

Weather

Private Pilot Ground Lesson 3

Relevant FARs

CFR § 61.105(b) - Aeronautical Knowledge, Required Areas
Area
(1) Applicable Federal Aviation Regulations of this chapter that relate to private pilot privileges, limitations, and flight operations;
(2) Accident reporting requirements of the National Transportation Safety Board;
(3) Use of the applicable portions of the “Aeronautical Information Manual” and FAA advisory circulars;
(4) Use of aeronautical charts for VFR navigation using pilotage, dead reckoning, and navigation systems;
(5) Radio communication procedures;
(6) Recognition of critical weather situations from the ground and in flight, windshear avoidance, and the procurement and use of aeronautical weather reports and forecasts;
(7) Safe and efficient operation of aircraft, including collision avoidance, and recognition and avoidance of wake turbulence;
(8) Effects of density altitude on takeoff and climb performance;
(9) Weight and balance computations;
(10) Principles of aerodynamics, powerplants, and aircraft systems;
(11) Stall awareness, spin entry, spins, and spin recovery techniques for the airplane and glider category ratings;
(12) Aeronautical decision making and judgment; and
(13) Preflight action that includes - <ul style="list-style-type: none"> (i) How to obtain information on runway lengths at airports of intended use, data on takeoff and landing distances, weather reports and forecasts, and fuel requirements; and (ii) How to plan for alternatives if the planned flight cannot be completed or delays are encountered.

Relevant ACS

I. Preflight Preparation

Task	C. Weather Information
References	14 CFR part 91; FAA-H-8083-25; AC 00-6, AC 00-45, AC 00-54; AIM
Objective	To determine that the applicant exhibits satisfactory knowledge, risk management, and skills associated with weather information for a flight under VFR.
Knowledge	The applicant demonstrates understanding of:
PA.I.C.K1	Sources of weather data (e.g., National Weather Service, Flight Service) for flight planning purposes.
PA.I.C.K2	Acceptable weather products and resources required for preflight planning, current and forecast weather for departure, en route, and arrival phases of flight.
PA.I.C.K3	Meteorology applicable to the departure, en route, alternate, and destination under VFR in Visual Meteorological Conditions (VMC) to include expected climate and hazardous conditions such as:
PA.I.C.K3a	a. Atmospheric composition and stability
PA.I.C.K3b	b. Wind (e.g., crosswind, tailwind, windshear, <u>mountain wave</u> , etc.)
PA.I.C.K3c	c. Temperature
PA.I.C.K3d	d. Moisture/precipitation
PA.I.C.K3e	e. Weather system formation, including air masses and fronts
PA.I.C.K3f	f. Clouds
PA.I.C.K3g	g. Turbulence
PA.I.C.K3h	h. Thunderstorms and microbursts
PA.I.C.K3i	i. Icing and freezing level information
PA.I.C.K3j	j. Fog/mist
PA.I.C.K3k	k. Frost
PA.I.C.K3l	l. Obstructions to visibility (e.g., smoke, haze, volcanic ash, etc.)
PA.I.C.K4	Flight deck displays of digital weather and aeronautical information.
Risk Management	The applicant demonstrates the ability to identify, assess and mitigate risks, encompassing:
PA.I.C.R1	Factors involved in making the go/no-go and continue/divert decisions, to include:
PA.I.C.R1a	a. Circumstances that would make diversion prudent
PA.I.C.R1b	b. Personal weather minimums
PA.I.C.R1c	c. Hazardous weather conditions to include known or forecast icing or turbulence aloft
PA.I.C.R2	Limitations of:
PA.I.C.R2a	a. Onboard weather equipment
PA.I.C.R2b	b. Aviation weather reports and forecasts
PA.I.C.R2c	c. Inflight weather resources
Skills	The applicant demonstrates the ability to:
PA.I.C.S1	Use available aviation weather resources to obtain an adequate weather briefing.
PA.I.C.S2	Analyze the implications of at least three of the conditions listed in K3a through K3l above, using actual weather or weather conditions in a scenario provided by the evaluator.
PA.I.C.S3	Correlate weather information to make a competent go/no-go decision.

