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Sub-grid heterogeneity representation of soil parameters for distributed hydrological modelling

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In the perspective of distributed hydrological modelling at catchment scale it is important to understand the scale at which heterogeneities are averaged and how much of the heterogeneity should be included in modelling units. If it is selected a coarse spatial resolution, the spatial variability effect may be lost and errors may occur due to omitting relevant information. However, if high spatial resolution is used, parameter identifiability is reduced. So, it is valuable the study of the spatial variability effect on the aggregation of hydrological processes.

In this work, we present an approach to analyze the relevance of sub-grid heterogeneities of soil parameters in the framework of a distributed hydrological model. It was studied the spatial scale effect on the effective static storage capacity parameter Hu and effective saturated hydraulic conductivity parameter ks at two supports. Those parameters are used by infiltration process conceptualization in the TETIS distributed hydrological model. First, it was performed stochastic simulations based on latin hypercube sampling and Cholesky factorization to generate random parameter fields at microscale support (sub-grid level). And then, effective parameters were calculated at mesoscale support by solving the inverse problem for each realization of the different stochastic processes. Results of the aggregation procedure point out that the value of the effective parameters at mesoscale support is between zero and the mean value of the parameter at the sub-grid level, and depends strongly on sub-grid heterogeneity and input variables.

Results showed that the statistical structure of a set of random parameter fields influences the determination of a cell size that describes the characteristics of a representative elementary area, and that REA size depends mainly on the correlation length, which can vary spatially. In a particular case, REA size would therefore be dominated not only by hydrological attributes, but would also be influenced by the statistical characteristics of the attributes. This means that the concept and determination of REA size are associated with both the hydrological attributes of a watershed and its statistical characteristics. We found that the ratio between spatial cell discretization and spatial correlation length is an important factor in the transfer of uncertainty between scales. From this perspective, the uncertainty in estimating the effective parameters could be reduced if the relationship between cell size and correlation length of the parameters at the sub-cell level is included in the criteria for establishing optimum cell size in the context of distributed hydrological modelling.