National report of Slovakia 2016

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Donostia - San Sebastian
May 25th - 27th, 2016

EUREF 2016, annual symposium

25-27.May 2016, San Sebastian, Spain

Outline

- Slovakian activities and contributions to EPN
- Status, activities and news from:
  - SK*POS*® (Slovak real time determination system)
  - 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 EPN Operational centers

Geodetic and Cartographic Institute Bratislava (GKÚ)

Slovak University of Technology in Bratislava (SUT)

Slovakian EPN Local analysis center

Slovak University of Technology in Bratislava (SUT)

NEW

Bernese GNSS Software
Version 5.2
used since GPS week 1883

- 4 new EPN permanent stations added to LAC SUT network solution (IRBE, NPAZ, ONS1, SABA)
- GMF: Vienna Mapping Function is used instead Niell Mapping Function
- GPS and GLONASS observations are used since GPS week 1878
- ESA ephemerides are used

Slovakian EPN permanent stations

EPN CB HOME

EUREF PERMANENT NETWORK

ROB GNSS RESEARCH GROUP

EUREF

NETWORK & DATA | PRODUCTS & SERVICES | DOCUMENTATION

Station list | Maps | Tracking status | Data access | Proposed stations | Station log submission | Station picture submission

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

Formats | Guidelines | Equipment & calibration | Papers | FAQ

News | FTP

MAPS

Active Inactive Former

Locate station on map

Antenna manufacturer:

3S NAVIGATION
AOA
ASHTECH

Status:

ACTIVE
INACTIVE
FORMER

Update map

Katowice Kraków Tarnów Ostrava Wieliczka Nowy Sącz Krosno Olomouc Zlín Zakopane Krynica-Zdrój Národný park Nízke Tatry Prešov Košice Slovakia Nitra Bratislava Miskolc Eger Győr Esztergom Budapest Székesfehérvár Szolnok Szombathely Zalău

Údaje máp ©2015 GeoBasis-DE/BKG (©2009), Google 50 km Zmluvné podmienky Nahlásiť chybu mapy

MOPI

GANP

MOP2

BBYS

Slovakian EPN Real-time permanent stations

EPN CB HOME

EUREF PERMANENT NETWORK

GNSS

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,
News | Mails | FTP serve

NETWORK & DATA > **MAPS**

INTERACTIVE MAP

GANP

MOP2

Legend

Station status (active, inactive, former)

Active | Inactive | Former

Locate station on map

Antenna manufacturer:

3S NAVIGATION
AOA
ASHTECH

Status:

ACTIVE
INACTIVE
FORMER

Mapa

Katowice, Kraków, Tarnów, Ostrava, Wieliczka, Olomouc, Zlín, Nowy Sącz, Zakopane, Národný park Nízke Tatry, Slovensko Slovakia, Košice, Ужгород Uzhhorod, Trnava, Nitra, Bratislava, Miskolc, Eger, Nyíregyháza, Satu Mare, Debrecen, Szolnok, Mukachevo

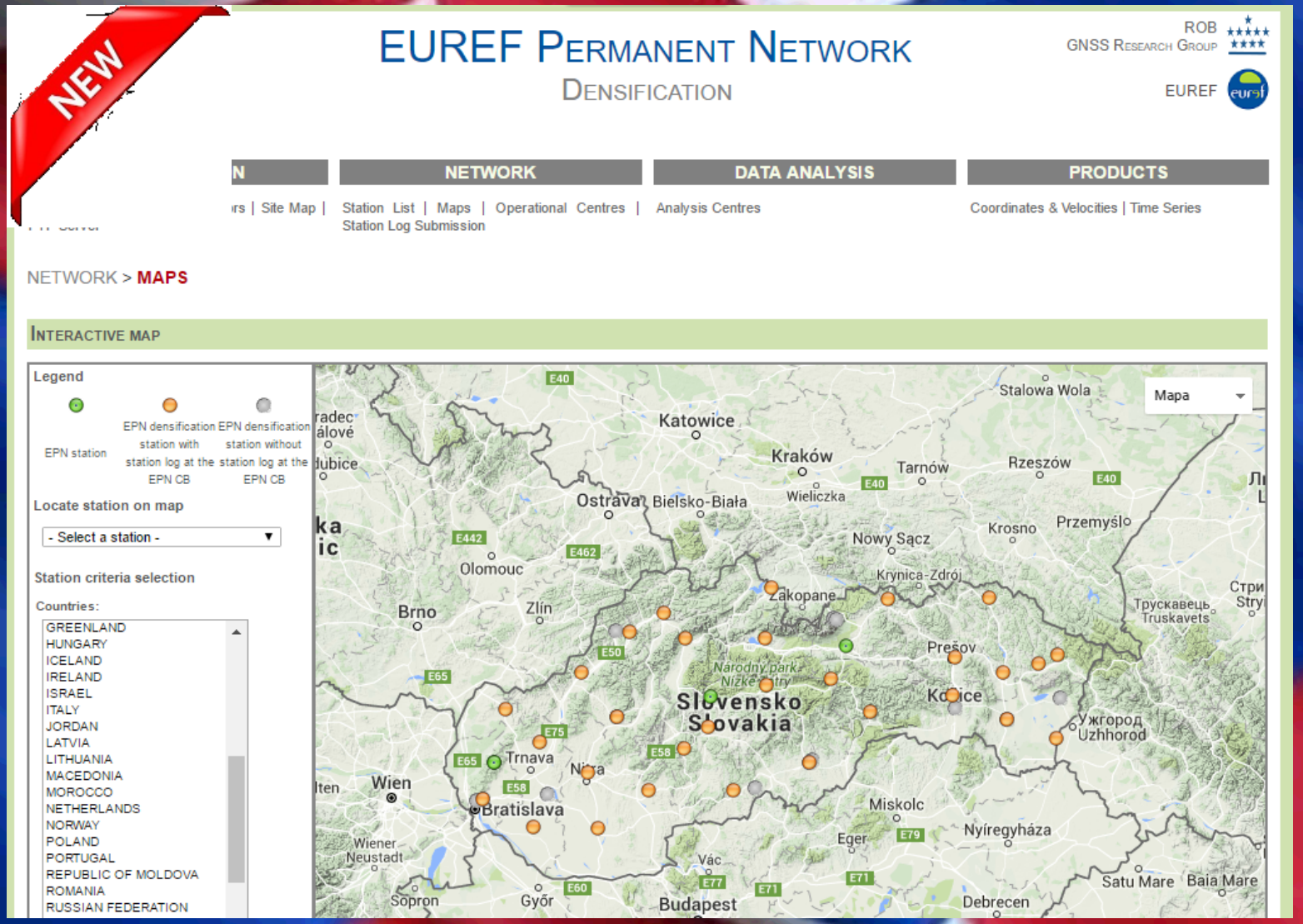
E40, E442, E462, E65, E75, E58, E71

Description	Status
Stream:	GANP0
Broadcaster:	www.euref-ip.net
Location:	Ganovce, Slovakia
Operated by:	GKU
Receiver type:	TRIMBLE NETR9 (GPS+GLO+GAL+BDS+QZSS+SBAS)
Data format:	RTCM 3.1 : 1004(1),1006(10),1008(10),1012(1),1013(10),1019(10),1020(10),1033(10),1230(10)
More details:	EPN station information

Description	Status
Stream:	MOP20
Broadcaster:	www.euref-ip.net
Location:	Modra-Piesok, Slovakia
Operated by:	SUT
Receiver type:	TRIMBLE NETR5 (GPS+GLO)
Data format:	RTCM 3.1 : 1004(1),1005(5),1007(5),1012(1),1033(5)
More details:	EPN station information

