NATIONAL REPORT OF POLAND TO EUREF 2015

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Symposium of the IAG Subcommission for Europe
European Reference Frame – **EUREF 2015**
Leipzig, Germany, 3 - 5 June 2015

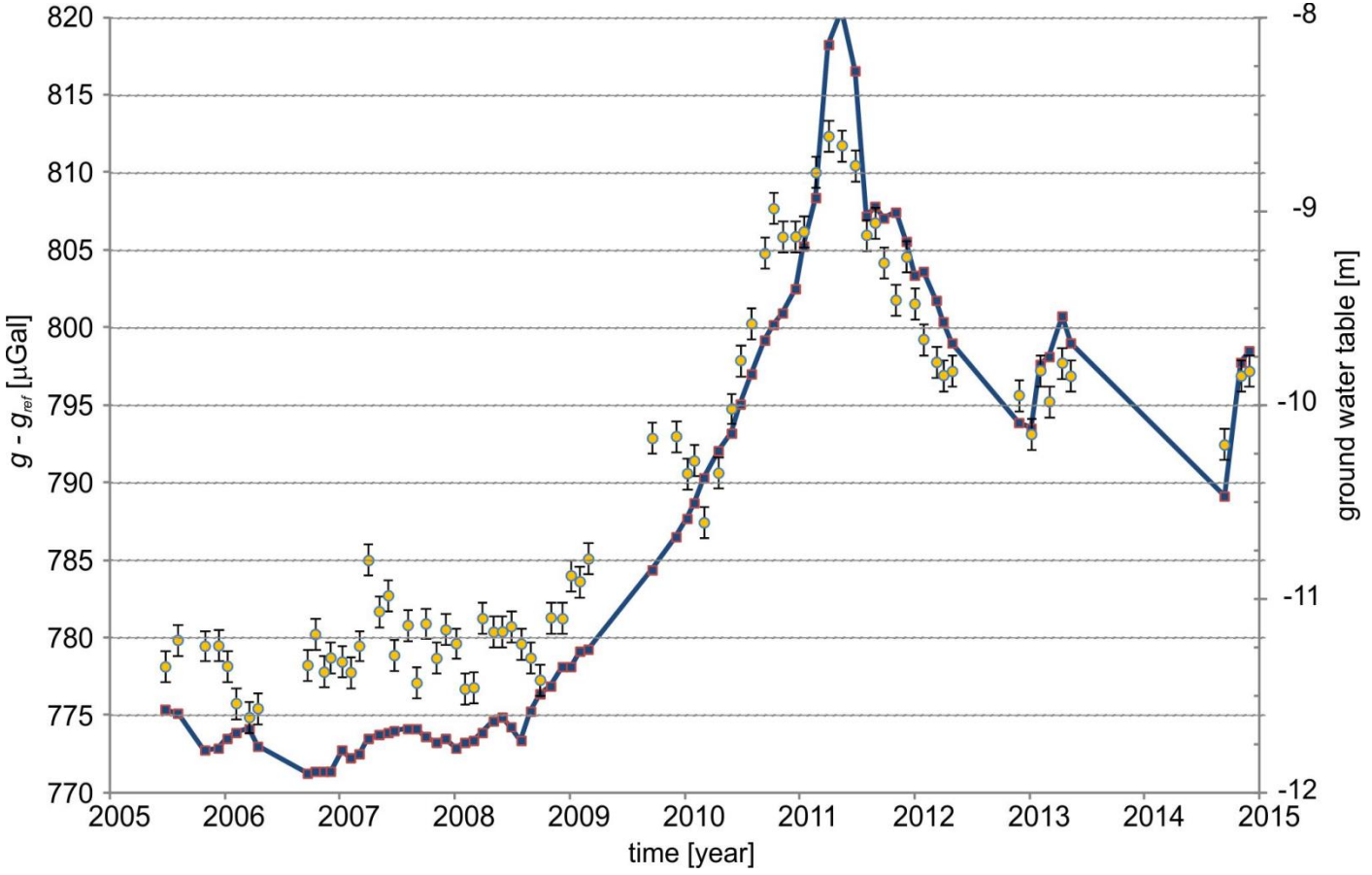
Main geodetic activities at the national level in Poland since 2013

- maintenance of the gravity control
- modelling precise geoid
- the use of data from satellite gravity missions
- operational work of permanent EPN/IGS stations
- data processing at Local Analysis Centres at WUT and MUT
- GNSS for meteorology
- monitoring of ionosphere
- status of the ASG-EUPOS network in Poland
- Earth tides monitoring
- activity in SLR
- geodynamics

Maintenance of national gravity control (1)

Jozefoslaw Astrogeodetic Observatory of WUT

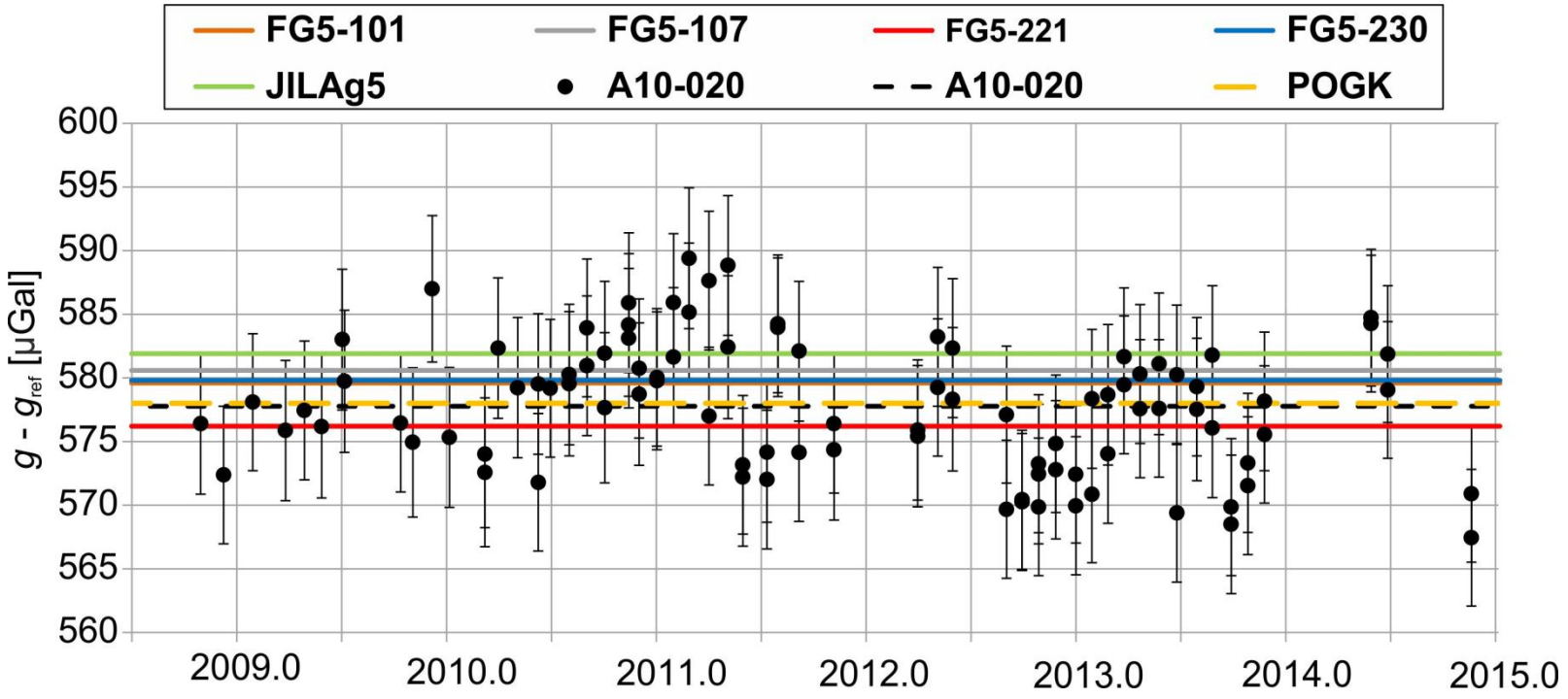
quasi-permanent absolute gravity measurements with FG5-230



Maintenance of national gravity control (2)

