UN GEONOW 2024
首届联合国地信周

European Geodetic Reference Systems

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European Geodetic Reference Systems

How many geodetic reference systems do you think there are in Europe?

European Geodetic Reference Systems

How many geodetic reference systems do you think there are in Europe?

To get the information select a country in the list or click on the corresponding red dot in the map

Albania
Austria
Belarus
Belgium
Bosnia / Herceg.
Bulgaria
Croatia
Cyprus
Czech Republic
Denmark
Estonia
Finland
France
Germany
Gibraltar
Great Britain
Greece
Hungary
Iceland
Ireland

Italy
Latvia
Lithuania
Luxembourg
Malta
Netherlands
Northern Ireland
Macedonia
Norway
Poland
Portugal
Romania
Russia
Slovak Republic
Slovenia
Spain
Sweden
Switzerland
Turkey
Ukraine

The border of Kosovo is used without prejudice to positions on status and is in line with UNSC 1244 and the ICJ Opinion on the Kosovo declaration of independence.

https://www.crs-geo.eu/crs-national.htm

If you look at the map you will see that there are almost as many countries in Europe.

At present there are 46 countries in Europe and, according to Grothenn (1994), 5 different reference ellipsoids and at least 8 cartographic projections.

"MODERN GEODETIC NETWORK AND DATUM IN EUROPE",
ŠIMEK, KOSTELECKÝ

European Geodetic Reference Systems

How many geodetic reference systems do you think there are in Europe?

Position	
GR_GGRS87 / GR_TM	Datum GGRS87 in Transverse Mercator Projection with special Greek parameters

Position	
IT_ED50 / UTM	Datum ED50 with UTM Projection
IT_ROMA40 / EAST_WEST	Datum Roma40 in Transverse Mercator Projection in two zones East and West with special Italian parameters
Height	
IT_GENO / OH	orthometric heights referred to tide gauge Genova

https://www.crs-geo.eu/crs-national.htm

European Geodetic Reference Systems

How many geodetic reference systems do you think there are in Europe?

Position	
BE_BD72 / LAMB72	Datum BD72 in Lambert Projection with special Belgian parameters (Lambert 1972)
BE_ETRS89 / LB08	Datum ETRS89 in Lambert Projection with special parameters (LB08)
Height	
BE_OOST / UNCOR	pure levelled heights referred to tide gauge Ostend (also known as DNG)

https://www.crs-geo.eu/crs-national.htm

European Geodetic Reference Systems

How many geodetic reference systems do you think there are in Europe?

Position	
SE_ETRS89 / SE_TM_dd_mm	Datum ETRS89 in Transverse Mercator Projection in 12 Zones with <dd mm> as length of central meridian
SE_ETRS89 / UTM_SE	Datum ETRS89 in UTM Projection with special modification for Sweden
SE_RT90 / SE_TM	Datum RT90 in Transverse Mercator Projection with special Swedish parameters
Height	
SE_AMST2000 / NH	normal heights referred to tide gauge Amsterdam
SE_AMST / NH	normal heights referred to tide gauge Amsterdam

https://www.crs-geo.eu/crs-national.htm

European Geodetic Reference Systems

How many geodetic reference systems do you think there are in Europe?

Position	
IE_IRELAND65 / IRELAND75_IRISHGRID	Datum Ireland65 in Transverse Mercator Projection with special Irish parameters
Height	
IE_MALH / OH	orthometric heights referred to tide gauge Malin Head

Position	
LV_LKS-92 / LV_TM	Datum LKS-92 in Transverse Mercator Projection with special Latvian parameters
Height	
LV_AMST2000 / NH	normal heights referred to tide gauge Amsterdam
LV_KRON / NH	normal heights referred to tide gauge Kronstadt

https://www.crs-geo.eu/crs-national.htm

European Geodetic Reference Systems

How many geodetic reference systems do you think there are in Europe?

