Atmospheric Heating

You will be able to

- Describe what happens to solar energy that reaches Earth
- Summarize the processes of radiation, thermal conduction, and convection
- Explain the relationship between the greenhouse effect and global warming

Quick Write

Write your own definition for **transfer** and **circulation**.

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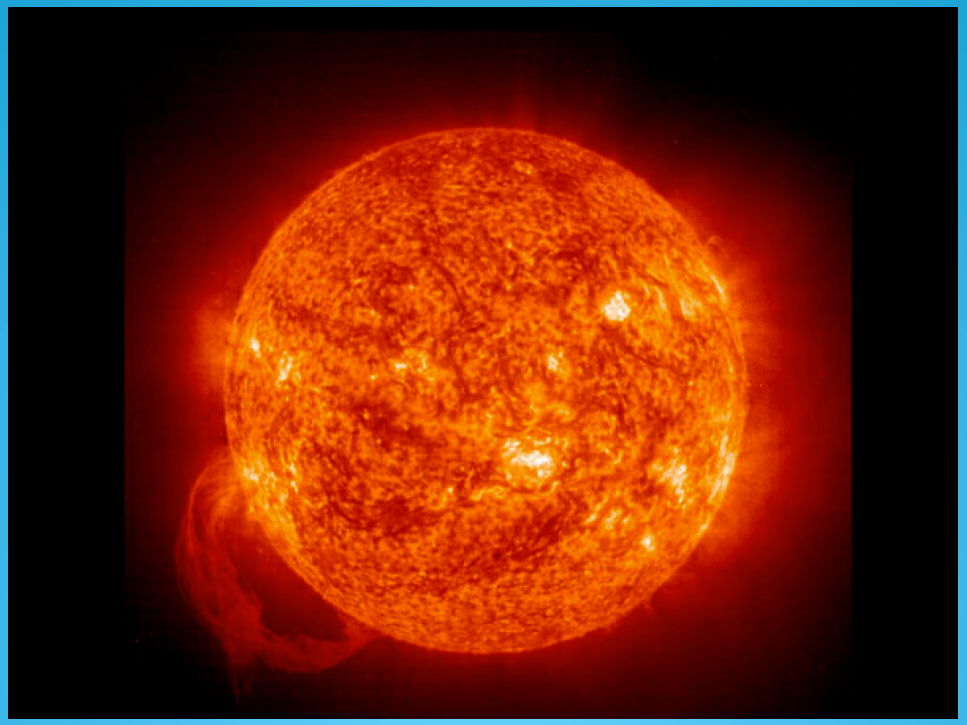
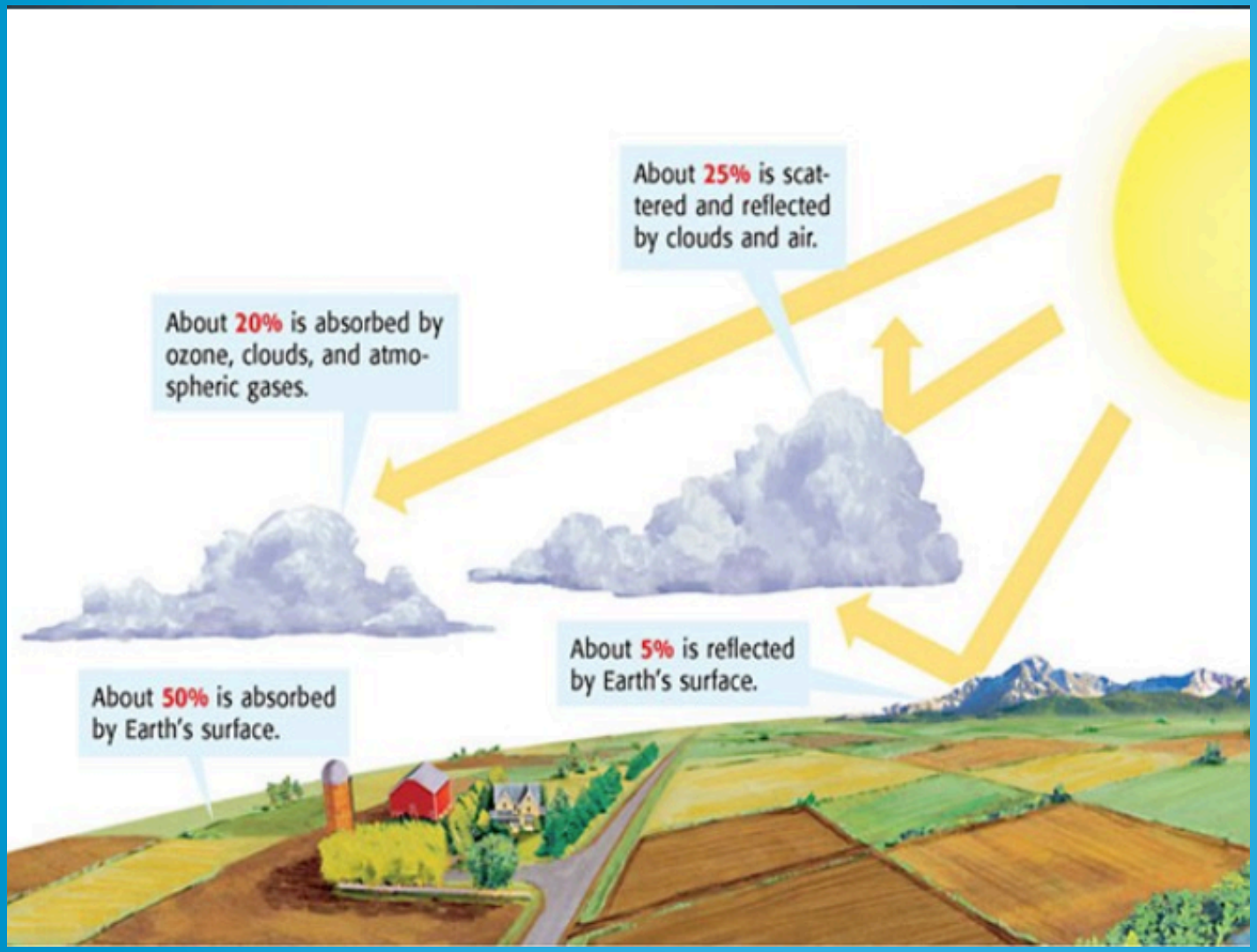


Earth and its atmosphere are warmed by energy from the Sun.

