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

\[ a := \rho_v = \frac{m}{V} = \frac{e}{R_v T} \]

⇒ Not conserved!!!!!!
Specific humidity or specific mixing ratio

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

\[ p = \rho_d R_d T + \rho_v R_v T \]

\[ q = \frac{e}{R_v T} \frac{R_d}{p - e} = \frac{e}{R_v T} = 0.622 \frac{e}{p - 0.378 e} \]
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

\[
\frac{p}{R_m T} = \rho_m = \rho_d + \rho_v = \frac{p-e}{TR_d} + \frac{e}{TR_v} =: \frac{p}{R_d T_v}
\]

\[
\frac{p}{R_d} \left( \frac{p-e}{R_d T} + \frac{e}{R_v T} \right) = T \frac{p}{p-e+\frac{R_d}{R_v}e} = T \frac{p}{p-(1-\frac{R_d}{R_v})e}
\]

\[
p - (1 - \frac{R_d}{R_v})e = \frac{R_d}{R_v} e.
\]

\[
T_v := T \frac{(1 - \frac{R_d}{R_v})e + \frac{R_d}{R_v} e}{\frac{R_d}{R_v} q} = T (1 + \frac{(1 - \frac{R_d}{R_v})}{\frac{R_d}{R_v}} q) = T (1 + 0.61 q)
\]

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

\[
p = \rho_d R_d T (1 + 1.61 r) = \rho_d R_d T_v
\]
Virtual temperature is combined temperature-moisture measure.