The Front

NOAA's National Weather Service

July 2012

# Hot, High and Heavy—The Deadly Cocktail of Density Altitude

By Jim Reynolds, Meteorologist in Charge, Center Weather Service Unit, Albuquerque, NM

It is easier for most of us to believe in things we can see, and there is certainly no exception for pilots.

Just about any pilot can tell you what impacts thick haze, a solid low ceiling, or a wall of rain under black thunderstorm clouds will have on a flight. For those new to flying aircraft, especially, it is often difficult to have faith in the negative effects density altitude can have on a flight because it is not so easily seen. Density altitude really can only be seen through aircraft performance. Unfortunately, density altitude can have deadly consequences before a pilot has a chance to sense its presence.

*Sign on a hangar at the Leadville, CO, airport, the highest airport in North America at 9,927 feet above sea level (source, AOPA)*

By definition, density altitude is "the pressure altitude adjusted for non-standard temperature." Simply put, increasing temperature at a given atmospheric pressure will cause the air density at that pressure to appear as though it resides at a higher physical altitude. Pilots fly through an atmosphere of air made up of invisible gases. Only when there is an excess of particulate matter or water vapor in the air can anything be seen in the flight environment. Because air is otherwise invisible, it is not possible to tell when it becomes thinner. Thinning happens due to increased space between molecules when an air mass is either warmed, has water vapor added to it, or is raised in elevation. Increased spacing between air molecules, which causes air to become thinner, has the following three effects on aircraft performance:

- Slower acceleration on takeoff because of a power production reduction
- Higher true airspeed required to produce the same lift associated with a lower temperature, which generally requires a longer takeoff roll to achieve
- Slower climb because of the reduction in power production and lift

## Inside



## When's the Next *Front?*

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The Front

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## Mission Statement

*To enhance aviation safety by increasing the pilot's knowledge of weather systems and processes and National Weather Service products and services.*

Any mix of the atmospheric conditions that cause aircraft to perform at the minimum range of their operating envelope are "high density altitude" situations and are usually quite dangerous. Keep in mind that the greater loading of an aircraft by either people or gear will eat away further at the diminished capabilities of the aircraft in high density altitude situations.

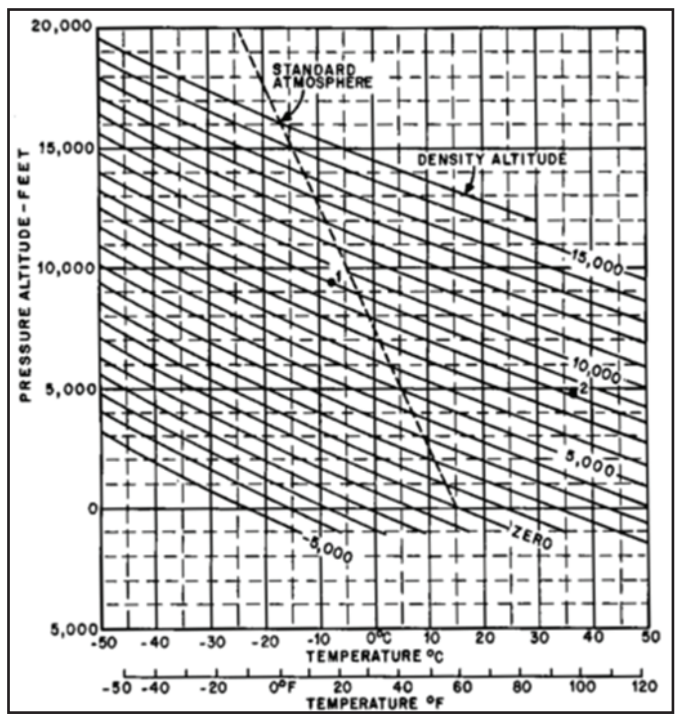
*High elevation flight (source, AOPA)*

For the uninitiated pilot, it is easy to miss developing high density altitude situations. Of course, it is easy to have a general sense of the temperature just by noting what you experience when you step outside. Similarly, you might sense an increase in humidity, or mugginess, in your surroundings or observe hazy conditions. You might also get a sense of being at an increased altitude because you find yourself catching your breath when doing tasks that don't usually cause you to breathe deeply.

