

Area of Operation **III** - Task **B**

Weather Information

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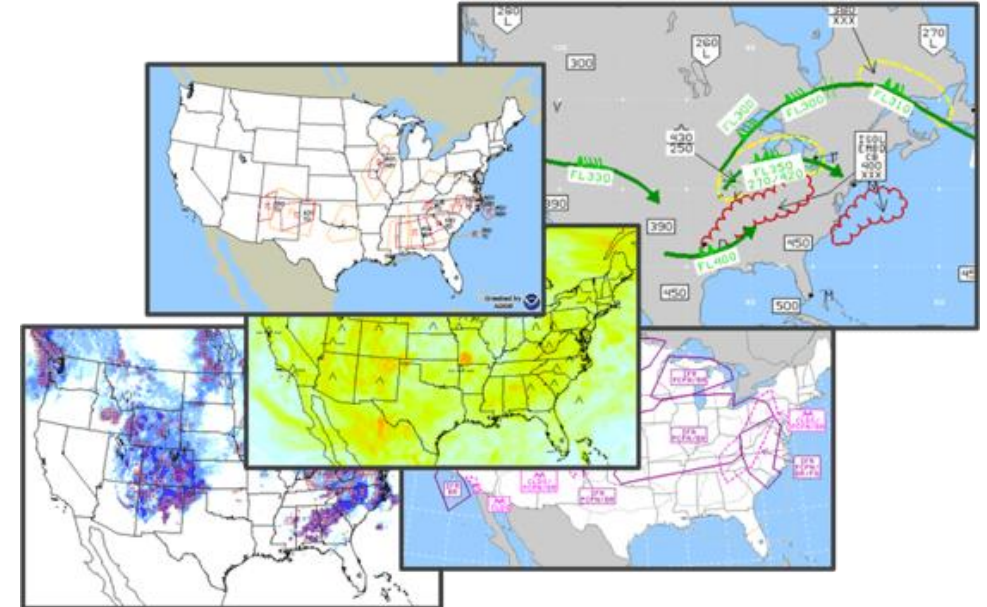


Key References:

- Pilot's Handbook of Aeronautical Knowledge
- Aviation Weather Handbook

1. Introduction

- **What:** Review products available to pilots regarding weather patterns, trends, and characteristics, provided by government agencies, weather services, independent observers and 3rd party companies
- **Why:** Reports and forecasts enable pilots to make informed decisions regarding weather and flight safety
- **Importance of a proper Weather Briefing:**
 1. Pre-flight Action ([FAR 91.103](#)) → Requires PIC to review weather reports and forecasts (all info concerning the flight)
 2. Know what to expect and be alert to changing or unexpected conditions enroute
- **Make an Informed “Go / No-Go” Decision:**
 - Consider Weather, Aircraft and Equipment to be used and yourself
 - Weather briefing, charts, reports, PIREPs
 - PAVE and IMSAFE Checklists
 - **Set personal limits**
 - Continual process of decision making while enroute
 - Don't be afraid to discontinue the flight or divert

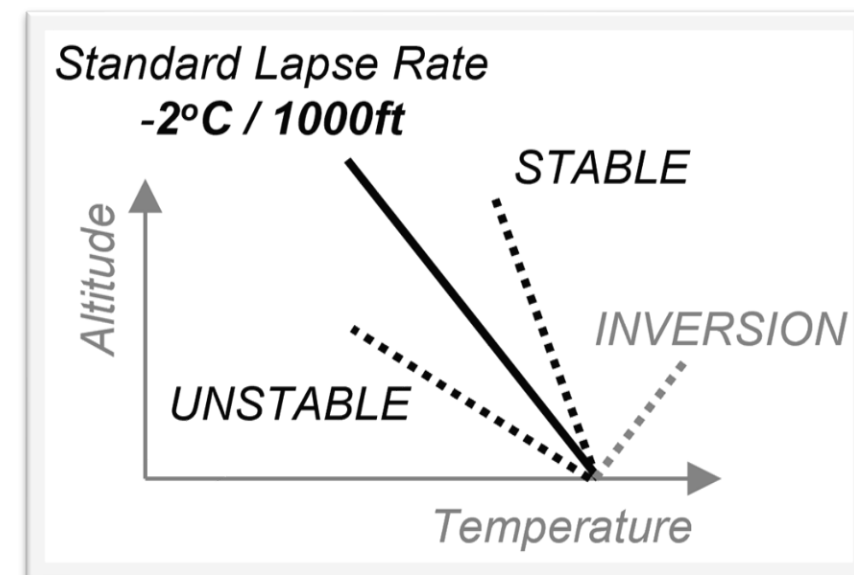


2. Weather Theory

- **Winds:** caused by the uneven heat of the surface of the earth by the sun
- **Standard Atmosphere and other Definitions**
 - Standard Temperature: 59°F or 15°C
 - Standard Pressure: 29.92 inHg or 1013.2 mb
 - Drop per 1000ft altitude → Temperature 2° C, Pressure 1 inHg
 - Valid up to the Tropopause (divides the Troposphere and Stratosphere), which is 20,000ft over the poles, 60,000ft above the equator
- **Stability of the Atmosphere**
 - Stable: lapse-rate lower than standard
Associated w/ low clouds and smooth air
 - Unstable: temperature drops rapidly (faster than standard)
Associated w/ cumulus clouds and bumpy air

Example:

Alt. (MSL)	Standard	Stable	Unstable
9,000 ft	-3°C (ISA+0)	-3°C (ISA+0)	-3°C (ISA+0)
12,000 ft	-9°C (ISA+0)	-6°C (ISA+3)	-12°C (ISA-3)
15,000 ft	-15°C (ISA+0)	-9°C (ISA+6)	-21°C (ISA-6)

