

CUBIT

1. Wayne Crawford: **I just logged onto CUBIT this morning, they say they'll write back about letting me upload once they check my credentials. What's the typical wait?**

* Charles Williams: If you've logged into csimsoft, the turnaround is usually pretty fast. I would guess you'll have a response sometime tomorrow.

* Charles Williams: To follow up with my response, if you don't have a licensed version of CUBIT from csimsoft yet, you can download a trial version for now.

2. Wayne Crawford: **They were checking my credentials for the trial version!**

* Charles Williams: OK. I didn't know they had to do that. Randy Morris there has usually been pretty prompt in his responses.

chris pearson 2: **what is the address for evaluation version cubit again**

ziyadin: <http://cubit.sandia.gov/downloads.html>

4. EOS: Hello. **Is there a way to automatically record the CUBIT commands in a journal file?**

* Charles Williams: The journal files I'll be showing today are all contained in the examples/3d/hex8/mesh directory.

If you want to record your own commands, that happens automatically.

* Brad Aagaard: CUBIT automatically records all commands for an entire session in cubit01.jou or cubit02.jou. The difficulty is that sometimes you run a command several times to get what you want and then have to go back and figure out which one was the correct one. This is why I usually edit the journal file and play the commands from the journal file or copy/past from the command line into the journal editor.

9. Bill Harbert: **URL is wrong; You mean cubit.sandia.gov**

* Brad Aagaard: Yes, the CUBIT website is cubit.sandia.gov not sandia.cubit.gov.

10. Gerald Galgana: **is cubit available for foreign organizations?**

* Brad Aagaard: Yes, CUBIT is available to foreign organizations. There are export limitations on some software that affect some countries. We know of a number of institutions outside the US that have access to CUBIT.

22. Sang-Ho Yun: **Sorry, how did you open the geometry.jou file?**

* Brad Aagaard: Use the journal editor "scroll with the pen" icon. Then click on the "open folder" in the journal editor. Charles will demonstrate this.

24. Christian Baillard: **I didn't get how to rotate the block. How did you do?**

* Brad Aagaard: Rotate, zoom, and pan are the three mouse buttons. You can set what these are in the preferences.

25. Christian Baillard: **(Thanks, actually the problem is that I have a Mac mouse, is there any interface button?)**

* Brad Aagaard: I haven't been able to figure out how to emulate a 3 button mouse. I usually remap rotate to left-click and zoom to-right click. These work with normal Mac gestures.

26. Yajing Liu: **how to get the 3d view? mine only shows the 2d plane**

* Brad Aagaard: You need to rotate the model. I think the default rotate binding is middle-click and drag. You can remap the bindings in the CUBIT preferences.

* David Bekaert: you can also go to top menu display viewpoint and then isometric view.

28. Bobby Karimi: **Do you need the journal file to create the mesh structure, or is there a way to do the same things through the main interface?**

* Brad Aagaard: Everything can be done using the GUI. We usually use journal files so that we can reproduce everything in exactly the same way. You can also play journal files in batch mode.

30. Nina: **the face_xpos, face_xneg are all fixed identifiers, is that correct?**

* Brad Aagaard: The names of surfaces, curves, volumes are assigned by the user. The numeric identifier is set by CUBIT. For nodesets, the user controls the both the numeric value and the name.

31. Bobby Karimi: **I can count 7 node sets (each of the body surfaces, the fault surface) is there also an additional nodeset at the boundary between the elastic/viscoelastic materials?**

* Brad Aagaard: No, we don't apply any BC to the material interface so we did not create a nodeset for it. You only need to create nodesets for where you want to create a fault or BC.

32. Nina: **how do we know what are the identifiers available to us?**

* Brad Aagaard: The names are shown in the tree for the various surfaces, volumes, curves, etc. Same with nodesets and groups. Also immediately after creating an entity the id value is shown in the command window.

33. Sang-Ho Yun: **Can you record what you do in GUI as a journal file?**

* Brad Aagaard: Yes. You can cut and paste from the CUBIT Command Line window at the bottom or from the journal file cubit01.jou (or cubit02.jou) that is created automatically and records all the commands for the entire session.

34. Kirill Palamartchouk 2: **Could you let us download the journal files just demonstrated?**

* Matt Knepley: The journal files are in `examples/3d/hex8/mesh/*`.jou

35. Surendra Nadh Somala: **Faults reaching the ends of the domain seem to work well when there are a few faults. With complex fault systems, planar surfaces exactly of the length of fault makes much sense. Otherwise the book keeping to put barriers on each and every fault is cumbersome. Is there a way out?**

* Brad Aagaard: CUBIT requires airtight volumes. You cannot create a fault surface in the middle of the domain. It must extend to

meet either other surfaces or the boundary of the domain to form airtight volumes.

