How Temperature Inversions Impact Pesticide Applications

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Brief overview

• What is a temperature inversion?
• How and when do they form?
• Clues to identifying temperature inversions
• Why do I need to worry?
• Detecting or predicting temperature inversions

In a normal pattern...
Temperatures decrease with increasing altitude
Typically drops 5°F every 1000 ft

In a temperature inversion...
Denser cold air gets trapped below warmer air
Usually under high pressure systems:
CooIdry air, clear skies & stable winds

The infamous “Brown Cloud” of Denver

Short wave radiation
Long wave radiation

Radiation waves from objects move in all directions into the air

Radiation into atmosphere heats the air

Warmer

Objects lose heat, cool the air near the earth surface

Coldest

Cloud cover blocks radiation, so no inversion

Partial cloud cover allows some radiation, so a weak inversion develops

On a clear & calm 24 hour day, when will inversions begin and end?

Exceptions

Stagnant air conditions, inversions may not dissipate for days
Early afternoon temperature profile on a hot day with 4 mph or less wind:

- 90 degrees F at 60 inches or 5 feet
- 92.5 degrees F at 39 inches or 3.25 feet
- 95.5 degrees F at 24 inches or 2 feet
- 99.4 degrees F at 12 inches or 1 foot
- 105 degrees F at 4 inches

Early morning temperature profile with a strong inversion (calm & clear):

- 50 degrees F at 60 inches or 5 feet
- 48 degrees F at 39 inches or 3.25 feet
- 46 degrees F at 24 inches or 2 feet
- 45 degrees F at 12 inches or 1 foot
- 44 degrees F at 4 inches

All the conditions we’ve talked about assumes very little wind.

Sufficient wind will mix the air, thus preventing or destroying the inversion.

On a cloudy and/or windy 24 hour day, when will inversions begin and end?

Relative intensity:

- Strong
- Weak

Relative times:

- Noon
- Sunset
- Midnight
- Sunrise

Clues:

You can smell them.
You can hear them

You can see them
Dust particles hang in the air

Visible dust particles are about 200 microns in size

If there is sufficient moisture in the air, dew and frost will form because of cool air near the ground.

If there is sufficient moisture in the air, fog will also form.

If the light and fog reflect just so, one can actually see the inversion.

Why should I worry about inversions?

• DRIFT!...
  It is more likely to occur during temperature inversions!
  Physical Drift vs Vapor Drift
High percentage of fine drops is never good, but they are especially bad in an inversion.

Spraying during an inversion = trapping of fine droplets

Physical Drift & Fine Drops

Helicopter application of glyphosate
- Application from 2:00 pm to 5:00 pm
- Wind 2-3 mph from North

When will an inversion impact my spray operation?

Pesticide spray droplets or vapors can become suspended and drift off target

Other factors - Humidity

- Low humidity desert
  - inversion builds faster
  - intensity is greater
  - dissipates faster

- High humidity

- rainforest

- Bare compact soil
- Loose tilled soil
- Mulched soil

- Warmer Surface
- Colder Surface

- Open row
- Partial row closure
- Canopy
Wind Breaks

Trees will interfere with wind, inversion builds more quickly and cold air layer becomes trapped.

Tree shadow causes inversion earlier in the afternoon and will prevent dissipation longer into the morning.

Fine spray drops hang in the air

Tracer dye, late afternoon spray, conducted in early May

Fine pesticide laden droplets move off target

Vaporization of pesticide from the soil or foliage during an inversion

Light wind moves pesticide down range

Cold air traps vapors near surface

Mandatory On-site Weather Readings
Can we predict temperature inversions?

High Pressure Areas are associated with cool /dry air, clear skies & stable winds

Excellent ingredients for inversion formation

Scroll Down & Select Tabular Forecast

Select
NOAA Tabular Weather Forecast for Sioux, Falls, SD

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<thead>
<tr>
<th>Date</th>
<th>10/02</th>
<th>10/03</th>
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<td>15 16 17 18 19 20 21 22 00 01 02 03 04 05 06 07 08 09 10</td>
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<td>Temperature (°F)</td>
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<td>Dewpoint (°F)</td>
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<td>Wind (mph)</td>
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<td>Sky Cover (%)</td>
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<tr>
<td>Rel. Humidity (%)</td>
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</tbody>
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Using Weather Station Reports Are NEVER a Substitute for On-site Observations!

- Weather stations are miles away, even 70 to 80 miles
- Radio & television reports are time sensitive
- Wind is measured at 33 ft. for NOAA and 6.5 ft. for CoAgMet (CSU Stations). Wind speed at application height can be 20 to 25% slower
- Remote instrumentation can fail because of calibration or maintenance errors
- Labels are specifying on-site readings and state law often demands site of application data

Tools that can help you!....

Smoke generator fuels
- Commercially available fuel
- Crumble newspaper
- Burlap
- Leaves or dried grass
- Pine needles

Use Anemometers with/without temperature
Example: Handheld Anemometer 0.5 to 99 mph within 3% accuracy <$100

Just a reminder...

- Think ‘INVERSION’ when...
  - You have clues (sound, sight, smell)
  - We are under a high pressure system
    - CALM or little wind
    - Cool/dry air
    - Clear Skies
  - Especially mid-afternoon to mid-morning

- Tools to detect inversion conditions
  - Anemometer /Thermometer /Smoke generator
  - Weather.gov – Tabular forecasts

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