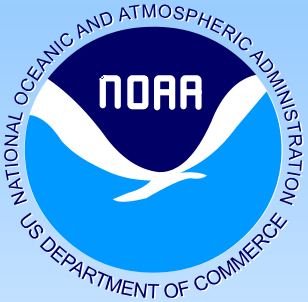


# Understand Atmospheric Mixing to Anticipate & Avoid Weather Hazards

David Craft  
Aviation Products & Services Program Leader





# Overview



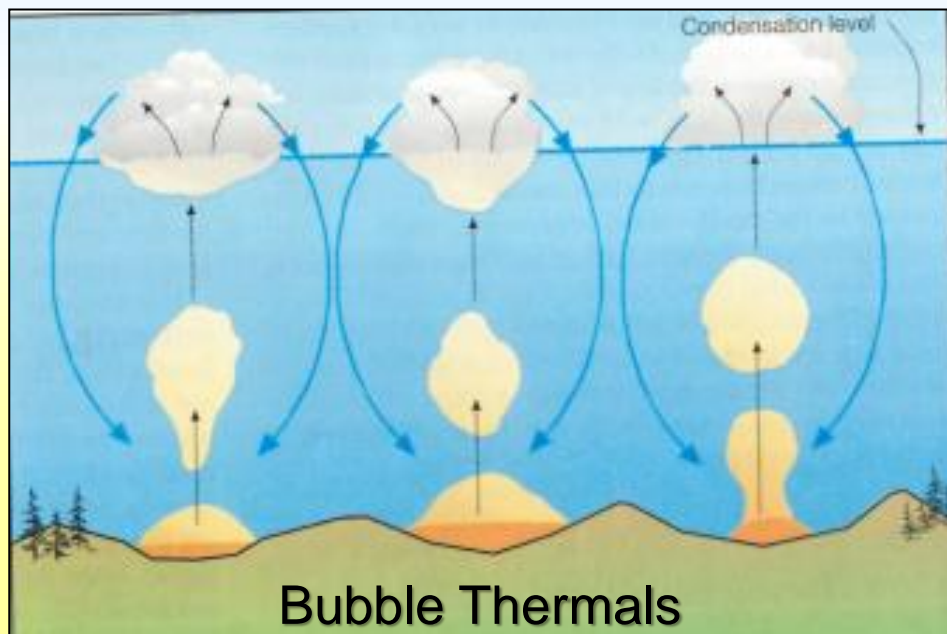
- What is atmospheric mixing?
- How mixing works
- Evolution through the day
- Case study
- Aviation weather hazards influenced by mixing
  - Convective turbulence
  - The dry line
  - Wildfire smoke
  - Haboobs

## Learning Objective

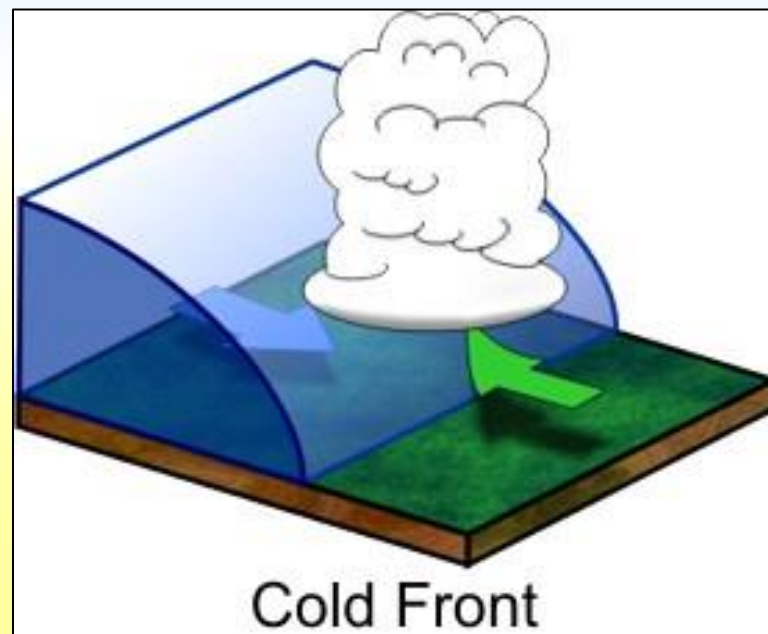
Understand the evolution and timing of atmospheric mixing, so you can better anticipate the development, intensification and dissipation of aviation weather hazards.

# What is Atmospheric Mixing?

The transfer of momentum from stronger flow aloft to the surface by thermals and other sources of wind shear (like cold fronts, outflow boundaries and jet streams).

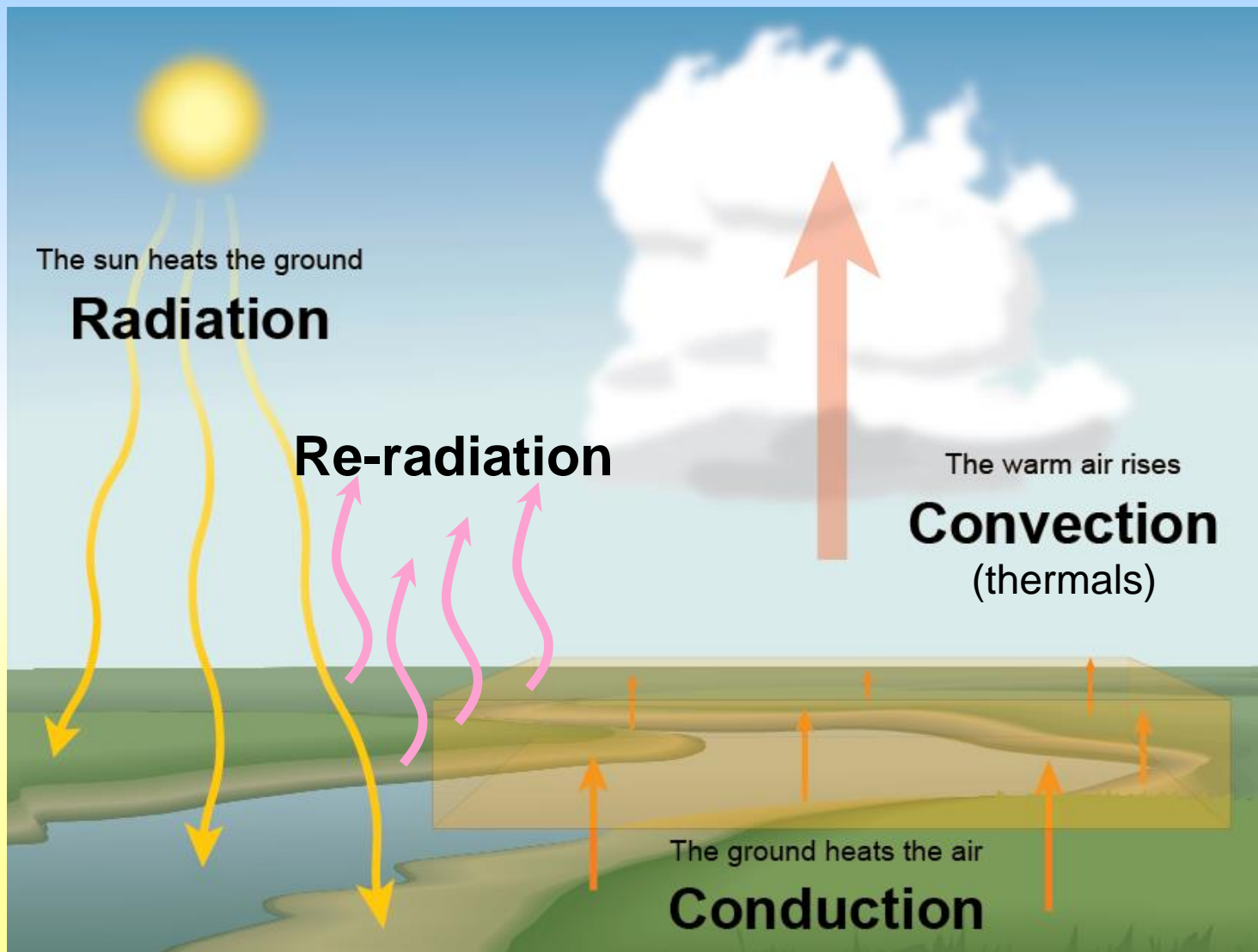


*Essentials of Meteorology, C. Donald Ahrens*



[www.weather.gov/Jetstream/airmass](http://www.weather.gov/Jetstream/airmass)

