

Chapter 3: Atmosphere and Climate

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Chapter at a Glance: *The atmosphere is the blanket of gases surrounding the Earth. It supports life, protects us from harmful solar radiation, regulates temperature and strongly influences weather and climate.*

- The atmosphere is mainly made of nitrogen and oxygen, with small quantities of other gases, water vapour and dust.
- Its five major layers are the Troposphere, Stratosphere, Mesosphere, Thermosphere and Exosphere.
- Weather is the short-term condition of the atmosphere; climate is the average weather over a long period, usually 30 years or more.
- India has a tropical monsoon climate and four main seasons recognised by the IMD.
- The monsoon is a seasonal reversal of winds and is vital for agriculture, water supply and livelihoods.
- Climate change is mainly linked to human activities that increase greenhouse gases.
- We can reduce our carbon footprint by saving energy, using cleaner transport, conserving water and reducing waste.

1. Composition of the Atmosphere

Component	Approximate Share / Role
Nitrogen	78% - most abundant gas
Oxygen	21% - essential for respiration
Argon	0.93%
Carbon dioxide	0.04% - important greenhouse gas
Other gases	Very small quantities
Water vapour	About 0.1% to 0.4%; important for clouds and precipitation
Dust particles	Help influence atmospheric processes

Why the Atmosphere is Important

- Provides gases necessary for life.
- Protects Earth from harmful ultraviolet radiation.
- Helps regulate Earth's temperature.
- Controls weather elements such as temperature, humidity, air pressure and rainfall.

2. Structure of the Atmosphere

Layer	Height / Position	Main Features
Troposphere	Surface to about 12 km	Air we breathe, most water vapour and clouds; almost all weather occurs here; temperature decreases with altitude.
Stratosphere	Above troposphere to about 50 km	Cloud-free and stable; suitable for aeroplanes; contains the ozone layer.
Mesosphere	About 50-80 km	Temperature decreases with altitude; most meteorites burn up here.
Thermosphere	About 80-700 km	Temperature rises rapidly; ionosphere is part of it; helps radio transmission; auroras occur here.
Exosphere	Uppermost layer	Very thin air; light gases such as helium and hydrogen can go to space.

- Temperature decreases with altitude mainly in the Troposphere and Mesosphere.
- Ozone in the Stratosphere filters harmful ultraviolet radiation.
- Aurora Borealis occurs in the Northern Hemisphere; Aurora Australis occurs in the Southern Hemisphere.

3. Weather and Climate

Weather	Climate
Hour-to-hour or day-to-day condition of the atmosphere.	Average weather conditions over a long period, usually 30 years or more.
Changes quickly.	Shows long-term patterns.
Example: rain today, cloudy tomorrow.	Example: a region generally having hot, wet summers.

4. Main Elements of Weather and Climate

Element	Meaning / Key Point
Temperature	Degree of hotness or coldness; influenced by insolation.
Humidity	Amount of water vapour present in the air.
Precipitation	Water falling from the atmosphere as drizzle, rain, snow, sleet or hail.
Atmospheric Pressure	Pressure exerted by the weight of air on Earth's surface.
Wind	Movement of air from high-pressure areas to low-pressure areas.

Insolation and Temperature Zones

- Insolation means incoming solar energy intercepted by the Earth.
- It generally decreases from the equator towards the poles, so temperatures also tend to decrease poleward.
- The major temperature zones are Torrid, Temperate and Frigid zones.

5. Atmospheric Pressure and Wind

- Air pressure is highest near sea level and decreases with altitude.
- Warm air rises and creates a low-pressure area; low pressure is often linked with cloudy and wet weather.
- Cold air is heavier and sinks, creating a high-pressure area; high pressure is generally linked with clear weather.
- Wind blows from high-pressure areas to low-pressure areas.
- Winds are named after the direction from which they blow, e.g. a wind from the west is called a westerly.

6. Land Breeze and Sea Breeze

Sea Breeze	Land Breeze
Blows from sea to land.	Blows from land to sea.
Occurs mainly during the day, especially afternoon.	Occurs mainly during the night.
Land heats faster and develops lower pressure.	Land cools faster than sea at night.
Helps moderate coastal climate.	Usually weaker because the temperature-pressure difference is smaller.

7. Seasons in India

India has a tropical monsoon climate. The Indian Meteorological Department (IMD) recognises four main seasons:

Season	Approximate Period	Key Feature
Winter	December to early April	Coldest months are December and January.
Summer / Pre-monsoon	April to June; up to July in north-west India	High temperatures across inland India.
Advancing Monsoon / Rainy	June to September	Humid south-west monsoon brings most annual rainfall.
Retreating / Post-monsoon	October to December	Monsoon withdraws; south-eastern India receives important rainfall.

- Himalayan states also experience spring and autumn because of their more temperate conditions.

