Re-examination Quaternary Geology and Climate Change GEO3-4303

Tuesday 23 May 2006; Room C008 AW Building
Teacher: Dr. H. Middelkoop

Carefully read the questions and provide complete answers (with explanation)! You may answer in English or Dutch language (or a combination of the two).

1. Definitions

Briefly indicate the meaning of *5 out of the following* 6 items:

a. Forebulge
b. Bond cycle
c. SRES scenarios
d. Termination
e. Orbital tuning
f. Tephrachronology

2. Time control

a. To convert ^{14}C-ages to calendar years we use calibration curves. Explain how these calibration curves are established, and for how far back in time this can be done.
b. Describe at least 4 methods that can be used to determine age-depth curves of the Greenland ice cores, and indicate the main limitations of each method.
c. Which methods can be used to date corals and what are the associated time ranges?
d. Describe the principle of OSL-dating and explain for which types of sediment and over what time range it can be applied.

3. Climate forcing and response

Orbital variations are a major cause of climate change during the Quaternary. Figure 1 shows the changes in 3 orbital parameters during the past 800 ka.

a. Indicate which curve represents which parameter, and explain the mechanism that causes the variation in amplitude of the lower of the three curves.
b. June insolation at 65 degrees latitude seems the main control for the occurrence of ice sheets. Which orbital parameter mostly determines this variation? Which insolation variation and which orbital parameter control variations in monsoons?
c. The $\partial^{18}O$ curves of benthic forams in Ocean cores reflect the volume of continental ice sheets, but the timing of the curves does not exactly fit the timing of the orbital forcing. Is there a lead or lag, and explain why this happens.
d. Sapropel records in the Mediterranean Sea and freshwater diatom records in ocean cores near Africa reflect variations in monsoon intensity. Do these show a lag or lead when compared to the timing of the orbital forcing? Explain why this is so.

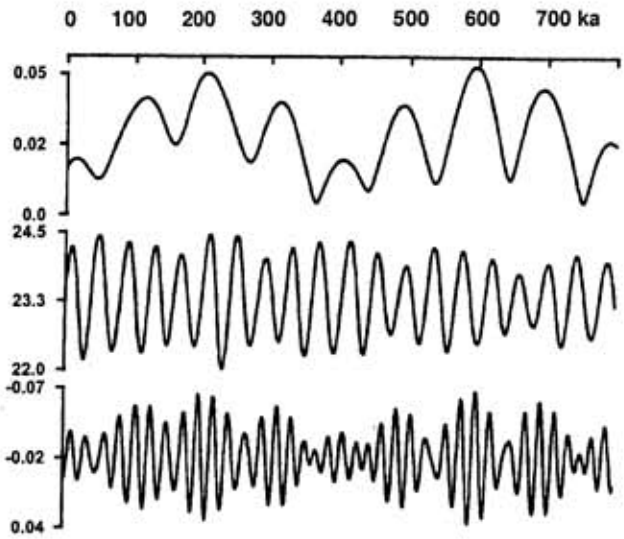

Figure 1 Variation in orbital parameters during the past 700 ka.

4. Ice and oceans

a. Explain how continental ice sheets can be a consequence of climate change as well a cause of changes in the climate.
b. Use the equilibrium model for ice sheets by Oerlemans to demonstrate the feed-back effects that arise both during the growth and decay of continental ice sheets. Indicate whether these are positive and/or negative feedbacks.
c. Give two methods to reconstruct variations in precipitation on the Antarctic ice sheet from ice cores. Explain how this is done.
d. Describe the mechanism that caused the rapid cooling of the Younger Dryas.

5. Climate modelling

A research team proposes to use a Atmosphere-Ocean General Circulation Model (AOGCM) to reconstruct the climate during the Last Glacial Maximum. For this experiment three groups of data are required: 1) climate forcing; 2) geographical boundary conditions, 3) climate proxy data to verify the model results.

a. When was the Last Glacial Maximum period?
b. Which external forcings determined the climate during this period, and how can the magnitude of each of these forcings be reconstructed for this period? Mention at least 3 different types of forcings.
c. Which geographical data that influence the global climate patterns are required as input for the model to carry out the simulations, and how are these reconstructed (and dated) for the simulated period?
d. Which proxies (and how can these be dated) for the LGM climate might be used to evaluate the climate model results?