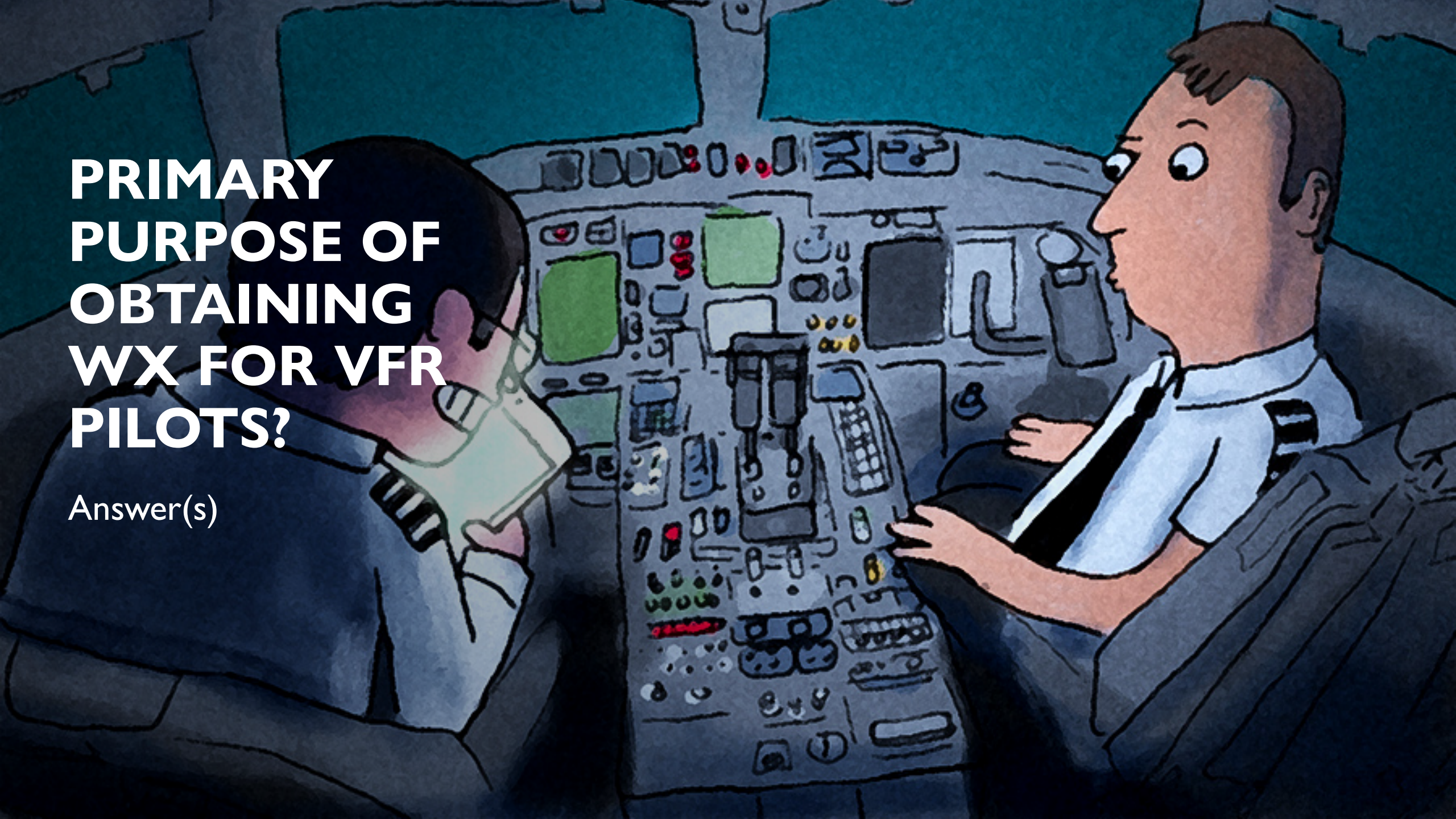
BLACK HOUND AVIATION

WEATHER PREP FOR PPL

by Gary A. White
Chief Instructor, Black Hound Aviation
Meteorologist

http://w5gw.com/images/PPL%20WX.pdf



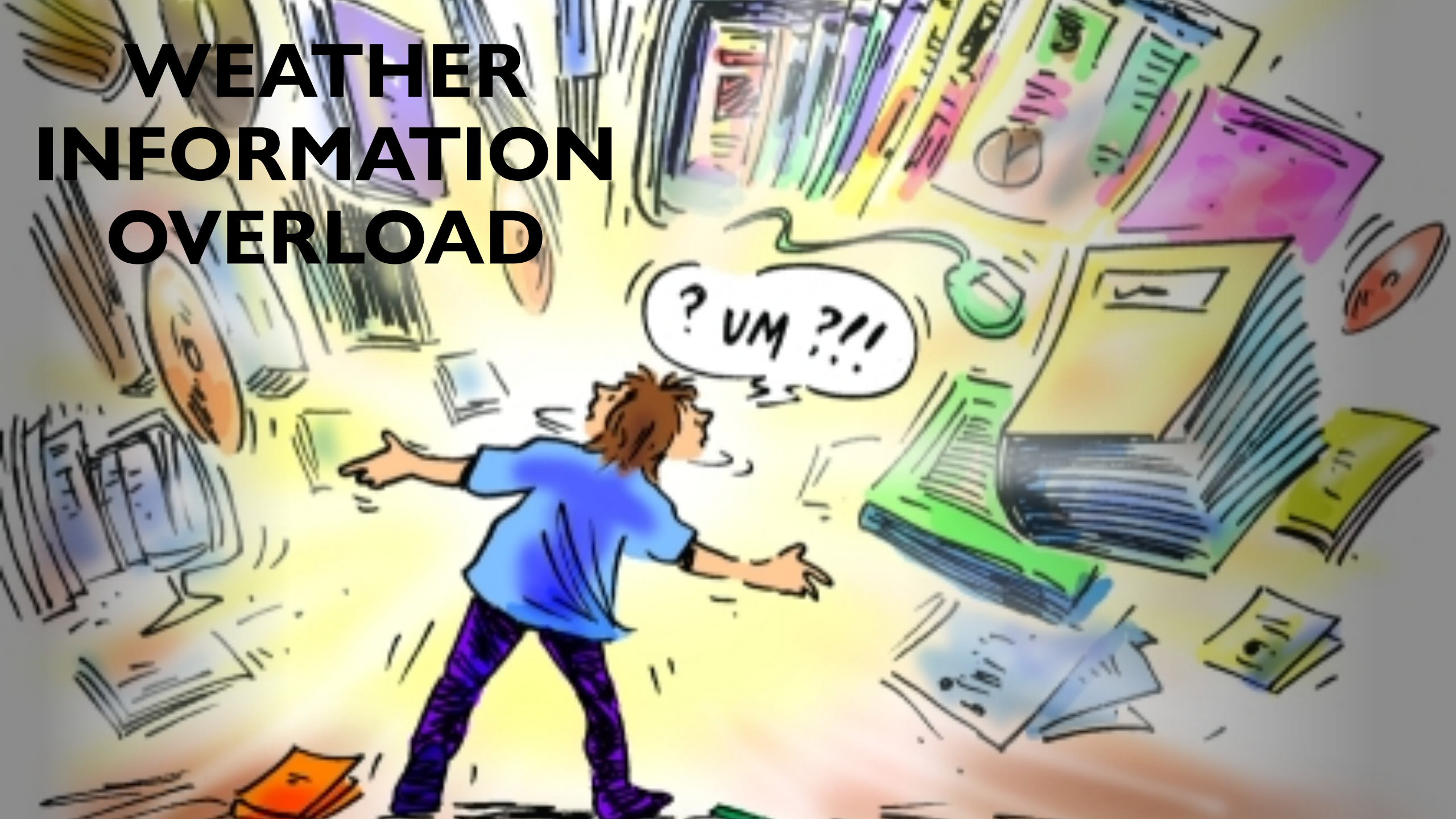
PRIMARY PURPOSE OF OBTAINING WX FOR VFR PILOTS?

Answer(s)

Keep out of All WX That Will:

Bend	Bend You: (Thunderstorms, Turbulence, Etc.)
Blind	Blind You: (Clouds, Fog, Obscurations)
Break	Break You: (Low Ceilings, Downdrafts, Density Altitude, Etc.)

WEATHER INFORMATION OVERLOAD



- Theory
- Services
- Products

References

- PPL ACS Preflight Preparation, Task C. Weather Information
- References: FAR 91, PHAK, AC 00-06 and 00-45, and AC 00-54*

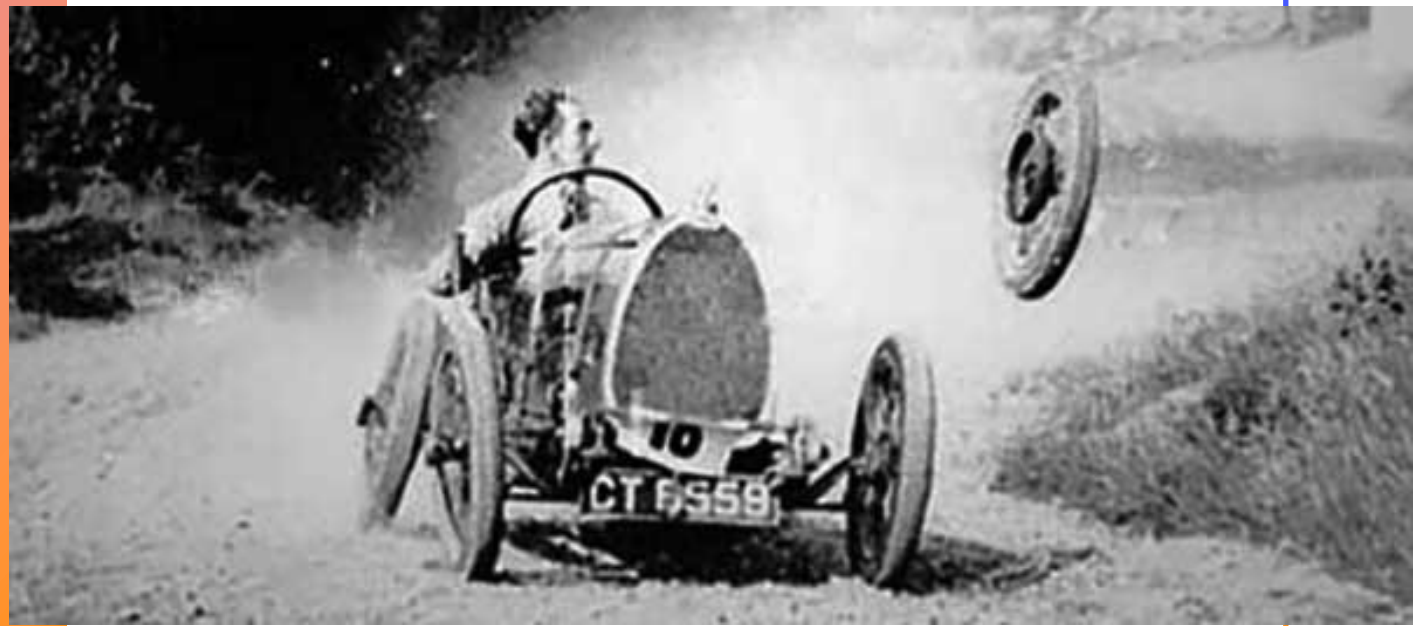
* Commonly Not Studied, Yet is Very Important in Understanding Windshear

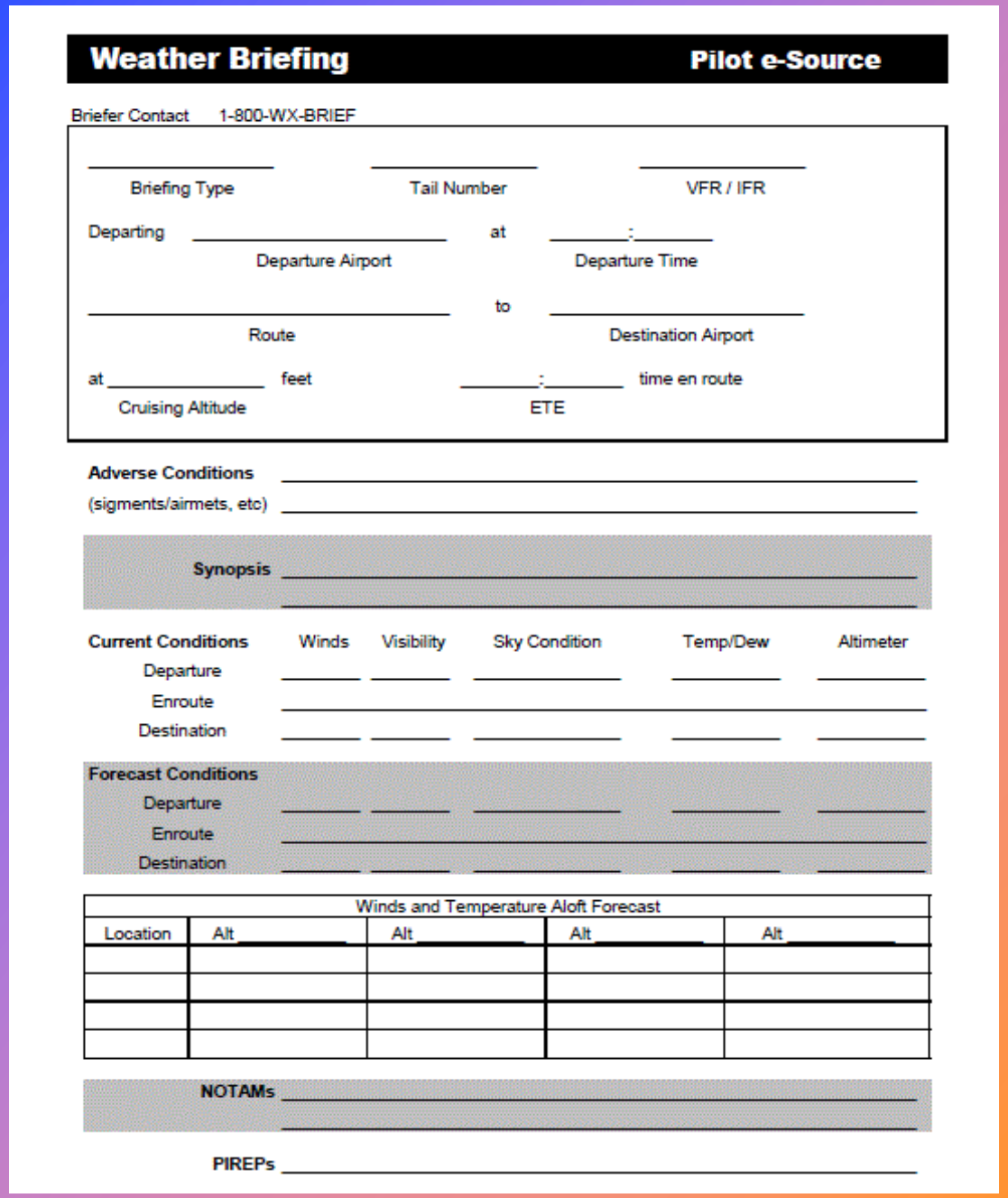
PA.I.C.K1 – Sources of WX Data/Products

- National Weather Service: (https://aviationweather.gov/)
- Flight Service Stations:
  - 1-800-WXBRIEF, or
  - https://www.1800wxbrief.com/
- Foreflight or EFB
- Internet – Weather Channel
- Television

- PA.I.C.K2
  - Acceptable Products for Planning, Departure, Enroute and Arrival

- Here is Where the Wheels Begin to Fall Off!





Weather Briefing **Pilot e-Source**

Briefer Contact 1-800-WX-BRIEF

Briefing Type | Tail Number | VFR / IFR

Departing _____ (Departure Airport) at _____:_____ (Departure Time)

_____ (Route) to _____ (Destination Airport)

at _____ (Cruising Altitude) feet _____:_____ (ETE) time en route

Adverse Conditions _____

(sigments/airmets, etc) _____

Synopsis _____

Current Conditions	Winds	Visibility	Sky Condition	Temp/Dew	Altimeter
Departure					
Enroute					
Destination					

Forecast Conditions					
Departure					
Enroute					
Destination					

Winds and Temperature Aloft Forecast				
Location	Alt	Alt	Alt	Alt

NOTAMs _____

PIREPs _____

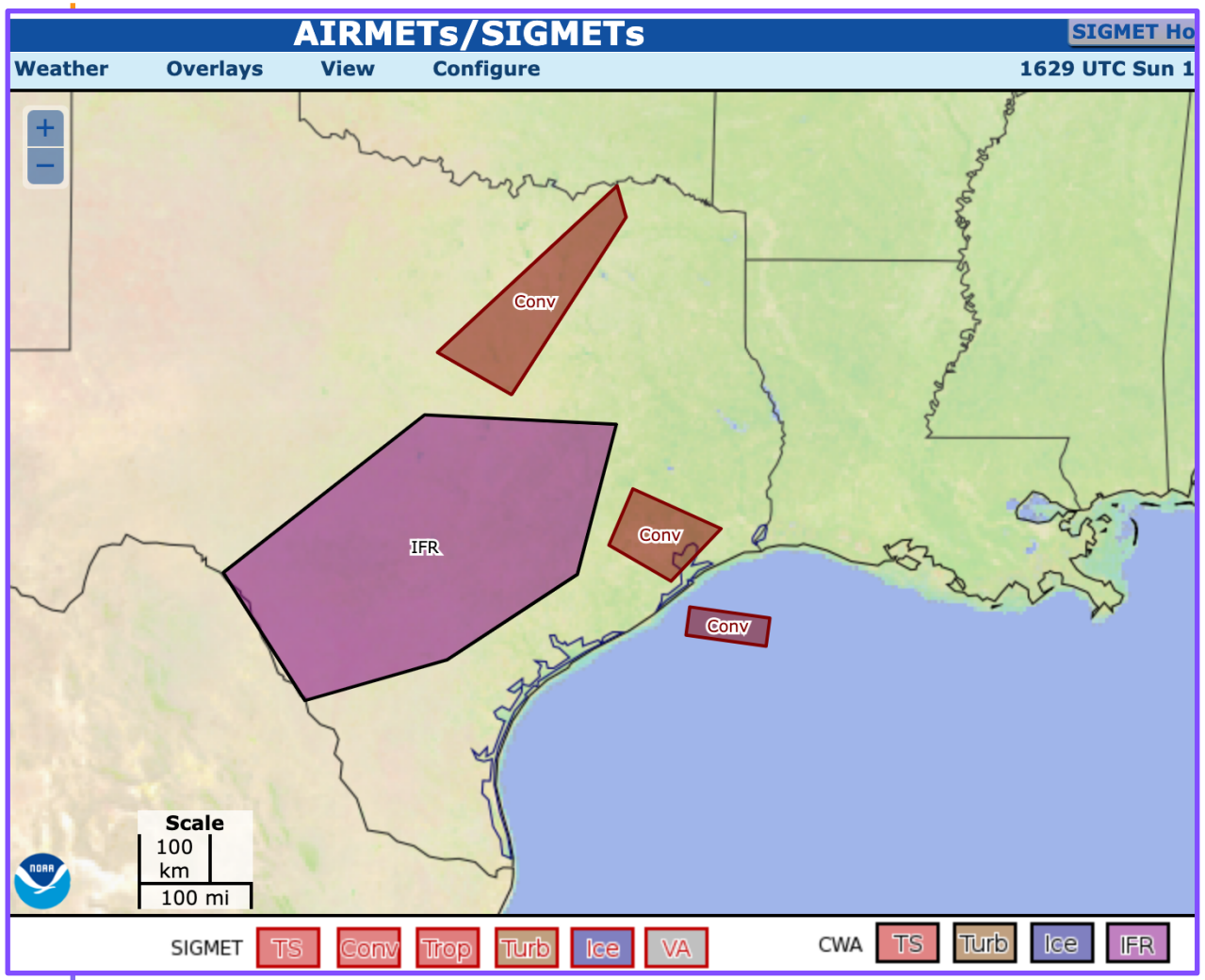
Planning Phase

- Get a WX Briefing from FSS
- Elements Usually In Specified Order

Listen for Phrase: 'VFR Flight Not Recommended'

Planning Products (cont.)

- Adverse Conditions [SIGMETS and AIRMETS (Zulu, Sierra, and Tango) and Radar]
- Synopsis (Surface Analysis Charts, METARS, PIREPS, Cloud Coverage, Visibility, Surface Winds and Precip, Radar and Satellite)
- Forecast (TAFs, Prog Charts, Winds Aloft)
- NOTAMS (Departure, Enroute and Destination)



Planning Requires Practice – Here is an Exercise

- Exercise aviationweather.gov and 1800wxbrief.com for a Sample Flight Plan and Find all the Products on the Previous Page
- Many Products are Both Graphical and Textual
- Then, Ask Yourself: "Can I Avoid the Three Bs?"
- Then, Create a Flight Plan and Call 1 800-WXBRIEF and Get a FSS Briefing

PA.I.C.K3 WX Theory

a) Atmosphere and Stability

78% Nitrogen and 21% Oxygen

H2O as Either Gas, Liquid or Solid

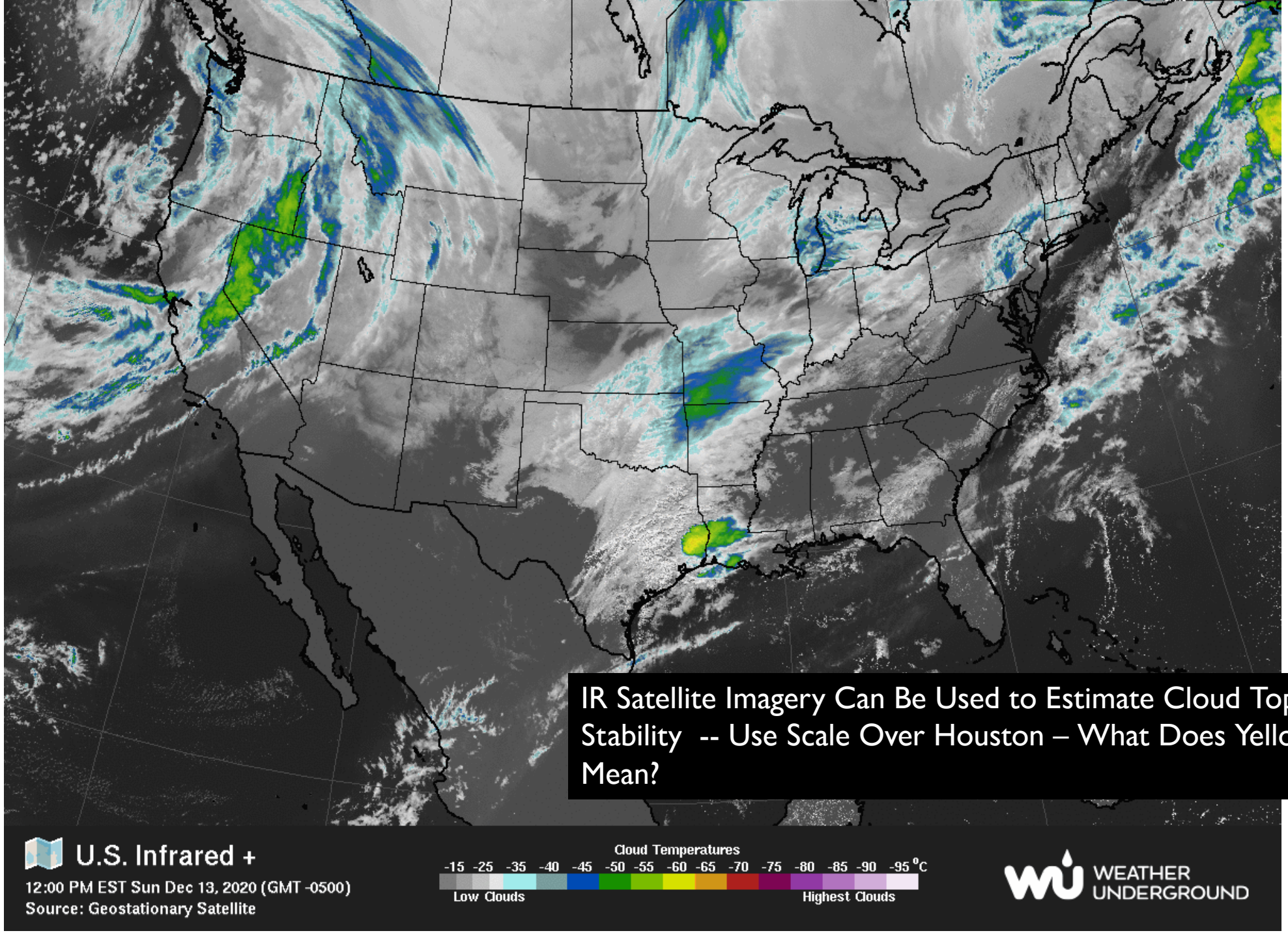
ISA Standard Lapse Rate = -2 Deg C/1000 feet

15 deg C at Sea Level with a Pressure = 29.92" Hg

Exercise: What is ISA at 10,000'?