These physical signs, however, are not enough for pilots to gain a true understanding of how their aircraft will perform given current conditions. The only way to truly ascertain how an aircraft will perform is to first compute density altitude according to a chart or a calculator and then correlate this information with aircraft performance data in the aircraft's operating handbook.

If you don't have a physical copy of a density altitude chart in an aviation book, these charts can easily be found online by doing a search for a "density altitude computation chart." (See sample below.) An even easier way to determine density altitude is to use an online calculator. NWS El Paso, TX, has a [handy calculator online.]

While most density altitude effects are experienced at higher elevations, extremely high temperatures at lower elevations can lead to equally negative aircraft performance problems. Case in point: high temperatures across portions of the desert southwest can easily exceed 115°F in the summer months. Chris Kesler, Operations Support Manager for the Terminal Radar Control facility at the Phoenix Sky Harbor Airport states that "while high density altitude situations do not officially cause the closure of the airport, a temperature of 120°F will cause most pilots to choose not to fly into or out of the airport until temperatures cool down some." Interestingly, the Phoenix Sky Harbor Airport resides at an elevation of only 1,124 feet above sea level.




*Density Altitude Computation Chart (source Wikipedia)*

While the effects of density altitude can be insidious, there are ways to beat this foe.

- If at all possible, fly early or late in the day. Any reduction in temperature may add hundreds of feet to the elevation the airplane thinks it is operating at.
- Fly as light as possible. If you don't need full fuel tanks to reach your destination, take on a lesser amount of fuel, much less if possible. Leave behind all of the baggage you don't really

need. Ask yourself, will you actually play golf with the clubs you want to bring on your trip?

- Bring along only those passengers necessary for the trip. High density altitude situations are bad ones for those individuals that just want to tag along.

In short, don't let the cocktail of "hot, high and heavy" be hazardous to your health! ✈

*Intense heat rising from a sun-baked runway causes the air to shimmer above it (source, NASA).*

# International Departure Gate Tactical Decision Aid

*Scott Reynolds, MIC, CWSU Nashua NH*

The International Departure Gate Forecast (IDGF) was developed during the winter and spring of 2010-11 by the Center Weather Service Unit (CWSU) at the Boston (ZBW) Air Route Traffic Control Center.

This Tactical Decision Aid (TDA) provides a convective planning forecast focused on peak traffic times for oversees international flights. A significant amount of those international-bound flights departing the New York metro area are routed through ZBW airspace.

The IDGF is produced twice per day, from May through September, covering the major departure gates used for international departures from core Northeast Corridor airports: Boston (BOS), Laguardia (LGA), Kennedy International (JFK), Newark Liberty International (EWR), Philadelphia (PHL), Baltimore-Washington (BWI), Dulles (IAD), and National Airport (DCA). The evening issuance is a next-day planner issued around 0000 UTC with an update issued the following morning between 1300 and 1330 UTC. From the IDGF site, mouse over international departure gates.

Each issuance contains forecasts for Gate Impact and Forecaster Confidence for 3-hourly forecast periods: 1800-2100 UTC, 2100-0000 UTC, and 0000-0300 UTC. The Gate Impact estimates the likelihood a gate, or group of gates, will see an impact from thunderstorms during a given 3-hour period. For this product, a thunderstorm is defined as any convective element within 20 nautical miles of a departure gate or airport or grouping of such. Given the proximity of some of the forecast points, i.e., less than 20 nm apart, several gates or airports were grouped together. **Figure 1** shows an example IDGF product from May 29, 2012. At least two of the three following criteria must be met in order to be considered for verification purposes.

