The Water Cycle

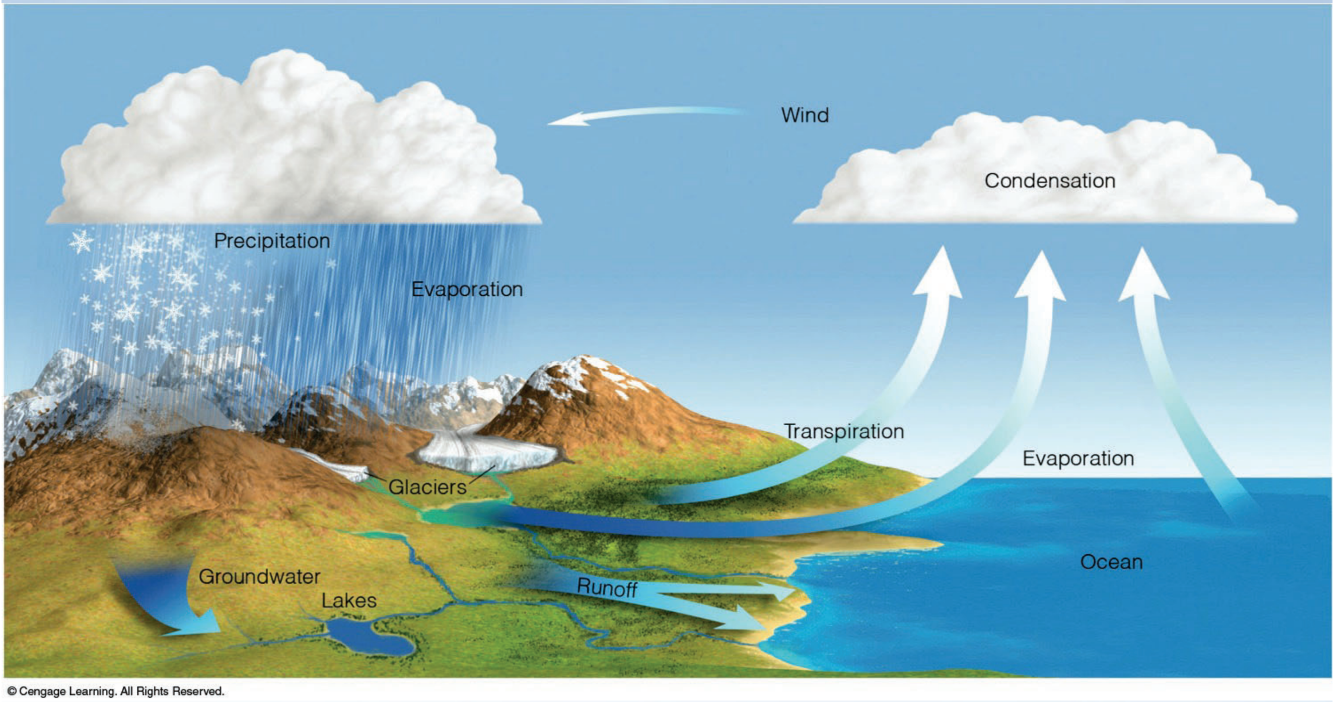


Fig 4.1: ***Essentials of Meteorology***

The Water Cycle

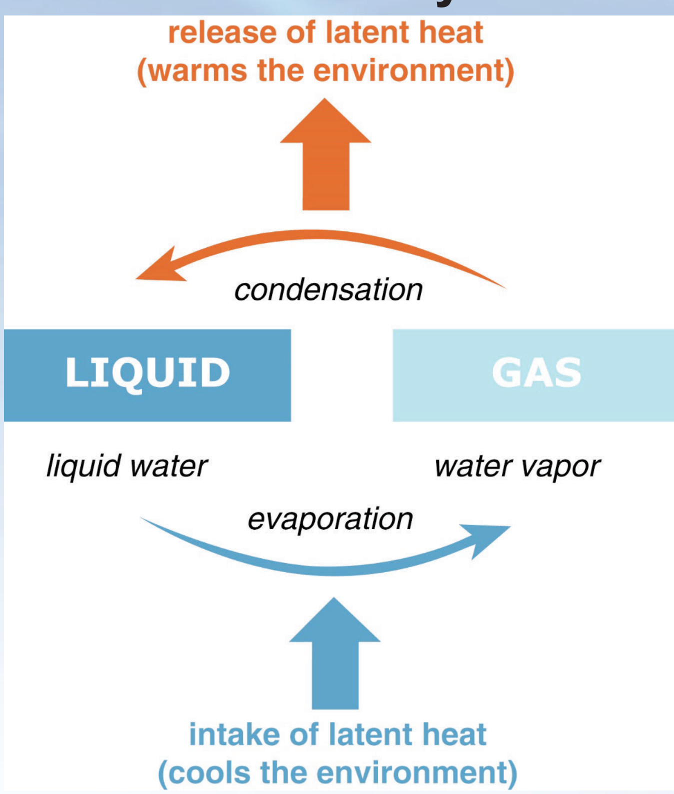
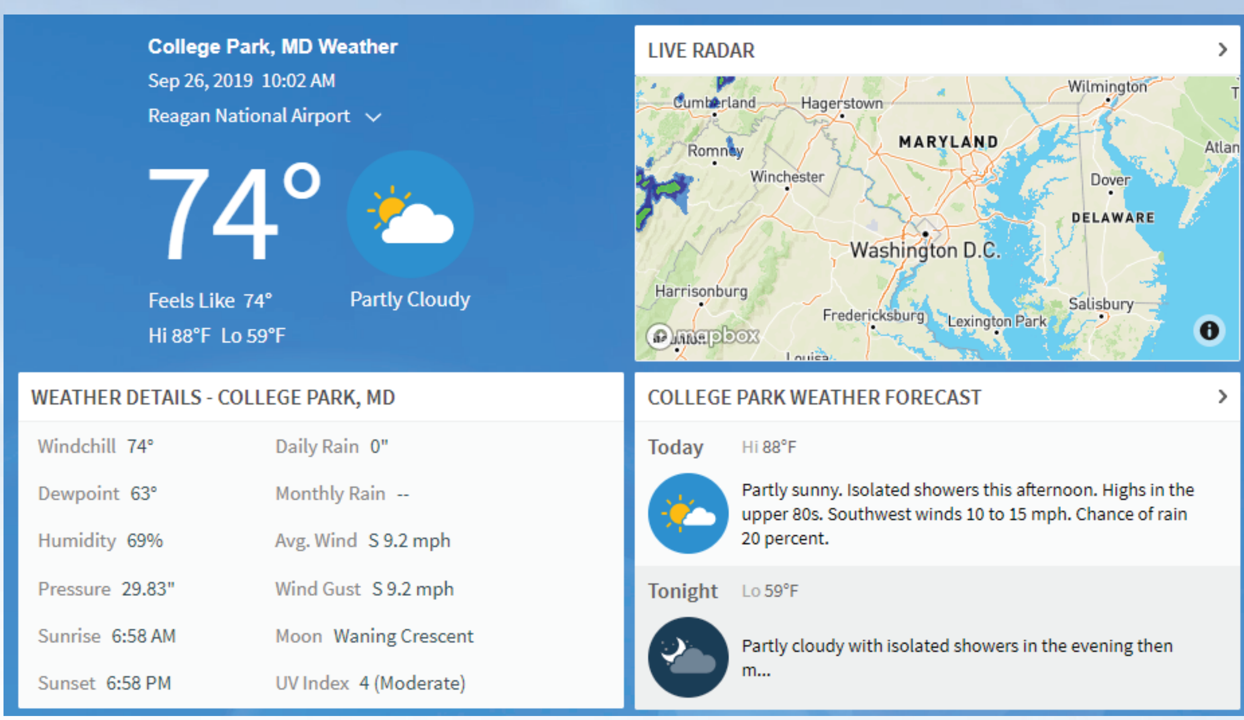


