SUB-DAILY SITE COORDINATES VARIATIONS IN EUREF PERMANENT NETWORK

Jan Hefty, Marian Kovac, Miroslava Igondova, Michal Hrcka

Department of Theoretical Geodesy, Slovak University of Technology,
Faculty of Civil Engineering, Radlinskeho 11, 813 68 Bratislava, Slovak Republic
Tel.: +421 2 5927 4533, Fax: +421 2 5292 5476
E-mail: jan.hefty@stuba.sk

ABSTRACT

The sub-network of EUREF Permanent Network (EPN) analysed at Local Analysis Centre at Slovak University of Technology (LAC SUT) is besides the routine processing analysed also in 4-hour batches to allow investigation of sub-daily coordinate variations of monitored sites. In the paper are described main features of the processing method and discussed results from almost one-year interval observations for 22 sites.

1. ITRODUCTION

The set of 30 EUREF permanent GPS network stations processed at Local Analysis Centre at Slovak University of Technology in Bratislava is besides the standard 24-hour observing intervals analyzed also in 4-hour intervals. The network sites are distributed almost over the whole territory of the continent as is shown on Fig. 1. Processing of the sub-daily intervals applies similar strategy as for the 24-hour sessions. The only difference is that troposphere parameters and ambiguities for the 4-hour sessions are not estimated but adopted from 24-hour solutions. Corrections of ocean loading effects based on tidal maps of Schwiderski, Le Provost, Szeto and Flather (McCarthy, 1996, Hugentobler et al., 2001) are included in the processing. The sub-daily solutions yield the time series of site *X*, *Y* and *Z* geocentric coordinate variations. In this paper we analyse the 47 weeks interval (GPS weeks from 1182 to 1229) of 4-hour sessions for 23 stations for which the homogeneous, uninterrupted data were available.

2. PROCESSING AND ANALYSIS METHODS

The processing method of the 24-hour sessions strictly follows the rules applied for EUREF permanent network analysis. At LAC SUT the Bernese GPS software, version 4.2 (Hugentobler et al., 2001) is used. IGS orbits are applied for celestial reference frame realisation. The terrestrial reference frame ITRF 2000 in the period mentioned was realised by constraining Zimmerwald (ZIMM) actual position as reference. The 4-hour sessions are separately adjusted limiting only to site coordinates estimates. The resulting geocentric coordinates are transformed to local system with *n*, *e*, and *up* components and reduced for the mean site position. The example of 7 days of sub-daily series showing variations up to 10-20 mm in all three local components is in Fig. 2.

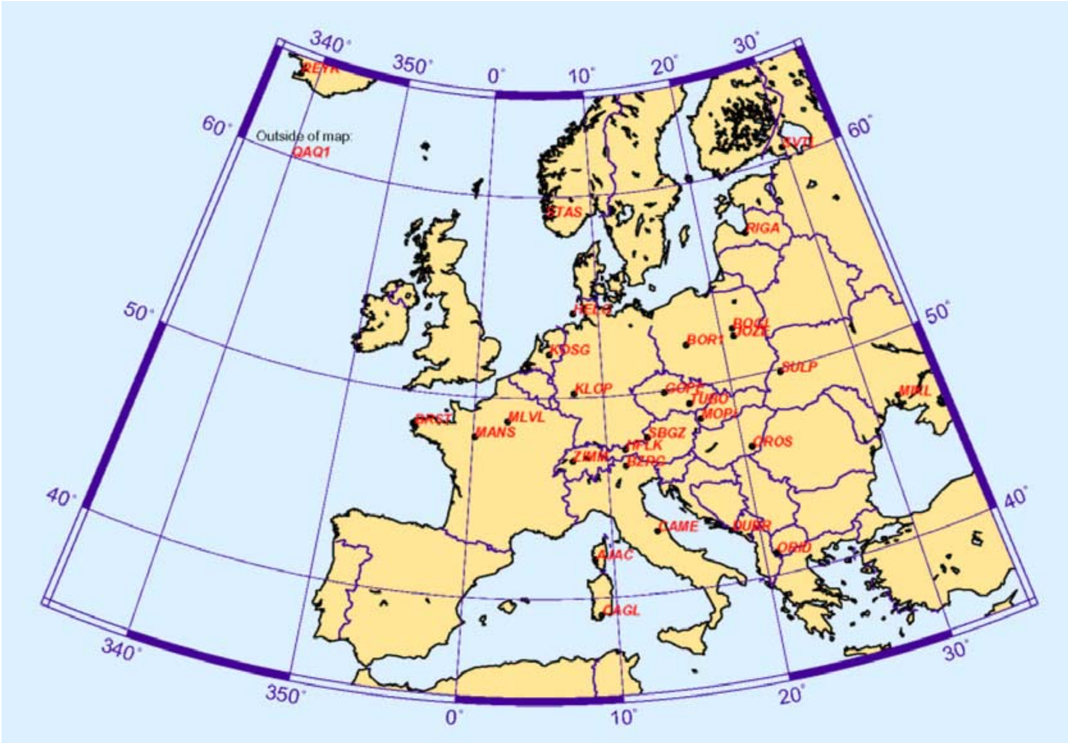

Fig. 1 EPN stations analysed and LAC SUT in Bratislava

The time series comprising of nearly 2000 values of coordinates *n*, *e* and *up* for each station were analysed in two ways:

- Time series approach: separate analysis of *n*, *e* and *up* components at each site. Firstly the series are smoothed by Vondrak's method (Vondrak, 1969), then the spectral analysis of high frequency residuals is performed.
- Least-squares approach: simultaneous estimate of linear trend, and sine and cosine terms for annual, semi-annual, diurnal (K1, S1, P1, O1) and semi-diurnal (M2, K2, S2) frequencies for all the network stations.

3. RESULTS

Typical example of spectral analysis of high-frequency site coordinate variations is shown in Fig. 3. All the analysed stations have similar spectra pattern. The spectra of KOSG station clearly show that dominant peaks are exclusively in diurnal and semi-diurnal bands. Amplitudes from 0.5 to 1.5 mm for terms with diurnal tidal frequencies K1, S1, O1 and semi-diurnal frequencies M2, K2 and S2 are typical for majority of stations. Remarkable is the fact that the amplitudes in *up* component are of the same magnitude as amplitudes in *n* and *e* components. It is worth to mention that all the site variations are of relative character as the network solutions are referenced to one site ZIMM.

In Fig. 4 are displayed amplitudes of *n*, *e*, and *up* variations with diurnal S1 and O1 frequencies for 22 sites. The bottom part of each bar represents one-sigma uncertainty. The S1 variations, which are significant for all the stations could be associated with troposphere and ionosphere mismodelling,