9), Google 50 km Zmluvné podmienky Nahlásiť chybu mapy

Slovakian contribution to EPN Densification

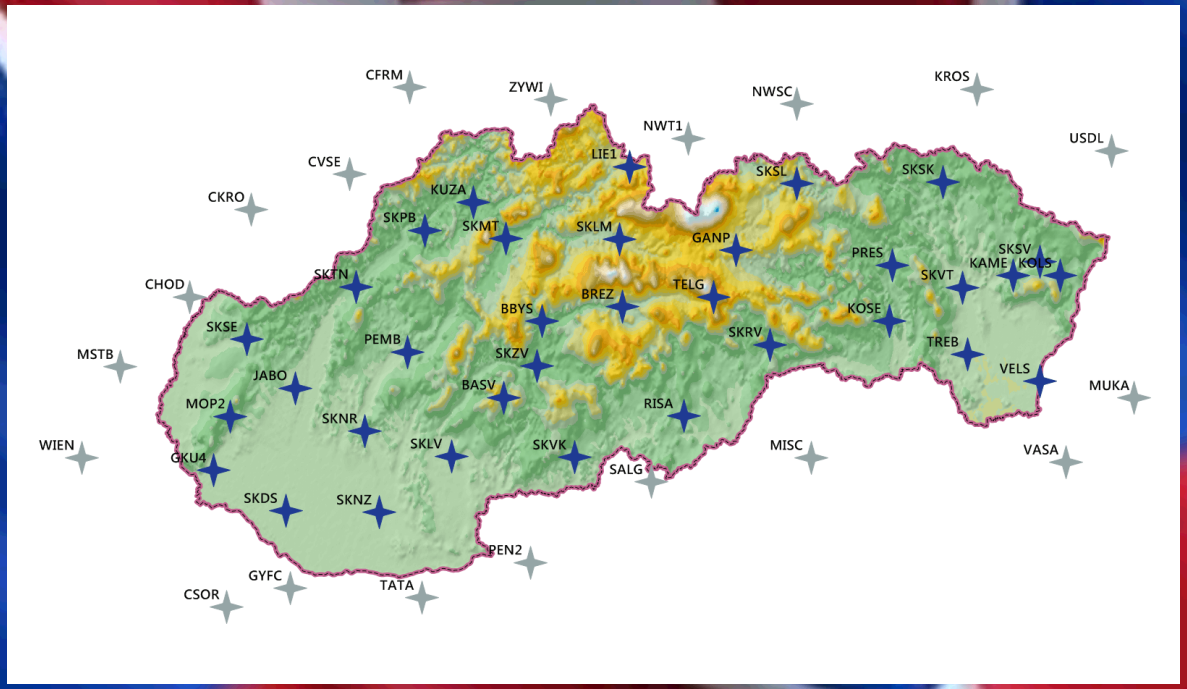


Status and news from Slovakian real-time determination system - SK*POS*®

2006 – 2016 => 10 years of SK*POS*®

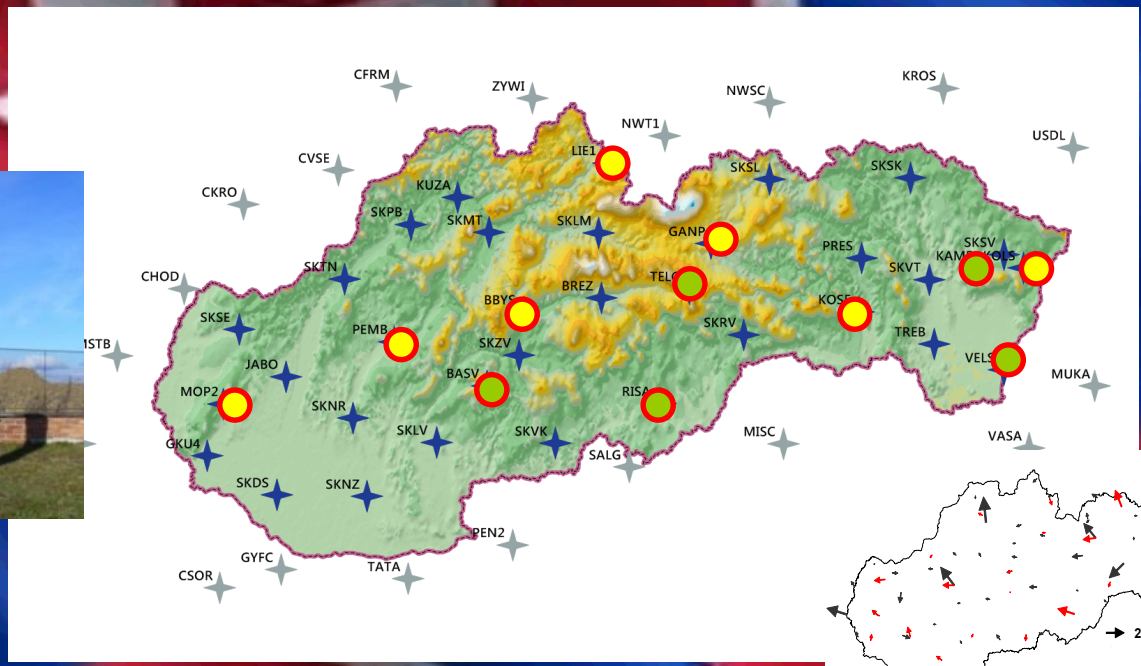
SKPOS®
infrastructure status (May 2016)

- **34 Slovakian permanent stations (14 individual calibrated)**
  - All stations observe GPS+GLONASS signals (few Galileo)
  - Network density - average distance between stations : 44,6 km
- **19 foreign permanent stations (APOS, gnssnet.hu, CZEPOS, ASG-EUPOS, ZAKPOS)**
- **----------**
- **Totally 53 permanent stations**



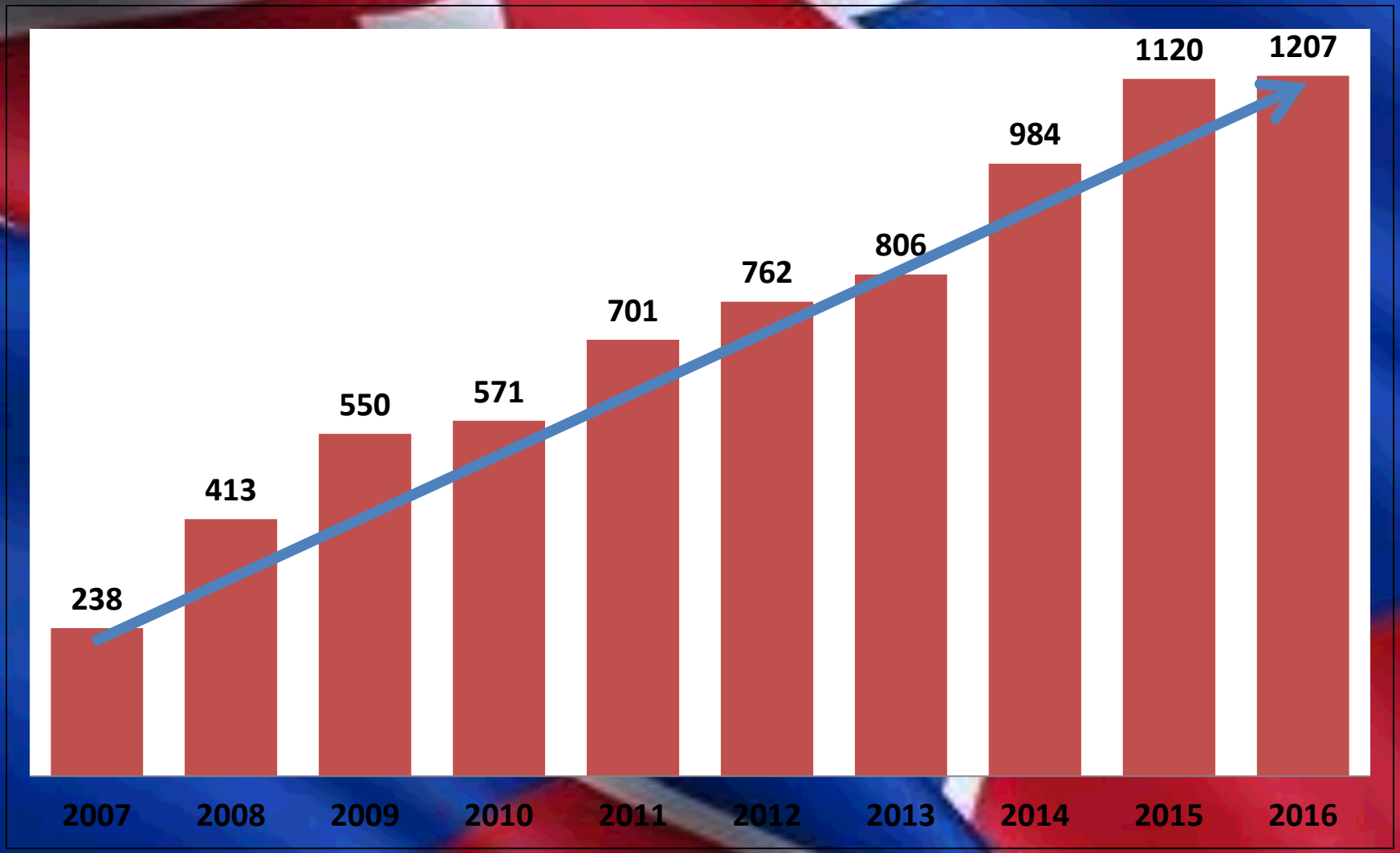
SK*POS*®
infrastructure for geodynamics research

- **12 from 34 slovakian SK*POS*® permanent stations have monumentation suitable for geodynamic research purposes**
  - 7 stations reinforced-concrete pilier monumentation
  - 5 stations deep drilled braced mark monumentation (5m deep)



SKPOS®

number of users



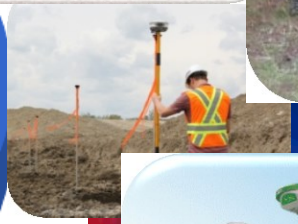
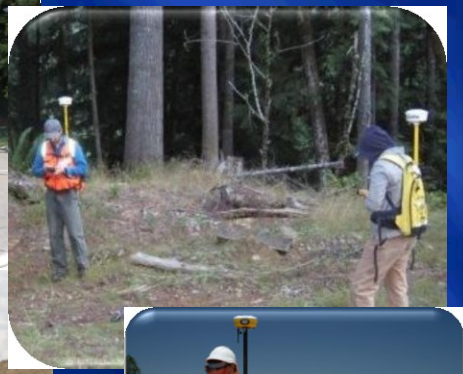
SKPOS®
type of users

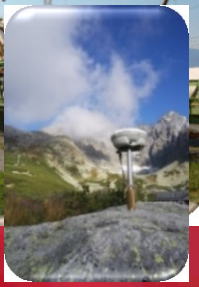
- Surveying fields (cadastre, surveying, mapping, GIS) - **84%**
- Other fields (precise agriculture, machine guarding) - **16%**







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)	RTK unlimited + 50 h RINEX	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 €

