

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

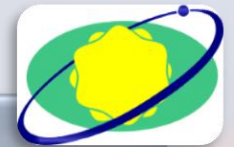
Outline

- Slovakian activities and contributions to EPN
- Status, activities and news from:
 - SKPOS[®] (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



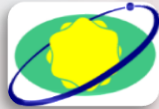
Geodetic and Cartographic Institute
Bratislava (GKÚ)



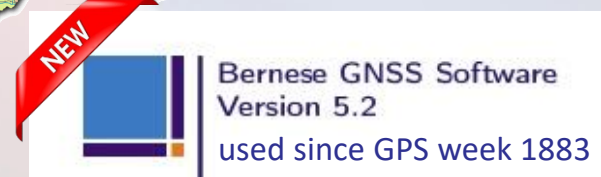
Slovak University of Technology in
Bratislava (SUT)



Slovakian EPN Local analysis center



Slovak University of
Technology in Bratislava (SUT)



GMD 2016 May 16 03:10:42

<http://www.epncb.oma.be/>

- 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 eur-93

NETWORK & DATA | **PRODUCTS & SERVICES** | **DOCUMENTATION**

Working Station list | Maps | Tracking status | Data analysis | Daily/weekly positions | Positions & velocities | Formats | Guidelines | Equipment & News |
Autors | Data access | Proposed stations | Tropospheric delays | ETRF/ITRF calibration | Papers | FAQ |
Station log submission | Station picture submission | Transformation | Position time series | Satellite orbit & clock correction streams

MAPS

Locate station on map


Antenna manufacturer:
3S NAVIGATION
AOA
ASHTECH

Status:
ACTIVE
INACTIVE
FORMER


Update map

Údaje map ©2015 GeoBasis-DE/BKG (©2009) Google 50 km Zmluvné podmienky Nahliásiť chybu mapy


MOPI




MOP2



GANP



BBYS



The image shows a screenshot of the EUREF Permanent Network website. The main content is a map of Central Europe, including parts of Poland, Czech Republic, Slovakia, and Hungary. Four specific stations in Slovakia are highlighted with red circles and red lines pointing to their respective photographs: MOPI (near Bratislava), MOP2 (near Bratislava), GANP (near Košice), and BBYS (near Košice). The website header includes the EUREF logo and navigation tabs for Network & Data, Products & Services, and Documentation. A sidebar on the left contains filters for station status (Active, Inactive, Former) and antenna manufacturer (3S NAVIGATION, AOA, ASHTECH).

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 server

NETWORK & DATA > MAPS

INTERACTIVE MAP

Legend

Station status (active, inactive, former)

Active ● Inactive ● Former ●

Locate station on map

Antenna manufacturer:

3S NAVIGATION
AOA
ASHTECH

Status:

ACTIVE
INACTIVE
FORMER

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), 1008(10), 1008(10), 1012(1), 1013(10), 1019(10), 1020(10), 1033(10), 1230(10)	
More details: EPN station information	

MOP20

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	

GANP

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), 1008(10), 1008(10), 1012(1), 1013(10), 1019(10), 1020(10), 1033(10), 1230(10)	
More details: EPN station information	

Slovakian contribution to EPN Densification

NEW DENSIFICATION HOME

EUREF PERMANENT NETWORK DENSIFICATION

ROB GNSS RESEARCH GROUP *****
EUREF eur5

ORGANISATION **NETWORK** **DATA ANALYSIS** **PRODUCTS**

About | How to Join | Contributors | Site Map | FTP Server Station List | Maps | Operational Centres | Station Log Submission Analysis Centres Coordinates & Velocities | Time Series

NETWORK > **MAPS**

INTERACTIVE MAP

Legend

- EPN station
- EPN densification station with station log at the EPN CB
- EPN densification station without station log at the EPN CB

Locate station on map
- Select a station -

Station criteria selection
Countries:
GREENLAND
HUNGARY
ICELAND
IRELAND
ISRAEL
ITALY
JORDAN
LATVIA
LITHUANIA
MACEDONIA
MOROCCO
NETHERLANDS
NORWAY
POLAND
PORTUGAL
REPUBLIC OF MOLDOVA
ROMANIA
RUSSIAN FEDERATION

Mapa

Map showing station locations in Slovakia and surrounding regions. Key cities include Bratislava, Košice, Prešov, and Trnava. Major roads (E40, E42, E44, E46, E50, E58, E60, E65, E71, E75, E77, E79) and geographical features like the Carpathian Basin are visible.

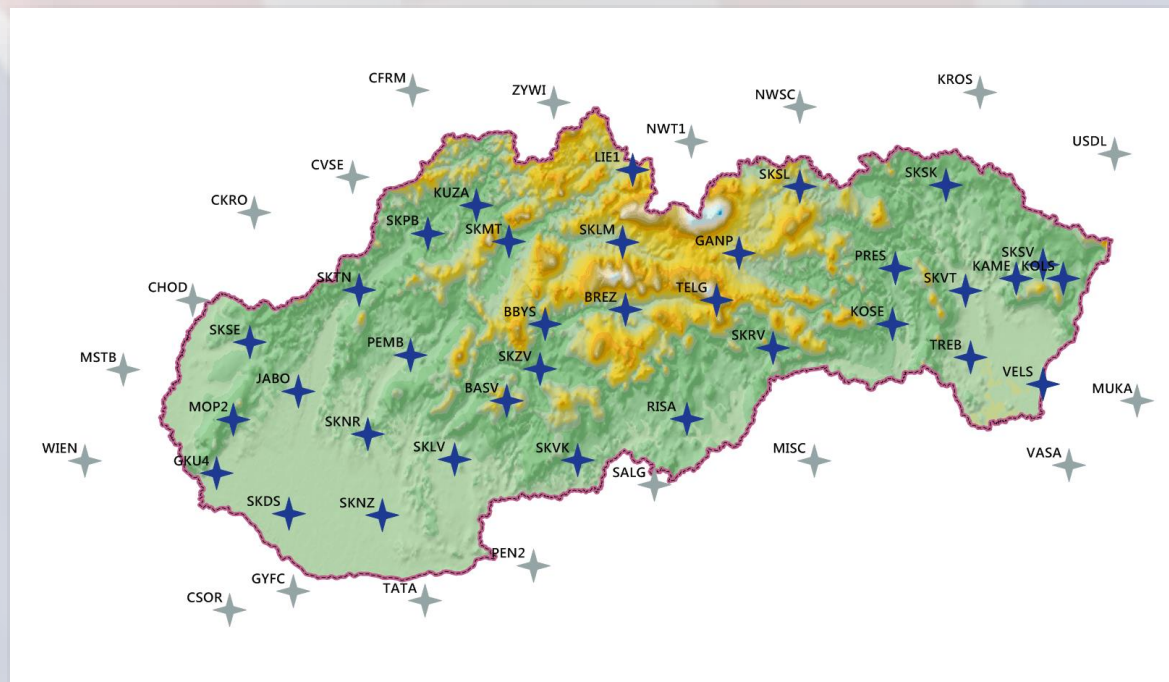
Status and news from Slovakian real-time
determination system - **SKPOS**[®]



2006 – 2016 => 10 years of **SKPOS**[®]

infrastructure status (May 2016)

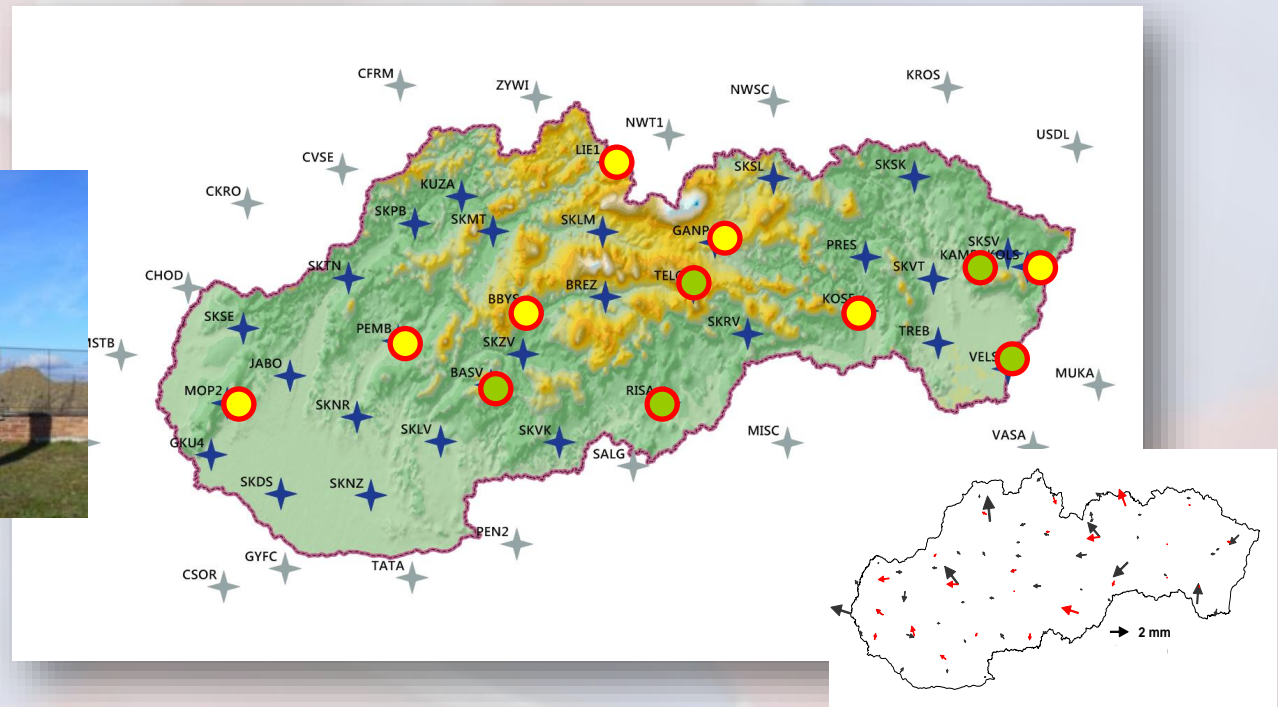
- **34 Slovakian permanent stations (14 individual calibrated)**
 - All stations observe GPS+GLONASS signals (few Galileo)
 - Network density - average distance between stations : 44,6 km
- **19 foreign permanent stations (APOS, gnsnet.hu, CZEPOS, ASG-EUPOS, ZAKPOS)**
- -----
- **Totally 53 permanent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



