ATMOSPHERIC STABILITY CONDITION

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Definition

- Atmospheric stability is defined as that condition in the atmosphere in which vertical motions are absent or definitely restricted; and, conversely, instability is defined as the state where in vertical movement is prevalent.

Determination of Atmospheric Stability

The determination of atmospheric stability is possible with the help of data regarding change of temperature with respect to the height or altitude. The graph of temperature vs height is known as '**lapse rate graph**'. Depending upon the relative position of ALR and ELR lines on the graph sheet, the stability of the atmosphere can be determined

Types of Atmospheric Condition

On the basis of these relative positions of both the lines of Adiabatic Lapse Rate (ALR) and Environmental Lapse Rate (ELR), there are three different atmospheric conditions are available –

i) Unstable atmospheric condition

ii) Stable atmospheric condition

iii) Neutral condition.

Unstable Atmospheric Condition

The atmosphere is said to be **unstable** when ELR (say 15°C/km.) is more than ALR (say 8°C/km.). In such case, if a pocket of artificially heated air introduce to the atmosphere, it will move in the upward direction and always be warmer than the surrounding air. This is so because as we go up, the environment is getting cooler more quickly than the rising heated air (as ELR 〉 ALR). As a result, the upward movement of warmer and lighter air will continue. This is called **vertical mixing of air**. In such circumstances, the **dispersion of pollutants will be rapid**. This is called absolute instability in atmosphere. In this particular case, **Environmental Lapse Rate (ELR)** is greater than **Adiabatic Lapse Rate (ALR)** and so it (ELR) is called as **Super-adiabatic Lapse Rate**.

