

Temperature Inversions and Pesticide Drift



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OMAFRA, Simcoe, 2015



- Working to reduce pesticide wastage and off-target contamination
- Developing methods to spray crops consistently
 - Developing educational resources for sprayer operators



Andrew Thostenson

- **In 2012 Andrew Thostenson, Pest Program Specialist (North Dakota State University Extension) spoke on temperature inversions in Boise, Idaho.**
- **Andrew graciously allowed me to base this presentation on his.**



the basics

- **Particle drift** is the off-target movement of pesticide droplets (or solid particles). This occurs at the time of application, and while it is generally on a scale of tens-of-metres, inversions can carry it much farther

the basics

- **Vapour drift** is the off-target movement of pesticide vapours. This generally occurs in hot conditions after the application and if caught up in an inversion or redistributed by rain, movement is on a scale of kilometres

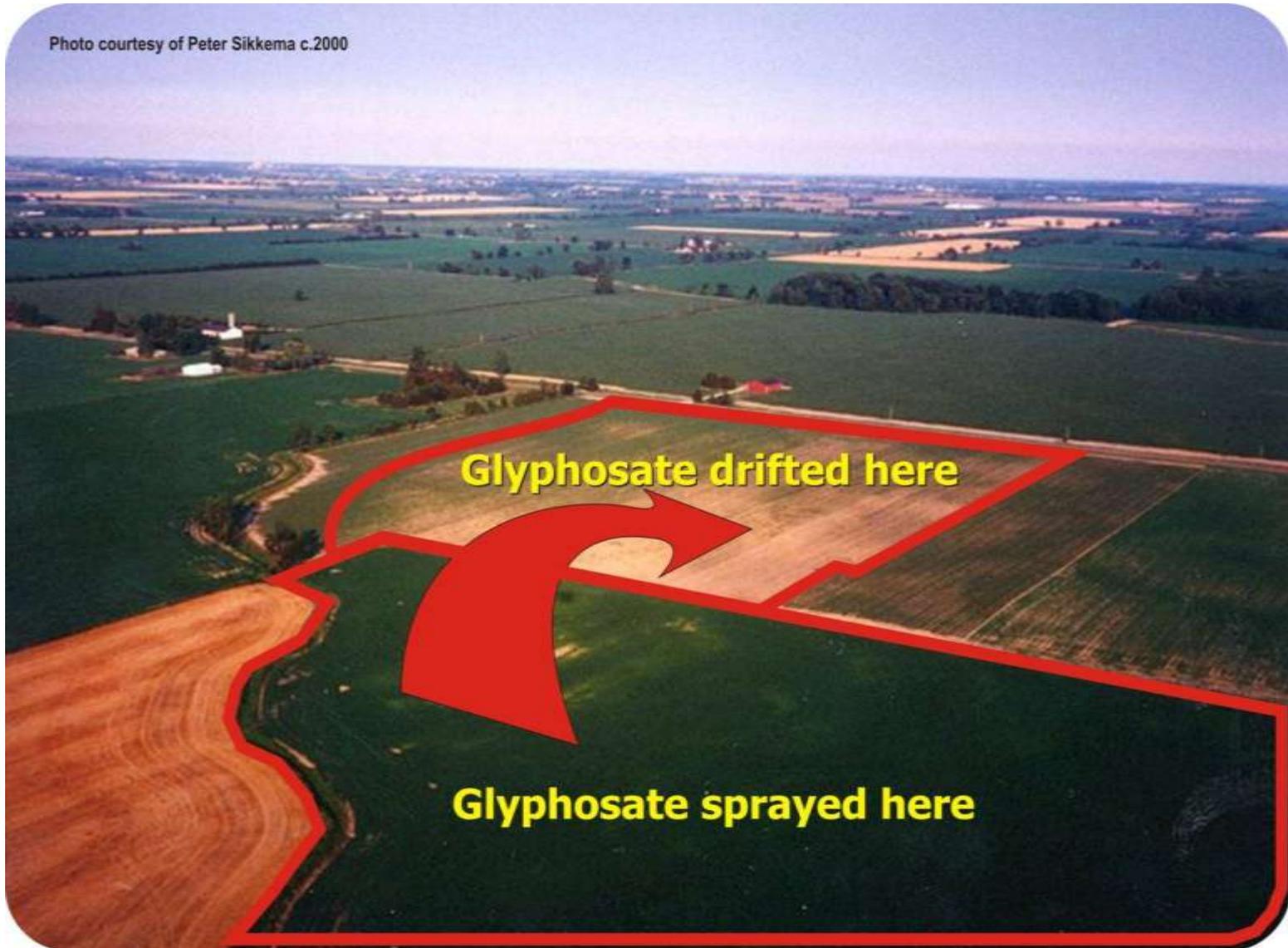
agricultural impact

Photo courtesy of Peter Sikkema c.2000



agricultural impact

Photo courtesy of Peter Sikkema c.2000



Glyphosate drifted here

Glyphosate sprayed here

agricultural impact



**Tomato planted
after
drift incident**

**Tomato planted
before
drift incident**

Soybean

- **When pesticide drift warrants legal action, it can have a monetary penalty, affect insurance, and destroy neighbourly relations**

