Geophysical Research Abstracts,
Vol. 11, EGU2009-6244-1, 2009
EGU General Assembly 2009

Spatially-restricted spectral constraint for planetary gravity field recovery: Application to the global gravity field determination of the Moon and other planets

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The gravitational fields of the planetary bodies have been modeled by analyzing satellite tracking data with spherical harmonic basis functions. However, the direct tracking of the lunar-orbiting satellites from the Earth is not possible due to synchronous rotation of the Moon about the Earth. There are no direct Doppler measurements over a large part of the far side, accounting for 40% of the entire surface. Consequently, the modeling of the lunar gravity field with such large data gap on the far side with spherical harmonic functions (non-localized and global spherical basis functions) requires some kind of empirical regularization by controlling the spectral power of each coefficient (such as Kaula constraint) to obtain stable (although possibly biased) solutions. Han [2008] has argued that the global gravity field can be modeled using the raw Doppler shift data by implementing the alternative basis functions, regionally-concentrated harmonic basis. Its advantage over the ubiquitous spherical harmonic representation is that the near side of lunar gravity field can be estimated without introducing a bias such as Kaula constraint. It will be also possible to construct the near side gravity field to a higher resolution (higher degrees and orders) and the far side gravity with a low resolution simultaneously. We present the on-going effort on the planetary gravity modeling by means of localized harmonic basis. We discuss new methods to implement the Kaula constraints effective only within a limited area on a sphere. The results from the actual data processing for the global gravity fields of the Moon and other planets are presented.