CIG News Elements

A Quarterly Newsletter

Computational Infrastructure for Geodynamics

Research Highlight

Combining CitcomS and MAG to Investigate Core Evolution

Olson et al.'s (2013) recent paper *Controls on Geomagnetic Reversals and Core Evolution by Mantle Convection in the Phanerozoic* uses two CIG codes, CitcomS and MAG, to model core-mantle thermal interaction and its effects on the geodynamo. The geodynamo is sensitive to conditions at the core-mantle boundary (CMB) and comparison to geomagnetic polarity reversals offers a test for competing histories of the lower mantle. Hence, numerical dynamos driven by non-uniform heat flux at the core-mantle boundary are used to investigate the connections between geomagnetic field structure, geomagnetic reversal frequency, core evolution, and mantle convection through Phanerozoic time. Polarity reversal sequences and time average magnetic field structures are calculated using dynamos driven by two representations of lower mantle history. A dynamo model based on hotspot locations with a time independent pattern of CMB heat flux derived from the present day seismic shear wave heterogeneity of the lower mantle that produces a monotonic evolution of the core shows minor fluctuations in reversal frequency with age. A dynamo model based on reconstruction of mantle convection with plate motions[1] produces time variable CMB heat flux and an irregular evolution of the core. For this model, the figure to the left shows CMB heat flux (left) with plate boundaries superimposed (black lines) and the corresponding time average dynamo radial magnetic field on the CMB (right) . This model produces large fluctuations in reversal rate, including stable polarity at 275 and 475 Ma and frequent reversals at other times. As seen in the figure, this dynamo produces departures from geocentric axial dipole symmetry during the time of supercontinent Pangaea as well as a heterogeneous growth history of the inner core.
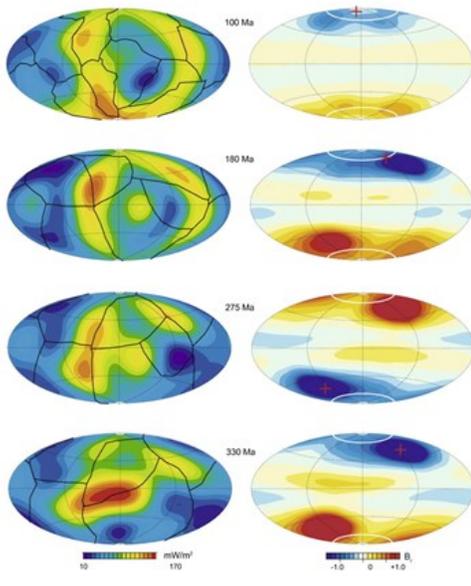
[1]Zhang, N., S.J. Zhong (2011) Heat fluxes at the Earth's surface and core-mantle boundary since Pangea formation and their implications for the geomagnetic superchrons, Earth Planet. Sci. Lett., 306, 205–216, http://dx.doi.org/10.1016/j.epsl.2011.04.001.

CIG Strategic Plan 2013

Work is beginning on CIG's rolling five year strategic plan for 2013-2018. The plan is compiled from current research, as well as input from the community. The strategic plan is updated annually and submitted to the NSF as part of our Collaborative Agreement. Please contact your disciplines Working Group or members of the Science Steering Committee with your development ideas and short-, intermediate, and long-term goals for CIG. As a community governed organization, CIG actively seeks your comments and suggestions.

Download last year's strategic plan:

http://www.geodynamics.org/cig/community/documents/SP2012/stratplan/view

http://blog.vistage.com/wp-content/uploads/2011/08/Vistage-article-image-8-26-11-1024x500.jpg

Announcements

- **Next Webinar Thursday February 14**
- **HPC for Geodynamics**
- **Summer Workshops and Meetings**

Inside this issue:

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NEW RELEASES
⇒ Relax 1.0.4 [2012 December 2012]
⇒ Specfem2D_V7.0.0 [2012 November 11]

Computing

XSEDE Resources.
Considering using XSEDE Resources but don't know how to get started? Check out the XSEDE training classes at: https://www.xsede.org/web/xup/overview. From writing a successful allocation proposal to GPU programming, XSEDE offers training classes to teach users how to maximize their productivity and learn new technologies for using

XSEDE services. The training classes focus on systems and software supported by the XSEDE Service Providers, covering programming principles and techniques for using resources and services effectively. Training classes are offered in high performance computing, visualization, data management, distributed and grid computing, science gateways, and more.

