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PROPOSAL FOR PARTICIPATION TO ESEAS (EUROPEAN SEA-LEVEL SERVICE)

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IAG SUBCOMMISSION FOR EUROPE - EUREF-

INTRODUCTION

Regarding the future needs of precise basic reference systems for both practical and scientific applications and for the investigation of geokinematic and geodynamic aspects, the IAG, at its General Assembly in August 1987, formed the new subcommission for Europe –EUREF. EUREF should continue the work of RETrig, employing new space techniques for the implementation of a European Reference Frame.

More than ten years ago, EUREF recognized the advantages of the GPS technology and a first GPS campaign covering the western part of Europe was organized in order to establish a uniform European Reference Frame (EUREF). Through successive GPS campaigns, the network has been extended towards the eastern parts of Europe and various countries have undertaken densification campaigns. The international co-operation within Europe has resulted in the establishment of a high accuracy, three-dimensional geodetic network with links to global and national reference systems.

Strategies and guidelines have been developed for network densification, observation procedures, data flow and data analysis. This has resulted in today's EUREF Permanent GPS Network (EPN) comprising almost 120 stations, a data handling service and supported by 14 analysis centers. The results show an accurate and consistent network (+/- 3 mm in the horizontal component, +/- 6 mm in the height component).

Since 1995, emphasis has been place on the height component, resulting in an extended and improved adjustment of the United European Levelling Network (UELN) and the establishment of the European Vertical GPS Reference Network (EUVN). Today, the EUREF Network contributes to multi-disciplinary activities such as the estimation of meteorological parameters and links to tide gauges.

LINK TO THE IGS

Recognizing the growing number of permanent installed GPS receivers in Europe, which were collecting continuously GPS tracking data, following the IGS (International GPS Service) regulations, the EUREF Subcommission made use of this situation for the maintenance of EUREF. Werner Gurtner (University of Berne) proposed in 1995 in accordance to the IGS, the organization of the EUREF permanent GPS network consisting of the following components:

- Permanent GPS Stations
- Operational Centers (OC)
- Local Data Centers (LDC)
- Regional Data Center (RDC)
- Local Analysis Centers (LAC)
- Regional Analysis Center (RAC)
- Network Coordinator

As most of the components already existed, the realization was more or less a question of coordination. In October 1995, Carine Bruyninx (Royal Observatory of Belgium) has been appointed as network coordinator.

Following IGS rules, the EUREF permanent network could be regarded as a densification of the global IGS network in the European area. In January 1996 IGS released a "Call for participation as IGS Regional Networks Associate Analysis Center (RNAAC), to which the EUREF subcommission responded and expressed, at that time, the willingness of CODE to act as IGS Regional Associated Analysis Center. The free-network solutions delivered by CODE were obtained by combining weekly solutions from the Local Analysis Centers (LAC). The IGS has officially accepted the EUREF proposal in May 1996.

EUREF products are -next to the data of the tracking stations- weekly estimations of the coordinates of the EUREF permanent stations and their covariance information as a combined solution of subnetwork solutions, submitted by EUREF Local Analysis Centers. The LACs process their subnetwork following specific strategies and exchange the results using the Software Independent Exchange Format (SINEX). To align the EUREF weekly solution with the International Terrestrial Reference Frame (ITRF) a selected set of "reference stations" is fixed to their successive realizations of their ITRS coordinates. In addition, the coordinates are updated monthly using the corresponding ITRF velocity field. Applying guidelines for reference frame fixing, the weekly EUREF solutions, available in ITRFxx, at the epoch of observation can be linked to the European Terrestrial Reference System (ETRS89).

NETWORK STATIONS AND OPERATIONAL CENTERS

The EPN network is shown in Figure 1. It consists of almost 120 stations, permanent operating geodetic GPS receivers with antennae mounted on suitable geodetic markers. The stations fulfil the EUREF specifications before they obtain the label of a permanent EUREF station. The criteria are strong in order to ensure data quality, the timeliness and the reliability of the provision of data, the stability of monumentation and the availability of documentation. Guidelines and data file conventions have been set up which strictly have to be fulfilled. Data provision is required on daily basis via local data centers to the regional data center. Some stations provide data files every hour. Operational Centers, mainly identical with the agencies responsible for the stations, perform data validation, conversion of raw data into RINEX (Receiver Independent Exchange Format), data compression, and data upload to a data center through the Internet.