Fig 5.1 *Weather: A Concise Introduction*

Ways to get water to condense:

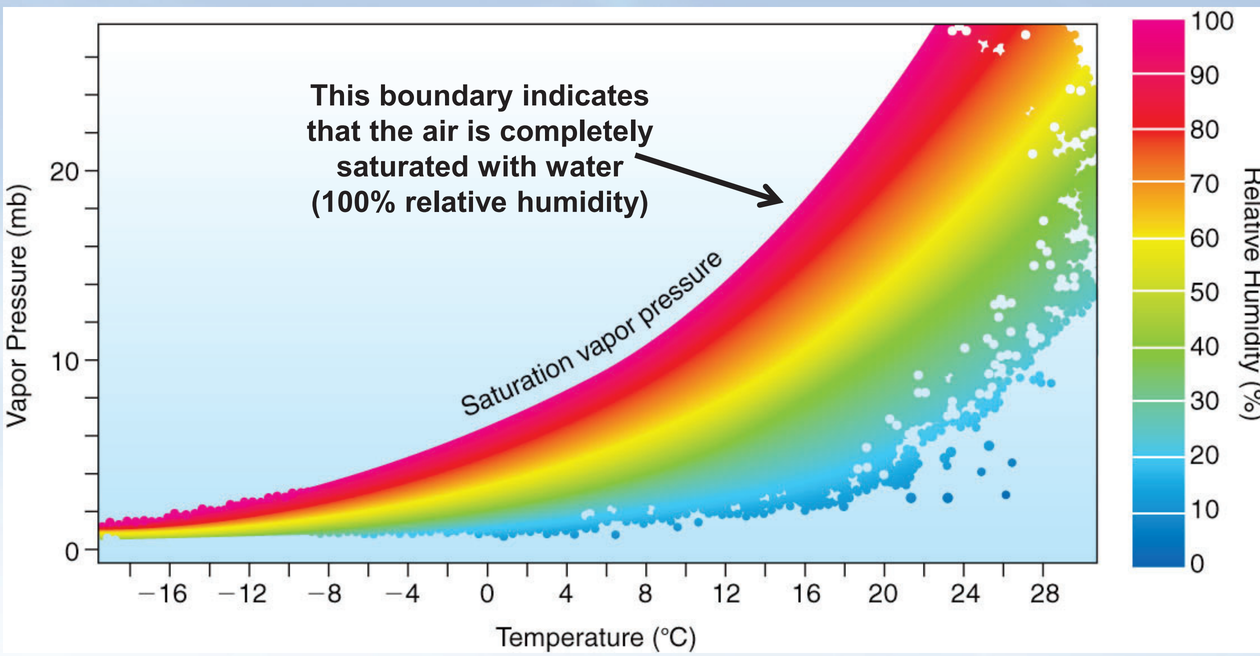
1) Decrease the air temperature

2) Increase the amount of water vapor



http://weather.weatherbug.com/MD/College%20Park-weather.html

Vapor Pressure

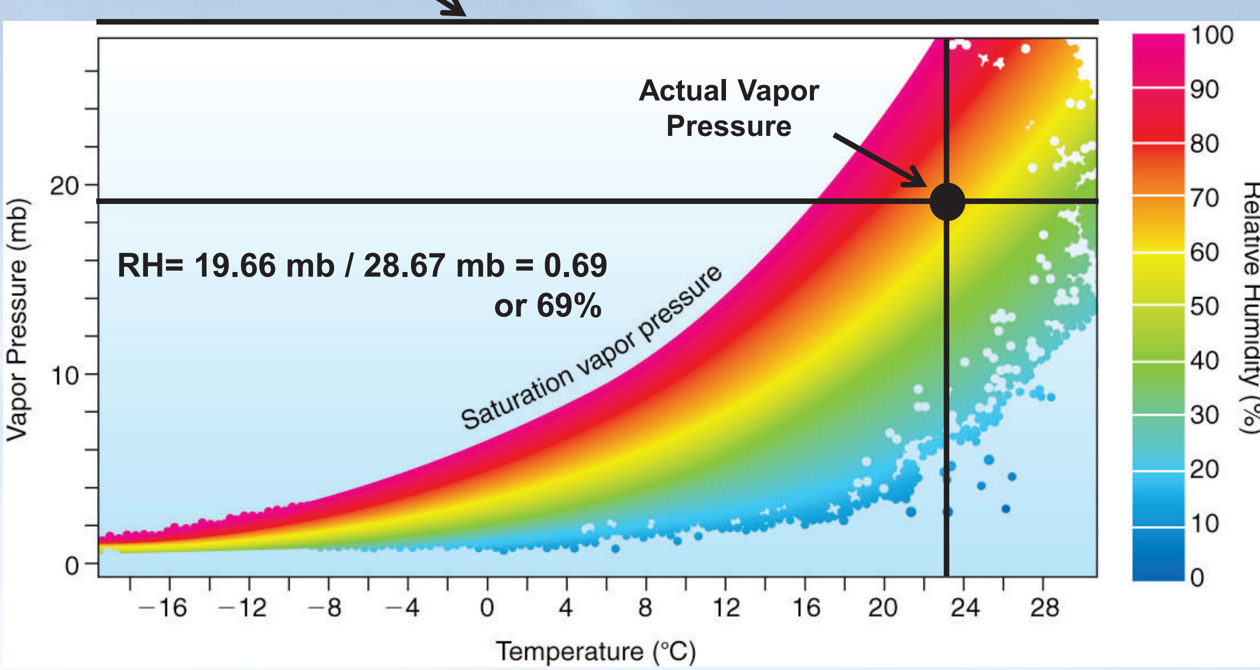


Actual vapor pressure: the atmospheric pressure due to water
Saturation vapor pressure: the atmospheric pressure if the air was saturated

