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ATMOSPHERIC TURBULENCE

by L. P. Harrison of the Weather Bureau

CONDITIONS NEAR MOUNTAINS

Mountains create numerous peculiarities in wind flow which depend upon local topography, and heating and cooling of the surfaces involved. Thus, under stable lapse rate conditions and light to moderate wind velocities, there is a corresponding upward component of velocity in a shallow layer of the air flowing up along the windward slope. However, the air from the base of the mountain is not transported to the crest by the upslope motion on account of the stable lapse rate. Instead, it flows around the side of the mountain more or less horizontally after a slight lift.

Along the slope, friction drags some of the air in a direction opposite to the wind and so produces eddies rotating in a sense similar to that of a wheel rolling along the ground with the wind. Between the opposing directions of flow is a thin transient zone of relative calm. These conflicting motions produce hazards for airplanes or gliders coming within the zone.

Above the leeward slope, there is a general descending current as air carried to the crest from the upper portion of the windward slope flows downhill for a short distance with the stream, but it soon becomes a horizontal turbulent current. Lower down the leeward slope, and sometimes near the crest frictional drag of the air adjacent to the surface coupled with a suction effect (described in the next paragraph) produce eddies rotating in a sense similar to that indicated in the preceding paragraph. This implies a tendency for upslope motion adjacent to the lower leeward surface of the mountain, or under favorable circumstances, even near the crest, but downslope motion a short distance aloft, above the mountainside. Juxtaposition of the oppositely flowing currents creates a thin transient zone of relative calm between them.

A phenomenon which helps to explain the upslope wind component along leeward mountainsides and some other peculiarities of airflow in mountainous regions is that depending upon the Bernoulli effect. This is controlled by a relationship between local air pressure and velocity. In consequence of the relationship, it follows that the speeding up of the air is accompanied by a fall in pressure, as illustrated by the following table:

Illustrating Bernoulli Effect—

Fall in Air Pressure Due to Speeding up of Air*

Original speed of air M.P.H.	Final Speed of air M.P.H.	Fall in air pressure Millibars	inch (of Mercury)
25	30	0.28	0.008
25	35	0.60	0.018
50	55	0.51	0.016
50	60	1.10	0.032
50	65	1.72	0.051
75	85	1.60	0.047
75	90	2.47	0.073

Acceleration of air occurs over a mountain top during stable conditions as a result of the compression of stream lines or the lessening of cross-section of the channel through which the air blows.

Thus, the wind component perpendicular to the ridge near the top lifts the superposed atmospheric layer against the resistance offered by the stable stratification, and this acts to thin the stream of air flowing over the crest, thereby speeding it up. The accompanying pressure fall exerts an influence both on the windward and leeward sides near the crest. When the wind is sufficiently strong, the pressure fall is great enough to induce an appreciable pressure gradient. This may be regarded as directed inward and upward relative to the lee slope, that is, from the higher pressure at slightly lower levels in the undisturbed air away from the slope to the deficient pressure adjacent to the lee side of the crest in the zone where the stream lines have been crowded and the air speeds increased. A tendency for upslope winds thus comes into being on the leeward side. The upslope wind component may often become greater than the effective velocity of the downslope wind spilling over the ridge near the surface. Whereupon an actual upward drift of air develops along favorable portions of the slope. Under these circumstances, lee eddies with horizontal axes are produced. Close to the surface the local wind direction is then uphill, hence

* Air density assumed to be 0.001 gram per cubic centimeter which is about the average at 6,500 feet altitude. The pressure fall is proportional to air density.