GEOP 572 Geodetic Methods – Homework 3

The following homework is to be turned in by 5pm on Wednesday, November 18. Late submissions will not be accepted.

Please drop off **well-ordered printouts** (solutions, description of solution, code, figures in order of assignment) in class, my EES department mailbox or slip it under my office door. In addition, email digital copies of your solution to rg@nmt.edu. Do all of this before the deadline!

Problem 1

Assume an infinitely long, vertical strike slip fault, which is locked to 18 km depth. You may want to imagine this fault to be somewhere in Alaska and a fortunate grad student got to go out on annual campaigns to re-measure the positions of 30 sites across the fault and ultimately come up with the following velocity profile:

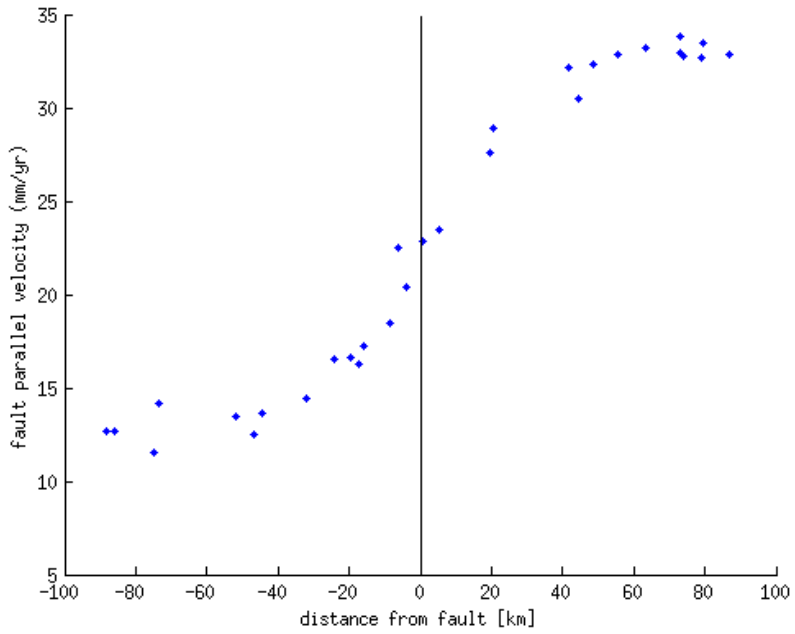

Figure 1: Velocity profile for 30 GPS sites across a vertical strike slip fault (black) with 18 km locking depth.

Clearly the entire network is being translated parallel to the fault; this might be due to a different process. You can find long term velocities (strike parallel)

for 30 GPS stations here: `http://www.grapenthin.org/teaching/geop572_2015/homework/hw3_velocities.txt`.

Use *Savage & Burford's (1973)* model to determine the fault parallel velocity on the fault:

$$v(x) = \frac{s}{\pi} atan\left[\frac{(x - x_f)}{D}\right] \tag{1}$$

Where:

- x is the perpendicular distance between GPS station and the fault
- x_f is the position of the fault
- $v(x)$ is the fault parallel velocity at position x
- s is the long term slip rate (mm/yr)
- D is the locking depth (km)

Note that in this formulation the velocity of a site on the fault must be zero!

Given the GPS velocities and the model in Equation 1, set up and solve the inverse problem to recover the long-term slip rate on the fault (explain the how you set this up in your write-up). Create a plot that shows the observations and superimposes the model velocity profile that is based on the recovered fault slip rate s. Make a second figure that shows the residuals at each site. Are there any systematic features in the residuals? If so, what may these be caused by?

Create a third plot that is similar to the first figure (observations and model results), but adds two more velocity profiles where you change the locking depth to 5 km and 25 km respectively using the same, recovered slip rate s. How does a change in locking depth affect the velocity profile?