36. birendra jha: **How to (smartly) create a pinch out layer in CUBIT so that grid cell aspect ratios are not too bad around the pinch point**

* Brad Aagaard: We will discuss this in Session III when we discuss a subduction zone. Please remind us if we forget to discuss it.

103. Sang-Ho Yun: **Why was the angle increased at the surface?**

* Matt Knepley: In order to avoid very small angles in mesh triangles, which make the linear systems much harder to solve.

104. bob smalley: **what about putting "kink" in surface (trench)?**

* Matt Knepley: Yes, you could alter the surface instead of the slab to maintain larger angles.

39. Bobby Karimi: **In reference to what Surendra Nadh Somala asked, is it possible to make non-airtight volumes using LaGrit? Or, does it behave the same way as Cubit in needing airtight volumes?**

* Brad Aagaard: In LaGrit there are more options for inserting faults. Carl Gable has some examples where he inserts a fault into the middle of the volume (see the slides from the 2010 Crustal Deformation Modeling workshop). This is a rather advanced approach. For simple geometry (planar fault in a box) it is easier to have airtight volumes (similar to CUBIT).

Ahmet Akoglu: **everything is working fine: only the journal editor window is behaving this way. Can't move/position it.**

Brad Aagaard: You might try to maximize the window and then unmaximize it.

Ahmet Akoglu: Brad: thanks, it seems to be due to my dock which is positioned on the left of the desktop. It's alright now.

69. Wayne Crawford: **Sorry, I missed the command to use to open a journal file. "Open" doesn't work for me**

* Brad Aagaard: To open a journal file, use the journal editor, not File-Open. The journal editor is the scroll icon with the pen.

70. EOS: **Are we correct in thinking that the projection line is so that PyLith can convert back to geographic coordinates?**

* Charles Williams: The projection conversion is used to geo-reference the model and various parameters and geometry information. PyLith uses Cartesian coordinates. PyLith will not convert things to geographic coordinates, although it can use a projected coordinate system. Spatial databases can also use various coordinate systems.

71. Wayne Crawford: **Sorry, the vertices commands work, but create Curve doesn't**

* Brad Aagaard: Make sure you run the APREPRO commands that begin with the comment character. This is rather odd syntax, but this is what CUBIT uses.

73. Wayne Crawford: **I found the problem. I hadn't played the {Units('si')} line (it was commented out)**

* Brad Aagaard: Yes. This is an APREPRO command. #{} are APREPRO commands.

75. Lujia Feng: **if I want to run a journal file without interaction with people, is there any other way?**

* Charles Williams: If you want to run it without the GUI, you can run it from the command line with the -batch flag.

* Charles Williams: Actually, looking at the manual, there is a -batch flag (no interactive input) as well as a -nographics flag.

76. Wayne Crawford: **I just tried "draw nodeset" in the popup and I only see the node! How can I get back to the whole model?**

* Charles Williams: If you right-click anywhere in the graphics window, you should see a 'refresh' option.

77. Emma Hill: **So if you were going to have a fault that ruptures all the way to the surface, we'd need to remove the nodes that are common to fault and groundsurf?**

* Charles Williams: No, unless you're going to apply BC there.

79. Emma Hill: **Sorry, but I missed how to make the different regions different colors. Please can you repeat?**

* Brad Aagaard: draw block all

84. EOS: **If we have a cloud of vertices in CUBIT, what is the best command to fit a surface through these points? Is there a surface equivalent to the create curve spline function?**

* Charles Williams: Actually, I'm going to try to address this in the next session. The short answer is that CUBIT doesn't directly provide this sort of ability. The solution I'll be showing this afternoon is to externally triangulate the points (I used the triangle code from within GMT), import the triangulated surface into CUBIT, create a mapped mesh from this surface, and then use CUBIT to generate a net surface from that.

* Charles Williams: I forgot to mention that if you want a best-fit surface, the solution will be even more complicated. I don't have a simple solution for that at present.

86. Lujia Feng: **How we keep track of the id number of vertex?**

* Brad Aagaard: There are several ways to keep track of the ids of CUBIT entities. When the object is created CUBIT will output the id in the command window. When you select an entity on the screen, the id will be printed in the command window and in the property window (lower left) if only one entity is selected. You can also browse through the object tree (upper left) to find the id and name of an entity.

87. Lujia Feng: **It seems like id number would change, if I do some operations like split, merge etc.**

* Charles Williams: New ID numbers can be created when doing these operations; however, if an existing ID disappears (by merging, for example), it is not reused. After creating your geometry, you will generally find 'gaps' in the numbering of different objects.

