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IFR

The Magazine for the Accomplished Pilot

Real students controlling virtual airplanes ... page 6

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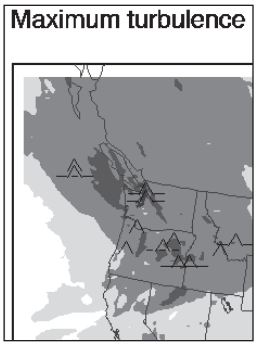

Big bumps ... page 20

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GRAPHICAL TURBULENCE

Turbulence-predicting tools aren't as good as ones for icing or thunderstorms, but they're getting better and worth a look.

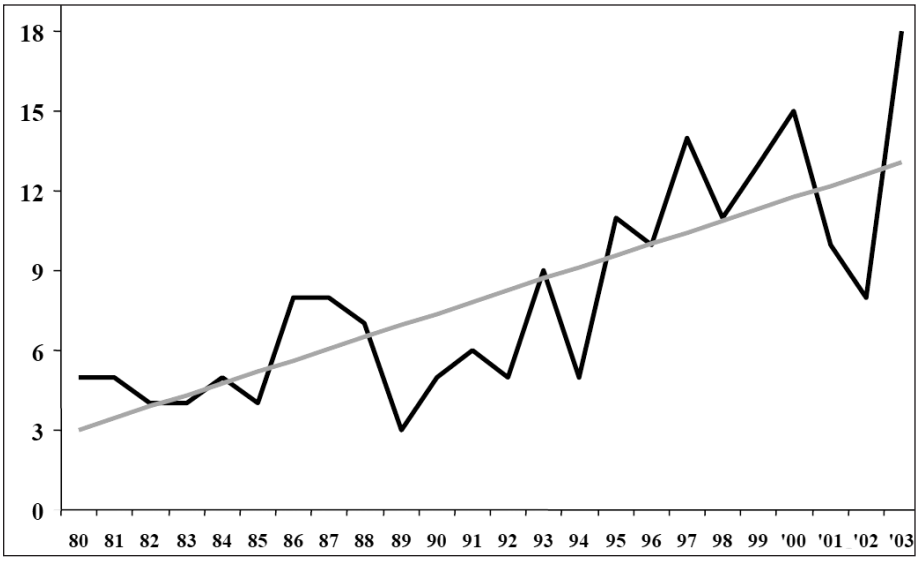
by Scott C. Dennstaedt

The number of accidents where turbulence was a contributing or causal factor has steadily increased over the last two decades. Joe the pilot is not doing a good job minimizing his exposure to dangerous turbulence, dealing with unexpected turbulence or, most likely, both.

Compared to scheduled air-carrier operations, a general aviation pilot is a couple orders of magnitude more likely to be fatally injured in a turbulence-related accident, according to a recent Federal survey. Turbulence was the culprit in 664 accidents that resulted in 609 deaths, 239 serious injuries and 584 minor injuries. All but one of the 609 deaths happened in GA.

While pilot training could be better, improved forecasts are the key to a smoother flight. The newest release of the Graphical Turbulence Guidance (GTG2) product might extend some hope, but don't count on this product to be of tremendous help to most GA pilots anytime soon.

Below: *Part 121, turbulence-related accidents (y-axis) are on the rise and cost the airlines over $100 million per year*



It's About Size

The atmosphere is a fluid that is predominantly non-turbulent when compared to the scale of most aircraft (10 to 100 meters). It often has a laminar (smooth) flow. However, mix that fluid up a bit and turbulence is the end result. What we feel in flight is the rapid acceleration and deceleration as our aircraft interacts with this mixing process.

Whether or not we feel this turbulence largely depends on scale. Imagine driving your vehicle rapidly over speed humps that are spaced close together. Now drive a small, radio-controlled (RC) car over those same speed humps. The speed humps are turbulent to your car, but the RC car follows the flow like an aircraft in steady mountain waves. Now imagine nickel-sized gravel on the road. The RC car now feels bumps with each piece of gravel. Your vehicle, on the other hand, drives over the gravel without any significant effects.

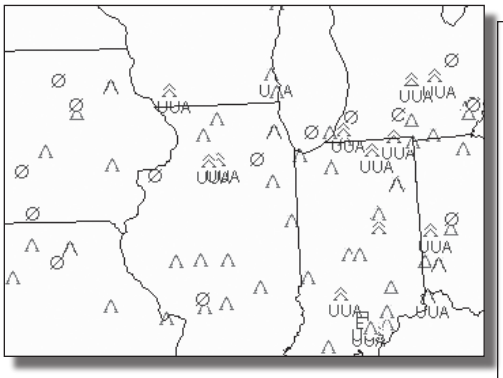
While turbulence is a simple concept, it manifests itself in so many ways that it's difficult to forecast. It has taken years of research and millions of dollars to create the Graphical Turbulence Guidance (GTG) product. On March 19, 2003, GTG became a NWS operational product and now appears on the Aviation Digital Data Service website, better known as ADDS (adds.aviationweather.gov).

