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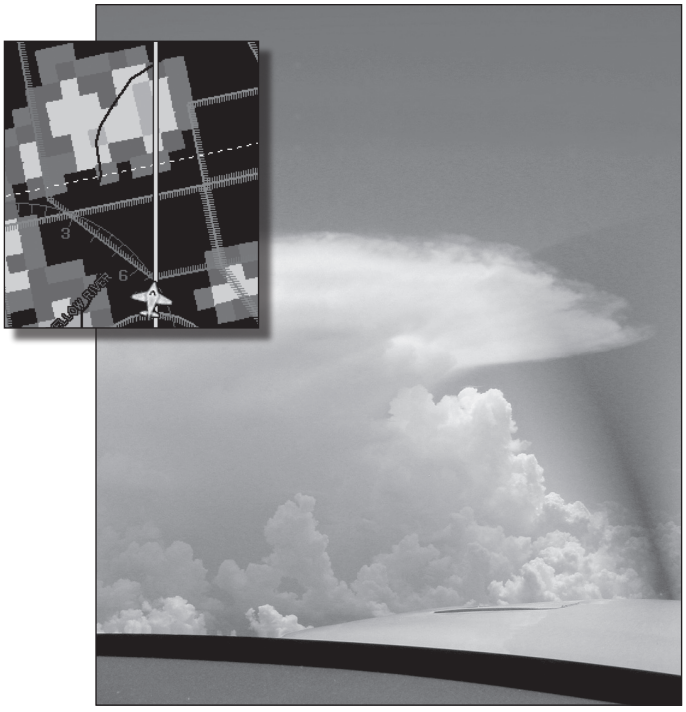
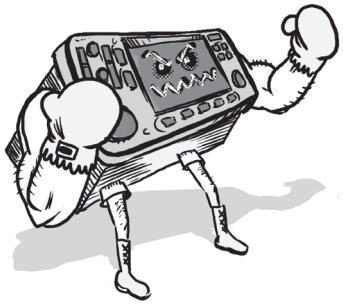


It doesn't look that bad, does it? ... page 6



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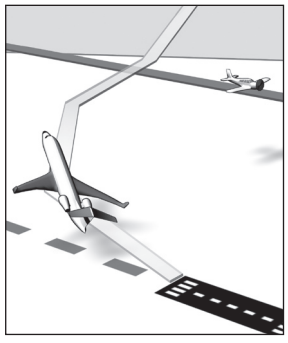
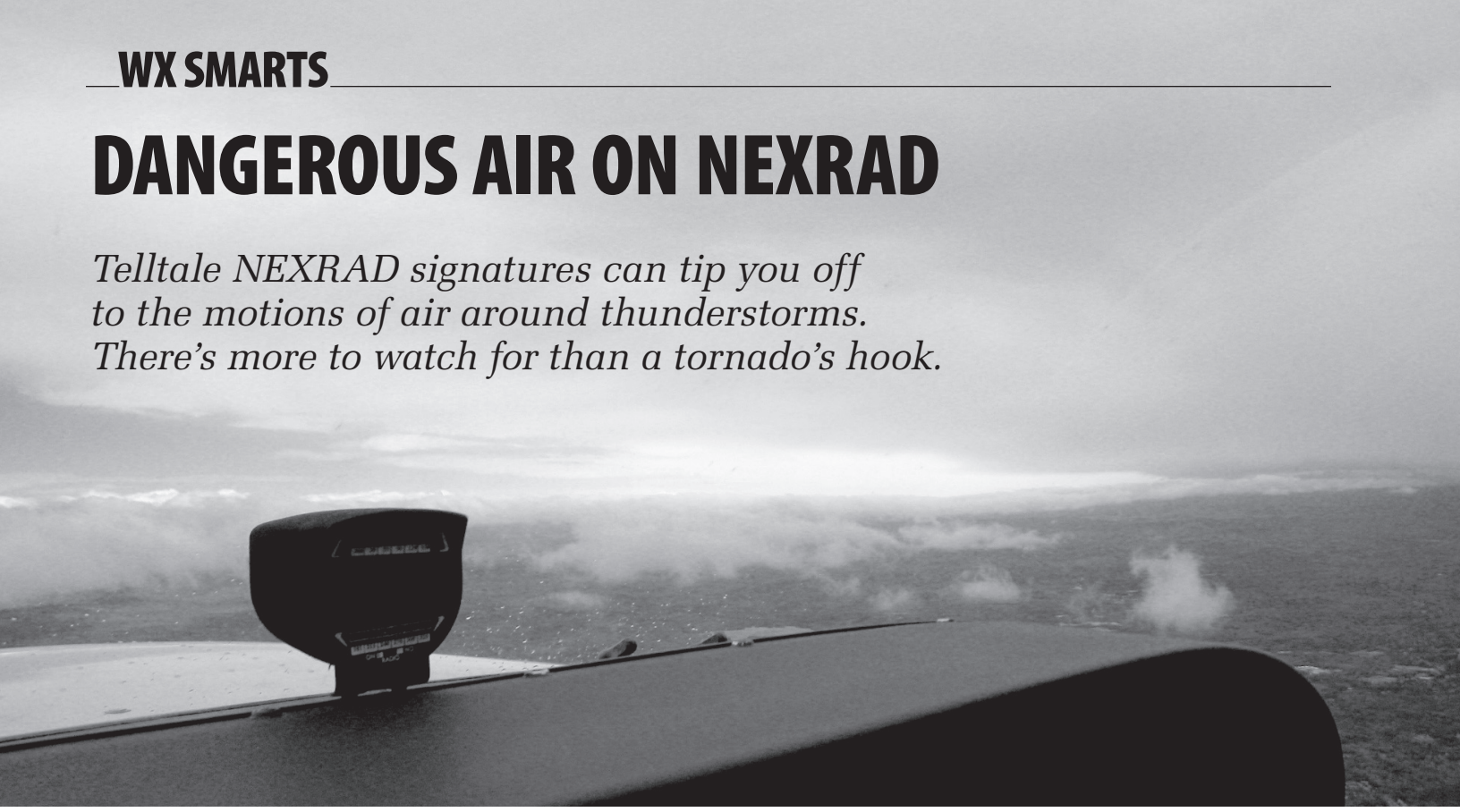


