Modelling water flux

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The modelling of water infiltration in soil is satisfactorily solved only at laboratory scale, using PDEs, especially the so-called Richards' equation. At lysimeter scale, i.e. small field scale, PDEs present various difficulties, such as high computer costs, vaguely known initial conditions and sparse information about the spatial variation of material properties. Consequently, various ways to attack the problem are pursued. The more traditional one is to replace the unknown parts, especially the spatially variable conditions, by stochastic models. On the other hand, simpler, stochastic models that do not try to describe the physical processes in all details are also sought.
The scope of the R package SoPhy is to provide tools for the analysis and the modelling of infiltration experiments at lysimeter scale including both physically based methods and novel stochastic approaches. In the talk, some of the features are presented. The interactive surface for physically based modelling incooperates deterministic information such has atmospherical data and material constants, but also stochastic models for the spatial variability of the material properties and for the distribution of the roots and the stones, see Fig. 3 for a snapshot. Fig. 1 and Fig. 2 show simulation results of a simple, purely stochastic model. The model consists of two components, the availability of water near the surface and the tortuosity of the paths. The former is modelled by a two-dimensional random field, whereas the latter is constructed from two independent random fields. The depth of the water front is then a function of the tortuosity and the water availability. Great depths are reached if locally, the tortuosity is small and the availability of water is high.
SoPhy V1.0 is based on the contributed R packages RandomFields V1.1 and SoPhy V0.91. The latter is essentially an R wrapper for SWMS_2D by Šimunek et al. (1994), a Fortran program for solving the Richards' equation using the Galerkin finite element method. SoPhy V1.0 will appear in summer this year.

References

J. Šimunek, T. Vogel, and M. Th. van Genuchten. The SWMS_2D code for simulating water flow and solute transport in two-dimensional variably saturated media, version 1.21. Technical Report 132, U.S. Salinity Laboratory, Riverside, California, February 1994.

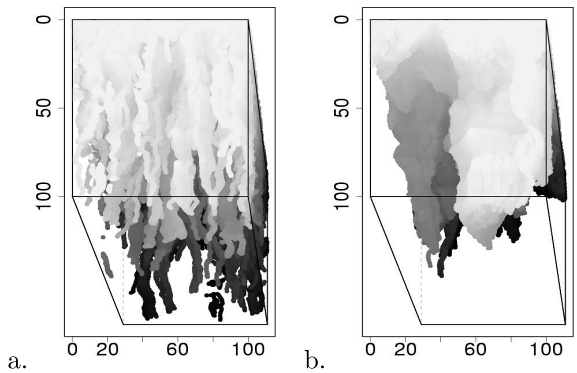

Figure 1: Influence by the scale parameter for the spatial dependence structure of the water availability: a. low value, b. high value for the scale parameter.

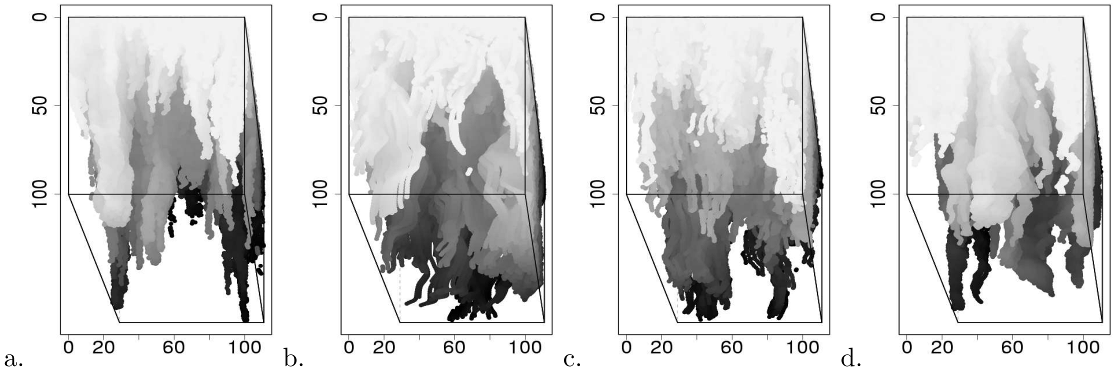

Figure 2: Influence by the scales for horizontal and vertical dependence structures of the tortuosity: In a. and b. the value for the vertical scale parameter is varied; in c. and d. the value for the horizontal scale parameter; a. and c. low values; b. and d. high values.

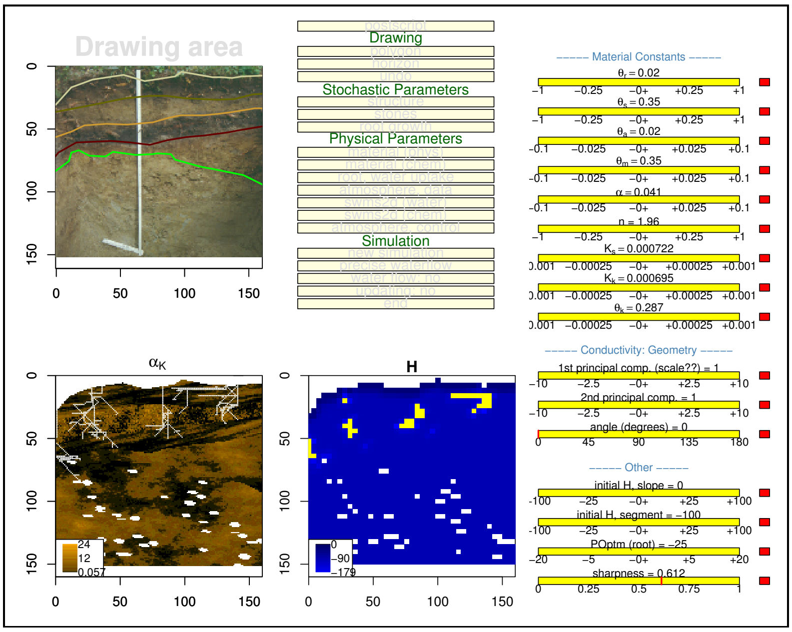

Figure 3: Snapshot of the interactive surface for physical water flux modelling; upper left: the invetsigated profile; bottom left: simulation of the material including stones and roots; bottom center: calculated matrix potential; top center: inactive main menu; right: active submenu.