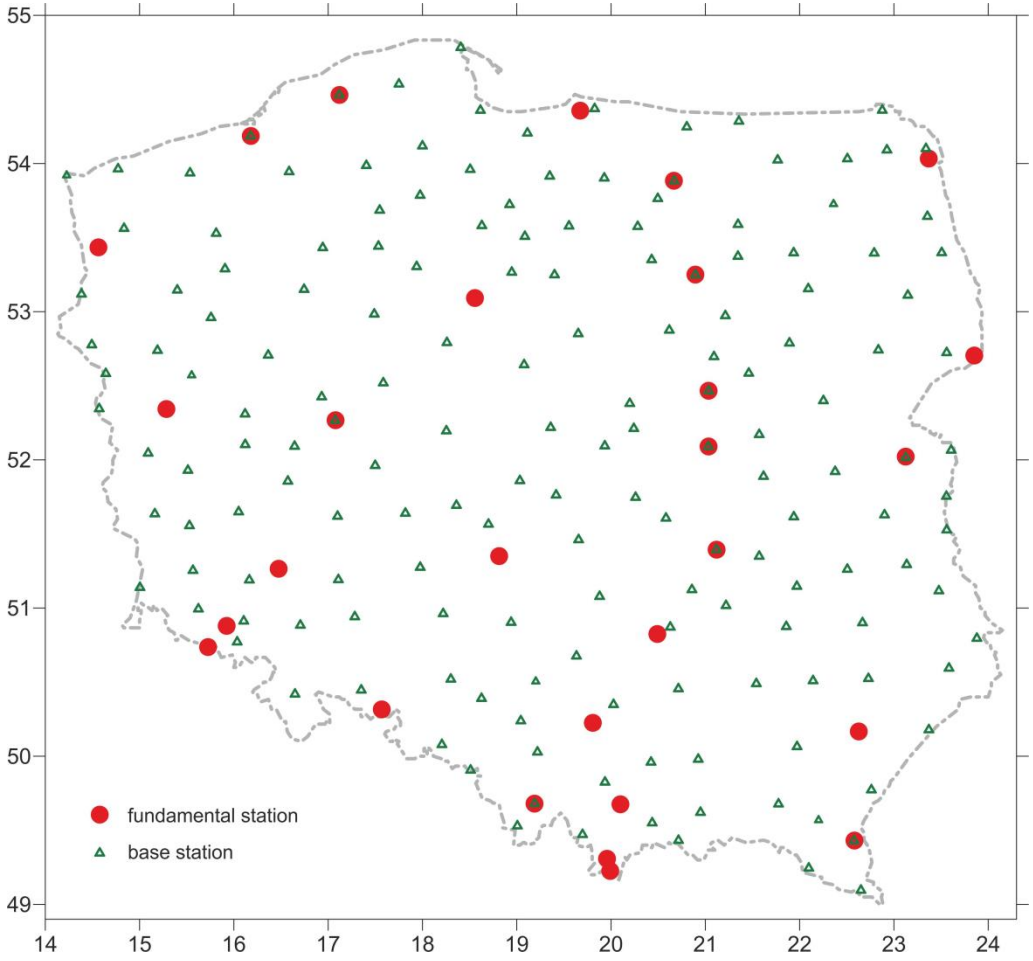
Borowa Gora Geodetic-Geophysical Observatory of IGiK

quasi-permanent absolute gravity measurements with A10-020



Maintenance of national gravity control (3)

Modernization of the gravity control in Poland (WUT & IGiK) (2012-2014)



Absolute gravity stations

27 – fundamental stations (FG5)

169 – base stations (A10)

In 2014

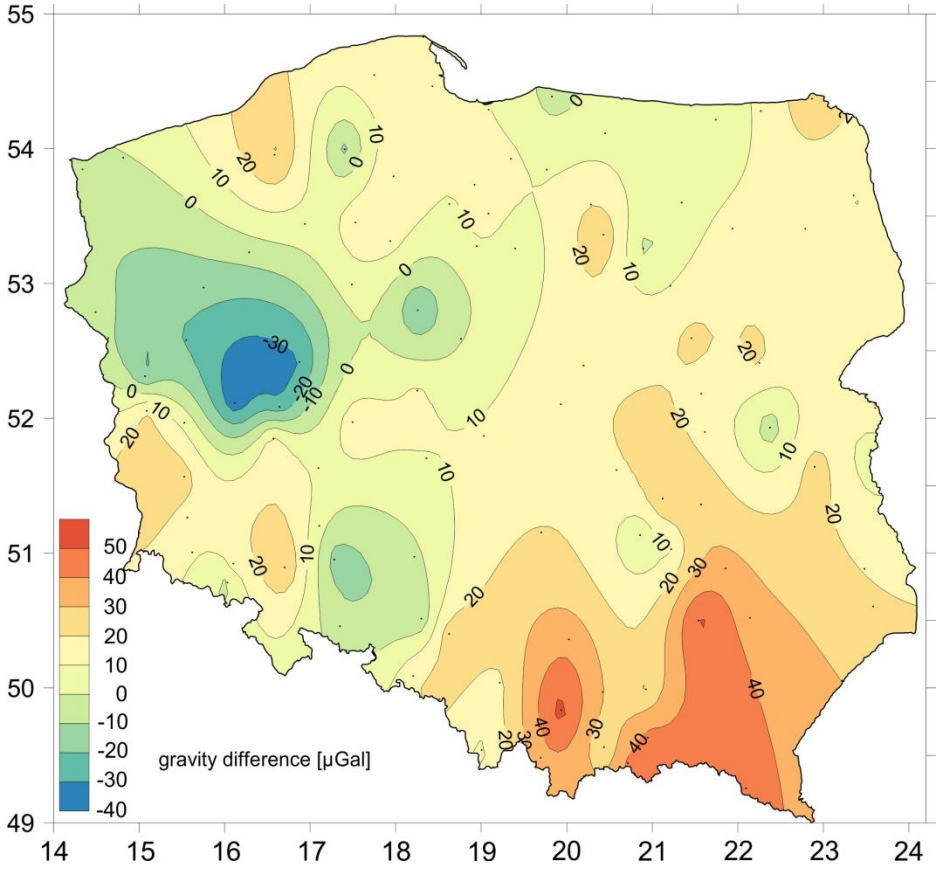
21 – fundamental stations

- **gravity (FG5-230)**
- **vertical gravity gradient**
- **link with an excentric station and a base station (relative gravity survey)**

Maintenance of national gravity control (4)

Modernization of the gravity control in Poland (WUT & IGiK) (2012-2014)

gravity differences between PBOG14 and POGK98



Modelling precise geoid

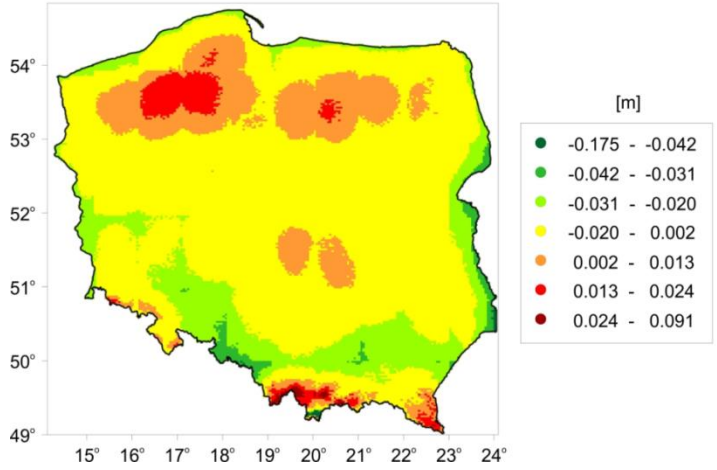
New gravimetric quasigeoid model GDQM-PL13 for Poland (IGiK)

Data:
- 1'×1' mean Faye Δ*g*
- deflections of the vertical (Poland)
- Δ*g* (neighbouring countries)
- EGM2008

Method:
- remove-compute-restore (RCR)
- least squares collocation with planar logarithmic covariance function of Δ*g*

GNSS/level. sites	Number of Pt.	Min	Max	Mean	Std. dev.
Contr. trav. 1st order	44	0.064	0.124	0.097	0.014
Contr. trav. 2nd order	140	0.040	0.127	0.083	0.016
EUVN	58	0.060	0.145	0.097	0.018
ASG-EUPOS	98	0.041	0.133	0.074	0.018
POLREF	315	0.032	0.169	0.105	0.022

GDQM-PL13 vs GDQ08 model



New gravimetric quasigeoid model SUD-GM2014 for Sudan (IGiK)

New gravimetric quasigeoid model for Brunei (UWM, UPWr)

Use of data from satellite gravity missions

Institute of Geodesy and Cartography, Warsaw

- evaluation of 4th and 5th release GOCE-based GOCE global geopotential models (GGMs) over the area of Poland
  - EGM2008
  - high precision GNSS/levelling data
- estimation of contribution of GOCE mission to the long/medium wavelength component (approximately 100 km half wavelength spatial resolution) of the Earth gravity field
  - Poland
  - Sudan

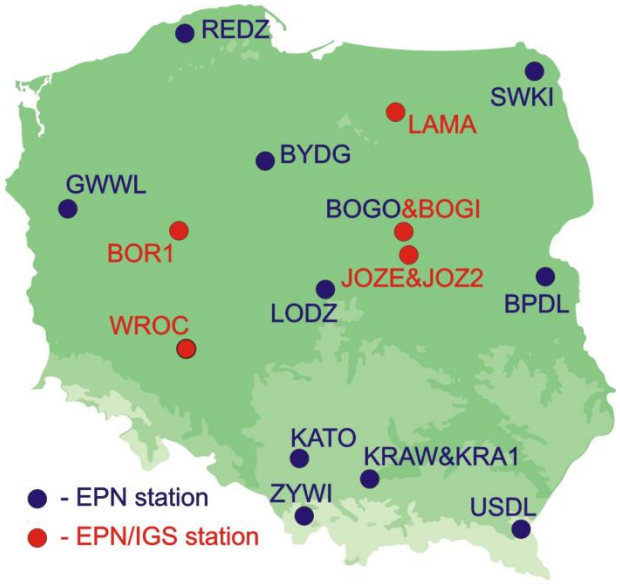
UWM, Olsztyn + Space Research Center, Warsaw