If Actual Temperature at 10,000' is -15C and Temperature at Sea Level is 20C What Might be a Conclusion?

An Unstable Atmosphere is One Measure of Thunderstorm Likelihood



IR Satellite Imagery Can Be Used to Estimate Cloud Tops, Stability -- Use Scale Over Houston – What Does Yellow Mean?

PA.I.C.K3b WX Wind

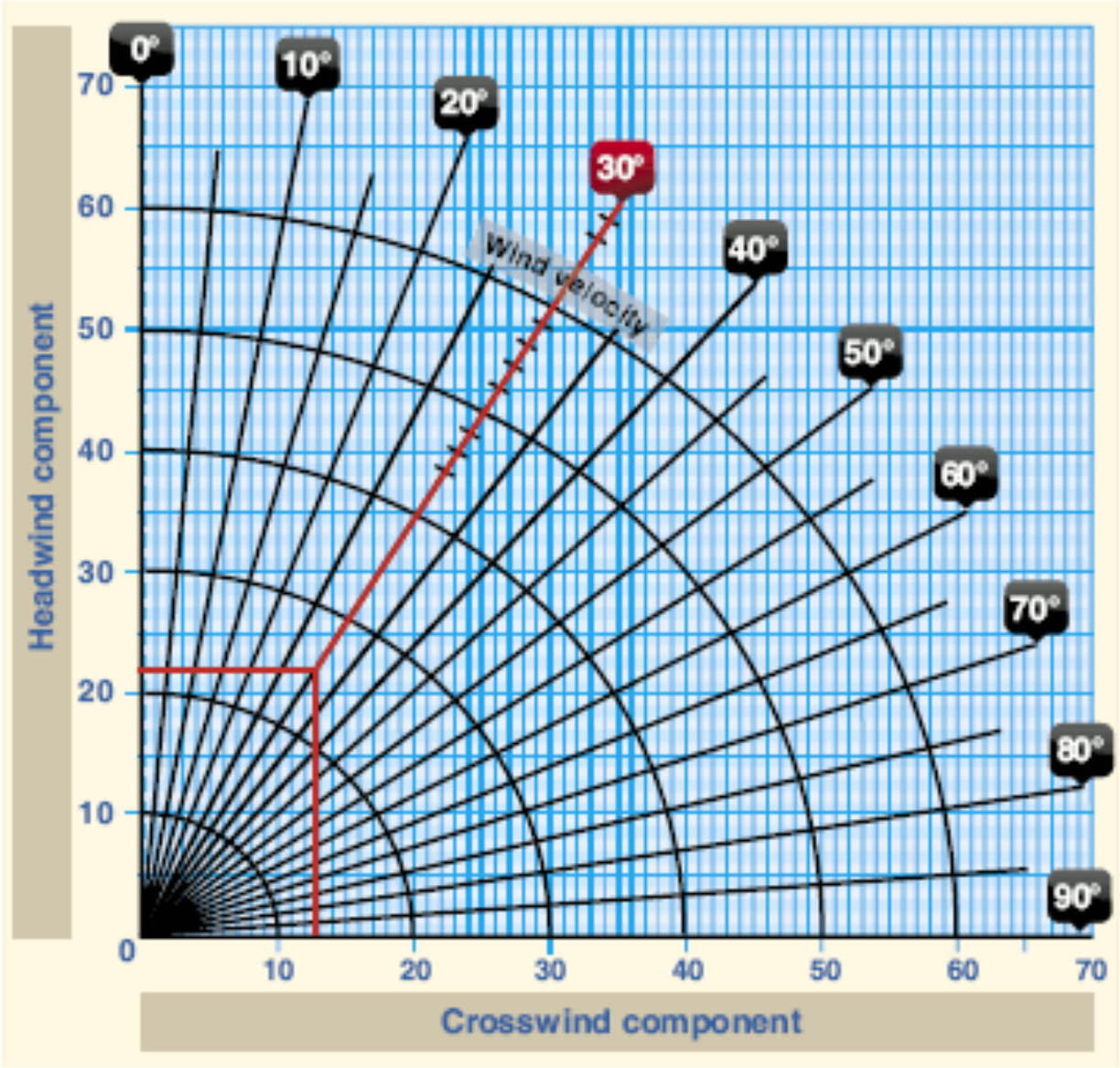
- Wind
  - Movement of Air Molecules
  - Recall Relative Wind Acting on an Airfoil Creates? _____
  - Crosswind or Tail Wind Can Disrupt Normal Performance, Control, and Aircraft Stability
  - Especially an Issue During Takeoff and Landing

Exercise: What is the Result of a 10 knot Tailwind on a Takeoff Roll?

Answer: Increases 50' Obstacle Clearance TO Distance From 1632' (at ISA conditions) to 2449'

Wind (cont.)

- What Does Demonstrated Crosswind Component Mean?
- Be Able to Compute Crosswind from a METAR

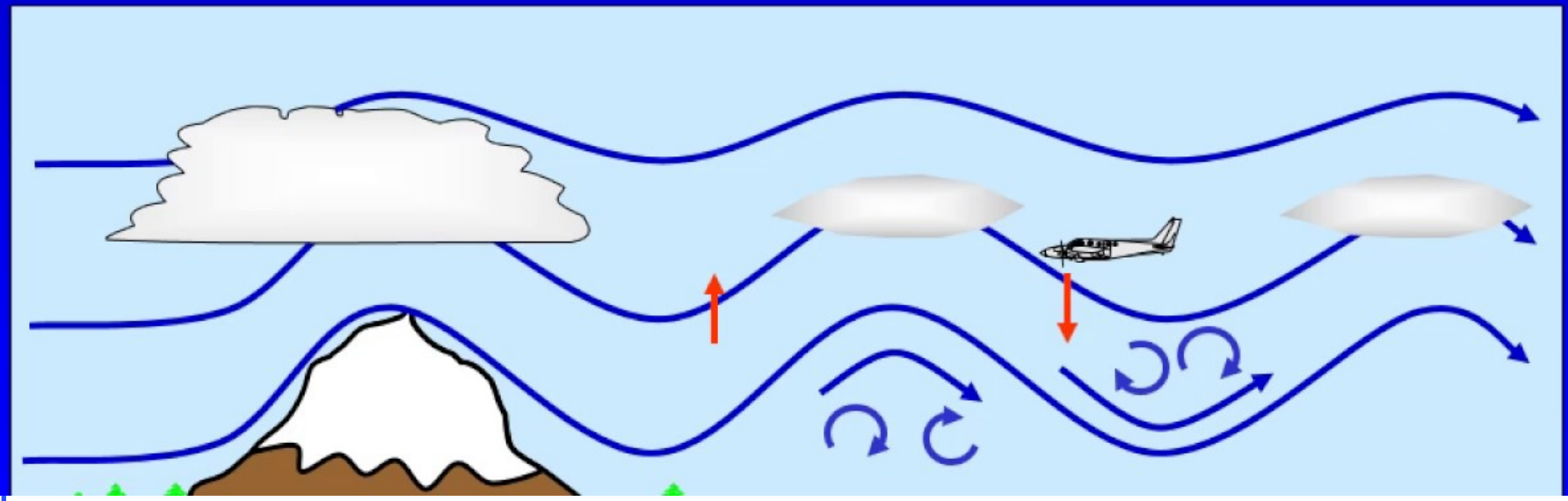


Rwy 17 at KHYI, wind is 220/25; What is the Approximate Crosswind? What Might You Do?

Wind (cont.) (Mountain Wave)

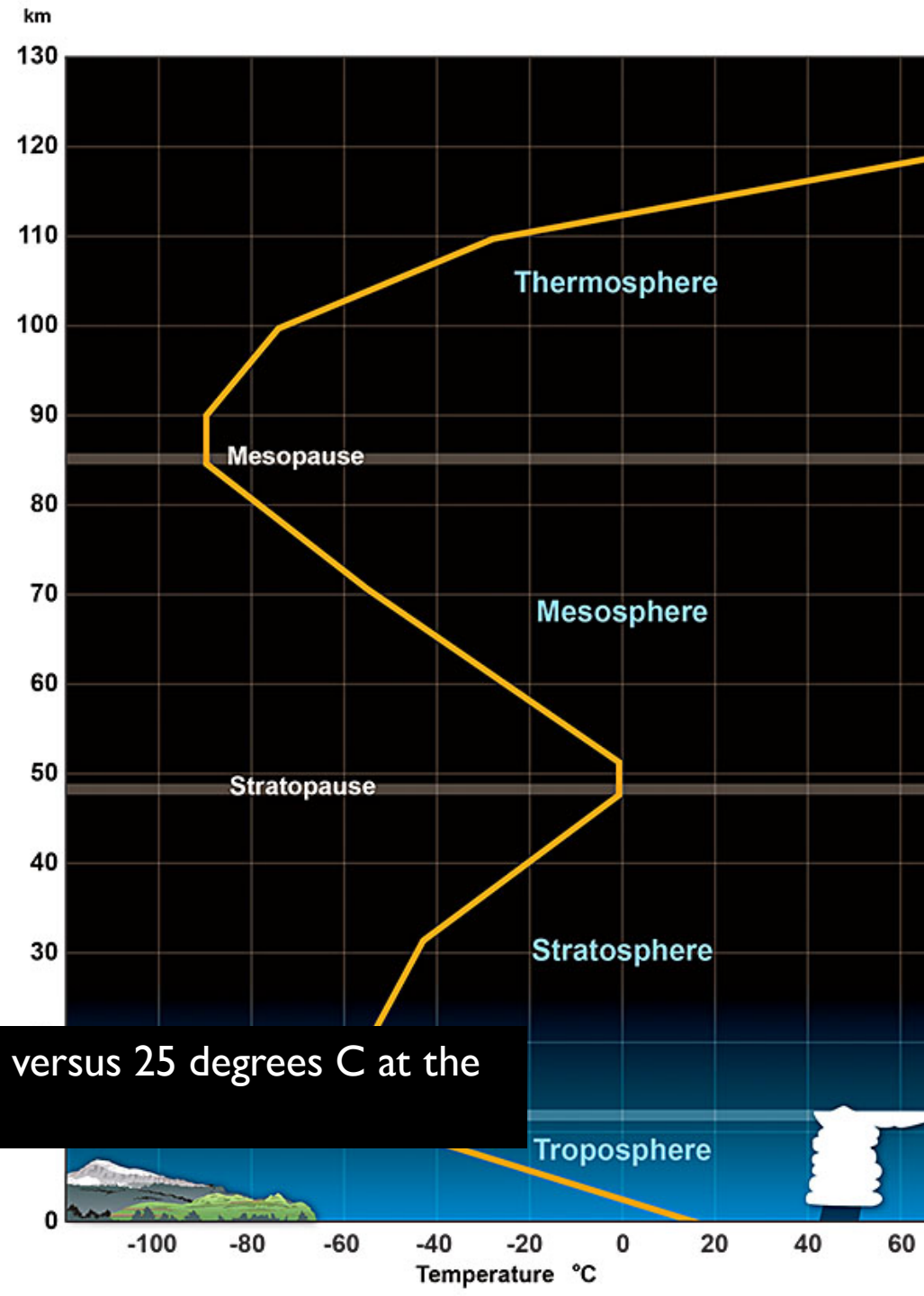
Trapped Lee Wave

- **Hazards**
  - **Strong updrafts & downdrafts**



PA.I.C.K3c Temperature

- Temperature
  - Varies Almost at a Linear Rate Up to Tropopause
  - We Fly In Troposphere



What is the Practical Implication of 15 degrees versus 25 degrees C at the Airports Elevation?

Temperature (cont.)

As Atmospheric Temperature Increases, Kinetic Energy Increases and Gas Molecules Separate– Density Decreases

Exercise, Assume You are at Sea Level, Use E6B and Compute Density Altitude at 29.92" Hg at 15 deg C ?
Repeat for 29.92" at 30 deg C?
Repeat for 30.50" at 15 deg C?

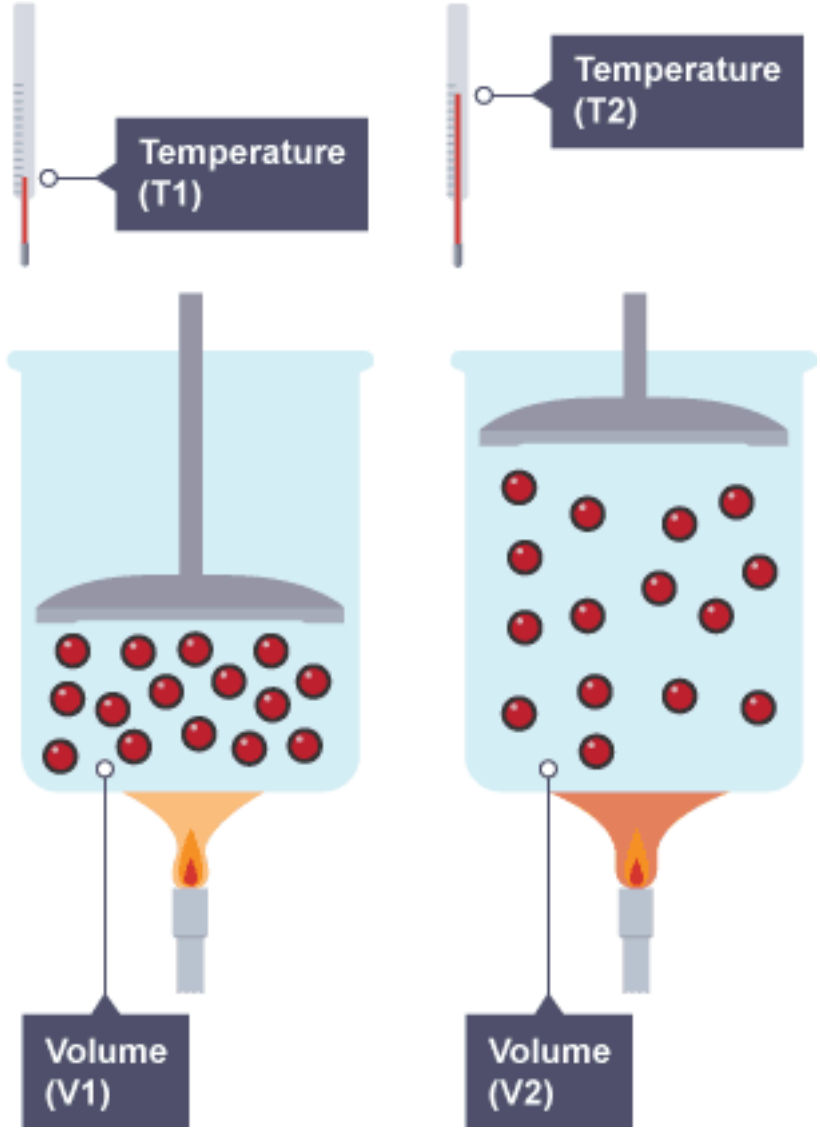
Conclusions:

As Temperature of an Uncontained Gas Increases Its Density ?

_____

As the Pressure of a Gas Increases for the Same Temperature Its Density?

_____



PA.I.C.K3d Moisture and Precipitation

- Moisture and Precipitation
  - H2O Exists as a Gas, Liquid, or Solid in the Atmosphere

The Mass of Moisture, as a Gas, is Less Than the Mass of Dry Air

Mix H2O as a Gas with Dry Air, The Resulting Density Will?

_____

Conclusions:

Air Density is a Function of:

a. _____
b. _____
c. _____

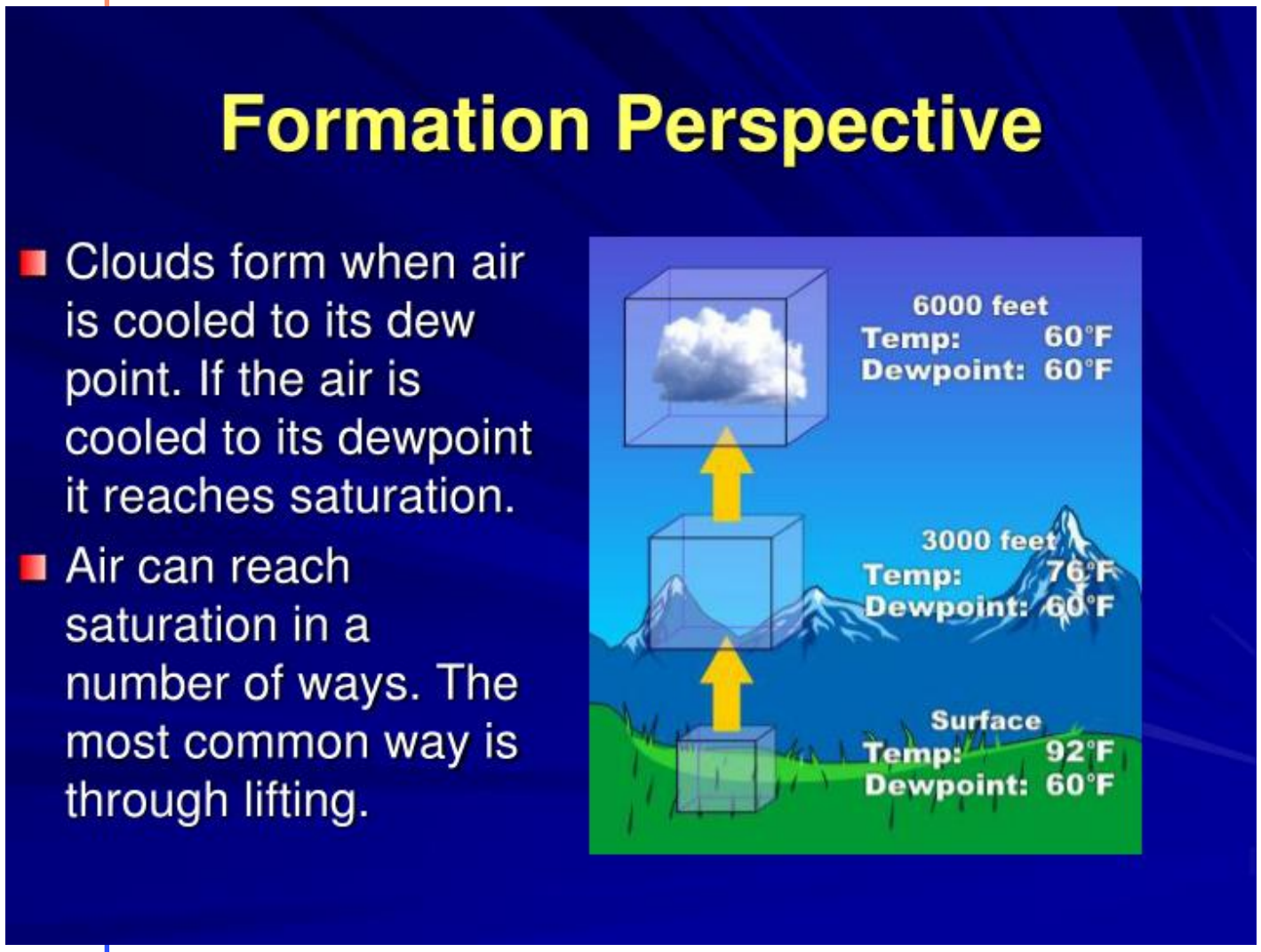
Moisture and Precipitation (cont.)

Name 3 Hazards to Flight as a Result of:

1. Rain or Mist
2. Freezing Rain
3. Snow
4. Hail

What Causes Precipitation?

Moisture and Precipitation (cont.)

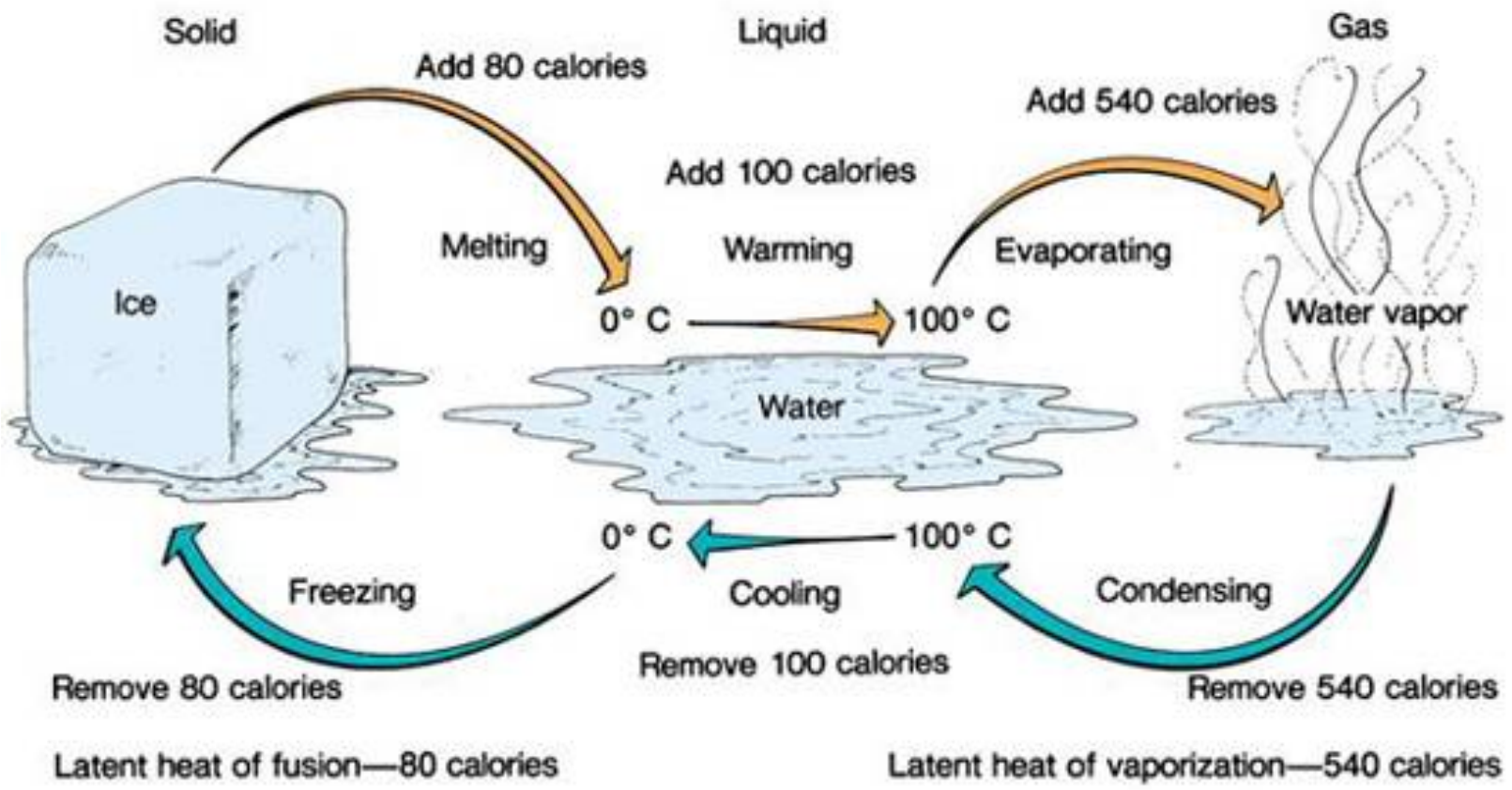


- Dewpoint
- Cooling Ambient Air Results in Saturation
- H2O Gas Changes to Liquid or Solid
- This is Called Changing State

What Happens When We Change State?

