3D stream function based Hydraulic Impedance Tomography

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Determination of the spatially heterogeneous hydraulic conductivity is one of the great challenges in groundwater flow modeling. To this end, this paper presents Hydraulic Impedance Tomography (HIT) to calculate spatially distributed impedivities (inverses of conductivities) in a discretized modeling domain. HIT is a direct inversion method using two types of input data: (i) hydraulic data and (ii) geohydrologic data. The hydraulic data consist of measured flux-head pairs at locations on the boundary of the modeling domain including wells. The geohydrologic data consist of initial hydraulic impedivities, the priors, conceived by the geohydrologist. In HIT, first a forward model is run using the flux boundary conditions and initial impedivities. This constraining run yields fluxes throughout the modeling domain. Then these constraining fluxes and the head boundary conditions are used in a back projection run to condition the impedivities in such a way that both the measured head and the measured flux conditions are honored. In HIT not only the constraining forward model, but also the back projection is linear. In addition, HIT satisfies the continuity equation exactly. If the impedivities cannot be determined by the measured flux-head pairs, they become equal to the perceived priors. The applicability of the method is demonstrated on several test cases by using actual and noisy data.