CENTRE OF APPLIED GEOMATICS ACTIVITIES IN THE CONTEXT OF THE EUREF PROJECT

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1. INTRODUCTION

The paper summarizes CAG's (Centre of Applied Geomatics) involvement in the EUREF project. CAG is the newest, seventeenth LAC (Local Analysis Centre), which was established at the end of 2009. The main task of the Analysis Centre is to process data from the network consisting of 114 stations with weekly ellipsoidal coordinates as the result. CAG also participates in the EPN Reprocessing project which is another form of processing the archive GNSS data, using the newest strategies, products and models, gathered since the EPN (EUREF Permanent Network) establishment. CAG processes data from national satellite system ASG-EUPOS and combines its solutions with regional network and investigates data from weather prediction models (COAMPS and WRF) for GNSS slant delay estimation.

2. EPN PROCESSING

Centre of Applied Geomatics is the research unit, which operates within Military University of Technology (MUT) in Warsaw. The main field of interests covers GNSS (Global Navigation Satellite Systems) data processing and analyzing. Since the end of 2009 CAG runs the newest, seventeenth Local Analysis Centre (LAC) of the EPN (www.epncb.oma.be). The main task is to process data from the network consisting of 114 stations (Fig. 1) with weekly ellipsoidal coordinates and troposphere parameters as the result. Every week, the solutions are being sent to Regional Data Centre, which is run by Bundesamt für Kartographie und Geodäsie (BKG), where they are combined with other sub-networks in order to create European free-network solution that is transferred to International GNSS Service (IGS).

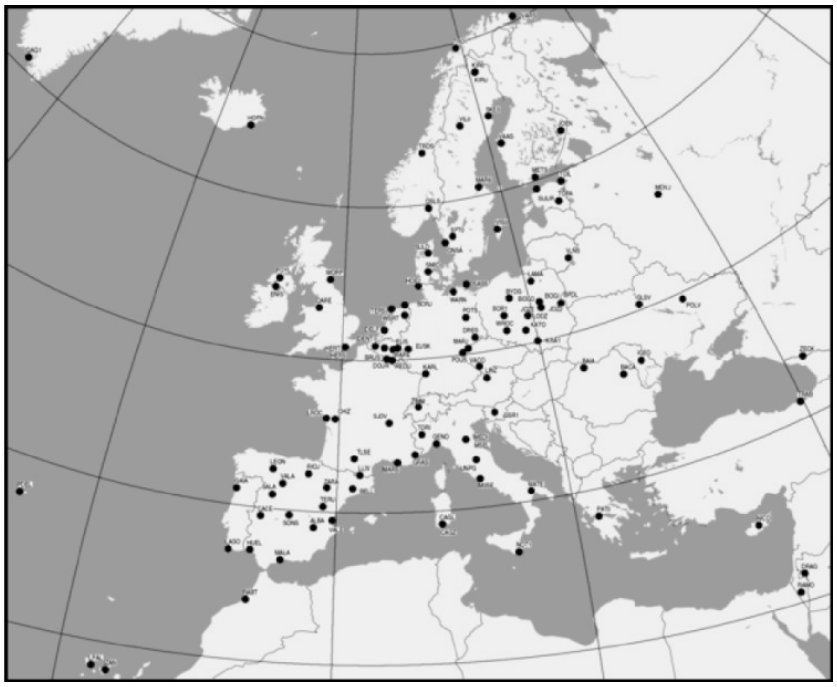

Fig. 1. EPN subnetwork processed by CAG.

3. EPN REPROCESSING

CAG participates in the EPN Reprocessing project (http://epn-repro.bek.badw.de/) which is another form of processing of the archive GNSS data using the newest strategies, products and models, gathered since the EPN establishment. The main purpose of this project is to obtain homogenous time series of sites' coordinates and to realize European Terrestrial Reference System (ETRS'89) using cumulative weekly solutions obtained with the highest possible accuracy. Results of the reprocessing (daily and weekly coordinates time series) give a comprehensive set of data for various geodetic, geodynamical and geophysical analysis.