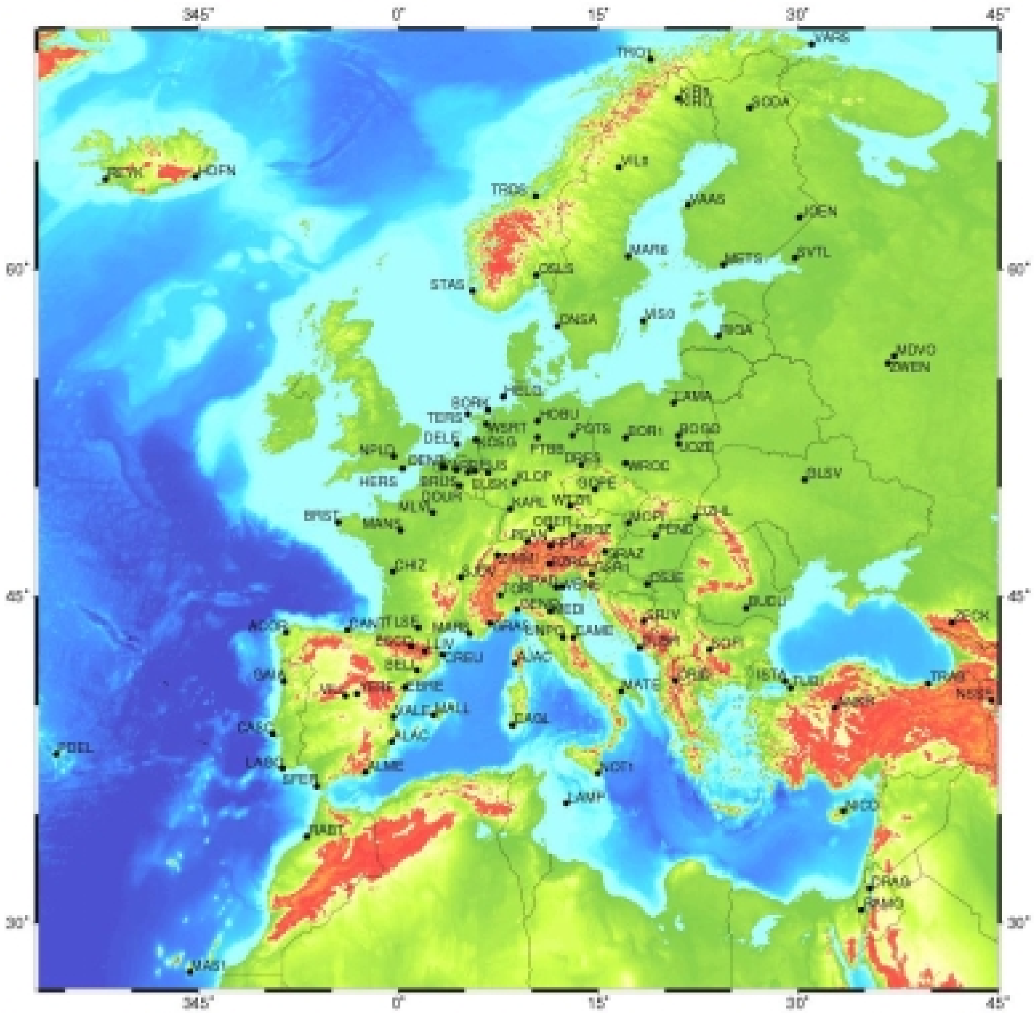

Figure 1- Map of the stations belonging to the EUREF Permanent Network (not shown in map are: Thule (THU1) and Kellyville (KELY) in Greenland, Ny Alesund (NYA1) in Norway.

DATA CENTERS

Local Data Centers (LDC) are collecting data from all local network stations, then distribute the data or provide access to the data. Not all the local stations need to be EUREF stations. The LDC forwards the data or a selection of the data, to a Regional Data Center (RDC), which collects the data from all EUREF stations. While the LDC's in general are identical with the operational centers, only one RDC exists within Europe (Table 1).

Acronym	***Name***	***Type***
ASI	CGS Centro di Geodesia Spaziale "G. Colombo", Italy	L
BKG	Bundesamt für Kartographie und Geodäsie, Germany	L R
IGN	Institut Géographique National, France	L G
OLG	Space Research Institute, Austria	L
ROB	Royal Observatory of Belgium, Belgium	L
DUT	Delft University of Technology, Netherlands	L

Table 1- Local (L), Regional (R) and Global (G) Data Centers

Detailed information about the data flow and data availability within the EPN is available at: http://www.epncb.oma.be/datacent.html

ANALYSIS CENTERS

The data analysis within EPN is based on the principle of distributed processing. EUREF assures that the data from all the stations in its network are processed by at least three analysis centers. This redundancy is used for quality control and outlier detection. The Local Analysis Centers process subnetworks out of the EUREF permanent network following the rules and guidelines as set up by the IGS and supplemented by the EUREF Technical Working Group.

EPN COORDINATION

The EUREF Technical Working Group (EUREF TWG) is responsible for the general management of the EUREF Permanent GPS network.

In 1995, when EUREF started to coordinate the activities related to the permanent GPS stations in Europe, the coordination task was attributed to one network coordinator. The main usage of the network was at that time purely reference frame related: the realization and maintenance of the ETRS89.

Since that time, the EUREF network has evolved from about 30 permanent tracking sites processed by four analysis centers to close to 120 stations and thirteen analysis centers. In addition to this, the data, structure and results of the EPN have drawn the interest of a wide variety of scientific users.

