Geophysical Research Abstracts
Vol. 12, EGU2010-3773, 2010
EGU General Assembly 2010

Soil Hydraulic Properties for Large Scale Transient Absorption and Redistribution

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Large scale soil hydraulic properties are essential for many hydrological, environmental or climate studies. The fundamental soil hydraulic properties are the soil water potential and the hydraulic conductivity as functions of soil water content. In this study, we investigate 1) how the large scale hydraulic properties are impacted by the hydrologic processes of interest; and 2) how the effective hydraulic properties evolve for different hydrologic processes. The main idea is whether the important process behavior in heterogeneous soils can be captured by a process that assumes one set of soil parameters, such that the heterogeneous system is replaced by an equivalent homogeneous system. By using field and re-generated hydraulic data sets, we derive effective hydraulic properties under transient flow conditions. Infiltration and redistribution and their effects on the effective hydraulic properties are considered. We examine the concepts of using both constant and time-dependent effective hydraulic properties and explore the conditions under which the constant effective hydraulic properties are feasible in large scale hydro-climate simulations. Three heterogeneous fields of hydraulic parameters of saturated hydraulic conductivity, saturated water content, and shape parameter are particularly investigated in terms of their impact on the large scale hydraulic parameters in simulating large scale infiltration and redistribution. When only the saturated hydraulic conductivity is heterogeneous, the effective parameter does not change significantly and is between arithmetic mean and geometric mean. When only the saturated water content is heterogeneous, the effective parameter is between geometric mean and arithmetic mean for initial absorption and is above arithmetic mean for subsequent redistribution. When only the shape parameter is variable, the effective parameter is between geometric mean and harmonic mean for initial absorption and is below harmonic mean for subsequent redistribution. For a more realistic situation when all the three hydraulic parameters are variable, the effective parameter ranges from below harmonic mean to above arithmetic mean.