- evaluation of hydrological and gravimetric excitation function of polar motion from GRACE data
- study of the use of GRACE data for local hydrological conditions

Operational work of permanent GNSS IGS/EUREF stations

EPN stations in Poland

- Biala Podlaska (BPDL)
- Borowa Gora (BOGI)
- Borowa Gora (BOGO)
- Borowiec (BOR1)
- Bydgoszcz (BYDG)
- Gorzow Wielkopolski (GWWL)
- Jozefoslaw (JOZE)
- Jozefoslaw (JOZ2)
- Katowice (KATO)
- Krakow (KRAW)
- Krakow (KRA1)
- Lamkowko (LAMA)
- Lodz (LODZ)
- Redzikowo (REDZ)
- Suwalki (SWKI)
- Ustrzyki Dolne (USDL)
- Wroclaw (WROC)
- Zywiec (ZYWI)



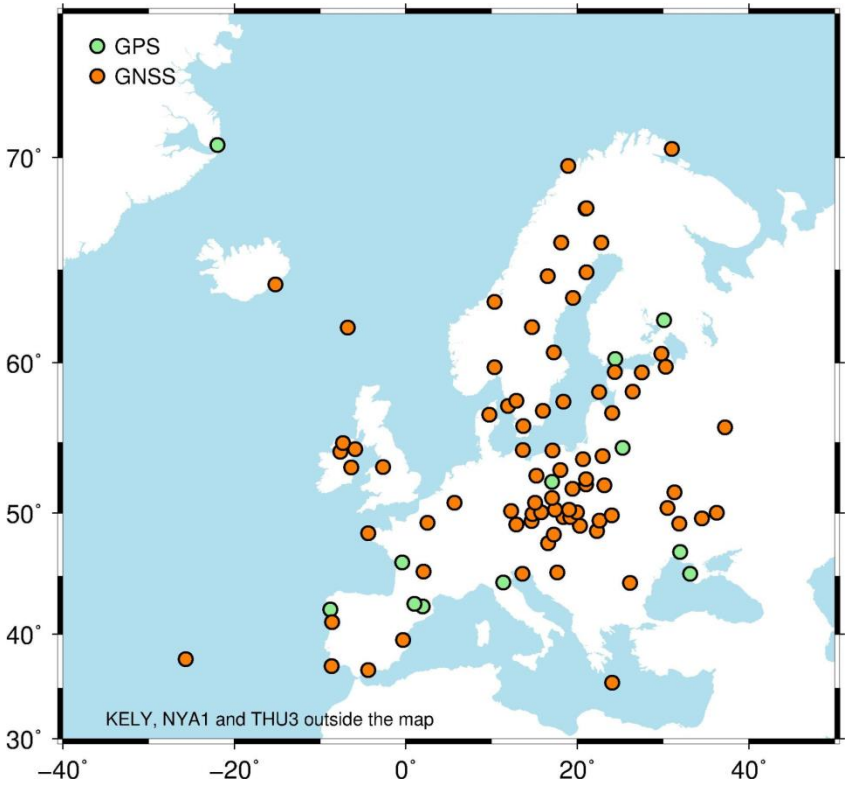
EPN Stations participating in EUREF-IP

- ♥ BOGI
- ♥ BOR1
- ♥ JOZ2
- ♥ KRA1
- ♥ KRAW
- ♥ LAMA
- ♥ WROC

Data processing at LACs

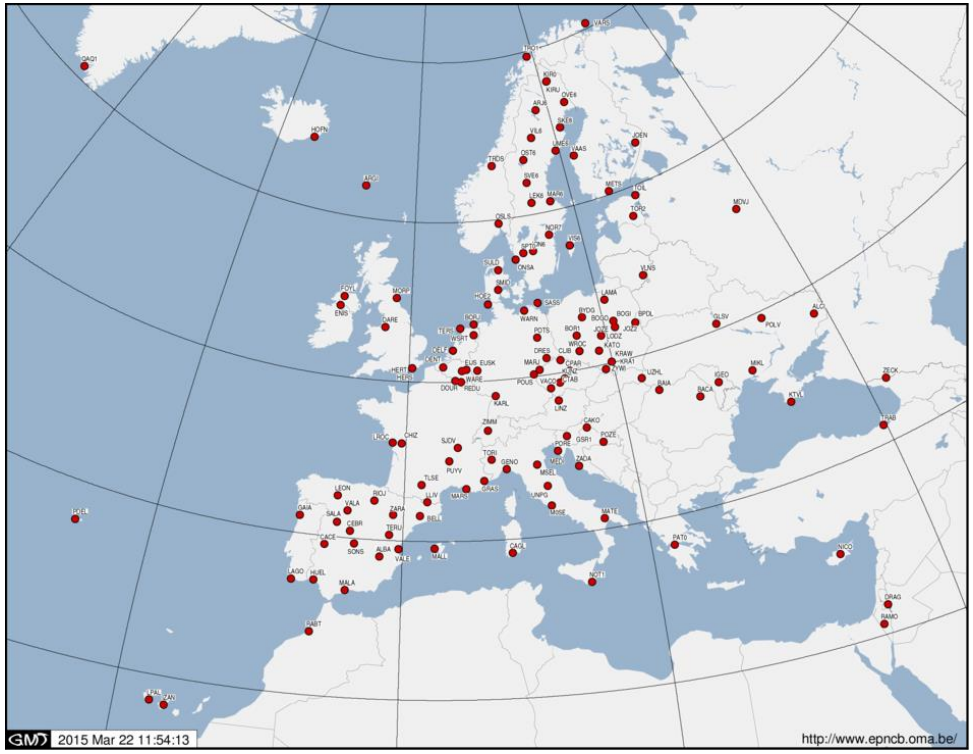
WUT

data from 100 EPN stations routinely processed



MUT

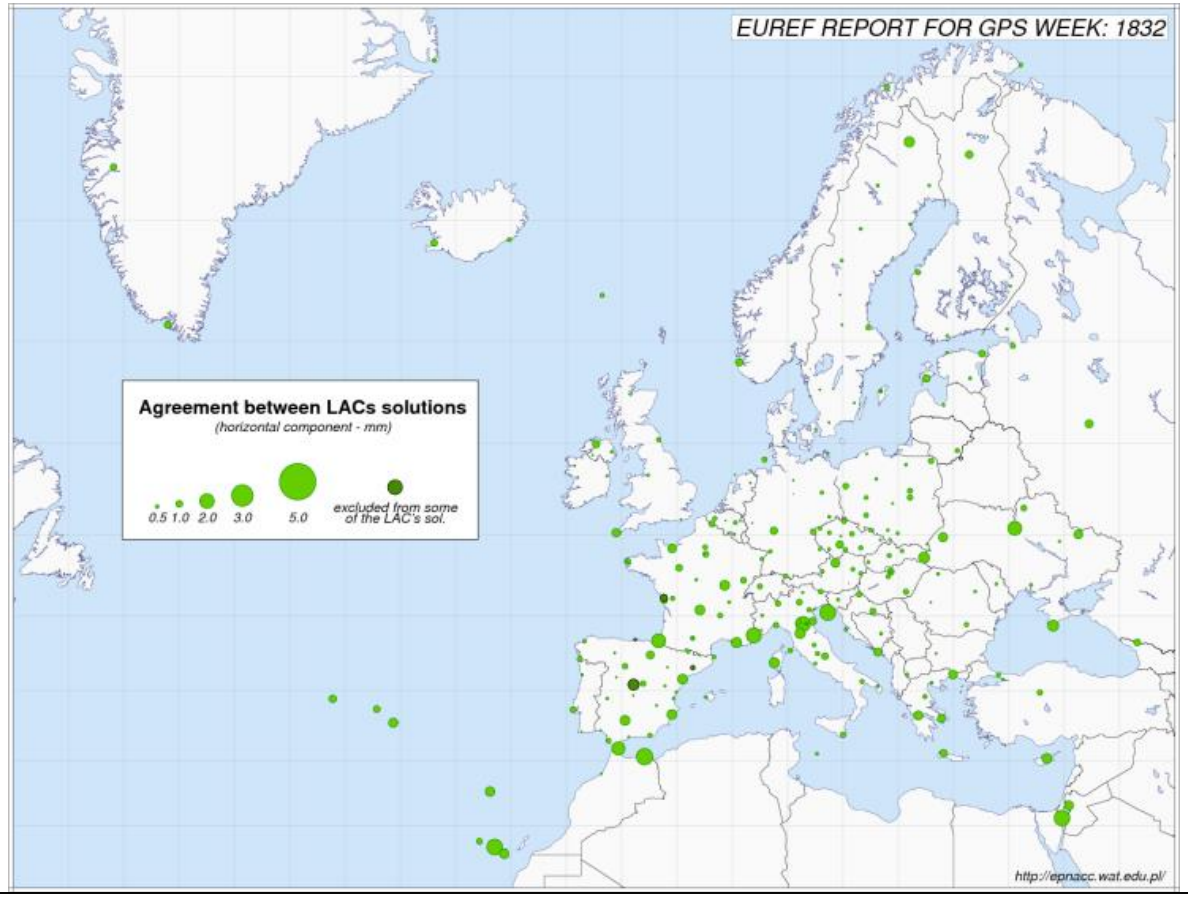
data from 138 EPN stations routinely processed



