Solutions of the linearized Richards equation with arbitrary boundary and initial conditions: flux and soil moisture respectively

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Analytical solutions of differential equations describe physical problems and provide general insight of the studied natural mechanisms. Although they may be not suitable to solve complex hydrological problems, they are fast and useful to test numerical procedures. The solutions proposed in this work are obtained for arbitrary flux boundary conditions and arbitrary soil moisture initial conditions. This permits to use standard meteorological data: precipitation data (incoming flux) and Bowen ratio data (outgoing flux), which are very common, while soil volumetric water content measurements are usually not available exactly at the soil-atmosphere interface. A first class of solutions is obtained with a uniform initial condition for the soil moisture and a time dependent surface flux, which well represents experimental precipitation/evaporation cases. A solution with a more general boundary condition is derived using a sum of simple solutions obtained for constant boundary conditions. Finally the same technique is applied to the soil moisture initial condition too. The vertical profiles of the soil water content computed by this simple sum of solutions are compared with the results of the aforementioned analytical solutions.