Crustal Deformation Modeling Tutorial

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Workshop Instructors

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Objectives of Tutorials

- Learn more about numerical modeling of crustal deformation
- Increase the productivity and quality of your numerical models
- Progress along the CUBIT/Trelis learning curve
- Progress along the PyLith learning curve
  - Make simple changes to examples
  - Create a simple model of your research problem of interest
- Progress along the ParaView learning curve
Context of Tutorials

Examples use Cascadia Subduction Zone for realistic context
Getting Started

PyLith v2.2.1rc1 contains the examples we will be discussing

1. Download v2.2.1rc1 from https://github.com/geodynamics/pylith/releases
2. **If you do not have CUBIT/Trelis**, download the mesh from the PyLith Wiki: https://wiki.geodynamics.org/software:pylith:cdm2017
3. 3-D subduction zone example is in examples/3d/subduction
Getting Help After the Tutorial Ends

- Read the PyLith manual
- Try to work through the problem on your own
- Submit questions to cig-short@geodynamics.org
  - Describe the problem
  - Send complete output log and JSON parameters file.
- Subscribe to cig-short@geodynamics.org
  - Answers to most questions will be cc’ed to this email list
  - Short-term tectonics working group issues are posted here
What is CIG?
Computational Infrastructure for Geodynamics (www.geodynamics.org)

Objective: Develop, support, and disseminate software for the geodynamics 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

Underlying principle: Earth scientists need help from computational scientists to develop state-of-the-art modeling codes
CIG: Institution-Based Organization
Educational and not-for-profit organization

- Open-organization
  - Any institution seeking to collaborate on the development of open-source geodynamics software
  - No cost or size requirements

- Current members
  - 61 member institutions
  - 15 foreign affiliates
CIG Working Groups
Organized by sub-disciplines

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

- Formed through efforts by Brad Hager and Mark Simons before CIG started
- Strong connection to SCEC Stress and Deformation through Time (SDOT) focus group
- Building connections with SCEC Fault and Rupture Mechanics (FARM) focus group
CIG Activities

- **Software development**: primary activity
- **Workshops**
  - Sponsors workshops organized by one or more working groups
  - Holds workshops focusing on scientific computing and geodynamics
- **Training in use of CIG software**
  - Tutorials at workshops
  - Specialized training sessions (like this one)
- **Web site**: geodynamics.org
  - Distribution of software and documentation
  - Mailing lists for each working group
  - Wiki-like web pages for community involvement
CIG Software for Crustal Deformation

- **Relax**
  - Solves 3-D problems associated with earthquake faulting and quasi-static viscoelastic deformation
  - Short-term tectonics in a homogeneous half-space where geometry does not change significantly

- **PyLith**
  - Solves 2-D and 3-D problems associated with earthquake faulting and quasi-static and dynamic viscoelastic deformation
  - Short-term tectonics where geometry does not change significantly

- **Gale (obsolete) → Aspect**
  - Solves problems in orogenesis, rifting, and subduction, including free surfaces with coupling to surface erosion models
  - Long-term tectonics where geometry changes significantly

- **Virtual Quake**
  - Boundary element code that simulates earthquakes on fault systems based on stress interactions
Welcome to Golden!

Meals
- Breakfast and lunch are in Mines Market
- Dinner is on your own

All sessions are in this room

Reimbursement: CIG and SCEC

We are all visitors, please be respectful to our hosts!