Practical 2 – Part 1

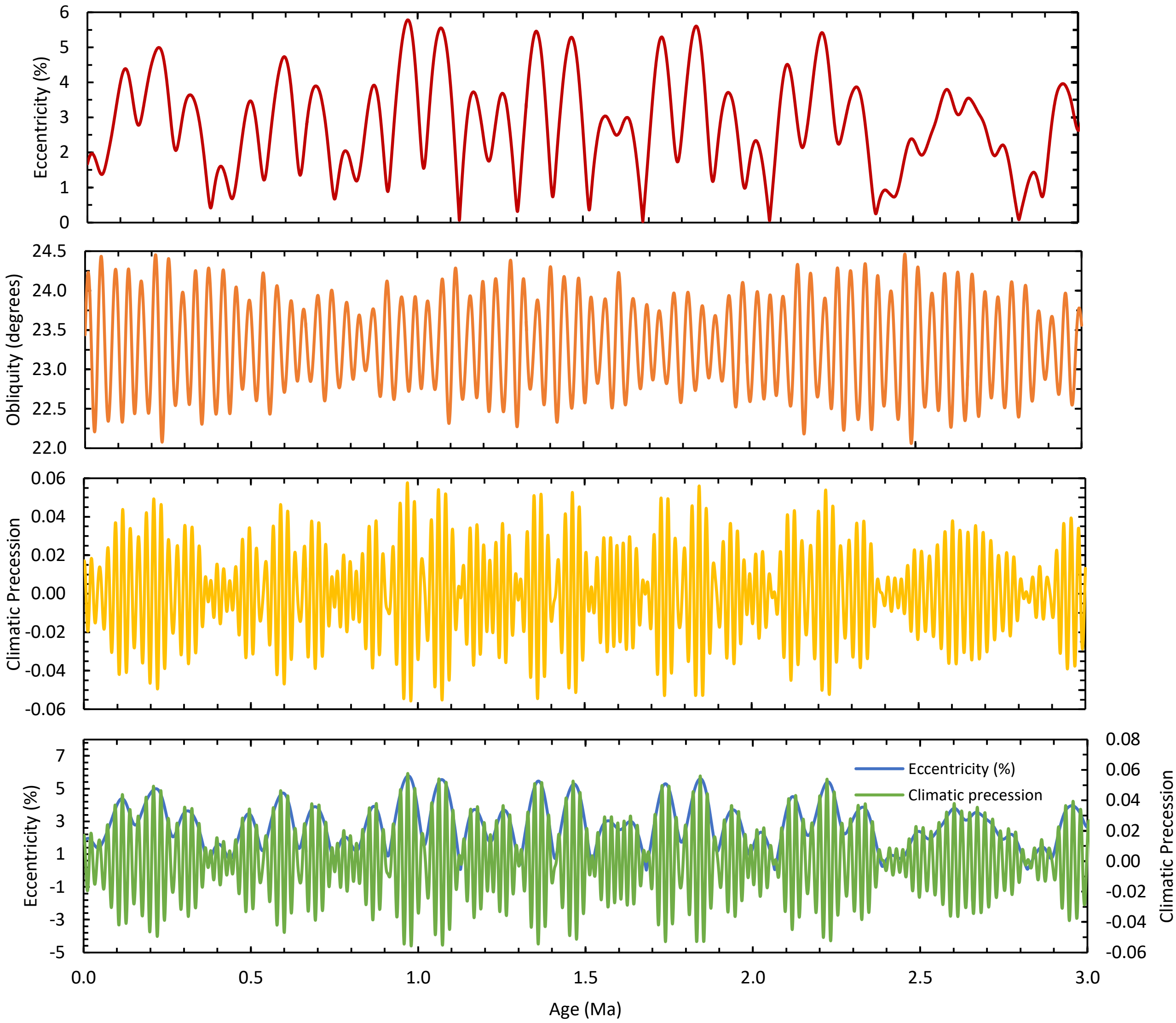


Figure 2A. Eccentricity, precession and obliquity plotted over the past three million years. In the bottom plot, the strong modulation on precession by eccentricity is visible as eccentricity line follows the crests of the precession. Both the 100 kyr cycles and 400 kyr cycles of eccentricity are visible in the plots, with the 400 kyr cycle dominating before about 2.4 Ma. These same cycles can be seen in the amplitude of precessions line. Obliquity period at about 41 kyr can clearly be seen in orange.

The remaining graphs have been attached on individual pages.

