Research Institute of Geodesy, Topography, and Cartography – Geodetic Observatory Pecny
Land Survey Office, Prague

EUREF Related Activities in the Czech Republic 2016 - 2017

National Report

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Symposium of the IAG Subcommission for Europe – EUREF 2017
Wroclaw, Poland, 17 – 19 May 2017

Geodetic reference frames in the CR
Managed by Land Survey Office

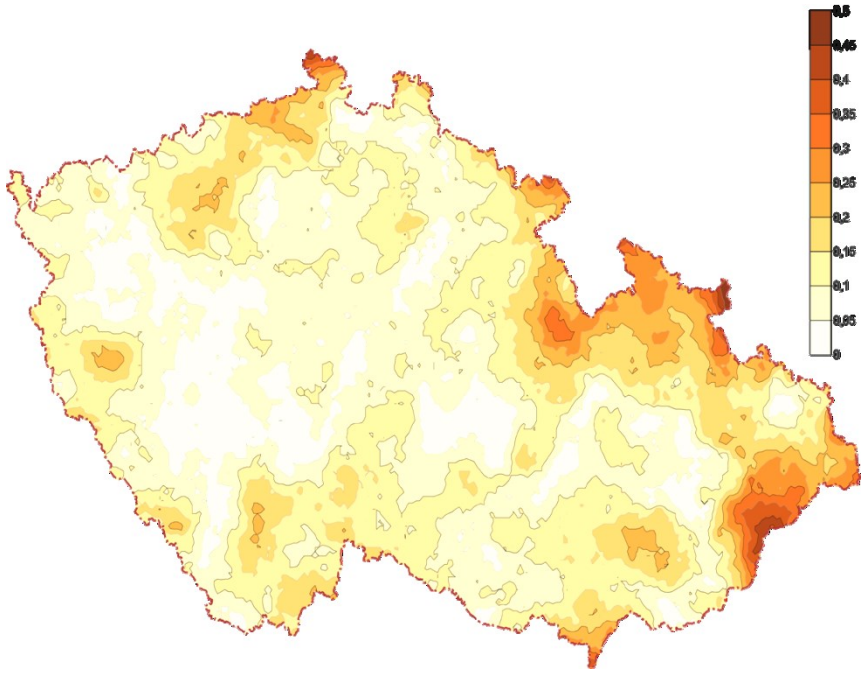
- Czech Republic – area 78,864 km^2
- 74,962 triangulation points
- 35,415 associated points
- 1313 levelling lines – total 24,711 km
- 119,526 levelling benchmarks (82,722 of the Czech State Levelling Network)
- 427 gravity control stations

Activities related to the coordinate reference systems

- COSMC+RIGTC+LSO WG on a new improved transformation table between ETRS89 x S-JTSK (new ETRS89 coordinates of 279 TP)
- Action Plan GeoInfo Strategy → analysis of a unique coordinate and height reference system , see www.mvcr.cz/soubor/analyza-referencnich-systemu-pro-nasapo.aspx

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

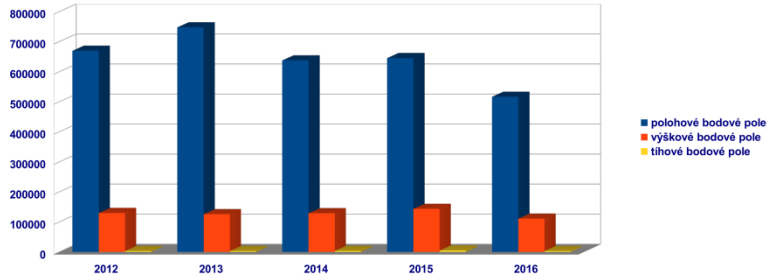


Database of control point fields

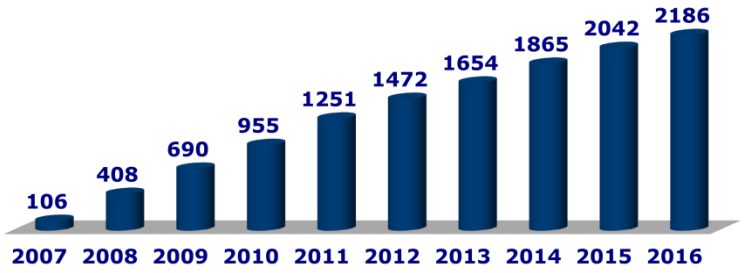
- Open and free access to the DB of fundamental and densification TP and height points
- Feedback to users through applications „Reporting on Damages“ and „Statistics“
- Update according to periodic and dynamic maintenance
- Interrelation between DBCPF and ISCRE (Inf. System of Cadastre of Real Estates)
- Outputs from DBCPF to Information System of State Map Work and to Fundamental Database of Geographic Data (ZABAGED)

