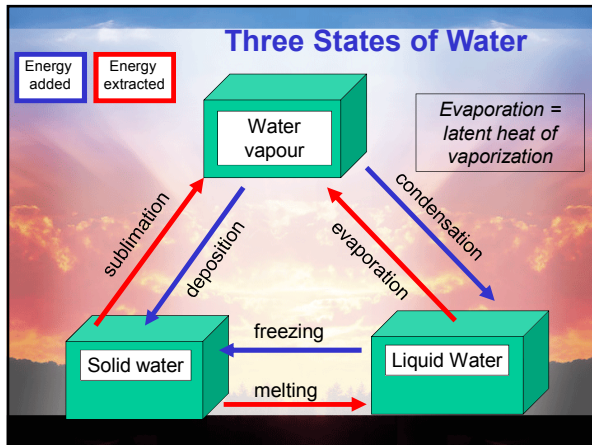
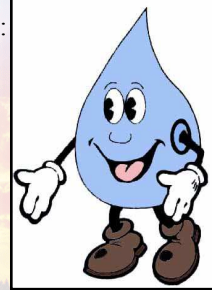


## Atmospheric Moisture and Precipitation

- Three States of Water
- The Hydrosphere and the Hydrologic Cycle
- Humidity
- The Adiabatic Process
- Clouds
- Precipitation

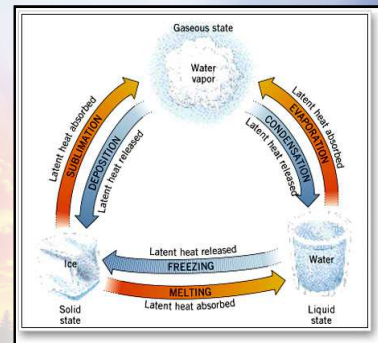
## Three States of Water

- ❑ Water exists in three states: **solid, liquid and gas**
- ❑ A change of state requires the input of heat energy called latent heat



### Three States of Water

Water exists in the air in the form of water vapor, clouds, fog, and precipitation



### Heating Effect

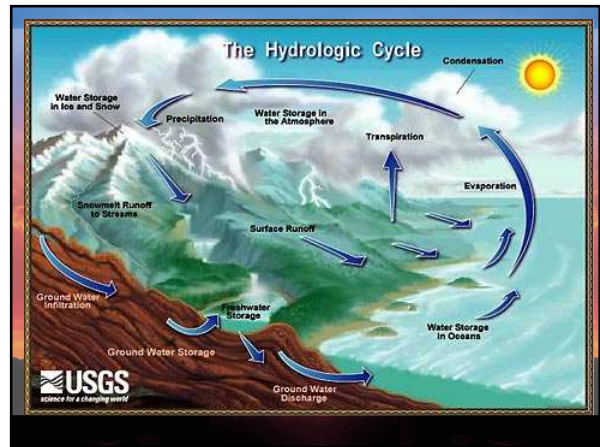
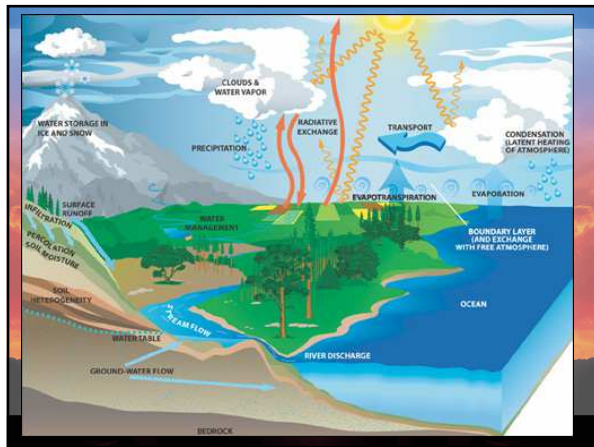
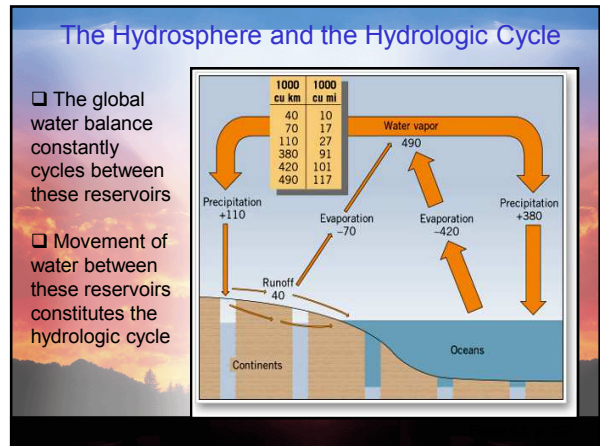
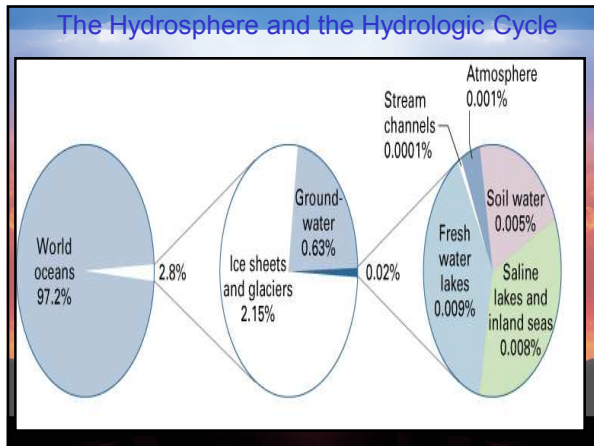