# How Mixing Works

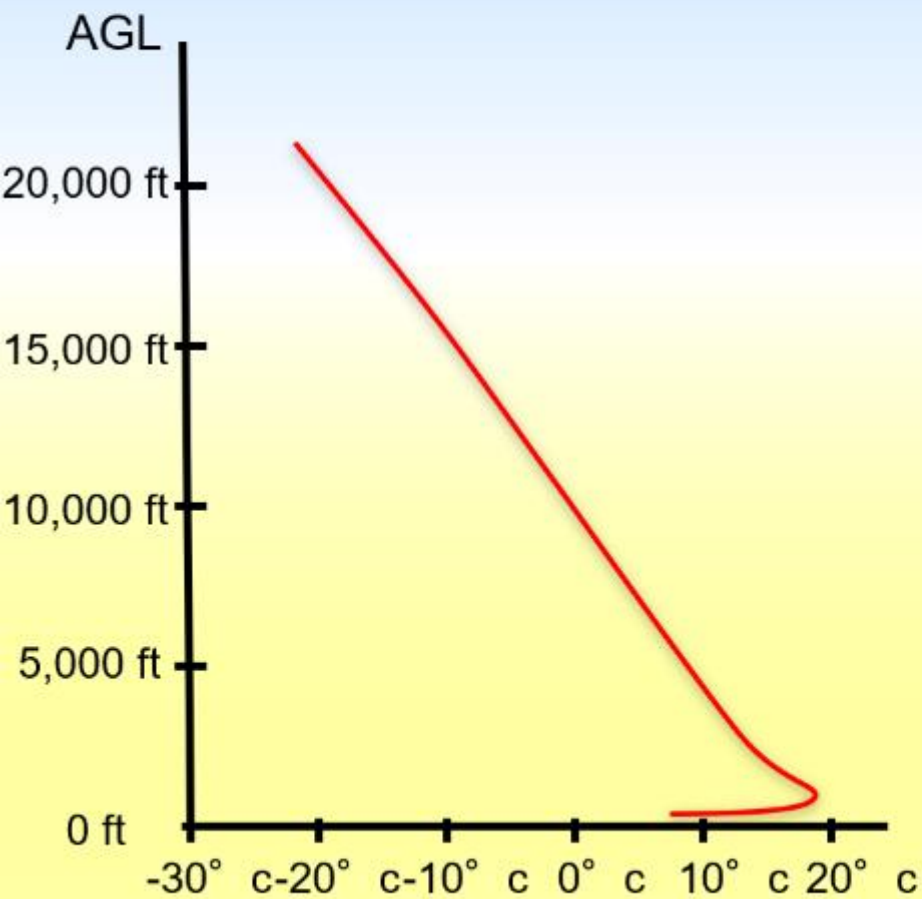


**Re-radiation:** The ground absorbs then re-radiates energy at a wavelength air molecules can absorb.

<https://www.weather.gov/jetstream/heat>  
(adapted)