Radiation: energy transfer by electromagnetic waves

- Radiation is how the Sun's energy reaches Earth.
- Electromagnetic waves do not have to travel through matter.
- Energy from the sun is absorbed by the atmosphere, land, and water and is converted into thermal energy.
- Earth receives about two-billionths of the energy radiated from the Sun.

Where does that two-billionths of Sun's radiated energy go?



-25% scattered and reflected (clouds/air)

-5% reflected by Earth's surface

-20% absorbed in atmosphere (ozone/ clouds/ gases)

-50% absorbed by Earth's surface

70% is absorbed by the atmosphere and the Earth

Thermal conduction: energy transfer through a material by direct contact.

- Thermal energy is always transferred from warmer to colder areas/objects.
- When air molecules come in direct contact with the warm surface of the Earth, thermal energy is transferred to the atmosphere.

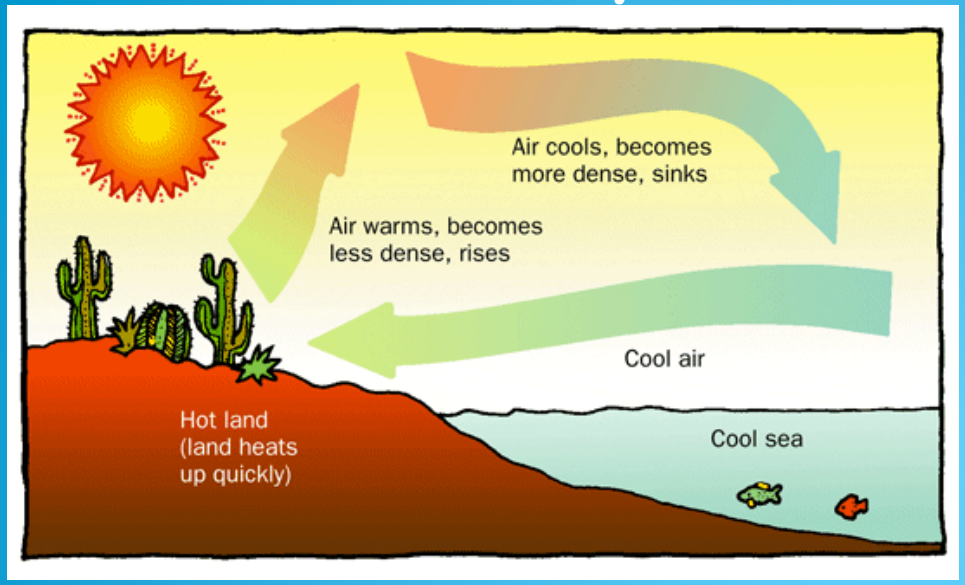
Convection: energy transfer by the **circulation** or movement of a **liquid or gas**

Most thermal energy in the atmosphere is transferred by convection.

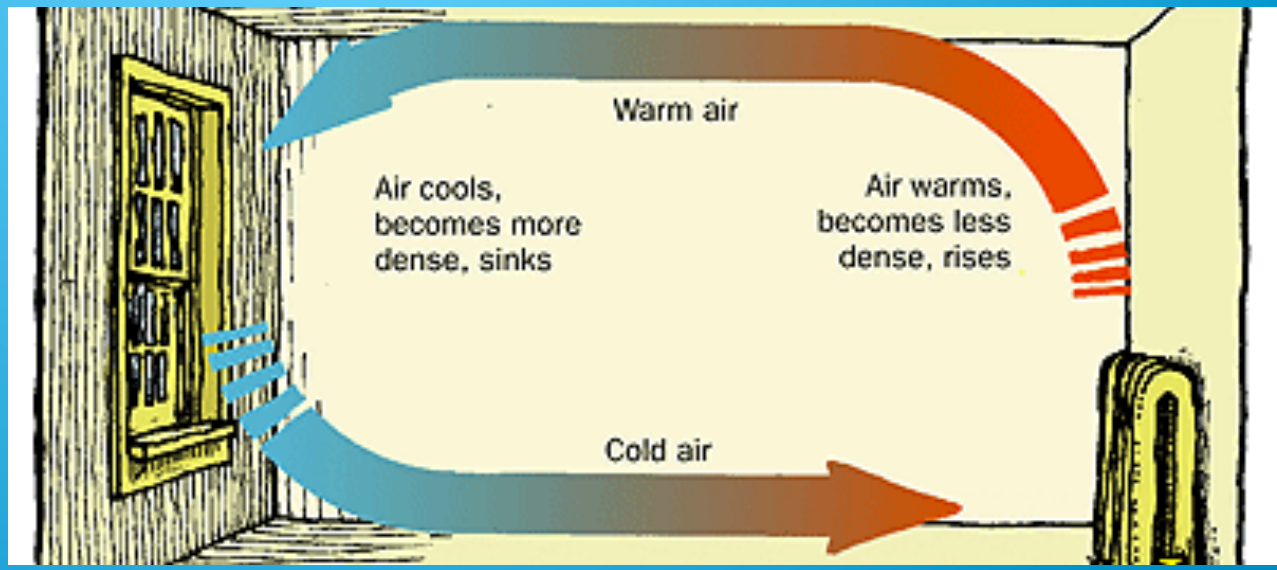
Convection current: the cycle of warm air rising and cool air sinking that causes a **circular movement of air**

- When air is heated, it becomes less dense and rises.
- Cool air is denser, so it sinks.
- As the cool air sinks, it pushes the warm air up.
- The cool air is eventually heated by Earth's surface and begins to rise again.

