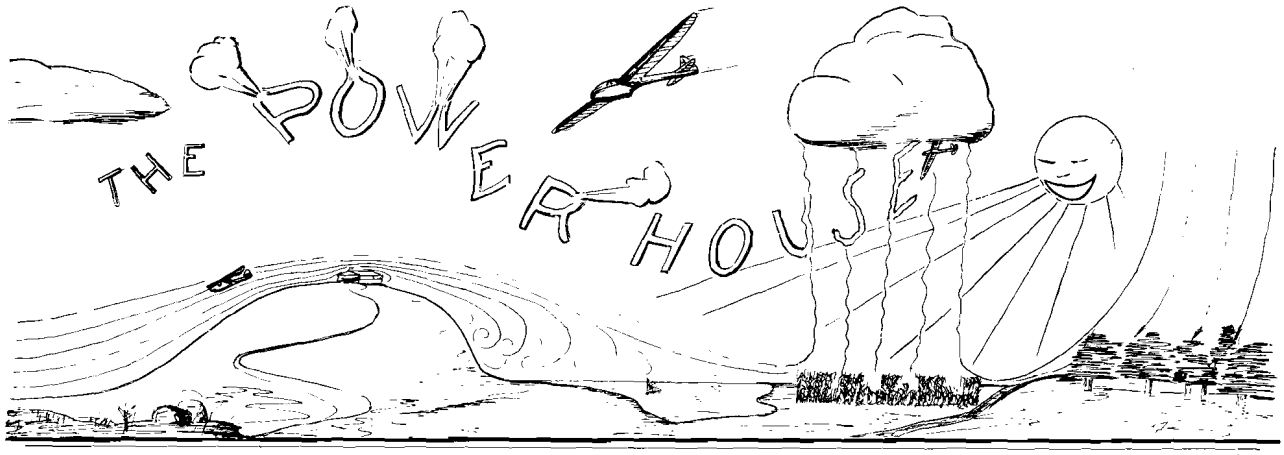

Conducted by Barney Wiggin of the U. S. Weather Bureau

Turbulence Associated With Miscellaneous Types of Clouds

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

(B) *Unstable Lapse Rate Within Clouds.*

THE existence within clouds of a lapse rate that exceeds the lapse rate of saturated air undergoing expansion adiabatically during ascent through the atmosphere is indicative of an unstable condition for the saturated air.[1] At times this condition prevails in stratus clouds, but not as a rule. (Growing cumuliform clouds invariably have an unstable lapse rate for saturated air.)

Very often, unstable lapse rates for saturated air are found in low stratus clouds formed by mechanical turbulence near the surface accompanied by thermal convection. Sometimes the unstable lapse rate does not extend through the entire depth of the stratus cloud but occurs in a few thin strata interspersed with strata characterized by stable lapse rates for saturated air.

Thermal convection currents develop within the layer or layers of unstable lapse rate for saturated air. These are similar to thermal convection currents in unsaturated (dry) air, except that liquid cloud droplets, or ice crystals are carried in suspension.

Considerable bumpiness may result from such saturated, thermal convection currents. Inasmuch as some of the energy for these currents comes from latent heat of condensation, they tend to become especially strong when the source is bountiful. This is particularly true when there is rapid transport of water vapor by vigorous convection and turbulence from a moist surface to the cloud base. Two localities satisfying this condition are oceans whose surfaces are whipped up into high waves by strong winds, and coastal areas whose winds are prevailingly from the sea. In regard to the latter situation, it is worthy of note that when the waters off the coast are relatively cold and the land is warm, the maritime air mass crossing the coast quickly becomes unstable near the surface by conduction of heat from the ground. This is assisted by increase in mechanical turbulence attending passage of the air from the comparatively smooth sea to the rougher land. For these reasons, the stratus clouds that form in the manner outlined exhibit marked turbulence.

(C) *Resilience of Inversion Layers.*

Many clouds are limited at their upper boundaries by inversions or at least by layers with very stable lapse rates (*e.g.* isothermal conditions, *i.e.* constant temperature with height). These stable layers, no matter what their origin,* serve as lids to prevent penetration of convection currents from below. When the convection currents are of unusual strength they may pierce the layer and possibly continue their ascent above the inversion, provided that the air there is unstable for them. Piercing of inversions by cumulus clouds is not uncommon, but is rare when the clouds are of the stratus type.

When a convection current not strong enough to pierce an inversion impinges against its base (that is, the level at which the temperature begins to increase with height), the current is decelerated, and forced to spread out horizontally. Partial penetration of the inversion occurs in such cases, depending upon the velocity and dimensions of the current. The upward momentum of the cur-

* Outward radiation of heat from the top of a cloud or haze layer which may extend along the base of an inversion accentuates the latter, and may contribute to the instability of underlying layers.