



WeatherWise

Practical Tips and Tactical Tricks

Weather is the most critical and complex variable that affects your flying. But you don't have to be a meteorologist to understand what makes weather, and use that understanding to help make sound flight decisions. This is what being weather wise is all about—the ability to integrate official reports and forecasts with what you can see outside to cope with changing flight conditions in the real world. Wouldn't you like to be *WeatherWise*?

Fronts

Fearsome weather often occurs when different air-masses—that is, large areas of air with similar properties of temperature, pressure, humidity and stability—collide. The collision line is called a front. The four basic types of fronts are:

Cold Front

Cooler air is pushing warmer air out of the way. If you're looking for violent weather, you're more likely to find it along a cold front than a warm front.

Warm Front


Warmer air is slowly displacing cooler air. Though less severe than a cold front, warm fronts frequently cause low ceilings and visibilities.

Stationary Front

Occurs where two airmasses meet, but neither is displacing the other. These fronts can exhibit characteristics of a warm front, cold front, or both.

Occluded Front

Occurs when a cold air-mass overtakes a warm air-mass, so that the leading edge of both occupies the same location. Occluded fronts occasionally have severe weather.



The moment a person says, “I’m going to learn to fly,” that person needs to add, “and I’ll learn weather, too.” Flying and weather should be thought of as one skill, one art, never separated.



—Captain Robert N. Buck, “Weather Flying”



Practical Tips

- Seeing the windsock change direction is one of the most obvious signs of frontal passage. To determine frontal passage in the air watch for a change in your wind correction angle, or monitor changes in the OAT gauge and pressure readings as reported by ATC, on ASOS and on ATIS broadcasts.
- For longer cross-countries, a rule of thumb is that weather typically changes every 450 miles. But it can also change much more quickly.
- Note any nearby fronts, even if they're not expected to be a factor for your flight. This will give you a better big picture *when* (not if) the forecast proves wrong.
- If a front is forecast to pass your destination call the airport before departing to see if passage has already occurred. Forecasts are not always correct.
- To check on a front's progress look at stations on either side of the front and compare actual conditions to the forecast weather.

Stability

Is the air around you stable or unstable? The more stable an airmass, the less likely you'll see violent weather. Cloud types reflect the degree of stability.

Practical Tips

What do stable and unstable airmasses look like?

- Stable air has smooth air, sometimes-poor visibility, and steady precipitation. Clouds form in horizontal layers.



Stratus clouds - a sign of stable air

- Unstable air has turbulence, usually (but not always) good visibility, and often thunderstorms and intense precipitation. Clouds develop vertically. The higher the vertical development, the more unstable the air.

Precipitation and Visibility

When it comes to accident statistics, **low ceilings and visibilities rank as *the greatest weather hazard*** to the VFR pilot. Not thunder, not ice, not high winds or turbulence—nothing seems less threatening, or is more dangerous than condensed water vapor. Learn to respect it!

Precipitation occurs in both liquid (rain) and solid (snow, hail) forms. Precipitation type and intensity affect your visibility. In weather reports and forecasts, a minus sign (-) usually means VFR or marginal VFR (MVFR) visibilities. “Moderate” precipitation may reduce visibility to MVFR or IFR, while a plus sign (+) most likely means IFR visibilities will prevail. Chances of precipitation and its forecast level of intensity can be found in aviation area forecasts.

Visibility is a critical part of flight safety. Water in the atmosphere might appear as precipitation or fog, or hold suspended particles that cause haze. The amount of water the air can hold rises with the temperature. As the temperature goes down (such as in the evening), it may reach the temperature at which the airmass just can’t hold any more water. That’s called the dew point. The difference between the temperature and the dew point is called the *temperature-dew point spread*. When the temperature and dew point meet at altitude, water appears as rain, clouds or snow. When they meet near the ground, water condenses into fog.

Practical Tips

- The temperature-dew point spread decreases as the temperature drops, usually in the very early morning and at night. Fog is most likely to occur at these times, and can form quickly after sundown or at sunrise.
- At night fog obscures lights, and gives them a hazy or fuzzy cast. Look down occasionally as you fly at night, since fuzzy lights are likely the first indication that fog is forming below you. VFR pilots need to get on the ground fast or divert to better weather.
- When precipitation is in the forecast, visibility may deteriorate.



