Atmosphere

6th Grade Science

Solar Energy as Radiation

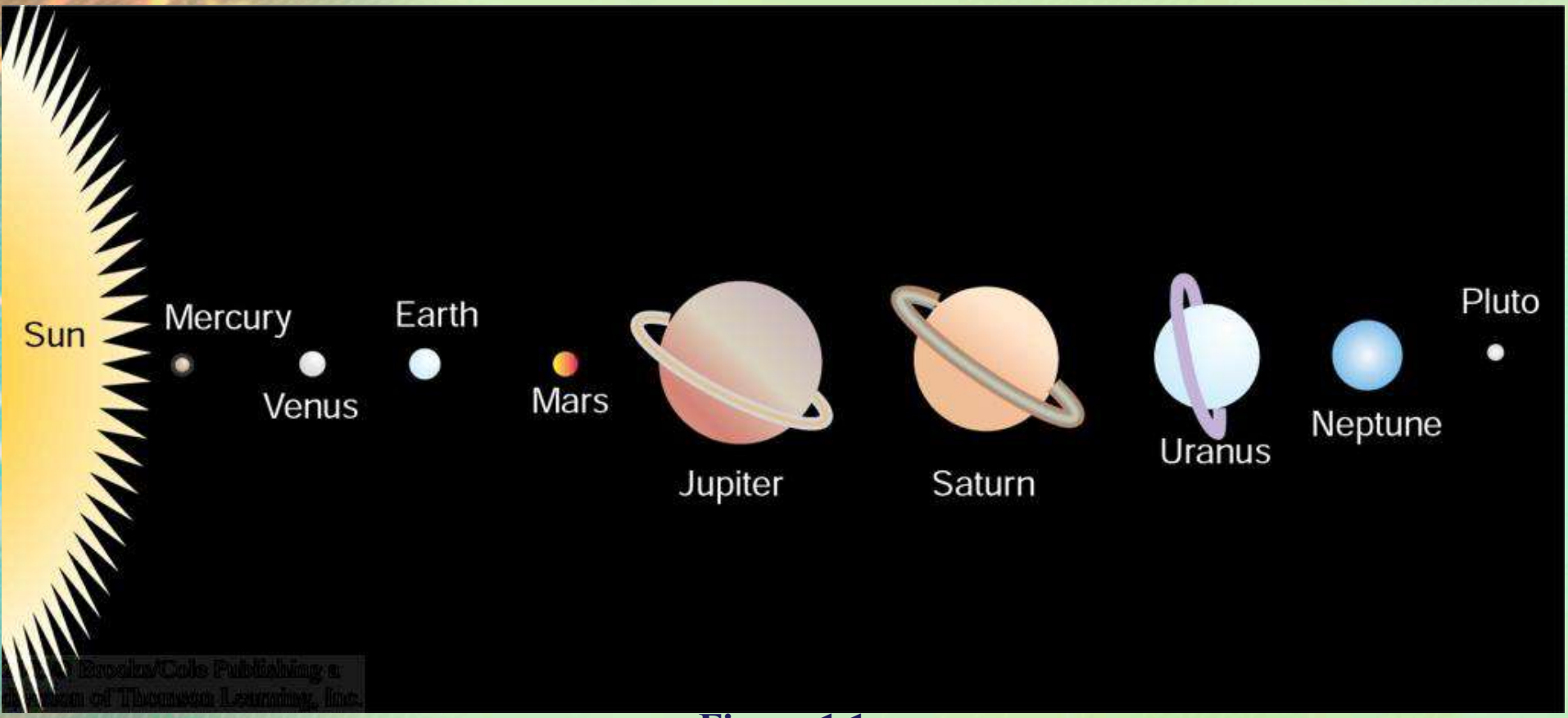


Figure 1.1

Nearly 150 million kilometers separate the sun and earth, yet solar radiation drives earth's weather.

Earth's Atmosphere

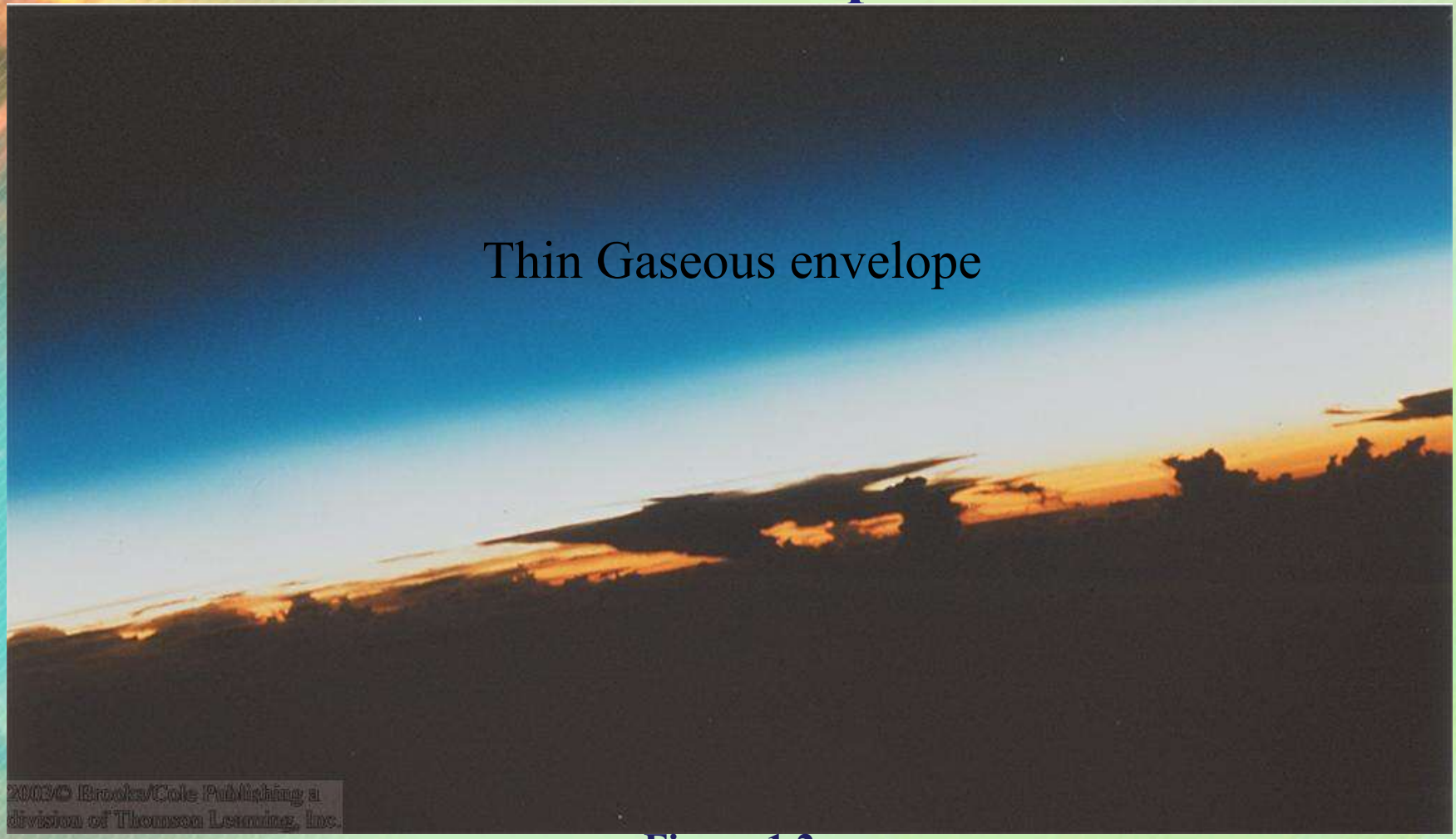


Figure 1.2

The atmosphere is a thin layer of air that protects the Earth's surface from extreme temperatures and harmful sun rays

Composition of Atmosphere
(Mixture of gases, solids, and liquids)

- Early atmosphere was much different than today
  - Volcanoes produced nitrogen and carbon dioxide, but little oxygen
  - More than 2 billion years ago, early organisms began producing oxygen
  - Eventually, oxygen formed an ozone layer that protected Earth from harmful rays
  - Green plants and diverse life forms developed

Atmospheric Gases

(Mixture of gases, solids, and liquids)

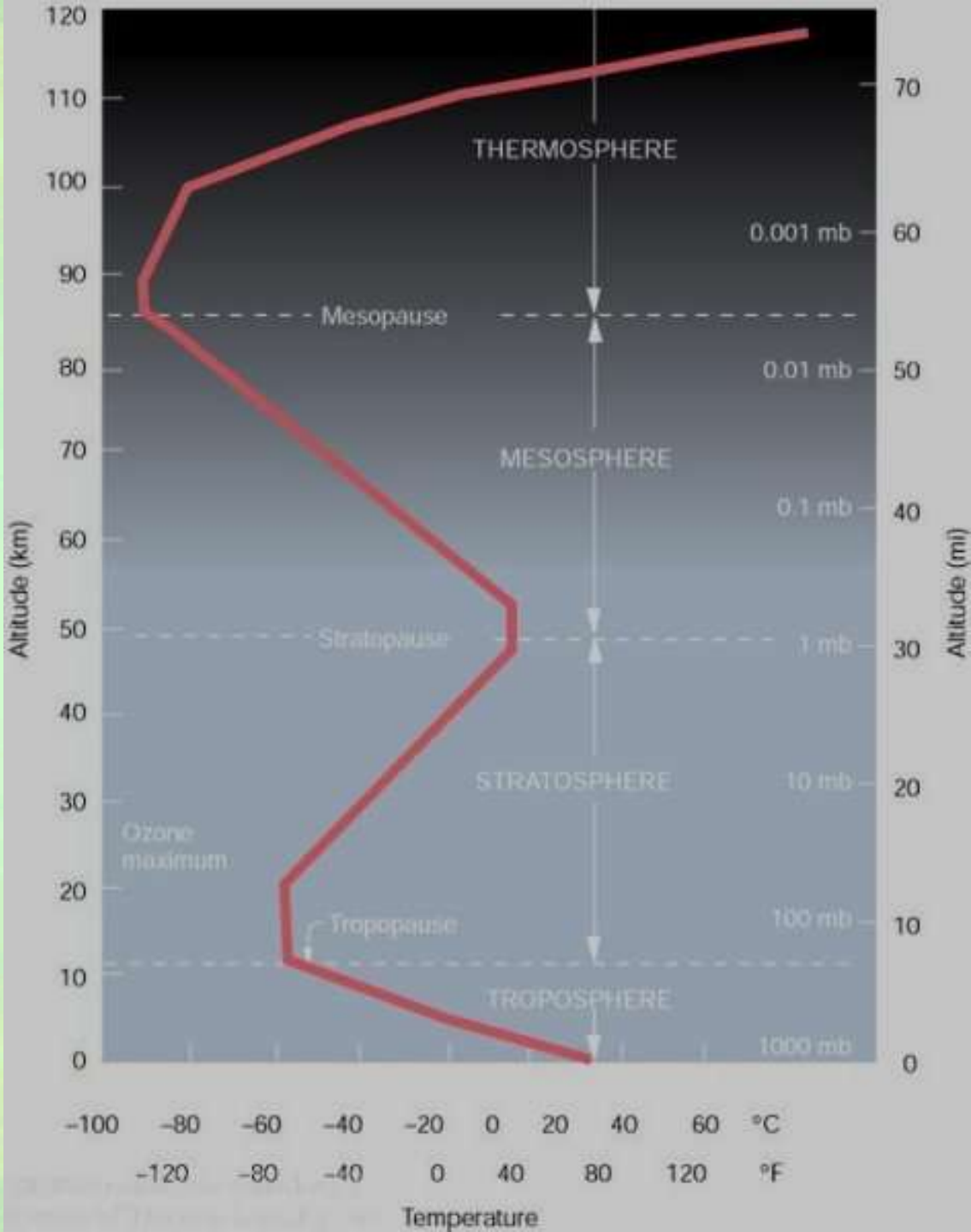
- Nitrogen - 78%
- Oxygen - 21%
- Water Vapor – 0 to 4%
  - Used for clouds and precipitation
- Carbon Dioxide - .037%
  - Keeps Earth warm and is used by plants to make food
- Argon - .93%
- Traces of neon, helium, methane, krypton, xenon, hydrogen, and ozone

