



Weather Information

Overview

WHAT

- A discussion of how weather forms, interacts, and its relation to flying
- Weather charts and their interpretation and application

WHY

- Weather can have a profound affect on the safety of flight. The better the understanding of weather theory, and how to read weather data, the better the pilot is prepared

CONTENT

- | | |
|----------------------------|------------------------------------|
| • The Atmosphere | • Frost & Icing |
| • Wind | • Fog & Mist |
| • Temperature | • Obstruction to Visibility |
| • Moisture & Precipitation | • Importance of a Weather Briefing |
| • Weather System Formation | • Weather Reports & Charts |
| • Clouds | • In-Flight Weather Advisories |
| • Turbulence | • Recognizing Weather Hazards |
| • Thunderstorms | • Go/No Go Decision |



Atmospheric Composition & Stability

Composition

- 4 gases make up 99.98% of the atmosphere
- Nitrogen, Oxygen, Argon & Carbon Dioxide



Atmospheric Composition & Stability

Vertical Structure

- Troposphere
 - Surface to about 36,000'
 - Air becomes thinner & temperature decreases with height
 - Almost all weather occurs here
- Stratosphere
 - Tropopause to about 31 miles above the surface
 - Temperature increases with height due to absorption of UV radiation
- Mesosphere
 - Stratopause to about 53 miles above the surface
 - Temperature decreases with height
- Thermosphere
 - Mesopause to about 430 miles above the surface
 - Temperature increases with height - up to 2,000° C
- Exosphere
 - Thermopause to 6,200 miles above the surface
 - Satellites orbit and atoms & molecules escape into space



Atmospheric Composition & Stability

Standard Atmosphere

- Average of conditions throughout the atmosphere for all latitudes, seasons & altitudes
- Hypothetical vertical distribution of temperature, pressure, and density

15°C (59°F) & 29.92" Hg



Wind

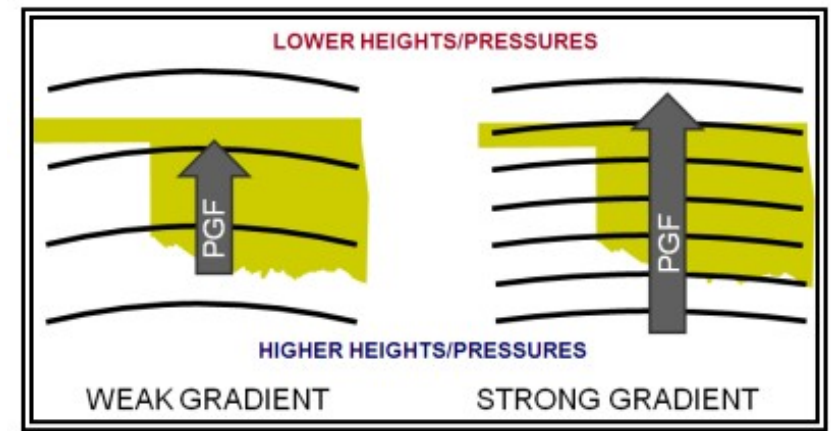
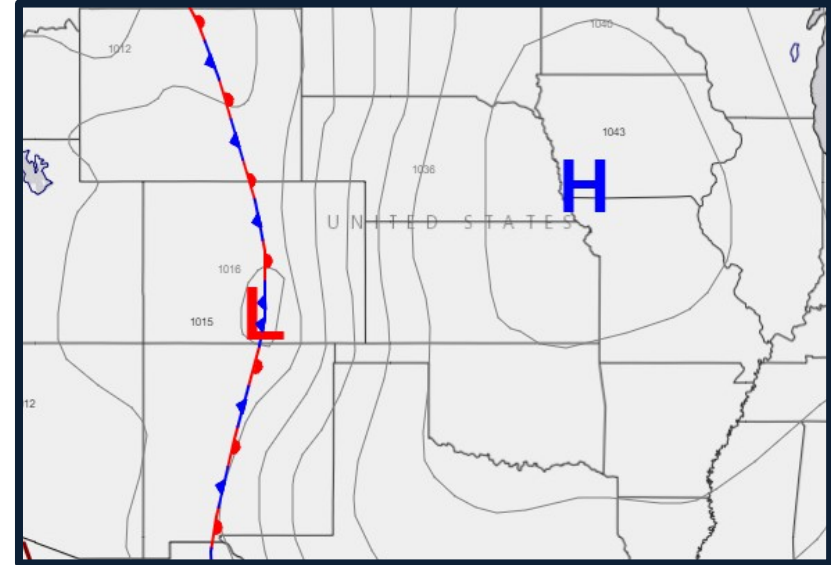
- Air motion relative to the surface
- Causes the formation, dissipation and redistribution of weather
- Affects all phases of flight
- 3 primary forces affect the flow of wind
 - Pressure Gradient Force (PGF)
 - Coriolis Force
 - Friction



Wind

Pressure Gradient Force

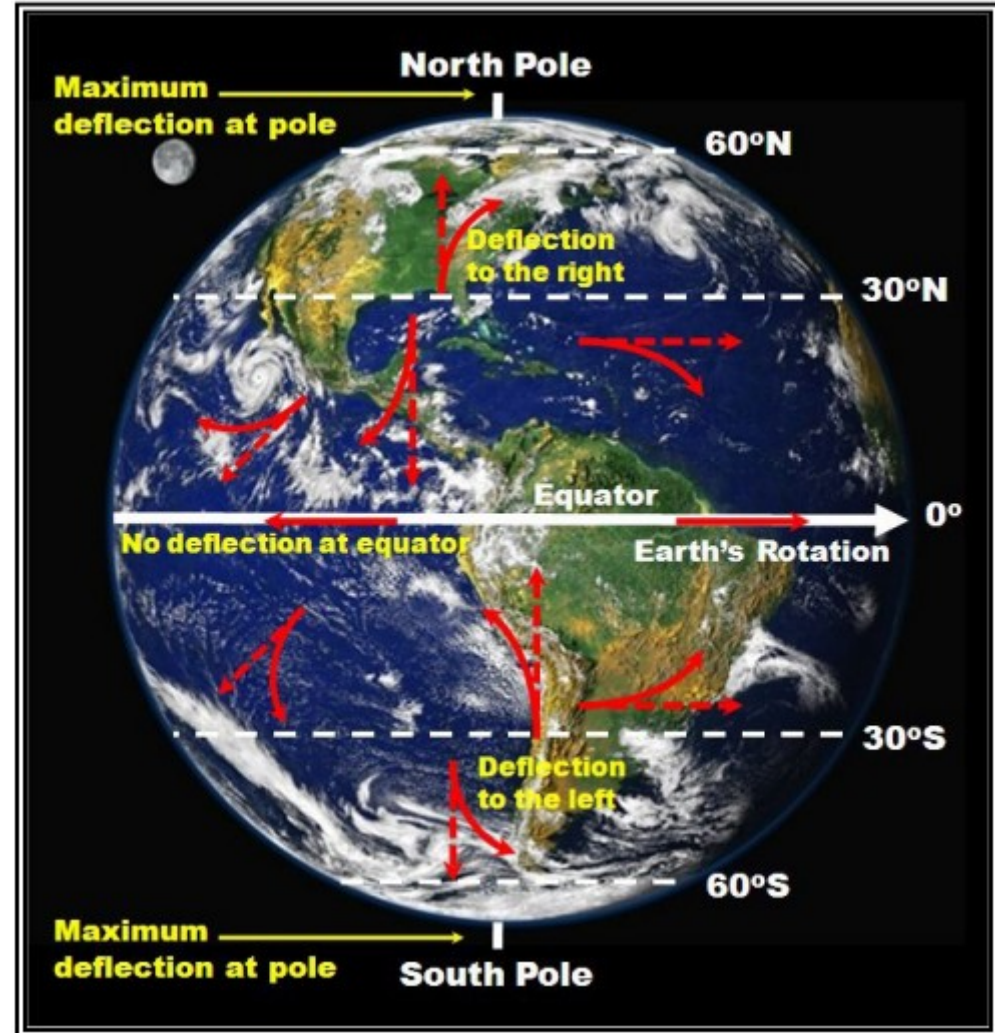
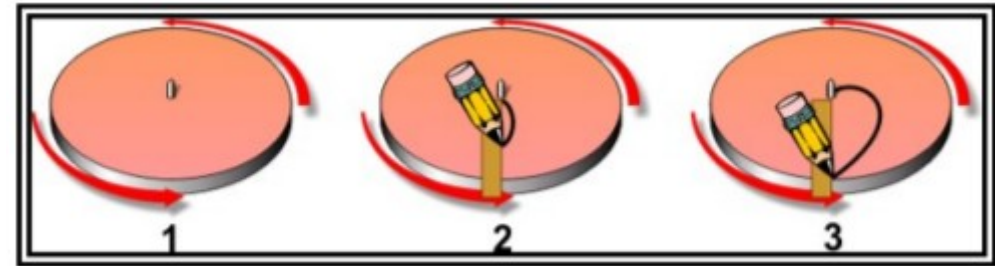
- Wind flows from high to low pressure
- Wherever a pressure difference exists, the PGF makes the wind blow to equalize the differences
- Wind speed is proportional to the PGF
- Displayed by contour gradients on pressure charts & isobar gradients on surface charts
 - Closely spaced isobars indicate strong winds



Wind

Coriolis Force

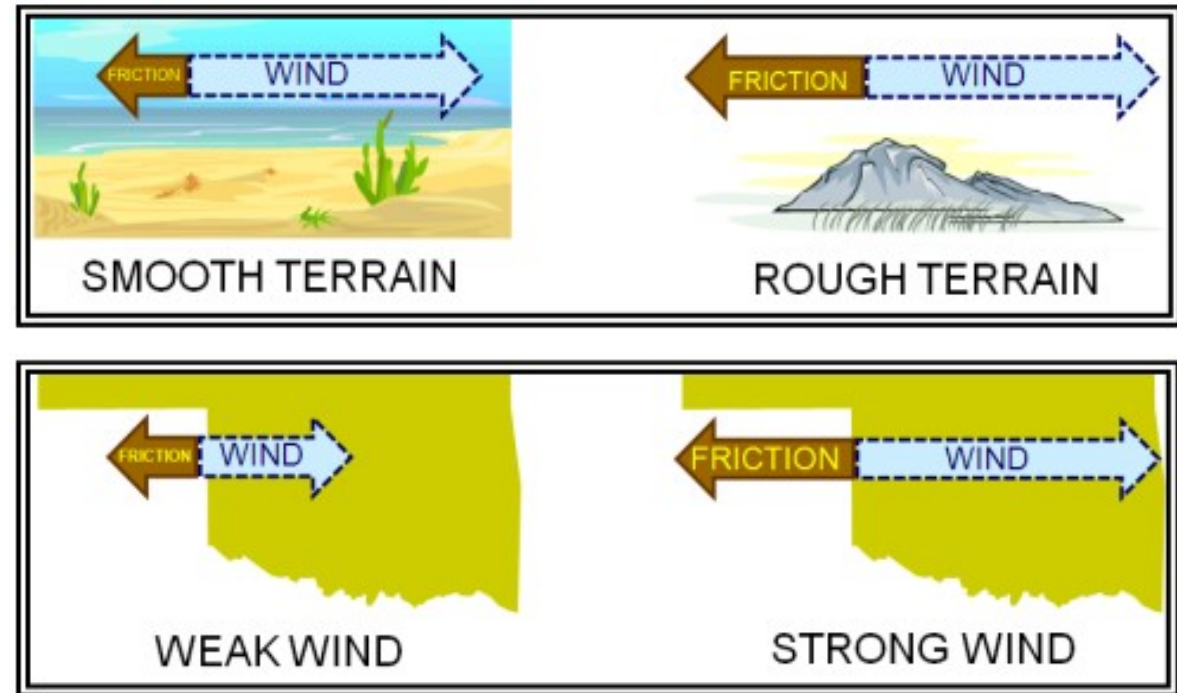
- Air is deflected to the right in the Northern Hemisphere & left in the Southern Hemisphere
- Turntable Illustration
- Acts at a right angle to wind direction
- Directly proportional to wind speed
- Varies with latitude
 - Zero at the equator & maximum at the poles



Wind

Friction

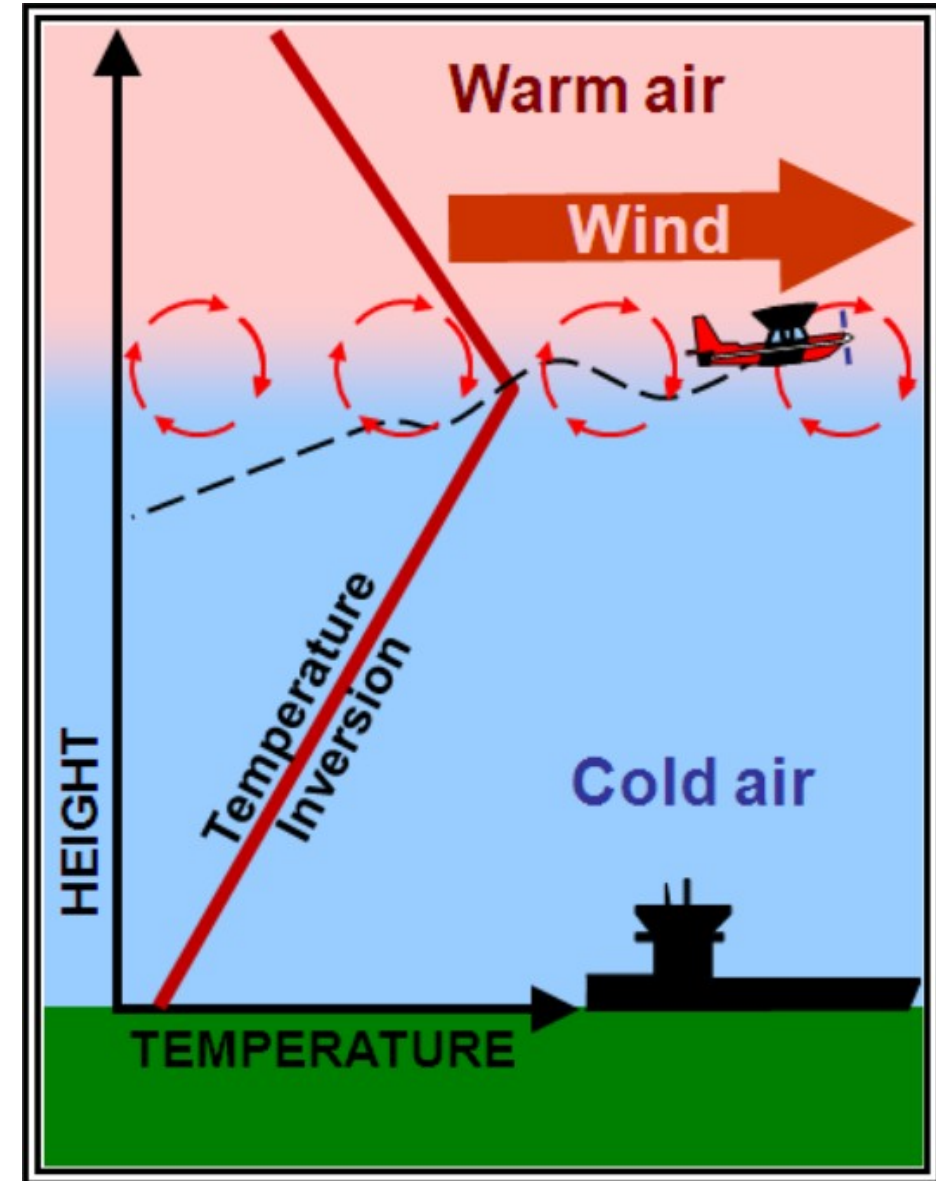
- Friction between the wind and terrain slows the wind
- Greater friction with rougher terrain and higher wind speeds
- Friction decreases with height
 - Insignificant above a few thousand feet AGL



