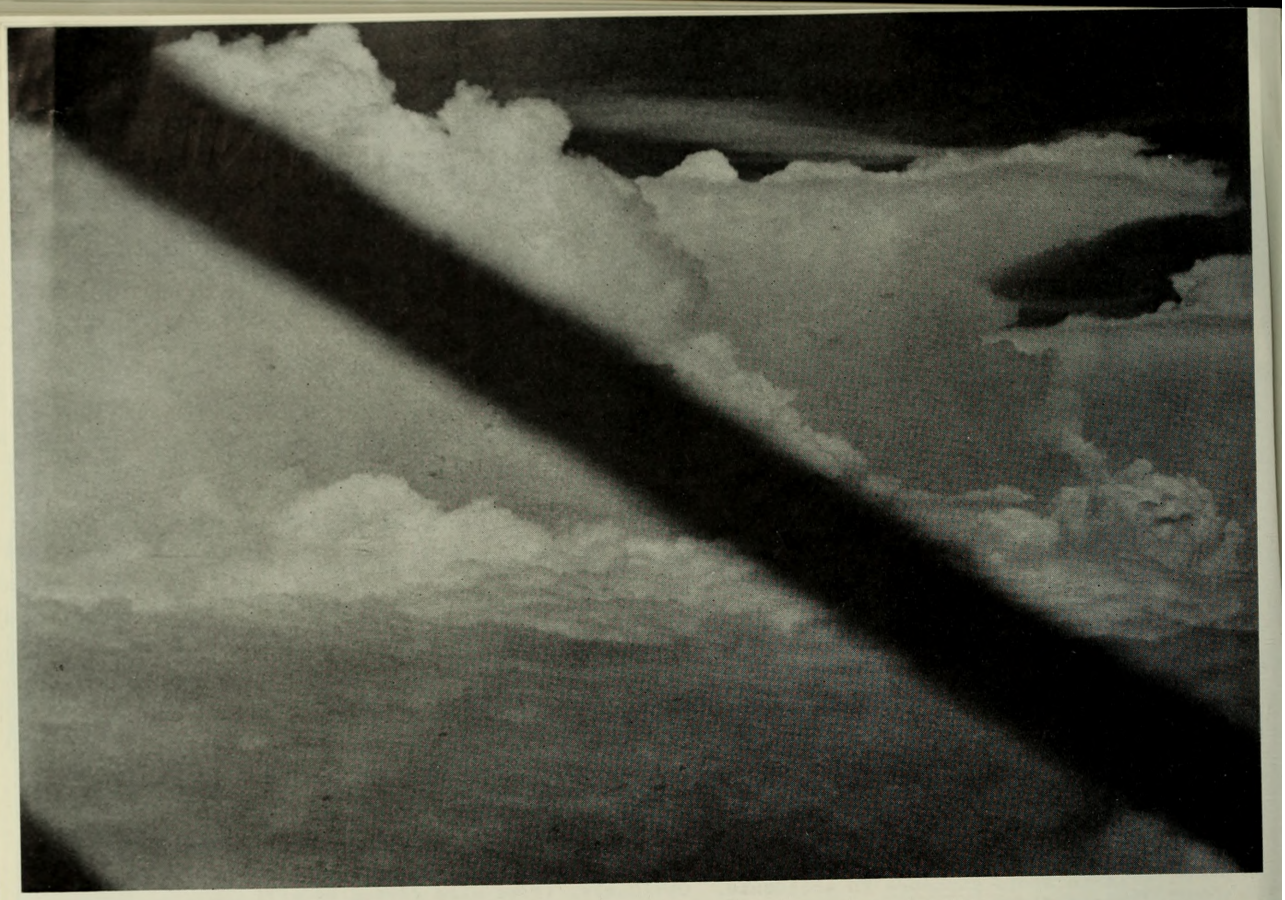


Tips on T-Storms

Thunderstorm activity will reach its annual maximum in the few months ahead. Pilots and navigators who have to deal with thunderstorm phenomena can benefit from a quick refresher. Following is a summary of thunderstorm features, beginning with some definitions, prepared primarily by United Airlines.

SIGMET. A Weather Bureau advisory concerning significant weather developments of such severity as to be potentially hazardous to transport category and military aircraft. SIGMETS are for periods of two to four hours and cover (1) tornadoes, (2) severe turbulence, (3) squall lines, (4) dust-sand storms, (5) hail three-fourths inch or more, (6) heavy icing.

