28*th* IUGG Conference on Mathematical Geophysics, June 7-11, 2010, Pisa, Italy
Session 9: Computational geophysics: Modern algorithms and applications

Mortar Spectral Element Method applied to the study of seismic response of 2D alluvial deposits

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Keywords: *spectral element; Mortar; elastodynamics*

Mortar element techniques, are discretization methods for partial differential equations, which use separate finite or spectral element discretization on nonoverlapping subdomains. In general the different meshes on the subdomains do not match on the interface, so the exact continuity condition at the skeleton of the decomposition is replaced with a weak one, that can be written in terms of a Lagrange multiplier and the jump of the traces. Then suitable quadrature formulas are used to evaluate the associated integrals, involving discrete functions defined on different non-matching grids or of different polynomial degree. Such strategies improve the geometrical flexibility of the spectral discretization, allow for mesh adaptivity, and help to circumvent the loss of accuracy near singularities. In the present work, we consider the Mortar Spectral Element Method coupled to second order time integration scheme to simulate the propagation of elastic waves in complex unbounded media. We consider geometrically non-conforming domain partition where meshes in to the subdomains are independently generated from the neighboring ones and associated with different spectral approximation degrees. We thus subdivide the domain into n non-overlapping subregions Ω_k, and in each Ω_k the grid is assumed to be conforming. The resulting skeleton, i.e., the intersection of subdomain boundaries, is then decomposed into mortar elements that are $(d-1)$-dimensional geometrical entities for a d-dimensional problem. The coupling between possible discontinuities at the interfaces of the subdomains, either in h (mesh size) or in N (spectral degree), is handled by mortars. In this contribution we present a first set of benchmark assessing the convergence, accuracy and flexibility of the previous method, implemented in the well known spectral elements based code GeoELSE. Furthermore we illustrate how this recent enhancement of GeoELSE can be effectively used also for the numerical analysis of soft soil alluvial deposit lying on the top of stiff sediments or rock. An applicative example will be provided focusing on the 2D seismic response of the Gubbio alluvial basin (central Italy). This numerical simulation includes the combined effect of strong lateral variations of soil properties and topographic amplification. Some hints on the work in progress to effectively handle 3D problems with MEM are also given.