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Anthropogenic impacts on the global water cycle – a multi model approach.

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Humans activities have a large impact on the global water cycle. Through the building of dams and irrigation schemes large amounts of water are diverted from river systems. Through the emission of greenhouse gases causing global warming, also the rainfall and evaporation patterns are changed across the globe. It is, however, still difficult to quantify current and future impacts on the global water cycle due to limited data availability, model imperfections and large uncertainties in climate change projections. To partly overcome these limitations we used a multi-model approach to study anthropogenic impacts on the global water cycle. Four different global hydrological models (H08, VIC, WaterGAP and LPJml) were forced with an historical climate dataset (Watch Forcing Data) and bias corrected output of three different global climate models (Echam, IPSL and CNRM) using two emission scenarios (A2 and B1). In addition the LPJml model was also run with two different land use change scenarios. Combining the water availability simulations with the water demand scenarios developed within the Watch project we also analyzed current and future water scarcity. The analyses show that current human impacts and on the water cycle are especially high in Central Asia, parts of Europe, the Southwestern US and the Murray-Darling Basin in Australia. The model comparison of agricultural water use and demand showed that the differences in total global agricultural demand and water use were relatively smaller than the differences in simulated water availability. All models showed agricultural water extractions are high in South and East Asia in particular in Northern India and Pakistan and in Northeast China. The most important spatial differences between the different models was observed for Northern China where H08 showed much higher water demands than VIC. Future analyses showed that climate change impacts on the global water cycle are potentially high especially in the semi-arid regions. Although there were considerable differences in the four hydrological models in general all models predicted the same direction of change. In conclusion the analyses showed that both under the B1 and the A2 scenarios the percentage of agricultural water demand than cannot be fulfilled by surface and ground-water will increase. Water shortages will be much higher under the A2 than under the B1 scenario. In conclusion using a multi model approach gives a more robust quantification of possible future anthropogenic impacts on the global water cycle.