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# Analysis of star-camera noise in GRACE data and its impact on monthly gravity field models

Pedro Inácio, Pavel Ditmar, Hassan H. Farahani, and Roland Klees
GeoSciences and Remote Sensing, Technische Universiteit Delft, Delft, Netherlands

Each GRACE satellite uses two star cameras (SCs) for the precise measurement of the spacecraft's attitude in the Celestial Reference Frame. In the context of gravity field modelling, the spacecraft's attitudes are critical to compute the 3-D offset between the K-Band antenna phase centre and the satellite's centre of mass. A detailed investigation of SC noise and its propagation into monthly gravity field models has not yet been done.

The presence of two (primary and secondary) SCs on each GRACE satellite creates a redundancy in the measurement of satellite attitudes. We interpret differences between primary and secondary SC data as observations of noise in the SC instruments. Two distinct noise components are revealed: a deterministic component, which is highly correlated with the satellite's true anomaly, and a stochastic component. We build noise models that accurately describe each component. This allows realistic realizations of SC noise to be generated.

We propagate SC noise realizations into inter-satellite accelerations (ISA) and analyse them in the spectral domain. We show that SC noise may provide a significant contribution to the overall error budget in ISA. In the frequency range 3–10 mHz, for instance, SC errors may become comparable with the total noise.

Furthermore, SC noise is propagated into monthly gravity field models and is compared with the estimated total impact of noise in GRACE data. We show that existing gaps in SC data series amplify SC noise by 20% above 10 mHz in terms of ISA and by 8% in terms of constrained (i.e. filtered) gravity field models. Furthermore, we identify periods of poor attitude control in the GRACE time-series by inspecting the inter-satellite pointing angles. We found that the attitude control was particularly poor between February 2003 and May 2003. During these months, SC noise is likely the dominant source of errors in GRACE gravity field models.

Our findings are particularly relevant for future satellite gravity missions, in which inter-satellite ranges will be measured with laser interferometers to achieve more accurate gravity field models. In order to benefit from the high performance of these sensors, the role of SC noise has to be carefully analysed.