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Terrestrial water storage change of European Russia and its impact on water balance

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Terrestrial water storages (TWS - storages of surface and ground waters in all aggregate states) have a significant impact on the water balance of river basins. There are four main methods to determine the value of TWS. The first is the calculation of TWS as a residual term in the water balance equation. In this case, TWS can be calculated only for a river basin or a section of a river basin between gauging sections. The second method is the component-wise accounting of all the components of TWS. It is rather time-consuming, requires ground-based observations and is applicable only for small catchment areas. The third option is to simulate a hydrological cycle for a certain area. Due to the fact that the study of the total water storages is rarely the aim of studies by itself, they are calculated to validate a model. The fourth method used in the GRACE (Gravity Recovery and Climate Experiment) project is based on the impact of water mass redistribution on the Earth's gravitational field. We used last two methods for evaluation of terrestrial water storages of river basins of European Russia (ER). The analysis of a change in TWS in ER, beginning with the second half of the 20th century, according to the GRACE data has shown that the growth of TWS in ER in the second half of the 20th century was replaced by a decline for the southern half of European Russia in the 21st century, which was the most significant in the Don basin, where the rate of a decline is 14 mm/year for 2002-2015. There were no significant changes for the northern half of European Russia. The months of the minimum and the maximum annual water storages were calculated for this period to analyze the seasonal movement of TWS. Clear zoning is noted both for the time of the maximum and the minimum water storages. The presence of a quasilinear relation between the values of terrestrial water storages and a river runoff for the low flow period for a number of rivers has been revealed. The obtained dependences can be used to calculate a river runoff and its probability distribution function.
Ninety-seven monthly TWS retrieval from GRACE data (from April 2002 to December 2009) was examined and compared with TWS-estimates obtained by the ECOMAG hydrological model simulations. The case study was carried out for the some northern rivers. Quantitative analyze between the hydrological model and GRACE-based TWS showed that latter is in good consistency with the simulation results on both seasonal and inter-annual time scales. Overall, the results highlight the benefit of assimilating GRACE data for hydrological applications, particularly in data-sparse regions, while also providing insight on future refinements of the methodology of GRACE-data application in watershed hydrology.
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