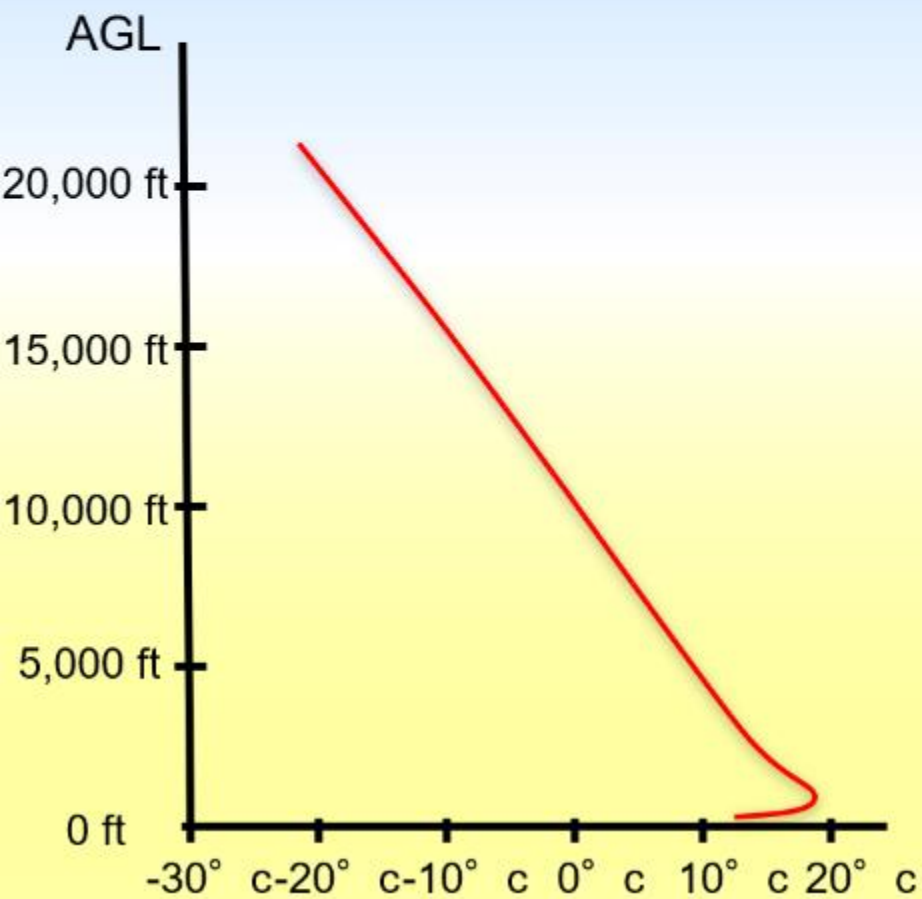


# Atmospheric Mixing in the Morning



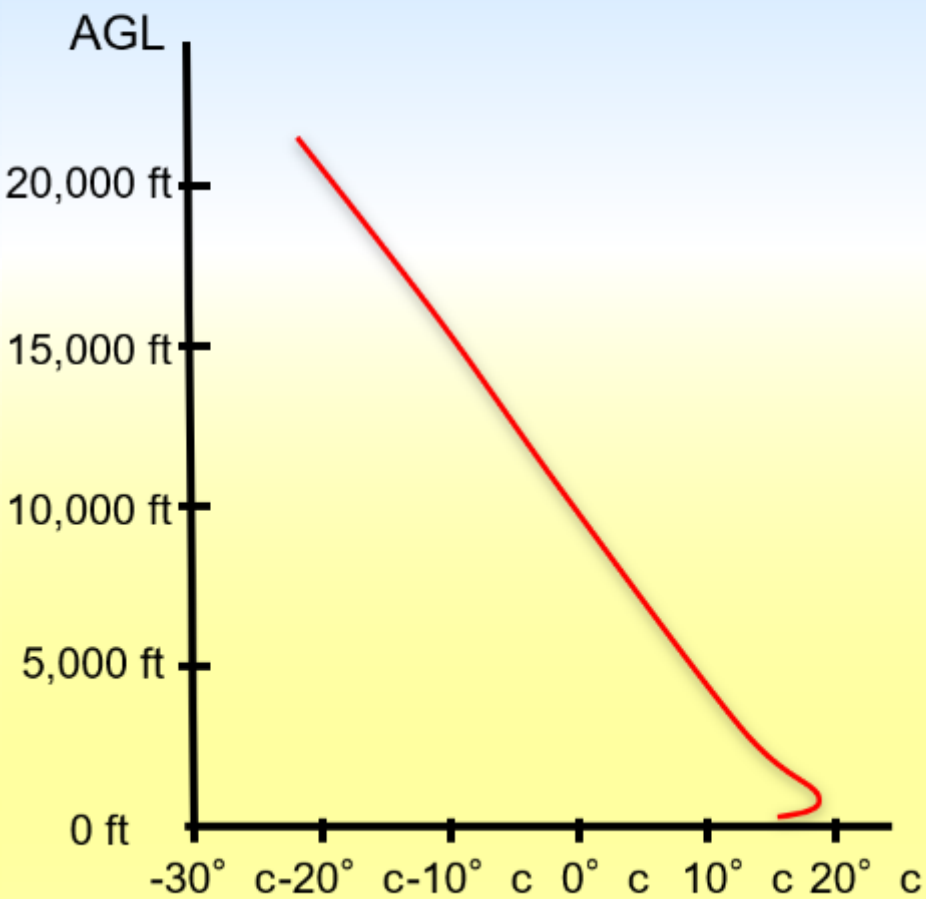


# Atmospheric Mixing in the Morning



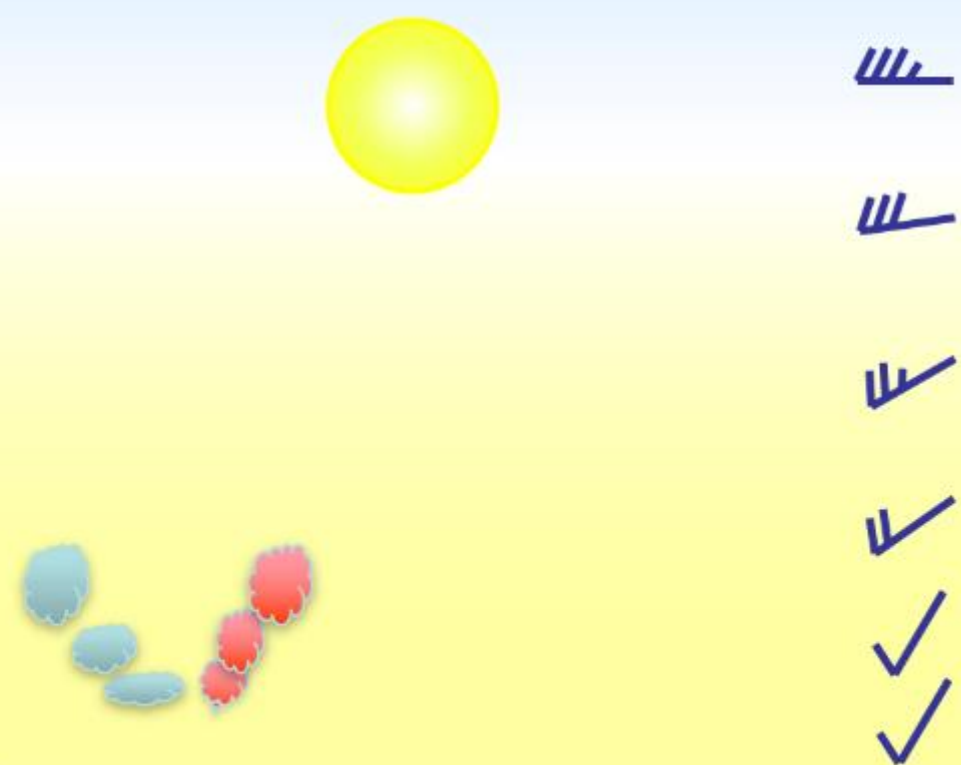
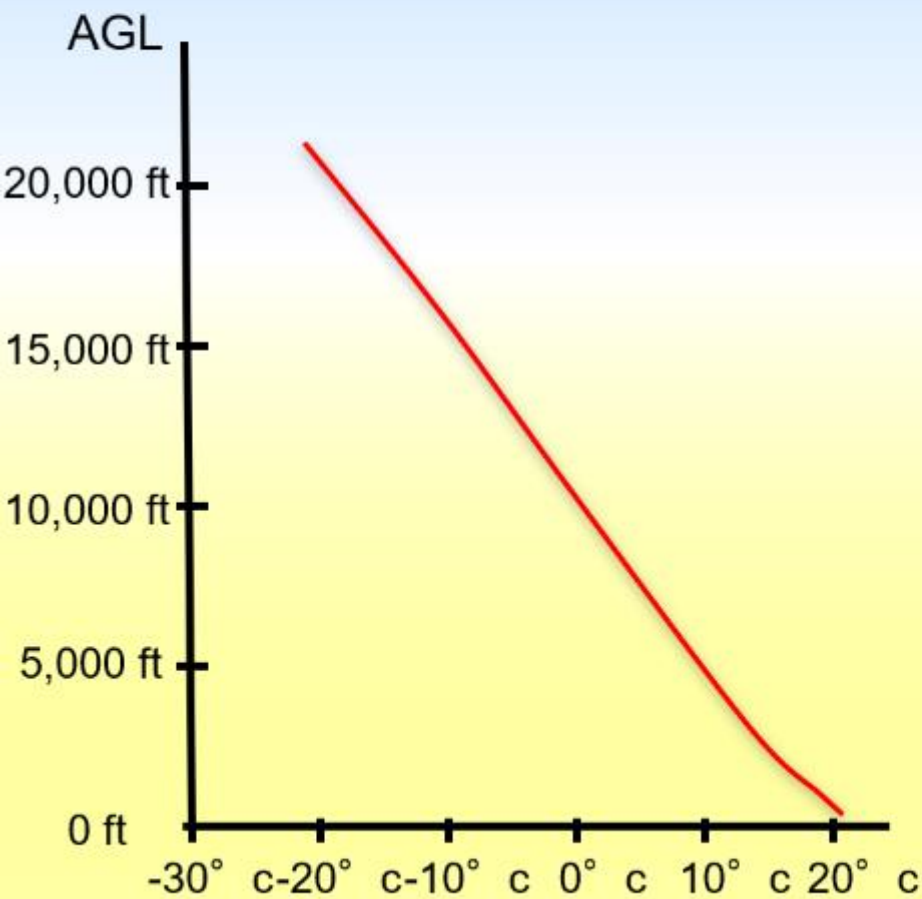