In order to continue to provide high quality data and products, EUREF decided, at its tenth Symposium in Tromsø, June 22-24, 2000 to formally establish an EPN Coordination Group, an EPN Central Bureau and EPN Special Projects.

The Coordination Group (CG) coordinates all activities related to the permanent network and special projects and proposes policy to the EUREF TWG. All members of the Coordination Group make a minimal commitment of 4 years.

The EPN Coordination Group consists of a:

- ✓ network coordinator
  Carine Bruyninx, Royal Observatory of Belgium
  C.Bruyninx@oma.be
- ✓ data flow coordinator
  Günter Stangl, Space Research Institute of the Austrian Academy of Sciences
  stangl@flubpc14.tu-graz.ac.at
- ✓ analysis coordinator
  Heinz Habrich, Bundesamt für Kartographie und Geodäsie, Germany
  Habrich@ifag.de
- ✓ representative of the EUREF TWG
  Werner Gurtner, Astronomical Institute, University of Bern, Switzerland
  werner.gurtner@aiub.unibe.ch
- ✓ special project liaisons

EPN Special Projects are set up by the CG for a minimal period of 4 years in order to introduce new applications into the EPN or study special aspects of the EPN.

Up to now two EPN Special Projects have been initiated:

- ✓ "*Generation of an EUREF tropospheric product*", chaired by Georg Weber, Bundesamt für Kartographie und Geodäsie, Germany (weber@ifag.de)
- ✓ "*Monitoring of the EUREF Permanent Network to produce Coordinate time series suitable for geokinematics*" (see EUREF mail No 572), chaired by Ambrus Kenyeres, FOMI Satellite Geodetic Observatory, Hungary (Kenyeres@sgo.fomi.hu)

The EPN Central Bureau, managed by the network coordinator, is responsible for the day-to-day general management of the EUREF permanent network consistently with the directives, policies and priorities set up by the EUREF TWG.
The EPN Central Bureau is located at:

Royal Observatory of Belgium
Av. Circulaire 3
B-1180 Brussels
Belgium
Tel: +32-2-373 02 92 (2 45)
Fax: +32-2-374 98 22
E-mail: eurefcb@oma.be or epncb@oma.be

It maintains the web-site http://www.epncb.oma.be/ that centralizes all EPN information and products.

TIME SERIES SPECIAL PROJECT

On its Tromsø meeting (June 21, 2000), the EUREF Technical Working Group created a new EPN Special Project charged with the task to monitor the EPN weekly combined SINEX solutions and to analyze the EPN time series in order to further improve the network performance. The basic idea behind this Special Project is to support the use of the EPN products for geokinematics by establishing an interface between geodesists and geophysicists.

The EPN may be considered as a kinematic network, where the stations have an increasing role in geokinematic interpretation as well. The quality of the EPN kinematic products (coordinate time series, velocities) is highly dependent on the station monumentation/data quality and the combination scheme used. In 2000, an EPN SP has been established in order to improve the EPN performance with a careful analysis and overview of each station encompassing the coordinate time series, the stability of the monumentation and the environmental effects. The SP is a joint effort of 6 different groups (see EPNCB web page), where each group is responsible for a specific sub-region of the whole EPN. The groups are also encouraged to involve additional, non-official EPN sites into the analysis in order to derive a more detailed kinematic pattern of Europe.

In the 1st work phase, the coordinates jumps and outliers are determined and collected into a uniform station problem file. This work is in progress and a retrospective analysis will be completed by the end of 2001. In the following work phases the spectral properties (periodical effects, noise spectra) of the time series will be analyzed.

Using all collected information an improved multi-year combination solution and time series are computed and also updated regularly. The improved time series including a table with station problems are displayed on the EPN CB web pages (www.epncb.oma.be/series_sp.html). These pages also summarize all activities related to the SP.

EPN DATA ANALYSIS

LOCAL ANALYSIS CENTERS AND SUBNETWORKS

Presently thirteen LACs (Table 2) contribute to the EUREF solution. They submit weekly solutions, which the Regional Analysis Center, presently located at BKG, is combining into the EUREF solution.

Acronym	***Name***	***Software***	***# stations***
ASI	CGS Centro di Geodesia Spaziale "G. Colombo", I	MicroCosm 9800.0	20
BEK	Bayerische Kommission für die Internationale Erdmessung, D	Bernese 4.2	36
BKG	Bundesamt für Kartographie und Geodäsie, D	Bernese 4.2	46
COE	Center for Orbit Determination in Europe, CH	Bernese 4.3	40
DEO	Delft Institute for Earth-Orientated Space Research, Delft University of Technology, NL	GIPSY 2.5	24
GOP	Geodetic Observatory Pecny, CR	Bernese 4.2	29
IGN	Institut Géographique National, F	Bernese 4.2	24