MUT – WUT EPN Combination Centre (1)

Results of comparison of repeatability of stations coordinates on web page (http://www.epnacc.wat.edu.pl)

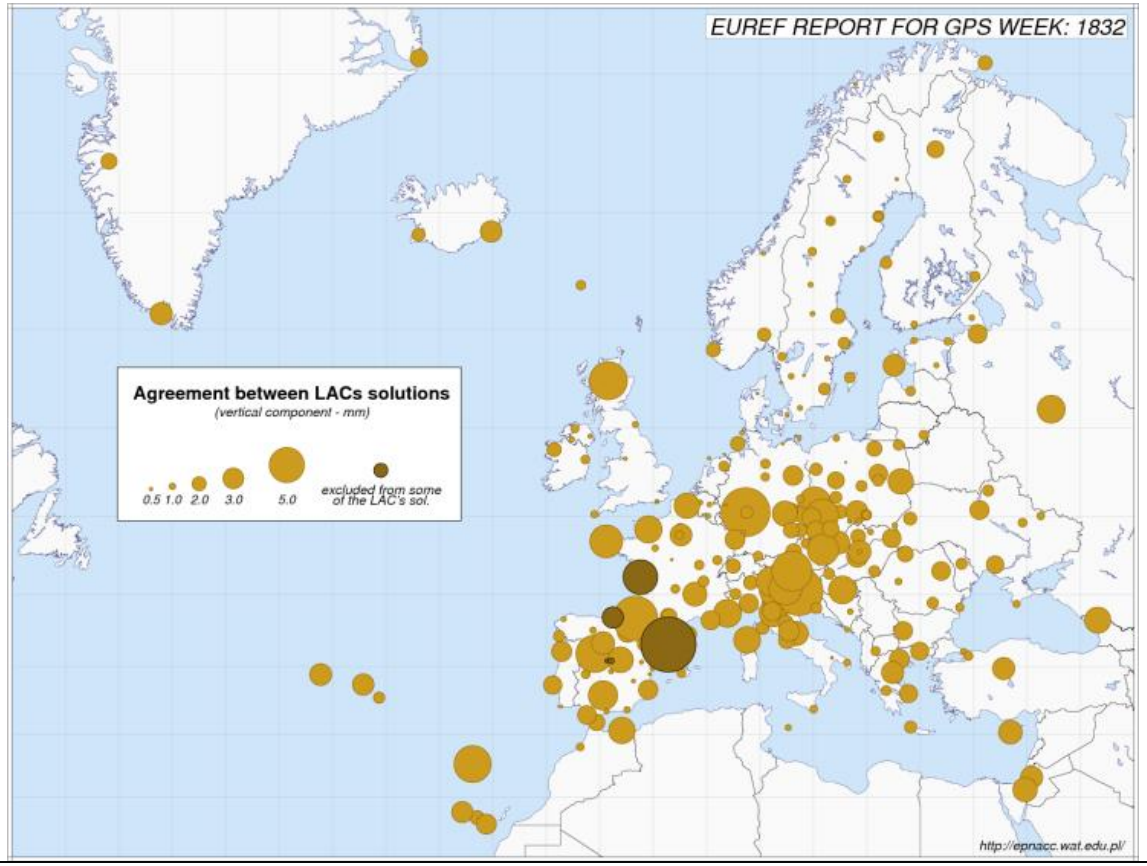
horizontal components after Helmert transformation for the GPS week 1832



MUT – WUT EPN Combination Centre (2)

Results of comparison of repeatability of stations coordinates on web page (http://www.epnacc.wat.edu.pl)

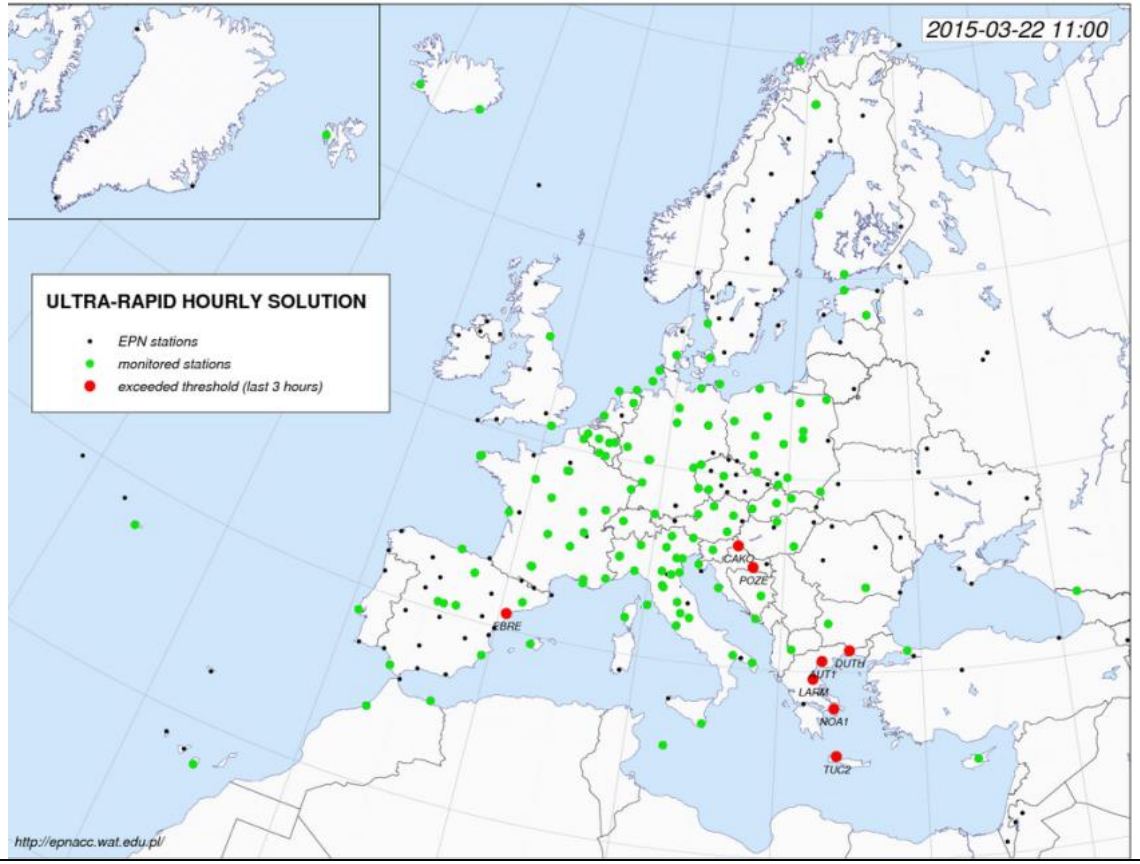
vertical components after Helmert transformation for the GPS week 1832



MUT – WUT EPN Combination Centre (3)

Results of comparison of repeatability of stations coordinates on web page (http://www.epnacc.wat.edu.pl)

ultra-rapid hourly solution corresponding to the 22 March 2015



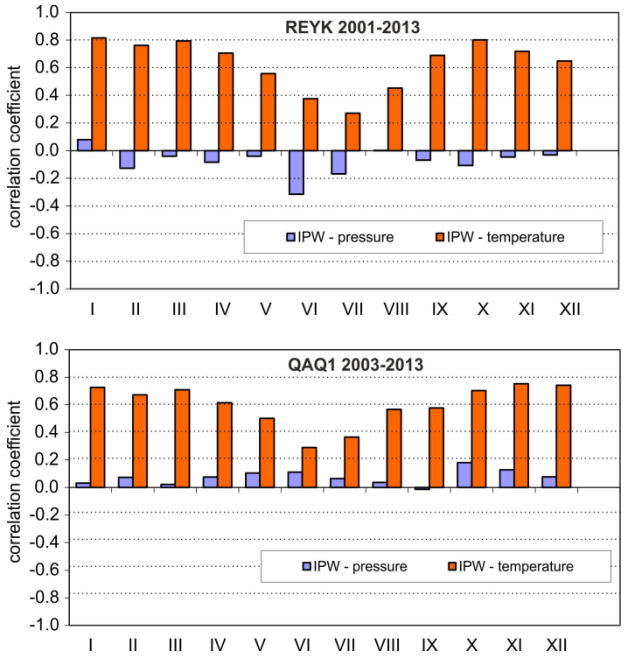

```
STATUS FOR EPOCH: 2015-03-22 (DOY: 081) 11:00
==============================================

List of the stations for which residual
exceeded specified threshold (0.01/0.01/0.02)
----------------------------------------------
NAME     North[m]   East[m]    Up[m]

AUT1     -0.0118    -0.0393     0.0027
CAKO     -0.0048    -0.0263     0.0082
DUTH     -0.0146    -0.0362     0.0018
LARM     -0.0183    -0.0408     0.0059
NOA1     -0.0129    -0.0419     0.0014
POZE     -0.0143    -0.0342     0.0031
TUC2     -0.0104    -0.0349     0.0100


List of the monitored stations:
---------------------------------------
AJAC AQUI AUT1 AUTN AXPV BADH BBYS BISK
BOGO BOR1 BORJ BRST BRUX BSCN BUCU BUDP
BYDG BZRG CAKO CANT CASC COMO DELF DENT
DOUR DUTH DYNG EGLT EIJS ENTZ EUSK GANP
GENO GOPE GRAS GRAZ GSR1 GUIP GWWL HELG
HERS HERT HOBU HOE2 HOFN IENG JOZ2 JOZE
KARL KIR0 KIRU KLOP KRAW LAMA LAMP LARM
LIL2 LINZ LODZ M0SE MALL MAN2 MARJ MARS
```

