Dewpoint estimation

This dewpoint calculator employs the 1996 revision of the Arden Buck equation

$$p_{ws} = 6.1121\, e^{\frac{\left(18.678 - \frac{T}{234.5}\right)T}{257.14 + T}} = 6.1121\, e^{\alpha(T)} \tag{1}$$

where

p_{ws} is the saturation wator vapor pressure measured in hPa
T is the measured air temperature measured in ºC

when we define

$$\alpha(t) = \frac{\left(18.678 - \frac{t}{234.5}\right)t}{257.14 + t} \tag{2}$$

Let p_w be the partial water vapor pressure. The definition the relative humidity states that

$$p_w = p_{ws} \times RH \tag{3}$$

By definition, the relative humidity is equal to 100% when the air is saturated, and the temperature is equal to the dewpoint temperature. This means that $p_w = p_{ws} = 6.1121e^{\alpha(T_{dp})}$. By inserting into equation (3) we can derive equation (4) for the dewpoint temperature T_{dp}:

$$T_{dp}(T, RH) = \frac{1}{a}\left(b(T, RH) - \sqrt{b(T, RH)^2 + 2\mathrm{ac}(T, RH)}\right) \tag{4}$$

where

$$a = \frac{2}{234.5}$$

$$b(T, RH) = 18.678 - \beta(T, RH)$$

$$c(T, RH) = -257.14 \times \beta(T, RH)$$

when we define

$$\beta(T, RH) = \ln RH + \alpha(T)$$

and T is the measured temperature in ºC and RH the measured relative humidity in percent (expressed as 0.0 - 1.0).

The Arden Buck equation is considered a good approximation in the temperature range -80 to +50 ºC.

References

- Buck, A. L., New equations for computing vapor pressure and enhancement factor, J. Appl. Meteorol., 20, 1527-1532, 1981
- Buck Research Manual (1996)

Relative humidity estimation

The relative humidity calculation is based on the definition of relative humidity (3) and the Arden Buck equation (1).

Similarly substituting for (1) into (3) and utilizing definition (2) for $\alpha(x)$ gives:

$$6.1121\, e^{\alpha(T_{dp})} = RH \times 6.1121\, e^{\alpha(T)}$$

Solving for RH results in the following estimation equation for relative humidity:

$$RH = e^{\alpha(T_{dp}) - \alpha(T)}$$