Atmospheric Gases

(Mixture of gases, solids, and liquids)

- Atmosphere is changing with the introduction of pollutants; increasing human energy use is increasing the amount of carbon dioxide
- Pollutants mix with oxygen and other chemicals to form smog
  - Aerosols include solids such as dust, salt, and pollen
  - Liquids include water droplets and droplets from volcanoes

Five Layers of the Atmosphere



Lower Layers of Atmosphere

- Troposphere: lowest layer – extends up to 10km; contains 99% of the water vapor and 75% of the atmospheric gases
- The troposphere is the first layer above the surface and contains most clouds and half of the Earth's atmosphere.
  - **Weather** occurs in this layer.
  - Most of the layer's heat is from Earth
  - Temperature cools about 6.5 degrees Celsius per kilometer of altitude.

Lower Layers of Atmosphere

- Stratosphere – directly above troposphere, extending from 10 km to about 50 km above Earth's surface
  - Portion of the upper layer contains high levels of a gas called ozone
  - Many jet aircrafts fly in the stratosphere because it is very stable. Also, the ozone layer absorbs harmful rays from the Sun.

Upper Layers of Atmosphere

- Mesosphere – extends from the top of the stratosphere to about 85 km above Earth
  - Coldest layer with little ozone
  - Meteors or rock fragments burn up in the mesosphere.
  - Ionosphere here – layer of charged particles

Upper Layers of Atmosphere

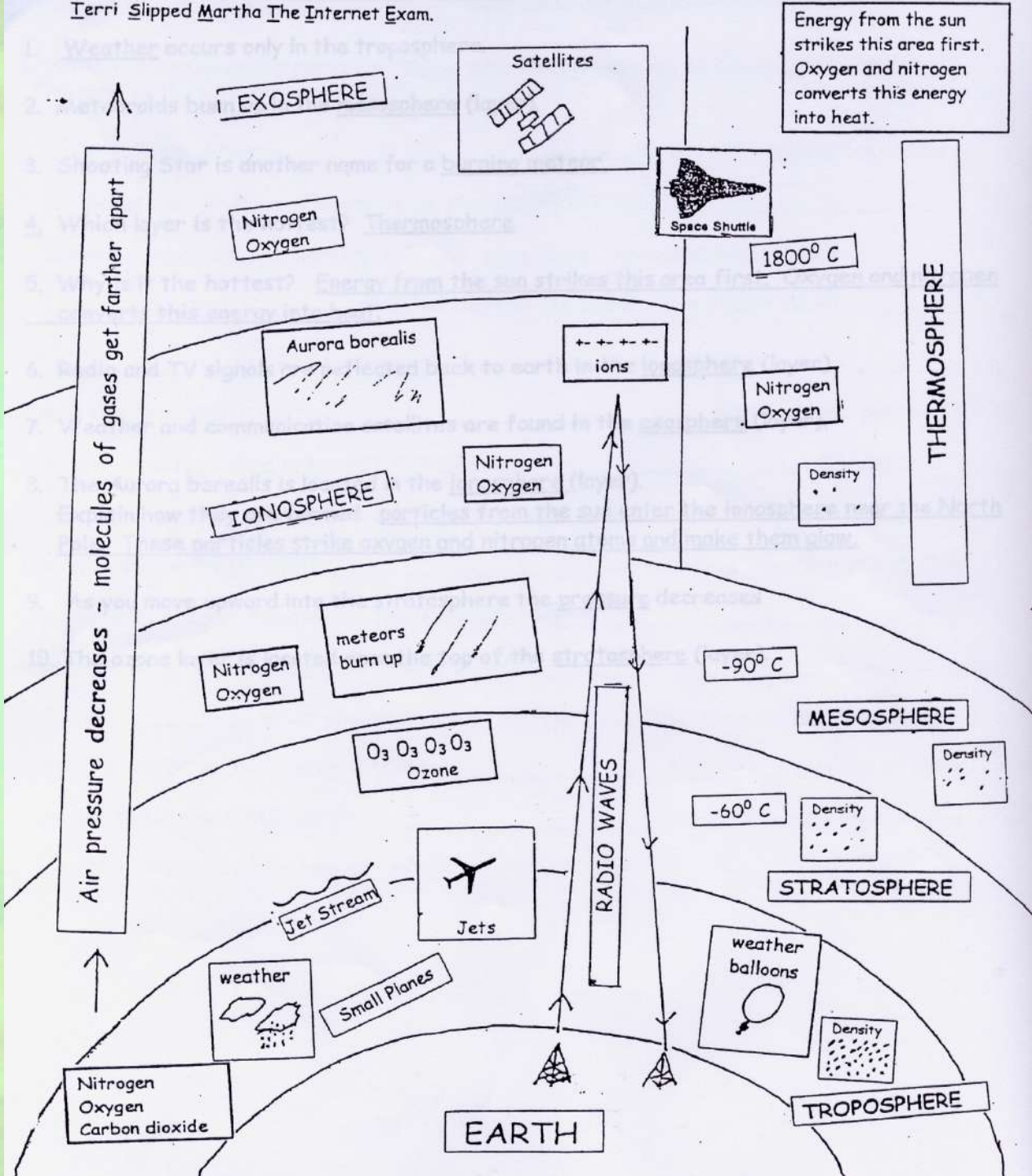
- Thermosphere – thickest atmospheric layer found between 85 km and 500 km above Earth's surface
- The thermosphere is a layer with auroras, known for its high temperatures.
  - Warms as it filters out X-rays and gamma rays from the Sun
  - Ionosphere here, too – help carry radio waves.

Upper Layers of Atmosphere

- **Exosphere - The atmosphere merges into space in the extremely thin exosphere. This is the upper limit of our atmosphere.**
- **Outer layer where space shuttle orbits.**

Layers of Atmosphere

Terri Slipped Martha The Internet Exam.



Atmospheric Pressure

- **Molecules closer to the surface are more densely packed (at higher pressure) together than those higher in the atmosphere because of the mass of gases pressing down on them from higher in the atmosphere**

Temperature in atmospheric layers

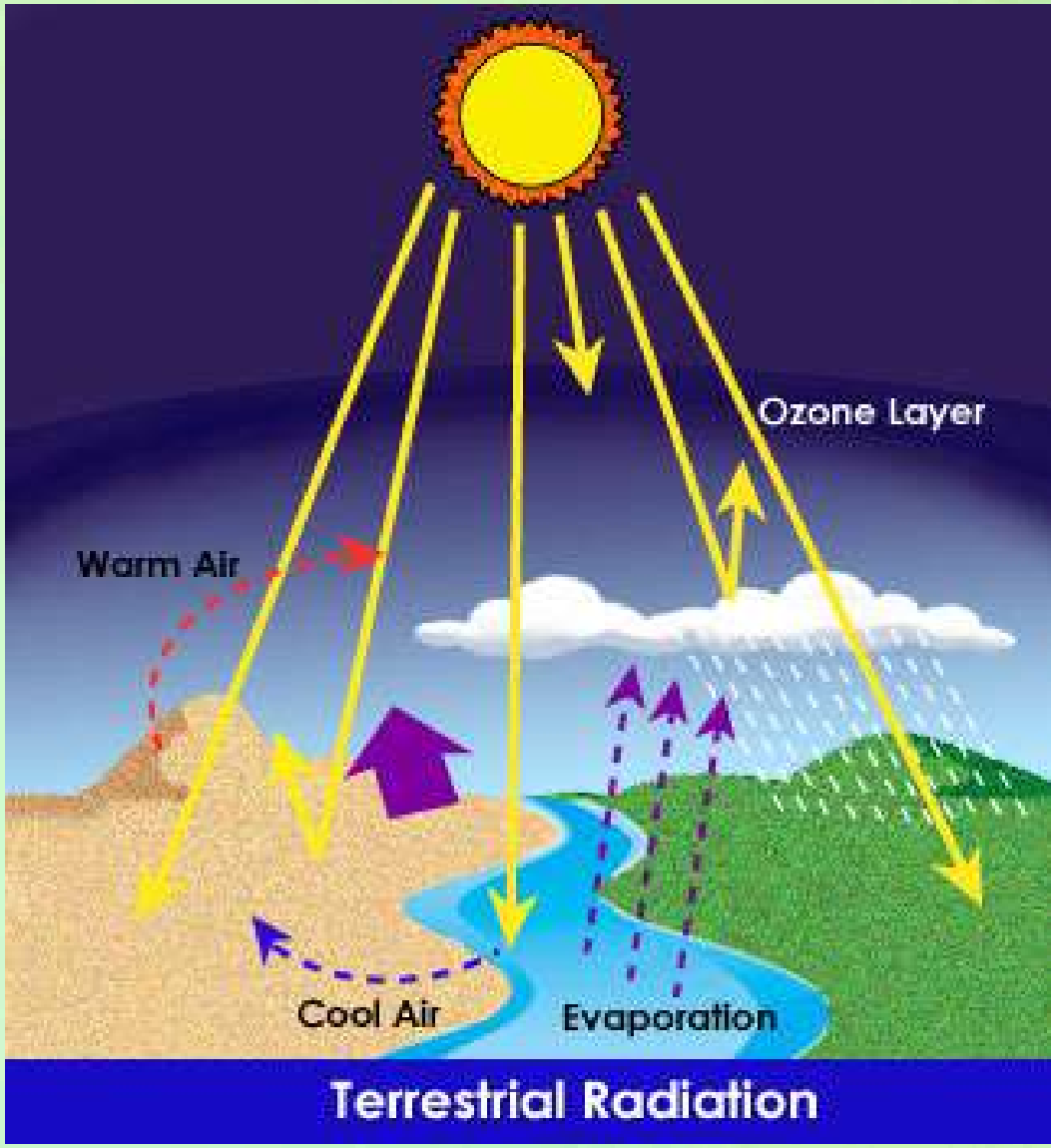
- The troposphere is warmed primarily by the Earth's surface; temperature decreases as altitude increases in this layer.
- Temperatures increase as altitude increases in the stratosphere, particularly in the upper portion – ozone
- Temperatures decrease with altitude in the mesosphere
- Thermosphere and exosphere are the first to receive Sun's rays, so they are very hot

