Monitoring of high-frequency positional variations by using GPS and its potential applications in geophysics

Ján Hefty, Ľubomíra Gerhátová, Juraj Papčo

Slovak University of Technology[1]

Abstract: For detection of long-term positional changes of the well-monumented sites located at earth's surface are nowadays exclusively used the observing techniques based on processing of signals broadcasted by satellites of Global Navigation Satellite Systems, mainly by the U.S Global Positioning System. Monitoring and analysis of long-term phenomena and the periodic variations with seasonal and diurnal frequencies is usually based on 15 s or 30 s sampling of GPS data. Such rate is sufficient for reliable detection of variety geodynamic or anthropogenic signals. Their interpretation is influenced predominantly by long-term biases, like effects of reference frame, GPS receiver and antenna changes, site environment variability, etc. The recent geodetic receivers allow performing GNSS observations also with significantly denser rate than 15 s. The usual standard is recording with 1 Hz frequency but some receivers have possibility of frequencies up to 50 Hz observations. Such recording is resulting to nearly continuous trajectory of the positional changes.

Practical application of high-frequency GPS observations are in monitoring of the points affected by seismic activity, monitoring the volcanoes, wind blowing effect, etc. The observed phenomena are manifested in short time intervals (from seconds to several minutes, eventually hours). The measurements are strongly affected by short-term acting disturbing phenomena, like multipath, short-term instability of satellite and receiver clocks, short-term variability in the ionosphere and troposphere, etc. Another problem that has to be taken in account is the structure of random noise, which is different in high frequency domain than in hourly or daily resolution.

[1] Department of Theoretical Geodesy, Faculty of Civil Engineering, SUT, Radlinského 11, 813 68 Bratislava, Slovakia, jan.hefty@stuba.sk, lubomira.gerhatova@stuba.sk, juraj.papco@stuba.sk

In the paper are presented results of experimental observations performed on the objects with extreme short-term positional variations as well as their analysis and interpretations. The role of processing strategy, software performance, filtering of random noise and reduction of ionosphere effect is investigated in detail. The potential of recording the seismic related phenomena is discussed.

Key words: 1 Hz GPS data recording and analysis, high-frequency biases, filtering and smoothing of time series of horizontal position variations

References

Dach, R., Hugentobler, U., Fridez, P., Meindl, M., 2007. (eds.): Bernese GPS Software Version 5.0. Astronomical Institute, University of Berne. 612 p.

Larson, K., Bodin, P., Gomberg, J., 2003: Using 1 Hz GPS data to measure deformations caused by the Denali Fault earthquake, Science, **300**, 1421-1424.