EUREF Symposium 2015

National report of Slovakia 2015

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EUREF 2015, annual symposium
3-5.June 2015, Leipzig, Germany

Outline

- Slovakian activities and contributions to EPN
- Status, activities and news from
  - **SK*POS*** (Slovak real time positioning service)
  - national levelling network
  - national gravimetric network
- Research and development
  - Activities of Geodetic and cartographic institute
  - Activities of Slovak university of Technology
- Other news from Slovakia

Slovakian activities and contributions to EPN

EPN Operational centers

Geodetic and Cartographic Institute Bratislava (GKÚ)

Slovak University of Technology in Bratislava (SUT)

Slovakian activities and contributions to EPN

EPN Local analysis center

EUREF LOCAL ANALYSIS CENTRE

Agency acronym	: SUT
Institution	: Slovak University of Technology
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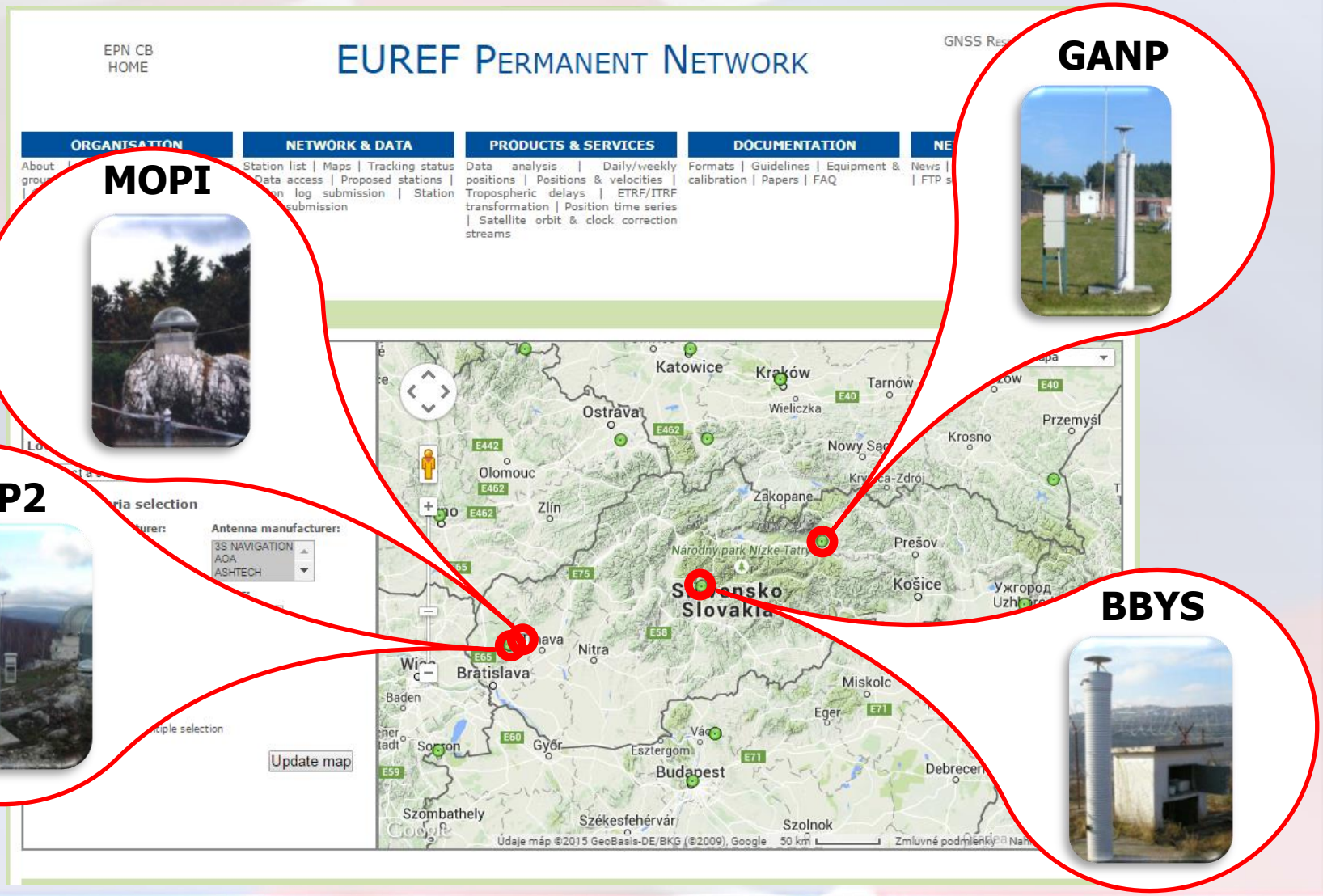
E-Mail	: martina.minarikova@stuba.sk
Third Contact	
Contact Name	: Miroslava Haque Igondova
Telephone	: + 421 2 5249 8047
Fax	: + 421 2 5292 5476
E-Mail	: miroslava.igondova@stuba.sk
Software Used	: Bernese GPS Software, v. 4.2, BPE (until 1339 week) : Bernese GPS Software, v. 5.0, BPE (since 1400 week)

Slovak University of Technology in Bratislava (SUT)

Slovakian activities and contributions to EPN
Permanent stations contribution



Slovakian activities and contributions to EPN

Permanent stations contribution

GANP

BBYS

EPN CB HOME

EUREF PERMANENT NETWORK

ROB GNSS RESEARCH GROUP

EUREF

ORGANISATION — About | Components | Working groups | Management | Contributors | Collaborations | Site map

NETWORK & DATA — Station list | Maps | Tracking status | Data access | Proposed stations | Station log submission | Station picture submission

PRODUCTS & SERVICES — Data analysis | Daily/weekly positions | Positions & velocities | Tropospheric delays | ETRF/ITRF transformation | Position time series | Satellite orbit & clock correction streams

DOCUMENTATION — Formats | Guidelines | Equipment & calibration | Papers | FAQ

NEWS, EVENTS & LINKS — News | Mails | Calendar | Workshops | FTP server | Web history | Links

NETWORK & DATA > **STATION LIST**

As of 21 May 2015, 266 permanent GNSS tracking stations (including 2 inactive) are part of the EUREF Permanent Network.

For a better understanding of the table, see the legend.

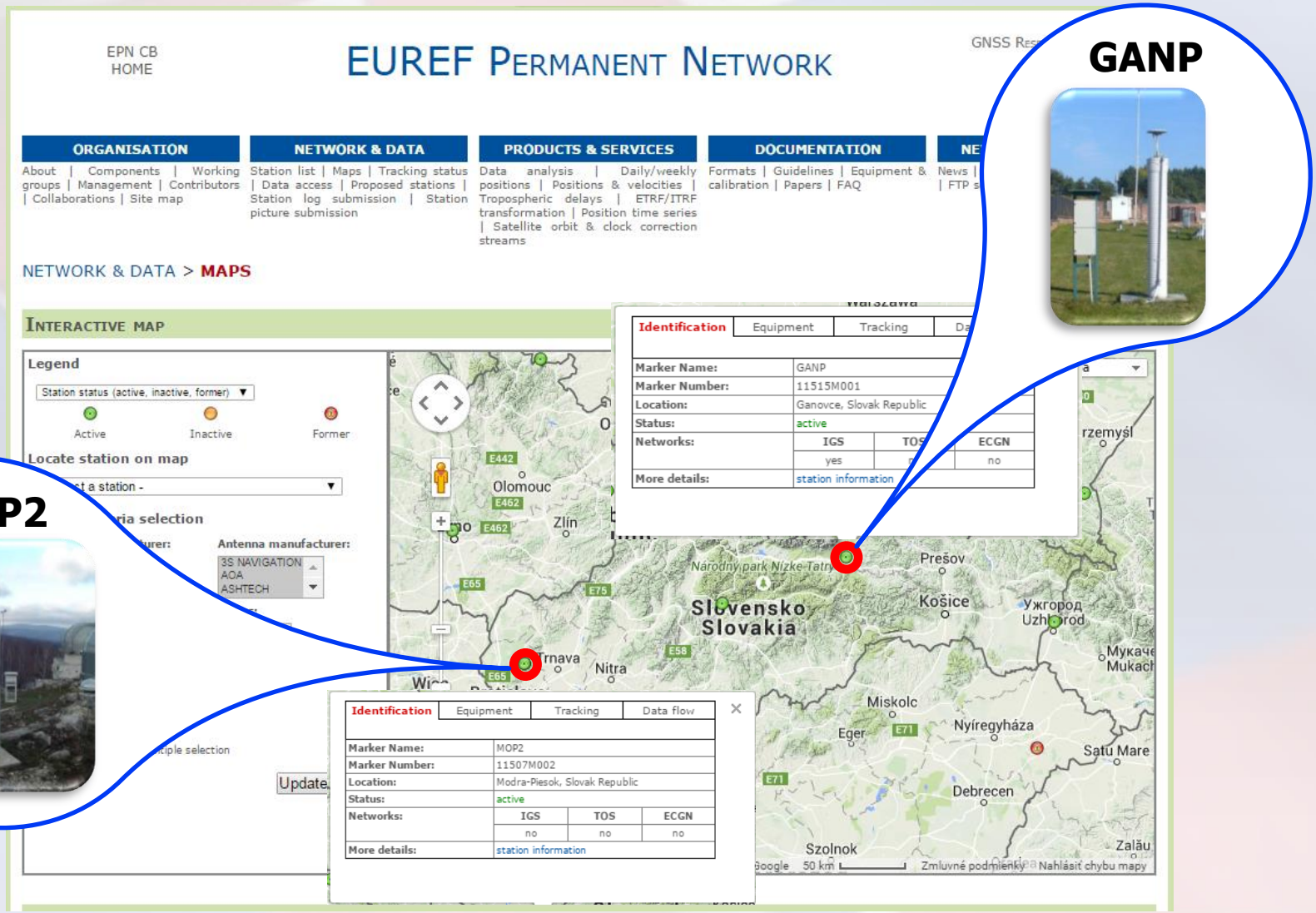
Station Identification | Station Location | Data | Receiver Information | Antenna Information | Meteorological Instr. | Additional Information | Station Status

Marker Name | City | Quality | Type | Type/Radome | Meteo data | Primary data centre

Long Station Name	City	Country	DQ (%) 0°	DQ (%) 15°	Daily (%) BKG	Daily (%) OLG	Hourly (%) BKG	Hourly (%) OLG	RT (%)	Last Data Available	Latency Hourly BKG	Latency Hourly OLG	Latency RT (s)	Receiver Sat. System G	R	E	C	J	S	RINEX 3 data available	Remarks
BBYS00SVK	Banska Bystrica	Slovak Republic	9	94	100	100	97	97	_	2015-05-20	97	96	_	✔	✔	✔	✔	✔	✔	3.02	
GANP00SVK	Ganovce	Slovak Republic	88	96	100	100	98	98	100	2015-05-20		96	0.5	✔	✔	✔	✔	✔	✔		
KI[illegible]NE	Kiruna	Swed[illegible]	88	100	100	100	100	100	_	2015-05-20	100	99	_	✔	✔	✔	✔	✔	✔	3.02	
WROC00POL	Wroclaw	Poland	95	100	100	89	100	100	100	2015-05-20	100	99	0.4	✔	✔	✔	✔	✔	✔	3.02	
LPAL00ESP	Roque de los Muchachos	Spain	91	100	100	100	99	99	100	2015-05-20	98	96	0.8	✔	✔	_	_	✔	✔	_	
STAS00NOR	Stavanger	Norway	94	100	100	100	100	100	100	2015-05-20	0	0	0.8	✔	✔	✔	✔	✔	✔	_	
PRAT00ITA	Prato	Italy	81	99	100	100	100	100	_	2015-05-20	88	83	_	✔	✔	_	_	_	_	_	
QAQ100GRL	Qaqortoq / Julianehaab	Greenland	94	100	93	93	97	97	_	2015-05-20	95	92	_	✔	✔	_	_	_	_	_	

Slovakian activities and contributions to EPN

EPN Real-time analysis WG



Slovakian activities and contributions to EPN

Monitoring of the official national ETRF coordinates on EPN web ("Elmars activity")

EPN CB HOME

EUREF PERMANENT NETWORK

ORGANISATION | NETWORK & DATA | PRODUCTS & SERVICES | DOCUMENTATION

5. POSITIONS PUBLISHED BY THE COUNTRY

The official ETRS89 coordinates used in Slovakia are maintained by ***GKU***. This agency is fully responsible for the information kindly provided to the EPN:

Valid (from - to)	epoch t_0	Position (m)			Velocity (m/y)		
		X	Y	Z	V_X	V_Y	V_Z
111/2012 - now	184/2008	3929181.851	1455236.510	4793653.699	NA	NA	NA
310/2006 - 111/2012	233/2006	3929181.849	1455236.511	4793653.696	NA	NA	NA
310/2006 - 111/2012	184/2008	3929181.850	1455236.509	4793653.700	NA	NA	NA

Following a recent initiative of the EUREF Technical Working Group (Monitoring of official national ETRF coordinates on EPN web), the differences between the national coordinates and the latest cumulative EPN solutions (section 1) are regularly monitored. They are given in two maps: [horizontal differences] and [vertical differences].

