Assignment #1 ESYS 104: The Earth System

Due 5 February 2013 at the beginning of class (Paper copy only, no e-mailed assignments)
Assignments turned in late lose 10% of value for each day or fraction of a day that you are late.
Please show your work, rather than give one number or one phrase answers.
You may work together, but your answers must be unique and written in your own words.
Please remember to put your name and student number on your answers.

Question 1

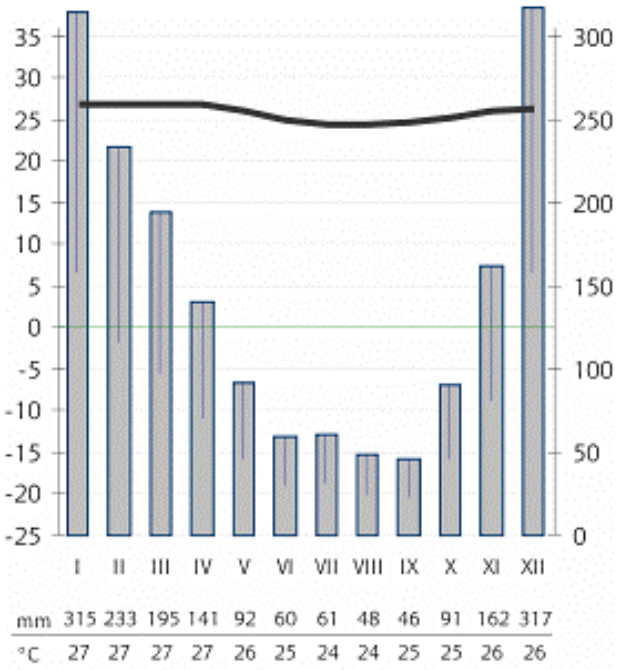
a) If the total radiated energy of the sun were to increase by 5%, by how much would its peak wavelength decrease?

b) And if the Earth's surface temperature was 15°C initially, by how much would it warm if the sun then increased its radiation output by 5% (as in 4a), assuming no feedbacks?

c) Now let us consider the feedbacks we have seen in the lectures. Given a 5% increase in solar radiation, would an Earth with an atmosphere without water vapor warm more, less, or the same as our Earth? Justify your answer, ignoring the effects of clouds.

Question 2

Consider the figure to the right showing, for every month, the average temperature (solid line, left axis, in °C) and monthly precipitation (vertical bars, right axis, in mm) somewhere on the planet. At about what latitude would you expect to see such climate? Justify your answer by referring to global circulation patterns that would explain these observations. For reference, Montreal gets about 80 mm of rain per month. (10 points)



Question 3
You are directing the design of power generation plants. You are given the task to build one hydro-electric plant, one solar power plant, and one wind power plant. One of those plants must go in the Central Plains of North America (40°N latitude), one to southern California (30°N latitude), and one near the equator in central Brazil. Neglecting issues of topography, which one will you build where? Justify your choice.

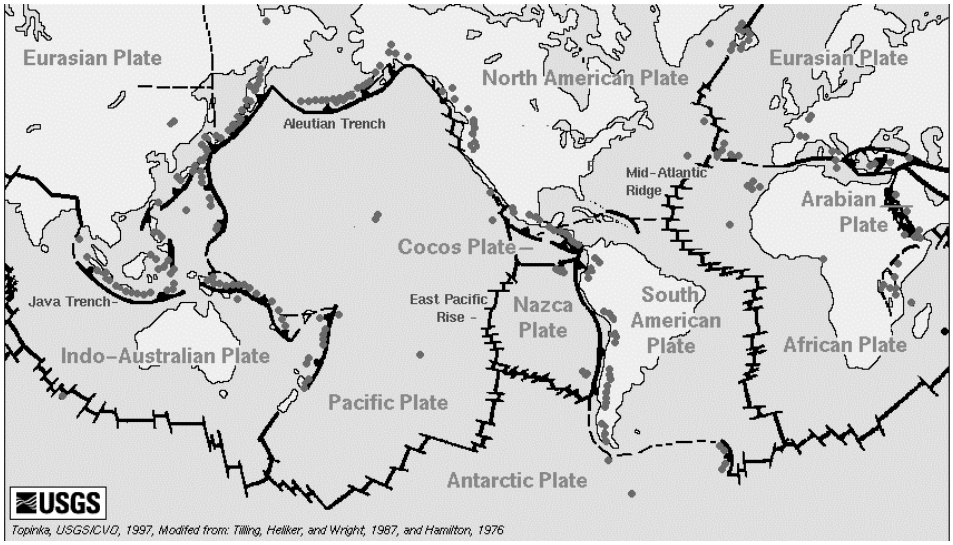
Question 4
It has been shown that weather forecasts are scientifically impossible to make beyond a few weeks. How do we refer to this phenomenon, and why does it occur in the atmosphere?