Test reprocessing of the whole EPN was done simultaneously by two centres: CAG (new orbits from the 'Potsdam-Dresden' IGS reprocessing were used) and Royal Observatory of Belgium (where global IGS stations were taken into consideration). CAG performed calculations using FENIX cluster consisting of 16 dual processor HP servers, which enabled obtaining 210 GFLOP of computing power (processing daily data from 200 lasts only 40 minutes). The results of the tests gave rise to a new strategy for official EPN reprocessing, which is under preparation at the moment (Kenyeres et. al., 2009).

As the majority of LACs uses Bernese software (Beutler et al., 2006), CAG chose to perform tests using also another tool: GAMIT/GLOBK (Herring et al., 2009). These tests are being made in cooperation with Landmäteriet (Gävle, Sweden). The EPN network was divided into 7 sub-networks. 3 networks (138 sites, Fig. 2) are processed by CAG.

Fig. 2. Sites processed by CAG using GAMIT/GLOBK software.

4. EUREF DENSIFICATION

National satellite positioning systems enable densification of regional network – the EPN, which plays a role of ETRS'89 realization. Elaborations made according to official guidelines allow to obtain homogenous, coherent reference frames in different European countries. Active Geodetic Network European Position Determination System (ASG-EUPOS, http://www.asgeupos.pl) is Polish GNSS Ground Based Augmentation System. It is a multifunctional system of precise positioning consisting of more than 100 GNSS reference stations (Fig. 3). Besides being IGS and EPN densification, it delivers real time or post-processing services for surveyors using GNSS receivers (differential technology). Polish Head Office of Geodesy and Cartography (HOGC) manages the system, while CAG processes the data and analysis solutions to ensure additional control and monitoring of the system. ASG-EUPOS will soon fulfil a role of main national geodetic frame and will enable ETRF (European Terrestrial reference Frame) conservation in Poland. Strategy of processing is compatible with the EPN processing strategy used by Local Analysis Centres. Weekly and daily solutions (North, East, Up components) are obtained in SINEX (Solution Independent Exchange) format.

Fig. 3. ASG-EUPOS sites.

Basing on weekly solutions, cumulated during long period, horizontal velocities and vertical movements can be determined. Horizontal velocities obtained from long-term GNSS observations are naturally expressed in ITRF (International Terrestrial Reference Frame), so they are a confirmation of theories about current plate movements (Fig. 4). National systems supply the regional velocity field and give information about local crust movements. Weekly solutions enable cumulative solutions (the most reliable ones for long period) determination. Daily and hourly solutions are analyzed by CAG in order to find periodic and non-periodic phenomena causing solutions accuracy decrease. Investigations of long time series allow different models verification and their possible improvements (e.g. tidal model).

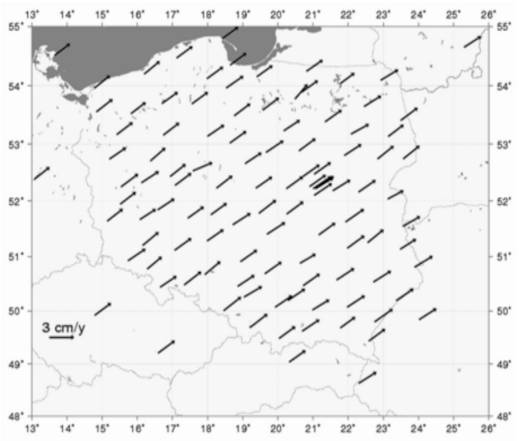

Fig. 4. Velocities expressed in ITRF2000.

CAG performs monitoring of solutions' quality, mainly in terms of their precision. Daily time series are published on CAG's webpage (www.cgs.wat.edu.pl) and they are observed to notice any incorrectness as soon as possible to ensure proper activity of the system, especially for precise positioning (surveying).
There are significant periodic disturbances that can be seen on some sites (especially regarding horizontal components). CAG analyses the disturbances in order to find reasons of such state. As the biases period is about 1 year it is possible that they are caused by some kind of thermal influence (Fig. 5).