*Thanks for the free
herbicide,
neighbour!*



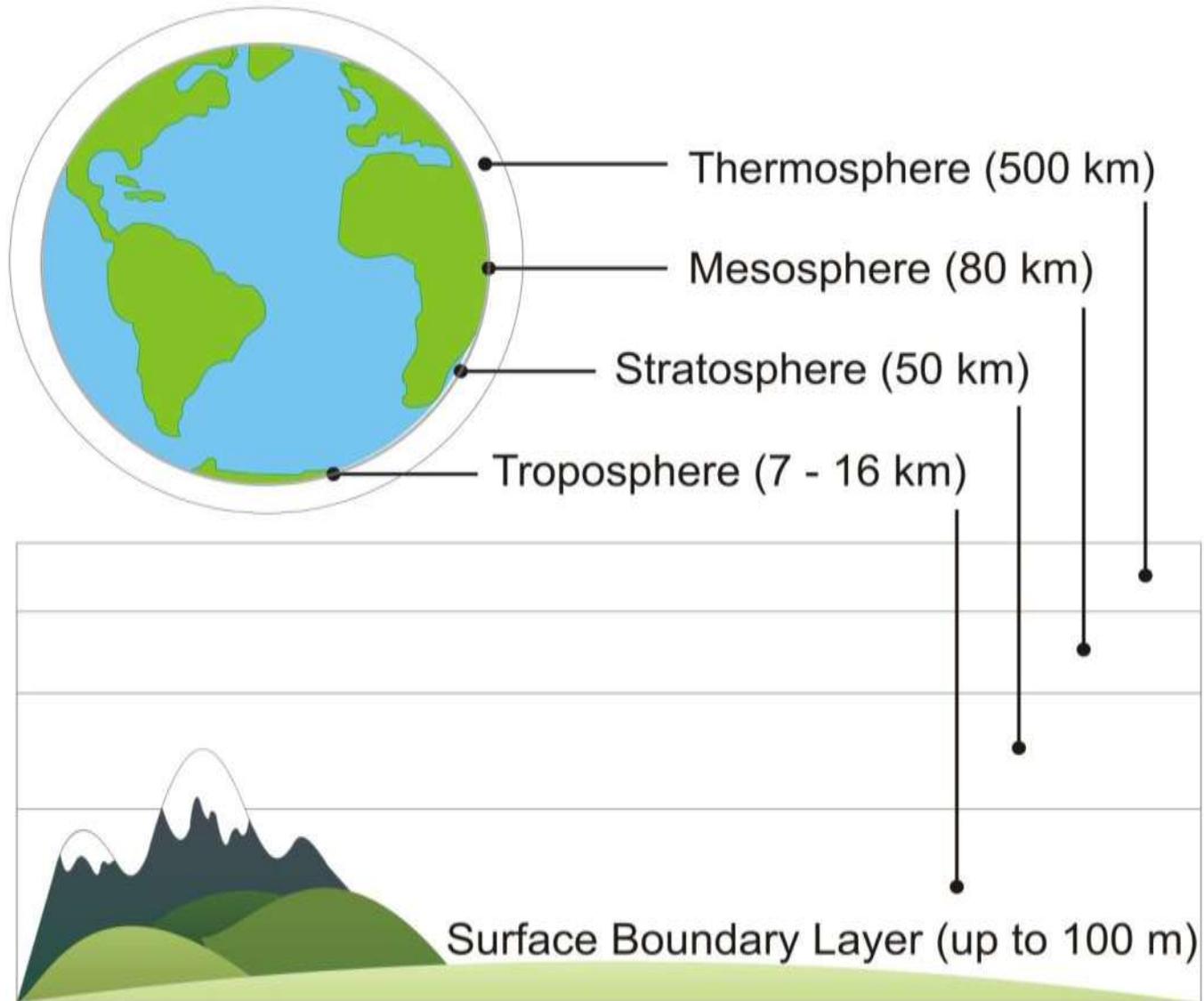
environmental conditions

- **We've heard the classic environmental warnings.**
- **Don't spray if:**
 - **temperature is too high**
 - **humidity is too low**
 - **air is calm**
 - **wind is too high**
 - **insects are pollinating**
 - **...or if anyone is watching...**



- **What about temperature inversions?**

our atmosphere (to scale!)

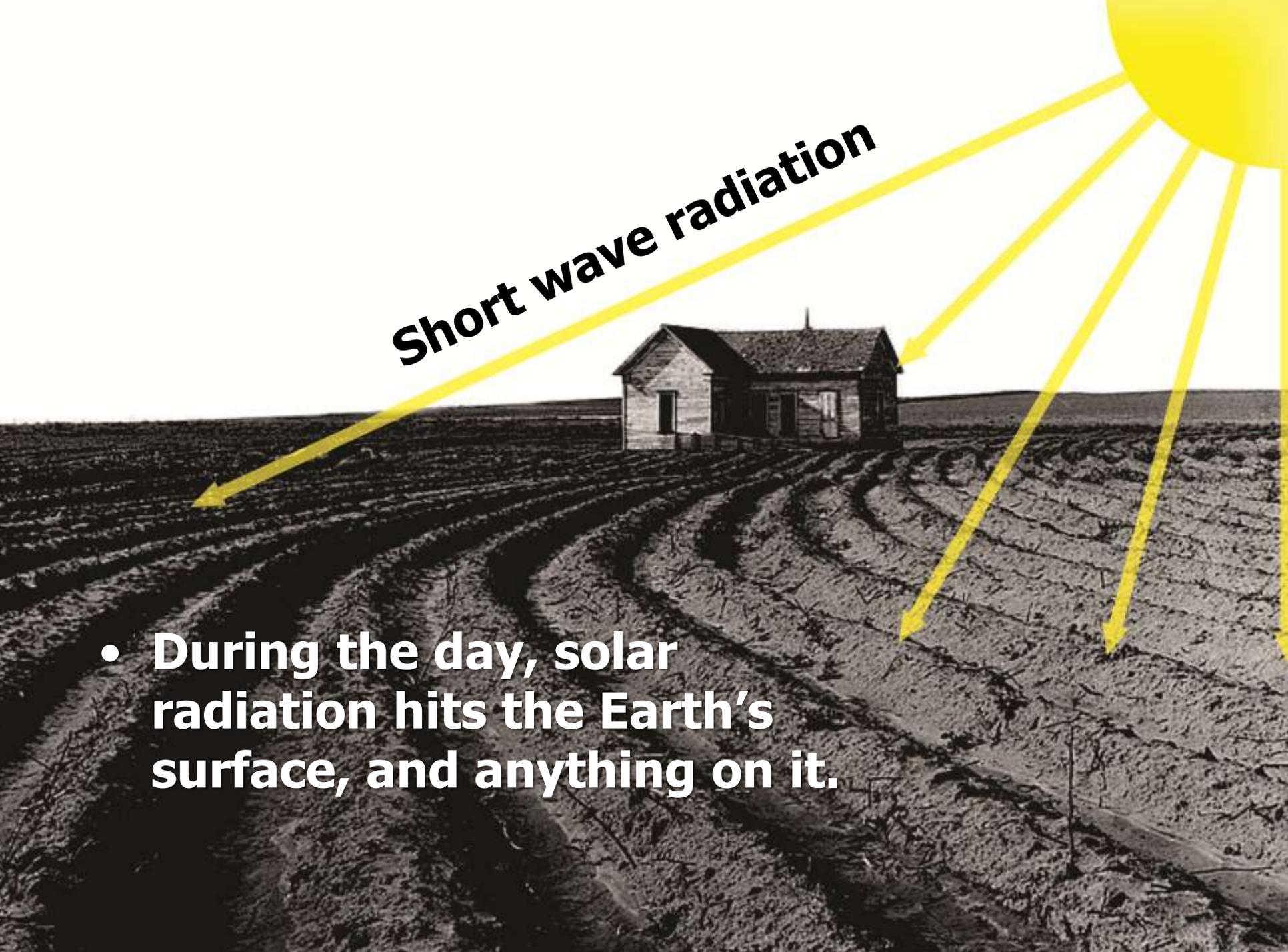


On a clear, relatively calm morning...



