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Classification of recharge regimes based on measures of hydrologic similarity

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Groundwater recharge is usually estimated with the use of detailed numerical models of the vadose zone, where it is treated as a steady state process or is analyzed over short time periods (e.g., after single rainfall events). In reality, in natural settings groundwater recharge needs to be seen as the residual effect of the competition between gravitation drainage, capillary action of the soils and evaporation and plant water uptake. The competition is mediated by the nature of the soils, biological activity of living organisms, including vegetation and its adaptive behavior. Due to intermittency of the precipitation driver and the nonlinearity of soil mediated processes, recharge behavior can exhibit complex, nonlinear and threshold like behavior. In many instances it may reflect memory of previous events going backs weeks and even months. What is the role of climate, soils and vegetation in governing such behavior? In this paper we will adopt a similarity framework to assess recharge behavior in different climate-soil settings, in order to classify a range of recharge regimes, and the climate and soil controls that lead to such organization. A simple "multiple wetting front" model of unsaturated zone fluxes is used to carry out long term simulations of recharge, driven by artificial rainfall time series that include multi-scale variability ranging from within-storm patterns, seasonality, and inter-annual and inter-decadal variations. The results suggest that the classification system based on the use of a ratio of time scales that characterize the propagation of variability through the vadose zone, and the competition between the different forces that act on the water, including vegetation functioning. The analysis can be extended to estimate the residence time and age of the water that recharges, factors that are important to quantify the chemical composition of the water