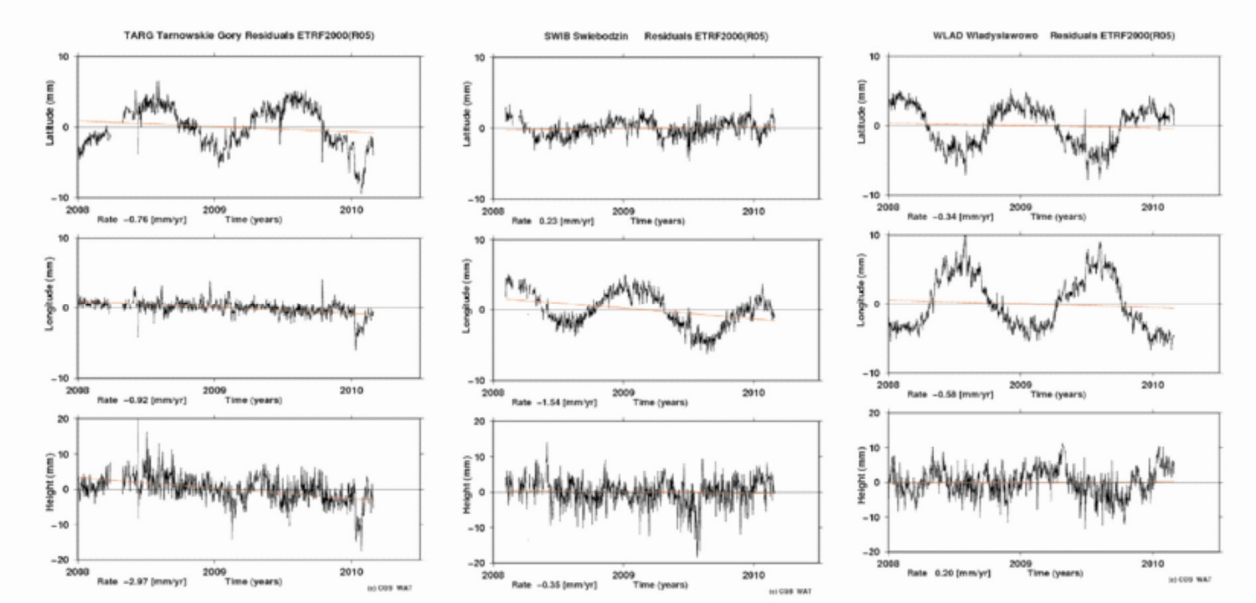

Fig. 5. Periodic oscillations of selected ASG-EUPOS sites.

During winter 2010 strong disturbances in time series were observed. Currently CAG is engaged in finding an answer to such a state. They are somehow related to the extreme weather conditions, but at the same time they can only be observed on several stations located in different regions of Poland. Perhaps the thermal effects should also be considered or snow cover (loading effect) causing antennas' displacements (Figurski et. al., 2010). Examples are given in Fig. 6.