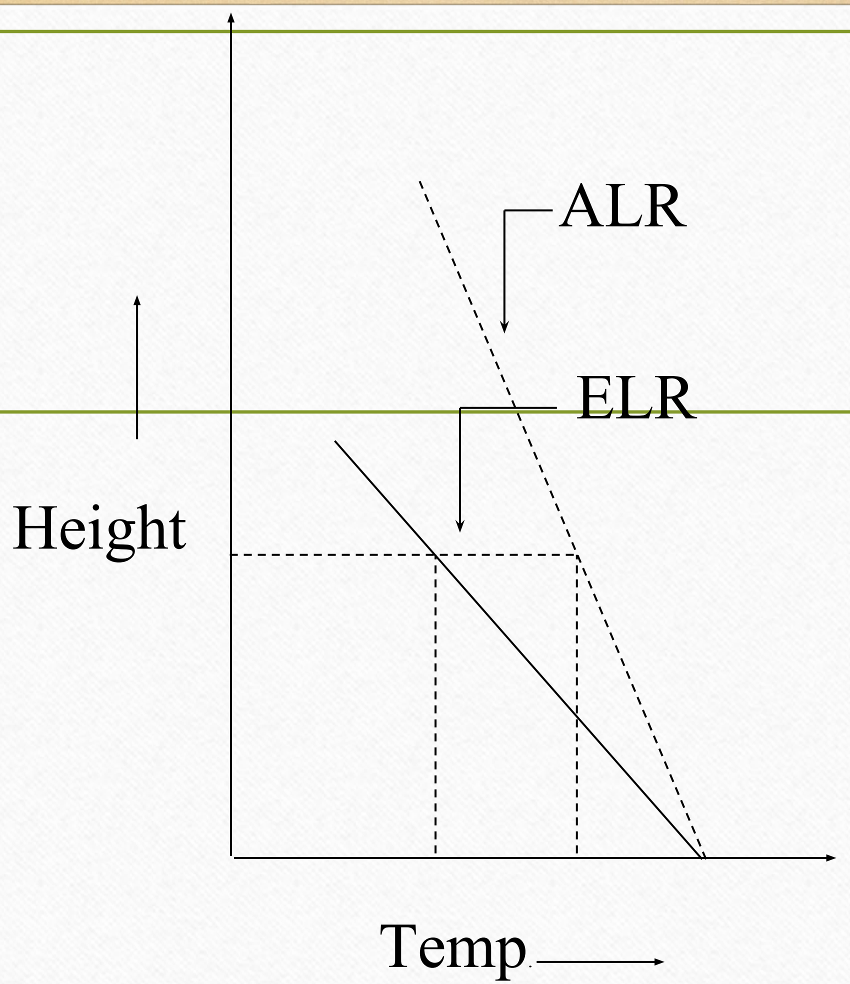

Fig. The above graph showing that ELR 〉 ALR i.e., unstable condition

Stable Atmospheric Condition

When ELR is less than ALR, then the atmospheric condition is called as **stable**. In this particular case, the rate of cooling of the artificially heated air will greater than that of surrounding air. As a result, instead of moving in the upward direction, it will start to fall to the ground. The vertical mixing of air is **restricted** here. In such case, dispersion of pollutants is very **slow**.

In this case, as Environmental Lapse Rate (ELR) is less than Adiabatic Lapse Rate (ALR) and so it (ELR) is called as **Sub-adiabatic Lapse Rate**.