SKPOS[®]

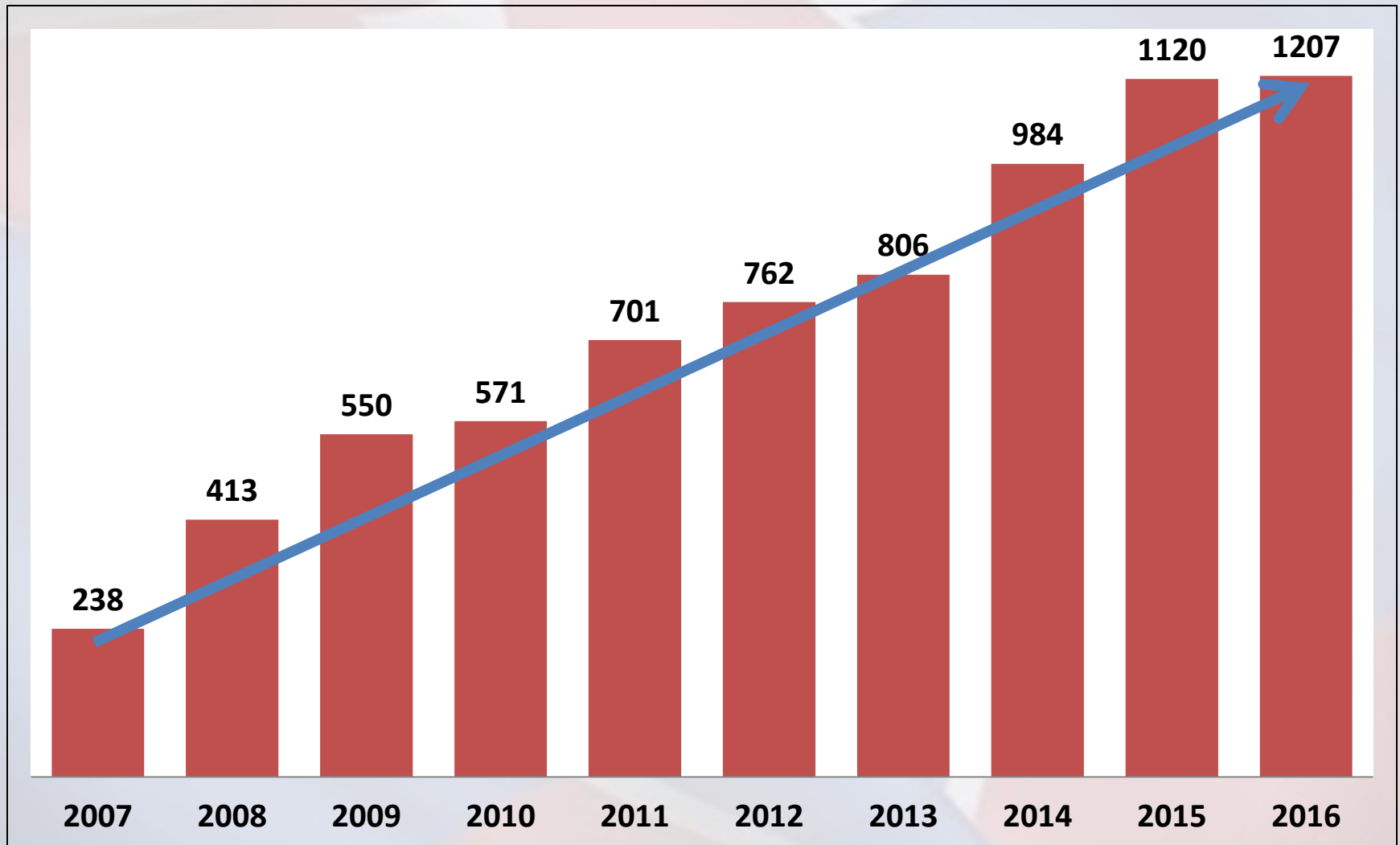
infrastructure for geodynamics research

- 12 from 34 slovakian SKPOS[®] permanent stations have monumentation suitable for geodynamic research purposes
 - 7 stations reinforced-concrete pillar monumentation
 - 5 stations deep drilled braced mark monumentation (5m deep)



SKPOS[®]

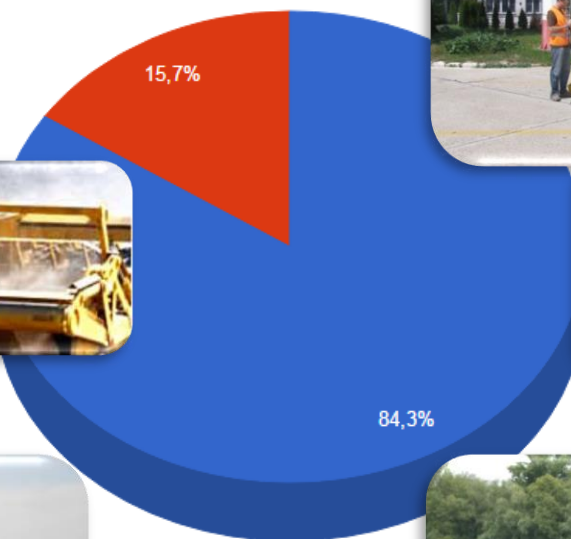
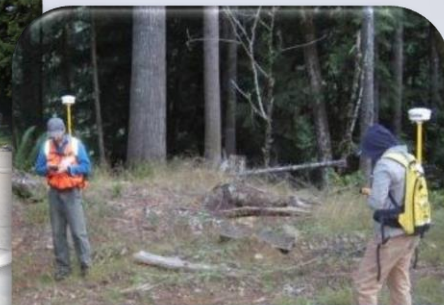
number of users



SKPOS[®]

type of users

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



SKPOS[®]