The Ozone Layer

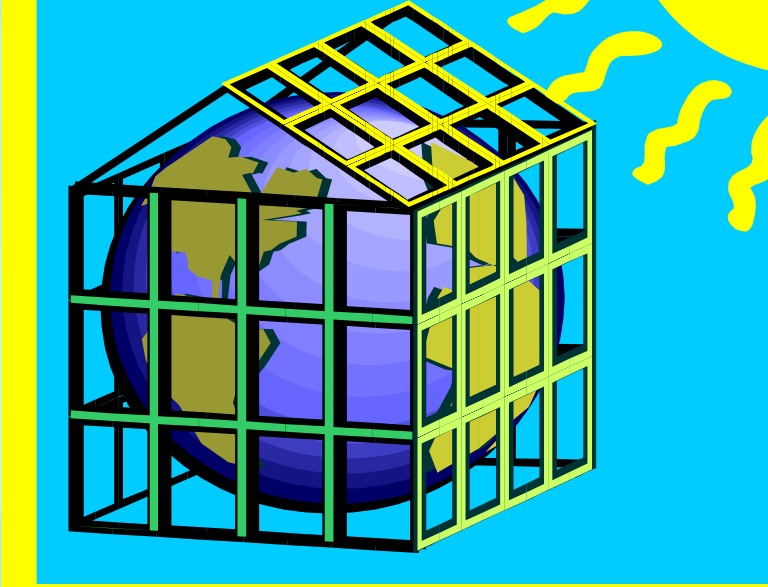
- About 19 km to 48 km above Earth in the stratosphere (90%) and troposphere (10%).
- Layer of 3-atom molecules that protects the Earth from the Sun's harmful ultraviolet radiation
- Life depends on the ozone!
- Pollutants called chlorofluorocarbons (CFCs) are destroying the ozone
- CFCs are used in refrigerators, air conditioners, aerosol sprays, and foam packaging ~ if products leak, CFCs enter atmosphere
- Ozone layers has a large hole over Antarctica and a smaller one over the North Pole

Solar energy

•Some of the Sun's energy coming through Earth's atmosphere is reflected or absorbed by gases and/or clouds in the atmosphere.

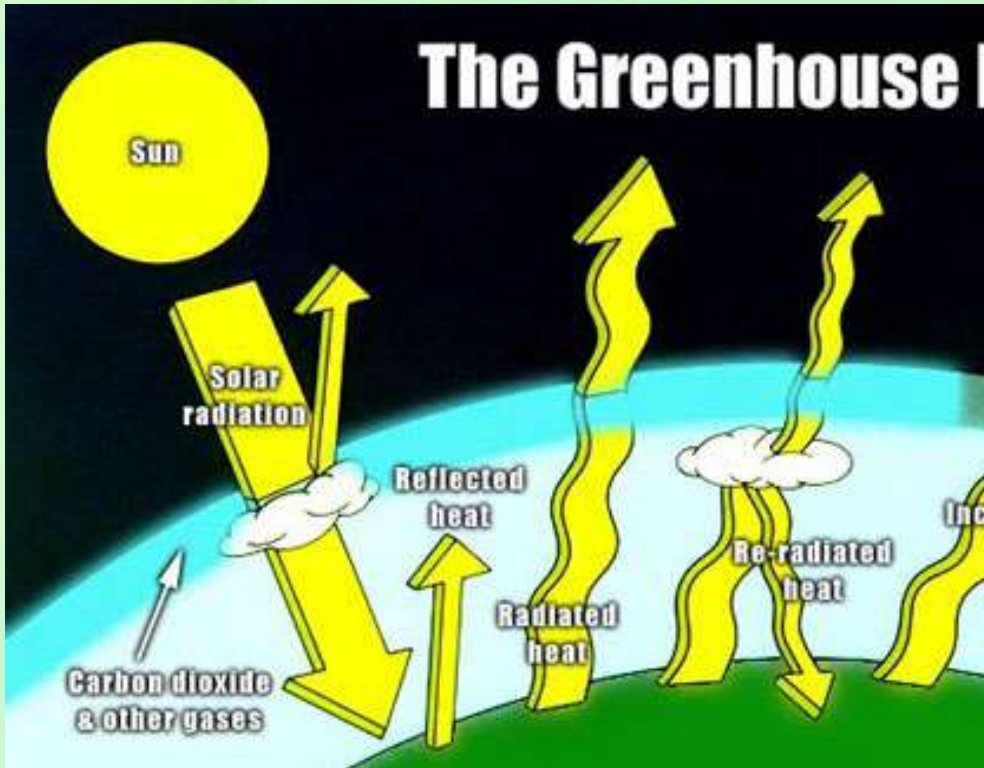


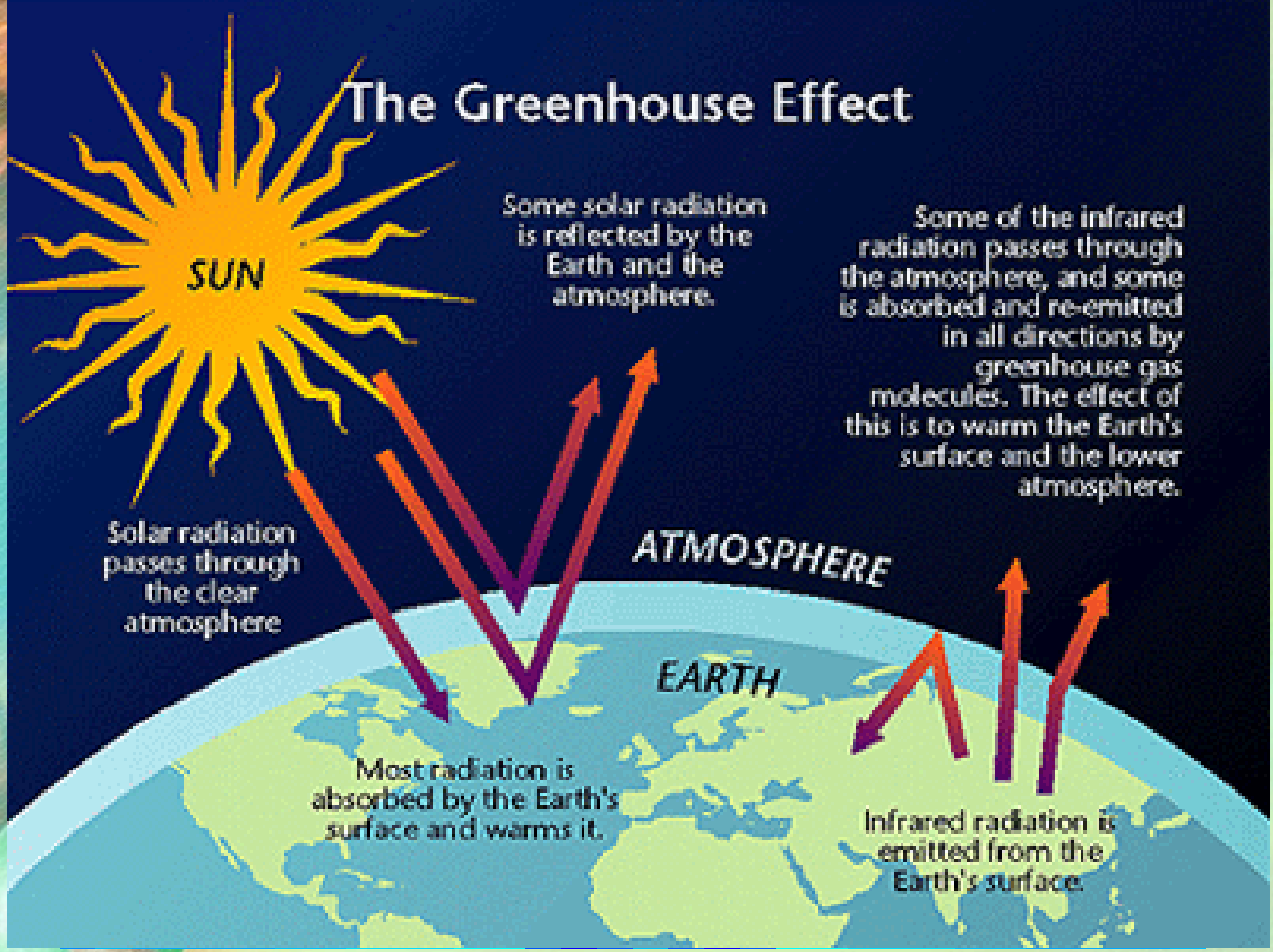
Solar energy



Greenhouse Effect

- Solar energy that is absorbed by the Earth's land and water is changed to heat that moves/radiates back into the atmosphere (troposphere) where gases absorb the heat, a process known as the greenhouse effect.



