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Geophysics 557 Week of 30 January 2017

Lab Skills Exam #1

When a graph or figure is required, **label axes and title each figure plot**. When your figure is complete, copy and paste it into this document at the indicated position.

The title of each figure should include the figure number and a brief description of the figure.
For best results, use the 'prepfig' command after each figure.

1) (10 pts) **Exploding reflector image of channel model.**
Use *channelmodel* as follows:
[vel,x,z]=channelmodel(dx,xmax,zmax,vhigh,vlow,zchannel,wchannel,hchannel,vchannel,nlayers);
with dx=5, xmax=3000, zmax=1500, vhigh=4000, vlow=1500, zchannel=zmax/2, wchannel=10*dx, hchannel=5*dx, vchannel=2000, and nlayers=9 (default all other parameters). Plot your channel model using imagesc and a colorbar. Label axes and call this Figure 1.

Now use a 30 Hz Ricker wavelet and create a synthetic zero-offset section or zos (a proxy for a stacked section) using afd_explode. Place your receivers on the z=0 surface at a 10 meter spacing, that is put a receiver at every other grid point. Use dt=.004, and tmax=1.5. Plot this zos as Figure 2.

Next create a noisy zos (zosn) by adding random noise using a signal-to-noise (s2n) ratio of 2. Do not overwrite your noise-free zos. To do this you will have to use a "for loop" over the columns of your zos. Inside your loop, use rnoise to generate the noise and be sure to add this noise to the trace:

```
>> zosn=zos;
>> for k=1:size(zos,2)
>>      tmp=zosn(:,k);
>>      n=rnoise(tmp,s2n);
>>      zosn(:,k)=tmp+n;
>> end
```

Plot your noisy zos as Figure 3.

Finally create fk spectra of zos and zosn and plot the amplitude spectra of these as Figures 4 and 5.

PASTE YOUR FULLY ANNOTATED FIGURES HERE.