Picture the Earth's surface...





Short wave radiation

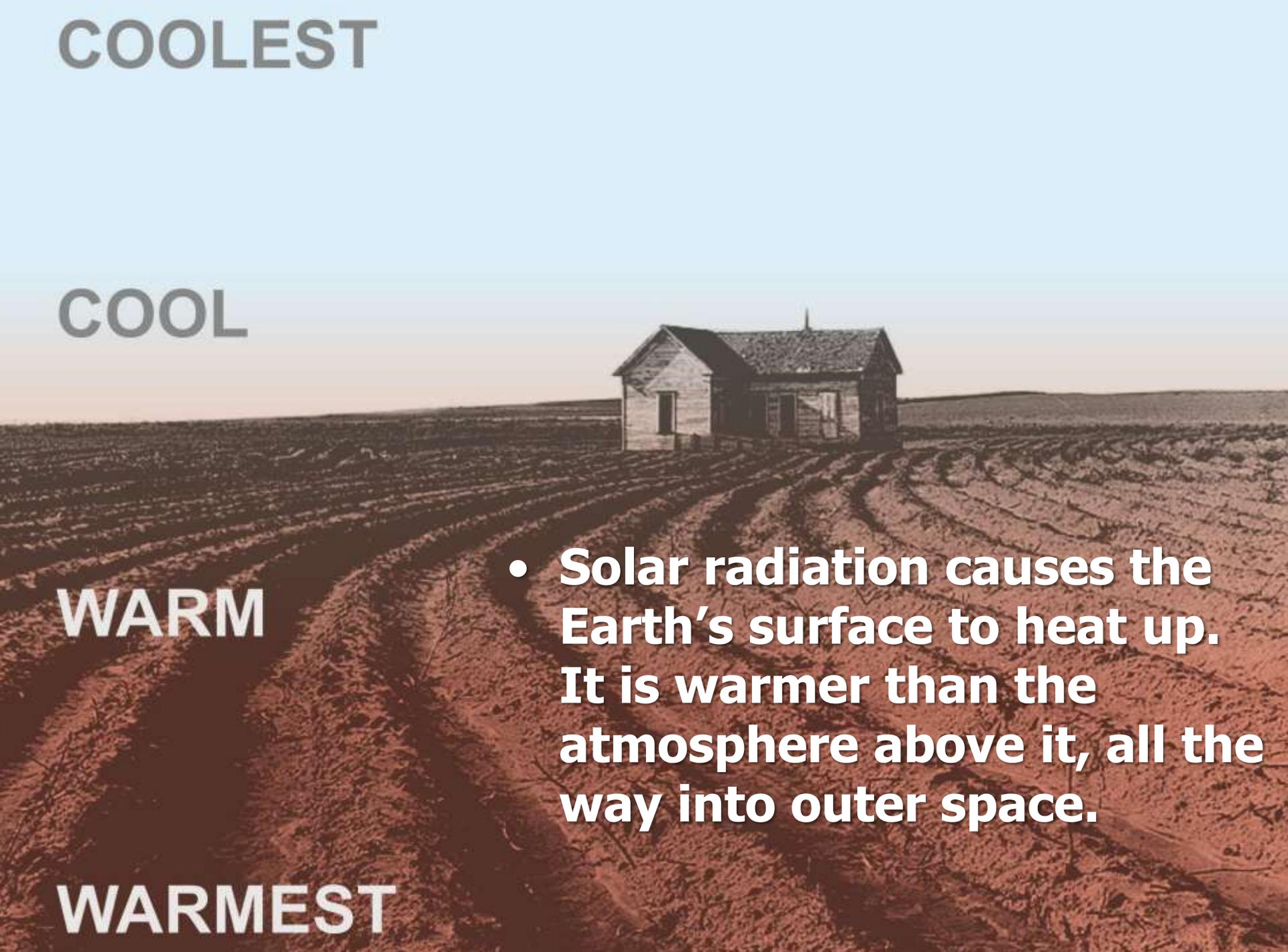
- **During the day, solar radiation hits the Earth's surface, and anything on it.**

