

**IAG SUB-COMMISSION FOR EUROPE - EUREF**  
**STATUS REPORT FOR THE PERIOD 1999-2003**

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## **1. Introduction**

The present report covers the period August 1999 – April 2003 and is focused on the following topics:

- Overview and Organisation
- EUREF Permanent Network (EPN)
- Improvements and extensions of ETRS89
- European Vertical Reference System (EVRS)
- European Combined Geodetic Network (ECGN)
- Symposia
- Communication layer
- External interfaces
- Publications

## **2. Overview and Organisation**

The purpose of EUREF, the Sub-Commission for Europe of IAG's (International Association of Geodesy) Commission X on Global and Regional Geodetic Networks, is the establishment and maintenance of the European Reference Frame. This is being achieved by means of a number of space geodetic reference stations (SLR and VLBI), an array of GPS permanent sites - the EUREF Permanent Network (EPN) -, a network of high-precision geodetic reference sites determined by various GPS campaigns, and the combination of the Unified European Levelling Network (UELN) and the European Vertical GPS Reference Network (EUVN).

The forum where the activities are discussed and decisions are taken is the annual symposium. The Technical Working Group (TWG) has the task to govern current activities, such as:

- to evaluate and classify results of campaigns presented to the TWG for acceptance as EUREF densification or extension and to prepare the respective recommendations for the EUREF plenary meeting
- to organise and coordinate European-wide GPS campaigns for the improvement of the European reference frame
- to implement and co-ordinate a European network of permanent GPS stations, the EUREF Permanent Network (EPN)
- to prepare recommendations for the definition and realisation of a European height system to the EUREF Sub-commission
- to set up the working groups to run the projects defined by the plenary.

The TWG is composed by 19 members. It met 11 times in the period covered by this report; one more meeting is already scheduled to take place during the Toledo Symposium (June 2003). The working groups established in order to run the projects during the period 1999-2003 are the following:

- Unified European Levelling Network (UELN)
- European United Vertical Network (EUVN)
- EUREF Internet Protocol (EUREF-IP)
- European Combined Geodetic Network (ECGN)
- EUVN Densification Action (EUVN\_DA)

It must also be mentioned the initiative to present an Expression of Interest for an Integrated Project submitted under the Framework Program 6 entitled "SCIGAL - Earth Science Applications using GALILEO". SCIGAL aims to establish an operational European GNSS network infrastructure exploring the full potential of the GALILEO and GPS systems serving high precision users in Geodesy, Geophysics, Meteorology, Timing and Navigation, superior to the existing science-driven infrastructure for GPS, taking advantage of the expertise in GNSS data communication and analysis within the EUREF group.

### **3. EUREF Permanent Network (EPN)**

The EUREF Permanent Network (EPN) consists presently of 137 permanent GNSS (Global Navigation Satellite System) stations. All sites have been installed following IGS standards, and about 50% of the EPN stations are also part of the IGS network. Due the enormous amount of tasks, a re-organisation of the permanent network was done in the period 2000-2001. Taking into account new technical evolutions, the EPN guidelines for the inclusion of new stations as well as for the routine operation and data flow were updated at regular intervals during the last 4 years. One of the results is that 58 % of the stations is now providing data on a near-real time basis.

The whole network is weekly processed on a routine basis, making use of the IGS precise orbits. Multi-year solutions of the EPN have been and will be submitted to IERS as contributions to the realisation of the International Terrestrial Reference Systems (ITRS), namely ITRF2000.

The EPN also runs two special projects using the installed infra-structure: 'Monitoring of the EPN to produce coordinate time series suitable for geokinematics' and 'Generation of a EUREF-troposphere product'. The goal of the first one is to support the use of the EPN products for geokinematics by establishing an interface between geodesists and geophysicists. The activity involves the following basic tasks :

- time series monitoring and correction, preparations for kinematic analysis;
- quality assessment and monitoring of site configuration;
- identification of stations with unreliable behaviour.

Within the second project tropospheric parameters are derived as part of the EPN estimation. Longer series of the zenith path delays, for example, support climate research. The basic task within this activity is to produce a combined troposphere solution with input from the individual troposphere solutions of all Analysis Centers, which contribute to the coordinate solution. Presently, the EUREF troposphere solution is recognized as the European reference solution for the troposphere and it is part of the global IGS troposphere solution.

