Temperature Inversions:

Their Impact On Pesticide Applications

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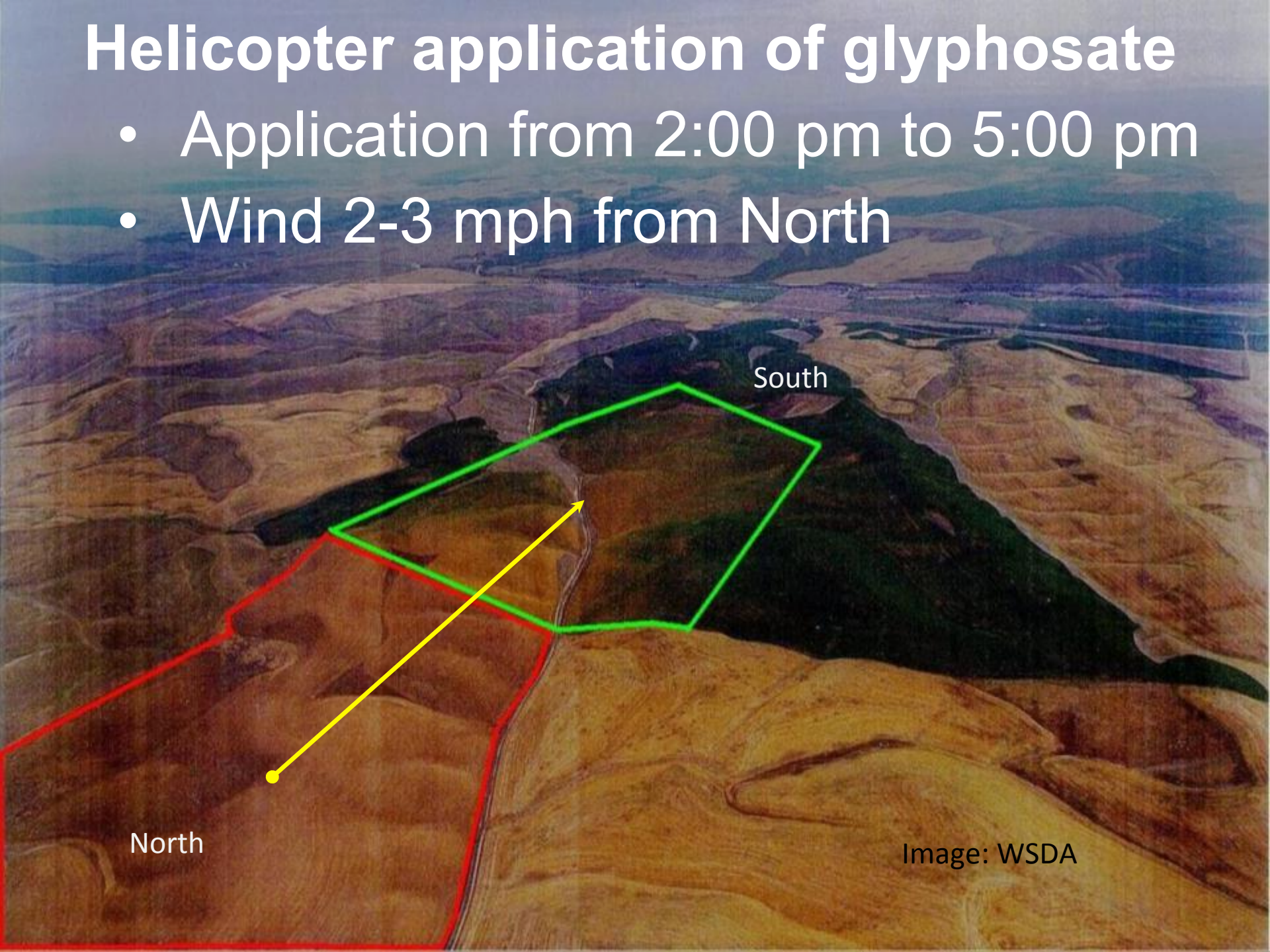
NDSU Extension Service
PESTICIDE PROGRAM
NDSU Extension Service

Helicopter application of glyphosate

- Application from 2:00 pm to 5:00 pm
- Wind 2-3 mph from North



This is *physical drift*, the spray droplets, as they are discharged from the nozzle, become trapped in a cool air inversion layer and move off target.

FARM PRESS
TIMELY RELIABLE INFORMATION FOR DELTA AGRICULTURE

2,4-D herbicide drift damage stuns east Arkansas cotton

David Bennett
Aug. 11, 2006 4:00pm

The young, east Arkansas cotton farmer turns in a slow circle trying to find a plant within his line of sight that isn't "smoked" by herbicide drift. There isn't one — leaves in the top third of every plant are off-color, curling and blistered.

He says excuses won't cut it. He wants those responsible for the 2,4-D drift that's harmed more than half his crop held liable. After that, he suggests banning or restricting 2,4-D might be a good idea.

"This is beyond ugly and has got to stop," he says throwing up his hands in frustration. "We're trying to make a living and this bush-league (stuff) starts happening. It's the same story up and down the road here. It's on everyone's cotton.

This is easily seen in east Arkansas where multiple counties have been affected by the recent drift. After visiting with Extension agents and consultants, Bill Robertson says there's easily upwards of **200,000 to 250,000 acres** of damaged cotton in Craighead, Greene, Poinsett, Mississippi and Cross counties.

Recognizing and dealing with an inversion is a label requirement

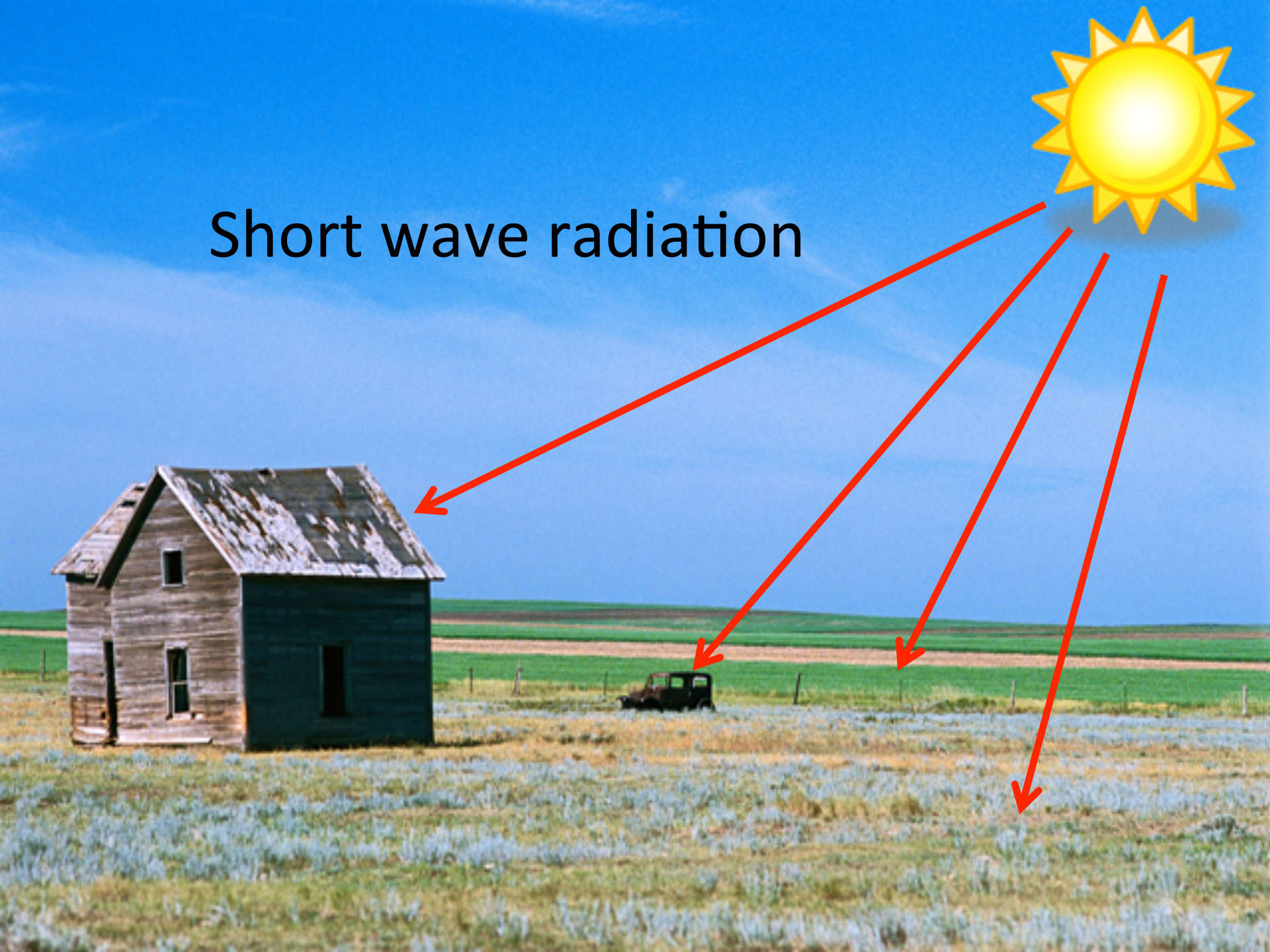
"Temperature Inversions

If applying at wind speeds less than 3 mph, the applicator must determine if:

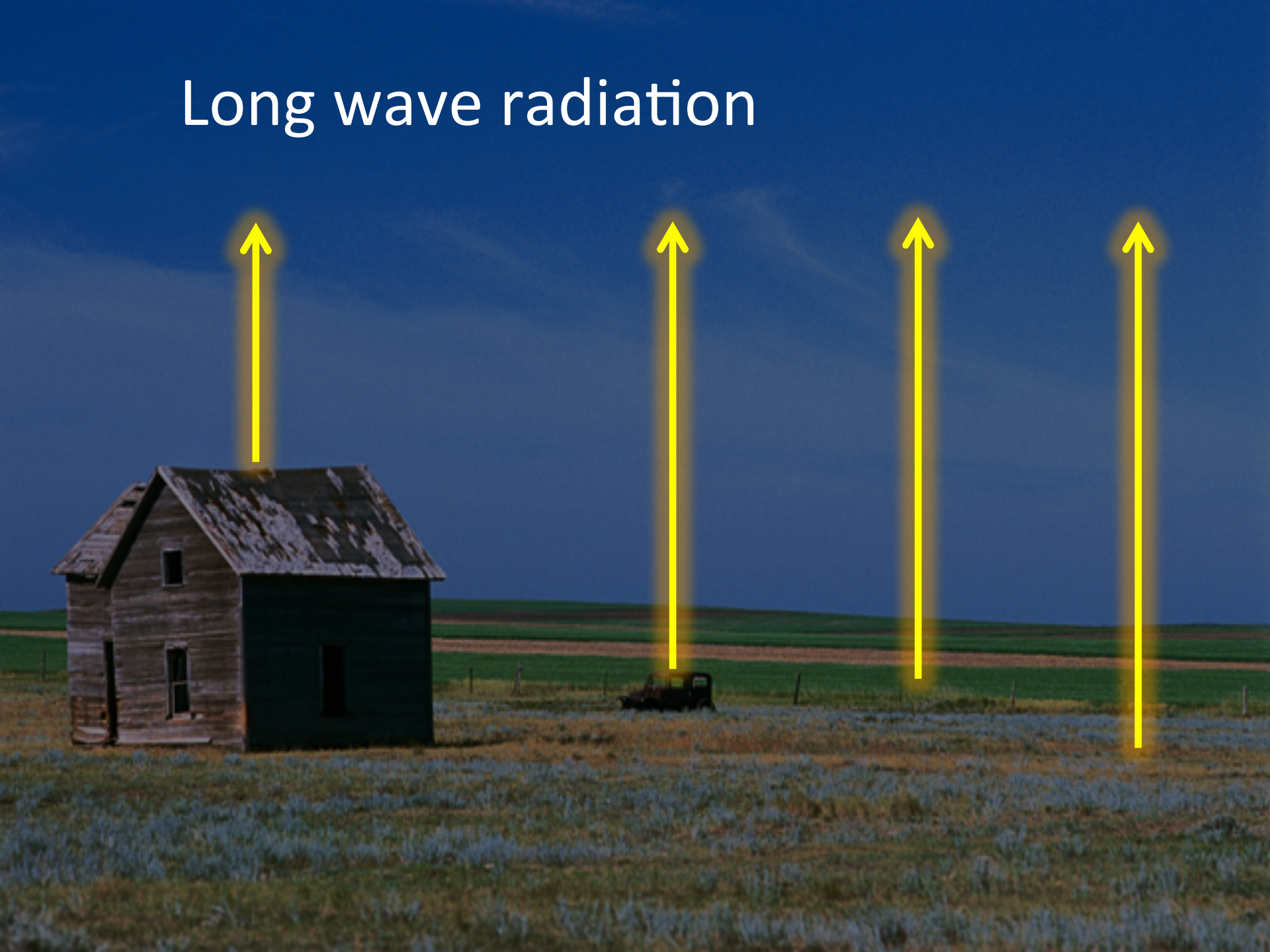
a) conditions of temperature inversion exist, or

b) stable atmospheric conditions exist at or below nozzle height.

