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On the Feasibility and Applicability of Multipath Mitigation Maps as an IGS Product

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Multipath is a largely unmodelled source of error and causes large range errors in Global Navigation Satellite System (GNSS) observations. The effects have strong site-specific characteristics and impact each receiver differently. Multipath errors can propagate and can cause in-situ position and velocity biases and are also contributing to the pervasive draconitic harmonic signals. We employ an empirical approach to reducing the effects of multipath by stacking one-way post-fit carrier phase residual observations by applying an appropriate averaging scheme. Our processing is based on static multi-GNSS observations using various scientific GNSS software packages (Bernese GNSS Software, NAPEOS, GAMIT-GLOBK, PRIDE and GINS). Our multipath stacking (MPS) uses the stacking of individual residuals generated by variable azimuth cell size (congruent cells) by allocating carrier phase residuals in each cell, unlike fixed azimuth cell resolution in the standard MPS approaches. This reduces the binning of fewer residuals at higher elevation angles. Before stacking, we also apply rigorous statistical outlier screening tests for each one-way post-fit carrier phase residual assigned to each of the congruent cells. We thus correct the multipath effects by subtracting the stacked multipath map from the post-fit carrier phase residual. Using this technique we produce a model available in the form of the Antenna Exchange (ANTEX) file format, that can potentially be implemented in routine GNSS analysis with no or little additional overhead for individual analysis centers (ACs).

In this study, we assess the feasibility and applicability of the MPS maps as an International GNSS Service (IGS) product for routine GNSS analysis. We have selected a subset of IGS stations with and without known multipath issues in different climatic zones. We demonstrate the multipath stacking technique to result in a significant reduction of the variation in the one-way post-fit carrier phase residuals. For GPS-only solutions, the MPS technique shows a decrease of up to 30% in the RMS value of the one-way post-fit carrier phase residuals. We have also tested our MPS for other constellations such as GLONASS, Galileo and BeiDou, and combinations of these .