Activities of the EUREF Technical Working Group

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Abstract. The IAG Sub-commission 1.3a EUREF is a joint effort of research agencies and National Mapping and Cartographic Agencies with the goal to define, realize and maintain the European Reference Frame. The EUREF key infrastructures are the EPN (EUREF Permanent Network) and the UELN (United European Levelling Network). The EUREF activities are coordinated by the EUREF Technical Working Group (TWG). This paper describes the main activities of the TWG during the last year. More details about EUREF can be found at http://www.euref.eu/.

Keywords. EUREF, ETRS89, EVRS, EPN

1 Introduction

The EUREF sub-commission was created at the IUGG (International Union of Geodesy and Geophysics) General Assembly held in Vancouver in 1987 in order to deal with the future needs of precise basic reference networks for both practical and scientific applications. Today, EUREF, the "Reference Frame Sub-Commission for Europe" is part of the Sub-Commission 1.3, Regional Reference Frames, under Commission 1 of the IAG. EUREF is responsible for defining, providing access and maintaining the European Terrestrial Reference System (ETRS89) and European Vertical Reference System (EVRS). The EUREF activities are coordinated by the EUREF Technical Working Group (TWG) which brings together representatives from both European research agencies as national mapping agencies. The TWG was created at the EUREF symposium in Bern, 1992, and its current member list is given in Table 1. The EUREF TWG is constituted by members elected by the plenary, ex-officio members, honorary members and members in charge of specific tasks. The positions of elected members are filled for terms of 4 years, which are renewable once (see EUREF Terms of Reference, http://www.euref.eu/Overview_of_EUREF/Terms_of_reference/EUREF-ToR-2008.pdf).
Typically, the TWG has three one-day meetings a year: a spring meeting, a meeting just before each annual EUREF symposium (May-June) and a fall meeting. During these meetings, the EUREF goals and their implementation are discussed.

The minutes of the TWG meetings are published in the EUREF proceedings, but are also available on-line at the EUREF web site from http://www.euref.eu/euref_twg_meetings.html.

Table 1. Members of the EUREF Technical Working Group.

Members	Agency	Country
Z. Altamimi	IGN/ENSG	France
E. Brockmann	SwissTopo	Switzerland
C. Bruyninx	Royal Observatory of Belgium	Belgium
A. Caporali	University of Padua	Italy
J. Dousa	Geodetic Observatory Pecny	Czech Republic
R. Fernandes	UBI,CGUL, IDL	Portugal
H. Habrich	Bundesamt für Kartographie und Geodäsie	Germany
H. Hornik	Deutsche Geodaetische Kommission	Germany
J. Ihde	Bundesamt für Kartographie und Geodäsie	Germany
A. Kenyeres	FÖMI Satellite Observatory	Hungary
M. Lidberg	Lantmäteriverket	Sweden
J. Mäkinen	Finish Geodetic Institute	Finland
M. Poutanen	Finish Geodetic Institute	Finland
W. Söhne	Bundesamt für Kartographie und Geodäsie	Germany
G. Stangl	Institut für Weltraumforschung	Austria
J. Torres	SPUIAGG, Instituto Geofisico D. Luis	Portugal

2 Recent Activities

The following gives a non-exhaustive overview of the major activities of the EUREF Technical Working Group since the last EUREF symposium held in Chisinau, May 2011.

2.1 Definition and Realization of the ETRS89

With the goal to provide European users with a set of "stable" coordinates, EUREF defined in 1990 the European Terrestrial Reference System (ETRS89) to be coincident with the ITRS (International Terrestrial Reference System) at the epoch 1989.0 and fixed to the stable part of the Eurasian plate. However, in practice ETRS89 coordinates have been subject to variations. A first type of variations is due to reference frame changes. Indeed, each new realization of the ITRS (i.e. ITRFyy) is followed by a new realization of the ETRS89 (i.e. ETRFyy), and could cause coordinate jumps in the ETRS89. In order to remedy to this, from ITRF2005 on, the TWG decided to use the ETRF2000 as the conventional realization of the ETRS89. The ETRF2000 is thus also adopted in conjunction with the latest release of the ITRS, ITRF2008 (released May 2010, see http://itrf.ign.fr/ITRF_solutions/2008/ for more information).

