

Re-Exam MSc-Paleoceanography January 14, 2009

1.

Northern and southern hemisphere glaciations have been in-phase during the Pleistocene.

- a) Only considering insolation, would you expect temperature changes to have been synchronous on both hemispheres? Explain why. *prec.*
- b) What mechanism(s) could be responsible for (involved in) the in-phase behavior of the ice sheets at high northern and southern latitudes? *obl.*

(10 pt)

2.

The most important source for intra-annual climate variability is the El Nino-La Nina tropical oscillation.

- a) Describe the effect of an El Nino event on tropical atmospheric circulation in terms of the Walker circulation.
- b) The 2.5 to 7.5 year cycles associated with the El Nino Southern Oscillation have been explained by two hypothesis: "the recharge/discharge theory" and "the delayed oscillator theory". Explain for both how they could result in a certain periodicity.
- c) What would you expect to happen to the El Nino southern oscillation when Earth's climate warms? Explain why.

(15 pt)

3.

Dysoxic conditions in the world's oceans affected global climate several times during earth history.

- a) Which two basic parameters determine together oxygen concentrations below the mixed layer? *bottom water volume prod.*
- b) Give three proxies for water column disoxia. Explain how these proxies respond to oxygen. *redox bioturb. Ni*
- c) How will short term (~1000 yrs) low oxygen conditions affect global greenhouse gas contents? Explain the processes involved.
- d) How will longer term (~100,000 yrs) low oxygen conditions affect global greenhouse gas contents? Explain the processes involved.

(15 pt)

4.

During the last glacial (and probably also during previous glacial) abrupt and strong climate change occurred on a millennial time scale. Every about 7 kyr the northern hemisphere ice sheet collapsed, resulting in large armadas of ice bergs in the northern Atlantic Ocean.

- a) What happened simultaneously in the Southern Ocean (circum Antarctic) and why? *slow growth*
- b) It has been suggested that the interaction between northern and southern hemisphere was responsible for the quasi-cyclic nature of the millennial scale climate change. Please explain the mechanism invoked in this explanation.
- c) Discuss one other alternative explanation for the quasi-cyclic millennial scale climate change during the last glacial. *THC ?*

(15 pt)

5. give in your own words a definition for Burial Efficiency and Export Productivity (no formula but description !)  
(4 pt)

6. some of these questions relate to Figure BP1.

- Give in your own words a definition of steady state *geen veranderend*
- Briefly describe a typical example to illustrate a steady state situation
- If the difference between on-land evaporation and precipitation is transported to the ocean (i.e. runoff or riverine flux), then calculate how much this represents in cm/yr relative to the total ocean surface area
- What precipitation do you expect over the ocean (in the same cm/yr units as indicated in figure)
- How does this riverine flux compare to the upwelling flux (in the same units, over the total ocean surface area; give a rough estimate, no calculation)

{15 pt}

7. part of these questions relate to Table MG-2 and Figure MG-1. The half-decay time for  $^{210}\text{Pb}$  is 22.3 yr

- What is the rule of thumb for the maximum dating potential for a radio-active isotope ?
- Till what potential maximum age do you expect that  $^{210}\text{Pb}$  can be used as a dating tool?
- In most near-coastal sediments, there is a relatively constant level of  $^{210}\text{Pb}$  for the upper 5-10 cm. This is not observed here; give a potential explanation for this deviation.
- Determine the average sedimentation rate for the upper 30 mm of this core (in cm/ky)
- Give a brief explanation of Reservoir Age ( what is it, what contributes to it, by what processes may it be affected,..)
- Do we have to take reservoir age into account for question d. ? motivate briefly.

{15 pt}

8. Part of these questions relate to figure MAP1 and Figure 1.

- If the organic matter oxidized in the upper F-turbidite consisted of average marine organic matter alone, what decrease in the N and P content would you then expect to observe ? Motivate briefly
- From the figures you can deduce that not all the organic matter can have been marine alone, but must also partly be terrestrial. If average terrestrial organic matter has a  $\delta^{13}\text{C}_{\text{org}} = -26.0\text{‰}$  here, then determine for the un-oxidized and oxidized interval the %marine and % terrestrial material. Clearly demonstrate how you come to your conclusion (calculations)

