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EUREF Related Activities in the Czech Republic 2015 - 2016 National Report

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Geodetic reference frames in the CR

- Czech Republic area 78,864 km²
- 74,904 triangulation points
- 35,460 associated points
- 1313 levelling lines total 24,705 km
- 119,441 levelling benchmarks (82,856 of the Czech State Levelling Network)
- 462 gravity control stations

Activities related to the coordinate reference systems

•COSMC+RIGTC+LSO WG on a new improved transformation table between ETRS89 x S-JTSK

Implementation of the INSPIRE theme

"Geographical Coordinate Grids": new data set including geographical rectangular ETRS89/GRS80 grid (from 100 km down to 1m); along with ETRS89-LAEA projection published at the COSM Geoportal

 Conversion of heights by the QGZÚ-2013 quasigeoid model (90 x 60 m)

Transformation S-JTSK ↔ ETRS89

- Deformations of the user system S-JTSK: 0 – 0.5 m
- Since 2014: analyses
- 2015: completing measurements of TP along the borders + inland
- 2016: completing measurements of TP and DP inland
- 2017: final computation of a conversion table



Database of control point fields

- Open and free access to the DB of fundamental and densification TP and height points
- Feedback to users through applications "Reporting on Damages" and "Statistics"
- Update according to periodic and dynamic maintenance (2,042 cooperating users, 1,881 messages about defects of geodetic control points)
- 2016: Modernization of DBP: current functionality in new environment (Java EE); concept of a new functionality and new data model: implementation of Cyber-security Law, integration of databases, INSPIRE requirements (coordinate systems + networks)

Database of geodetic control points: Statistics of the use and user's feedback



<u>User's feedback:</u> messages about control point defects 2007 – 2015

- Detailed horizontal control points
- Benchmarks of height control points
- Triangulation and densification points

Number of cooperating users 2007 - 2015





Maintenance of horizontal geodetic control point field (2008 – 2015)



Permanent GNSS Stations and Networks in the Czech Republic 2015

- Fundamental Geodetic Observatory Pecný GOPE, http://www.pecny.cz (IGS, EPN, CZEPOS, VESOG, E-GVAP II)
- CZEPOS: http://czepos.cuzk.cz, Czech Positioning System, 28 PS, operated by the Land Survey Office + 27 PS of neighbour countries
- GEONAS: http://geonas.irsm.asc.cz, 19 PS, experimental monitoring network operated by the Institute of Rock Structure and Mechanics, Acad. Sci. CR
- VESOG: http://pecny.asu.cas.cz/vesog/, research and experimental GNSS network operated by the RIGTC GOP and academic institutions, 8 PS
- TopNet: http://www.geodis.cz, **27 PS**, includes also 11 GEONAS and 3 VESOG PS, operated by the private company GEODIS Brno
- Trimble VRS NOW Czech: http://www.geotronics.vrsnow, 29 sites + 8 sites of Trimble VRS NOW Deutschland, operated by Geotronics Praha, s.r.o. private company
- several smaller networks or individual stations, operated by private companies, e.g. *byS@T* and others
- Total: 108 permanent stations, 12 EPN

Permanent GNSS stations and networks in the Czech Republic



CZEPOS operated by Land Survey Office since 2004/2005 Status 2015/2016: 28 + 27 stations, 1445 users GPS + GLONASS, Galileo ready; 2015/16: 1 station changed, 2 stations coordinate update, SW update, new service VRS3-VirtualRS-GG



Number of CZEPOS – users 2015/2016: today1445



CZEPOS Services



- Real-time services: RTK, RTK-FKP, RTK- PRS, RTK3, VRS3 = 80 Kč (3,26 €) / 1 hour, DGPS = 20 Kč (0,82 €) / 1 hour
- New VRS service with CMR/CMR+ formats
- Post-processing: data interval 1 - 4 sec = 80 Kč (3.26 €), 5 - 9 sec = 16 Kč (0.65 €), 10 - 19 sec = 8 Kč (0.33 €), ≥ 20 sec = 4 Kč (0.16 €)

CZEPOS monitoring

- 75 triangulation test areas
- 3 test baselines in each area
- each baseline tested using site x VRS service
- Web application (cooperation with CTU)
- Operational since April
 2010



