

## Airplanes and “Thermals”

Imagine a hot day in the middle of July. The weather is beautiful with calm winds and a few harmless cumulus clouds in the sky. This nice day is a good thing because you are scheduled to fly later that afternoon and you would like to have a smooth flight. As the plane takes off, you are very surprised at how bumpy the ride is because the weather is clear. Bumpy airplane rides only occur during bad weather, right? Has this ever happened to you, and if so, what causes this phenomenon?

The answer is that even though the weather is generally clear, the air can be very turbulent due to an invisible phenomenon meteorologists and pilots call “thermals.” To understand how thermals work, a person must understand how air parcels (bubbles of air) act in certain situations, such as on a hot day. One property of an air parcel is that if it is warmer than the air immediately surrounding it, the bubble of air will rise until it is either the same temperature or cooler than the air around it. Have you ever heard the expression “hot air rises and cold air sinks?” The reason this is true has to do with the density of the air. When a bubble of air is warmed, it expands because it has a greater pressure. This expansion of the bubble makes it less dense than its surroundings, just like a balloon! If the air parcel is warmer than its surrounding environment, the parcel is considered to be positively buoyant. The best way to imagine buoyancy is to picture a small beach ball at the bottom of a pool. Pretend that the beach ball is the parcel of warmer air and that the pool is the surrounding colder environment. If you let the beach ball go what happens? It rises as fast as it can. This is exactly what it means to be buoyant and explains exactly why you can have a bumpy ride in an airplane on a clear day!

In general, the atmosphere cools as you get to higher and higher altitudes. So once an air parcel becomes warmer than its surroundings and starts to rise, it has the possibility to rise thousands of feet into the air! This rising air creates what we call a “thermal” or an “updraft.” There is more to the process, however. Another expression you might have heard of is “what goes up must come down.” This holds true for the warm air because it eventually reaches a height where it cannot climb anymore. Air that is cooler than its surroundings will sink because its pressure is lower and the parcel is denser. Now you might be able to imagine your airplane flying through air that is rising and falling at different speeds, creating the bumpy, and sometimes very bumpy, ride. Imagine the airplane flying through a pool of beach balls!

Now you might be wondering what causes the parcel of air to become warmer than its surroundings near the ground. The answer is found in the energy of the sun. On a clear day the sun is able to heat the ground to the best of its ability, which makes the air near the ground warmer than the air directly above it. The rising process then begins. Another factor in warming

air near the ground deals with how absorbent the surface is of the sun's radiation. Have you ever walked barefoot across a parking lot in the middle of the summer? Did you notice how much hotter the black parking lot is than green grass? The type of surface (color, texture, etc.) helps determine how absorbent of the sun's radiation that particular object is. One other fact to note is that different areas on the earth's surface heat at different rates. Therefore, differential heating of air parcels cause different speeds and heights at which the parcels are rising and falling, adding to the bumpiness!

So, how can you avoid a bumpy ride? The best time to fly to avoid the "bumps" is normally early morning or late evening. In the morning, the sun has not had a chance to heat the surface, so the air should be relatively smooth as long as there is little wind. Another good time to fly is in the evening close to sunset. The sun is not positioned at a good angle to heat the surface, so the energy provided to cause the rising thermals is gone and the atmosphere is more stable.

So the next time there is a fair weather day, think about what might be going on with the air above you, and what type of ride aircraft may be experiencing. If there are cumulus clouds in the sky, it will be a good indicator that thermals are present. Having knowledge of what type of environment an airplane is flying in will better help you prepare for the flight. Glider pilots are especially aware of their situation because they cannot fly without thermals.

**Picture courtesy of: [atmos.washington.edu](http://atmos.washington.edu)**



**Pictured above is a smoke plume rising into the air and creating a cumulus cloud. This picture is a great way to visualize how "thermals" work. The smoke plume is warmer than its surroundings, so the less dense air rises to the point of condensation, creating the cloud!**

