PILOT proficiency

Wind Shear

Grief encounters of the worst kind

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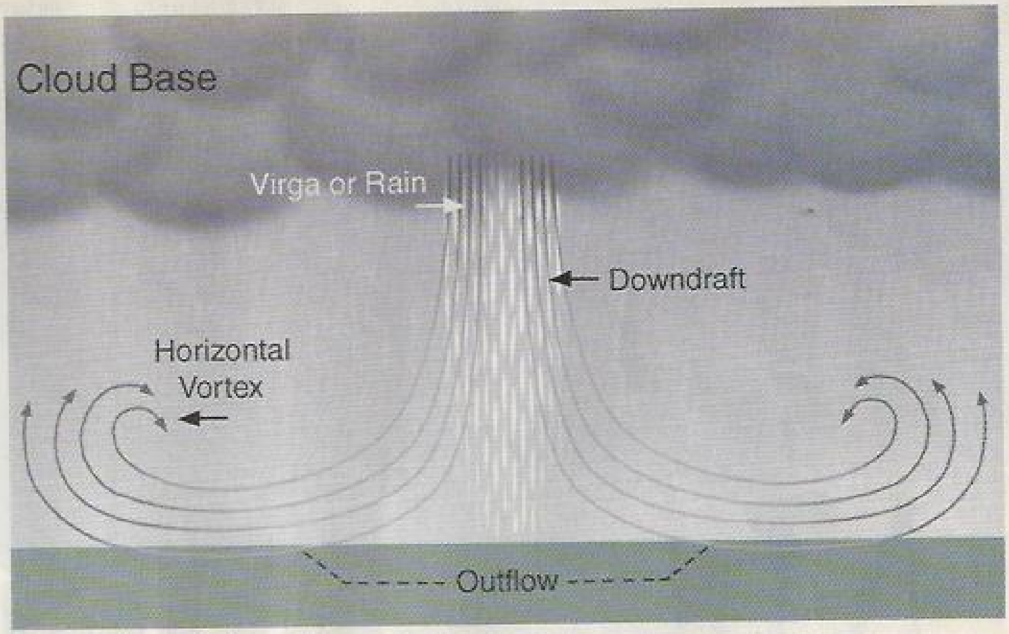
None of us would intentionally fly into a thunderstorm. Every groundschool class, weather video and aviation publication repeatedly warns about the severe possibilities associated with some of nature's nastiest flying weather. But interestingly, pilots can encounter some of the worst trouble associated with these storms without ever entering a cloud. Some of the most severe problems related to convection aren't encountered in the clouds, but in their vicinity.

By their very nature, building thunderstorms move a lot of air around. While we can watch the vertical development of the cloud itself, we can't see the related rivers of air that are twisting and turning in almost every direction. Obviously, airplanes flying near convective activity will move through areas where the air makes rapid changes in direction or velocity. Meteorologists call this wind shear.

Wind Shear

Rapid changes in horizontal air movement of 15 knots or vertical changes of greater than 500 feet per minute (that's only five to six miles per hour) qualify as severe wind shear. Aircraft entering the shear typically experience an unexpected but significant change in lift and airspeed, requiring the immediate application of power. This can be a significant problem for turbine engines, which require several seconds to "spool up." General-aviation aircraft may be less at risk due to the speedy response of piston engines. Still, hundreds of piston singles, twins and turboprops have had grief encounters with wind shear.

National Transportation Safety Board records provide thousands of examples of wind-related accidents. Problems specifically due to wind shear may be even more common than we know. While shears can cause violent and dangerous turbulence at altitude, they can be the most hazardous for aircraft approaching or departing an airport. Unless the airport has a low-level wind shear alert system, however, a shear can roll through and never



be recorded. Without data to prove the existence of a wind shear, any resulting aircraft incidents or accidents would merely be attributed to "adverse winds" as the probable cause.

