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Analytical solutions of the linearized Richards equation for arbitrary surface boundary conditions and arbitrary initial conditions

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Unsaturated flow processes are subject to either atmosphere control or soil control, often switching from one to the other. In order to study the water flow in a sub-surface unsaturated layer, the linearized Richards equation is analytically solved for arbitrary surface boundary conditions and arbitrary soil moisture initial conditions. Approximating the supplementary conditions by step-wise functions, the solution results a sum of solutions obtained for constant boundary conditions. This approach is quite useful because it permits to use standard meteorological data as boundary conditions. In fact, precipitation data can be used as incoming flux and evaporation data (Bowen ratio) as outgoing flux. Meteorological data are very common, while soil volumetric water content measurements, excluding saturation and air dry soil, are usually not available exactly at the soil-atmosphere interface. The procedure proposed in this work automatically switches from flux boundary conditions to soil moisture boundary conditions accounting for atmosphere controlled or soil controlled evaporation or infiltration.