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Impact of the differential signal bias of pseudo-range on precise GNSS data processing

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Affected by various frequencies, pseudo-random-noise (PRN) codes, and tracking techniques, the pseudo-range observations from different channels of the Global Navigation Satellite Systems (GNSS) contain systematic biases. The International GNSS Service (IGS) releases the latest Differential Signal Biases (DSB) products, which include more signals and multi-GNSS constellations than the Differential Code Biases (DCB) products. Currently, DSB and DCB products are used in parallel, even though the signal classification and the bias values are rather different. We investigate the performance of DCB and DSB products in precise GNSS data processing, including the satellite orbits and clock determination, Uncalibrated Phase Delay (UPD) derivation, and precise point positioning with ambiguity resolution (PPP-AR). We demonstrate: (1) using DCB or DSB in the same signal setting causes a systematic difference up to 0.73 ns, 0.47 cycle, and 0.46 cycle in the satellite clocks, wide-lane (WL), and narrow-lane (NL) UPDs estimates, respectively, although their impact on satellite orbits is only around 3 mm in general, (2) using the same bias product in different signal settings can bring more significant differences up to 5.3 mm, 1.7 ns, 0.47 cycle, and 0.47 cycle for orbit, clock, WL, and NL UPDs, respectively, and (3) using DSB products improves the convergence time of PPP-AR solutions compared with DCB solutions and reduces the systematic biases of the pseudo-range observation residuals.