# ATMOSPHERIC TURBULENCE

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

## Special Winds

About as spectacular as the foregoing, if not more so, is the behavior of "fallwinds." Generally speaking, these are generated in the neighborhood of high plateaus or mountain ranges covered with snow. When a high pressure area (anticyclone) with its clear air lies over the region, intense radiation out to space occurs from the snow surface during the cloudless nights. This greatly cools the air in contact with the surface and it thereby becomes denser than the free air at the same level over adjacent lowlands or valleys. The denser air therefore tends to flow down the slopes under the action of gravity. If the slopes themselves are snow-covered, further cooling and density increases take place. On long, shaded slopes, therefore, especially those free from obstructions, the air can glide down with accelerating velocity, mainly as a shallow stream. Upon reaching the lowlands, extremely high velocities will have been attained by the sinking air. Swift, turbulent cold, dry winds of destructive violence may thus be produced.

Under certain circumstances, the winds have their origin in high-altitude valleys hemmed in by mountain ridges and possibly plateaus. The cold air resulting from the radiation drains down into the valleys, eventually filling them up. Under favorable general wind conditions especially associated with occurrence of low-pressure disturbances over the lowlands, the cold air overflows the valleys where it has been dammed up, and rushes out of gaps and passes in the ridges. It cascades down canyons, ravines, and steep slopes, bursting upon the adjacent lowlands with great force. The winds so formed are most pronounced in the winter, especially in the morning.

Examples of such winds are: the Bora (a northeasterly wind from the mountains on the eastern, and especially northeast shore of the Adriatic Sea); the Mistral (a northwesterly or northerly wind which blows offshore along the north coast of the Mediterranean from the Ebro to Genoa, especially strong near the Rhone delta); the fjord winds and the fallwinds off the northwest coast of Norway; the fallwinds from higher glacier-covered plateaus of Greenland and Antarctica; and the Santa Ana (a very strong wind which blows down the Santa Ana canyon, in Southern California, extending about 25 to 50 miles out to sea).

The possible intensity of such winds may be seen from the following illustrations:

(1) In the case of the Bora at Trieste, Italy, the wind speed has averaged over 80 miles per hour, with gusts exceeding 125 miles per hour.

(2) In regard to the fallwinds from the icy interior of the Antarctic Continent, best observed on the Coast, Sir Douglas Mawson has reported that at Adelie Land (latitude 67°S.) near the foot of a steep slope leading to the plateau, the average wind velocity for an entire year was over 50 miles per hour. Wind speeds of over 100 miles per hour and gusts of even greater magnitude have been observed. (Out to sea the fallwinds gradually weaken and were not found beyond about 185 miles from the coast.)

Other winds found to occur in mountainous regions, but of considerably less force than those mentioned above, are valley breezes and mountain breezes.

*Valley breezes* are breezes which blow up valleys and up the sides of mountains on warm, clear days when there is little or no general wind. Involved in this daytime phenomenon are two processes:

(a) The air in the center of the valley is heated by contact with the thermal convection from the valley floor which receives its major heat supply through absorption of incoming solar radiation. The heating expands the valley air vertically and so causes the valley air to be at a higher pressure than the mountainside, level for level, since atmospheric pressure is determined by the weight of the superimposed column of air. The pressure difference drives air from the valley toward the mountain slopes.

(b) Solar radiation absorbed by the mountain slopes warms the rocks, vegetation, etc., which in turn heat the air in immediate contact therewith. The heating expands this air and thus makes it less dense than the