

Thermal Basics

Red Smith

First, some basics about the atmosphere:

- Heat is transferred from the ground to the atmosphere. This transfer takes place in the boundary layer at the surface.
- If a parcel of heated air becomes warmer than the surrounding air, it will rise.
- As air rises it cools at a rate of 5.5 degrees Fahrenheit per 1000 feet (dry adiabatic lapse rate). But as long as it stays warmer than the surrounding air, it will continue to rise.
- As air cools, the RH increases and moisture condenses into small droplets (cumulus clouds form) if RH reaches 100%. Once moisture condenses, the lapse rate decreases for any continued rise to that of the moist adiabatic lapse rate.
- When moisture condenses heat is released (and absorbed when it evaporates).
- When moisture freezes, additional heat is released. This is what gives the kick to Thunderstorms.

Safety Comments

We are in the midst of thunderstorm season & I can think of seven hazards associated with thunderstorms (downwash, updrafts, wind-shift, hail, lightning, icing & anoxia). I will limit the discussion to the first three.

We can avoid the first two by never ever flying under a thunderstorm.

Downwash can exceed 3000 feet per minute down & that can put you on the ground in a hurry.

- A friend (a very experienced pilot, flying in one of his first contest was in position to win the day. All he had to do was dart under a small cloud that was becoming a cumulus. He was just at 3000 feet, 2-3 miles from the glider port in a high performance glider. He made it as far as the high voltage lines about a quarter mile from the glider-port and lost most of the sight in one eye.
- A contestant in the World contest in Eastern Europe some years back was found fatally injured in his plane, which had slammed into the ground in a normal flying attitude as a result of a down-draft.

And getting sucked up into a thunderstorm will result in coming out in pieces unless you have blind flying equipment and are very skilled in blind flying. Even then, it will be a BIG adventure. Dick Schreder reported experiencing 12.6 g's once and 12.3 g's twice when it happened to him.

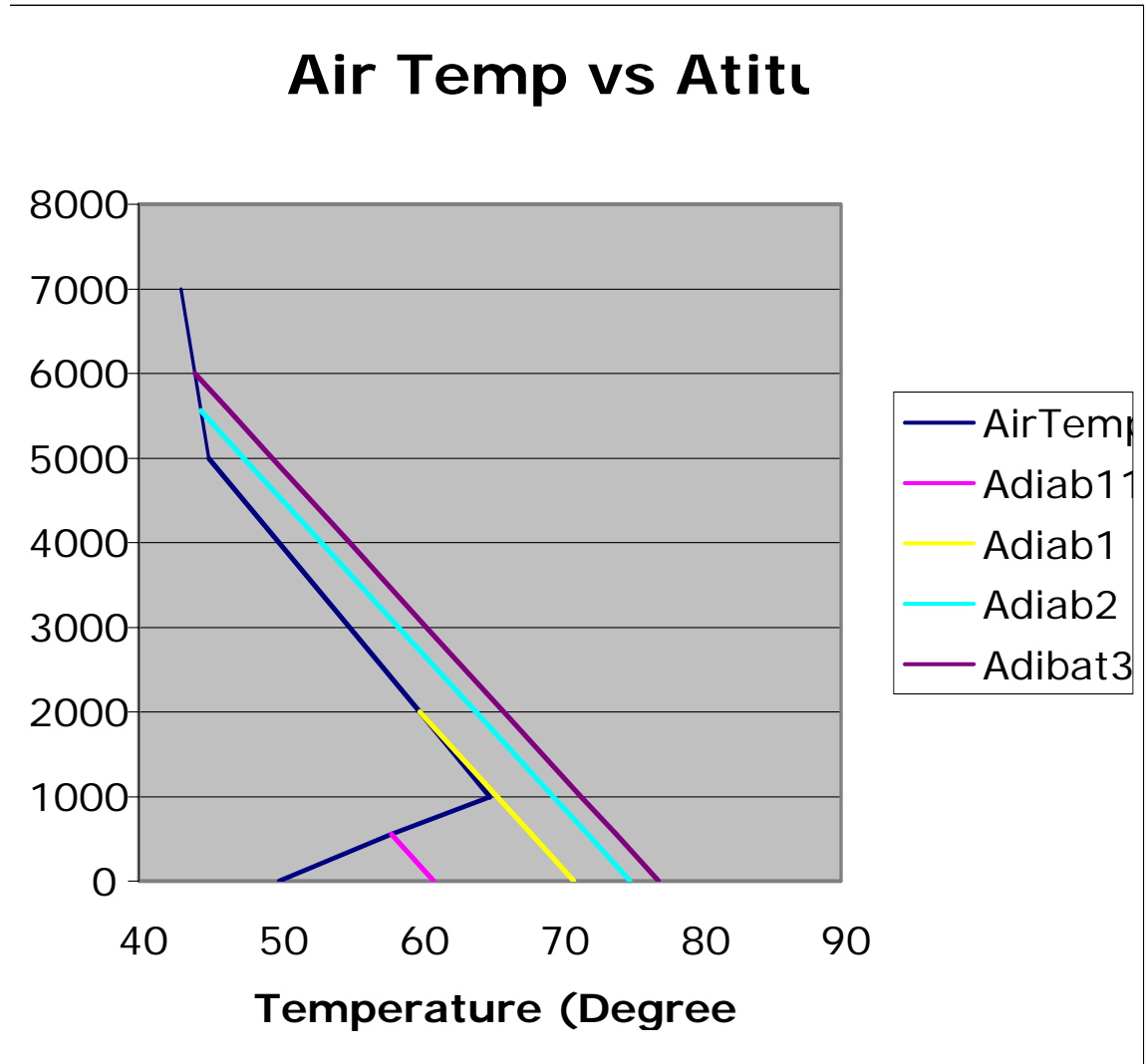
- Updrafts below a thunderstorm can easily exceed the sink rate with full spoilers at redline.

