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Comparison of 1D models of water flow in unsaturated soils

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Understanding the interaction between soil, vegetation and atmosphere processes and groundwater dynamics is of paramount importance in water resources planning and management in many practical applications. Hydrological models of complex water resources systems need to include a number of components and should therefore seek a balance between capturing all relevant processes and maintaining data requirement and computing time at an affordable level. Water transfer through the unsaturated zone is a key hydrological process connecting atmosphere, surface water and ground water. The paper focuses on the analysis of the modelling approaches that are generally used to describe vertical water transfer through the unsaturated soil in hydrological models of water resources systems: a physically based approach, using numerical solutions of Richards equation, and two conceptual models, based on reservoirs cascade schemes, are compared. The analysis focuses on the soil water content in the top soil (first meter) and on the outflow from the profile (i.e. recharge to the aquifer). Results show that the water contents simulated by the mechanistic and conceptual models are in good agreement, unless when the capillary fringe reaches the top soil (i.e. groundwater table very close to the soil surface). The ability of conceptual models to capture the daily recharge dynamics is generally rather poor, especially when fine textured soils and thick profiles are considered; a better agreement is found when recharge is cumulated over longer time periods (e.g. months). Improvements can be achieved by allowing the number of reservoirs in cascade to vary with changing profile depth, although scientifically sound rules for fixing the number of reservoirs need to be established.