GOPE – Fundamental GNSS Station

- Established in 1993, since 1995 has been contributing to IGS (International GNSS Service)
- Topcon Net-G3 receiver, Topcon CR-G3 antenna with a spherical radom TPSH, individual PC calibration
- Tracking the following GNSS: GPS NAVSTAR (L1C, L1P, L2P, L2C), GLONASS (L1C, L2P)
- Post-processing data + real-time data
- Post-processing data downloaded in RINEX 2.10 format in daily files with 30 sec sampling rate, hourly files/ 1 and 30 sec, 15-min files/ 1 sec
- Data are forwarded to the following data centers:
- GOP RIGTC, Czech Republic (hourly and daily 30 sec data)
- BKG, Frankfurt am Main, Germany (hourly and daily 30 sec data)
- OLG, Graz, Austria (hourly and daily 30 sec data)
- CZEPOS, Land Survey Office, Czech Republic (hourly 1 sec data)
- CDDIS, NASA, U.S.A. (15-min 1 sec data)
- Real-time RTCM 2.3 and RTCM 3 data streams forwarded in NTRIP protocol to VESOG caster and further to BKG and CZEPOS casters

GOPE in the M-GEX IGS project

- station GOP6 excentric site of the main GOPE station in the Multi-GNSS Experiment
- Leica GRX1200+GNSS receiver + Leica AR25.R4 antenna with a spherical radom LEIT and individual PC calibrations
- Satellite tracking: GPS NAVSTAR (L1C, L1P, L2P, L2C, L5), GLONASS (L1C, L2P), Galileo (E1, E5a, E5b, AltBoc), SBAS (L1)
- Post-processing data in RINEX 2.10 (directly generated by the receiver) and RINEX 3.01 (conversion from 2.11 using own software in the operation centre):
- hourly and daily files/ 30 sec data
- 15 min files of 1 sec data
- Post-processing data forwarded to:
- CDDIS, NASA, USA (only RINEX 3.01)
- BKG, Frankfurt am Main, Germany (only RINEX 3.01)
- IGN, Paris, France(RINEX 2.10 and 3.01)
- GOP, RIGTC, Czech Republic (only RINEX 2.10)
- Real-time data streams
- binary data Leica LB2
- RTCM 2.3 a RTCM 3
- NTRIP protocol forwarded to NTRIPcaster VESOG/GOP, RIGTC, Czech Republic, binary data LB2 forwarded to the M-GEX caster of the BKG, Frankfurt/Main, Germany

GOP6 M-GEX Site - antenna





GOPE in the JAXA MGM Project

- MGM (Multi-GNSS Monitoring network) Project organized by the Japan Aerospace Agency JAXA – GOPE participates as a hosting station operating a receiver provided on loan by JAXA
- Javad DELTA-G3T receiver is connected through a signal splitter to the Leica AR25.R4 antenna with a spherical radom LEIT installed at the GOP6 site
- Satellite tracking:
- GPS NAVSTAR (L1C, L1P, L2P, L2C, L5)
- GLONASS (L1C, L1P, L2P, L2C)
- Galileo (E1, E5)
- SBAS (L1, L5) including the first QZSS satellite
- Real-time data forwarded to the NTRIP caster of the MGM project in Japan as Javad binary data
- Providing post-processing data generated by the Javad receiver for the M-GEX project under negotiations

GNSS receivers operating at GOPE



Topcon Net-G3: IGS, EPN, CZEPOS



Leica GRX1200+GNSS at GOP6: MGEX



Javad DELTA-G3T at GOP7/GOP6:MGM



Trimble SPS 855 at GOP3: EGNOS, SBAS

Analysis and Research

- EPN GOP Data Center
- EPN GOP Dedicated Analysis Center
- G-Nut Software Development
- Monitoring of permanent GNSS sites
- GNSS-based international projects
- Geodynamics EPN velocities, CEGRN
- IDS Analysis Center GOP

EUREF GOP Data Centre

- Since 2002 daily and hourly GNSS data, navigation messages and precise products
- Since 2007 RT data flows of selected national, regional and global stations via a local NTRIP caster
- Since 2010 historical EPN archive of daily files has been mirrored in support of the full EPN re-processing, data quality monitoring
- Since 2013 EUREF and IGS RINEX 3.X data pool maintained for multi-GNSS data quality monitoring and for developments of new multi-GNSS product generation (ultra rapid orbits, coordinates, troposphere etc.)
- More than 350 stations; 2015 SKPOS and LATPOS included

