Tutorial 2

Latent heats

Latent heat of condensation is given by a relation

$$L_{lv}(T) = L_{lv0} - (c_l - c_{pv}) \cdot (T - T_0).$$

Latent heat of sublimation is given by a relation

$$L_{iv}(T) = L_{iv0} - (c_i - c_{pv}) \cdot (T - T_0).$$

1. Plot L_{lv} and L_{iv} as a function of temperature:

   – assume $c_l - c_{pv} = const$, and $c_i - c_{pv} = const$; values are given in thermodynamic_5 lecture in slide 27,

   – take the exact values (L_{SMT}) from the Smithsonian Meteorological Tables (slide 27 in thermodynamic_5).

2. Are assumptions $c_l - c_{pv} = const$, and $c_i - c_{pv} = const$ correct? What is the relative error $((L_{SMT} - L_{lv})/L_{lv}$?

3. Are the assumptions $L_{lv} = const$ and $L_{iv} = const$ correct? Calculate relative errors.

Specific humidity versus mixing ratio

Specific humidity is idefined as the ratio of the masses of vapor and mixture

$$q_v = \frac{m_v}{m},$$

where m_v is the mass of water vapor and m is the mass of mixture, i.e. dry air and water vapor, and ε =0.622. Specific humidity can be expresses in terms of the vapor partial pressure e and the total pressure of mixture p as:

$$q_v = \varepsilon \frac{e}{p - (1 - \varepsilon)e}.$$

Another way of description of the quantity of water vapor in the air is by introducing the mixing ratio defined as the ratio of the masses of vapor and dry air (m_d):

$$r_v = \frac{m_v}{m_d}.$$

In terms of pressures the mixing ratio is expresses by:

$$r_v = \varepsilon \frac{e}{p - e}.$$

For atmospheric temperatures and pressures the water vapor mixing ratio seldom exceeds 30 g/kg.
Show what is the difference between mixing ratio and specific humidity. Discuss the results.

Quite often approximative formulae for specific humidity and mixing ratio are used:

$$q_v = \varepsilon \frac{e}{p}, \quad r_v = \varepsilon \frac{e}{p}.$$

Discuss the error one makes when using those approximate formulae.