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武汉九峰地震台超导重力仪观测分析研究

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Observation of superconducting gravimeter at Jiufeng seismic station

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摘要 连续重力观测和GPS的技术结合能够监测到物质迁移和地壳垂直形变之间的量化关系.和相对重力测量以及绝对重力测量技术相比,其避免了时间分辨率和观测精度低,无法精细描述观测周期内的物质迁移过程问题.本文利用武汉九峰地震台超导重力仪SGC053超过13000 h连续重力观测数据;同址观测的绝对重力仪观测结果;气压数据;周边GPS观测结果;GRACE卫星的时变重力场;全球水储量模型等资料,采用同址观测技术、调和分析法、相关分析方法在扣除九峰地震台潮汐、气压、极移和仪器漂移的基础上,利用重力残差时间序列和GPS垂直位移研究物质迁移和地壳垂直形变之间的量化关系.结果表明:在改正连续重力观测数据的潮汐、气压、极移的影响后,不仅准确观测到2009年的夏秋两季由于水负荷引起的约$(6\sim8)\times10^{-8}$m·s^{-2}短期的重力变化.而且在扣除2.18×10^{-8}(m·s^{-2})/a仪器漂移和水负荷的影响后,验证了本地区长短趋势垂直形变和重力变化之间具有一致的负相关性规律.同时长趋势表明该地区地壳处于下沉,重力处于增大过程,增加速率约为1.79×10^{-8}(m·s^{-2})/a.武汉地区重力梯度关系约为-354×10^{-8}(m·s^{-2})/m.

关键词 SGC053超导重力仪, FG5-232绝对重力, 陆地水负荷, 地壳垂直形变

Abstract: The relationship between the mass transfer beneath the earth surface and the vertical deformation could be studied using continuous relative gravimetry and continuous GPS observation. Compared to mobile relative gravimetry and absolute gravimetry, continuous relative gravimetry could be used to monitor the whole process of gravity changes and mass transfer, avoiding low measurement precision and temporal resolution. In this paper, more than 13000 hours gravity data recorded at Jiufeng seismic station using superconducting gravimetry (SGC053) are analyzed along with co-located absolute gravimetry data, air pressure, vertical displacement of surrounding GPS stations, WUHN IGS site and WHJF site, GRACE monthly time-variable gravity and two global continental water storage models (GLDAS, CPC). Gravity variations induced by solid earth tide, air pressure, pole tide and continental water loading are corrected using harmonic analysis method, atmospheric pressure admittance model, pole tide model and the correlation analysis with GRACE results and/or water storage models, then instrument drift is also corrected using co-located absolute gravity measurements. Based on the above processing, the relationship between the residual gravity time series and GPS vertical deformation is addressed. The harmonic analysis result for SGC053 gravity records, spanning about one and half years, shows that the white noise is about $1.14\sim1.40\times10^{-8}$m·s^{-2} and the tidal factor errors of dominant tidal groups reach about 0.1‰. Compared to ocean tide loading (3×10^{-8}m·s^{-2}), the gravity due to air pressure (12×10^{-8}m·s^{-2}) and pole tide (10×10^{-8}m·s^{-2}) is much larger. The drift of SGC053, about 2.18×10^{-8}(m·s^{-2})/a, is estimated using 4 absolute gravity co-located records of FG5-232. The result shows that the residual gravity caused by continental water loading in summer and autumn is about $(6\sim8)\times10^{-8}$m·s^{-2}, by comparing residual gravity variations with both GARCE result and global continental water loading (GLDAS, CPC). Gravity variations corrected for water loading show perfect negative correlation with the vertical deformation of the GPS station, about 15km away from SGC053, so as to data in spring and winter. And the long-term vertical crustal deformation is subsidence and the gravity change rate is about 1.79×10^{-8}(m·s^{-2})/a. The ratio of the changes in gravity and altitude related to the local vertical crustal movement is about -354×10^{-8}(m·s^{-2})/m.

Keywords SGC053, FG5-232, Continental water loading, Vertical crustal movement

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