Paleoklima - Solutions

November 17, 2015

Oppgave 1

(a) Hva er en klima-proxy? *A climate proxy is a quantity that we can measure from somewhere on earth, that is possible to track back in time, and that depends relatively simply on some parameter of the climate system that we want to know something about. A simple example is tree-rings, and their dependence on local climate.*

(b) Hva mener vi med δO_{18}? *δO_{18} is the ratio between the two isotopes of oxygen $O_1 6$ and $O_1 8$. This ratio of oxygen isotopes can be measured in ice cores, or in calcite minerals that are deposited from shells of small marine animals.*

(c) Hva fungerer δO_{18} som en proxy for? *The δO_{18} in fossillized calcite shells is a function of the δO_{18} in the ocean. O_{18} in the shells increases as the temperature of the water increases. Thus the δO_{18} is a proxy for oceanic temperatures.*

(d) Hva viser δO_{18} om temperaturen i dyphavet over de siste 55 My? Hva sier dette om forholdene på overflaten? *The δO_{18} record shows that temperatures in the deep ocean have been up to $16^\circ C$, compared to $2^\circ C$ now. If the deep oceans were ventilated at the poles, like in the present, the temperatures at the poles must have been very warm indeed.*

(e) Hvordan foregår utveksling av karbon på veldig lange tidsskalaer? *Over very long time scales the biogeochemical carbon cycle interacts with geological and geochemical process with long time scales. Volcanism is the dominant source of CO_2 to the atmosphere over long times, while removal is through weathering of rocks which are deposited in the ocean as sediment. On even longer time scales, this sedimentary crust is recycled into the earth's interior by tectonic activity.*

(f) Hvordan kan utvekslingen fungere som en termostat? *Volvanic activity is not thought to depend on climate, but the weathering processes are thought to be enhanced in a warm, wet climate with high CO_2 concentrations and suppressed in a cold arid climate. This limits the excursions in CO_2 concentrations in the atmosphere over very long time scales.*

(g) Hvordan har CO_2-konsentrasjonen i atmosfæren variert over geologisk tid? Hvordan har ismengden på jorda variert? *Figure 12.14. The concentrations of CO_2 are thought to have been up to 10-20 times larger over the last 500 million years. In general high CO_2 concentrations coincide with low ice cover conditions and vice versa.*

(h) Hva er de tre Milankovic-syklusene? Hvordan relaterer disse til istidene? *The Milankovic cycles are the cycles of the earth's orbit and orientation in space. There are three such cycles: Eccentrictiy, the deviation of the orbit from a circle (100 ky time scale); Obliquity, the tilt of the earth's rotational axis relative to the plane of orbit (41 ky time scale); Precession, the direction of the earth's spin vector (23 ky time scale). These cycles changes the amount and distribution of insolation that the earth recieves, and can thus have global and regional climate effects, that through feedbacks can have global impacts. Figure 12.18 shows the clacial interglacial cycles over the last 2.5 My. The 41 ky Milankovic cycle is clearly visible in the record, while in the later period there is a clear 100 ky periodicity as well. This might be more related to internal ice sheet dynamics, but there is an interesting discussion about the shift between the two modes at around 1 My going on in the scientific community.*

(i) Hva er "The faint early sun paradox?" Hvordan kan dette løses? *The faint early sun paradox is the observation that the sun was maybe 20% weaker in the distant past, while we know that life has existed for periods when the earth should have been frozen over if everything was as it is today. The solution to this paradox is usually that the CO_2 concentrations were much higher in the distant past to compensate, and that we have had a long term decrease in the concentrations over geological time.*

(j) Oppgave 12.5.6 i boka. *Estimate the surface area of the ice sheet. Calculate the volume by mutiplying by $2km$ thickness. Calculate the flux by dividing by the melting time. 1 Sv is $10^6 m^3 s^{-1}$*