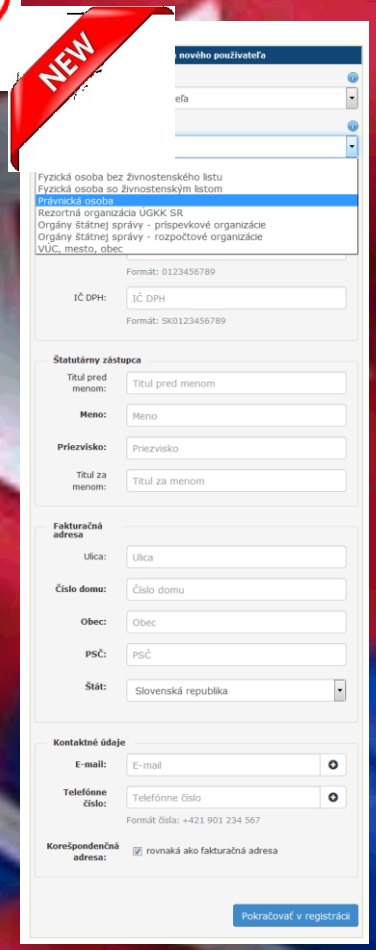
New SKPOS® web page

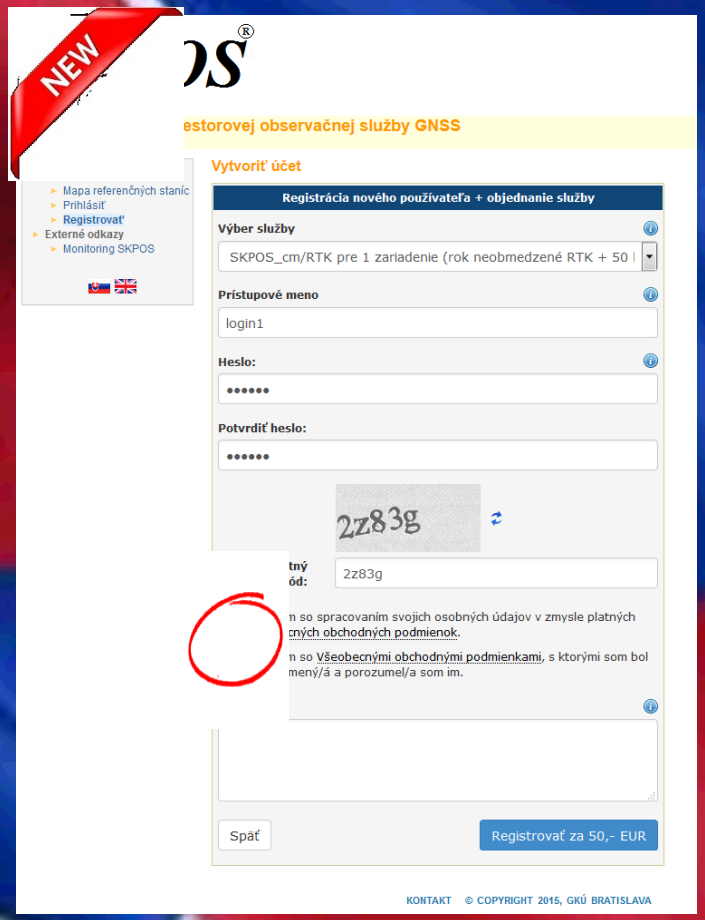
- 13.10.2015 – new (redesign) web page was launched
- Full of interesting information (SVK/ENG):
  - News
  - Infrastructure
  - Packages and prices
  - Quality Monitoring
  - Availability Monitoring
  - Registration
  - ...

http://skpos.gku.sk

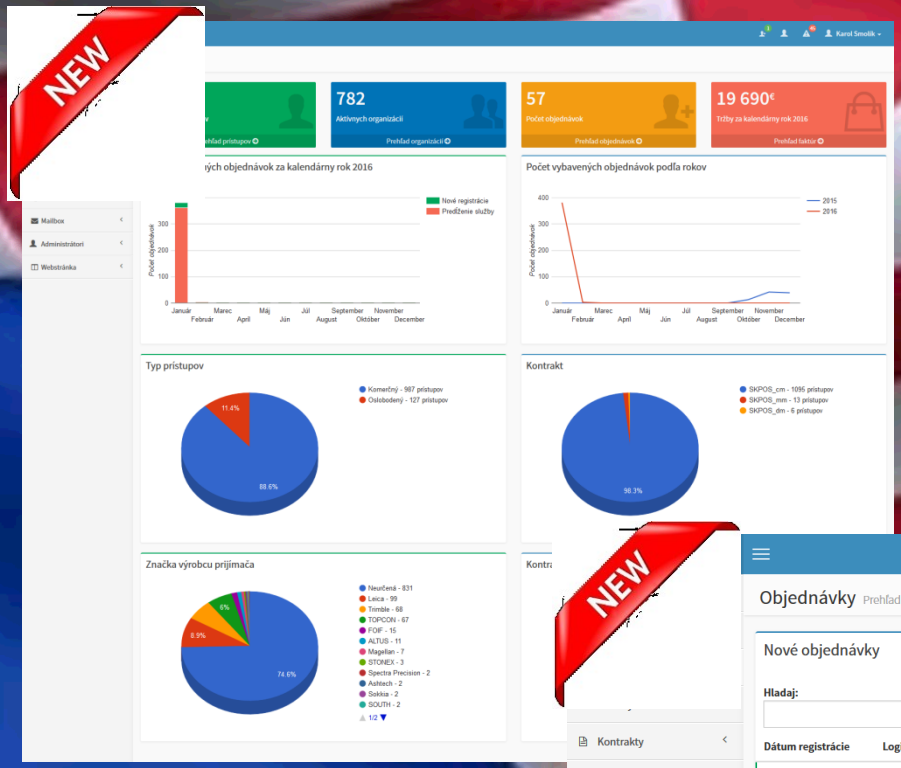
New SKPOS® registration a ordering system
User interface

