**Mechanical Earth, Homework 5 due February 19, 2020**

On August 17, 1999, an earthquake of magnitude 7.6 occurred in northwestern Turkey near the city of Izmit. The event lasted 37 seconds, killed 17,000 people and left more than 250,000 people homeless. Based on GPS movements and surface ruptures (Figure 1) the earthquake appears to have occurred along a right-lateral strike-slip fault that ruptured to the surface.

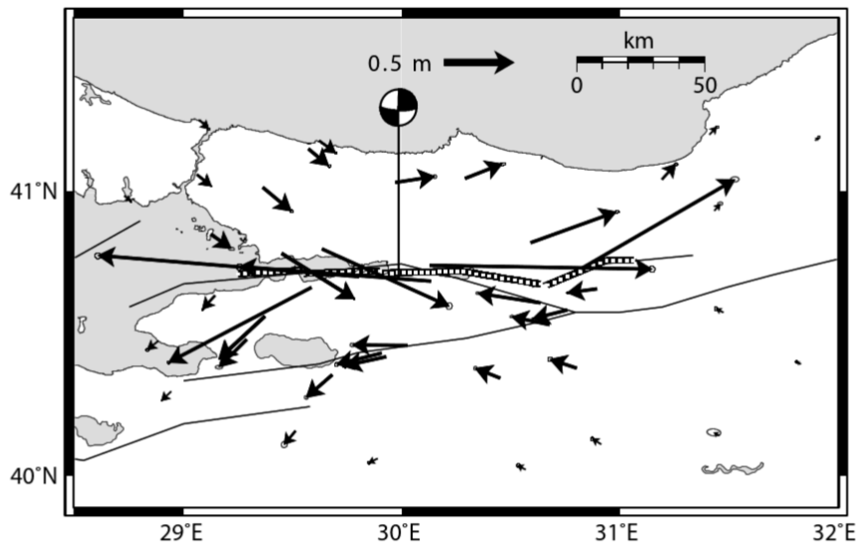


**Figure 1**. Black arrows represent co-seismic horizontal GPS displacements from the 1999 Izmit earthquake. Dashed line shows the surface rupture location. (Fig 2.13 of Segall, 2010 from Reilinger et al., 2000)

**The goal of this exercise is to compare the GPS displacements during the earthquake to the surface displacements predicted from the dislocation model for a strike-slip fault in order to constrain the depth of the fault and the amount of slip that occurred.**

You will model the surface displacements during the Izmit earthquake using the dislocation model for an infinitely long, vertical strike-slip fault with uniform slip over a finite depth range in an elastic half-space (Segall, 2010 Chapter 2). For this case, we will assume the fault is planar and strikes east-west, consistent with the orientation of the surface rupture (Fig. 1), so that the $x_3$-direction in the model represents east-west with positive values of $x_3$ to the west. The $x_1$-direction will therefore be oriented north-south, with positive values to the south. At the surface, $x_2 = 0$, and the equation for the displacements in the $x_3$ direction is (Segall, 2010 equation 2.26):

$$u_3(x_2 = 0) = \frac{-s}{\pi}\left[\tan^{-1}\frac{x_1}{d_1} - \tan^{-1}\frac{x_1}{d_2}\right]$$

where $s$ is the magnitude of slip (in meters), $d_1$ is the deepest extent of the fault surface, and $d_2$ is the shallowest extent of the fault surface. Since the fault in this case ruptured to the surface, $d_2$ is zero.

The GPS displacements clearly are not perfectly east-west; there is some component of north-south movement. Nonetheless, the east-west component of displacement does appear to be significantly greater than the north-south component. So, we will compare our solution for $u_3$ in the model fault against the east-west component of the GPS displacements. These data are contained in a file "Izmit_data.mat" with the first column containing values of the north-south distance between the GPS receiver and the fault (in kilometers), and the second column containing values of the westward component of displacement (in meters).

Write a MATLAB script that plots $u_3$ versus $x_1$ for some given value of $s$ and $d_1$. Load the file "Izmit_data.mat" and plot these data on top of your model (hint: "hold on" is a useful command for this). Label your x and y axes, provide a legend so we know which is the model and which are the data, and make sure your range of $x_1$ appropriately spans the Izmit dataset (remember $x_1$ assumes meters but the data is given in kilometers).

1. Fix the slip to be 1 meter, and print out (on one figure, please) the predicted displacements for fault depths of 1 km, 10 km, and 20 km. For a given amount of slip, describe what happens to the predicted displacements as the fault gets deeper?

2. Now fix the fault depth to be 10 km, and print out the predicted displacements for slip of 1 m, 4 m, and 7 m. For a given fault depth, describe what happens to the predicted displacements as the slip increases?

3. Vary $s$ and $d_1$ until you find a decent match to the data. (Hint: you will not find a perfect match, but just try your best). Print your final model result with the data on top. What might be some reasons that the model does not perfectly fit the displacement data?