3 July 2018
International School of Physics Enrico Fermi on Mechanics of Earthquake Faulting
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Exercise for Lecture 1.

Rate and State Friction Simulator with 1D Elastic Coupling

Step 1: Set up the program to run on your machine (see also: http://www3.geosc.psu.edu/Courses/Geosc508/)

This version will run on your mac:
Compiled executable program for unix/linux Intel processor. Download and run from your unix command line   Run terminal and type the program name at a command line. See the usage instructions and examples.

If you need to compile the code, you'll need a c compiler and these two files (rsp.h, rsfs.c):
rsfs.c rate state friction simulator. Download
rsp.h: header file with structure definitions. Download and put in the same folder as the C code.
Compile with: gcc -o rsfs rsfs.c -lm

On a mac: To compile, install command line tools and a c-compiler, like gcc. You can use a package manager like home-brew, or use the "OSX GCC Installer".   OSX GCC Installer   **On a PC:** Windows users should first install cygwin.

Installation instructions for cygwin
During the installation you will need the Debug and Devel packages.   Once cygwin is installed, rsfs.c can be compiled in the cygwin terminal using the command above. The result is an executable file named rsfs.exe.   To run, use the command: ./rsfs.exe See the usage instructions and examples.   An example of a full command: ./rsfs.exe file1 d 10 10 1 .1 .1 200 .001 .008 .009 5 1 -10 -t

2.0 Calculate the friction response for a load point velocity jump from 1 to 10 μm/s using Ruina state evolution and the following parameters: a=0.01, b=0.015, Dc = 10 μm, k=1e-2/μm. Plot friction vs. load point displacement for these data, showing results out to 300 μm of slip after the velocity step. Label all relevant parameters and provide a brief description of the friction response, including the instantaneous response and the evolution with slip.

2.1 What are the initial and final values of the state variable?
2.2 Measure the change in steady state friction. Compare your value to the theoretical prediction given by the friction constitutive parameters a-b and the velocity step size. Comment briefly on the comparison. Is this what you expected?
2.3 Measure the slip necessary for friction to reach a new steady state after the velocity step. How does this value compare to the parameter Dc?

3. repeat 2.0 – 2.3 for the Dieterich state evolution law. Describe and compare the friction responses for the two laws.

4. Compute the friction response for 2.0, with the Ruina law, but use k=9e-4/μm. Make a comparison plot of friction vs. load point displacement for the two responses, showing results out to 300 μm of slip. Describe and compare the friction responses. Measure peak friction, relative to the initial value, for the two cases and compare your value(s) to the friction parameter *a*. Why are they the same/different?

5. repeat #4 for the Dieterich state evolution law, but use k=1e-3/μm. Describe and compare the friction responses for the two laws. What happens if you use a smaller value of k? Why does this happen?

6. Use the parameters for 2.0 and run a series of slide-hold-slide simulations with the Dieterich law. Plot frictional healing as a function of log_e time and determine the asymptotic healing rate for hold times > 1000 sec. Compare this value with the friction parameter b and comment on the form of the curve for short hold times and long hold times.