Do not make applications into areas of temperature inversions or stable atmospheric conditions."


Short wave radiation

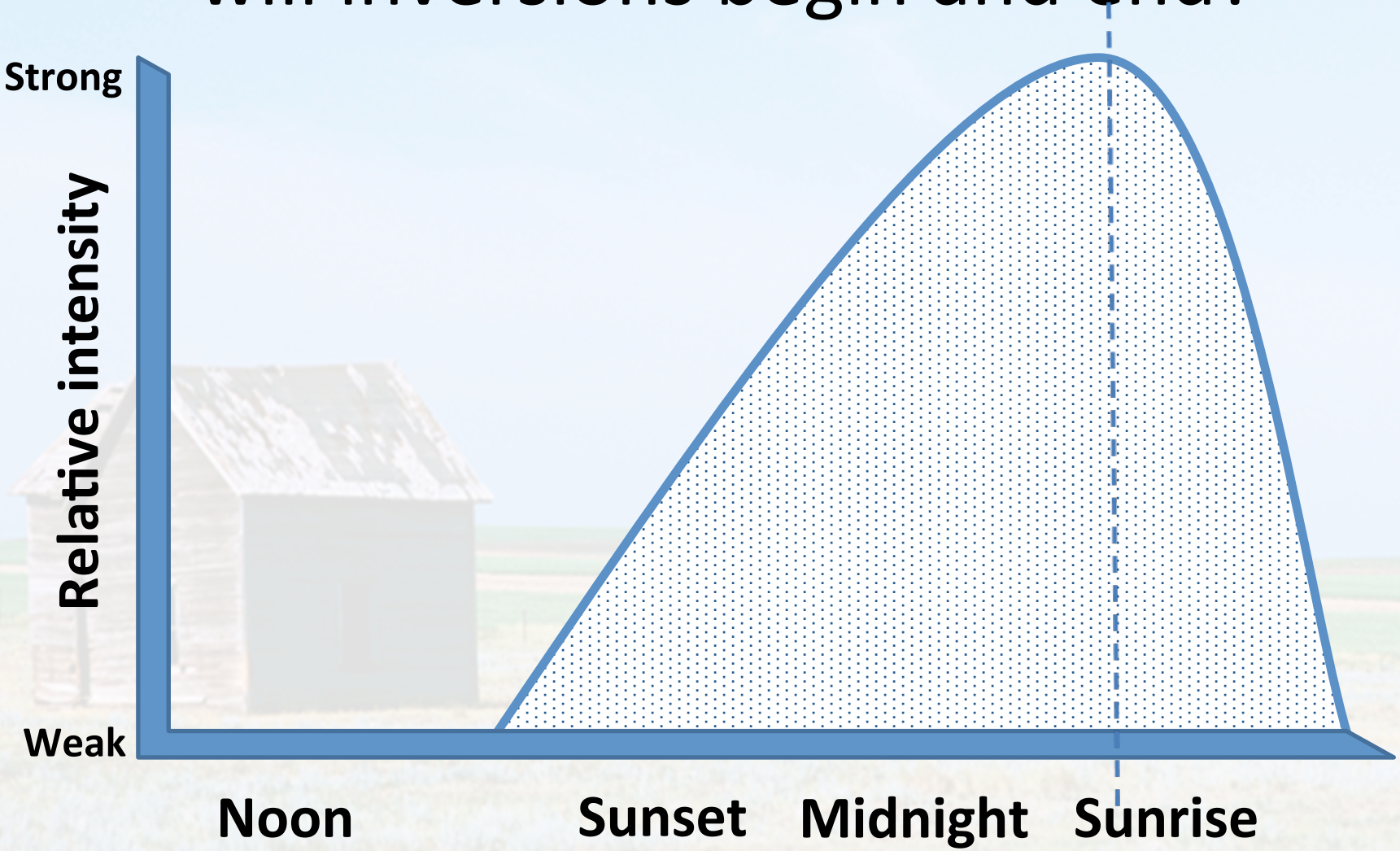
Long wave radiation



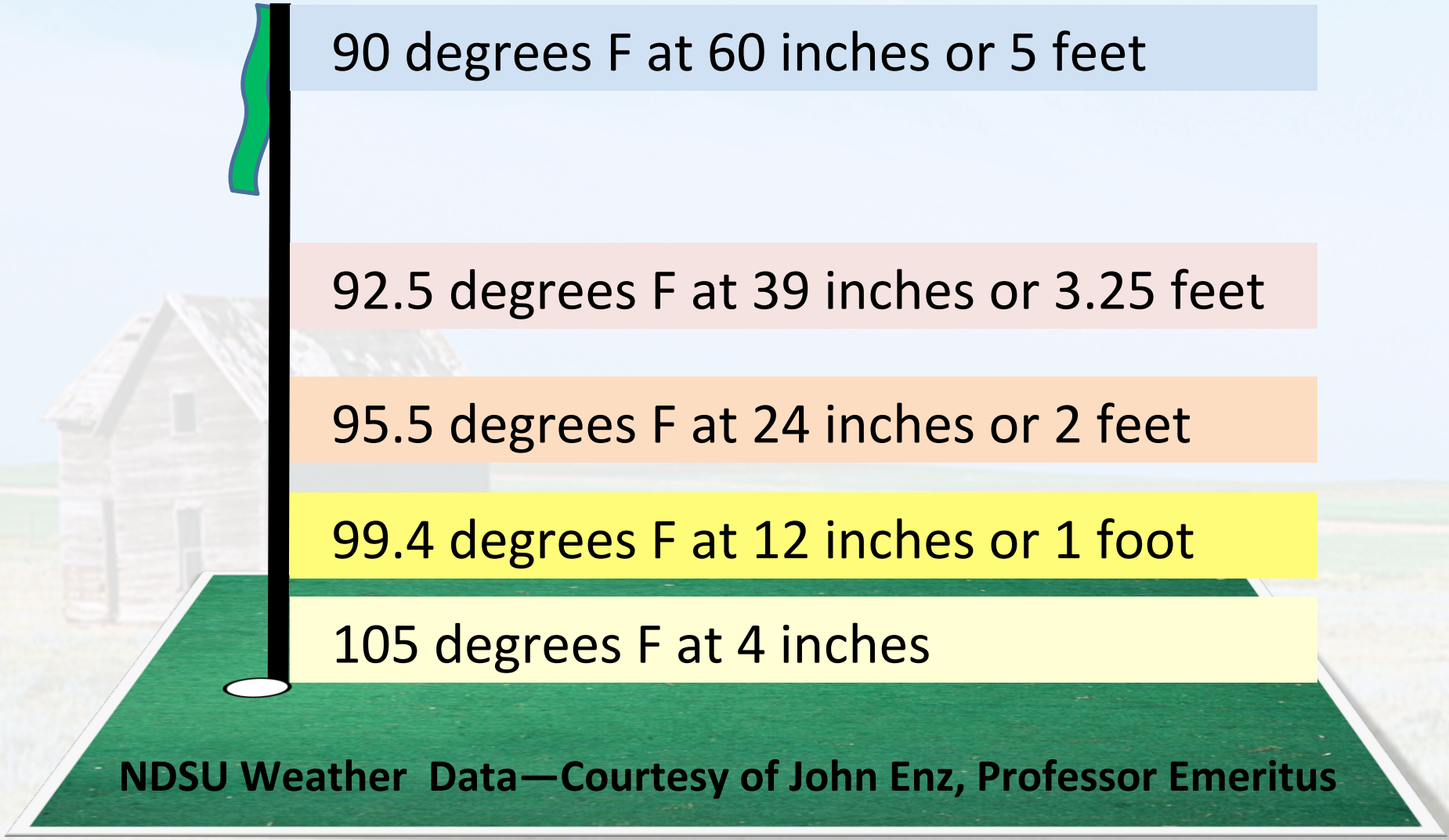
Radiation waves from objects move in all directions into the air


