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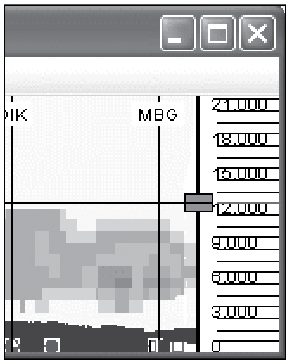
IFR®

The Magazine for the Accomplished Pilot

Pushing the ILS envelope ... page 6



Over the top ... page 9

Stupid junk ... page 14

ALSO INSIDE THIS ISSUE ...

fer beneath you. Your glideslope indicator hits the limit at about 0.7 degrees, so you only have about 0.6 degrees below before you can pick up leaves and branches with your landing gear.

On glideslope and about one mile before DH, you have about 250 feet of clearance between your glideslope antenna and possible ground contact (deduct a couple feet for your landing gear). It takes only a few moments of inattention to lose 250 feet of altitude. You can do some math in the bathroom to scare yourself.

Thus, if you are to favor one or the other, favor high on glideslope as opposed to low on glideslope. Most ILS systems are sited at nice, long runways and it is always better to land long than in the approach lights. Some pilots trim for a very slight nose-up condition so the aircraft will climb above glideslope rather than descend below glideslope if they get distracted.

Remember, I said you were flying in a trough. At glideslope intercept, you are not very far into the trough. As you progress down final, the sides of the trough rise further above glideslope. That Y buffer almost goes away; so if you get full-scale localizer deflection near DH, stay on or above glideslope. Strive to never exceed one dot low on glideslope.

Getting Busted

Worried that the FAA will jump on you for pushing the limits of the localizer needle? For the record, I have to thank some nice folks at the FAA in Oke-city for confirming some really obscure facts on the ILS system to create this article. (I owe these folks a lot of beer for putting up with me.) Remember, the goal here is safety. If you know what's available and how to use it, you can be a safer pilot even when you have to recover a botched approach.

Dog Brenneman shakes up people's assumptions about the IFR system from his home in northern California.

FLIGHT PLANNING FOR ICE

Flying is all about managing acceptable risk. There are no guarantees for staying ice-free, but there are some good options.

by Scott Dennstaedt

If you're totally averse to structural icing, flying during the winter means staying out of most visible moisture when the ambient temperature outside of the aircraft (or the aircraft skin temperature) is at or below 0 degrees C.

While this simple rule will keep the aircraft out of structural icing, we know that weather isn't always as predicted. Never leaving the ground when winter dishes out any kind of clouds isn't a great solution, either, as it can mean staying earthbound for weeks.

If you're willing to accept a little more risk for a lot more utility, your goal should be to minimize our exposure to adverse weather, including structural icing.

It's Not All Ice

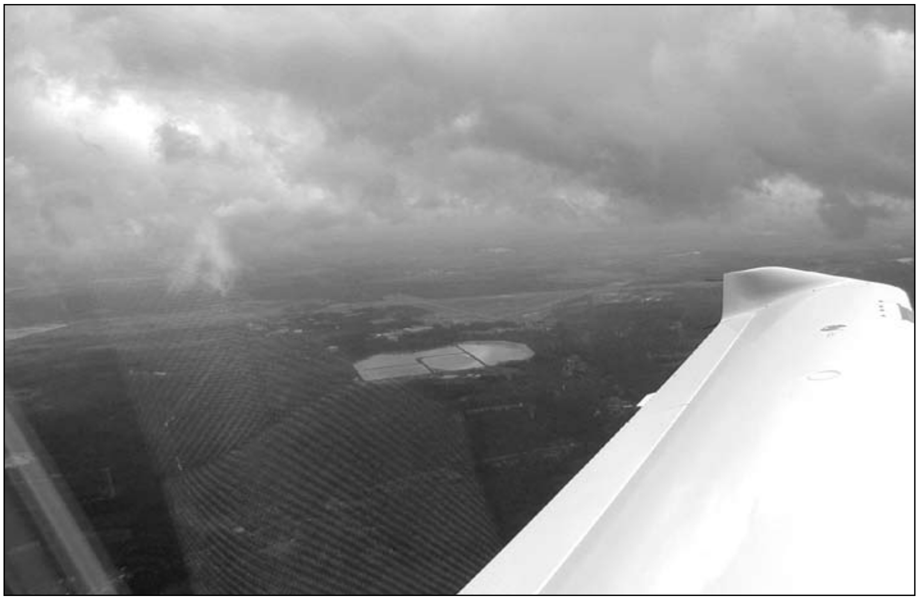
Not all visible moisture is a structural-icing threat. Snow that isn't mixed with other forms of precipitation falling from the base of a cloud won't adhere to the aircraft. It is extremely rare for supercooled liquid water to exist at temperatures below -30 degrees C. Consequently, most cirrus clouds contain only ice crystals, which just flow over the aircraft surfaces.