Traditional Indian Six Seasons

Ṛtu	Indian Months	Gregorian Months
Vasanta	Chaitra-Vaiśhākha	March-April
Grīṣhma	Jyeshṭha-Āṣhāḍha	May-June
Varṣhā	Śhrāvaṇa-Bhādrapada	July-August
Śharad	Āśhvina-Kārtika	September-October
Hemanta	Mārgaśhīrṣha-Pauṣha	November-December
Śhiśhira	Māgha-Phālguna	January-February

8. Monsoon

The word 'monsoon' comes from the Arabic word 'mausim', meaning season. It refers to the seasonal reversal of wind direction during a year.

South-West Monsoon

- Occurs mainly from June to September.
- In summer, the Indian landmass heats faster than the surrounding ocean.
- Low pressure develops over land, while relatively high pressure remains over the ocean.
- Moist winds blow from sea to land through the Arabian Sea and Bay of Bengal.
- These winds bring most of India's annual rainfall.

North-East Monsoon

- Occurs mainly from October to February.
- The land cools faster than the sea, producing high pressure over land and lower pressure over the ocean.
- Cold, dry winds generally blow from land to sea.
- After crossing the Bay of Bengal, some winds pick up moisture and bring rainfall to the eastern coast, especially Tamil Nadu, Andhra Pradesh and parts of Karnataka.

9. Why Monsoon is Important

- Supports sowing and growth of crops.
- Replenishes rivers, reservoirs, wells and groundwater.
- Affects food production, rural employment, transport, festivals and daily life.
- Excessive rainfall may cause floods; weak monsoon may lead to drought.

Monsoon Forecasting

- Kṛīṣhiparāśhara and Bṛīhatsamhitā describe traditional methods of rainfall prediction.
- Varāhamihira used lunar mansions (nakṣhatras) in seasonal rainfall prediction.
- The National Monsoon Mission aims to improve monsoon prediction.
- Mission Mausam aims to strengthen weather and climate services and make India more 'Weather Ready' and 'Climate Smart'.

Monsoon Maps - What to Remember

- The advancing south-west monsoon normally reaches southern India first and then moves progressively northward.
- The retreating monsoon withdraws from north-west India first and then moves southward.
- These maps show that monsoon arrival and withdrawal occur gradually, not everywhere on the same date.

10. Climate Change

Climate change means long-term changes in weather patterns such as temperature, rainfall and wind. The climate change and human activities.

Major Causes	Major Effects
Burning fossil fuels	Rising global temperatures
Deforestation	Melting glaciers and rising sea levels
Industrial pollution	More frequent floods and droughts
Increase in greenhouse gases such as CO ₂ , methane and nitrous oxide	Loss of biodiversity and impacts on health, agriculture and livelihoods

11. Carbon Footprint

Carbon footprint is the total amount of greenhouse gases released into the atmosphere because of human activities such as energy use, transport and production of goods and services.

How to Reduce Our Carbon Footprint

- Walk or cycle for short distances.
- Use public transport or carpool whenever possible.
- Switch off lights, fans and other electrical appliances when not in use.
- Use renewable energy where possible.
- Use water carefully and avoid wastage.
- Reuse and recycle materials; avoid single-use plastics.
- Protect forests and plant trees.
- Adopt an eco-friendly and sustainable lifestyle.

12. Punjab Floods 2025 - Case Study

- The Punjab floods as an example of how extreme weather and human factors can combine to create a disaster.
- Natural causes included very heavy monsoon rainfall, western disturbances and already swollen rivers such as the Satluj, Beas, Ravi and Ghaggar.
- Human-made factors included weak embankments, construction close to rivers, silt accumulation and delayed or unclear warnings.
- Effects included loss of life, displacement, crop damage, damage to roads and bridges, livestock losses and health problems.
- The case highlights the importance of flood preparedness, better planning and timely warnings.

13. Quick Revision

Remember	Key Point
Atmosphere	Blanket of gases surrounding Earth and held by gravity.
Main gases	Nitrogen 78%, Oxygen 21%, Argon about 0.93%, Carbon dioxide about 0.04%.
Layers	Troposphere, Stratosphere, Mesosphere, Thermosphere, Exosphere.
Weather	Short-term atmospheric conditions.
Climate	Long-term average weather, usually 30 years or more.
Wind	Air moving from high pressure to low pressure.
Monsoon	Seasonal reversal of winds.
South-west monsoon	Sea-to-land summer winds; main source of rainfall.
North-east monsoon	Land-to-sea winter winds; gives important rain to south-east India after crossing the Bay of Bengal.
Climate change	Long-term weather changes, mainly intensified by human activities.
Carbon footprint	Total greenhouse gases released because of human activities.

One-Line Conclusion

The atmosphere controls weather and climate, while India's monsoon shapes life and livelihoods; protecting the atmosphere and reducing our carbon footprint are essential for a safer future.