Conflicts ... page 14

DANGEROUS AIR ON NEXRAD

Telltale NEXRAD signatures can tip you off to the motions of air around thunderstorms. There's more to watch for than a tornado's hook.



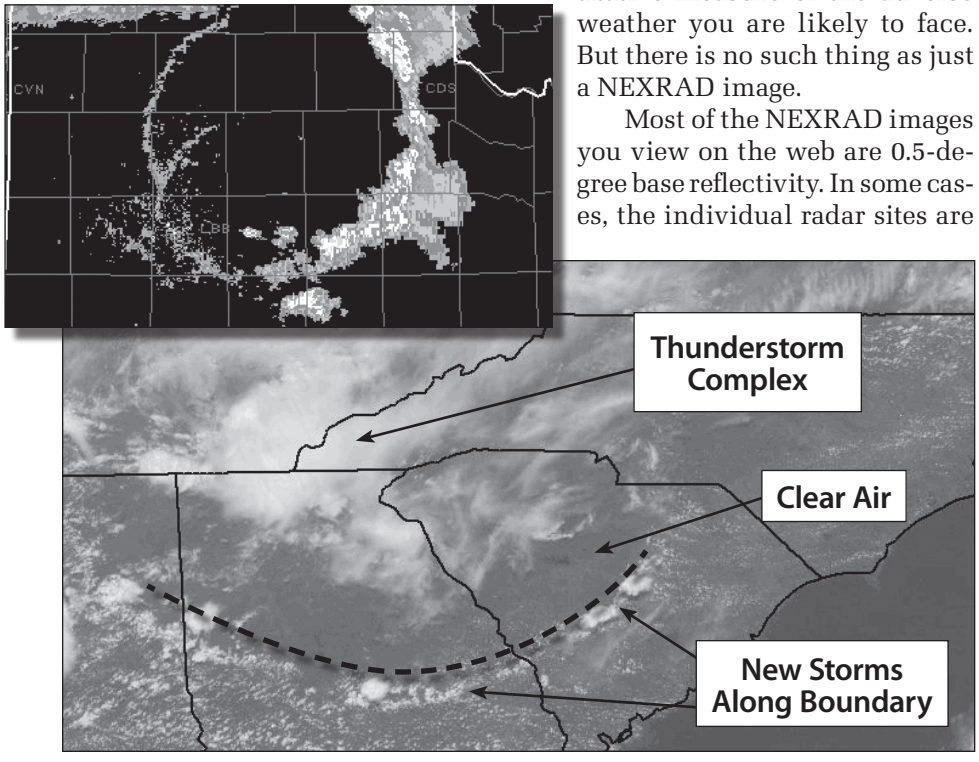
by Scott C. Dennstaedt

Getting your first taste of satellite-based weather is bittersweet. On one hand, you are happy to have a familiar product in the cockpit. On the other hand, it's now tempting to bungle into a convective jungle you would have simply avoided in the past. Part of keeping yourself safe is knowing what shapes to watch for on the screen and what information might be missing.