Active Inactive Former

Locate station on map

Antenna manufacturer:

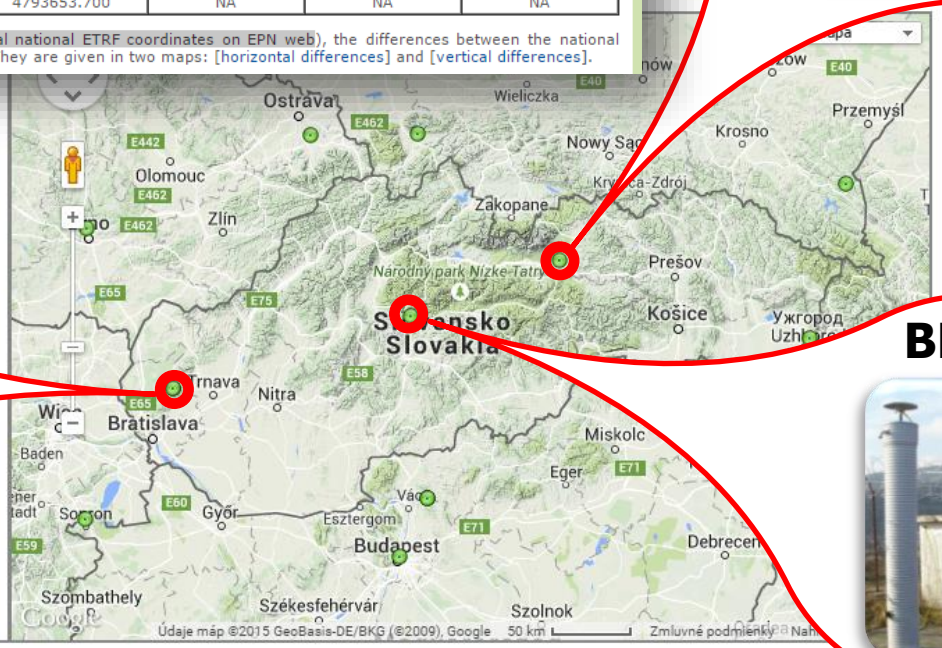
3S NAVIGATION
AOA
ASHTECH

Update map

GANP

MOP2

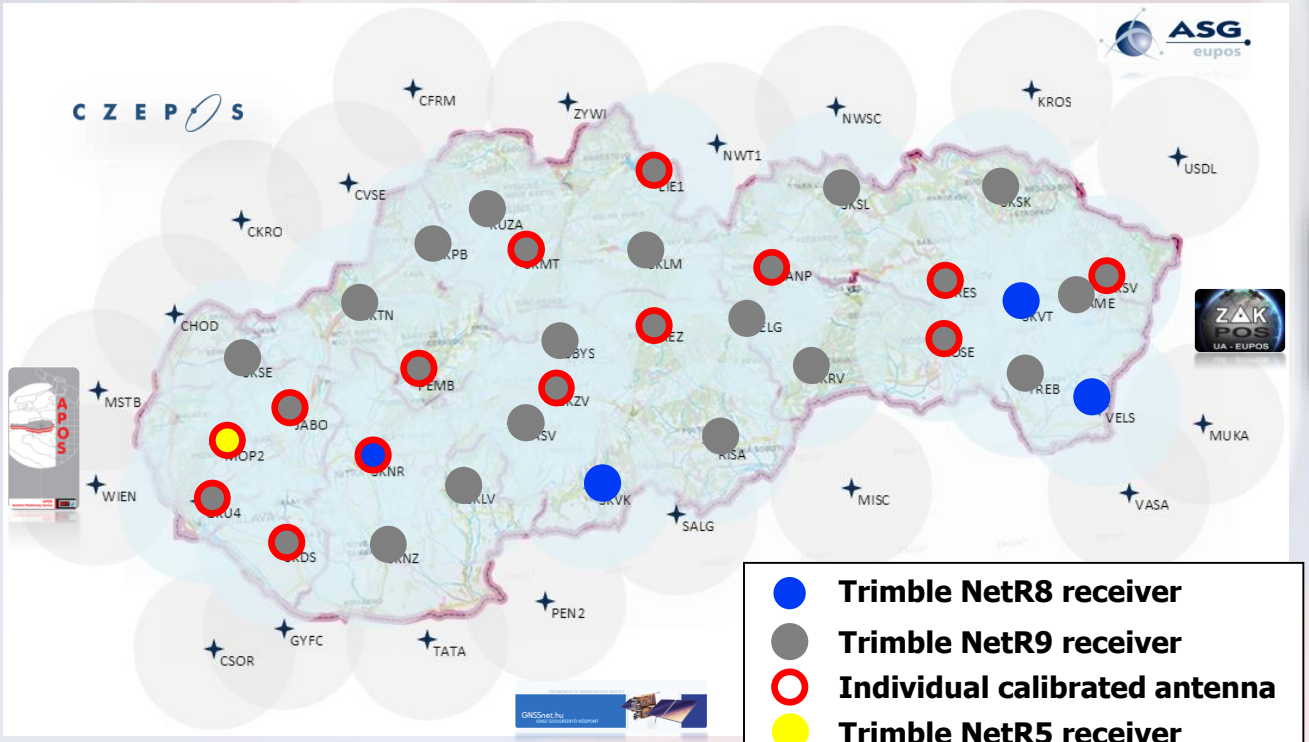
BBYS



News from national spatial network (GNSS positioning)

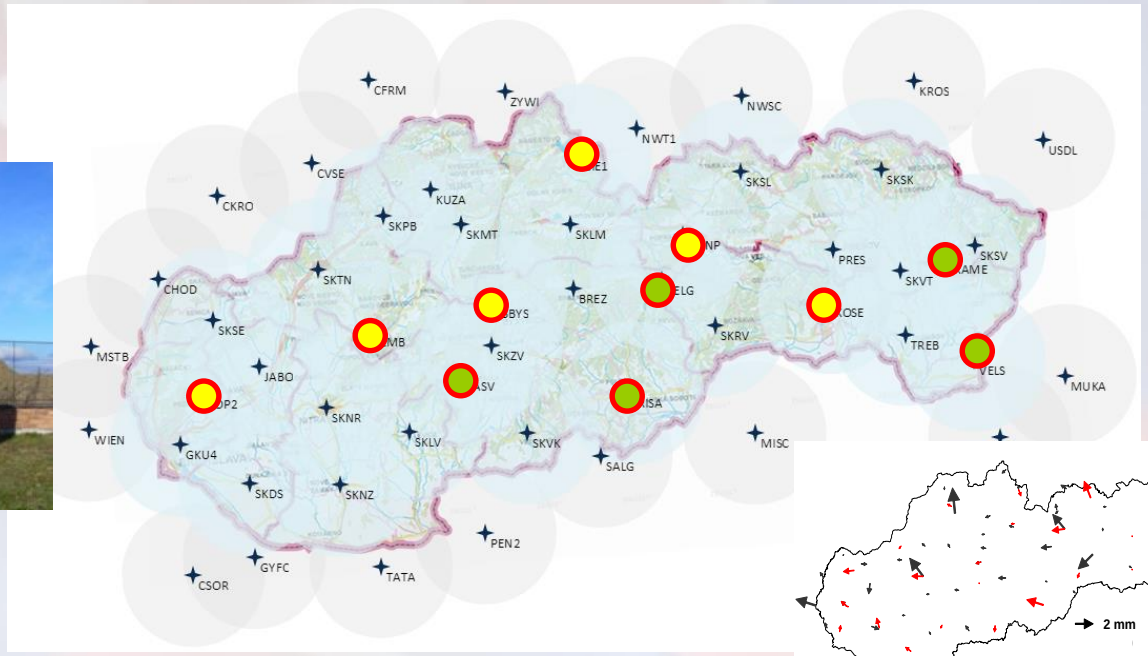
Slovak real time positioning service - SK*POS*® infrastructure (status in May 2015)

- **33 Slovakian permanent stations (14 individual calibrated)**
  - All stations with TRIMBLE receivers and antennas
  - All stations observe GPS+GLONASS signals (few Galileo)
- **19 foreign permanent stations (APOS, gnssnet.hu, CZEPOS, ASG-EUPOS, ZAKPOS)**



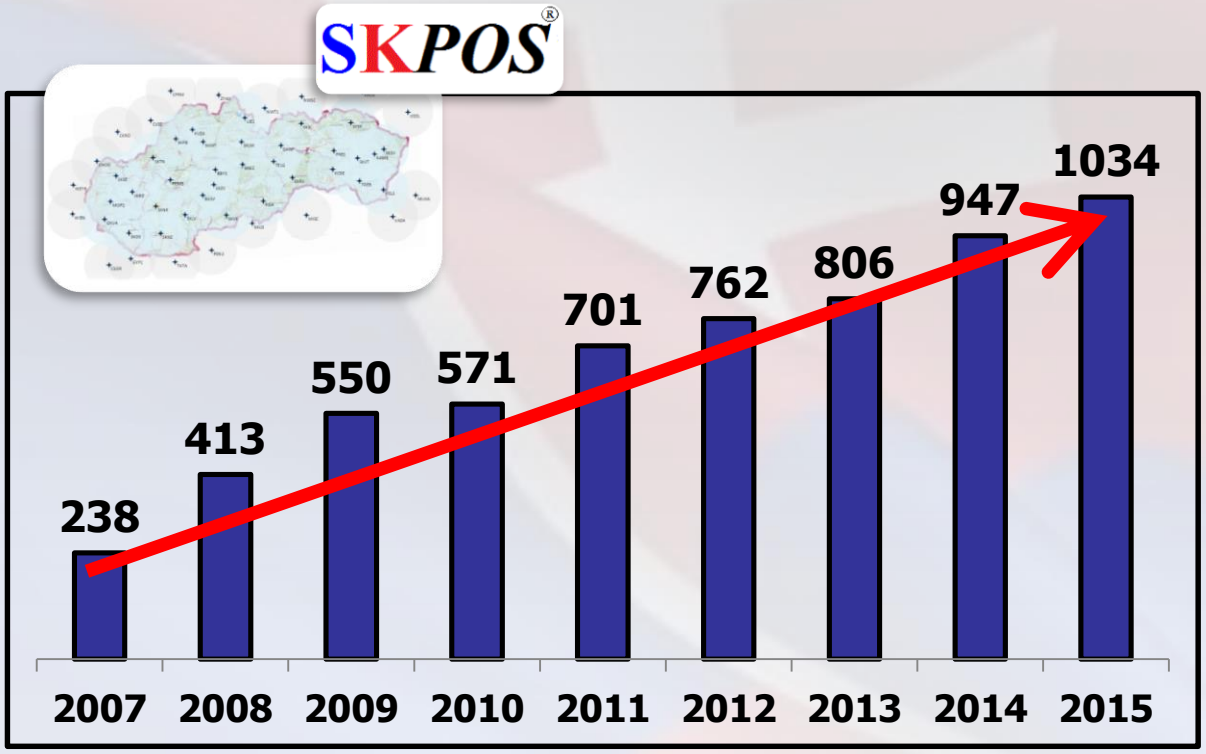
SK*POS*®
infrastructure for geodynamics research

