Login to account "class227" with password "sio227b". In the directory "data.dir", you will find some files of seismic recordings of a few of the large recent earthquakes. These files are "GFS" files which are really Unix directories and can be manipulated with appropriate software. For example, typing "curse bolivia94.gfs" will start the interactive editor on the vertical component recordings of the Bolivian earthquake. BEWARE! It is easy to change data with this program.

Of the five events in the directory, 2 are deep (Flores and Bolivia) and the rest are shallow. Choose 1 deep and 1 shallow event and use RSPEC to look at amplitude spectra of various recordings. This program allows you to change record length and start time, taper type, frequency sampling, etc, and to zoom in frequency and use the cursor to measure peak frequencies. (The reprint from the AGU volume by Masters and Widmer has a listing of mode frequencies with an indication of which modes have (and can) be observed.)

At first, all I really want you to do is to play and get a feel for how the spectrum changes depending on how you compute it. For example, using the Bolivian data, you can use 50 hours of recording starting 0,10, and 20 hours after the event and look at spectra in the 1–3 mHz band and the 2–6 mHz band. Play with tapers (though the Hanning will probably be best). Now use a very long record (e.g. 100 hours). Now do the same thing for one of the shallow events. Some narrow frequency bands have two closely spaced modes with very different Q values (e.g. $_3S_1/_1S_3$ or $_8S_1/_0S_{20}$) and you should experiment to see if you can separate the modes using the Earth as an "attenuation filter". On records of the deep events, you'll be able to see splitting of some high Q modes if you take a long enough record. How long a record do you have to take to see splitting of $_{13}S_2$?

Use program TPDSK to estimate the frequencies and Q's of the following modes: $_0S_{20}$, $_0S_{25}$, $_0S_{30}$, and $_0S_{35}$. You should use about Q cycles of data for each mode and start about 1 hour into the recordings. The program will prompt you with the calculated value for Q cycles though you should not use less that about 8 hours since record truncation effects then broaden the spectrum too much. You can also adjust the frequency spacing chosen by the program. There should be 6 to 10 points above the half-amplitude point of the mode and the bigger you make the frequency spacing the more of the spectrum you will see (the program plots 50 points). Seeing more of the spectrum makes it easier to evaluate noise levels. Figure 1 shows the result of using TPDSK on a GUA record to measure $_0S_{23}$. The measured frequency is about $3.173 mHz$ and $1000/Q$ is 4.95. You use the cross-hair to estimate signal to noise which then allows the program to calculate errors. This estimate had a SNR of about 10 giving an error in frequency of $1.0 \mu Hz$ and an error in $1000/Q$ of 0.64. The results are written to an ASCII file (an example is shown in figure 2). Discard measurements with low SNR (a peak amplitude to noise ratio of about 3 is the minimum signal level you should consider) and discard measurements which do not de-mode properly. Pool your results so that you have as many measurements as possible for each mode. Explore your data (e.g. make histograms and look for outliers). Plot up the statistics of your measurements (mean, median, variance, s.d. of mean, SMAD, etc.) and try and interpret your results. In particular, try and explain why the mean attenuation varies as it does as a function of harmonic degree; explain what you think causes the scatter in attenuation and frequency measurements; explain why you think the variance of the measurements changes as a function of harmonic degree; explain your reasons for discarding measurements. Since you have error estimates on both your frequency and Q measurements, decide if the observed scatter in the data is consistent with the estimated errors (use a statistical test).