NEXRAD images have high glance-value woven into each and every frame. These images provide more than just weather data; they provide both a qualitative and quantitative measure of the adverse weather you are likely to face. But there is no such thing as just a NEXRAD image.

Most of the NEXRAD images you view on the web are 0.5-degree base reflectivity. In some cases, the individual radar sites are sewn together into an image called a mosaic. Sometimes you'll see an image that's a composite of all of the elevation scans of a particular radar. Satellite-delivered cockpit weather is a composite image and may hide critical information.

The other thing to remember is that any thunderstorm is worthy of your attention. A severe thunderstorm exploding upward through the atmosphere can ruin a day like a sinkhole on the freeway at rush hour. But understand that torrential rain, microbursts, lightning, turbulence and reduced visibility don't qualify a storm as severe. That means pi-



*Two outflow boundaries on Nexrad (**upper left**) move westbound away from a complex of thunderstorms moving to the southeast. Outflow boundaries such as these are rarely a threat to aviation unless they trigger new storms along the boundary. That's what's happening in this visible satellite image (**lower left**). Outflow from thunderstorms over eastern Tennessee is stabilizing the air immediately behind the boundary, but it ascends later to generate new storms in South Carolina and Georgia.*

lots need to use a more refined set of criteria when evaluating the bite a thunderstorm might deliver, independent of what the NWS says.

Which Way Is It Going?

NEXRAD can show the direction of movement and, to a lesser extent, speed of movement. Most thunderstorms we see on radar will be on the move. Horizontal movement of air masses or other boundaries typically induces vertical motion or lift. This allows thunderstorms to tap into the available potential energy stored aloft, as well as the upper-air movement. In most cases, there are two motion vectors that drive the direction of storm movement.

The simplest case is a line of thunderstorms that develops on an air-mass boundary such as a cold front. The entire line itself moves in the same direction as the air mass. However, the individual convective cells in the line typically follow the upper-level flow above 500 mb (about 18,000 feet). Most cold fronts move northwest to southeast, with an upper-level flow from the west or southwest. So it's like these storms are flying in a crosswind: The entire line of storms is moving on a northeast heading, but individual cells are drifting eastward while they do so.

Weak flow, pulse or air-mass thunderstorms may sit almost stationary or move in unexpected directions, especially when associated with sea breeze fronts or outflow boundaries. In stagnant situations where there's no important change of air mass, daily heating is usually sufficient to get a new round of thunderstorms going. Each day's thunderstorms lay down outflow boundaries that will almost certainly play a role in the next day's activity.

Cold Air On The Move

Perhaps one of the most common NEXRAD signatures is an outflow boundary. These are seen as a thin, low-reflectivity, crescent-shaped returns moving rapidly away from a thunderstorm or complex of thunderstorms in just about any direction. Cold, stable air is the exhaust of deep, moist convection, descending in downdrafts and then spreading outward like pancake batter poured on a griddle. The radar is essentially seeing the density of this cold air.

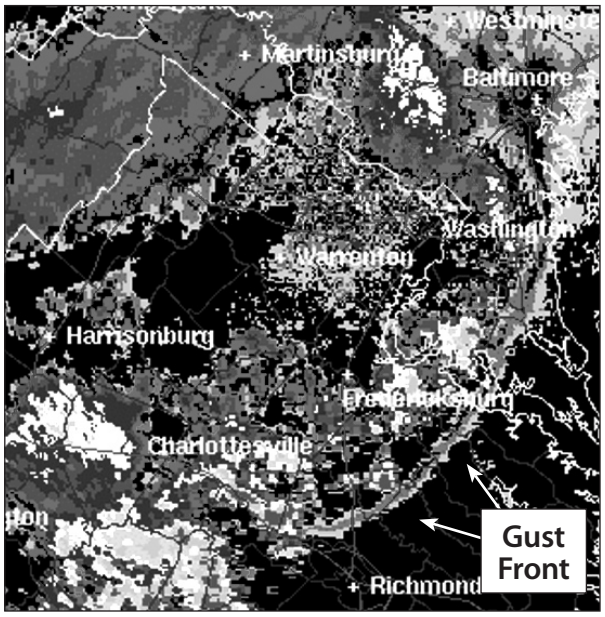
Most outflow boundaries are benign, low-level events. I heard of one pilot who flew through one at a fairly low altitude and picked up a ton of static on his radio, effectively wiping out communications for a little while. No bumps, just static. Because they are a low-level event, outflow boundaries are only seen when they are within about 100 miles of the radar site. It may appear to dissipate on the radar loop, when in fact, it has essentially ducked under the radar as it propagates away from the radar site.