Fig 4-3 *Meteorology: Understanding the Atmosphere*

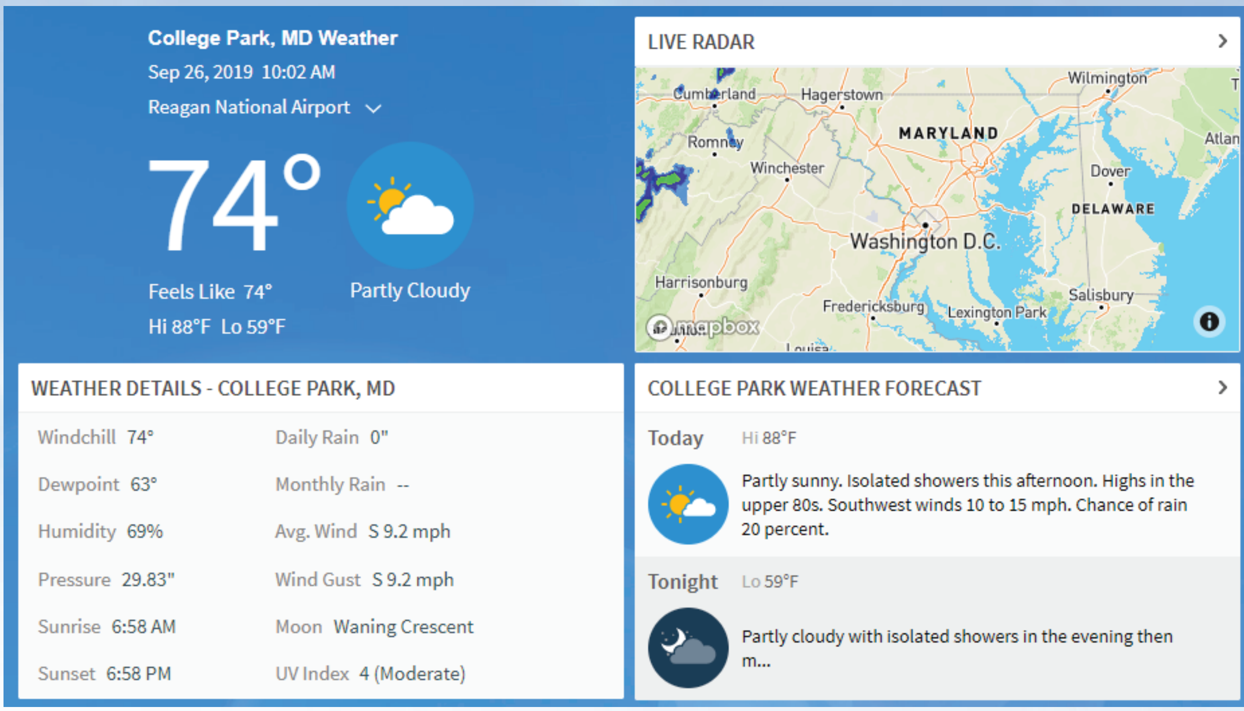
Vapor Pressure

Sat'n Vapor Pressure



Actual vapor pressure: the atmospheric pressure due to water
Saturation vapor pressure: the atmospheric pressure if the air was saturated

Fig 4-3 *Meteorology: Understanding the Atmosphere*

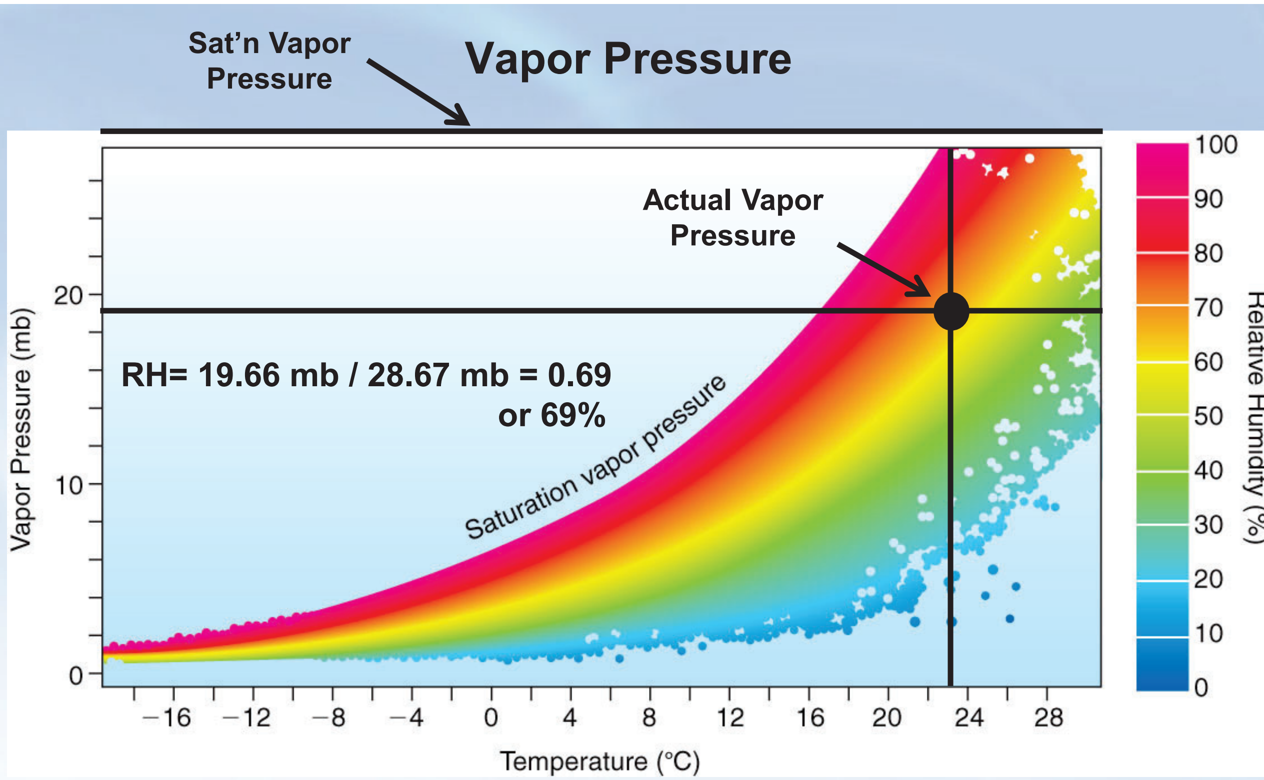


http://weather.weatherbug.com/MD/College%20Park-weather.html

Different ways to think about humidity

1. **Absolute humidity: the mass of water vapor per volume**
2. **Specific humidity: the mass of water vapor per mass of dry air**
3. **Relative humidity: percent of water vapor present in air compared to the maximum at saturation; RH= e/e_s**

