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Development of a stand-alone Multiscale Parameter Regionalization (MPR) tool for the estimation of effective model parameters for any distributed model

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A common challenge in environmental modeling is to make use of available data at hand in the estimation of a variable of interest. In particular, modeling requires parameters and forcing variables at a given modeling scale. There often exist concepts to handle aggregation (upscaling) or disaggregation (downscaling) on a temporal scale in case of diverging model and forcing data time steps. The establishment of common best practices for handling spatial heterogeneity at different scales still remains an open task.
A robust approach to tackle this challenge is the Multiscale Parameter Regionalization (MPR). In principle, it translates local land surface properties into model parameters and performs their upscaling to the relevant scale for hydrological processes. MPR consists of two steps. First, the regionalization of available geophysical land surface characteristics (e.g., soil texture classes) into model parameters using pedotransfer functions. Second, the regionalized parameters are upscaled to the required modeling scale by an appropriate upscaling operator. The technique was introduced into the mesoscale hydrologic model (mHM, Samaniego et al. 2010, Kumar et al. 2013) and is key factor for its success on transferring parameters across scales and locations. In addition to that, it effectively addresses the problem of over-parameterization. Applications of MPR to other models were so far hindered by hard-coded configurations and its non-modular software design.

For these reasons we redesign MPR as a model-agnostic, stand-alone tool. Its object-oriented, modern Fortran code was rewritten and modularized so that it can be easily coupled to any spatially distributed model. The user can now freely set any pedotransfer function, choose upscaling operators from an extended library or use own plug-ins. Another key feature allows the user to estimate effective parameters at non-regular grids and even polygons through the use of weights.

We verify our tool against its previous version and show results when coupling it with mHM, as a proof-of-concept. Examples of the generation of soil hydraulic parameters for the land-surface model Noah-MP using well-established pedotransfer functions is also shown.

References:
Samaniego L., et al. https://doi.org/10.1029/2008WR007327
Kumar, R., et al. https://doi.org/10.1029/2012WR012195