Pilots flying aircraft not certified for flight into known icing conditions rarely go right through the heart of a winter weather system. In fact, it's often a bad plan in an ice-certified ship, too. Short of a lucky hole or inversion, you have three options to minimize your exposure to an icing threat: go under, go over or go around (or perhaps a combination of the three). Each of these options has some level of inherent risk.

The Lower-Risk Options

Going around the icing conditions simply means proper fuel planning

Below: *When things turn out worse than you expected, don't pass by a safe airport; instead, land and reevaluate.*



(unless you're going around because the other two options didn't work out for you). Diverting around weather eats into those precious fuel reserves, so you must resist the temptation to stretch the leg to make it to your destination or planned fuel stop.

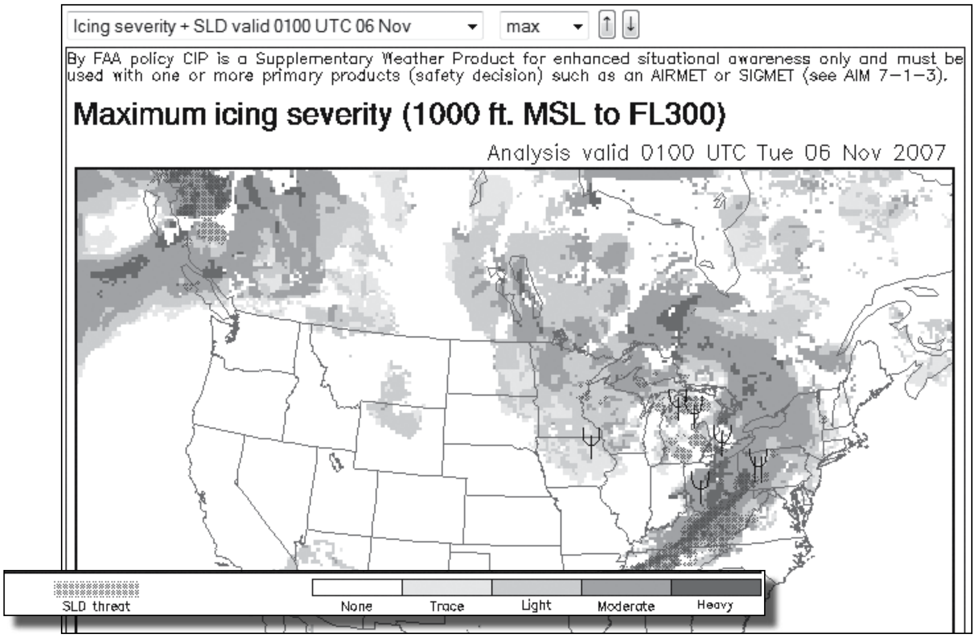
For this option, one of the best planning tools is the maximum icing product found on the Aviation Weather Center's Aviation Digital Data Service (ADDS) at http://adds.aviationweather.gov/icing/icing_nav.php. The maximum icing severity plus SLD (supercooled large drops) from the Current Icing Product (CIP) is the default image and is the one you want to examine first. It's updated about 20 minutes past each hour.

