EGU2020-2874
https://doi.org/10.5194/egusphere-egu2020-2874
EGU General Assembly 2020

Using Convolutional Neural Networks for the prediction of groundwater levels

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The temporal prediction of groundwater levels plays an important role in groundwater management, such as the estimation of anthropogenic impacts as well as consequences of climatic changes. Therefore, the modeling of groundwater levels using physics-based approaches is an integral part of hydrogeology. However, data-driven approaches have only recently been used, in particular for the prediction of groundwater levels using machine learning techniques (e.g., Random Forest and Neural Networks). For this purpose, one model per observation well or time series is always set up. In order to further develop this, an approach is presented which uses a single model for the prediction of groundwater levels at several observation wells (n > 200). The model is a three-dimensional Convolutional Neural Net (CNN).
In addition to the time series of groundwater levels meteorological data on precipitation (P) and temperature (T) serves as additional input channels. The CNN "sees" not only the P- or T-value of the grid cell in which the observation well lies, but also surrounding values. This has the advantage that even influences of meteorological patterns in the spatial vicinity of the observation well on the groundwater level can be learned. The forecasts are calculated for periods up to six months. In addition to the comparison with the measured values, a comparison of the error averaged over all observation wells compared to a baseline model is used for the validation. To further improve predictability, the hyperparameters are optimized and other area data (e.g., geology, soil properties, land use) used as input. This model should form the basis for a regionalized forecast of groundwater levels.