Waveflow above Convection Streets

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In 1964 K. Lamparter, a German glider pilot, published a detailed report of his combined thermal and waveflight near Stuttgart on the 5. 7. 1964. This flight was very remarkable because after having reached the top of the convection layer at 6000 ft Lamparter got through the inversion and gained another 6000 ft within a system of waves which had no orographic origin. The direction of the upper flow was nearly oblique to that of the convection layer below (fig. 1).

Fig. 1 Sounding Stuttgart 5. 7. 1964, 12 h GMT

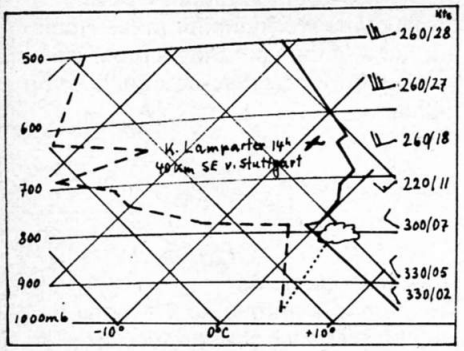


Fig. 2 Sounding Wiesbaden 16.5. 1965, 15 h GMT

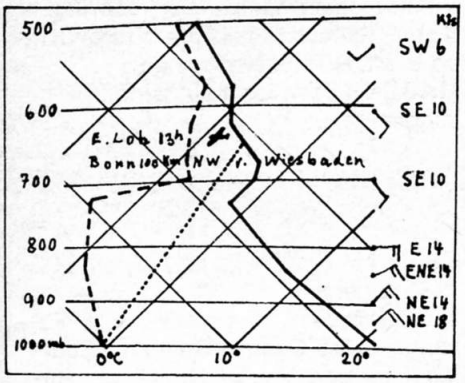
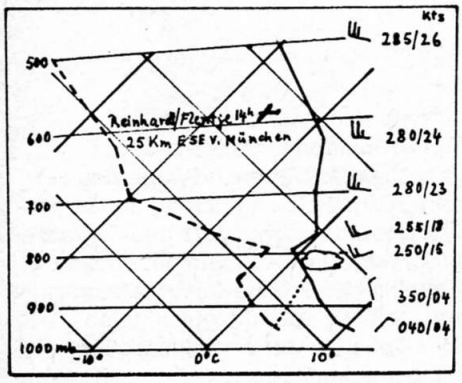


Fig. 3 Sounding München 27. 9. 1960, 12 h GMT



Two other flights with lift above the convection layer show similar meteorological conditions. In each of these cases the convection layer is limited by a rather stable layer which does not allow gliders to get through into higher levels by thermal updraft.
After four hours thermal flight within a weak northerly flow near Stuttgart Lamparter found good lift below a flat cloudstreet which extended from N to S. In order to avoid the cloud he first transformed the lift into speed and then he had to turn towards a blue gap reducing speed by pulling up. But then instead of the expected sink he observed constant lift in calm air west of the cloud and keeping a heading of 240° and speed 38 kts he reached nearly 12 000 ft above ground. The groundspeed seemed to be zero.
The second case has been published by G. Kant with a paper presented at S. Cerney in 1965 (fig. 2). This flight of E. Loh near Bonn may belong to the same type of high altitude flights if we agree with the assumption of Kant that the radiosounding of Wiesbaden 100 km SE of Bonn was representative for the flight area. It was nearly cloudless. The convection layer shows a moderate NE'ly airstream and the direction of the light and moist flow above was a SE'ly one.
The third case, a flight with light aircraft near Munich on 27. 9. 1960 carried out by M. Reinhardt and G. Flentje also under conditions with a sharp windshear on top of the convection layer revealed a marked upper waveflow (fig. 3). The aircraft was equipped with meteorographs and a recorder for vertical acceleration. Instrumental test was the purpose of the flight. But when the special cloudformation SE of Munich was noticed photographs were made and crosswindflights above the clouds were carried out. Plate I and II show the cumulusbanks which extend from N to S.
Fig. 4 shows a cross section from W to E with the paths of five crossings. The thickness of the convection layer is