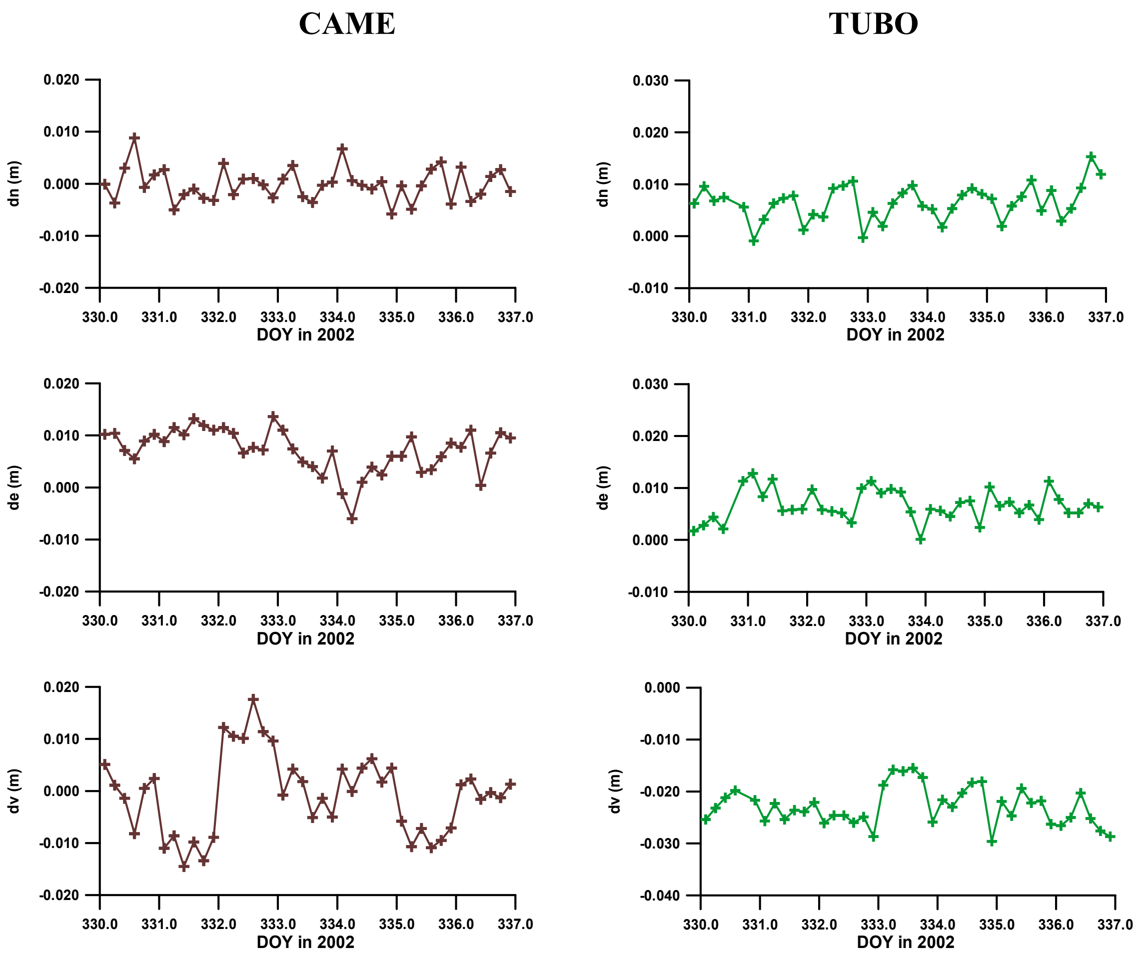

Fig. 2 Sub-daily coordinates variations of CAME and TUBO stations for 7-day interval

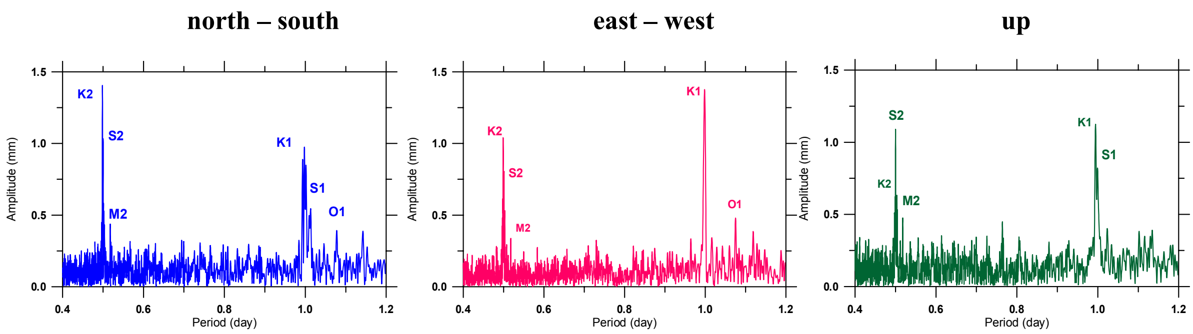

Fig. 3 Spectra of high-frequency residuals for KOSG stations

thermal effects, and other strictly diurnal phenomena. The O1 wave could reflect the unmodelled ocean loading effects, however the amplitudes for *e* and *up* components are at the noise level.

In Fig. 5 are represented amplitudes of semi-diurnal K2 and M2 waves. The origin of K2 wave, which is significant for all the sites, is spurious as the both solid earth tides and oceanic tidal loading have small theoretical amplitudes. The only relevant phenomenon with K2 frequency is related to orbiting of GPS satellites. The M2 variations could be associated with unmodelled ocean loading.

