Geophysical Research Abstracts,
Vol. 10, EGU2008-A-05009, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-05009
EGU General Assembly 2008

Modeling the effect of capillary rise from ground water on probabilistic soil moisture dynamics

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In the past decade, a framework has been developed for the water balance and soil moisture dynamics of semi arid water-controlled ecosystems, under the comprehensive term Ecohydrology. Significant advances have been made to understand the soil water loss function for the case that the contribution of water from groundwater is negligible. We have adopted this framework (e.g. Laio et al., 2001), to consider the effect of groundwater depth on both the loss function and soil moisture dynamics. To do so, we first developed a mechanistic capillary rise model and incorporate it into the soil water loss function using an empirical expression that excellently fits the mechanistically derived function, but is analytically more tractable. Following the framework of the literature, we derive explicit expressions for the probability density function of soil moisture. We parameterize our model using data from the literature and Australian data bases. For different capillary rise models (literature and newly developed), soils, and climatic forcing, we follow the soil moisture saturation as a function of time and compare the results. The differences are discussed in the presentation. In addition, we show how groundwater depth affects the pdf of soil water saturation and the agreement with the case where capillary rise is ignored.