A second reason why ETRS89 coordinates may change in time are local geodynamics. In order to provide concerned countries with advice on how to model these geodynamics while maintaining the highest possible level of cross-boundary consistency with the ETRS89, the TWG is considering the creation of a new Working Group on 'Deformation Modeling'. Delegates from countries facing large deformations will be invited to become members of this Working Group on "Deformation Modeling".

Fig. 1: Locations of GNSS tracking stations included in the EUREF Permanent Network (status May 2012)

2.2 EUREF Permanent Network

The primary way to access to the ETRS89 is through the EUREF Permanent GNSS Network (EPN) managed by EUREF (see Figure 1). Within the last year, 4 new continuously observing GNSS stations joined the EPN bringing the total number of EPN stations to 244; more details can be found at the web site of the EPN Central Bureau (http://epncb.oma.be). The EPN provides full access to the ETRS89 through its publicly available GNSS observation data and the regularly updated ETRS89 coordinates of its stations (http://www.epncb.oma.be/nn_productsservices/coordinates/).

2.3 EPN Reprocessing Project

In 2011 a first major reprocessing (known as EPN-REPRO1) of all EPN GNSS observations gathered between Jan. 1996 and Jan. 2007 has been performed by the EPN Local Analysis Centers (LAC). The reprocessing was performed using the epn_05.atx antenna calibration model which is based on the igs05.atx antenna calibration model. The reprocessed results from the LAC were the basis for weekly combined positions (in SINEX format) and tropospheric delays (see http://www.epncb.oma.be/_productsservices/sitezenithpathdelays/) generated by the resp. the EPN Analysis Coordinator and EPN Troposphere Coordinator. At its fall meeting in Oct. 2011, the EUREF TWG endorsed the EPN-REPRO1 results of and gave the green light to the EPN Reference Frame Coordinator for the generation of a new cumulative EPN position/velocity solution including the EPN-REPRO1 results.
More information the EPN reprocessing is available from http://epn-repro.bek.badw.de/.

2.4 Update of EPN Coordinates

Table 1 gives an overview of the weekly SINEX files available for the computation of a new EPN cumulative position/velocity solution:

Solution	Start	End	Antenna Calibration Model
EPN-REPRO1	835	1399	epn_05.atx
Routine	1400	1631	epn_05.atx
Routine	1632	Now	epn_08.atx

Table 1: Overview of the weekly EPN SINEX files including the antenna calibration model used in the analysis.

In order to have a consistent set of weekly SINEX solutions, the EUREF TWG asked the ROB (Royal Observatory of Belgium, see Baire et al. 2011) to correct the solutions before week 1632 to make them consistent with the epn_08.atx antenna calibration model. Using these corrected SINEX files, complemented with the present-day EPN weekly SINEX file, a new cumulative EPN position/velocity solution has been created and tied to the IGS08 reference frame (see Kenyeres, 2012). This cumulative solution will be released to the EUREF community in the Summer of 2012 and will be followed by 15-weekly updates.

2.5 Densification of the EPN

Resolution no 4 of EUREF symposium in Gävle , 2010 stated:

"The IAG Reference Frame Sub-commission for Europe (EUREF)
Noting that the European contribution to the IAG WG on Regional Dense Velocity Fields is coordinated by EUREF
Considering that there are permanent tracking stations, not included in the EPN, but are of scientific importance
Encourages analysis of the data following the guidelines for EUREF densifications and transmission of weekly SINEX solutions to EUREF."

In the meantime several countries (Poland, Estonia, Latvia, Slovakia, Hungary, Austria, Bulgaria, Czech Republic, and Italy) responded positively to this resolution and provided weekly SINEX solutions to the EPN Reference Frame Coordinator who combined these solutions with the weekly EPN solution and then stacked them to get consistent cumulative position/velocity solutions for the resulting densified EPN network (containing today already about a 1000 sites). Thanks to EUREF's Memorandum of Understanding with CERGN, also a CERGN solution (bi-annual campaigns) was submitted. This work is still in progress (see Kenyeres et al, 2012) and it will be an important input for the new EUREF WG on "Deformation Modeling".

2.6 EPN GNSS Working Group

The EPN tracking network is now a multi-GNSS tracking network with 66% of the EPN stations observing both GPS as GLONASS signals and with 46 stations that are already Galileo-ready. However, not all EPN analysis centers are processing GLONASS data in addition to GPS and there are still many concerns with respect to the proper tracking of the new satellite signals by the different receiver types, formats issues, handling and availability of receiver antenna calibrations, etc…. In order to deal with all this issues, the EUREF TWG is setting up a new Working Group on GNSS.