AVIATION SVR WX FCSTS (WW). Warnings for civil aviation are issued by the Weather Bureau Severe Local Storms Center (SELS) at Kansas City, and are basic forecasts that are issued farther in advance and for longer periods than the SIGMETS. They are used by FAWS centers for guidance in issuing short-period advisories. Military Weather Warning System (CONUS only)—this system provides four scheduled weather warning advisory charts issued by the Kansas City Centralized Forecast Center. These forecasts are transmitted via COMET II weather teletype circuit every six hours and are valid for the ensuing 12-hour period. In addition Kansas City Centralized Forecast Center provides spot weather warnings to over 500 military locations when required. Warnings are issued for the following criteria: (1) tornadoes, (2) thunderstorms (regardless of intensity), (3) hail, (one fourth inch or larger), (4) surface winds (exceeding 35 knots), (5) rainfall (more than two inches in 12 hours), (6) freezing precipitation, (7) snowfall (more than two inches), and (8) severe dust storms. These forecasts and warnings are tailored to meet the requirements of the USAF, US Army, ANG and Air Force Reserve units.

SEVERE THUNDERSTORM. For the purpose of the WW, the Weather Bureau defines a severe storm

Courtesy United Air Lines

as one that has (a) surface wind gusts of 65 knots or more or (b) sustained winds of 44 knots or more or (c) three-quarter inch hail or (d) severe turbulence.

THUNDERSTORM GEOGRAPHY. Where are tornadoes found most frequently? In "Tornado Alley" which runs from Oklahoma NNE to Iowa. In this band, which has no known counterpart anywhere in the world, there is a pronounced maximum centering on Wichita where six tornadoes occur every average year within an approximate radius of 55 miles. There is a second "Little Tornado Alley" in the south running from Jackson, Mississippi, to Columbus, Georgia. Charleston, West Virginia, enjoys the least exposure of any United terminal east of Grand Junction.

Where do nocturnal thunderstorms occur most often?

The maximum is closely parallel to Tornado Alley running from Oklahoma to Iowa but the belt is broad. Chicago lies well within the eastern edge and North Platte the western fringe. A second area of high frequency is found along the gulf coast at New Orleans, Mobile and Tampa.

Are there favored areas for squall lines to form?

We can forget the true squall line as an operating problem west of Denver. They have occurred but only at the rarest intervals. From Denver east severe squall lines may occur anywhere each year. If there is any favored section for formation, it would be to the southeast of Lakes Michigan, Erie and Ontario in March, April and May when the lakes are still cold in comparison with the Tropical Gulf airmasses moving in against them.

Where is the "Marfa Front" found?

The Marfa Front lies, day after day in summer, in a north-south line running typically along the eastern borders of Colorado and New Mexico and thence south to Marfa, Texas, where the name originated. It is a dewpoint "front" separating moist Gulf air with dewpoints in the 60s on the east side from continental air and dewpoints in the 20s and 30s on the west side. It has great significance in connection with development of squall lines and tornadoes. It may be entirely cloudless.

Where do we find our most troublesome orographic storms?

Orographic thunderstorms are more frequent in the four-state area of the southern Rockies in July and August but these storms don't compare in potency with those found in the southern Appalachians from northern Georgia to Pennsylvania. Storms in Arizona and Colorado often have surface dewpoints in the 30s but those in the southeast are invariably in the 60s.

Are there favored areas for big hail to form?

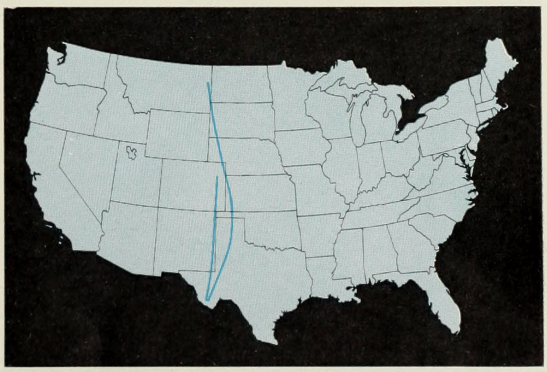
Yes! The worst hail belt in the country is a band running north-south from about Miles City, Montana, to Rapid City, South Dakota, to Sidney, Nebraska, to Goodland, Kansas, to Amarillo, Texas, to Marfa, Texas. (Note how this parallels the Marfa Front). There are counties near Goodland where ranchers must pay prohibitive premiums of more than $20 per hundred to insure their crops against hail damage. Big hail can also occur all through the east and midwest but with nothing like the frequency found in the high plains. Air Force jets have encountered four-inch hailstones at 30,000 feet and three-inch hailstones at 40,000 feet through the Marfa Front zone at Amarillo and Goodland. Three-inch hailstones occur somewhere in this belt on the ground every year.

Are there favored areas for static discharges to occur? Yes. The recent UAL survey showed maximum piston cases from Lake Erie eastward to New Jersey while the maximum jet incidents were found in the Chicago traffic pattern.

