Local Winds in the Upper Rhone Valley

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Abstract: Balloon soundings during July and August 1979, 1981 and 1982 showed the vertical structure of the flow in the upper Rhone Valley. Between the low level winds up to a height of about 2000 m asl and the gradient winds above 3000 m asl, in 73 % of the 107 ascents, a counterflow was detected. It appeared more often in connection with down-valley flow (89 %) than with up-valley flow (38 %) above the ground. This flow pattern was found to be almost unaffected by the upper winds.

The horizontal structure of the wind was studied with 3 ground weather stations that were separated 2 and 5 km along the valley axis. Up-valley winds occur in the average of 32 fair weather days only around noon. During the time of strongest up-slope winds, the valley wind is down-valley. That was already found in the climatic mean by Yoshino (1964) with wind shaped trees.

As the wind recordings show, the down-valley flow develops first at the end of the valley and the resulting convergence zone moves down with about 2 m/s until it stops above a characteristic step near Fiesch (Fig 6).

An explanation can be given by differential heating within the Rhone Valley itself and due to neighbouring valleys. The measured differences in the diurnal pressure changes of 5 stations is consistent with that hypothesis.

Introduction

Geography

The upper Rhone Valley (Oberwallis, Goms) is the SW-NE orientated part of the 150 km long Rhone Valley above Lake Geneva in southwestern Switzerland. Characteristic for the 35 km stretch is a step in the height of the valley bottom, where it rises from some 800 m asl up to about 1300 m asl, the altitude remaining constant for the last 25 km. Ridge heights are around 3100 m asl. The measurements were mostly taken near Muenster, 46° 29'N, 8° 16'E, 1350 m asl. The many neighbouring valleys are important for the discussion (Fig 6).

History

For more than 20 years a group of glider pilots have held their annual summer camp in the region during July and August. A qualitative knowledge of local weather conditions inspired a closer look at some particular details. Therefore we began to make windsoundings in 1979. These showed interesting structure in the valley flow. The research continued in 1981 with better defined goals and more equipment including temperature radiosondes. The main activities were:

- Measurement of the sensible heat input as the most important parameter for forecasting convection.
- Comparison of the local radio soundings with the Temp-messages from stations like Payerne, Stuttgart, Munich or Lyon and with data from automatic ground weather stations to derive some semiempirical rules for estimating local profiles without own ascents. (Unfortunately no operational soundings within the Alps themselves are available.)
- Test flights with a newly developed measuring system for light carriers (e.g. gliders).
- Production of time lapse movies to visualize convection and other cloud tracered flows.
Fig 1 to 4 Typical wind profiles dotted lines: wind direction; solid lines: wind speed; Windprofil = wind profile; Ballonwegprojektion = vertical projection of the balloon trajectory; Talachse = Valley direction.

Fig 1 Counterflow even when lower and higher winds have the same direction (SW).

In 1982, the activities were focused on the unorthodox valley flow:
- Measurement of wind and pressure with other stations along the Rhone Valley and in neighbouring valleys to check the hypothesis that the reverse valley flow is caused by differential heating within the Rhone Valley itself and relative to other valleys.
- Test of the forecast procedure derived in the year before.
- Continuation of profile measurements and time lapse photography.

Valley Wind System

Vertical Structure

Valley and slope wind models are extensively treated by several authors (Thyer and Buettner, 1962; Defant, 1949; Vergeiner, 1982a, b; Freytag 1982; Urfer-Henneberger 1970; Yoshino 1975) and will not be treated here. The four examples of wind profiles (Fig 1 to 4) are typical for the conditions in the upper Rhone Valley. The counterflow between heights of 2040 m and 2980 m shows up in most profiles (Tab 1). It cannot be explained only by the backflow of the air that was brought upvalley with the valley wind and ascended on the slopes (antiwind), because it is too strong to maintain continuity. But the height of 2100 m is typical for the height of the barriers (passes) to the neighbouring valleys and 3000 m is typical for ridge heights. This suggests an influence from neighbouring valleys that is even more obvious in the horizontal.

Horizontal Structure

The wind recordings 5 m above the ground do not show a typical valley wind behaviour and tell us no more than local people knew already and trees have recorded with their shapes (Yoshino, 1964): Upvalley winds do not occur regularly. The mean of the recordings from 1981 (Fig 5) shows only an up-valley component around noon. During the time of maximum convection, the wind blows down-valley. Similar effects were also found in other valleys (e.g. Malojawind).