

CHAPTER 4: CLIMATE

PREMIUM EXAM-ORIENTED STUDY NOTES • CLASS 9 GEOGRAPHY

SECTION 1: Chapter Introduction

The study of atmospheric conditions is essential to understanding the natural environment and human lifestyles. While previous chapters focused on landforms and drainage, this chapter examines the complex atmospheric mechanisms governing the Indian subcontinent. India's climate is described as a **monsoon type**, shared primarily with South and Southeast Asia. Understanding the structural differences between momentary weather variations and long-term climatic patterns allows students to appreciate the deep regional variations in temperature and precipitation that shape India's cultural, agricultural, and economic identity.

SECTION 2: Detailed Explanation of Concepts

- **Climate:** Refers to the sum total of weather conditions and variations over a large area for a long period of time (more than thirty years).
- **Weather:** Refers to the state of the atmosphere over an area at any point in time. Its elements fluctuate rapidly within a single day.
- **Elements of Weather & Climate:** Temperature, atmospheric pressure, wind, humidity, and precipitation are identical for both concepts.

The Six General Climatic Controls

The climate of any locality globally is determined by six primary factors:

- **1. Latitude:** Due to the curvature of the earth, the amount of solar energy received varies according to latitude. Air temperature generally decreases from the equator toward the poles.
- **2. Altitude:** As one ascends from the surface of the earth to higher altitudes, the atmosphere becomes less dense and temperature decreases. Hills are therefore cooler during summers.
- **3. Pressure and Wind System:** Depends entirely on the latitude and altitude of the area. It influences the temperature and rainfall patterns directly.
- **4. Distance from the Sea (Continentality):** The sea exerts a moderating influence on climate. As distance from the sea increases, this moderating effect decreases and people experience extreme weather conditions (very hot summers and very cold winters).
- **5. Ocean Currents:** Ocean currents along with onshore winds affect the climate of coastal areas. For instance, any coastal area with warm or cold currents flowing past it will be warmed or cooled if the winds are onshore.

- **6. Relief Features:** High mountains act as barriers for cold or hot winds; they may also cause precipitation if they are high enough and lie in the path of rain-bearing winds (windward side vs. leeward rain-shadow side).

SECTION 3: Factors Affecting India's Climate

A. Latitude

The **Tropic of Cancer** ($23^{\circ}30'N$) passes through the middle of the country from the Rann of Kachchh in the west to Mizoram in the east. Almost half of the country, lying south of the Tropic of Cancer, belongs to the tropical area. All the remaining area, north of the Tropic, lies in the sub-tropics. Therefore, India's climate has characteristics of both tropical as well as subtropical climates.

B. Altitude

India has mountains to the north, which have an average height of about **6,000 meters** . India also has a vast coastal area where the maximum elevation is about 30 meters. The Himalayas act as an effective shield, preventing the frigid central Asian winds from entering the subcontinent. Consequently, India experiences much milder winters compared to central Asia.

C. Pressure and Winds

The climate and associated weather conditions in India are governed by unique atmospheric systems:

- **Surface Pressure and Winds:** India lies in the region of north-easterly winds. Originating from the subtropical high-pressure belt of the Northern Hemisphere, they blow southwards, get deflected to the right due to the **Coriolis force**, and move toward the equatorial low-pressure area. Since they originate over land, they carry very little moisture and generally bring no rain. Thus, India should have been an arid land, but unique wind reversals change this completely.
- **Upper Air Circulation (Jet Streams):** The upper air circulation over India is dominated by a westerly flow. A critical component is the **Subtropical Westerly Jet Stream**, located north of the Himalayas all through the year except in summer.
- **Western Cyclonic Disturbances:** Shallow cyclonic depressions originating over the Mediterranean Sea are brought into India by the westerly jet streams, causing crucial winter rainfall in northwestern plains and snowfall in the mountains.

SECTION 4: Monsoon System in India

The word monsoon is derived from the Arabic word '*mausim*', meaning season. It refers to the seasonal reversal in the wind direction over a year.

Mechanism of the Indian Monsoon

The monsoon mechanism is driven by several distinctive structural factors:

- **Differential Heating and Cooling:** Land heats up and cools down faster than water, creating low pressure on the Indian landmass and high pressure over the surrounding seas.
- **Shift of the ITCZ:** In summer, the **Inter Tropical Convergence Zone (ITCZ)**—the equatorial low-pressure trough—shifts northwards over the Ganga plains (around 20°N – 25°N).
- **High-Pressure Area East of Madagascar:** Located approximately at 20°S over the Indian Ocean, its intensity and position affect the strength of the Indian Monsoon.
- **Tibetan Plateau Heating:** During summer, the Tibetan plateau gets intensely heated, resulting in strong vertical air currents and the formation of low pressure over the plateau at about 9 km above sea level.
- **Jet Stream Shifts:** The movement of the westerly jet stream to the north of the Himalayas and the introduction of the tropical easterly jet stream over the peninsular plateau during summer.
- **SO and El Niño:** Changes in pressure conditions over the southern oceans affect the monsoon. Normally, the tropical eastern South Pacific Ocean experiences high pressure and the eastern Indian Ocean experiences low pressure. A reversal in this system is called the **Southern Oscillation (SO)**. **El Niño** is a warm ocean current that flows past the Peruvian coast in place of the cold Peruvian current every 2 to 5 years, leading to a temporary decrease in monsoon rainfall over India.

