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Comparison of two mathematical models for 3D groundwater flow: block-centered heads and edge-based stream functions

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Traditionally, groundwater flow models, as well as oil reservoir models, are based on the block centered finite difference method, in which the hydraulic heads (pressures) in the grid block centers are the primary variables. Well known models based on this approach are MODFLOW (groundwater), Eclipse and MoRes (oil and gas). Such models are well proven and robust; their underlying principles are well understood by hydrologists and petroleum reservoir engineers. Nevertheless, the desire to improve the block centered finite difference paradigm has always been alive, for instance to be able to apply deformed grid blocks, or to model anisotropy that is not aligned along the coordinate axes. Recently, renewed interest has arisen in an alternative based on stream functions, not only to mitigate the above-mentioned limitations of the "paradigmatic model," but especially for its promises to inverse modeling. This paper introduces a 3-D stream function, its gauging, and its testing by comparing some synthetic forward modeling problems to results obtained by the conventional method.

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