How Air Traffic Control Helps Pilots Avoid Storms

By Fred Simonds, Special to Aviation.com
posted: 01 July 2008 02:00 pm ET

While you're buckled comfortably in your airplane seat, the public address system unexpectedly crackles to life. "From the flight deck, passengers please return to your seats and fasten your seat belts." No great surprise, it's thunderstorm season. But when the announcement is followed by "And we'd like the cabin attendants to take their seats as well," that means there is bumpy or even downright rough weather ahead.

Even so, the ride turns out better than you expected. The airplane turns this way and that as the pilots seek smooth air. But how do they know which way to turn? Yes, they have weather radar in the cockpit. But pilots get help from air traffic control (ATC), too.

The thunderstorm threat

The major hazard to an airplane from a thunderstorm is not lightning. Nor is it rain or clouds. It's the convective motion of the air — the powerful up and downdrafts that can be muscular enough, in extreme cases, to upset an airplane and even damage it or worse. Not even the best-built airplane can defy strong thunderstorms, which ATC grades from Level 1 ("weak") to Level 6 ("extreme"). ATC helps airplanes deviate around these storm cells with radar.

In a word, radar "sees" precipitation — which might mean rain, hail or snow to ATC, since current radars cannot tell the difference. Radar waves bounce off moisture and some of that energy reflects back to the radar antenna. The radar receiver detects that energy and after computer processing, shows the return on the controller's screen.

The right radar for the right job

In the world of ATC, there are two general kinds of radar. Those used near airports are called Airport Surveillance Radars and show precipitation as a mosaic of small squares, with the darker ones indicating more precipitation. Approach controllers overlay this quilt-like mosaic atop their aircraft target display and then guide airplanes around darker areas.

Radars that track aircraft at greater distances and at higher altitudes are called Air Route Surveillance Radars. Since ARSRs show only two levels of precipitation, most are augmented by a more helpful weather overlay system called WARP, which stands for Weather And Radar Processing.

WARP gets its information from NEXRAD, or Next Generation Radar. You may be familiar with NEXRAD through its well-publicized tornado warning center in Norman, Okla. and/or its availability on the Internet. WARP processes NEXRAD data into a form useful to center controllers, which they again overlay atop aircraft blips.

NEXRAD works through its own set of 158 radars designed specifically to analyze weather. Unlike traffic control radars, NEXRAD uses Doppler-shift technology that takes advantage of the fact that a radar return has a slightly different frequency from the pulse that was sent.

This simple truth allows NEXRAD to derive valuable information of great use to controllers, including:

- The highest altitude of the storm
- An estimate of how much water is in the storm
- The probability of hail, severe hail and the hail's size
- The speed and direction of the storm
- Detecting rotating thunderstorms, which can mean the presence of tornadoes

WARP information can be up to 6 minutes old, but even so it is impressively accurate. Next to keeping airplanes safely separated, severe-weather avoidance is a controller's highest priority.

Ask the weather man

For high-altitude aircraft such as jetliners and for radar coverage in between airports, the Federal Aviation Administration (FAA) operates 21 Air Route Traffic Control Centers across the United States. Each one is staffed with Center Weather Service Unit (CWSU) meteorologists. These specialists provide minute-by-minute weather information to aircraft, with special emphasis on hazardous weather. They also advise on weather that might affect the flow of air traffic.

Their briefings can be scheduled or unscheduled as weather conditions evolve. One of the most useful unscheduled briefings is the Center Weather Advisory (CWA), which warns in part about thunderstorms, icing and turbulence. CWAs are broadcast on receipt by both center and approach controllers to all aircraft on their frequencies and serve as a heads-up to aircraft in flight.

Ride reports

Sometimes a controller will simply query an aircraft for a "ride report." The pilot answers informally as to how smooth or bumpy it is. Pilots can also ask controllers for a ride report. With several reports, the controller can assemble a mental picture of where the bumps are in his or her area. Equally, the pilots can form the same general picture since they get to know where other aircraft are as they listen to one another on the radio.

Airlines will not hesitate to spend fuel — even at today's prices — if pilots need to deviate for reasons of turbulence. It's a non-issue. One experienced flight attendant told the author that a co-worker on another flight had been injured because of turbulence. "It's nothing to fool around with," she said.

When it's turbulent, perhaps the safest thing we can do is to cinch our seat belts a bit tighter. We might, however, stop short of praying for winter.

- NORAD: Watching the Skies for 50 Years
- Image Gallery: NASA Dryden Flight Tests
- The Top 10 Airline Meals