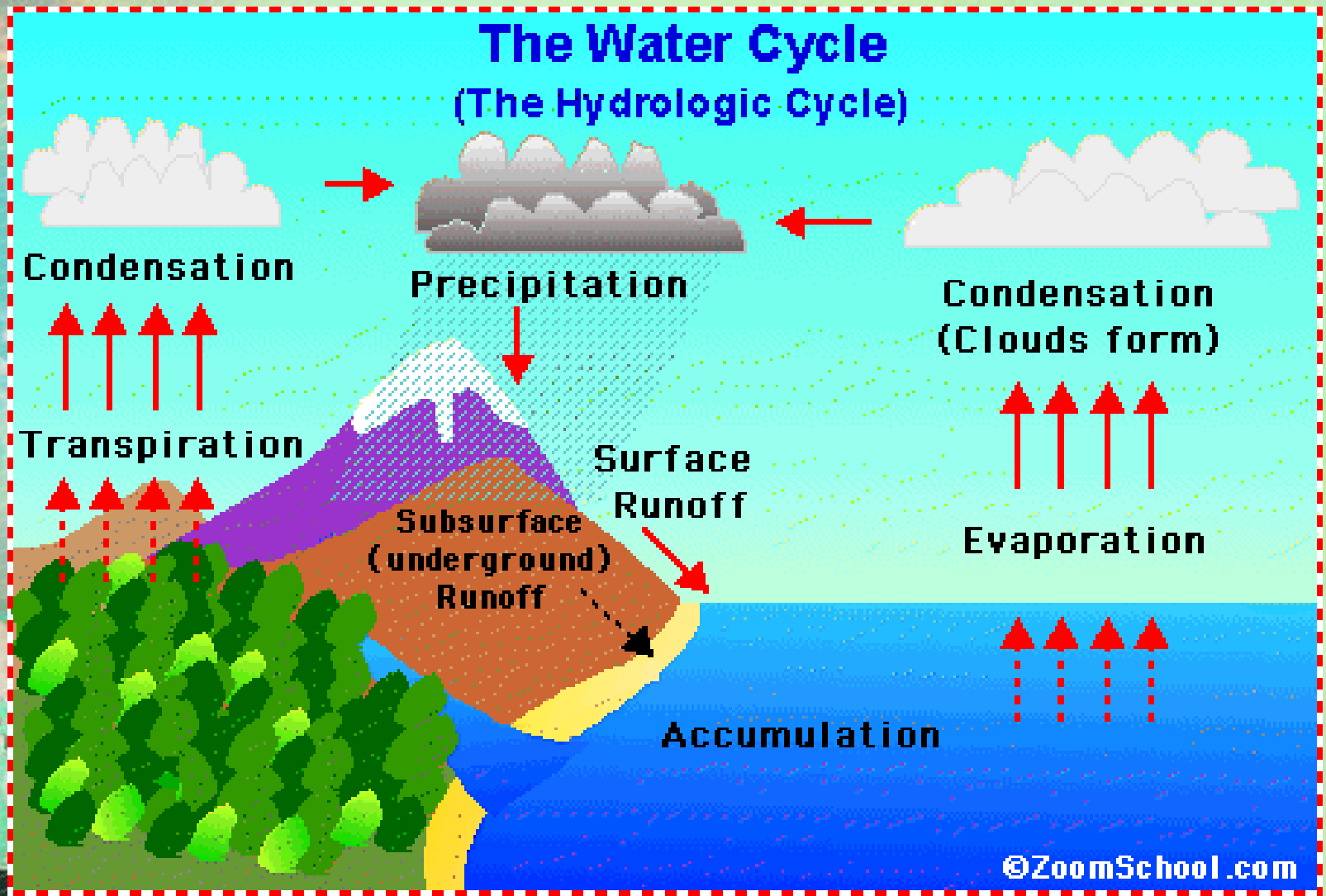


Greenhouse Animation

Heat

- Energy that flows from an object with a higher temperature to an object with a lower temperature
- Heat is transferred through the atmosphere by:
  - Radiation:energy that is transferred in the form of rays or waves
  - Conduction:energy that is transferred when molecules bump into each other
  - Convection:energy that is transferred by flow of material
    - Molecules move closer together, making air more dense, and air pressure increases
    - Cold air sinks, pushing up warm air, which then cools and sinks, pushing up more warm air

Water Cycle – water makes up 70% of Earth's surface!!



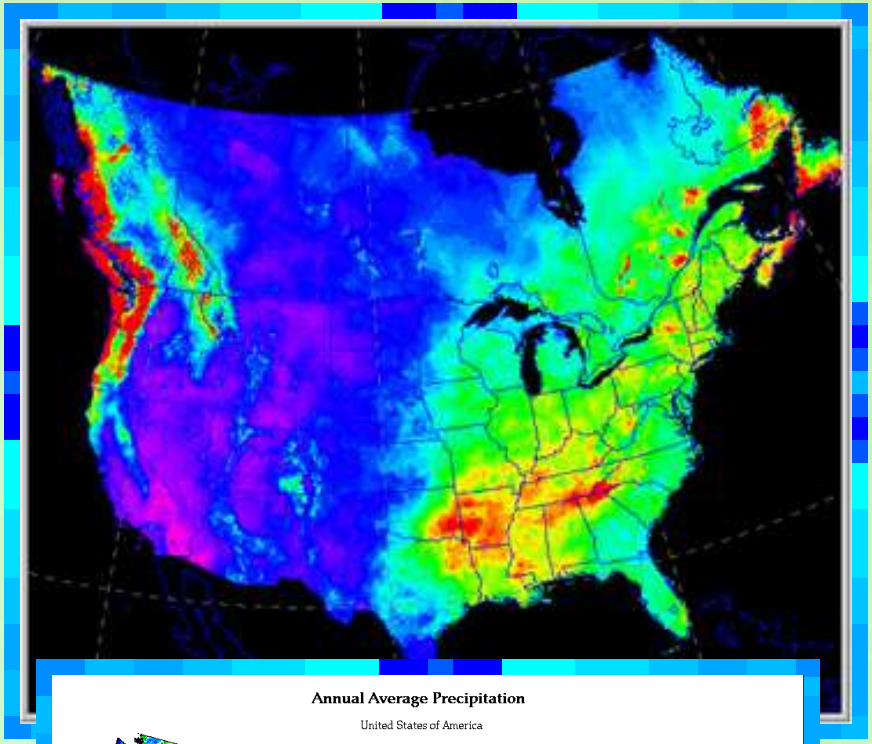
Water Cycle

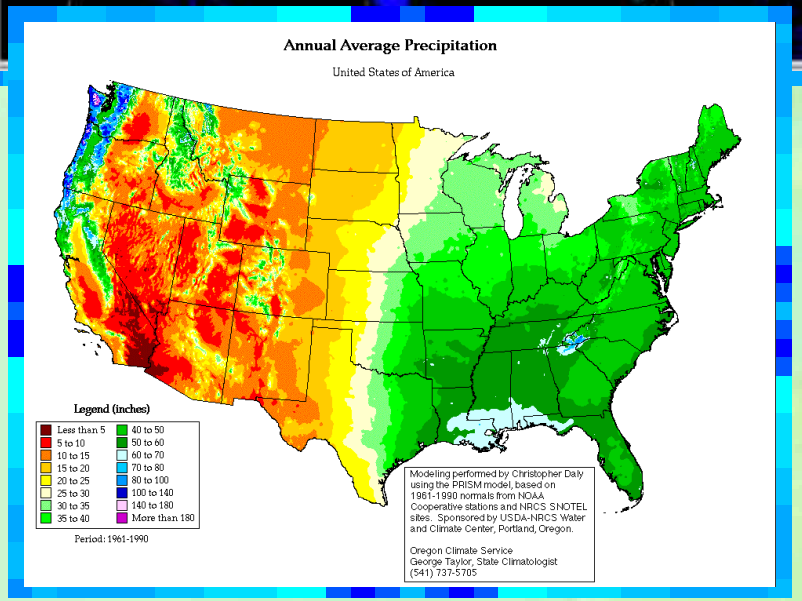
Video Link

- Water moves back and forth between Earth's atmosphere and surface
- Energy from the sun causes water to evaporate from the hydrosphere and rise as vapor
  - Sun provides water cycle's energy
  - Water on the surface absorbs heat and evaporates, entering the atmosphere
  - Condensation – water vapor changes back into liquid
  - Clouds of water become heavy and water falls to Earth as precipitation
  - The cycle repeats itself continuously

Precipitation

- Rain & Drizzle- most common type of precipitation.
- Freezing Rain- drizzle from stratus clouds.
- Freezing Rain- raindrops freeze when they hit the ground.
- Sleet- raindrops that freeze before they hit the ground.





Waters 3 States Video

Precipitation

- snow- as ice grows and merges into clouds they form snowflakes.
- hail- is the largest type of precipitation.
- Lumps or balls of ice that fall from cumulonimbus clouds in warm weather.

The Sun, Water Cycle, & Climate Video
The Water Cycle and Clouds Video

All precipitation forms from water droplets or ice crystals in clouds. Some precipitation freezes or melts after it falls from the clouds.

1 **Rain** and **drizzle** form from water droplets or ice crystals that melt as they fall.

2 **Freezing rain** is rain that freezes when it hits the ground or other surfaces.

freezing rain

3 **Sleet** is rain that freezes into ice pellets while falling through cold air.

4 **Snow** forms from ice crystals that merge in clouds.

5 **Hail** forms when ice pellets move up and down in clouds, growing larger as they gain layers of ice.

hail

Let's take a look at the weather picture and why we have weather!

What is Weather?

- State of the atmosphere at a specific time and place
- Includes such conditions as air pressure, wind, temperature, and moisture in the air
- Temperature is a measure of air molecule movement
  - Sun's energy causes air molecules to move rapidly; temperatures are high and it feels warm
  - When less of the Sun's energy reaches air molecules, they move less rapidly and it feels cold

What is Weather?

- Energy is transferred between fast-moving molecules and slower-moving molecules
  - CONDUCTION – transfer of energy when molecules collide
  - CONVECTION – occurs when warm air rises and cool air sinks; it's the transfer of heat, usually in liquids or gases

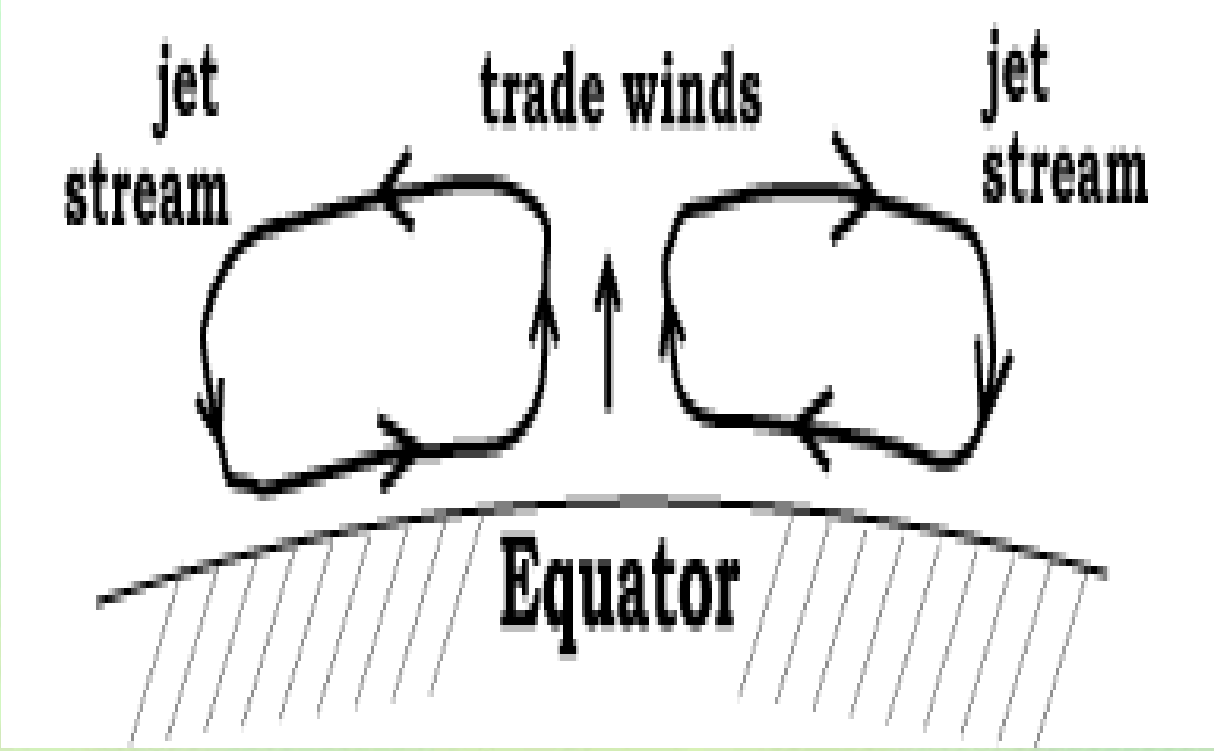
If we were to pick one term to help explain why we have weather, what do you think would be a good word?