Wind

Wind Shear

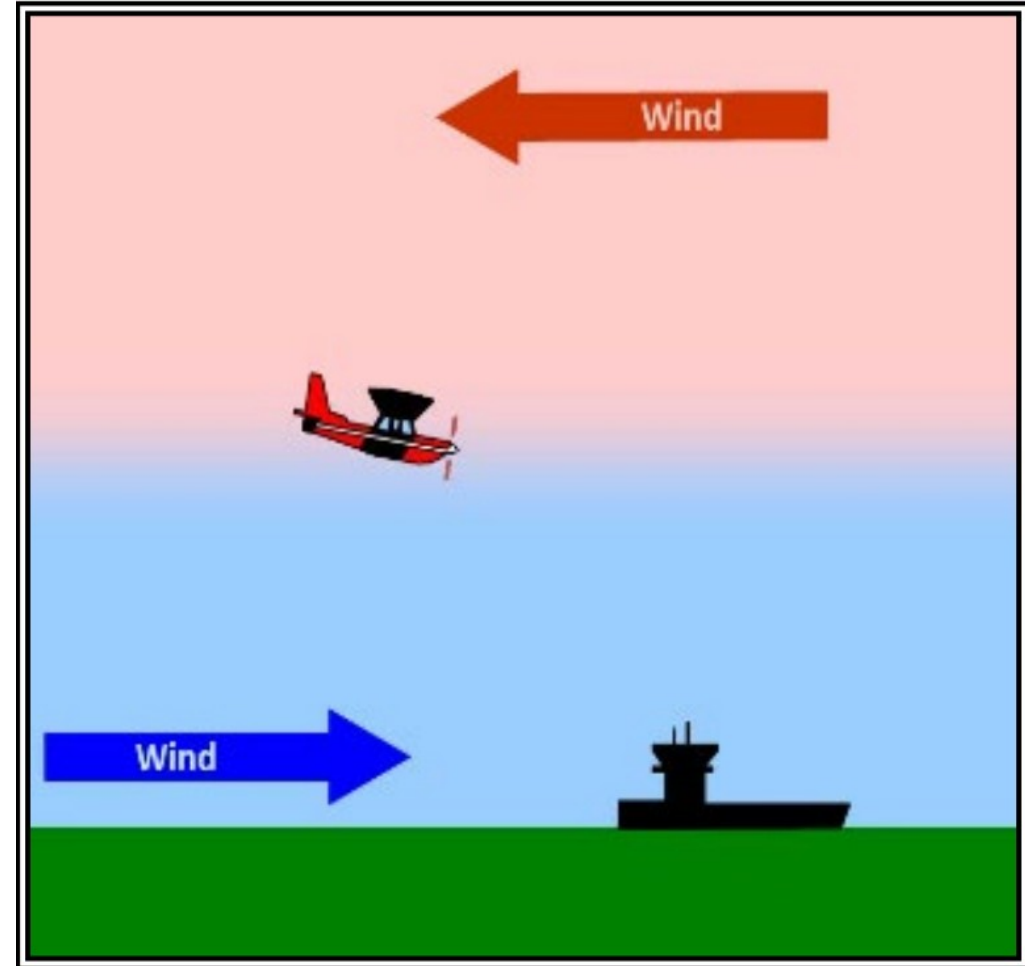
- Sudden, drastic change in wind speed and/or direction over a small area
 - Can occur at any altitude
- Low level WS is commonly associated with:
 - Passing frontal systems
 - Thunderstorms
 - Temperature inversions
 - Strong upper-level winds



Wind

Wind Shear

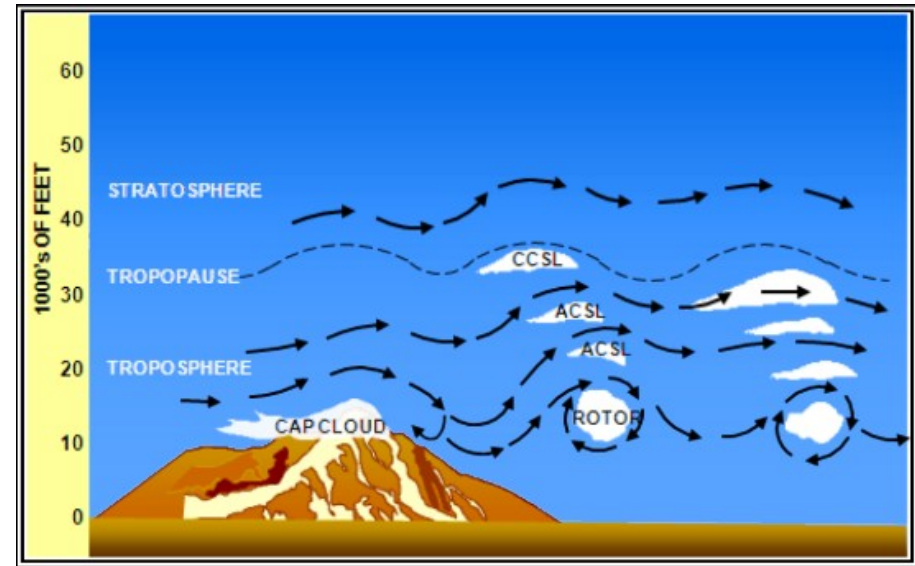
- Dangers
 - Violent updrafts/downdrafts & changes to horizontal movement
 - Rapid performance changes
 - Increasing Headwind: Performance Increases
 - Increasing Tailwind: Performance Decreases
 - Often remains undetected



Wind

Mountain Waves

- Occur when air is blown over a mountain range
 - Air hits the upwind side, creating a smooth updraft
 - Passing the crest, it becomes a turbulent downdraft
 - Turns into a wave that can last for miles
- Hazards
 - Strong downdrafts and/or turbulence on the immediate leeward side of the mountain
- Visual Indicators
 - Cap clouds, Cirrocumulus Standing Lenticular, Altocumulus Standing Lenticular, Rotor Clouds



Temperature

Heat Transfer



Represents the average kinetic energy of the molecules in matter



Radiation

Sun radiates heat to the earth



Conduction

Transfer of energy by molecular activity in contact
Heat always flows from the warmer substance to the colder



Convection

Transport of heat within a fluid
Plays a vital role in earth's atmospheric heat transfer process



Temperature

Temperature & the Earth/Atmosphere

- Water is more resistant to temperature changes than land
 - Warms/cooling slowly & helps moderate nearby temperatures
- Temperature decreases about 2° Celsius per 1,000'
 - Not always the case
 - Isothermal Layer: Temperature remains constant with height
 - Temperature Inversion: Temperature increases with altitude
 - Surface-based Inversion
 - Inversion Aloft



Moisture & Precipitation

Necessary Ingredients

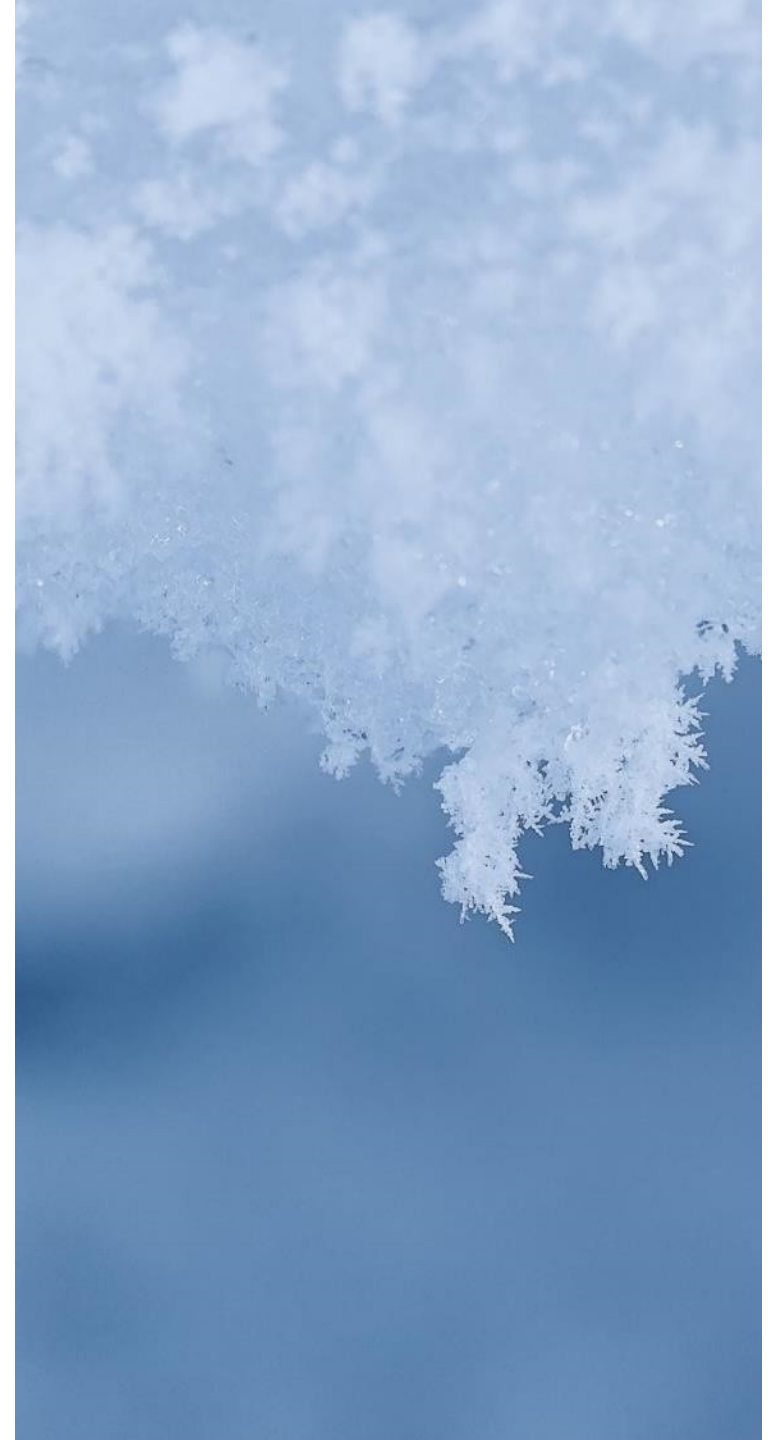
- Water Vapor
- Sufficient Lifting
 - Condenses water vapor into clouds
- Growth Process
 - Allows droplets to grow large & heavy enough to fall as precipitation
 - Collision-Coalescence: Collisions between droplets cause them to coalesce to larger droplets
 - Ice Crystal Process: Water vapor deposits directly onto ice crystals



Moisture & Precipitation

Types of Precipitation

- Rain
 - Deep layer of above freezing air at the surface
- Ice Pellets
 - Shallow layer of above freezing air aloft
 - Deep below freezing layer at the surface
- Freezing Rain
 - Deep layer of above freezing air aloft
 - Shallow below freezing layer at the surface
- Snow
 - Below freezing layer of air from top to bottom



Weather System Formation

Air Masses

- Large body of air with mostly uniform temperature & humidity
- Source Region: Area from which an air mass originates
- Classified based on temperature & moisture properties of the source region
 - Temperature: Arctic, Polar, Tropical
 - Moisture: Continental, Maritime



Weather System Formation

Air Masses

TYPES OF AIR MASSES

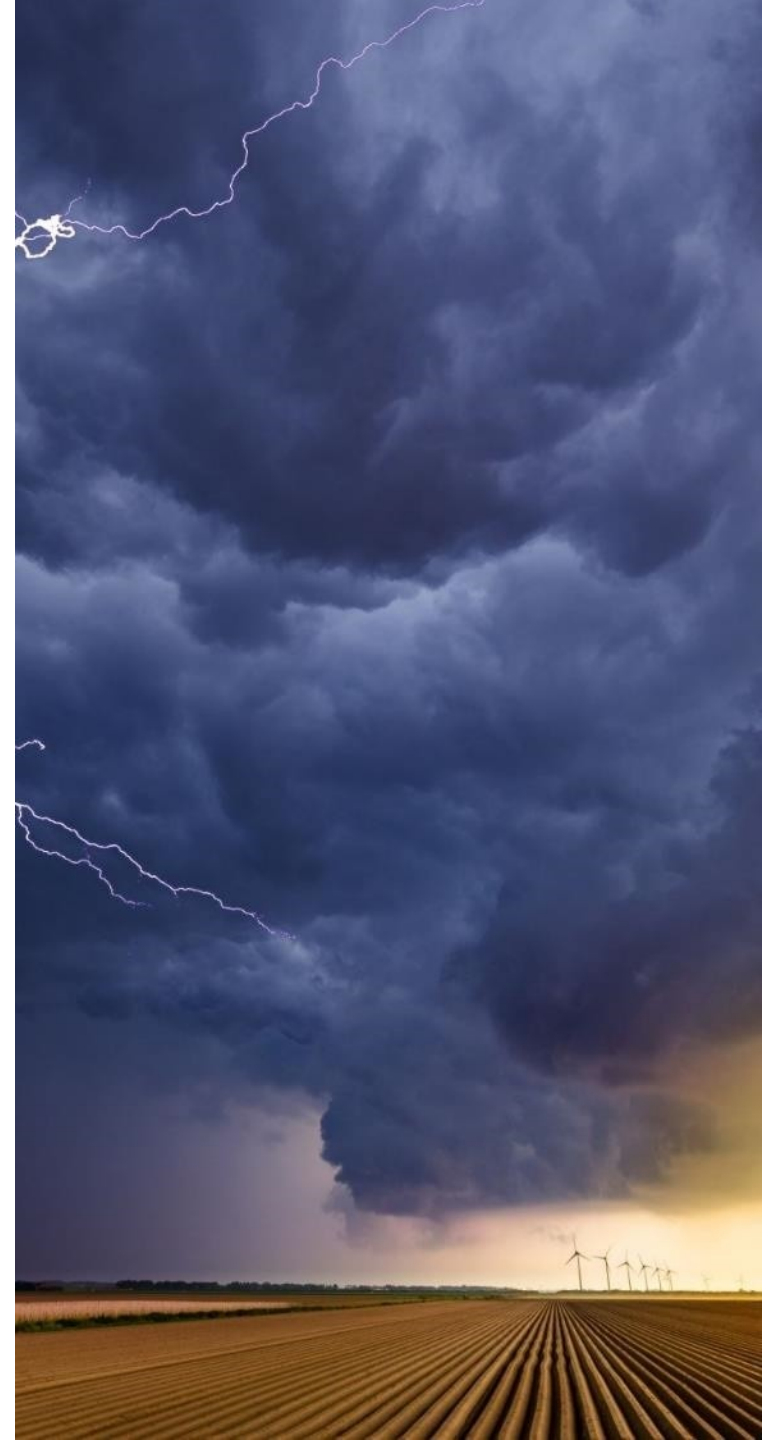
- Continental Arctic & Polar: Cold, dry
- Continental Tropical: Hot, dry
- Maritime Polar: Cool, moist
- Maritime Tropical: Warm, moist
- Maritime Arctic: Seldom, if ever, forms
- As an air mass moves around the Earth, it can acquire different attributes



Fronts

Overview

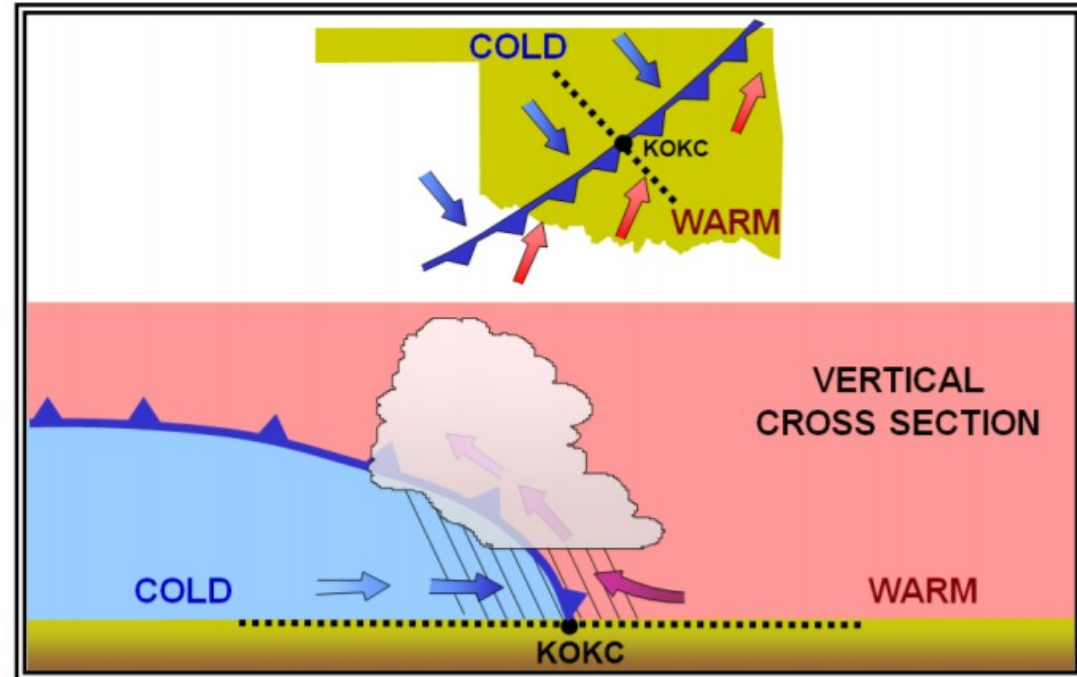
- Front: Boundary or transition between two air masses
 - Most weather occurs at the periphery of air masses, the front
 - Classified by which type of air mass is replacing the other
- Detectable in several ways:
 - Significant temperature gradients
 - Converging winds
 - Decreased pressure as the front approaches, increased pressure after it passes