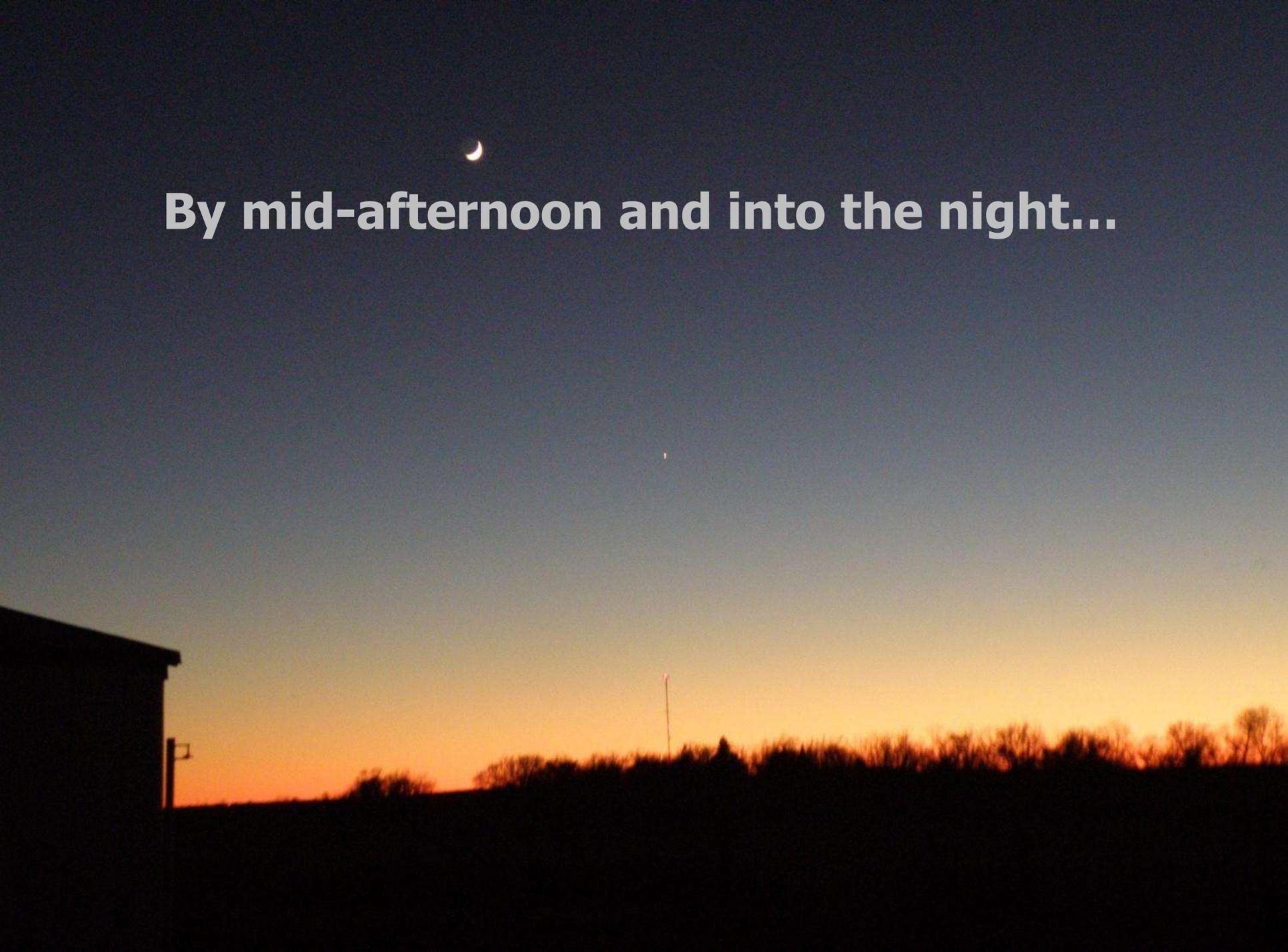
COOLEST

COOL

WARM

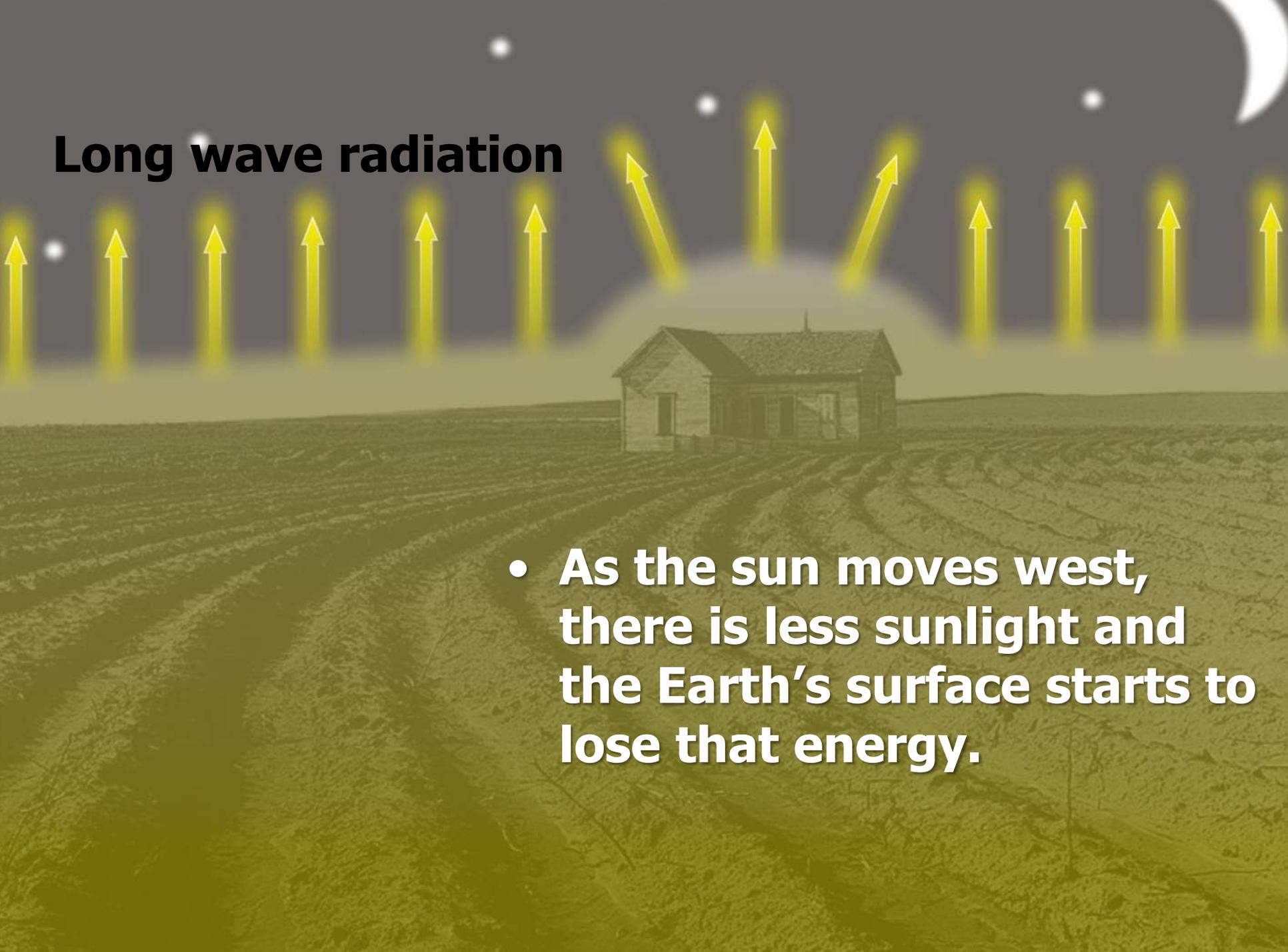
WARMEST

- 
- **Solar radiation causes the Earth's surface to heat up. It is warmer than the atmosphere above it, all the way into outer space.**

A photograph of a sunset or sunrise. The sky is a gradient of colors, from a deep blue at the top to a bright orange and yellow near the horizon. A thin crescent moon is visible in the upper left portion of the sky. In the foreground, there is a dark silhouette of a building on the left and a line of trees or bushes along the horizon. A small, bright light source, possibly a star or planet, is visible in the center of the sky.

