AVIATION WEATHER – METEOROLOGY

WHAT THE FAA REQURES YOU TO KNOW ABOUT AVIATION METEROLOGY.

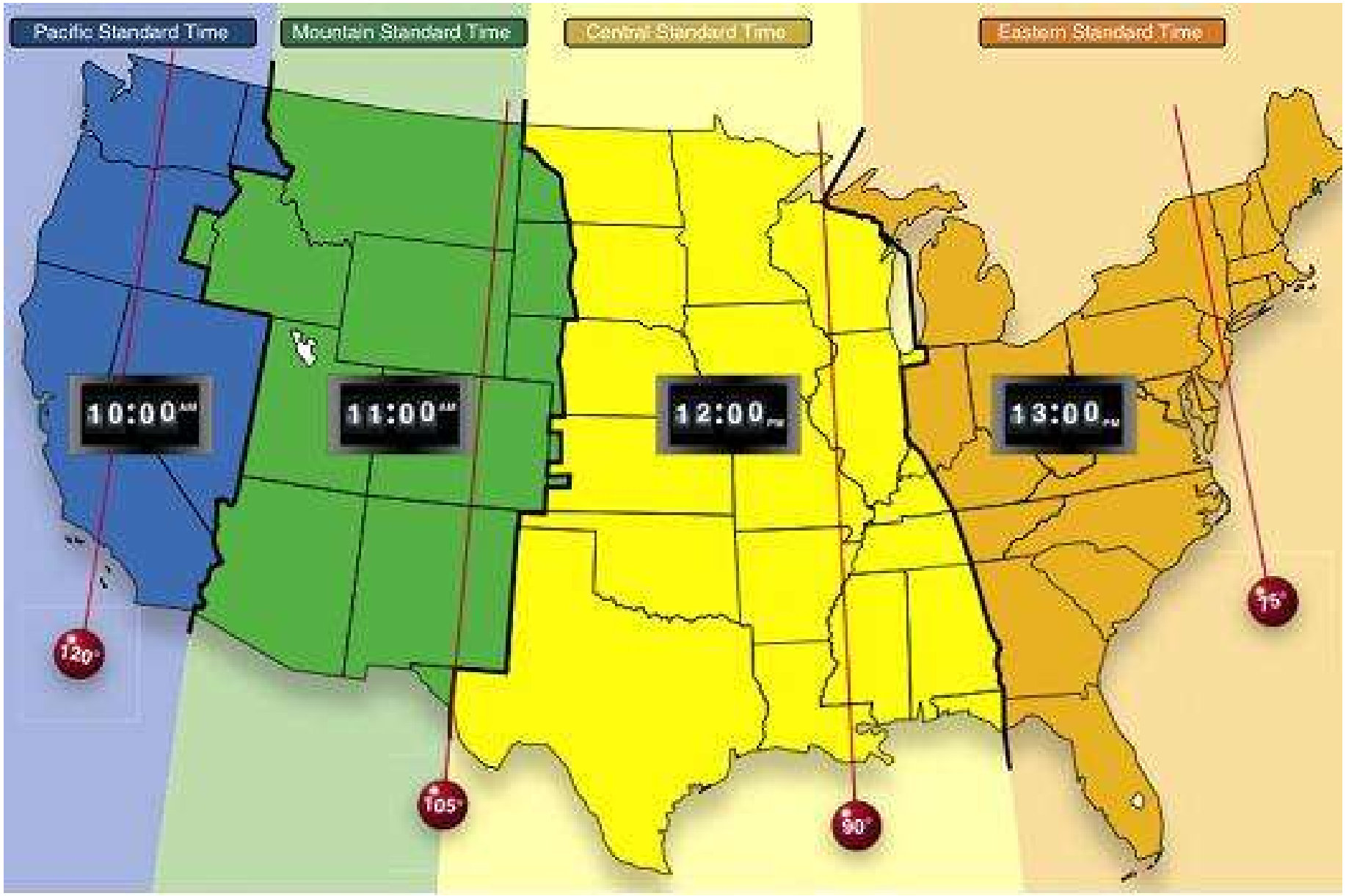
You must have knowledge of elements related to weather information by analyzing weather reports, charts, and forecasts from various sources with emphasis on:

- METAR, TAF, and FA
- Surface Analysis Charts
- Radar Summary Charts
- Winds and Temperature Aloft Charts
- Significant Weather Prognostic Charts
- Convective Outlook Charts
- AWOS, ASOS and ATIS Report

You must be able to make a competent "go/no-go" decision based on available weather information.

To enable you to do this we must study weather theory, patterns, hazards, forecasting, printed/ and graphic weather products, and sources of weather info.

Be aware of Time Zones



Know US Time Zones (continental)

PST	MST	CST	EST(FL)
-3	-2	-1	***
-1	**TO**	+1	+2

Types of Time ***Civilian*** (Local) AM and PM

Military 00:01 to 24:00, Civilian time 1 PM become 13:00 (PM time +12)

ALL aviation reporting are given in *Universal Coordinated Time (UTC)*

*which is designated as **Zulu (Z)*** This is GMT (Greenwich Mean Time)

To convert **Local to Zulu** as you will do in preparing a flight plan:

1. Convert Local to Military
2. Add Zulu Offset (Florida for EDT = +4, EST = +5)

To convert **Zulu to Local** as you will do in interpreting weather reports

1. Subtract Offset (Florida EDT = -4, EST = -5
2. If hour is greater than 12, then subtract 12

<u>Likely problem on Aeronautical Knowledge Exam involving conversion</u>

Take off from Denver at 1PM (MDT) and fly to Ogallala NE (CDT)

Depart at 1 PM for 2 hour flight. *What is the ETA in Zulu Time*?

a. Z time *at Denver* (1PM), military time 1300 then add +6(MDT) = *1900Z*

b. ETA at Ogallala 19+2(flight duration) = 2100Z

What is local time at Ogallala? 2100**-5**=1600, -12 = 4 PM

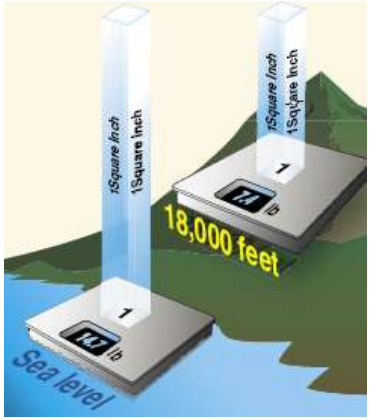
Return to Denver departing from Ogallala at 2200Z, what is local ETA at Denver?

a. 2200+2=2400, **-6** for Zulu offset =18:00 mil, -12 = 6 PM

Convert	Type	Pacific	Mountain	Central	Eastern
Daylight Savings	***Local>Z***	+7	**+6**	+5	+4
	Z>Local	-7	-6	**-5**	-4
Standard	***Local>Z***	+8	+7	+6	+5
	Z>Local	-8	-7	-6	-5

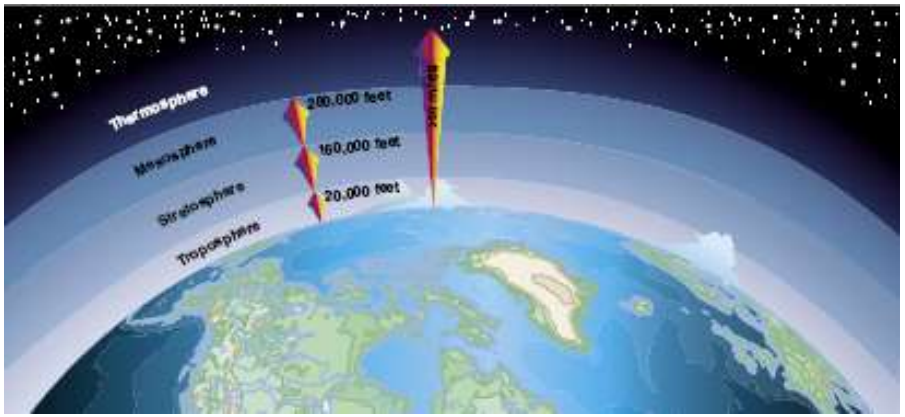
METEOROLOGY – BASIC WEATHER THEORY

1. CHANGES IN OUR ATMOSHERE OCCUR BECAUSE OF THE **SUN**



2. **95 PERCENT** OF ALL ACTIVE WEATHER HAPPEN IN THE <u>TROPOSPHERE</u> (AVERAGE = 36 MILES [Higher at equator, lower at poles).

3. Air has weight and exerts **14.7 lbs/sq**. inch at the sea level Measured by as Standard Pressure of **29.92** inches of mercury and also as **1013.2** millibars of pressure.



Cooler, less dense (lower pressure)

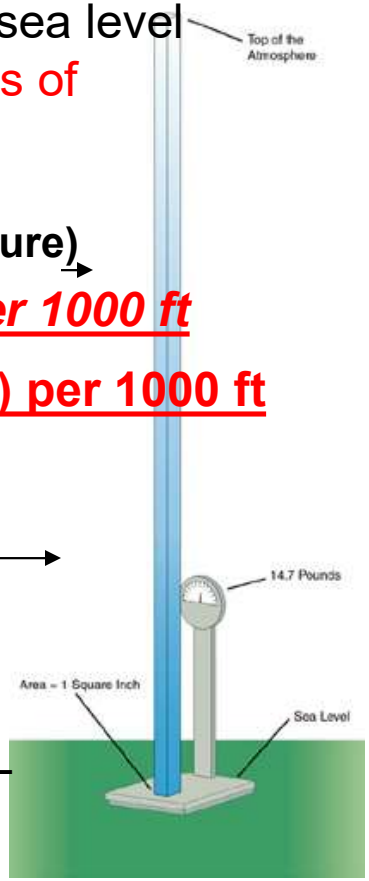
<u>Pressure drops about 1" per 1000 ft</u>

<u>Temperature drops 2C(3.5F) per 1000 ft</u>

"Adiabatic Lapse Rate"

Dry = 3C or 5.4F

Saturated = 2C or 3.5F



4. TEMPERATURE RISES WHEN HOT AND FALLS WHEN COOL
Referred to as "Convective Heating and Cooling."

Created by Steve Reisser

Pressure Altitude

Pressure altitude is the height above a standard datum plane (SDP), which is a theoretical level where the weight of the atmosphere is 29.92 "Hg (1,013.2 mb) as measured by a barometer.

Standard Atmosphere			
Altitude (ft)	Pressure (Hg)	Temperature	
		(°C)	(°F)
0	29.92	15.0	59.0
1,000	28.86	13.0	55.4
2,000	27.82	11.0	51.9
3,000	26.82	9.1	48.3
4,000	25.84	7.1	44.7
5,000	24.89	5.1	41.2
6,000	23.98	3.1	37.6
7,000	23.09	1.1	34.0
8,000	22.22	-0.9	30.5
9,000	21.38	-2.8	26.9
10,000	20.57	-4.8	23.3
11,000	19.79	-6.8	19.8
12,000	19.02	-8.8	16.2
13,000	18.29	-10.8	12.6
14,000	17.57	-12.7	9.1
15,000	16.88	-14.7	5.5
16,000	16.21	-16.7	1.9
17,000	15.56	-18.7	-1.6
18,000	14.94	-20.7	-5.2
19,000	14.33	-22.6	-8.8
20,000	13.74	-24.6	-12.3

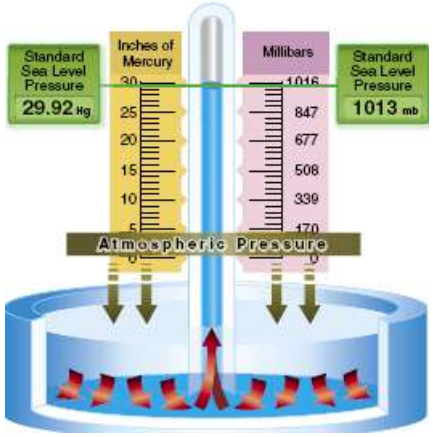
Density Altitude

SDP is a theoretical pressure altitude, but aircraft operate in a nonstandard atmosphere and the term density altitude is used for correlating aerodynamic performance in the nonstandard atmosphere. *Density altitude is the vertical distance above sea level in the standard atmosphere at which a given density is to be found*. The density of air has significant effects on the aircraft's performance because **as air becomes less dense, it reduces:**

- **Power because the engine takes in less air.**
- **Thrust because a propeller is less efficient in thin air.**
- **Lift because the thin air exerts less force on the airfoils.**

Effect of Pressure on Density

Since air is a gas, it can be compressed or expanded. *When air is compressed, a greater amount of air can occupy a given volume*. If the pressure is doubled, the density is doubled*; if the pressure is lowered, the density is lowered.*



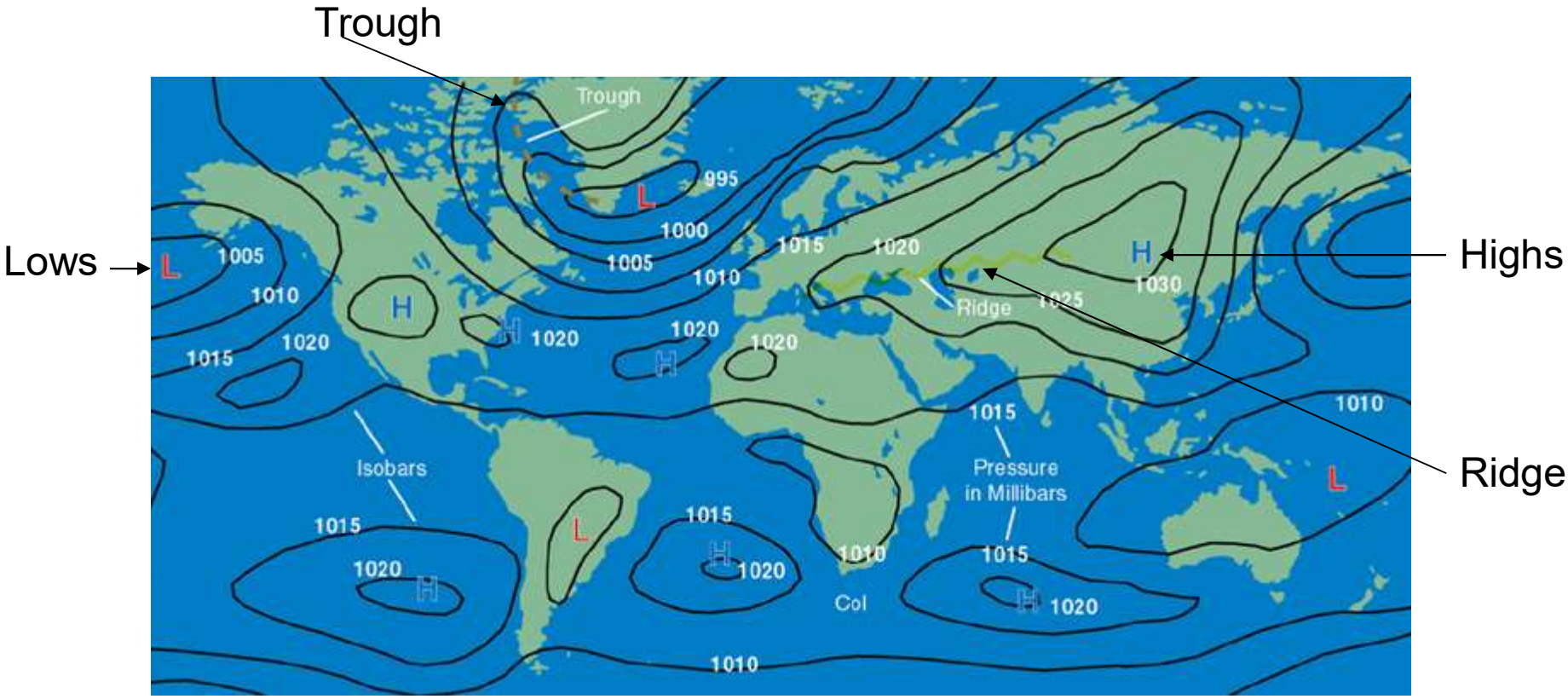
Effect of Temperature on Density

Increasing the temperature of a substance decreases its density. Thus, the density of air varies inversely with temperature. This statement is true only at a constant pressure.

Effect of Humidity (Moisture) on Density

Water vapor is lighter than air; consequently, as the water content of the air increases, the air becomes less dense, increasing density altitude and decreasing performance.

METEOROLOGY – BASIC WEATHER THEORY



High: Area of higher pressure surrounded by area of lower pressure
Elongated area of high pressure is called a "**Ridge**."
Low: Area of lower pressure surrounded by area of high pressure
Elongated area of low pressure is called a "**Trough**"
Elongated area of neutral pressure (intersection of Ridge & Trough) is called a "**Col**"
Isobars reveals the pressure gradient or change in pressure over distance.

Created by Steve Reisser

Isobars and Pressure Gradients *<u>Difference in pressure create WIND</u>*. *The closer the isobars the higher the pressure gradient and associated winds*.

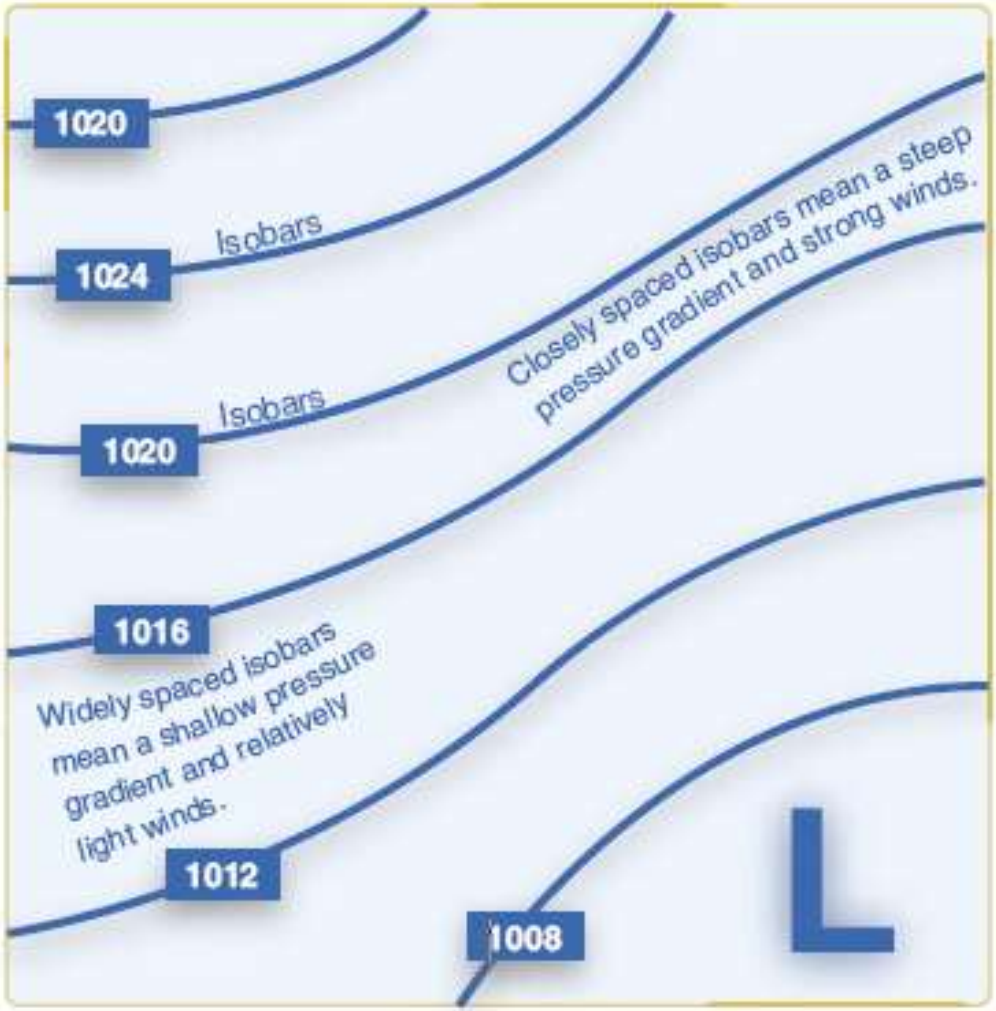
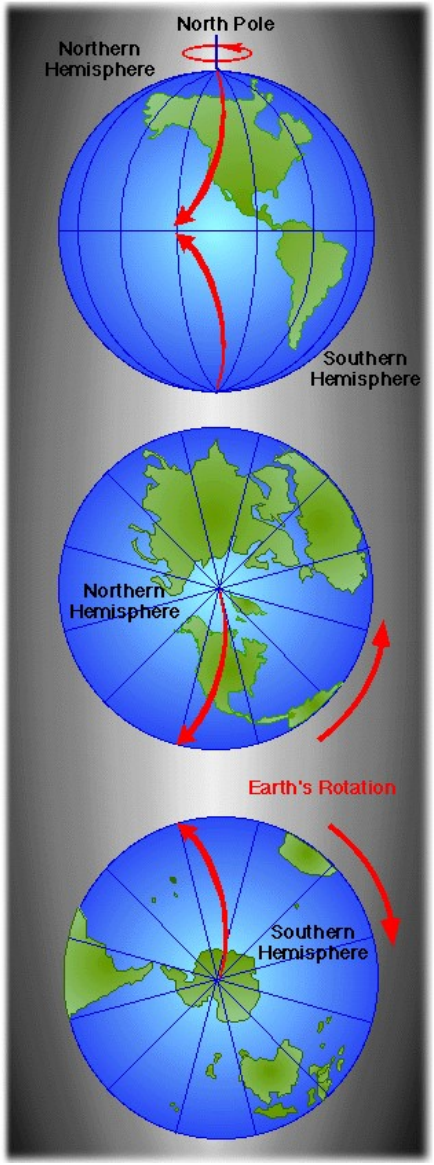
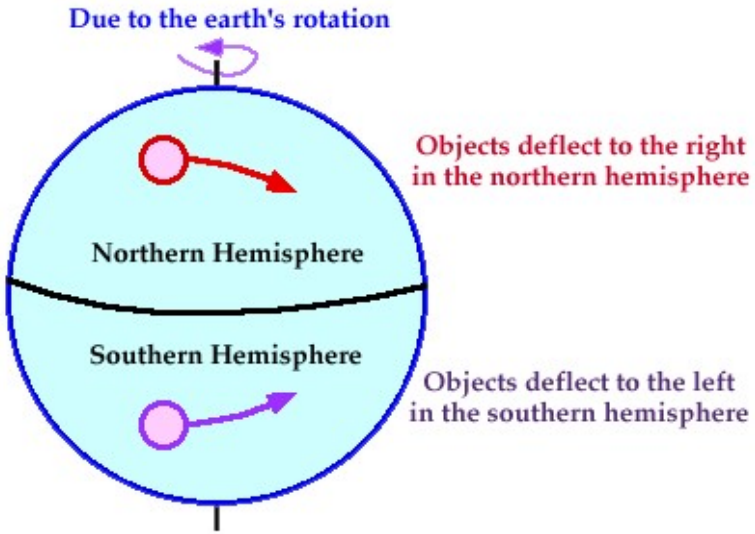
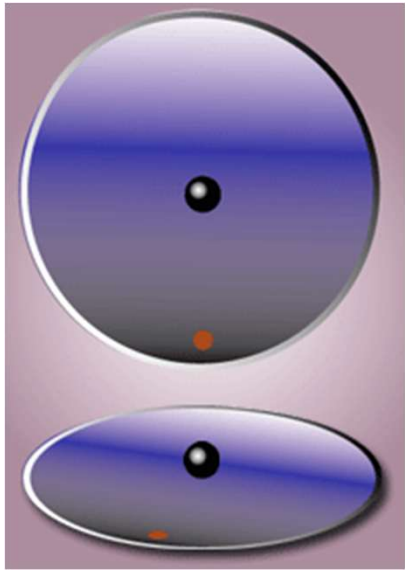


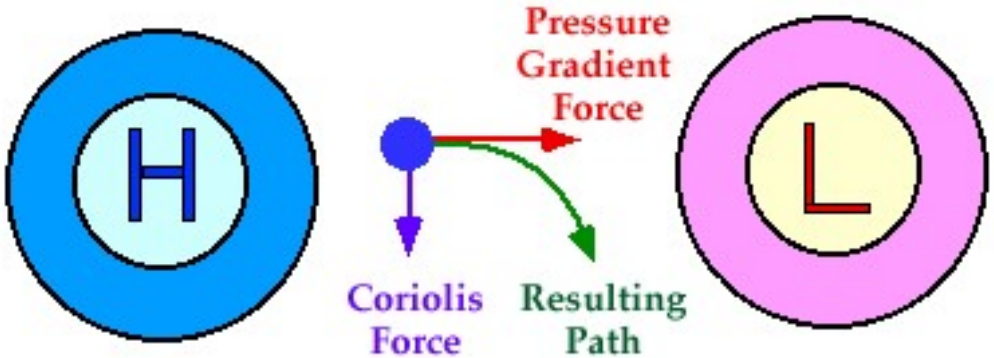
Figure 11-19. *Isobars reveal the pressure gradient of an area of high- or low-pressure areas.*

METEOROLOGY – BASIC WEATHER THEORY
CORIOLIS EFFECT



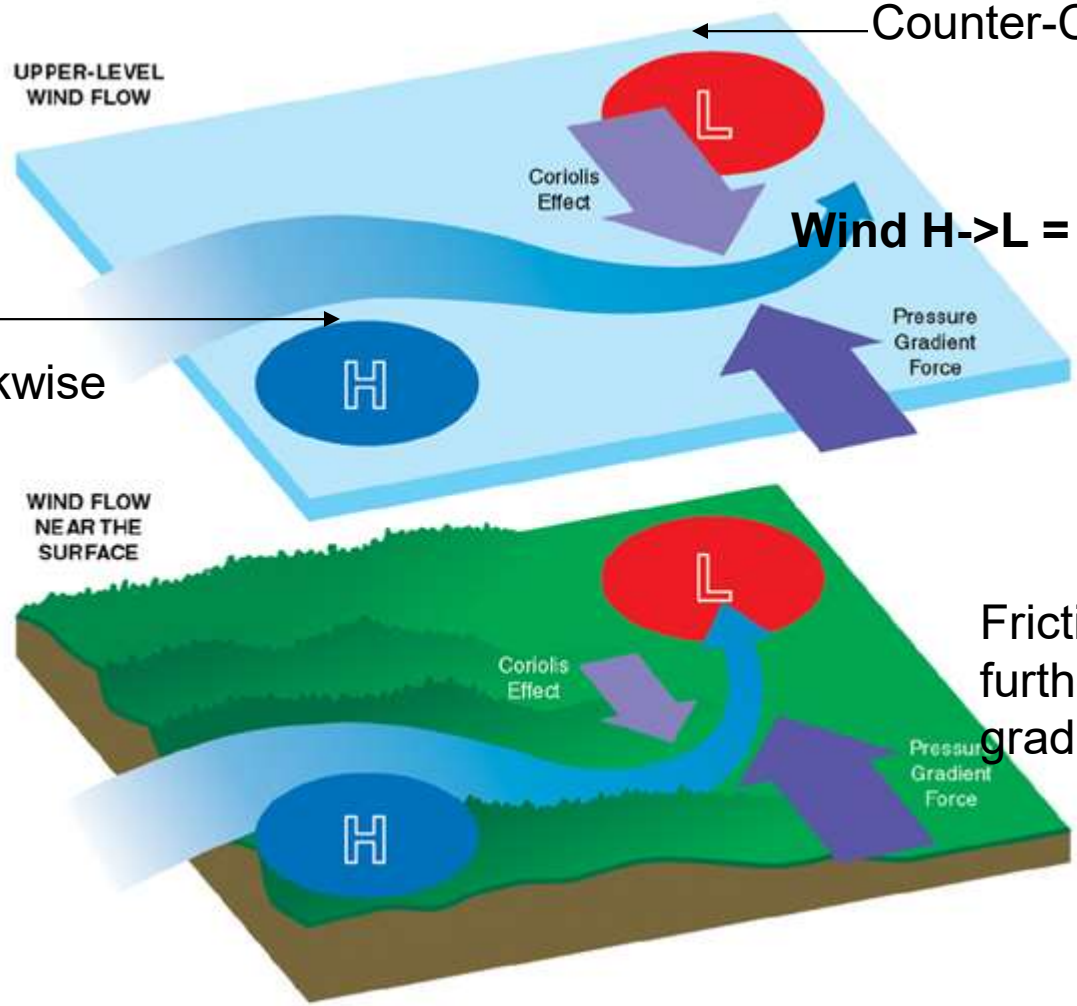






METEOROLOGY – BASIC WEATHER THEORY
FRICTIONAL FORCES

Counter-Clockwise



Wind H->L = Pressure Gradient

Clockwise

Frictional effects at surface further alter Coriolis and pressure gradient movement of wind

Take advantage of winds from pressure regions.

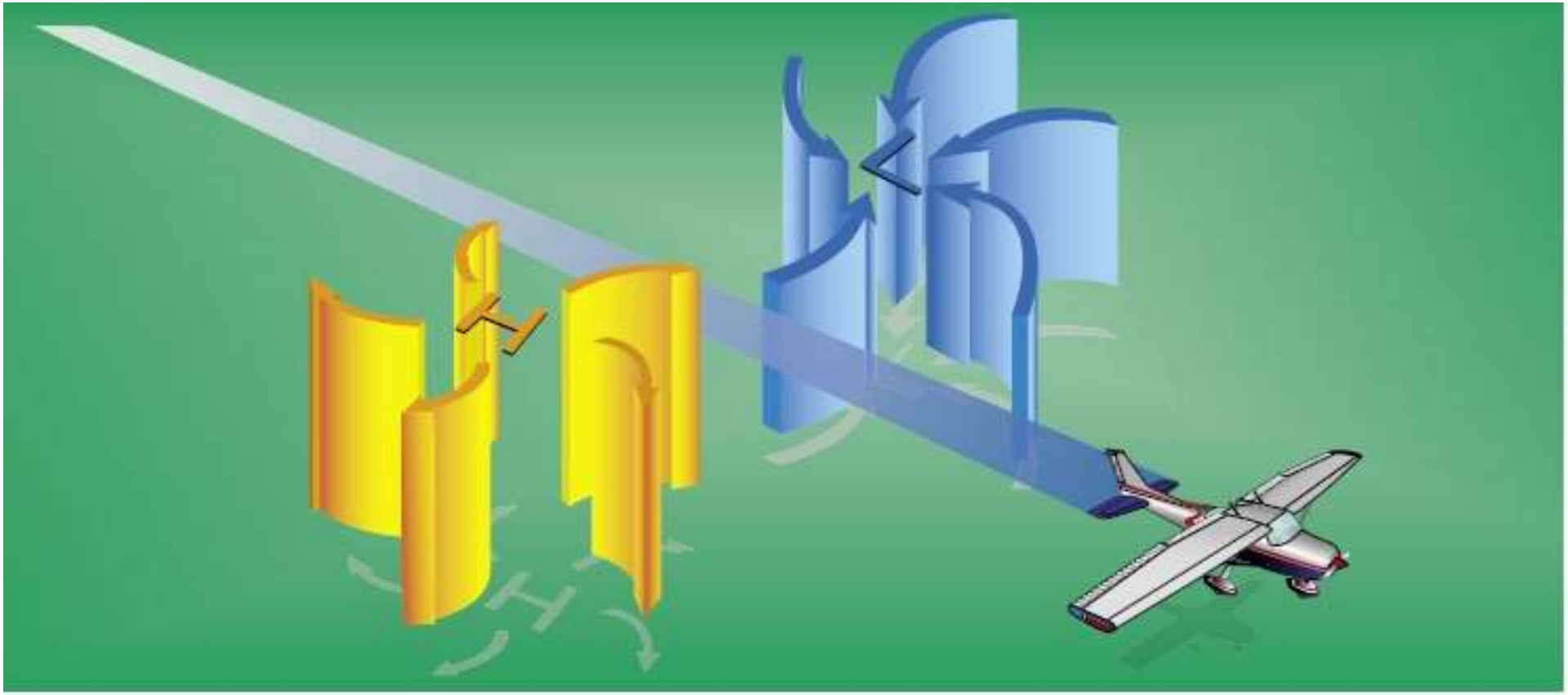


Figure 11-11. *Favorable winds near a high pressure system.*

Convective currents cause the bumpy, turbulent air sometimes experienced when flying at lower altitudes during warmer weather. On a low altitude flight over varying surfaces, updrafts are likely to occur over pavement or barren places, and downdrafts often occur over water or expansive areas of vegetation like a group of trees. Typically, these turbulent conditions can be avoided by flying at higher altitudes, even above cumulus cloud layers.

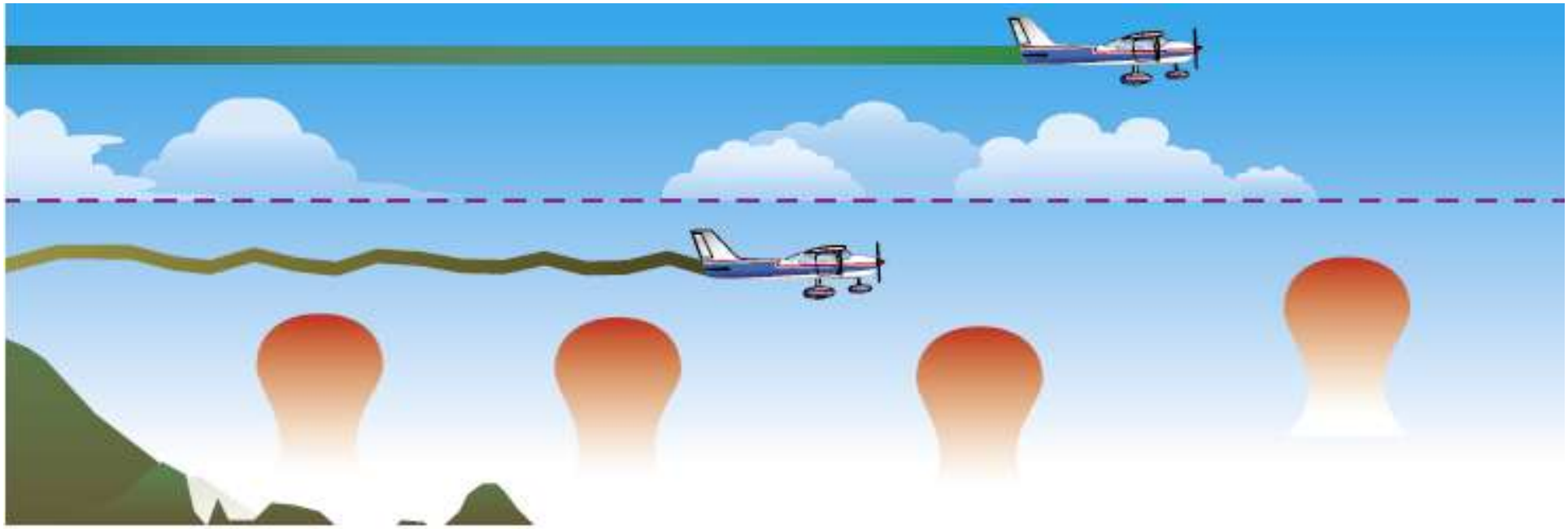
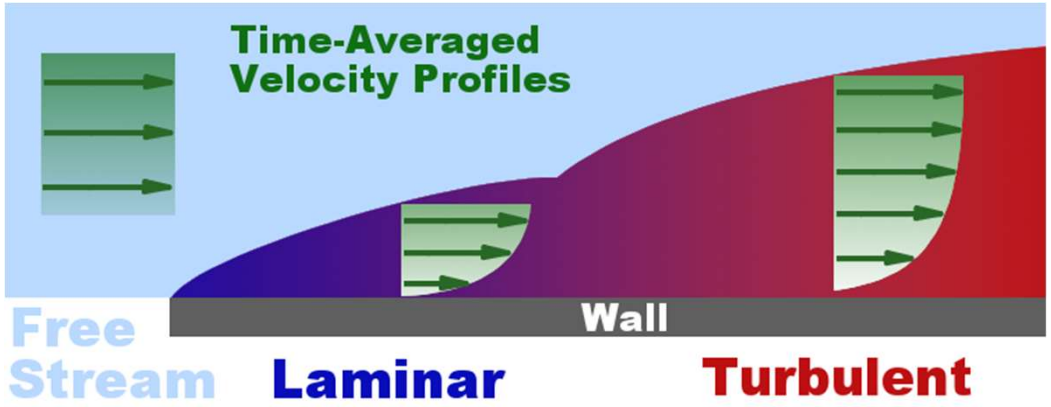


Figure 11-12. *Convective turbulence avoidance.*

METEOROLOGY – PLANETARY BOUNDARY LAYER

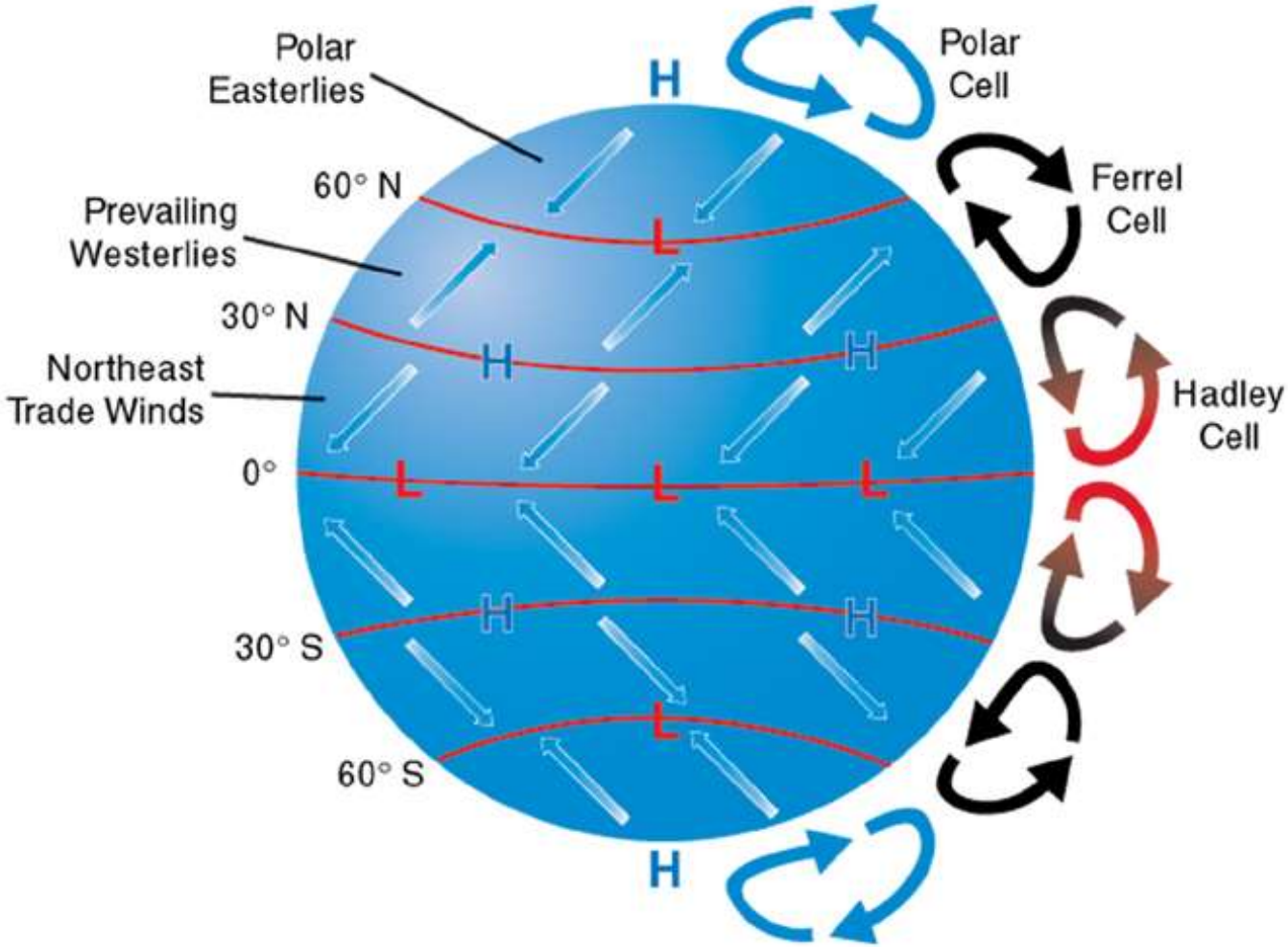
The planetary boundary layer (**PBL**) is also known as the atmospheric boundary layer **(ABL**) is a *marked thermal layer at approximately the 850 ML level (5000-7000). You will see a marked drop in temperature because of a thermal inversion right at the PLB*. Due to aerodynamic drag, there is a wind gradient in the wind flow just a few hundred meters above the earth's surface—the surface layer of the planetary boundary layer. the wind gradient effect could cause a reduction of 40% to 50% of the geostrophic wind speed aloft (balance between the Coriolis effect and the pressure gradient) while over open water or ice, the reduction may be only 20% to 30%. Wind speed increases with increasing height above the ground.



