

Solving an Earth-Sized Jigsaw Puzzle

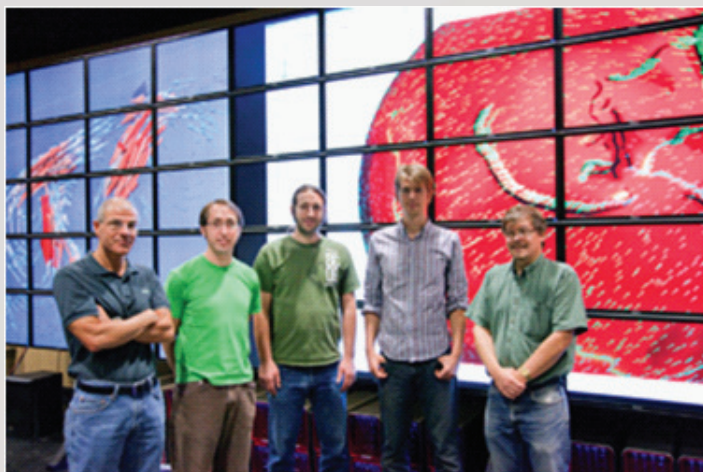
Breakthrough geodynamics software maps the Earth's mantle

Scientists have had a basic understanding of plate tectonics for several decades, but only recently have they been able to simulate the Earth's entire mantle with enough resolution to explore where plates collide, causing earthquakes and volcanoes.

Omar Ghattas from The University of Texas at Austin and Michael Gurnis from Caltech developed a geodynamics software package that models plate motion with greater accuracy than ever before. Their findings, enabled by the Ranger supercomputer at the Texas Advanced Computing Center and the Jaguar supercomputer at Oak Ridge National Laboratory, were published in the Aug. 27, 2010, issue of *Science* and featured on the cover.

These simulations are helping to answer significant questions in geophysics: What controls the speed of plates? How do microplates interact? How much energy do plates generate and how does the energy dissipate?

In 2010, the research team carried out global geodynamic simulations of the Earth's mantle on Ranger with 1km resolution at plate boundaries. These simulations closely matched observational data and answered long-standing geophysics questions.



Team members from the Mantle Convection PetaApps project with visualizations from the Rhea mantle convection code on TACC's Stallion tiled display. L to R: Omar Ghattas (UT Austin), Lucas Wilcox (UT Austin), Carsten Burstedde (UT Austin), Georg Stadler (UT Austin), Michael Gurnis (Caltech). Not pictured: Laura Alisic (Caltech). Photo by Leigh Brodie.

"It's almost as if we jumped over a whole generation of computation in the sense of being able to reproduce all of the fine-scaled details, the deformations and earthquakes, which occur regionally, but that come out of a global model," Gurnis said.

The researchers believe they've created a valuable tool that can be used for a wide range of problems. For example, the team is applying their algorithms to simulate the dynamics of ice sheets in Antarctica, which like the Earth's mantle, is modeled as a slowly flowing nonlinear fluid.

"We're finding that the methodology we've developed for the mantle convection project has implications and direct applications to this very important problem in climate science," Ghattas said.

The Ranger supercomputer is funded through the National Science Foundation (NSF) TeraGrid (www.teragrid.org) Office of Cyberinfrastructure.

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