

Temperature Inversions: Their Impact On Pesticide Applications

When spraying with a 2 mph
wind is worse than 20 mph

NDSU Extension Service
**PESTICIDE
PROGRAM**



NDSU
Extension Service

**Presentation will be released to
AAPSE Members:**

First Half October, 2012

- * Will include the PPTX
- * Will include narrated PPTX video clips

Helicopter application of glyphosate

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

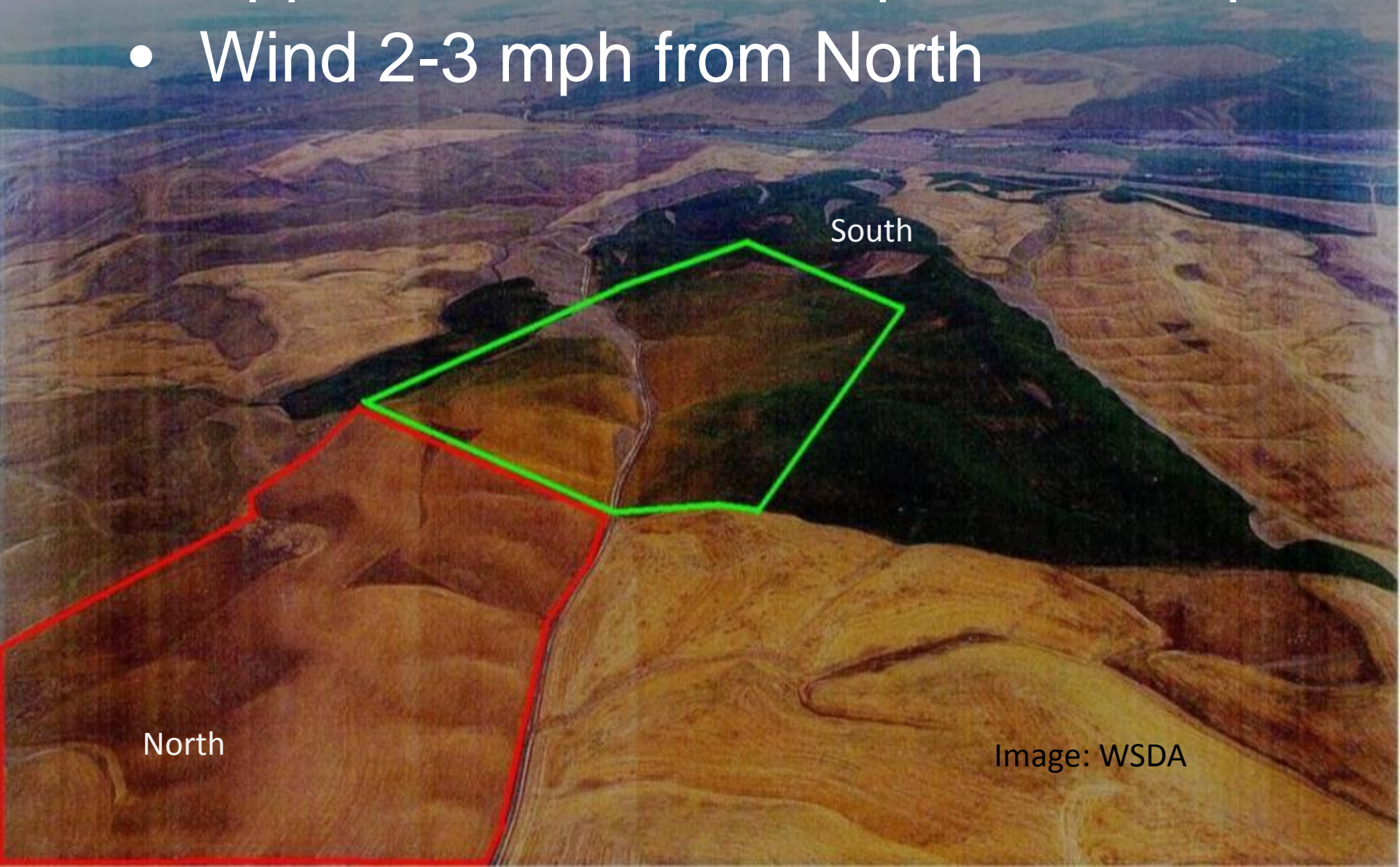


Image: WSDA

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.

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

David Bennett

Aug. 11, 2006 4:00pm

RSS  Comments  0

PRINT

SAVE

EMAIL

SHARE

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.

Advertisement

[Herbicide Application](#)

Review Tank Mixing and Application Instructions for Everest® Here www.flushafterflush.com

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.

This is *likely* a combination of physical drift & vapor drift (the spray droplets reach the target but then vaporize off the foliage or soil and then become trapped in a cool air inversion layer and move off target).

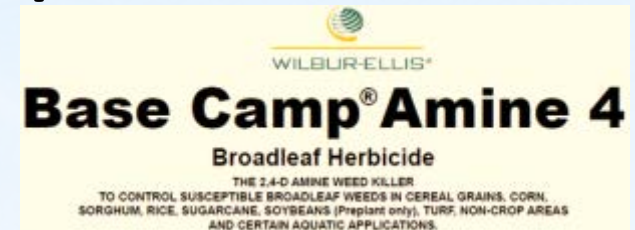
Recognizing and dealing with an inversion is a label requirement

“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.

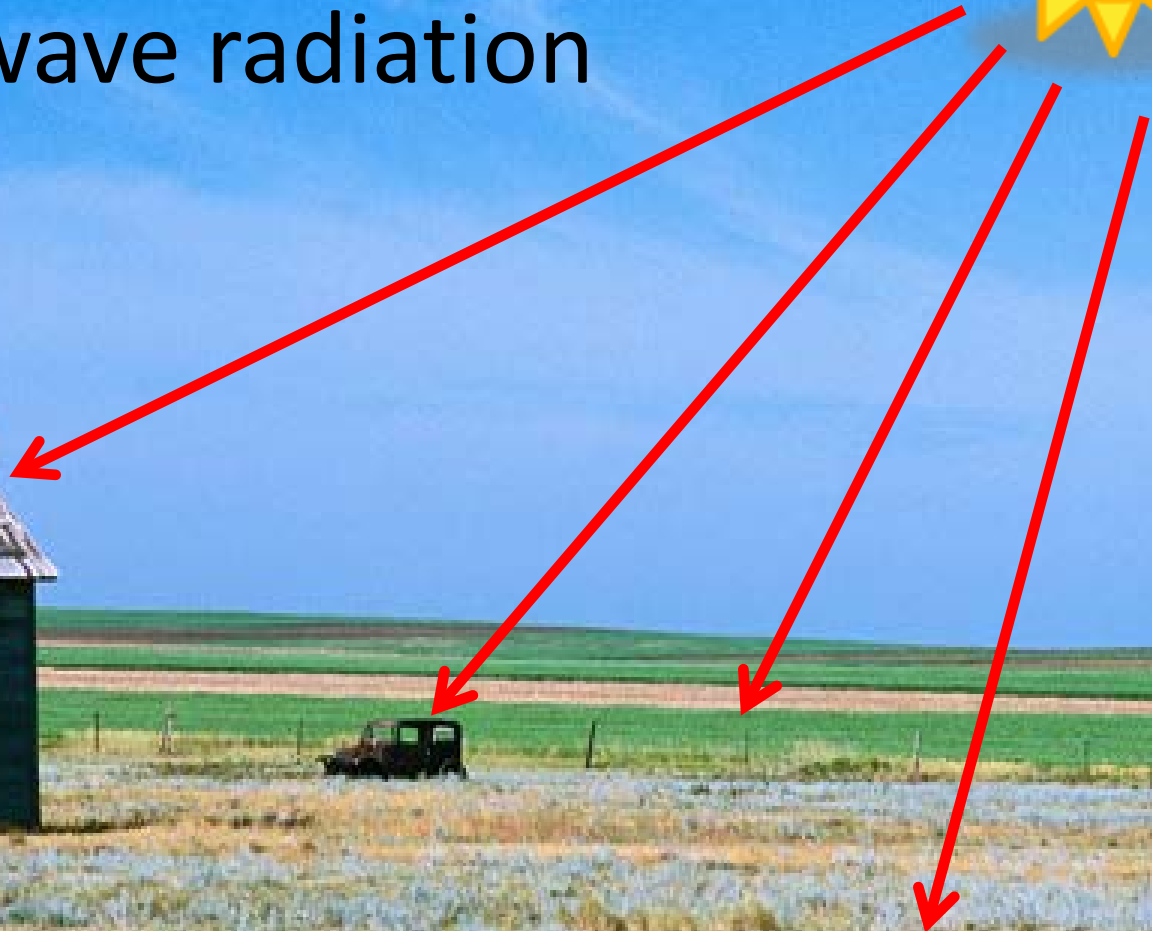
Do not make applications into areas of temperature inversions or stable atmospheric conditions.”



