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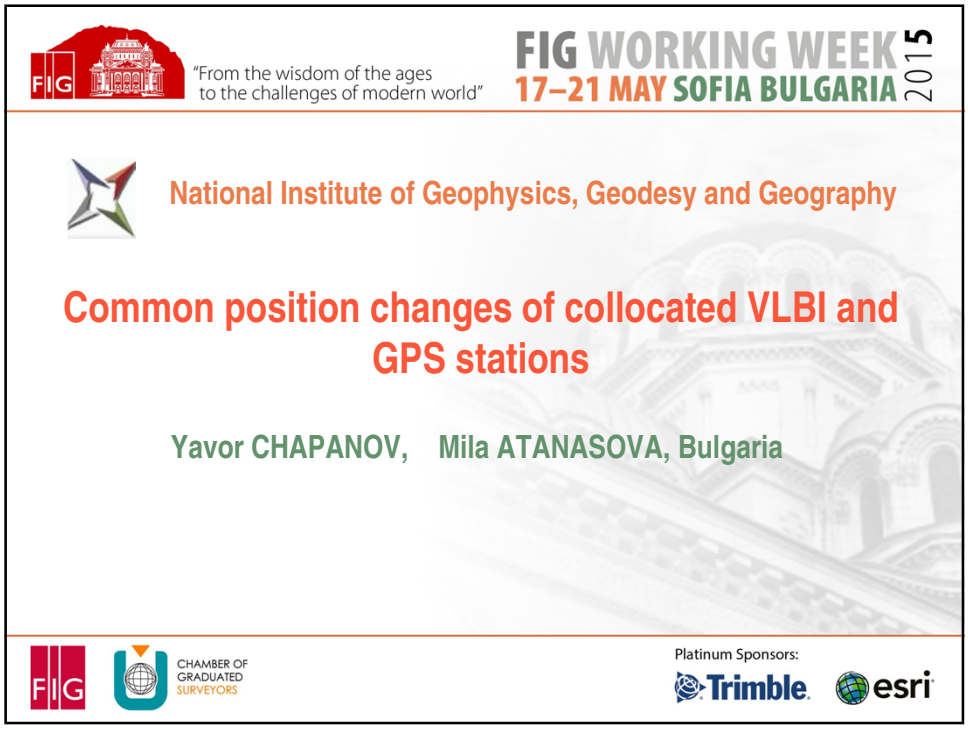
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National Institute of Geophysics, Geodesy and Geography
Common position changes of collocated VLBI and GPS stations
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SUMMARY

- The periodical and impulse variations of the coordinates of collocated VLBI and GPS stations at the observatory Wettzell are compared and analyzed.
- The data jumps are determined by means of a new useful high-sensitive method of impulse detection, which is able to estimate very small changes of mean data values and velocities. The periodical oscillations of the station coordinates are determined by means of partial Fourier approximation.
- The amplitudes and phases of common seasonal, interannual and 11-year variations of Wettzell VLBI and GPS stations are compared. This research may prove the reliability of modern geodetic time series and the possibility to use them in the field of various geodynamical investigations.

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INTRODUCTION

- The global changes play important role in all human activity. A significant part of the modern knowledge is obtained from the results of time series analysis. It is possible to study global changes by means of high density geodetic time series obtained by the space based techniques like GPS, VLBI, SLR etc.
- The VLBI and SLR observations from great number permanent stations with global location form large massive of high density geodetic data since 1983 and GPS observations - since 1993.
- The comparision of time sries variations of coordinates of colocated statins may help to determine the existence of systematics in modertn observational data and to prove the reality of periodical motions of the stations in different frequency bands and their connection with the real envirenmental changes.

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TIME SERIES AND DATA PROCESSING

GPS and VLBI time series

- The time series of collocated GPS and VLBI station coordinates are taken from IGN solution (Collilieux et al., 2007), applied to ITRF2008 station position residual time series.
- The latest IGN solution for ITRF2008 station position residual time series has advantage of uniform determination of all coordinates in a common reference frame, so many systematics, due to individual solutions of different space techniques, are avoided.
- The GPS and VLBI data from stations WETZEL are shown in Fig.1, where the VLBI time series cover the period 1983.9-2009.0 and GPS time series – the period 1997.0-2009.5, and only the common data from the period 1997.0-2009.0 will be processed.

