PyLith Modeling Tutorial
Troubleshooting PyLith Simulations

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What parameters are available?
Parameters are specified as a hierarchy of components and properties

- Components (Facilities) are the object building blocks
  Appendix B of the PyLith manual lists all of the components
  - Problem **TimeDependent**
  - Boundary conditions **DirichletBC**
  - Faults **FaultCohesiveKin**
  - Materials **MaxwellViscoelastic3D**
  - Output managers **OutputSolnSubset**
  - Readers **MeshIOCubit**

- Properties are the basic types
  - String `mat_viscoelastic.spatialdb`
  - Integer 4
  - Float 2.3
  - Dimensioned quantity `2.5*year`
  - Array of Strings, Integers, or Floats `[0, 0, 1]`
Parameter Files
Simple syntax for specifying parameters for properties and components

# Syntax
[pylithapp.COMPONENT.SUBCOMPONENT]; Inline comment
COMPONENT = OBJECT
PARAMETER = VALUE

# Example
[pylithapp.mesh_generator]; Header indicates path of mesh_generator in hierarchy
reader = pylith.meshio.MeshIOCubit; Use mesh from CUBIT/Trelis
reader.filename = mesh_quad4.exo; Set filename of mesh.
reader.coordsys.space_dim = 2; Set coordinate system of mesh.

[pylithapp.problem.solution_outputs.output]; Set output format
writer = pylith.meshio.DataWriterHDF5
writer.filename = axialdisp.h5

[pylithapp.problem]
bc = [x_neg, x_pos, y_neg]; Create array of boundary conditions
bc.x_neg = pylith.bc.DirichletTimeDependent; Set type of boundary condition
bc.x_pos = pylith.bc.DirichletTimeDependent
bc.y_neg = pylith.bc.DirichletTimeDependent

[pylithapp.problem.bc.x_pos]; Boundary condition for +x
constrained_dof = [0]; Constrain a DOF
label = edge_xpos; Name of nodeset from CUBIT/Trelis
db_auxiliary_fields = spatialdata.spatialdb.SimpleDB; Set type of spatial database
db_auxiliary_fields.label = Dirichlet BC +x edge
db_auxiliary_fields.iohandler.filename = axial_disp.spatialdb; Filename for database
Parameters Graphical User-Interface

cd parametersgui; ./pylith.paramviewer
Parameters Graphical User-Interface

Case study: examples/3d/subduction/step02

1. Generate the JSON file with the parameters
   
   ```
   cd examples/3d/subduction
   pylithinfo step03.cfg mat_elastic.cfg solver_fieldsplit.cfg
   ```

2. Start the web-server (start at your top-level PyLith directory)
   
   ```
   cd parametersgui
   ./pylith_paramviewer
   ```

3. Point your web browser to http://127.0.0.1:9000

4. Load the parameter file
Show values of parameters using the command line

Case study: examples/3d/subduction/step02

- Components and properties for given component --help
  
  step02.cfg  [pylithapp.problem.bc.z_neg]
  shell pylith step02.cfg --problem.bc.z_neg.help

- Current components of a given component --help-components
  
  step02.cfg  [pylithapp.problem.bc.z_neg]
  shell pylith step02.cfg --problem.bc.z_neg.help-components

- Current properties of a given component --help-properties
  
  step02.cfg  [pylithapp.problem.bc.z_neg]
  shell pylith step02.cfg --problem.bc.z_neg.help-properties
What about a GUI for editing parameters?

On the wish list but will require time or a developer

- Parameter viewer → editor
  - See possible choices for components and properties
  - Basic validation of parameters
  - ⇒ Generate JSON schema from component specifications
  - ⇒ Translate JSON schema into GUI

- Export parameters to single file
  Facilitates archiving parameters used in given simulation
Debugging Examples

*Step01*  Simple shear using Dirichlet BC in static simulation

*Step02*  Prescribed fault slip with Dirichlet BC
- Static simulation
- Fault is embedded within the domain

*Step03*  Spontaneous rupture with Dirichlet BC
- Static simulation
- Static friction ($\mu_f = 0.6$)
- Slip driven by simple shear

Correct files are provided for reference.
Step01: Error 1
Error found while doing very basic validation of parameters

$ pylith step01.cfg

Python stacktrace

Traceback (most recent call last):
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/bin/pylith”, line 27, in <module>
    start(applicationClass=PyLithApp)
  File "/Volumes/Tools/unix/cig/clang-3.6.0/lib/python2.7/site-packages/pythia-0.8.1.15-py2.7.egg/pyre/applications/init.py”, line 41, in start
    shell.run(**kwds)
  File "/Volumes/Tools/unix/cig/clang-3.6.0/lib/python2.7/site-packages/pythia-0.8.1.15-py2.7.egg/pyre/applications/Shell.py”, line 125, in run
    app.applyConfiguration(context)
  File "/Volumes/Tools/unix/cig/clang-3.6.0/lib/python2.7/site-packages/pythia-0.8.1.15-py2.7.egg/pyre/inventory/Configurable.py”, line 84, in applyConfiguration
    raise ValueError("%s
  Backtrace — Component %s” % (err.message, aliases))

Error message

ValueError: Error while configuring Dirichlet boundary condition (dirichletbc, x_pos):
Error while configuring boundary condition (dirichletbc, x_pos):
Label for group/nodeset/pset in mesh not specified.

Component hierarchy

Backtrace — Component dirichletbc, x_pos
Backtrace — Component bc
Backtrace — Component timedependent, problem
Backtrace — Component pylithapp
Step01: Error 1 Resolution
Error found while doing very basic validation of parameters

Error message

ValueError: Error while configuring Dirichlet boundary condition (dirichletbc, x_pos):
Error while configuring boundary condition (dirichletbc, x_pos):
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Component hierarchy

Backtrace — Component dirichletbc, x_pos
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Error message

ValueError: Error while configuring Dirichlet boundary condition (dirichletbc, x_pos):
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Label for group/nodeset/pset in mesh not specified.

