CIG News Elements

A Quarterly Newsletter

Computational Infrastructure for Geodynamics
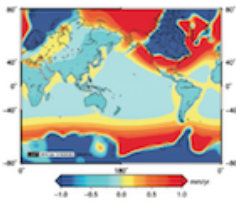
https://bluewaters.ncsa.illinois.edu/welcome

COMPUTATIONAL INFRASTRUCTURE FOR GEODYNAMICS (CIG)

SELEN

User Manual
Version 2.9

SELEN 2.9

www.geodynamics.org

Giorgio Spada
Daniele Melini

Announcements

♦ **Next Webinar Thursday May 16**

♦ **Git CIG**

♦ **Summer Workshops and Meetings**

Research Highlight

Specfem3D_ Globe Sustains over 1 Petaflop

Specfem3D_GLOBE is one of 4 large-scale science applications to have sustained performance of 1 petaflop on the Blue Waters supercomputer. SPECFEM3D_GLOBE models propagation of waves from earthquakes through the entire earth and is designed to scale to systems with hundreds of thousands of processor threads. The code can perform adjoint inversions on waveform data and synthesize ground displacements from earthquakes. This is used, among other things, to model near field ground motions to understand and mitigate their impact on buildings. The goal for the current model problem is to run at a high enough resolution to accurately simulate seismic waves at shorter periods, <2 sec, or ideally, down to 1 sec. The runtime process involves two phases: the mesh generation and the solver. The mesh for a SPECFEM3D_GLOBE simulation is based upon a mapping from the cube to the sphere called the cubed sphere that breaks the globe into six chunks, each of which is further subdivided. The spectral-element method solver is a continuous Galerkin technique with optimized efficiency because of its tensorized basis functions and has very good accuracy and convergence properties. NCSA improved the mesher performance by using system memory to store the mesh files for each MPI rank and MPI task reordering reduced communication overhead for both the mesh generator and the solver. Optimizations applied to the solver consisted of a small number of compiler directives to improve the generally excellent vectorization done by the Fortran compiler. These compiler directives inhibited overall aggressive loop unrolling and reordering in a few places. Higher-level optimizations by subroutine inlining were also helpful. The run was done on 21,675 XE nodes with 693,600 MPI ranks and sustained over 1 PF/s.

For the full story see: http://www.ncsa.illinois.edu/News/Stories/BW1year/

SELEN: Sea Level EquationN Solver

SELEN – Sea Leval EquatioN solver, is now available. Donated by Daniele Melini and Giorgio Spada, this open source program SELEN solves numerically the so-called "Sea Level Equation" (SLE) for a spherical, layered, non-rotating Earth with Maxwell viscoelastic rheology. The SLE is an integral equation that was introduced in the 70's to model the sea level variations in response to the melting of late Pleistocene ice sheets, but it can also be employed for predictions of geodetic quantities in response to present-day melting of continental ice-sheets. SELEN can compute vertical and horizontal surface displacements, gravity variations and sea level changes on a global and regional scale. SELEN is particularly oriented to scientists at their first approach to the glacial isostatic adjustment (GIA) problem and can be successfully applied to teaching. Download at: http://www.geodynamics.org/cig/software/selen

NEW RELEASES

⇒ Relax 1.0.4 on Fink [2013 February 11]
⇒ SELEN 2.9 [2013 March 29]
⇒ ASPECT 0.2 [2013 May 4]

Computing

Git CIG

CIG will soon be offering support for Git based source repositories for code development. Git offers several advantages over Subversion, including faster operation, more flexible and powerful tools for making changes to repositories, and strong support from various development platforms. All current repositories will remain in Subversion until their re-spective community ready to change. Look for the CIG announcement when the Git based system is ready for community use.

Computing Summary.
Cycles are available using CIG's community software allocation on the following machines:

Yellowstone	490,000
Stampede	100,000
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).

