Relationship between Relative Humidity and Dew Point Pressure
BE-381, Dr. C. S. Tritt, Fall '08, v. 1.1

The dew point pressure, P_{dp}, is defined as the total pressure, P, at which the partial pressure of water vapor in the air, P_v, equals the vapor pressure of water, P_g, at the specified temperature. Or simply,

$$P_g = P_v$$

Since the partial pressure of any gas in a mixture is simply its mole faction in the mixture, y, times the total pressure. So,

$$P_v = yP$$

At the dew point

$$P_g = yP_{dp}$$

or

$$P_{dp} = \frac{P_g}{y}$$

Since the mole fraction y is defined as

$$y = \frac{P_v}{P}$$

Combining the previous two equations gives

$$P_{dp} = \frac{P_g}{P_v/P}$$

And rearranging gives

$$P_{dp} = \frac{P_g}{P_v} P$$

Relative humidity, Φ, is defined as:

$$\phi = \frac{m_v}{m_g} = \frac{P_v}{P_g}$$

where m_v is the mass of the water vapor in the air and m_g is the mass of water vapor in the air if it were saturated at the specified temperature.

Finally, combining the previous 2 equations gives

$$P_{dp} = \frac{P}{\phi}$$

This equation provides an extremely simple way to find the dew point pressure given the relative humidity at the specified temperature.