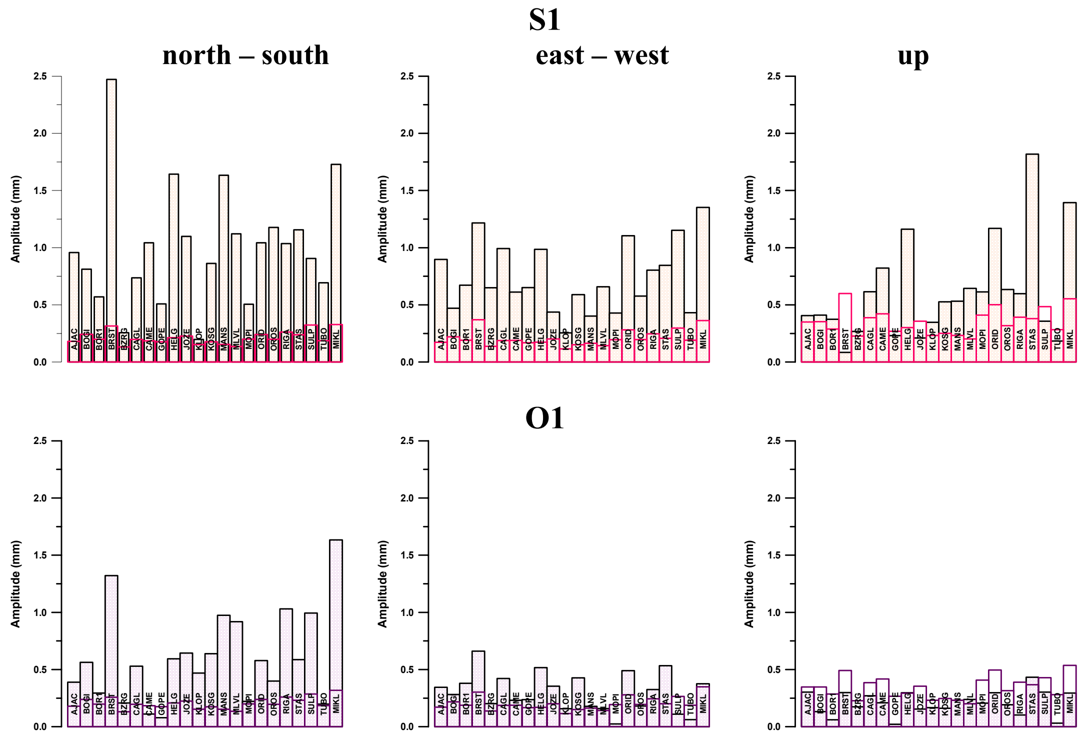

Fig. 4 Amplitudes of diurnal variations with S1 and O1 frequencies

4. CONCLUSIONS

Processing of permanent GPS observations with sub-daily resolution clearly shows the presence diurnal and semi-diurnal signal in station coordinate series. In the high-frequency part of the spectra at all the stations the variations with tidal periods K1, S1, O1, K2, S2 and M2 dominate. The question if the observed diurnal and semi-diurnal variations reflect the short-term site movements or are only an artefact due to processing and reference frame shortcomings is still open.

***ACKNOWLEDGEMENT*:** This work was supported by grant No. 1/1033/04 of the Grant Agency of Slovak Republic VEGA.

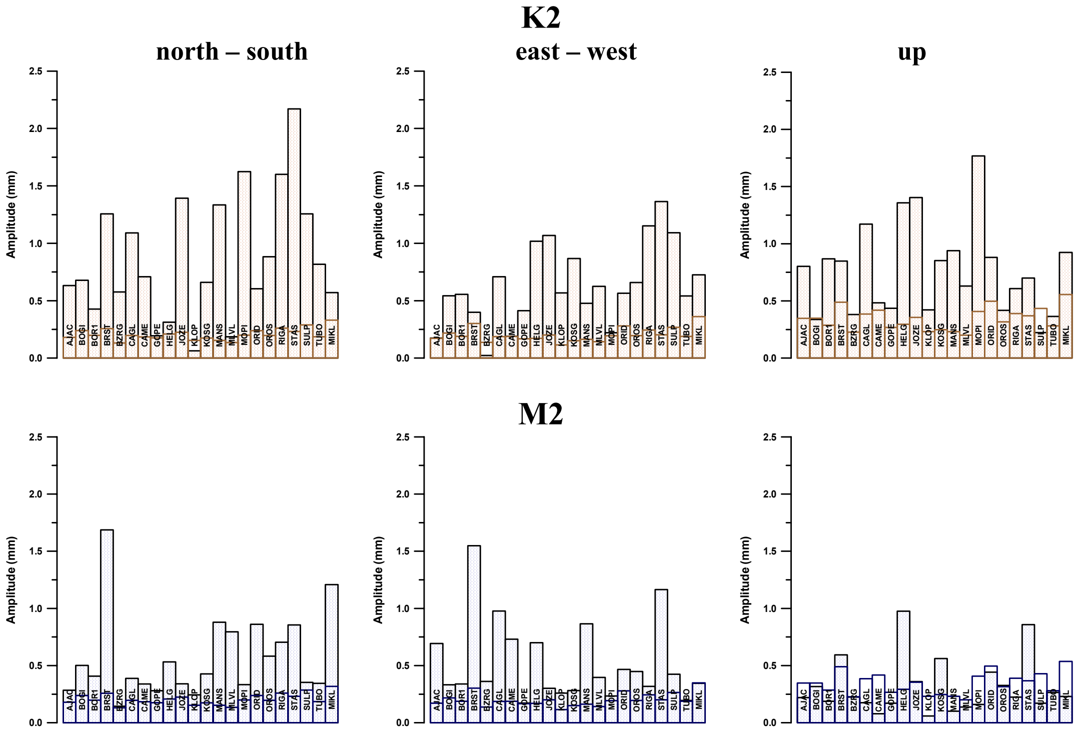

Fig. 5 Amplitudes of semi-diurnal variations with K2 and M2 frequencies

REFERENCES

HUGENTOBLER, U. – SCHAER, S. – FRIDEZ, P. (eds) 2001. *Bernese GPS Software Version 4.2*. Bern: Astronomical Institute, University of Berne. 515 p.

McCARTHY, D (ed.) 1996. *IERS Conventions 1996.* IERS Technical Note 21. Paris: Central Bureau of IERS, Observatoire de Paris, 1996. 95 p.

VONDRAK, J. 1969. A contribution to the problem of smoothing observational data. Bull. Astron. Inst. Czechoslovakia, 20, pp. 349-355.