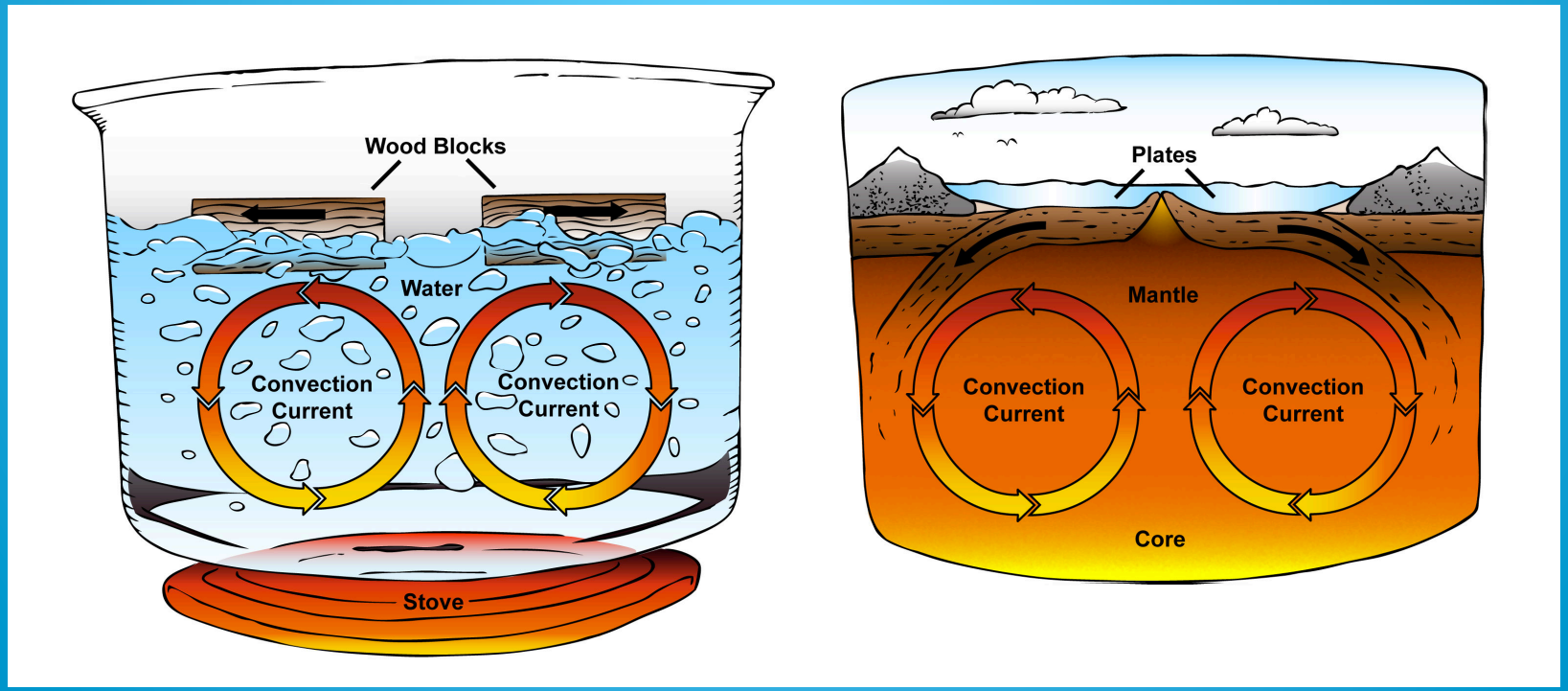
Convection currents occur in the atmosphere.



They also occur in the air in a room.



Convection currents also occur when your boil water on the stove and as the mantle circulates in the Earth.