You might pick heat or sun….but another good choice would be

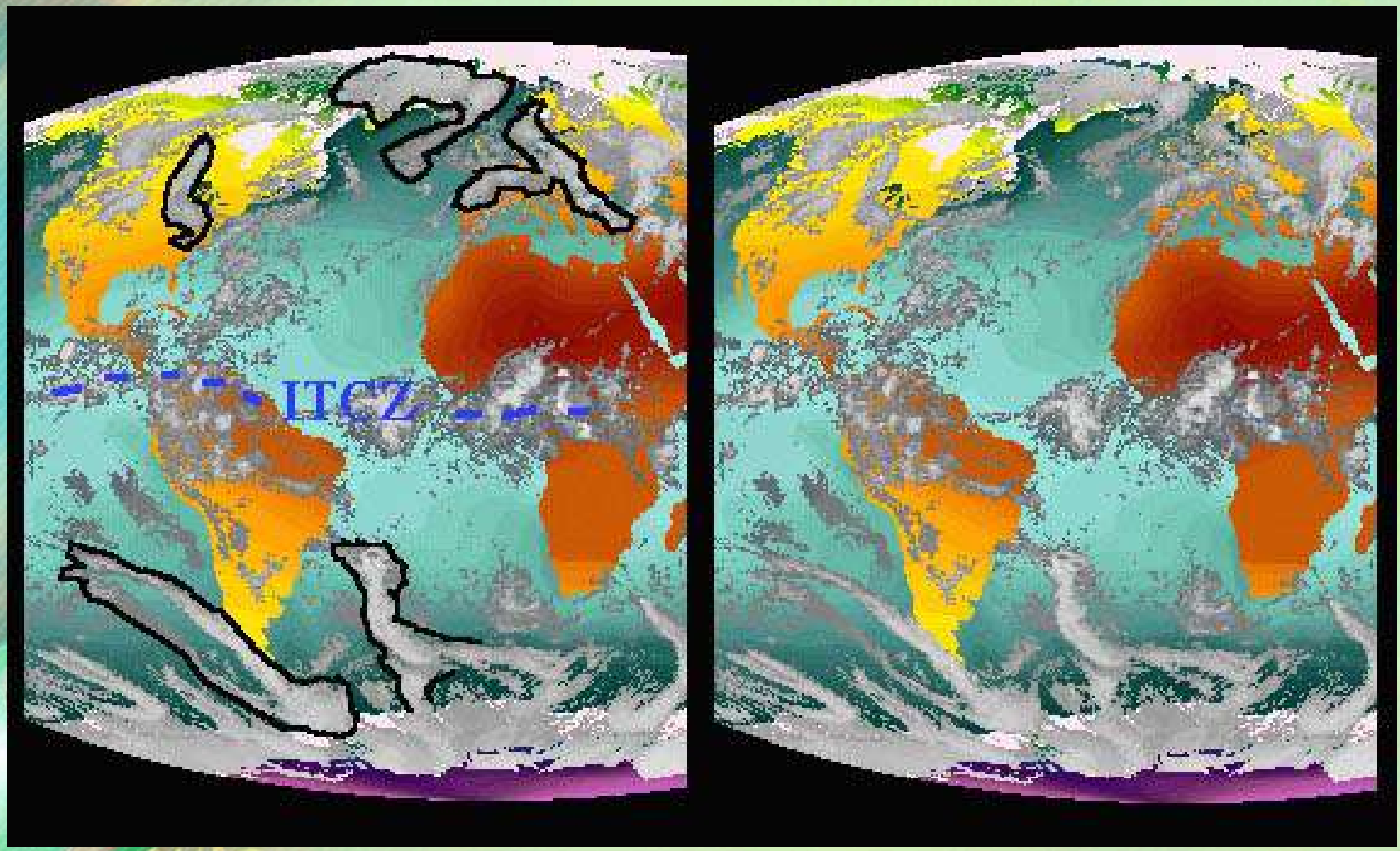
Convection

After the atmosphere is warmed by radiation and conduction, the heat is transferred throughout the atmosphere by convection.

- Since warmed air has more space between the molecules, it's less dense and rises
- Cooled air is more dense and tends to sink
- In general, air near the equator tends to rise and air near the poles tends to sink



Why do you think there is this band of clouds near the equator?



Did you figure it out?

- Warm, moist air in the tropics rises
- Cold air can hold less moisture than warm air
- As the moist air rises, it condenses and forms clouds!

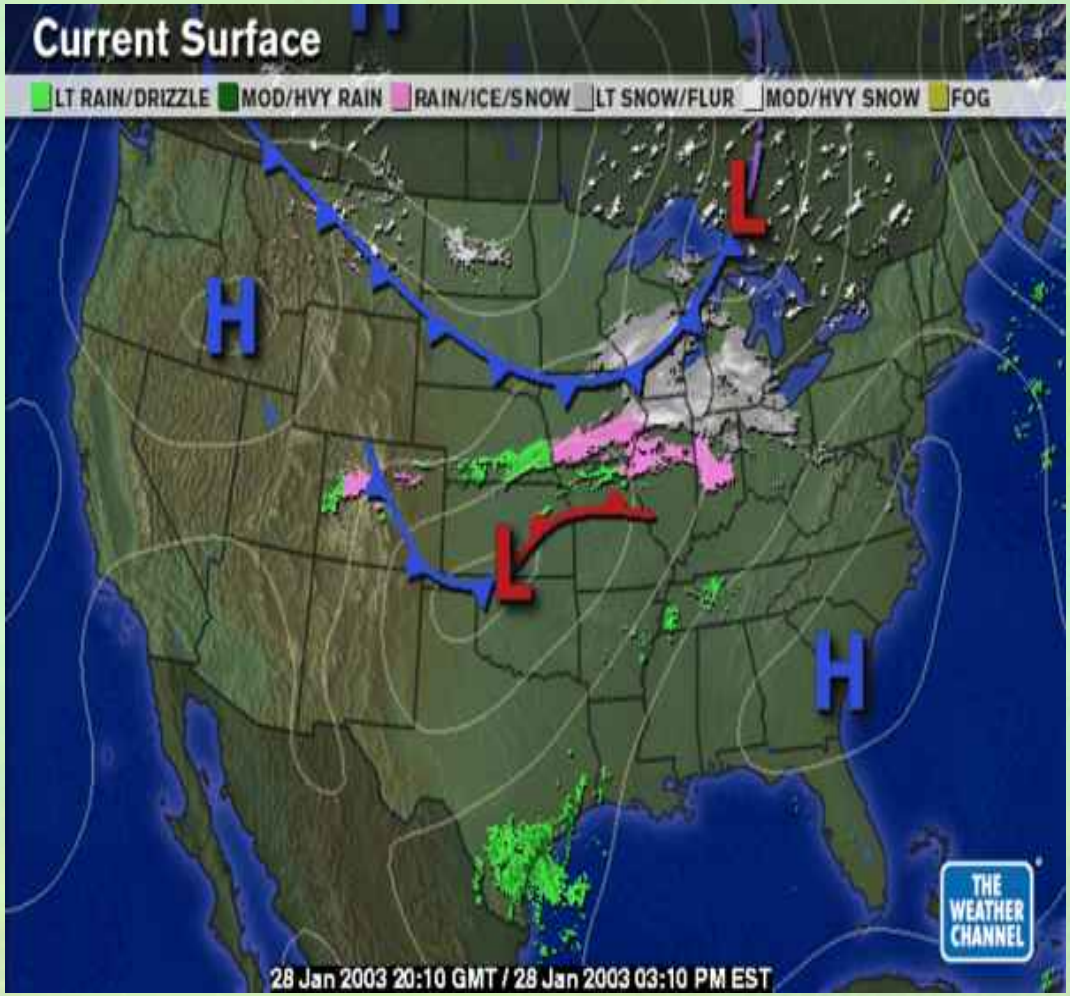
Now What?

- Ok, so we know that the weather moves around on these highways and that warm air rises and cold air sinks.

- But why is it sunny one day, and rainy the next?

Let's take another look at the weather map

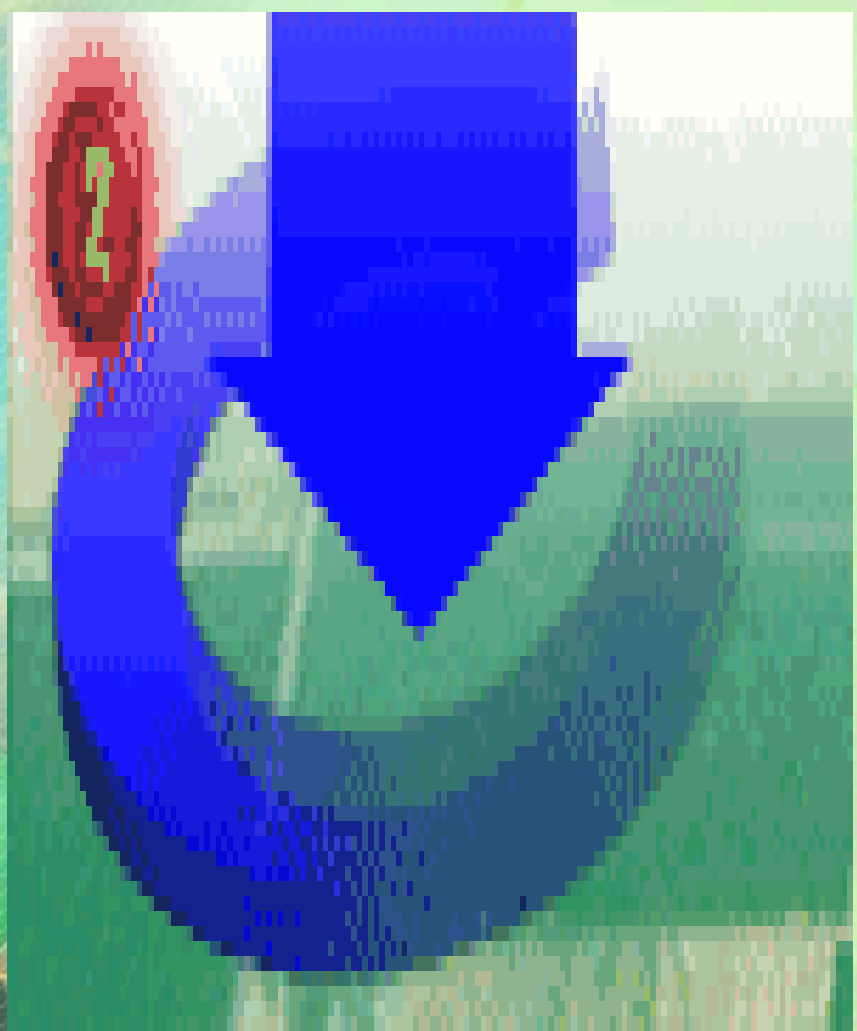
- Notice that there are H's and L's on the map
- There are also blue lines with spikes and red lines with half circles
- Let's take a closer look!



