GEOS F4/693 Geodetic Methods – Homework 4

The following homework is to be submitted via blackboard, as PDF, before the first day of finals week.

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:

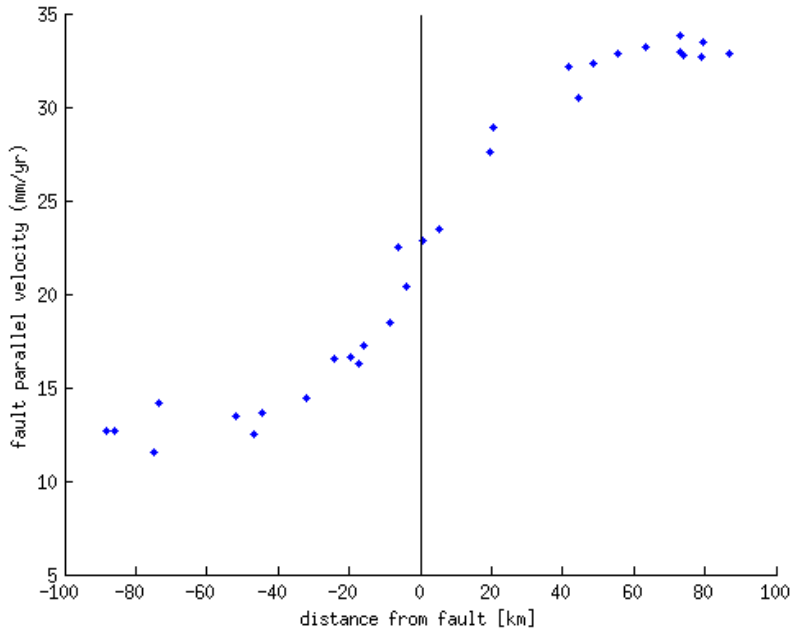

Figure 1: Velocity profile for 30 GPS sites across a vertical strike slip fault (black) with 18 km locking depth.

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/geodesy/homework/hw4_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? Why would this occur in nature?