88. Lujia Feng: **I wanted to set up an automatic script importing the slab and topography, but it looks like it is not very easy to do it without searching for the id numbers manually.**

* Brad Aagaard: Using APREPRO use the function (see the CUBIT appendix) `Id("type")` Returns the ID of the entity most recently created with the specified type. Acceptable types include: "body", "volume", "surface", "curve", "vertex", "group", "node", "edge", "quad", "face", "tri", "hex", "tet", or "pyramid".

98. Lujia Feng: **not sure I understand "imprint" well. How is it different from "merge" and another term "assembly" used by other softwares?**

* Charles Williams: Imprint identifies intersecting/coincident objects within CUBIT, while merge actually removes duplicate objects.

109. Sang-Ho Yun: **Are you going to check the quality of the mesh, just for demonstration?**

* Brad Aagaard: Yes. I usually use the aspect ratio and condition number mesh quality metrics via the GUI.

116. Nina: **bndry_east_crust and fault_slabbot have one common node. Does that matter?**

* Brad Aagaard: We never use bndry_east_crust at the same time as the fault interface associated with fault_slabbot, so it is okay for these nodesets to overlap.

117. Stephen Holtkamp: **Journalled Command: stitch volume all***** Now playing C:/Program Files (x86)/PyLith/src/pylith/examples/2d/subduction/geometry.jou *****CUBIT> CUBIT> split curve slabtop distance {80.0*km} from endERROR: Unrecognized Identifier: 'slabtop'ERROR: syntax error (<stdin>, line 569)**

* Brad Aagaard: Turn off undo (undo off or Edit->Enable Undo (uncheck)).

150. Stephen Holtkamp: **I think I fixed the naming problem. After `stitch volume all` had to add `curve 27 name "slabtop"`, `curve 29 name slabbot`, and `curve 24 name "slabtop@A"`; and then at the end of the file I had to add `curve 35 name "slabtop@D"`, `curve 41 name "slabbot@C"`, and `curve 23 name "conmoho"`. I'm working on a windows 7 machine, so that may be it.**

* Brad Aagaard: You do not need to rename the curves. The names should be retained during the stitching. This issue will disappear if you turn undo off.

151. Bobak Karimi: **Is there a "snapping" option in Cubit? I'm having trouble creating surfaces because no closed loop was found**

* Matt Knepley: There is no "snapping" option. Make sure you have not accidentally duplicated curve ids.

* Emily Montgomery-Brown: The error went away when I made sure the curve id numbers were unique.

* Brad Aagaard: Yes, repeating curve ids when creating surfaces results in an error message about curves not forming a closed loop.

154. Bobak Karimi: **I'm not sure if I need to stitch the surfaces into a single volume to split the curves and define the discretization size portions of the curves.**

* Brad Aagaard: You need to "stitch volume all". If you try to mesh without stitching the surfaces, then the mesh will only have nodes at the vertices associated with the geometry. This is likely related to how CUBIT does bookkeeping of bodies, volumes, and surfaces. Without stitching the surfaces are all in different bodies and volumes.

169. Emily Montgomery-Brown: **Don't know if it would help, but I was having trouble with cubit crashing my video driver this morning ... using in non-gui mode fixed the problem.**

* Brad Aagaard: This may be a video settings issue. If it persists, I recommend contacting CUBIT support.

171. Bobak Karimi: **when you group nodesets, should nodes appear along the curves you selected?**

* Brad Aagaard: No. You have to select the nodesets for them to appear in the graphics window.

199. Louisa Tsang: **Do you have an example in the examples folder of how to build multiple fault segments in CUBIT and model ruptures on each of these fault segments?**

* Brad Aagaard: We have benchmarks with multiple fault surfaces. See

<http://www.geodynamics.org/wsvn/cig/short/3D/PyLith/benchmarks/trunk/dynamic/scecdynrup/tpv14-2d> and <http://www.geodynamics.org/wsvn/cig/short/3D/PyLith/benchmarks/trunk/dynamic/scecdynrup/tpv14>

197. Louisa Tsang: **I wonder what is an effective way of converting shapefiles into xyz formats which can be imported into CUBIT to build a mesh, together with the bounding blocks? This comes in the context of trying to build a fault geometry based on a mapped surface trace of a fault.**

* Brad Aagaard: The general workflow is to extract the values into an ASCII from shapefiles (either using ArcGIS or a shapefile library) and then add the points into a journal file (as Charles did in his meshing examples with contours on Wed) or a Python script.

