



EUREF's Efforts to Meet the Challenge of the Changing Geodetic Landscape

*International Association of Geodesy Reference Frame
Sub-Commission for Europe*

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and EUREF TWG Members

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November 26-29, 2012**



EUREF sub-commission



- **Creation in 1987 at the IUGG General Assembly in Vancouver, Sub-commission 1.3a of IAG**
- **Central Bureau of EPN in Brussels, Secretary in Padova after 30 years in Munich**
- **Permanent committee is the Technical Working Group with about 15 members (3 meetings per year)**
- **Links to about 130 European organizations, agencies, universities – related to geo-referencing, positioning, and navigation**
- **Main goals: Definition, realization, maintenance, and promotion of the adoption of**
 - ETRS89 European Terrestrial Reference System
 - EVRS European Vertical Reference System



Outline - EUREF's Efforts to Meet the Challenge of the Changing Geodetic Landscape

- I. ITRS – ETRS89 – National Reference Frames***
- II. Access to ETRS89***
- III. Reference Frames in Real-Time with PPP-RTK***
- IV. EUREF's Infrastructure Galileo Ready***
- V. European Vertical Reference System EVRS2007***
- VI. EUREF: How to proceed?***

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I. ITRS – ETRS89 – National Reference Frames

ITRS coordinates : ~2,5 cm/y in Europe
→ *unusable for day-to-day geo-referencing activities*

European Terrestrial Reference System 1989 (ETRS89)

- coincident with ITRS at the epoch 1989.0
- fixed to the stable part of the Eurasian Plate
→ *Coordinates expressed in ETRS89 have minimal time-dependency and are consequently useable for geo-referencing in Europe.*

**Transformations : ITRF_{yy} ↔ ETRF_{yy} published in Memo
(Boucher & Altamimi, 2008)**

 **ETRS89 – ITRS** <http://epncb.oma.be/> 

ORGANISATION **TRACKING NETWORK** **DATA & PRODUCTS** **NEWS & MAILS** **FTP & WEB ACCESS**

Creation, Management, Structure, Relation to IGS, Projects, Guidelines, FAQ Maps, Stations, Equipment & calibration, Station coordinates, Site log validation & submission Data products, Time series, ETRS89/ITRS transformation, Formats News, Mails, Calendar, Papers, Workshops, Web site history Anonymous FTP, Web site index, Related links

[DATA & PRODUCTS](#) > ETRS89/ITRS TRANSFORMATION

ETRS89/ITRS TRANSFORMATION

The following tool allows to transform coordinates (position and velocity) from any ETRFxx to any ITRFyy (or ITRFyy to ETRFxx). In case input and output coordinates are requested at different epochs, then site velocities are mandatory.

Input

Frame : ITRF2005
 Epoch : 2006.00

Lines starting by # are treated as comments
 # Fields (in decimal format) should be separated by at least one space
 #
 # Example with velocity - StationName(no space character) X[m] Y[m] Z[m] VX[m/yr] VY[m/yr] VZ[m/yr] :
 StationName 4027894.006 307045.600 4919474.910 0.01 0.2 0.03


Output





Frame : ETRF96
 Epoch : 1995.45

StationName 4027894.0387 307043.4240 4919474.4772 0.0230 0.1825 0.0178

Options

show intermediate steps Change epoch format: Decimal Year:YYYY.DDD

 **Adoption of ETRS89/EVRS**

- Large part of European NMCA have officially adopted ETRS89 and it is part of legal framework in many European countries (evolving process)
- **EuroControl** : ETRS89 is part of technical specifications (*European Organisation for Safety of Air Navigation*) 
- **European Commission**: recommendation to adopt ETRS89 and EVRS as reference systems for their geo-referenced information 
- ETRS89/EVRS play a fundamental role in **INSPIRE** (Infrastructure for Spatial Information) with EU 
- EUREF takes over all geodetic activities for the 55 members of EuroGeographics 

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ETRS89 – National CRS



Each country has each own National Coordinate Reference System (CRS)

