CIG Software for the Geophysics Community

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NSF Award 0426271

Introduction

Computational Infrastructure for Geodynamics (CIG) is a membership-governed organization that supports and promotes Earth science by providing state-of-the-art tools for computational geophysics using modern software development practices. CIG currently has 41 member institutions and 9 foreign affiliates. CIG is managed by the California Institute of Technology for the National Science Foundation.

All CIG software can be found via the CIG website. Geophysics researchers are encouraged to participate in the CIG community, CIG-supported workshops and training sessions, and to visit our website, http://geodynamics.org, to sign up for various mailing lists.

Research Areas

CIG software development efforts are directed towards several areas in Earth science:

Mantle Dynamics Earth's mantle and its convection are responsible for plate tectonics and continental drift, but the processes are poorly understood.

Magma Dynamics and Geochemical Transport The dynamics and evolution of Earth's interior can be inferred from the chemistry of the materials erupted from the mantle, but there are still many open questions, including how melted and solid materials are distributed and interact to affect the geochemical evolution of the planet.

Crustal and Lithospheric Dynamics on Million-Year Timescales The crust we live on undergoes deformations over long timescales, and better modeling could lead to increased understanding of how erosion from climate change and crustal changes are related.

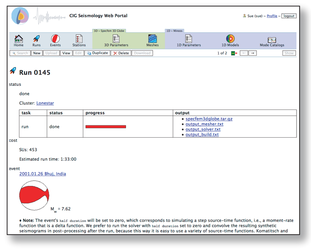
Crustal Dynamics on Earthquake Timescales Advances in understanding how stress relates to the triggering of earthquakes and aftershocks could lead to better knowledge of earthquake hazards.

Seismic Wave Propagation Data from existing instruments has been augmented by data from the EarthScope project, necessitating better computational tools for analysis and modeling.

The Geodynamo Progress in understanding Earth's magnetic field requires extensive numerical investigations.

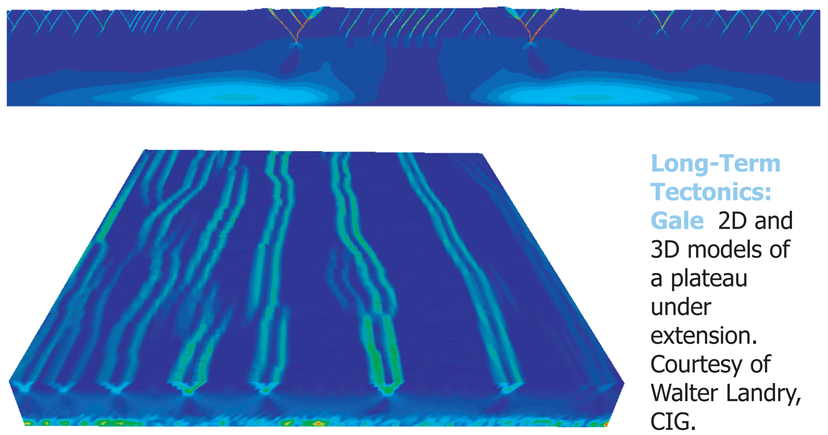
Science Gateways

Seismology Science Gateway Provides automated and on-demand simulations, e.g., seismic wave propagation and synthetic seismograms, using the TACC Lonestar TeraGrid cluster. Users can request synthetic seismograms for any given earthquake, selecting from assortment of 3D and 1D earth models. 3D-simulation runs use SPECFEM3D GLOBE, which simulates global and regional (continental-scale) seismic wave propagation using the spectral element method. The portal's 1D simulations are performed by the serial Mineos code, which uses normal mode summation.

