

Water and the Atmosphere

Chapter 5: Climate and Climate Change

8th Grade

Lesson 1 (What Causes Climate?)

Weather – the condition of Earth’s atmosphere at a particular time and place

- The weather changes every day, no matter where you live

Climate – the average, year-after-year conditions of **temperature, precipitation, wind, and clouds** in an area

Temperature of an area is affected by:

1. latitude
2. altitude
3. distance from large bodies of water
4. ocean currents

1. Latitude:

- the distance north or south of the equator
- Areas near the equator generally have warmer climates because the sun’s rays hit Earth’s surface more directly at the equator.
- At the poles, the same amount of solar radiation is spread over a larger area, bringing less warmth.

Tropical zone – the area near the equator between about 23.5° north latitude and 23.5° south latitude

- receives direct sunlight all year

Polar zones – the areas near both poles from about 66.5° to 90° north and 66.5° to 90° south latitudes

- The sun’s rays strike at the lowest angles here.

Temperate zones – the areas between the tropical and polar zones

- They have the greatest temperature ranges throughout the year. (In summer, the rays strike more directly than in winter where the rays strike at a lower angle, resulting in hot summers and cold winters.)

2. Altitude:

- This can be a greater factor in climate than latitude.
- As you rise in the atmosphere, temperature decreases.
- This results in some high altitude areas near the equator actually having glaciers on them.

3. Distance From Large Bodies of Water:

- Water heats up more slowly than land.
- Water also cools down more slowly than land.
- Winds coming off large bodies of water prevent extremes of hot and cold on coastal regions.
- This results in relatively mild winters and cool summers called **maritime climates**.
- Areas that are too far inland to be warmed or cooled by the ocean have **continental climates**.

Marine climate – the climate of some coastal regions, with relatively warm winters and cool summers

- Winds off the ocean prevent the air over land from becoming too cold or too hot.

Continental climate – the climate of inland areas with cold winters and warm hot summers

- With no ocean nearby, temperatures are allowed to become extreme.

4. Ocean currents:

- Warm ocean currents along a coastline warm the air above the water, which in turn affects the climate on land.
- Cold ocean currents along a coastline cool the air above the water, resulting in a cooler climate on land.

Factors that affect precipitation in an area:

- 1. Prevailing winds** – winds that usually blow in one direction in an area
 - They move air masses from place to place.
 - These air masses can be warm or cold, dry or humid.
 - The amount of water vapor in the air mass influences rainfall amount.
 - The amount of water vapor in prevailing wind depends on where the wind blows from. (If coming from over an ocean, more water vapor is carried).

2. Presence of mountains:

- Mountains in the path of prevailing winds can influence where precipitation falls.
- When humid wind blows from the ocean toward coastal mountains, they are forced to rise.
- The rising air cools, water vapor condenses, clouds form and precipitation falls on the **windward** side of the mountains.
- As the air moves over the mountains, much of its water vapor has been lost, leaving little precipitation to fall on the **leeward** side of the mountains.

windward – the side of a mountain range that faces the oncoming wind

leeward – the side of a mountain range that faces away from the oncoming wind

3. Seasonal winds:

- Prevailing winds can change directions with the change in seasons in some areas.
- This affects the precipitation they would normally get.
- If winds blow inland from the ocean, heavy rains are produced.
- These seasonal changes in wind patterns are called **monsoons**.

monsoon – sea or land breeze over a large region that changes direction with the seasons

Lesson 2 (Climate Regions)**Factors in Classifying Climates:**

1. Temperature
2. Precipitation

The Main Climate Regions:

1. tropical rainy
2. dry
3. temperate marine
4. temperate continental
5. polar
6. highlands

Tropical Rainy Climates:

Tropical Wet – have many rainy days and frequent afternoon thunderstorms
– **Rain forests** are common.

Tropical Wet-and-Dry – get slightly less rain and have distinct dry and rainy seasons
– Tropical grasslands called **savannas** are common.

Dry Climates:

Semi-arid – large areas on the edge of deserts that are dry, but get enough rainfall to grow grasses and low bushes.
– Dry prairies or grasslands called **steppes** are common.

Arid – deserts

– Only specialized plants, such as cactus and yucca can survive such low rainfall.

Temperate Marine Climates:

Humid Subtropical – wet and warm, but not constantly hot like the tropics (due to being a marine climate)
– the warmest temperate marine climate

Marine West Coast – temperate climates found on the west coasts of continents north of 40° north latitude and south of 40° south latitude
– the coolest temperate marine climate

Mediterranean – mild, with two seasons

– Summers are warm and dry, winters are cool and rainy.

Temperate Continental Climates:

- not influenced by oceans
- have extremes of temperatures
- found only on continents in the Northern Hemisphere
- There are no large land masses at the right latitude in the Southern Hemisphere for this climate to occur.

Humid Continental – shifting tropical and polar air masses bring constantly changing weather

- In winter, polar air masses bring bitter cold temperatures.
- In summer, tropical air masses bring high heat and humidity.

Subarctic – lies north of the humid continental climates

Polar Climates:

Tundra – dry because cold air contains little moisture

- short cool summers, bitterly cold winters
- contains **permafrost**, or soil that never thaws
- Because of permafrost, water in the summer can't drain away (the surface is wet and boggy), and trees cannot grow.

