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Application of the Multiscale Parameter Regionalization (MPR) to the land-surface model HTESSEL

Stephan Thober, Robert Schweppe, Sabine Attinger, and Luis Samaniego
Helmholtz Centre for Environmental Research - UFZ, Computational Hydrosystems, Leipzig, Germany
(stephan.thober@ufz.de)

Environmental models are common tools to simulate fluxes and states within the terrestrial energy and water cycles. Simulation results serve a wide range of purposes from infrastructure planning to weather forecasting. Regardless of the purpose, it is a common task to accurately estimate parameters within the process formulations used in environmental models for each computational unit (i.e. grid cell). The dimensionality of the parameter space is equal to the number of parameters per grid cell times the number of grid cells in distributed large-domain modelling, such as in weather forecasting. Without proper regularization of the parameter space, it is impossible to efficiently estimate parameters in this case. One regularization approach is to estimate constant parameters across the modelling domain, but this does not make use of high-resolution data that is available today (i.e. soil maps and land cover information). The Multiscale Parameter Regionalization (MPR) is a promising alternative that makes use of exactly these data sets.

The multiscale parameter regionalization (MPR) translates local land surface properties into model parameters. It consists of two steps: first, it relates local geophysical data sets (e.g., soil maps) to high-resolution model parameters via transfer functions at the native resolution of the input data sets. Second, it upscales the high-resolution model parameters to the modeling scale (i.e. the scale at which the model has been applied). MPR has been introduced in the mesoscale hydrologic model (mHM, Samaniego et al. 2010, Kumar et al. 2013), but has recently been made available as a stand-alone tool.

In this study, we use the stand-alone tool of MPR to apply it to the land-surface model HTESSEL. This model is the land-surface component of the ECMWF seasonal forecasting system. It uses a tiling approach to differentiate between different land cover types (e.g., high-grown vegetation and shrubs) and assumes constant parameters for each type. Soil related parameters are also considered for few soil classes for the entire domain. While this covers a large extent of subgrid variability at coarse resolutions, we find that its effect at high resolutions is reduced. In this study, we apply MPR for soil water parameters (e.g., conductivity and porosity) and vegetation parameters (e.g., stomatal conductance) that were identified as sensitive in Orth et al. (2016). We find that MPR provides more accurate fluxes over Europe across different resolutions than constant parameters in HTESSEL because it considers the subgrid variability of parameters. We also find a reduced difference between fluxes estimated at different resolutions by applying MPR (i.e. improved flux-matching).

References:
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