Report
on the EUREF-Symposium in Tromsø
June 22 – 24, 2000

Schedule

Wednesday, June 21, 2000

09:00 - 12:30: EUREF Technical Working Group

14:00 - 17:30: EUREF Technical Working Group

Thursday, June 22, 2000

09:00 - 10:00: Registration

10:00 - 11:00: Opening session

11:00 - 12:30: Working session

14:00 - 17:30: Working session

19:00 Ice breaking party

Friday, June 23, 2000

09:00 - 12:30: Working session

14:00 - 17:30: Working session

18:30 traditional midsummer celebration, Sommarøya

Saturday, June 24, 2000

09:00 - 11:30: Working session

11:30 - 12:00: Closing session

13:30 - 18:00: Excursion to the Auroral Observatory and Tromsø Satellite Station

Wednesday, June 21 – Saturday, June 24, 2000: Posters

Sunday, June 25 morning – Tuesday night June 27, 2000: Post conference tour to North Cape

Agenda

1. Opening Session (chairperson: B. G. HARSSON)
2. EUREF Technical Working Group / Status of the EUREF Permanent Network (chairperson: E. GUBLER)
3. EUREF Permanent Network – Developments and Applications (chairperson: W. GURTNER)
4. European Vertical System (chairperson: H. V. D. MAREL)
5. EUREF Reference Frame (chairperson: C. BRUYNINX)
6. Adoptions of ETRS89 (chairperson: J. A. TORRES)
7. National reports (chairperson: W. AUGATH)
8. Related contributions (chairperson: J. SIMEK)
9. Resolutions (chairperson: G. ANDRÉ)
10. Closing Session

Posters during all the symposium

Participants

Adam Jozsef, Hungary
André Giles, England
Augath Wolfgang, Germany
Bacic Zeljko, Croatia
Balodis Janis, Latvia
Baran Lubomir, Poland
Basic Tomislav, Croatia
Becker Matthias, Germany
Boucher Claude, France
Bray Colin, Ireland
Bruyninx Carine, Belgium
Buga Arunas, Lithuania
Buren Johan Van, The Netherlands
Campbell James, Germany
Caporali Alessandro, Italy
Cheremshynskyi Mykhailo, Ukraine
Cisak Jan, Poland
Del Rosso Domenico, Italy
Dousa Jan, Czech Republic
Ehrnsperger Walter, Germany
Engen Bjørn, Norway
Engsager Karsten, Denmark
Erker Erhard, Austria
Feil Ladislav, Croatia
Ferianc Dusan, Slovakia
Ferraro Carmela, Italy

Fetai Jakup, FYROM/Macedonia
Garayt Bruno, France
Grønlie Grete, Norway
Gubler Erich, Switzerland
Gurtner Werner, Switzerland
Hanssen Rune, Norway
Harmel Alain, France
Harsson Bjørn Geirr, Norway
Hornik Helmut, Germany
Hugentobler Urs, Switzerland
Ihde Johannes, Germany
Jivall Lotti, Sweden
Juceviciute Vitalija, Lithuania
Kabelac Josef, Czech Republic
Kaftan Vladimir, Russia
Kaniuth Klaus, Germany
Kenyeres Ambrus, Hungary
Knudsen Per, Denmark
Kostelecky Jan, Czech Republic
Krynski Jan, Poland
Kääriäinen Jussi, Finland
Lenk Onur, Turkey
Leonard John, England
Lidberg Martin, Sweden
Lorentzen Lilliann, Norway
Marel Hans Van der, The Netherlands
Medic Zlatko, Croatia
Milev Georgi, Bulgaria
Minchev Momchil, Bulgaria
Morgan Roy, Ireland
Mulahusic Admir, Bosnia and Herzegovina
Muls Alain, Belgia
Mæhle Mette, Norway
Mäkinen Jaakko, Finland
Nørbech Torbjørn, Norway
Ollikainen Matti, Finland
Pahler Karlheinz, Germany
Pazus Richard, Poland
Pesec Peter, Austria
Pinto Jorge, Portugal
Plag Hans-Peter, Norway
Prelipin Mikhail, Russia
Provázek Jiri, Czech Republic
Rekkedal Svein, Norway
Rodriguez Enrique, Spain
Rogowski Jerzy, Poland
Roosbeek Fabian, Belgium
Rozic Nevio, Croatia
Sacher Martina, Germany
Schneider Dieter, Switzerland
Seeger Hermann, Germany
Sharpak Gregory, Republic of Moldova
Silabriedis Gunars, Latvia
Simek Jaroslav, Czech Republic
Sledzinski Janusz, Poland
Solheim Dag, Norway
Stampe Villadsen Sigvard, Denmark
Stangl Guenter, Austria
Stopar Bojan, Slovenia
Stratulat Ion, Republic of Moldova
Titz Helmut, Austria
Torres João, Portugal
Tretyak Kornyliy, Ukraine
Tätilä Pekka, Finland
Willigen Gert van, The Netherlands
Vasiljev Jevgenijs, Latvia
Vestøl Olav, Norway
Voet Pierre, Belgium
Weber Georg, Germany
Wöppelmann Guy, France
Zaprov Gorgi, FYROM/Macedonia
Zeman Antonin, Czech Republic

Minutes

All sessions took place in the Congress Hall of the Polarmiljøsenteret, Tromsø. The following minutes of the sessions should be read together with the referenced reports.