Be aware that when we look at Winds Aloft (FB) forecasts. *You are likely to see marked changes in air temperature and wind speed between published 6000 and 9000 foot forecasts.*

METEOROLOGY – BASIC WEATHER THEORY
GLOBAL WIND FORCES

Convective Heating and Cooling sets up basic global circulation patterns



METEOROLOGY – LOCAL WIND FORCES

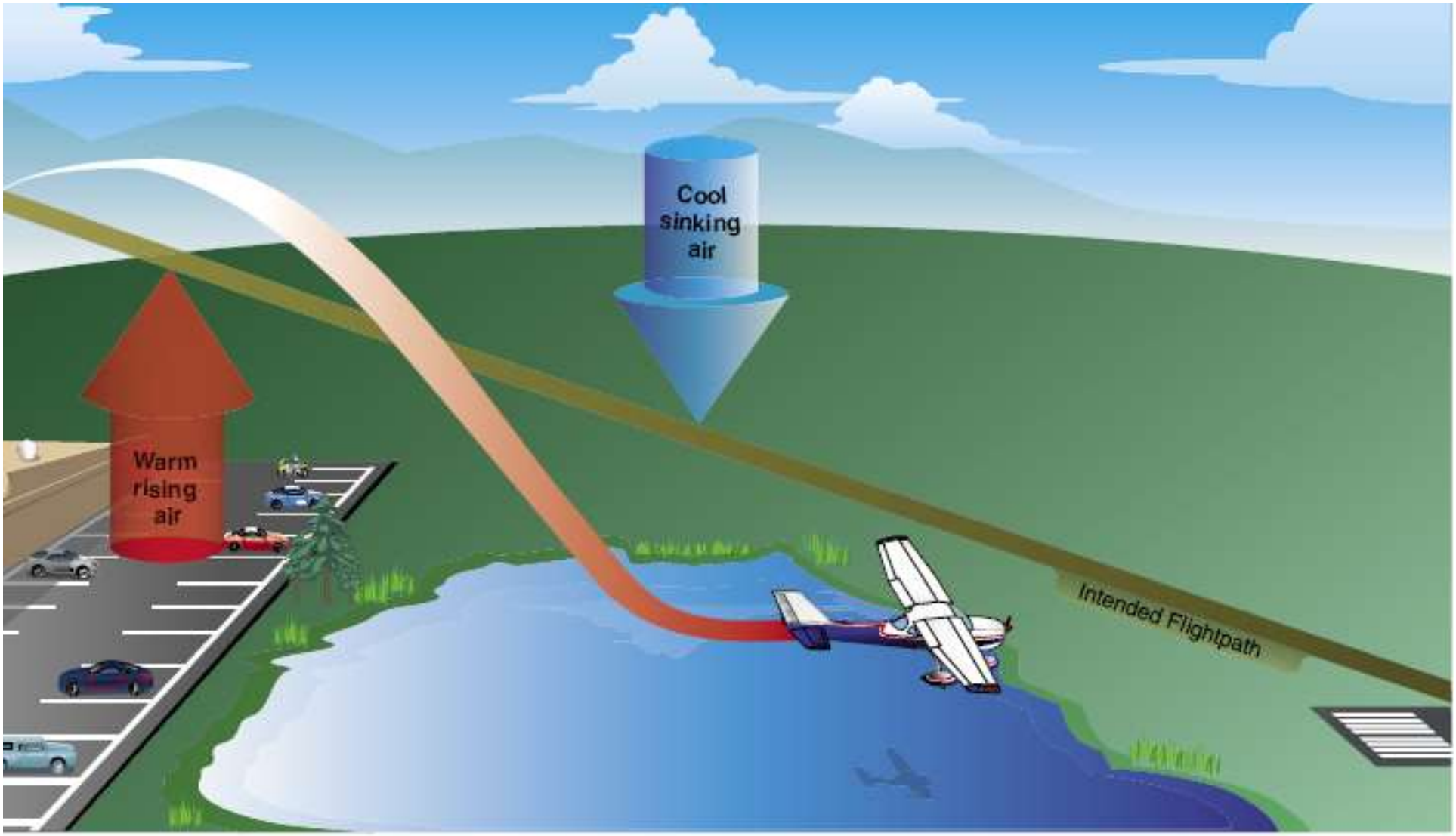


Figure 11-14. *Currents generated by varying surface conditions.*

METEOROLOGY – LOCAL WIND FORCES

Effect of Obstructions on Wind

Another atmospheric hazard exists that can create problems for pilots. Obstructions on the ground affect the flow of wind and can be an unseen danger. Ground topography and large buildings can break up the flow of the wind and create wind gusts that change rapidly in direction and speed. These obstructions range from manmade structures like hangars to large natural obstructions, such as mountains, bluffs, or canyons. It is especially important to be vigilant when flying in or out of airports that have large buildings or natural obstructions located near the runway.

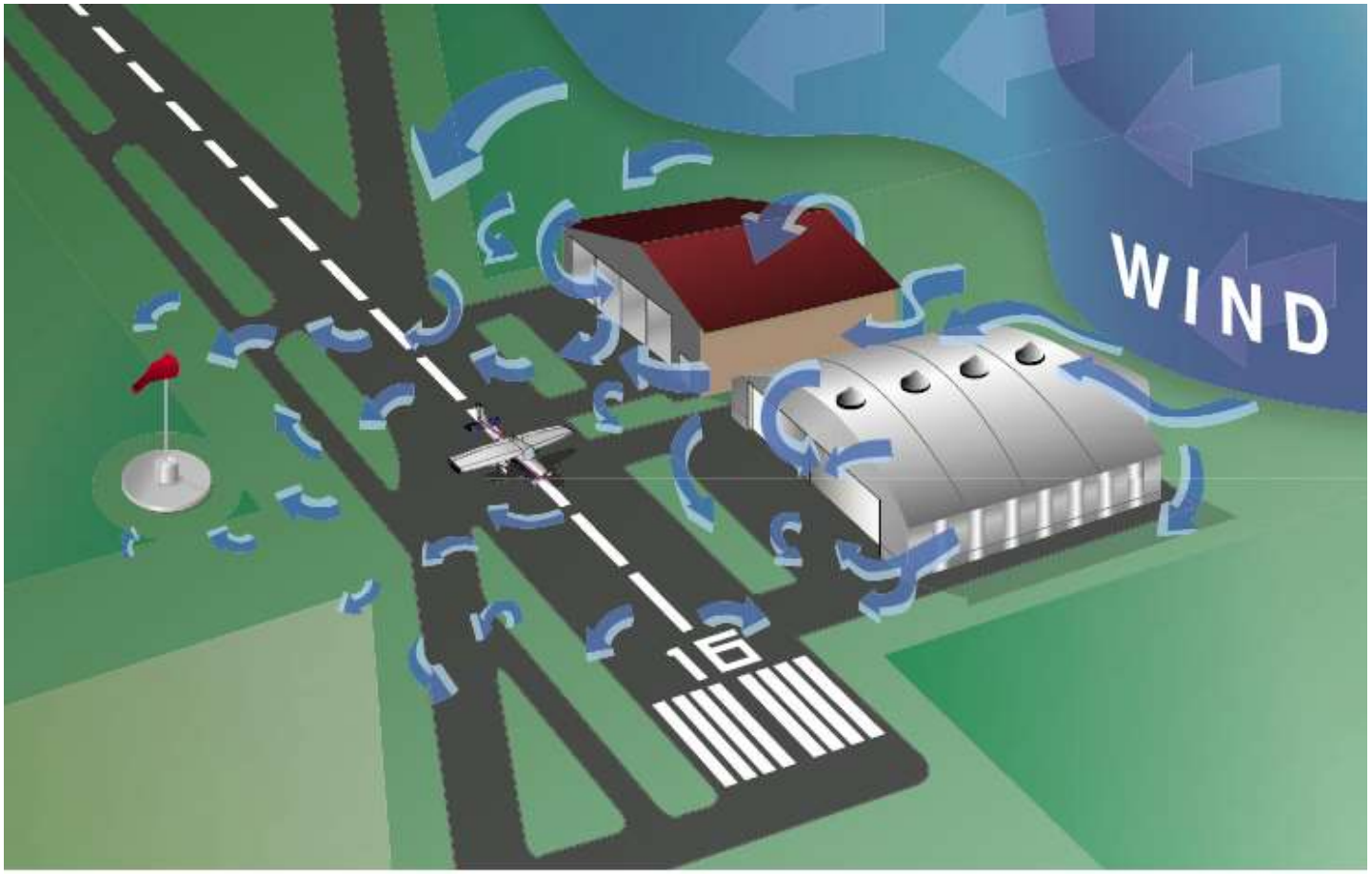


Figure 11-15. *Turbulence caused by manmade obstructions.*

METEOROLOGY – LOCAL WIND FORCES

Mountains: While the wind flows smoothly up the windward side of the mountain and the upward currents help to carry an aircraft over the peak of the mountain, the wind on the leeward side does not act in a similar manner. *As the air flows down the leeward side of the mountain, the air follows the contour of the terrain and is increasingly turbulent. This tends to push an aircraft into the side of a mountain. The stronger the wind, the greater the downward pressure and turbulence become*.

Due to the effect terrain has on the wind in valleys or canyons, **downdrafts can be severe**. Before conducting a flight in or near mountainous terrain, it is helpful for a pilot unfamiliar with a mountainous area ***to get a checkout with a mountain qualified flight instructor.***

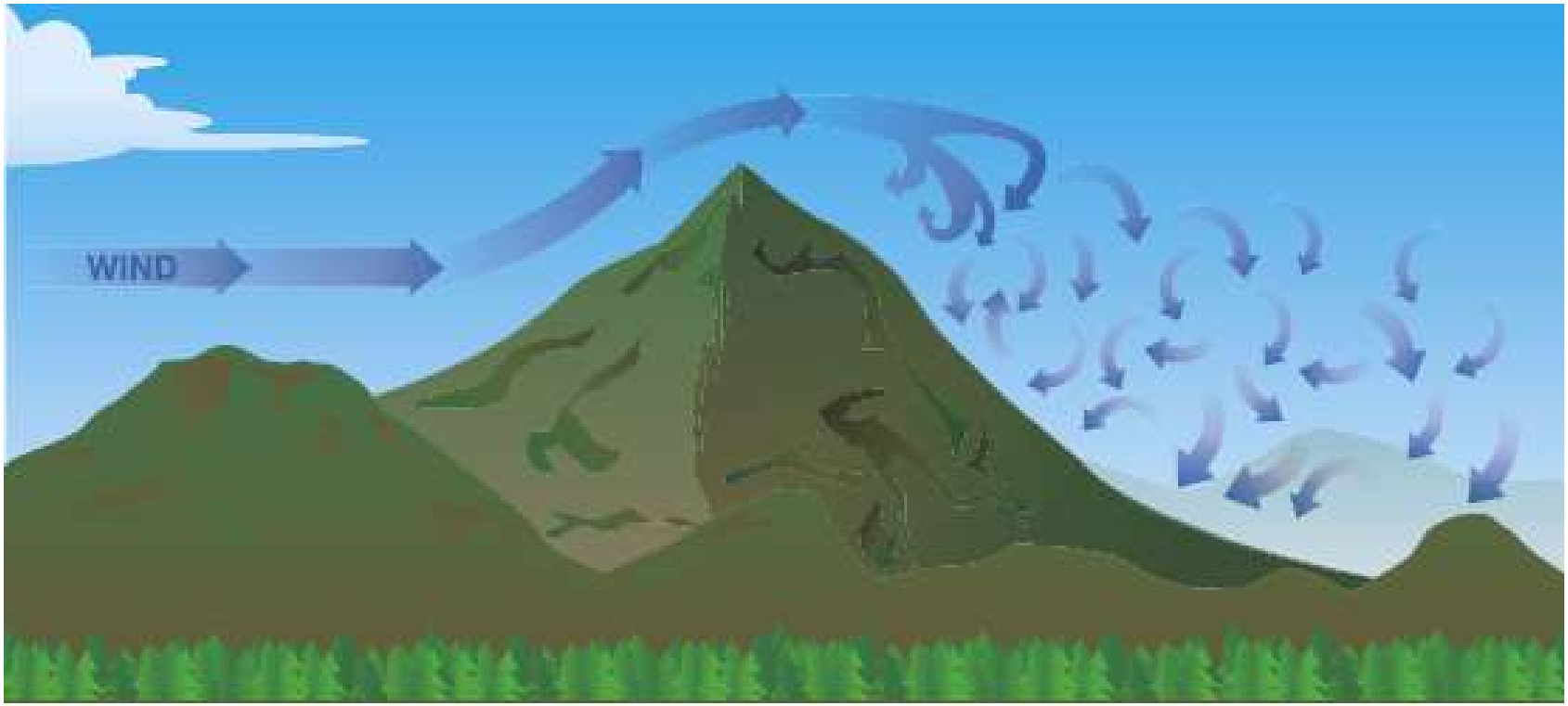
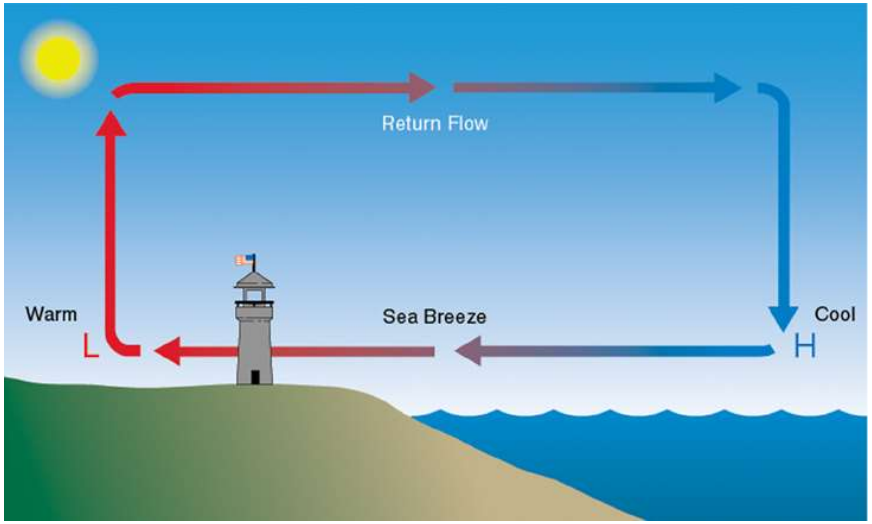


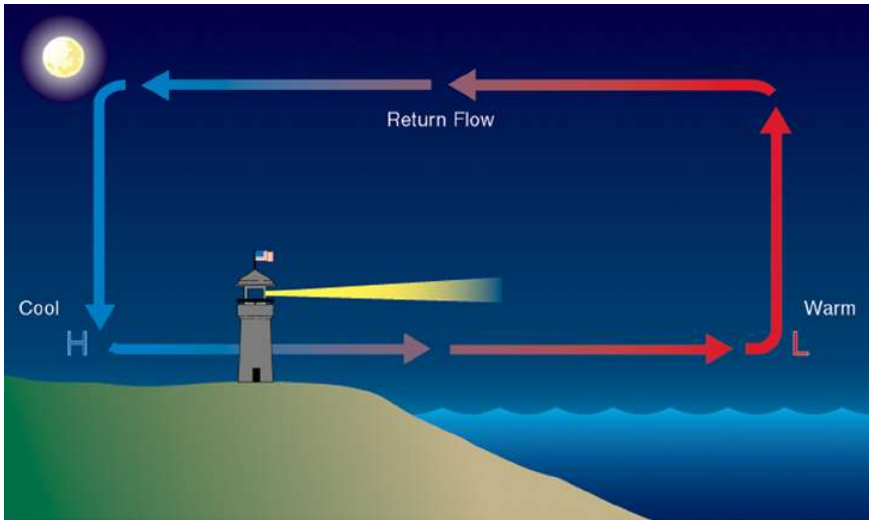
Figure 11-16. *Turbulence in mountainous regions.*

METEOROLOGY – LOCAL WIND FORCES

SEA BREEZES
(off the sea)



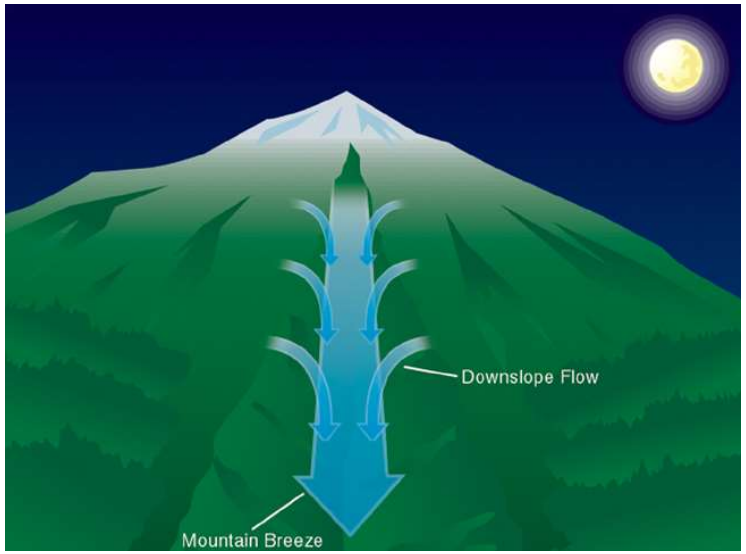
LAND BREEZES
(off the land)



METEOROLOGY – BASIC WEATHER THEORY
LOCAL WIND FORCES

Valley Breezes

Mountain Breezes

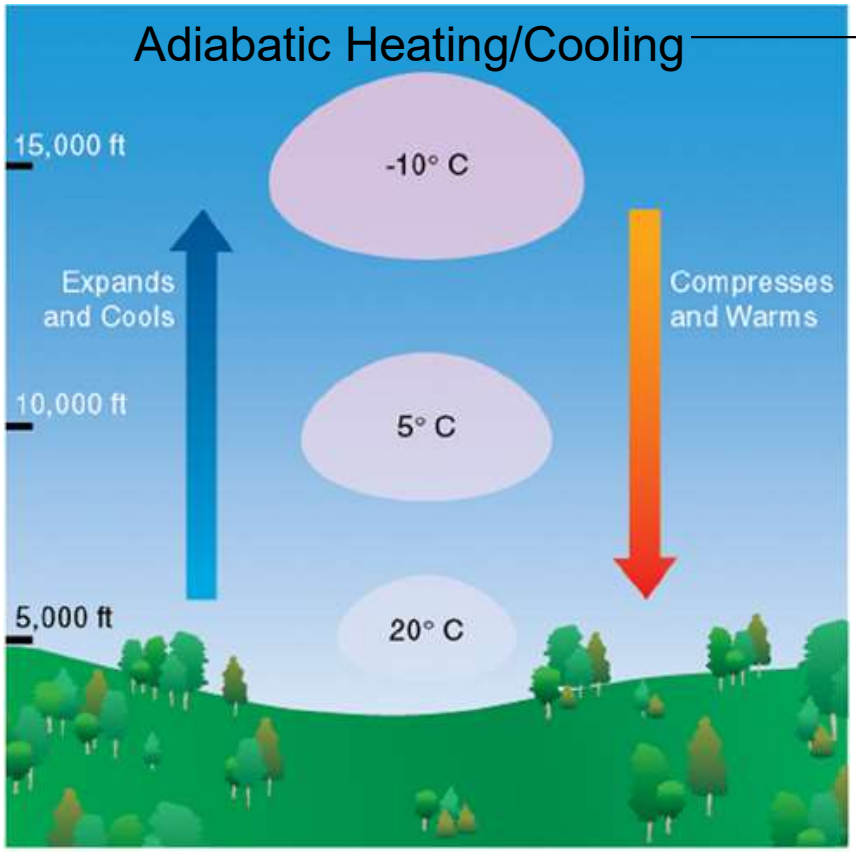


COLD AND WARM DOWNSLOPE WINDS (KATABATIC)
CAN BE UP TO 50 KNOTS.

DO NOT FLY IN OR NEAR MOUNTIANS WITHOUT SPECIAL FLIGHT INSTRUCTION. SERIOUS CONSEQUENCES IF YOU ARE NOT FULLY PREPARED FOR THIS AND OTHER HAZARDS (I.E. LENTICULAR CLOUDS)

METEOROLOGY – WEATHER PATTERNS
STABILITY

Stability is the resistance to vertical motion. Florida is not a stable environment except during winter. CONVECTION (heat rising and producing high instability) Stable air cools at a rate less than standard lapse rate, unstable air cools at rate greater than standard lapse rate.



Produces average "Lapse Rate" of -2 C or -3.5 F per 1000 feet.

Standard Temperature at Sea Level is 15 C or 59 F.

General rule for estimating standard atmospheric temperature (C) up to 35,000 feet

1. Double the altitude.
2. Divide by 1,000.
3. Subtract 15.
4. Change the sign.

INVERSIONS work backwards. Increase temperature with altitude to the "roof" of the inversion layer.

Atmospheric Stability

The stability of the atmosphere depends on its ability to resist vertical motion.
It is determined by the “Adiabatic” lapse rate

Adiabatic heating and adiabatic cooling

Rising air expands and cools due to the decrease in air pressure as altitude increases. The opposite is true of descending air; as atmospheric pressure increases, the temperature of descending air increases as it is compressed.

The rate at which temperature decreases with an increase in altitude is referred to as its lapse rate. As air ascends through the atmosphere, the **AVERAGE adiabatic lapse rate of temperature change is 2 °C (3.5 °F) per 1,000 feet**

Since water vapor is lighter than air, moisture decreases air density, causing it to rise. Conversely, as moisture decreases, air becomes denser and tends to sink. Since moist air cools at a slower rate, it is generally less stable than dry air since the moist air must rise higher before its temperature cools to that of the surrounding air. *The dry adiabatic lapse rate (unsaturated air) is 3 °C (5.4 °F) per 1,000 feet. The moist adiabatic lapse rate varies from 1.1 °C to 2.8 °C (2 °F to 5 °F) per 1,000 feet.*

Inversions

Inversion layers are commonly shallow layers of smooth, stable air close to the ground. *The temperature of the air increases with altitude to a certain point, which is the top of the inversion. The air at the top of the layer acts as a lid, keeping weather and pollutants trapped below*. If the relative humidity of the air is high, it can contribute to the formation of clouds, fog, haze, or smoke, resulting in diminished visibility in the inversion layer.

Adiabatic Rates of Parcels of Air

- For each parcel (region) of air, be aware that it can be localized and the adiabatic rates can vary.

HOW MIGHT YOU BE ABLE TO DETERMINE BOTH BEFORE AND DURING YOUR FLIGHT?

- "A rising parcel of air expands and cools at a constant rate of 5.4F for every 1000ft of climb as long as that parcel remains *unsaturated*."
- "A rising parcel of *saturated* air cools at rates between 2F and 5F per 1000ft."
- Be aware that the published *average* of 2C(3.5) adiabatic rate is not common except between 10,000-20,000ft.

Characteristics of stable and unstable air

	Stable	Unstable
Clouds	Stratiform (flat, layered)	Cumuliform (billowy, cumulus)
Turbulence	Relatively little	Turbulent, strong updrafts
Visibility	Poor	Good
Precipitation	Steady	Showery, intermittent

METEOROLOGY – WEATHER PATTERNS
MOISTURE

EVAPORATION	Liquid to Vapor
CONDENSATION	Vapor to Liquid
SUBLIMATION	Ice to Vapor
DEPOSITION	Vapor to Ice
FREEZING	Water to Ice
MELTING	Ice to Water

HUMIDITY – Amount of moisture in air. "Relative Humidity" is the actual moisture compared to the total that could be present in the air.

DEWPOINT – Temperature where air can no longer hold water (just above +4F, expect fog)
*Calculation for expected cloud base AGL = ((Temp(F) – Dew point(F)) / 4.4) * 1000*

We divide by 4 as an average because unsaturated air cools at 3/1000ft, two point decreases at 1/1000 ft. Thus in convective current the dew point converges at about 4.4 degrees (2.5C)/1000 ft
Ex*: temp 82F, dewpoint 62 [diff=20). Divide by 4=5 * 1000 give expected level clouds at 5000 AGL.*

FOG OCCURS WHEN TEMPERATURE IS WITHIN 2 DEGREES OF DEWPOINT !! Fog is a cloud that begins within 50 feet of the surface.
More later on Fog.

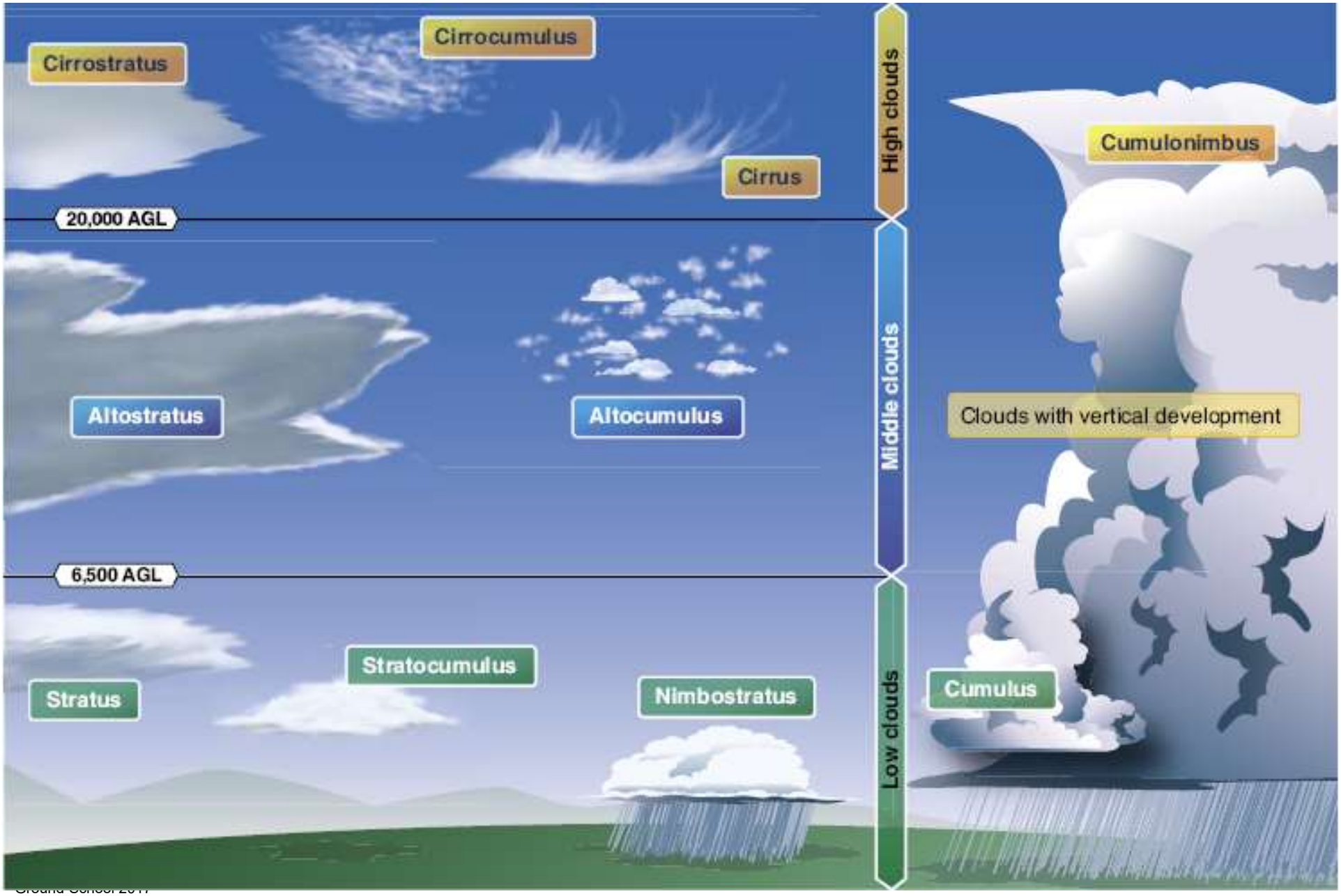
METEOROLOGY – WEATHER PATTERNS
CLOUDS

Stratus clouds (Stratoform) - no vertical development – flat but can be puffy
Cumulous clouds (Cumuloform) - vertical development – puffy
Cirrus clouds – very, very high and composed of ice – wisp appearance.

Low Level clouds – SL to 6,500 feet
Middle Level clouds – 6,500 to 20,000 feet (clouds usually prefixed “alto”
High Level clouds – above 20,000 feet (clouds always cirrus [cirroform])

- Cumulus—heaped or piled clouds
- Stratus—formed in layers
- Cirrus—ringlets, fibrous clouds, also high level clouds above 20,000 feet
- Castellanus—common base with separate vertical development, castle-like
- Lenticularus—lens shaped, formed over mountains in strong winds
- Nimbus—rain-bearing clouds
- Fracto—ragged or broken
- Alto—meaning high, also middle level clouds existing at 6,500 to 20,000 feet

BASIC CLOUD TYPES



METEOROLOGY – WEATHER PATTERNS
LOW LEVEL CLOUDS

LOW CLOUDS

Stratus Clouds
Stratus clouds are layered clouds that form in stable air near the surface due to cooling from below. Stratus clouds have a gray, uniform appearance and generally cover a wide area. Although turbulence in these clouds is low, they usually restrict visual flying due to low ceilings and visibility. Icing conditions are possible if temperatures are at or near freezing. Stratus clouds may form when moist stable air is lifted up sloping terrain, or when warm rain evaporates as it falls through cool air.

Nimbostratus Clouds
Nimbostratus clouds are gray or black clouds that can be more than several thousand of feet thick, contain large quantities of moisture, and produce widespread areas of rain or snow. If temperatures are near or below freezing, they may create heavy aircraft icing.

Stratocumulus Clouds
Stratocumulus clouds are white, puffy clouds that form as stable air is lifted. They often form as a stratus layer breaks up or as cumulus clouds spread out.

METEOROLOGY – WEATHER PATTERNS - LOW LEVEL CLOUDS

FOG: Base within 50 ft AGL

TYPES OF FOG

Ground: less than 20 ft thick

Radiation - →
forms in low-lying areas on clear, calm, humid nights in stable air associated with high pressure systems. Dissipates with rising sun.

Advection: Warm moist air moving over a cooler surface Wind is required to form advection fog. Up to 15Kts intensifies, above lifts to form stratus clouds.

Upslope: Warm moist air forced up a sloping land mass. Upslope and advection fog, unlike radiation fog, may not burn off with the morning sun, but instead can persist for days. They can also extend to greater heights than radiation fog.

Steam (sea smoke): cold, dry air - - - - - - - - - →
moves over comparatively warm water. Also know as precipitation induced

Ice Fog Temperature is much below freezing (-25F) and water vapor forms directly into ice crystals.

“**Aspertus**”- 1st discovered 2009 – Stratoform, now more prevalent in Midwest and other parts of the world.

METEOROLOGY – WEATHER PATTERNS
MIDDLE LEVEL CLOUDS

Altostratus Clouds
Altostratus clouds are flat, dense clouds that cover a wide area. They are a uniform gray or gray-white in color. Although they produce minimal turbulence, they may produce moderate aircraft icing.

MIDDLE CLOUDS

Altocumulus Clouds
Altocumulus clouds are gray or white, patchy clouds of uniform appearance that often form when altostratus clouds start to break up. They usually extend over a wide area, produce light turbulence, and may contain supercooled water droplets.

METEOROLOGY – WEATHER PATTERNS
MIDDLE LEVEL CLOUDS

Altocumulus-Castlellanus

Super Lenticular

Altocumulus-Lenticular

Created by Steve Reisser

METEOROLOGY – WEATHER PATTERNS
HIGH LEVEL CLOUDS

Cirrus Clouds
Cirrus clouds form in stable air at high altitudes. They are thin and wispy and usually form above 30,000 feet. White or light gray in color, they often exist in patches or narrow bands that cross the sky. Since cirrus clouds are sometimes blown from the tops of thunderstorms, they can be an advance warning of approaching bad weather.

HIGH CLOUDS

Cirrostratus Clouds
Cirrostratus clouds also are thin, white clouds that often form in long bands or sheets against a deep blue background. Although they may be several thousands of feet thick, moisture content is low and they pose no icing hazard.

Cirrocumulus Clouds
Cirrocumulus clouds are white patchy clouds that look like cotton. They form as a result of shallow convective currents at high altitude and may produce light turbulence.

METEOROLOGY – WEATHER PATTERNS
CUMULOUS CLOUDS (Vertical Development)

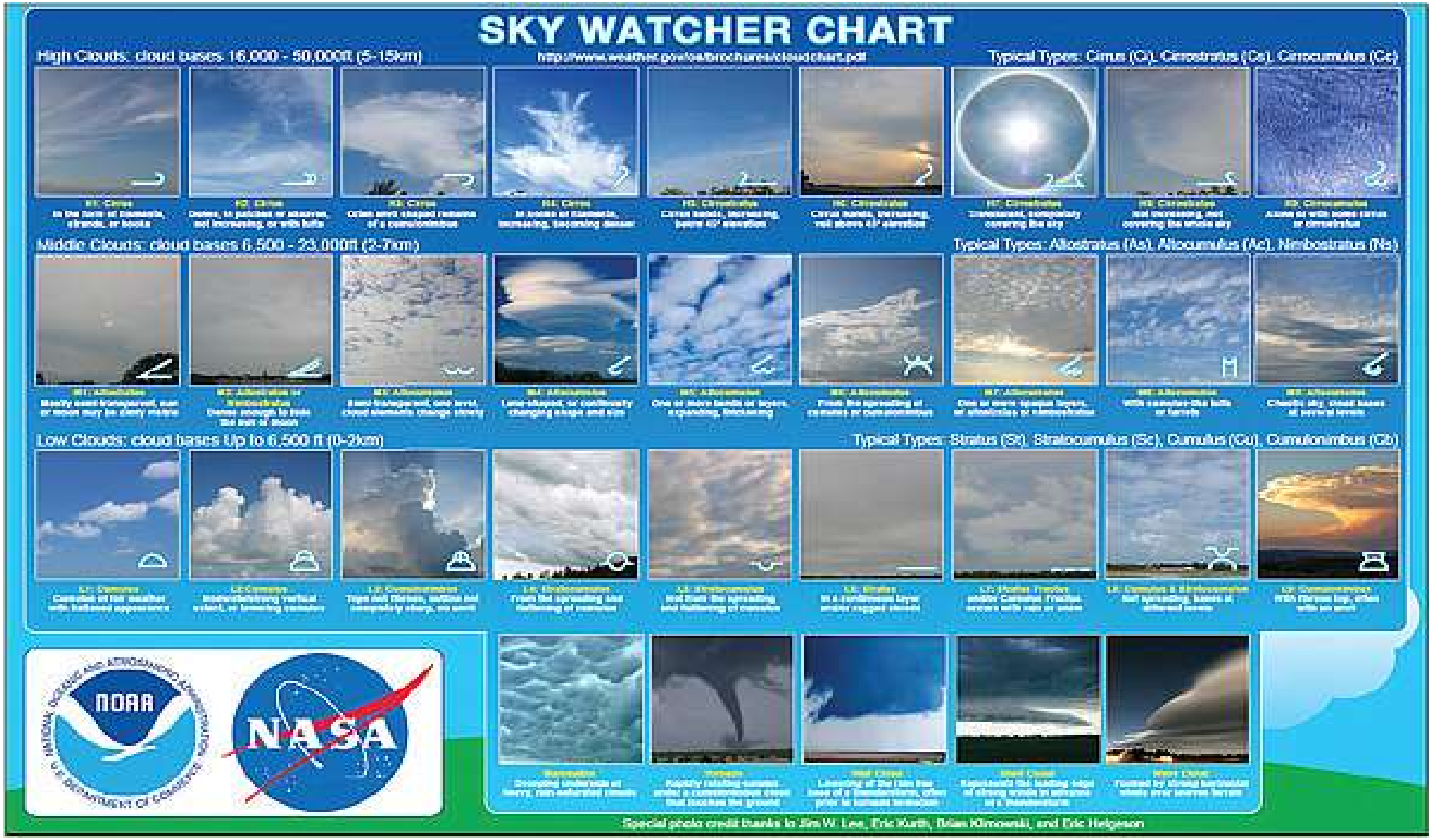
Cumulus Clouds
Cumulus clouds form in convective currents resulting from the heating of the earth's surface. They usually have flat bottoms and dome-shaped tops. Widley spaced cumulus clouds that form in fairly clear skies are called fair weather cumulus and indicate a shallow layer of instability. You can expect turbulence, but little icing and precipitation.

Towering Cumulus
Towering cumulus clouds look like large mounds of cotton with billowing cauliflower tops. Their color may vary from brilliant white at the top to gray near the bottom. Towering cumulus clouds indicate a fairly deep area of unstable air. They contain moderate to heavy turbulence with icing and often develop into thunderstorms.

Cumulonimbus Clouds
Cumulonimbus clouds, which are more commonly called thunderstorms, are large, vertically developed clouds that form in very unstable air. They are gray-white to black in color and contain large amounts of moisture. Many flying hazards are linked with cumulonimbus clouds.