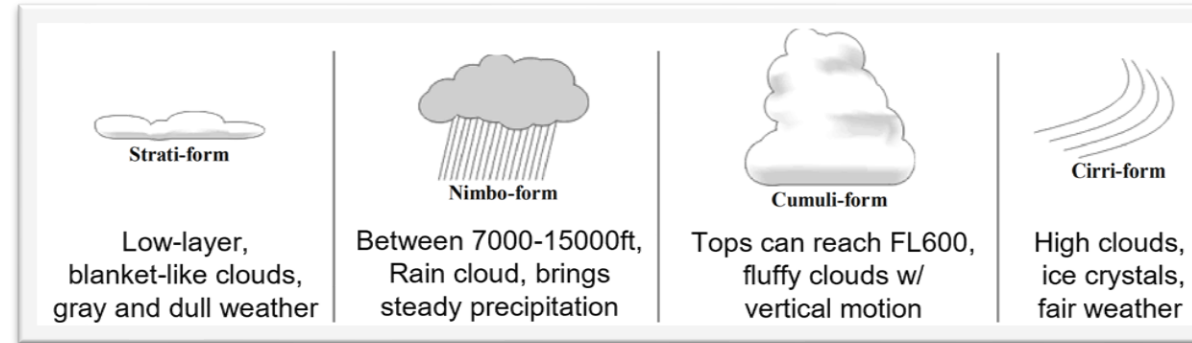


2. Weather Theory

• Types of Clouds

- High (16,500ft-40,000ft)
- Middle (6,500ft-23,000ft)
- Low (<6,500ft)

Cloud
Forms

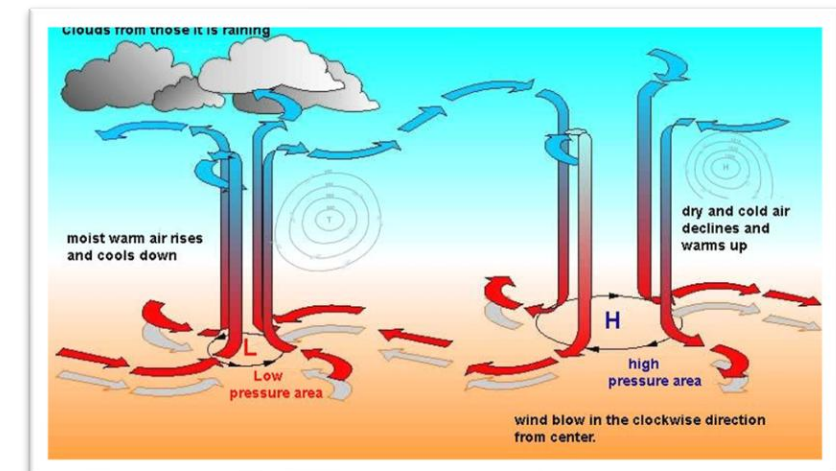
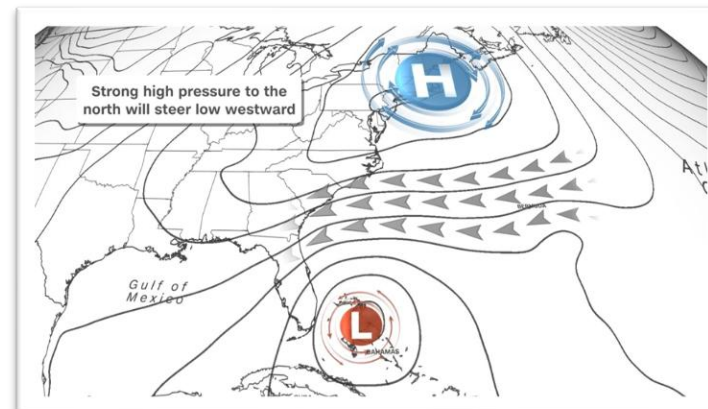


• Pressure Systems

- High Pressure: Pushes air into the surface (downwards and outwards) → Dry clear and good weather **H**
- Low Pressure: Sucks air out of the surface (inwards and upwards) → Rainy/stormy and bad weather **L**
- Trough (trof): An elongated area of relatively low pressure — — —
- Ridge: An elongated area of relatively high pressure ~~~~~

Winds aloft flow parallel to isobars

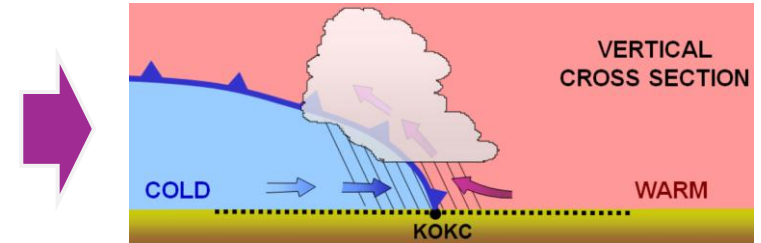
(the closer to the surface, the less parallel because of surface friction)



2. Weather Theory

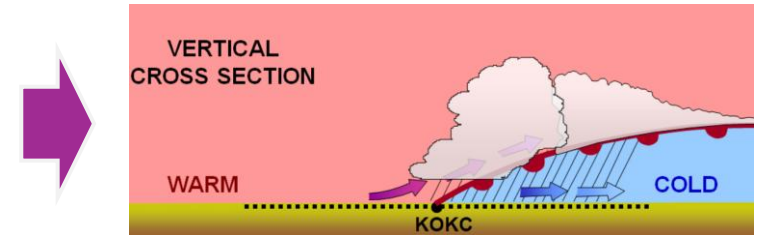
• Cold Front

- Travels fast (~30mph). Comes as a snowplow lifting warmer air abruptly, forming clouds
- Usually associated with towering cumulus and thunderstorms
- If fast-moving and two cold air masses collides (~50 knots) → Squall Lines



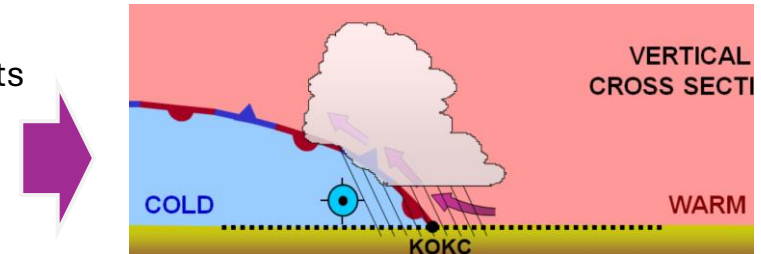
• Warm Front

- Travels slower (10-25mph). Gentle slope, overtaking from the above: stratiform clouds w/ fog
- Associated w/ light to moderate precipitation (rain, sleet, snow) and poor visibility
- Affect extensive area (deteriorating weather, lower ceilings along the route towards the front)



