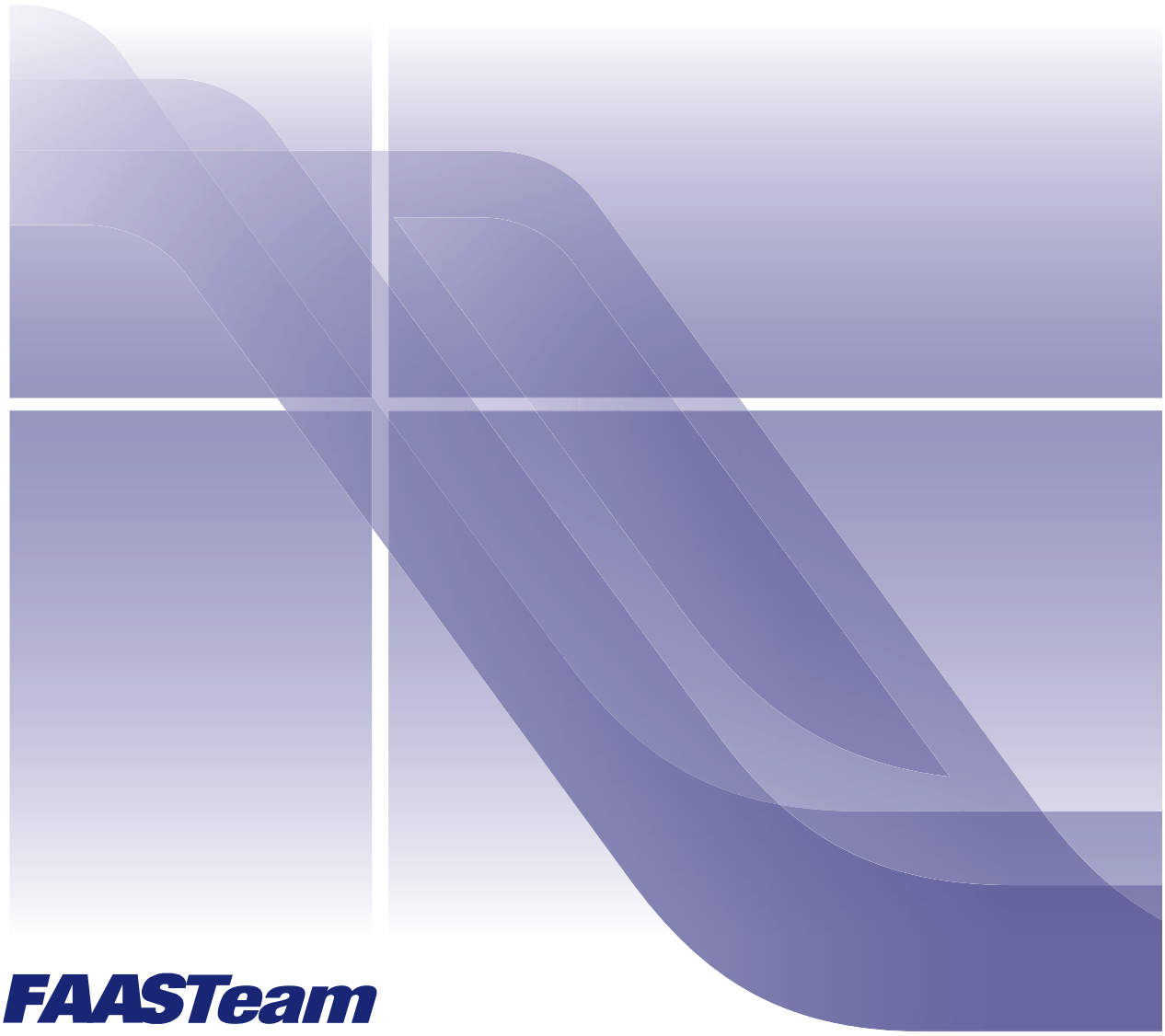
Federal Aviation Administration

Thunderstorms—Don't Flirt...Skirt 'Em



FAASTeam

FAA–P–8740–12 • AFS–8 (2008)