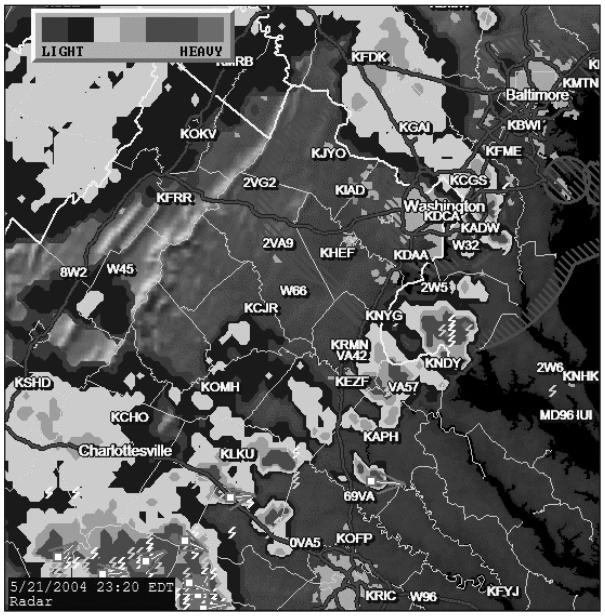
Outflow boundaries that are seen propagating out away from the leading edge (in front) of the thunderstorm should be avoided, however. After spreading outward, the leading edge of the outflow—often called a gust front—can develop new storms.

A serious gust front is normally associated with a strong line of thunderstorms or a mesoscale convective system (MCS). Gust fronts contain potentially severe straight-line winds. The further the gust front is from the radar, the less likely the radar will see it. When it does, it is characterized by a bow-shaped, low reflectivity return five or more miles ahead of the actual line of thunderstorms. Normally it propagates about the same speed as the line and may connect up with the line. It's best seen on the 0.5-degree, base reflectivity image.

Don't count on your satellite-based weather to pick up an outflow boundary or gust front. Low-power returns are typically filtered as non-precipitation echoes. For this reason, don't try to beat a line of thunderstorms to the airport based on their

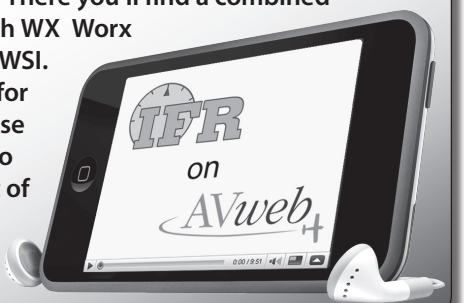
Below: *The low-power returns ahead of a line of thunderstorms in the upper image is a gust front. Gust fronts such as this may appear in some Nexrad images. The lower image is the same storm over the same area but from XM satellite weather. You can see the gust front is filtered out.*





PODCAST **What really goes into cockpit Nexrad?**

Log onto our sister publication, www.avweb.com, and click the PODCAST button in the upper right of the page. Or go to http://www.avweb.com/alm?ifrmag_podcast20090621. There you'll find a combined interview with both WX Worx (XM weather) and WSI. They suggest tips for how pilots could use this data in flight to generally stay out of trouble in stormy skies, as well as traps to avoid.



NEXRAD position; you may make it to the airport before the rain and hail begin, but you might also be met with 50-knot gusty winds. This could push your limits for a crosswind landing.

Shapes to Know

Most gust fronts occur with lines of thunderstorms that exhibit a bow-like structure in the reflectivity data called a bow echo. These show up nicely on satellite-based weather. Any line of thunderstorms that exhibits a bow echo will often contain strong and potentially severe straight-line convective winds ahead of the line, even if there's no apparent gust front.

