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TRANSMISSION OF CONTINUOUSLY RECORDED DATA FROM REMOTE GPS PERMANENT STATIONS TO IRSM CENTRAL UNIT

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ABSTRACT
Within activities of the Centre of Earth Dynamic Research, Institute of Rock Structure and Mechanics Academy of Sciences CR (IRSM), five permanent GPS observatories were established to the purpose of geodynamic studies of the Bohemian Massif. Their positions in the Massif were set up with respect to its geological structures and the existence of already operated GPS observatories as well as position of the IRSM networks for GPS epoch measurements. The IRSM GPS observatories are situated at the following sites:

a) SNEC – at a top of the Sněžka Mt., the highest point of the Czech Republic, in operation since 2001,
b) BISK – on a stone watchtower at the Biskupská kupa hill near Zlaté Hory, in operation since 2001,
c) MARI – on the chimney of building in Mariánská village near Jáchymov located at the eastward wing of the seismoactive Mariánské Lázně tectonic zone, in operation since 2003,
d) POST – at a roof of panel house in Poustka village near Františkovy Lázně situated at the opposite westward wing of the same tectonic zone, in operation since 2003, and
e) VACO – at a roof of panel house in Vacov near Vimperk, in operation since 2004.

The observatories SNEC and BISK are linked to WEST and EAST SUDETEN regional geodynamic networks to ensure reasonable movement evaluations detected on network sites during individual annual epoch GPS measurements. The observatories MARI and POST are close to the German GPS observatories Grünbach (GRNB) and Neustadt (NEUS) to monitor geodynamic motions along the seismoactive Mariánské Lázně fault zone in the west part of the Bohemian Massif. The observatory VACO is located on an opposite side of the shear zones of the Bavarian Pfahl with respect to the EPN German observatory Wettzell (WTZR). All IRSM observatories are equipped with Ashtech Z-18 receivers and precise choke-ring Ashtech antennas that allow both NAVSTAR and GLONASS satellite signals to be monitored. Moreover, the BISK observatory is equipped with meteorological sensors for temperature, atmospheric pressure and relative humidity registrations. The observatories are connected on-line to the IRSM centre to transmit hour-data observed to the centre. The remote control of the observatories, continual GPS data transmission from observatories to IRSM server and routine data processing will be presented.

KEYWORDS: permanent GPS observations, EUREF network, the Bohemian Massif, geodynamics

1. INTRODUCTION

Institute of Rock Structure and Mechanics Academy of Sciences CR (IRSM) operates at present five permanent GPS observatories. The main purpose of these observatories is to monitor geodynamic motions at the region of the Bohemian Massif (Schenk, 2002; Schenk at al., 2004a, 2004b, 2005).

The permanent GPS observatories IRSM were set up since 2001. First two observatories were located in the territories of the epoch GPS regional networks, the observatory Biskupská Kupa (BISK) in the area of the East Sudeten network (Schenk at al., 2002a) and the observatory Sněžka (SNEC) in the area of the West Sudeten network (Schenk at al., 2000; Schenk at al., 2001; Schenk at al., 2002c).

In 2003 two other observatories were set up in the west Bohemian seismoactive region, the observatory Mariánská (MARJ) and Poustka (POUS). The fifth observatory Vacov (VACO) operates since October 2004 in Southern Bohemia.

The observatories BISK, MARJ, SNEC and VACO are involved in the EUREF permanent network (EPN). At present the station POUS is operating as a candidate for the EPN.

On-line data delivery from the stations is necessary to comply with the rules for data exchange within EUREF permanent stations. In consequence an operational centre at IRSM (IRS) was established that provides the necessary data downloading, checking, archiving and delivery.

Fig. 1 Antenna position at the chimney of the Česká Poštovna building - station SNEC.

Fig. 2 The BISK permanent station.