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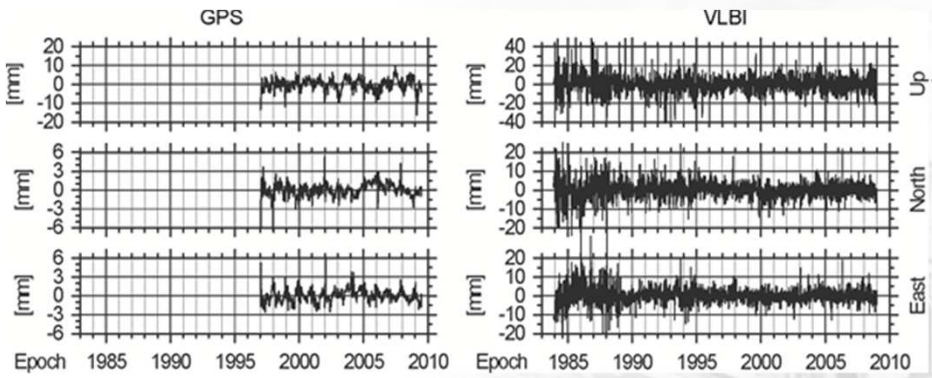

Figure 1. Time series of GPS and VLBI stations WETZEL.

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Data processing methods

The GPS and VLBI time series will be processed by well recommended methods:

- Normal point and moving average
- The Danish Method of robust estimation
- Method of Partial Fourier Approximation
- Method of impulse determination in time series

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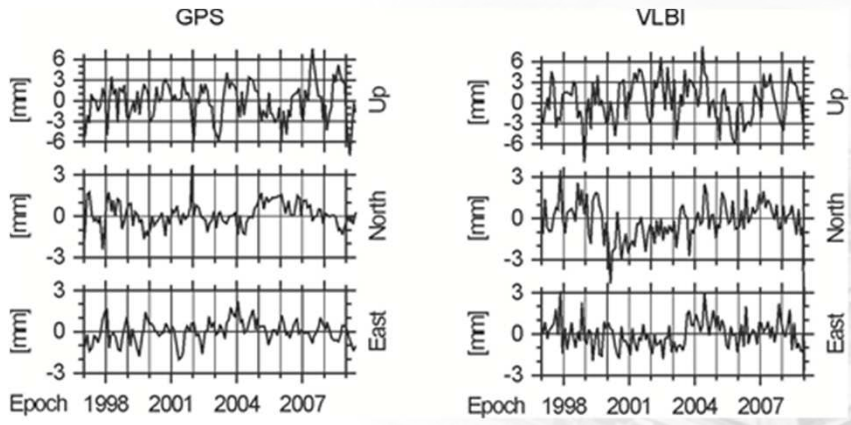

Figure 2. Normal points of GPS and VLBI stations WETZEL for the period 1997-2009.

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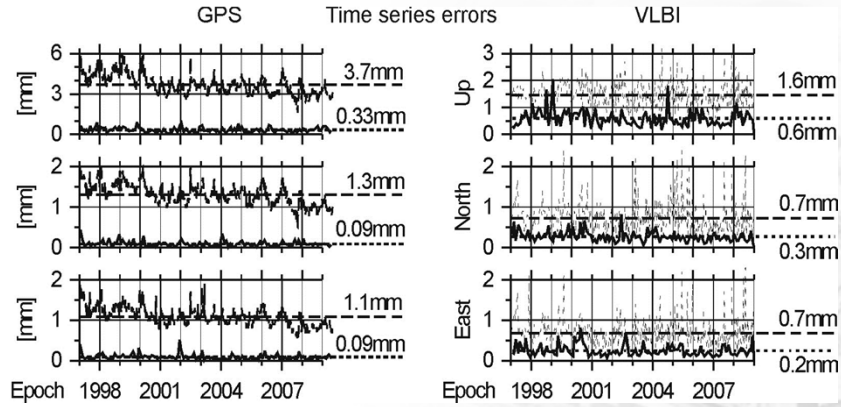

Figure 3. Time series errors of GPS and VLBI stations WETZEL for the period 1997-2009. The errors of the original data are denoted by dashed lines and errors of normal points – by bold lines. The mean values are marked by horizontal lines.

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COMMON VARIATIONS OF COLLOCATED VLBI AND GPS STATIONS

Time series spectra

- The amplitude spectra of coordinate time series variations are determined from the partial Fourier approximation of GPS and VLBI data, where the amplitudes *Ak* are determined from the Fourier coefficients *ak* and *bk* by the expression (7) and their errors are given in Table 1. All components have common seasonal oscillations. The Up components are expected to have common interannual cycles.

