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Spacetime Trefftz-DG Formulation for Modelling Wave Propagation in Unbounded Domains

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In order to develop a method in time domain for wave problems that can combine sufficient flexibility to accommodate geophysical heterogeneities, rapidity of the algorithm, and precision of the solution, we consider Trefftz-DG methods. In Trefftz spaces, the basis functions are defined as elementwise solutions. The approximation space includes thus the Physics of the problem, which contributes to accuracy, a lower number of degrees of freedom and less numerical dispersion. Moreover, it is composed of Discontinuous Galerkin functions as the continuity at the interfaces of the elements cannot be imposed strongly. The resulting Trefftz-DG variational formulation is then applied on the boundaries of each cell of the mesh of the domain of interest with appropriate transmission conditions between the cells. However, the major drawback of this method is that it leads to an implicit scheme, which requires to solve a huge linear system. To overcome this difficulty, our Trefftz-DG formulation is implemented with the Tent-Pitching algorithm, which allows us to construct a causal mesh, hence leading to a locally-implicit scheme.

We have developed a Trefftz-DG framework for solving the acoustic wave equation using Tent-Pitching algorithms. One of the novelties of our approach is to use basis functions which are not necessarily polynomials. In the first part of this talk, we will present the method applied to structured meshes in a fully parallel environment and next, unstructured meshes. In the second part, we will address the natural question of truncating the computational domain. For that purpose, we have constructed Perfectly Matched Layers (PML). These boundary conditions were first introduced by Bérenger in 1994 [1], as an artificial absorbing layer. We will present the Trefftz-DG method with PML, based on the use of Green's functions as basis functions in the PML.

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