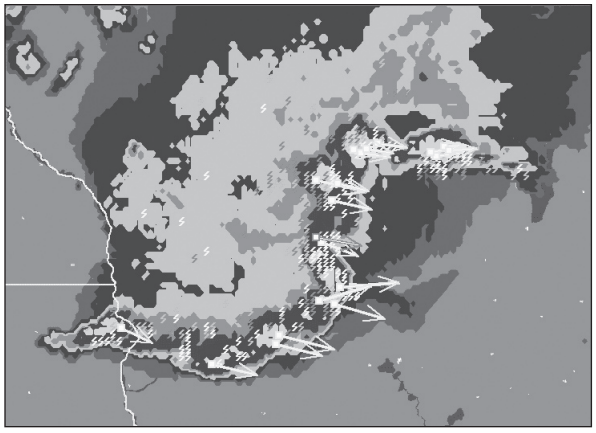
A derecho (pronounced deh-REY-cho) is a long-lived, convective windstorm that is normally associated with a rapidly moving line of thunderstorms or MCS. It can persist through the night, traveling hundreds of miles, covering a 250-mile-wide path, with winds that vary in strength but can exceed 60 knots. Often derechos are associated with curved signatures similar to a bow echo.

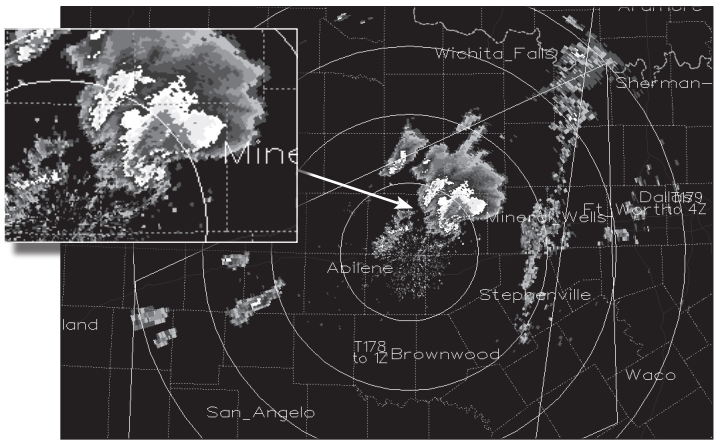
A hook echo is perhaps one of the few signatures that many pilots may recognize easily. Best seen on the 0.5-degree base-reflectivity product, a hook echo is a sign of rotation within a thunderstorm. These are typically associated with supercell thunderstorms. Supercell thunderstorms are often isolated from other thunderstorms and are characterized by the presence of a mesocyclone or a thunderstorm that has a deep, continuous rotation. In the Southern U.S., thunderstorms often have heavier precipitation and that tends to obscure the classic hook signature, and not all supercell thunderstorms produce a hook echo even when they do spawn a tornado or two.

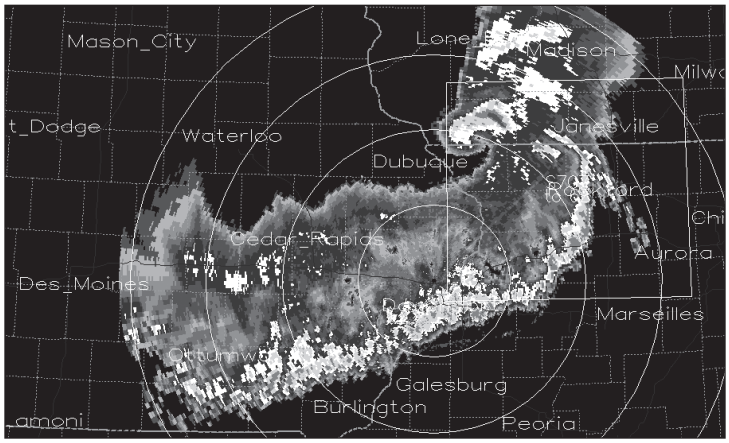
Since the XM-based satellite weather product is a composite image, don't count on seeing the hook echo. Often it is masked out by high-level returns that make up the composite image.

Combine the bow echo and hook echo and you've got a book-end vortex. A book-end vortex normally forms on the north end of a bow echo. It can be associated with tornadoes, especially with small/compact bowing segments in the cool season. Usually in the warm season, it's just broad areas of low pressure that forms as the middle portion of a developing squall line accelerates out along the leading gust front.

