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NETWORKED SENSING IN SUPPORT OF REAL-TIME TRANSPORT MODEL PARAMETER ESTIMATION

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This work examines the potential role of embedded, networked sensing (ENS) protocols in monitoring the fate and transport of contaminants in the subsurface. The ultimate goal is to deploy a large dense array of chemical sensors for the purpose of identifying key transport parameters that are spatially distributed (e.g., porous media dispersivity) and, in some cases, temporally varying (e.g., nonaqueous phase liquid source zones). While there is clearly a need for further development in chemical sensor technology, the need to prepare to deploy new sensors in distributed networks is equally great. In this work, we first examine heat transfer phenomena as a surrogate for mass transfer in an intermediate scale physical aquifer model. Using a relatively standard data acquisition system (National Instruments A/D converter with Labview software), we continuously monitor water temperature over time and space throughout the model system. For well-defined heat sources, we developed closed-form solutions to the governing differential equations that are suitable for analyzing our data. Then, by embedding these closed solutions into our data acquisition routines, we were able to identify phenomenological parameters in real-time. Moving toward more relevant systems, we next demonstrate the use of a single nitrate sensor placed down-gradient of a finite pulse source of nitrate in a three-dimensional porous medium. Other potential applications and implications of ENS protocols in environmental monitoring networks will be discussed in terms of supporting ENS issues of self-adaptation, self-calibration, and coordinated actuation of responses.