FIG1 (1pt): Channel model showing velocities in color

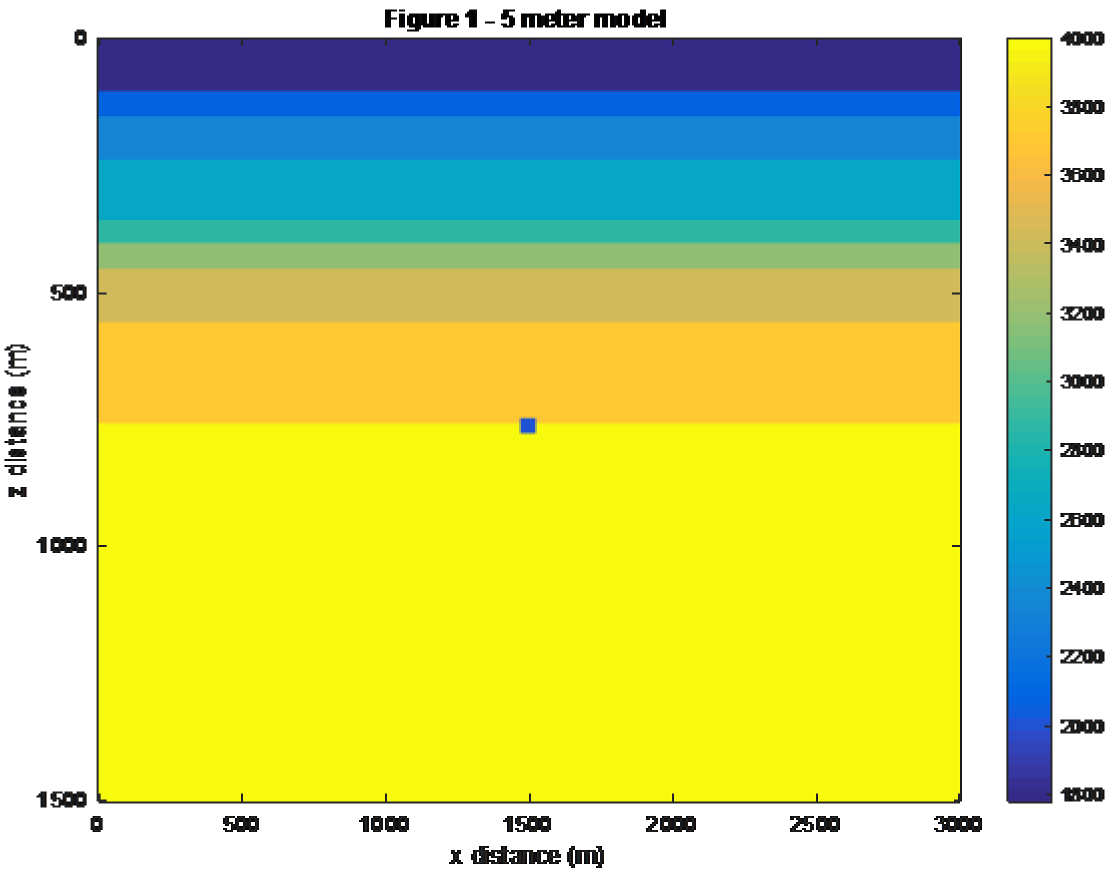


FIG2 (2pts): (x,t) plot of the zos section, Mean scaling, clip=4.

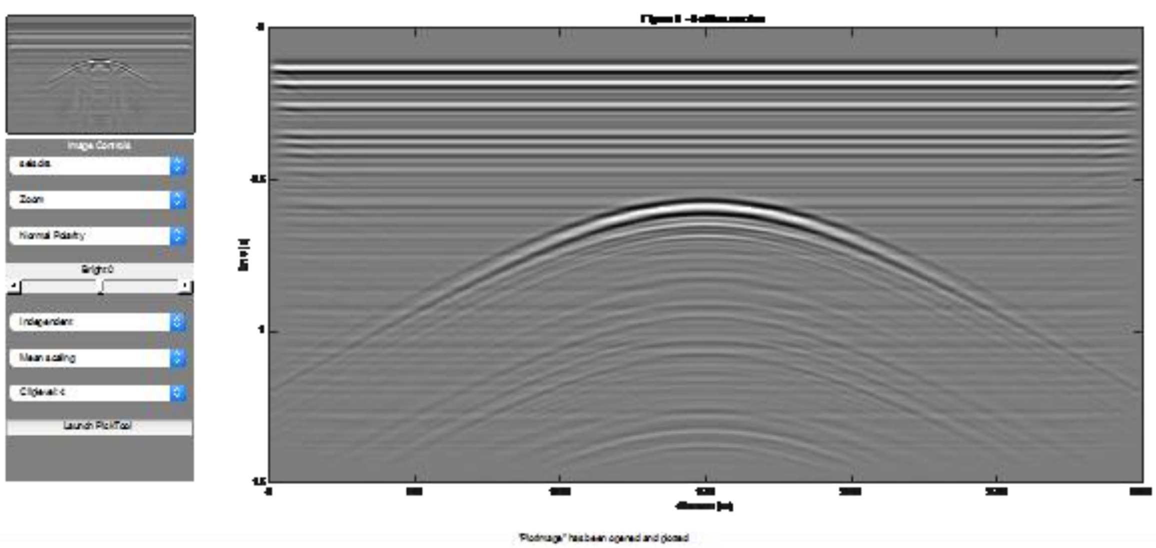


FIG3 (1pt): (x,t) plot of the noisy zos section, Mean scaling, clip=4.