Introduction

Pilots, beware. A summer hazard —the thunderstorm—may lie in wait on the route you intend to fly. As nature's uncontrolled "heat engine," the thunderstorm can create some of the worst weather hazards known to aviation. This document offers a review of thunderstorm hazards along with tips for avoiding this kind of weather. *Note: In addition, be sure to read the Learning Center Library documents on spring 2006 changes to how Air Traffic Control describes weather radar echoes to pilots.*

Thunderstorm Basics

Ingredients for a Thunderstorm

As you may remember from ground school, the basic requirements for the formation of a thunderstorm are these:

- **Unstable air.**
- **An initial updraft.**
- **High moisture content in the air.**

You may wonder why these conditions produce only fair weather cumulus clouds one day but create violent thunderstorms the next. There is no simple answer; however, it is known that latent heat released by condensation of existing water vapor may increase the buoyancy of a rising air column until that rising air column becomes self-sustaining. The updraft then becomes the "burner chamber," drawing "fuel" from below until its source is exhausted or until it reaches an intermediate layer of dry, stable air. The by-products of this uncontrolled heat engine are clouds and precipitation and, sometimes, vertical currents strong enough to literally tear apart the ordinary light aircraft.

Thunderstorm Development

The general aviation pilot must contend with thunderstorms of varying intensities in virtually all parts of the country. As a pilot, you should be aware that all thunderstorm cells progress through three distinct stages—more commonly called the lifecycle of the storm—that include the following:

- **Cumulus.**
- **Mature.**
- **Dissipating.**

The severity of any thunderstorm is governed by the makeup of the mature stage. Although most cumulus clouds do not become thunderstorms, the initial stage is always the cumulus cloud. The main feature of a cumulus cloud that will develop into a thunderstorm is the predominate updraft. This updraft may extend from the earth's surface to several thousand feet above the visible cloud tops. During the cumulus stage, tiny cloud droplets grow into raindrops as the cloud builds upward. When these droplets become so large they can no longer be supported by the existing updraft, they begin to fall.

This development marks the beginning of the mature stage and usually occurs some 10 to 15 minutes after the cumulus cloud has built upward beyond the freezing level. Thunderstorm cells that progress rapidly through the mature stage are said to be "limited state" thunderstorms.

In the limited state thunderstorm, the mature stage is self-destructive until the updraft will no longer support the raindrops and precipitation begins to fall through the updraft. The buoyancy of the air is decreased until the updraft becomes a downdraft. The cool precipitation tends to cool the lower portion of the cloud and, with its "fuel supply" thus cut, the cell loses its energy and the storm dissipates. When all water droplets have fallen from the cloud, the dissipating stage is complete.

If, in the mature stage, the updraft and downdraft areas remain equally balanced, the mature stage may then become a "steady state" thunderstorm cell in which extreme turbulence and large hail may predominate. The limited state thunderstorm cell may last from 20 minutes to 1.5 hours, while the steady state thunderstorm may last as long as 24 hours and travel for 1,000 miles.

Although pilots have flown through limited state thunderstorms with little or no damage to the aircraft or passengers, these pilots should consider themselves ***extremely*** fortunate to be alive. Any thunderstorm is an uncontrolled heat engine that may produce any or all of the most violent weather hazards (for example, hail, ice, turbulence) that a pilot will ever encounter.

Thunderstorm Avoidance

General Rules

Pilots should observe the following rules for any flight routed even potentially near actual or possible thunderstorm activity:

- Avoid all thunderstorms.
- Never go closer than 5 miles to any visible storm cloud with overhanging areas, and strongly consider increasing that distance to 20 miles or more. You can encounter hail and violent turbulence anywhere within 20 miles of very strong thunderstorms.
- Do not attempt flight beneath thunderstorms, even when visibility is good, because of the destructive potential of shear turbulence in these areas.
- At the first sign of turbulence, reduce airspeed immediately to the manufacturer's recommended airspeed for turbulent air penetration for a specific gross weight (that is, maneuvering speed, or Va).
- If the aircraft inadvertently penetrates the thunderstorm, maintain a straight and level altitude on a heading that will take you through the storm area in the minimum time.
- Never let compulsion take the place of good judgment.

