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Development and validation of PCR-GLOBWB 2.0: a 5 arc min resolution global hydrology and water resources model

Edwin H. Sutanudjaja (1), Ludovicus P. H. van Beek (1), Yoshihide Wada (1), Dominik Wisser (3), Inge E. M. de Graaf (1), Menno W. Straatsma (1), Marc F. P. Bierkens (1,2)

(1) Utrecht University, Dept. of Physical Geography, Utrecht, Netherlands (e.h.sutanudjaja@uu.nl, +31 (0)30 253 2988), (2) Deltares, Unit Soil and Groundwater Systems, Utrecht, Netherlands, (3) University of Bonn, Center for Development Research, Bonn, Germany

PCR-GLOBWB (PCRaster Global Water Balance) is a grid-based global hydrological model developed at the Department of Physical Geography, Utrecht University. For each grid cell, PCR-GLOBWB simulates moisture storage in vertically stacked soil layers, as well as the water exchange to the atmosphere and underlying groundwater reservoir. Exchange to the atmosphere comprises of precipitation, evaporation and transpiration, as well as snow accumulation and melt. All fluxes are all simulated by considering vegetation phenology and sub-grid variations in elevation, land cover and soil saturation. The model includes physically-based schemes for runoff-infiltration partitioning, interflow, groundwater recharge and baseflow, as well as river routing of discharge.

Here we present and summarize the latest developments of PCR-GLOBWB. The new version of the model, PCR-GLOBWB 2.0, now runs at a spatial resolution of 5 arc min (about 10 km at the equator) and supersedes the previous generation of the model (30 arc min PCR-GLOBWB 1.0, van Beek et al., 2011). PCR-GLOBWB 2.0 consolidates all components that have been introduced since PCR-GLOWB 1.0 was first published (2011). Examples of these new components are:

- A comprehensive water demand and irrigation module (Wada et al., 2012).
- A dynamic attribution and return flow of water demand to surface water and groundwater resources (de Graaf et al., 2013).
- An advanced surface water routing scheme with wetland, lakes and floodplains of variable extent, thus simulating flooding and flood wave attenuation (Winsemius et al., 2013).
- An online scheme for dynamic withdrawal, allocation and consumptive use of groundwater and surface water resources, including a progressive introduction of reservoirs (Wada et al., 2013).
- Further development will include the inclusion of a dynamic reservoir operation/optimization scheme and a MODFLOW lateral groundwater flow module (Sutanudjaja et al., 2011; Sutanudjaja et al., 2014).

Also, scripts used for deriving the parameterization from global data sources for the original model have been coupled with the model, resulting in a near-scalable model that facilitates its application for different domains and at varying resolutions.

Results are very promising. When comparing simulated discharges to those observed by GRDC stations, the coefficient-of-determination is high. Human impacts, altering the seasonal and inter-annual variability of terrestrial water storage (TWS) signals, are well simulated by PCR-GLOBWB 2.0 and evident in the validation of simulated TWS with GRACE satellite observation (Tapley et al., 2004). Moreover, the simulation results of PCR-GLOBWB 2.0 compare well to several other remote sensing products, such as the soil moisture datasets of ERS/MetOp (Wagner et al., 1999) and AMSR-E (de Jeu and Owe, 2003), as well as the GLEAM evaporation product (Miralles et al., 2011).

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