- Link between CRS and ETRS89 necessary in order to change national reference system to ETRS89
- Information System (EUREF and EuroGeographics)
 - Description of all national CRS
 - Transformation parameters between CRS and ETRS89
 - provided and validated by NMCAs
 - On-line transformation services
 - 1-2 m accuracy (GIS applications)



ETRS89 – National CRS

<http://www.crs-geo.eu/>

CRSEU Coordinate Reference Systems in Europe

national CRS

News
CRS Overview
CRS Description
Content
national CRS
pan-European CRS
References
Links

Service
Sitemap
Contact
Imprint

Home > CRS Description > national CRS

Description of national Coordinate Reference Systems (CRS) of European Countries

Contains

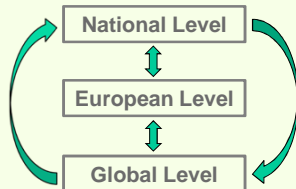
- descriptions of Coordinate Reference Systems
- transformation parameters to pan-European CRS ETRS89, EVRF2000 and EVRF2007
- verification data for transformation
- online-transformation of single points for position from national CRS of a country to pan-European CRS ETRS89 for test and verification purposes

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

Albania		Latvia
Austria		Lithuania
Belgium		Luxembourg
Bosnia / Herceg.		Macedonia
Bulgaria		Malta
Croatia		Netherlands
Cyprus		Northern Ireland
Czech Republic		Norway
Denmark		Poland
Estonia		Portugal
Finland		Romania
France		Russia
Germany		Slovak Republic
Gibraltar		Slovenia
Great Britain		Spain
Greece		Sweden
Hungary		Switzerland
Iceland		Turkey
Ireland		Ukraine
Italy		

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EPN Regional Densification in Europe: Provide reference system data and information in ITRS and ETRS89 to European users by GNSS technologies



GNSS Permanent Network (EPN) with 250 stations

- 130 EPN stations are part of ITRF2008
- About 150 stations provides RT and GLONASS data ⇔ 40 Galileo
- Station movements monitored

EUREF Permanent Network

ORGANISATION: Creation, Management, Structure, Revision in IGS, Projects, Guidelines, FAQ

TRACKING NETWORK: Site maps, Site list, Proposed sites, Equipment & operations, Site coordinates, Site log submission, Site public information

DATA & PRODUCTS: Data access, Analysis centres, Products, Time series, ETRF(EPN) transformations, Formats

NEWS & MAIL: News, Alerts, Calendar, Papers, Workshops, Web site history

FTP & WEB ACCESS: Anonymous FTP, Web site index, Referred links

GNSS & PRODUCTS > TRACKING STATUS

Details on the GNSS signals included in the daily RINEX v2.11 data files available from the EPN data centres are given below. The GPS L1 signal is mandatory included in all GNSS data files and cannot be de-activated. When GLONASS is selected, the GLONASS L1 signal is also considered as mandatory (and cannot be de-activated).

Status on 20120422

Locate site on map:

Tracking criteria selection

GPS

using the signals: C1 C2 C5 P1 P2 P5

phase: L1 L2 L5

not using the signals: C1 C2 C5 P1 P2 P5

phase: L1 L2 L5

GLONASS

using the signals: C1 C2 P1 P2

phase: L1 L2

not using the signals: C1 C2 P1 P2

phase: L1 L2

IFU Central Bureau - Royal Observatory of Belgium

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Apr 26, 2012

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- Local RTK networks
 - better realisation of ETRS89 in all countries
 - long term maintenance of ETRS89 also in tectonically affected areas
 - a few cm accuracy within a few observation epochs
 - local reference stations and reference frames realization
 - no activity from EUREF in this domain
- PPP-RTK
 - PPP is global approach
 - provide and apply precise SSR information
 - concept doesn't request local reference stations
 - global reference frame realization; if needed transformed to regional or local reference frames
- Added value: basic input for science and safety (e.g., tectonic risk assessment)



Reference Frames in Real-Time with PPP-RTK

Why is EUREF Involved in Real-Time GNSS?

