

DEW POINT CALCULATION

Dew Point: $T_d = T - \frac{100 - RH}{5}$ (Note @ RH=100%
 $T_d = T$)

EXAMPLE: Air @ ground - RH = 50%
 $T = 23^\circ C$ Ambient air near ground is $\sim 20^\circ C$

Air rises because its warmer & moister than ambient air near the surface
At what altitude do clouds form?

AT WHAT ALTITUDE DOES AIR REACH ITS DEW POINT?

h_{clouds} ? h @ which $T_2 = T_d$

$T_d = 23^\circ - \frac{100 - 50}{5} = 13^\circ C$ $\Delta T = 10^\circ C$

At D.A.L. = $9.8^\circ C / 1000m$

$h_c = \frac{10^\circ C}{9.8^\circ C / 1000m} \cdot 1000m = 1020m$ (= 3200 ft)

HOW MUCH HEAT IS RELEASED TO THE AIR WHEN WATER CONDENSES INTO CLOUDS?

Now air loses moisture. Say, 10% RH
(RH drops from 50% \rightarrow 40%)

How much (grams) of H_2O are condensing to change $\Delta RH = 10\%$?

Total water density: Vapor Press (sat'd) @ $10^\circ C$
 $= 0.012 atm$

$\rho^H = \frac{V.P.}{P_T} \cdot \rho_{air}$
 $= \frac{0.012 atm}{1.00 atm} (1.2 kg/m^3) = 0.014 \frac{kg}{m^3} = 14 g/m^3$

So 10% RH = $(0.10)(14 g/m^3) = 1.4 g/m^3$ CONDENSES @ $10^\circ C$

Latent Heat RELEASED = $(1.4 g/m^3)(580 \frac{cal}{g}) = 840 \frac{cal}{m^3}$

WHEN LATENT HEAT IS RELEASED, HOW MUCH DOES THE TEMP. OF AIR RISE?

How much does 1 m³ ~~of~~ heat up when 840 cal are released

Use specific heat (heat capacity) of air @ 10°C look up in Table:

$$C_p = 0.24 \text{ cal/g}\cdot\text{C}$$

$$\Delta T = \frac{H}{m_{air} C_p} = \frac{H}{(\rho V) C_p} = \frac{840 \text{ cal}}{(1200 \text{ g/m}^3)(1 \text{ m}^3) 0.24 \frac{\text{cal}}{\text{g}\cdot\text{C}}}$$

$$\Delta T \approx 3^\circ\text{C}$$

HOW THICK (TALL) WILL A CLOUD LAYER GROW?

So, air parcel expands, has less density, and thus rises further. How high will the cloud grow before all the moisture has condensed out?

For initial RH = 50%, need to lose 50% RH. As rough cut, showed 3°C change per 10°C so

$$50\% = (5 \times 10\%) = (5 \times 3^\circ\text{C}) = 15^\circ\text{C} \leftarrow \text{Total temp change}$$

One way to estimate cloud thickness:

How much higher would the air parcels have to rise to cool an "extra" 15°C

$$\Delta h = \frac{15^\circ}{9.8^\circ\text{C}/1000\text{m}} \cdot 1000\text{m} = 1,530 \text{ m}$$

So expect cumulus cloud layer to be approx 1,500 m or 1.5 km = 0.9 mile thick

(sounds about right for average cumulus clouds.)

Dew Point and Comfort Range

Humans tend to react with discomfort to a high dew point, i.e. greater than 15 °C (60 °F). The body perspires and produces sweat to cool down. High relative humidity and consequently high dew point, prevent the evaporation of sweat and reduce evaporative cooling. As a result, the body may overheat, resulting in discomfort.

Discomfort also exists when dealing with low dew points (i.e below -20 degrees Fahrenheit). The drier air can cause skin to crack and become irritated more easily.

Lower dew points, less than 10 °C (50 °F), correlate with lower ambient temperatures, and the body requires less cooling. A lower dew point can go along with a high temperature only at extremely low relative humidity (see graph below), allowing for relative effective cooling.

Those accustomed to continental climates often begin to feel uncomfortable when the dew point reaches between 15 and 20 °C (59 to 68 °F). Most inhabitants of these areas will consider dew points above 21 °C (70 °F) oppressive.

Dew Point °C	Dew Point °F	Human Perception ^[1]	Rel. Humidity at 90°F (32°C)
>Higher than 26°C	>Higher than 80°F	Severely high. Even deadly for <u>asthma</u> related illnesses	65% and higher
24 - 26°C	75 - 80°F	Extremely uncomfortable, fairly oppressive	62%
21 - 24°C	70 - 74°F	Very humid, quite uncomfortable	52% - 60%
18 - 21°C	65 - 69°F	Somewhat uncomfortable for most people at upper edge	44% - 52%
16 - 18°C	60 - 64°F	OK for most, but all perceive the humidity at upper edge	37% - 46%
13 - 16°C	55 - 59°F	Comfortable	31% - 41%
10 - 12°C	50 - 54°F	Very comfortable	31% - 37%
<10°C	<49°F	A bit dry for some	30%

A dew point of 35 °C (95 °F) was reported in Dhahran, Saudi Arabia at 3 p.m. July 8, 2003. The temperature was 42 °C (108 °F), resulting in an apparent temperature or heat index of 80 °C (176 °F).^[2]