1. Opening (chairperson: J. KOSTELECKÝ)

After the performance of traditional Norwegian songs, B. G. HARSSON as chairman of the Local Organizing Committee opens the tenth symposium of the IAG Subcommission for Europe (EUREF). The participants are welcomed by K. ELLINGSEN, representative from Norwegian Ministry of Environment (cf. p. 11), followed by the President (Fylkesmann) of Troms County Administration, L. HELØ, Both emphasize the importance of modern control networks for various practical applications especially in this northern region of Tromsø.

C. BOUCHER as president of IAG commission X – Global and Regional Geodetic Networks thanks the hosts for the invitation and organization of this symposium as well as all support given to EUREF. In a summarizing review he points out the successful work of EUREF up to now and the steps for the next future. Especially the well attended annual symposia give the geodetic community an interesting insight into the project and help efficiently to keep the necessary balance between scientific research and practical application. He also thanks the EUREF Technical Working Group (TWG) for all its efforts to develop the project and treat upcoming new tasks between the symposia. The main tasks in the past were the establishment of the fundamental network, later on the establishment of the well operating EUREF Permanent Network, then the European Vertical Network and meanwhile the analysis of time series for

diverse purposes and the involvement in navigation systems such as Galileo.

Within the international geodetic community EUREF is regarded as a well organized group. EUREF is contributing efficiently to IGS and IERS; the African states ask EUREF for technical advise to establish an own continental network. Moreover the EUREF Subcommission is considered as a positive example for the planned general organization of the IAG. C. BOUCHER thanks especially C. BRUYNINX and W. GURTNER for all their great efforts for EUREF.

Finally J. AGRIA TORRES as president of the EUREF Subcommission welcomes the participants to this symposium and expresses his warm thanks for all who have contributed to organize, support and sponsor this meeting (cf. p. 12).

Obituaries

The EUREF secretary informs the plenary on the passing away of KRESIMIR COLIC, Zagreb, STEPAN KLAK, Zagreb, and DUSAN MISKOVICS, Ljubliana. The plenary observe a moment of silence for the deceased colleagues, their work and contributions to EUREF are described in obituaries by Z. BASIC and B. STOPPAR.

Scientific sessions

The TWG has appointed J. ADAM, G. ANDRÉ (chairman), C. BRUYNINX, J. IHDE, J. KRYNSKI and H. V. D. MAREL as members of the resolutions committee. The plenary accepts the proposal.

EUREF Technical Working Group / Status of the EUREF Permanent Network (chairperson: E. GUBLER)

As chairman of the EUREF TWG, W. GURTNER gives a detailed report on the activities of this group. The TWG was founded on occasion of the EUREF symposium 1992 in Berne under the chairmanship of C. BOUCHER (since the 1999 symposium in Prague: W. GURTNER, cf. also http://www.euref-iag.org/OrganizationStaff.html). Since the last symposium 1999 in Prague the TWG held three meetings (Dresden, 28-29.1999, Brussels 20-21.3.2000, Tromsø 21.6.2000, cf. the minutes on pp. 377, this vol.). The action items comprised campaign validations, EUREF permanent network, interface with GALILEO and EGNOS, European Vertical Network, guidelines, reorganization of the EUREF homepage, discussion on COST activities, GLONASS, ISO etc. On behalf of CERCO WG VIII, E. GUBLER adds, that the TWG with its continuous meetings and permanent activities and discussions is an urgently necessary group to guarantee the successful work of EUREF.

The introducing report on the activities within the EUREF Permanent network (EPN) is given by C. BRUYNINX in *Overview of the EUREF Permanent Network and the Network Coordination Activities* (cf. p. 24). As usual some stations were deleted from the list of EUREF Permanent stations due to various reasons, numerous others were included. Originally the EPN was planned for about 35 stations, but comprises now almost 100 regularly operating sites. The information flow is mostly done via EUREF mail letters (540 circulars since April 1997). C. BRUYNINX asks all colleagues urgently to submit any information concerning the EPN data immediately in order to avoid time and personnel extensive investigations on not fitting data. Much research is still needed to collect and evaluate all kind of information on influences on antennae and thus the accuracy of GPS time series. The planned contribution to meteorology research needs still much work, especially a reliably working real time data flow and an improved automatical data checking.

Concerning the data checking the organization has been improved such that no site is analyzed by less than 3 Analysis Centers. The experiences show that sometimes relatively small antenna changes only become visible after weeks, so one should be very careful to derive geophysical effects from coordinate variations.

The EPN has contacts to COST action 716 - Exploitation of Ground-Based GPS for Climate and Numerical Weather Prediction, an own EPN Special Project *Creation of a troposphere product* is chaired by G. WEBER, BKG Frankfurt.