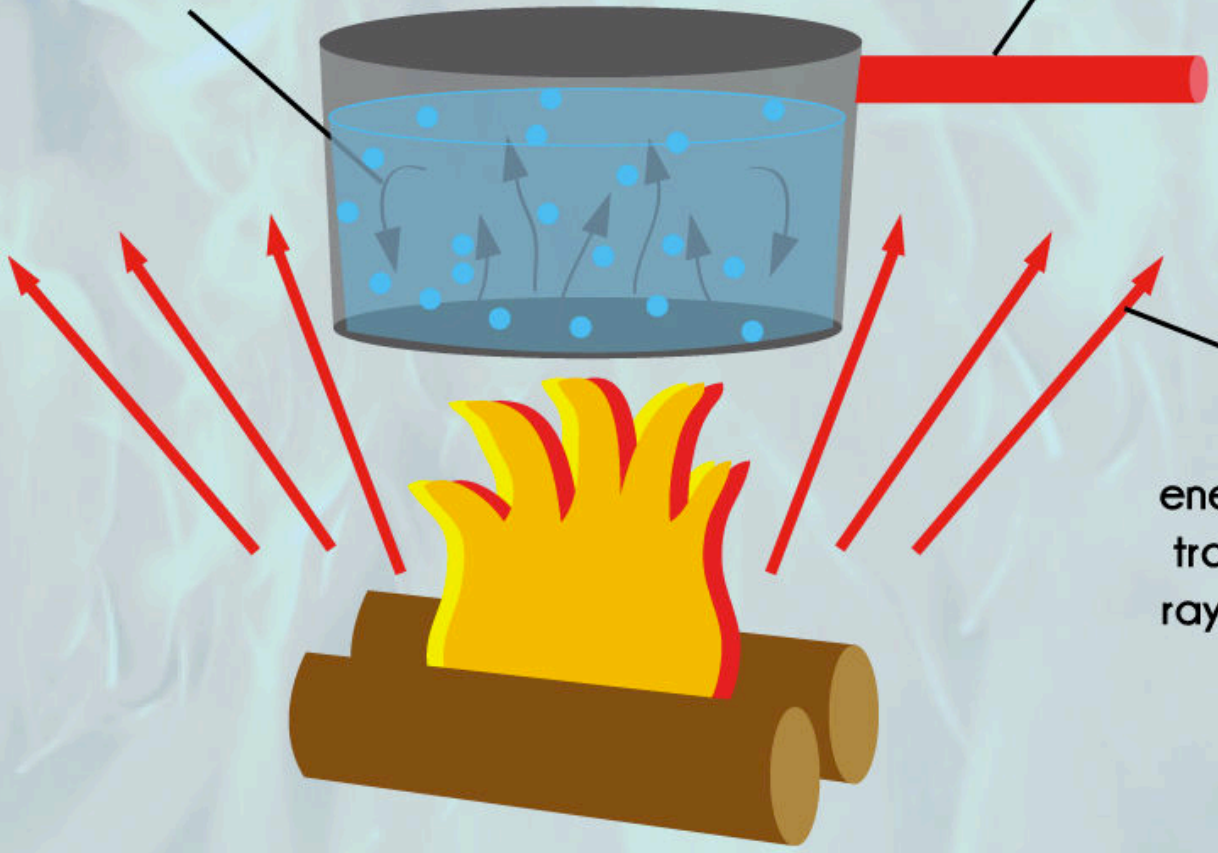


CONVECTION

the transfer of heat through a fluid (liquid or gas) caused by molecular motion

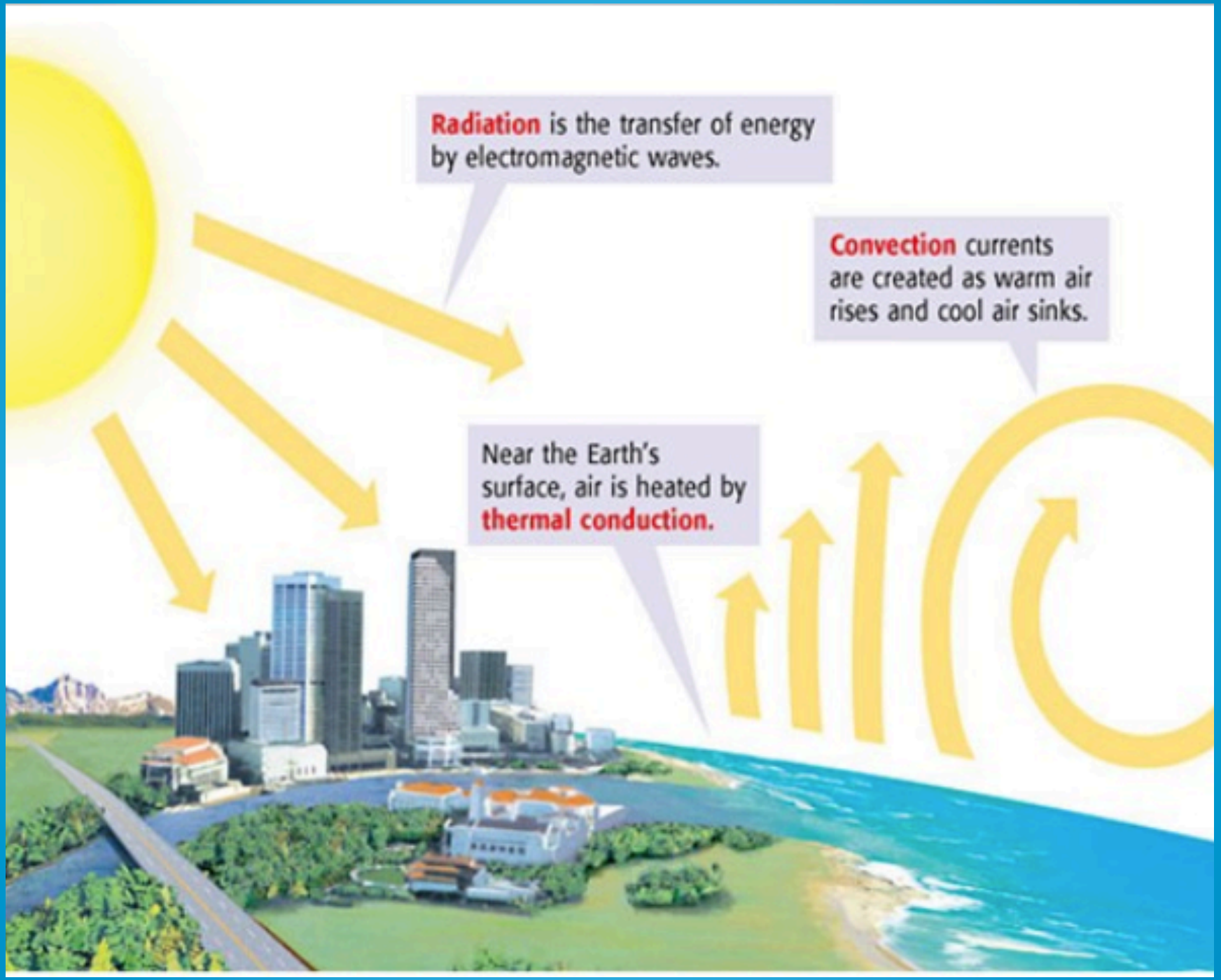
CONDUCTION

the transfer of heat or electric current from one substance to another by direct contact.