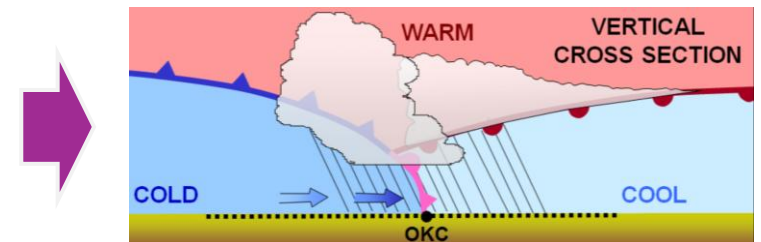
• Stationary

- Forces of the two air masses relatively equal. Weather associated is a mix of cold/warm fronts
- Usually last several days



• Occluded

- Fast-moving cold front catches up with a slow-moving warm front.
- **Cold Front Occlusion**: fast-moving cold front is colder than the cold air in front of the warmer front. Weather is a mixture of cold/warm fronts
- **Warm Front Occlusion**: fast-moving cold front is warmer than the cold air in front of the warmer front. Causes embedded thunderstorms

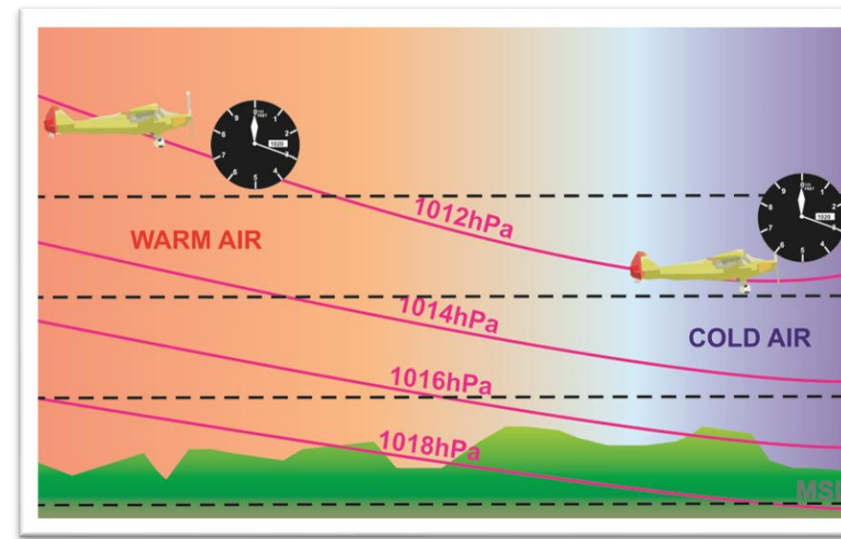
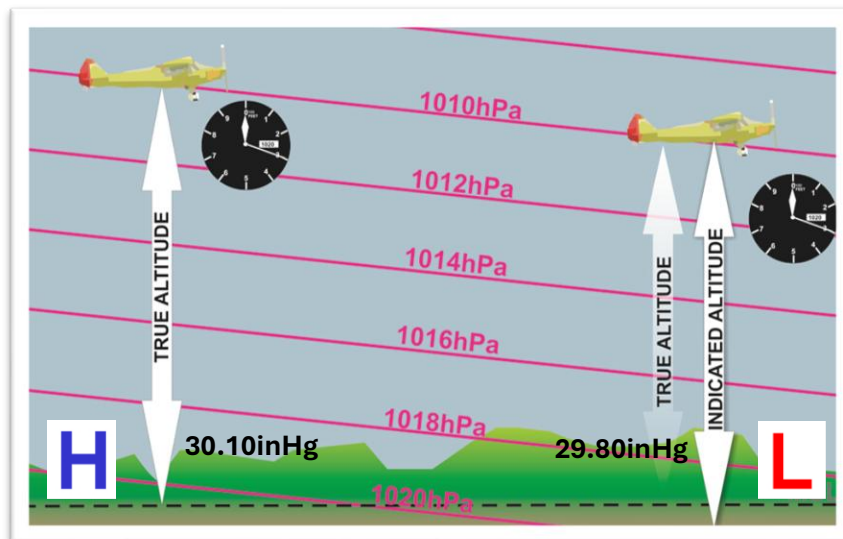


2. Weather Theory

• Effect on Altimeter

- When air is colder than standard → the aircraft is at lower altitude than altimeter indicates
 - Rule of thumb: *Altitude = 4% lower for every 10°C below ISA at low altitudes*
- When flying from higher to lower pressure area without adjusting the altimeter:
 - The aircraft will be at lower altitude than altimeter indicates
- **High to Low or Hot to Cold → Look out Below**
 - The higher you are, the higher the error will be (more air below you)

The altimeter is calibrated assuming standard atmosphere



3. Weather Hazards

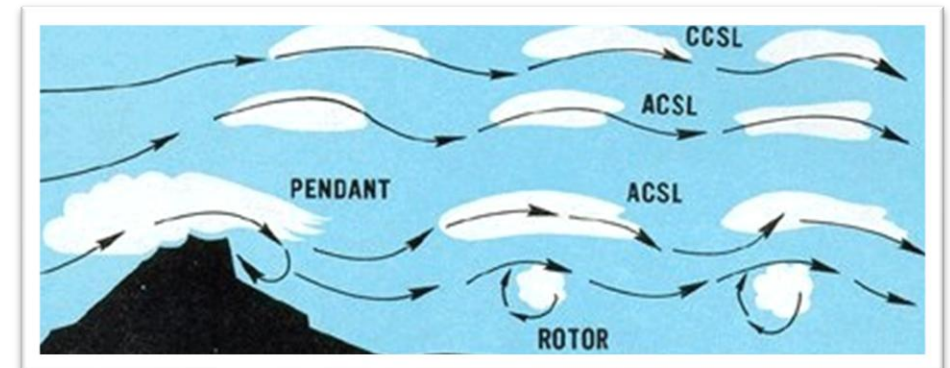
Inversion

- Happens when temperature rises with altitude
- A layer of inversion traps the colder calm weather below (it is often associated with wind shear)