For a larger preview: check the following websites

[Forecasting Weather by Clouds]
[Examples of 10 Main Cloud Types]
[Cloud Flashcards]
[Online Cloud Identification Guide]



METEOROLOGY – WEATHER PATTERNS
PRECIPITATION

CAUSES

1. Condensation/Deposition: grows in weight until it falls
2. Coalescence: Big drops fall thru and absorb smaller droplets.
3. Ice-Crystal Process at mid-high altitudes where water can exist below freezing as evidenced by “Super Cooled Droplets” that can exist down to -40 C.

TYPES

<u>DRIZZLE (DZ) and RAIN (RA)</u>

Drizzle (less than .02 inches in diameter

Rain (equal or greater than .02 inches.

Virga – Rain that evaporates before reaching the ground.

Precipitation induced fog: evaporation from falling rain (very dense)

METEOROLOGY – WEATHER PATTERNS PRECIPITATION

ICE PELLETS (PL) and HAIL (GR)

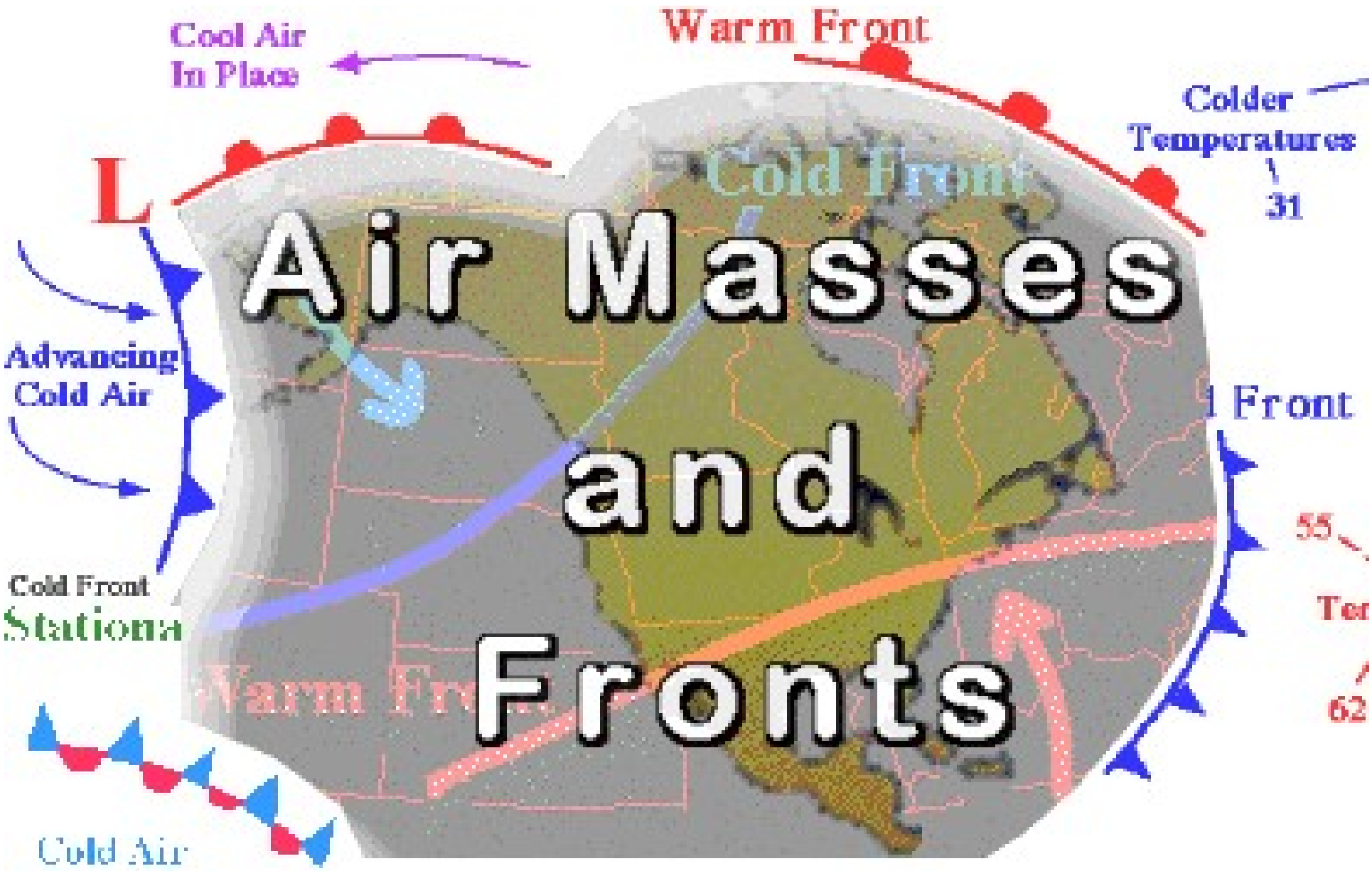
Ice Pellets usually are associated with inversions when precipitation at the higher level falls down to lower temperatures below and begin to freeze into small ice pellets. EXPECT FREEZING RAIN ABOVE !!! Also-most often associated with warm fronts rather than cold fronts.

Hail is caused by vertical cloud development (cumulonimbus) and ice grows to such a size as cannot be help up any longer. Can get up to 5 inches – 1 ½ pounds in weight.

SNOW (SN)

Not the same as Ice Pellets. Flat – do not bounce or shatter on impact. They can exist in high level cloud formations within cirrus and are called "Fallstreaks." →

Air Masses and Fronts



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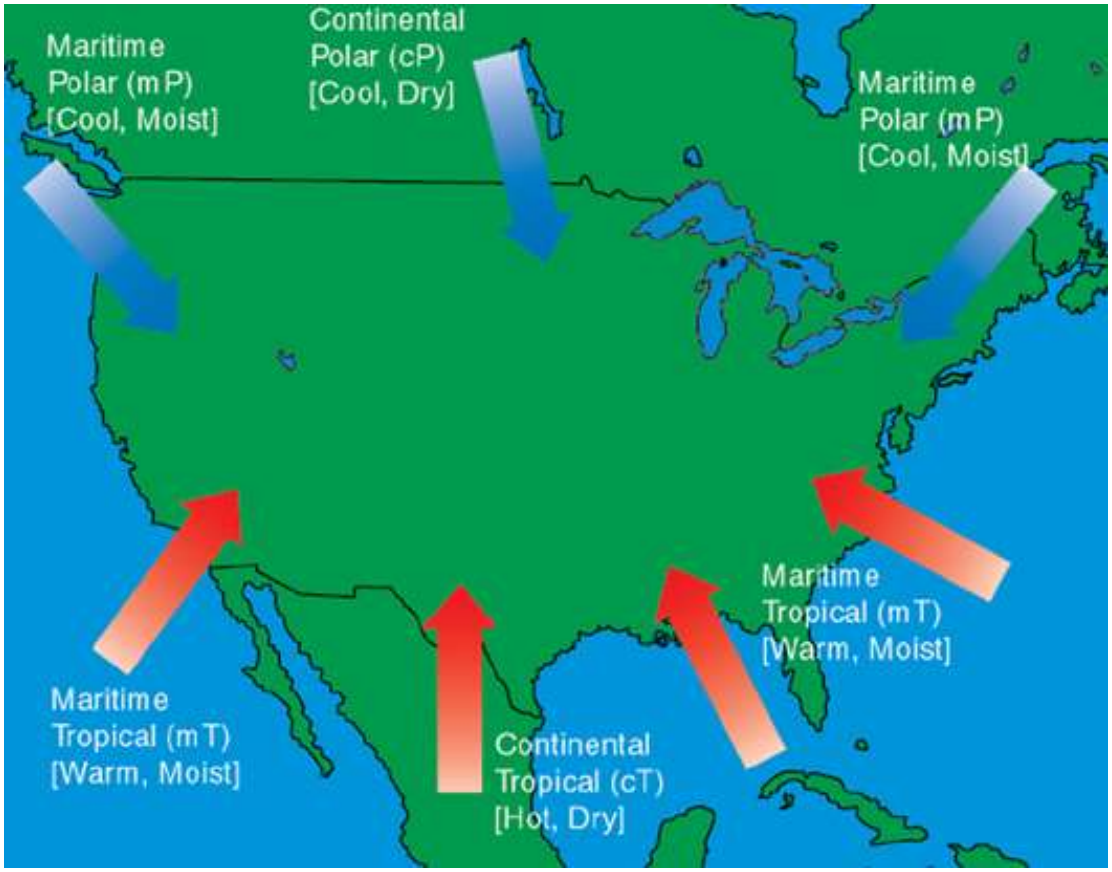
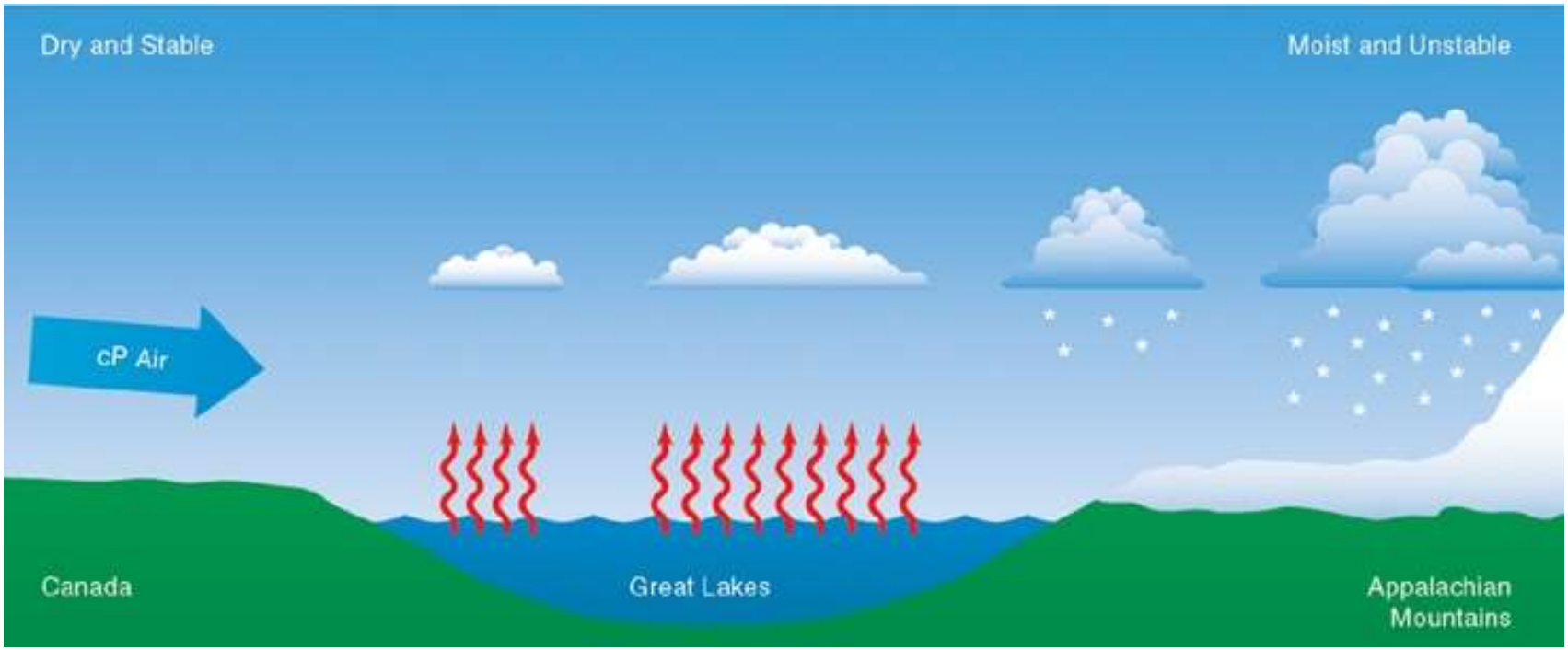
METEOROLOGY – WEATHER PATTERNS
AIR MASSES

AIRMASS Body of air with uniform temperature and moisture**,**
ORIGINATING from land “Continental” or from water “Maritime”



METEOROLOGY – WEATHER PATTERNS
AIR MASSES

Air masses change in speed, temperature & depth when moving out of source region.



HEATED FROM BELOW the air mass is modified to become unstable with "lake effect snows" and snowfall on "lee" side of mountains.

Conversely, air masses COOLED FROM BELOW can result in a stable, condensation effects with statoform clouds and fog.

METEOROLOGY – WEATHER PATTERNS
FRONTS

FRONT: A boundary between air masses having different temperature and moisture content. Often a "line of confrontation" with serious flying hazards.

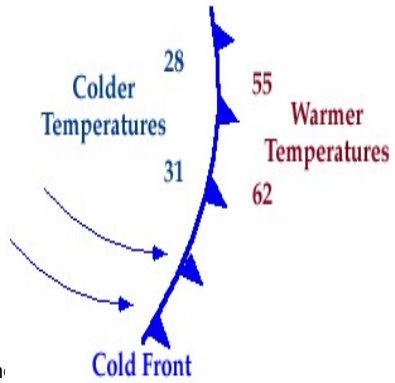
TYPES

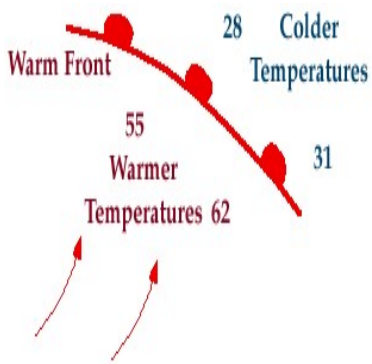
Cold Front: Colder air slips beneath and overtakes warmer air.

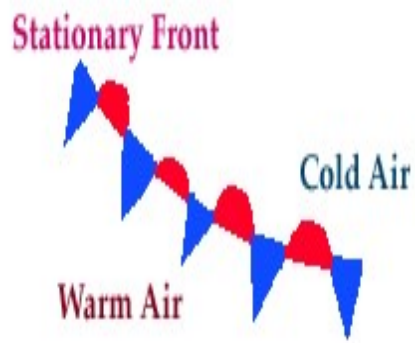
Warm Front: Warmer air rides above and overtakes cooler air.

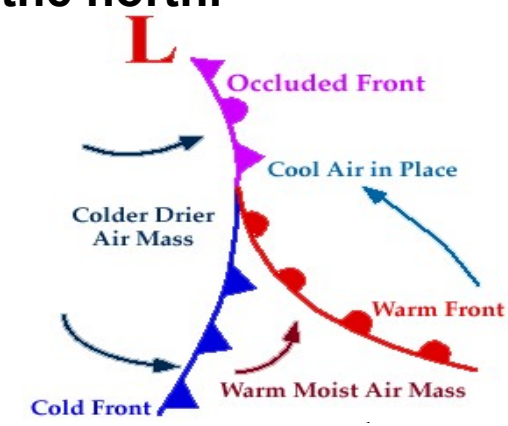
Stationary Front: (no movement) cool and warm air coexist in same region.

Occluded Front: Fast moving cool air mass catches and merges with the warm front often causing a low pressure area to form to the north.

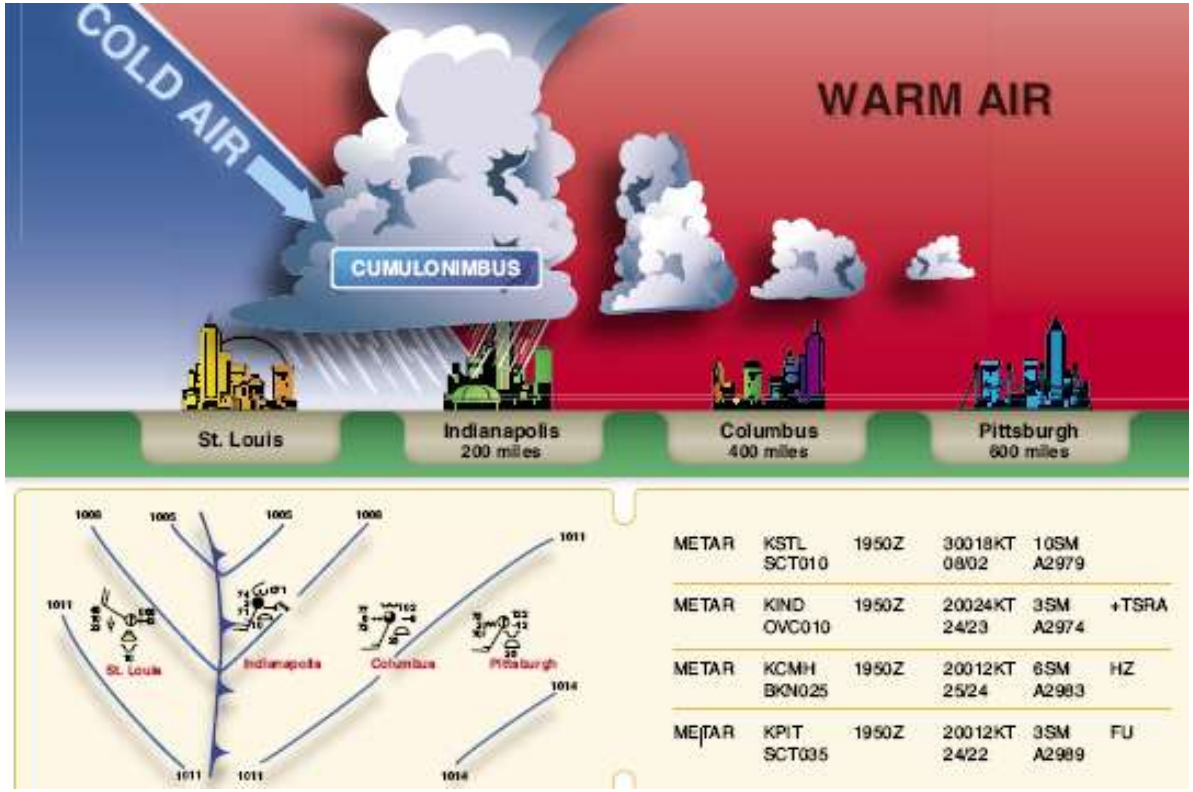








METEOROLOGY – COLD FRONTS



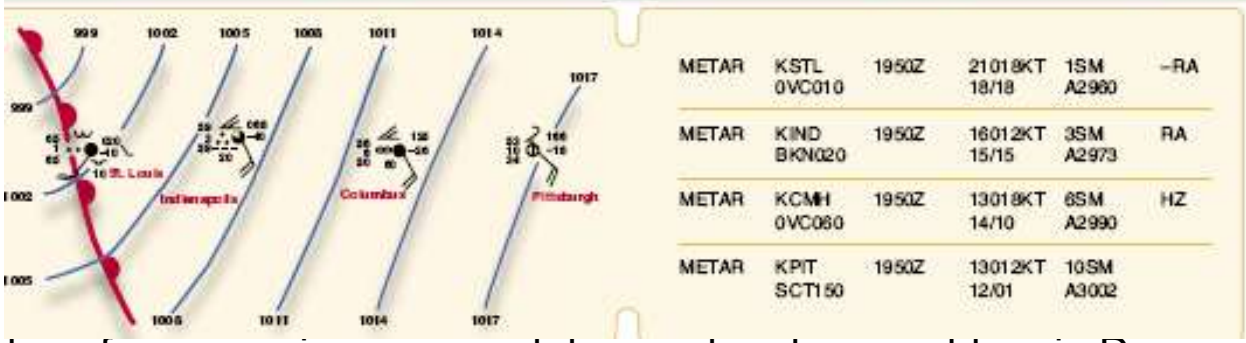
The leading edge of a cold air mass overtakes and replaces warmer air at the surface. Cold fronts generally move faster and have a steeper slope than warm fronts.

Winds/clouds/precipitation — Cold-front passage is characterized by a temperature decrease; by a wind shift from a southerly to a northwesterly direction; and, on occasion, by gusty winds. Convective clouds often develop in the warm air ahead of the front. The warm and wet ground behind the front generates low-level convection and fair-weather cumulus in the cold air.

Fast-moving cold front — Very steep slopes and narrow bands of clouds, usually found ahead of the front. Showers and thunderstorms develop along the surface position, and a line of thunderstorms (squall line) frequently develops ahead of the front.

Slow-moving cold front — Less steep slopes and cloud systems that may extend far to the rear of the surface position of the front.

METEOROLOGY – WARM FRONTS



The leading edge of a warm air mass overtakes and replaces colder air. Denser cold air close to the surface forces the warm air to slide over it. This causes the front to lack direct push on the cold air, which in turn retreats slowly, resulting in a gentle frontal slope and a relatively slow-moving warm front.

Winds/clouds/precipitation —

Moist and stable air — Produces clouds that are stratiform and widespread over the shallow front. Precipitation is continuous and induces widespread stratus in the cold air.

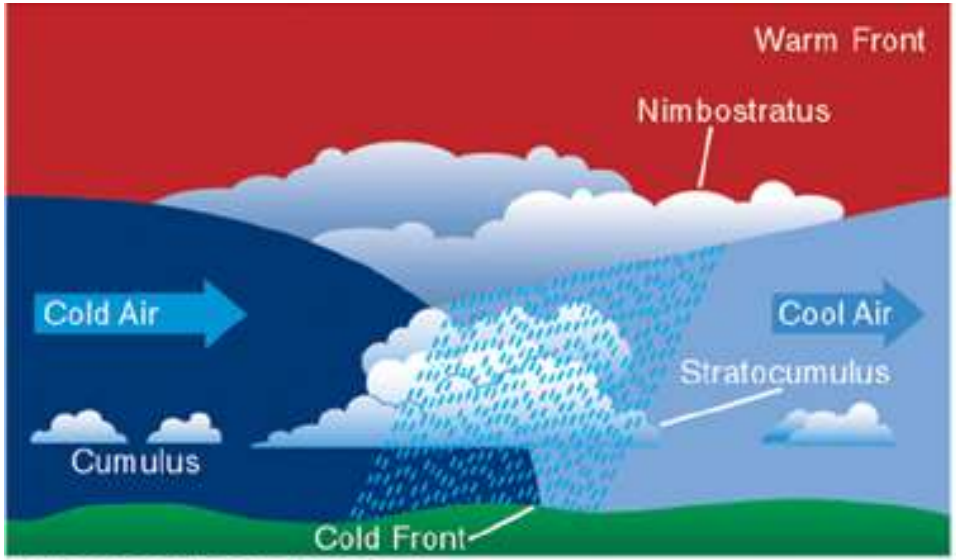
Moist and unstable air — Produces widespread cloud masses in which altocumulus, cumulonimbus, and thunderstorms are embedded. Watch out for ice pellets and freezing rain above.

STATIONARY AND OCCLUDED FRONTS

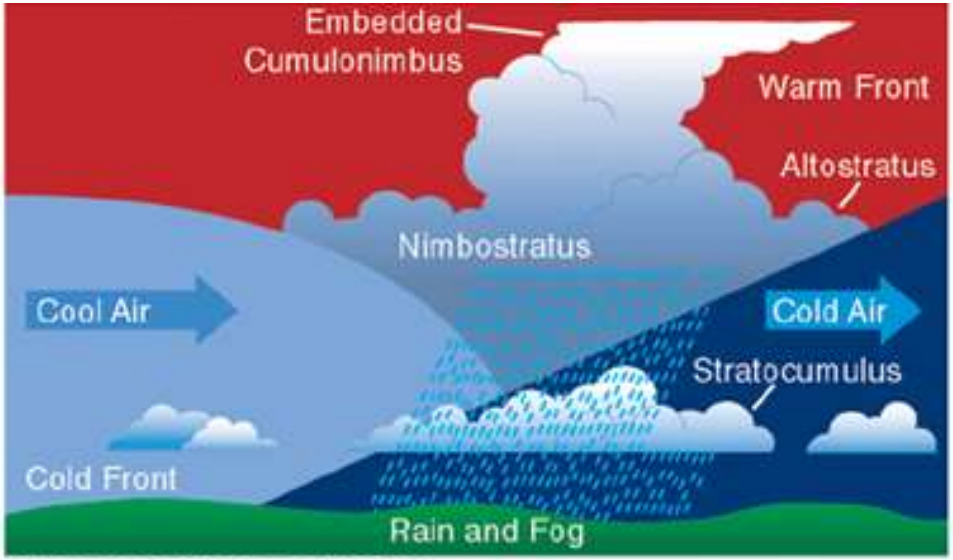
Stationary: “relatively” balanced between masses but incorporates whatever conditions exist below (sea – moisture, dry land – reduced moisture, etc.)

<u>Warm-front occlusion</u> — Occurs when the warmest air is under the cold front. When it overtakes the warm front, the less cold air rides over the colder air, and cool air replaces cold air at the surface.

<u>Cold-front occlusion</u> — Occurs when the coldest air is under the cold front. When it overtakes the warm front, it lifts the warm front aloft, and cold air replaces cool air at the surface.

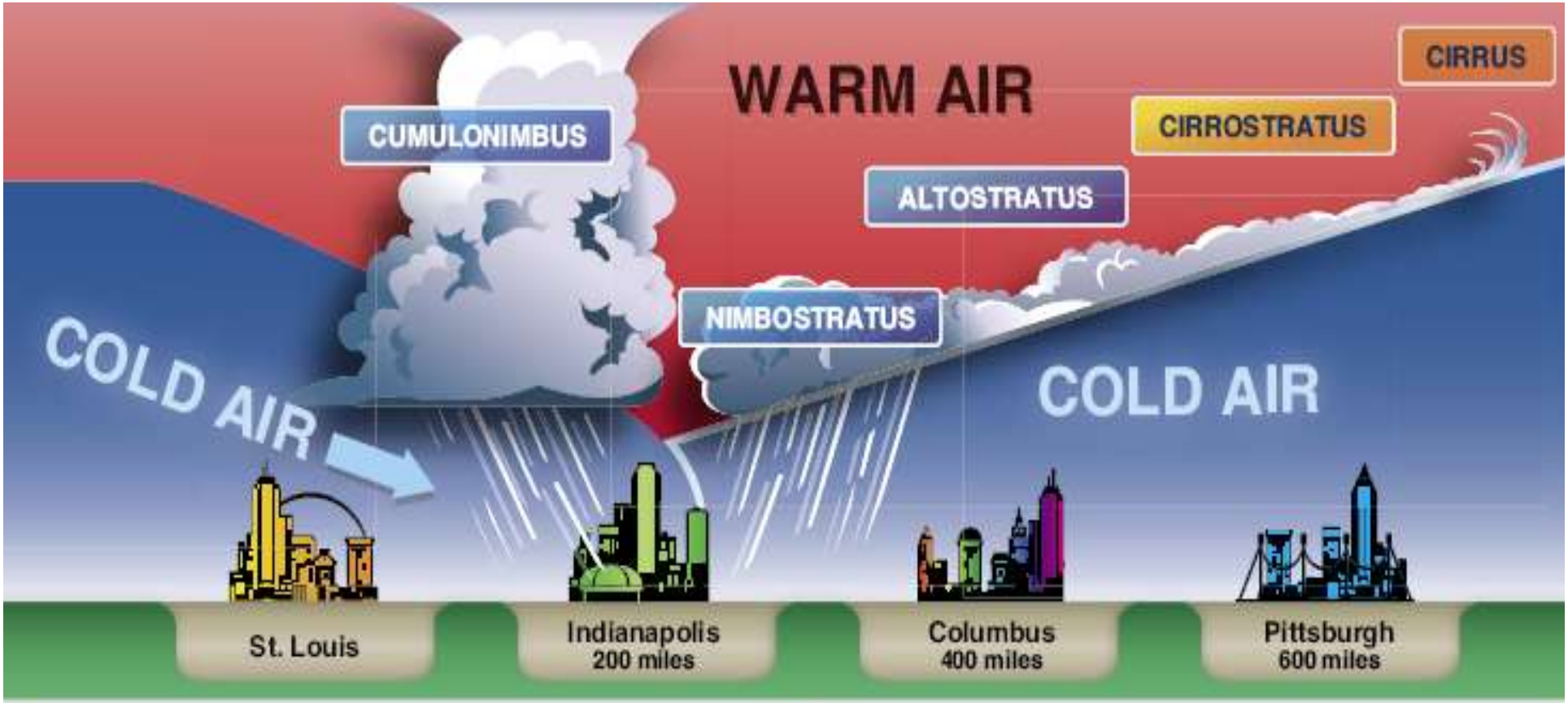


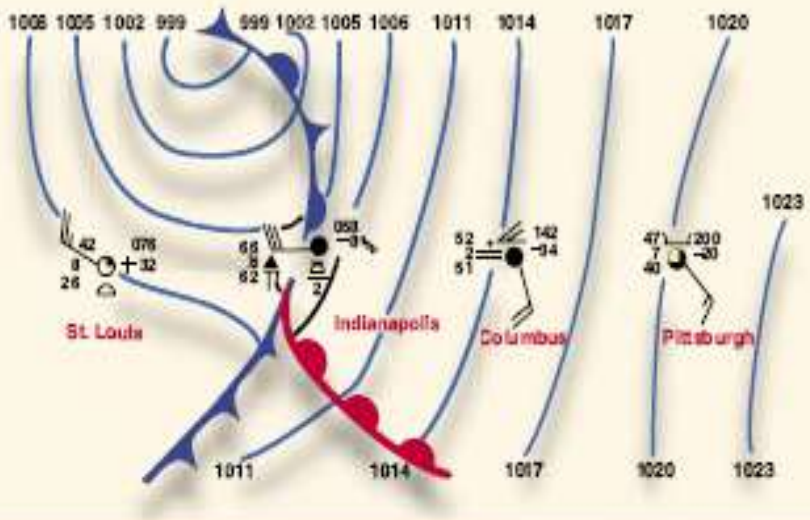
COLD FRONT OCCLUSION



WARM FRONT OCCLUSION

Created by Steve Reisser





METAR	KSTL SCT035	1950Z	31023G40KT 05/M03	8SM A2976	
METAR	KIND VV005	1950Z	29028G45KT 18/16	1/2SM A2970	TSRAGR
METAR	KCMH OVC080	1950Z	16017KT 11/10	2SM A2970	BR
METAR	KPIT BKN130	1950Z	13012KT 08/04	75SM A3012	

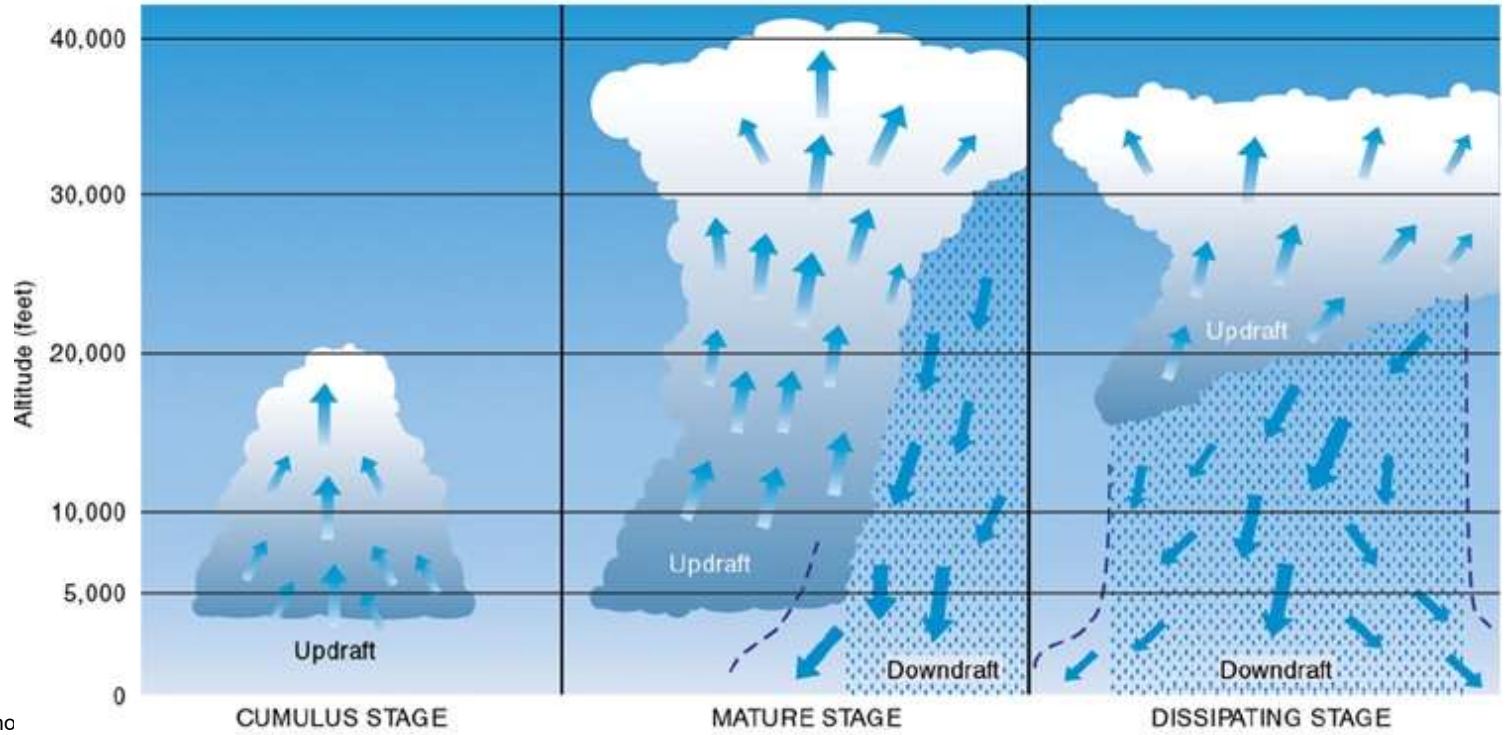
METEOROLOGY – WEATHER HAZARDS

T H U N D E R S T O R M S

Formation when 1) Source of lift (heating, fast-moving front), 2) unstable air (nonstandard lapse rate), 3) high moisture content (temp/dew point close)

Florida experiences **"airmass thunderstorms"** with Sea-Land breezes and associated instability, but can turn to **"Severe"** with winds at or greater than 50 KTS, hail ¾ inches or greater, and tornadoes.

Single-cell, multi-cell and **super-cell thunderstorms** are common here. Frontal passage sometimes produces **SQUALL LINES** up to 300 miles in front**.**



Updrafts and Downdrafts can exceed <u>3,000 fpm</u>

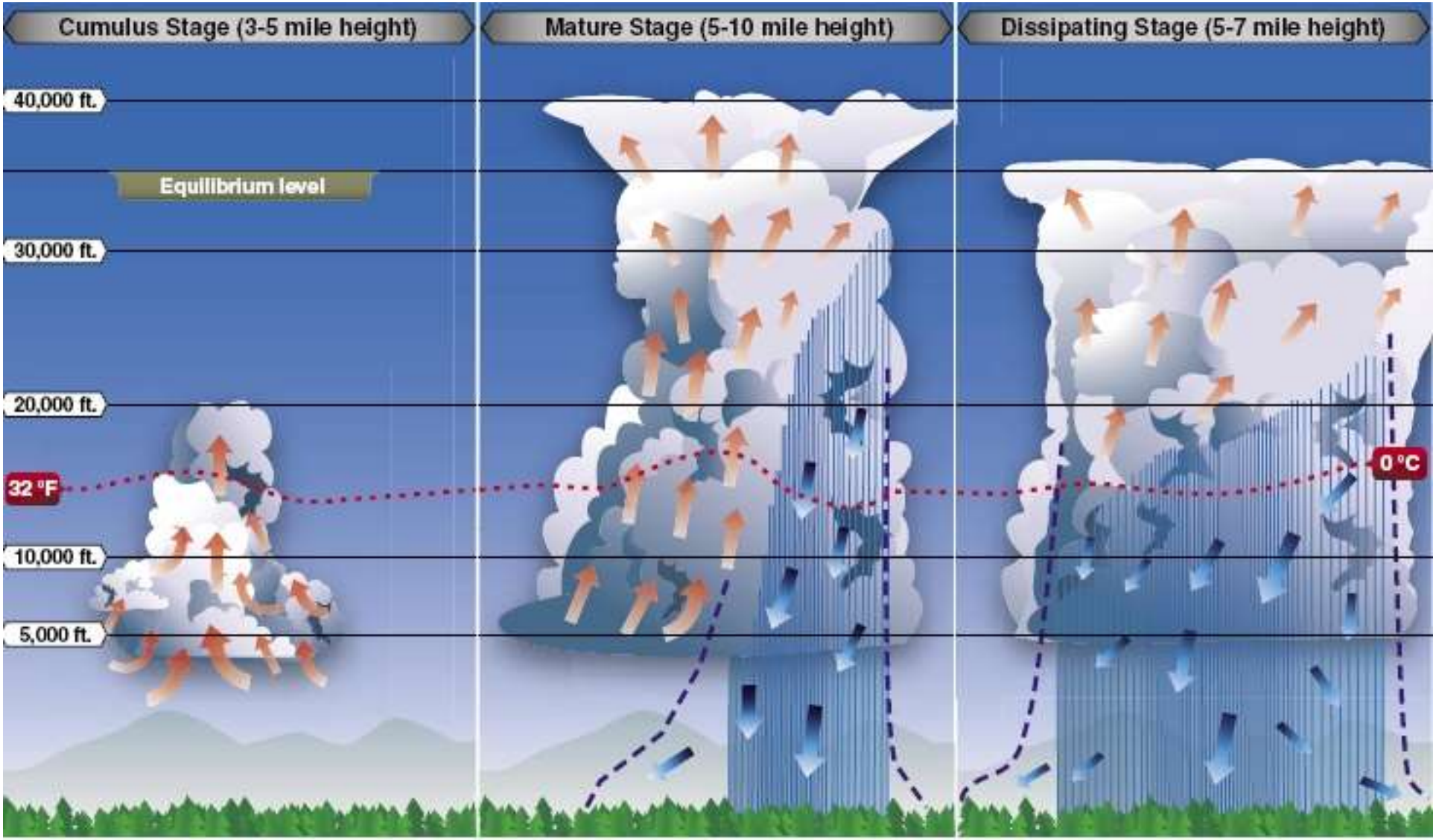
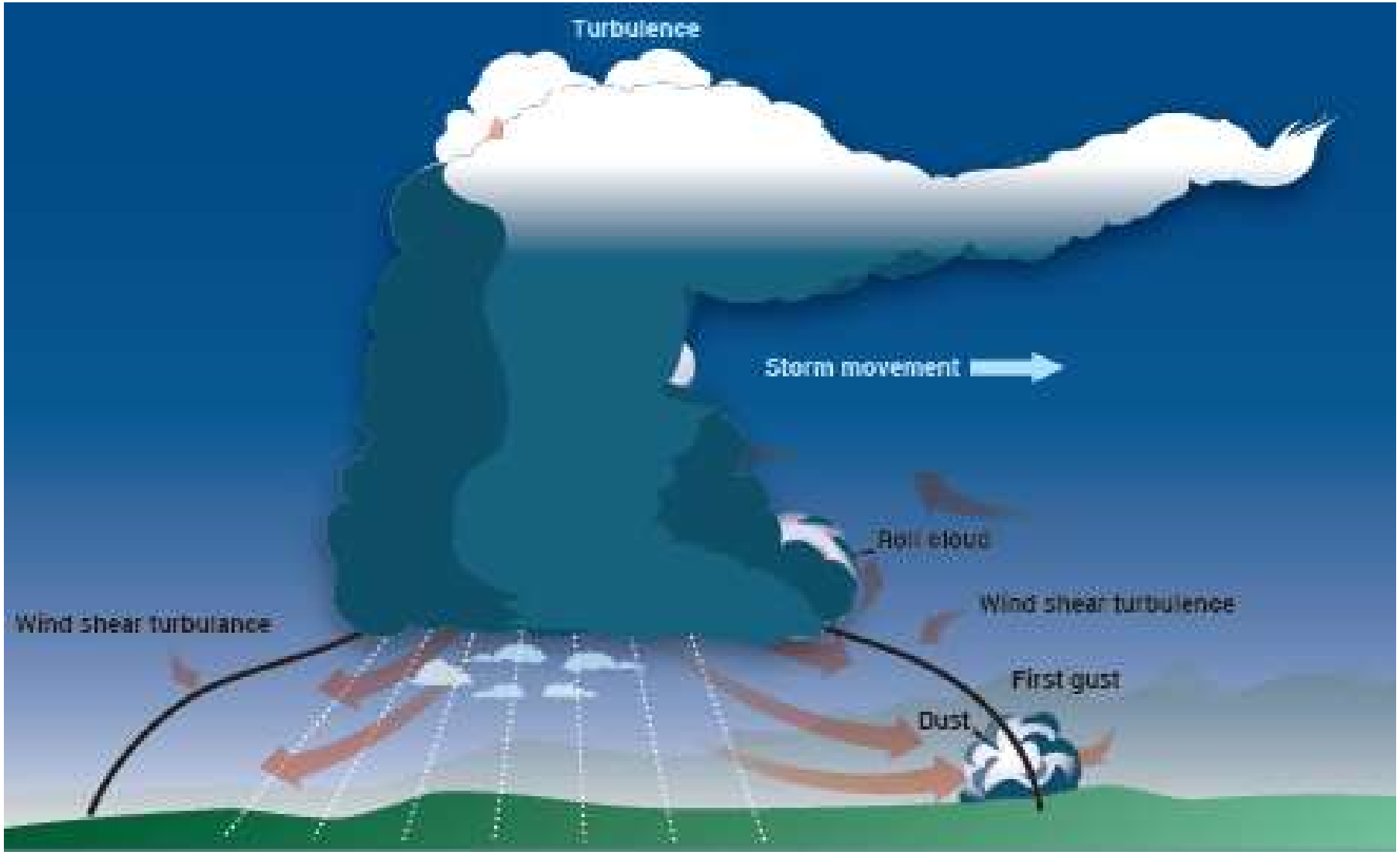


Figure 11-23. *Life cycle of a thunderstorm.*

Some storms occur at random in unstable air, last for only an hour or two, and produce only moderate wind gusts and rainfall. These are known as **air mass thunderstorms** and are generally a result of surface heating. **Steady-state thunderstorms** are associated with weather systems. Fronts, converging winds, and troughs aloft force upward motion spawning these storms which often form into squall lines. In the mature stage, updrafts become stronger and last much longer than in air mass storms, hence the name steady state.



