The National Center for Atmospheric Research (NCAR) is developing a powerful system to accurately forecast turbulence in near real-time.

Graphical Turbulence Guidance Nowcast, or GTGN, derives turbulence data from weather forecasts, the most recent available observations, and an advanced algorithm.

The nowcasts are designed to be used by pilots in the continental U.S. to avoid potentially turbulent areas within a few minutes notice.

Why It’s Important
Turbulence refers to wind gusts or eddies caused when the flow of air is disturbed or obstructed. Effects on aircraft range from relatively benign bumpiness to violent up and down motions that cause injuries.

This aviation hazard causes airlines up to $100 million in damages each year, according to the NASA Weather Accident Prevention Project. Turbulence resulted in 391 serious injuries in the U.S. from 2006 to 2015, reported the Federal Aviation Administration.

The location and severity of turbulence within thunderstorms is very difficult to predict, partly because the mechanisms that cause turbulence are not well known. Turbulence also can form in clear air, posing an even greater prediction challenge.

How the System Works
Underlying the nowcast system is the NCAR-developed Graphical Turbulence Guidance (GTG) system, which uses weather model forecasts and available observations to compute turbulence forecasts.

GTG, available on the NOAA Aviation Weather Center website, is designed to aid in airline route planning. The product provides turbulence forecasts with lead times of up to 18 hours, updated every hour.

The nowcast system, based on recent short-term GTG forecasts, blends in the following to derive a near real-time forecast:

- Weather radar–based estimates of in-cloud turbulence
- Recent turbulence observations from pilot reports
- Automated turbulence measurements from airplanes in flight (provided by certain airlines on a proprietary basis). Data provided by those sensors include pitch, roll and wind speed.

Turbulence costs airlines up to $100 million in damages each year and resulted in 391 serious injuries in the U.S. from 2006 to 2015.
A key component of the NCAR system is the NEXRAD Turbulence Detection Algorithm (NTDA). This algorithm derives turbulence potential in clouds from the frequency and movement of the particles that show up on weather radar.

GTGN uses multiple streams of information to nudge the short-term forecasts toward an accurate, real-time nowcast.

**Steady Improvement**

NCAR scientists are constantly improving GTG and GTGN.

A main focus in recent years is to better analyze and forecast turbulence related to mountains, clear-air turbulence, and turbulence in clouds, specifically incorporating convectively-induced turbulence as heated air rises and cooled air falls.

For its second nowcast version, NCAR is developing an algorithm to forecast convectively-induced turbulence in clear air near storms, or in areas not detectable by Doppler radar. The second version will also incorporate ground-based wind observations that are used to infer near surface level turbulence.

The NCAR team also is working on expanding geographic coverage to areas such as Alaska and, eventually, a global forecast.

Researchers working on the algorithm are drawing from data gathered from field studies, case studies using high-resolution simulations, and controlled environments to test turbulence formation and diagnostics.

Scientists are understanding turbulence better, in part by leveraging more detailed observations that come from improved measurement methods, remote-sensing techniques, and understanding of turbulence mechanisms.

**Applications**

The first nowcast version has been evaluated by the Federal Aviation Administration and authorized for use initially on a demonstration basis. NCAR expects approval for wider use in the near future.

The GTG nowcast can be used by pilots in the cockpit on either internet-connected computer tablets or on customized displays.

For more information, contact:

Robert Sharman 303-497-8457 sharman@ucar.edu
Wiebke Deierling 303-497-8760 deierlin@ucar.edu
National Center for Atmospheric Research Research Applications Laboratory P0 Box 3000 Boulder CO 80307-3000 303-497-8401 fax www.ral.ucar.edu

The GTG nowcast can be used by pilots to avoid potentially turbulent areas within a few minutes notice.