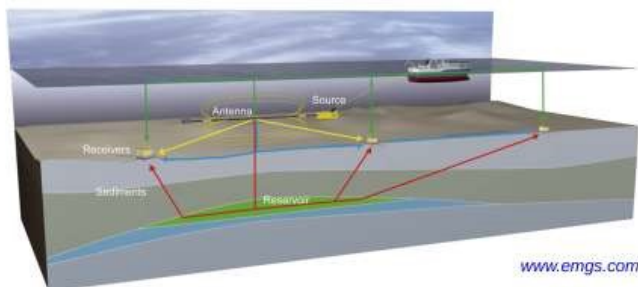


Towards an HPC tool for simulation of 3D CSEM surveys: an edge-based approach

Motivation & goal

- Exploration geophysics is of great societal value
- Electromagnetic Methods (EM) are an established tool in geophysics
- Edge-elements for electromagnetic simulations: No spurious solutions



- Complex geometries
- Anisotropic domains
- Reduce uncertainty
- Increase awareness of the earth's subsurface

Edge finite element formulation for CSEM

- Maxwell's equations in their diffusive form:

$$\nabla \times \mathbf{E} = i\omega\mu_0\mathbf{H}$$

$$\nabla \times \mathbf{H} = \mathbf{J}_s + \tilde{\sigma}\mathbf{E}$$

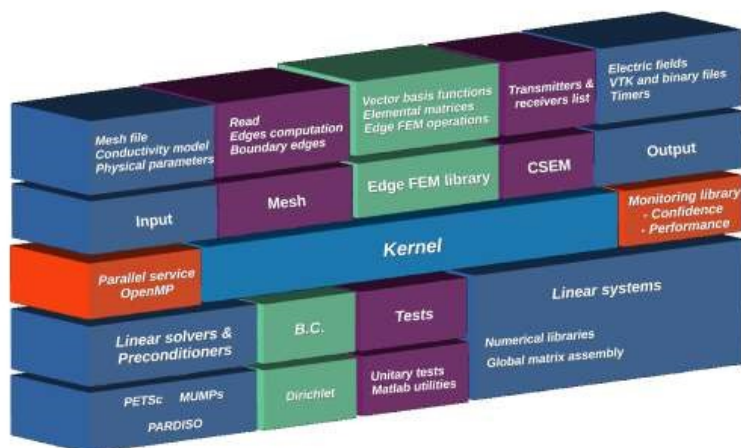


- Compact discretized form by Edge finite element method:

$$[K_{jk}^e + i\omega\tilde{\sigma}_e M_{jk}^e] \cdot \{E_{sk}\} = -i\omega\mu\Delta\tilde{\sigma}_e R_k^e$$

where K^e and M^e are the elemental stiffness and mass matrices

Framework

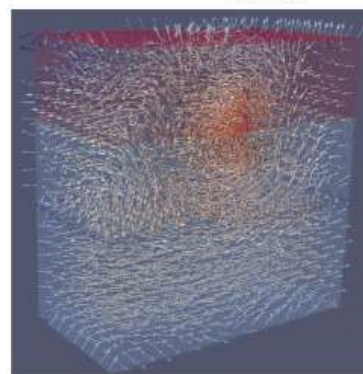
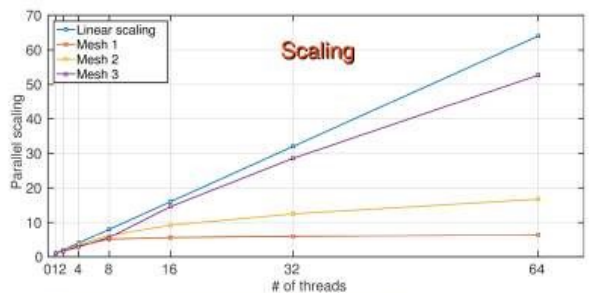
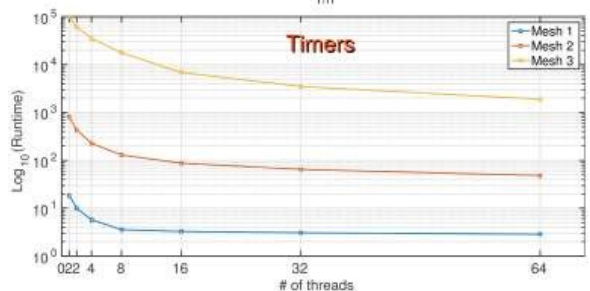
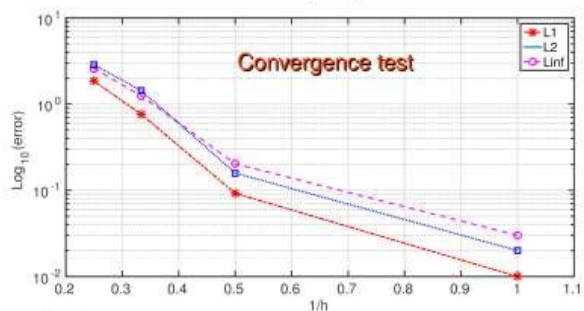
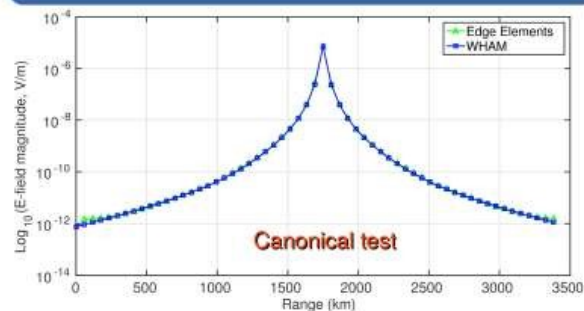


- Modular & extensible kernel
- Independent of problem formulation
- Parallel processing support
- Confidence & performance monitoring
- Post-processing support
- Efficient solvers & preconditioners
- Interface to mesh generators
- Edge FEM library
- Linear systems library
- CSEM module

Acknowledgements

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 644602.
Authors gratefully acknowledge the support from the Mexican National Council for Science and Technology (CONACYT).

Results



Post-processing for analysis

Total field for a four-layers model

References

- [1] Hongzhu, C. (2014). 3D controlled-source electromagnetic modeling in anisotropic medium using edge-based finite element method. *Computer & Geosciences* 73, 164-176.
- [2] Jin, J. (2002). *The finite element method in electromagnetics*. John Wiley & Sons.
- [3] Weiss, C. J., & Newman, G. A. (2002). Electromagnetic induction in a fully 3-D anisotropic earth. *Geophysics*, 67(4), 1104-1114.