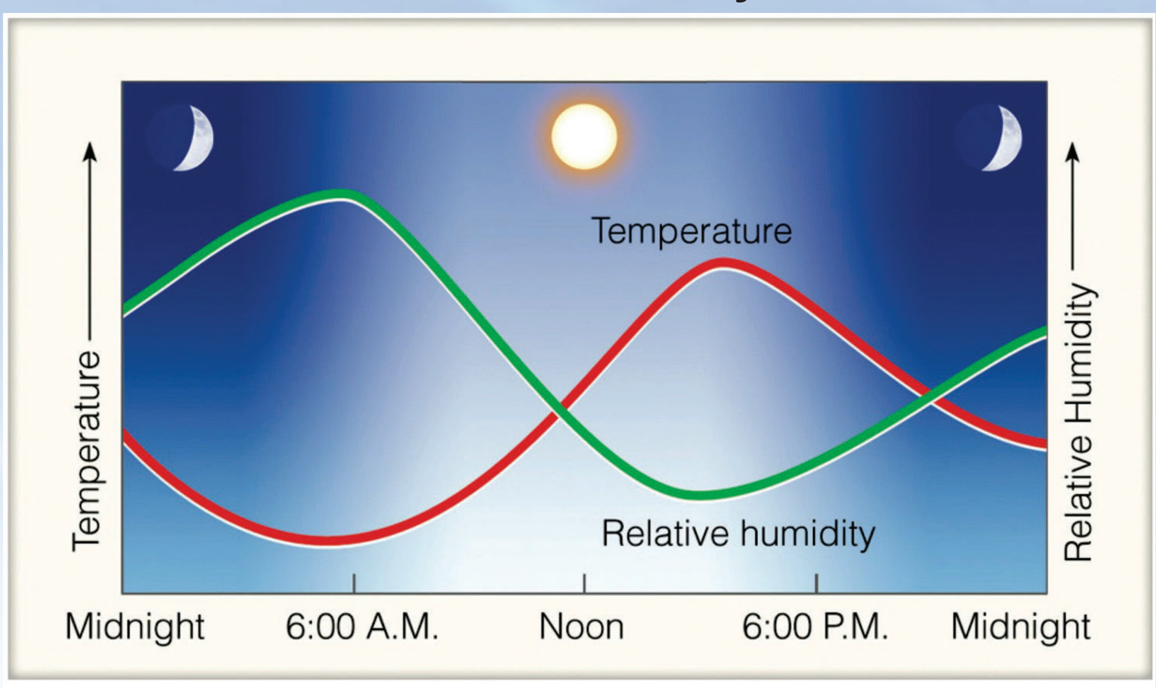
Vapor Pressure



Actual vapor pressure: the atmospheric pressure due to water
Saturation vapor pressure: the atmospheric pressure if the air was saturated

Fig 4-3 *Meteorology: Understanding the Atmosphere*

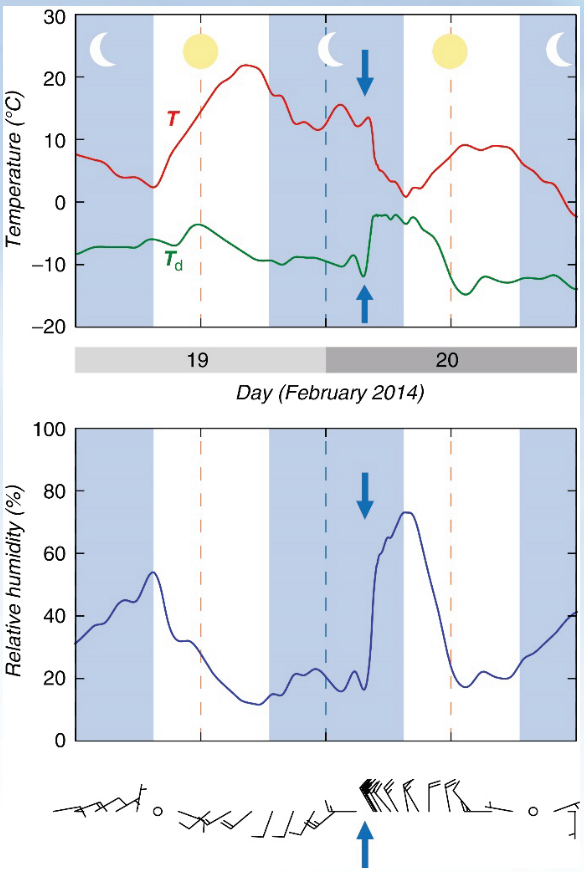
Relative Humidity



Temperature and relative humidity are "anti-correlated"

Fig 4.7: *Essentials of Meteorology*

Relative Humidity



As T and T_d get closer, relative humidity increases

The blue arrows indicate when a cold front passed through

Fig 5.8 *Weather: A Concise Introduction*

Relative Humidity

T (°C)	e_s (hPa)	*e* (hPa)	RH (%)
20	23	15	65
19	22	15	68
18	21	15	72
17	19	15	75
16	18	15	83
15	17	15	88
14	16	15	94
13	15	15	100
12	14	14	100
11	13	13	100
10	12	12	100

As T decreases, saturation vapor pressure (e_s) decreases while vapor pressure (*e*) stays constant

Relative humidity increases

Vapor pressure does start to decrease after RH reaches 100% and e_s continues to drop

Why?

Table 5.1 *Weather: A Concise Introduction*

Dew Point

Fig 5.5 *Weather: A Concise Introduction*

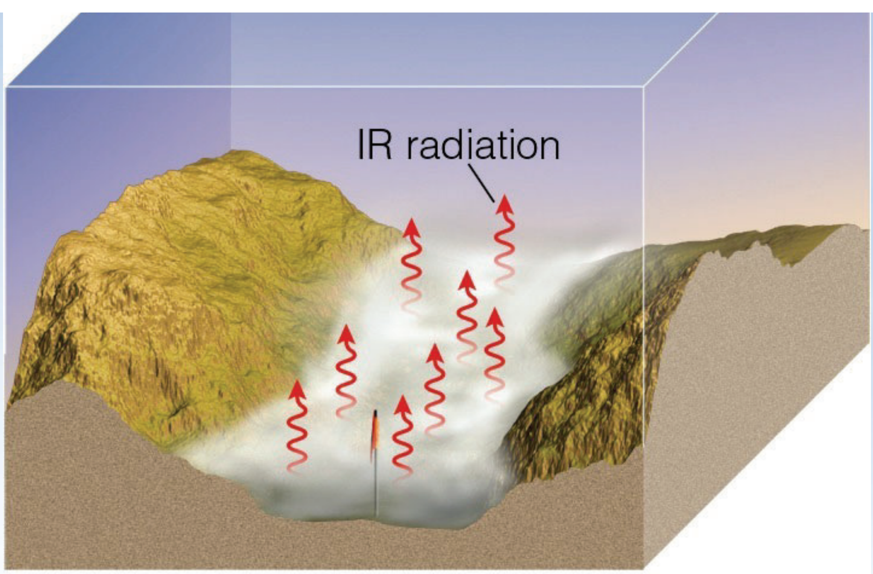
Frost Point (when T_d is at or below freezing)

