A 3-D MODEL STUDY FOR MARINE EM USING VECTOR FINITE ELEMENTS

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The finite element (FE) method is a very powerful tool to solve partial differential equations. Whereas the finite difference method is restricted to structured, orthogonal grids the FE method allows for unstructured grids. These grids provide a means to mesh arbitrary geometric features, like topography or curved surfaces, and to adapt the grid size to the character of the solution. If the mesh is suited to a particular problem the number of degrees of freedom that is required to obtain a solution of desired accuracy can be reduced substantially.
We have implemented a FE solver for Maxwell's equations in frequency domain. In order to validate our implementation we study the canonical disk model of Weiss and Constable (2006) and compare their finite volume (FV) results with our FE solution. In general, both solutions agree very well. A higher order polynomial approximation and a locally refined mesh render our FE approach more accurate at selected locations within the computational domain. The system of linear equations arising from the FE or FV method is solved using the Jacobi preconditioned quasi minimum residual method (QMR; Freund and Nachtigal, 1994). Compared to the large but orthogonal and almost equidistant FV grid, the unstructured and locally highly refined FE grid dramatically increases the number of QMR iterations to reduce the residual norm to a given threshold.
The geometric flexibility of FE is finally demonstrated by a halfspace model with synthetic bathymetry. The seafloor topography is shown to significantly distort the otherwise regular field pattern.

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