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Using a suite of modeling approaches to gain insight into complex models

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Abstract: With a growing focus in water management studies on large, regional flow systems, aquifer interconnections, and surface-groundwater interactions, groundwater model development must grapple with ever-increasing degrees of freedom and growing parameter uncertainty. For example, the transient Illinois Groundwater Flow model has 198 stress periods and requires complex geology, with 21 layers and several interconnected aquifers, presenting untold degrees of freedom and making traditional calibration techniques difficult. Additionally, head observations from dedicated monitoring wells are scarce in the Cambrian-Ordovician sandstones; calibration targets are largely in the form of non-pumping observations from active production wells under the influence of regional pumping, as well as one-time observations accompanying well completion reports. This non-traditional monitoring data has inherent variability that makes arriving at a unique model calibration impracticable. However, insights can be garnered from this data by applying novel modeling approaches at both local and regional scales, allowing the modeler to validate model properties and begin to bracket components of flow in a regional system. Some of the examples we will discuss include 1) validating hydrologic properties from daily fluctuations in monitoring wells near active production wells, 2) using analytic element simulations of production tests to identify low-flow barriers and regions of lower hydraulic conductivity, and 3) applying a transient, three-dimensional head-specified model to quantify flow excesses and deficits both spatially and temporally, identifying unmodeled sinks and sources within the system. Using this suite of novel modeling approaches to target specific model uncertainties often allows for greater insights into overall model properties, ultimately expediting and improving conceptualization and calibration for a more complicated model.

***Keywords**:* deep uncertainty, monitoring data, groundwater modeling