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

Number of accesses to DB: position, height and gravity

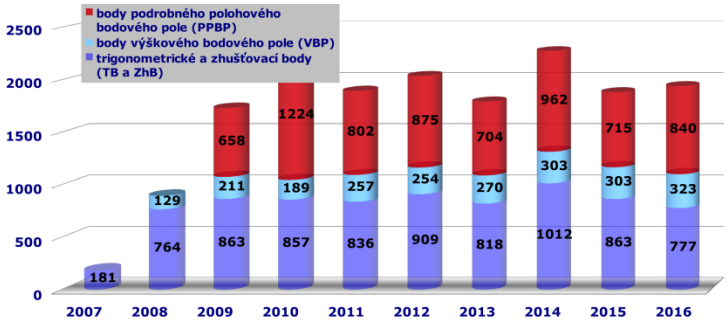


Number of cooperating users 2007 - 2016

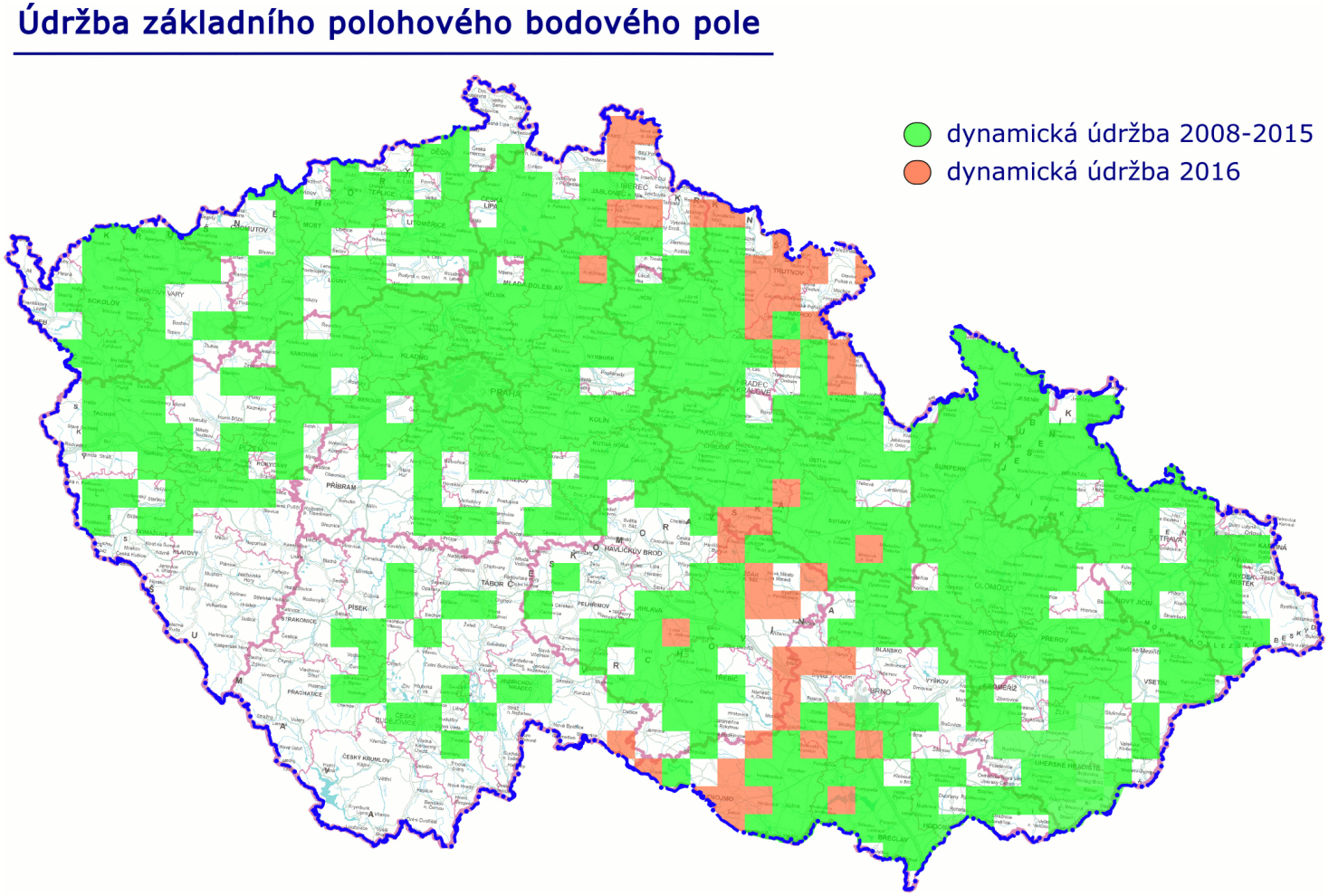


User´s feedback: messages about control point defects 2007 – 2015

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



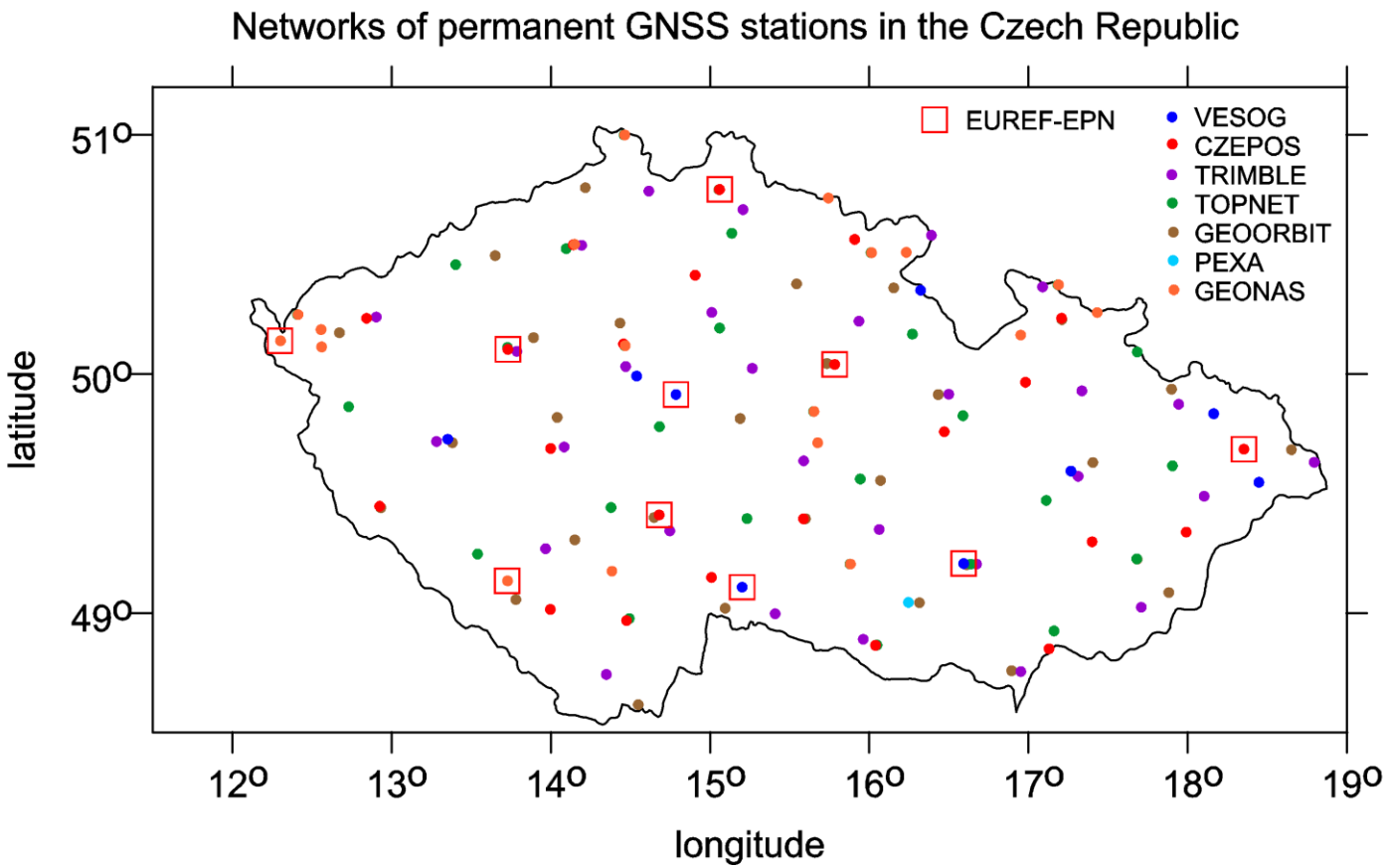
Maintenance of horizontal geodetic control point field (2008 – 2016)