By mid-afternoon and into the night...

Long wave radiation

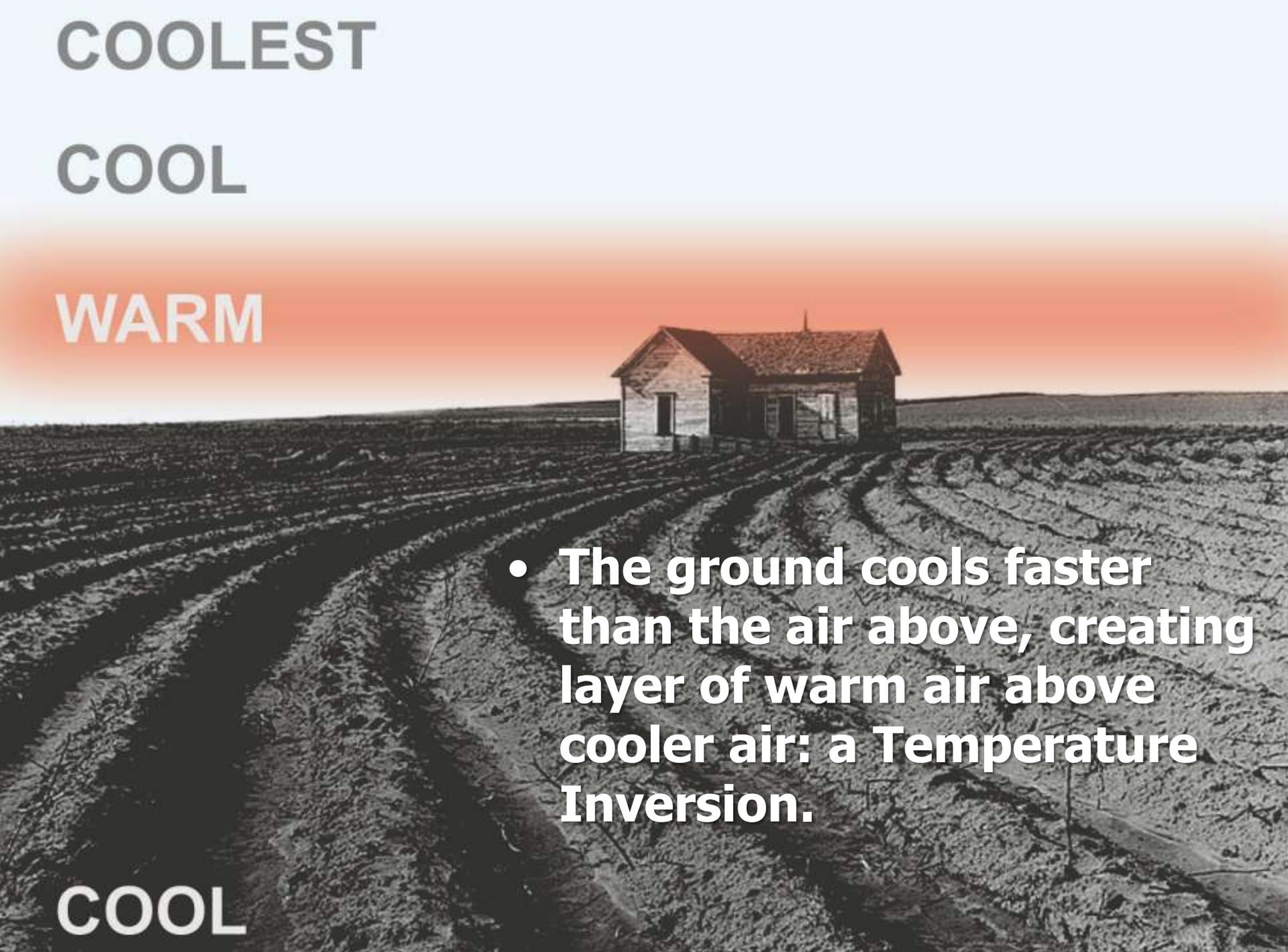


- As the sun moves west, there is less sunlight and the Earth's surface starts to lose that energy.

