

Thursday 3 February 2011

Teacher: Prof. Dr. H. Middelkoop

Carefully read the questions and provide complete answers in English or Dutch!

1. Definitions

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

- a) Lichenometry
- b) EMIC model
- c) North Atlantic Oscillation
- d) Lysocline
- e) Heinrich event
- f) Isostatic rebound

2. Time control

- a. Explain how U-Th dating is applied in Quaternary age determination of marine deposits and corals.
- b. Describe the principle of OSL-dating and explain for which types of sediment and over what time range it can be applied.
- c. Which characteristics of the Earth's magnetic field are used as a dating method in Quaternary climate research, and which are the associated time scales?
- d. Explain why AMS dating yields much more precise ^{14}C dating results when compared to the older conventional method.

3. Oceans and sea level change

- a. Indicate 2 types of changes that have occurred in the N-Atlantic Ocean circulation during the past 200 ka which have affected the climate in NW Europe.
- b. The ^{13}C isotope records ($\delta^{13}\text{C}$) from forams in Atlantic Ocean cores show fluctuations that reflect glacial cycles. There are three mechanisms that have caused these $\delta^{13}\text{C}$ fluctuations. Describe these mechanisms and indicate whether and how these influence the $\delta^{13}\text{C}$ values in planktonic and/or benthic forams.
- c. Explain how changes in sea level since the Eemian can be reconstructed using ancient coral reefs on Barbados.

4. Isotope records

Figure 1 (on next page) shows an oxygen isotope curve of the past 160 ka.

- a. The smooth graph is associated to orbital forcing. Which orbital parameter is reflected here, and what units are shown on the righthand vertical axis?
- b. The other graphs are isotope records. Explain from which types of sites these are obtained, what they reflect and how this relates to the orbital forcing.
- c. Draw the shape of the $\delta^{18}\text{O}$ curve (draw units on the axis!) for the past 150,000 years in the Summit (GISP2/GRIP) ice record from Greenland; indicate (schematically) glacial and interglacial periods, stadials, Younger Dryas, Dansgaard-Oeschger events and Bond cycles.
- d. Which characteristics in the Greenland Ice record are also reflected in the record shown in figure 1? What is the mechanism behind that?

5. Recent and future climate forcing

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).

- Which signals are indicated by the curves A, B, C? Choose from the following: CO₂ emission, ozone hole, aerosols, glacier melting, volcanic eruptions, ~~varying orbital precession~~, El Niño, deforestation of the Amazon area, sea level rise, changes in oceanic circulation, variations in solar activity, reforestation of northern hemisphere. Explain your answer.
- Explain which of the forcings mentioned under 5a should be used as input for an experiment using a combined Ocean-Atmospheric GCM for the period 2010-2100.
- Mention at least three potential 'ticking time-bombs' within the Earth system that might drastically affect our climate in the next centuries. How will these influence the climate and what will be the effects? Explain whether these can be determined using the GCM experiment.

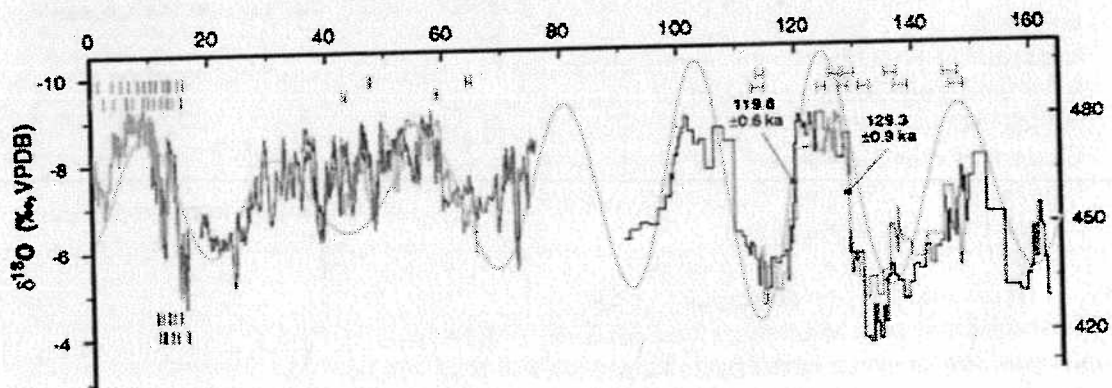


Figure 1 Oxygen isotope curves and orbital forcing

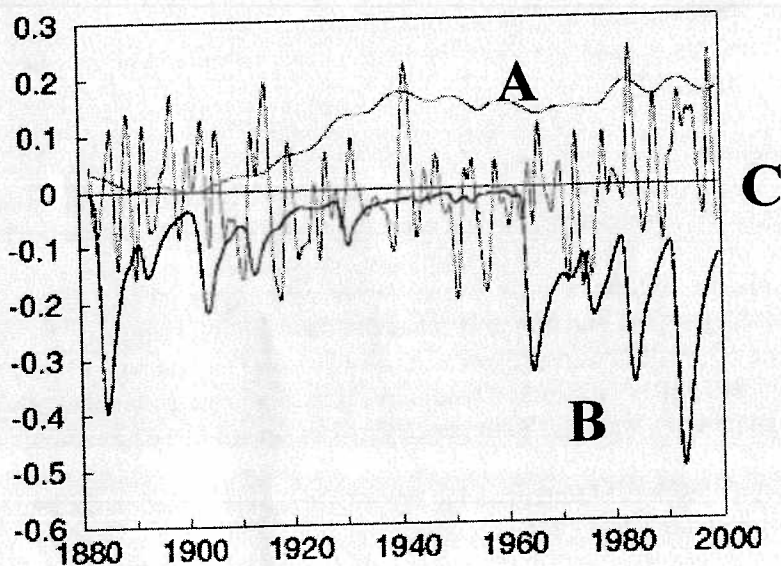


Figure 2

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