PyLith

Features

3. Emma Hill: Hello. **I have a question about the difference between SPECFEM and PyLith. We see it's possible to estimate both static and dynamic displacements with SPECFEM, and also PyLith, so we're wondering what the difference is between the two if you're using them for that. This question comes in the context of trying to produce Green's functions for 1 Hz GPS data that has both static displacement and waveforms in the time series. Thanks!**

* Brad Aagaard: Even though both PyLith and SPECFEM solve dynamic elasticity equation there are several differences in the discretization schemes they use and the way they implement faults. For static problems, PyLith will be more efficient because it can directly solve the static problem without inertia. However, for dynamic problems there are currently a few advantages of SPECFEM for problems where you want to compute Green's functions. It uses point sources and can compute the solution (time histories) at arbitrary points. PyLith, on the other hand, currently requires a fault interface and you have to interpolate the solution from the mesh to get the time histories at an arbitrary point. We hope to add these two features in the next year. SPECFEM doesn't not currently have a frictional fault interface, but Pablo Ampuero has a couple students working on that.

7. Bill Harbert: **Cool, the uniform global refinement is new?**

* Matt Knepley: Yes, it has just been added in the latest release.

8. birendra jha: **Does the order of new features for 2012-13, with respect to heat flow and fluid flow, means it's 2nd in line?**

* Brad Aagaard: The order of features listed for v1.7 and v2.0 are up for discussion. I think everything listed for v1.7 will be included. For v2.0 Green's functions have a high priority because there is strong demand from many people. The multicycle features are currently next in line. The multiphysics capability requires redoing the data structures and changes to big blocks of code, so it may require more time.

38. Sang-Ho Yun: **How likely would we need to adjust the solver option values?**

* Matt Knepley: For the example problems, the solvers work fine. You will likely have to increase iteration tolerances for distorted meshes, you might increase tolerances to get rough solutions, but we do not anticipate having to change the settings often.
* Brad Aagaard 2: Using the recommended parameters you may also need to adjust the maximum number of iterations as the problem size or complexity increases.

40. Nina: **Under each category of variables (such as [pylithapp.time-dependent]), there seems to be lots of variables that we can specify. Is there a complete list of what they are?**

* Brad Aagaard: The properties and facilities that are available depend on the settings. Use the pylithinfo utility to see the current properties and components with their values.

45. Nina: **I don't understand the "quadrature.cell" variable... when is this required?**

* Brad Aagaard: Numerical quadrature is used for all integrations. So any BC, material, or interface entity that involves integration will have a quadrature object. Dirichlet (prescribed) BC do not involve integration; the solution is being specified at a point directly.

55. Nina: **In paraview, is there a way to export the plot of the time evolution history of a specific point in the volume**

* Brad Aagaard: We recommend using HDF5 output and Matlab (or Python/PyTables) to extract time histories. This requires considerably less work than processing the output in ParaView.

56. David Bekaert: **Is the format/way of loading the files into matlab specified in the manual?**

* Brad Aagaard: See the Matlab documentation for the commands to access HDF5 files. The organization of the HDF5 files and the dimensions of the datasets are in the PyLith manual.

57. birendra jha: **Anything special to know for using the new multigrid solver?**

* Brad Aagaard: The algebraic multigrid solver does not work if the problem contains a null space (such as a sliver between two faults, see step02 of examples/2d/subduction). It should work very well for most real world problems (and better than the ASM settings).

93. Leonor Mendoza: **Is there any possibility of studying gravity or tilts with PyLith?**

* Brad Aagaard: Tilts would be computed in post-processing from the displacement field. PyLith currently doesn't have support for computing gravity fields. We welcome suggestions on how this might be added to PyLith.

96. Emma Hill: **Could you talk a little bit about modeling changing surface loading conditions (e.g., changes in surface water during monsoon season)? Presumably we add time-dependent Dirichlet conditions on the surface?**

* Brad Aagaard: You can use either time-dependent Dirichlet or Neumann boundary conditions, depending on if you know the displacements or you know the tractions. See Section 6.2 of the manual. Let us know if you need more flexibility in the expression for the time dependence.

97. EOS: **We're wondering if we should include earth curvature for an area the size of Sumatra. How best to deal with this? Can see you could remove a curved surface from the volume, but when we also have topography...?**

* Brad Aagaard: CSGeoLocalCart is an Earth-centered Earth-fixed coordinate system with the origin at a given location (surface).

105. Sang-Ho Yun: **Is it possible to put sea water there?**

* Matt Knepley: PyLith cannot currently solve purely viscous problems (coming in the spring). If you want to include loading from seawater, you can use tractions at the boundary..

108. Sang-Ho Yun: **So would the spring version be able to let a P-wave propagate through water and create some reasonable wave pattern on the water surface?**

* Matt Knepley: I do not believe so, at least not with any accuracy.