COOLEST

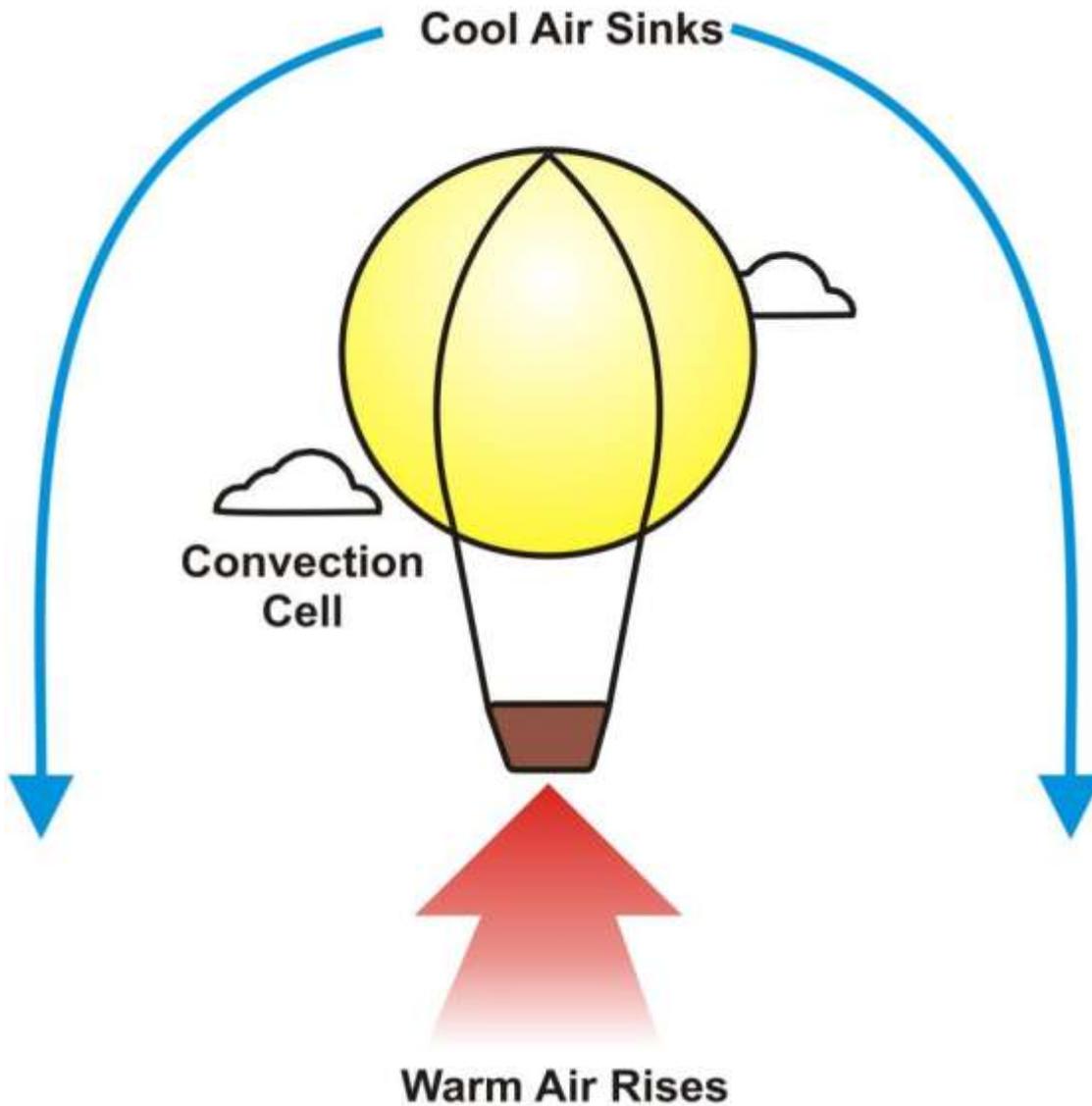
COOL

WARM

- 
- A photograph of a small, weathered wooden house in a field. The sky is a gradient from white at the top to orange at the bottom. The ground is dark and textured, with a path leading towards the house. The text 'COOLEST', 'COOL', 'WARM', and 'COOL' is overlaid on the sky and ground respectively. A bullet point is overlaid on the ground in the lower right.
- **The ground cools faster than the air above, creating layer of warm air above cooler air: a Temperature Inversion.**

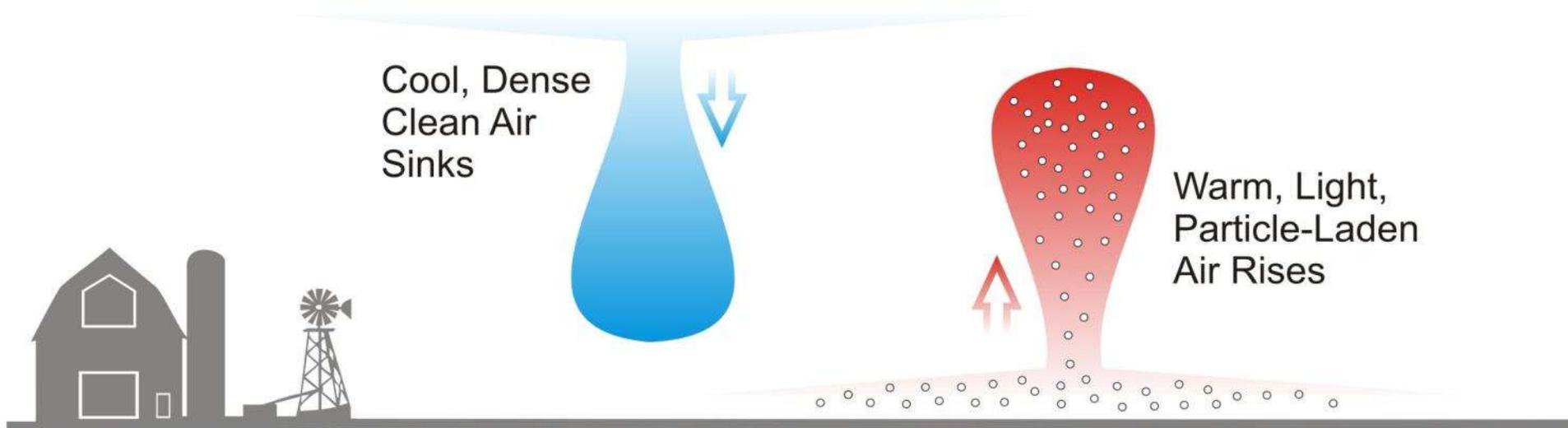
COOL

convection cells



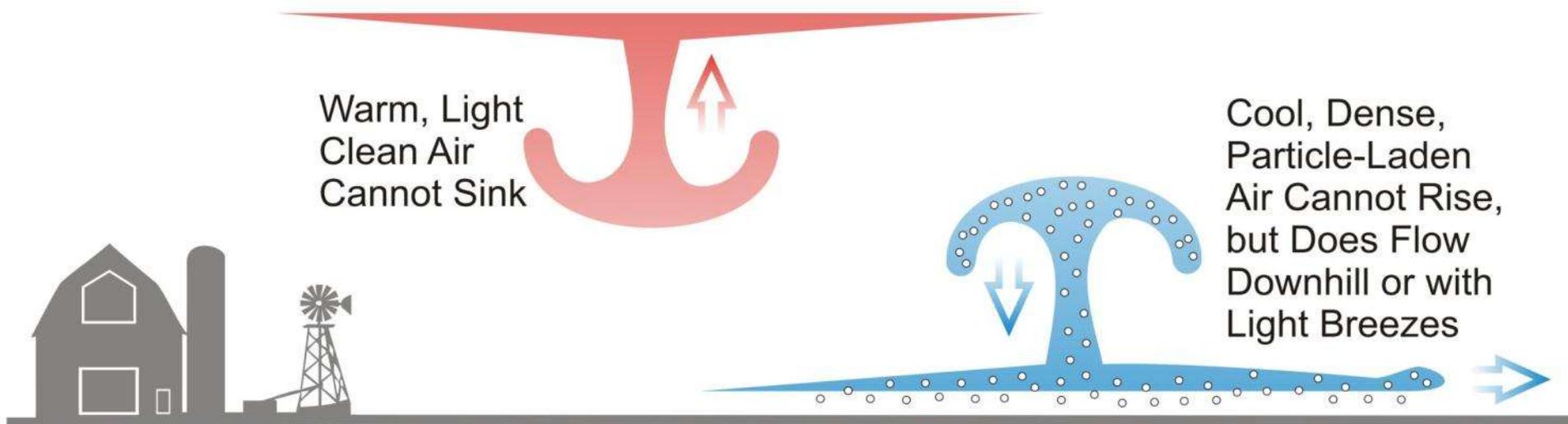
- **The air around us bubbles like the goo in a lava lamp...**

