# Are existing large-scale simulations of water dynamics wrong?

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Soils are complicated porous media that are highly relevant for the sustainable use of water resources. Not only the essential basis for agriculture, soils also act as a filter for clean drinking water, and, depending on soil properties, they dampen or intensify surface runoff and thus susceptibility to floods. Moreover, the interaction of soil water with the atmosphere and the related energy flux is an important part of modern weather and climate models.

An accurate modeling of soil water dynamics thus has been an important research challenge for decades, but the prediction of water movement, especially at large spatial scales, is complicated by the heterogeneity of soils and the sometimes complicated topography.

Simulation models are typically based on Richards' equation, a nonlinear partial differential equation, which can be solved using numerical solution methods. A prerequisite of most solution algorithms is the partitioning of the simulated region into discrete grid cells. For any fixed region, such as a soil profile, a hill slope, or an entire watershed, the grid resolution is usually limited by the available computer power. But how does this grid resolution affect the quality of the solution"

This problem was explored by Hans-Joerg Vogel from the UFZ - Helmholtz Center of Environmental Research in Leipzig, Germany and Olaf Ippisch from the Institute for Parallel and Distributed Systems of the University of Stuttgart, Germany. The results are published in the article "Estimation of a Critical Spatial Discretization Limit for Solving

Richards' Equation at Large Scales," Vadose Zone J. Vol. 7, p. 112-114, in the February 2008 issue of Vadose Zone Journal.

Vogel and Ippisch found that the critical limit for the spatial resolution can be estimated based on more easily available soil properties: the soil water retention characteristic. Most importantly, this limit came out to be on the order of decimeters for loamy soils, and is even lower, on the order of millimeters, for sandy soils. This is much smaller than the resolution used in many practical applications.

This study implies that large-scale simulations of water dynamics in soil may be imprecise to completely wrong. But, it also opens new options for a specific refinement of simulation techniques using locally adaptive grids. The derived critical limit could serve as an indicator that shows where a refinement is necessary. These findings should be transferable to applications such as the simulation of oil reservoirs or models for soil remediation techniques.

Source: Soil Science Society of America