### Cooling Effect



## Atmospheric Moisture and Precipitation

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- ### Atmospheric Moisture and Precipitation
- Three States of Water
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  - Precipitation

- ### Atmospheric Moisture
- Invisible in the form of water vapor gas (only what we can't see)
  - Where does it come from?  
Solar radiation heats water changing it into a gaseous state
- 
- Warm air can hold much more water than cold air

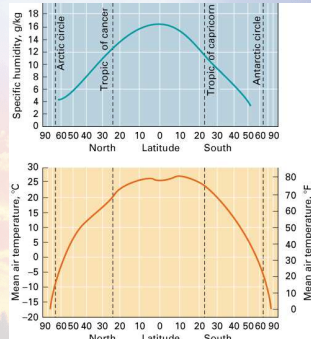
## Measures of water vapor

- **Humidity:** is the amount of water vapor present in the atmosphere
- Two ways to describe humidity
  - specific humidity and
  - relative humidity



## Specific Humidity

- The actual quantity of water vapor in the air
- Measure of the quantity of water in the atmosphere that can be extracted as precipitation



## Relative Humidity

(The measure we encounter daily)

- Measure of the amount of water vapor present in air *relative* to the maximum amount that the air can contain at a given temperature (%)
  - e.g. if relative humidity is 50%, then it contains 1/2 the amount of water vapor it could hold at a given temperature
- Relative humidity decreases as temperature increases

Temp. ↑ Increase, ability to hold water increases  
Then RH ↓ Decreases

## Relative Humidity and Temperature

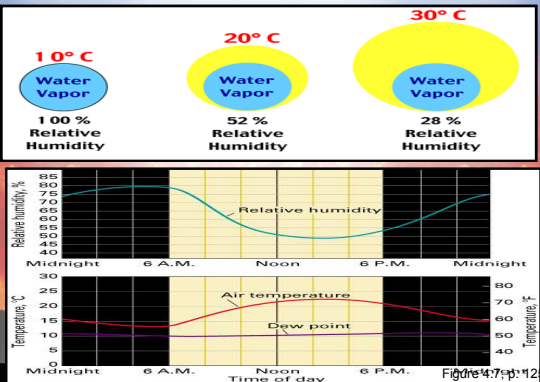
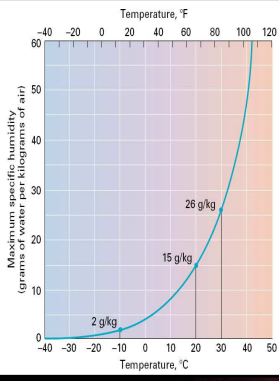
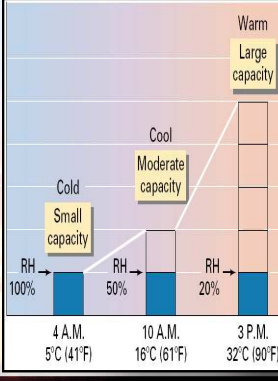