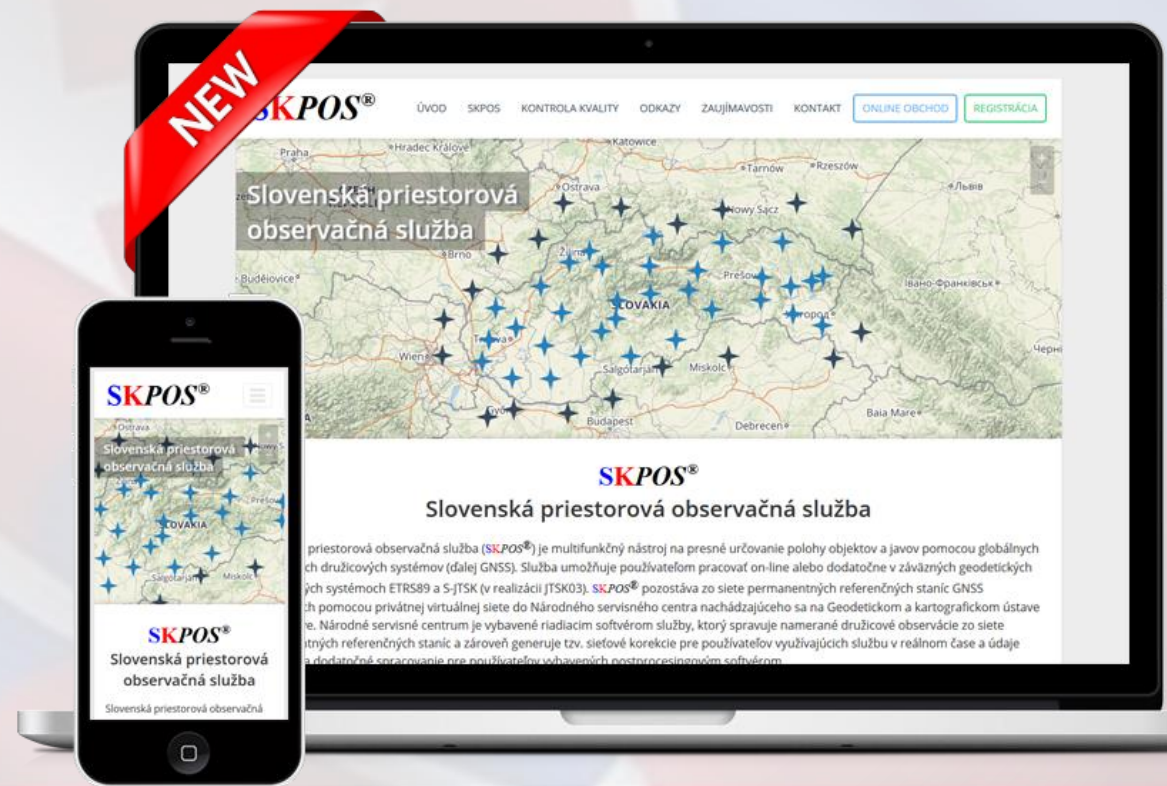
packages - data formats - charges

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

NEW

ÚVOD SKPOS KONTROLA KVALITY ODKAZY ZAUJÍMAVOSTI KONTAKT **ONLINE OBCHOD** **REGISTRÁCIA**



Slovenská priestorová observačná služba

SKPOS[®]
Slovenská priestorová observačná služba

Slovenská priestorová observačná služba (SKPOS[®]) je multifunkčný nástroj na presnú určovanie polohy objektov a javov pomocou globálnych navigačných družicových systémov (ďalej GNSS). Služba umožňuje používateľom pracovať on-line alebo dodatočne v zvláštnych geodetických referenčných systémoch ETRS89 a S-JTSK (v realizácii JTSK03). SKPOS[®] pozostáva zo siete permanentných referenčných staníc GNSS pripojených pomocou privátnej virtuálnej siete do Národného servisného centra nachádzajúceho sa na Geodetickom a kartografickom ústave v Bratislave. Národné servisné centrum je vybavené riadiacim softvérom služby, ktorý spravuje namerané družicové observácie zo siete permanentných referenčných staníc a zároveň generuje tzv. sieťové korekcie pre používateľov využívajúcich službu v reálnom čase a údaje službu na dodatočné spracovanie pre používateľov vybavených postprocesingovým softvérom.

Aktuálne informácie

- 19.11.2015 Upgrade firmvéru prijímačov Trimble NetR9 na verziu 5.10/5.02
- 13.10.2015 Spustenie nového webu služby SKPOS
- 13.10.2015 Spustenie online registrácie do služby SKPOS
- 06.10.2015 Upgrade riadiaceho softvéru služby Trimble Pivot Platform na verziu 3.5.8
- 25.08.2015 Upgrade firmvéru prijímačov Trimble NetR9 na verziu 5.03/5.02 a prijímačov Trimble NetR8 na verziu 4.87/3.62
- 10.08.2015 Nastavenie absolútnej kalibrácie na referenčnej stanici BBYS
- 10.03.2015 Upgrade riadiaceho softvéru služby Trimble Pivot Platform na verziu 3.5.6, pripojenie novej referenčnej stanice VELS do sieťového riešenia služby
- 01.03.2015 Úprava služieb SKPOS: zrušenie limitov RTK meraní v službách SKPOS_cm a SKPOS_dm
- 18.02.2015 Pripojenie zahraničnej stanice KROS do sieťového riešenia služby
- 03.02.2015 Upgrade firmvéru prijímačov Trimble NetR9 na verziu 4.93/4.93

© 2015 - Geodetický a kartografický ústav Bratislava

NEW

Vytvoriť

Registrácia nového používateľa

Učtovná jednotka:

Typ registrácie nového používateľa:

Fakturačné údaje

Právnická osoba
Zvoľte typ používateľa
Fyzická osoba bez živnostenského listu
Fyzická osoba so živnostenským listom
Právnická osoba
Rezorčná organizácia ÚGKK SR
Orgány štátnej správy - príspevkové organizácie
Orgány štátnej správy - rozpočtové organizácie
VÚC, mesto, obec

Formát: 0123456789
IČ DPH: IČ DPH:
Formát: SK0123456789

Štatutárny zástupca

Titul pred menom: Titul pred menom
Meno:
Priezvisko:
Titul za menom:

Fakturačná adresa

Ulica:
Číslo domu: Číslo domu
Obec:
PSČ: PSČ
Štát: Slovenská republika

Kontaktné údaje

E-mail: E-mail
Telefónne číslo: Telefónne číslo
Formát čísla: +421 901 234 567

Korešpondenčná adresa: rovnaká ako fakturačná adresa

Pokračovať v registrácii

From 13.10.2015

NEW

SKPOS[®]

Prístup Slovenskej priestorovej observačnej služby GNSS

Domov > Registrovať

Vytvoriť účet

Registrácia nového používateľa + objednanie služby

Výber služby

SKPOS_cm/RTK pre 1 zariadenie (rok neobmedzené RTK + 50 |

Prístupové meno

login1

Heslo:

Potvrdiť heslo:

Bezpečnostný kód:

Zz83g

Súhlasím so spracovaním svojich osobných údajov v zmysle platných **Všeobecných obchodných podmienok**.

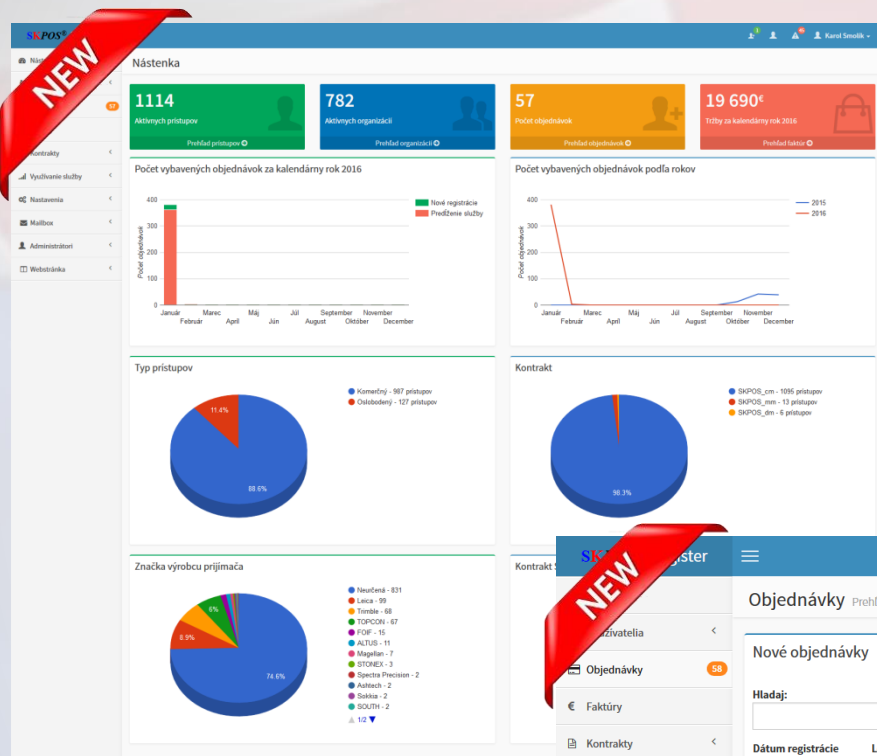
Súhlasím so **Všeobecnými obchodnými podmienkami**, s ktorými som bol obznámený/á a porozumel/a som im.

Poznámka

Späť **Registrovať za 50,- EUR**

KONTAKT © COPYRIGHT 2015, GKÚ BRATISLAVA

New SKPOS[®] registration a ordering system Administrator interface



From 13.10.2015

NEW

Objednávky Prehľad nových objednávok

Nové objednávky

Hľadaj:

Typ objednávky: Predĺženie služby | Nová registrácia | Nový prístup | Nový prístup aj používateľ