Warmer
Objects lose heat, cool the air near the earth’s surface
Coldest

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

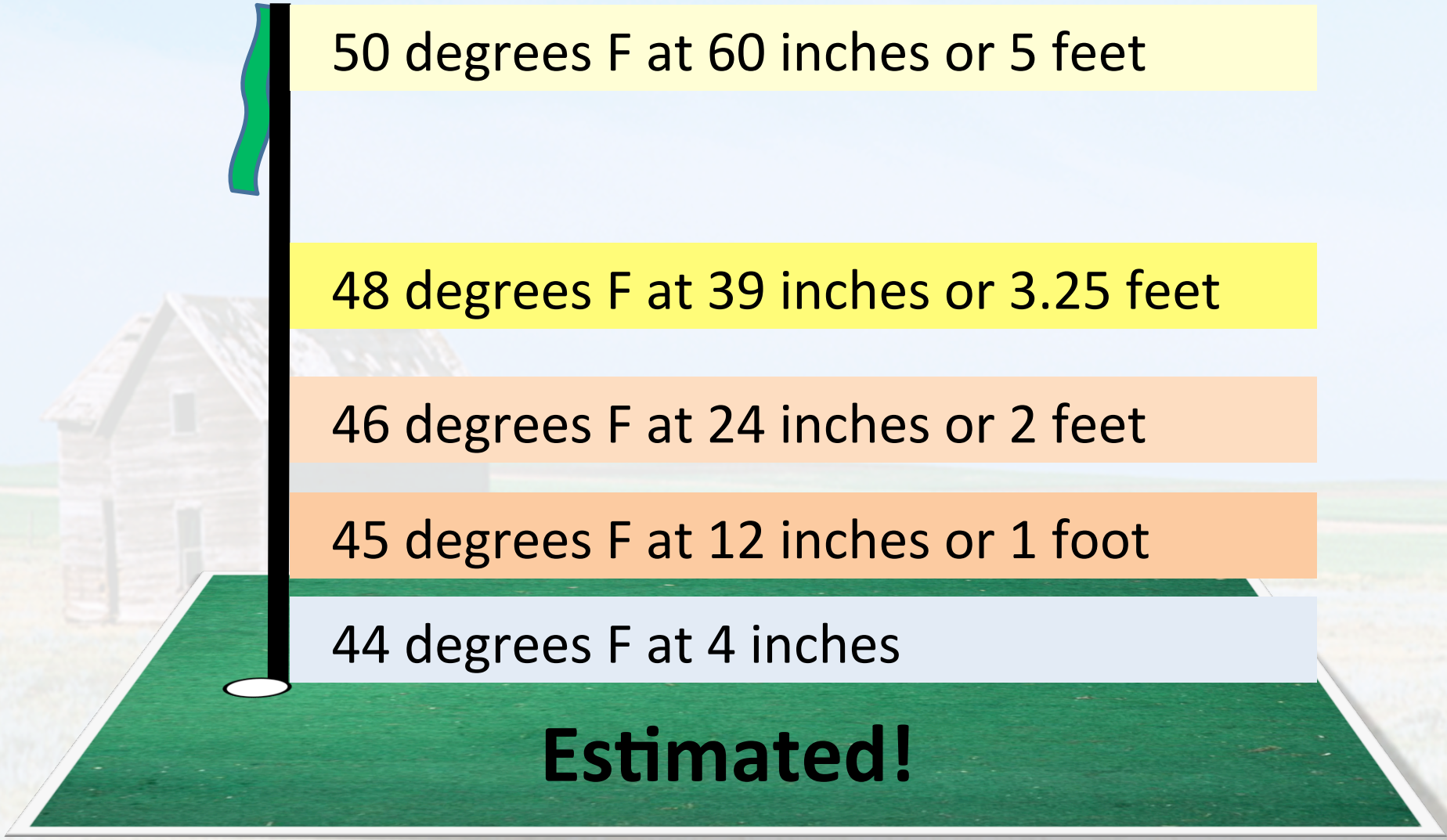


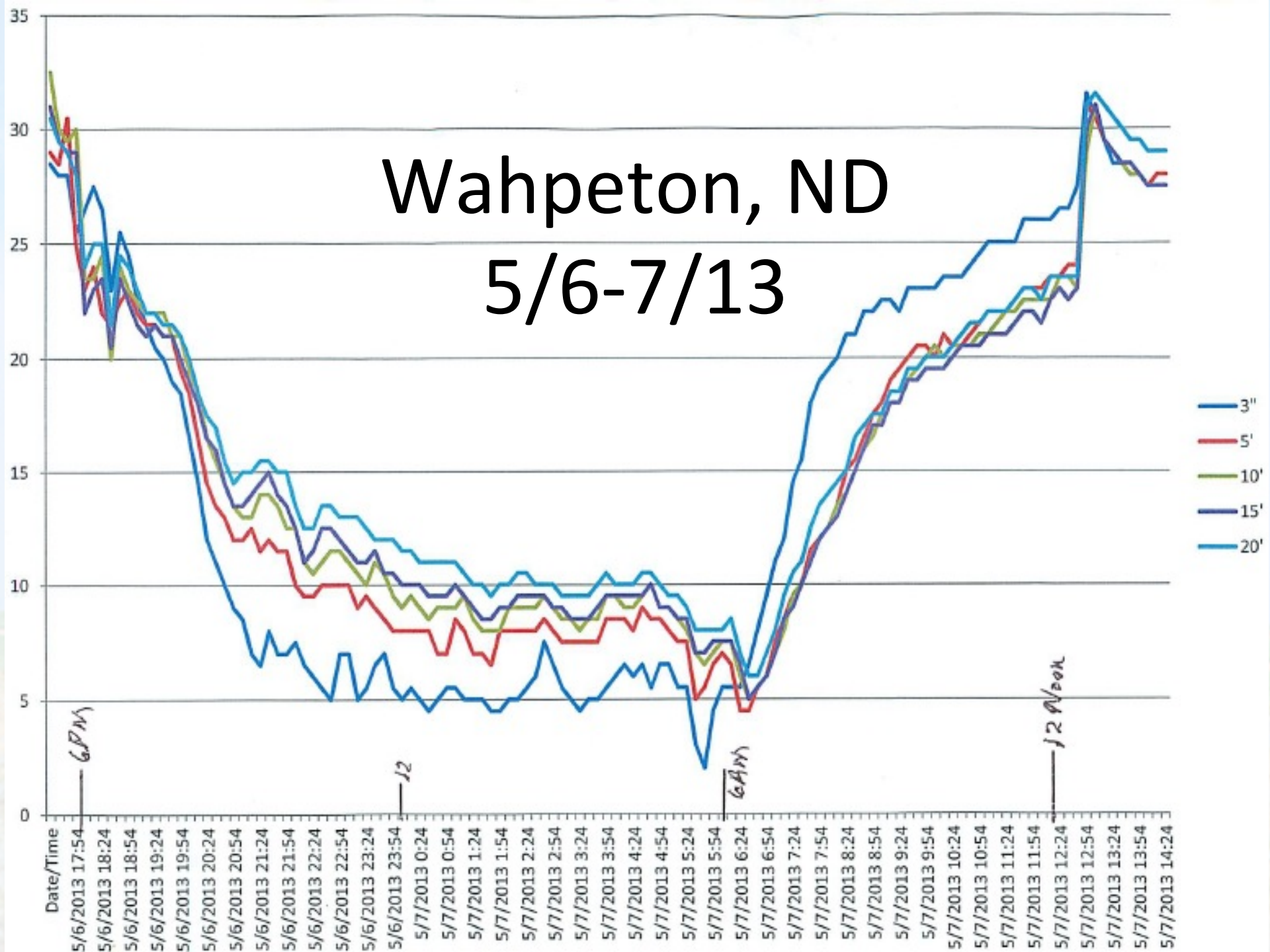
Early afternoon temperature profile on a hot day with 4 mph or less wind



NDSU Weather Data—Courtesy of John Enz, Professor Emeritus

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




Wahpeton, ND
5/6-7/13
35
30
25
20
15
10
5
0
3"
5'
10'
15'
20'
Date/Time
5/6/2013 17:54
5/6/2013 18:24
5/6/2013 18:54
5/6/2013 19:24
5/6/2013 19:54
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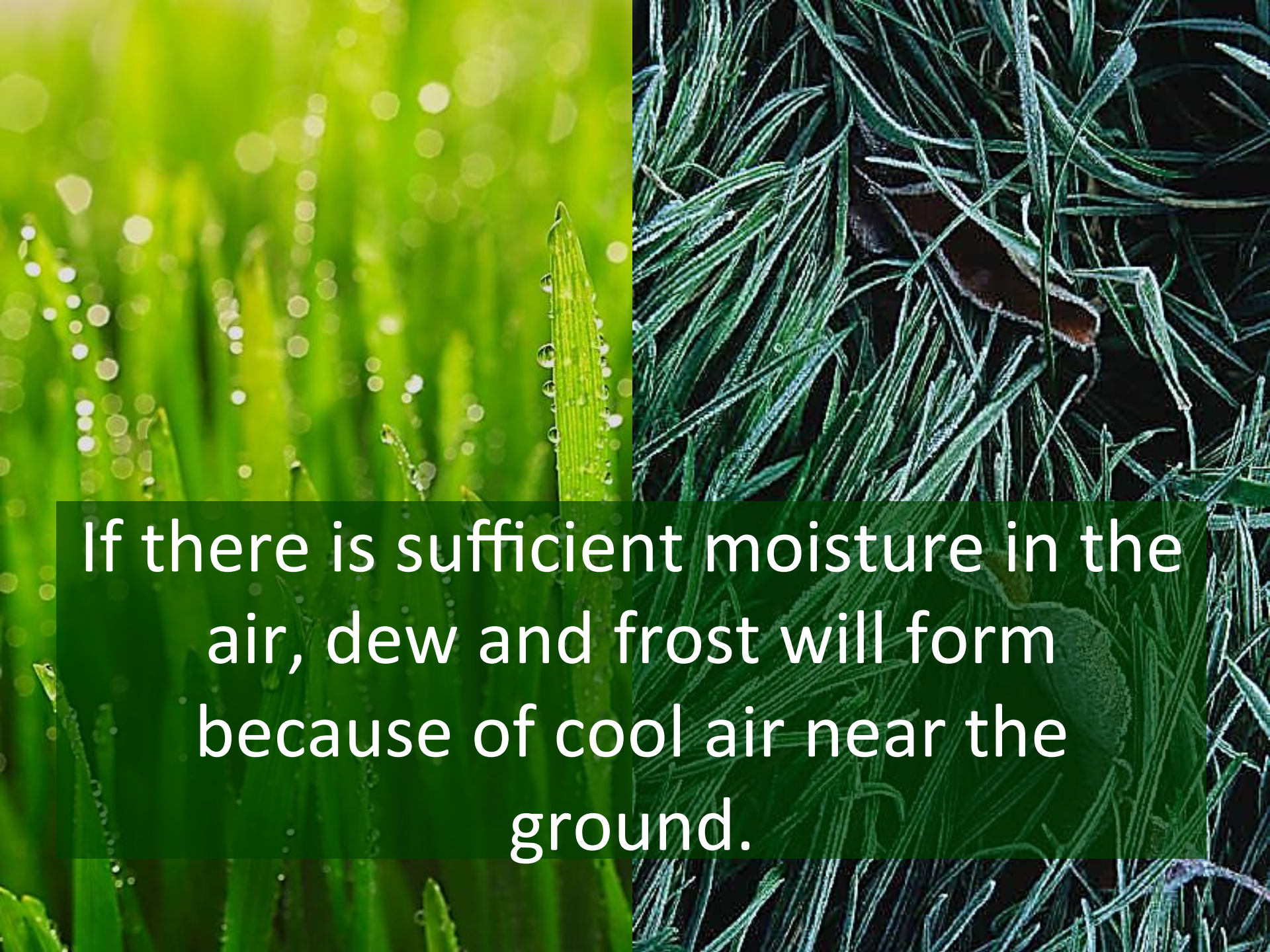
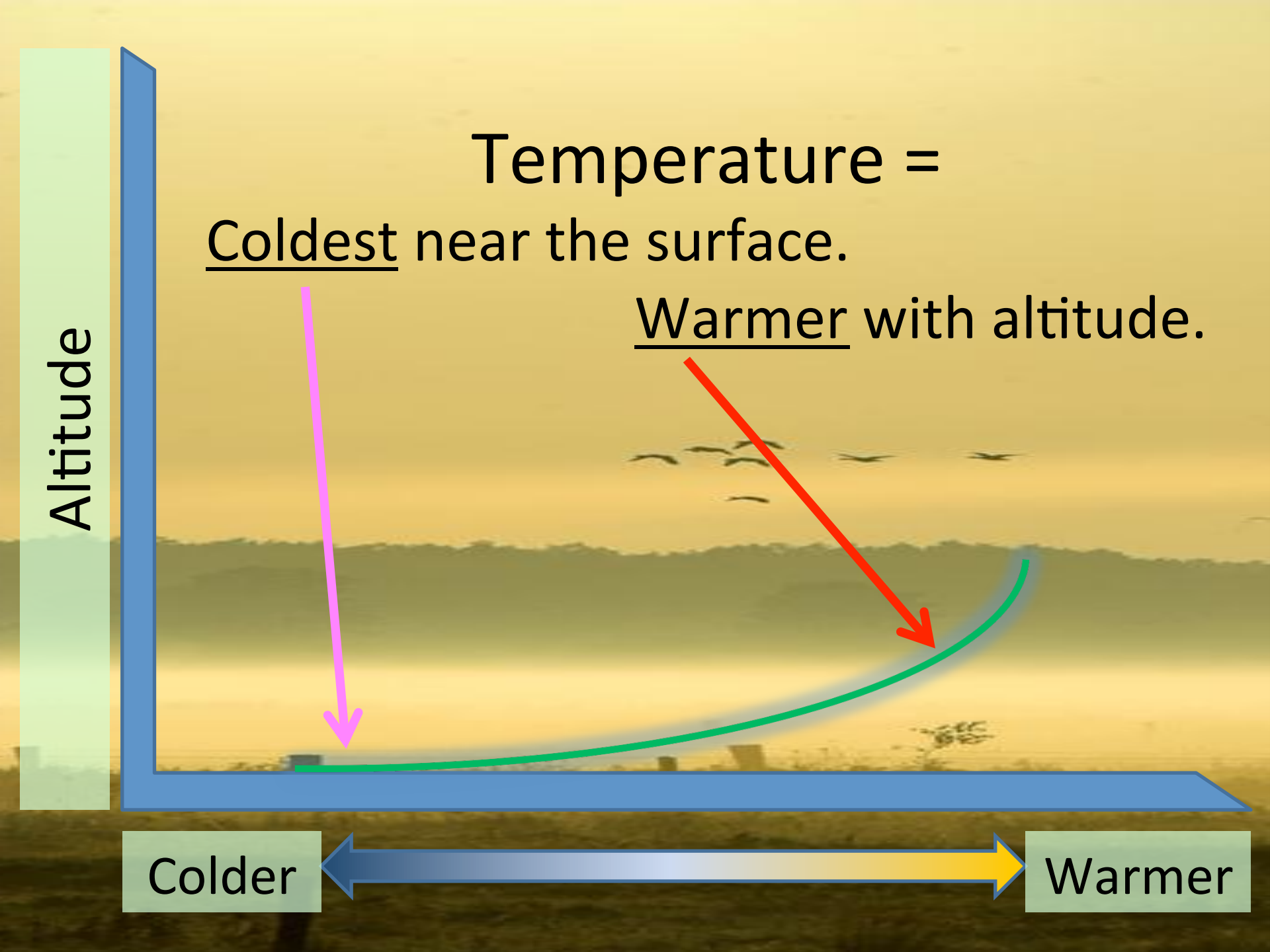


If there is sufficient moisture in the air, dew and frost will form because of cool air near the ground.