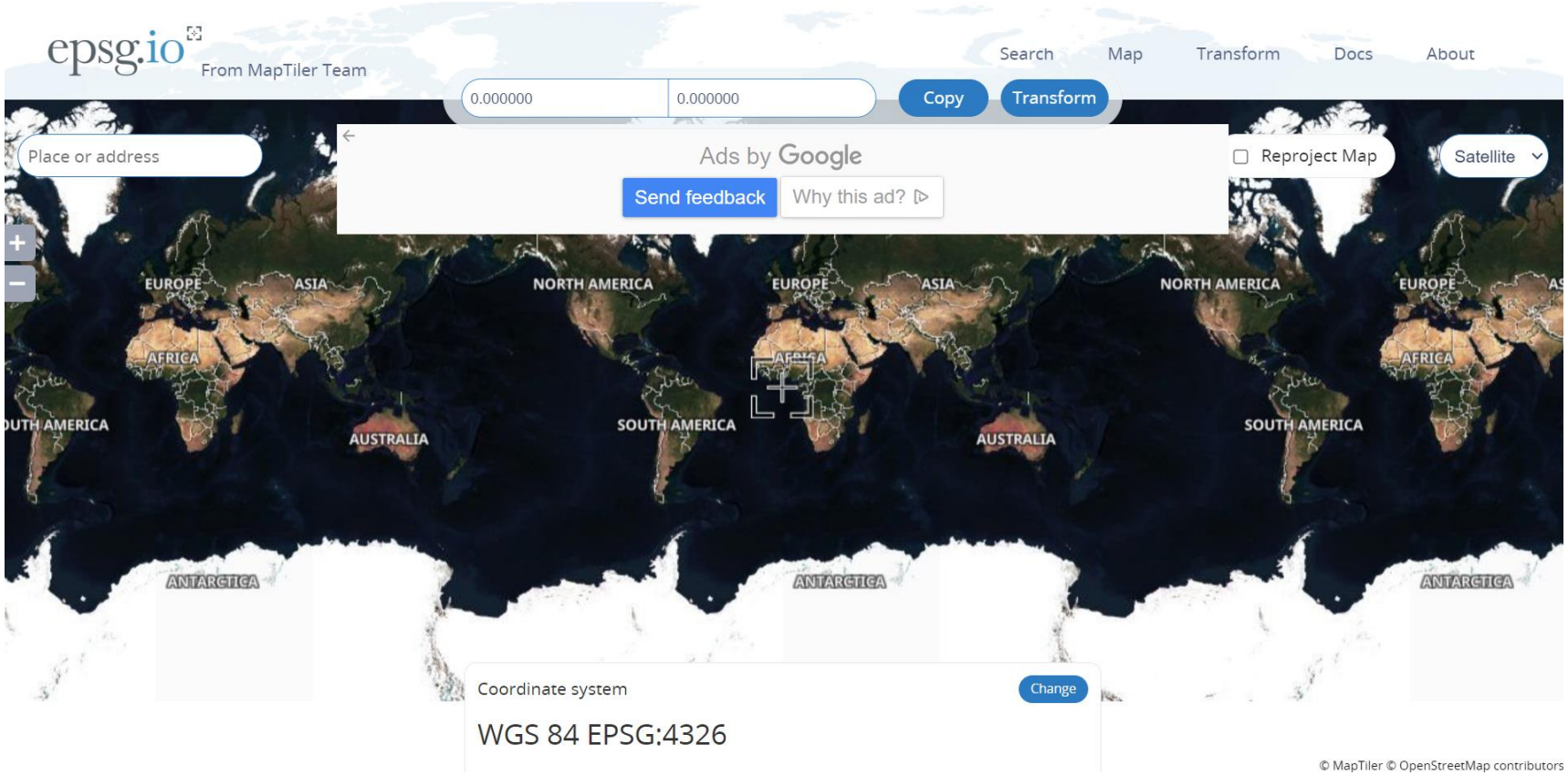
Position	
GB_OSGB36 / NATIONALGRID	Datum OSGB36 in Transverse Mercator Projection with special parameters for Great Britain
Height	
GB_NEWL / NOH	normal-orthometric heights referred to tide gauge Newlyn (also known as ODN)

Position	
ES_ED50 / UTM	Datum ED50 with UTM Projection
Height	
ES_ALIC_2008 / OH	orthometric heights referred to tide gauge Alicante
ES_ALIC / OH	orthometric heights referred to tide gauge Alicante (also known as REDNAP)

https://www.crs-geo.eu/crs-national.htm

European Geodetic Reference Systems

The same is happening all over the world.