Fig 5.6 *Weather: A Concise Introduction*

Fog

Radiation Fog

**The surface cools as heat radiates away.
Air close to the ground cools enough for water to condense in the air**



(a) Radiation fog

Fig 4.21: *Essentials of Meteorology*

Radiation Fog

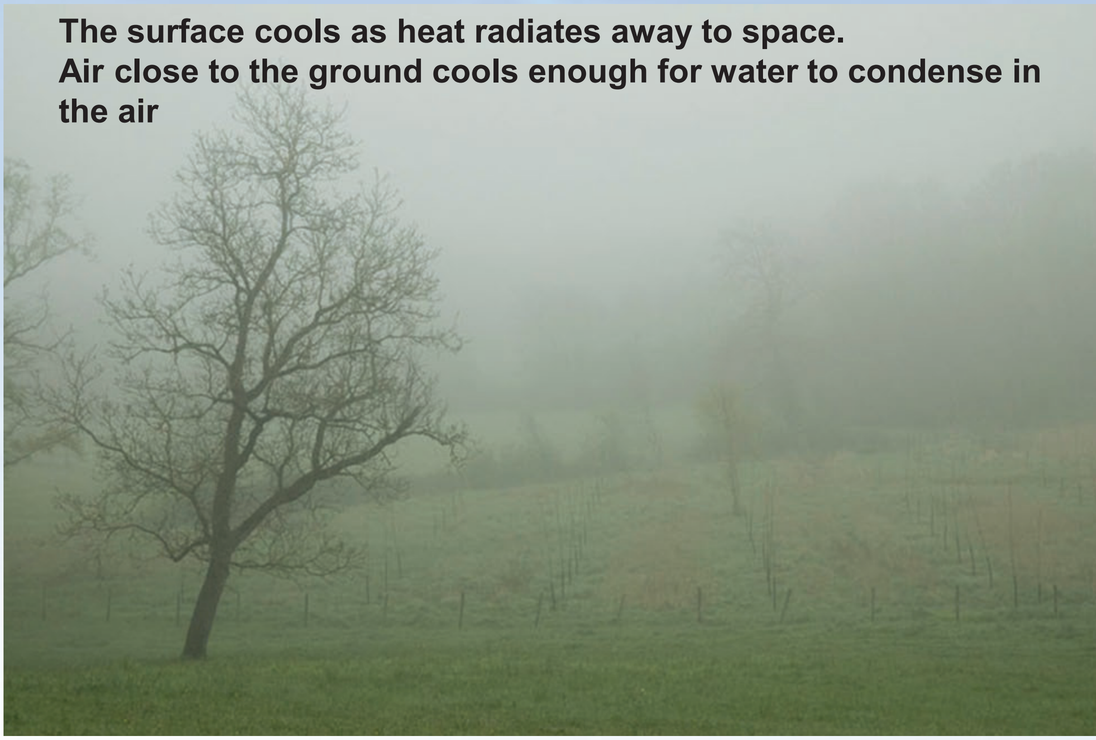
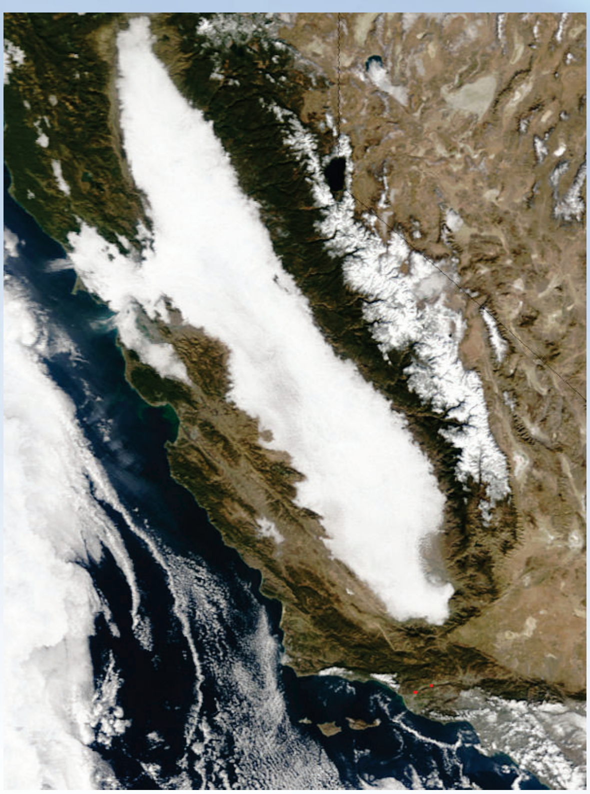


Fig 6.1.2 *Weather: A Concise Introduction*

Tule Fog



Tule fog: radiation fog that occurs in the central valley of California from late Fall to early Spring.

http://eoimages.gsfc.nasa.gov/images/imagerecords/72000/72843/California.A2005350.1850.1km.jpg

Valley Fog

The surface cools as heat radiates away to space.
Air close to the ground cools enough for water to condense in the air.

© C. Donald Ahrens

Fig 4.19: ***Essentials of Meteorology***

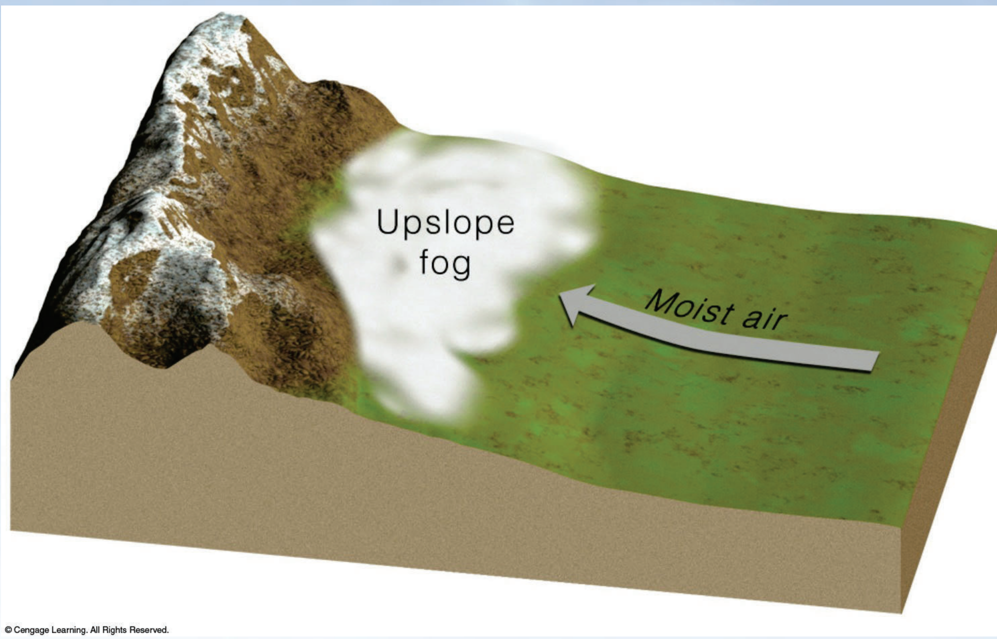
Advection Fog

Warm, moist air blows over a cold surface (land or water) and cools enough for droplets to form

© Herbert Spichtinger/Corbis Edge/Corbis

Fig 4.20: ***Essentials of Meteorology***

Upslope Fog



Winds push moist air uphill to an altitude where temperatures are cold enough for condensation to occur

