Solution of problem 1:

1. Temperature T_1 where the cloud ceiling forms

$$T_1 = T_0 \cdot \left(\frac{p_1}{p_0}\right)^{1-\frac{1}{\varkappa}} = 279\,\mathrm{K} \tag{1}$$

2. Height h_1 of the cloud ceiling:

$$p_0 - p_1 = \frac{\rho_0 + \rho_1}{2} \cdot g \cdot h_1, \text{ with } \rho_1 = \rho_0 \cdot \frac{p_1}{p_0} \cdot \frac{T_0}{T_1}.$$

$$h_1 = 1410\,\mathrm{m} \tag{2}$$

3. Temperature T_2 at the ridge of the mountain.

The temperature difference when the air is ascending from the cloud ceiling to the mountain ridge is caused by two processes:

– adiabatic cooling to temperature T_x,

– heating by ΔT by condensation.

$$T_2 = T_x + \Delta T \tag{3}$$

$$T_x = T_1 \cdot \left(\frac{p_2}{p_1}\right)^{1-\frac{1}{\varkappa}} = 265\,\mathrm{K} \tag{4}$$

For each kg of air the heat produced by condensation is $L_v \cdot 2.45\ \mathrm{g} = 6.125\ \mathrm{kJ}$.

$$\Delta T = \frac{6.125}{c_p} \cdot \frac{\mathrm{kJ}}{\mathrm{kg}} = 6.1\,\mathrm{K} \tag{5}$$

$$T_2 = 271\ \mathrm{K} \tag{6}$$

4. Height of precipitated water column

$$h = 35\ \mathrm{mm} \tag{7}$$

5. Temperature T_3 behind the mountain

$$T_3 = T_2 \cdot \left(\frac{p_3}{p_2}\right)^{1-\frac{1}{\varkappa}} = 300\,\mathrm{K} \tag{8}$$

The air has become warmer and dryer. The temperature gain is caused by condensation of vapour.

Grading Scheme

Theoretical problems

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