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ABSTRACT

Convolution modeling is useful for investigating the temporal distribution of groundwater age based on environmental tracers. The framework of a quasi-transient convolution model that is applicable to two-domain flow in karst aquifers is presented. The model was designed to provide an acceptable level of statistical confidence in parameter estimates when only chlorofluorocarbon (CFC) and tritium (^{3}H) data are available. We show how inverse modeling and uncertainty assessment can be used to constrain model parameterization to a level warranted by available data while allowing major aspects of the flow system to be examined. As an example, the model was applied to water from a pumped well open to the Madison aquifer in central USA with input functions of CFC-11, CFC-12, CFC-113, and ^{3}H, and was calibrated to several samples collected during a 16-year period. A bimodal age distribution was modeled to represent quick and slow flow less than 50 years old. The effects of pumping and hydraulic head on the relative volumetric fractions of these domains were found to be influential factors for transient flow. Quick flow and slow flow were estimated to be distributed mainly within the age ranges of 0-2 and 26-41 years, respectively. The fraction of long-term flow (>50 years) was estimated but was not dateable. The different tracers had different degrees of influence on parameter estimation and uncertainty assessments, where ^{3}H was the most critical, and CFC-113 was least influential.