UNIT TWO

CLIMATE CLASSIFICATION AND CLIMATE REGIONS OF OUR WORLD

Introduction: Climate is a complex concept that involves understanding various aspects of the Earth's environment. Since the climate can differ significantly from one place to another, scientists have developed methods to classify climates to better understand and compare them. This section will introduce you to different climatic classification methods, the criteria used in these classifications, and how these methods help in understanding global climatic regions.

What is Climate Classification? Climate classification is a system used to categorize the climate of different regions based on specific criteria like temperature, precipitation, and vegetation. This classification helps in predicting weather patterns, comparing climates of different regions, and understanding climate changes over time.

Historical Background and Ancient Greek Classification: The ancient Greeks were among the first to attempt classifying climates by dividing the Earth into zones based on their perceptions of habitability. They identified three major zones:

- **Frigid Zone:** Near the polar regions, characterized by extremely cold temperatures.
- **Temperate Zone:** Located between the Frigid and Torrid Zones, considered to have the most favorable climate.
- **Torrid Zone:** The tropics, where temperatures are warmer.

Types of Climate Classification Methods:

1. **Genetic Classification:**
    - This method classifies climates based on the processes that shape them, such as air masses, circulation systems, and solar radiation. It is more scientific but also more complex to apply.
    - Example: Air mass classification.
2. **Empirical Classification:**
    - This method classifies climates based on observable data like temperature and precipitation. It is simpler to apply and widely used.
    - Examples: Köppen's and Trewartha's classification systems.

Köppen Climate Classification System: Developed by Vladimir Köppen, this system is one of the most widely used methods for classifying world climates. It focuses on temperature, precipitation, and the seasonality of these factors. The Köppen system identifies five major climate types:

1. **Tropical Climate (A):**
    - All months have an average temperature above 18°C (64°F).
    - Example: Amazon rainforest.
2. **Dry Climate (B):**
    - Low precipitation throughout the year.
    - Example: Sahara Desert.
3. **Mesothermal Climate (C):**
    - Mild winters with average temperatures of the coldest month below 18°C (64°F) but above -3°C (27°F).
    - Example: Mediterranean region.
4. **Microthermal Climate (D):**
    - Cold winters with the warmest month averaging above 10°C (50°F), and the coldest month below -3°C (27°F).
    - Example: Siberia.
5. **Polar Climate (E):**
    - Extremely cold with the warmest month below 10°C (50°F).
    - Example: Antarctica.

Modified Köppen-Geiger Classification: Rudolf Geiger modified Köppen's system to better align climate zones with vegetation types. The modified system includes subdivisions based on specific criteria like precipitation patterns (e.g., "f" for wet all year, "w" for dry winters) and temperature variations (e.g., "a" for hot summers, "b" for warm summers).

Trewartha's Climate Classification: Trewartha's system combines elements from both genetic and empirical methods. It emphasizes basic weather parameters such as temperature and precipitation while also considering the impact of water bodies on climate.

Conclusion: Understanding climatic classification helps in recognizing the similarities and differences in climate across different regions of the world. These classifications are crucial for predicting weather patterns, studying environmental changes, and planning for future climatic shifts.

Key Points to Remember:

- Climate classification is a system used to categorize climates based on specific criteria.
- Köppen's system is widely used and identifies five major climate types.

- The modified Köppen-Geiger system and Trewartha's system are also important methods of classification.

2.4 World Climatic Regions

Understanding the world's climatic regions is essential for grasping the variety of climates across the globe. Climate regions are primarily classified based on the Köppen classification system, which considers the seasonal dominance of air masses. The world is divided into three broad climatic regions: low-latitude, mid-latitude, and high-latitude climates.