144. Bill Harbert: **You might mention for the windows people that python is available in pylith. Perhaps everyone already knows that?**

* Brad Aagaard: Python is bundled with PyLith for all platforms, although most Linux and Darwin systems have it installed by default.

137. Jeanne Sauber: **Thanks, my questions was just for general "planning" purposes. I am trying to figure out how to set up a subduction grid for southern Alaska.**

* Brad Aagaard: Charles will be discussing how to import contours and create a surface for subduction zone modeling this afternoon.

139. Gerald Galgana: **what about axisymmetric models?**

* Brad Aagaard: Axisymmetric models can be setup using Dirichlet boundary conditions to control the deformation along the line/surface of symmetry. See section 8.2 in the manual for an example.

141. Nina: **How to design a time-dependent creep/slip rate**

* Brad Aagaard: There are several options for specifying a time-dependent creep or slip rate. If the creep is constant and continuous (once it starts), then you can use the slip time spatial database to specify spatial variation in the time at which the creep begins. A more flexible option is to use the TimeHistorySlipFn (see section 6.4.4.4 of the manual) to specify a spatial varying creep rate and a more complex temporal variation.

142. Nina: **is frictional properties something that we can assign to the materials?**

* Matt Knepley: You can assign frictional properties to a fault

* Brad Aagaard: Instead of using FaultCohesiveKin, you would use FaultCohesiveDyn and specify which fault constitutive model (static friction, linear slip-weakening, or rate- and state-friction) you want to use.

148. Nina: **is it possible to input volume data (such as tomography) to create the volume in cubit?**

* Brad Aagaard: CUBIT builds volumes from surfaces, so importing a tomography model doesn't make much sense. If you want the physical properties from tomography, then you want to construct a seismic velocity model and use it as a spatial database.

149. Jeanne Sauber: **For modeling post-glacial rebound could you just apply a unloading traction to represent the removed**

load instead of what Brad suggested in response to Bob Smalleys email on gia

* Matt Knepley: I think that the best solution here is to solve a simple (maybe coarse, simple geometry) system for the initial stress given an estimate of the load, and then use this as the initial stress state in a high resolution PyLith run.

157. Gerald Galgana: **do you have plans of incorporating the Hoek Brown criteria**

* Brad Aagaard: We currently have a Drucker-Prager elastoplastic model without hardening and softening. So we are planning to add hardening and softening and then an viscoelastic version.

160. **Gerald Galgana: how do you implement depth-dependent lithostatic stresses?**

* Brad Aagaard: You can use gravitational body forces with initial stresses (see examples/3d/hex8/step16). For complex surface topography and lateral density variables, it is difficult to setup the model without introducing deformation. We have plans to add incompressibility to compute the stresses induced by gravity without significant deformation.

163. Sang-Ho Yun: **it'd be nice to fill the crack with a compressible magma.**

* Charles Williams: You could do this by creating an internal volume with different material. At present, there may be some difficulties with simultaneously applying pressure BC because of the way PyLith currently deals with tractions.

164. Sang-Ho Yun: **apply normal traction only..**

* Charles Williams: You can create a cavity and apply normal tractions.

166. Sang-Ho Yun: **I see. I remember I had to make a hollow in FEMLAB to make a magma chamber...**

* Charles Williams: Yes.

198. Lujia Feng: **Can I ask a basic question about the terminology about Dirichlet and Neumann BC. How to define those in terms of fixing which degrees of freedom (displacement, rotation)?**

* Brad Aagaard: Dirichlet BC are for specifying the displacement at a point, Neumann BC are for specifying an external traction on the surface. In quasi-static problems you need Dirichlet BC to keep from having rigid body motions (nonzero null space).

182. Emma Hill: **In the next section, please can we talk a little about producing Green's functions?**

* Charles Williams: OK. We don't have a really official method of doing this right now, but I have some kludgy stuff put together.

Faults

46. Sang-Ho Yun: **Do you mean dip-slip by "reverse-slip"?**

* Brad Aagaard: Yes. The fault normal and up directions define the sense of slip (reverse is positive).

47. Sang-Ho Yun: **It looks to me like the fault is vertical, and the "reverse slip" sounds confusing.**

* Brad Aagaard: Yes. This is why the fault normal direction is a parameter. It allows PyLith to define an unambiguous sense of slip for all three components (left lateral, vertical, and opening).

48. Sang-Ho Yun: **Does the materail penetrate to each other, or was it just the visual exaggeration?**

* Matt Knepley: That is visual exaggeration

49. birendra jha: **what does it mean "traction_change" on the fault surface? Is it the traction on the fault at that time step?**

* Matt Knepley: The change in traction necessary to generation the imposed fault slip

* Brad Aagaard: "traction_change" refers to the fact that the slip is associated with a change in the tractions on the fault, not any absolute level of the tractions.