Figure 4-7a p. 112

## Dew Point Temperature

- As air is cooled it eventually becomes saturated (100% relative humidity)
- the temperature of saturation is called the **dew point temperature**
- If cooling continues, condensation begins and dew forms

## Atmospheric Moisture and Precipitation

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- **The Adiabatic Process**
- Clouds
- Precipitation

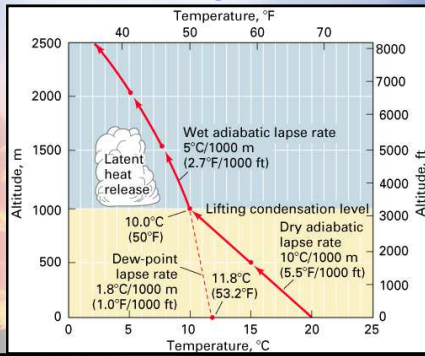
## The Adiabatic Process

(heating or cooling of air that results from a change of the volume of air)

- ❑ When a gas expands, its volume increases and its pressure and temperature decrease and vice-versa.
- ❑ The adiabatic lapse rate is used to quantify how the temperature of air decreases as it rises or increases as it ascends
- ❑ Lapse rates differ for dry (unsaturated) and wet (saturated) air masses

## Dry Adiabatic Lapse Rate

Decrease in temperature with altitude: 5.5°F/1000ft  
(decrease in air pressure, air expands)

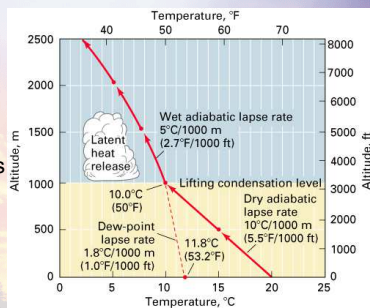


## Wet (Saturated) Adiabatic Lapse Rate

- ❑ Ranges from 2 to 4° F/1000ft – 3.5°F/100ft
- ❑ Varies because it depends on temperature, pressure and water vapor content
- ❑ Less than the DALR because as water condenses it releases latent heat, so the temperature decrease is less

## Wet Adiabatic Lapse Rate

- ❑ As a parcel of air rises, it cools and becomes saturated at the dew point
- ❑ When it reaches its dew point, condensation occurs (**lifting condensation level**)



## Atmospheric Moisture and Precipitation

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- Clouds
- **Rising Air**

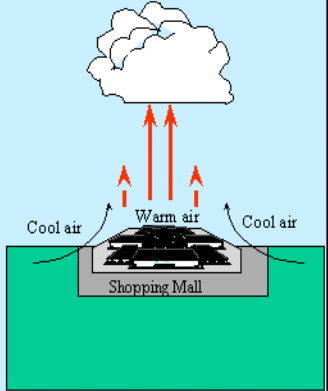
## 3 WAYS AIR RISES

Convective  
Orographic  
Frontal (cyclonic)