2.4.1 Low-Latitude Climatic Regions

I. Tropical Wet Region

- **Location:** This climate region is found along the equator, between 6°N and 6°S latitude.
- **Climate Characteristics:** The region is characterized by high daily temperatures (20°C to 30°C) and consistent monthly temperatures (24°C to 28°C). Rainfall is abundant throughout the year, with over 80 inches of total annual precipitation.
- **Air Masses:** Maritime tropical air masses dominate year-round. The region is also influenced by the Intertropical Convergence Zone (ITCZ), which brings heavy rainfall.
- **Vegetation:** The dominant vegetation is dense tropical rainforests, composed of tall, broad-leafed evergreen trees.
- **Weather Patterns:** High surface heat, marine humidity, and air convergence result in frequent cumulus and cumulonimbus cloud formations, leading to daily thunderstorms.
- **Examples:** The Amazon Basin, Congo Basin, and areas in Southeast Asia, such as Sumatra and New Guinea.

II. Tropical Wet and Dry Region

- **Location:** This region is found between 6° and 15° N and S latitudes.
- **Climate Characteristics:** It lies between the wet tropics and the subtropical deserts. It experiences a wet season influenced by the high sun season and a dry season associated with the low sun season.
- **Air Masses:** The climate is shaped by maritime tropical air masses during the wet season and continental tropical air masses during the dry season.
- **Vegetation:** Savanna, characterized by grasslands with scattered trees, is the predominant vegetation type.
- **Weather Patterns:** The wet season brings thunderstorms, while the dry season has semi-desert conditions.

- **Examples:** Regions in India, West Africa, southern Africa, South America, and northern Australia.

III. Dry Desert and Steppe Region

- **Location:** Found between 15° and 25° N and S latitudes, often on the western sides of continents.
- **Climate Characteristics:** This region has low relative humidity, sparse cloud cover, low precipitation, and high temperatures.
- **Air Masses:** Continental tropical air masses dominate, and the climate is heavily influenced by the subtropical high-pressure zones.
- **Vegetation:** Deserts and steppe plains, with sparse vegetation, are typical of this region.
- **Examples:** Southwestern USA, Northern Mexico, North Africa, South Africa, and central Australia.

2.4.2 Mid-Latitude Climatic Region

I. Mid-Latitude Desert and Steppe

- **Location:** Situated between 30° and 55° N and S latitudes.
- **Climate Characteristics:** Summers are dominated by warm, dry continental tropical air, while winters are influenced by cold continental polar air. Precipitation is low, with moderate to high average temperatures.
- **Weather Patterns:** Precipitation mainly comes from maritime sources, and mountain ranges often block moisture, leading to dry conditions.
- **Vegetation:** Deserts and steppe grasslands are common.
- **Examples:** Regions near the Caspian Sea, north of the Himalayas, western USA, and east of the Andes.

II. Mid-Latitude Wet Region

- **Climate Characteristics:** This region experiences abundant, evenly distributed precipitation throughout the year, with thunderstorms in summer and frontal weather in winter.
- **Vegetation:** Deciduous forests are the most common vegetation type.
- **Examples:** This climate is found in parts of North America, southeastern South America, New Zealand, and southeastern Australia.

III. Mid-Latitude Winter Dry Region

- **Climate Characteristics:** Distinct seasonal patterns, with hot, humid summers and cold, dry winters. Precipitation in winter is minimal, mostly from mid-latitude cyclones.
- **Vegetation:** Grasslands dominate this region.
- **Examples:** Found in the interiors of North America and Eurasia.

IV. Mid-Latitude Summer Dry Region

- **Location:** Located between 30° and 50° latitude, typically on the western coasts of continents.
- **Climate Characteristics:** Known as the Mediterranean climate, it has dry summers due to subtropical high-pressure systems and wet winters due to mid-latitude cyclones.
- **Vegetation:** The chaparral biome, consisting of sclerophyllous plants, is common.
- **Examples:** Central and southern California, coastal regions around the Mediterranean Sea, and coastal zones in Australia, Chile, and South Africa.

2.4.3 High-Latitude Climate

I. Polar Tundra

- **Climate Characteristics:** Characterized by cold winters, cool summers, and minimal summer rainfall. Annual precipitation is typically less than 10 inches.
- **Vegetation:** Sparse vegetation due to the harsh climate, with permafrost present in many areas.
- **Examples:** Found along the Arctic coasts of North America, Europe, and Asia, as well as in Iceland, Greenland, and some Southern Hemisphere islands.