Fronts

Cold Front

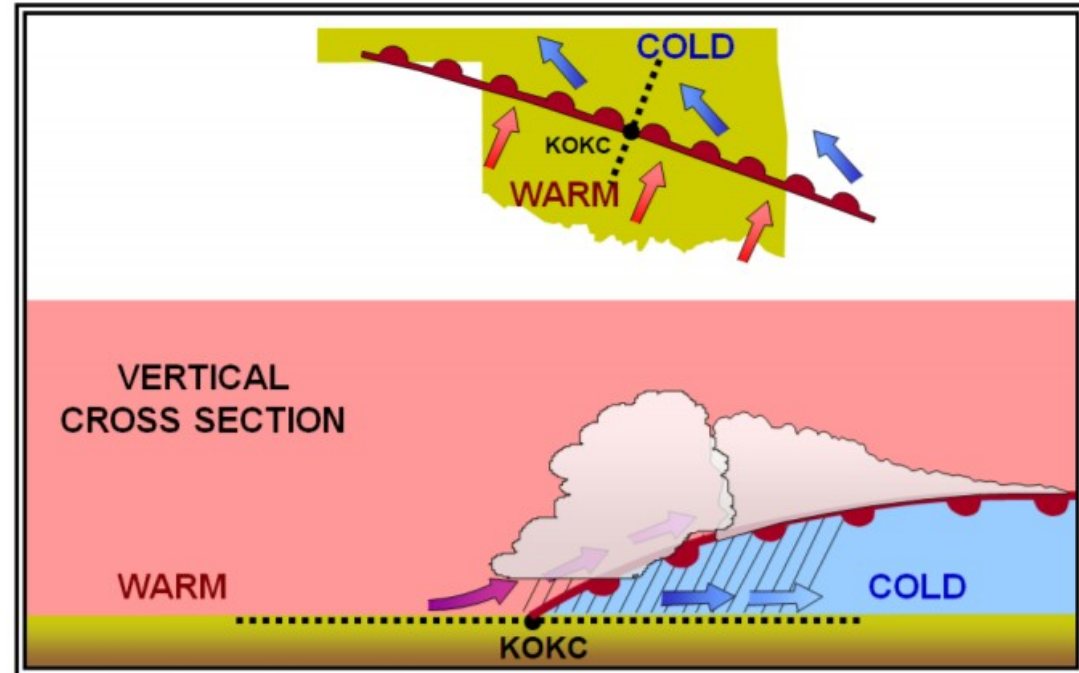
- Steep slope
- Warm air is forced up abruptly
- Unstable warm air often leads to a band of showers and thunderstorms along the front



Fronts

Warm Front

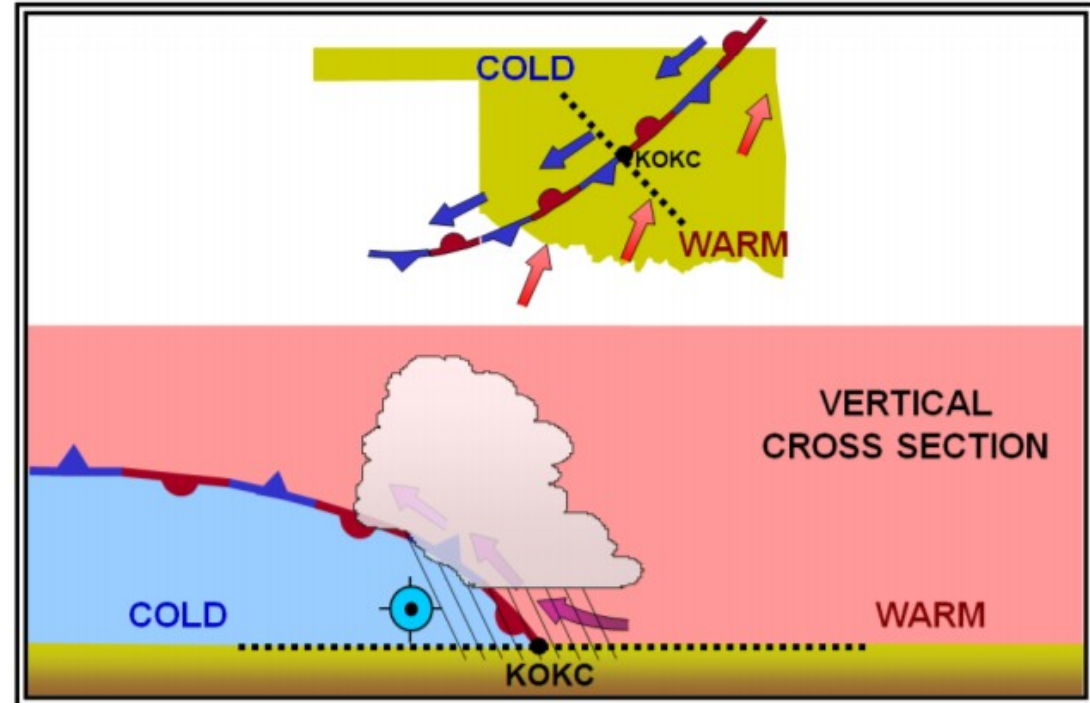
- Gentle slope
- Warm air rises gradually
- Stable warm rising air leads to widespread layered or stratiform cloudiness and precipitation along and ahead of the front



Fronts

Stationary Front

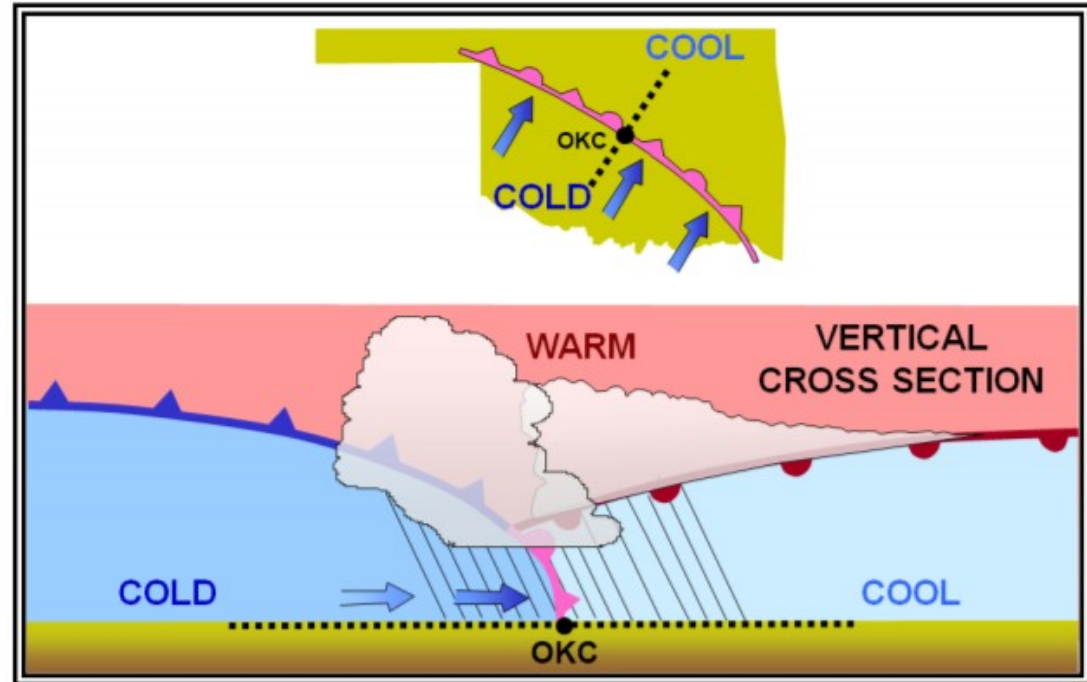
- Slopes vary
- Clouds and precipitation form in the warm rising air along the front



Fronts

Occluded Front

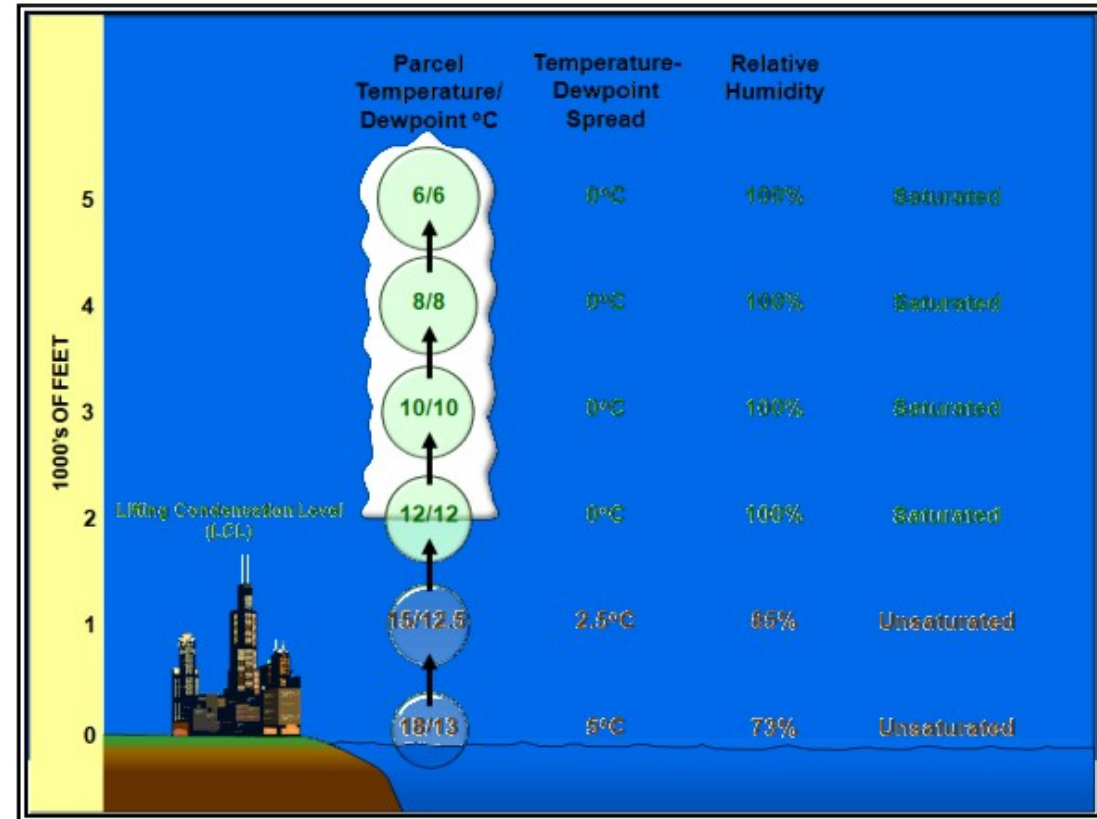
- Cold fronts typically move faster than warm fronts
 - As a cold front catches up to a warm front and they merge, an occluded front forms
- Cold air undercuts a retreating cooler air mass further lifting the already rising warm air
- Clouds and precipitation can occur in the areas of frontal lift along, ahead of, and behind the occluded front



Clouds

Vertical Motion & Cloud Formation

- Air cools as it rises
 - Temp decreases 3°C per 1,000'
 - Dry Adiabatic Lapse Rate
 - Dewpoint decreases 0.5°C per 1,000'
- Lifted Condensation Level (LCL)
 - Temp/Dewpoint spread = 0
 - Relative humidity = 100%
 - Temp decreases about 2°C per 1,000'
- As air expands and cools, vapor decreases
 - Water vapor condenses to droplets/ice crystals
 - Forms clouds



Clouds

Vertical Motion

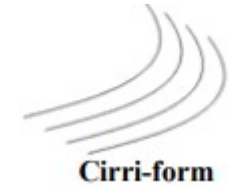
- Orographic Effects
 - Mountains & valleys causing air to ascend/descend
- Frictional Effects (Northern Hemisphere)
 - High Pressure: Surface wind spirals clockwise & outward
 - Winds diverge away, causing air to sink, compress and warm
 - Low Pressure: Surface wind spirals counter-clockwise & inward
 - Winds converge causing air to rise, expand and cool
- Frontal Lift
 - Cold, denser air wedges under warm, less dense air, forcing it up
 - Overrunning: Warm air rises up and over cold air
- Buoyancy
 - Air near the ground warms at different rates
 - Differing air densities allow warm air to rise and cold to sink



Clouds

Cloud Forms

- Cirri-form
 - High level clouds above 20,000' composed of ice crystals
 - Thin & white
- Nimbo-form
 - Latin word meaning “rain”
 - 7,000 to 15,000' with steady precipitation
- Cummuli-form
 - White, fluffy cotton balls
 - Show vertical motion in the atmosphere
- Strati-form
 - Latin for “layer” or “blanket”
 - Featureless low layer that can cover the entire sky



Cirri-form



Nimbo-form



Cumuli-form



Strati-form



Clouds

Cloud Levels

- High, Middle, Low

Level	Polar Regions	Temperate Regions	Tropical Regions
High Clouds	10,000–25,000 ft (3–8 km)	16,500–40,000 ft (5–13 km)	20,000–60,000 ft (6–18 km)
Middle Clouds	6,500–13,000 ft (2–4 km)	6,500–23,000 ft (2–7 km)	6,500–25,000 ft (2–8 km)
Low Clouds	Surface–6,500 ft (0–2 km)	Surface–6,500 ft (0–2 km)	Surface–6,500 ft (0–2 km)

- Each cloud level is divided by type of cloud



Clouds

High Clouds



CIRRUS

Ice crystal particles often trail downward in wisps called mares' tails

No significant turbulence or icing



CIRROCUMULUS

Composed of highly super cooled water droplets and/or ice crystals

Expect some turbulence and icing



CIRROSTRATUS

Primarily ice crystals. So thin and transparent that it can be hard to discern

Little, if any, icing and no turbulence



Clouds

Middle Clouds



ALTOCUMULUS

Primarily small liquid water droplets resulting in sharp outline and small internal visibility

Expect some turbulence and small amounts of icing



ALTOCUMULUS
LENTICULARIS

Formations are caused by wave motions in the atmosphere

Don't necessarily give an indication of turbulence or up/down drafts



ALTOSTRATUS

Sheet of clouds often totally covering the sky with irregularly shaped and spaced gaps and rifts

Little to no turbulence, but light to moderate icing



NIMBOSTRATUS

Composed of suspended water droplets, and falling raindrops/snow (no lighting, thunder, or hail)

Very little turbulence, but can pose serious icing issues



Clouds

Low Clouds



CUMULUS &
TOWERING CUMULUS

First stage of a thunderstorm, vertically developed with rising mounds. Showery rain

Cumulus: Little icing & some turbulence
Towering: Clear icing & strong turbulence



STRATOCUMULUS

Composed of water droplets, soft hail, even snowflakes. Virga may form below. Precipitation is rare

Expect some icing & turbulence



STRATUS

Uniform composition of widely dispersed water droplets creates a gray layer with a uniform base. Precipitation is rare

Icing can be hazardous, but little or no turbulence



CUMULONIMBUS

Exceptionally dense and vertically developed. Associated with heavy precipitation and lightning

Entire spectrum of flying hazards



Turbulence

Convective

- Results from convective currents and subsequent rising/sinking of air
- Cumuliform clouds are convective turbulence signposts
 - Expect turbulence in and beneath the clouds
 - No indication in dry air



Turbulence

Mechanical

- Caused by obstructions to wind flow
 - Trees, buildings, mountains, etc.
- Mountain Waves
 - Stable air over a mountain or ridge creating waves downwind & above the mountain



Turbulence

Wind Shear

- Rate of change in wind direction and/or speed causing turbulence
- Temperature Inversion
 - Strong wind shears often occur across inversion layers
- Clear Air Turbulence
 - High altitude turbulence in cloud-free areas with wind shear
 - Particularly between the core of a jet stream and the surrounding air



Thunderstorms

Overview

- Ingredients
 - Sufficient Water Vapor
 - Unstable Air
 - Lifting Mechanism
- Life Cycle
 - Towering Cumulus: Strong convective updraft
 - Mature: When precipitation reaches the surface
 - Descending precipitation drags air downward creating a downdraft alongside the updraft
 - Dissipating: Downdraft replaces the updraft
 - Moisture supply is cut off