METEOROLOGY – WEATHER HAZARDS
Stages of Thunderstorms

CUMULOUS (vertical motion),

MATURE (beginning rain)

DISSIPATING (predominantly downdrafts and visible “anvil” at top).

HAZARDS: Squalls, Tornados, Turbulence Icing, Hail, Ceilings, Engine water ingestion Lightning.

Created by Steve Reisser

THUNDERSTORMS

AVOIDANCE - - - AT ALL COSTS

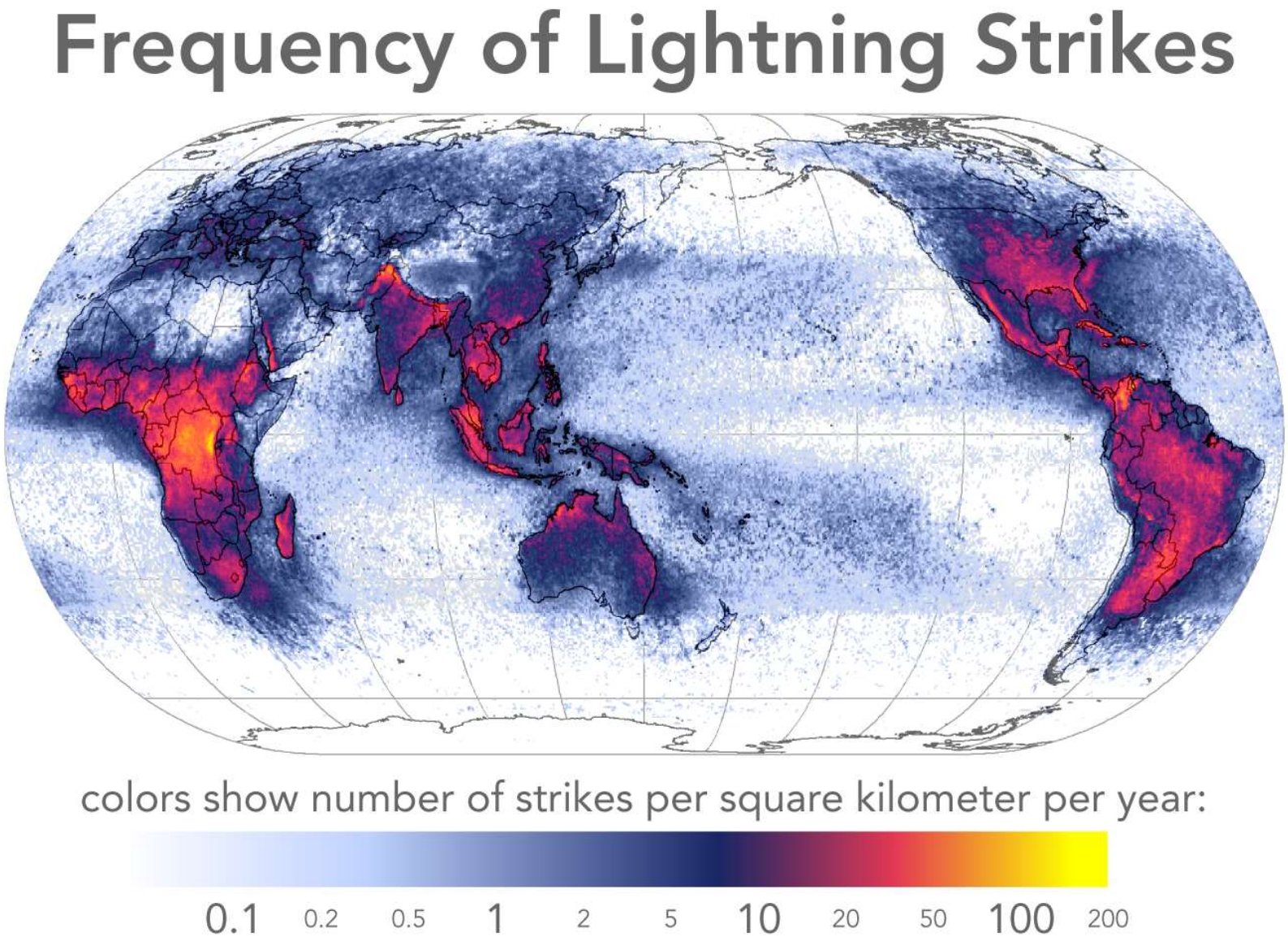
What Convective Outlook, Low Level Prognostic Charts, AIRMETs, SIGMETs, PIREPS (to be covered) for possible formation.

If using EFB (onboard radar or radar services, electronic flight bag with weather capability- watch for potential in flight path)

STAY 20 MILES FROM ACTIVE CELLS

In or near pattern? Consider alternative airport

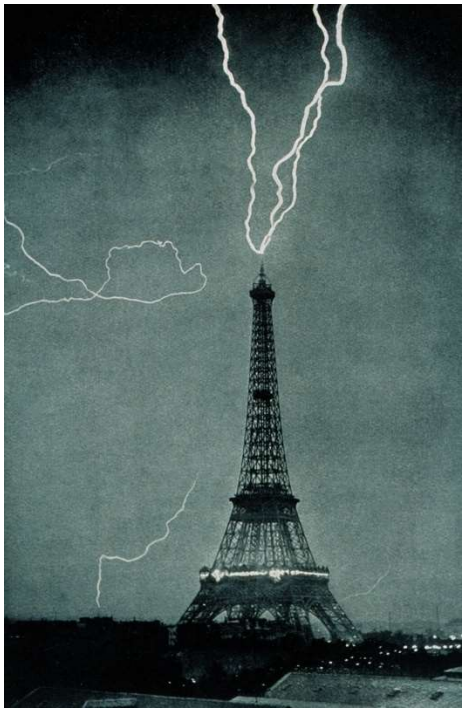
LIGHTNING



Ground S

ALL TYPES OF LIGHTNING: <u>JUST KNOW THAT AIRPLANES & LIGHTNING DON'T MIX WELL</u>

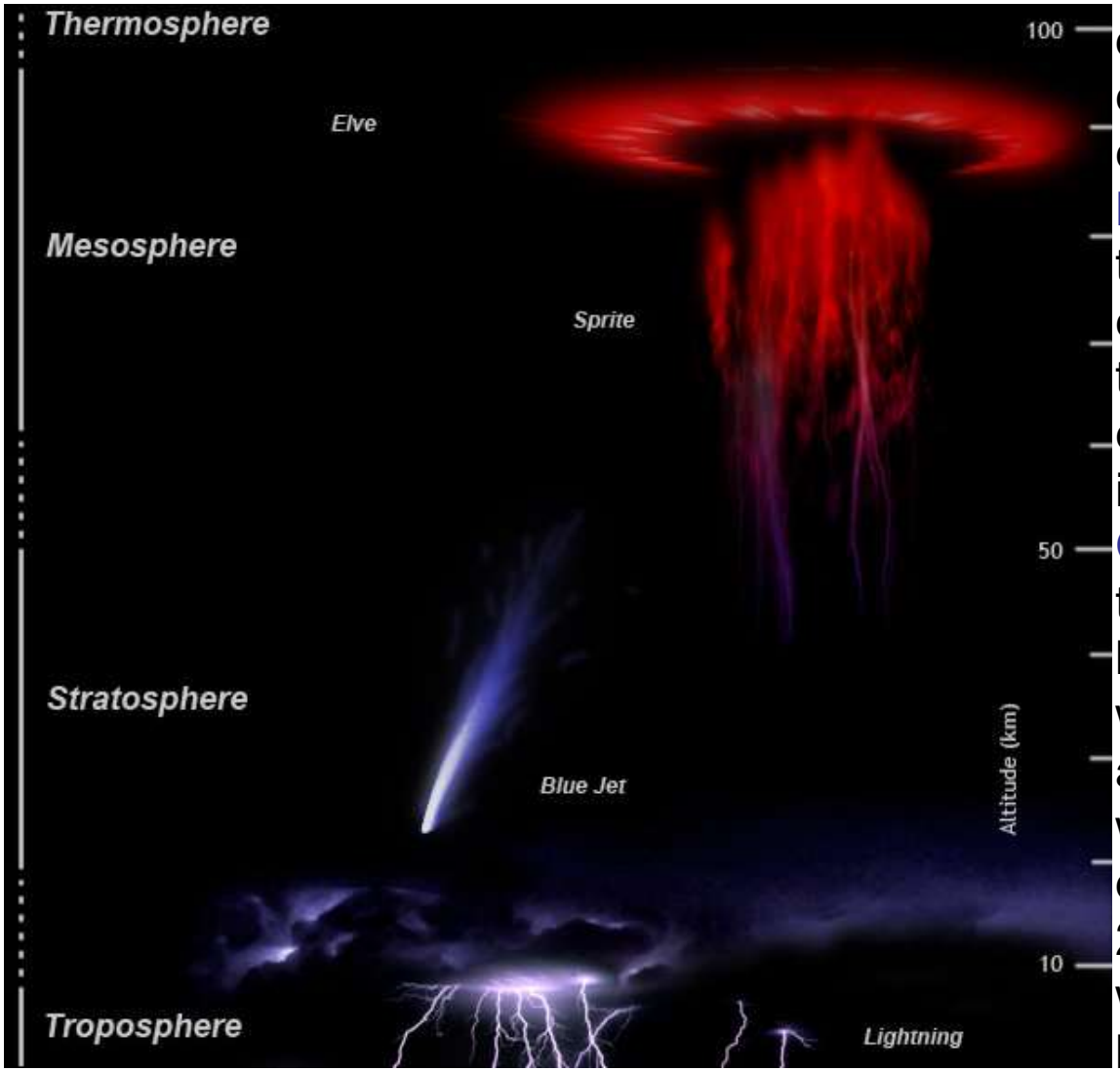
Average Output: 1 Terawatt/30,000 Amps for about 30 Microseconds @ 36,000 degrees F.(3 times the Sun's surface temperature).



Cloud to Ground
Cloud to Cloud
Bead
Ribbon
Staccato
Fork
Sheet
Heat
Dry
Rocket
Positive ("Bolts from the Blue")
Ball
Volcanic

Volcanic (Chili – May 2009)

Upper-Atmospheric Lightning



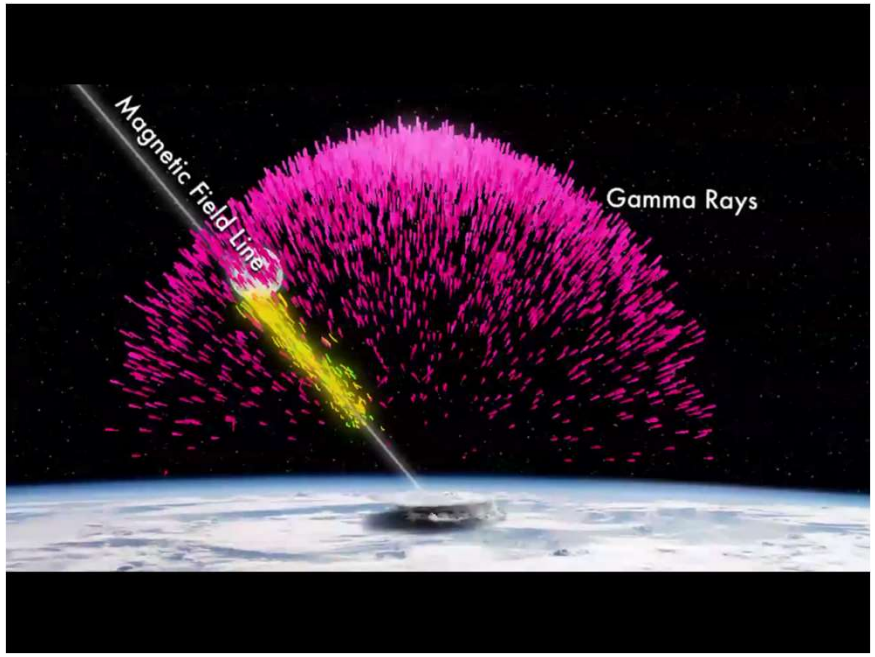
Sprites are large scale electrical discharges which occur high above cumulonimbus, They often occur in clusters, lying 50 miles to 90 miles. **Blue jets** differ from sprites in that they project from the top of the cumulonimbus above a thunderstorm, typically in a narrow cone, to the lowest levels of the ionosphere 25 to 30 mile in altitude. **Giant jets** are located above a thunderstorm over the ocean, and lasted under a second. Lightning was initially observed traveling up at around 50,000 m/s in a similar way to a typical blue jet, but then divided in two and speed at 250,000 m/s to the ionosphere, where they spread out in a bright burst of light.

Elves (**E**missions of **L**ight and **V**ery Low Frequency Perturbations from **E**lectromagnetic Pulse **S**ources) often appear as a dim, flattened, expanding glow around 400 km (250 miles) in diameter that lasts for, typically, just one millisecond .

Upper-Atmospheric Transient Luminous Event – Aurora Borealis

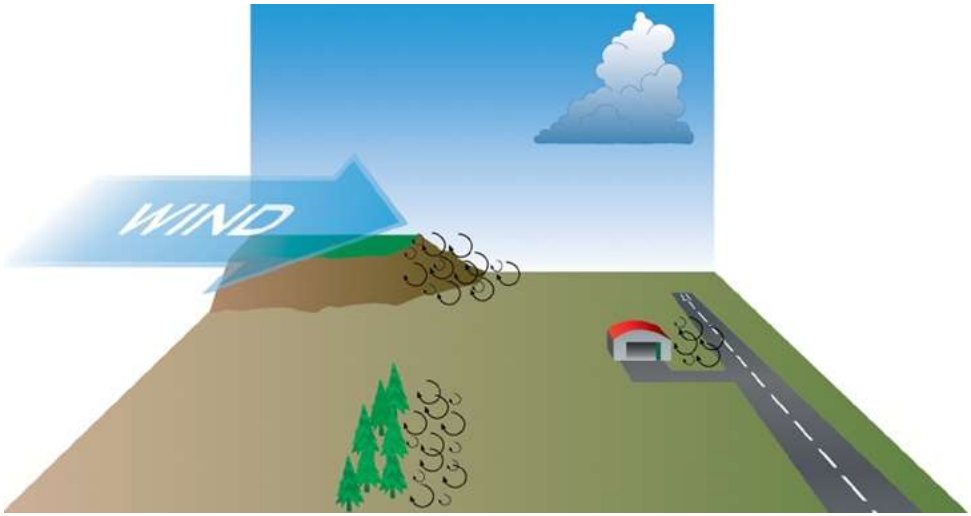
Terrestrial Based Gamma Ray Bursts (TGBs)

Newest to be discovered are TGBs primarily near equator from super cell lightning. Generation of anti-matter occur when electrons ejected at near speed of light create positrons (anti-matter electrons) which when striking other matter generates the detectable gamma ray burst. These are very short, intense events.



METEOROLOGY – WEATHER HAZARDS TURBULENCE

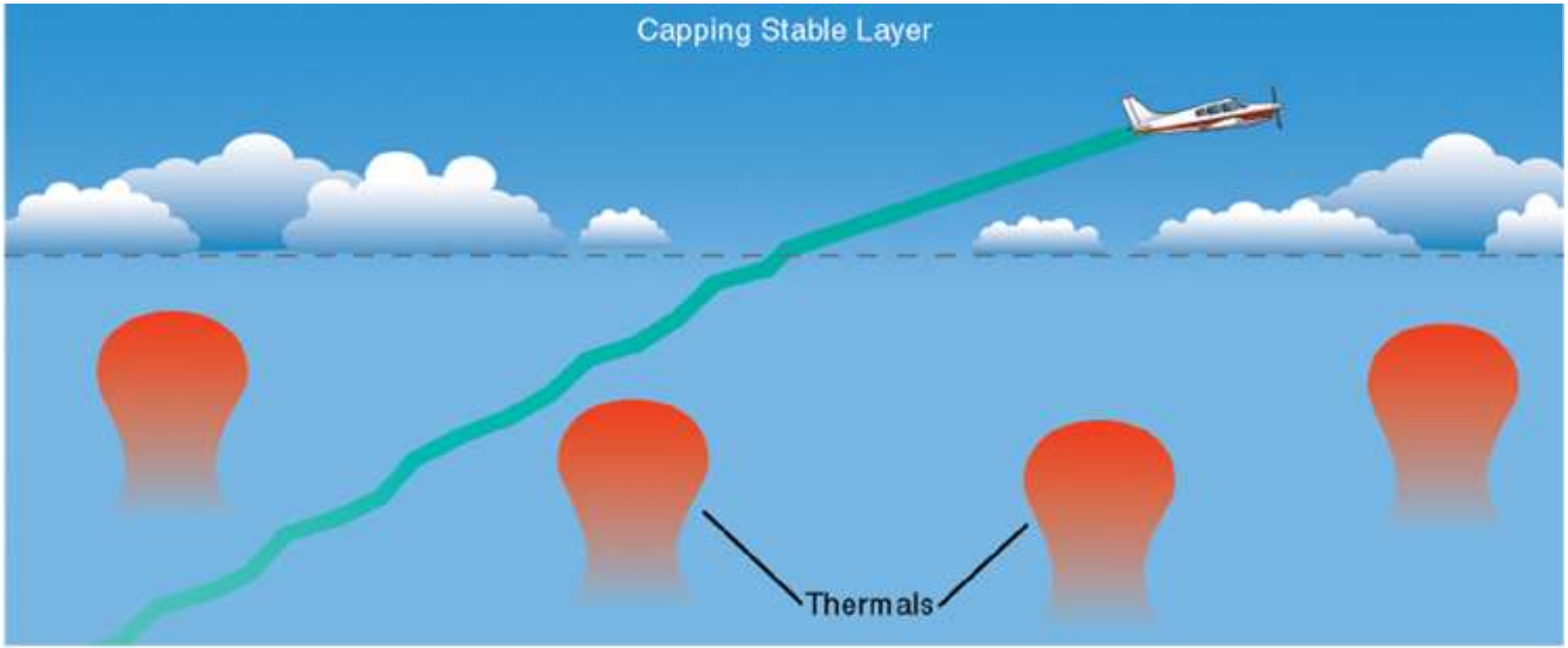
Low Level Turbulence (usually less than 15,000 ft)



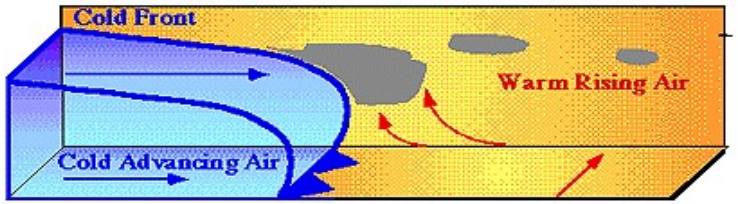
<u>Mechanical Turbulence</u>
Friction, Surface Winds, Valley Winds, etc

Interesting side note: These winds interact with earths rotation and can slow the rotation of the earth by friction effects causing difference in rotation of earth by several milliseconds a day.

METEOROLOGY – WEATHER HAZARDS
TURBULENCE



Convective (also referred to as Thermal) Turbulence
TURBULENCE BELOW – SMOOTH ABOVE



Frontal Turbulence (fast moving cold fronts can produce 3000 fpm updrafts.

METEOROLOGY – WEATHER HAZARDS
TURBULENCE

LIGHT TURBULENCE: Causes slight, erratic changes in altitude and/or altitude.
MODERATE TURBULENCE: Expect where vertical wind shear exceeds 6 kts'100 ft.
CLEAR AIR TURBULENCE (CAT) is a high-level phenomena above 15,000 AGL and not associated with cumuliform cloudiness.

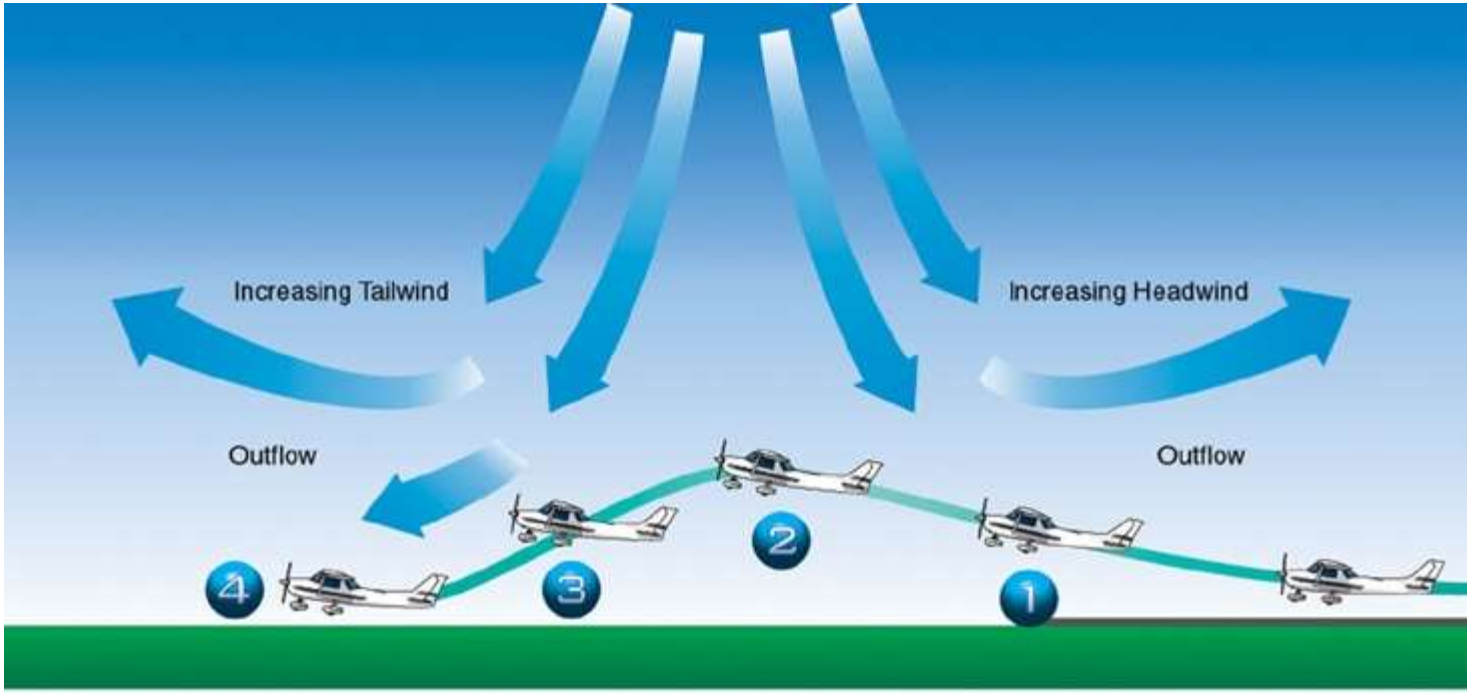
- CAT typically found in the upper trough on the polar side of a jet stream
- CAT are sometimes visually identified by long streaks of cirrus clouds

WIND SHEAR: A change in wind direction and/or speed within a short distance in the atmosphere. It can be both a vertical and horizontal direction.

Hazardous wind shear is commonly encountered during periods of strong temperature inversion and thunderstorms. Low-level WS may occur when there is a low-level temperature inversion with strong winds above the inversion.

During an approach, possible wind shear is indicated by changes in power and vertical velocity required to remain on the proper glide path. A sudden decrease in headwind results in a loss of indicated airspeed equal to the decrease in wind velocity. You could suddenly STALL. While approaching for landing when either possible wind shear or convective turbulence is indicated, you should increase approach airspeed slightly above normal to avoid stalling

METEOROLOGY – WEATHER HAZARDS
TURBULENCE – WIND SHEAR

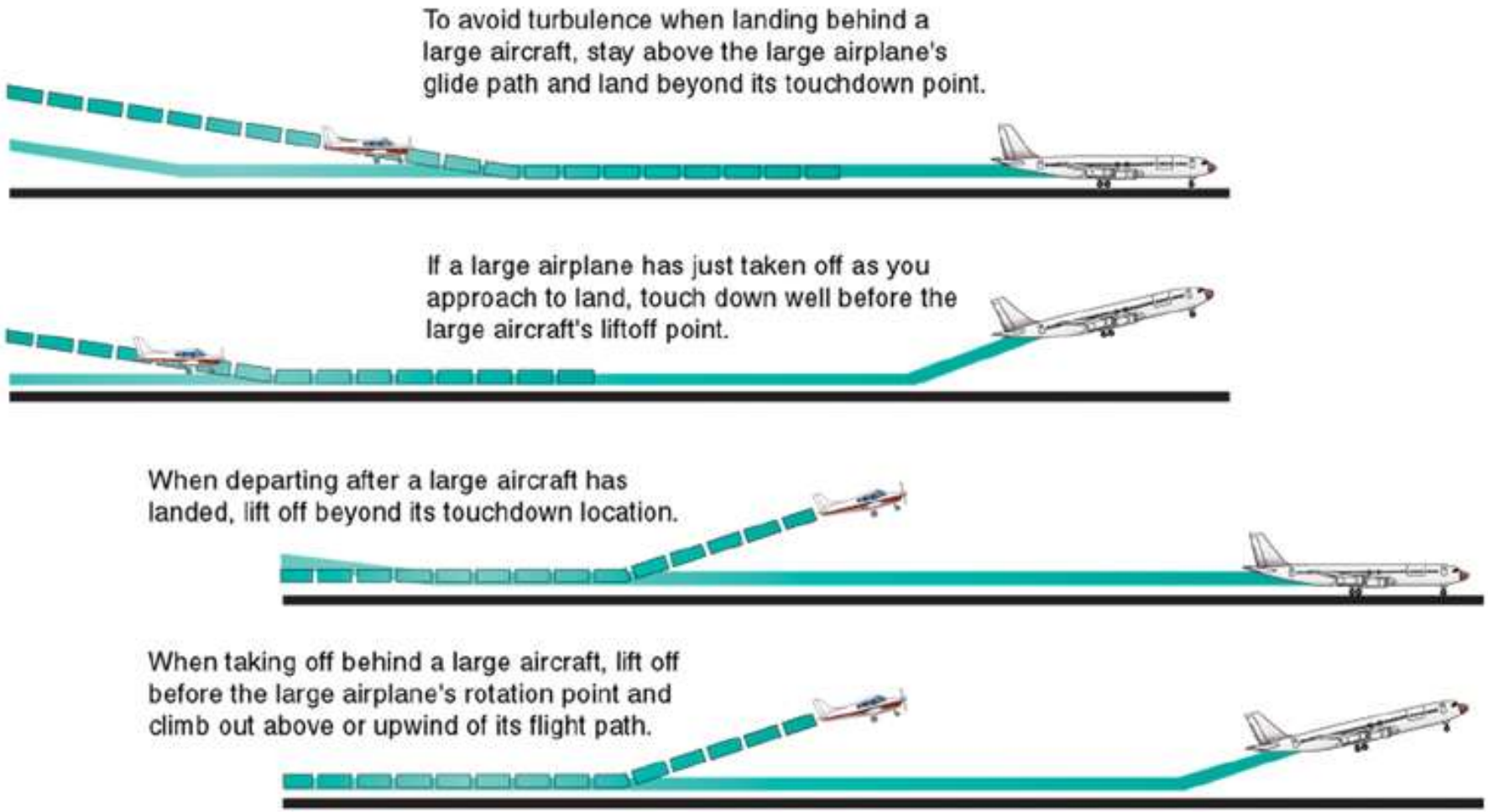


1. Headwind, 2. Downdraft, 3. Downdraft & tailwind, 4. Impact

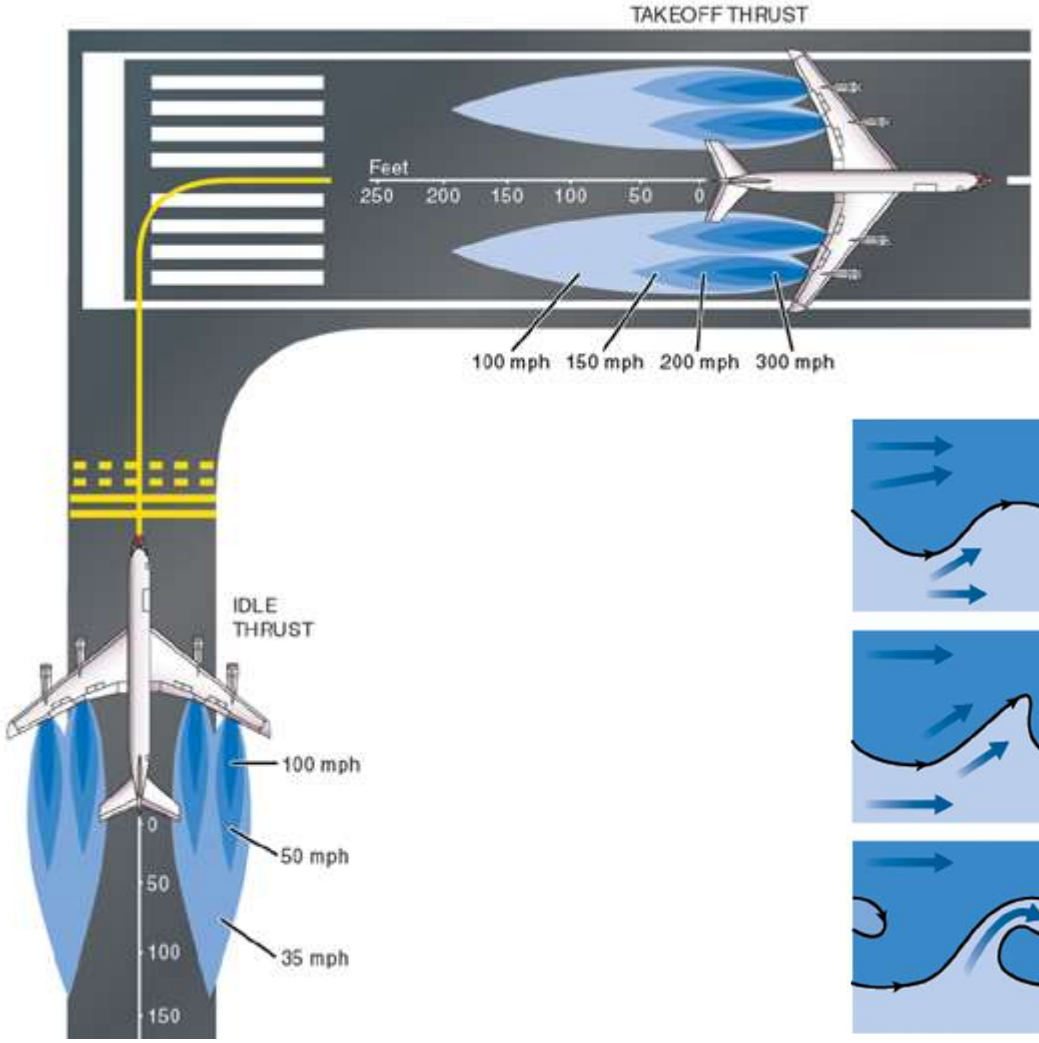
Around MICROBURSTS, brief (15m) with 1000-6000 fpm downdrafts, wind 25-100 kts.

LLWAS and Doppler Radar assist in detection. Inflight – watch for rain shafts.

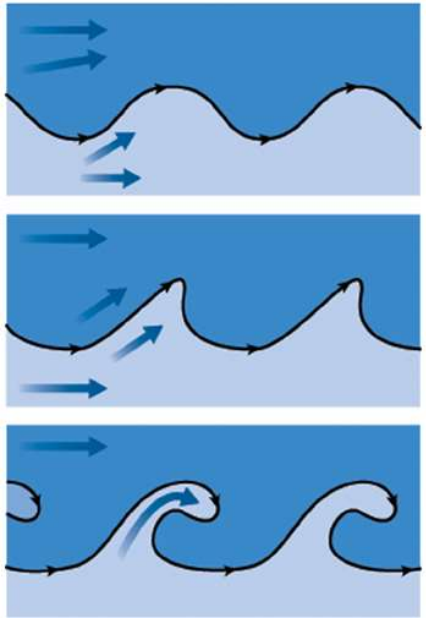
METEOROLOGY – WEATHER HAZARDS
WAKE TURBULENCE



METEOROLOGY – WEATHER HAZARDS
TURBULENCE



Jet Blast



CLEAR AIR TURBULENCE

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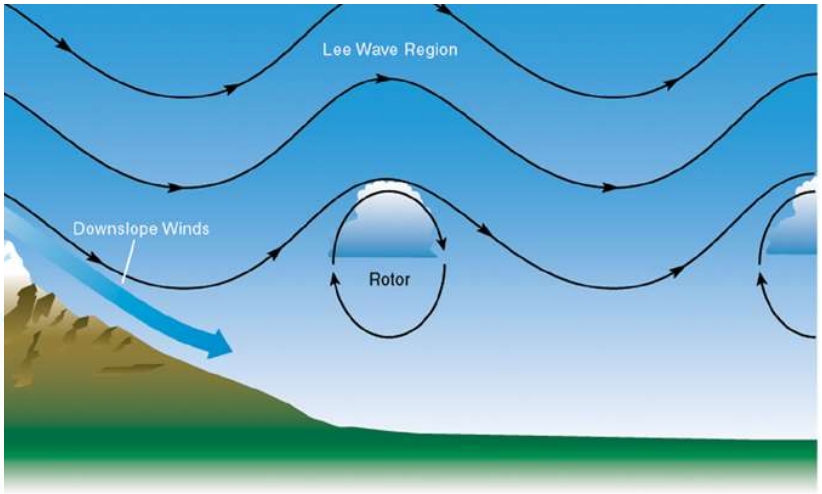
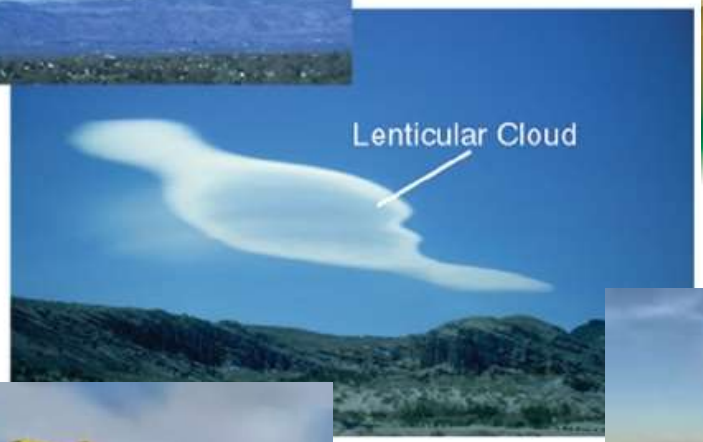
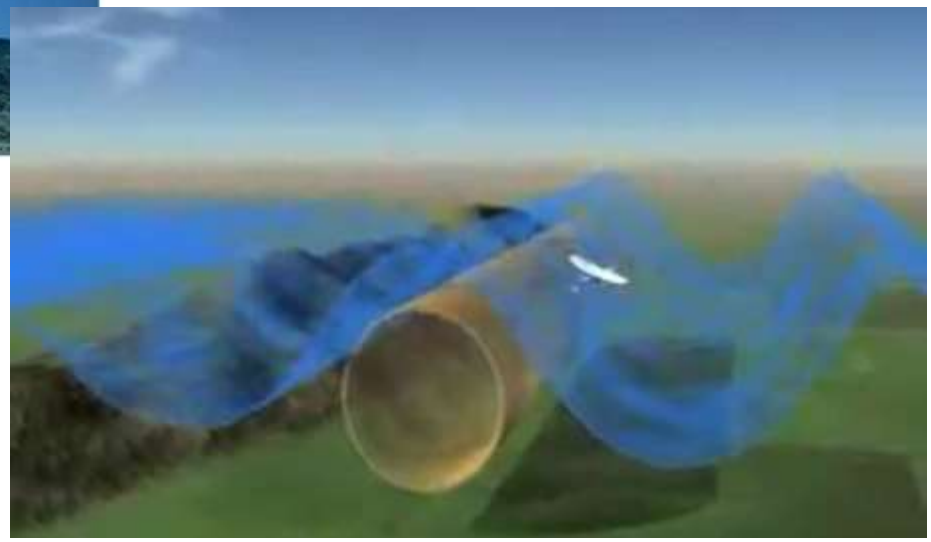
METEOROLOGY – WEATHER HAZARDS
TURBULENCE

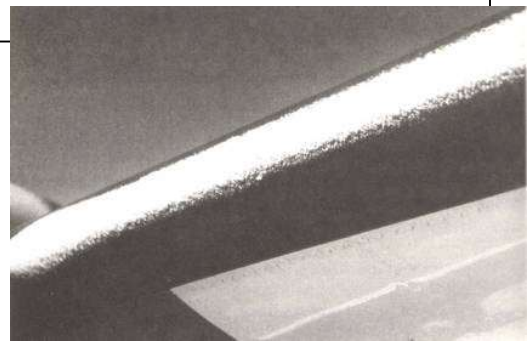


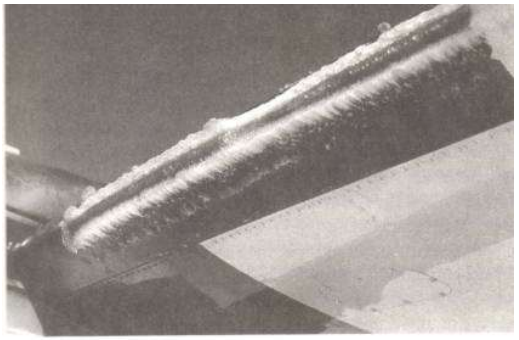




METEOROLOGY – WEATHER HAZARDS: ICING

RIME -15 to -20 c	Rough, milky, opaque ice formed by instantaneous freezing of small super cooled water droplets. Similar in appearance as FROST – ALWAYS REMOVE FROST BEFORE FLIGHT
CLEAR 0 to -10 c	A glossy, clear or translucent ice formed by the relatively slow freezing of large super cooled water droplets. Caution: Ice pellets below good indication of super cooled water droplets above – serious icing hazard.
MIXED -10 to -15 c	Mixture of rime and clear ice.
FROST	Temperature & dew point lower than freezing





METEOROLOGY – WEATHER HAZARDS ICING

RISK/ TYPE	CUMULUS	STRATIFORM	RAIN DRIZZLE
HIGH	**0 to -20 C**	**0 to -15 C**	**0 and below**
MEDIUM	**-20 to -40 C**	**-15 to -30 C**	
LOW	Less than -40 C	Less than -30 C	

DON'T UNDERESTIMATE ICING AND EFFECTS

1. Check the *AIRMETs, SIGMETs, METARs and TAFs*. YOU HAVE THE RESPONSIBILITY TO KNOW THE ICING LEVELS ON YOUR FLIGHT.
2. Check for icing on the aircraft when on ground.
3. Use your pitot heat and if necessary carburetor heat.
4. Be extra careful when flying in:
    - Temperatures below 0 degrees Celsius
        - Cumulonimbus or stratiform clouds
            - Rain
            - Snow
            - Ice pellets
            - Haze
            - Hail
5. Use anti-icing equipment if you suspect that icing might arise.
6. If encountering moderate or severe icing, ask for another altitude.
7. If you encounter light icing and suspect it might get moderate and severe ask for a change too.