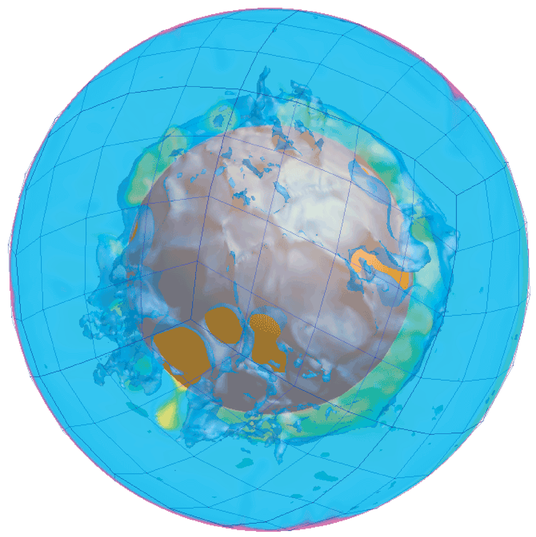


MAG Web Portal Allows investigators to run the geodynamo code MAG without compiling it locally. Users create and submit a MAG job to a selected TeraGrid site, monitor its progress and, when complete, download a tar-ball with the job results to further analyze locally or visualize with IDL software. With the MAG portal, one can queue up a long serial run rather than tie up a local machine.

Software



Long-Term Tectonics: Gale 2D and 3D models of a plateau under extension. Courtesy of Walter Landry, CIG.



CitcomS: Result of Thermal-Chemical Convection The composition isosurface is shown with the temperature field in a cross section. Courtesy of Eh Tan, CIG.

Examples of codes available through CIG at http://geodynamics.org

Cigma A suite of tools intended to facilitate the comparison of numerical models, and performs error analysis, benchmarking, and code verification.

CitComCU A finite element parallel code capable of modeling compressible thermochemical convection in a three dimensional domain appropriate for convection within the Earth's mantle.

CitComS A finite element code designed to solve compressible thermal convection problems relevant to Earth's mantle.

Gale A 2D/3D parallel code that solves problems in orogenesis, rifting, and subduction with a variety of boundary conditions, including free surfaces with coupling to surface erosion models.

MAG Serial version of a rotating spherical convection/magnetoconvection/ dynamo code that solves the non-dimensional Boussinesq equations for time-dependent thermal convection in a rotating spherical shell filled with an electrically conducting fluid.

Mineos A 1D code that simulates synthetic seismograms in the spherical symmetric nonrotated Earth by normal mode summation.

PyLith A finite element code for the solution of visco-elastic/plastic deformation that was designed for lithospheric modeling problems.

SPECFEM3D and SPECFEM3D_GLOBE These spectral-element packages propagate seismic waves on global, regional, and local scales.

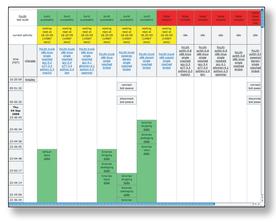
Infrastructure

CIG has moved geodynamics in new directions through the creation of community infrastructure. This infrastructure consists of:

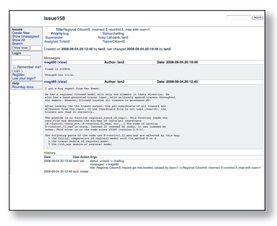
- A coordinated effort to develop reusable, well-documented and open-source geodynamics software.
- The basic building blocks — an infrastructure layer — of software by which modeling codes could be quickly assembled.
- Extension of existing software frameworks to interlink multiple codes and data through a superstructure layer.
- Strategic partnerships with complementary activities in the larger world of computational science and geoinformatics.
- Specialized training and workshops for both the geodynamics and larger Earth science community.
- Hardware resources for software development and community use.

Tools

Software Repository
CIG software is available via the open-source Subversion version control system (subversion.tigris.org). A PHP-based web interface, WebSVN, allows users to view the log of any file or directory and see a list of all the files changed, added, or deleted in any given revision. http://geodynamics.org/websvn/



Automatic Building and Testing
CIG uses BuildBot (buildbot.sourceforge.net), an automated system, to compile and test a code each time it is checked into the repository. The code is built on a number of platforms. Follow the progress following each software commit at (for example) http://geodynamics.org/buildbot/Gale/



Bug Tracking
Users can submit bug reports through the CIG website, which utilizes the Roundup Issue Tracker (roundup.sourceforge.net). Reports are assigned to a CIG software developer. Users can check the status of their bugs and how close they are to resolution, including messages and history. http://geodynamics.org/bugs/

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