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Improvement of the simulation of the water and energy cycle using Multiscale Parameter Regionalization (MPR)

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The representation of the water and energy cycle in environmental models is closely linked to the parameter values used in the process parametrizations. The dimension of the parameter space in spatially distributed environmental models corresponds to the number of grid cells multiplied by the number of parameters per grid cell. For large-scale simulations on national and continental scales, the dimensionality of the parameter space is too high for efficient parameter estimation using inverse estimation methods. A regularization of the parameter space is necessary to reduce its dimensionality. The Multiscale Parameter Regionalization (MPR) is one approach to achieve this.

MPR translates local geophysical properties into model parameters. It consists of two steps: 1) local high-resolution geophysical data sets (e.g. soil maps) are translated into model parameters using a transfer function. 2) the high-resolution model parameters are scaled to the model resolution using suitable upscaling operators (e.g., harmonic mean). The MPR technique was introduced into the mesoscale hydrologic model (mHM, Samaniego et al. 2010, Kumar et al. 2013) and it is key factor for its success on transferring parameters across scales and locations.

In this study, we apply MPR to vegetation and soil parameters in the land surface model HTESSEL. This model is the land-surface component of the European Centre for Medium-Range Weather Forecasting seasonal forecasting system. About 100 hard-coded parameters have been extracted to allow for a comprehensive sensitivity analysis and parameter estimation.

We analyze simulated evaporation and runoff fluxes by HTESSEL using parameters estimated by MPR in comparison to a default HTESSEL setup over Europe. The magnitude of simulated long-term fluxes deviates the most (up to 10% and 20% for evapotranspiration and runoff, respectively) in regions with a large subgrid variability in geophysical attributes (e.g., soil texture). The choice of transfer functions and upscaling operators influences the magnitude of these differences and governs model performance assessed after calibration against observations (e.g. streamflow).

References:

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