

Homework 5

assigned: Wed Nov 12

due: Thurs Nov 20

Readings for Week 7: Ancient Climates

Topic (Book Section)	pages	Figures
Introduction/Overview	8:152-153	8-1
Formation of Early Atmosphere	8:158-159	8-7
Faint Young Sun paradox	8:159-161	8-8, 8-9
Long Term Climate Record	8:161-164	8-10, 8-11
Low Latitude Glaciations Box	8:165	
Warm Mesozoic Era	8:167-169	8-15
Cooling During Cenozoic Era	8:169-170	8-17
Modern Controls on Atmos. O ₂	9:188-189	9-17

also: "Snowball Earth" article (get from class website)

Readings for Week 8: Recent Climates and Climate Variability

Topic (Book Section)	pages	Figures
Geological Evidence of glaciations	11:212-215	11-2, 11-3, 11-4
Milankovitch Cycles (orbital theory)	11:215-219	11-5, 11-7, 11-9
Glacial-climate feedbacks	11:219-221	11-10, 11-11
Time Scales of Change	12:229-232	12-1, 12-2
Volcanoes and Climate	12:236-240	12-6
Solar Variability	12:240-242	12-7, 12-8
El Nino-Southern Oscillation	12:244-247	12-10, 12-16

1. *Earth history*: Give the approximate dates associated with the following and commit them to memory. Example: Formation of Earth. Answer: 4.6 billion ybp (years before present). (a) Origin of life. (b) Atmospheric oxygen reaches levels similar to today. (c) Late Proterozoic glaciations that encased the entire earth just prior to the Cambrian explosion of life. (d) Beginning of the abundant fossil record of multicellular life. (e) Extinction of the dinosaurs by an asteroid impact. (f) Beginning of Pleistocene Glaciations - that is, the modern epoch of alternating glacial/interglacial conditions. (g) End of the most recent glaciation. [2 pts each]

2. *Evidence of glaciations*: Pick any three of the following four geological phenomena and briefly explain why they are diagnostic of glaciations: glacial striations, erratics, U-shaped valleys, and a high fraction of ¹⁸O in ocean sediments. [4 pts each or 12 total]

3. *Orbital parameters*: (a) Name the three characteristics of the Earth's orbit around the sun that vary on the time scale of the Pleistocene glaciations and state the time scale of variation associated with each one. [6 pts] Referring to Fig 11-9, (b) Which of these is associated with the smallest change in energy to the Northern Hemisphere in June? [2 pts] (c) Which of these is associated with the largest climate response? [2 pts]

[over >>>]

4. Match each climate phenomenon with a time scale [2 pts each]

Climate phenomena: ENSO, sunspots, ice ages, seasons, a single volcanic eruption

Time scales: 1 year, 1-2 years, 2-10 years, 11 years, 40 years, 1000 years, 100,000 years

5. Sun and climate: (a) Using the evidence provided in Figure 12-8, argue that global warming observed over the past century is mostly due to the sun. [6 pts] (b) What is the key weakness with this argument? [6 pts]

6. (a) What are the four lines of geological evidence discussed in the Hoffman and Schrag article that led scientists to propose the "Snowball Earth" hypothesis? [8 pts] (b) Pick one of these lines of evidence and explain it in a few sentences. [8 pts]

Extra credit: (a) Calculate the equilibrium temperature of the planet for a snowball Earth in which the sun is 6% less bright and the planetary albedo is 0.8. (b) Assuming the same greenhouse effect (ΔT_g) as today, calculate the global-mean surface temperature, T_s . (c) How large would the greenhouse effect (ΔT_g) have to be in order to raise the global-mean surface temperature above the freezing point of water? [10 extra credit points]