GNSS for meteorology (1)

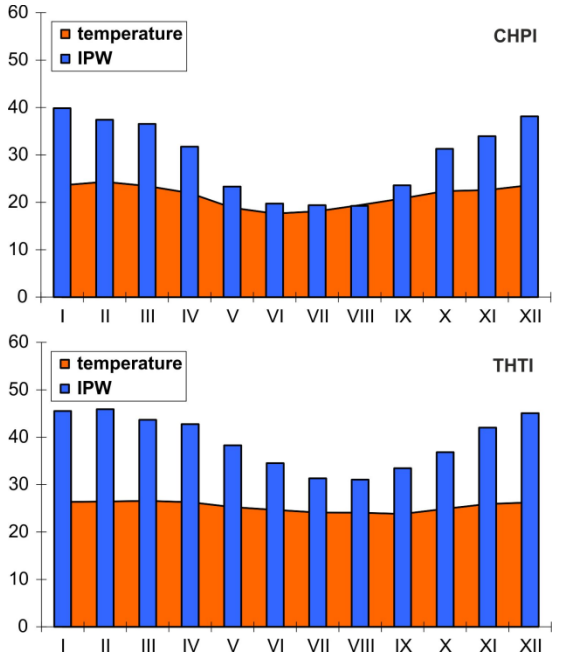
WUT

1. ZTD form WUT LAC solutions
2. IPW from GNSS, NWP and radiosounding

Monthly correlation coefficients (IPW-temperature and IPW-atmospheric pressure) for REYK (Reykjavik, Iceland) and QAQ1 (Qaqortoq, Greenland); multi-year series



Climatologic chart temperature [ºC] vs. IPW [mm] for southern hemisphere: CHPI (Cachoeira Paulista, Sao Paulo, Brazil) and THTI (Tahiti, French Polynesia); IGS tropospheric product, multi-year series

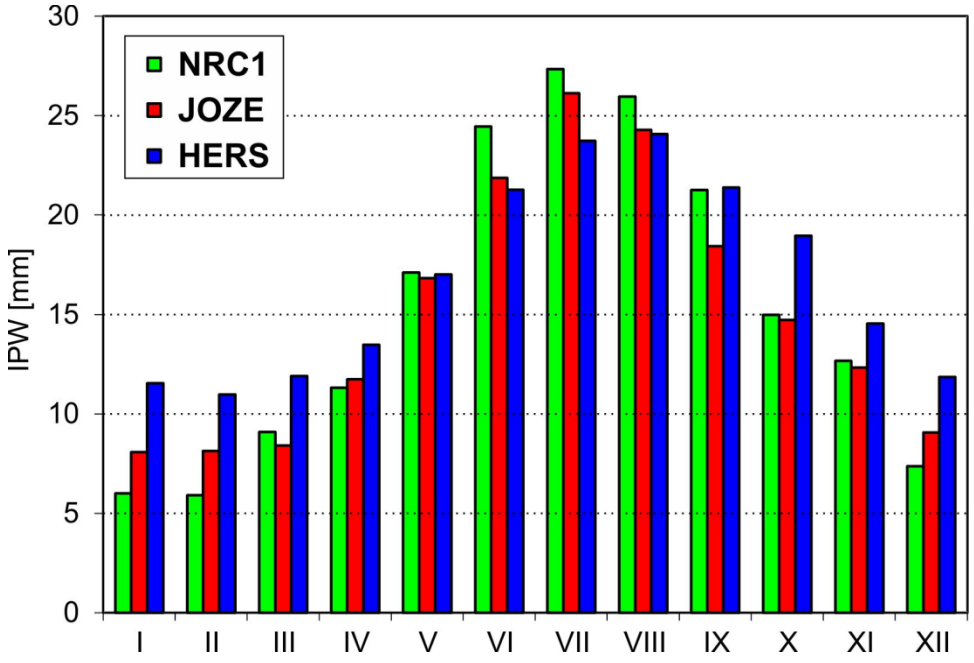


GNSS for meteorology (2)

WUT

1. ZTD form WUT LAC solutions
2. IPW from GNSS, NWP and radiosounding

IPW monthly averages for three IGS stations in temperate climate zone of the Northern Hemisphere: NRC1 (Ottawa, Canada) is definitely continental, HERS (Hailsham, Sussex, UK) definitely oceanic, JOZE (Jozefoslaw, Poland) falls in between

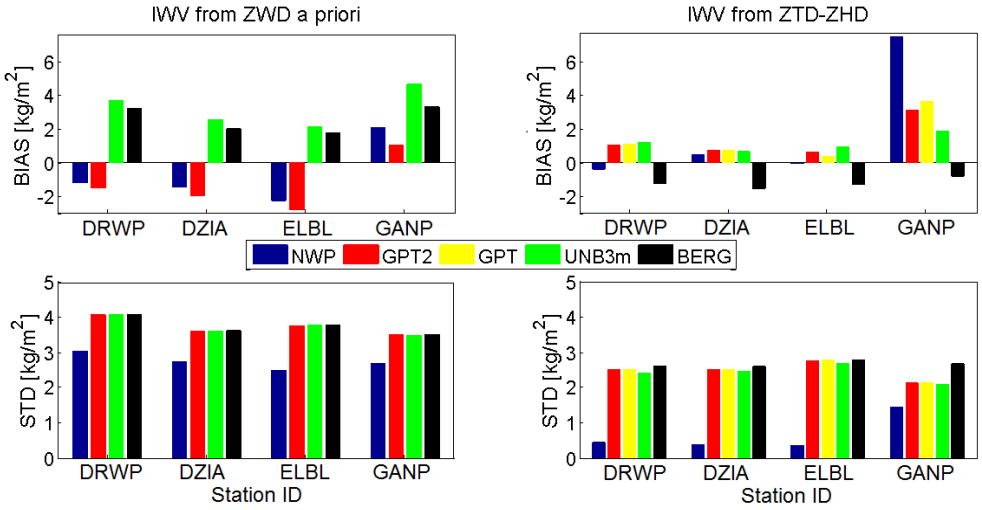


GNSS for meteorology (3)

Wroclaw Univ. of Envir. & Life Sciences

ZTD to IWD conversion and quality
ASG-EUPOS meteo ground stations)

Mean bias and standard deviation [kg/m^2] for IWV from ZWD a priori (left) and IWV from ZWD using ZTD estimates (right) w.r.t. IWVs in-situ

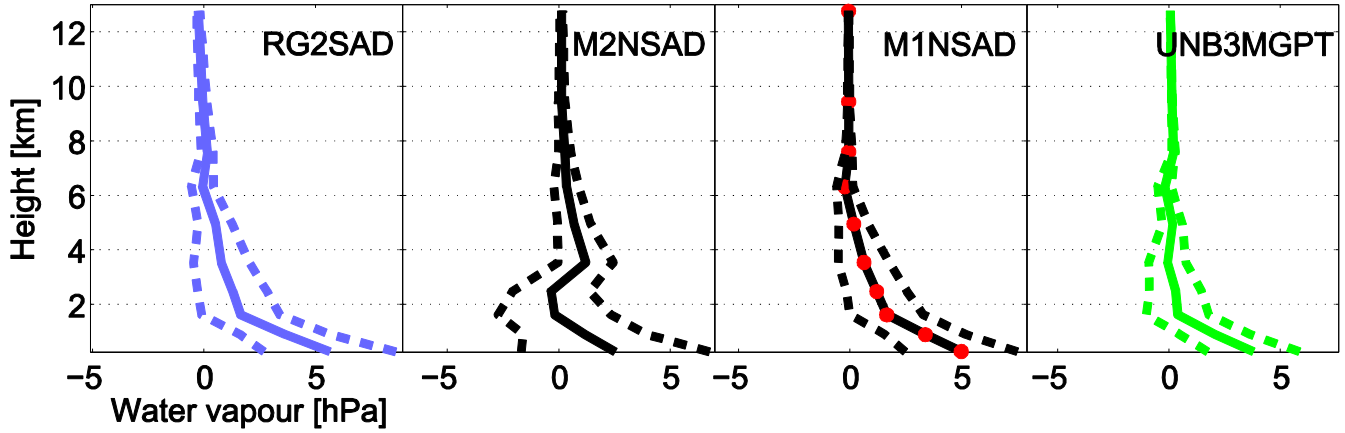


GNSS for meteorology (4)