Thunderstorms

Types

- Single Cell
 - One cell storm (rare)
 - Easily circumnavigated, except at night or if embedded in clouds
- Multicell
 - Cluster of cells at various stages of their life cycle
 - Difficult to circumnavigate & too high to fly over
 - Lines of thunderstorms can extend for hundreds of miles and persist for many hours
- Supercell
 - Single, quasi-steady rotating updraft persisting for an extended period
 - Very organized structure leading to especially dangerous weather



Thunderstorms

Hazards

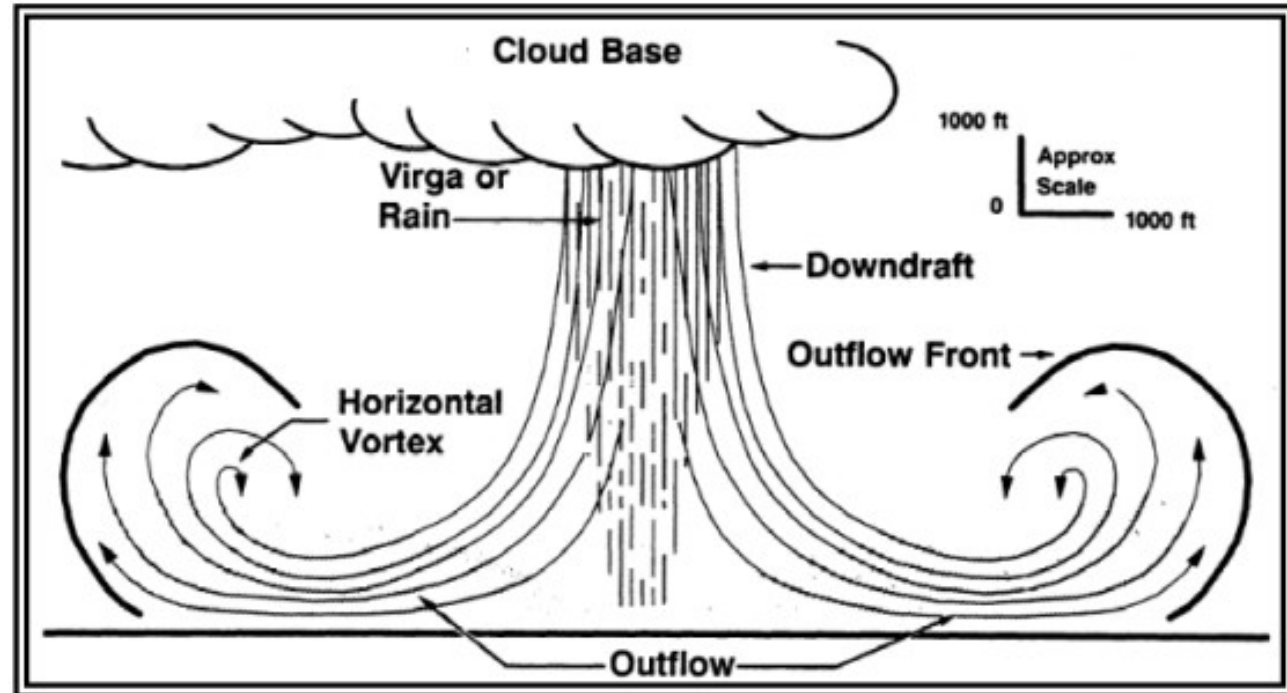
- Lighting
- Adverse Wind
- Downbursts / Microbursts
- Turbulence
- Icing
- Hail
- Rapid Altimeter Changes
- Static Electricity
- Tornados



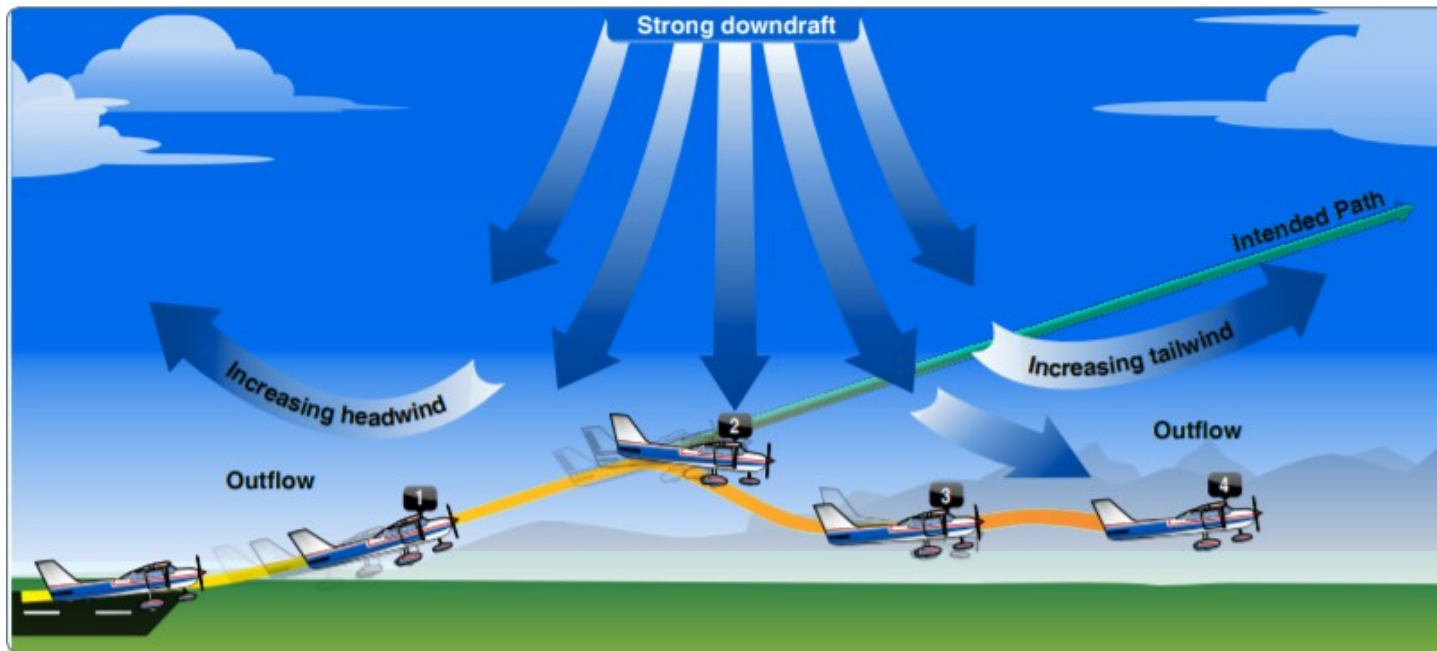
Thunderstorms

Microbursts

- Most severe type of windshear (convective)
- 1-2-mile diameter, 1,000' depth
- Lasts 5-15 minutes
- Downdrafts up to 6,000 fpm
- Headwind losses of 30-90 knots
- Very strong turbulence and hazardous changes in wind



Thunderstorms



Microbursts

- Performance increasing headwind
- Performance decreasing downdrafts
- Rapidly increasing tailwind / decreasing performance
- Potential to force the airplane to the ground



Thunderstorms

Microbursts

- Visual Indications of a Microburst
 - Convective activity (very general)
 - Intense rain shaft at the surface, but virga at the cloud base
 - Ring of blowing dust
- Windshear / Microburst Alerting Systems
 - Major airports contain alerting systems (LLWAS, TDWR, ASR-9 WSP)
 - Many smaller airports have no wind shear or microburst alerting systems
- Avoiding Windshear
 - Don't fly near or during thunderstorms or wind shear
 - Be alert for visual cues
 - PIREPs, LLWAS



Frost & Icing

Frost

- Frost = Dew in freezing temperatures
- Poses a flight safety hazard
 - Disrupts the smooth airflow over the wing, drastically reducing lift and increasing drag
- Aircraft should be thoroughly cleaned & free of frost



Frost & Icing

Icing

- Rime
 - Small, supercooled water droplets freezing as they strike the aircraft
 - Rough, milky and opaque ice
- Clear
 - Slow freezing of large super-cooled water droplets
 - A small portion of the drop freezes while the remaining smears over the surface and gradually freezes
 - Glossy, clear, or translucent ice
 - More hazardous than rime icing
- Mixed
 - Mixture of clear and rime ice



Frost & Icing

Icing Hazards

- Degrades engine performance
- Destroys smooth airflow over the wing, reducing lift & increasing drag
 - Ice as thick as sandpaper reduces lift 30% & increases drag by 40%
 - Larger amounts of ice can reduce lift & increase drag 80% or more
- Weight of ice is insignificant compared to airflow disruption
- Clear icing is more hazardous than rime icing



Frost & Icing



Freezing Level

- Be alert for icing in temperatures near or below 0° C with visible moisture
- Water carried above the freezing level becomes supercooled
 - Freezes on impact with an aircraft
 - Below -15° C, most water vapor becomes ice crystals
 - Between 0 & -15° C, abundance of large, supercooled droplets makes clear icing very rapid
 - Higher levels & colder temperatures tend to produce rime (or mixed) icing



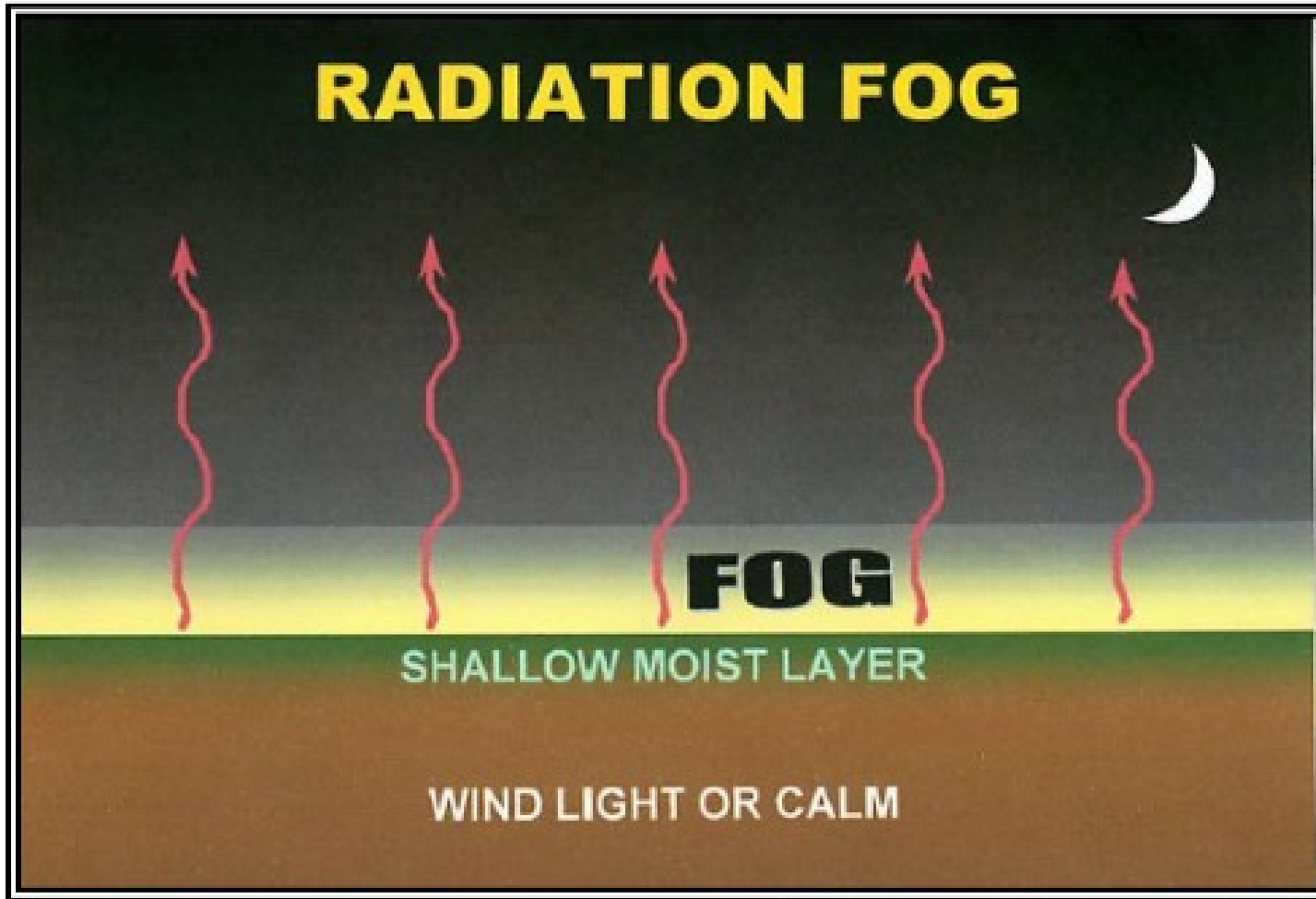
Fog & Mist

Fog

- Visible aggregate of minute water droplets at the surface reducing visibility to < 1 km
 - 5/8 statute miles
- Clouds at the surface



Fog & Mist



Radiation Fog

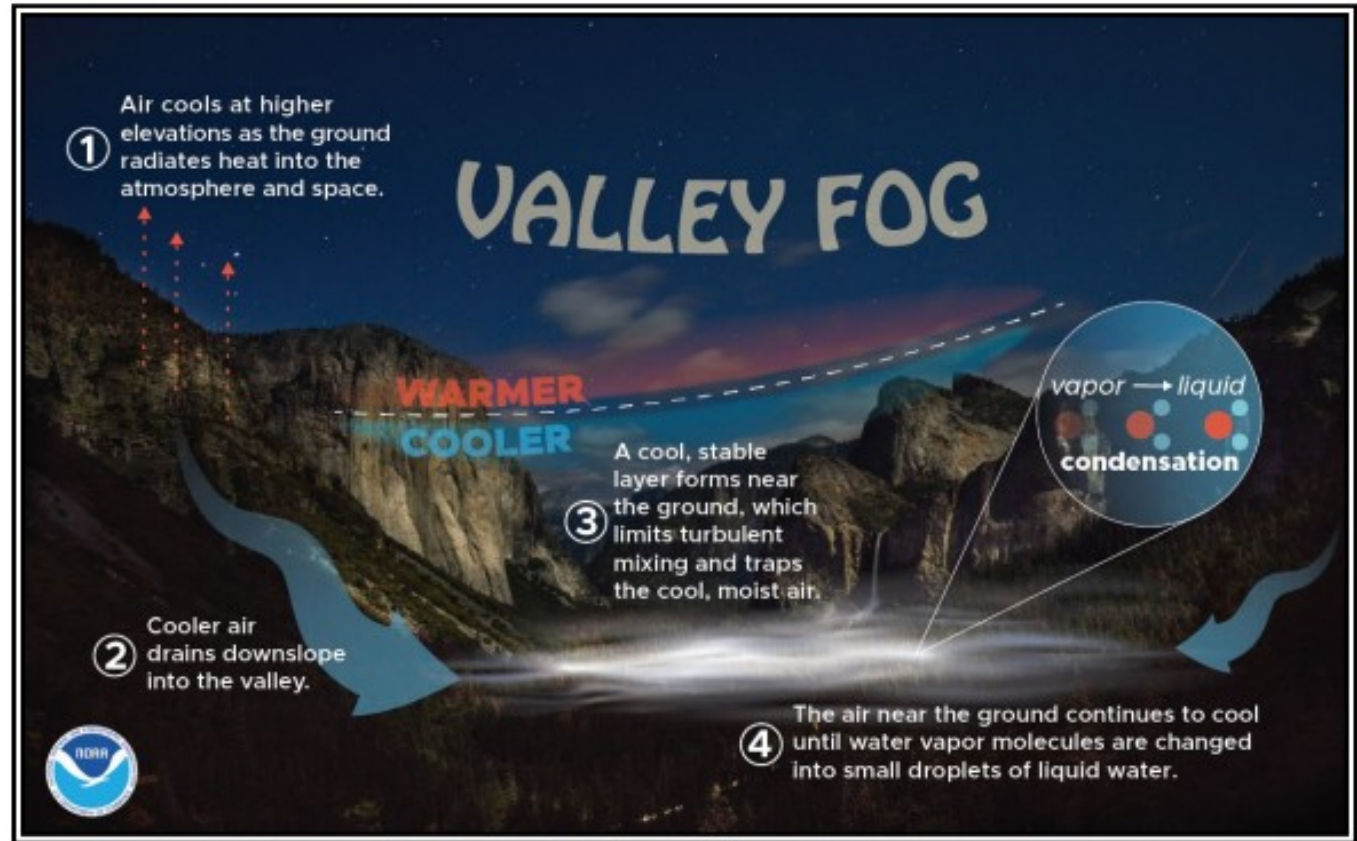
- Terrestrial radiation cools the ground, the ground cools the air, & fog forms
 - Generally, nighttime occurrence that burns off soon after sunrise
- Factors favoring Radiation Fog
 - Shallow surface layer of moist air beneath a dry layer, clear skies, and light surface winds