Component hierarchy

Backtrace — Component dirichletbc, x_pos
Backtrace — Component bc
Backtrace — Component timedependent, problem
Backtrace — Component pylithapp

Debug: Examine parameters for pylithapp.problem.bc.x_pos
Step01: Error 1 Resolution
Error found while doing very basic validation of parameters

Error message

ValueError: Error while configuring Dirichlet boundary condition (dirichletbc, x_pos):
Error while configuring boundary condition (dirichletbc, x_pos):
Label for group/nodeset/pset in mesh not specified.

Component hierarchy

Backtrace — Component dirichletbc, x_pos
Backtrace — Component bc
Backtrace — Component timedependent, problem
Backtrace — Component pylithapp

Debug: Examine parameters for pylithapp.problem.bc.x_pos

Resolution

[pylithapp.timedependent.bc.x_pos]
Step01: Error 2
Error found in parsing .cfg file

$ pylith step01.cfg

.cfg file with line number

>> step01.cfg:99:

Error message

— pyre.inventory(error)
— pylithapp.timedependent.implicit.output.outputsoln.write.filename ← 'output/step01.vtk'
— unknown component
'pylithapp.timedependent.implicit.output.outputsoln.write'

Usage information

usage: pylith [---<property>=<value>] [---<facility>,<property>=<value>] [FILE.cfg] ...
component 'pylithapp'
    properties: help, help-components, help-persistence, help-properties, initialize-only, job,
    facilities: job, launcher, mesh_generator, perf_logger, petsc, problem, scheduler, weaver
For more information:
    --help-properties: prints details about user settable properties
    --help-components: prints details about user settable facilities and components
pylithapp: configuration error(s)
Error message

```
pyre.inventory(error)
pylithapp.timedependent.implicit.output.outputsoIn.write.filename ← 'output/step01.vtk'
unknown component
'pylithapp.timedependent.implicit.output.outputsoIn.write'
```
Step01: Error 2 Resolution
Error found in parsing .cfg file

Error message

```python
pyre.inventory(error)
pylithapp.timedependent.implicit.output.outputsoIn.write.filename ← 'output/step01.vtk'
unknown component
'pylithapp.timedependent.implicit.output.outputsoIn.write'
```

Debug: Look up the properties of the OutputSoln object
Step01: Error 2 Resolution

Error found in parsing .cfg file

Error message

```py
— pyre.inventory(error)
— pylithapp.timedependent.implicit.output.outputsoln.write.filename ← 'output/step01.vtk'
— unknown component
'pylithapp.timedependent.implicit.output.outputsoln.write'
```

Debug: Look up the properties of the OutputSoln object

Resolution

```py
[pylithapp.problem.formulation.output.domain]
writer.filename = output/step01.vtk
```
Step01: Error 3
Error found when initializing integrators

$ pylith step01.cfg

Python stacktrace

Fatal error. Calling MPI_Abort() to abort PyLith application.
Traceback (most recent call last):
  File "/Volumes/Tools/unix/pylith-dev clang-3.6.0/lib/python2.7/site-packages/pylith/apps/PetscApplication.py", line 64, in onComputeNodes
    self.main(*args, **kwds)
  File "/Volumes/Tools/unix/pylith-dev clang-3.6.0/lib/python2.7/site-packages/pylith/apps/PyLithApp.py", line 125, in main
    self.problem.initialize()
  File "/Volumes/Tools/unix/pylith-dev clang-3.6.0/lib/python2.7/site-packages/pylith/problems/TimeDependent.py", line 120, in initialize
    self.formulation.initialize(self.dimension, self.normalizer)
  File "/Volumes/Tools/unix/pylith-dev clang-3.6.0/lib/python2.7/site-packages/pylith/problems/Implicit.py", line 121, in initialize
    self._initialize(dimension, normalizer)
  File "/Volumes/Tools/unix/pylith-dev clang-3.6.0/lib/python2.7/site-packages/pylith/problems/Formulation.py", line 470, in initialize
    integrator.initialize totalTime, numTimeSteps, normalizer
  File "/Volumes/Tools/unix/pylith-dev clang-3.6.0/lib/python2.7/site-packages/pylith/feassemble/ElasticityImplicit.py", line 56, in initialize
    ModuleElasticityImplicit.initialize(self, self.mesh())
  File "/Volumes/Tools/unix/pylith-dev clang-3.6.0/lib/python2.7/site-packages/pylith/feassemble.py", line 357, in initialize

Error message

RuntimeError: Error occurred while reading spatial database file 'mat_elastic.spatialdb'.
Spatial distribution with data dimensions of 0 cannot have more than one point.
Found 3 points in distribution.

Abort message

application called MPI_Abort(MPI_COMM_WORLD, -1) – process 0
    /Volumes/Tools/unix/cig clang-3.6.0/bin/nemesis: mpirun: exit 255
    /Volumes/Tools/unix/pylith: /Volumes/Tools/unix/cig clang-3.6.0/bin/pylith: exit 1

Error Messages

Step01
Error message

```
RuntimeError: Error occurred while reading spatial database file 'mat_elastic.spatialdb'. Spatial distribution with data dimensions of 0 cannot have more than one point. Found 3 points in distribution.
```
Step01: Error 3 Resolution
Error found when initializing integrators

Error message

```
RuntimeError: Error occurred while reading spatial database file 'mat_elastic.spatialdb'. Spatial distribution with data dimensions of 0 cannot have more than one point. Found 3 points in distribution.
```

Debug: Look at mat_elastic.spatialdb for errors in data
Step01: Error 3 Resolution
Error found when initializing integrators

Error message

RuntimeError: Error occurred while reading spatial database file 'mat_elastic.spatialdb'.
Spatia l distribution with data dimensions of 0 cannot have more than one point.
Found 3 points in distribution.