AIR PRESSURE

- Air weight that varies over Earth's surface
  - Warmer air is less dense and exerts less pressure
  - Cooler air is more dense and exerts more pressure

High Pressure Areas



- When cooler air sinks and is warmed, the air can hold more moisture
- This usually means sunny skies
- Winds tend to move clockwise around a high

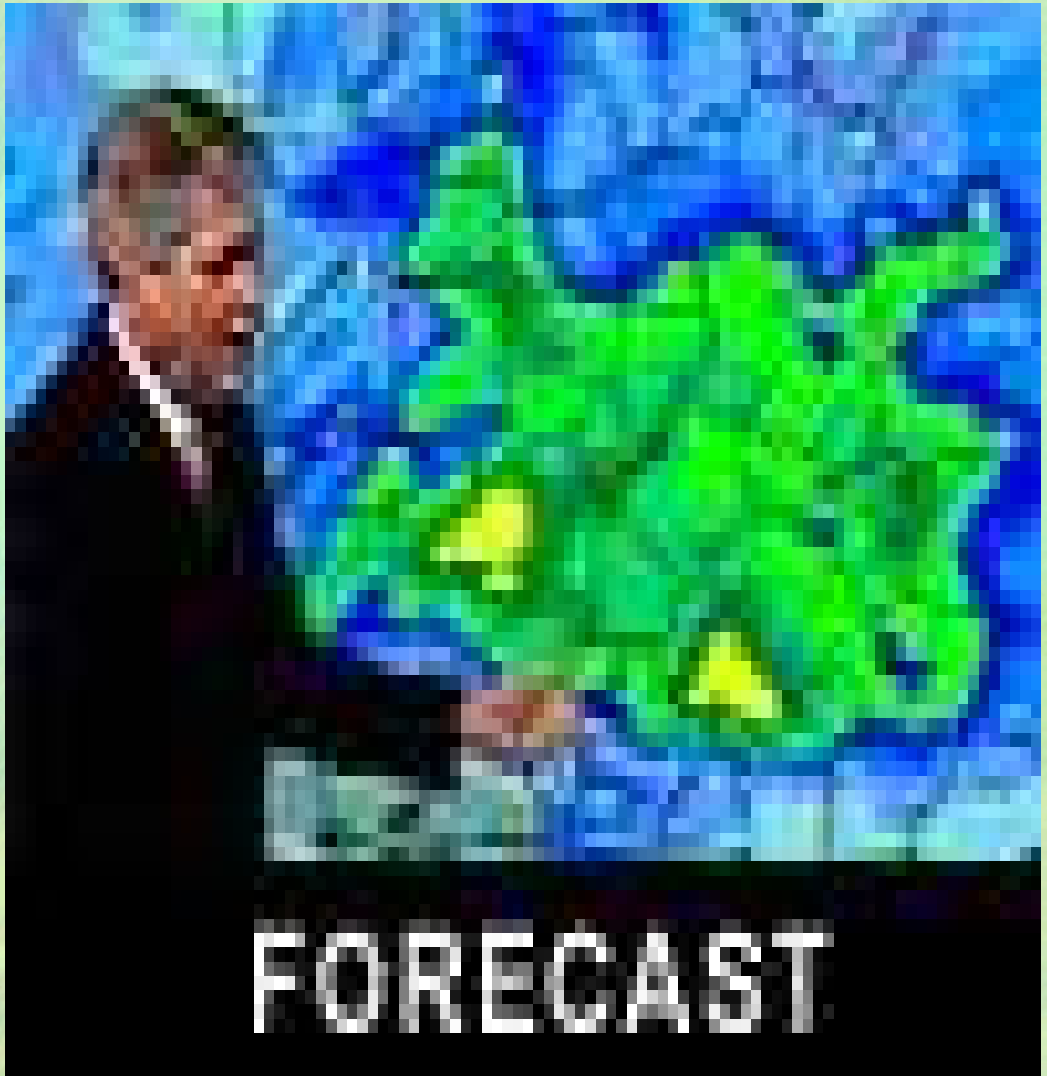
Low Pressure Areas

- When warm air rises and is cooled, the air can not hold as much moisture
- Often, these areas are associated with precipitation and stormy weather
- Winds tend to move counter clockwise around the low

So, if you see a big H on the weather map over the area you live, you can expect fair weather

When you see a big L in your area, there will probably be stormy weather

These highs and lows move or less along the jet stream and bring us our weather changes



Humidity

- The amount of water vapor in the air
- Temperature affects how much moisture is in the air - warmer air can hold more water vapor, tending to make it more humid
- Relative humidity – the amount of water vapor in the air compared to what it can hold at a specific temperature
- When air cools, it can't hold as much water vapor, so the water vapor condenses to liquid or forms ice crystals
- Dew point – the temperature at which air is saturated and condensation forms

Clouds

- Form when air rises, cools to its dew point, and becomes saturated
- Shape and height of clouds vary with temperature, pressure, and water vapor in atmosphere

Clouds

- Shape
  - Stratus-smooth, even sheets or layers at low altitudes
  - Cumulus-puffy, white clouds, often with flat bases
  - Cirrus-high, thin, white feathery clouds made of ice crystals
- Height
  - Cirro – high clouds
  - Alto – middle-elevation clouds
  - Strato – low clouds
  - Nimbus clouds are dark and so full of water that sunlight can't penetrate them

Clouds

- LOW CLOUDS – form at 2,000 m or less in altitude
  - Cumulus – puffy clouds formed when air currents rise and carry moisture
  - Stratus – layered dull, gray sheets that can cover the entire sky
  - Nimbostratus – low, dark, thick layers that hide the Sun

Clouds

Cumulus

· Clouds formed at medium or low elevation.

· Cumulus clouds are puffy with flat bottoms.

· When cumulus clouds are white they often signal fair weather, but when they are darker, they may signal rain or thunderstorms.

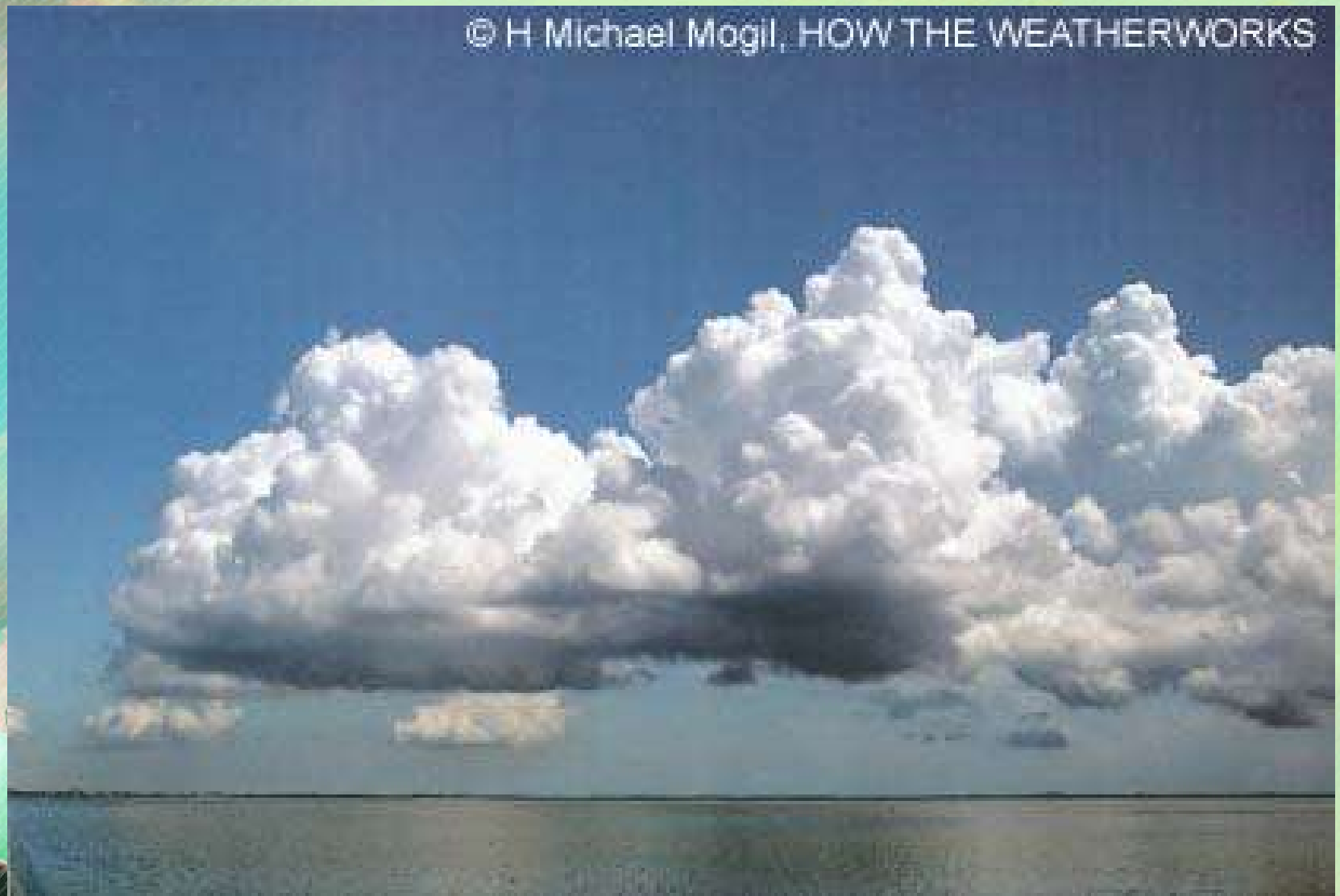
Clouds

Stratus

•Clouds formed at medium or low elevation; spread out layer upon layer covering a large area

•As stratus clouds thicken, precipitation usually occurs over that area.