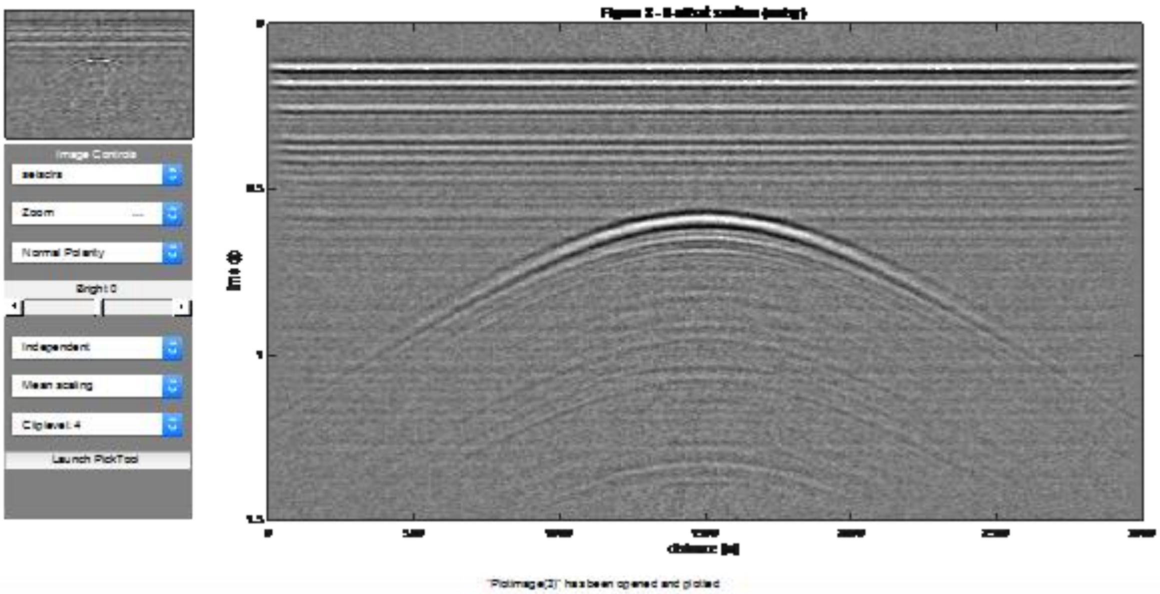


FIG4 (2pts): (k,f) plot of the spectrum of noise free zos, Mean scaling, clip=4.

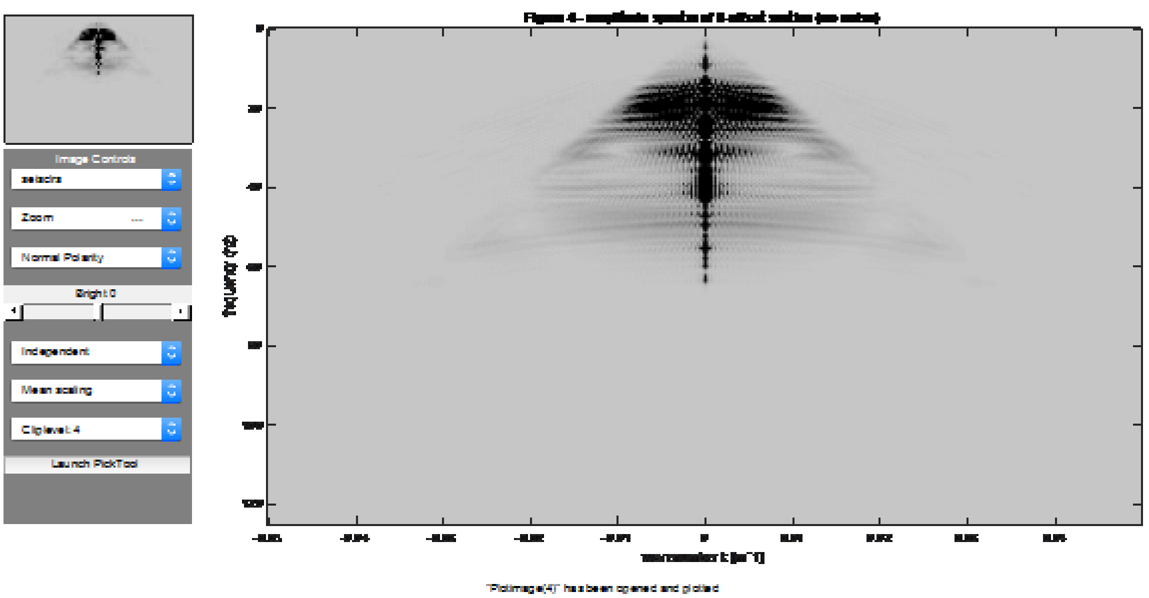
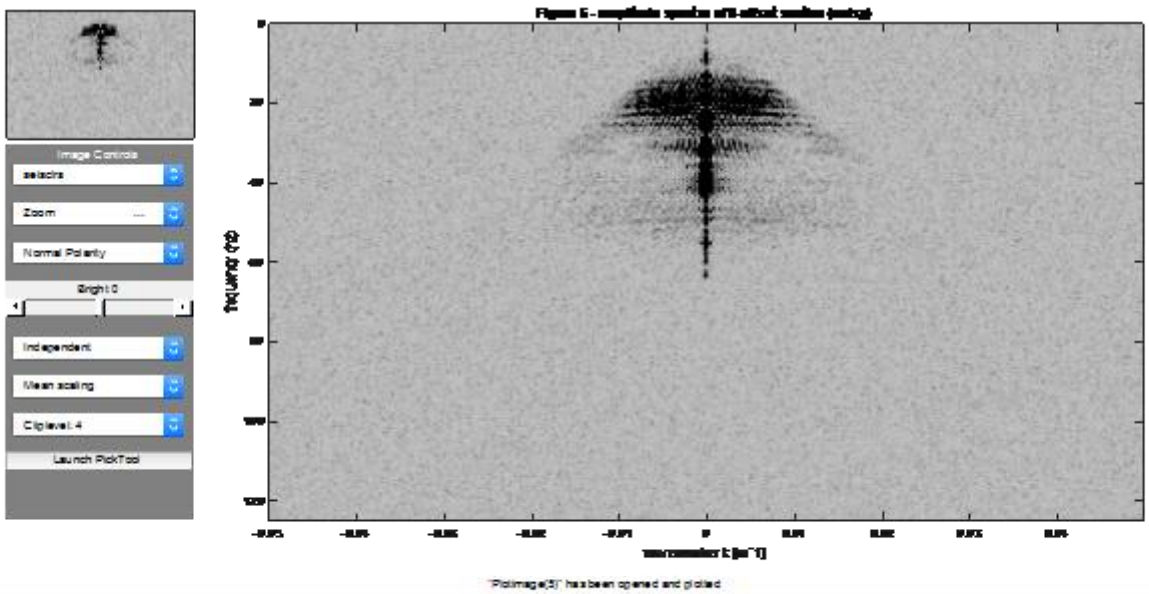