Fog

- Fog “burns off” in the morning because the rising sun heats the air, pushing the airmass’s temperature above its dew point, vaporizing the water. If there is a higher overcast layer on a foggy morning, however, it can block the sun and inhibit the burn off.
- Flying in very hazy conditions is tough enough for VFR pilots, but it gets even more challenging when flying into the sun. In such conditions, five or even six miles visibility might not be enough for safe VFR.
- In hazy air, visibility appears to drop dramatically just after sunset, but will generally improve just as quickly when total darkness arrives.

Thunderstorms

Thunderstorms can be categorized by their origin, and each has its associated characteristics, but you can think of them as *bad, worse, and impossible!*

Frontal thunderstorm

Caused by a cold front pushing into a warmer airmass with lots of moisture; difficult, if not impossible to circumnavigate.

Airmass thunderstorm

Occurs on summer afternoons as a result of daytime heating. Usually isolated; you *may* be able to maneuver around them.

Embedded thunderstorm

Thunderstorms hidden in solid masses of other clouds. These storms can sometimes be avoided by getting on top of the cloud layer and watching for buildups, or by staying low (if ceilings and visibilities permit), and navigating around columns of water

pouring from the sky. Instrument pilots plowing through the clouds without thunderstorm detection equipment hate embedded thunderstorms.

Practical Tips

- Stay at least 20 nautical miles away from a thunderstorm. Wind shear, gust fronts, turbulence and hail can all occur within this distance.
- A storm moves in the direction of the anvil. To approximate speed and direction of the storm use winds aloft at 12,000 feet.
- It's usually better to circumnavigate on the backside of a thunderstorm away from the anvil. However, the southwest corner is often where tornadoes form.
- Use caution under the anvil between cloud layers. This area sometimes contains hail.
- Select an altitude that will let you see the cloud buildups. Recognize that it may be higher than most light aircraft can fly and may require oxygen for the pilot.
- Ask for ATC assistance in avoiding convective activity you can't visually identify, but remember weather separation is a secondary duty for controllers. As PIC, the ultimate safety of the flight rests with you. There is an art to flying around thunderstorms that can't be developed just by reading or taking courses. It must be learned by experience—very carefully.
- If caught in a thunderstorm, focus on keeping the airplane right side up. If possible, avoid making turns. Adjust to your aircraft's maneuvering speed (Va). Lowering the landing gear may also help stabilize the airplane. Do NOT lower the flaps.



“Billows” cloud - a sign of turbulent air

Turbulence

At altitude, turbulence can range from uncomfortable to catastrophic. Close to the ground, it can turn a routine landing into an accident. Turbulence is classified by intensity and type:

Intensity

Light turbulence can momentarily cause slight erratic changes in altitude and/or attitude. Many GA pilots will report vigorous light turbulence as moderate. Aircraft type (wing loading) may greatly influence the perception of severity.

Moderate turbulence can cause changes in attitude and/or altitude, and usually, variations in indicated airspeed, as well. The aircraft remains under control but the ride will be uncomfortable.

Severe turbulence induces large, abrupt changes in attitude and/or altitude, as well as airspeed. *The aircraft may momentarily become out of control.*

Extreme turbulence, in addition to all of the above, renders the aircraft nearly impossible to control, and may cause structural damage.

Type

The three most common types of turbulence are convective, mechanical, and wind shear.

Convective turbulence results from lifting action. This is the turbulence associated with thunderstorms.

Topography can cause **mechanical** turbulence. Airports



Thunderstorm

known for having “squirrelly” winds, for example, typically earn their reputation due to topographical factors. Strong winds near mountains often create moderate or severe turbulence.

Wind shear occurs at the point of a change in wind direction and/or speed. Wind shear is often associated with thunderstorms or microbursts, but strong winds aloft and light winds on the surface may also cause wind shear.

Clouds are excellent signposts for rough air. Standing lenticular clouds and rotor clouds signify the presence of turbulence, and should be given a wide berth. Similarly, any clouds that resemble crashing waves or appear as if they’ve been shredded indicate turbulence. Towering cumulus or cumulonimbus will also generate severe or extreme turbulence.

