宇宙と地球と人間 (1st semester, 2015) (Geophysics part)

## Final examination

Question 1:

If there were no atmosphere, the averaged heat budget of the planet surface could be expressed as follows:

$$\frac{(1-\alpha)S_0}{4} = \sigma T^4$$

where α is the albedo, and T is the surface temperature (absolute temperature). Moreover, S_0 and σ are the solar constant and the Stefan-Boltzmann constant, respectively. Obtain T, by solving this equation.

Question 2:

Let us consider the heat budgets of the surface and the atmosphere when there is greenhouse gas. Assume that the heat budget can be expressed by the following diagram.
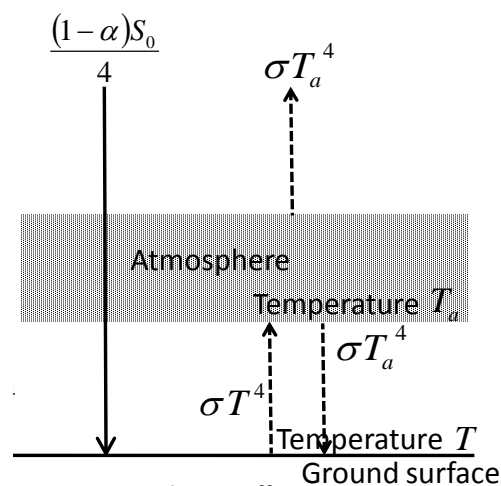
where T is the surface temperature, and T_a the atmospheric temperature. The heat budget of the ground surface gives

$$\frac{(1-\alpha)S_0}{4} + \boxed{\text{(a)}} = \sigma T^4$$

And, the heat budget of the atmosphere is

$$\boxed{\text{(b)}} = 2\sigma T_a^{\,4}$$

(1) Fill in blank (a).
(2) Fill in blank (b).
(3) Obtain T and T_a by solving the equations.

Question 3:

An English dictionary explains the meaning of 'greenhouse effect' as follows:

> **greenhouse effect** n [sing] slow warming of the earth's atmosphere, caused by increased carbon dioxide.

Explain briefly what is wrong with this description.