



EUREF's Mission for Precise Positioning in a Network of European Stakeholders

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

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EUREF's Mission for Precise Positioning in a Network of European Stakeholders

- (1) About EUREF**
- (2) EUREF's Infrastructure**
- (3) European Reference Systems ETRS89 and
EVRF2007**
- (4) Multi GNSS (esp. Galileo)**
- (5) From Re-processing and Velocity Fields to
Real-Time Service**
- (6) EUREF & NMCAAs - How to proceed?**

(1) About EUREF

- **Creation in 1987 at the IUGG General Assembly in Vancouver**
- **Sub-commission 1.3a of IAG**
- **Central Bureau of EPN in Brussels, Secretary in Padua, EUREF webpage in Portugal**
- **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**

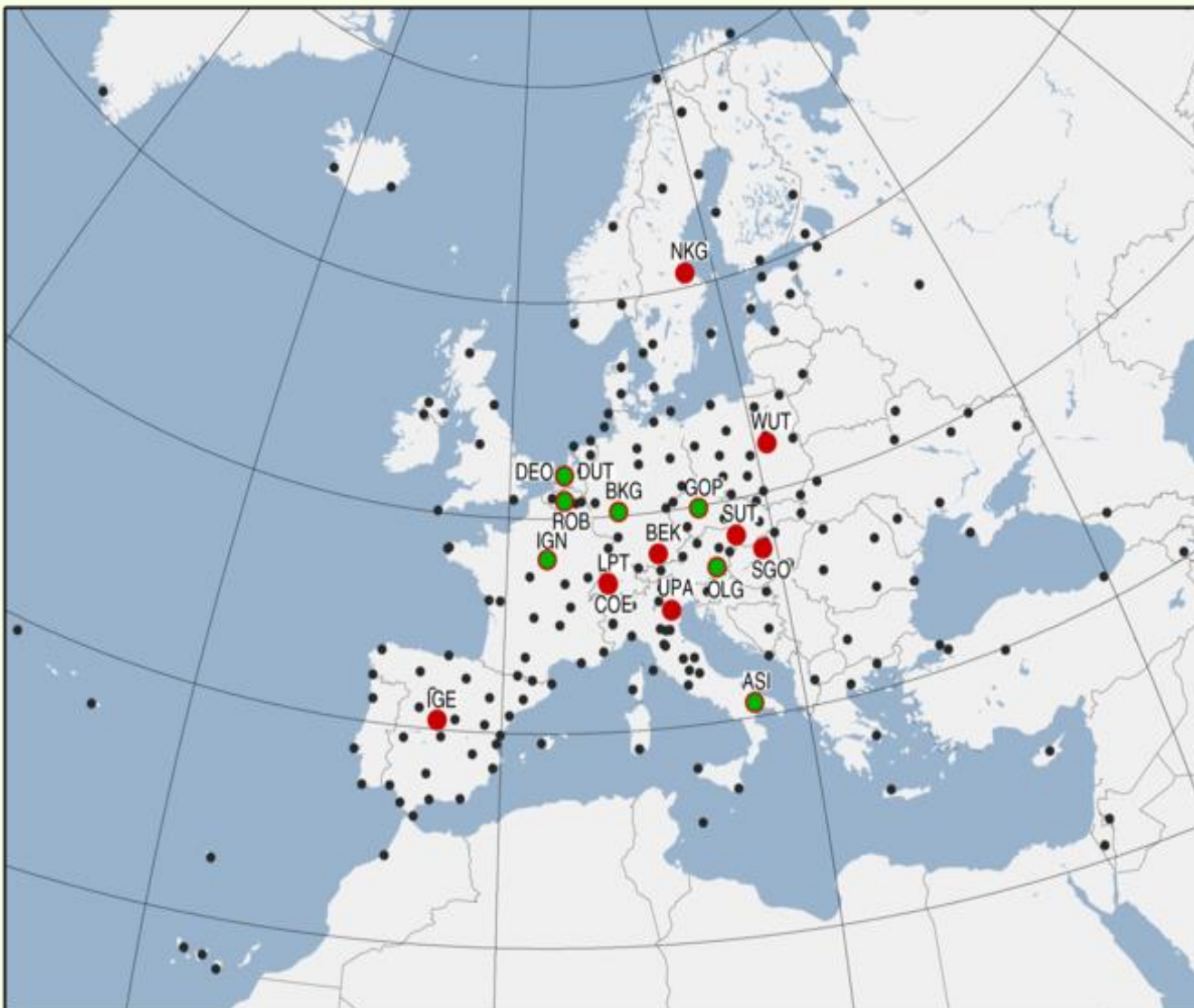
Definition, realization and maintenance of the European Geodetic Reference Systems

