How We Stopped Airplanes Falling From The Sky

Solving the Windshear Problem

NCAR 50th Anniversary Presentation
Rita Roberts, Jim Wilson, Robert Marfuta
Changes in Wind Speed or Direction Along Flight Path Can Be Catastrophic
Frequency of Accidents Caused by Wind Shear (1975-1985)*

*Accidents occurred about every 18 months.
1975 Eastern Airlines Flight 66 crashed in New York

122 passengers and crew died in the crash

Dr. Theodore “Ted” Fujita at the University of Chicago was asked to investigate the mysterious winds that caused the crash.

Fujita had conducted detailed analyses of wind patterns following the bombing of Hiroshima, and later, for many tornadic events.
Fujita’s Conclusion:

Eastern Flight 66 Crash was caused by strong wind shear.

He called this type of wind shear a Downburst or Microburst.
NIMROD Experiment
Chicago, Illinois 1978
First experiment to study wind shear using Doppler radars

Discovered extremely high winds (35 knots) near the ground over a very small (10 km) distance

A few downbursts were detected by radar during NIMROD, but it was still considered a very rare event.....

Approaching O'Hare airport

Chicago O'Hare Airport
Planning by NCAR scientists and Fujita for another wind shear experiment in Denver began in 1980. John McCarthy (NCAR) lobbied the FAA heavily to get funding support for this wind shear experiment, but to no avail. Bill Hess saved the day and covered the costs of the "JAWS" experiment.

Scientists from NCAR, NOAA, and several Universities participated in the experiment.
JAWS NETWORK 1982

CP-2 Radar
CP-3 Radar
CP-4 Radar

DENVER
ENGLEWOOD
AURORA
GOLDEN
ARVADA
BOULDER
LAFAYETTE
BLOOMFIELD

Map showing the network coverage of JAWS in 1982.
Microburst Causes Pan American FLT 759 to Crash on July 9, 1982

While on departure from New Orleans Airport

Following this disaster, the FAA immediately provided NCAR funding for JAWS and for the ensuing years for research on wind shear.
Data was collected on >150 microbursts!

On radar, microbursts have these characteristic wind signatures and time evolution:

**Time = 0**
Only a hint of downdraft hitting surface

**Time = 2 min**
Downdraft and outflow spreading along ground in opposite directions

**Time = 5 min**
Wind speed is strengthening in both directions

**Time = 7 min**
Wind change associated with spreading outflow is greatest at this time

**Time = 9 min**
Wind speeds are decreasing

JAWS Experiment Continued in Earnest.....
Visual Clues of a Microburst

- Vertical curl of dust along leading edge of microburst
- Circular Ring of Blowing

Small scale rainshaft spreading horizontally along the ground
During JAWS........

A Very Close Call at Denver Stapleton Airport....... 

NCAR Senior Scientist, Rit Carbone was on the airline flight coming in to land that encountered this strong wind shear event!
NCAR scientists conducted detailed research on microbursts:

- To understand how they form
- When they are likely to occur
- To train pilots to avoid them

In 1984, 2 years after JAWS..., NCAR Conducted...

**CLAWS**

Classify, Locate and Avoid Wind Shear

Objectives:

- Transfer our knowledge of microbursts to the aviation community
- Test how to make this information operationally useful to pilots and Air Traffic controllers
- Provide information on dangerous microbursts and wind shear to pilots and Air Traffic controllers

Airport with scientists present at the Air Traffic Control Tower and at research radar sites
Delta 191 crashes on arrival to Dallas/Ft. Worth Airport on 2 August 1985
Pilot attempts a go-around after encountering a 50 knot tailwind of a microburst…

….but the manuver was too late…
Late in 1980’s, NCAR built a new Wind Shear Display for Air Traffic Controllers.

Display lets controllers know when a microburst is impacting the runways and the intensity of the wind shear (here: 38 knots). Controllers alert pilots on approach and departure.
Another Microburst-Related Crash on July 9, 1994
Charlotte International Airport
Federal Aviation Administration (FAA) Response

• Approved and funded the installation of Doppler radars within 15 km of all major airports in the U.S.

• These radars are called TDWR for “Terminal Doppler Weather Radar(s)”

• The radars run continuously to detect microburst storms and measure wind shear intensity
A Rewarding Scientific Experience
And it’s a Never Ending Story ……

as TDWR systems are now being installed around the world
We Can Keep Airplanes From Falling From The Sky
A Success Story: One of the Best Aviation Safety Fixes