EPSG takes you to the global database of reference systems

European Geodetic Reference Systems

For this reason:

2013: The United Nations (UN) Committee of Experts on Global Geospatial Information Management (UN-GGIM 3rd session in 2013) decided to formulate and facilitate a resolution for a global geodetic reference frame and established a working group on the Global Geodetic Reference Frame (GGRF). The task of the working group was to formulate the resolution and prepare a roadmap for GGRF for sustainable development according to the UN GA resolution.

2015: In February 2015 the United Nations General Assembly adopted the resolution on a Global Geodetic Reference Frame for Sustainable Development (A/RES/69/266), recognizing the importance of a globally coordinated approach to geodesy – the discipline focused on accurately measuring the shape, rotation and gravitational field of the Earth.

2016: At the UN-GGIM sixth session in New York in August 2016, the UN-GGIM endorsed the GGRF Roadmap and decided to elevate the GGRF working group to a permanent sub-committee on geodesy. The UN-GGIM: Europe working group “GRF-Europe” was established.

European Geodetic Reference Systems

GRF-Europe intends to be a link between the technical/expert level and the UN-related level, without duplicating the work done on either level. There are many geodesy or georeferencing related organizations in Europe, which may contribute to or participate in the GRF Europe WG.

Among these are EUREF, EUPOS, EuroGeographics, International Federation of Surveyors (FIG), Council of European Geodetic Surveyors (CLGE), and European Plate Observing System (EPOS).

