EGU22-3825
https://doi.org/10.5194/egusphere-egu22-3825
EGU General Assembly 2022

Karst spring discharge modeling based on deep learning using spatially distributed input data

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Despite many existing approaches, modeling karst water resources remains challenging and often requires solid system knowledge. Artificial Neural Network approaches offer a convenient solution by establishing a simple input-output relationship on their own. However, in this context, temporal and especially spatial data availability is often an important constraint, as usually no or few climate stations within a karst spring catchment are available. Hence spatial coverage is often unsatisfying and can introduce severe uncertainties. To overcome these problems, we use 2D-Convolutional Neural Networks (CNN) to directly process gridded meteorological data followed by a 1D-CNN to perform karst spring discharge simulation. We investigate three karst spring catchments in the Alpine and Mediterranean region with different meteorologic-hydrological characteristics and hydrodynamic system properties. We compare our 2D-models both to existing modeling studies in these regions and to own 1D-models that are conventionally based on climate station input data. Our results show that our models are excellently suited to model karst spring discharge and rival the simulation results of existing approaches in the respective areas. The 2D-models show a better fit than the 1D-models in two of three cases, learn relevant parts of the input data themselves and by performing a spatial input sensitivity analysis we can further show their usefulness to localize the position of karst catchments.