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Carmen Chicone* (chiconec@missouri.edu), Department of Mathematics, Columbia, MO 65211. *Time domain reflectometry with applications to electric properties of soils*. Preliminary report.

A time-domain reflectometer produces a front type traveling wave of voltage (and current) on a transmission line, the wave is reflected from regions along the line where the dielectric properties of the media surrounding the conductors change, and the time-trace of reflected voltages is recorded by the instrument. The problem is to recover the positions and dielectric parameters of the media from the recorded voltage. The basic dynamical model is a hyperbolic system of PDEs with spatially dependent coefficients, which in the simplest special case is a system of hyperbolic conservation laws. The modeling challenges include appropriate formulation of boundary conditions for well-posed PDEs and specialization to well-posed inverse problems. Numerical challenges include the appropriate choices of discretization, time stepping, and boundary conditions to approximate solutions of the system of PDEs and numerical methods to approximate solutions of the inverse problem. A tutorial on the general problem will be presented. As time permits a specific application to soil structure and moisture content will be discussed. (Received January 27, 2014)