Simple methods for do-it-yourself monitoring of temperature inversions and atmospheric stability

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Spraying must not occur where a temperature inversion prevents the spray cloud settling within the treated area.

Temperature inversions are associated with STABLE atmospheric conditions.
Surface Inversion - STABLE CONDITIONS

Source: Ramsey (2001)
http://www.cdpr.ca.gov/docs/enforce/drtinit/confs/2001/ramsey.ppt
Stability Ratio

- Is a function of temperature at two heights and wind speed.

- When temperature increases with height and this is combined with low enough wind speed, the stability ratio may indicate STABLE atmosphere.

- Application should not be made under these conditions.
SR = \frac{T_{z_2} - T_{z_1}}{WS_{z_3}^2} \cdot 10^5

where:

\( T_{z_1} \) and \( T_{z_2} \) are temperature (°C) at height \( z_1 \) and \( z_2 \)

\( WS_{z_3} \) the wind speed (cm/sec) measured at a height of \( z_3 \) between \( z_1 \) and \( z_2 \), equidistant between \( z_1 \) and \( z_2 \) on a log scale.

Use 8 and 30 feet for temperature sensors; 15 feet for wind sensor
<table>
<thead>
<tr>
<th>Atmospheric Stability Category</th>
<th>SR Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unstable</td>
<td>-1.7 to -0.1</td>
</tr>
<tr>
<td>Neutral</td>
<td>-0.1 to 0.1</td>
</tr>
<tr>
<td>Stable</td>
<td>0.1 to 1.2</td>
</tr>
<tr>
<td>Very Stable</td>
<td>1.2 to 4.9</td>
</tr>
</tbody>
</table>

OK to spray
Typical response from instruments on a tall tower

- Temperature at 8 ft (°C)
- Temperature at 30 ft (°C)
- Wind speed at 15 ft (miles/h)
- Stability ratio
- Wind direction (degree)
We wanted portability since field surface conditions influence the rate of ground heating.

We used a portable tower at first.

These were OK, but they were not as easy to set up and move as first thought.
Soil texture also affects rapidity of soil warming.
New System
Large Helium Balloon.

Precision temperature sensors at 8 and 30 ft

Kestrel 4500 Bluetooth wind logger at eye level.
Some temperature sensing systems

Bluetooth

Radio
Recommendations to applicators

- We are still defining how much faster bare soil surface warms compared with a crop canopy.
- Final form of recommendations will be referenced to sunrise and sunset.
- What about conditions early in the season?
  - Data shows that we lose up to one hour in the morning and one hour at night when it is acceptable to spray, shortening the time window.
  - Cloud cover appears to have the same effect.
- Wind effects are being considered in recommendations.
Data can be obtained at the field level using a Windows-based tablet (via Bluetooth).

This chart lists the daily high and low temperatures as well as the latest (current) observations per weather station. Stations that have recorded temperatures at least three degrees higher than the morning low will be marked in green. They will remain green until they are five degrees or more below the daily high. Green indicates a low potential for temperature inversion. Stations not meeting this criteria will be marked in red indicating that the potential for temperature inversion is high.

For the latest observations and calculations, please click your browser’s refresh button.

<table>
<thead>
<tr>
<th>Station</th>
<th>Low Temp (°F)</th>
<th>Time Of Low</th>
<th>Current Temp (°F)</th>
<th>Current Time</th>
<th>Wind Speed (MPH)</th>
<th>Wind Dir (°)</th>
<th>High Temp (°F)</th>
<th>Time Of High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arkansas</td>
<td>38.5</td>
<td>12:54 AM</td>
<td>45.0</td>
<td>9:44 PM</td>
<td>0.0</td>
<td>0</td>
<td>47.0</td>
<td>2:29 PM</td>
</tr>
<tr>
<td>Ashley</td>
<td>39.4</td>
<td>3:34 AM</td>
<td>46.4</td>
<td>9:44 PM</td>
<td>0.0</td>
<td>50</td>
<td>48.8</td>
<td>1:54 PM</td>
</tr>
<tr>
<td>Bradley</td>
<td>39.1</td>
<td>12:19 AM</td>
<td>46.1</td>
<td>9:39 PM</td>
<td>0.0</td>
<td>0</td>
<td>47.2</td>
<td>4:44 PM</td>
</tr>
<tr>
<td>Calhoun</td>
<td>40.4</td>
<td>1:39 AM</td>
<td>46.3</td>
<td>9:44 PM</td>
<td>0.2</td>
<td>43</td>
<td>50.1</td>
<td>2:59 PM</td>
</tr>
<tr>
<td>Chicot</td>
<td>38.4</td>
<td>12:44 AM</td>
<td>46.8</td>
<td>9:44 PM</td>
<td>0.0</td>
<td>0</td>
<td>52.7</td>
<td>2:44 PM</td>
</tr>
<tr>
<td>Clay East</td>
<td>38.4</td>
<td>12:04 AM</td>
<td>40.7</td>
<td>9:44 PM</td>
<td>2.1</td>
<td>34</td>
<td>41.6</td>
<td>11:09 AM</td>
</tr>
<tr>
<td>Clay West</td>
<td>38.2</td>
<td>12:09 AM</td>
<td>41.4</td>
<td>9:44 PM</td>
<td>0.0</td>
<td>22</td>
<td>43.4</td>
<td>2:54 PM</td>
</tr>
<tr>
<td>Cleveland</td>
<td>38.2</td>
<td>3:19 AM</td>
<td>45.2</td>
<td>9:39 PM</td>
<td>0.0</td>
<td>0</td>
<td>46.9</td>
<td>4:04 PM</td>
</tr>
</tbody>
</table>
We are working on a web interface to monitor sensors remotely and present recommendations.
Thank You!

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