

SITE VELOCITIES FROM LONG-TERM EPOCH GPS OBSERVATIONS – CASE STUDY: CENTRAL EUROPE REGIONAL GEODYNAMIC PROJECT 1994-2005

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(Received May 2006, accepted August 2006)

Abstract

Series of repeated epoch-wise GPS campaigns performed in Central European region are used for estimation of site velocities. The main features of campaign processing and combination of network solutions are outlined. The velocities obtained from epoch observations within the Central Europe Regional Geodynamic Project covering the 11-year time span are compared at some sites with velocities derived from permanent GPS observations.

KEYWORDS: epoch GPS network, Central Europe Geodynamic Reference Network, site velocities – horizontal and vertical, intraplate velocity field in Central Europe

ANALYSIS OF STABILITY OF PERMANENT GPS STATIONS KRAW, KATO AND ZYWI

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(Received February 2006, accepted June 2006)

Abstract

GPS permanent stations KRAW, KATO and ZYWI are part of so called Active Geodetic Network which covers entire area of Upper Silesian Coal Basin (USCB) in Poland and forms precise reference frame for geodetic and geodynamic applications. Moreover the above mentioned stations belong to EUREF Permanent Network. The stations, as datum points, play important role in precise positioning and geoid determination in area of USCB. The study of the stability of these points is one of the main components in precise monitoring of ground deformation in mining areas. The analysis of stability of permanent GPS stations KRAW, KATO and ZYWI are based on the coordinate time series obtained from the EUREF weekly solutions. The relative coordinate time series of weekly solutions for the vectors KRAW - KATO, KRAW - ZYWI, KATO - ZYWI are presented. The consistency, linearity, seasonal variations and jumps in the relative coordinate time series are discussed.

KEYWORDS: time series analysis, GPS permanent stations, relative site velocities

PRELIMINARY RESULTS OF THE ANALYSIS OF THE GPS TIME SERIES SOLUTIONS (GPSSTS) IN ASG-PL PERMANENT NETWORK

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(Received February 2006, accepted June 2006)

Abstract

The permanent GPS stations are particularly important for studying various phenomena because they provide uninterrupted measurements allowing to form the time series of station coordinates. Analysis of GPS solutions time series (GPSSTS) for short meridian baselines were explored in the paper (Kryński and Zanimonskiy, 2000). In our article we intend to extend the analysis of the GPSSTS for baselines of different lengths and azimuths. GPS observation data from the ASG-PL network have been used in the research. The GPSSTS in time and frequency domain have been analyzed. The spectrums of the GPSSTS with the using coherence function were compared. Moreover, a practical approach to correct any unmodeled effects in GPS baseline solutions that cannot be computed using classical GPS adjustment was presented.

KEYWORDS: permanent GPS stations, time series, GPS data processing

THE USE OF PERMANENT AND EPOCH GPS COORDINATE TIME SERIES IN GEODYNAMIC INVESTIGATIONS OF SUDETES AREA - PROPOSAL OF A NEW APPROACH

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(Received March 2006, accepted July 2006)

Abstract

*The future of the global and local geodynamic researches belongs to permanent monitoring. The conception of the semipermanent GPS observations' application in geodynamic research in Sudetes area is presented in this paper. The conception is based on spatial modeling of the disturbing phenomena in the coordinate time series of (semi) permanent stations.

The local interplate movements and their correlation with major European tectonic structures are determined on the strength of coordinate time series of these stations. The problem of epoch integration with semipermanent and permanent (EPN/IGS) observations for local geodynamic monitoring is also investigated.

KEYWORDS: recent tectonic movements, GPS time series, semipermanent GPS stations, Sudeten

ON GPS HEIGHTING IN LOCAL NETWORKS

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(Received March 2006, accepted June 2006)

Abstract

Determination of heights with help of GPS in local geodetic networks is still more actual respecting the fact that the GPS technology becomes more and more effective with hardware progress, with improvements in measuring and evaluating procedures, and with better modelling of the disturbing influences. In comparison with GPS the employment of classical terrestrial measuring technologies is often more difficult namely in broken mountain environment.

In period 1998-2005 authors carried out repeated measurements of GPS baselines of various length and various height differences in local geodynamical network Sněžník and in other experimental areas. On ground of analyses of large GPS data sets the modified procedure for GPS observation was designed. The procedure is based on repetition of shorter static sessions separated by time intervals of optimal length. This technology represents an alternative to the usual long static sessions, and is offering better effectivity of vertical GPS measurements with minimal loss of accuracy.