In recognition of the growing need for European-wide improved real-time positioning and navigation, and using the recent developments in the interconnection of mobile communication and the Internet, a new EUREF initiative, the EUREF-IP Pilot Project, was set up during the last year. It aims to distribute differential GNSS data based on the EPN network.

Further information about the EPN can be found at <http://www.epncb.oma.be>.

### **4. Improvements and extensions of ETRS89**

Besides the EPN, the establishment and maintenance of the European Reference Frame is also achieved by a network of high-precision geodetic reference sites determined by various GPS campaigns. In the last 4 years, the following campaigns have been validated by the TWG and accepted as class B standard (about 1 cm at the epoch of observation):

- EUREF-FIN-96/97 campaigns in Finland (sub-set of points)
- EUREF-Estonia-1997 campaign in Estonia (sub-set of points)
- EUREF-Balkan-98 campaign in Albania, Bosnia and Herzegovina, and Yugoslavia (final selection of points and publication of the coordinates pending)
- EUREF-Moldavia-99 campaign in Moldavia (sub-set of points)
- EUREF-SWEREF-99 campaign in Sweden (sub-set of points)
- EUREF-Balear-98 campaign on the Balearic islands (Spain) (sub-set of points)
- EUREF-CRO-94/95/96 (re-computation)
- EUREF GB2001

Three more campaigns have been already validated by the TWG as class B and are waiting for approval by the plenary at the Toledo Symposium:

- EUREF campaigns in Slovenia in 94/95/96 (re-computation)
- EUREF-SK 2001 campaign in Slovakia
- HUNREF2002 campaign in Hungary

Further information about the EUREF campaigns and the data base of stations can be found at <http://www.geo.tudelft.nl/mgp/euref/>.

### **5. European Vertical Reference System (EVRS)**

As result of the UELN and EUVN projects the IAG Sub-commission EUREF defined the European Vertical Reference System 2000 (EVRS), including a European Vertical Datum and related parameters as realisation, and for practical use as a static system. A document with the definition of EVRS was produced.

The UELN network is being densified and extended with new levelling observations. The existence of repeated observations in some areas presents the chance to take a first step on the way to a geokinematic height network. Some computations are being carried out in order to achieve this goal.

The EUVN has the objective to connect different kinds of height related observations as a contribution to a unified European height system, the European geoid determination consistent with the existing geodetic reference network EUREF/ETRS89 and the most recent realisation of UELN, and the monitoring of the sea level variations. The EUVN network consists of about 200 UELN sites observed with GPS. This project has been successfully finalised and the final report has been already published (see Publications).

Meanwhile, an action for the densification of the existing EUVN network (EUVN\_DA) was initiated, in cooperation between EUREF and the IGGC ESc (International Gravity and Geoid Commission, European Sub-commission). The purpose is to separate gross errors in the levelling data and long wave biases in the geoid and/or levelling, at those areas where the greatest discrepancies between the current gravimetric geoid (EGG97) and the point-wise EUVN geoid have been found.

Further information about the European Vertical Reference System, UELN and EUVN can be found at <http://evrs.leipzig.ifag.de/>.

## **6. European Combined Geodetic Network (ECGN)**

Another important issue for EUREF is to ensure the long time stability of the terrestrial reference system, including more gravity field related data in the evaluation models. So, a new project for the realisation of the European Combined Geodetic Network (ECGN) was launched.

The ECGN aims at the combination of geometric and gravity-related techniques for reference frame refinement, and will be developed in close cooperation with the International Gravity and Geoid Commission, European Sub-commission (IGGC Esc) of the IAG and the International Hydrographic Organisation (IHO).

Besides its scientific and practical implications, providing a better knowledge of the link between the geo-spatial and the vertical components, the ECGN project represents an important step ahead in the improvement of the European Reference Frame, and it is expected to be a remarkable contribution to the Integrated Global Geodetic Observing System (IGGOS) that is under development by the IAG.

## **7. Symposia**

Following the symposium held in Prague in June 1999, three other symposia took place in Tromso (Norway) in June 2000, in Dubrovnik (Croatia) in May 2001 and Ponta Delgada (Portugal) in June 2002.

These meetings have been attended by more than 100 participants, representing more than 30 countries in Europe.

The next symposium is under preparation and will be held in Toledo (Spain) in June 2003.