Practical tips

- Ask local pilots about topography or other airport conditions that may create mechanical turbulence.
- Summertime bumps almost always end at the top of the haze layer. Climb above the haze and your passengers will thank you.
- Climb above a deck of puffy cumulus and your ride will generally smooth out. In the summer, the tops may quickly climb to 11,000 or 12,000 feet, and climbing above may not be practical. Tops during winter tend to be lower.
- Fly early or late. The air is most turbulent between the hours of 10 a.m. and 5 p.m., when the heating of the ground sets updrafts in motion.
- When encountering turbulence, slow to maneuvering speed (V_a). Maintain attitude; but don’t fight to hold altitude—if IFR, advise ATC that you need a block altitude.
- Tighten seat belts; use the belts on unoccupied seats to secure any loose items. It’s much easier to secure the cabin *before* takeoff. Incorporate this task into your pre-flight checklist.
- If flying in a complex airplane, lower the gear to help stabilize the aircraft.
- Advise passengers when turbulence is expected, so they are prepared for the encounter. Assign them tasks, such as looking for checkpoints or other landmarks, which will keep them focused outside the aircraft.

Icing

Structural and carburetor ice are both serious. Structural ice on your airplane can make it incapable of flight. The good news is that VFR-only pilots should almost never have to worry about structural ice, since it can only form on your airplane when the temperature is zero degrees centigrade or below in visible moisture—that is, in a cloud, or perhaps in freezing rain. Icing can occur under VFR, but it’s rare. Carburetor ice can occur on warm, sunny days, and cause engine failure. Thankfully, all airplanes susceptible to carburetor ice have a carburetor heat system. For more information on handling icing condition please read the AOPA Air Safety Foundation’s Safety Advisor *Aircraft Icing* (<http://www.aopa.org/asf/publications/sa11.pdf>).

Practical tips

- Take the freezing level and cloud bases into account when planning an IFR flight, and choose an altitude that will keep you out of either freezing cold air or clouds, unless your aircraft is approved for flight in icing conditions.
- Watch the OAT gauge as you climb to cruising altitude, and note the freezing level. This way you’ll know how far to descend to find warm air if ice begins to form.
- If you encounter ice when flying above the MEA on an IFR flight plan, remember you can descend to the MEA, or MOCA—Minimum Obstruction Clearance Altitude—and still be clear of obstructions. Know these altitudes, and be ready to descend to, but not below them unless it’s an emergency.
- Icing is subject to regional and seasonal influences. Be familiar with the icing factors that dominate the skies in which you fly.
- Check Airmets and Sigmet for areas of potential icing.



- Look for the freezing level in the winds aloft chart and area forecast.
- The absence of pilot reports (pireps) of icing may merely indicate that no one in the area is flying.
- Seeing rainbows in the cloud tops when flying above a cloud deck usually indicates icing conditions.
- The iciest part of the cloud is always near the tops. When descending into clouds in below freezing temperatures, expedite your descent to minimize any icing encounter.
- Monitor the EGT in potential carburetor icing conditions. The EGT will fluctuate when carburetor ice is initially forming, giving an earlier warning than the traditional symptom of lower manifold pressure or decreasing RPM.
- **Help other pilots by making pireps if you encounter ice.** Learn how to make a pirep by visiting www.aopa.org/asf/skyspotter/.

Forecast vs. Reality

Forecasts are educated guesses, not guarantees. Compare terminal (TAF) and area (FA) forecasts, and you'll find the two aren't always in agreement. As in any endeavor, practice improves performance: pay attention to the weather even when you're not flying. Note what kind of weather system predominates, how it looks and what it does. When flying, compare the forecast to actual conditions you encounter. Check ASOS and ATIS broadcasts along the way. Contact Flight Watch and Flight Service for updates on conditions ahead and at the destination. Pay attention to trends. **And always leave yourself an out.** That's what being *WeatherWise* is all about.

Satisfy your Weather Curiosity

You can learn even more about weather by visiting www.aopa.org/asf/wx. This website not only provides additional information on the weather topics discussed in this Safety Advisor, but also has information on other weather related topics.

Use the space below as a checklist for the items you would like to learn more about.

- Fronts
- Stability
- Visibility
- Thunderstorms
- Turbulence
- Icing
- Clouds as Sign Posts
- Online weather resources
- Flight Planning to Avoid Terrain
- PIREPs
- Test Your Knowledge
- ASF Safety Advisors
- Flight Preparations
- AOPA Member Resources
- In-flight Weather Resources





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