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CZECH PERMANENT GPS OBSERVATORIES FOR GEODYNAMIC INVESTIGATIONS OF THE BOHEMIAN MASSIF OPERATED BY THE INSTITUTE OF ROCK STRUCTURE AND MECHANICS, PRAGUE

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ABSTRACT
Since 2001 four GPS permanent observatories (BISK, MARI, POST and SNEC) monitoring NAVSTAR and GLONASS satellite signals were established by the Institute of Rock Structure and Mechanics Acad. Sci. (IRSM) to detect recent geodynamic movements of the Bohemian Massif. Their geographic positions, technical equipment and standard setting are described. Firstly the remote observatories were controlled using GSM modem and monitored data were stored on the PC hard disk, later GPRS technology was used for GPS data transfer from the observatories to the IRSM server.

KEYWORDS: geodynamics, GPS (NAVSTAR/GLONASS) permanent observatories, the Bohemian Massif

1. INTRODUCTION

Since 2001 the Institute of Rock Structure and Mechanics (IRSM) has built up in the frame of the national research centre "Dynamics of the Earth" activities four permanent GPS observatories BISK, MARI, POST and SNEC. The observatories monitoring NAVSTAR and GLONASS satellite signals are situated in the Bohemian Massif in places suitable for investigations of recent geodynamic movements of geological structures. Two of them (BISK and SNEC) provide more accurate GPS epoch measurements linkage to neighbouring EPN observatories. These annual epoch measurements are organized on two WEST and EAST SUDETEN regional geodynamic networks (Schenk et al., 2002a, c, 2003). To GPS data be used for geodetic tasks they have to be transmitted to centres in hourly or in daily intervals.

In last years data transmissions from remote observatories to centres were technically possible, but financial expenses exceeded funds of the national research centre (Kottnauer et al, 2003). A new way how to realize quick data transmissions from the permanent GPS observatories to the IRSM server appeared in 2003 when telecommunication companies offered financially available data transmissions using GPRS technology.

2. GEOGRAPHIC POSITIONS OF THE PERMANENT OBSERVATORIES

Localities suitable for buildings of permanent GPS observatories were selected in a way to detect geodynamic recent movements of geological structures of the Bohemian Massif. Altogether IRSM plans to establish five permanent GPS observatories. Up to now four observatories SNEC, BISK, MARI and POST have been put into operation (Fig. 1). Technical parameters of their equipment and their standard settings in monitoring satellites GPS signals are given below, in the next Paragraph, and partly in Schenk et al. (2002b) and Kottnauer et al. (2003). The GPS observatory BISK lies inside the EAST SUDETEN regional geodynamic network (Schenk et al., 2002a, 2003) and the GPS observatory SNEC inside the WEST SUDETEN regional geodynamic network (Schenk et al., 2002c) on that seven and three annual 48 hours GPS campaigns have been provided, respectively.

Observatory SNEC, originally entitled SNEZ***,*** is situated on the Sněžka Mt. (1602 m), the highest summit of the Czech Republic. First of all GPS measurements were realized on 8 meters high stone column, the basic Austria-Hungarian triangulation point built in 1824. Due to weather conditions in winter the second measuring point was built on the reinforced chimney of the building "Česká poštovna" (Czech post office). One year later GPS measurements were performed on both these points to link mutually both GPS measurements. In the frame of the collaboration of the IRSM with Agriculture University of Wroclaw, Department of Geodesy and Photogrammetry, GPS measurements in the Czech side were completed by GPS registration on the Polish point on the Sněžka Mt. (Cacoń et al., 2004). Distance and angle measurements with precise Leica TCA 2003 Total Station were realized to verify and mutually link relative positions of all three GPS points (Cacoń et al.,

