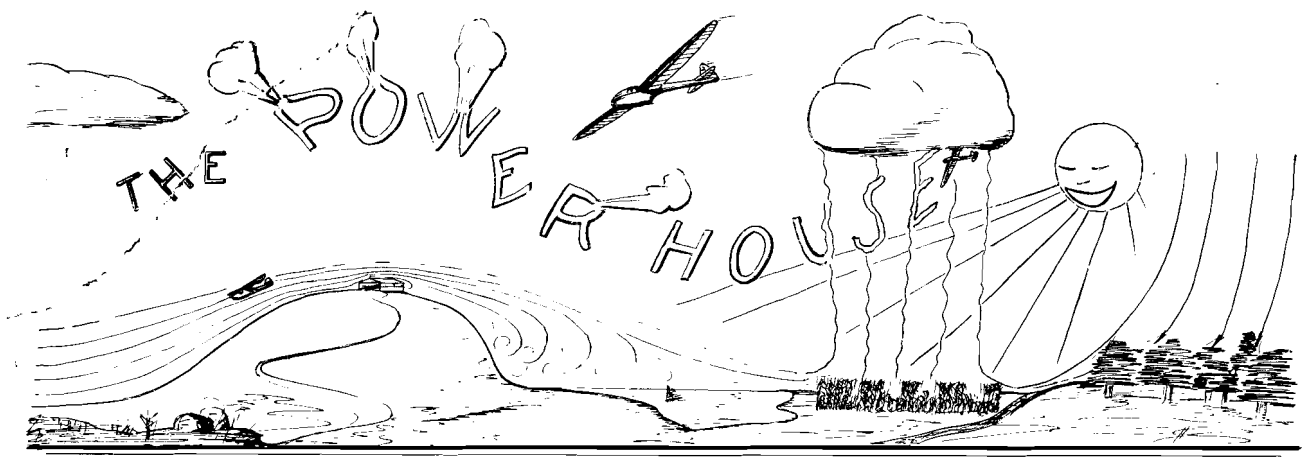

Conducted by Barney Wiggin of the U. S. Weather Bureau

Turbulence Associated With Miscellaneous Types of Clouds

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

A GLANCE at the sky on days when cirro-cumulus, alto-cumulus or stratocumulus clouds prevail indicates that there is a certain tendency to form cell-like patterns, with the clouds arranged in lines. The shape of the clouds also presents a roughly polygonal horizontal cross-section.

Experiments in the laboratory with unstable fluids heated from below or cooled above have shown that similar cell-like patterns can be created under controlled conditions in the fluids. The experiments indicate that the peculiar pattern assumed by the cells depends upon the degree of instability and vertical shear, that is, the rate of change of horizontal velocity with height.

Three principal forms of cells, which have their counterparts in natural clouds, have been discovered. It has been shown that whenever a cloud sheet is broken into polygons, rectangles or strips, the layer is vertically unstable; but whenever the sheet is unbroken and continuous, it is stable. Such a convective layer gives rise to a polygonal pattern when the shear is zero, to a rectangular pattern when the shear is small, and to strips when the shear is large.

Ordinarily, ascending currents exist in the center of the polygonal and rectangular cloud-cell patterns and descending currents on the periphery and in the clear spaces around the cells. An exception to this is found in the case of mammatocumulus clouds which exhibit descending motion in the center. (These represent a form of cloud showing pendulous sack-like protuberances.) Since sinking of a cloud tends to evaporate the water droplets, downward motion acts as a dissipative agency.

Convection within cirro-cumulus, alto-cumulus, and strato-cumulus clouds is not likely to be very strong so that they do not offer the hazards which may be met with in towering cumulus and in cumulonimbus clouds.

Long rolls of cloud (usually alto-cumulus or strato-cumulus) running parallel to the wind often form in streets (fig. 1). These have proven useful to gliders by providing lift, through the aid of ascending currents to one side of and slightly below the rolls. Spiral markings have also been reported on such longitudinal rolls. These facts provide evidence that the circulation around these longitudinal roll clouds is spiral.

Laboratory experiments tend to confirm this conclusion, for longitudinal strips of unstable fluid in a channel form vortices with adjacent rolls rotating in opposite directions. Thus two adjacent rolls having such opposed rotations form a stable cell when the shear is large. In the natural laboratory of the sky, the cloud particles condensing from the water vapor within the ascending portion make only a part of the cell visible, whereas the dissipation on the descending portion due to evaporation renders the remaining part invisible.

Rolls of cloud at right angles to the wind are often formed. These are called transverse rolls (fig. 2) and can be distinguished from longitudinal rolls (which are parallel to the wind) by their branching and sinuous lines like those of sand ripples. Transverse rolls occur with extremely small shear. When markings are observed on them, they are generally at right angles to the length.