Wroclaw Univ. of Envir. & Life Sciences

GNSS tomography methodology

Quality of limited GNSS tomography retrieval with respect the height. RG2SAD - real data a priori for inner and outer model, M2NSAD - synthetic data (normal noise level) a priori for inner and outer model, M1NSAD - synthetic (low observation noise) a priori for inner and outer model, UNB3MGPT – comparison of reference data with UNB3M/GPT field



Advanced methods for satellite positioning

University of Warmia and Mazury, Olsztyn (UWM)

- development of the algorithm for GPS + Galileo and multi-frequency Galileo precise positioning
- analysis of the inter system biases (ISB) in multi-GNSS relative positioning
- development of the regional ionosphere model based on carrier-phase data only
- development of ionospheric MSTID warning service for Polish users
- analysis of phase centre correction models for GNSS antennas, and testing of new automatic postprocessing module for ultra-fast static positioning (POZGEO-2) designed for the ASG-EUPOS system

Warsaw University of Technology (WUT)

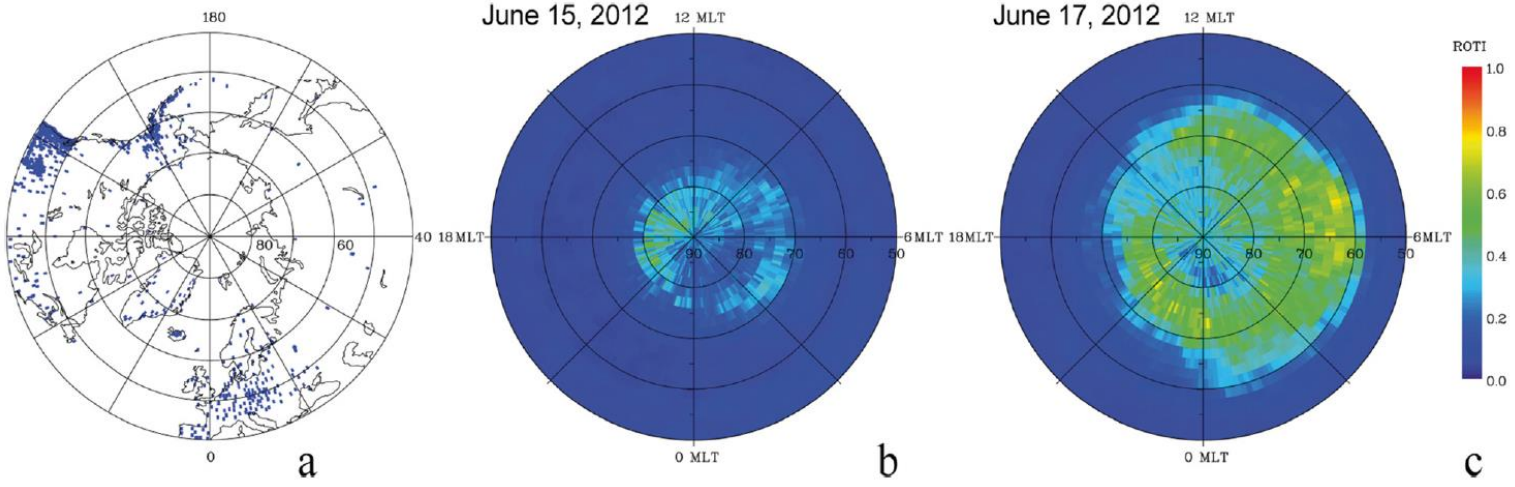
- research on stochastic properties of correction terms in GNSS Network RTK positioning

Monitoring ionosphere (1)

UWM

A methodology and service that provide estimation of the ionospheric fluctuation activity based on ROT/ROTI calculations

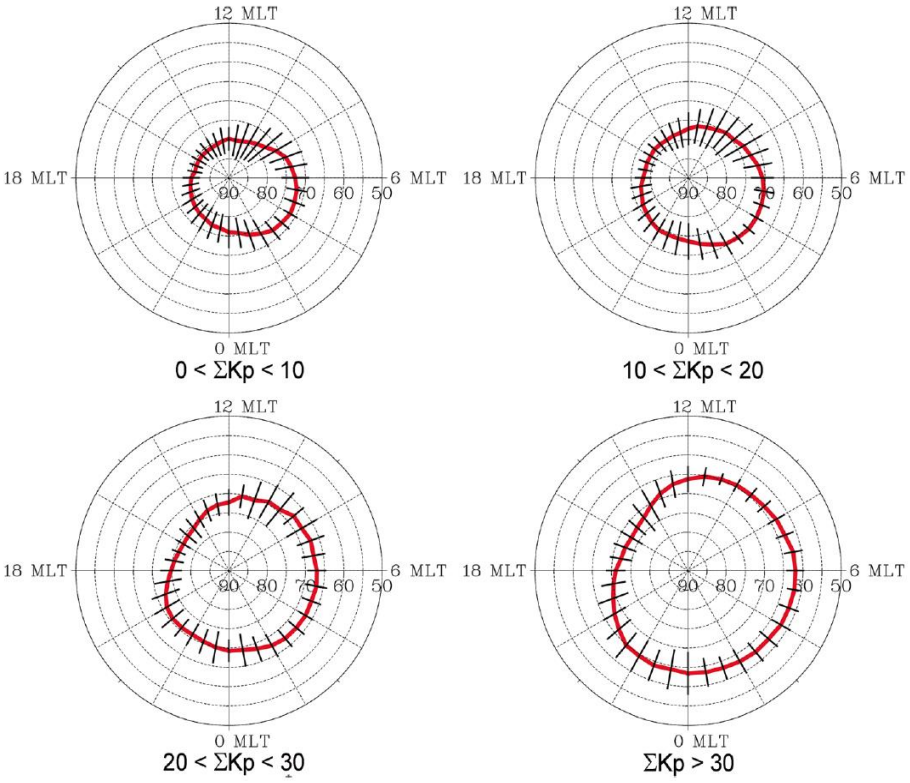
Location of the processed GNSS stations (a), and ROTI maps for quiet (b) and disturbed (c) geomagnetic conditions



Monitoring ionosphere (2)

UWM

Southern border of the ionospheric irregularities oval for different levels of geomagnetic activity



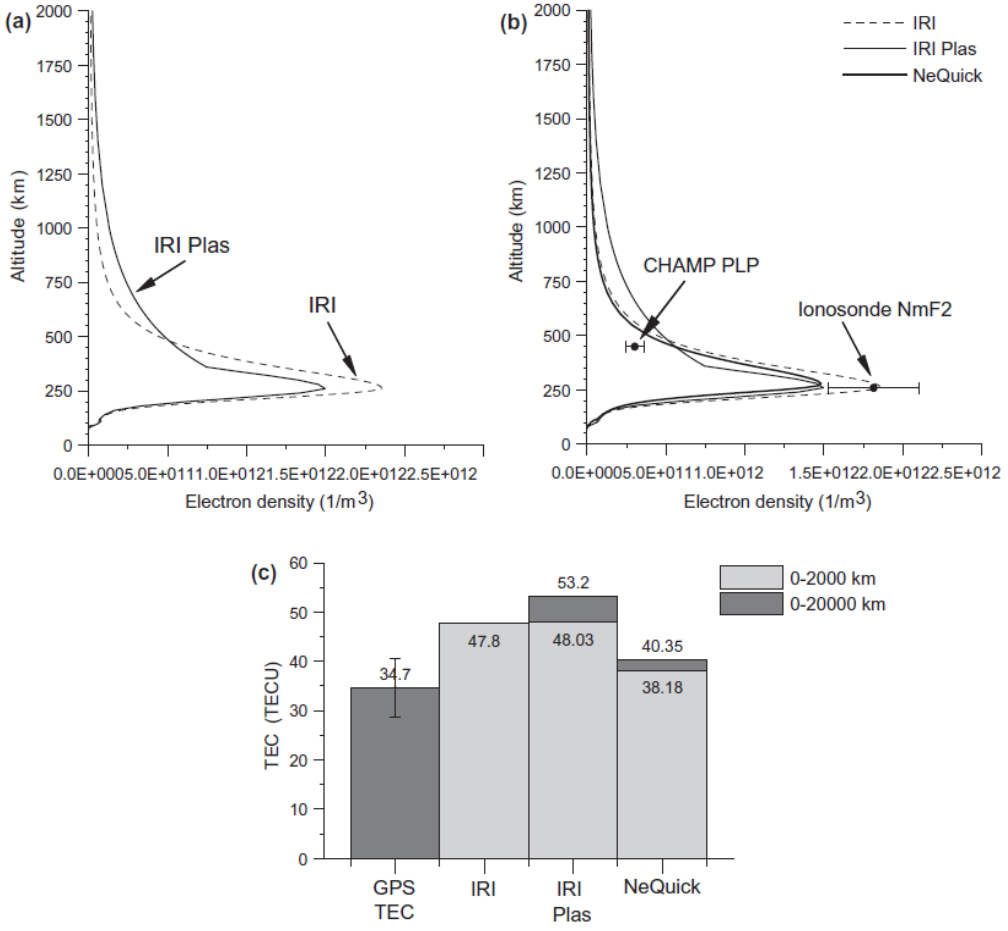
Monitoring ionosphere (3)