Turbulence

- **Types:** Frontal (friction of air masses), Mechanical (e.g. mountain waves or obstruction), Thermal (convection) or Wind Shear
 - **Light:** *momentarily causes slight changes in altitude/attitude*
 - **Moderate:** *same as above plus changes in airspeed. Still positive control*
 - **Severe:** *abrupt changes in alt/attitude/airspeed. Momentarily out-of-control*
 - **Extreme:** *impossible control (violently tossed around). Structural damage*
- **Clear Air Turbulence (CAT)**
 - Not associated to clouds, usually at/above 15,000ft and commonly associated with Jet Streams (near tropopause)
- **Mountain waves**
 - Turbulence felt in the lee-side of mountains. Can extend for hundreds of miles. Look for Lenticular clouds →

ACLS: Altopumulus Standing Lenticular Clouds



3. Weather Hazards

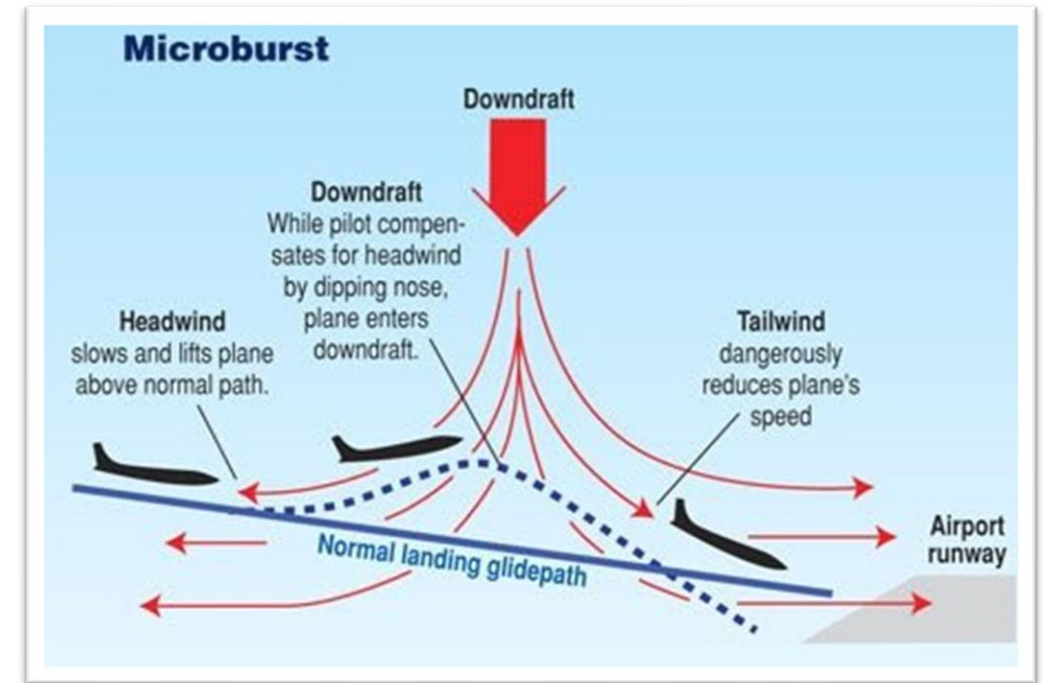
Windshear: Sudden, drastic change in wind speed and / or direction over a very small area

- **Why is it Dangerous?**

- Violent updrafts and downdrafts (up to 6,000 fpm)
- Rapid changes in performance
- **Microbursts** – Most severe type of windshear
 - 1-2 miles across, strong downdrafts
 - Gains / losses of 30 – 90 knots
 - Signs: virga at cloud base, blowing dust, PIREPs

- **Handling Windshear**

- If possible, avoid it
- General techniques include:
 - Higher power and faster approach; Stay as high as feasible until necessary to descend
 - Go-around at the first sign of windshear – Full power and establish a maximum performance climb



3. Weather Hazards

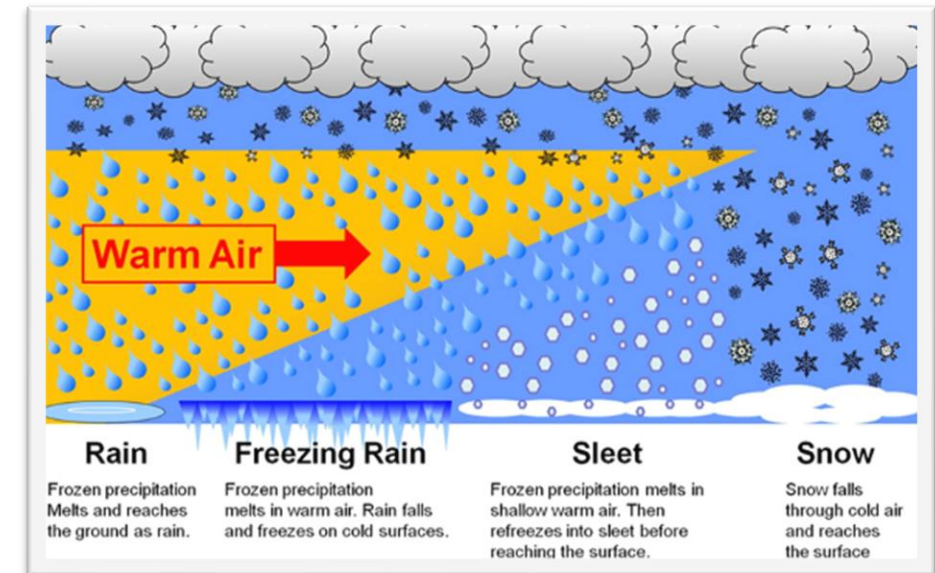
Fog

- Happens when air is cooled down to the dewpoint (visibility <5/8sm).
- Types of Fog:
 - **Radiation:** stable calm night → ground cools faster, cooling air above
 - **Advection:** moist air moving over a cold surface. Common along the coast
 - **Steam:** cold dry air moves over warm water (fog over the water)
 - **Upslope:** terrain lifts moist/stable air up, and cools it down to its dewpoint
 - **Icing:** composed of ice crystals in very cold temperatures (< -20°F)
 - **Precipitation:** warm rain falls through cool air (saturates the cool air)