The paper presents detailed description of the modified procedure together with some statistical analyses of results. The possibilities of elimination or mitigation of some disturbing influences are discussed. Two testing vertical profiles were marked in Sněžník network – longitudinal profile in N-S direction, and transversal profile in E-W direction – which were measured in course of several years by classical method of very precise levelling, and also by modified GPS heighting procedure in repeated sessions. Results obtained contributed to the local quasigeoid model creation.

KEYWORDS: geodynamics, GPS, height measurements, geoid modelling

PRELIMINARY SITE MOVEMENTS IN THE GPS WEST SUDETEN NETWORK
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(Received May 2006, accepted August 2006)

Abstract

The WEST SUDETEN geodynamic network consists of 11 sites on that five annual GPS epoch measurements in period of 2001-2005 were carried out. The 48-hour epoch data linked to 4 permanent EPN station observations created reasonable GPS data base for a preliminary evaluation of site movement velocities. General movement pattern over the network has been obtained and some regional and local movement relations among network sites were observed and discussed. The whole region under study displays three areas with relatively different movement trends. The northern area, i.e. the Krkonoše Mts. structural block, displays pronounce motion to the NW with respect to the central area that involves the Permian piedmont of the Krkonoše Mts. covered in its southern part by the Cretaceous sediments. Besides, conspicuous dextral movement along the Železné hory Mts. fault zone was detected too.

KEYWORDS: epoch GPS observations, geodynamics, the Sudeten area, the Bohemian Massif

RESONANT PERIOD OF FREE CORE NUTATION – ITS OBSERVED CHANGES AND EXCITATIONS

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(Received January 2006, accepted April 2006)

Abstract

The motion of Earth's spin axis in space is monitored by Very Long-Baseline Interferometry (VLBI), and since 1994 also its rate is measured by Global Positioning System (GPS). From the direct analysis of the combined VLBI/GPS solution in the interval 1994.3-2004.6 we recently found that the apparent period of the Retrograde Free Core Nutation (RFCN) grew from original 435 days to 460 days during the past ten years, but the resonance effects yielded a stable period of about 430 days. Now we repeat the same study with VLBI-only data, covering much longer interval (1982.4 – 2005.6). Direct analysis shows again a substantial increase of the apparent period during the last decade or so. The resonant period is given by internal structure of the Earth (mainly by the flattening of the core), so it is highly improbable that it is so much variable. From the same observations we derive corrections of certain nutation terms. A subsequent study of indirect determination of resonance RFCN period from the observed forced nutation terms through the resonance effects proves that the natural resonance period remains stable and is equal to 430.32 ± 0.07 solar days. From this follows that an excitation by outer layers of the Earth (atmospheric, oceanic) should exist, with a terrestrial frequency close to that of RFCN (of about -1.0050 cycles per solar day, i.e. with period of $-23\text{h}53\text{m}$ mean solar time), invoking the apparent changes of the directly observed RFCN period. Thanks to a close proximity of the resonance, any excitation with this period is extremely amplified so that the excitation necessary to explain the difference can be very small. The atmosphere alone contains enough power to excite the observed changes.

KEYWORDS: geodynamics, Earth orientation, Free Core Nutation, space techniques, VLBI

**CONTRIBUTION TO THE THEORY OF THE DETERMINATION OF THE
ORBITAL ELEMENTS OF SOLAR SYSTEM BODIES: REPLACING GAUSS'S
RATIO OF SECTOR TO TRIANGLE**

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(Received January 2006, accepted April 2006)

Abstract

The aim of this paper is the determination of six orbital elements if two positions (1 and 2) of a solar system body are known. The task was solved using the ratio of the elliptical sector to the area of the corresponding triangle. This relationship was labelled as η and derived by K. F. Gauss (1809), see sections 1 and 2. This paper presents four easy methods that supply the ratio, see section 3. These methods simplify this task by removing long and very complicated derivations and by clarifying the theory and calculations. The methods are not used in the case of more than two observations.

KEYWORDS: celestial mechanics, orbital elements

**IMPACT OF SUMATRA 2004 EARTHQUAKE ON GEODYNAMIC STATION
GOPE (CZECH REPUBLIC)**

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(Received January 2006, accepted April 2006)