II. Polar Ice Cap

- **Climate Characteristics:** Found at extremely high latitudes, with no sunlight for half the year. Summers have long days but are still cold due to the high albedo of snow, reflecting up to 90% of sunlight.
- **Vegetation:** Virtually no vegetation due to the extreme cold.
- **Examples:** Greenland, Antarctica, and other polar regions.

2.4.4 Highlands Climate

- **Climate Characteristics:** Highland climates vary greatly depending on altitude and location. Higher altitudes typically mean cooler temperatures and increased precipitation due to orographic lifting.
- **Vegetation:** Vegetation varies from one mountain region to another and can range from dense forests to alpine tundra.
- **Examples:** Highland climates are found in mountainous regions across the world, from the Andes in South America to the Himalayas in Asia.

2.5 Factors Affecting Global Climate Zones

Several factors influence the formation and distribution of climate zones globally. These include:

- **Latitude:** Determines the amount of solar energy received and the intensity of seasons. Regions closer to the equator experience more consistent sunlight and less seasonal variation, while higher latitudes experience more extreme seasonal changes.
- **Earth's Revolution, Rotation, and Tilt:** These factors influence the length of days and nights throughout the year, affecting the climate by changing the amount of sunlight received at different times of the year. For example, during the June solstice, the Northern Hemisphere experiences longer days and shorter nights, leading to warmer temperatures.

2.5.3. Continentality (Distance to Large Water Bodies)

Concept Overview: Continentality refers to the effect of a location's distance from large bodies of water (like oceans and lakes) on its climate. Water bodies have a significant influence on climate because they can absorb and store large amounts of heat during the summer and slowly release it during the winter. This moderating effect of water leads to smaller temperature variations in coastal areas compared to inland areas, where temperature fluctuations are more extreme.

Impact on Climate:

- **Coastal Areas:** Places near large water bodies experience milder climates with smaller temperature ranges. The water absorbs heat during the summer, which cools the surrounding areas, and releases this heat during the winter, warming the area.
- **Inland Areas:** Locations far from large water bodies experience more extreme temperatures because land heats up and cools down faster than

water. This results in hotter summers and colder winters, leading to a wider range of temperatures throughout the year.

Examples:

- **Asia:** The world's largest landmass, Asia, experiences the greatest seasonal temperature extremes due to its vast interior regions that are far from oceans.
- **Lakes and Smaller Water Bodies:** Even smaller water bodies like lakes, swamps, and marshes can cause significant temperature variations. Windward sides of these water bodies (the side from which the wind is coming) often experience greater temperature changes compared to the leeward sides (the side sheltered from the wind).

Other Influences:

- **Insolation (Sunlight):** The amount of solar energy received at the surface, whether land or water, contributes to temperature variation. Over water bodies, some of this energy is used for evaporation rather than heating the air, which moderates temperature fluctuations.
- **Cloud Formation:** In tropical and mid-latitude regions, clouds formed by the evaporation of water from large water bodies play a significant role in daily temperature changes, particularly during the summer months.

This concept of continentality helps explain why two locations at the same latitude might have very different climates based on their proximity to large bodies of water.

2.5.4. Atmospheric Circulation

Concept Overview: Atmospheric circulation refers to the large-scale movement of air around the Earth, which distributes heat and moisture across different regions. This circulation is crucial in determining the climate of a region, as it moves warm and cold air, influencing temperature and precipitation patterns.

Key Points:

- **Energy Balance:** The atmosphere works to balance energy differences across the Earth. For example, warm air from the tropics is moved towards the poles, while cold air from the poles is brought towards the equator.
- **Pressure Systems:** Climate differences arise from variations in atmospheric pressure. High-pressure areas (where the air is denser) push air toward low-

pressure areas (where the air is less dense). This movement of air creates winds and weather patterns that affect local climates.

Practical Example: Even if two locations share the same latitude and distance to the ocean, their climates might differ if they are influenced by different atmospheric circulation patterns. For instance, one location might be under the influence of a warm, moist wind from the ocean, while the other might experience dry, cold air from a continent.