Practical 2-Part 3

1. *What is the sampling interval of the insolation curve you are analysing? What is the Nyquist frequency here (i.e. the highest possible frequency that can be resolved)? What is the frequency resolution?*

    Sampling interval is 1 kyr = dt

    n=2001

    Frequency resolution: df=1/(ndt) = 1/(2001*1)= 0.0005

    Nyquist frequency: f=1/(2dt) = 1/(2*1) = 0.5 cycles/kyr

2. *Write down the value of frequencies corresponding to the dominant peaks. What orbital cycles do they correspond to?*

    Table 1. Insolation Spectral Analysis for 65 N

	Frequency	**T (kyr)**	**Orbital Cycle**
peak 1	0.024375	41.02564	obliquity
peak 2	0.04225	23.66864	precession
peak 3	0.044688	22.37737	precession
peak 4	0.052625	19.00238	precession

3. *Repeat the 'Spectral Analysis' for insolation data from 0 N and 90 N. What are the dominating frequencies and their corresponding orbital cycles? Do you notice any pattern for different latitudes insolation data? Can you explain why?*

    Table 2. Insolation Spectral Analysis for Equator (0)

	Frequency	**T (kyr)**	**Orbital Cycle**
peak 1	0.04225	23.66864	precession
peak 2	0.044688	22.37737	precession
peak 3	0.052625	19.00238	precession

Table 3. Insolation Spectral Analysis for 90 N

	Frequency	**T (kyr)**	**Orbital Cycle**
peak 1	0.024313	41.13026	obliquity
peak 2	0.04225	23.66864	precession
peak 3	0.044688	22.37737	precession
peak 4	0.052625	19.00238	precession

All latitudes above experience precession similarly, but the equator does not exhibit effects on insolation from obliquity. Because it is the farthest latitude from either pole, it feels a smaller effect of the obliquity tilt on its insolation. Obliquity will have a greater effect on insolation as you increase distance from the equator.

Practical 2- Part 4

1. *Try this and see what dominant frequencies are in the LR04 data.*

Table 4. Redfit spectral analysis of d18O

	Frequency
peak 1	0.0105
peak 2	0.0245

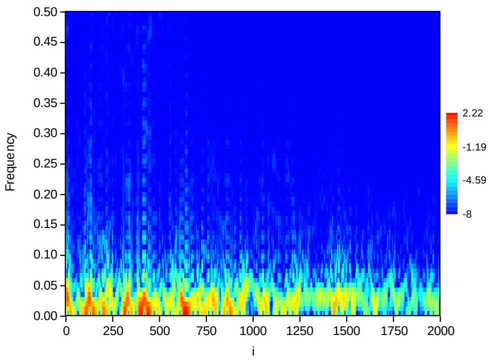
2. *Select the interpolated oxygen isotope data column, then do a 'Spectral analysis' (as you did for the insolation data) to find the dominant frequencies/cycles. Compare your results with those you acquired directly using the 'REDFIT spectral' above.*

Table 5. Spectral analysis of interpolated data

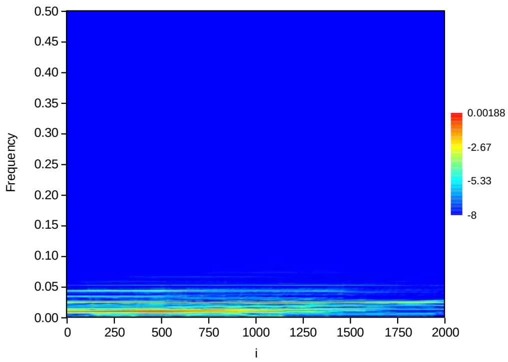
	Frequency
peak 1	0.0106
peak 2	0.0243

The REDFIT and interpolation method benthic d18O dominant frequency values are very similar. Peak one values only differ by 0.0001, and peak two values differ by 0.0002.

3. *Change the 'Window size' and try different 'Window' (i.e. rectangle, hanning etc.). What changes in the spectra do you see? Can you explain why?*



Window size = 32



Window size = 1024

Increasing the window size means worse time resolution but better spectral resolution, as more data points are included within a larger window. In fact, a major disadvantage of this method is losing frequency resolution because there are fewer data points per window than in the total data set, but as you increase window size time resolution decreases.

4. *Compare the wavelet spectra with the short-time Fourier spectra, do they show similar patterns? What is the advantage of using wavelet transform (compared with shorttime Fourier analysis)?*

Wavelet and Fourier spectra show similar large patterns, such as a significant peak cycle around 40,000 years and 100,000 years at different points in time. In the Fourier, frequency resolution has been compromised, and is visible in the plot as "noise," visualized as splotchiness in light blue. This makes sense because a short-time Fourier has fixed windows that inevitable compromise frequency resolution. The plot produced using wavelet spectra, on the other hand, exhibits less noise (visualized by light blue in the plot). This is because in a Wavelet we get the best of both worlds by adapting window length according to frequency. If looking at low frequency, better spectra resolution is needed and smaller number of windows are used. For higher frequencies, higher time resolution is needed and a large number of windows are used.

5. *On the wavelet spectra, what dominant frequencies/cycles do you see? Note that the vertical axis is on log2 scale. Are they stable through time? What changes do you see between about 800 kyr to 1300 kyr (check Mid-Pleistocene transition if interested)?*

Two main dominant cycles can be seen: one around 40,000 years, and another around 100,000. The dominance of these cycles changes with time; they are not stable and vary significantly. Around 800 kyr, the 100,000 yr cycle begins and continues until present, and the 40,000 year cycle signal is somewhat weakened.

Wavelet Spectral Analysis