Coordinate	GPS [mm]	VLBI [mm]
North	0.03	0.14
East	0.02	0.12
Up	0.08	0.30

$$A_k = \sqrt{a_k^2 + b_k^2}$$

Table 1. Errors of estimated amplitudes *Ak* by the Least Squares Method.

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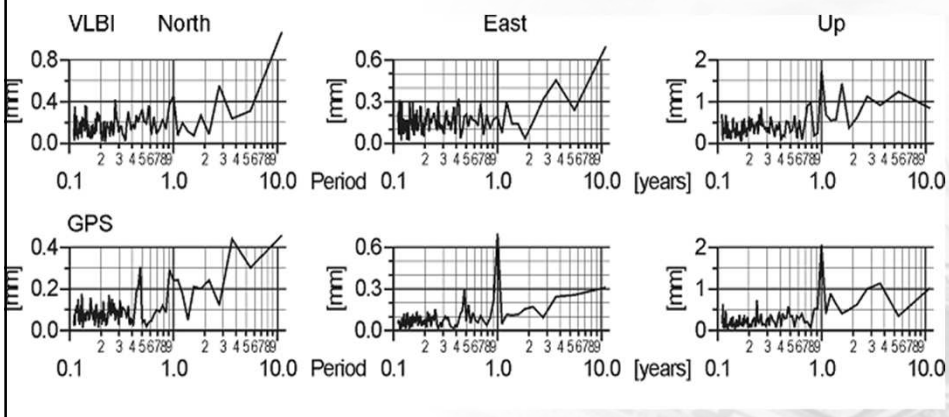

Figure 4. Amplitude spectra of VLBI and GPS stations WETZEL variations for the period 1997-2009.

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3.2. Mean station motions

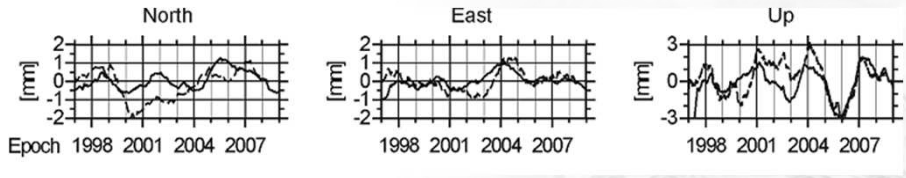

Figure 5. Mean motion of VLBI (dashed line) and GPS (solid line) stations WETZEL determined in 1-year moving window.

- Generally, a good agreement exists between the variations of the mean components of VLBI and GPS stations, especially for the component in East direction. Small differences exist between the mean components in North direction in 2000-2003 and 2005-2007. The mean vertical components have discrepancies during 2000-2005 due to shifted interannual oscillations

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Schwabe-Wolf cycle with 11-year period

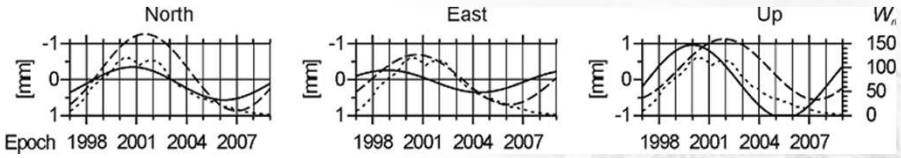

Figure 6. 11-year cycles of VLBI (dashed line) and GPS (solid line) stations WETZEL compared with the smoothed monthly mean Wolf's numbers the solar activity (dotted line).

•The phases of 11-year GPS and VLBI cycles are shifted by 1 year in North direction and by 2 years in East and Up directions. The VLBI oscillations better agree with the Wolf's numbers, so this is a signature of some disturbing systematic in GPS data.

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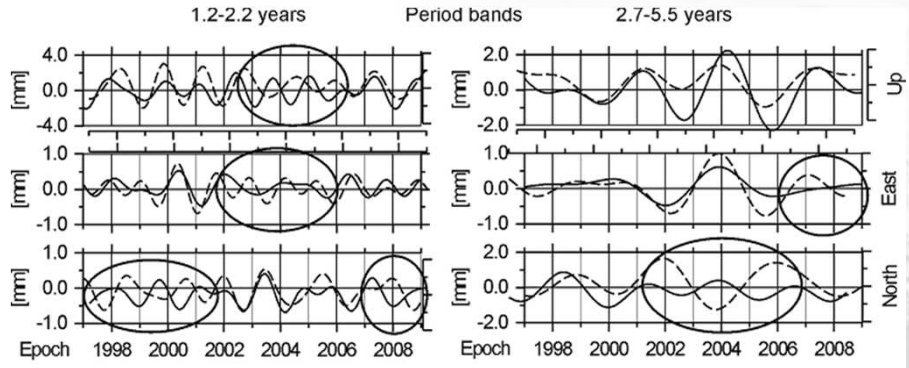

Figure 7. Interannual cycles of VLBI (dashed line) and GPS (solid line) stations WETZEL in period bands 1.2-2.2 years and 2.7-5.5 years. The ellipses surround parts with significantly discrepant variations.

