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GRAIL gravity field recovery using the short-arc integral equation technique

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Abstract

We present an updated version of the lunar gravity field model GrazLGM200a [1] derived from inter-satellite observations collected by the GRAIL mission. We propose to exploit the ranging measurements by an integral equation approach using short orbital arcs. To improve the predecessor model we refined modeling and parameterization. Validation shows that the applied technique is well suited to recover the lunar gravity field.

1. Introduction

The NASA lunar science mission Gravity Recovery And Interior Laboratory (GRAIL) uses Ka-band range-rate measurements (KBRR) between the two satellites “Ebb” and “Flow” in order to resolve the lunar gravity field with unprecedented resolution and accuracy. This satellite-to-satellite tracking technique is independent of the tracking capability from Earth, thus allowing data acquisition on the near side and the far side of the Moon. The GRAIL mission plays a key role to improve our understanding of the Moon’s interior structure and its thermal evolution, as well as the evolution of the terrestrial planets in the solar system. The science phase was subdivided into a primary mission (March 1 to May 29, 2012) and an extended mission (August 30 to December 14, 2012). For our current gravity field investigations we focus on data from the primary mission.

2. Methods & Results

To determine the lunar gravity field we analyze the KBRR observations within an integral equation approach using short orbital arcs. The basic idea of the technique is to reformulate Newton’s equation of motion as a boundary value problem. This method has already been successfully applied for the recovery of the Earth’s gravity field [2] from data provided by the Gravity Recovery And Climate Experiment (GRACE, [3]). In this contribution we pay particular attention to processing details associated with the error structure of the observations (covariance functions), time bias estimation between Ka-band measurements and orbit information, and the modeling of non-gravitational forces acting on the spacecraft. On this basis we computed a refined version of the lunar gravity field model GrazLGM200a. Finally, a validation with recent GRAIL models computed at NASA-GSFC [4] and NASA-JPL [5] is performed.

Acknowledgement

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References

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