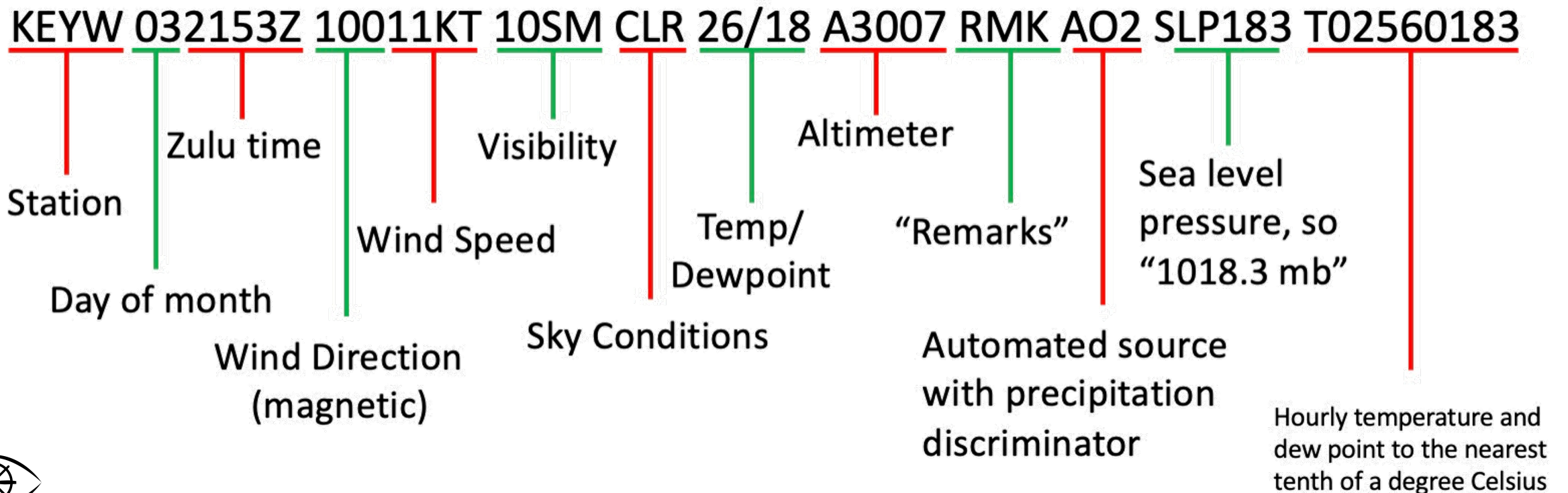


Reading

- PHAK 12: Weather Theory
- PHAK 13: Weather Services

Sources of weather data (e.g., National Weather Service, Flight Service) for flight planning purposes

- **METAR (Meteorological Aerodrome Report)** – Surface aviation weather observations; compilation of elements of the current weather at individual ground stations across the United States; updated hourly



Sources of weather data (e.g., National Weather Service, Flight Service) for flight planning purposes

- **TAF (Terminal Aerodrome Forecast)** – Forecast for the five-statute mile radius around an airport. TAF reports are usually given for larger airports. Each TAF is valid for a 24 or 30-hour time period and is updated four times a day

KEYW 031958Z 0320/0418 08009KT P6SM FEW025 SCT070

The diagram shows a TAF report with color-coded brackets and labels below it. Red brackets point to 'KEYW', '1958Z', and '08009KT'. Green brackets point to '03', '0320/0418', and 'P6SM'. A red bracket points to 'FEW025 SCT070'. Labels are placed below the brackets: 'Station' under 'KEYW', 'Day of month' under '03', 'Time Issued' under '1958Z', 'Window of day and hour Zulu valid' under '0320/0418', 'Wind' under '08009KT', 'Sky conditions P = more than' under 'P6SM', and 'Sky conditions' under 'FEW025 SCT070'.

