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Terrestrial Water Storage Variations in the Heihe River Basin Recovered by GRACE Time-Variable Earth Gravity Field

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Abstract: Heihe River is a larger inland river in the Northwestern China across the three provinces of Qinghai, Gansu and Inner Mongolia, located in the Hexi Corridor and the middle of the Qilian Mountains, from eastern longitude of 97˚37' to 102˚06' and from northern latitude 37˚44' to 42˚40'. The terrain there is complex and the water storage variation display strongly seasonal and regional features due to the precipitation difference of time and spatial distribution. It is of important significance for the ecological environment and economic construction by investigating the terrestrial water storage variations in the Heihe River basin. 48 monthly GRACE (Gravity Recovery and Climate Experiment) Earth's gravity field models for the period from January 2004 until December 2007 are used in the paper, from which the tidal effects, including oceanic tide, solid Earth tide and solid Earth pole tides are removed, as well as the non-tidal effects of atmospheric and oceanic contributions. During data processing, the GRACE Earth's gravity field models are truncated to complete degree and order 60, and the time series C_{20} are replaced by those obtained from analyzing SLR (Satellite Laser Ranging) data. Using the Gaussian filtering method with smoothing radius 700km, the terrestrial water storage variations in the Heihe River basin are recovered from the spherical harmonic coefficients of the monthly GRACE Earth's gravity field models, and then the characteristics of the terrestrial water storage changes are analyzed. The results show that the seasonal and annual feature of the terrestrial water storage variations is revealed in the Heihe River basin. The annual variations amplitude is approximately 1.6cm in terms of equivalent water height, and achieves the maximum in April and August each year. The similarities are shown well by comparing the terrestrial water storage variations recovered from GRACE temporal gravity field to those from CPC (Climate Prediction Center) hydrological model. Both of them reveal the obviously seasonal characteristics of the terrestrial water storage variations, and the amplitude difference is less than 0.5cm. The groundwater storage variation are obtained by combining the terrestrial water storage variation recovered from GRACE with the changes in solid moister and snow water equivalent calculated from GLDAS (Global Land Data Assimilation System) hydrological model. It is concluded that GRACE time variable gravity field can reveal the variations of the terrestrial water storage more or less in Heihe River basin in the spatial scale, and the seasonal and annual changes obviously in the time scale. The terrestrial water storage variations recovered from GRACE temporal gravity field still have valuable applications in smaller river basin.

Key words: Heihe River basin; GRACE; time-variable Earth's gravity field; terrestrial water

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