Freezing Rain

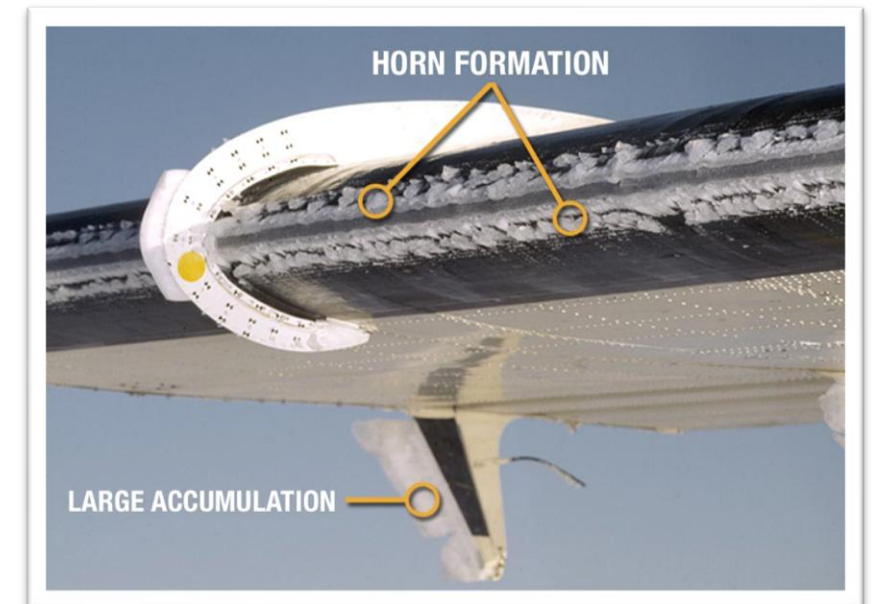
- Ice pellets at the surface may indicate freezing rain aloft
- When under freezing rain, there is usually warmer air above



3. Weather Hazards

Icing

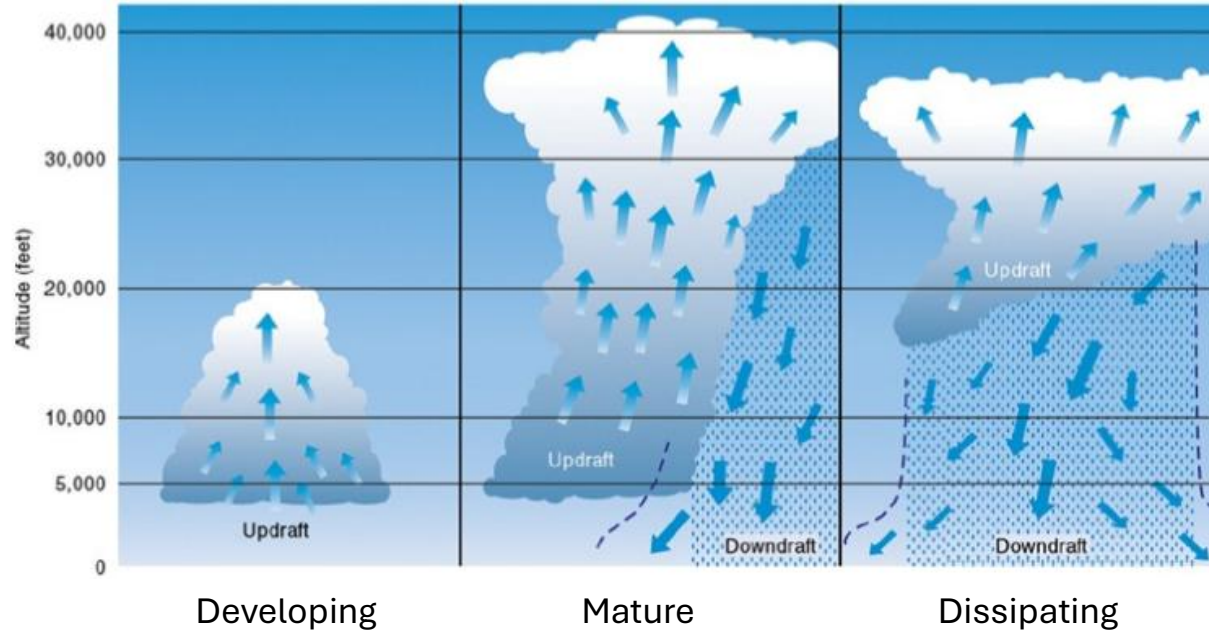
- Causes Induction icing (blocked air intake), Carburetor icing (type of induction icing, possible from 10°F to 100°F), instrument icing (pitot-static) and structural icing (*temperature <0°C and visible moisture*).
- Types of structural icing:
 - **Clear**: large supercooled droplets (cumuliform clouds or freezing rain) spreads out, freeze slowly. Heavy, forms horns. (0°C to -10°C)
 - **Rime**: most common. Freezes instantaneously (trap air inside). Typically from stratus clouds. Lighter than clear ice. (-10°C to -20°C)
 - **Mixed**: characteristics of both above. Harder to remove. (-10°C to -15°C)
 - **Frost**: surface below dewpoint, and dewpoint below freezing
- Intensity of Ice
 - **Trace**: usually not hazardous even if de-icing/anti-icing is not used
 - **Light**: occasional use of de/anti-icing removes/prevents accumulation
 - **Moderate**: even short encounters become potentially hazardous
Action → *use of de-icing/anti-icing required, and/or flight diversion*
 - **Severe**: de-icing/anti-icing not enough to reduce the hazard → *Divert immediately*