- Promotion and assistance of the adoption and use of **European Terrestrial Reference System (ETRS89)** in Europe in alignment to ITRFxx
- Development of the **EUREF GNSS Permanent Network (EPN)** - the ground based GNSS infrastructure for scientific and practical applications in positioning and navigation (GGOS, IGS-RT)
- Definition and realization of the **European Vertical Reference System** - has arrived a new stage in 2007 (**EVRS2007**)
- Provides all its products and services on the “best effort” basis and free of charge to the public

(2) EUREF Infrastructure

EUREF PERMANENT NETWORK (EPN)

EPN stations providing data of the Global Navigation Satellite Systems (GNSS) is the key infrastructure



EPN runs GNSS stations in a well organized environment and serves as the backbone of the realization of and access to the ETRS89.

266 stations

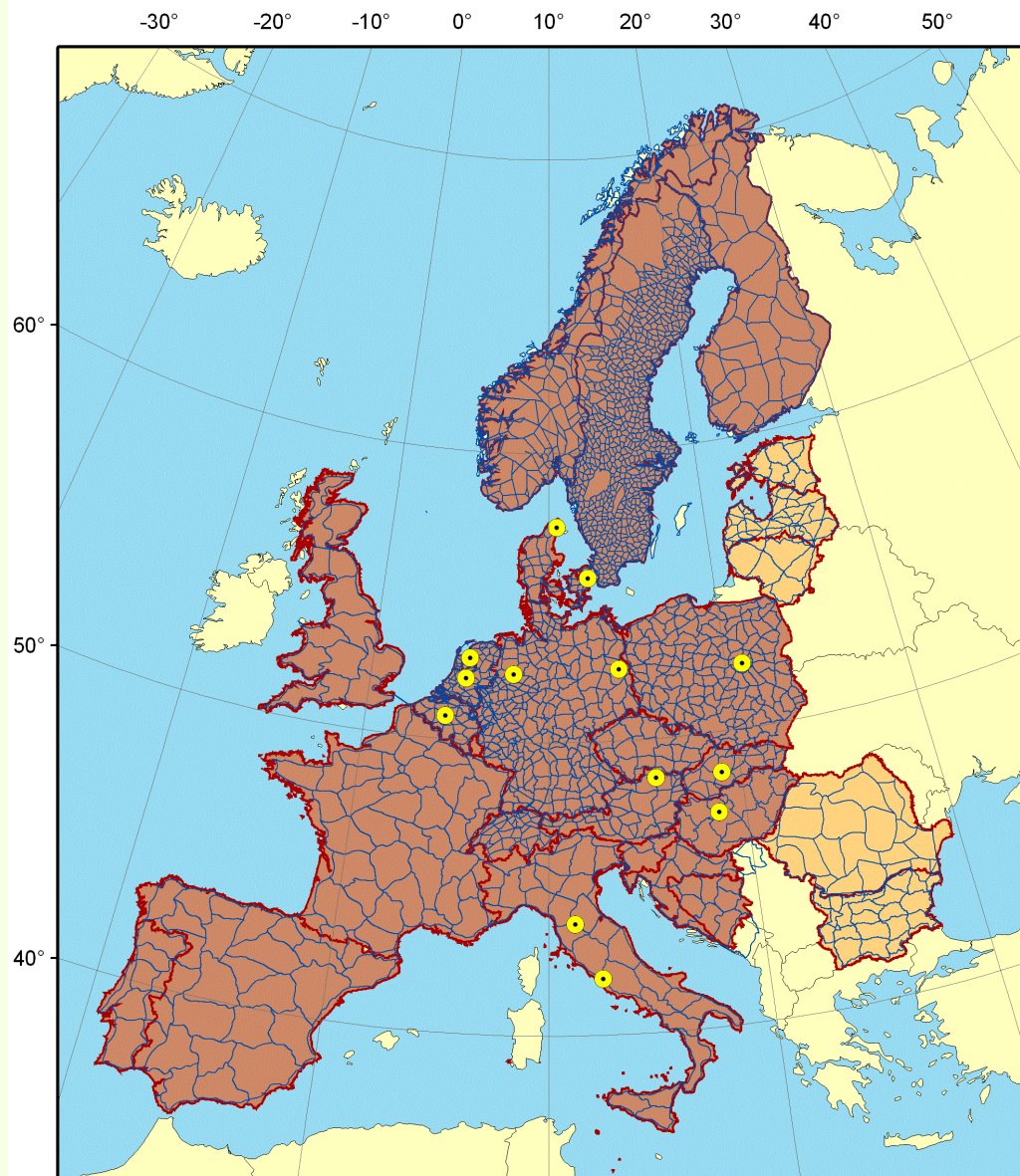
7 Data Centres

17 Analysis centers

Since 2013
MUT/WUT acting as
analysis coordinator

United European Levelling Network (UELN)

