

Abstract Submitted
for the DFD09 Meeting of
The American Physical Society

A Phase-field Model of Wetting in Porous Media – Origin of Gravity Fingering During Infiltration RUBEN JUANES, LUIS CUETO-FELGUEROSO, MIT — We present a new continuum mathematical model of wetting into dry soil. The inspiration for the new model is the flow of thin films (like water down a plane), which also displays fingering instability. The key idea is very simple: the macroscopic equations must reflect the presence of a macroscopic interface—the wetting front. We then cast the model in the rigorous framework of phase-field models and nonlocal thermodynamics. The new model is appealing. It is a simple extension of the traditional model—Richards' equation—with a new term (a fourth-order derivative in space) but without any new parameters. It reproduces the two key features of unsaturated flow: a nonmonotonic saturation profile, and gravity fingering. It explains why, when, and how, fingers form. It shows excellent quantitative agreement with experiments in terms of tip saturation, tip velocity and finger width. The most attractive aspect is, however, that the new model offers a starting point for fundamentally new formulations of multiphase flow in porous media.

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Date submitted: 30 Jul 2009

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