Understanding temperature inversions, mitigating pesticide drift – and maintaining friendly neighbors

True or false: ***Applying pesticides is* always safer when there is a 2-mile per hour wind than when the wind is blowing 20 mph?**

Read on to find the answer.

Landowners take pride in their windbreaks and flower and vegetable gardens; they strive to ensure peak performance each year. One step a landowner might take to maximize growth is applying an appropriate pesticide to help battle pesky weeds or insects. This use is meant to provide benefits to plants we want to grow, but sometimes the weather can increase the chance of unintended damage to plants.

In our example, the landowner reads the label (which includes laws related to the appropriate application) and sees it says "potential pesticide drift is lowest between wind speeds of 2 to 10 mph" – depending on any number of variables such as droplet size and application equipment. Drift is when a pesticide moves through the air after you spray it and lands somewhere you didn't intend it to. It's easy to see how drift would happen when windy.

However, less easy to understand is when the landowner goes on to read that the pesticide should not be applied during a temperature inversion (TI), because "drift potential is high" during these conditions.

What is this about?

A temperature inversion is when stable layers of air, with different temperatures, are created close to the earth (like a sandwich). With a temperature inversion, pesticide droplets might not be able to penetrate the cooler, denser air, which is closest to the ground. The slightest air movement can cause pesticides to move sideways through the air rather than down onto the weed or insect we are interested in controlling.

Let's take a closer look at each ingredient in a temperature inversion to better understand when one could develop – and help landowners protect windbreaks and other adjacent vegetation from pesticide drift.

Radiation from Earth

In general, we think about the Earth's surface and objects that cover it (buildings, plants) as being warmer than the air or atmosphere high above us; however, when objects on the Earth's surface lose heat, they emit long-wave radiation, which warms the air, and as the warm air rises, the air closer to the ground cools – resulting in one of the key ingredients to creating a temperature inversion.

Take a moment to think about a 24-hour day – when might the Earth's surface begin to cool? Depending on the day, this varies; however, the lower the sun is in the sky, the less direct short-wave radiation we receive to continue to heat or maintain the warmth of the Earth – especially at Wyoming latitudes.

Cloudless to near-cloudless skies

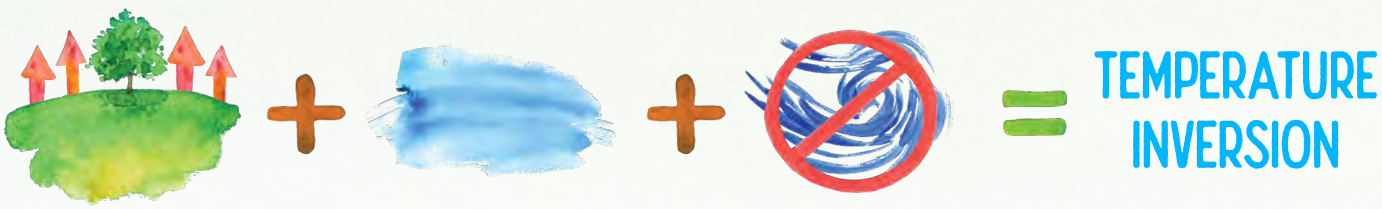
Cloudless or near-cloudless skies is the second key ingredient. Ever notice when there is cloud cover at night, the outside temperature remains warmer than nights when there are little to no clouds?

Why?

Cloud cover serves a similar role to a bed comforter – the comforter holds the warm air, coming from your body, next to you – resulting in more

The recipe for a temperature inversion is:

Radiation from either the Earth or objects on the Earth's surface into the sky + Cloudless to near cloudless skies + Light to no wind = Temperature Inversion



warmth than when the comforter is off. Similarly, clouds block the escape of the long-wave radiation resulting in warm air staying closer to the Earth's surface. However, when there are few (for example, 25 percent or less) or no clouds, the radiation continues to travel farther into the atmosphere resulting in a cooling of the air closer to the Earth's surface.

Light to no wind

To recap: the first two key ingredients of a temperature inversion are the Earth's surface and objects covering it cooling down as long-wave radiation is emitted from them into the sky, and 25 percent or less cloud cover; however, sufficient wind can prevent a temperature inversion or weaken one already formed by mixing the air.

You might ask, what is considered sufficient wind to prevent or disrupt a TI? As with many things, it depends – and will vary based on different variables. The short answer is temperature inversions can form and persist when there is 0 to 3-mph winds – and typically, a TI is stable enough to withstand 4 to 5 mph winds.

A good rule of thumb is if it seems like a stellar time to spray pesticides, take a moment to think about whether the Earth's surface is cooling – or will start to cool soon – and how much cloud cover exists, then evaluate wind speed. If planning to spray for quite a while, remember to monitor the conditions as they evolve throughout the day. It may be safe to spray now, but as the sun moves lower in the sky later in the day (which results in less direct short-wave radiation from the sun to warm the Earth's surface and objects that cover it), conditions may cause a temperature inversion to develop.

Throw it all in the mix – and what happens …

Wyoming's climate affords a very short growing season and in many places the wind frequently blows above 10 mph. We tend to want to get outside as soon as conditions appear favorable to apply pesticides; however, we must be able to identify when a temperature inversion has developed or has the potential to develop – because a TI can be a more dangerous pesticide drift culprit than high winds.

And to answer the question at the beginning of this article, applying pesticides with a 2-mph wind during a temperature inversion can be less safe than applying them when there is a 20-mph wind.

But why is spraying pesticides when a temperature inversion is forming or has formed more dangerous? Cooler air closer to the Earth's surface is denser than the warmer air it replaced – and with little to no wind this layer of air remains stable from vertical flow; however, horizontal or laminar flow usually still occurs.

The dense air is able to suspend spray droplets, such as pesticides, while the horizontal airflow moves the droplets away from the intended target – sometimes many miles away. Many variables influence how long a spray droplet will be suspended, including droplet size and rate of evaporation.

The key takeaway is never apply a pesticide when there is a temperature inversion or risk of an inversion forming.

Consider when the worst time of day to spray a pesticide might be. The answer might not be as obvious as some people think – so let's cut to the chase.

Temperature inversions tend to develop later in the day (a few hours before sunset) and continue through the night – peaking at or a few hours before sunrise. The worst time of day to spray a pesticide (as it relates to a temperature inversion) is the few hours before sunset when the Earth's surface and the air in the lower atmosphere begins to cool. If the other two inversion ingredients are present and a TI forms – the risk of your pesticide landing off target increases, as does the potential distance for travel.

So, remember to assess and monitor conditions throughout the day to ensure you don't accidentally damage non-target species such as your wind break, someone else's flower or vegetable garden, or a neighbor's cash crop (their livelihood!).

We're assuming **Windy Kelley** NEVER gets comments about her name and her career area. Kelley is with the University of Wyoming Extension and is the Regional Extension Program coordinator for the USDA Northern Plains Climate Hub. She can be reached at wkelley1@uwyo.edu

Additional Resources:

Enz, JW; Hofman, V; Thostenson, A. Revised 2019. *Air Temperature Inversions: Causes, Characteristics and Potential Effects on Pesticide Spray Drift*, Bulletin AE1705. North Dakota State University Extension.

Nowatzki, J., 2018. *Understanding Air Temperature Inversions Relating to Pesticide Drift,* Bulletin AE1876. North Dakota State University Extension.