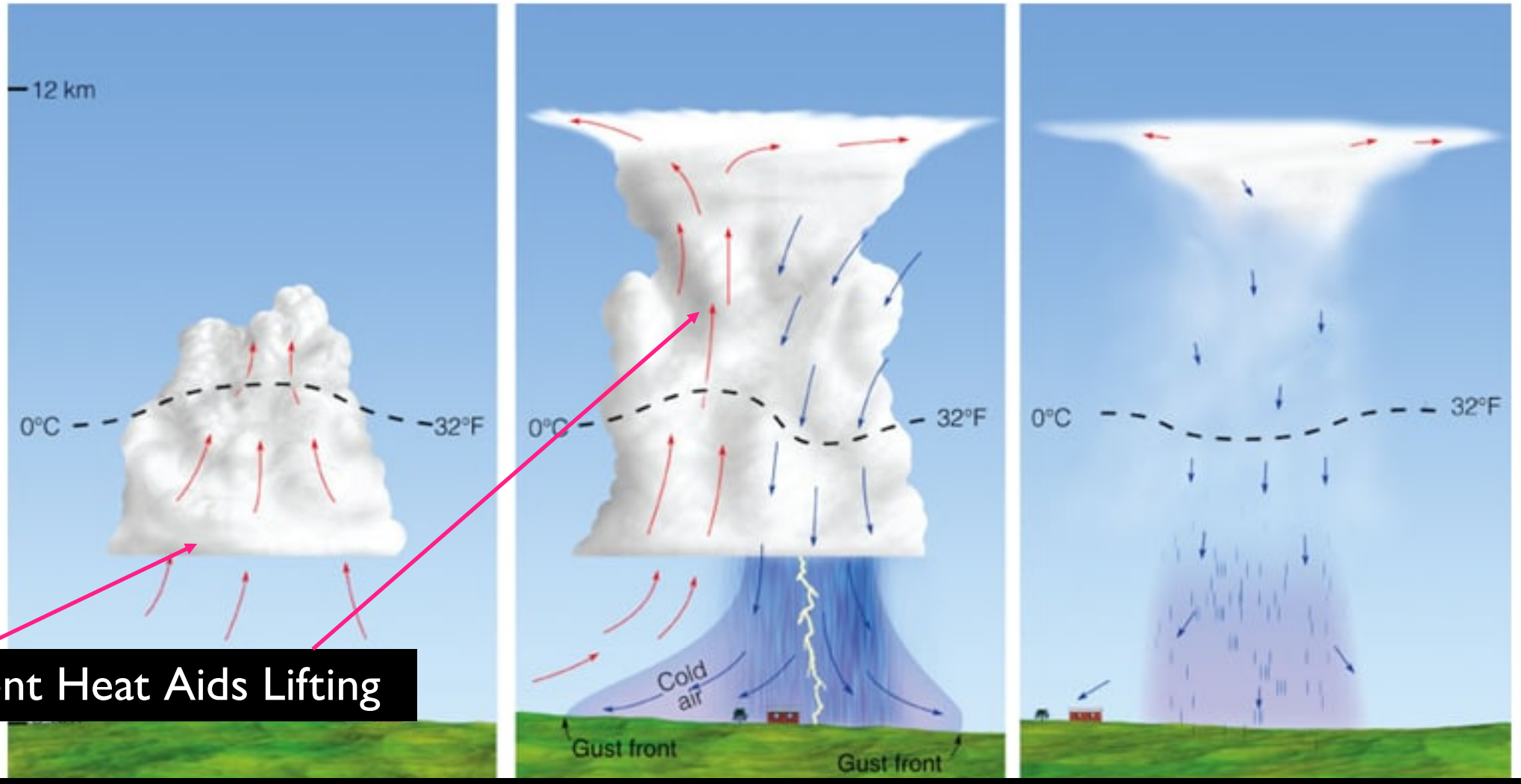
Moisture and Precipitation (cont.)

Latent Heat Cycle



When a Cloud Forms Where Does Latent Heat Go?

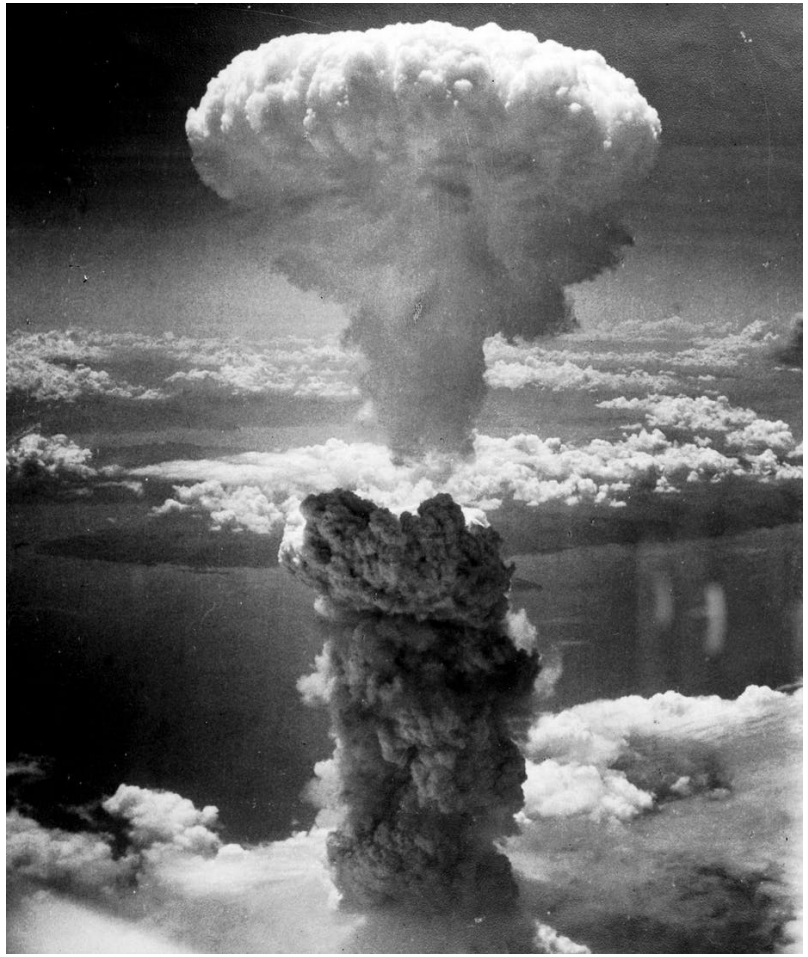
Latent Heat Creates Lift



Latent Heat Aids Lifting

Condensation Releases Thermal Energy (Heat) Into Atmosphere

Latent Heat (Energy) in Thunderstorm



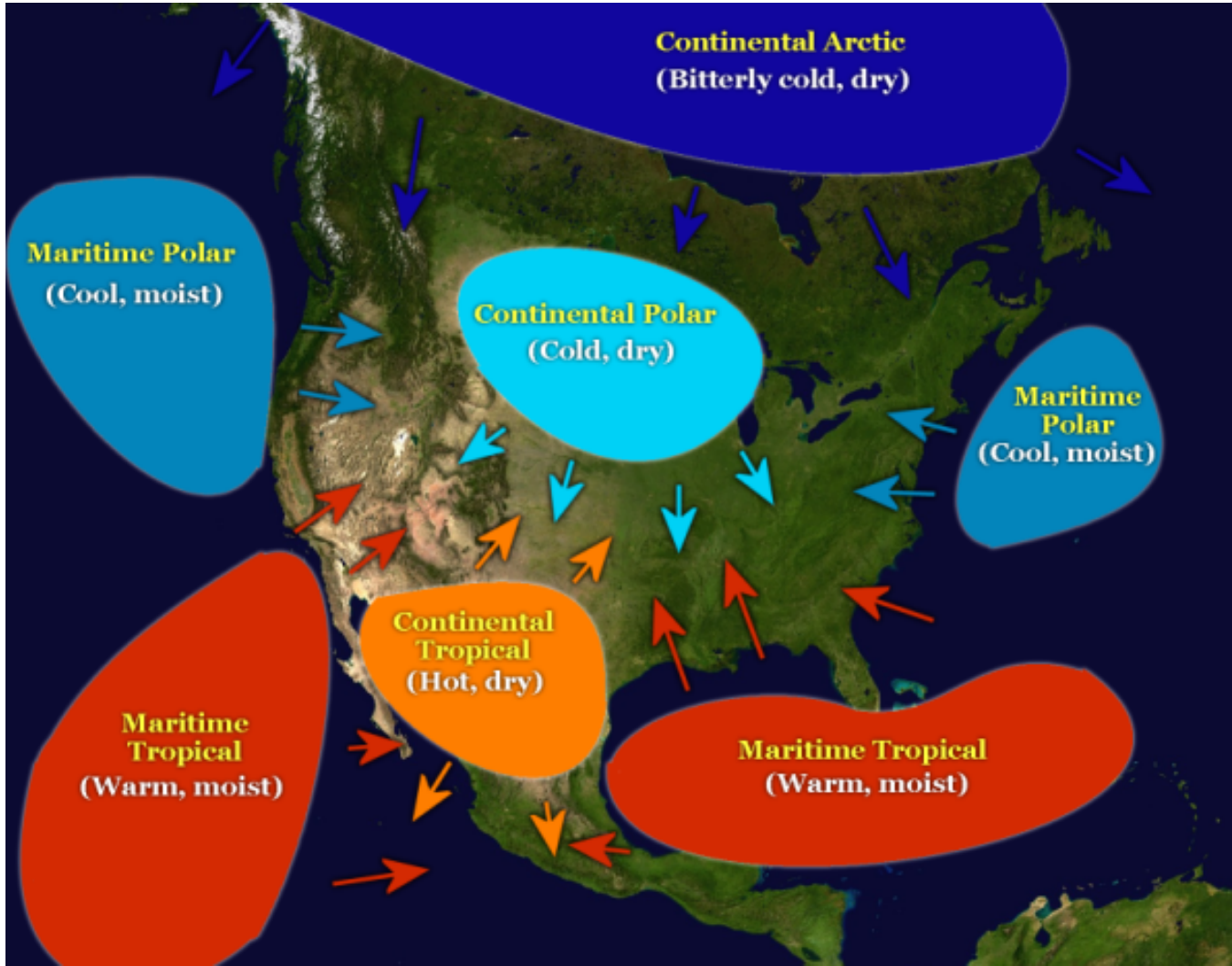
Compared to a Strategic Atomic Warhead (100 K tons) a Thunderstorm Can Release Between 10 to 450 K tons of Energy

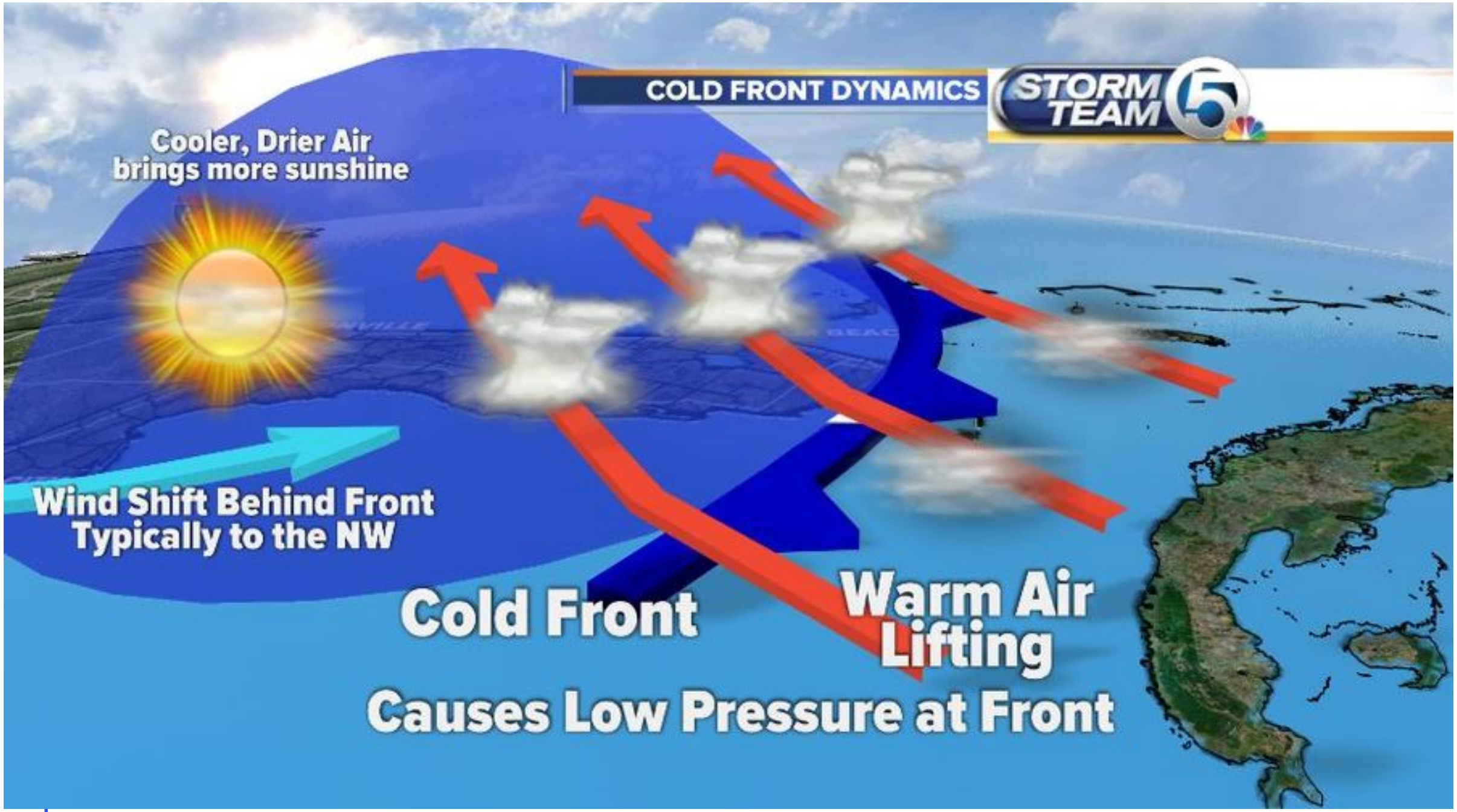
PA.I.C.K3e WX Systems, Air Masses, Fronts

Not Much Discussion of Air Mass Theory Anymore

Air Masses Characterized By Region, Temperature Moisture

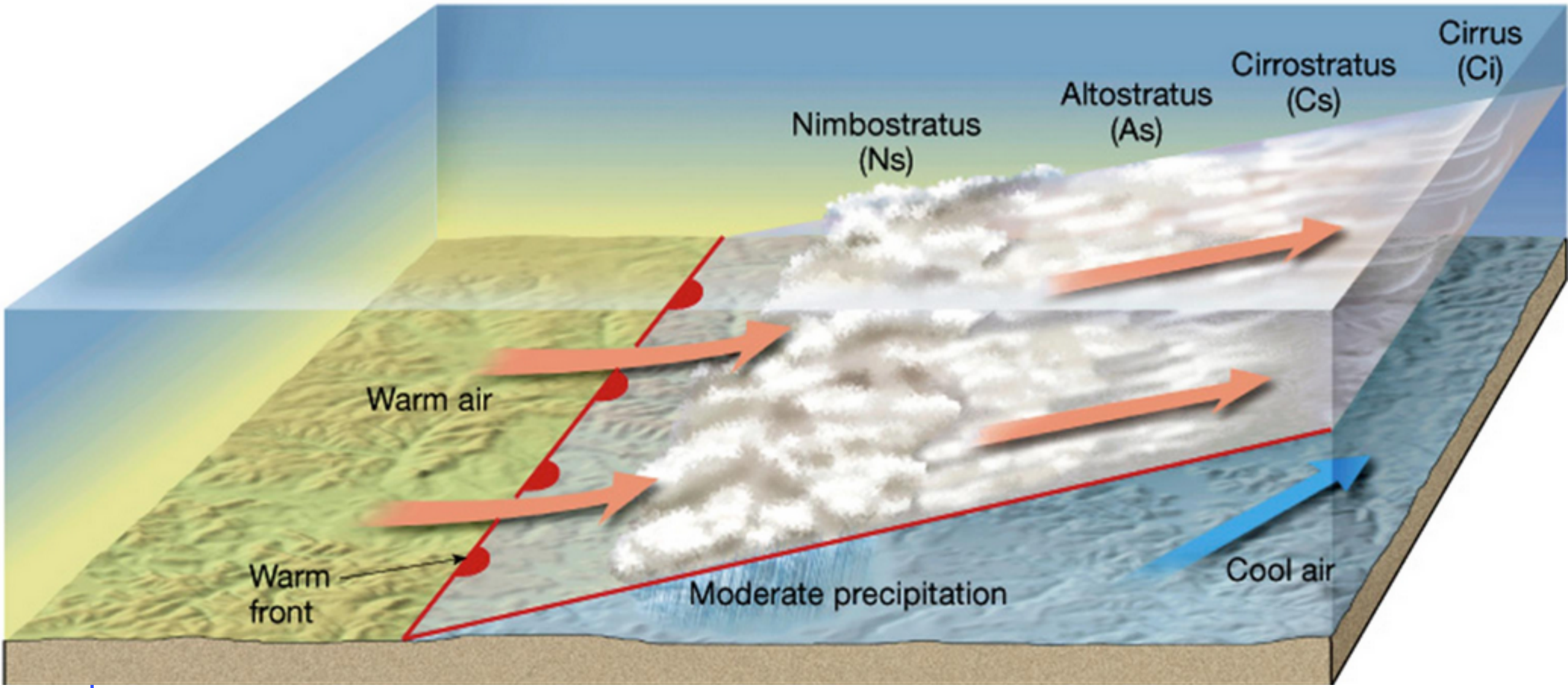
Two or More Air Masses Meet Results in a Front




COLD FRONT DYNAMICS
STORM TEAM 5
Cooler, Drier Air
brings more sunshine
Wind Shift Behind Front
Typically to the NW
Cold Front
Warm Air
Lifting
Causes Low Pressure at Front

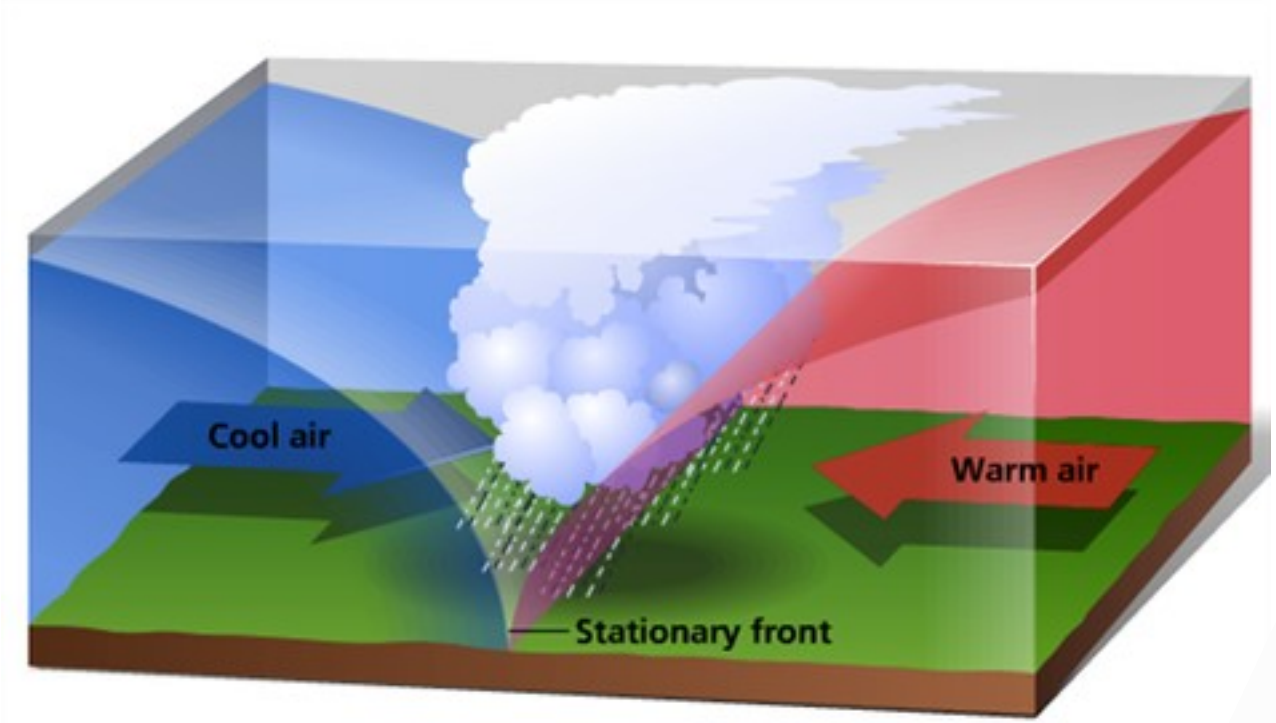
Warm front

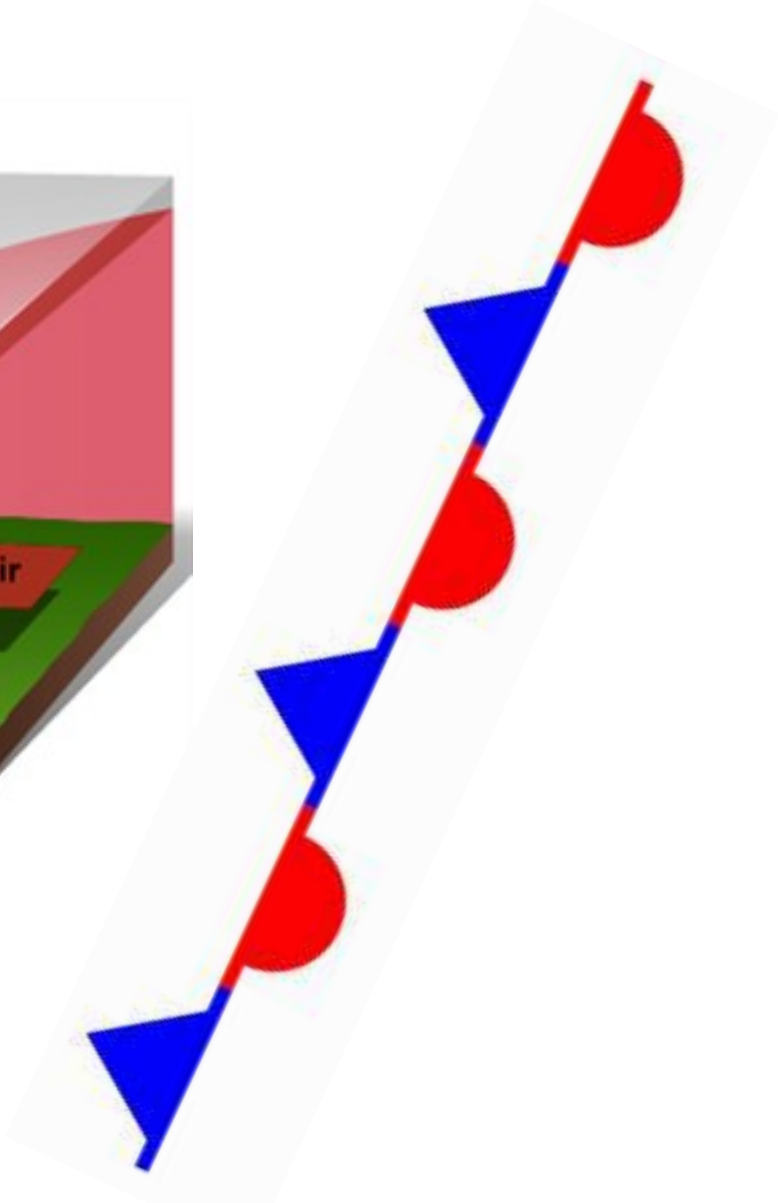
Source: Lutgens and Tarbuck, 2004



- Warm Fronts and Cold Fronts are caused by air pressure.

