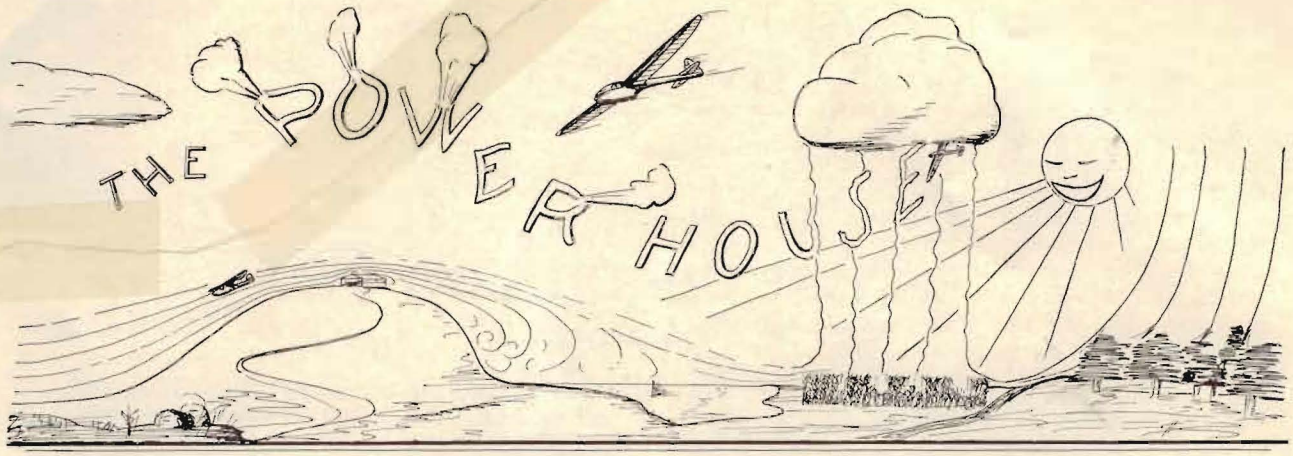

Conducted by Barney Wiggin of the U. S. Weather Bureau

Atmospheric TURBULENCE

This is the final installment of a serial article on atmospheric turbulence written by Mr. L. P. Harrison of the U. S. Weather Bureau

The downward velocities of currents within the cloud may generally be expected to be of the order of ½ to ¾ of the upward velocities. Under certain conditions greater values are possible, especially at the lower levels.

The violent character of turbulence in the upper reaches of growing cumulus and cumulonimbus clouds is manifest by the behavior of the cauliflower-like heads. They grew by progressive steps involving an explosion-like expansion to greater heights attended by overshooting of the equilibrium level, and followed by partial collapse with rapid descent toward the main body of the cloud.

There is reason to believe that turbulence between the ascending core of the active towering cumulus and cumulonimbus clouds and the largely descending exterior is greater toward the windward side of the clouds. (Floyd Sweet and I can attest to this for that's how we found it on our cross-country flight September, 1941.) This may be expected where greater differences of velocity exist and where greater disturbances are produced by external influences. Explanations for the former may possibly be found in the probability that evaporation proceeds more rapidly on the exterior of the windward side of the cloud than on the leeward side, hence the resulting cooling and the consequent density increase of the air are greater. This would easily lead to greater descent velocities on the windward than on the leeward surface of the cloud. In addition to influencing the rate of evaporation, the wind may produce disturbances on the windward side and thereby increase turbulence.

Near the top of less active clouds more complex arrangements than described above may be encountered. This is illustrated by the following description given by the British glider expert, Mr. Philip Wills: "In less active clouds I have frequently come across a most curious phenomenon. The up-current having failed, one straightens up and flies out. On approaching the clear air, but still inside, it gets much rougher and currents rapidly alternating between 5 feet/sec. up and down are met. Just at the edge the air moves rather more strongly *up*, and just outside rather less strongly but definitely *up*. A circle done half in and half out of the cloud produces say in the open-air half 3 ft./sec., at the very beginning of the blind-part 3-6 ft./sec., *up*, during the rest of the blind-part 3 ft./sec., up and down."

The mechanical turbulence induced in the wind near the upper portion of the windward side of less active cumuliform clouds can be expected to reflect itself in weak ascending currents on the cloud exterior in that region. Generally speaking, however, descending currents are to be expected in the broad zone around cumuliform clouds. The pilot is especially cautioned about dangerous, strong downdrafts and severe turbulence which are often present in the clear space between adjacent cumulonimbus clouds.

To get some concept of the intensity of the strongest ascending currents in well-developed, energetic cumulonimbus clouds (thunderclouds), it may be noted that hailstones larger than baseballs have been sustained within the currents. This could have been accomplished only if the vertical velocities of the currents exceeded 100 miles per hour (about 150 feet per second), at least for short periods. Such violent currents are probably the result of the air accelerating its upward movement through a considerable period.

** "Gliding and Meteorology" by Sir Gilbert Walker, Quarterly Journal of the Royal Meteorological Society, London, Vol. 65, Oct. 1939, p. 502.