Onset and Withdrawal of Monsoon

The monsoon is a pulsating wind system, not steady. It arrives at the southern tip of the Indian peninsula generally by the first week of June. It then splits into two branches: the **Arabian Sea Branch** and the **Bay of Bengal Branch**. Around the time of its arrival, the normal rainfall increases suddenly and continues constantly for several days; this is known as the '**burst**' of the monsoon. Withdrawal or retreat of the monsoon is a more gradual process, beginning in northwestern states by early September and completely clearing by December.

SECTION 5: Seasons in India

The monsoon climate is characterized by a distinct seasonal pattern. Four main seasons can be identified in India:

1. The Cold Weather Season (Winter)

- **Duration:** Begins from mid-November in northern India and stays till February. December and January are the coldest months.
- **Characteristics:** Clear skies, low temperatures, low humidity, and feeble, variable winds. Days are warm and nights are cold. Frost is common in the north.
- **Features:** Northeast trade winds blow from land to sea, making it dry for most parts of the country except the Tamil Nadu coast, which receives rain from these winds blowing onshore. Winter rainfall in the north, locally called '**mahawat**', is small but crucial for growing *rabi* crops.

2. The Hot Weather Season (Summer)

- **Duration:** March to May. The global heat belt shifts northward due to the apparent movement of the sun.
- **Characteristics:** Rising temperatures and falling air pressure. High temperatures in the north reach up to 45°C .
- **Features:** A striking feature is the '**Loo**'—strong, gusty, hot, dry winds blowing during the day over north and northwestern India. Dust storms are common in May. Towards the close of summer, pre-monsoon showers occur in Kerala and Karnataka, helping in the early ripening of mangoes; these are called '**Mango showers**'. **Kaal Baisakhi** refers to violent thunderstorms with torrential downpours in West Bengal.

3. Advancing Monsoon (The Rainy Season)

- **Duration:** June to September. The low-pressure condition over the northern plains intensifies and attracts the trade winds of the Southern Hemisphere.
- **Characteristics:** These South-West monsoon winds cross the equator, blow over warm oceans, carry a massive amount of moisture, and enter India to cover the entire country in about a month.
- **Features:** Heavy rainfall on the windward side of the Western Ghats (over 250 cm). Mawsynram in the southern hills of the Khasi Range receives the highest average rainfall in the world. The monsoon is characterized by '**breaks**'—periods of dry spells interspersed with rainy intervals, controlled by the movement of the monsoon trough.

4. Retreating/Post-Monsoon (Transition Season)

- **Duration:** October and November. The sun moves towards the south, making the northern low-pressure trough weaker. It is gradually replaced by a high-pressure system.
- **Characteristics:** Clear skies and a rise in temperature. While days are warm, nights are cool and pleasant. The combination of high temperature and high humidity makes the weather oppressive during the day. This is commonly known as '**October Heat**'.
- **Features:** The low-pressure center shifts to the Bay of Bengal, giving rise to cyclonic depressions. These tropical cyclones cross the eastern coast of India (deltas of Godavari, Krishna, and Kaveri), causing widespread destruction.

SECTION 6: Distribution of Rainfall

- **Areas of Heavy Rainfall (Over 400 cm annual):** Western coast, Northeastern India (Assam, Meghalaya, Arunachal Pradesh).
- **Areas of Low Rainfall (Less than 60 cm annual):** Western Rajasthan, adjoining parts of Gujarat, Haryana, and Punjab. Also, the interior part of the Deccan plateau east of the Western Ghats (Leeward rain-shadow side) and Leh in Ladakh.
- **Variable Nature:** Rainfall is highly variable in regions of low precipitation. Consequently, while areas of high rainfall are prone to floods, areas of low rainfall face frequent droughts.

