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Uncertainty Quantification of the Minimum Hydraulic Resistance and its Implications on Data Acquisition

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Characterization of subsurface physical properties, such as the hydraulic conductivity field, is a challenging problem. These properties usually vary in space by many order of magnitude, and their value is known only in few selected sampling locations. Critical key structures, such as high conductivity channels, are often unknown and this leads to a relative high level of uncertainty for critical quantities. For example, high conductivity channels are linked to first arrival times of a solute plume. In this work we propose a methodology to decrease the uncertainty associated with first arrival times by retrieving additional information about high conductivity channels. We develop a computationally efficient iterative site characterization framework to detect high conductivity channels, by increasing the probability of sampling along them. To achieve this task, we adopt the concepts of minimum hydraulic resistance and least resistance path introduced in Rizzo & de Barros, WRR, 2017. These quantities can be efficiently computed using graph theory, therefore the entire framework is computationally efficient and add little to no time overhead to the sampling procedure. Multiple Monte-Carlo simulations are executed for different scenarios, being able to estimate the uncertainty reduction due to the new sampling protocol.