According to a call for participation from May 2000 by the IGS for a GLONASS Service pilot project 2000 - 2003, 31 EPN sites announced their interest to participate. Plans are discussed to integrate GLONASS data into the EUREF data flow processing.

Due to the increasing number of processed stations and new subjects of interest of the EPN the tasks have been split among several colleagues, i.e. C. BRUYNINX (network coordinator), M. BECKER[1] (data analysis coordinator), G. STANGL (data flow coordinator), G. WEBER (troposphere, link to COST Action 716), A. Kenyeres (coordination of time series analysis).

The next presentation *EUREF Contribution to ITRF2000 and Analysis Coordinator Report for 8/99 – 6/00* (cf. p. 31) is given by M. BECKER, being responsible for the tasks of the EPN analysis coordinator. At the 1999 EUREF symposium Prague, the Bundesamt für Kartographie und Geodäsie (BKG) got the approval as EUREF combination centre and global solutions. The combined solutions are evaluated in close cooperation with the Astronomical Institute of the University of Berne (AIUB). Extensive investigations of time series proved various systematic influences on the results (e.g. snow), thus any geophysical interpretations basing on coordinate changes should only be derived after the careful exclusion of all possible other influences.

The report on *Frequency Analysis of GPS Coordinate Time Series from the ROB EUREF Analysis Centre* (cf. p. 37) is given by C. BRUYNINX. Presently the time series data is corrected for solid earth tides and ocean loading, a correction for atmospheric loading is not yet implemented. The data sets for a time span of 2 1/2 years were combined from daily

[1] After the change of M. BECKER to the University of the Federal Armed Forces, Munich, H. HABRICH has taken now the responsibility as data analysis coordinator.

to yearly solutions the repeatability of station coordinates up to be 2 – 3 mm in the horizontal and about 5 mm for the height component.

The application of the Fourrier series for frequency analysis proved in many cases as less efficient while wavelets are more informative, showing that the frequency over a longer time span is not always as stable as expected. In all, it has to be stated that a tremendous work is necessary for the analysis of time series before reaching the goal for using coordinate changes for reliable interpretations.

Similar topics are handled in the report by J. DOUSA on the *New activities and products at GOP analysis center (period 1999-2000)* (cf. p. 43), who used different analysis strategies such as weighting correlated with elevations, low elevation data or a horizon gradient model. The hourly data are available with 1 – 1,5 hours delay after delivery.

The activities in cooperation with Italy and Slovenia of the *OLG Analysis Centre Activities – Standards, Problems and New Developments*, presented by G. STANGL, especially treat the Adriatic tectonic area. The activities of the OLG are not completely related to EUREF but also instant GPS, processing of GPS data as service or DGPS monitoring, however can be seen all under an EUREF umbrella.

The tectonical behavior of the Adriatic Plate is also treated in The *New Investigations and Contributions to Geodesy of the Italian GPS Fiducial Network at EUREF Analysis Center ASI/CGS*, presented by C. FERRARO (cf. p. 50). The investigations comprise combinations of different space solutions, using the GPS, SLR and VLBI (baselines Wettzell - Matera - Cagliari) data of the fundamental station Matera. The analysis show a shift of the Adriatic Plate towards north-west as well as a counterclockwise rotation. Sardinia obviously is located on the Eurasian Plate. As another product tropospheric and atmospheric applications are to be mentioned. The Italian GPS fiducial network has been increased by four new stations.

The reports *Concatenation of Hourly RINEX Files* (cf. p. 55) and *Status Report on EUREF's Regional GPS/GLONASS Data Center at BKG* are presented by G. WEBER. The BKG Data Center processes about 450 sites producing 50 – 100 000 files/week. This enormous work needs extensive collaboration with other data centers as ASI (cf. reports above) to solve the various time and personnel consuming problems where in many cases the original data have to be checked for errors and systematic influences. In general the product flow runs rather satisfying, however, some data delays causes severe problems for the data set as a whole. So one of the main tasks is to develop procedures to accelerate and stabilize the communication and data flow. Besides these problems a solution has to be found to avoid the presently occurring double work with hourly and daily data files. The tendency goes into direction for hourly data, nevertheless much work has to be invested to unificate a records to a commonly running system. The issued results contribute to IGS, EUREF and the internal DSAPOS.

EUREF Permanent Network – Developments and Applications (chairperson: W. GURTNER)

The first contribution *EUREF Data Flow - Diagnostics, Proposals and Possible Improvements* to this topic is given by G. STANGL (cf. p. 62, see also the presentation in the TWG session before). As already handled in the previous reports one of the presently main tasks is to improve, secure and automize the communication and data checking. Generally the local station managers have few communication among each other and to the Analysis Centers so that in cases of data delay or erroneous data causes much work.

