Geophysical Research Abstracts
Vol. 17, EGU2015-12157, 2015
EGU General Assembly 2015

Simulation of shallow groundwater levels: Comparison of a data-driven and a conceptual model

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Despite an abundance of models aimed at simulating shallow groundwater levels, application of such models is often hampered by a lack of appropriate input data. Difficulties especially arise with regard to soil data, which are typically hard to obtain and prone to spatial variability, eventually leading to uncertainties in the model results. Modelling approaches relying entirely on easily measured quantities are therefore an alternative to encourage the applicability of models.

We present and compare two models for calculating 1-day-ahead predictions of the groundwater level that are only based on measurements of potential evapotranspiration, precipitation and groundwater levels. The first model is a newly developed conceptual model that is parametrized using the White method (which estimates the actual evapotranspiration on basis of diurnal groundwater fluctuations) and a rainfall-response ratio. Inverted versions of the two latter approaches are then used to calculate the predictions of the groundwater level. Furthermore, as a completely data-driven alternative, a simple feed-forward multilayer perceptron neural network was trained based on the same inputs and outputs.

Data of 4 growing periods (April to October) from a study site situated in the Spreewald wetland in Northeast Germany were taken to set-up the models and compare their performance. In addition, response surfaces that relate model outputs to combinations of different input variables are used to reveal those aspects in which the two approaches coincide and those in which they differ. Finally, it will be evaluated whether the conceptual approach can be enhanced by extracting knowledge of the neural network. This is done by replacing in the conceptual model the default function that relates groundwater recharge and groundwater level, which is assumed to be linear, by the non-linear function extracted from the neural network.