free air over the valley unaffected by the slopes. Buoyancy of the lighter air adjacent to the slopes then creates an upslope convection current or breeze, aided by the indraft from the center of the valley.

This ascending motion of the valley breeze along the slopes up to and beyond the mountain top, where it generally attains its maximum velocity, is accompanied by a compensating gentle downward motion of the air over the valley. Passage of the breeze along the rough mountain surface renders it turbulent.

The contrasts of vertical motions described above, and the turbulent character of the breeze emerging from the valley along the upper mountain slopes give rise to bumpy flying conditions over mountains even during relatively calm, sunny weather.

Mountain breezes are breezes which blow down the sides of mountains and down valleys on clear, cool nights. Involved in this phenomenon are two processes:

(a) The valley floor cools by radiating heat outward to space, and the air in contact with the valley floor cools by conduction of heat to the surface. As a consequence, the column of air over the center of the valley contracts more than the air over the mountain slope, and therefore the pressure at any level on the slope exceeds the pressure at the same level over the valley. Owing to this pressure difference, air is driven towards the central air column from the slopes.

(b) The slopes radiate heat rapidly during the clear night, thereby cooling and also lowering the temperature of the air in contact with them. The latter air therefore becomes denser than the free air over the valley not subject to this cooling effect. Gravity then causes the denser air to flow down along the mountain sides as a relatively shallow but turbulent breeze. Though not as strong as the fallwinds previously described, it may acquire sufficient velocity under favorable circumstances to present seriously adverse conditions for local night operations of aircraft, especially near the foot of ravines or passes fed by flow down long slopes covered with ice. The more intense manifestations of these gravity winds are usually forthcoming when the general wind movement relative to the mountain tends towards spilling of air over the crest and down the colder slope.

Each region with hilly or mountainous terrain exhibits peculiarities of air flow dependent upon local conditions and the general meteorological situation. Thus a wind blowing against a mountain generates eddies around the sides with axes oriented in every direction from horizontal to vertical. A wake of eddies forms on the leeward side, extending roughly along the line of the prevailing wind but spreading out laterally until the eddies have decayed and dissipated under the action of atmospheric viscosity. In addition, the wake is accompanied by a zone of eddies around the extremities of the mountain, at least for a short distance to right and left of the wind-stream which strikes it. Great turbulence and difficult flying conditions will be found in these areas when the winds are of considerable strength.

The rotating motion of the eddies around the lateral extremities give rise to powerful sweeps of air that twist into the lee-wake region behind the mountain. Near the barrier, the twisting motion may be regarded as helical or similar to that of a corkscrew. When stable conditions exist, descending components will predominate in the trajectory of the air particles participating in the motion beyond the crest of the windward side uplift. Therefore, an airplane carried along in an eddy near the lateral extremities of a mountain may be projected around toward the lee side and downward toward the slope. Jutting crags may interpose, with fatal consequences.

When unstable conditions exist, both ascending and descending motions will occur and the turbulence will be very severe. Control of an airplane may be readily lost in close proximity to the ground under these circumstances. The presence of clouds, fog, or precipitation may obscure the threatening obstructions, while heavy rain may give rise to unusually strong downdrafts. In low temperature conditions danger of ice accretion also exists.

Associated with these hazards is one arising from the fact that pressure altimeters read higher than they should when lower than standard atmospheric temperatures prevail. To compensate for any over-confidence that this may give during instrument flying conditions to pilots not familiar enough with this fact, *at least* 2,500 feet clearance above the highest obstructions would appear to be necessary and justifiable from a safety standpoint in relation to flight over mountains in the winter under such conditions.

While it is not practicable to cover all the peculiarities of winds and turbulence over rugged terrain, the principles set forth in the foregoing discussion should assist the reader in deducing the probable character of the atmospheric motions in a great many cases, and in avoiding the areas of greatest hazard. Only by being familiar with the pertinent meteorological phenomenon and their effects upon aircraft can the pilot take all necessary precautions. A recapitulation of the facts which bridge the gap between the meteorological aspect of the subject and the aeronautical applications is therefore useful.