EDGE-BASED PARALLEL FRAMEWORK FOR THE SIMULATION OF 3D CSEM SURVEYS

Octavio Castillo[1], Josep de la Puente[1], Vladimir Puzyrev[1] and José María Cela[1]

[1] Computer Applications in Science & Engineering Department
Barcelona Supercomputing Center
Nexus II – Campus Nord UPC – Barcelona - Spain
contact: octavio.castillo@bsc.es

Abstract: The last decade has been a period of rapid growth of electromagnetic methods (EM) in geophysics, mostly because their industrial adoption. In particular, the marine controlled-source electromagnetic (CSEM) method has become an important technique for reducing ambiguities in data interpretation in hydrocarbon exploration.

On the other hand, the use of edge-based finite element method (EFEM) has become very popular for solving electromagnetic field problems. EFEM is able to deal with many difficulties that are encountered in the modeling (particularly eliminating spurious solutions) and they yield accurate results with a substantial reduction of the computational modeling cost. However, the state of the art is marked by a relative scarcity in practice of robust codes to simulate geophysical electromagnetic problems that may be attributed to their theoretical and implementational threshold. Indeed, more care and effort are required to implement them: vectorial basis functions, edge directions (global/local) and numbering strategy, among others.

Based on previous ideas and considering the societal value of exploration geophysics, we present an edge-based parallel tool for the data computation that arise when applying the CSEM. In order to avoid the source singularity, we solve Maxwell's equations with respect to anomalous electric field, namely, the total electric field is decomposed into primary and secondary field. The primary field is calculated analytically using an horizontal layered-earth model and the secondary field is discretized by EFEM.

The framework's structure is modular, simple and flexible which allows to exploit the embarrassingly-parallel tasks and the advantages of the geometric flexibility. In order to represent complex geological bodies, our tool works with unstructured tetrahedral meshes. The result is an implementation that allows users to specify edge-based variational forms of H(curl) for the simulation of 3D electromagnetic surveys with the CSEM. Finally, the code's performance and accuracy is studied through a scalability tests and comparisons to other results respectively.

Topic: EM exploration.

Keywords: CSEM, parallel, finite element, numerical.