Vocab

- Insolation: incoming solar radiation
- Albedo: The second cause of the uneven warming of Earth is variation in the amount of surface area over which the Sun's rays are distributed
- Troposphere: The layer of atmosphere that is closest to the Earth
- Stratosphere: Above the troposphere, also has the Ozone layer
- Mesosphere: Above stratosphere
- Thermosphere: Second to last layer, extremely hot.
- Exosphere: Last layer of the atmosphere, where it thins into space.
- Saturation Point: The maximum amount of water vapor in the air at a given temperature.
- Adiabatic Cooling: The cooling effect of reduced pressure on air as it rises higher in the atmosphere and expands.
- Adiabatic Heating: The heating effect of increased pressure on air as it sinks toward the surface of Earth and decreases in volume.
- Latent Heat Release: The release of energy when water vapor in the atmosphere condenses into liquid water.
- Atmospheric Convection currents: Global patterns of air movement that are initiated by the unequal heating of Earth.
- Hadley cells are convection currents that cycle between the equator and approximately 30° N and 30° S.
- Intertropical Convergence Zone(ITCZ): The latitude that receives the most intense sunlight, which causes the ascending branches of the two Hadley cells to converge.
- Polar Cells: A convection current in the atmosphere, formed by air that rises at 60° N and 60° S and sinks at the poles, 90° N and 90° S
- Ferrel Cells: A convection current in the atmosphere that lies between Hadley cells and polar cells.
- Coriolis Effect: The deflection of an object's path due to the rotation of Earth.
- Prevailing Winds: surface winds that blow predominantly from a particular direction over a specific region or area on Earth
- Gyre: A large-scale pattern of water circulation that moves clockwise in the Northern Hemisphere and counterclockwise in the Southern Hemisphere.
- Upwelling: The upward movement of ocean water toward the surface as a result of diverging currents.
- Thermohaline circulation: An oceanic circulation pattern that drives the mixing of surface water and deep water.
- Windward sides: the side of the mountain facing the wind; air rises, cools, and often produces precipitation.
- Leeward side: the side of the mountain not facing the wind; air descends, warms, and creates dry conditions.
- El Niño–Southern Oscillation (ENSO): A reversal of wind and water currents in the South Pacific.

Concepts

Effects of Latitude

- First cause of unequal warming is variation of exposure to light.
- The second cause of the uneven warming of Earth is variation in the amount of surface area over which the Sun's rays are distributed
- The higher the latitude, the more atmosphere that the sunlight has to go through, and the it is spread over a larger surface area ## Effects of Seasons
- Earth Tilt is 23.5 degrees, causing Seasons ## Atmosphere
- Stretches to 10,000 km above the Earth
- Nitrogen: 78.08 percent, Oxygen: 20.95% percent of the atmosphere
- Troposphere temp variation: Gets colder as you go up, has all the weather events too.
- Peak ozone layer: slightly lower than the stratosphere, temp increases as you go up. Absorbs the UV rays.
- Stratosphere: Above ozone layer, temperature increases as you go up.
- Mesosphere: Temperature decreases as you go up, and meteors get burnt up here.
- Thermosphere: Lower half temp increases slowly, and the upper half increases exponentially, blocks important X-ray and Gamma rays from the sun.
- Exosphere: Has the aurora borealis ## Atmospheric Circulation
- 4 Air circulation properties: density, water vapor capacity, adiabatic heating or cooling, and latent heat Release
- Density: The warmer, the higher it goes in the atmosphere beacause of less pressure. The colder, the more it sinks because of the higher density
- Water vapor capacity: When the temperature of air falls, its saturation point decreases, water vapor condenses into liquid water, clouds form, and precipitation occurs.
- Adiabatic Cooling and Heating: The increased pressure caused by compression as the air decreases in temperature causes it to heat up again, sending it back up. It cools down due to adiabatic cooling as well.
- The circulation of the Hadley cells are caused by the intense and direct sunlight strikes at the equator.
- The latitude of the ITCZ isn't fixed. The area that is hit by the most sunlight changes between 23.5 degrees North and