From 13.10.2015

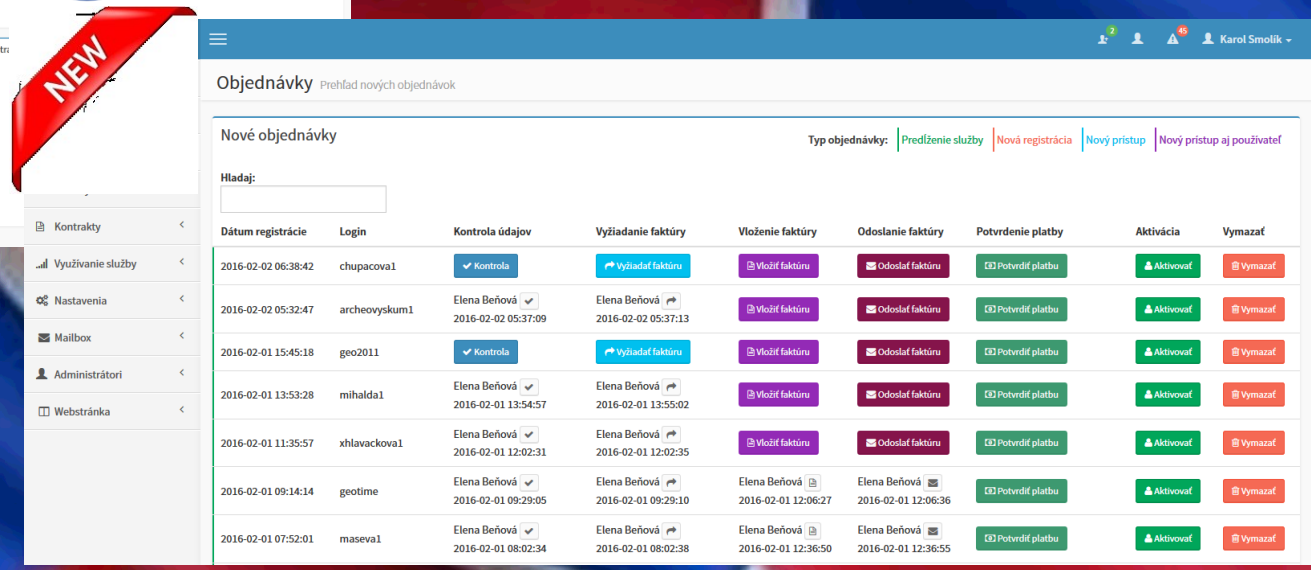




New SKPOS® registration a ordering system
Administrator interface



From 13.10.2015

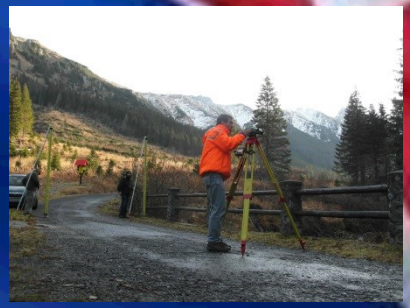


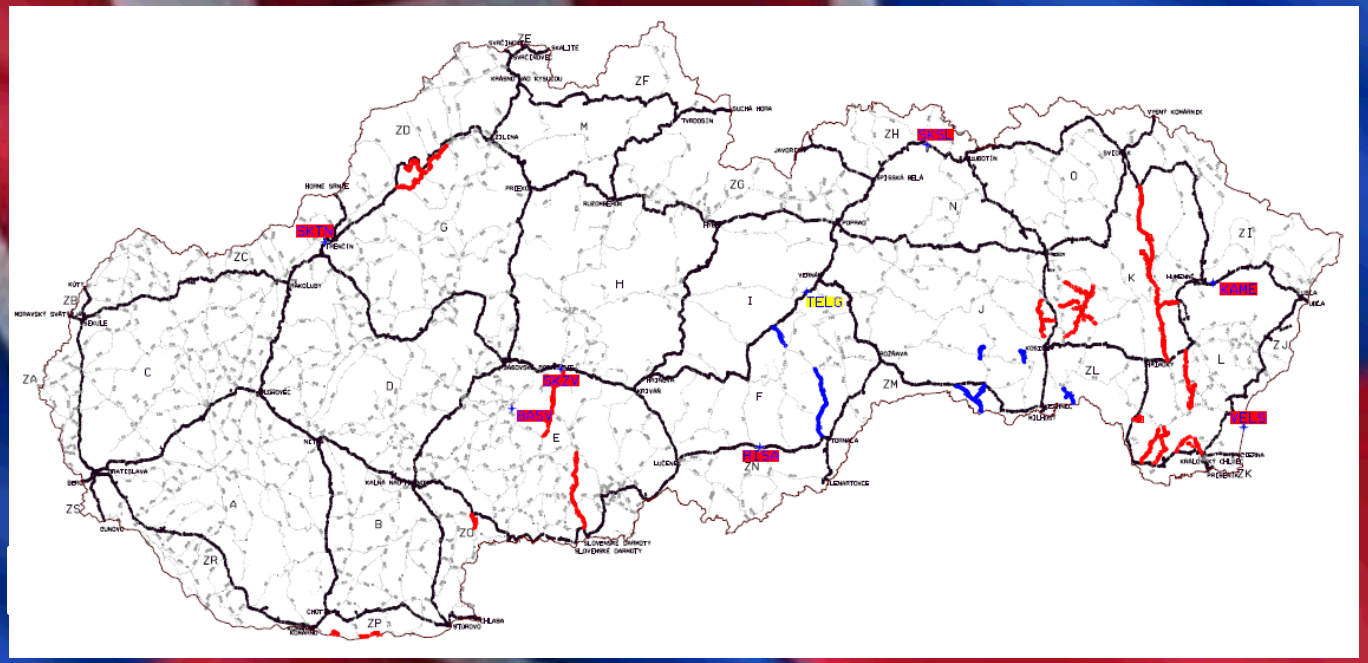
Dátum registrácie	Login	Kontrola údajov	Vyžiadanie faktúry	Vloženie faktúry	Odoslanie faktúry	Potvrdenie platby	Aktivácia	Vymazať
2016-02-02 06:38:42	chupacova1	Kontrola	Vyžiadať faktúru	Vložiť faktúru	Odoslať faktúru	Potvrdiť platbu	Aktivovať	Vymazať
2016-02-02 05:32:47	archeovyskum1	Elena Beňová 2016-02-02 05:37:09	Elena Beňová 2016-02-02 05:37:13	Vložiť faktúru	Odoslať faktúru	Potvrdiť platbu	Aktivovať	Vymazať
2016-02-01 15:45:18	geo2011	Kontrola	Vyžiadať faktúru	Vložiť faktúru	Odoslať faktúru	Potvrdiť platbu	Aktivovať	Vymazať
2016-02-01 13:53:28	mihalda1	Elena Beňová 2016-02-01 13:54:57	Elena Beňová 2016-02-01 13:55:02	Vložiť faktúru	Odoslať faktúru	Potvrdiť platbu	Aktivovať	Vymazať
2016-02-01 11:35:57	xhlavackova1	Elena Beňová 2016-02-01 12:02:31	Elena Beňová 2016-02-01 12:02:35	Vložiť faktúru	Odoslať faktúru	Potvrdiť platbu	Aktivovať	Vymazať
2016-02-01 09:14:14	geotime	Elena Beňová 2016-02-01 09:29:05	Elena Beňová 2016-02-01 09:29:10	Elena Beňová 2016-02-01 12:06:27	Elena Beňová 2016-02-01 12:06:36	Potvrdiť platbu	Aktivovať	Vymazať
2016-02-01 07:52:01	maseva1	Elena Beňová 2016-02-01 08:02:34	Elena Beňová 2016-02-01 08:02:38	Elena Beňová 2016-02-01 12:36:50	Elena Beňová 2016-02-01 12:36:55	Potvrdiť platbu	Aktivovať	Vymazať

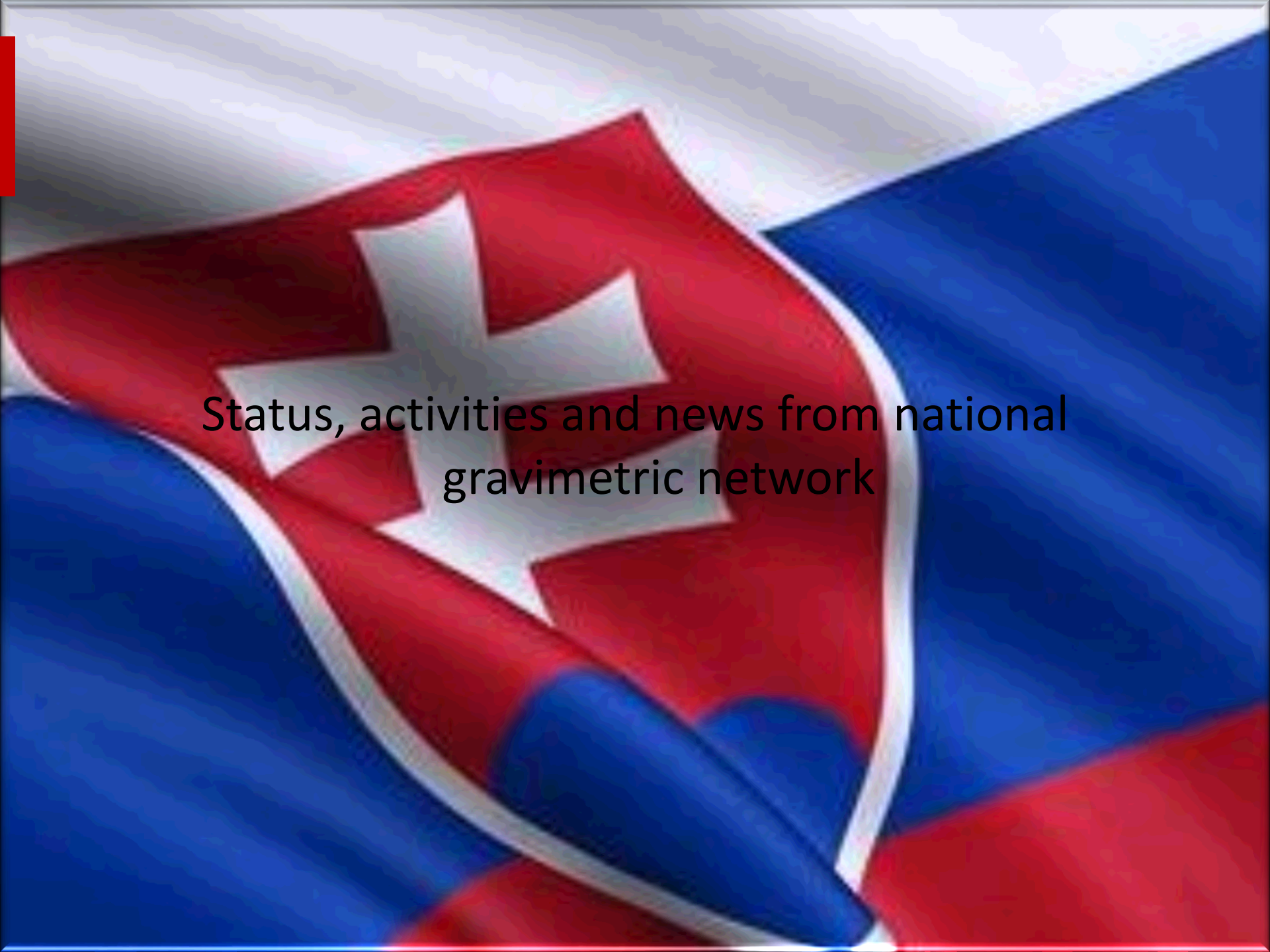
Status, activities and news from national levelling network

National levelling network

- Measurements in 2015:
  - 564 km of 2nd order levelling lines
  - worked done by 3 levelling groups
- 2020 target: New vertical reference system realization (data from 1987 - 2016) – more information in Droscak et al. presentation

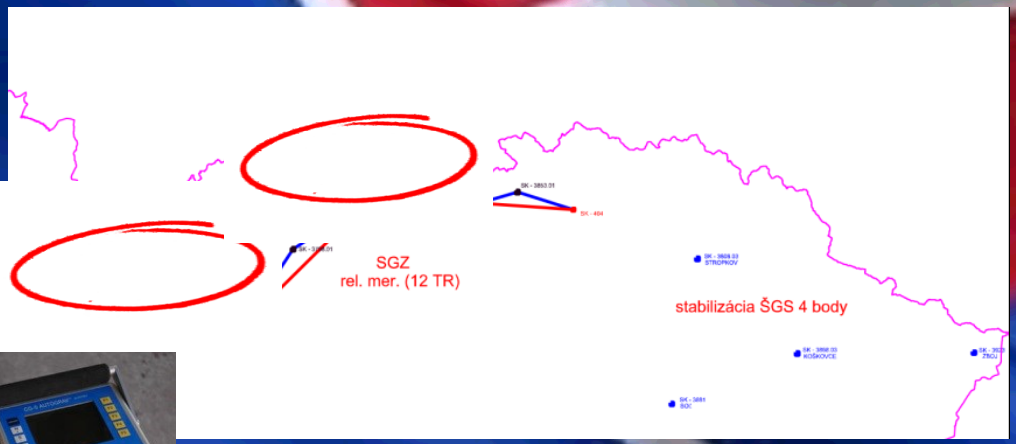


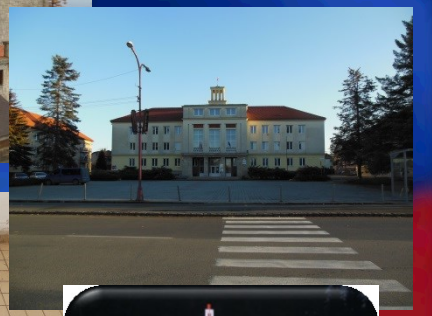



Status, activities and news from national gravimetric network

National gravimetric network

- Renovation of Slovakian gravimetric baseline:
  - 2 monumentations for absolute measurements
  - 4 monumentations for relative measurements
  - 64 gravity difference measured
  - worked done by 1 leveling groups
- 2020 target: New Slovakian gravimetic baseline (partly in Tatra mountain region)





Research and development

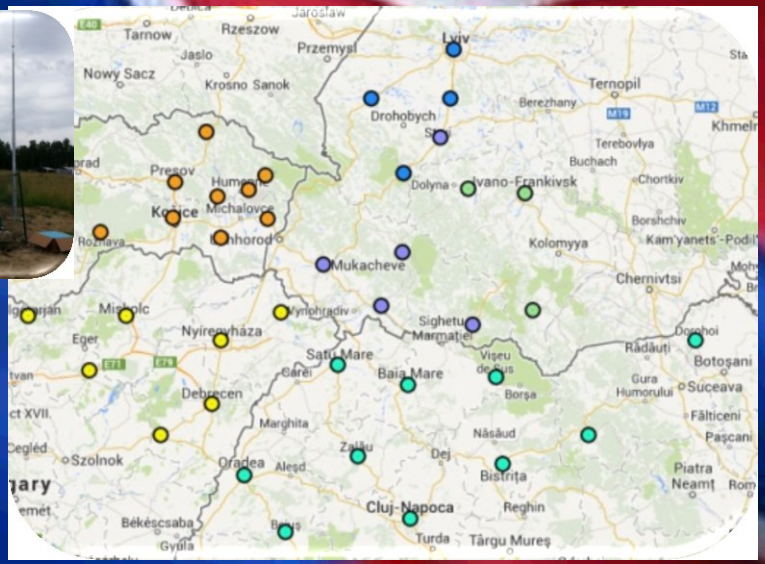
Projects supported by data from SK*POS*®