In the following T. NØRBECH reports on *Practical Consequences of having a "Moving" Geodetic Network with Fixed Coordinates* (cf. p. 66). The investigations in Norway treat the question how to derive reliable terrain movements depending on the number of permanently observing station or campaigns. In Norway two campaigns were observed in 1994 and 1998 from which partly considerable coordinate differences are to be derived. These differences obviously are caused partly by the change of the reference frame, however, it seems that northern Norway is moving as a rigid body with 16.5 resp. 14.2 mm/y in north and east direction. However, the observation technique and analysis methods as well as time series have to be improved considerably before such results can be interpreted in geophysical sense.

A contribution on the long term accuracy and repeatability of results is presented in the paper *The EUREF Permanent Network: Ocean Tide Loading, Height and Troposphere Estimates* by K. KANIUTH (cf. p. 69). An investigation of 25 one day records for 21 sites showed coordinate deviations up to the dm level for some sites while for the most stations the location dependant influences are too small to be distinguished from other influences. A non-ocean tide loading modelling causes errors only below some cm, so other effects which still are not yet known must influence the data.

The *Status of strain in the crust in the Alpine Mediterranean area using a local densification of the European permanent network* is treated in a report by A. CAPORALI (cf. p. 75). The application of tectonic processes hypotheses from geophysics on geodetic data records cannot yet be used to derive quantitative results, however allows to get a qualitative idea on the occurring tectonic effects. In all it has also to be considered that the velocity of each station is significant due to tectonics, however, sometimes local motions occur which hardly can de distinguished from global ones or errors in the registrations.

The report *Analysis of the EUREF-Stations in the South-East of Europe with Respect to the Izmit Earthquake August 1999* by E. EHRNSPERGER (cf. p. 79) investigates the coordinate jumps of EPN station in Turkey in time correlation with the enormous Izmit Earthquake. Basing on the reference stations reference stations CAGL, CASC, EBRE, MEDI, VILL and ZIMM, the length variations up to 25 mm/y of the straight lines between various sites within the Mediterranean and especially Turkey were computed by monthly time

series. These variations obviously increase in the period before the hazardous earthquake. C. BRUYNINX states that behaviour of various other data records from other Analysis Centers and stations prove these findings at least in a qualitative sense. – The next report by A. MULS gives a detailed presentation of *The Information and Communication Layer for a Network of Permanent Reference Stations* in Belgium (cf. p. 89).

Finally M. PRILEPIN informs in his presentation *EUREF and Geodetic Model of Eurasian Plate Movement* (cf. p. 90) on the various existing methods to derive point and plate velocities, especially by paleomagnetic and geodetic methods shown by examples in the areas of the Bering Sea, Baikal region and Caucasian zone. As mentioned in the presentations before the geophysical and geodetic models are fitting rather good, but qualitative predictions are still difficult. Moreover the number of high precise permanent stations has to be increased to improve the data quality.

European Vertical System (chairperson: H. V. D. MAREL)

The introducing presentation to this topic *EVS 2000 – Status and Requirements* is given by W. AUGATH (cf. p. 96). The practical side of this project is still in the phase of beginning. For the geometric levelling data the selection of stations, the adjustment model, modelling of errors, behaviour of monuments have to be studied in detail. Meanwhile a valuable input from space techniques especially permanent GPS stations provides informations with similar accuracy as levelling. The connection of both data sets needs a stochastic modelling of these observations and an accurate connection to levelling points. For absolute gravity data restrictions by accuracy and external effects have to be considered, but with collocation to other techniques valuable information may be gained. The needed software for a common adjustment of levelling, adjusted older heights, space data, gravity and tide gauge records has still to be developed, but promising attempts are already made by the Swiss Federal Office of Topography and the Bundesamt für Kartographie und Geodäsie (BKG). Test data from The Netherlands (5 levelling epochs, Denmark and Germany (each 3 epochs) are available. As outlook W. AUGATH states that this project will still need much time, however one can be confident to make real progress in the near future.

The detailed and important report *The Vertical Reference System for Europe* is presented by J. IHDE (cf. p. 99 and the minutes of the TWG meeting on June 21, cf. this vol. p. 377). The Comité Européen des Responsables de la Cartographie Officielle (CERCO) has officially asked EUREF to provide a common European Height System for cartographic purposes. The requested level of accuracy is limited so such the cartographic demands are fulfilled on the one hand, but on the other hand national restrictions on precise data are normally not touched. In a review J. IHDE reminds the resolutions of the EUREF Subcommission since the 1994 Warsaw symposium. It has to be stated that UELN and EUVN are important steps into this direction, however both represent the realization of a frame but do not define a vertical system in scientific sense. To fulfil this demand the definition of a European Vertical Reference System (EVRS) has been proposed. It has to be considered that presently no accurate connection of this height system to the Amsterdam reference point is possible.

Concerning the kind of height definition it is mentioned that a system for the whole of Europe will be based on normal heights. The individual countries are free to use orthometric heights internally by computing these values via geopotential numbers. It has to be stated that a height system is no static system, but can de referred to some "static" frame.

It is decided to form a small group to formulate clear statements and guidelines for a resolution (cf. Res. no. 5, p 340).