SECTION 7: Important Terms & Definitions

- **Coriolis Force:** An apparent force caused by the earth's rotation, responsible for deflecting winds towards the right in the Northern Hemisphere and towards the left in the Southern Hemisphere (also known as **Ferrel's Law**).
- **Jet Stream:** A narrow belt of high altitude (above $12,000\text{ m}$) westerly winds in the troposphere, with speeds varying from 110 km/h in summer to about 184 km/h in winter.
- **ITCZ (Inter Tropical Convergence Zone):** A broad trough of low pressure in equatorial latitudes where the northeast and southeast trade winds converge.
- **El Niño:** A warm ocean current that develops off the coast of Peru as a temporary replacement of the cold Peruvian current, disrupting global weather profiles.
- **October Heat:** A transition period condition in October marked by clear skies, high temperature, and high humidity, making the climate oppressive.
- **Breaks in Monsoon:** Wet and dry spells during the rainy season when the monsoon winds fail to bring rain for a few days or weeks.

SECTION 8: NCERT Key Points

NCERT HIGH-YIELD DATA

- **Mawsynram** is known for its cave formations of stalagmites and stalactites, along with holding the world record for the highest mean annual precipitation.
- The Indian landscape, its animal and plant life, agricultural calendar, and life of the people revolve around the rhythmic cycle of the **Monsoon as a Unifying Bond**.
- The western cyclonic disturbances experienced in the north and northwestern parts of India during winter originate over the **Mediterranean Sea**.

SECTION 9: Tables & Flowcharts

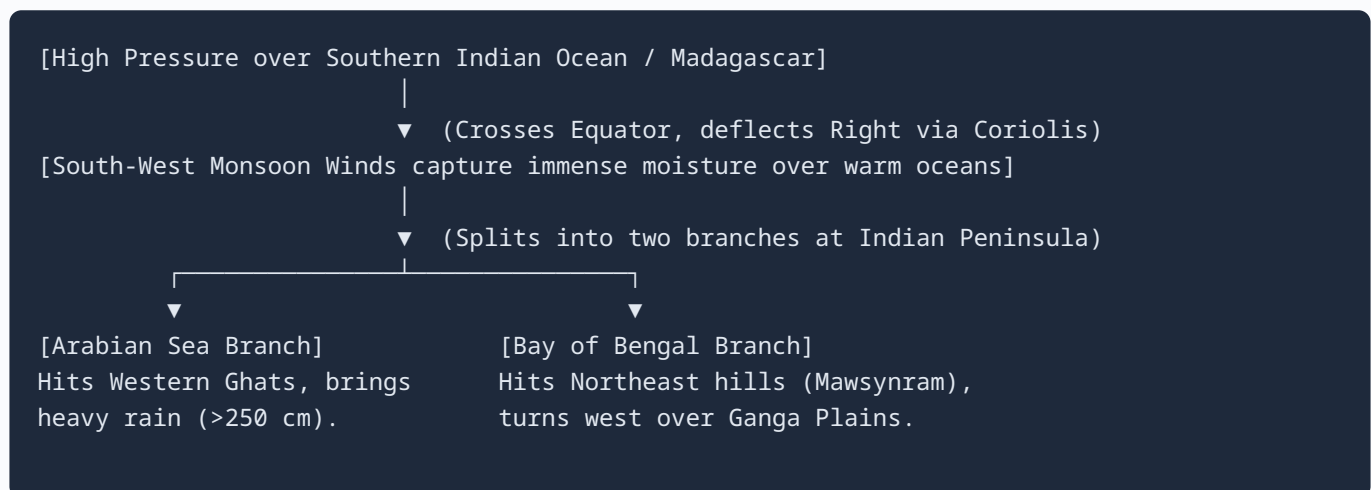
Table 9.1: Structural Difference Between Weather and Climate

PARAMETERS	WEATHER	CLIMATE
Time Frame	Short-term state of atmosphere (hourly/ daily changes).	Long-term average pattern (calculated over 30+ years).
Area Size	Limited localized area (e.g., a city or town).	Large regional or subcontinental zone.
Stability	Highly dynamic; can fluctuate multiple times a day.	Relatively stable and permanent over centuries.

Table 9.2: Summary of Indian Seasons

SEASON	MONTHS ACTIVE	PREDOMINANT WIND FLOW	KEY ATMOSPHERIC FEATURES
Cold Weather (Winter)	Mid-Nov to Feb	Northeast Trade Winds (Land to Sea)	Frost in north, Mahawat rains, clear skies.
Hot Weather (Summer)	March to May	Local convective currents	Loo winds, Kaal Baisakhi, Mango showers.
Advancing Monsoon	June to Sept	South-West Monsoon Winds (Sea to Land)	Burst of monsoon, heavy rain, monsoon breaks.
Retreating Monsoon	Oct to Nov	Reversing North-East transition winds	October heat, toxic tropical coastal cyclones.

