Geophysical Research Abstracts, Vol. 8, 02719, 2006
SRef-ID: 1607-7962/gra/EGU06-A-02719

New functional model for computing the Earth's gravity field on the basis of KBR data from the GRACE satellite mission

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There is a number of criteria that a functional model must satisfy in order to make gravity field modeling accurate and numerically efficient, e.g.: (i) the primary observations must be treated as they are; corrections that introduce not negligible errors must be avoided whenever possible; (ii) the functional model must be linear; (iii) the functional model must be "local", i.e. measurement(s) at a particular location must be related to the gravity field in the vicinity of this location; (iv) nuisance parameters must be avoided whenever possible; (v) it is advisable to have a matrix of normal equations that allows a preconditioner (an approximation of the normal matrix) to be computed and inverted efficiently; a very powerful pre-conditioned conjugate gradient technique can be used then to solve the system of normal equations. A number of functional models for processing GRACE KBR data have been already proposed (e.g. variational equations approach, energy balance approach, acceleration approach, approach based on integration of short arcs). Unfortunately, neither of the proposed functional models fully satisfies the criteria listed above. This was the reason to develop a new functional model that matches the identified criteria much better. The proposed functional model is analyzed both in terms of the accuracy of results and in terms of the numerical efficiency. A special attention is paid to proper modeling of data noise, which is strongly dependent on frequency in our case.