

CIG Business Meeting

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Impressions from the AMR
Workshop, October 24-27,
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WHERE DISCOVERIES BEGIN

What is AMR?

- Methods for locally refining a computational mesh to capture features that are of a finer spatial scale than the rest of the mesh.
- Primary advantages are that the spatial details of the solution are accurately represented while dramatically reducing the computational costs.

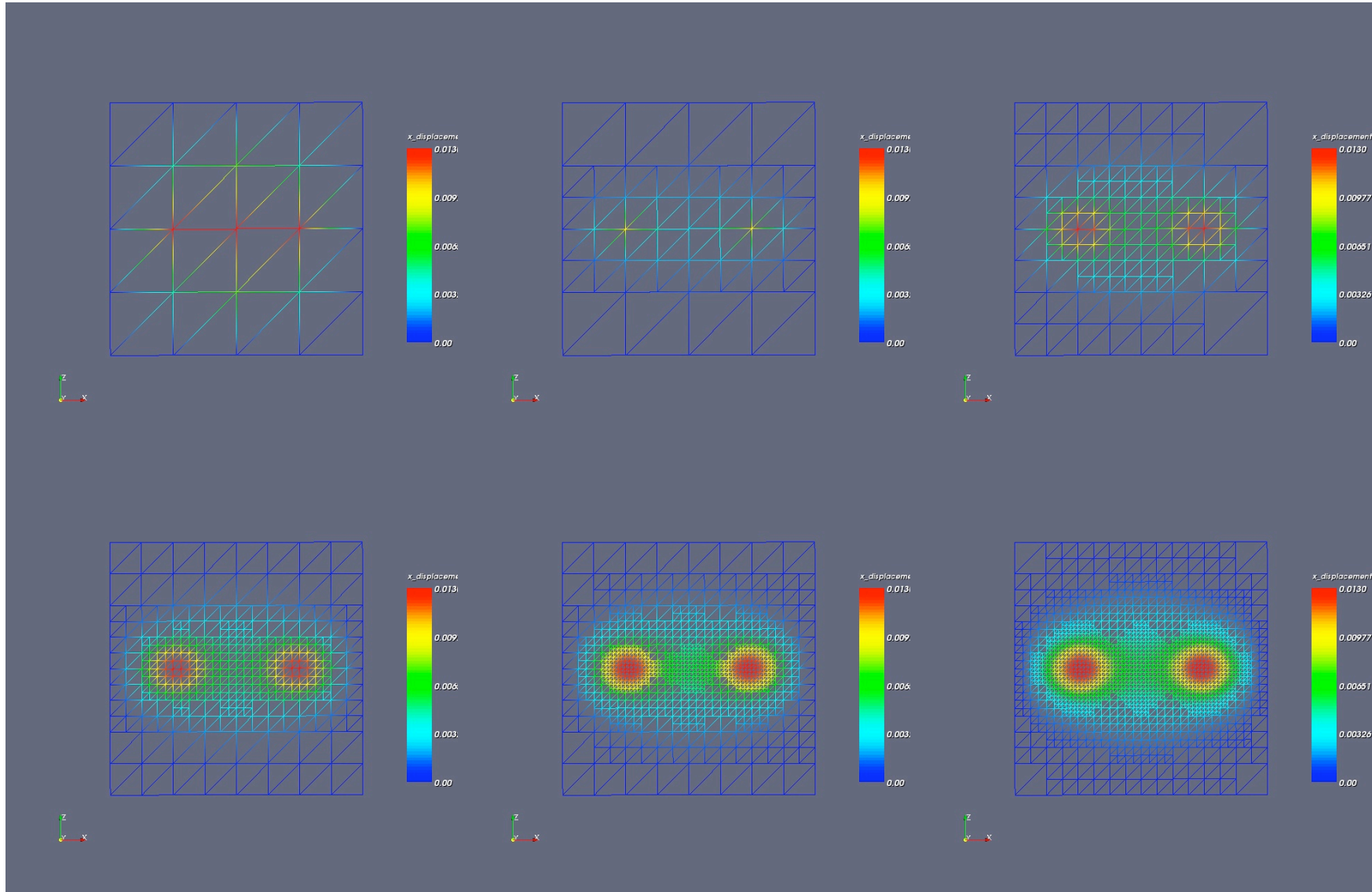
Workshop Summary

- Several talks on various AMR methods.
- Main focus of workshop was a tutorial on the deal.II package by Wolfgang Bangerth (Texas A&M).
 - Demonstration of deal.II capabilities.
 - 'Hands-on' examples.
 - Existing examples were modified by attendees.

