

Crustal Deformation Modeling Tutorial

2-D Subduction Zone with
Coseismic and Interseismic Deformation

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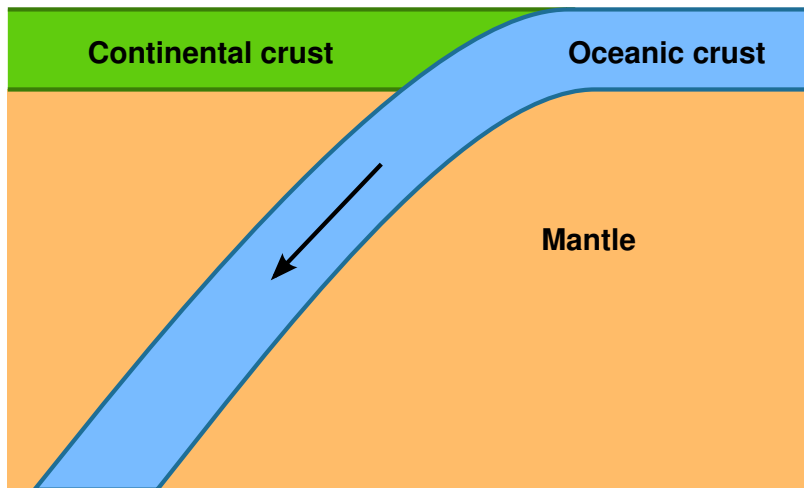
2-D Subduction Zone Example

Features illustrated in this example

- Generating a finite-element mesh using CUBIT
 - Nonplanar geometry
 - Variable mesh resolution
 - Marking buried edges of faults
- Spatially variable coseismic slip
- Maxwell viscoelastic relaxation
- Files are located in
`src/pylith-2.0.0/examples/2d/subduction`
- Steps 1-3: This tutorial
- Step 4: Tomorrow's afterslip tutorial

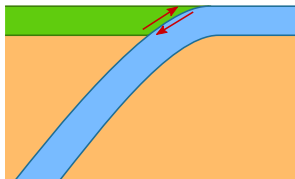
2-D Subduction Zone Example

Based on 2011 M9.0 Tohoku, Japan, earthquake

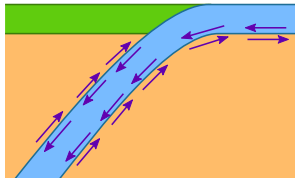


Steps in Subduction Zone Example

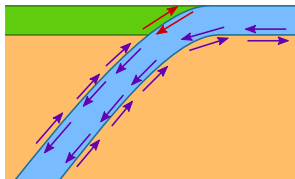
Step01: Coseismic slip



Step02: Interseismic deformation



Step03: Seismic cycle



Parameters Common to All Steps

- Bulk constitutive models
 - **Crust** Linear elastic w/plane strain (ElasticPlaneStrain)
 - **Mantle** Linear Maxwell viscoelastic w/plane strain (MaxwellPlaneStrain)
- Faults w/prescribed slip
- Fixed boundaries (except subducting slab)