Many of these rotational storms







*This bow echo (**left**) was moving almost due south, despite the fact that the individual cells in the bow were moving more southeasterly with the upper-level flow. Moral: The storm arrows might not tell the whole story on hazardous-weather movement. A bit easier to overlook is a small hook echo (lower left), but that could spell tornados, so you'll want to steer well clear. Combine a bow and a hook echo and you get a book-end vortex (below), which is worthy of avoidance by a wide margin.*

start out with a tornadic vortex signature (TVS). This is a rotation seen on Doppler radar products that are usually diagnosed by computer software warning the meteorologist that a tornado may be imminent. Essentially the computer detects both inbound and outbound velocities (how fast the air is moving toward and away from the radar) and determines when these exist in a close proximity to one another and in sufficient magnitude. At this point it is rare to see any clue on the base reflectivity image. Not all TVSs result in the generation of a tornado.

Microbursts are impossible to see on the base-reflectivity NEXRAD. They are easily identified, however, on the Doppler image as a dual-node structure that can be detected by computer software.

You may remember the fate of Delta Flight 191 at Dallas/Fort-Worth (KDFW) that fell victim to a microburst from a high-based thunderstorm (10,000 feet). High-based thunderstorms with heavy rain should be of particular concern to pilots, because they signal a deep, mixed layer, a high lapse-rate and plenty of precipitation to fuel a strong downdraft. High-based thunderstorms do not seem threatening (especially to those pilots flying turbojets), which makes a pilot more likely to stumble into the path of one.

In a high-based thunderstorm with an extremely dry environment between the base and the surface, little or no rain may reach the surface, but the winds may exceed hurricane force and approach the speeds of a moderate tornado—168 mph.

Most of the training that is available has said to avoid large, supercell-type thunderstorms in the belief that this will prevent encounters with microbursts. However, none of the known microburst encounters with aircraft have occurred in or around supercell storms. In fact, microbursts are frequently generated from benign-appearing cells and not necessarily always in the dissipating stage of a thunderstorm.

(continued on page 23)

GPS APPROACH BLUNDERS

You've pressed the buttons and turned the knobs. Now you're ready for the RNAV approach. What could possibly go wrong?

by John Ewing

Sophisticated GPS receivers give us the ability to fly instrument approaches with greater accuracy and safety, but these systems are also providing new ways to screw up. Data culled from the NASA Aviation Safety Reporting System (ASRS) shows that pilots regularly experience "What's it doing now?" moments.

Here are six simple steps you can take to avoid the most common errors in flying RNAV approaches.

Know Your Equipment

Launching into the soup with a GPS you're not sure you know how to use is a fundamentally bad idea. Yet that's exactly what many pilots have done and continue to do. The error part of "trial and error" has no place in hard IMC. Without knowing how to program and manage your aircraft's systems, you may find yourself behind the eight ball, as this Cessna 310 pilot did:

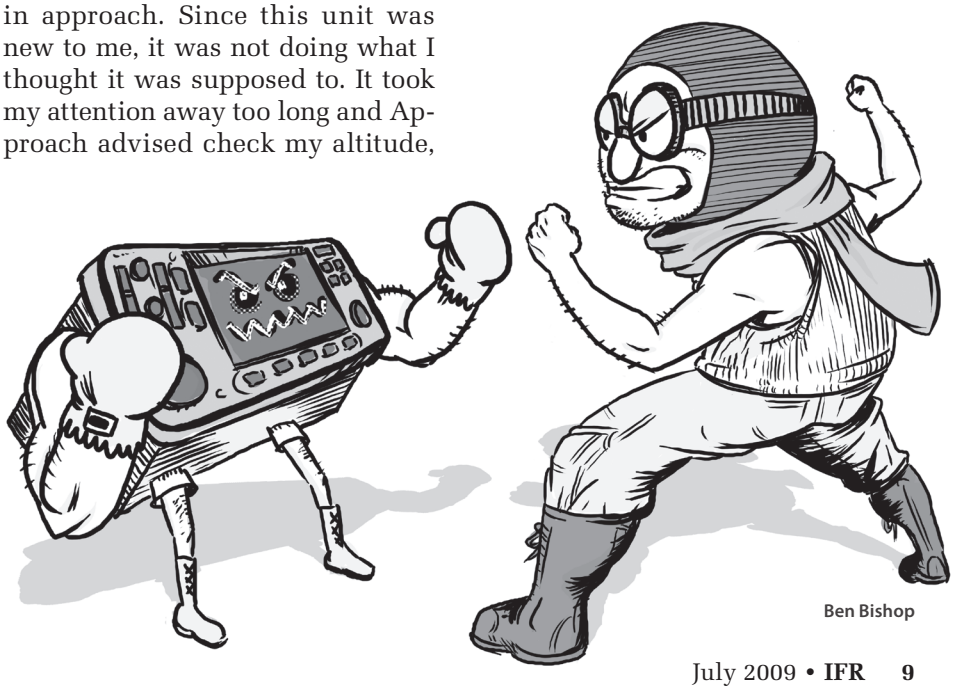
"… went to Garmin 430 to put in approach. Since this unit was new to me, it was not doing what I thought it was supposed to. It took my attention away too long and Approach advised check my altitude, and I was at 1700 feet not at 2100 feet … I probably need much more training on the Garmin 430 before next IFR flight"