Support research organizations, universities, national mapping and cadastral agencies:

- GNSS performance monitoring
- Providing precise positioning data and information
- Rapidly detecting, locating, and characterizing hazardous events such as earthquakes and tsunamis
- Geophysical hazard detection and warning systems
- Space weather forecasting

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MULTI-GNSS Working Group EUREF

Topics:

- Handling RINEX3.xx and/or RINEX2.xx and compatibility to RTCM 'High Precision Multiple Signal Messages' (HP MSM) and procedure to implement it to the EPN
- Enhancing the EPN infrastructure by Multi-GNSS-ready receivers and antennas
- Enhancement method: double stations versus replacing existing analysis of GLONASS data (till now, only the minority of the EUREF analysis centers provide GPS-GLONASS products)
- Developing of software (post-processing and real-time) capable to handle multi-GNSS signals.
- Define the optimal procedure to have PCV calibrations available which are consistent between the GNSS systems
- Setting up a time schedule in order to plan the operational switch to RINEX3 which also is in line with IGS.

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A Data Center for the IGS Multi-GNSS Experiment (M-GEX)



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EUREF Real-Time Data Streams



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IMPROVED REALISATION OF ETRS89 I.

The ETRS89 definition is only valid over the 'stable' part of Europe.

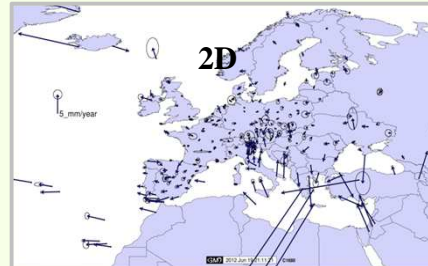
Tectonic displacements:

Limited lifetime of the ETRS and EVRS coordinates (Mediterranean and Fennoscandian region)

ITRS and ETRS89 provides sparse information ->

Densification is needed to model the coordinate changes:

EPN + national GNSS networks



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Improved Realization of ETRS89 II.

IGAG and EUREF activities targeting the realisation of the unified and homogeneous velocity model over Europe :

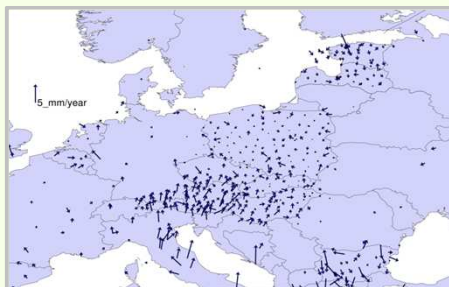
- IAG Working Group on Regional Dense Velocity Fields 2007-2015
- EUPOS Combination Centre
- EUREF Working Group on Deformation modeling

TOOL :

INTEGRATION OF EPN AND DENSE NATIONAL ACTIVE GNSS NETWORKS

BENEFITS :

- better realisation of ETRS89 in all countries,
- long term maintenance of ETRS89 also in tectonically affected areas,
- basic input for scientific deformation analyses and for tectonic RISK estimation,
- cost effective : uses EXISTING infrastructures and analysis facilities



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EPN Cumulative Solution

15-weekly updated EPN cumulative position/velocity solution

- Expressed in ITRF2005
- Using ITRF2005 discontinuities
 - + discontinuities for non-IGS stations
 - + discontinuities since last ITRFyy

Up to date ITRFyy positions/velocities with validity epochs

ITRF2005	epoch t_0	Position (m)			Velocity (m/y)		
		X	Y	Z	V_x	V_y	V_z
309/2006 - 149/2010	001/2005	4917536.945 ± 0.001	-815726.211 ± 0.000	3965857.382 ± 0.000	-0.0078 ± 0.0001	0.0195 ± 0.0000	0.0130 ± 0.0001
269/1999 - 308/2006	001/2005	4917536.950 ± 0.000	-815726.209 ± 0.000	3965857.384 ± 0.000	-0.0078 ± 0.0001	0.0195 ± 0.0000	0.0130 ± 0.0001
305/1998 - 268/1999	001/2005	4917536.953 ± 0.001	-815726.209 ± 0.000	3965857.391 ± 0.001	-0.0078 ± 0.0001	0.0195 ± 0.0000	0.0130 ± 0.0001