FIG

EPOS-N
EUROPEANPLATEOBSERVINGSYSTEM - NORWAY

CLGE

eurogeographics

EUPOS
European Position Determination System

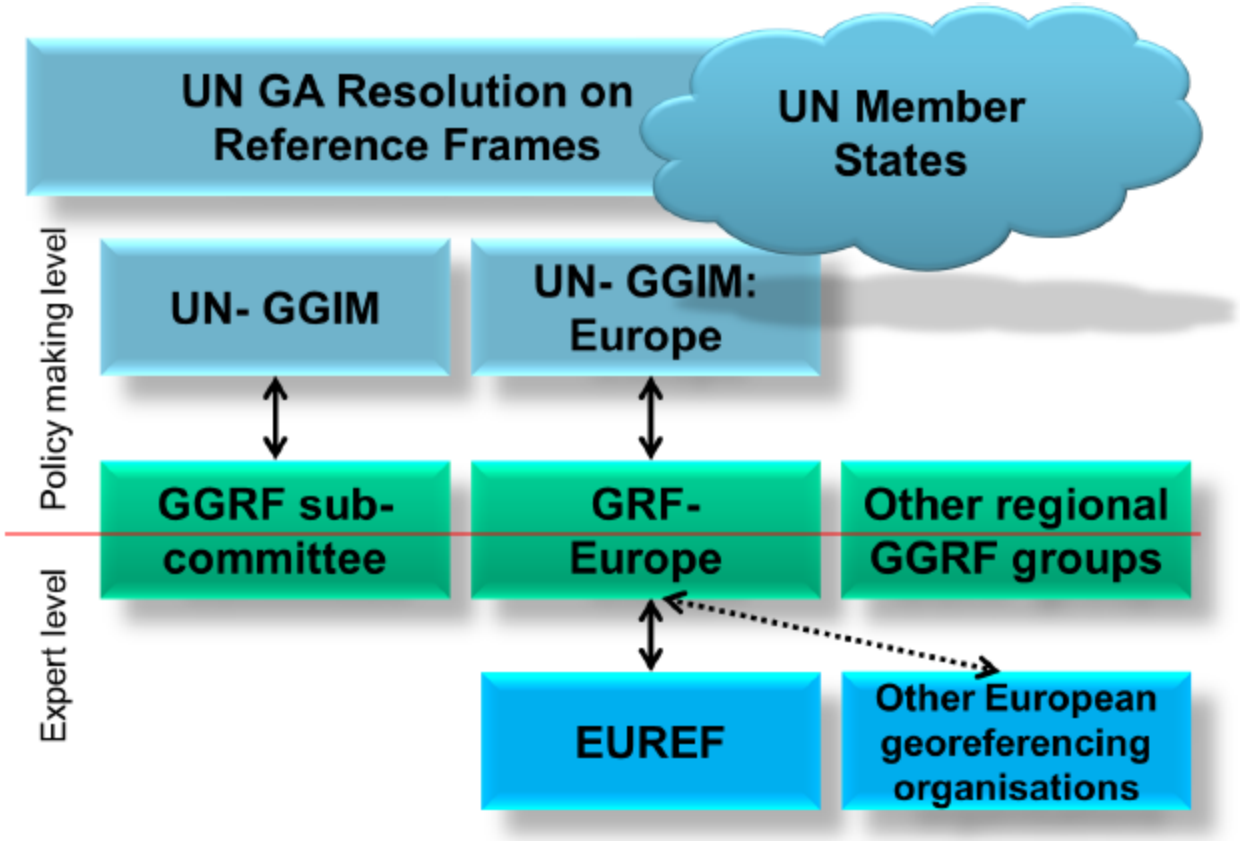
euref

2020: The United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM) welcomed and supported the offer from the Federal Republic of Germany to establish and host a Global Geodetic Centre of Excellence (UN-GGCE) at the United Nations Campus in Bonn, Germany.

UN-GGCE's overarching goal is to assist Member States and geodetic organizations to coordinate and collaborate to sustain, enhance, access and utilise an accurate, accessible and sustainable GGRF to support science, society and global development. The objective is to support, within available resources, the implementation of General Assembly resolution 69/266 through strengthening and advancing: global geodetic cooperation and coordination; worldwide geodetic infrastructure; standards and policies; education, training and capacity development; and communication and awareness.

European Geodetic Reference Systems

At European level, the EUREF initiative is very important, as shown in the GRF-Europe organisation chart.



European Geodetic Reference Systems

What is EUREF?

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

2003: 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, following the implementation of the new IAG structure at the IUGG (International Union of Geodesy and Geophysics) General Assembly held in Sapporo.

EUREF deals with the definition, realization and maintenance of the European Reference Frame - the geodetic infrastructure for multinational projects requiring precise geo-referencing (e.g. three-dimensional and time dependent positioning, geodynamics, precise navigation, geo-information) - in close cooperation with the IAG components (Services, Commissions, and Inter-commision projects) and EuroGeographics, the consortium of the National Mapping Agencies (NMA) in Europe.

euref

IUGG

IAG AIG
International Association of Geodesy

eurogeographics

European Geodetic Reference Systems

The activities and tasks of EUREF are to:

•develop, in close cooperation with the IGS (International GNSS Service), the EUREF Permanent Network (EPN) for the maintenance of the European Reference Frame, as contribution to the ITRF and as infrastructure to support other relevant projects, namely the European initiatives related to Galileo;

•improve the United European Leveling Network (UELN) by extending it to all European countries, taking into account the perspective of a geokinematic computation;

•implement the necessary projects for the long-term maintenance of the ETRS89 (European Terrestrial Reference System) and the EVRS (European Vertical Reference System), as well as for the improvement of the coherence between both systems, and this in close cooperation with other IAG components;

•promote the adoption of the reference systems defined by EUREF (ETRS89 and EVRS) in the European countries and European-wide organizations involved in geo-referencing activities.

European Geodetic Reference Systems:

ETRS89 - European Geodetic Reference Frame based on GPS
EVRS - European Vertical Reference System
CRS-EU - Information system for European Coordinate Reference Systems
ECGN - European Combined Geodetic Network

ETRS89 European Geodetic Reference Frame

In 1987, the IAG and CERCO decided to develop a new European Geodetic Reference Frame based on GPS.

This reference should be a precise continent-wide modern reference near to the WGS84 and usable for multinational Digital Cartographic Datasets, no longer derived from multiple national datums across Europe.

