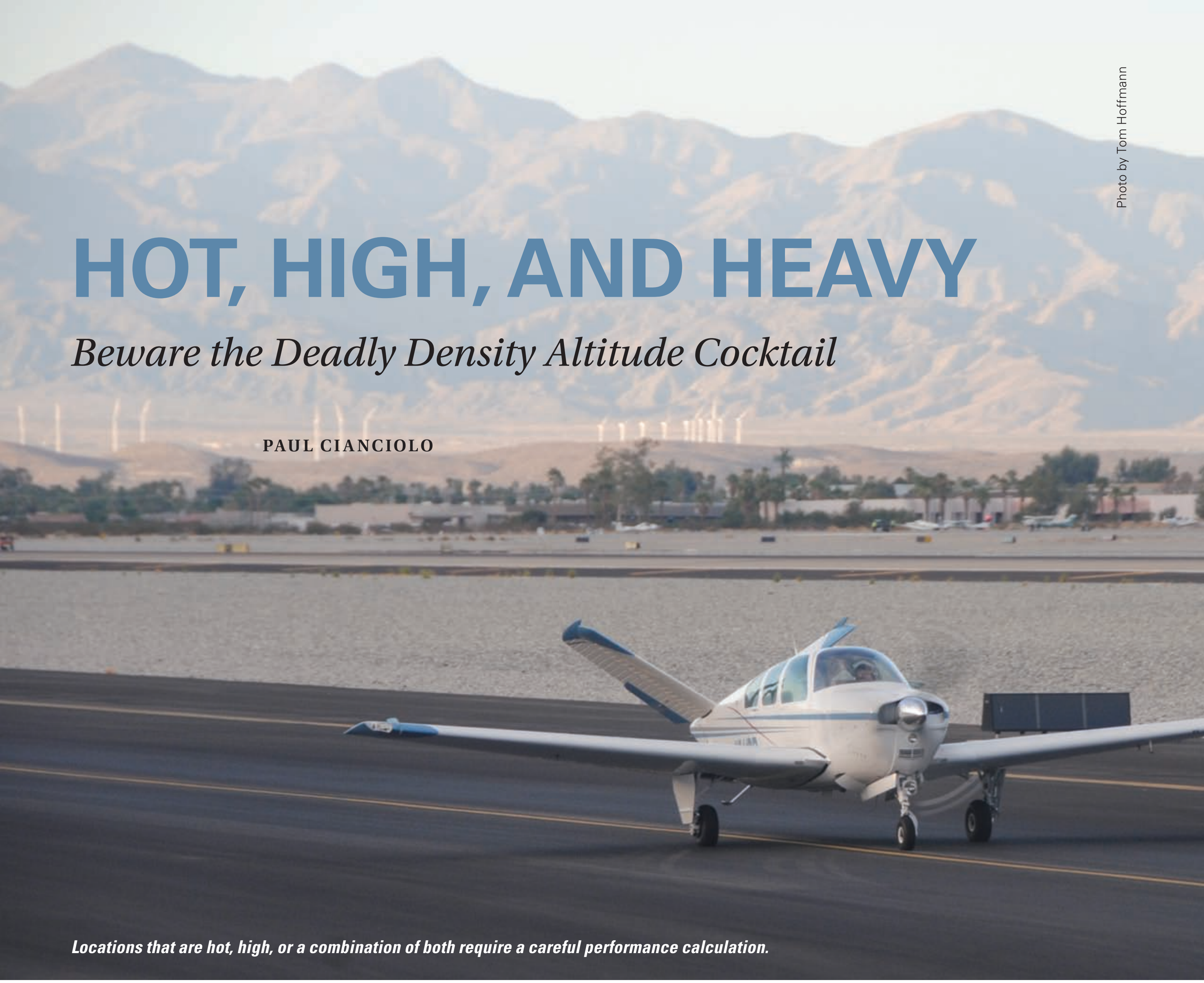

HOT, HIGH, AND HEAVY

Beware the Deadly Density Altitude Cocktail

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Locations that are hot, high, or a combination of both require a careful performance calculation.

It's not possible to talk about weather without mentioning the negative effects that density altitude can have on your aircraft. If you're not careful, this invisible phenomenon, which can only be *experienced* through the performance of the aircraft, can sneak up and rob you of lift, thrust, and power. The only other option you are left with is "down."

Hindsight is 20/20

Before getting too detailed about what density altitude is, let's take a look at how its performance-robbing effects took a serious toll on a Stinson 108 during takeoff in the following National Transportation Safety Board (NTSB) accident report. A YouTube video filmed from inside the cockpit provides a more chilling perspective of the event; it's available at http://youtu.be/OVM3RRd1vf0.