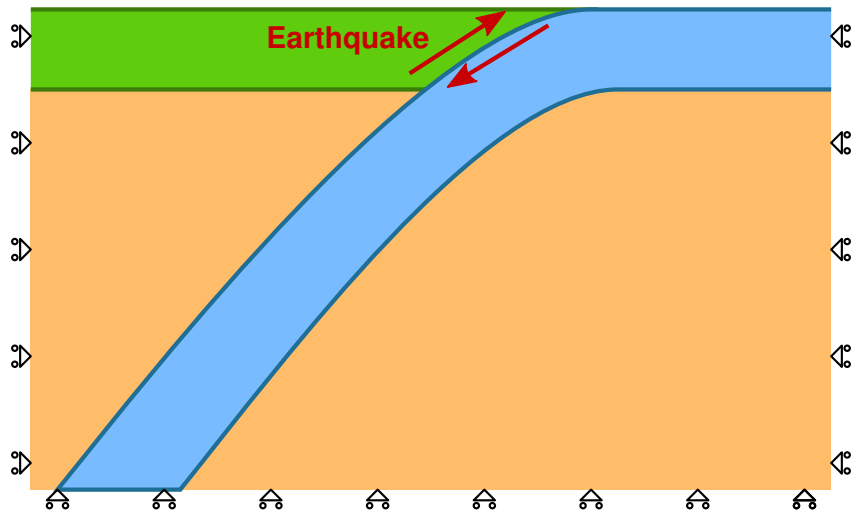
Mesh Generation via CUBIT

Include topography/bathymetry and slab geometry

- 1 Create geometry
 - 1 Create points
 - 2 Connect points into spline curves
 - 3 Split curves to form bounding curves
 - 4 Connect curves into surfaces
 - 5 Stitch surfaces together
- 2 Define meshing scheme and cell size variation
 - 1 Define cell size along curves near fault
 - 2 Increase cell size away from fault at geometric rate (bias)
- 3 Generate mesh
- 4 Create boundary conditions
- 5 Export mesh

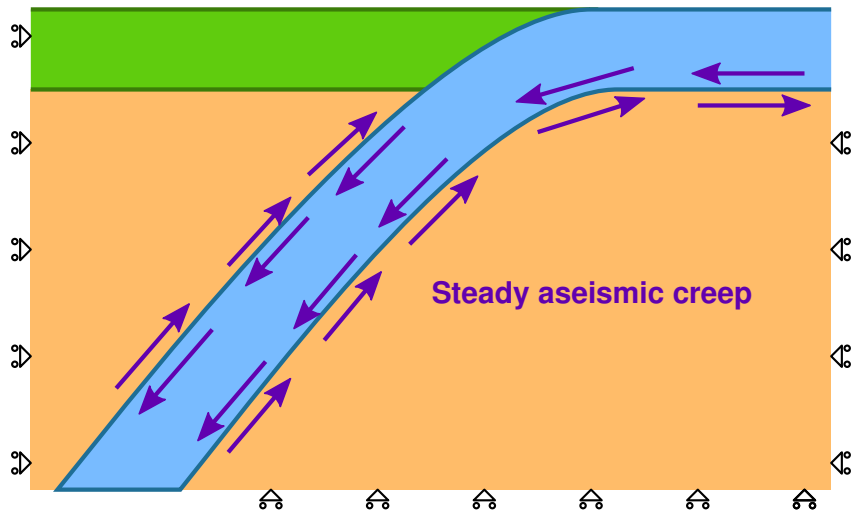
Step01: Coseismic Slip

Prescribed slip based on Gavin Hayes's rupture model



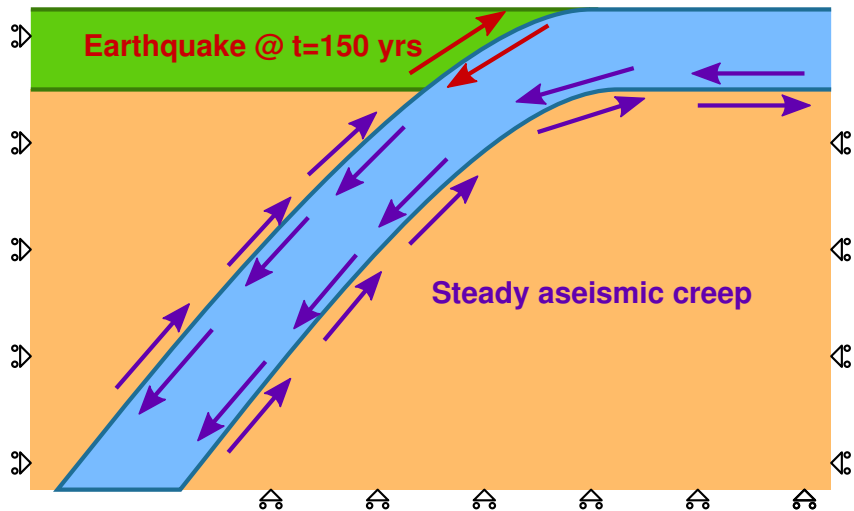
Step02: Interseismic Deformation

Aseismic creep along interface between slab and mantle



Step03: Seismic Cycle

Interseismic deformation with coseismic slip at 150 years



Suggested Modifications

Examples of how to work towards real research problems

- Add depth dependent viscosity to the mantle
- Add viscosity to the oceanic crust to permit relaxation at depths below 50 km
- Modify the spatial database files for the material properties to use depth-dependent elastic properties based on PREM
- Mesh the geometry using quad4 cells rather than tri3 cells
- Add multiple, repeated earthquake ruptures and examine spinup towards a steady-state solution