

Unit 5

Moist processes

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All moisture measures apply exclusively to water vapor!

Vapor pressure

$$e = \rho_v R_v T$$

⇒ Not conserved

Absolute humidity

$$a := \rho_v = m/V = e/R_v T$$

⇒ Not conserved!!!!

Specific humidity or specific mixing ratio

$$q := \frac{\rho_v}{\rho_m} = \frac{\rho_v}{\rho_d + \rho_v} = \frac{m_v}{m_m}$$

$$p = \rho_d R_d T + \rho_v R_v T$$

$$q = \frac{\frac{e}{R_v T}}{\frac{p-e}{R_d T} + \frac{e}{R_v T}} = \frac{R_d}{R_v} \frac{e}{p - (1 - \frac{R_d}{R_v})e} = 0.622 \frac{e}{p - 0.378e}$$

Mixing ratio

$$r := \frac{\rho_v}{\rho_d} = \frac{\frac{e}{R_v T}}{\frac{p-e}{R_d T}} = \frac{R_d}{R_v} \frac{e}{p-e} = 0.622 \frac{e}{p-e}$$

Defintion of virtual temperature

$$\frac{p}{R_m T} = \rho_m = \rho_d + \rho_v = \frac{p-e}{T R_d} + \frac{e}{T R_v} =: \frac{p}{R_d T_v}$$

$$\frac{p}{R_d} \frac{1}{\frac{p-e}{R_d T} + \frac{e}{R_v T}} = T \frac{p}{p-e + \frac{R_d}{R_v} e} = T \frac{p}{p - (1 - \frac{R_d}{R_v}) e}$$

$$p - (1 - \frac{R_d}{R_v}) e = \frac{R_d}{R_v} \frac{e}{q}$$

$$T_v := T \frac{(1 - \frac{R_d}{R_v}) e + \frac{R_d}{R_v} \frac{e}{q}}{\frac{R_d}{R_v} \frac{e}{q}} = T \left(1 + \frac{(1 - \frac{R_d}{R_v})}{\frac{R_d}{R_v}} q\right) = T(1 + 0.61q)$$

$$p = \rho_m R_d T(1 + 0.61q) = \rho_m R_d T_v$$

$$p = \rho_d R_d T(1 + 1.61r) = \rho_d R_d T_v$$

Virtual temperature is combined temperature-moisture measure