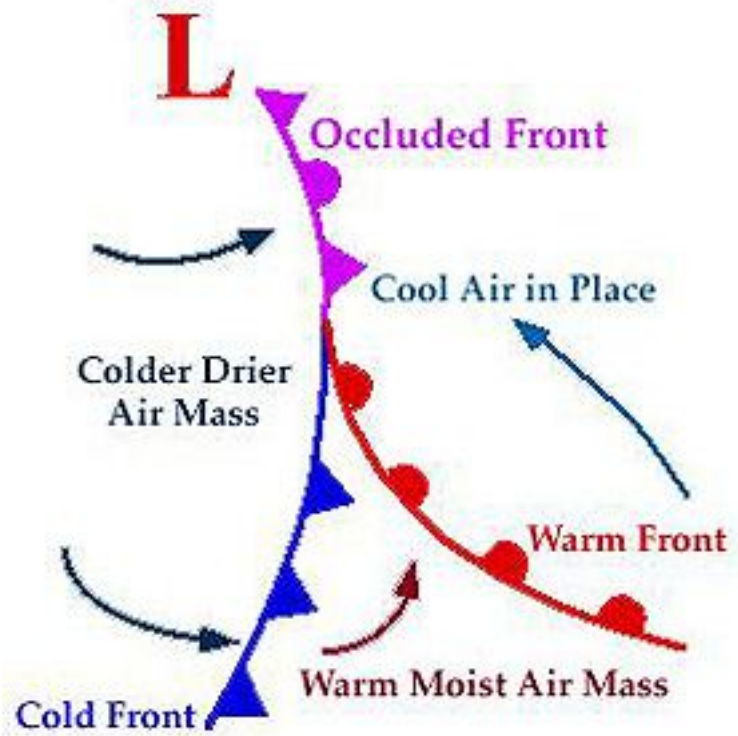
Stationary Front



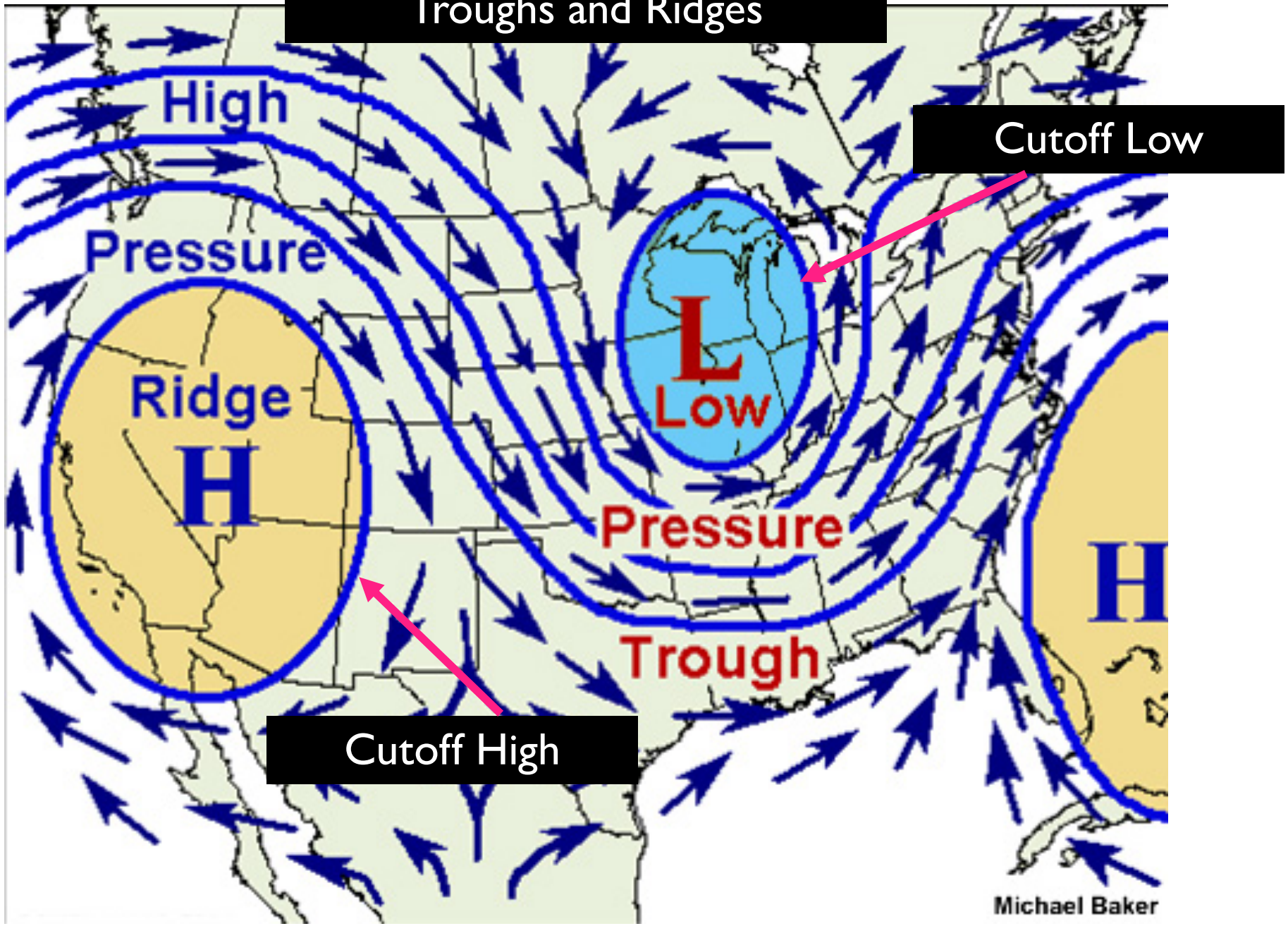


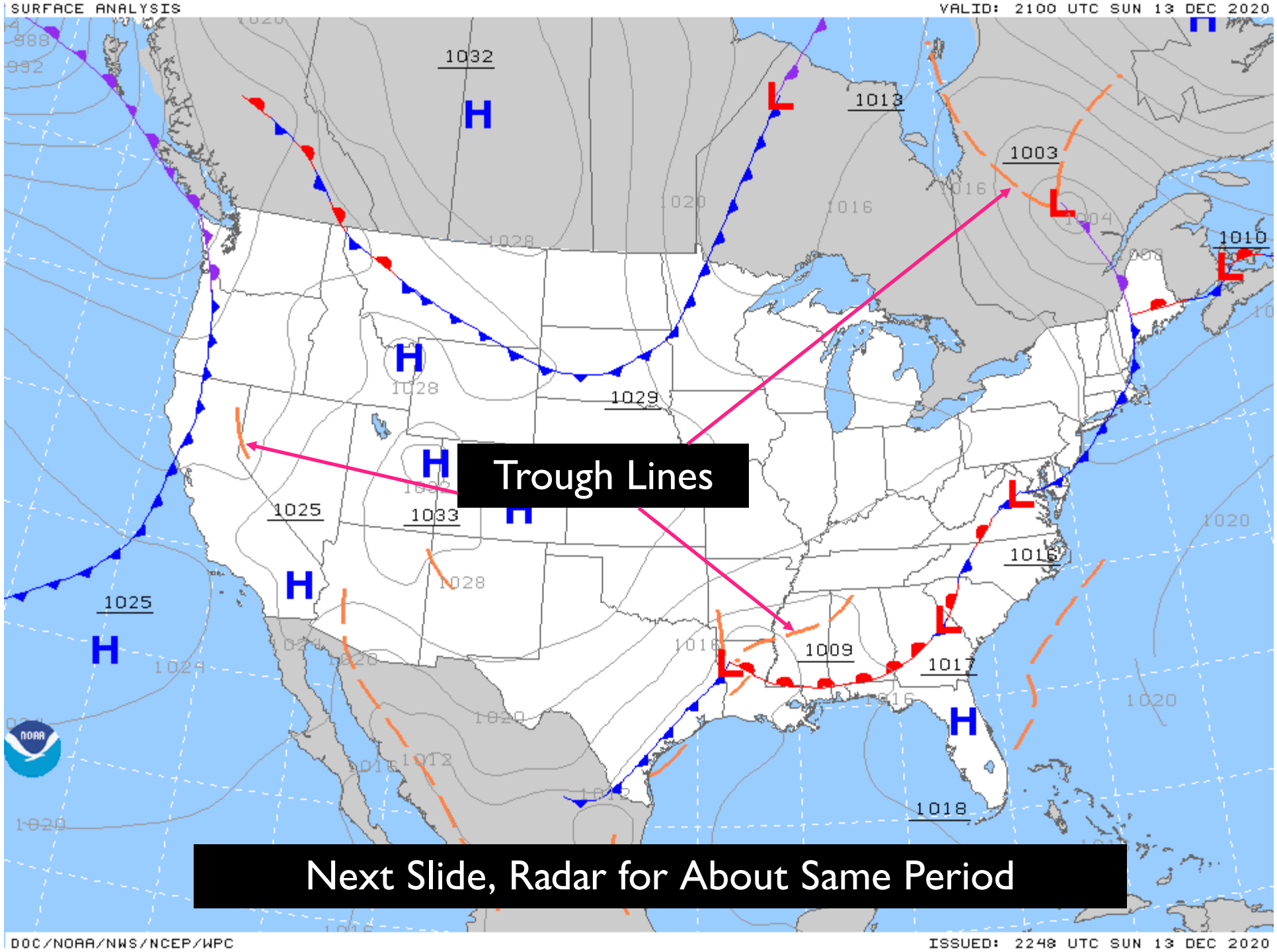
Characterized by Little or No Frontal Movement

Occluded Front or Upper Air Front

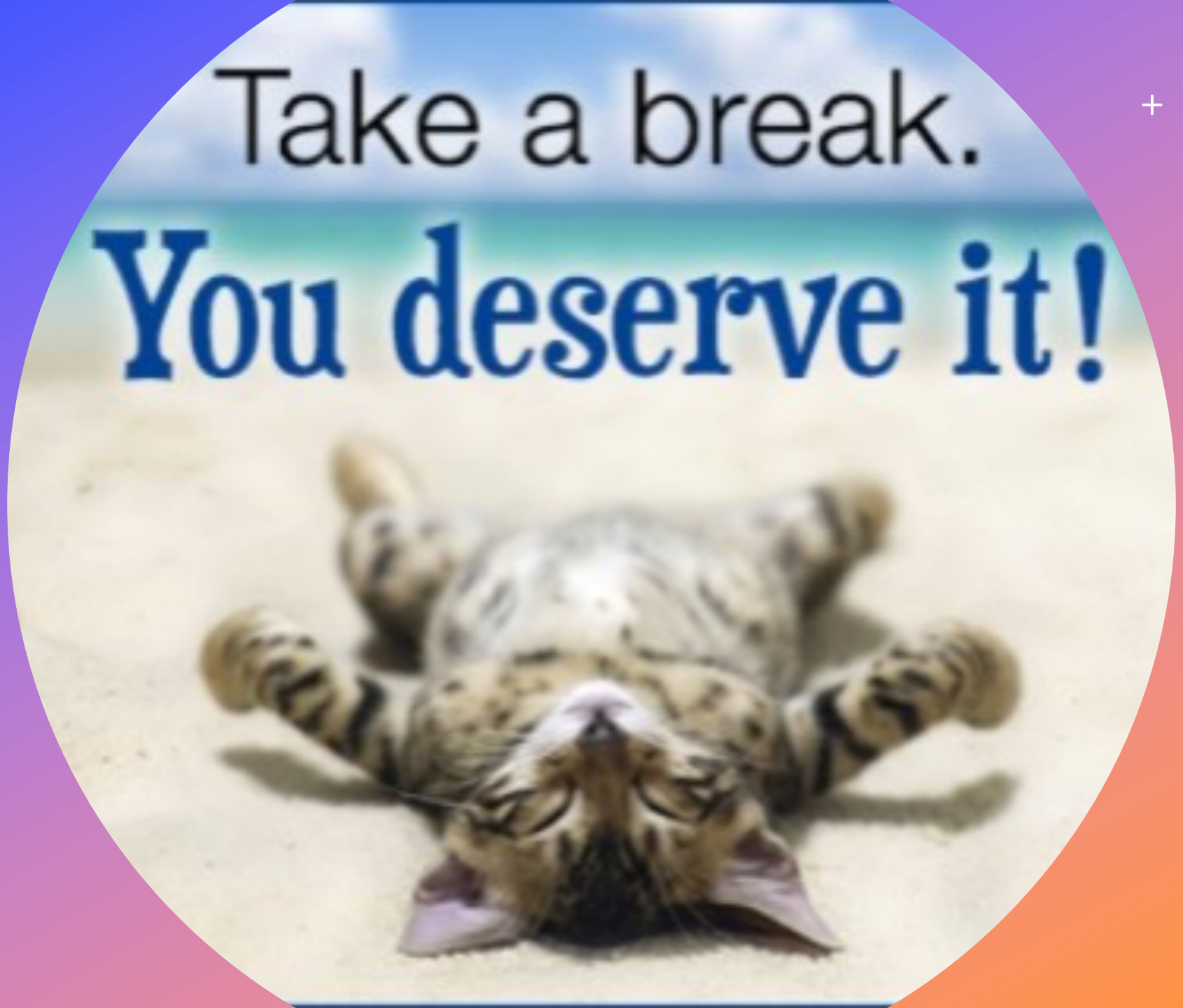


Troughs and Ridges



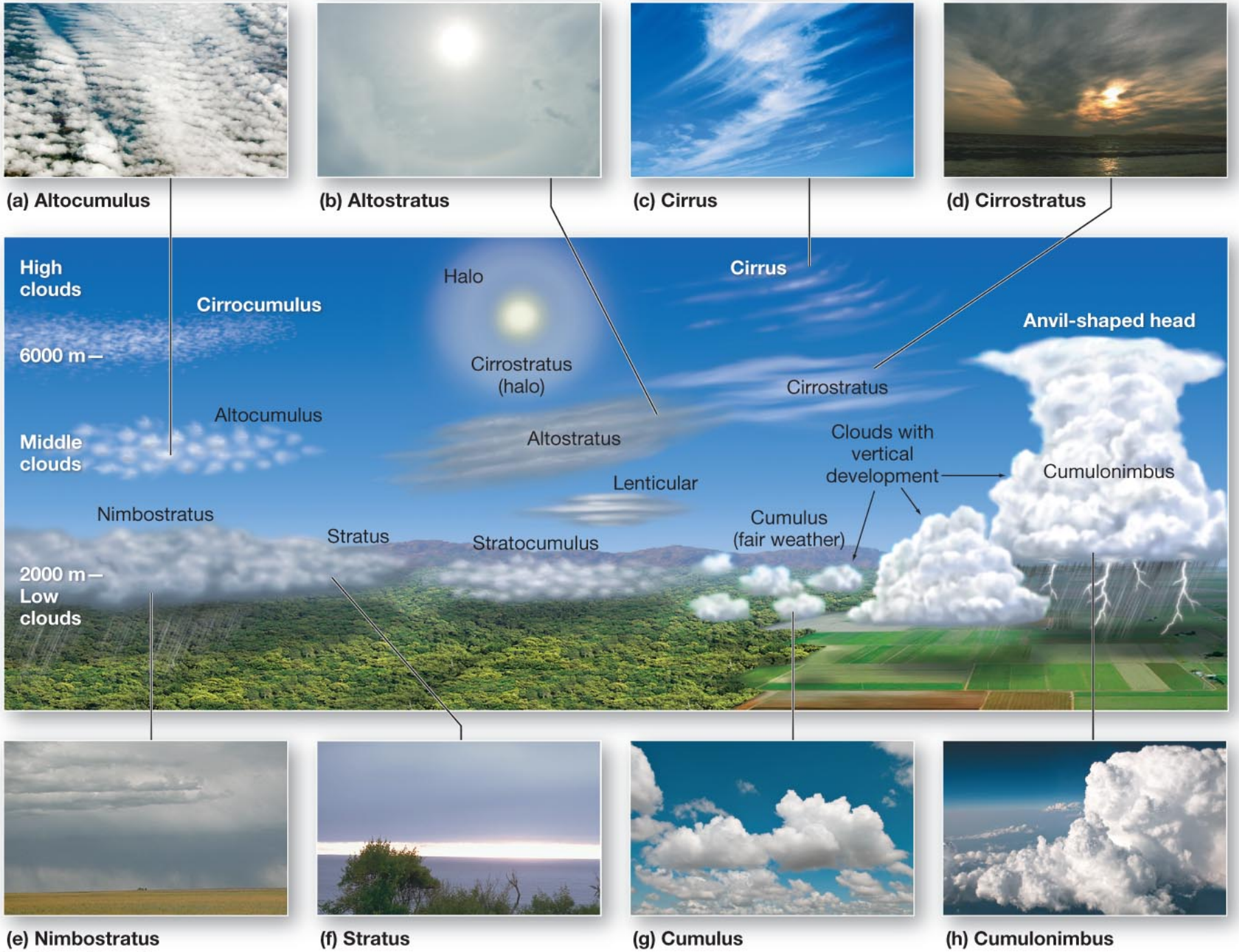

SURFACE ANALYSIS
VALID: 2100 UTC SUN 13 DEC 2020
1032
H
1013
L
1003
L
1010
L
H
1028
1029
H
1033
H
1025
H
1025
H
1009
L
1017
L
1016
L
H
1018
1020
1016
1012
Trough Lines
Next Slide, Radar for About Same Period
DOC/NOAA/NWS/NCEP/WPC
ISSUED: 2248 UTC SUN 13 DEC 2020


Radar Coded Message
www.aviationweather.gov
0015 UTC Mon 14 Dec 2020
15 30 40 45 50 55
220
120
160
230
210
210
210
220
240
210
280
270
200
100
220
320
280
360
330
290
270
320
350
240
190
400
360
150
090
Look at This Then Go Back and Examine Trough Lines


Take a break.
You deserve it!

PA.I.C.K3f Clouds

- Characterization by Height (approximation)
  - High Clouds (Cirrus – Ice Particles) > 18,000’
  - Middle (Alto) 6,000’ to 18,000’
  - Low < 6,000’
- Characterization by Precipitation
  - Nimbo – Rain
- Characterization by Shape
  - Cumulus
  - Stratus
  - Lenticular

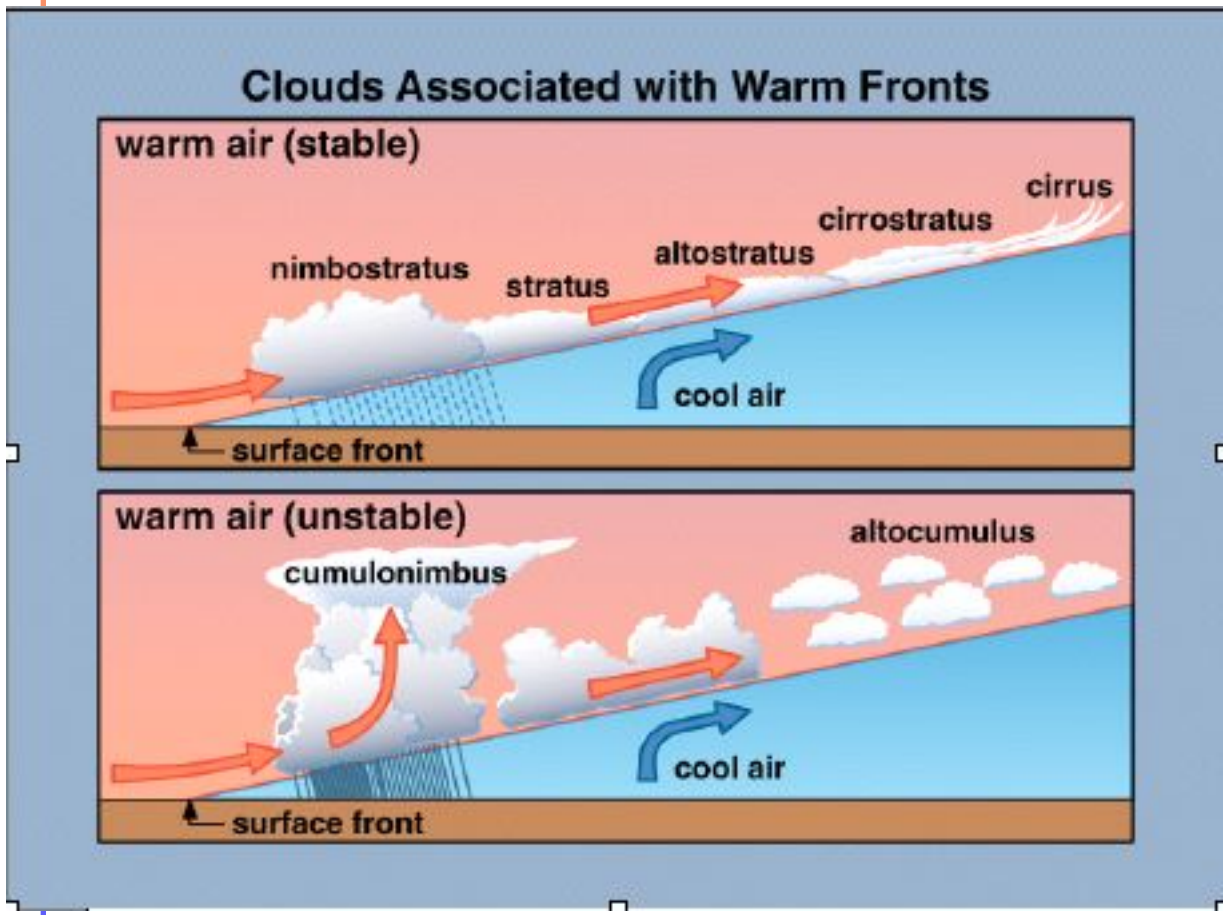


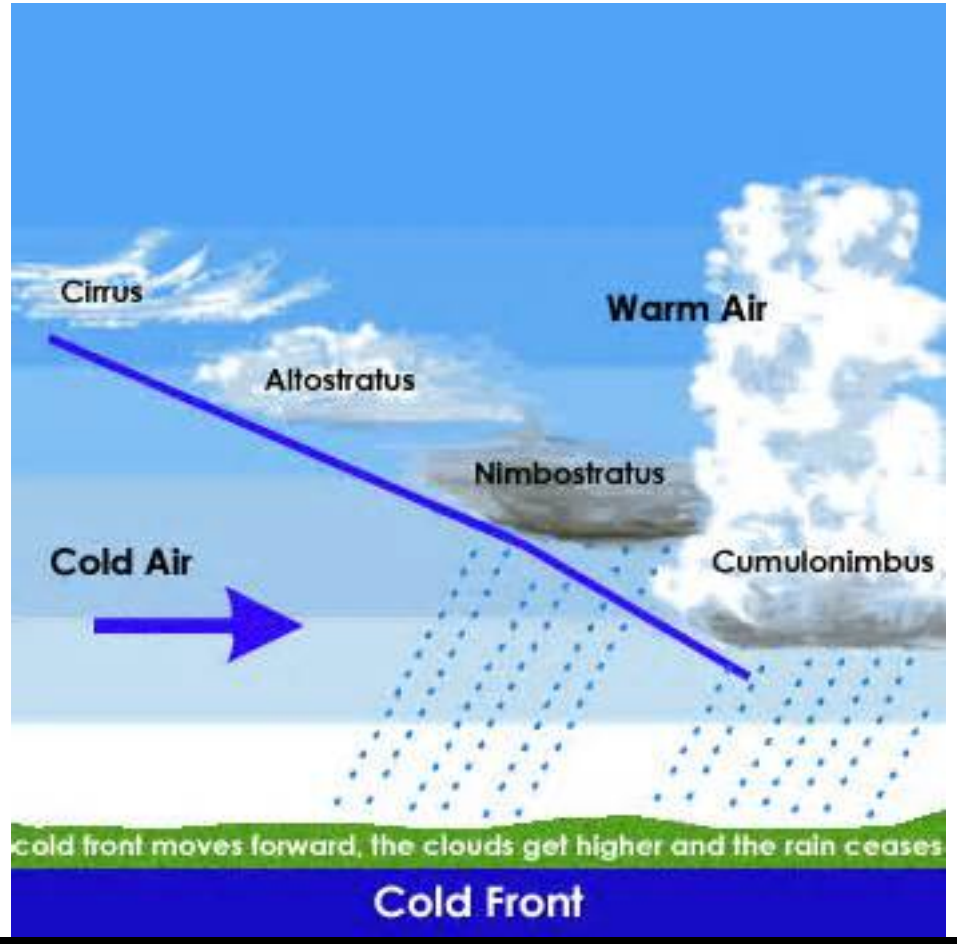
Recall Formation of a Cloud Means Gas Has Changed to Liquid

Therefore, What are Hazards of Flying Through or Near a Cloud?

