model, we transformed from IGS20 to ETRF2000, and then we reduced epoch from 2023 to 2010 using Lantmäteriet model (EuVeM2022).

XC: what is the coordinate difference for 12 years? Is there improvement with deformation model? JK: it is very homogenic, average RMS in x and Y coordinate is 10 mm and the height 15 mm. XC: What is the coordinate change due to the propagation from 2023 to 2010? JK: About 1 cm to 1,65 cm. XC: do you see any improvement when you use the deformation model? JK: yes, we need to use deformation model.

JZ: I have seen large gaps in terms of reference stations in the south of your network, why you didn't consider to use other reference stations from EPN or IGS? JK: For reference stations we used EPN tool, and from that we derived used 16 reference stations. We were using only EPN stations. JZ: you could use some stations from neighbouring countries. LJ: We chose stations from higher class as said in the guidelines.

JL: I see its sort of the fault of the tool, so I would like to comment on the EPN reference station tool. The EPN Reference Station Tool helps identify the best stations, but there are not always very good reference stations in the border regions. Therefore, to guarantee a good spatial coverage, users should supplement with additional less good stations if needed.

Guidelines suggest prioritizing C0 and C1 class stations (after checking the guidelines it is not the case), but lower-class stations can be used, if necessary, the tool is meant for pre-selection, not strict exclusion. There is may be a need to clarify the guidelines for future campaigns. Suggestion is to compare with IGS cumulative solutions and hybrid solution for validation.

Remark from JL while reviewing the minutes: after checking the guidelines it is quite clear that the spatial coverage around the campaign is very important and there is no mention of station classes that should be used, only that the agreement of the station coordinates and/or velocities between the densification solution and the reference solution should be good.

XC: are you going to change the official coordinates? JK: no, it is just to check the integrity between this and older EUREF solutions.

Suggestion by GB: FK to share the SINEX files with JL, JL will run comparisons, and we will discuss this later.

WS: GB concludes that we are not at the point that we can make a resolution on the acceptance of the Serbian campaign just yet.

Part III: The Serbian colleagues will present the results of their campaign during the symposium. ZA emphasizes that the prerequisites for a resolution are not given since the results won't be official coordinates of Serbia. He also has concern that the request for validation by the EUREF GB without the goal of a new official realization may open the door for several other campaigns.

JL and JZ, which have been in contact with the colleagues from Serbia with regard to the report, are asked to pose their questions and request directly to them.

Action Item for JL, JZ and CB: Update and specify the "Guidelines for Densifications", e.g. concerning the schedule for the deliverables, the goal of the

campaign, request for validation, etc.

7. AOB – Workshop on “Georeferencing in the digital era” in May/June in Oslo (Lidberg, Collilieux)

In October 2024 there was a first EUREF-EUROSDR workshop in Tromsø, Norway, on reference frames and spatial data (see minutes GB96). End of May a follow-up meeting with the title “Georeferencing in the digital era” is planned. The workshop aims to address confusion among geographic information users regarding reference frames and CRS (Coordinate Reference Systems). Differences in national CRS implementations and EPSG codes contribute to user confusion. From EUREF side ML will participate and contribute. He is planning to give a report on the Study Group on ETRS89 realisation led by XC. XC and ZA express their concern about a possible overlap of terrestrial reference frames with EUREF. CB and ZA express their concern about EUREF’s co-organisation without a clear mandate for collaboration with EuroSDR from, e.g. the GB. GB notices that while EPSG registries may fall slightly outside EUREF’s traditional scope, but we need to understanding user needs, be Engaged more actively in CRS-related discussions and promote EUREF work and resources more effectively. 18.06.2025: (1) ETRS89 harmonization and EPSG code confusion. European countries have harmonized ETRS89 realizations well. However, non-geodetic users (e.g., GIS professionals) face confusion due to multiple EPSG codes for essentially the same reference frames and lack of clarity that these codes refer to equivalent systems, leading to formal distinctions in GIS software. (2) Dynamic reference frames and future demands. Some sectors (e.g., autonomous vehicles, drones) are pushing for dynamic reference frames where coordinates change over time. These systems rely on ITRF-based positioning with real-time updates. There is a growing expectation for Europe to provide infrastructure for such dynamic systems. (3) Two parallel challenges Identified: there are two distinct issues: EPSG code management and dynamic frame implementation. Trying to solve both with the same approach causes confusion. (4) Registry and standardization efforts. Roger Lott, a key figure in the EPSG registry and ISO geodetic registry, will present at the European Symposium. He will address how national ETRS89 realizations are handled in registries. Conclusion. Europe already has dynamic frame solutions (e.g., ITRF time series), but they are not well promoted. As a result, external stakeholders are often unaware of existing capabilities. The discussion emphasized the need for: better communication of existing geodetic solutions, clarification of EPSG code usage for GIS users and continued dialogue at upcoming events like the European Symposium.