3. Weather Hazards

Thunderstorm

- **Necessary for Formation** → Moisture (water vapor), Unstable air and Lifting force
- **Types** → Single-cell, Multi-cell, Super-cell
- **Hazards** → low ceiling/visibility, lightning, turbulence, downbursts, icing, hail, CAT above the clouds
- **Action** → *Avoid TS by at least 20nm*



4. Weather Sources

• On the Ground

- Leidos (www.1800wxbrief.com)

1 FSS

2 Aviation Weather Center (GFA)

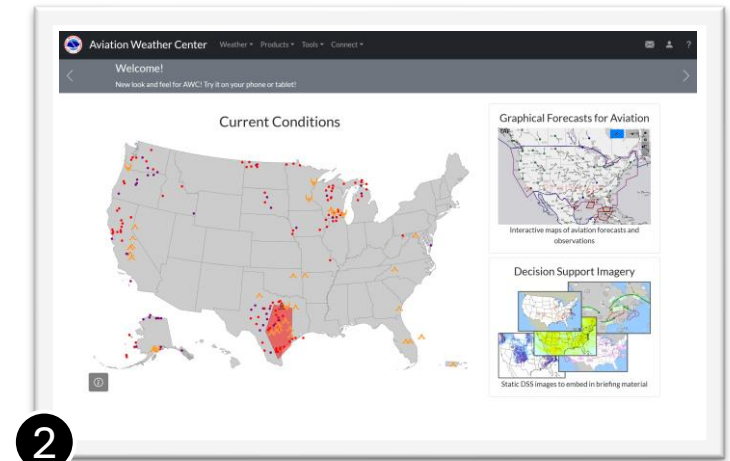
- National Weather Service (NWS/SPC, Storm Prediction Center)
- Foreflight, etc (*AIM 7-1-2(C): Pilots can receive reg. compliant briefing w/o contacting FSS*)

• In Flight

- FSS (as published or 122.2)
- AWOS/ASOS, ATIS
- SiriusXM
- Onboard Radar
- Onboard lightning detector
- ARTCC Broadcasts (all freq. except 121.5)
- PIREPs
- FIS-B (978MHz: METAR, TAF, NEXRAD, NOTAM, AIRMET, SIGMET (+Conv), TFR, PIREP)

1 Types of Weather Briefing (AC 91-92, AIM 7-1-5)

- **Outlook:** for planning purposes, indicates weather to expect. 6-48h before flight
- **Standard:** complete picture of weather elements and risks. Within 6h of departure
- **Abbreviated:** updated info, focus on specific dynamic elements. Just before flight.



5. Weather Services

- **In-flight Weather Advisories** (AIM 7-1-6)

- Forecasts to advise aircraft of development of potentially hazardous weather

	Description	Issued/Expiration
AIRMET	Inform all pilots. Potentially hazard to <u>small aircraft</u> . • (S) <u>Sierra</u>: IFR, Mountain obscuration • (T) <u>Tango</u>: mod turbulence, LLWS, surface winds >30kts • (Z) <u>Zulu</u>: Icing, freezing levels	Every 6h
SIGMET	• <u>Non-convective</u>, potentially hazardous to <u>all aircraft</u>. • Severe icing and turbulence (not associated to TS), CAT, volcanic ash, dust / sandstorm	Unscheduled (valid 4h) <i>(valid 6h if volcanic ash or tropical cyclones)</i>
Convective SIGMET	• Hazardous <u>convective weather</u> • Severe thunderstorm (surface winds >50kts, surface hail > ¾ in, tornadoes) • Severe turbulence, Icing, LLWS, embedded TS, line of TS (squall line)	Every 1h (valid for 2h)
CWA	• Center Weather Advisory • Unscheduled inflight advisory to supplement existing SIGMET (+Conv) or AIRMET	As needed, usually to expect within 2h

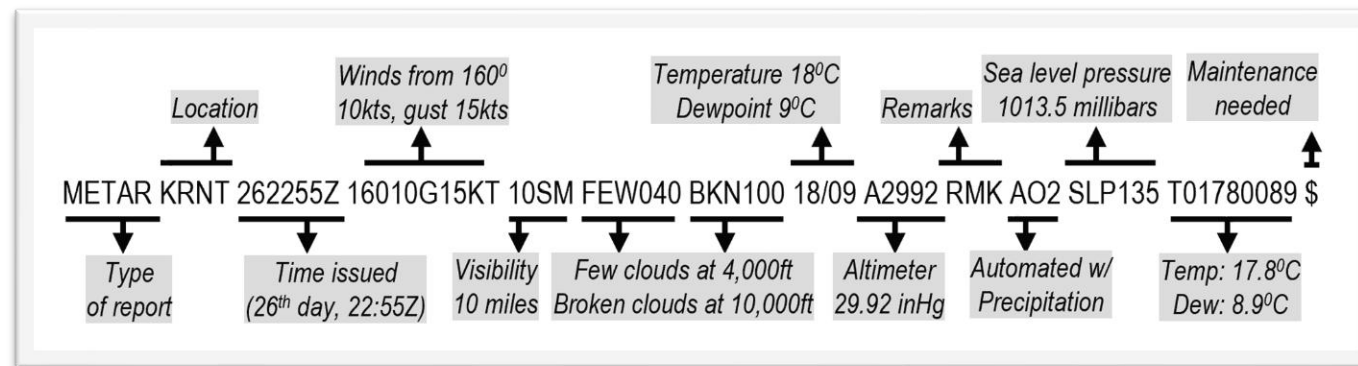
- **Terminal Weather Services** (AIM 7-1-10, AIM 4-1-13) **OBS**

- **AWOS** (Automated Weather Observing System): Levels: **(A)** altimeter setting, **(1)** adds winds/temp/dew point, **(2)** adds visibility, **(3)** adds cloud/ceiling data, **(3P)** adds precipitation differentiator, **(3P/T)** adds TS/lightning. Updated every 1 min
- **ASOS** (Automated Surface Observing System): similar to AWOS L3P/T but more advanced. Updated every 1min
 - *Note: ASOS is the backbone of the U.S. surface weather observation system used for TAF.*
- **ATIS** (Automatic Terminal Information Service): weather/airport information. Updated every 1h

