# The EUREF Strategy - May 2021

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# Background to the work

In resolution 5 from the EUREF 2018 Symposium in Amsterdam, the EUREF Governing Board is asked to develop a strategy and implementation plan on how to adopt new technologies and techniques such as e.g. the Galileo system and InSAR.

# EUREF's primary mission *and vision*

"EUREF's primary mission is to establish and maintain the European coordinate reference system and physical height reference system"[1,2]

*EUREF's vision is to serve the European society with homogenous and sustainable geodetic reference frames, height and gravity systems, including data and products, services and tools, based on best available scientific background and taking into account user needs.*

[1] *From EUREF Terms of References 2017*
[2] *"physical heights" or "gravity related heights"*

# What is EUREF?

## –"WHO WE ARE"

"EUREF is the IAG Reference Frame Sub-Commission for Europe, integrated in the Sub-Commission 1.3, Regional Reference Frames, under Commission 1 – Reference Frames"

The Sub-Commission EUREF was founded in 1987[1] at the IUGG General Assembly held in Vancouver.

However, since we also deals with gravity related heights etc., we are somewhat more and take a wider scope and responsibility for geodetic infrastructure (in a broad sense) for Europe.

We aim at continue to being the recognized expert organization on geodesy for Europe.

[1] *From: http://www.euref.eu/*

# List of scientific challenges in geodesy 1(2)

As a basis for the strategic considerations, it is good to have a common view on current and coming challenges. These may be of various kinds – scientific, administrative, organizational, technical, and external changes. We in the EUREF GB have worked on the scientific challenges in geodesy from a broad perspective. Therefore, some of the discussed challenges go beyond the immediate responsibility of EUREF.

a) The global goal of **1 mm and 0.1 mm/yr for ITRF** is not met yet. For EUREF it is an important piece in order to improve the consistency and accuracy of the ETRF;

**b) Realization of the IHRS** (International Height Reference System) in IHRFs at the 1 cm level or better globally. It means that we from EUREF should realize the IHRF within Europe and establish precise, and well defined, relations between IHRF and recent releases of the EVRF;

c) Realize the **European geoid model** at the "half centimeter" uncertainty level at dense spatial resolution;

# List of scientific challenges in geodesy 2(2)

d) Develop European **models of intraplate velocities and crustal deformations** at the sub-mm/yr and nano strain/yr uncertainty level for the purpose of reference frame management and use, as well as increased scientific understanding of underlying geophysical processes;

e) Contribute with quality checked time series of observations and analysis results for **climate monitoring and research** (the GNSS technology and its infrastructure is approaching 3 decades, which is the time period where change in atmospheric conditions can be considered as "climate change")

f) 4D geodesy: the presence of **several GNSS** implies the introduction of respective time scales which are not necessarily synchronous with each other. Hence the challenge is to define the temporal frame with similar criteria as for the spatial frame;

g) Frontiers in Geodesy: **Geodesy and General Relativity** are tightly connected. Hence the challenge to embody the geometric approach to gravity into the definition of reference frames. Gravity dependent scale factors on time and length are first measurable consequences

# The Terrestrial Reference Frame in Europe

ETRS89[1] is the recognized terrestrial reference system for Europe. The EPN[2] is the primary infrastructure for maintaining and development of the ETRS89 which is realized into ETRF[3].

Since ETRF is derived from the global ITRF[4], the quality of the regional densification of ITRF at EPN stations are fundamental for ETRF. Identified aspects are:

- Ensure the use of satellite constellations within the EPN which are aligned with the operational IGS[4] orbit/clock/atx products
- Revisit the EUREF's current strategy for using individual antenna calibration to avoid inconsistencies with IGS
- Extend the EPN to include more IGS core stations, preferably with good geographical distribution
- Consider the need for consistency between EPN re-processing results and the operational EPN analysis.

1,3. European Terrestrial Reference System and Frame, 2. EUREF Permanent GNSS Network, 4. International Terrestrial Reference Frame, 4. International GNSS Service.

# Knowledge of crustal deformations

The knowledge of crustal deformations in the EUREF area of interest has booth scientific interest and is of practical value in e.g. handling of geodetic reference frames. Increased dual use of booth ITRF and realizations of ETRS89 is foreseen. This require accurate transformation relations between global (ITRF) and regional (ETRF) frames, which may include "functional models" for crustal deformations.

Steps to achieve this:

- Good knowledge build on good observations and therefore the EUREF WGs EPN Densification and European Dense Velocities are fundamental
- Develop European models of inter- and intraplate velocities and crustal deformations at sub-mm/yr and nano strain/yr uncertainty level, (*horizontal and vertical*) and provide it as a functional product.

# Gravity related heights, EVRS, IHRS, geoid and gravity

*…an area of enhanced ambitions from EUREF…*

- EVRS[1] is the recognized gravity related height system for Europe and activities on UELN[2] and the realization of EVRS into EVRF[3] continues
- the establishment and realization of IHRS[4] into IHRF[5] have been of high priority within IAG in recent years, and progress has been fundamental. IHRS should therefore be realized in the EUREF area of interest, and a well determined relation between IHRF and EVRF should be established,
- Access to the vertical reference frame are usually done through GNSS-RTK and a "geoid model". The realization of the European (quasi-) geoid model (or height reference surface, HRS) at the "half centimeter" uncertainty level at dense spatial resolution is therefore of strategic importance.
- This would benefit from a robust dataset of points with booth ETRS89 and EVRS realizations (GNSS-levelling). The review and update of the EUVN-DA[5] may therefore be considered.

1,3. European Vertical Reference System and Frame, 2. United European Levelling Network, 4,5. International Height Reference System and Frame, 5. European Unified Vertical Network – Densification Act

# Organizational perspective

*We see an emerging organizational landscape* where e.g. the European Plate Observing System (EPOS) has entered its pre-operational phase, progress is reported from UN-GGIM Sub-Committee of Geodesy (SCoG) and the establishment of a Global Geodetic Center of Excellence (GGCE) hosted in Bonn, Germany, UN-GGIM:Europe develops, EuroGeographics have worked on a revised strategy, also E-GVAP and EUPOS etc.

In this context,

- EUREF's ambition is to continue as a recognized expert organization on geodetic infrastructure and geodetic reference frames for Europe,
- cooperation are welcomed in order to facilitate progress in areas where we have mutual interests and for the benefit of the wider user society,
- cooperation may be formalized through memorandum of understanding (MoU)
- EUREF is not a legal entity and has no plans to establish such a structure.