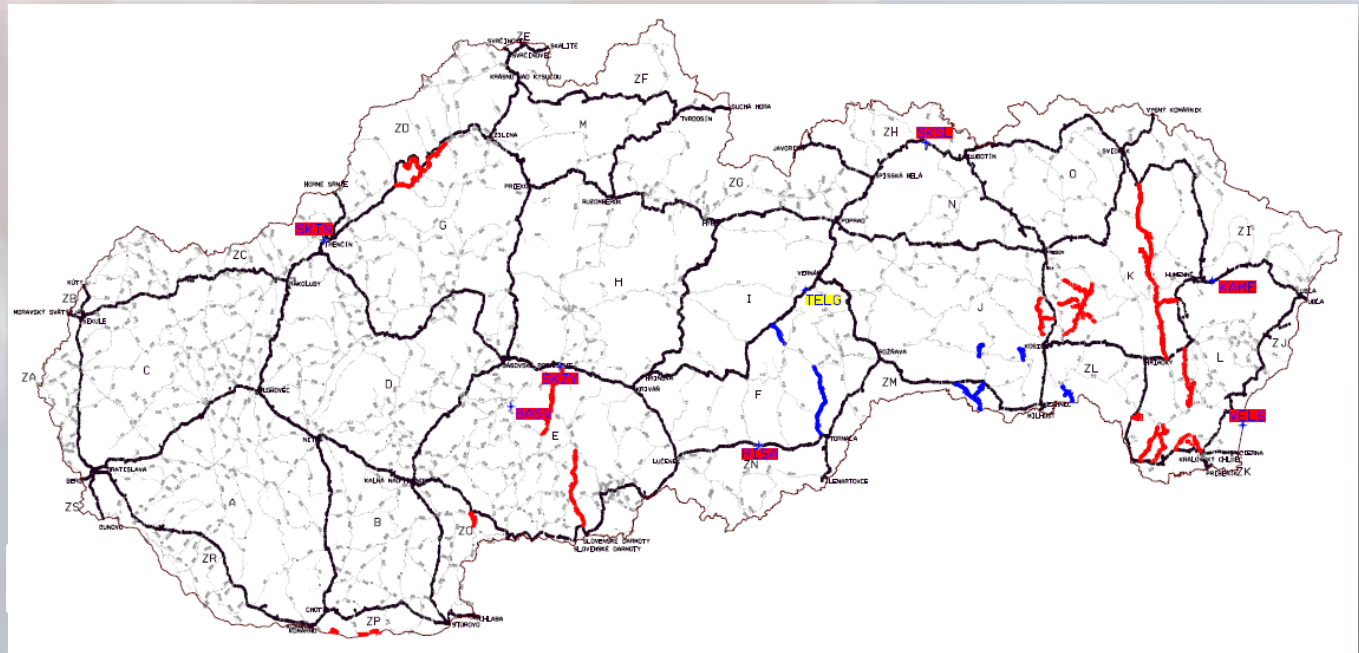
Dátum registrácie	Login	Kontrola údajov	Vyžiadanie faktúry	Vloženie faktúry	Odoslanie faktúry	Potvrdenie platby	Aktívacia	Vymazať
2016-02-02 06:38:42	chupacova1	Kontrola	Vyžiadať faktúru	Vložiť faktúru	Odoslať faktúru	Potvrdiť platbu	Aktivovať	Vymazať
2016-02-02 05:32:47	archeovyskum1	Elena Beňová 2016-02-02 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

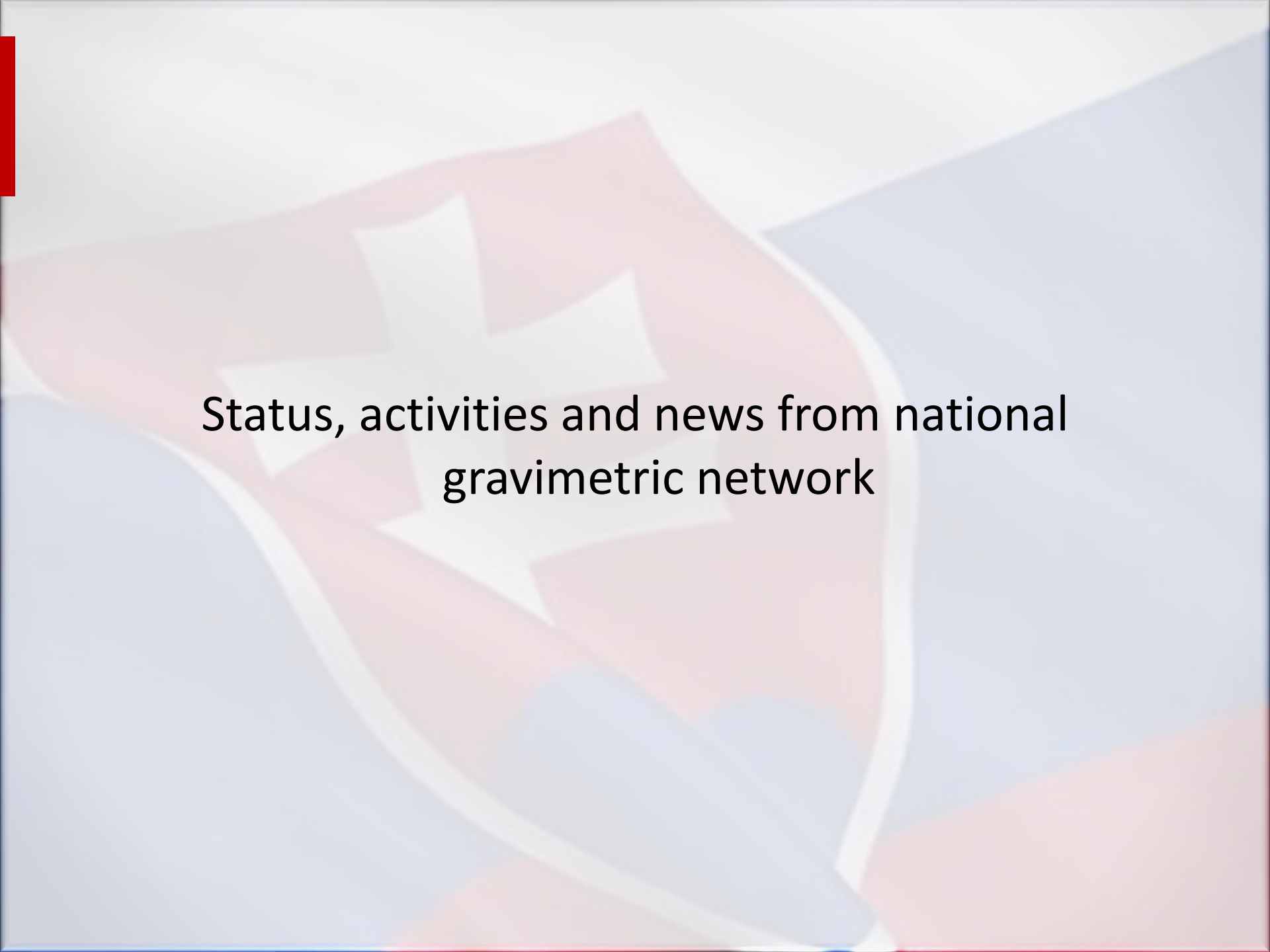


Status, activities and news from national levelling network

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 gravimetric baseline (partly in Tatra mountain region)





Research and development

Projects supported by data from SKPOS[®]

- 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

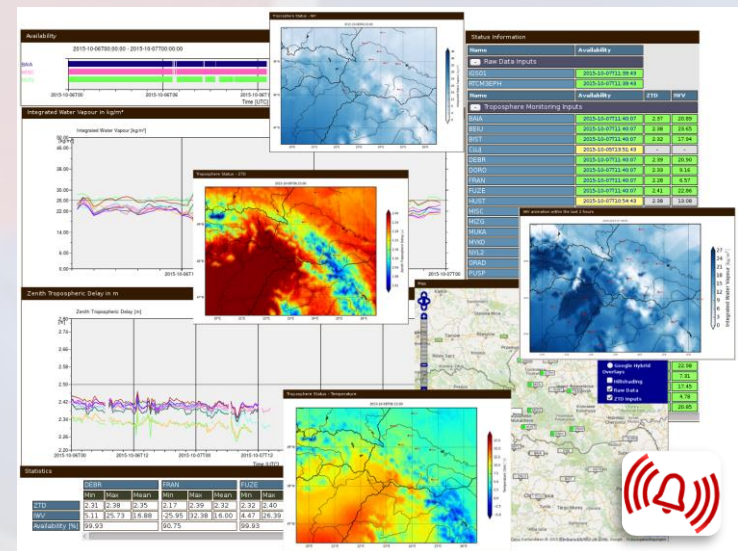
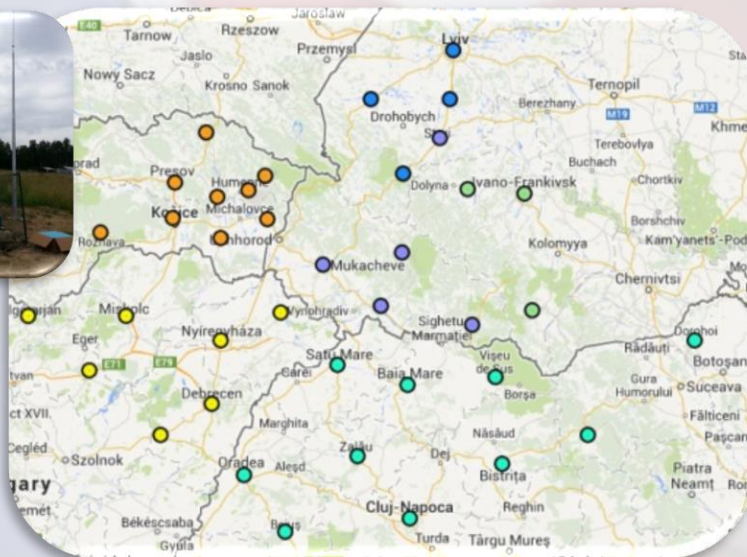


