GPS Monitoring of the Footprint Network of the Fundamental Station Wettzell

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Summary. A footprint network in the vicinity of a fundamental station allows the monitoring of local instabilities. At the Fundamental Station Wettzell four footprint markers are observed continuously with GPS since 2001. The data spanning a period of 2.7 years are analyzed. The horizontal position is monitored with a daily repeatability of better than 1,5mm. The vertical component has a repeatability of 4mm. Such a permanent GPS network is well-suited to monitor the stability.

1 Motivation

Fundamental stations are important reference sites for the global reference frames in particular for the terrestrial reference frame as ITRF. Such a site represents an extended area for plate tectonic motions. Local instabilities or movements have an impact to the results and should be taken into consideration for the interpretation. Local control measurements are of importance to guarantee that no local effects influence the results and lead to wrong conclusions. For the monitoring of local motions, in addition to a local survey network for the determination of local ties, a footprint network has to be setup. Typically a footprint network with an extension of 20-30km should be established. Geodetic measurements have to be carried out periodically e. g. every two or three years with highest geodetic accuracy. Performing the observations is a tremendous amount of work, which requires a lot of manpower. Today permanent installed GPS receiver at footprint markers allow automatic and continuous monitoring of the sites with high accuracy and high resolution in time. Long time series of the station coordinates help to detect periodical signals and significant local movements. Such time series provides accurate information about the local stability in the vicinity of the fundamental station.

2 Footprint network at the Fundamental Station Wettzell

Since January 2001 additional permanent GPS receivers (ASHTECH ZXII) were installed at four locations around the Fundamental Station Wettzell which gather continuously 30s GPS data. Figure 1 shows the GPS footprint network. Separated by a distance of 7 km to 19 km from the permanent installed receiver at the station Wettzell (WTZZ), the stations Arber (ARBR), Miltach (MILT), Hohenwarth (HOWA) and Prackenbach (PRAC) operate routinely.

The station heights vary between 488m and 1505m. Figure 2 shows the network geometry with respect to the height differences between the stations.

The data are transmitted to a server and stored for further analysis.

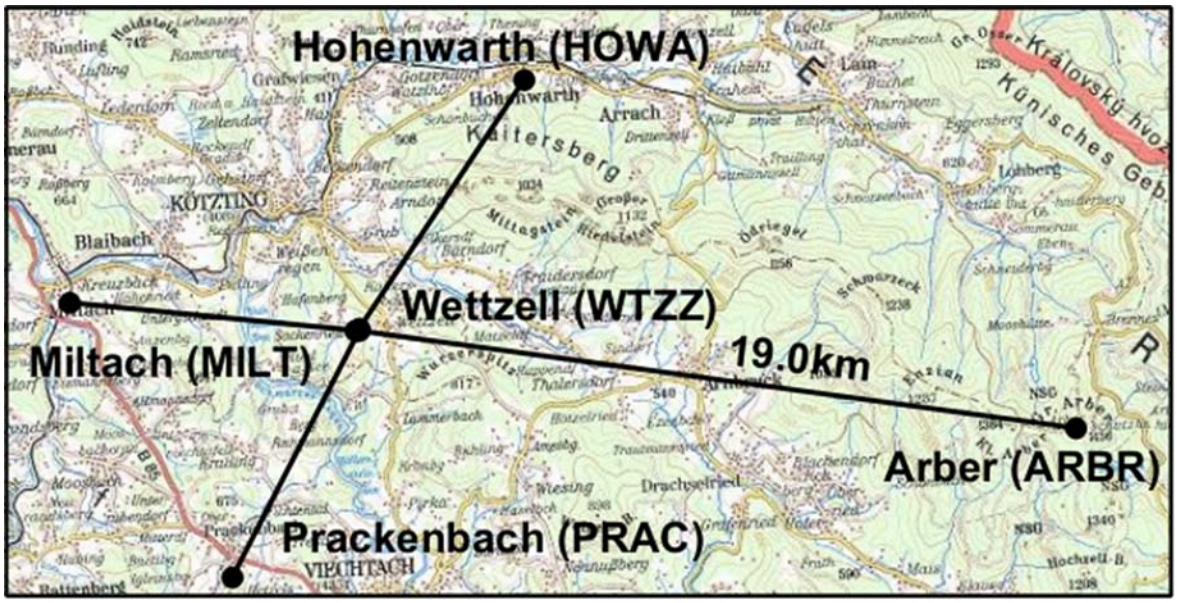


Fig. 1: GPS Footprint Network in the vicinity of the Fundamental Station Wettzell