Abstract

The aim of this contribution is a detection of geodynamic effects at a very distant geodynamic station GOPE in the middle of Europe (Czech Republic). Strong earthquake, followed by strong indirect effect (tsunami), with the parameters (26.12.2004, 00:58:53.4 UTC, mag. 9.0, latitude 3.295N, longitude 95.982E, depth 30 km) was analysed from the records of tidal gravimeter (ASK No.228) with respect to free oscillations of the Earth (spheroidal component), by spectral analysis. This analysis detected significant vertical component of GOPE position in relatively long time interval (several hours) after the beginning of the earthquake. To verify the geodynamic tendencies of the GOPE station movements the GPS observations were analysed at the same time interval. We had data with 1s sampling interval at our disposal. For analysis we used PPP (Precise Point Positioning) method which produces absolute values of the coordinates in the ITRF 2000 system. Possible correlations between the results of both ways have been searched. We concentrated consequently to the determination of mean displacements and on the attempt of detection of some amplitudes of following free oscillations of the Earth. Mean change of position of the station GOPE during and after the earthquake, detected from the results of GPS observations is about 1.5 cm in horizontal and height components. Amplitude magnitudes for frequencies of the free oscillations of the Earth, which were analysed either from gravimetric data or from the GPS data, are equal in order. The study of free oscillations of the Earth by application of GPS is completely new. Studying of free oscillations is usually accomplished by data from seismometers, tiltmeters or superconducting gravimeters.

KEYWORDS: free oscillations, tidal gravimeter, GPS, PPP - Precise Point Positioning, spectral analysis

EARTH FREE OSCILLATIONS OBSERVED IN PLUMB LINE VARIATIONS FROM THE 26 DECEMBER 2004 EARTHQUAKE

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(Received January 2006, accepted March 2006)

Abstract

The long water-tube tiltmeter observations of the plumb line variations were begun about four years ago. Since 2001, twice, the instrument registered strong plumb line variations associated with earthquake. Earthquake in September 2003 made opportunity for verification of hydrodynamic system of tiltmeter. We obtained in observations large number of cycle-slip effects, which made impossible correct interpretation of data during main phase of phenomenon. Results of tests of dumping system of water waving helped us to introduce some improvements in hydrodynamic system of instrument. Catastrophic earthquake with magnitude 9.1 which took place in the area of Indian Ocean on 26th December 2004 generated phenomenon of the Earth free oscillations associated with anomalous plumb line variations of the order of single milliseconds of arc (mas). The effects of surface waves passing associated with Earth free oscillations were registered by the tiltmeter as series of anomalous plumb line variations. Surface waves produced several milliseconds of arc amplitude of plumb line variations. Results of observations showed that low-pass filters considerably reduce contribution of short-period effects and effectively protect hydrodynamic system of instrument against resonance. Nevertheless during first two hours of phenomenon cycle-slip effects occurred several times. Plot of plumb line variations in space from 26th December 2004 showed us large complication of tilt signals as well as dominated role of tidal signal. Spectral analysis of the time series of the plumb line variations obtained with help of the long water-tube tiltmeter on 26 December 2004 appeared existing fundamental modes ($n = 0$) in the Earth free oscillations didn't exceed 0.2 mas.

KEYWORDS: geodynamic, earth tides, earth free oscillation, plumb line variations, long water-tube tiltmeter

SEISMIC EVENTS IN THE ORAWA-NOWY TARG BASIN, WESTERN CARPATHIANS, NOVEMBER 30, 2004 - DECEMBER 2005

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(Received March 2006, accepted August 2006)

Abstract

An earthquake of magnitude $M = 4.4$, macroseismic intensity $I_0 = 7$ in the EMS scale, followed by a long series of aftershocks occurred on November 30, 2004 in southern margin of the Orawa–Nowy Targ Basin, Western Carpathians. Macroseismic epicentral data were determined for the main earthquake and the strongest aftershocks. The foci were shallow, less than 5 km i.e., originated in the Podhale Flysch. An array of seismic stations located in this seismically active area is necessary for better recognizing of the ongoing tectonic process.

KEYWORDS: Orawa-Nowy Targ Basin, Pieniny Klippen Belt, series of earthquakes, macroseismic data

SOME FEATURES OF SEISMIC WAVES OBSERVED IN THE TERRITORY OF NORTHERN MORAVIA AND SILESIA

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(Received February 2006, accepted May 2006)

Abstract

A grant project for the period 2003-2005, supported by the Grant Agency of the Czech Republic, was set up to determine properties of seismic waves and the structure of the uppermost part of the Earth's crust in the territory of northern Moravia and Silesia. Quarry blasts and mining induced seismic events served as seismic sources. Permanent, temporary and portable seismic stations were used for the monitoring of these seismic events. During the experiments local microearthquakes were also detected and localized. For the complex evaluation of seismic wave features, data of the CELEBRATION 2000 and SUDETES 2003 refraction experiments were incorporated, as well. The velocity-depth dependence of body waves was searched by joint inversions of travel times of Pg/Sg phases. A special feature of the wave trains, generated by quarry blasts, was a pronounced dispersive character of short-period Rayleigh surface waves. These waves enabled us to establish their dispersion curves, on the basis of which the structure of superficial layers was determined down to a depth of several hundreds of meters.