- 11 from 33 SK*POS*® permanent stations have monumentation suitable for geodynamic research purposes
  - 6 stations reinforced-concrete pier monumentation
  - 5 stations deep drilled braced mark monumentation (5m deep) – 5 stations



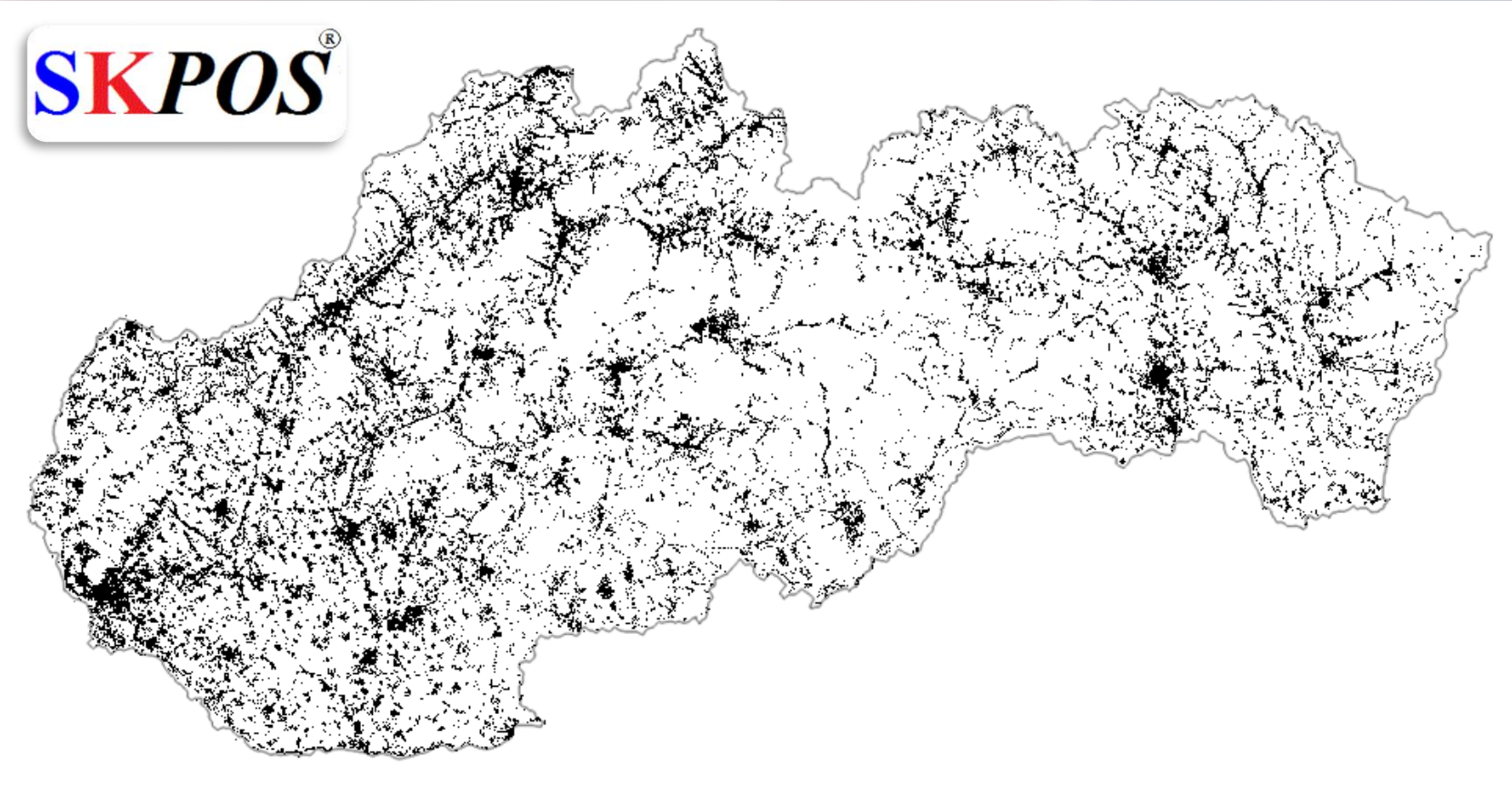
SKPOS®
number of users

- over 1000 registrations (May 2015)
- number is still increasing



SKPOS®
service usage in 2014

- all users logins in 2014



SKPOS®
type of users

- Surveying fields (cadastre, surveying, mapping, GIS) - **92%**
- Other fields - **8%**

SKPOS®
packages – data formats - charges

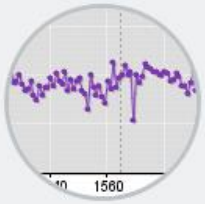
Package	Content	Duration	Format	Flat rate
SKPOS_mm	RINEX 1000 h	year	RINEX 2.x, 3.x	50 €
SKPOS_cm (year)	New! RTK unlimited + 50 h RINEX ~~RTK 1000 hours~~	year	RTCM 2.3, 3.1, CMRx, CMR+	50 €
SKPOS_cm (month)	RTK unlimited	month	RTCM 2.3, 3.1, CMRx, CMR+	19 €
SKPOS_dm	DGNSS unlimited	year	RTCM 2.1	20 €

SKPOS®

Applications for analysis and administration

ASMARUP

Analýza inicializačných časov používateľov SKPOS

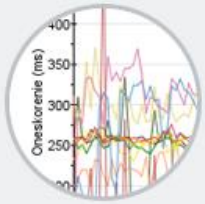


Časové rady

Časové rady referenčných staníc SKPOS

Monitoring používateľov

Počet pripojených používateľov



Oneskorenie staníc

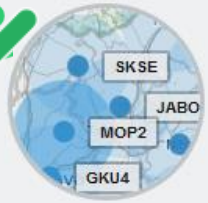
Oneskorenie referenčných staníc SKPOS

Monitoring sieťového riešenia Desktop

Desktop verzia - Monitoring kvality sieťového riešenia

Monitoring sieťového riešenia Mobile

Mobilná verzia - Monitoring kvality sieťového riešenia



EUPOS monitoring

EUPOS network RTK quality monitoring

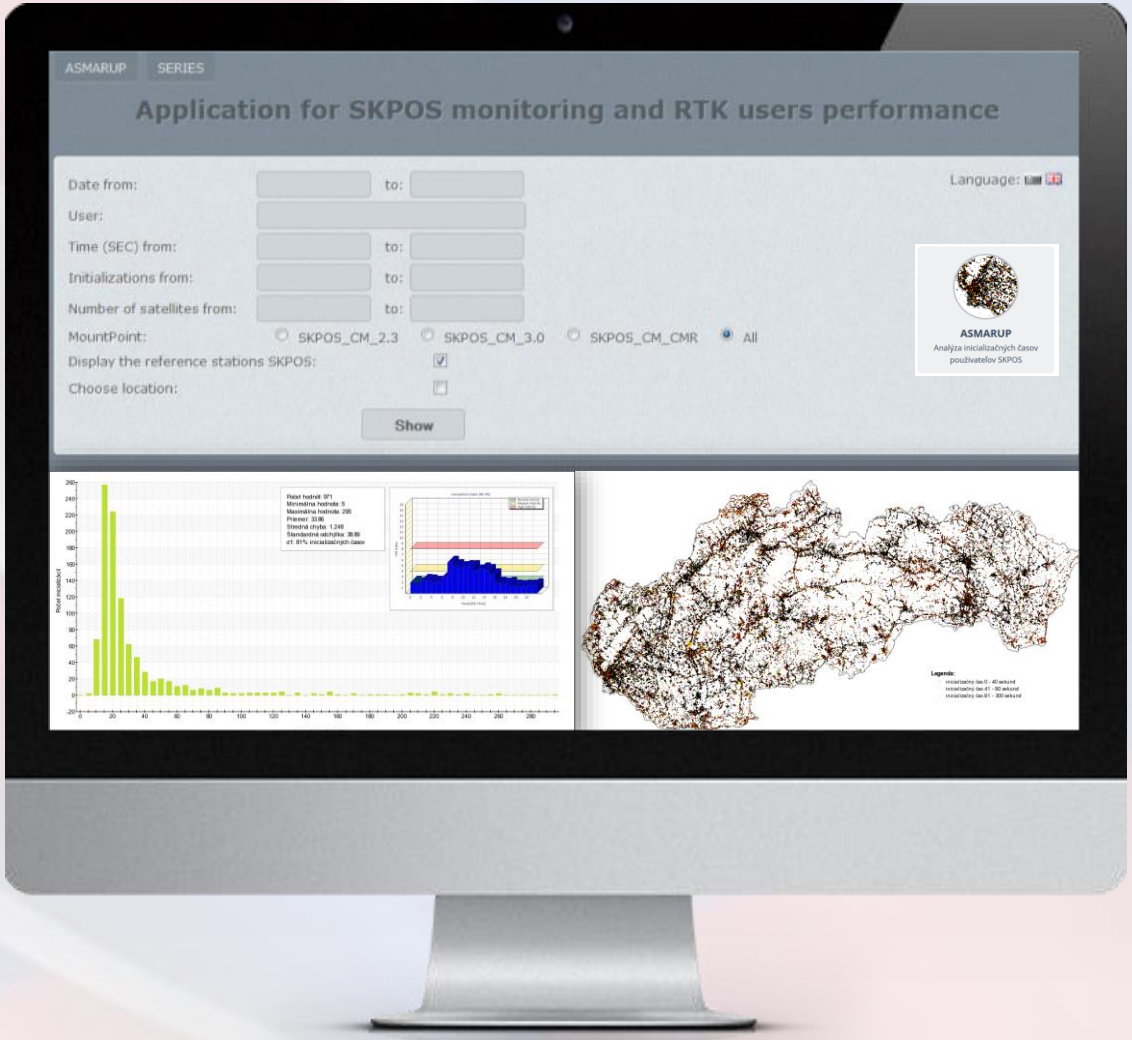
NMEA Analyzer

Analýza meraní používateľov z NMEA správy

public available application

Application for SKPOS® Monitoring And RTK Users Performance (ASMARUP)

- application for users initialisation times analysis
- analysis enabled according to:
  - date and time,
  - particular user,
  - length of the initialisation time,
  - number of satellites,
  - mountpoint,
  - user position