Debug: Look at mat_elastic.spatialdb for errors in data

Resolution

num_locs = 1  // number of locations
Step01: Error 4
Error found when initializing integrators

$ pylith step01.cfg

Python stacktrace

Fatal error: Calling MPI_Abort() to abort PyLith application.
Traceback (most recent call last):
  File “/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/apps/PetscApplication.py”, line 64, in onComputeNodes
    self.main(*args, **kwds)
  File “/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/apps/PyLithApp.py”, line 125, in main
    self.problem.initialize()
  File “/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/problems/TimeDependent.py”, line 120, in initialize
    self.formulation.initialize(self.dimension, self.normalizer)
  File “/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/problems/Implicit.py”, line 121, in initialize
    self._initialize(dimension, normalizer)
  File “/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/problems/Formulation.py”, line 470, in _initialize
    integrator.initialize(totalTime, numTimeSteps, normalizer)
  File “/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/feassemble/ElasticityImplicit.py”, line 56, in initialize
    ModuleElasticityImplicit.initialize(self, self.mesh())
  File “/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/feassemble/feassemble.py”, line 357, in initialize
    def initialize(self, *args):
        return _feassemble.IntegratorElasticityInitialize(self, *args)
      Fatal error: Calling MPI_Abort() to abort PyLith application.
      Process: 0

Error message

RuntimeError: Error occurred while reading spatial database file ‘mat_elastic.spatialdb’. Number of dimensions in coordinates of spatial distribution (2) does not match number of dimensions in coordinate system (3)

Abort message

application called MPI_Abort(MPI_COMM_WORLD, −1) — process 0
sis: mpirun: exit 255
python /Volumes/Tools/unix/cig/clang-3.6.0/bin/nemesis: exit 1
Step01: Error 4 Resolution
Error found when initializing integrators

Error message

```
RuntimeError: Error occurred while reading spatial database file 'mat_elastic.spatialdb'.
Number of dimensions in coordinates of spatial distribution (2) does not match number of dimensions in coordinate system (3)
```
Step01: Error 4 Resolution
Error found when initializing integrators

Error message

RuntimeError: Error occurred while reading spatial database file 'mat_elastic.spatialdb'. Number of dimensions in coordinates of spatial distribution (2) does not match number of dimensions in coordinate system (3)

Debug: Look at coordinate system in mat_elastic.spatialdb header
Error message

```
RuntimeError: Error occurred while reading spatial database file 'mat_elastic.spatialdb'.
Number of dimensions in coordinates of spatial distribution (2) does not match number of dimensions in coordinate system (3)
```

Debug: Look at coordinate system in `mat_elastic.spatialdb` header

Resolution

`space--dim = 3`
Step01: Error 5

Error found when setting up solution field

$ pylith step01.cfg

Python stacktrace

Fatal error. Calling MPI.Abort() to abort PyLith application.
Traceback (most recent call last):
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/apps/PetscApplication.py", line 64, in onComputeNodes
    self.main(*args, **kwds)
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/apps/PyLithApp.py", line 125, in main
    self.problem.initialize()
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/problems/TimeDependent.py", line 120, in initialize
    self.formulation.initialize(dimension, normalizer)
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/problems/Implicit.py", line 121, in initialize
    initialize(dimension, normalizer)
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/problems/Formulation.py", line 516, in initialize
    constraint.setConstraintSizes(solution)
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/bc/bc.py", line 218, in setConstraintSizes
    def setConstraintSizes(self, *args): return
  _bc.DirichletBC.setConstraintSizes(self, *args)

Error message

RuntimeError: Found overly constrained point while setting up constraints for DirichletBC boundary condition

Abort information

application called MPI.Abort(MPI_COMM_WORLD, -1) — process 0
/Volumes/Tools/unix/cig/clang-3.6.0/bin/nemesis: mpirun: exit 255
/Volumes/Tools/unix/pylith-dev/clang-3.6.0/bin/pylith: /Volumes/Tools/unix/cig/clang-3.6.0/bin/
Step01: Error 5 Resolution
Error found when setting up solution field

Error message

```
RuntimeError: Found overly constrained point while setting up constraints for DirichletBC bound
```

Error message

```python
RuntimeError: Found overly constrained point while setting up constraints for DirichletBC boundary condition.
```

**Debug:** Look at overlap of constraints in Dirichlet BC
Step01: Error 5 Resolution
Error found when setting up solution field

Error message
RuntimeError: Found overly constrained point while setting up constraints for DirichletBC boundary condition 'face zneg'. Number of DOF at point 503 is 3 and number of attempted constraints is 4.

Debug: Look at overlap of constraints in Dirichlet BC
Resolution

```python
[pylithapp.timedependent.bc.y_pos]
bc_dof = [0]
...
[pylithapp.timedependent.bc.y_neg]
bc_dof = [0]
```
Step02: Error 1
Error found in parsing .cfg file

$ pylith step02.cfg

Configuration error

>>> step02.cfg:30:
   — pyre.inventory(error)
   — timedependent.nondimelasticquasistatic.relaxation_time ← '2.0*years'
   — name 'years' is not defined
pylithapp: configuration error(s)
Step02: Error 1 Resolution
Error found in parsing .cfg file

Error message

```python
>>> step02.cfg:30:
    − pyre.inventory(error)
    − timedependent.nondimelasticquasistatic.relaxation_time ← '2.0*years'
    − name 'years' is not defined
pylithapp: configuration error(s)
```
Step02: Error 1 Resolution
Error found in parsing .cfg file

Error message

>>> step02.cfg:30:
   — pyre.inventory(error)
   — timedependent.nondimelasticquasistatic.relaxation_time ← '2.0*years'
   — name 'years' is not defined
pylithapp: configuration error(s)

Debug: Pyre is poorly documented. Look for example. :(
Step02: Error 1 Resolution
Error found in parsing .cfg file

Error message

```python
>>> step02.cfg:30:
    −− pyre.inventor(error)
    −− timedependent.nondimelasticquasistatic.relaxation_time ← '2.0*years'
    −− name 'years' is not defined
pylithapp: configuration error(s)
```