Station

Day of month

Time Issued

Window of day and hour Zulu valid

Wind

Sky conditions
P = more than

Sky conditions

Sources of weather data (e.g., National Weather Service, Flight Service) for flight planning purposes

- Abbreviations

Sky Cover	Contraction
Less than 1/8 (Clear)	SKC, CLR, FEW
1/8–2/8 (Few)	FEW
3/8–4/8 (Scattered)	SCT
5/8–7/8 (Broken)	BKN
8/8 or (Overcast)	OVC

Figure 13-6. Reportable contractions for sky condition.

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		
<p>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).</p> <p>* Automated stations only</p>				

Figure 13-5. Descriptors and weather phenomena used in a typical METAR.

Sources of weather data (e.g., National Weather Service, Flight Service) for flight planning purposes

- **Automated Terminal Information Service (ATIS)** – Voice recording of current conditions
- **AWOS (Automated Weather Observing System) and ASOS (Automated Surface Observing Systems)** – Automated equivalents of the ATIS
- **www.aviationweather.gov** – Website with official aviation weather resources
- **www.1800wxbrief.com** – Website version of the weather briefing phone-number

Acceptable weather products and resources

- **Preflight Planning** –www.aviationweather.gov, 1800wxbrief for an outlook briefing, TAFs
- **Current and Forecast Weather** – METAR, TAF, Graphical Forecasts for Aviation (GFA) tool
- **En Route** – ATIS, Flight service stations (FSS)
- **Arrival** – ATIS

Atmospheric composition and stability

- **Composition** – 78% Nitrogen and 21% Oxygen
- **Stability** – The ability of the atmosphere to resist vertical motion. As air ascends through the atmosphere, the average rate of temperature change is 2 °C (3.5 °F) per 1,000 feet.
- **Stable Atmosphere** – When the lapse rate is such that the temperature changes little throughout the atmosphere it is considered stable.
 - Expect stratus clouds, steady rain, smooth air, and poor visibility (atmospheric contaminants are stationary and not being cleared)
- **Unstable Atmosphere** – When the lapse rate is less than the dry adiabatic lapse rate (unsaturated air) of 3 °C (5.4 °F) per 1,000 feet the atmosphere is unstable.
 - Expect cumulus clouds, showery rain, rough air, and good visibility.

Wind

- **Crosswind** – The horizontal component of the wind, calculated by $V \times \sin(\theta)$; airplanes have a published crosswind component limitation.
- **Tailwind** – Wind from behind the aircraft, this will significantly impact landing and takeoff performance.
- **Windshear** – Drastic change in wind speed and/or direction over a very small area; this can result in updrafts, downdrafts, or sudden change in airspeed.
- **Mountain Wave** – As wind passes over a mountain, the other side will experience turbulence that pilots should be aware of, sometimes rotor currents can form over mountains and produce the very characteristic lenticular clouds. These represent extreme turbulence.

Temperature

- The temperature generally decreases as you ascend through the atmosphere. Sometimes, the temperature can actually increase during ascent, this is called a temperature inversion. It's important to be aware of these because the wind and atmospheric conditions can change when crossing an inversion.

Moisture/precipitation

- If air reaches the saturation point while temperature and dew point are close together, it is highly likely that fog, low clouds, and precipitation will form.

Air masses

- Large bodies of air that take on the characteristics of the surrounding area or source region.
- **Continental Polar Air Mass** – A continental polar air mass forms over a polar region and brings cool, dry air with it.
- **Maritime Tropical Air Mass** – Maritime tropical air masses form over warm tropical waters like the Caribbean Sea and bring warm, moist air.