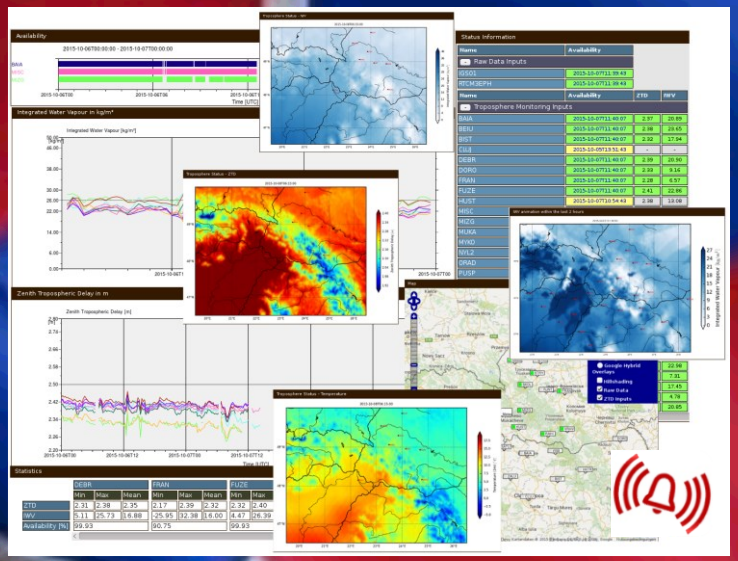
- EPN real-time analysis project
- ECC (EUPOS Combination Centre)
- EUPOS monitoring system
- Project „ National center for diagnosing the earth surface deformations in Slovakia“
- SES - Space Emergency System in Transcarpathian region
- EGVAP

Space emergency system

Program cezhraničnej spolupráce ENPI
Maďarsko–Slovensko–Rumunsko–Ukrajina

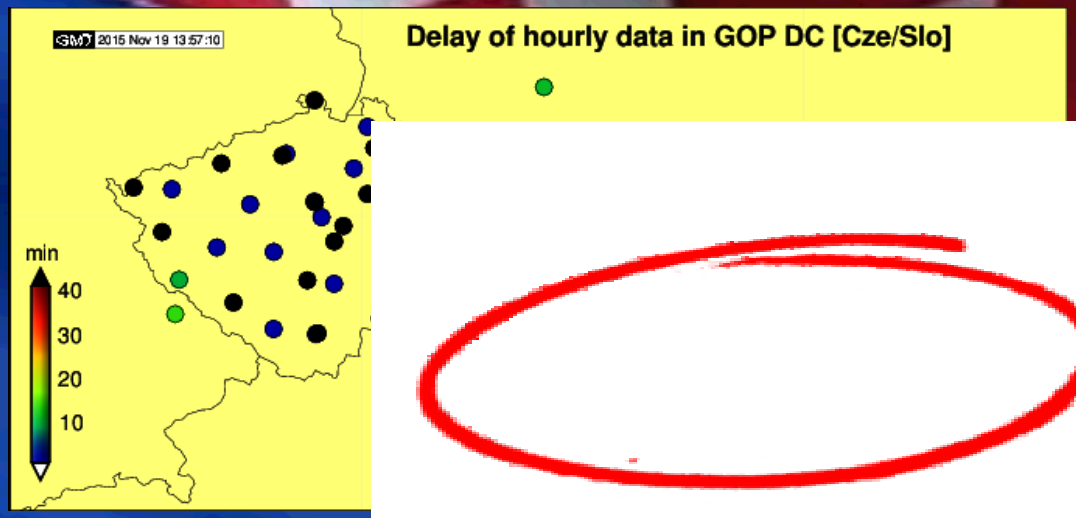
- Multilateral project: Ukraine-Slovakia-Hungary-Romania
- Agreement signed in December 2015
- goal: creation of Space emergency system
- more: www.meteognss.net
- GKU contributes with data from SK*POS*®

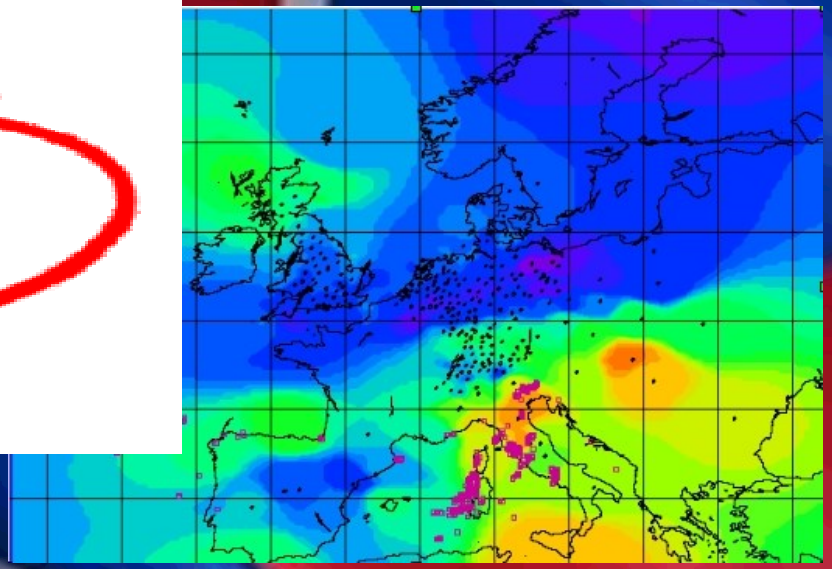




E-GVAP programme

- EUMETNET GPS Water Vapour Programme
- data from SK*POS*® stations supports E-GVAP via GOP data center (Tropnet)

