FYS 3610

EXERCISES WEEK 37

EXERCISE 1

Problem 1 from mid-term exam 2005:

a) The Earth atmosphere is subdivided in regions according to the temperature altitude profile. Draw a temperature versus altitude profile with realistic scales. Annotate the different regions by name. Point out the heat sources along this profile.

b) The barometric equation for an isothermal atmosphere is given as:

$$p = p_0 \cdot e^{-\frac{mg}{kT} z}$$

Show how to derive this equation. Define the scale height. What is the typical scale height in the meteorological region?

c) Draw a figure that qualitatively demonstrates the Chapman layer variations with altitude z and zenith angle χ.

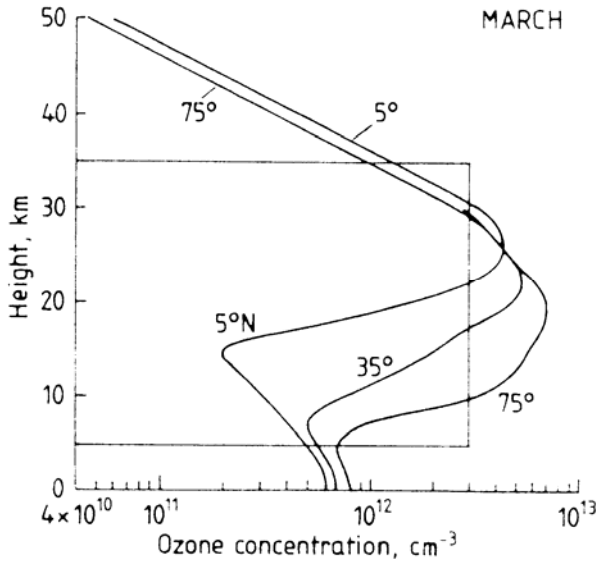


Figure 1

d) Describe Figure 1 above. Explain the latitude variation of the peak magnitude and peak altitude.

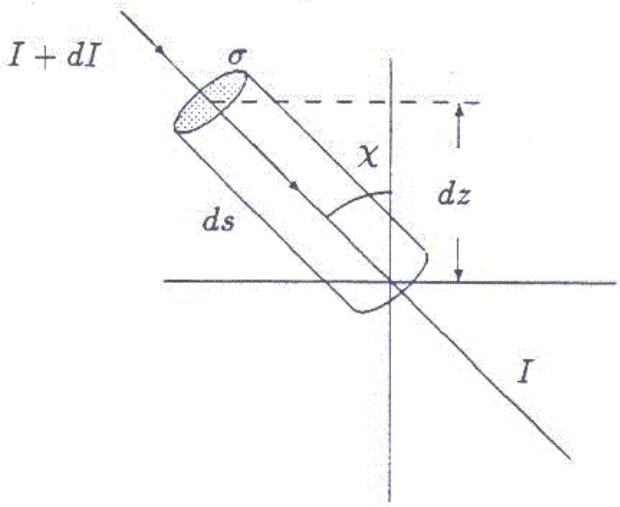
EXERCISE 2
Problem 4 c-f from mid-term exam 2004

a) ~~Draw a sketch of the height variation of temperature in the Earth's atmosphere from sea level to 150 km. Explain in general terms what are the physical mechanisms responsible for this structure. Annotate the different regions of the atmosphere by name.~~

b) ~~Derive the barometric equation for an isothermal atmosphere and explain the physical meaning of the term scale height.~~

c) What do we mean by an adiabatic atmosphere? In which of the two cases do we have a convective instability: i) when $\frac{\partial \rho}{\partial z} < \frac{\partial \rho}{\partial z}_{|ad}$ or ii) when $\frac{\partial \rho}{\partial z} > \frac{\partial \rho}{\partial z}_{|ad}$? Draw a sketch and justify your answer.

d) Assume monochromatic light at a sloping incidence with a horizontally stratified atmosphere as shown in the figure below.



Set up an expression for the absorbed radiation in an element ds of this radiation path. Define the parameters involved. Show that the intensity of incoming radiation varies with solar zenith angle as: $I = I_\infty e^{-\tau \sec \chi}$. Define τ and explain the meaning of this parameter.

e) The ion production rate for an exponential atmosphere can be written as:

$$q(\chi, z) = \frac{I_\infty \eta}{H} \tau \cdot e^{-\tau \sec(\chi)}$$

Show that the maximum production rate can be expressed as:

$$q_m(\chi, z_m) = \frac{I_\infty \eta \cos\chi}{eH} = q_m(0, z_{m0})\cos\chi$$

Sketch a graph demonstrating how maximum ion production varies with zenith angle.

f) Draw a sketch of the altitude variation of electron density in the ionosphere and identify the ionospheric layers. What are the most important production mechanisms for these layers during quiet and disturbed conditions?