UWM

a) comparison of IRI-2012 and IRI Plas electron density profiles for 1200 LT of December 2000,

b) comparison of IRI-2012, IRI Plas, NeQuick electron density profiles, ionosondes NmF2 and in situ CHAMP measurements for the same time,

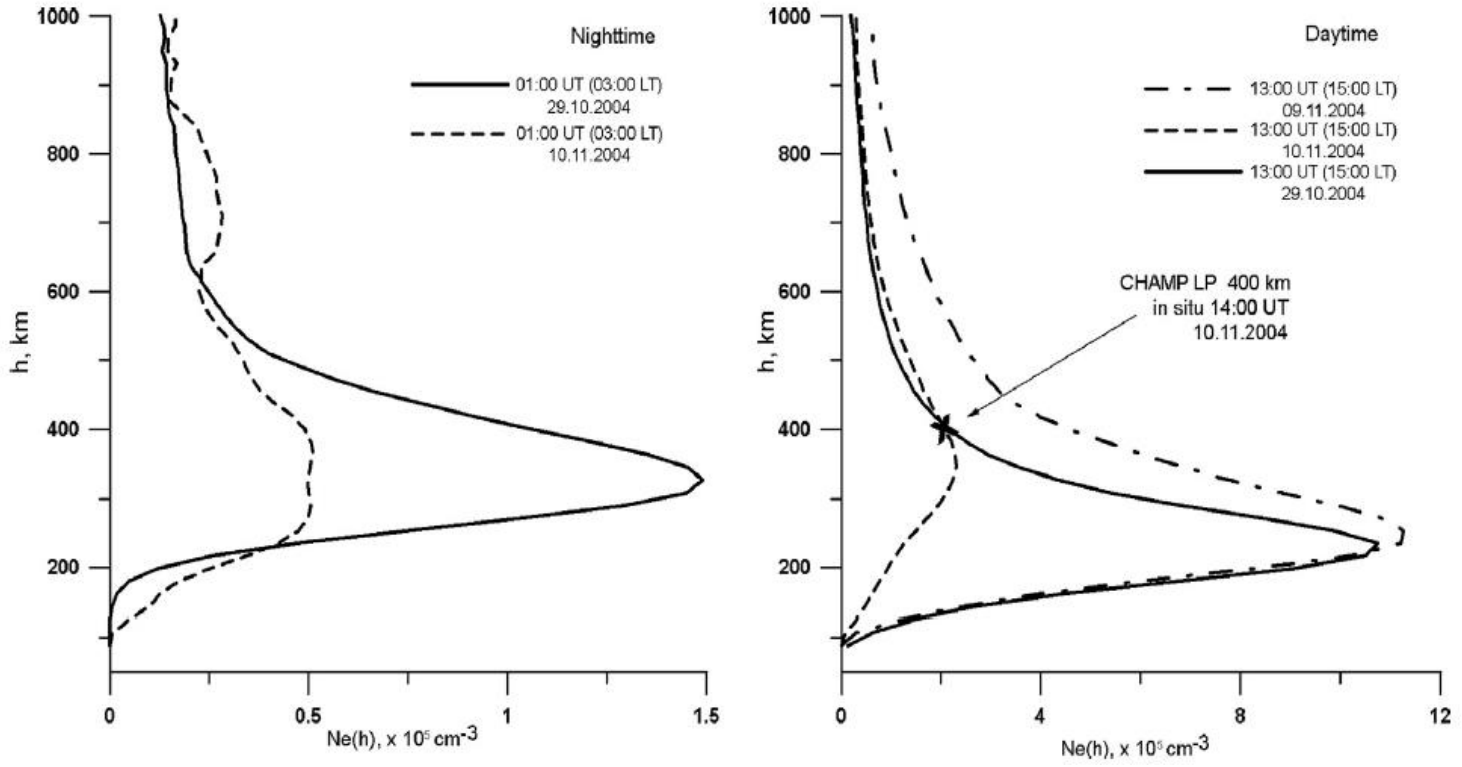
c) the comparison of GPS vTEC with vTEC derived by IRI-2012, IRI Plas, NeQuick models with different upper limit for EDP integration



Monitoring ionosphere (4)

UWM

EDP in the height range 100–1000 km for night and day time for the reference quiet period (typical) in 29 October 2004 and during the storm; the black cross indicates position of CHAMP PLP observations

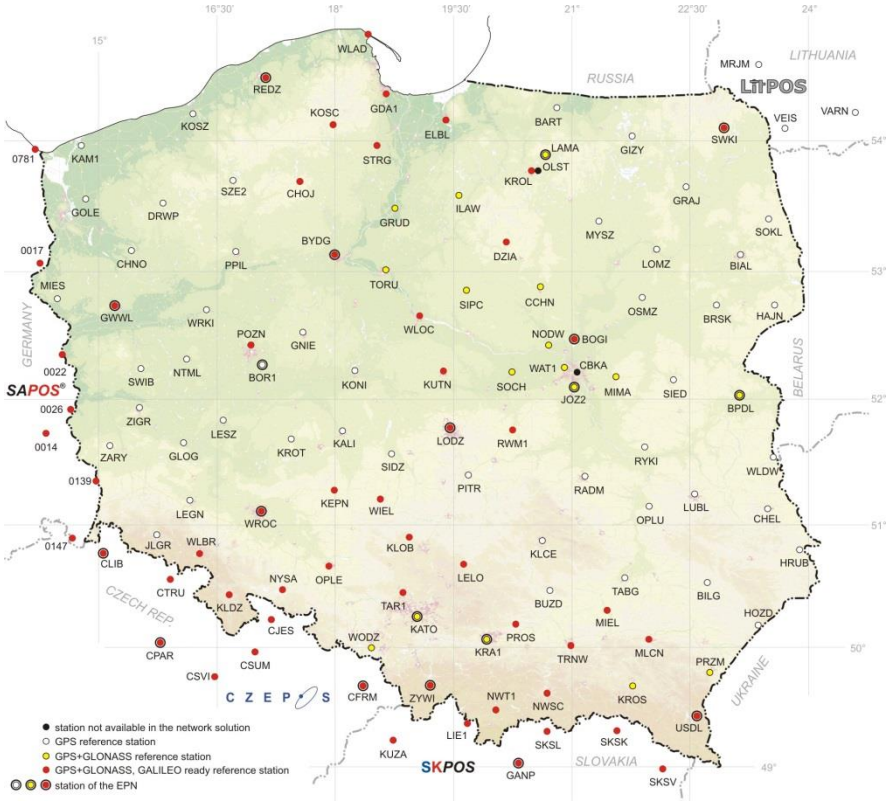


ASG-EUPOS network in Poland

Head Office of Geodesy and Cartography

reference stations of ASG-EUPOS network

- **125 stations (53 GPS/GLONASS)**



- **2 stations excluded**
- **2 stations moved**
- **28 stations – new receiver and antenna**

