YOU VS. THE THUNDERSTORM

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"There is no reason to fly through a thunderstorm in peacetime."

— Sign over squadron ops desk at Davis-Monthan AFB, AZ, 1970.

As pilots we become our own personal meteorologist. Every flight is an aerial battle against Mother Nature: gusty winds, low ceilings, rain, fog and thunderstorms. Some days seem as though the planet just does not want us flying. Those are the days we, as pilots, need to learn to avoid. As pilots we need to decide which battles we can win and which ones we cannot. Is it a matter of our limits as the PIC or the aircraft's, possibly both and we have to draw a well defined line when we say, "Lets walk away from this one."

One weather phenomena that should always be a NO GO decision is a thunderstorm. This would seem obvious but people still manage to plow right into them. Thunderstorms can be very insidious, not making themselves obvious to a pilot until it is too late. Here we will attempt to cover some of the basic weather patterns involved with thunderstorms, the different types, how they develop and some ways to identify and avoid them.

> Definition – A local storm produced by a cumulonimbus cloud, and always accompanied by lightning and thunder. It is usually short in duration, rarely over two hours for a single storm.

Thunderstorms come in two main types; airmass, and severe, severe being much greater in intensity with winds of 50 knots or more, and/or hail three-quarters of an inch in diameter or more and/or strong tornadoes. Severe to extreme turbulence is always associated with thunderstorms. Thunderstorms may be just a single cell airmass storm of 5-10 miles in diameter at its greatest strength and lasting not more and an hour. Multi-cell airmass or severe storms are composed of several single celled storms in varying stages of development that interact with one another to increase the duration of the group. These extreme weather conditions may extend several miles away from the storm and as a general rule of thumb thunderstorms should be avoided be at least 20 miles. If in the event a pilot enters a thunderstorm, an attempt to maintain a level flight attitude should be made. Due to the possibility of extreme turbulence the airspeed should be set at or below maneuvering speed. The intensity of the raising and descending air may make it impossible to maintain altitude.

First, what conditions must be present for thunderstorms to occur? There are three general conditions necessary for the development of a cumulonimbus cloud. Those are: a source of moisture, a lifting action and unstable air. These conditions can be produced in several ways. Initial lift can be created by solar heating of the surface, orography(lifting caused by terrain), frontal activity and low level convergence or upper level divergence. Large bodies of water can provide a source of moisture, such as the Gulf of Mexico. Combining some of these factors with a good understanding of atmospheric properties and circulation can help predict possible thunderstorm acticity.

The life cycle of a thunderstorm consists of three stages: cumulus, mature, dissipating. Starting with concentrated updrafts, the cumulus stage is predominately marked by the appearance of towering cumulus clouds. The updrafts are normally more powerful than any of the surrounding thermals making the ***Vertical Development (first way to identify a Thunderstorm)*** of one particular cloud visibly standout, typically growing to approximately 20,000 feet. The shear power of the updrafts can cause the smaller surrounding clouds to dissipate. While the updrafts are strong they are also uneven and cause the clouds to grow in a non-linear manner, making them look billowy and bulgy. Late in this stage the development of precipitation in the cloud causes a downdraft to begin transitioning to the next stage.

Precipitation-induced downdrafts at the surface indicate the beginning of the mature stage. ***Thunder and Lightning (second way to identify a Thunderstorm)*** are the most prominent meteorological phenomena during the mature stage as the storm grows to 5-10 miles in diameter. This stage shows a well organized convective circulation, cool down drafts have reached their maximum potential at the cloud base while the most powerful updrafts exists simultaneously in the higher regions of the cloud. These updrafts can push the cloud tops into the very stable air of the lower stratosphere. The stability of the stratosphere resists any more upward movement and the tops of the cloud now pancakes out creating an ***Anvil Shaped Top (Third way to identify a Thunderstorm).*** The anvil top points in the approximate direction the storm is moving, this can be a valuable tool in deciding which direction to divert around a storm.