RADIATION

energy that is radiated or transmitted in the form of rays or waves or particles

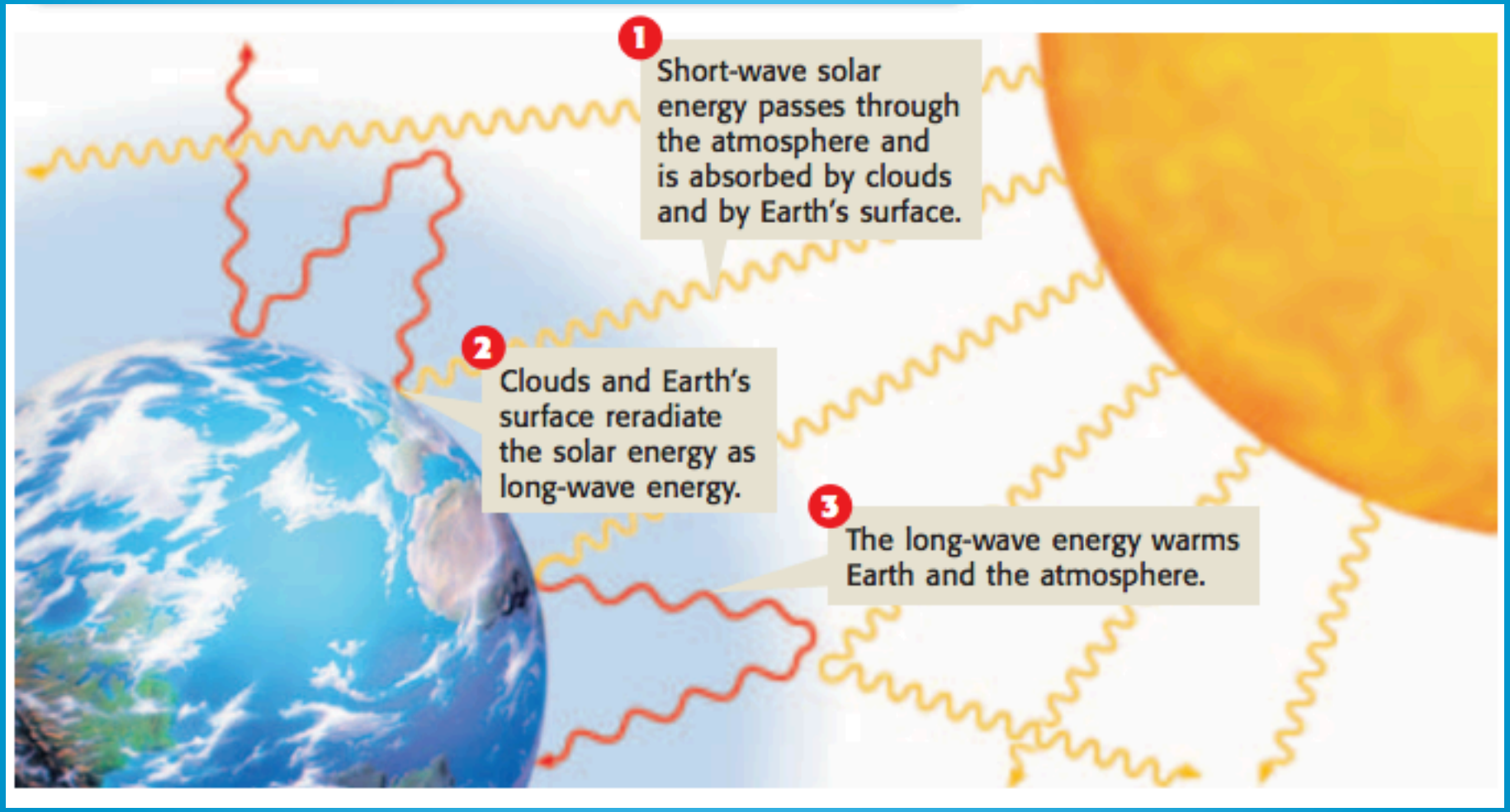

Radiation is the transfer of energy by electromagnetic waves.
Convection currents are created as warm air rises and cool air sinks.
Near the Earth's surface, air is heated by thermal conduction.

QW2: Describe thermal conduction, convection and radiation. Use the term transfer and circulation at least once. Draw and label pictures to illustrate the concepts.

The Greenhouse Effect and Global Warming

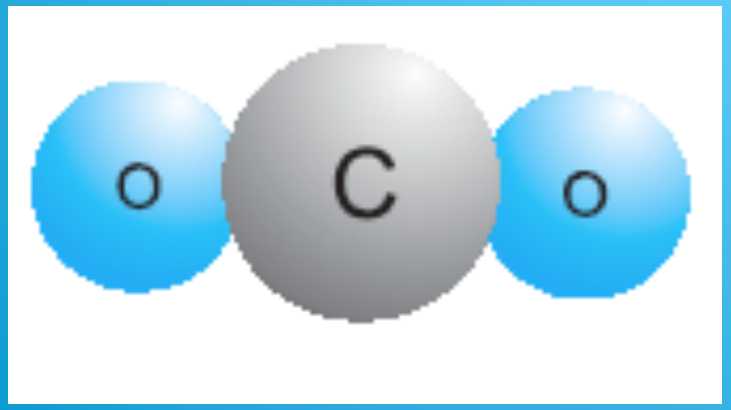
- 70% of the radiation that enters Earth's atmosphere is absorbed by clouds and Earth's surface.
- This energy is converted into thermal energy that warms the planet.

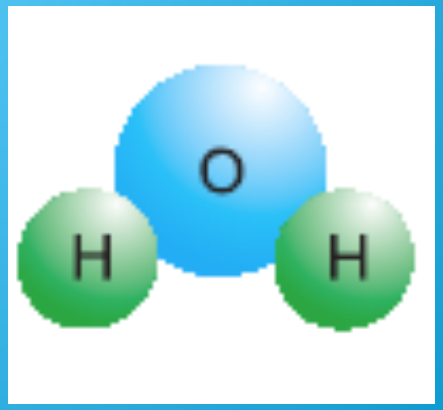
Short-wave visible light is absorbed and reradiated into the atmosphere as long-wave thermal energy.



The greenhouse effect is the process by which gases in the atmosphere absorb thermal energy and radiate it back to Earth.

Greenhouse gases include:
carbon dioxide (CO_2) and water vapor (H_2O)





The gases function like the glass walls and roof of a greenhouse, which allow solar energy to enter but prevent thermal energy from escaping.

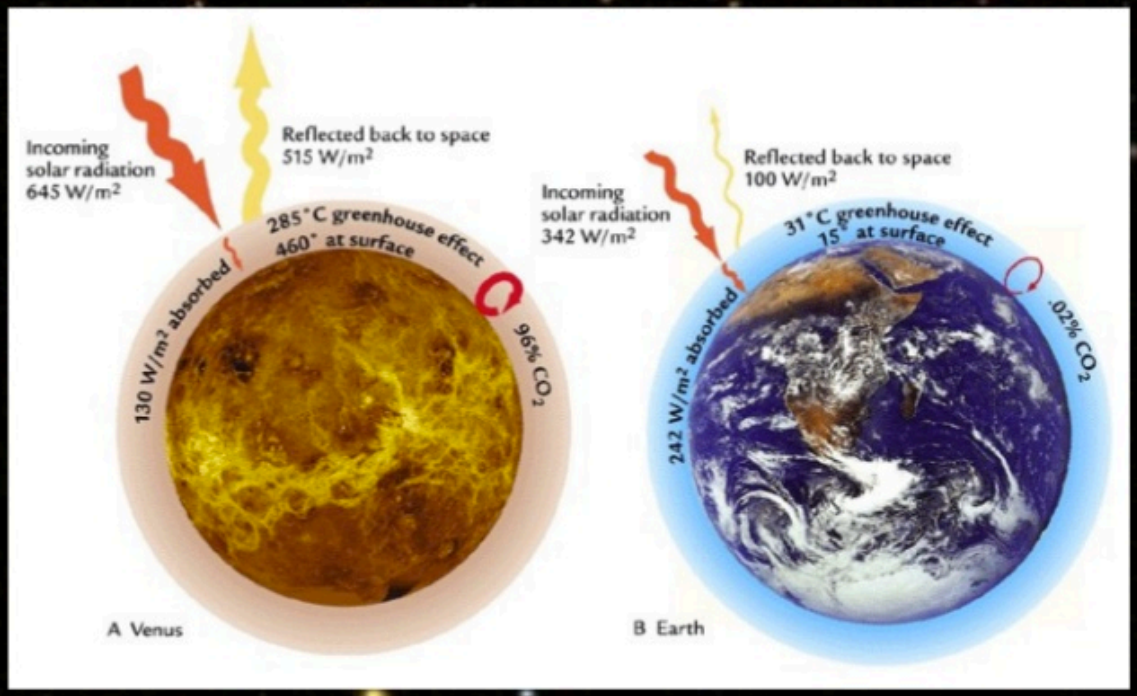
The balance between incoming and outgoing energy is known as the **radiation balance**.

For Earth to remain livable, the amount of energy received from the sun and the amount of energy returned to space must be approximately equal.

energy in = energy out

The Earth would be too cold for life without the greenhouse effect. But what if the greenhouse effect increases?