FIG5 (1pt): (k,f) plot of the spectrum of noisy zos, Mean scaling, clip=4.



Questions:

a) (2pts) Examine Figure 4 and note the triangular region within which the data is confined. By direct measurement off this plot, what is the apparent velocity of the right-hand boundary of this triangle? What event(s) in Figure 2 cause this boundary?

The apparent velocity of the right-hand boundary of this triangle is 2000m/s. The cause of the boundary is there is a dipping reflector beneath the surface/in the subsurface which is causing the event to occur.

b) (1pt) Explain, in two sentences or less, why the spectrum of Figure 5 has energy outside the triangular region noted in a).

The spectrum of figure 5 has energy outside of the triangular region compared to figure 4 simply due to the addition of the random noise. Depending on how strong the noise is, it will affect the amplitude spectra as demonstrated, causing energy to appear outside region.

2) (10 pts) **The f-k response of trace mixing**

Note: This problem depends on having completed question 1. If you failed to do that, then download the file data_problem2b.mat from D2L. This contains the matrix zosn and its time coordinate, t, and x coordinate, xrec.

A simple way to attenuate noise, both coherent and random, is called trace mixing. A trace mix sums n input traces into one output trace. For example, if n=9, then an output trace at x=1000, is the sum of the input trace at 1000 and four more traces from each side. In addition to suppressing noise, a trace mix attenuates dipping events. Conceptually, a trace mix is computed by convolving a spatial boxcar with the seismic section. Here we will study this process using the noisy zos (zosn) from question 1.

First compute a 9 trace mix using the command:
>> **zosnm=conv2(zosn, ones(1,9)/9,'same');**

Plot both zosn and zosnm in the x-t domain as Figures 6 and 7.

Next compute the f-k transforms of zosn and zosnm and plot the amplitude spectra as Figures 8 and 9. Note that Figures 6 and 8 should be identical to Figures 3 and 5 of the previous question.

Comparing Figures 8 and 9, you should be able to see the presence of vertical stripes of zero amplitude (called spectral notches) occurring at regularly spaced wavenumbers. To make this more apparent, compute the average over frequency of these fk spectra with a command like:
>>**fkave=mean(abs(fkzosn));** (where fkzosn is the fk spectrum of the noisy zos) and similarly for zosnm. In a new Figure window, plot these average spectra versus wavenumber, put a legend on this plot, and label your axes. You should clearly see spectral notches at regular intervals on this plot. This is Figure 10.