Fig 4.22: ***Essentials of Meteorology***

Evaporation or Steam Fog

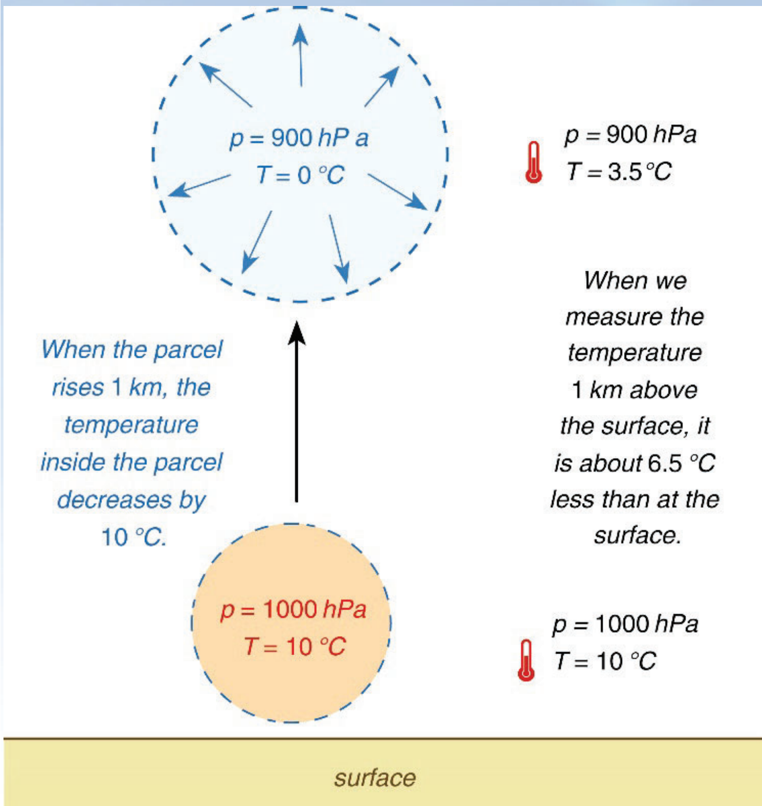
Fig 6.1.1 *Weather: A Concise Introduction*

Where do clouds come from?

Hot air rises!

What happens then?

Dry Adiabatic Lapse Rate

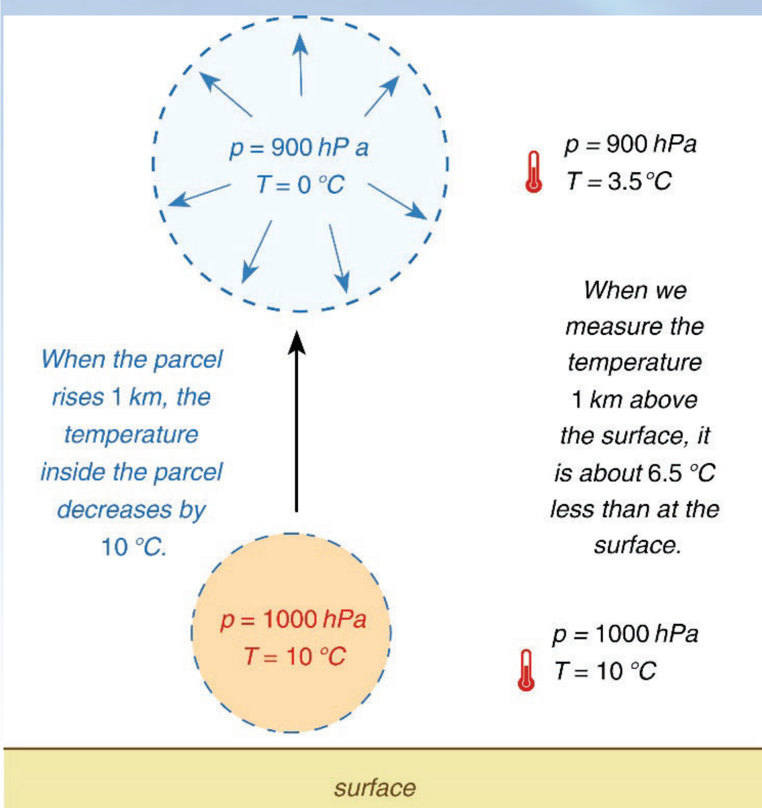


As an air parcel rises, it expands into lower pressure air. As it expands, all of the energy inside is spread out over a larger volume so the temperature drops

If there's no interaction between the air inside the parcel and the outside environment the process is said to be **adiabatic**

Fig 6.2 *Weather: A Concise Introduction*

Dry Adiabatic Lapse Rate

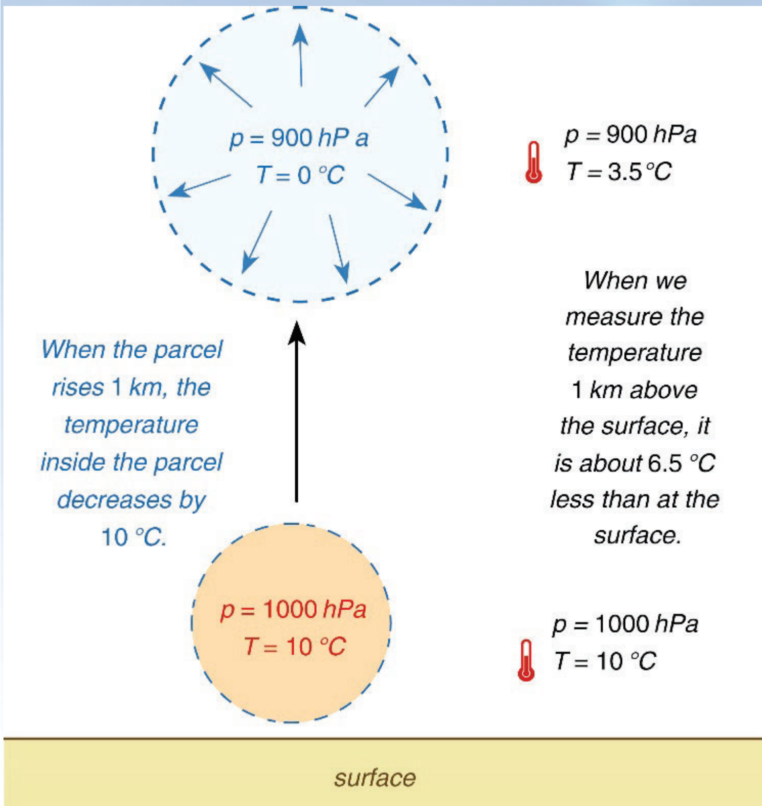


The drop in temperature is called "adiabatic cooling".

What is it called when temperature decreases with height?