Coordinates are expressed as either three dimensional (X, Y, Z) Cartesian coordinates or as three dimensional ellipsoidal coordinates (Φ, λ and H, Ellipsoidal height), based on the GRS80 ellipsoid.

WGS84 originally used the GRS80 reference ellipsoid, but has undergone some minor refinements in later editions since its initial publication.

As in the late eighties the International Terrestrial Reference System (ITRS) was the most precise global reference system available, EUREF decided to base its reference on the ITRS which is maintained by the International Earth Rotation and Reference Systems Service (IERS).

However, in the global ITRS, plate tectonics cause the coordinates of European stations to slowly change in the order of about 2.5 cm/year. By the year 2000 the two coordinate systems differed by about 25 cm.

ETRS89 European Geodetic Reference Frame

The 89 in its name does not refer to the year of solution (realization), but rather the year of initial definition, when ETRS89 was fully equivalent to ITRS. The solutions of ETRS89 correspond to the ITRS solutions. For each ITRS solution, a matching ETRS89 solution is being made. ETRF2000, for example, is an ETRS89 solution, which corresponds to ITRF2000.

The acceptance of ETRS89 by several communities (civil aviation, industry, national and regional agencies) as the backbone for geo-referencing in Europe is a continuous process.

EuroControl (European Agency for Safely of Air navigation) uses ETRS89 since a long time in its technical specifications and there is a recommendation by the European Commission to adopt ETRS89 as the geodetic datum for geo-referenced information and to promote the use of ETRS89 within its member states.

European Geodetic Reference Systems

ETRS89 European Geodetic Reference Frame - Parameters

European Terrestrial Reference System 1989 (ETRS89)

CS_NAME	ETRS89
SRID	4258
AUTH_NAME	EPSG. See 3D CRS for original information source.
Coordinate System Type	Geographic
Datum	European Terrestrial Reference System 1989 (EPSG ID 6258)
Spheroid	GRS 1980 (EPSG ID 7019)
Semi-Major Axis	6378137.000
Semi-Minor Axis	298.257222101
Prime Meridian	Greenwich
PM Units	Decimal Degree, 0.01745329251994328

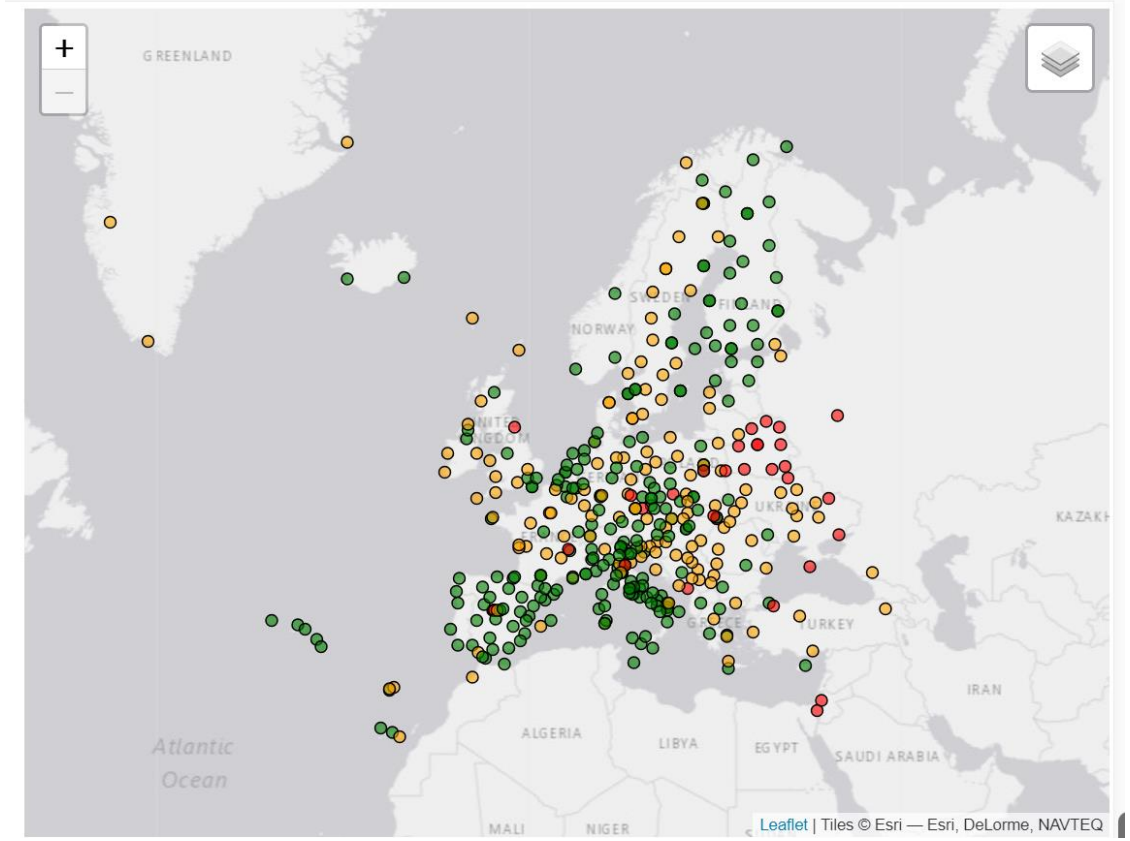
World Geodetic System 1984 (WGS84)