Fog & Mist

Mountain/Valley Fog

- Formation
 - Ground cools overnight
 - Dense, cool mountaintop air sinks into valleys
 - Valley fills from the bottom with cold layers of air
 - Cooler air lowers the temp toward the dewpoint
 - With sufficient moisture, fog forms
- Most common in fall & spring
- Densest around sunrise





Advection Fog

MOIST AIR

WIND 5-15 KT

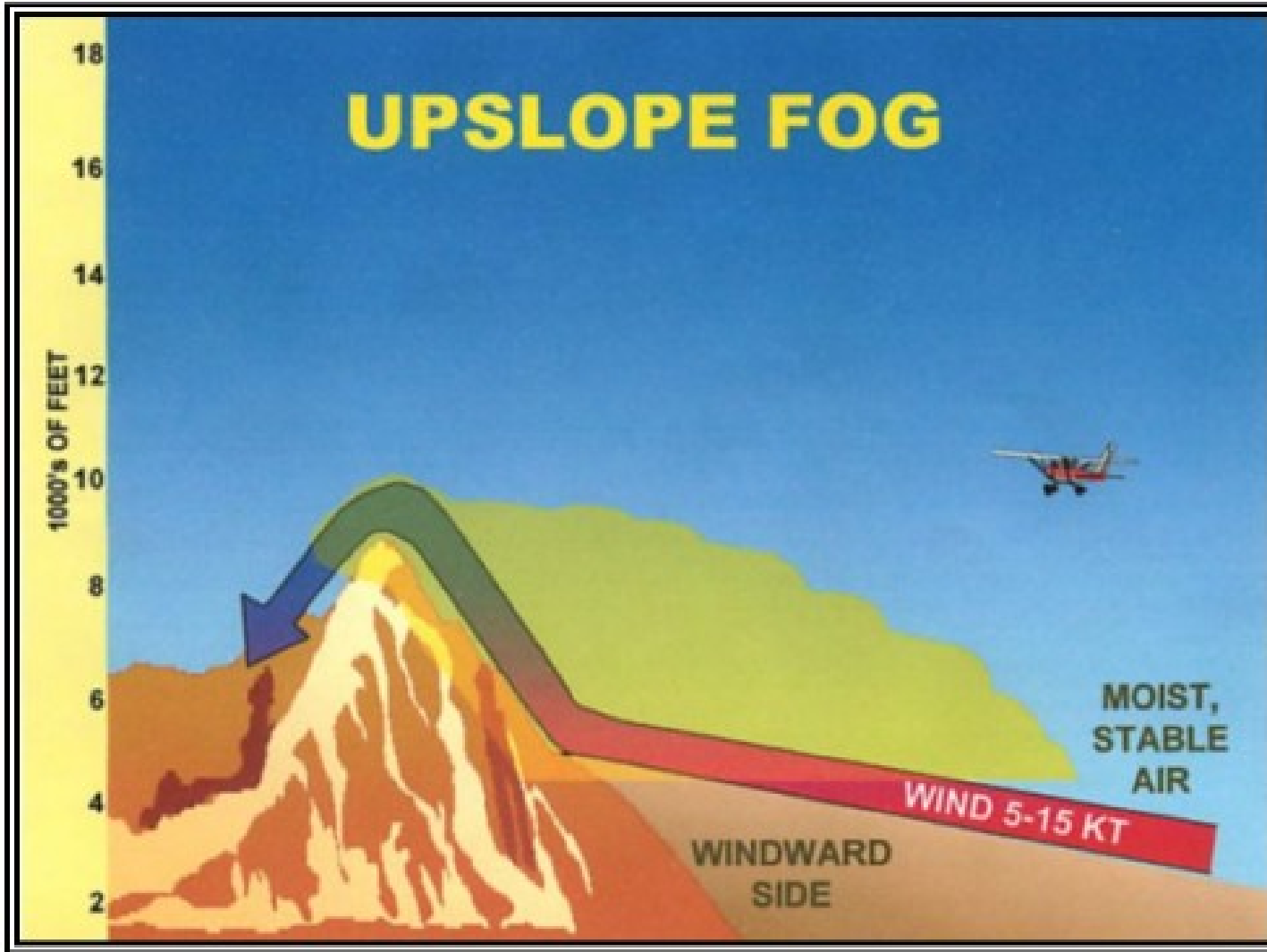
COLDER SURFACE

FOG

- Moist air moves over a colder surface, cooling it below the dewpoint
- Common along coastal areas
- Deepens with winds up to 15 knots
 - Stronger winds tend to lift the fog to low stratus or stratocumulus clouds



Fog & Mist



Upslope Fog

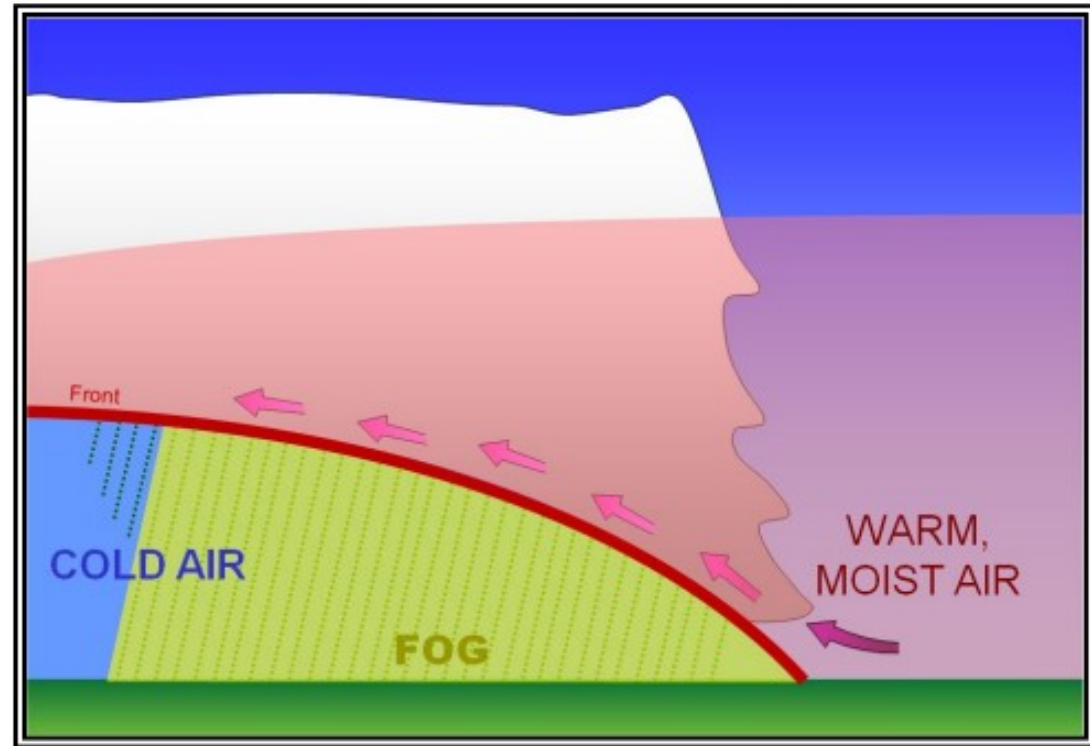
- Moist stable air cooling to the dewpoint as it moves up sloping terrain
- Winds of 5-15 knots are most favorable
 - Stronger winds tend to lead to a low layer of stratus clouds

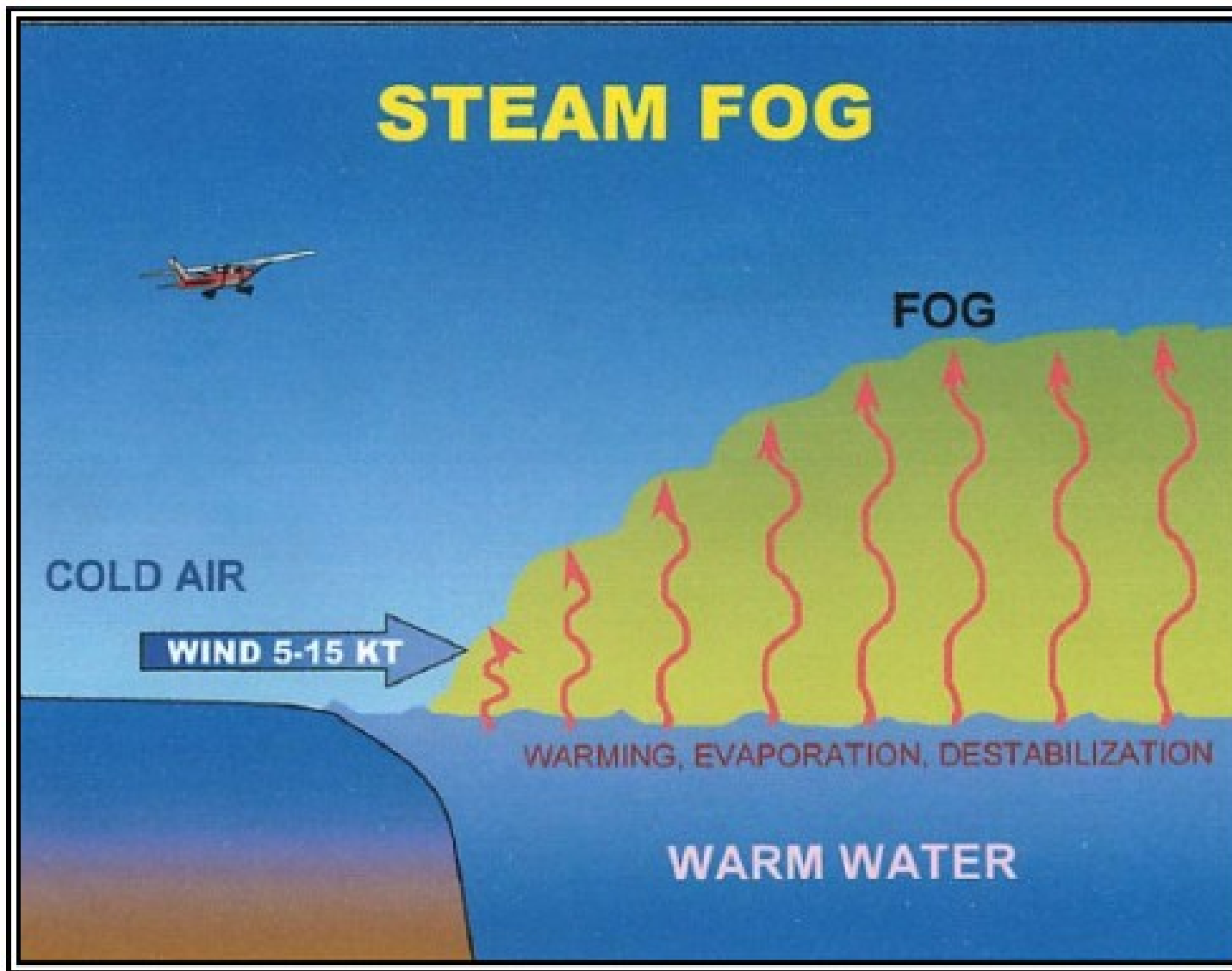


Fog & Mist

Frontal Fog

- When warm, moist air is lifted over a front, clouds & precipitation may form
- If the cold air below is near its dewpoint, evaporation may saturate the cold air and form fog
- Commonly associated with warm fronts
- Can be quite dense and continue for an extended period





Steam Fog

- Very cold air moves over relatively warm water
- Moisture evaporates saturating the air
- Rising water vapor meets the cold air and immediately recondenses
- Fog appears as rising streamers resembling steam
- Often very shallow



Fog & Mist



Steam Fog

- Tiny, supercooled liquid water droplets in fog freeze on exposed surfaces when temperatures are at/below freezing
- Can form a layer of ice on the aircraft, making flight very dangerous



Mist

- Tiny water droplets reducing visibility to < 7 SM but $\geq 5/8$ SM
- Intermediate between fog & haze

Obstructions to Visibility

Haze

- Numerous extremely small particles giving the air an opalescent appearance
- Occurs in stable air
 - Usually only a few thousand feet thick, can extend upwards of 15,000'
- Visibility varies greatly depending on if you're facing toward or away from the sun



Obstructions to Visibility

Smoke

- Suspension of small particles produced by fires, industrial burning, etc.
- Can reduce visibility to near zero
- Many highly toxic compounds (CO)
- Must be dispersed by movement of air



Obstructions to Visibility

Volcanic Ash

- Fine particles of rock powder
 - Ash is composed of silica or glass
- Ash may not be visible at night or in IMC
 - Hard to distinguish from clouds
- Very hazardous to aircraft
 - Severe engine damage is likely



Obstructions to Visibility

Blowing Snow

- Snow lifted to a height of 6' or more
- Reduces visibility to less than 7 SM
- Whiteout: Strong winds keep snow suspended up to 50', reducing visibility to zero
- Visibility improves rapidly when the wind subsides



Obstructions to Visibility

Dust Storms

- Originate in regions where fine-grained soils, rich in clay & silt, are exposed to strong winds
 - Most common in Southwest US
- Can reduce visibility to zero
- Creation & Dissipation
 - Extreme heating of barren ground + turbulent unstable air mass
 - Strong cooling after sunset settles the dust
- Hazards
 - Visibility can drop to zero in seconds
 - Dust can clog intakes, damage systems, and affect human health
 - Slant range visibility is greatly reduced compared to surface reported visibility



Obstructions to Visibility

Sandstorms & Haboobs

- Sandstorms
 - Particles of sand carried aloft by strong winds
 - Like dust storms, but more localized since the sand particles are heavier
 - 10-50' AGL
- Haboobs
 - Dust storm that forms as cold downdrafts from a thunderstorm lift dust & sand airborne
 - Often short lived, but can be intense



Importance of a Weather Briefing

- First step in determining a flight can be conducted safely & where problems may occur
- FAR 91.103
 - PIC shall become familiar with weather reports & forecasts
- Know what to expect and be alert to changing or unexpected conditions enroute
- Make an informed Go/No Go Decision



Weather Sources

- General Awareness
 - Internet, weather apps, TV, etc.
 - Used in the days leading up to a flight
- Detailed Briefing (Day of the flight)
 - FSS (1-800-WXBRIEF) - Primary source for preflight weather
 - AviationWeather.gov
 - ForeFlight
 - Self-Brief ([AIM 7-1-2-C](#) & [AC 91-92](#))
- Inflight
 - FSS (as published, or 122.2)
 - ForeFlight, or other apps
 - FIS-B (Flight Info Service Broadcast) & Satellite Weather



Weather Reports & Charts

METAR



- Aviation Routine Weather Report
- Current surface weather at an airport in a standard, international format
- Updated hourly
 - Special Weather reports (SPECI) published as necessary
- <https://aviationweather.gov/metar>



Weather Reports & Charts

METAR

METAR KBTR 161753Z 14021G26 ¾SM -RA BR BKN008 OVC012 18/17 A2970 RMK PRESFR

- **Type**
 - Routine or special (SPECI)
- **Station**
- **Date & Time**
 - First two digits are date, last 4 are UTC time
- **Modifier** (automated source or corrected)
- **Wind**
 - 3 digits for wind direction, 2 digits for speed
 - Gusting winds (G) show peak gust speed
 - V shows wind varying by more than 60 degrees
- **Visibility**
 - Statute miles
 - RVR: R, runway number, slant, visual range (feet)
- **Weather**
 - Qualifiers show intensity, proximity, or descriptors
 - -, +, VC, SH, TS, FZ, etc.
 - Phenomena describe different types of weather
 - DZ, RA, HZ, SS, DS, SN, etc.
- **Sky Condition**
 - Amount, height, type
 - 3 digits in hundreds of feet AGL
- **Temp & Dewpoint**
 - Degrees Celsius (below zero is preceded by “M”)
- **Altimeter**
 - 4 digits preceded by “A”
- **Remarks**
 - Wind data, variable visibility, pressure info, etc.



