# Crustal Deformation Modeling Tutorial

Brad Aagaard, Charles Williams, and Matthew Knepley

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# Workshop Instructors

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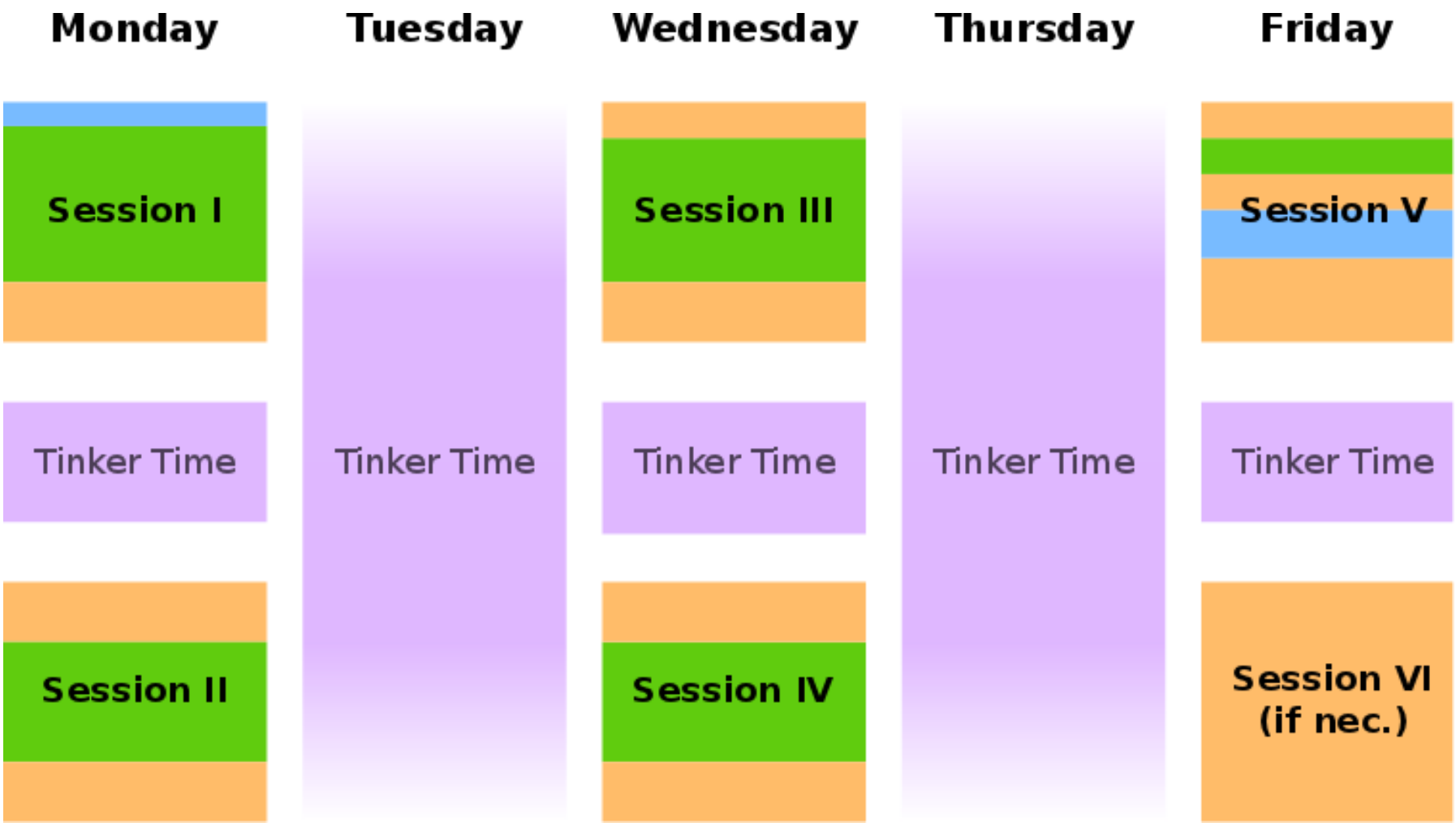
# Overview of Workshop

Draft agenda posted on geodynamics.org






CIG COMPUTATIONAL INFRASTRUCTURE for GEODYNAMICS

# Overview of Adobe Connect

- Audio input/output
  - Participants microphones are muted by default
  - Click on raised arm icon to “Raise your hand”
  - Your microphone will be enabled when hosts respond to your raised hand
- Q & A Pod
  - Submit questions using this tool.
  - Adobe Connect tracks which ones have not been answered.
- Chat Pod
  - Useful for exchanging urls, text for commands, etc.
  - Sessions will be recorded and archived for on-demand playback.

# CIG's First Online Tutorial

**WARNING**

This is CIG's first attempt at an online tutorial. We have practiced using Adobe Connect but there may be bumps in the road!