8. Coordinators

a. Report of the Analysis Centre Coordinator (Liwosz)

Part I: TL gives a status report of the EPN Repro3 combination. 11 out of 12 contributions to the EPN Repro3 are complete, only for UPA there are some periods missing. JL asks for the timeline of the completion of the individual contributions as well as the combination, which she needs as input for the accumulated solution. CV recommends to not put any combination results in open directories of the EUREF Data Centres.

b. Report of the Reference Frame Coordinator (Legrand)

Part II: still waiting for daily combined solutions from repro 3 to be able to estimate a new solution fully based on Repro 3 in IGS20. Plan: preparation for Repro3 multi-year solution as soon as the daily combined Repro 3 solution are available, publication a preliminary reference station solution as soon as possible (with SINEX, discontinuities and outliers but with no classification at first), in a second time the official solution together with station classification will be published. A new Hybrid cumulative solution C2355 has been published before the EUREF symposium. The Position and velocity discontinuities have been

harmonized with IGS20. Publication of reference frame products through EPOS portal: ROB-EUREF reference frame product -> cleaned position time series and velocity field, available via EPOS GNSS product portal (<https://gnssproducts.epos.ubi.pt/>) and EPOS data portal (<https://www.ics-c.epos-eu.org/>). For velocity – one velocity per station, PBO format for velocities. Velocity estimated using Hector, more realistic velocity error estimate.

National ETRF coordinates of EPN stations: they are a bit outdated, resolution on update of the National ETRF coordinates of EPN stations. E-mail sent; some answers received.

Question from CV about classification – not done at first hand, but later, because needs more time to look into. Idea to have first preliminary solution, ask feedback, and after that make official reference frame solution. Remark from ZA: formal error of CATREF is optimistic, good point to have noise model. ML: comment on having just one velocity per station – other disciplines won't understand what to use at the end, JL: to give the best solution at the end. XC: IGS20 or IGB20? JL: Next one to be aligned to IGB20.

9. EPN – Request for coordinates certification for ROMPOS reference stations (Söhne et al.)

Part I: Due to lack of time only a very short summary of the meeting of April, 17 is given. ZA, KK, JL, ML, and WS met three colleagues from Romania. They plan to process the network of approx. 86 Romanian stations of ROMPOS 32 stations from the National Institute for Earth Physics (NIEP) and 10 stations from Moldova (MOLDPOS - written agreement exists). They made already the benchmark test initiated by the EPN Densification Working Group. The GB members recommended the processing of at least four weeks of data of the complete network, including some more EPN reference stations in the south, and submit the results plus report to the EUREF GB for validation.

10. EUREF collaboration / external interfaces – EUREF-EPOS collaboration (Söhne et al.)

Part I: Short summary: AA, CB, AK, JL, ML, RP, WS and CV had an initial meeting on May, 12. Short term goal of the meeting was the preparation of the AC workshop in Covilhã. Contributions of EPOS Analysis Centres, at least hybrid, are recommended. The EPOS GNSS product chain with the various solutions from EPOS-only, EUREF-EPOS and EUREF-only were discussed. The visibility of the individual EPN Analysis Centres and Densification Analysis Centres was discussed. Beside the AC workshop, a EUREF-EPOS meeting on the product chain before end of 2025 is recommended. Potential topics for the next EUREF-EPOS workplan were discussed, e.g. campaign data and results, highrate data, real-time data, comparison of processing results. Also, gravity data has been mentioned and is of interest for both EUREF and EPOS. CB recommends to add TL to the group because of the combination product.

11. AOB

a. Next meetings

GB98, Part III in-person meeting in Covilhã: Tuesday, June 24, 0930-1030 CEST and/or Wednesday, June 25, 2025, 1700-1830 CEST? Decision to have the meeting on Wednesday evening.

ML proposes a longer – possibly full two-days – in-person meeting and invites to Gävle, for CW44 (Oct, 28-29 or 29-30, 2025) or CW46 (Nov, 11-12, 2025). Decision for Oct, 28-29, 2025, allowing for travelling on Monday and Thursday, resp. Important and general topics for discussion shall be prepared and distributed beforehand.