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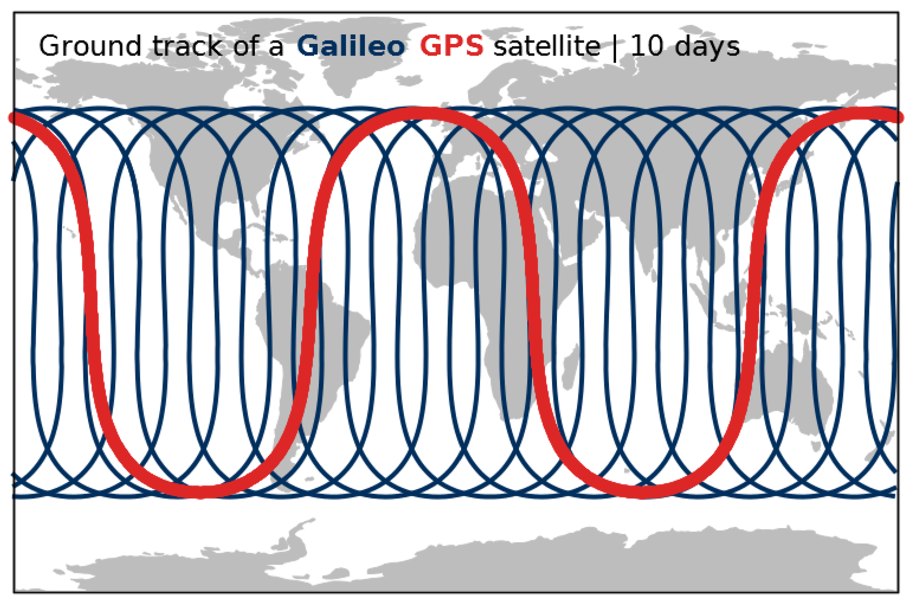
Faculty of Environmental Sciences | Department of Geosciences | Geodetic Institute

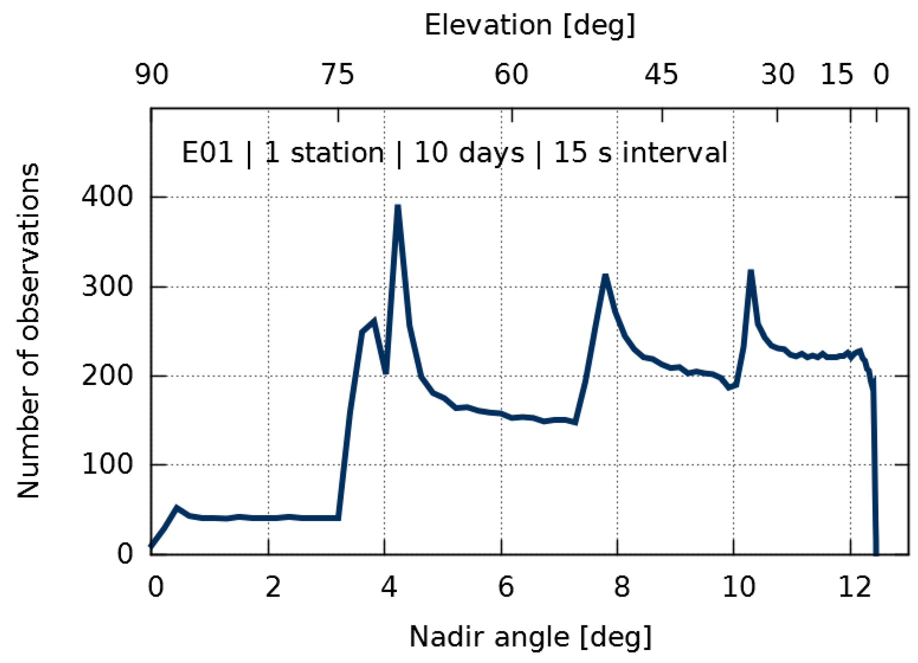
Group Delay Variations of Galileo Satellite Antennas