Space emergency system



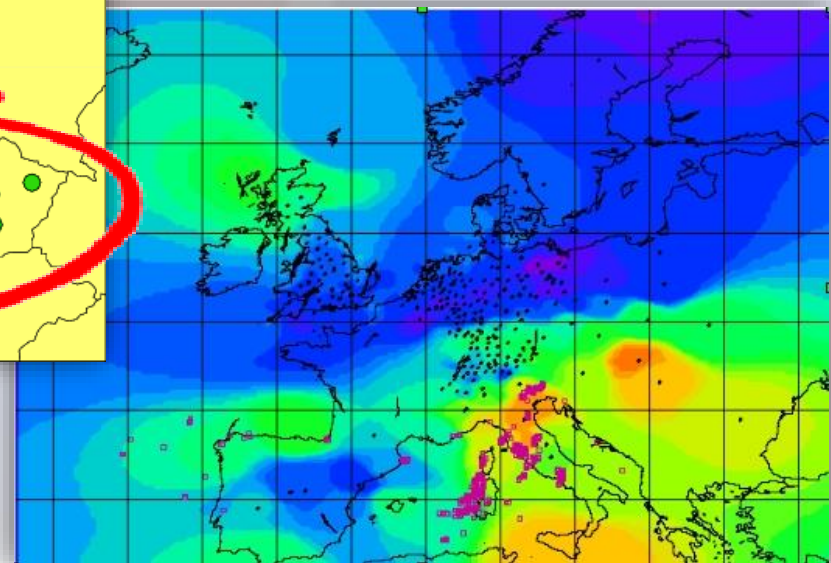
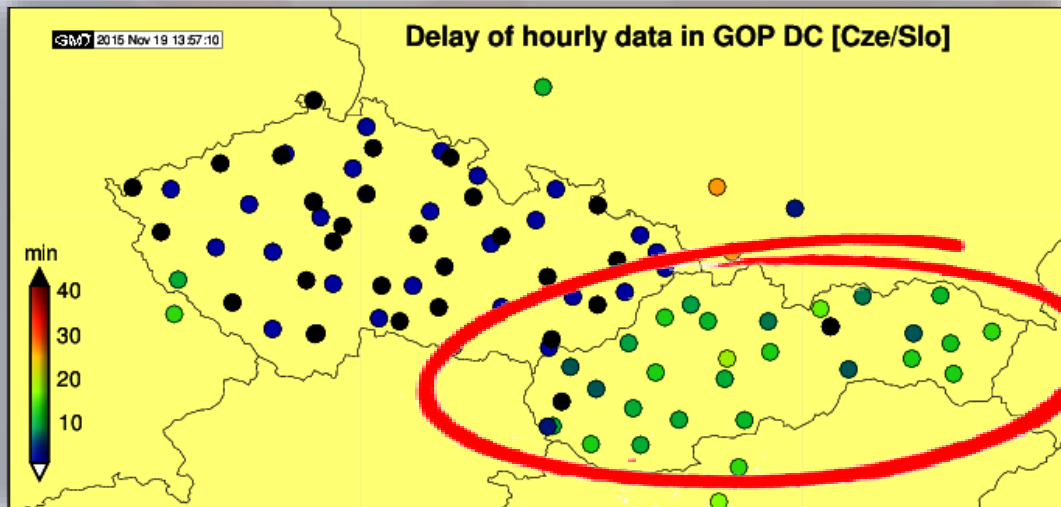
Program cezhraničnej spolupráce ENPI
Maďarsko-Slovensko-Rumunsko-Ukrajina

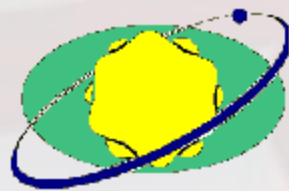
- Multilateral project: Ukraine-Slovakia-Hungary-Romania
- Agreement signed in December 2015
- goal: creation of Space emergency system
- more: www.meteognss.net
- GKU contributes with data from SKPOS®



E-GVAP programme

- EUMETNET GPS Water Vapour Programme
- data from SKPOS[®] 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

The screenshot shows the website for the National Center for Diagnosing the Earth Surface Deformations in Slovakia. The page includes a navigation menu, a header with logos for the European Union and the project, and a main content area. The main content area features a title, a project ID (ITMS: 26220220108), and a brief description of the project's goals and objectives. A sidebar on the left contains links to various sections of the website.

NATIONAL CENTER FOR DIAGNOSING THE EARTH SURFACE DEFORMATIONS IN SLOVAKIA
ITMS: 26220220108
START OF THE PROJECT: 1 DECEMBER 2010 / END OF THE PROJECT: 30 NOVEMBER 2013

ABOUT THE PROJECT

MONITORED SITES NETWORK

SATELLITE AND GRAVIMETRIC MEASUREMENTS ANALYSIS

PROJECT OUTPUT

CONTACT

ABOUT THE PROJECT

The aim of the National Center For Diagnosing the Earth Surface Deformations in Slovakia is to identify the Earth surface deformations on the basis of research results by applying the satellite, gravimetric and tropospheric measurements.

The output of the national center is a permanently updated database of earth crust dynamics in Slovakia focused on determination of risk areas for construction and monitoring of large structures.

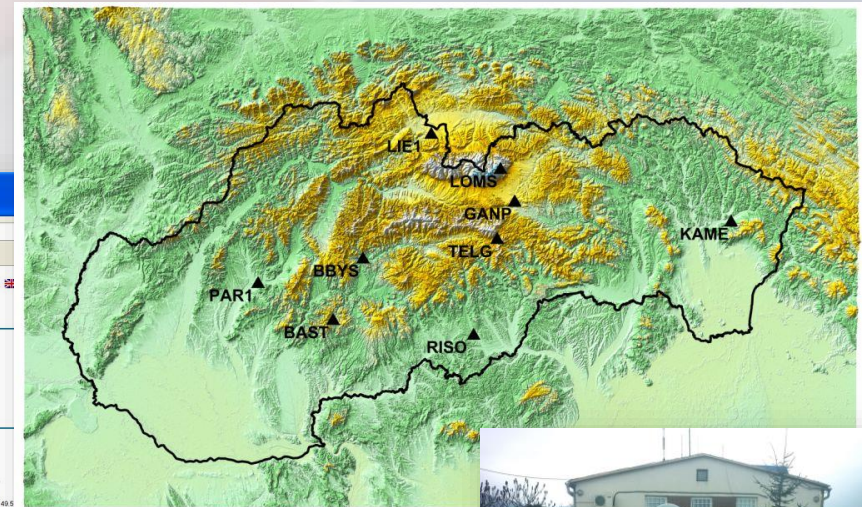
The national center carries out the measurements of geometric and physical variations on the Earth's surface on 9 reference stations of the monitoring network.

The position variations at all sites of the monitoring network are continually tracked by GNSS receivers. On the regular basis, the absolute and relative gravimetric measurements are carried out at the network sites as well as levelling measurements for improving the vertical deformation information.

Sieť monitorovaných bodov

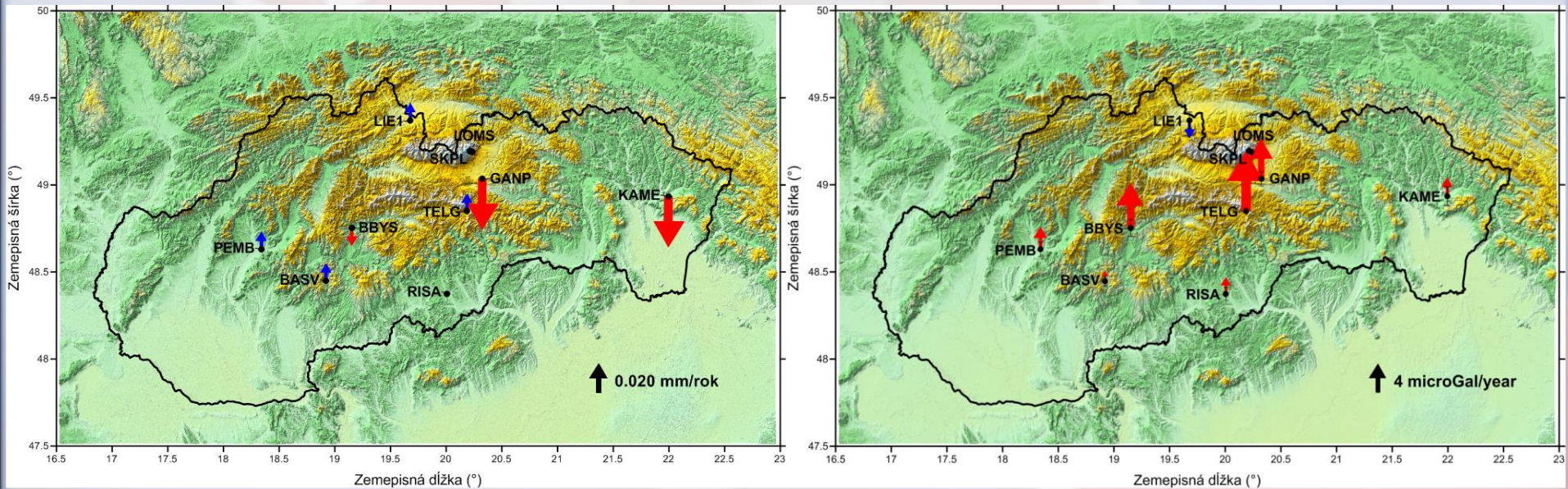
The map shows the geographical distribution of the 9 monitoring stations across Slovakia. The stations are labeled with their names: PAR1, BBYS, BAST, LIE1, LOMS, GANP, TELG, RISO, and KAME. The map includes latitude and longitude coordinates and a scale bar.

