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IFR

The Magazine for the Accomplished Pilot

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Control freak ... page 6 *Partial Panel ... page 21*

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THE STEALTHY STORMS

Embedded thunderstorms can be deadly poison any IFR flier. The best antidote is reading the signs before takeoff.

by Scott C. Dennstaedt

Ever read about or talked to a pilot who has "stumbled" into a thunderstorm and survived? It was probably an embedded thunderstorm they found. Embedded thunderstorms are not visible to the naked eye. They don't look impressive from a distance and you cannot discern any classic storm structures.

Embedded thunderstorms don't visibly start out in that FAA-predicated cumulus stage and build into an FAA-predicated mature thunderstorm. Instead, they are part of a large scale precipitation event normally associated with a messy frontal zone or area of low pressure.

They may also be associated with lake-effect instability or orographic instability (lifting due to rising terrain). They are often found around the remnants of a tropical storm or hurricane. Embedded cells can be found on either side of the frontal zone and rarely become severe. They might not have a gust front or low-level wind shear of any kind.

They are incognito and stealthy, however, and can rear their ugly countenance for anywhere from a few moments to several hours.

Flying Blind

With embedded thunderstorms you lose your best defense: Your eyes.

Staying visual is nearly impossible unless you are flying over these cells at FL300. Visibilities and ceilings near the embedded thunderstorms may be low, with light to moderate rain including drizzle one hundred or more miles around the embedded cell.

Embedded thunderstorms are normally part of a region of heavier precipitation that hangs around warm and stationary fronts. Gentle lifting typically occurs in such fronts, however, the right upper-level support opens the door for convective onset and thunderstorms.

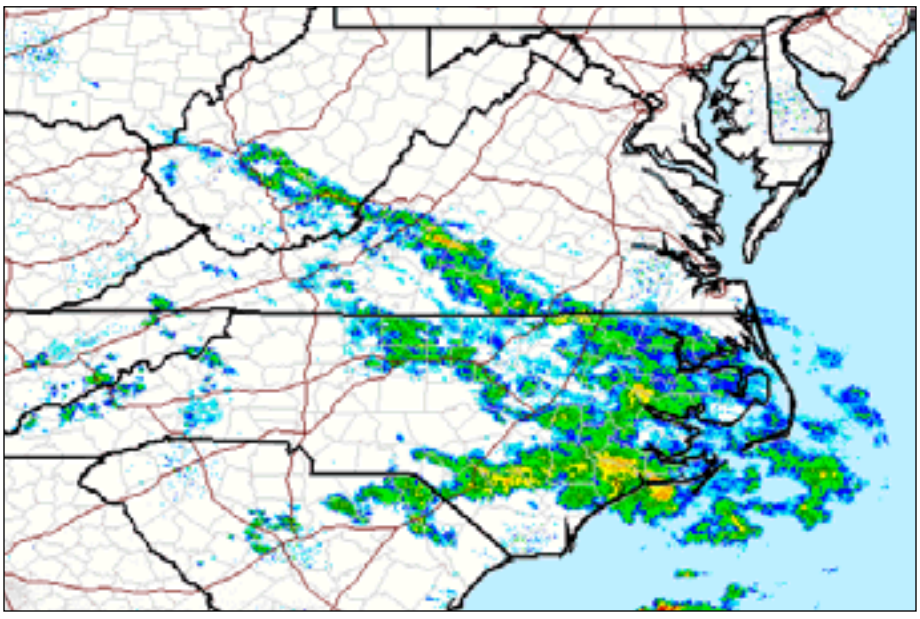
The key is determining, before you depart, if the area is likely to be convective.

Here's the scenario. You are about to depart IFR and you notice an area of precipitation on the NEXRAD image that concerns you. Of course, it's right along your route. You don't remember seeing a forecast for thunderstorms when you looked at the weather the previous night. But you are in the Mid-Atlantic U.S. where thunderstorms are common, including embedded thunderstorms. What now?