5. Weather Services

• METAR (Meteorological Aerodrome Report) OBS

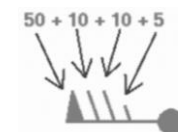
- Aviation Routine Weather report published every hour (SPECI if unscheduled)
- Observation of current surface weather reported in standard international format



- Descriptor: **MI** (shallow), **BC** (patches), **DR** (low drifting), **BL** (blowing), **SH** (showers), **TS** (thunds.), **FZ** (freezing), **PR** (partial), **VC** (vicinity)
- Precipitation: **DZ** (drizzle), **RA** (rain), **SN** (snow), **SG** (snow grains), **IC** (ice crystals), **PL** (ice pellets), **GS** (small hail), **GR** (hail)
- Obscuration: **BR** (mist), **FG** (fog), **FU** (smoke), **DU** (dust), **SA** (sand), **HZ** (haze), **PY** (spray), **VA** (volcanic ash)
- Others: **DS** (dust storm), **SS** (sand storm), **FC** (funnel clouds), **SQ** (squalls)

• Winds Aloft FCST

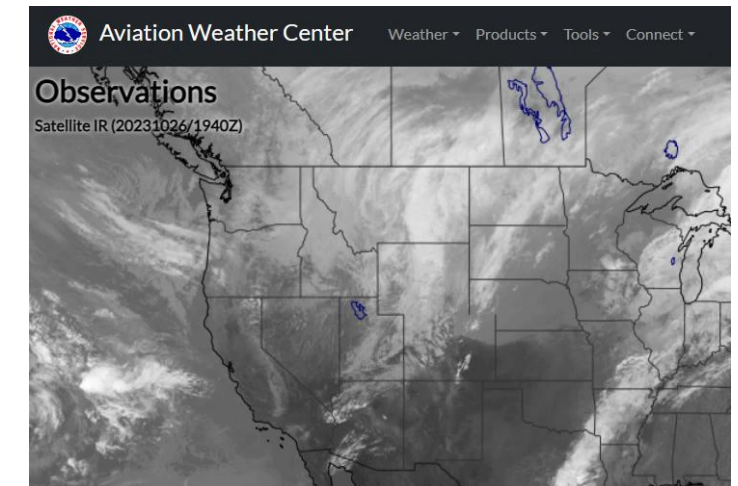
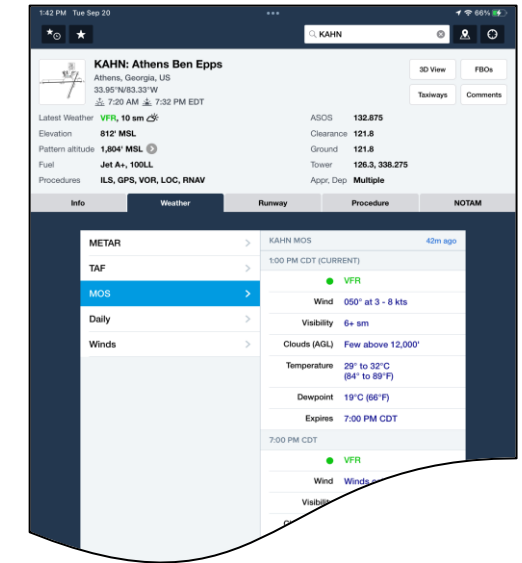
- Forecast of winds/temperature at altitude
- Issued every 6h (4x/day) – Graphical or Table
- Winds not listed within 1500ft, Temp not listed within 2500ft of location's elevation (only avail for 6,000ft+)



DATA BASED ON 201200Z									
VALID 201800Z FOR USE 1400-2100Z. TEMPS NEG ABV 24000									
FT	3000	6000	9000	12000	18000	24000	30000	34000	39000
BRL	2012	2329+16	2432+11	2336+04	2550-08	2649-18	254333	264544	245157
DBQ	1818	2236+13	2443+08	2546+02	2640-08	2641-19	244834	245345	256056
DSM	1820	2326+17	2424+12	2630+05	2834-08	2647-20	273834	263944	264155
MCW	1916	2517+15	2616+10	2718+04	2931-09	2643-21	264835	265444	265156

5. Weather Services

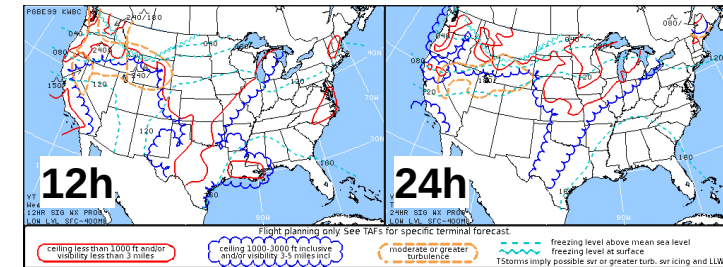
- **TAF (Terminal Aerodrome Forecast)** FCST
 - Weather forecast for 5sm radius of an airport
 - Issued every 6h (4x/day) → (0000Z, 0600Z, 1200Z, 1800Z), covers 24h or 30h
- **MOS (Model Output Statistics)** FCST
 - Similar to TAF, but derived from numerical models (statistic & history)
 - Completely automated and can be found on Foreflight
 - Advisory only, not an official source of weather
- **Satellite Weather** OBS
 - Provides observation (images) on cloud coverage and other weather phenomena
 - There are 3 types:
 - Visible: display as a **picture taken from space**
 - Infrared: measures and show temperature of clouds (estimate altitude)
High clouds (bright white), Middle (shades of gray), Low (dark gray)
 - Water Vapor: areas of moist (white) and dry (black) air.



