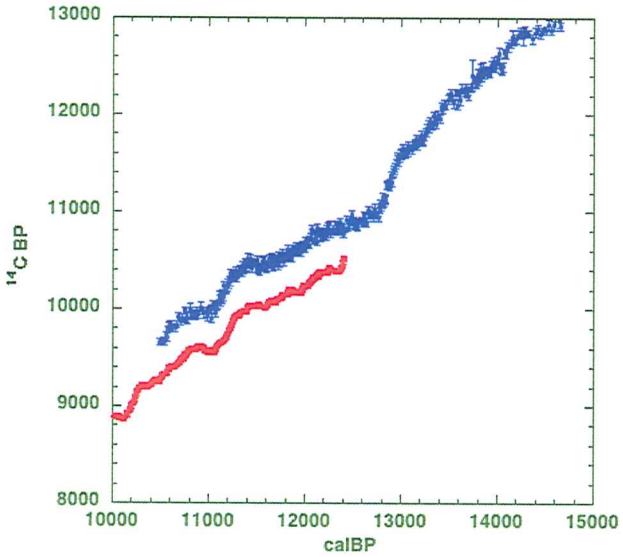
EES GLOBAL CHANGE 13-05-2008 51.14.0004 14-17 hr

1.

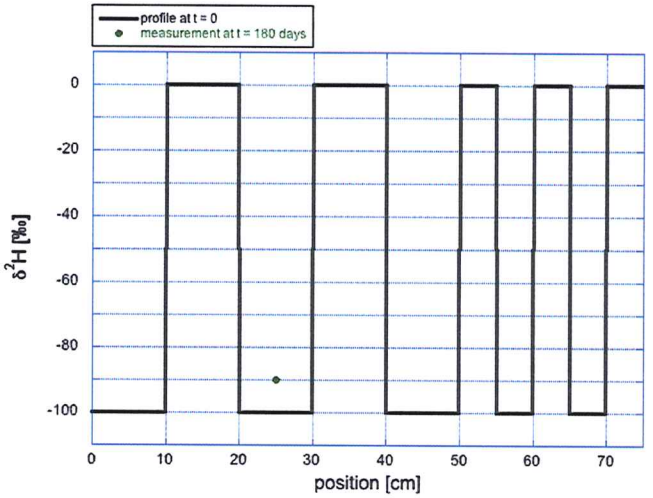
The graph below shows parts of the ^{14}C calibration records. The red datapoints are based on dendrochronology, the blue data on deepsea shells.



a). Explain the difference between both curves.
b). How are the timescales (BP, calBP) defined.
c). Make a sketch (not detailed) for the atmospheric $\Delta^{14}C$ signal based on both datasets.
d). The Younger Dryas (YD) cold period is icecore dated to 11600-12900 calBP.
What does the $\Delta^{14}C$ signal tell us on the atmosphere/ocean system during that time?
e). What are Heinrich (H) events; can the YD be a H-event?

2.

A researcher wants to measure the effect of diffusion in snow. Therefore he creates 2 portions of snow with different isotope concentrations and stacks them in 5 layers of 10 cm and 5 layers of 5 cm (see figure). He stores the snow in a freezer. After approximately half a year he takes a sample from the middle of a thick layer (indicated by the dot at 25 cm) and measures a delta ^{2}H value of -90 ‰ (originally -100 ‰).
Assuming no error in the measurement, what will be the profile according to the diffusion theory? Sketch the profile in the figure and give an explanation (no detailed calculation or formulas required).



3.

Around Chernobyl, the environment shows elevated ^{14}C concentrations in the biosphere due to the nuclear accident in 1986. For an insect (sampled during that year), we measured the normalised ^{14}C activity as:

$$^{14}a_N = 171.72\ \%$$

For this sample, the $^{13}\delta$ value is measured as:

$$^{13}\delta = -34.8\ ‰$$

Determine from these numbers the radioactivity in Bq/gC of the insect.

Hint: the activity has to be de-normalised and corrected for radioactive decay.
The ^{14}C activity for the oxalic acid standard is 13.56 dpm/gC (desintegrations per minute per gram Carbon).

4.

a).

Mr. Rietema wants to buy a new car, and has to choose between a car with a diesel- or a gasoline engine. He drives 20.000 km per year.

a1). calculate how much kg CO_2 is emitted after combustion in one year by the diesel car.

a2). same question for the gasoline car.

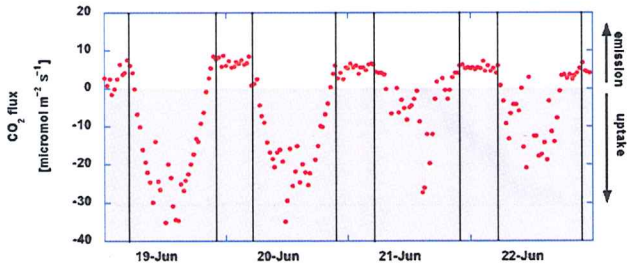
Given:

diesel: $C_{16}H_{34}$, 1 liter weighs 830 g, usage 1 liter per 16 km

gasoline: C_8H_{18}, 1 liter weighs 720 g, usage 1 liter per 14 km

b)

On the 6 ha (1 ha = 10.000 m^2) of land of Mr. Rietema, CO_2 uptake/emission of crops is measured. An example of the data are shown in the figure:



b1) explain the variations in the signal.

b2) given that on 19 june, the average net CO_2 flux for the total field was 10 micromol/m^2/s (net uptake of CO_2 by the crops), calculate the net amount of CO_2 taken up on that day.

b3) Mr. Rietema has bought the gasoline car (from question a). What distance can he drive in order to emit as much CO_2 as was taken up on 19 june?

5.

a) Trace gas history

Which measurement and analysis steps must be taken, in order to determine the historic concentration record (i.e. the concentration over time before atmospheric measurements could be done) of an anthropogenic trace gas (e.g. SF_6) from a firn air profile? Which conditions and processes are responsible for the actual depth profile and how can we correct for them, which (molecular) constants have therefore to be taken into consideration?

b) CO_2 rectifier effect

Explain for both the diurnal CO_2 rectifier effect and the seasonal CO_2 rectifier effect how they are formed. In which way is the diurnal resp. annual mean CO_2 concentration influenced? What does this mean for the simulated strength of the carbon sources and sinks?

c) Isotopic disequilibrium

Atmosphere and biosphere are in an "isotopical disequilibrium" for carbon. Explain what this means. In which direction (i.e. depletion or enrichment in the biosphere) is there an isotopic disequilibrium for ^{13}C and ^{14}C, and how could the disequilibria in these two cases develop?