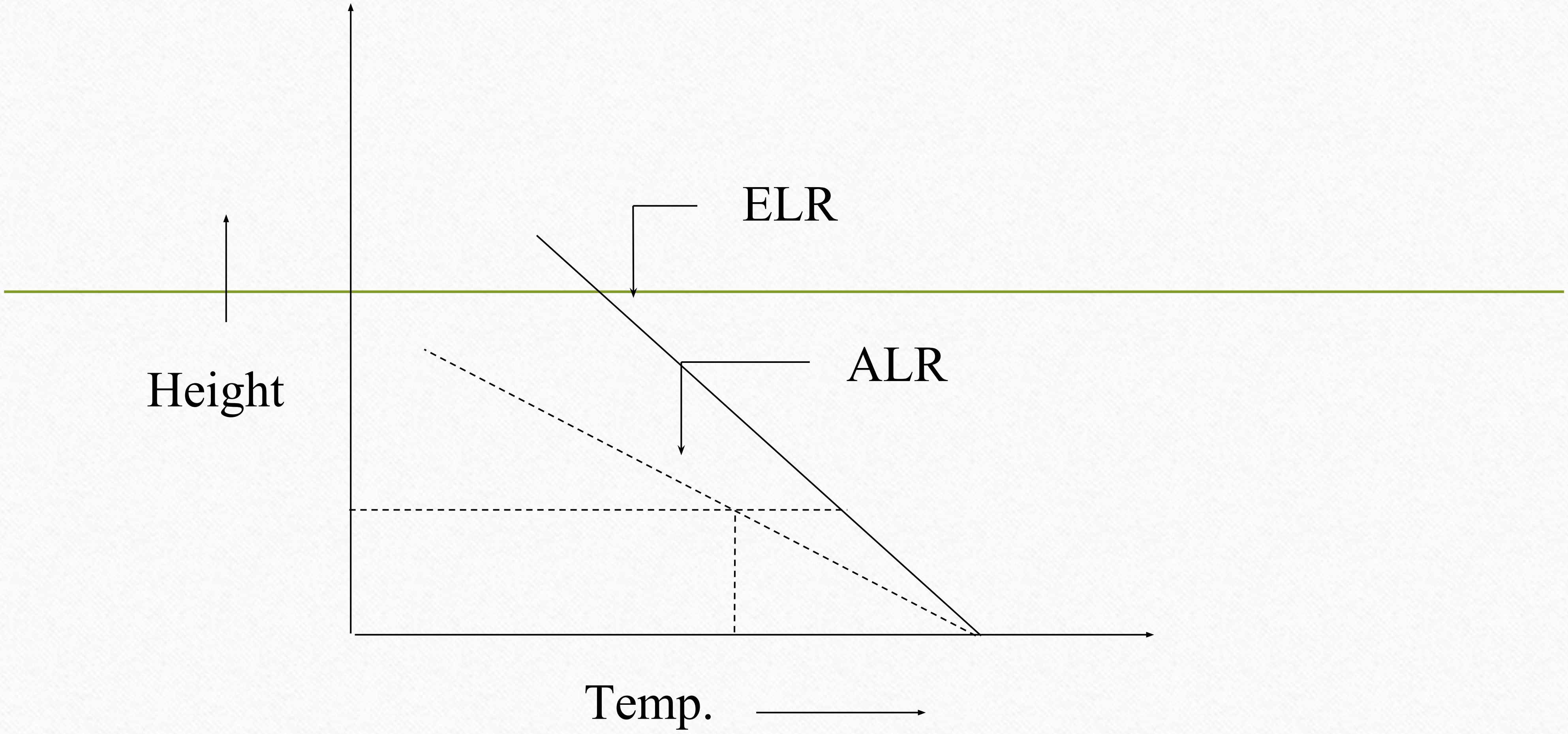

Fig. The above graph showing that ELR 〈 ALR i.e., stable condition

Neutral Atmospheric Condition

When ELR is equal to ALR, the atmospheric condition is considered as **neutral**.

Temperature Inversion

In an unusual case, when the temperature of the environment (i.e., ambient air) increases with altitude, then the lapse rate becomes inverted or negative from its normal state. This is called **negative lapse rate**.

Negative Lapse rate takes place under the conditions where the **warmer air lies over the cooler air**. As a result, temperature here increases instead of decreasing with height. This is called **temperature inversion**.

Types of temperature inversion

There are three types of temperature inversion in atmosphere –

i) Radiation inversion

ii) Subsidence inversion

iii) Advective inversion.

Negative Lapse Rate

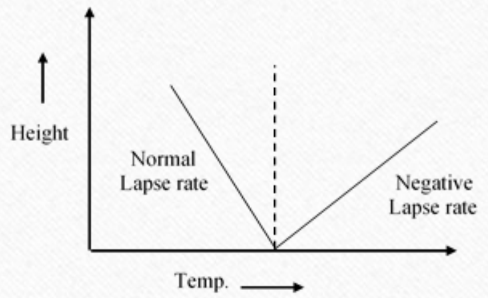

Fig. 3.15 The above graph showing the negative Lapse rate

Radiation Inversion

When the Earth surface cools rapidly than the air above it (as may happen at nights when the Earth may loose heat by radiation and thereby cooling the surrounding air), then naturally the temperature of the surrounding air increases with the height. This causes **negative lapse rate** and **inversion condition**. This type of inversion is taking place due to unequal rate of radiation of Earth's surface and air above it and so it is called **radiation inversion**.

This type of inversion may extend a **few hundred meters** and characteristically a nocturnal phenomenon and that is likely to break up easily with the rays of the morning Sun. Such an inversion in the environment helps in formation of fog. This type of inversion is more common in winter than in summer because of the longer nights.

Subsidence Inversion

This type of inversion is usually associated with a high pressure system and is caused by the characteristic sinking or subsiding motion of air in a high pressure area surrounded by low pressure area. The air, circulating around the stationary high pressure area, descends gently at the rate of about 1000 mt per day. As the air sinks, it is compressed and gets heated to form a warm dense layer over the cooler air below. Such inversion layers may be formed from the ground surface to around 1600 mt. Such an inversion layer, by stopping the upward movement of polluting smokes, will cause the concentration of the pollutants in our immediate environment. Such type of inversion may be more dangerous than radiational inversion and may occur at modest altitudes and may remain for several days.

Advective Inversion

This type if inversion is formed when warm air moves over a cold surface or cold air. The inversion can be ground-based in the former case or elevated in the latter case. An example of an elevated advective inversion occurs when a hill range forces a warm land breeze to flow at high levels and a cool sea breeze flows at low levels in the opposite direction.

Advective inversion