{11 pt}

$$(26 - 19) \cdot \%_{\text{terre.}} = 19.9$$

$$(26 - 19) \cdot \%_{\text{terre.}} + 19 = 19.9$$

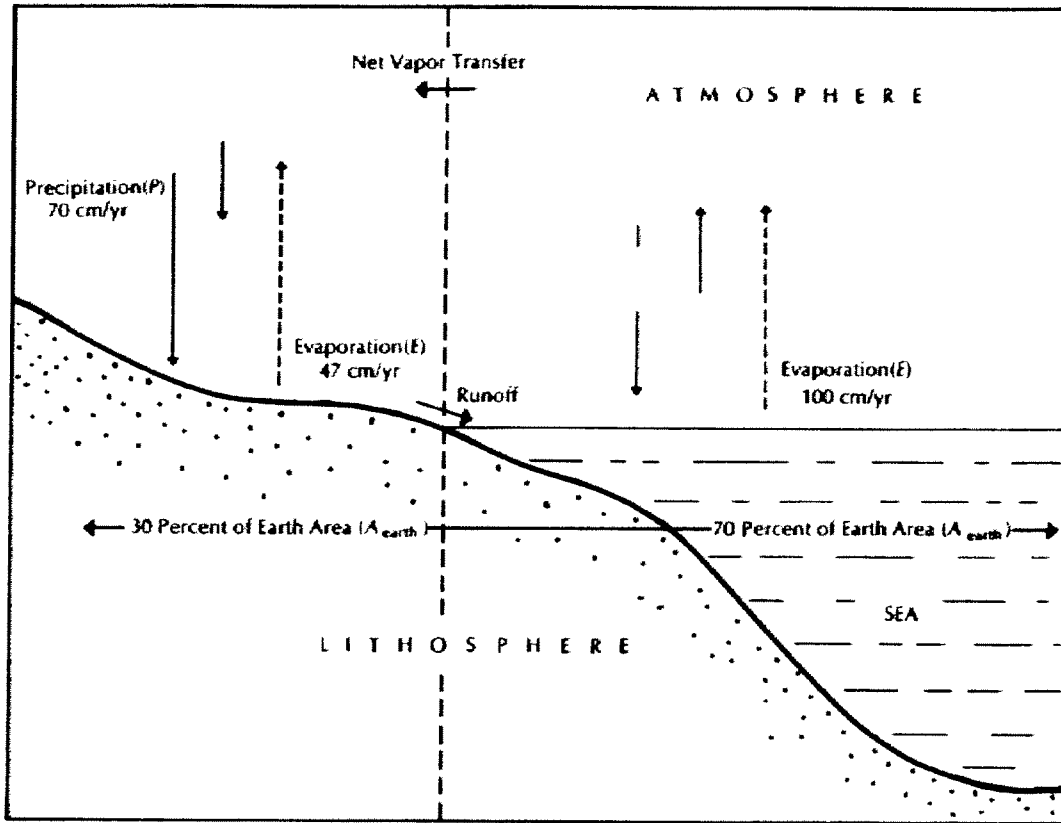


Fig.BP1. Illustration of the Global water system, indicating the total precipitation and evaporation over land, and the total evaporation over the ocean (all expressed as cm/yr relative to total land-surface area and total ocean surface area respectively). The system may be assumed to be in steady state

Table MG-2.  $^{210}\text{Pb}$  activities in samples from core NU15MC taken in a permanently anoxic basin (after Jilbert 2008)

Sample Nr	depth mm	$^{210}\text{Pb}$ dpm/g
1	1.5	73.2
2	4.5	51.9
3	7.5	30.6
4	10.5	19.2
5	13.5	14.4
6	16.5	10.5
7	19.5	8.4
8	22.5	7.74
9	25.5	6.36
10	28.5	6.3
11	31.5	5.52
12	34.5	5.34
13	37.5	4.62
14	40.5	4.62
15	43.5	4.56
16	71.5	4.62

