Geophysical Research Abstracts, Vol. 8, 05308, 2006
SRef-ID: 1607-7962/gra/EGU06-A-05308

Estimating prediction uncertainty in distributed hydrologic simulations from a combined input-parameter ensemble

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The combined uncertainty from precipitation inputs and distributed model parameters in rainfall-runoff simulations is estimated using an ensemble approach. The rainfall estimates are derived from rain gauges, radar, satellite, and combinations, and their probability distribution is assumed to encompass the true, but unknown, rainfall. The model is physics-based and its parameters are spatially distributed. Scalar multipliers are used to perturb distributed fields of saturated hydraulic conductivity, initial degree of soil saturation, and Manning roughness coefficient within their physical bounds. Probability distributions are then derived from the combined input-parameter ensemble. If all major sources of uncertainty are accounted for, then observations of river discharge should fall within simulation bounds.

Uncertainty bounds encompass observed streamflow for three events simulated on the Blue River Basin in Oklahoma, USA. Simulations for an event that occurred in August, however, dramatically overforecast the discharge peak and volume. This warm season case is used to identify a source of uncertainty in the model state that was not accounted for in the combined input-parameter ensemble. Observations of soil moisture are introduced to reveal that abstractions such as interception, evapotranspiration, and deep cracks in the soil structure contribute to enhanced infiltration rates during the warm season.