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ORIGINAL ARTICLE

Performance assessment of single- and dual-frequency BeiDou/GPS single-epoch kinematic positioning

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Abstract The first results of the short baseline single-epoch kinematic positioning based on dual-frequency real BeiDou/GPS data are presented. The performance of the BeiDou/GPS single-epoch positioning is demonstrated in both static and kinematic modes and compared with corresponding GPS-only performance. It is shown that the availability and reliability of the single-frequency BeiDou/GPS and dual-frequency BeiDou single-epoch kinematic positioning are comparable to those of the dual-frequency GPS. The fixed rate and reliability of ambiguity resolution for the single- and dual-frequency BeiDou/GPS are remarkably improved as compared to that of GPS-only, especially in case of high cutoff elevations. For positioning accuracy with fixed ambiguities, the BeiDou/GPS single-epoch solutions are improved by 23 and 4 % relative to the GPS-only case for two short baseline tests of 8 km, respectively. These results reveal that dual-frequency BeiDou real-time kinematic (RTK) is already applicable in Asia–Pacific areas and that single-frequency BeiDou/GPS RTK is also achievable but only with initialization of several seconds. More promisingly, the dual-frequency BeiDou/GPS RTK can overcome the difficulties with GPS-only RTK under the challenging conditions assuming, of course, that the additional BeiDou satellites are visible.

Keywords BeiDou · GPS · BeiDou/GPS · Single-epoch RTK · Ambiguity resolution · High-precision positioning

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Introduction

As a commonly used high-precision positioning technology, the dual-frequency GPS real-time kinematic (RTK) has proven its efficient and reliable performance during the past a few years. However, both its availability and reliability deteriorate dramatically under some challenging conditions, for instance, deep open pit mines, urban canyon and river valleys when not all available satellites are visible. In addition, the initialization of single-frequency GPS RTK takes about several minutes depending on the number of tracked satellites, the baseline length and the observation environment (Odijk et al. 2007; Takasu and Yasuda 2008). Such low efficiency limits its application only to, for instance, attitude determination and deforming monitoring where some constraints can be imposed (Cosser et al. 2003; Cosser 2004; Teunissen et al. 2011a, b). Nevertheless, these shortcomings can be overcome by combining utilization of multiple-GNSS systems (Dai 2000; Yamada et al. 2010; Al-Shaery et al. 2013).

With Galileo in-orbit validation element (GIOVE) satellites, the advantage of the GPS/Galileo RTK has been demonstrated based on a ISB-corrected (Inter-System Bias, ISB) model (Odijk et al. 2012). Compared to the GPS-only case, the reliability of GPS/GIOVE ambiguity resolution (AR) can be significantly improved (Odijk and Teunissen

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