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Footprint Observations at the Fundamental Station Wettzell

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Abstract

Footprint observations are performed in order to document the geological stability of a geodetic observatory. Beside a local survey network, which usually covers the observatory area of some 100 meters, some geodetic footprint markers, forming a footprint network, should be established at about 10 to 50 km apart from the observatory. The markers had to be included in the geodetic survey to monitor regional movements.

7-20 km apart from the Fundamental Station Wettzell, four footprint points were established, permanently observed with GPS. Observations were available for a period of more than two years from the four sites. The data was analysed together with the GPS observations taken from those GPS-receivers which are integrated in the international networks, such as IGS and EUREF and in the national network GREF. With respect to a selected geodetic reference marker in Wettzell, for which motion is observed with a tilt meter, the observations are evaluated and day to day coordinates are generated by employing the GPS Bernese Software Processing Engine. The time series show a precision in the order of a few millimeters. Moreover systematic and seasonal effects can be seen.

1. The Footprint Network, Local Survey Network, and GPS Array

The footprint network (Figure 1) of the Fundamental Station Wettzell consists of four geodetic markers in the area of the observatory, spread out to 8 km in north-south and up to 20 km in east-west. The site selection was dependent on the geological structure of the area and on logistical aspects for the operation of permanent GPS receivers. Continuous geodetic observations, done with the highest accuracy, allowed the demonstration of the local, geological stability of the observatory site. This information is important in ensuring that the plate motion is represented by the observed station motion derived from VLBI, SLR and GPS techniques. The footprint network is required in addition to the local survey network (Figure 2), which allows the determination of local ties between the VLBI, SLR and GPS reference points.

On top of the observation platform of the main building, five GPS antennas were set up and combined to form a GPS array (Figure 3). The array includes the IGS, EUREF and GREF GPS receivers, which are named WTZR, WTZA, WTZZ , WTZT and WTZJ. An official description can be found in the site sheets of the respective GPS Services. In addition, a webcam was installed, in order to monitor the weather conditions day-by-day.

Pillar 21 (Figure 4) of the local survey network was equipped with an ASHTECH GPS antenna. Inside the pillar, an AGI 722 borehole tilt meter was installed, providing information about the pillar motion with a resolution of 0.1 microradian. For a period of five years, it could be stated that the overall motion is less than 0.4 mm.

Figure 1. Footprint network of the Fundamental Station Wettzell.

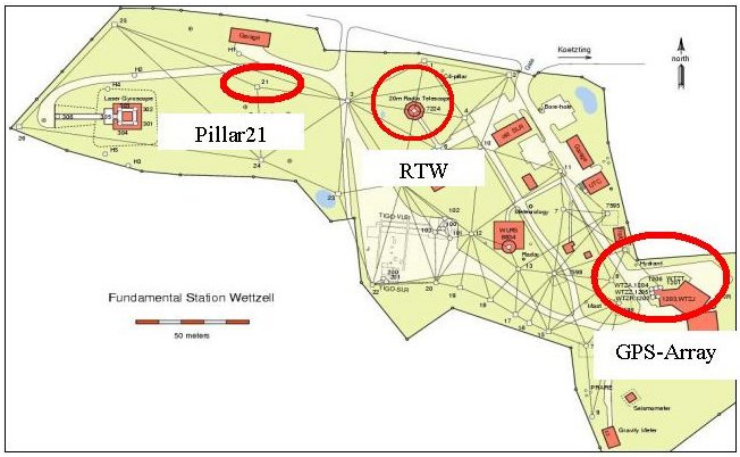

Figure 2. Local Survey Network of the Fundamental Station Wettzell.

2. Data Analysis

Employing the Bernese Software Processing Engine, Version 5, GPS observations covering a period of more than two years were analysed. Pillar 21, which shows a stability of better than 0.4 mm, was fixed. The residuals in the north, east, and height components, derived from the L3 phase solutions, are shown in Figure 5 for two selected points, WTZA and WTZR of the GPS array. Seasonal influences of the order of 1 mm could be seen in the east component and of the order of 0.5 mm in the north component. There was no significant variation in the height component. More scatter could be seen in the winter periods, when snow covered the antennas.