Weather Reports & Charts

METAR

- Wind
 - Reported in degrees true
 - 00000 = Calm wind
 - Winds greater than 100 knots are preceded by “P”
 - P99KT
- Sky Condition
 - Amount of sky coverage is reported in eighths of the sky from horizon to horizon



Sky Cover	< 1/8 Clear	1/8 – 2/8 Few	3/8 – 4/8 Scattered	5/8 – 7/8 Broken	8/8 Overcast
Contraction	SKC/CLR/FEW	FEW	SCT	BKN	OVC



Weather Reports & Charts

TAF



- Terminal Aerodrome Forecast
- Weather outlook for the 5 sm radius around an airport
- Valid for 24-hours
 - Updated 4 times a day (0000Z, 0600Z, 1200Z, 1800Z)
- Same descriptors and abbreviations as the METAR
- <https://aviationweather.gov/taf>



Weather Reports & Charts



TAF

- Type
 - Routine (TAF) or amended (TAF AMD)
- Station
- Date & Time
 - First two digits are date, last 4 are UTC time
- Valid Period Date & Time
 - 6 digits: First two are date, next two are the start time and last two are the end time
- Wind
 - 3 digits for wind direction, 2 digits for speed
- Visibility
 - Statute miles
 - Greater than 6 SM is shown as P6SM
- Weather
 - Same as METAR
 - NSW: No significant weather forecast
- Sky Condition
 - Same as METAR
 - Only “CB” clouds are forecast
- Change Group
 - FM: Rapid, significant change usually within an hour
 - BECMG: Gradual change over no more than 2 hours
 - TEMPO: Conditions lasting less than 1 hour
- Probability
 - % probability of thunderstorms/precipitation



Weather Reports & Charts

TAF

TAF

KPIR 111130Z 111212 15012KT P6SM BKN090

TEMPO 1214 5SM BR

FM1500 16015G25KT P6SM BKN080 OVC150
PROB40 0004 3SM TSRA BKN030CB

FM0400 1408KT P6SM SCT040 OVC080

TEMPO 0408 3SM TSRA OVC030CB
BECMG 0810 32007KT=



Weather Reports & Charts

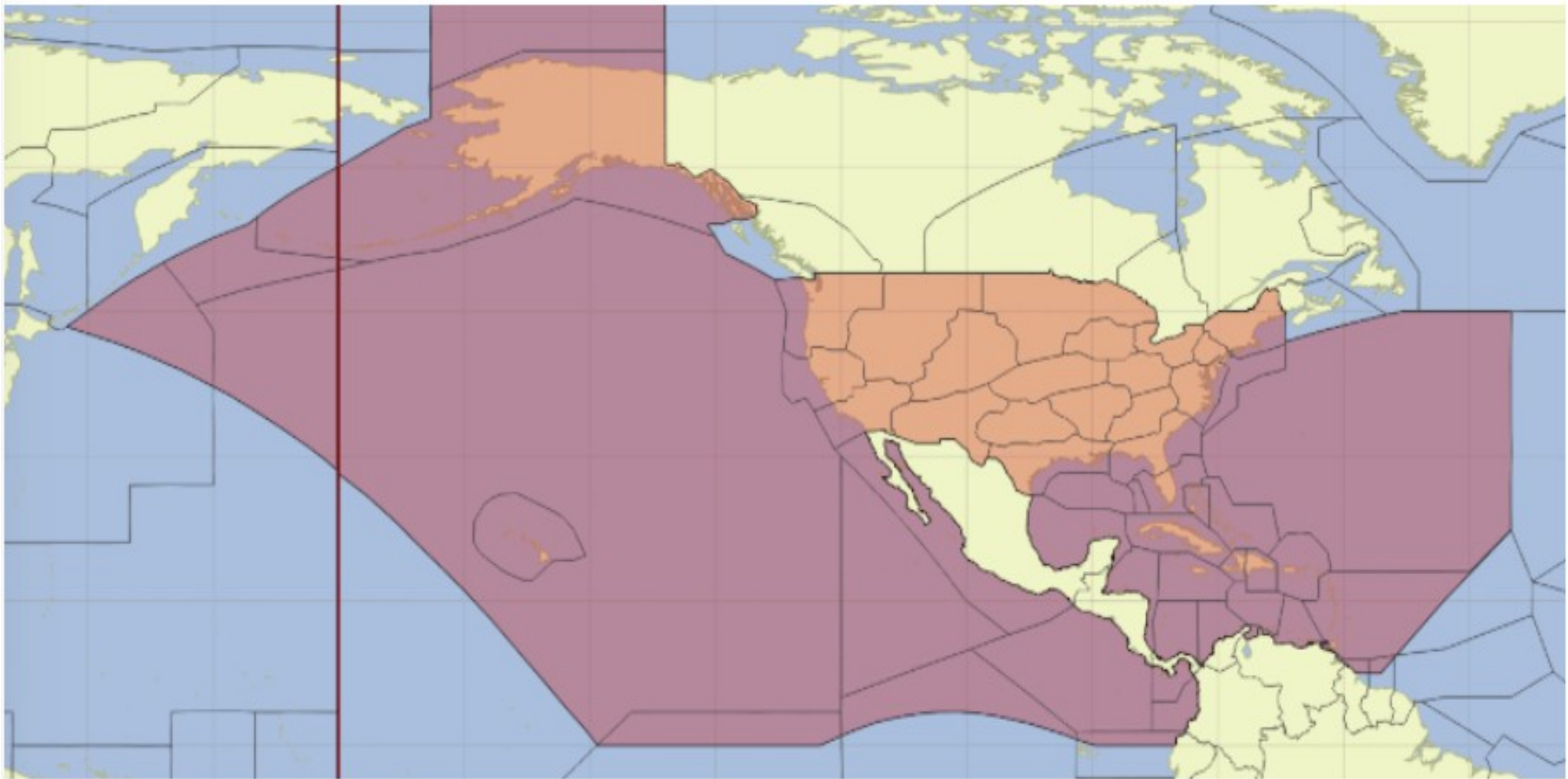
Graphical Forecast for Aviation (GFA)

- Scope
 - Set of web-based displays intended to give a complete picture of weather than may affect a flight
 - Weather systems and conditions affecting flight over relatively large areas
- Purpose
 - Forecast for the enroute phase of flight and locations without a TAF
- Description
 - Web-based displays providing observations and forecasts of safety critical weather phenomena
 - Complete weather picture of US, Alaska, Hawaii, Gulf, Caribbean, and portions of the Atlantic/Pacific
 - Observational data, forecasts & warnings – 14 hours in the past to 18 hours in the future
 - Thunderstorms, clouds, flight category, precipitation, icing, turbulence, and wind
 - Hourly models & forecasts
- <https://aviationweather.gov/gfa>



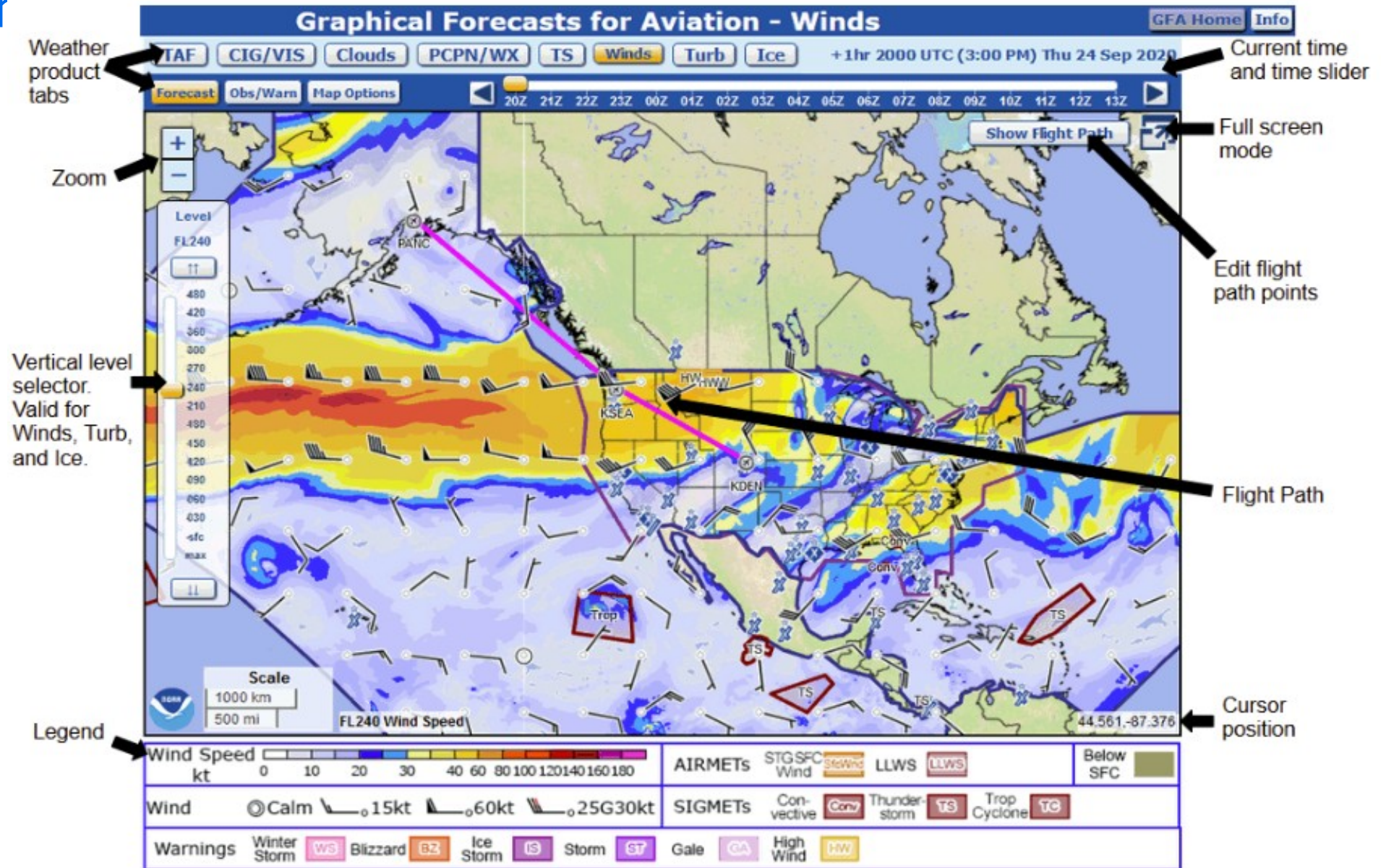
Weather Reports & Charts

Graphical Forecast for Aviation (GFA)



Weather

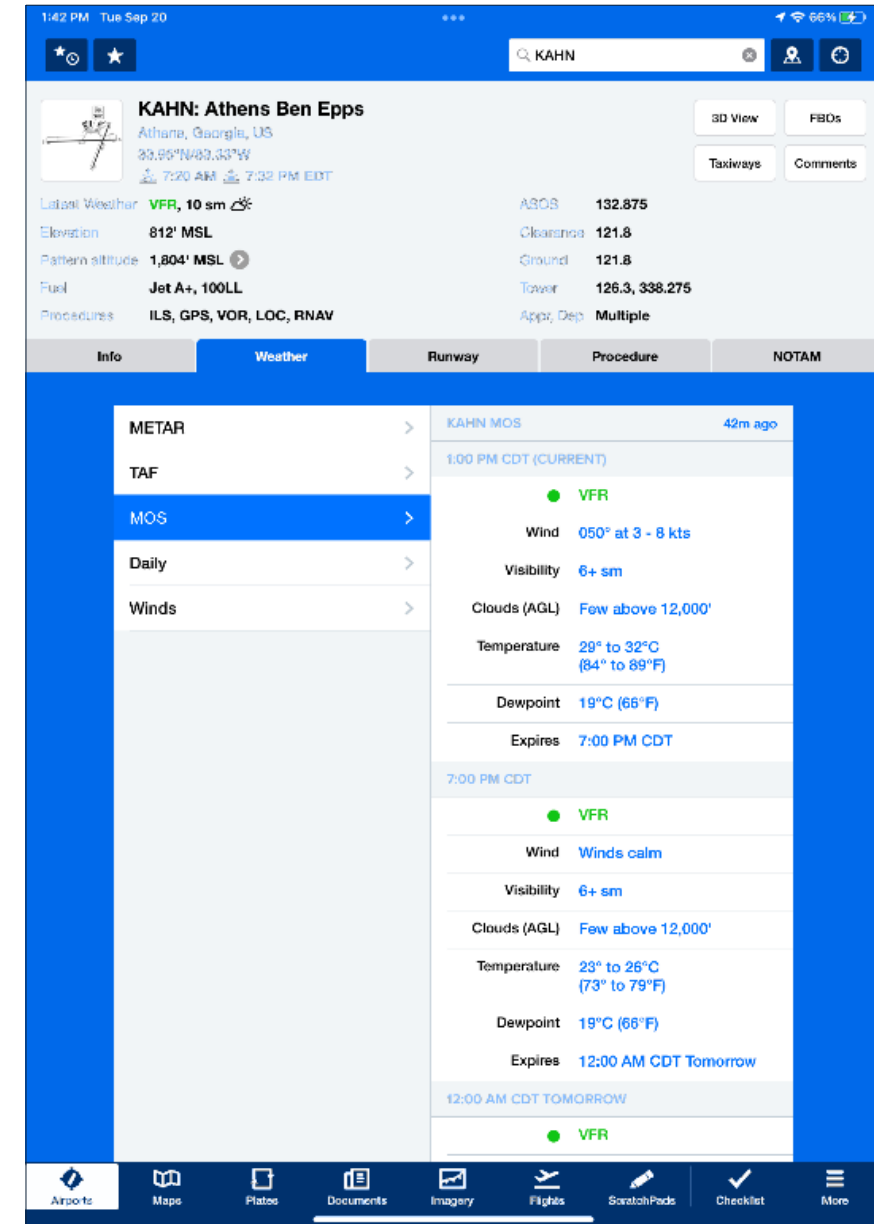
GFA



Weather Reports & Charts

Model Output Statistics (MOS)

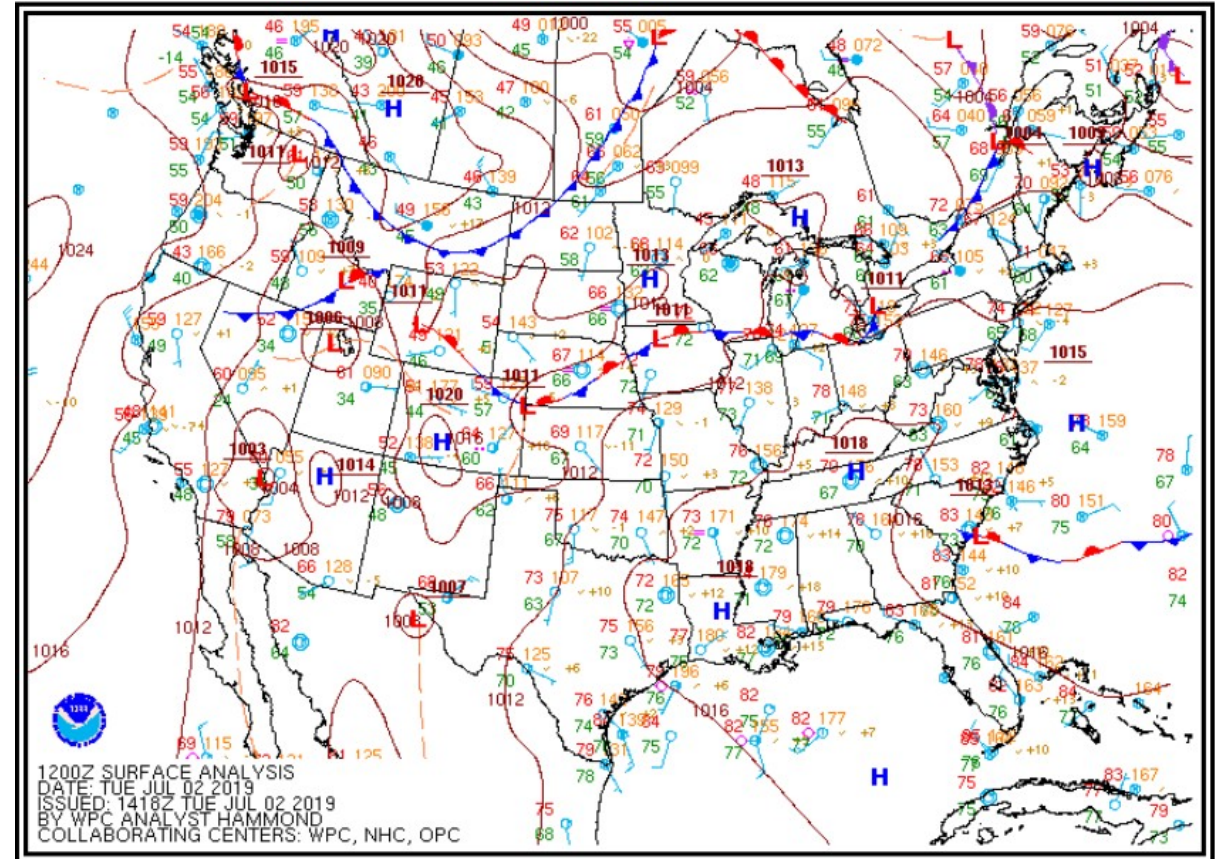
- What is it?
 - Applies statistical methods & historical observations to weather models to produce a specific point forecast
 - Completely automated
 - Temperature/dewpoint, visibility, chance & type of precipitation, cloud cover/height, wind speed/direction
- Uses
 - Improved weather reporting
 - Improved aviation weather planning
- Limitations
 - Not a legal weather source
 - Forecasting
 - Precipitation discrimination
 - US only