Cumulus



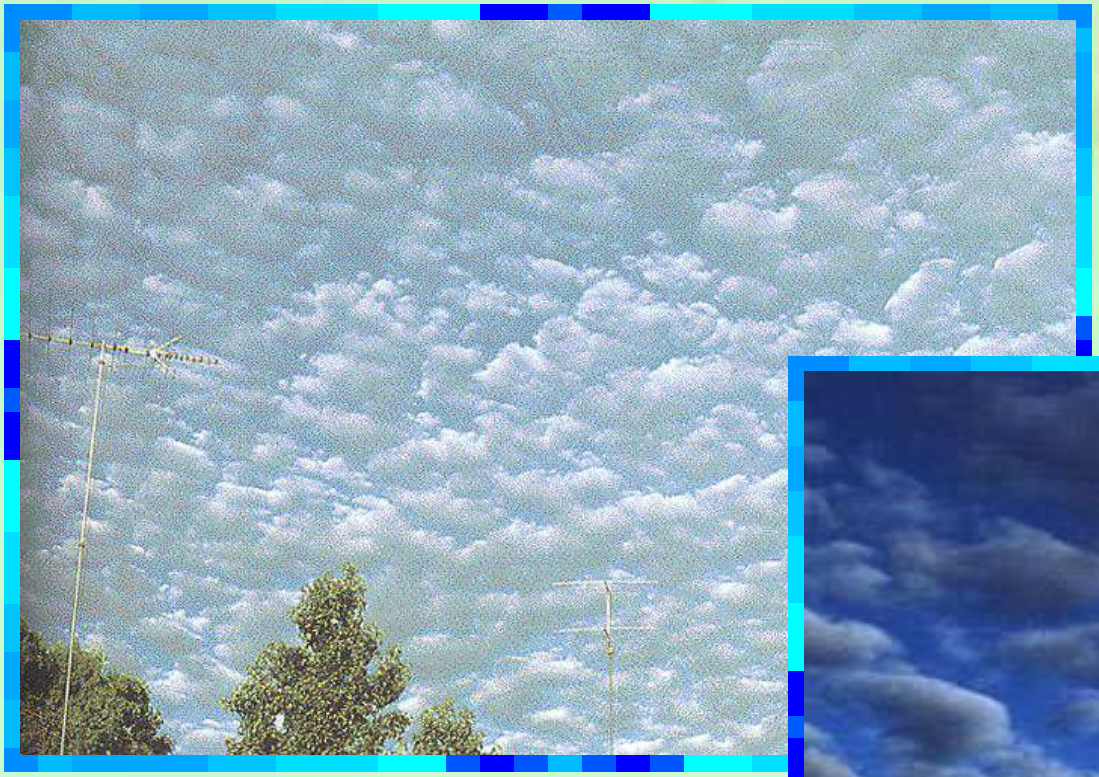
Stratus

Nimbo-stratus clouds

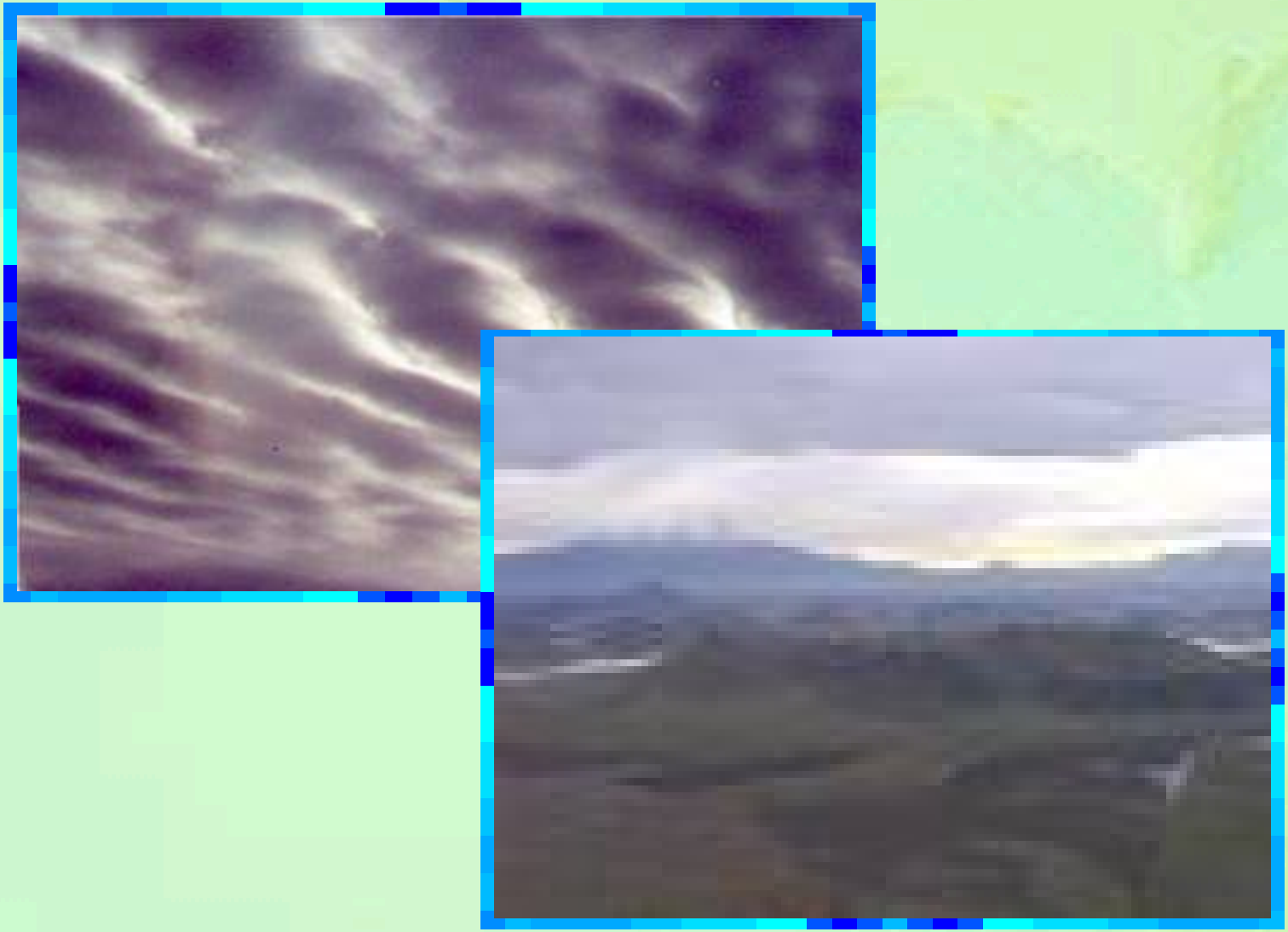
Clouds

- MIDDLE CLOUDS – form between 2,000 m and 8,000 m in altitude
  - Most are layered
  - Names have alto- prefix (altocumulus and altostratus)
  - Can produce light precipitation

Alto-cumulus clouds



Alto-stratus Clouds



Clouds

- HIGH AND VERTICAL CLOUDS
  - Cirrus – wispy, high-level clouds
  - Cirrostratus – high, layered clouds that can cover the sky
  - Cumulonimbus – known as thunderstorm clouds; produce heavy precipitation

Clouds

Cirrus

- Clouds formed at high elevations; wispy clouds usually consisting of ice crystals that signal fair weather or may also signal an approaching warm front.