Surviving an encounter with severe wind shear requires a three-part plan: 1) prevent altitude loss; 2) prevent a stall; and 3) climb to a safe altitude. Add power at the first sign of a sudden plunge in airspeed or altitude. If obstacles are near or terrain is a factor, try for the best angle of climb speed (V_X). If obstructions and terrain aren't factors, then obtain the best rate of climb speed (V_Y) and establish a climb attitude to safely reenter the traffic pattern. You might also consider diverting to an alternate airport with more favorable wind conditions.

The best antidote to wind shear, however, is good situational awareness. Dealing with shear requires good judgement and judicious airspeed management. If conditions suggest possible wind shear at low altitude, push in a margin of airspeed above normal climb speed to reduce the chance of stalling in turbulence or with a sudden change in wind velocity. If forecasts mention low-level wind shear, push in extra power on final approach and be prepared for a go-around. Different airplanes use different procedures, but the usual recommendation is to add one-half the gust factor to your usual 1.3 V_{SO} approach speed. So, if the wind is 10 knots gusting to 20, add about five knots to your final approach speed. Don't try to rocket through a wind shear zone, though. You could overstress the aircraft if you encounter turbulence. Consider using partial flaps for landing; the extra lift and drag caused by full flaps could hamper your ability to maintain a stabilized approach in gusts or a wind shear, and may even lead to an inadvertent liftoff or other control problems once on the runway.

Downdrafts

Equally dangerous as the currents of air moving upward into a thunderstorm is the river of air moving down and outward. As warm air rises, it begins cooling as temperatures aloft decline. Eventually the air can rise no further, and it turns and falls back toward earth. This virtual waterfall is called a downdraft.

Combined with moisture that has reached the dew point (rain), downdrafts can be the most powerful part of a thunderstorm. When they reach the ground, the air spreads out to form one or more horizontal vortex rings, sometimes rising as much as 2000 feet above the ground. Pilots venturing into these invisible rings may find it difficult to control their aircraft. If the downdraft has intensified into a microburst, control could be impossible.

A microburst is a short, extremely violent, concentrated downburst only a few hundred to a few thousand feet across. Wind speeds above 120 mph aren't uncommon; in 1996, wind speeds in a microburst were clocked at 136 mph at Grissom Air Force Base in Indiana. The highest microburst ever recorded—149.5 mph—was observed at Andrews Air Force Base, five minutes after President Ronald Reagan had landed in Air Force One. Recent research indicates that some storm damage originally attributed to tornadoes was actually the result of microbursts.

"Wet" microbursts are common from the Rockies eastward because showers and thunderstorms are more common there. This variety of severe downdraft can be accompanied by intense columns of rain. "Dry" microbursts, which occur more frequently in the West, happen when precipitation evaporates on its way to the ground (virga). This evaporative cooling creates even colder, heavier air that continues to pick up speed as it tumbles earthward. While a typical microburst may last only one to five minutes, accident records for both general-aviation and commercial aircraft portray them as a critical threat to aviation safety.

An aircraft encountering a microburst on approach to land will experience a dramatic increase in headwind, causing increased lift. The extra lift will keep the airplane from descending to the runway. An unsuspecting pilot might pull back on the power to counteract the sudden increased lift. Wrong move, because now the airplane has flown through the shear and is on the other side, with the wind on its tail. When the wind speed is subtracted from the groundspeed, the airplane may not have enough airspeed to remain airborne. Many of the techniques recommended for surviving microburst encounters have resulted from the posthumous contributions of the flight crew of Delta Flight 191 at the Dallas-Fort Worth Airport, Texas, and USAir 1016 at Charlotte, N.C.

While technologies to alert pilots to the possibilities of wind shear, downdrafts and microbursts are developing rapidly, there's still a long way to go. More information will certainly make the pilot's job easier and flying safer. But no matter how informative and sophisticated weather observations become, when airplanes fly in the vicinity of adverse weather, the most important observations will always come from the left seat. P&P