50. birendra jha: **will we do a dynamic faulting example with larger grid size?**

* Brad Aagaard: There are some simple dynamic rupture examples in examples/bar_shearwave/quad4. More complex examples are in the benchmarks repository (see the last section of the Tutorials Chapter in the manual). We won't have time to cover these advanced topics in this week's tutorial (perhaps a subject for a future tutorial).

65. **EOS: In Pylith, are there issues with faults intersecting boundaries?**

* Charles Williams: Faults cannot intersect other faults. You cannot apply displacement (Dirichlet) boundary conditions to a fault node, but you can apply Neumann (traction) and absorbing boundary conditions to fault nodes. With absorbing boundaries you probably don't want them near a fault because the absorbing boundaries act as free surfaces for static deformation. If you want to approximate an infinite domain, your boundaries should be several rupture widths from your fault.

100. Emma Hill: **For something like setting ConstRateSlipFn, if I have multiple earthquake times is there a way to set them all at once, or do I have to repeat the settings for each rupture time?**

* Brad Aagaard: Pyre (the simulation framework we use) treats all components individually. We set default values that are typical, but if you want to change them from the default values, you have to set each one. If this is too much copy/paste, you could write a script to generate the .cfg file.

185. Liqing: **May I know what is the difference between Pylith and Flac**

* Matt Knepley: FLAC uses particles to track properties (like material properties) over very lage deformations, and then interpolates them back on the mesh. PyLith is Lagrangian, and thus everything is stored as a field on the mesh, and the mesh follows the deformation.

186. Liqing: **I means the defination of the fault.**

* Matt Knepley: No FLAC code I am familiar with has an explicit fault model, but I might not know every code.

187. Liqing: **I know the fault in Flac is defined using Goodman element, which is using the normal stiffness and shear stiffness to simulate the contact along the fault.**

* Brad Aagaard: We are not familiar with the Goodman element. It may be similar to our cohesive cells. The difference is often in how the slip or relative displacement is enforced. Some modeling codes using moment tensors (double couple point sources) for prescribed slip ruptures. For spontaneous ruptures, many finite-element codes use tractions at splits nodes (TSN) as developed by Joe Andrews. PyLith's cohesive cells are similar to Joe Andrews's TSN, but uses Lagrange multipliers to prescribe the fault slip or enforce a fault constitutive model.

188. Lijing: **Flac is using finite difference element. Pfc is using particles.**

* Brad Aagaard: Flac appears to be a finite volume code but has some techniques from finite elements.

189. Lijing: **the fault occupies codes and elements without area. am I right?**

* Matt Knepley: Yes, the cohesive cell formulation uses zero volume elements. The residual calculated on these elements must be zero for the fault constitutive relation

192. Lijing: **what criertion to judge that the fault should slip?**

* Brad Aagaard: Yes, the fault will open if the fault is under tension.

194. Lijing: **the fault should open or slip depends on the friction and cohesion, right?**

* Brad Aagaard: $T_{\text{shear}} = C + \mu_f * T_{\text{normal}}$

* Brad Aagaard: This is similar to what is often referred to as Coulomb friction, where the friction is equal to the cohesion plus the coefficient of friction times the normal traction. In Coulomb friction, usually the coefficient of friction is just a constant. For spontaneous rupture, the coefficient of friction is often a function of the slip, slip rate, and/or state variables (rate and state friction).

200. Lujia Feng: **I remember you said slips modeled by cohesive cells should be << the size of cells. For the two collocated vertices on the two sides of fault, do they share the same stress and strain even when they are displaced?**

* Brad Aagaard: The Lagrange multipliers are associated with the tractions on the fault surface. The stress and strain state variables are derived from the displacement field, so they are not necessarily continuous across cell boundaries.

Examples

15. Nina: **In the twocells/twotri3/sheardisp.cfg case, why is the displacement increasing from left to right? where is the zero slip point?**

* Brad Aagaard: The x and y DOF are pinned on the -x edge, but only the y DOF is pinned on the right side. This asymmetry combined with free surfaces on the +y and -y edges results in x displacements on the +x face. In other words this problem involves deformation that is more complicated than simple shear.

17. Nina: **fig 7.3 in tutorial**

* Brad Aagaard:

21. Nina: **can you explain more about how to determine the dof in cfg files?**

* Matt Knepley: The number of dof is determined by the mesh, boundary conditions, and dimension

* Brad Aagaard: The bc_dof property in the .cfg files are associated with what degrees of freedom are constrained on a boundary. Usually you will pin the degree of freedom perpendicular to the boundary. For example, bc_dof = [2] for the bottom -z boundary to prevent vertical deformation.