- Possibility to use ITRF as well as non-ITRF stations as fiducial stations
- Need for classification of EPN stations

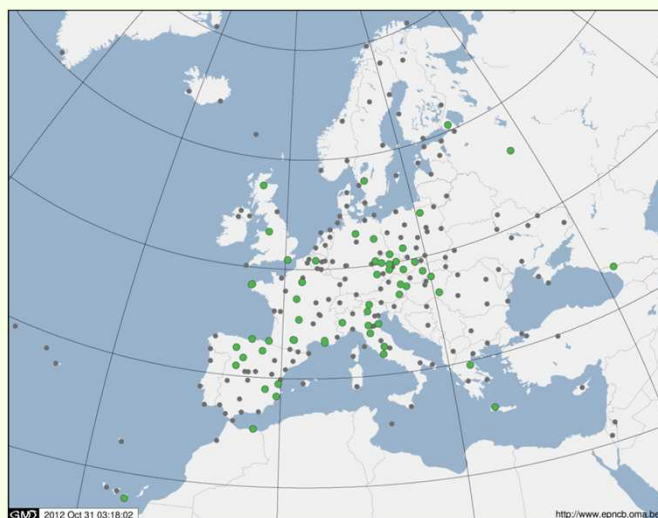


III. EUREF's Infrastructure Galileo Ready



GNSS Permanent Network (EPN) with 250 stations

- About 150 stations provides Real Time and GLONASS data
- ⇨ 40 Galileo stations

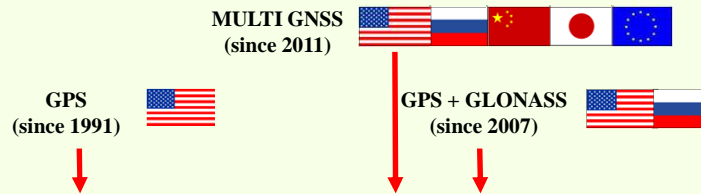


GMN 2012 Oct 31 03:18:02

<http://www.epncb.oma.be/>

Double / Triple Station Concept Example Zimmerwald (swisstopo, Uni Bern)

Usefull for stations with long time series



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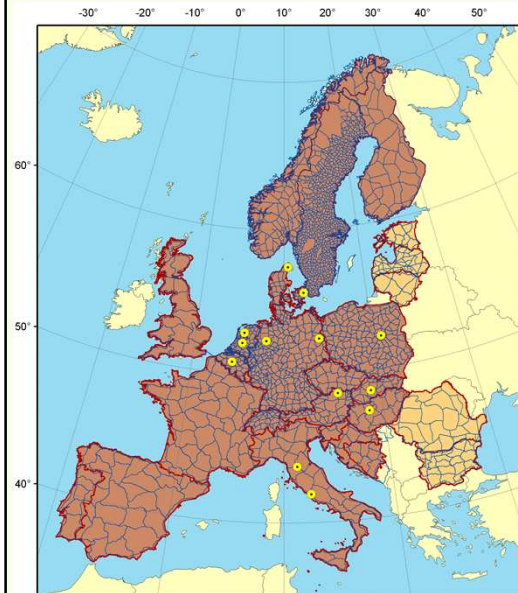
RINEX3 data availability

- **Status October 2012**
 - BKG-EUREF: 18 sites (alac alba axpv bbys cant dyng eglt guip ildx m0se rio1 scoa smne tlmf usal vale ven1 vfch)
 - BKG-IGS: 26 sites (brst brux conz ganp harb hofn lhaz lmmf mars mat1 mate nklg nurk ous2 pots reun reyk sass tash tlse ulab warn wind wtzr wtzz zim2)
- **BKG:**
 - Identical upload directory + automatic recognition which RINEX version is submitted
 - Archive under:
 - RINEX3: ftp://igs.bkg.bund.de/IGS/obs_v3/yyyy/ddd
 - RINEX2.11 <ftp://igs.bkg.bund.de/IGS/obs/yyyy/ddd>
- **CDDIS:**
 - Send RINEX2.11 and RINEX3 files to different upload directories
 - Archive under: <ftp://cddis.gsfc.nasa.gov/pub/gps/data/rinex3test/daily>