# Atmospheric Mixing in the Morning





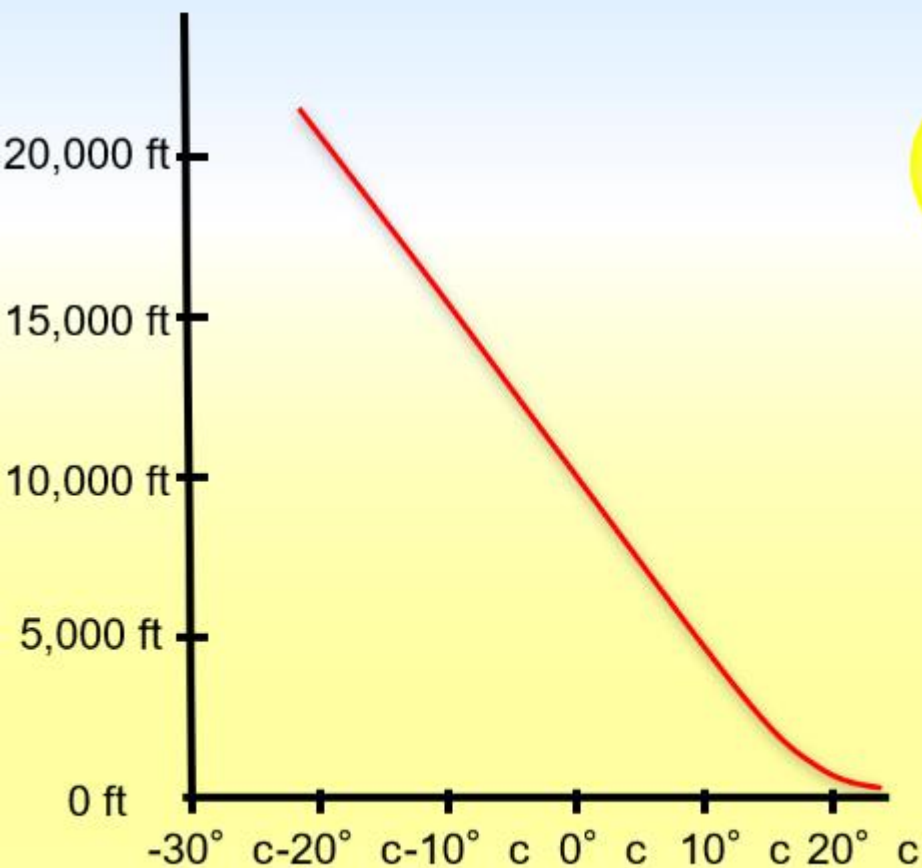
# Atmospheric Mixing in the Morning





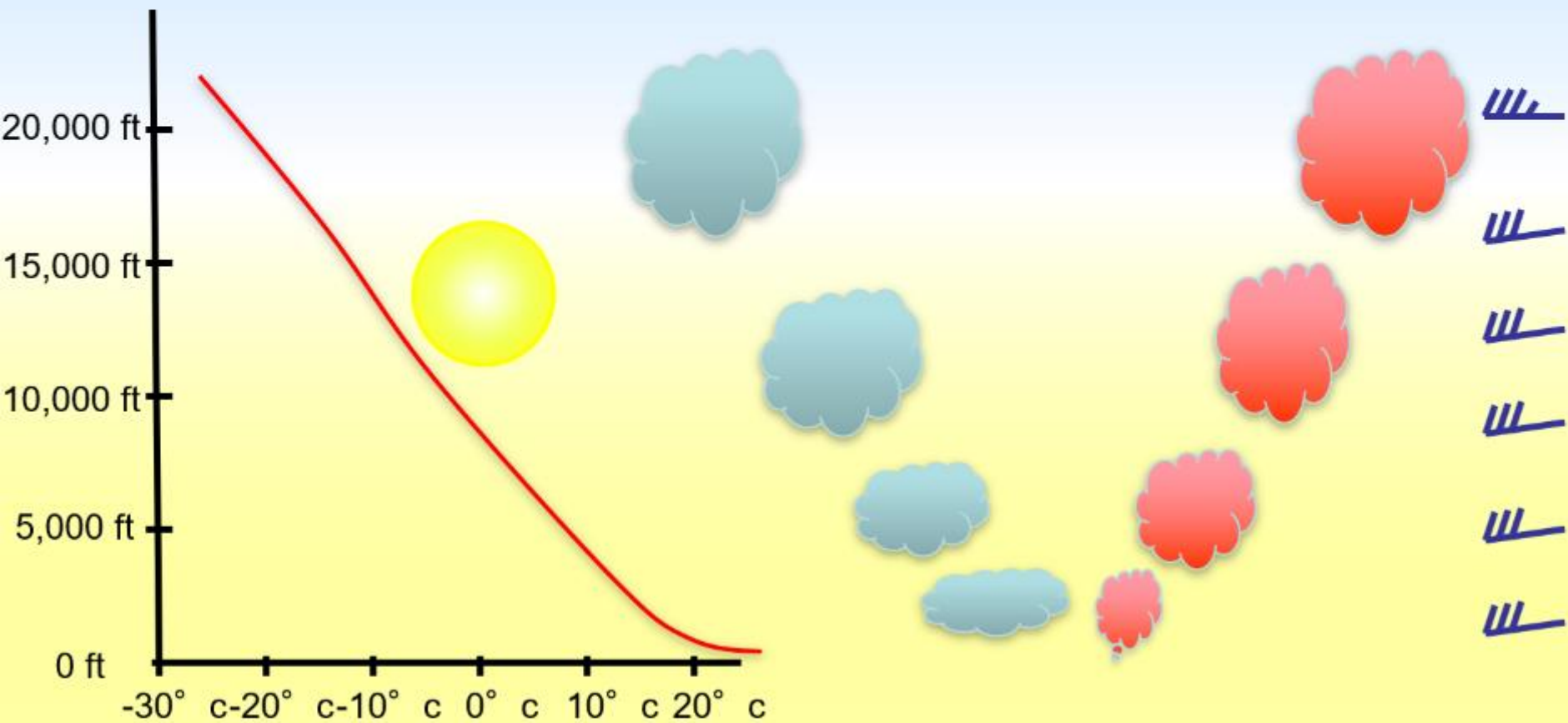


# Atmospheric Mixing by Early Afternoon

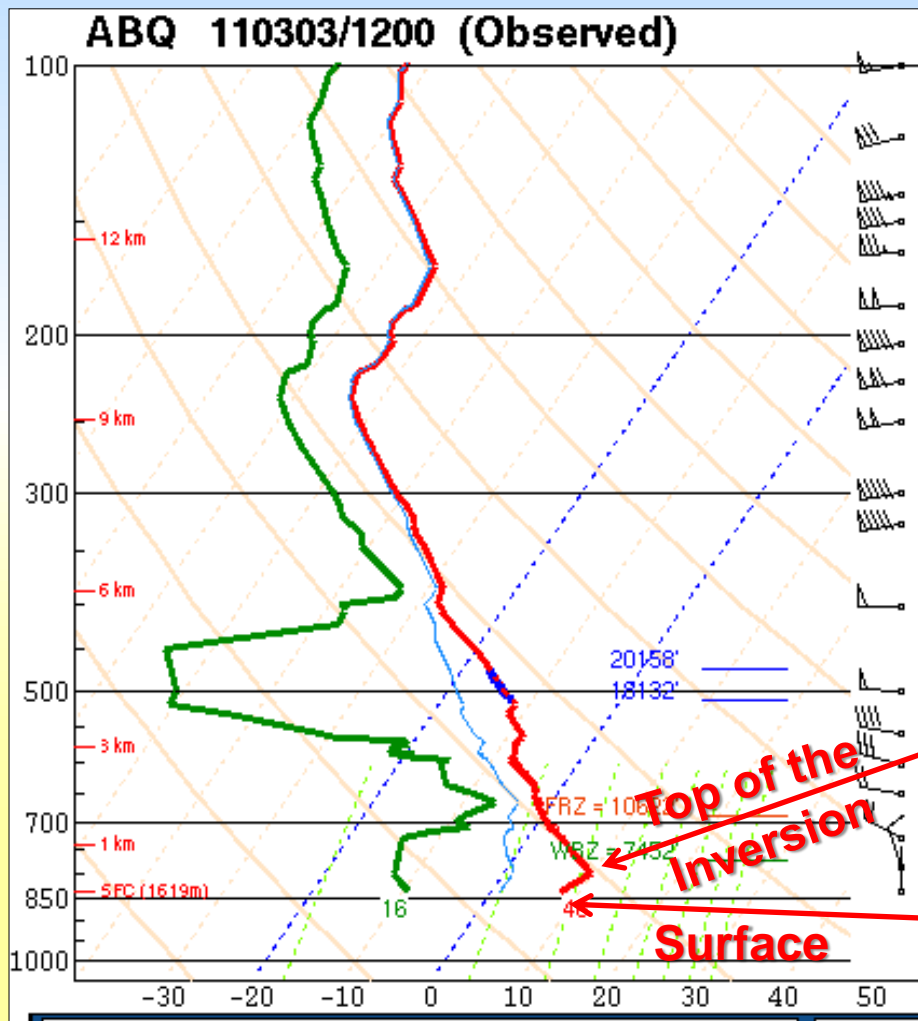




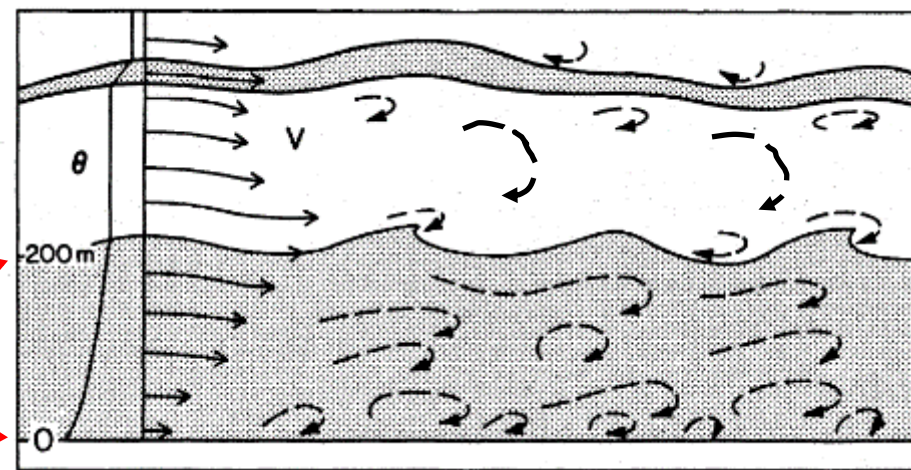
# Atmospheric Mixing by Late Afternoon



# Case Study Overnight Decoupling



Note the nearly calm surface winds