STATUS REPORT FOR THE PERIOD 2003-2007

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1. Introduction

The EUREF Sub-Commission was constituted at the IUGG *(International Union of Geodesy and Geophysics*) General Assembly held in Vancouver, 1987, under the umbrella of Commission X - Global and Regional Geodetic Networks of Section 1 – Positioning. As a result of the implementation of the new IAG (*International Association of Geodesy*) structure at the IUGG General Assembly held in Sapporo, 2003, EUREF was integrated within Sub-Commission 1.3, Regional Reference Frames, under Commission 1 – Reference Frames, with the designation *Sub-Commission 1.3a, Reference Frame Sub-Commission for Europe (EUREF).*

The present report covers the activities carried out in the period August 2003 – April 2007 and is focused on the following topics:

- Overview and organisation
- EUREF Permanent Network (EPN)
- Improvements and extensions of ETRS89
- European Vertical Reference System (EVRS)
- Symposia
- Outreach and external liaisons
- Publications

2. Overview and organisation

At the annual Symposium held in Bratislava (June 2004), the Terms of Reference (ToR) of EUREF were adopted. The ToR contain the description of EUREF, its objectives, activities, organization and the rules for membership according to the general rules expressed in the Statutes and By-laws of IUGG and, consequently, of IAG. The complete text can be found in http://www.euref-iag.net/html/Overview_of_EUREF_Terms_of_reference.html.

The long-term objective of EUREF is the definition, realization and maintenance of the European Reference Systems. All the work is done in close cooperation with the pertinent IAG components and EuroGeographics, the consortium of the European NMCA (*National Mapping and Cadastre Agencies*).

The forum where the activities are discussed and decisions are taken is the annual symposium. A fundamental element in the structure is the EUREF Technical Working Group (TWG), with the task to govern current activities, such as:

- to coordinate and develop the EPN;
- to evaluate and classify results of GNSS campaigns as EUREF densification or extension;
- to coordinate the actions for the realisation of a European Height System;
- to identify the relevant actions for the continuation and development of EUREF, with respect to innovation and the changing user needs;
- to set up the working groups to run the projects defined by the plenary;
- to prepare the recommendations for the EUREF plenary.

The TWG is composed by 17 members. It met 11 times in the period covered by the report. Information about TWG membership, agenda of the meetings and some contributions are available at http://www.euref-iag.net/html/twg.html.

3. EUREF Permanent Network (EPN)

During the period between June 2003 and April 2007, about 70 continuously operating GPS stations were integrated into the EUREF Permanent Network (EPN) bringing the total number of EPN stations to 200. The number of stations providing hourly data has increased from 58% to 84%. In addition, 42% of the EPN stations also submits data to the International GNSS Service, ten of them contributing to the TIGA (Tide Gauge Benchmark monitoring) Pilot Project of the IGS. 37 EPN stations provide GPS+GLONASS data.

The "Procedure for becoming an EPN station" has been completely revised. The new procedure is effective since Dec. 2006, and can be downloaded via the EPN Central Bureau (CB) web site http://epncb.oma.be/. The most important changes concerns the new requirements to submit a commitment letter guaranteeing that the station will be operated

following EPN guidelines for a minimal duration of 5 years and the fact that all new EPN stations must have an antenna/radome with true absolute calibrations available from the EPN CB.

In addition, the 'Guidelines for EPN Stations and Operational Centres' have also been reviewed. The new guidelines were issued in order to improve the data flow within the EPN and to guarantee the availability of the EPN data at the regional (European) level. This will be achieved by making all EPN data available to two regional data centres: BKG (Federal Office of Cartography and Geodesy, Germany) and OLG (Space Research Institute, Department of Satellite Geodesy Austrian Academy of Sciences, Austria). In addition, the new guidelines include now a section with guidelines for stations streaming real-time data.

The web site of the CB has added some new web pages showing the results of the monitoring of the long-term quality of the GPS observations. These pages have proven to be a valuable tool for indicating tracking changes. As a complement to the "Station latency reports" distributed monthly through EUREF mail, the EPN CB web site is now also displaying in graphical form the results of the monitoring of the delays of the hourly data and real-time data files.

