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Multiscale parameter regionalization of a grid-based hydrologic model at the mesoscale

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The requirements for spatially distributed hydrologic models at the mesoscale have increased considerably during the previous decades to cope with the resolution of extensive remotely sensed datasets and a number of demanding applications such as regional circulation models and/or realtime streamflow forecasting. Most of the existing models, however, exhibit deficiencies for these applications, namely: the overparametrization, the lack of an effective technique to integrate the spatial heterogeneity of soils, vegetation and topography into the model, the non-transferability of the model parameters across scales and locations, and the large predictive uncertainty of model outputs. These issues are intrinsically related with the parameterization of a given model. A multiscale regionalization technique is proposed as a way to address these issues. Using this technique, the model parameters at a coarser scale, in which the dominant hydrological processes are represented, are linked with their corresponding ones at a finer resolution in which the datasets are available. Usually, the resolution of these scales is (1000×1000) m and (100×100) m, respectively. The linkage is done with upscaling operators such as the harmonic mean, the geometric mean, the maximum value, among others. Model parameters at the finer scale, in turn, are regionalized with catchments descriptors through nonlinear transfer functions. The global parameters—which are very few compared with the total number of model parameters—required for these transfer functions are found through calibration. Results obtained in 38 river basins located in Southern Germany indicated that this regionalization technique is an effective way to reduce overparametrization and hence predictive uncertainty of model outputs (up to 50% in peak flows). Crossvalidation tests indicated that the transferability of the global parameters to other basins is possible. The maximum reduction of the model efficiency in the crossvalidation experiments was at most 5%. Moreover, this regionalization technique appears to be much more robust than other regionalization techniques frequently used in the literature.