at the bottom of the inversion and the region of wind shear at the top of the inversion

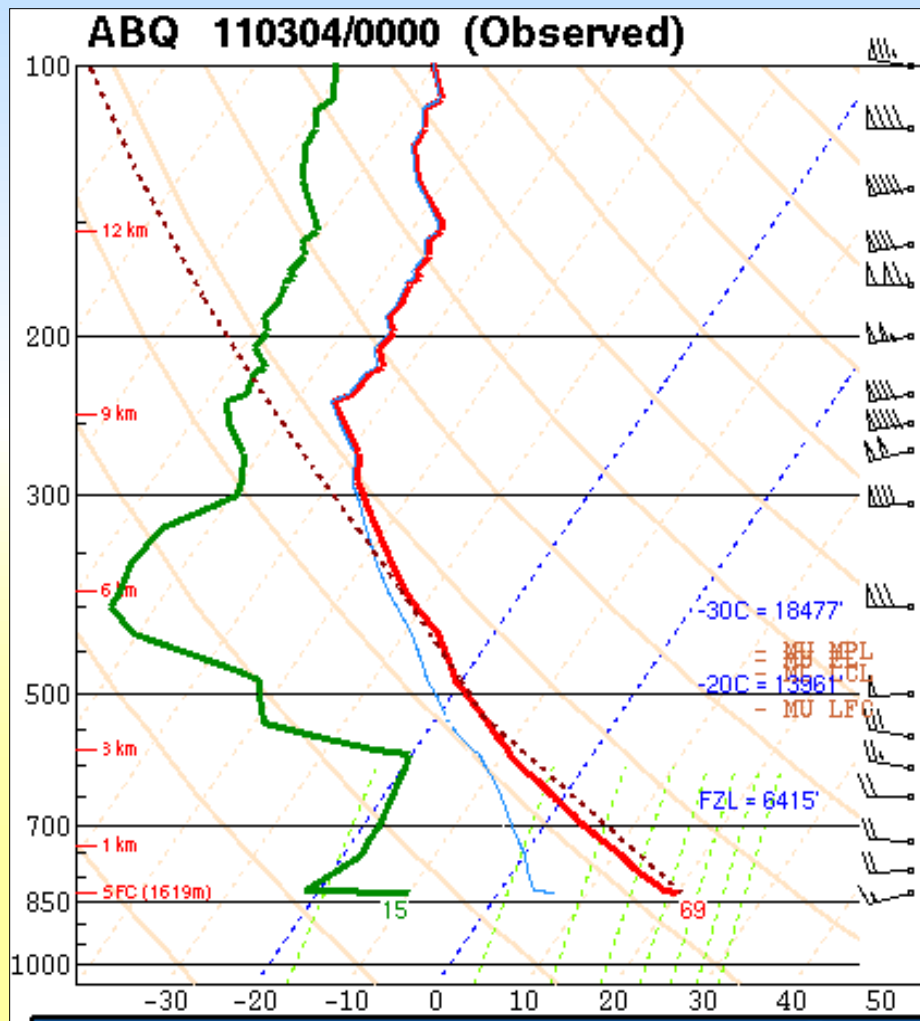


## Conceptual Model

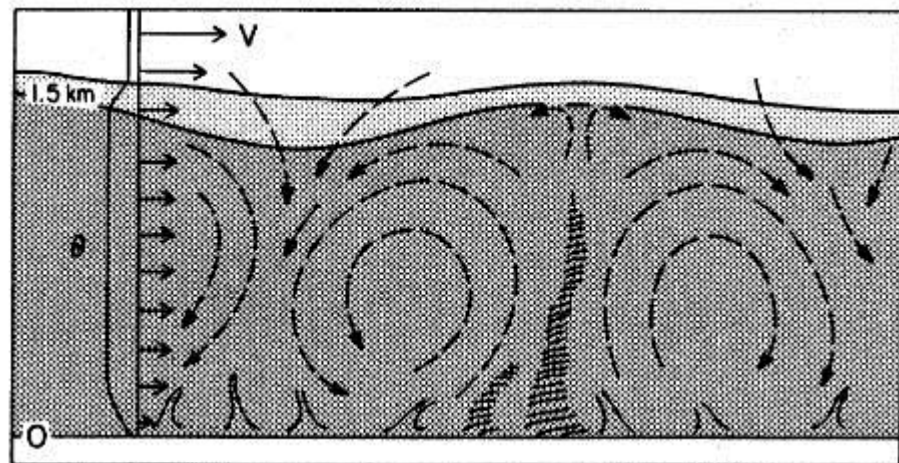
## Early Morning Sounding

# Case Study (Continued)

## Afternoon Mixing



The descending couplet in the thermal circulation transfers stronger momentum aloft downward causing surface winds to strengthen