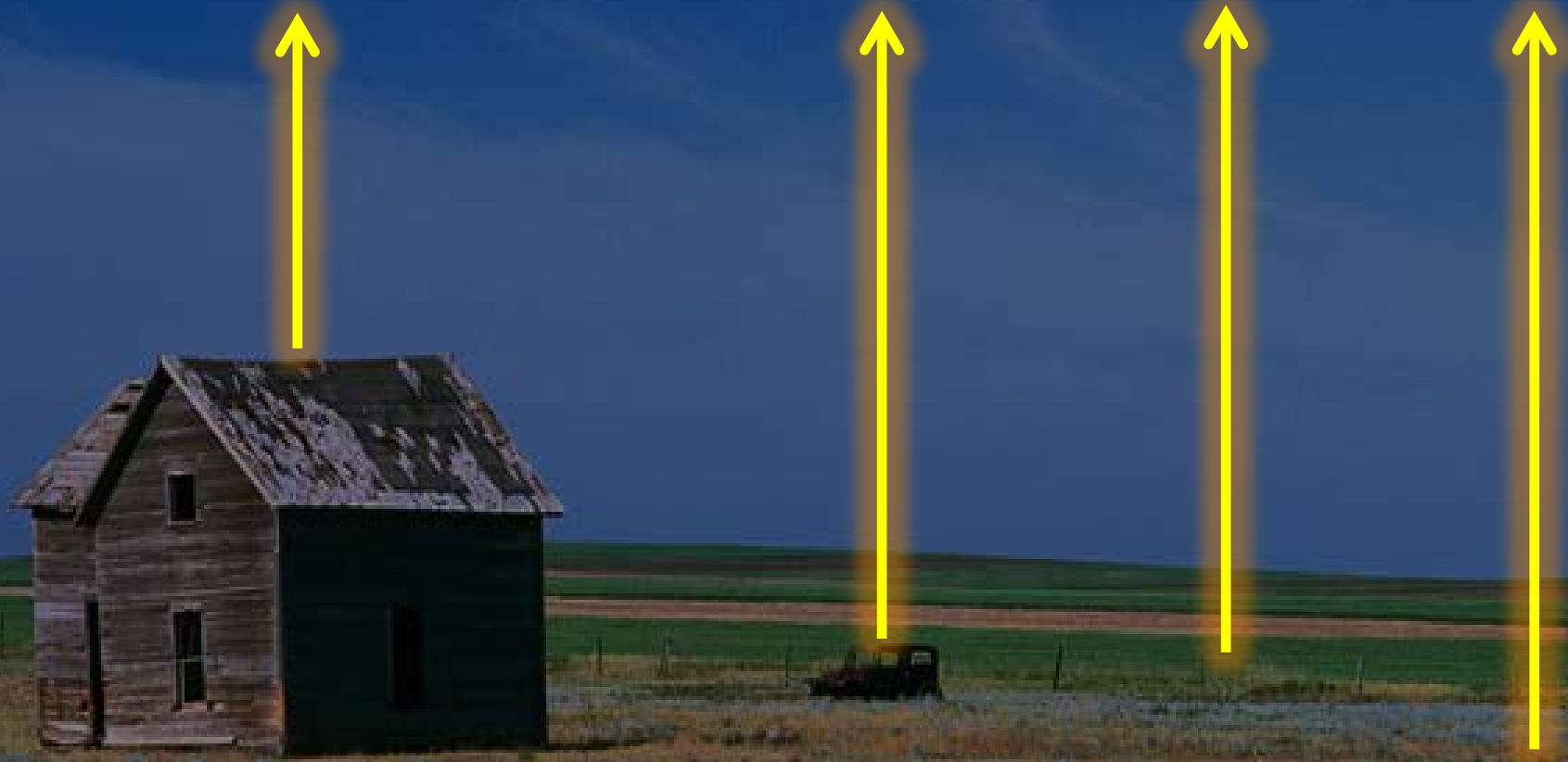
Inversion + Soil Fumigants = Hundreds Evacuated, Dozens Hospitalized



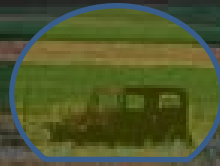
Short wave radiation



Long wave radiation



Radiation waves from objects
move in all directions into the air



Radiation into
atmosphere heats the air

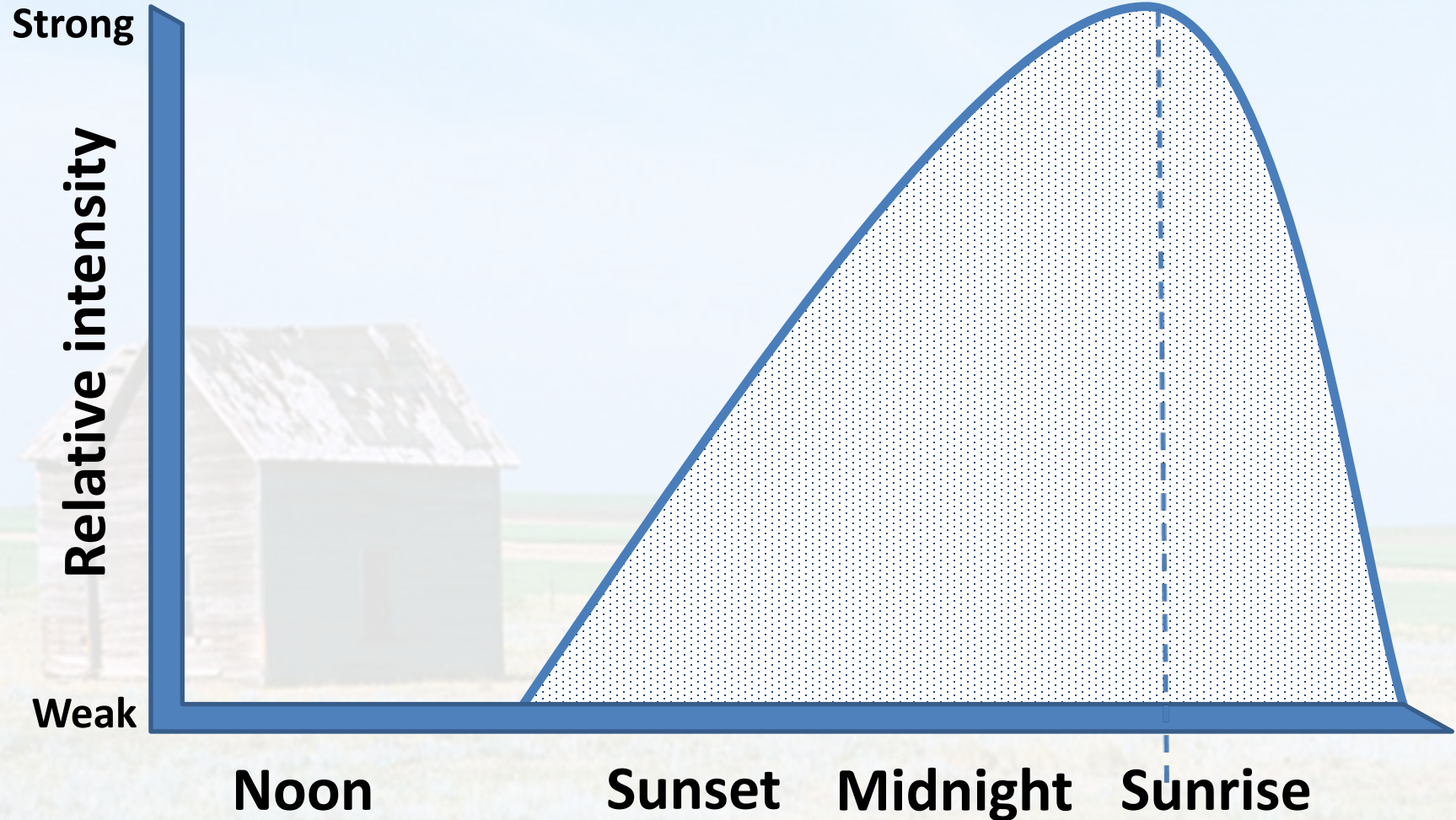
Warmer

Objects lose heat,
cool the air near the
earth surface

Coldest



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



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

NDSU Weather Data—Courtesy of John Enz, Professor Emeritus

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

Estimated!



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.



