Pollutant transport in shallow aquifers

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Résumé

In this work, we are interested in the modeling the water flow in shallow aquifers. In particular, we are concerned with the contamination of the water table by pollutants flowing from the surface (e.g., from fertilized fields) under the influence of rain. In this context, it is crucial to accurately describe the subsurface flow in the whole aquifer, i.e., in the saturated water table and in the unsaturated vadose zone. In the latter, which is rich in oxygen, the contaminants transported from the surface continue indeed to undergo chemical reactions that can change their nature. This type of subsurface flow is classically described by the 3d-Richards model, which is known to be very difficult to handle numerically, especially in the considered situation of a large geometry and over long time periods. To avoid these difficulties, we exploit the shallow geometry of the aquifer to provide numerically efficient alternatives to the 3d-Richards model.

In a first part of the presentation, we show that in shallow aquifers, the flow admits a {fast} component characterized by 1d-vertical Richards problems and a {slow} component described by a reduced 2d-horizontal problem in which the hydraulic head is constant with respect to the vertical variable.

Second, we couple these types of flows to derive two new models that approximate the Richards model (they admit the same dominant components). These models models allow for a numerical treatment that reduces the high computational cost associated with the Richards model.

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