Merely 30 minutes after the start of the storm the dissipating stage begins. Precipitation-induced downdrafts cover the lower levels, strangulating the very same storm that produced them by severing the source of energy for the updrafts. Finally, all the energy from heat and moisture has been exhausted causing the storm to falter. This is the end for the thunderstorm. The short life of the storm, which lasted less than an hour, is only succeeded by the remnants of the anvil top. This is because of the clouds ice crystal anatomy. The cumulus clouds precipitation decreases and the clouds themselves become more stratiform shape.

These stages are merely a generic representation of a typical airmass thunderstorm. These are by no way laws absolute, more of guidelines to assist in the identification of thunderstorms. For example, developing cumulus clouds can produce the tell tale signs of the mature stage, including wind gusts and downdraft-induced precipitation, however the storm never reaches the mature stage. This is indicated by the lack of thunder and lightning. It is also possible for a storm to have grown to the mature stage with no rain at the surface. Arid regions favor this because the dry air promotes higher cloud bases and will make the rain evaporate prior to contact with the ground. The phenomena of rain evaporating before it hits the earths surface is called virga. All the other dangers associated with a thunderstorm still occur in this case, so it is still possible to encounter high winds, lightning, and turbulence and so on.

Multicell thunderstorms are a group of single-cells that individually act in a similar way as the airmass storm but as a group are very different. In a multicell storm each cell helps to fuel others and propagate new cells increasing the duration of the storm. The key to the multicell storm is an organized gust front. A gust front is present during most thunderstorms, they are created by the outward movement of the cold air of the downdraft as is comes in contact with the ground, it is a sharp boundary at the edge of the area of cold air below the storm. These gust fronts are more organized in the multicell because of a significant increase of wind as altitude increases. All of these factors contribute to stronger downdrafts. As the multicell moves through, the gust front can extend several miles out front in its direction of movement, and its characteristics are similar to a cold front passing. The intensity of a multicell storm can vary greatly.

Posing an even greater threat is the supercell, or steady state, thunderstorm. These supercells favor the mid-latitude regions, specifically Texas, Oklahoma, and Kansas during the spring. Supercell storms are much greater in size, duration and intensity. This is due to a much more complicated structure than even a multicell storm. The complication of its structure is caused by the difference of the southeasterly wind patterns at the surface and the westerly winds aloft. This drastic change in wind direction causes a tilting and twisting of the updraft and also separates the vertical movement of air. The updrafts and downdrafts are kept from interfering with one another allowing stronger steadier updrafts. This separation of the drafts creates two distinct areas under the cloud base, an area with precipitation and an area without. The rain free cloud base can create a low area in the cloud referred to as a “wall could”. Wall clouds can have significant rotation and are the area of the storm that produces the strongest tornados. The supercell storm can last for more than an hour and can also develop individually or in conjunction with other supercells, or other airmass storms.

Thunderstorms can form in lines that are referred to as “squall lines”. These lines can be produced from cold fronts, due to the lifting caused by the front and they are generally fast moving. However, squall lines do not have to be associated with a front. They are often formed in the warm air preceding a front. These lines can be several hundred miles long and consist of single, multi or supercells. Thunderstorms can be produced by warm fronts as well; this often causes the thunderstorms to be embedded in stratoform clouds. Embedded thunderstorms pose a threat simply because they cannot be seen easily unless viewed from above the cloud deck, at which time it could be too late.

Thunderstorms pose a great threat to pilots and while it would seem easy to identify them from the extreme phenomena they produce pilots still find their way into them, whether through inexperienced or complacency. This is true of even the most experienced pilots. If there is any indication that there may be convective activity in the area, landing at the nearest airport or diverting around a storm is possible is a necessity.

“Just remember, if you crash because of weather, your funeral will be held on a sunny day.”—
Layton A. Bennett

-Andrew Kisela CFII