Here is the official NTSB accident report synopsis:

Before taking off from the 5,000-foot turf-dirt airstrip located at an altitude of 6,370 feet mean sea level, the pilot checked his performance charts and calculated that the density altitude was about 9,200 feet; this was 3,200 feet above the 6,000-foot maximum altitude listed in the takeoff performance charts. He also noted that at the time of departure, the wind was from 30 degrees at 10 knots, with gusts to 20 knots, which was close to a nearly direct tailwind for the takeoff from runway 23. The pilot indicated that the airplane was within 86 pounds of its maximum gross takeoff weight.

When the airplane was about three-quarters of the way down the runway during the takeoff roll and not yet airborne, the pilot was about to abort the takeoff, but a gust of wind lifted the airplane in the air. The pilot thought the airplane would remain airborne, but when he could not get the airplane to climb as expected, he attempted to locate an open field to land in.

However, the airplane subsequently encountered a downdraft, collided with a stand of trees, and came to rest inverted about 1.64 nautical miles from the departure end of the runway. A post-accident examination of the airplane and engine revealed no mechanical malfunctions or failures that would have precluded normal operation.

Luckily, all four onboard survived the accident. Even though the pilot had nearly 5,000 hours of flight time, the effects of density altitude caught him by surprise. The NTSB determined that the probable cause of the accident was "the pilot's inadequate preflight planning and decision to takeoff at a density altitude outside of the airplane's takeoff performance envelope, with a tailwind, and near the airplane's maximum gross weight, which resulted in the airplane's inability to climb and clear trees."

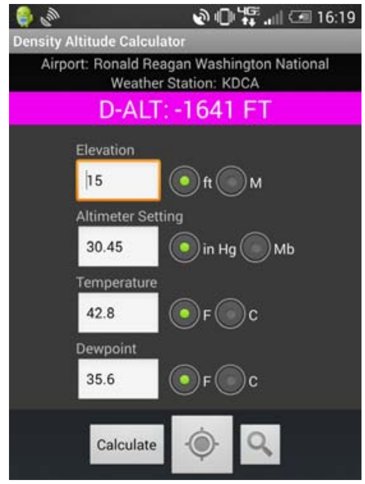
Editor's Note to the pilot — thank you for keeping this video on YouTube so other pilots may learn from this accident.

Thin Air

By definition, density altitude is pressure altitude corrected for nonstandard temperature. In other words, an increase in temperature at a particular atmospheric pressure causes the density of air at that pressure to appear as though it resides at a higher physical altitude.

When density altitude is high, the air is less dense. As a result, an aircraft will perform as if it is flying at a higher altitude, which results in degraded climb performance and acceleration. Lift is reduced because the thin air exerts less force on the airfoils. Thrust is slower because a propeller is less efficient in thin air. Power output is also reduced, because the engine is taking in less air. Instead of measuring density altitude in height, think of it as a measure of aircraft performance.

In the accident report we reviewed, the runway was considered to be at an elevation of 9,200 feet according to the density altitude calculation, which is above the aircraft maximum altitude on the performance chart. The airplane was also pretty close to its maximum takeoff weight. It physically could not perform under those conditions. The only way to know this fact is to calculate the density altitude and luckily, there is now an app for that.



This is an example of an app used to calculate density altitude. It's as simple as opening the app and reading the calculated altitude. The negative altitude shown here is due to the location of FAA headquarters near sea level and during the winter.

Getting There

The effects of density altitude can be insidious. You can mitigate these risks in many ways:

1. Avoid takeoffs and landings when midday temperatures are scorching hot. Take advantage of cooler mornings and evenings when the effects of density altitude are less.
2. A lighter load means more flexibility when trying to take off at a high-elevation airfield on a hot and humid day. To maximize this benefit, be prudent when considering fuel and non-essential passengers, and be extra vigilant of how much everyone and everything weighs.
3. If flying in a high-density altitude situation, you may need to adjust the mixture control on takeoff to maximize engine power. Consult your POH for the best mixture setting given the conditions at your takeoff airport.
4. Know before you go, and plan for performance. The reduction of lift and power may require a longer takeoff roll than normal, which may result in being tempted to prematurely rotate — possibly resulting in a stall. Even low-altitude airports can be negatively affected by density altitude under the right conditions.

The right combination of warm and humid air can drastically impair your aircraft's performance and push it beyond its limits. Don't wait until it is too late to realize that your aircraft cannot perform. Make density altitude a check in your preflight planning process.

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