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## Investigating the long-term variations of coordinate time series at co-located GNSS stations

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Global Geodetic Observing System (GGOS) requires an accuracy of 1 mm and a stability of 1 mm/decade for the Terrestrial Reference Frame (TRF), which is not achieved yet. Global Navigation Satellite Systems (GNSS) play a critical role in TRF determination, thanks to its continuous observations collected from hundreds of globally distributed stations. GNSS observations at the user side are affected by antenna, receiver, and the local environment. The impact of the antenna is more significant to carrier-phase observations and handled with the phase center offset and variation corrections, meanwhile that of the receiver is more significant to the pseudo-range observations. In this study, we investigate the long-term agreement of station coordinates at co-located GNSS stations, i.e., more than one GNSS stations within a few hundreds of meters. We demonstrate that (1) the coordinate difference between co-located GNSS stations could have seasonal variations and long-term trends, (2) discontinuities are often observed after instrument changes, especially the antenna change, and (3) different receiver types could cause station coordinate bias up to 1 mm. A preliminary investigation of the possible reasons is carried out and addressed as well.