FAA Says VFR Pilots Should Remain Greater Than 20 Miles Away From CBs (Cumulonimbus or Thunderstorms)

Note Effect of Stability With Warm Front and Type of Cloud/Precipitation





Nimbostratus – Large Area - Sustained

Cumulonimbus – Smaller Area - Showery

PA.I.C.K3g Turbulence

- Six Levels

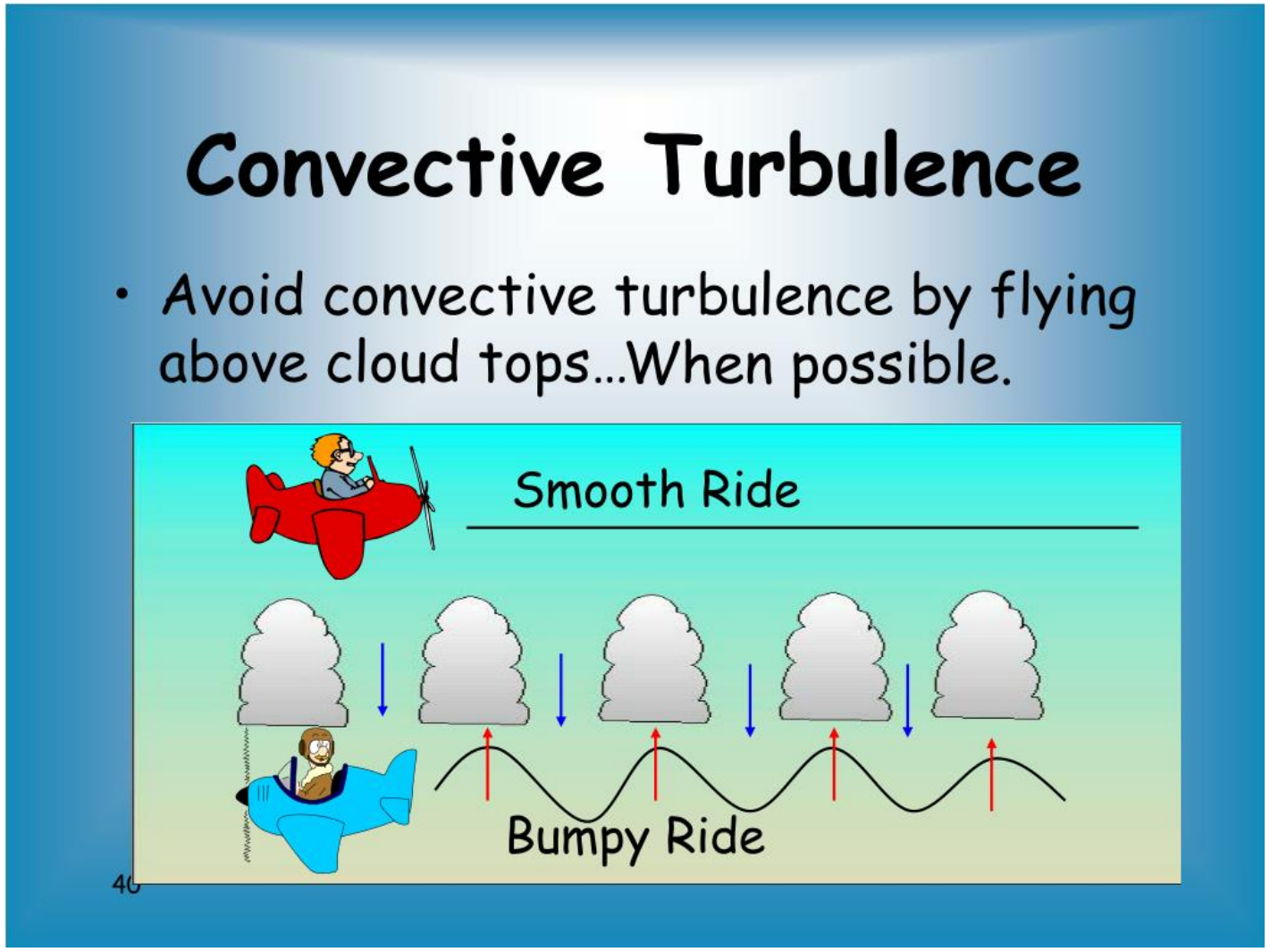
1. Light Chop, Rhythmic, No Altitude or Attitude Deviations

Turbulence Levels (cont.)

2. Light, Momentary Change in Attitude or Altitude

Turbulence Levels (cont.)

3. Moderate Chop, Similar to Light Chop But More Consistent, Slight Change in Altitude or Attitude



Turbulence Levels (cont.)

4. Moderate – Deviations in Altitude and Attitude but Airplane Remains in Control

Turbulence Levels (cont.)

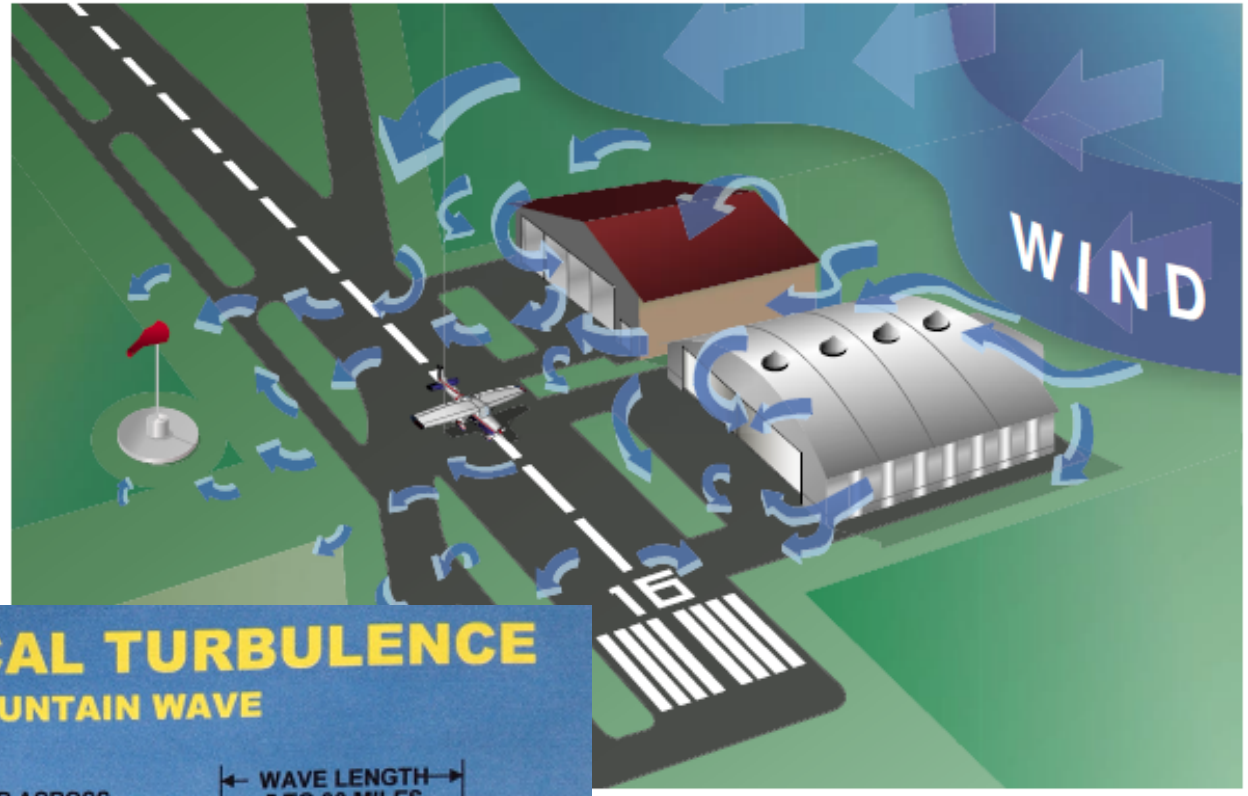
5. Severe – Temporary Loss of Control, Large Abrupt Changes in Altitude and Attitude

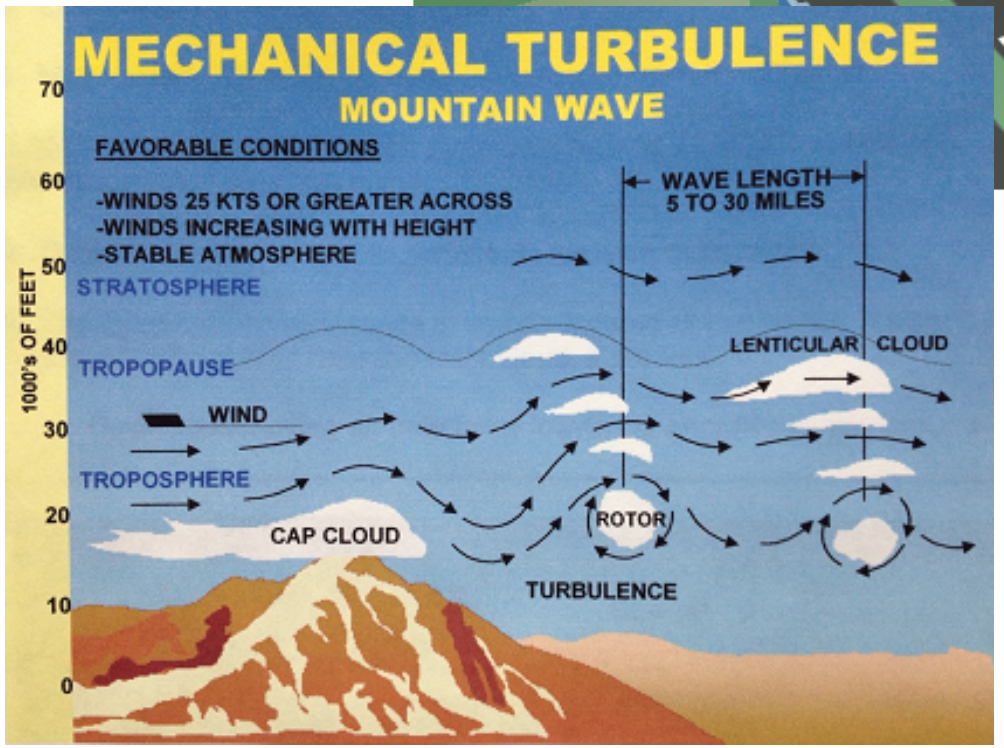
Turbulence Levels (cont.)

6. Extreme – Airframe Damage and Likely Total Loss of Control – This Airplane Flew Into Squall Line and Broke-up Mid-Air

Causes of Turbulence

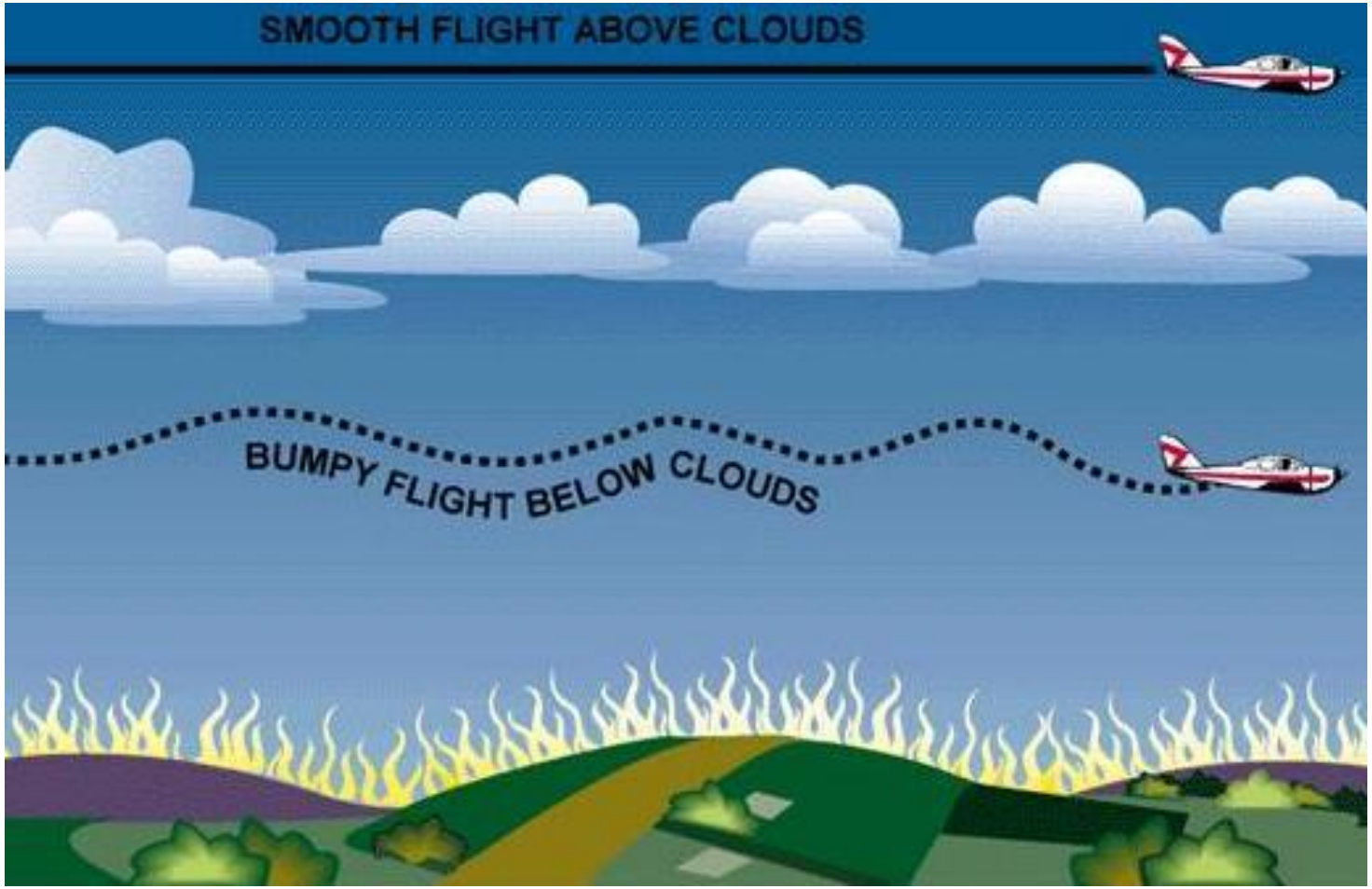
1. Mechanical – Air Friction With Objects on the Ground; This Includes Mountain Waves





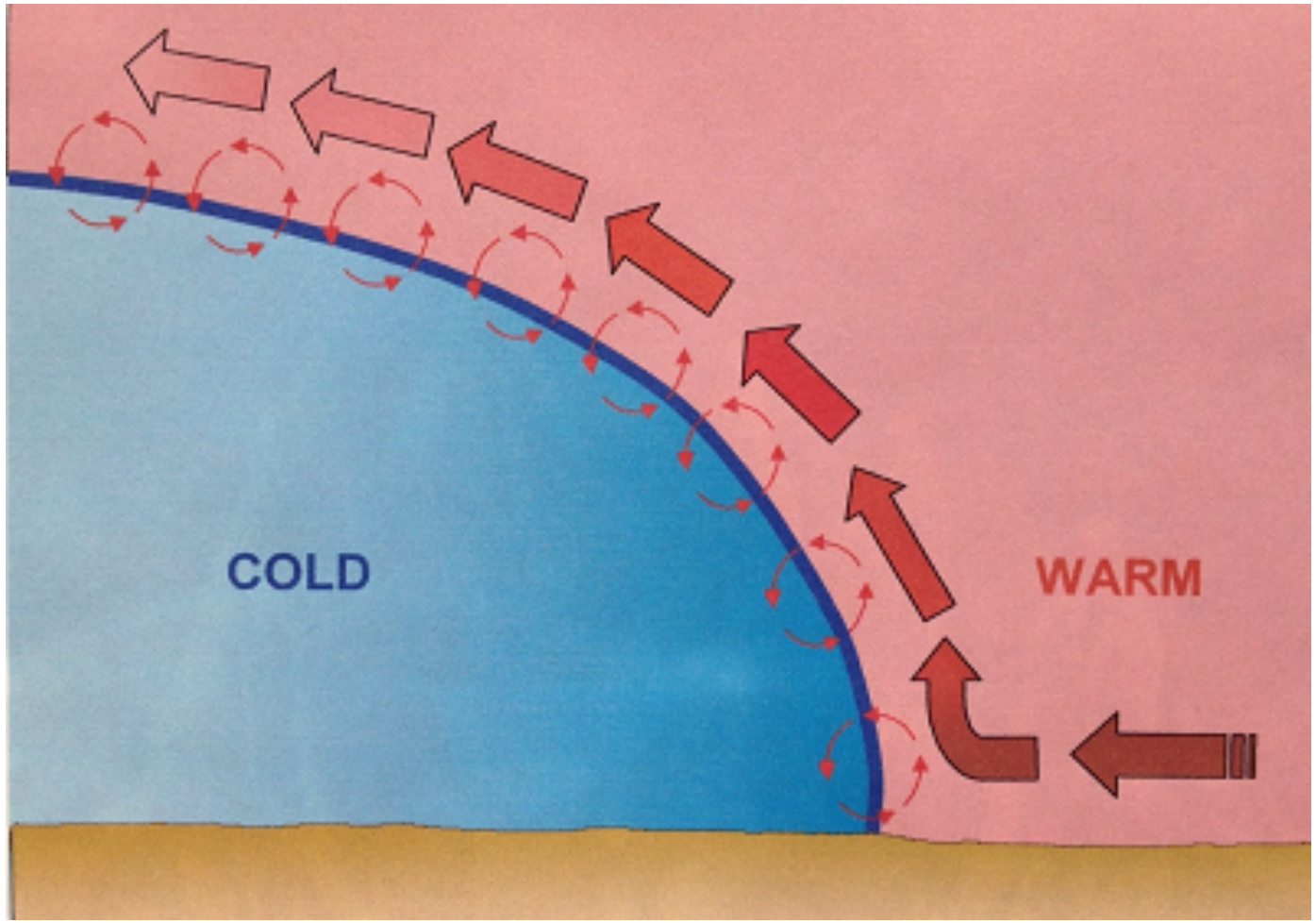
Causes of Turbulence (cont.)

2. Thermal or Convective – Mixing in Atmosphere Usually Following or as an Inversion Begins to Dissipate



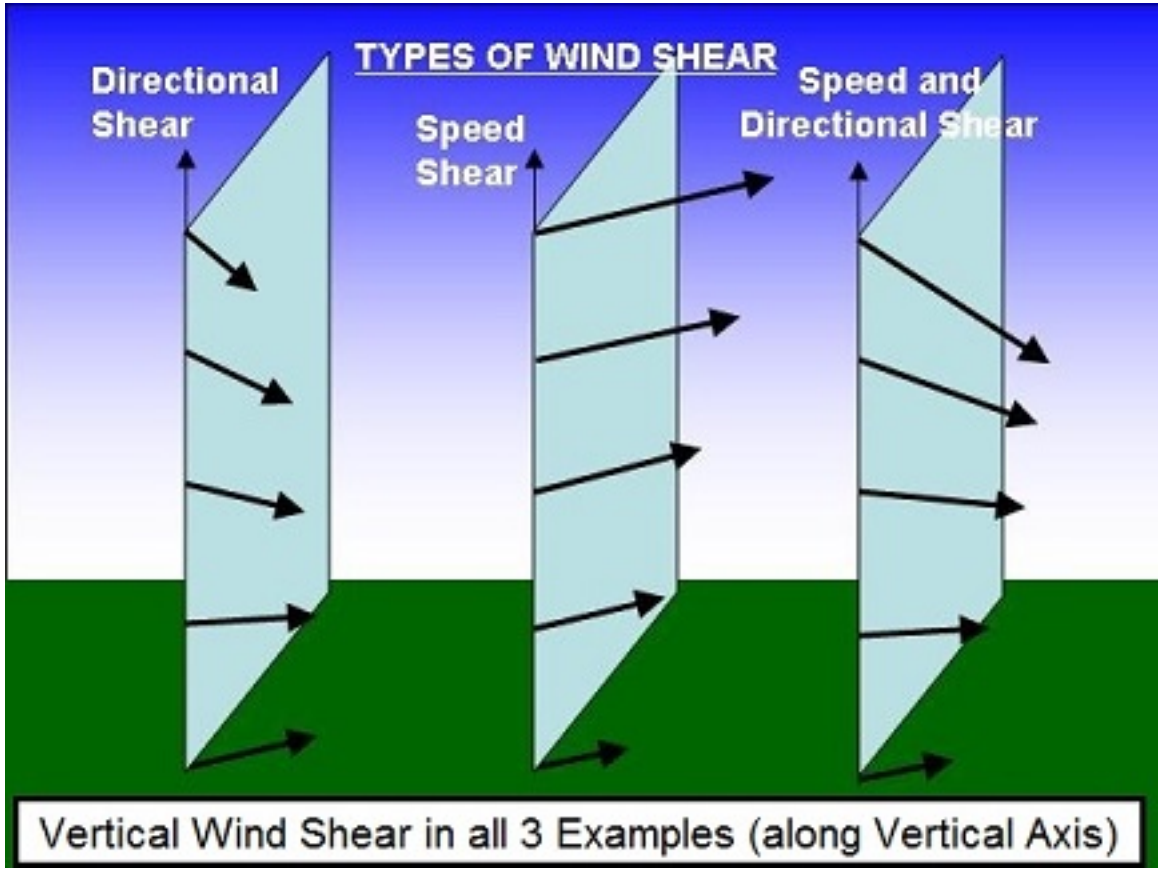
Causes of Turbulence (cont.)

3. Frontal Lifting – Most Common With Cold Fronts



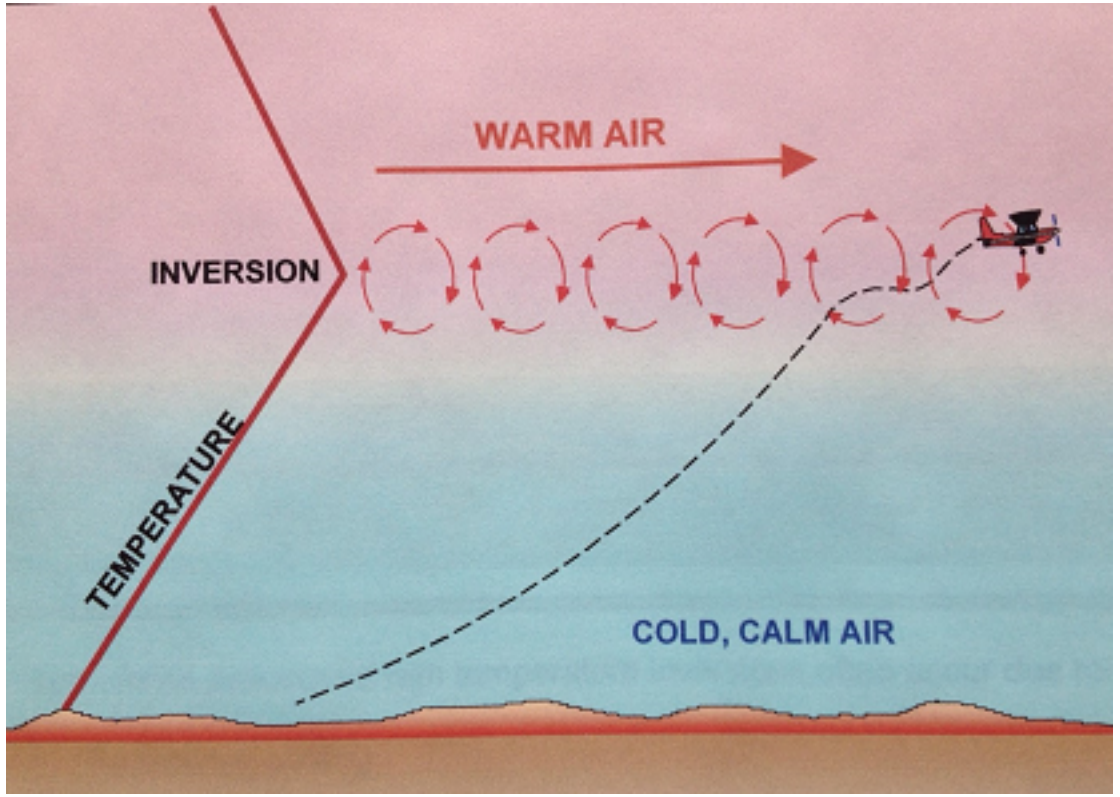
Causes of Turbulence (cont.)