- Radar echo tops greater than or equal to 20,000 feet (FL200)
- Radar reflectivity of at least 40 dBz, roughly equating to a level 4 echo on the Corridor Integrated Weather System
- Lightning strikes observed with or near a convective cell

Customer feedback from the summer 2011 season was very positive. Verification for the 2011 season was focused on big event days during July and August. The 16 event days were defined by

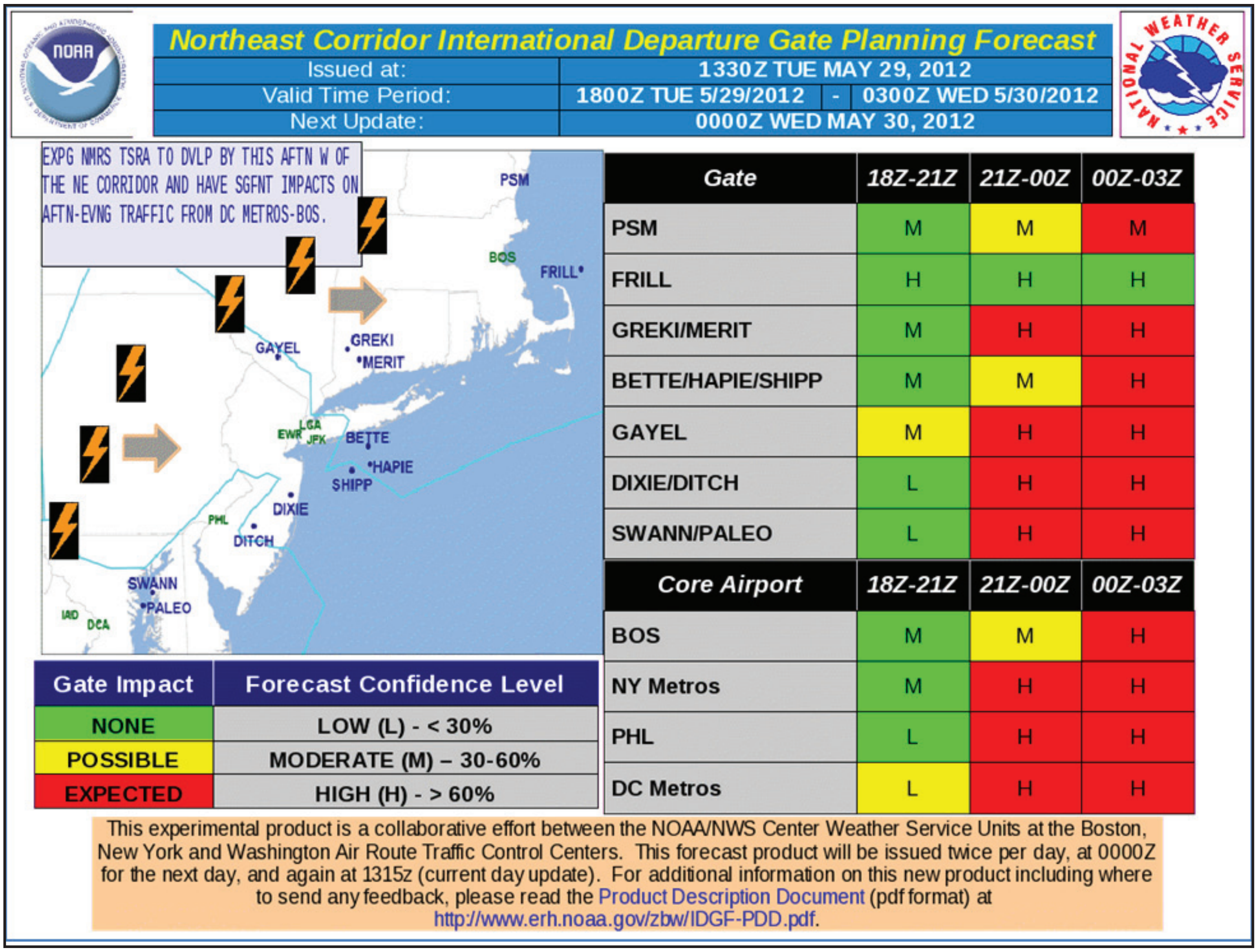



***Figure 1.*** *International Departure Gate Forecast from Tuesday 29 May 2012*

the ZBW Traffic Management Unit as days with a significant impact to ZBW and international departure operations. These numbers are quite representative of overall summer 2011 performance.

