

April 10-1225%.
 April 19-2135%.
 April 2535%.

Warmest days: April 17, 21, and 24.
 Cloudiest days: April 13 and 19.
 Easter Sun.: Warm & partly cloudy.

Having come up with a sort of soaring almanac, let's turn to specific examples of wave flying in April. By far the choicest exhibit of these past twelve seasons is April 1955. During the Mountain Wave — Jet Stream Project there were wave occurrences on ten of the seventeen days from 9 through 25 April and seven of these occurred in the nine days from 9 through 17 April. Figures 1, 2, and 3 show scenes from the latter period. Flights exceeding 30,000 ft. were made on the 10th, 13th, 14th, and 17th; the 16th was missed because the sailplanes could not be made ready in time.

HIGH ALTITUDE FLIGHTS

The best lee wave formations for attaining very high altitude are those similar in form to that of 14 April 1955, as shown in Figure 2. In these there are enough clouds to indicate the flow pattern and guide one to the updraft areas, but not so much cloud as to obscure landmarks and make the descent difficult. Moderate turbulence is usually experienced only in the roll cloud zone; thereafter the ascent is usually in smooth air. The rate of climb of the order of 2000 ft. per minute to 20, or 25,000 ft., decreasing to the order of 1,000 ft. per minute to above 30, or 35,000 ft. On 14 April 1955 Dr. Kuettner reached 35,000 ft. in 16 minutes after release at 13,000 ft. while Betsy Woodward, in less favorable lift, reached 39,000 ft. within 60 minutes after release from tow at 12,000 ft. This particular wave, as sometimes happens, lasted all day allowing for careful preparation, take-off at a convenient time, and several other flights including one by Oats Schwarzenberger in a TG-3A to 36,000 ft. for the Swiss record.

However, more often than not, the weather timing is not so accommodating and one has to act fast to meet the schedule of the Early Wave or the Late Wave. The former recognized as a mature wave appearing in full battle dress — cloud fall, roll cloud, and arch clouds — at dawn. A wave of this type occurred on 10 April 1955 (Fig. 1). These can usually be anticipated from the weather maps when a cold front is expected to reach Bishop by mid-day. Visible warning is often given by the appear-



Photo: Betsy Woodward

Figure 2. Wave cloud formation on April 15, 1955, in a view SSE from the Bishop Airport. Dr. Kuettner in the Schweizer 2-25 sailplane reached an altitude of 43,000 feet, an unofficial single-place world soaring record, on this day while a women's world altitude record of 39,994 feet was set by Betsy Woodward in the P-R sailplane.

ance of a weak or moderate wave near sundown of the previous day. If one delays too long in getting into the air, the strong lift may disappear as the winds across the mountains shift direction, or a rather complete overcast may develop as the front moves in.

The "4 o'clock 40,000 ft. waves" as Dr. Kuettner has called them with mixed awe and frustration, are a phenomenon observed several times during the 1954 and 1955 spring seasons. After a rather slow evolution during the morning hours, and often with very little warning, a strong wave frequently forms rapidly in the afternoon reaching maximum development between 1400 and 1600 local time. This type is often associated with fast-moving wind maxima, or "jetlets," in the upper air flow, and its timing is probably related also to the diurnal warming of the lower air layers near the ground. It may carry a sailplane to 40,000 ft. in plenty of time for the pilot to land before dark. The frustration comes when one wants to use that great altitude as a starting point for a cross-country flight and dares not with night approaching.

There are many other types of lee waves including the more frequent patterns of lesser amplitude, but one further type ought to be noted because it is the most dangerous. Its characteristic appearance is of a very dense roll cloud which has a steep windward face but no clear downdraft zone — the great cloud mass trails downwind across the next mountain range. The dangers are that one's possibilities for a descent in clear air are limited to the gap between the dense roll cloud and great

cloud fall over the Sierra slope; and there he must penetrate the severe and possibly destructive turbulence in cloud puffs which form explosively ahead of the roll cloud. Experiences in this type of wave on 25 April 1955 and the flight problems are vividly told by Dr. Kuettner and Larry Edgar in references given at the end of this survey. As a result of these adventures, it has been agreed that flights in such waves should not be attempted.

One final note on the best geographical region for encountering strong lift prior to release: it has been found from the experience of Bob Symons and the Mountain Wave Projects of 1951-2 and 1955 that in the vicinity of Big Pine, near Red Mountain (a small volcano on the Valley floor) and downwind of Taboose Pass, the wave develops strongest and the highest altitudes are most often attained. This region is about 15 miles south of Bishop.

CROSS-COUNTRY FLIGHTS

Distance flights from Bishop using the Sierra Wave for the initial altitude offer the greatest challenge to the expedition. They also demand more exacting preparation and planning and something more from the upper air flow besides the static stability and wind speed profile necessary for formation of a strong wave. The classic technique, and the most promising and least time con-

Meteorology Research, Inc.
 RESEARCH IN ATMOSPHERIC PHYSICS
 RESEARCH EQUIPMENT & INSTRUMENTATION
 Paul MacCready, Jr., Ph.D., Pres.
 2420 N. Lake Av., Altadena, Calif.
 MUrray 1-5742