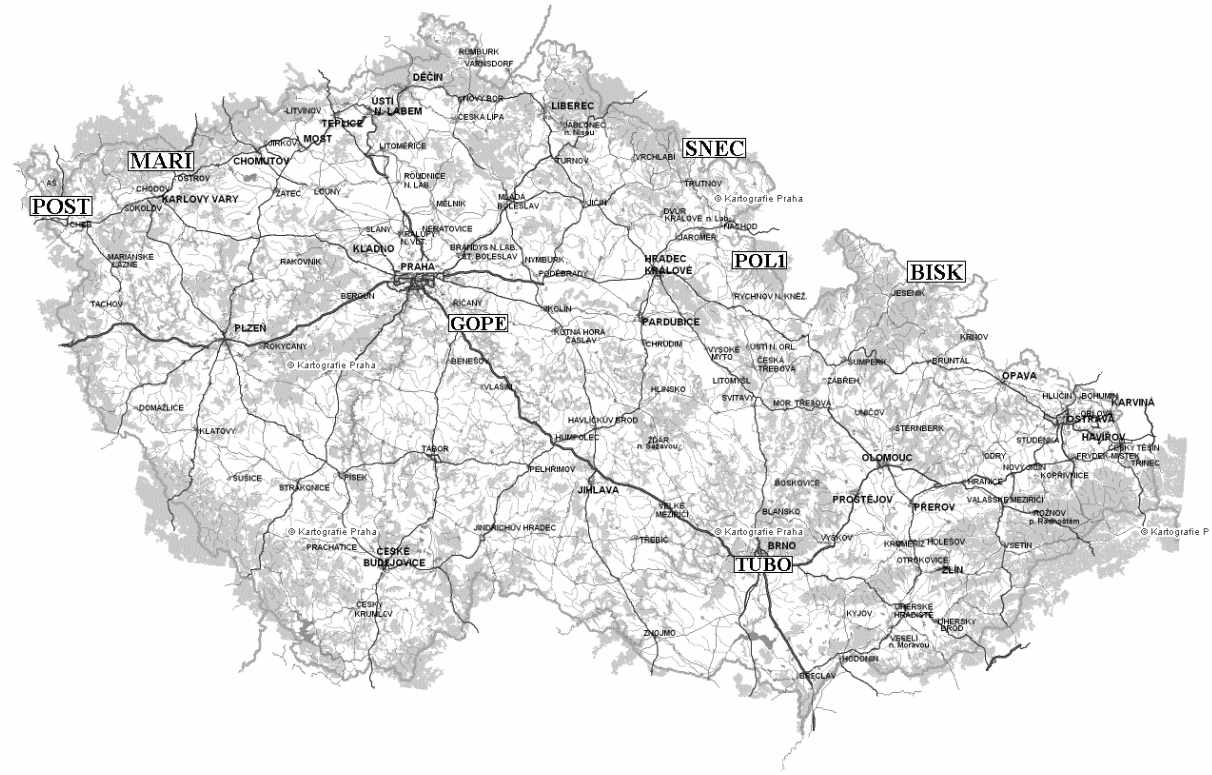

Fig. 1 Permanent GPS observatories in the territory of the Czech Republic

2004). Meteorological data can be obtained on the request from the Polish meteorological station working on the summit of the Sněžka Mt.

Observatory BISK is placed inside the stone 19.3 m high watchtower built in 1898 on the summit of the Biskupská kupa Mt. (888 m) near Zlaté Hory town in Silesia, equally like the observatory SNEC at the Czech-Polish border. The choke-ring antenna is located on the walkway of this watchtower. Its walls are about one meter thick. Together with monitoring GPS signals, standard meteorological data are recorded in 5 minutes interval. Moreover, BISK and SNEC sites belong to significant Laplace points.

Observatory MARI is situated on loft spaces of the building of the Institute of Rock Structure and Mechanics in Mariánská, which is a part of Jáchymov town in the Krušné hory Mts. The antenna choke-ring is fixed on newly reinforced chimney, which is no more used.

Observatory POST, the last IRSM observatory is situated on the highest floor of a prefabricated house in Poustka, which is a part of Františkovy Lázně town. This house was built more than twenty years ago on the Smrčiny granite and so far no cracks or fissures have been detected. For choke-ring antenna placement a concrete rectangular block of 40x40x40 cm was constructed on the level roof.