Acronym	*Name*	*Software*	*# stations*
LPT	Bundesamt für Landestopographie, CH	Bernese 4.2	18
NKG	Nordic Geodetic Commission, S	Bernese 4.2	32
OLG	Austrian Academy of Science, A	Bernese 4.2	34
ROB	Royal Observatory of Belgium, B	Bernese 4.2	26
UPA	University of Padova, I	Bernese 4.2	19
WUT	Warsaw University of Technology, P	Bernese 4.2	31
IGE	Instituto Geografico National, E	Bernese 4.2	19

Table 2- Analysis Centers

Detailed information about the individual subnetworks is available at:
http://www.epncb.oma.be/analcent.html

WEEKLY COMBINATION

Each week, the individual LAC solutions are successively compared to the combined solution. Stations or even complete LAC solutions which show such a difference to the combined quantity that exceeds a predefined range (5 mm for the position or 10 mm for the height) are excluded in the final combined solution. Graphical visualization tools, e.g., the plot of correlation coefficients of the coordinates, are used for quality control.

The ADDNEQ program of the Bernese Software (Beutler et al., 1996) is used to combine the weekly SINEX files. At that time the a priori constraints of the station coordinates are removed. The normal equations are first combined into a free network solution, where 13 stations are selected to define the "minimum constrained conditions" in the ADDNEQ program. This solution is used for outlier detection.

After the exclusion of all outliers the official EUREF solution is generated where the coordinates of 13 stations are fixed to the newest ITRS realization (currently ITRF-97). In order to check the coordinate time series, a free network combination of the last seven EUREF combined solutions is routinely computed. This may lead to the exclusion of more stations and may require an additional iteration of all combination steps.

Each week, when the BKG computes a new EUREF combined solution, the EPN CB uses this solution to generate a multi-year solution which is the basis for the coordinate time series displayed at the EPN CB web site: http://www.epncb.oma.be/series.html.

SUBMISSION OF MULTI-YEAR SOLUTIONS TO THE IERS

The EUREF - RNAAC has computed a multi year combination of the weekly EUREF solutions as regional densification of the ITRF. This was done for the ITRF97 and has been repeated for the ITRF2000.

In order to avoid the problems in the transition from ITRF93 to ITRF94 at GPS week 860 (June 30th, 1996), the weeks 834 to 859 were not used in the combination submitted for the ITRF2000. Because of the long time series now available and due to the fact that for most of the sites the noise in this leading week is higher as in recent times, this seems to be justified. The combination was based on the SINEX files of the weekly solutions and was computed by use of the program ADDNEQ2 of the Bernese Software Vers.4.3. (Mervart, pers. comm. March 2000). The solution is summarized in Table 4.

Observation-Interval	Week 0860 – 1042
Time period	June, 30, 1996 – January 1, 2000)
Number of GPS weeks used	183
Number of weeks neglected	26
Program used	ADDNEQ2, Bernese 4.3

Table 3- Summary of EUREF contribution to ITRF2000.

The so-called STACRUX-file, containing all information about site changes, antenna changes etc… was used to assure the generation of consistent coordinates and velocities. In addition, less than 15 outliers of single sites were eliminated. At some sites discontinuities in one of the coordinate components occurred which could not be associated to logged eccentricities or antennas changes. The reliability of the estimated coordinates and velocities for these sites is guaranteed by estimating two sets of coordinates and one velocity vector before and after the discontinuity. Sites with a recording history shorter than 6 months were constrained to their NUVEL 1A NNR velocities.

Two versions of the solution have been generated, a loosely constrained solution and a solution constrained to the ITRF97 coordinates and velocities of the following core sites: MATE, ONSA, POTS, WTZR, ZWEN.

For a first assessment of the accuracy of the EUREF contribution the solution was compared to the ITRF2000 contribution of CODE (Springer, pers. comm.). The rms of the differences of the 38 sites in common are 0.9, 2.7 and 4.9 mm in North, East and Up components at a central epoch. The agreement is excellent and is rather consistent with the internal precision of the weekly solutions.

Number of stations	95
Additional coordinates of identical sites	5
Number of sites with velocity estimation	82
Number of Input NEQ-files	183
Number of Observations:	9583735
Number of Parameters	5835305
Number of Unknowns	600
A posteriori RMS	0.0036 m

Table 4 - Statistics of the EUREF submission to the ITRF2000

CONCEPT OF EUVN

The initial practical objective of the EUVN project is to unify different European height datums within few centimeters.

The application of the GPS technique for practical levelling would dramatically extend if the geoid would be known precisely enough in relation to the concerned GPS reference system and the levelling reference system. To derive such a geoid, an European reference geoid is required in the reference system ETRS89 and the reference system of UELN. Up to now there is no precise geoid available for Europe with an accuracy of a few centimeters which fulfils the requirement for the practical applications. This proposal points out a possibility to derive a geoid tailored for the GPS-levelling methods by combining the existing reference network EUREF/ETRS89 with the UELN95.