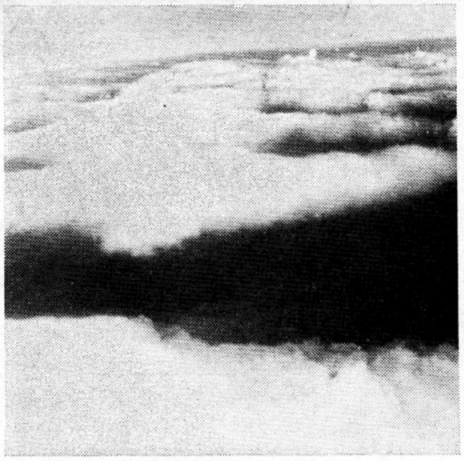
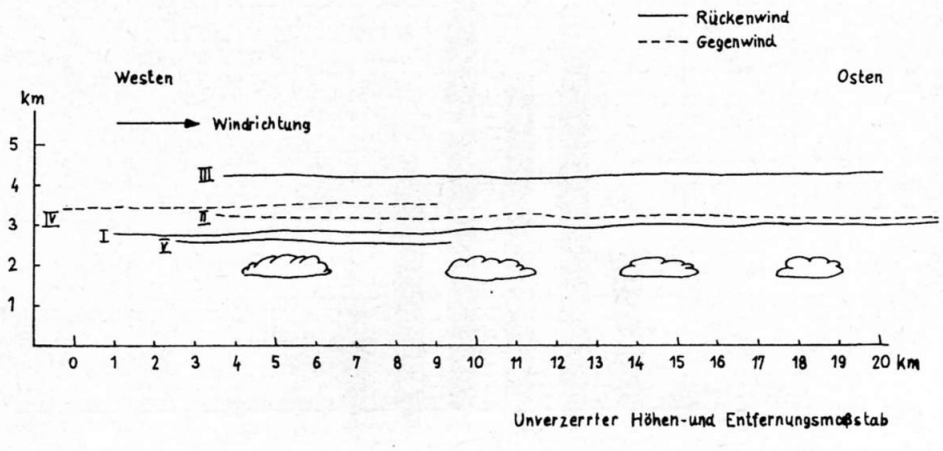


Plate I Cumulus banks near München 27. 9. 1960, 15 h GMT, seen from above

Plate II Cumulus banks near München 17. 9. 1960, 15 h GMT, seen from the ground

Fig. 4 Flight paths across cumulus banks near München, 27. 9. 1960, 14–15 h GMT



1.5 km and the spacing between the cumulus bands (from center to center) is 4.5 km. In fig. 5 we see the vertical motions of the aircraft.
During the flight a mark was made on the record overhead of each cumulus bank. Thus in the drawing the clouds are plotted with their correct horizontal positions relative to the flightpath.
Over the western broders of the clouds along flightpath I updraft of 1.1 m/sec was found. On crossflight III 7000 ft above the clouds the flightpath shows updraft of 0.8 m/sec.

The wavelength calculated from the static stability and the windvelocity between 770 mb and 620 mb is 4.7 km. This agree well with the observation. The whole phenomenon suggests a co-operation between the organized convection in streets and the waveflow above. The question is whether the waves initiate the convection streets or vice versa.
Although observations of the circulation within the convection layer are not available the pattern of fig. 6 appears likely.

A glider pilot who tries to utilize such a situation for a high altitude flight has to turn against the upper flow from the highest point of thermal updraft in order to get through the sloping inversion or thin boundary layer, exactly as Lamparter happened to do. Thus it seems possible to gain 10 000 ft of height by a combined thermal and wave flight over flat ground. We may expect a favourable situation whenever the following meteorological conditions are present:
1. The direction of the wind above the convection layer is nearly normal to that of the flow below.
2. The calculated wavelength of free oscillations in the upper flow is two to three times the value of the thickness of the convection layer.