Figures 6, 7, and 8 show the residuals of the footprint markers ARBR, HOWA, MILT and PRAC. Compared to the residuals of the GPS array results, the scatter of the residuals for the footprint markers is larger. At short baselines, common systematic errors like tropospheric or ionospheric delays or orbit errors are cancelled out, which result in more precise coordinates for

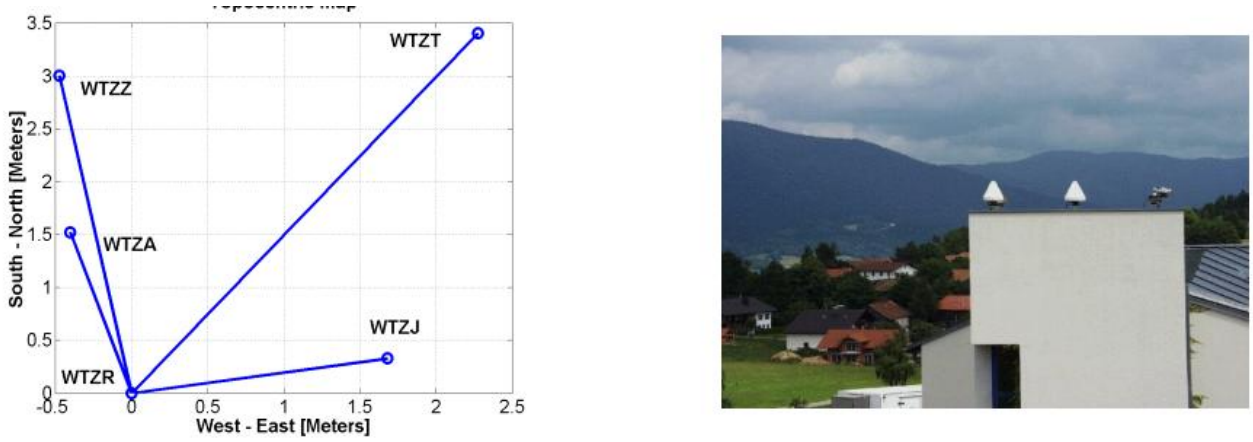

Figure 3. Map (left) and platform view (right) of the GPS array.

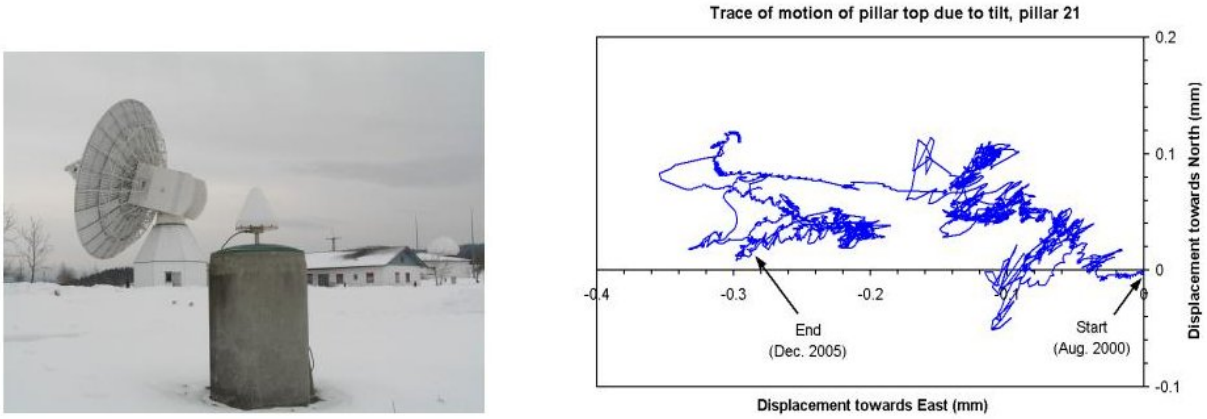

Figure 4. (left) Pillar 21 with the tilt meter. (right) Motion of the pillar from August 2000 to Dec 2005.

the GPS array than for the footprint network with baselines of several km. Seasonal variations can be seen in the residuals of the footprint markers, but the variations are not as significant as those for the GPS array stations. No changes in the height could be seen.

3. Conclusions

The monitoring of the site stability was performed with a precision better than 1 mm. This indicates that the area around the Fundamental Station Wettzell is stable. Seasonal effects of the order of less than 2 mm, particularly in the east component, were detected. No significant height changes occurred.