Rather surprisingly, one of the most susceptible airway segments (on the UAL system) seems to be the Portland-Seattle. This is the best proof we have that active thunderstorms are not necessary to produce the discharge. They will occur wherever we have a high exposure to IFR flight through clouds with temperature near 32°F and icy-type precipitation occurring.

THUNDERSTORM PHYSICS. Why would

Tornado Alley (Okla. NNE to Iowa), Little Tornado Alley in Southeast US, and nocturnal thunderstorm area (hatched area) are shown above.



The Marfa (dewpoint) Front lies day after day in summer from Marfa, Texas, northward along eastern borders of New Mexico and Colorado.

Tips on T-Storms

Storm A be rough and Storm B smooth when they look alike from outside?

Storm A is in the building state, Storm B in the decaying stage. Even radar may miss this distinction at the first stage of development. To the experienced observer, the hard cauliflower outlines of the cumulonimbus are the tipoff the storm is new and building.

Can damaging hail occur at 40,000 feet?

Yes! A number of Air Force jet aircraft have been badly beaten up at that level in Texas and Kansas. Typical "last words" read like this, ". . . we were flying IFR in cirrus type clouds" or ". . . we had just entered altostratus type clouds."

What causes nocturnal thunderstorms?

A low level jet at 3000 to 8000 feet and strong warm air advection at those levels are generally considered to be the prime ingredients. The jet is from S or SSW and often exceeds 50 knots at 3000 msl. Over the ocean, where storms also show a maximum at night, the explanation has to be different. In areas like the Gulf of Mexico it seems likely that slight cooling at upper levels is what upsets the delicate stability balance prevailing in the tropical air.

Why does Omaha, for example, have more thunderstorms at night than during the day?

Because it lies right in the path of the low-level jet stream from the S or SSW at 3000 to 8000 feet that invariably reaches a maximum speed during the period from midnight to 0500 CST. This jet characteristically brings in warmer air from Texas to steepen the lapse rate and cause overturning.

Tall thunderheads that have lightning flashing incessantly are most likely to spawn tornadoes.

Do nocturnal thunderstorms always have high bases?

Don't count on it. Some nocturnals generate full-fledged squall lines attended by hail, severe surface gusts and thick scud clouds or roll clouds.

Does lightning have anything to do with tornadoes?

It has been observed that tall thunderheads that have lightning flashing incessantly are most likely to spawn tornadoes. Some scientists believe electricity has an important role in generating large tornadoes.

How high do tornado funnels extend? There is increasing evidence that they reach up to 30,000 feet or higher at times.

There was one instance several years back in Arkansas where an airline captain reported a funnel reaching down from a cumulonimbus overhang starting at 30,000 feet estimated. More recently a U-2 aircraft at 65,000 feet photographed a tornado-spawning cumulonimbus with a hole in the top at 51,000 feet which was 6.3 miles in diameter and rotating. Speed of rotation was estimated at 90 knots near the top and considerably higher down inside.

What is the role of electricity in the thunderstorm mechanism?

We don't know. In the past it was always assumed that shattering raindrops generate lightning discharges. The Arthur D. Little researcher, Dr. Bernard Vonnegut, has turned up impressive evidence that electrical charges in the atmosphere may precede the development of large cloud drops and rain.

What conditions precede a static discharge?

This we do know, thanks originally to a study by TWA's E. J. Minser back in the '30s. The factors that Minser discovered to be associated with the static discharge on the DC-2 and DC-3 are just as appropriate today with the subsonic jets. These are typically:

1. Flight on instruments or in and out of clouds.
2. Air temperature 40° and lower (true). (A recent UAL survey of 100 jet discharges showed 67 per cent between 30°F and 45°F.)
3. Active precipitation with some icy types involved.
4. St. Elmo's Fire. (Not always visible.)
5. Radio static. (This not as severe today.)

Do the jets have a lesser exposure to static discharges?

Given the same meteorological conditions, the jet should be more prone to discharges. Since the jets are not exposed to the same conditions at cruising levels (because of low temperatures and minimal water content), they are experiencing fewer "strikes" than the pistons and turboprops. (In the recent UAL survey, 78 per cent of the jet discharges occurred during climb or descent.)

Can anything be done to avoid static discharges?

The only sure evasive action is to avoid IFR flight through clouds and mixed precipitation types. Radar can help on this—winter as well as summer—but traffic rules and procedures obviously conspire to make this impractical in most instances. It is unnecessary for radar to show "cells"—grainy or fuzzy echoes may produce discharges. As increasing signs point to an impending discharge, the only defense is to turn up the cockpit lights brightly and to have one pilot concentrate on looking away from the windshield for protection against the blinding flash. The discharge flash may be the only "lightning" observed. ☆