thermal turbulence



- **Spray-laden, warm air rises and dissipates as cooler, clean air falls**

temperature inversion



- **Temperature inversions suppress thermal turbulence, and concentrated spray-laden air flows laterally. Either downhill (like water) or with light breezes**

Air flows like water. The moisture in the air condenses as it rolls downhill into cooler temperatures.



Photo Credit: Andrew Thostenson

DEW

FROST





**Red dye spraying
from a plane.**

Photo Credit: Gail Amos

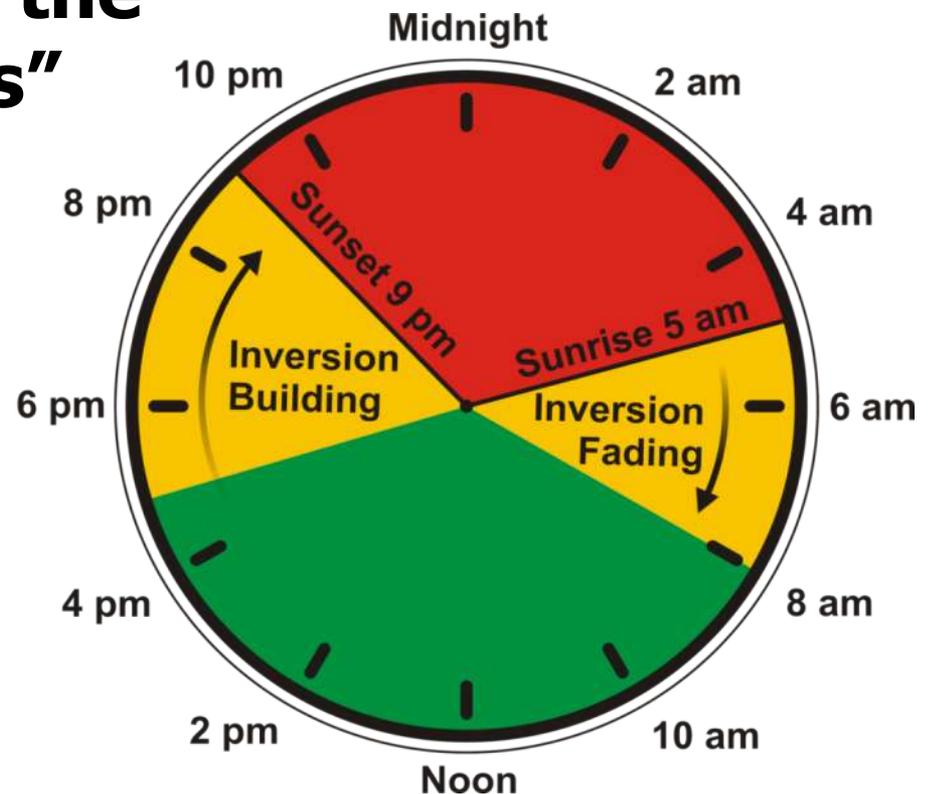
**Red dye applied aerially on an
afternoon in May during an
inversion. Fine mist hangs above
the cold ground.**



Photo Credit: Andrew Thostenson

when do inversions occur?

- **Inversions, once formed, persist until the sun rises and warms the Earth's surface, or until winds increase and mix the stationary "layers" of air together**
- **At sunrise, the inversion will be at its **maximum height****



inversion intensity varies

- **Humidity** slows the formation and reduces the intensity of an inversion
- **Cloud cover** bounces long wave radiation back to Earth, making it warmer and reducing inversion intensity
- **Wind** (>6 or 8 km/h) stirs the air vertically, reducing inversion intensity

soil surfaces affect inversions

- **Surface area radiates heat and has a localized cooling effect. So, the more surface area, the faster and more intense the local inversion**