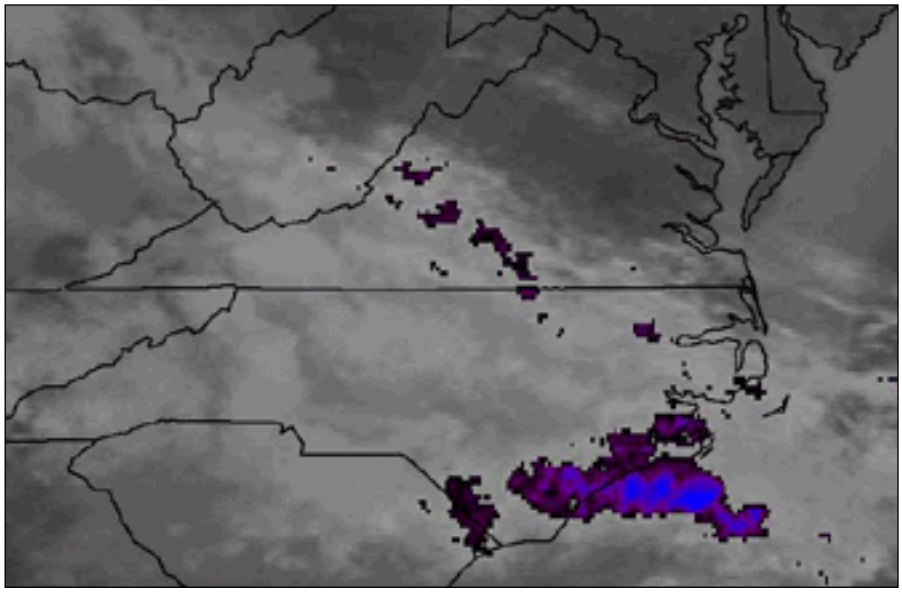
The key is to determine if the area of clouds or precipitation is convective or likely to be convective before you depart. Up-to-the-minute lightning data is very sparse on the internet. Even if there are no lightning strikes at the moment, convectively-driven precipitation isn't pleasant to experience first hand.

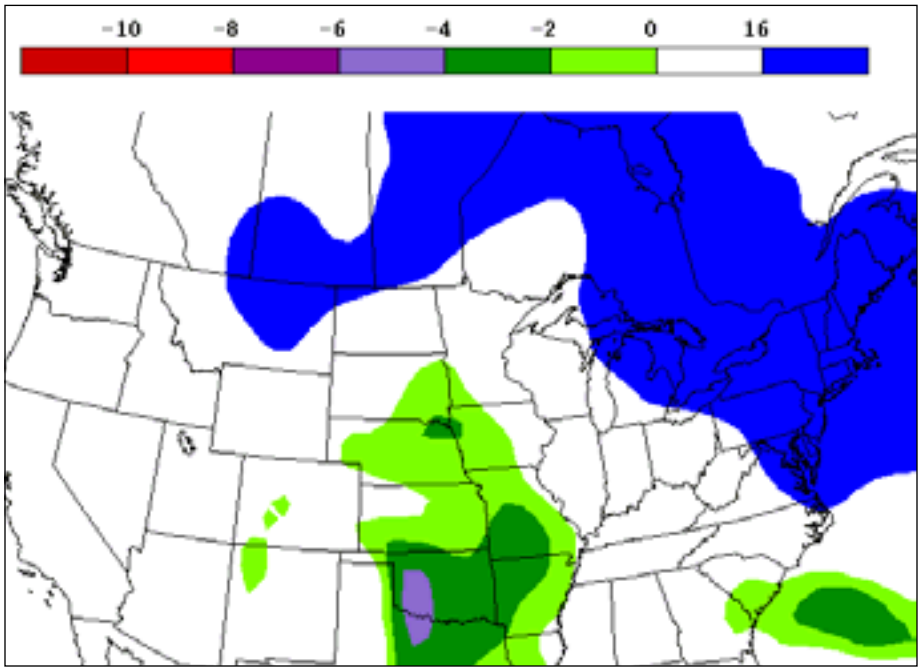
It is rare to see thunderstorms that are embedded appear in a terminal aerodrome forecast (TAF). The terminal area is small (five statue mile radius) and the chance of an embedded thunderstorm rolling through the terminal area or terminal area's vicinity (10-mile radius) is rather small.

