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CONSTRAINING METHODS FOR DIRECT INVERSE MODELING

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Summary. We consider 3-dimensional groundwater flow models based on the block centered finite difference method. In a forward model the hydraulic conductivities are given in every grid block, and at each face on the boundary (including the wells) either the flow rate or the head is specified. In an inverse model conductivities are unspecified in a number of grid blocks, while both flow rate and head are specified in a number of boundary faces. Direct inversion means that the conductivities are obtained directly from Darcy's law. In the Double Constraint Method (DCM) grid block conductivities are initially estimated. From a forward run with flow rate boundary conditions all flow rates are calculated, and from a forward run with head boundary conditions all head gradients are calculated. Then, for each grid block the conductivity is updated using Darcy's law: conductivity is equal to minus the calculated specific flow rate divided by the calculated head gradient. Finally, artificial anisotropy is removed by iterations. DCM has been applied successfully, but to mitigate some disadvantages we have developed an extension called Hydraulic Impedance Tomography (HIT). A system of linear algebraic "back projection" equations for the grid block impedivities (the inverses of the conductivities) is based on flow rates calculated by a forward run with flow rate boundary conditions. This system is solved with head boundary conditions. Synthetic examples show that the method works well. In practical applications heads (obtained from observation wells) and flow rates (obtained from recharge data) are time-dependent. As a consequence, time series of impedivities obtained by HIT may be considered as noisy observations.