## **8. Communication layer**

A new web page has been installed at <http://www.euref-iag.org>. This page links to all the EUREF structures and projects. The main contents are:

- What is EUREF?
- Technical Working Group
- ETRS89 (European Terrestrial Reference System)
- Permanent Network
- GPS Campaigns
- European Vertical Reference System (EVRS)
- European Coordinate Reference Systems
- Symposia
- Documentation
- Links

In response to the interest demonstrated by the managers of the Framework Program 6, an article explaining SCIGAL and the role of EUREF in the geo-referencing activities in Europe was published in the 29<sup>th</sup> April's issue of the Parliament Magazine.

It must also be mentioned the running process for the trademark of the 'EUREF' name in all the European countries where this process is applicable; it is expected that the results will be presented during the Toledo Symposium.

## 9. External interfaces

The relationship with other organisations, the external interfaces of EUREF, has been growing. The liaison with EuroGeographics, the consortium of the National Mapping Agencies (NMA) in Europe, through its Expert Group on Geodesy (ExG-G) continues. A special reference has to be made to the financial support to EUREF for the organisation of the symposia.

Another result of the cooperation between EUREF and EuroGeographics is the publication of the description of national coordinate reference systems (CRS) in Europe and the transformation parameters between CRS and ETRS89 for practical purposes, following the ISO 19111 Spatial referencing by coordinates standard. This information is available at <http://crs.ifag.de>.

Presently, the cooperation has been extended to the definition of the geodetic components to be included in a project to be submitted by EuroGeographics to the INSPIRE initiative of the EU.

Following the initiative of the Northern African Countries to define and implement a common geodetic reference frame, EUREF was invited to participate in workshops held in TUNIS in May 2000 and Alger in 2001, in order to start a co-operation on this subject in the frame of the AFREF initiative within Commission X.

## 10. Publications

The proceedings of the EUREF symposia are the main source of information concerning the EUREF activities. In the period covered by this report were published:

- Publication No. 8 of the Sub-commission for Europe (EUREF), 1999
  - Report on the Symposium of the IAG Sub-commission for Europe (EUREF) held in Prague, 2 – 5 June 1999.
  - Reports of the EUREF Technical Working Group.Bayerische Kommission für die Internationale Erdmessung, No. 60, München 1999; ISBN 3 3 7696 9622 0.
- Publication No. 9 of the Sub-commission for Europe (EUREF), 2000
  - Report on the Symposium of the IAG Sub-commission for Europe (EUREF) held in Tromso 22 – 24 June 2000.
  - Reports of the EUREF Technical Working GroupBayerische Kommission für die Internationale Erdmessung, No. 61, München 2000; ISBN 3 7696 9623 9.
- Publication No. 10 of the Sub-commission for Europe (EUREF), 2001
  - Report on the Symposium of the IAG Sub-commission for Europe (EUREF) held in Dubrovnik 16 – 18 May 2001.
  - Reports of the EUREF Technical Working GroupMitteilungen des Bundesamtes für Kartographie und Geodäsie, Band 63, Frankfurt am Main 2002; ISBN 3 89888 860 6.
- Publication No. 11 of the Sub-commission for Europe (EUREF), Volume I and II, 2002
  - European Vertical Reference Network (EUVN) Final DocumentationMitteilungen des Bundesamtes für Kartographie und Geodäsie, Band 63, Frankfurt am Main 2002; ISBN 3 89888 869 X, ISBN 3 89888 870 3.

The proceedings of the symposium held in Ponta Delgada, 2002, are under preparation. The web page contains the papers presented at the symposia held in Tromso, Dubrovnik and Ponta Delgada. This procedure will be followed in the subsequent symposia, in order to have a faster diffusion of the information.

## 11. Conclusions

The Permanent Network is still developing and increasing its contribution to international projects. The GPS campaigns continued, extending and densifying the terrestrial GPS network and improving existing solutions. The EUVN project was finalised, and UELN is being densified and extended to countries in eastern Europe. Other projects have been launched (ECGN, EUVN-DA), aiming at the refinement of the existing solutions for the European Reference Frame, providing a better link between the geo-spatial and the vertical components.

The future situation of EUREF within the next IAG structure was also discussed, and the EUREF group looks forward to continue its activities in the frame of the new Commission I - Reference Frames

The importance of the activities of EUREF is demonstrated by the involvement of more and more organisations and countries, covering almost all the map of Europe. The ETRS89 (European Terrestrial Reference System), defined more than 12 years ago, is being adopted by several countries and organisations in Europe as the official system for geo-referencing. The European Community will use ETRS89 and EVRS as conventional reference systems as well to promote widespread use as a *de facto* standard for future pan-European data products and services.