The maximum icing severity product is a composite image that shows the highest or maximum intensity of icing (trace, light, moderate or heavy) in the column of air from the surface through FL300. The maximum icing composite represents a worst-case scenario with respect to icing. It won't tell you if the icing threat shown is limited to FL180 and higher or entirely below 10,000 feet. But for those pilots who want to give all icing a wide berth, this is the preferred method. Plan your flight around the blue (and red) areas and you will almost certainly stay clear of ice.

Discovering the altitude of the cloud tops falls into one of three categories: Incredibly easy, incredibly difficult or throw-your-hands-up-impossible.

The CIP is a glimpse of the recent past. If your planned departure is a few hours away, check the Forecast Icing Product (FIP) for the same kind of data, but predicted into the future. See the FIP maximum icing probability by clicking on the pull-down selection just above the maximum icing severity image. The last selections are forecasts from one to 12 hours out. FIP isn't as accurate as CIP, but will show you where icing may be moving, dissipating or developing with time. Don't forget to recheck CIP before you depart.

Below: *If you're departing Chicago headed for Rapid City, S.D., and the least bit squeamish of icing, plan on visiting northern Missouri. The hard part might be convincing ATC to allow the U-shaped route.*

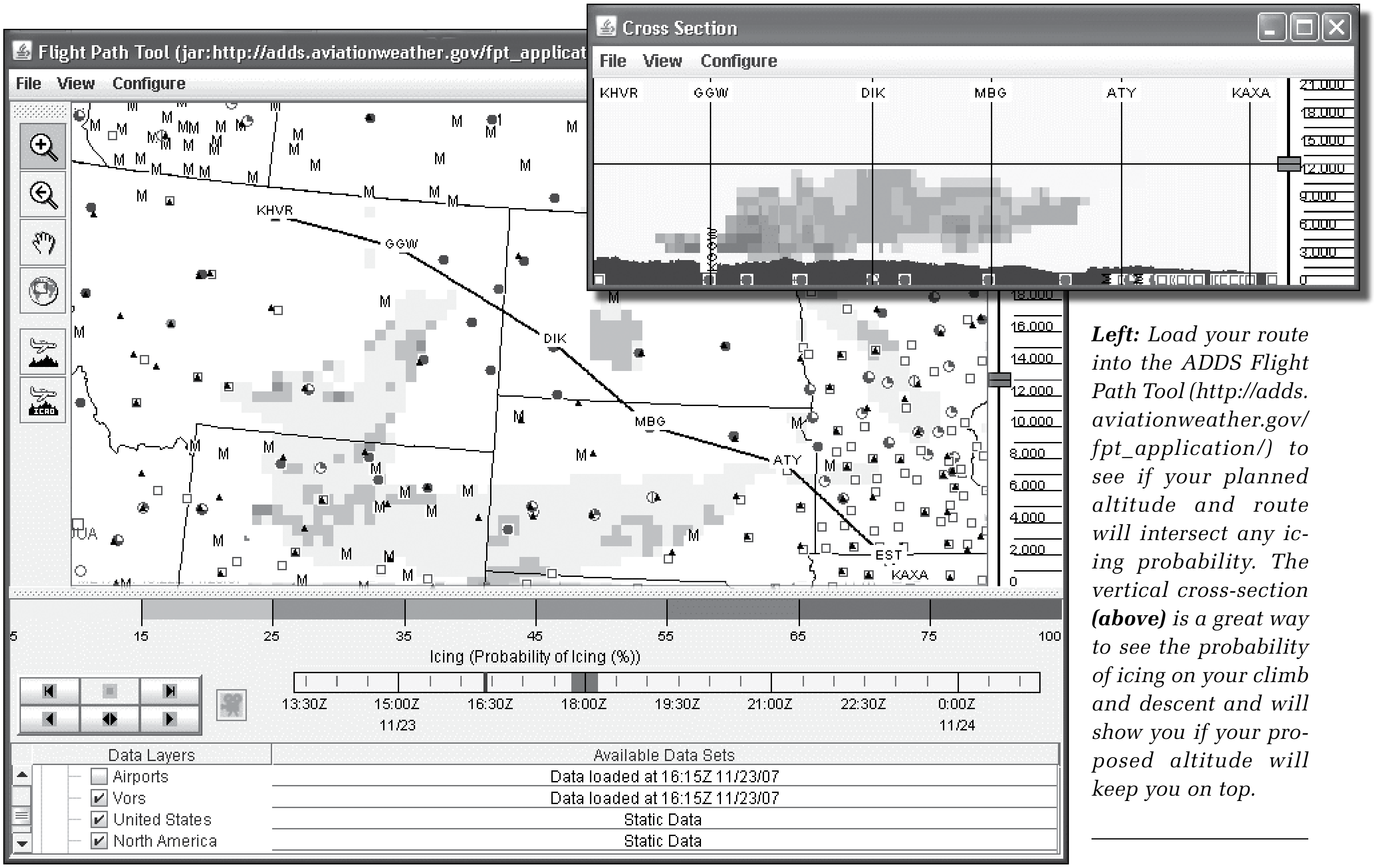


Going under the ice generally requires comparing the minimum icing altitude to the minimum instrument altitude along your proposed route. The minimum instrument altitude is right on your chart, but the minimum icing altitude can be a challenge, especially if you are crossing a fast-moving frontal zone.

At a gross level, if the lowest freezing level is higher than the minimum instrument altitude, you're golden. You'll be basking in temperatures above freezing. There may be other adverse weather to contend with, but you should be ice-free. Be careful, though. It's not unusual for the lowest freezing level to drop by four or five thousand feet when crossing a cold front. Crossing a warm front during the winter can put you in air that has multiple freezing levels. This can get messy even for the most savvy ice dog.

If the lowest freezing level is below the minimum instrument altitude somewhere along your route of flight, then you must determine if clouds and/or precipitation (other than snow) will be present. Using a combination of METARs, TAFs, area forecasts, and AIRMETs as well as CIP and FIP, you might get lucky.