UELN lines and datum points of EVRF2007



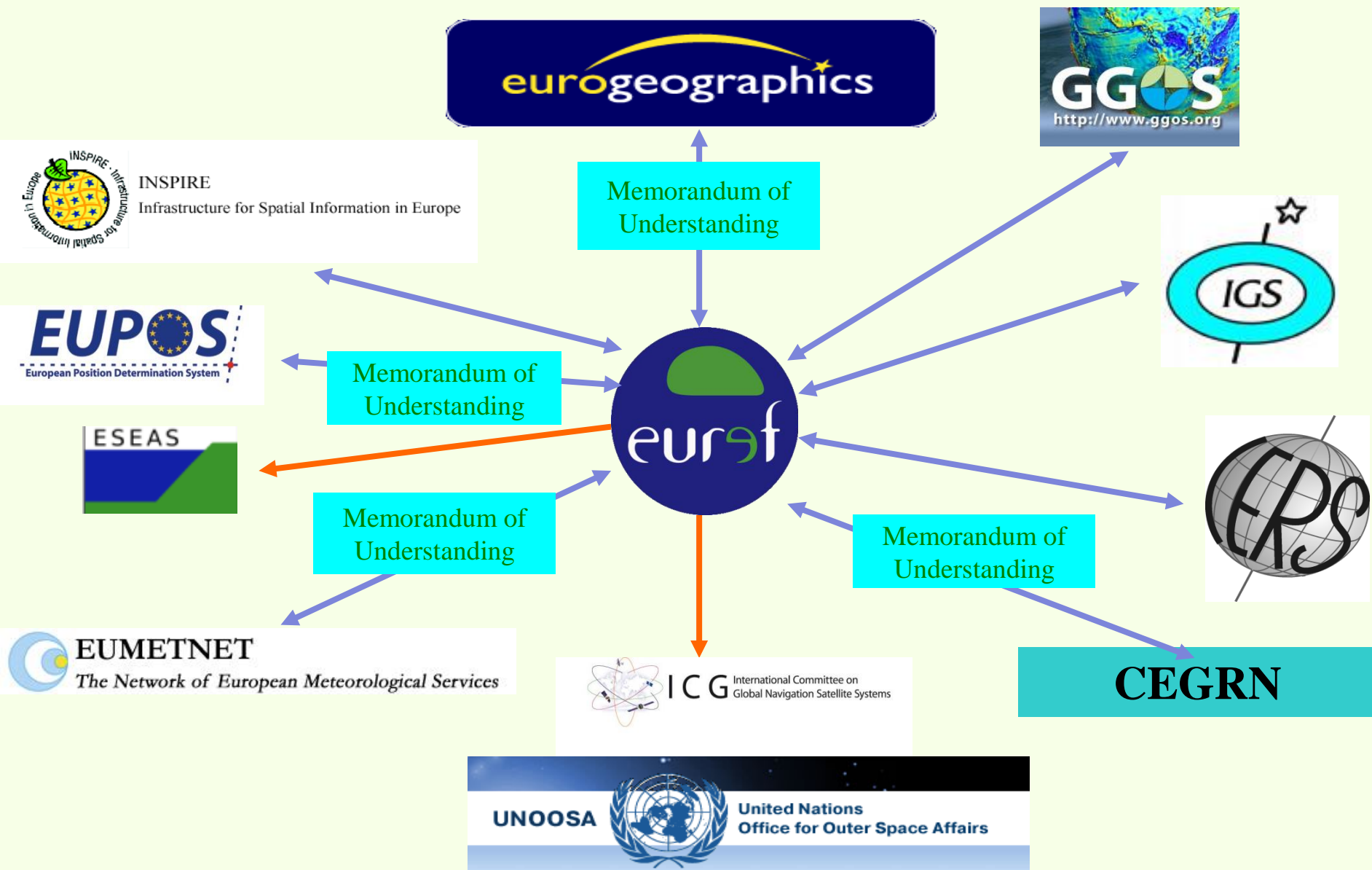
• Datum points of EVRF2007

Extension of UELN

up to 1998

as from 2003

UELN lines



In 2014 a Knowledge Exchange Network (PosKEN) was installed.

Partners are:

- EuroGeographics
- CLGE – representing users of permanent GNSS networks for precise positioning, especially surveyors
- EUPOS and EUREF.

From the objectives and roles of all four organizations within the KEN, the following goals were identified for its initial operations:

