地球物理学报
CHINESE JOURNAL OF GEOPHYSICS

地球物理学报 » 2012, Vol. 55 » Issue (3) :822-832 doi:10.6038/j.issn.0001-5733.2012.03.012
空间物理学★大气物理学★重力学与大地测量学

引用本文(Citation):
郑伟, 许厚泽, 钟敏, 员美娟.插值公式、相关系数和采样间隔对GRACE Follow-On 星间加速度精度的影响. 地球物理学报, 2012,55(3): 822-832,doi: 10.6038/j.issn.0001-5733.2012.03.012

ZHENG Wei, HSU Hou-Tse, ZHONG Min, YUN Mei-Juan.Impacts of interpolation formula, correlation coefficient and sampling interval on the accuracy of GRACE Follow-On intersatellite range-acceleration.Chinese J.Geophys. (in Chinese),2012,55(3): 822-832,doi: 10.6038/j.issn.0001-5733.2012.03.012

插值公式、相关系数和采样间隔对GRACE Follow-On 星间加速度精度的影响

郑伟[1], 许厚泽[1], 钟敏[1], 员美娟[2]*

1. 中国科学院测量与地球物理研究所大地测量与地球动力学国家重点实验室,武汉 430077;
2. 武汉科技大学应用物理系,武汉 430081

Impacts of interpolation formula, correlation coefficient and sampling interval on the accuracy of GRACE Follow-On intersatellite range-acceleration

ZHENG Wei[1], HSU Hou-Tse[1], ZHONG Min[1], YUN Mei-Juan[2]*

1. State Key Laboratory of Geodesy and Earth's Dynamics, Institute of Geodesy and Geophysics, Chinese Academy of Sciences, Wuhan 430077, China;
2. Department of Applied Physics, Wuhan University of Science and Technology, Wuhan 430081, China

摘要 本文基于星间加速度法开展了插值公式、相关系数和采样间隔对GRACE Follow-On星间加速度精度影响的研究. 模拟结果表明:1)适当增加数值微分公式的插值点数可有效提高插值精度. 基于9点Newton插值公式,星间加速度的插值误差为4.401×10^{-13} m•s^{-2},分别基于7点、5点和3点插值公式,插值误差增加了1.192倍、6.912倍和274.029倍. 2)适当增大相关系数可有效降低星间加速度的误差. 基于相关系数0.99,星间加速度方差为3.777×10^{-24} m^2•s^{-4},分别基于相关系数0.90、0.70、0.50和0.00,方差增加了9.780倍、22.404倍、26.217倍和26.820倍. 3)随着采样间隔增大,星间加速度方差逐渐降低,但卫星观测值的空间分辨率也同时降低,因此合理选取采样间隔有利于地球重力场精度的提高. 4)基于9点Newton插值公式、相关系数(K波段测量系统星间距离和星间速度0.85、GPS轨道位置和轨道速度0.95、星载加速度计非保守力0.90)和采样间隔10 s,利用预处理共轭梯度迭代法,精确和快速反演了120阶GRACE Follow-On地球重力场,在120阶处累计大地水准面精度为4.602×10^{-4} m.

关键词 GRACE Follow-On, 星间加速度法, 插值公式, 相关系数, 采样间隔, 地球重力场

Abstract: The studies of the impacts of the interpolation formula, correlation coefficient and sampling interval on the accuracies of the GRACE Follow-On intersatellite range-acceleration are developed using the Intersatellite Range-Acceleration Method (IRAM). The results of numerical simulation show: Firstly, the interpolation accuracy can be efficiently improved with appropriately increasing the number of the interpolation points from the numerical differential formula. The interpolation error of intersatellite range-acceleration is 4.401?10^{-13} m稫$^{-2}$ using the nine-point Newton's interpolation formula, and errors are enhanced 1.192 times, 6.912 times and 274.029 times based on the seven-point, five-point, three-point interpolation formulas, respectively. Secondly, the error of intersatellite range-acceleration is observably decreased with the proper increase of the correlation coefficients. The variance of intersatellite range-acceleration is 3.777?10^{-24} m^2稫$^{-4}$ using a correlation coefficient of 0.99, and the variances are respectively increased 9.780 times, 22.404 times, 26.217 times and 26.820 times based on the correlation coefficients 0.90, 0.70, 0.50 and 0.00. Thirdly, with increasing sampling intervals, the variances of intersatellite range-acceleration are gradually decreased, however, the spatial resolution of satellite observations will be simultaneously reduced. Therefore, the accuracy of the Earth's gravitational field can be improved due to an preferred selection of sampling intervals. Finally, the Earth's gravitational field from GRACE Follow-On complete up to degree and order 120 is accurately and rapidly recovered using the nine-point Newton's interpolation formula, correlation coefficients (0.85 in intersatellite range and intersatellite range-rate, 0.95 in orbital position and orbital velocity, and 0.90 in non-conservative force) and a sampling interval of 10 s based on the Pre-Conditioned Conjugate-Gradient (PCCG) approach, and the cumulative geoid height error is 4.602?10^{-4} m at degree 120.

Keywords GRACE Follow-On, Intersatellite range-acceleration method, Newton&rsquo, s interpolation formula, Correlation coefficient, Sampling interval, Earth&rsquo, s gravitational field

Received 2011-09-06;

Fund:

中国科学院知识创新工程重要方向青年人才项目(KZCX2-EW-QN114), 国家自然科学基金青年项目(41004006)和重点项目(41131067), 国家留学人员科技活动项目择优资助基金(2011),湖北省自然科学基金(2010CDB05301), 中国测绘科学研究院地理空间信息工程国家测绘地理信息局重点实验室开放基金(201031), 中国科学院计算地球动力学重点实验室开放基金(2011-04), 中国科学院动力大地测量学重点实验室开放基金(L09-14), 中国科学院测量与地球物理研究所知识创新工程领域前沿项目, 西南石油大学油气藏地质及开发工程国家重点实验室开放基金(PLN1113),湖北省耐火材料与高温陶瓷重点实验室-省部共建国家重点实验室培育基地开放基金(G201009)联合资助.

About author: 郑伟, 男, 1977年生, 理学博士, 副研究员, 硕士生导师, 日本京都大学博士后, 日本外籍特别研究员, 主要从事基于卫星重力测量反演地球、月球和火星重力场的理论和方法等方面研究. E-mail: wzheng@asch.whigg.ac.cn

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http://118.145.16.227/geophy/CN/10.6038/j.issn.0001-5733.2012.03.012 或 http://118.145.16.227/geophy/CN/Y2012/V55/I3/822