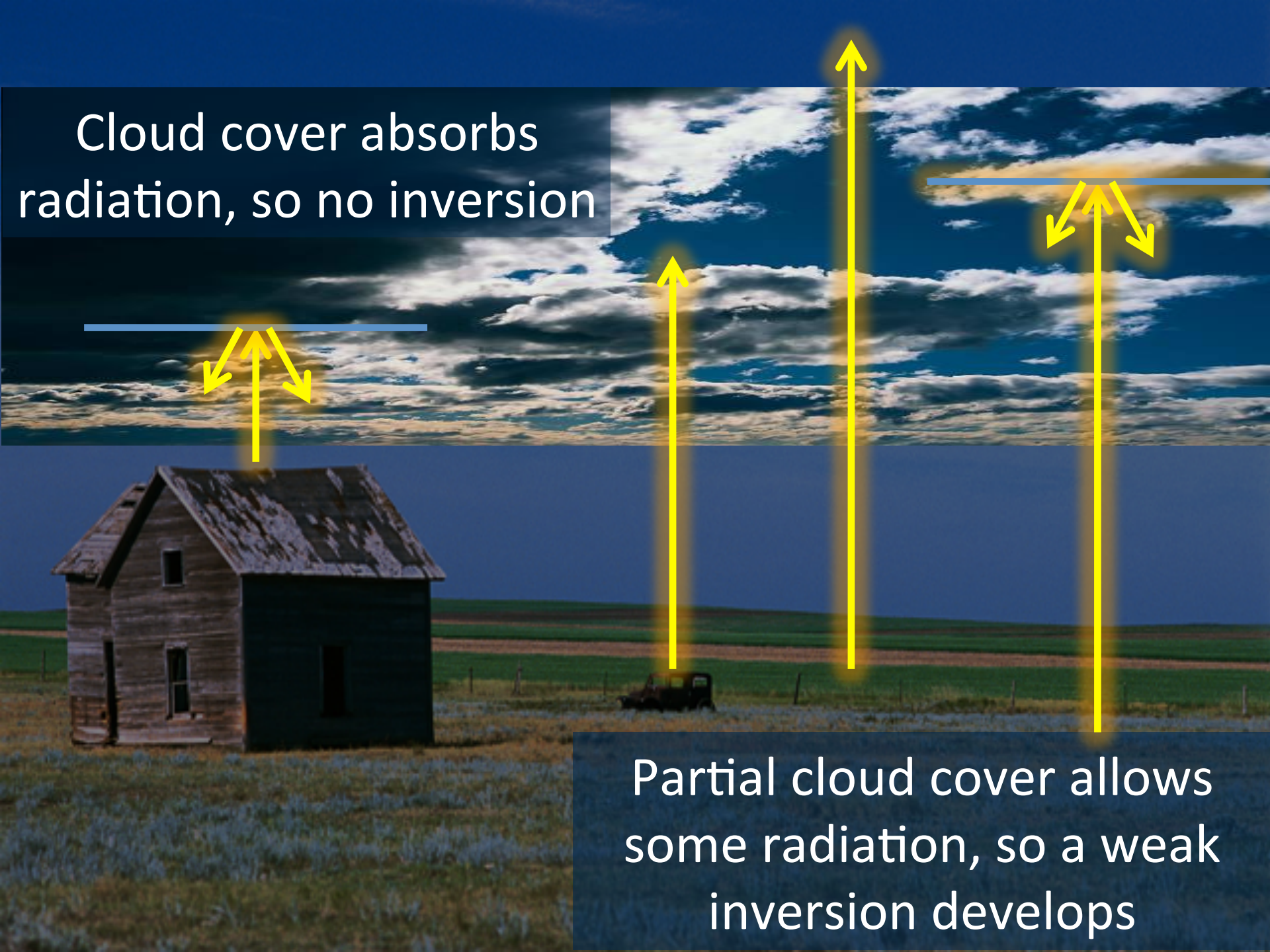
If there is sufficient moisture in the air, fog will also form.


Dew point
Temperature

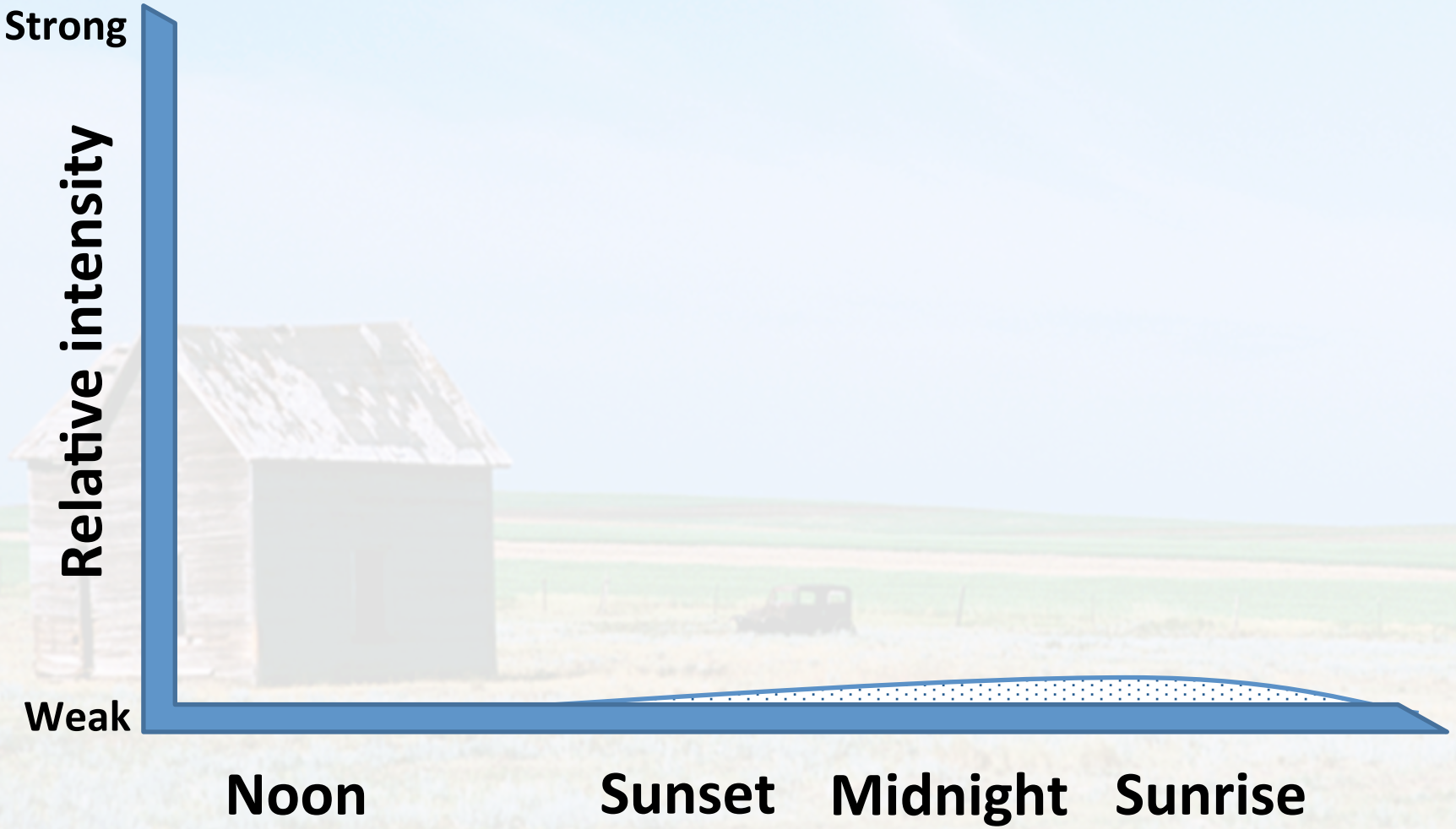

Temperature =
Coldest near the surface.
Warmer with altitude.
Altitude
Colder
Warmer

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

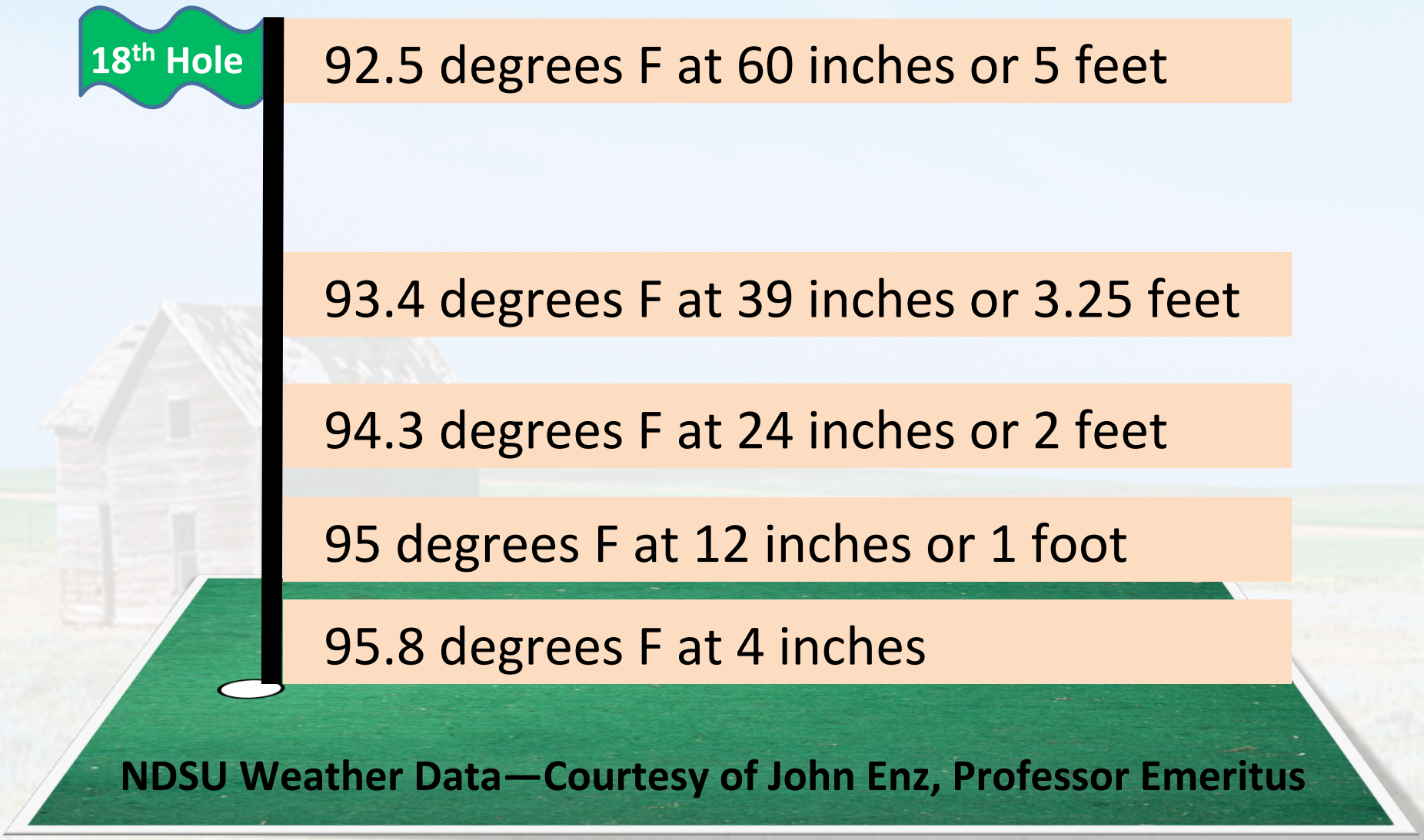
Sufficient wind will mix the air, thus preventing or destroying the inversion.