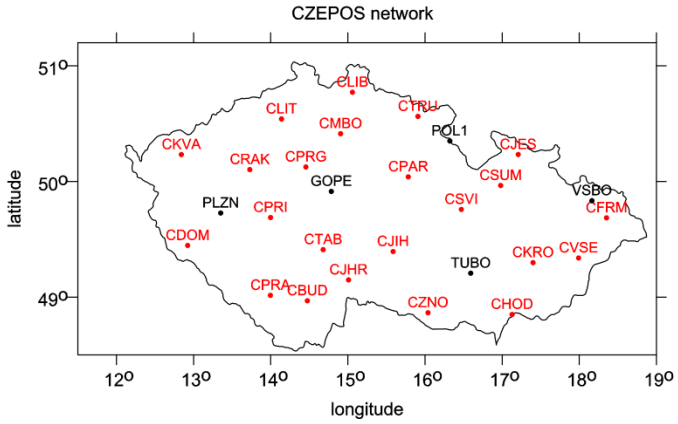
Permanent GNSS Stations and Networks in the Czech Republic 2015

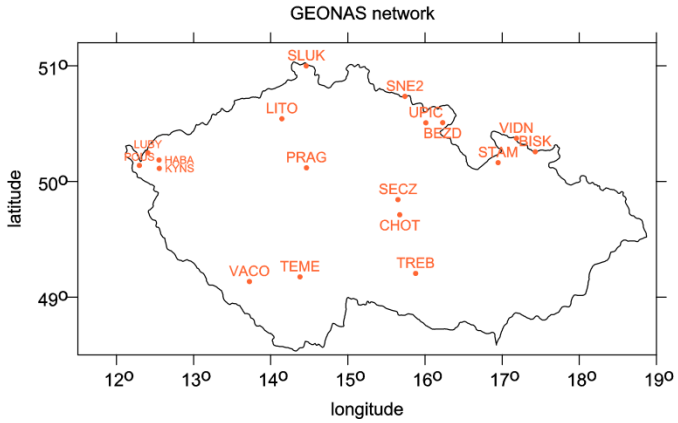
- Fundamental Geodetic Observatory Pecný – GOPE, http://www.pecny.cz (IGS, EPN, CZEPOS, VESOG, E-GVAP II)
- CZEPOS: http://czepos.cuzk.cz, Czech Positioning System, **28 PS**, operated by the Land Survey Office + **27 PS** of neighbour countries
- GEONAS: http://geonas.irsm.asc.cz, **19 PS**, experimental 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
- GEOORBIT https://www.geoorbit.cz, **30 PS,** geoobchod, s.r.o.
- several smaller networks or individual stations, operated by private companies, e.g. *byS@T,* PEXA and others
- **Total: 139 permanent stations, 11 EPN**

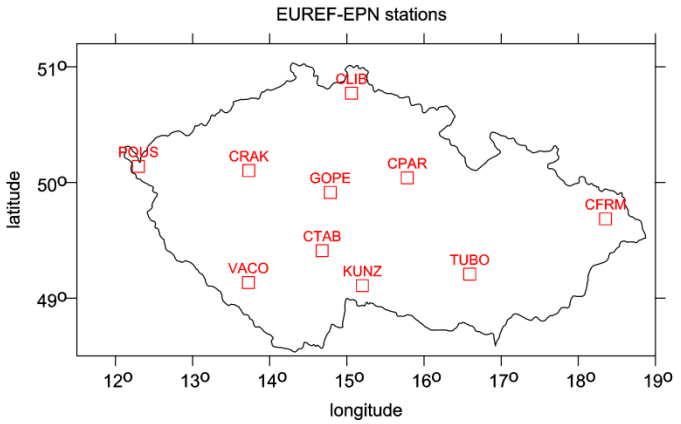
Permanent GNSS stations and networks in the Czech Republic: Status May 2017



GNSS Permanent sites in CR (1)

