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首页 | 期刊介绍 | 编委会 | 投稿指南 | 期刊订阅 | 广告合作 | 留 言 板 |

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基于卫星轨道扰动理论的重力反演算法

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The algorithm of Earth's gravitational field recovery based on satellite's orbital perturbatic

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摘要 为了更充分利用低轨重力卫星的高精度观测数据,根据卫星轨道的扰动理论,导出了应用卫星轨道与星间距离观测值联合 重力场模型的算法.该算法的实质是将牛顿运动方程在卫星轨道处进行展开,转化为第二类Volterra积分方程,并采用基于移 次多项式内插公式进行数值求解.给出了该算法的观测方程,用QR分解法消去局部参数矩阵,最后采用预条件共轭梯度法求解 用GRACE卫星2008-01-01~2008-08-01时间段内的轨道及星间距离观测数据,解算了120阶次的地球重力场模型SWJTU GRACE01S,该模型在120阶处的阶方差为1.58×10^{-8},大地水准面差距累计误差为22.29 cm,与美国GPS水准网比较的标 0.793 m,结果表明:SWJTU-GRACE01S模型精度介于EIGEN-GRACE01S与EIGEN-GRACE02S模型之间,从而验证了该 性.

关键词: 卫星轨道扰动 地球重力场模型 牛顿运动方程 星间距离 多项式内插 QR分解

Abstract: In order to make full use of precise observations of low orbital gravity satellites, the algorith Earth's gravitational field recovery by using the combined observations of satellite's orbits and inter-sate ranges has been presented based on satellite's orbital perturbation theory. The key point of this algorith derive the linearized expression from Newton's nonlinear equation of motion by Taylor linear expansion or measured orbits such as kinematical orbits as approximate values. The interpolation formula of shifted po to degree 9 has been used to resolve the second Volterra integration equations. The observational equa related to the satellite's orbits and inter-satellite's ranges have been derived. The regional parameters a eliminated by using QR decomposition, the global parameters are then solved by the preconditioned conj gradient approach. An Earth's gravitational field model up to degree and order 120 named SWJTU-GRACE been resolved by using GRACE datum between 2008-01-01~2008-08-01. The degree variance and cumu geoid height of the model are 1.58×10^{-8} and 22.29 cm respectively. The standard deviation of the mode compared to GPS leveling networks of USA is 0.793 m. The results show that the precision of the model GRACE01S is between EIGEN-GRACE01S and EIGEN-GRACE02S up to the same degree and order.

Keywords: Satellite's orbital perturbations Earth's gravitational field model Newton's equations of m Inter-satellite's ranges Polynomial interpolation QR decomposition

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