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IV. European Vertical Reference System EVRS2007



- 27 European countries 1st O. levelling networks
- Related to the NAP level by 13 datum points
- Reduction to the zero tidal system
- Reduction of the geopotential numbers to the epoch 2000 using the whole NKG2005LU model
- Number of adjusted normal heights 7900
- A-posteriori standard deviation referred to 1 km levelling distance 1.1 mm

• Datum points of EVRF2007

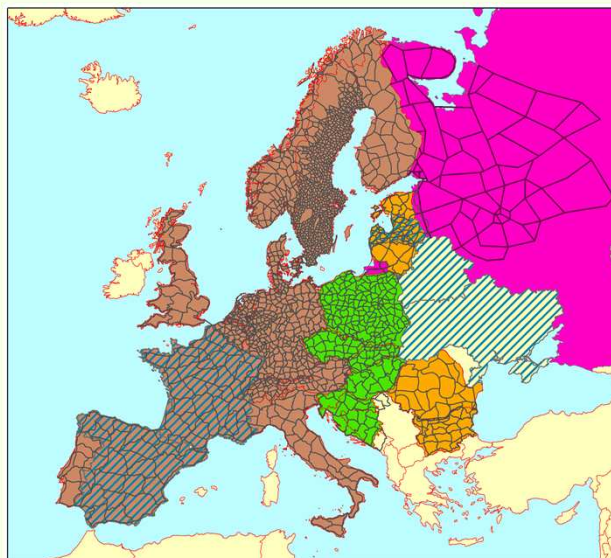
Extension of UELN

- up to 1998
- as from 2003
- UELN lines

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Future development of EVRS



- Extension to East
- Releveling in several countries

UELN extension

- up to 1986
- up to 1998
- up to 2007
- Data announced
- Russia
- UELN status 2008
- Lines of Russia

05.12.2012

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V. EUREF: How to proceed? Summary



- **EUREF supports all satellite navigation systems**
 - data archive extended by RINEX version 3
 - GLONASS recommended in analysis guidelines
 - website at EPN central bureau ready for multi-GNSS
- **EUREF established real-time services**
 - data and product streams
 - permanent PPP monitoring
 - development of tools, e.g., BNC
- **EUREF organizations take part in Galileo developments**
 - Galileo reference frame
 - Galileo geodetic working group

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NMAs: How to proceed?

- Today's Network RTK resources will not become obsolete, PPP-RTK just develops towards an alternative
- Pick up EUREF's PPP product for further dissemination through national Ntrip resources
- Test & validate EUREF's PPP in their countries, Open Source software available through BNC and RTKLIB
- Consider making use of EUREF's real-time product part of the national real-time product portfolio

EUREF prepare a Multi-GNSS-RT-Service

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Outlook

- Implement the necessary projects for the long-term maintenance and improvements of ETRS89 and EVRS
- EPN stations shall be configured, where possible, with Galileo and GPS L5 signals ready receivers
- National UELN/EUVN levelling data providers shall submit new or repeated levelling measurements to the UELN data centre especially connections between countries for a new EVRS realization
- Regional and local densification of RT infrastructure testing of real-time precise point positioning (PPP) in the ETRS89 with recent available corrections in the RTCM standard for satellite orbits, clocks and biases
- Promote the adoption of the ETRS89 and EVRS in the European countries and European-wide organizations



LINKS

- | | |
|---------------------------|---|
| - EUREF | http://www.euref.eu/ |
| - EUREF Permanent Network | http://epncb.oma.be/ |
| - ETRS89 | http://etrs89.ensg.ign.fr/ |
| - EVRS | http://www.bkg.bund.de/geodIS/EVRS/ |
| - CRS | http://www.crs-geo.eu/ |
| - INSPIRE | http://inspire.jrc.ec.europa.eu/ |