Debug: Pyre is poorly documented. Look for example. :(

```
$ python
>>> from pyre.units.time import *
>>> dir()
["__builtins__", "__doc__", "__name__", "__package__", "day", "hour", "micro", "microsecond", "milli", "millisecond", "minute", "ms", "nano", "nanosecond", "ns", "pico", "picosecond", "ps", "s", "second", "us", "year"]
```

Resolution

```
relaxation_time = 2.0*year
```
Step02: Error 2
Error doing some basic validation of input

$ pylith step02.cfg

Python stacktrace

Fatal error. Calling MPI_Abort() to abort PyLith application.
Traceback (most recent call last):
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/apps/PetscApplication.py", line 64, in onComputeNodes
    self.main(*args, **kwds)
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/apps/PyLithApp.py", line 123, in main
    self.problem.verifyConfiguration()
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/problems/TimeDependent.py", line 105, in verifyConfiguration
    self.formulation.verifyConfiguration()
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/problems/Formulation.py", line 180, in verifyConfiguration
    integrator.verifyConfiguration()
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/faults/FaultCohesiveKin.py", line 140, in verifyConfiguration
    ModuleFaultCohesiveKin.verifyConfiguration(self, self.mesh())
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/faults/faults.py", line 365, in verifyConfiguration
    def verifyConfiguration(self, *args):
        return _faults.FaultCohesiveLagrange_verifyConfiguration(*args)

Error message

RuntimeError: Quadrature is incompatible with cell for fault 'fault_ext'. Cell 256 has 4 edges

Abort info

application called MPI_Abort(MPI_COMM_WORLD, -1) — process 0
/Volumes/Tools/unix/cig/clang-3.6.0/bin/nemesis: mpirun: exit 255
/Volumes/Tools/unix/pylith-dev/clang-3.6.0/bin/pylith: /Volumes/Tools/unix/cig/clang-3.6.0/bin/
Error message

```
RuntimeError: Quadrature is incompatible with cell for fault 'fault_ext'. Cell 256 has 4 edges
```
Step02: Error 2 Resolution
Error doing some basic validation of input

Error message

RuntimeError: Quadrature is incompatible with cell for fault 'fault_ext'. Cell 256 has 4 edges

Debug: Turn on journal for quadrature

$ pylith step02.cfg --problem.interfaces.fault.quadrature.help-components

facilities of 'quadrature':
  cell=<component name>: Reference cell with basis fns and quadrature rules.
    current value: 'fiatsimplex', from {default}
    configurable as: fiatsimplex, cell
Step02: Error 2 Resolution
Error doing some basic validation of input

Error message

RuntimeError: Quadrature is incompatible with cell for fault 'fault_ext'. Cell 256 has 4 edges

Debug: Turn on journal for quadrature

$ pylith step02.cfg --problem.interfaces.fault.quadrature.help-components

facilities of 'quadrature':
  cell=<component name>: Reference cell with basis fns and quadrature rules.
    current value: 'fiatsimplex', from {default}
    configurable as: fiatsimplex, cell

[pylithapp.journal.info]
fiatlagrange = 1
fiatsimplex = 1

Resolution

[pylithapp.timedependent.interfaces.fault]
quadrature.cell = pylith.feassemble.FIATLagrange
Step02: Error 3
Error found when initializing integrators

$ pylith step02.cfg

Python stacktrace

Fatal error. Calling MPI_Abort() to abort PyLith application.
Traceback (most recent call last):
  File "/Volumes/Tools/unix/pylith−dev/clang−3.6.0/lib/python2.7/site−packages/pylith/apps/PetscApplication.py", line 64, in onComputeNodes
    self.main(*args, **kwds)
  File "/Volumes/Tools/unix/pylith−dev/clang−3.6.0/lib/python2.7/site−packages/pylith/apps/PyLithApp.py", line 125, in main
    self.problem.initialize()
  File "/Volumes/Tools/unix/pylith−dev/clang−3.6.0/lib/python2.7/site−packages/pylith/problems/TimeDependent.py", line 120, in initialize
    self.formulation.initialize(self.dimension, self.normalizer)
  File "/Volumes/Tools/unix/pylith−dev/clang−3.6.0/lib/python2.7/site−packages/pylith/problems/Implicit.py", line 121, in initialize
    self._initialize(dimension, normalizer)
  File "/Volumes/Tools/unix/pylith−dev/clang−3.6.0/lib/python2.7/site−packages/pylith/problems/Formulation.py", line 470, in initialize
    integrator.initialize(totalTime, numTimeSteps, normalizer)
  File "/Volumes/Tools/unix/pylith−dev/clang−3.6.0/lib/python2.7/site−packages/pylith/feassemble/ElasticityImplicit.py", line 56, in initialize
    ModuleElasticityImplicit.initialize(self, self.mesh())
  File "/Volumes/Tools/unix/pylith−dev/clang−3.6.0/lib/python2.7/site−packages/pylith/feassemble/feassemble.py", line 357, in initialize

Error message

RuntimeError: Determinant of Jacobian (1.25e−07) for cell 0 is smaller than minimum permissible value (1e−06)!
The two most likely causes of this are highly distorted cells and nondimensionalization with a

Abort info

application called MPI_Abort(MPI_COMM_WORLD, −1) − process 0
/Volumes/Tools/unix/cig/clang−3.6.0/bin/nemesis: mpirun: exit 255
/Volumes/Tools/unix/pylith: /Volumes/Tools/unix/cig/clang−3.6.0/bin/nemesis: exit 1
Step02: Error 3 Resolution
Error found when initializing integrators

Error message

```
RuntimeError: Determinant of Jacobian (1.25e-07) for cell 0 is smaller than minimum permissible value (1e-06)!
The two most likely causes of this are highly distorted cells and nondimensionalization with a
```
Step02: Error 3 Resolution
Error found when initializing integrators