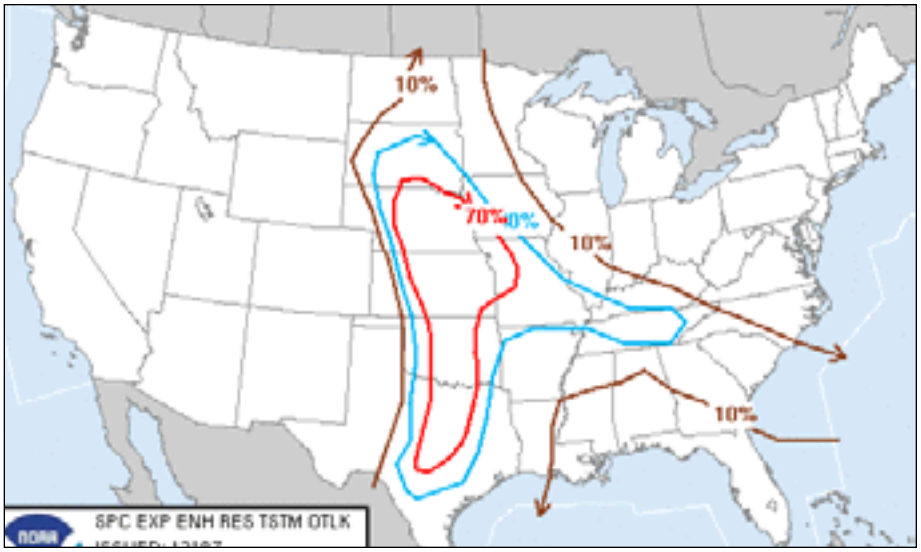
As a result, the forecaster will likely only include –RA or –SHRA in the TAF. In some cases, the terminal forecaster might include a cloud type of CB (cumulonimbus) as in 4SM VCSH OVC005CB. This is a hint that thunderstorms will be in the area even though they may not be expected in the terminal area or the terminal area's vicinity. Any



Right: *You are headed from Charlotte, NC to Baltimore, MD. The Nexrad loop shows some healthy precipitation between your departure and destination airports. Is it safe to fly through? Or will there be convective trouble?*







terminal forecast with TSRA, VCTS or CB in the cloud group is worthy of your attention when embedded thunderstorms are a possibility.

Assuming there's a real risk of embedded thunderstorms, you are more likely to find them embedded (pun intended) in the Area Forecast (FA) as WDLY SCT -SHRA/ISOL EMBD –TSRA ... CB TOPS FL280.

Besides the FA, the Aviation Weather Center (AWC) also issues a Convective Outlook and Convective SIGMETs (http://adds.aviationweather.gov/data/airmets/airmets_CB.gif). The Convective Outlook is valid for six hours and defines a larger area where one or more Convective SIGMETs are likely in the six-hour forecast window.

Even with a Convective Outlook present, specific criteria must be met before a Convective SIGMET can be issued. This includes a component of time. Active embedded thunderstorms are typically protected by a Convective SIGMET regardless of size or coverage of the area of thunderstorms. Keep in mind that Convective SIGMETs are a snapshot at 55 minutes past the hour unless the forecaster feels the need to issue a special Convective SIGMET before the next 55-minute valid time. Normally, the area of embedded thunderstorms must persist for at least

Left: *Some images to combine with the NEXRAD on the previous page. The Enhanced Infrared Satellite Image* ***(top)*** *shows a few spots of colder (taller) cloud tops in Southern Va. Cold enough for precipitation, but thunderstorms are not likely. Any lifted index that is negative implies unstable air. When precipitation and instability overlap, the potential for convective turbulence increases. The lifted index* ***(middle)*** *only shows unstable air off the coast of S.C. In fact, stable air exists over the route. The area of precipitation in Southern Va. is outside the 10-percent region of the Enhanced Thunderstorm Outlook* ***(bottom)****. Embedded thunderstorms are not likely within this line of precipitation.*

DATALINK WEATHER IN THE COCKPIT HELPS, BUT ISN'T PERFECT

Is satellite datalink weather helping with the embedded T-storm issue? Maybe.