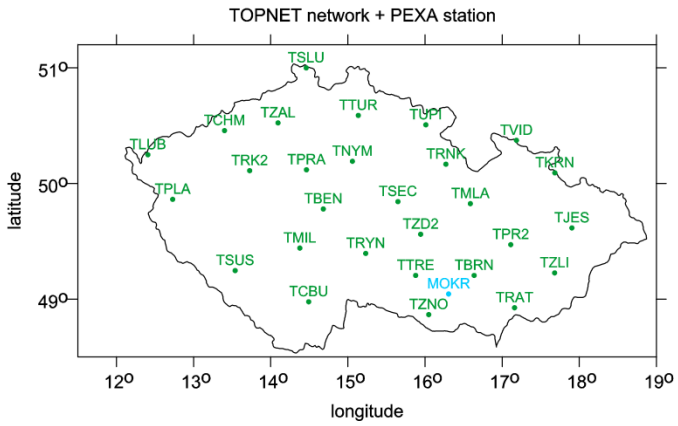


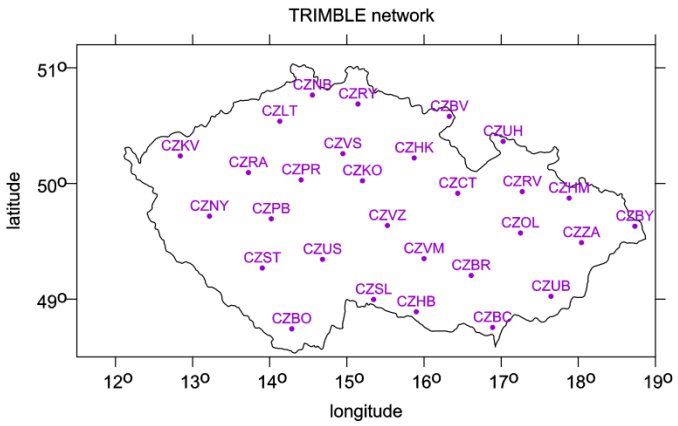


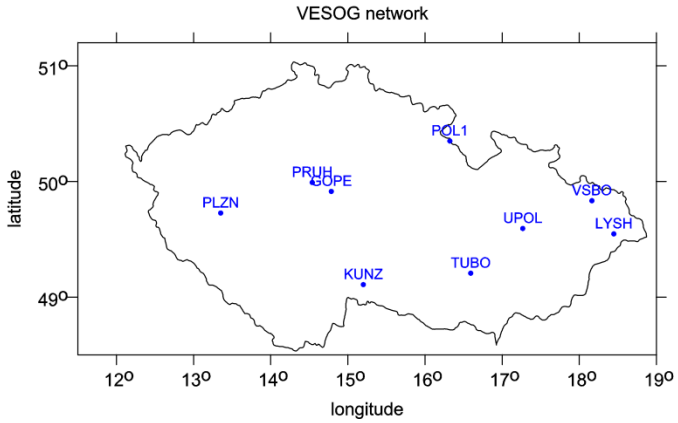


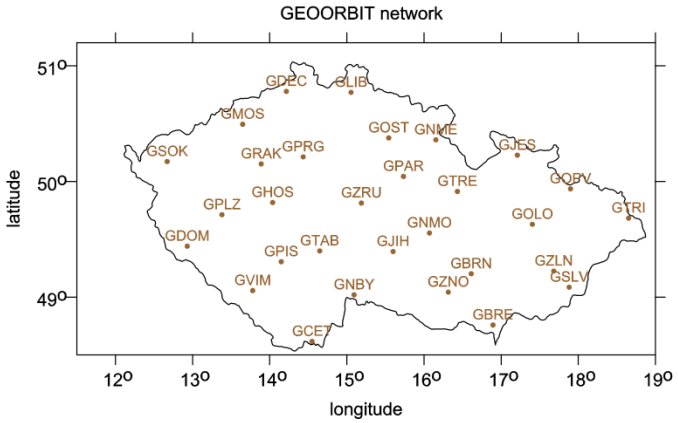
- Since April 2017 LSO has been delivering Galileo data from 5 CZEPOS/EPN sites to EPN
- RINEX 3.02

GNSS Permanent sites in CR (2)





