Low-cost multi-GNSS receiver precise positioning - are we there yet?

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Abstract: When the Global Positioning System (GPS) was the only satellite constellation in orbit, instantaneous single-frequency precise (millimeter-level) positioning was not possible, and more expensive high-grade multiple-frequency receivers had to be used. With the advent of the Global Navigation Satellite Systems (GNSSs), such as the Chinese BeiDou Navigation Satellite System (BDS), low-cost receiver precise positioning will potentially become feasible. In this contribution we investigate the performance of such a low-cost single-frequency GPS+BDS model and compare its performance to a survey-grade dual-frequency GPS receiver solution. The least-squares variance-component estimation (LS-VCE) procedure is used to investigate the precision of the receiver code and phase observables of the low-cost receivers. The estimated (co)variances are namely needed as to formulate a realistic stochastic model for precise real-time kinematic (RTK) positioning, whereas an unrealistic stochastic model will deteriorate the ambiguity resolution performance and hence the achievable positioning precisions. Receiver-induced time correlation will also be investigated, which if neglected can give overly optimistic positioning precision estimates. The results indicate that the quality of the antennas used plays an important role in suppressing multipath. It will also be shown that the low-cost solution, which costs a few hundred dollars, can give comparable precise positioning performance to survey-grade receivers, which cost more than ten thousand dollars. There is thus possibilities for precise millimeter-level positioning in a range of different disciplines at a much lower cost, potentially even in mobile phones.

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