Weather Reports & Charts

Surface Analysis Chart

- Analysis of the surface weather covering 48 states & nearby areas
 - High/low pressure, fronts, temperatures & dewpoints, wind direction & speed, weather, and visual obstructions
- Computer prepared every 3 hours
 - (00, 03, 06, 09, 12, 15, 18, 21 UTC)
- Surface Weather Observations
 - Specific reporting points across the US are depicted with various weather information

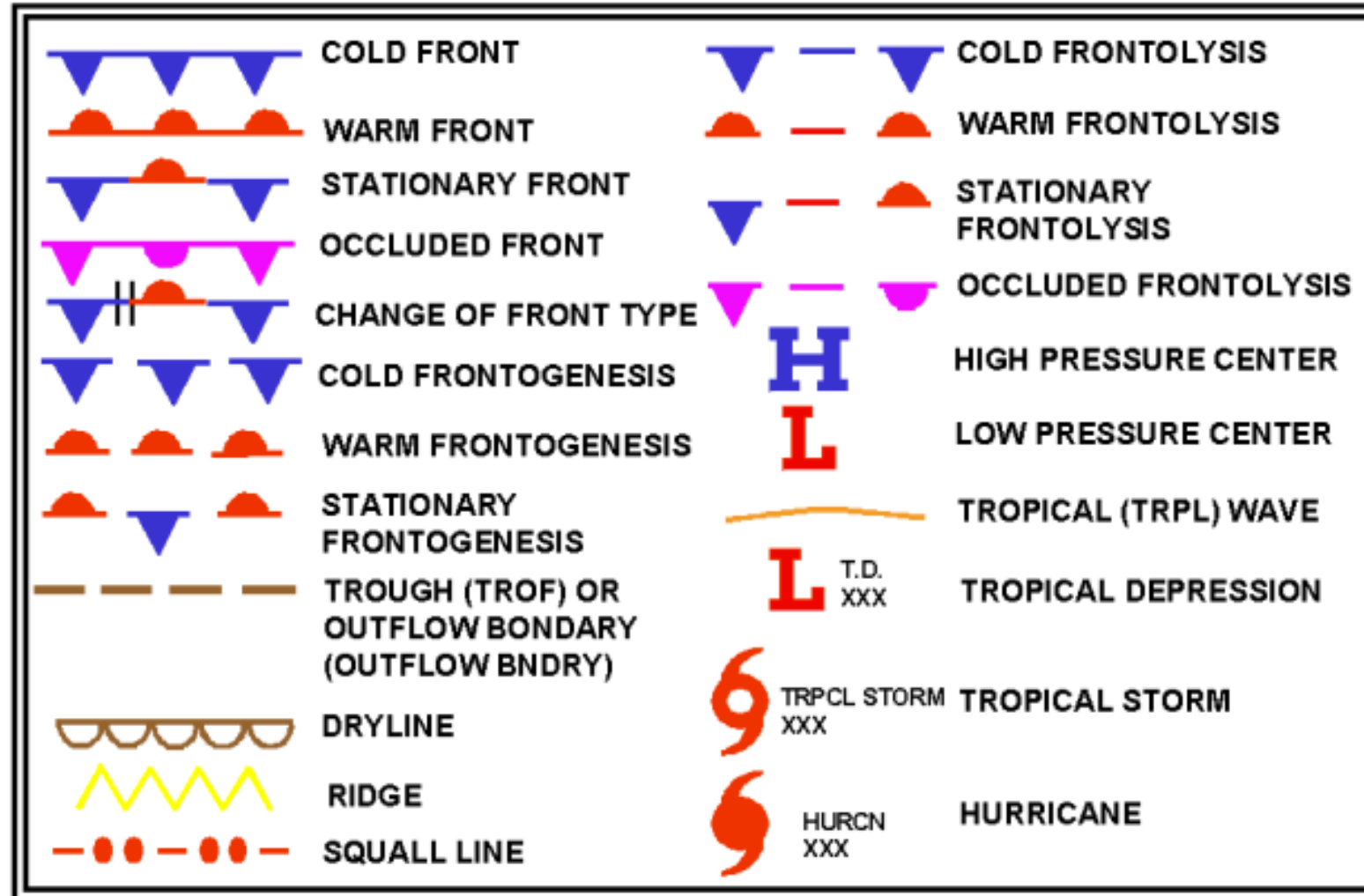


Source: AviationWeather.gov, FAA



Weather Reports & Charts

Surface Analysis Chart

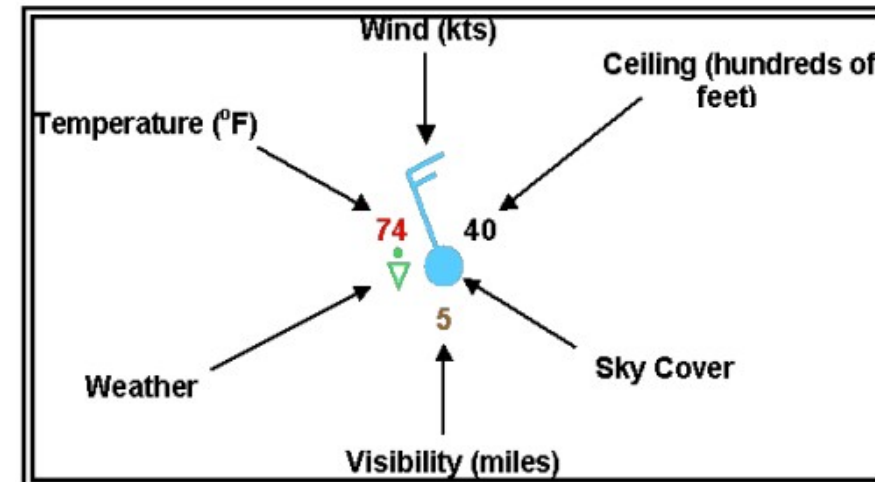
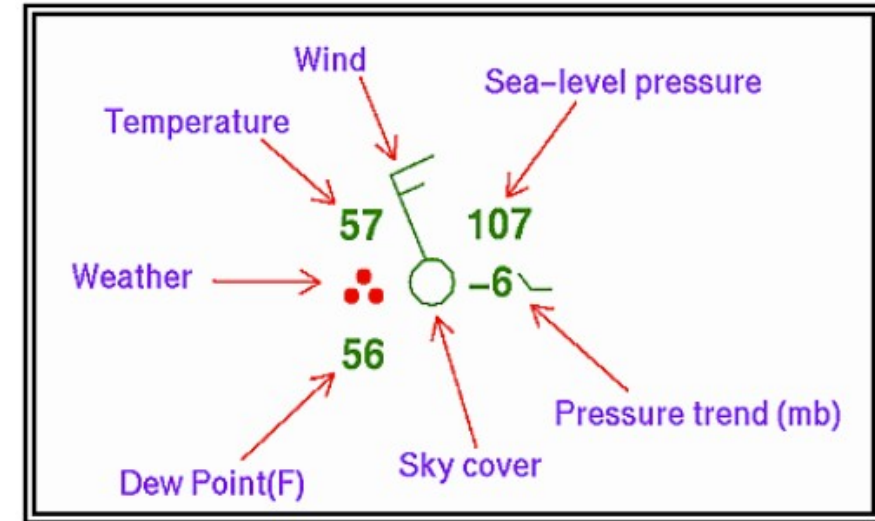


Source: Aviation Weather Handbook, FAA

Weather Reports & Charts

Surface Analysis Chart

- Surface Weather Observations
 - Aid in analyzing and interpreting surface weather
 - NWS Plot Model (top picture)
 - NWS Aviation Plot Model (bottom picture)
- Surface Weather Observation Information
 - Ceiling: Hundreds of feet AGL
 - Visibility: Whole statute miles
 - Temperature: Degrees Fahrenheit
 - Dewpoint: Degrees Fahrenheit



Source: Aviation Weather Handbook, FAA

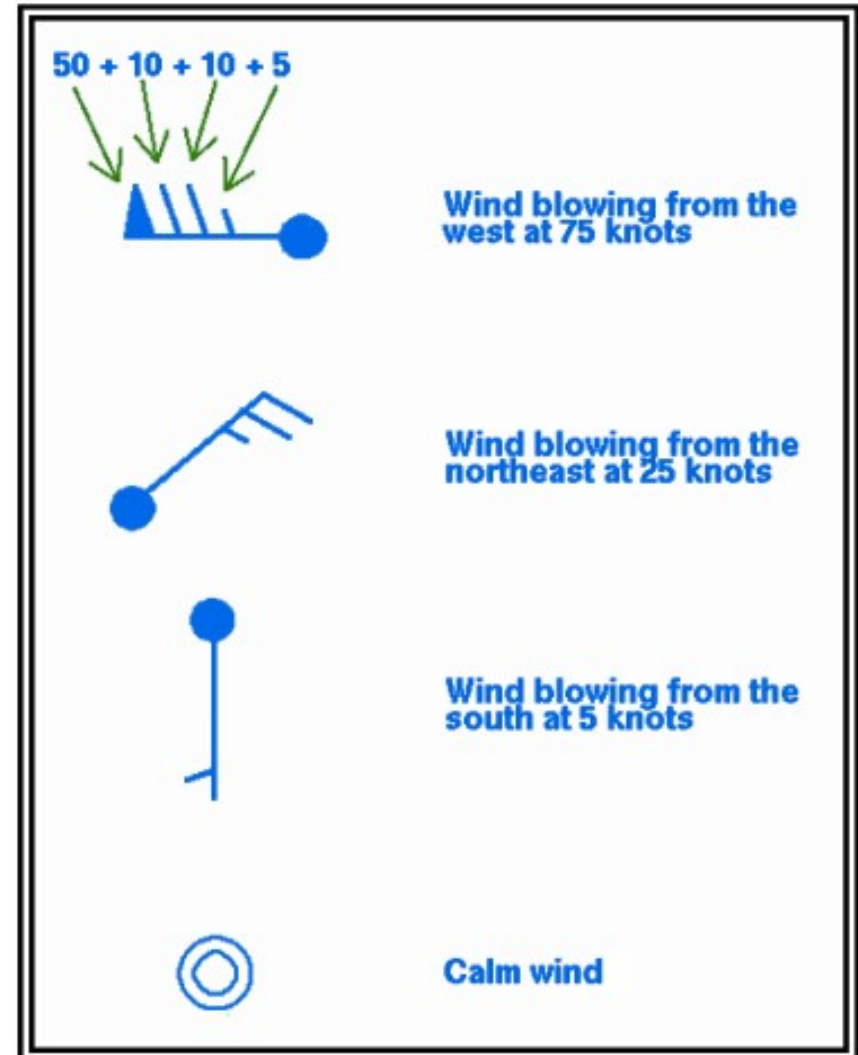


Weather Reports & Charts

Surface Analysis Chart

SURFACE WEATHER OBSERVATION INFO

- Wind
 - Plotted in increments of 5 kt.
 - Referenced to true north
 - Calm wind = only a circle over the station



Weather Reports & Charts

Surface Analysis Chart

SURFACE WEATHER OBSERVATION INFO

- Weather
 - Plotted if, at the time of observation, precipitations is occurring or there is reduced visibility

			Rain (light,moderate,heavy)
			Snow (light,moderate,heavy)
			Thunder (with rain,snow,no precipitation)
			Shower (rain,snow)
			Drizzle
			Freezing rain, Freezing drizzle
			Ice pellets/Sleet
			Fog (shallow,deep)
			Haze



Weather Reports & Charts

Surface Analysis Chart

SURFACE WEATHER OBSERVATION INFO

- Sky Cover
 - Amount the circle is filled reflects sky cover

	Clear
	Scattered clouds (approximately 25% cloud cover)
	Partly cloudy (approximately 50% cloud cover)
	Mostly cloudy (approximately 75% cloud cover)
	Overcast
	Sky Obscured
	Sky Cover Missing



Weather Reports & Charts

Surface Analysis Chart

SURFACE WEATHER OBSERVATION INFO

- Pressure
 - Plotted in tenths of millibars
- Pressure Trend
 - Number: 3-hour change in tenths of millibars
 - Symbol: Graphical illustration of change