Warm air

Cold air

Temperature =

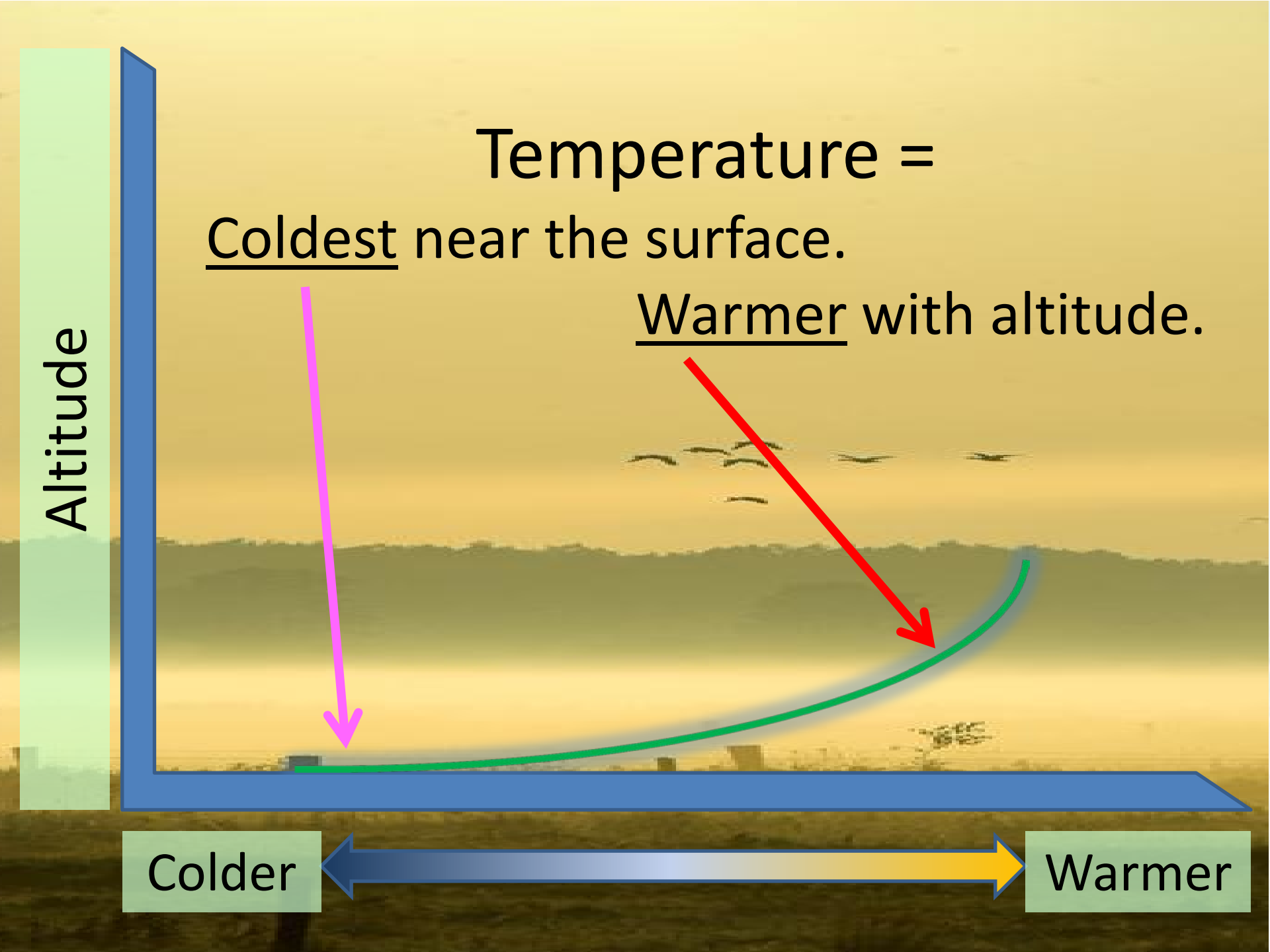
Coldest near the surface.

Warmer with altitude.

Altitude

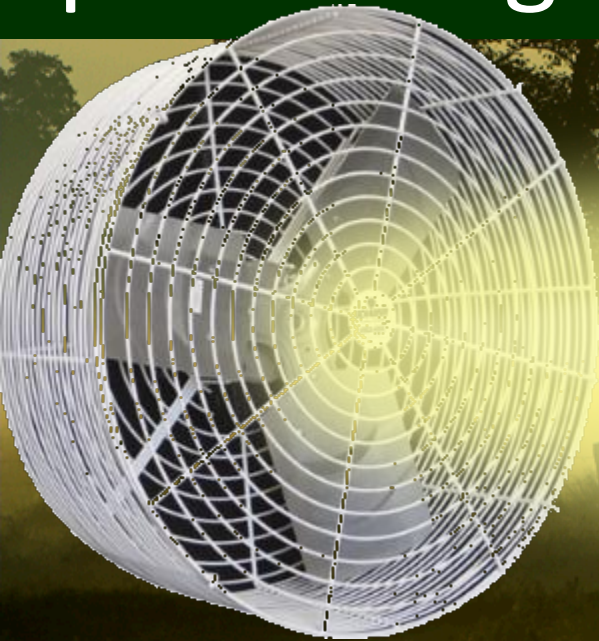
Colder

Warmer

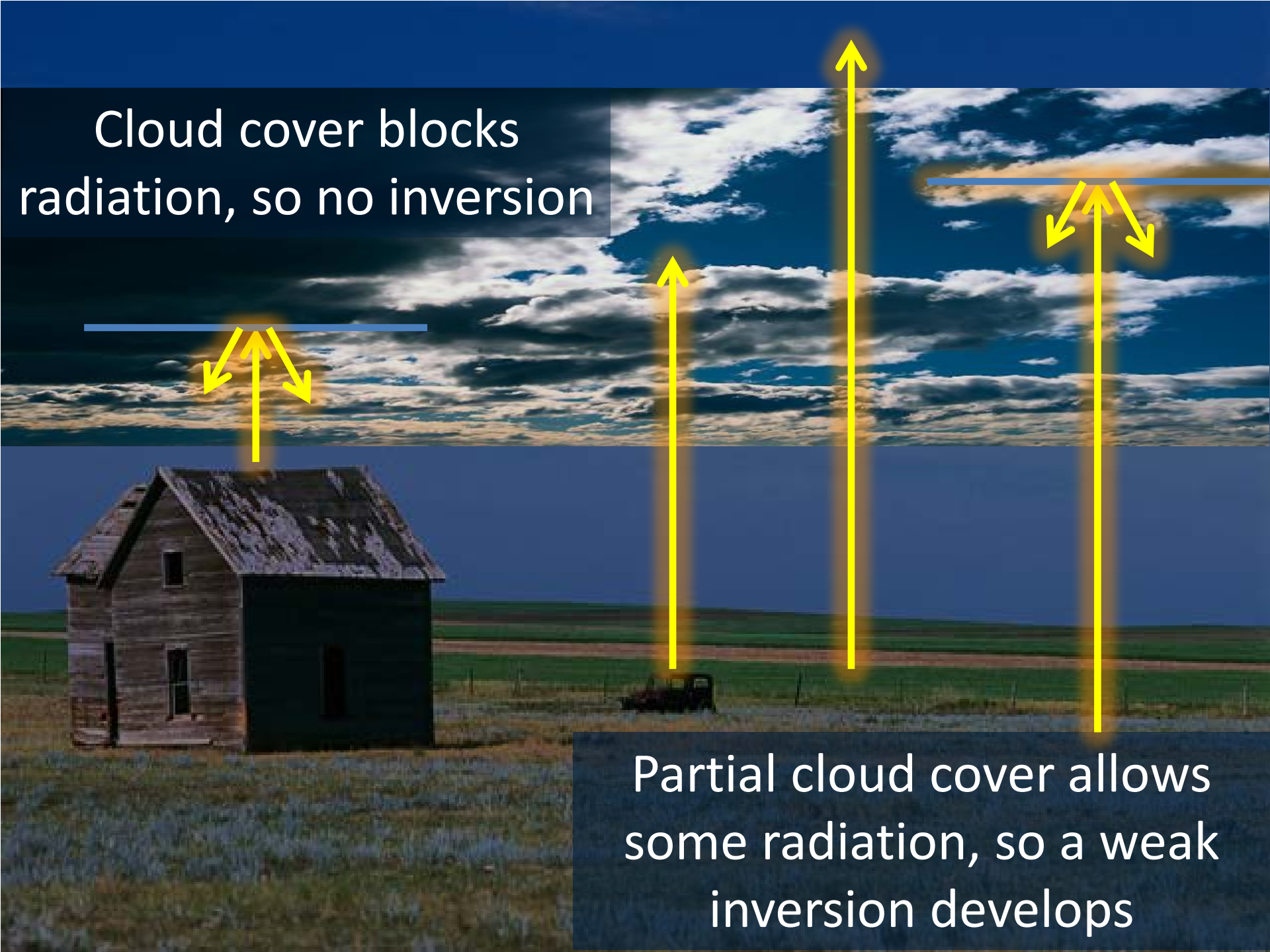


All the conditions we've talked about
assumes very little wind.