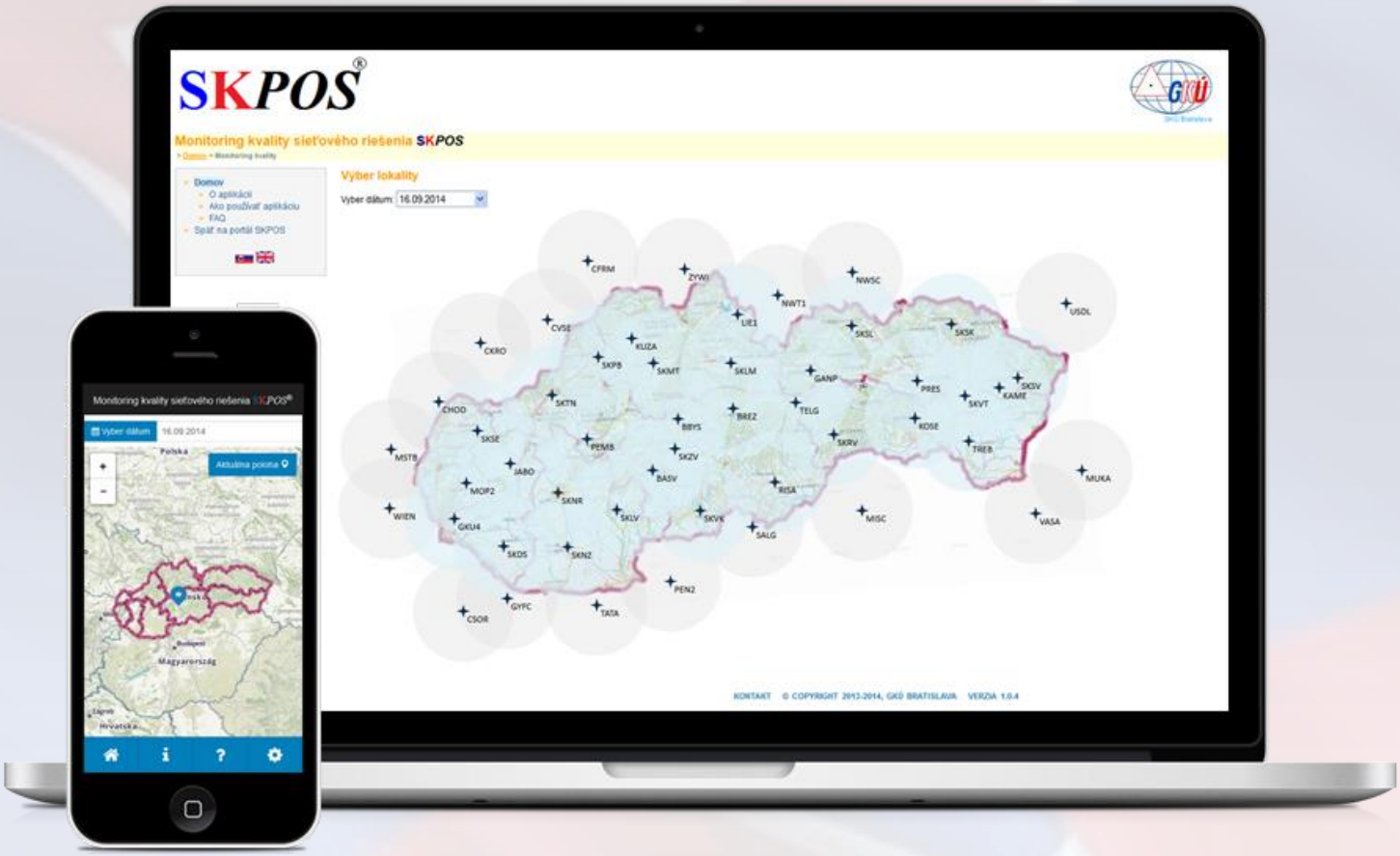
Application for automatic visualization of SK*POS*® permanent stations time series

- RAW time series input: SINEX from Bernese software
- CLEAN time series input: topocentric coordinates from MathCAD sw

Application „SKPOS® network solution quality monitoring“

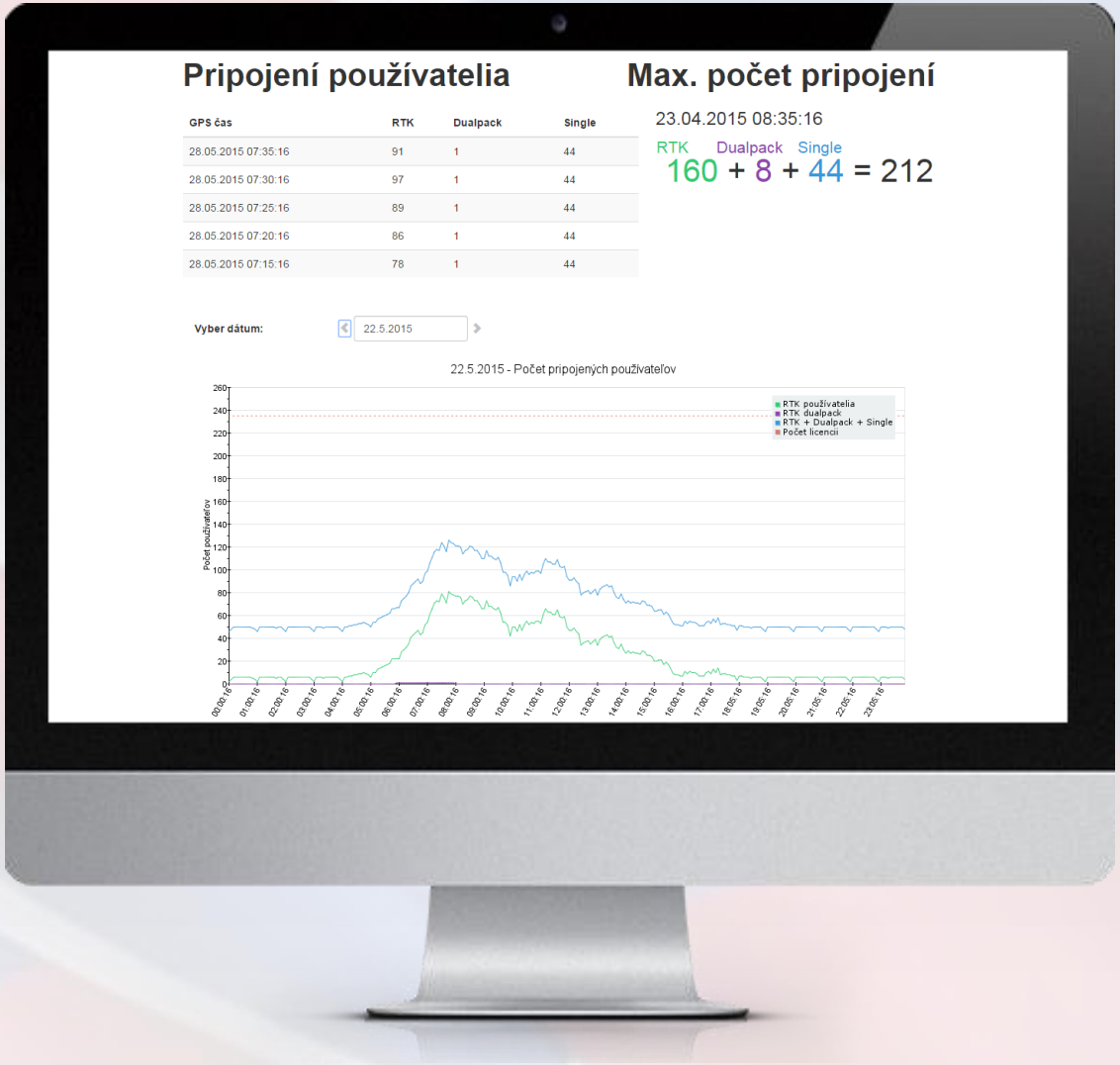
http://monitoringSKPOS.gku.sk/m

http://monitoringSKPOS.gku.sk



Application for Monitoring of number of on-line connected users

- Application visualizes and archives:
  - Number of on-line connected users in graph
  - Maximal number of connected users
  - Graphical history of users connections

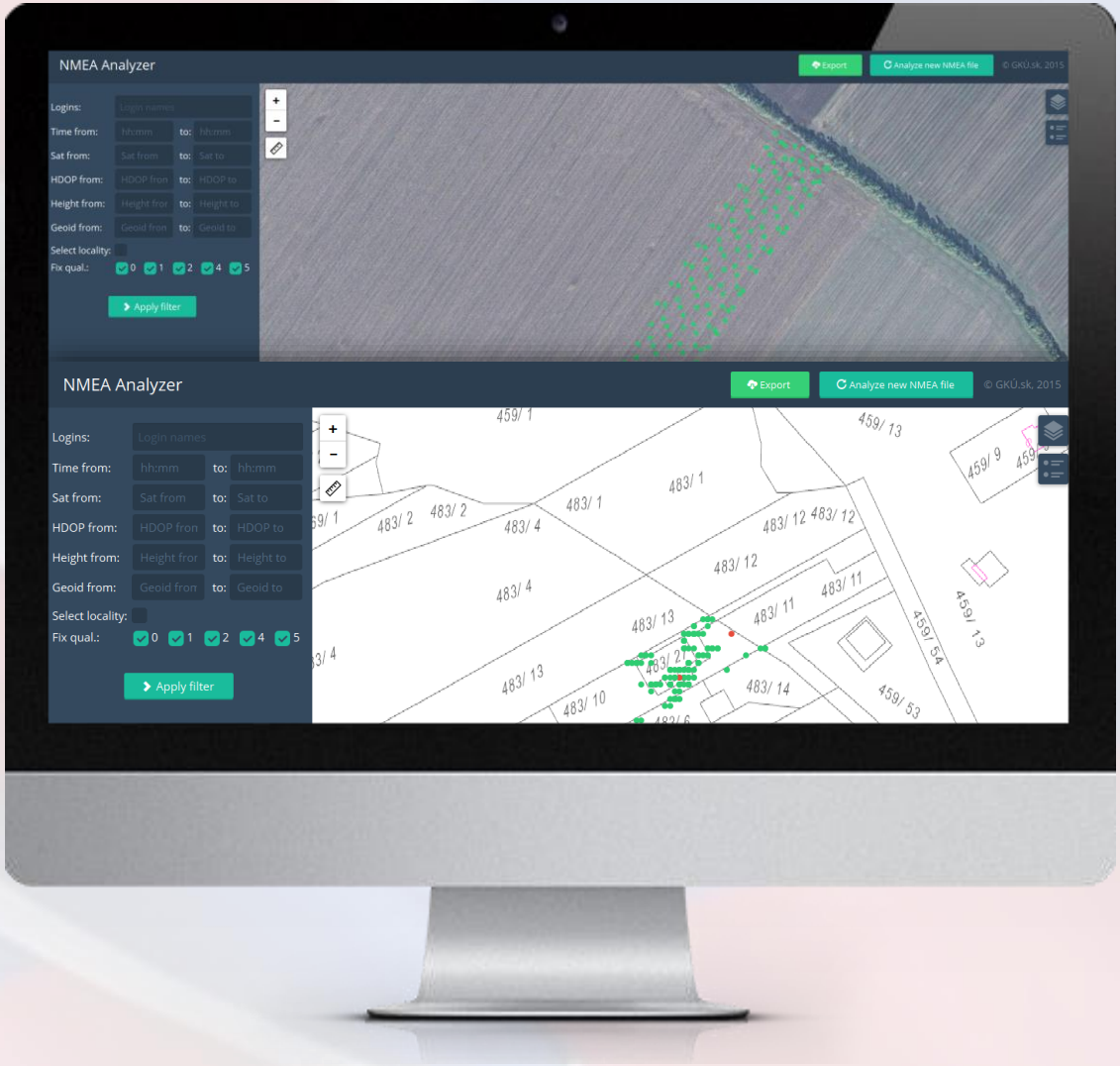


Application for Monitoring of SKPOS® permanent station data delay

- All stations monitored
  - Maximal delay values
  - Actual delay values
- Data archived
- Graph of data delays provided

Application „NMEA Analyzer“

- Application for NMEA data handling
- Application enable:
  - Analyzing
  - Filtering
  - Exporting
  - Visualizing
- Underlay map
  - Terrain,
  - Satellite
  - Cadastral
  - **ZBGIS®**
- Color range output (according FIX)

