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How sensitive is the estimation of renewable water resources on a global scale to input data and model structure?

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Large scale hydrological models and land surface models are applied to simulate the global terrestrial water cycle and to estimate global renewable water resources. In recent years the growing availability of global data sets to force and constrain these models, e.g. remote sensing and reanalysis products, has essentially improved estimates of renewable water resources. However, results still vary significantly between models and/or input data sets highlighting the uncertainty of those estimates.

In this study, we will test the sensitivity of simulated renewable water resources to climate and land use data sets and to varying model complexity using the global hydrological model WaterGAP (Water Global Analysis and Prognosis), version 2.2. The model is calibrated against observed discharge records by adjusting one independent parameter, which controls the fraction of total runoff from effective precipitation. The aim is to minimize the discrepancy in simulated long-term annual discharge compared to measured ones. Due to e.g. model structure or input data uncertainty this calibration procedure is not successful in all river basins, i.e. simulated long-term annual discharge still deviates more than +/- 1 % from the observed one. In these cases, correction factors are applied to avoid error propagation to downstream catchments. In this context, we define calibration success as the ability to calibrate with a minimum of correction factors, which is an indicator of the model's ability (including the underlying input data) to reproduce observed long term discharge.
In order to assess the impact of different input data sets and modified model structure on calibration success, model calibration was performed in three different experimental setups: (1) WaterGAP was forced with different climate input data sets (WATCH Forcing Data; CRU TS 3.2/GPCC v.6) to evaluate the impact of climate input, especially precipitation; (2) WaterGAP simulations were based on two different global land cover products, the Global Land Cover Characteristics Data Base (GLCC) and the MODIS Land Cover Type product to see the impact of land use and its dependent attributes; and (3) the model structure was reduced to examine the influence of structural model changes on the calibration success.

First results show a strong impact of input data on renewable water resources, especially due to the precipitation input. Also, land use has a significant influence on radiation and PET calculation. Within this presentation, first results of the modeling experiment are shown, including input data characteristics and estimates of renewable water resources from the different calibration configurations. Furthermore, the influence on the calibration success is discussed.