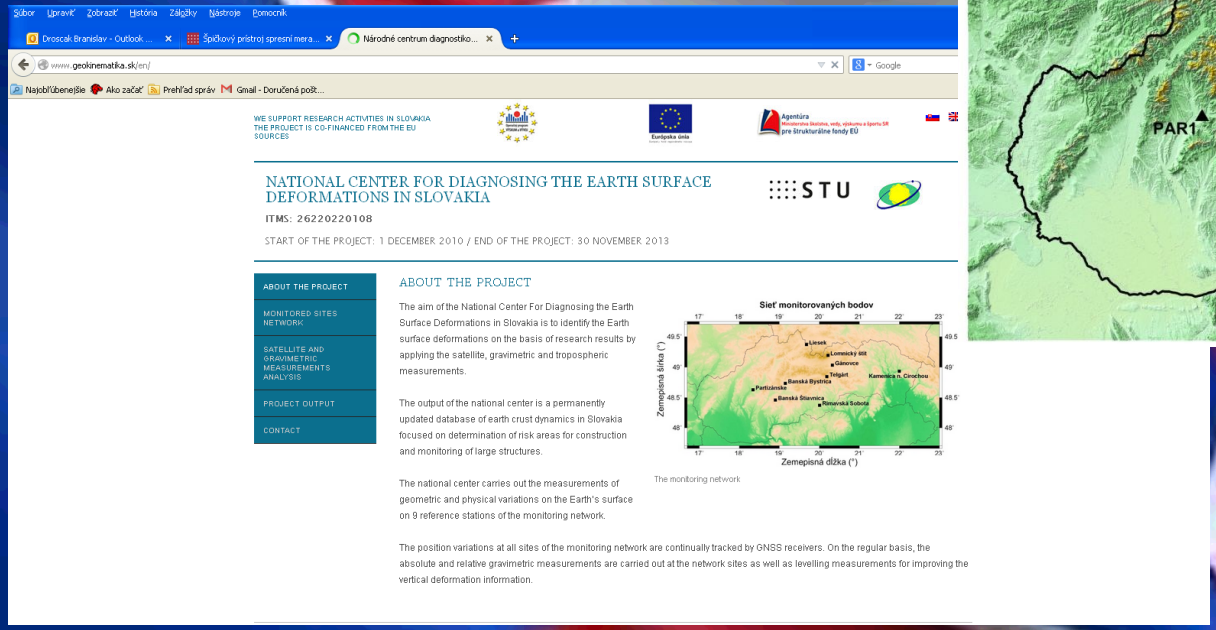


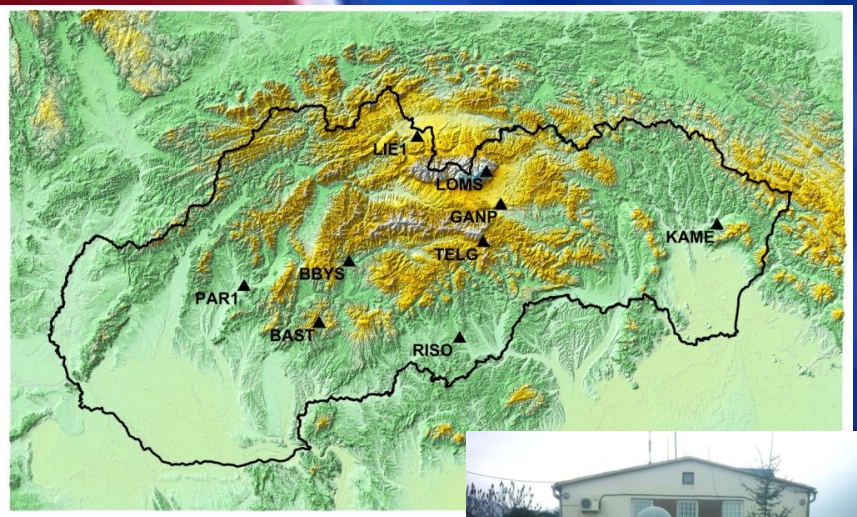


Slovak University of Technology
Research and development activities

National center for diagnosing the Earth surface deformations in Slovakia

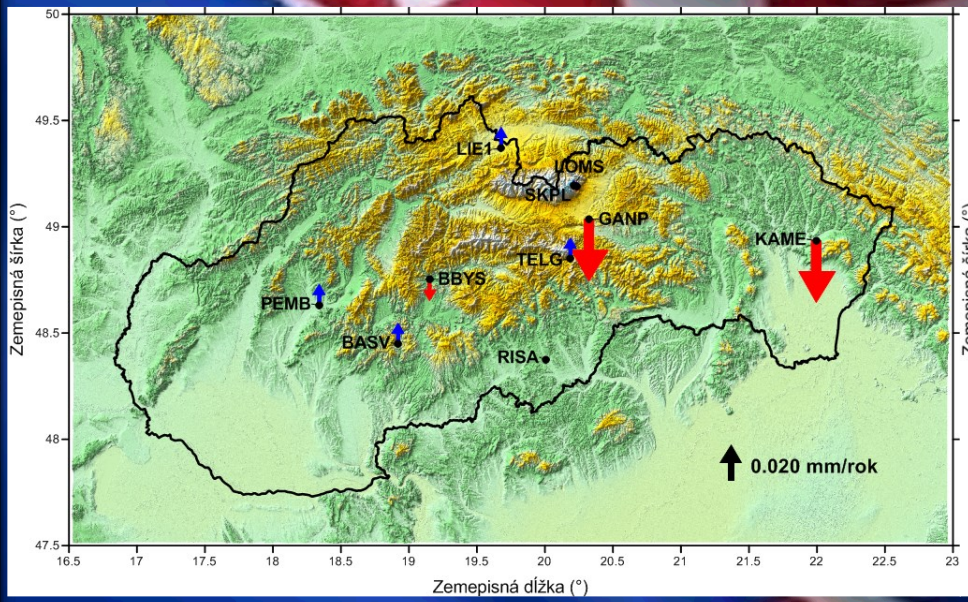
- ITMS research project (http://www.geokinematika.sk)
- Surface deformations monitored on 9 geodynamics points by
  - Permanent GNSS stations
  - Absolute gravity measurements

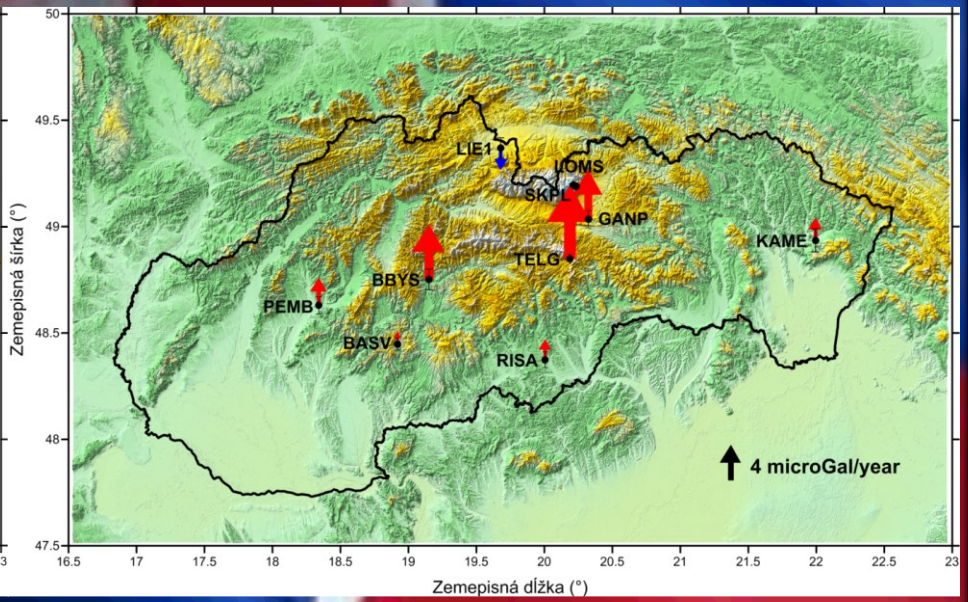




National center for diagnosing the Earth surface deformations in Slovakia

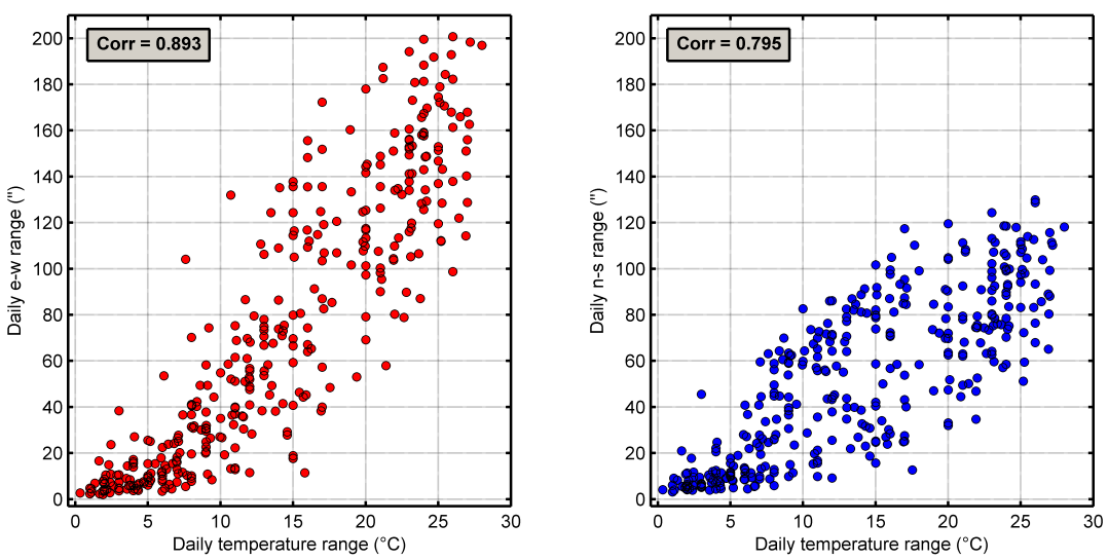
- Preliminary results (only 1.3 year):
  - vertical velocities (left picture)
  - absolute gravity changes (right picture)





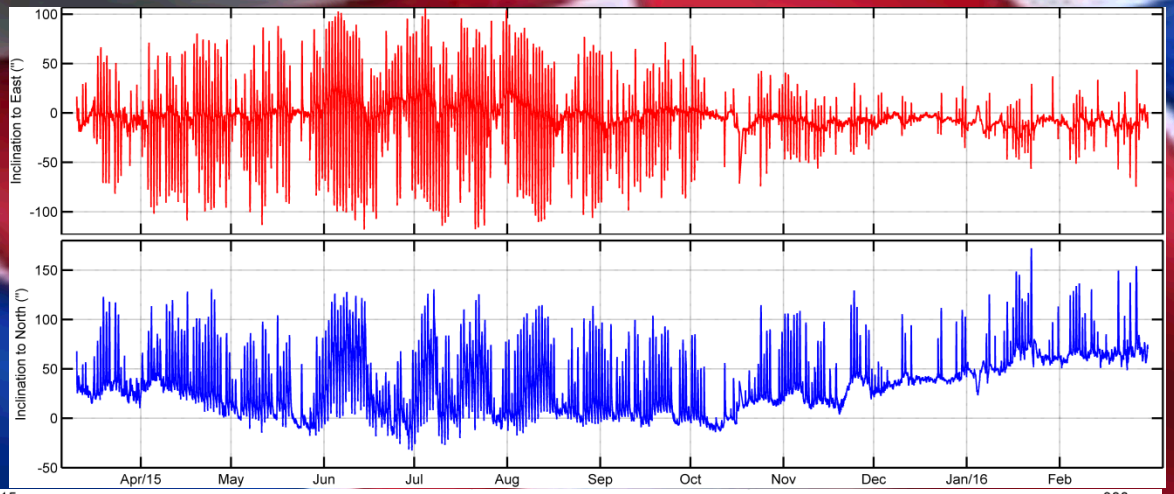
Short-term and Long-term variability of antenna position due to thermal bending of pillar monument at permanent station SUT1

- The most significant impact on concrete pillar movements has diurnal variability of temperature and the sunshine activity. Effects of these factors is warming up of pillar's sun-side and consequent inclination from the sun. Inclination's direction is determined by irregular thermal expansion of pillar.