PASTE YOUR FULLY ANNOTATED FIGURES HERE.

FIG6 (0pts): (x,t) plot of *zosn*, Mean scaling, clip=4.

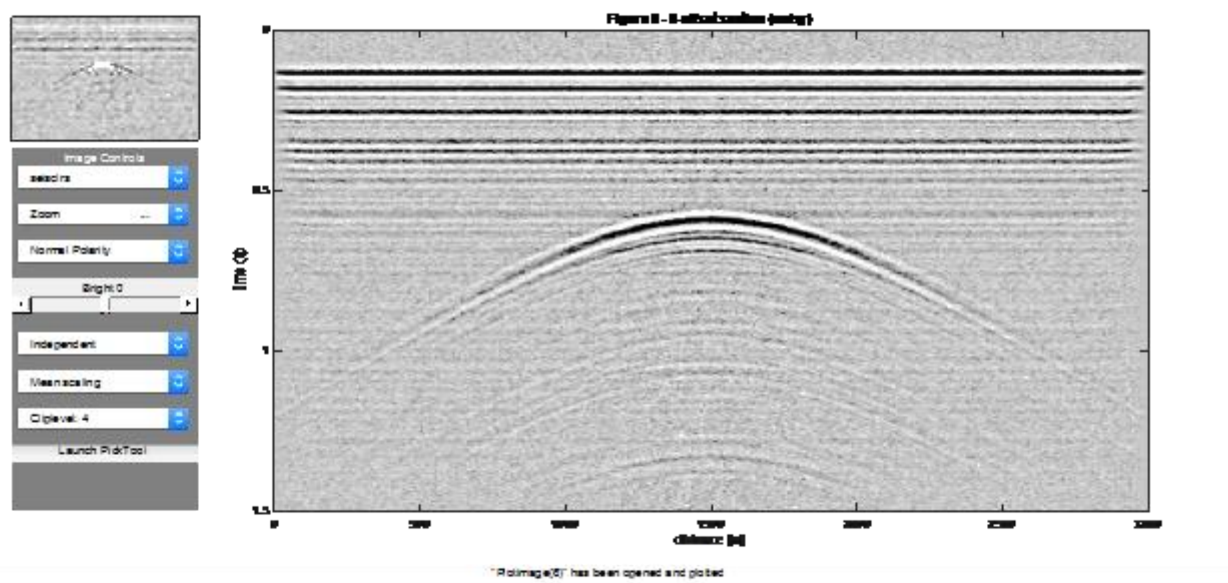


FIG7 (2pts): (x,t) plot of *zosnm*, Mean scaling, clip=4.

