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Editorial

Special Issue on "NUPUS: Non-linearities and Upscaling in PoroUS Media"

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This special issue of Transport in Porous Media contains contributions from the community of researchers within the NUPUS collaboration. Submissions are authored by the full range of NUPUS members, from senior faculty members to the young researchers whose studies have been shaped by this international training network. Many of the contributions highlight the strong inter-university, inter-disciplinary and international connections which are reviewed in the accompanying foreword (Helmig et al. 2016). The topics of this special issue reflect those of NUPUS itself, and the contributions are grouped in the NUPUS research areas as follows.

1 Research Area A: Fundamental Methods and Concepts

Bárdossy and Hörning (2015) present a novel methodology for the geostatistical inverse modeling of groundwater flow and transport problems which is based on the concept of random mixing of spatial random fields.

Bode et al. (2015) propose to optimize existing or new monitoring networks in well catchment areas in a multiobjective setting. Their concept brings insight into the costs of

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reliability, early warning and uncertainty, as well as into the trade-off between covering only severe risks versus the luxury situation of controlling almost tolerable risks as well.

van Duijn et al. (2015) investigate a two-phase porous media flow model, in which dynamic effects are taken into account for the phase pressure difference. Compared to the equilibrium case, their results suggest that operating in a dynamic regime reduces the amount of oil trapped at interfaces, leading to an enhanced oil recovery.

Motivated by observations of saturation overshoot, Hönig et al. (2016) analyze generic classes of smooth travelling wave solutions of a system of two coupled nonlinear parabolic partial differential equations resulting from a flux function of high symmetry. They derive a complete representation of the five-dimensional manifold connecting wave velocities and boundary data.

Jambhekar et al. (2016) extend an REV-scale coupled free-flow porous-medium-flow model concept for salinization to describe reactive transport of ionic species and mixed salt precipitation.

2 Research Area B: Numerical Methods

Bringedal et al. (2015) present a two-dimensional pore scale model of a periodic porous medium where the ions in the fluid are allowed to precipitate onto the grains, while minerals in the grains are allowed to dissolve into the fluid. They perform a formal homogenization procedure to obtain upscaled equations.

Fetzer et al. (2016) extend a concept for the coupling of free and porous-medium flow to turbulent free-flow conditions and integrate eddy-viscosity and boundary layer models for a rough interface. Results demonstrate the effect of these extensions on the evaporation rate.

Magiera et al. (2015) consider a model problem for coupled surface–subsurface flow that consists of a nonlinear kinematic wave equation for the surface fluid's height and a Brinkman model for the subsurface dynamics. They establish the existence of weak solutions and apply a finite volume method to solve the coupled problem numerically.

Pettersson (2015) presents a stochastic Galerkin formulation for the transport of carbon dioxide in a tilted aquifer with uncertain heterogeneous properties. Employing the polynomial chaos framework admits low-cost post-processing of the output to obtain statistics of interest.

Skogestad et al. (2015) propose a two-scale nonlinear preconditioning technique for multiphase flow problems in porous media that allows for incorporating physical intuition directly in the preconditioner. The developed preconditioner exhibits good scalability properties for challenging problems regardless of dominant physics.

3 Research Area C: Modeling Strategies for Selected Applications

Beck et al. (2016) present a conceptual approach to model fault reactivation in porous media. They interpret failure as a dissipation of elastic energy and thus replace the originally linear elastic material law by a visco-elastic law. The dissipation of elastic energy leads to additional displacements which are interpreted as slip on the fault plane.

Ehlers and Häberle (2016) treat transitions between liquid and gaseous phases for a multicomponent porous aggregate in a non-isothermal environment while accounting for the thermodynamics of the fluid-phase transitions. Geometrical and fluid-flow-dependent parameters are included into the phase change process.

Hommel et al. (2015) present a numerical investigation of the effect of various initial biomass distributions and initial amounts of attached biomass on the attachment of bacteria in porous media. This is performed for various injection strategies, changing the injection rate as well as alternating between continuous and pulsed injections.

Kunz et al. (2015) present simulations and experiments of drainage processes in a micro-model and compare them for quasi-static and pure dynamic processes. For both, simulation and experiment, the interfacial area and the pressure at the inflow and outflow are tracked.

In the context of thermally enhanced remediation of soil, Weishaupt et al. (2016) investigate the impacts of preheating the soil on the thermal radius of influence. They consider different preheating scenarios with a full-complexity, 3D, non-isothermal numerical model including phase change and discuss the achievable benefits of preheating.

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