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Modelling evaporation in partially saturated deformable porous media

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ABSTRACT

Partially saturated flow in porous media describes the simultaneous flow of water and air in unsaturated systems such as the vadose zone [1]. In arid zones or during drought seasons, high evaporation rates result in soil desiccation, which under constrained conditions can lead to the formation and utterly propagation of desiccation cracks [2]. Modeling the desiccation process requires a correct representation of both, the multiphase flow and the mechanical soil responses. Such a model is commonly written as an extension of the Biot equations to account for multiple phases [3].

However, unlike linearized saturated poroelasticity, the resulting set of partial differential equations becomes non-linear. Consequently, robust solvers are needed to obtain numerical solutions in decent computational times. In this respect, recent advances have been obtained thanks to the use of the *L*-scheme (and its variants) together with Anderson acceleration [4, 5].

In this work, we study a model based on robust multi-point finite volume discretizations (to be precise, multipoint flux approximation (MPFA) for the flow problem [6], and multipoint stress approximation (MPSA) for the mechanics problem [7]) to explore different representations of the evaporation process in unsaturated systems accounting with deformation effects with the potential inclusion of fractures. Finally, with simple yet constructive numerical examples we aim at gaining insight and understanding of the challenges related to desiccation in porous media.

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