44. bob smalley 2: **what are "roller boundaries"**

* Brad Aagaard: By roller boundaries we mean we are constraining the degree of freedom normal to the boundary. Shear motion is unconstrained.

51. Christian Baillard: **I ran step03 but I couldn't find outputs...?**

* Brad Aagaard: The files should be in the output directory. Make sure you have an output directory, otherwise PyLith will generate an error when it tries to create the file and exit.

52. Christian Baillard: **I've my output directory but it kept the outputs of my last run with step01 (verified with paraview)**

* Brad Aagaard: Output from step03 should have been added. The files should begin with the "step03" prefix.

58. Nina: **In examples/3d/hex8/step06, since there's the viscoelastic layer, does it mean that only viscoelastic relaxation is considered in the postseismic deformation? what about afterslip?**

* Brad Aagaard: In examples/3d/hex8/step06 there is steady aseismic creep at the bottom of the fault. So, the interseismic/postseismic deformation is the superposition of the aseismic creep and viscoelastic relaxation.

Nina: **does anybody have the "file locking failed in ADIOI_Set_lock" error when they run step06.cfg?**

UNRESOLVED

89. Emma Hill: **The script seems to be crashing for us. Running cont2lines.py cont2lines.cfg ... is this correct? I can't seem to paste in here so can't add the error message.**

* Brad Aagaard: You don't need any arguments. You also need to run fill_contours.py first. Make sure you have your environment setup to use pylith because these scripts use pyre (which is included with PyLith).

```
./fill_contours.py
./cont2lines.py
```

92. EOS: **How to mesh a subset of ETOPO1?**

* Brad Aagaard: See the deem example. It converts a grd file to ASCII and uses lines. Since ExodusII files are also NetCDF grd files, you can also translate the grd file to an ExodusII file which CUBIT can read. It is analogous to a facet surface, so it must be converted to a NURB just like a facet surface (see the facet example).

94. Emma Hill: **Could we go over the command fault_slabtop = pylith.faults.FaultCohesiveKin (what is FaultCohesiveKin, and what are the other options?)**

* Brad Aagaard: There are two fault implementations in PyLith. FaultCohesiveKin = Fault + Cohesive Cells + Kinematic (prescribed) slip. FaultCohesiveDyn = Fault + Cohesive Cells + Dynamic (spontaneous) rupture; this uses a fault constitutive model to determine the slip as a result of tractions driving slip on the fault.

95. Wayne Crawford: **I'd be interested in seeing how Charles converts GMT coastlines to VTK files**

* Brad Aagaard: We will create a tarball of these scripts as examples and post it a link to it from the workshop webpage.

99. Emma Hill: **Would it be possible to talk a bit about common errors coming out of Pylith? I tried to modify the subduction example to include 3 earthquake times, but it's crashing. The log file is still a bit cryptic to me so I'm having trouble seeing what the problem is.**

* Charles Williams: Hopefully, Brad's mini-tutorial was helpful.

135. Jeanne Sauber: **Have you created a 3-D grid for the Japan event & if were you able to run it on your Mac?**

* Brad Aagaard: We created just this simple 2D model for the Tohoku event. A 3D model would be take too long to mesh and run for us to use it as an example. Depending on the resolution used, it might fit on a desktop machine with 16+ GB of RAM. Running in parallel speeds up runtime significantly for 3D problems.

145. David Bekaert: **What did you change in the file format of the *.jou files?**

* Brad Aagaard: sab (binary ACIS) -> sat (ASCII ACIS) in the generated .jou file or in the cont2lines.cfg. We will update these files and fix any problems and include these in a PyLith 1.6.1 release.

147. Bobak Karimi: **I have multiple lines with an error wc/n1 "command not found"**

* Brad Aagaard: These are shell utilities that may not be on your machine. If you are using windows, we did not include these in the cygwin bundle. There are other utilities you can use to assemble these files.

Solver issues

173. EOS: **How big should the problem be before we start thinking MPI?**

* Brad Aagaard: The two factors that you need to consider are speed (runtime) and size. Usually people run out of memory on the machine and choose to run with multiple nodes.

174. EOS: **Are the number of MPI processes problem-dependent at all?**

* Brad Aagaard: No. Usually you want at least 10k-100k unknowns on each processor, so small problems are best run in serial. The physics does not dictate the number of processors; it is entirely dependent on the problem size and amount of memory and processor speed.

