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Benefits of parsimonious representations of hydrological processes in Earth System Models

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The representation of hydrological processes in Earth System Models has improved significantly over recent years. This advancement has led to more realistic and higher resolution models, but has come at the cost of higher computational demand as well as a larger number of parameters that have to be estimated from often uncertain information. Higher complexity can make model testing more difficult to due to a high degree of parameter interactions and a related inability to assess the controlling processes in a model. Parsimonious models can, on the other hand, provide useful insight into dominant controls while being more applicable to a model diagnostic approach (incl. uncertainty and sensitivity analyses). They can also be rejected easier, which means we can better evaluate assumptions regarding key hydrologic processes. Here, we discuss benefits of building and using parsimonious parameterizations of key hydrological processes which are ultimately targeted at ESM applications. We present key steps in model development focusing on surface-subsurface interactions, in particular the role of groundwater dynamics, on preferential flow of water in soils, and on vegetation controls. We discuss the benefits of using more complex models in the development of such parsimonious representation of these hydrological processes. In addition, we highlight the benefits of model testing using both synthetic experiments as well as real-world observations.