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Two numerical models to solve Richards and energy equations

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It is known that water viscosity and the water capillary pressure in unsaturated soil depends on the temperature. Specifically, the capillary pressure varies with the temperature because the surface tension and the contact angle (Bachmann 2002). This dependence of the water properties on the temperature manifests as temperature-affected soil water retention curves and soil hydraulic conductivity.
To consider the effects of temperature on the water flow in soil it is necessary to solve both the Richards equation and the energy equation. Considering the 1D problem, we compare two numerical models to solve these equations. The first one solves the Richards equation (Casulli and Zanolli, 2010) (Casulli, 2017) and the energy equation in a coupled way (Casulli and Zanolli, 2005) but without considering the temperature effect on the soil water retention curve. The second one considers the effect of temperature also on the soil water content. The equations are numerically solved in a decoupled way: firstly, we integrate the energy equation written in the non-conservative form and then the Richards equation is solved. These are intended to be the first step towards a method that simultaneously solves the two equations with a conservative method. Freezing soil is not included but extension of the method including it is also discussed.
Besides the numerical aspects, we also discuss the reasons of developing the code using an Object-Oriented programming paradigm. As an example, we can easily add new parameterization of the hydraulic and thermal properties of the soil without changing the core of our code.

Bachmann, Jörg, et al. Temperature dependence of water retention curves for wettable and water-repellent soils. Soil Science Society of America Journal, 2002, 66.1: 44-52.
Casulli, Vincenzo; Zanolli, Paola. High resolution methods for multidimensional advection–diffusion problems in free-surface hydrodynamics. Ocean Modelling, 2005, 10.1-2: 137-151.
Casulli, Vincenzo; Zanolli, Paola. A nested Newton-type algorithm for finite volume methods solving Richards' equation in mixed form. SIAM Journal on Scientific Computing, 2010, 32.4: 2255-2273.
Casulli, Vincenzo. A coupled surface-subsurface model for hydrostatic flows under saturated and variably saturated conditions. International Journal for Numerical Methods in Fluids, 2017, 85.8: 449-464.