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Coupling of hillslope-storage Boussinesq and analytic element groundwater models for layered aquifer systems

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Flow models based on the Boussinesq approach are widely used in groundwater modeling. These models, however, only account for unconfined flow. A leakage term was recently introduced into the hillslope-storage Boussinesq (hsB) model of Troch et al. [2003], in order to allow a coupling of this model to a (semi)confined regional scale groundwater flow model. A model based on the analytic element method (AEM) has been adopted to represent two-dimensional confined flow conditions below the Boussinesq aquifer. This choice is motivated by conceptual analogies between the hsB and AEM models, such as the AEM's ability to account for arbitrary hillslope planform shape (polygonal regions), and by the high computational efficiency of both models. As a preliminary to the coupling of the hsB and AEM models, test simulations were performed on layered hillslope aquifers with a three-dimensional finite element model based on the Richards equation for variably saturated flow. These tests show that there is significant temporal and spatial variability in the leakage rates across an aquitard separating the unconfined and confined aquifers. Additional tests will be conducted with the coupled model on laboratory hillslopes of different shapes (straight, convergent, divergent) under drainage and recharge conditions to determine whether and under what conditions the overall hydrologic response of a layered unconfined/confined aquifer system can be captured by the combination of an extended

hillslope scale model and an AEM-based representation of deeper regional scale flow.