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Implicit Temporal Integration and Preconditioner Management for Richards' Equation

We propose an adaptive time stepping scheme based on error control for Richards' equation, a model for flow in unsaturated porous media given by a nonlinear, parabolic PDE. The motivation for this work is a production code being developed by the U.S. Engineering Research Development Center called the **AD**aptive **H**ydrology Model. ADH simulates three dimensional groundwater and surface water flow using unstructured, adaptive finite elements in space and implicit temporal integration, regridding after each time step. ADH advances in time using an inexact—Newton method with a two-level domain decomposition preconditioner. The coarse mesh component of the preconditioner is too costly to update every time step. The nonlinearity in Richards' Equation is non-Lipschitz and standard theory for temporal integration does not apply. We consider methods for error control and time dependent updates for the coarse component of the preconditioner.