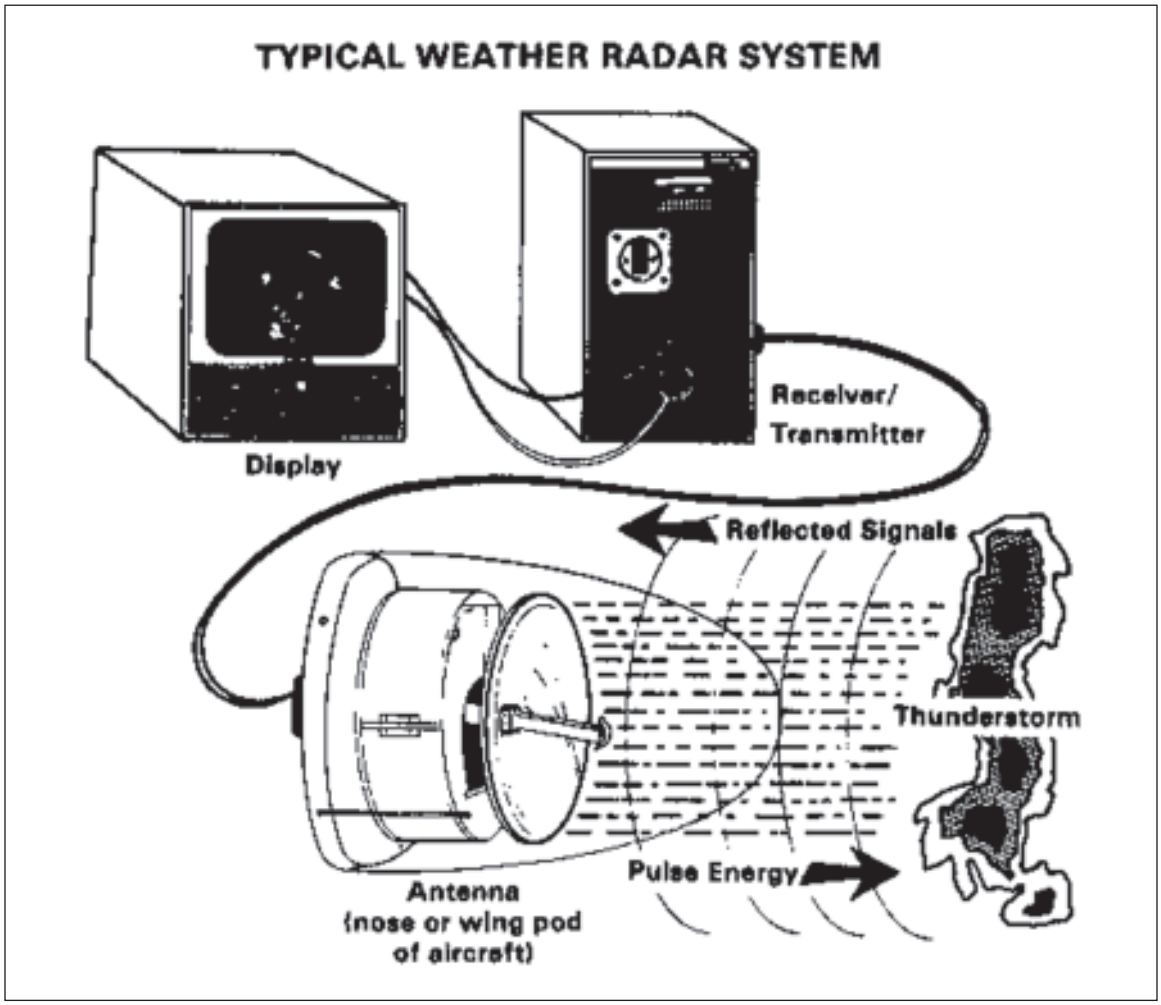
Weather Radar System

Capabilities of Weather Radar

Note: Be sure to read the separate Learning Center Library documents on spring 2006 changes to how Air Traffic Control describes weather radar echoes to pilots.