Two EPN Analysis Workshops have been held. The first one was held from September 17-18, 2003, in Graz, Austria and the second one from March 15-16, 2006 in Padua, Italy. The minutes of both workshops are available from http://epncb.oma.be/_newsmails/workshops/

The EPN 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 general task of the Time Series Analysis Special Project (TSA_SP) is to promote the use of the EPN products for geophysical studies. Based on the periodically computed cumulative solution of the EPN combined weekly SINEX product, the TSA_SP maintains a database of the station coordinate offsets and outliers, estimates the most up-to-date coordinate and velocity solutions and performs noise and harmonic analysis of the time series. The TSA_SP contributed to the ITRF2005 by providing the offset and outlier database of the EPN stations. After the release of ITRF2005, the regularly updated EPN coordinate and velocity solution computed by the TSA_SP is considered as official for the EPN stations. All results are displayed at the EPNCB web-pages.

The goal of the second one is to derive tropospheric (zenith total delay) parameters as part of the estimation. 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. A 'rapid' combination derived to a given time contributes to the global IGS combined troposphere product.

Information about these projects and further information can be found at http://epncb.oma.be/organisation/projects/ .

Following the request to contribute to the computation of ITRF2005 as a regional densification, the relevant information is being prepared by the analysis coordinator and analysis centres, in collaboration with the chair of the time series special project, in order to fulfil the requirements.

Another project based on the EPN structure is EUREF-IP (IP for *Internet Protocol*), with the goal to collect and disseminate GNSS data in real-time over the Internet. Under this project the transport protocol Ntrip (*Networked Transport of RTCM via Internet Protocol*) was developed. In September 2004 has been included in the standards of RTCM (*Radio Technical Committee for Maritime Services*). EUREF-IP established a specific IP address for its Ntrip Broadcaster service at http://www.euref-ip.net/home.

The total number of world-wide Ntrip Broadcaster installations known today is approximately 85. The total number of reference stations available via Ntrip technology amounts to approximately 1700, 52 of them are EPN stations, which is about one quarter of the EPN stations. Further information at http://www.rtcm-ntrip.org/home.

The current EUREF-IP efforts focus on developing a real-time Ntrip Monitoring/Notification system to reach and maintain a professional level of service availability, develop Ntrip towards full HTTP compatibility, introduce UPD as an additional data transport option, and encourage more EPN station operators to participate in EUREF-IP with real-time raw or RTK data.

4. Use and adoption of ETRS89

The ETRS89 (*European Terrestrial Reference System*) is being adopted as the official system for geo-referencing by several organisations in Europe and most of the European countries. In 2005 it was decided to continue to promote the use and adoption of the ETRS89 and to collect the most accurate and complete information on this subject. Consequently, a survey was conducted jointly by EUREF and EuroGeographics among 41 National Mapping and cadastral Agencies (NMCA). From the 41 countries contacted, 28 answered the questionnaire representing about 68% of the universe. The 3 different situations are as follows:

- 2 will not adopt (7% of the answers);
- 5 will adopt in the near future (18% of the answers);
- 21 have already adopted (75% of the answers).

The countries that informed that will not adopt the ETRS89 are Luxembourg and Turkey. On the other hand, since the realization of the questionnaire, 1 of the countries that announced to adopt the ETRS89 in the near future has already done it, increasing to 22 the number of countries that adopted this system.

5. Improvements and extensions of ETRS89

The establishment and maintenance of the European Reference Frame is achieved by a network of geodetic reference sites determined at national and multi-national level by 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-Slovakia-2001 campaign in Slovakia;
- EUREF-Pol-2001 campaign in Poland;
- EUREF-Austria-2002 campaign in Austria;
- EUREF-Hungary-2002 campaign in Hungary;
- EUREF-Armenia-2002 campaign in Armenia;
- EUREF-GB-2001 (re-computation of the campaign in Great Britain);
- EUREF-NKG-2003 campaign in the Baltic countries. Points from Latvia and Lithuania included in the data base;
- EUREF-BG-2004 campaign in Bulgaria, combined with the EUREF-BG92/93, previously accepted in 1996.