- provide the European platform for networking and sharing best practice and expertise in the field of GNSS positioning
- aim at creating the uniform GNSS services for Europe, under the working name of European Positioning System
- develop common standards, policies and guidelines that require active contribution of experts in different fields

(3) ETRS89 and EVRF2007

Improvements of EUREF Products

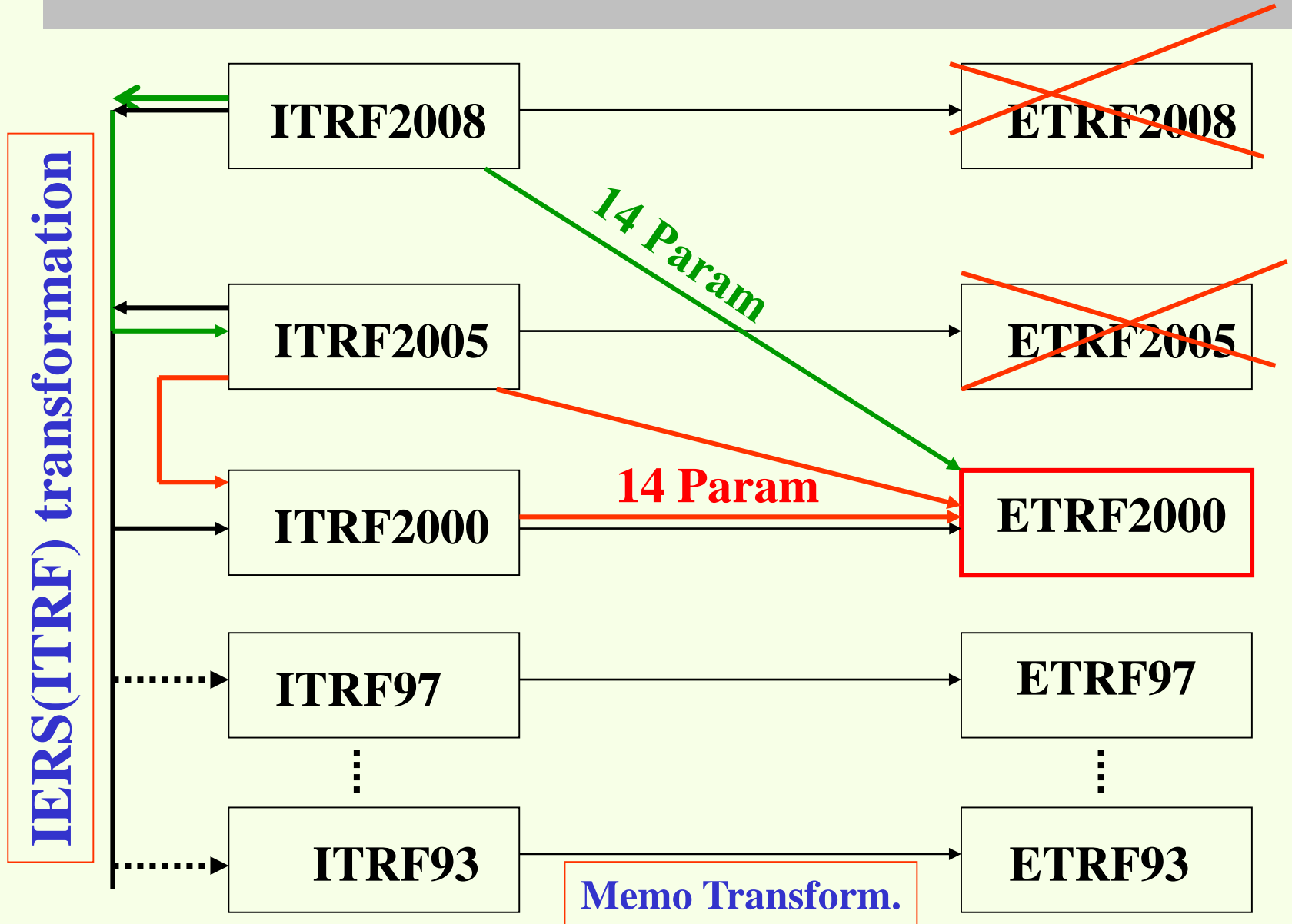
ETRS89 (European Terrestrial Reference System 89)