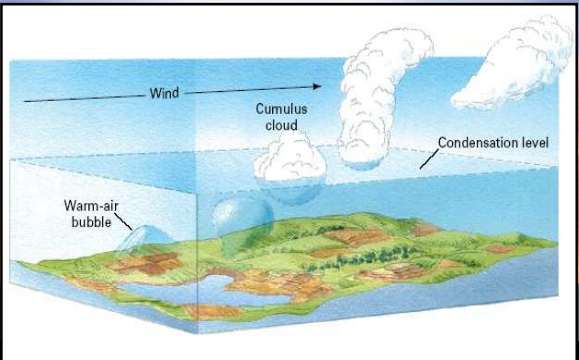


## Convective Precipitation

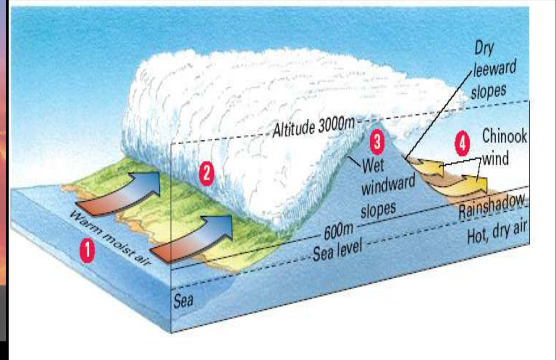
- Unequal heating at the earth's surface creates a local hot spot.
- Air in contact with the hot spot expands and rises.
- Rising air cools adiabatically to dew point temperature.



## Convective

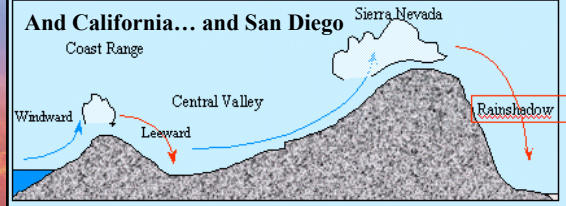


## 2. Orographic lifting



## Orographic Precipitation

And California... and San Diego

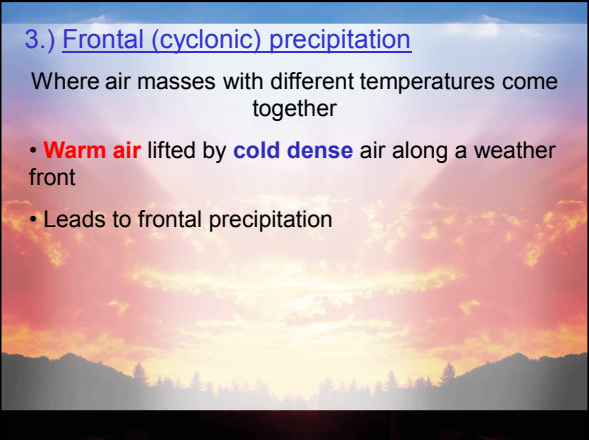


- Air rises to cross mountains
- Rising air expands and cools adiabatically.
- At dew point temperature, it condenses and forms clouds.
- Continued condensation may produce rain or snow.

## 3.) Frontal (cyclonic) precipitation


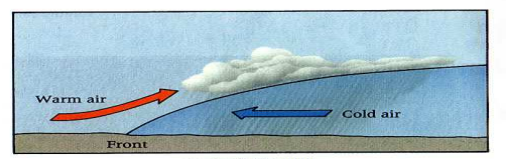
Where air masses with different temperatures come together

- **Warm air** lifted by **cold dense** air along a weather front
- Leads to frontal precipitation



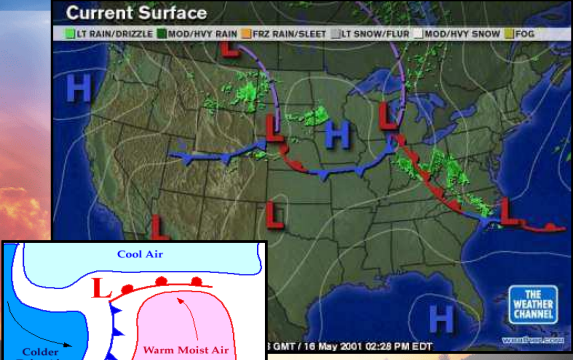
### Cyclonic or Frontal Precipitation

- Warm air in contact with cold air rises.
- As it rises, it cools adiabatically.
- Moist air condenses and forms clouds.