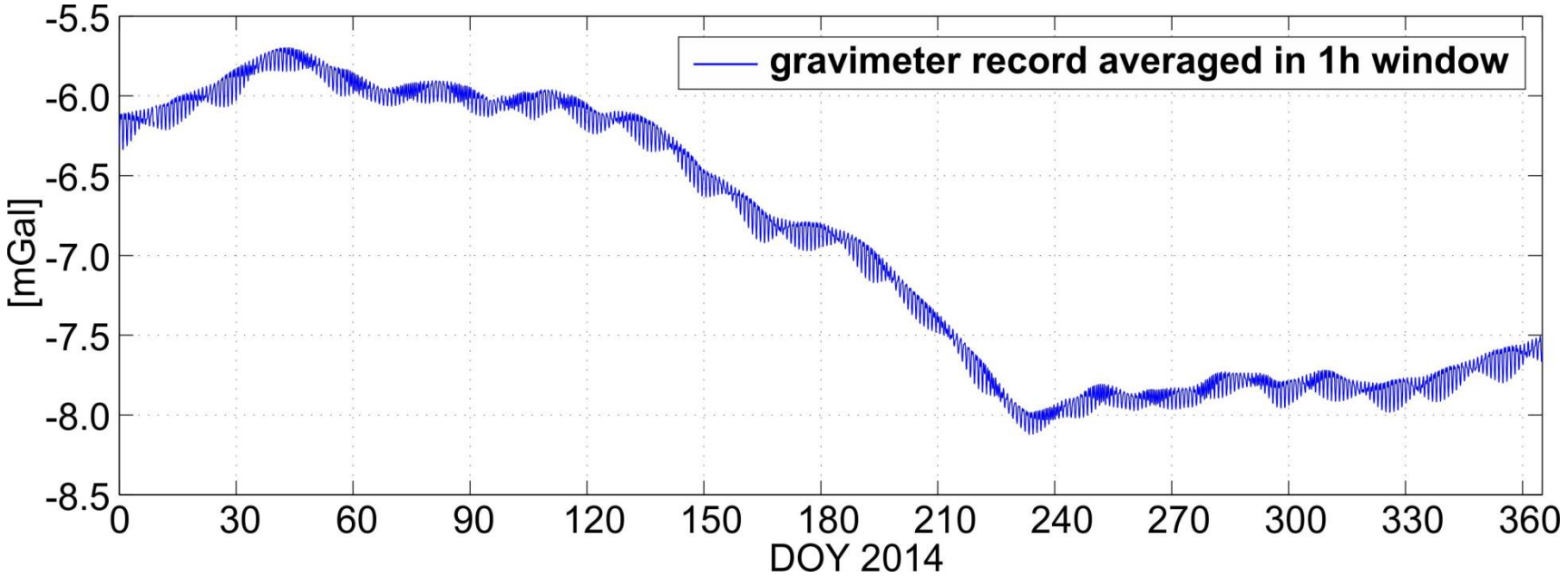
- **since 12 July 2014 all services in ASG-EUPOS system are fully payable**

- **number of regular users dropped down to 5 100**
- **RTK service stabilized at 3700 active licenses**

Earth tides monitoring (1)

Borowa Gora Geodetic-Geophysical Observatory of IGiK

- **gravity record using LCR G gravimeter since January 2010**
  - **analysis of tidal record**

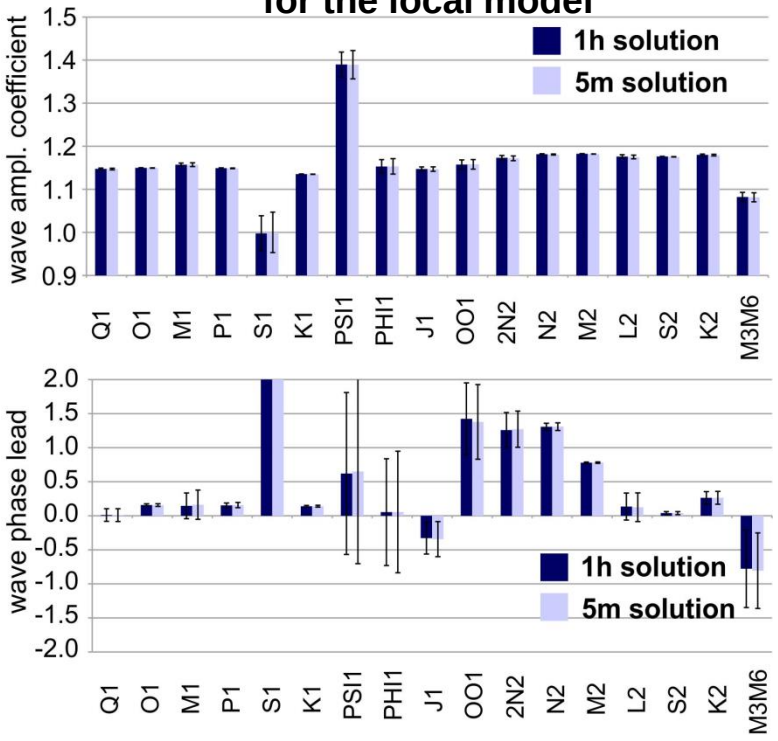


Earth tides monitoring (2)

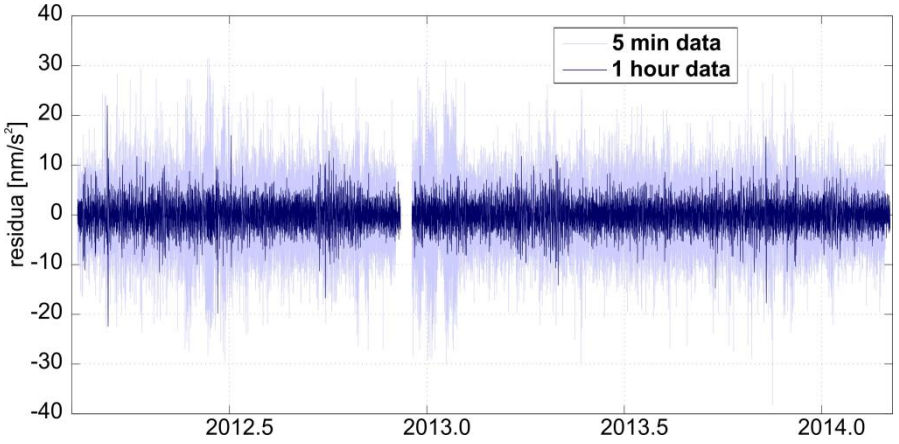
Borowa Gora Geodetic-Geophysical Observatory of IGiK

- **gravity record using LCR G gravimeter since January 2010**
  - **local tidal model**

Tidal factors (top) and phase leads (bottom) for the local model



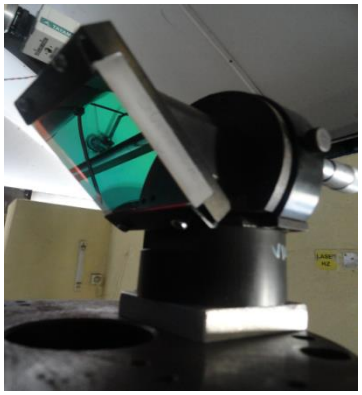
Adjustment residuals for a 5 min and 1h tidal records data



Satellite Laser Ranging

SRC PAS Borowiec station operates within ILRS and EURULAS

- **no SLR observations in 2013 – 2014 – laser damage**
- **new optic system & new laser installed in 2014**
- **analysis of SLR data continued**
  - **use of SLR and GNSS stations located close to each other for mutual control of coordinates**
  - **quality of SLR stations**
  - **analysis of SLR data with GNSS data**



Geodynamics

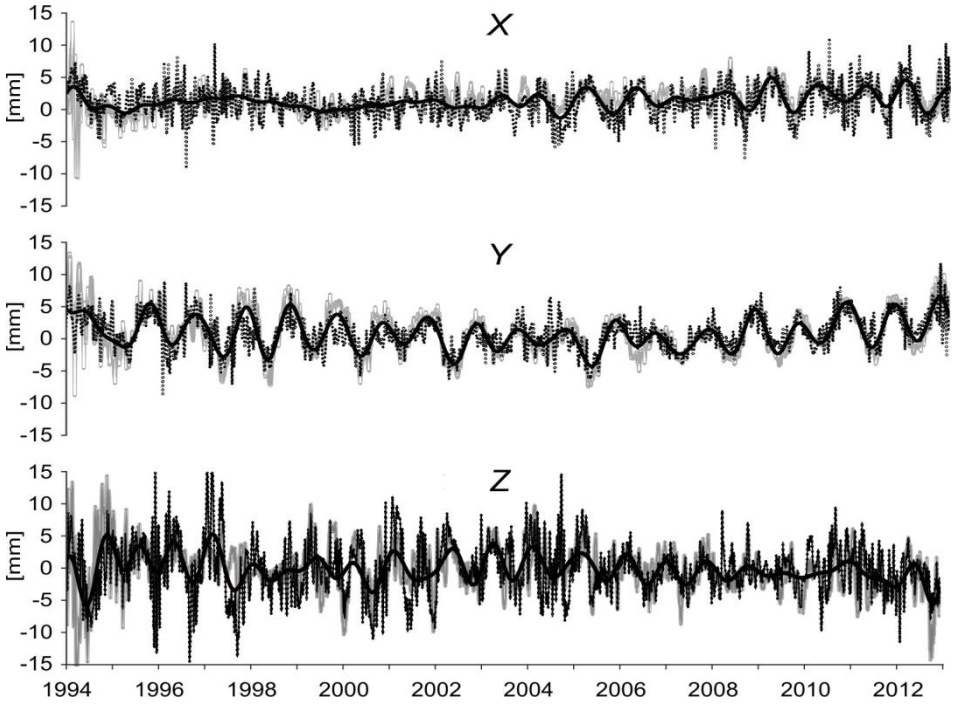
Research on geocenter motion

Model centre of mass time series (bold)

computed

as the average of the GNSS (gray) and

SLR (dotted) common oscillations composed of only 6 lower frequency components together with the filtered oscillations



WUT

Investigation of the atmospheric effects in gravity measurements records

Geodynamics (2)

SRC PAS

Recent tectonic activity in the area of Swiebodzice Depression based on GNSS observations in Ksiaz

Time series of KSIA-KSI1 vector components for the period of 1.36 years (from 2013:139 to 2014:270)