Many manufacturers now offer training tailored to specific aircraft types. If you have an older aircraft with a newer GPS, the AIM Section 1-1-19(p), lists the tasks you should know cold.

An instructor savvy on your model of GPS can help you learn these tasks, such as performing a RAIM check, loading procedures, flying via vectors or on your own navigation, flying published missed-approach procedures, flying ATC-modified missed approach procedures and navigating holds. That instructor should also give you tips about using your own equipment, such as customizing the fields on the GNS 430s Nav 2 screen to meet your personal preferences.

Brief the Approach

Mistakes can happen even without GPS on board, and briefing the ap-



Ben Bishop

a visual segment, there's something strange enough with the nearby terrain to make a careful analysis of the approach highly recommended. These approaches occasionally appear within the U.S., such as at Lake Tahoe, Nevada (KTVL).

It's common on these approaches for the MAP to be located further away than the required minimum visibility for the approach. At the VOR-A approach into St. Thomas (TIST), just 20 miles west of Beef Island, the MAP is roughly four miles from the airport while the required minimum visibility is only two statue miles. In fact, at the MAP on this approach, the runway will be about four miles behind you. Now you don't see that very often. Essentially, these are procedural approaches that terminate in a contact approach. Throw in some darkness, rain and unfamilar terrain and you've got some serious pucker factor.

Living History

Some day in the not-too-distant future, NDBs and ADFs will exist only in history books and fading memories. That day hasn't come to the Caribbean, as NDBs remain the only way to get into many out-of-the-way airports.

It's easy to fall into the groove of flying nothing but ILS and GPS approaches. Next time you're up for some recurrent, consider a Monty Python-themed session: "And Now for Something Completely Different."

You never know when you'll have a similarly-themed flight.

Lee Smith has taken his bathing suit and Hawaiian shirt out of his flight bag, but sometimes still pines for a night NDB.

DANGEROUS AIR ON NEXRAD

continued from page 9

Speaking of sneaky cells that can turn dangerous, a cell that turns away from a line or group of cells is often severe. If you see a single cell doing its own thing among a cluster of storms, that's one to give a wide berth. This is especially true of a thunderstorm that turns to the right of the main, upper-level flow.

NEXRAD on the Web

There are literally hundreds of websites that host some form of ground-based radar, and not always from the NWS WSR-88D Doppler radars. Most TV stations have their own Doppler radars that can be viewed online. Also, WxWorx has just announced WxWorx Online. This is the same data you'd get on your satellite weather receiver in the cockpit (see www.wxworx.com).

When looking at the various images on the web, there's no accepted standard from a color perspective, so you need to pay attention to the reflectivity values. I like radar images that allow you to zoom in on the weather. If you are interested in a fairly comprehensive site for pilots, try http://maps.avnwx.com.

When thunderstorms begin to show visible signs that are easily recognizable, they are already dangerous and powerful. But many thunderstorms can drop a tornado without ever having any classic reflectivity signatures described here. Midget supercell thunderstorms with tops of only 24,000 feet can produce tornadoes. Lightning is not always present so don't rely on that as an indicator of severe, convective turbulence. What looks like a harmless congested cumulus can pack a serious punch.

Weave a couple different NEXRAD presentations into your preflight, and plan for a 50-mile distance from any storms that may exhibit any of these classic signatures. Then use your satellite weather to keep making decisions en route, remembering it may be filtering out some telltale storm signatures.

See Scott's aviation weather website at www.avwxworkshops.com