Computing Summary. Cylces are available using CIG's community software allocation on the following machines:
Yellowstone   490,000
Ranger (expiring) 682,000
Stampede   228,000
Longhorn   215
Allocations can be used to run pre-installed software, benchmarking and project development. For more information see our website or contact Eric Heien (emheien @geodynamics.org).

Around the Water Cooler *conversations at CIG HQ*

Approximating a piecewise differentiable periodic function by a Fourier series results in overshoots at the points where the periodic function has a discontinuity. This is the well-known Gibbs phenomenon.

An analogous phenomenon appears in numerical software that tries to model

problems with sharp gradients in field values. The CIG codes CitcomS and Aspect both exhibit this behavior. The figure right shows this for a 2D Stokes problem in Aspect, where the sphere is being modeled by a single compositional field. The compositional field's value inside the sphere should be 1, and outside should be 0,
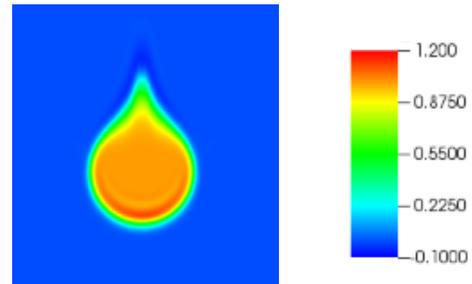
however this range is being exceeded. When modeling fine scale features, this phenomenon becomes of concern. To fix this, ASPECT uses artificial viscosity stabilization. A similar feature is being implemented in CitcomS. Go to the CIG Geodynamics YouTube channel to view the video of the falling sphere.

Events

HPC at LLNL
Over 20 leaders from the U.S. geophysics and HPC communities including national labs, federal agencies, research consortia and universities met at LLNL in November 2012 to identify a number of key scientific issues, broadly related to energy security and national security, requiring high performance computing from the mesoscale to the largest possi-

ble scale. Shared interests were identified including access to large computing resources, software and algorithm development, data and model integration, establishing and supporting collaborations among computational and domain experts, and workforce development. Strategies for moving forward including a white paper for NSF and DOE on the scientific targets and

needed HPC resources is in preparation.

Events *continued*
CIG at Fall AGU 2012
CIG scientists were well represented at AGU with over 50 presentations on a wide breadth of subjects spanning geodynamics.

A list of presentations can be viewed on our website at:

http://www.geodynamics.org/cig/community/documents/agu2012.

Thanks to all that attended the Business Meeting and stopped by our AGU booth. We enjoyed meeting all of you and learning about your research and ideas for CIG.

AGU Booth drew visitors from Ilia University in Georgia. Georgian students are currently collaborating using LidarViewer developed by KeckCAVES for archeological preservation of the 6th century church shown.

Webinar

CIG webinars draw from a pool of experts from mathematicians, to computer scientists, and to geoscientists, among others to bring together a cross-cutting community of faculty, students and researchers to both inform and disseminate knowledge on the tools and methodologies employed to further the study of problems in geodynamics.

The one hour webinars will be held the 2nd Thursday of each month October through May (no webinar in December due to AGU) at 2pm PT unless otherwise noted. Webinars will be recorded for later viewing. Reminders and details will be sent out through the cig-all mailing list.

http://www.trinitysem.edu/images/webinar.jpg

Thursday, February 14, 2013 @ 2pm PT
Bayesian Earthquake Modeling
Sarah Minson, Ph.D.
US Geological Survey
This seminar will provide an introduction to Bayesian analysis and its advantages and disadvantages relative to traditional optimization approaches for solving geophysical inverse problems. Bayesian methods have particular value for solving ill-posed inverse problems. Demonstrations of how to apply Bayesian methods to real geophysical problems will be given. Although these examples will be drawn primarily from earthquake source modeling, the methods and tools presented are completely generic and applicable to a wide array of geophysical inverse problems, and the discussion will be broadly directed to the modeling community.   *Submitted by Sarah Minson, USGS*

Thursday, March 21, 2013
Using Relax to Probe the Rheology of the Lithosphere
Asst. Professor Sylvain Barbot
Nayang Technological University
The Relax software implements a semi analytic solver in the Fourier domain to simulation stress change and deformation in the lithosphere caused by earthquakes and other environmental changes. Recently, Rousset et al. (2012) used Relax to simulate coupled afterslip and viscoelastic flow following the 1999 Chi-Chi earthquake. In the webinar, we will explore how to use Relax to simulate Coulomb stress change, afterslip, and 3D viscoelastic model of postseismic deformation. We will learn how to setup the input files, and visualize the simulation. We will generate maps of surface displacement and stress with GMT and explore large data sets in 3D using Paraview. Through examples, we will see how Relax can be used for education and research. And most important of all: Relax!   *Submitted by Sylvain Barbot*

