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Verification of an Overlapping Multidomain Chebyshev Method for Seismic Wave Propagation

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We develop and implement a multidomain Chebyshev method for 3D simulation of seismic wave propagation. The pseudospectral Chebyshev operator is applied to a large number of overlapping local Chebyshev subdomains, each representing only a small portion of the whole computational domain. This allows for exploiting the accuracy of a spectral operator with a comparatively small number of points per shortest wavelength, while its global character is avoided. The overlap implicitly ensures the continuity of the field variables in space and time and complicated coupling schemes are not needed. The calculation of each subdomains is nearly independent from the other ones and are easily distributed among an arbitrary number of computational nodes. The amount of data that has to be exchanged between contiguous subdomains is limited to the node values on the overlap. This allows for an efficient and highly scalable implementations on distributed memory machines, where the bandwidth of the interconnect between computational nodes is a critical resource. The power of modern high performance computers or computer clusters can be fully exploited to reach realistically high frequency content of the synthetic seismograms. The classical, global pseudospectral operators, on the contrary, feature large data interdependency, and the communication costs often turn out to be prohibitive for massive parallelisation.

The overlapping multidomain Chebyshev method and our implementation is tested with various setups in order to a assess the properties and limits of the method, and to ensure correctness of the implementation. Different implementations and combinations of boundary conditions are evaluated and compared against each other. The dependencies on the various parameters are estimated in order to find appropriate setups for productive runs.