Fig 6.2 *Weather: A Concise Introduction*

Dry Adiabatic Lapse Rate



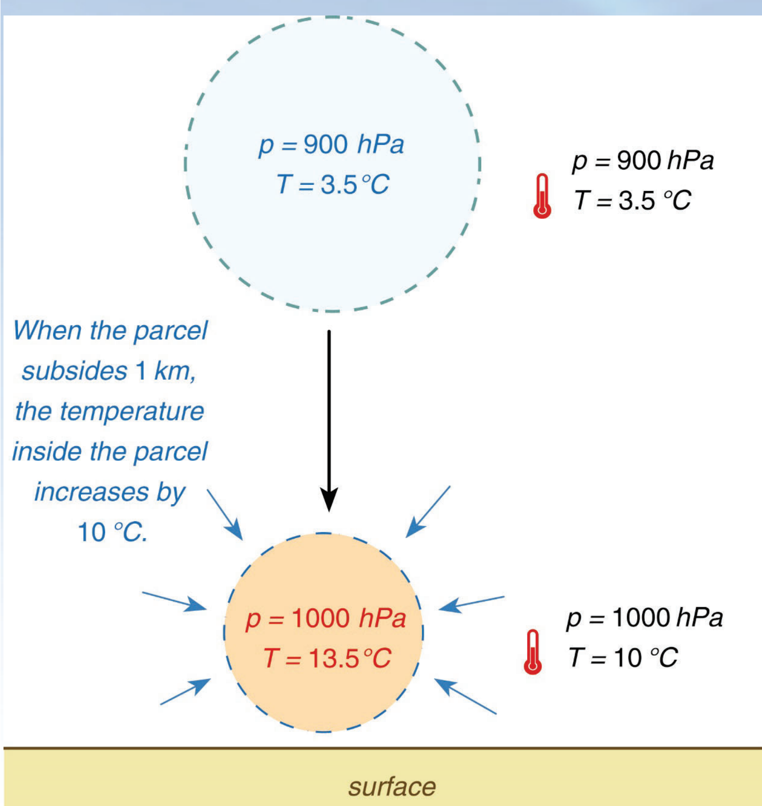
For every kilometer **increase**, the temperature inside the parcel **cools** by 10°C

The environmental lapse rate is 6.5°C per km.

The air inside the parcel cools more quickly than the air outside.

Fig 6.2 *Weather: A Concise Introduction*

Dry Adiabatic Lapse Rate



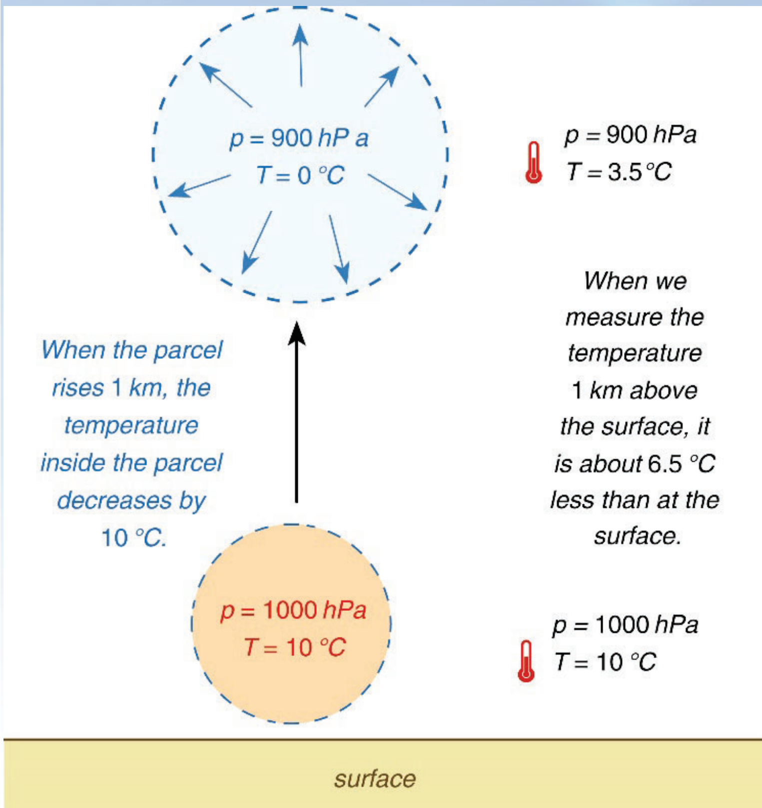
For every kilometer **decrease**, the temperature inside the parcel **warms** by 10°C

The environmental lapse rate is 6.5°C per km.

The air inside the parcel warms more quickly than the air outside.

Fig 6.3 *Weather: A Concise Introduction*

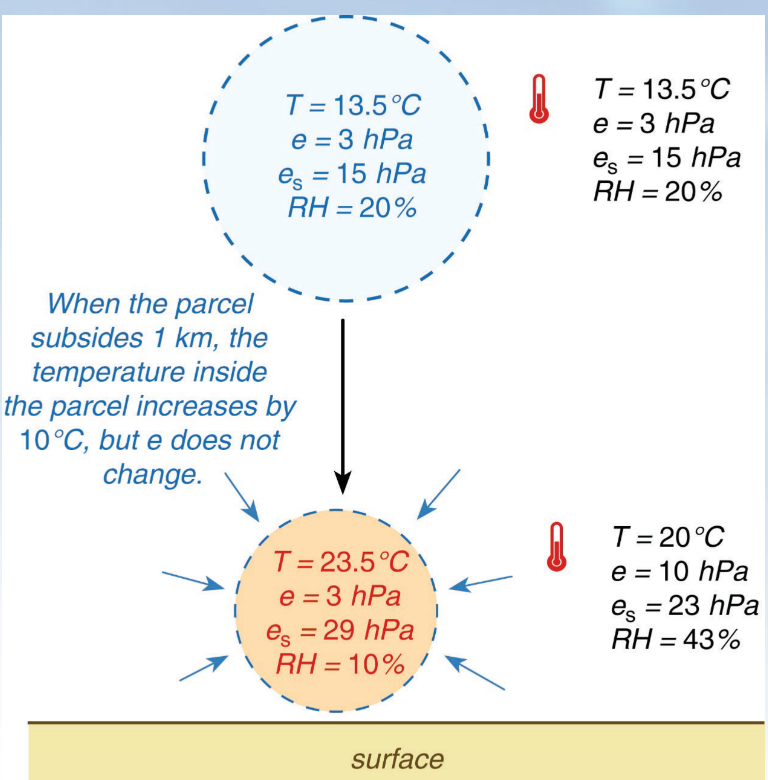
Dry Adiabatic Lapse Rate



When the air parcel cools, what will happen to the RH inside the parcel?