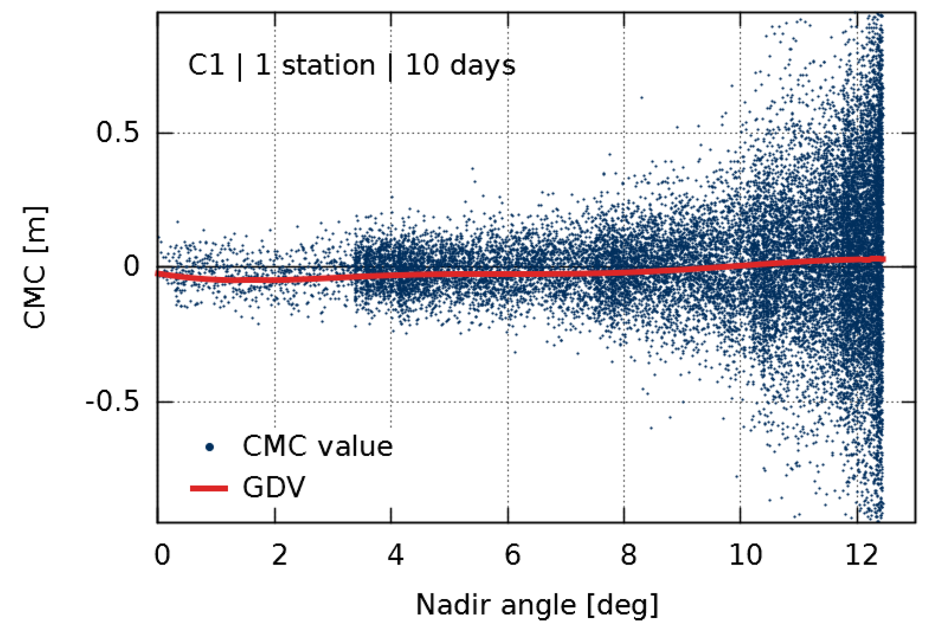
Susanne Beer, Lambert Wanninger | TU Dresden, Germany

Motivation

Group delay variations (GDV) of satellite and receiving GNSS antennas affect code pseudorange measurements. They are frequency-dependent and vary with nadir angle and elevation of the transmitted and the received signal, respectively. We present nadir-dependent GDV for all five frequencies of the Galileo satellites and for linear combinations of C1 and C5.







Ground tracks of Galileo satellites repeat every 10 days and, thus, produce a much better worldwide coverage as compared to GPS with its daily orbital repetition period. As a consequence, single terrestrial reference stations are able to provide Galileo GDV information for the entire elevation and nadir angle range. This simplifies GDV determination as compared to GPS where global networks of reference stations are required (Wanninger et al. 2017). The combined GDV of satellite and receiver antenna is contained in the ionosphere-corrected code-minus-carrier (CMC) observable, also known as multipath linear combination.

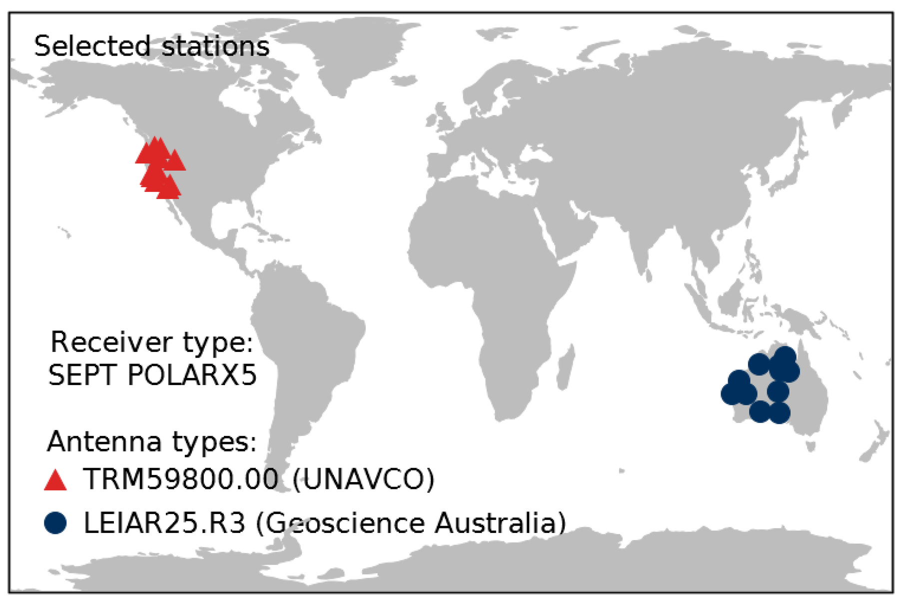
Method and Data

The ionosphere-corrected, geometry-free CMC_i observable is computed by

$$CMC_i = C_i - \Phi_i + 2\lambda_i^2 \frac{\Phi_j - \Phi_i}{\lambda_j^2 - \lambda_i^2} - B \ ,$$

with code pseudorange C, carrier phase Φ, and wavelength λ at frequencies i, j. Biases between the observables and carrier phase ambiguities are lumped together in B. Since they remain unknown, only variations of the group delays can be determined.