Satellite datalink weather does include convective SIGMETs, NEXRAD and lightning data. All of these are excellent sources to show that an area of precipitation might be best viewed while on the ground. However, there are a few important limitations.

The Garmin G1000 shows the actual text of the AIRMET or SIGMET. Avidyne, on the other hand, does not serve the text, just the AIRMET or SIGMET graphic. In either case, if a Convective SIGMET popped up on the display, it should certainly draw your attention about the potential for convection. You can get the text over the radio from flight watch if need be.

IR satellite images are available including a cloud tops product. Cloud tops, normally shown in shades of grey, can be nearly impossible to interpret. What's needed is a "show me tops that are higher than x feet" to highlight the tallest tops and show tops at or above your current flight level. Some satellite weather products have this feature and others do not. Keep in mind that these have a 5000-foot vertical resolution and are downloaded once every 15 minutes at best. Another method is to have a way to activate a cursor or tap the screen to show the particular cloud height at that location.

Data for echo tops and composite reflectivity are created by the same WSR-88D NWS Doppler weather radars. Echo tops are updated once every five minutes and are only used for determining the relative height of thunderstorm tops which typically equates to the strength of the storm. They should never be used to determine the top of an icing layer, for example. Similar to the satellite mosaic, echo tops have a 5000-foot vertical resolution. Echo tops exceeding FL250 should be avoided.

NEXRAD can offer a high glance value and provide strategic positioning when thunderstorms are visible. It should be used as a gross vectoring aide and is a glimpse of the recent past. Even embedded thunderstorms have a typical hard-to-miss NEXRAD signature of yellow, orange and red colors within a mass of other, lighter precipitation. In an expansive area of clouds, avoid penetrating an area that is demonstrating a high dBZ (> 40) along your route of flight. From an embedded thunderstorm perspective, sometimes NEXRAD may be inconclusive and may not exhibit any of the classic thunderstorm high reflectivity values.

Perhaps the best indicator of convective turbulence is the presence of lightning. If you don't have a Stormscope, lighting received with satellite datalink weather might be a good substitute. An important limitation, however, is that datalink weather lightning will only show cloud-to-ground lighting strikes. In other words, no cloud-to-cloud strikes are shown. Embedded thunderstorms are not typically the strongest thunderstorms on the planet and may have little electrical activity. There may be no lightning shown on datalink. *— S.D.*

30 minutes before a Convective SIGMET can meet official criteria. Consequently, the Convective SIGMET forecaster won't issue a special unless he or she feels that the embedded thunderstorm will last for more than 30 minutes.

Pictures of the Sky

Satellite images can provide a good source of information about the magnitude of a precipitation event. The satellite measures the temperature of the cloud tops as well as the surface of the Earth with an infrared sensor. The temperature of the clouds indicates how tall they are since temperature is inversely proportional to height in the atmosphere. The colder the cloud top the more likely it is to produce rain. Very cold cloud tops can indicate convectively-driven precipitation. If no precipitation is falling, then these clouds might simply be a high-level cirrus deck.

Specifically, the infrared satellite image can be enhanced (http://wwwghcc.msfc.nasa.gov/GOES/goeseastconusir.html) to depict regions that contain higher cloud tops. Clouds with warmer cloud tops will be coded typically as shades of grey. Any area that is colored-enhanced is a likely region of heavier precipitation. If the enhancement has multiple concentric levels, convective potential is likely.

There are infrared satellite images that depict the cloud top temperatures using various colors (see http://www.rap.ucar.edu/weather/satellite). How cold is of concern? Any temperature approaching -30 degrees Celsius or colder is likely to produce convective turbulence.

At this temperature, tops are likely at FL250 or higher and should be avoided if precipitation is falling from these clouds. While exceptions do exist, embedded thunderstorms don't necessarily sport tops to FL400 or higher. Frequently, tops average around FL300.

There are also cloud tops products that will equate cloud top temperatures to cloud top heights; certainly ideal for pilots. Heights are typically depicted with colors at a resolution of 5,000 feet. Be aware that the cloud top height analysis

charts are conservative. In other words, actual tops are typically lower than shown by these products (http://www.rap.ucar.edu/icing/cip/loop_cip_ctz.html).