Cloud cover absorbs radiation, so no inversion
Partial cloud cover allows some radiation, so a weak inversion develops

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

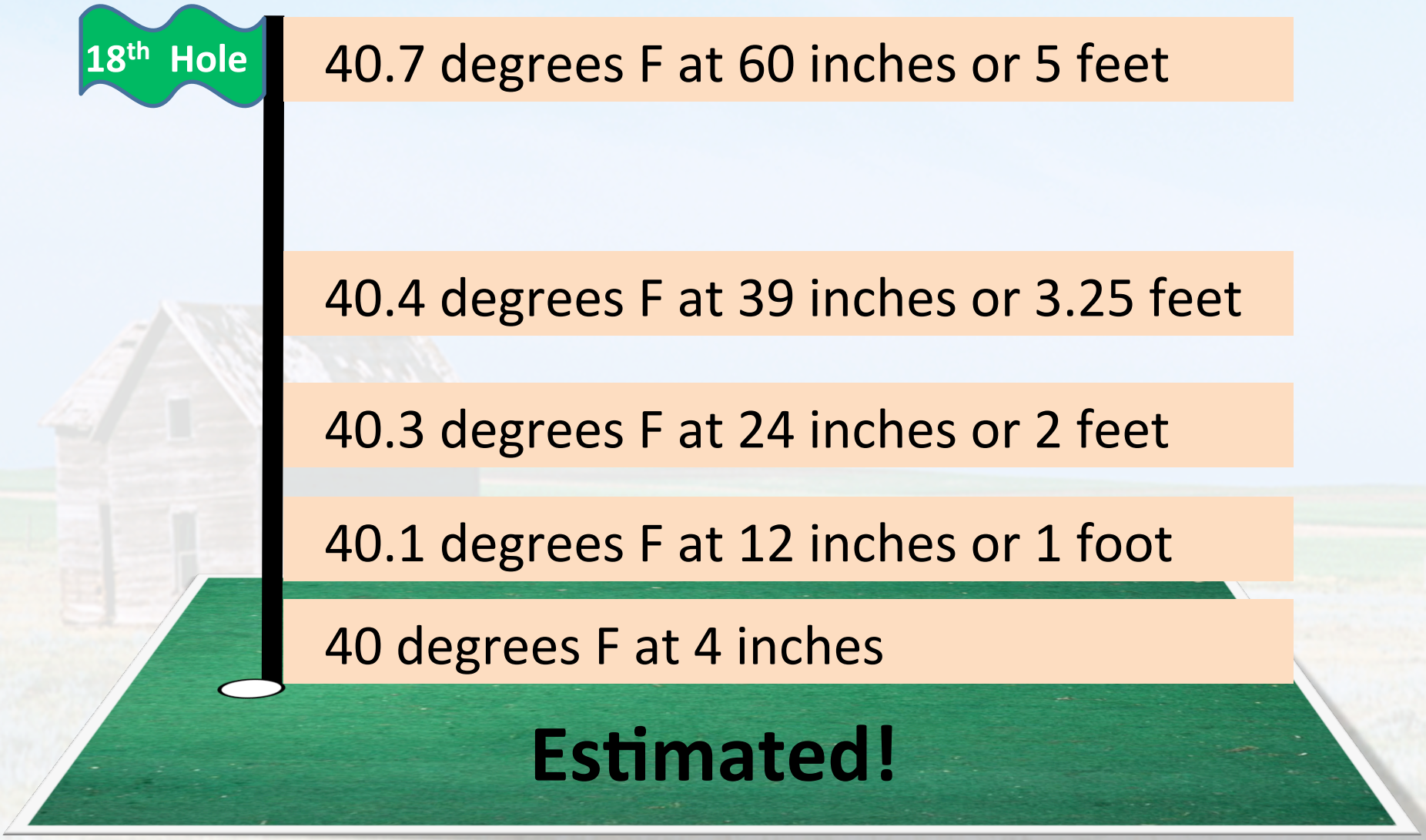


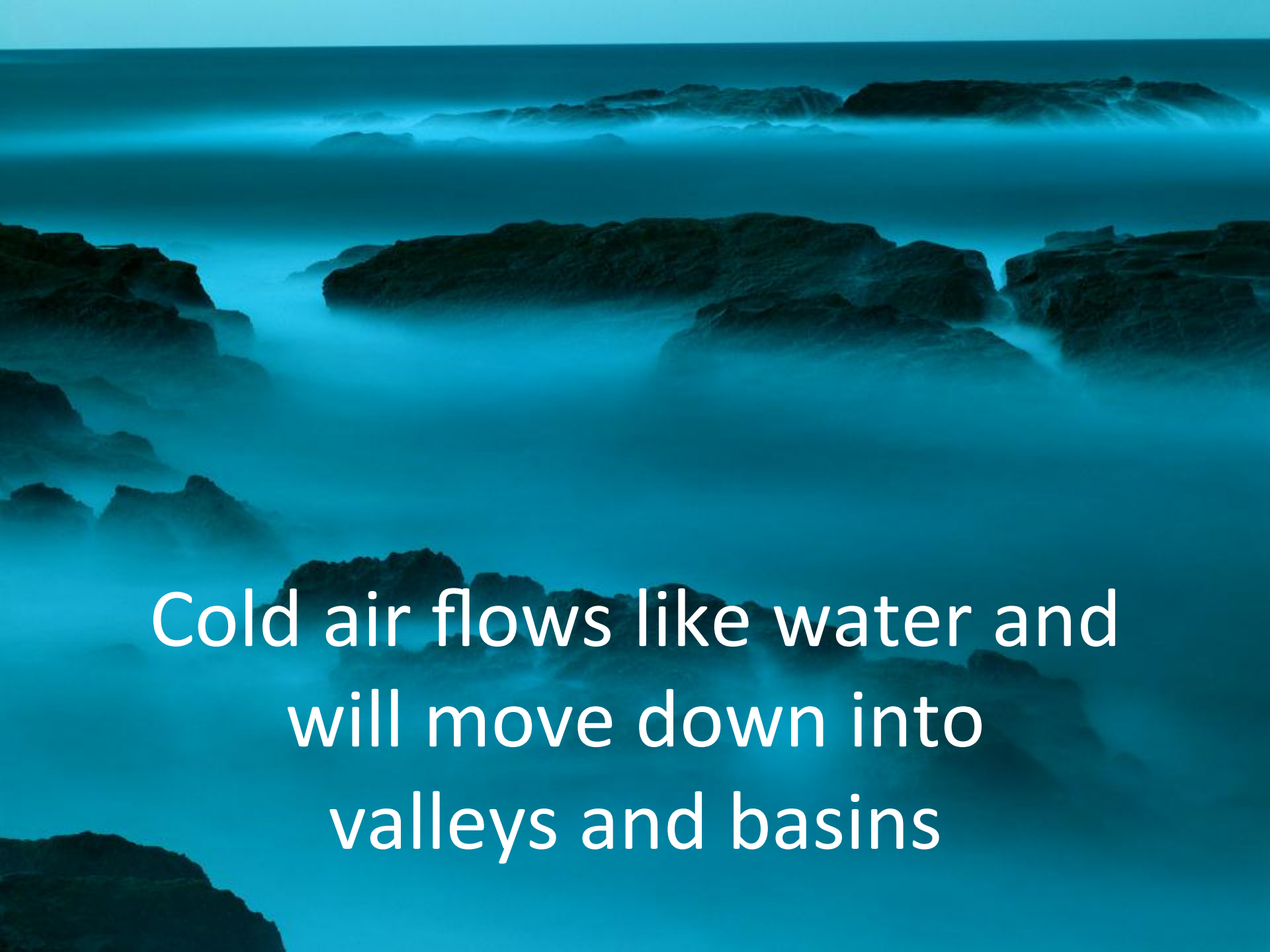
Early afternoon temperature profile on a hot & windy day



NDSU Weather Data—Courtesy of John Enz, Professor Emeritus

Early morning temperature profile with little or no inversion (windy & cloudy)

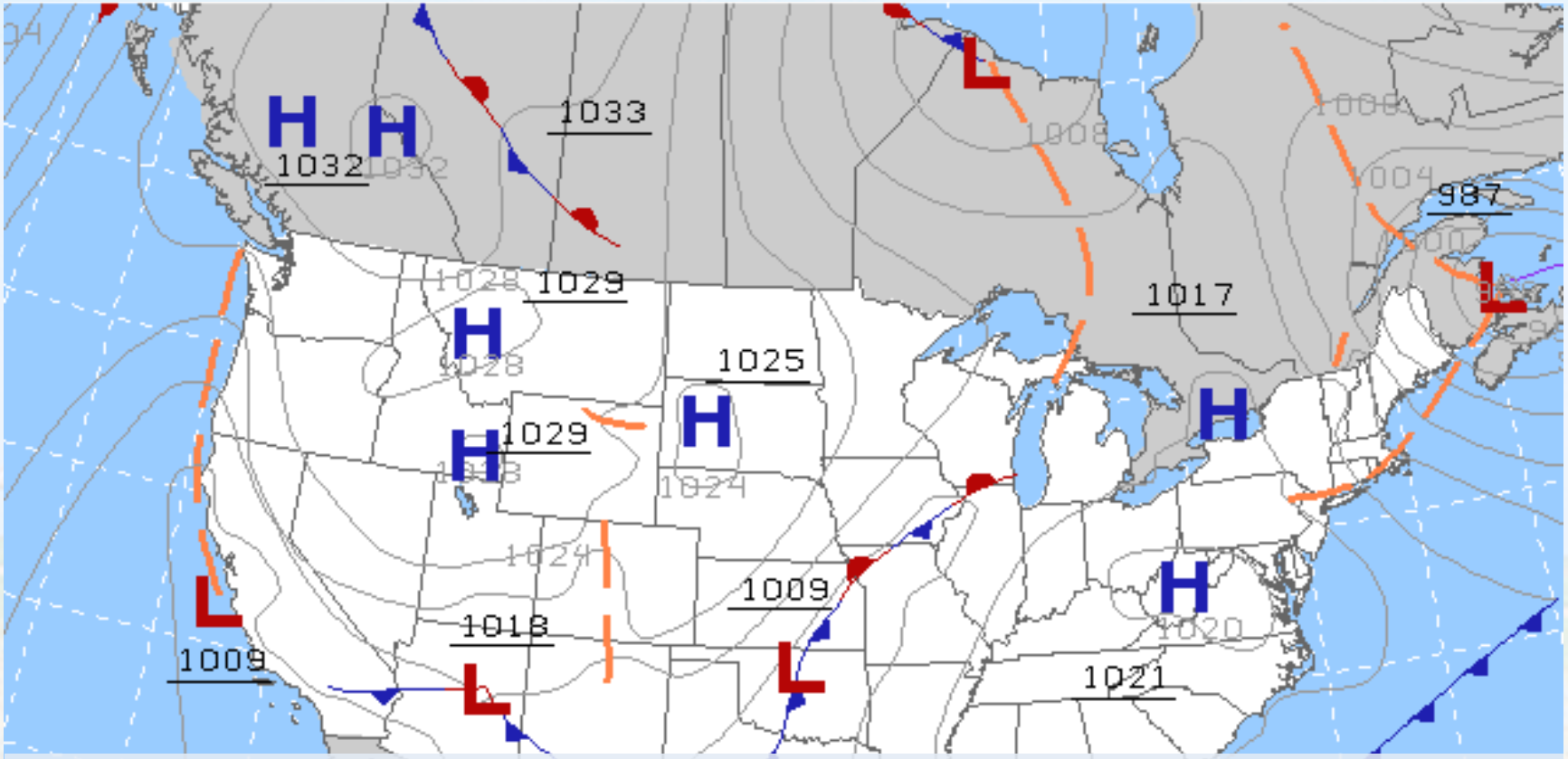



Cold air flows like water and
will move down into
valleys and basins

Cold air moves into a low lying pasture

Moisture in the air condenses and creates fog..