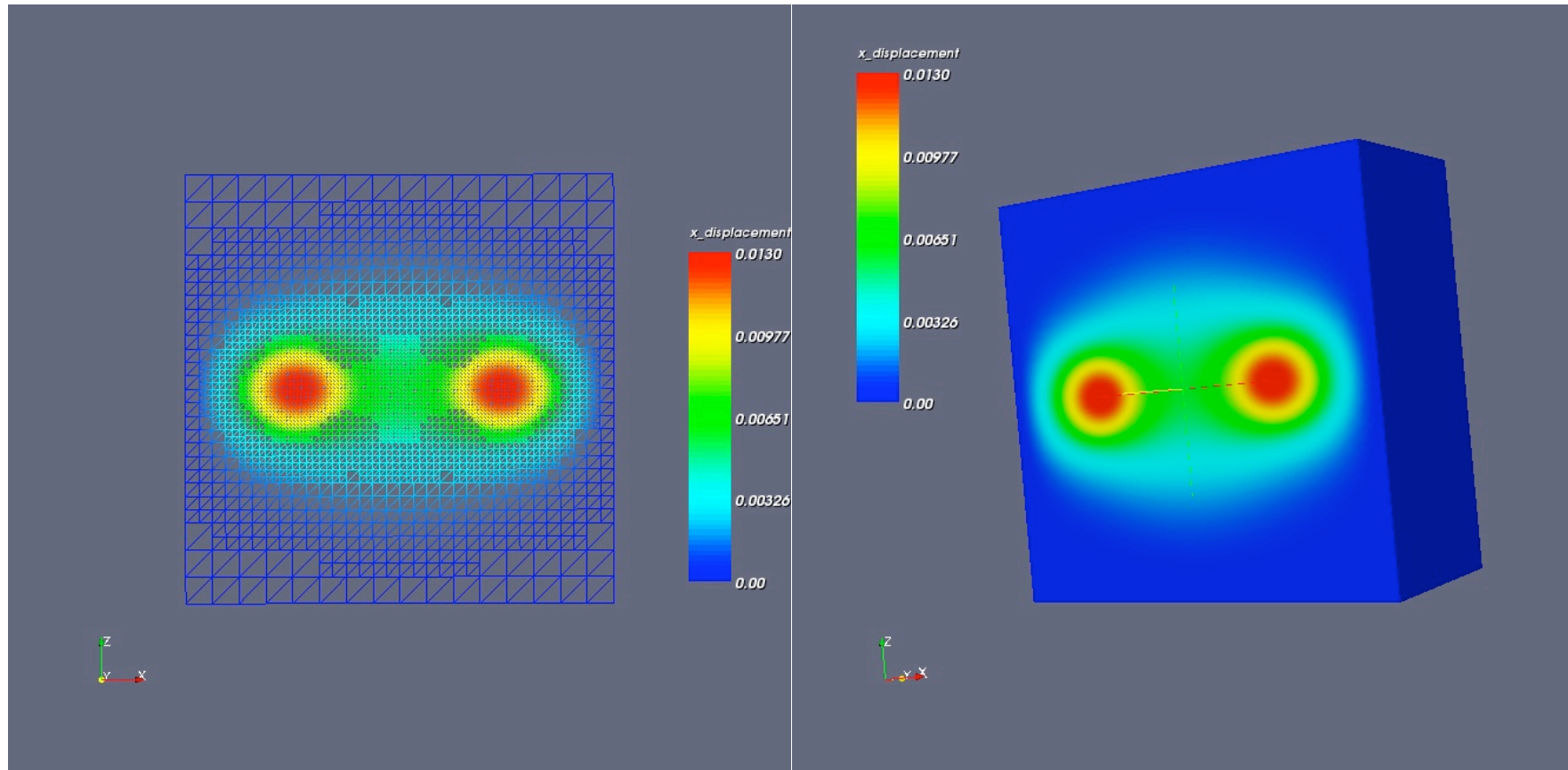
What is deal.II?

- Complete package for developing finite element codes.
 - Includes AMR.
 - Dimension-independent programming supports 1D, 2D, 3D.
 - Supports Lagrange elements of any order.
 - Fast solution algorithms.
 - Several graphics formats built-in.

Elasticity Example



Elasticity Example (cont.)



Other Aspects to Consider

- AMR is easier for structured meshes.
 - Pyramid can do unstructured tet meshes.
- Most AMR packages have limitations on mesh size.
 - Entire mesh must be able to fit into memory for a single process.
- Deal.II is an excellent package for experimenting with AMR.
- Wolfgang would like to work with the community to build a suite of simple AMR-enabled geophysical codes.

What Types of Problems Could Benefit from AMR/deal.II?

- Problems with a high degree of spatial localization.
- Problems that are easily solved on structured meshes.
- Examples:
 - Convection.
 - Magma dynamics.
 - Long-term lithospheric deformation.

Short-Term Crustal Dynamics

- AMR viewed as useful.
- AMR/deal.II could be used to develop rules for initial mesh design for different types of problems.
- Current PyLith development includes some aspects of AMR, such as refining/coarsening in bilevel multigrid solver, that could eventually lead to more direct support for AMR.

Mantle Dynamics and Long-Term Tectonics

- Would benefit from AMR.
- It would be difficult to add AMR to existing codes (CitcomS, CitcomCU, GALE).
- Particle tracing with AMR is a difficult bookkeeping problem.
- Despite scalability issues, deal.II is very useful for teaching and research (e.g., algorithm development).
- Current effort underway to develop scalable AMR-based mantle convection code (Omar Ghattas, UT-Austin; Mike Gurnis, CIG; Shijie Zhong, Univ. Colorado).