GPS positions of all permanent observatories mentioned above are in Table 1. The observatories SNEC and BISK, respectively, lying in centres of the WEST and EAST SUDETEN regional geodynamic networks follow possible recent movements on the Sudetic marginal fault and on other Sudetic faults. The observatories MARI and POST are placed on both sides of the Mariánské Lázně tectonic fault zone that is known by earthquake swarm occurrences. They are prepared to detect mutual recent movements of structural blocks. Unfortunately, since the establishment of both observatories MARI and POST in 2003 only one micro-swarm in the Nový Kostel area (around 50 micro-earthquakes in the magnitude range –0.5 to 1.3) has occurred on February 22, 2004 (http://www.ig.cas.cz).

3. TECHNICAL EQUIPMENT OF GPS OBSERVATORIES AND STANDARD SETTINGS IN MONITORING SATELLITE GPS SIGNALS

An identity and a mutual compatibility of hardware and software equipment of all GPS permanent observatories were the basic assumptions at their setting up. This assumption simplifies the operation of all observatories. It makes them maximum effective and in the case of possible technical failures of monitoring system enables quick hardware exchange or adjustment of control software. At each permanent observatory there is the Ashtech Z-18 receiver equipped with choke-ring antenna, which can monitor both GPS signals of the American

Table 1 GPS positions of the permanent observatories.

Observatory	Geocentric coordinates [m]	Geographic coordinates	Beginning of GPS monitoring
BISK	X = 3898951	latitude = 50º257488	Sept.6, 2001
	Y = 1223998	longitude = 17º429574	
	Z = 4881840	ellipsoid height = 965.3 m	
MARI	X = 3975138	latitude = 50º357671	May 15, 2003
	Y = 909953	longitude = 12º894538	
	Z = 4888918	ellipsoid height = 916.0 m	
POST	X = 4002431	latitude = 50º139235	Oct. 20, 2003
	Y = 872515	longitude = 12º298922	
	Z = 4873124	ellipsoid height = 585.8 m	
SNEC	X = 3894169	latitude = 50º736646	Aug. 23, 2001
	Y = 1097519	longitude = 15º740758	
	Z = 4916295	ellipsoid height = 1651.5 m	

positioning system NAVSTAR and the Russian system GLONASS. The Ashtech Z-18 receiver is connected through the serial interface to the PC Pentium with OS Windows 2000 (Fig. 2). The GPS signals are monitored in minimum zenith angle 80°, regularly stored to a hard disk in 30 seconds sampling interval in original binary and converted RINEX formats. The RINEX format is the input format for GPS data evaluation softwares, e.g. BERNESE. The data flow is approximately 350 MB per month.

The antennas at all observatories are situated in a way to be protected against possible alienations. To ensure the receivers and the PCs against power failures the observatories are equipped by 230/12V power sources/chargers and lead-acid 12V/220Ah batteries (Kottnauer et al., 2003). Under normal situation 230V AC mains is converted to 12V DC by switching power source/charger. In the case of mains fail energy is taken from 12V/220 Ah battery (Fig. 2). This configuration makes possible to record GPS signals almost for another two days.

4. GPS DATA AND GPRS TRANSFER TECHNOLOGY

In view of higher transfer speed and the payment according to the amount of transmitted data and not according to their transfer time the GPRS technology is highly suitable for the data transfer from observatories to the server of an institution carrying on their operation, in our case from the observatories BISK, MARI, POST and SNEC to the IRSM server. This fact enables to keep the permanent connection with the PCs at observatories and to transfer GPS data in accordance with a necessity. The connection works in both directions, so that it is possible to modify registration parameters, e.g. interval of the data storage on the hard disk from 1 second above. The protocol TCP/IP is used and the fixed IP address is allocated to every observatory. In this way it is ensured the higher safety of the data transfer during connections with the IRSM server.