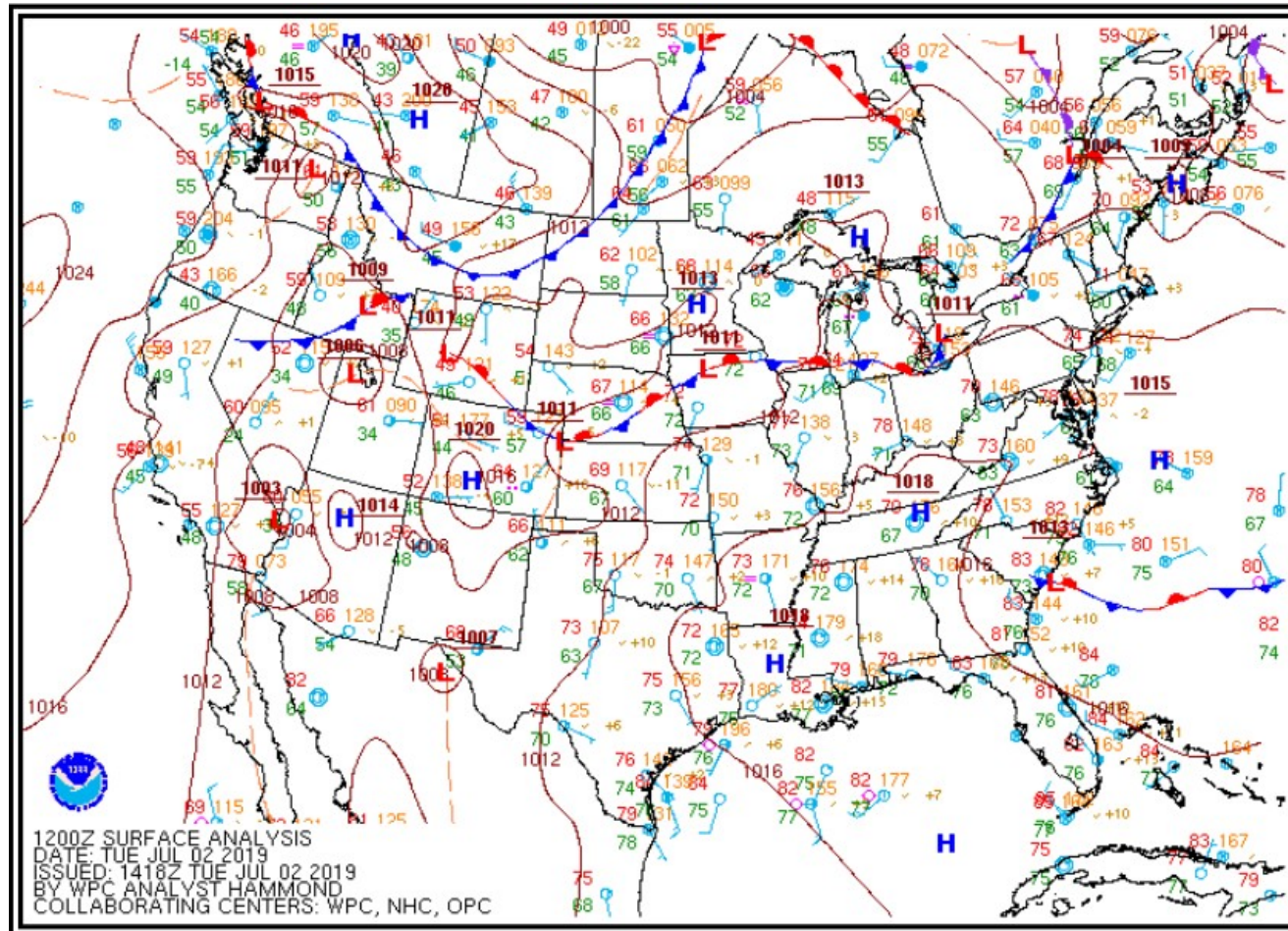


Source: Aviation Weather Handbook, FAA



Weather Reports & Charts

Surface Analysis Chart



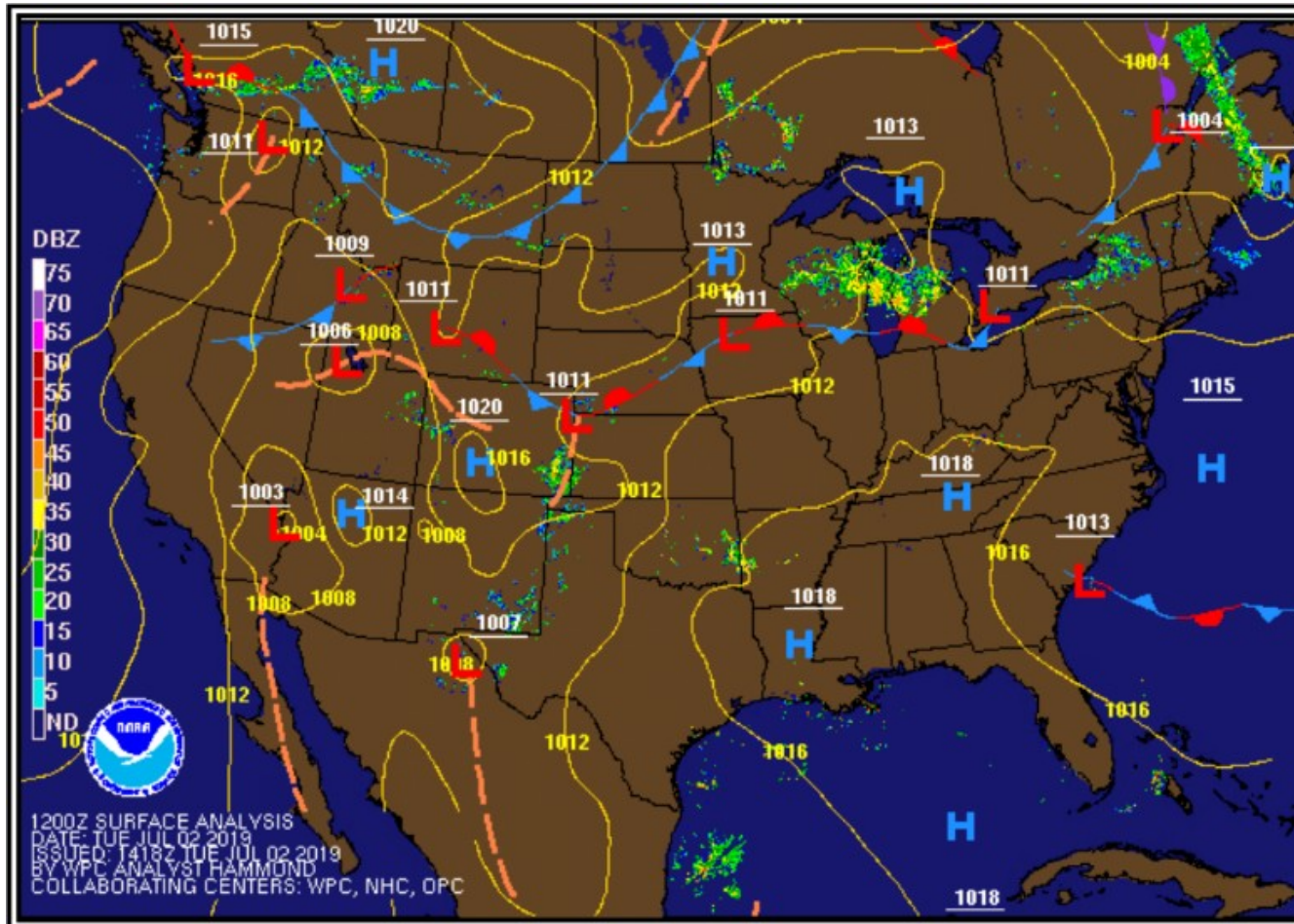
Source: Aviation Weather Handbook, FAA

Surface analysis with surface observations



Weather Reports & Charts

Surface Analysis Chart



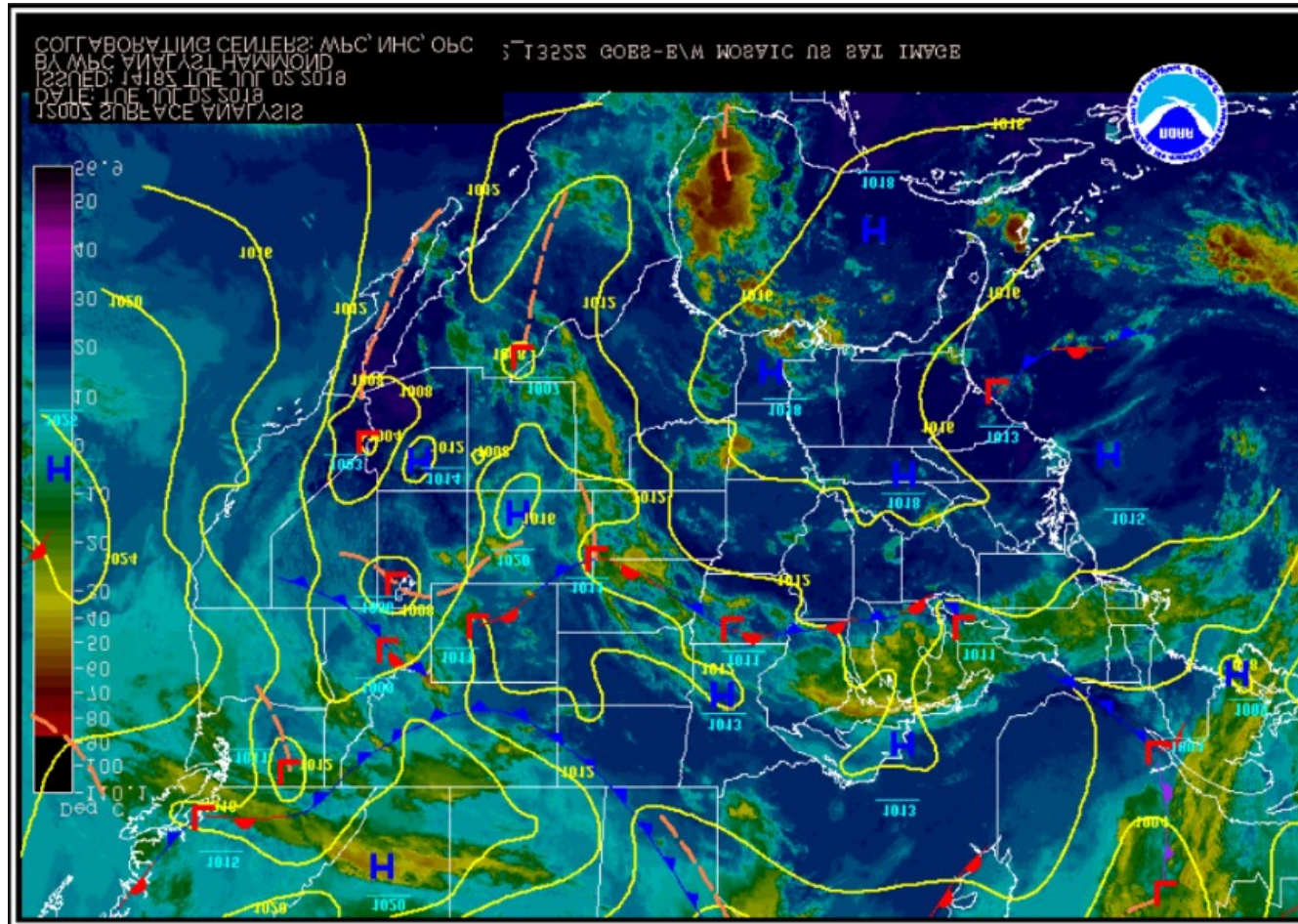
Source: Aviation Weather Handbook, FAA

Surface analysis with radar composite



Weather Reports & Charts

Surface Analysis Chart



Source: Aviation Weather Handbook, FAA

Surface analysis with satellite composite



The map displays the Eastern United States, including parts of Canada and the Caribbean. Key features include:

- Precipitation:** Blue areas indicate rain, while pink areas indicate snow. A large blue area covers the northern part of the map, and a large pink area covers the southern part.
- Cloud Cover:** Shaded blue areas represent different levels of cloud cover, with darker shades indicating higher coverage.
- Terrain:** Shaded brown areas represent different elevations, with darker shades indicating higher terrain.
- Weather Symbols:** Various symbols are used to represent different weather conditions, such as sun, clouds, and precipitation.

Legend:

- Temp:** 36, 998, 24, 33
- Wx:** 9, 36, 998, 24, 33
- Vis:** 9, 36, 998, 24, 33
- Dew:** 9, 36, 998, 24, 33
- Cloud Cover:** 9, 36, 998, 24, 33
- Weather Symbols:** Sun, Cloud, Rain, Snow, Wind, etc.
- Ceiling (ft AGL):** 100, 300, 500, 700, 1000, 2000
- Terrain:** Below, Surface
- SIGMET:** Convective, Thunder storm, Blowing Dust/Sand, Volcanic Ash
- G-AIRMET/AIRMET:** Cig/Vis (IFR)

2347U

-

Weather Reports & Charts

Winds & Temperatures Aloft Forecast

- Wind and temperature forecasts based on altitude for specific locations
 - Published twice a day (0000Z & 12000Z)
 - <https://aviationweather-cprk.ncep.noaa.gov/windtemp>
- Wind
 - Direction = True North; Speed = Knots
 - First 2 numbers are direction, second two are speed
 - 100-199 knots: Subtract 50 from wind direction, and add 100 to wind speed
 - > 200 knots: Subtract 50 from wind direction; Wind group is coded as 99
- Temperature (Celsius)
 - Temperatures > 24,000' MSL are negative

FD KWBC 151640							
BASED ON 151200Z DATA							
VALID 151800Z FOR USE 1700-2100Z							
TEMPS NEGATIVE ABV 24000							
FD	3000	6000	9000	12000	18000	24000	30000
AMA		2714	2725+00	2625-04	2531-15	2542-27	265842
DEN			2321-04	2532-08	2434-19	2441-31	235347



Weather Reports & Charts

Convective Outlook Chart

- Depicts area forecast to have severe & non-severe convection
 - Severe: Tornado, wind gusts 50 knots or greater, or hail 1" in diameter or greater
- 4 Charts covering 8 Days
 - Day 1, 2, 3, & 4-8
- General thunderstorm area + 5 levels of risk depict weather & intensity



Weather Reports & Charts

Convective Outlook Chart

Levels of Risk

- TSTM
 - Area of general thunderstorms ($\geq 10\%$ probability of storms)
- MRGL
 - Severe storms of limited organization/longevity or low coverage & marginal intensity
- SLGT
 - Severe/organized storms expected in low coverage with varying intensity



Weather Reports & Charts

Convective Outlook Chart

Levels of Risk

- ENH
 - Greater concentration with varying intensity
- MDT
 - Potential for widespread severe weather with several tornados and/or storms
- HIGH
 - Severe weather expected from tornados or long-lived derecho



Weather Reports & Charts

Convective Outlook Chart

Day 4-8 Chart

- Show 15% or 30% probability forecast
- Highlighted areas represent SLGT or ENH
- If no 15% forecast, it shows:
 - Predictability too low
 - Potential too low
- More Info
 - [Current Charts](#)
 - [Probabilities](#)



In-Flight Weather Advisories

- AIRMETs (WA)
- SIGMETs (WS)
- Convective SIGMETs (WST)
- PIREPs – Pilot generated weather report



In-flight Weather Advisories

AIRMET (WA)

- Weather information of interest to all, but specific to phenomena dangerous to light aircraft
- Types of AIRMETs (WA)
 - Sierra: IFR and mountain obscurement
 - Tango: Turbulence, strong surface winds, and low-level windshear
 - Zulu: Icing and freezing levels
- Issued every 6 hours with intermediate updates as needed
- Aviation Weather Graphical AIRMETs



In-flight Weather Advisories

SIGMET (WS)

- In flight non-convective weather advisory potentially hazardous to all aircraft
- Issued for
 - Severe icing
 - Extreme turbulence
 - Clear air turbulence
 - Dust / sandstorms (visibility < 3 miles)
 - Volcanic ash
- SIGMETs are unscheduled advisories
 - Valid for 4 hours
 - Hurricane related SIGMETs are valid for 6 hours
- Aviation Weather SIGMETs



In-Flight Weather Advisories

Convective SIGMET (WST)

- Hazardous convective weather that affects the safety of all aircraft
- Issued for:
 - Severe thunderstorms with:
 - Surface winds > 50 knots
 - Hail at the surface $\frac{3}{4}$ inch or greater in diameter
 - Tornadoes
 - Embedded thunderstorms
 - Line of thunderstorms
 - Thunderstorms with heavy or greater precipitation affecting at least 40% of an area $\geq 3,000$ square miles
- Aviation Weather SIGMETs



In-Flight Weather Advisories

Center Weather Advisories (CWA)

- Unscheduled inflight, flow control, air traffic, and air crew advisory
- Produced for weather beginning in the next 2-hours
- Issued:
 - As a supplement to existing SIGMET, Convective SIGMET, or AIRMET
 - When an inflight advisory has not been issued, but pilot reports & other conditions indicate it should be
 - When observed or developing weather doesn't meet SIGMET, Convective SIGMET, or AIRMET criteria but pilot reports indicate the weather will adversely affect the safe flow of air traffic



In-Flight Weather Advisories

PIREP

- Pilot generated weather report of phenomena encountered in flight
- Allows for real time weather reports
 - Cloud tops, icing, turbulence, temperatures, wind, etc.
- Helps fill the gaps between reporting stations
- Aviation Weather PIREPs



In-Flight Weather Advisories

PIREP

- Prepared using a prescribed format
 - Type of PIREP
 - Location of Phenomena
 - Time
 - Altitude
 - Aircraft Type
 - At least one element to describe reported phenomena

The diagram illustrates the standard PIREP format with callouts for each field:

UA /OV APE230010/TM 1516/FL085/TP BE20

- MESSAGE TYPE
- LOCATION
- TIME
- ALTITUDE/ FLIGHT LEVEL
- TYPE AIRCRAFT

/SK BKN040-TOP065/WX FV03SM BR/TA M02

- SKY CONDITION
- FLIGHT VISIBILITY AND WEATHER
- AIR TEMPERATURE

/WV 23008KT/TB LGT/IC TRACE RIME/RM TCU W

- WIND
- TURBULENCE
- ICING
- REMARKS



In-Flight Weather Advisories

PIREP

- Urgent PIREP (UUA)
 - Tornados
 - Severe/extreme turbulence
 - Severe icing
 - Hail
 - LLWS within 2,000' of the surface
 - Volcanic ash
 - Any weather considered to be hazardous
- Routine PIREP (UA)
 - Doesn't contain any urgent information

The diagram shows a PIREP form with the following fields and callouts:

- MESSAGE TYPE**: UA
- LOCATION**: /OV APE230010
- TIME**: /TM 1516
- ALTITUDE/ FLIGHT LEVEL**: /FL085
- TYPE AIRCRAFT**: /TP BE20
- SKY CONDITION**: /SK BKN040-TOP065
- FLIGHT VISIBILITY AND WEATHER**: /WX FV03SM BR/TA M02
- AIR TEMPERATURE**: /TA M02
- WIND**: /WV 23008KT
- TURBULENCE**: /TB LGT
- ICING**: /IC TRACE
- REMARKS**: RIME/RM TCU W



In-Flight Weather Advisories

Other Info

- FSS
 - Updated briefing enroute
- Onboard Weather Equipment
 - ADS-B
 - Free weather information, if your system can receive it
 - FIS-B
 - Free weather information, if your system can receive it
 - Satellite Weather
 - Be proficient in any installed weather equipment



Go / No Go Decision

- Consider weather, aircraft, equipment, as well as yourself
 - Weather briefing, charts / reports
 - PAVE Checklist
 - Consider overall and recent flight experience
- Set personal minimums and do not bend them
- Consider recent flight experience
 - Currency and, more importantly, proficiency



Go / No Go Decision

- Recognizing Weather Hazards
 - Interpretation of aviation charts & reports
 - Enroute updates and inflight reports
 - Visual indications
- Continual process of decision making
 - Flight planning, pre-flight, *and* enroute
 - Don't be afraid to discontinue the flight or divert
 - Potential No Go Conditions: Reduced visibility, hazardous weather, UUA/UA PIREPs, personal minimums, etc.



Questions?