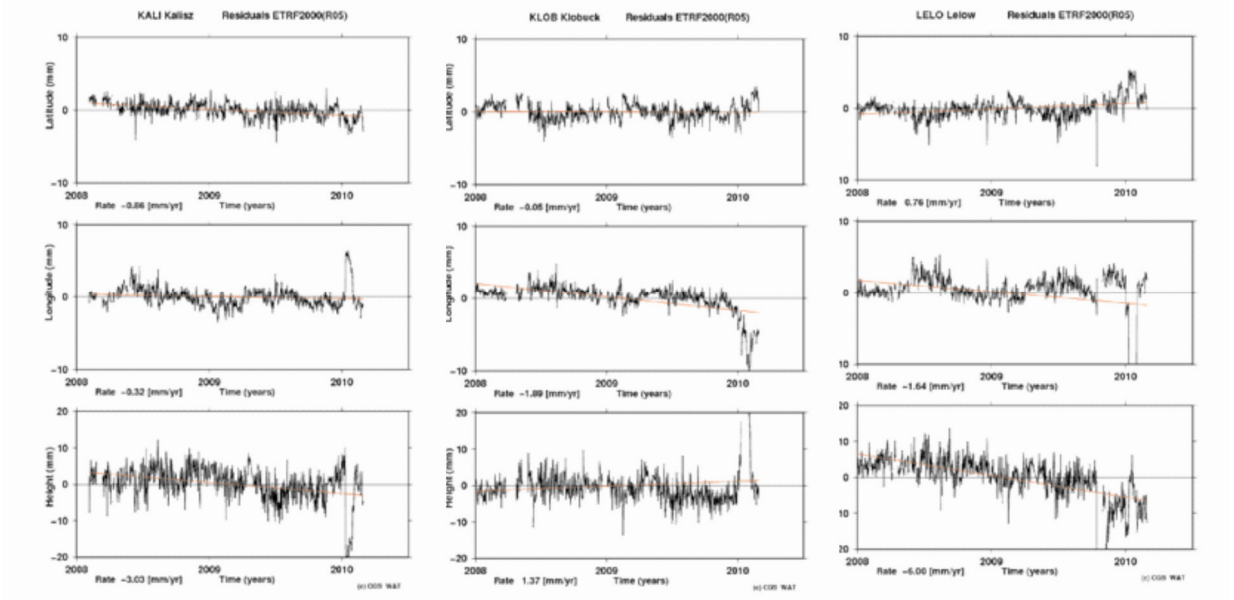

Fig. 6. Disturbances in geodetic coordinates during winter 2010.

5. GNSS AND METEOROLOGY

CAG carries out investigations concerning methods of GPS tropospheric zenith and slant delay determination on the basis of data from mezoscale weather model - Coupled Ocean/Atmosphere Mezoscale Prediction System (COAMPS). The calculations of tropospheric delay are related to 3D(2D) maps of GPS signal propagation speed in the atmosphere and associated maps of distances, which contain information about geodetic distances (time of propagation) between GPS station and atmosphere's points (Kroszczynski et. al., 2009). The Fast Marching method is being used for the estimation of different weather conditions impact on zenith and slant delay. Anisotropic slant delay fields can be used as the direct 3D prognostic mapping functions. Currently, the tests are carried out on ASG-EUPOS system (Bosy et. al., 2010). The calculations were done for the whole system (more than 100 sites, Fig. 7), but this paper presents solutions (values of zenith delay for different prognosis time) for sites from Mazovian region only (Fig. 8-10).

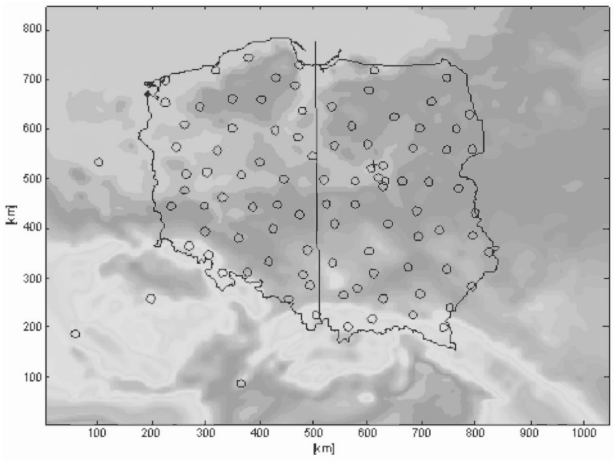

Fig. 7. Area selected for prognosis – 20 ASG-EUPOS sites.