The monitoring network



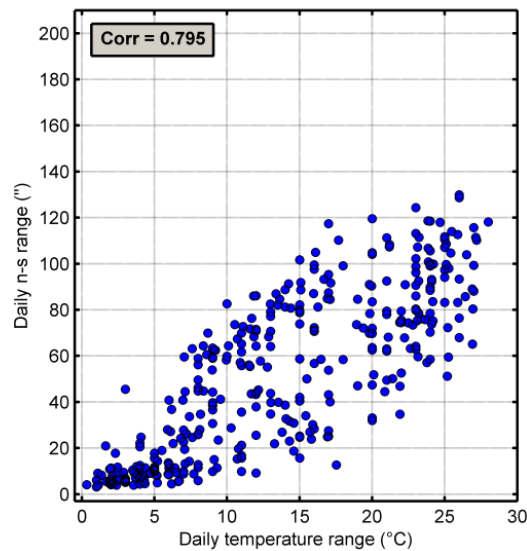
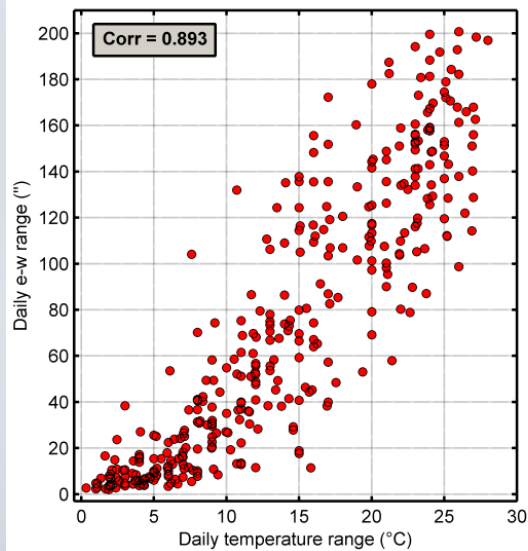
National center for diagnosing the Earth surface deformations in Slovakia

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



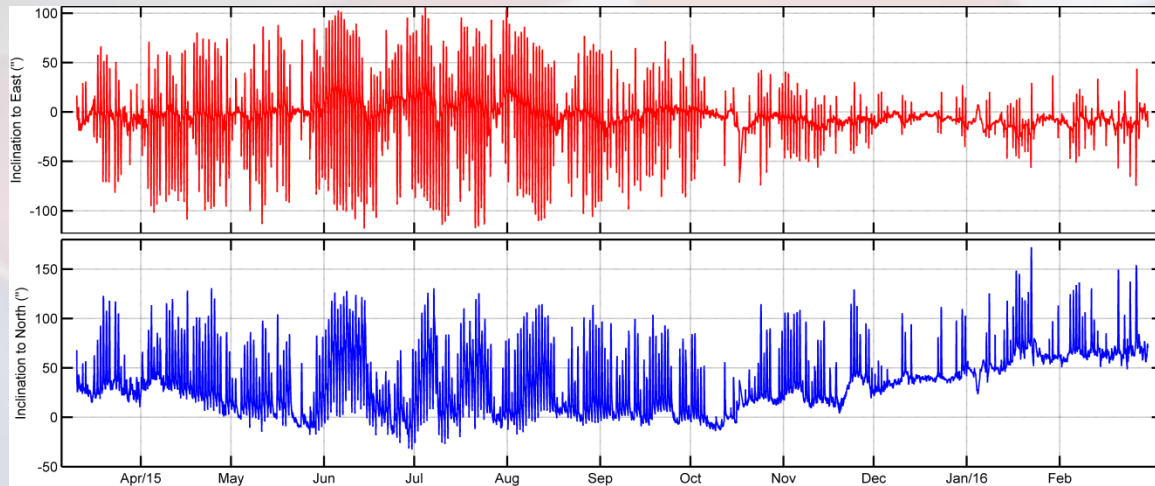
Short-term and Long-term variability of antenna position due to thermal bending of pillar monument at permanent station SUT1

- 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.

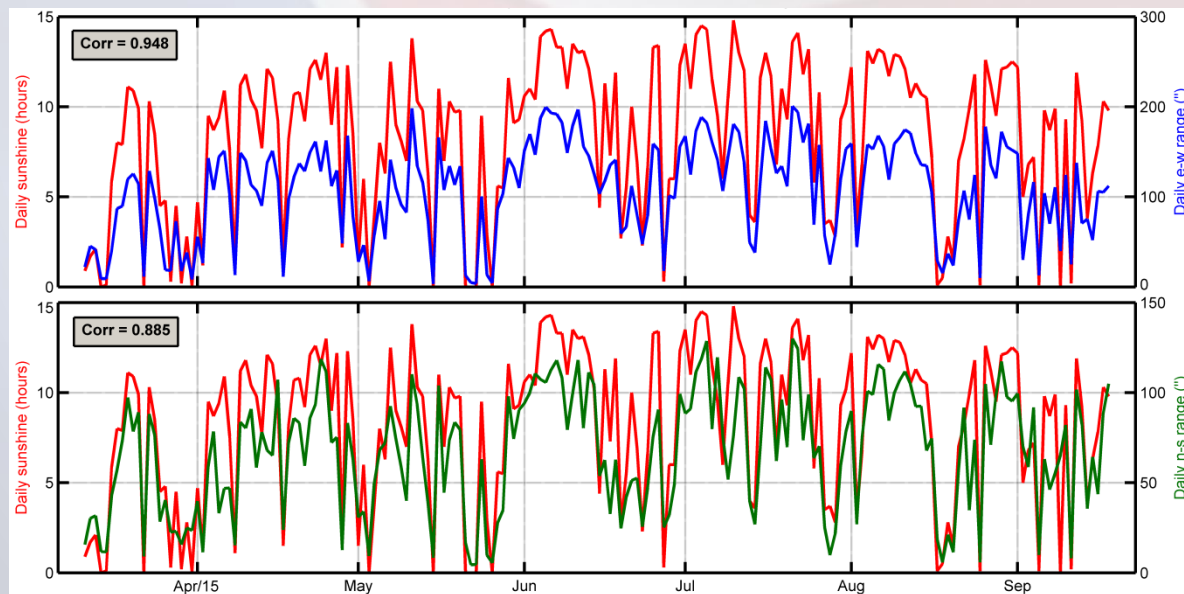


Daily temperature range versus inclination ranges (east-west and north-south) observed at SUT1 pillar. Daily variability of temperature ranges from 0 to 28°C (experiment was made throughout the year). To these ranges belong values from 0" to 200" in east-west direction and from 0" to 130" in north-south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

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



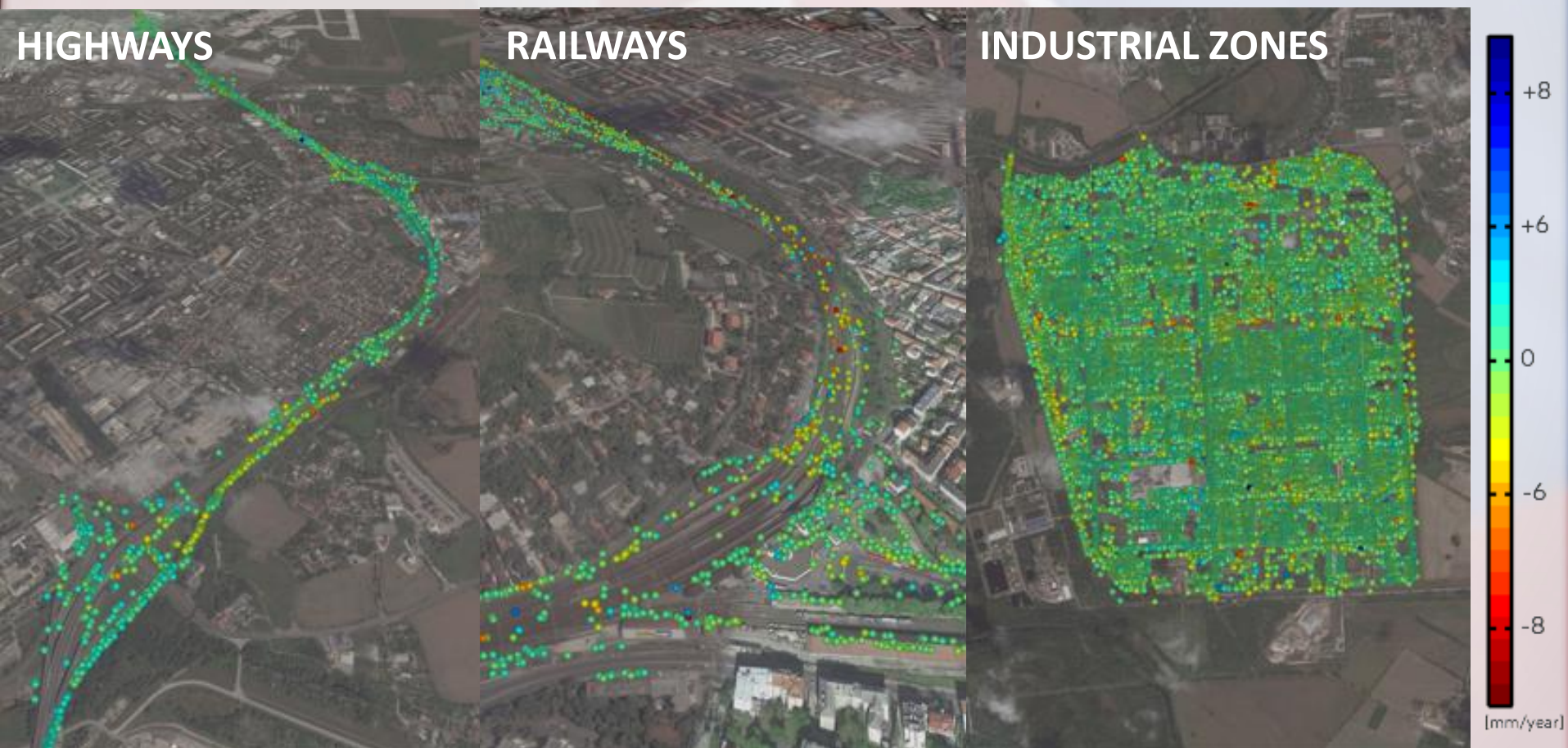
Long-term time series of inclination observations at SUT1 pillar.