Fronts

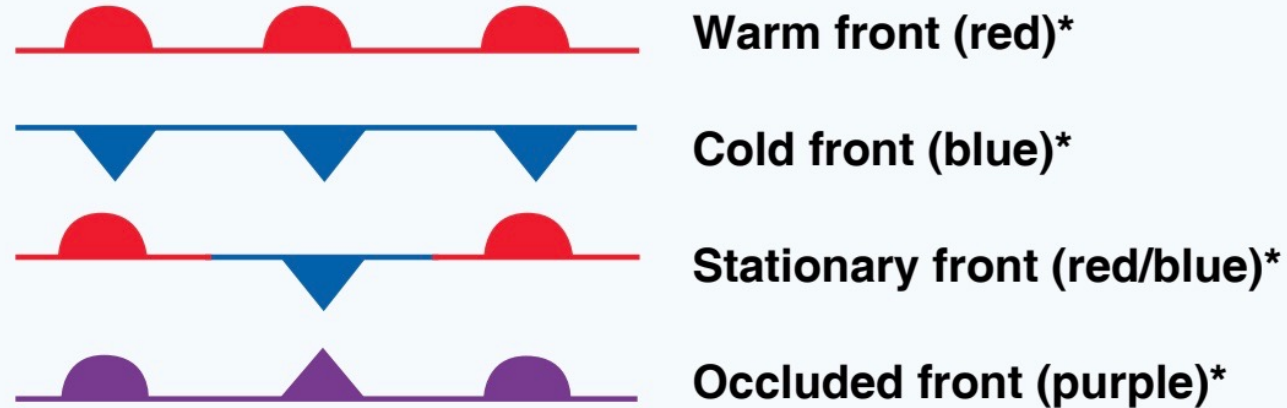
- The boundary layer between two types of air masses is known as a front.
- **Warm Front** – A warm front occurs when a warm mass of air advances and replaces a body of colder air.
 - Warm fronts move slowly
 - Warm fronts contain warm air that often has very high humidity
- **Cold Front** – A cold front occurs when a mass of cold, dense, and stable air advances and replaces a body of warmer air. Associated with thunderstorms. A continuous line of thunderstorms, or squall line, may form along or ahead of the front.
 - Cold fronts move more rapidly than warm fronts
 - It is so dense, it stays close to the ground and acts like a snowplow, sliding under the warmer air and forcing the less dense air aloft.

Fronts

- **Stationary Front** – When the forces of two air masses are relatively equal, the boundary or front that separates them remains stationary and influences the local weather for days.
- **Occluded Front** – A cold front occlusion occurs when a fast moving cold front is colder than the air ahead of the slow moving warm front. A warm front occlusion occurs when the air ahead of the warm front is colder than the air of the cold front. When this is the case, the cold front rides up and over the warm front.

Fronts

Symbols for surface fronts and other significant lines shown on the surface analysis chart



* Note: Fronts may be black and white or color depending on their source. Also, fronts shown in color code do not necessarily show frontal symbols.

Figure 12-24. *Common chart symbology to depict weather front location.*

Clouds

- **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** — Middle level clouds existing at 5,000 to 20,000 feet