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

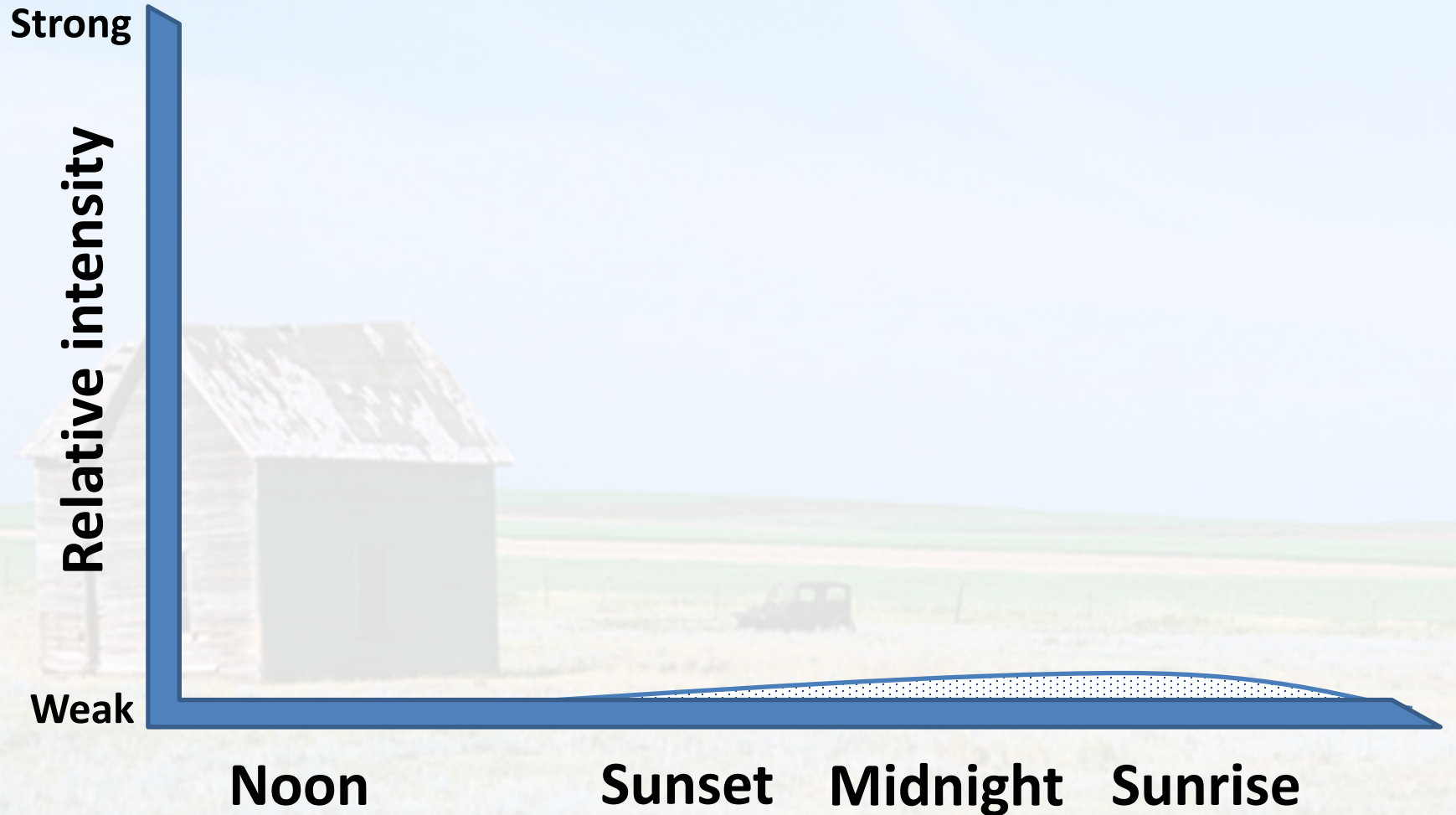


Cloud cover blocks radiation, so no inversion



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

18th Hole

92.5 degrees F at 60 inches or 5 feet

93.4 degrees F at 39 inches or 3.25 feet

94.3 degrees F at 24 inches or 2 feet

95 degrees F at 12 inches or 1 foot

95.8 degrees F at 4 inches

NDSU Weather Data—Courtesy of John Enz, Professor Emeritus

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

18th Hole

40.7 degrees F at 60 inches or 5 feet

40.4 degrees F at 39 inches or 3.25 feet

40.3 degrees F at 24 inches or 2 feet

40.1 degrees F at 12 inches or 1 foot

40 degrees F at 4 inches

Estimated!

There's more to come
so hang on!



Inversions that
cause problems
for pesticide
applicators are
like:



*The
Perfect
Inversion Storm*

GEORGE
CLOONEY

MARK
WAHLBERG

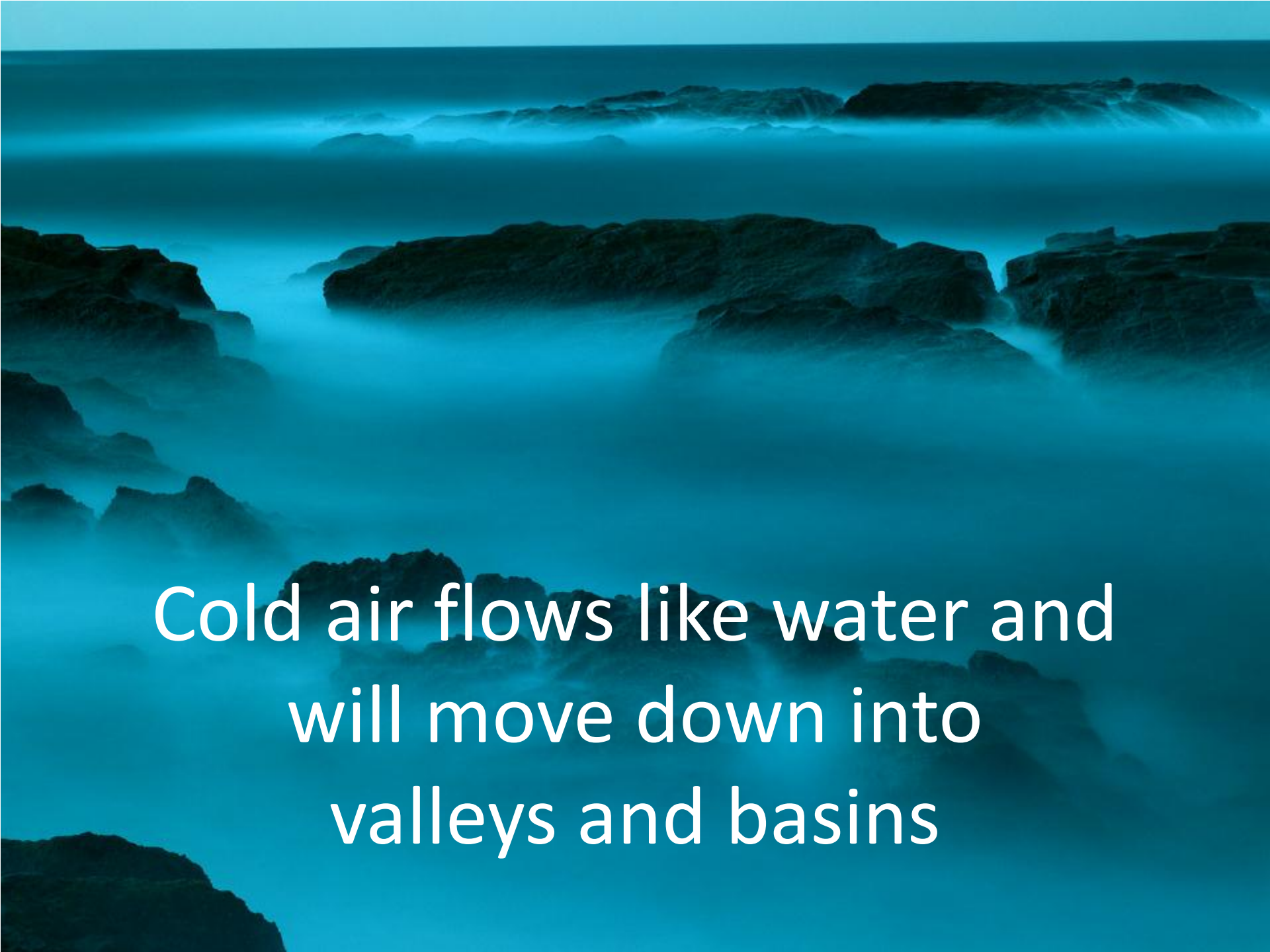


In the Fall of 1991,
the *Andrea Gail* left Gloucester, Mass.
and headed for the fishing grounds
of the North Atlantic.

Two weeks later, an event
took place that had never occurred
in recorded history.