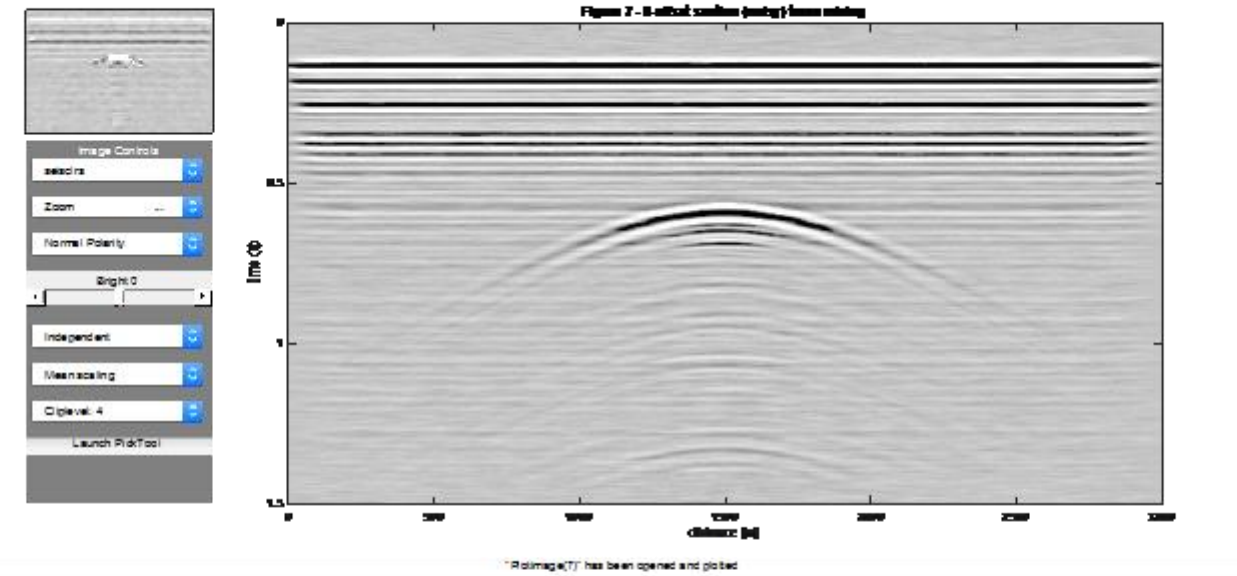


FIG8 (0pts): f-k plot of *zosn* (amplitude spectrum), Mean scaling, clip=4.

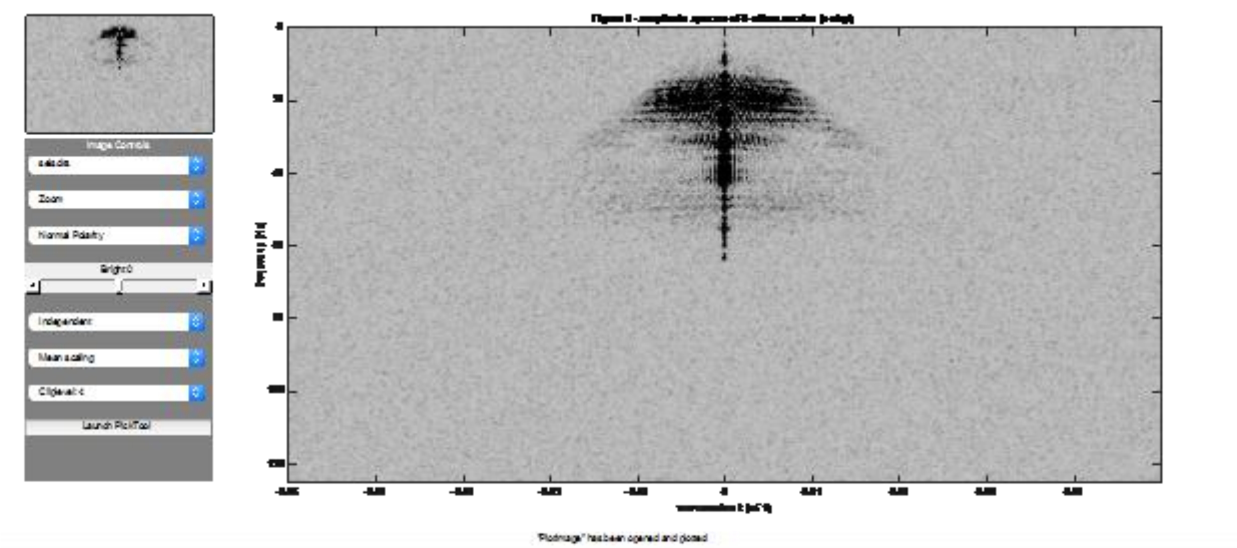


FIG9 (2pts): f-k plot of *zosnm* (amplitude spectrum), Mean scaling, clip=4.