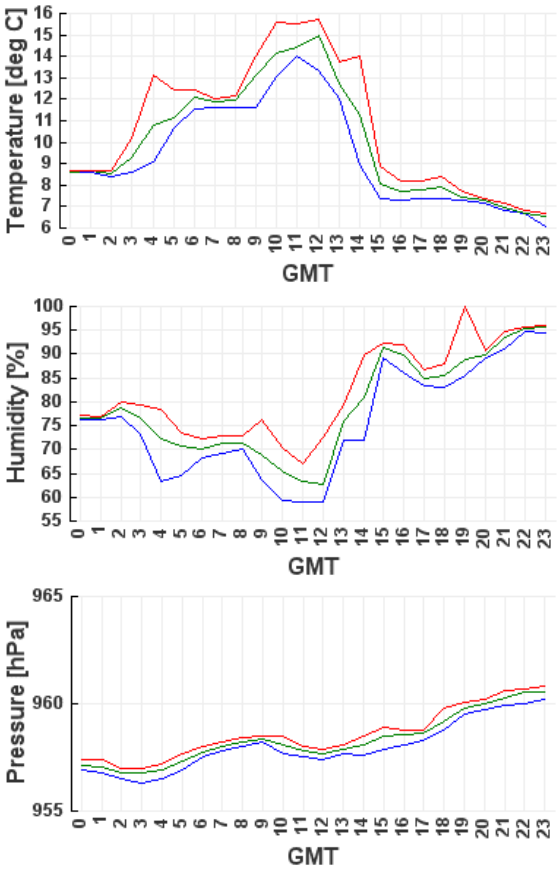

Fig. 3 Examples of hourly minimum, average and maximum measured temperatures, humidity and air pressures at station BISK.

2. OVERVIEW OF CURRENTLY OPERATING IRSM GPS STATIONS

Permanent GPS station SNEC is located on the Sněžka Mt., the highest mountain of the Czech Republic at more than 1600 meters above sea level. The GPS antenna is at present sited on the unused reinforced chimney of the small house of Česká Poštovna (Fig. 1). The previous position of the antenna was at the 8 meters high geodetic pilot on top of the mountain. The antenna had to be moved because of extreme climatic conditions. Simultaneous measurements were performed to join both antenna positions on the Sněžka Mt. (Schenk et al., 2002b, Cacoń et al. 2004). The observatory Sněžka operates continuously since August 2001.

The permanent GPS station BISK was set up at the beginning of September 2001 on top of the Biskupská Kupa hill to the east from Zlaté Hory town, district of Jeseník. The antenna is located on the concrete block 40x40x60 cm at the top of a stone tower (Fig. 2). The meteorological equipment for registering air temperature, relative humidity and atmospheric pressure operates at the BISK station.

Meteorological parameters at the BISK station are stored in Meteo RINEX data files every 30 seconds (Fig. 3).

Fig. 4 The MARJ permanent station.

Fig. 5 The POUS permanent station

Fig. 6 Antenna location at the VACO permanent station.

The third IRSM GPS station MARJ is sited on the unused chimney of the Institute building in Mariánská village near Jáchymov town (Fig. 4). The MARJ station was set up in May 2003.

The observatory POUS operates since October 2003 and is located in Poustka village near Františkovy Lázně town, district of Cheb. The antenna is positioned on the flat roof of a block of flats (Fig. 5).

Similar location of the antenna on the roof of a block of flats was chosen for the fifth station VACO in Vacov near Strakonice. The station operates since October 2004 (Fig. 6).

3. PERMANENT STATION EQUIPMENT AND PRINCIPLES OF OPERATION

All five permanent GPS stations IRSM are equipped with Ashtech Z18 receivers and Ashtech Choke Ring antennas with snow domes. The receiver Z18 allows signals from NAVSTAR as well as GLONASS satellite systems to be registered. Because of no internal memory in the Z18 receiver, it has to be connected directly to the station's computer and monitored data are registered directly on the computer hard disk. The communication between the receiver and the station computer is provided using the original Ashtech Geodetic Base Station Software (GBSS). All receiver's and registration parameters can be set up from the GBSS and that makes it possible to apply changes on request. The receiver is set according to EPN rules for data registration with 5º elevation mask and the recording interval is set to minimum of 30 seconds. The data are stored in combined RINEX files containing registered signals from NAVSTAR as well as GLONASS satellites.

After data storing on the internal PC hard disk, they are transferred automatically to the data centre in IRSM (IRS). Internet connections from the stations to the IRS are used. The station BISK is connected via WiFi, all the other stations are equipped with the GPRS modem to provide the Internet connection (Kottnauer et al., 2003).

Data delivery from the station to the IRS centre is provided by the RSYNC protocol (Linux RSYNC command). Every 4 minutes new RSYNC session starts automatically at the IRS server to synchronize the recorded data with the station directories. The RSYNC protocol operates so that only newly monitored data are transmitted from each station and provides an automatic compression of transmitted data. This approach provides very effective use of connection capacity, so that hourly RINEX data are available at the IRS centre within 1-2 minutes after each full hour even if slow GPRS connection is used.

To avoid problems with electrical power failures at the stations, each station is equipped with a spare battery, which can power the station receiver as well as the computer independently for at least 24 hours.