Bare,
Compact Soil



Loose,
Tilled Soil



Mulched
Soil



Open
Row



Partially
Closed Row



Closed
Canopy





- **Why is there fog on either side of the road, but none over it?**

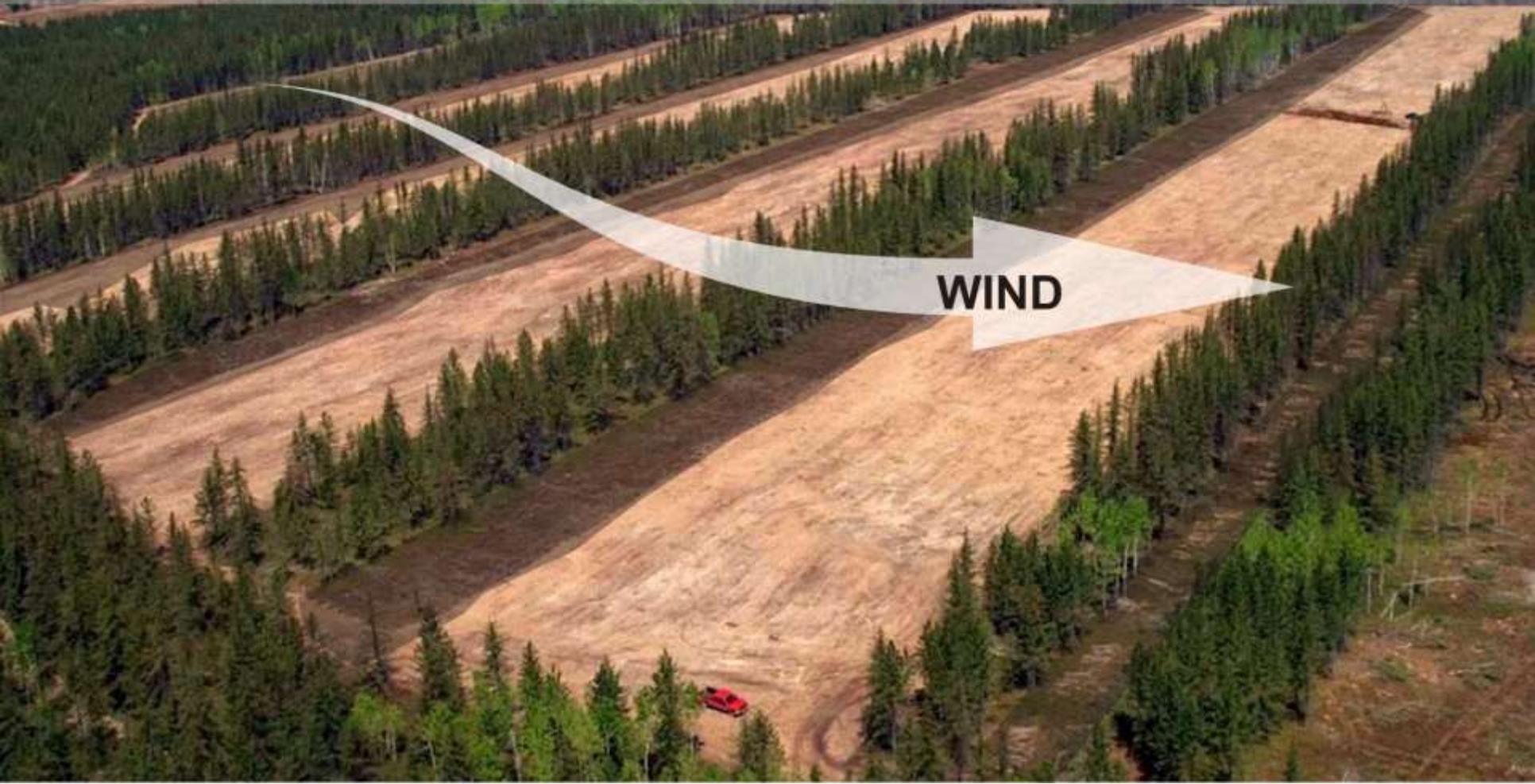


- **Because the canopy is colder than the road and caused moisture to condense.**

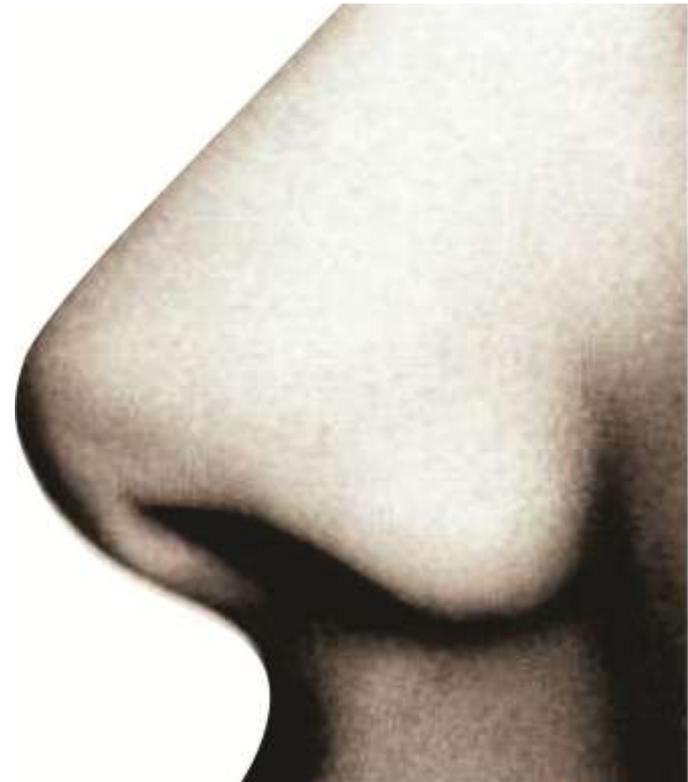




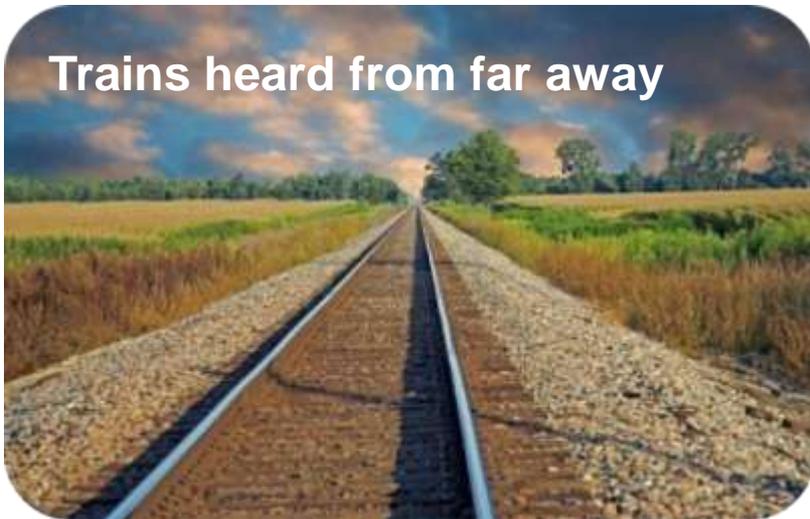
Windbreaks create still, cold conditions. Inversions start sooner and persist longer.



you can smell an inversion



you can hear an inversion



you can see an inversion



you can feel an inversion



HIGH PRESSURE

H

- Sunny
- No or few clouds in sky
- Cool and dry
- Relatively Still



- **Know the topography and local features surrounding where you spray (Google Earth is good for this)**



- **Dying to know more about thermal inversions and drift? Of course you are!**
- **This is great 2014 factsheet from NDSU:**
<http://tinyurl.com/NDSU-ae-1705>
- **This is an article Tom Wolf and I wrote in 2014:**
<http://bit.ly/1nNpgSf>



- **When possible, choose products with low volatility. When labels say to avoid spraying during warm temperatures, it may be a clue to volatility**



and there's so much more...

- **Thanks for listening. This was too much, too quickly, but hopefully it inspires you to go here to learn more:**

Sprayers 101 



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Tom Wolf

@ **nozzle_guy**