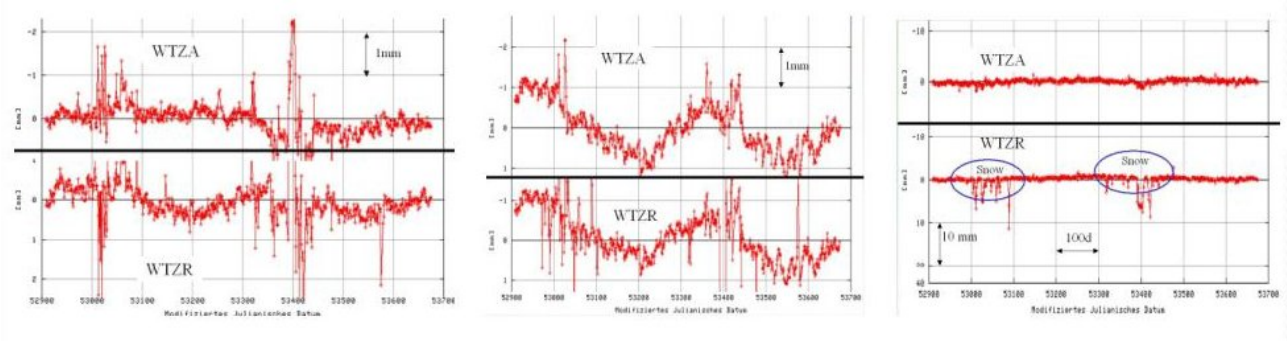

Figure 5. Residuals in the north, east, and height component of WTZA and WTZR.

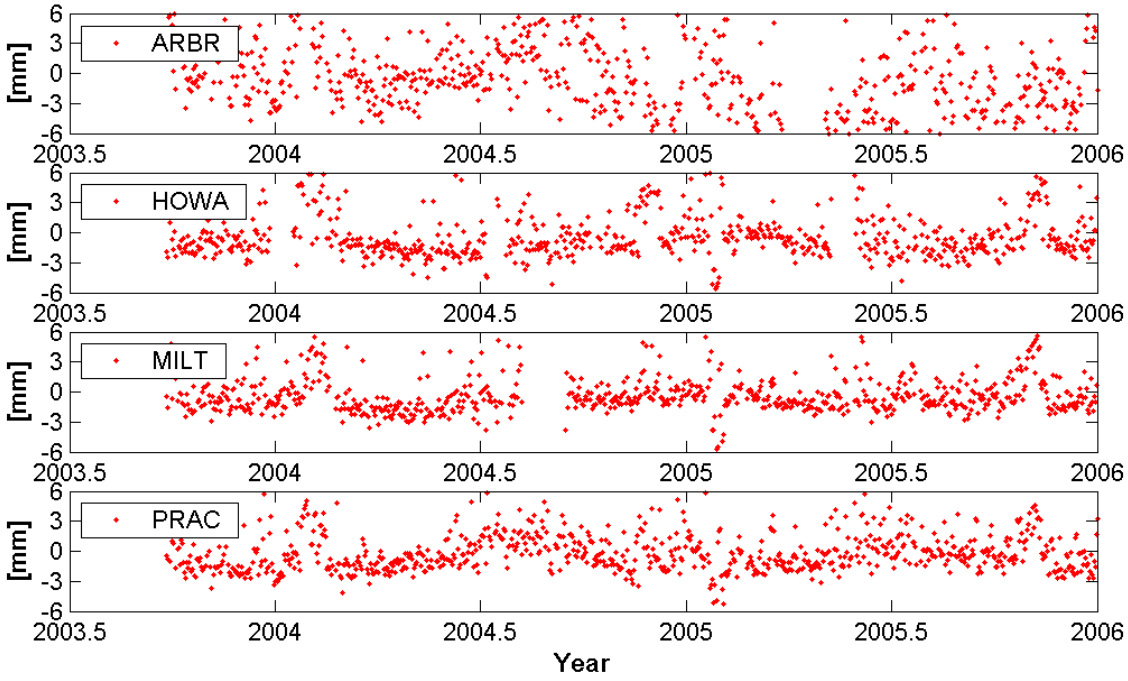

Figure 6. Residiuals in north of the footprint points.