- **Venus has a runaway greenhouse effect because its atmosphere is rich in CO_2**



Global warming is a gradual increase in average global temperature.

NASA's Facts about Climate Change

https://climate.nasa.gov/evidence/

Global and Local Winds

You will be able to

- Explain the relationship between air pressure and wind direction
- Describe global wind patterns
- Explain the causes of local wind patterns

Quick Write

What causes the wind?

What are some local geographic features that can affect the wind?

Wind is the movement of air caused by **differences in air pressure**.

The **greater the pressure difference**, the **faster** the wind moves.

Air rises at the equator and sinks at the poles.

- Differences in air pressure are generally caused by the **unequal heating of the Earth**
- Air at the equator is warmer and less dense than the surrounding air. It rises and creates and area of low pressure. It flows toward the poles.
- At the poles, air is colder and denser than the surrounding air, so it sinks. As the cold air sinks, it creates areas of high pressure around the poles. This cold polar air then flows toward the equator.

Pressure belts are found every 30°

- **Convection cells** are the **large, circular patterns that air travels in**, separated by pressure belts.
- **Pressure belts** are **bands** of **high pressure** and **low pressure** found at about **every 30° latitude**.

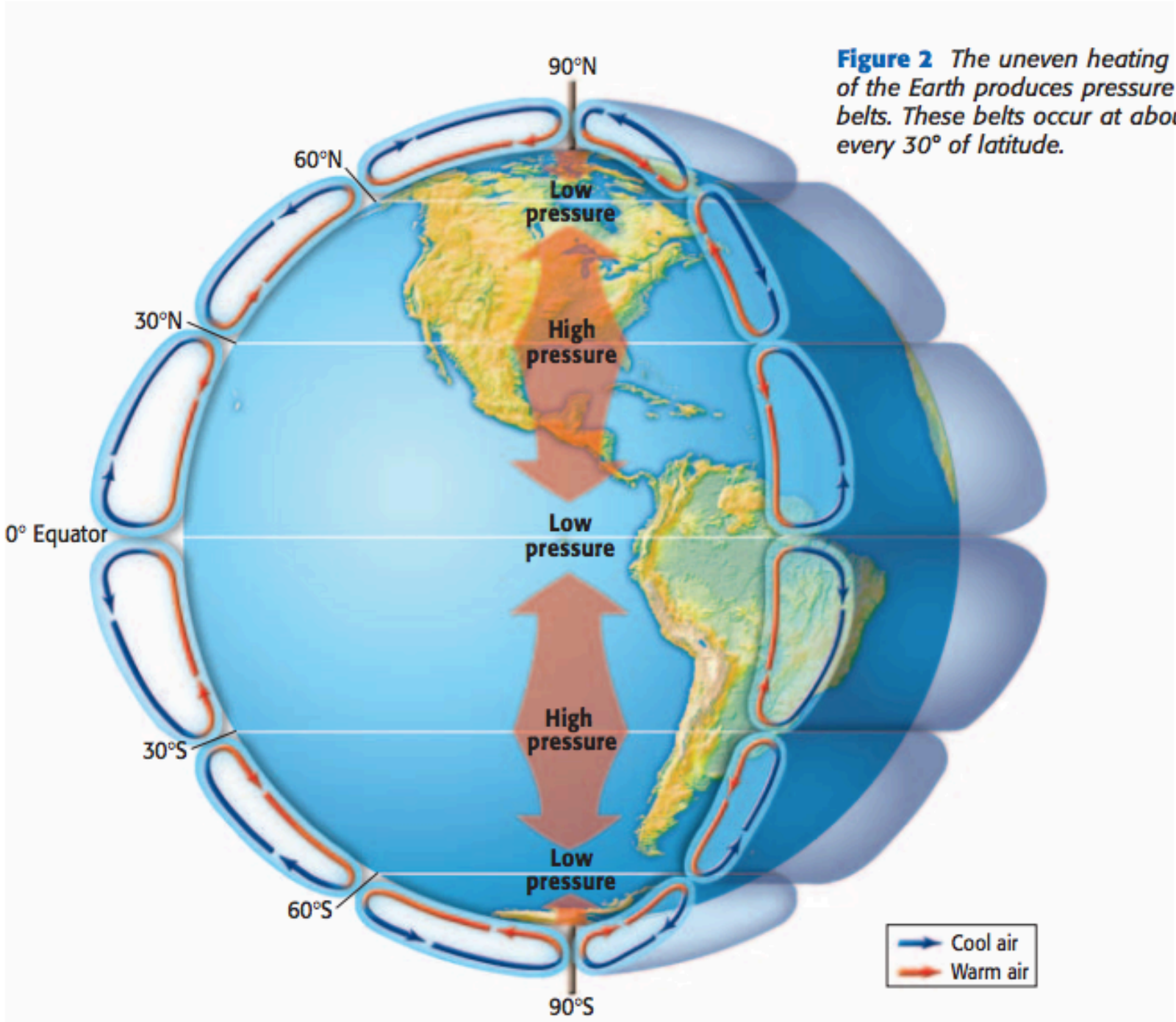
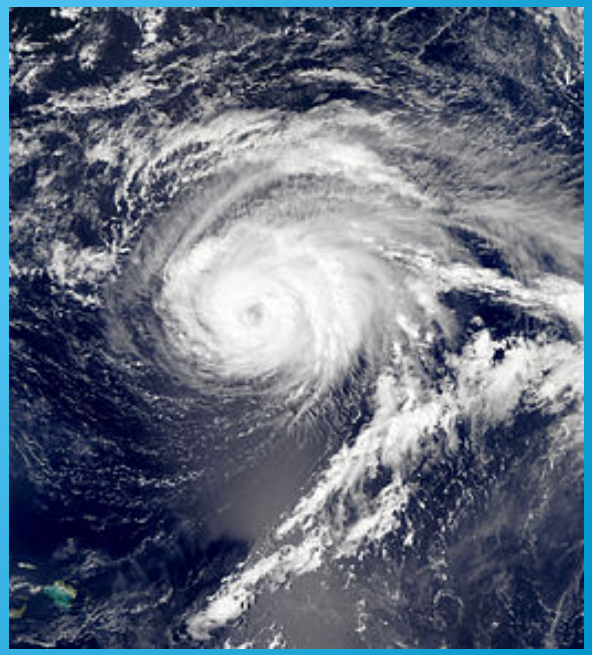


Figure 2 *The uneven heating of the Earth produces pressure belts. These belts occur at about every 30° of latitude.*

The Coriolis Effect is the apparent curving of the path of winds and ocean currents due to the Earth's rotation.