GOP Analysis Centre

- Dedicated AC complete EPN re-processing using Bernese SW; Implementing up-to-date models to comply with the Repro2 campaign specifications
- GNSS data processing from national, European and global stations → IGS ultrarapid orbits (100 stations, each 6 h), E-GVAP (200 stations, ZTD hourly solution),

G-Nut software development

- GNSS SW library G-Nut developed since 2011 four end user applications derived from the library up to now
- G-Nut/Geb for estimating precise coordinates in offline/real-time mode
- G-Nut/Tefnut for monitoring tropospheric parameters in offline/real-time mode
- G-Nut/Anubis for the data quality check supporting all GNSS constellations, modern frequency bands and signals
- G-Nut/Shu for calculating tropospheric corrections using 3D numerical weather data fields

GNSS Meteorology at GOP

- GOP routine NRT troposphere estimates contributing to E-GVAP-III project
- Hourly troposphere product provided with a maximum latency of 45 minutes from 4 variants (regional GPS, regional GPS+GLONASS, global GPS, RT GPS)
- Products operationally assimilated in several NWP models in Europe and worldwide
- Routine evaluation using newly developed tropospheric database GOP-TropDB
- Since May 2013 active participation in GNSS4SWEC (COST action 1216)

GNSS Meteorology at GOP (2)

- Contribution to the IGS WG Troposphere see http://www.igs.org <u>http://www.igs.org</u>
- Development of an automated system of comparison and evaluation of troposphere parameters (ZTD, horizontal gradients) from different space geodesy techniques (data provided by IAG scientific services) and from NWP models
- Cooperation between GOP and US Naval Observatory

IDS Analysis Centre GOP

- Contribution to the DORIS combination for the realization of ITRF 2014
- Testing SAA data correction model for SPOT-5 satellite and its impact on precise positioning
- Analysis of the impact of "cross track harmonic parameters" on positioning
- DORIS long time series processing (coordinates, troposphere, EOP, orbit parameters) with special regard to modelling earth gravity field parameters and ocean tidal variations
- Implementation and testing "box-wing" model for Saral satellite
- Standards for DORIS processing

GOP participation in international projects

- E-GVAP-III, GNSS4SWEC COST ES1206
- Development and Assessment of Regional Tropospheric Model for Augmented GNSS Positioning and Navigation (ESA)
- EPOS through the CzechGeo project: GNSS, gravimetry, PPGNet GNSS CORS array in Greece
- EPOS-IP (H2020)
- EUPOS[®] contribution to ECC
- CEGRN Consortium MoU between CEGRN and EUREF
- EGNOS SPMS (GSA)

Monitoring and reporting of the Czech permanent GNSS sites – Analysis Center GOP

- Check of stability and quality
- Rapid solution used as a basis
- EPN processing standards and guidelines
- 8:00 UTC the daily solution compared with coordinates + statistical test
- Limits: 7mm, 7 mm and 15 mm for N,E,U components

ECGN, gravity, geodynamics

- Very precise levelling lines in the geodynamic network (longterm rms/1 km error 0.62 mm)
- New gravity reference system S-Gr95/2010
- Detailed gravimetric quasigeoid OGZÚ-2013 (resolution 90 x 60 m)
- superconducting (OSG-050) and absolute gravimetry (FG5 No. 215) at GOP, environmental effects on gravity, contribution to GGP
- Absolute gravity measurements: Hungary (2015 5 sites Torokkoppany, Zalalovo, Sopron-Bánfalva, Sopron-Muck, Fertorákos; 2016 – 4 sites – Debrecen, Csemo, Felsotárkány + Budapest)
- Operation of 6 permanent stations in Greece
- Repeated absolute gravity measurements at GNSS permanent stations (3 EPN): GOPE (11), POL1 (3), KUNZ (3), ZDIB (3), PLZE (2), BRNO (2)

Land Survey Office: Progress in Fundamental Geodynamical Network 2015



Absolute gravity measurements with FG5 No 215 in Czechia, Slovakia and Hungary



Tidal Gravimetry at GO Pecný and Environmental Effects

- gravity time series by GWR OSG-050, Askania Gs15 No. 228 and by LCR 137
- calibration by FG5 No. 215 absolute gravimeter
- very broadband 3-D seismometer
- climatological station
- meteorological parameters
- soil moisture
- ground water level









Thank you for your attention !

for more detailed information please visit http://czepos.cuzk.cz http://www.cuzk.cz http://pecny.cz