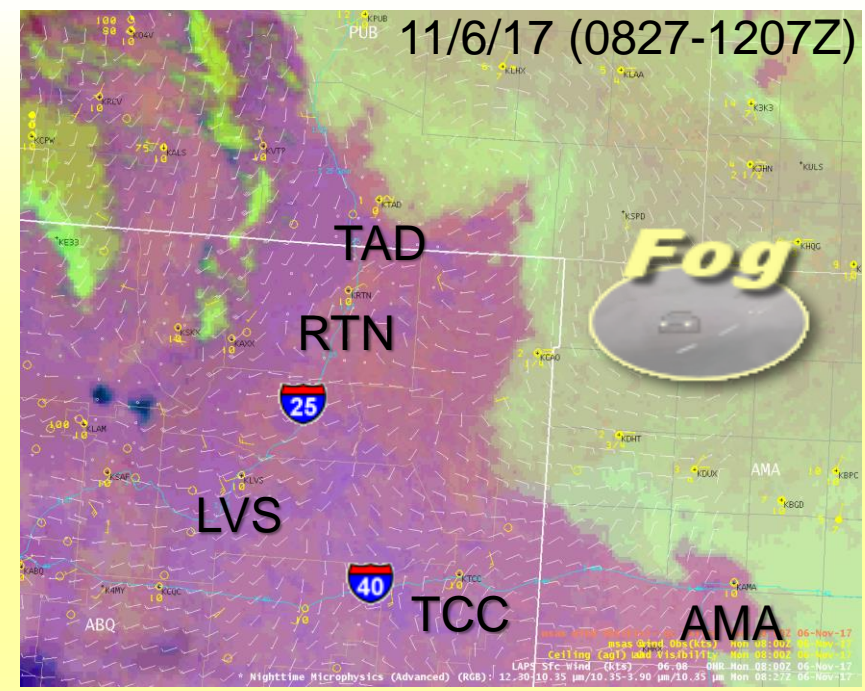
## Conceptual Model

Late Afternoon Sounding

# Weather Hazards Influenced by Atmospheric Mixing

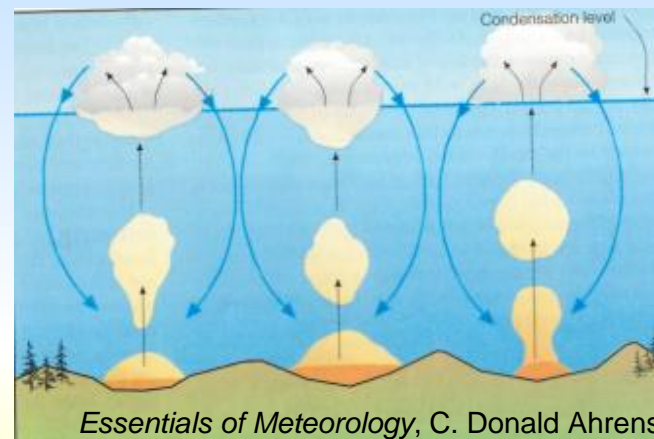
- Today we discuss:
  - Convective turbulence
  - The dry line
  - Wildfire smoke
  - Haboobs
  
- On your own consider:
  - Nocturnal low clouds and fog
  - Nocturnal low level jet on the southern plains
  - Some gap wind events, like ABQ's notorious east canyon wind
  - Thunderstorms
  - What else comes to mind?

Many weather hazards depend on the diurnal cycle of atmospheric mixing to develop, intensify, and diminish



# Convective Turbulence

- Caused by thermals in a well mixed atmosphere
- To Avoid:
  - Climb above the cumulus clouds
  - Fly before the temperature inversion breaks

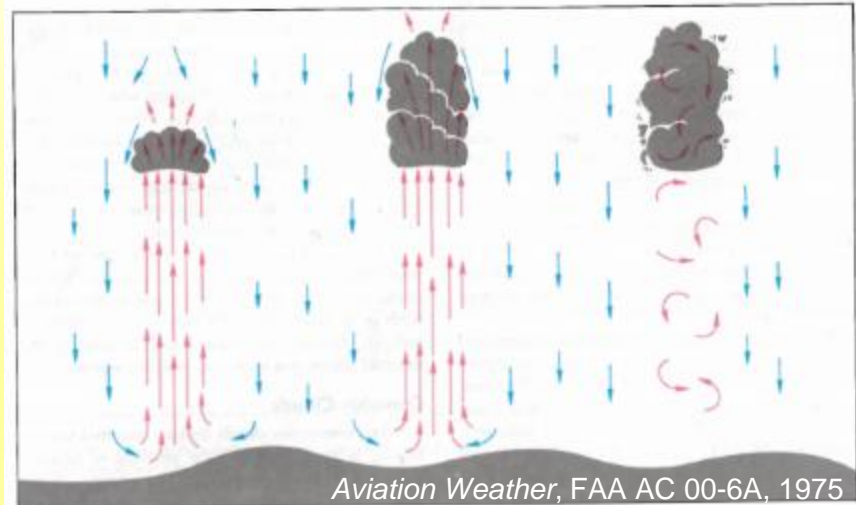


Bubble Thermals ←

Chimney Thermals ↓

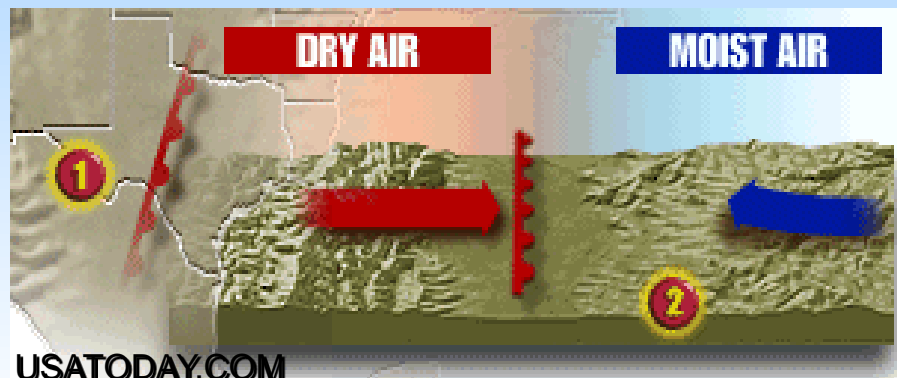


Todd Shoemake



Aviation Weather, FAA AC 00-6A, 1975

# The Dry Line

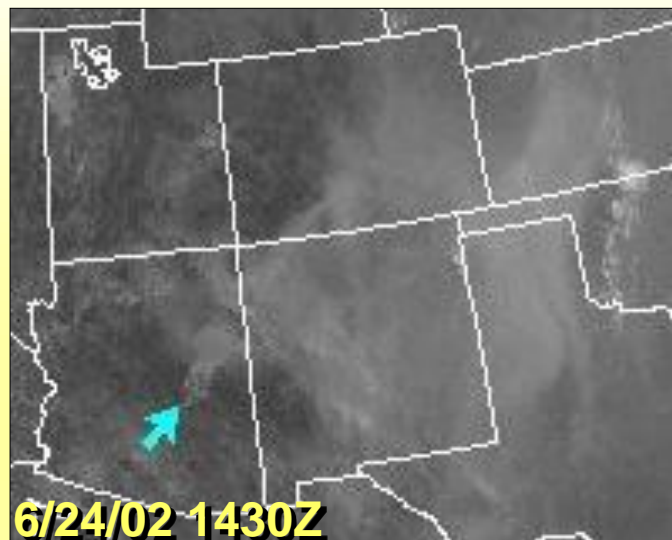
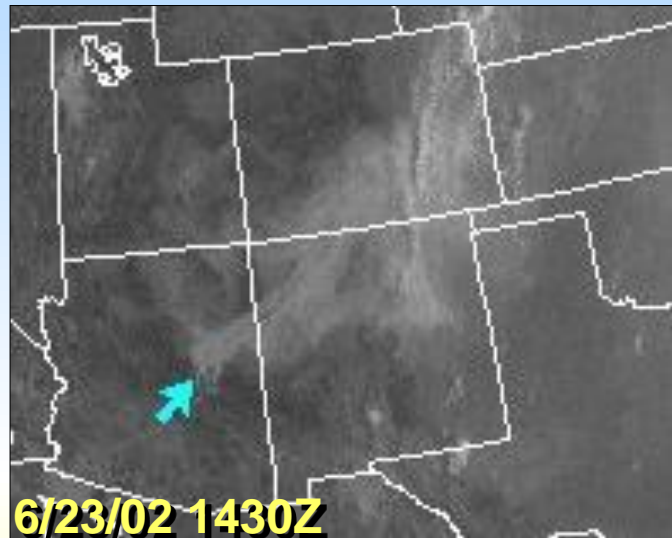