Independently of an uniform height level for the maritime countries the knowledge of the sea level and, under special conditions, of the variations of the adjacent oceans is vitally important. Tide gauges provide access to a local information which generally results from a combination of sea level changes and vertical movements of the earth crust at the tide gauge site. Therefore, global sea level studies based on tide gauge data require to monitor the vertical crustal velocities at the tide gauge sites with respect to a geocentric reference frame, in order to recover a global geocentric assessment of the sea level variations.

The EUVN project contributes to the realization of an European vertical datum and to connect different sea levels of European oceans with respect to the work PSMSL (Permanent Service of Mean Sea Level) and of anticipated accelerated sea level rise due to global warming. The project provides a contribution to the determination of an absolute world height system.

Three kinds of observation groups are necessary:

- GPS measurements for the determination of the ellipsoidal heights of all defined EUVN points,
- levellings between the EUVN sites and the UELN nodal points for the determination of the physical height of all defined EUVN points,
- observations of sea level at tide gauge stations.

At all EUVN points P three-dimensional coordinates in the ETRS89 (Xp, Yp, Zp)ETRS and geopotential numbers cp = Wo UELN - Wp will be derived. Finally the EUVN is representing a geometrical-physical reference frame. In addition to the geopotential numbers cp normal heights $H_n = c_p / \bar{\gamma}$ will be provided ($\bar{\gamma}$ is the mean normal gravity value between the ellipsoid and the telluroid.).

In total the EUVN consists of about 196 sites: 66 EUREF and 13 national permanent sites, 54 UELN and UPLN (United Precise Levelling Network of Central and Eastern Europe) stations and 63 tide gauges (Figure 2).

The EUVN is a step to establish a fundamental network for a further geokinematic height reference system such as EVS 2000 under the special consideration of the Fennoscandian uplift and the uplift in the Carpathian-Balkan region.

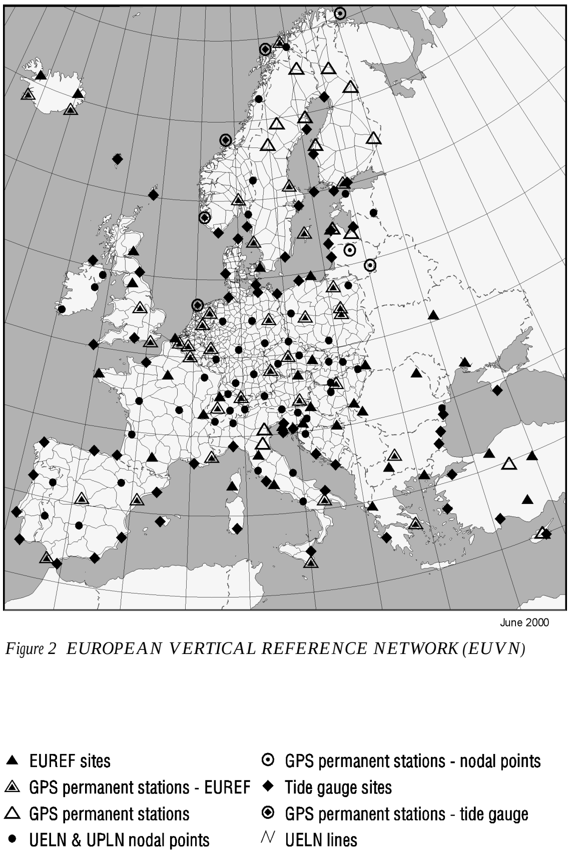

Figure 2 EUROPEAN VERTICAL REFERENCE NETWORK (EUVN)

GPS FRAME

The GPS observations for the EUVN were carried out in the period from May 21 to May 29, 1997. Three types of receiver were used: 35 Turbo Rogue Receivers, 134 Trimble SSI or SSE and 51 Ashtech Z12. The time interval was set to 30 s, the elevation mask was 5°. The campaign was running very smoothly and everybody who participated in the campaign supported the action successfully.

The data preprocessing after the EUVN campaign performed by 9 EUVN Preprocessing Centers (PPC) was mainly a check concerning completeness and consistency of the data and the auxiliary information. The PPCs were requested to prepare complete access information and/or data flow guidelines for the observing agencies before the start of the campaign.

The task of the EUVN GPS Analysis Center (AC) was to process the data of a special subnetwork. A subdivision of the whole EUVN Network was done under the aspect of receiver type and regions.

10 European institutions were ready to contribute as Analysis Centers. On the Analysis Center Workshop in September 1997 in Leipzig the subdivision of EUVN was discussed and decided. Simultaneously with the EUVN 97 Campaign the Baltic Sea Level (BSL) GPS campaign was performed. The BSL 97 GPS campaign was processed by the Finnish Geodetic Institute.

The Astronomical Institute of the University of Bern (AIUB) and the BKG were responsible for the computation of the final GPS solution of EUVN.