4. Wind Shear
   a) Near Temperature Inversions
   b) Along Troughs and Lows
   c) Jet Streams

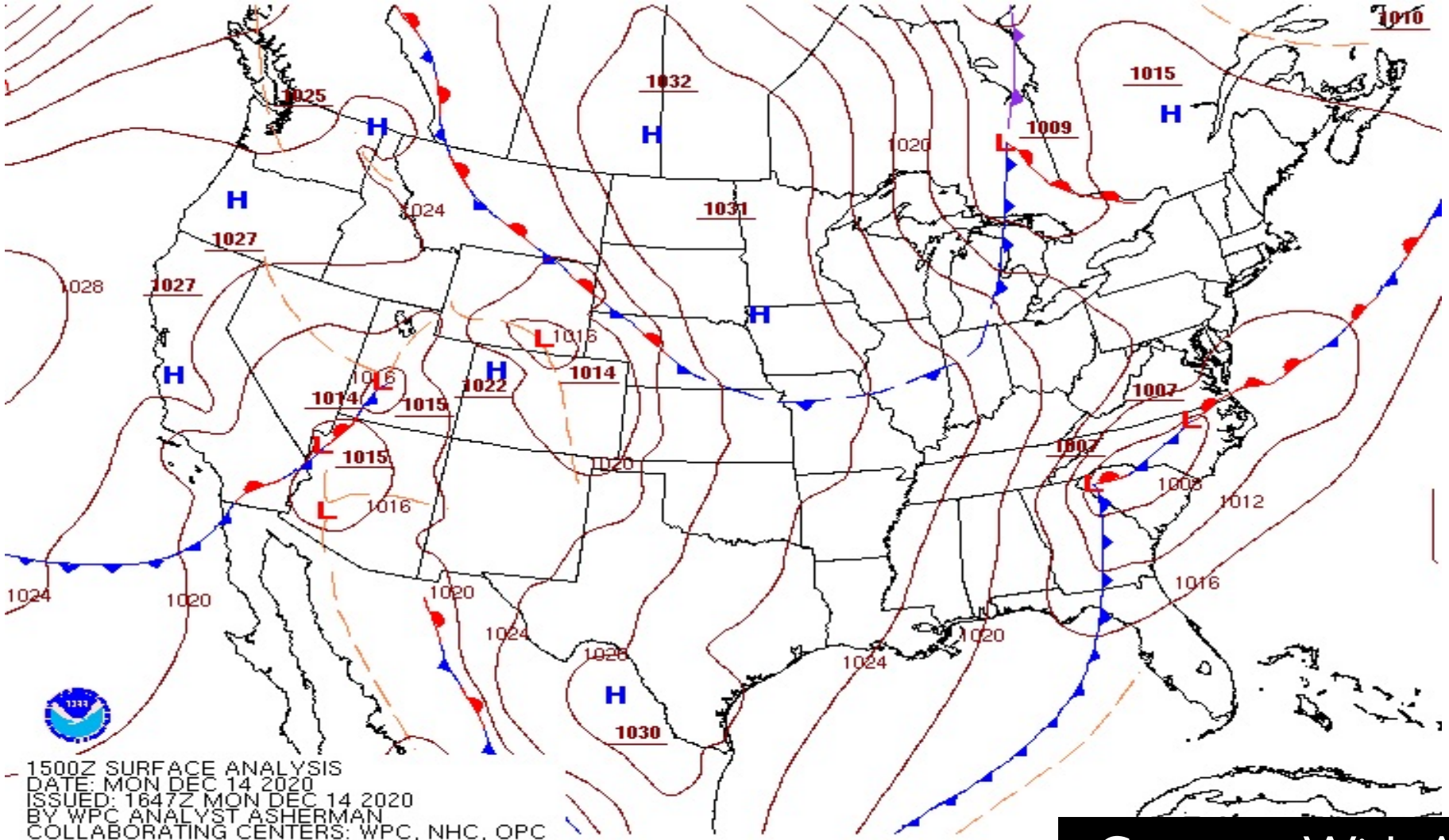


Temperature Inversion Turbulence

- The Inversion Prevents Mixing With Cooler Air Below; Usually Associated With Radiation on Clear Nights – Mostly a Vertical Wind Shear Type



Turbulence Near Lows and Troughs



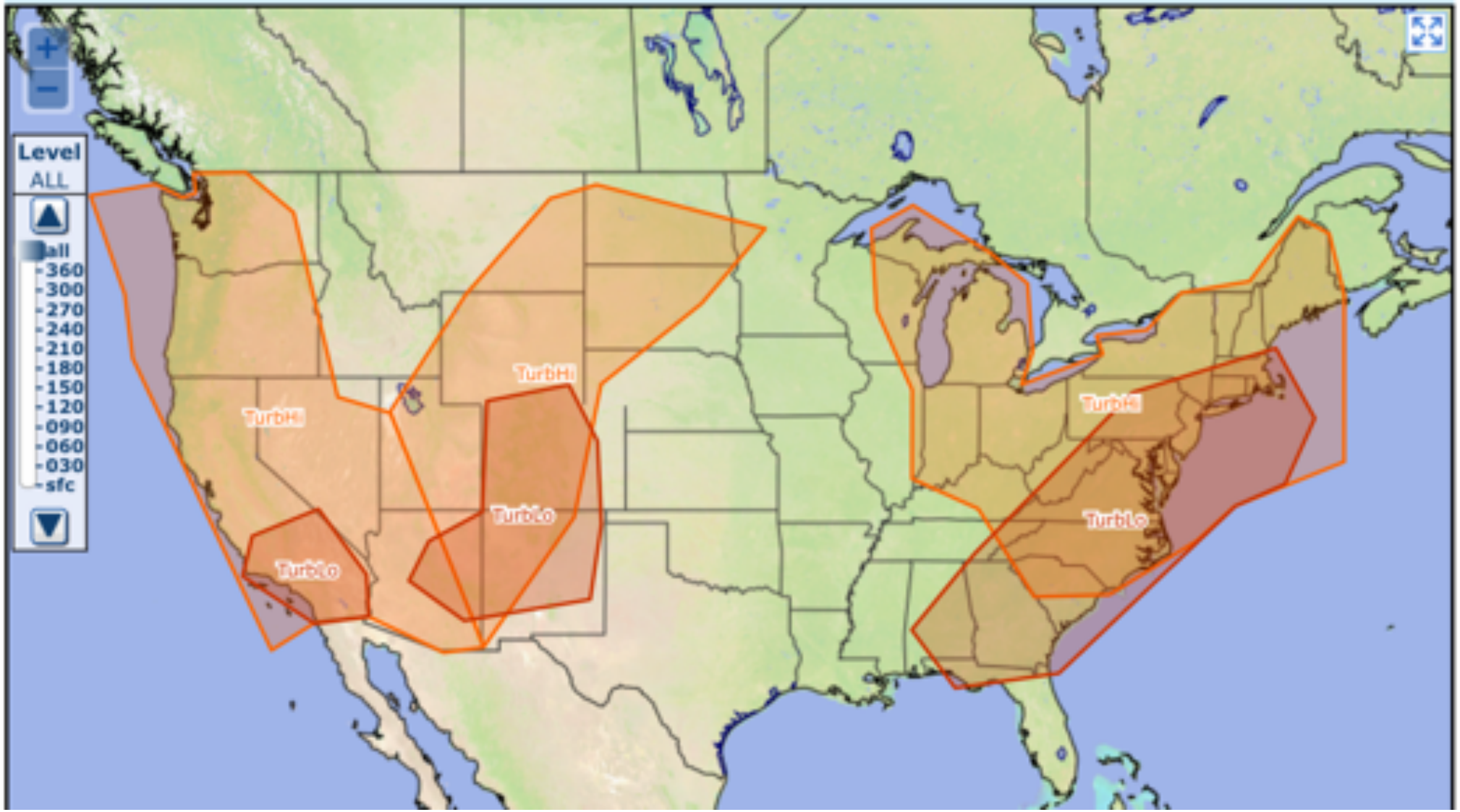
Compare With AIRMET Tango Next Page

Graphical AIRMETs

Overlays View Configure +3hr 1800 UTC Mon 14 Dec 2020

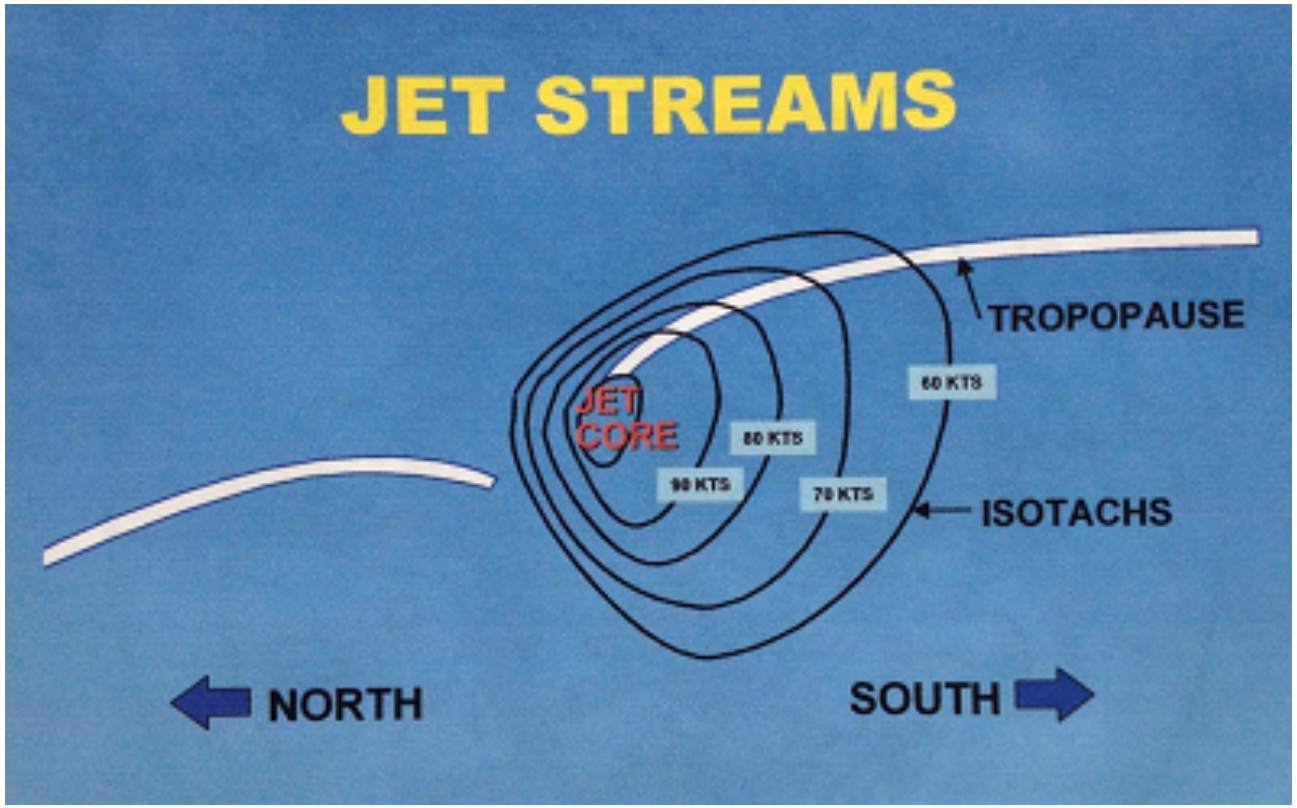
Types: Turb-Hi Turb-Lo LLWS Sfc Wnd Ice Fzlvl IFR Mtn Obs

Valid Time: 15Z 18Z 21Z 00Z 03Z



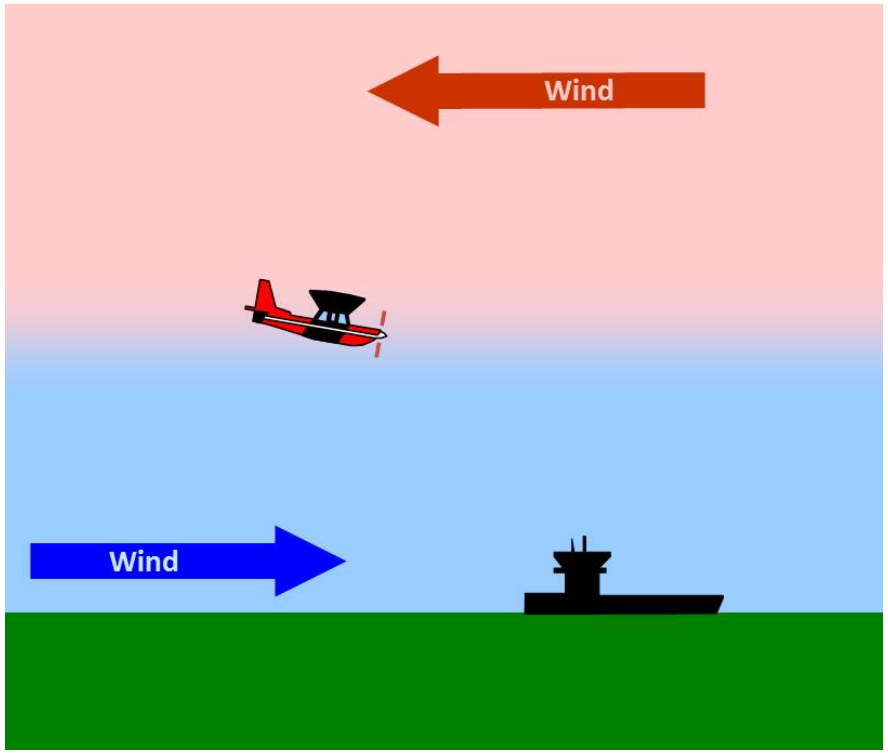
Turbulence Near Jet Stream

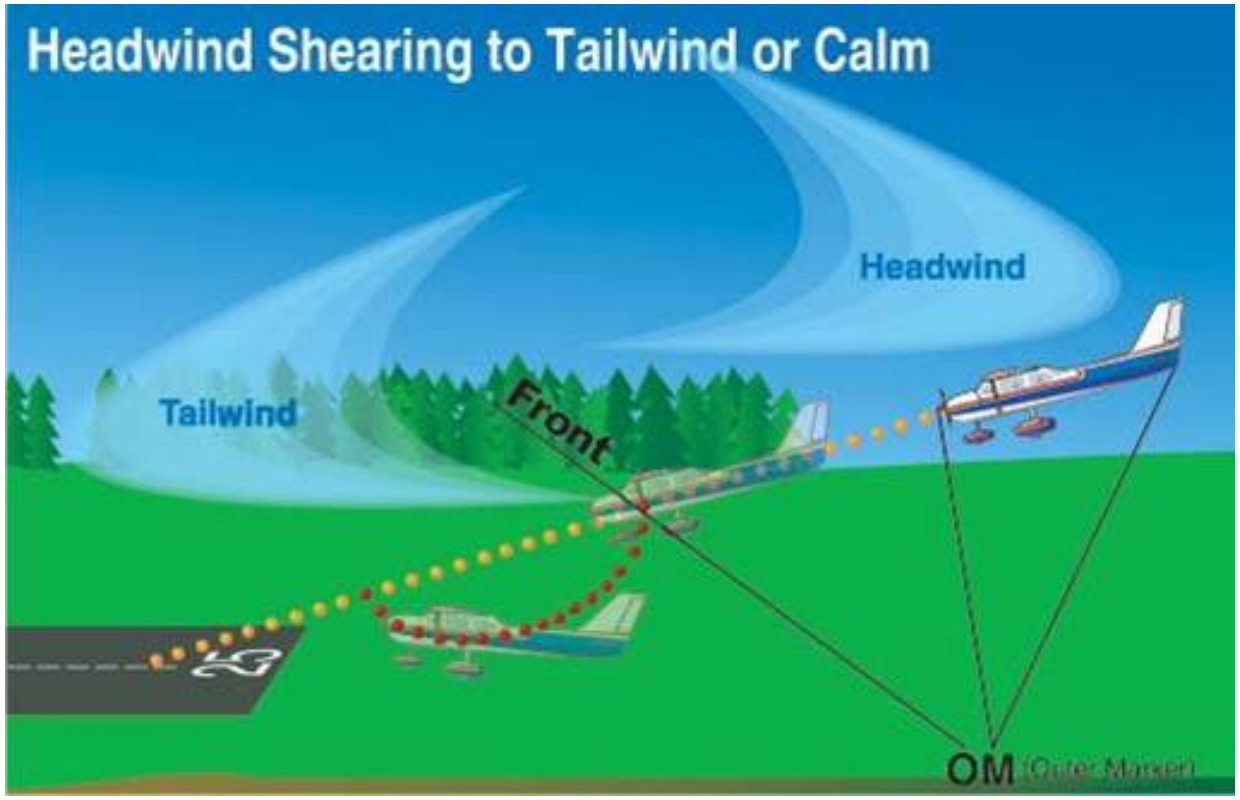
- Generally Stronger on Non-Equatorial Side of Jet
- Tighter Wind Gradients and a Break in the Tropopause



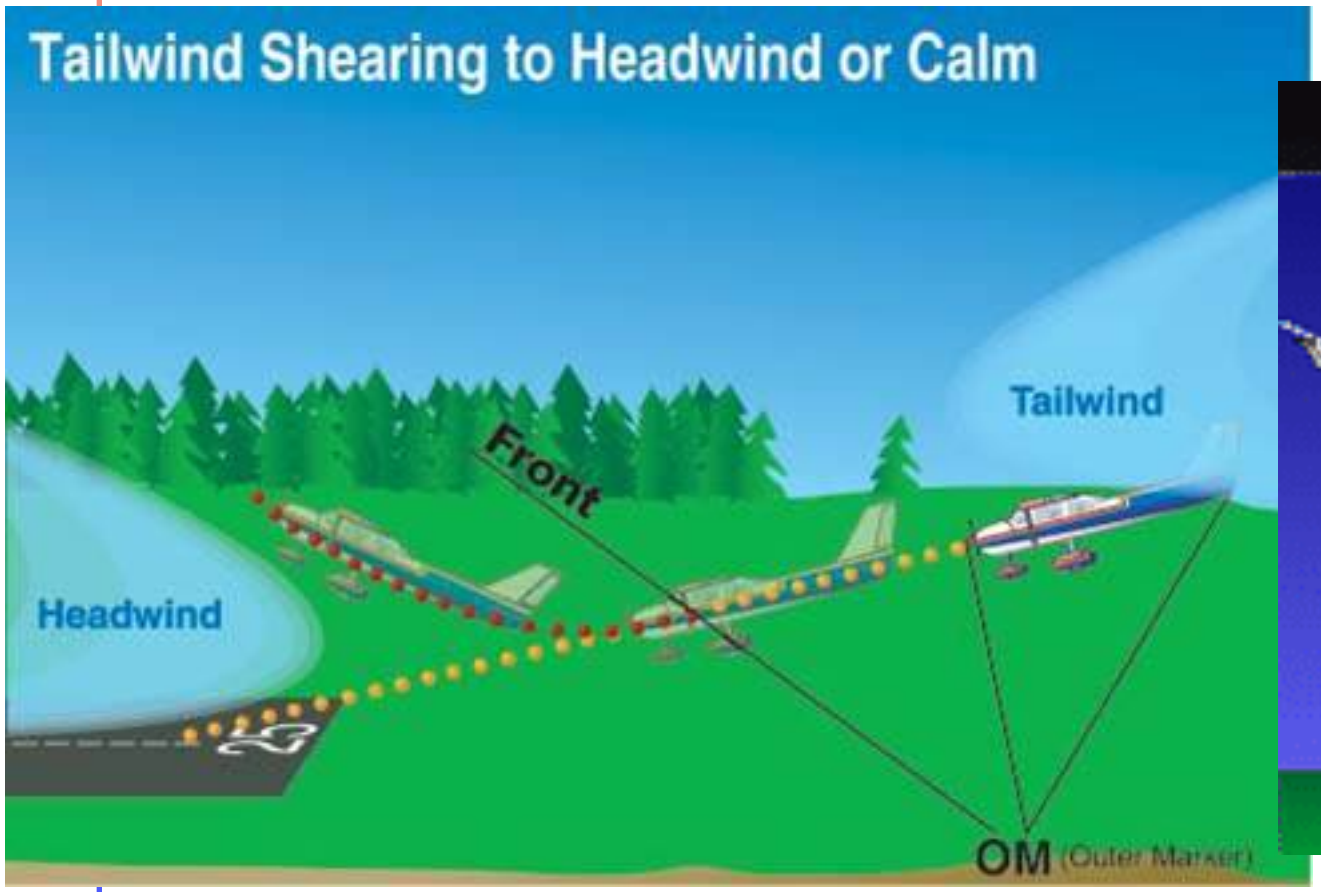
Low Level Wind Shear (LLWS)

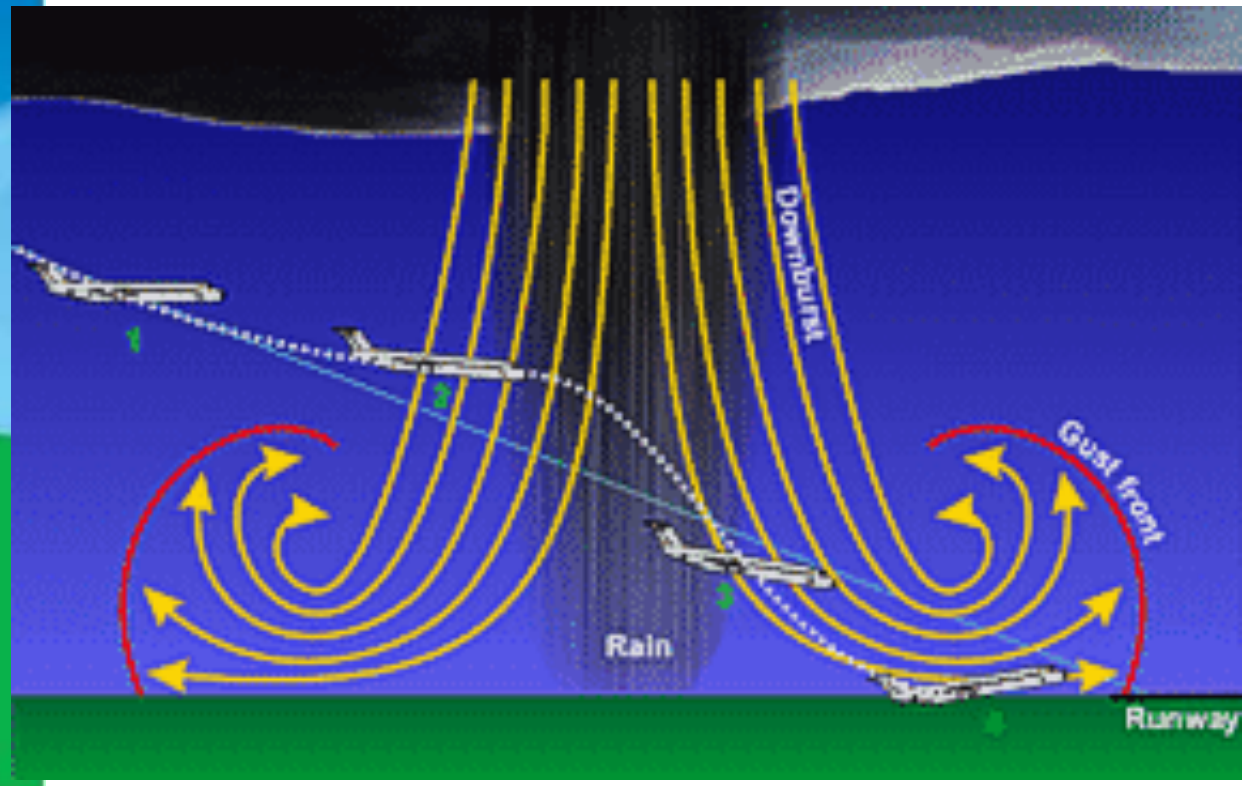
"A wind shear of 10 knots or more per 100 feet in a layer more than 200 feet thick which occurs within 2,000 feet of the surface"

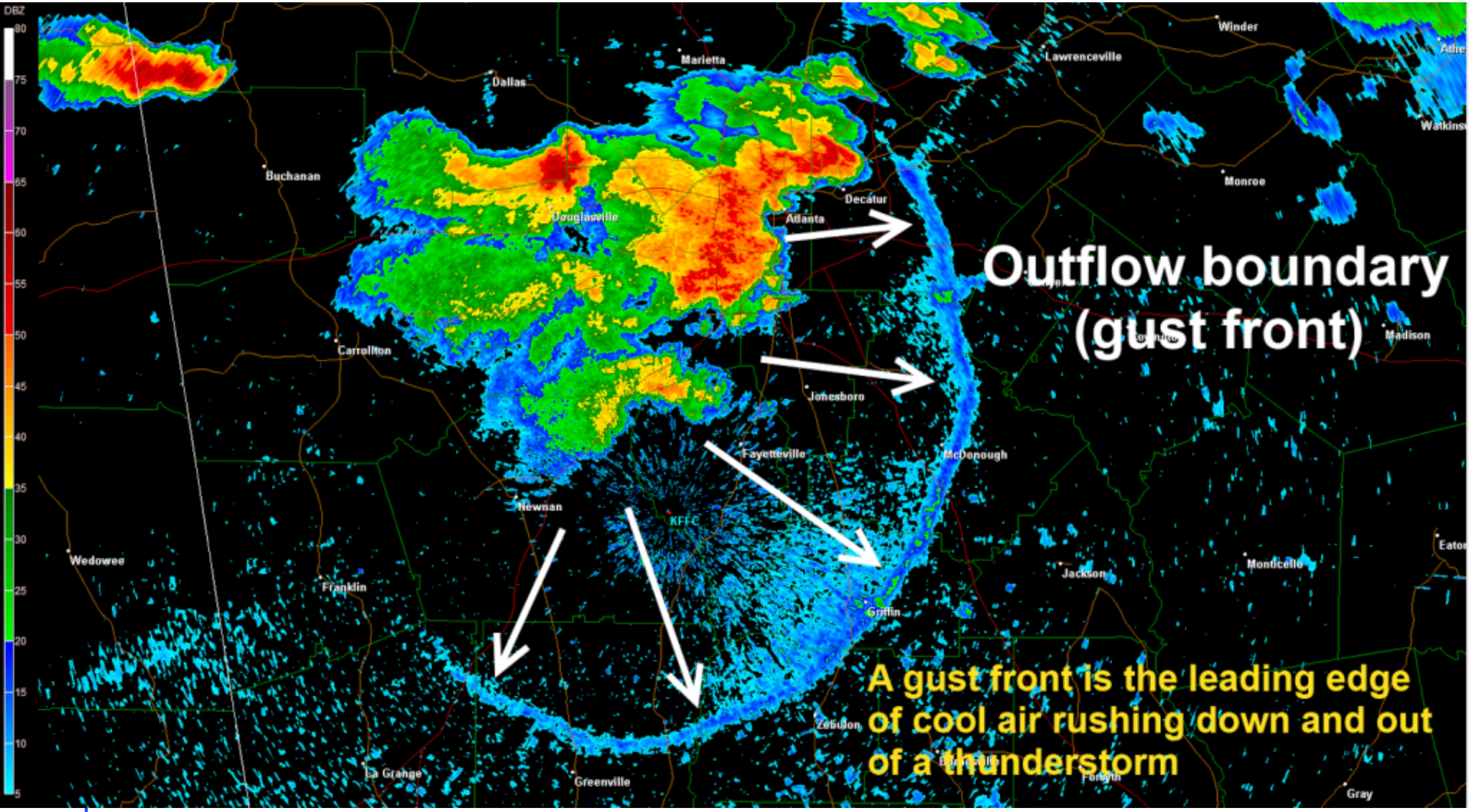




LLWS and Gust Front (cont.)