Data transfers between the PC and the IRSM server were tested for several months. It was detected that the connection GPRS "freezes" from time to time and is restored after disconnection and repeated connection. For this reason on each PC the task scheduler is run that every UT midnight initiates a restart of the system. The origin of the "freezing" is not quite clear. After the PC installation at observatories this "freezing" cannot be identified. The problem could be connected with the GSM network loading and will be further solved with system operator cooperation.

In the present period entire RINEX data file stored during 24 hours on observatory PC is transferred to the IRSM server about 40 minutes.

5. CONCLUSION

The four contemporaneous permanent GPS observatories SNEC, BISK, MARI and POST operated by IRSM are working in self-controlled regimes and are secured against power failures. Their remote control and data transfer to the IRSM server are carried out by GPRS technology. The observatories are prepared for including into EUREF or IGS stations. Monitored data can be used not only in the frame of national or international research projects, but also for solutions of standard geodetic tasks. The fifth permanent observatory will be established in South Bohemia.

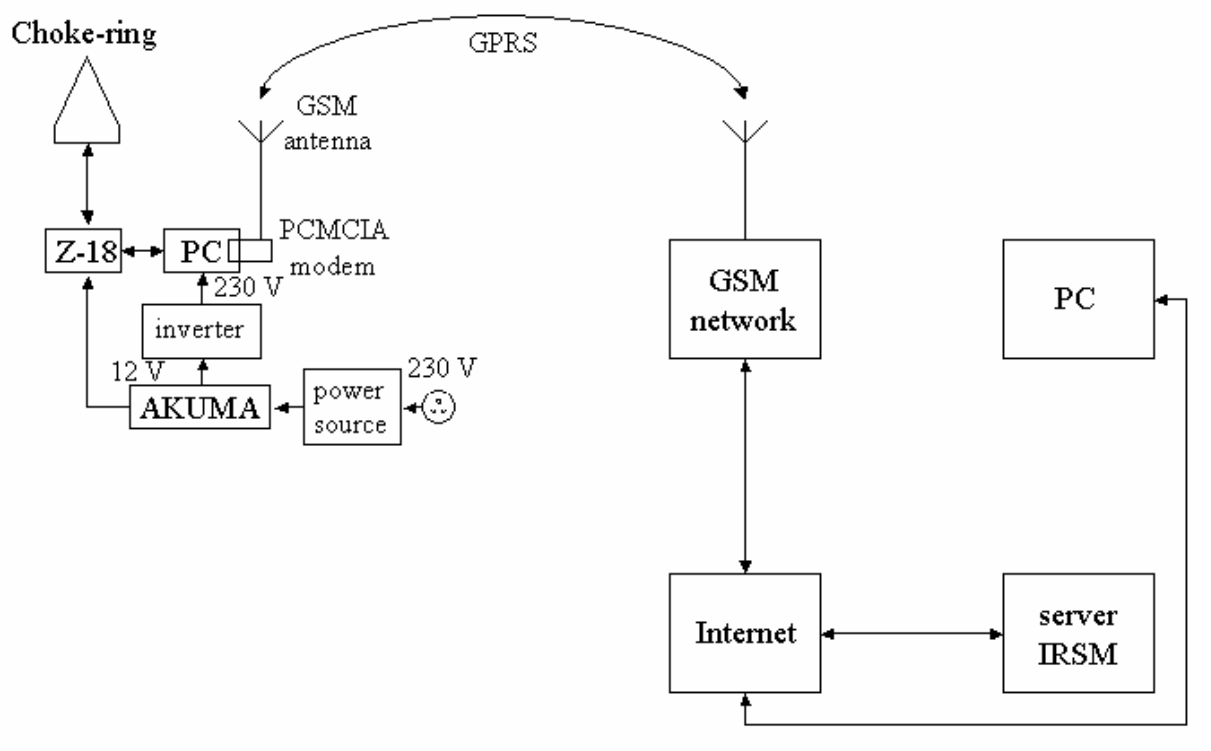

Fig. 2 Scheme of observatory equipment connection with the IRSM server and the control PC

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