ALL FROST MUST BE DISIPATED, NOT MECHANICALLY REMOVED BEFORE FLIGHT-AS OF 2011 FARs

METEOROLOGY – WEATHER HAZARDS
RESTRICTED VISIBILITY

HAZE (HZ), SMOKE (FU), SMOG , DUST (DU) , AND VOLCANIC ASH (VA)

Haze/Smoke from Above

Visibility below is very restricted

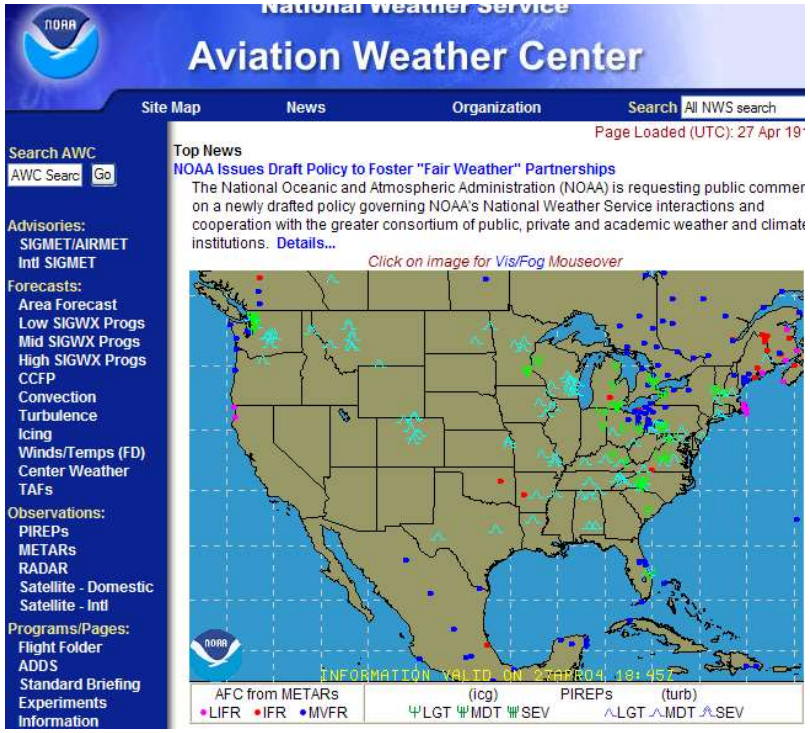
DVD REINFORCEMENT LEARNING

METEOROLOGY – PRINTED REPORTS & FORECASTS

Getting Weather Reports and Forecasts

BY TELEPHONE – TALK TO A HUMAN BEING ☺
1-800-WX-BRIEF Flight Service

INTERNET
http://avaitionweather.gov http://www.aopa.org/members/wx/



AIRMET

An **AIRMET**, or **Airmen's Meteorological Information**, is a concise description of weather phenomena that are occurring or may occur (forecast) along an air route that may affect aircraft safety. Compared to SIGMETs, AIRMETs cover less severe weather: moderate turbulence and icing, sustained surface winds of 30 knots or more, or widespread restricted visibility.

AIRMETs are broadcast on the ATIS at ATC facilities, and are referred to as **Weather Advisories**. AIRMETs are valid for six hours. NOTE: The definition has changed and no longer says "light aircraft"; AIRMETs are intended for *all* aircraft.

There are three types of AIRMET, all identified by a phonetic letter: S (Sierra), T (Tango), and Z (Zulu). [1]

- **AIRMET SIERRA** (Mountain obscuration or IFR) ceilings less than 1000 feet and/or visibility less than 3 miles affecting over 50% of the area at one time; extensive mountain obscuration
- **AIRMET TANGO** (Turbulence) Light - moderate turbulence, sustained surface winds of 30 knots or more
- **AIRMET ZULU** (Icing) Light - moderate icing, freezing levels

AIRMET	Aviation Hazard
SIERRA	IFR Ceiling
	IFR Visibility
	Mountain Obscuration
TANGO	Turbulence
	Strong Surface Wind
	Low Level Wind Shear Potential
ZULU	Icing
	Lowest Freezing Levels
	Multiple Freezing Levels

AIRMET Examples:

SFOS WA 222045
AIRMET SIERRA FOR IFR VALID UNTIL 230300
.
AIRMET IFR...CA
FROM 30NW FMG TO 40SSW FMG TO 70WNW OAL TO 20WNW CZQ TO 20SW
MOD TO 40ESE RBL TO 30NW FMG
CIG BLW 010/VIS BLW 3SM PCPN/BR/FG. CONDS CONTG BYD 03Z THRU 09Z.

SLCS WA 222045
AIRMET SIERRA FOR IFR AND MTN OBSCN VALID UNTIL 230300
.
AIRMET MTN OBSCN...ID WY UT
FROM 80SSW BIL TO 20WSW JNC TO 50SW BCE TO 20NW DBS TO 80SSW BIL
MTNS OBSC BY CLDS/PCPN/BR. CONDS CONTG BYD 03Z ENDG 06Z.

DFWZ WA 222045
AIRMET ZULU FOR ICE AND FRZLVL VALID UNTIL 230300
.
NO SGFNT ICE EXP OUTSIDE OF CNVTV ACT.
.
FRZLVL...RANGING FROM 020-120 ACRS AREA
MULT FRZLVL 030-080 BOUNDED BY 40NE ABI-40NE LCH-50S IAH-60SE
DLF-MAF-40NE ABI
040...30W LBL-40N AUS-50E AUS-AEX-30SE MEI-30SW GQO
080...20W INK-DLF-50SSW SAT-60S IAH-MSY-50WSW ABY
120...70WNW BRO-BRO

CHIZ WA 222045
AIRMET ZULU FOR ICE AND FRZLVL VALID UNTIL 230300
.
NO SGFNT ICE EXP OUTSIDE OF CNVTV ACT
.
OTLK VALID 0300-0900Z...ICE MN WI LM LS MI LH IL IN
BOUNDED BY 60W YQT-30SSE SSM-DXO-FWA-20SW JOT-40NNW DLL-30W
EAU-20S BRD-70SW YQT-60W YQT
MOD ICE BTN 030 AND 120. CONDS DVLPG AFT 03Z CONTG THRU 09Z.

SLCZ WA 222045
AIRMET ZULU FOR ICE AND FRZLVL VALID UNTIL 230300
.

SIGMET

SIGMET,[1] or **Significant Meteorological Information**,[2] is a weather advisory that contains meteorological information concerning the safety of all aircraft. There are two types of SIGMETs - convective and non-convective. The criteria for a non-convective SIGMET to be issued are severe or greater turbulence over a 3,000-square-mile (7,800 km^2) area, severe or greater icing over a 3,000-square-mile (7,800 km^2) area or IMC over a 3,000-square-mile (7,800 km^2) area due to dust, sand, or volcanic ash.

This information is usually broadcast on the ATIS at ATC facilities, as well as over VOLMET stations. They are assigned an alphabetic designator from N through Y (excluding S and T).[2] SIGMETs are issued as needed, and are valid up to four hours. SIGMETS for hurricanes and volcanic ash outside the CONUS are valid up to six hours.[3]

A **Convective SIGMET** is issued for convection over the Continental U.S. Convective SIGMETs are issued for an area of thunderstorms affecting an area of 3,000 square miles (7,800 km^2) or greater, a line of thunderstorms at least 60 nm long, severe thunderstorms or embedded thunderstorms affecting any area that are expected to last 30 minutes or longer.[4] Severe thunderstorms are characterized by tornado(s), hail 3/4 inches or greater, or wind gusts 50 knots or greater.[5] A Convective SIGMET is valid for 2 hours and they are issued every hour + 55 min.[6]

SIGMETS

The following examples are actual SIGMET reports followed by plain-English interpretations. Read through these examples to ensure that you understand SIGMET terminology and interpretation.

```
BOSR WS 050600
SIGMET ROMEO 2 VALID UNTIL 051000
ME NH VT
FROM MLT TO YSJ TO CON TO MPV TO MLT
OCNL SEV TURB BLW 080 EXP DUE TO STG NWLY FLOW.  CONDS CONTG BYD 1000Z.
```

SIGMET issued for the Boston Area Forecast region on the 5th day of the month at 0600 UTC. This is the second (2nd) issuance of SIGMET series Romeo and is valid until the 5th day of the month at 1000 UTC. The affected states are Maine (ME), New Hampshire (NH) and Vermont (VT). Within an area bounded from Millinocket, Maine; to St. Johns, New Brunswick; to Concord, New Hampshire; to Montpelier, Vermont; to Millinocket, Maine. Occasional severe turbulence below 8,000 feet due to strong northwesterly flow. Conditions are expected to continue beyond 1000 UTC.

```
KZOA SIGMET TANGO 1 VALID 010400/010800 PHFO-
OAKLAND OCEANIC FIR ACT TS OBS BY SATELLITE WITHIN 100 NM EITHER SIDE
OF LINE N3006 W14012 - N2012 W15016.  CB TO TOPS FL400.  MOV W 10 KT.
WKN.
```

SIGMET issued for the Honolulu area of the Oakland Oceanic FIR. This first (1) issuance of SIGMET Series Tango valid from the 1st day of the month at 0400 UTC to the 1st day of the month at 0800 UTC. Issued by the Honolulu Weather Forecast Office. Within the Oakland Oceanic FIR, active thunderstorms observed by satellite within 100 nautical miles either side of a line from 30 degrees, 6 minutes north to 140 degrees, 12 minutes west to 20 degrees 12 minutes north, 150 degrees, 16 minutes west. Cumulonimbus tops to 40,000 feet. The thunderstorms are moving west at 10 knots and weakening.

```
KZOA SIGMET DELTA 2 VALID 081530/081930 KKCI-
OAKLAND OCEANIC FIR FRQ TS WITHIN AREA BOUNDED BY N3935 W16920 - N3414
W17050 - N3010 2 17325 TOPS FL470 MOV NNE 10KT NC.
```

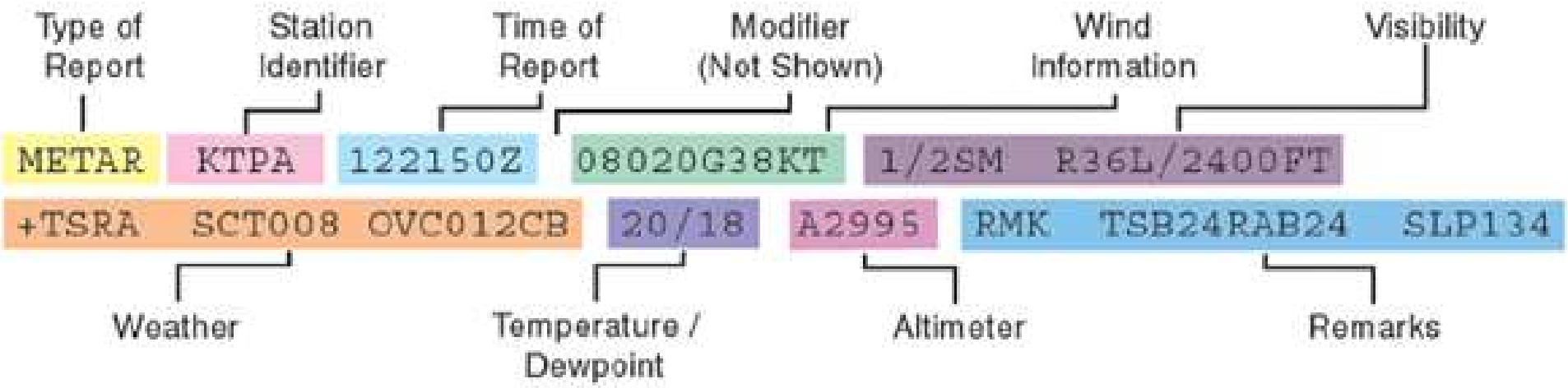
SIGMET issued for the Aviation Weather Center's area of the Oakland FIR. This is the second (2) issuance of SIGMET series Delta valid from the 8th day of the month at 1530 UTC to the 8th day of the month at 1930 UTC. Within the Oakland Oceanic FIR, frequent thunderstorms within an area bounded by 39 degrees 35 minutes north, 169 degrees 20 minutes west to 34 degrees 14 minutes north, 170 degrees, 50 minutes west to 30 degrees 10 minutes north, 173 degrees 25 minutes west. Thunderstorm tops to 47,000 feet, thunderstorms are moving to the north-northeast at 10 knots with no change observed.

METEOROLOGY – PRINTED REPORTS & FORECASTS

METAR (***<u>Aviation Route Information Report</u>***)

Hourly report of weather conditions ***at the specific reporting station***.

WHY: NEED TO KNOW WHAT TYPE OF WEATHER IS AT DEPARTURE, DESTINATION AND ALONG ROUTE OF FLIGHT (SHOULD WE NEED TO DIVERT TO AN DESTINATION).



FORMAT

METEOROLOGY – PRINTED REPORTS & FORECASTS

METAR (Aviation Route Information Report)

Types: standard "METAR" or "SPECI" for special notification (change)

Identifier (USA always begin with letter "K"

Date/Time: DDHHMM (Day#, ITC "Zulu Time" HHMM ending "Z"

Modifier: none=manual input, or AUTO (check remarks A01/A02 or COR meaning automated facility with no remarks.

Wind: XXX(direction) YY (speed) G=GUST TO ZZ=speed minimum 5 digits (1st 3 direction, next 2 speed) end KTS.

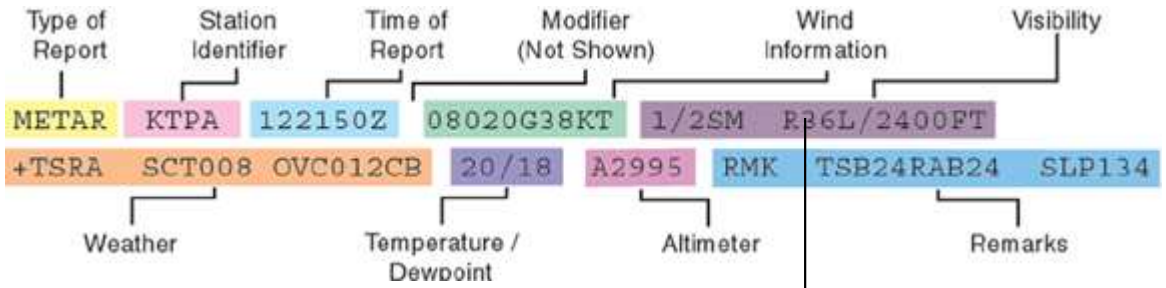
Type of Report	Station Identifier	Time of Report	Modifier (Not Shown)	Wind Information
METAR	KTPA	122150Z		08020G38KT

samples

00000KT	Wind calm
20014KT	Wind from 200° at 14 knots
15010G25KT	Wind from 150° at 10 knots, gusts to 25 knots
VRB04KT	Wind variable in direction at 4 knots
210103G130KT	Wind from 210° at 103 knots with gusts to 130 knots

METEOROLOGY – PRINTED REPORTS & FORECASTS

METAR (Aviation Route Information Report)She



WIND INFORMATION

<u>Prevailing Visibility</u> in Statue Miles. If preceded by "P" (i.e., P2SM) it means "greater than" (P2SM = visibility greater than 2 stature miles). "M" preceding visibility is translated "less than." (i.e., M2SM = less than 2 SM)

<u>Runway Visual Range</u> (how far can a pilot see down a runway) giving as Runway / feet of visibility above is Runway 36 Left visibility 2400 ft. if given as R36L/2400V3600FT it means 2 measures were taken with the lowest visibility at 2,400 ft and the greatest visibility at 3,600 ft

METEOROLOGY – METAR (Aviation Route Information Report)

Weather: Describes conditions and cloud coverage. These codes are the most complex and require some study

+TSRA SCT008 OVC012CB

Weather

Sky Cover	Contraction
Less than ⅛ (Clear)	SKC, CLR, FEW
⅛-⅜ (Few)	FEW
⅜-⅝ (Scattered)	SCT
⅝-⅞ (Broken)	BKN
⅞ or (Overcast)	OVC

Qualifier		Weather Phenomena		
Intensity or Proximity 1	Descriptor 2	Precipitation 3	Obscuration 4	Other 5
– Light	MI Shallow	DZ Drizzle	BR Mist	PO Dust/sand whirls
Moderate (no qualifier)	BC Patches	RA Rain	FG Fog	SQ Squalls
+ Heavy	DR Low drifting	SN Snow	FU Smoke	FC Funnel cloud
VC in the vicinity	BL Blowing	SG Snow grains	DU Dust	+FC Tornado or waterspout
	SH Showers	IC Ice crystals (diamond dust)	SA Sand	SS Sandstorm
	TS Thunderstorms	PL Ice pellets	HZ Haze	DS Dust storm
	FZ Freezing	GR Hail	PY Spray	
	PR Partial	GS Small hail or snow pellets	VA Volcanic ash	
		UP *Unknown precipitation		

The weather groups are constructed by considering columns 1–5 in this table in sequence:
intensity, followed by descriptor, followed by weather phenomena (e.g., heavy rain showers(s) is coded as +SHRA).
* Automated stations only

METEOROLOGY – PRINTED REPORTS & FORECASTS

METAR (Aviation Route Information Report)

VISIBILITY AND HEIGHT INFORMATION

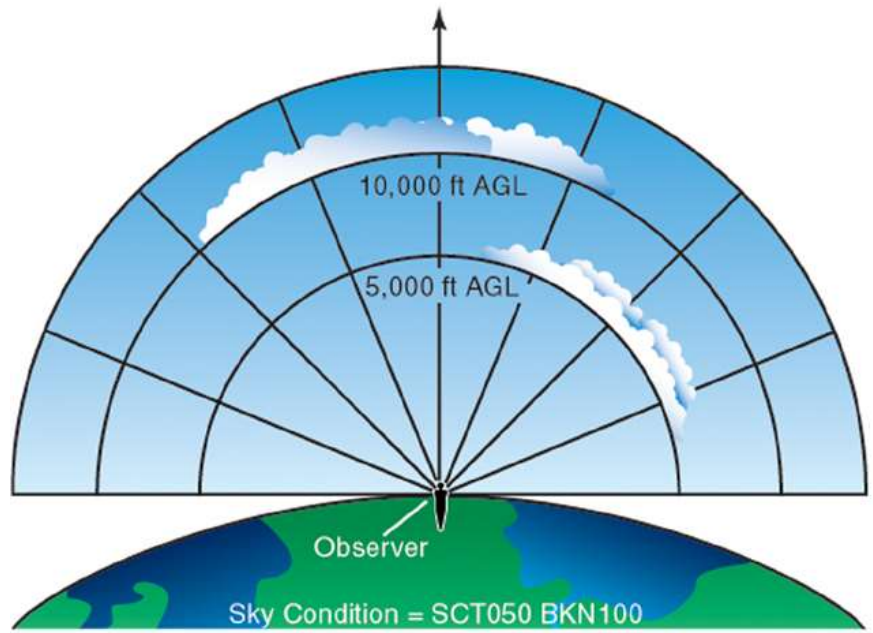
CLEAR (SKC OR CLR)
0-1/4 = FEW
3/8-1/2 = SCT
5/8-7/8 = BKN
OVERCAST = OVC

>50% coverage = "ceiling"

+TSRA SCT008 OVC012CB ← **Type (CB)**

Weather

Height (AGL): add 2 zeros



20/18 A2995

Temperature / Dewpoint

Altimeter

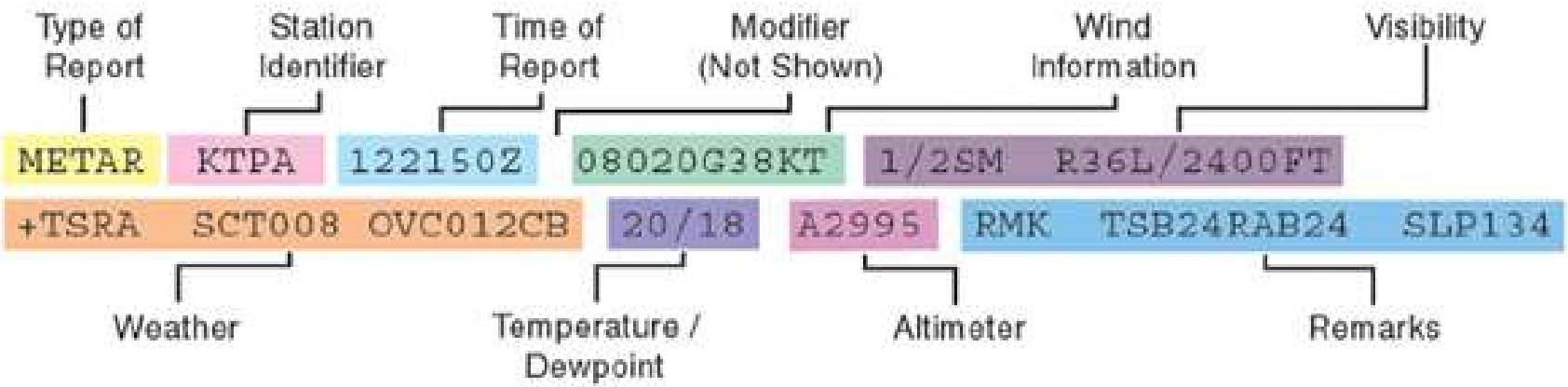
Barometric Pressure preceded with "A"

WHY SHOULD WE CARE ABOUT THE DEW POINT ? **FOG** **& PREDICT CEILINGS**

Calculation for expected cloud base AGL = ((Temp (F) – Dew point (F)) / 4.4) x 1000
With temp/dp spread of 20/18, we can expect cloud bases as low as (2/4.4x1000) 455 ft AGL

METEOROLOGY – PRINTED REPORTS & FORECASTS

METAR (Aviation Route Information Report)



REMARKS HAVE GREAT VARIETY AND TAKE PRACTICE TO INTERPRET AND MASTER .. BE PATIENT

A02	Automated station with precipitation discriminator
PK WND 20032/25	Peak wind from 200° at 32 knots, 25 minutes past the hour
VIS 3/4V1 1/2	Prevailing visibility variable 3/4 to 1 and 1/2 miles
FRQ LTG NE	Frequent lightning to the northeast
FZDZB45	Freezing drizzle began at 45 minutes past the hour
RAE42SNB42	Rain ended and snow began at 42 minutes past the hour
PRESFR	Pressure falling rapidly
SLP045	Sea level pressure in millibars (hPa), 1004.5 mb (hPa)
T00081016	Temperature/dewpoint in tenths °C, .8 °C/–1.6 °C*

*Since the first digit after the T is a 0, it indicates that the temperature is positive; the dewpoint in this example is negative since the fifth digit is a 1.

METAR Oddities: not easily recognized

Peak Wind (PK_WND)
Wind Shift (WSHFT_time)
BINOVC (Breaks in Overcast)
BINOVC denotes a few, small clear patches in the overcast sky
Tower or Surface Visibility (TWR_VIS SFC_VIS)
CIG (Ceiling=Lowest BKN/OVC layer or height of VV)
V (Variable)
i.e. BKN V SCT, VIS 2V3 [2 variable 3 miles], CIG 025V030 [2500 ft-3000ft])
Lightning (Frequency_LTG-type)
CG: Cloud to ground
IC: Intracloud
CC: Cloud to Cloud
CA: Cloud to Air
OCNL: Occasional
FRQ: Frequent
CONS: Continuous
Beginning/Ending of Thunderstorms/Rain/Snow (TSB, SNE, RAB, etc)
Thunderstorm Location (TS_LOC_(MOV_DIR)
LOC=Location (N, NE, S, VC, OHD [Overhead], ALQDS [All Quadrants])
DIR=Direction (N, NE, S, etc)
Hailstone Size (GR_[size])
Virga (VIRGA_[DIR])
Cumulonimbus or Cumulonimbus Mammatus (CB or CBMAM_LOC_(MOV_DIR).
Towering cumulus (TCU_[DIR])
Altocumulus castellanus (ACC_[DIR])
Standing lenticular or Rotor clouds (CLD_[DIR])
Pressure Rising or Falling Rapidly (PRESRR/PRESFR)
Sea-Level Pressure (SLP###)
Aircraft Mishap (ACFT_MSHP)
Snow Increasing Rapidly (SNINCR_amount this hour/total)

Hourly Precipitation Amount (P####).
3- and 6-Hour Precipitation Amount (6####)
24-Hour Precipitation Amount (7####).
Snow Depth on Ground (4/###)
Water Equivalent of Snow on Ground (9####)
Hourly Temperature and Dewpoint (Tsn###sn###)
T=Temp
sn=Type (0=above zero celcius, 1=below zero celcius)
###=celcius temperature to nearest tenth of a degree
6-Hourly Maximum Temperature (1sn###)
6-Hourly Minimum Temperature (2sn###)
24-Hour Maximum and Minimum Temperature (4sn######)
First three numbers=maximum temp to nearest tenth of a degree celcius
Last three numbers=mimimum temp to nearest tenth of a degree celcius
-Hourly Pressure Tendency (5a###)--see table below for a (type)

Primary Requirement	Description	Code Figure
Atmospheric pressure now higher than 3 hours ago.	Increasing, then decreasing.	0
	Increasing, then steady, or increasing then increasing more slowly.	1
	Increasing steadily or unsteadily.	2
	Decreasing or steady, then increasing; or increasing then increasing more rapidly.	3
Atmospheric pressure now same as 3 hours ago.	Increasing, then decreasing.	0
	Steady	4
	Decreasing then increasing.	5
Atmospheric pressure now lower than 3 hours ago.	Decreasing, then increasing.	5
	Decreasing, then steady, or decreasing then decreasing more slowly.	6
	Decreasing steadily or unsteadily.	7
	Steady or increasing, then decreasing; or decreasing then decreasing more rapidly.	8

METEOROLOGY – PRINTED REPORTS & FORECASTS

METAR (Aviation Route Information Report)

M E T A R P R A C T I C E

KAPF	242253Z 28004KT 10SM FEW035 31/23 A2998 RMK AO2 SLP150 T03060228
KBCT	242148Z 13006KT 10SM CLR 30/24 A3000
KBKV	242253Z AUTO 28007KT 10SM CLR 29/24 A2998 RMK AO2 LTG DSNT N AND E SLPNO T02940239
KCEW	242253Z AUTO 20005KT 10SM CLR 32/24 A2999 RMK AO2 SLP152 T03170239
KCOF	242255Z 12011KT 7SM FEW022CB FEW100 FEW240 28/25 A3001 RMK WND DATA ESTMD CB DSNT S-SW MOV S SLP162
KCRG	242253Z 12009KT 8SM FEW095 28/23 A3000 RMK AO2 SLP157 T02830233
KCTY	242253Z AUTO 06003KT 32/22 A2997 RMK AO2 SLP149 T03220222 PWINO TSNO $
KDAB	242253Z 06009KT 10SM CLR 28/23 A3002 RMK AO2 SLP166 CB DSNT S-SW T02780228
KDTS	242253Z AUTO 21005KT 10SM CLR 29/23 A2998 RMK AO2 SLP150 T02940233
KEYW	242253Z 10006KT 10SM FEW031 31/25 A2998 RMK AO2 SLP151 T03060250
KFLL	242253Z 14006KT 10SM FEW030 SCT120 29/23 A2999 RMK AO2 SLP155 T02940228
KFMY	242253Z 26006KT 10SM SCT055 31/24 A2997 RMK AO2 LTG DSNT NW-E SLP149 T03110244

METEOROLOGY – PRINTED REPORTS & FORECASTS
SD RADAR WEATHER REPORTS

***Issued* 35 minutes passed each hour**

- Location and time (UTC)
- Echo pattern: CELL = single cell; LN = line;
- Coverage in tenths
- Type intensity and trend of weather
  - TRW++/+ = Thunderstorm, very heavy rain showers/increasing intensity
- Azimuth (true north) and range (nm) of points defining the echoes
- Pattern movement
- Maximum tops
- Remarks

Example: **LIC 1825 CELL RW/NEW 162/30 D8 MT 180 AREA 1R-/NC 14/104 105/72 298/5(C3005 MT U140 ISOLD R ^JM11 KM1 LM121 MO1 NN2=**

INTERPRETATION AS FOLLOWS:

LIC (LIMON, CO) RADAR WEATHER REPORT AT 1825 UTC

A CELL OF ECHOES OF RAIN SHOWERS, NEWLY DEVELOPED 162 DEGREES, 30 NM, 8 MILES IN DIAMETER MAX TOP18000 FT AN AREA OF ECHOES 1 TENTH COVERAGE OF LIGHT RAIN NO CHANGE 14 DEGREES, 104 NM/105 DEGREES, 72 NM AND 298 DEGREES, 56 NM

CELL MOVEMENT FROM 300 DEGREES AT 5 KNOTS. MAXIMUM TOP UNIFORM 14000 FEET

REMARKS:ISOLATED RAIN

SYMBOL	MEANING
R	Rain
RW	Rain Shower
S	Snow
SW	Snow Shower
T	Thunderstorm
SYMBOL	**INTENSITY**
-	Light
(none)	Moderate
+	Heavy
++	Very Heavy
X	Intense
XX	Extreme
CONTRACTION	**OPERATIONAL STATUS**
PPINE	Radar is operating normally but there are no echoes being detected.
PPINA	Radar observation is not available.
PPIOM	Radar is inoperative or out of service.
AUTO	Automated radar report from WSR-88D.

METEOROLOGY – PRINTED REPORTS & FORECASTS
PILOT REPORTS (PIREPS)

PILOTS ARE EXPECTED TO REPORT TURBULENCE, ICING, OR OTHER HAZARDS ENCOUNTERED.

Translation:
Routine pilot report (UA)...15 n.m. on the 063° radial from the Will Rogers VOR (OV OKC 063015)...at 1522Z (TM 1522)...at 8,000 feet MSL (FL 080)...type of aircraft is a Cessna 172 (TP C172) ...outside air temperature is -4 °C (TA -04)...wind is from 245° at 40 kts (WV 245040)...light turbulence between 5,500 feet MSL and 7,500 feet MSL (TB LGT 055-075)...the aircraft is in clear skies (RM IN CLR).

PIREP FORM

Pilot Weather Report	→ = Space Symbol
3-Letter SA Identifier → ___ ___ →	1. UA → _____ Routine Report; UUA → _____ Urgent Report
2. /OV →	Location: In relation to a NAVAID
3. /TM →	Time: Coordinated Universal Time
4. /FL →	Altitude/Flight Level: Essential for turbulence and icing reports
5. /TP →	Aircraft Type: Essential for turbulence and icing reports
Items 1 through 5 are mandatory for all PIREPs	
6. /SK →	Sky Cover: Cloud height and coverage (scattered, broken, or overcast)
7. /WX →	Flight Visibility and Weather: Flight visibility, precipitation, restrictions to visibility, etc.
8. /TA →	Temperature (Celsius): Essential for icing reports
9. /WV →	Wind: Direction in degrees and speed in knots
10. /TB →	Turbulence: Turbulence intensity, whether the turbulence occurred in or near clouds, and duration of turbulence
11. /IC →	Icing: Intensity and type
12. /RM →	Remarks: For reporting elements not included or to clarify previously reported items

Encoding Pilot Weather Reports (PIREPS)			
1	XXX	3-letter station identifier	Nearest weather reporting location to the reported phenomenon
2	UA	Routine PIREP, UUA-Urgent PIREP.	
3	/OV	Location	Use 3-letter NAVAID idents only. a. Fix: /OV ABC, /OV ABC 090025. b. Fix: /OV ABC 045020-DEF, /OV ABC-DEF-GHI
4	/TM	Time	4 digits in UTC: /TM 0915.
5	/FL	Altitude/Flight level	3 digits for hundreds of feet. If not known, use UNKN: /FL095, /FL310, /FLUNKN.
6	/TP	Type Aircraft	4 digits maximum. If not known, use UNKN: /TP L329, /TP B727, /TP UNKN.
7	/SK	Sky cover/Cloud layers	Describe as follows: a. Height of cloud base in hundreds of feet. If unknown, use UNKN. b. Cloud cover symbol. c. Height of cloud tops in hundreds of feet.
8	/WX	Weather	Flight visibility reported first: Use standard weather symbols; intensity is not reported: /WX FV02 R H, /WX FV01 TRW.
9	/TA	Air temperature in Celsius (C)	If below zero, prefix with a hyphen: /TA 15, /TA -06.
10	/WV	Wind	Direction in degrees magnetic north and speed in six digits: /WV 270045, WV 280110.
11	/TB	Turbulence	Use standard contractions for intensity and type (use CAT or CHOP when appropriate). Include altitude only if different from /FL, /TB EXTREME, /TB LGT-MDT BLO 090.
12	/IC	Icing	Describe using standard intensity and type contractions. Include altitude only if different than /FL: /IC LGT-MDT RIME, /IC SVR CLR 028-045.
13	/RM	Remarks	Use free from to clarify the report and type hazardous elements first: /RM LLWS -15KT SFC-030 DURC RNWY 22 JFK.

UA/OV GGG 090025/TM 1450/FL 060/TP C182/SK
080 OVC/WX FV 04R/TA 05/WV 270030/TB LGT/RM HVY RAIN
Explanation:
Type: .....Routine pilot report
Location: ..... 25 NM out on the 090° radial, Gregg County VOR
Time: ..... 1450 Zulu
Altitude or Flight Level: 6,000 feet
Aircraft Type: ..... Cessna 182
Sky Cover: ..... 8,000 overcast
Visibility/Weather: ..... 4 miles in rain
Temperature: .....5 °Celsius
Wind: ..... 270° at 30 knots
Turbulence: .....Light
Icing: ..... None reported

METEOROLOGY – PRINTED REPORTS & FORECASTS
PILOT REPORTS (PIREPS)

Turbulence Intensity	
Intensity	**Aircraft Reaction**
Light	Loose objects in aircraft remain at rest.
Moderate	Unsecured objects are dislodged. Occupants feel definite strains against seat belts and shoulder straps.
Severe	Occupants thrown violently against seat belts. Momentary loss of aircraft control. Unsecured objects tossed about.
Extreme	Aircraft is tossed violently about, impossible to control. May cause structural damage.

Icing Intensity	
Intensity	**Aircraft Reaction**
Trace	Ice becomes perceptible. Rate of accumulation slightly greater than sublimation. Deicing/anti-icing equipment is not used unless encountered for an extended period of time (over 1 hour).
Light	The rate of accumulation may create a problem if flight is prolonged in this environment (over 1 hour). Occasional use of deicing/anti-icing equipment removes or prevents accumulation. It does not present a problem if this equipment is used.
Moderate	The rate of accumulation is such that even short encounters become potentially hazardous, and use of deicing/anti-icing equipment or diversion is necessary.
Severe	The rate of accumulation is such that deicing/anti-icing equipment fails to reduce or control the hazard. Immediate diversion is necessary.

Created by Steve Reisser

METEOROLOGY – PRINTED REPORTS & FORECASTS
PILOT REPORTS (PIREPS)

FAA facilities are required to solicit PIREPs when the following weather conditions exist, are reported, or forecast to occur:

1. Ceilings at or below 5,000 feet.
2. Visibility reported on the surface or aloft is 5 miles or less.
3. Thunderstorms and related phenomenon.
4. Turbulence of moderate degree or greater.
5. Icing of light degree or greater.
6. Wind shear.
7. Volcanic ash clouds are reported or forecast.

PIREP 1:28Z 11/18/03
DEH UUA /OV UKN/TM 0128/FL170/TP BE20/TA M08/TB MDT/IC SVR MXD

PIREP 02:34Z 11/18/03
LAX UA /OV LAX350050/TM 0234/FL240/TP FA10/TA M25/WV 33036KT

TERMINAL AREA FORECAST(TAF): 24-30 Hour Surface Forecast

TAFs are issued every six hours for major civil airfields: 0000,0600,1200,1800 UTC,[1] and generally apply to a 24 or 30-hour period, and an area within approximately five statute miles (or 5NM in Canada) from the center of an airport runway complex. TAFS are issued every 3 hours for military airfields and some civil airfields and cover a period ranging from 3 hours to 24 hours.