# Getting Help

- Read the PyLith manual
- Try to work through the problem on your own
- Submit questions to `CDMhelp@geodynamics.org`
  - Describe the problem
  - Send complete error messages
  - Include the platform you are using, the PyLith version, and whether it is a binary package or you built PyLith from source
  - We will try to respond but may defer detailed responses to the next online session
- 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
  - 50 member institutions
  - 10 foreign affiliates
- NSF funding Jul 2010 – Jun 2015

# 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 Crustal Deformation Modeling focus group
- Building connections with SCEC Earthquake Source Physics focus group

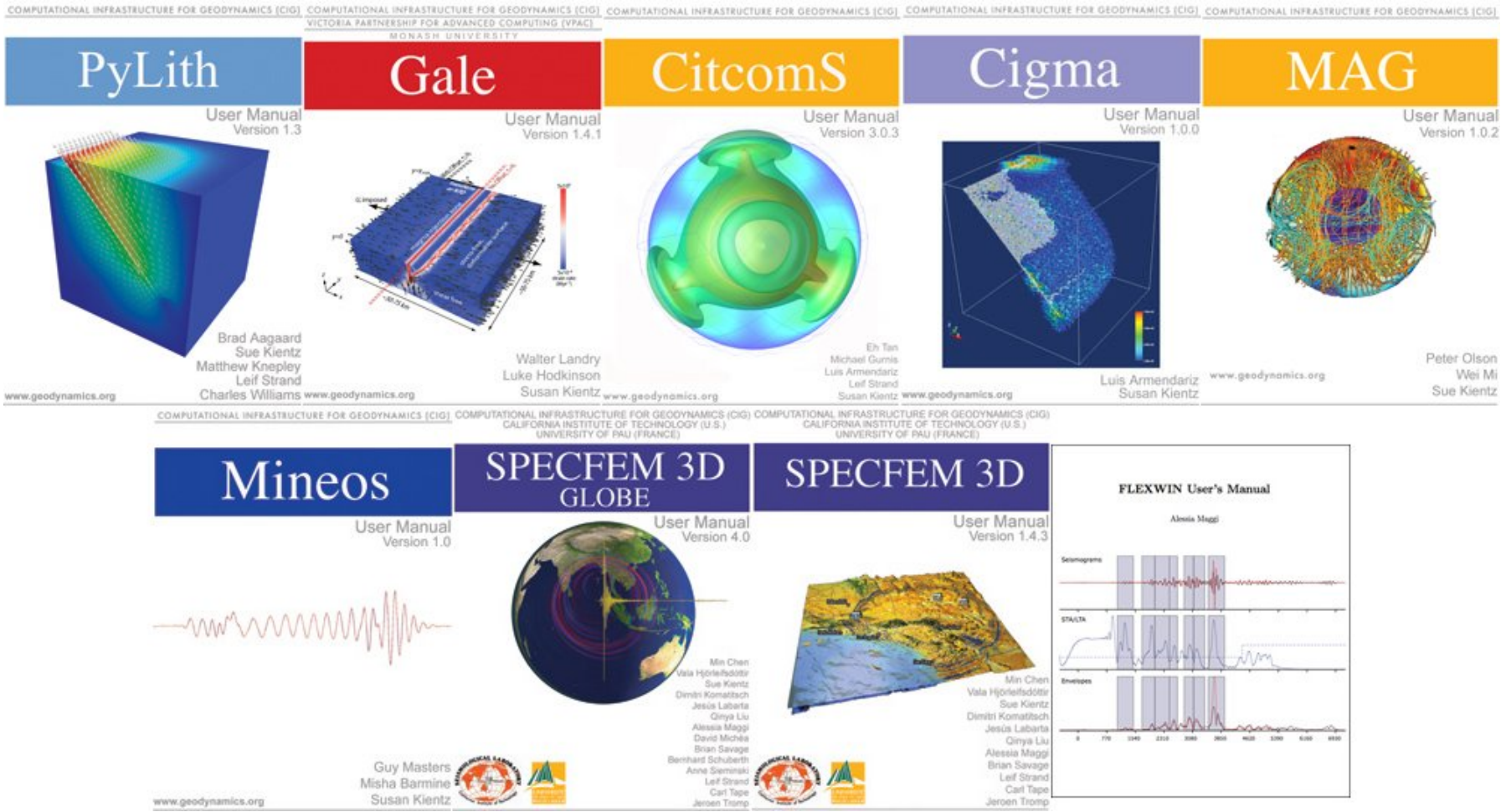
# CIG Organizational Structure

- 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
  - Vote on membership applications and bylaws
- Community members
  - Collaborate with staff to develop software

# 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



# CIG Software for Crustal Deformation

- 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
  - Solves problems in orogenesis, rifting, and subduction, including free surfaces with coupling to surface erosion models
  - Long-term tectonics where geometry changes significantly