QMDA Homework 9

Spectral analysis

The file 'QMDA_HW_09.mat' (in 'Files/Homework' on CourseWorks) contains data that simulate a record of sediment properties in the geological past. It defines two vectors of 2000 elements each: time 't' in thousands of years before the present (kyr) and a measured sediment property in a data vector 'd'. The data vector has zero mean and no significant large-scale trend. The goal of this assignment is to run a spectral analysis of the data to determine if they contain prominent harmonic components whose frequencies match those of Milankovitch orbital cycles.

A) Take the Fourier transform of the data in d and compute the periodogram. Plot the periodogram values on a linear and logarithmic scale. Is the broadband background spectrum white or red? Are there peaks in the periodogram that rise above the background fluctuations? What are the approximate peak frequencies (cycles/kyr) and periods (kyr)?

B) Apply Welch's method with overlapping Hann tapers to estimate the power spectrum. You can use the Matlab function 'hanntaper.m' (also in 'Files/Homework') to compute each taper; make sure you understand how it works and that you set up a sequence of N_w tapers that covers the length of the data. Change the number N_w of overlapping tapers and describe the corresponding changes in the background spectral fluctuations decrease and in how much spectral peaks are smeared.

C) The table below lists Milankovitch cycles that may be recorded in sediment sequences. Note that the eccentricity, obliquity, and precession cycles have power at multiple periods; the table lists those that have the largest amplitudes. Given the results of your spectral analysis, which Milankovitch cycles (if any) do you think are present in the data?

Orbital cycle	Period (kyr)	Amplitude
Long eccentricity	406.182	0.0109
Short eccentricity	94.830	0.0092
Short eccentricity	123.882	0.0071
Short eccentricity	98.607	0.0059
Short eccentricity	130.019	0.0053
Obliquity	40.996	0.0112
Obliquity	39.657	0.0044
Obliquity	40.270	0.0030
Obliquity	53.714	0.0029
Obliquity	41.674	0.0026
Climatic precession	23.680	0.0188
Climatic precession	22.385	0.0170
Climatic precession	18.956	0.0148
Climatic precession	19.097	0.0101
Climatic precession	23.114	0.0042