- **The datum is fixed to the stable part of the European Plate at the epoch 1989.0 (Coincides with ITRS at epoch 1989.0)**
- **Realized by ETRF2000(Rxx) derived from ITRFxx by removing the mean velocity of the European plate (xx is currently 2008)**
- **based on EUREF Permanent GNSS Network (EPN)**
- **European Commission adopted ETRS89 as the geodetic datum for geo-referenced information of INSPIRE**

EVRS (European Vertical Reference System 2007)

- **Related European Vertical Datum (NAP)**
- **Realized by the United European Levelling Network (UELN)**
- **The use of EVRS 2007 vertical datum for INSPIRE data**

ITRFyy to ETRF2000



EVRS realization

EVRF2007 –Summary of the adjustment parameters

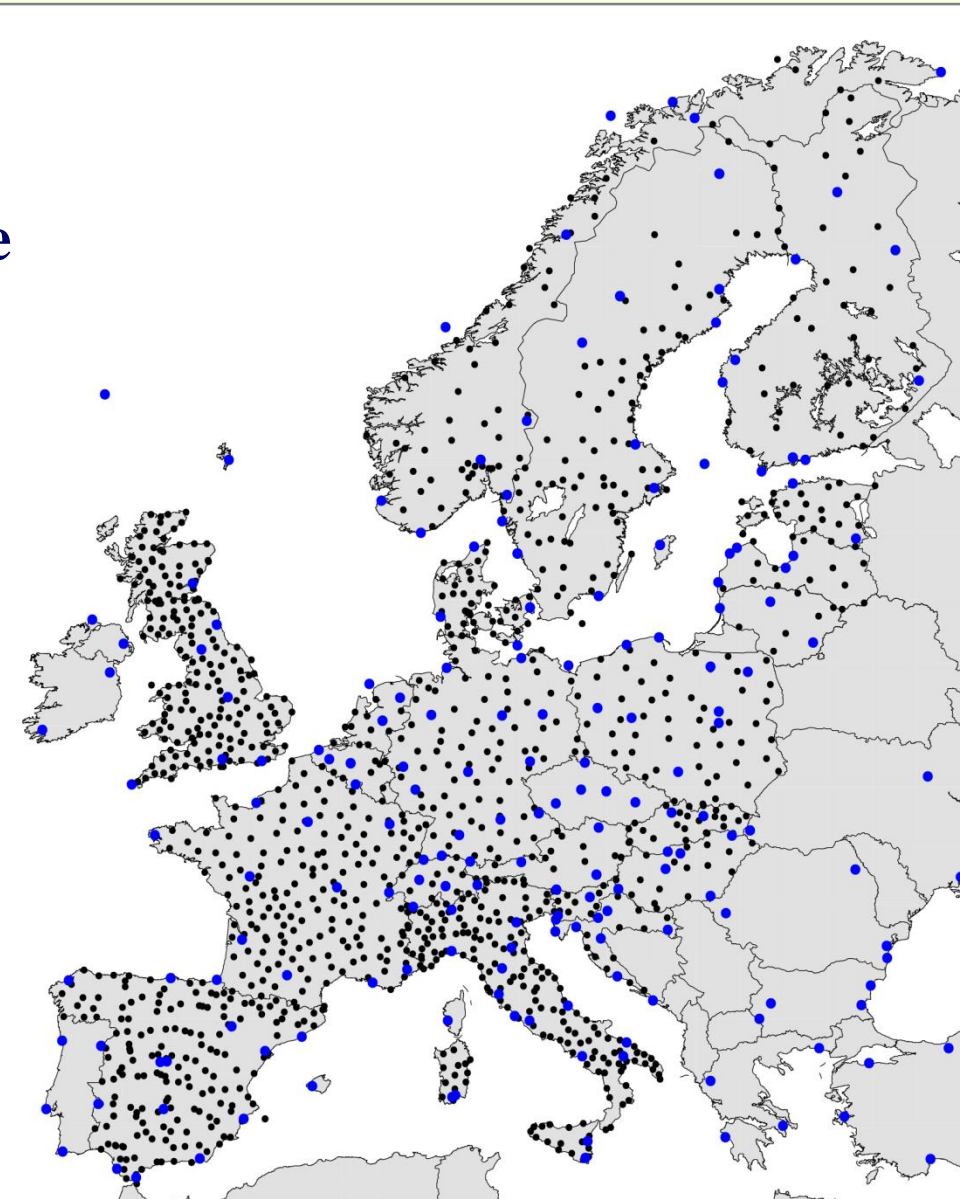
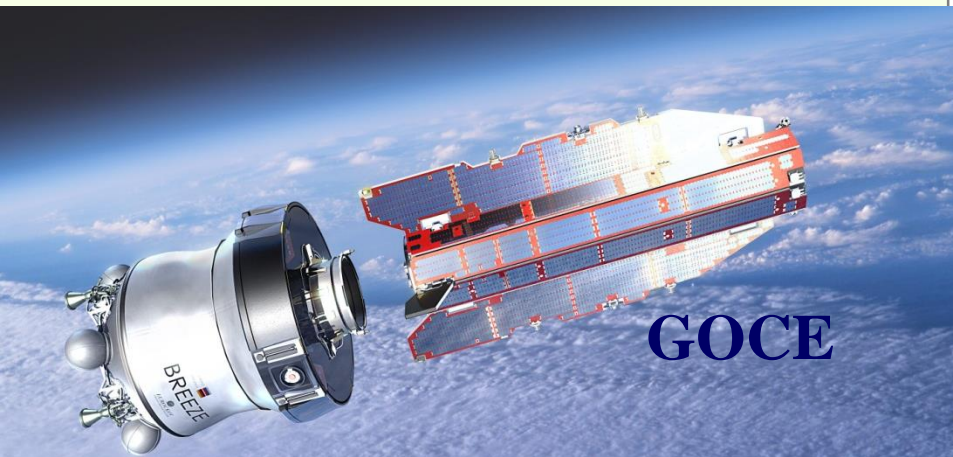
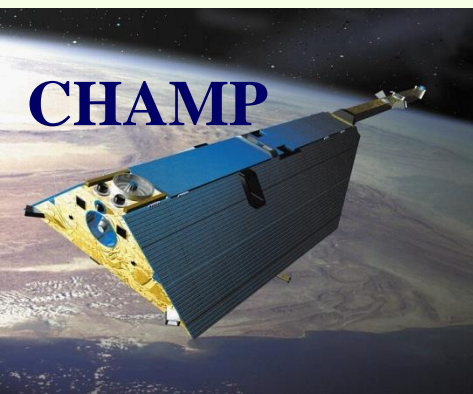
- Datum realization by 13 datum points
- Reduction to the zero tidal system
- Reduction of the measurements to the epoch 2000 using the whole NKG2005LU model