METARs and TAFs tell you about cloud bases and precipitation type. If your route of flight takes you over or near a METAR or TAF station, compare the reported or forecast base of the clouds to the minimum instrument altitude. Remember that METARs and TAFs describe bases by reference to the height above the airport; so be sure to add in the field elevation before comparing with an minimum altitude on your route. Area forecasts (FAs) can describe cloud bases in mean sea level or above ground level (AGL or CIGS). Watch for showery precipitation, which means locally variable conditions and the potential for high liquid-water content in and around clouds.



Left: *Load your route into the ADDS Flight Path Tool (http://adds.aviationweather.gov/fpt_application/) to see if your planned altitude and route will intersect any icing probability. The vertical cross-section* ***(above)*** *is a great way to see the probability of icing on your climb and descent and will show you if your proposed altitude will keep you on top.*

If you're flying underneath and ceilings unexpectedly start to drop or precipitation other than snow starts to fall into the subfreezing altitudes you occupy, it can mean that the cloud depth is increasing. This is a bad thing. Increasing cloud depth normally exacerbates the icing situation. Fortunately, you are in the bases of the clouds, where the liquid-water content is normally the lowest and cloud drops are the smallest — unless liquid precipitation is falling out of the base. If the precipitation falling out of the cloud base is snow, then the risk of icing decreases. Snow tends to scour out the liquid water in the cloud, leaving behind a much "dryer" cloud.

If precipitation other than snow is falling from the base of the cloud, then you probably have freezing drizzle or freezing rain aloft. Not all freezing-rain or freezing-drizzle events are alike. They range in intensity, so don't panic. It may be highly localized or it may be the beginning of something worse. The precipitation could even be ice pellets, which are not an icing hazard (although they'll take the paint off the leading edge of the wing). But ice pellets often have other forms of precipitation mixed in, and a sign that liquid water exists in the clouds above.

When conditions worsen underneath icing, the best strategy is to turn around and head back to the area you knew was precipitation-free. In my opinion, climbing is a crap-shoot. Unless you've made an honest attempt to check prior to your flight, you don't know if the warmer air exists and how far you'll have to climb to get there. Moreover, a majority of the freezing-drizzle situations don't actually have safe (warm enough) haven above you.

