Geophysical Research Abstracts
Vol. 14, EGU2012-11295, 2012
EGU General Assembly 2012

A novel discontinuous Galerkin time-domain method for ground-penetrating radar simulation with applications to the ASSESS-GPR test site

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The simulation of ground-penetrating radar (GPR) measurements requires the solution of Maxwell's equations. While finite-differences time-domain (FDTD) solvers are faster on structured grids, finite-element time-domain (FETD) and discontinuous Galerkin time-domain (DGTD) allow to resolve complicated structures and avoid staircase approximations. Soil horizon boundaries can be resolved exactly by the finite element mesh.

In this contribution 3D simulations are compared with measurements from the ASSESS-GPR test site which is an artificial GPR testbed with a well known geometry and ground-truth on volumetric water content provided by 32 TDR probes.

For the simulations a DGTD method is used in a dual-field formulation and compared to a standard FETD method with conforming edge-based finite elements. The software for the simulation has been developed using the Distributed and Unified Numerics Environment (DUNE) and its PDELab discretization module. The programs have been parallelized using MPI to make computations on the size of 10^8 unknowns feasible.