A "correct" forecast is defined as one in which no convective element was observed during the 3-hour window for a green forecast, or was observed with a yellow or red forecast. The 3-hourly forecasts were "correct" 71 percent of the time for the 16 events. For red-only (impacts "expected") forecasts, the percentage of correct forecasts number was 76%. The probability of detection for a convective event within the 9-hour forecast period was 78%, with red forecasts correct almost 97% of the time.

The first widespread convective event of the 2012 season occurred on May 29, 2012. A broken line of thunderstorms developed ahead of a cold front during the morning and early afternoon of the 29th, moved east, reaching central New England just west of the New York Metros by 2300Z (**Figure 2**). Storm Prediction Center (SPC) Storm Reports show a significant number of hail and wind damage reports accompanied these thunderstorms (**Figure 3**).

There were significant delays and rerouting needed to keep as much traffic moving on the 29th as possible. A ZBW Supervisory Traffic Management Coordinator commented: "Good coordination and preplanning done by all allowed for a smooth operation."

CWSU ZBW began alerting ZBW TMU of the potential for a "bad day" the day before and re-emphasized it both with verbal briefings and the 1300Z IDGF Tuesday morning. IDGF seems to be a successful initiative. ✈

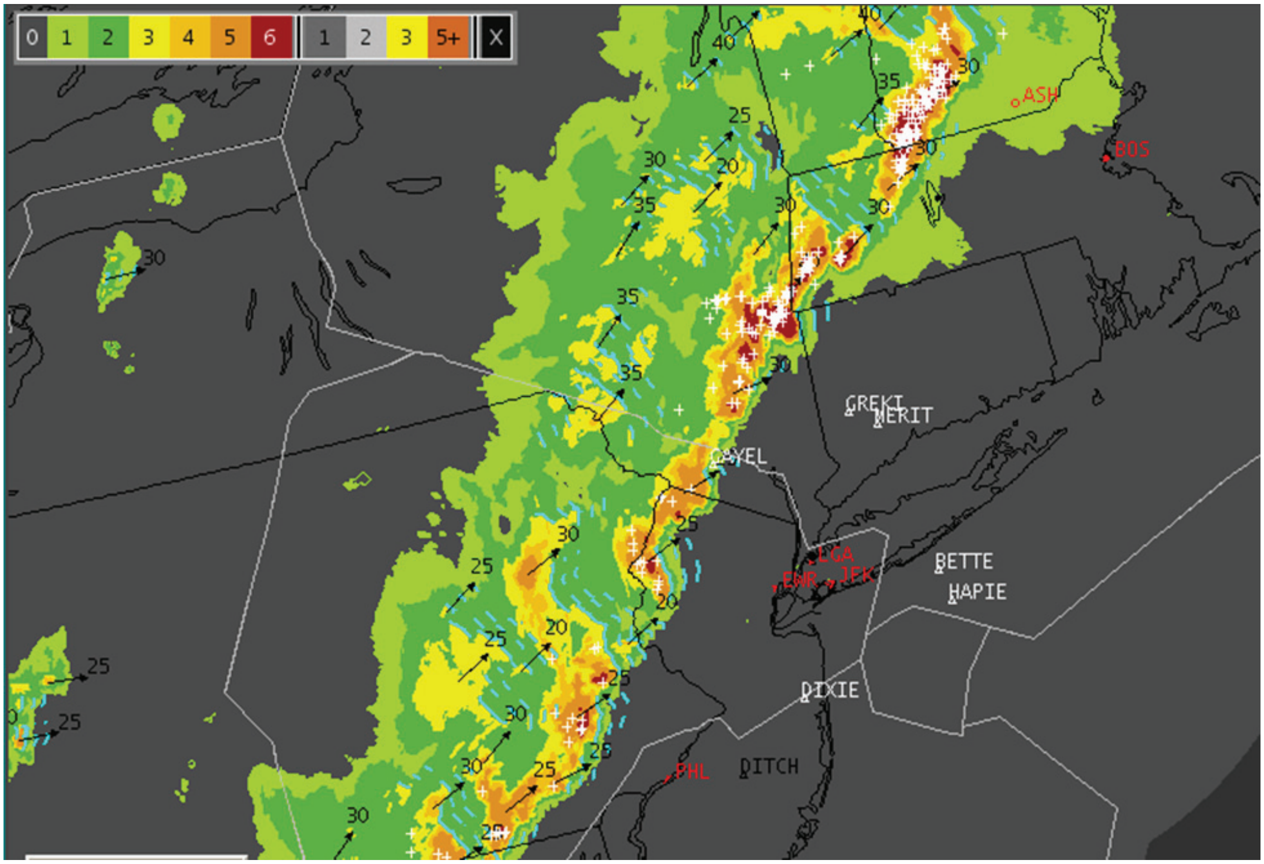