The majority of these recent campaigns had the purpose to improve the accuracy of the former national reference frames expressed in ETRS89, as well as the densification of the existing network and/or replacement of old markers by GPS permanent stations.

For the long-term maintenance of the European Reference Frame, the project European Velocity Field (EVF) aiming at the establishment of a dense velocity field model in Europe was started. The first results were presented at the EUREF Symposium held in Riga in 2006.

6. European Vertical Reference System (EVRS)

The definition of the European Vertical Reference System 2000 (EVRS), including a European Vertical Datum and related parameters as realisation, is being revised, considering that the progress in global gravity models will soon make possible the realization of EVRS as a genuine World Height System.

The UELN (*Unified European Levelling Network*) is being densified and extended with new levelling observations. Contacts are being established with Russia for the inclusion of new levelling data in the Baltic area. The existence of repeated observations in some areas presents the chance to take a first step on the way to a geokinematic height network.

The projects EUVN_DA (*European Vertical GPS Reference Network Densification Action*) and ECGN (*European Combined Geodetic Network*) are under development.

Further information about the European Vertical Reference System can be found at http://crs.bkg.bund.de/evrs/.

7. Symposia

Following the symposium held in Toledo in June 2003, three more symposia took place at Bratislava (Slovakia) in June 2004, at Vienna (Austria) in June 2005, at Riga (Latvia) in June 2006. The 2007 symposium that will take place in London (UK) in June 2007 is in preparation.

These meetings are usually attended by more then 100 participants from more than 30 countries in Europe. The web portal contains the contributions presented at the symposia, as well as the full set of resolutions of all the EUREF symposia since 1990 (http://www.euref-iag.net/html/symposia.html).

8. Outreach and external liaisons

The old web portal address was replaced by the new one http://www.euref-iag.net. In the mean time, a new address was created in the eu domain, http://www.euref.eu. Both addresses coexist and give access to a portal that links to all the EUREF structures and projects; its main contents are information about the EUREF structure and documentation related with the symposia and TWG meetings.

The liaison with EuroGeographics, the consortium of the National Mapping and Cadastre Agencies (NMCA) in Europe, continued through its Expert Group on Geodesy (ExGG). This liaison is concretized by the support of EuroGeographics to the organization of EUREF symposia, where a special session of ExGG is usually included. In order to upgrade this liaison, a Memorandum of Understanding (MoU) is being established between both organizations.

Furthermore, a Memorandum of Understanding is established with EUMETNET, a network of 21 European national meteorological services, with the purpose to create the conditions to facilitate the data exchange and to promote the increase in the cooperation between the two parties, for the benefit of both the meteorological and geodetic communities.

9. 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:

- EUREF Publication No. 12, 2003
  – Report on the Symposium of the IAG Sub-commission for Europe (EUREF) held in Ponta Delgada, 5 – 8 June 2002.
  – Reports of the EUREF Technical Working Group.
Mitteilungen des Bundesamtes für Kartographie und Geodäsie, Band 29, Frankfurt am Main; ISBN 3-89888- 873-8, 425 pages.

- EUREF Publication No. 13, 2004
  – Report on the Symposium of the IAG Sub-commission for Europe (EUREF) held in Toledo, 4 – 7 June 2003.
  – Reports of the EUREF Technical Working Group
Mitteilungen des Bundesamtes für Kartographie und Geodäsie, Band 33, Frankfurt am Main; ISBN 3-89888- 885-1, 451 pages.

- EUREF Publication No. 14, 2005
  – Report on the Symposium of the IAG Sub-commission for Europe (EUREF) held in Bratislava, 2 – 5 June 2004.
  – Reports of the EUREF Technical Working Group (TWG)
Mitteilungen des Bundesamtes für Kartographie und Geodäsie, Band 35, Frankfurt am Main; ISBN 3-89888- 795-2, 413 pages.

The proceedings of the symposia held in Vienna, 2005 and Riga, 2006, are under preparation.

For enabling the early access to the contributions presented to symposia and TWG meetings for the interested geodetic community, the original presentations are also pre-published in the EUREF homepage.