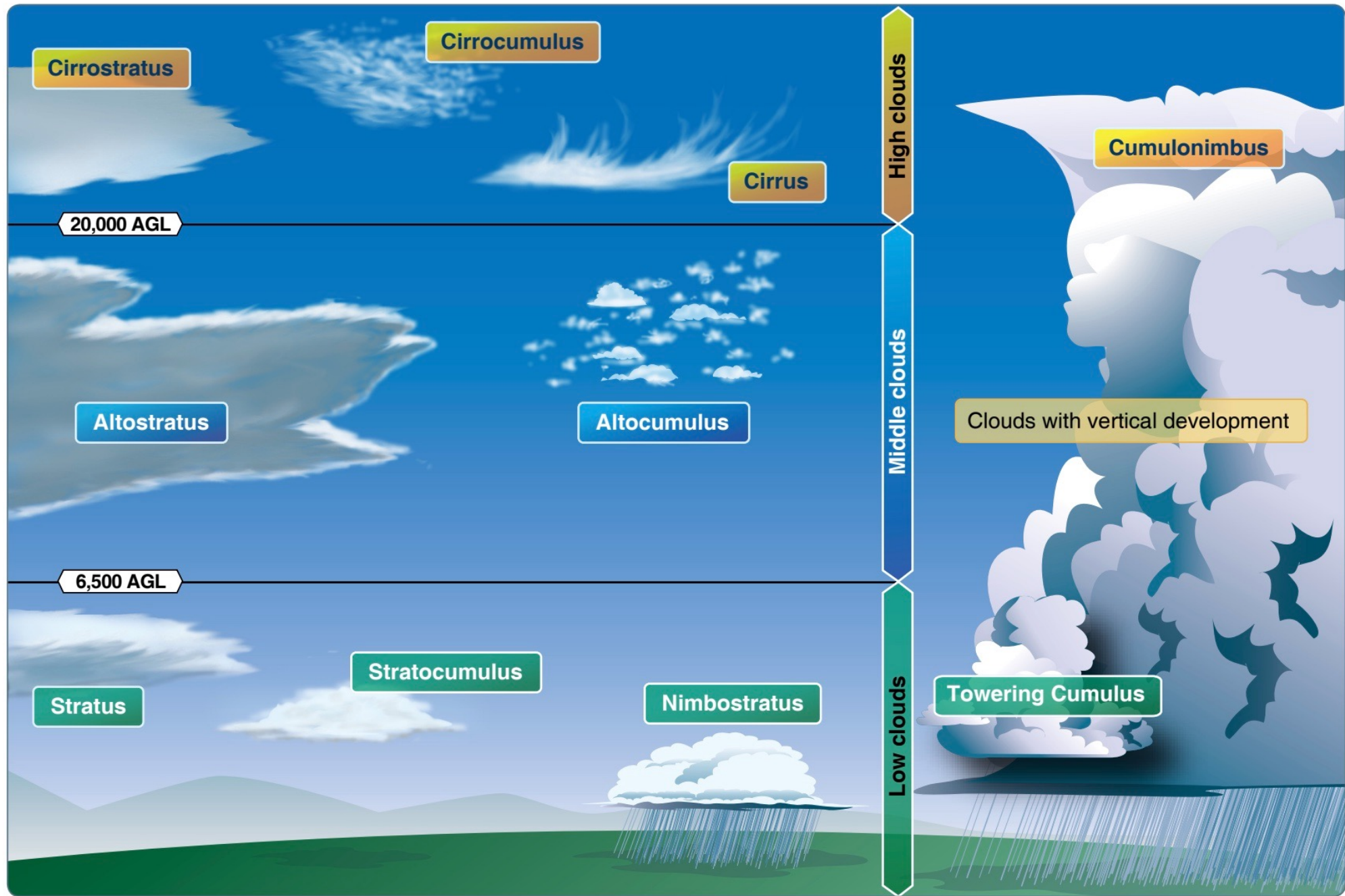


Figure 12-22. *Basic cloud types.*

Turbulence

- Turbulence can be caused by ground obstructions, mountains, and varying surface conditions.

Thunderstorms

- For thunderstorms to form, the air must have sufficient water vapor, an unstable lapse rate, and an initial lifting action to start the storm process. A thunderstorm has three stages:
 - **Cumulus Stage** – The lifting action of the air begins; clouds continue to increase in vertical height. *Updrafts* prevent rain from falling.
 - **Mature Stage** – Precipitation (rain or hail) begins; there are updrafts and downdrafts. Avoid cells by 20 miles or more.
 - **Dissipating Stage** – Downdrafts spread out and replace the updrafts needed to sustain the storm.