Question 5
a) What is the composition of the Earth? How is this different from the average composition of the Earth materials that you are likely to find on the Earth's surface? List the five most abundant elements in the Earth and the surface layer. What is the surface layer of the solid Earth called?

b) Hardness is one property of a mineral; it depends on the atomic structure of the mineral. What are three aspects of this structure that makes one mineral harder than the other?

c) You just purchased a marble kitchen countertop (marble is a metamorphic rock formed when limestone is buried and heated; it's made mostly of the mineral calcite). You have four choices of cleanser to clean it without leaving scratches: The expensive stuff containing real rubies, the supermarket brand containing orthoclase feldspar, talc powder from the baby's room or the (also expensive) stuff sold by your kitchen contractor made of ground-up toenails from European Royalty. Which do you choose and why (use Mohs Hardness Scale to justify your answer)?

Question 6: Use this world map to help you:



a) What are two pieces of evidence in the rock record that supports the theory of continental drift?

b) Identify one example of
a convergent boundary:
a divergent boundary:
a transverse (strike-slip) boundary:

c) Where would you expect to find volcanoes?

d) Why are there volcanoes in Hawaii?

e) Describe the boundaries of the Antarctic plate.

Question 7
The continents of Earth can be thought of being made of (mostly) granite, which is made (mostly) of the minerals quartz and feldspar. Granites are constantly weathering, especially in warm, wet climates (the tropics). Potassium feldspar can react with weak acids such as dissolved carbon dioxide to form another mineral (kaolinite, a clay) and dissolved ions and molecules:

$2KAlSi_3O_8 + 2H_2CO_3 + H_2O \Rightarrow Al_2Si_2O_5(OH)_4 + 4SiO_2 + 2K^+ + 2\,HCO_3^-$
feldspar + carbonic acid + water => kaolinite (clay) + silica (dissolved) + potassium ion (dissolved) + bicarbonate ion (dissolved)

a) Seawater contains about 0.04 weight percent potassium as dissolved ions. A typical granite has about 4 weight percent potassium. How much salty seawater can you make if you completely weather 1 kilogram of granite? (hint: think in terms of mass (weight) of potassium).

b) If an estimate can be made of how fast the continents weather, then you can estimate how fast the ocean became salty (this is the **flux** to the ocean **reservoir**). This was used (before modern methods were developed) to estimate the age of the oceans back to Sir Edmund Halley's time (the Halley of the comet). The age estimates are always too young. Why doesn't the ocean keep getting saltier and saltier over time (hint: the Bonneville salt flats: http://epod.usra.edu/blog/2006/06/bonneville-salt-flats.html)?

c) If the continents react with the atmosphere and dissolve (a summary of the reaction above), why do we still have land above sea level? Why hasn't it all weathered away?

Question 8
We'd like to form four groups of students, one for each of the TA's in the course. It would be best if persons of similar interests are grouped together and associated with the appropriate TA. Please indicate below your primary and secondary interst (there are no wrong answers!).

Oceans_____
Solid Earth_____
Atmosphere/Climate_____
Life____