LIFESIZE PICTURES

THE
PERFECT STORM



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

Cold air moves into a low lying pasture

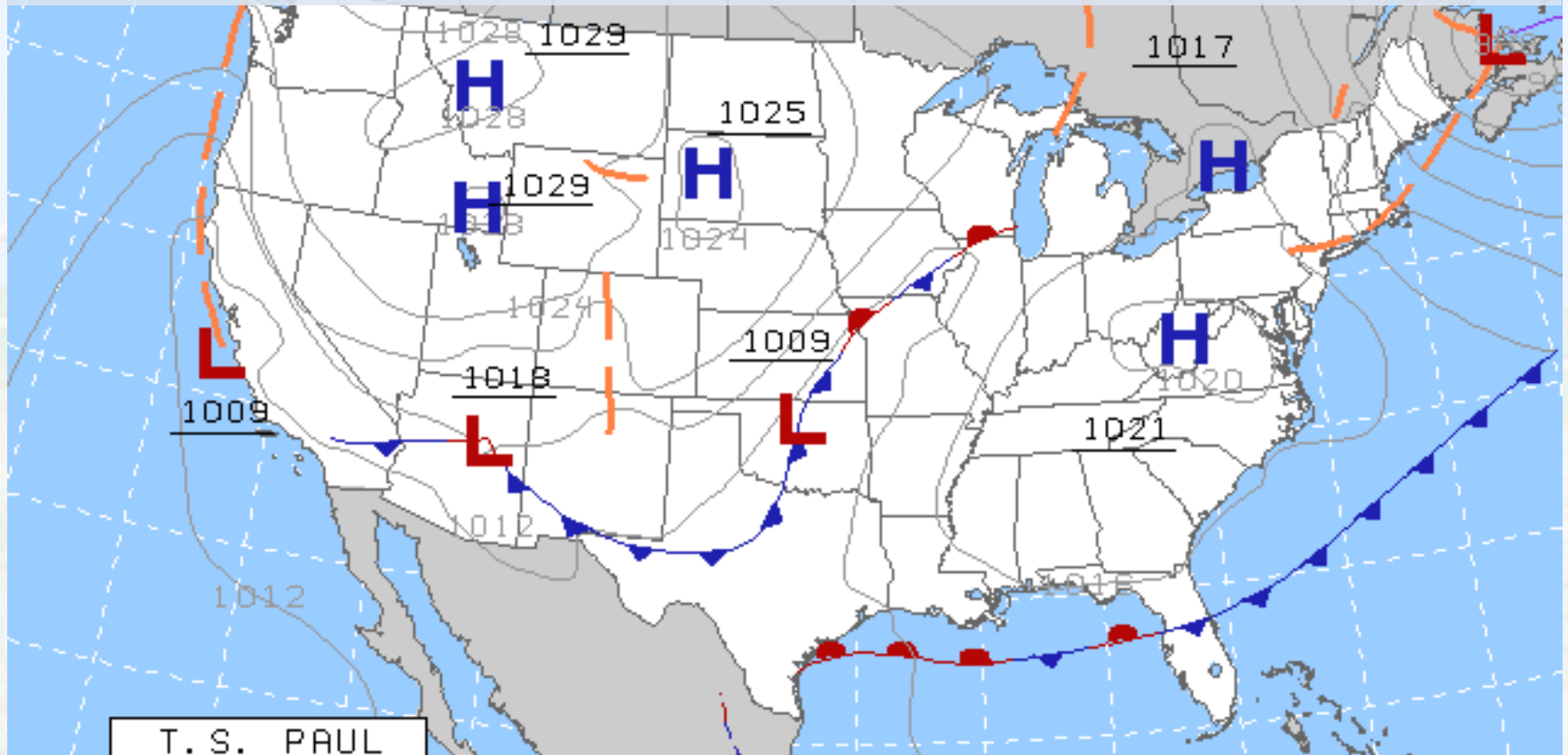


Cold air moves into a low lying ditch



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

Excellent ingredients for inversion formation

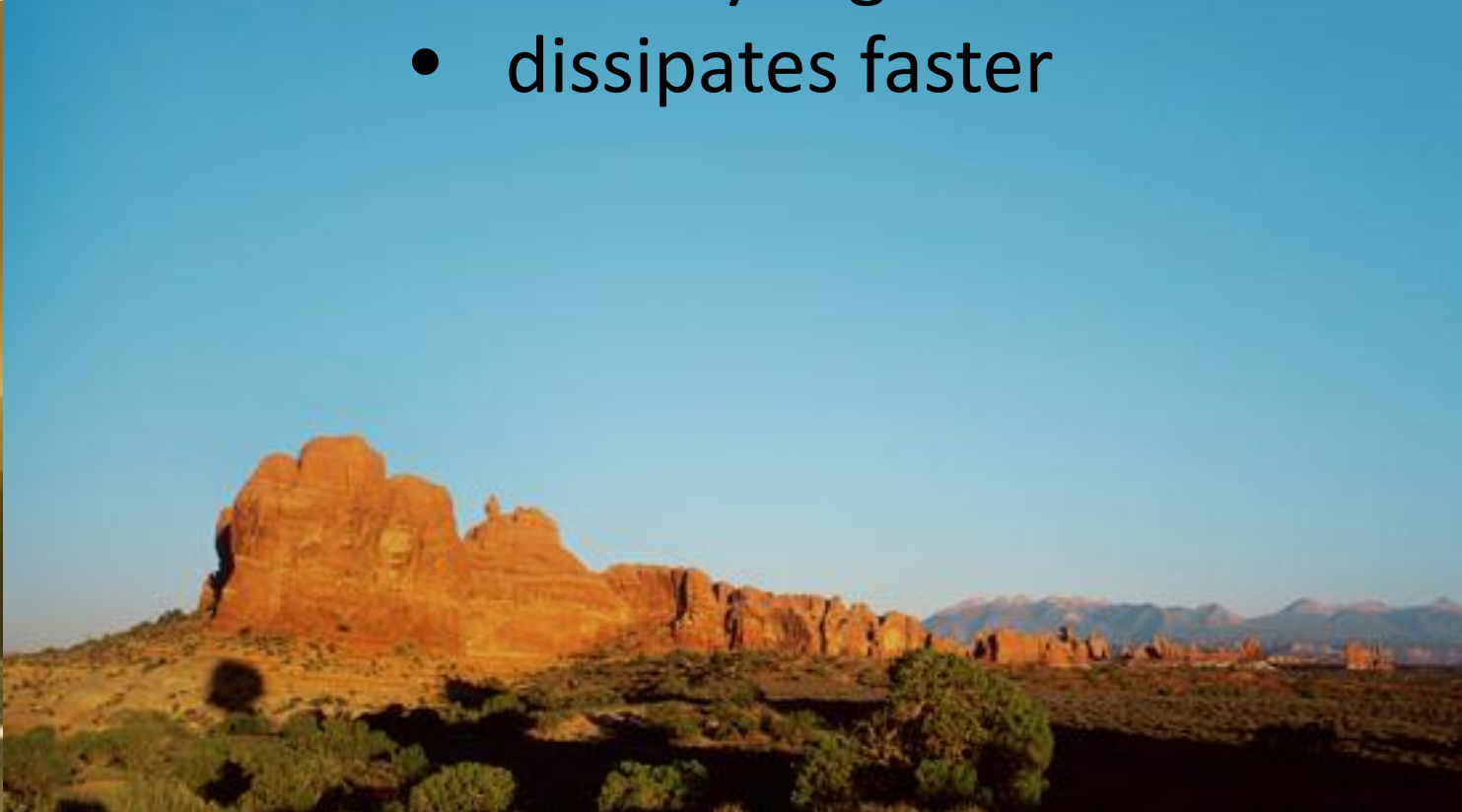


Humidity

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

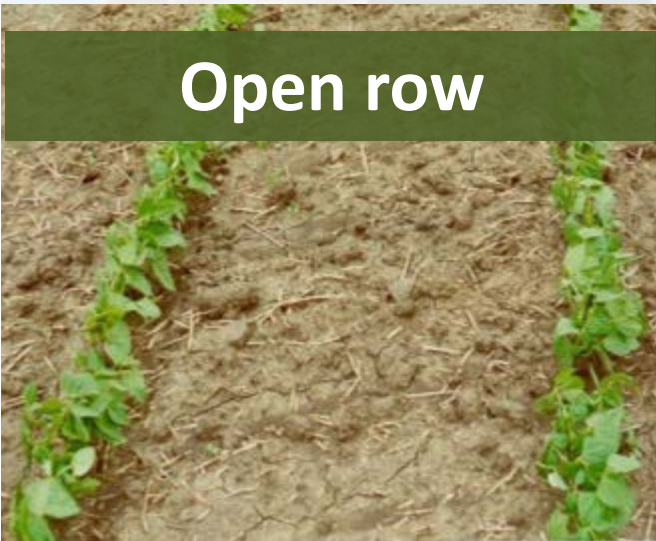


**Warmer
Surface**



**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



What about time of the day?



