Model calibration for high flow estimations – Effect of the choices of objective function

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Hydrologic model calibration is an essential part of hydrologic modeling to improve the accuracy of hydrologic simulations for many water resources applications. One of the decisions related to the model calibration is a selection of the objective function. One common objective function, Nash-Sutcliffe Efficiency (NSE) is often considered to improve high flow estimates. This presentation first addresses deficiency of NSE for the objective function use to improve high flow events, such as annual peak flow estimates that used for flood frequency estimates. We compare performances of high flow metrics simulated at over 500 unimpaired catchments across the contiguous United States from the Variable Infiltration Capacity (VIC) model and meso-scale Hydrologic model (mHM) calibrated with 1) NSE, 2) Kling-Gupta Efficiency (KGE), and 3) application-specific "hydrologic signature" metrics that quantify a specific aspect of hydrograph, here annual peak flow. We found that annual peak flow estimate is severely degraded by the use of NSE primarily due to underestimation of flow variability. Use of an application-specific metric i.e. annual peak flow bias, produces the best estimate of annual peak flow, but the other metrics related to high flow, such as high flow volumes over 80-percentile, are substantially degraded, indicating application-specific objective function can be used for only target application. KGE is a versatile metric to use for the model calibration.