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Extensive validation of the global water resources model PCR-GLOBWB 2.0: the added value of human impacts

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With growing populations, economic expansion, and rising standards of living the demand for water is increasing across the globe. Demographic developments and a changing climate will further aggravate the pressure on global water resources. In the EU FP7 project EartH2Observe in-situ data, earth observations, and models will be assimilated to provide a comprehensive reanalysis of the global water resources system, accounting for all components of the global water cycle including information on the impacts of human activities, e.g., through water consumption and man-made reservoirs. Synthesizing as many sources of information as possible bears great potential to improve global water balance estimates and to consequently allow for consistent and informed decisions in water management.

One of the modelling suites participating in EartH2Observe is the global hydrological model PCR-GLOBWB (Van Beek et al., 2011) which already accounts for anthropogenic perturbations in the water cycle. Here we present an extensive validation of the latest model version PCR-GLOBWB 2.0 (Sutanudjaja et al., 2014) which comprises dynamic withdrawal, allocation and consumptive use of ground- and surface water resources, irrigation, return flows of unconsumed water to surface water and groundwater resources, and more than 6000 reservoirs of the GRanD database.

This study presents the first step towards a full reanalysis merging earth observations, in-situ data and models. We focus on human activities altering the hydrologic cycle over the past 30 years by evaluating PCR-GLOBWB "natural" and "humanly-modified" simulations in $0.5^\circ \times 0.5^\circ$ spatial and daily temporal resolution. To this end our model is forced with the newly available WFDEI (WATCH Forcing Data methodology applied to ERA-Interim data) data set. PCR-GLOBWB 2.0 simulations of river discharge, water abstraction and water use are validated against observations from the Global Runoff Data Centre as well as available national and globally reported statistics on human water consumption (e.g. AQUASTAT, USGS water data). Terrestrial water storage (TWS) simulated by our model is compared with TWS-signals from the GRACE satellite observation to analyze anthropogenic impacts particularly in highly regulated basins.

The first evaluation results indicate that "humanly-modified" simulations are overall in better agreement with the observed reference data. However, for some areas of the world the introduction of man-made components in the water cycle reduces the model performance. This could be attributed to simplistic process representation (of e.g. abstraction and reservoirs) for some catchments but still has to be investigated in more depth. The presented simulations serve as important benchmark. Their performance will allow for constant evaluation of planned improvements in the representation of water cycle processes through forcing, modelling, and assimilation of earth observation data.