23.5 degrees South. (So effectively between the 2 tropics)
- At 60 degrees north and south, the rising air cools and water vapor condenses into precipitation(Polar cells)
- Polar cells: Air rises at 60 degrees north and south, sinks at 90 N and 90
- Ferrel Cells: These are formed because of the circulation of the polar and the hadley cells, due to things like friction and the 4 properties. ## Effects of UV rays
- can destroy DNA
- Can cause several skin cancers ## Coriolis effect
- If you throw a ball from the north pole directly south, it will land slightly west of the target.
- The deflection occurs because of the differences in the speed of planet's surface between the areas close to the equator compared to the higher latitudes
- This also causes the trade winds to occur ## Causes of the Ocean Currents
- Temperature, gravity, prevailing winds, salinity, the Coriolis effect, and the locations of the continents
- Unequal Heating and gravity: As warm water rises in the equator, it increases the height of the ocean level by 8 cm, which causes water to rush out of the equator due to gravity.
- Wind and Coriolis Effect: The prevailing winds, using the friction between the wind currents and the water, cause the water to go in the same direction. And since the prevailing winds and other winds are also driven by the coriolis effect, so is the water.
- Gyres redistribute the heat in the ocean, just like atmospheric currents. ## Effects of Ocean currents
- Due to upwelling, nutrients from the deep ocean are able to reach the soil in the land.
- Due to thermohaline circulation, which is caused by the unusual amounts of salt in certain parts of the ocean, higher latitudes can recieve warmer water therefore being hotter than they usually would be. ## Other things that affect ocean and air stuff
- Mountains influence local weather and climate despite global-scale processes.

- Moist ocean air moves inland → hits mountains → rises → adiabatic cooling → condensation → precipitation.

- Condensation releases latent heat → strengthens upward air movement.

- Windward side = lush, wet environment (high precipitation).

- After precipitation, air is dry → moves down leeward side → adiabatic heating → arid conditions.

- This creates a **rain shadow effect**, explaining why deserts (e.g., Great Basin, Mojave) exist east of the Sierra Nevada and Cascade ranges.
  ## ENSO
- ENSO is a **cyclical climate pattern** involving interactions between the Pacific Ocean and atmosphere.

- **Normal conditions**: strong trade winds push warm water west → western Pacific is warm and wet, eastern Pacific is cool and dry (due to upwelling).

- **El Niño event**: trade winds weaken → warm water shifts east → reduces upwelling → eastern Pacific warms and gets wetter, western Pacific becomes drier.

- **La Niña event**: trade winds strengthen → warm water pushed further west → eastern Pacific gets cooler, upwelling intensifies → often brings opposite effects of El Niño.

- ENSO disrupts global weather patterns (e.g., floods, droughts, changes in hurricane activity).

- Occurs irregularly every **2–7 years**, lasting **9–12 months** on average.

- Major impacts on ecosystems, agriculture, and economies worldwide. ## Causes of ENSO
- **Interaction between atmosphere and ocean in the tropical Pacific.**

- Driven by changes in **trade winds** (east–west winds along the equator).

- **Normal state**: strong trade winds push warm water westward → western Pacific = warm/wet, eastern Pacific = cool/dry with strong upwelling.

- **El Niño trigger**: trade winds weaken or reverse → warm water sloshes back east → reduces upwelling in eastern Pacific.

- **La Niña trigger**: trade winds strengthen → more warm water pushed west → eastern Pacific cools even more, upwelling

intensifies.

- **Southern Oscillation**: shift in air pressure between western (Indonesia) and eastern (South America) Pacific helps flip the system between El Niño, La Niña, and neutral phases.

- Small disturbances (like random wind bursts or ocean circulation shifts) can tip the balance and start an ENSO cycle. ## El Niño (warm phase) ### Crops
- Can cause **crop failures** in regions dependent on predictable rainfall.

- **Droughts** in Australia, Southeast Asia, and India → reduced rice, wheat, and coffee yields.

- **Flooding** in South America (Peru, Ecuador) → damage to crops but can also enrich soils with nutrients from flooding sediments.

- Warmer waters reduce upwelling off South America → decline in fish populations (e.g., anchovies), harming fishing industries.

Environment

- **Flooding and landslides** in western South America.

- **Droughts and wildfires** in Australia, Southeast Asia, and Africa.

- Disruption of marine ecosystems due to loss of nutrient upwelling.

- Global increase in average temperatures during strong El Niño years.

La Niña (cool phase)

Crops

- **Increased rainfall** in Southeast Asia, India, and northern Australia → can boost rice and wheat production.

- **Drought conditions** in South America (Peru, Chile) → crop stress and losses.

- More hurricanes in the Atlantic → can damage agriculture in Central America and the Caribbean.

- Sometimes favorable for fisheries off South America (stronger upwelling brings nutrients).

Environment

- **Flooding** in Southeast Asia, India, and Australia.

- **Droughts** in western South America and parts of the U.S. (southwest).

- **Colder winters** in northern U.S. and Canada due to jet stream shifts.

- Healthier marine ecosystems off South America (nutrient-rich upwelling). # Images
- Albedo:
- Atmosphere:
- Water Saturation:
- Air Circulation:
- Hadley Cell:
- Coriolis:
- Wind Currents:
- Ocean Currents:
- Thermohaline:
- Rain Shadow: