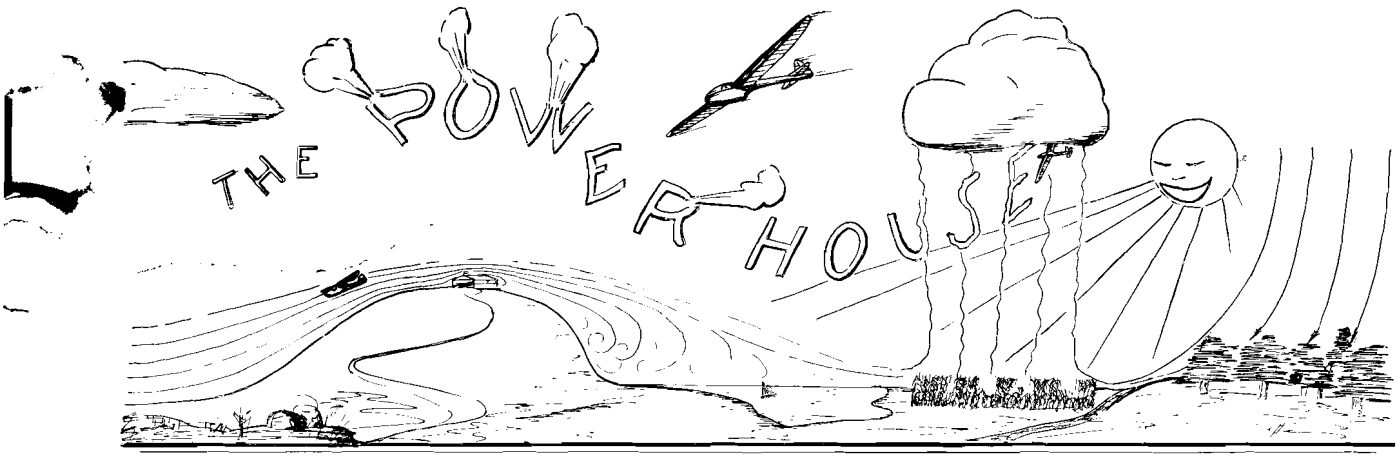

Conducted by Barney Wiggin of the U. S. Weather Bureau

Convection Beneath and Within Cumulonimbus Clouds When Rain Is Present

by Mr. L. P. Harrison of the U. S. Weather Bureau

WHEN liquid water droplets are carried up by convection in cumulonimbus clouds to heights above the freezing level, ice crystals and sleet pellets are generally formed. In some instances hail will also be produced, when the ice particles undergo several up and down transits by convection across the freezing level within the cloud, between the lower liquid portion where a film of water is collected and the higher frozen portion where the water is frozen on, in a layer.

As an ice particle falls through a portion of the cloud mainly composed of liquid water droplets at a temperature below 32° F., the particle grows through condensation of vapor on its surface. This growth removes water vapor from between the droplets which in turn evaporate by an equivalent amount. The increased weight of the particle enables it to fall appreciably more rapidly than the water droplets through any up currents. On this account, the particle may collide with a number of supercooled droplets during its descent and so take on considerable ice accretion as the droplets freeze upon impact. In this manner, the growth of the particle accelerates as it falls more and more rapidly through the supercooled water portion of the cloud, and so by the time it reaches the freezing level it has attained considerable size.

In an analogous fashion, large snow flakes may be formed, following sublimation, upon the tiny ice crystal that formed the original nucleus.

Falling of the ice particles and large snow flakes into levels where above-freezing temperatures prevail will cause melting, either partial or complete. In the latter case, rain drops have been formed by the process outlined above.

The melting of the ice particles and snow flakes takes heat from the surrounding air and cloud particles suspended within it. Thus the air is chilled and grows denser than the surrounding air where ice particles and snow flakes have not fallen or have fallen in lesser degree. Also the ice pellets and snow flakes have fallen from higher levels where temperatures appreciably less than freezing temperatures prevail. Heat must be conducted from the surrounding air to these particles in order to bring them to the melting temperature. This process, too, abstracts heat and chills the surrounding air. Accordingly, the increase in density of the air where the warming up and melting of the frozen particles takes place causes it to sink relative to the air some distance away not similarly affected. This results in downdrafts, especially where unstable lapse rates arise by the process, namely cooling at one level without corresponding cooling below.

If an upward convection current which has sustained great masses of frozen particles suddenly fails, the particles descend with unusually great velocity and so may create correspondingly marked showers that suddenly intrude into the zone of melting. The cooling is then accentuated and strong downdrafts are created.

When a considerable quantity of water is suspended in an upward convection current following the formation of raindrops, it may spread laterally under the influence of turbulence and so collect in unsually heavy concentrations under favorable circumstances, especially