## Dewpoints

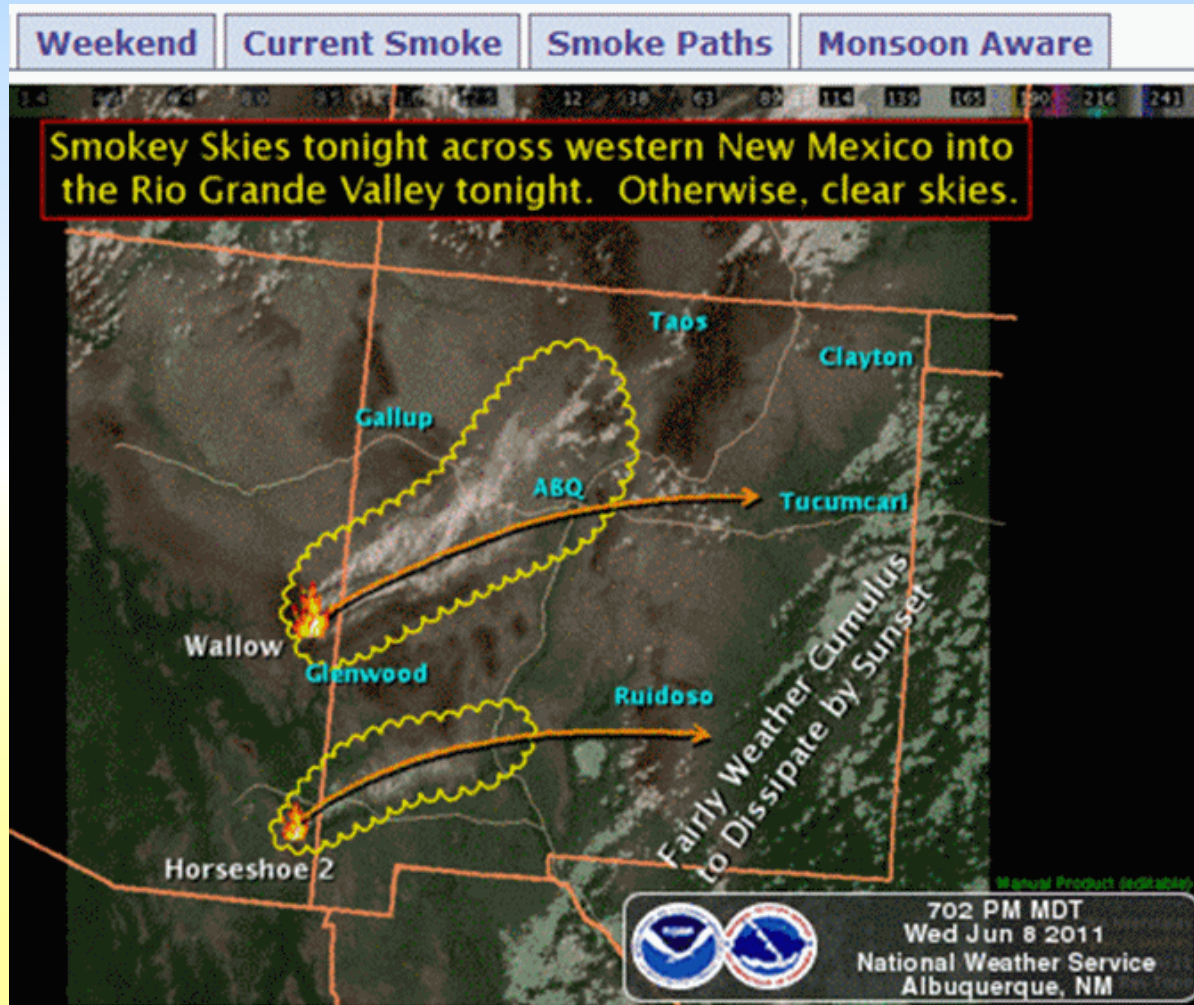


- Dry/moist convergence zone
  - Daytime advances east
  - Nighttime usually retreats west
- Flying hazards
  - Thunderstorms
  - Low Level Wind Shear
- Most common and intense in spring and early summer

# Wildfire Smoke

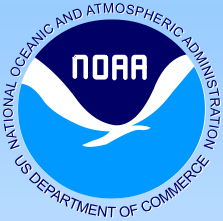


**Mogollon Rim Wildfire**



**NWS ABQ Website: [www.weather.gov/abq](http://www.weather.gov/abq)**





# AZ Haboobs



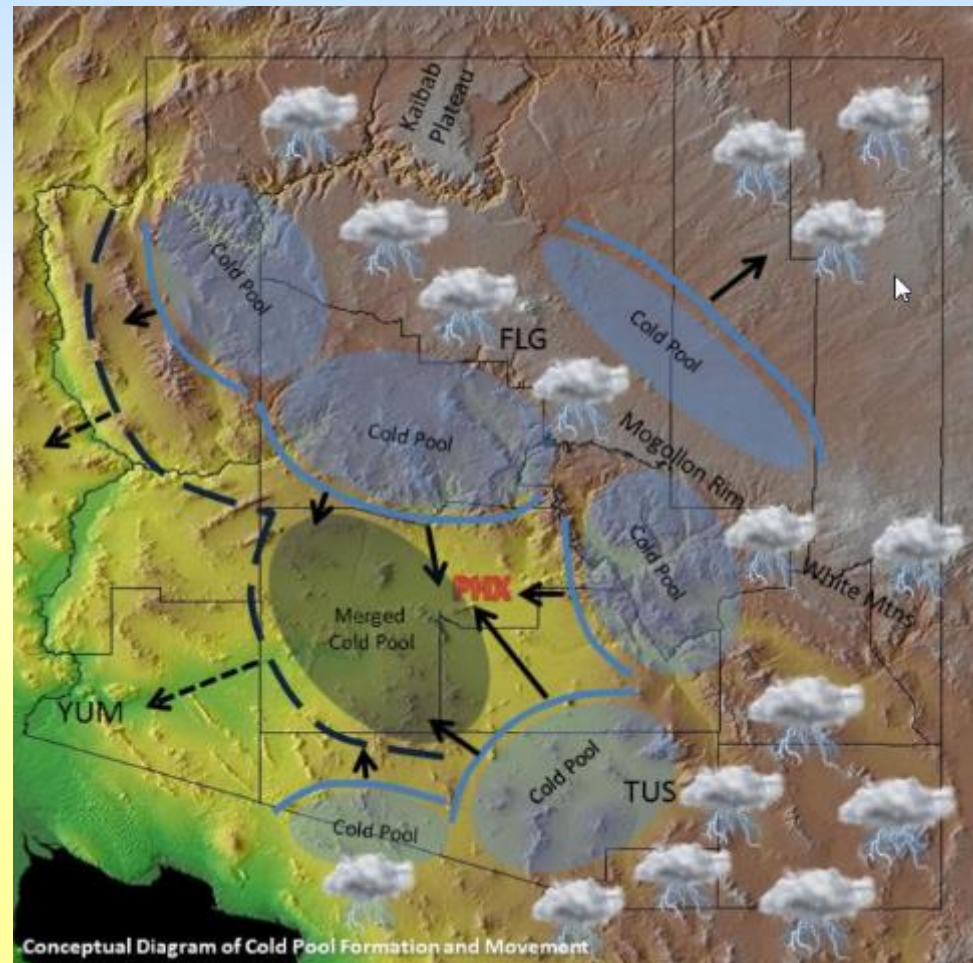
- Wall of dust that can extend up to 6500 feet high and several kilometers long
  - Near zero visibility for up to 45 minutes
  - Erratic wind gusts may reach 50 mph or more
- Occur most often when monsoon thunderstorm outflows merge over AZ's central and western deserts
- High risk locations:
  - Abandoned farmland
  - Tilled farmland
  - Land disturbed by animals or ATVs
  - Construction sites
  - Areas in drought