Cirrus

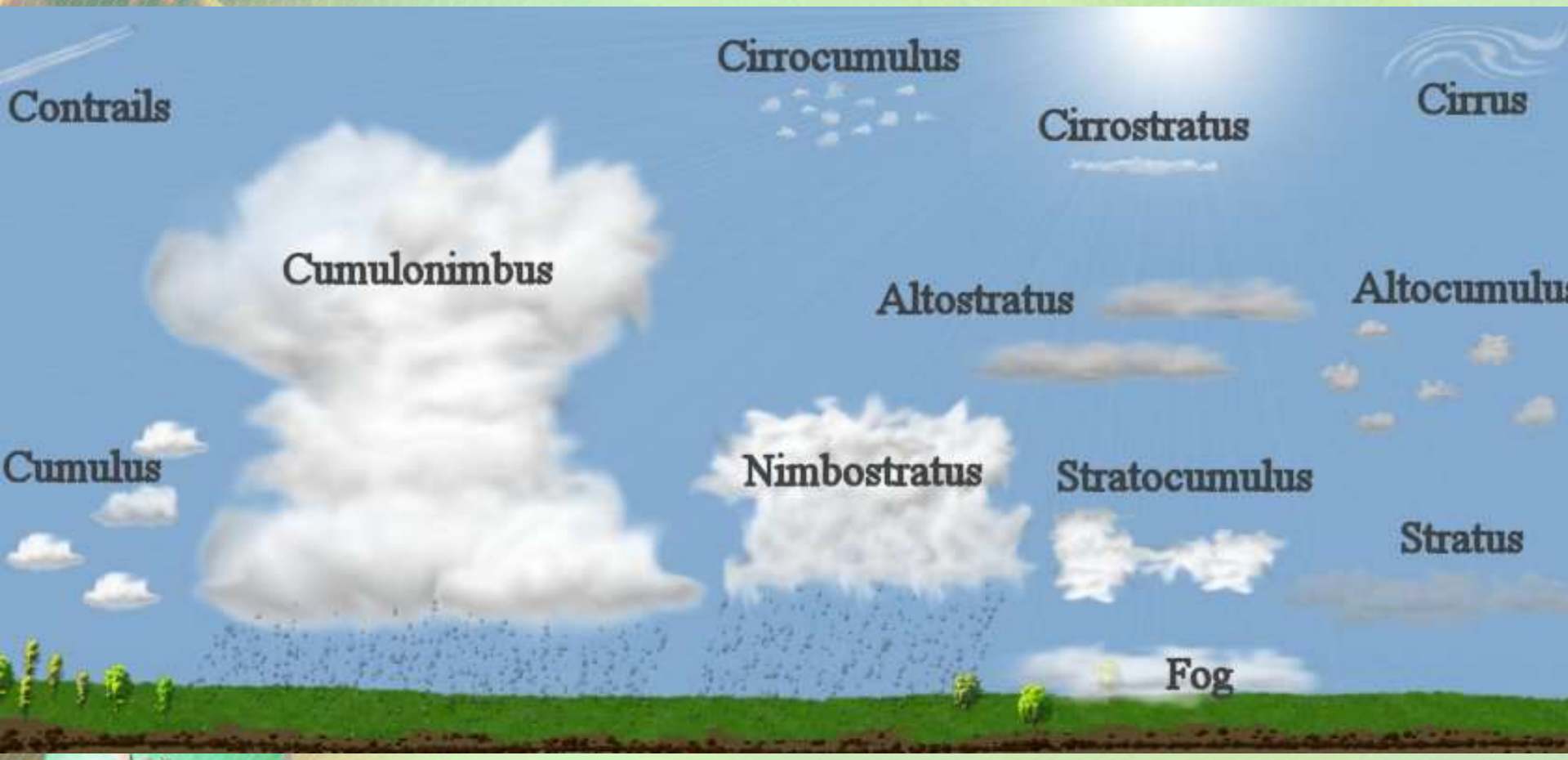
lo-nimbus

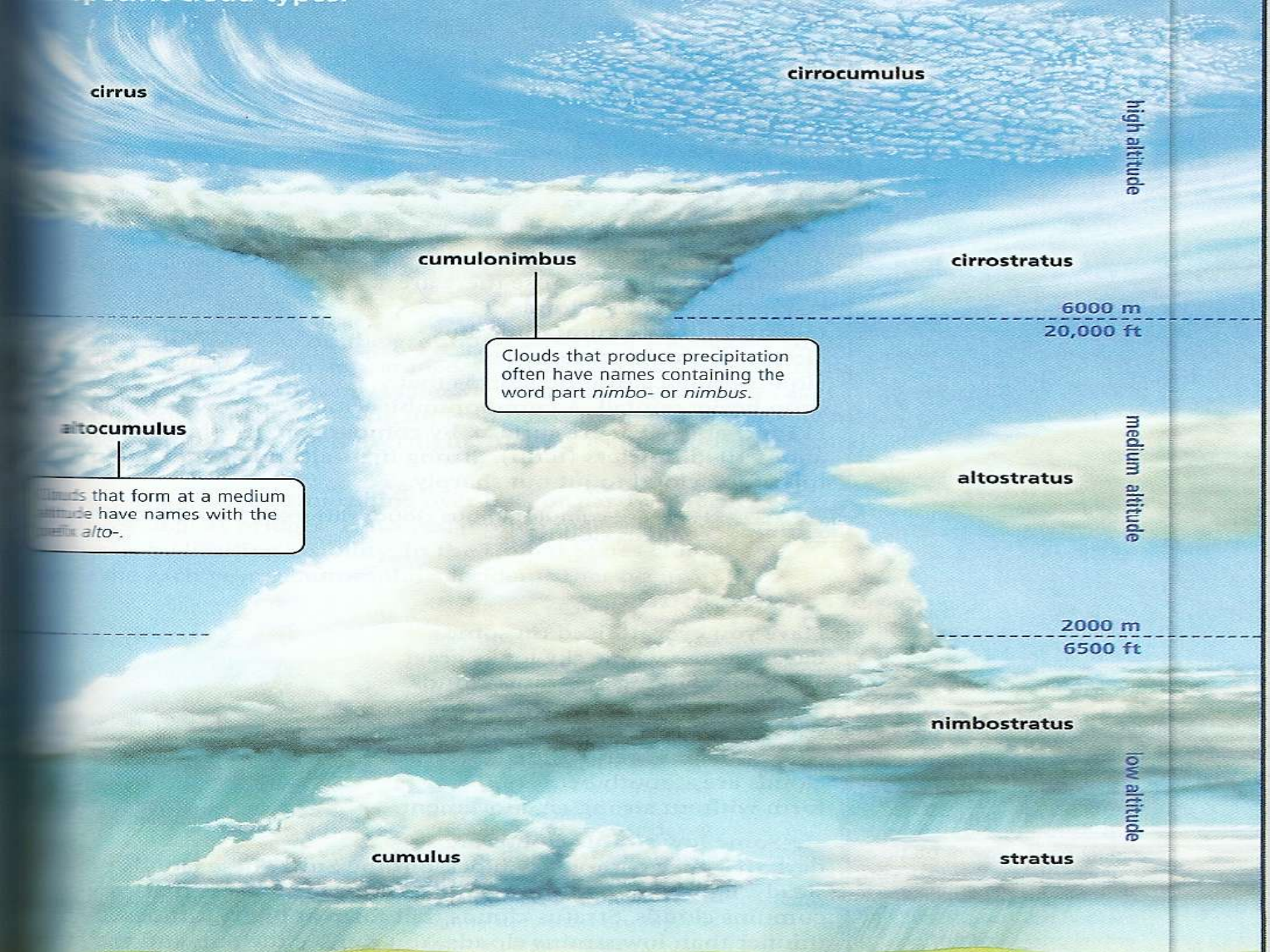
louds

aka:

derheads

Cirro-cumulus clouds


Contrails
Cirrocumulus
Cirrostratus
Cirrus
Cumulonimbus
Altostratus
Altocumulus
Cumulus
Nimbostratus
Stratocumulus
Stratus
Fog


cirrus
cirrocumulus
high altitude
cumulonimbus
cirrostratus
6000 m
20,000 ft
Clouds that produce precipitation often have names containing the word part *nimbo-* or *nimbus*.
altocumulus
Clouds that form at a medium altitude have names with the prefix *alto-*.
altostratus
medium altitude
2000 m
6500 ft
nimbostratus
low altitude
cumulus
stratus

Fog

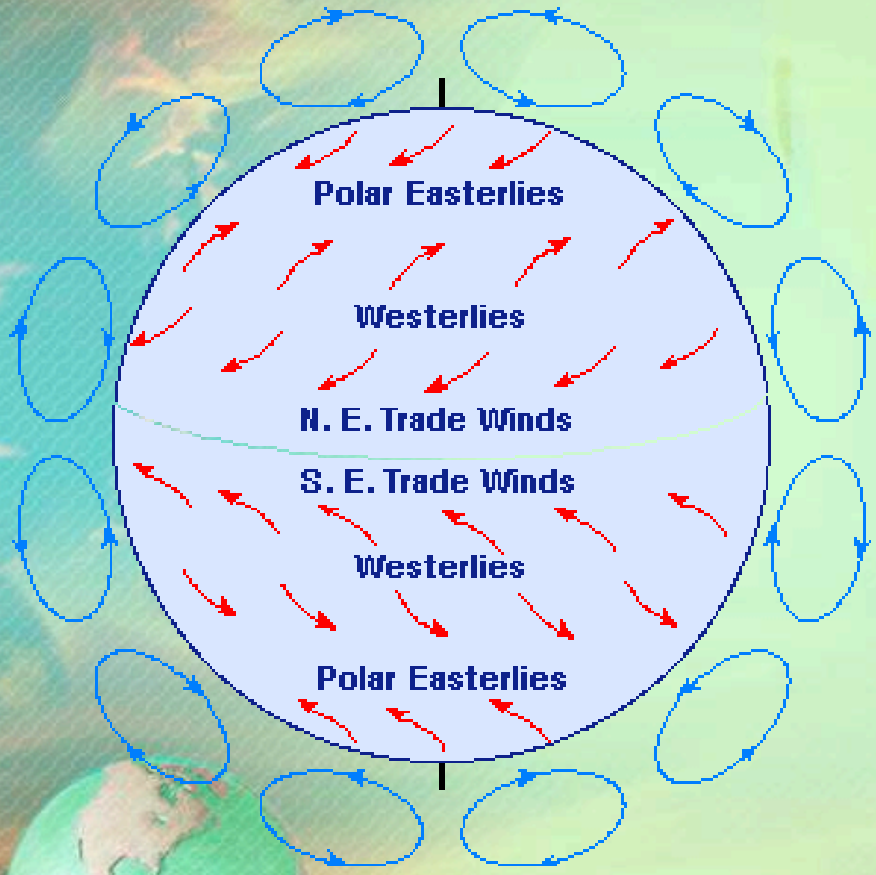
Air Movement

- **Wind: Movement of air from one temperature or pressure area to another**
- **Different areas of Earth receive different amounts of the Sun's energy**
  - **Equator's warm air, being less dense, is pushed upward by denser, colder air**
  - **Poles' cold air, being more dense, sinks and moves along Earth's surface**
  - **CORIOLIS EFFECT: spinning of the Earth causes moving air to turn to the right in the northern hemisphere and to the left in the southern hemisphere**

Global Winds

- **Wind patterns, caused by convection currents combined with the Coriolis effect, of Earth that affect the world's weather**
  - **Near equator, very little wind and daily rain patterns called the doldrums**
  - **Surface winds:**
    - **Between equator and 30 degrees N and S latitude are steady trade winds**
    - **Between 30 and 60 degrees N and S latitude, the westerlies blow in opposite direction from the trade winds.**
    - **The polar easterlies blow from northeast to southwest near the north pole and from southeast to northwest near the south pole**

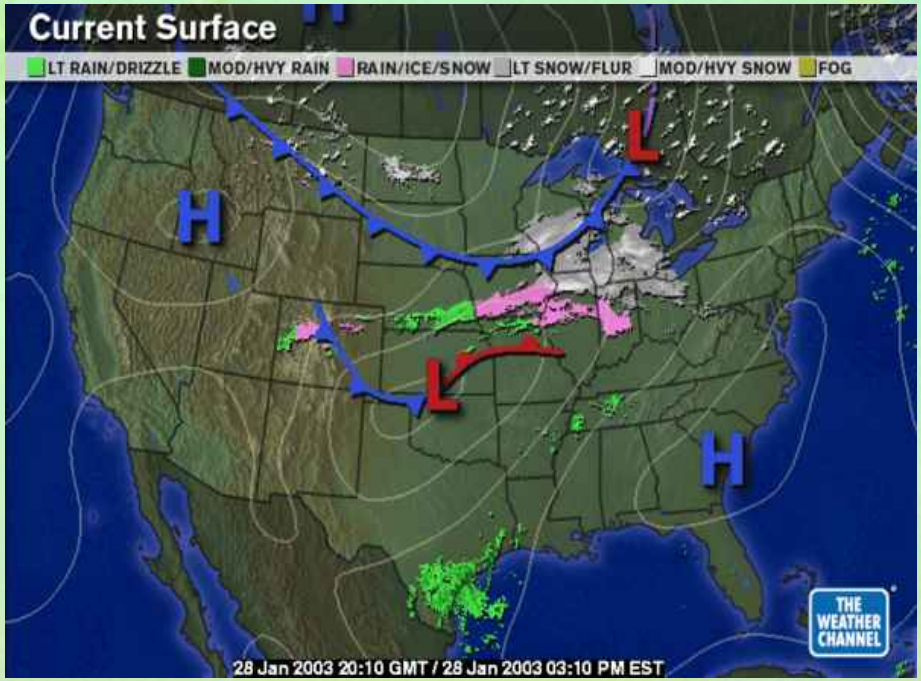
The Weather Highways



- The rotation of the earth creates the Coriolis effect.
- The Coriolis effect causes the air and water to be deflected to the right north of the equator.
- This creates global weather highways

The Westerlies

- Because of our latitude, most of our weather comes from the west
- Looking at the weather map, what type of weather might we expect?
- What type of weather might we expect in a few days?



Weather Tools

Anemometer- A tool used to measure wind speed in miles per hour.

Wind vane

· A tool used to measure wind direction

· Sometimes referred to as a wind-weather vane or a wind sock.

· Wind direction is described by the direction from which the wind is blowing.

Thermometer - A tool used to measure air temperature in degrees Fahrenheit or Celsius.

Weather Tools

Sling Psychrometer-

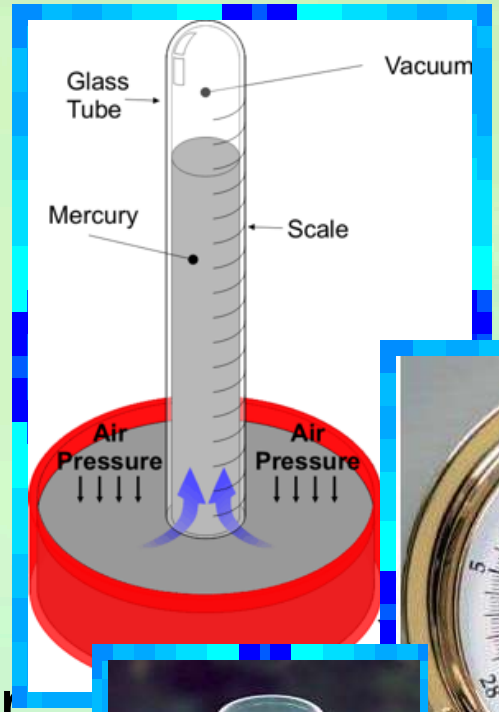
•A two-thermometer instrument also referred to as a wet-dry bulb used to measure *relative humidity* (the amount of water vapor in the air).

• Temperatures readings are converted using a relative humidity table.

Weather Instruments Video 1
Weather Instruments Video 2

Weather Tools

Barometer- A tool used to measure air pressure in inches of mercury or millibars (mb).



Rain gauge- A tool used for measuring the amount of precipitation in inches or centimeters.

Blizzard

- A winter storm with strong winds, cold temperatures, and low visibility, that lasts more than three hours ☺