Climate Dynamics (NS-MO429M)
3 February 2005

1. Why is hydrogen the dominant atmospheric species in Earth's atmosphere above a height of 1000 km above sea level and not oxygen and nitrogen, which together make up about 99% of the total mass in the troposphere?

2. Explain why the temperature over the summer pole in the mesosphere is relatively low compared to the temperature of the winter pole at the same height.

3. Explain why the average net incoming radiation at the top of the atmosphere in June, July and August is negative over the Sahara.

4. For the whole planet (atmosphere - earth system) and neglecting the effects of ororgraphy, we have the following expression for radiative balance:

$$Q(1 - \alpha) - I_0 - bT = 0.$$

Here, Q is the solar radiation coming to the outer boundary of the atmosphere, α is the average albedo of the earth, T is the temperature at sea level and I_0 and b are parameters determined from observations.

   a) Why is Stefan-Boltzmann's law not used to express the terrestrial outgoing radiation in the above equation?
   b) From the above expression for radiative balance, derive an expression for the climate sensitivity of the atmosphere-earth system to changes in the incoming solar radiation.
   c) Does climate sensitivity of the atmosphere-earth system to changes in the incoming solar radiation increase when the degree of snow and ice cover increases?

5. The Antarctic continent is located around the South Pole for already 100 mln years. Glaciation, however, started only about 34 mln years ago. Evidently, the polar locations is not enough to intiate glaciation. Give two possible explanations for why glaciation started around this time and not earlier.

6. How can volcanic eruptions affect global climate?

7. Give 3 examples of how to date paleoclimatological records, explain them and give advantages and disadvantages of their use.

8. Explain why the ozone concentration in the lower stratosphere is highest poleward of $\pm 60°$ latitude, while it is produced in the tropics.