Error message

```
RuntimeError: Determinant of Jacobian (1.25e-07) for cell 0 is smaller than minimum permissible value.
The two most likely causes of this are highly distorted cells and nondimensionalization with a
```

Debug: Look at nondimensional scales relative to the parameters

```
$ pylith step02.cfg --problem.normalizer.help-properties

length_scale=<dimensional>: Value to nondimensionalize length scale.
  default value: 1000*m
  current value: 1e+06*m, from {file='step02.cfg', line=28, column=-1}
  validator: (greater than 0*m)

relaxation_time=<dimensional>: Relaxation time to nondimensionalize time.
  default value: 3.15576e+07*s
  current value: 6.31152e+07*s, from {file='step02.cfg', line=30, column=-1}
  validator: (greater than 0*s)

shear_modulus=<dimensional>: Shear modulus to nondimensionalize pressure.
  default value: 3e+10*m**-1*kg*s**-2
  current value: 3e+10*m**-1*kg*s**-2, from {file='step02.cfg', line=29, column=-1}
  validator: (greater than 0*m**-1*kg*s**-2)
```
Step02: Error 3 Resolution

Error message

```
RuntimeError: Determinant of Jacobian (1.25e-07) for cell 0 is smaller than minimum permissible value. The two most likely causes of this are highly distorted cells and nondimensionalization with a very large length scale.
```

Debug: Look at nondimensional scales relative to the parameters

```
$ pylith step02.cfg --problem.normalizer.help-properties

length_scale=<dimensional>: Value to nondimensionalize length scale.
  default value: 1000*m
  current value: 1e+06*m, from {file='step02.cfg', line=28, column=-1}
  validator: (greater than 0*m)

relaxation_time=<dimensional>: Relaxation time to nondimensionalize time.
  default value: 3.15576e+07*s
  current value: 6.31152e+07*s, from {file='step02.cfg', line=30, column=-1}
  validator: (greater than 0*s)

shear_modulus=<dimensional>: Shear modulus to nondimensionalize pressure.
  default value: 3e+10*m**-1*kg*s**-2
  current value: 3e+10*m**-1*kg*s**-2, from {file='step02.cfg', line=29, column=-1}
  validator: (greater than 0*m**-1*kg*s**-2)
```

Resolution

```
[pylithapp.problem.normalizer]
length_scale = 1.0*km
```
Step02: Error 4
Error found when initializing fault

$ pylith step02.cfg

Python stacktrace

Fatal error. Calling MPI_Abort() to abort PyLith application.
Traceback (most recent call last):
File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/apps/PetscApplication.py", line 64, in onComputeNodes
  self.main(*args, **kwds)
File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/apps/PyLithApp.py", line 125, in main
  self.problem.initialize()
File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/problems/TimeDependent.py", line 120, in initialize
  self.formulation.initialize(self.dimension, self.normalizer)
File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/problems/Implicit.py", line 121, in initialize
  self.initialize(self.dimension, normalizer)
File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/problems/Formulation.py", line 470, in initialize
  integrator.initialize(totalTime, numTimeSteps, normalizer)
File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/faults/FaultCohesive.py", line 166, in initialize
  FaultCohesive.initialize(self, totalTime, numTimeSteps, normalizer)
File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/faults/faults.py", line 321, in initialize
  def initialize(self, *args):
    return faults.Fault_initialize(self, *args)

Error message

RuntimeError: Could not find value left-lateral-slip in spatial database
Final slip. Available values are:
  lateral-slip
  reverse-slip
  fault-opening
Step02: Error 4 Resolution
Error found when initializing fault

Error message

```
RuntimeError: Could not find value left-lateral-slip in spatial database
Final slip. Available values are:
  lateral-slip
  reverse-slip
  fault-opening
```
Step02: Error 4 Resolution
Error found when initializing fault

Error message

```
RuntimeError: Could not find value left-lateral-slip in spatial database
Final slip. Available values are:
  lateral-slip
  reverse-slip
  fault-opening
```

Resolution

```
slip.values = [left-lateral-slip, reverse-slip, fault-opening]
```
Step02: Error 5
Error found when setting up solution field

$ pylith step02.cfg

Python stacktrace

Fatal error. Calling MPI.Abort() to abort PyLith application.
Traceback (most recent call last):
  File "/Volumes/Tools/unix/pylith-dev/gcc-4.7.3/lib/python2.7/site-packages/pylith/apps/PetscApplication.py", line 64, in onComputeNodes
    self.main(*args, **kwds)
  File "/Volumes/Tools/unix/pylith-dev/gcc-4.7.3/lib/python2.7/site-packages/pylith/apps/PyLithApp.py", line 125, in main
    self.problem.initialize()
  File "/Volumes/Tools/unix/pylith-dev/gcc-4.7.3/lib/python2.7/site-packages/pylith/problems/TimeDependent.py", line 119, in initialize
    self.formulation.initialize(dimension, normalizer)
  File "/Volumes/Tools/unix/pylith-dev/gcc-4.7.3/lib/python2.7/site-packages/pylith/problems/Implicit.py", line 122, in initialize
    self._initialize(dimension, normalizer)
  File "/Volumes/Tools/unix/pylith-dev/gcc-4.7.3/lib/python2.7/site-packages/pylith/problems/Integrator.py", line 522, in initialize
    integrator.checkConstraints(solution)
  File "/Volumes/Tools/unix/pylith-dev/gcc-4.7.3/lib/python2.7/site-packages/pylith/problems/Faults.py", line 366, in checkConstraints
    return faults.FaultCohesiveLagrange.checkConstraints(*args)

Error message

RuntimeError: Vertex with label '396' on negative side of fault 'fault_ext' is constrained. Fault vertices cannot be constrained.

