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Extending the applicability of analytical contaminant transport models

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Both numerical and analytical subsurface transport models are used to support important policy decisions regarding the management of polluted aquifers. Numerical models are able to simulate complex reactive transport phenomena, but can be time-consuming to construct, difficult to validate, and subject to numerical and user error. These models typically include tens to hundreds of input parameters. In contrast, simpler analytical models often capture the key features of reactive transport using a smaller set of "lumped" input parameters. They are free from computational error and are typically easier to apply, understand, and calibrate. However, due to necessary simplifying assumptions, particularly that of uniform flow, they are currently limited in their applicability.

The research project described herein addresses two key limitations of existing 2D and 3D analytical models through the development of novel time-of-flight mapping techniques and more flexible treatment of source terms and geometry in analytical solutions. The time-of-flight coordinate mapping approach allows the existing library of 2D and 3D solute transport solutions to be mapped to non-uniform flow fields with wells, surface water features, and recharge. Preliminary results from the development of these new methods are introduced for discussion and analysis is applied to interpret the error incurred from the mapping procedures. These initial improvements of analytical transport models are hoped to contribute to a powerful new suite of hybrid analytical-numerical tools for science-based environmental management.