Final Exam

Paleoceanography and Climate Variability (GEO4-1405)

Educatorium Alfa: 17:00-19:00
(with medical certificate until 19:30)

The total of 100 points.

Question 1

Oxygen isotopes in foraminifera are one of the most important proxy methods in paleoceanography

1a) Explain the relationship between the oxygen isotopic composition of the seawater and of the foraminifera calcite. (5 Points)

1b) Explain the modern spatial variability in sea surface oxygen isotope composition. (5 Points)

1c) During the Early Cenozoic the world was essentially ice-free. Use a simple $\delta^{18}O$ mass balance to calculate the $\delta^{18}O$ (vs. SMOW) of the global ocean during the Early Cenozoic. Make educated guesses concerning the necessary $\delta^{18}O$ endmembers (ice, ocean) and the necessary volumes (hint: instead of volumes you can also work with ocean depth and sea-level equivalents). (5 Points)

1d) The $\delta^{18}O$ (vs. PDB) of benthic foraminifera during the Early Cenozoic were around 0 ‰ (vs. PDB). Using this value in combination with the value calculated above, estimate/calculate deep-sea temperatures for the Early Cenozoic. (5 Points)

Question 2

The last deglaciation

Give an overview of the sequence of events across the last deglaciation: consider in your description changes in atmospheric CO_2, sea-level, orbital forcing, temperature in northern and southern hemisphere, Southern Ocean circulation, sea-ice cover, dust, the biological pump and ice rafted debris in the North Atlantic. Mention in your description also proxies that can be used to reconstruct the above mentioned aspects. (20 Points)

Question 3

Ocean circulation

The following figure is from a recent *Nature* paper. The new datasets are presented in the blue and red lines.

Come up with a short title for this paper and write a short Nature style abstract that could