Concerning the practical realizations to the topics treated above, M. SACHER presents two reports *Preliminary Results of Test Computations as a First Step to a Kinematic Height Network (= Test Computations as Preparation for a Kinematic Height Network for Europe)* and *Status of the UELN/EVS Data Base and Results of the Last UELN Adjustment (= Status and Results of the Adjustment and Enlargement of the United European Levelling Network)* (cf. p. 116, 126). For the test blocks Netherlands and Denmark interesting results could be yielded but the adjustment of the complete system will need still much work for collecting and checking the input data (partly from the end of the 19. century), the definition of covariance matrices, bench mark data etc.

For the UELN adjustment Romania has made available its data set now (6620 km levelling lines, 6400 points, 19 polygons), further data from the Czech Republic, Denmark, Germany, Netherlands and Switzerland could be collected. As next steps the data from Bulgaria and Lithuania (then already available data of Latvia and Estonia can be connected) will be delivered. In all 24 European countries are involved now in the UELN.

Concerning the EUVN, J. IHDE presents a report *The Height Solution of the European Vertical Reference Network (EUVN) (= Report of the EUVN Working Group)* (cf. p. 132). The EUVN was initiated at the 1994 Warsaw symposium. The final GPS solution was presented to the 1998 symposium in Bad Neuenahr – Ahrweiler (cf. EUREF proceedings vol. 7). Meanwhile the very time and personnel consuming levelling part could be completed. The concept is to provide precise heights for all observed stations and to give detailed input for a European geoid solution. By the end of 1997 only for 10% of all points accurate information was available while now due to large efforts for most of points (10% missing) geopotential numbers can be computed. The plenary is asked to accept this solution as the final one. It is emphasized that the request for 100% of all points is practically hardly possible or at least would cause an enormous time delay, the results, however, would not change significantly. If considerable new data will be delivered, an extended solution can be provided easily.

Relating the yielded accuracy it has to be mentioned that the solution still included some errors due to erroneous eccentricity elements or other influences. The internal differences between the derived GPS heights and those from the levelling are generally small, for some points, however, relatively large. It can be assumed that these differences mostly are due to the levelling data or/and a non accurate geoid in the respective area.

For the tide gauge part of the EUVN, G. WÖPPELMANN presents the *Status Report on sea-level data collection and analysis within the EUVN Project* (cf. p. 146). The EUVN originally comprised 79 tide gauges, but only for 57 reliable data are available. The majority of the stations are part of the Permanent Mean Sea Level (PSML), but in many cases it is rather difficult to get usable accurate data for the connection of these points to the corresponding EUVN sites. The work for the tide gauge part is still going on, but it is hoped to present the final solution to the 2001 EUREF symposium.

In context with the EUVN the next reports relate national computations. J. MÄKINEN reports on *The Nordic Height system NNH60 and its relationship with UELN-73, UELN-95/98, and the national height systems of Finland, Norway, and Sweden*, followed by D. SOLHEIM with *A New Height Reference Surface for Norway* (cf. p. 154).

EUREF Reference Frame (chairperson: C. BRUYNINX)

The results of the *The Moldavia EUREF Campaign 99* are presented by U. HUGENTOBLER (cf. p. 160). The campaign was observed as a joint Swiss-Moldavian project in May 1999. 5 sites in Moldavia and 4 additional ones in Ukraine were observed for 5 days. Analysing he results it was decided to exclude Ankara as fiducial point due to discrepancies on cm level. Kiev also was let free. A test computation keeping Ankara and Kiev fixed shows discrepancies for these stations of 5 resp. 4 cm. A comparison for the Ukrainian points with those from the EUVN showed also differences of about 4 cm, it is assumed that a centering error in the SLR station Simeiz caused the error.

Following the recommendation of the TWG, the plenary accepts this campaign principally as improvement and extension of EUREF89 as class B standard (about 1 cm at the epoch of observations), but considering that 3points in the Ukraine observed during the EUVN97 and EUREF-Moldavia-99 campaigns show significant height differences, the Ukrainian points are not added to the EUREF database until checked (cf. res. no. 1, p. 340 this vol. and minutes of the TWG session on Tromsø 21.6.2000, pp. 377 this vol.).

The next report given by M. LIDBERG treats *SWEREF 99 – an Updated EUREF Realisation for Sweden* (cf. p. 167) as update of a solution presented before which had to improved to fulfil the EUREF guidelines. The present solution comprises altogether 49 stations, 21 of which are now proposed to be accepted as EUREF stations. Unfortunately the satellite station Onsala is not included in this solution due to a change of the radome which caused unacceptable coordinates differences. Therefore the TWG recommended to install a small secondary network around Onsala to connect this station to the SWEREF-99. It can be adopted that the inclusion of Onsala will not change the existing coordinates, however, it would be useful if this internationally important site would be included within the newest Swedish reference network.