In flatlander territory, with gobs of alternate airports, just land. Don't overfly a perfectly good airport trying to get 20 miles closer to your destination. In mountainous terrain with airports every 75 miles or so, consider doing a 180 degree turn to return to conditions you know are acceptable. Don't let ATC force you to an altitude that puts you in worse conditions. Tell them that you need to do a 180 due to icing conditions and you cannot accept a higher altitude.

Running On Top

The third option is flying over the icing conditions. This one is perhaps the hardest for most pilots to get their arms around and feel confident after looking at the traditional forecast products. You're also counting on the good grace of the engine gods. The risk of flying on top can be mitigated if you have an aircraft with a safety-net ice-protection system such as TKS.

To succeed going over ice, you must be able to climb on top in essentially ice-free air (not necessarily in moisture-free air), fly a route and altitude that keeps the icing conditions below you, and descend in relatively

THE QUIZ

Don't have access to a slick new bird that does all the flight math for you? All this math can be done in your head. Answers on page 22.

1. **You're starting your flight on the warm side of an approaching cold front. The METAR says the temp is 5 degrees C. Your passenger doesn't speak Celsius and asks how cold that is. Without a calculator, you could estimate that it's:**
   - a. 37 degrees F
   - b. 40 degrees F
   - c. 43 degrees F
   - d. 46 degrees F

2. **Crossing the frontal line, you start tapping the headliner with your hat. Va in your Cessna 182 is 110 knots, but that's at 3100 pounds. You're around 2600 pounds at this point.**
   - a. Va is now 90 knots.
   - b. Va is now 95 knots.
   - c. Va is now 100 knots.
   - d. Va is now 105 knots.

3. **Your present position and destination are both drawn on the folded sectional that's bouncing around the cabin. What's a quick way to measure the distance to your destination?**
   - a. Use your thumb. It's probably 30-nm long.
   - b. Measure against a pen. They're often 10 nm long.
   - c. Use anything to get the distance between two points on the chart and slide that to a longitude line to convert to nm.
   - d. Just keep telling the passenger you're almost there.

4. **The turbulence has died down but winds are still strong as you line up for Runway 16. The ASOS is calling winds 190 @ 22. Quick: how much crosswind component is this?**
   - a. Five knots
   - b. Seven knots
   - c. 11 knots
   - d. 17 knots

ice-free air before landing.

It's no surprise that most icing encounters on the climb-out occur when the skies are reported as broken or overcast. So check those METARs and TAFs against the freezing level. If those clouds are at or above the freezing level, driving through them may not be a wise choice unless you can find a big enough hole.

If there are no clouds within 40 miles of your departure airport, then the climb to cruising altitude will be painless. I plan 40 miles because it gives me enough wiggle room if ATC happens to delay my climb due to traffic congestion.

Scattered clouds are harder to judge. A scattered layer of healthy cumuliform clouds can coat the aircraft pretty good. In the winter, most cumuliform clouds occur in more southern regions, where the freezing level rarely gets below 6000 feet. If scattered cumulus clouds extend above the freezing level, negotiate with ATC to deviate around them.

If your drive to the airport doesn't confirm clear skies, a quick peek at the satellite image or METARs will. Don't forget that satellite images of higher clouds also may obscure a lower cloud deck and that automated stations (AUTO) will only report "clear below 12,000 feet." If your proposed cruising altitude is higher than this, you'd better dig further. I find the Mark-one eyeballs are great for the cloudy-clear determination, but using them to estimate the height of an overcast cloud deck is stretching the technology.

Any of the maximum icing products from CIP or FIP mentioned earlier are excellent candidates to determine if you'll have a good chance to make a clean climb. No colors depicted around your point of departure means the air is ice free above the airport.

Discovering the altitude of the tops falls into one of three categories: Incredibly easy, incredibly difficult or throw-your-hands-up-impossible. The area forecast (FA) tops forecast is not much help to pilots when the highest clouds are a cirrus deck at 25,000 feet. There still could be plenty of clear air below. Other than the area forecast and pilot reports (PIREPs), there are no weather products that provide a direct indication of cloud tops.