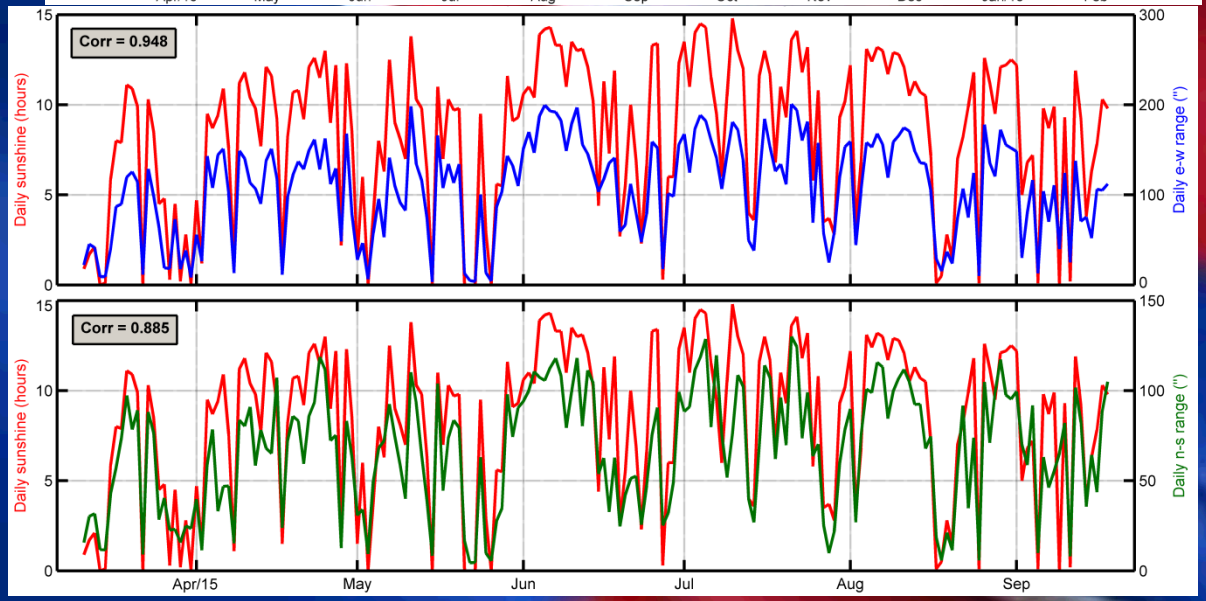


Daily temperature range versus inclination ranges (east-west and north-south) observed at SUT1 pillar. Daily variability of temperature ranges from 0 to 28°C (experiment was made throughout the year). To these ranges belong values from 0" to 200" in east-west direction and from 0" to 130" in north-south direction.

Short-term and Long-term variability of antenna position due to thermal bending of pillar monument at permanent station SUT1



Long-term time series of inclination observations at SUT1 pillar.



Time series of daily inclination ranges in east-west (in blue) and north-south (in green) constituents observed at SUT1 pillar, and the duration of daily sunshine (in red). Correlation between daily inclination's range and sunshine hours is strong in case of stable sunny or cloudy weather throught the day, in case of varying weather the correlation is low.

Multi-sensor InSAR deformation monitoring over bulidings and infrastructures in Bratislava (SLOVAKIA)

- Persistent Scatterer InSAR analysis spanning **24 years** (1992 - 2016) of spaceborne SAR measurements using ERS, ENVISAT, TERRASAR-X, RADARSAT-2 and SENTINEL-1.

Multi-sensor InSAR deformation monitoring over bulidings and infrastructures in Bratislava (SLOVAKIA)

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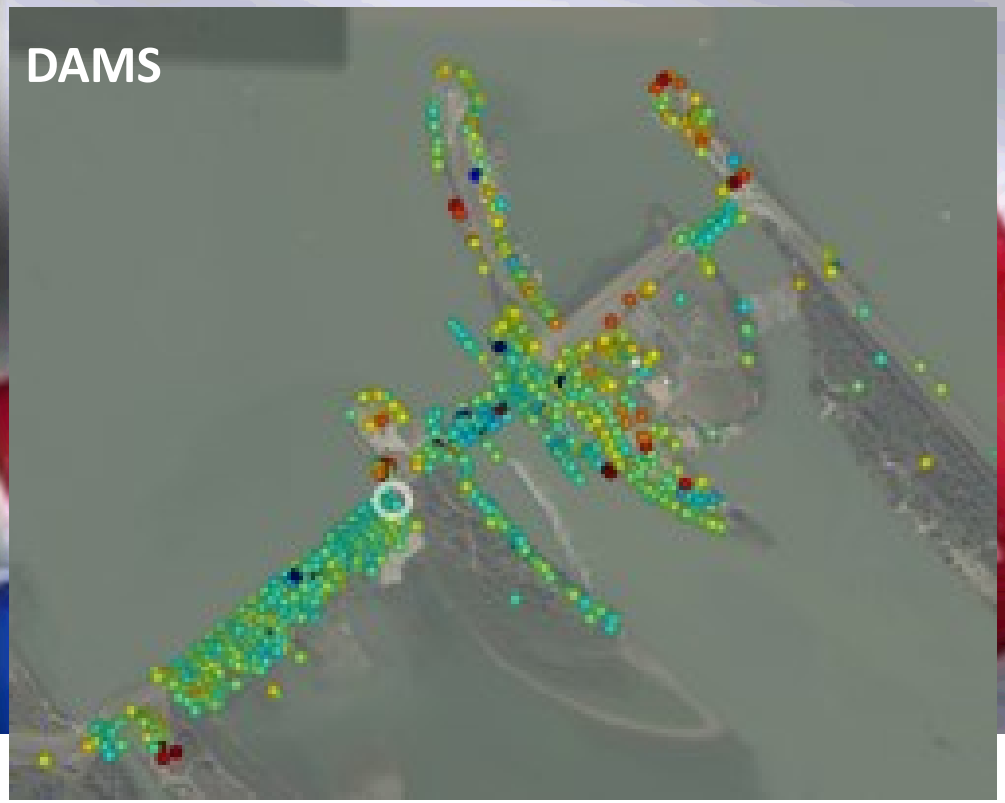
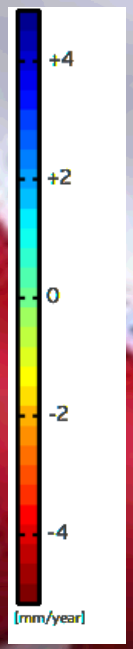
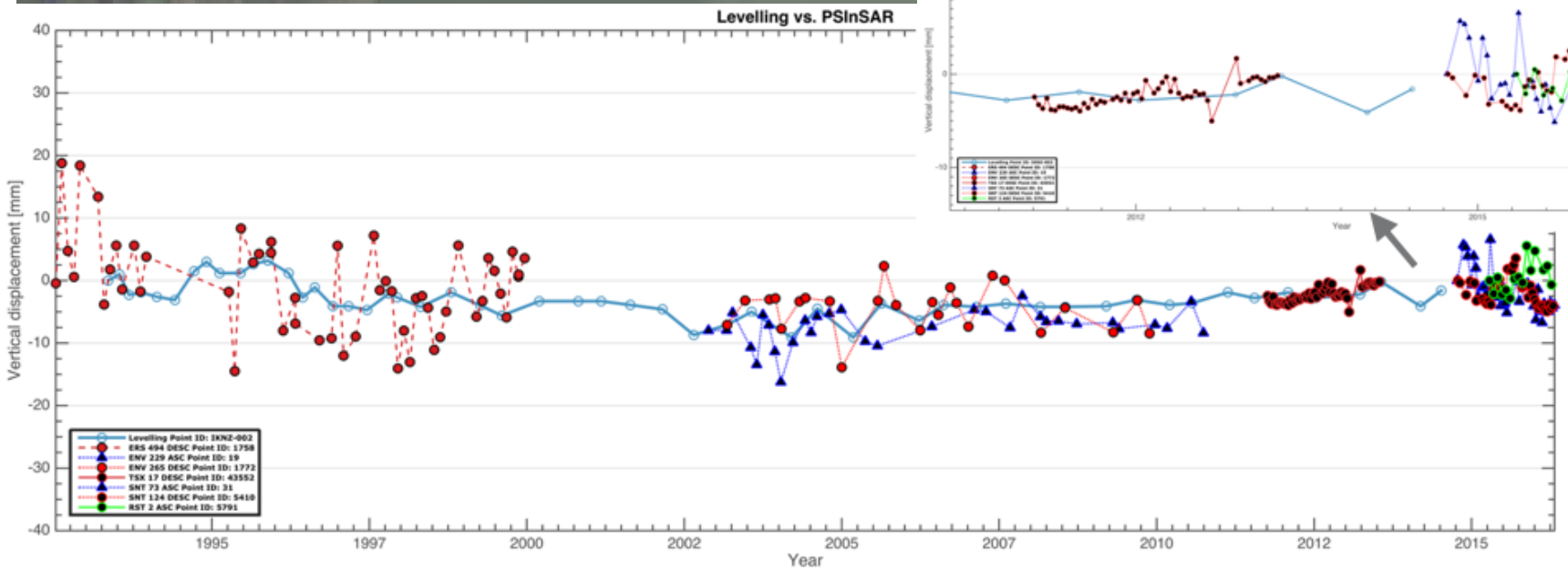
DAMS

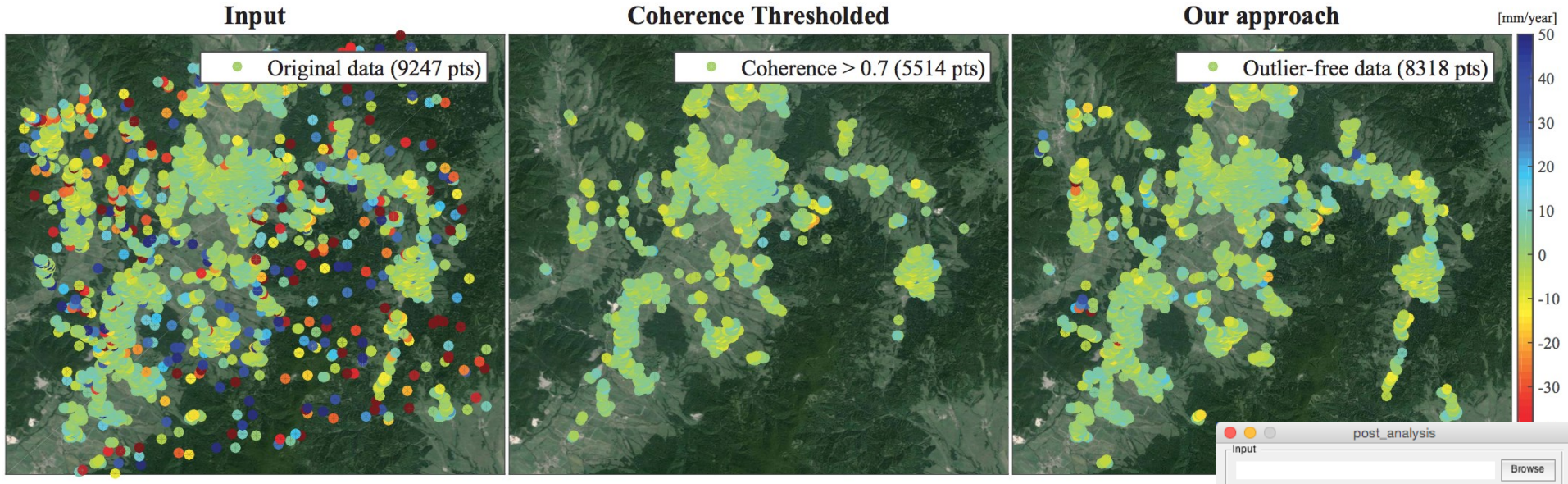


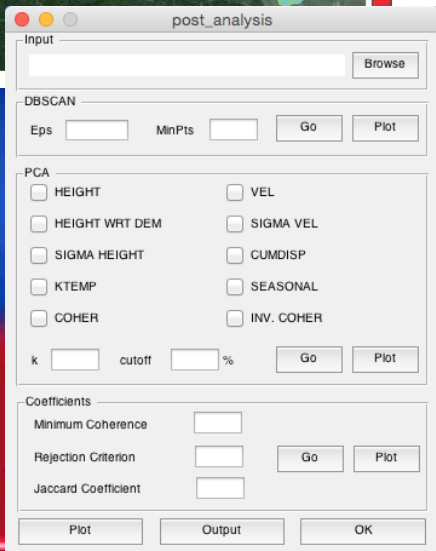


Comparison with ground truth measurements (levelling) over strategic objects such as dams.