4. DATA PROCESSING OVERVIEW IN THE OPERATIONAL CENTRE IRS

When hourly data are delivered to the IRS data centre, a routine check is performed using standard TEQC procedure (Estey et al., 1999). In case of any problem, incorrect data will be invalidated and new synchronization with a given station is performed. Data files that passed all tests correctly are stored according to the IRS centre rules and registered in the IRS database. Then hourly data are submitted to the EPN data centres and can there be publicly accessed as so called near-real-time data.

When all 24 hourly data files are present in the IRS data centre, automatic merging procedure combines final daily data and submits them to the EPN data centres. Usually this procedure takes place after 1:00 GMT and the data are publicly available about 5-30 minutes later depending on the procedure at the corresponding EPN data centre.

Thorough data flow monitoring and data quality mapping is available at the IRS data centre too. The operators have to have full on-line overview of the data transmission and processing procedures using the user-friendly web interface. Thanks to this any transmission problems as well as problems with data quality at any permanent station can be discovered immediately. The operators can see this web interface easily on the Internet and take any action necessary to return to normal operations (Fig. 7).

5. CONCLUSION

The five permanent GPS stations IRSM AS CR are recording high quality GPS data at well chosen and built sites. They provide precise reference frame for GPS measurements especially for geodynamic studies. The data registered by these stations are available on the EUREF EPN data centres BKG and OLG mostly within 1-2 minutes after every hour the registration is completed.

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REFERENCES

Cacoń, S., Schenk, V., Mąkolski, K., Kaplon, J., Schenková, Z. and Kottnauer, P.: 2004, Analysis of mutual positions of geodetic observation points situated on the Sniezka mountain based on GPS and total station technologies. Acta geodynamica et geomaterialia, 1, No. 3(135), 69-73.

Estey, L.H. and Meertens, C.M.: TEQC: 1999, The Multi-Purpose Toolkit for GPS/GLONASS Data, GPS Solutions (pub. by John Wiley & Sons), 3, No. 1, 42-49.

Kottnauer, P., Rucký, A., Schenk, V. and Schenková, Z.: 2003, Note to remote control of GPS observatory using GSM modem. Acta Montana, Series A, No. 24(131), 163-165.

Schenk, V., Cacoń, S., Bosy, J., Kontny, B., Kottnauer P. and Schenková, Z.: 2000, GPS network "SUDETEN". Preliminary results of the campaigns 1998-1999. Reports on Geodesy, 53, No. 7, Warsaw University of Technology, Warsaw, 25-33.

Schenk, V., Cacoń, S., Bosy, J., Kontny, B., Kottnauer, P. and Schenková, Z.: 2002a, The GPS geodynamic network EAST SUDETEN – Five annual campaigns (1997-2001), data processing and results. Acta Montana, Series A, No. 20 (124), 13-23.

Schenk, V., Kottnauer, P and Schenková, Z.: 2004a, Permanent GPS observatories operated by IRSM AS CR (in Czech). In: Sborník Semináře s mezinárodní účastí "Současný stav a vývoj bodových polí" , FAST VUT v Brně, ECON Brno, 55-59.

Schenk, V., Kottnauer, P., Schenková, Z. and Hájek, P.: 2004b, Czech permanent GPS observatories for geodynamic investigations of the Bohemian Massif operated by the Institute of Rock Structure and Mechanics, Prague. Acta geodynamica et geomaterialia, 1, No. 3 (135), 111-114.

Schenk, V., Kottnauer, P., Schenková, Z., Rucký, A., Pšenička J. and Řehák, J., Jr.: 2002c, Regional geodynamic network WEST SUDETEN. A westward wide-ranging extension of present EAST SUDETEN network. Acta Montana, Series A, No. 20 (124), 31-35.

Schenk, V., Kottnauer, P., Schenková, Z., Rucký, A., Pšenička, J. and Řehák, J., Jr.: 2002b, New permanent GPS observatories in the Czech Republic – SNĚŽKA and BISKUPSKÁ KUPA. Acta Montana, Series A, No. 20 (124), 41-44.

Schenk, V., Mantlík, F., Kottnauer, P. and Schenková, Z.: 2005, Permanent GPS observatories of the Institute of Rock Structure and Mechanics AS CR and their applications in needs of standard geodetic practice (in Czech). In Sborník Semináře s mezinárodní účastí "Vývoj metod a technologií GPS v geodézii", FAST VUT v Brně, ECON publishing s.r.o., Brno, 95-99.

