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Advancing Solutions of the Two-Zone Temperature and Solute Transport Model by Solving A Simplified Temperature Transport Component

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Simultaneous application of a solute and heat transport model has the potential to enhance the confidence and predictive capacity, and ultimately could further our understanding of in-stream and transient storage processes. Solute transport solutions have demonstrated promising results, and analytic solutions to these solute transport models yield solutions serving as verification of numerical results, aid in interpretation of results, and may support a better understanding of transport processes by allowing use of remotely sensed data accounting for spatial variability. The two-zone temperature and solute (TZTS) transport model takes the simple one-zone transient storage model, separates storage into surface and subsurface (hyporheic) zones, and predicts the movement of both heat and solute through each zone. This distinction between the surface and subsurface is particularly important because each zone is recognized as having significantly different residence times and heat transfer processes acting on them. Analytical solutions to the solute component of the TZTS model have been established and applied to a 6.5 km reach of the Virgin River, a low gradient desert river with sand to gravel substrate, in southwestern Utah, United States. Here we take the initial step to developing an analytical solution to the temperature component by considering only the main channel flow in the TZTS transport model and assume no exchange between the two storage zones. We solve the temperature component of the transport model by first linearizing the heat flux term allowing us to apply the same solution techniques used for the solute transport model. Validation of the linearized approach with point in-stream temperature measurements allow for further development of a complete analytical solution of the TZTS transport model.