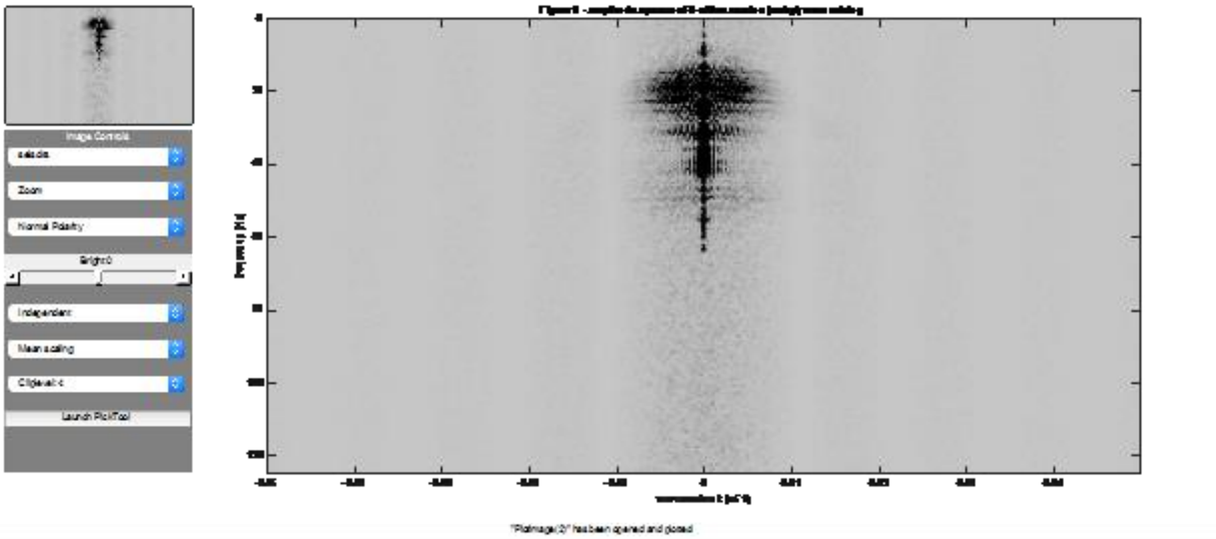
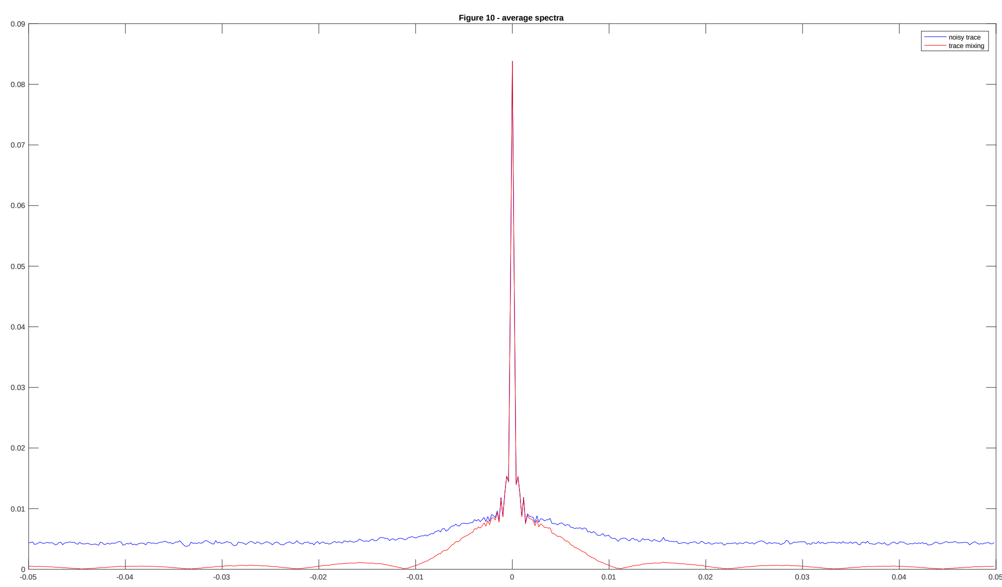


FIG10 (2pts): Plot of average spectra versus wavenumber for zosn and zosnm (two curves).



Questions
a) (2pts): Use the convolution theorem (MSDP 2-27 & 2-28) to explain the presence of the spectral notches caused by mixing. Can you explain why they occur at the wavenumbers that they do?

The presence of vertical spectral notches is apparent in figure 9 where there is trace mixing. This is due to the artificial noise we inserted earlier being convolved with our boxcar trace and becoming ‘zeroed out’. This occurs at the very wavenumbers where our boxcar trace is 0 and as such, when we mix the traces, spectral notches appear at those wavenumbers due to the convolution.

b) (2pts): Referring to Figure 10, why is the average spectrum after mixing generally lower than that before mixing at all non-zero wavenumbers?

The average spectrum is lower after mixing because it attenuates dipping events. Essentially what we are doing is convolving a spatial boxcar with the seismic section and due to the nature of our boxcar trace, when convolved the average spectra will obviously be lower than when not convolved, as seen in figure 10. The nature of our boxcar being a lower amplitude spectrum and when averaged, mixed trace is lower.