Schenk, V., Schenková, Z. and Kottnauer, P.: 2001, A few remarks to GPS SUDETEN network data evaluation in relation to the EUREF stations (in Czech). In: Regional Conference with International Participation „Seismology and Engineering Geophysics – Past, Present and Future", (Ed. Z. Kaláb), Inst. of Geonics, Acad. Sci. Czech Rep., Ostrava-Poruba, 166-176.

Schenk, V: 2002, Geodynamics of Central Europe based on observations of the GPS EUREF stations. Geophysical Research Abstracts 4.

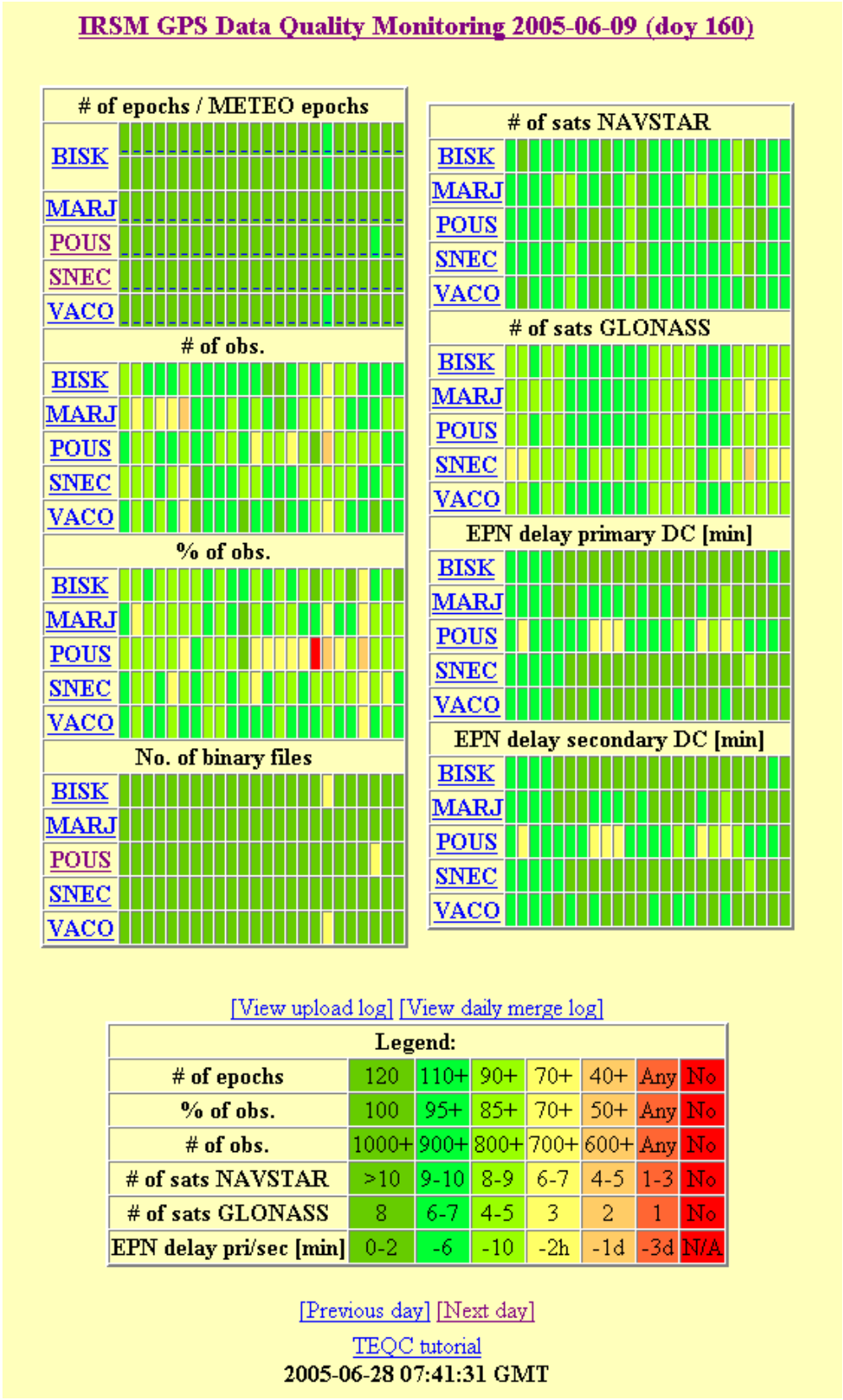

Fig. 7 WWW data quality interface check – sample of quality maps.