Finally the TWG recommends to the plenary to accept the presented EUREF-SWEREF-99 solution as contribution to EUREF as class B standard (about 1 cm at the epoch of observations), however, the present number of 21 sites has to be reduced according to the EUREF guidelines (cf. res. no. 1, p. 340 this vol. and minutes of the TWG session on Tromsø 21.6.2000, pp. 377 this vol.).

The last report on EUREF campaigns *The BALEAR98 Project: final results* is presented by E. R. PUJOL (cf. p. 176). The results of this campaign were already presented to the last symposium, however, some items had to be investigated in detail or changed. The updated version shows that the results are somewhat stabilized after these improvements.

According to the recommendation of the TWG, the plenary accepts the EUREF-Balear-98 campaign on the Balearic islands (Spain) as class B standard (about 1 cm at the epoch of observations) and endorses the subsets of points as improvement and extension of EUREF89 on class B standard (about 1 cm at the epoch of observations) (cf. res. no. 1, p. 340 this vol. and minutes of the TWG session on Tromsø 21.6.2000, pp. 377 this vol.).

A most interesting presentation relating the EUREF Reference Frame is given by J. CAMPBELL with *The significance of the European VLBI network for the concept of EUREF* (cf. p. 187). J. CAMPBELL thanks for the invitation to inform the public on the VLBI activities which generally only are known to internals. In Europe fortunately a relatively dense network of VLBI stations, financially supported by the European Community, exists by which concentrated actions can be carried out. As one of the common VLBI projects the determination of crustal motions in a first project phase and a second phase concerning especially vertical motions (June 95 – Oct 2001) are to be mentioned.

The number of VLBI stations in Europe is gradually increasing although not all stations are permanently active or are engaged in non-geodetic activities. A great amount of the correlation work is processed by the VLBI group in the Geodetic Institute of the University of Bonn. In average 6 campaigns/y à 24 hours are observed, more extensive campaigns would exceed the financial limits. Within the European campaigns Wettzell is mostly kept fixed, but the data simultaneously are mostly used for global solutions, often combined with SLR experiments, too. Fortunately the Ukrainian station Simeiz which in the past delivered only few usable data now is operating sufficiently and contributes successfully to the common projects.

Comparisons of station velocities from GPS versus VLBI are generally rather good fitting, however, some significant differences occur. These differences give a good chance to investigate the systematic parameters of both systems and also their respective weak parts.

The future plans aim at a stable grid determined by a VLBI frame with a GPS densifying network linked to VLBI, e.g. for a zone in middle Europe by which mm-effects from longer time series could be derived. Presently, however, as also mentioned in the reports above, these data do not allow a reliable interpretation for geophysics. A test area with densifying GPS is observed in the *Rheinischer Graben*. Other areas of special interest are the Fennoscandian uplift, Adriatic region and the Central European Fault.

As conclusion the benefit of VLBI input into EUREF is emphasized, now indirectly via the ITRF to which the VLBI contribute. The comparison with VLBI data offer the chance to model GPS antenna effects and to distinguish non tectonic effects from real ones.

Adoptions of ETRS89 (chairperson: J. A. TORRES)

An introducing review *Report to EUREF 2000 on CERCO & MEGRIN* is presented by the CERCO General Secretary, J. LEONARD (cf. p. 194). He describes CERCO as a *voice of Europe* presenting 35 European countries. In MEGRIN[2] presently 20 countries intend to merge in cartography for a planned Euromapping 2001 (www.cerco.org / www.megrin.org). This common system could help much to avoid the present confusion *what is what* in cartography.

As main objectives of CERCO J. LEONARD mentions the improvement of the exchange of information between its members towards an active cooperation, to reinforce the presence and importance of members, to identify subjects of common policies and to facilitate useful pan-European basical information and products. To fulfil these tasks MEGRIN serves as contract manager and producer for CERCO. In all it can be stated that the European idea is growing in spite of all bureaucracy. EUREF, CERCO WG VIII and GALILEO can really contribute to promote this idea, so their work should be continued as efficiently as possible.

A supplementary report *National CERCO Work Group VIII and EUREF* is given by the chairman of CERCO WG VIII, E. GUBLER (cf. p. 195). He outlines the correlations between practical and scientific geodesy as the community of National Mapping Agencies (NMA) forms CERCO, this organisation is linked via its WG VIII to EUREF which is a subcommission of IAG as an international body of universities and geodetic research institutes. E. GUBLER emphasizes the valuable efforts of H. SEEGER, former chairman of WG VIII, to bring the two groups successfully together and thus join practical and scientific geodesy, otherwise this work would hardly be possible.

E. GUBLER praises the substantial financial support by CERCO for WG VIII to invite colleagues from economical weak countries and support their travel costs to EUREF symposia. Another special fund is available for the collaboration with countries to join UELN.

As a special task of MEGRIN the help for the NMA's for the increasing demand in common GIS requirements to establish a boundary-less data set for Europe is to be emphasized. Meanwhile 20 countries are collaborating in this project.

