Antenna Code Phase Variations (GDVs) and the Impact on Ambiguity Resolution
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Introduction
This contribution discusses the current investigations at the Institut für Erdmessung (IEE) on Code Phase Variations (GDV) within a combined code and carrier phase processing strategy. An analysis of the GDV impact on the important Melbourne-Wübbena linear combination (MW-LC) - which is widely used for cycle slip detection and ambiguity resolution – is of special interest since effects which origin from GDV are amplified on both code phases (P1 and P2).

GNSS Receiver Antenna Code Phase Variations (GDV)

Variations of the Code Phase Observation at GNSS Antennas?

- **Ideal** Antenna is an isotropic radiator for the reception of code phase observation independent of incident angle.
- **Real** Systematic effects occur due to imperfections during the design and production process of the important characteristics of GNSS antennas (sensitivity, bandwidth, etc.).

Review Melbourne-Wübbena Linear Combination (MW-LC)

- GDV amplified by a factor of 0.562 ($L_1$) and 0.438 ($L_2$) due to MW-LC
- accumulation of GDV for MW-LC and for different frequencies
- degradation of observation precision and additional uncertainties in coordinate domain

Experiment on Laboratory Network

- common clock mode on a short baseline
- long sessions (>5 hours) ensure a good geometry (satellite coverage)
- asymmetrical setup with antennas providing different GDV pattern, determined by IEE, [Kersten et al., 2012]

Observation Domain - Double Differences of MW-LC

Figure 1: Methodology and principle concept (a) of the Harmonic Concept of absolute antenna calibration in the field (b).

The effect of azimuth and elevation dependent GDV is currently known in literature for satellite as well as for receiver antennas, cf. [Murphy et al., 2007].

Widelane Ambiguity Fixing

- GDV correction applied
- GDV correction applied

Figure 5: Differences of WL ambiguity fixing induced by GDV corrections for situation of reference satellite PRN01 (a) and PRN32 (b).

Impact on Coordinate Domain - Reference PRN32

Figure 6: Double Difference coordinate solution using Widelane phase and ambiguities obtained without GDV correction (a-b), with GDV correction (c-d) and identical observation weighting.

Conclusions

- Code Phase Variations (GDV)
  - Significant and repeatable GDV depending on the antenna design are obtained (Fig. 3).
  - GDV can reach magnitudes of $\geq 1$ cycle and the effect on DD of MW-LC depends also on the selected reference satellite and the processing strategy, cf. Fig. 4.

Observation Domain

- GDV induce wrong Widelane ambiguities (up to 1 cycle) as shown in Fig. 5.
- Wrong Widelane ambiguity introduces wrong Narrowlane ambiguity.

Coordinate Domain

- GDV influence directly and repeatable the coordinate time series via incorrectly fixed WL ambiguities and induce jumps of up to 0.4 m (cf. Figure 7(a) & 7(b)).

Outlook and Challenges

- GDV are interesting for future GNSS signals since a reduced observation noise can be expected and will be an important element in navigation approaches with small antennas.
- GDV degrade code based and code/carer combined applications.

References