Flowchart: Monsoon Wind Path Mechanism



SECTION 10: Maps & Diagram Notes

Map questions from this chapter are highly frequent. Practice mapping the following elements:

- **Wind Trajectories:** Draw directional arrows for Advancing South-West Monsoons (entering from the Arabian Sea and Bay of Bengal) and Reversing North-East Monsoons (exiting northern landmass toward the seas).
- **Rainfall Zones:** Highlight the high-rainfall strips along the Western Ghats and Northeast India, contrasted against the low-rainfall zones of Western Rajasthan and Ladakh.

SECTION 11: How to Remember This Chapter Quickly (Memory Tricks)

A. MNEMONIC FOR THE SIX CLIMATIC CONTROLS

Use the acronym phrase: "**LANDFORM**" (Modified for simple recall)

- **L** → Latitude
- **A** → Altitude
- **N** → Nearness to Sea (Distance from Sea)
- **D** → Direction of Winds / Pressure systems
- **O** → Ocean Currents
- **R** → Relief Features

B. QUICK RULES FOR WIND REVERSALS

Remember: "**Winds always flow from High Pressure to Low Pressure**". In summer, the hot land is Low Pressure (Lp), so moist sea winds rush in (Rainy Season). In winter, the cold land is High Pressure (Hp), so winds blow out toward the sea (Dry Season).

SECTION 12: Common Mistakes Students Make

1. Confusion on Coriolis Force Deflection Directions

Mistake Stating that winds deflect to the left in the Northern Hemisphere.

Correction According to Ferrel's Law, winds always deflect to the **right** in the Northern Hemisphere and to the **left** in the Southern Hemisphere.

2. Attributing October Heat to Summer Season

Mistake Describing October heat as a characteristic of the hot weather season.

Correction October heat occurs during the **Retreating Monsoon/Transition season** due to high humidity trapped under clear skies, not during the dry summer peak of May.

SECTION 13: Quick Revision Notes

- **Monsoon Type:** India has a monsoon climate, characterized by rhythmic seasonal wind reversals.
- **Highest Rain:** Mawsynram, India receives the largest average rainfall globally.

- **Mahawat:** Small winter rainfall in Northern India caused by Western Cyclonic Disturbances; essential for Rabi crops like wheat.
- **Loo:** Harmful, hot, dry summer winds typical of northern plains.

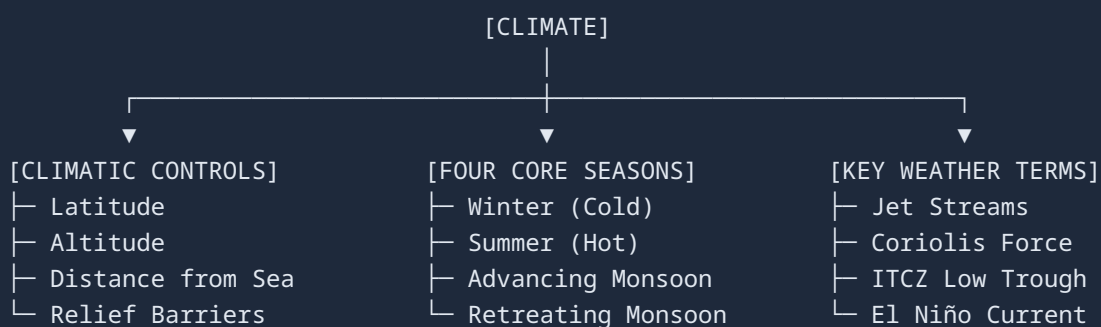
SECTION 14: One-Page Summary

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|                CHAPTER 4: CLIMATE  |
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| CONTROLS: Latitude, Altitude, Pressure/Winds, Sea Distance, Currents, Relief. |
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| MONSOON MECHANISM:                |
|   - Driven by differential heating of land/sea and the ITCZ shifting north.  |
|   - Southwest Monsoon (June-Sept) brings widespread rain.                   |
|   - Reversal to Northeast Monsoons starts in Sept/Oct (Retreating phase).    |
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| SEASONS SUMMARY:                  |
|   - Winter (Nov-Feb): Cold, dry, North-East trades, Mahawat showers in north. |
|   - Summer (Mar-May): Intense heat, Loo winds, Mango showers in south.       |
|   - Advancing Monsoon (June-Sep): Deep rainfall, bursts, and break intervals. |
|   - Retreating Monsoon (Oct-Nov): October heat, destructive coastal cyclones. |
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SECTION 15: Mind Map



SECTION 16: Exam Tips

- **Identify Regional Wind Names:** Clearly distinguish between *Mango Showers* (Karnataka/Kerala), *Kaal Baisakhi* (West Bengal), and *Loo* (North Plains) in descriptive answers.
- **Explain Rain Shadows:** When explaining why Pune receives less rainfall than Mumbai, clearly define the terms **windward side** (Mumbai) and **leeward rain-shadow side** (Pune) of the Western Ghats.