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



Excellent ingredients for inversion formation

Humidity

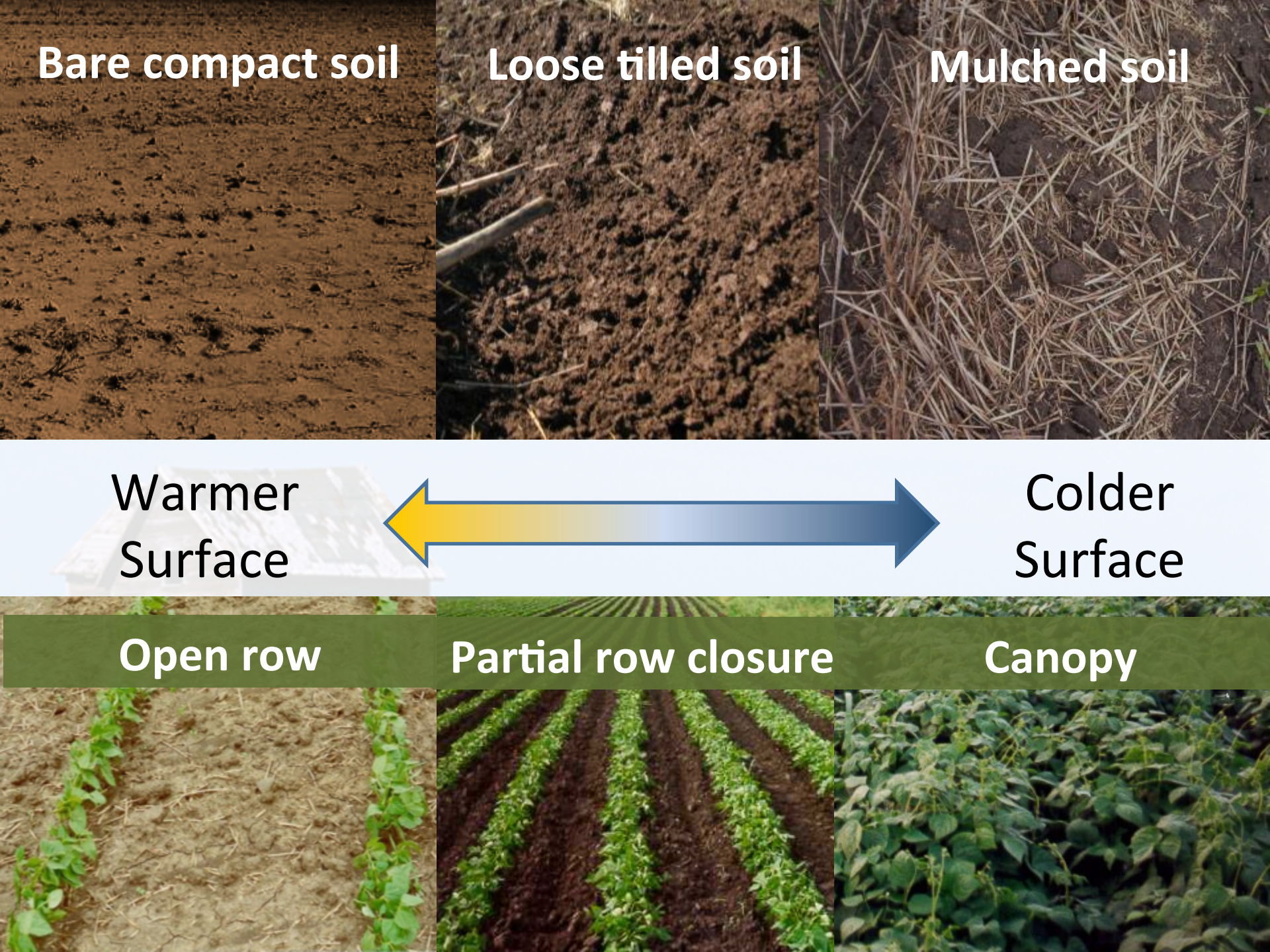
High humidity rainforest

Low humidity desert

- inversion builds faster
- intensity is greater
- dissipates faster

Surface conditions making matters worse

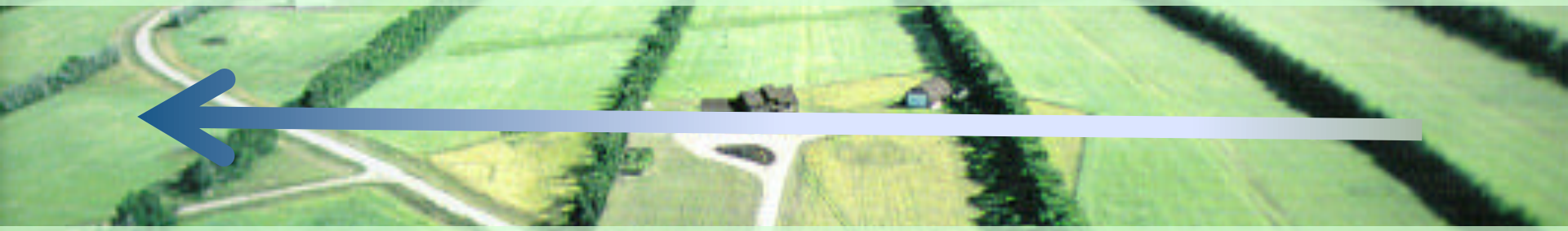
- Exposed soil that:
  - Has a low moisture content
  - Is sandy or coarse textured
  - Has been freshly tilled
- Soil that is heavily mulched and/or covered with heavy crop residue
- Closed crop canopy and or complete vegetative ground cover
- Wind breaks and/or shelter belts


Bare compact soil
Loose tilled soil
Mulched soil
Warmer Surface
Colder Surface
Open row
Partial row closure
Canopy

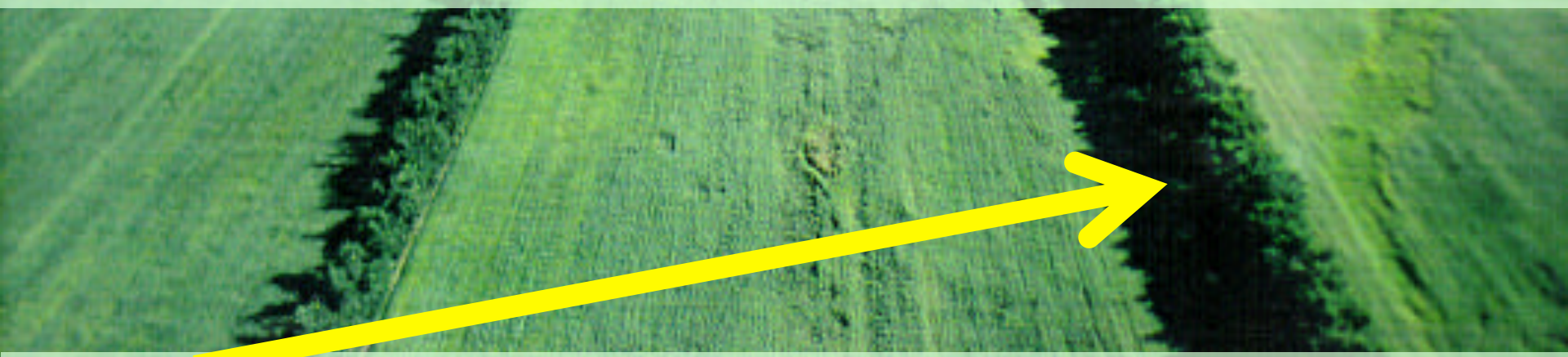
Open row
surface
temperature
slightly colder than
bare ground

Closed row
surface
temperature
much colder than
bare ground

Wind Breaks



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

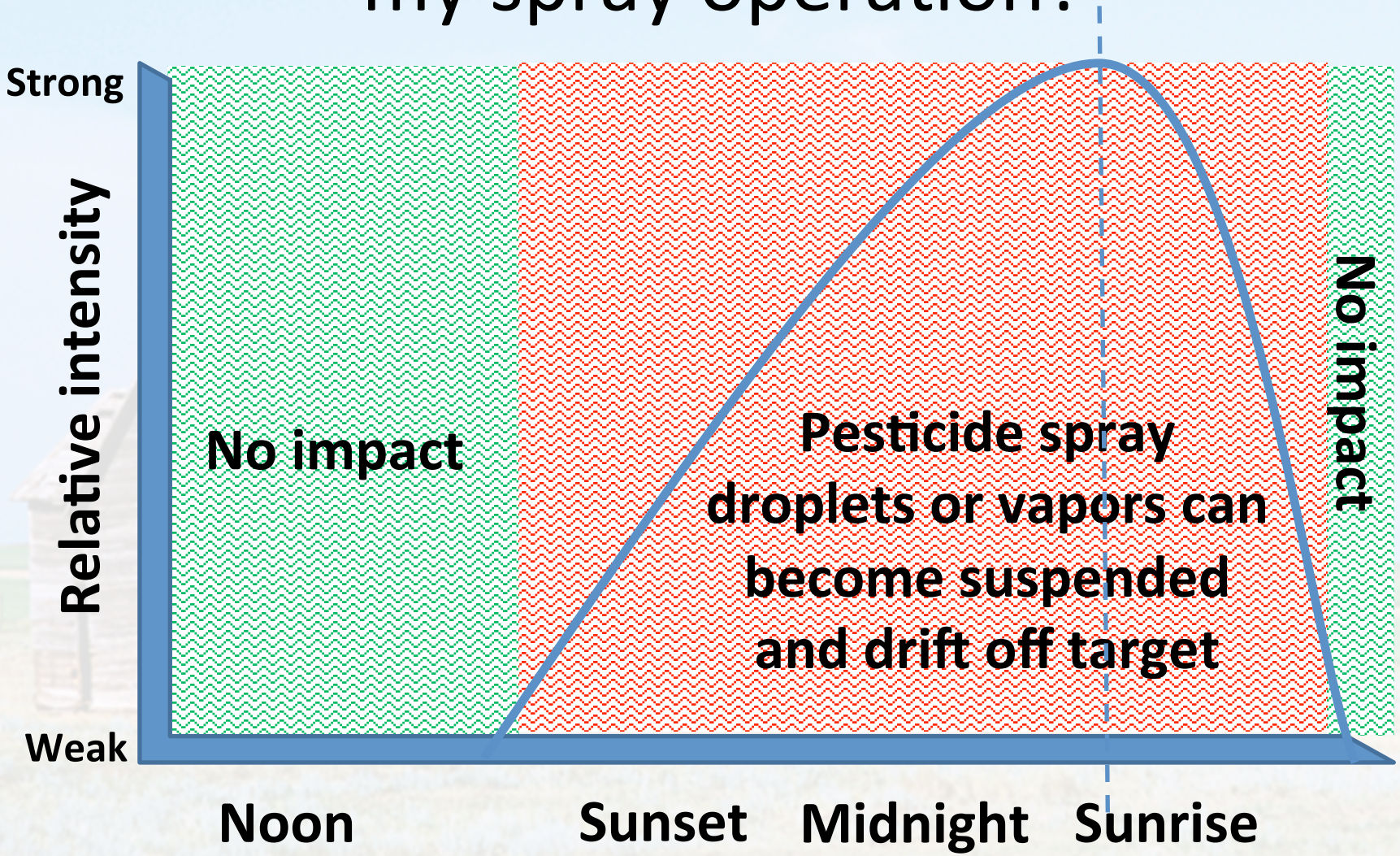


Tree shadow causes inversion earlier in the afternoon and will prevent dissipation longer into the morning

Late Afternoon / Evenings

Mornings

When will an inversion impact my spray operation?