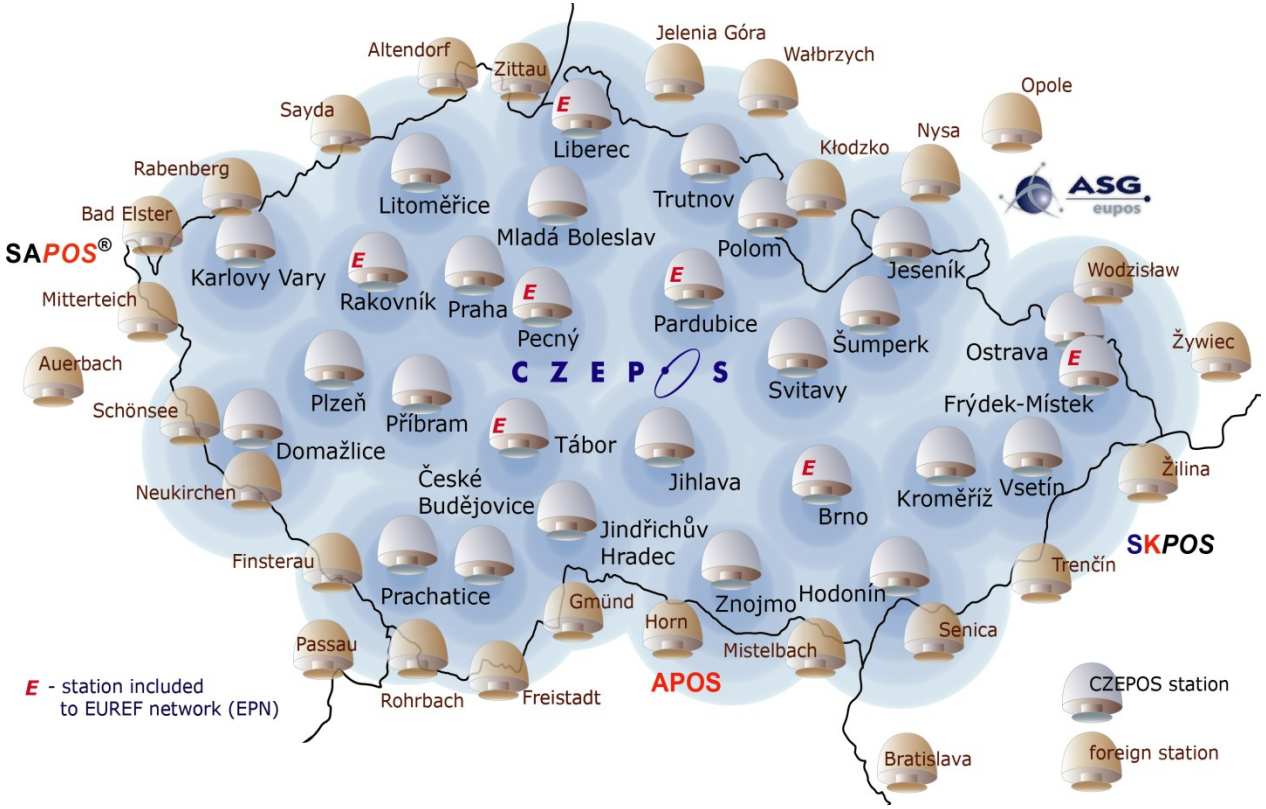


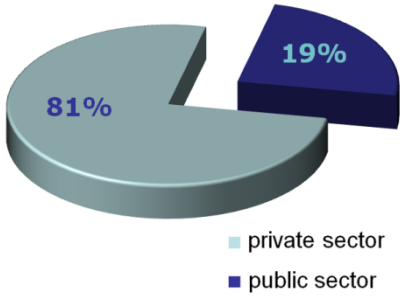


CZEPOS operated by Land Survey Office since 2004/2005

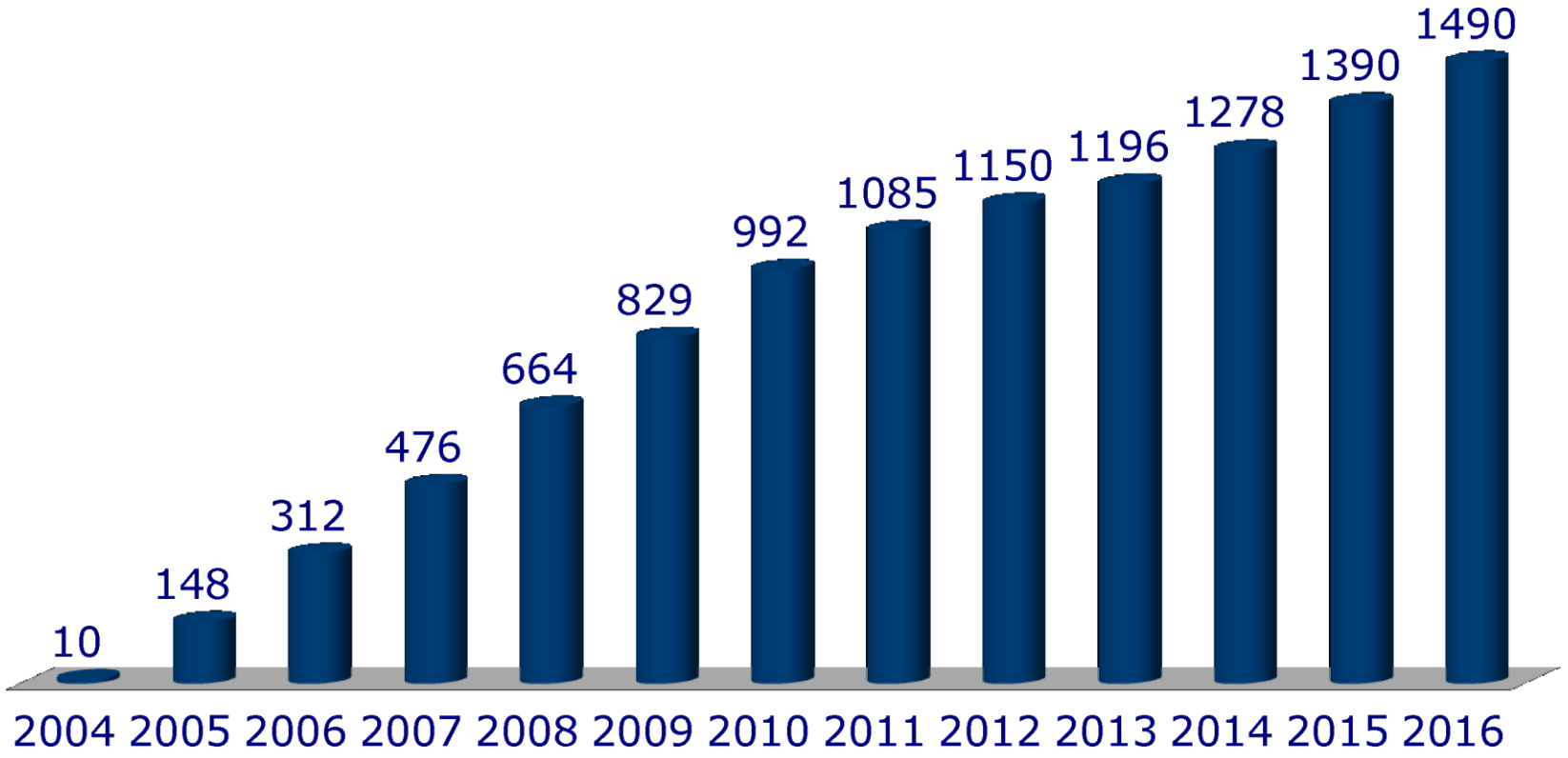
Status 2015/2017: 28 + 27 stations, 1490 users

