Geophysical Research Abstracts,
Vol. 10, EGU2008-A-06819, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-06819
EGU General Assembly 2008

Explaining Soil Moisture Variability as a Function of Mean Moisture Content: Numerical Simulations in Three-Dimensional Heterogeneous Porous Media

R. Kasteel (1), J. Vanderborght (1) and H. Vereecken (1)

(1) Agrosphere, ICG 4, Forschungszentrum Jülich GmbH, Jülich, Germany.

Understanding soil moisture variability and its relationship with water content at various scales is a key issue in hydrological research. Due to the heterogeneity of soils, atmospheric forcing, vegetation, and topography, soil moisture is spatially variable. Especially the relationship between mean soil moisture content and its standard deviation has received considerable attention in the hydrological community. The standard deviation increases during drying from a very wet stage, reaches a maximum value at a specific or critical mean moisture content, and then decreases during further drying. Using one-dimensional stochastic theory and under premise of gravity flow, one can show that this relationship is provoked by the spatial variability of the hydraulic properties. The goal of this study was to perform numerical simulations in three-dimensional heterogeneous porous media to verify the findings predicted by stochastic theory. The geometry of the flow domain consisted of a cube with 2.5 m side length. The flow domain had a heterogeneous parameter distribution represented by independent random fields of scaling factors for pressure head and hydraulic conductivity, which were defined by an exponential auto-covariance function. Simulations were performed for three soils with different reference hydraulic properties by imposing a constant potential evaporation flux to an initially wet soil. We looked at the effect of hydraulic properties, correlation length and variance of the scaling factors, and flow rate. Numerical simulations gave similar shapes for the relationship between mean soil moisture content and its standard deviation as predicted by stochastic theory. The correlation length of the underlying stochastic field and flow rate does not affect this relationship, whereas the variance in the auto-covariance function showed larger standard deviations of moisture content for the coarser soils. The shape factor n of the van Genuchten model is the most sensitive hydraulic parameter. The maximum value of the standard deviation of moisture content increases with increasing n-values, whereas the position of this maximum moves to lower mean water content. We demonstrate the potential for hydraulic parameter estimation that the simple relationship between mean soil moisture content and its standard deviation offers, using a data set of soil moisture contents measured with TDR under field conditions.