MEGRIN has been asked by the European Community to organize a spatial workshop. This *Spatial Reference Workshop was held from 29-30 November 1999 in Marne-la-Vallée.* The aim is to connect national data to a common reference frame (ETRS89) which will become de facto standard and also to promote a wider use of ETRS89. The NMA's need much help and advice to fulfil this task. The planned European height system is not yet completed to be used practically, but is can be hoped that it will be available in the near future (cf. the reports by J. IHDE above). *As* experts from EUREF C. Boucher, P. Dunkley, E. Gubler, J. Ihde and G. Weber participated and presented contributions (www.eurogeographics.org/megrin/NEWS_AND_EVENTS/recommendations.pdf).

Concluding it is stated that ETRS89 and EVRS are becoming standards for the European Community and also for countries not yet in EU or in the near neighbourhood. The necessary transformation parameters between the common and national systems are urgently to be estimated and published.

The following report *A European Spatial Reference Systems – Frames for Geoinformation Systems* is presented by J. IHDE (cf. p. 198). He shortly describes the work of ISO TC 211 with many member states and observers for standardization, e.g. rules how to change coordinates from one datum to another or within one datum from one system/set to another one.

Concerning the EUREF/CERCO activities, J. IHDE mentions a letter by E. GUBLER to all European NMA's to install an exactly defined reference on 1 m level for all countries in Europe. Much data is already collected by EUROCONTROL, so mostly only acceptance is needed. All national representatives are urgently asked to contribute to this goal.

An *Introduction of ETRS89 in the Netherlands and how to keep the users of the existing national geometric infrastructure satisfied* is presented by J. V. BUREN. The use of ETRS89 in the Netherlands yields for GPS users more benefits than costs, for data base managers, however, the case is opposite. The differences between the National Datum and ETRS89 not exceed 25 cm in NL. These differences are principally too small to induce real problems in practice, on other hand to large to be neglected when switching from one to the other system. Therefore a so called *polder model* is introduced, fixing 5 sites through stations

[2] With Nov. 1, 2000, CERCO and MEGRIN were combined to EuroGeographics (http://www.eurogeographics.org/megrin/NEWS_AND_EVENTS/Press_release.html)

of active GPS in the ETRS89 as official 3D-system and linking all coordinates to these national reference sites.

G. V. WILLIGEN continues the report concerning the Vertical System in NL. Heights play an important role in the Netherlands where large areas are located below the sea level to control the flooding danger. From 1996 – 99 a 5th primary levelling campaign supported by GPS and gravity measurements was carried out with the focus to install 200 ground marks to monitor the significant distortions found in data and land movements.

The European Reference System in Bulgaria is presented by M. MINCHEV (cf. p. 216). Bulgaria joined to EUREF in 1991/92, the national campaign was carried out in 1996. Thanks to help by the staff of Wettzell a mobile Laser will observe on a site nearby to the Sofia permanent GPS station which is operating very well since May 1997 and included in the EPN. To the EUVN Bulgaria contributed with 3 tide gauges (Varna, Irakli, Burgas). Further Bulgaria also participates in the CERGOP with its CEGRN network.

An interesting historical review on *The European Triangulation Net South East (ENSE) – Site Descriptions and Coordinates* is given by G. WEBER (cf. p. 223). With the ETRS89 accepted as common European Reference System, older data are collected to be linked to this new system and transformation parameters to be derived. The Central European Triangulation Net was initiated by BAYER in 1864 and completed by EGGERT in 1936, cf. the *Veröffentlichungen des Instituts für Erdmessung, Bamberg*, 1946-48. The central part of ED50, computed after World War II, is based on the data of blocks A, B, CH, CS, D, DK, F, L, Lit, NL and P. The south-east part of Europe was adjusted and linked in 1948/49. In the ED50 information of about 60 years is included, numerous points still exist due to exact descriptions and can be linked to EUREF GPS sites as contribution to accurate dense networks.

J. KOSTELECKY adds his ideas on the *Geodetic Integration of Europe: Practical Problems* (cf. p. 226) concerning the various systems and frames used in Europe. Their unification by transformations between ETRS89 and the national systems is shown by an example for the network of the Czech Republic.

Another paper presented by T. BASIC describes the Tra*nsformation between the Local and Global Geodetic Datum in Croatia* (cf. p. 229). As reported in the contribution by G. WEBER above, about 120 identical points from the old Croatian control HR1901 were transformed to the ETRS. After relating the old data to an accurate geoid, both data sets fitted very well. The analysis of the residuals showed the importance to subdivide the old network into adequate blocks.

