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On the design of robust and consistent metrics for the stability of receiver antenna calibration sets

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The bottleneck of precise GNSS based applications is caused by the receiver antenna and their precision and accuracy. This work aims to contribute to the design of a model and the development of metrics to estimate and evaluate GPS/GNSS antenna calibration values in several networks. At present, there is neither information on the absolute accuracy of antenna calibration values nor a consistent handling of their uncertainties. Rather, these uncertainties repeatedly introduce inaccuracies into time series, which are used to determine global and regional reference frames as a basis for a broad variety of geophysical approaches such as meteorology, hydrography, etc. Several contributions have addressed the issue of the desired quality of GNSS receiver antenna calibrations and the assessment of their impact on GNSS data processing. All approaches lead to the open question regarding the precision and accuracy as well as stability of receiver antenna phase centre corrections. However, comprehensive and fundamental answers to this scientific question are difficult to achieve as complex interactions prevent simple estimation.

In this paper, the authors present results regarding the stability of receiver antenna calibrations in the context of time, calibration facility and strategy to help GNSS operators of regional and global GNSS stations to estimate the impact of calibration values on their sites. The quality of the calibration values also has a direct impact on the derived results, such as the zenith path delay (ZPD). We show that deviations of up to 5 mm for different high-grade antenna types occur. In addition, the normal distribution of pattern differences deviations and systematic effects have been found that lead to drifts and offsets in the parameter domain. The frequency dependence is underlined as well, e.g. L1 versus L2(P) and L2(C). The temporal stability of the calibration values is a fundamental issue, which is discussed in this context. Based on a sample of more than 30 different geodetic grade antennas, we identified variations like drifts and azimuth dependencies with magnitudes of up to 5 mm on each individual frequencies. Furthermore, the stability of the type mean versus individual calibrations shows larger differences on the signals L2 and hence leads to higher variances in the derived ionosphere-free linear combination. The results are examined using PPP time series. The derivation of metrics will be an important step to improve the consistency of regional and global GNSS products.