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Climate change impact on terrestrial water balance components at continental and global scales

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This work is a continuation of our previous investigations performed within the framework of the International Inter-Sectoral Impact Model Intercomparison Project (ISI-MIP) on a regional scale when hydrological projections and their uncertainties were obtained for 11 large-scale river basins using the physically based land surface model Soil Water – Atmosphere – Plants (SWAP) driven by meteorological projections from five Global Climate Models (GCMs). In the present work, we decided to spread our investigations to continental and global scales. The main goals are as follows: (i) projecting changes in terrestrial water balance components in the 21st century due to possible climate change for different continents and for the whole globe, (ii) evaluation of uncertainties in the obtained projections sourced from application of different GCMs and different climatic scenarios, (iii) studying the patterns of spatial distribution of changes in the water balance components and their uncertainties.

Simulations of the water balance components (evapotranspiration and runoff) for the entire land surface of the globe (with the exception of Antarctica) were performed by the SWAP model with a spatial resolution of 0.5^{o}×0.5^{o} for the period of 1961-2099. The model was driven by daily meteorological outputs from five GCMs (including GFDL-ESM2M, HadGEM2-ES, IPSL-CM5A-LR, MIROC-ESM-CHEM, and NorESM1-M) obtained for each of four Representative Concentration Pathway (RCP) scenarios (RCP2.6, RCP4.5, RCP6.0, and RCP8.5). As a result, 20 variants of daily values of evapotranspiration, runoff, and precipitation were obtained for each calculational grid cell. Then, the climatic annual values of the water balance components for four periods (historical and three prognostic ones: 2006-2036, 2037-2067, 2068-2099) were obtained and their changes for different prognostic periods compared to historical values were calculated. Besides, uncertainties in the projected changes of the water balance components resulted from application of different GCMs and RCP scenarios were estimated. The obtained results were mapped and averaged over the continents, latitudinal zones, and the globe that allowed us to identify spatio-temporal patterns of changes in the water balance components and their uncertainties due to possible climate changes.