TAF for:	KDEN (Denver Intl, CO, US)
Text:	**KDEN 080943Z 0810/0912 24006KT 1/4SM FG VV001**
Forecast period:	1000 to 1600 UTC 08 March 2014
Forecast type:	FROM: standard forecast or significant change
Winds:	from the WSW (240 degrees) at 7 MPH (6 knots; 3.1 m/s)
Visibility:	0.25 miles (0.40 km)
Ceiling:	indefinite ceiling with vertical visibility of 100 feet AGL
Clouds:	obscured sky
Weather:	FG (fog)
Text:	**TEMPO 0810/0812 4SM BR SCT004 SCT025 OVC050**
Forecast period:	1000 to 1200 UTC 08 March 2014
Forecast type:	TEMPORARY: The following changes expected for less than half the time period
Visibility:	4 miles (6 km)
Ceiling:	5000 feet AGL
Clouds:	scattered clouds at 400 feet AGL, scattered clouds at 2500 feet AGL, overcast cloud deck at 5000 feet AGL
Weather:	BR (mist)
Text:	**FM081600 25006KT P6SM BKN005 BKN015**

TERMINAL AERODROME FORECAST (TAF)

TAF
KPIT 091730Z
0918/1024 15005KT
5SM HZ FEW020
WS010/31022KT

FM091930 30015G25KT
3SM SHRA OVC015

TEMPO 0920/0922
1/2SM +TSRA
OVC008CB

FM100100 27008KT
5SM SHRA BKN020
OVC040

PROB30 1004/1007
1SM -RA BR

FM101015 18005KT
6SM -SHRA OVC020

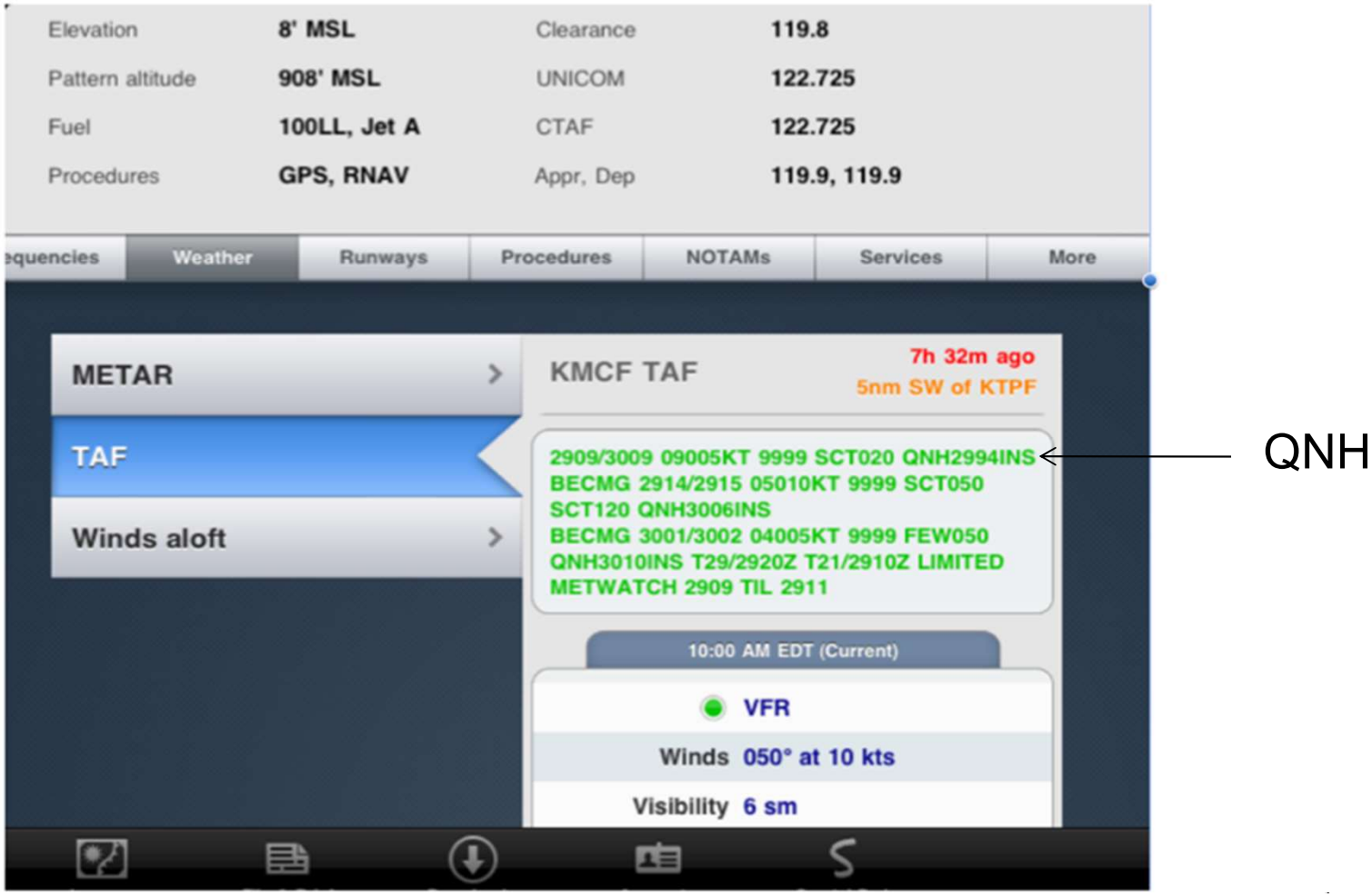
BECMG 1013/1015
P6SM SKC

091730Z Issuance time: ALL times in UTC "Z", 2-digit date, 4-digit time **091955Z**
0918/1024 Valid period, either 24 hours or 30 hours. The first two digits of EACH four digit number indicate the date of the valid period, the final two digits indicate the time (valid from 18Z on the 9th to 24Z on the 10th).
In U.S. METAR: CORrected of; or AUTOmated ob for automated report with no human intervention; omitted when observer logs on.
15005KT Wind: 3 digit true-north direction , nearest 10 degrees (or VaRiaBle); next 2-3 digits for speed and unit, KT (KMH or MPS); as needed, Gust and maximum speed; 00000KT for calm; for METAR, if direction varies 60 degrees or more, Variability appended, e.g., 180V260
5SM Prevailing visibility; in U.S., Statute Miles & fractions; above 6 miles in TAF Plus6SM. Runway Visual Range: R; 2-digit runway designator Left, Center, or Right as needed; "/", Minus or Plus in U.S., 4-digit value, FeeT in U.S., (usually meters elsewhere); 4-digit value Variability 4-digit value (and tendency Down, Up or No change) **R28L/2600FT**
HZ Significant present, forecast and recent weather
FEW020 Cloud amount, height and type: SKy Clear 0/8, FEW >0/8-2/8, SCaTtered 3/8-4/8, BroKeN 5/8-7/8, OVerCast 8/8; 3-digit height in hundreds of ft; Towering CUmulus or CumulonimBus in **METAR**; in **TAF**, only CB. Vertical Visibility for obscured sky and height "VV004". More than 1 layer may be reported or forecast. In automated **METAR** reports only, CLeaR for "clear below 12,000 feet" **OVC 010CB**
Temperature: degrees Celsius; first 2 digits, temperature "/" last 2 digits, dew-point temperature; Minus for below zero, e.g., M06 **18/16** Altimeter setting: indicator and 4 digits; in U.S., A-inches and hundredths; (Q-hectoPascals, e.g., Q1013) **A2992**
WS010/31022KT In U.S. **TAF**, non-convective low-level (≤ 2,000 ft) Wind Shear; 3-digit height (hundreds of ft); "/"; 3-digit wind direction and 2-3 digit wind speed above the indicated height, and unit, KT In **METAR**, ReMarK indicator & remarks. For example: Sea- Level Pressure in hectoPascals & tenths, as shown: 1004.5 hPa; Temp/dew-point in tenths _C, as shown: temp. 18.2_C, dew-point 15.9_C **RMK SLP045 T01820159**
FM091930 FroM: changes are expected at: 2-digit date, 2-digit hour, and 2-digit minute beginning time: indicates significant change. Each FM starts on a new line, indented 5 spaces
TEMPO 0920/0922 TEMPOrary: changes expected for <1 hour and in total, < half of the period between the 2-digit date and 2-digit hour beginning, and 2-digit date and 2-digit hour ending time
PROB30 1004/1007 PROBability and 2-digit percent (30 or 40): probable condition in the period between the 2-digit date & 2-digit hour beginning time, and the 2-digit date and 2-digit hour ending time
BECMG 1013/1015 BECoMinG: change expected in the period between the 2-digit date and 2-digit hour beginning time, and the 2-digit date and 2-digit hour ending time

Created by Steve Reisser

QNH is a Q code which is an acronym for "Question Nil Height". It is a pressure setting used by pilots, air traffic control (ATC), and low frequency weather beacons to refer to the barometric altimeter setting which will cause the altimeter to read altitude above mean sea level within a certain defined region. This region may be fairly widespread, or apply only to the airfield for which the QNH was given. An airfield QNH will cause the altimeter to read field elevation on landing irrespective of the temperature

QNH differs from QFE, which refers to the altimeter setting that will cause the altimeter to read the height above a specific aerodrome or ground level, and therefore read zero on landing.

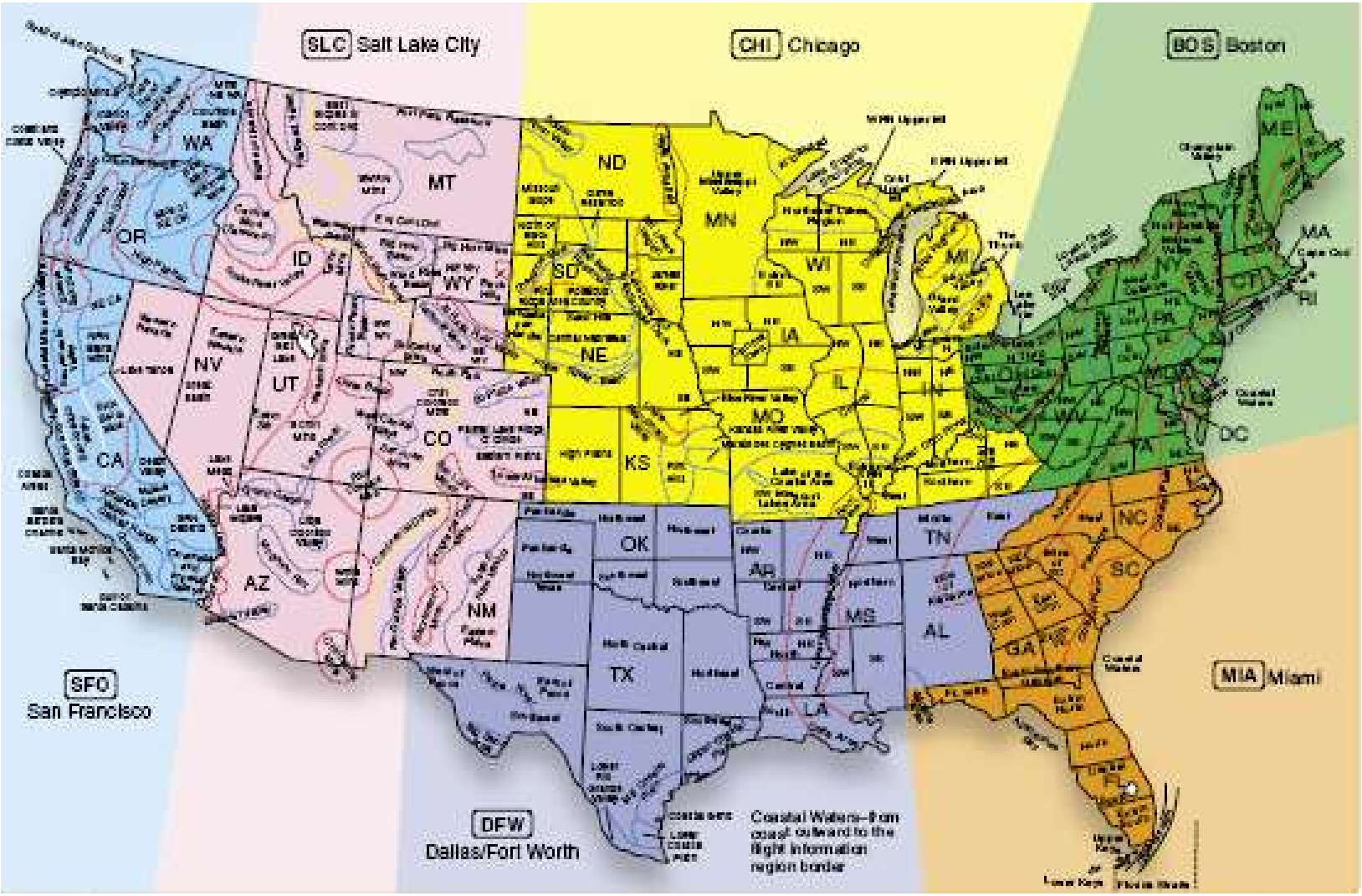


METEOROLOGY – PRINTED WEATHER FORECASTS
TERMINAL AERODROME FORECAST (TAF)-PRACTICE

```
KAPF    241123Z 241212 04003KT P6SM SKC
        FM1400 10004KT P6SM FEW025 SCT250
        FM1600 24007KT P6SM VCTS SCT025CB SCT080
        BKN250
        FM1900 27007KT P6SM SCT030 SCT080
        FM2200 30005KT P6SM SCT030
        FM0100 06005KT P6SM SKC
        BECMG 0305 00000KT P6SM SKC=

KDAB    241741Z 241818 07009KT P6SM FEW030
        FM0000 00000KT P6SM FEW080
        FM1300 VRB03KT P6SM FEW025
        FM1600 09008KT P6SM FEW030=
KEYW    241120Z 241212 09007KT P6SM SCT025 PROB30 2124 2SM +SHRA
        BKN020=
KFLL    241729Z 241818 13008KT P6SM SCT025 BKN250
        TEMPO 1822 3SM TSRA BKN015CB
        FM2200 13005KT P6SM VCSH SCT030 BKN080
        TEMPO 2224 3SM TSRA BKN015CB
        FM0000 11004KT P6SM SCT030 SCT080
        FM1400 14007KT P6SM SCT025 SCT250=
```

METEOROLOGY – PRINTED REPORTS & FORECASTS
AREA FORECASTS (FA)



REGIONAL – EACH HAS MANY STATES

METEOROLOGY – PRINTED REPORTS & FORECASTS
WINDS AND TEMPERATURE ALOFT (FD)

Heading Information
The heading includes the type of forecast, the day of the month, and the time of transmission.

Time
The second line tells you the forecast is based on observations at 1200Z and is valid at 1800Z on the 15th. It is intended for use between 1700Z and 2100Z on the same day.

```
FD KWBC 151640

BASED ON 151200Z DATA

VALID 151800Z FOR USE 1700-2100Z TEMPS NEG ABV 24000

FD    3000    6000     9000      12000     18000     24000     30000

ALA                    2420      2635-08   2535-18   2444-30   245945

AMA           2714     2725+00   2625-04   2531-15   2542-27   265842

DEN                    2321-04   2532-08   2434-19   2441-31   235347

HLC           1707-01  2113-03   2219-07   2330-17   2435-30   244145
```

Winds and Temperatures
Since temperatures above 24,000 feet are always negative, a note indicates that the minus sign is omitted for 30,000 feet and above. The column on the left lists the FD location identifiers. The columns to the right show forecast information for each level appropriate to that location.

WHY?

CALCULATE GS/TRACK

FAVORABLE CRUISE ALTITUDE

FREEZING LEVELS

Created by Steve Reisser

FD (Winds Aloft Forecast) Greater than 100 Kts i.e., *73<u>19</u>*60

Wind direction is coded as a number between **51 and 86** (vice 01 to 36) when the wind speed is 100 knots or greater.

To derive the actual wind direction, subtract 50 from the first pair of numbers. To derive wind speed, add 100 to the second pair of numbers. For example, a forecast at 39,000 feet of "*73<u>19</u>*60" shows a wind direction from 230 degrees (*73-50=23*) with a wind speed of 119 knots (*100+19=119*). Above 24,000 feet the temperature is assumed to be negative, therefore the third pair of numbers indicate a temperature of minus 60 degrees Celsius.

If the wind speed is forecast to be 200 knots or greater, the wind group is coded as 199 knots. For example, "7799" is decoded as 270 degrees (77-50=27) at <u>199 knots or greater</u>.

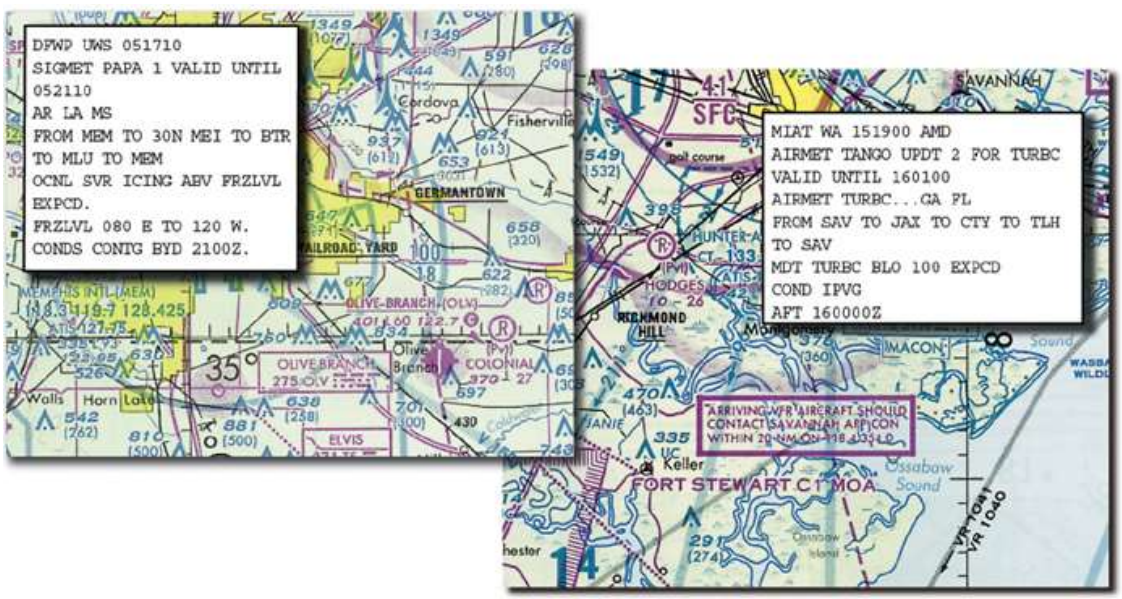
METEOROLOGY – PRINTED REPORTS & FORECASTS
WINDS AND TEMPERATURE ALOFT (FD) Practice

ON 241200Z
VALID 250000Z FOR USE 2100-0600Z. TEMPS NEG ABV 24000

FT	3000	6000	9000	12000	18000	24000	30000	34000	39000
SSM	2625	2935+16	2939+10	2944+09	3044-07	3046-19	296534	296343	296353
TVC	2634	2938+18	2936+13	2948+08	3036-08	2940-18	293834	303643	303853
MKG	2437	2933+20	3041+15	3042+08	3132-07	2927-18	282534	292543	312253
ECK	2325	2830+16	3037+13	3144+08	3129-07	3136-18	304733	294843	313653
BUF	2419	2519+12	2922+10	3238+05	3245-07	3247-18	325333	316244	315555
SYR	2814	2916+10	3023+06	3037+02	3045-08	3150-19	325934	326644	327054
ALB	3018	3418+09	3225+06	3135+02	3447-09	3356-20	337434	338145	337955
PLB	2923	3325+07	3229+03	3133+00	3351-10	3368-20	328035	328544	328654
BML	2925	3231+06	3238+03	3341+00	3352-11	3261-21	327036	328245	328554
CAR	3126	3328+01	3240-02	3249-07	3269-13	3274-23	327938	328246	327451
BGR	3225	3427+05	3338+01	3349-03	3251-13	3362-22	327337	328146	327653
PWM	3119	3526+08	3332+03	3341+00	3147-13	3362-21	326836	338245	338454
BOS	3121	3422+09	3325+04	3338+01	3245-13	3360-20	336536	338045	348755
ACK	3218	3326+09	3327+05	3442+01	3247-10	3361-21	336637	347846	348355
BDL	3119	3518+10	3221+06	3232+02	3245-11	3356-20	337035	337645	338355
FWA	2324	2915+20	3329+15	3338+09	3327-07	3018-18	262433	262442	292153
IND	2316	9900+21	3518+15	3430+09	3518-07	3118-18	262333	262542	272254
CVG	2409	0506+19	0125+15	3630+09	3522-07	3221-17	271833	281943	271954
CMH	2311	3505+18	3527+14	3634+08	3434-07	3327-17	282233	282143	272554
CLE	2316	2809+16	3329+13	3439+08	3434-07	3232-17	293433	293143	293354
AGC	2306	2410+14	3316+12	3527+06	3327-06	3334-16	324333	323943	313555

METEOROLOGY – PRINTED REPORTS & FORECASTS
SEVERE WEATHER REPORTS/FORECASTS

HURRICANE ADVISORIES (WH) – Issued when at least 300 miles offshore.
<u>CONVECTIVE OUTLOOK</u> (AC) -2 day prediction of "convection" activity [THUNDERSTORMS]
SEVERE WEATHER WATCH (WW) – Notification of severe thunderstorms (preceded by "alert" AWW)
AIRMETS (WA) – Concerns for "GENERAL AVIATION PILOTS" (light aircraft hazards)
Issued for moderate icing/turbulence, winds > 30, CIG < 1000 and/or visibility < 3 over 50% area.
"Sierra" identifier used for IFR conditions & mountain obscuration.
"Tango" identifier used for turbulence, strong surface wind, LLWS.
"Zulu" identifier used for icing and freezing levels.
SIGMETS (WS) - Concerns for "COMMERCIAL AND GA PILOTS" - "SIGNIFICANT WEATHER"
Issued for severe icing/turbulence, CAT, sand/dust storms, visibility < 3, and for volcanic ash.
CONVECTIVE SIGMENTS (WST) significant convective activity and thunderstorms.



MKCC WST 221655
CONVECTIVE SIGMET 18C
VALID UNTIL 1855Z
SD NE IA
FROM FSD TO DSM TO GRI TO BFF
TO FSD
AREA TSTMS WITH FEW EMBDD
CELLS MOVG FROM 2725 TOPS 300
FCST TO 1855Z DSPTG AREA WILL
MOV EWD 25 KT.

Stability for Instrument/Commercial

First a bit of history. We used to have to determine stability potentially effecting our instrument-commercial flights by reviewing an old style of Lift Index Chart and compare the Lift and K-Indexes to Radar Summaries to get a reliable prediction of instability, convection, and thunderstorm development. Used to be on the Instrument written examination.

Lifted Index Chart

Description:

This chart depicts the two common measures of air stability, the Lifted Index and the K-Index. The lifted index is most often used as an indicator of severe weather, while the K-Index is more closely related to general convection. The more negative the lifted index the more unstable the air mass is. The higher the K-Index the greater the likelihood of convection.

Lifted Index

The Lifted Index is compu ted by lifting an imaginary parcel of air from the surface up to the 500 millibar level (about 18,000 feet). As the air is lifted, it cools by exp ansion. The tempera-ture that the parcel would be at that altitude is subtracted from the actual temp erature. Th e d ifference is the Lifted Index.

Temperatures are expressed in de-grees Celsius and the result can be positive, zero, or negative. Should the lifted air be cooler than the measured air, the result will be positive. That is the lifted air would sink, and therefore stable. If the lifted airparcel is warmer, theresult would benegative. Thelifted air would rise, and the air is considered unstable. If the result is zero, it indi-cates that the air lifted to 500 millibars would be the same temperature as the existing 500 millibar temperature. This is neutrally stable air.

K Index

The K Index indicates the mois-ture content. It combines moisture and stability, but does not depend on lift-ing. K Index is computed using the following formula:

K = [Temperature (C) at 850 mil-libar level minus Temperature (C) at 500 millibar level] + [Dew point at 850 millibar level minus Temperature Dew point spread at 700 millibar level]

The Lifted Index deals with the lapse rate and is proportional to the mean lapse rate. A large temperature difference shows a steep or unstable lapse rate. Put another way, the greater the difference, the more unstable the air. The KIndex equation involves two elements. The first is a measure of low-level moisture, the second a measure of saturation. The greater the spread, the drier the air.

Table 1 - Stability Index Operational Impact

Lifted Index	K Index	Probable Weather	Operational Impact
Zero or Negative (Unstable)	High (Wet)	Instability showers or thunderstorms	Turbulence, may be hazardous
Zero or Negative (Unstable)	Low (Dry)	Some cumulus activity; light precipitation	Bumpy with thermals
Positive (Stable)	High (Wet)	Stratus clouds; steady precipitation	Poor visibility; light winds
Positive (Stable)	Low (Dry)	Predominantly fair	Smooth air; light winds

Using the Chart -From the chart you can make a quick estimate of areas of probable convective turbulence. K index can also be used to estimate most likely areas of clouds and precipitation. The K index should be compared with the Lifted Index. Correlation between the indices and resulting weather vary with seasons and in different sections of the country. Also, extent of instability that develops depends on the degree of surface heating or on forced lifting such as by sloping terrain or a front. First estimates made from the chart are only preliminary to detailed flight planning.

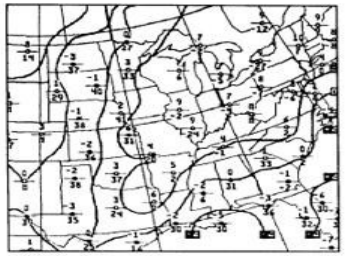


Figure1: Lifted Index and KIndex issued at 1200Z. Noteunstable conditions along the Gulf Coast and upper midwest. Stable conditions exist across Illinois, Indiana and Ohio in contrast.

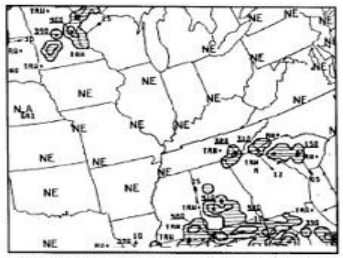
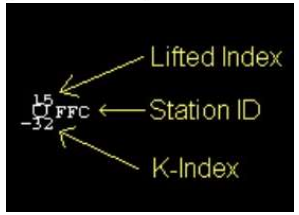


Figure 2: Radar Summary Chart issued at 1735Z. Note the thunderstorm activity along Gulf Coast and upper midwest.



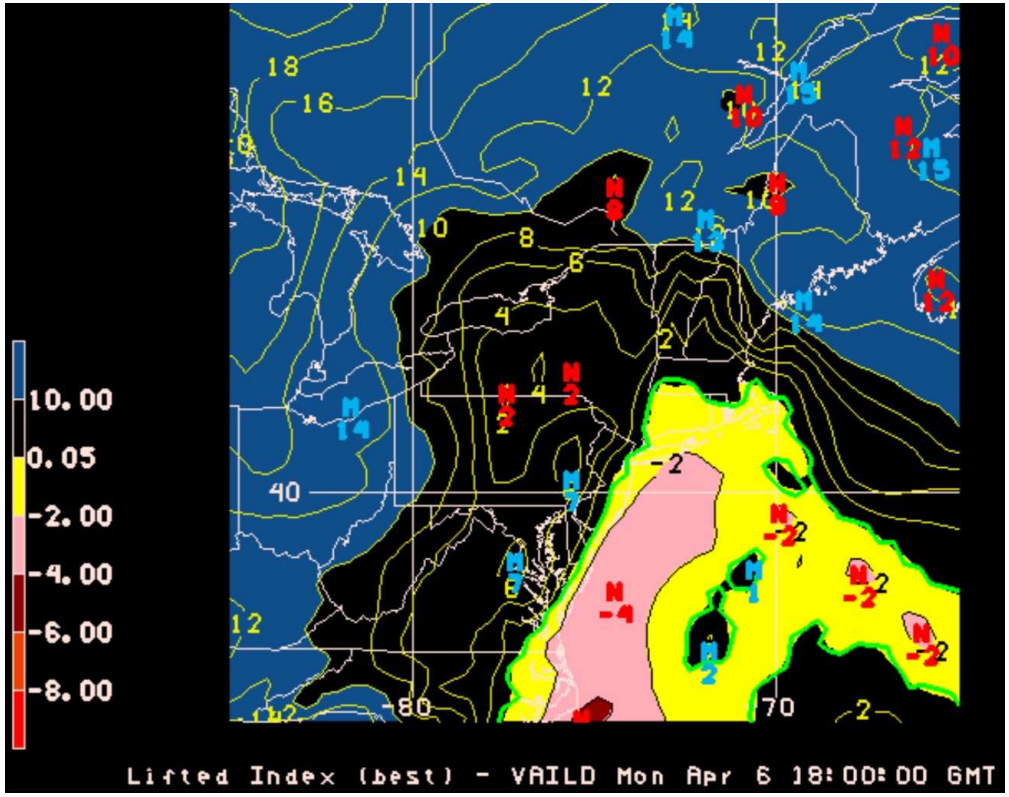
Thunderstorm Potential:

Lifted Index (LI)	Severe Potential	K-Index *	Airmass Thunderstorm Probability
0 to -2	Weak	<15	near 0%
		15-20	20%
-3 to -5	Moderate	21-25	21-40%
		26-30	41-60%
< -6	Strong	31-35	61-80%
		36-40	81-90%
		>40	near 100%

It is essential to note that an unstable Lifted Index does NOT automatically mean thunderstorms. Look at the synoptic situation and if thunderstorms are expected to develop in the unstable air, this table may be used.

* Use caution when applying these values in the western mountainous terrain due to elevation

Stability for Instrument/Commercial NOAA has now made it easy!

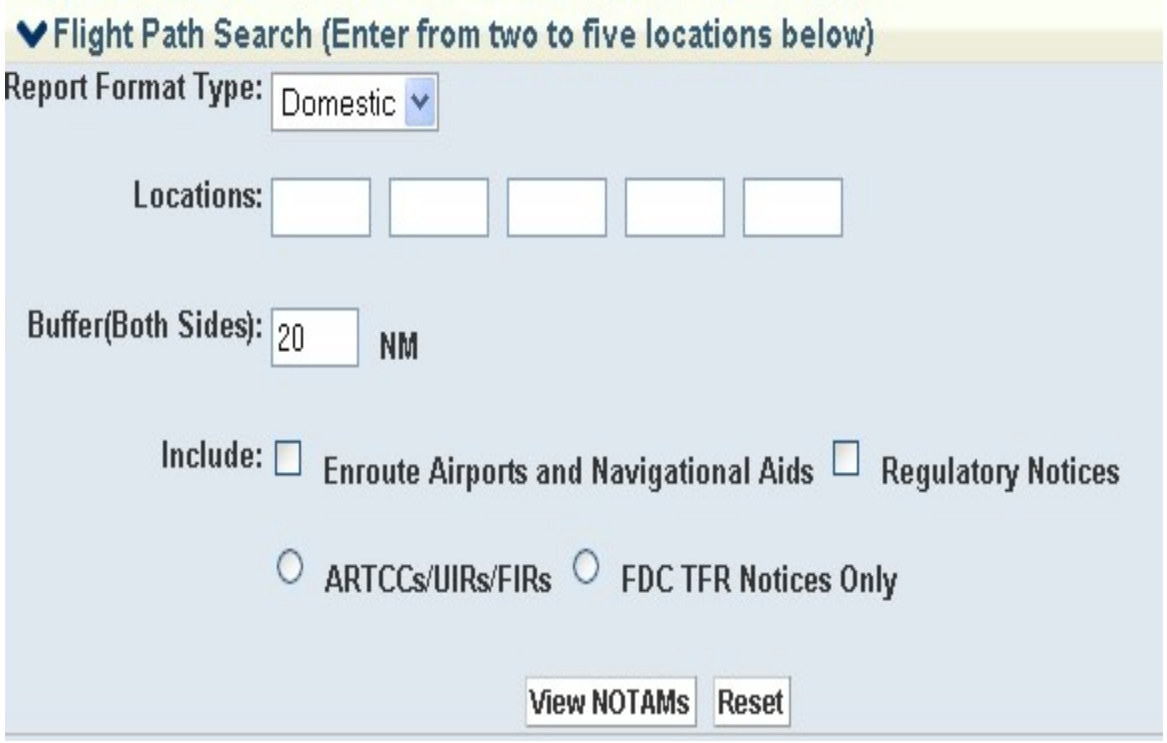


- LI Between 1 and 6 : Stable Conditions, Thunderstorms Not Likely
- LI Between 0 and -2 : Slightly Unstable, Thunderstorms Possible, With Lifting Mechanism (i.e., cold front, daytime heating, ...)
- LI Between -2 and -6 : Unstable, Thunderstorms Likely, Some Severe With Lifting Mechanism
- LI Less Than -6: Very Unstable, Severe Thunderstorms Likely With Lifting Mechanism

NOTICE TO AIRMEN: NOTAMS https://pilotweb.nas.faa.gov/PilotWeb/

Aeronautical Information

Advisories Database
ATCSCC Operational Information System (OIS)
ATCSCC Real-time Airport Status
Graphic TFRs
Aeronautical Navigation Products
NOTAM Contractions JO 7340.2
Published NOTAMs
National Flight Data Center
Construction Notices
Foreign Terminal Instrument Procedures
NAV Canada NOTAM



METEOROLOGY – PRACTICE EXERCISES

STANDARD BRIEFING PRINTED PRACTICE MATERIALS

Created by Steve Reisser

Graphic Weather Products
Winds Aloft Comparison (text and graphic)

(Extracted from FBUS31 KWNO 021958)
FD1US1
DATA BASED ON 021800Z
VALID 030000Z FOR USE 2000-0300Z. TEMPS NEG ABV 24000

FT	3000	6000	9000	12000	18000	24000	30000	34000	39000
EYW	2639	2748+08	2560+06	2569+00	2583-11	7604-20	761633	761444	761957
JAX	2831	2530+00	2833-03	2844-07	2651-22	2659-34	258741	259344	259147
MIA	2543	2650+07	2572+06	2575-02	2395-13	7611-22	753734	753645	763456
MLB	2638	2553+03	2555+01	2577-03	2486-17	7504-27	755537	754947	754352
PFN	3333	3330-01	3033-05	2740-08	2747-22	2855-34	287646	288347	278347
PIE	2837	2644+00	2748+00	2659-06	2678-19	7602-29	765538	763946	753949
TLH	3231	3332-01	2938-04	2740-08	2748-22	2850-35	285947	267245	278146
ATL	3421	3324-05	3422-08	3415-12	2927-22	3128-35	352650	322252	274647
CSG	3523	3529-06	3525-07	3120-11	2929-22	3029-35	342250	293350	275746
SAV	2414	2723+01	2631-05	2531-11	2638-24	2650-37	255443	245542	246945
HAT	1152	1554+04	1856-01	2052-06	2237-17	2042-30	208446	710854	239353
ILM	0916	2019+03	2326-02	2225-07	2138-19	1951-32	176747	207451	227149
RDU	0429	0823-02	1432-04	2322-09	1829-21	1734-33	184849	205251	215150
CAE	0434	2511+00	2917-06	2509-12	2319-24	2113-37	241747	243345	255046
CHS	2612	2723+01	2627-05	2428-10	2232-23	2239-37	235543	235243	246446
FLO	0543	2014+02	2624-04	2515-09	1926-22	1825-36	204048	224645	235147
GSP	0333	3610-04	2612-06	2709-11	2108-23	2907-36	351650	271449	243448
2XG	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

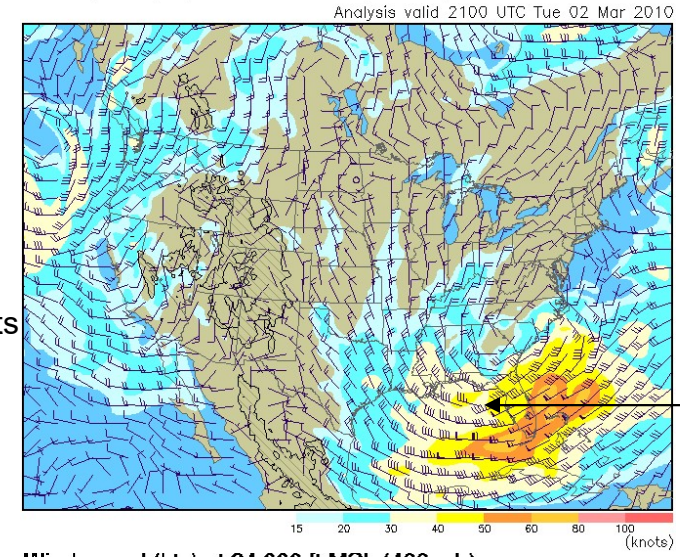
Special notes

If 9900 direction Variable and <= 5 kts

Wind direction >36 indicates that wind speed is 100-199 kts wind direction = value – 50. (7602) = 76-50= 26 and 102 kts

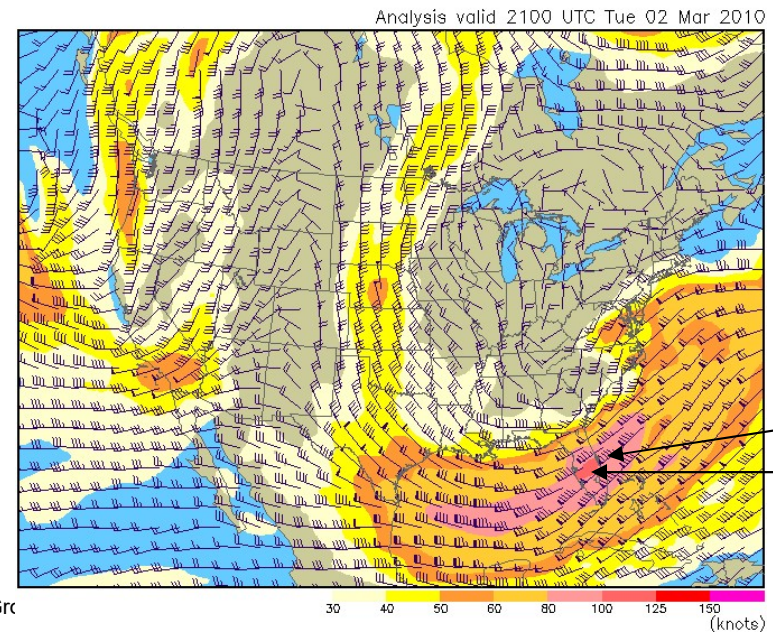
If wind is 99 then speed is => 200 kts

Wind speed (kts) at 6,000 ft MSL (800 mb)