Abort info

application called MPI.Abort(MPI_COMM_WORLD, -1) — process 0
/Volumes/Tools/unix/cig/gcc-4.7.3/bin/nemesis: mpirun: exit 255
Step02: Error 5 Resolution
Error found when setting up solution field

Error message

```
RuntimeError: Vertex with label '396' on negative side of fault 'fault_ext' is constrained. Fault vertices cannot be constrained.
```
Step02: Error 5 Resolution
Error found when setting up solution field

Error message

```
RuntimeError: Vertex with label '396' on negative side of fault 'fault_ext' is constrained. Fault vertices cannot be constrained.
```

Debug: Oops. Didn’t mean to use through-going fault!
Step02: Error 5 Resolution

Error found when setting up solution field

Error message

```
RuntimeError: Vertex with label '396' on negative side of fault 'fault_ext' is constrained.
Fault vertices cannot be constrained.
```

Debug: Oops. Didn’t mean to use through-going fault!

Resolution

```
[pylithapp.timedependent.interfaces.fault]
label = fault
```
Step02: Error 6
Error when initializing fault

$ pylith step02.cfg

Python stacktrace

Fatal error. Calling MPI_Abort() to abort PyLith application.
Traceback (most recent call last):
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/apps/PetscApplication.py", line 64, in onComputeNodes
    self.main(*args, **kwds)
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/apps/PyLithApp.py", line 125, in main
    self.problem.initialize()
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/problems/TimeDependent.py", line 120, in initialize
    self.formulation.initialize(self.dimension, self.normalizer)
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/problems/Implicit.py", line 121, in initialize
    initialize(self, dimension, normalizer)
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/problems/Formulation.py", line 470, in initialize
    integrator.initialize(totalTime, numTimeSteps, normalizer)
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/faults/FaultCohesive.py", line 166, in initialize
    FaultCohesive.initialize(self, totalTime, numTimeSteps, normalizer)
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/faults/faults.py", line 321, in initialize

Error message

RuntimeError: Error computing orientation of cell face. Cannot resolve tangential components into unambiguous directions.
Up direction (0, 0, 1) cannot be parallel to the face normal (0, 0, 1).
If the face is horizontal, adjust the up_dir parameter.

Abort info

Error Messages
Error message

RuntimeError: Error computing orientation of cell face. Cannot resolve tangential components in face normal (0, 0, 1).
Up direction (0, 0, 1) cannot be parallel to the face normal (0, 0, 1).
If the face is horizontal, adjust the up_dir parameter.
Step02: Error 6 Resolution
Error found when initializing fault

Error message

```
RuntimeError: Error computing orientation of cell face. Cannot resolve tangential components into unambiguous directions.
Up direction (0, 0, 1) cannot be parallel to the face normal (0, 0, 1).
If the face is horizontal, adjust the up_dir parameter.
```

Debug: Change up-dir

```
up_dir = [1, 0, 1]
```
Step02: Error 6 Resolution
Error found when initializing fault

Error message

```
RuntimeError: Error computing orientation of cell face. Cannot resolve tangential components into unambiguous directions.
Up direction (0, 0, 1) cannot be parallel to the face normal (0, 0, 1).
If the face is horizontal, adjust the up_dir parameter.
```

Debug: Change up-dir

```
up_dir = [1, 0, 1]
```

Debug: Look at fault surface
Step02: Error 6 Resolution
Error found when initializing fault

Error message

RuntimeError: Error computing orientation of cell face. Cannot resolve tangential components in Up direction (0, 0, 1) cannot be parallel to the face normal (0, 0, 1).
If the face is horizontal, adjust the up_dir parameter.

Debug: Change up-dir

up_dir = [1,0,1]

Debug: Look at fault surface

Resolution: Mark buried edges

[pylithapp.timedependentinterfaces.fault]
label = fault
detail = fault.edge
up_dir = [0,0,1]
Insertion of Cohesive Cells

(a) Original mesh

(b) Add colocated vertices

(c) Update cells with fault faces

(d) Classify cells and update remaining cells

Error Messages

Fault Edges
Forgetting to Mark Buried Edges

PyLith will extend the fault one cell in an arbitrary fashion.

Purple region shows intended fault surface.
Step03: Error 1
Error doing basic validation on parameters

$ pylith step02.cfg

Python stacktrace

Fatal error. Calling MPI_Abort() to abort PyLith application.
Traceback (most recent call last):
  File "/Volumes/Tools/unix/pylith-dev/gcc-4.7.3/lib/python2.7/site-packages/pylith/apps/PetscApplication.py", line 64, in onComputeNodes
    self.main(*args, **kwds)
...
  File "/Volumes/Tools/unix/pylith-dev/gcc-4.7.3/lib/python2.7/site-packages/pylith/faults/FaultCohesive\_verifyConfiguration(self)
  File "/Volumes/Tools/unix/pylith-dev/gcc-4.7.3/lib/python2.7/site-packages/pylith/faults/Fault\_output\_verifyConfiguration(self.mesh())
  File "/Volumes/Tools/unix/pylith-dev/gcc-4.7.3/lib/python2.7/site-packages/pylith/meshio/OutputManager\_verifyFields(self.dataProvider().availableFields)
raise ValueError(msg)

Error message

ValueError: Requested fields not available for output.
Data provider: 'faultcohesivedyn'
Field type: 'vertex'
Data type: 'data'
Available fields: 'slip' 'slip\_rate' 'traction'
Fields not available: 'initial\_traction'

Abort info

application called MPI_Abort(MPI_COMM_WORLD, -1) – process 0
Abort info: mpirun: exit 255
Error message

ValueError: Requested fields not available for output.
Data provider: 'faultcohesivedyn'
Field type: 'vertex'
Data type: 'data'
Available fields: 'slip' 'slip_rate' 'traction'
Fields not available: 'initial_traction'
Error message

ValueError: Requested fields not available for output.
Data provider: 'faultcohesivedyn'
Field type: 'vertex'
Data type: 'data'
Available fields: 'slip', 'slip_rate', 'traction'
Fields not available: 'initial_traction'

Resolution

vertex_data_fields = [slip, slip_rate, traction]
Step03: Error 2
Error creating solution field

