

Computational Infrastructure for Geodynamics

Short-Term Tectonics Working Group

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What is CIG?

Objective: Develop, support, and disseminate software for the geoscience community.

- Coordinated effort to develop reusable, well-documented, open-source geodynamics software
- Strategic partnerships with the larger world of computational science and geoinformatics
- Specialized training and workshops for both geodynamics and larger Earth-science communities

CIIG: Institution-Based Organization

Educational and not-for-profit organizations

- **Open-organization**
 - Any institution seeking to collaborate on the development of open-source software
 - No cost or size requirements
- Current members
 - 39 member institutions
 - 8 foreign affiliates
- NSF funding Sep 2004 – Aug 2009

CIG Working Groups

Organized by sub-disciplines

- Short-term tectonics
- Long-term tectonics
- Mantle convection
- Computational seismology
- Geodynamo
- Magma dynamics

CIG Organizational Structure

- Staff
 - Responsible for software development
 - Director handles day-to-day decisions
- Science Steering Committee
 - Voice of geophysics community
 - Prioritizes the competing needs of all sub-disciplines
- Executive Committee
 - Primary decision-making body
 - Approves SSC recommendations and contractual arrangements
- Member institution representatives

CIG Staff

Mike Gurnis Director

Michael Aivazis Chief Software Architect

Luis Armendariz Software Engineer

Walter Landry Software Engineer

Leif Strand Software Engineer

Matt Knepley Software Engineer

Wei Mi Software Engineer and System Administrator

Sue Kientz Technical Writer and Web Manager

Ariel Shores Administrative Assistant

CIG Science Steering Committee (SSC)

- Peter Olson (Chairman), John Hopkins University (term expired)
- Brad Aagaard, U.S. Geological Survey
- Wolfgang Bangerth, Texas A&M University
- Omar Ghattas, University of Texas at Austin (term expired)
- Jeroen Tromp, Caltech (term expired)
- Shijie Zhong, University of Colorado at Boulder
- Laurent Montesi, Woods Hole Oceanographic Institution
- Louise Kellog, University of California, Davis

CIG Executive Committee (EC)

- Mark Richards (Chairman), University of California, Berkeley
- Marc Spiegelman (Vice Chairman), Columbia University
- Bill Applbe, Victorian Partnership for Advanced Computing
- Brad Hager, Massachusetts Institute of Technology
- Peter Olson (*ex-officio*), Brown University
- Mike Gurnis (*ex-officio*), Caltech
- Michael Aivazis (*ex-officio*), Caltech

Short-Term Tectonics Working Group

Objective: Simulate crustal deformation across spatial scales from 1 m to 10^3 km and temporal scales ranging from 0.01 s to 10^5 years.

- Strong connection to SCEC Fault Systems working group
- Potential connection with SCEC Eq Source Physics working group

Short-Term Tectonics Working Group

How does the community participate?

- Workshops (like this one)
- Mailing list
 - `cig-all` (entire CIG community)
 - `cig-short` (this working group)
- Submitting proposals for software development
- Submitting feature requests & bug reports

CIG Strategic Plan

Rolling 5-year plan submitted to NSF

- Overview
 - Includes Science Plan outlining software development projects
 - Written by SSC, approved by EC
 - Submitted to NSF in July of every year
- This year's plan
 - Request for comments on draft sent to `cig-short`, Jun 16
 - Request for comments sent to `cig-all` (very soon)

Summary of Strategic Plan (common)

Current projects

- Adaptive mesh refinement
 - Hands-on developer workshop, Oct 2007
 - Begin coordinated effort on AMR enabled codes
- Automated testing/benchmarking utilities
 - Run on several platforms
 - Build software, run tests, report errors
 - Benchmark comparisons

Summary of Strategic Plan (common)

Future projects

- On-demand/on-request simulations
 - Seismology (Fall 2007)
 - Geodynamo
- Framework for Earth Structure Models
 - Unified data structures and interfaces for Earth models
 - Querying models for properties
 - Generating/updating models based on simulation output
- Coupled models
 - Implement fundamental interaction between physical processes

Working Group Priorities (Sep 2007 - Aug 2008)

1. PyLith releases 1.1 and 1.2
 - Solution of quasi-static and dynamic problems
 - Dirichlet (displacement), Neumann (traction), and absorbing BC
 - Kinematic and frictional fault interfaces
 - Viscoelastic material models
2. Improve support for computing Green's functions
3. Support for adaptive mesh refinement

Working Group Priorities (beyond 2008)

1. Integrated modeling of multiple earthquake cycles
 - Buildup of strain in crust
 - Release of strain in propagating earthquake rupture
 - Post-seismic deformation
2. Support for sensitivity modeling
3. Support for formal data assimilation
4. Update of Lagrangian coordinates to allow large deformations

Next Phase of CIG

1. No longer able to borrow techniques from other disciplines
2. Need to engage computational scientists in directing their research to solve our computational issues
3. What might the next phase look like?
 - Continue developing codes for geodynamics modeling
 - Funding of basic research
 - Develop new methods in computational science
 - Apply those methods to geodynamics problems
 - Seek NSF funding from programs that have significant computational science focus
4. Community participation
 - Business Meeting: Fall AGU
 - Proposal writing Winter–Spring 2008