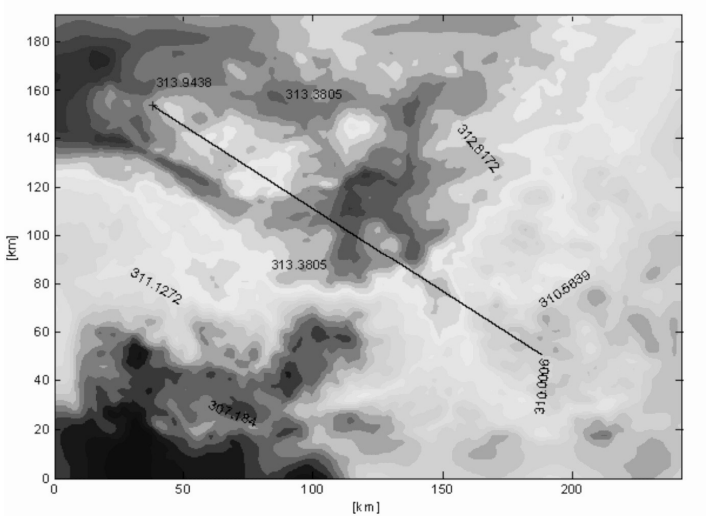

Fig. 8. Horizontal section of refractivity N field for the Mazovian region in Poland.

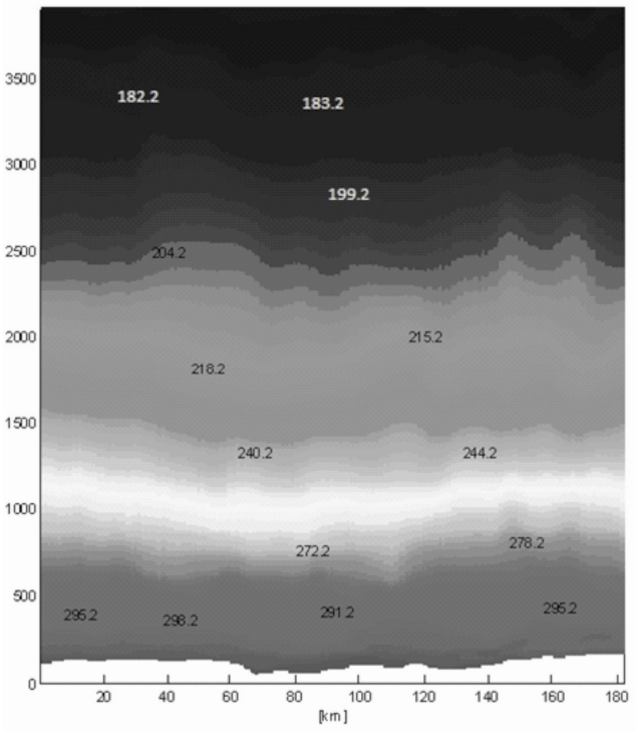

Fig. 9. Vertical section of refractivity N field for the Mazovian region in Poland (vertical section corresponds to the marked line in Fig. 9).

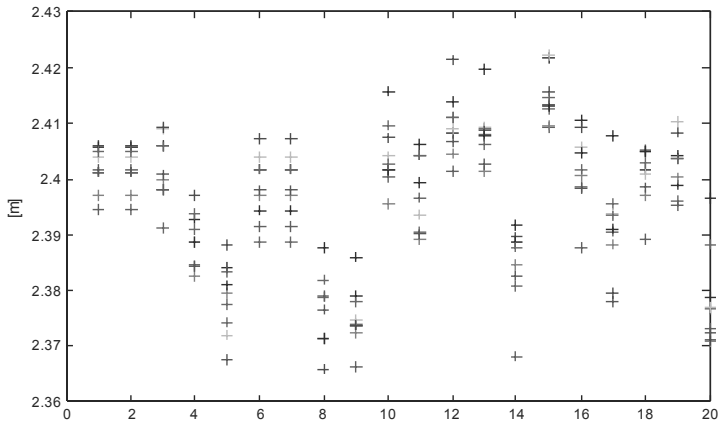

Fig. 10. Zenith delay for ASG-EUPOS sites from selected area for prognosis, which corresponds to 00, 03, 06, 09, 12, 15, 18, 21, 24 hour (different markers for each hour) for 1.44 km resolution grid.

6. PLANS FOR THE FUTURE

In acknowledgement of achievements of the CAG the EPN Central Bureau admitted the Military University of Technology the organization of Analysis Centres meeting, which will be held in Warsaw in November 2010.

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