Parameter	EVRF2000	EVRF2007
Number of datum points	1	13
Number of unknowns	3063	7939
Number of measurements	4263	10347
Number of condition equations	0	1
Degrees of freedom	1200	2409
A-posteriori standard deviation referred to 1 km levelling distance in kgal·mm	1.10	1.11
Mean value of the standard deviation of the adjusted geopotential numbers ($\hat{=}$ heights), in kgal·mm	19.64	16.05
Average redundancy	0.281	0.233

EUVN Densification Action (EUVN_DA)

1200 GNSS/levelling points

- for European geoid determination EGGXX
- for the validation of the satellite gravity field missions



(4) Multi GNSS and Galileo

EUREF Multi-GNSS Working Group

In 2012 a Multi-GNSS Working Group was established by the EUREF Technical Working Group. Main goals of the WG are:

- Handling RINEX3.xx and/or RINEX2.xx and compatibility to RTCM 'High Precision Multiple Signal Messages' (HP MSM) and procedure to implement it into the EPN
- Enhancing the EPN infrastructure by Multi-GNSS-ready receivers and antennas
- Enhancement method: double stations versus replacing existing analysis of GLONASS data
- Developing of software (post-processing and real-time) capable to handle multi-GNSS signals
- Setting up a time schedule in order to plan the operational switch to RINEX3 which also is in line with IGS

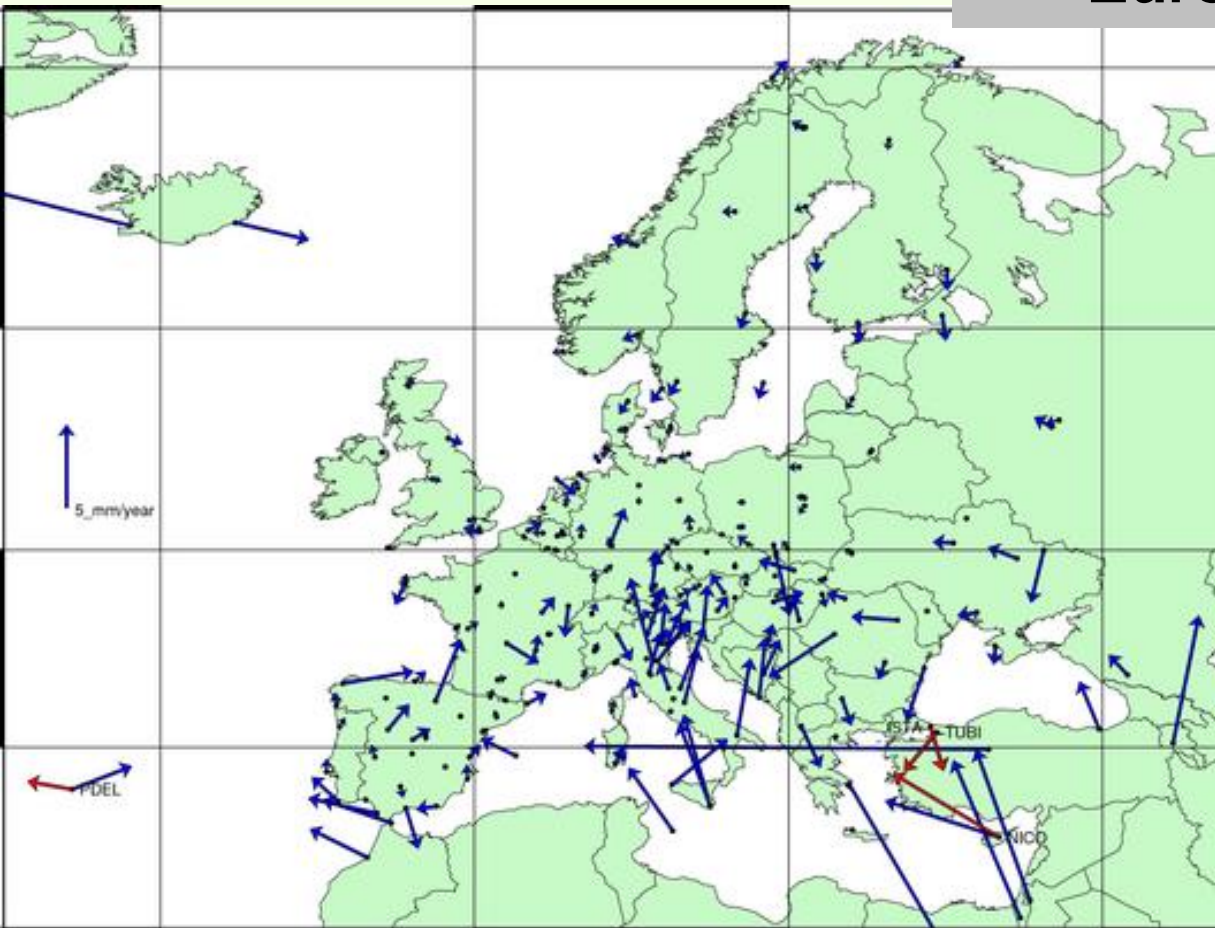
IGS Multi-GNSS Experiment (M-GEX)