$ pylith step03.cfg

Python stacktrace

Fatal error. Calling MPI_Abort() to abort PyLith application.
Traceback (most recent call last):
  File "/Volumes/Tools/unix/pylith-dev/gcc-4.7.3/lib/python2.7/site-packages/pylith/apps/PetscApplication.py", line 64, in onComputeNodes
    self.main(*args, **kwds)
  File "/Volumes/Tools/unix/pylith-dev/gcc-4.7.3/lib/python2.7/site-packages/pylith/apps/PyLithApp.py", line 125, in main
    self.problem.initialize()
  File "/Volumes/Tools/unix/pylith-dev/gcc-4.7.3/lib/python2.7/site-packages/pylith/problems/TimeDependent.py", line 119, in initialize
    self.formulation.initialize(self.dimension, self.normalizer)
  File "/Volumes/Tools/unix/pylith-dev/gcc-4.7.3/lib/python2.7/site-packages/pylith/problems/Implicit.py", line 122, in initialize
    self._initialize(dimension, normalizer)
  File "/Volumes/Tools/unix/pylith-dev/gcc-4.7.3/lib/python2.7/site-packages/pylith/problems/Formulation.py", line 516, in _initialize
    constraint.setConstraintSizes(solution)
  File "/Volumes/Tools/unix/pylith-dev/gcc-4.7.3/lib/python2.7/site-packages/pylith/bc/bc.py", line 218, in setConstraintSizes
    def setConstraintSizes(self, *args):
        return _bc.DirichletBC.setConstraintSizes(self, *args)

Error message

RuntimeError: Found overly constrained point while setting up constraints for DirichletBC boundary condition 'face_zneg'. Number of DOF at point 535 is 3 and number of attempted constraints is 4.

Abort info

application called MPI_Abort(MPI.COMM_WORLD, -1) — process 0
/Volumes/Tools/unix/cig/gcc-4.7.3/bin/nemesis: mpirun: exit 255
/Volumes/Tools/unix/pylith-dev/gcc-4.7.3/bin/pylith: exit 1
Step03: Error 2 Resolution
Error creating solution field

Error message

RuntimeError: Found overly constrained point while setting up constraints for DirichletBC boundary condition 'face_zneg'. Number of DOF at point 535 is 3 and number of attempted constraints is 4.
Error message

RuntimeError: Found overly constrained point while setting up constraints for DirichletBC boundary condition 'face_zneg'. Number of DOF at point 535 is 3 and number of attempted constraints is 4.

Debug: Look for overlap of constraints in Dirichlet BC
Step03: Error 2 Resolution
Error creating solution field

Error message

RuntimeError: Found overly constrained point while setting up constraints for DirichletBC boundary condition 'face_zneg'. Number of DOF at point 535 is 3 and number of attempted constraints is 4.

Debug: Look for overlap of constraints in Dirichlet BC

Resolution

```python
[pylithapp.timedependent.bc.x_pos]
bc_dof = [0, 1]
...
[pylithapp.timedependent.bc.x_neg]
bc_dof = [0, 1]
```
Step03: Error 3
Error creating solution field

$ pylith step03.cfg

Python stacktrace

Fatal error. Calling MPI_Abort() to abort PyLith application.
Traceback (most recent call last):
  File "/Volumes/Tools/unix/pylith-dev/gcc-4.7.3/lib/python2.7/site-packages/pylith/apps/PetscApplication.py", line 64, in onComputeNodes
    self.main(*args, **kwds)
  File "/Volumes/Tools/unix/pylith-dev/gcc-4.7.3/lib/python2.7/site-packages/pylith/apps/PyLithApp.py", line 125, in main
    self.problem.initialize()
  File "/Volumes/Tools/unix/pylith-dev/gcc-4.7.3/lib/python2.7/site-packages/pylith/problems/TimeDependent.py", line 119, in initialize
    self.formulation.initialize(dimension, normalizer)
  File "/Volumes/Tools/unix/pylith-dev/gcc-4.7.3/lib/python2.7/site-packages/pylith/problems/Implicit.py", line 122, in initialize
    self._initialize(dimension, normalizer)
  File "/Volumes/Tools/unix/pylith-dev/gcc-4.7.3/lib/python2.7/site-packages/pylith/problems/Formulation.py", line 522, in _initialize
    integrator.checkConstraints(solution)
  File "/Volumes/Tools/unix/pylith-dev/gcc-4.7.3/lib/python2.7/site-packages/pylith/faults/faults.py", line 366, in checkConstraints
    def checkConstraints(self, *args):
        return faults.FaultCohesiveLagrange.checkConstraints(self, *args)

Error message

RuntimeError: Vertex with label '605' on negative side of fault 'fault_ext' is constrained.
Fault vertices cannot be constrained.

Abort info

application called MPI_Abort(MPI_COMM_WORLD, -1) — process 0
/Volumes/Tools/unix/cig/gcc-4.7.3/bin/nemesis: mpirun: exit 255
/Volumes/Tools/unix/pylith-dev/gcc-4.7.3/bin/pylith: exit 255
/Volumes/Tools/unix/cig/gcc-4.7.3/bin/nemesis: exit 1
Error message

```
RuntimeError: Vertex with label '605' on negative side of fault 'fault_ext' is constrained. Fault vertices cannot be constrained.
```
Step03: Error 3 Resolution
Error creating solution field

Error message

```
RuntimeError: Vertex with label '605' on negative side of fault 'fault_ext' is constrained.
Fault vertices cannot be constrained.
```

Debug: Look for overlap in fault and BC nodesets
Error message

RuntimeError: Vertex with label '605' on negative side of fault 'fault_ext' is constrained. Fault vertices cannot be constrained.

