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GNSS processing with the raw observation approach in the context of gravity field recovery

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The raw observation approach is a GNSS processing technique that has been developed to meet the substantial increase in complexity of GNSS processing that has taken place in the recent years with the introduction of new systems and signals. It has been shown that applying this approach results in GPS products (satellite orbits, station positions etc.) of a similar quality to well-established processing techniques used by the analysis centers of the International GNSS Service (IGS). The raw observation approach has also been used in a Precise Point Positioning (PPP) mode for high-low satellite-to-satellite (hlSST) tracking to derive kinematic orbits for low Earth orbit (LEO) satellites with an accuracy of a few centimeters.

Consistent processing of GNSS satellite orbits, ground station positions, and LEO satellite orbits is important for and benefits many scientific applications. One application is the combination of loading-induced station displacements and kinematic LEO orbits to recover Earth's time-variable gravity field. While dedicated gravity missions like GRACE offer a very high accuracy compared to other techniques, continuous availability of satellite gravity measurements is not guaranteed. This has been evidenced by the increasing number of gaps in the GRACE time series caused by aging hardware and the significant time span between the decommissioning of GRACE and the launch of its successor mission GRACE Follow-On. Gravity field recovery from hlSST tracking has been applied successfully to generate a continuous, gapless time series of gravity field solutions, although with a significantly decreased accuracy compared to satellite gravimetry. The spatial resolution of these gravity field solutions can be increased by incorporating highly accurate measurements of loading-induced displacements provided by permanently operating GNSS stations worldwide. We will demonstrate an improvement in terms of accuracy for continental areas with sufficient station density in the combined solution. Processing issues like the nonuniform global station distribution and difficulties in signal separation of ground station time series will also be discussed.