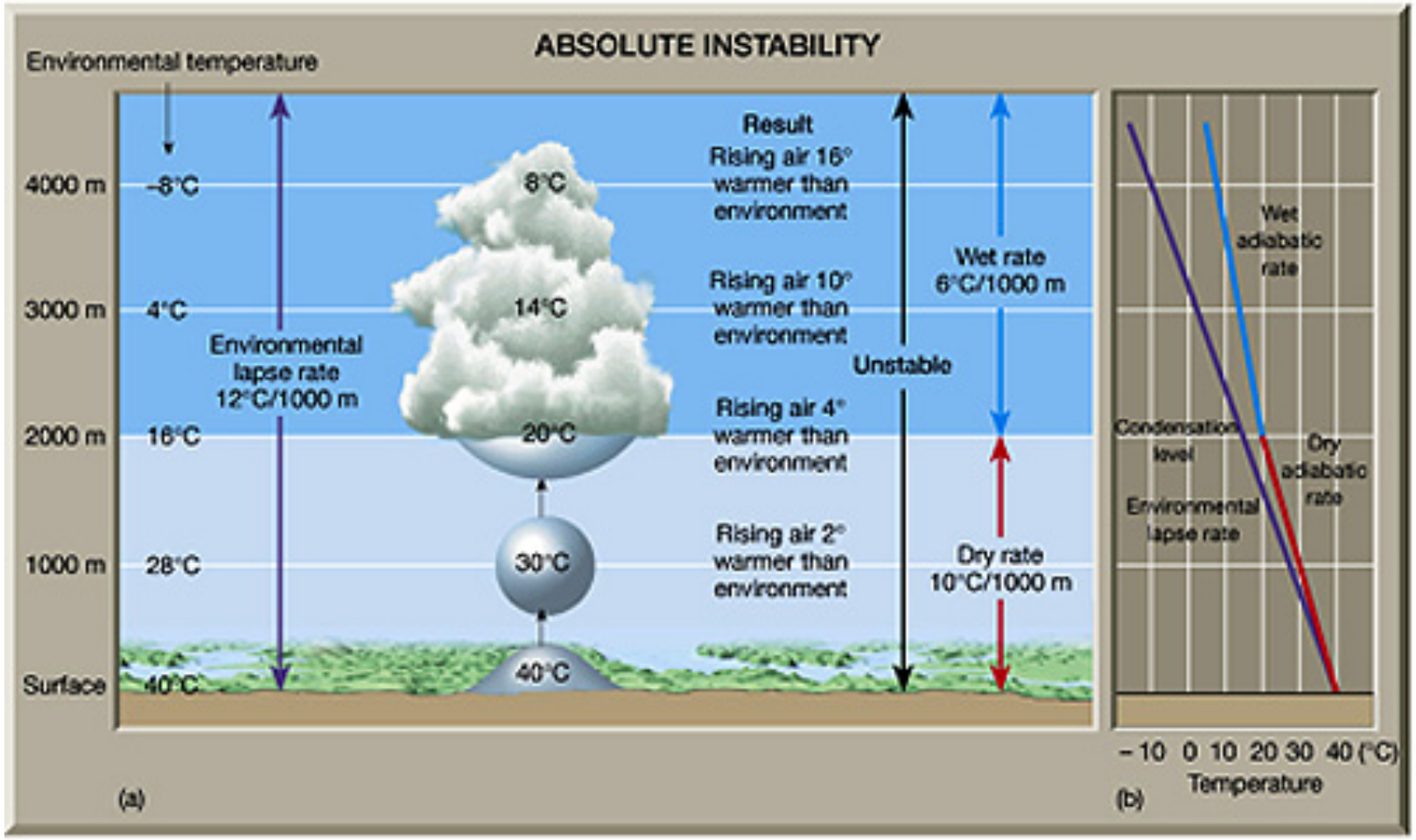





DBZ
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
Marietta
Dallas
Buchanan
Douglasville
Atlanta
Decatur
Winder
Lawrenceville
Monroe
Carrollton
Jonesboro
Fayetteville
McDonough
Newnan
KFFC
Wedowee
Franklin
Griffin
Jackson
Monticello
Madison
Zebulon
La Grange
Greenville
Gray
Outflow boundary
(gust front)
A gust front is the leading edge
of cool air rushing down and out
of a thunderstorm

PA.I.C.K3h Thunderstorms & Microbursts

- Sufficient Moisture
- Unstable Air
- Lifting Mechanism



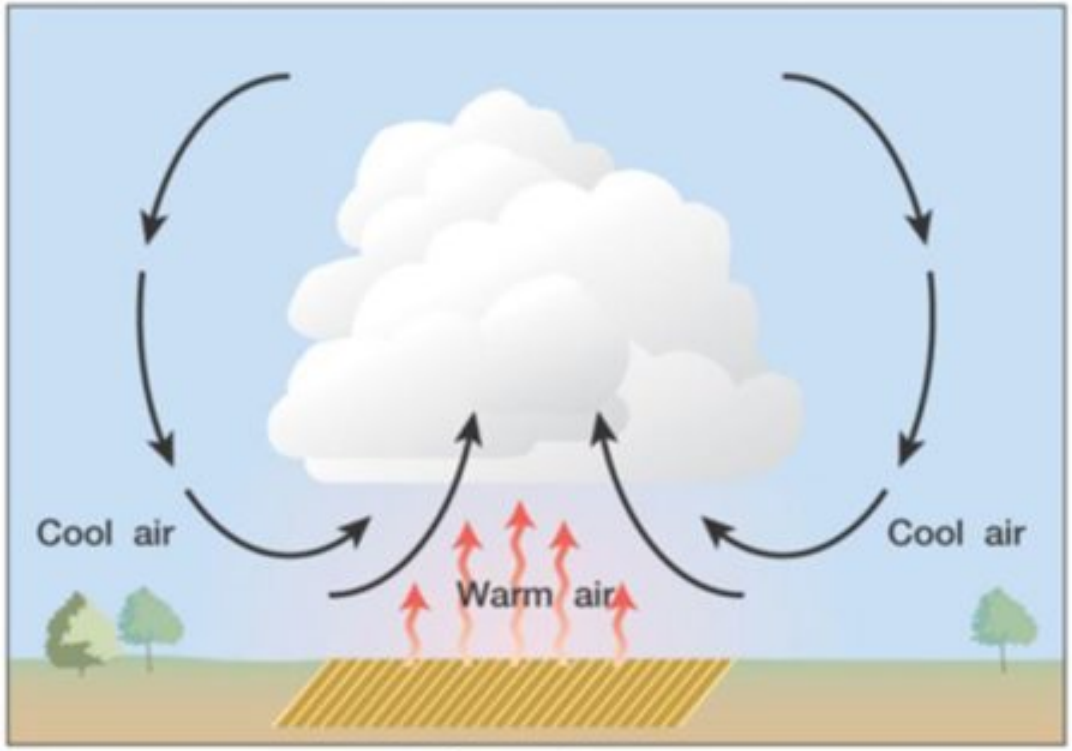
Thunderstorm Lifting vs Advection

Convection Means Vertical Transportation of an Air Mass (LIFT)

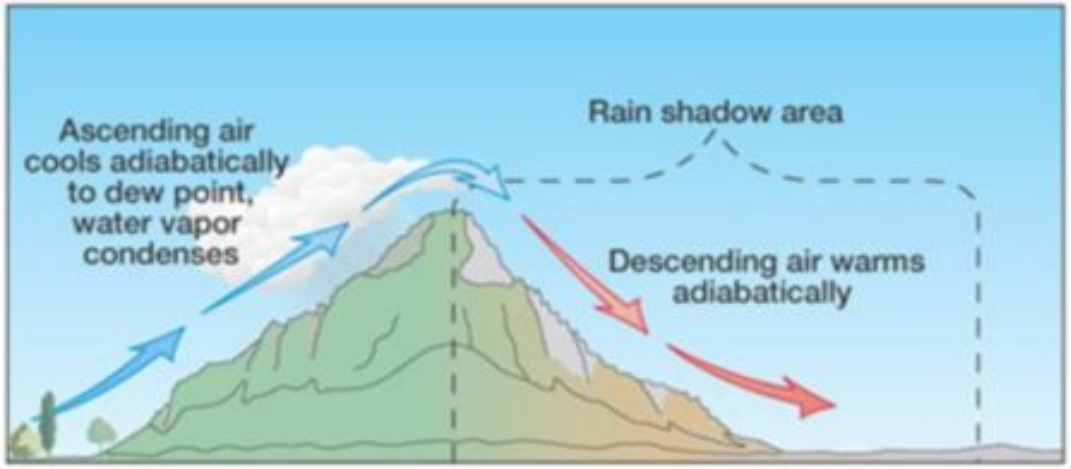
Lifting Mechanisms – There are at Least 8-10 Different Lifting Mechanisms – Anything That Can Cause Air to Move Vertically

Advection Generally Means Regional Transfer or Loosely a Horizontal Transportation

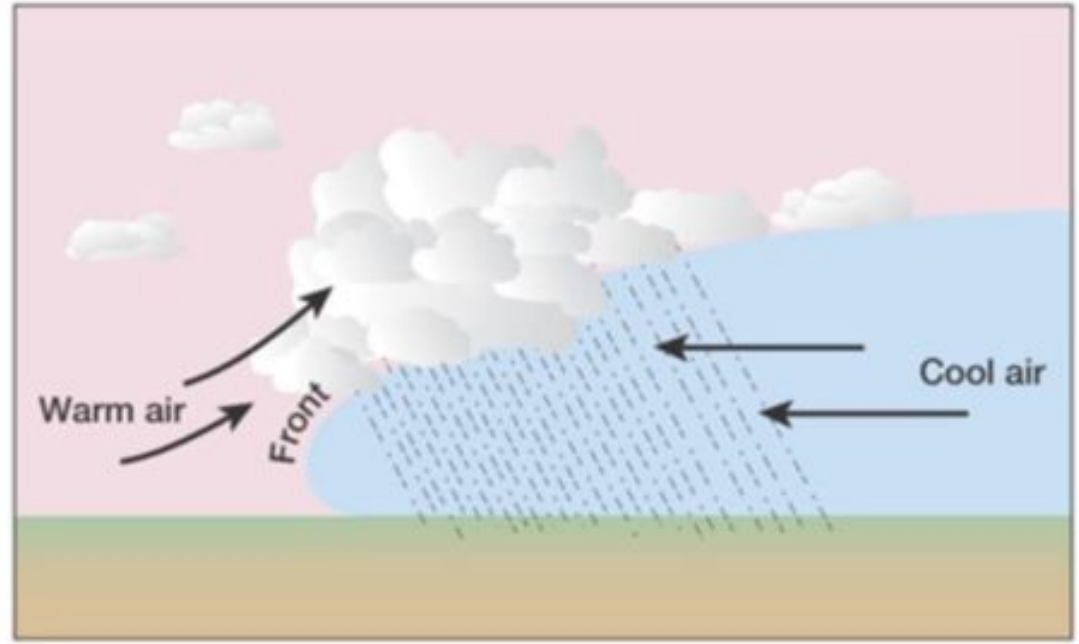
Neither Term Means a Heat State Exchange – Although Both May Be The Movement Necessary to Trigger an Energy Event



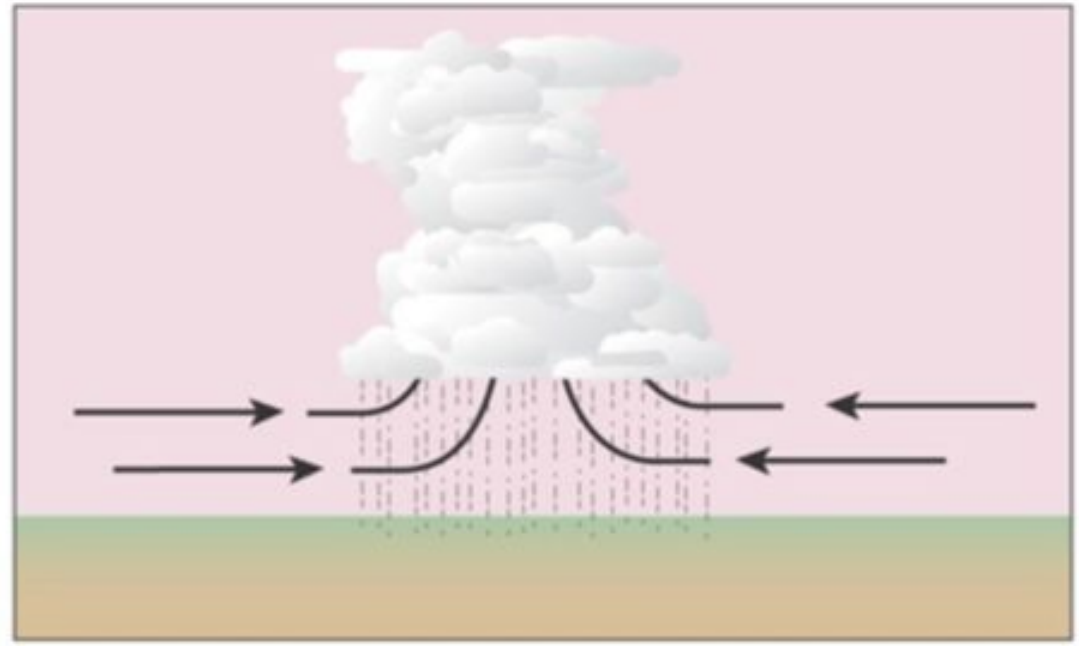
(a) Convective



(b) Orographic



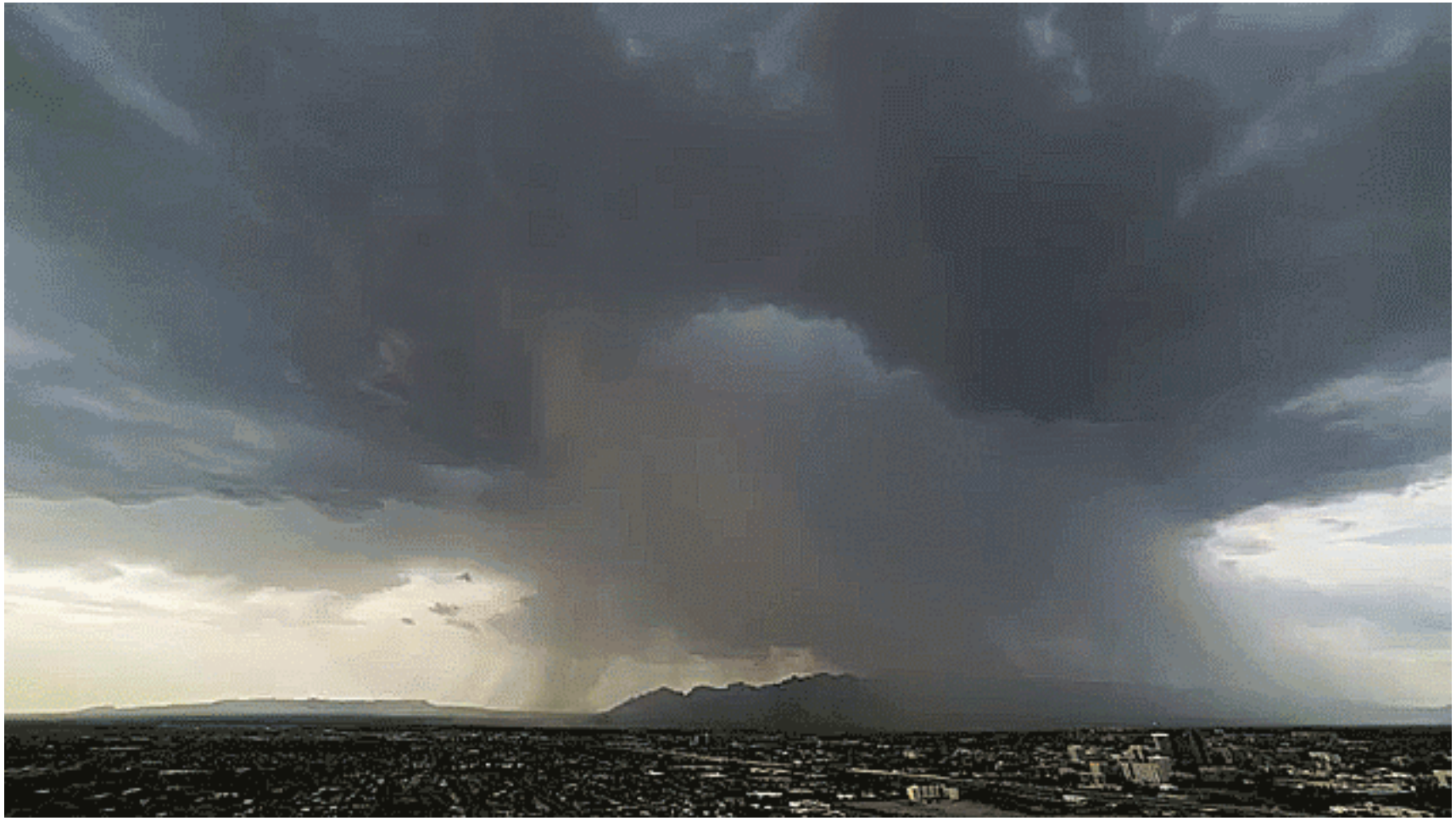
(c) Frontal



(d) Convergent

Microbursts (Can Be Wet or Dry)

- Small (less than 2.5 mile) Yet Intense Downdraft
- In 1985 Delta Flt 191 Encountered Microburst in Dallas



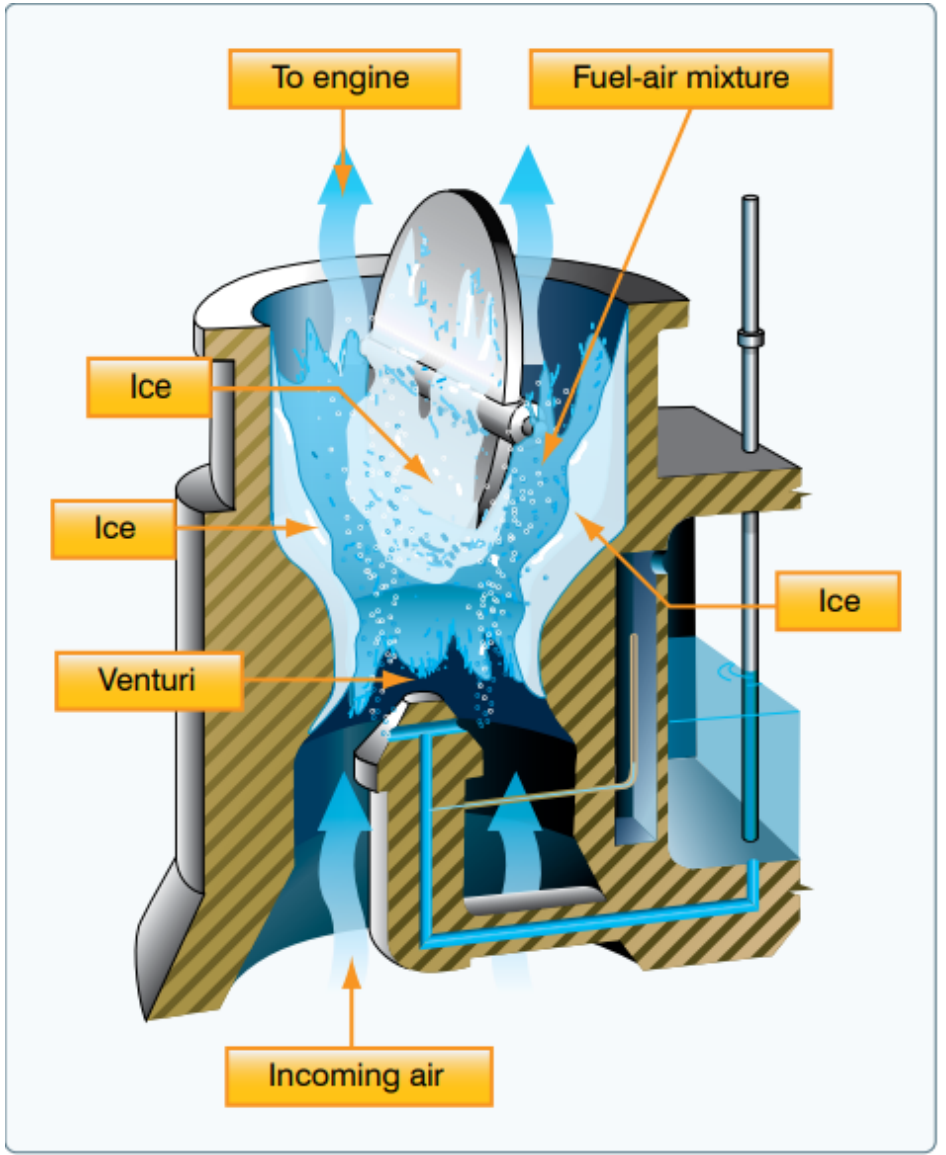
Be Sure to UseYour Mark I Eyeball !