Extreme-Scale Computing Training.
The Argonne National Lab will host training on extreme-scale computing July 28-August 9, 2013 geared towards train-ing computational scientists on the key skills, approaches, and tools necessary for implanting and executing projects on leadership computing facility systems. Deadline for applications is May 22. See: http://extremecomputingtraining.anl.gov/

ASPECT 0.2.
This release adds new features, including: support for active and passive "compositional" fields, more flexibility to output only some variables, support for user-defined mesh refinement criteria, support for GPlates-generated velocity boundary conditions, support for passive tracer particle, provision of an "introspection" module as part of the source code. The manual has also been significantly expanded, with many new Cookbooks.

CIG Researchers in the News

1.3M Awarded to CIG Researcher, Wolfgang Bangerth to expand the deal.ii library and make it more adaptable and useful to researchers. deal.ii is used by hundreds of researchers around the world studying a variety of topics. deal.ii forms the backbone of the new mantle convection code Aspect under development by CIG. View the full story here: http://www.hpcwire.com/hpcwire/2013-03-25/texas_a_m_researcher_receives_$1.3_million_to_make_supercomputing_easier.html

Don't miss Professor Bangerth's FE lectures on YouTube. Link to them through: https://www.youtube.com/user/CIGeodynamics

Events

EarthCube Modeling for the Geosciences.
CIG together with CSDMS and CUAHSI convened an EarthCube Workshop April 22-23, 2013 in snowy Boulder, CO focusing on modeling needs in the geosciences. The workshop engaged over 60 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 in the geosciences. The final workshop report makes recommendations for continued interdisciplinary support, advanced computing, training and education, and needs for societal and cultural changes. See: geodynamics.org/cig/community/workshops/Earthcube13
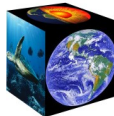
Comings and Goings

Departing.
Long time CIG Staff member Ariel Shoresh will be leaving headquarters in May. Ariel has been with CIG since Phase I. Her organizational skills and sense of humor will be missed!

New CIG Staff.
CIG welcomes Gilda Garcia and Hiroaki Matsui to HQ. Gilda will provide executive and event support stepping in with over 30 years experi-ence at UC with organizations with similar operational needs.

Hiro is the newest member of our the software development team. Hiro received his Ph.D. from Tohoku University concentrating on numerical modeling of the geodynamo. HIro will join other CIG experts in developing the next generation geodynamo code.

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.

Thursday, May 16, 2013 @ 2pm PT
Stellar Scalable Pseudospectral Methods and the Geodynamo
Nick Featherstone, Ph.D.
HOA NCAR

This webinar will begin with a brief overview of recent efforts to model convection and dynamos in the Sun and other stars. Such models (massive stars in particular) share many fundamental aspects in common with geodynamo models. Until recently, stellar dynamo studies that employed pseudospectral methods involving spherical harmonics also faced the same fundamental challenge as geodynamo models; scalability. After describing how this obstacle has been overcome within the last year for the Anelastic Spherical Harmonic code, I will present the essential elements of a scalable pseudo-spectral framework (based on MPI) that CIG is now assembling into a community dynamo model. I will conclude with some thoughts on how this framework may be extended to incorporate GPUs and/or a hybrid OpenMP/MPI approach.

Submitted by Nick Featherstone, HOA NCAR

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

2013-2014 Webinar Schedule

Do you have a suggestion for a talk or theme for next year's seminar series? Let us know by contacting lorraine@geodynamics.org

---

Recent Publications

Flament, N., M. Gurnis, and R.D.Müller, (2013), A review of observations and models of dynamic topography, Lithosphere, April 2013, v. 5, p. 189-210, first published on February 4, 2013, doi:10.1130/L245.1

Groh, A., H. Ewert, M. Scheinert, M. Fritsche, A. Rülke, A. Richter, R. Rosenau, and R. Dietrich (2012), An investigation of Glacial Isostatic Adjustment over the Amundsen Sea sector, West Antarctica, Global and Planetary Change, Volumes 98–99, December 2012, Pages 45-53, ISSN 0921-8181, 10.1016/j.gloplacha.2012.08.001.