MGEX stations in Europe as taken from the MGEX web page (igs.org/mgex) – not all of them also EPN

(5) From Re-processing and Velocity Fields to Real-Time Service

European velocity field



2D velocities wrt the EURA plate,
derived from observations

- EPN cumulative solution may serve as reference for the densification of the European regional velocity field
- (IAG WG on “Regional Dense Velocity Fields”, chaired by C.Bruyninx)

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**

Reference Frames in Real-Time

- 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)

EUREF Real-Time Product Streams

Message	Contents
1057	GPS orbit corrections to Broadcast Ephemeris
1058	GPS clock corrections to Broadcast Ephemeris
1059	GPS code biases
1060	Combined orbit and clock corrections to GPS Broadcast Ephemeris
1061	GPS User Range Accuracy
1062	High-rate GPS clock corrections to Broadcast Ephemeris
1063	GLONASS orbit corrections to Broadcast Ephemeris
1064	GLONASS clock corrections to Broadcast Ephemeris
1065	GLONASS code biases
1066	Combined orbit and clock corrections to GLONASS Broadcast Ephemeris
1067	GLONASS User Range Accuracy

Caster IP:Port	Mountpoint & Input Streams	Ref. Point	GNSS	Messages	Orbits	Reference System	Analysis Center & SW	Register for access
www.euref-ip.net:2101	EUREF01	APC	GPS	1059, 1060	IGS Ultra Rapid	ETRF2000	KF Combination BNC	Registration
www.euref-ip.net:2101	EUREF02	APC	GPS GLO	1057,1058,1059 1063,1064,1065	CODE Ultra Rapid	ETRF2000	KF Combination BNC	Registration

Helmert Transformation Parameters for Transformation to Regional Systems

Regional System	Tx, Ty, Tz (m)	dTx, dTy, dTz (m/y)	Rx, Ry, Rz (mas)	dRx, dRy, dRz (mas/y)	S (10**-9) dS (10**-9/y)	T0 for Rates
ETRF2000	0.0541 0.0502 -0.0538	-0.0002 0.0001 -0.0018	0.891 5.390 -8.712	0.081 0.490 -0.792	0.40 0.08	2000.0

(6) EUREF & NMCAAs - How to proceed?

EUREF: How to proceed?

- **EUREF supports all satellite navigation systems: especially GLONASS and Galileo recommended from data collection to analysis**
- **EUREF establishes real-time services: data and product streams, permanent PPP monitoring, development of tools, e.g., BNC, G-Nut**
- **Introduction of the upcoming European GNSS Galileo will be a big challenge for EUREF by upgrading the station equipment while keeping a stable reference frame**

NMCA's: 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/service for further dissemination through national Ntrip resources**
- **Test & validate EUREF's PPP in their countries, Open Source software available through, e.g. 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

EUREF in the next four-year periode

- **supports the IAG (IGS, GGOS, ...) items in EUROPE**
- **will certainly be an important partner in the implementation of INSPIRE (EC), GGOS (IAG), GEOSS (GEO)**
- **Assistance in developing standards for monitoring GNSS networks (NTRIP, EUREF-IP)**
- **Develops of GNSS real-time applications in geodynamics**
- **Supports for Site Quality, Integrity and Interference Monitoring in real time and post-processing mode**

www.euref-iag.net

www.euref.eu

