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Spectral-element seismic wave propagation on emerging HPC architectures

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Seismic tomography is the most prominent approach to infer physical properties of Earth's internal structures such as compressional- and shear-wave speeds, anisotropy and attenuation. Using seismic signals from ground-motion records, recent advances in full-waveform inversions require increasingly accurate simulations of seismic wave propagation in complex 3D media to provide access to the complete 3D seismic wavefield. However, such numerical simulations are computationally expensive and need high-performance computing (HPC) facilities for further improving the current state of knowledge.

During recent years, new multi- and many-core architectures such as graphics processing units (GPUs) have been added to available large HPC systems. GPU-accelerated computing together with advances in multi-core central processing units (CPUs) can greatly accelerate scientific applications. To employ a wide variety of hardware accelerators for seismic wave propagation simulations, we incorporated a code generation tool BOAST into an existing spectral-element code package SPECFEM3D_GLOBE. This allows us to use meta-programming of computational kernels and generate optimized source code for both CUDA and OpenCL languages, running simulations on either CUDA or OpenCL hardware accelerators. We show here benchmark applications of seismic wave propagation on GPUs and CPUs, comparing performances on emerging hardware architectures.