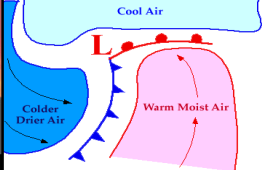
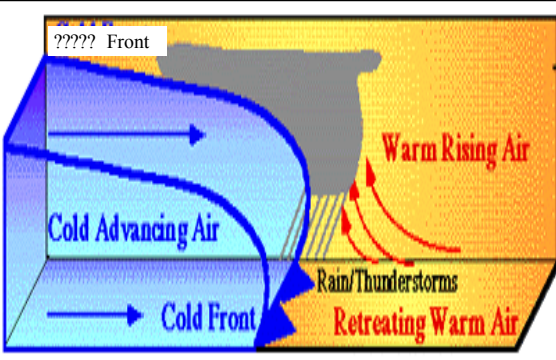



Cyclonic (frontal)

### Current Surface



GMT / 10 May 2001 02:28 PM EDT

????? Front

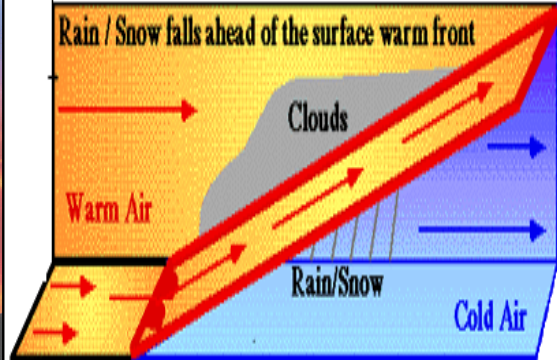
Cold Advancing Air

Warm Rising Air

Rain/Thunderstorms

Cold Front

Retreating Warm Air



Rain / Snow falls ahead of the surface warm front

Warm Air

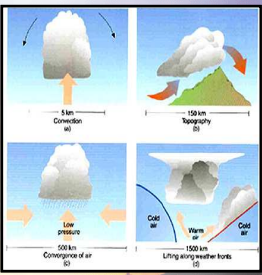
Cold Air

Clouds

Rain/Snow

Clouds are the source of precipitation

1. Water vapor condenses around particles, water droplets collide forming larger droplets until they are too large to stay in the air and fall to the ground as precipitation
2. In Cold clouds water freezes forming ice crystals that are too heavy and fall to the ground



### Types of Precipitation:

- Rain
- Freezing rain (ice crystals freeze onto a frozen surface)
- Snow (ice crystals have not melted)
- Sleet (ice crystals melt as they fall)

## Atmospheric Moisture and Precipitation

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## Clouds

- ❑ Made up of water droplets and/or ice particles
- ❑ Form when air is saturated AND contains particles (condensation nuclei) e.g. dust, salts



## Clouds

### Families and Forms:

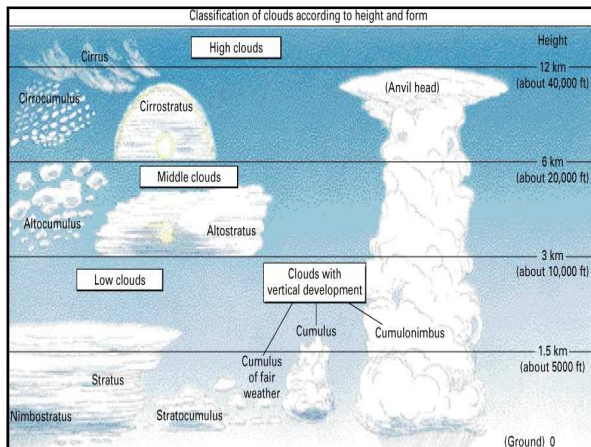
- Classified into four families: high, medium and low clouds and clouds with vertical development
- Two major classes:
  - Stratiform (layered): blanket like covering large areas
  - Cumuliform (convective or piled up): globular masses associated with parcels of rising air.

## Naming Clouds

Latin Root	Translation	Example
cumulus	heap	cumulus
stratus	layer	altostratus
cirrus	curl of hair	cirrus
nimbus	rain	cumulonimbus



Cloud Height determines cloud Prefix. Ex: "cirr"=high level  
"alto"=mid-level



## Fog

- Cloud layer at or close to the Earth's surface
- **Radiation fog** forms at night when air near the ground falls below the dew point temperature
- **Advection fog** forms when warm moist air moves over a cool surface
- **Sea fog** forms when cool marine air comes in contact with cold ocean currents



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