Equations of the humid air

Here the list of equations governing the physics properties of the humid air:

- vapour pressure parametrization for water : p_v (vapour pressure of the water) [Pa] as a function of the dry temperature T [K] [Buck (1981), J. Appl. Meteorel., 20: 1527-1532]

$$p_v(T) = \exp\left[a_{-1}/T + a_0 + a_1 T + a_2 T^2 + a_3 T^3 + a_4 \log(T)\right] \quad (1)$$

with the following coefficients:

a_{-1}	$-5.8002206 \times 10^{+3}$
a_0	1.3914993
a_1	$-4.8640239 \times 10^{-2}$
a_2	4.1764768×10^{-5}
a_3	$-1.4452093 \times 10^{-8}$
a_4	6.5459673

- Relative humidity rh [no unit] as a function of the dry temperature T [K], the pressure p_0 [Pa] and the absolute humidity ah [kg water / kg dry air]:

$$rh = \frac{\mu}{1 - (1-\mu)\dfrac{p_v(T)}{p_0}} \text{ where } \mu = \frac{ah}{w} \cdot \left(\frac{p_0}{p_v(T)} - 1\right) \quad (2)$$

- The previous relation can be inverted in order to express the absolute humidity ah [kg water / kg dry air] as a function of the dry temperature T [K], the pressure p_0 [Pa] and the relative humidity rh [no unit]:

$$ah = \frac{w \cdot \mu}{\dfrac{p_0}{p_v(T)} - 1} \text{ where } \mu = rh \cdot \frac{p_0 - p_v(T)}{p_0 - rh \cdot p_v(T)} \quad (3)$$

- Specific volume v as a function of the dry temperature T [K] and the absolute humidity r [kg water / kg dry air]:

$$v = \frac{RT\left(1 + \dfrac{ah}{w}\right)}{M_a \cdot p_0} \quad (4)$$

- Density ρ as a function of the specific volume v:

$$\rho = 1/v \quad (5)$$

- Specific enthalpy h as function of the dry temperature T [K] and the absolute humidity ah [kg water / kg dry air]:

$$h = 2501 \cdot ah + (1.805 \cdot ah + 1.006)(T - 273.15) \tag{6}$$

Constants:

R	ideal gas constant	8.3144621 J/mol/K
M_a	molar mass of dry air	28.9653×10^{-3} kg/mol
M_w	molar mass of water	18.0153×10^{-3} kg/mol
w	ratio of molar masses	M_w/M_a

Physics observables:

ah	absolute humidity [kg water / kg dry air]
rh	relative humidity [no unit]
h	specific enthalpy [J / kg dry air]
v	specific volume [m^3 / kg dry air]
ρ	density [kg dry air / m^3]
T	dry temperature [K]
p_v	vapour pressure of water [Pa]
p_0	total pressure [Pa]