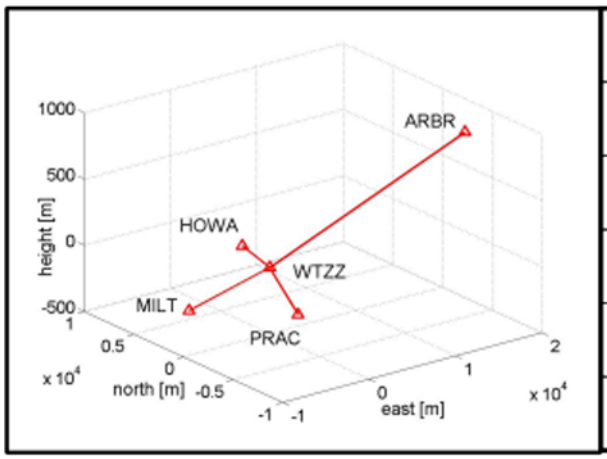
3 Data Analysis

In the frame of a thesis performed at the Technical University of Munich, the data were analysed and routines for further continuous analysis were set up [1]. The Bernese GPS Software 5.0 was employed, which allows the automatic processing of the data. All data observed in the period from 01.01.2001 to 09.08.2003 (2.7 years) were analysed. Figure 3 shows the analysis strategy for daily solutions.

4 Results

Figure 4, 5 and 6 show the time series of the stations ARBR, HOWA, MILT and PRAC of the north-, east- and height-component with respect to the station WTZZ , which has been kept fixed.

The repeatability of the daily solutions for the stations HOWA, MILT and PRAC is a factor of two better than the repeatability of the station ARBR. The explanation is that the antenna at the station ARBR is housed under a large radom of a radar system, which has been used previously by the military. As the infrastructure at the station ARBR is provided by the military, we accept the higher noise in the data due to our dependence on the support.



Station	Station Height
ARBR	1505 m
HOWA	562 m
MILT	488 m
PRAC	588 m
WTZZ	665 m

Fig. 2: Height differences between the footprint station

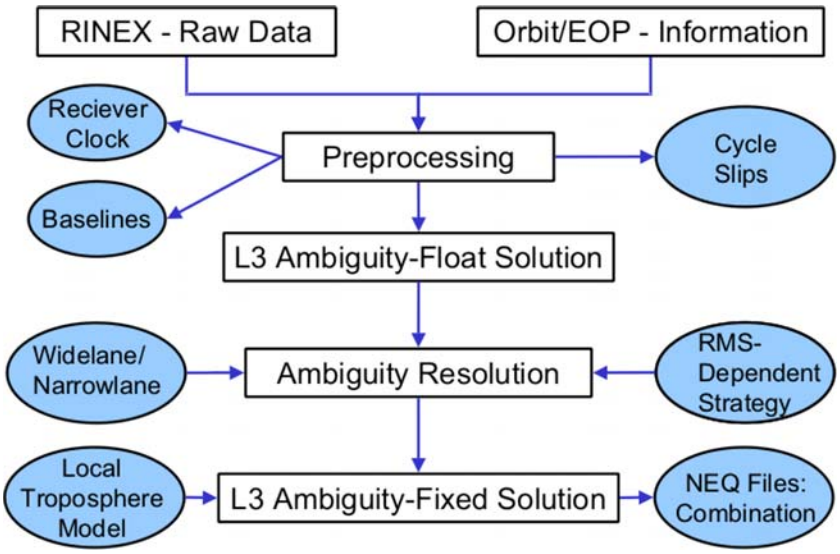


Fig. 3: Analysis Strategy for daily solutions

Figure 5 shows the repeatability of the east components of the stations. A periodic effect occur for the stations HOWA and MILT with an amplitude of approximately 2mm. The reason is unknown. It might come from seasonal motions of the stations, e.g. due to deformations of the buildings which houses the antennas.