50

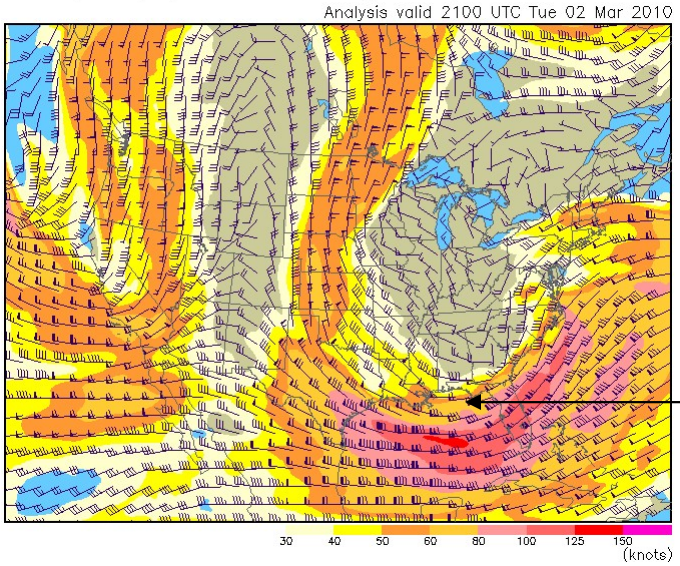
Wind speed (kts) at 18,000 ft MSL (500 mb)



95

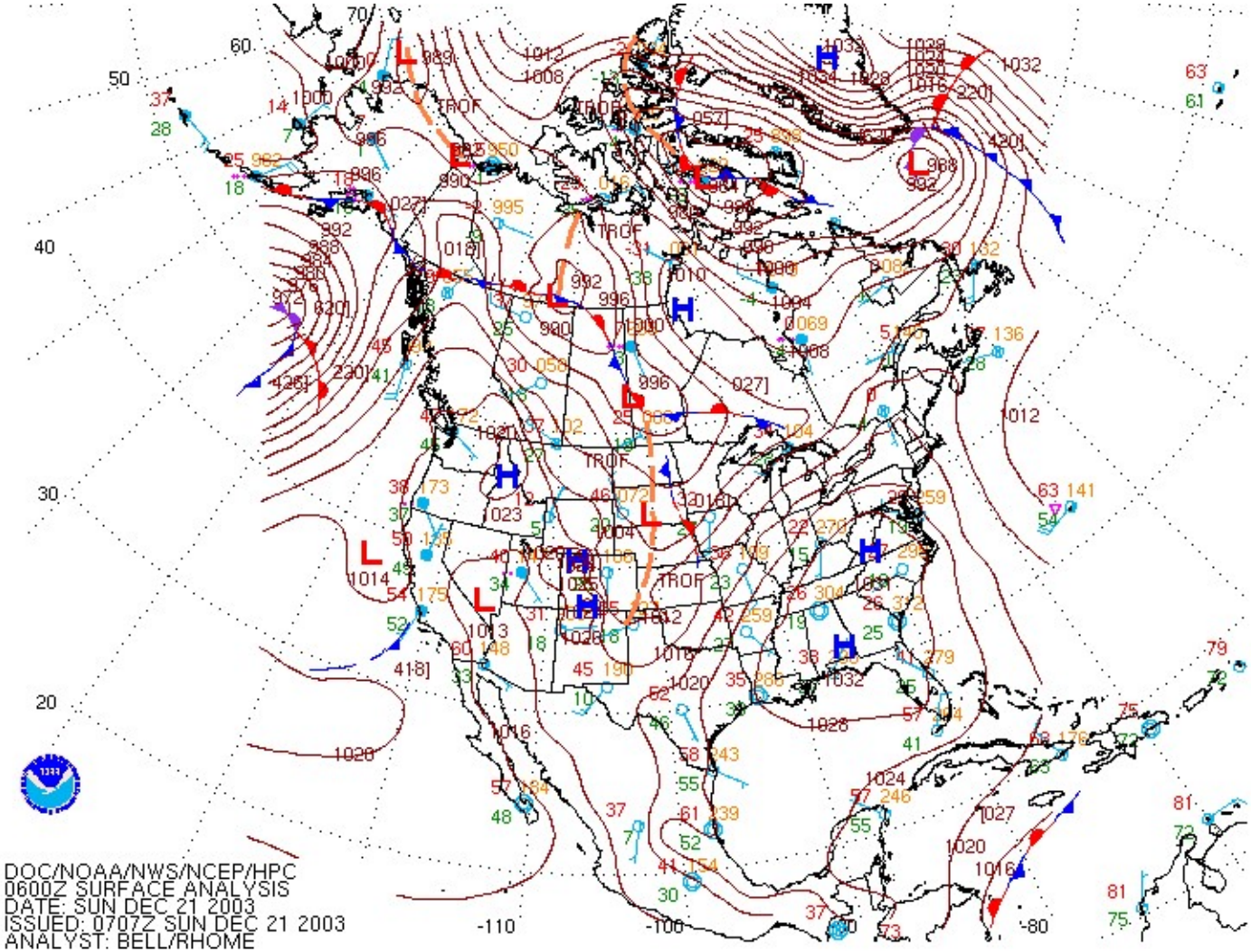
50

Wind speed (kts) at 24,000 ft MSL (400 mb)



100+

METEOROLOGY – GRAPHIC WEATHER PRODUCTS

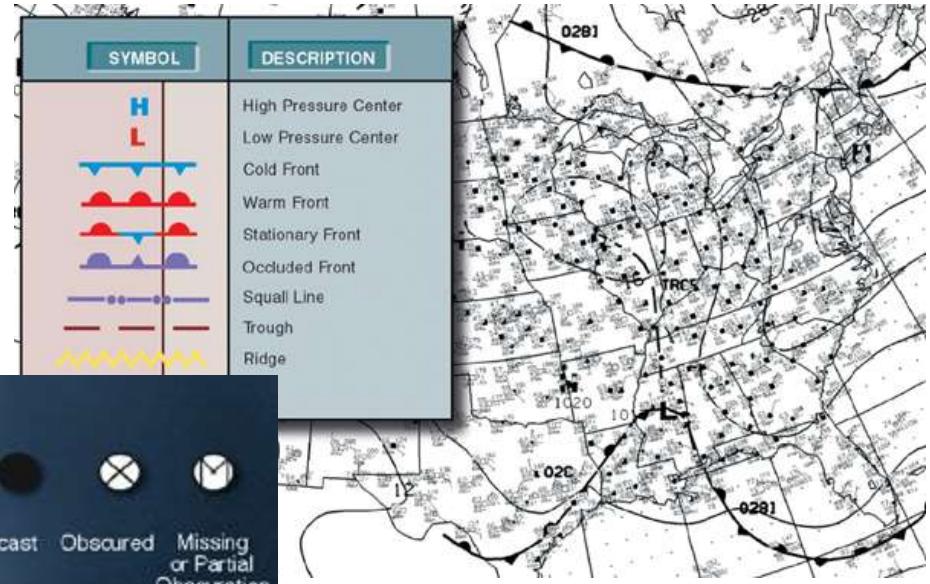


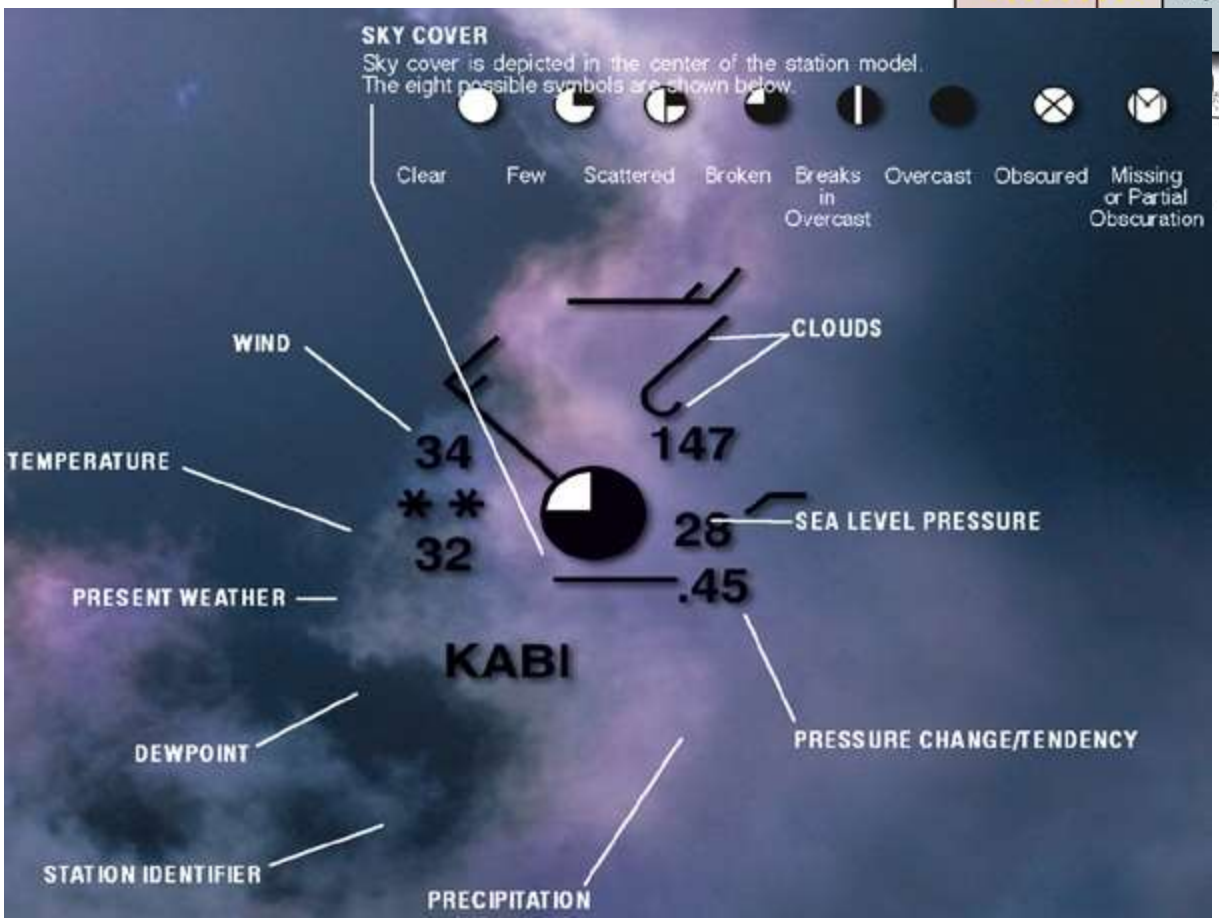
Surface Analysis Chart

The surface analysis chart depicts an analysis of the current surface weather. This chart is a computer prepared report that is transmitted every 3 hours and covers the contiguous 48 states and adjacent areas. A surface analysis chart shows the areas of high and low pressure, fronts, temperatures, dew points, wind directions and speeds, local weather, and visual obstructions.

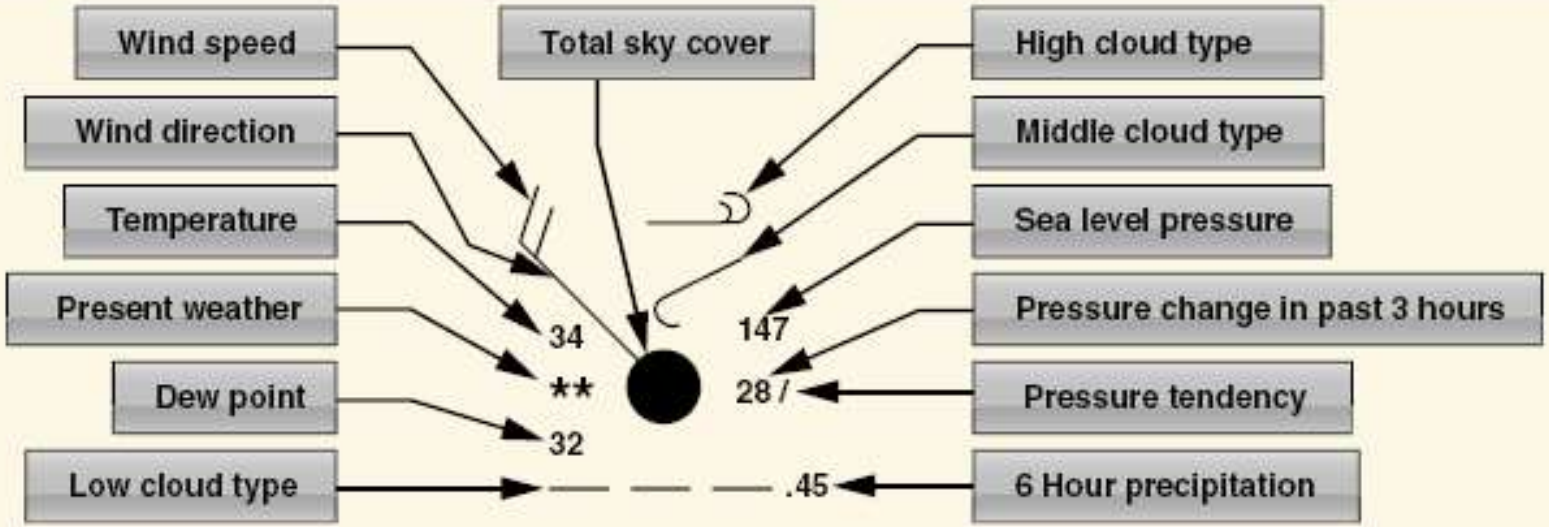
METEOROLOGY – GRAPHIC WEATHER PRODUCTS

SURFACE ANALYSIS – Computer generated graphic of surface conditions. Patterns and station models help visualize conditions across the continental United States.



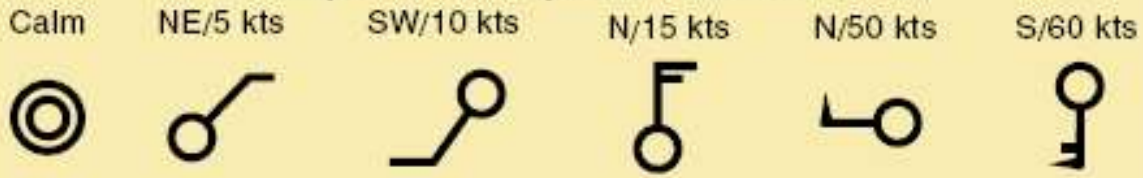


Created by Steve Reisser



1. Total sky cover:	**Overcast**
2. Temperature/Dew point:	**34 °F/32 °F**
3. Wind:	**From the northwest at 20 knots** (relative to true north)

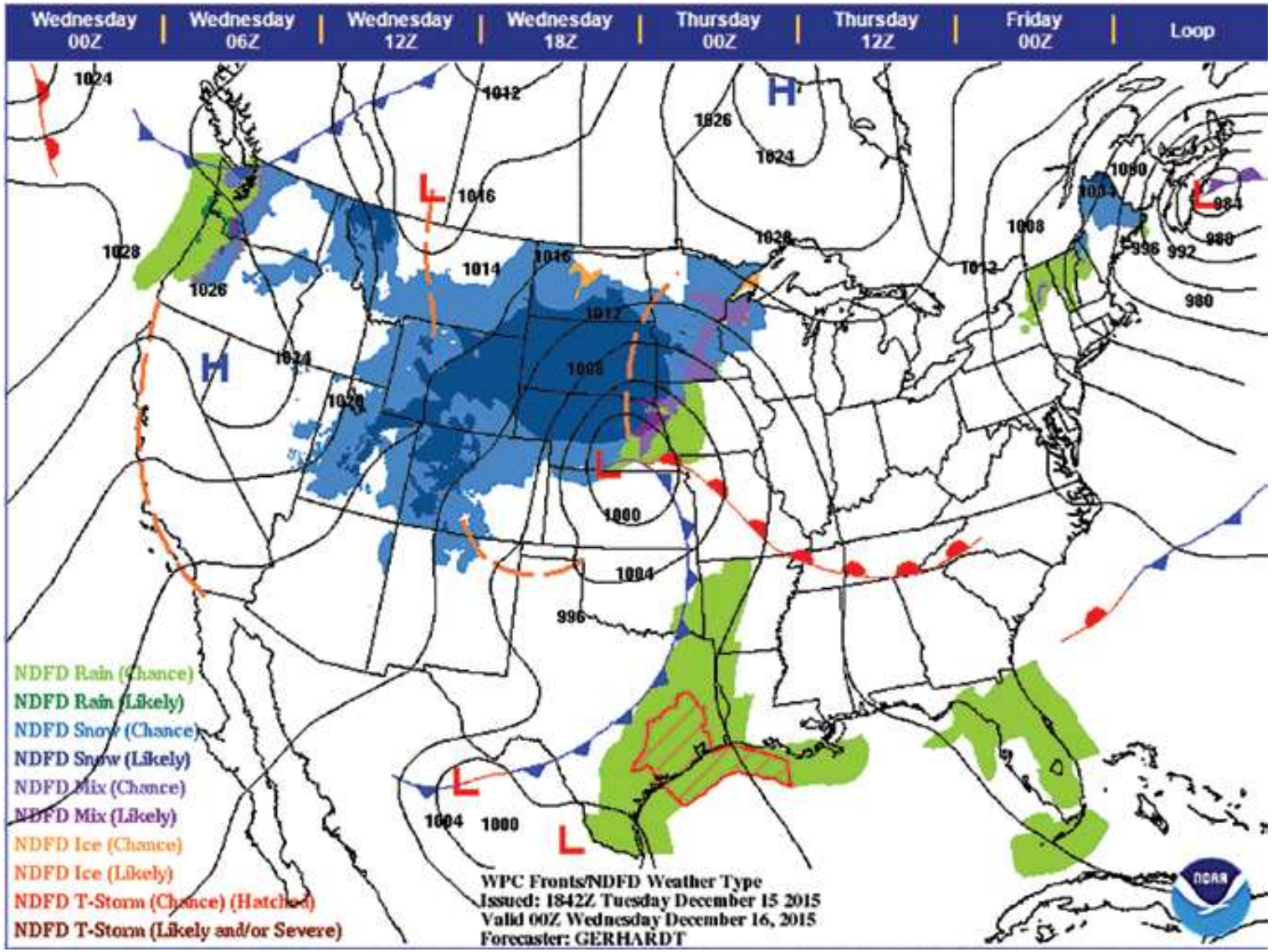
Examples of Wind Speed and Direction Plots



4. Present weather:	**Continuous light snow**
5. Predominant low, middle, high cloud reported:	**Strato fractus or cumulus, fractus of bad weather, altocumulus in patches and dense cirrus**
6. Sea level pressure:	**1014.7 millibars** (mb) Note: Pressure is always shown in 3 digits to the nearest tenth of a millibar. For 1,000 mb or greater, prefix a "10" to the 3 digits For less than 1,000 mb, prefix a "9" to the 3 digits
7. Pressure change in past 3 hours:	**Increased steadily or unsteadily by 2.8 mb**
8. 6-hour precipitation:	**45 hundredths of an inch.** The amount is given to the nearest hundredth of an inch.

METEOROLOGY – Weather Depiction Charts

This type of chart typically displays major fronts or areas of high and low pressure. The weather depiction chart also provides a graphic display of rain, snow and mix, ice, and thunderstorms.



METEOROLOGY – Radar Summary Charts

RADAR SUMMARY CHARTS: Graphic depiction of RADAR SUMMARY REPORTS. Helps understand shape, size, intensity, and movement of adverse weather. Published every 35 minutes past the hour. SATELLITE WEATHER PICTURES "GREAT"

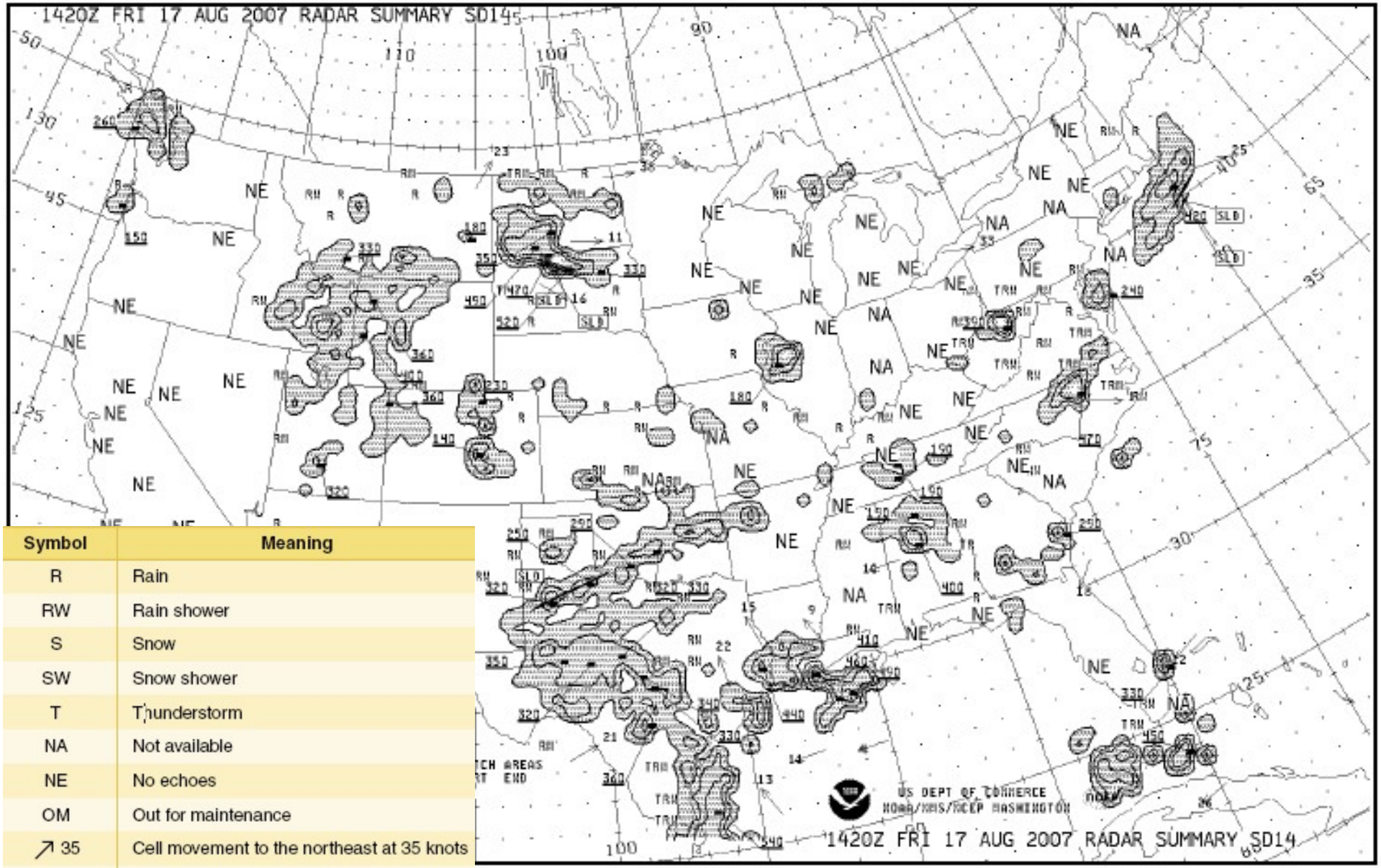
Precipitation

- No information—if information is not reported, the chart will say "NA." If no echoes are detected, the chart will say "NE."
- Precipitation intensity contours—intensity can be described as one of six levels and is shown on the chart by three contour intervals.
- Height of tops—the heights of the echo tops are given in hundreds of feet MSL.

Movement of cells—individual cell movement is indicated by an arrow pointing in the direction of movement. The speed of movement in knots is the number at the top of the arrow head. "LM" indicates little movement.

- Type of precipitation—the type of precipitation is marked on the chart using specific symbols. These symbols are not the same as used on the METAR charts.
- Echo configuration—echoes are shown as being areas, cells, or lines.
- Weather watches—severe weather watch areas for tornadoes and severe thunderstorms are depicted by boxes outlined with heavy dashed lines.

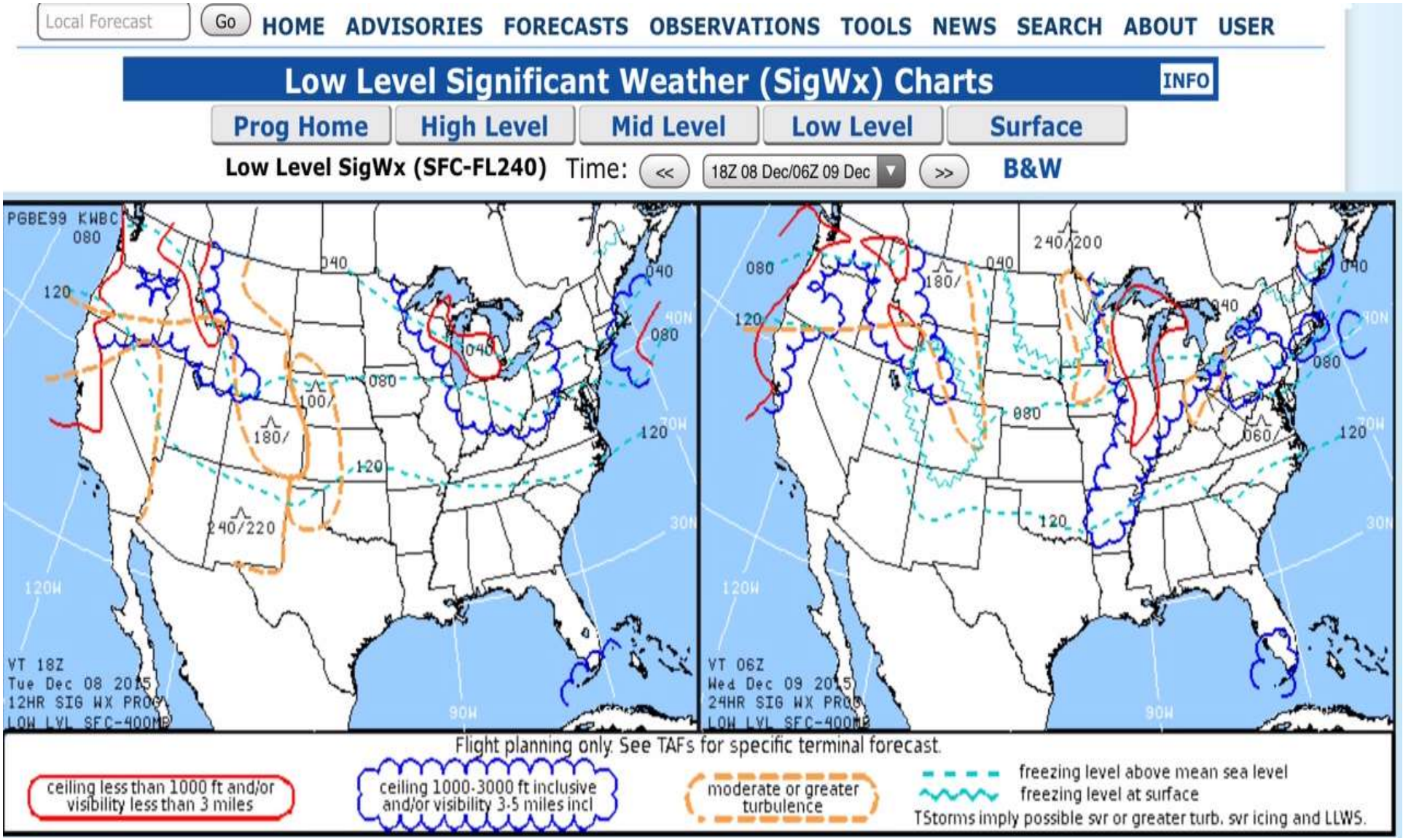
The radar summary chart is a valuable tool for preflight planning. It does, however, contain several **limitations** for the usage of the chart. This chart **depicts only areas of precipitation**. It will not show areas of clouds and fog with no appreciable precipitation, or the height of the tops and bases of the clouds. Radar summary charts are a depiction of current precipitation and should be used in conjunction with current METAR and weather forecasts.

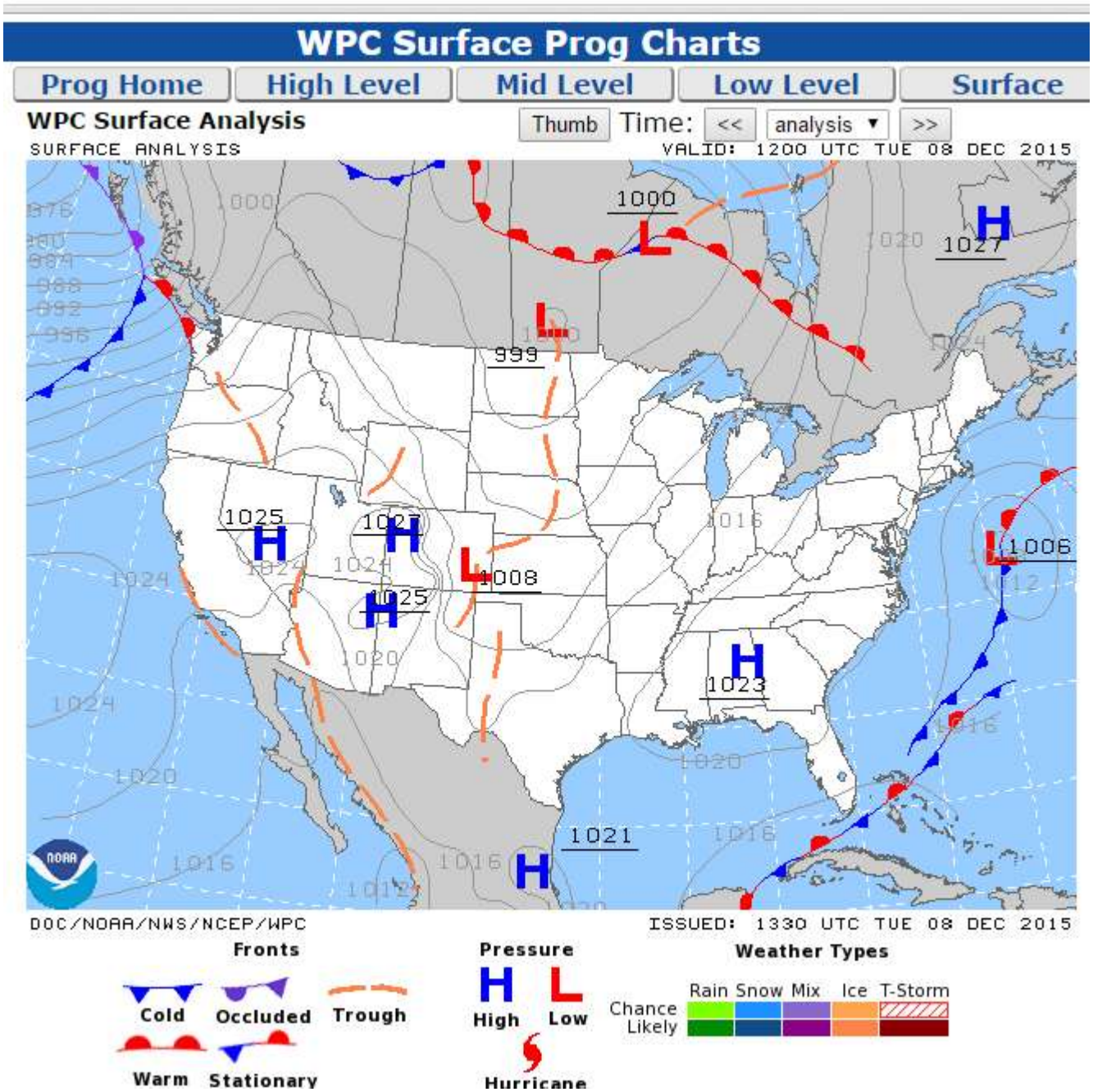


Symbol	Meaning
R	Rain
RW	Rain shower
S	Snow
SW	Snow shower
T	Thunderstorm
NA	Not available
NE	No echoes
OM	Out for maintenance
↗ 35	Cell movement to the northeast at 35 knots
LM	Little movement
WS999	Severe thunderstorm watch number 999
WT210	Tornado watch number 210
SLD	8/10 or greater coverage in a line
◢	Line of echoes

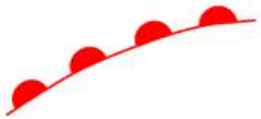
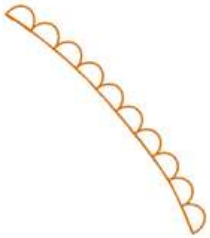
Low Level Significant Weather Prognostic Chart

<u>LOW LEVEL SIGNIFICANT WEATHER PROG CHART</u>: 2 PANELS, 12&24 hr Surface to FL240
http://www.aviationweather.gov/



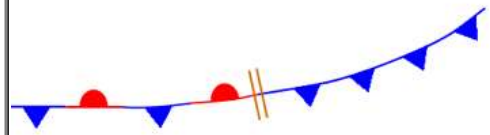

WPC Surface Prog Charts
Prog Home
High Level
Mid Level
Low Level
Surface
WPC Surface Analysis
Thumb
Time:
<<
analysis
>>
SURFACE ANALYSIS
VALID: 1200 UTC TUE 08 DEC 2015
1000
1027
999
1025
1008
1006
1023
1021
DOC/NOAA/NWS/NCEP/WPC
ISSUED: 1330 UTC TUE 08 DEC 2015
Fronts
Cold
Occluded
Trough
Warm
Stationary
Pressure
High
Low
Hurricane
Weather Types
Rain Snow Mix Ice T-Storm
Chance
Likely

FRONTAL DESIGNATIONS ON SURFACE AND LOW LEVEL PROGNOSTIC CHARTS

	**Cold Front** - a zone separating two air masses, of which the cooler, denser mass is advancing and replacing the warmer.
	**Warm Front** - a transition zone between a mass of warm air and the cold air it is replacing.
	**Stationary Front** - a front between warm and cold air masses that is moving very slowly or not at all.
	**Occluded Front** - a composite of two fronts, formed as a cold front overtakes a warm or quasi-stationary front. Two types of occlusions can form depending on the relative coldness of the air behind the cold front to the air ahead of the warm or stationary front. A cold occlusion results when the coldest air is behind the cold front and a warm occlusion results when the coldest air is ahead of the warm front.
	**Trough** - an elongated area of relatively low atmospheric pressure; the opposite of a ridge. On HPC's surface analyses, this feature is also used to depict outflow boundaries.
	**Squall Line** - a line of active thunderstorms, either continuous or with breaks, including contiguous precipitation areas resulting from the existence of the thunderstorms.
	**Dry Line** - a boundary separating moist and dry air masses. It typically lies north-south across the central and southern high Plains states during the spring and early summer, where it separates moist air from the Gulf of Mexico (to the east) and dry desert air from the southwestern states (to the west).
	**Tropical Wave** - a trough or cyclonic curvature maximum in the trade wind easterlies.

Hash marks

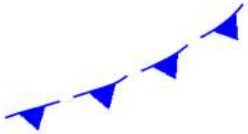
A hash mark denotes a change in frontal type, as in the example below.



Note: The hash mark will always be drawn perpendicular to the boundaries. They are not drawn at "triple points" (the intersection of an occluded, cold and warm or stationary front) and where a low pressure center separates the different frontal types.

Depiction of frontogenesis and frontolysis

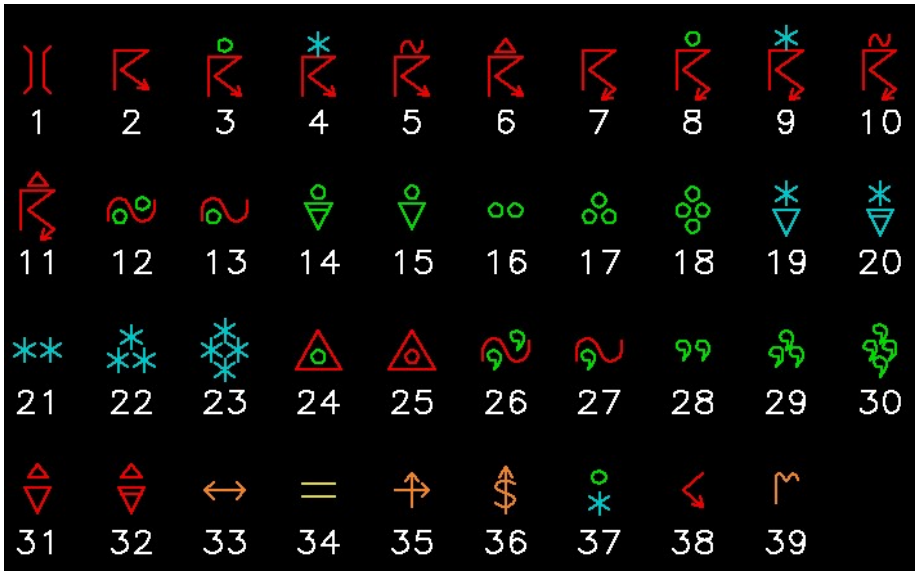
Frontogenesis refers to the initial formation of a surface front or frontal zone, while frontolysis is the dissipation or weakening of a front. Frontogenesis is depicted on HPC's surface analysis and forecast charts as a dashed line with the graphical representation of the developing frontal type (the blue triangle for cold fronts, the red semicircle for warm fronts, etc...) drawn on **each** segment. For example, the image below shows a forming cold front.



Frontolysis is depicted as a dashed line with the graphical representation of the weakening frontal type drawn on every **other** segment. Below is an example of a dissipating warm front.