2.7 EPN Real-time Analysis Project

The EPN Project on "Real-time Analysis" (http://epncb.oma.be/_organisation/projects/RT_analysis) focuses on the processing of the EPN real-time data to derive and disseminate new (or extended) real-time GNSS products. As a Pilot Project, the EPN regional broadcaster at BKG (http://www.euref-ip.net) is broadcasting satellite orbit corrections in the ETRS89 (ETRF2000 frame) that allow users to directly derive in real-time coordinates in the ETRS89 at the few dm-level. More details are given in (Söhne, 2011). The EUREF community is invited to test these orbits and provide feedback to the TWG.

2.8 New EUREF Campaigns

One EUREF densification campaign has been validated by the TWG in the last year; it concerns the EUREF BE/2011 campaign (Voet, 2012).

2.9 Monitoring of Official ETRS89 Coordinates

Since 1989, many European countries have defined their national reference frames in (or closely aligned to) ETRS89 by calculating national ETRS89 coordinates following the EUREF guidelines.
The national ETRS89 coordinates, adopted by the different countries, can differ from each other due to differences in datum definition: they are often based on different ETRFyy frames and each of them refers to different observation times.
The differences between the ETRS89 adopted in each of the different countries wrt the most recent estimates of the ETRS89 coordinates of the EPN stations is monitored on a regular basis by EUREF (Brockmann, 2010). Since 2011, Estonia, Switzerland, Croatia, Moldova, Macedonia, Serbia, Netherlands, Czech Republic, and Ireland have included/updated their ETRS89 coordinates in the data base. The results of the comparison shows an agreement of a few cm and are available from http://www.epncb.oma.be/_productsservices/coordinates/stationcoordinates4onestation.php?station=XXXX (with XXX=4-char identification of the EPN station).

2.10 INSPIRE

The EUREF TWG is following the work related to the new ISO TC211 "Geographic Information/Geomatics" project on "Geodetic References". Simultaneously attempts are being made for making ITRS an ISO standard (Boucher, 2012). This includes several geodetic items. Also the registry of national reference systems is an important aspect; we refer the interested read to Ihde, 2012.

2.11 EVRF2007

The European Vertical Reference Frame EVRF2007 is the common European height reference, as recommended by INSPIRE. The EVRF2007 has been distributed to the National Mapping Agencies in the contributing countries in 2010 together with the transformations between the EVRF2007 and the national height systems. The countries have been asked to check their transformation and if the values for their countries can be made publically available together with the on-line transformation to EVRF2007. The result is available at http://www.crs-geo.eu (more details in Sacher et al., 2012).

In the meantime, the UELN is continuously updated using new and updated leveling network submitted by the different countries. In 2009 EUREF received the European part of first order leveling network of Russia allowing a new adjustment closing the loop around the Baltic Sea (with connection measurements to Finland). In 2011, the current first order leveling network of Latvia, observed between 2000 and 2010, was submitted and in 2012 a new first order leveling network of Spain, observed from 2001 to 2008 was received by EUREF. A new UELN adjustment is foreseen for 2013.

2.11 European Combined Geodetic Network

The European Combined Geodetic Network ECGN aims connecting the GNSS-derived height with gravity field related observations and parameters including precise leveling, tide gauge records, gravity observations, solid Earth and ocean tides, and modeling their time-dependent variations. The objectives also include maintenance of the long-term stability of the terrestrial reference frame with an accuracy of 10-9 for Europe, especially in the height component.

At the EUREF TWG meeting, in Chisinau, May 2011, it was decided to propose a pilot project within the Nordic Geodetic Commission (NKG) to demonstrate the ECGN concept. NGOS (Nordic Geodetic Observing System), a task force of the NKG 2004-2010, already had very similar goals. The pilot project is meant to demonstrate ideas and usefulness of an observing system in a more compact plan and to utilize excellent geodetic networks, data and knowhow within the NKG. The project was accepted by the NKG Presidium as a part of NKG projects under the title NCGN – NKG Combined Geodetic Network, with a subtitle Understanding the Sea Level Variation in the Fennoscandian area. The first step of the Nordic pilot project will be completed in 2012.

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