Re-examination Quaternary Geology and Climate Change - GEO3-4303

Monday 29 August 2005; AW Building room C116
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Please carefully read and answer the questions.

1. Definitions

Briefly indicate the meaning of the following items:

a) Compensation depth
b) Interstadial
c) Tephrochronologie
d) GCM
e) Termination

2. Time control

The ^{14}C method has been widely applied in dating materials containing carbon. Due to various reasons ^{14}C ages must be converted to absolute, calibrated ages.

a. How far back in time can the ^{14}C method be applied for dating materials? Why?
b. Explain how variations in solar activity may cause apparent older or younger ^{14}C ages of a sample.
c. Which year is used as 'Present' when ^{14}C dates are given in years BP?
d. Describe at least 3 methods that can be used to determine age-depth relationships of the Greenland ice cores, and indicate the main limitations of each method.
e. Indicate how the chronology of $\delta^{18}O$ curves in oceanic cores can be determined for the past 2 million years.

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 700 ka.

a. Indicate which curve represents which parameter.
b. Explain the variation in amplitude of the lower of the three curves.
c. The combination of the three orbital parameters results in temporal variations in insolation, which are different over the globe. Which orbital parameter(s) mostly determine(s) the occurrence of ice sheets? Explain which is the critical time and latitude where insolation variations may result in ice sheet growth.

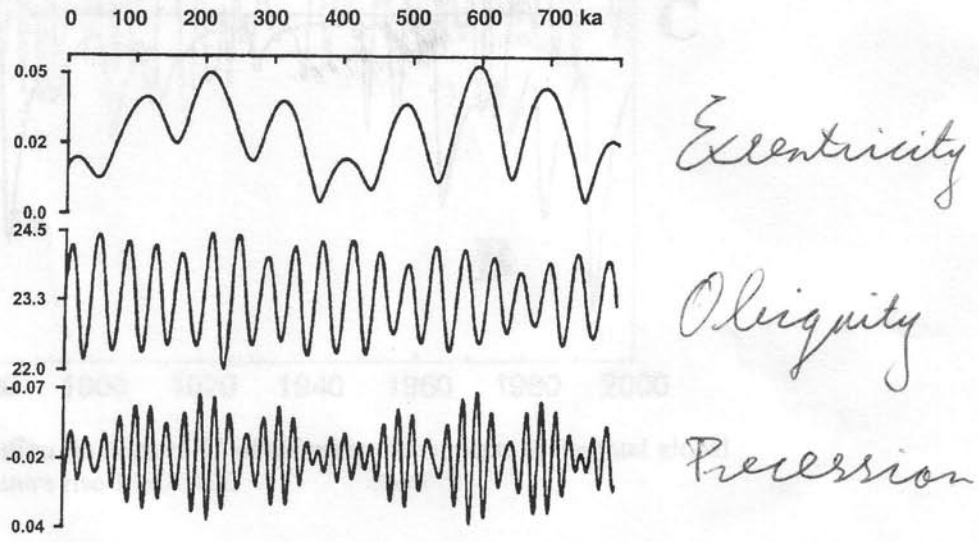

Figure 1 Variation in orbital parameters during the past 700 ka

4. Ice and marine records

a. Draw the shape of the $\delta^{18}O$ curve for the past 150.000 year in the Summit (GISP2/GRIP) ice record from Greenland; indicate (schematically) Glacial and interglacial periods, Dansgaard-Oeschger cycles and Bond cycles.

b. To what extent are the $\delta^{18}O$ curves of the Summit ice cores similar to the marine $\delta^{18}O$ curves established from benthic forams from the equatorial Pacific, and which are the main differences? Explain in your answer what exactly each of the two $\delta^{18}O$ curves reflects.

c. ^{13}C isotope records from benthic forams from the equatorial Pacific also show fluctuations that reflect glacial cycles. Explain the mechanisms why this is so, and compare the ^{13}C fluctuations with those in the $\delta^{18}O$ curves from the same cores.

5. Sea level change

a. Which are the components making up together the relative sea level changes measured at a certain location?

b. Explain how changes in sea level since the Eemian can be reconstructed using ancient coral reefs on Barbados.

6. Climate forcings in historic time

Van Ulden and Van Dorland of KNMI investigated the contribution of different components to the global temperature rise since 1880 AD. Three of these components are shown in figure 2 as curves A, B and C (the total temperature curve is NOT indicated in this figure).

a. Which signals are indicated by the curves A, B, C? Choose from the following: CO_2 emission, methane emission, aerosols, glacier melting, volcanic eruptions, varying orbital precession, el-Niño, ozon hole, deforestation of the Amazon area, sea level rise, changes in oceanic circulation, variations in solar activity, reforestation of northern hemisphere. Explain your answer.

b. Indicate whether the three you selected under a) are of natural origin and whether they are external forcings or internal mechanisms.

c. Explain the negative values of one of the curves.

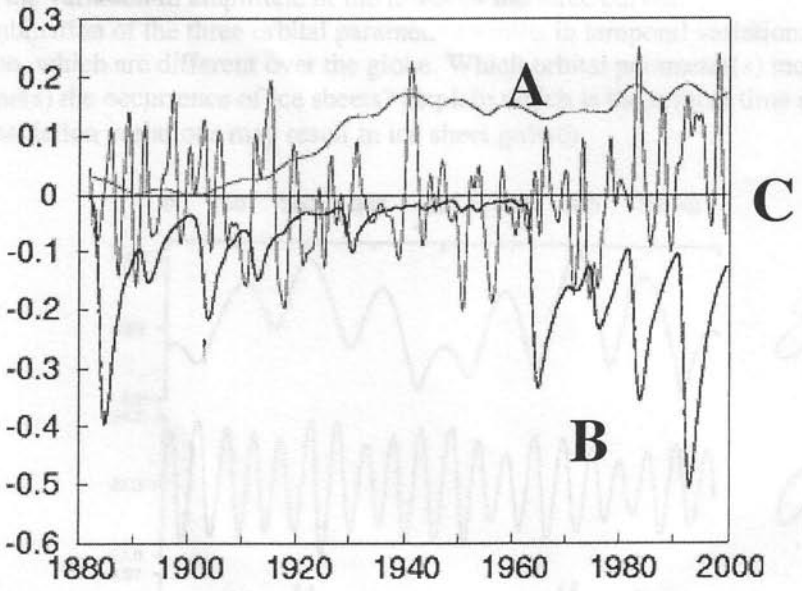

Figure 2 Contribution (in degrees C) of different components to the total global Temperature rise 1880-2000