NWS Phoenix

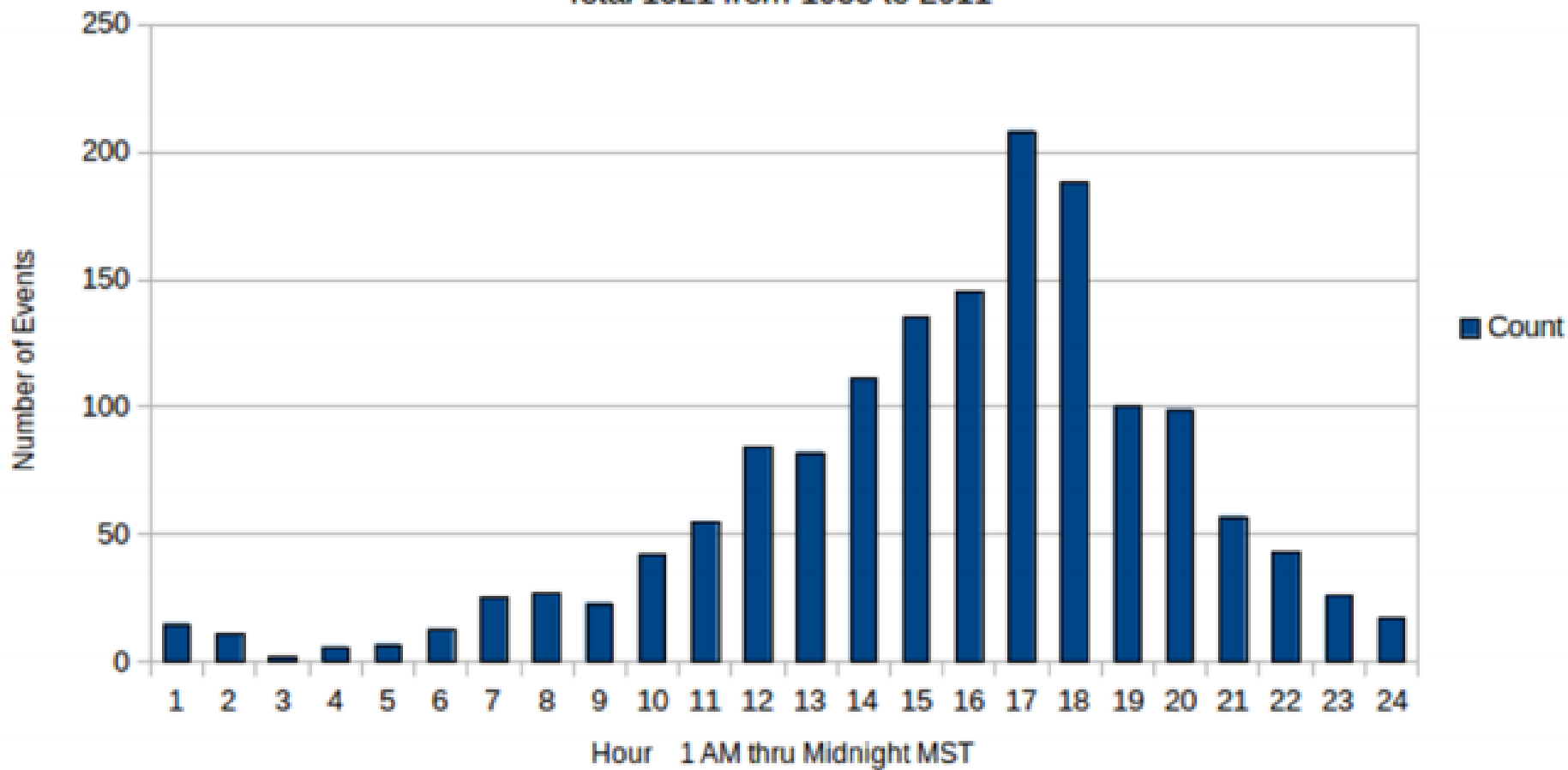
# AZ Haboobs

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# AZ Haboobs

Arizona Statewide  
Number of Blowing Dust and Dust Storm Events by Hour  
Total 1521 from 1955 to 2011



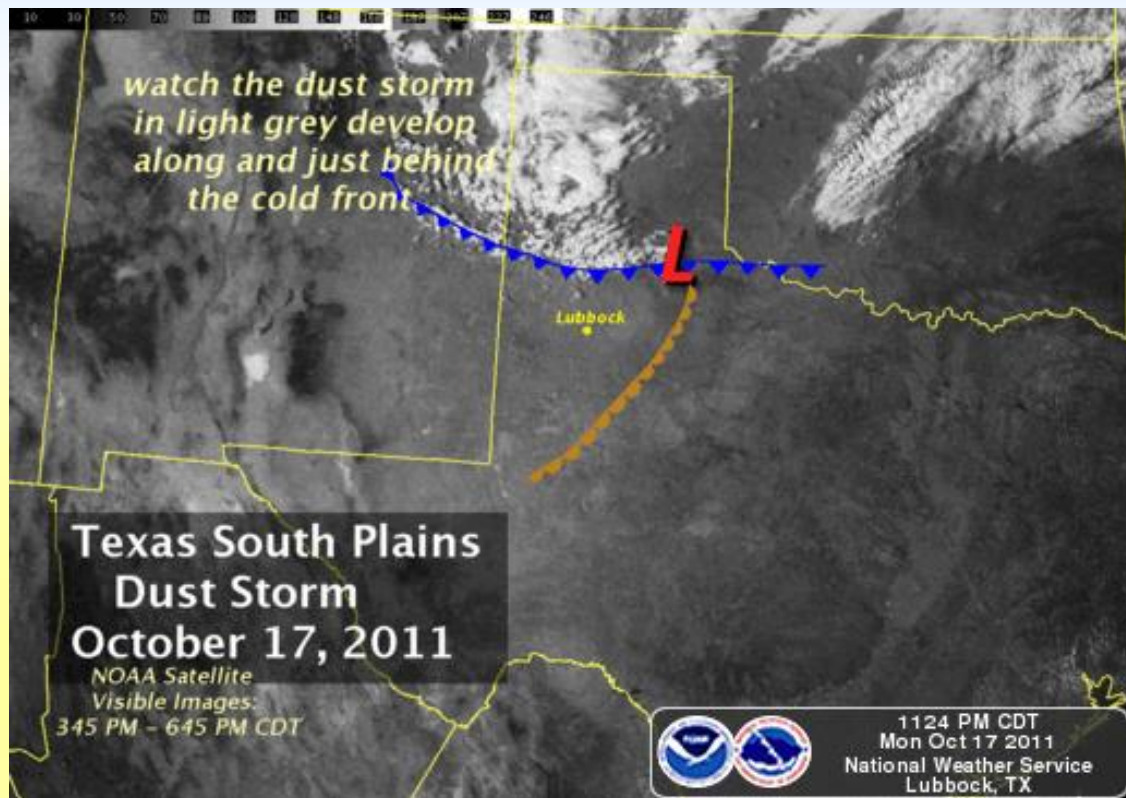
# NM/W TX Haboobs

- More common with strong back door cold fronts, especially in drought
- Best developed when buoyant mixing intensifies mechanical mixing by front

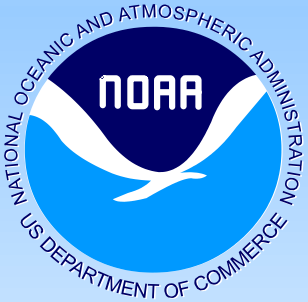
Lubbock, TX, Oct 17, 2011



Emily Davenport



Erin Shaw



# Summary



- What is atmospheric mixing?
  - How mixing works
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  - Case study
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- Others to Consider
- Nocturnal low clouds and fog
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  - Some gap wind events
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## QUESTIONS?

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