***Figure 2.*** *Radar mosaic from Corridor Integrated Weather System, MIT-Lincoln Labs, Tuesday, May 29, 2012, 2300z*

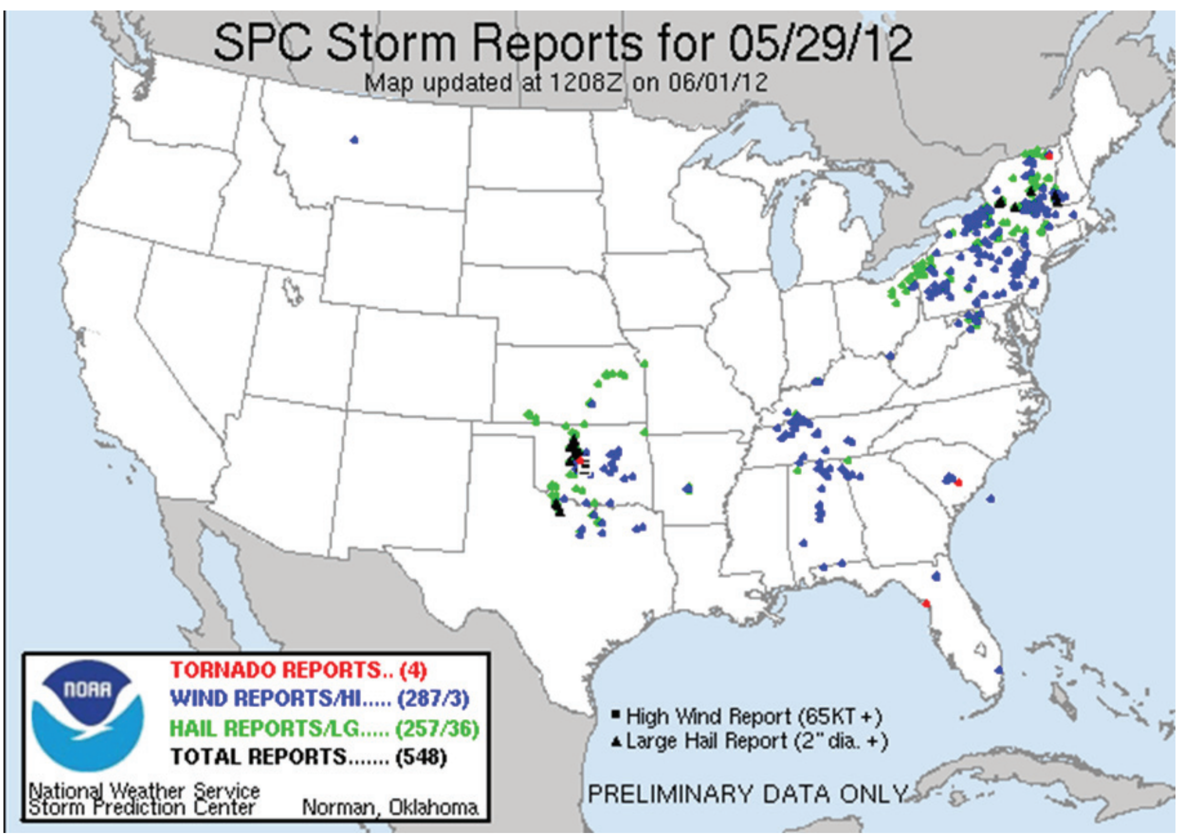



***Figure 3.*** *SPC severe weather reports from May 29, 2012, (courtesy, SPC)*

# Follow-On Weather Training

*Mike Graf, Meteorologist, NWS Aviation Services Branch*

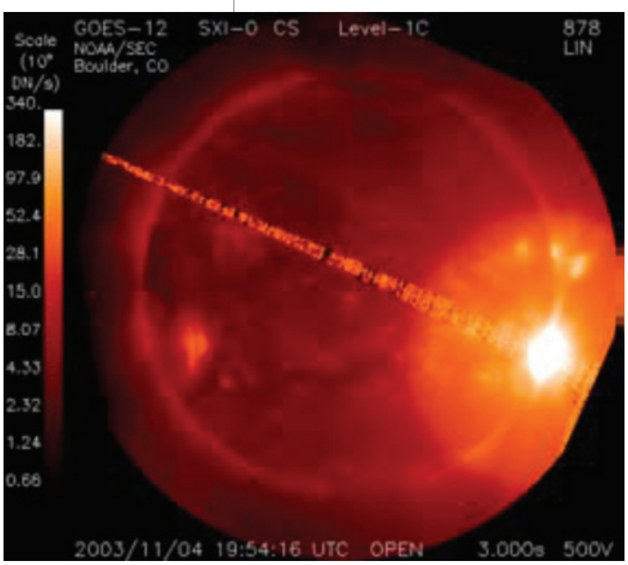
Follow on weather training can sometimes be a hit or miss proposition, sort of like Mother Nature. But there's a Website available to the pilot and dispatcher community that some folks are not aware of: MetEd.

This free site provides high quality education and training resources to the weather community, and while not exclusive to aviation, includes substantial aviation-related training for the pilot and dispatcher community, as well as anyone else interested in learning more about aviation meteorology.

MetEd is populated and maintained by the COMET® Program.

Some topics on the MetEd Website include:

- Space Weather Impacts On Aviation
- The Impact of Weather on Air Traffic Management
- Customer Impacts: Forecasting Fog and Low Stratus




Solar Flare

While many of the topics on MetEd are tailored towards forecasters who write Terminal Aerodrome Forecasts (TAF), pilots and others who work with aviation can benefit by understanding how forecasters develop products that directly impact the National Air Space. When you understand some of the nuances of how forecasts are prepared, you're more likely to grasp the reasoning and content in a TAF. Many of these topics have been translated into Spanish to benefit Caribbean and South American users.

With the solar maximum coming up in 2013 bringing increased sunspot activity, the COMET program recently released a new module, "Space Weather Impacts on Aviation." As the anticipated 2013 solar maximum nears, space weather events are likely to affect radio, navigation, and other systems on Earth more frequently. This 1.5-hour module examines the effects of solar flares, coronal mass ejections, and other solar phenomena on aviation operations. The module gives forecasters and others an overview of the information and products available from NOAA's Space Weather Prediction Center and provides practice interpreting and using those products for aviation decision support.

Please follow this link to the MetEd description page that provides additional information as well as a link to begin the module: Space Weather Impacts on Aviation.

Most COMET modules use JavaScript and Adobe® Flash® for navigation, animation, or presentation of multimedia elements. Ensure you have a browser updated to its latest version with JavaScript enabled and the latest version of the free Adobe Flash Player installed. For technical support for this module, visit the Registration and Support Frequently Asked Questions.

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