(N.B. Use $1000/Q$ as your measure of attenuation. $1000/Q$ is typically between 0 and 10 whereas Q lies between 100 and infinity.)
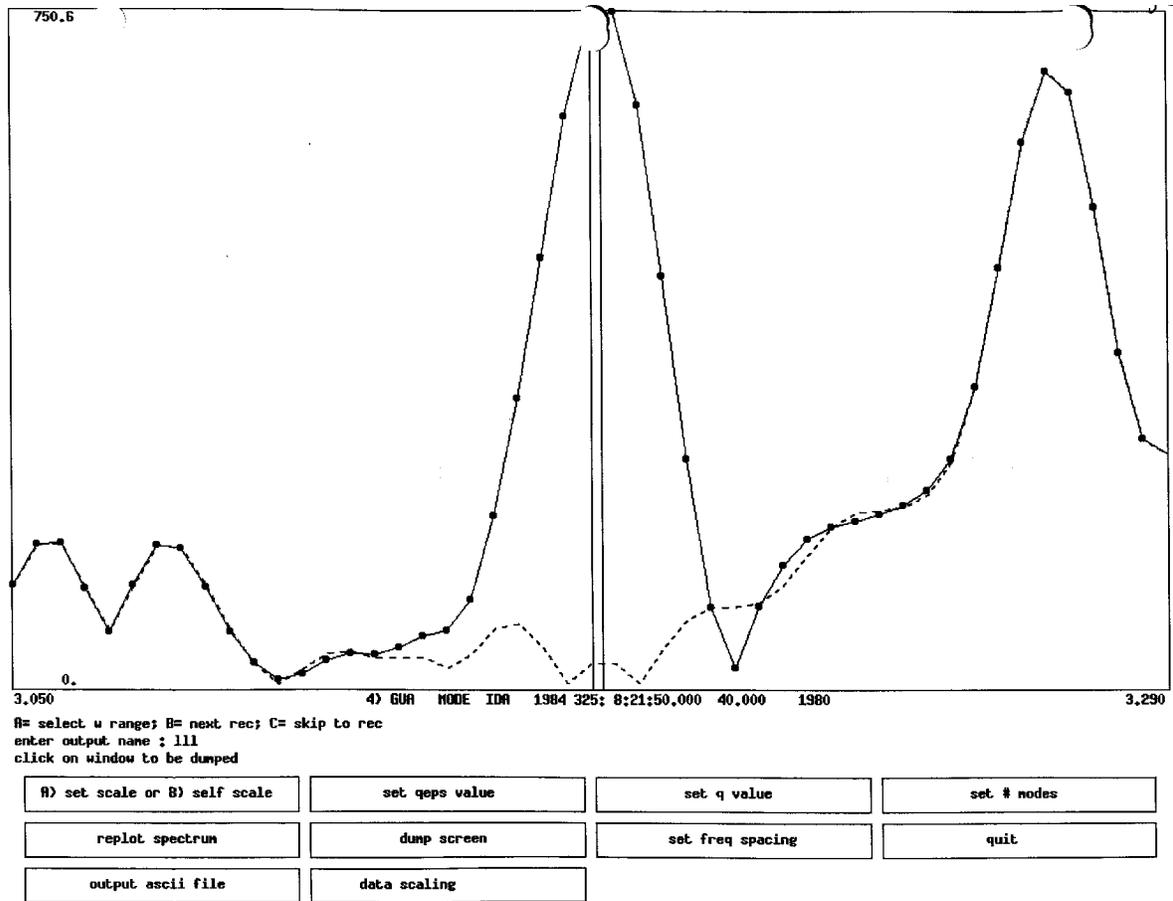
Figure 1. A sample of the screen after demoding

	Mode	freq(mHz)	1000/Q	stat	yr	day	reclen	snr	%error freq	%error 1000/Q
4	0 S 23	3.16761	3.79812	HAL	1977	63	22.00	14.3	0.219E-01	0.115E+02
6	0 S 23	3.16871	4.42178	RAR	1977	63	22.00	10.3	0.307E-01	0.139E+02
7	0 S 23	3.17411	7.86620	SUR	1977	77	22.00	7.8	0.441E-01	0.112E+02
8	0 S 23	3.16773	1.67590	GAR	1977	77	22.00	5.3	0.664E-01	0.792E+02
9	0 S 23	3.17056	4.43818	NNA	1977	77	22.00	15.0	0.210E-01	0.946E+01
11	0 S 23	3.17066	4.40168	NNA	1977	77	22.00	13.6	0.233E-01	0.106E+02
12	0 S 23	3.17000	1.08708	PFO	1977	77	22.00	6.4	0.603E-01	0.111E+03
13	0 S 23	3.16781	3.10244	RAR	1977	77	22.00	17.0	0.185E-01	0.120E+02
14	0 S 23	3.17884	2.68681	HAL	1977	77	22.00	4.6	0.699E-01	0.520E+02
15	0 S 23	3.17278	2.55567	SUR	1977	92	22.00	11.7	0.275E-01	0.215E+02
16	0 S 23	3.16580	4.02291	CAN	1977	92	22.00	25.4	0.124E-01	0.616E+01
17	0 S 23	3.16600	3.88494	GAR	1977	92	22.00	9.0	0.349E-01	0.180E+02
18	0 S 23	3.16664	7.22230	HAL	1977	92	22.00	6.6	0.517E-01	0.143E+02

Figure 2. A sample of the output of tpdsk