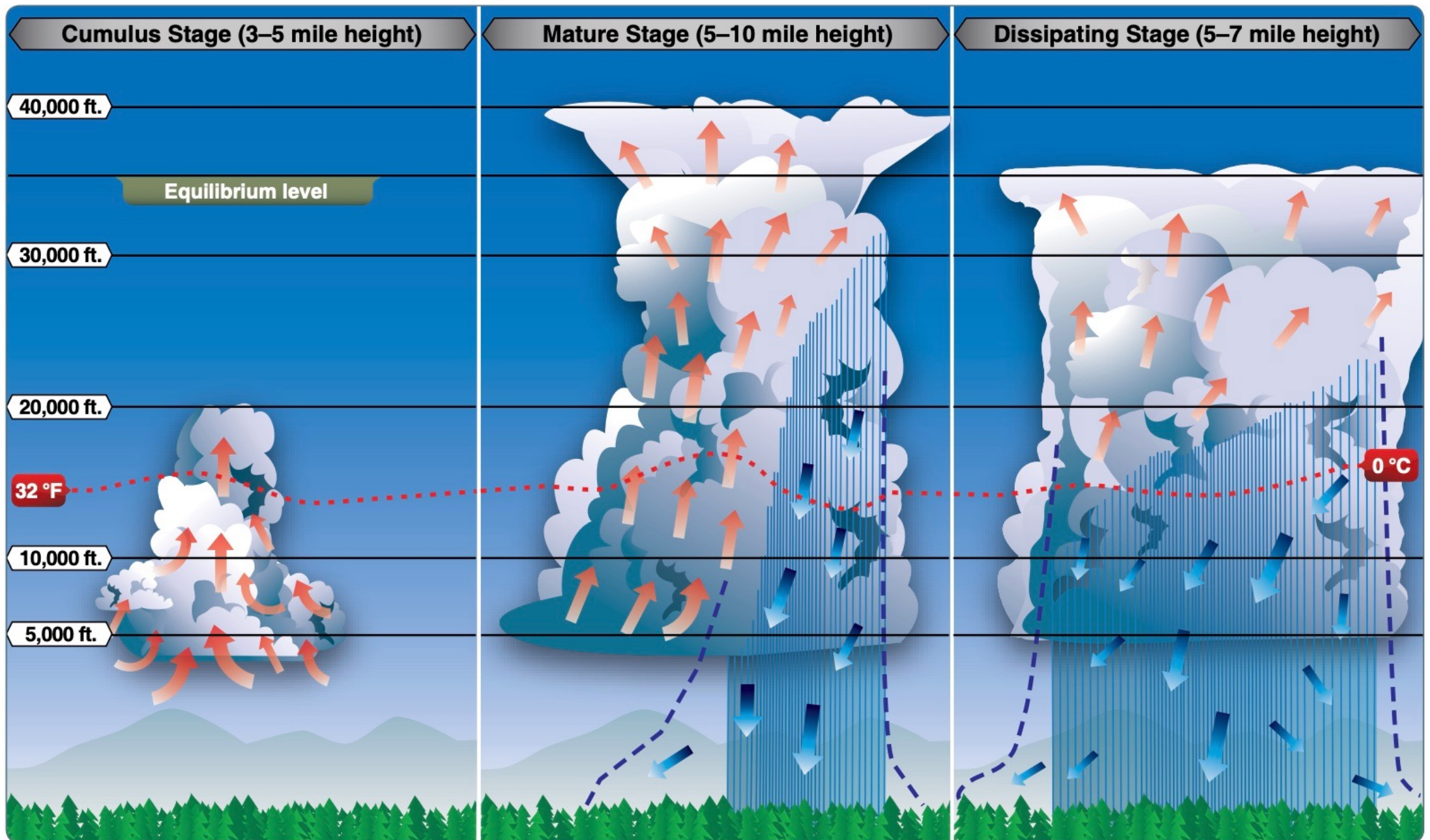


Figure 12-28. *Life cycle of a thunderstorm.*

Microbursts

- The most severe type of low-level wind shear; the lifespan of a microburst is about 5–15 minutes during which time it can produce downdrafts of up to 6,000 FPM and headwind losses of 30–90 knots with severe turbulence.

Icing/Freezing

- Icing can be encountered during thunderstorms or whenever the temperature approaches freezing and there is visible moisture.
- **Carb icing** – Carburetor ice is most likely to occur when temperatures are below 70 degrees Fahrenheit (°F) or 21 degrees Celsius (°C) and the relative humidity is above 80 percent. Due to the sudden cooling that takes place in the carburetor, icing can occur even in outside air temperatures as high as 100 °F (38 °C) and humidity as low as 50 percent.

Icing/Freezing

- **Freezing Level** – The freezing level is estimated by taking the current temperature at field elevation and subtracting 2° C per 1,000 feet (average lapse rate). Add AGL of the field elevation and this is the freezing level in MSL.