Yang, Hongfeng; Liu, Yajing; Lin, Jian; (2013) "Geometrical effects of a subducted seamount on stopping megathrust ruptures", *Geophysical Research Letters* n/a-n/a DOI:10.1002/grl.50509

(a) Height change trend [m/yr]

(b) Elastic uplift [mm/yr]
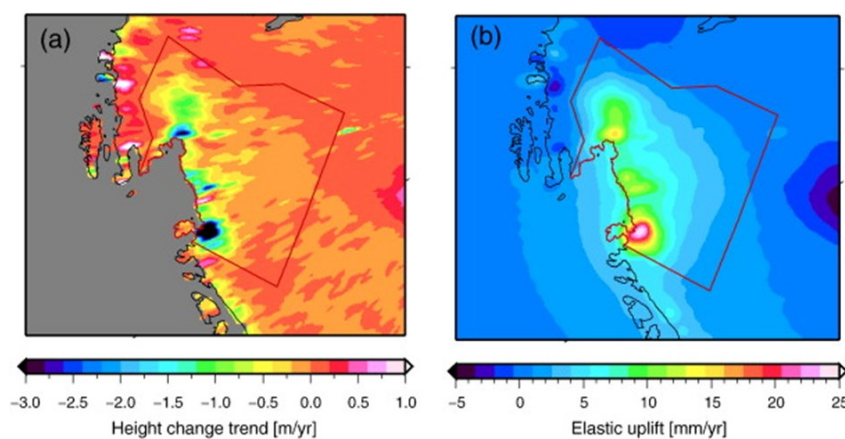
(Left) ICESat-derived height change trend for the period from September–November 2003 to September–October 2009. (Right) Elastic response of the Earth's crust due to the changing ice load. Mass conservation is accounted for by the water redistribution over the ocean according to the sea-level equation (Groh, et al., 2012)

Have a recent publication using CIG code? Submit to: geodynamics.org/cig/community/documents/reference

Recent Publications *continued*

Kronbichler, M., T. Heister, and W.Bangerth, (2012), High accuracy mantle convection simulation through modern numerical methods, Geophys. J. Int. (2012) 191(1): 12-29 doi:10.1111/j.1365-246X.2012.05609.x

Nielsen, K., S.A.Khan, Ni.J. Korsgaard, K.H. Kjær, J.Wahr, M. Bevis, L.A. Stearns, and L.H. Timm (2012), Crustal uplift due to ice mass variability on Upernavik Isstrøm, west Greenland, Earth and Planetary Science Letters, Volumes 353–354, 1 November 2012, Pages 182-189, ISSN 0012-821X, 10.1016/j.epsl.2012.08.024.

Wallace, L. M., J. Beavan, S. Bannister, and C. Williams (2012), Simultaneous long-term and short-term slow slip events at the Hikurangi subduction margin, New Zealand: Implications for processes that control slow slip event occurrence, duration, and migration, J. Geophys. Res., 117, B11402, doi:10.1029/2012JB009489.

> 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

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 24-28, 2013 Crustal Deformation Modeling Virtual Tutorial, Adobe Connect
Please join us for the Crustal Deformation Modeling Tutorial, featuring PyLith, June 24-28th.
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. Registration is now open: http://www.geodynamics.org/cig/community/workinggroups/short/workshops/cdm2013

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
The University of Alaska Fairbanks will host the 2013 CIG-QUEST-IRIS joint workshop on Seismic Imaging of Structure and Source. The workshop will include poster sessions, discussion sessions, invited talks, and computing lab tutorials on highlighted codes. A focus of the workshop will be on how tools in computational seismology can be used within inverse problems to obtain parameters estimates of earthquake sources and seismic velocity structures. Topics will include: meshing complex geologic domains, scalability of wave propagation solvers, efficient workflows, resolution and estimation of uncertainties, and horizons for computational seismology and seismic imaging.

For more information on all CIG hosted events, please got to geodynamics.org.

CIG COMPUTATIONAL INFRASTRUCTURE for GEODYNAMICS

Computational Infrastructure for Geodynamics

2119 Earth and Physical Sciences Building
One Shields Avenue
University of California, Davis, CA 95616

Phone: 530-752-2889
Fax: 530-752-0951
www.geodynamics.org

Computational Infrastructure for Geodynamics (CIG) is a membership-governed organization that supports and promotes Earth science by developing and maintaining software for computational geophysics and related fields.

For more information contact:

Louise Kellogg, Director
530.752.3690
kellogg@ucdavis.edu