KEYWORDS: Moravo-Silesian region, body waves, surface waves, quarry blast, microearthquake, crustal structure

**PERIODIC GRAVITY CHANGES IN YOUNG TECTONIC MOVEMENT
INVESTIGATION IN ORAWSKA VALLEY AND DUNAJEC FISSURE VALLEY
AREA – FIRST RESULTS**

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(Received February 2006, accepted May 2006)

Abstract

Geodynamic processes take place in the Carpathians even nowadays. For tracing them, a research project employing gravity measurements was undertaken. Movements in the crust result in a change of mass distribution, which may be traced with the use of a gravimetric method. Two measurement profiles were designed for tracing geodynamic changes, and in the years 2004-2005 gravimetric measurements were realised. The first results of observed gravity changes are presented in the paper and are followed by preliminary conclusions on the observed changes and the assumed measurement methods.

KEYWORDS: gravity measurements, geodynamic processes, temporal gravity changes

GRAVITY MEASUREMENTS IN THE GEODYNAMIC NETWORK SUDETY

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(Received January 2006, accepted March 2006)

Abstract

The Geodynamic Network Sudety was joined to the Czech Gravity Reference Network (CGRN) by two weeks of the relative gravity measurements. The gravity stations of the CGRN were used as the anchor stations. There were used two relative gravimeters LaCoste & Romberg G. The method of measurement, used instruments, mathematical processing, variants of result computations and their accuracy are discussed.

KEYWORDS: gravity measurements, gravity network, gravity acceleration, geodynamic

THE USE OF SAR INTERFEROMETRY FOR THE STUDY OF LANDSLIPS IN THE POLISH FLYSCH CARPATHIANS

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(Received January 2006, accepted April 2006)

Abstract

The article discusses techniques for interpreting satellite images, which are capable of detecting and monitoring landslip zones, and presents a research plan for the study of landslips with the use of satellite interferometry. The exceptionally long-lasting and heavy rainfall that occurred in 1997 initiated more than 20,000 landslips within the Polish Carpathians. These landslips continue to pose a threat. Some of them move almost imperceptibly – slowly but continually – yet long-lasting periods of heavy rainfall can lead to catastrophe. The price can be human lives, as well as losses into the millions connected with the devastation of technical infrastructures and entire housing estates. The sheer number of landslips that occur in the Polish Carpathians makes the traditional ways of researching them insufficient. Satellite remote sensing allows capturing a large area of interest on a single photo. Many various satellites photograph the surface of the Earth using different techniques, allowing for the selection of the best-suited image type for a given application. Synthetic Aperture Radar (SAR) images are utilized in landslip studies. The images may be interpreted using the InSAR and/or PSInSAR techniques. Both methods are capable of detecting landslip zones and monitoring them in order to assess the risk of a sudden landslide. Information of this type is significant to local authorities when planning the activities necessary to protect the safety of inhabitants and the local technical infrastructure.

KEYWORDS: satellite remote sensing, InSAR, landslips

**APPLICATION OF RESISTIVITY IMAGING TO RECOGNITION OF
GEOLOGICAL STRUCTURE IN THE AREA OF SHALLOW Zn-Pb ORE BODIES
(PRELIMINARY STUDY)**

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(Received January 2005, accepted April 2006)

Abstract

Depletion of exploited mineral ore resources and their constant price increase have contributed to active interest in recognition and exploitation of new workable deposits. Exploration work which has been carried out in the vicinity of non-exploited ore areas such as Klucze, Zawiercie and Laski results in confirmation of Zn-Pb commercial deposits. In this region Zn-Pb ores occur in the Devonian and Triassic carbonate formation at a depth of 70 - 80 metres under the surface. Geological recognition is based on the analysis of data taken from bore-holes. To determine the mode of the ores occurrence and service conditions, it is necessary to work out a spatial image of overburden structure. For this reason resistivity measurements with highly distributed LUND Imaging System were introduced in the area of Zawiercie I. The studies were carried out according to three measuring protocols: Schlumberger, Wenner and dipole-dipole. The measurements were performed along three parallel six-hundred-metre profiles. The resistivity cross sections were elaborated using Res2D software. The results of the geophysical research were correlated with the data taken from bore-holes in order to testing the efficiency of applied geoelectrical methods. The study showed a significant diversification of geoelectric characteristics of the rockmass and thus it allowed to recognise accurately the overburden structure of the deposit and to locate precisely zones of faulting. In future, the applied geoelectrical methods are certainly to be used for localization ore bodies at a considerable depth range.

KEYWORDS: resistivity imaging, geophysics ore recognition, Zawiercie Zn-Pb ore deposits