Geophysical Research Abstracts,
Vol. 10, EGU2008-A-02671, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-02671
EGU General Assembly 2008

Simulation study for the determination of the lunar gravity field from PRARE-L tracking onboard the German LEO mission

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A simulation study has been performed at GFZ Potsdam, which shows the anticipated improvement of the lunar gravity field model with respect to current (LP150Q model) or near-future (SELENE) knowledge in the framework of the planned German Lunar Explorations Orbiter (LEO) mission (currently in phase A), based on PRARE-L (Precise Range And Range-rate Equipment – Lunar version) Satellite-to-Satellite (SST) and Earth-satellite (EST) tracking observations. It is shown that the global mean error of the lunar gravity field can be reduced to about 0.2 mGal at a spatial resolution of 50 km. In the spectral domain, this means a factor of 10 (long wavelengths) and some 100 (mid to short wavelengths) improvement as compared to predictions for SELENE or a factor of 1000 with respect to LP150Q. Furthermore, a higher spatial resolution of up to 28 km seems feasible and would correspond to a factor of 2-3 improvement of SELENE results. Moreover, PRARE-L is expected to derive the low-degree coefficients of the lunar gravity field with unprecedented accuracy. Considering long mission duration (at least 1 year is planned) this would allow for the first time a precise direct determination of the low-degree tidal Love numbers of the Moon and, in combination with high precision EST, would provide an experimental basis to study relativistic effects such as the periselenium advance in the Earth-Moon system.