- In the Northern Hemisphere, winds traveling north curve to the east.
- In the Northern Hemisphere, large storms spin counterclockwise.



Hurricane Maria

Global winds are patterns of air circulation caused by convection cells and the Coriolis effect.

- 3 major global wind systems:
  - Polar easterlies
  - Westerlies
  - Trade winds
- Also know:
  - The Doldrums
  - The Horse Latitudes
  - Jet Streams

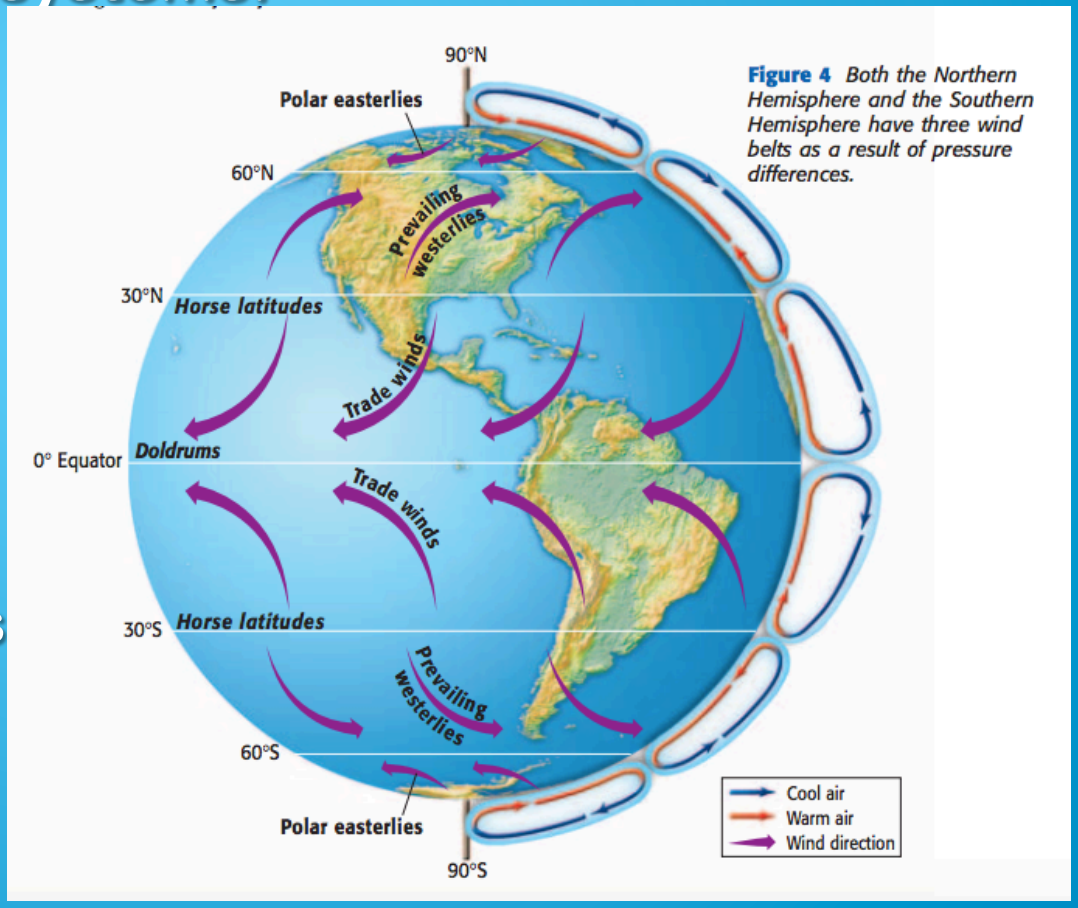
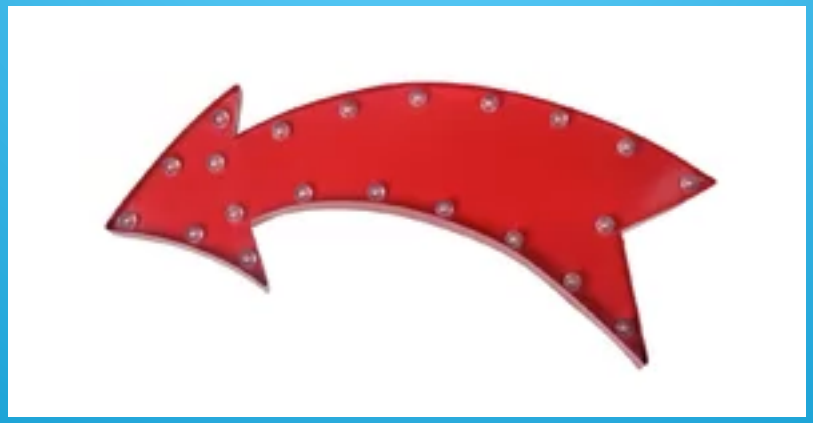


Figure 4 *Both the Northern Hemisphere and the Southern Hemisphere have three wind belts as a result of pressure differences.*

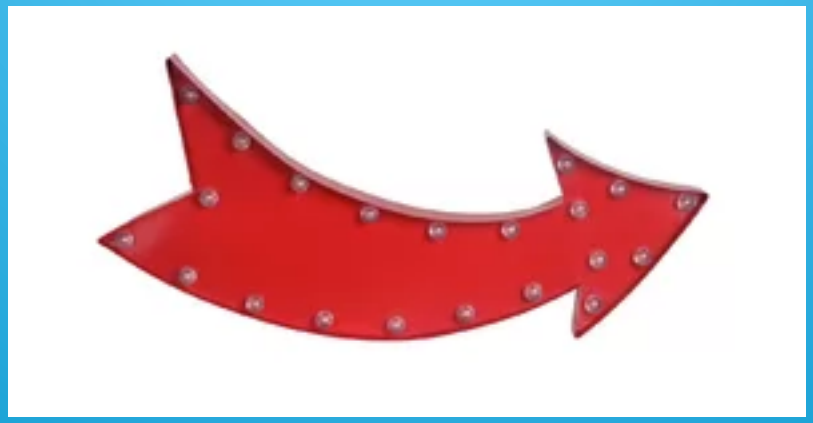
Polar Easterlies

- Extend from the poles to 60° latitude in both hemispheres, flowing from the east to the west
- Form as cold, sinking air moves from the poles toward 60° in each hemisphere
- In the Northern Hemisphere, they carry cold arctic air over the US, producing snow and freezing weather.



