

Crustal Deformation Modeling Tutorial

Brad Aagaard, Charles Williams, and Matthew Knepley



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Workshop Instructors



Brad Aagaard
USGS
Menlo Park, CA



Charles Williams
GNS Science
Lower Hutt, NZ



Matthew Knepley
Rice Univ.
Houston, TX

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

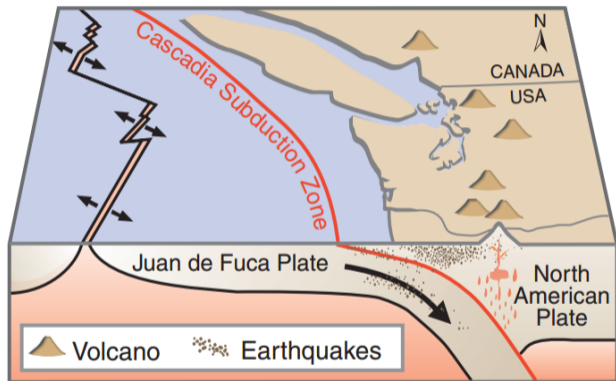
Overview of Tutorials

Agenda posted on geodynamics.org

| Mon | Tue |
|-----------------|-----------------|
| Overview | Fault Friction |
| PyLith 2.2.1 | 3-D Green's Fns |
| Meshing | Tinker Time |
| Group Exercise | |
| | Gravity |
| BC & Eqs | Tinker Time |
| Group Exercise | PyLith v3.0 |
| Troubleshooting | |

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

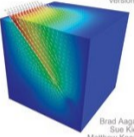
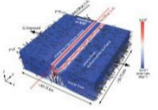
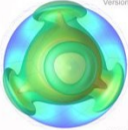
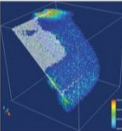
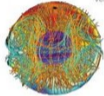


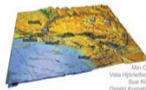
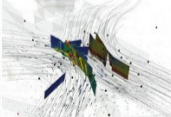
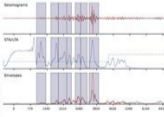
Organized by sub-disciplines

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

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

- 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

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|--|---|---|---|---|
| <p>COMPUTATIONAL INFRASTRUCTURE FOR GEODYNAMICS (CIG) VICORIA PARTNERSHIP FOR ADVANCED COMPUTING (VPAC) BONNEDC 2011-12-31-17</p> | | | | |
| <h2>PyLith</h2> <p>User Manual Version 1.3</p>  <p>Bred Aagaard Sue Kientz Matthew Knepley Leif Strand Charles Williams</p> <p>www.geodynamics.org</p> | <h2>Gale</h2> <p>User Manual Version 1.4.1</p>  <p>Walter Landry Luke Hodgkinson Susan Kientz</p> <p>www.geodynamics.org</p> | <h2>CitcomS</h2> <p>User Manual Version 3.0.3</p>  <p>En Tan Michael Gurnis Luis Ammendariz Leif Strand Susan Kientz</p> <p>www.geodynamics.org</p> | <h2>Cigma</h2> <p>User Manual Version 1.0.0</p>  <p>Luis Ammendariz Susan Kientz</p> <p>www.geodynamics.org</p> | <h2>MAG</h2> <p>User Manual Version 1.0.1</p>  <p>Peter Olson Wei M Sue Kientz</p> <p>www.geodynamics.org</p> |
| <p>COMPUTATIONAL INFRASTRUCTURE FOR GEODYNAMICS (CIG) CALIFORNIA INSTITUTE OF TECHNOLOGY (U.S.) UNIVERSITY OF CALIFORNIA</p> | | | | |
| <h2>Mineos</h2> <p>User Manual Version 1.0</p>  <p>Guy Masters Misha Barmine Susan Kientz</p> <p>www.geodynamics.org</p> | <h2>SPECFEM 3D GLOBE</h2> <p>User Manual Version 4.0</p>  <p>Min Chen Vita Horvath-Kobze Sue Kientz Dimitri Komaritsch Amica Labarta Gergo Liu Alessia Maggi David Mohles Brian Savage Bernhard Schuberth Alexey Suvarev Leif Strand Carl Tape James Tromp</p> <p>www.geodynamics.org</p> | <h2>SPECFEM 3D</h2> <p>User Manual Version 1.4.3</p>  <p>Min Chen Vita Horvath-Kobze Sue Kientz Dimitri Komaritsch Amica Labarta Gergo Liu Alessia Maggi Brian Savage Leif Strand Carl Tape James Tromp</p> <p>www.geodynamics.org</p> | <h2>Relax</h2> <p>User Manual Version 1.0.2</p>  <p>Sylvain Barbot</p> <p>www.geodynamics.org</p> | <h3>FLEXWIN User's Manual</h3> <p>Alexis Maggi</p>  |

- 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

- 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!