Earth Science

Chapter 9
Climate & Climate Change
Section 9-1 What Causes Climate?

- **Climate:**
  - long term, average temperature, precipitation, winds & cloud cover in an area.
- **Microclimate:**
  - Small areas with climate conditions that differ from those around them.
Main factors that affect climate
Temperature and Precipitation:

- Factors affecting Temperature:
  - Latitude
  - Altitude
  - Distance from large bodies of water
  - Ocean currents

- Climate zones of the Earth:

  - Tundra
  - Temperate
  - Tropical
  - Desert
  - Polar

Factors affecting Precipitation:

- Proximity to ocean currents
- Distance from large land masses
- Altitude
- Latitude
- Ocean currents

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The main factor affecting Temperature is Latitude.

Know these zones and Latitudes:
- Polar zones
- Temperate zones
- Tropical zones
- Equator (0°)
- 23.5° N (Tropic of Cancer)
- 66.5° N (Arctic Circle)
- 23.5° S (Tropic of Capricorn)
- 66.5° S (Antarctic Circle)
Generally speaking:
- The higher the latitude the cooler the temp
  - 0° to 23.5° – Tropical Zone: warm summer warm winter
  - 23.5° – 66.5° – Temperate Zone: warm summer/cold winter
  - 66.5° – 90° – Polar Zone: cool summer very cold winter
- The higher the altitude the cooler the temp
  - Temps drop on average 6.5° for each kilometer rise in elevation
Generally speaking:

- Large bodies of water
  - Water heats up slower but retains its heat better than land. Oceans moderate the climate around them.
  - **Continental Climates** have warm/hot summers & colder winters.
  - **Marine climates** have cool summers & warmer winter

The 2 other factors affecting temperature is distance from Oceans & types of Ocean Currents.
The other factor affecting temperature is Ocean Currents

- Ocean currents moderate the climate.
  - Warm water currents make the climate warmer in winter & summer.
  - Cold water currents make the climate cooler than the climate found at the same latitudes inland.
The main factors affecting precipitation:

- Prevailing winds
- Presence of mountains
- Seasonal winds
The main factors affecting precipitation: Prevailing Winds

- Prevailing winds move huge air masses from place to place.
- There can be both warm and cold air masses.
- There can be high and low humidity air masses.
The main factors affecting precipitation: Mt. Ranges

- Mt. ranges in the path of moving air masses force the air up and over the mountains.
- As the air is forced up and over, it cools and holds less water vapor.
- **Windward** side of the mt. receives lots of rain/snow
- **Leeward** side is dry w/ little or no rain.
The main factors affecting precipitation:

- Seasonal Winds
  - Sea and Land breezes over a large region that change direction with the seasons are called Monsoons.
  - Regions receive tremendous amounts of rain in the summer.
  - Regions receive very little rain in winter.
  - Monsoons in Thailand, India, Pakistan, Indonesia.
- Southern Calif. receives its Santa Ana Winds blowing warm dry winds in the fall & early winter.
The 4 seasons are caused by the tilt of the Earth and its path around the sun.
- Earth is tilted at a 23.5° angle
- Summer: June 21st: Summer Solstice
- Winter: Dec. 21: Winter Solstice
- Spring: March 21: Vernal Equinox
- Fall: Sept 22: Autumnal Equinox
Seasons, Latitude, and the Tilt of the Earth

- March 21: Spring Equinox
- June 21: Summer Solstice
- September 23: Autumnal Equinox
- December 21: Winter Solstice

During our winter months, the Southern Hemisphere is tilted away from the sun, causing shorter days and colder temperatures. Conversely, during our summer months, the Northern Hemisphere is tilted towards the sun, resulting in longer days and warmer temperatures. These changes in the tilt of the Earth's axis are responsible for the variation in seasons across the globe.
NTK Temperature Scales

<table>
<thead>
<tr>
<th>Fahrenheit</th>
<th>Celsius</th>
<th>Kelvin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water boils</td>
<td>212°</td>
<td>100°</td>
</tr>
<tr>
<td>Body temperature</td>
<td>98.6°</td>
<td>37°</td>
</tr>
<tr>
<td>Room temperature</td>
<td>68°</td>
<td>20°</td>
</tr>
<tr>
<td>Water freezes</td>
<td>32°</td>
<td>0°</td>
</tr>
<tr>
<td>Absolute Zero</td>
<td>-459°</td>
<td>-273°</td>
</tr>
</tbody>
</table>
Section 9-2 Currents & Climate

- **Current:**
  - Large streams of moving water that flow through the oceans.

- **Surface Current**
  - Driven by winds affect water to depths of several hundred meters.
  - **The Coriolis Effect** — causes currents to curve to the right in Northern Hemisphere & left in the Southern Hemisphere.
  - The surface current warms or cools the air above it and influence the climate.
  - **El Nino** — causes warm water currents in eastern Pacific to replace normal cold water off Calif. coast. Produces heavy rain & severe weather conditions.
  - **La Nina** — Waters along Calif. coast are colder than normal. Produces heavy rain in Pacific northwest.
Section 9-2 Currents & Climate

Earth's Surface Currents

Surface Currents

The Coriolis Effect

Deep Currents

Circulation of Deep and Surface Currents

Surface currents:
- Storms move from surface currents, helping to keep the ocean mixed.
- Weather patterns in areas of surface currents can influence weather.

Deep currents:
- Warm water from deep currents helps to keep the ocean mixed.
- Water movement in deep currents can influence ocean circulation.