A weather radar system does the following:

- Detects and displays significant weather within a specified sector related to the route of flight.
- Measures rainfall density, which can be related to turbulence associated with rainfall gradients.
- Provides greater comfort for passengers and crew.
- Substantially increases aircraft utilization.
- Promotes safer weather flying.

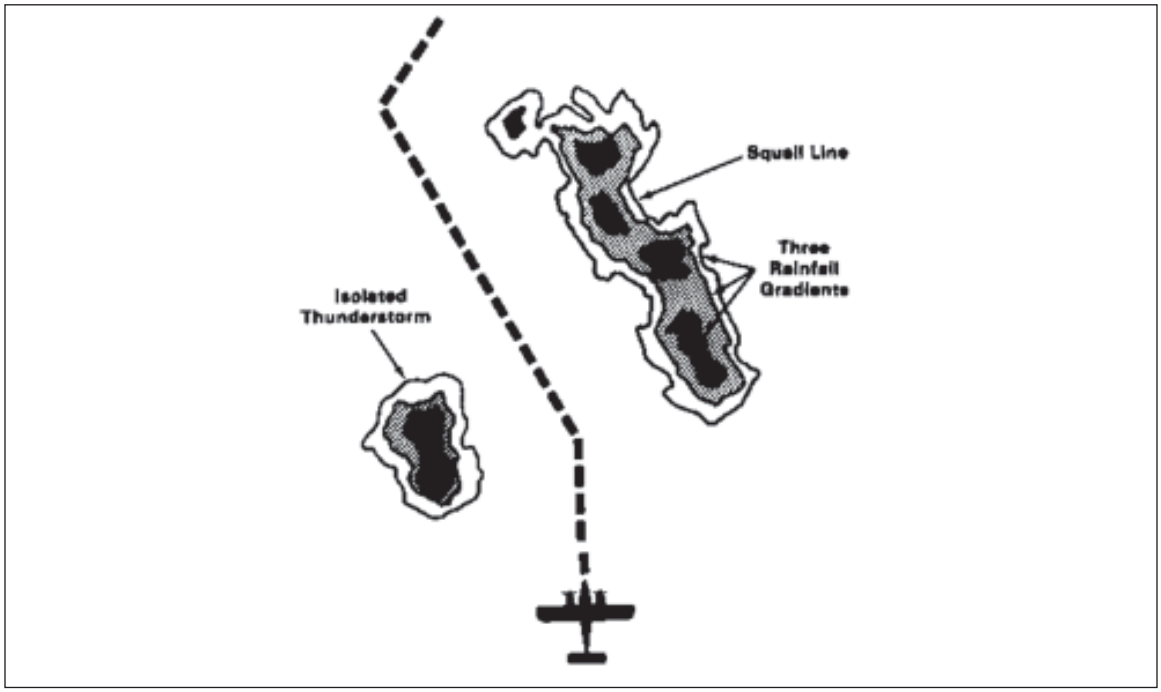


Limitations of Weather Radar

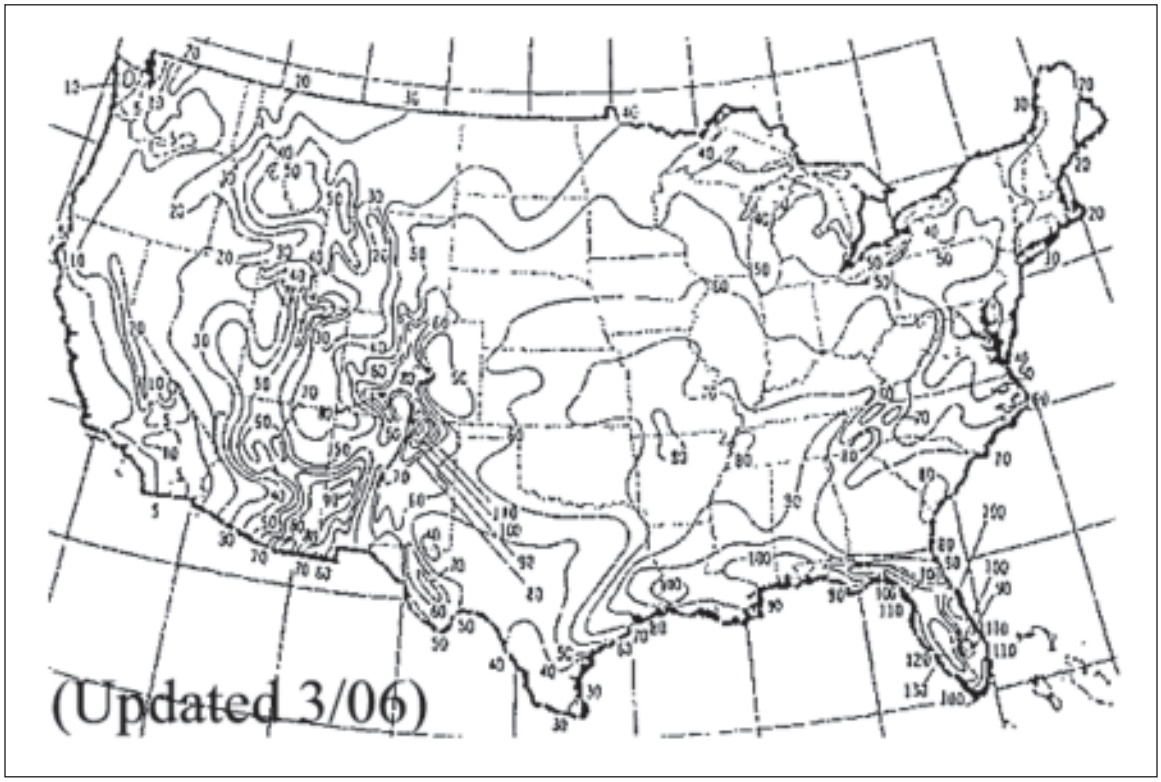
- Weather radar cannot directly detect turbulence, even though it might be related to thunderstorm activity.
- Using radar for weather avoidance requires operational experience and expertise. Interpreting the display is not an exact science; instead, much depends on the operator's general knowledge of thunderstorms and on his or her knowledge of the forecast weather. The operator also must be intimately acquainted with the specific radar system's capabilities and limitations.
- Weather radar cannot detect dry snowfall, cloud icing (unless associated with precipitation), or other aircraft.
- Weather radar detects weather targets only when the radar beam illuminates them. Tilt management of the radar antenna is, therefore, very important.

Operational Functions and Features

- Weather radars available today usually provide good to excellent terrain-mapping capability.
- Some weather radars also detect surface targets on water, such as ships, buoys, and oil-drilling rigs.
- Some systems provide radar homing beacon capability, which is the ability to "home in" using radar with a particular cooperating (transmitting) ground station.
- Digital memory technology permits continuous nonfading displays, similar to that of televisions in homes.
- Multifunction color displays provide levels of rainfall intensity in discrete colors, along with HSI/RNAV/VOR navigation profiles in a "moving map" presentation. Programmable checklists, RNAV waypoint data, pilot-controlled electronic azimuth trackline, and many other types of information can be programmed and displayed in the new multifunction airborne weather information systems.
- Installations in certain single-engine aircraft, using wing pods, are now available. Look for continued developments in this area.



Average U.S. Thunderstorm Days Per Year



About This Series

The purpose of this series of Federal Aviation Administration (FAA) safety publications is to provide the aviation community with safety information that is informative, handy, and easy to review. Many of the publications in this series summarize material published in various FAA advisory circulars, handbooks, other publications, and audiovisual products developed by the FAA and used by the FAA Safety Team (FAASTeam) for educational purposes.

Some of the ideas and materials in this series were developed by the aviation industry. The FAASTeam acknowledges the support of the aviation industry and its various trade and membership groups in the production of this series.

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