JET STREAM PROJECT—IV

A Preliminary Report on Its Soaring Aspects

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First, we will have to collect the (now customary) back log from earlier installments, namely some further cross-sections of the airflow over the Sierra Nevada. Then we will discuss the Jet Stream and some operational problems of sailplane flights at or above 40,000 ft. (The navigational problems were described in the last issue). After stressing some side aspects of the field work, an all too brief review of the cooperation of the participants and friends of the project will (believe it or not) conclude the series.

Further Vertical Cross-Sections

Fig. 4 shows a complete graph of the mountain wave of 1 April 1955 *(Fig. 1)* as measured by our bombers. The 35,000 ft. traverses of the B-47 have been added and all scales have been adjusted. (As mentioned earlier, these are actually vertical displacements of the air as encountered in level flight, not strictly streamlines).

It was most difficult to derive and define the 35,000 ft. air motions from the temperature measurements as illustrated in *Fig. 3*. The tropopause descended right into the flight level during the time the traverses took place carrying with it a general warming trend in the stratosphere and a cooling trend in the troposphere. Thanks to the skill of Mr. Solot (Geophysical Research Directorate) this intricate analysis was successful.

A short discussion of the results is appropriate.

The Structure of the Sierra Wave

The typical Sierra Wave seems to be composed of several superimposed phenomena. The leewave prevails mainly in the middle and upper troposphere, apparently as a succession of internal gravity-shear waves. In lower levels the enormous rotor over the center of the valley stands out, with little indication of downwind leewaves. Also in the stratosphere successive leewaves are weak. As mentioned earlier, the flow resembles there a mirror image of the ground contours, descending continuously over the flat West slope of the mountain range and turning steeply upward over the sharp East slope. This step-like pattern creates a vast solitary updraft area. Further downwind there is a peculiar downward dip of the streamlines, about 40 miles east of the Sierras, followed by a new excitation of the flow east of it. Whether this is a terrain effect (East wall of the Eureka valley) or the manifestation of a wave of much longer wavelength (such as that postulated by Prof. Wurtele, M.I.T.) remains to be seen.

There are a few indications that this dip is a general phenomenon. On earlier cross-country flights at high altitudes I noticed that the "Second Waves," although intense, were not marked by wave clouds as was the "First Wave" suggesting a general descent of the wave axis, just as seen in Fig. 1.

The analysis of another wave (13 April 1955, B47 traverses at 40,000 ft) confirms this downward dip at the 40 mile point and the new excitation further east *(Fig. 4)*. On this particular day the tropopause was very close to the 40,000 ft level (1500 ft below in contrast to 5000 ft below on 1 April 1955) and the tropospheric leewaves were more perceptible in the lowest stratosphere. Vertical motions were too weak to support a glider in the stratosphere. An analysis of the wave pattern reveals furthermore the existence of a 40 mile wave of small amplitude throughout the 150 mile traverse.

Fig. 5 is a belated illustration of the mechanism of the rotor cloud discussed in the last issue. While the normal rotor (depicted in the lower part resembles the "undular hydraulic jump," the dangerous type, responsible for the Pratt-Reed accident, has many features of the "breaking jump" (upper portion), the difference being determined by the ratio of the layer depths in front and in back of the jump. However, we are still far from understanding the rotor phenomenon which may be of an entirely different nature.

The Jet Stream

It has been shown in Fig 3 of the third article (Jan./Feb. issue) that the wind speed is severely affected by the mountain wave. As a consequence, the vertical profile of the jet stream may be entirely changed. Unfortunately on our flights the automatic wind recording equipment broke down on the traverses at 30,000 ft and higher and the details of the jet center are not known so far. A synoptic analysis by Mr. Klieforth (UCLA) reveals that the westerly jet stream lies consistently north of the mature Sierra Wave. While moving its core continuously southward it seems to be hampered by the mountain range and tends to form a secondary jet south of the range before jumping entirely over to the south side. This jump is frequently accompanied by the passage of a gusty cold front from the north leading to a breakdown of the wave. The time immediately before the southwar[d] jump of the jet stream is the best for the development of the wave. Besides this migration of the main jet stream there is evidence of the lateral movement of intense "jetlets" not wider than 50 miles. They are not recognizable on the normal synoptic map and therefore are rather unpredictable with present methods.

Much to our surprise we observed one southwesterly jet stream moving from south to north over the Sierra Range. All jetlets happened in the late afternoon and eliminated cross-country possibilities. We are not sure whether or not the preference of a certain time of day was accidental or is a consequence of the thermal rythm. There is some evidence that the low thermal stability during the afternoon is responsible. We learned that it is quite difficult to catch these jetlets with a sailplane. If one does not wish to rely on luck and guesswork a persistent and full readiness of the high altitude glider and its pilot has to be combined with a continuous thorough analysis of the synoptic upper air maps. In spite the relentless efforts of our small staff we did not succeed in this respect.