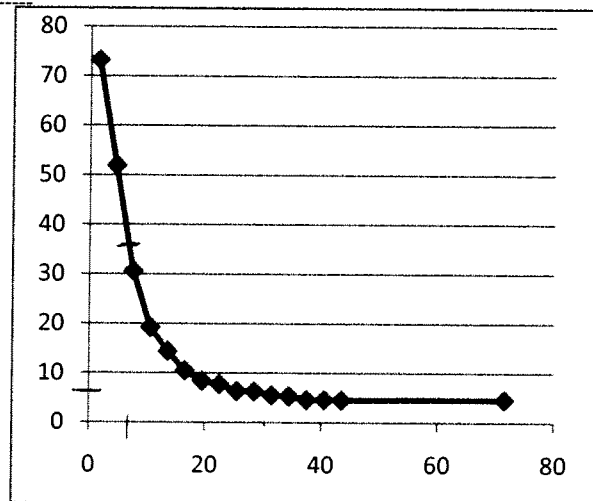


Fig.MG-1.  $^{210}\text{Pb}$  activity (dpm/g) versus depth (mm) in the sediment of anoxic basin core NU15MC (data after Jilbert : Thesis defence at Utrecht University, 11 Dec. 2008)

$$2^x = 13.26$$

$$x =$$

$$\ln e^x = x$$

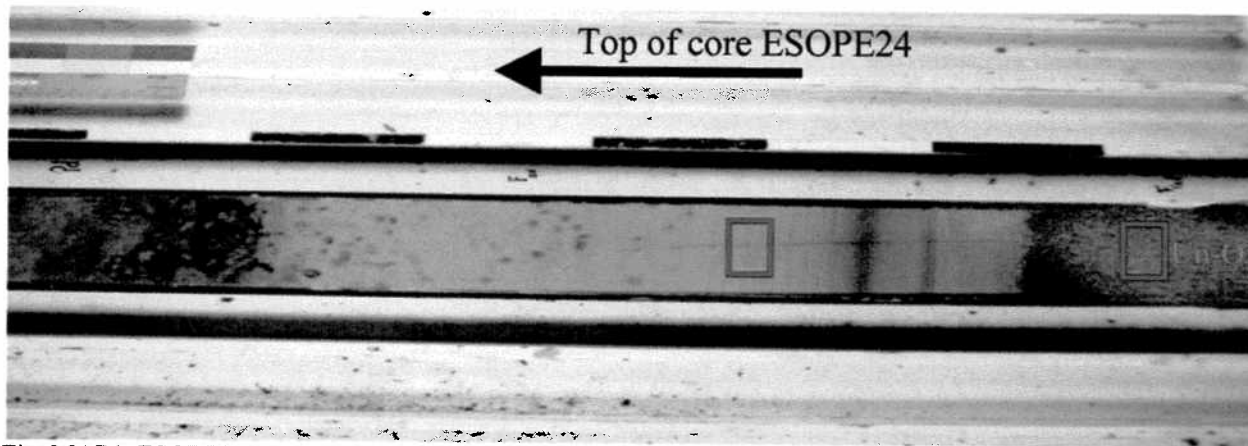


Fig. MAP1. ESOPE24 core section: in the middle the oxidized light-bluish coloured upper part of the F-turbidite, and on the right the darkgreen coloured un-oxidized part of the F-turbidite. Upon deposition the sediment of the entire F-turbidite may be assumed to have had a homogenous composition, thus any changes now observed has resulted from the postdepositional downward oxidation process alone. The %Corg for oxidized and un-oxidized intervals are 0.20 and 0.98% respectively, whereas the  $\delta^{13}\text{C}_{\text{Corg}}$  is -22.1 and -19.9‰ respectively.

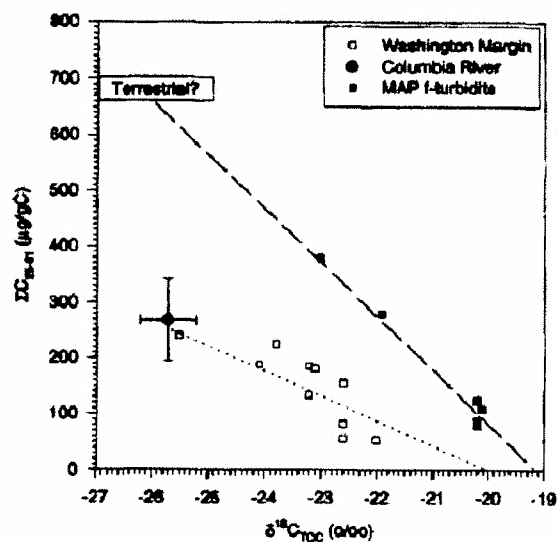


Fig. 1. Scatterplot for plantwax  $n$ -alkane concentration ( $\text{EC}_{25-31}$ ) and isotopic composition of TOC ( $\delta^{13}\text{C}_{\text{TOC}}$ ) measured in sediment samples from the Washington margin (Prahl *et al.*, 1994) and the MAP f-turbidite