Tutorial 2

Comparison of specific humidity and mixing ratio

Specific humidity is idefined as the ratio of the mass of water vapor to the total mass of moist air:

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

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

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

Another way to describe the amount of water vapor in the air is by introducing the mixing ratio, defined as the ratio of the mass of water vapor to the mass of dry air (m_d):

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

In terms of pressure, the mixing ratio is expressed as:

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

where ε =0.622, e is the water vapor partial pressure, and p is the total air pressure.
For typical atmospheric temperatures and pressures, the water vapor mixing ratio seldom exceeds 30 g/kg.
Show the difference between mixing ratio and specific humidity, and discuss the results.

Quite often, approximate formulae for specific humidity and the mixing ratio are used:

$$q_{v,a} = \varepsilon \frac{e}{p}, \quad r_{v,a} = \varepsilon \frac{e}{p}.$$

Discuss the error introduced using these approximate formulae.