Practice session 3 - Moment magnitude determination

November 7, 2012

In this practice session we will determine the moment tensors of the Ometepec earthquake on March 20 2012, 18.02, using ObsPy.

To review topics from *Fuente Sísmica* , read Stein and Wysession, 4.3, 4.4 and 4.6.1.

To estimate the moment I have provided records from the event registred in Boston, USA (station HRV) and synthetic seismograms calculated for this event. The instrument response has been removed and the observed traces have been band-pass filtered between 5 and 500 seconds. Both observed and synthetic traces are in displacement and the unit is meters. The synthetic traces were calculated for a point source with scalar moment $M_0^{unit} = 10^{20} Nm = 10^{27}$ dyne-cm. Note that the starting time is not the origin time.

1 Read the data

Read synthetics into one variable and observed into another variable.

2 Filter the data

Bandpass filter both observed and synthetic records between 50-100 seconds.

3 Rotate the data

Rotate the horizontal components to radial and transverse components, using the back-azimuth in the header.

4 Plot data and synthetics

For each event, plot each component of the data and synthetics together (synthetic and observed vertical together, synthetic and observed radial together and finally, synthetic and observed tangential) together.

5 Determine scalar moment and moment magnitude

The scalar moment can be determined by simply multiplying the synthetic traces by a constant. The constant the achieves the best match between the observed and synthetic traces is the best value for the scalar moment, $M_0 = constant * M_0^{unit}$. Calculate the moment magnitude based on the scalar moment.

6 Tarea

1. Explain your criteria for estimating the "best match" between data and synthetics.
2. Give your best estimate of the scalar moment for the two events.
3. Turn in the plots of observed and synthetic traces together (from section 4) for the selected value of the scalar moment (one plot for each earthquake).
4. What do you think are the most important errors in your estimates? How would you improve them?

7 Some helpful code snippets

```
import numpy as np
import matplotlib.pyplot as plt
from obspy.core import read
from obspy.signal import rotate_NE_RT

station="HRV"
scale = 1

#READ DATA
obs = read("DATA/*"+station+".00*.LHZ*SAC.p")
obs += read("DATA/*"+station+".00*.LH1*SAC.p")
obs += read("DATA/*"+station+".00*.LH2*SAC.p")

#FILTER DATA
obs.filter('bandpass', freqmin=0.01,freqmax=0.02, corners=2, zerophase=True)

#ROTATE HORIZONTALS

baz = obs[0].stats.sac.baz
obs[1].data, obs[2].data = rotate_NE_RT(obs[1].data, obs[2].data, baz)
```

```
obs[1].stats.channel = obs[1].stats.channel[:-1] + 'R'
obs[2].stats.channel = obs[2].stats.channel[:-1] + 'T'

#### PLOT ####

#Vertical
obs1 = obs[0]
t = np.arange(0, obs1.stats.npts / obs1.stats.sampling_rate, obs1.stats.delta)
plt.subplot(311)
plt.xlim(0,1200)
plt.plot(t, obs1.data, 'k')
plt.ylabel('Vertical')

#Final stuff
plt.xlabel('Time [s]')
plt.suptitle(obs1.stats.starttime)
plt.savefig(station+'.png')
```