Polar region

Surface currents:
- Storms move along the surface currents, forming polar regions.

Deep currents:
- Warm water from deep currents helps to keep the ocean mixed.
- Water movement in deep currents can influence ocean circulation.
Section 9-2 Currents & Climate

- **Current:**
  - Large streams of moving water that flow through the oceans.

- **Deep Current**
  - Driven by different densities in water.
  - As ice forms (ice is made from freshwater) the water left behind is saltier.
  - Increase in salinity causes an increase in density.
  - Cold water is more dense than warm water.
  - **Global Conveyor Belt** - deep currents move and mix water around the world. They carry cold water from the poles to the equator.
    - Movement is slow – may take 1000 years to move from pole to equator.
  - **Upwelling** – upward movement of deep cold water to replace warm water blown away by surface currents – high in nutrients.
Section 9-2 Deep Currents

Formation of Deep Currents

- Formation of Deep Currents
- Ocean Salinity

- The formation process involves the cooling of surface water, which becomes more dense and sinks into the ocean.

- Deep currents are formed as cooler, denser water moves from the surface to the ocean depths, creating a thermocline.

Ocean Salinity

- Ocean salinity plays a crucial role in the formation of deep currents.

- High salinity water is lighter and tends to stay near the surface, while low-salinity water is denser and sinks.

- The movement of deep currents is influenced by the salinity gradient in the oceans.
Section 9-3 Climate Regions

- Climates classified by:
  - Temperature
  - Precipitation
- 6 main regions:
  - Tropical Rainy
  - Dry
  - Temperate Marine
  - Temperate Continental
  - Polar
  - Highlands
Climatic Regions

- **Tropical Rainy** — low-lying lands near equator
- **Tropical Wet** — Year round heat w/ heavy rainfall. Rain forest, in US only found on windward side of Hawaiian Islands.
- **Tropical Wet and Dry** — distinct dry & rainy seasons. Savanna (tropical grasslands)
- **Dry** — potential evaporation > potential precipitation (may be hot or cold)
  - **Arid** — deserts — have < 25 cm rain/year
  - **Semi-arid** — a steppe — found on edge of deserts, dry but enough to grow grasses & low brush: grasslands & prairies
Climatic Regions

- **Temperate Marine** — along coasts in temperate zone
- **Marine West Coast** — west coast of continents north & south of 40° latitude. Pacific northwest — mild winters, Redwood forest. Associated w/ heavy precipitation
- **Mediterranean** — drier & warmer than West Coast Marine. Mild w/ 2 seasons — summer (warm w/ little rain) & winter (cool w/ rainy weather) — Chaparral vegetation types
- **Humid Subtropical** — wet & warm (but not as hot as tropics). Summers are hot & humid w/ more rain than in the winters. SE USA; Florida, Georgia
Climatic Regions

- **Temperate Continental** — away from the effects of the oceans, commonly with extremes in temperature. Found only in North America.
- **Humid Continental** — bitter cold winters from Polar air masses, summer brings heat & high humidity from tropical air masses. Found in the Northeast USA & Midwest.
- **Subarctic** — found north of the Humid Continental Region. Summers are very short and cool. Winters are long and bitterly cold.
- **Polar** — coldest climate region—found only near the poles. Relatively dry because cold air holds little humidity.
- **Ice Cape** — average tempos are at or below freezing year round. Intense cold dry air. Only lichens and a few small plants grow on exposed rocks. Found only on Antarctica and northern Greenland.
- **Tundra** — found in northern Alaska, Canada & Russia. Very short cool summers followed by intensely cold winters. Some layers of soil stay frozen year round. (Permafrost)
Climatic Regions

- **Highlands** — since temp drops as altitude increases, Highlands are colder than the regions that surround them.
- **Similar climate as latitudes farther North**
  - Precipitation also increases as altitude increases until clouds dump remaining humidity.
  - 1000 meters in elevation is similar to going 1200 km north.
Section 9-4 Climate Change

- Global Warming: an increase of 0.7°C to the troposphere over the last 120 years.
- Theory – based upon:
  - Greenhouse gases – Carbon dioxide, water vapor, and methane
  - Increased levels of CO₂ may be from man made causes
  - Industrial Revolution starts in the 1800’s corresponds to the beginning of the rise in CO₂ levels.
  - Samples of CO₂ taken from ice cores in the Antarctic
- Climate Variation Hypothesis: some say CO₂ increase NOT due human activities.
  - Some say variations in the output of the sun’s energy is the cause of climate change.
Theory of Global Warming due to the Greenhouse Effect

1. Sunlight shines through the glass into the greenhouse.
2. Sunlight is absorbed by objects inside the greenhouse, changing the energy into heat.
3. The glass stops the heat from escaping to the outside.
Section 9-4 Climate Change

- Ozone depletion:
  - Atmospheric ozone reflects harmful UV solar rays back into space, protecting Earth’s inhabitants.
  - Chemicals produced by humans have been damaging the ozone layer of the atmosphere.
  - Ozone hole over Antarctica caused by CFCs:
    - Chlorofluorocarbons
      - Chlorine converts ozone into oxygen, depleting ozone.
  - Less ozone allows more UV to penetrate to the surface.
  - More UV hitting the surface can cause more damage:
    - Increased skin cancer
    - Eye damage
  - Environmental agreements to stop use of CFCs and are fixing the ozone hole.
Ozone Depletion due to the formation of the Ozone Hole over Antarctica