Abstract

Several contributions and papers discuss the impact of the variability of receiver antenna calibration models on the coordinate or parameter domain, respectively. This can only be a first approximation since complex interactions depending on the processing philosophy, propagates carrier phase center variations (PCCVs) differently to the parameters, so that unexpected discrepancies on the parameter domain can occur and have to be analyzed consequently.

This approach categorizes the impact of carrier phase center corrections (PCCs) on all geodetic parameters and is based on improved simulation methods with generic patterns initially investigated by [Geiger, 1988] and [Santerne, 1991]. The propagation of error functions for several generic antenna models is investigated, [Hieker et al., 2015]. Simulations are validated by empirical experiments through adding generic PCC patterns to individual calibrated antennas and computing Precise Point Positioning (PPP) w/o generic patterns. The impact of different software packages are studied therefore, too.

Background - Generic Patterns and Simulations

Generic patterns as investigated by [Geiger, 1988] are used in several configurations to simulate error functions on PCC patterns.

Discussion - Impact of Complex Patterns

1-wire helix (c) and 4-wire helix (d) w.r.t. Figure 3 and Figure 4

Discussion - Impact of Generic Patterns on Position Domain

Methodology - PPP Analysis

Set-Up (reference station equipment)

- 24 hour data set (incl. sidereal repetition from DOY339-342, 2011), 1 sec sampling, 3’ cut off angle, with LEIAR85.83 LEIT antenna and Javad TBE3G3 receiver
- Laboratory network at IfE, Leibniz University Hannover (mean geographical latitude of 54°)

Parameters

- Reference solution determined by PPP with original absolute and individual PCCs
- Further processing with manipulated PCC patterns (generic patterns on L1/L2, ref. Figure 1)
- Differences of subsequent PPP solutions show impact on coordinate, receiver clock error, tropospheric delay as well as ambiguity parameters.

Software (commercial and open source)

- Software packages used for study: Bernese GNSS Software 5.2, CSRS-PPP (NRCan), GPS Toolkit, Matlab GNSS Toolbox V6.0 of IfE and RTKLib 2.4.2 (Figure 3 shows results from the first three packages).
- Additionally, Bernese processing with weighted (cor = 1) and equally weighted (P = 1) observations and different tropospheric mapping functions to study these impacts in detail.

Homogeneity - Sky Distribution

Discussion - Impact of Simple Generic Patterns

Turnstile (a) and Micro Strip (b) w.r.t. Figure 3

- Turnstile (a) (bar 1) only affects the height whereat Micro Strip (b) (bars 2-5) affects the horizontal component only and magnitude in the position equals the amplitude in observation domain.
- All software packages (except GPS Toolkit) agree on sub-mm level w.r.t. to the suggested model.
- Observation weighting shows no impact.

Conclusions - Further Steps

- The theoretical model gives valuable and qualitative information on the impact of PCC pattern on the estimated parameters.
- Overall behavior is predicted very well. However, obtained values are smaller than from observations.
- Study and analyze all estimated parameters including; clock, troposphere as well as ambiguities.
- Improvements are needed for quantitative comparisons like e.g.: improved model for ambiguity terms (geometrical conditions, initial ambiguity term, Figure 2).
- extended modeling of the satellite sky distribution (e.g. extended probability density function).

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References


Discussion - Impact of Generic Patterns Position Domain

Model
Bernese (weighted)
NRCan GPS Toolkit

Figure 5: Differences between solutions obtained with different software packages. How to read the bars from left to right: (1) Turnstile. (2-5) Micro Strip with orientations a1 from 0° to 360°. (6) 1-wire helix. (7) 4-wire helix. (8) 4-wire helix with higher amplitude.

Model
Bernese (weighted)
NRCan GPS Toolkit

Figure 6: Further exemplary studies with Bernese and 1-wire/4-wire generic patterns with GMP Model and weighted as well as unweighted observations with field are shown.