CS_NAME	WGS 84
SRID	4326
AUTH_NAME	EPSG. See 3D CRS for original information source.
Coordinate System Type	Geographic
Datum	World Geodetic System 1984 (EPSG ID 6326)
Spheroid	WGS 84 (EPSG ID 7030)
Semi-Major Axis	6378137.000
Semi-Minor Axis	298.257223563
Prime Meridian	Greenwich
PM Units	Decimal Degree, 0.01745329251994328

http://www.dnf.org/registry/coordinate_reference_systems

European Geodetic Reference Systems

The primary purpose of the EPN is to provide access to the European Terrestrial Reference System 89 (ETRS89) which is the standard precise GNSS coordinate system throughout Europe.



https://epncb.oma.be/

The **EUREF Permanent GNSS Network** consists of

- a network of continuously operating GNSS (Global Navigation Satellite Systems, such as GPS, GLONASS, Galileo, Beidou, ...) reference stations,
- data centres providing access to the station data,
- analysis centres that analyze the GNSS data,
- product centres or coordinators that generate the EPN products,
- and a Central Bureau that is responsible for the daily monitoring and management of the EPN.

Endorsed by the INSPIRE (D2.8.I.1Data Specification on Coordinate Reference Systems).

All contributions to the EPN are provided on a voluntary basis, with more than 100 European agencies/universities involved.

As of 19 October 2024, 422 permanent GNSS tracking stations are part of the EUREF Permanent Network.

EVRS - European Vertical Reference System

EUREF started in 1994 with its activities for development and establishment of European height systems.

The work is based on a cooperation between EUREF, National Mapping Agencies (NMA) and Working Group VIII of CERCO (Comité Européen des Responsables de la Cartographie Officielle - now EuroGeographics).

The heights of the European Vertical Reference System (EVRS) are determined by the common adjustment of national leveling networks in the United European Leveling Network (UELN). Simultaneously to the UELN adjustment, definitions and standards of the EVRS were developed.

At the EUREF symposium 2000 in Tromsø, a first definition of the EVRS was adopted.

Up to now, three realizations of EVRS have been released: EVRF2000, EVRF2007 and EVRF2019. The latest realization, EVRF2019, provides uniform European height data for 30 countries.

https://evrs.bkg.bund.de/Subsites/EVRS/EN/Home/home.html

EVRS - European Vertical Reference System - Definition

The European Vertical Reference System (EVRS) is a kinematical height reference system. The EVRS definitions fulfil the following four conventions:

(1) The vertical datum is defined as the equipotential surface for which the Earth gravity field potential is constant: W0 = W0E = const. and which is in the level of the Normaal Amsterdams Peil.

(2) The unit of length of the EVRS is the meter (SI). The unit of time is second (SI). This scale is consistent with the TCG time coordinate for a geocentric local frame, in agreement with International Astronomical Union (IAU) and International Union of Geodesy and Geophysics (IUGG) resolutions (1991). This is obtained by appropriate relativistic modelling.

