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Inter-comparison of three distributed hydrological models with respect to seasonal variability of soil moisture patterns at a small forested catchment.

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The objective of this study is to inter-compare three spatially distributed hydrological models (HydroGeoSphere, MIKE SHE and ParFlow-CLM) by means of their ability to simulate soil moisture patterns. This study pools the catchment modelling efforts which have been undertaken at the Wüstebach catchment; one of TERENO's hydrological observatories. The catchment is densely instrumented with a wireless sensor network (SoilNET) which allows continuous measurements of the spatio-temporal soil moisture dynamics. This unique dataset is ideal to benchmark hydrological models as it poses distinct challenges like seasonality and spatial heterogeneity. Two scenarios of soil parametrization assess the modelling implications of moving from homogeneous to heterogeneous porosity. The three given models perform well in terms of discharge and accumulated water balance components. However, their ability to predict soil moisture is found to be more diverging. Interpretations are ambiguous and depend on what performance metric and what level of spatial aggregation is chosen. In comparison to the other models, ParFlow-CLM performs more accurate at predicting the temporal dynamics and the heterogeneity aggregated to catchment scale. Nevertheless, at local scale HydroGeoSphere and MIKE SHE provide more detailed soil moisture predictions. Overall, a clear increase in performance can be attested to the scenario that includes heterogeneous porosity. Next to soil parametrization, topography is among the main drivers of soil moisture variability which was found to have an overemphasized feedback in ParFlow-CLM compared to the other models. This study stresses that further efforts toward spatially distributed input data need to emerge alongside a more suitable soil parametrization that can account for the observed heterogeneity and seasonality of soil moisture.