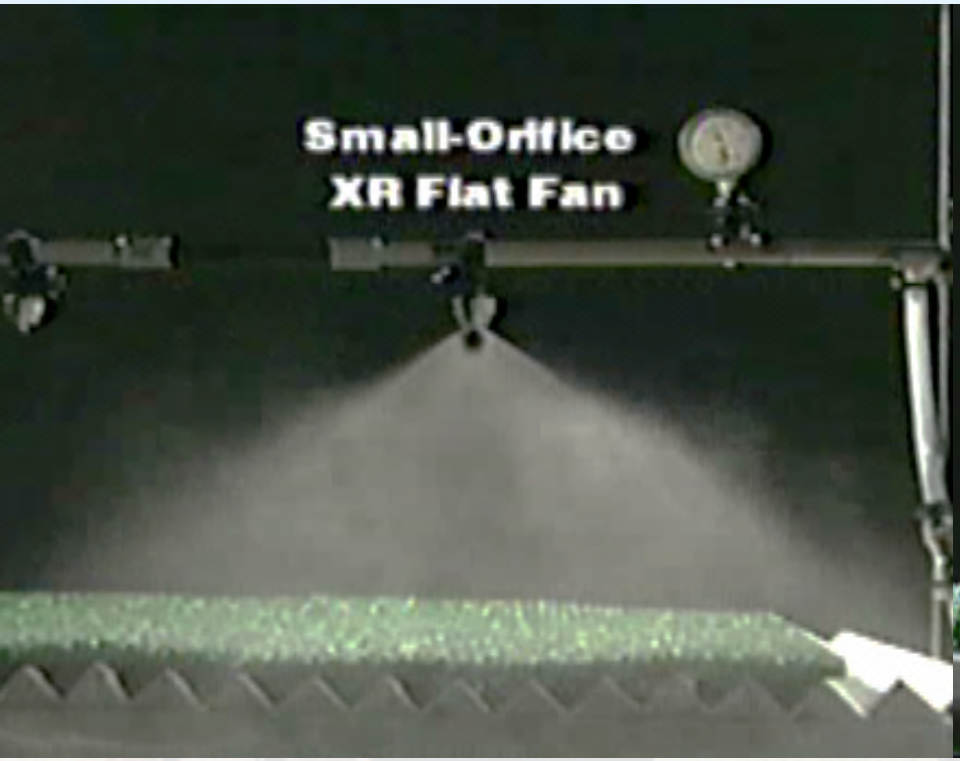
Exceptions

Stagnant air conditions, inversions may not dissipate for days

What happens when I spray during an inversion?

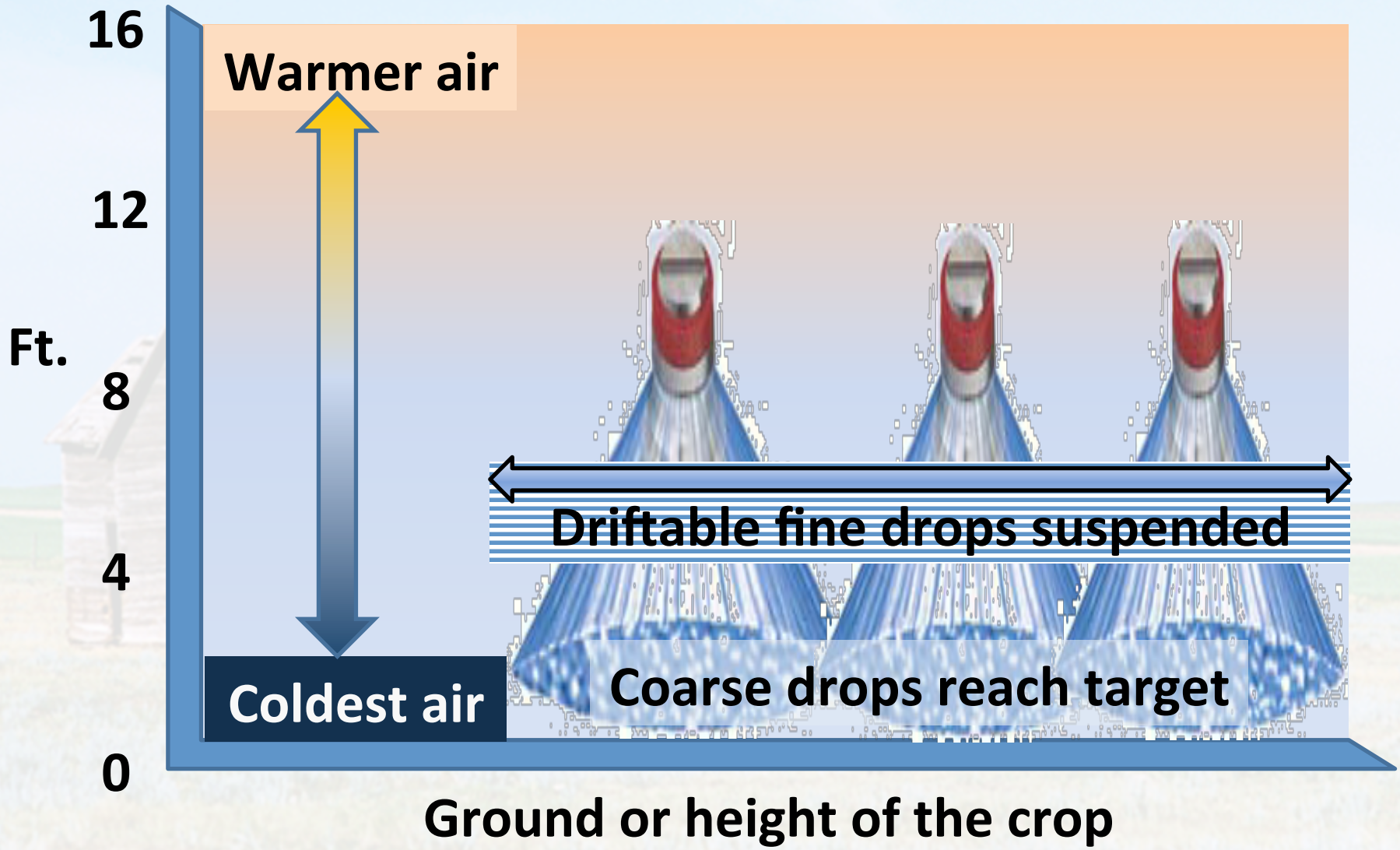
It depends on the type of application and the inversion intensity.

Physical Drift & Fine Drops



High percentage of fine drops is never good, but they are especially bad in an inversion.

Spraying during an inversion = trapping of fine droplets




Dust particles hang in the air
Visible dust particles are about
200 microns in size

Fine spray drops hang in the air

Tracer dye, late afternoon spray, conducted in early May

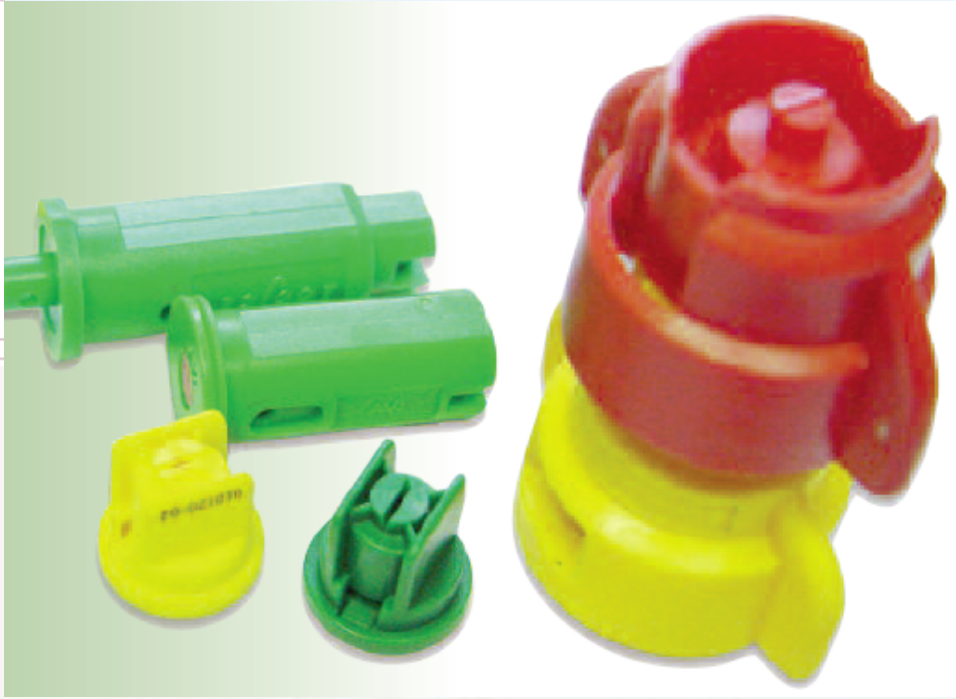
Fine pesticide laden droplets move off target

Create the best droplet pattern possible with the right nozzle

CP-06

CP-01-3

CP-03



Operate them based on the nozzle manufacturer's specifications!

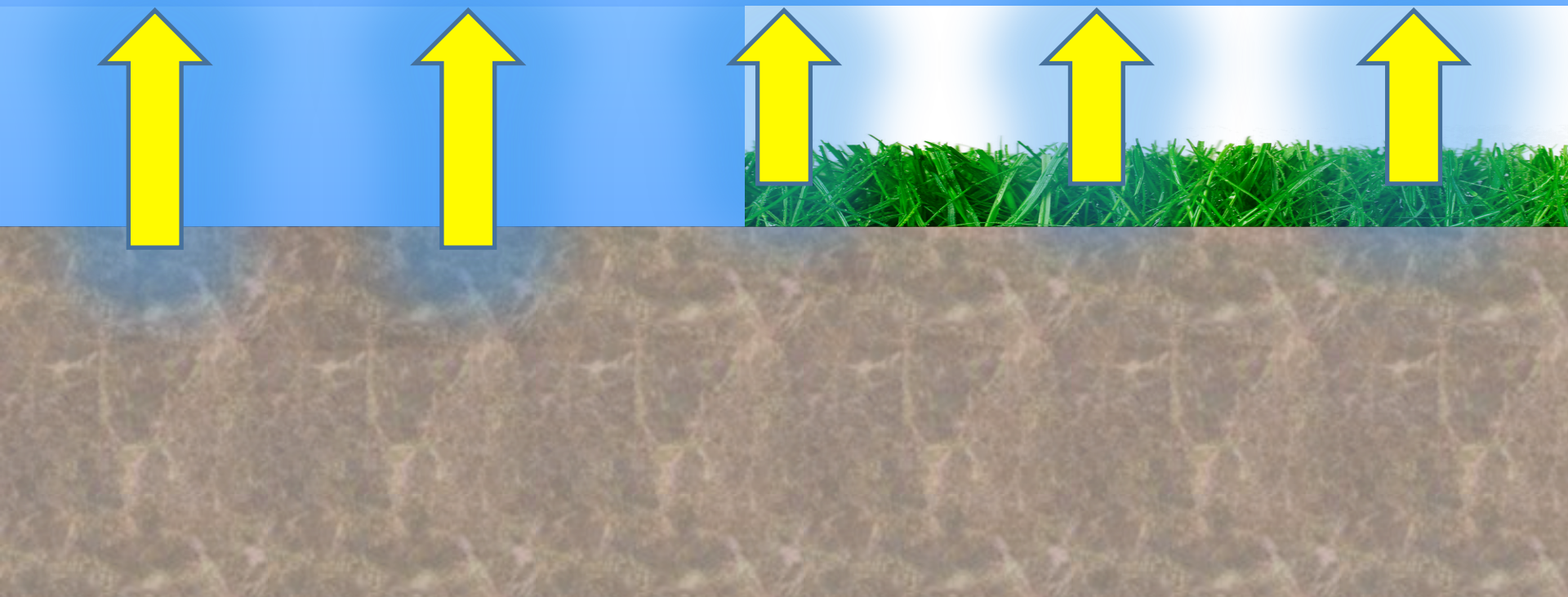
Be wary of pesticides that are sensitive to vaporization