Two sets of reference stations with different antenna types were chosen (TRM59800.00 and LEIAR25.R3) to determine nadir-dependent GDV.

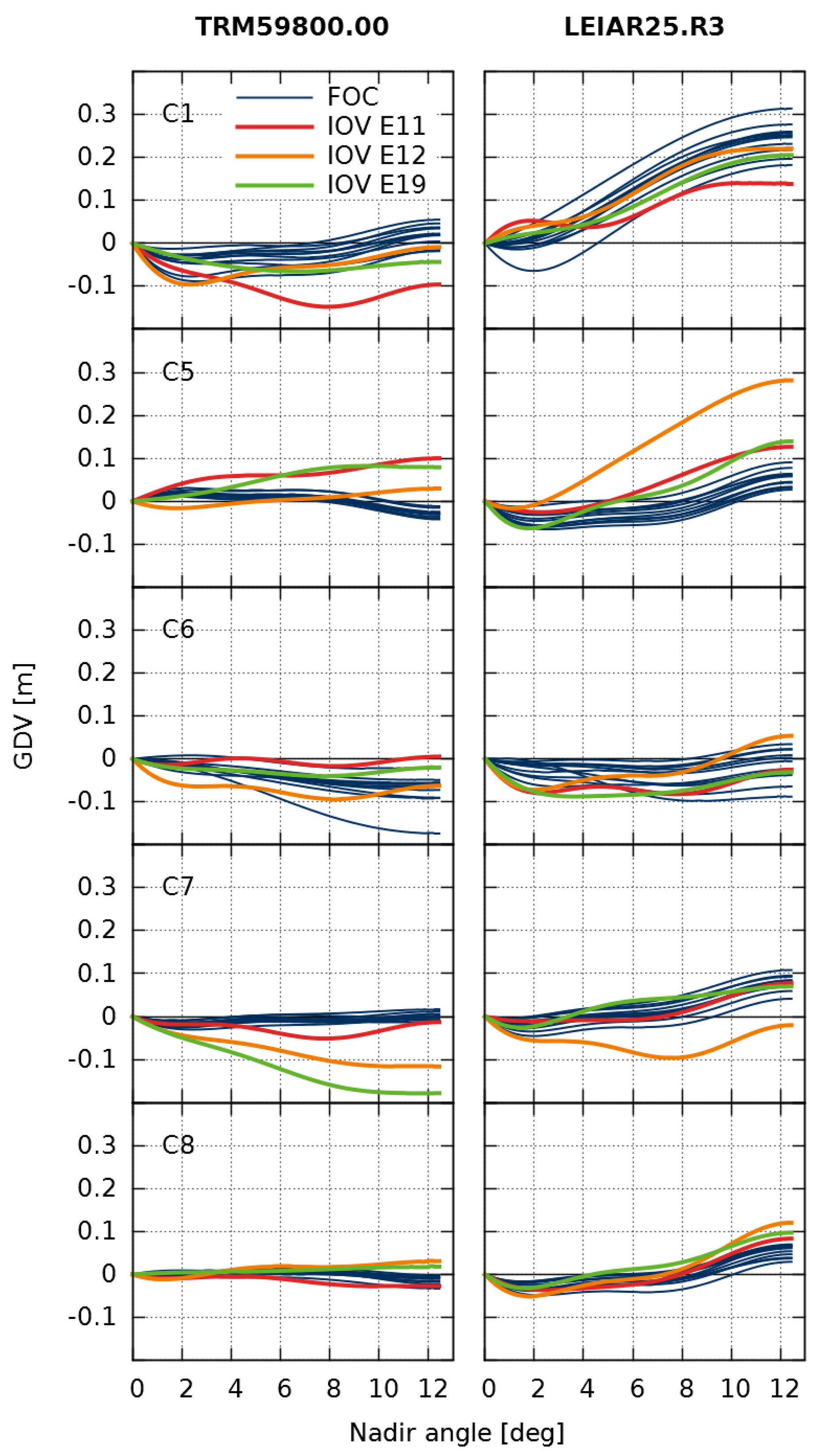


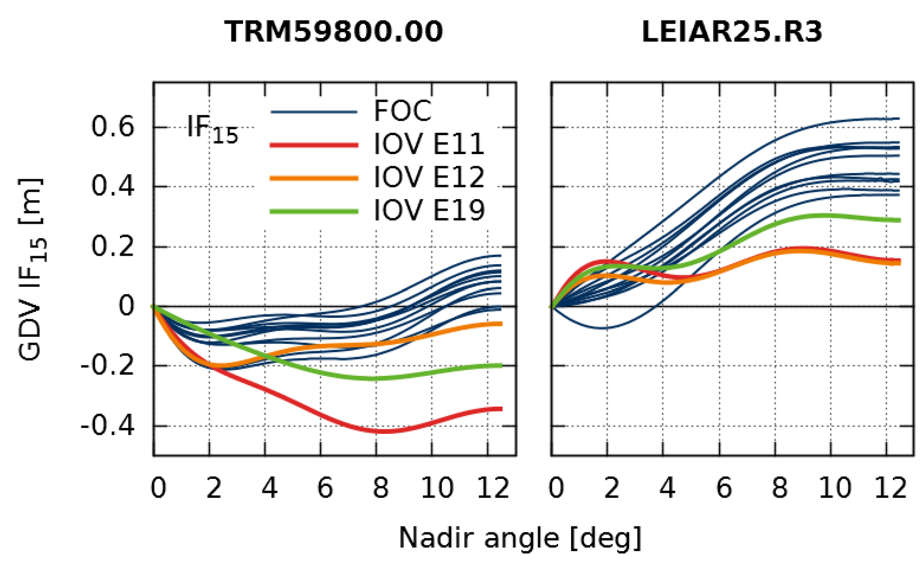
Even if a single reference station can provide observations for the entire nadir angle range, we selected 12 stations in each set of reference stations in order to reduce site-specific code multipath.

Results

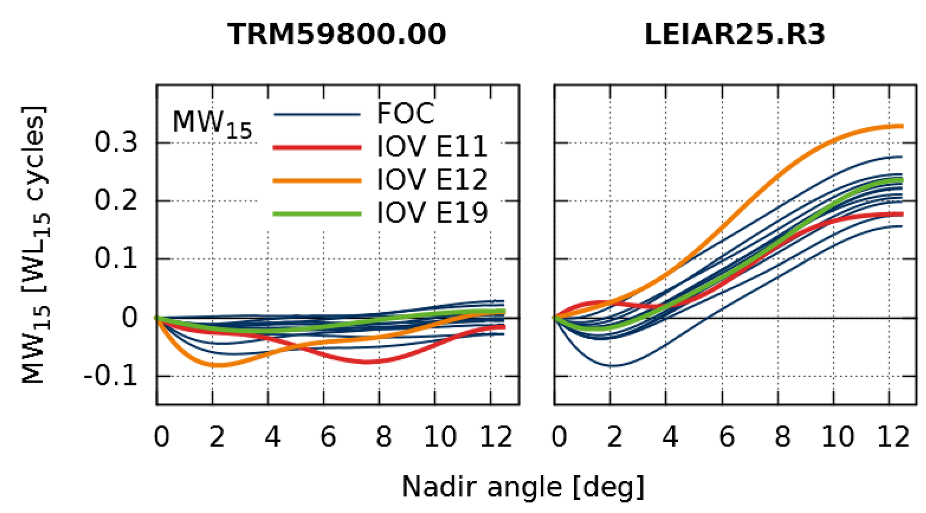
Whereas GDV of the full operational capability satellites (FOCs) agree well, GDV vary within the group of in-orbit validation satellites (IOVs).

The two receiving antenna types show different GDV, being in accordance with earlier findings for GPS signals (Wanninger et al. 2017). They are most pronounced for the LEIAR25.R3 antenna with up to 30 cm and 10 cm peak-to-peak for C1 and C5, respectively, resulting in up to 60 cm peak-to-peak for the ionosphere-free linear combination of C1 and C5 (IF_{15}) for FOCs. The corresponding values for the TRM59800.00 antenna are barely half of that.





In case of the LEIAR25.R3 antenna, the effect of GDV on the Melbourne-Wübbena linear combination (MW_{15}) can reach 0.3 widelane (WL_{15}) cycles for both, FOCs and IOVs, while it stays below 0.1 WL_{15} cycles for the TRM59800.00 antenna.



References

Wanninger L, Sumaya H, Beer S (2017): Group delay variations of GPS transmitting and receiving antennas: Journal of Geodesy, DOI:10.1007/s00190-017-1012-3

Acknowledgements

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susanne.beer@tu-dresden.de