Vertical Integration for Modelling Seawater Intrusion

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ABSTRACT
In this paper we present a novel effective formulation for modelling seawater intrusion that relies on a dimensional reduction of the original flow and transport problem. Seawater intrusion in coastal aquifers is a three-dimensional process. Over the last decades the three-dimensional simulation of seawater intrusion has received increasing attention in the literature. However, three-dimensional regional aquifer models are limited by the availability of geological and hydrological data, and by numerical constraints. We probe simplified formulations for the coupled flow and transport problem which allow for a realistic yet efficient modelling of seawater intrusion into coastal aquifers. To this end, we develop a two-dimensional areal formulation for regional seawater intrusion that correctly reflects the effective dynamics in the three-dimensional system. We carry out a vertical integration of the three-dimensional coupled flow and transport problem and arrive at a coupled set of two-dimensional equations for the spatial mean flux and salt concentration. The impact of vertical fluxes on mixing and thus on flow and transport is integrated into this effective dimensionally reduced formulation in terms of an effective dispersion tensor and a sink/source term for the flow equation. The proposed methodology is verified by direct numerical simulations of the full threedimensional problem and numerical simulation of the projected two-dimensional flow and transport problem.

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