Wind-shift can occur at large distances from a large thunderstorm. At the World contest in Spain quite a few years ago, there was a wind-shift of >20 knots perhaps 20 miles away from a large thunderstorm in the mountains. Several accidents occurred as planes were landing.

- Keep extra speed when landing whenever a cumulus is around.

Thermal Formation

- The blue curve shows air temperature vs altitude shortly after dawn on a spring day after a cold front has passed through.
- The other curves show thermals as the surface warms during the day (at 11, 1, 2 & 3).
- Heated air rises until it is the same temperature as the surrounding air. Conversely, if air becomes cooler than surrounding air, it will sink, usually all the way to the ground.
- The slide is designed to show basic concepts. Real life is slightly more complicated but conclusions drawn from the slide are still valid.
- A process is adiabatic if no heat is exchanged with the surroundings. Not strictly true for thermals but only a little heat is exchanged, primarily by mixing, at the edges of the thermal.
- The greater the temperature difference between a thermal and the surroundings, the faster the thermal will rise (think hot air balloons).



Best chances for a strong thermal soaring day

- Cool Air (just after a cold front has passed).
- But too soon after the front has passed and winds will be high and there may be significant wind shear).
- Bright sunshine with long days (late spring, early fall).
- Enough humidity to cause clouds to form at the top of a thermal (but some blue days are very strong).

Complications

- Thermals come in many different sizes, some so small, that you may need to bank as much as 60 degrees to stay in the strongest lift, some very large.
- Once a thermal leaves the ground, it drifts with the wind (think smoke from a bonfire). If wind velocity changes with altitude (magnitude or direction), the thermal will bend over at that point and may be very difficult to work at that level.
- Thermal lifetimes vary (up to several hours for some & only time for a few turns in others) but average lifetime is 20 minutes.
- A stronger thermal can steal the warm air feeding your thermal causing lift to drop and downwash from the strong thermal may distort your thermal making it hard to work.

Complications (cont.)

- A stronger thermal can steal the warm air feeding your thermal causing lift to drop and downwash from the strong thermal may distort your thermal making it hard to work.
- Small thermals down low often merge at higher altitudes but a pair may stay near one another to high altitudes.
- Lift may be directly under a cloud or just just upwind or downwind of a cloud or even at the crosswind edges. But a pattern generally persists all day.
- When wind is blowing, thermals can line up in “streets” along the direction of the wind, sometimes marked with clouds, but on dry days, there are no visual clues.
- But wave can give rise to thermals perpendicular to the wind.
- The same factors leading to good thermals can lead to thunderstorms when there is sufficient atmospheric moisture at the altitude of cloud formation.
- Down wash from a thunderstorm can be 3000 ft per minute and may spread out over large areas at the surface.

Rules of Thumb

- Thermal diameter increases with altitude.
- The higher the thermal tops, the further apart they will be.
- Lift will be strongest near well shaped cumulus clouds.
- If you’ve found nothing better than zero sink since release, there will be good lift on downwind.