The question which solution to choose as the official EUVN97 solution (the unweighted 15-degree solution or the weighted 5-degree solution), was discussed. The unweighted 15-degree solution was selected as the official one. The following aspects had to be taken into account:

- The comparison of the height component of redundant points in both solution types showed a slightly better repeatability for the unweighted 15-degree solution.
- Not all sites within EUVN97 were tracking satellites below 15 degrees with the same quality and quantity. For some sites the number of observations is hardly increasing when changing to the lower cut-off angle, whereas for others the number of observations increased by up to 20 %. Therefore the site coordinates within the EUVN97 GPS network could be more inhomogeneous in the 5-degree solution.
- The elevation-dependent antenna phase center variations are not yet well known below 10 degrees. Introduction of poorly defined corrections could lead to additional systematic errors.
- We do not have enough experience yet with the performance of the tropospheric mapping functions at very low elevations.

The final solution was constrained to ITRF96 coordinates (epoch 1997.4) of 37 stations with an a-priori standard deviation of 0.01 mm for each coordinate component.

A comparison for the combined solutions of BKG and AIUB showed that these two solutions were identical.

For many practical purposes it is useful to have the ETRS89 coordinates available. To get conformity with other projects, the general relations between ITRS and ETRS were used.

HEIGHT SOLUTION

In order to reach the goal it is necessary to connect the EUVN stations by levellings with nodal points of relevant levelling networks. So it is possible to use levelling observations to update the gravity related EUVN heights in context with the new adjustment of UELN.

The available information and measurements for the single EUVN stations were used to compute normal heights in the UELN-95/98 system. Countries which are not members of UELN have made directly available the heights in their national height system.

As the EUVN is a static height network it is necessary to know the value of the mean sea level in relation to the tide gauge bench mark at the epoch of EUVN GPS campaign 1997.5. However for future tasks it is useful to have available the monthly mean values over a period of some years.

To get an integrated European spatial reference system a tailored geoid solution is necessary. At present the European gravimetric quasigeoid EGG97 is available for practical use. For further developments of combined geoid solutions with gravity and GPS/levelling data the EUVN gives a Europe-wide basis. Figure 3 shows the differences between the EGG97 quasigeoid and the GPS/levelling quasigeoidal height anomalies of the EUVN stations.

The heights of the Scandinavian EUVN stations in Finland, Norway, Sweden were reduced from the epoch 1960 to the epoch of the GPS measurement (1997) by the values of the land uplift which were delivered from the countries for the adjustment version UELN-73/86. For the countries which are not members of the UELN and which have a national height system in relation to the tide gauge Kronstadt, the heights were reduced to the UELN level by + 15 cm. These are Bulgaria and Ukraine.

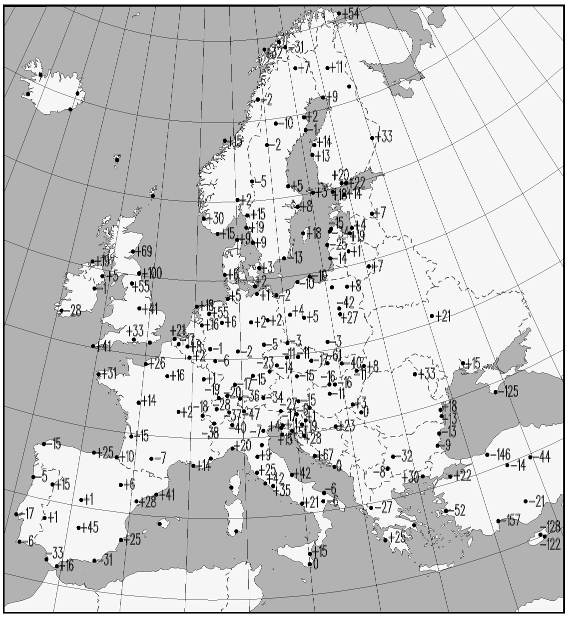

Figure 3- Difference between EUVN GPS / levelling geoid and EGG97 geoid (in cm).

TIDE GAUGE PART

The Permanent Service for Mean Sea Level (PSMSL), as member of the Federation of the Astronomical and Geophysical Data Analysis Service (FAGS), is in principle in charge of the data collection. The information which are sent to the PSMSL databank in general should also be made available for the EUVN project.

The map in figure 4 summarises the status of the mean sea level data collection. Two types of datasets are available at the PSMSL. The first is called "Metric" and contains data as provided by the organisms. The second is called "RLR" and provides data which has passed through some quality control checks to spot inconsistent or erroneous values. Full TGBM datum history is theoretically available for RLR stations. This information is used to reduce the data to a common local datum, the Revised Local Reference (RLR). Thus, the RLR dataset is the most convenient for long term sea level analysis.

