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Impacts of GNSS position offsets on global frame stability

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Positional offsets appear in Global Navigation Satellite System (GNSS) time series for a variety of reasons. Antenna or radome changes are the most common cause for these discontinuities. Many others are from earthquakes, receiver changes, and different anthropogenic modifications at or near the stations. Some jumps appear for unknown or undocumented reasons. The accurate determination of station velocities, and therefore geophysical parameters and terrestrial reference frames, requires that positional offsets be correctly found and compensated. Williams (2003) found that undetected offsets introduce a random walk error component in individual station time series. The topic of detecting positional offsets has received considerable attention in recent years (e.g., Detection of Offsets in GPS Experiment; DOGEx), and most research groups using GNSS have adopted a combination of manual and automated methods for finding them. The removal of a positional offset is usually handled by estimating the average station position on both sides of the discontinuity, assuming a constant, continuous velocity. This is sufficient in the absence of time-correlated errors. However, GNSS time series contain systematic and power-law errors (white to random walk noise). In this paper, we aim to evaluate the impact to both individual station results and the overall stability of the global reference frame from adding increasing numbers of positional discontinuities. We use the International GNSS Service (IGS) weekly SINEX files, and iteratively insert positional offset parameters at the midpoint of each data segment. Each iteration includes a restacking of the modified SINEX files using the CATREF software from Institut National de l'Information Géographique et Forestière (IGN) to estimate: regularized station positions, secular velocities, Earth orientation parameters, Helmert frame alignment parameters, and the empirical shifts across all positional discontinuities. A comparison of the successive cumulative solutions is used to assess the impact on station velocities and Earth orientation and Helmert parameters due to the growing number of positional offsets.