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Temporal and spatial scales in hydrological model calibration

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Distributed hydrological models, even those that are physically based, contain physically meaningless parameters that require calibration for optimal model performance. Even with today's increased computational power and automated calibration methods, the time needed to calibrate a model can be prohibitive. To reduce computational time, we chose to calibrate the VIC land surface model on a sparse grid and then interpolated the parameters to the uncalibrated grid cells. In the U.S., we calibrated the model to the monthly runoff ratio, which was calculated for 1100 small basins and interpolated to those grid cells not located within a small gaged basin. Globally, we used gridded runoff climatology data as the observation and validated the model results to observed river discharge where available, demonstrating that this approach is sufficiently accurate and computationally efficient for large scale applications.

The second portion of our study examined the effect of model spatial and temporal resolutions on calibrated parameter sets to evaluate the transferability of parameters across different scales. The effect of calibrating at a different temporal resolution is minimal if the calibration time step captures the diurnal dynamics the model experiences at the smaller time step. Therefore, calibrating the model at a three hour time step and applying the parameter set hourly produces similar model behavior as calibrating and running the model at the hourly time step. Calibrating at a larger spatial resolution can cause non-negligible differences in model results at smaller resolutions. For example, applying the parameter set calibrated at a 1° spatial resolution to the 1/8° grid cells in the grid box causes a 10% overestimation in runoff during winter months. Therefore, as modelers develop multi-scale frameworks that apply parameter sets across spatial and temporal scales, they should carefully consider the effect of transferring parameters on model performance.