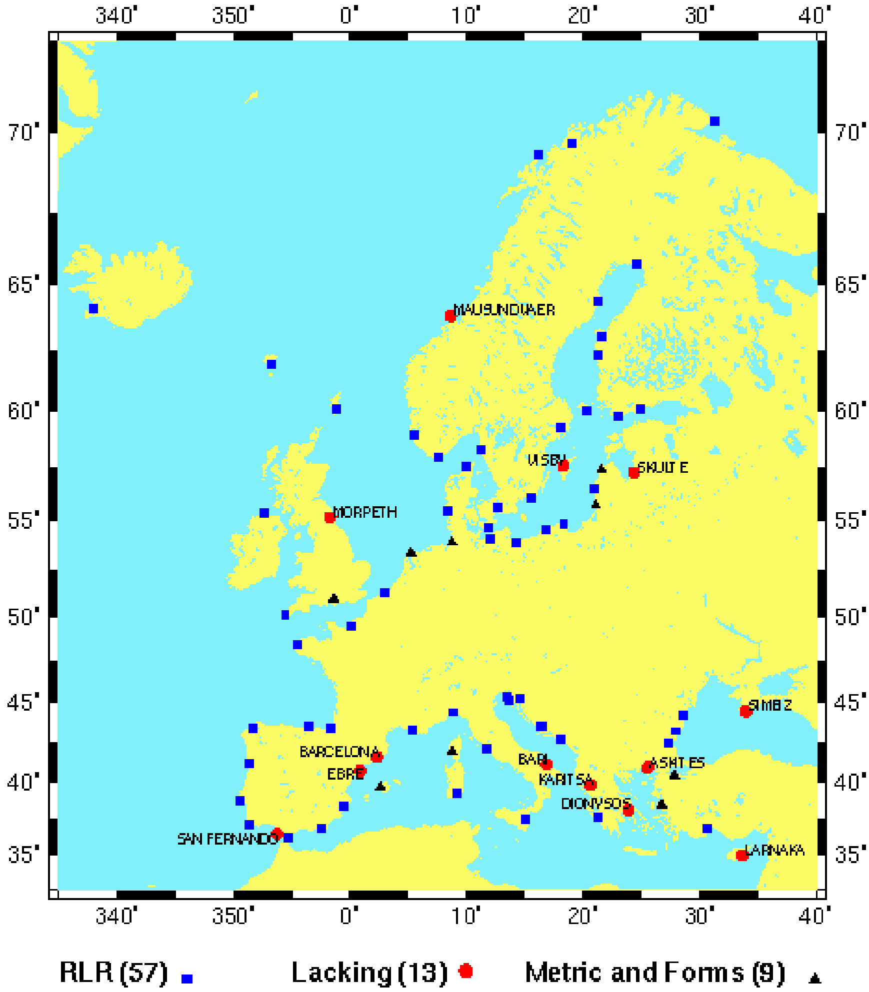

Figure 4- Sea level data collection for the EUVN'97 observed tide gauge sites.

PROPOSAL

BACKGROUND

Presently, the EUREF Permanent Network (EPN) consists of about 120 permanent stations, 32 of which are close to tide gauges (listed in Table 5). About 47 percent of the EPN stations are also part of the IGS global network. All sites have been installed following IGS standards.

EUREF is periodically (weekly) processing the whole network, making use of IGS-products as much as possible or feasible. Multi-year solutions of the EPN have been and will be submitted to IERS as contributions to the realization of the International Terrestrial Reference Systems.

Although primarily set up for pure reference frame maintenance, the EPN has shown to be useful for different types of applications. The interest of EUREF for multi-disciplinary applications was formally endorsed by the EUREF subcommission at its Symposium in Prague:

Resolution 4 of the EUREF Symposium in Prague, June 1999.
(Extract)

The IAG Subcommission for Europe (EUREF)

considering that the primary purpose of establishing the Permanent EUREF Network was the maintenance of the ETRS89, and

recognising the achievements of the project,

recognising that the data, structure and results of the Permanent Network are valuable for a wide variety of scientific investigations,

invites agencies and organisations interested in these investigations (such as geodynamics, sea level monitoring and meteorology) to closely collaborate with EUREF.

Resolution 5 (Extract)

The IAG Subcommission for Europe (EUREF)

recognising the progress in the UELN95 and EUVN as static height networks,

accepts the concept of an integrated kinematic height network for Europe proposed by the Technical Working Group (e.g. GPS permanent stations, repeated levellings, tide gauge observations, repeated gravity measurements).

EUREF proposes its participation in the ESEAS by delivering for all EPN stations close to tide gauges:

- *validated GPS meta-data information (through the EPN web-site and ftp archive)*
- *free access to the GPS data (ftp archive)*
- *weekly coordinate estimates in SINEX format (ftp archive).*

If requested, special SINEX files could be prepared containing only those permanent stations actually accepted as TIGA stations by the Pilot Project.