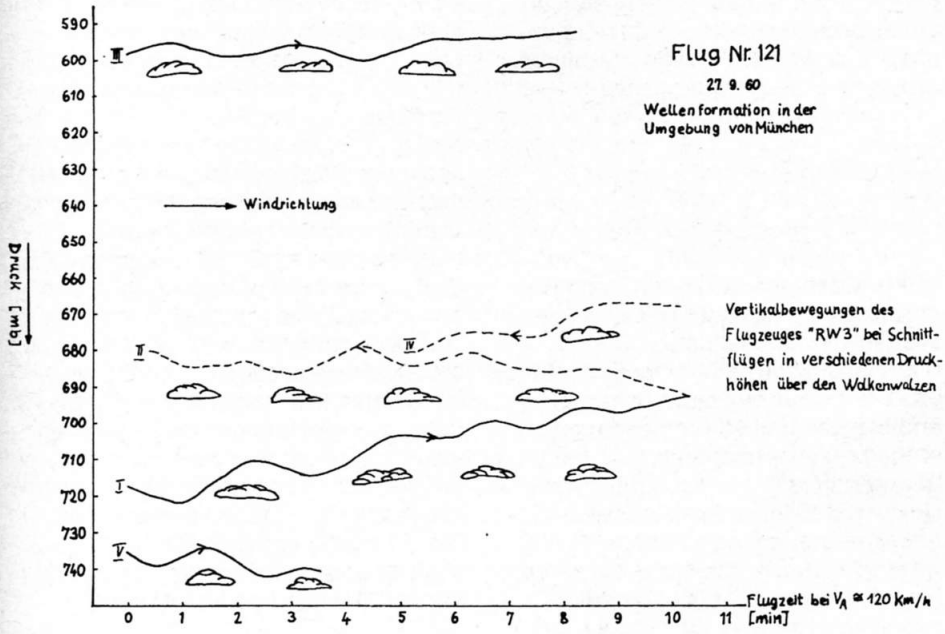


Fig. 5 Vertikal movements of the aircraft RW 3 on crossings at different pressure altitudes above cumulus banks near München, 27. 9. 1960, 14–15 h GMT

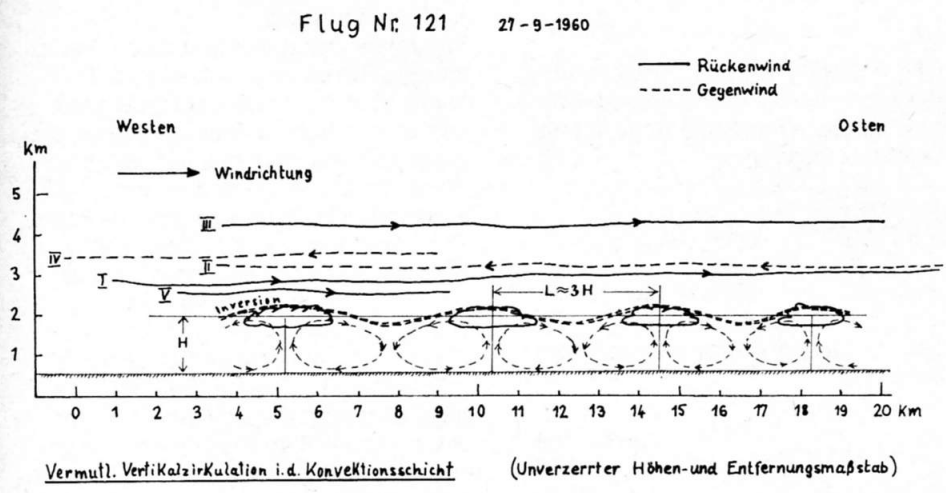


Fig. 6 Assumed circulation within the convection layer and deformation of the inversion near München, 27. 9. 1960, 15 h

References

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Zusammenfassung

3 Fälle von Wellensegelflug über Wolkenstrassen im Flachland werden beschrieben. In jedem Falle war die untere (Konvektions-) Schicht durch eine scharfe Inversion von der oberen Schicht getrennt, welche senkrecht zur Orientierung der Wolkenstrassen und zur Windrichtung der unteren Schicht strömte.

Abstract

Three cases are discussed which enable glider pilots to soar above cloudstreets in clear sky. The aerological data indicate that a sharp inversion separates two airmasses and that the upper flow is almost normal to the cloudstreets which form in the lower layer and are orientated along the (lower) wind direction. This type of situation allows the glider pilot to do wave soaring over flat ground.