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High-resolution 3D modeling of wave scattering by an oil reservoir

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Rocks forming oil reservoirs are heterogeneous systems with extremely nonuniform porosity with heterogeneities spanning range of scales from 1micron to 1km. The resolution of existing reservoir data can reach 1000ˆ3 data points. Standard reservoir modeling software cannot handle direct numerical simulations on this amount of data and instead employs some form of upscaling. High computational resolution helps to directly resolve scattering attenuation of waves on different spatial scales of heterogeneities. With help of modern supercomputers simulations at the resolutions of the industrial data sets are feasible, and can at very least be used for the verification and validation of upscaling approaches. We present the comparison of 3D numerical simulations of acoustic scattering around ellipsoidal inhomogeneity and compare the results to analytical estimates. Next, scattering around high resolution real-world reservoir model is studied.

Operator-splitting methods (Alternating Directions Implicit and Locally One Dimensional schemes) have been employed. In this approach the full 3D problem is split into a sequence of implicit 1D subproblems, which can be efficiently solved by Thomas algorithm. Consequently, there is no time step restriction inherent to explicit methods. Our scalable parallel OpenMP implementation reaches 1 Gflops performance for models of up to 2000ˆ3 grid points.