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A non-local Richards equation to model infiltration into highly heterogeneous media under macroscopic non-equilibrium pressure conditions

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Infiltration into dry strongly heterogeneous media, such as fractured rocks, can often not be modelled by a standard Richards equation with homogeneous parameters, as the averaged water content is not in equilibrium with the averaged pressure. Often, double continua approaches are used for such cases. We describe infiltration into strongly heterogeneous media by a Richards model for the mobile domain, that is characterized by a memory kernel that encodes the local mass transfer dynamics as well as the geometry of the immobile zone. This approach is based on the assumption that capillary flow can be approximated as diffusion. We demonstrate that this approximation is in many cases justified. Comparison
of the model predictions to the results of numerical simulations of infiltration into vertically layered media shows that the non-local approach describes well non-equilibrium effects due to mass transfer between high and low conductivity zones.