NEW ADVANCES IN IMPLEMENTING MATERIAL HETEROGENEITY IN THE FINITE-DIFFERENCE MODELLING

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The finite-difference, spectral-element and discontinuous Galerkin methods are the most important time-domain numerical methods in the earthquake and structural seismology and seismic prospecting. A finite-difference time-domain (FDTD) scheme is more than competitive for example for local surface sedimentary structures. It is sufficiently accurate and, at the same time, computationally efficient if it is explicit, heterogeneous and formulated on a uniform spatial grid (the latter does not contradict the use of an efficient discontinuous grid composed of several uniform grids).

Having a scheme explicit and on a uniform grid is relatively easy to achieve in relation to grid dispersion and stability.

Having a scheme heterogeneous and capable of a sub-cell resolution (the necessary condition for efficiency of a uniform-grid scheme) is not trivial. In fact, schemes believed to be heterogeneous had been developed for more than three decades. Those schemes were based on equations for smooth weakly heterogeneous media and could not in principle account for a presence of a material discontinuity.

Moczo and Kristek developed their heterogeneous schemes based on equations which equally applied to smooth and discontinuous heterogeneity and sufficiently accurately accounted for boundary conditions at interfaces. This made it possible to develop schemes with sub-cell resolution and for an arbitrary position and shape of an interface in a uniform grid.

We present recently developed unified discrete representation of strongly heterogeneous media in the elastic, viscoelastic, poroelastic and poroviscoelastic media.