Precise orbit determination for GRACE using undifferenced or doubly differenced GPS data

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The two GRACE satellites provide the ideal platform to study the performance of different strategies for precise orbit determination (POD) using undifferenced or doubly differenced GPS observations. For single low Earth orbiters (LEOs) the undifferenced approach is attractive thanks to its efficiency because the GPS data of each spaceborne receiver may be processed independently if high-rate GPS satellite clocks are available. For the two GRACE satellites, however, profit should be taken out of a combined processing of the GPS data from both satellites by means of double differences because the space-baseline offers the possibility to fix a significant number of GPS carrier phase ambiguities to their integer values. As a drawback, however, a large number of GPS ground stations has to be processed simultaneously with the GRACE satellites in order to attach the orbits to a well defined reference frame.

We use GPS data from both GRACE satellites to perform reduced-dynamic and kinematic POD based on zero or double differences and assess the quality of the different solutions by independent measurements like K-band, SLR, and accelerometer observations. We focus in particular on the comparison between reduced-dynamic trajectories based on undifferenced and doubly differenced GPS data and discuss the impact of ambiguity fixing on the space-baseline, and, possibly also on space-ground baselines. In this context, we present our most recent algorithmic developments of reduced-dynamic POD. They significantly reduce CPU processing times even when processing doubly differenced GPS observations between a LEO and a large number of ground stations due to a full exploitation of the structure of the resulting normal equations.