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Comparing spatial and temporal transferability of hydrological model parameters

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Operational use of hydrological models requires the transfer of calibrated parameters either in time (for streamflow forecasting) or space (for prediction at ungauged catchments) or both. Although the effects of spatial and temporal parameter transfer on catchment streamflow predictions have been well studied individually, a direct comparison of these approaches is much less documented. In our view, such comparison is especially pertinent in the context of increasing appeal and popularity of the "trading space for time" approaches that are proposed for assessing the hydrological implications of anthropogenic climate change. Here, we compare three different schemes of parameter transfer, viz., temporal, spatial, and spatiotemporal, using a spatially lumped hydrological model called EXP-HYDRO at 294 catchments across the continental United States. Results show that the temporal parameter transfer scheme performs best, with lowest decline in prediction performance (median decline of 4.2%) as measured using the Kling-Gupta efficiency metric. More interestingly, negligible difference in prediction performance is observed between the spatial and spatiotemporal parameter transfer schemes (median decline of 12.4% and 13.9% respectively). We further demonstrate that the superiority of temporal parameter transfer scheme is preserved even when: (1) spatial distance between donor and receiver catchments is reduced, or (2) temporal lag between calibration and validation periods is increased. Nonetheless, increase in the temporal lag between calibration and validation periods reduces the overall performance gap between the three parameter transfer schemes. Results suggest that spatiotemporal transfer of hydrological model parameters has the potential to be a viable option for climate change related hydrological studies, as envisioned in the "trading space for time" framework. However, further research is still needed to explore the relationship between spatial and temporal aspects of catchment hydrological variability.