Numerical Analysis and Scientific Computing Seminar

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Forwarding modelling of geophysical electromagnetic data on unstructured grids using an adaptive mimetic finite-difference method

Abstract:

In this study, we propose a mimetic finite-difference schemes for the solution of the geophysical electromagnetic (EM) modelling problem on unstructured grids. While the mimetic finite-difference method shares many traits with the conventional finite-element and finite-volume methods, it has the advantage that it naturally accommodates grids with arbitrary polyhedral elements. We use a total-field scheme where the electric field is defined at the edges of the elements. Using benchmark magnetotelluric and controlled-source models, we show the similarity of the presented mimetic scheme with the standard edge-based finite-element method. We then show the generality of the mimetic finite-difference method, in accommodating arbitrary elements, by using this scheme for adaptive mesh refinement. The mesh adaptation is applied by an iterative h-refinement where goal-oriented error estimates are used to mark the elements for refinement. The marked elements are then decomposed into eight smaller tetrahedra, creating an octree mesh. Since arbitrary polyhedra are naturally permitted in the mimetic finite-difference method, no modification of the scheme or averaging is required to deal with the hanging nodes. This characteristic allows preserving the quality of the initial grid and helps avoiding any extra refinement, and hence, simplifying the refinement procedure.