(3) The height components are the differences between the potential ΔWP of the Earth gravity field through the considered points P, and the potential WP of the EVRS conventional zero level. The potential difference -ΔWP is also designated as the geopotential number cP $-\Delta WP = cP = W0E - WP$
Normal heights are equivalent with geopotential numbers, provided that the reference gravity field is specified.

(4) The EVRS is a zero tidal system, in agreement with the IAG resolutions No. 9 and 16 adopted in Hamburg in 1983 - Appendix 2.

https://evrs.bkg.bund.de/Subsites/EVRS/EN/DefEVRS/evrs.html#Start

EVRS - European Vertical Reference System - Reference ellipsoid and normal gravity field

The EVRF2007 is defined in terms of geopotential. It is realized using geopotential numbers determined by leveling, or alternatively a geopotential model and 3-dimensional coordinates. None of these quantities depend on ellipsoidal reference, and therefore a reference ellipsoid is not part of the EVRS definitions as long as we are only concerned with geopotential numbers. However, to convert the geopotential numbers to normal heights, a normal gravity field and geodetic latitude is required. The GRS80 normal gravity field is adopted for the purpose, evaluated at ETRS89 coordinates.

Normal gravity at the ellipsoid is computed from the Gravity Formula 1980 (Moritz H., 1980) using the series expansion

$$\begin{aligned}\gamma_0 = 9.783\,267\,715\big(1 &+0.005\,279\,0414\sin^2\varphi \\ &+0.000\,023\,2718\sin^4\varphi \\ &+0.000\,000\,1262\sin^6\varphi \\ &+0.000\,000\,0007\sin^8\varphi\big)\ \mathrm{m\,s^{-2}}\end{aligned} \qquad (1)$$

where the latitude ϕ is in ETRS89. The normal heights HP were computed by HP = cP / γ where γ is the average value of the normal gravity along the normal plumb line between the ellipsoid and the telluroid. The average value of the normal gravity along the normal plumb line is determined by the formula

$$\bar{\gamma} \approx \bar{\gamma}_H = \gamma_0\left[1-\left(1+f+m-2f\sin^2\varphi\right)\frac{H}{a}+\frac{H^2}{a^2}\right] \qquad (2)$$

where H is an approximate value for HP and γ is from equation (1). The notation and the numerical values for the other quantities are according to (Moritz H., 1988).

https://evrs.bkg.bund.de/Subsites/EVRS/EN/DefEVRS/evrs.html#Start

CRS-EU - Information system for European Coordinate Reference Systems

The information system CRS_EU containing the description of pan-European and national coordinate reference systems as well as their relations with each other. It is based on information of the National Mapping Agencies of European countries, is edited in accordance with an ISO standard and verified by test computations.

The information offered includes:

•description (reference system, coordinate system or map projection) of the pan-European coordinate reference systems ETRS89, EVRF2000 and EVRF2007 and the coordinate reference systems of most European countries
•parameters for the transformation of the national coordinate reference systems into the pan-European coordinate reference systems for position and height.
•verification coordinates for check transformation and online-transformation of single points for position from national coordinate reference systems to pan-European coordinate reference systems ETRS89 for test and verification purposes

This way, the requirements imposed by the users of geoinformation and by other users of geodetic-cartographic information shall be met in a better way regarding such issues as geodetic referencing.