GPS + GLONASS, Galileo ready

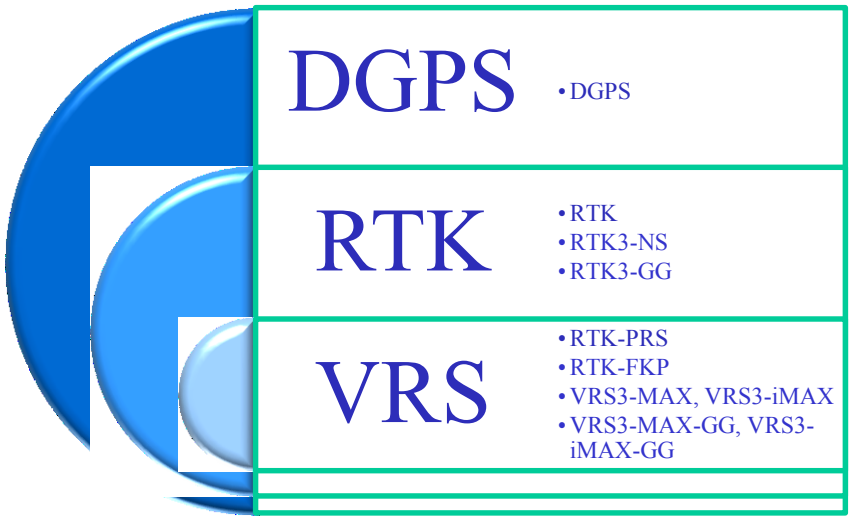




Number of CZEPOS users 2004 - 2016



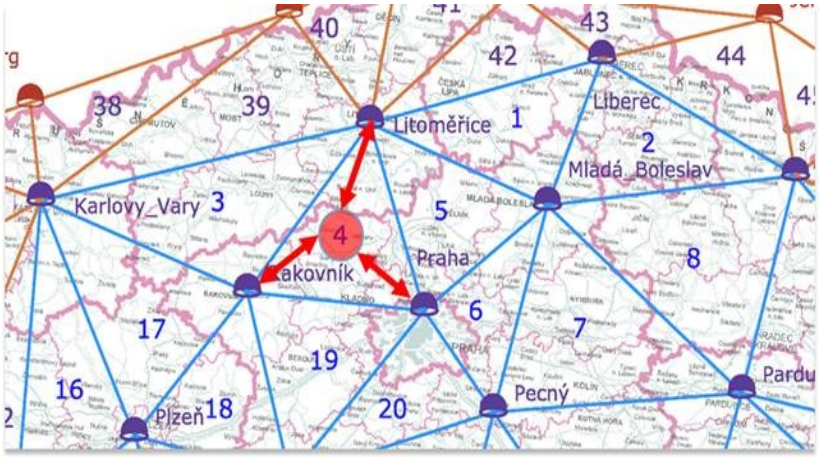
CZEPOS Services

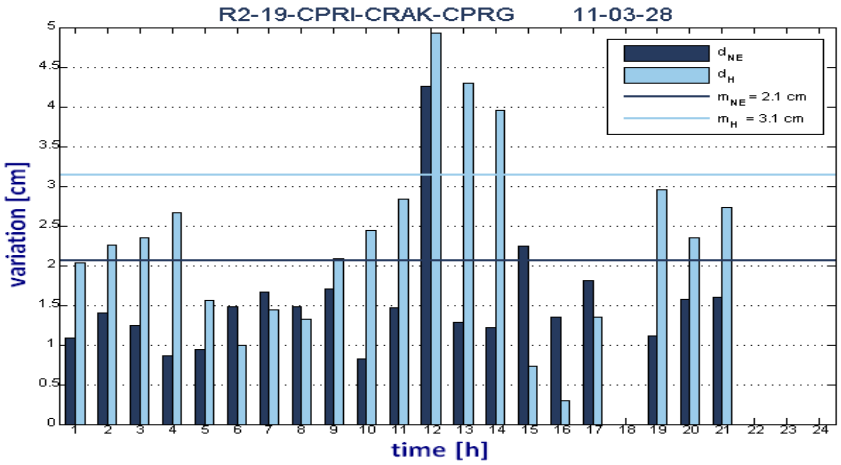


- **Real-time services:** RTK, RTK-FKP, RTK-PRS, RTK3, VRS3 = 80 Kč (3,26 €) / 1 hour, DGPS = 20 Kč (0,82 €) / 1 hour
- New VRS service with CMR/CMR+ formats
- **Post-processing:** data interval 1 – 4 sec = 80 Kč (3.26 €), 5 – 9 sec = 16 Kč (0.65 €), 10 – 19 sec = 8 Kč (0.33 €), ≥ 20 sec = 4 Kč (0.16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

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), EPN since 1996
- Topcon Net-G3 receiver, Topcon CR-G3 antenna with a spherical radom TPSH, individual PC calibration
- Participation in IGS M-GEX Project
- Station GOP6 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)
- JAXA MGM Project: + QZSS; Javad DELTA-G3T receiver connected through a signal splitter to the Leica AR25.R4 antenna with a spherical radom LEIT installed at the GOP6 site
- **EGNOS SPMS** project – station GOP3 (GSA)
- **GRC** Project (GSA)

GOP6 M-GEX Site - antenna

GNSS receivers operating at GOPE

Topcon Net-G3: IGS,EPN,CZEPOS

Javad DELTA-G3T at GOP7/GOP6:MGM

Leica GRX1200+GNSS at GOP6: MGEX

Trimble SPS 855 at GOP3: EGNOS, SBAS

Analysis and Research

- GOP Data Center
- EPN GOP Dedicated Analysis Center
- G-Nut Software Development
- Monitoring of Czech permanent GNSS sites
- GNSS-based international projects
- Geodynamics – EPN velocities
- IDS Analysis Center GOP (DORIS)

EPN GOP Data Centre

- Since 2002 daily and hourly GNSS data, navigation, observation and meteo files,from EPN, part of IGS + other non-anonymous (project oriented) data and precise products (CODE, IGS, EPN)
- 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 ultra-rapid 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 http://www.igs.org
- 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

GNSS Meteorology at GOP (3)

- Development and assessment of tropospheric model for augmented GNSS positioning and navigation (ESA)
- Development of advanced methods of GNSS processing in synergy with meteorological and climatological data – activities in support of GNSS4SWEC: Benchmark and RT campaign for development, evaluation and demonstration of troposphere products
- COST ES1206: WG1 (Advanced GNSS Processing Techniques); data and product preparation for Benchmark campaign – slant TD from GNSS, WVR and NWM; systém of monitoring and evaluation of the results

IDS Analysis Centre GOP

- Contribution to the DORIS combination for the realization of ITRF 2014
- Testing SAA data correction model for Jason-1 satellite and its impact on precise positioning
- Implementation and testing Jason-2 attitude
- Analysis of the impact of „cross track harmonic parameters“ on positioning
- DORIS long time series processing (coordinates, troposphere, EOP, orbit parameters) 2006 – 2016 with special regard to modelling earth gravity field parameters and ocean tidal variations
- OPTIDOR – model optimization
- 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)** – development of GLASS system for an efficient data distribution; Anubis modification
- EUPOS® – contribution to ECC
- CEGRN Consortium – MoU between CEGRN and EUREF
- EGNOS - SPMS (GSA)
- GRC (GSA)

