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The effects of model complexity and calibration period on groundwater recharge simulations

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A significant number of groundwater recharge models exist that vary in terms of complexity (i.e. structure and parametrization). Typically, model selection and conceptualization is very subjective and can be a key source of uncertainty in the recharge simulations. Another source of uncertainty is the implicit assumption that model parameters, calibrated over historical periods, are also valid for the simulation period. To the best of our knowledge there is no systematic evaluation of the effect of the model complexity and calibration strategy on the performance of recharge models. To address this gap, we utilized a long-term recharge data set (20 years) from a large weighting lysimeter. We performed a differential split sample test with four groundwater recharge models that vary in terms of complexity. They were calibrated using six calibration periods with climatically contrasting conditions in a constrained Monte Carlo approach.

Despite the climatically contrasting conditions, all models performed similarly well during the calibration. However, during validation a clear effect of the model structure on model performance was evident. The more complex, physically-based models predicted recharge best, even when calibration and prediction periods had very different climatic conditions. In contrast, more simplistic soil-water balance and lumped model performed poorly under such conditions. For these models we found a strong dependency on the chosen calibration period. In particular, our analysis showed that this can have relevant implications when using recharge models as decision-making tools in a broad range of applications (e.g. water availability, climate change impact studies, water resource management, etc.).