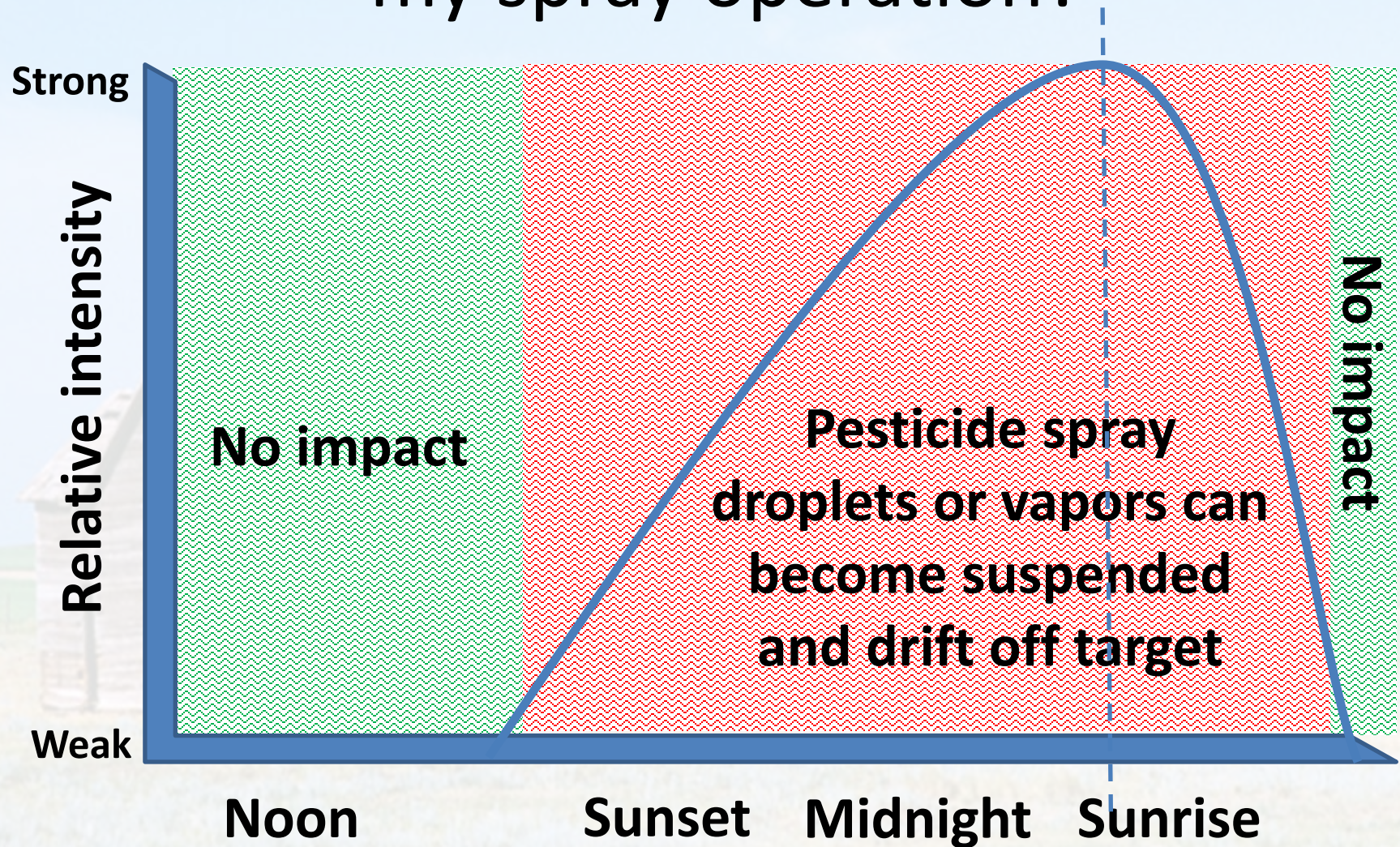
Late Afternoon / Evenings



Mornings



When will an inversion impact my spray operation?



Exceptions

Stagnant air conditions, inversions may not dissipate for days



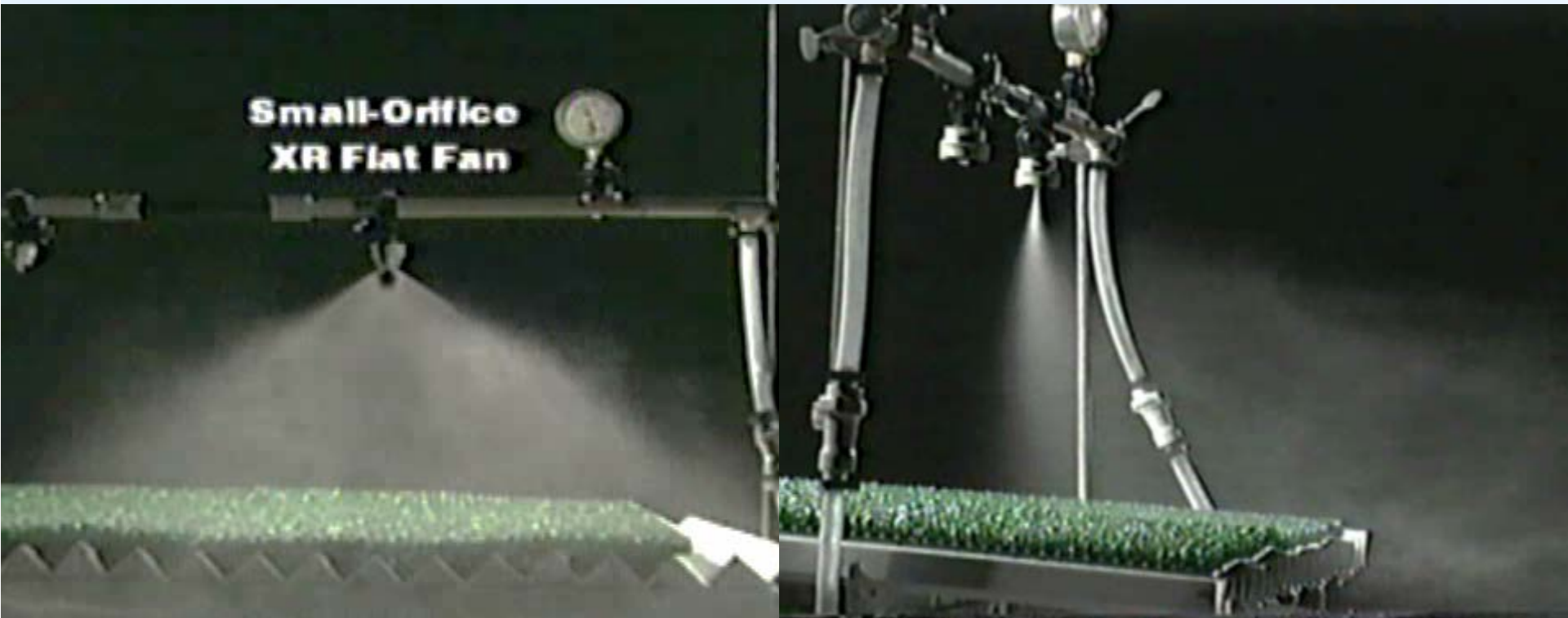


What happens
when I spray
during an
inversion?

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.

