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Simulating Horton runoff based on a two-phase flow approach

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Surface runoff models employ the Richards' approach to reproduce streamflow generation mechanisms (e.g. Horton, Dunne, subsurface stormflow) in the nearsurface environment. By design, they implicitly assume that the air phase is infinitely mobile and at atmospheric pressure in the entire soil compartment. To relax this assumption and numerically study the impact of air pressure gradients in surface runoff generation mechanisms, we coupled a diffusive wave overland flow model and a two-phase flow model. The coupled model reproduces for a classic Horton flow test case the observed air transfer through the flume surface, which considerably hindered infiltration. The implemented extension of the surface-subsurface fluid exchange fluxes is potentially important for the numerical assessment of gas transfer (CO_2, CH4, N2O) from soils to the atmosphere in wetland / peatland regions, where surface and subsurface water interact regularly.