Ice Cap – average temperatures are always below freezing

Highlands:

- regions that are colder than the regions around them due to colder temperatures at high altitudes
- Increasing altitude produces climate changes similar to the climate changes produced by increasing latitude.

Lesson 3 (Changes in Climate)

Scientists assume that if plants and animals today need certain conditions to live, then similar plants and animals in the past also required those conditions.

To learn about past climates, scientists examine:

1. **Pollen** – By analyzing pollen from thousands of years ago found in lake bottoms, we can learn what types of plants lived there, and infer the type of climate.
2. **Tree Rings** – can be used to determine past climates
 - Wide rings indicate a good growing season that was long and wet.
 - Narrow rings indicate a dry year or short growing season.
3. **Ice Cores** – have a layer for each year, just like tree rings
 - These layers can give information about past climates by looking at what is trapped in the ice, such as pollen, dust, and gases.

Possible Natural Causes for Major Climate Changes:**1. Movement of the continents**

- Evidence shows that most of the land on Earth was once part of a single continent called **Pangaea**.
- At that time, most continents were far from their current locations.
- The movements of continents over time changed the locations of land and sea.
- These changes affected the global patterns of winds and oceans currents, which slowly changed climates.

2. Changes in the position of Earth relative to the sun:

- The angle of Earth's axis and the shape of Earth's orbit affect Earth's climate.
- These two factors change over the course of 100,000 years.
- When Earth's orbit is more elliptical, less sunlight reaches Earth during the year.
- When Earth's orbit is more circular, Earth is warmer.
- The changes in the angle of Earth's axis affects the angle that sunlight hits Earth.
- These changes cause repeating 100,000 year cycles of ice ages interrupted by warm periods.

3. Major volcanic eruptions:

- Major eruptions release large amounts of solid ash and liquid drops (called **aerosols**) into the air that can stay in the upper atmosphere for months or years.
- As long as these particles remain in the air, they can reflect some of the incoming solar radiation and lower temperatures.

Aerosols – solid particles or liquid drops dispersed in a gas

4. Changes in the sun's energy output:

- The sun's energy output changes over a regular 11-year cycle.
- It also can change over hundreds of years.
- The sun has darker, cooler regions called **sunspots**.
- As the sun's magnetic field changes, the number of sunspots changes.
- This affects the amount of radiation received on Earth during different times.

sunspots – relatively dark, cool regions on the surface of the sun

solar maximum – the period in the sunspot cycle when solar activity is highest and sunspots are most abundant

solar minimum – the period in the sunspot cycle when solar activity is lowest and sunspots are least abundant

Lesson 4 (Human Activities and Climate Change)

Greenhouse Effect – the trapping of heat near a planet's surface by certain gases in the planet's atmosphere

How the Greenhouse Effect Works:

- When the sun's energy reaches Earth, much of the energy is absorbed to heat Earth's surface.
- Some of this heat is radiated off Earth's surface back into space.
- Some of this heat is absorbed by gases (called **greenhouse gases**) in the atmosphere and then radiated back toward Earth.
- These greenhouse gases act as an insulating blanket around Earth.
- The balance of energy entering our atmosphere and energy leaving the atmosphere makes temperatures suitable for life on Earth (not too hot, not too cold).
- If greenhouse gases become too numerous, the temperature balance can be changed, affecting climate.

Greenhouse gases – gases that absorb heat leaving Earth's surface

- Oxygen and nitrogen, which make up 99% of Earth's atmosphere, are **not** greenhouse gases, as heat passes easily through them.

major greenhouse gases:

1. **water vapor**
2. **carbon dioxide**
3. **methane**
4. **nitrous oxide**

How Carbon Dioxide Gets Into the Air:

- as a waste product from cellular respiration in living things
- from the decay of living things
- deforestation
- burning of fossil fuels

How Methane Gets Into the Air:

- anaerobic (without oxygen) decay of organic material in wetlands
- fermentation of plant material in cattle, goats, and sheep
- manure and wastewater treatment facilities
- burning of fossil fuels

How Nitrous Oxide Gets Into the Air:

- fertilizer use
- animal waste management
- burning of fossil fuels

Global warming – a gradual increase in the average temperature of the atmosphere, thought to be caused by an increase in greenhouse gases from human activities

Effects of Global Warming:

- melting glaciers
- rising sea levels
- regional changes in temperatures
- drought
- desertification
- changes to the **biosphere** (air, land, and water that is occupied by living things)

Limiting Global Warming:

1. Find clean, renewable sources of energy that release fewer greenhouse gases.
 - solar (to produce electricity)
 - wind (to produce electricity)
 - hydroelectric (moving water to produce electricity)
 - geothermal (using heat from the earth)
 - nuclear (to produce electricity)
 - tidal energy (using the rise and fall of tides to produce electricity)
2. Be more energy efficient.
 - Use less energy (less electricity, less driving)
 - Develop technology that uses less energy to provide the same service.
3. Remove carbon from fossil fuel emissions (exhaust).
 - Technologies are being developed that removes carbon dioxide from exhausts and puts it where it cannot enter the atmosphere.