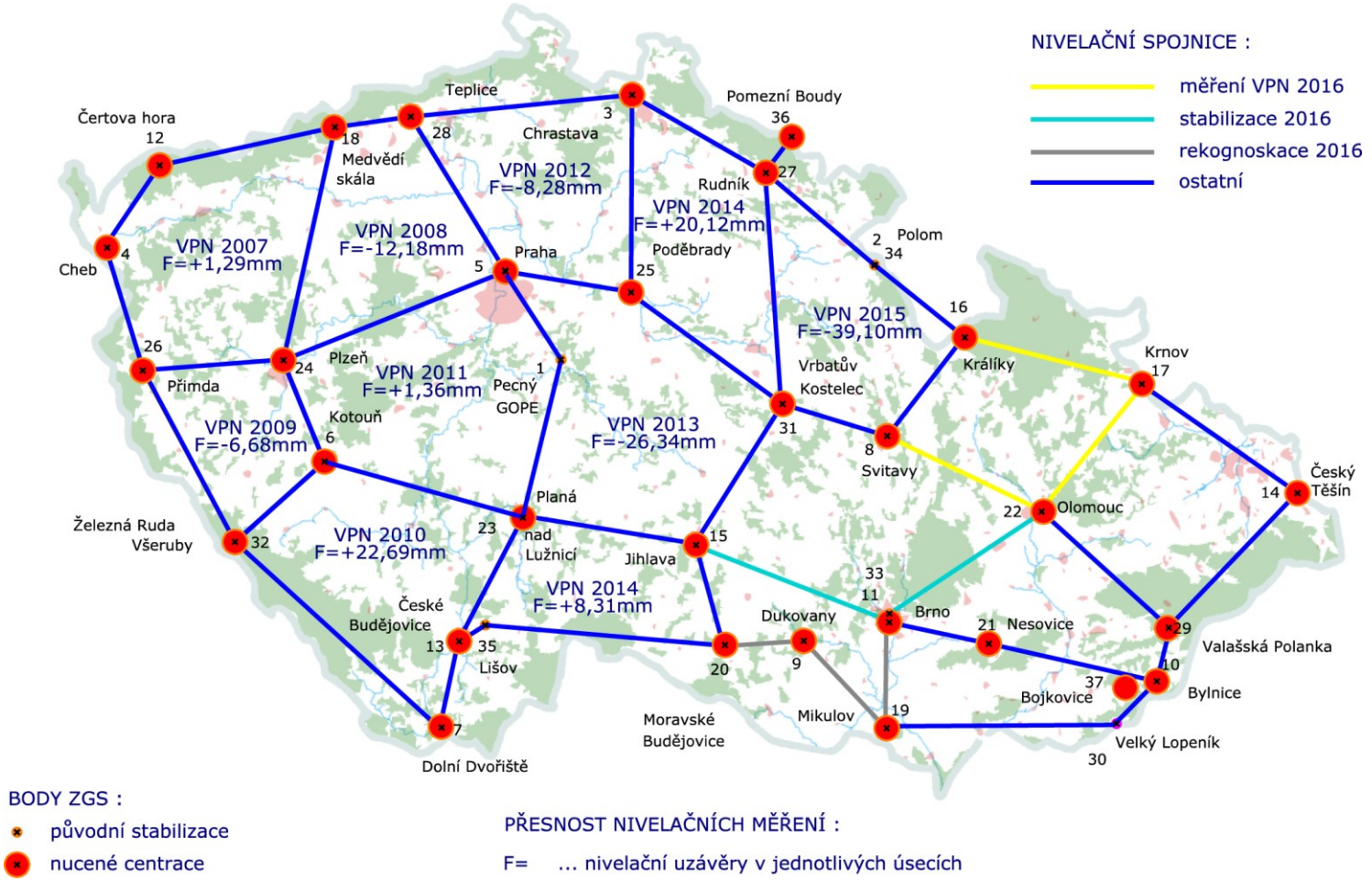
Monitoring and reporting of the Czech permanent GNSS sites – Analysis Center GOP

- Check of stability and quality
- Currently 123 stations in monitoring
- 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
- Reporting for NMA

