

# Adiabatic Lapse Rate, Definition, Type, Dry and Saturated Lapse Rates

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The Adiabatic Lapse Rate (ALR) refers to the rate at which the temperature of an air parcel changes as it rises or descends in the atmosphere without exchanging heat with the surrounding air. This temperature change occurs due to the expansion and compression of air under varying atmospheric pressure.

The concept is fundamental to understanding atmospheric stability, cloud formation, rainfall, and weather systems, making it highly relevant for UPSC Geography.

## What is Adiabatic Lapse Rate?

The Adiabatic Lapse Rate is defined as the rate of temperature decrease (or increase) of an air parcel with altitude when the parcel does not gain or lose heat to its environment. It is expressed in degrees Celsius per 1,000 meters. This concept helps explain thunderstorm development, cloud height, orographic rainfall, and cyclonic systems.

## Types of Adiabatic Lapse Rate

The Adiabatic Lapse Rate has two types based on moisture content.

## 1. Dry Adiabatic Lapse Rate (DALR)

- Refers to the rate of temperature change in an **unsaturated air parcel** as it rises or descends in the atmosphere.
- The temperature of dry air decreases at a **constant rate of 9.8°C per 1,000 meters** during ascent due to **adiabatic expansion**.
- No condensation occurs because the air has not reached its **dew point temperature**.
- **Latent heat is not released**, so cooling is rapid and uniform.
- When the air descends, it **warms at the same rate** due to compression.
- DALR is important in explaining **mountain winds (foehn and chinook)**, **clear-sky conditions**, and the **initial uplift of air masses**.

## 2. Saturated / Moist Adiabatic Lapse Rate (SALR)

- Applies when the rising air becomes **saturated (relative humidity reaches 100%)** and condensation begins.
- The temperature decreases at a **slower and variable rate**, generally between **4°C and 7°C per 1,000 meters**.
- **Latent heat of condensation is released** during cloud formation, which offsets some of the cooling caused by expansion.
- Due to varying moisture content, the SALR is **not constant** and changes with altitude and temperature.
- Plays a vital role in **cloud growth, precipitation, thunderstorms, cyclones, and monsoon rainfall**.

## What is Temperature Inversion?

**Definition:** **Temperature inversion** is a condition in which **temperature increases with height**, instead of decreasing as per the normal lapse rate, leading to **atmospheric stability**.

**Cause:** It occurs when **cool air is trapped near the surface** by an overlying layer of warmer air, preventing vertical mixing of air.

### Radiation Inversion:

- Develops during clear, calm nights when the Earth loses heat rapidly by radiation.
- The ground cools faster than the air above it.
- Example: Dense winter fog and smog in the **Indo-Gangetic Plains**.

### Valley Inversion:

- Cold, dense air flows downslope and accumulates in valleys.
- Common in **mountainous regions**.
- Example: Lower temperatures in Himalayan and Kashmir valleys.

### Subsidence Inversion:

- Occurs when air descends under high-pressure systems and warms by compression.

- Produces dry and stable conditions.
- Example: Clear skies in subtropical high-pressure belts.

#### **Frontal Inversion:**

- Forms when warm air overrides colder air along a front.
- Common in **mid-latitude cyclones**.
- Example: Temperature inversion near warm fronts in temperate regions.

#### **Impact on Environment:**

- Traps pollutants, smoke, and dust, worsening air quality.
- Reduces rainfall and convection.
- *Example:* **Severe air pollution episodes in Delhi during winter.**

## **What is Latent Heat?**

- **Latent heat** is the heat energy **absorbed or released during a change of state** without any change in temperature.
- It becomes active during **phase changes** such as evaporation, condensation, melting, and freezing.
- In the atmosphere, latent heat is **absorbed during evaporation** of water vapor.
- **It is released during condensation**, warming the surrounding air.
- It plays a key role in **cloud formation, rainfall, thunderstorms, and cyclones**.
- Release of latent heat **reduces the saturated adiabatic lapse rate**.

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