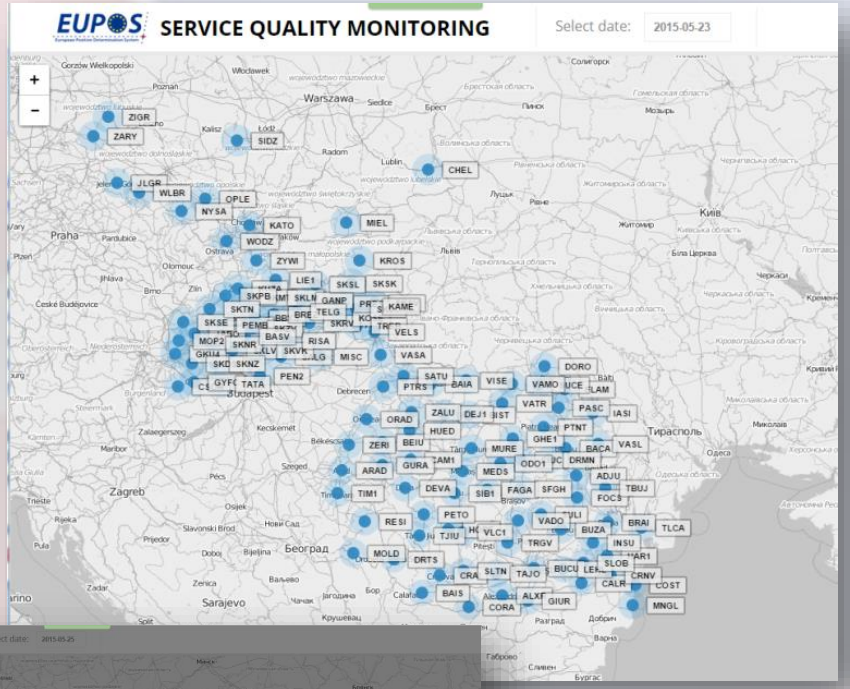


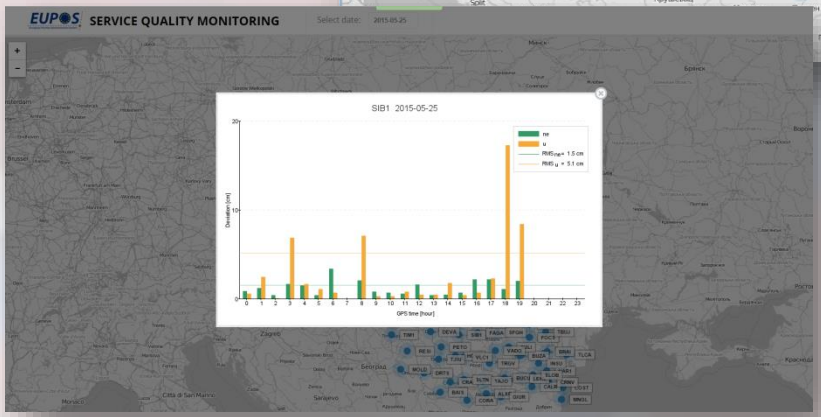
SK*POS*®
active part of *EUPOS*

- Follows *EUPOS* standards
- Keeps information in *EUPOS* station database
- Contributes to *EUPOS* combination centre (SINEX GKU)
- Leads *EUPOS* WG on Service Quality Monitoring

EUPOS WG on Service Quality Monitoring

- GKÚ Bratislava = administrator of **SK*POS*®** and *EUPOS* Service Quality Monitoring
- *EUPOS* SQM
  - Application for monitoring of *EUPOS* countries network RTK quality
  - http://monitoringeupos.gku.sk

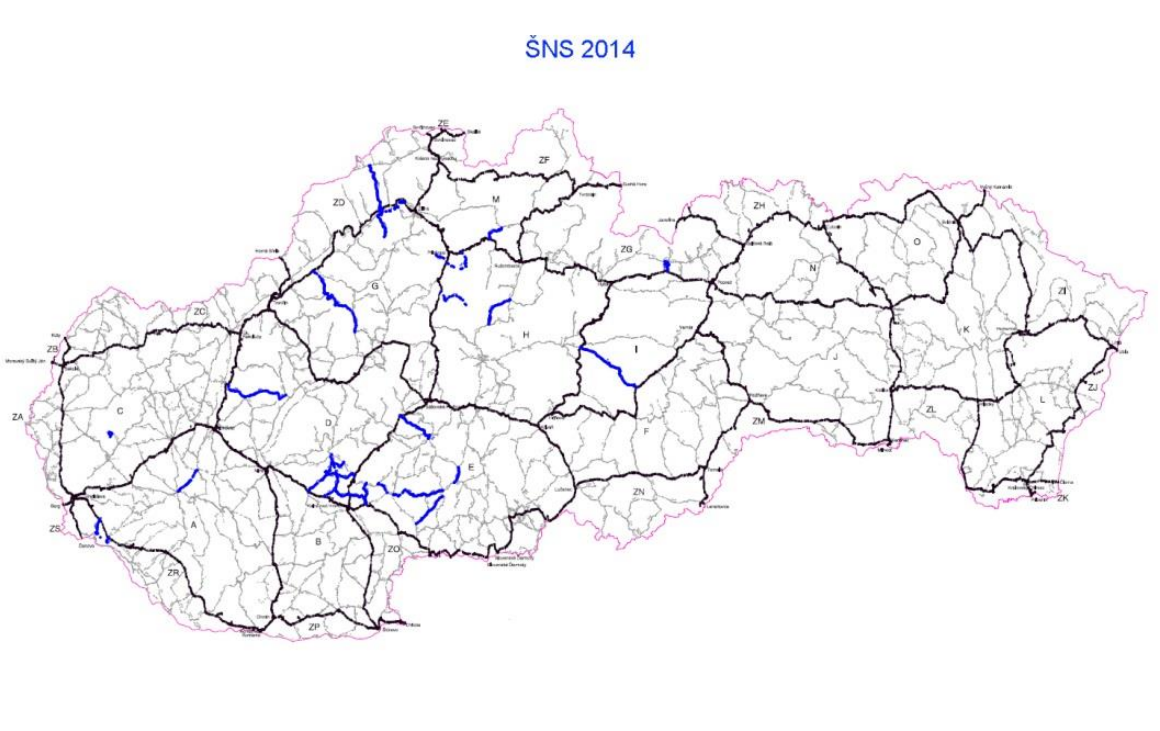




Status, activities and news from national levelling network

National levelling network (ŠNS)
Measurements on the 2nd order levelling lines

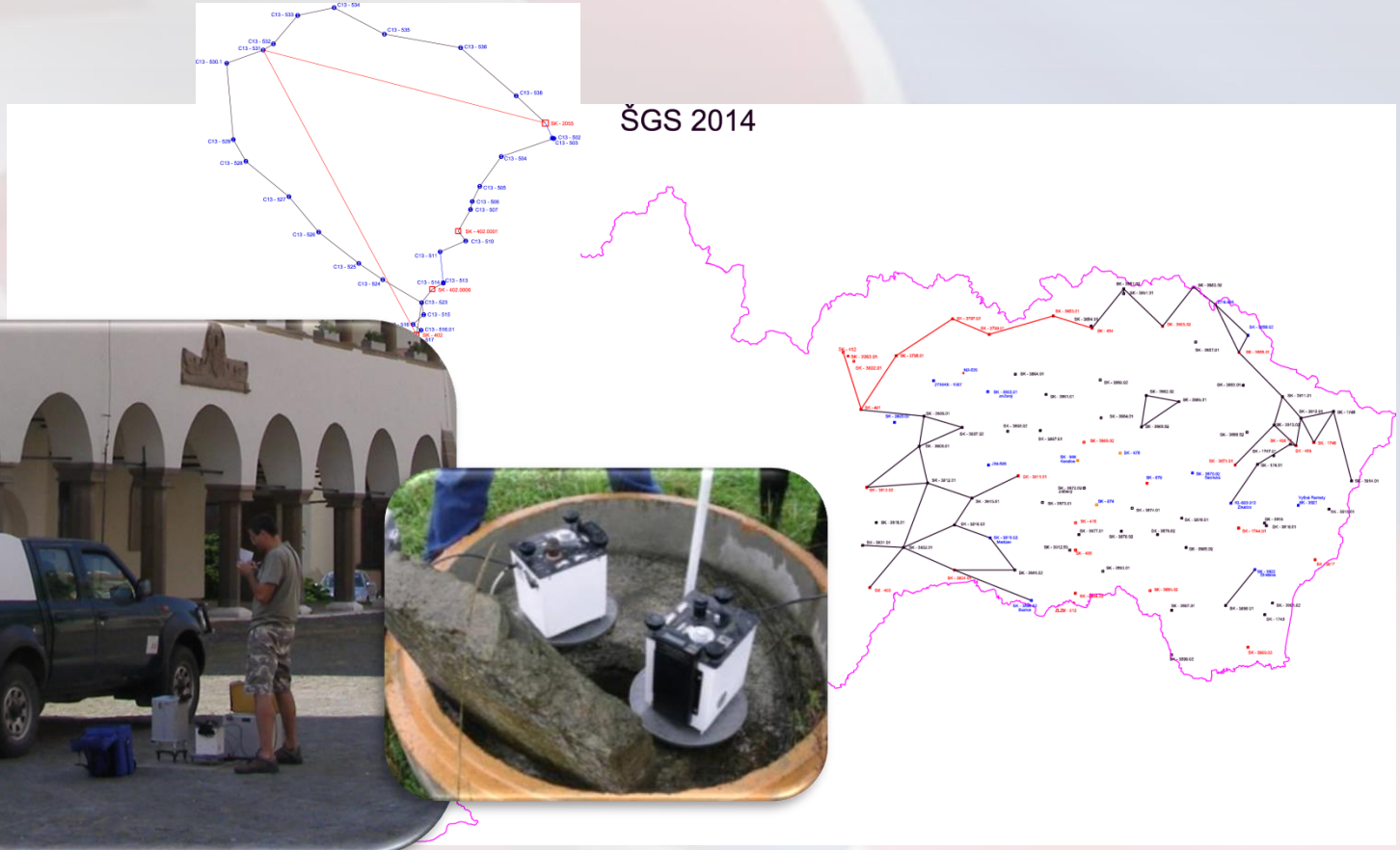
- Measurements in 2014:
  - Totally measured: 601 km
  - 3 levelling groups
- New reprocessing of ŠNS is preparing (Data from 1987 - 2015)



Status, activities and news from national gravimetric network

National gravimetric network (ŠGS)
Relative gravity measurements

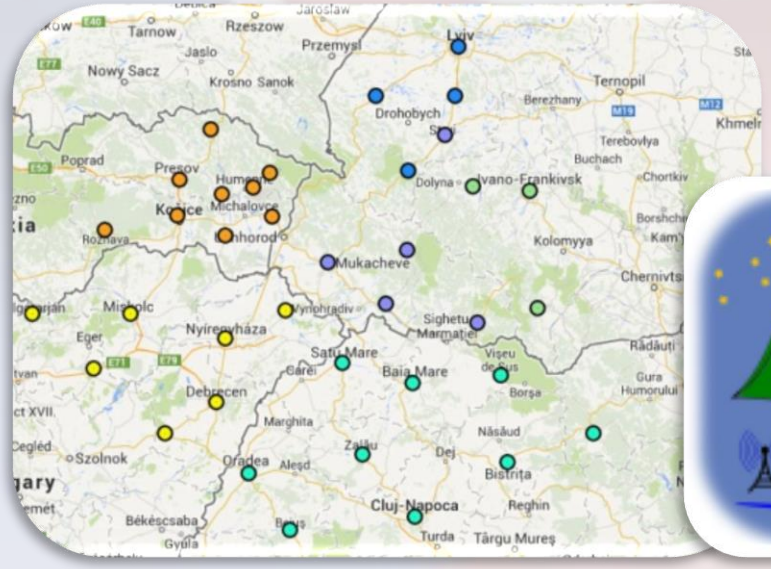
- **relative measurements on ŠGS network (111 differences)**
- 1 measuring group