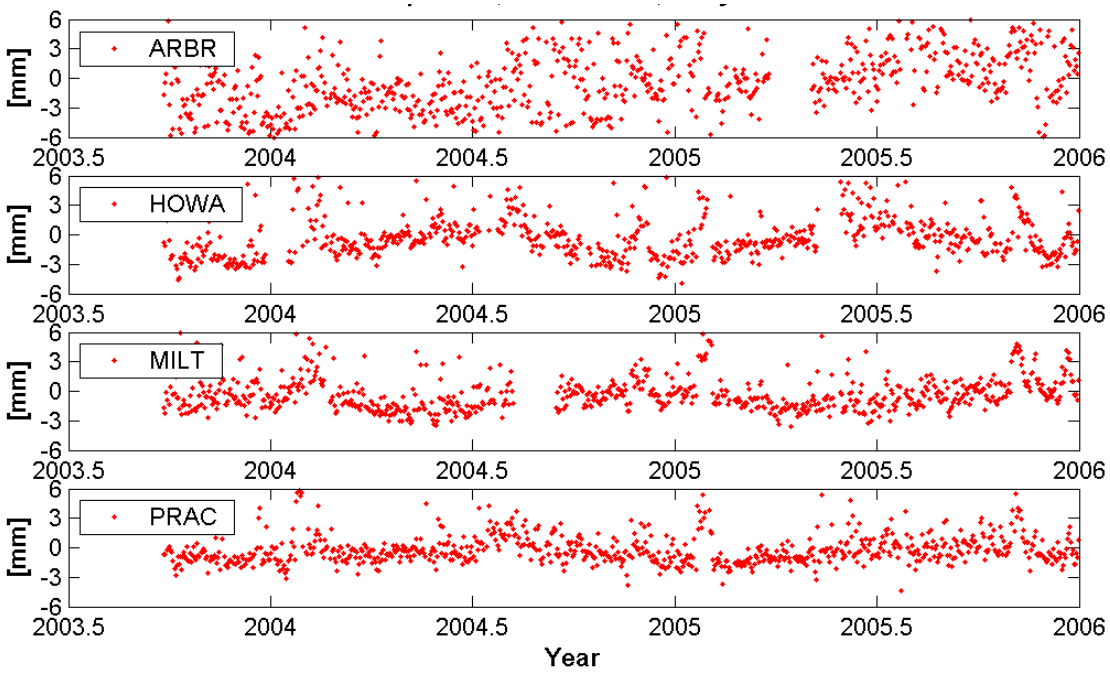

Figure 7. Residuals in east of the footprint points.

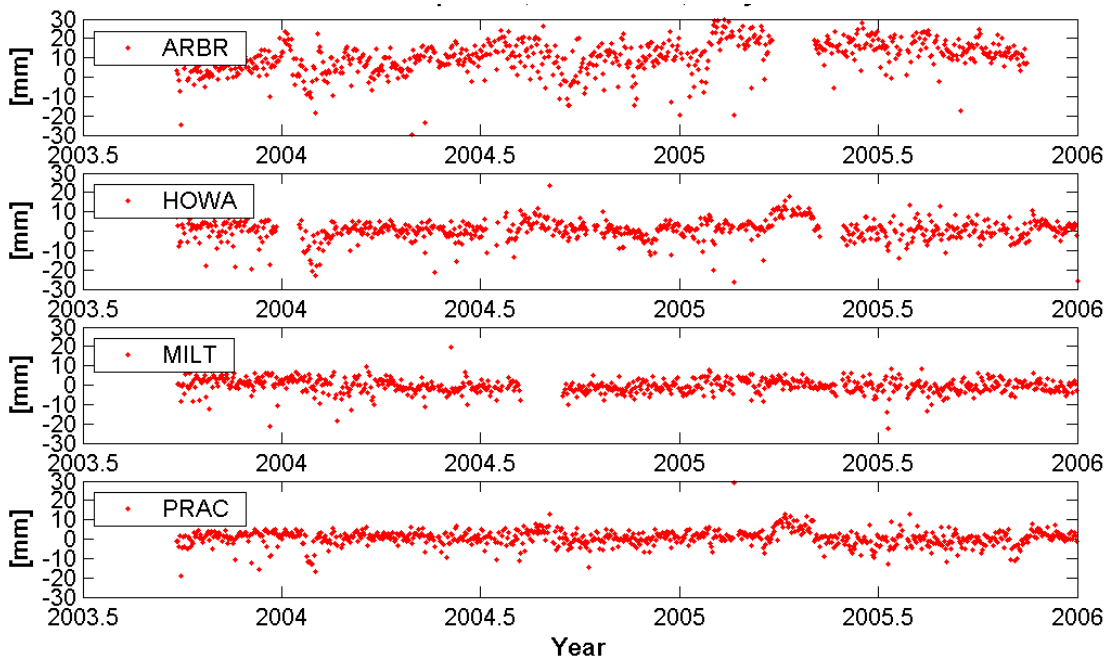

Figure 8. Residuals in height of the footprint points.