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Seamless continental-domain hydrologic model parameter estimations with Multi-Scale Parameter Regionalization

Naoki Mizukami, Martyn Clark, Andrew Newman, and Andy Wood
National Center For Atmospheric Research, Research Application Laboratory, Boulder, United States (mizukami@ucar.edu)

Estimation of spatially distributed parameters is one of the biggest challenges in hydrologic modeling over a large spatial domain. This problem arises from methodological challenges such as the transfer of calibrated parameters to ungauged locations. Consequently, many current large scale hydrologic assessments rely on spatially inconsistent parameter fields showing patchwork patterns resulting from individual basin calibration or spatially constant parameters resulting from the adoption of default or a-priori estimates.

In this study we apply the Multi-scale Parameter Regionalization (MPR) framework (Samaniego et al., 2010) to generate spatially continuous and optimized parameter fields for the Variable Infiltration Capacity (VIC) model over the contiguous United States(CONUS). The MPR method uses transfer functions that relate geophysical attributes (e.g., soil) to model parameters (e.g., parameters that describe the storage and transmission of water) at the native resolution of the geophysical attribute data and then scale to the model spatial resolution with several scaling functions, e.g., arithmetic mean, harmonic mean, and geometric mean. Model parameter adjustments are made by calibrating the parameters of the transfer function rather than the model parameters themselves.

In this presentation, we first discuss conceptual challenges in a “model agnostic” continental-domain application of the MPR approach. We describe development of transfer functions for the soil parameters, and discuss challenges associated with extending MPR for VIC to multiple models. Next, we discuss the “computational shortcut” of headwater basin calibration where we estimate the parameters for only 500 headwater basins rather than conducting simulations for every grid box across the entire domain. We first performed individual basin calibration to obtain a benchmark of the maximum achievable performance in each basin, and examined their transferability to the other basins. We then performed group calibration based on different spatial groups; a single CONUS-wide group, geographical groups, and hydroclimate-similar groups derived with clustering algorithm. We discuss the challenge in how estimated parameters for each spatial group can be merged to generate spatially consistent parameter fields over the CONUS.