Fig 6.2 *Weather: A Concise Introduction*

Dry Adiabatic Lapse Rate



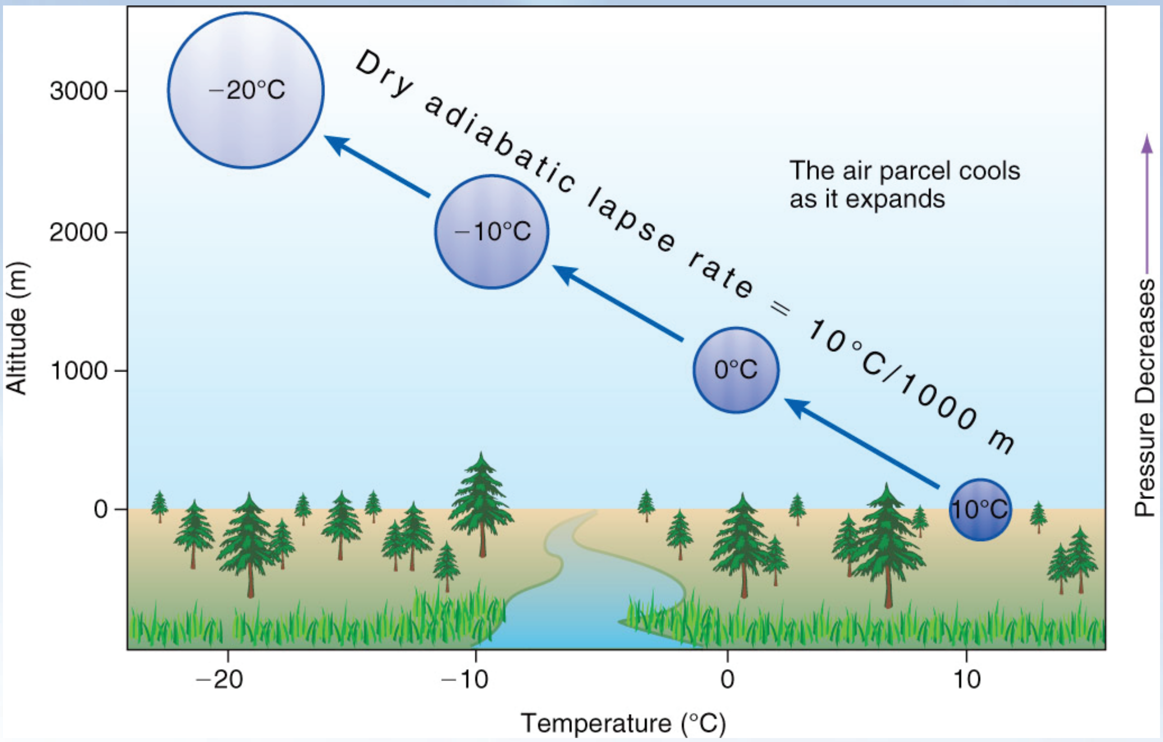
When the air parcel *subsides* (falls toward the surface) the parcel shrinks because of the higher pressure.

Temperature inside the parcel increases and the saturation vapor pressure increases.

RH goes down; the parcel dries out

Fig 6.6 *Weather: A Concise Introduction*

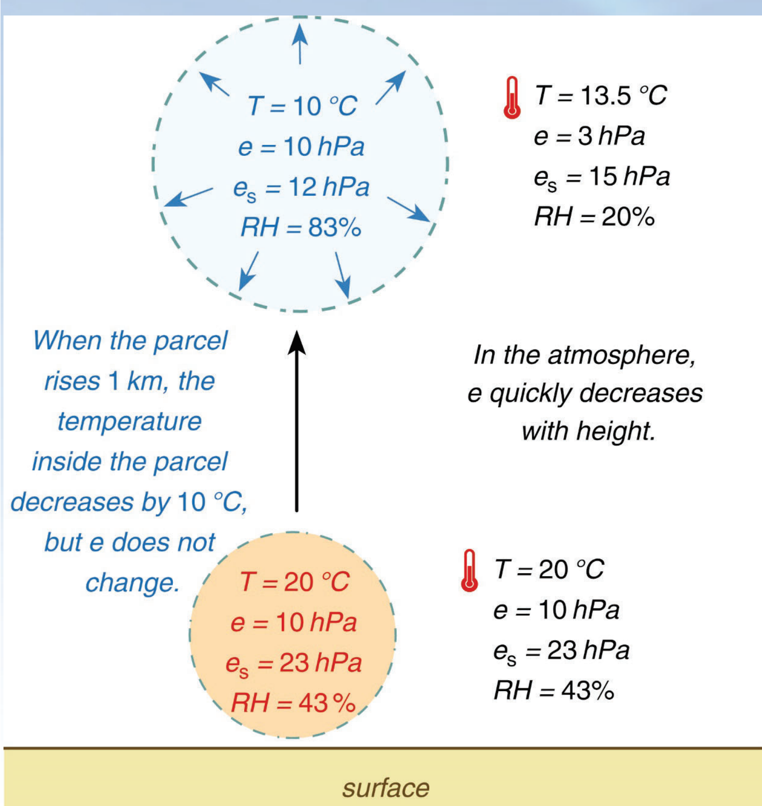
Lapse Rate



Dry adiabatic lapse rate: if no cloud forms, air will cool at 10°C per kilometer.

Fig 3-19 *Meteorology: Understanding the Atmosphere*

Dry Adiabatic Lapse Rate



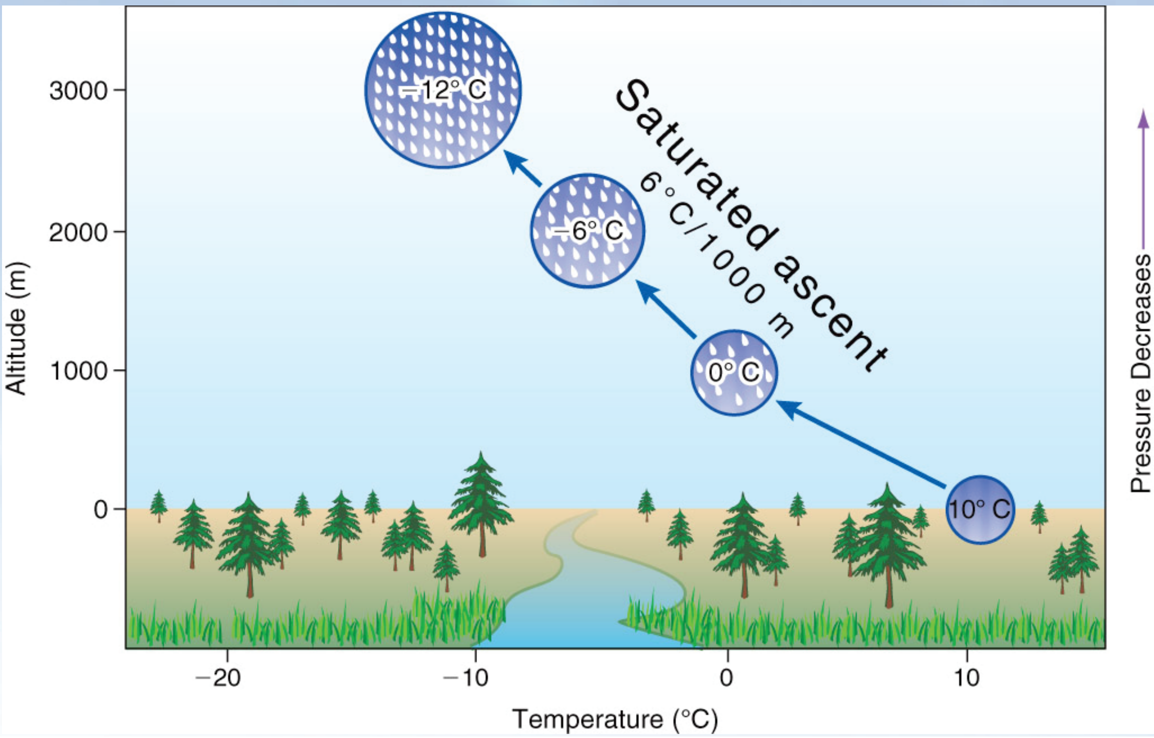
What happens when the RH reaches 100% but the parcel keeps rising?

The parcel still cools at 10°C per km…

but…

What is released when water vapor condenses???

Saturated Adiabatic Lapse Rate



Once water begins to condense, latent heat is released. The air parcel cools at a slower rate than if the air parcel was dry

Fig 4-14 *Meteorology: Understanding the Atmosphere*