2.5.5. Seasonal Movement of Subtropical High Pressure (STH)

Concept Overview: Subtropical High Pressure (STH) zones are areas of high atmospheric pressure typically found around 30° latitude in both hemispheres. These zones influence climate by guiding the direction of surface winds and affecting weather patterns.

Key Points:

- **Surface Westerlies:** The STH zones are the source of the surface westerly winds, which blow from the west to the east in the mid-latitudes.
- **ITCZ:** The Intertropical Convergence Zone (ITCZ) is a low-pressure area near the equator where warm air rises, leading to cloud formation and precipitation. The STH affects the position and movement of the ITCZ, which in turn influences rainfall patterns.

Practical Example: The seasonal migration of the STH zones can lead to shifts in weather patterns, such as the monsoons in Asia, where changes in the position of these high-pressure systems bring heavy rains or dry conditions.

2.5.6. Coriolis Effect, Centrifugal Acceleration, and Friction

Concept Overview: These are forces that influence the direction and speed of wind, which are crucial in understanding weather and climate patterns.

Key Points:

- **Coriolis Effect:** Due to Earth's rotation, moving air is deflected to the right in the Northern Hemisphere and to the left in the Southern Hemisphere, affecting wind direction.

- **Centrifugal Acceleration:** This is the apparent force that acts outward on an object moving in a circular path, affecting the movement of air.
- **Friction:** Friction between the Earth's surface and the atmosphere slows down winds, especially near the surface. The rougher the surface (e.g., mountains), the more friction there is, influencing wind patterns.

2.5.7. Ocean Circulation

Concept Overview: Ocean circulation refers to the large-scale movement of water within the oceans, which helps distribute heat around the planet. Surface currents, driven by winds and pressure zones, are particularly important in influencing climate.

Impact on Climate:

- **Warm Currents:** Warm ocean currents can raise temperatures in nearby coastal areas.
- **Cold Currents:** Cold ocean currents can lower temperatures, leading to cooler climates even in regions that would otherwise be warm.

2.5.8. Topography or Elevation

Concept Overview: Topography, or the physical features of the landscape, particularly elevation, significantly affects climate.

Temperature and Elevation:

- **Lapse Rate:** In the troposphere, temperature generally decreases by about 6.4°C for every 1,000 meters of elevation. This means higher elevations are cooler than lower ones.

Example Calculation:

- If the temperature at sea level is 30°C, the temperature at the top of Ras Dejene Mountain (4,620 meters above sea level) would be:
    - Decrease in temperature = (4,620 meters * 6.4°C) / 1,000 = 29.57°C
    - Temperature at the top = 30°C - 29.57°C = 0.43°C

Other Influences:

- **Orientation of Slopes:** South-facing slopes in the Northern Hemisphere receive more sunlight, making them warmer than north-facing slopes.
- **Orographic Rainfall:** Mountains force moist air to rise, cool, and condense, leading to precipitation on the windward side, while the leeward side remains drier (rain shadow effect).

Ethiopia's Local Climate Classification

Ethiopia's climate classification is based on elevation, temperature, and growing season length, dividing the country into five primary climatic zones:

1. **Bereha:** Hot, lowland desert-like climate below 500 meters, with high temperatures (above 30°C) and low rainfall.
2. **Kolla:** Warm to hot semi-arid climate between 500 and 1,500 meters, with temperatures between 20°C and 30°C.
3. **Woina-Dega:** Temperate highlands between 1,500 and 2,300 meters, with temperatures between 15°C and 20°C.
4. **Dega:** Cold temperate highlands between 2,300 and 3,300 meters, with temperatures below 10°C.
5. **Wurch:** Alpine climate above 3,300 meters, with temperatures below 10°C and significant rainfall.

Unit Summary

Climatic regions are categorized to simplify the understanding of global climate diversity. The Köppen classification system is widely used due to its alignment with vegetation and soil types. Key climate influencers include latitude, continentality, atmospheric circulation, elevation, and ocean currents. Ethiopia's local climate is categorized into zones based on height, temperature, and growing season length.