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Prediction of long-term trends in groundwater levels of a perialpine groundwater system: comparing different climate models and different downscaling procedures

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For Switzerland, due to the reduction of the storage of water in solid form (snow and glaciers) the importance of aquifers for water supply increases and the impact of climate change on groundwater resources is highly relevant. High resolution regional climate models are commonly used to analyze the impacts of climate change on hydrological systems. However, usually the focus is on streamflow, not on groundwater and only little attention is paid to the sensitivity of the results with respect to the driving climate model. We applied the MIKE-SHE model, which models land-atmosphere interaction by coupling the water and energy balance at the soil-atmosphere interface, on a perialpine, small catchment in northern Switzerland near Zurich. There, drinking water is pumped and a significant drawdown was observed during the summer drought in 2003. To examine the impact of climate change we forced the hydrological model with data from several regional climate models (RCM). To distinguish between the influence of the driving global climate model (GCM) and the used RCM on the climate change signal, calculations with different GCM-RCM combinations were carried out. Each of the GCM-RCM combinations shows systematic biases which are corrected by downscaling methods, not only for precipitation but also for the variables that govern potential evapotranspiration. The simulations for the period 2010-2100 show positive and negative trends in groundwater head, primarily dependent on the precipitation trend of the climate model. It was found that conceptual uncertainty with respect to the climate model and the downscaling procedure had an important impact on the uncertainty of the prediction of long-term groundwater level trends. These uncertainties are discussed and compared to the uncertainties deriving from parameter identification (soil and vegetation parameters) and possible adaption strategies (irrigation).