Estimating the tops depends on whether the clouds along your route are convective (cumuliform) or non-convective (stratiform). I tell all my online weather students that I can teach them to find the tops of non-convective clouds in about four minutes, but it will take four hours to learn how to determine the height of convective cloud tops.

In many stratus (non-convective) layers, the area forecast can give a reasonable estimate of the tops. A forecast temperature sounding easily depicts the top of the stratus layer. Look on the diagram for a saturated layer or the point where the temperature/dew point spread is small. The point at the top of this layer — where the temperature and dew point diverge, producing a dry layer aloft — is the tops of the stratus layer. This point may also be accompanied by a wind shift. In other words, the wind is from a moist source below the wind shift (in the cloud layer) and from a dryer source above the wind shift (above the cloud layer).

Another great product is the color-enhanced infrared satellite image. This displays the temperature of the cloud tops in degrees Celsius using various colors. In a stratus deck, the color will be uniform, since the tops are typically very flat. Find the temperature on the infrared satellite image in the area you want to know the tops height, find that same temperature on the sounding diagram valid at the same time as the satellite image, and read off the pressure altitude corresponding to that temperature. You'll likely get an answer that's within 1000 feet of the tops.

The tops of convective clouds may be difficult to ascertain with any confidence because they may be variable and localized. The key is to discover the vertical limit, understanding that this limit can in-

(continued on page 23)

approaching emergency vehicles' strobe lights. Now my first officer would be their responsibility, for mine was complete.

Correct that: Ours was complete. I looked over at my new first officer and said, "Well done." He nodded in response and sighed in relief. But then, with a hopeful smile on his face, he said, "About this box …"

Kevin Harold is an airline captain who sometimes has too much time on his hands.

FLIGHT PLANNING FOR ICE

continued from page 12

crease significantly in a short period of time.

One way to estimate convective cloud tops is to use a forecast temperature sounding such as a Skew-T log-P diagram. Forecast soundings provide a peek at the future vertical profile of the temperature aloft. If unstable conditions (large lapse rates) exist near the surface and the lapse rate above the unstable layer lessens significantly with height, that's a good sign that the cumuliform clouds will be capped. Convective cloud tops can also be capped by a temperature inversion. They are limited in their ability to grow vertically due to a small or negative lapse rate above them. Stratocumulus clouds are the best example of a capped cumuliform cloud.

AIRMET Zulu might help identify the tops of the icing layer, which normally is the height of the cloud tops during the winter. For example, the AIRMET text might say, "MOD ICE BLW 120." Convective tops, however, are not always covered by AIRMETs and it's rare to see an advisory issued for a healthy field of cumulus clouds that don't meet Convective SIGMET criteria.

CIP and FIP are one of the best sources to determine the height of the icing layer. CIP combines a two-hour model forecast of relative humidity, pilot reports and satellite cloud-top temperatures to depict icing probability. FIP relies solely on the computer model because it's a forecast. Even when the tops are flat, CIP and FIP may show some icing probability one or two thousand feet above the actual tops.

Getting from cruise altitude down to the surface in ice-free air is analyzed the same way as the climb. Hopefully you'll have an unobstructed view of the ground if you've planned everything just right. If not, most of the same points apply when you begin your descent. Depending on where the edge of the clouds might be, you'll want to coordinate your descent with ATC. Ask for a discretionary descent or a route that let's you make an uninterrupted descent into warm or clear air. Stay on top of the icing layer as long as you can.

Best We've Got

Icing forecasts have come a long way over the last 10 years. CIP and FIP are pretty much going to stay the same for a while. Graphical AIRMETs (G-AIRMETs), on the other hand, will eventually replace the current AIRMETs that are issued and will be able to provide better forecasts for icing in space and time. Stay tuned for those.

The final call on your route in icing season will come down to how well you can use these tools and how much risk-tolerance you have. The climb-on-top method will always be a balancing act between the height of the cloud tops, service ceiling of the aircraft, engine performance, and oxygen. Carefully review your options on the ground before departing. You have to be pretty confident that you won't suddenly be stuck with ice sticking to your airframe and no place to run.

Scott Dennstaedt teaches online weather seminars. Contact him through www.chesavtraining.com.