But then vaporizes or gasses off during or after application

Vaporization of pesticide from the soil or foliage during an inversion

Light wind moves pesticide down range

Cold air trapped vapors near surface



While the actual A.I. may not be volatile, solvent odors can be

Clues

You can smell them


Dust from vehicles or farm machinery will hang in the air

You can hear them

The newsletter of
The Acoustical Society of America

ECHOES

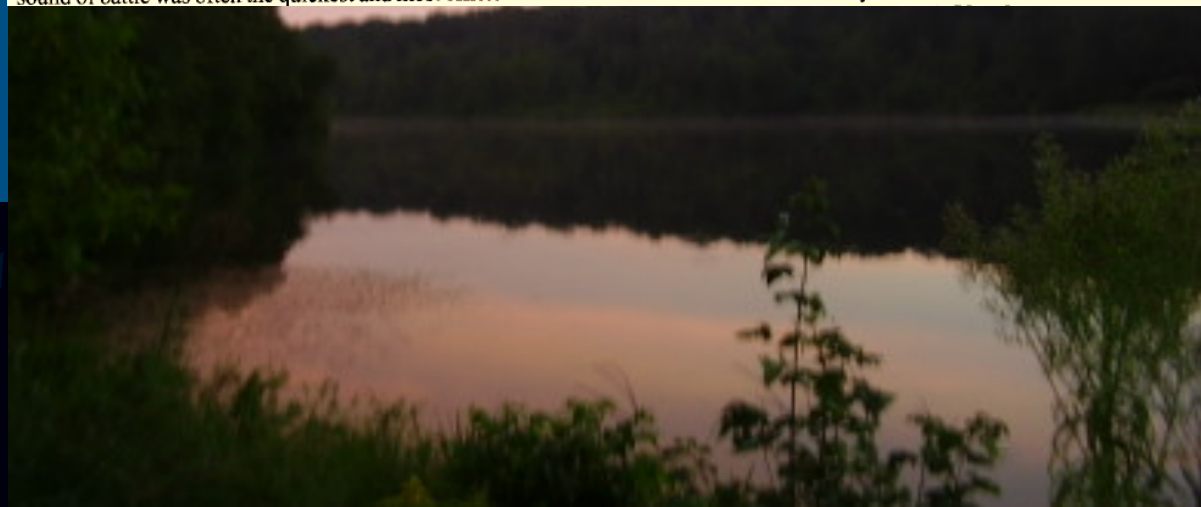
Volume 9, Number 1
Winter 1999

Outdoor Sound Propagation in the U.S. Civil War

by Charles D. Ross

Students of military history know that acoustic refraction and unusual audibility have often played significant roles in the outcome of battles. Before electrical and wireless communications became common on the tactical level, the sound of battle was often the quickest and most efficient method

entire war. The unusual acoustics at Seven Pines placed Confederate commander Joseph Johnston in a position of danger when the battle should have been over. Because of Johnston's wound, Robert E. Lee assumed command of the Confederate forces two days later.



A Perfect ***Inversion*** Storm

1. Requires radiation from surface objects into a cloudless or near cloudless sky
   - 25% or less cloud cover
2. Requires light and variable winds with minimal mixing of the lower atmosphere.
   - Especially 0 to 3 mph
   - Remain cautious with winds of 4 to 6 mph

A Perfect ***Inversion*** Storm

3. Begins in the mid to late afternoon and intensifies throughout the night until dawn. (The inversion will then dissipate into mid-morning.)
   - Especially 3-5 hours before sunset
   - Especially 2-3 hours after sunrise

A Perfect ***Inversion*** Storm

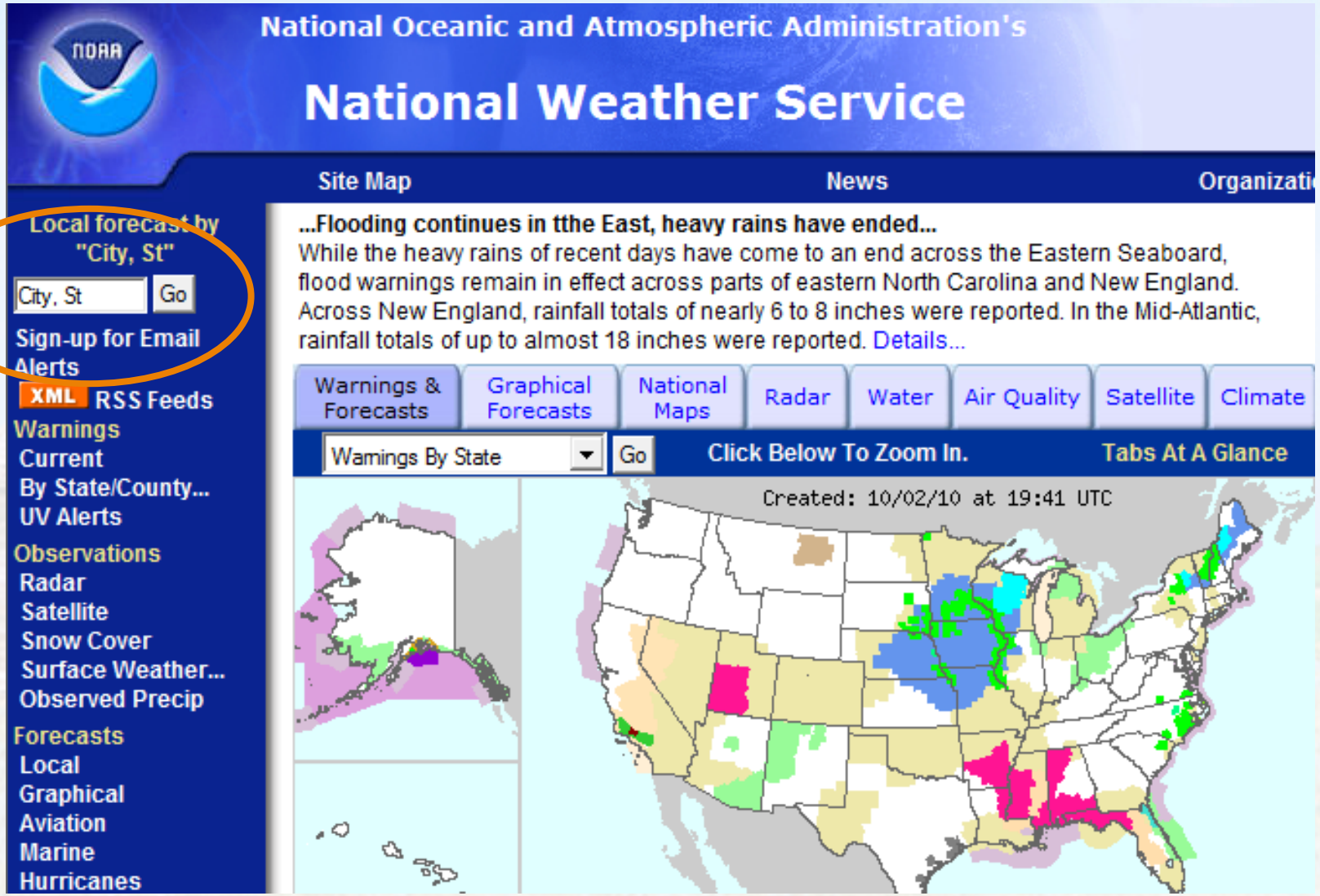
4. Includes an unsuspecting applicator who does not recognize there is a problem:
   - Applicator who has been shut down for several days (due to high winds) and is desperately looking for an opportunity to spray
   - Applicator who has been spraying for many hours and loses track of weather conditions, especially in the late afternoon / early evening

Late afternoon / evening spraying

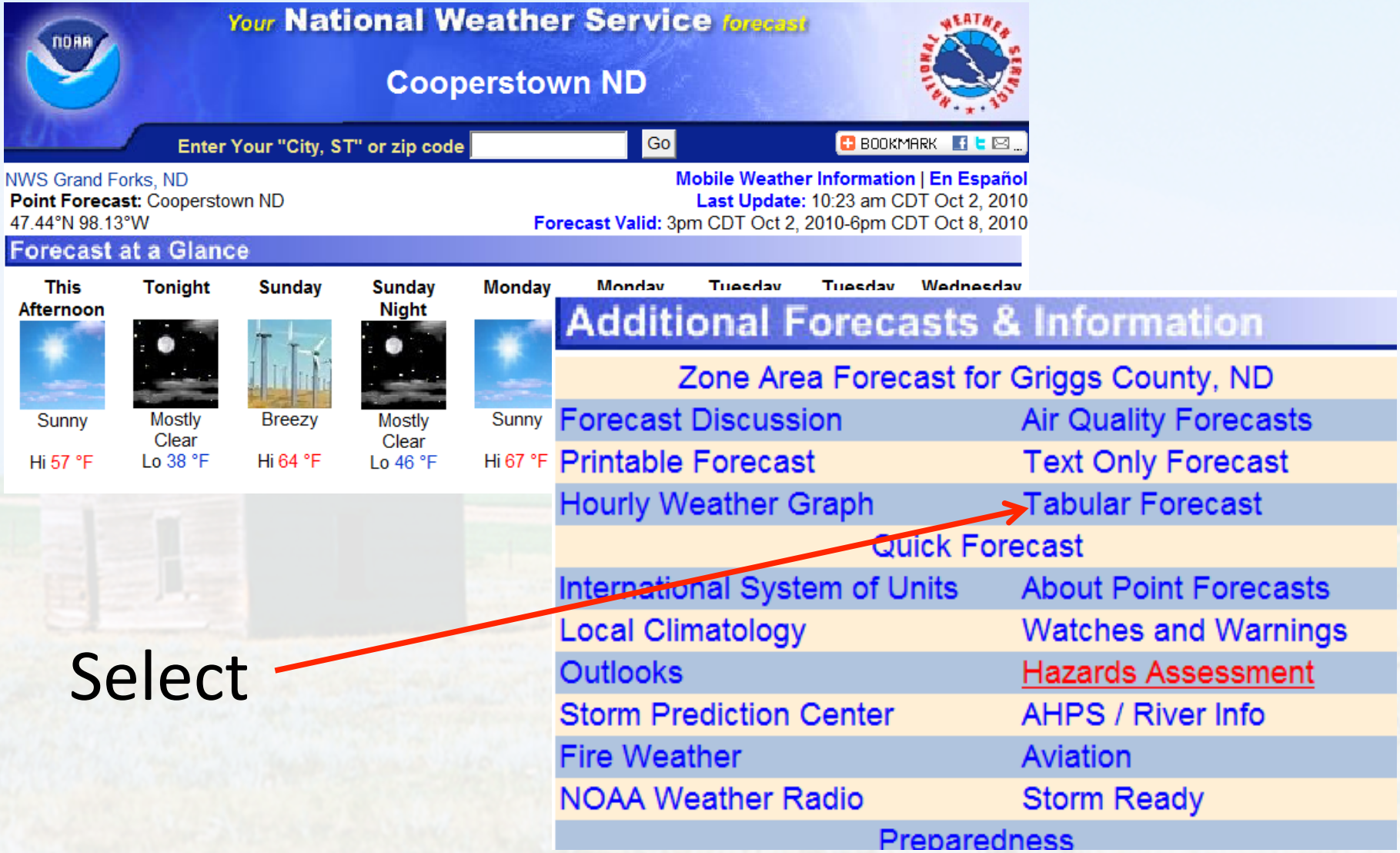
NOAA Tabular Weather Forecast for Sioux, Falls, SD

Date	10/02				10/03														
Hour (CDT)	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10
Temperature (°F)	58	58	57	56	51	48	45	41	39	38	37	36	35	35	34	34	35	37	40	44
Dewpoint (° F)	36	36	35	35	35	35	35	35	34	34	34	33	32	32	31	31	32	33	35	36
Wind (mph)	8	7	6	5	3	2	2	2	2	2	2	2	2	1	1	2	3	5	7	9
Wind Dir	NE	NE	NE	ENE	ENE	E	E	ESE	ESE	SE	SSE	SSE	SE	SE	SE	SE	SE	SE	SSE	SSE
Gust																				
Sky Cover (%)	38	36	30	24	18	12	6	0	0	0	0	0	0	0	0	0	0	0	0	0
Rel. Humidity (%)	44	43	44	46	53	60	69	78	81	85	89	89	88	89	88	88	89	86	82	74

www.weather.gov



Scroll Down & Select Tabular Forecast



Select

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 10 ft. for NDAWN (NDSU 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

Smoke hangs in the air and does not dissipate or rise

Aerial applicators can apply oil to the engine manifold to generate smoke. Observation of the smoke cloud can indicate inversion conditions.

Need to observe local conditions

Environmental conditions making matters worse

- Topography—low lying area or a protected area shielded from the sun and / or wind.
- Stagnant and / or intense high pressure system
- Relatively low humidity conditions

Surface conditions making matters worse

- Exposed soil that:
  - Has a low moisture content
  - Is sandy or coarse textured
  - Has been freshly tilled
- Soil that is heavily mulched and/or covered with heavy crop residue
- Closed crop canopy and or complete vegetative ground cover
- Wind breaks and/or shelter belts