DEWPOINT AND VAPOR PRESSURE DEFICIT EQUATIONS

From Tetens Formula, the relation between temperature and the partial pressure of water vapor:

e(millibars) = 6.1078 exp((17.269*T) / (237.3+T))

where,

e is saturated vapor pressure in millibars

T is temperature in degrees C

and the equation for relative humidity:

Rh=(ea/es)*100

where,

ea is the actual vapor pressure or vapor pressure at dewpoint temperature

es is the saturation vapor pressure or vapor pressure at air temperature

it can be shown that:

Dew point temperature = Tdew = (237.3*X) / (17.269-X)

where X=ln(Rh/100)+((17.269*Tair)/(237.3+Tair)), and

Tair is air temperature

Tdew is dew point temperature

And,

Vapor Pressure Deficit = es-ea = es-(Rh*es/100) at any instant.

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DEFINITIONS:

SATURATION VAPOR PRESSURE: water evaporating and condensing through the air-water interface yields zero net transport.

Ideal gas law to sat vap pr:

e = pRT

e=vapor pressure in millibars

p=vapor density in mass/unit volume (g/cubic meter)

T=absolute temperature (degrees Kelvin)

R=vapor gas constant

If we use the universal gas constant for R, the formula becomes

e = 1.61pRT

which becomes

p = 0.622e/RT

This is known as VAPOR DENSITY or ABSOLUTE HUMIDITY of the atmosphere.

RELATIVE HUMIDITY is the ratio of the vapor density (or pressure) to the saturation vapor density (or pressure) at the same temperature.

APPROXIMATIONS:

For saturated vapor pressure in temperature range 25-55 deg Fahrenheit:

e == 6.11 + 0.339(D-32)

e = sat vap pr in millibars

D = dew point temperature in Fahrenheit

For saturated vapor pressure in temperature range 25-55 deg Fahrenheit:

e == 0.18 + 0.01(D-32)

e = sat vap pr in inches of mercury

D = dew point temperature in Fahrenheit

Relative humidity can be approximated from air and dew point by

rh = 100 ((112 - 0.1T + D) / 112 + 0.9T)**8

T = temperature

D = dew point

(Range of valid temperatures is unknown).

Dew point can be approximated in temp range -40 to 50 deg C by

T - D = (14.55+0.114T)*x + ((2.5+0.007T)*x)**3 + ((15.9+0.117T)*x)**14

T = temperature

D = dewpt

x = complement of relative humidity in decimal form, ie. x = 1.0 - (rh/100)