Figure 6 shows the repeatability of the height components. The r.m.s values of the height components are by a factor of approximately 3 worse compared to the north- or east-components.

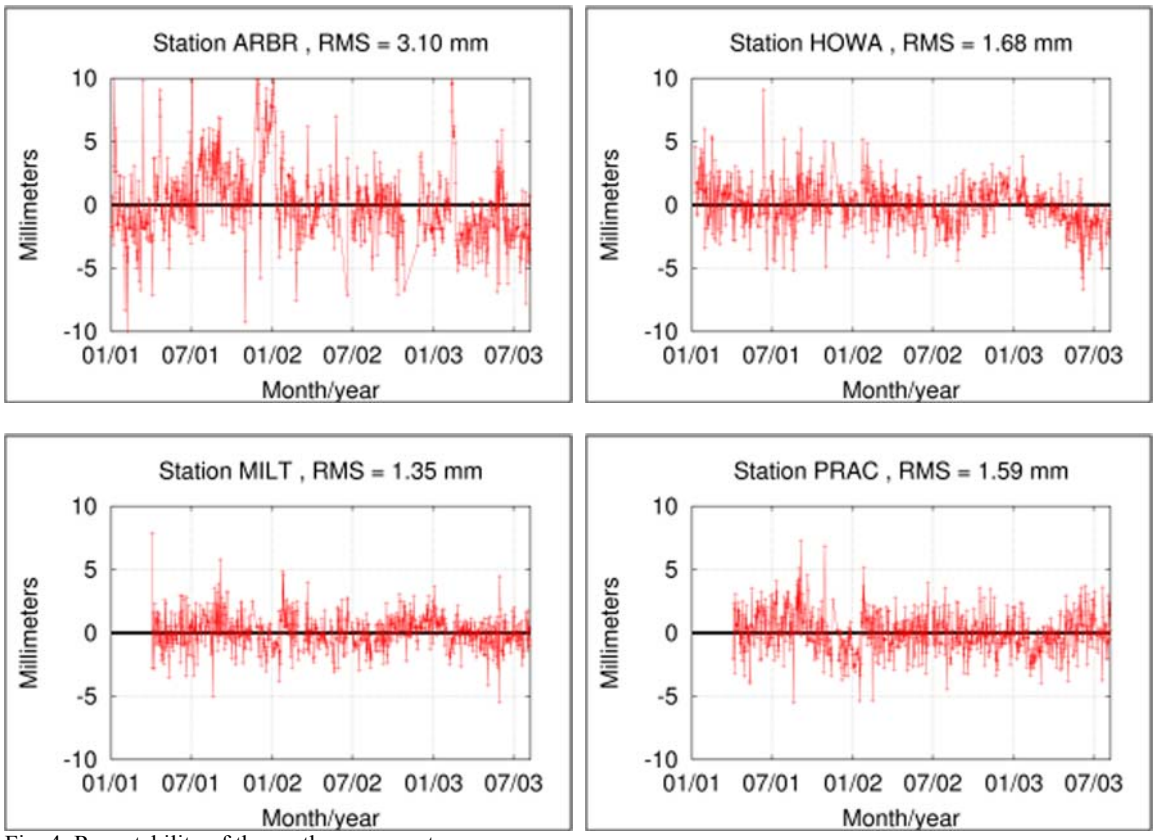


Fig. 4: Repeatability of the north component

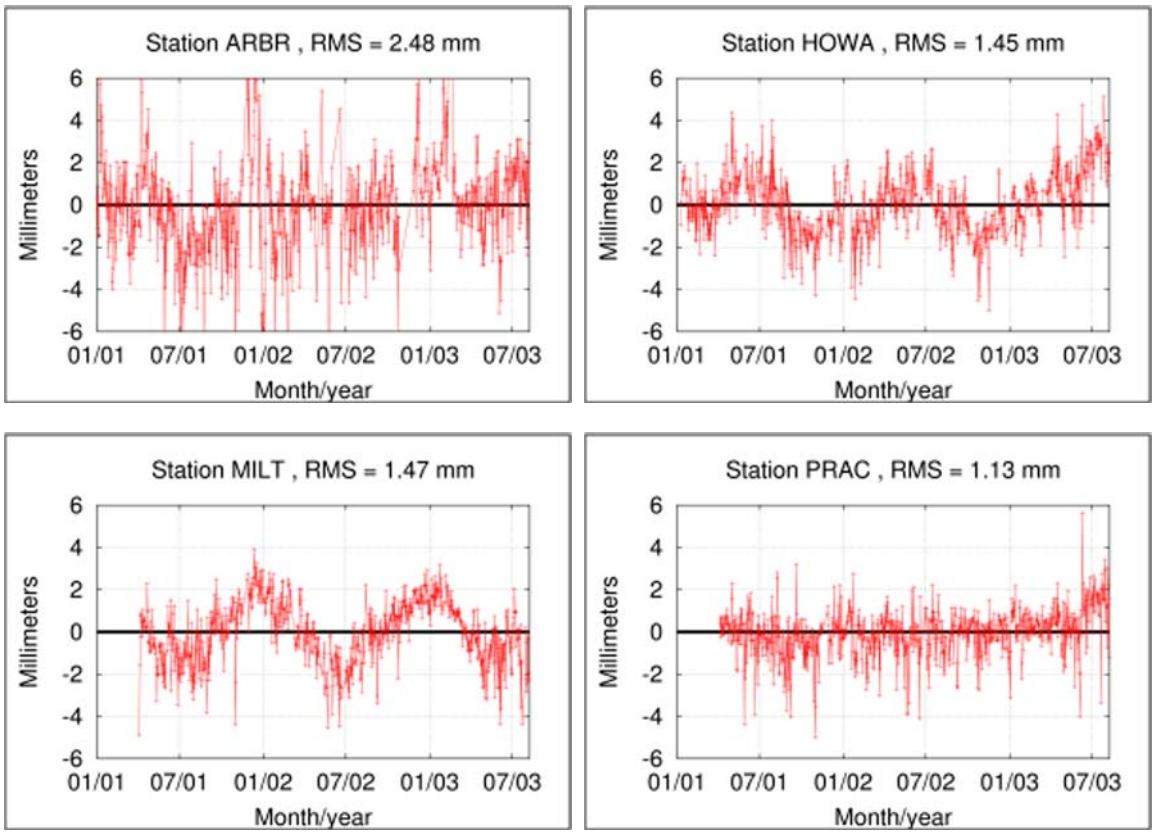


Fig. 5: Repeatability of the east components

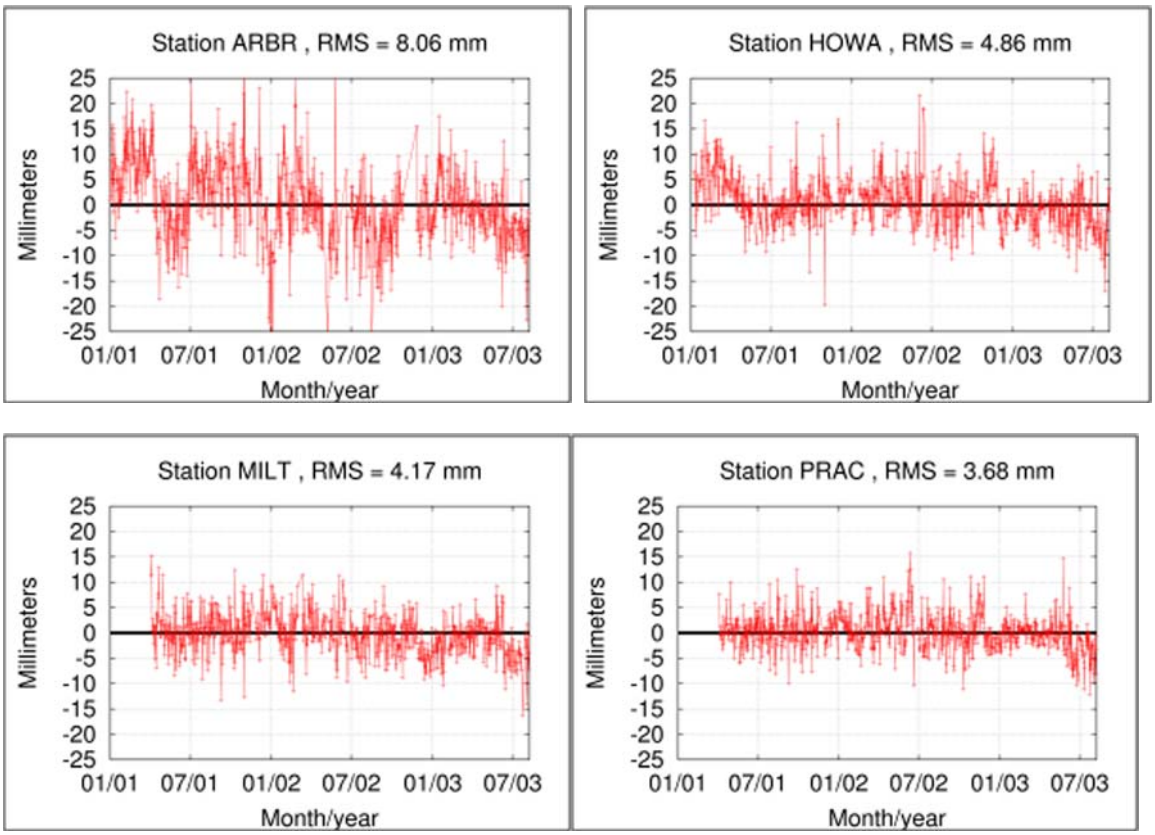


Fig. 6: Repeatability of the height components

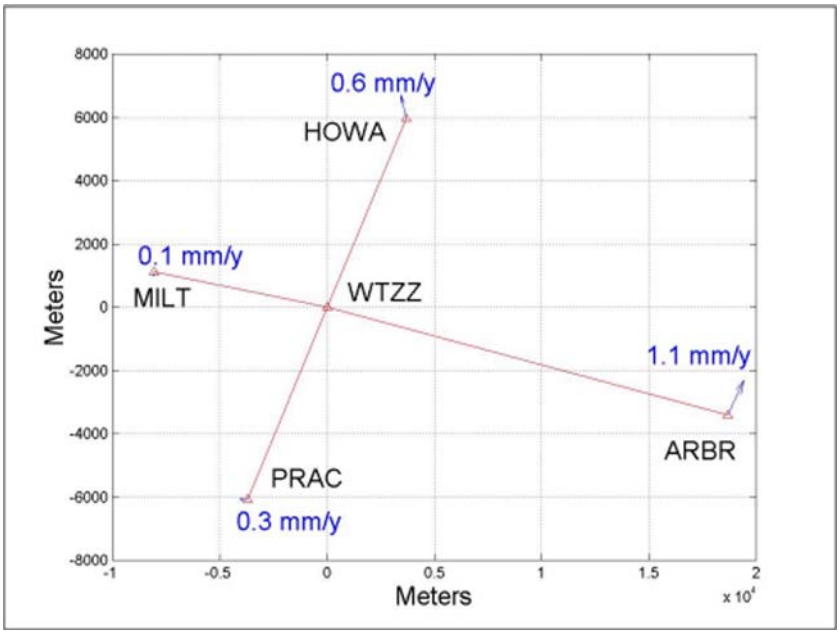


Fig. 7: velocities derived from the time series with respect to WTZZ

Velocities are estimated from the time series of the north- and east-components. The results are summarized in Figure 7. The calculated values are between 0.1mm/y and 1.1mm/y which are not significant.

5 Conclusion

Permanent GPS observations are an excellent tool to monitor the stability of the area around a fundamental station. The daily repeatability of the derived coordinates is approximately 1.5mm in horizontal and 4mm in the vertical position. The time series show systematic behaviour and local motions. The analysis show a seasonal signal for the station HOWA and MILT with an amplitude of 2mm. The reason might be any deformation of the buildings or any modelling problems. No significant movement could be detected during the 2.7 years of observation in the vicinity of Wettzell. The Fundamental Station Wettzell could be regarded as stable.

Reference

[1] Lechner, Veit: Analyse des GPS-Permanentnetzes der Fundamentalstation Wettzell, Diplomarbeit am Institut für Astronomische und Physikalische Geodäsie, Technische Universität München, Juni 2003