175. Lujia Feng: **Can we have an estimate how long it takes to run my models before I actually run them?**

* Brad Aagaard: We have a good model of how much memory you would need for a given problem size. Runtime is very different, because it is very difficult to estimate the time for a linear or nonlinear solve. Runtime for calculation of the Jacobian and residual do usually scale with problem size. Also, usually the solve per time step is relatively constant, so you can get a reasonable estimate of the solve time for multiple time steps by extrapolating from one or two type steps.

PyLith on Windows

41. Bill Harbert: **on the windows 7 (latest version) I get the error bash: tee: command not found.**

* Brad Aagaard: tee is not included in the cygwin commands we bundled. You can capture to a log file, pylith step01.cfg >& step01.log but it won't mirror to the terminal window.

43. Pete Olds: **Windows 7 64bit version of Pylith: Don't know how to backspace and correct text in Pylith command window.**

* Brad Aagaard: This is a keymapping issue. You may be able to find out how to map your keys properly by examining the cygwin documentation. Sorry, we don't use Windows so the support is rather limited.

ParaView

20. Sang-Ho Yun: **How do you show the arrows in Paraview?**

* Matt Knepley: Charles will show this today. You use the Glyph module

63. Gerald Galgana: **how do you display the deformed model again?**

* Brad Aagaard: Use the Warp by Vector filter (icon with the bending green bar).

Bill Harbert: **I forgot how to get the grid blocks onto the paraview screen.**

* Brad Aagaard: In the "Representation" drop down menu, select "Surface with edges" rather than "Surface".

bob smalley 2: **I got the same figures for the steps 1 and 3 in paraview, but get a non-deformed box for step06.**

* Brad Aagaard: This is a time-dependent problem, so you need to use the movie controls in the menu bar to advance in time.

80. Wayne Crawford: **Another thing I must have missed: when I try to open the h5 file, paraview asks me what reader to use. Is this normal? Which one should I choose?**

* Charles Williams: Open the .xmf file instead.

85. EOS: **Is there a way to visualize depths and distances in Pylith? We're wondering where Japan is relative to the subduction example, and also why there are two distinct areas of subsidence in the output vertical displacement model, when we're used to seeing only one. We can see a down-dip area of slip in the USGS solution, but it's pretty small compared to the main slip patch. Is it because the slip is so shallow?**

* Charles Williams: I don't know the specifics of the slip distribution, but you can see the coordinate axes using ParaView. If you have a file open, go to the Display tab (between Properties and Information). If you go down a bit in the Annotation category, you will see a check box for whether or not to show the cube axes. If you select this, you will see the coordinate axes. The distances will be relative to the origin in the CUBIT journal file.

In 3D, I typically convert GMT coastlines to VTK files, which makes a good geographic reference. I can send an example of how I do this if you want.

138. Bobak Karimi: **how do you open the calculator to enter the expression?**

* Brad Aagaard: Click on the calculator icon on the far left toolbar just below the colorbar icons. It is also available from Filters->Alphabetical->Calculator.

125. Bill Harbert: **Could you repeat the vector calculation?**

* Brad Aagaard: For the 2D subduction zone example, the calculator expression is $\text{displacement_x} \cdot \hat{i} + \text{displacement_y} \cdot \hat{k} + 0 \cdot \hat{k}$

129. Nina: **how do you reset colorbar in paraview**

* Brad Aagaard: Use the 2nd icon in the colorbar toolbar (circle + colorbar). You can toggle between linear and logarithmic scales as well as set the minimum and maximum values.

131. Nina: **how do you show the interpolated colors in paraview? the color on my plot looks pretty discrete**

* Matt Knepley: Brad has a logarithmic scale. Do you?

177. Liqing: **we also can't see the result in paraview in Ubuntu**

* Brad Aagaard: I think this is 3.8.0 even with the latest ubuntu.

* Brad Aagaard: We recommend ParaView 3.10.1.

* Brad Aagaard: Go to paraview.org and download the binary for linux. It is tarball.

Adobe Connect

5. Wayne Crawford 2: **Huge latency problems. Are you going to put the recordings up for offline viewing**

* Brad Aagaard: URLs for recorded sessions are being posted on the Agenda web page.

6. Wayne Crawford 2: **When I click on the "Flash movie recording of Session I, Schedule B" it just dumps me back into Adobe Connect. Maybe it will work when this session is over?**

* Brad Aagaard: I will check.

* Brad Aagaard: The movie is now public. If you don't see slides (just a big white region in the right portion of the screen) let the movie load and then go back to the beginning. The video/sharing portion seems to be susceptible to delays associated with network latency.

13. Gerald Galgana: **do we need to log out?**

* Brad Aagaard: No. At the end of the afternoon session, we will suspend the meeting so that we don't monopolize the Adobe Connect access from UC Davis. At that time, you will be logged off automatically.