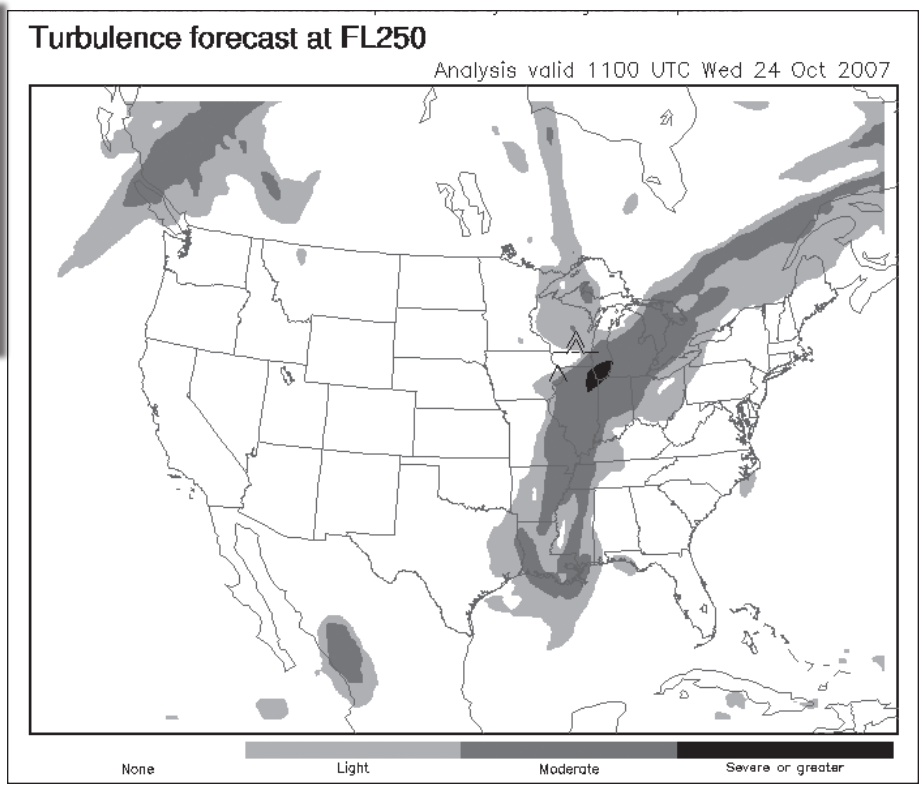
The dearth of detailed turbulence forecasts is part of the problem. At the moment, AIRMET Tango and SIGMETs for severe or greater turbulence issued by the Aviation Weather Center (AWC) are the only official forecast guidance available to pilots. Keep in mind that SIGMETs are usually issued only after pilots begin to report those severe conditions. GTG is designed to augment these en route advisories and provide a higher resolution forecast both temporally and spatially. GTG is automatically generated with no forecaster influence whatsoever.

Less Than Ideal Timing

The operational GTG product includes an hourly analysis of turbulence potential from FL200 through FL450. In addition to the hourly analysis, GTG provides a forecast for three, six, nine and 12 hours. These forecasts are updated every three hours. Turbulence potential is available every 3000 feet for individual altitudes beginning at FL210 (e.g., FL240, FL270, FL300, etc.). If you don't frequent the flight levels, then GTG isn't going to help. GTG2 will be released in 2009 and will extend down to 10,000 feet.

GTG is most useful in forecasting upper-level, clear-air turbulence (CAT) associated with upper-level fronts and jet streams. The algorithm is intended to identify regions of CAT but not thermal turbulence, turbulence associated with thunderstorms or breaking mountain waves.





Above: *Dozens of PIREPs on this day in October prompted a SIGMET for severe turbulence from FL240 through FL360. GTG did an OK job (right), but given this turbulence threat, we'd hope it did.*

Those items will be addressed in a future version of GTG.

