HYDROSCAPE: A new versatile software program for modeling contaminant transport in groundwater

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ABSTRACT
Understanding how contaminants are transported in the subsurface is a major problem in hydrogeology. To help resolve the uncertanties associated with groundwater transport, complex numerical models are often used to predict how a contaminant plume evolves through time. However, numerical simulations can be costly to develop and time consuming. Analytical solutions to the advection-dispersion equation (ADE), a partial differential equation that governs solute movement in groundwater, are invaluable for rapid and inexpensive assessments of contaminant scenarios and for verifying numerical models. These solutions often require simplified representations of the aquifer (homogeneous) and source region (constant concentration throughout time) which restrict their applicability to real-world systems.
We present HYDROSCAPE, a new easy-to-use software package that contains a library of analytical solutions to the ADE. The program produces high-quality outputs such as contour maps of the plume, breakthrough curves, concentration profiles and videos of the plumes progression. Unlike other programs that use analytical solutions, HYDROSCAPE utilizes novel mathematical techniques to circumnavigate some of the limitations of the solutions. These new features allow the user to: 1) build a fully customized source region, and 2) implement horizontal layers, with different hydraulic conductivities, within the domain. By allowing the domain to be heterogeneous and the source region to vary in shape, concentration and time, more complexity is possible in these models and they are then more applicable to real-world settings. Additionally, HYDROSCAPE also allows the user to place the plume into real-world regional context by importing maps from Google Maps™. This visualization allows the user to evaluate how the plume evolves relative to real-world boundaries and objects. While some limitations still exist within the models, HYDROSCAPE represents a bridge between simple models using analytical solutions and complex numerical simulations, and may be a valuable tool for hydrogeologists in the future.

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