Lifted index charts are also of value to pilots (http://www.emc.ncep.noaa.gov/mmb/namsvrfcst/lift.animate.html). Knowing where the stable and unstable air is located will help you decide if the precipitation might be convective. Any lifted index that is negative is worthy of your attention. If your route includes a negative lifted index, be prepared for the likelihood of embedded thunderstorms.

The Storm Prediction Center (SPC) produces an enhanced thunderstorm outlook that is valid from 12Z through 03Z (http://www.spc.noaa.gov/products/exper/enhtstm). This product provides the probability of thunder over the CONUS. It divides the probability into four distinct regions that includes a 10, 40, and 70 percent region as well as the remainder which is less than 10 percent. If the precipitation is in a region of 10 percent or greater, thunderstorms, including embedded thunderstorms may be likely.

Once you are airborne, a spherics device such as a Stormscope is your best defense against penetrating an area of precipitation containing embedded thunderstorms. Occasionally, you might see a false return or two that might convince you to avoid the area of precipitation or clouds. A Stormscope, for example, will typically display a symbol for any lightning strike that has some vertical component (which most do). This means that both cloud-to-ground and cloud-to-cloud strikes will be shown. Essentially, if you see any activity, it is best to avoid the precipitation area unless you can climb on top.

When in doubt, don't go there. With respect to embedded thunderstorms, that's the best advice I can give.

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THE QUIZ

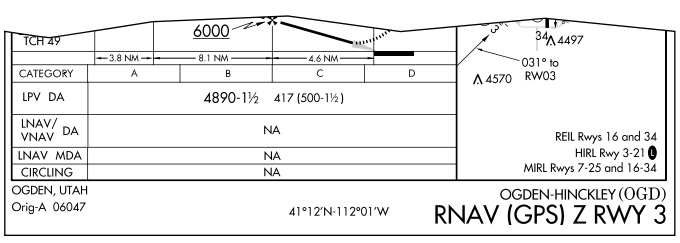
The FAA has made final its most recent take on RNAV as well as many of the terms associated with it and new RNAV approaches. How much do you know on the topic? If you're really motivated, the complete text can be found here: http://a257.g.akamaitech.net/7/257/2422/01jan20071800/edocket.access.gpo.gov/2007/E7-10609.htm. The answers to just these questions are on page 23.

1. The term RNAV actually stands for:
- **a. Area Navigation**
- **b. Random Navigation**
- **c. Radial Navigation**
- **d. Radial Navigation and Approach Vectoring**

2. True or False: The LNAV/VNAV and LPV approaches you can fly with a WAAS IFR GPS are neither precision nor non-precision. They are called Approach Procedures with Vertical Guidance.

3. What does LPV officially stand for?
- **a. Lateral Navigation with Vertical Guidance**
- **b. Localizer Precision with Vertical Navigation**
- **c. Lateral Precision Vectoring**
- **d. Localizer Performance with Vertical Guidance**

4. Minimum Safe Altitude (MSA) is now ``expressed in feet _____, depicted on an approach chart that provides at least ___ feet of obstacle clearance for ___ use within _____ from the specified navigation facility or fix.''
- **a. AGL, 1000, navigational, 25 miles**
- **b. MSL, 1000, emergency, a certain distance**
- **c. AGL, 2000, navigational, 10 miles**
- **d. MSL, 2000, emergency, 25 miles**



5. FAR 91.183 is titled "IFR Radio Communications." Given that our brave new world of technology may use something other than a traditional radio to communicate, the FAA is changing this to:
- **a. IFR Voice Communications**
- **b. IFR Communications by Radio or Other Method**
- **c. IFR Communications**
- **d. The FAA change something in anticipation rather than in reaction? Get real.**

6. True or False: The new rule will allow IFR-certified GPS units to meet the requirement for DME above FL240.

7. Changes to FAR 91.177 would clarify that flights may be conducted below the Minimum En route Altitude (MEA) but at or above the Minimum Obstruction Clearance Altitudes (MOCA) will be OK
- **a. only within 22 miles of the VOR defining the route.**
- **b. only within 25 miles of the VOR defining the route**
- **c. anywhere along the route.**
- **d. anywhere along the route, provided applicable navigation signals are available.**