5. Weather Services

• Significant Weather (SigWX) FCST

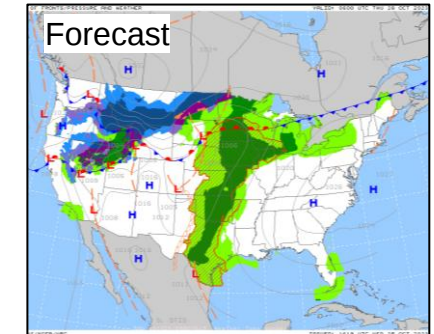
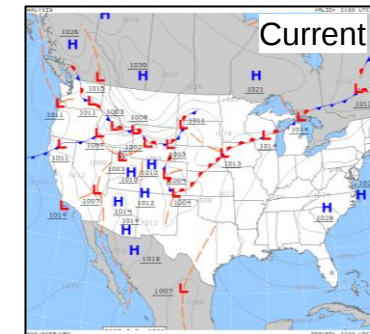
- Forecast of selected weather conditions
- Low (<24,000'), Mid (FL100-450), High (FL250-630)
- Issued every 6h (Low 12/24h, Mid/High 24h only)



aviationweather.gov

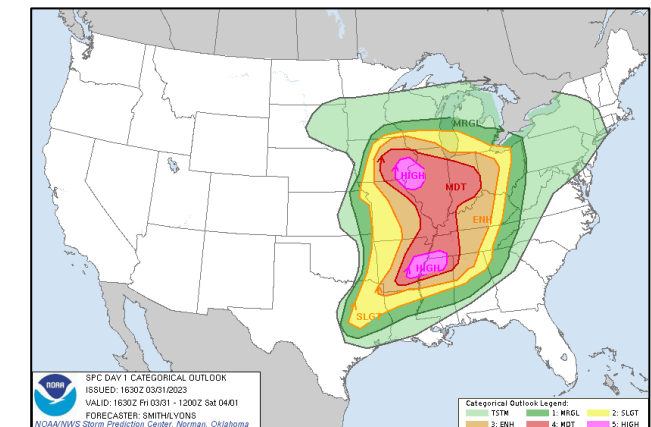
• Surface Analysis (Prog Chart) FCST OBS

- Pressure systems, fronts, precipitations
- **Surface Analysis**: issued every 3h
- **Forecast**: 12/24h (every 6h), 36/48/60h (every 12h), 3-7 days (daily)



• Convective Outlook FCST

- Depicts area for potential convective activity and probability of severe activity to happen (TS, tornadoes)
- Issued: Day 1 (5x/day), Day 2 (2x/day), Day 3+ (1x/day)
- **Risk**: marginal, slight, enhanced, moderate, high
- Access via SPC (storm prediction center)



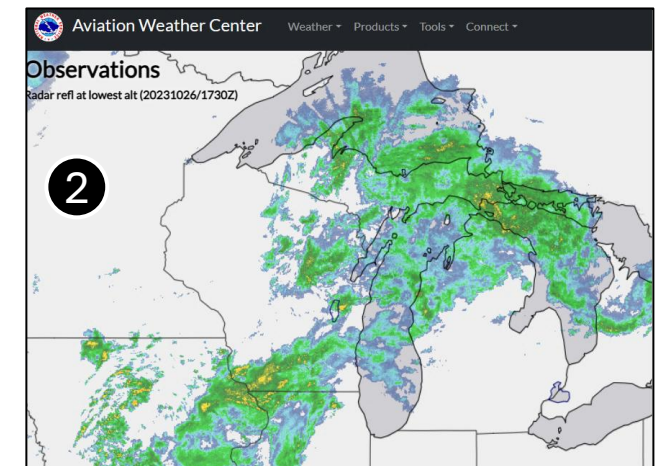
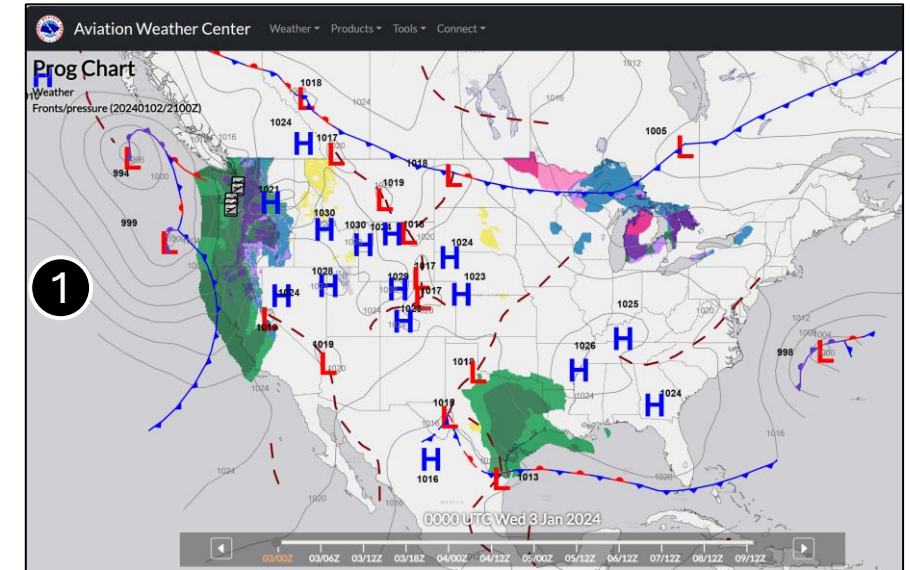
5. Weather Services

1 GFA Tool (Graphical Forecast for Aviation) FCST OBS

- Interactive map of weather observations and forecast
- Accessible via <http://aviationweather.gov>
- Consolidates all weather products in a single interface w/ overlays

2 NEXRAD Radar (Precipitation) OBS

- Doppler radar sends out a signal that reflects once hits precipitation (echo). Updated every ~10min
- **Higher reflectivity (dBZ) → more intense precipitation**
- **Types:** base (lowest angle), top (each top height colored), composite (highest reflectivity of all echoes)
- **Limitations** (not all):
 - Attenuation: closer heavy precipitation absorb energy, showing other precipitation lighter (weaker echo). Also, beyond 50-75nm the intensity of the radar beam decreases
 - Blockage: radar beam blocked by terrain
 - False echoes: Ghosts (refraction in clear air), Angels (echoes from bats/birds)
 - Over/Undershoot: radar is in high elevation (doesn't detect 'down') or when target too close (up) to radar



Questions?