Westerlies

- Wind belts between 30° and 60° latitude in both hemispheres
- Flow toward the poles from west to east
- They can carry moist air over the US, producing rain and snow.



Trade Winds

- Winds that blow from 30° almost to the equator in both hemispheres
- They curve toward the west in the Northern Hemisphere and toward the east in the Southern Hemisphere.
- Early traders used them to sail from Europe to the Americas

The Doldrums

- Area near the equator where the trade winds from both hemispheres meet.
- There is very little wind because the warm, rising air creates and area of low pressure.
- “Doldrums” means “dull” or “sluggish”.

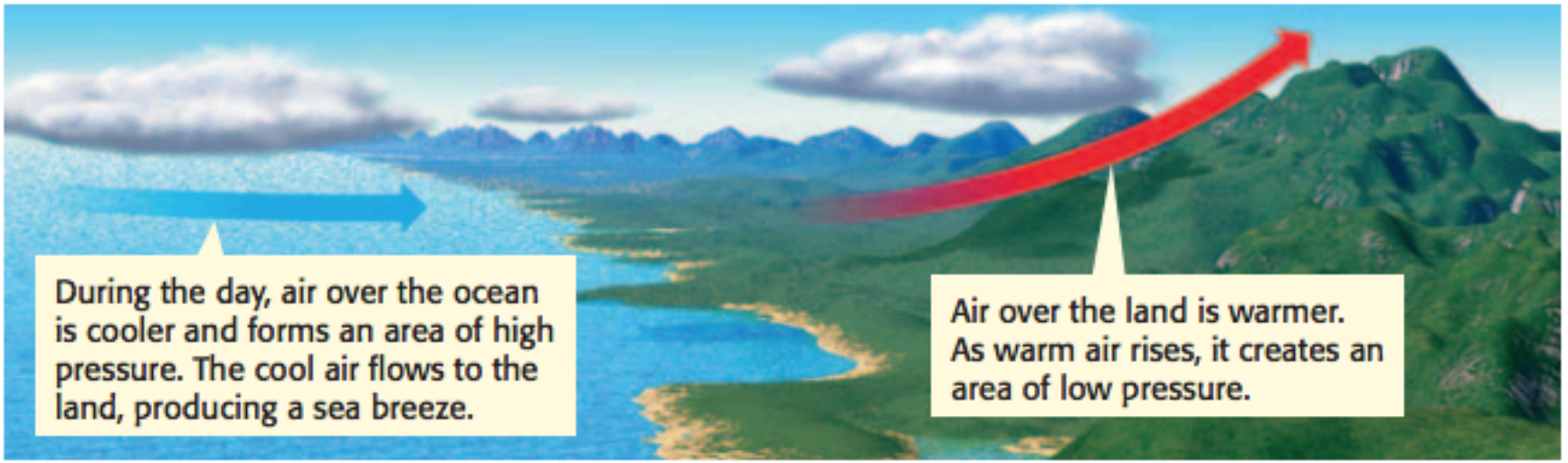
The Horse Latitudes

- Area at about 30° latitude in each hemisphere where sinking air creates an area of high pressure.
- The winds are weak.
- Most of the world's deserts are located here because the sinking air is very dry.
- According to legend, this is where sailors threw horses overboard to conserve water.

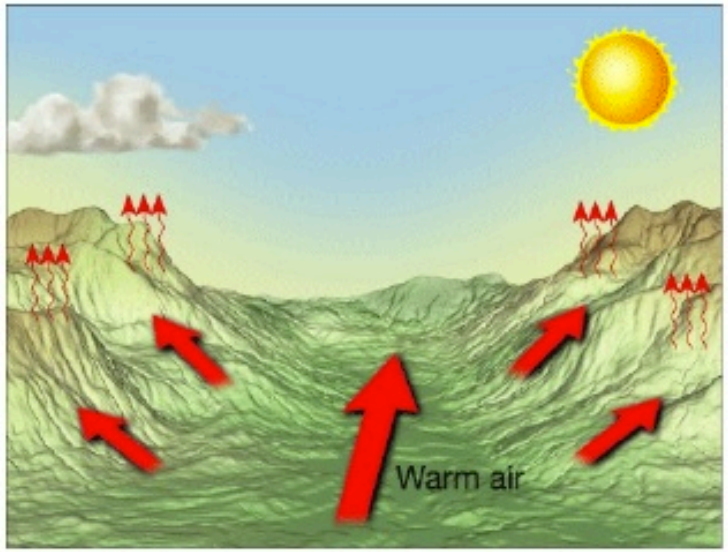
Local winds generally move short distances and can blow from any direction.

- They can be caused by local geographic features that produce temperature differences, such as a shoreline or mountain.
  - Sea and land breezes
  - Mountain and valley breezes

Sea and Land Breezes



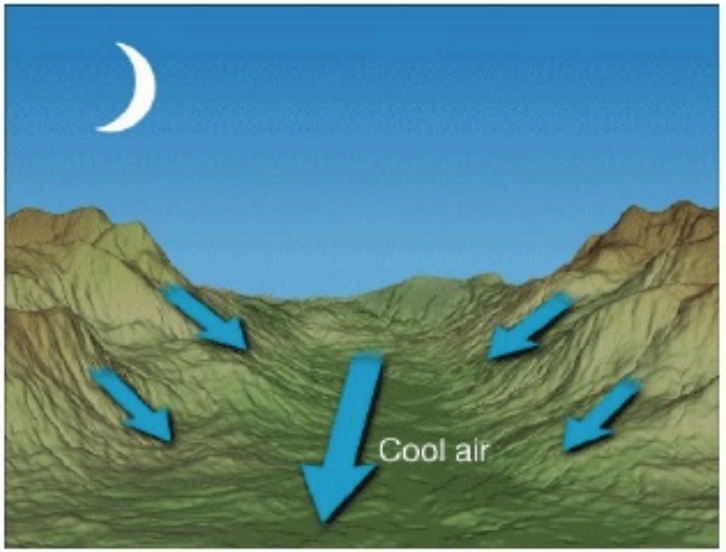
Mountain and Valley Breezes



Valley Breeze

Warm valley, cooler air overhead

Low pressure in valley causes winds to flow upward



Mountain Breeze

Cool valley, warmer air overhead

High pressure in valley causes winds to flow downward