Demonstration sprayer



Drift reduction
nozzles



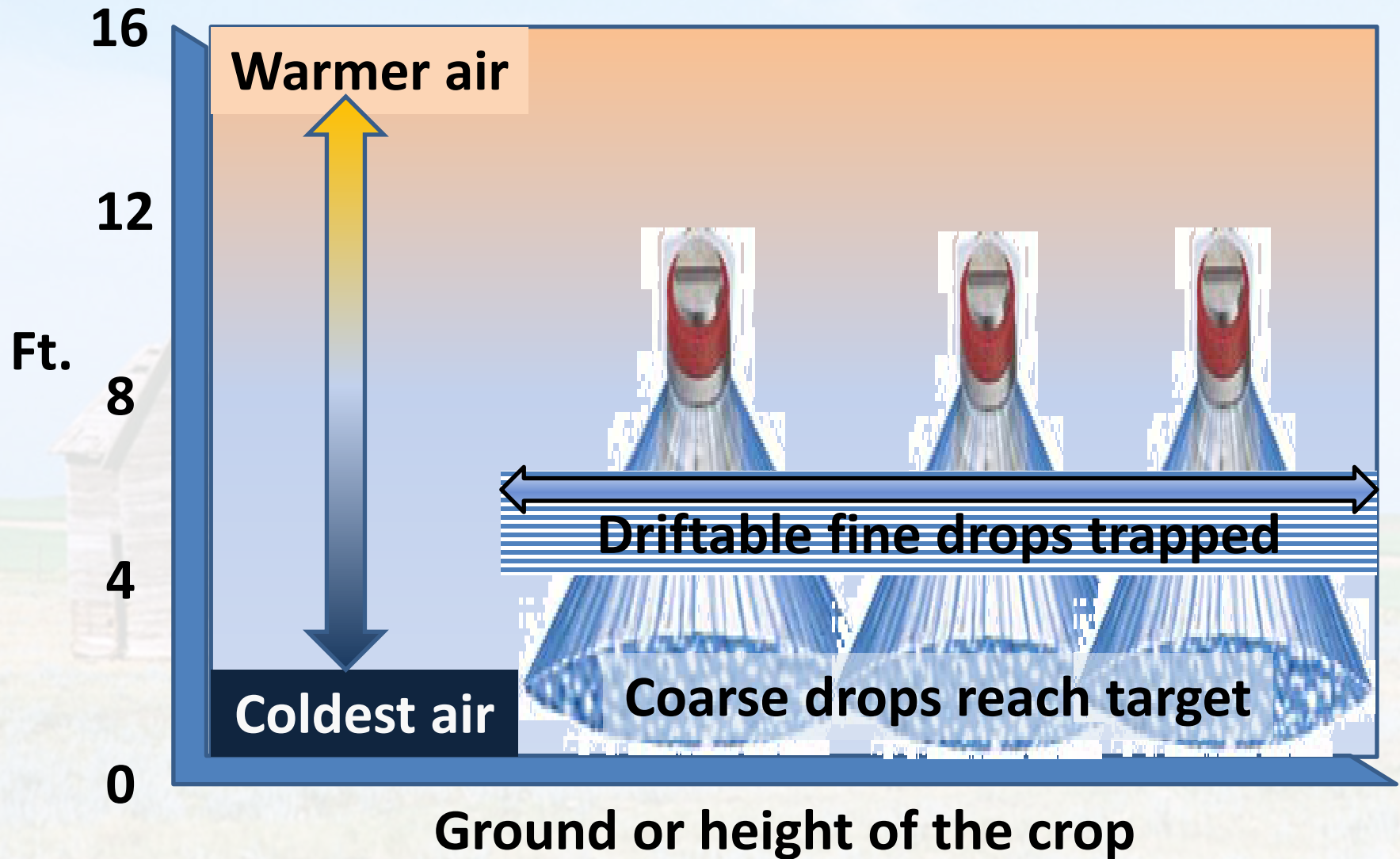
Note fine drops
misting off of the
boom



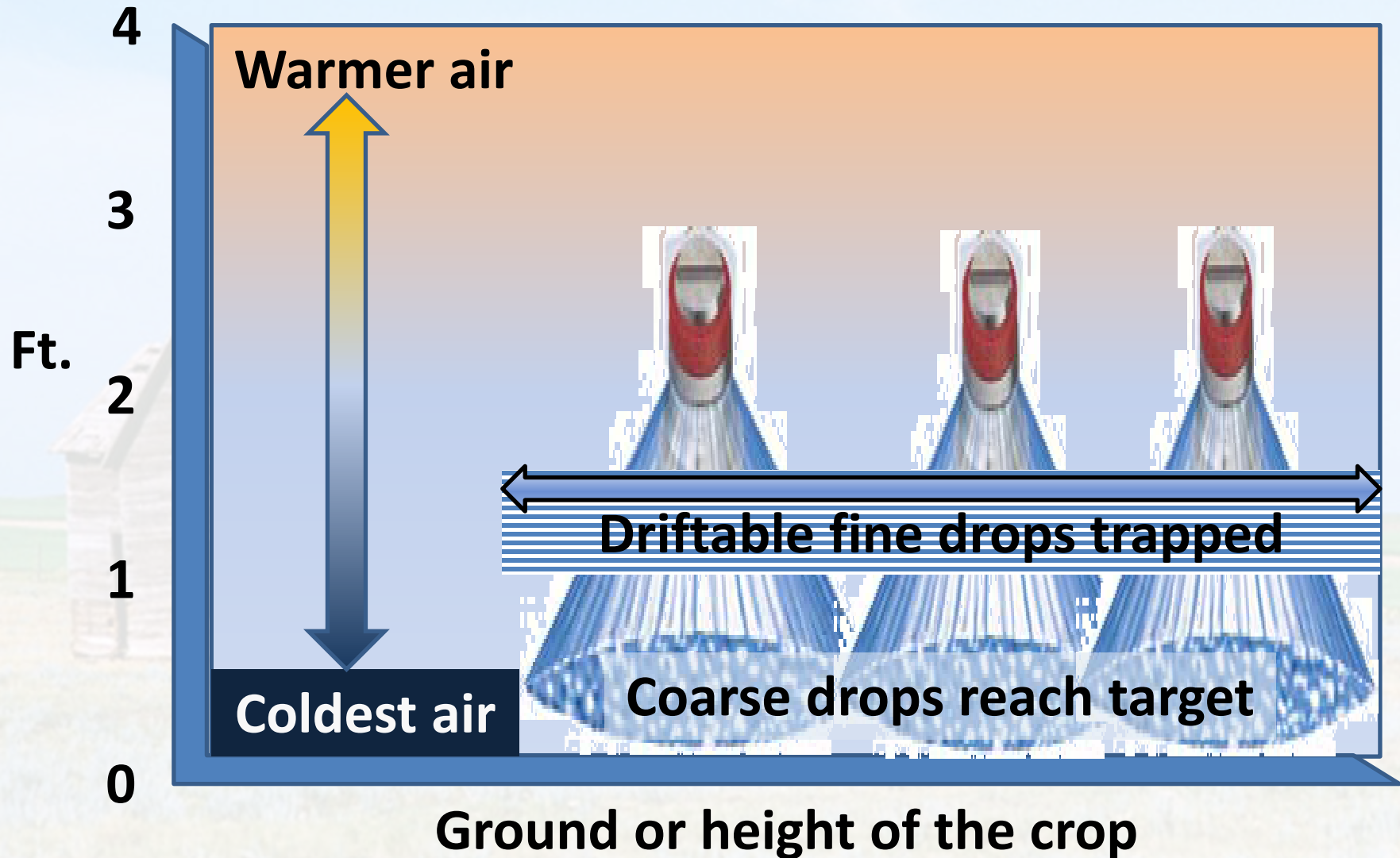
Standard
droplet nozzles



Spraying during an inversion = trapping of fine droplets



Spraying during an inversion = trapping of fine droplets



Dust particles hang in the air

Visible dust particles are about 200
microns or more 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



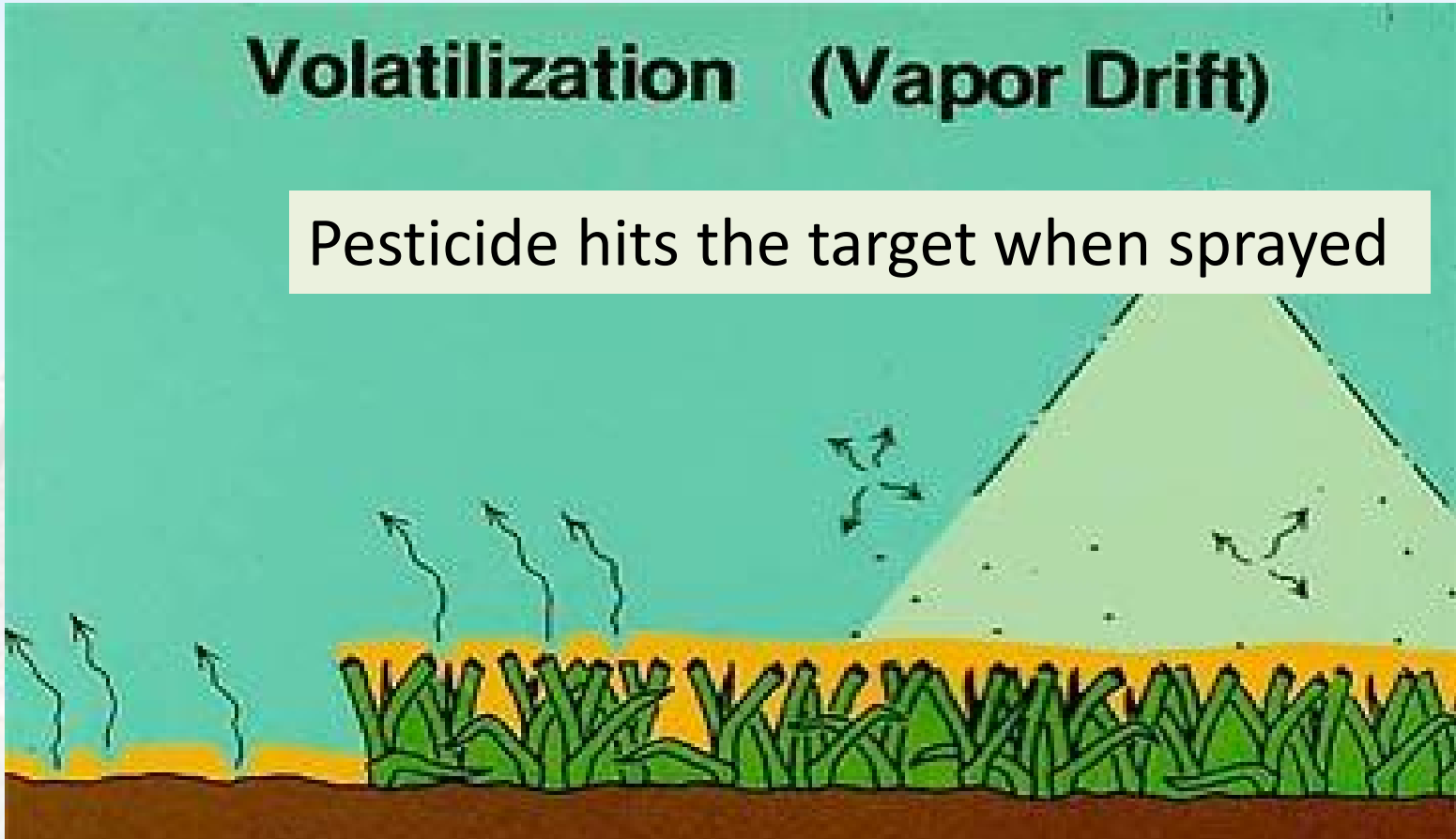
CP-03

Operate them based on the nozzle manufacturer's specifications!