Created by Steve Reisser

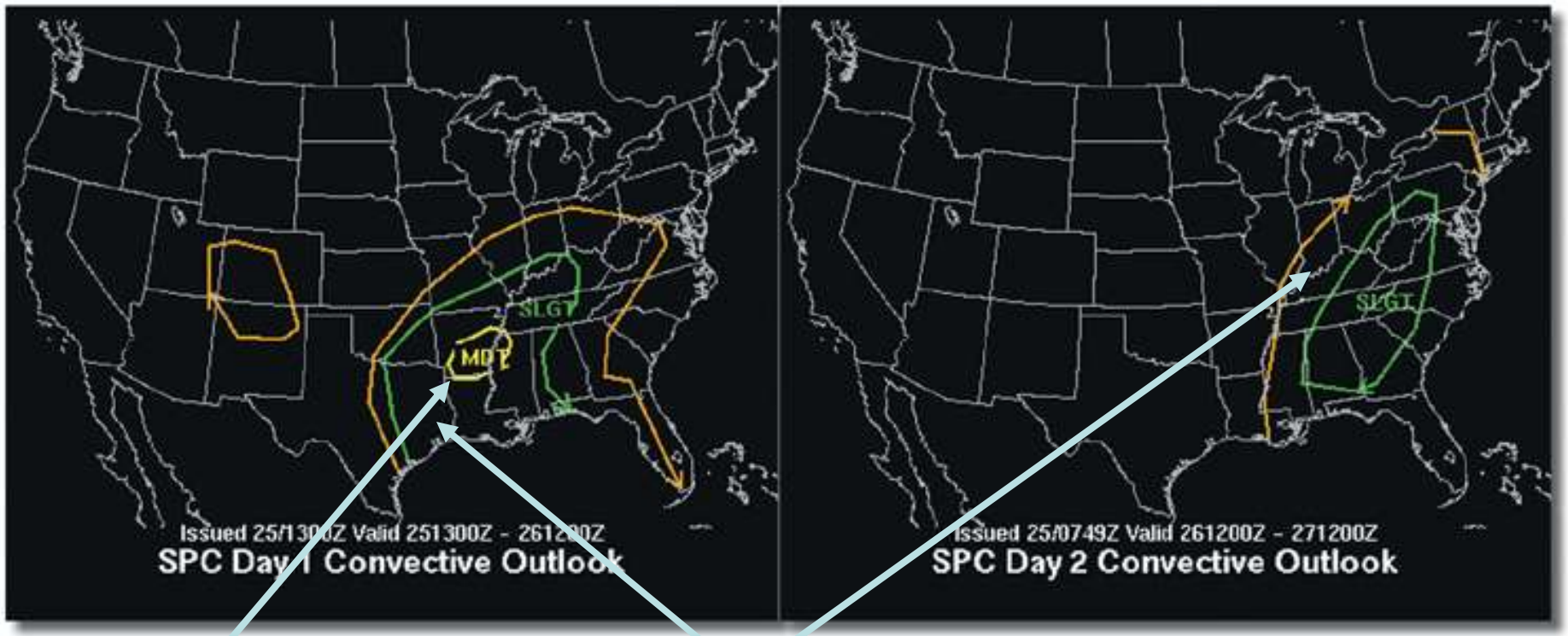
METEOROLOGY – GRAPHIC WEATHER PRODUCTS SYMBOLS



1 = Tornado [not used]	14 = Moderate/Heavy rain shower	27 = Light Freezing Drizzle
2 = Thunderstorm	15 = Light rain shower	28 = Light Drizzle
3 = Thunderstorm with rain	16 = Light rain	29 = Moderate Drizzle
4 = Thunderstorm with snow	17 = Moderate rain	30 = Heavy Drizzle
5 = Thunderstorm with freezing rain	18 = Heavy rain	31 = Light sleet shower
6 = Thunderstorm with hail or sleet	19 = Light snow shower	32 = Moderate/Heavy sleet shower
7 = Heavy Thunderstorm	20 = Moderate/Heavy snow shower	33 = Ice Crystals
8 = Thunderstorm with heavy rain	21 = Light snow	34 = Fog or Mist
9 = Thunderstorm with heavy snow	22 = Moderate snow	35 = Drifting snow [not used]
10 = Thunderstorm with heavy frzg rain	23 = Heavy snow	36 = Blowing sand/dust
11 = Thunderstorm with heavy sleet/hail	24 = Light Sleet	37 = Mix of rain and snow
12 = Moderate/Heavy freezing rain	25 = Moderate/Heavy Sleet	38 = Thunder without precipitation
13 = Light freezing rain	26 = Moderate/Heavy freezing drizzle	39 = Smoke

METEOROLOGY – GRAPHIC WEATHER PRODUCTS

2 Day Convective Outlook. Heads up for instability!



MODERATE (MDT) Convection

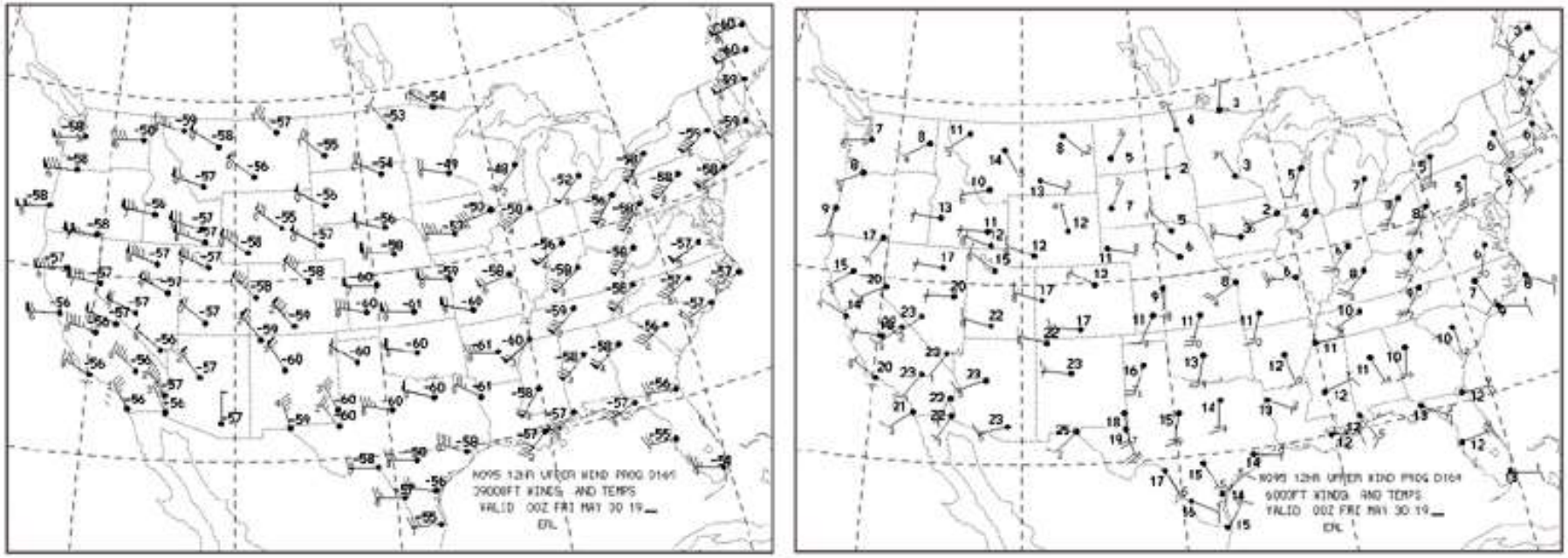
SLIGHT(SLT) Convection

Expect THUNDERSTORMS in areas of convective activity

HIGH not shown above

Created by Steve Reisser

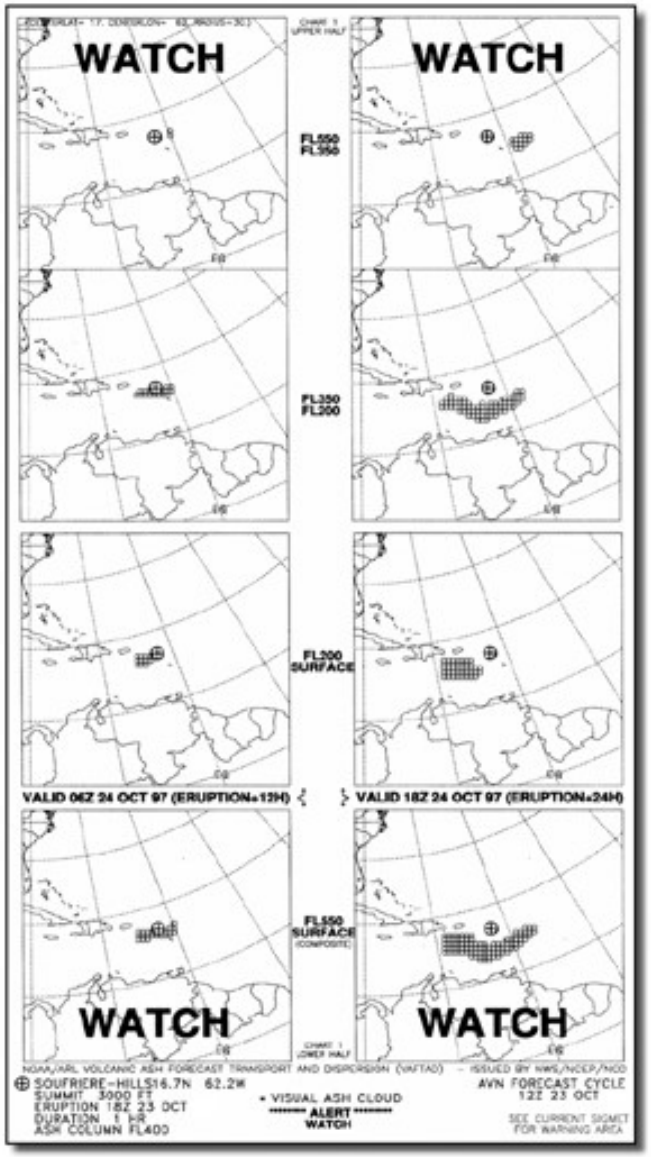
METEOROLOGY – GRAPHIC WEATHER PRODUCTS
FORECAST WINDS / TEMP ALOFT



Two of 8 panels on a 12 hour forecast winds and temperatures. Wind/Speed shown by pointers and temperature (C) indicated by numbers. They are a graphic representation of the standard winds aloft forecast (FDs).

Created by Steve Reisser

METEOROLOGY – GRAPHIC WEATHER PRODUCTS
VOLCANIC ASH GRAPHICS



METEOROLOGY – WEATHER REPORTING FREQUENCY

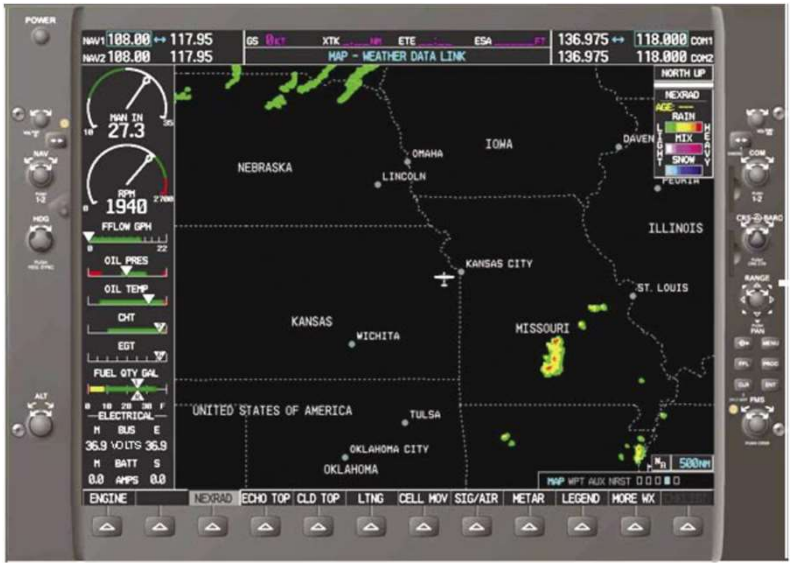
Weather Reports	Issued	Age when recv'd	Valid Period
Aviation Routine Weather Reports (METAR)	Hourly (50-55 past Hr.)	Few Minutes to 30	Until the next METAR or SPECI issued
RADAR Weather Reports (SD)	Hourly (35 past Hr.)	Approximately 20 mins.	Until next SD issued
Pilot Weather Reports (PIREP)	On Observation	Few Minutes to 30	Observed Data
Terminal Aerodrome Forecast (TAF)	0000z, 0600z, 1200z, 1800z	Forecasted Data	24 Hr. Forecast
Winds and Temperature Aloft Forecast (FD), (CHART)	0000z, 1200z	Forecasted Data	Time interval of use is stated on forecast.
Area Forecast (FA)	0045z, 0845z, 1745z	Forecasted Data	Total 18 Hrs., Synopsis 18 Hrs., 12 Hr Forecast with 6 Hr Outlook.
AIRMETS (WA)	Every 6 Hrs.	Observed with forecasted data	Maximum forecast period is 6 Hrs.
SIGMETS (WS)	When specific SIGMET whether phenomena occurs	Observed with forecasted data	Maximum forecast period is 4 Hrs.
Convective SIGMETS (WST)	Hourly (55 past the hour)	Few minutes	Until next WST or 2 Hrs. Outlook 2 to 6 Hours.
Surface Weather Analysis (CHART)	Every 3 Hours	1.5 to 2 Hours	Observed Data
RADAR Summary (CHART)	Hourly (35 past Hr.)	One Hour	Until next SD report
Weather Depiction (CHART)	Every 3 Hours	Approximately 60-80 mins.	Observed Data
Low-Level Significant Weather Prognostic (CHART)	0000z, 0600z, 1200z, 1800z	Forecasted Data	Left Panels-12 Hr, Right Panel=24 Hr
Composite Moisture Stability (CHART)	0000z, 1200z	Approximately 1 Hour	Observed Data
Sever Weather Outlook (CHART)	0800z	Forecasted Data	Left Panel-1st 24Hrs,Right=2nd 24Hrs
Constant Pressure Analysis (CHART)	0000z, 1200z	2 to 3 Hours	Observed Data

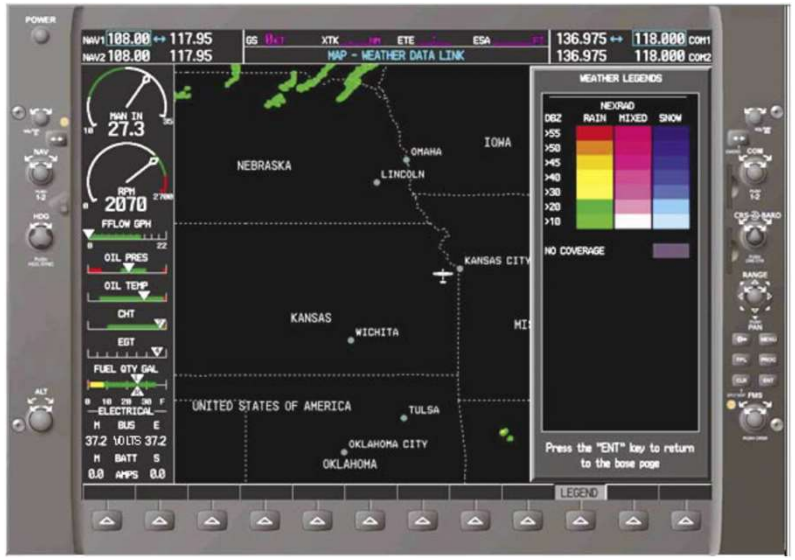
Electronic Flight Displays (EFD) /Multi-Function Display (MFD) Weather

- Graphical NEXRAD data (NEXRAD)
- Graphical METAR data (METAR)
- Textual METAR data
- Textual terminal aerodrome forecasts (TAF)
- City forecast data
- Graphical wind data (WIND)
- Graphical echo tops (ECHO TOPS)
- Graphical cloud tops (CLD TOPS)
- Graphical lightning strikes (LTNG)
- Graphical storm cell movement (CELL MOV)
- NEXRAD radar coverage (information displayed with the NEXRAD data)
- SIGMETs/AIRMETs (SIG/AIR)
- Surface analysis to include city forecasts (SFC)
- County warnings (COUNTY)
- Freezing levels (FRZ LVL)
- Hurricane track (CYCLONE)
- Temporary flight restrictions (TFR)

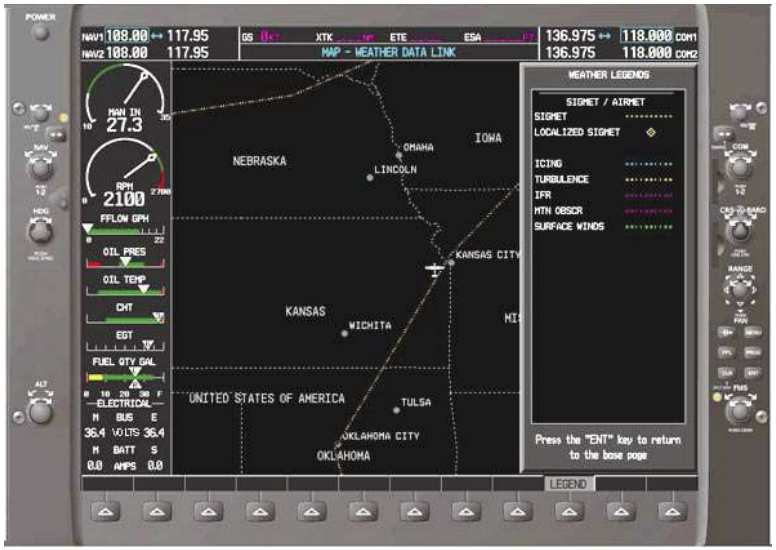
The Next Generation Weather Radar System (NEXRAD)

The NEXRAD system is comprised of a series of 159 Weather Surveillance Radar–1988 Doppler (WSR-88D) sites situated throughout the United States as well as selected oversees sites.

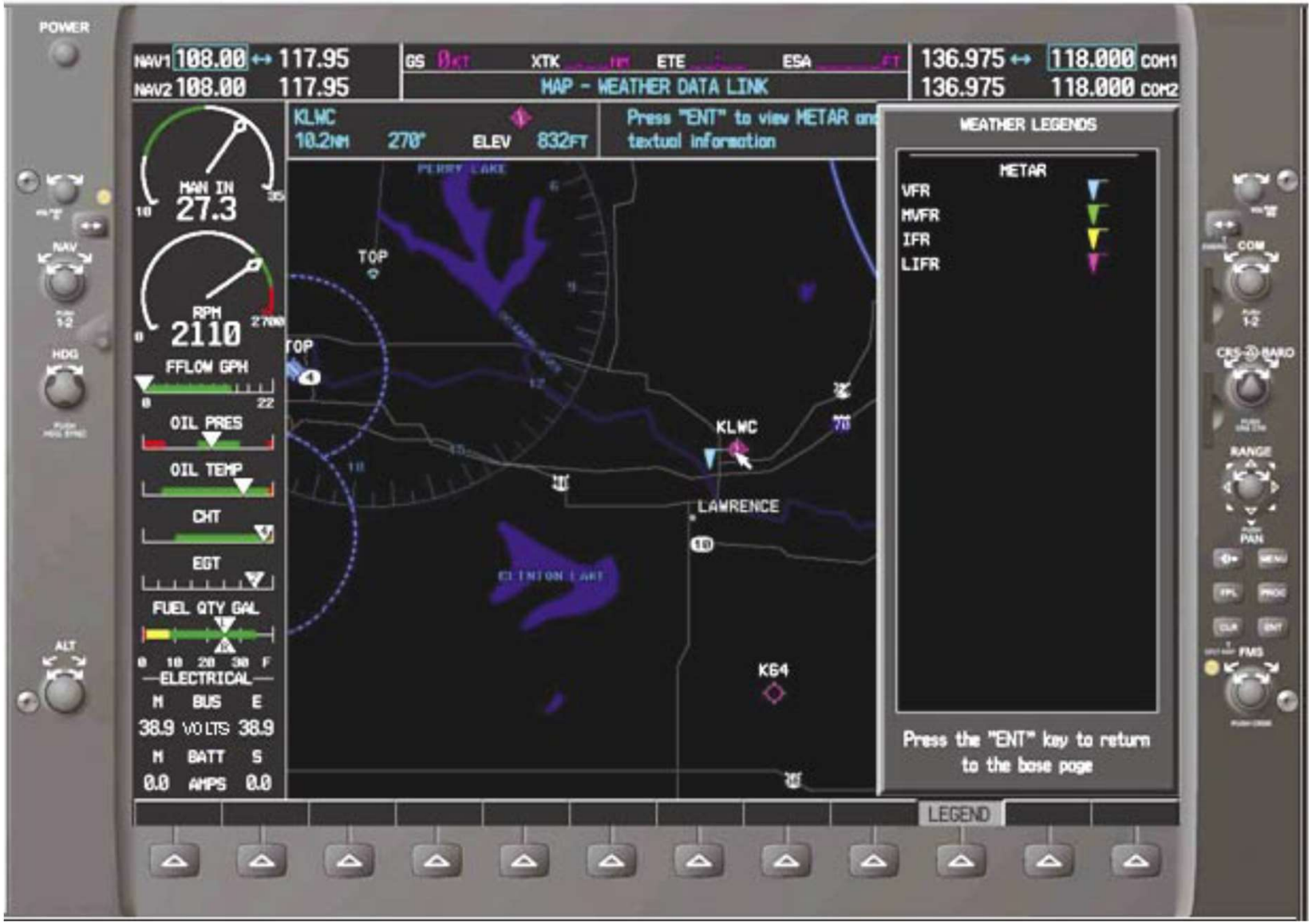




AIRMET information Box and addt'l info



AIRMET/SIGMET Legend information



Graphical METARS: Each flag is color coded to depict the type of weather that is currently reported at that station.

METEOROLOGY – SOURCE OF WEATHER INFO

AUTOMATED FLIGHT SERVICE STATION (AFSS)
24 HOURS A DAY
Centralized (6 centers nationwide) service calls.

1 800 WX BRIEF
(1 800 992-7433)

- Press 1 to speak to a Briefer; enter state code (FL=35).
- Press 2 to issue, cancel, or amend Notams (authorized persons only).
- Press 3 to listen to TIBS (transcribed information briefing service); enter state code.
- Press 4 to record a Fast File Flight Plan.
- Press 5 to hear Special Announcements.

METEOROLOGY – SOURCE OF WEATHER INFO

FSS provides person weather briefings. You are required to give the "N" number of the aircraft, type (VFR) flight plan (or just local information request), type aircraft, point of depart, route of flight, destination, estimated time of departure (ETD, and estimated time enroute (ETE) and TYPE OF BRIEFING (Outlook, Standard, or Abbreviated).

OUTLOOK BRIEFING

Used to make an initial judgment as to <u>feasibility</u> of the future flight (more than 6 hrs out). It provides initial forecast information that is limited in scope due to the timeframe of the planned flight.

METEOROLOGY – SOURCE OF WEATHER INFO

STANDARD BRIEFING

<u>DETAILED BRIEFING</u> with all applicable information for the intended flight.
"Most complete" briefing. Weather service gives you more than you will need.

Standard Briefing | **Abbreviated Briefing** | **Outlook Briefing**

Standard Briefing

If your flight will take place within the next six hours, and this is the first time you've called, ask for a standard briefing. You'll receive:

- Information on any adverse weather conditions
- A "VFR Not-Recommended" warning if, in the briefer's judgment, the situation warrants it (remember that the decision ultimately rests with you)
- A synopsis of weather systems along the route
- A summary of current conditions, if the departure time is less than two hours away
- An en route forecast
- A destination forecast
- A winds aloft forecast
- Notams and TFRs
- Any known ATC delays

STANDARD BRIEFING

A **standard briefing is the most complete report and provides the overall weather picture**. This type of briefing should be obtained prior to the departure of any flight and should be used during flight planning. A standard briefing provides the following information in sequential order if it is applicable to the route of flight.

1. **Adverse conditions** —this includes information about adverse conditions that may influence a decision to cancel or alter the route of flight. Adverse conditions include significant weather, such as thunderstorms or aircraft icing, or other important items such as airport closings.
2. **VFR flight not recommended** —if the weather for the route of flight is below VFR minimums, or if it is doubtful the flight could be made under VFR conditions due to the forecast weather, the briefer may state that VFR is not recommended. It is the pilot's decision whether or not to continue the flight under VFR, but this advisory should be weighed carefully.
3. **Synopsis** —an overview of the larger weather picture. Fronts and major weather systems that affect the general area are provided.
4. **Current conditions** —this portion of the briefing contains the current ceilings, visibility, winds, and temperatures. If the departure time is more than 2 hours away, current conditions are not included in the briefing.
5. **En route forecast** —a summary of the weather forecast for the proposed route of flight.
6. **Destination forecast** —a summary of the expected weather for the destination airport at the estimated time of arrival (ETA).
7. **Winds and temperatures aloft** —a report of the winds at specific altitudes for the route of flight. The temperature information is provided only on request.
8. **Notices to Airmen (NOTAM)** —information pertinent to the route of flight which has not been published in the NOTAM publication. Published NOTAM information is provided during the briefing only when requested.
9. **ATC delays** —an advisory of any known ATC delays that may affect the flight.
10. **Other information** —at the end of the standard briefing, the FSS specialist provides the radio frequencies needed to open a flight plan and to contact EFAS. Any additional information

METEOROLOGY – SOURCE OF WEATHER INFO

ABBREVIATED

Update of the standard briefing received by the pilot just prior to departure to find changes that may have occurred since the standard briefing.

Standard Briefing | **Abbreviated Briefing** | **Outlook Briefing**

Abbreviated Briefing

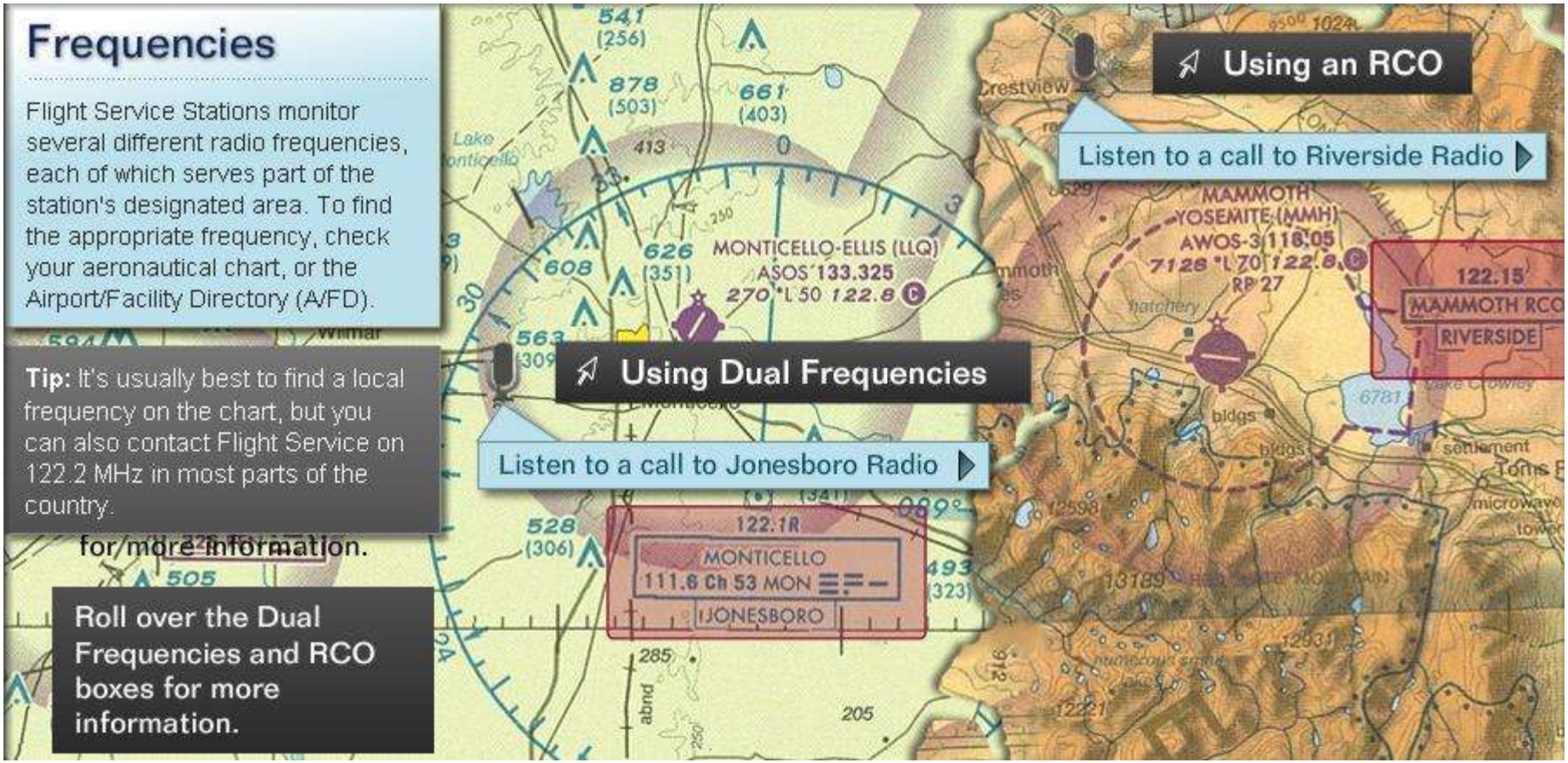
Depending on the situation, an abbreviated briefing might provide all the information you need. If you request an abbreviated briefing, be prepared to ask for the specific information you want. For example:

- If you've already received a standard briefing for the flight, you could request a briefing on items that may have changed—weather forecasts, for example.
- If you already have preflight information from another source, you might request information (notams, for example) to supplement it.
- If you only needed one or two items, you could simply ask the briefer for that specific information.

In-flight Weather Service

- Get weather updates
- Activate a flight plan
- Check temporary flight restriction (TFR) or special use airspace (SUA) status
- Get or give pilot reports (pireps)
- Update flight plan ETA
- Request help in an emergency situation

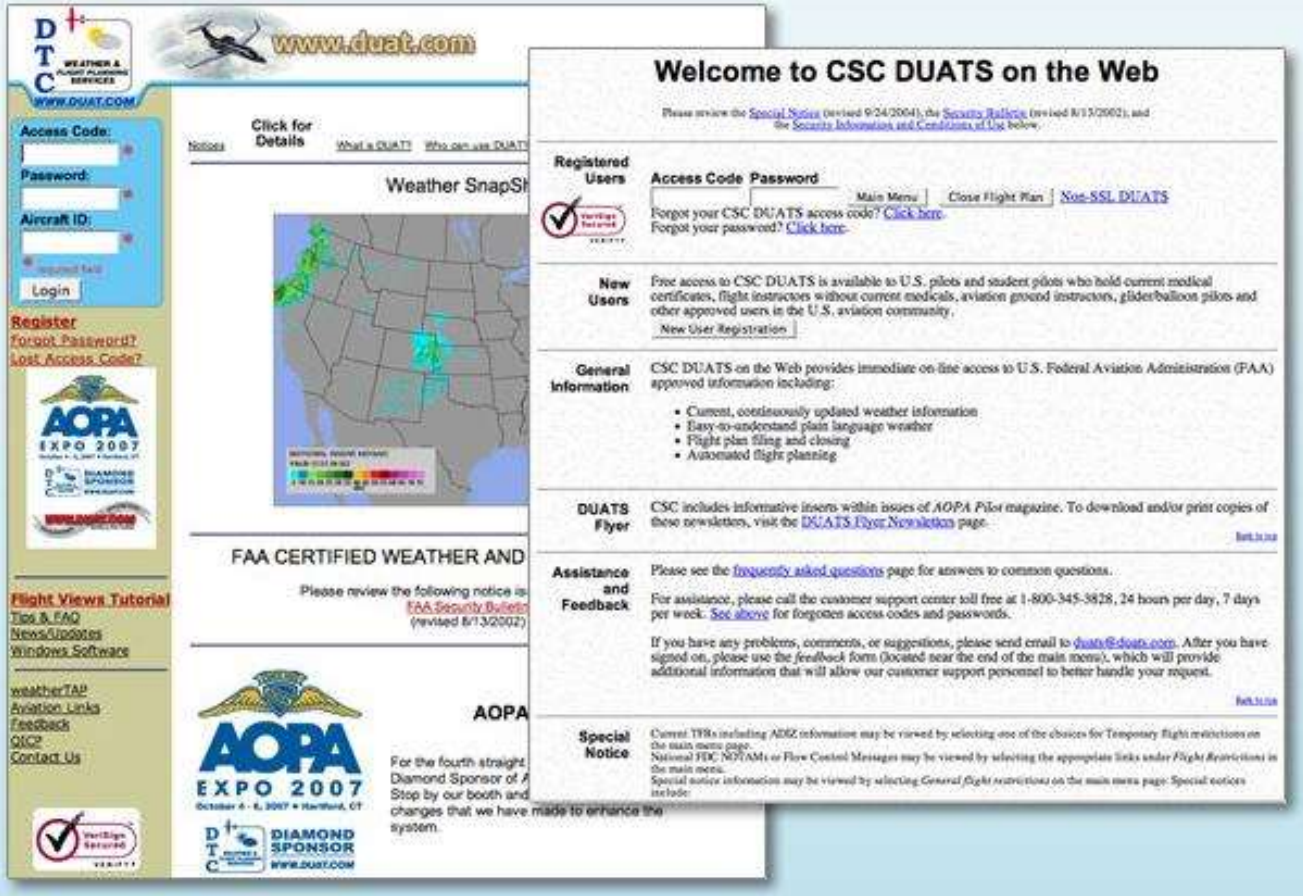
In-flight Weather Service



Internet Services Weather

Direct User Access Terminal

Apart from Flight Service, the only official source for a preflight briefing is DUAT (Direct User Access Terminal)—a web-based flight information service. The DUAT system operates independently of Flight Service, and is provided free of charge by two different FAA contractors: DTC DUAT and CSC DUATS.



METEOROLOGY – SOURCE OF WEATHER INFO

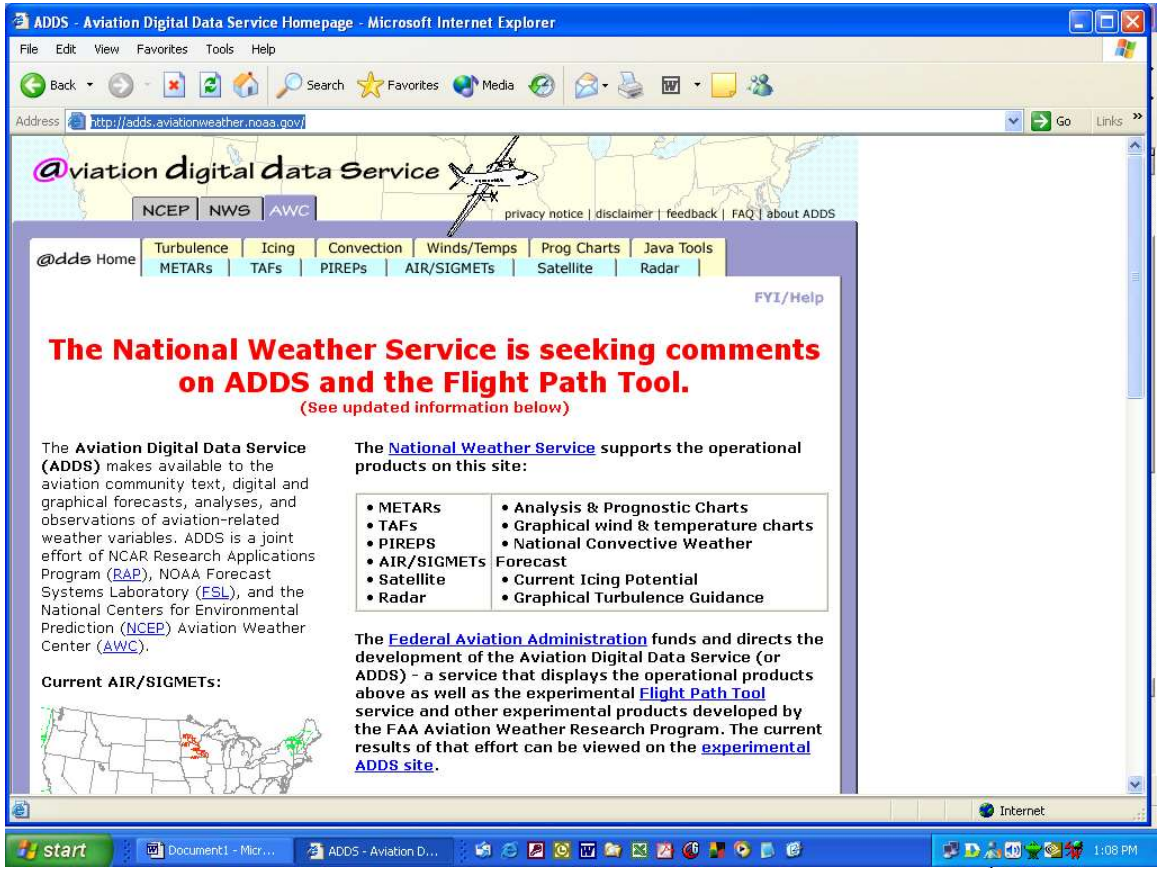
AOPA and EAA

Both organizations have flight planning and briefing internet access that integrates DUAT information. AOPA also permits AIRCRAFT PROFILE to provide not only briefing, route planning, but with aircraft performance will prepare a valid FLIGHT PLAN you can use to file a VFR flight plan with FSS.

GOOD PLANNING WEATHER SITES

AVIATION WEATHER
http://www.aviationweather.gov

AVIATION DIGITAL DATA SERVICES
http://adds.aviationweather.noaa.gov



METEOROLOGY – SOURCE OF WEATHER INFO

IN-FLIGHT WEATHER SOURCES

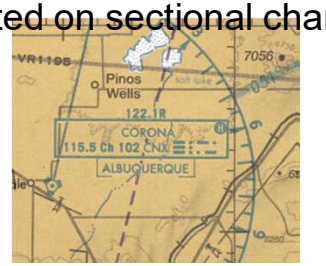
FSS – Provide services by radio communications and via navigation facilities. Frequencies are indicated at SECTIONAL CHARTS and the AIRPORT FACILITIES DIRECTORY (AFD).

ENROUTE FLIGHT ADVISORY SERVICE (EFAS)
Available advise (not radar service) for weather between 6 A.M. to 10 P.M. flying between 5,000 – 17,500 AGL.

TRANSCRIBED WEATHER BROADCAST (TWEB)
Broadcasts on VORs and NDBs (Navigation facilities) hourly when so indicated on the sectional charts. VORs/NDB also broadcast HIWAS as required (Hazardous In-Flight Weather Advisories) as indicated on sectional charts.

CENTER WEATHER ADVISORIES (CWA)
Air Route Traffic Control Centers (ARTCC) are primarily used for IFR traffic but can be monitored (listen) for weather information within 50 miles of airspace under their jurisdiction

HAZARDOUS INFLIGHT WEATHER ADVISTORY (HIWAS)
Broadcasting hazardous weather information continuously over selected navigation aids (NAVAIDs). The broadcasts include advisories such as AIRMETS, SIGMETS, convective SIGMETS, and urgent PIREPs. NAVAIDs that have HIWAS capability are depicted on sectional charts with an “H” in the upper right corner of the identification box.



METEOROLOGY – SOURCE OF WEATHER INFO

AUTOMATED WEATHER REPORTING SYSTEMS

Pilots can "tune" on radio (25nm – up to 10000 ft AGL) or telephone these devices

AWOS

Automated Weather Observing Systems

Voice synthesized "real time" weather data transmitted and available by phone on some fields without control towers.

- **AWOS-A Altimeter setting only**
- **AWOS-1 Altimeter, wind speed, direction/gusts, temperature, & dew point**
- **AWOS-2 AWOS-1 plus visibility**
- **AWOS-3 AWOS-2 plus info on clouds and ceilings**

ASOS

Automated Surface Observation Systems

More common than AWOS contains all info as AWOS-3 PLUS variable cloud heights/visibility, rapid pressure changes, precipitation (intensity, accumulation, times beginning/ending). Two types designated:

- **A01 (as described above)**
- **A02 (as described above PLUS capability to differ liquid/frozen precipitation**

Next Session – Airports/Airspace/Charts

- Study for exam on Aviation Weather.

BRING A SECTION CHART TO THE NEXT CLASS

"That's All Folks"