Debug: Look for overlap in fault and BC nodesets

Resolution

```python
[pylithapp.timedependent.bc.z_neg]
...
lable = face_zneg_nofault
```
Step03: Error 4

No error but funky results
Step03: Error 4 Resolution

No error but funky results

Debug: Did the solver converge?
Step03: Error 4 Resolution

No error but funky results

**Debug**: Did the solver converge?

**Resolution**

```python
[pylithapp.petsc]
ksp_monitor = true
ksp.converged_reason = true
ksp.error_if_not_converged = true

snes.converged_reason = true
snes.error_if_not_converged = true
snes.monitor = true
```
Step03: Error 5
Nonlinear solver diverges

PETSc error message

[0]PETSC ERROR: ---------------------- Error Message ----------------------
[0]PETSC ERROR: SNESolve has not converged
[0]PETSC ERROR: Petsc Development GIT revision: v3.4.4-4559-g852d360 GIT Date: 2014-05-19 15:04:32.0500

...[0]PETSC ERROR: #1 SNESolve() line 3765 in /Volumes/Tools/unix/petsc-dev/src/snes/interface/snes.c
[0]PETSC ERROR: #2 SNESLogConvergenceHistory() line 150 in /Users/baagaard/src/cig/pylith/libsrc

Debugging
Examine KSP and SNES residuals

Fatal error. Calling MPI_Abort() to abort PyLith application.
Traceback (most recent call last):
  File "/Volumes/Tools/unix/pylith-dev/gcc-4.7.3/lib/python2.7/site-packages/pylith/apps/PetscApplication.py", line 64, in onComputeNodes
    self.main(*args, **kwds)
  File "/Volumes/Tools/unix/pylith-dev/gcc-4.7.3/lib/python2.7/site-packages/pylith/apps/PyLithApp.py", line 135, in main
    self.problem.run(self)
  File "/Volumes/Tools/unix/pylith-dev/gcc-4.7.3/lib/python2.7/site-packages/pylith/problems/TimeDependent.py", line 154, in run
    self.formulation.step(t, dt)
    self.solver.solve(dispIncr, self.jacobian, residual)
  File "/Volumes/Tools/unix/pylith-dev/gcc-4.7.3/lib/python2.7/site-packages/pylith/problems/problems.py", line 179, in solve

Abort info

RuntimeError: Error detected while in PETSc function.

Aborting application (called MPI_Abort(MPI_COMM_WORLD, −1)) – process 0
Exit: mpirun: exit 255
Exit: pylith: /Volumes/Tools/unix/cig/pylith/bin/nemesis: exit 1
Step03: Error 5 Resolution
Nonlinear solver diverges

PETSc error message

[0]PETSC ERROR: _________________ Error Message ________________________________
[0]PETSC ERROR: SNESolve has not converged
[0]PETSC ERROR: Petsc Development GIT revision: v3.4.4-4559-g852d360 GIT Date: 2014-05-19 15:04:32...

[0]PETSC ERROR: #1 SNESolve() line 3765 in /Volumes/Tools/unix/petsc-dev/src/snes/interface/snes.c
[0]PETSC ERROR: #2 SNESLogConvergenceHistory() line 150 in /Users/baagaard/src/cig/pylith/libsrc
Step03: Error 5 Resolution
Nonlinear solver diverges

**PETSc error message**

```
[0]PETSC ERROR: ------------------------------- Error Message -------------------------------
[0]PETSC ERROR: SNESolve has not converged
[0]PETSC ERROR: Petsc Development GIT revision: v3.4.4-4559-g852d360 GIT Date: 2014-05-19 15:04:32.000000

[0]PETSC ERROR: #1 SNESolve() line 3765 in /Volumes/Tools/unix/petsc-dev/src/snes/interface/snes.c
[0]PETSC ERROR: #2 SNESLogConvergenceHistory() line 150 in /Users/baagaard/src/cig/pylith/libsrc
```

**Debug:** Examine KSP and SNES residuals using log file

```
$ pylith step03.cfg >& step03.log

$ grep "norm" step03.log
```
Step03: Error 5 Resolution
Nonlinear solver diverges

PETSc error message

```plaintext
[0]PETSC ERROR: -------------------------------- Error Message --------------------------------
[0]PETSC ERROR: SNESolve has not converged
[0]PETSC ERROR: Petsc Development GIT revision: v3.4.4-4559-g852d360
... 4559-g852d360
[0]PETSC ERROR: #1 SNESSolve() line 3765 in /Volumes/Tools/unix/petsc-dev/src/sn
[0]PETSC ERROR: #2 SNESLogConvergenceHistory() line 150 in /Users/baagaard/src/cig/pyli
```

Debug: Examine KSP and SNES residuals using log file

```bash
$ pylith step03.cfg >& step03.log
$ grep "norm" step03.log
```

Resolution

```plaintext
[pylithapp.timedependent.interfaces.fault]
zero_tolerance = 1.0e-10

[pylithapp.petsc]
ksp_rtol = 1.0e-20
ksp_atol = 1.0e-12

snes_rtol = 1.0e-20
snes_atol = 1.0e-8
```
Step03: Error 6
Intended shear to drive fault slip

Debug: Check fault tractions
Step03: Error 6
Intended shear to drive fault slip

Debug: Check fault tractions
Compare $T_{\text{shear}}/T_{\text{normal}}$ against $\mu_f$
Step03: Error 6
Intended shear to drive fault slip

Debug: Check fault tractions
Compare $T_{\text{shear}}/T_{\text{normal}}$ against $\mu_f$

Resolution

```python
[pylithapp.timedependent.bc.x_pos]
...
db_initial.data = [-1.0*m, 3.0*m, 0.0*m]

[pylithapp.timedependent.bc.x_neg]
...
db_initial.data = [1.0*m, -3.0*m, 0.0*m]
```
Asking For Help
Send email to cig-short@geodynamics.org

- Try to debug on your own first
- Describe what you are trying to do
  - Overview of problem, BC *(diagrams/sketches are very helpful)*
  - 2-D or 3-D
  - Cell type (tri, quad, hex, tet)
  - Prescribed slip or spontaneous rupture
- Send the entire error message, not just what you think is important *(log of all output is best)*
- Send the JSON parameter file *(pylith_parameters.json).*