- 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 throughout the day, in case of varying weather the correlation is low.

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

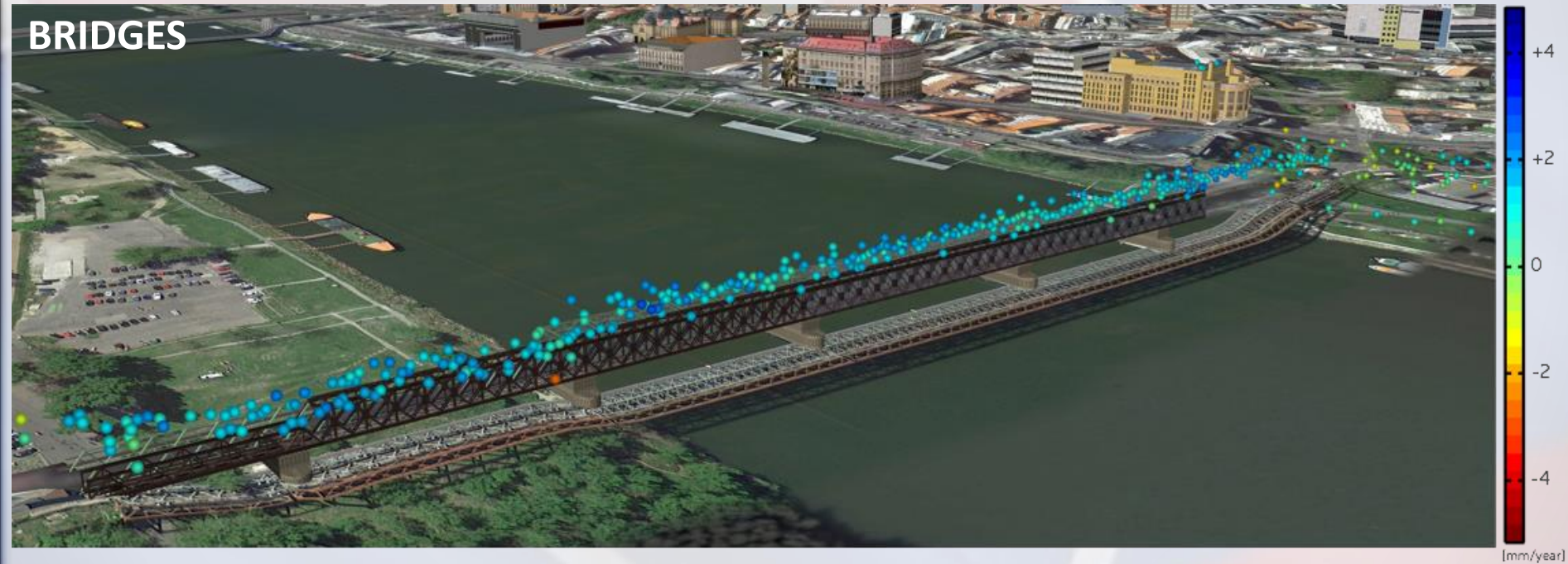
- Persistent Scatterer InSAR analysis spanning **24 years** (1992 - 2016) of spaceborne SAR measurements using ERS, ENVISAT, TERRASAR-X, RADARSAT-2 and SENTINEL-1.



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

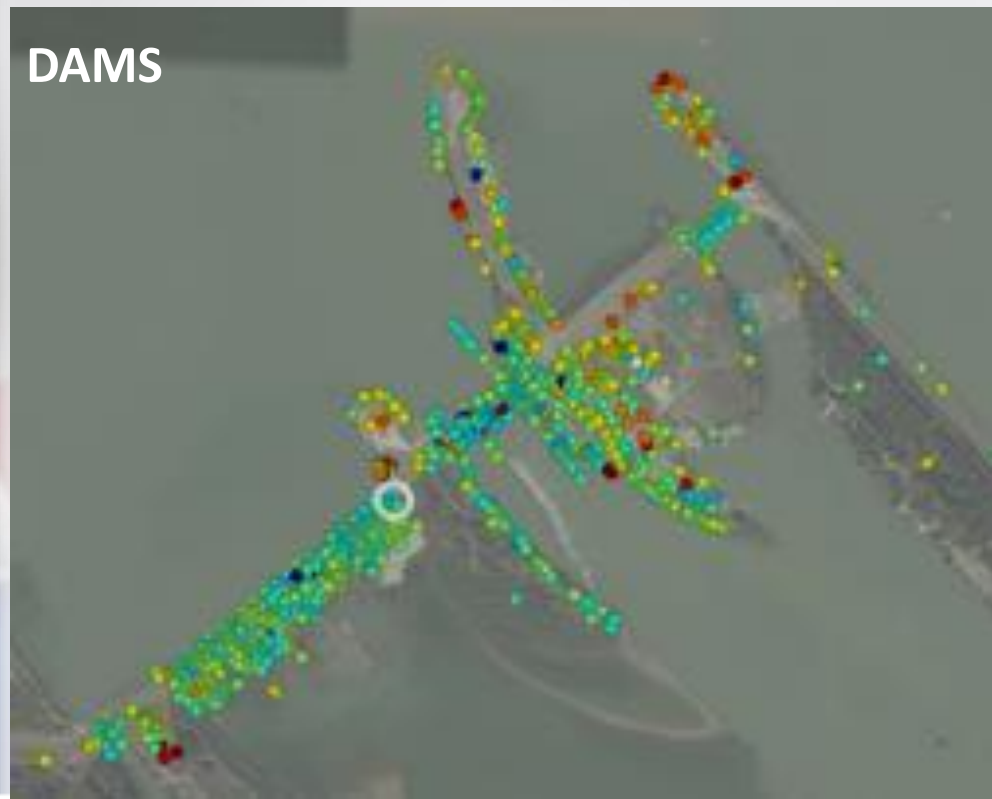
- Persistent Scatterer InSAR analysis spanning **24 years** (1992 - 2016) of spaceborne SAR measurements using ERS, ENVISAT, TERRASAR-X, RADARSAT-2 and SENTINEL-1.

BRIDGES

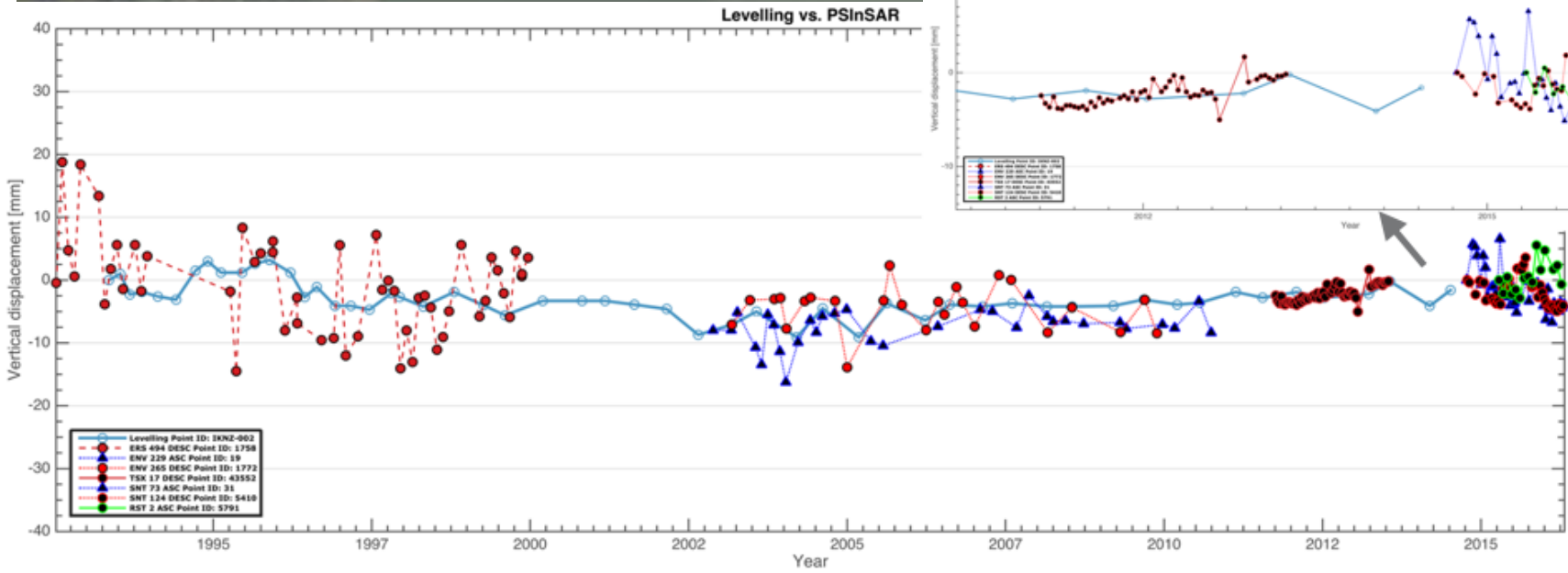


[mm/year]

