Concepts Covered in this Session

- When are gravitational stresses necessary?
- Usage of gravitational body forces in 2D
- Usage of initial stresses and state variables
- Usage of small strain formulation in 2D
- Viscoelastic relaxation with a linear Maxwell model
- Spatial database with irregular distribution of points in 2D
- Turning off elastic prestep for a postseismic simulation

NOTE: Accuracy and convergence for gravitational problems will be much improved once PyLith includes higher-order elements.
When Do We Need to Use Gravitational Stresses?

- Pressure/stress-dependent rheology
  - Pressure-dependent bulk rheology (e.g., plasticity)
  - Stress-dependent fault rheology (e.g., friction)
- Viscoelastic simulations where we care about vertical deformation
- Other simulations where we care about the absolute stress state
Gravity Examples

- **2-D examples:** [examples/2d/gravity]
  - Steps 1-3: Body forces, initial stresses, infinitesimal strain
    - Step 1: Body forces + infinitesimal strain
    - Step 2: Body forces + infinitesimal strain + initial stress
    - Step 3: Step 2 + local density variation
  - Steps 4-7: Body forces, initial stresses, finite/infinite strain with postseismic relaxation
    - Step 4: Relaxation with infinitesimal strain and no gravity
    - Step 5: Relaxation with finite strain and no gravity
    - Step 6: Relaxation with infinitesimal strain and gravity
    - Step 7: Relaxation with finite strain and gravity
  - Step 8: Usage of initial state variables and density variation

- **3-D examples:** [examples/3d/hex8/step15-17]
2D Gravity Simulations
Elastic layer over Maxwell viscoelastic layer
Steps 1-2 in Gravity Example
Infinitesimal strain with and without initial stress

Step01: Infinitesimal strain

Step02: Infinitesimal strain + initial stress
Step 3 in Gravity Example
Infinitesimal strain, initial stress, variable density

Density variation

Displacements

Time: 10 years
Postseismic Relaxation Problem Description
Thrust fault plus postseismic relaxation
Finite strain with gravity
Finite strain without gravity
Infinitesimal strain with gravity
Infinitesimal strain without gravity

Time: 3990 years
Step 8 in Gravity Example

Variable density and initial state variables
Spatial Databases

- matprops_unidensity.spatialdb Material properties for all simulations except step03 and step08
- matprops_vardensity.spatialdb Material properties for simulations step03 and step08
- eqslip.spatialdb Fault slip for all postseismic simulations (step04-step08)
- gravity_isostatic.spatialdb Isotropic stresses for all simulations using initial stresses (step02-step03, step06-step08)
- grav_statevars-xx.spatialdb State variables generated by Python script for step08
Configuration Files
Settings shared between simulations

- **pylithapp.cfg** Base settings for all simulations
- **postseismic.cfg** Settings for all postseismic simulations (step04-step08)
- **gravity_initstress.cfg** Settings for all simulations using initial stresses (step02-step03, step06-step08)
- **nogravity.cfg** Settings for all simulations without gravity (step04-step05)

All other .cfg files are for a specific simulation