Research and development

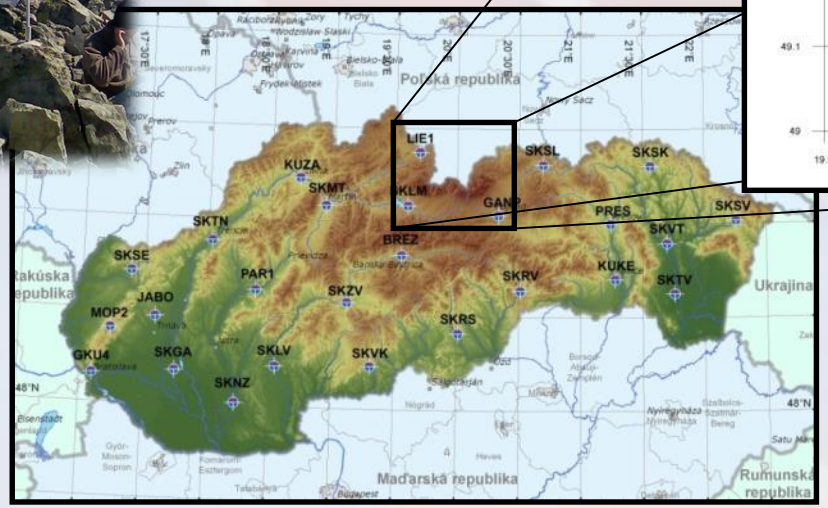
Collaboration with Vihorlat observatory
Space emergency system

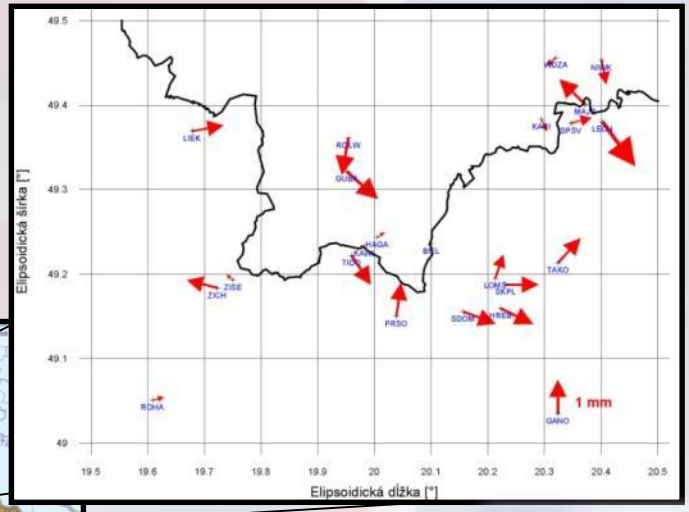
- Multilateral project: Ukraine-Slovakia-Hungary-Romania
- Agreement signed in December 2015
- new KOLS permanent station will be part of **SK*POS*®**
- goal: creation of Space emergency system
- www.meteognss.net



Geokinematics research of Tatra mountains
GNSS Campaign measurement

- Re-measuring of local geodynamics network LGS Tatry
- Method: min. 72 hours GNSS campaign every year from 1998
- Cooperation: Slovakian institutions (TOPU, STU) and Poland TUW
- Processing in Bernese software
- Velocities – in milimeters

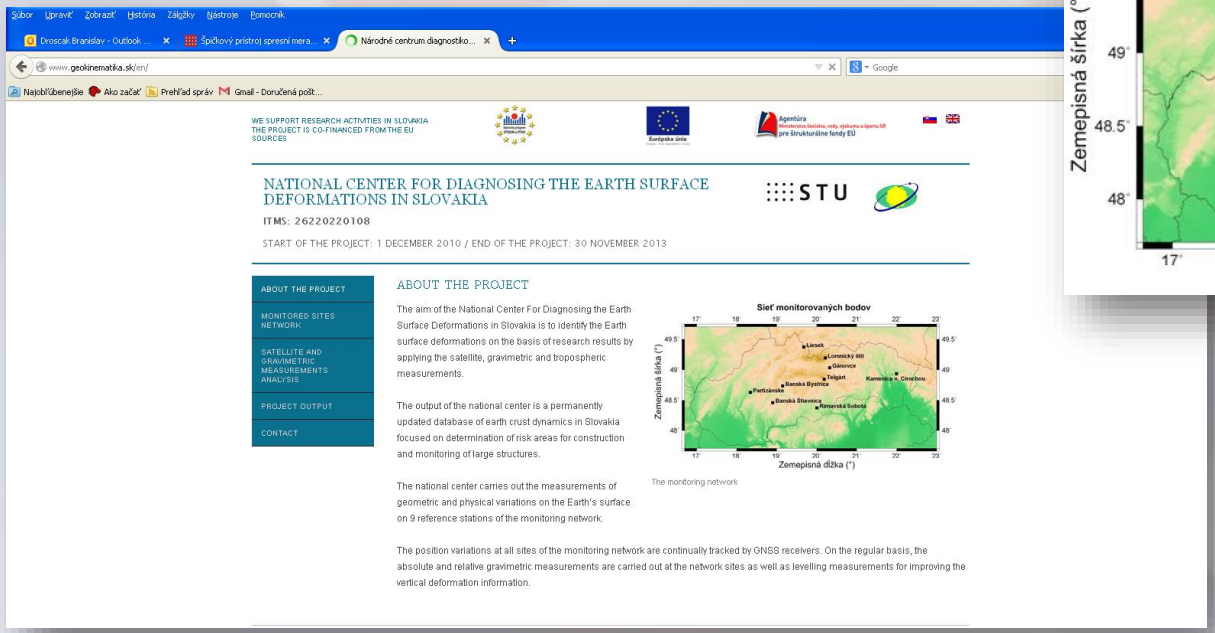




Slovak University of Technology
Research and development activities

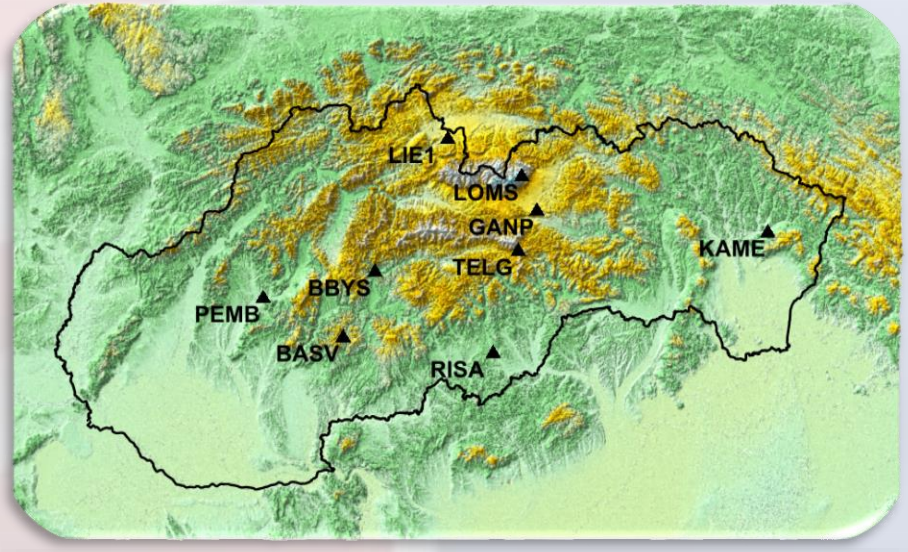
National center for diagnosing the earth surface deformations in Slovakia

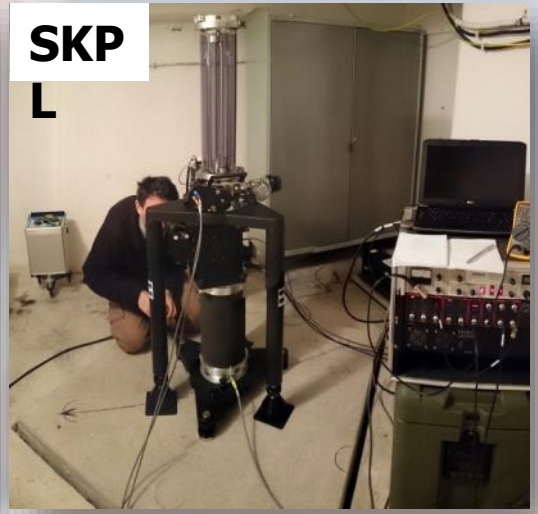
- ITMS research project (**http://www.geokinematika.sk**)
- Surface deformations monitored on 9 geodynamics points by
  - Permanent GNSS stations
  - Absolute gravity measurements



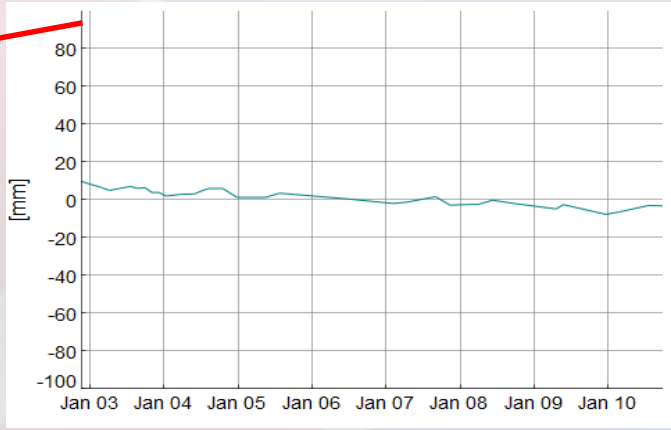
National center for diagnosing the earth surface deformations in Slovakia

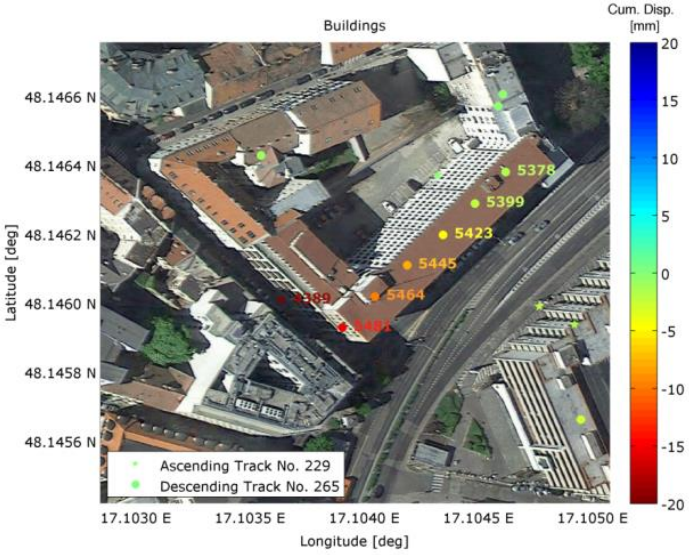
- Repeated absolute gravity measurements
- absolute gravimeter FG5X-247
- 3 campaigns performed:
  - June 2014 - October 2014 - April 2015