DAMS



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



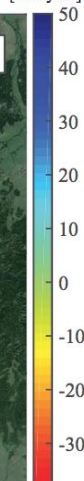
A data mining approach for multivariate outlier detection in heterogeneous 2D point clouds

Input

Coherence Thresholded

Our approach

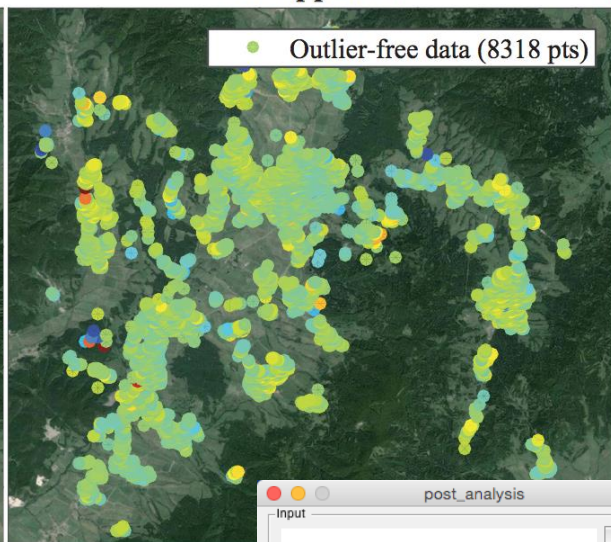
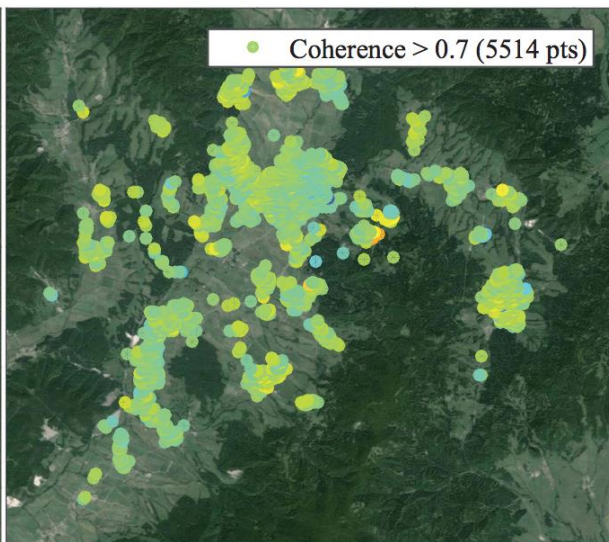
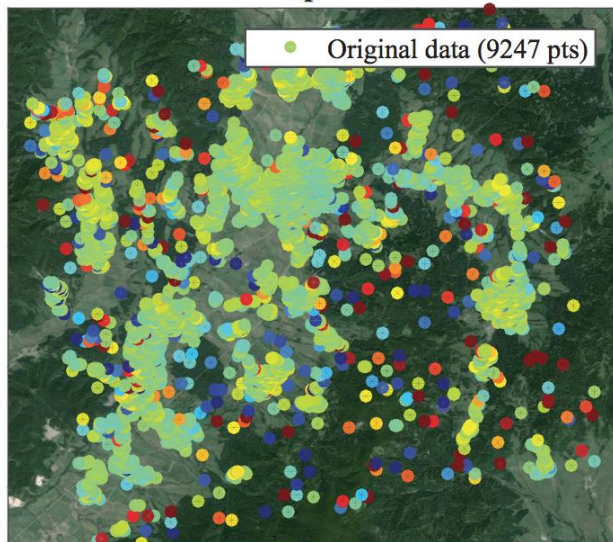
[mm/year]



Original data (9247 pts)

Coherence > 0.7 (5514 pts)

Outlier-free data (8318 pts)



post_analysis

Input

DBSCAN

Eps MinPts

PCA

HEIGHT VEL

HEIGHT WRT DEM SIGMA VEL

SIGMA HEIGHT CUMDISP

KTEMP SEASONAL

COHER INV. COHER

k cutoff %

Coefficients

Minimum Coherence


Rejection Criterion

Jaccard Coefficient

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

References:

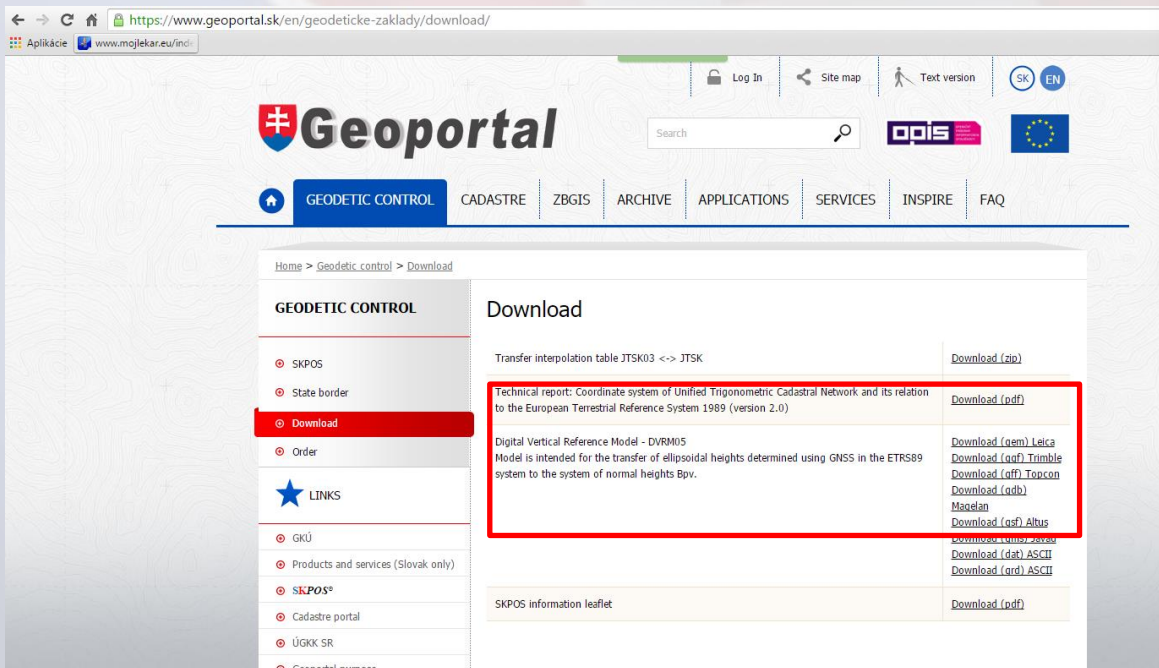
- M. Bakon, I. Oliveira, D. Perissin, J. Sousa and J. Papco, "A data mining approach for multivariate outlier detection in heterogeneous 2D point clouds: An application to post-processing of multi-temporal InSAR results," Geoscience and Remote Sensing Symposium (IGARSS), 2016 IEEE International, Beijing,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



Other news

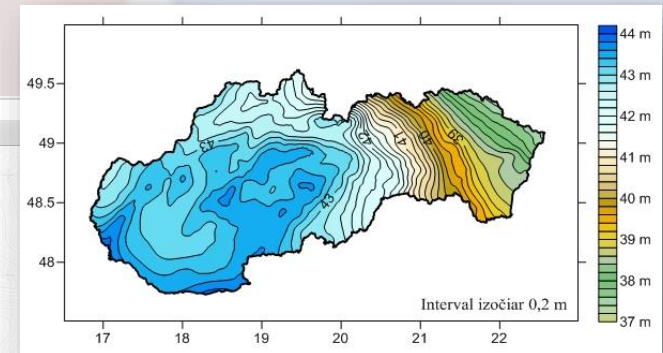
Slovakian quasigeoid DVRM

- 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



The screenshot shows the Geoportal website interface. The main navigation bar includes 'GEODETTIC CONTROL', 'CADASTRE', 'ZBGIS', 'ARCHIVE', 'APPLICATIONS', 'SERVICES', 'INSPIRE', and 'FAQ'. The 'Download' section is highlighted in the left sidebar. The main content area displays a table of download options:

Download	Download (zip)
Transfer interpolation table JTSK03 <-> JTSK	Download (zip)
Technical report: Coordinate system of Unified Trigonometric Cadastral Network and its relation to the European Terrestrial Reference System 1989 (version 2.0)	Download (pdf)
Digital Vertical Reference Model - DVRM05 Model is intended for the transfer of ellipsoidal heights determined using GNSS in the ETRS89 system to the system of normal heights Bpv.	Download (gem) Leica Download (ogf) Trimble Download (off) Topcon Download (adb) Maedelan Download (ogf) Altus Download (ogf) JTSK03 Download (dat) ASCII Download (ord) ASCII
SKPOS information leaflet	Download (pdf)





Thank you
for your attention