The GTG analyses and forecasts are shown on the ADDS display as contour maps of predicted CAT *intensity*, namely, null, light, moderate, severe and extreme. The good news is that these categories are familiar to Joe the pilot. The bad news is this isn't probability. When GTG shows a region of severe turbulence potential, you don't know whether the event has a low, medium or high probability of occurring. Consequently, the product may tend to overstate the turbulence experienced by pilots at any given altitude on any given day and time.

The further out in the forecast you go, the less certain it is. But when you see an area of severe turbulence on the 12-hour forecast, there's no weight factored in to account for the uncertainty that comes with forecast time.

The GTG analysis field doesn't get updated until about one hour or so after its valid time. So if the 1600 UTC analysis is the latest available, the 1700 UTC analysis won't be available until after 1800 UTC. But the analysis is still valid at 1700 UTC. So it's over an hour old when it's fresh off the press. Then this image won't be updated for another hour. That's an eternity given the scale of turbulence Joe the pilot is trying to avoid.

A new product called GTGN represents more of a "nowcast" that will combine GTG with updated PIREPs and other in-situ turbulence observations from commercial aircraft to produce an analysis that's updated every 15 minutes. This will be more useful, especially if this product can be incorporated into the satellite weather broadcasts. GTGN is years from becoming reality. It'll be a year or more beyond that before it shows up on your cockpit display.

Speaking of satellite weather broadcasts, as of July 2008, XM Satellite Weather broadcasts the GTG analysis field in a similar form to what you'll see on ADDS. However, it's part of the premium service referred to as Aviator Pro ($99/month).

How soon will you see these new products on your portable or panel-mounted displays? Here's what Garmin told me. "We are investigating the possibility of displaying new XM weather products from the Aviator Pro package; however, we are unsure if the GPSMAP 396/496 units and panel-mount units will be able to display the new products. There is no time frame as to when we will know for sure if the new products will be supported."

Your PIREP Counts

The GTG algorithm uses pilot reports. Pilot reports can be problematic, however. They are the subjective measures of the aircraft response to the turbulence, not a quantitative measure of the atmosphere. But they still represent one of the only sources of turbulence observations.

This past summer I had the pleasure to talk to Dr. Robert Sharman of the National Center for Atmospheric Research (NCAR) and lead developer of GTG. He said pilots can improve their turbulence reports by accurately reporting their time, location and altitude. Turbulence can be isolated and ephemeral. A PIREP of "25 northeast of the ABC VOR" puts the report into the system on the 045 radial. They may actually be on the 065 degree radial and this difference matters.

When making the report, add a remark that states if you were in-cloud or out-of-cloud. For example, "Light chop at 7000 feet, sky clear," or, "Moderate at 10,000 feet in cloud tops, smooth above," are good re-

ports. Knowing if the turbulence was due to instability or convection (in-cloud) is important from a research perspective. Report the actual altitudes you experienced turbulence. Instead of saying, "Moderate-severe turbulence on climb out," say, "Moderate-severe turbulence on climb through a cumulus deck, 4000 feet through 8200 feet."

Dr. Sharman indicated that there are not enough "null" reports. That is, pilots are not reporting smooth or nearly smooth conditions. Researchers find they have lots of moderate reports, but very few null reports of turbulence. Pilots are under-reporting severe turbulence events as well. Maybe they're too busy right then.

I also asked Dr. Sharman about future releases of GTG. Beyond the GTG 2 mentioned above, GTG 3 will include a calibrated probability field and an algorithm to identify turbulence associated with mountain waves. It will also ingest in-situ turbulence observations from commercial aircraft. GTG 5 (due by 2013) will extend down to the surface.

For the flying public, high-altitude forecasts are more important. Upper-level turbulence forecasting is also easier because terrain influences can usually be ignored.

Beyond the GTG, we are on the verge of a new era with respect to turbulence detection. This includes NEXRAD in-cloud Turbulence Detection Algorithm (NTDA), measure-

QUIZ ANSWERS *(questions on page 12)*

1. **b.** You've used the MEYRS IAF and are on the transition. It looks like the LOC is headed your way. The GPS is to the airport center, 1/2-mile short of the DME source. Don't even try to argue **d**.

2. **a.** The NoPT transition is 11,400. In the absence of an approach clearance from Denver Center specifying an altitude to maintain until established, the aircraft is too low for the published transition.

3. **d.** No trick. You have 18 degrees of left drift, causing you to correct 18 degrees right of the no-wind course.

4. **c.** Even without a readout, an educated guess is possible using these markers.

5. **c.** If IAS is 105, then TAS spins out around 125. DME groundspeed is 165, which is a tailwind component of 40 knots. The crab angle says the wind is actually stronger from the right quarter. Spin the vector on a whiz wheel to get 224 at 57.

