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Latest Moon gravity field solutions from GRAIL data using the Celestial Mechanics Approach

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The NASA mission GRAIL inherits its concept from the GRACE mission to determine the gravity field of the Moon. The use of inter-satellite Ka-band range-rate (KBRR) observations enables data acquisition even when the spacecraft are not tracked from the Earth. The data allows for a highly accurate estimation of the lunar gravity field on both sides of the Moon, which is leading to huge improvements in our understanding of its internal structure and thermal evolution. In this presentation we discuss the latest GRAIL-based lunar gravity fields generated with the Celestial Mechanics Approach using the Bernese GNSS Software.

We recently presented our solutions up to d/o 200, where KBRR observations and position data (GNI1B products) were used to solve for the lunar gravity field parameters in a generalized orbit determination problem. As a further extension of our processing, the GNI1B positions are now replaced by the original Doppler observations of the Deep Space Network (DSN) to allow for a completely independent determination of the lunar gravity field. Based on Doppler data, we perform orbit determination by solving six initial orbital elements, dynamical parameters, and stochastic parameters in daily arcs using least-squares adjustment. The pseudo-stochastic parameters are estimated to absorb deficiencies in our dynamical modeling (e.g. due to non-gravitational forces). Doppler and KBRR data are then used together with an appropriate weighting for a combined orbit determination process. We present our latest results in the orbit determination of GRAIL over the primary mission phase (PM, March-May 2012) and our first lunar gravity fields based on Doppler and KBRR observations.

We compare all of our results from the PM with the most recent lunar gravity field models released by other groups, as well as their consistency with topography-induced gravity.