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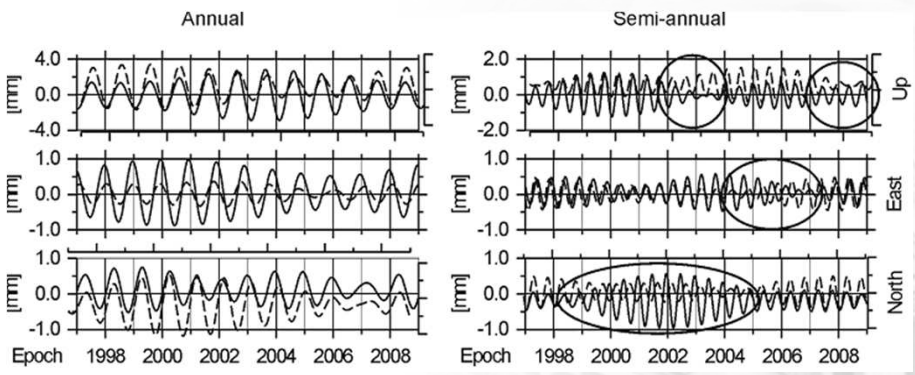

Figure 8. Annual and semi-annual cycles of VLBI (dashed line) and GPS (solid line) stations WETZEL. The ellipses surround parts with significantly discrepant variations.

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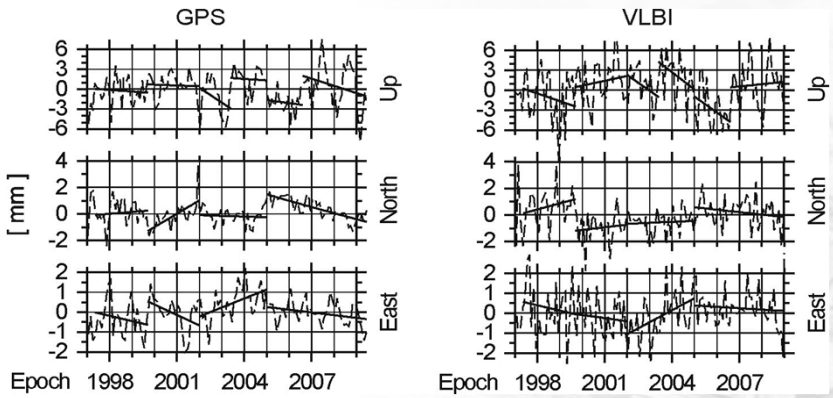

Figure 10. Impulse variations of time series of GPS and VLBI stations WETZEL for the period 1997-2009.

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CONCLUSIONS

- The time series of collocated GPS and VLBI stations WETZEL determined from the IGN solution in the ITRF2008 have significant common changes for the period 1997-2009.
- The mean station motions, determined by 1-year moving average expose relatively good agreement between the components of VLBI and GPS stations, especially for the component in East direction. Small differences exist between the mean components in North direction in 2000-2003 and 2005-2007. The mean vertical components have discrepancies during 2000-2005 due to shifted interannual oscillations.
- The 11-year oscillations of the coordinates of VLBI time series have good agreement with the smoothed monthly mean Wolf's numbers of the solar activity, while the 11-year GPS cycles expose significant phase shift due to systematic errors.
- Almost perfect agreement between seasonal GPS and VLBI variations exist according their phases, but the amplitude variations differ significantly.
- These impulse variations produce jumps of the mean data values up to 2mm for North and East components and up to 5mm for Up component. The corresponding velocity jumps are up to 1mm/year for North and East components and up to 2.4mm for Up component.
- We should note that at least part of seasonal, interannual and 11-year oscillation and all impulse variations of the WETZEL GPS and VLBI time series have a common origin connected with the external natural influences and these time series are suitable to detect and research small ground motion due to local and global geodynamical changes.

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