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The issue of switching between non-freezing and freezing in soils

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The freezing process in soils is important in many natural systems and, consequently, it is of great interest to model it accurately.
The freezing of water in soil is coupled to the heat equation as freezing releases latent heat and temperature is an important variable that determines whether water is in solid or liquid state. In soils, water can remain liquid under sub-zero temperatures (freezing-point depression). This effect is often modeled with the Clapeyron equation. With the Clapeyron equation, a temperature dependent pressure head definition for the total water content (liquid + frozen water) and the liquid water can be derived. When the temperature of the soil system falls below the freezing point, the system switches between the pressure head definitions. However, this switch can cause a discontinuity at the freezing front leading to numerical issues and unrealistic results.

To compensate for the discontinuity, we discuss the use of regularisation of the switching term on, both, synthetic and experimental data of case studies of freezing column experiments.