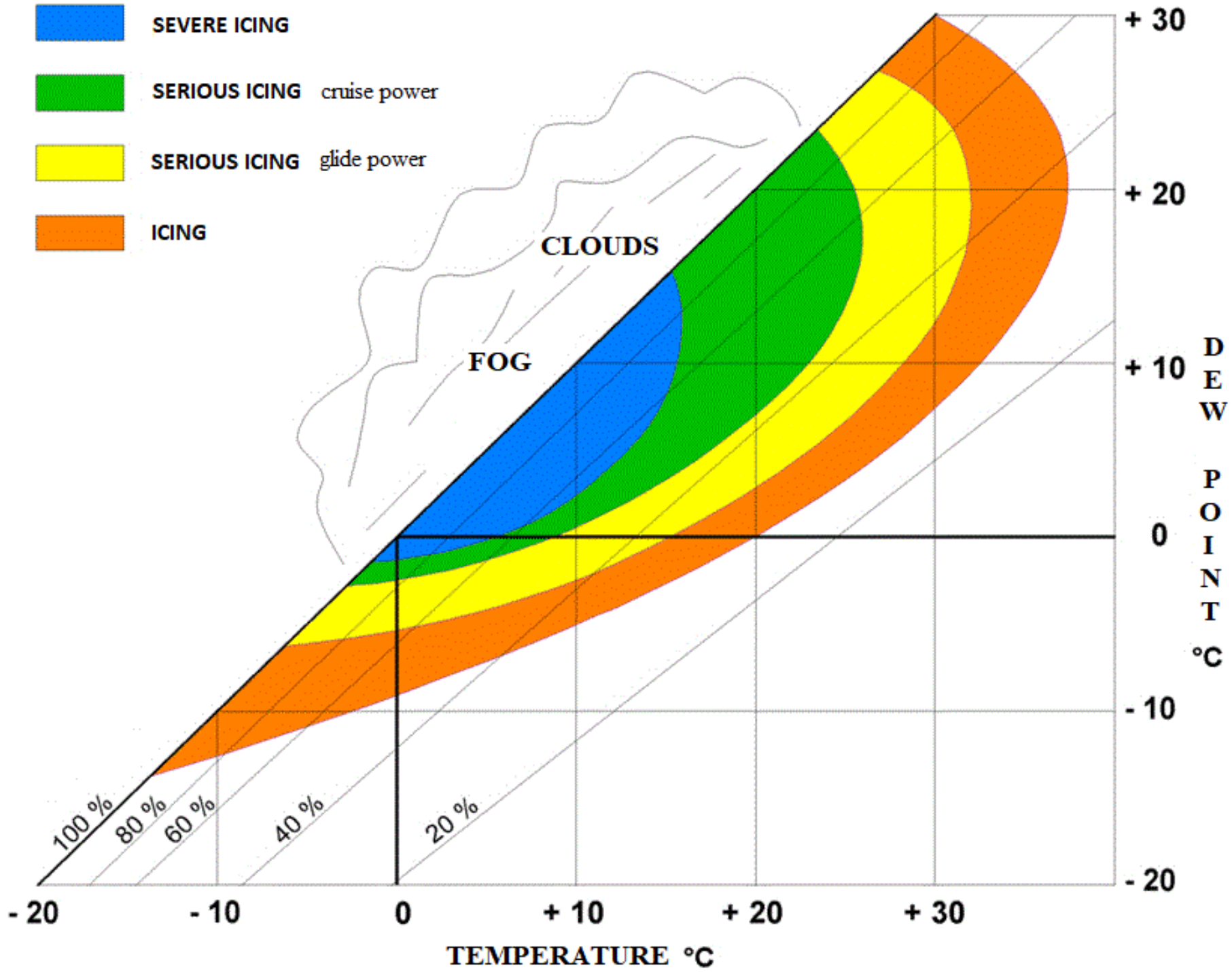
Virga (Rain That Evaporates Before Hitting Ground) Also a Clue to a Dry Microburst

PA.I.C.K3i Icing and Freezing Level

Induction and Structural

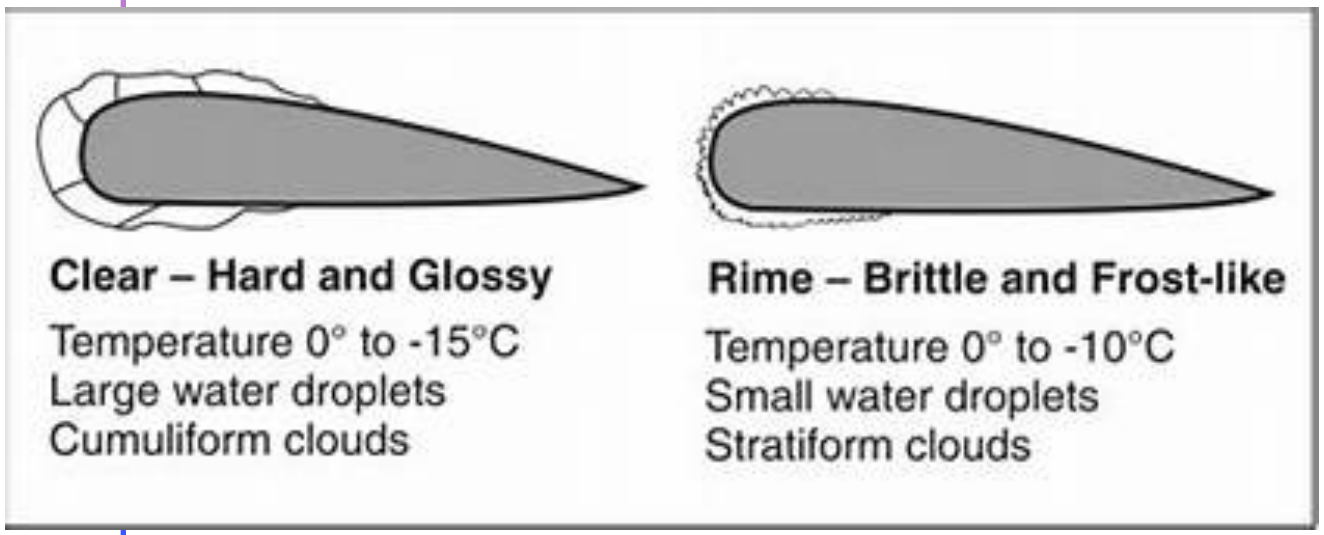
- Induction – Most Common on Normally Aspirated Carburetors
  - Caused by Cooling of Fuel as It Evaporates (Recall Latent Heat – Well This is Latent Cooling)
  - Can Occur in Fuel Injected Engines – Normally On Air Filter
  - Can Occur in Fuel Lines

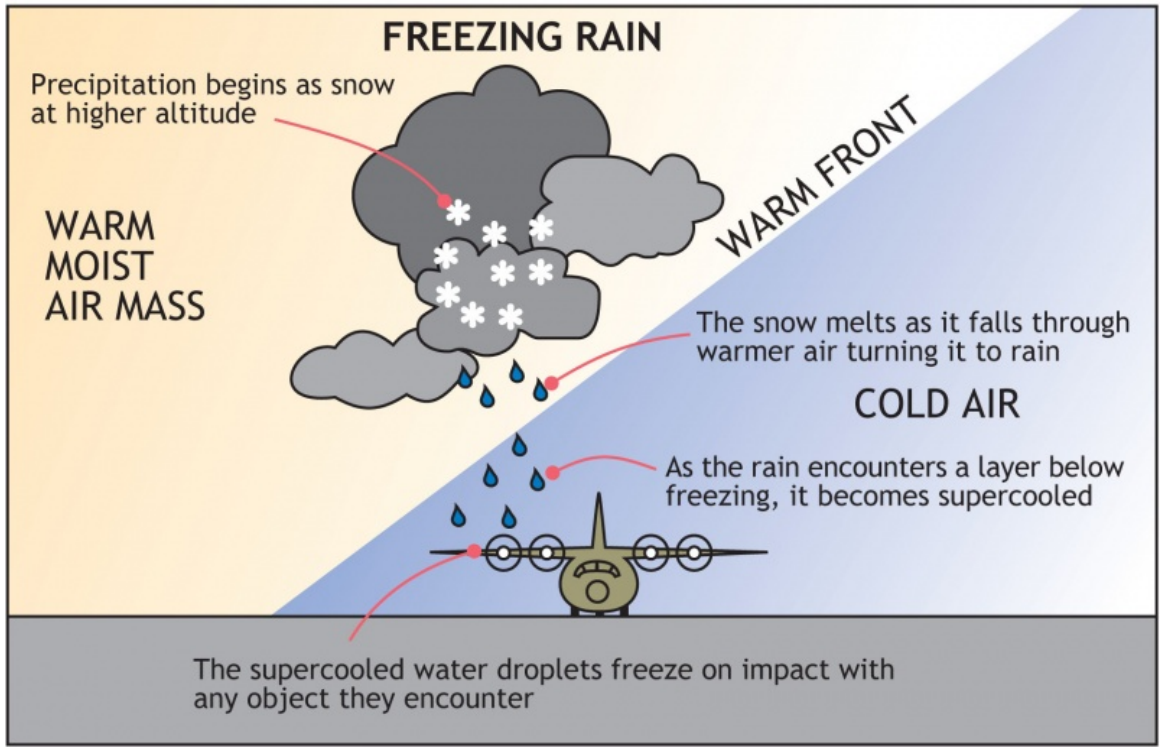



SEVERE ICING
SERIOUS ICING cruise power
SERIOUS ICING glide power
ICING
CLOUDS
FOG
100 %
80 %
60 %
40 %
20 %
+ 30
+ 20
+ 10
0
- 10
- 20
DEW POINT °C
- 20
- 10
0
+ 10
+ 20
+ 30
TEMPERATURE °C

Structural Ice – Three Types

1. Rime Ice – Rough, Coarse, Brittle and Opaque
2. Clear Ice – Hard, Clear
3. Mixed





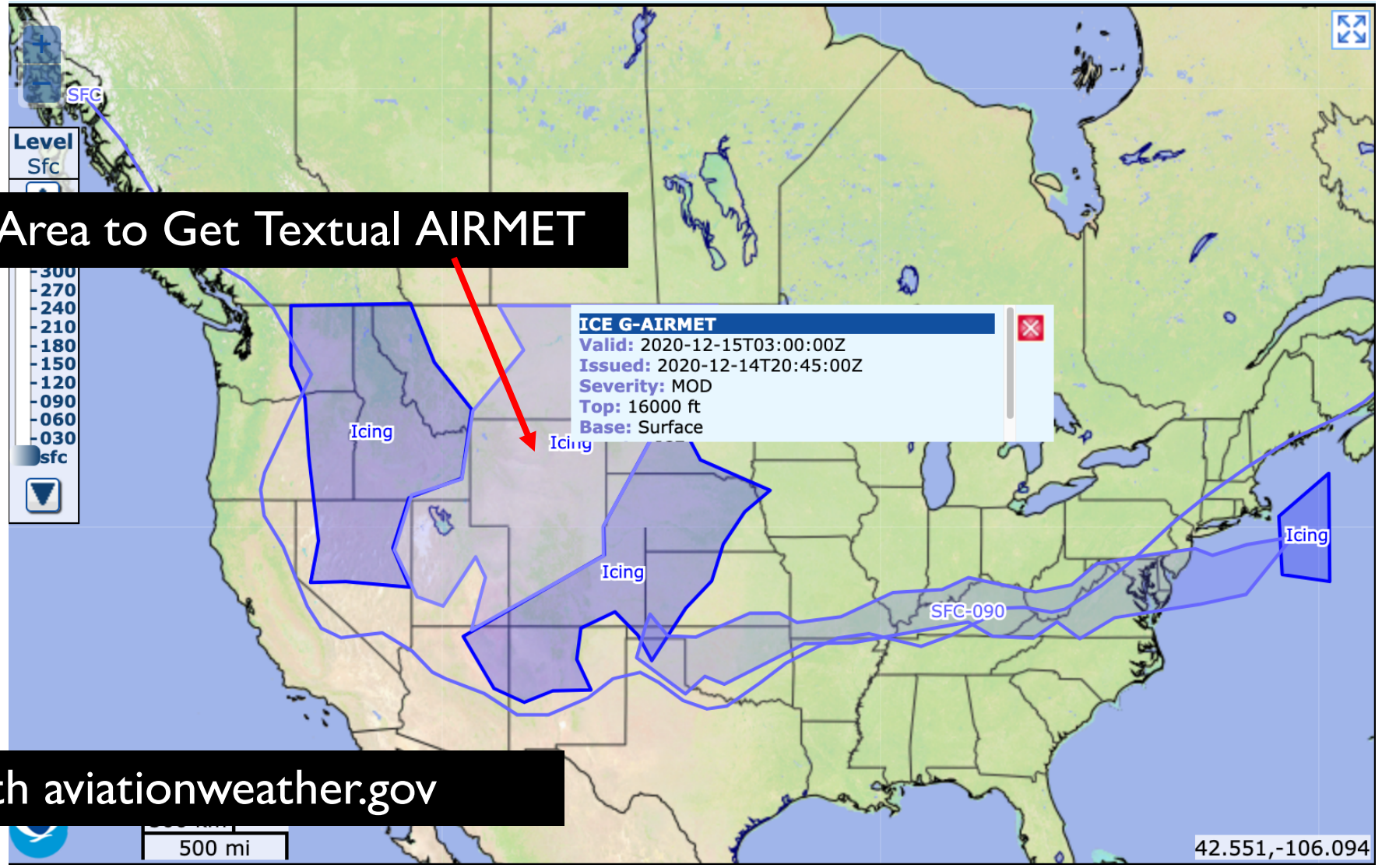
Structural Ice – a Bend or Break Situation

- Increases Weight and Drag
- Decreases Lift and Thrust
- Get Out of It ASAP
  - 180
  - Climb
  - Descend
  - Keep Speed Up
  - Avoid Configuration Changes Especially Flaps


Normal Flight

Tail Icing

Freezing AIRMETs (Zulu)



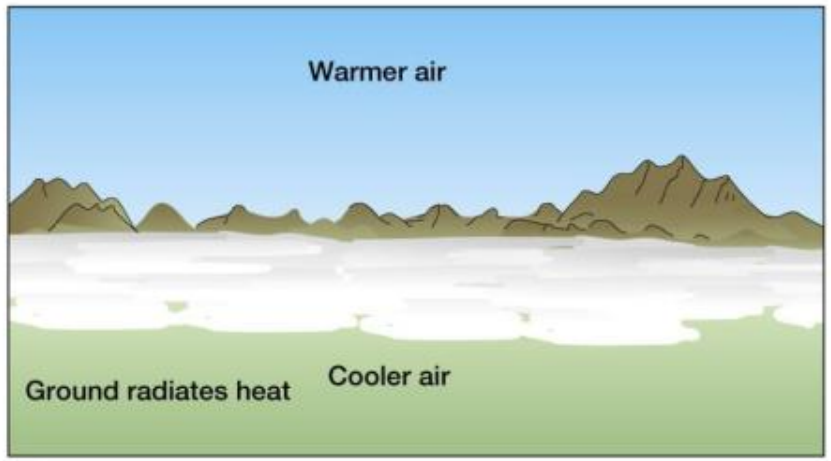
Play With aviationweather.gov

PA.I.C.K3j Fog and Mist

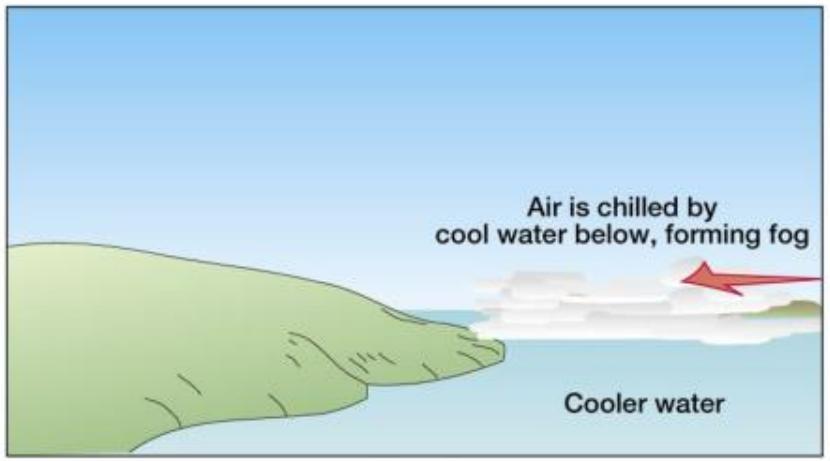
What is Fog?

Fog		
(≡)	VCFG	Vicinity fog
⁻ ⁻	BCFG	Patchy fog
⁻ ⁻	PRFG	Fog, sky discernable
≡	FG	Fog, sky undiscernable
⧗	FZFG	Freezing fog

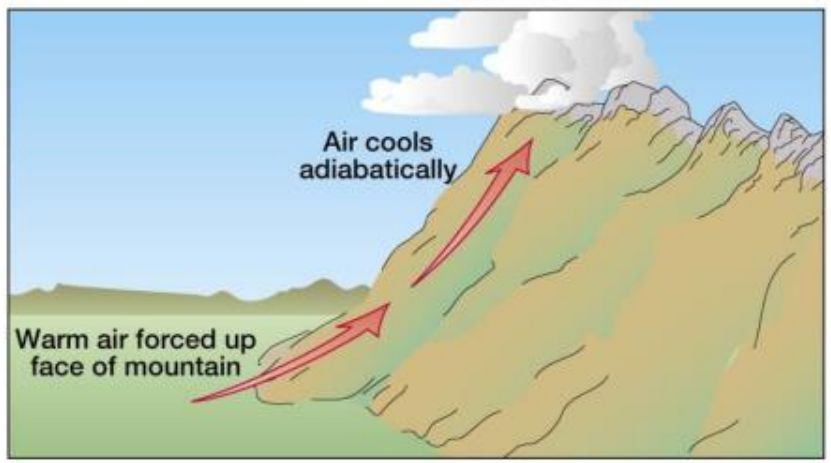
Four Types of Fog



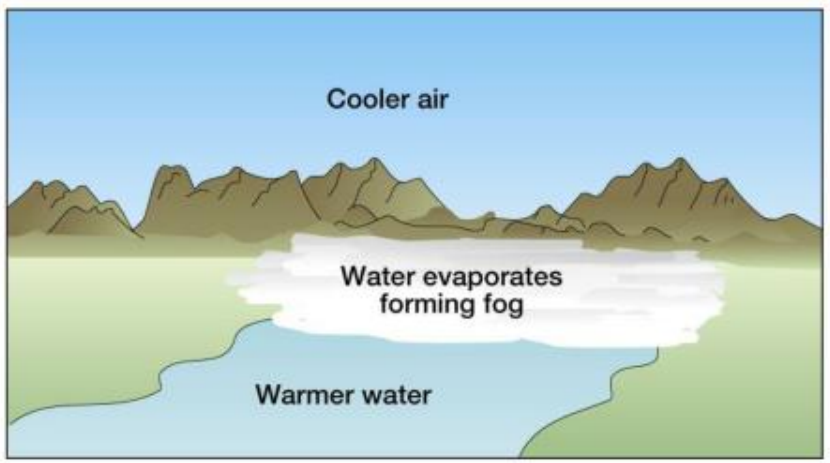
(a) Radiation



(b) Advection



(c) Upslope (orographic)



(d) Evaporation

Mist (BR)

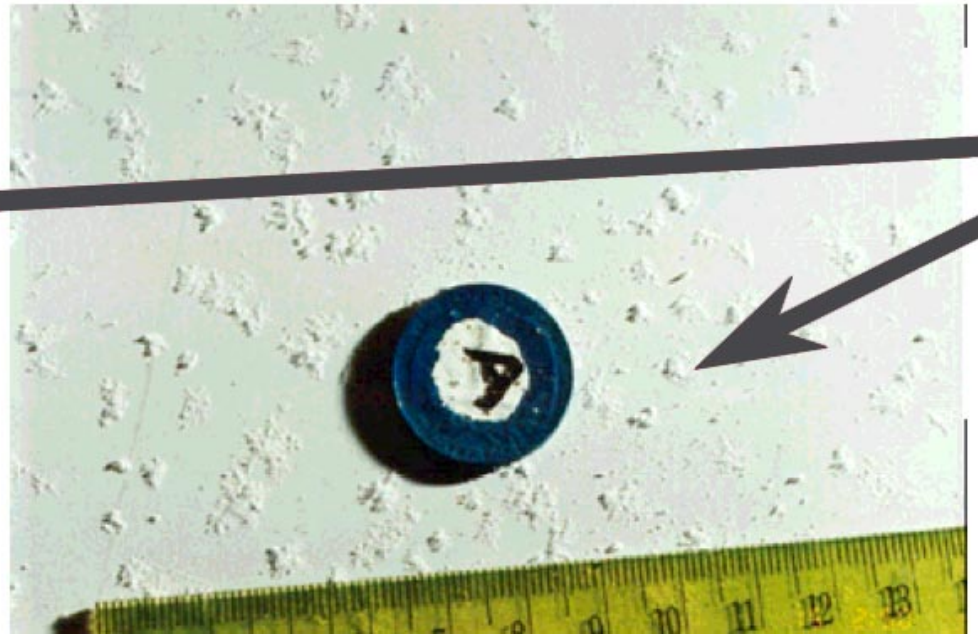
- Small Water Droplets (50-500 um) Suspended in Air
- Not as Thick or Obstruction to Visibility as Fog
- Sometimes the Difference Between Fog and Mist is Hard to Determine

PA.I.C.K3k Frost

- Technically Not an Icing Condition, But Some Examiners Lump it Into Icing
- Process Called *Deposition* Where:
  - Water Vapor (Gas) Changes State to Solid (Ice Crystals) Onto a Surface
- *Sublimation* is Opposite Phase Change from Solid to Gas

Frost (cont.)

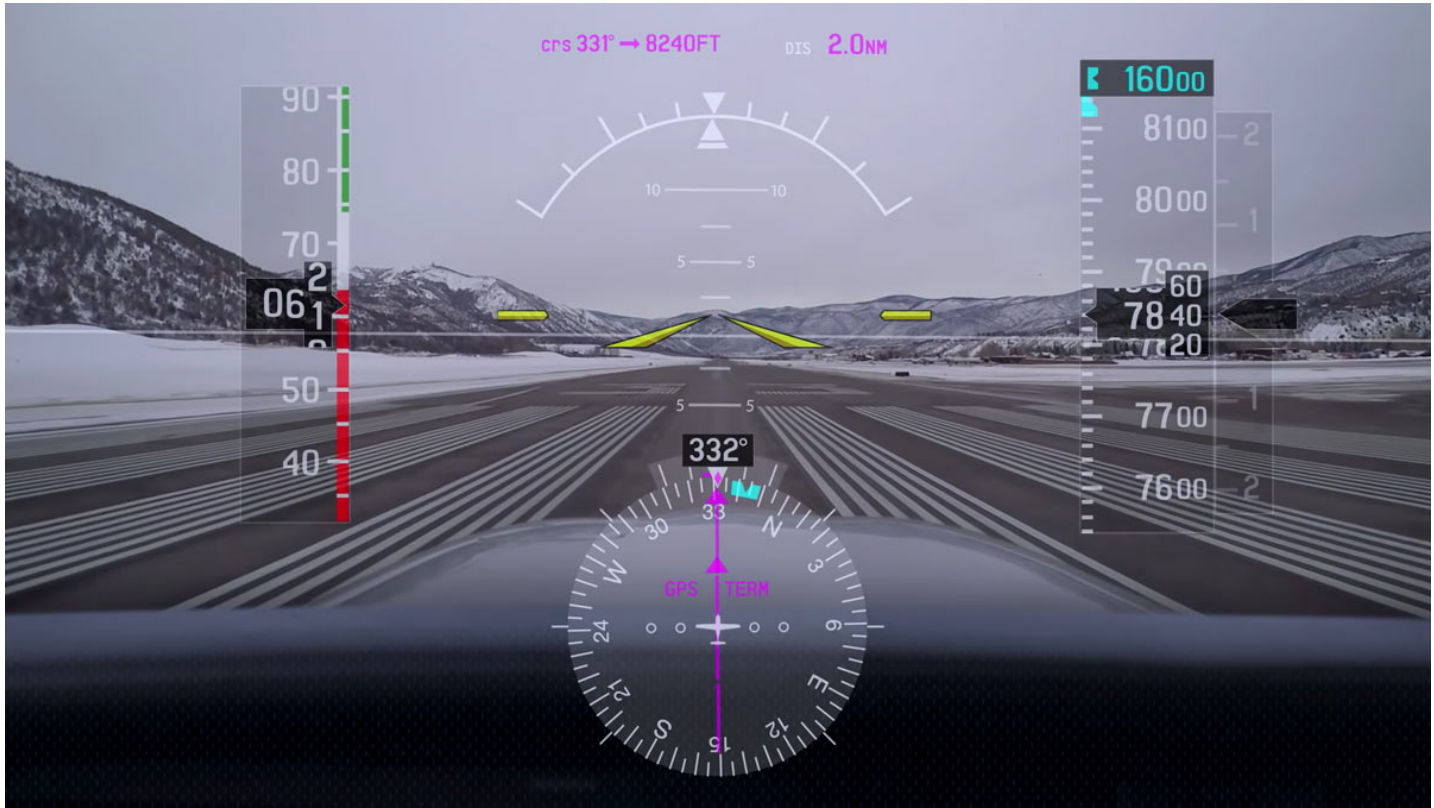
- **Frost the size of a grain of salt, distributed as sparsely as one per square centimeter over a wing's surface, can destroy enough lift to prevent your plane from taking off.**



Small, almost imperceptible frost accumulation

Frost (cont.)

- **Small patches of ice or frost on your wings can result in asymmetrical stalls, resulting in roll control problems during takeoff.**



Frost (cont.)

- **Frost can reduce your wing's max lift by 30 percent or more.**
- **Climb May be Reduced or Impossible**

Frost (cont.)

- **Because frost disrupts airflow over your entire aircraft, it can increase drag by up to 40%.**
- **The combined effects of reduced lift and increased drag raises stall speed**

PA.I.C.K3I (Obstructions to Visibility)

- Dust (DU), Haze (HZ)
- Smoke (FU), Volcanic Ash (VA)

PA.I.C.K3m Flight Deck Weather

- Know How to Use, If You Have
  - ADS-B
  - Foreflight or Other Displays
- Recognize Time Delay, Especially Radar
- Use Mark I Eyeball Sensor – Stay Away From the 3 Bs

Homework and Review

- Forty Essential WX Topics (note item 7. changed – be able to obtain and use GFA Tool see next bullet) http://w5gw.com/images/Essential%20WX.pdf
- Aviationweather.gov Handout
  - Use This as a Guide to Explore Your Official WX Source
- Call FSS With Mock Flight Plan and Get a Standard WX Briefing