6. **c.** It looks as if you're nose high with a significant amount of power yet still losing altitude. The next leg is 10,000 but you'd better get this figured out quickly. Answer **a** is also an issue, presuming you've been cleared to at least intercept the localizer.

7. **d.** You're in a mountain wave (downward wave and tailwind). Full throttle may be necessary; however there's no guarantee that you can out-climb this downward trend.

8. **a** and **d.** Never underestimate mountain wave. While it's possible you could fly this approach with nary a ripple in the air, it's also possible you could smack into turbulence so severe the aircraft would be completely uncontrollable.

9. **a** or, maybe, **b.** Without the local altimeter setting, the approach is not authorized. Someone on the Unicom frequency might not be a certified observer using certified equipment, so that's a risk. Center typically does not have AWOS weather.

10. **a.** Flying the slope here gets you nearly 200 feet lower at PLATO and hopefully that much closer to breaking out. Note the circling mins and be prepared to accept the tailwind for landing if you must go lower. The broken layer, low vis, and light winds at the surface indicate the winds may only be an issue aloft.

11. **c.** You've got quite a tailwind and the resulting high groundspeed will require a serious rate of descent to stay on the glideslope. You should also be ready for windshear as well as moderate to severe turbulence (or worse).

12. **c.** We'd change that DME source right away. Everything from KEEZR on is off the IGUC DME. You could end up with some serious confusion or screwed up stepdowns (for the localizer-only approach) with the DME on HBU.

13. It depends how you count it. Officially, there are 11 changes. We counted 17 notable differences on the plate.

ments of turbulence through GPS signals (called GPS occultations) and the new Turbulence Protection and Warning System (TPAWS) installed on some commercial aircraft.

While we're still a decade away from having this technology in the GA cockpit, more observations for turbulence will allow Joe the Pilot to see turbulence in real time, providing a way for them to minimize his exposure to dangerous turbulence.

Consult the Dennstaedt weather oracle online at AvWxWorkshops.com.

STUPID PILOT TRICKS

continued from page 15

sionally with unforeseen results. Witness the Cessna U206 pilot operating out of the newly famous little town of Wasilla. He was toting 500 pounds of plywood inside and another 200-pounds worth slung underneath in an unapproved lumber rack. While en route, the 8000-hour pilot smelled fire and headed for the gravel bar of a river as flames entered the cockpit. He jumped out during the landing roll and watched as the aircraft continued forward and nosed over, the plywood underneath on fire.

Then there was the North Carolina pilot operating a Beech D-95A (TravelAir) who lost an engine in cruise. Despite doing everything by the book, he couldn't figure out which engine had packed it in and wound up coming down in a local landfill and collapsing the gear. Presumably while they were picking their way off Garbage Mountain, the passenger allowed as how he had "assisted" during the initial engine failure by holding right rudder, unbeknownst to the hapless pilot. All together now: Dead foot, dead engine. No dead foot, dead passenger.

Best of the Worst

This year's Grand Prize goes to the Delaware ATP who was attempting to retrieve his Cessna 172 from the field where it ended up (undamaged) from a forced landing by a renter. The pilot/owner told investigators he took off from the "small open space" at night but the engine didn't sound right so he put it back down—hitting a sign, a roadway embankment and a plowed field in the process. His statement also detailed the complex and exhaustive calculations he and his chief CFI performed before undertaking the unfortunate excursion.

Witnesses, however, had a different take. According to the aforementioned CFI, "He was at full throttle the whole time. He pitched up, and never lowered the nose. He drug the tail the whole time. He was at full throttle and went up over a barn, hit a sign, went over the road, under the power lines, up an embankment, and down in the field." The CFI also reported the engine was strong throughout.

When the NTSB asked if the CFI had endorsed the pilot's plan for takeoff, he responded, "No. We all discussed it, but he's pig-headed, you can't tell him anything. The FAA inspector told him not to do it, but he said, 'It's my airplane, and it's airworthy. I'm taking off.' " It might have been a case of he-said/she-said, except that the director of maintenance videoed the whole thing. The tape concurred in all particulars with the CFI.

So here's this year's redeeming social merit: When your chief pilot, your director of maintenance and the FAA inspector tell you not to do something, don't do it at night and on camera.

And with that useful tidbit we bid you adieu until this time next year, when we will once again spindle, fold and mutilate our airborne brethren. Let's be careful out there.

Jane Garvey is IFR*'s queen of aviator follies. Uh, not meaning her own follies. We're careful to remove the exploits of* IFR *contributors. Or at least their names.*