National Reports (chairperson: W. AUGATH)

A series of national reports is presented (cf. pp. 238):

- *Austria* (E. ERKER)
- *Belgium* (P. VOET)
- *Bosnia/ Herzegovina* (A. MULAHUSIC)
- *Bulgaria*: cf. the report above
- *Croatia* (Z. BACIC)
- *Czech Republic* (J. SIMEK)
- *Denmark* (K. ENSAGER, S. S. VILLADSEN)
- *Finland* (M. OLLIKAINEN)
- France (B. GARAYT)
- *FYROM/Macedonia* (G. LAZESKI)
- *Hungary* (A. KENYERES*)*
- *Ireland* (C. BRAY)
- *Italy* (A. CAPORALI)
- *Latvia* (J. VASILJEV)
- *Lithuania* (A. BUGA)
- *Moldavia* (G. SHARPAK)
- *Netherlands*: no oral presentation, cf. the report above and written report
- *Northern Ireland* (R. MORGAN)
- *Norway* (B. HARSSON)
- *Poland* (L. BARAN)
- *Portugal* (J. PINTO)
- *Russia* (V. KAFTAN)
- *Slovakia* (D. FERIANC)
- *Slovenia* (B. STOPAR)
- *Spain* (E. R. PUJOL)
- *Sweden* (M. LIDBERG)
- *Switzerland* (D. SCHNEIDER)
- *Turkey* (O. LENK)
- *Ukraine* (M. CHEREMSHYNSKY)

Resolutions (chairperson: G. ANDRÉ)

The resolutions committee prepared the texts of the six resolutions. G. ANDRÉ, chairman of the committee, reads and explains the drafts. The plenary discusses the texts extensively and some resolutions are revised. Finally, all resolutions are adopted (cf. p. 340).

Related Contributions (chairperson: J. SIMEK)

Two contributions are presented by J. SLEDZINSKI on *CERGOP-2: New phase of Geodynamic Studies in Central Europe* (cf. p. 326) and V. KAFTAN on *Local Control Network of the Fiducial GLONASS/GPS Station* (cf. p. 333), then J. ADAM informs in detail on the *IAG Scientific*

Assembly, 2 – 7 September 2001 in Budapest (http://www.sztaki.hu/conferences/iag2001/).

Elections

J. A. TORRES, informs that M. Vermeer has asked to retire from the TWG after having changed his duties and to be replaced by A. KENYERS. The plenary accepts the proposal.

Finally J. A. TORRES informs the plenary that W. EHRNSPERGER will retire in the next future. He outlines his longstanding valuable contributions to EUREF with various presentations and thanks for his most careful work for the EPN Analysis Centre as well as all important support for EUREF by the Bayerische Kommission für die Internationale Erdmessung (BEK). The plenary follows these thanks and expresses W. EHRNSPERGER the best wishes for the future.

Next EUREF Symposium

Z. BACIC invites the EUREF Subcommission to hold its 2001 symposium in Dubrovnik/Croatia. The meeting will take place from May 17 – 20, 2001 in the Interuniversity Centre of Dubrovnik (http://www.dgu.tel.hr/dgu/euref/euref2001-information.htm). The plenary thankfully accepts the invitation.

Closing Session

Summarizing the president of the EUREF Subcommission, J. A. TORRES, thanks all colleagues for their participation, presentation of papers, posters and oral contributions as well as for their fruitful discussions. Special thanks go to the Local Organizing Committee under the successful leadership of BJØRN GEIRR HARSSON for organizing this symposium and making our stay in Tromsø so agreeable and successful.

Posters

A series of posters was presents during the symposium where the participants took the opportunity of extensive discussions:

- A. CAPORALI: *Interferometric Attitude and Direction Sensor using GPS/GLONASS Carrier Phase Data* (cf. p. 344)
- J.BOGUSZ, M. KRUCZYK, T. LIWOSZ, M. PFEIL, J. B. ROGOWSKI: *Study on Geophysical Influences to the GPS Coordinates* (cf. p. 348)
- L. JIVALL, M. WESTBERG, A. FRISK, G.HEDLING, B. JONSSON: *SWEPOS Automated Processing Service* (cf. p. 352)
- M. FIGURSKI, M. KRUCZYK, T. LIWOSZ, J. B. ROGOWSKI: G*PS Monitoring of the Atmospheric Parameters* (cf. p. 354)
- J.CISAK, J. KRYNSKI, M. SEKOWSKI: *Performance of DGPS correction distribution using cellular phone* (cf. p. 357)
- L. N. ROŽIĆ, L. FEIL, S. PAVIČIĆ: *Review of Activities on Levelling Works in the Republic of Croatia 1999 – 200*0 (cf. p. 362)
- R. PAŻUS, K. CZARNECKI: *Resuming Zenithals*
- J. T. PINTO, H. C. RIBEIRO: *Resuming Zenithals geoidal heights* (cf. p. 366)
- I. FEJES , J. SLEDZINSKI: CERGOP-2: New Phase of Geodynamic Studies in Central Europe (cf. Related Contributions, p. 326)
- D. SCHNEIDER, E. BROCKMANN, U. MARTI, A. SCHLATTER, U. WILD: *National Report of Switzerland – Introduction of a Precise Swiss Positioning Service "swipos" and Progress in the Swiss National Height Network "LHN95"* (cf. National Reports, p. 315).

Remark: The coloured photos of the symposium participants generally printed with the minutes are due to the high costs for printing not published in this volume. The photos of this symposium as well as of previous ones can be seen on the EUREF homepage http://www.euref-iag.org/Symposia.html / Photo Gallery.