EUREF proposes furthermore its participation in the ESEAS by delivering for the EUVN tide gauge stations:

- *Description of the EUVN station*
- *Height solution*
- *Tide gauge solution*

SUBMISSION OF SOLUTIONS

1) Data analysis
    - All sites are processed by at least three EPN analysis centers (LACs) following agreed-upon analysis guidelines (a total of 14 LACs are participating)
    - Outlier detection performed thanks to redundancy of different solutions
    - Weekly combined solution available with a delay of about 1-2 months = EUREF SINEX solution
2) EUREF SINEX solutions combined into a multi-year solution to be submitted to the IERS for the ITRF realizations (e.g., ITRF97 and ITRF2000)
3) EUREF SINEX solutions delivered weekly to the IGS as RNAAC solution
4) EUVN solution consisting on
    - GPS solution (ellipsoidal heights)
    - Height solution in the system of UELN 95/98
    - GPS/levelling quasigeoidal height anomalies
    - Relations between the EUVN GPS site and the tide gauge (TGBM)
    - Tide gauge analysis for the EUVN tide gauge stations with complete data

GPS META-DATA INFORMATION

1) IGS-compliant site logs
2) All RINEX data available at EPN data centers
    - Data format/compression following IGS philosophy
    - Data holding files
    - Max. delays in data availability a few days (one week in exceptional cases)
    - Daily checks of consistency of RINEX headers versus site log files and generation of inconsistency tables
    - SINEX template for all EPN stations
    - Tables with Ocean Loading parameters for all sites
3) EPN Special Project for time series checks for each EPN station rigorously the coordinate time series and estimates coordinate jumps after antenna/radome configuration changes.
4) Individual web pages for each EPN station with links to all available meta-data, RINEX data, corresponding analysis centers, related EUREF and IGS mails, and coordinate time series.
5) Describing information on each EUVN station containing
    - Site identification of the GPS monument including photo and sketch
    - Site location information including addresses, coordinates …

EPN STATIONS CLOSE TO TIDE GAUGES

Table 5 shows the EPN stations that are close to tide gauges and the corresponding EPN CB web-page with additional information about the GPS meta-data and products, e.g. coordinate time series:

1. ACOR	La Coruna, Spain	http://www.epncb.oma.be/info/ACOR.html
2. AJAC	Ajaccio, France	http://www.epncb.oma.be/info/AJAC.html
3. ALAC	Alicante, Spain	http://www.epncb.oma.be/info/ALAC.html
4. ALME	Almeria, Spain	http://www.epncb.oma.be/info/ALME.html
5. BORK	Borkum, Germany	http://www.epncb.oma.be/info/BORK.html
6. BRST	Brest, France	http://www.epncb.oma.be/info/BRST.html
7. CAGL	Cagliari, Italy	http://www.epncb.oma.be/info/CAGL.html
8. CANT	Santander, Spain	http://www.epncb.oma.be/info/CANT.html
9. CASC	Cascais, Portugal	http://www.epncb.oma.be/info/CASC.html
10. DUBR	Dubrovnik, Croatia	http://www.epncb.oma.be/info/DUBR.html
11. EIJS	Eijsden, Netherlands	http://www.epncb.oma.be/info/EIJS.html
12. GENO	Genova, Italy	http://www.epncb.oma.be/info/GENO.html
13. HELG	Helgoland, Germany	http://www.epncb.oma.be/info/HELG.html
14. LAGO	Lagos, Portugal	http://www.epncb.oma.be/info/LAGO.html
15. LAMP	Lampedusa, Italy	http://www.epncb.oma.be/info/LAMP.html
16. MALL	Palma de Mallorca,Spain	http://www.epncb.oma.be/info/MALL.html
17. MAR6	Maartsbo, Sweden	http://www.epncb.oma.be/info/MAR6.html
18. MARS	Marseilles, France	http://www.epncb.oma.be/info/MARS.html
19. NYA1	Ny Alesund, Norway	http://www.epncb.oma.be/info/NYA1.html
20. PDEL	Ponta Delgada, Portugal	http://www.epncb.oma.be/info/PDEL.html
21. REYK	Reykjavik, Iceland	http://www.epncb.oma.be/info/REYK.html
22. RIGA	Riga, Latvia	http://www.epncb.oma.be/info/RIGA.html
23. SFER	San Fernando, Spain	http://www.epncb.oma.be/info/SFER.html
24. STAS	Stavanger, Norway	http://www.epncb.oma.be/info/STAS.html
25. TERS	Terschelling, Netherlands	http://www.epncb.oma.be/info/TERS.html
26. TRAB	Trabzon, Turkey	http://www.epncb.oma.be/info/TRAB.html
27. TRDS	Trondheim, Norway	http://www.epncb.oma.be/info/TRDS.html
28. TRO1	Tromso, Norway	http://www.epncb.oma.be/info/TRO1.html
29. VALE	Valencia, Spain	http://www.epncb.oma.be/info/VALE.html
30. VARS	Vardoe, Norway	http://www.epncb.oma.be/info/VARS.html
31. VENE	Venezia, Italy	http://www.epncb.oma.be/info/VENE.htm
32. VIS0	Visby, Sweden	http://www.epncb.oma.be/info/VIS0.html

Table 5- EPN stations close to tide gauges