Abstract

The number of GNSS satellites and their geometry directly affect the quality of positioning and derived satellite products. Accordingly, the International GNSS Service (IGS) recommends GNSS antennas to be installed away from natural and man-made structures, which may affect the incoming signals through severe multipath or obstructions. Following these recommendations, we conduct a study on the impact of different obstruction scenarios on vertical land movements observed at selected tide gauge stations in Europe. The Bernese GNSS Software version 5.2. We present our preliminary results on the impact of different obstruction scenarios and combined GPS and GLONASS solutions on coordinate and vertical land movement estimates.

Introduction

It is a well-known fact that GNSS positioning accuracy is dependent on the distribution of the observable satellites in the sky (Dach et al., 2007). The GNSS receivers measure the time-of-flight of signals arriving from the satellites. The time difference of arrival (TDoA) of signals from multiple satellites at a single receiver is used to determine the receiver’s position. The distribution of GNSS satellites and their geometry directly affect the quality of positioning and derived satellite products (Dach et al., 2007). The International GNSS Service (IGS) recommends GNSS antennas to be installed away from natural and man-made structures, which may affect the incoming signals through severe multipath or obstructions. Following these recommendations, we conduct a study on the impact of different obstruction scenarios on vertical land movements observed at selected tide gauge stations in Europe.

Methodology

In this study, we have simulated several artificial obstruction scenarios (no results shown here) and extracted scenarios from stations with severe obstructions (Figure 1). The obtained obstruction masks were then applied to unobstructed GNSS sites (green dots) to investigate the impact of limited visibility. In order to implement these different obstruction scenarios, we have added a new feature (Figure 3a) to the Bernese GNSS Software Version 5.2 (BSW52). This is done by providing azimuth-dependent masking information for stations with fixed columns or fixed azimuths (Figure 3b). The new feature is implemented after the RINEX files are converted into the BSW52-formatted observations and before forming baselines (see Figure 3c). Furthermore, we have used two different processing strategies, precise network processing (PnP) and precise point positioning (PPP). The PnP strategy is performed on GPS-only and multi-GNSS (GPS+GLONASS) observations, while PPP is based on GPS-only observations only.

Effects on Coordinate Time Series

We have processed twoPPP solutions from 2008 to 2014. The first solution is based on the real (unobstructed) observations while the second one is based on the same observation file but applied to the obstructed obstruction scenario P111 (as an example). To investigate the effect of the obstructions, position differences time series between the unobstructed and obstructed solutions were computed. We assume that all common signals and biases will cancel from the difference, highlighting the impact of the obstruction. Figure 4 shows the coordinate difference time series of the up component for 11 selected stations. The figure shows that the effect varies from station to station. Constant up biases (removed from the difference time series) caused by the obstructions reach 10 mm for nearly all stations. Rate estimates for the difference time series range from -1.43 mm/yr (TUX) to 0.40 mm/yr (DGAR).

Conclusions

An investigation of the effect of signal obstructions using simulated and real obstruction scenarios has been performed. The preliminary results confirm that the effect of the obstructions is to a large degree site-specific and latitude-dependent. The obstructing objects cause a compromised satellite geometry, increase scatter of the position time series, cause coordinate biases and may lead to biases in the rate estimates. The use of GPS+GLONASS observations instead of GPS-only observations benefits both unobstructed and obstructed stations with the improvement being more significant for the latter. More work is needed to better quantify the current results and to include observations from Galileo and BeiDou.

References

Dach, R., et al. (2007), Bernese GPS Software Version 5.2, Astronomical Institute, University of Bern, Switzerland.

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Figure 1: Skyplot of stations with severe obstructions from the IGS (BAMF, AUTF, UNAVCO/PO/AU44, AB44, P111 and P123) networks. The obstruction masks derived from these are named after the stations.