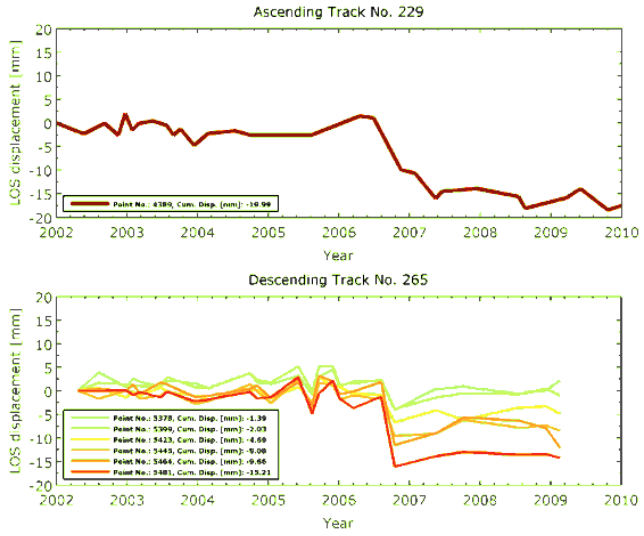




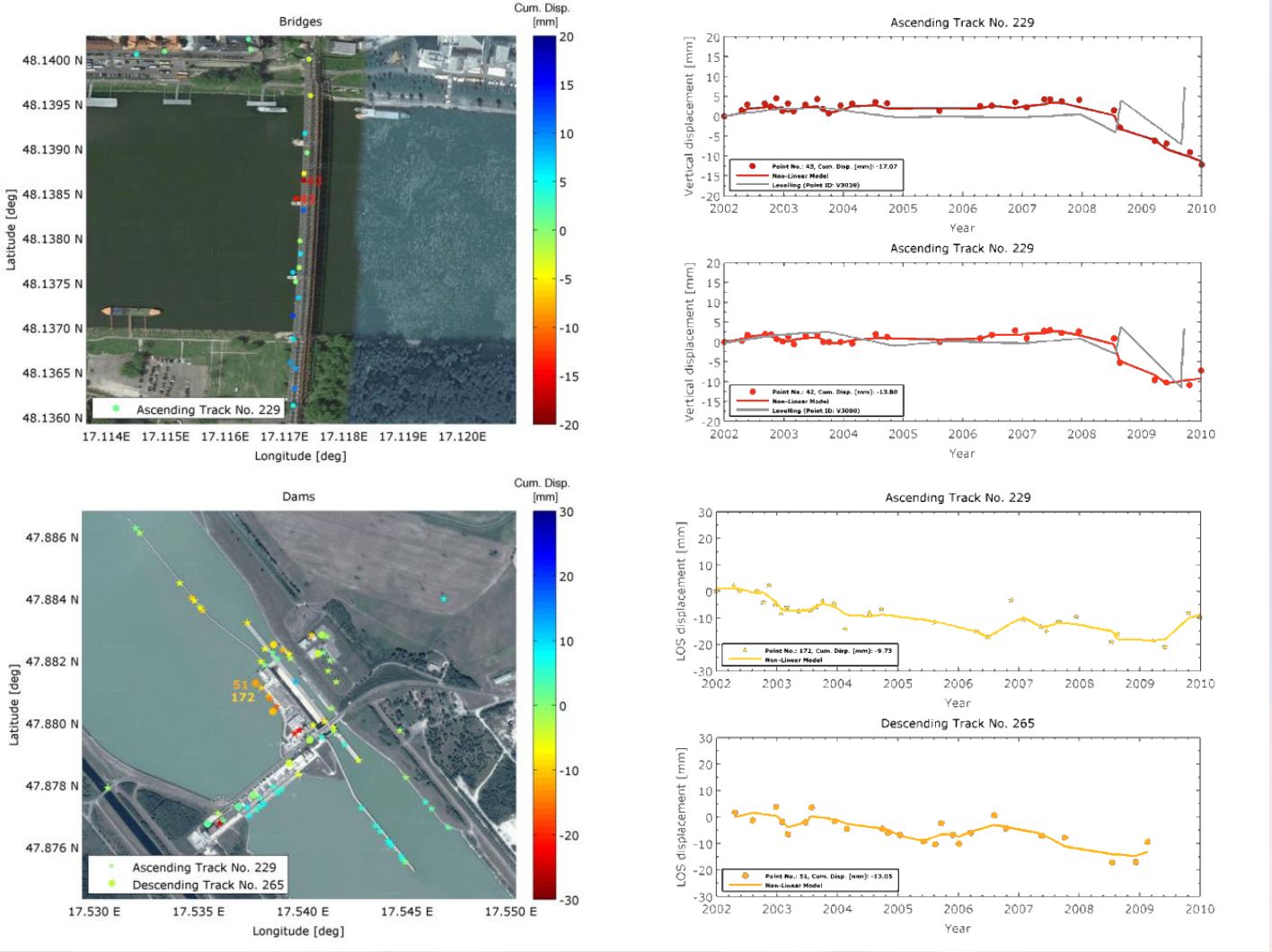
Ps InSAR monitoring - urban targets







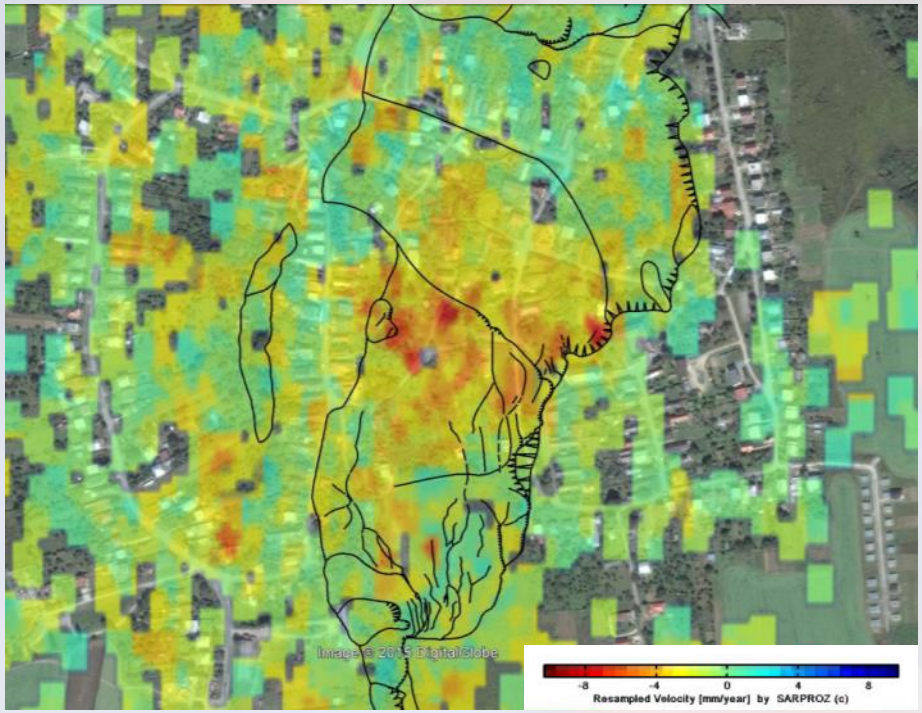
Ps InSAR monitoring - urban targets



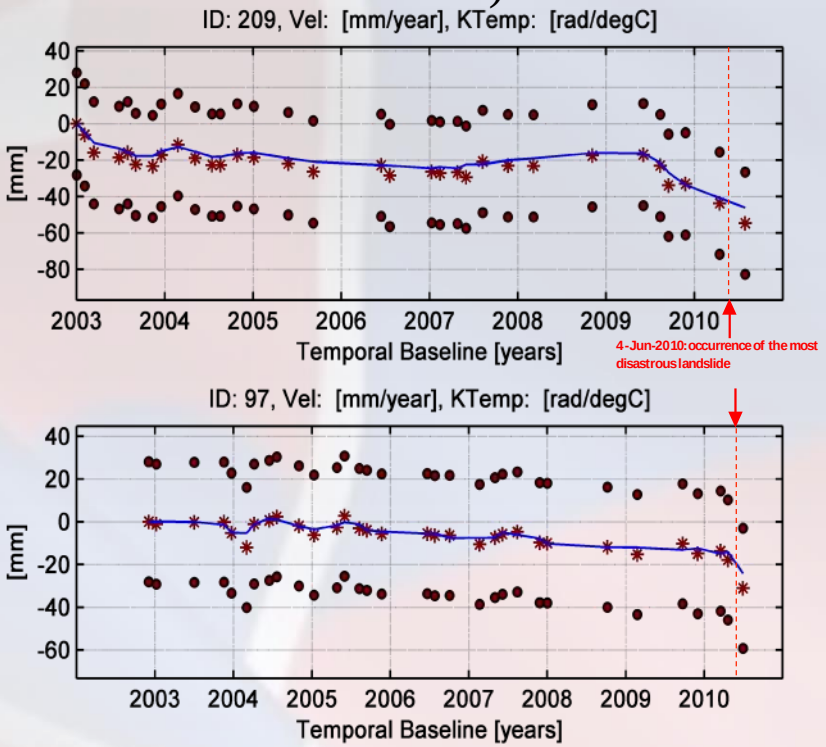
Ps InSAR monitoring - landslides

Devastating landslide in Nižná Myšla (SE Slovakia) - 4th of June, 2010
Monitoring of possible prerequisites – ERS & ENVISAT – period 1992 - 2010

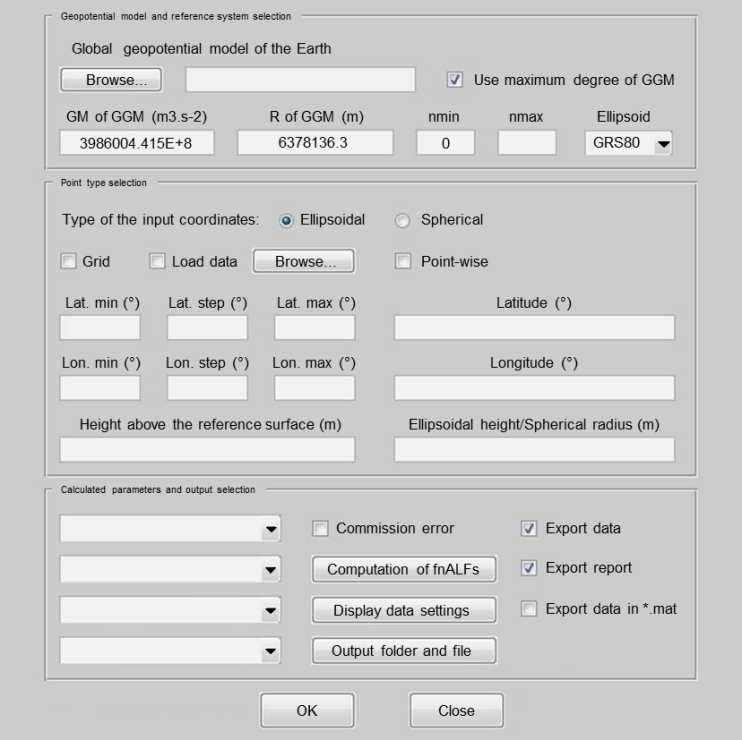
QUASI-PS INSAR approach ERS (1992-1999)



PS INSAR approach ENVISAT (2002-2010)



GrafLab (GRAvity Field LABoratory) software
Spherical harmonic synthesis (SHS)



- **GrafLab (GRAvity Field LABoratory)**
  - SHS up to ultra-high degrees (tens of thousands or even higher)
  - Point-wise and grid modes
  - Computes 38 frequently used gravity field quantities: e.g. geoid, height anomaly, gravity anomaly/disturbance, tensors, ...
- **isGrafLab (Irregular Surface GRAvity Field LABoratory)**
  - A modified version of GrafLab
  - Fast SHS on grids at irregular surfaces (e.g. the Earth‘s surface)
  - Based on the lumped coefficients approach and Taylor series expansion

References:

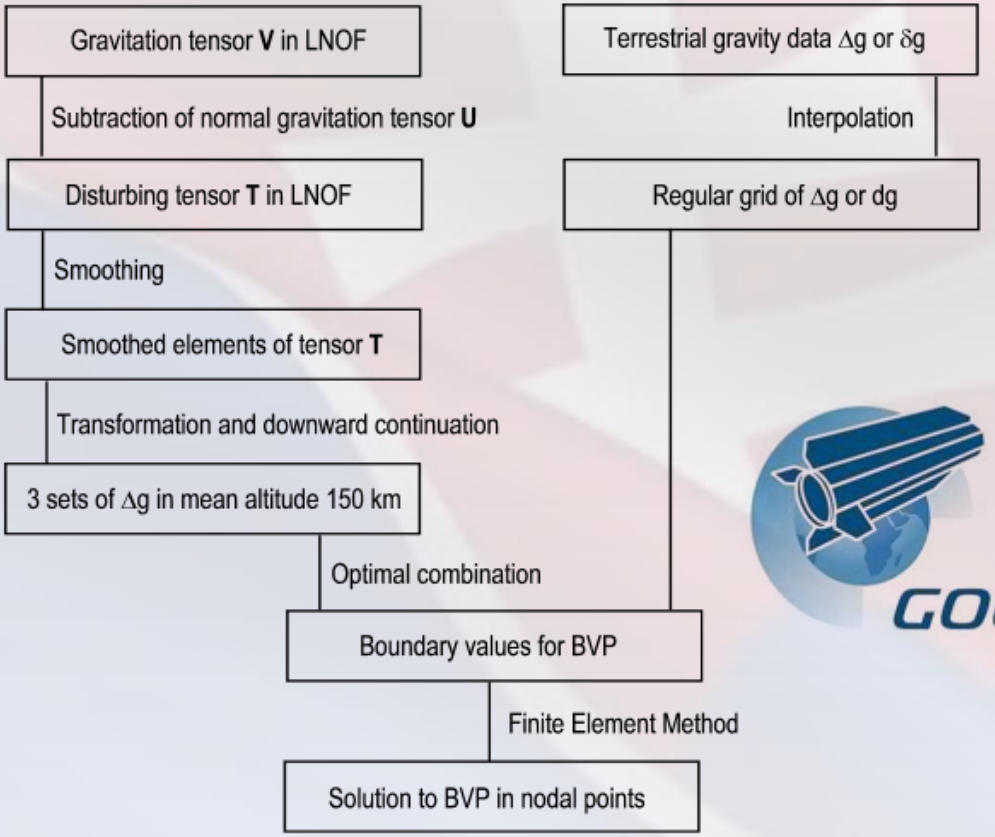
•Bucha, B., Janák, J., 2013. A MATLAB-based graphical user interface program for computing functionals of the geopotential up to ultra-high degrees and orders. DOI: http://dx.doi.org/10.1016/j.cageo.2013.03.012.

•Bucha, B., Janák, J., 2014. A MATLAB-based graphical user interface program for computing functionals of the geopotential up to ultra-high degrees and orders: Efficient computation at irregular surfaces. DOI: http://dx.doi.org/10.1016/j.cageo.2014.02.005.

Available at:

- www.svf.stuba.sk/en/departments/department-of-theoretical-geodesy/science-and-research/downloads.html?page_id=4996

Determination of regional quasigeoid from combination of GOCE and terrestrial measurements



Development of effective combination of satellite gravity gradiometry (SGG) from GOCE and terrestrial data gravity anomalies or gravity disturbances.

+

Gravity anomalies or ***gravity disturbances***

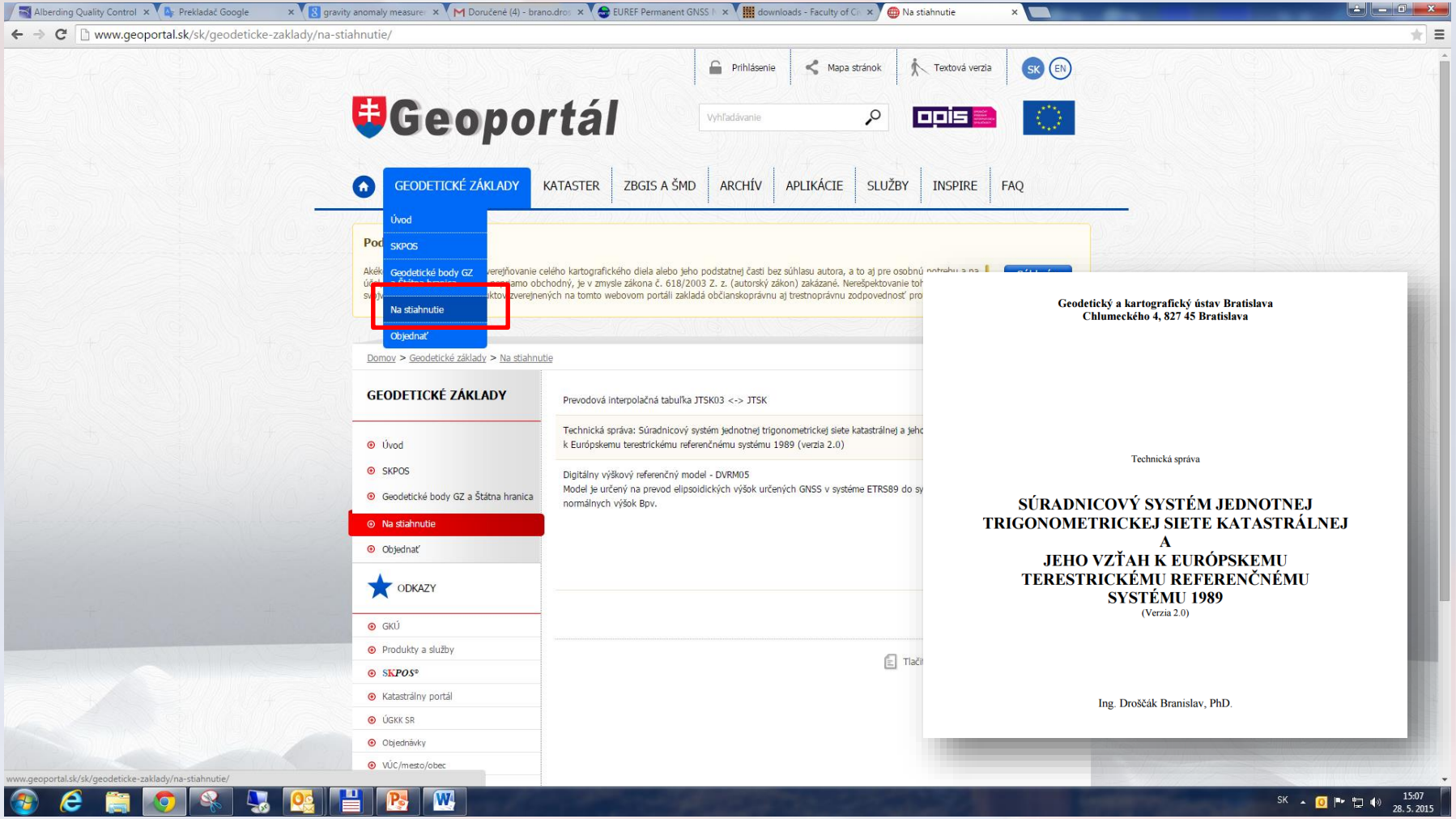
=>

Reference: Janák J., Pitoňák, M., Minarechová Z.: Regional quasigeoid from GOCE and terrestrial measurements. Stud. Geophys. Geod., 58, pp. 626-649

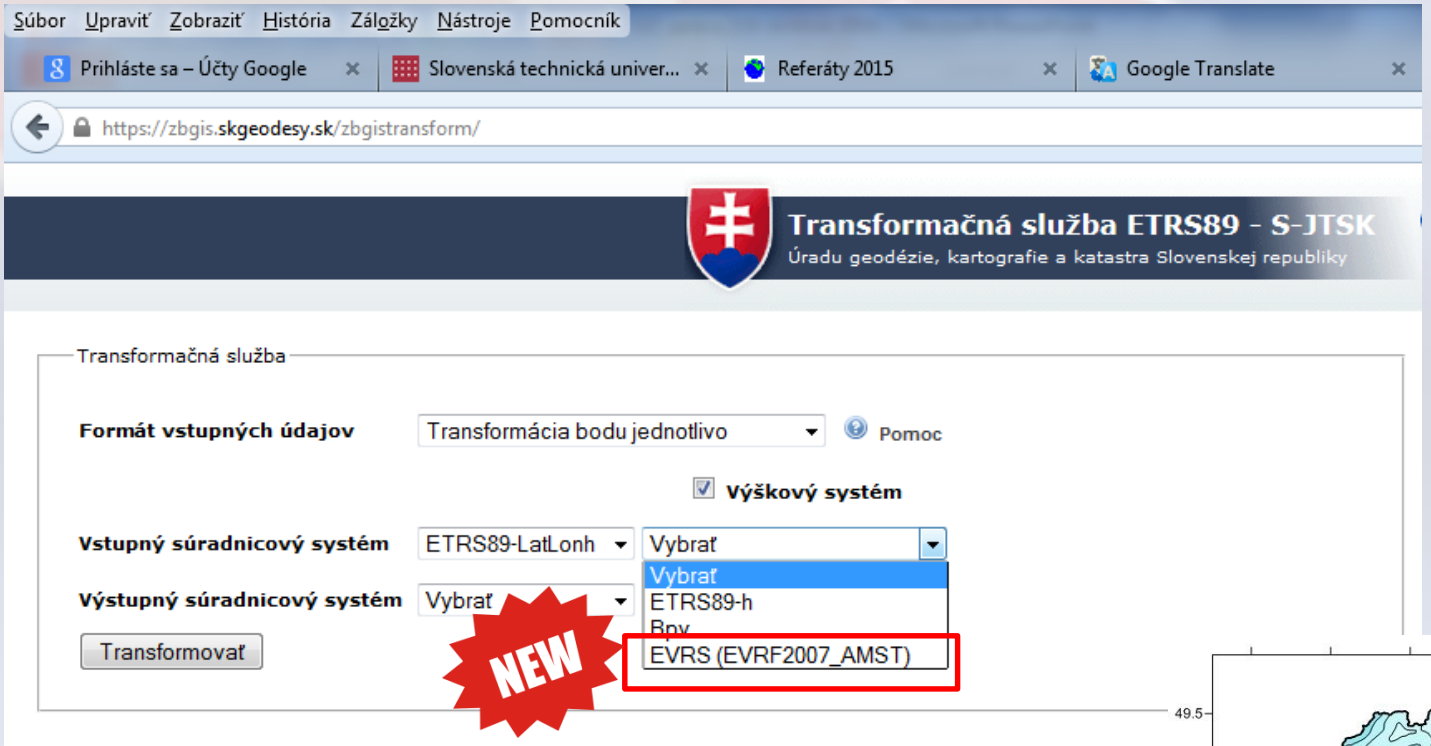
Other news

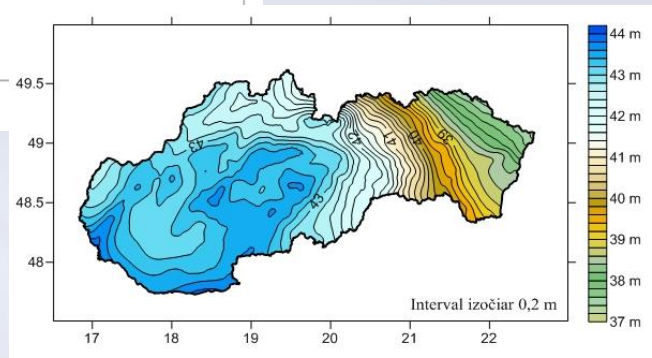
Geodesy, cartography and cadastre authority of Slovak republic – geoportal (www.geoportal.sk)

ETRS89 – S-JTSK relation
Official technical report published on Geoportal



Transformation service EVRS (EVRF2007) implemented





DMQSK2014-E = Digital model of quasigeoid ETRS89-h (ETRF2000) ↔ EVRS (EVRF2007)

Thank you
for your attention