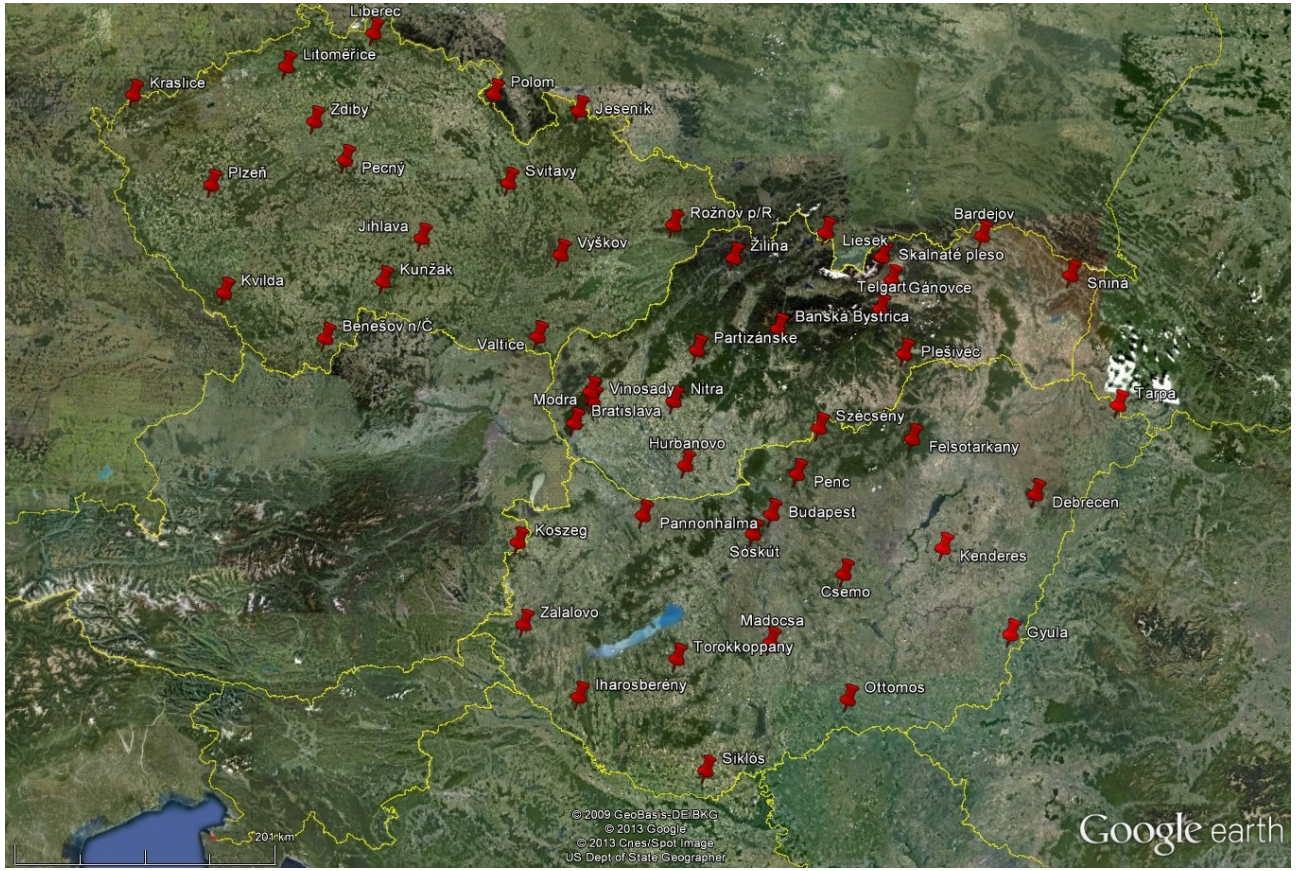
ECGN, gravity, geodynamics

- Very precise levelling lines in the geodynamic network (long-term (2007 – 2015) rms/1 km error 0.88 mm)
- Gravity field stability control around GO Pecny (LSO)
- Detailed gravimetric measurements in support of gravimetric quasigeoid OGZÚ-2013 improvement (825 gravity points)
- superconducting (OSG-050) and absolute gravimetry (FG5 No. 215 and FG5X) at GOP, environmental effects on gravity, contribution to GGP
- Absolute gravity measurements: Hungary, Slovakia, Czech Republic)
- Operation of 6 permanent GNSS stations in Greece in support of regional tectonic movements detection
- Repeated absolute gravity measurements at GNSS permanent stations (3 EPN): GOPE (11), POL1 (3), KUNZ (3), ZDIB (3), PLZE (2), BRNO (2) → ECGN approach

Land Survey Office: Progress in Fundamental Geodynamical Network Status 2016



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



List of absolute gravity stations measured by GOP absolute gravimeter FG5X 2016 - 2017

Czech Republic

- PECNY
- PLZEŇ ZČÚ
- POLOM
- PRAHA
- LITOMĚŘICE
- KUNŽAK
- BRNO
- BENEŠOV NAD ČERNOU

Slovakia

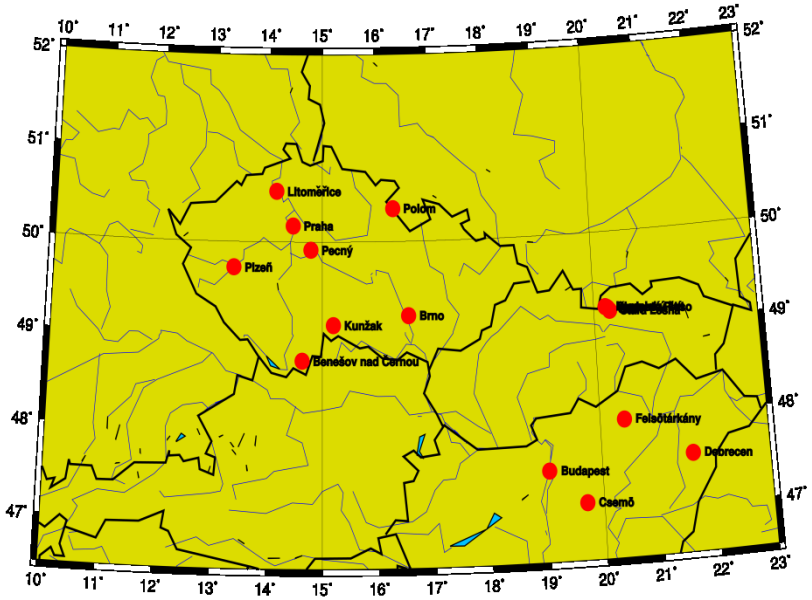
- LOMNICKÝ ŠTÍT
- SKALNATÉ PLESO
- STARÁ LESNÁ
- ŠTART

Hungary

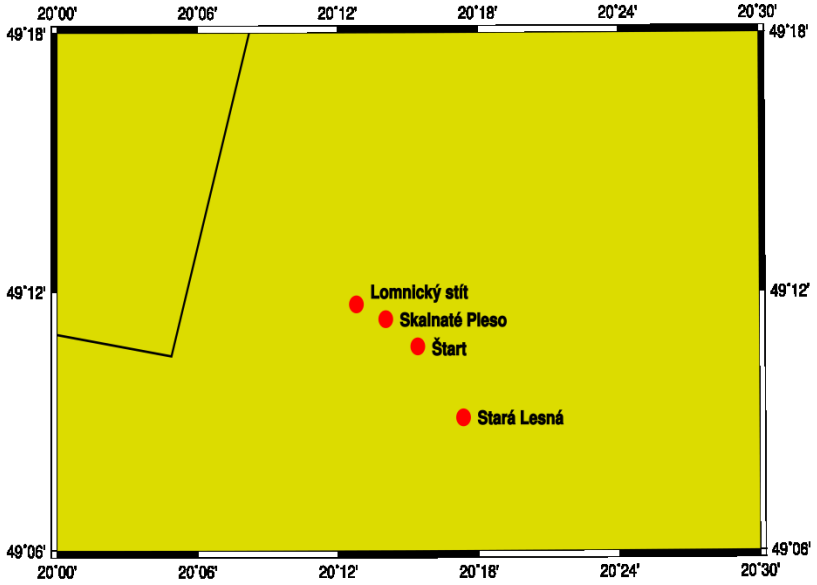
- BUDAPEST
- CSEMÖ
- DEBRECEN
- FELSÖTÁRKÁNY

Absolute gravity measurements with FG5X in Czechia, Slovakia and Hungary 2016 - 2017

Overview 2016 - 2017



Slovakia - detail



Tidal Gravimetry at GO Pecný and Environmental Effects

- gravity time series by superconducting GWR OSG-050 and by LCR 137
- calibration by FG5 No. 215 and FG5X absolute gravimeters
- very broadband 3-D seismometer
- climatological station
- meteorological parameters
- WV radiometry
- soil moisture
- ground water level

3rd *EUPOS*® Council Meeting
3rd EuroGeographics PosKEN Meeting
Prague, Czech Republic
November 2016

Thank you for your attention !

for more detailed information please visit

http://czepos.cuzk.cz

http://www.cuzk.cz

http://pecny.cz