https://www.crs-geo.eu/

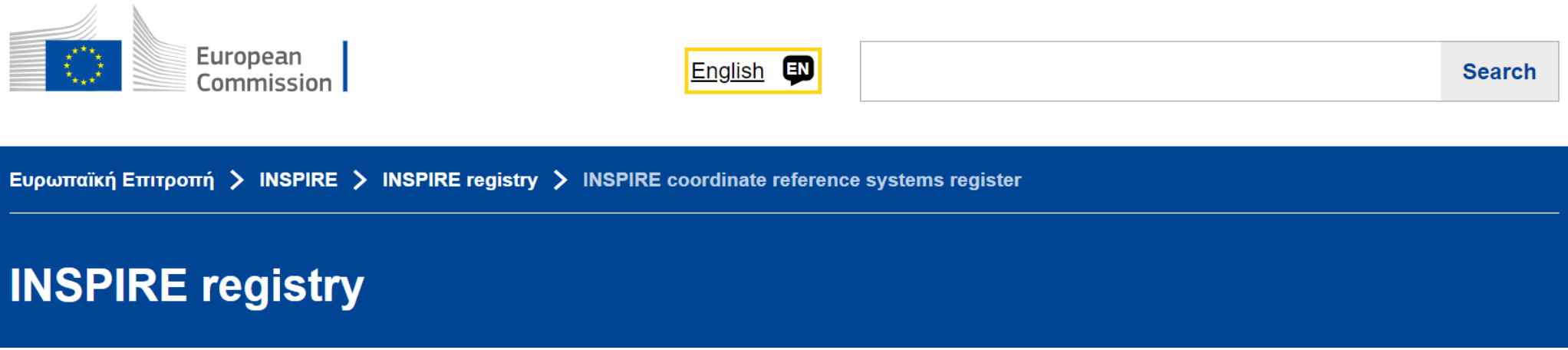
ECGN - European Combined Geodetic Network

European Combined Geodetic Network (ECGN) is a research project aimed at high accuracy geoid determination. The purpose of ECGN is to connect the height systems obtained via geometric positioning by GNSS with gravity-referenced heights with a cm-level accuracy.

The effects of the atmosphere, the oceans and time-dependent parameters of the solid Earth on the gravity field are investigated. ECGN uses the data of satellite gravity missions CHAMP, GRACE and GOCE to model the Earth's gravity field and is linked to other gravity-related projects (GMES, GEOSS, GGOS). The ECGN is considered as a European contribution to the International Association of Geodesy (IAG) project Global Geodetic Observation System (GGOS).

INSPIRE coordinate reference systems register

The INSPIRE coordinate reference systems register contains the coordinate reference systems allowed for the provision of INSPIRE spatial datasets and services, including their identifiers, while references the geodetic codes and parameters needed to describe them, as defined in the INSPIRE implementing rule on interoperability of spatial data sets and services (Commission Regulation (EU) No 1089/2010).



http://inspire.ec.europa.eu/crs

European Geodetic Reference Systems

The GGRF roadmap addresses each of the key areas of action described in the UN General Assembly resolution:

Data sharing: Development of geodetic standards and open geodetic data sharing are required to enhance and develop the GGRF.

Education and capacity building: Appropriate geodetic skills and educational programs are essential for the development, sustainability and utilization of the GGRF.

Geodetic infrastructure: A more homogeneous distribution of geodetic infrastructure is needed to develop and utilize an accurate GGRF.

Communication and outreach: It is imperative to develop communication and outreach programmes that enable the GGRF to be more visible and understandable to society.

Governance: The development and sustainability of the GGRF is reliant on an improved governance structure.

To act more to key areas of action described in the UN General Assembly as Communication and Governance, as CLGE, we promote 'The European Geodetic Surveyors Act'.

CLGE - The European Geodetic Surveyors Act

With this statement CLGE expresses its willingness to:

1. Develop a framework of guidelines for geodetic policies leading towards the adoption of a European Geodetic Surveyors Act,
2. Encourage cooperation within the geodetic profession, but also with other institutions and sectors of the society, in the interest of the geodetic profession and the society as a whole,
3. Raise awareness and understanding of the importance of geodetic surveyors, geodesy and geoinformatics as well as their role in the development of the Europe,
4. Advocate the achievement of qualitive solutions in geodesy with maximum effects for the society, and to encourage the evaluation of European geodetic heritage and achievements,
5. Initiate procedures that would enable the application of the adopted geodetic policy guidelines, as well as to star further activities on the acceptance and inclusion of geodetic policies in the societal and economic areas to which it applies.

THE COUNCIL OF EUROPEAN GEODETIC SURVEYORS
COMITÉ DE LIAISON DES GÉOMÈTRES EUROPÉENS

UN GEONOW 2024
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THANK YOU