A data mining approach for multivariate outlier detection in heterogenous 2D point clouds





Deformation map over area of active landslides in Prievidza, Slovakia.

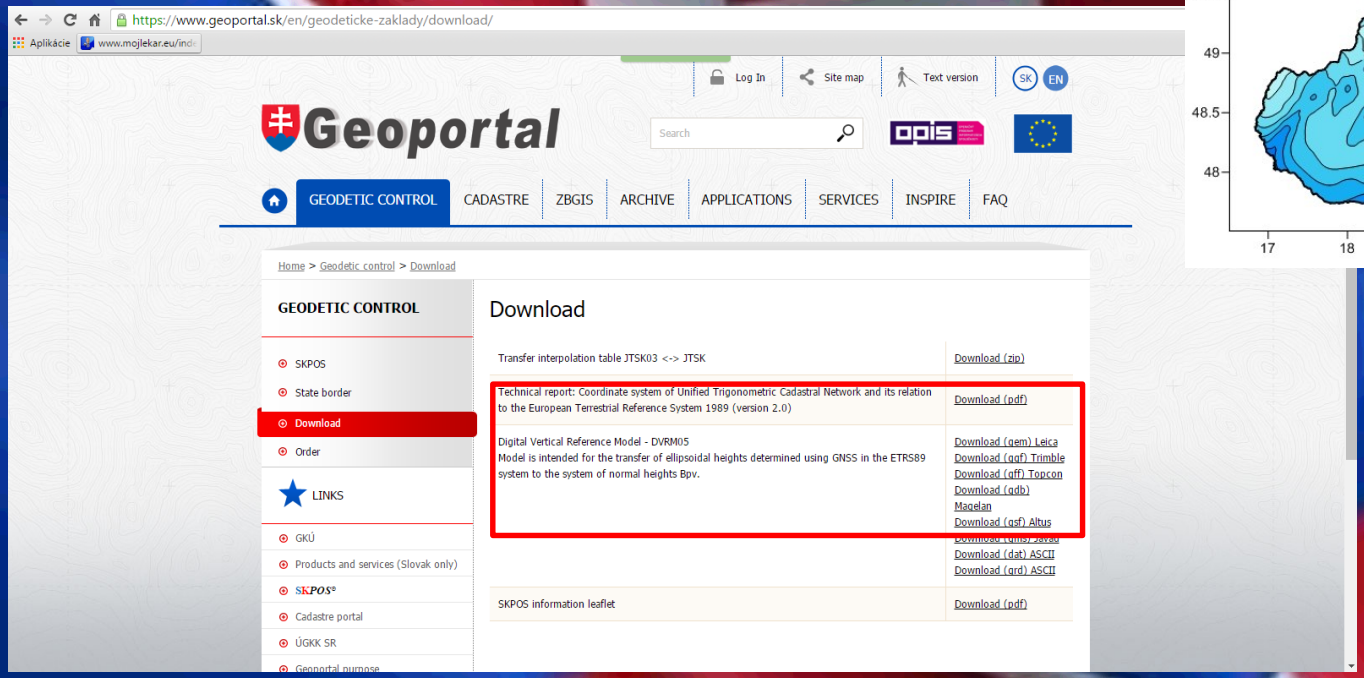
References:

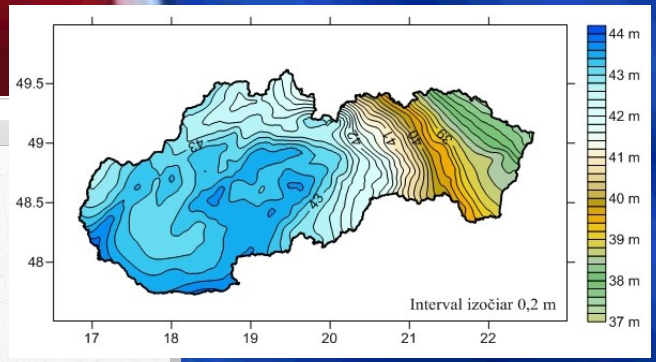
•M. Bakon, I. Oliveira, D. Perissin, J. Sousa and J. Papco, "A data mining approach for multivariate outlier detection in heterogeneous 2D point clouds: An application to post-processing ofmulti-temporal InSAR results," Geoscience and Remote Sensing Symposium(IGARSS), 2016 IEEE International, Beijing, 2016

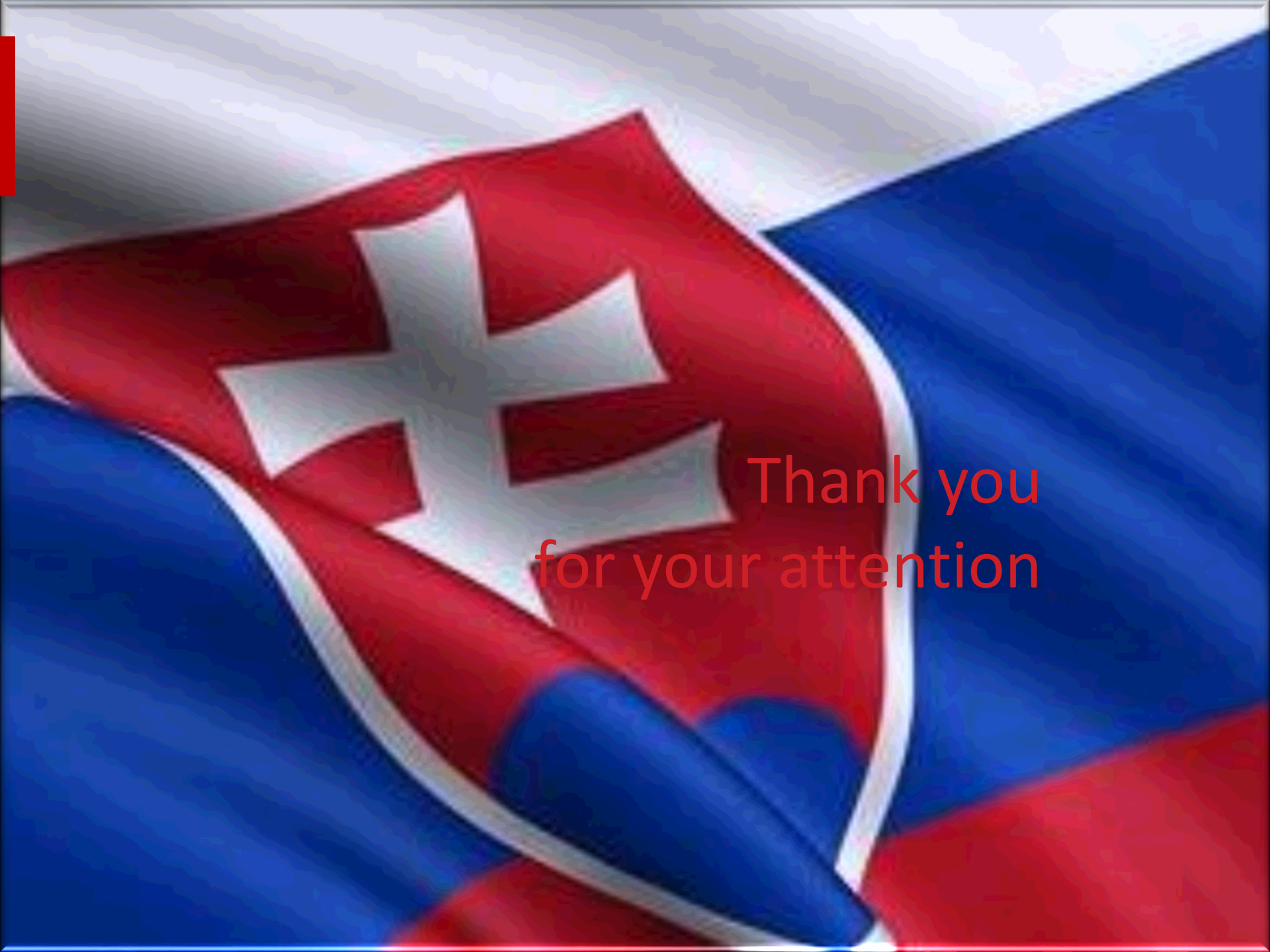

Other news

Slovakian quasigeoid **DVRM**

- since March 2015 available for free of charge
- https://www.geoportal.sk/en/geodeticke-zaklady/download/
- DVRM is intended for the transfer of ellipsoidal heights determined using GNSS in the ETRS89 system to the system of normal heights Bpv






Thank you
for your attention