Fog

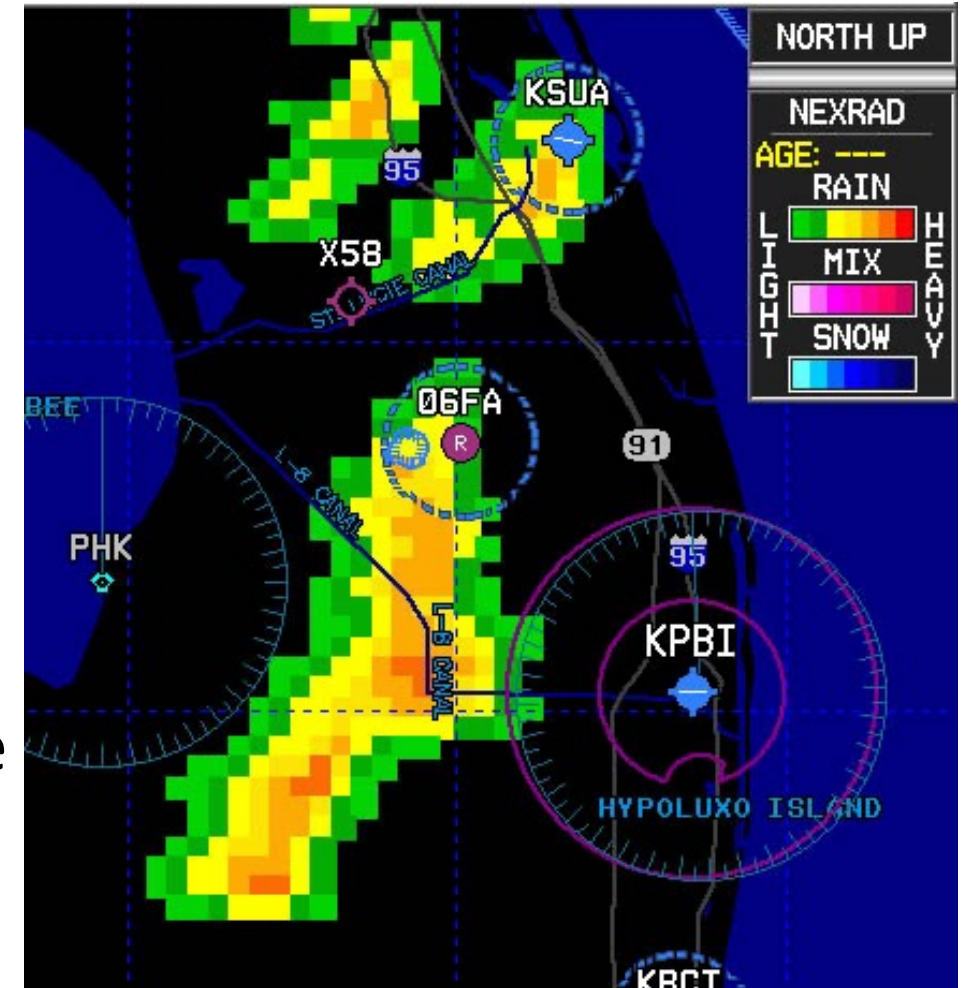
- **Radiation Fog** – On clear nights, with little wind, the ground cools rapidly and the surrounding air temperature reaches the dew point. This occurs in valleys and low areas.
- **Advection Fog** – When moist air moves over a cold surface (like San Francisco).
- **Upslope Fog** – stable air is forced up sloping land features like a mountain range.
- **Steam Fog** – When cold, dry air moves over warm water, the water evaporates and saturates the air. This occurs over bodies of water during cold times of the year.
- **Ice Fog** – When the temperature is much below freezing and water vapor forms directly into ice crystals, like radiation fog except in arctic climates.

Frost

- When the temperature is below freezing, dew freezes into frost. This can significantly disrupt airflow over a wing and drastically reduce lift production.

Flight Deck Displays

- **FIS-B** – Flight Information Services – Broadcast automatically transmits a wide range of weather products with national and regional focus to all ADS-B equipped aircraft.
- **NEXRAD** – Time-delayed radar imagery, displays rain cells but it's important to remember the image in the cockpit may be 12-14 minutes old. It's not meant to be used to weave between cells.



Questions?