2012-2013 Schedule

February 14	Sarah Minson. *Bayesian Earthquake Modeling ** 2pm PT*
March 21	Sylvain Barbot. *Using Relax to Probe the Rheology of the Lithosphere*
April 11	Oliver Kreylos. TBD
May 9	TBD

Do you have a suggestion for or have heard a talk recently you think may interest the CIG community? Let us know by contacting lorraine@geodynamics.org

Recent Publications

Olson, P., R. Deguen, L. Hinnov, and S. Zhong (2013), Controls on geomagnetic reversals and core evolution by mantle convection in the Phanerozoic, *Phys.Earth Planet. In.*, 214, 87-103, January 2013, http://dx.doi.org/10.1016/j.pepi.2012.10.003.

Rousset, B., S. Barbot, J.-P. Avouac, and Y.-J. Hsu (2012), Postseismic deformation following the 1999 Chi-Chi earthquake, Taiwan: Implication for lower-crust rheology, *J. Geophys. Res.*, 117, B12405, doi:10.1029/2012JB009571.

Please send us your recent publications as well as research highlights so we may continue to keep the geosciences community informed of all the current research being conducted in geodynamics with CIG codes.

Upcoming Meetings
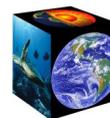
April 22-23, 2013 EarthCube Workshop for Modeling in the Geosciences
CIG together with CSDMS and CUAHSI will convene an EarthCube Workshop April 22-23, 2013 in Boulder, CO focusing on modeling needs in the geosciences. The workshop will engage approximately 65 scientists from geophysics, hydrology, surface processes, ocean modeling, atmospheric modeling, computational science, and related communities, to develop an understanding of the shared needs and capabilities for modeling. Attendance is limited. Early career scientists are encouraged to apply. Please visit geodynamics.org for more information and application. Application deadline is: February 28, 2013.

May 19-25, 2013 4th QUEST Workshop, Brittany, France
The fourth QUEST Workshop will be held from Sunday May 19 to Saturday May 25 in Benodet, Brittany, France. This workshop will focus on all aspects of passive imaging and monitoring using seismic noise and more classic seismic inverse problems for structure and source. The scientific program will be complemented by soft skill training for young researchers. For more information see: quest-itn.org.

June 2-7, 2013 Gordon Research Conference – Earth's Deep Interior, Mt Holyoke College, MA
The upcoming Gordon Research Conference (GRC) taking place on 2-7 June, 2013 at Mt Holyoke College, Massachusetts will focus on deep earth interiors and planetary topics. The conference will be preceded by a Gordon Research Seminar (GRS) on the same topic, for early career scientists and graduate students, 1-2 June, 2013. Partial funding for both the GRS and GRC may be available for students and Post-Docs. Application deadline is May 5th, 2013. For more details, see http://www.grc.org/programs.aspx?year=2013&program=interior.

June 10-14, 2013 Crustal Deformation Modeling Virtual Tutorial, Adobe Connect
Please join us for the Crustal Deformation Modeling Tutorial, featuring PyLith, June 10-14th.
As before, the workshop will be held over three days, with a 2 hour morning and afternoon session. These will allow for users in multiple time zones to receive hands-on training in the PyLith code. The sessions will be recorded and archived on the Geodynamics.org site, for future review. There will be an Overview session for PyLith in the spring of 2013, date TBD.

July 1 –20, 2013 CIDER 2013 Summer Program, From Mantle to Crust: Continental Formation and Destruction, UC Berkeley
CIDER 2013 will bring together scientists from different disciplines to better understand how and when continents are formed and destroyed. A specific objective is to draw together independent datasets, ranging from geophysics (seismology, mineral physics, rheology, geodynamics) to geochemistry to surface processes. One goal will be to develop a synthesized view of the thermal, compositional, rheological, and geochronological structure of continents, from the lithospheric mantle to the crust. For more information see: http://www.deep-earth.org/summer13.shtml

July 15-17, 2013, CIG/QUEST/IRIS Joint Workshop on Seismic Imaging of Structure and Source, University of Alaska, Fairbanks
We invite applications for the joint CIG, QUEST & IRIS workshop on Seismic Imaging of Structure and Source to be held at the University of Alaska, Fairbanks July 15-17. The workshop will span both the data and computation domains. Applications will be accepted through February 25. Attendees may submit abstracts beginning March 1. For more information, see geodynamics.org.