How the Jumbo Outbreak of 1974 Helped Lead to Safer Air Travel

It takes a sharp eye to find something positive in the wreckage of the worst swarm of U.S. tornadoes on record. Ted Fujita had just such an eye, and millions of Americans are safer in the air because of it.

Fujita, who died in 1998, is known around the world for devising the Fujita Tornado Damage Scale, or F-scale. Now reworked as the Enhanced Fujita Tornado Damage Scale, it’s the system most commonly used to rank tornado strength based on observed damage. A prolific researcher, Fujita made many other contributions to meteorology that are less well known to the public. One standout is his conceptualization of microbursts, the small yet dangerous pockets of descending wind that even weak showers can produce.

Fujita and colleagues at the University of Chicago joined with NCAR researchers in the late 1970s and 1980s in definitive work that clarified the danger posed to aviation by microbursts. The effort was a spectacular success—and it all started in the wake of a devastating round of tornadoes that struck more than 40 years ago.

Insight from Tragedy

On April 3, 1974, the U.S. South and Midwest were raked by more than 140 tornadoes that killed more than 300 people. The sheer scope of this disaster, which Fujita dubbed the Jumbo Outbreak (it’s also referred to as the Super Outbreak), went beyond anything previously measured. Since then, the only comparable event was the rash of more than 300 tornadoes across much of the eastern United States on April 25–28, 2011, again killing more than 300 people.

The deadliest single tornado of the Jumbo Outbreak on April 3, 1974, plowed through Xenia, Ohio, killing 36 people. (Wikimedia Commons image.)

While conducting an aerial survey of damage from the Jumbo Outbreak, Fujita—already known among peers as a meticulous observer—noticed something strange. He recounted the experience in a 1985 monograph, The Microburst:

“Unlike the swirling patterns of fallen trees, commonly seen from the air in the wake of tornadoes, hundreds of trees were blown outward in a starburst pattern. Trees near the starburst center were flattened or uprooted, spattered by a brownish topsoil.”

Fujita reasoned that such damage was produced not by the inflowing, rising air in a tornado, but rather from a focused surge of descending air that suddenly diverges when it hits the ground. He likened this to flow from a garden hose. If the hose is pointed directly downward, the water will spray outward in all directions, but if the hose is angled just slightly, the water fans out toward one side, much like the damage observed by Fujita.

Fujita concluded that about 15 percent of the jaw-dropping 2,598 linear miles of damage he mapped from the Super Outbreak was caused by these “outburst” winds, rather than by tornadoes.

The next critical event occurred on the stormy day of June 24, 1975, when an Eastern Airlines plane crashed on approach at New York’s Kennedy International Airport.
NCAR’s John McCarthy spent much of his time during the summers of 1984 and 1985 in the control tower of Denver’s Stapleton International Airport during the CLAWS project.

Quelling the Critics with Field Data
As with many transformative scientific ideas, Fujita’s concept came up against prominent detractors. Most researchers at the time believed that even strong downdrafts from thunderstorms ought to weaken before reaching the surface.

Fujita also bucked convention in how he carried out his research. “The large majority of his downburst work was not published in peer-reviewed journals,” noted Jim Wilson (NCAR) and Roger Wakimoto (now NSF assistant director for the Directorate for Geosciences) in a 2001 retrospective for the Bulletin of the American Meteorological Society (see PDF). They wrote: “It is likely that [the publication process] would have been an irritating, time-consuming activity for Fujita. He probably realized reviewers would have questioned his unorthodox analysis procedures and heavy use of unstated assumptions.”

As Fujita continued to gather data through aerial damage surveys in the late 1970s, he also enlisted the help of NCAR and its pair of portable Doppler radars, which were then among only a handful available in the world available for atmospheric research. With encouragement from Bob Serafin, who managed NCAR’s observing facilities at the time (and who later became NCAR director), NSF agreed to fund a field campaign. “At a time when many in the scientific community had serious doubts about Fujita’s downburst hypothesis, these two [entities (NSF and NCAR)] fully supported his efforts,” noted Wilson and Wakimoto.

Several landmark field projects over the next decade made it clear that Fujita was on the right track. Results from these field projects quickly convinced skeptics that microbursts were a bona fide threat to aviation. This initial awareness helped pilots and air traffic controllers stem the rate of major microburst-related accidents, which had been occurring every year or two in the 1970s and early 1980s. More intensive pilot training, much of it initiated by NCAR’s John McCarthy and sponsored by the Federal Aviation Administration, cemented the new concepts.

Technology also made a huge difference. Building on research led by McCarthy, and with FAA support, NCAR teamed up with the Massachusetts Institute of Technology’s Lincoln Laboratory to develop software that generated wind-shear alerts, drawing on observations from surface weather stations near airports and a new network of airport-based Doppler radars. As the new tools and observing systems spread nationwide, microburst-related accidents became increasingly rare: the last major U.S. flight mishap attributed to wind shear occurred in 1995. RAL is still actively helping international governments and airport authorities procure wind shear systems.

“The microburst/aircraft problem demonstrated how funding focused on a particular weather problem can lead to an operational solution,” says Wilson.

The Next Challenges
It’s likely that hundreds of deaths have been avoided thanks to Ted Fujita’s uncommon insight, his exhaustive documentation, and the careful field work carried out by NCAR scientists and their collaborators. Many of them remain active in research, savoring the microburst success even as they look to new areas where knowledge and technology can make transportation safer and more efficient. Much of this work now takes place within the framework of the FAA’s NextGen initiative, a comprehensive approach to aircraft navigation, weather information, and safety.

For More Information, Contact:
Matthias Steiner 303-497-2720 msteiner@ucar.edu
NCAR, Research Applications Laboratory
PO Box 3000 Boulder CO 80307-3000
www.ral.ucar.edu 303-497-8401 fax

Theodore “Ted” Fujita was renowned for his meticulous work in observing and analyzing meteorological phenomena, including tornadoes and microbursts, through photographs and damage surveys as well as weather data.

(Photo courtesy University of Chicago.)