Be wary of pesticides that are sensitive to vaporization

Volatilization (Vapor Drift)

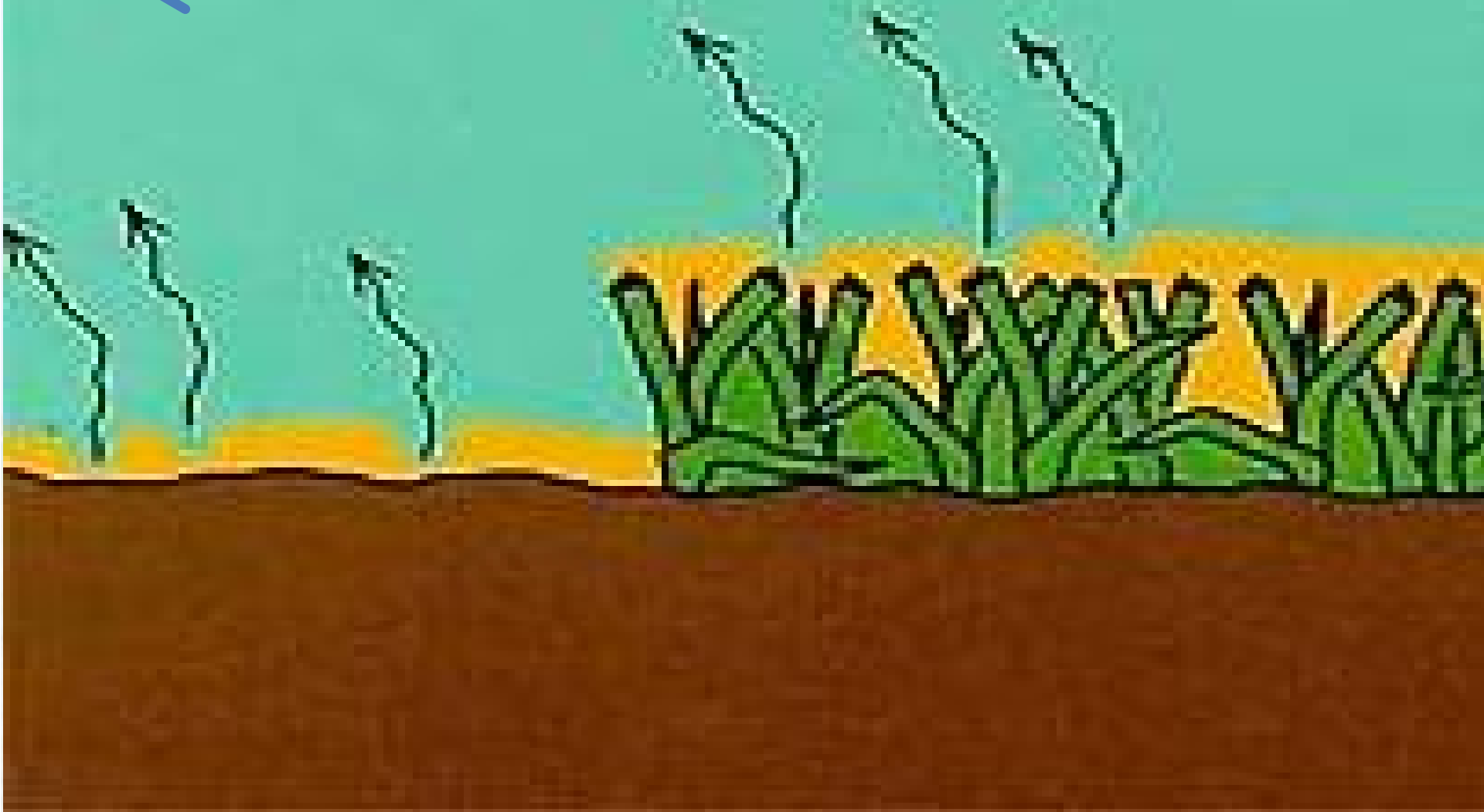
Pesticide hits the target when sprayed



But then vaporizes or gasses off during or after application

Pesticide molecules mix with air

Light winds move the molecules off target



How do you know if a pesticide will volatilize?

Especially look for high temperature warning statements on the label like:

“Do not apply CRUISE CONTROL adjacent to sensitive crops when the temperature on the day of application is expected to ***exceed 85°F*** as drift is more likely to occur.”

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

their direct supervision
Applicator's certificat



Insecticide
®Trademark of Dow Agrosciences

Headline®

fungicide

For use in disease control and plant health in the following crops:

Barley, citrus fruit, corn (all types), cotton, dried shelled peas and beans, edible podded legume vegetables, grass grown for seed, mint, peanut, pecan, rye, soybean, succulent shelled peas and beans, sugar beet, sunflower, tuberous and corm vegetables (includes potato), wheat and triticale

Active Ingredient*:

pyraclostrobin: (carbamic acid, [2-[[[1-(4-chlorophenyl)-1H-pyrazol-3-yl]oxy)methyl]phenyl]methoxy-, methyl ester) 23.6%

Other Ingredients:** 76.4%

Total: 100.0%

* Equivalent to 2.09 pounds of pyraclostrobin per gallon.


** Contains petroleum distillates.

Clues




You can smell them





You can see it in a morning or
evening mirage

A blurred landscape at sunset or sunrise. The sky is a gradient of light blue, yellow, and orange. The ground is dark and blurry, suggesting a road or field. The text is overlaid in the lower half of the image.

Dust from vehicles or farm
machinery will hang in the air

You can hear it



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 is has been spraying for many hours and loses track of weather conditions, especially in the late afternoon / early evening

Late afternoon / evening spraying

Inversions during this time of the day could have serious consequences



NOAA Tabular Weather Forecast for Sioux, Falls, SD

Date	10/02										10/03										
Hour (CDT)	15	16	17	18	19	20	21	22	23	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

The screenshot shows the National Weather Service website. At the top left is the NOAA logo. The main header reads "National Oceanic and Atmospheric Administration's National Weather Service". Navigation tabs include "Site Map", "News", and "Organizational". A news article titled "...Flooding continues in the East, heavy rains have ended..." is displayed. Below the article are buttons for "Warnings & Forecasts", "Graphical Forecasts", "National Maps", "Radar", "Water", "Air Quality", "Satellite", and "Climate". A "Warnings By State" dropdown menu is set to "Warnings By State" with a "Go" button. A map of the United States shows weather data with a color scale. The map is titled "Created: 10/02/10 at 19:41 UTC".

Local forecast by "City, St"

Sign-up for Email Alerts
XML RSS Feeds

Warnings
Current
By State/County...
UV Alerts

Observations
Radar
Satellite
Snow Cover
Surface Weather...
Observed Precip

Forecasts
Local
Graphical
Aviation
Marine
Hurricanes

Site Map News Organizational

...Flooding continues in the East, heavy rains have ended...
While the heavy rains of recent days have come to an end across the Eastern Seaboard, flood warnings remain in effect across parts of eastern North Carolina and New England. Across New England, rainfall totals of nearly 6 to 8 inches were reported. In the Mid-Atlantic, rainfall totals of up to almost 18 inches were reported. [Details...](#)

Warnings & Forecasts Graphical Forecasts National Maps Radar Water Air Quality Satellite Climate

Warnings By State Click Below To Zoom In. Tabs At A Glance

Created: 10/02/10 at 19:41 UTC

Scroll Down & Select Tabular Forecast




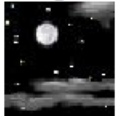
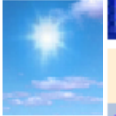
 **Your National Weather Service forecast** 

Cooperstown ND

Enter Your "City, ST" or zip code

NWS Grand Forks, ND [Mobile Weather Information](#) | [En Español](#)
Point Forecast: Cooperstown ND
47.44°N 98.13°W **Last Update:** 10:23 am CDT Oct 2, 2010
Forecast Valid: 3pm CDT Oct 2, 2010-6pm CDT Oct 8, 2010

Forecast at a Glance

This Afternoon	Tonight	Sunday	Sunday Night	Monday	Monday	Tuesday	Tuesday	Wednesday
								
Sunny	Mostly Clear	Breezy	Mostly Clear	Sunny				
Hi 57 °F	Lo 38 °F	Hi 64 °F	Lo 46 °F	Hi 67 °F				

Additional Forecasts & Information

- Zone Area Forecast for Griggs County, ND
- Forecast Discussion
- Printable Forecast
- Hourly Weather Graph
- International System of Units
- Local Climatology
- Outlooks
- Storm Prediction Center
- Fire Weather
- NOAA Weather Radio
- Preparedness
- Air Quality Forecasts
- Text Only Forecast
- Tabular Forecast
- Quick Forecast
- About Point Forecasts
- Watches and Warnings
- Hazards Assessment
- AHPS / River Info
- Aviation
- Storm Ready

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

Mandatory On-site Weather Readings



GROUP	1	6	27	HERBICIDE
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Wolverine™ Herbicide

For Selective Postemergence Control of Most Annual Grassy Weeds (Including Wild Oat and Foxtail Species) and Broadleaf Weeds in Wheat and Barley

ACTIVE INGREDIENTS:

Fenoxaprop Ethyl	4.47%
Pyrasulfotole	1.94%
Bromoxynil Octanoate	85%
Bromoxynil Heptanoate	4.79%
OTHER INGREDIENTS	1.85%
Total	100.00%

“For all non-aerial applications, wind speed must be measured adjacent to the application site, on the upwind side, immediately prior to application.”

Contains petroleum distillates.

Contains 0.17 pound Pyrasulfotole, 0.42 pound, Bromoxynil Octanoate, and 0.41 pound Bromoxynil Heptanoate.

EPA Reg. No. 264-1075

EPA Est.

Smoke hangs in the air
and does not dissipate or rise



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

Questions



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