Temperature Inversion...

Your Pesticides Will Drift!

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Temperature Inversion is a natural weather phenomenon that often goes unnoticed. Among the different types of temperature inversions, **Radiation Inversion** is the most common and significant in Agriculture. It typically occurs during calm wind conditions when the earth's surface cools rapidly after a warm day. The rising warm air creates a suspended boundary layer or a stable warm air mass that disrupts normal air movement. Instead of rising to the upper atmosphere, air in a temperature inversion can remain suspended or move horizontally over long distances with minimal winds (Fig. 1).

Conditions Inducing Temperature Inversion:

Inversions commonly occur early in the morning following warm days and cool nights with calm winds. Rapid cooling of the earth's surface causes warm air to rise, forming a stable air mass that results in inversion conditions. Research indicates that inversions can also occur at other times of the day with varying intensities and durations. Additionally, land topography and elevation influence inversion occurrence. Natural barriers or tree lines can alter wind patterns, leading to more frequent inversions in some areas and fewer in others with open topography, which facilitates better air movement and inversion dissipation.

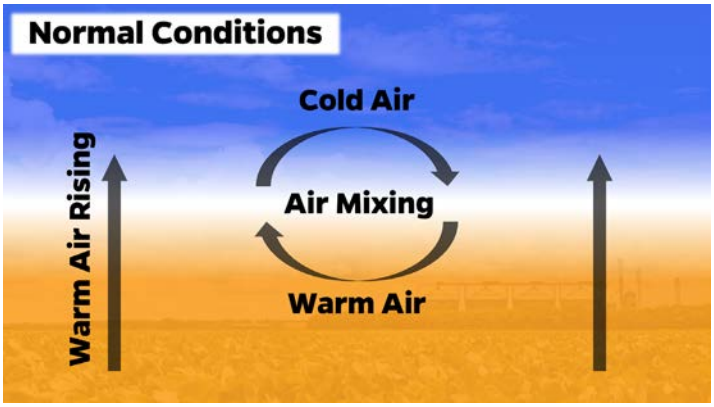
How to Recognize Temperature Inversion:

Temperature inversions are usually not visible. They require specialized weather instruments and expertise for accurate detection or prediction.

There are no definitive weather parameters or thresholds to confirm or predict inversion conditions. Instead, look for general conditions that favor inversions. Fog, smoke, or smog can aid in visualizing the presence of a warm air boundary layer when getting trapped underneath this layer (Fig. 2). Sometimes, fog or smoke moves horizontally for long distances under the boundary layer in calm wind conditions.

Signs of Potential Temperature Inversion:

1. Clear sky.
2. Calm wind.
3. Dew present.
4. Occurrence around sunset or sunrise.
5. Presence of horizontal, low-lying fog, smoke, or smog.
6. Cool steady breeze.
7. Distant sounds or smells are more noticeable.



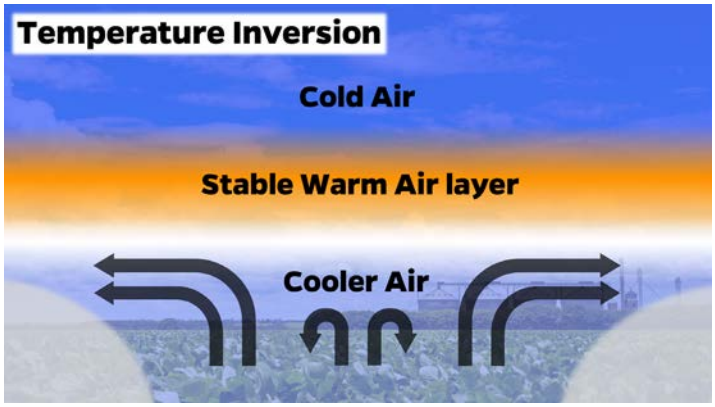


Figure 1: Normal conditions (Left): warm air rises and mixes with the upper colder layers of the atmosphere. Temperature inversion (Right): a stable/boundary warm air layer suspended above the earth's surface blocks normal upward air movement where cooler air above the ground can only sink or move horizontally possibly for miles until the boundary layer has dissapated.

Why Temperature Inversion Matters for Pesticide Applicators:

Broadcast spraying during a temperature inversion often results in poor deposition on the target area. Spray particles may remain suspended and potentially travel long distances horizontally before settling when the inversion dissipates. Minimal wind can lead to pesticide drift, causing harm to crops, humans, and the environment. Inversion conditions can also cause pesticide spray to move to a neighboring area, re-form, and become trapped under the boundary layer.

Therefore, it's crucial to be aware of the surrounding areas during pesticide applications. Additionally, spraying before an inversion can result in high volatility chemicals rising and drifting, leading to non-target damage, particularly with auxin-based pesticides. Applicators are responsible for drift damage, making it essential to plan for inversion conditions.

Figure 2: Smoke emitter demonstration during early morning temperature inversion conditions: smoke moves horizontally being trapped underneath the stable warm boundary layer (O'Brien, M. 2017).

How to Minimize Pesticide Drift Due to Temperature Inversion:

1. Recognize conditions that may induce temperature inversions.
2. Avoid spraying under these conditions.
3. Use on-farm weather stations that may help detect potential inversions.
4. Avoid relying on weather stations far from the application site.
5. Delay pesticide applications if an inversion has occurred or is likely, until the sun warms the surface and helps dissipate the boundary layer.
6. Train pesticide equipment operators to understand inversion conditions and appropriate actions if these conditions are suspected.

References:

O'Brien, M. 2017. Early morning inversion: what happens to fine spray droplets. CottonInfo: Connecting growers with research. Available: https://www.youtube.com/watch?v=FPUstarVuls

Bish M., Oseland E., and Bradley K. 2021. Off-target pesticide movement: a review of our current understanding of drift due to inversions and secondary movement. Weed Technol. 35: 345–356. doi: 10.1017/wet.2020.138