Tentamen Global Change 04-04-2011 9.00-12.00 rm. 15.0013

- *please write name and student number on each sheet of paper you hand in*
- *please use a separate sheet of paper for every question*

points per question: 2/2/2/1.5/1.5

1.

a) Explain (briefly) the main mechanisms causing the ice ages.
b) What periodicities in time are observed
c) What is the Younger Dryas (YD) climate period, and what caused it?
d) What happens during the YD with the isotopic signals: ^{14}C in the atmosphere, ^{2}H in ice cores, and ^{18}O in deep-sea marine shells.
e) Is $^{18}\delta$ in ice cores higher or lower during the Glacial periods (compared with Holocene values)? Explain.
f) Same question as e) for speleothems (i.e. stalagmites/stalactites) and marine shells. Explain.
g) How can ice cores be dated (name 3 methods with a brief explanation)?
h) How can we derive a relation between $^{18}\delta$ and (paleo)temperature in ice cores (name 2 methods)?

2.

For ^{14}C, the standard activity is defined as 95% of the activity of a specific batch of oxalic acid (Ox1) in 1950: $^{14}A^{0}_{RN} = 0.95\ ^{14}A^{0}_{Ox1N} = 13.56$ dpm/gC.
a) What is the meaning of the symbols "R", "N", "0"?
b) The original batch of Ox1 is no longer available, and replaced by a newly made Ox2. The activity of this Ox2 is measured as:
$^{14}A^{0}_{Ox2N} = 1.2736\ ^{14}A^{0}_{Ox1N}$
What is now the standard activity $^{14}A^{0}_{RN}$ expressed in the Ox2 value?
c) In 1986 the Chernobyl accident influenced the natural ^{14}C concentration on a local scale. A sample from the area is measured recently as: $^{14}a_N = 171.72\%$. The $^{13}\delta$ value of the sample is $^{13}\delta = -34.8‰$.
Calculate the $\Delta^{14}C$ ($=^{14}\delta^{S}_{N}$); explain the meaning of this quantity
d) bonus question:
Could we expect a similar ^{14}C-increase for the recent nuclear accident in Fukushima, Japan?

3.

a) Explain the so-called 'seasonal CO_2 rectifier effect': what is it, how it is formed, where is the name derived from?
In which way is the annual mean CO_2 concentration influenced? What does this mean for the strength of the simulated annual mean carbon sources and sinks determined by inverse modelling, when the rectifier effect is not taken into account?
b) Atmosphere and biosphere are in an "isotopical disequilibrium" concerning $^{13}CO_2$. What does this mean? In which direction (i.e. depletion or enrichment in the biosphere) is there an isotopic disequilibrium, and how could it develop?
What is the main driver for the tropics resp. the boreal zone?
c) At an atmospheric measurement station we observe the following CO_2-concentrations and associated $\delta^{13}CO_2$–values:

Local Time	$[CO_2]$ (ppm)	$\delta^{13}CO_2$ (‰)
17:00	400	-7.2
20:00	450	-9.0
24:00	500	-11

If we assume for both periods apart (17 – 20 h and 20 – 24 h, respectively) that the CO_2 concentration increase is due to a single source, what is the $\delta^{13}CO_2$ of the two sources involved? What might the sources be?

4.

a) Calculate the δ value of water for a completely mixed lake, where a river flows in with a δ value of -8‰. The fractionation for evaporation is a = 0.980 (amount of inflow and evaporation are equal).
b) What is the δ value of the lake water if in addition also a river flows out of the lake? Consider a stationary state (in- and outflow are equal), and completely mixed lake. The river outflow and the evaporation outflow are equal (so both half of the inflow).

5.

Give the two major physical causes for global temperature change.
Explain how 20th century Arctic temperature was related to which natural cause and why this relation does not undermine the theory of recent anthropogenic climate forcing.